Report of Contributions

https://indico.cern.ch/e/EPS-HEP2019
A Composite 2-Higgs Doublet Model

Friday, 12 July 2019 14:30 (15 minutes)

We consider a Composite Higgs Model with two isospin doublet Higgs fields arising as pseudo Nambu-Goldstone bosons from a SO(6)->SO(4)xSO(2) breaking. The main focus is to explicitly compute the properties of these Higgses in terms of the fundamental parameters of the composite sector such as masses, Yukawa and gauge couplings of the new spin-1 and spin-1/2 resonances. Concretely, we calculate the Higgs potential at one-loop level through the Coleman-Weinberg mechanism from the explicit breaking of the SO(6) global symmetry by the partial compositeness of fermions and gauge bosons. We derive then the phenomenological properties of the Higgs states and highlight the main signatures of this Composite 2-Higgs Doublet Model at the Large Hadron Collider, including modifications to the SM-like Higgs couplings as well as production and decay channels of heavier Higgs bosons.

Primary authors: DELLE ROSE, Luigi (University of Florence); DE CURTIS, Stefania (Universita e INFN, Firenze (IT)); MORETTI, Stefano (Science and Technology Facilities Council STFC (GB)); YAGYU, Kei (Seikei University)

Presenter: DELLE ROSE, Luigi (University of Florence)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
The NEWSdm experiment, based on nuclear emulsions, is proposed to measure the direction of WIMP-induced nuclear recoils. We discuss the potentiality, both in terms of exclusion limits and potential discovery, of a directional experiment based on the use of a solid target made by newly developed nuclear emulsions and read-out systems reaching sub-micrometric resolution. We also report results of the test exposure conducted in Gran Sasso last year.

**Primary authors:** GULER, Murat Ali (Middle East Technical University (TR)); NEWSDM COLLABORATION

**Presenter:** GALATI, Giuliana

**Session Classification:** Dark Matter

**Track Classification:** Dark Matter
Singlet-doublet fermion and triplet scalar dark matter with radiative neutrino masses

Thursday, 11 July 2019 10:45 (25 minutes)

We present a detailed study of a combined singlet-doublet fermion and triplet scalar model for dark matter. These models have only been studied separately in the past. Together, they form a simple extension of the Standard Model that can account for dark matter and explain the existence of neutrino masses, which are generated radiatively. However, this also implies the existence of lepton flavour violating processes. In addition, this particular model allows for gauge coupling unification. The new fields are odd under a new $Z_2$ symmetry to stabilise the dark matter candidate. We analyse the dark matter, neutrino mass and lepton flavour violation aspects both separately and in conjunction, exploring the viable parameter space of the model. This is done using a numerical random scan imposing successively the neutrino mass and mixing, relic density, Higgs mass, direct detection, collider and lepton flavour violation constraints. We find that dark matter in this model is fermionic for masses below about 1 TeV and scalar above. The narrow mass regions found previously for the two separate models are enlarged by their coupling. While coannihilations of the weak isospin partners are sizeable, this is not the case for fermions and scalars despite their often similar masses due to the relatively small coupling of the two sectors, imposed by the small neutrino masses. We observe a high degree of complementarity between direct detection and lepton flavour violation experiments, which should soon allow to fully probe the fermionic dark matter sector and at least partially the scalar dark matter sector.

Primary authors: FIASCHI, Juri (Westfälische Wilhelms-Universität Münster); KLASEN, Michael; MAY, Simon (WWU Münster)

Presenter: KLASEN, Michael

Session Classification: Dark Matter

Track Classification: Dark Matter
Inclusive dijet photoproduction in ultraperipheral heavy-ion collisions at the LHC in next-to-leading order QCD

Saturday, 13 July 2019 09:36 (18 minutes)

We present a calculation of the cross section of inclusive dijet photoproduction in ultraperipheral Pb-Pb collisions at the LHC using next-to-leading order perturbative QCD. We demonstrate that our theoretical calculations provide a good description of various kinematic distributions measured by the ATLAS collaboration. We find that the calculated dijet photoproduction cross section is sensitive to nuclear modifications of parton distribution functions (PDFs) at the level of 10 to 20%. Hence, this process can be used to reduce uncertainties in the determination of these nuclear PDFs, whose current magnitude is comparable to the size of the calculated nuclear modifications of the dijet photoproduction cross section.

Primary authors: KLASEN, Michael; GUZEY, Vadim
Presenter: KLASEN, Michael
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Pair production of electroweak superpartners at the LHC in NLO+NLL with resummation-improved parton densities

We make use of recently released parton density functions (PDFs) with threshold-resummation improvement to consistently calculate theoretical predictions for neutralino-chargino and slepton pair production at next-to-leading order and next-to-leading logarithmic accuracy. The updated cross sections have been computed for experimentally relevant higgsino/gaugino and slepton search channels at the ongoing Run II of the LHC. A factorisation method is applied to exploit the smaller PDF uncertainty of the global PDF sets and to avoid complications arising in the refitting of threshold-resummation improved PDF replicas in Mellin space. The reduction of the scale uncertainty due to the resummation is, however, explicitly taken into account. As expected, the resummation contributions in the PDF fits partially compensate the cross section enhancements induced by those in the partonic matrix elements.

Primary authors:  FIASCHI, Juri (Westfälische Wilhelms-Universität Münster);  KLASEN, Michael

Presenter:  KLASEN, Michael

Session Classification:  Searches for New Physics

Track Classification:  Searches for New Physics
In this work, we calculate limits on masses and couplings of neutral, mono and doubly-charged vector bosons predicted by a class of models based on the $SU(3)_C \times SU(3)_L \times U(1)_X$ symmetry group. These models offer an elegant explanation for the threefold replication of quark-lepton families. Different final states, including two, three and four leptons and leptons plus missing transverse energy are investigated. The processes cross-sections are estimated at the next to leading-order. A detector simulation is performed using the DELPHES package assuming the LHC center-of-mass energy of 13 TeV, with pile-up effects taken into account. Combining these calculations with the latest ATLAS results in different searches, we derive the most stringent bounds on masses and couplings for the predicted particles using LHC data. The results exclude the model vector bosons with masses within the range of 1 TeV to 4 TeV.

**Primary authors:** ASEVEDO NEPOMUCENO, Andre (Federal University of Rio de Janeiro (BR)); MEIROSE, Bernhard (University of Texas at Dallas (US))

**Presenter:** ASEVEDO NEPOMUCENO, Andre (Federal University of Rio de Janeiro (BR))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Searches for ultra long-lived particles with MATHUSLA

Friday, 12 July 2019 15:15 (15 minutes)

With the current experiments at the particle accelerators, no search strategy will be able to observe the decay of neutral long-lived particles with masses above \( ^{\text{\textnormal{3}}} \text{GeV} \) and lifetimes at the limit set by Big Bang Nucleosynthesis (BBN), \( c\tau \sim 10^7-10^8 \text{ m} \). The MATHUSLA detector concept (MAssive Timing Hodoscope for Ultra-Stable neutralL pArticles) will be presented. It can be implemented on the surface above ATLAS or CMS detectors in time for the high-luminosity LHC operations, to search for neutral long-lived particles with lifetimes up to the BBN limit. The large area of the detector allows MATHUSLA to make important contributions also to cosmic-ray physics. We will also report on the analysis of data collected by the test stand installed on the surface above the ATLAS detector, the on-going background studies, and plans for the MATHUSLA detector.

The observation of neutral long-lived particles at the LHC would reveal physics beyond the Standard Model and could account for the many open issues in our understanding of our universe. Long-lived particle signatures are well motivated and can appear in many theoretical constructs that address the Hierarchy Problem, Dark Matter, Neutrino Masses and the Baryon Asymmetry of the Universe.

Primary authors: POLICICCHIO, Antonio (Sapienza Università di Roma and INFN ROMA1); ALPIGIANI, Cristiano (University of Washington, Seattle); TORRO PASTOR, Emma (University of Washington (US))

Presenter: TORRO PASTOR, Emma (University of Washington (US))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Electromagnetic properties of neutrinos

Thursday, 11 July 2019 12:20 (20 minutes)

Abstract:
A review of theory and phenomenology of neutrino electromagnetic properties is presented. A massive neutrino even in the easiest generalization of the Standard Model inevitably has nonzero electromagnetic characteristics, at least nonzero magnetic moment. Although its value, determined by the neutrino mass, is very small, in other BSM theories much larger values of magnetic moments are predicted.

A short introduction to the derivation of the general structure of the electromagnetic interactions of Dirac and Majorana neutrinos is presented.

A thorough account of electromagnetic interactions of massive neutrinos in the theoretical formulation of low-energy elastic neutrino-electron scattering is discussed on the basis of our recently published paper. The formalism of neutrino charge, magnetic, electric, and anapole form factors defined as matrices in the mass basis with account for three-neutrino mixing is presented.

Then we discuss experimental constraints on neutrino magnetic and electric dipole moments, electric millicharge, charge radius and anapole moments from the terrestrial laboratory experiments. A special credit is done to bounds on neutrino electromagnetic characteristics (including magnetic and electric dipole moments, millicharge and charge radius) obtained by the reactor (MUNU, TEXONO and GEMMA) and solar Super-Kamiokande and the recent Borexino and COHERENT experiments.

The effects of neutrino electromagnetic interactions in astrophysical and cosmological environments are also reviewed. The main manifestation of neutrino electromagnetic interactions, such as: 1) the radiative decay in vacuum, in matter and in a magnetic field, 2) the Cherenkov radiation, 3) the plasmon decay, 4) spin light in matter, 5) spin and spin-flavour precession, 6) neutrino pair production in a strong magnetic field, and the related processes along with their astrophysical phenomenology are also considered.

The best world experimental bounds on neutrino electromagnetic properties are confronted with the predictions of theories beyond the Standard Model. It is shown that studies of neutrino electromagnetic properties provide a powerful tool to probe physics beyond the Standard Model.

References:


**Primary author:** Prof. STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University & JINR (RU))

**Presenter:** Prof. STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University & JINR (RU))

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
Neutrino CP Violation with the European Spallation Source neutrino Super Beam project

Friday, 12 July 2019 12:25 (20 minutes)

After measuring in 2012 a relatively large value of the neutrino mixing angle $\theta_{13}$, the door is now open to observe for the first time a possible CP violation in the leptonic sector. The measured value of $\theta_{13}$ also privileges the 2nd oscillation maximum for the discovery of CP violation instead of the usually used 1st oscillation maximum. The sensitivity at this 2nd oscillation maximum is about three times higher than for the 1st oscillation maximum inducing a lower influence of systematic errors. Going to the 2nd oscillation maximum necessitates a very intense neutrino beam with the appropriate energy. The world’s most intense pulsed spallation neutron source, the European Spallation Source, will have a proton linac with 5 MW power and 2 GeV energy. This linac, under construction, also has the potential to become the proton driver of the world’s most intense neutrino beam with very high potential to discover a neutrino CP violation. The physics performance of that neutrino Super Beam in conjunction with a megaton underground Water Cherenkov neutrino detector installed at a distance of about 500 km from ESS has been evaluated. In addition, the choice of such detector will extent the physics program to proton–decay, atmospheric neutrinos and astrophysics searches. The ESS proton linac upgrades, the accumulator ring needed for proton pulse compression, the target station optimization and the physics potential are described. In addition to neutrinos, this facility will also produce at the same time a copious number of muons which could be used by a muon collider. The ESS neutron facility will be fully ready by 2023 at which moment the upgrades for the neutrino facility could start.

This project is supported by the COST Action CA15139 “Combining forces for a novel European facility for neutrino-antineutrino symmetry-violation discovery” and the European Union’s Horizon 2020 research and innovation program under grant agreement No 777419.

Primary authors: Dr DRACOS, Marcos (Centre National de la Recherche Scientifique (FR)); CEDERKALL, Joakim (INP, Krakow)

Presenter: CEDERKALL, Joakim (INP, Krakow)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
New effects in neutrino spin and flavor oscillations

Monday, 15 July 2019 18:30 (1h 30m)

It is known [1] that neutrino electromagnetic interactions open a window to new physics. The present talk is dedicated to new results of our recently performed detailed studies of new effects in neutrino spin, spin-flavour and flavor oscillations under the influence of the transversal matter currents [2] and a constant magnetic field [3]. These two effects can be summarized as follows:

1) it is shown [2] that neutrino spin and spin-flavor oscillations can be engendered by weak interactions of neutrinos with the medium in the case when there are the transversal matter currents (for the appearance of neutrino spin oscillations in this case there is no need either for a neutrino nonzero magnetic moment or for an external magnetic field); different possibilities for the resonance amplification of these new kind of oscillations are discussed, the neutrino Standard Model and non-standard interactions are accounted for, the effect of an external magnetic field is also considered;

2) within a new treatment [3] of the neutrino flavor, spin and spin-flavour oscillations in the presence of a constant magnetic field, that is based on the use of the exact neutrino stationary states in the magnetic field, it is shown that there is an interplay of neutrino oscillations on different frequencies; in particular: a) the amplitude of the flavour oscillations $\nu_e L \leftrightarrow \nu_\mu L$ at the vacuum frequency is modulated by the magnetic field frequency $\omega = \mu_\nu B$, and b) the neutrino spin oscillation $\nu_e L \leftrightarrow \nu_e R$ probability in the magnetic field exhibits the dependence on the neutrino mass square difference $\Delta m^2$.

The discovered new phenomena in neutrino oscillations should be accounted for reinterpretation of results of already performed experiments on detection of astrophysical neutrino fluxes produced in astrophysical environments with strong magnetic fields and dense matter. These new neutrino oscillation phenomena are also of interest in view of future experiments on observations of supernova neutrino fluxes with large liquid-scintillator detectors like JUNO.

References:


Primary author: STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))

Presenter: STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Search for new physics with the SHiP experiment at CERN

Friday, 12 July 2019 16:00 (15 minutes)

The SHiP Collaboration has proposed a general-purpose experimental facility operating in beam dump mode at the CERN SPS accelerator with the aim of searching for light, long-lived exotic particles of Hidden Sector models. The SHiP experiment incorporates a muon shield based on magnetic sweeping and two complementary apparatuses. The detector immediately downstream of the muon shield is optimised both for recoil signatures of light dark matter scattering and for tau neutrino physics, and consists of a spectrometer magnet housing a layered detector system with heavy target plates, emulsion film technology and electronic high precision tracking. The second detector system aims at measuring the visible decays of hidden sector particles to both fully reconstructible final states and to partially reconstructible final states with neutrinos, in a nearly background free environment. The detector consists of a 50 m long decay volume under vacuum followed by a spectrometer and particle identification with a rectangular acceptance of 5 m in width and 10 m in height. Using the high-intensity beam of 400 GeV protons, the experiment is capable of integrating $2 \times 10^{20}$ protons in five years, which allows probing dark photons, dark scalars and pseudo-scalars, and heavy neutrinos with GeV-scale masses at sensitivities that exceed those of existing and projected experiments. The sensitivity to heavy neutrinos will allow for the first time to probe, in the mass range between the kaon and the charm meson mass, a coupling range for which baryogenesis and active neutrino masses can be explained. The sensitivity to light dark matter reaches well below the elastic scalar Dark Matter relic density limits in the range from a few MeV/$c^2$ up to 200 MeV/$c^2$.

Following the review of the Technical Proposal, the CERN SPS Committee recommended in 2016 that the experiment and the beam dump facility studies proceed to a Comprehensive Design Study phase. These studies have resulted in a mature proposal submitted to the European Strategy for Particle Physics Update.

Primary authors: SHiP, Collaboration (CERN); Dr KORZENEV, Alexander (Université de Genève (CH))

Presenter: Dr KORZENEV, Alexander (Université de Genève (CH))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Neutrino physics with the SHiP experiment at CERN

Saturday, 13 July 2019 12:10 (20 minutes)

The SHiP Collaboration has proposed a general-purpose experimental facility operating in beam dump mode at the CERN SPS accelerator with the aim of searching for light, long-lived exotic particles of Hidden Sector models. The SHiP experiment incorporates a muon shield based on magnetic sweeping and two complementary apparatuses. The detector immediately downstream of the muon shield is optimised both for recoil signatures of light dark matter scattering and for tau neutrino physics, and consists of a spectrometer magnet housing a layered detector system with heavy target plates, emulsion film technology and electronic high precision tracking. Using the high-intensity beam of 400 GeV protons, the experiment is capable of integrating $2 \times 10^{20}$ protons in five years. The sensitivity to light dark matter reaches well below the elastic scalar Dark Matter relic density limits in the range from a few MeV/$c^2$ up to 200 MeV/$c^2$. The tau neutrino deep-inelastic scattering cross-sections will be measured with a statistics a thousand times larger than currently available, with the extraction of the $F_4$ and $F_5$ structure functions, never measured so far, and allow for new tests of lepton non-universality with sensitivity to BSM physics.

Following the review of the Technical Proposal, the CERN SPS Committee recommended in 2016 that the experiment and the beam dump facility studies proceed to a Comprehensive Design Study phase. These studies have resulted in a mature proposal submitted to the European Strategy for Particle Physics Update.

Primary author: SHiP, Collaboration (CERN)
Presenter: PASTORE, Alessandra (Sezione di Bari (INFN) (IT))
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Probing Higgs Sector New Physics in Vector Boson Longitudinal Mode

Thursday, 11 July 2019 18:05 (15 minutes)

Off-shell Higgs at the high mass tail may shed light on the underlying mechanism of the electroweak symmetry breaking. In the Standard Model, there is an exact cancellation of the logarithmic divergence between the box and Higgs-mediated triangle diagrams due to unitarity, such that the $gg \to ZZ(WW)$ process in the SM is dominated by the vector boson transverse-mode. The cancellation can be delayed to a higher scale, when there is sufficiently large new physics contribution resulting in $VLVL$ longitudinal mode, which is commonly the case when the Higgs sector is modified. Thus the longitudinal mode in the high mass tail can be utilized as a sensitive probe for new physics. We thus propose to utilize the information in angular observables to maximize the sensitivity across various types of Higgs sector new physics.

Primary authors: QIAN, Zhuoni (IBS); LEE, Seung J. (Korea University); PARK, Myeonghun (Institute for basic Science (KR))

Presenter: QIAN, Zhuoni (IBS)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
A convincing observation of neutrino-less double beta decay (0νDBD) relies on the possibility of operating high-energy resolution detectors in background-free conditions. Scintillating cryogenic calorimeters are one of the most promising tools to fulfill the requirements for a next-generation experiment. Several steps have been taken to demonstrate the maturity of this technique, starting from the successful experience of CUPID-0.

The CUPID-0 experiment collected 10 kg·y of exposure, running 26 Zn^{82}Se crystals during two years of continuous detector operation. The complete rejection of the dominant alpha background was demonstrated, measuring the lowest counting rate in the region of interest for this technique. Furthermore, the most stringent limit on the Se-82 0νDBD was established.

In this contribution we present the final results of CUPID-0 Phase I, including a detailed model of the background and the measurement of the 2νDBD half-life.

**Primary authors:** CUPID-0 COLLABORATION; PATTAVINA, Luca Maria (INFN - National Institute for Nuclear Physics)

**Presenter:** PATTAVINA, Luca Maria (INFN - National Institute for Nuclear Physics)

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
Probing standard-model Higgs substructures using tops and weak gauge bosons

Manifest gauge-invariance requires that observable states in the standard-model are described by composite operators, which involve additional Higgs contributions beyond perturbation theory. This field-theoretical effects has been confirmed in lattice simulations. It has experimentally accessible consequences, of which two will be explored.

One is a non-trivial modification of the off-shell formfactor of the weak vector bosons, effectively increasing the apparent radius of the particles. Results of lattice measurements will be presented, which give an estimate of the size of the effect. It will be discussed how this could be accessed at LHC. The other is an additional Higgs contribution to the structure of the proton. (Differential) measurements of $pp \rightarrow tt(Z)$ are used together with HERWIG and CMS analysis setups to constrain this contribution. It is found that a sizable effect is still compatible with the currently available data.

**Primary author:** MAAS, Axel Torsten (University of Graz)

**Presenter:** MAAS, Axel Torsten (University of Graz)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Results from the CUORE experiment

Thursday, 11 July 2019 09:20 (20 minutes)

The Cryogenic Underground Observatory for Rare Events (CUORE) is the first bolometric experiment searching for neutrinoless double beta decay ($0\nu\beta\beta$) that has been able to reach the one-ton scale. The detector consists of an array of 988 TeO$_2$ crystals arranged in a compact cylindrical structure of 19 towers. The construction of the experiment was completed in August 2016 with the installation of all towers in the cryostat. Following a cooldown, diagnostic, and optimization campaign, routine data-taking began in spring 2017. In this talk, we present the $0\nu\beta\beta$ results of CUORE from examining a total TeO$_2$ exposure of 86.3 kg·yr, characterized by an average energy resolution of 7.7 keV FWHM and a background in the region of interest of 0.014 counts/(keV·kg·yr).

In this physics run, CUORE placed the current best lower limit on the $^{130}$Te $0\nu\beta\beta$ half-life of $> 1.3 \times 10^{25}$ yr (90% C.L.). We then discuss the additional improvements in the detector performance achieved in 2018, the latest evaluation of the CUORE background budget, and we finally present the most precise measurement of the $^{130}$Te $2\nu\beta\beta$ half-life to date.

Primary authors: CUORE COLLABORATION; BRANCA, Antonio (Universita e INFN (IT))

Presenter: BRANCA, Antonio (Universita e INFN (IT))

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Neutrino eigenstates and flavour, spin and spin-flavour oscillations in a constant magnetic field

*Monday, 15 July 2019* 18:30 (1h 30m)

We further develop a recently proposed new approach to the description of the relativistic neutrino flavour \( \nu_e^L \leftrightarrow \nu^L_\mu \), spin \( \nu_e^L \leftrightarrow \nu_e^R \) and spin-flavour \( \nu_{e}^L \leftrightarrow \nu_{\mu}^R \) oscillations in a constant magnetic field that is based on the use of the exact neutrino stationary states in the magnetic field. The neutrino flavour, spin and spin-flavour oscillations probabilities are calculated accounting for the whole set of possible conversions between four neutrino states. In general, the obtained expressions for the neutrino oscillations probabilities exhibit new inherent features in the oscillation patterns. It is shown, in particular, that: 1) in the presence of the transversal magnetic field for a given choice of parameters (the energy and magnetic moments of neutrinos and the strength of the magnetic field) the amplitude of the flavour oscillations \( \nu_{e}^L \leftrightarrow \nu_{\mu}^L \) at the vacuum frequency is modulated by the magnetic field frequency, 2) the neutrino spin oscillation probability (without change of the neutrino flavour) exhibits the dependence on the mass square difference \( \Delta m^2 \). It is shown that the discussed interplay of neutrino oscillations in magnetic fields on different frequencies can have important consequences in astrophysical environments, in particular in those peculiar for magnetars.

**Primary author:** POPOV, Artem (MSU)

**Co-author:** STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))

**Presenter:** POPOV, Artem (MSU)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Neutrino Physics
Neutrino spin and spin-flavour oscillations in transversal matter currents with standard and non-standard interactions

Monday, 15 July 2019 18:30 (1h 30m)

After a brief history of two known types of neutrino mixing and oscillations, including neutrino spin and spin-flavour oscillations in the transversal magnetic field, we perform systematic study of a new phenomenon of neutrino spin and spin-flavour oscillations engendered by the transversal matter currents on the bases of the developed quantum treatment of the phenomenon. Possibilities for the resonance amplification of these new types of oscillations by the longitudinal matter currents and longitudinal magnetic fields are analyzed. Neutrino spin-flavour oscillations engendered by the transversal matter currents in the case of nonstandard interactions of neutrinos with background matter are also considered.

based on paper Phys.Rev.D 98 (2018) no.11, 113009

Primary author: PUSTOSHNY, Pavel
Co-author: STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))
Presenters: PUSTOSHNY, Pavel; STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
Phenomenology of TeV-scale scalar Leptoquarks in the EFT

Thursday, 11 July 2019 15:15 (15 minutes)

We examine new aspects of leptoquark (LQ) phenomenology using effective field theory (EFT). We construct a complete set of leading effective operators involving SU(2) singlets scalar LQ and the SM fields up to dimension six. We show that, while the renormalizable LQ-lepton-quark interaction Lagrangian can address the persistent hints for new physics in B-decays and the anomalous magnetic moment of the muon, the LQ higher dimensional effective operators may lead to new interesting effects associated with lepton number violation. These include the generation of one-loop sub-eV Majorana neutrino masses, mediation of neutrinoless double-$\beta$ decay and novel LQ collider signals. For the latter, we focus on 3rd generation LQ ($\phi_3$) in a framework with an approximate $Z_3$ generation symmetry, and show that one class of the dimension five LQ operators may give rise to a striking asymmetric same-charge $\phi_3\phi_3$ pair-production signal, which leads to low background same-sign leptons signals at the LHC. For example, with $M_{\phi_3} \sim 1$ TeV and a new physics scale of $\Lambda \sim 5$ TeV, we expect about 5000 positively charged $\tau^+\tau^+$ events via $pp \rightarrow \phi_3\phi_3 \rightarrow \tau^+\tau^++2\cdot j_b$ ($j_b=b$-jet) at the 13 TeV LHC with an integrated luminosity of 300 fb$^{-1}$. We also consider the same-sign charged lepton signals in the LQ EFT framework at higher energy hadron colliders such as a 27 TeV HE-LHC and a 100 TeV FCC-hh.

Primary authors: Dr SONI, Amarjit (Brookhaven National Laboratory (BNL)); Mr COHEN, Jonathan (Technion); Prof. WUDKA, Jose (University of California at Riverside (UCR)); BAR-SHALOM, Shaouly (Physics Department Technion, Israel)

Presenter: BAR-SHALOM, Shaouly (Physics Department Technion, Israel)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
A universally enhanced light-quarks Yukawa couplings paradigm

Thursday, 11 July 2019 09:30 (15 minutes)

We propose that natural TeV-scale new physics (NP) with $O(1)$ couplings to the standard model (SM) quarks may lead to a universal enhancement of the Yukawa couplings of all the light quarks, perhaps to a size comparable to that of the SM b-quark Yukawa coupling, i.e., $y_q \sim O(y_b^{SM})$ for $q = u, d, c, s$. I will discuss this scenario in an effective field theory (EFT) extension of the SM, and show that the potential EFT contribution to the light quarks Yukawa couplings is $y_q \sim O(f^2 \Lambda^2)$, where $\Lambda$ is the typical scale of the underlying heavy NP and $f$ depends on its properties and details. For example, with $\Lambda \sim 1.5$ TeV and natural NP couplings $f \sim O(1)$, one obtains $y_q \sim 0.025 \sim y_b^{SM}$. I will also discuss this enhanced light quarks Yukawa paradigm in extensions of the SM which contain TeV-scale vector-like quarks (VLQ) and match them to the EFT description. The flavor structure and the constraints on this scenario will also be explored as well as the resulting “smoking gun” signals that should be searched for at the LHC, e.g., multi-Higgs production $pp \to hh, hhh$ and single Higgs production in association with a high $p_T$ jet or photon and with a single top-quark, i.e., $pp \to hj, h\gamma$ and $pp \to ht$.

Primary authors: Dr SONI, Amarjit (BNL); BAR-SHALOM, Shaouly (Physics Department Technion, Israel)

Presenter: BAR-SHALOM, Shaouly (Physics Department Technion, Israel)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
How to properly formulate QCD sum rules for exotic tetraquarks

Monday, 15 July 2019 18:30 (1h 30m)

We show the proper way to extract characteristics of tetraquark states within the method of QCD sum rules. We emphasize that duality relations for correlators involving tetraquark currents have fundamental differences compared with the duality relations for the correlators of bilinear quark currents: namely, the $\mathcal{O}(1)$ and $\mathcal{O}(\alpha_s)$ terms in the OPE for the exotic correlators exactly cancel against the contributions of the two-meson states on the phenomenological side of QCD sum rules. Consequently, the tetraquark properties turn out to be related to the specific non-factorizable parts of the OPE for the exotic Green functions; the relevant non-factorizable diagrams start at order $\mathcal{O}(\alpha_s^2)$. Moreover, we demonstrate that all appropriate diagrams may be easily obtained from those Feynman diagrams for the four-point function of bilinear quark currents which contain four-quark $s$-channel singularities. Our findings call for a massive revision of the existing results for tetraquarks and pentaquarks obtained from QCD sum rules.

**Primary authors:** MELIKHOV, Dmitri (HEPHY); Prof. SAZDJIAN, Hagop (University Paris-Sud); LUCHA, Wolfgang (Austrian Academy of Sciences)

**Presenter:** LUCHA, Wolfgang (Austrian Academy of Sciences)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** QCD and Hadronic Physics
The effect of neutrino quantum decoherence

Monday, 15 July 2019 18:30 (1h 30m)

The origin of neutrino oscillations is the coherent superposition of different neutrino states. The loss of coherence of neutrino states due to neutrino interactions with an external environment leads to damping of oscillations. The neutrino quantum decoherence is studied in the formalism of open quantum systems using a density matrix. In the framework of this approach, it is possible to obtain the quantum optical equation for neutrinos with a dissipator that is responsible for decoherence. The exact form of the dissipator is determined by the neutrinos interaction with the external environment. The neutrino quantum decoherence is considered for an environment peculiar for supernovae bursts.

Primary authors: STANKEVICH, Konstantin (Lomonosov Moscow State University); STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))

Presenter: STANKEVICH, Konstantin (Lomonosov Moscow State University)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Intrinsic quantum mechanics behind the Standard Model?

Monday, 15 July 2019 18:30 (1h 30m)

We suggest the gauge groups SU(3), SU(2) and U(1) to share a common origin in U(3).

We take the Lie group U(3) to serve as an intrinsic configuration space for baryons. A spontaneous symmetry break in the baryonic state selects a U(2) subgroup for the Higgs mechanism. The Higgs field enter the symmetry break to relate the strong and electroweak energy scales by exchange of one quantum of action between the two sectors. This shapes the Higgs potential to fourth order.

Recently intrinsic quantum mechanics has given a suggestion for the Cabibbo angle from theory (EPL124-2018) and a prediction for the Higgs couplings to gauge bosons (EPL125-2019). Previously it has given the nucleon mass and the parton distribution functions for u and d quarks in the proton (EPL102-2013). It has given a quite accurate equation for the Higgs mass in closed form (IJMPA30-2015) and an N and Delta spectrum essentially without missing resonances (arXiv:1109.4732).

The intrinsic space is to be distinguished from an interior space. The intrinsic space is non-spatial, i.e. no gravity in intrinsic space. The configuration variable is like a generalized spin variable excited from laboratory space by kinematic generators: momentum, spin and Laplace-Runge-Lenz operators.

The baryon dynamics resides in a Hamiltonian on U(3) and projects to laboratory space by the momentum form of the wavefunction. The momentum form generates conjugate quark and gluon fields. Local gauge invariance in laboratory space follows from unitarity of the configuration variable and left-invariance of the coordinate fields in the intrinsic space.

Future work should aim to invoke leptons in the second and third generations and quarks in the third.

Primary author: TRINHAMMER, Ole Lynnerup (Technical University of Denmark)
Presenter: TRINHAMMER, Ole Lynnerup (Technical University of Denmark)
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Physics Without Frontiers

Friday, 12 July 2019 14:45 (15 minutes)

The ICTP Physics Without Frontiers (PWF) programme works with volunteer physicists to inspire, train and motivate physics and mathematics university students worldwide with some focus on science and technology lagging countries. The aim is to promote physics research and help build the next generation of scientists. Each project is unique, developed with the country’s specific needs in mind. The educational resources, tools and approach used in the HEP chapter of PWF will be discussed, highlighting issues encountered, and the achievements and impact.

Primary authors: Dr SHAW, Kate (University of Sussex (GB)); ACHARYA, Bobby Samir (Abdus Salam Int. Cent. Theor. Phys. (IT))

Presenter: Dr SHAW, Kate (University of Sussex (GB))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
AugerPrime: The upgrade of the Pierre Auger Observatory

Saturday, 13 July 2019 11:50 (20 minutes)

The Pierre Auger Observatory is the largest observatory in the world for the detection of ultrahigh-energy cosmic rays. The Auger Collaboration started collecting data in 2004. In this period many significant discoveries were made, but some observations are still puzzling.

To improve the capability of the Observatory to identify the mass of the primary particles, the Observatory has started a major upgrade, called AugerPrime. The key points of the upgrade are the extension of the dynamic range of the surface detector (SD), the improvement of the data quality using a faster acquisition electronic, and the installation of new scintillator detectors on top of the 1660 water-Cherenkov detectors of the SD. After introducing the physics motivation of AugerPrime, technical details of the upgrade will be described, and the status of the deployment and the expected performance of the Observatory will be discussed.

Primary author: BUSCEMI, Mario (INFN - National Institute for Nuclear Physics)
Co-author: PIERRE AUGER COLLABORATION
Presenter: BUSCEMI, Mario (INFN - National Institute for Nuclear Physics)
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Constraints on neutrino millicharge and charge radius from neutrino-atom scattering

Monday, 15 July 2019 18:30 (1h 30m)

We consider possible effects of neutrino electric charge (millicharge) and charge radius [1,2] on the neutrino-atom interaction processes such as (i) atomic ionization by neutrino impact and (ii) coherent elastic neutrino-nucleus scattering. The bounds [3,4] on the neutrino millicharge and charge radius that follow from, respectively, the GEMMA and COHERENT experiments are presented and discussed.

References

Primary authors: KOUZAKOV, Konstantin (Lomonosov Moscow State University); STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))
Co-authors: CADEDDU, Matteo (INFN); GIUNTI, Carlo (INFN - National Institute for Nuclear Physics); LI, Yufeng (Institute of High Energy Physics, Chinese Academy of Sciences); ZHANG, Yiyu (Institute of High Energy Physics, Chinese Academy of Sciences)
Presenters: KOUZAKOV, Konstantin (Lomonosov Moscow State University); STUDENIKIN, Alexander (M.V. Lomonosov Moscow State University (RU))
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
Searches for dark matter with the CRESST-III Experiment

Thursday, 11 July 2019 17:55 (20 minutes)

CRESST-III is a cryogenic dark matter experiment operated at the Gran Sasso laboratory in Italy. The primary research interest is the search for dark matter in the sub-GeV mass region. Dark matter particles are detected by measuring the nuclear recoil energy from the elastic scatter with the dark matter particle. The experimental challenge for reaching such a low mass region is to achieve the lowest possible energy detection threshold. Currently CRESST-III has obtained an energy detection threshold of 30.1 eV. The target material is a 24g CaWO$_4$-crystal operated at a temperature of about 15 mK and using a dual read-out scheme. By measuring the phonons and the scintillation light an active background suppression can be reached.

We will present spin-independent results from direct dark matter searches. We will discuss electromagnetic background sources and its composition, based on a Geant4-simulation. The simulation contains the CaWO$_4$-crystal as well as the Cu-support structure. We will also discuss spin-dependent results obtained with a a CaWO$_4$- and a Li$_2$MoO$_4$-crystal.

Finally we will present first results from a new data taking campaign, which started end of 2018 and will give an outlook of the future stages of the experiment.

Primary author: SCHIECK, Jochen (Austrian Academy of Sciences (AT))

Presenter: SCHIECK, Jochen (Austrian Academy of Sciences (AT))

Session Classification: Dark Matter

Track Classification: Dark Matter
Study on HQ-LAB for the JUNO Experiment

Monday, 15 July 2019 18:30 (1h 30m)

A 20 kton large volume liquid scintillator detector is being constructed at Jiangmen, China, to determine the neutrino mass hierarchy, and measure the neutrino oscillation parameters. The excellent energy resolution and the large fiducial volume anticipated for the JUNO detector offer exciting opportunities for addressing many important topics in neutrino and astroparticle physics. High quality Linear Alkylbenzene (HQ-LAB) will be used as a solvent for the liquid scintillation system, and its light attenuation lengths should be comparable to the diameter of the JUNO central detector.

In this poster, we briefly introduce the LAB samples prepared by the various methods, especially by the improved techniques that are more suitable for large-scale mass productions. We measured their light attenuation lengths and then analyzed their chemical composition by a Q Exactive GC-MS technique, and some of the structure formulas of organic impurities were determined. By studying the overall optical transparency of LAB samples, it will further help us to promote the LAB preparation processes suitable for the mass production, to meet the stringent requirements of producing 20 kton HQ-LAB in the near future.

Primary authors: Prof. MING, QI (Nanjing University); Mr WU, FANG-LIANG (Nanjing University); Dr CAO, DE-WEN (Nanjing University); Mr ZHANG, RUI (Nanjing University); Dr LOH, CHANG-WEI (Nanjing University); Mr LIU, YOU-HANG (Nanjing University); Mr ZHANG, JIA-LIANG (Nanjing University)

Presenter: Prof. MING, QI (Nanjing University)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Possible effect of mixed phase and deconfinement upon spin correlations in the $\bar{\Lambda}\Lambda$ pairs generated in relativistic heavy-ion collisions

Spin correlations for the $\Lambda\Lambda$ and $\bar{\Lambda}\bar{\Lambda}$ pairs, produced in relativistic heavy-ion collisions, and related angular correlations at the joint registration of space-parity nonconserving hadronic decays of two hyperons are theoretically analyzed. These correlations give important information about the character and mechanism of multiple processes, and the advantage of the $\Lambda\Lambda$ and $\bar{\Lambda}\bar{\Lambda}$ systems over other ones is conditioned by the fact that the $P$-odd decays $\Lambda \rightarrow p + \pi^-$ and $\bar{\Lambda} \rightarrow \bar{p} + \pi^+$ serve as effective analyzers of spin states of the $\Lambda$ and $\bar{\Lambda}$ particles – thus, the respective spin correlations can be rather easily distinguished and studied experimentally, which is especially important for studies of multiple particle generation at modern and future ion colliders (RHIC, LHC, NICA). The correlation tensor components can be derived by the method of "moments" – as a result of averaging the combinations of trigonometric functions of proton (antiproton) flight angles over the double angular distribution of flight directions for products of two decays. The properties of the "trace" $T$ of the correlation tensor (a sum of three diagonal components), which determines the angular correlations as well as the relative fractions of the triplet states and singlet state of respective pairs, are discussed.

In the present talk, spin correlations for two identical ($\Lambda\Lambda$) and two non-identical ($\bar{\Lambda}\bar{\Lambda}$) particles are generally considered from the viewpoint of the conventional model of one-particle sources, implying that correlations vanish at enough large relative momenta. However, under these conditions (especially at ultrarelativistic energies), in the case of two non-identical particles ($\Lambda\bar{\Lambda}$) the two-particle – quark-antiquark and two-gluon – annihilation sources start playing a noticeable role and lead to the difference of the correlation tensor from zero. In particular, such a situation may arise, when the system passes through the "mixed phase" and – due to the multiple production of free quarks and gluons in the process of deconfinement of hadronic matter – the number of two-particle sources strongly increases.

Primary author: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)
Co-author: Dr LYUBOSHITZ, Vladimir (Joint Institute for Nuclear Research, Dubna)
Presenter: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)
Session Classification: Wine & Cheese Poster Session
Track Classification: Heavy Ion Physics
On the pair correlations of neutral $K$, $D$, $B$ and $B_s$ mesons with close momenta produced in inclusive multiparticle processes

Thursday, 11 July 2019 11:30 (18 minutes)

The phenomenological structure of inclusive cross-sections of the production of two neutral $K$ mesons in hadron–hadron, hadron–nucleus and nucleus–nucleus collisions is theoretically studied taking into account the strangeness conservation in strong and electromagnetic interactions. Relations for the dependence of correlations of two short-lived and two long-lived neutral kaons $K_S^0 K_S^0$, $K_L^0 K_L^0$ and correlations of “mixed” pairs $K_S^0 K_L^0$ at small relative momenta upon the space-time parameters of the generation region of $K^0$ and $\bar{K}^0$ mesons are obtained – involving the contributions of Bose-statistics and $S$-wave strong final-state interaction of two $K^0$ ($\bar{K}^0$) mesons and of the $K^0$ and $\bar{K}^0$ mesons, as well as the additional one of transitions $K^+ K^- \rightarrow K^0 \bar{K}^0$, and depending upon the relative fractions of generated pairs $K^0 K^0$, $\bar{K}^0 \bar{K}^0$, $K^0 \bar{K}^0$. It is shown that under the strangeness conservation the correlation functions of the pairs $K_S^0 K_S^0$ and $K_L^0 K_L^0$, produced in the same inclusive process, coincide, and the difference between the correlation functions of the pairs $K_S^0 K_L^0$ and $K_L^0 K_S^0$ is conditioned exclusively by the generation of pairs of non-identical neutral kaons $K^0 \bar{K}^0$.

For comparison, analogous correlations for the pairs of neutral heavy mesons $D^0$, $B^0$ and $B_s^0$, produced in multiple inclusive processes with charm (beauty) conservation, are also theoretically analyzed – neglecting, just as for the case of $K^0$ mesons, the weak effects of $CP$ violation. These correlations have the quite similar character and they are described by quite similar expressions: in particular, just as for $K^0$ mesons, the correlation functions for the pairs of states with the same $CP$ parity ($R_{SS} = R_{LL}$) and with different $CP$ parity ($R_{SL}$) do not coincide, and the difference between them is conditioned exclusively by the production of pairs $D^0 \bar{D}^0$, $B^0 \bar{B}^0$ and $B_s^0 \bar{B}_s^0$. However, contrary to the case of $K^0$ mesons, here the distinction of $CP$-even and $CP$-odd states (and, hence, the experimental observation of respective pair correlations) encounters difficulties – due to the insignificant differences of their lifetimes and the relatively small probability of purely $CP$-even and $CP$-odd decay channels. Nevertheless, one may expect that this will become possible at future colliders.
On the spin correlations of final leptons produced in the high-energy annihilation processes
\[ e^+e^- \rightarrow \mu^+\mu^-, e^+e^- \rightarrow \tau^+\tau^- \]

Monday, 15 July 2019 19:40 (20 minutes)

The electromagnetic processes of annihilation of \((e^+e^-)\) pairs into heavy flavor lepton pairs are theoretically studied in the one-photon approximation, using the technique of helicity amplitudes. For the process \(e^+e^- \rightarrow \mu^+\mu^-\), it is shown that – in the case of the unpolarized electron and positron – the final muons are also unpolarized but their spins prove to be strongly correlated. For the final \((\mu^+\mu^-)\) system, the structure of triplet states is analyzed and explicit expressions for the components of the spin density matrix and correlation tensor are derived; besides, the formula for angular correlation at the decays of final muons \(\mu^+\) and \(\mu^-\) is obtained.

It is demonstrated that the spin correlations of muons in the process \(e^+e^- \rightarrow \mu^+\mu^-\) have the purely quantum character, since one of the Bell-type incoherence inequalities for the correlation tensor components is always violated (i.e., there is always at least one case when the modulus of sum of two diagonal components exceeds unity). Besides, the additional contribution of the weak interaction of lepton neutral currents through the virtual \(Z^0\) boson is considered in detail, and it is established that, when involving the weak interaction contribution, the qualitative character of the muon spin correlations does not change.

Analogous analysis can be wholly applied as well to the final tau leptons formed in the annihilation process \(e^+e^- \rightarrow \tau^+\tau^-\), which becomes possible at considerably higher energies.

Primary author: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)  
Co-author: Dr LYUBOSHITZ, Vladimir (Joint Institute for Nuclear Research, Dubna)  
Presenter: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)  
Session Classification: Wine & Cheese Poster Session  
Track Classification: Flavour Physics and CP Violation
Heavy resonances at energy-frontier hadron colliders

Friday, 12 July 2019 17:15 (15 minutes)

This talk explores the physics reach of the proton-proton Future Circular Collider (FCC-hh) and of the High-Energy LHC (HE-LHC) for searches of new particles produced in the $s$-channel and decaying to two high-energy leptons, jets (non-tops), tops or $W/Z$ bosons (as discussed in arXiv:1902.11217). We discuss the expected discovery potential and exclusion limits for benchmark models predicting new massive particles that result in resonant structures in the invariant mass spectrum. We also present a detailed study of the HE-LHC potential to discriminate among different models, for a $Z'$ that could be discovered by the end of High-Luminosity LHC (HL-LHC).

Primary authors: HESENS, Clement (CERN); JAMIN, David Olivier (Academia Sinica (TW)); MANGANO, Michelangelo (CERN); SELVAGGI, Michele (CERN); RIZZO, Thomas

Presenter: HESENS, Clement (CERN)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Light neutral meson production in the era of precision physics at the LHC

Thursday, 11 July 2019 11:48 (18 minutes)

The production of light neutral mesons in different collision systems is interesting for a variety of reasons: In AA collisions the measurements can provide important information on the energy loss of partons traversing the Quark-Gluon Plasma (QGP) which is formed in heavy-ion collisions at the LHC. Measured in pp collisions, neutral meson spectra serve as a reference for pA and AA collisions. Also, they allow us to test with high precision the predictions of perturbative QCD and other model calculations. In pA collisions, cold nuclear matter effects are studied. In addition, decays of $\pi^0$ and $\eta$ mesons are the dominant background for all direct photon measurements. Therefore, pushing the limits of the precision of neutral meson production is key to learning about the temperature and space-time evolution of the QGP.

In the ALICE experiment, which is dedicated to the study of the QGP, neutral mesons can be detected via their decay to two photons. The latter can be reconstructed using the two calorimeters EMCal and PHOS or via conversions in the detector material. Combining the excellent momentum resolution of the conversion photons down to very low transverse momenta ($p_T$) and the high reconstruction efficiency and triggering capability of calorimeters at high $p_T$, we are able to measure neutral mesons and direct photons over a wide transverse momentum range.

Combining state-of-the-art reconstruction techniques with the high statistics delivered by the LHC in Run 2 gives us the opportunity to enhance the precision of our measurements. In this talk, new results together with an overview of neutral meson production in pp, p–Pb and Pb–Pb collisions at LHC energies, as measured with the ALICE experiment will be presented.

Primary authors: ALICE COLLABORATION; SAS, Mike Henry Petrus (Nikhef National institute for subatomic physics (NL))

Presenter: SAS, Mike Henry Petrus (Nikhef National institute for subatomic physics (NL))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Opportunities and Challenges of Standard Model Production Cross Section Measurements at 8 TeV using CMS Open Data

The CMS Open Data project offers new opportunities to measure Standard Model (SM) Production Cross Sections which have not been probed so far. In this work, we evaluate the challenges and the opportunities of the CMS Open Data project in the view of cross-section measurements. In particular, we reevaluate SM cross-sections of the production of W-bosons, Z-bosons, top-quark pairs and WZ dibosons in several decay channels at a center of mass energy of 8 TeV with a corresponding integrated luminosity of 1.8 fb⁻¹. Those cross-sections have been previously measured by the ATLAS and CMS collaborations and hence can be used to validate our analysis and calibration strategy. This gives an indication to which precision also new, so far unmeasured cross-sections can be determined at this point using CMS Open Data by scientists who are not members of the LHC collaborations and hence lack detailed knowledge on experimental and detector related effects and their handling.

Primary author: SCHOTT, Matthias (CERN / University of Mainz)
Presenter: SCHOTT, Matthias (CERN / University of Mainz)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Status of the MUonE experimental proposal

*Friday, 12 July 2019 12:15 (15 minutes)*

The precision measurement of the anomalous magnetic moment of the muon presently exhibits a 3.5σ discrepancy with the Standard Model (SM) prediction. In the next few years this measurement will reach an even higher precision at Fermilab and J-PARC. While the QED and electroweak contributions to the muon g-2 can be determined very precisely, the leading hadronic (HLO) correction is affected by a large uncertainty which dominates the error of the SM prediction.

A novel approach has been proposed to determine the HLO contribution to the muon g-2 based on the measurement of the effective electromagnetic coupling in the space-like region at low-momentum transfer. We will discuss the possibility of performing this measurement at CERN by the MUonE experiment, which is part of the CERN PBC Study Group and aims at a very precise determination of the muon-electron elastic differential cross-section, exploiting the scattering of 150 GeV muons (currently available at CERN’s North area) on atomic electrons of a low-Z target.

The challenges posed by this measurement on the detector, the proposed solution, and the status of this proposal will be discussed.

**Primary author:** VENANZONI, Graziano (INFN Sezione di Pisa, Universita’ e Scuola Normale Superiore, P)

**Presenter:** VENANZONI, Graziano (INFN Sezione di Pisa, Universita’ e Scuola Normale Superiore, P)

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Determination of the strong coupling constant $\alpha_s(m_Z)$ in next-to-next-to-leading order QCD using H1 jet cross section measurements

Friday, 12 July 2019 17:00 (15 minutes)

The strong coupling constant $\alpha_s$ is determined from inclusive jet and dijet cross sections in neutral-current deep-inelastic ep scattering (DIS) measured at HERA by the H1 collaboration using next-to-next-to-leading order (NNLO) QCD predictions. The dependence of the NNLO predictions and of the resulting value of $\alpha_s(m_Z)$ at the Z-boson mass $m_Z$ are studied as a function of the choice of the renormalisation and factorisation scales. Using inclusive jet and dijet data together, the strong coupling constant is determined to be $\alpha_s(m_Z) = 0.1157 (20)_{\text{exp}} (29)_{\text{th}}$. Complementary, $\alpha_s(m_Z)$ is determined together with parton distribution functions of the proton (PDFs) from jet and inclusive DIS data measured by the H1 experiment. The value $\alpha_s(m_Z) = 0.1142 (28)_{\text{tot}}$ obtained is consistent with the determination from jet data alone. The impact of the jet data on the PDFs is studied. The running of the strong coupling is tested at different values of the renormalisation scale and the results are found to be in agreement with expectations.


Primary authors: SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE)); LEVONIAN, Sergey (Deutsches Elektronen-Synchrotron (DE)); H1, Collaboration (DESY)

Presenter: RIZVI, Eram Syed (Queen Mary, University of London)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Determination of electroweak parameters in polarised deep-inelastic scattering at HERA

Friday, 12 July 2019 17:45 (15 minutes)

The parameters of the electroweak theory are determined in a combined electroweak and QCD analysis using all deep-inelastic $e^+p$ and $e^-p$ neutral current and charged current scattering cross sections published by the H1 Collaboration, including data with longitudinally polarised lepton beams. The mass of the $W$ boson in the on-shell scheme is determined as $m_W = 80.520 \pm 0.115$ GeV. The axial-vector and vector couplings of the light quarks to the $Z$ boson are also determined. Both results improve the precision of previous H1 determinations based on HERA-I data by about a factor of two. Possible scale dependence of the weak coupling parameters in both neutral and charged current interactions beyond the Standard Model is also studied. All results are found to be consistent with the Standard Model expectations.


Primary authors: SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE)); LEVONIAN, Sergey (Deutsches Elektronen-Synchrotron (DE)); SPIESBERGER, Hubert (Mainz University); H1, Collaboration (DESY)

Presenters: BRITZGER, Daniel (Deutsches Elektronen-Synchrotron (DE)); BRITZGER, Daniel (Max-Planck-Institut für Physik München)

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Diffractive PDF determination from HERA inclusive and jet data at NNLO QCD

Friday, 12 July 2019 17:15 (15 minutes)

A new fit of diffractive parton distribution functions (DPDFs) to the HERA inclusive and jet data in diffractive deep-inelastic scattering (DDIS) at next-to-next-to-leading order accuracy (NNLO) is presented. The inclusion of the most comprehensive dijet cross section data, together with their NNLO predictions, provide enhanced constraints to the gluon component of the DPDF, which is of particular importance for diffractive PDFs. Compared to previous HERA fits, the presented fit includes the high-precision HERA-II data of the H1 collaboration, which corresponds to a 40-fold increase in luminosity for inclusive data (six-fold increase for jet data). In addition to the inclusive sample at nominal centre-of-mass energy $\sqrt{s}=319$, inclusive H1 data at 252 and 225 GeV are included. The extracted DPDFs are compared to previous DPDF fits, and are used to predict cross sections for a large number of available measurements and different observables.

H1prelim-19-013

Primary authors:  LEVONIAN, Sergey (Deutsches Elektronen-Synchrotron (DE));  SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE));  H1, Collaboration (DESY)

Presenter:  ZLEBCIK, Radek (Deutsches Elektronen-Synchrotron (DE))

Session Classification:  QCD and Hadronic Physics

Track Classification:  QCD and Hadronic Physics
Crab cavities for the HL-LHC: Status and first tests with beams at the SPS

Friday, 12 July 2019 16:30 (20 minutes)

The high luminosity LHC (HL-LHC) will use transverse deflecting superconducting cavities (aka crab cavities) to achieve head-on collisions at the interaction points (IP1 and IP5). Crab cavities will recover the geometric luminosity loss due to the finite crossing angle at the IPs without which the peak luminosity loss can be up to 70%. The development of the superconducting crab cavities which were tested for the first time with proton beam in the Super Proton Synchrotron (SPS) is discussed. The main highlights from the beams tests are outlined.

Primary author: CALAGA, Rama (CERN)
Presenter: CALAGA, Rama (CERN)
Session Classification: Accelerators for HEP
Track Classification: Accelerators for HEP
Study of TeV neutrinos in the FASER experiment at the LHC

Friday, 12 July 2019 17:10 (15 minutes)

FASER is a new experiment at the LHC aiming to search for light, weakly-interacting new particles, complementing other experiments. A particle detector will be located 480 m downstream of the ATLAS interaction point. In addition to searches for new particles, we also aim to study high-energy neutrinos of all flavors, as there is a huge flux of neutrinos at this location. To date, muon neutrino cross-section data exist up to 350 GeV with accelerator-based neutrino beams, but we still miss data at the TeV energy scale. At the LHC-FASER, the neutrino cross-sections will be measured in the currently unexplored energy range between 350 GeV and 6 TeV. In particular, tau neutrinos will be measured at the highest energy ever. Furthermore, the channels associated with heavy quark (charm and beauty) production could be studied. As a feasibility study, a test run was performed in 2018 at the proposed detector location with a 30-kg lead/tungsten emulsion-based neutrino detector. Data of 12.5 fb$^{-1}$ was collected and about 30 neutrino interactions are expected to be recorded in the detector. For Run 3 of the LHC (2021-2023), we are planning to deploy an emulsion detector with a target mass of 1 ton, coupled with the FASER magnetic spectrometer, which would yield >10,000 muon neutrinos and about 50 tau neutrinos interacting in the detector. Analysis of the 2018 test run, as well as the prospects for future runs, will be presented.

**Primary author:** ARIGA, Tomoko (Kyushu University)

**Presenter:** ARIGA, Tomoko (Kyushu University)

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
Study of tau-neutrino production at the CERN SPS

Monday, 15 July 2019 18:30 (1h 30m)

DsTau is a project which has been proposed at the CERN SPS to study tau-neutrino production aiming at providing important data for future $\nu_\tau$ studies. A precise measurement of the $\nu_\tau$ cross section would enable a search for new physics effects in $\nu_\tau$ CC interactions. It also has practical importance for the next generation experiments for neutrino oscillation studies and astrophysical $\nu_\tau$ observations. The practical way of producing a $\nu_\tau$ beam is by the sequential decay of $D_s$ mesons produced in high-energy proton interactions. However, there is no experimental measurement of the $D_s$ differential production cross section in fixed target experiments using proton beams, which leads to a large systematic uncertainty on the $\nu_\tau$ flux estimation. The DsTau project aims to reduce the systematic uncertainty in the current $\nu_\tau$ cross section measurement to 10% or below, by measuring the $D_s$ differential production cross section (especially longitudinal dependence). For this purpose, emulsion detectors with spatial resolution of 50 nm will be used allowing the detection of $D_s \rightarrow \tau \rightarrow X$ double kinks in a few mm range. During the physics run, $2.3 \times 10^8$ proton interactions will be collected in the tungsten target, and 1000 $D_s \rightarrow \tau$ decays are expected to be detected. Results from the pilot run in 2018 will be presented together with a prospect for physics runs in 2021 and 2022.

Primary authors: Dr ARIGA, Akitaka (Universitaet Bern (CH)); ARIGA, Tomoko (Kyushu University)

Presenter: ARIGA, Tomoko (Kyushu University)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Combination and QCD analysis of charm and beauty production cross-section measurements in deep inelastic ep scattering at HERA

Saturday, 13 July 2019 10:00 (15 minutes)

Measurements of open charm and beauty production cross sections in deep inelastic ep scattering at HERA from the H1 and ZEUS Collaborations are combined. Reduced cross sections are obtained in the kinematic range of negative four-momentum transfer squared of the photon \(2.5 \text{GeV}^2 \leq Q^2 \leq 2000 \text{GeV}^2\) and Bjorken scaling variable \(3 \cdot 10^{-5} \leq x_{Bj} \leq 5 \cdot 10^{-2}\). The combination method accounts for the correlations of the statistical and systematic uncertainties among the different datasets. Perturbative QCD calculations are compared to the combined data. A next-to-leading order QCD analysis is performed using these data together with the combined inclusive deep inelastic scattering cross sections from HERA. The running charm- and beauty-quark masses are determined as \(m_c(m_c) = 1.290^{+0.046}_{-0.037}^{\text{param}}\) GeV and \(m_b(m_b) = 4.049^{+0.134}_{-0.109}^{\text{param}}\) GeV.


Primary authors:  SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE)); WING, Matthew (University College London); H1 AND ZEUS, Collaboration (DESY); GEISER, Achim (Deutsches Elektronen-Synchrotron (DE))

Presenter:  GEISER, Achim (Deutsches Elektronen-Synchrotron (DE))

Session Classification:  QCD and Hadronic Physics

Track Classification:  QCD and Hadronic Physics
Comprehensive measurement of pp-chain solar neutrinos with Borexino

Thursday, 11 July 2019 10:20 (20 minutes)

The sun is fueled by fusion reactions that convert hydrogen into helium. The vast majority of the resulting energy is produced through the proton-proton (pp) chain reaction. The byproducts of the various stages of the pp-chain are the so-called pp, pep, 7Be, 8B and hep solar neutrinos. They are a unique tool to gain information about the internal structure of the sun, as well as an intense natural source of neutrinos that can be used to study neutrino properties. Another known set of fusion reactions is the carbon-nitrogen-oxygen (CNO) catalytic cycle which also produces neutrinos, but has not yet been observed.

The Borexino detector is a liquid scintillator detector located in Laboratori Nazionali del Gran Sasso in the mountains of central Italy. It is particularly suitable for measuring the solar neutrinos due to its unprecedented radio-purity and resolution at low energies. A comprehensive study of the pp-chain was presented in a recent Nature publication by the Borexino collaboration.

The measurement reports pp, 7Be and pep neutrino fluxes with the highest precision ever achieved, 8B with the lowest energy threshold, the first Borexino limit on hep neutrinos, as well as the best limit on CNO neutrinos. These results and their physics interpretations concerning, for example, the so-called solar metallicity puzzle and the electron-neutrino survival probability, as well as other highlights of the analysis, will be summarized in this talk. The talk is presented in the name of the Borexino collaboration.

Primary author: REDCHUK, Mariia (Forschungszentrum Jülich)
Presenter: REDCHUK, Mariia (Forschungszentrum Jülich)
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Exotic and Conventional Quarkonium Physics Prospects at Belle II

*Thursday, 11 July 2019 14:45 (15 minutes)*

The Belle II experiment at the SuperKEKB energy-asymmetric $e^+e^-$ collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is $8 \times 10^{35}$ cm$^{-2}$s$^{-1}$ and the Belle II experiment aims to record 50 ab$^{-1}$ of data, a factor of 50 more than its predecessor. From February to July 2018, the machine has completed a commissioning run and main operation of SuperKEKB has started in March 2019. Belle II is uniquely capable of studying the so-called "XYZ" particles: heavy exotic hadrons consisting of more than three quarks. First discovered by Belle, these now number in the dozens, and represent the emergence of a new category within quantum chromodynamics. This talk will present the prospects of Belle II to explore both exotic and conventional quarkonium physics.

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**Presenter:** LAUTENBACH, Klemens (Giessen University)

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Missing energy and electroweak penguin modes in early Belle II data

Friday, 12 July 2019 09:55 (20 minutes)

The Belle II experiment at the SuperKEKB energy-asymmetric \(e^+e^−\) collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is \(8 \times 10^{35}\) cm\(^{-2}\)s\(^{-1}\) and the Belle II experiment aims to record 50 ab\(^{-1}\) of data, a factor of 50 more than its predecessor. From February to July 2018, the machine has completed a commissioning run, achieved a peak luminosity of \(5.5 \times 10^{33}\) cm\(^{-2}\)s\(^{-1}\), and Belle II has recorded a data sample of about 0.5 fb\(^{-1}\). Main operation of SuperKEKB has started in March 2019.

In this presentation we show first results from studying missing energy signatures, such as leptonic and semileptonic B meson decays based on early Belle II data. We report first studies on re-measuring important standard candle processes, such as the abundant inclusive \(B \to X\ell\nu\) and \(B \to D^* \ell\nu\) decays. Furthermore, we will also present an overview of the semileptonic B decays that will be measured in the upcoming years at Belle II and discuss prospects for important B-anomalies like \(R(D)\) and \(R(D^*)\), as well as other tests of lepton flavor universality. Early physics goals of the Belle II physics program are also to rediscover rare B decays. Especially radiative \(b \to s\gamma\) decays can be measured on a small dataset and in the near future Belle II can provide independent tests of anomalies in \(b \to s\ell\ell\) decays. Ultimately, the clean Belle II environment will allow to study modes with large missing energy such as \(B \to K^*\nu\bar{\nu}\).

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**Presenter:** SUTCLIFFE, William (Karlsruhe Institute of Technology (KIT))

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Dark Sector Physics with Belle II

Thursday, 11 July 2019 15:10 (20 minutes)

The Belle II experiment at the SuperKEKB energy-asymmetric $e^+e^-$ collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is $8 \times 10^{35} \text{cm}^{-2}\text{s}^{-1}$ and the Belle II experiment aims to record 50 ab$^{-1}$ of data, a factor of 50 more than its predecessor. From February to July 2018, the machine has completed a commissioning run, achieved a peak luminosity of $5.5 \times 10^{33} \text{cm}^{-2}\text{s}^{-1}$, and Belle II has recorded a data sample of about 0.5 fb$^{-1}$. Main operation of SuperKEKB has started in March 2019. Already this early data set with specifically designed triggers offers the possibility to search for a large variety of dark sector particles in the GeV mass range complementary to LHC and dedicated low energy experiments; these searches will benefit from more data in the process of being accumulated. This talk will review the state of the dark sector searches at Belle II with a focus on the discovery potential of the early data.

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Presenter: CUNLIFFE, Sam (DESY)

Session Classification: Dark Matter

Track Classification: Dark Matter
Nonfactorizable charm-loop effects in exclusive FCNC B-decays

Saturday, 13 July 2019 09:00 (20 minutes)

We revisit the calculation of nonfactorizable corrections induced by charm-quark loops in exclusive FCNC $B$-decays. We demonstrate that the calculation of the corresponding correlation function requires the knowledge of the full generic three-particle quark-antiquark-gluon distribution amplitude of the $B$-meson with non-aligned arguments, $\langle 0 | \bar{q}(x) G_{\mu\nu}(y) b(0) | B \rangle$. The dependence of this quantity on $(x-y)^2$ is essential for a proper account of large $(\Lambda_{QCD} m_b/m_c^n)^n$ terms in the amplitudes of exclusive FCNC $B$-decays.

Primary authors: KOZACHUK, Anastasiia (Lomonosov Moscow State University); MELIKHOV, Dmitri (HEPHY)

Presenter: MELIKHOV, Dmitri (HEPHY)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Flavor-exotic tetraquarks in large-$N_c$ QCD: do they exist?

Saturday, 13 July 2019 10:45 (15 minutes)

A salient feature shared by all tetraquark candidates observed in experiment is the absence of flavor-exotic states of the type $\bar{a}b\bar{c}d$, with four different quark flavors. This phenomenon may be understood from the properties of large-$N_c$ QCD: On the one hand, previous work shows that consistency conditions for flavor-exotic Green functions, potentially containing these tetraquark poles, require the existence of two tetraquarks $T_A$ and $T_B$: each of them should decay dominantly via a single two-meson channel, $T_A \to M_{ab}M_{cd}$ and $T_B \to M_{ad}M_{cb}$. On the other hand, we have at hand only one diquark-antidiquark flavor structure $(\bar{a}c)(\bar{b}d)$ that might produce a compact tetraquark bound state. Taking into account that the diquark-antidiquark structure is the only viable candidate for a compact tetraquark state, one concludes that it is impossible to obtain two different narrow tetraquarks decaying dominantly into distinct two-meson channels. This contradiction suggests that large-$N_c$ QCD does not support the existence of narrow flavor-exotic tetraquarks. This argument does not rule out the possible existence of broad molecular-type flavor-exotic states, or of molecular-type bound states lying very close to the two-meson thresholds.

Primary authors: MELIKHOV, Dmitri (HEPHY); SAZDJIAN, Hagop (University Paris-Sud); LUCHA, Wolfgang (Austrian Academy of Sciences)

Presenter: MELIKHOV, Dmitri (HEPHY)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Within quantum field theory, the homogeneous Bethe–Salpeter formalism offers a Poincaré-covariant (albeit not always easy-to-handle) description of bound states. Driven by the desire to arrive at a (hopefully more easily controllable) analytic approach to bound states, various instantaneous reductions of the Bethe–Salpeter equation have been proposed. Among these are the well-known spinless Salpeter equation as well as various further (yet to some extent still semirelativistic) simplifications in the direction of the (nonrelativistic) Schrödinger equation. We subject the reliability of such kind of bound-state equations to rigorous scrutiny by formulation of exact constraints on the implied spectra, such as bounds on the number of discrete states or on their energy eigenvalues. In order to cover a wide variety of instances, we illustrate the application of these tools for a class of interaction potentials that has found frequent utilization in several areas of science, in particular, in both physics and chemistry, namely, the generalized Hellmann potentials, each of which consists of an attractive Coulomb term and an either attractive or repulsive Yukawa term. Clearly, not all proposed approximations pass this test.

**Primary author:** LUCHA, Wolfgang  
**Presenter:** LUCHA, Wolfgang  
**Session Classification:** Wine & Cheese Poster Session  
**Track Classification:** QCD and Hadronic Physics
Bayesian and frequentist approaches to discoveries

Monday, 15 July 2019 18:30 (1h 30m)

I discuss findings from my recent comparison of Bayesian and frequentist approaches to resonance searches ([1902.03243](https://arxiv.org/abs/1902.03243)). I introduce a counting experiment based on a search for the Higgs boson from which I generate pseudo-data. With that pseudo-data, I contrast the evolution of the $p$-value and posterior as we accumulate data and directly compare global $p$-values and the posterior of the background model. I find that in this toy problem $p$-values are typically smaller than the posterior by one or two orders of magnitude. I discuss the implications of this result for our interpretation of anomalies in resonance searches and searches for new physics in general.

**Primary author:** Dr FOWLIE, Andrew (Nanjing Normal University)

**Presenter:** Dr FOWLIE, Andrew (Nanjing Normal University)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
JUNO potential for neutrino oscillation physics

Thursday, 11 July 2019 11:50 (15 minutes)

JUNO is a Liquid Scintillator (LS) detector currently under construction in the south of China (Jiangmen city, Guangdong province). JUNO aims to detect the disappearance of reactor antineutrinos at an average baseline of 53 km, with the primary goal of determining the neutrino mass ordering and performing a sub-percent measurement of three of the neutrino oscillation parameters. This physics program is rooted in the detector’s capability to resolve, for the first time, the interference pattern between the solar and atmospheric oscillation modes, thanks to an unprecedented 3% energy resolution at 1 MeV.

The main purpose of this talk is to elaborate on JUNO expected sensitivity in terms of neutrino oscillation physics, showing the impact of JUNO prospective results within the global neutrino landscape. The talk will also address how the JUNO design is geared to achieve the target energy resolution by deploying more than 40000 PMTs of different size to detect at least 1200 photoelectrons per MeV of deposited energy. PMTs cover 78% of the detector surface, and are arranged in a spherical geometry to monitor 20 kton of ultra-pure Linear AlkylBenzene acting as the antineutrino target mass, which make JUNO the largest LS detector currently being built. The relation between the overall detector performance and physics sensitivity will also be briefly described.

Primary author: GRASSI, Marco (IN2P3 - CNRS)

Presenter: GRASSI, Marco (IN2P3 - CNRS)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
\( \mu \rightarrow e \) conversion and the Mu2e experiment at Fermilab

Friday, 12 July 2019 17:50 (20 minutes)

The Mu2e experiment aims to measure the charged-lepton flavor violating (CLFV) neutrino-less conversion of a negative muon into an electron in the field of a nucleus. The coherent conversion process results in a monochromatic electron with an energy slightly below the muon rest mass (104.97 MeV). The goal of the experiment is to improve the previous measurement by four orders of magnitude and reach a single event sensitivity of \( 2.5 \times 10^{-17} \) on the conversion rate with respect to the muon capture rate with a 5\( \sigma \) discovery level of \( 2 \times 10^{-16} \).

Although the SM is very well tested in many regimes, it appears likely to be incomplete. In many of the Beyond the Standard Model (BSM) scenarios, rates for CLFV processes are within the reach of the next generation of experiments. In particular, if SUSY particles have masses and couplings within the discovery reach of the LHC, CLFV rates may well be observable. On the contrary, many CLFV searches have a sensitivity to new physics that exceeds the LHC reach bringing the reach of new mass scale up to \( 10^4 \) TeV. In this contest indirect measurements of CLFV will be crucial evidence of new physics.

A possible secondary goal would be the search for a Lepton Number Violation process where the negatively charged muon converts into a positron, again without neutrinos. Neutrinoless double beta decay (0\( \nu \)\( \beta \beta \)) has set the most stringent limit on this process: \( T_{1/2}^{0\nu\beta\beta} > 1.07 \times 10^{26} \) yr at 90\% CL for \(^{136}\text{Xe}\) but it is sensitive only to \( ee \) LNV transitions.

The process where the stopping negative muon transitions to a positron in the field of a nucleus, \( \mu^- + N(A, Z) \rightarrow e^+ + N(A, Z - 2) \), is an example of both CLFV and LNV. This process is important because some models have this type of process occurring at much higher rates than the \( ee \) LNV process.

The experiment goal is obtained with a very intense pulsed negative muon beam sent to an Aluminum target for a total number of \( 10^{18} \) stopped muons in three years of running. The production and transport of the muons is achieved with a complicated and sophisticated magnetic systems composed of a production, a transport and a detector solenoid; last of these contains the aluminum stopping target followed by a straw-tube tracker and a crystal calorimeter. The entire detector region is surrounded by a Cosmic Ray Veto system.

Mu2e is under design and construction at the Muon Campus of Fermilab. In the current schedule, the experiment start is foreseen for 2023 followed by 3 years of data-taking.

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Presenter: DIOCIAIUTI, Eleonora (INFN - National Institute for Nuclear Physics)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
NNLO QCD fits to extract PDFs from HERA inclusive and jet data

Friday, 12 July 2019 17:30 (15 minutes)

NNLO predictions for jet production in Deep Inelastic Scattering have recently become available. These are used to extend the QCD HERAPDF2.0Jets fits, that were made to extract PDFs from inclusive HERA data and HERA jet data, from NLO to NNLO. In addition new jet data sets have become available since the publication of HERAPDF2.0 and these are also considered.

Primary authors:  WING, Matthew (University College London); SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE)); SARKAR, Amanda (University of Oxford (GB))

Presenter:  SARKAR, Amanda (University of Oxford (GB))

Session Classification:  QCD and Hadronic Physics

Track Classification:  QCD and Hadronic Physics
Limits on contact interactions and leptoquarks at HERA

Thursday, 11 July 2019 15:00 (15 minutes)

High-precision HERA data corresponding to a luminosity of around 1 fb$^{-1}$ have been used in the framework of $eeqq$ contact interactions (CI) to set limits on possible high-energy contributions beyond the Standard Model to electron-quark scattering. Measurements of the inclusive deep inelastic cross sections in neutral and charged current $ep$ scattering were considered. The analysis of the $ep$ data has been based on simultaneous fits of parton distribution functions including contributions of CI couplings to $ep$ scattering. Several general CI models and scenarios with heavy leptoquarks were considered. Improvements in the description of the inclusive HERA data were obtained for a few models. Since a statistically significant deviation from the Standard Model cannot be established, limits in the TeV range were set on all models considered.

Primary authors: WING, Matthew (University College London); ZARNECKI, Aleksander Filip (University of Warsaw)

Presenter: ZARNECKI, Aleksander Filip (University of Warsaw)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Charms production in charged current deep inelastic scattering at HERA

**Monday, 15 July 2019 18:30 (1h 30m)**

Charm production in charged current deep inelastic scattering has been measured for the first time in $e^\pm p$ collisions, using data collected with the ZEUS detector at HERA, corresponding to an integrated luminosity of $358 \text{ pb}^{-1}$. Results are presented separately for $e^+ p$ and $e^- p$ scattering at a centre-of-mass energy of $\sqrt{s} = 318 \text{ GeV}$ within a kinematic phase-space region of $200 \text{ GeV}^2 < Q^2 < 60000 \text{ GeV}^2$ and $y < 0.9$, where $Q^2$ is the squared four-momentum transfer and $y$ is the inelasticity. The measured cross sections of electroweak charm production are consistent with expectations from the Standard Model within the large statistical uncertainties.

**Primary authors:** SARKAR, Amanda (University of Oxford (GB)); NAM, Jae (Temple University)

**Presenter:** SARKAR, Amanda (University of Oxford (GB))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** QCD and Hadronic Physics
Investigation of parton densities at very high $x$

_Friday, 12 July 2019 10:45 (15 minutes)_

The knowledge of the proton parton densities for large $x$ is very important in the search for new physics signals at the LHC. For Bjorken-$x$ larger than 0.6 they are however poorly constrained by the data used in extracting the proton parton density functions (PDFs) and different pdf sets have large uncertainties, and differ considerably, in this regime. We compare the pdf sets most widely used by the LHC community to the ZEUS high-$x$ data. This data has not been previously used in PDF set determinations. Due to the small expected and observed numbers of events in this kinematic regime, Poisson statistics is used in the evaluation of the probabilities assigned to the different PDF sets. A wide variation is found in the ability of the PDF sets to predict the observed results.

**Primary authors:** WING, Matthew (University College London); AGGARWAL, Ritu

**Presenter:** AGGARWAL, Ritu

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Recent observations at RHIC and the LHC of two- and multi-particle correlations in high multiplicity relativistic proton-proton and proton-ion collisions and similarity of the results to those observed in central heavy-ion collisions are often interpreted as evidence for collective particle production in small collision systems. These results motivate a study in even smaller systems, such as produced in relativistic electron-proton collisions. We present a measurement of two-particle correlations in collisions of electron beams at 27.5 GeV with beams of protons at 920 GeV, which corresponds to 318 GeV centre-of-mass energy. A sample of events equivalent to the integrated luminosity of 380 \( \text{pb}^{-1} \) was recorded with the ZEUS experiment in 2003-2007. The correlations are measured for charged hadrons as a function of event multiplicity for the lab pseudo-rapidity range \(-1.5 < \eta_{\text{lab}} < 2\). To probe the possible contribution due to collective effects, the correlations are studied as a function of the particle’s pair separation in pseudo-rapidity and the pair mean transverse momentum. The observed correlations are compared to available Monte Carlo models of deep inelastic electron-proton scattering. Observations based on the analysis of the ZEUS data put a limit on the possible collective effects in high multiplicity electron-proton collisions.

**Presenter:** GANGADHARAN, Dhevan Raja (Lawrence Berkeley National Lab. (US))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Measurement of the Psi(2S) to J/Psi cross section ratio in photoproduction with the ZEUS detector at HERA

Monday, 15 July 2019 18:30 (1h 30m)

The exclusive photoproduction reaction $\gamma p \rightarrow \psi(2S)p$ has been studied with the ZEUS detector in ep collisions at HERA using an integrated luminosity of $350 \text{ pb}^{-1}$, in the kinematic range $30 < W < 180 \text{ GeV}$, $Q^2 < 1 \text{ GeV}^2$, $|t| < 5 \text{ GeV}^2$, where $W$ is the photon proton centre-of-mass energy, $Q^2$ - the photon virtuality and $t$ – four-momentum transfer at the proton vertex. The $\psi(2S)$ mesons were identified via the decay channels: $\psi(2S) \rightarrow \mu^+\mu^-$ and $J/\psi \pi^+\pi^-$ with $J/\psi \rightarrow \mu^+\mu^-$. The ratio of the production cross sections $R = \sigma(\psi(2S))/\sigma(J/\psi)$ was measured as a function of $W$ and compared to predictions of the perturbative QCD.

Primary authors: WING, Matthew (University College London); ZARNECKI, Aleksander Filip (University of Warsaw); GRZELAK, Grzegorz

Presenter: ZARNECKI, Aleksander Filip (University of Warsaw)

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
Further studies of isolated photon production with a jet in deep inelastic scattering at HERA

Thursday, 11 July 2019 18:15 (15 minutes)

Isolated photons with high transverse energy have been studied in deep inelastic $ep$ scattering with the ZEUS detector at HERA, using an integrated luminosity of $326\,pb^{-1}$ in the range of exchanged-photon virtuality $10 - 350\, GeV^2$. Outgoing isolated photons with transverse energy $4 < E_T^\gamma < 15\, GeV$ and pseudorapidity $-0.7 < \eta^\gamma < 0.9$ were measured with accompanying jets having transverse energy and pseudorapidity $2.5 < E_T^{jet} < 35\, GeV$ and $-1.5 < \eta^{jet} < 1.8$, respectively. Differential cross sections are presented for the following variables: the fraction of the incoming photon energy and momentum that is transferred to the outgoing photon and the leading jet; the fraction of the incoming proton energy transferred to the photon and leading jet; the differences in azimuthal angle and pseudorapidity between the outgoing photon and the leading jet and between the outgoing photon and the scattered electron. Comparisons are made with theoretical predictions: a leading-logarithm Monte Carlo simulation, a next-to-leading-order QCD prediction, and a prediction using the $k_T$-factorisation approach.

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**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Measurement of single and multiple horizontal cosmic muons at high altitudes with the MEV telescope

Saturday, 13 July 2019 12:50 (20 minutes)

The study of very inclined (nearly horizontal) cosmic muons is of special interest for several reasons. Due to the Earth atmosphere the quantitative effect of the mechanisms leading to the formation of extensive air showers is different with respect to vertical showers, with strong suppression of some components in the shower, and a different energy distribution of the particles. The investigation of muon bundles in cosmic ray showers, especially at large zenithal angles, is also an important benchmark for hadronic shower calculations. The role of nearly horizontal muons has also been discussed in the context of upward $\tau$ air showers generated by $\tau$ neutrino conversion in the Earth crust. Nearly horizontal, but downward going muons from the opposite side would represent a background when searching for these events. In such a case the presence of a close mountain could act as muon absorber, eliminating a large fraction of muons from one of the two sides, thus allowing to reduce the background.

An experimental investigation of single and two muon tracks events detected by the MEV cosmic ray telescope has been carried out during a commissioning phase of the project. The MEV telescope, which is based on three 1x1 m$^2$ tracking planes segmented into scintillation strips with wavelength fibers and multianode PMT readout, has been installed at an altitude of about 3100 m a.s.l. in front of the North-East Etna crater (Sicily) since the summer of 2017. The main aim of this facility is to provide a detailed muography of the crater interior. An additional analysis of a first sample of data, taken during a period of approximately two months in 2017 has been undertaken to measure the abundance and topology of nearly horizontal multiple cosmic muons. A small sample of multiple track events was identified and typical rates for such events in front of a solid mountain were estimated.


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Presenter: RIGGI, Francesco (Universita e INFN, Catania (IT))

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
The milliQan experiment: search for milli-charged particles at the LHC

Friday, 12 July 2019 10:00 (15 minutes)

The status of the milliQan experiment is discussed. milliQan is a proposed search for milli-charged particles produced at the LHC with expected sensitivity to charges of between 0.1e and 0.001e for masses in 0.1 - 100 GeV range. The proposed detector is an array of 4 stacks of 60 cm long plastic scintillator arrays read out by PMTs. It will be installed in an existing tunnel 33 m from the CMS interaction point at the LHC, with 17 m of rock shielding to suppress beam backgrounds. In the fall of 2017 a 1% scale "demonstrator" of the proposed detector was installed at the planned site in order to study the feasibility of the experiment, focusing on understanding various background sources such as radioactivity of materials, PMT dark current, cosmic rays, and beam induced backgrounds. In this talk I will discuss the general concept of the experiment, the results from the demonstrator, and the plan for the future.

Primary authors:  HAAS, Andrew (New York University); HILL, Chris (Ohio State University (US))

Presenters:  ZARAKET, Haitham (Lebanese University (LB)); ZARAKET, Haitham (Lebanese University)

Session Classification:  Searches for New Physics

Track Classification:  Searches for New Physics
Luminometers for Future Linear Collider Experiments

The electromagnetic sampling calorimeters projected for the forward region of the future linear collider are presently being designed by the FCAL Collaboration. The LumiCal and BeamCal detectors are dedicated systems for luminosity measurements at the ILC/CLIC experiments. The LumiCal detector provides a precise measurement of the integrated luminosity, while the BeamCal is designed for instantaneous luminosity measurement and beam-tuning when included in a fast feedback system, as well as for tagging beam particles scattered through low angles. To achieve the stringent ILC performance requirements, it is necessary for the calorimeter designs to be as compact as possible and to identify radiation tolerant sensors and readout technologies.

The performance of a prototype LumiCal was studied in an electron beam at DESY with a momenta in the range of 5 GeV. We’ll present the design of this prototype as well as the result of this test beam study.

In addition, efforts are underway to develop a multi-channel ultra-low power ASIC for the LumiCal readout as well as an ASIC with a dual readout scheme for the BeamCal. We will also present the status of these development efforts, as well as radiation-damage results on candidate sensor technologies.

**Primary authors:** Dr GHENESCU, Veta (Institute of Space Science (RO)); LOHMANN, Wolfgang (DESY); LOHMANN, Wolfgang Friedrich (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** Dr GHENESCU, Veta (Institute of Space Science (RO))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Application of Quantum Machine Learning to High Energy Physics Analysis at LHC using IBM Quantum Computer Simulators and IBM Quantum Computer Hardware

Friday, 12 July 2019 09:30 (15 minutes)

Using IBM Quantum Computer Simulators and Quantum Computer Hardware, we have successfully employed the Quantum Support Vector Machine Method (QSVM) for a ttH (H to two photons), Higgs coupling to top quarks analysis at the LHC.

We will present our experiences and results of a study on LHC high energy physics data analysis with IBM Quantum Computer Simulators and IBM Quantum Computer Hardware using IBM Qiskit. The work is in the context of a Qubit platform. Taking into account the limitation of a low number of qubits, the result expressed in a ROC curve is comparable with the results using a classical machine learning method. This study is applied to a Higgs-coupling-to-two-top-quarks (ttH) physics analysis, one of the flagship physics channels at the LHC. Here the ROC curve is defined as the Receiver Operating Characteristics curve in the plane of background rejection versus signal efficiency. At our current stage, with 5 qubits and 800 events, we have reached an AUC of 0.86, which is similar to the AUC of 0.87 from a classical machine learning method (BDT), where the AUC is the area under the ROC curve. By the time of the conference, we expect to have results with 20 qubits.

In addition, collaborating with IBM Research Zurich, we have finished training with machine learning on the IBM Quantum Computer Hardware with 100 training events, 100 test events, and 5 qubits, again for a ttH (H to two photons) analysis at the LHC. Because of hardware access time and timeout limitations, we finished only a few iterations. By the time of the conference, we expect to have performed the study on 20 qubits hardware with a large number of iterations.

The work is performed by an international and interdisciplinary collaboration with high energy physicists (Physics Department, University of Wisconsin), computational scientists (Computing Science Department, University of Wisconsin and IT Department, CERN Openlab), and quantum computing scientists (IBM Research Zurich).

This work pioneers a close collaboration of academic institutions with industrial corporations in a High Energy Physics analysis effort.

Primary authors: CHAN, Jay (University of Wisconsin Madison (US)); GUAN, Wen (University of Wisconsin (US)); SUN, Shaonian (University of Wisconsin Madison (US)); WANG, Alex Zeng (University of Wisconsin Madison (US)); WU, Sau Lan (University of Wisconsin Madison (US)); ZHOU, Chen (University of Wisconsin Madison (US)); Prof. LIVNY, Miron (University of Wisconsin-Madison); DI MEGLIO, Alberto (CERN); CARMINATI, Federico (CERN); Dr BARKOUTSOS, Panagiotis (IBM Research Zurich); Dr TAVERNELLI, Ivano (IBM Research Zurich); Dr WOERNER, Stefan (IBM Research Zurich); Dr ZOUFAL, Christa (IBM Research Zurich)

Presenter: ZHOU, Chen (University of Wisconsin Madison (US))

Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
Commissioning of the Cylindrical Drift Chamber for the COMET experiment

Thursday, 11 July 2019 15:00 (15 minutes)

The COMET experiment at J-PARC searches for the neutrinoless coherent transition of a muon to an electron in the field of an aluminum nucleus, which violates the lepton flavor conservation and has never been observed yet so far. The conversion rate is predicted to be enhanced in new physics models beyond the Standard Model, while the process is extremely suppressed in the Standard Model. The goal of the COMET Phase-I is to explore the muon-to-electron conversion with a single event sensitivity of $3 \times 10^{-15}$, which is 100 times better than the current limit.

In the COMET Phase-I, the converted electrons, which possess monochromatic momentum of 105 MeV/$c$, are detected with a cylindrical drift chamber (CDC) in a solenoidal magnetic field of 1 T. An inevitable physical background is the decay-in-orbit electrons emitted from the normal 3-body muon decay in an atomic orbit. The momentum distribution of the decay-in-orbit electrons has a high-momentum tail which is able to reach nearly 105 MeV/$c$. In order to distinguish the signal from the background, good momentum resolution of 200 keV/$c$ is required. Therefore, the CDC is designed to reduce the amount of material to suppress the multiple scattering effect. We adopt a gas mixture of He:iC$_4$H$_{10}$ (90:10) as well as unplated 126-µm aluminum field wires and a 0.5-mm thin inner wall made of carbon-fiber-reinforced plastic. In addition, an alternated all stereo layer configuration for 20 layers in total is adopted to achieve good spatial resolution for the axial direction.

The construction of the CDC was successfully completed, and thereafter performance tests using cosmic rays are being carried out. We have achieved spatial resolution of 170 µm and efficiency of 95% so far. A future commissioning plan of the CDC will also be presented in this talk.

Primary author: MORITSU, Manabu (KEK)
Presenter: MORITSU, Manabu (KEK)
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
New results from the DANSS experiment

Recently the MiniBooNE collaboration observed electron (anti)neutrino appearance in the muon (anti)neutrino beams. The significance of the effect reaches 6.0σ level when combined with the LSND result. Even more recently the NEUTRINO-4 collaboration claimed the observation of electron antineutrino oscillations to sterile neutrinos with a significance of about 3σ. If these results are confirmed, New Physics beyond the Standard Model would be required.

On the other hand, the DANSS experiment and several other reactor experiments at short baseline obtained quite strict limits on the hypothetical sterile neutrino parameters. We present new results of the DANSS experiment on the searches for sterile neutrinos. They are based on more than 2.3 million of inverse beta decay events collected at 10.7, 11.7 and 12.7 meters from the reactor core of the 3.1 GW Kalinin Nuclear Power Plant in Russia. This data sample is 2.4 times larger than the data sample in the previous DANSS publication. The neutrino spectrum dependence on the fuel composition is also presented. We have also measured the reactor power using the IBD event rate during 17 months with the statistical accuracy 1.5% in 2 days and with the relative systematic uncertainty of about 0.5%.

Primary authors:  Prof. DANILOV, Mikhail (Lebedev Physical Institute of RAS); ON BEHALF OF THE DANSS COLLABORATION

Presenter:  Prof. DANILOV, Mikhail (Lebedev Physical Institute of RAS)

Session Classification:  Neutrino Physics

Track Classification:  Neutrino Physics
Particle physics applications of the AWAKE acceleration scheme

Saturday, 13 July 2019 11:20 (20 minutes)

After a breakthrough year which saw acceleration of electrons up to 2 GeV in 10 metres of self modulated, proton driven plasma wakefields, the AWAKE experiment looks forward to further development in Run 2 (2021-4). The AWAKE experimental program plans to demonstrate scalability by the production high quality, high energy electron beams. With proton bunches provided by the SPS or the LHC, stable high energy electron beams of 50 GeV or multi TeV level respectively would be available and serve as a unique facility for novel physics applications. Here we discuss three possible future experiments. Dark photon searches in untested parameter regions would be possible due to the combination of high energy and high luminosity AWAKE electrons. New tests of non perturbative QED can be performed via interactions with an intense laser, by boosting the laser field to above the Schwinger level in the rest frame of AWAKE electrons. New electron-proton physics can also be envisaged by the combination of high energy AWAKE electrons and LHC protons. Further novel physics applications are sure to emerge in the coming years as the field develops.

Primary author:  Dr HARTIN, Anthony (UCL)
Presenter:  Dr HARTIN, Anthony (UCL)
Session Classification:  Accelerators for HEP
Track Classification:  Accelerators for HEP
BSM search with high intensity muon beam in MEG II experiment

Friday, 12 July 2019 16:50 (20 minutes)

Flavor violating decay of muon is a good probe of new physics beyond SM. Many well motivated new physics models predict $\mu \rightarrow e\gamma$ decay to occur at large branching ratio (e.g. $O(10^{-14})$ in SUSY-seesaw). MEG II experiment will search for $\mu \rightarrow e\gamma$ decay with target sensitivity down to $6 \times 10^{-14}$, which is an order of magnitude better than the sensitivity of MEG.

MEG II experiment utilizes world’s most intense DC muon beam at Paul Scherrer Institute. All of the detectors are upgraded from MEG to cope with increased rate of accidental backgrounds. In 2018, pre-engineering run was performed with all the upgraded detectors installed for the first time. Status and prospect of MEG II will be presented.

Primary author: Dr IEKI, Kei (University of Tokyo (JP))
Presenter: Dr IEKI, Kei (University of Tokyo (JP))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
CMS High Level Trigger performance in Run 2

Monday, 15 July 2019 19:40 (20 minutes)

The CMS experiment selects events with a two-level trigger system, the Level-1 (L1) trigger and the High Level trigger (HLT). The HLT is a farm of approximately 30K CPU cores that reduces the rate from 100 kHz to about 1 kHz. The HLT has access to the full detector readout and runs a streamlined version of the offline event reconstruction. In Run 2 the peak instantaneous luminosity reached values above $2 \times 10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$, posing a challenge to the online event selection. An overview of the object reconstruction and trigger selections used in the 2016-2018 data-taking period will be presented. The performance of the main trigger paths and the lessons learned will be summarized, also in view of the coming Run 3.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: SERT, Hale (Rheinisch-Westfaelische Tech. Hoch. (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Data Scouting and Data Parking with the CMS High Level Trigger

Friday, 12 July 2019 11:30 (15 minutes)

The CMS experiments has devised two new strategies at the High Level trigger, to search for new physics in difficult corners of the phase space, or in large samples with B hadrons. The first strategy, called Data Scouting and already introduced in Run 1, allows to take data that would otherwise be rejected by the normal trigger filters. It is based on event-size reduction rather than event filtering and it is useful for instance to search for low mass resonances. The second strategy, called Data Parking, aims at overcoming the main limitation in the CMS data taking, which is the computing power involved in the prompt reconstruction. In 2018, a large amount of additional data, more than 1X10^{10} events containing a pair of B hadrons, was collected by CMS and parked for a delayed offline reconstruction during the Long Shutdown 2. This dataset was triggered requiring a soft displaced muon originating from the decay of a B hadron, without applying any selection on the other B hadron, allowing an unbiased sample for competitive measurements on rare B-meson decays. The challenges of both methods are reviewed in this talk.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: MUKHERJEE, Swagata (Rheinisch Westfaelische Tech. Hoch. (DE))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The CMS Tracker Upgrade for the High Luminosity LHC

Thursday, 11 July 2019 12:30 (15 minutes)

The LHC machine is planning an upgrade program which will smoothly bring the luminosity to about $5 - 7.5 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$ in 2028, to possibly reach an integrated luminosity of $3000 - 4500 \text{fb}^{-1}$ by the end of 2039. This High Luminosity LHC scenario, HL-LHC, will require an upgrade program of the LHC detectors known as Phase-2 upgrade. The current CMS Outer Tracker, already running beyond design specifications, and CMS Phase-1 Pixel Detector will not be able to survive HL-LHC radiation conditions and CMS will need completely new devices, in order to fully exploit the highly demanding conditions and the delivered luminosity. The new Outer Tracker should have also trigger capabilities. To achieve such goals, R&D activities have explored options for both the Outer Tracker and for the Inner Tracker. The solutions developed will allow to include tracking information in the first level trigger stage. The design choices for the Tracker upgrades are discussed along with some highlights on technological approaches and R&D activities.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: PAOLETTI, Simone (Universita e INFN, Firenze (IT))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
The High Luminosity upgrade of the CERN Large Hadron Collider (HL-LHC) calls for a new high-radiation tolerant solid-state pixel sensor, capable of surviving irradiation fluencies up to a $2.3 \times 10^{16}$ 1 MeV equivalent neutrons per cm$^2$ at 3 cm from the interaction point. To this extent, the INFN ATLAS-CMS joint research activity, in collaboration with Fondazione Bruno Kessler, is aiming at the development of thin n-in-p type pixel sensors to be operated at the HL-LHC. The R&D covers both planar and single-sided 3D columnar pixel devices made with the Si-Si Direct Wafer Bonding technique, which allows for the production of sensors with 100 μm and 130 μm active thickness, for planar sensors, and 130 μm for 3D sensors, the thinnest ones ever produced so far. Prototypes of hybrid modules have been bump-bonded to the RD53A readout chip. The RD53A readout chip have been developed by the RD53 collaboration as a first step to the design of a readout chip for the pixel detectors of the ATLAS and CMS experiments during the high luminosity phase of the LHC. Test beam studies, both of thin planar and 3D devices, have been performed by the CMS collaboration at the Fermilab and CERN test beam facilities. First results of the modules performance before and after irradiation are reported in this presentation.
Study of the Effects of Radiation at the CERN Gamma Irradiation Facility on the CMS Drift Tubes Muon Detector for the HL-LHC

Monday, 15 July 2019 19:40 (20 minutes)

The CMS drift tubes (DT) muon detector, built for standing up the LHC expected integrated and instantaneous luminosities, will be used also in the High Luminosity LHC (HL-LHC) at a 5 times larger instantaneous luminosity and, consequently, much higher levels of radiation, reaching about 10 times the LHC integrated luminosity. Initial irradiation tests of a spare DT chamber at the CERN gamma irradiation facility (GIF++), at large ($\sim O(100)$) acceleration factor, showed aging effects resulting in a degradation of the DT cell performance; however, full CMS simulations have shown almost no impact in the muon reconstruction efficiency over the full barrel acceptance and for the full integrated luminosity. A second spare DT chamber was moved inside the GIF++ bunker in October 2017. The chamber was being irradiated at lower acceleration factors, and only 2 out of the 12 layers of the chamber are switched at working voltage when the radioactive source is active, being the other layers in standby. In this way the other non-aged layers are used as reference and as a precise and unbiased telescope of muon tracks for the efficiency computation of the aged layers of the chamber, when set at working voltage for measurements. An integrated dose equivalent to two times the expected integrated luminosity of the HL-LHC run has been absorbed by this second spare DT chamber and the final impact on the muon reconstruction efficiency is under study. Direct inspection of some extracted aged anode wires presented a melted resistive deposition of materials. Investigation on the outgassing of cell materials and of the gas components used at the GIF++ are underway. Strategies to mitigate the aging effects are also being developed. From the long irradiation measurements of the second spare DT chamber, the effects of radiation in the performance of the DTs expected during the HL-LHC run will be presented.


Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: GONZALEZ, Juan (Universidad de Oviedo (ES))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
The High Luminosity upgrade of the CERN Large Hadron Collider will deliver proton-proton collisions at 14 TeV with instantaneous luminosities up to $7.5 \times 10^{34}$ cm$^{-2}$ s$^{-1}$. The physics program of the Compact Muon Solenoid (CMS) Experiment strongly depends on the ability to identify muons at an early trigger stage, over a momentum range spanning from few GeV to the TeV scale. Several upgrades of the muon triggers are foreseen in order to retain such capabilities in view of the the High Luminosity LHC, including the acceptance on electroweak processes and the sensitivity to physics beyon the Standard Model. With this contribution, we review the current status of the design of highly efficient muon trigger, its architecture, based on state-of-the-art FPGAs and O(10) Gbps serial optical links, and the foreseen muon identification algorithms. We will discuss the local trigger primitives generation, depending on the new read-out of several detectors, their increased acceptance, and online muon reconstruction algorithms, both standalone and with the contribution of the silicon tracker at Level 1. The expected benefits for the HLLHC physics program are presented as well.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** FOLGUERAS, Santiago (Universidad de Oviedo (ES))

**Session Classification:** Detector R&D and Data Handling

**Track Classification:** Detector R&D and Data Handling
Upgrade of the CSC Muon System for the CMS Detector at the HL-LHC

Monday, 15 July 2019 19:40 (20 minutes)

The Large Hadron Collider (LHC) will be upgraded in several phases to significantly expand its physics program. After the current long shutdown from 2018-2020 (LS2) the accelerator luminosity will be increased to $2 - 3 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$ exceeding the design value of $1 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$ allowing the CMS experiment to collect approximately 100 fb$^{-1}$/year. A subsequent upgrade in 2022-23 will increase the luminosity up to $5 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$. The CMS muon system must be able to sustain a physics program after the LS2 shutdown that maintains sensitivity to electroweak scale physics and for TeV scale searches similar to what was achieved up to now. For the Cathode Strip Chamber (CSC) muon detectors, the electronics will be upgraded to handle the expected higher rates. The design of the upgraded CSC electronics will be discussed as well as the status of the first phase of the electronics installation. In view of the operating conditions at HL-LHC, it is vital to assess the detector performance for high luminosity. Accelerated aging tests are being performed to study the behavior of the CSC detectors under conditions which are nearly an order of magnitude beyond the original design values. The status of this irradiation campaign and results will be presented.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** NGUYEN, Vivan Thi (Northeastern University (US))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Muon performance with CMS detector in Run2 of LHC

Monday, 15 July 2019 19:40 (20 minutes)

The Compact Muon Solenoid (CMS) detector is one of the two multi-purpose experiments at the Large Hadron Collider (LHC) and has a broad physics program. Many aspects of this program depend on our ability to trigger, reconstruction and identify events with final state muons in a wide range of momenta, from few GeV to the TeV scale. Displaced muons can also be used as a benchmark for new physics searches and do require special reconstruction techniques.

In this talk we present the full process of muon reconstruction in CMS, both offline and online. The identification and isolation strategies to discriminate prompt muons from background, and their performance with 13 TeV data collected with the CMS experiment. Finally, the performance on benchmark channels will be shown.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: BATTILANA, Carlo (Università e INFN, Bologna (IT))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Heavy flavour jet identification with the CMS experiment in Run 2

Monday, 15 July 2019 19:40 (20 minutes)

A review of the heavy flavour identification methods and the performance results of the calibration of various taggers in Run 2 data at CMS is presented. The Machine Learning methods play an important role in the development of the identification algorithms and significantly improve the performance of heavy flavour jet tagging in the offline event reconstruction, as well as in the online event selection. An essential gain is also observed in the performance of the methods used in the identification of the decays of the lorentz-boosted objects resulting in reconstructed jets containing multiple hadrons. The outlook and projections of heavy flavour tagging performance at HL-LHC are also discussed.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: NOVAK, Andrzej (RWTH Aachen (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Optimising the performance of the CMS Electromagnetic Calorimeter to measure Higgs properties during Phase I and Phase II of the LHC

Monday, 15 July 2019 19:40 (20 minutes)

The CMS Electromagnetic Calorimeter (ECAL), is a high granularity lead tungstate crystal calorimeter operating at the CERN LHC. The original design placed a premium on excellent energy resolution. Excellent energy resolution and efficient identification for photons are essential to reconstruct the Higgs boson in the $H\rightarrow gg$ decay channel, for measurements of the self-coupling of Higgs bosons and other related parameters.

The ECAL performance has been crucial in the discovery and subsequent characterisation of the Higgs boson. The original ECAL design considerations, and the actual experimental energy reconstruction and calibration precision will be reviewed.

The improvements to the energy reconstruction and energy calibration algorithms for LHC Run II are described. These are required to maintain the stability of the ECAL energy scale and resolution for the higher LHC luminosities that have been experienced compared to Run I. The precision measurement of the Higgs decay modes is central to the HL-LHC physics program. In addition, the search for di-Higgs production is important to understand the details of the vacuum potential. The crystals in the barrel region will be retained for HL-LHC. The decrease of operating temperature and upgrades to the readout electronics that are needed to maintain the required performance of the barrel region from 2026 onwards will be described.

These upgrades will ensure that radiation-induced noise increases will not dominate the energy resolution for photons from Higgs boson decays, and will preserve the ability of CMS to trigger efficiently on these signals. They will also permit precision time measurements (30 ps rms error on the arrival time of photons from Higgs boson decays) which will improve the determination of the location of the production vertex for di-photon events. Time measurement performance of the new readout electronics has been characterized in beam tests.

The predicted electron and photon energy resolution and identification efficiencies expected for HL-LHC will be described, and the performance relevant to a number of key Higgs decay channels will be presented.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: VALSECCHI, Davide (Università degli Studi e INFN di Milano-Bicocca (IT))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Precision Timing with the CMS MIP Timing Detector

Thursday, 11 July 2019 09:00 (15 minutes)

The Compact Muon Solenoid (CMS) detector at the CERN Large Hadron Collider (LHC) is undergoing an extensive Phase II upgrade program to prepare for the challenging conditions of the High-Luminosity LHC (HL-LHC). In particular, a new timing layer with hermetic coverage up to a pseudo-rapidity of $|\eta|=3$ will measure minimum ionizing particles (MIPs) with a time resolution of $\sim30$ ps. This MIP Timing Detector (MTD) will consist of a central barrel region based on LYSO:Ce crystals read out with SiPMs and two end-caps instrumented with radiation-tolerant Low Gain Avalanche Detectors. The precision time information from the MTD will reduce the effects of the high levels of pile-up expected at the HL-LHC and will bring new and unique capabilities to the CMS detector. The time information assigned to each track will enable the use of 4D reconstruction algorithms and will further discriminate interaction vertices within the same bunch crossing to recover the track purity of vertices in current LHC conditions. For instance, in the analysis of di-Higgs boson production decaying to two b quarks and two photons, 30 ps timing resolution is expected to improve the effective luminosity by 22% through gains in b-tagging and photon isolation efficiency. We present motivations for precision timing at the HL-LHC and the ongoing MTD R&D targeting enhanced timing performance and radiation tolerance.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: BORNHEIM, Adolf (California Institute of Technology (US))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
Design of the CMS upgraded trigger from Phase I to Phase II of the LHC

Monday, 15 July 2019 19:40 (20 minutes)

The CMS experiment implements a sophisticated two-level triggering system composed of the Level-1, instrumented by custom-design hardware boards, and the High Level Trigger, a streamlined version of the offline reconstruction software running on a computer farm (more than 30k CPU cores). In 2017, the LHC delivered proton-proton collisions at a centre-of-mass energy of 13 TeV with a peak instantaneous luminosity larger than $2 \cdot 10^{34} cm^{-2}s^{-1}$, more than twice the peak luminosity reached during Run1 and far larger than the design value. The CMS Level-1 trigger was upgraded during the end-of-the year technical stop between 2015 and 2016, to improve its performance at high luminosity and large number of simultaneous inelastic collisions per crossing (pile-up). All the electronic boards have been replaced and the upgraded electronics tested and commissioned with data. Smarter, more sophisticated, and innovative algorithms are now the core of the first decision layer of CMS: the upgraded trigger system implements pattern recognition and MVA (Boosted Decision Tree) regression techniques in the trigger boards for $p_T$ assignment, pile-up subtraction, and isolation requirements for electrons and tau leptons. In addition, the new global trigger is capable of evaluating complex selection algorithms such as those involving the invariant mass of trigger objects. The High Level Trigger features a trade-off between the offline complexity of the algorithms and the available computing power, and between the selection efficiency the maximum sustainable output rate. The trigger selections used in Run-2 will be presented, ranging from simpler single-object selections to more sophisticated algorithms combining different objects and applying analysis-level reconstruction and selection. This presentation will cover the design and performance of the Phase I trigger and how it influences the path towards the Phase II upgrade necessary for the LHC run at a center-of-mass energy of 14 TeV with luminosity of $5 - 7 \cdot 10^{34} cm^{-2}s^{-1}$, corresponding to 140–200 pile-up events. The addition of the tracker information at Level-1 and the enhanced computing resources at HLT will maintain the trigger efficiency at a similar level as the present one.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: JEITLER, Manfred (Austrian Academy of Sciences (AT))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Overview of the HL-LHC Upgrade for the CMS
Level-1 Trigger

Friday, 12 July 2019 09:45 (15 minutes)

The High-Luminosity LHC will open an unprecedented window on the weak-scale nature of the universe, providing high-precision measurements of the standard model as well as searches for new physics beyond the standard model. Such precision measurements and searches require information-rich datasets with a statistical power that matches the high-luminosity provided by the Phase-2 upgrade of the LHC. Efficiently collecting those datasets will be a challenging task, given the harsh environment of 200 proton-proton interactions per LHC bunch crossing. For this purpose, CMS is designing an efficient data-processing hardware trigger (Level-1) that will include tracking information and high-granularity calorimeter information. The current conceptual system design is expected to take full advantage of advances in FPGA and link technologies over the coming years, providing a high-performance, low-latency computing platform for large throughput and sophisticated data correlation across diverse sources.

Primary author: MEYER, Arnd (Rheinisch Westfälische Technische Hoch. (DE))
Presenter: CAILLOL, Cécile Sarah (University of Wisconsin Madison (US))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The High-Luminosity Large Hadron Collider (HL-LHC) is expected to deliver an integrated luminosity of up to 3000 fb⁻¹. The very high instantaneous luminosity will lead to about 200 proton-proton collisions per bunch crossing (“pileup”) superimposed to each event of interest, therefore providing extremely challenging experimental conditions. Prospects for selected Standard Model (SM) measurements at the High-Luminosity LHC are presented. In particular, the performance of the upgraded CMS detector at the HL-LHC for precision measurements of the global SM parameters, top mass, and electroweak mixing angle is studied. Prospects for flavour changing neutral currents search in single top quark production and also for QCD-oriented measurements are also presented.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** WANG, Jian (University of Florida (US))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Beyond-Standard-Model Physics at the High-Luminosity LHC with the CMS detector

Monday, 15 July 2019 18:30 (1h 30m)

The High-Luminosity Large Hadron Collider (HL-LHC) is expected to deliver an integrated luminosity of up to 3000 fb⁻¹. The very high instantaneous luminosity will lead to about 200 proton-proton collisions per bunch crossing (“pileup”) superimposed to each event of interest, therefore providing extremely challenging experimental conditions. The sensitivity to find new physics Beyond the Standard Model (BSM) physics is significantly improved and will allow extending the reach for heavy vector bosons, for BSM Higgs, SUSY, dark matter and exotic long-lived signatures, to name a few.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: CAILLOL, Cecile Sarah (University of Wisconsin Madison (US))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Higgs Boson Measurements at the High-Luminosity LHC with CMS

Friday, 12 July 2019 17:30 (15 minutes)

The High-Luminosity Large Hadron Collider (HL-LHC) is expected to deliver an integrated luminosity of up to 3000 fb⁻¹. The very high instantaneous luminosity will lead to about 200 proton-proton collisions per bunch crossing ("pileup") superimposed to each event of interest, therefore providing extremely challenging experimental conditions. Prospects for measurements of the properties of the standard model Higgs boson and searches for beyond the standard model Higgs bosons with the CMS experiment at the HL-LHC are presented.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** DAS, Pallabi (Tata Inst. of Fundamental Research (IN))

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
HH production at the High-Luminosity LHC with CMS

Thursday, 11 July 2019 15:15 (15 minutes)

The High-Luminosity Large Hadron Collider (HL-LHC) is expected to deliver an integrated luminosity of up to 3000 fb⁻¹. The very high instantaneous luminosity will lead to about 200 proton-proton collisions per bunch crossing ("pileup") superimposed to each event of interest, therefore providing extremely challenging experimental conditions. CMS prospects on Higgs self-coupling measurements and HH production at the HL-LHC are presented.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: BRAIBANT-GIACOMELLI, Sylvie (Universita e INFN, Bologna (IT))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Measurements of Higgs boson differential distributions and couplings at CMS

Friday, 12 July 2019 17:00 (15 minutes)

Most recent CMS measurements on Higgs boson differential distributions will be presented, together with the latest results on Higgs boson couplings from the combination of multiple channels.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** SCHROEDER, Matthias (KIT - Karlsruhe Institute of Technology (DE))

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Measurements of Higgs boson properties in bosonic final states at CMS

Latest CMS results on Higgs boson property measurements in final states with photons, W and Z bosons will be presented.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: ERRICO, Filippo (University of Florida (US))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Measurements of Higgs boson properties in leptonic final states at CMS

Thursday, 11 July 2019 09:00 (15 minutes)

This presentation will cover the most recent results on Higgs boson measurements using decays into leptons from the CMS experiment at the LHC.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: HLUSHCHENKO, Olena (RWTH Aachen)
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Measurements of Higgs boson properties in hadronic final states at CMS

Thursday, 11 July 2019 10:15 (15 minutes)

This presentation will cover the most recent results on Higgs boson measurements using decays into quarks from the CMS experiment at the LHC

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: GIANNINI, Leonardo (INFN Sezione di Pisa, Università e Scuola Normale Superiore, P)
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Measurements of ttH and tH production at CMS

Thursday, 11 July 2019 14:30 (15 minutes)

Most recent CMS results on Higgs boson production in association with top quarks will be presented.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: MARTIN PEREZ, Cristina (Centre National de la Recherche Scientifique (FR))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Higgs boson rare and exotic decays at CMS

Thursday, 11 July 2019 17:05 (15 minutes)

This talk will present the most recent results on CMS searches for Higgs boson rare and exotic decays.

Primary author:  MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter:  ZHANG, Fengwangdong (University of California Davis (US))
Session Classification:  Higgs Physics
Track Classification:  Higgs Physics
Searches for additional neutral Higgs bosons at CMS

Friday, 12 July 2019 14:45 (15 minutes)

This presentation will summarize the status and latest results of the searches for neutral Higgs bosons at CMS.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

Presenters: MORAN, Dermot Anthony (Centro de Investigaciones Energéticas Medioambientales y Tecnológicas); MORAN, Dermot Anthony (Universidad Autónoma de Madrid (ES)); MORAN, Dermot Anthony (Universidad Autónoma de Madrid (ES)); MORAN, Dermot Anthony (University of Manchester (GB))

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Searches for charged Higgs bosons at CMS

Friday, 12 July 2019 15:00 (15 minutes)

This presentation will summarize the status and latest results of the searches for charged Higgs bosons at CMS.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: HU, Miao (Massachusetts Inst. of Technology (US))
Session Classification: Higgs Physics

Track Classification: Higgs Physics
Searches for non-resonant HH production at CMS

*Thursday, 11 July 2019 15:30 (15 minutes)*

The most recent results from searches for non-resonant production of Higgs boson pairs at CMS will be presented.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** CAPPATI, Alessandra (Università e INFN Torino (IT))

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Searches for resonant di-boson production at CMS

*Thursday, 11 July 2019 17:30 (15 minutes)*

Most recent CMS results on searches for heavy resonances decaying into gauge and Higgs bosons (VV, VH where V = W, Z) are presented. The results are based on the large dataset collected during Run 2 of the LHC at a centre-of-mass energy of 13 TeV. The analyses are optimised for high sensitivity over a large range in resonance mass. Jet substructure techniques are used to identify hadronic decays of highly-boosted W, Z, and H bosons.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** ROY, Dennis (Rheinisch Westfaelische Tech. Hoch. (DE))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Search for heavy BSM particles coupling to third generation quarks at CMS

*Thursday, 11 July 2019 17:15 (15 minutes)*

We present results from searches for new particles with enhanced couplings to third generation quarks, based on proton-proton collision data at a centre-of-mass energy of 13 TeV recorded by CMS. The signatures include single and pair production of vector-like quarks and heavy resonances decaying to third generation quarks. A wide range of final states, from multi-leptonic to entirely hadronic is covered. Jet substructure techniques are employed to identify highly-boosted heavy SM particles in their hadronic decay modes.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** REIMERS, Arne Christoph (Hamburg University (DE))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Searches with uncommon jet substructure at CMS

Friday, 12 July 2019 15:45 (15 minutes)

We present results from searches for new physics with uncommon jet substructure. The results cover a variety of final states that have been uncovered so far. The models considered range from stealth SUSY where a hard photon is merged with gluons into a single jet, to light resonances produced with a high Lorentz boost, decaying to quark-antiquark and reconstructed in a single jet.

Primary author:  MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter:  IORIO, Alberto Orso Maria (Universita e sezione INFN di Napoli (IT))
Session Classification:  Searches for New Physics
Track Classification:  Searches for New Physics
Searches for leptoquarks in CMS

Thursday, 11 July 2019 14:30 (15 minutes)

We present latest results from searches for leptoquarks with the CMS detector. A variety of final states is considered, probing leptoquark couplings to all three generations of quarks and leptons.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** ROMEO, Francesco (Vanderbilt University)

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Recent ttbar and single top inclusive cross sections results in CMS

Thursday, 11 July 2019 12:00 (15 minutes)

Latest results on inclusive top quark pair and single top quark production cross sections are presented using proton-proton collision data collected by CMS. The single top quark analyses investigate separately the production of top quarks via t-channel exchange, via associated production with a W boson (tW), and via the s-channel.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: GONZALEZ, Juan (Universidad de Oviedo (ES))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Top quark pair and single top differential cross sections in CMS

Thursday, 11 July 2019 12:15 (15 minutes)

Differential measurements of top quark pair and single top quark production cross sections are presented using data collected by CMS. The cross sections are measured as a function of various kinematic observables of the top quarks and the jets and leptons of the event final state. The results are confronted with precise theory calculations. Multidifferential $tt$ cross sections are presented and used to constrain simultaneously the top quark pole mass, $\alpha_S$, and PDFs.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: HINDRICHS, Otto Heinz (University of Rochester (US))
Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Recent top quark properties in CMS

Thursday, 11 July 2019 10:00 (15 minutes)

(Includes single top) Measurements of top quark properties using data collected by the CMS experiment are presented. Among them, latest results on top mass, ttbar spin correlations, Yukawa coupling, charge asymmetries, and others will be discussed.

Primary author:  MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter:  DE IORIO, Agostino (Universita e sezione INFN di Napoli (IT))
Session Classification:  Top and Electroweak Physics
Track Classification:  Top and Electroweak Physics
tt+X and t+X production in CMS: ttZ, ttW, ttgamma, tZ, t gamma in CMS

(Does not include EFT interpretation of ttV and any FCNC) A comprehensive set of measurements of top quark pair production in association with EWK bosons (W, Z or $\gamma$) is presented.

Primary author:  MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter:  PALENCIA CORTEZON, Jose Enrique (Universidad de Oviedo (ES))
Session Classification:  Top and Electroweak Physics
Track Classification:  Top and Electroweak Physics
Measurements of $t\bar{t}+jets$ and $t\bar{t}+bb$ production and $tttt$ production in CMS

(Does not include EFT interpretation and any FCNC) A comprehensive set of measurements of top quark pair and single top quark production in association with light and b-jets is presented. The status of the search for four top quark production, to which the LHC experiments are starting to be sensitive, and that has important BSM re-interpretations, is also reported.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: Dr WERTZ, Sebastien (Universitaet Zuerich (CH))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
FCNC and EFT interpretations in top quark events in CMS

Thursday, 11 July 2019 10:15 (15 minutes)

Top quark production can probe physics beyond the SM in different ways. This talks reviews the current limits on FCNC searches in the top sector, and EFT interpretations in many top quark production modes.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: SKOVPE, Kirill (Vrije Universiteit Brussel (BE))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurements of heavy-flavor production at CMS

Saturday, 13 July 2019 09:15 (15 minutes)

Recent results on beauty and charm production with the CMS experiment, based on data collected in Run 1 and Run 2 of the LHC, are presented. Measurements of open charm production cross sections, a study of Upsilon(1S) production versus charged-particle multiplicity, and a study of jet fragmentation in J/psi mesons are presented.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: NIGAMOVA, Aliya (National Research Nuclear University MEPhI (RU))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
We report new results on rare decays involving heavy flavors and tau leptons, using pp collision data collected by the CMS experiment at the LHC during the Run 2. The most recent measurements of angular variables in $B \rightarrow K(*)\mu\mu$ decays are also presented.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** FIOREN DI, Sara (CERN)

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
The Compact Muon Solenoid (CMS) experiment implements a sophisticated two-level triggering system composed of the Level-1, instrumented by custom-design hardware boards, and a software High Level Trigger. A new Level-1 trigger architecture with improved performance is now being used to maintain high physics efficiency for the more challenging conditions experienced during Run II. We present the performance of the upgraded CMS electron and photon trigger in the context of Higgs boson decays into final states with photons and electrons. The calorimeter trigger system plays a central role in achieving the ambitious physics program of Run II. The upgraded trigger benefits from an enhanced granularity of the calorimeters to optimally reconstruct the electromagnetic trigger objects. The performance of the new trigger system will be presented, based on proton-proton collision data collected in Run II. The selection techniques used to trigger efficiently on these benchmark analyses will be presented, along with the strategies employed to guarantee efficient triggering for new resonances and other new physics signals involving electron/photon final states. Plans for the LHC Run III optimizations will be described.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** KOLOSOVA, Marina (University of Cyprus (CY))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
The High-Luminosity LHC will open an unprecedented window on the weak-scale nature of the universe, providing high-precision measurements of the Standard Model as well as searches for new physics beyond the standard model. The Compact Muon Solenoid (CMS) experiment is planning to replace entirely its trigger and data acquisition system to achieve this ambitious physics program. Efficiently collecting those datasets will be a challenging task, given the harsh environment of 200 proton-proton interactions per LHC bunch crossing. The new Level-1 trigger architecture for HL-LHC will improve performance with respect to Phase I through the addition of tracking information and subdetector upgrades leading to higher granularity and precision timing information. In this poster, we present a large panel of trigger algorithms for the upgraded Phase II trigger system, which benefit from the finer information to reconstruct optimally the physics objects. Dedicated pile-up mitigation techniques are implemented for lepton isolation, particle jets and missing transverse energy to keep the rate under control. The expected performance of the new trigger algorithms will be presented, based on simulated collision data of the HL-LHC. The selection techniques used to trigger efficiently on benchmark analyses will be presented, along with the strategies employed to guarantee efficient triggering for new resonances and other new physics signals.
New insights into proton structure and QCD parameters using CMS measurements.

Friday, 12 July 2019 18:00 (15 minutes)

Production of jets, top quarks and electroweak bosons in proton-proton collisions at the LHC probes the fundamental parameters of the Standard Model as quark masses or the strong coupling constant. Furthermore, the constraints on the parton distribution functions of the proton can be probed by including the measurements of these processes in a QCD analysis. New insights into the proton structure and the fundamental QCD parameters will be presented, as obtained by the CMS collaboration, using the recent measurements of W+charm, top quark and jet production at 13 TeV.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: LIPKA, Katerina (Deutsches Elektronen-Synchrotron (DE))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Start of the Belle II Experiment at SuperKEKB: rediscovery of B Physics

Thursday, 11 July 2019 14:50 (20 minutes)

The Belle II experiment at the SuperKEKB energy-asymmetric $e^+e^-$ collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is $8 \times 10^{35}$ cm$^{-2}$s$^{-1}$ and the Belle II experiment aims to record 50 ab$^{-1}$ of data, a factor of 50 more than its predecessor. With this data set, Belle II will be able to measure the Cabibbo-Kobayashi-Maskawa (CKM) matrix, the matrix elements and their phases, with unprecedented precision and explore flavor physics with $B$ and charmed mesons, and $\tau$ leptons. Regular operations with the full detector have successfully started on March 25, 2019. In this presentation, we will review the status of the Belle II detector, and discuss the first results; these, while confirming known B Physics, prove the detector ability and the software readiness to reach the experiment’s goals.

Primary authors: PERUZZI, Ida (Laboratori Nazionali di Frascati dell’INFN); HARTBRICH, Oskar (University of Hawaii at Manoa)

Presenter: HARTBRICH, Oskar (University of Hawaii at Manoa)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Detection of supernova neutrinos with JUNO

Monday, 15 July 2019 18:30 (1h 30m)

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi purpose neutrino experiment, currently under construction in China, whose main detector consists in a spherical tank filled by 20 kt of liquid scintillator. Beside the determination of the neutrino mass hierarchy, JUNO can be operated to study astrophysical phenomena that presume the emission of a huge number of neutrinos, such as supernova (SN) explosions. JUNO can detect all the flavors of the supernova neutrinos via different interaction channels, and then it will be able to locate SN, to explore the SN nucleosynthesis and to observe the diffuse supernova neutrino background.

Primary author: BUSCEMI, Mario (INFN - National Institute for Nuclear Physics)
Presenter: BUSCEMI, Mario (INFN - National Institute for Nuclear Physics)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
A low cost reconfigurable mini-array facility for (under)graduate studies in cosmic ray physics

Friday, 12 July 2019 16:30 (15 minutes)

Coincidence measurements between cosmic ray detectors placed some distance apart are the standard way to detect extensive air showers created in the Earth atmosphere. While the detection of the highest energy cosmic rays requires distances in the order of km, compact arrays would probe the low energy region of the energy spectrum of primary particles. In this Project we exploited the potential of a detection strategy based on the use of small area individual detectors, which can be easily moved and re-configured in different detection geometries, to be employed for different physics investigations. An important aspect of this Project is the educational activity in cosmic ray physics being planned for undergraduate and graduate students, together with the outreach and citizen science involvements. However, also a series of physics investigations (among which the study of muon bundles and of nearly horizontal showers) are within the reach of this facility, when operated in stand-alone mode or in combination with other existing detectors. In order to keep as low as possible the overall cost of the facility, the layout of each detection module is based on scintillator tiles, Wavelength Shifter (WLS) bar and Silicon Photomultiplier (SiPM) for light collection and readout. Signals from each detector are discriminated and shaped, then sent to an Arduino MEGA board for triggering, data acquisition, GPS time stamping and event storage. A first set of 30 detection modules were already fully built and characterized [1,2]. Commissioning measurements under different topological configurations of the array have been carried out both in stand-alone mode and in coincidence with other cosmic ray detectors.


Primary authors: LA ROCCA, Paola (Università e INFN, Catania (IT)); Mr NICOTRA, Davide (Centro Siciliano di Fisica Nucleare e Struttura della Materia); RIGGI, Francesco (Università e INFN, Catania (IT)); Mr PARASOLE, Orazio (Università di Catania and INFN sezione di Catania); PINTO, Chiara (INFN - National Institute for Nuclear Physics)

Presenter: PINTO, Chiara (INFN - National Institute for Nuclear Physics)

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
QCD Monte Carlo model tuning studies with CMS data at 13 TeV

Thursday, 11 July 2019 17:15 (15 minutes)

New CMS PYTHIA 8 event tunes are presented. The new tunes are obtained using minimum bias and underlying event observables exploiting Monte Carlo configurations with consistent parton distribution functions and strong coupling constant values in the matrix element and the parton shower, at leading order (LO), next-to-leading order (NLO) and next-to-next-to-leading order (NNLO). Validation and performance studies are presented by comparing the predictions of the new tunes to a wide range of different CMS measurements at 7, 8 and 13 TeV with CMS.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: COVARELLI, Roberto (University/INFN Torino (IT))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Recent jet results in heavy-ion collisions with CMS

Thursday, 11 July 2019 10:14 (20 minutes)

The quenching of jets in heavy-ion collisions probes the transport properties of the quark-gluon plasma. We present selected recent inclusive jet and photon+jet measurements from the CMS experiment.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** KUCHER, Inna (Centre National de la Recherche Scientifique (FR))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Precision luminosity measurement of proton-proton collisions at the CMS experiment in Run 2

Monday, 15 July 2019 19:40 (20 minutes)

Precision luminosity calibration is critical to determine fundamental parameters of the standard model and to constrain or to discover beyond-the-standard-model phenomena at LHC. The luminosity determination at the LHC interaction point 5 with the CMS detector, using proton-proton collisions at 13 and 5.02 TeV during Run 2 of the LHC (2015–2018), is reported. The absolute luminosity scale is obtained using beam-separation ("van der Meer") scans. The dominant sources of systematic uncertainty are related to the knowledge of the scale of the beam separation provided by LHC magnets and the non-factorizability between the spatial components of the proton bunch density distributions in the transverse direction. When applying the van der Meer calibration to the entire data-taking period, a substantial contribution to the total uncertainty in the integrated luminosity originates from the measurement of the detector linearity and stability. The reported integrated luminosity in 2015–2016 is among the most precise luminosity measurements at bunched-beam hadron colliders.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: MAJOR, Peter (Eotvos Lorand University (HU))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
The main goal of the MPD experiment at NICA in Dubna is to study hot and dense baryonic matter in ion-ion collisions at energies $\sqrt{s_{NN}} = 4$-11 GeV. For a detailed study of the processes and registration of the slightest fluctuations occurring under these conditions, it is necessary to identify particles produced in interactions with high efficiency. The time-of-flight identification system of the MPD based on the MRPC has characteristics that make it possible to cope with this task as efficiently as possible. The TOF system performance and results of a realistic simulation of hadrons identification are presented in this report.

**Primary author:** BABKIN, Vadim (Joint Institute for Nuclear Research (RU))

**Presenter:** BABKIN, Vadim (Joint Institute for Nuclear Research (RU))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
GENUINE, MATTER-INDUCED AND INTERFERENCE COMPONENTS OF CPV, TRV, CPTV ASYMMETRIES FOR NEUTRINO OSCILLATIONS

Friday, 12 July 2019 12:45 (15 minutes)

This work represents the culmination of the solution for the historical problem of the contamination of matter effects in the discrete CP, T, CPT asymmetries for neutrino propagation. The goal is accomplished in terms of a basis of three independent components: genuine CPT-even, matter-induced T-even, interference CP-even. Independent of the theoretical framework for the dynamics of the active neutrino flavors,

\[ A(\text{CP}) = A(\text{CP,T}) + A(\text{CP,CPT}) \]

\[ A(\text{T}) = A(\text{T,CP}) + A(\text{T,CPT}) \]

\[ A(\text{CPT}) = A(\text{CPT,CP}) + A(\text{CPT,T}) \]

for the three independent experimental asymmetries. For even a T-symmetric matter, \( A(\text{T}) \) is affected by matter due to quantum interference. For the effective Hamiltonian written as the sum of free mass propagation plus the matter potential for electron-neutrinos, the three components have definite parities under the baseline \( L \), the matter potential \( a \), the imaginary part \( \sin(\delta) \) of the PMNS mixing matrix and the hierarchy \( h = \pm 1 \) in the neutrino mass ordering: \( A(\text{CP,T}) \) is odd in \( L \) and \( \sin(\delta) \) plus even in \( a \) and \( h \); \( A(\text{CP,CPT}) \) is even in \( L \) and \( \sin(\delta) \) plus odd in \( a \) and \( h \); \( A(\text{T,CPT}) \) is odd in all \( L \), \( \sin(\delta) \), \( a \) and \( h \). The last interference component contains then terms like \( a.\sin(\delta) \).

The independent measurement of the three asymmetries could only be made in neutrino factories and atmospheric neutrinos. For present terrestrial accelerator sources of muon-neutrinos and antineutrinos, the two components of the appearance CPV asymmetry \( A(\text{CP}) \) can be disentangled, at a fixed baseline, by energy dependence. At the DUNE baseline, the higher energy region above the first oscillation node provides a dominant matter-induced \( A(\text{CP,CPT}) \) component. On the contrary, there is a “magic energy” \( E \) around the second oscillation maximum in which the fake \( A(\text{CP,CPT}) \) component has a first-rank zero whereas the genuine \( A(\text{CP,T}) \) component has a maximum (proportional to \( \sin(\delta) \)). With a modest energy resolution \( \Delta E \sim 200 \text{ MeV} \) an effective zero remains.

Primary authors: Prof. BERNABEU, Jose (University of Valencia and IFIC); Mr SEGARRA, Alejandro (University of Valencia and IFIC)

Presenter: Prof. BERNABEU, Jose (University of Valencia and IFIC)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Emittance Scans for CMS Luminosity Calibration in run 2

Monday, 15 July 2019 19:40 (20 minutes)

The absolute luminosity calibration for LHC experiments is derived from dedicated beam separation scans, known as van der Meer (VdM) scans. However, VdM scans are performed with special beam optics, wide beams, and fewer, well-separated bunches to reduce potential systematic effects, and only once a year. In order to use the calibration obtained from a VdM scan under physics data-taking conditions with more bunches and significantly higher instantaneous luminosity, an additional measurement of the stability and linearity of the luminometers is required. Potential nonlinear effects are important especially during Run 2 (2015–2018), where pileup during physics data taking reached up to about 50. Short VdM-type (“emittance”) scans were thus performed regularly in CMS since 2017 in the x and y planes in nine displacement steps at the beginning and end of each fill. They allowed for powerful diagnostic performance of the luminosity subdetectors in CMS throughout the year. In addition, the subdetectors that publish luminosity measurements online (BCM1F, HF, and PLT) are read out at 40 MHz, allowing the possibility of studying effects on a per bunch crossing level, correcting for beam-beam effects per bunch, and separating effects due to sequential bunches (“bunch trains”), as well as monitoring beam evolution during the fill. Linearity effects can also be measured using dedicated “mu scans” which probe a wide range of instantaneous luminosity values under physics conditions. Analyses techniques and the great potential of emittance scans in Run 3 are illustrated.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: KARACHEBAN, Olena (CERN)
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Studies of the factorization of proton densities in van der Meer scans and its impact on precision luminosity measurements for CMS

Monday, 15 July 2019 19:40 (20 minutes)

The factorizability of the transverse proton density functions in x and y is assumed in the analysis of single-plane van der Meer (VdM) scans for absolute luminosity calibration. A correction to the calibration constants for nonfactorization effects in the proton density is then determined. The precision of the evaluation of this correction is one of the dominant sources of systematic uncertainty for the Run 2 (2015–2018) luminosity measurement in CMS. The VdM calibration technique and the methods used to estimate the bias due to the nonfactorization assumption are discussed.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: MAJOR, Peter (Eotvos Lorand University (HU))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Performance of the BRIL Luminometers at CMS for Run 2

Monday, 15 July 2019 19:40 (20 minutes)

CMS features three luminosity subdetectors capable of providing real-time (“online”) luminosity on a bunch-by-bunch level independently of the main CMS data acquisition system: the Fast Beam Conditions Monitor (BCM1F), the hadronic forward calorimeter (HF), and the Pixel Luminosity Telescope (PLT). These luminometers have operated since the beginning of Run 2 (2015–2018) at the LHC. In order to obtain an accurate luminosity measurement, we use van der Meer scans to provide the absolute calibration, whereas corrections for effects such as efficiency loss due to radiation damage, nonlinear effects at high instantaneous luminosity, or effects due to the bunch train structure of the beams, are measured and subsequently applied. The calibration of the online luminosity subdetectors, the applied corrections, and comparisons with offline measurements using the pixel cluster counting (PCC) method and the radiation monitoring system (RAMSES) are covered.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

Presenter: KARACHEBAN, Olena (CERN)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Fast Online Trigger using FPGA-based Event Classification for the COMET Phase-I

The COMET Phase-I experiment searches for a muon-to-electron conversion at a target sensitivity of $3 \times 10^{-15}$, which has never been observed. The event signature is the emission of a monoenergetic electron of 105 MeV from a muonic atom of aluminum. This electron is detected by a Cylindrical Drift Chamber (CDC) and a set of trigger counters (TC) in a 1 T solenoidal magnetic field.

A high intense muon beam is used to achieve our sensitivity goal. It leads to an unacceptable trigger rate of a few MHz. For stable data acquisition, a trigger system which can reduce it down to a few kHz is required. The total system latency of $<5 \mu s$ is also required due to buffer sizes of readout electronics.

In order to fulfill these requirements, we are developing a fast online trigger system using a machine learning based event classification with Field Programmable Gate Arrays (FPGA). This system finds helical electron tracks from the aluminum target. It differs from finding tracks from a point source, and traditional methods such as Hough transform cannot be processed within the required latency. Therefore, we adopt a Gradient Boosted Decision Tree (GBDT) with using multivariate information from CDC; position, energy deposition, and timing. In this system, the trigger electronics collect the hit information from 5000 wires of CDC and make a trigger decision every 100 ns. For the decisions, look-up-tables inside FPGA convert from it to GBDT outputs within a clock cycle.

From a simulation study, it is found that the classification can reject >90% of background events with a 99% of signal acceptance, which corresponds to the trigger rate of a few kHz in conjunction with the information of TC. The prototypes of trigger electronics were developed, and the total latency was measured to be 2.8 $\mu s$, which meets the requirement. Furthermore, we successfully took cosmic-ray data by using the trigger system installed in a CDC setup. We present these results and prospects.

Primary authors:  Mr NAKAZAWA, Yu (Osaka University); Dr FUJII, Yuki (Monash University); Mr CHAU, Tai Thanh (Osaka University); Dr GILLIES, Ewen (Imperial College London); Mr IKENO, Masahiro (KEK); Dr LEE, MyeongJae (IBS); Prof. MIHARA, Satoshi (KEK); Mr SHOJI, Masayoshi (KEK); Dr UCHIDA, Tomohisa (KEK); Dr UENO, Kazuki (KEK)

Presenter:  Mr NAKAZAWA, Yu (Osaka University)

Session Classification:  Detector R&D and Data Handling

Track Classification:  Detector R&D and Data Handling
A search for a charged lepton flavour violating process; muon to electron conversion in COMET

Friday, 12 July 2019 17:30 (20 minutes)

The COMET experiment is designed to search for a muon to electron ($\mu$-$e$) conversion without associating neutrinos, where the lepton flavour is violated at the charged lepton sector, with unprecedented sensitivity. The charged lepton flavour violating processes (CLFV) are forbidden in the Standard Model, while many plausible models beyond the SM (BSM) predict the detectable rates of CLFV processes. Therefore the CLFV searches are strong tools to probe the BSM. If any of CLFV process is discovered, it would be the clear evidence of BSM.

The aiming sensitivity of COMET is 10,000 times better than the present upper limit, $7 \times 10^{-13}$ (90%CL). This corresponds to the energy scale of new physics up to $\sim 10,000$ TeV, enabling the effective new physics search complimentary to direct searches in high energy colliders, other CLFV searches, precision flavour physics, and muon’s anomalous magnetic moment.

The experiment adopts the staging approach and the first stage of COMET is now under construction at J-PARC/Japan, to search for the $\mu$-$e$ conversion with the intermediate sensitivity, $\sim 3 \times 10^{-15}$ in the early 2020s, followed by the COMET Phase-II experiment to achieve 100 times further improved sensitivity. We recently measured the quality of proton beam at J-PARC and it satisfied our exceedingly strict requirement to achieve the target sensitivity. Preparations for the beam-line, detectors and electronics are intensively progressing on schedule. In addition, we recently started further optimisations for Phase-II experiment in order to improve the target sensitivity by factor 2–10 from the current baseline sensitivity of $\sim 3 \times 10^{-17}$.

In this talk, I will summarise the current status of the COMET experiment, mainly focus on the recent highlights those of above mentioned together with future prospects.

Primary author: FUJII, Yuki (Monash University)
Presenter: FUJII, Yuki (Monash University)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Search for long distance time correlations between cosmic air showers with the MRPC telescopes of the EEE network

Saturday, 13 July 2019 12:30 (20 minutes)

P. La Rocca for the EEE Collaboration

The possibility to observe time correlations between cosmic ray detectors separated by distances much larger than the extent of the highest energy Extensive Air Showers (EAS), i.e. a few km, has been discussed for many years. Although a physical mechanism, based on the photodisintegration of a heavy primary nucleus in the solar field was originally proposed by Gerasimova and Zatsepin in 1960 and later discussed by many authors to justify the existence of such events, the mere observation of long distance time correlations could require by itself novel physics interpretations.

A few experimental searches for such events have been reported over the past years, without any definite conclusion reached so far. Although largely depending on many factors, current rate expectations for such events are very low and could stay well below 1 event per year, even with a large detector coverage.

The Extreme Energy Events (EEE) network, based on a relatively large number (>50) telescopes with Multigap Resistive Plate Chambers (MRPC), distributed over all the Italian territory, reconstructs cosmic muons with high efficiency and good angular resolution. The wide coverage, number of sites and large time exposure, due to continuous data taking, are unique characteristics of the EEE network, which in principle allow for an investigation of such events. Several strategies are currently employed by the EEE Collaboration to search for long distance time correlations between far detectors, making use of the single-track and multi-track information associated to the various telescopes. A few candidate events with unusually small time differences have been observed, especially from an analysis of multi-track events.

This contribution will describe and compare the different strategies adopted so far and will focus on the results of the analysis carried out on a large sample (several years) of data reconstructed by the EEE telescopes.

Primary author: Dr LA ROCCA, Paola (Università e INFN, Catania (IT))
Presenter: Dr LA ROCCA, Paola (Università e INFN, Catania (IT))
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
The Tile Calorimeter (TileCal) is a sampling hadronic calorimeter covering the central region of the ATLAS experiment. TileCal uses steel as absorber and plastic scintillators as active medium. The scintillators are read-out by the wavelength shifting fibres coupled to the photomultiplier tubes (PMTs). The analogue signals from the PMTs are amplified, shaped, digitized by sampling the signal every 25 ns and stored on detector until a trigger decision is received. The TileCal frontend electronics reads out the signals produced by about 10000 channels measuring energies ranging from about 30 MeV to about 2 TeV. Each stage of the signal production from scintillation light to the signal reconstruction is monitored and calibrated. A summary of the performance results using pp collisions from the LHC Run-2 at 13 TeV, including the calibration, stability, absolute energy scale, uniformity and time resolution, will be presented.

The High-Luminosity phase of LHC, delivering five times the LHC nominal instantaneous luminosity, is expected to begin in 2026. TileCal will require new electronics to meet the requirements of a 1 MHz trigger, higher ambient radiation, and to ensure better performance under high pileup conditions. Both the on- and off-detector TileCal electronics will be replaced during the shutdown of 2024-2025. PMT signals from every TileCal cell will be digitized and sent directly to the back-end electronics, where the signals are reconstructed, stored, and sent to the first level of trigger at a rate of 40 MHz. This will provide better precision of the calorimeter signals used by the trigger system and will allow the development of more complex trigger algorithms. Changes to the electronics will also contribute to the data integrity and reliability of the system. The ongoing developments for on- and off-detector systems, together with expected performance characteristics and recent results of test-beam campaigns with the electronics prototypes will be discussed.

**Primary author:** ATLAS COLLABORATION

**Presenter:** NIBIGIRA, Emery (Université Clermont Auvergne (FR))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
ORIGIN-Mexico: an Art-Science exhibit for the LHCP 2019 conference

Friday, 12 July 2019 11:45 (15 minutes)

ORIGIN is a network founded in January 2018 by several high energy & astrophysics collaborations and research centres. It builds on the art@CMS methodology to create and support events, exhibits and workshops where public engagement and education are enhanced by both art and science.

The exhibit setup in Puebla, Mexico, in parallel with the LHCP conference, will be used to illustrate how the integration of the 4 LHC collaborations and the ideas brought by local Art and Science University departments, schools and teachers lead to specific flavours, colours and developments. Pros and cons will be discussed, in comparison with prior and future ORIGIN projects.

ORIGIN network web site

Primary author: ADAM BOURDARIOS, Claire (Centre National de la Recherche Scientifique (FR))

Presenter: ADAM BOURDARIOS, Claire (Centre National de la Recherche Scientifique (FR))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
Events containing muons in the final state are an important signature for many analyses being carried out at the Large Hadron Collider (LHC), including both standard model measurements and searches for new physics. To be able to study such events, it is required to have an efficient and well-understood muon trigger. The ATLAS muon trigger consists of a hardware-based system (Level 1), as well as a software-based reconstruction (High Level Trigger). Due to the high luminosity in Run 2, several improvements have been implemented to keep the trigger rate low, while still maintaining high efficiency. Some examples of recent improvements include requiring the coincidence of hits in the muon spectrometer and the calorimeter and optimized muon isolation. We will present an overview of how we trigger on muons, recent improvements, the performance of the muon trigger in Run 2 data and an outlook for the improvements planned for Run 3.

**Primary author:** AOKI, Masato (High Energy Accelerator Research Organization (JP))

**Presenter:** KODAMA, Takafumi (University of Tokyo (JP))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Precision predictions for $B \rightarrow \rho \tau \nu$ and $B \rightarrow \omega \tau \nu$ in the SM and beyond

*Friday, 12 July 2019 10:35 (20 minutes)*

We present new precision predictions for semitauonic decays involving rho and omega final state mesons. These decay channels offer an interesting orthogonal probe to study the existing B anomalies in semitauonic transitions and are accessible with the Belle II experiment. The predictions are based on combining existing light-cone sum-rule calculations for the form factors with measured experimental spectra from the BaBar and Belle collaborations. This allows us to extrapolate the light-lepton form factor predictions reliably to large values of the four-momentum transfer squared, $q^2$, and in turn to derive precise predictions for $R(\rho)$ and $R(\omega)$, the ratio of the total decay rates of $B \rightarrow \rho \tau \nu$ and $B \rightarrow \omega \tau \nu$ for tau final states with respect to light leptons in the SM. In addition, we investigate the impact of all four-fermi operators on the semitauonic $q^2$ spectra and these ratios.

**Primary authors:** BERNLOCHNER, Florian Urs (KIT - Karlsruhe Institute of Technology (DE)); PRIM, Markus (KIT)

**Presenter:** PRIM, Markus (KIT)

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
The ATLAS Electron and Photon Trigger Performance in Run 2

Monday, 15 July 2019 19:40 (20 minutes)

ATLAS electron and photon triggers covering transverse energies from 5 GeV to several TeV are essential to record signals for a wide variety of physics: from Standard Model processes to searches for new phenomena in both proton-proton and heavy ion collisions. Main triggers used during Run 2 (2015-2018) for those physics studies were a single-electron trigger with ET threshold around 25 GeV and a diphoton trigger with thresholds at 25 and 35 GeV. Relying on those simple, general-purpose triggers is seen as a more robust trigger strategy, at a cost of slightly higher trigger output rates, than to use a large number of analysis-specific triggers. To cope with ever-increasing luminosity and more challenging pile-up conditions at the LHC, the trigger selections needed to be optimized to control the rates and keep efficiencies high. The performance of the ATLAS electron and photon triggers during Run 2 data-taking is presented as well as work ongoing to prepare to even higher luminosity of Run 3 (2021-2023).

Primary author: AOKI, Masato (High Energy Accelerator Research Organization (JP))
Presenter: SPINA, Mario (University of Sussex (GB))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
The LHC is expected to increase its center-of-mass energy to 14 TeV and an instantaneous luminosity to $2.4 \times 10^{34}$ cm$^{-2}$s$^{-1}$ for Run 3 scheduled from 2021 to 2023. An upgrade of the ATLAS trigger system is required to cope with the high event rate. The level-1 Endcap Muon trigger system identifies muons with high transverse momentum by combining data from a fast muon trigger detector, TGC. In the ongoing phase-1 upgrade, new detectors called the New-Small-Wheel (NSW) and RPC-BIS78, will be installed in the inner station region for the endcap muon trigger. Excellent granularity track information from the NSW and RPC-BIS78 can be used as a part of the muon trigger logic to enhance the performance significantly. New electronics have been developed to handle data from both TGC and NSW, including the trigger processor board called Sector Logic (SL). The SL board has a modern FPGA to make use of Multi-Gigabit transceiver technology, which will be used to receive data from the NSW. The readout system for trigger data has also been re-designed, with the data transfer implemented with TCP/IP instead of a dedicated ASIC. This new system makes it possible to minimize the use of custom readout electronics and instead use commercial PCs and network switches to collect, format and send the data. This presentation describes the upgrades of the level-1 Endcap Muon trigger system as mentioned above, particularly emphasizing on the new algorithm in Sector Logic as well as the expected trigger performance.

**Primary author:** AOKI, Masato (High Energy Accelerator Research Organization (JP))

**Presenter:** KISHIMOTO, Tomoe (University of Tokyo (JP))

**Session Classification:** Detector R&D and Data Handling

**Track Classification:** Detector R&D and Data Handling
New Level-1 jet feature extraction modules for ATLAS phase-I upgrade

Monday, 15 July 2019 19:40 (20 minutes)

After the second long-shutdown, in 2021, the LHC will be a new machine in many respects and produce collisions with a center-of-mass energy at or near 14 TeV. The instantaneous luminosities can be expected to reach $3 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$, which is three times the original design value. The mean number of interactions per bunch crossing is expected to go up to 80. To meet these challenges of this high-luminosity environment, the ATLAS detector will have several major upgrades to be installed during Long Shutdown 2 (Dec. 2018 to Feb. 2021). As a part of the updates, the Level-1 calorimeter trigger will be upgraded to exploit the finer granularity data by using a new system of feature extraction (FEXs) modules, which each reconstructs different physics objects at Level-1.

The Jet FEX (jFEX) is one of three FEXs and has been conceived to identify small/large area jets, large-area tau leptons, missing transverse energy and the total sum of the transverse energy. The use of the latest generation Xilinx Field Programmable Gate Array (FPGA), the UltraScale+, was dictated by the physics requirements which include substantial processing power and large input bandwidth, up to 3Tb/s, within a tight latency budget less than 390 ns. The jFEX board is characterized by a modular design that makes it possible to optimize within the limited space of an ATCA board a large number of high-speed signals. To guarantee the signal integrity, the board design has been accompanied by simulation of the power, current and thermal distribution. The printed circuit board has a 24-layer stack-up and uses the MEGTRON6 material, commonly used for signal transmission above 10 Gb/s.

The talk will focus on the technological aspects of the jFEX board, reporting on the simulation studies and on the design solutions of the board. Two jFEX prototypes and one preproduction module have been produced and being tested at CERN with other systems, these test results will be presented. The firmware implemented on the trigger board will be illustrated in connection with the FPGA performance and board power consumption. The whole jFEX system, consisting of 6 boards, will be produced by the end of 2019 to allow the installation and commissioning the full system in time for the LHC restart at the beginning of 2021.

Primary author:  AOKI, Masato (High Energy Accelerator Research Organization (JP))
Presenter:  WANG, Renjie (Johannes Gutenberg-Universität Mainz (DE))
Session Classification:  Wine & Cheese Poster Session
Track Classification:  Detector R&D and Data Handling
ATLAS Level-0 Endcap Muon Trigger for HL-LHC

Friday, 12 July 2019 10:45 (15 minutes)

The design for the Level-0 endcap muon trigger of the ATLAS experiment at High-Luminosity LHC (HL-LHC) and the status of the development are presented. HL-LHC is planned to start the operation in 2026 with an instantaneous luminosity of $7.5 \times 10^{34} \text{ cm}^{-2}\text{ s}^{-1}$. In order to cope with the proton-proton collision rate higher than that of LHC, the trigger and readout system needs to be replaced. The new Level-0 endcap muon trigger system is required to reconstruct muon candidates with an improved momentum resolution to suppress the trigger rate with keeping the efficiency. That can be achieved by combining the signals from various subdetectors, thin gap chambers, resistive plate chambers, micromesh gaseous detectors, and scintillator-steel hadronic calorimeters, to form more offline-like tracks. The combined muon track reconstruction was demonstrated with Monte-Carlo simulation samples produced with the condition at HL-LHC. The efficiency was estimated to be greater than 90%, a few percents higher than the current system. The trigger rate was evaluated with proton-proton collision data taken with random trigger overlaid to account for a pileup of 200, which is expected at HL-LHC. The obtained value for momentum threshold of 20 GeV, primary threshold assumed for single muon trigger, is about 30 kHz, which constitutes only about 3% of the assumed total Level-0 trigger rate of 1 MHz. Hardware implementation is planned with ATCA blades. Each blade is designed to have a Virtex UltraScale+ FPGA with about hundred pairs of transceivers, which can be used to receive detector signals, and with huge memory resources suited for track reconstruction. The track reconstruction is based on a pattern matching algorithm using the detector hits and the predefined lists of hits corresponding to tracks. A memory resource UltraRAM integrated into the FPGA is exploited to store the predefined lists of hits. Initial test with the evaluation kit VCU118 showed high efficiency and angular resolution better than the requirement with reasonable memory resources. The bit error ratio of the data transmission with GTY transceivers was evaluated with transfer rates up to 25 Gbps.

The power consumption of a hundred pairs of transmitter and receiver of GTY running with 10 Gbps, which is an average transfer rate assumed for the system, was evaluated to be about 30 W.

Primary author: AOKI, Masato (High Energy Accelerator Research Organization (JP))

Presenter: ASADA, Haruka (Nagoya University (JP))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
The global feature extractor: A new component of the Level-1 Calorimeter trigger Phase-I upgrade for the ATLAS experiment

Monday, 15 July 2019 19:40 (20 minutes)

The global feature extractor (gFEX) is a component of the Level-1 Calorimeter trigger Phase-I upgrade for the ATLAS experiment. It is intended to identify patterns of energy associated with the hadronic decays of high momentum Higgs, W, & Z bosons, top quarks, and exotic particles in real time at the LHC crossing rate. The single processor board is packaged in an Advanced Telecommunications Computing Architecture (ATCA) module and implemented as a fast reconfigurable processor based on three Xilinx Vertex Ultra-scale FPGAs. The board will receive coarse-granularity information from all the ATLAS calorimeters on optical fibers with the data transferred at the 40 MHz Large Hadron Collider (LHC) clock frequency. The gFEX is controlled by a single system-on-chip processor, ZYNQ, that will be used to configure all the processor Field-Programmable Gate Array (FPGAs), monitor board health, and interface to external signals. This talk will focus on the design of the gFEX and its integration tests with ATLAS.

Primary author: AOKI, Masato (High Energy Accelerator Research Organization (JP))
Presenter: DATTAGUPTA, Aparajita (University of Oregon (US))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Implementation of the ATLAS trigger within the multi-threaded AthenaMT framework

Friday, 12 July 2019 12:00 (15 minutes)

Athena is the software framework used in the ATLAS experiment throughout the data processing path, from the software trigger system through offline event reconstruction to physics analysis. The shift from high-power single-core CPUs to multi-core systems in the computing market means that the throughput capabilities of the framework have become limited by the available memory per process. For Run 2 of the Large Hadron Collider (LHC), ATLAS has exploited a multi-process forking approach with the copy-on-write mechanism to reduce memory use. To better match the increasing CPU core count and the, therefore, decreasing available memory per core, a multi-threaded framework, AthenaMT, has been designed and is now being implemented. The ATLAS High Level Trigger (HLT) system has been remodeled to fit the new framework and to rely on common solutions between online and offline software to a greater extent than in Run 2.

We present the implementation of the new HLT system within the AthenaMT framework, which will be used in ATLAS data-taking during Run 3 (2021-2023) of the LHC.

Primary author:  AOKI, Masato (High Energy Accelerator Research Organization (JP))
Presenter:  YILDIZ, Cenk (University of California Irvine (US))
Session Classification:  Detector R&D and Data Handling
Track Classification:  Detector R&D and Data Handling
Sensitivity for heavy resonances at the HL-LHC with the Phase-2 CMS detector

Monday, 15 July 2019 19:40 (20 minutes)

To extend the LHC physics program, it is foreseen to operate the LHC in the future with an unprecedented high luminosity. To maintain the experiment’s physics potential in the harsh environment of this so-called phase-2, the detector will be upgraded. At the same time the detector acceptance will be extended and new features such as a L1 track trigger will be implemented. Simulation studies evaluated the physics reach of benchmark searches for physics beyond the SM. One of the open question being discussed right now, are models explaining the observed flavour anomalies. They postulate leptoquarks or Zprime-like new bosons, with enhanced couplings to third generation particles. In this context future searches in the ttbar mass spectrum are discussed, as well as searches for leptoquarks and heavy bosons with tau in the final state. Another class of interesting models suggest compositeness, a fermion substructure, leading to a potential observation of excited leptons or composite neutrinos. All these studies show a significantly enhanced sensitivity and will shape the future research program.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: HOEPFNER, Kerstin (Rheinisch Westfaelische Tech. Hoch. (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
New physics solutions for $b \rightarrow c \tau \bar{\nu}$ anomalies after the measurement of $D^*$ polarization

Monday, 15 July 2019 19:40 (20 minutes)

The anomalies in the flavor ratios $R_D$ and $R_{D^*}$ provide a hint of physics beyond the Standard Model. Previously it was shown that the polarization fraction of the $D^*$ meson in the $B \rightarrow D^* \tau \bar{\nu}$ decay provides a defining signature for tensor new physics. Recently Belle collaboration measured this quantity to be $0.60 \pm 0.08 \pm 0.04$. Here we do a re-analysis of all the data in $b \rightarrow c \tau \bar{\nu}$ sector, including the $D^*$ polarization fraction. We find that the Belle measurement rules out the tensor new physics solutions at $5\sigma$. We also identify the presently allowed new physics solutions and the six variables needed to distinguish between them.

Primary authors: ALOK, Ashutosh (IIT Jodhpur); KUMAR, DINESH (IIT BOMBAY); KUMBHAKAR, Suman (IIT Bombay); UMASANKAR, Sankagiri (IIT Bombay)

Presenter: KUMBHAKAR, Suman (IIT Bombay)

Session Classification: Wine & Cheese Poster Session

Track Classification: Flavour Physics and CP Violation
Reconstruction in an imaging calorimeter for HL-LHC

Thursday, 11 July 2019 18:00 (15 minutes)

The CMS endcap calorimeter upgrade for high luminosity LHC in 2025 uses, for the most part, silicon sensors to achieve radiation tolerance, with the further benefit of a very high readout granularity. Developing a reconstruction sequence that fully exploits the granularity, and other significant features of the detector like precision timing, is a challenging task. The aim is for operation in the high pileup environment of HL-LHC. An iterative clustering framework (TICL) is being developed. This takes as input clusters of energy deposited in individual calorimeter layers delivered by an “imaging” algorithm which has recently been revised and tuned to deliver excellent performance. Mindful of the projected extreme pressure on computing capacity in the HL-LHC era the algorithms are being designed with GPUs in mind. In addition, reconstruction based entirely on machine learning techniques is being developed and studied. This talk will describe the approaches being considered and show first results.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: MARTELLI, Arabella (Imperial College (GB))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The present CMS muon system consists of three different detector technologies: drift tubes (DT) and cathode strip chambers (CSC) are used in the barrel and end-cap regions of the spectrometer as offline tracking and triggering devices, whereas resistive plate chambers (RPC) are installed both in barrel and end-caps and are exploited mostly in the trigger. In order to cope with the challenging conditions of increasing luminosity expected at HL-LHC, several upgrades of the muon detectors and trigger system are planned. In the case of DT and CSC, the electronics will be upgraded to handle higher rates, but there is no plan to replace the existing DT, CSC and RPC chambers. Therefore, accelerated ageing tests are being performed to assess the performance stability of all muon detectors under conditions which exceed, by one order of magnitude, the design specifications. New micro-pattern gas detectors will be added to improve the performance in the forward region, more critical in terms of rates and characterized by a less uniform magnetic field. Large-area triple-foil gas electron multiplier (GEM) detectors are being already installed during the second LHC long shutdown covering the pseudo-rapidity (η) region 1.6 < |η| < 2.4. They will allow to control the rate of background triggers while preserving high trigger efficiency for low transverse momentum muons. For the HL-LHC operation the muon forward region will also be enhanced with another large area GEM based station, called GE2/1, and with two new generation RPC stations, called RE3/1 and RE4/1, having low resistivity electrodes. These detectors will combine tracking and triggering capabilities and can stand particle rates up to few kHz/cm^2. In addition to take advantage of the pixel tracking coverage extension a new detector, ME0 station, behind the new forward calorimeter, covering up to |η| = 2.8. We present results about the expected performance stability of the existing muon detectors at HL-LHC. Moreover, we report on the outcome of simulation-based studies which describe the impact of the muon upgrades to the trigger and the reconstruction of muon physics objects.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** BATTILANA, Carlo (Universita e INFN, Bologna (IT))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Results and prospects with the CMS-TOTEM Precision Proton Spectrometer

Friday, 12 July 2019 12:00 (15 minutes)

The PPS (Precision Proton Spectrometer) detector system consists of silicon tracking stations as well as timing detectors to measure both the position and direction of protons and their time-of-flight with high precision. They are located at around 200 m from the interaction point in the very forward region on both sides of the CMS experiment. PPS is built to study Central Exclusive Production (CEP) in proton-proton collisions at the LHC, including the photon-photon production of W and Z boson pairs, high-mass diphoton and dilepton production, high-$p_T$ jet production, as well as searches for anomalous couplings and new resonances.

The PPS detector has taken data at high luminosity while fully integrated to the CMS experiment. The total data collected correspond to around $100\,\text{fb}^{-1}$ during the LHC Run 2. In this presentation the PPS operation, commissioning and performance are discussed.

Exclusive dilepton production at high masses has been observed in the CMS detector while one or two outgoing protons are measured in PPS using around $10\,\text{fb}^{-1}$ of data accumulated in 2016 during high-luminosity LHC operation. These results show a good understanding, calibration and alignment of the new PPS detectors.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: FORTHOMME, Laurent (Helsinki Institute of Physics (FI))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Technicolor coupled models

Monday, 15 July 2019 18:30 (1h 30m)

When technicolor (TC), QCD, extended technicolor (ETC) and other interactions become coupled through their different Schwinger-Dyson equations, the solution of these equations are modified compared to those of the isolated equations. The change in the self-energies is similar to that obtained in the presence of four-fermion interactions, but without their ad hoc inclusion in the theory. In this case TC and QCD self-energies decrease logarithmically with the momenta, which allows us to build models where ETC boson masses can be pushed to very high energies, and their effects will barely appear at present energies. We develop the basic ideas of how viable TC models may be built along this line, where the different fermionic mass scales are dictated by the different strong interactions, and where ordinary lepton masses are naturally lighter than quark masses. One specific unified TC model associated with a necessary horizontal (or family) symmetry is described. The values of scalar and pseudo-Goldstone boson masses in this class of models are also discussed, as well as the consistency of the models with the experimental constraints.

Primary author: Prof. NATALE, Adriano (IFT-SAIFR)
Presenter: Prof. NATALE, Adriano (IFT-SAIFR)
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Fluoride production in CMS Resistive Plate Chambers (RPC) and long-term aging studies

Thursday, 11 July 2019 17:15 (15 minutes)

The Resistive Plate Chambers (RPC) are gaseous detectors widely used in the muon trigger systems of LHC experiments. Gas mixtures based on HydroFluoroCarbon (HFC) components are generally used. The pollutants produced in the gas under high electrical discharge may accelerate the detectors aging, in particular the Fluorine ions (F-) produced in connection with Hydrogen Fluoride (HF) may damage the inner detector surface due to its high chemical reactivity. Dedicated measurements to estimate the HF production rate has been performed at the CERN Gamma Irradiation Facility (GIF++) operating a spare CMS-RPC detector at different background gamma rate and with different gas volumes changes. The HF trapped inside the detector gas volume has been also estimated. The HF deposited on the inner bakelite surface has been estimated operating the detector with pure Argon. The HF study results will be presented. In addition, in view of High Luminosity LHC (HL-LHC) period, a dedicated aging study is ongoing at GIF++, where few spare CMS-RPC detectors are exposed to an intense gamma radiation to estimate the impact of HL-LHC conditions, in order to confirm that the CMS-RPC system will survive to the harsher background rate expected at HL-LHC. The main detectors parameters (currents, rate, resistivity, etc.) are under monitoring as a function of the accumulated charge, and the performance studied with muon beam. After having collected a significant amount of the total irradiation preliminary results will be presented.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: GELMI, Andrea (Universita e INFN, Bari (IT))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The upgrade of the CMS Resistive Plate Chamber (RPC) chambers consists partially of the installation of new RPC detectors in the forward region. High background conditions are expected in this region during the high-luminosity phase of the Large Hadron Collider (HL-LHC), therefore an improved RPC detector has been proposed which sustains a higher rate capability. Apart from the modified detector design, a new front-end electronics has been used which significantly reduces the threshold, being able to work with lower operational high voltage and hence reducing the effect of aging. In this work the results of the tests at the CERN Gamma Irradiation Facility are presented, in which the improved RPC detector with the new front-end electronics has been tested under a large gamma background using a dedicated intense muon beam. Performance results are reported as function of the background conditions, validating this detector to work under the expected background conditions at the HL-LHC.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** EYSERMANS, Jan (Autonomous University of Puebla (MX))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Intermediate dynamics of the four pions production in e+e- annihilation and tau decay processes

Monday, 15 July 2019 18:30 (1h 30m)

The contribution is dedicated to an amplitude analysis of the $e^+e^-$ and $\tau \rightarrow 4\pi\nu$ processes. The amplitude analysis is performed using experimental data from the CMD-3 detector at the VEPP-2000 collider in the energy range 0.9–2.007 GeV. In the study the dominance of the $e^+e^-$ $\rightarrow \omega\pi^0 \rightarrow 4\pi$ and $e^+e^- \rightarrow a_1\pi \rightarrow 4\pi$ amplitudes is proved, as well as sizable contributions of the $\rho^+\rho^-$, $\rho_0\rho\sigma$ and etc. states are observed. The obtained amplitude is used for the test of the isospin relations and hypothesis of conserved vector current (CVC) in the comparison of spectra and probabilities of $e^+e^- \rightarrow 4\pi$ and $\tau \rightarrow 4\pi\nu$ reactions. Also a precise measurement of the cross section of $e^+e^- \rightarrow 4\pi$ is performed and will be shown in the relationship to g-2 puzzle.

Primary author: Mr KOZYREV, Evgeny (Budker Institute of Nuclear Physics)
Presenter: Mr KOZYREV, Evgeny (Budker Institute of Nuclear Physics)
Session Classification: Wine & Cheese Poster Session
Track Classification: QCD and Hadronic Physics
Electroweak and QCD aspects in $V+\text{jets}$ in CMS

Friday, 12 July 2019 15:30 (15 minutes)

The study of the associated production of vector bosons and jets constitutes an excellent testbench to check numerous QCD predictions. Total and differential cross sections of vector bosons produced in association with jets have been studied in pp collisions at 7, 8 and 13 TeV center-of-mass energies. Differential distributions as function of a broad range of kinematical observables are measured and compared with theoretical predictions. Final states with a vector boson and jets can be also used to study electroweak initiated processes, such as the vector boson fusion production of a Z or W boson that are accompanied by a pair of energetic jets with large invariant mass.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

Presenter: COOPERSTEIN, Stephane Brunet (Univ. of California San Diego (US))

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
V+heavy flavor jets and constraints to PDFs in CMS

Friday, 12 July 2019 18:00 (15 minutes)

The associated production of vector bosons V (W, Z or gamma) and jets originating from heavy-flavour (c or b) quarks is a large background source in measurements of other standard model processes, Higgs boson studies, and many searches for physics beyond the SM. The study of events with a vector boson accompanied by heavy-flavour jets is crucial to refine the theoretical calculations in perturbative QCD, as well as to validate associated Monte Carlo predictions. Differential cross sections in V+ c/b jets are measured as a function of several kinematic observables with the CMS detector at 8 and 13 TeV. The study of the associated production of a vector boson with jets from a c-quark is especially interesting, as it allows to extract information on the proton parton density functions.

Primary authors: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE)); FERNANDEZ RAMOS, Juan Pablo (Centro de Investigaciones Energética cas Medioambientales y Tecno)

Presenter: FERNANDEZ RAMOS, Juan Pablo (Centro de Investigaciones Energética cas Medioambientales y Tecno)

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Inclusive jet results from CMS Experiment

*Friday, 12 July 2019 17:45 (15 minutes)*

This talk will include a review of inclusive jet measurements performed by the CMS collaboration.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** Mr CHATTERJEE, Suman (Tata Inst. of Fundamental Research (IN))

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
This talk reviews precision EW measurements at CMS.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** SEIDEL, Markus (University of Maryland (US))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Electroweak physics in multiboson final states at CMS

Saturday, 13 July 2019 10:30 (30 minutes)

This talk reviews recent measurements of multiboson production and constraints on anomalous gauge couplings.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: KUO, Chia-Ming (National Central University (TW))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Two natural scenarios for dark matter particles coexisting with supersymmetry

*Monday, 15 July 2019 18:30 (1h 30m)*

We describe two natural scenarios in which both dark matter weakly interacting massive particles (WIMPs) and a variety of supersymmetric partners should be discovered in the foreseeable future. In the first scenario, the WIMPs are neutralinos, but they are only one component of the dark matter, which is dominantly composed of other relic particles such as axions. (This is the multicomponent model of Baer, Barger, Sengupta and Tata.) In the second scenario, the WIMPs result from an extended Higgs sector and may be the only dark matter component. In either scenario, both the dark matter WIMP and a plethora of other neutral and charged particles await discovery at many experimental facilities. The new particles in the second scenario have far weaker cross-sections for direct and indirect detection via their gauge interactions, which are either momentum-dependent or second-order. However, as we point out here, they should have much stronger interactions via the Higgs. We estimate that their interactions with fermions will then be comparable to (although not equal to) those of neutralinos with a corresponding Higgs interaction. It follows that these newly proposed dark matter particles should be within the reach of emerging and proposed facilities for direct, indirect, and collider-based detection.

**Primary author:**  Prof. ALLEN, Roland (Texas A&M University)  
**Presenter:**  Prof. ALLEN, Roland (Texas A&M University)  
**Session Classification:**  Wine & Cheese Poster Session  
**Track Classification:**  Dark Matter
The Deep Underground Neutrino Experiment (DUNE) provides a rich science program with the focus on the neutrino oscillation physics and proton decay studies. The high-intensity wide-band neutrino beam will be produced at Fermilab and will be directed to the 40 kt Liquid Argon far detector at the Sanford Underground Research Facility (SURF), 1300 km from Fermilab. One of the most important goals of the experiment is to determine the neutrino mass ordering and the measurement of the CP violating phase. The underground location of the large DUNE far detector and its excellent energy and spatial resolution will allow also conducting non-accelerator physics programs predicted by GUT models, such as nucleon decay or n-nbar oscillations. Moreover, it will be sensitive to measure of the electron neutrino flux from a core-collapse supernova providing valuable information on the mechanism of a supernova. This ambitious project involves world-wide contribution and extensive prototyping and testing program to guarantee that all parts of the technology are fully understood and well tested. In 2018, the single-phase prototype took successfully data in the test beam and protoDUNE dual phase will start data taking with cosmics during summer this year. Both protoDUNEs will take date after LS2.

**Primary author:**  DAWSON, Jaime (APC Paris)

**Presenter:**  DAWSON, Jaime (APC Paris)

**Session Classification:**  Neutrino Physics

**Track Classification:**  Neutrino Physics
Phase 3 beam commissioning of SuperKEKB

Saturday, 13 July 2019 09:00 (25 minutes)

SuperKEKB, the upgraded successor to KEKB, is an asymmetric electron-positron collider. Aiming for 40 times higher luminosity than KEKB by shrinking the beams to “nano-beam” size at the interaction point while doubling the beam currents, SuperKEKB has been commissioned in a phased manner. In the Phase 2 operation of SuperKEKB, the first collisions were recorded and the smallest value in the world of the vertical beta function at an interaction point was achieved. Phase 3 starts in March 2019, and the first physics run also starts with a fully equipped Belle II detector. The recent progress and performance of the SuperKEKB accelerator are reported on here.

Primary author: Dr OKI, Toshiyuki (KEK)
Presenter: Dr OKI, Toshiyuki (KEK)
Session Classification: Accelerators for HEP
Track Classification: Accelerators for HEP
The upgrade of the T2K Near Detector ND280

Friday, 12 July 2019 09:00 (20 minutes)

In view of the J-PARC program of upgrades of the beam intensity, the T2K collaboration is preparing towards an increase of the exposure aimed at establishing leptonic CP violation at 3 $\sigma$ level for a significant fraction of the possible $\delta_{CP}$ values. To reach this goal, an upgrade of the T2K near detector ND280 has been launched, with the aim of reducing the overall statistical and systematic uncertainties at the appropriate level of better than 4%.

We have developed an innovative concept for this neutrino detection system, comprising the totally active Super-Fine-Grained-Detector (SuperFGD), two High Angle TPC (HA-TPC) and six TOF planes.

The SuperFGD, a highly segmented scintillator detector, acting as a fully active target for the neutrino interactions, is a novel device, (JINST 13 (2018) no.02, P02006; NIM A923 (2019) 134), with dimensions of $\sim$2x1.8x0.6 m$^3$ and a total mass of about 2 tons. It consists of about 2x106 small scintillator cubes each of 1 cm$^3$. Each cube is covered by a chemical reflector. The signal readout from each cube is provided by wavelength shifting fibers inserted connected to micro-pixel avalanche photodiodes MPPCs. The total number of channels will be $\sim$60,000. We have demonstrated that this detector, providing three 2D projections, has excellent PID, timing and tracking performance, including a $4\pi$ angular acceptance, especially important for short proton and pion tracks.

The HA-TPC will be used for 3D track reconstruction, momentum measurement and particle identification. These TPC, with overall dimensions of 2x2x0.8 m$^3$, will be equipped with 32 resistive Micromegas. The thin field cage (3 cm thickness, 4% rad. length) will be realized with laminated panels of Aramid and honeycomb covered with a kapton foil with copper strips. The 34x42 cm$^2$ resistive bulk Micromegas will use a 500 kOhm/square DLC foil to spread the charge over the pad plane, each pad being appr. 1 cm$^2$. The front-end cards, based on the AFTER chip, will be mounted on the back of the Micromegas and parallel to its plane.

The time-of-flight (TOF) detector will allow to reject events generated in the passive areas of the detector and improve particle identification. The TOF will consist of 6 planes with about 5 m$^2$ surface area surrounding the SuperFGD and the TPCs. Each plane will be assembled with 2.2 m long cast plastic scintillator bars with light collected by arrays of large-area MPPCs from two ends. The time resolution at the bar centre is 150 ps.

In Summer 2018 we have tested prototypes of the SuperFGD, the resistive Micromegas and the TOF in a CERN PS test beam with excellent results.

We have recently completed the detailed TDR describing all the components of the ND280 Upgrade (arXiv:1901.03750). The project has been recently approved by CERN as part of the Neutrino Platform (NP07). In this talk we will report on the design of these detectors, their performance, the results of the test beam and the plan for the construction.

Primary author: ZITO, Marco (Université Paris-Saclay (FR))
Presenter: NOAH, Etam (Universite de Geneve (CH))
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Weak vector boson scattering (VBS) is a sensitive probe of new physics effects in the electroweak symmetry breaking. Currently, experimental results at the LHC are interpreted in the effective field theory approach, where possible deviations from the Standard Model in the quartic-gauge-boson couplings are often described by 18 dimension-8 operators. By assuming that a UV completion exists, we derive a new set of theoretical constraints on the coefficients of these operators, i.e. certain combinations of coefficients must be positive. These constraints imply that the current effective approach to VBS has a large redundancy: only about 2% of the full parameter space leads to a UV completion. By excluding the remaining unphysical region of the parameter space, these constraints provide guidance for future VBS studies and measurements.

**Primary authors:** Prof. ZHANG, Cen (Institute of High Energy Physics, CAS); Prof. ZHOU, Shuang-Yong (University of Science and Technology of China)

**Presenter:** Prof. ZHOU, Shuang-Yong (University of Science and Technology of China)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Increasing the precision for Z production at colliders: including mixed QCD-QED effects

Friday, 12 July 2019 14:30 (15 minutes)

In this talk, we briefly describe the recent progress on the inclusion of mixed QCD-QED corrections for collider observables. In particular, we developed a formalism to extend $q_t$-resummation to deal with simultaneous emission of gluons and photons. We applied it to $Z$-production at colliders, and discuss extensions to more complicated final states.

Primary author: SBORLINI, German (Università di Milano, INFN Milano and IFIC-Valencia)
Co-authors: CIERI, Leandro; FERRERA, Giancarlo (University of Milan)
Presenter: SBORLINI, German (Università di Milano, INFN Milano and IFIC-Valencia)
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
MADMAX: A new way to search for QCD Axion Dark Matter with a Dielectric Haloscope

Light Dark Matter candidates have increasingly come under the focus of scientific interest. In particular the QCD axion is also able to solve other fundamental problems such as CP-conservation in strong interactions. Galactic axions and axion-like particles can be converted to photons at boundaries between materials of different dielectric constants under a strong magnetic field. Combining many such surfaces, one can enhance this conversion significantly using constructive interference and resonances. The proposed MADMAX setup containing 80 high dielectric disks in a $10^7$T magnetic field could probe the well-motivated mass range of $40 - 400 \mu$eV, a range which is at present inaccessible by existing cavity searches. The experimental idea and the proposed design of MADMAX will be discussed. Among recent R&D results from 3D simulations and proof of principle prototype measurements, the prospects of reaching sensitivity to the QCD axion will be presented.

Primary author: KNIRCK, Stefan (Max-Planck-Institute for Physics, Munich, Germany)
Presenter: KNIRCK, Stefan (Max-Planck-Institute for Physics, Munich, Germany)
Session Classification: Dark Matter
Track Classification: Dark Matter
Searches for supersymmetry via strong production in all-hadronic final states at CMS

Thursday, 11 July 2019 09:00 (15 minutes)

We present searches for new physics in events with one or more jets accompanied by large missing transverse momenta produced in proton-proton collision data recorded by the CMS experiment during the LHC Run2 operations (2016-18). Compressed chargino-neutralinos appearing in gluino cascades are studied using short tracks. The results are interpreted in the context of several simplified models of pair-production of gluinos and squarks.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** THOMAS, Laurent (Université Libre de Bruxelles (BE))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Searches for direct production of third generation squarks at CMS

*Thursday, 11 July 2019 10:30 (15 minutes)*

We present searches for third generation of supersymmetric top and bottom quarks based on proton-proton collision data recorded by the CMS experiment during the LHC Run2 operations (2016-18). The searches are performed in zero, single lepton (including taus) and dilepton final states, and the results are interpreted in the context of several decay modes of stop quarks.

**Primary author**: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter**: COLLARD, Caroline (Centre National de la Recherche Scientifique (FR))

**Session Classification**: Searches for New Physics

**Track Classification**: Searches for New Physics
Search for electroweak production of
supersymmetry at CMS

Thursday, 11 July 2019 09:45 (15 minutes)

We present searches for pair production of supersymmetric partner of tau-leptons, and of partners of electroweak gauge bosons in events with at least one tau-lepton and missing transverse momenta produced in proton-proton collision data recorded by the CMS experiment during the LHC Run2 operations. The results are interpreted in terms of simplified models of supersymmetry production and decay of these of these particles.

Primary author:  MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter:  DUTTA, Valentina (Univ. of California Santa Barbara (US))
Session Classification:  Searches for New Physics
Track Classification:  Searches for New Physics
Search for RPV and stealth top squarks at CMS

Thursday, 11 July 2019 11:45 (15 minutes)

We present searches for new physics scenarios like R-parity violating supersymmetry or compressed mass spectra which predict low missing transverse momenta, many jets and top quarks. The searches are based on proton-proton collision data recorded by the CMS experiment during the LHC Run2 operations.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: Dr LO, Kin Ho (University of Florida (US))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Searches for new resonances decaying to leptons, photons or jets with CMS

Thursday, 11 July 2019 15:45 (15 minutes)

Various physics models beyond the standard model predict new particles that decay to leptons, photons or jets. This talk presents the status of CMS searches for new resonances decaying to a pair of leptons, photons or jets, as well as other states such as lepton + missing transverse momentum. Searches for boosted dijet resonances recoiling against some high pT initial state radiation, as well as searches using dijet angular distributions are also covered.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: BEGHIN, Diego (Universite Libre de Bruxelles (BE))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Searches for non-resonant new phenomena in final states with leptons, photons and jets at CMS

Thursday, 11 July 2019 16:30 (15 minutes)

Several new physics models such as those involving extra dimensions, leptoquarks, heavy neutrinos, W bosons with right handed couplings, excited fermions, seesaw models, etc. are expected to manifest themselves in non-resonant signatures with multiple leptons, photons or jets. This talk presents CMS searches for new non-resonant phenomena in the final states that involving leptons, photons and/or jets, focusing on the recent results obtained using data collected in the LHC run 2.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: HEINDL, Maximilian (Rutgers State Univ. of New Jersey (US))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Searches for dark matter with CMS

Thursday, 11 July 2019 16:40 (20 minutes)

Searches for dark matter in various final states with invisible particles recoiling against standard model particles are presented. Various topologies and kinematic variables are explored, as well as jet substructure as a means of tagging heavy bosons. The focus of the talk is on the recent CMS results obtained using data collected in the LHC run 2.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: DE BRUYN, Isabelle (University of Wisconsin Madison (US))
Session Classification: Dark Matter
Track Classification: Dark Matter
Several theories predict dark matter to be a part of a larger dark sector of particles and forces. These dark sector particles such as dark photons, dark scalars or dark quarks may interact very weakly with standard model particles resulting in several distinct signatures in the high energy pp collision events at the LHC. This talk presents recent results from CMS on dark sector searches using data collected in LHC Run-2.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** SHARMA, Varun (University of Wisconsin Madison (US))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Many extensions of the standard model including supersymmetry predict new particles with long lifetimes, such that the position of their decay is measurably displaced from their production vertex, and particles giving rise to other non-conventional signatures. We present recent results of CMS searches for long-lived particles and other non-conventional signatures obtained using data recorded in LHC in run 2.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** HART, Andrew Evan (Rutgers State Univ. of New Jersey (US))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
The GEM (GE1/1) Phase II Upgrade for the CMS muon system: results from in-situ demonstrator, production detector qualification, and commissioning plans

Thursday, 11 July 2019 12:15 (15 minutes)

In the next years the Large Hadron Collider (LHC) will be upgraded to significantly expand its physics program, increasing the luminosity up to $5 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$, well beyond the design value. An upgrade of the CMS detector is needed accordingly to cope with the expected growth in background rates, with the goal of keeping a high trigger efficiency. In this context, a first new station called GE1/1 will be installed in 2019-2020 in the CMS muon system. It will be composed by 144 Triple Gas Electron Multiplier (GEM) detectors to be integrated in the CMS muon endcaps in the region closest to the beam line. A fundamental operational experience has been already achieved in 2017-2018, when a demonstrator composed of ten GE1/1 Triple-GEM detectors was installed to prove the integration of the GE1/1 system into CMS itself. In parallel, a dedicated production chain has been setup in seven production sites spread around the world, for the construction and qualification of all the detectors for the complete station. This contribution will give a complete overview of the GE1/1 project: the detectors design and performance will be discussed, together with the lessons learned from the GE1/1 demonstrator installation, integration and operation. The construction and qualification processes will be presented, with great emphasis to the results obtained with the 144 GE1/1 detectors. Finally, the plans for the installation and commissioning of the full station will be outlined.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: VAI, Ilaria (Università and INFN (IT))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
The CMS ECAL calibration and monitoring

Monday, 15 July 2019 19:40 (20 minutes)

Precise calibration and monitoring of the CMS electromagnetic calorimeter (ECAL) is a key ingredient in achieving the excellent ECAL performance required by many physics analyses employing electrons, photons and jets. This poster describes the methods used to monitor and inter-calibrate the ECAL response, using physics channels such as W/Z boson decays to electrons, $\pi^0$ decays to photon pairs, and also exploiting the azimuthal symmetry of the minimum bias events. Results of the calibrations obtained with Run 2 data are presented.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** WADUD, Mohammad Abrar (Univ. of Minnesota)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Recent advances in neural networks and harsh pileup conditions in the second half on LHC Run 2 with on average 38 PU interactions, have sparked significant developments in techniques for jet tagging and missing transverse momentum reconstruction. Through the study of jet substructure properties, jets originating from quarks, gluons, W/ Z/Higgs bosons, top quarks and pileup interactions are distinguished, surpassing previous performance at lower pileup conditions by using new approaches. This talk will give an overview of the new jet substructure and pileup mitigation tools and advances in performance of jet and missing transverse momentum reconstruction in CMS.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: SZNAJDER, Andre (Universidade do Estado do Rio de Janeiro (BR))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
The GAPS experiment for dark matter detection with cosmic ray antinuclei.

Thursday, 11 July 2019 10:05 (20 minutes)

The General Antiparticle Spectrometer (GAPS) will carry out a sensitive dark matter search by measuring low-energy ($E < 0.25$ GeV/nucleon) cosmic ray antinuclei. The primary target are low-energy antideuterons that might be produced in the annihilation or decay of dark matter. At these energies the antideuteron intensity from secondary/tertiary interactions is expected to be several orders of magnitude lower with respect to those predicted by beyond the standard model theories. GAPS will also conduct a low-energy antihelium search and will provide the highest-statistics spectral measurement of antiproton at these energies. Combined, these observations will provide a powerful search for dark matter and for primordial black hole evaporation.

GAPS will use a novel particle identification method based on exotic atom formation and decay with emission of pions, protons and atomic X-rays from a common annihilation vertex. This detection technique will give GAPS the high rejection factors necessary for rare antinuclei searches.

The detector consists of a tracker, made up by ten planes of lithium-drifted silicon Si(Li) detectors, surrounded by a plastic scintillator time-of-flight system.

The first of a series of a long-duration Antarctic balloon flight is expected for the austral summer of 2020 or 2021. This presentation covers the scientific motivation for the GAPS experiment, its design and its current status.

Primary author: MUNINI, Riccardo (INFN - Universita Studi Trieste)
Presenter: MUNINI, Riccardo (INFN - Universita Studi Trieste)
Session Classification: Dark Matter
Track Classification: Dark Matter
A high precision narrow-band neutrino beam: the ENUBET project

Friday, 12 July 2019 12:05 (20 minutes)

The knowledge of initial flux, energy and flavor of current neutrino beams is currently the main limitation for a precise measurement of neutrino cross sections. The ENUBET ERC project (2016-2021) is studying a facility based on a narrow band neutrino beam capable of constraining the neutrino fluxes normalization through the monitoring of the associated charged leptons in an instrumented decay tunnel. In particular, the identification of large-angle positrons from $K_{e3}$ decays at single particle level can potentially reduce the $\nu_e$ flux uncertainty at the level of 1%. This setup would allow for an unprecedented measurement of the $\nu_e$ cross section at the GeV scale. Such an experimental input would be highly beneficial to reduce the budget of systematic uncertainties in the next long baseline oscillation projects (i.e HyperK-DUNE). Furthermore, in narrow-band beams, the transverse position of the neutrino interaction at the detector can be exploited to determine a priori with significant precision the neutrino energy spectrum without relying on the final state reconstruction.

This contribution will present the advances in the design and simulation of the hadronic beam line. Special emphasis will be given to a static focusing system of secondary mesons that, unlike the other studied horn-based solution, can be coupled to a slow extraction proton scheme. The consequent reduction of particle rates and pile-up effects makes the determination of the $\nu_\mu$ flux through a direct monitoring of muons after the hadron dump viable, and paves the way to a time-tagged neutrino beam. Time-coincidences among the lepton at the source and the neutrino at the detector would enable an unprecedented purity and the possibility to reconstruct the neutrino kinematics at source on an event by event basis. We will also present the performance of positron tagger prototypes tested at CERN beamlines, a full simulation of the positron reconstruction chain and the expected physics reach of ENUBET.

References:
A. Berra et al. Enabling precise measurements of flux in accelerator neutrino beams: the ENUBET project CERN-SPSC-2016-036 / SPSC-EOI-014, 05/10/2016.
A. Meregaglia et al., ENUBET: Enhanced NeUtrino BEams from kaon Tagging, JINST 11 (2016) no.12, C12040.

**Primary authors:** PUPILLI, Fabio (Università e INFN, Padova (IT)); BRUNETTI, Giulia (Università e INFN, Padova (IT))

**Presenter:** BRUNETTI, Giulia (Università e INFN, Padova (IT))

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
Progress in the development of Fast Timing Micro-pattern Gaseous Detectors

Monday, 15 July 2019 19:40 (20 minutes)

Advances in photo-lithographic techniques during the last twenty years have lead to the development of micro-pattern gaseous detectors (MPGD). Their main features include high rate capability and radiation hardness, excellent spatial resolution, good time resolution, reduced radiation length and possible flexible geometries. In recent years the further development of MPGDs concentrated on using resistive materials to build compact spark-protected detectors. The use of resistive materials also opened the possibility to make electrically transparent structures with external signal pick-up. This allowed for a new idea to improve the time resolution through a multi-layered detector, consisting of alternating drift and amplification regions, where the fastest signal determines the detection time. This so-called Fast Timing MPGD (FTM) was firstly introduced by Rui de Oliveira et al. in 2015 [1] and aims to combine both the high spatial resolution and the high rate capability of a MPGD with a high time resolution of the order of 300ps. Here, we introduce the design of a new single-layer prototype to test the gain of the amplification structure. Preliminary results on the detector characterization will be shown.


Primary authors: DE OLIVEIRA, Rui (CERN); MAGGI, Marcello (Universita e INFN, Bari (IT)); ROSKAS, Christos (Ghent University (BE)); TYTGAT, Michael (Ghent University (BE)); VERWILLIGEN, Piet (Universita e INFN, Bari (IT)); VAI, Ilaria (Universita and INFN (IT))

Presenter: ROSKAS, Christos (Ghent University (BE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Azimuthal anisotropy in Pb+Pb, Xe+Xe and p+Pb collisions and \(v_n\)-pt correlations in Pb+Pb and p+Pb collisions with the ATLAS experiment

ATLAS measurements of differential and global Fourier harmonics of charged particles \((v_n)\) in 5.02 TeV Pb+Pb and 5.44 TeV Xe+Xe collisions in a wide range of transverse momenta (up to 60 GeV), pseudorapidity \(|\eta|<2.5\) and collision centrality (0-80%) are presented. The higher order harmonics, sensitive to fluctuations in the initial state, are measured up to \(n=7\) using the two-particle correlation, cumulant and scalar-product methods. The elliptic and triangular flow harmonics show an interesting universal \(p_T\)-scaling. The flow results allow to improve the understanding of initial conditions of nuclear collisions, hydrodynamical behavior of quark-gluon plasma and parton energy loss. The dynamic properties of the QGP can also be studied using a modified Pearson’s correlation coefficient, \(\rho(v_n, p_T)\), that quantifies correlation between the mean transverse momentum and the magnitude of the flow vector. The \(\rho\) coefficient is presented for 5.02 TeV Pb+Pb and p+Pb collisions. Azimuthal anisotropy in Pb+Pb collisions is also compared with new measurements in pp and p+Pb collisions.

**Primary author:** ATLAS COLLABORATION

**Presenter:** BOLD, Tomasz (AGH Univ. of Science and Technology, Krakow)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Observation of light-by-light scattering and new results from ultra-peripheral heavy-ion collisions in the ATLAS experiment

Saturday, 13 July 2019 09:00 (18 minutes)

Light-by-light (LbyL) scattering, $\gamma\gamma \rightarrow \gamma\gamma$, is a very rare process allowed in Quantum Electrodynamics via a loop diagram. The precise measurement of this process is potentially sensitive to contributions from Beyond Standard Model. Despite the small cross-section, the LbyL scattering can be observed in ultra-peripheral high energy heavy-ion collisions due to strong electromagnetic fields accompanying the lead beam. In this talk we discuss the first direct observation of LbyL scattering established by ATLAS Collaboration using 2018 Pb+Pb dataset. We also summarize other new measurements done using ultra-peripheral events such as the measurement of multi-particle correlations and measurement of di-muon production.

**Primary author:** ATLAS COLLABORATION

**Presenter:** TAYALATI, Yahya (Universite Mohammed V (MA))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Production of electroweak bosons in Pb+Pb, p+Pb and pp collisions with the ATLAS detector

Friday, 12 July 2019 12:08 (20 minutes)

Electroweak bosons produced in ultrarelativistic heavy-ion collisions serve as excellent probes of the collision geometry and centrality. Their production rates should be unaffected by initial-state effects. Due to the correlation between the kinematics of quarks from incoming nuclei and the rapidity of produced electroweak bosons, they also provide insight into nuclear modifications of parton distribution functions (PDFs). This talk presents the latest ATLAS results on massive electroweak boson production in Pb+Pb and pp collisions at $\sqrt{s_{NN}} = 5.02$ TeV using data collected by the ATLAS experiment in 2015. The yields of $W$ and $Z$ bosons produced per inelastic Pb+Pb collision are compared to cross-sections measured in pp collisions and used to construct nuclear modification factors. A comparison of the measured yields and cross-sections to calculations obtained with various (nuclear) PDF sets is also presented. This talk also summarizes selected results on photon production in p+Pb collisions.

Primary author: ATLAS COLLABORATION
Presenter: PRZYBYCIEN, Mariusz (AGH Univesity of Science and Technology (PL))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
The ATLAS Hardware Track Trigger design towards first prototypes

In the High Luminosity LHC, planned to start with Run4 in 2026, the ATLAS experiment will be equipped with the Hardware Track Trigger (HTT) system, a dedicated hardware system able to reconstruct tracks in the silicon detectors with short latency. This HTT will be composed of about 700 ATCA boards, based on new technologies available on the market, like high speed links and powerful FPGAs, as well as custom-designed Associative Memories ASIC (AM), which are an evolution of those used extensively in previous experiments and in the ATLAS Fast Tracker (FTK).

The HTT is designed to cope with the expected extreme high luminosity in the so called L0-only scenario, where HTT will operate at the L0 rate (1 MHz). It will provide good quality tracks to the software High-Level-Trigger (HLT), operating as coprocessor, reducing the HLT farm size by a factor of 10, by lightening the load of the software tracking.

All ATLAS upgrade projects are designed also for an evolved, so-called “L0/L1” architecture, where part of HTT is used in a low-latency mode (L1Track), providing tracks in regions of ATLAS at a rate of up to 4MHz, with a latency of a few micro-seconds. This second phase poses very stringent requirements on the latency budget and to the dataflow rates.

All the requirements and the specifications of this system have been assessed. The design of all the components has being reviewed and validated with preliminary simulation studies. After these validations are completed, the development of the first prototypes will start. In this paper we describe the status of the design review, showing challenges and assessed specifications, towards the preparation of the first slice tests with real prototypes.

Primary author: STOCKTON, Mark (CERN)
Presenter: PASTORE, Francesca (Royal Holloway, University of London)
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The ATLAS experiment aims at recording about 1 kHz of physics collisions, starting with an LHC design bunch crossing rate of 40 MHz. To reduce the significant background rate while maintaining a high selection efficiency for rare physics events (such as beyond the Standard Model physics), a two-level trigger system is used.

Events are selected based on physics signatures such as the presence of energetic leptons, photons, jets or large missing energy. The trigger system exploits topological information, as well as multivariate methods to carry out the necessary physics filtering for the many analyses that are pursued by the ATLAS community. In total, the ATLAS online selection consists of around 1500 individual triggers. A Trigger Menu is the compilation of these triggers, it specifies the physics selection algorithms to be used during data taking, and the rate and bandwidth a given trigger is allocated. Trigger menus must reflect the physics goals for a given run, and also must take into consideration the instantaneous luminosity of the LHC and limitations from the ATLAS detector readout and offline processing farm. For the 2017-2018 run, the ATLAS trigger has been enhanced to be able to handle higher instantaneous luminosities and to ensure the selection robustness against higher average multiple interactions per bunch crossing.

We will describe the design criteria for the trigger menu for Run 2. We discuss several aspects of the process of planning the trigger menu, starting from how ATLAS physics goals and the need for detector performance measurements enter the menu design, and how rate, bandwidth, and CPU constraints are folded in during the compilation of the menu. We present the tools that allow us to predict and optimize the trigger rates and CPU consumption for the anticipated LHC luminosities. We outline the online system that we implemented to monitor deviations from the individual trigger target rates, and to quickly react to the changing LHC conditions and data taking scenarios. Finally, we give an overview of the 2015-2018 Trigger Menu and performance, allowing the audience to get a taste of the broad physics program that the trigger is supporting.

Primary author: STOCKTON, Mark (CERN)
Presenter: RUSSELL, Heather (McGill University (CA))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Performance of the ATLAS tau-lepton trigger at the LHC in Run 2.

Monday, 15 July 2019 19:40 (20 minutes)

The ATLAS experiment has a rich physics program of Standard Model measurements and searches for physics Beyond the Standard Model involving tau leptons. Most of these analyses depend on an efficient tau-lepton trigger that can cope with the overwhelming background from multi-jet events produced in proton-proton collisions at the Large Hadron Collider.

The ATLAS trigger system is composed of two stages. At Level-1, tau leptons are reconstructed as energy deposits in neighbouring towers of calorimeter cells. The High Level Trigger (HLT) exploits the full calorimeter granularity as well as inner-detector tracks, and runs reconstruction and identification algorithms similar to those used in the offline reconstruction.

The performance of the tau-lepton trigger in ATLAS Run-2 data will be discussed, and trigger efficiencies measured with a tag-and-probe method will be presented. An emphasis will be made on the improved HLT algorithms deployed in 2018 and mentioned below. The association of tracks to the energy deposit in the calorimeter was tightened to reduce the contamination from fake tracks at high pileup. An energy calibration based on a Boosted Regression Tree with improved energy resolution has replaced the simpler calibration based on pileup subtraction and calorimeter response correction. An identification algorithm based on a Recurrent Neural Network was also deployed, which provides increased jet rejection compared to the previously-used Boosted Decision Tree identification algorithm.

Primary author: STOCKTON, Mark (CERN)

Presenter: ORDEK, Serhat (Georg August Universitaet Goettingen (DE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
ATLAS Transverse Missing Energy Momentum Trigger Performance

Monday, 15 July 2019 19:40 (20 minutes)

Transverse missing energy momentum from non-interacting particles is one of the important characteristics for many analyses especially for Beyond Standard Model physics searches. To study these events at the Large Hadron Collider (LHC) with the ATLAS experiment an efficient trigger selection is needed. The ATLAS transverse missing momentum trigger uses calorimeter-based global energy sums together with specifically developed pile-up mitigation techniques. The high number of pile-up interactions was one of the major challenges faced during Run II and a continuous effort was needed to improve the pile-up rejection and to keep the trigger rate reasonable. This talk presents the techniques used to improve the Run 2 transverse missing momentum trigger performance, the full Run 2 performance and an outlook on further improvements for Run 3.

Primary author: STOCKTON, Mark (CERN)
Presenter: RONZANI, Manfredi (New York University (US))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
ATLAS Trigger and Data Acquisition Upgrades for the High Luminosity LHC

Monday, 15 July 2019 19:40 (20 minutes)

The ATLAS experiment at CERN has started the construction of upgrades for the "High Luminosity LHC", with collisions due to start in 2026. In order to deliver an order of magnitude more data than previous LHC runs, 14 TeV protons will collide with an instantaneous luminosity of up to $7.5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$, resulting in much higher pileup and data rates than the current experiment was designed to handle. While this is essential to realise the physics programme, it presents a huge challenge for the detector, trigger, data acquisition and computing. The detector upgrades themselves also present new requirements and opportunities for the trigger and data acquisition system.

The approved baseline design of the TDAQ upgrade comprises: a hardware-based low-latency real-time Trigger operating at 40 MHz, Data Acquisition which combines custom readout with commodity hardware and networking to deal with 5.2 TB/s input, and an Event Filter running at 1 MHz which combines offline-like algorithms on a large commodity compute service augmented by hardware tracking. Commodity servers and networks are used as far as possible, with custom ATCA boards, high speed links and powerful FPGAs deployed in the low-latency parts of the system. Offline-style clustering and jet-finding in FPGAs, and track reconstruction with Associative Memory ASICs and FPGAs are designed to combat pileup in the Trigger and Event Filter respectively.

This paper will report recent progress on the design, technology and construction of the system. The physics motivation and expected performance will be shown for key physics processes.

Primary author: STOCKTON, Mark (CERN)

Presenter: VALENTE, Marco (Universite de Geneve (CH))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
The ATLAS Level-1 Topological Processor: experience and upgrade plans

Monday, 15 July 2019 19:40 (20 minutes)

During Run-2 the Large Hadron Collider (LHC) has provided, at the World’s energy frontier, proton-proton collisions to the ATLAS experiment with high instantaneous luminosity (up to 2.1x10^34 cm^-2s^-1), placing stringent operational and physical requirements on the ATLAS trigger system in order to reduce the 40 MHz collision rate to a manageable event storage rate of 1 kHz, while not rejecting interesting collisions.

The Level-1 trigger is the first rate-reducing step in the ATLAS trigger system with an output rate of up to 100 kHz and decision latency of less than 2.5 μs. Until the end of 2018, an important role was played by the Level 1 Topological Processor (L1Topo). This innovative system consists of two blades designed in AdvancedTCA form factor, mounting four individual state-of-the-art processors, and providing high input bandwidth and low latency data processing. Up to 128 topological trigger algorithms can be implemented to select interesting events by applying kinematic and angular requirements on electromagnetic clusters, hadronic jets, muons and total energy reconstructed in the ATLAS apparatus. This resulted in a significantly improved background event rejection rate and improved acceptance of physics signal events, despite the increasing luminosity. The L1Topo system has become more and more important for physics analyses making use of low energy objects, commonly present in the Heavy Flavour or Higgs physics events for example.

In this presentation, an overview of the L1Topo architecture, simulation and performance results during Run-2 is discussed alongside with upgrade plans for the L1Topo system to be installed for the future data taking that will start in 2021.

Primary author: STOCKTON, Mark (CERN)
Presenter: ALDERWEIRELDT, Sara (CERN)
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Muon identification and performance in the ATLAS experiment

Thursday, 11 July 2019 10:30 (15 minutes)

Muon reconstruction and identification play a fundamental role in many analyses of central importance in the LHC run-2 Physics programme. The algorithms and the criteria used in ATLAS for the reconstruction and identification of muons with transverse momenta ranging from a few GeV to the TeV scale will be presented. Their performance is measured in data based on the decays of Z, Υ, and J/ψ to pairs of muons. Reconstruction and identification efficiencies are evaluated, as well as momentum scales and resolutions, and the results are used to derive Monte Carlo simulation corrections that in several cases reach the permit-level precision. Isolation selection requirements and their performance in presence of high pileup will also be presented.

Primary author: ATLAS COLLABORATION
Presenter: KLUIT, Peter (Nikhef National institute for subatomic physics (NL))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
We analyze in detail the LHC prospects at the center-of-mass energy of 14 TeV for charged electroweakino searches, decaying to leptons, in compressed supersymmetry scenarios, via exclusive photon-initiated pair production. This provides a potentially increased sensitivity in comparison to inclusive channels, where the background is often overwhelming. We pay particular attention to the challenges that such searches would face in the hostile high pile-up environment of the LHC, giving close consideration to the backgrounds that will be present. The signal we focus on is the exclusive production of same-flavour muon and electron pairs, with missing energy in the final state, and with two outgoing intact protons registered by the dedicated forward proton detectors installed in association with ATLAS and CMS. We present results for slepton masses of 120-300 GeV and slepton-neutralino mass splitting of 10-20 GeV, and find that the relevant backgrounds can be controlled to the level of the expected signal yields. The most significant such backgrounds are due to semi-exclusive lepton pair production at lower masses, with a proton produced in the initial proton dissociation system registering in the forward detectors, and from the coincidence of forward protons produced in pile-up events with an inclusive central event that mimics the signal. We also outline a range of potential methods to further suppress these backgrounds as well as to enlarge the signal yields.

**Primary authors:** TASEVSKY, Marek (Acad. of Sciences of the Czech Rep. (CZ)); RYSKIN, Mikhail (Petersburg Nuclear Physics Institute); KHOZE, Valery (University of Durham (GB)); Dr HAR-LAND-LANG, Lucian (University of Oxford)

**Presenter:** TASEVSKY, Marek (Acad. of Sciences of the Czech Rep. (CZ))

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Search for 2HDM neutral Higgs bosons through the process $H \rightarrow Z\phi \rightarrow llbb$ with the CMS detector

Monday, 15 July 2019 18:30 (1h 30m)

The standard model is one of the most successful theories at describing the strong, weak, and electromagnetic forces and the interactions between the elementary particles. The scalar boson discovered in 2012 at the Large Hadron Collider (LHC) might be consistent with the Higgs boson predicted by the standard model, thus further validating this theoretical framework. However, the experimental data still leave plenty of room to determine whether or not an extension of the scalar sector is allowed. The standard model fails to explain physical phenomena in nature, such as the presence of dark matter, the observed matter-antimatter asymmetry, the existence of massive neutrinos etc. In this respect, an extension of the scalar sector would somewhat account for phenomena not yet explained. The Two-Higgs-Doublet-Model (2HDM) is one of the simplest extensions of the Higgs sector in the Standard model. It is theoretically built by adding a second doublet to the scalar sector, thus giving rise to three neutral and two charged Higgs bosons. With data collected at the LHC at $\sqrt{s}=13$ TeV and $L=35.9$ fb, a search for a CP-even Higgs boson decaying to a lighter CP-odd Higgs boson (then decaying to $bb$) and a $Z$ boson (then decaying to $l^+l^-$) is performed at CMS. The search is carried out under the assumption of classical or twisted custodial symmetry and the hypothesis of Type II Yukawa couplings.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: SAGGIO, Alessia (Universite Catholique de Louvain (UCL) (BE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Higgs Physics
Search for a heavy Higgs boson decaying to a pair of W bosons in proton-proton collisions at 13 TeV with CMS

Monday, 15 July 2019 18:30 (1h 30m)

A search for a heavy Higgs boson decaying to a pair of W bosons in the mass range from 200 GeV to 5 TeV is presented. The analysis is based on proton-proton collisions recorded by the CMS experiment at the CERN LHC in 2016, corresponding to an integrated luminosity of 35.9 fb−1 at $\sqrt{s} = 13$ TeV. The decay of the W boson pair is reconstructed in fully leptonic and semi-leptonic final states. Combined upper limits at the 95% confidence level on the product of the cross section and branching fraction for heavy Higgs boson with Standard Model-like couplings and decays in the mass range are evaluated. Exclusion limits are also set in the context of two Higgs doublet models.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: ROY, Dennis (Rheinisch Westfaelische Tech. Hoch. (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Higgs Physics
Rare decays of Higgs boson in dilepton plus one photon final state with CMS detector at $\sqrt{s} = 13$TeV

Monday, 15 July 2019 18:30 (1h 30m)

This poster presents the search for Higgs boson decays into Z/γ or J/$\psi$ plus a photon, in the dilepton plus one photon final state. These are important rare decay channels to be pinned down for the standard model (SM) measurement and can be used to probe new physics. The results are based on data collected by the CMS detector at the LHC from proton-proton collision at 13TeV with a corresponding integrated luminosity of 35.9 /fb. When combined with earlier CMS searches at 8 TeV, 95% CL upper observed (expected) limits are set at 3.9(2.0) times the SM predicted cross-section in the Z/γ final state, and 220 (160) and for J/$\psi$ channel.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: LEE, Ming-Yan (National Central University (TW))

Session Classification: Wine & Cheese Poster Session

Track Classification: Higgs Physics
Higgs to WW measurements with CMS

Monday, 15 July 2019 18:30 (1h 30m)

The latest set of results on Higgs decay to a W boson pair is presented. With a statistics of 36/ fb collected by the CMS experiment at the LHC at 13 TeV center of mass energy, the Higgs to WW decay has been observed at CMS with more than 5 sigma for the first time, providing a significant contribution to the current fit of the Higgs boson couplings to fermions and vector bosons.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** DI CROCE, Davide (University of Antwerp (BE))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Higgs Physics
Higgs to tau tau measurements with CMS

Monday, 15 July 2019 18:30 (1h 30m)

The latest results with Higgs boson decays to tau leptons at a centre-of-mass energy of 13 TeV are presented.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: HLUSHCHENKO, Olena (RWTH Aachen)
Session Classification: Wine & Cheese Poster Session
Track Classification: Higgs Physics
Search for lepton flavour violation decays of the Higgs boson with CMS

Monday, 15 July 2019 18:30 (1h 30m)

Recent CMS searches for lepton flavour violating decays of the Higgs boson and of a heavy Higgs boson will be shown in this poster.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: SIDDIREDDY, Prasanna Kumar (University of Notre Dame (US))
Session Classification: Wine & Cheese Poster Session
Track Classification: Higgs Physics
Higgs pair production in the $\gamma\gamma bb$ final state at $\sqrt{s} = 13$ TeV with the CMS detector

Monday, 15 July 2019 18:30 (1h 30m)

The production of pairs of Higgs bosons provides us unique information on the Higgs sector and on the mechanism underlying electroweak symmetry breaking. This poster will present the search for the resonant and non-resonant production in the production of a pair of Higgs bosons, where one decays into two photons and the other one into a bottom quark-antiquark pair. The analysis used proton-proton collision data at $\sqrt{s} = 13$ TeV recorded in 2016 by the CMS detector at the LHC, corresponding to an integrated luminosity of 35.9 fb$^{-1}$.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: KUO, Chia-Ming (National Central University (TW))
Session Classification: Wine & Cheese Poster Session
Track Classification: Higgs Physics
Measuring the muon precession frequency in the E989 Fermilab g-2 experiment

Friday, 12 July 2019 12:30 (15 minutes)

The E989 Muon g-2 Experiment has completed its first physics run and collected a dataset roughly two times larger than the previous Brookhaven experiment. With a target precision of 140 ppb, divided equally between statistics and systematics, E989 will achieve the most precise measurement to date of the muon’s anomalous magnetic moment and will thus be able to confirm or resolve the larger than 3 sigma discrepancy between theory and measurement on the muon anomaly $\amu = (g-2)/2$. The measurement requires extracting the muon anomalous precession frequency in a highly uniform magnetic field. Systematic effects originating both from storage ring beam dynamics and detector effects must be kept under control better than 100 ppb. This presentation will describe the analysis techniques as they are applied to data from the 2018 run and show blinded analysis results that demonstrate the quality of the data collected.

Primary author: INCAGLI, Marco (INFN Sezione di Pisa, Universita’ e Scuola Normale Superiore, P)

Presenter: INCAGLI, Marco (INFN Sezione di Pisa, Universita’ e Scuola Normale Superiore, P)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Operational Experience and Performance with the ATLAS Pixel detector at the Large Hadron Collider at CERN

Monday, 15 July 2019 19:40 (20 minutes)

ATLAS is one of the four major experiments at the Large Hadron Collider (LHC) at CERN. It is a general-purpose particle physics experiment run by an international collaboration and is designed to exploit the full discovery potential and the huge range of physics opportunities that the LHC provides.

The tracking performance of the ATLAS detector relies critically on its 4-layer Pixel Detector, located at the core the ATLAS tracker. The ATLAS pixel detector consists of four barrel layers and a total of six disk layers, three at each end of the barrel region. The four barrel layers are composed of n+-in-n planar oxygenated silicon sensors at 33, 50.5, 88.5, and 122.5 mm from the geometric center of the ATLAS detector. The sensors on the innermost barrel layer (the insertable B-layer or IBL) are 200 µm thick, while the sensors in the other layers are 250 µm thick. At both ends of the innermost barrel layer, there are n+-in-p 3D sensors that are 230 µm thick. The innermost barrel layer pixels pitch is 50 × 250 µm²; everywhere else the pixels pitch is 50 × 400 µm².

It has undergone significant hardware and readout upgrades to meet the challenges imposed by the higher collision energy, pileup and luminosity that are delivered by the Large Hadron Collider (LHC), with record breaking instantaneous luminosities of 2 × 10³⁴ cm⁻² s⁻¹ recently surpassed. The key status and performance metrics of the ATLAS Pixel Detector are summarised, and the operational experience and requirements to ensure optimum data quality and data taking efficiency will be described, with special emphasis to radiation damage experience.

By the end of the proton-proton collision runs in 2018, the IBL had received an integrated fluence of approximately Φ = 9 × 10¹⁴ 1 MeV neq/cm². The innermost of the three outer layers (B-layer) has been exposed to about half the fluence of the IBL, and lower fluences for other layers.

The ATLAS collaboration is continually evaluating the impact of radiation on the Pixel Detector. In particular, signs of degradation are visible but are not impacting yet the tracking performance (but will): a trend of decreasing charge collection, dE/dX, occupancy reduction with integrated luminosity, under-depletion effects with IBL, effects of annealing that are significant for the innermost layers.

A quantitative analysis of all these effects will be presented and discussed, as well as the operational issues and mitigation techniques adopted during the LHC run and the ones foreseen during the LHC Long Shutdown 2.

In addition, the strategy to contain the readout bandwidth limitation will be discussed, required by the LHC over-performing.

Primary authors: TRONCON, Clara (Milano Universita e INFN (IT)); CHU, Xiaotong (Chinese Academy of Sciences (CN))

Presenter: CHU, Xiaotong (Chinese Academy of Sciences (CN))

Session Classification: Wine & Cheese Poster Session
**Track Classification:** Detector R&D and Data Handling
Modeling Radiation Damage to Pixel Sensors in the ATLAS Detector

Thursday, 11 July 2019 17:45 (15 minutes)

Silicon pixel detectors are at the core of the current and planned upgrade of the ATLAS detector at the Large Hadron Collider (LHC). As the closest detector component to the interaction point, these detectors will be subjected to a significant amount of radiation over their lifetime: prior to the High-Luminosity LHC (HL-LHC), the innermost layers will receive a fluence in excess of $10^{15}$ neq/cm² and the HL-HLC detector upgrades must cope with an order of magnitude higher fluence integrated over their lifetimes. Simulating radiation damage is critical in order to make accurate predictions for current future detector performance that will enable searches for new particles and forces as well as precision measurements of Standard Model particles such as the Higgs boson. We present a digitization model that includes radiation damage effects to the ATLAS pixel sensors for the first time and considers both planar and 3D sensor designs. In addition to thoroughly describing the setup, we compare predictions for basic pixel cluster properties on leakage currents, depletion voltage, charge collection efficiency, Lorentz angle etc. with real data collected at LHC proton-proton collisions.

Primary authors: TRONCON, Clara (Milano Universita e INFN (IT)); ROSSINI, Lorenzo (Università degli Studi e INFN Milano (IT))

Presenter: ROSSINI, Lorenzo (Università degli Studi e INFN Milano (IT))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
Single Event Upsets in the ATLAS IBL Frontend ASICs at the Large Hadron Collider at CERN

Thursday, 11 July 2019 17:30 (15 minutes)

ATLAS is one of the four major experiments at the Large Hadron Collider (LHC) at CERN. The tracking performance of the ATLAS detector relies critically on its 4-layer Pixel Detector, located at the core the ATLAS tracker.

During operation at instantaneous luminosities of up to $2 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$ the frontend chips of the ATLAS innermost pixel layer (IBL) experienced single event upsets affecting its global registers as well as the settings for the individual pixels, causing, amongst other things loss of occupancy, noisy pixels, and silent pixels. A quantitative analysis of the single event upsets as well as the operational issues and mitigation techniques will be presented.

Primary authors: ATLAS COLLABORATION; TRONCON, Clara (Milano Universita e INFN (IT)); LIU, Peilian (Lawrence Berkeley National Lab. (US))

Presenter: LIU, Peilian (Lawrence Berkeley National Lab. (US))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
Three-loop soft anomalous dimensions for top-quark production

Thursday, 11 July 2019 11:30 (15 minutes)

I present results through three loops for soft anomalous dimensions that control soft-gluon emission in processes involving the top quark. In particular I present results for channels in single-top production and top-pair production as well as for processes with new physics, including $tZ$, $tZ'$, $t\gamma$, and $tH$-production. These calculations are ingredients to resummations at N3LL accuracy and to derivations of N3LO soft-gluon corrections.

Primary author: KIDONAKIS, Nikolaos (Kennesaw State University)
Presenter: KIDONAKIS, Nikolaos (Kennesaw State University)
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Simulation studies with the Gas Electron Multiplier (GEM) Foils & Detectors for the CMS muon system upgrade

Monday, 15 July 2019 19:40 (20 minutes)

The Gas Electron Multiplier (GEM) was first introduced by Fabio Sauli in 1997, which is a thin layer of an insulating polymer, coated on both sides with copper and chemically perforated with a high density of microscopic holes. The GEM detectors, which are built using GEM foils, have been utilized for various applications due to their excellent spatial resolution, high rate capabilities and flexibility in design. As this is comparatively new technology at the outset, we are performing simulation studies for R&D of GEM foils as well as GEM detectors. Large areas of GEM are foreseen in several experiments such as the future upgrade of the CMS muon detection system, where triple GEM based detectors will be installed and operated. Since a GEM foil is stretched while building a GEM detector, we check for any deformation in the perforated holes and change in operational characteristics caused due to stretching of the foil. Using Finite Element Analysis, stress-strain curves are obtained to estimate possible hole and shape deformation. Further studies are being performed corresponding to different operating conditions. All these studies are very useful for design and performance of next CMS muon endcap upgrade, namely GE2/1 & ME0, and will prove to be beneficial for future detector development and upgrade programs at LHC, CERN.

Primary authors:  MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE)); BOUHALI, Othmane (Texas A & M University (US))

Presenter:  BOUHALI, Othmane (Texas A & M University (US))

Session Classification:  Wine & Cheese Poster Session

Track Classification:  Detector R&D and Data Handling
Probing heavy quark dynamics in PbPb collisions with CMS

Thursday, 11 July 2019 17:24 (20 minutes)

Measurements of heavy flavour hadrons in PbPb collisions provide information about the heavy quark dynamics inside the quark-gluon plasma (QGP). Heavy quarks are sensitive to the transport properties of the medium and may interact with the QCD matter differently from light quarks. At low pT, heavy quarks provide a direct window on the in-medium QCD force. At high pT, the comparison of results for light and heavy particles provides insights into the expected flavor dependence of in-medium parton energy loss. Recently, the CMS collaboration established a comprehensive heavy flavor program in heavy ion collisions including the detection of charm and beauty mesons. Using the large statistics heavy ion data samples collected during LHC Run2, high precision open charm and beauty measurements are performed over a wide transverse momentum range. In this talk, the first measurement of the radial distributions of D0 mesons in jets in PbPb and pp collisions is presented, sensitive to the energy loss and diffusion of charm quarks in the QGP. Such effects for the bottom quarks are probed with the measurement of D0 mesons from b hadron decays in pp and PbPb collisions. In addition, the hadronisation of charm quarks and the importance of coalescence are constrained with the study of Lambda_c baryons in pp and PbPb collisions. Finally, results on Ds and Bs production are reported and compared to D0 and B+ production, respectively, with implications on the importance of the recombination mechanism due to strangeness enhancement.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: VERES, Gabor (Eotvos Lorand University (HU))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Top quark pair-production cross-section measurements with the ATLAS detector

Thursday, 11 July 2019 12:30 (15 minutes)

Measurements of the inclusive and differential top-quark pair production cross sections in proton-proton collisions at 13 TeV with the ATLAS detector at the Large Hadron Collider are presented. The inclusive measurements reach high precision and are compared to the best available theoretical calculations. Differential measurements of the kinematic properties of the top quark production are also discussed. These measurements, including results using boosted top quarks, probe our understanding of top-quark pair production in the TeV regime. The results, unfolded to particle and parton level, are compared to predictions of Monte Carlo generators implementing NLO matrix elements matched with parton showers and NNLO QCD theory calculations.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: FAUCCI GIANNELLI, Michele (University of Edinburgh)
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurement of $t\bar{t}$ with additional jets with the ATLAS detector

Measurements of the production cross-section of top-quark-antiquark pairs with additional jets provide important tests of quantum chromodynamics (QCD). The ATLAS experiment has measured several final state observables that are sensitive to additional radiation in top-quark-antiquark final states at 13 TeV. These measurements are compared to predictions of modern Monte Carlo generators based on NLO QCD matrix element or LO multi-leg matrix elements. The process of the production of jets originating from b-quarks (b-jets) associated top-q pair produced in association with is particularly important to measure, as there are many uncertainties in the calculation of the process due to the relevance of multiple energy scales. The ATLAS Collaboration has performed fiducial cross-section measurements in the dilepton and lepton-plus-jets $t\bar{t}$ decay channels. Results are presented at particle level in the form of inclusive cross-sections of $t\bar{t}$ final states with three and four b-jets as well as differential cross-sections as a function of global event properties and properties of b-jet pairs.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: THEVENEAUX-PELZER, Timothee (Deutsches Elektronen-Synchrotron (DE))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurements of \( \text{ttbar} \) pairs produced in association with electroweak gauge bosons using the ATLAS detector

Friday, 12 July 2019 09:30 (15 minutes)

The large centre-of-mass energy available at the proton-proton collider LHC allows for the copious production of top-quark-antiquark pairs in association with electroweak gauge bosons (W / Z / gamma) at high transverse momenta. The \( \text{tt} \overline{Z} \) and \( \text{tt} \overline{W} \) production cross sections are simultaneously measured using a combined fit in several analysis regions. The measurement of the \( \text{tt} \overline{Z} \) cross section is used to set constraints on effective field theory operators which modify the \( \text{tt} \overline{Z} \) vertex. The \( \text{tt}\gamma \) measurements are performed in single-lepton and dilepton final states in a fiducial volume. The differential cross-sections are measured as a function of several photon kinematic variables.

**Primary author:** JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

**Presenter:** LOPEZ SOLIS, Alvaro (University of Sheffield (GB))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Top quark pair property measurements using the ATLAS detector at the LHC

Thursday, 11 July 2019 10:30 (15 minutes)

Precise measurements of the properties of the top quark test the Standard Model (SM) and can be used to constrain new physics models. The top-quark is predicted in the SM to decay almost exclusively into a W boson and a b-quark. We present a wide range of searches for non-SM top quark decays using the 13 TeV ATLAS datasets, including $t \rightarrow q H$ and $t \rightarrow q Z$. In addition, measurements of the spin correlation and colour flow in $t \bar{t}$ production are also presented.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: HOWARTH, James William (University of Manchester (GB))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurements of the top quark mass using the ATLAS detector at the LHC

Thursday, 11 July 2019 10:45 (15 minutes)

The latest measurements of the top quark mass using the ATLAS experiment are presented. A measurement based on a multi-dimensional template fit that can constrain the uncertainties on the energy measurements of jets is presented and combined with measurements using dilepton and all-hadronic events. In addition, an analysis of the top quark mass using leptonic kinematic variables is discussed. The measurement uses a novel technique to measure the top quark mass with minimal dependence on hadronic jets. The measurements that use precision theoretical QCD calculations for both inclusive ttbar production and ttbar production with an additional jet to extract the top quark mass in the pole-mass scheme are also presented.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: KNUE, Andrea Helen (Albert-Ludwigs-Universitaet Freiburg (DE))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Single-top-quark production cross section using the ATLAS detector at the LHC

*Thursday, 11 July 2019 12:45 (15 minutes)*

Measurements of single-top-quark production in proton-proton collisions are presented based on the 8 TeV and 13 TeV ATLAS datasets. The recent combination of the ATLAS and CMS Run 1 single-top-quark measurements is discussed. This combination leads to the most precise direct measurement of the CKM-matrix element Vtb. An interesting quantum effect is the interference of tW and top-quark-pair production which is studied in a dedicated analysis. Differential cross-sections of the tW process have also been measured. The large Run 2 data set gives also access to rare single-top-quark processes, such as tZ production. The latest results on this production mode will be reviewed.

**Primary author:** JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

**Presenter:** ALHROOB, Muhammad (University of Oklahoma (US))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Fine-tuning arguments suggest the mass of the supersymmetric partner of the Higgs boson, the higgsino, is not too far from the weak scale. The search for higgsinos represents an experimental challenge due to the near mass-degeneracy resulting in soft decay products, and the low production cross section. This talk presents recent ATLAS results of analyses explicitly targeting the higgsino with a variety of experimental techniques, as well as searches for electroweak production of supersymmetric particles in final states involving the Higgs boson.

**Primary author:** JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

**Presenter:** ALONSO, Francisco (National University of La Plata (AR))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Searches for charginos, neutralinos and sleptons with the ATLAS detector

Thursday, 11 July 2019 10:00 (15 minutes)

Many supersymmetry models feature gauginos and sleptons with masses less than a few hundred GeV. These can give rise to direct pair production rates at the LHC that can be observed in the data sample recorded by the ATLAS detector. The talk presents recent ATLAS results from searches for pair produced charginos and neutralinos or sleptons in final states with leptons (including hadronic taus) and missing transverse momentum.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: WILLIAMS, Sarah Louise (University of Cambridge (GB))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Searches for promptly decaying squarks and gluinos with ATLAS

Thursday, 11 July 2019 09:15 (15 minutes)

Despite the absence of experimental evidence, weak-scale supersymmetry remains one of the best motivated and studied Standard Model extensions. This talk summarizes recent ATLAS results on inclusive searches for supersymmetric squarks of the first two generations and gluinos. It covers both R-parity conserving models that predict dark matter candidates and R-parity violating models that typically lead to high-multiplicity final states without large missing transverse momentum. The searches target final states including jets, leptons, photons, and missing transverse momentum.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: MAKOVEC, Nikola (LAL-Orsay (FR))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Searches for supersymmetric particles with macroscopic or stable lifetimes using the ATLAS detector

Friday, 12 July 2019 15:30 (15 minutes)

Supersymmetric models present a wide variety of signatures that might be accessible at the LHC. In some cases supersymmetric particles may acquire finite lifetimes, and once produced in collisions, their direct trajectories or decay products can be observed as highly distinctive signatures with relatively small backgrounds. In recent years, the capability of the ATLAS experiment to search for such long-lived supersymmetric particles has been expanded, as these scenarios have been capturing more attention. The latest results of these searches will be presented in this talk.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

Presenter: OHM, Christian (KTH Royal Institute of Technology (SE))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Searches for direct pair production of third generation squarks with the ATLAS detector

Thursday, 11 July 2019 10:45 (15 minutes)

Naturalness arguments for weak-scale supersymmetry favour supersymmetric partners of the third generation quarks with masses light enough to be produced at the LHC. The ATLAS experiment has a variety of analyses devoted to stop direct production exploiting advanced analysis techniques. This talk presents recent results of searches for stops and sbottoms, including models with long decay chains involving Higgs and/or Z bosons, and their interpretation in associated-production DM models.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: YOSHIHARA, Keisuke (University of Pennsylvania (US))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Reconstruction techniques in supersymmetry searches in the ATLAS experiment

Monday, 15 July 2019 18:30 (1h 30m)

Many supersymmetric scenarios feature final states with non-standard final state objects. The production of massive sparticles can lead to the production of boosted top quarks or vector bosons, high-pt b-jets. At the same time, transitions between nearly mass-degenerate sparticles can challenge the standard reconstruction because of the presence of very soft leptons or jets (including the flavour tagging of very soft jets). The talk will review the application of innovative reconstruction techniques to supersymmetry searches in ATLAS.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: AKATSUKA, Shunichi (Kyoto University (JP))
Session Classification: Wine & Cheese Poster Session

Track Classification: Searches for New Physics
Search for chargino and neutralino production in final states with one lepton, a Higgs boson and missing transverse momentum with the ATLAS detector

Supersymmetry is a promising extension of the Standard Model of Particle Physics (SM) as it provides a solution to some of the open questions of the SM. If squarks and gluinos are beyond the reach of the LHC, the production of charginos and neutralinos could be the dominant production mode of supersymmetric particles in $\sqrt{s}=13$ TeV proton-proton collisions at the LHC. A search for electroweak production of supersymmetric particles, using 139 fb$^{-1}$ of proton-proton collisions recorded from 2015 to 2018 by the ATLAS detector, is presented. In the signal scenario considered, a chargino $\tilde{\chi}^\pm_1$ is produced together with a next-to-lightest neutralino $\tilde{\chi}^0_2$. The chargino decays via $\tilde{\chi}^\pm_1 \rightarrow W^\pm \tilde{\chi}^0_2$ while the neutralino decays through $\tilde{\chi}^0_2 \rightarrow h\tilde{\chi}^0_2$. The final state of this signal scenario can thus in many cases be characterised by the presence of two $b$-jets from the Higgs decay, missing transverse momentum and exactly one lepton from $W^\pm \rightarrow l^\pm \nu$, providing high discrimination against SM background. In this work, the analysis strategy is introduced, exploiting the varying shapes of signal and background distributions in a two-dimensional shape fit and estimating the SM background through semi-data-driven techniques. Finally, the results of the search are presented and discussed.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: Mr SCHANET, Eric (Ludwig Maximilians Universitat (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Search for the strong pair production of squarks and gluinos in events with an isolated lepton, jets and missing transverse momentum at $\sqrt{s} = 13$ TeV with the ATLAS detector

This poster presents the search for the strong pair production of squarks and gluinos in events with one isolated lepton, jets and missing transverse momentum in the final state. In this analysis, strongly interacting supersymmetric particles are assumed to decay into charginos $\tilde{\chi}^\pm_1$ and light quarks, and each chargino subsequently decays into a $W$ boson and the lightest neutralino $\tilde{\chi}^0_1$. The analyzed ATLAS data from 2015 to 2018 corresponds to a total integrated luminosity of 139 fb$^{-1}$ of proton-proton collisions at $\sqrt{s} = 13$ TeV. The general description of the targeted signal models, expected background processes and an overview of the analysis strategy is shown. In the context of this model, a statistical interpretation of the observed data is provided and the exclusion limits on the squarks/gluinos, chargino and lightest neutralino masses are illustrated in two benchmark scenarios.

**Primary author:** JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

**Presenter:** GEANTA, Andrei Alexandru (IFIN-HH (RO))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
Search for squarks and gluinos in final states with jets and missing transverse momentum using 139 fb-1 of \( \sqrt{s} = 13 \) TeV pp collision data with the ATLAS detector

Monday, 15 July 2019 18:30 (1h 30m)

A search for the supersymmetric partners of quarks and gluons (squarks and gluinos) in final states containing hadronic jets and missing transverse momentum, but no electrons or muons, is presented. Two analysis techniques, the multi-bin fit and multi-variate analysis, are newly introduced in order to further discriminate target signals and backgrounds. Starting from the definition of the analysis methods, recent ATLAS results obtained with these techniques using the full Run 2 dataset corresponding to 139 fb-1 are shown.

**Primary author:** JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

**Presenter:** AGAPOPOULOU, Christina (Centre National de la Recherche Scientifique (FR))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
Search for compressed top squarks with one lepton final state in $\sqrt{s}=13$ TeV pp collisions with the ATLAS detector

Monday, 15 July 2019 18:30 (1h 30m)

Natural supersymmetry suggests a light top squark (t1), possibly within the discovery reach of Run 2 of the LHC. This poster presents the latest result of an analysis targeting a compressed region of the stop phase space where the mass difference between the stop and the lightest neutralino ($\tilde{\chi}_0^1$) is smaller than the top-quark mass, using pp collision data collected over the full Run-2 of the LHC. A machine learning technique was employed in the analysis to improve the discrimination of signals from backgrounds dominated by the $t\bar{t}$ process.

Primary author:  JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: ARRUBARRENA TAME, Zulit Paola (Ludwig Maximilians Universitat (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Searches for high-mass resonances decaying into leptonic final states using the ATLAS detector

Thursday, 11 July 2019 15:30 (15 minutes)

Many theories beyond the Standard Model predict new phenomena which decay to well isolated, high-pt leptons. Searches for new physics models with these signatures are performed using the ATLAS experiment at the LHC. The results reported here use 13 TeV pp collision data; prospects for HL-LHC will also be shown.

Primary author:  JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter:  TAKUBO, Yosuke (High Energy Accelerator Research Organization (JP))
Session Classification:  Searches for New Physics
Track Classification:  Searches for New Physics
Search for resonances in hadronic final states with the ATLAS detector

Thursday, 11 July 2019 17:00 (15 minutes)

Many theories beyond the Standard Model predict new phenomena which decay to quarks. Light-quarks are of particular interest at the LHC since new phenomena produced in parton collisions are likely to produce final states with (at least) two partons. On the other hand, b- and top-quarks offer great potential to reduce the Standard Model background, although with significant challenges in reconstructing and identifying the decay products and modelling the remaining background. Recent searches in various hadronic final states performed with the ATLAS experiment at the LHC on the 13 TeV data will be presented, along with some prospects for HL-LHC.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: DATTAGUPTA, Aparajita (University of Oregon (US))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
The presence of a non-baryonic dark matter (DM) component in the Universe is inferred from the observation of its gravitational interaction. If dark matter interacts weakly with the Standard Model (SM) it could be produced at the LHC. The ATLAS experiment has developed a broad search program for DM candidates. The results of recent searches on 13 TeV pp data, their interplay and interpretation will be presented, including in particular the recent interpretation in the context of a 2HDM+pseudoscalar model. Prospects for HL-LHC will also be discussed.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

Presenter: RIFKI, Othmane (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Dark Matter

Track Classification: Dark Matter
Searches for new phenomena in final states involving leptons and jets using the ATLAS detector

Thursday, 11 July 2019 14:45 (15 minutes)

Many theories beyond the Standard Model predict new phenomena which decay to final states containing both leptons and jets. Searches for new physics models with these signatures are performed using the ATLAS experiment at the LHC. The results of the most recent searches on 13 TeV pp data will be presented.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: MILIC, Adriana (University of Toronto (CA))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Search for BSM physics using challenging signatures with the ATLAS detector

Friday, 12 July 2019 09:45 (15 minutes)

Many theories beyond the Standard Model (BSM) predict unique signatures which are difficult to reconstruct and for which estimating the background rates is also a challenge. Signatures of new particles with fractional or multiple value of the charge of the electron or high mass stable charged particles are examples of experimentally demanding signatures. The talk will focus on the most recent results using 13 TeV pp collision data collected by the ATLAS detector.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: TORRO PASTOR, Emma (University of Washington (US))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
The production of a top quark in association with a W boson (tW) is one of the single top processes that takes place at LHC. The interest of this production relies on the quantum interference at NLO with the top-antitop pair production: one of the most relevant processes in the LHC. The measurements of the tW production cross section using data collected by CMS at 13 TeV are presented.

The results are confronted with precise theory calculations.

Primary authors: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE)); Mr RODRIGUEZ BOUZA, Victor (Universidad de Oviedo (ES))

Presenter: Mr RODRIGUEZ BOUZA, Victor (Universidad de Oviedo (ES))

Session Classification: Wine & Cheese Poster Session

Track Classification: Top and Electroweak Physics
Measurement of the ttbb production cross section in the all-jet final state with CMS

Monday, 15 July 2019 18:30 (1h 30m)

We present a measurement of the ttbb cross section, using data collected in pp collisions at $\sqrt{s} = 13$ TeV by the CMS experiment at the LHC corresponding to an integrated luminosity of 35.9 fb$^{-1}$. The cross section is measured in the all-jet decay channel of the top quark pairs by selecting events containing at least eight jets, of which two are identified as b jets. A combination of multivariate analysis techniques is used to reduce the large background consisting uniquely of jets produced through the strong interaction, and to discriminate the jets originating from the top quark decays and additional jets. The cross section is measured for the visible ttbb phase space, as well as for the full phase space. The measured cross sections are compared with predictions of several event generators and are found to be generally higher than the theoretical predictions. This measurement provides valuable input to studies of the ttH and four top quark processes, for which the normalisation and modelling of the ttbb process represents a leading source of systematic uncertainty. Furthermore, these results represent a stringent test for perturbative QCD predictions at the LHC.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: WERTZ, Sebastien (Universitaet Zuerich (CH))
Session Classification: Wine & Cheese Poster Session
Track Classification: Top and Electroweak Physics
Single top quark production and CKM matrix elements measurements with CMS

Monday, 15 July 2019 18:30 (1h 30m)

The study of single top quark inclusive production provides important insight into the electroweak processes of the standard model of elementary particles and into the structure of the proton. It also enables a direct measurement of the magnitude of the Cabibbo–Kobayashi–Maskawa (CKM) matrix elements. Among the production channels, the t-channel process is the dominant mechanism in proton-proton collisions at the CERN LHC accounting for approximately 70% of the total single top quark production cross section at center-of-mass energy of 13 TeV. The state of the art of on single top quark t-channel measurements performed by the CMS experiment, and their impact on our knowledge of the CKM matrix elements and top quark couplings will be presented.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: DE IORIO, Agostino (Universita e sezione INFN di Napoli (IT))
Session Classification: Wine & Cheese Poster Session
Track Classification: Top and Electroweak Physics
Effects of saturation in high-multiplicity pp collisions

Saturday, 13 July 2019 11:30 (15 minutes)

Coherence leads to $p_T$ broadening of partons in high-multiplicity events, which is a manifestation of the effect of parton saturation. Appearance of the saturation scale generates via DGLAP evolution an enhancement of low-$x$ gluons. Mutual enhancement of low-$x$ gluons in both colliding hadrons (pp, AA) results in an even stronger boost of the saturation scales. This explains the observed steep rise of the $J/\psi$ production rate vs hadron multiplicity in pp collisions.

Primary author: KOPELIOVICH, Boris (UTFSM)
Presenter: KOPELIOVICH, Boris (UTFSM)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Breakdown of QCD factorization in hard diffraction

Monday, 15 July 2019 18:30 (1h 30m)

Factorization of short and long-distance interactions is heavily broken in hard diffractive hadronic collisions. In particular, abelian forward diffractive radiation of direct photons, Drell-Yan dileptons, and gauge bosons Z, W, by a parton is forbidden. Nevertheless, a hadron can diffractively radiate in the forward direction due to a possibility of soft interaction with the spectators. This property of abelian radiation breaks down diffractive factorization resulting in a leading twist dependence on the boson mass, $1/M^2$.

Non-abelian forward diffractive radiation of heavy flavors, diffractive di-jets and diffractive Higgstrahlung are permitted even for an isolated parton. However, interaction with spectators provides the dominant contribution to the cross section. Hard diffraction turns out to be semi-hard, semisoft. It comes from the interplay between large and small distances. Data well confirm the leading twist behavior. Diffractive Higgs production is found to be dominated by coalescence of intrinsic heavy quarks in the proton.

Primary author: KOPELIOVICH, Boris (UTFSM)
Presenter: KOPELIOVICH, Boris (UTFSM)
Session Classification: Wine & Cheese Poster Session
Track Classification: QCD and Hadronic Physics
Universality of high-$p_T$ hadron suppression in AA collisions

Quenching of high-$p_T$ hadrons observed in AA collisions is controlled by color transparency, rather than by induced energy loss. This mechanism leads to universality of nuclear suppression, which is confirmed by data for light, light-heavy mesons, heavy quarkonia and even high-$p_T$ protons. Nevertheless, for heavy flavored mesons energy loss turns out to be important, but not the one induced by the dense medium, but vacuum energy loss, i.e. the same as in pp collisions.

**Primary author:** KOPELIOVICH, Boris (UTFSM)

**Presenter:** KOPELIOVICH, Boris (UTFSM)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Heavy Ion Physics
A discovery of neutrinoless double beta ($0\nu\beta\beta$) decay would establish neutrinos as Majorana fermions and imply a violation of lepton number conservation. The GERDA collaboration searches for $0\nu\beta\beta$ decay by operating germanium detectors enriched in $^{76}\text{Ge}$ in a cryostat filled with liquid argon. Instrumenting the cryostat with photosensors to enable read out of scintillation light from the argon, an unprecedented low background in the region of interest is reached, rendering the experiment effectively background free up to its design exposure of 100 kg yr. With the latest data release in mid 2018, GERDA was the first experiment to surpass a half-life sensitivity of $10^{26}$ yr for $0\nu\beta\beta$ decay. The experiment was recently upgraded, deploying a new type of germanium detector and improving the liquid argon instrumentation for the last stretch of its runtime until the end of 2019.

We will summarize the latest results and report on the performance since the upgrade.

**Primary author:** Dr HILLER, Roman (for the GERDA collaboration)

**Presenter:** Dr HILLER, Roman (for the GERDA collaboration)

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
The KM3NeT project: status and future perspectives

Friday, 12 July 2019 16:50 (20 minutes)

The KM3NeT Collaboration is constructing a multi-site research infrastructure in the Mediterranean Sea, hosting the next generation underwater neutrino observatory. The infrastructure will host two neutrino detectors: ORCA, offshore Toulon (France) at a depth of 2500 m, and ARCA, offshore Capo Passero (Italy) at a depth of 3500 m. ORCA will be a Mton scale detector, optimized to detect neutrinos of tens of GeV. It will be dedicated to study neutrino oscillations aiming in particular at determining the mass hierarchy. ARCA will be the km3-scale neutrino telescope in the Northern hemisphere, dedicated to search for astrophysical neutrino sources in the TeV-PeV range. Its location will allow surveying a large part of the sky, including most of the Galactic Plane and the Galactic Centre. The first detection units were deployed and the data analysis is ongoing to validate performances of both the detectors. In this talk we will give a general overview of the project, reporting its present status and the future perspectives.

Primary author: Dr DISTEFANO, Carla (LNS-INFN)
Presenter: Dr DISTEFANO, Carla (LNS-INFN)
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Interaction-point stabilisation of beams to the nanometer level for future high-energy electron-positron colliders

Monday, 15 July 2019 18:30 (1h 30m)

In order to achieve high luminosity, next-generation high-energy electron-positron colliders demand beam overlap at the interaction point to the nanometer level. The design of low-latency, high-bandwidth beam-collision feedback systems will be presented. The latest experimental results of prototype systems tested with beam at the KEK/ATF2 will be shown. The performances achieved with the prototype systems have been implemented in start-to-end simulations of beam transport and luminosity production at the proposed future linear colliders ILC and CLIC. Simulation results will be presented that demonstrate that the feedback systems enable the challenging design luminosity of these future colliders to be met.

Primary author: Prof. BURROWS, Philip Nicholas (University of Oxford (GB))
Presenter: Prof. BURROWS, Philip Nicholas (University of Oxford (GB))
Session Classification: Wine & Cheese Poster Session
Track Classification: Accelerators for HEP
The constituents of dark matter are still unknown, and the viable possibilities span a very large mass range. Specific scenarios for the origin of dark matter sharpen the focus on a narrower range of masses: the natural scenario where dark matter originates from thermal contact with familiar matter in the early Universe requires the DM mass to lie within about an MeV to 100 TeV. Considerable experimental attention has been given to exploring Weakly Interacting Massive Particles in the upper end of this range (few GeV – TeV), while the region ~MeV to ~GeV is largely unexplored. Most of the stable constituents of known matter have masses in this lower range, tantalizing hints for physics beyond the Standard Model have been found here, and a thermal origin for dark matter works in a simple and predictive manner in this mass range as well. It is therefore a priority to explore. If there is an interaction between light DM and ordinary matter, as there must be in the case of a thermal origin, then there necessarily is a production mechanism in accelerator-based experiments. The most sensitive way, (if the interaction is not electron-phobic) to search for this production is to use a primary electron beam to produce DM in fixed-target collisions. The Light Dark Matter eXperiment (LDMX) is a planned electron-beam fixed-target missing-momentum experiment that has unique sensitivity to light DM in the sub-GeV range. This contribution will give an overview of the theoretical motivation, the main experimental challenges and how they are addressed, as well as projected sensitivities in comparison to other experiments.

**Primary authors:** GROUP, Robert (University of Virginia); DUTTA, Valentina (Univ. of California Santa Barbara (US))

**Presenter:** DUTTA, Valentina (Univ. of California Santa Barbara (US))

**Session Classification:** Dark Matter

**Track Classification:** Dark Matter
I review the experimental indications in favor of short-baseline neutrino oscillations and discuss their interpretation in the framework of 3+1 neutrino mixing with a sterile neutrino at the eV scale. I show that the recent results of the NEOS and DANSS reactor neutrino experiments give a model-independent indication in favor of short-baseline electron antineutrino disappearance, in partial agreement with the reactor and Gallium anomalies. On the other hand, the recent results of the MINOS+ experiment disfavor the LSND anomaly. I also discuss the interpretation of the Daya Bay fuel evolution data.

**Primary author:** Dr GIUNTI, Carlo (INFN)

**Presenter:** Dr GIUNTI, Carlo (INFN)

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
In this talk, I will review the current status of the searches for neutrino non-standard interactions. I will present the current constraints on the size of these exotic processes obtained from different types of neutrino sources. The interpretation of these results in terms of a consistent particle physics model will also be addressed. Finally, I will discuss the prospects to get more precise measurements in the future neutrino experiments.

**Primary author:** Dr TÓRTOLA, Mariam (IFIC, Valencia University/CSIC)

**Presenter:** Dr TÓRTOLA, Mariam (IFIC, Valencia University/CSIC)

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
Thermal radiation and inclusive production in the CGC/saturation approach at high energies

Monday, 15 July 2019 19:40 (20 minutes)

In this talk, we discuss the inclusive production of hadrons in the framework of the CGC/saturation approach. We argue, that gluon jet inclusive production stems from the vicinity of the saturation momentum, even for small values of the transverse momenta $p_T$. Since in this region, we theoretically, know the scattering amplitude, we claim that we can provide reliable estimates for this process. We demonstrate, that in a widely accepted model for confinement, we require a thermal radiation term to describe the experimental data. In this model the parton (quark or gluon) with the transverse momenta of the order of $Q_s$ decays into hadrons with the given fragmentation functions, and the production of the hadron with small transverse momenta is suppressed by the mass of the gluon jet. In addition we show that other approaches for confinement, also describe the data, without the need for thermal emission.

Primary authors: Prof. LEVIN, Eugene (Tel Aviv University/UTFSM); Prof. GOTSMAN, Errol (Tel Aviv University)

Presenter: Prof. LEVIN, Eugene (Tel Aviv University/UTFSM)

Session Classification: Wine & Cheese Poster Session

Track Classification: Heavy Ion Physics
In this paper we discuss the inclusive $J/\psi$ production in proton-proton collisions accompanied by production of two parton showers. We demonstrate that this mechanism gets dominant contribution from the region which can be theoretically described by CGC/Saturation approach. Numerically, it gives a substantial contribution to the $J/\psi$ production, and is able to describe the experimentally observable shapes of the rapidity, momenta and multiplicity distributions. The latter fact provides a natural explanation of the experimentally observed enhancement of multiplicity distribution in $J/\psi$ production.

**Primary author:** Prof. LEVIN, Eugene (Tel Aviv University/UTFSM)

**Presenter:** Prof. LEVIN, Eugene (Tel Aviv University/UTFSM)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** QCD and Hadronic Physics
Characterization of large-size diamond sensors for medical and nuclear applications

Monday, 15 July 2019 19:40 (20 minutes)

For several years, LPSC Grenoble and collaborators have been studying the particle detection performance of large-size diamond sensors with the prospect of using them in medical or nuclear applications. CVD single & poly crystals as long as heteroepitaxial sensors have been exposed to beta and alpha particles, to 8.5 keV x-ray bunches at ESRF, to fission products at ILL, to protons at ARRONAX and CAL and carbon ions at GANIL. They were also scanned with an EBIC setup at Institut Néel in order to draw a 2D map of their response. The charge collection, time and energy performance has been measured. A summary of the results will be presented together with a prospect for the targeted applications.

Primary author: COLLOT, Johann (university Grenoble Alpes (FR))

Co-authors: GHIMOUZ, Abderrahmane (LPSC, université Grenoble Alpes, CNRS/IN2P3); Dr BES, Alexandre (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Prof. LACOSTE, Ana (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr SAGE, Christophe (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr DAUVERGNE, Denis (LPSC, CNRS/IN2P3- Grenoble University); RARBI, Fatah Ellah (Centre National de la Recherche Scientifique (FR)); BOSSON, Germain (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr KESSEDJIAN, Grégoire (LPSC, Université Grenoble Alpes, CNRS/IN2P3); MURAZ, Jean-François (Centre National de la Recherche Scientifique (FR)); Dr ADAM, Jean-François (RSM, Université Grenoble Alpes); Dr MOTTE, Jean-François (Institut Néel); HOSTACHY, Jean-Yves; ABBASSI, Latifa (Centre National de la Recherche Scientifique (FR)); GALLIN-MARTEL, Laurent (LPSC/IN2P3 Grenoble); TRIBOUILLO, Lucas (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr ISKRA, Lukasz (Institute of Nuclear Physics, Polish Academy of Sciences); YAMOUNI, Mahfoud (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr JASTRZAB, Marcin (Institute of Nuclear Physics, Polish Academy of Sciences); GALLIN-MARTEL, Marie-Laure (LPSC Laboratoire de Physique Subatomique et de Cosmologie (LPSC)); Dr FONTANA, Mattia (IPNL, Université de Lyon, Université Lyon 1, CNRS/IN2P3); Prof. RAMDHANE, Mourad (LPSC, Université Grenoble Alpes, CNRS/IN2P3; Dr SALOMÉ, Murielle (ESRF); ROSUEL, Nicolas (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr ROSSETTO, Olivier (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr MARCATILI, Sara (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr BRAMBILLA, Sergio (INFN Milano); CURTONI, Sébastien (LPSC, Université Grenoble Alpes, CNRS/IN2P3); Dr CROZES, Thierry (Institut Néel); KOESTER, Ulli (Institut Laue-Langevin (FR)); Dr DE NOLF, Wout (ESRF); Dr KIM, Yung Hee (ILL); Dr TESTA, Étienne (IPNL, Université de Lyon, Université Lyon 1, CNRS/IN2P3)

Presenter: COLLOT, Johann (university Grenoble Alpes (FR))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
The Deep Underground Neutrino Experiment (DUNE) is a dual-site experiment for long baseline neutrino oscillation studies, and for neutrino astrophysics and nucleon decay searches. DUNE will comprise four 10 kton fiducial liquid argon time-projection-chamber (LAr TPC) modules placed at the Sanford Underground Research Facility (South Dakota, USA). One of these modules will profit from the dual phase (DP) technology where the charge is extracted, amplified, and detected in gaseous argon above the liquid surface allowing a fine readout pitch, a low energy threshold, and good pattern reconstruction of the events. To gain experience in building and operating such a large-scale DP LAr detector, a prototype is currently being assembled at the CERN Neutrino Platform. The ProtoDUNE-DP detector consists of a 6x6x6 m³ LAr TPC and commissioning will start in Summer 2019. An overview of the status and progress of ProtoDUNE-DP will be addressed in this talk.
Supernova Neutrino Detection at the Deep Underground Neutrino Experiment

Monday, 15 July 2019 18:30 (1h 30m)

The Deep Underground Neutrino Experiment (DUNE) is a dual-site experiment for long-baseline neutrino oscillation studies, and for neutrino astrophysics and nucleon decay searches. The Far Detector of DUNE will consist of four 10-kt liquid argon time-projection-chambers (LAr TPC) placed in the Sanford Underground Research Facility (SURF) at 1300 km distance from the neutrino beam. The underground location of the Far Detector, at 4300 m.w.e. depth, is essential to be able to study rare and low-energy processes. DUNE will have a unique sensitivity to the electron flavor component of the core collapse of a massive star. With a large mass DUNE will be able to detect core collapse events in the Milky Way and its neighborhood. The talk will cover the recent progress on detection and reconstruction of supernova burst neutrinos in DUNE, including the contribution of the light detection system.

Primary author: GALLEGOS ROS, Ana (Centro de Investigaciones Energéticas Medioambientales y Tecno)

Presenter: GALLEGOS ROS, Ana (Centro de Investigaciones Energéticas Medioambientales y Tecno)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Testing the waters for the DUNE experiment

Friday, 12 July 2019 10:25 (20 minutes)

The huge size of the liquid argon based Deep Underground Neutrino Experiment (DUNE) has motivated efforts to validate its technology at its full scale, in the form of the ProtoDUNE setups at CERN. The 770-ton Single-Phase ProtoDUNE setup was constructed in about two years, and successfully took beam data in late 2018, just before the shutdown of the CERN accelerator complex. A grand total of over four million triggers were collected, for a variety of beam particle optimisations (protons, pions, positrons, kaons), and with beam energies in the 300 MeV to 7 GeV range as appropriate for the neutrino oscillation programme driving the DUNE design.

We will discuss the experience gained from constructing and operating the ProtoDUNE-SP detector, as well as the effort to overcome the specific problem of electric field distortions, introduced by the slow ion signal caused by the many cosmic-ray particles traversing the detector.

The collected data are invaluable to develop the reconstruction and calibration strategies for DUNE, and we will describe the status of the experiment and the energy calibration results obtained to date.

Primary author: FILTHAUT, Frank (Radboud University and Nikhef, Nijmegen (NL))

Presenter: FILTHAUT, Frank (Radboud University and Nikhef, Nijmegen (NL))

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Performance of the Muon identification and isolation efficiencies for Run II using CMS Experiment

*Monday, 15 July 2019 19:40 (20 minutes)*

The identification and isolation strategies to discriminate prompt muons from background, and their performance with 13 TeV data collected with the CMS experiment are shown. This poster will present main studies concerning muon performance of the CMS muon detector and muon reconstruction with proton-proton collisions in Run II.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** FONSECA DE SOUZA, Sandro (Universidade do Estado do Rio de Janeiro (BR))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
The Data Quality Monitoring and Data Certification for the CMS experiment at the LHC

Monday, 15 July 2019 19:40 (20 minutes)

The Data Quality Monitoring (DQM) Software is a central tool in the CMS experiment, used from the online monitoring of detector performance to the offline Data Certification for physics analysis. In this presentation, the current DQM Software, Structure and Workflow, and the Data Certification (DC) Procedure used for Run2 are described. Then, the performance and experiences with the DQM-DC system are discussed. The LHC has just entered in the Long Shutdown 2 period during which various improvements to the DQM-DC system for Run3 have been planned. Some details on the future DQM-DC upgrade are described.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: KALSI, Amandeep Kaur (Universite Libre de Bruxelles (BE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Discrimination between prompt and long-lived particles using convolutional neural network

Monday, 15 July 2019 18:30 (1h 30m)

Sophisticated machine learning techniques, like computer vision, are state of the art in modern day research. These technologically advanced algorithms have promising potential in search for physics beyond Standard Model in Large Hadron Collider (LHC). Most of the computer vision tasks are surrounded around convolutional neural networks (CNN), which can provide powerful tools for differentiating between patterns of calorimeter energy deposits by prompt particles of Standard Model and long-lived particles predicted in various models beyond the Standard Model. We demonstrate the usefulness of CNN by using a couple of physics examples from well motivated BSM scenarios predicting long-lived particles giving rise to displaced jets. Our work suggests that modern machine-learning techniques have potential to discriminate between energy deposition patterns of prompt and long-lived particles, and thus, they can be useful tools in such searches.

Primary authors: Dr MUKHERJEE, Swagata (Rheinisch Westfaelische Tech. Hoch. (DE)); Dr BHATTACHERJEE, Biplob (Indian Institute of Science); Ms SENGUPTA, Rhitaja (Indian Institute of Science)

Presenter: Dr MUKHERJEE, Swagata (Rheinisch Westfaelische Tech. Hoch. (DE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Searches for New Physics
QCD evolution based evidence for the onset of gluon saturation in exclusive photo-production of vector mesons

Monday, 15 July 2019 18:30 (1h 30m)

We investigate photo-production of vector mesons J/Psi and Upsilon measured both at HERA and LHC, using 2 particular fits of inclusive unintegrated gluon distributions. The fits are based on non-linear Balitsky-Kovchegov evolution (Kutak-Sapeta gluon; KS) and next-to-leading order Balitsky-Fadin-Kuraev-Lipatov evolution (Hentschinski-Sabio Vera-Salas gluon; HSS). We find that linear next-to-leading order evolution can only describe production at highest energies, if perturbative corrections are increased to unnaturally large values; rendering this corrections to a perturbative size, the growth with energy is too strong and the description fails. At the same time, the KS gluon, which we explore both with and without non-linear corrections, requires the latter to achieve an accurate description of the energy dependence of data. We interpret this observation as a clear signal for the presence of high gluon densities in the proton, characteristic for the onset of gluon saturation.

Primary authors: HENTSCHINSKI, Martin (Universidad de las Americas, Puebla); KUTAK, Krzysztof (Instytut Fizyki Jadrowej Polskiej Akademii Nauk); Mr ARROYO GARCIA, Alfredo (Universidad de las Americas)

Presenter: HENTSCHINSKI, Martin (Universidad de las Americas, Puebla)

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
Physics at FCC-ee

Thursday, 11 July 2019 16:30 (30 minutes)

The future circular collider (FCC) study released a conceptual design report (CDR) in January 2019. An electron machine is considered as a first step (FCC-ee) with up to four detectors. FCC-ee is capable of very high luminosities in a wide center-of-mass (ECM) spectrum from 90 to 365 GeV. FCC-ee provides a clean experimental environment, produces high luminosity for precision measurements of the Higgs boson, W and Z bosons, and the top-quark. Precision searches will test the consistency of the Standard Model and push the sensitivity to new physics at high scales.

Primary author: KLUTE, Markus (Massachusetts Inst. of Technology (US))
Presenter: LESIAK, Tadeusz (Polish Academy of Sciences (PL))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Higgs measurements at the FCC-ee

*Thursday, 11 July 2019 12:45 (15 minutes)*

The future circular collider (FCC) study released a conceptual design report (CDR) in January 2019. The CDR highlights the potential for precision measurements and searches for new phenomena in the Higgs sector are among the most important goals in particle physics. Electron-positron collisions up to an energy of 365 GeV (FCC-ee) provide the ultimate precision with studies of Higgs boson couplings, mass, total width, and CP parameters, as well as searches for exotic and invisible decays.

**Primary author:** DI MICCO, Biagio (Università degli Studi di Roma Tre e Istituto Nazionale di Fisica Nucleare (INFN))

**Presenter:** DI MICCO, Biagio (Università degli Studi di Roma Tre e Istituto Nazionale di Fisica Nucleare (INFN))

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Electroweak Physics at FCC-ee

Saturday, 13 July 2019 11:45 (15 minutes)

The Future Circular Collider with electron-positron beams (FCC-ee) should provide improvements of the electroweak precision measurement concerning Z, W, H and their masses by a large factor over the present status. The unparalleled experimental precision would open, via Electroweak loop corrections, a broad discovery potential for new, at least weakly interacting particles up to high energy scales. The Z boson mass and width, as well as the Z → bb partial width, and the forward-backward asymmetries for leptons and quarks can be measured with high precision with the run at the Z pole, where the instantaneous luminosity is expected to be five to six orders of magnitude larger than LEP. As a result, a precise determination of the effective weak mixing angle, as well as of the running electromagnetic coupling $\alpha_{\text{QED}}(m_Z)$ can be extracted directly from the data. Considerable improvements of the strong coupling constant determination down to a precision of $\Delta \alpha_s(mZ) \pm 0.0001$ will be possible with the measurements of the hadronic widths of the Z and W bosons.

Primary author: LOCCI, Elizabeth (Université Paris-Saclay (FR))
Presenter: LOCCI, Elizabeth (Université Paris-Saclay (FR))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
In the Standard Model theory, the mass of the W boson is predicted with an uncertainty of 4 MeV whereas the current experimental accuracy is of 12 MeV. Improving the accuracy of the W mass measurement is a crucial test of the overall consistency of the SM and any deviation might reveal the emergence of new physics. With more than $2 \times 10^7$ W pairs produced at the W threshold energy and above, the FCC-ee collider will be a W boson factory allowing for W mass measurement with unparalleled precision. With enough statistics in lepton collisions, the W mass can be directly measured at and above the threshold from the kinematic reconstruction of the W-pair decay products. In addition, $e^+e^-$ collisions offer the possibility to derive the W mass from the WW cross-section measured at the pair-production threshold. The precise measurement of the W mass and width, with both methods, is presented in the context of a future experiment at FCC-ee. A statistical uncertainty on the W mass below 1 MeV is expected and the experimental and theoretical systematic uncertainties must be reduced to match such a level of precision.
Global EFT fits from Higgs and EW at FCC-ee

Friday, 12 July 2019 17:45 (15 minutes)

The physics program at the FCC-ee offers unparalleled opportunities for precision measurements of the properties of the Z, W and Higgs bosons and the top quark. Deformations of these properties with respect to the SM predictions would provide indirect evidence of the presence of new physics modifying the electroweak sector. These indirect tests of new physics can be conveniently performed in a systematic and model-independent way using the theoretical framework of Effective Field Theories. In this talk, we illustrate the physics potential of the FCC-ee for indirect tests of physics beyond the SM using a Global EFT fit to the different precision measurements taken from the Z pole to the $t\bar{t}$ threshold in $e^+e^-$ collisions. We also highlight the importance of such measurements for the Higgs physics program of the pp and ep collider options (FCC-hh and FCC-eh).

Primary author:  KLUTE, Markus (Massachusetts Inst. of Technology (US))

Presenter: PAUL, Ayan (INFN, Sezione di Roma)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Top-quark physics at the FCC-ee

Friday, 12 July 2019 12:30 (15 minutes)

The future circular collider (FCC) study released a conceptual design report (CDR) in January 2019. FCC-ee can provide $e^+e^-$ collisions with center-of-mass energies of up to 365 GeV and luminosities at the highest energy of $1.4 \times 10^{34}$ cm$^{-2}$s$^{-1}$ in up to four IPs. Threshold scans enable precision measurements of the top mass and width constraining $\alpha_s$ and $Y_T$, while a run at higher center-of-mass energies allows a precise determination of the top electroweak couplings. These results test the consistency of the SM and push the sensitivity to new physics at high scales.

**Primary author:** BLEKMAN, Freya (IIHE, Vrije Universiteit Brussel (BE))

**Presenter:** BLEKMAN, Freya (IIHE, Vrije Universiteit Brussel (BE))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Right-Handed neutrino searches at the FCC-ee

*Friday, 12 July 2019 17:45 (15 minutes)*

Right-handed neutrinos are among the best-motivated extensions beyond the Standard Model. When they are subject to a protective symmetry they can have large mixings with the active neutrinos and masses at the electroweak scale. The effects of these particles can be studied in many different ways at the Future electron-positron Collider. In particular, the modifications of the weak currents due to neutrino mixing can be studied via precision measurements of electroweak observables. Searches for the spectacular signature of long-lived heavy neutrinos that decay with macroscopic displacement allow to almost test the type-I seesaw prediction, where the neutrino mixing is fixed by the ratio of the light and the heavy neutrino mass scale. Moreover, the new Yukawa interaction allows for modified Higgs boson production and decay modes. The FCC-ee has great discovery prospects and it is one of the most promising colliders to test this class of models.

**Primary author:** KLUTE, Markus (Massachusetts Inst. of Technology (US))

**Presenter:** HELSENS, Clement (CERN)

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Probing self-interacting dark matter through neutron stars

Friday, 12 July 2019 09:40 (20 minutes)

Compact stellar objects such as neutron stars (NS) are ideal places for capturing dark matter (DM) particles. We study the effect of self-interacting DM captured by the nearby NS that can reheat it to an appreciated surface temperature through absorbing the energy released due to DM annihilation. When DM-nucleon cross section $\sigma_{\chi n}$ is small enough, DM self-interaction will take over the capture process and make the number of captured DM particles increased as well as the DM annihilation rate. The corresponding NS surface temperature resulted from DM self-interaction is about hundreds of Kelvin and is potentially detectable by the future infrared telescopes. Such observations could act as the complementary probe on DM properties to the current DM direct searches.

Primary authors:  Prof. CHEN, Chian-Shu (Dept. of Physics, Tamkang University, Taiwan); Dr LIN, Yen-Hsun (Dept. of Physics, Nat’l Cheng Kung University, Taiwan)

Presenter:  Dr LIN, Yen-Hsun (Dept. of Physics, Nat’l Cheng Kung University, Taiwan)

Session Classification:  Cosmology

Track Classification:  Cosmology
Three fermion generations with two unbroken gauge symmetries from the complex sedenions

Monday, 15 July 2019 18:30 (1h 30m)

We show that three generations of leptons and quarks with unbroken Standard Model gauge symmetry $SU(3)_c \times U(1)_{em}$ can be described using the algebra of complexified sedenions $\mathbb{C} \otimes \mathbb{S}$. A primitive idempotent is constructed by selecting a special direction, and the action of this projector on the basis of $\mathbb{C} \otimes \mathbb{S}$ can be used to uniquely split the algebra into three complex octonion subalgebras $\mathbb{C} \otimes \mathbb{O}$. These subalgebras all share a common quaternionic subalgebra. The left adjoint actions of the 8 $\mathbb{C}$-dimensional $\mathbb{C} \otimes \mathbb{O}$ subalgebras on themselves generates three copies of the Clifford algebra $\text{Cliff}(6)$. It was previously shown that the minimal left ideals of $\text{Cliff}(6)$ describe a single generation of fermions with unbroken $SU(3)_c \times U(1)_{em}$ gauge symmetry. Extending this construction from $\mathbb{C} \otimes \mathbb{O}$ to $\mathbb{C} \otimes \mathbb{S}$ naturally leads to a description of exactly three generations.

**Primary authors:** Dr GRESNIGT, Niels (Xi’an Jiaotong-Liverpool University); Dr GILLARD, Adam

**Presenter:** Dr GRESNIGT, Niels (Xi’an Jiaotong-Liverpool University)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
Measurements of the CP violation phase \( \phi_s \) at LHCb

Thursday, 11 July 2019 09:20 (20 minutes)

Decays of the Bs meson via \( b \to c\bar{c}b \) transitions are excellent probes for physics beyond the Standard Model due to their sensitivity to the CP-violating phase \( \phi_s \). In addition, the Bs decay width and the decay width difference between the Bs mass eigenstates are measured precisely in these modes. We present the first Run 2 measurements of these quantities at LHCb.

**Primary author:** LHCB COLLABORATION  
**Presenter:** CHOBANOVA, Veronika Georgieva (Universidade de Santiago de Compostela (ES))  
**Session Classification:** Flavour Physics and CP Violation  
**Track Classification:** Flavour Physics and CP Violation
Searches for direct CP violation in two-body and quasi-two-body B meson decays at LHCb

Thursday, 11 July 2019 09:55 (15 minutes)

B meson decays with contributions from loop processes give access to physics within and beyond the Standard Model through measurements of their CP-violating parameters and branching fractions. We present the latest LHCb results of direct CP violation searches in B meson decays using a two-body approximation.

Primary author: LHBC COLLABORATION
Presenter: HADAVIZADEH, Tom (University of Oxford (GB))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
ATLAS Searches for Resonances Decaying to Boson Pairs

Thursday, 11 July 2019 17:45 (15 minutes)

Many extensions to the Standard Model predicts new particles decaying into two bosons (W, Z, photon, or Higgs bosons) making these important signatures in the search for new physics. Searches for such diboson resonances have been performed in final states with different numbers of leptons, photons and jets and b-jets where new jet substructure techniques to disentangle the hadronic decay products in highly boosted configuration are being used. This talk summarizes recent ATLAS searches with LHC Run 2 data collected.

Primary author: ATLAS COLLABORATION
Presenter: JANSKY, Roland (Universite de Geneve (CH))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Search for di-Higgs production at 13 TeV and prospects for HL-LHC

Thursday, 11 July 2019 16:30 (15 minutes)

The latest results on production of Higgs boson pairs at 13 TeV by the ATLAS experiment are reported, including a combination of six different decay modes. Results include bbtautau, bbbb, bbgamgam, bbWW, WWWW and WWgamgam final states, and they are interpreted both in terms of sensitivity to the SM and as limits on kappa_lambda, a scaling of the triple-Higgs interaction strength. Future prospects of testing the Higgs self-couplings at the High Luminosity LHC (HL-LHC) will also be presented.

Primary author: ATLAS COLLABORATION
Presenter: COSTANZA, Francesco (Centre National de la Recherche Scientifique (FR))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
The discovery of the Higgs boson with the mass of about 125 GeV completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many measurements, it is not capable to solely explain some observations. Many extensions addressing this fact introduce additional Higgs-like bosons which can be either neutral, singly-charged or even doubly-charged. Other theories suggest that the Higgs may couple to hidden-sector states, or other exotic Higgs decays to pseudoscalars that can explain the galactic center gamma-ray excess. This talk presents recent ATLAS searches for decays of the 125 GeV Higgs boson to a pair of new light bosons, and searches for additional Higgs bosons. The current status of searches based on full Run2 data of the ATLAS experiment at the LHC are presented.
Hunting for Beyond-Standard-Model physics with the ATLAS detector at the HL-LHC

Friday, 12 July 2019 17:00 (15 minutes)

The Large Hadron Collider (LHC) has been successfully delivering proton-proton collision data at the unprecedented center of mass energy of 13 TeV. An upgrade is planned to increase the instantaneous luminosity delivered by LHC in what is called HL-LHC, aiming to deliver a total of about 3000/fb of data to the ATLAS detector at a center of mass energy of 14 TeV. To cope with the expected data-taking conditions ATLAS is planning major upgrades of the detector.

In this contribution we present an overview of the physics reach expected for a wide range of measurements and searches at the HL-LHC for the ATLAS experiment, with particular focus on the expected reach for phenomena beyond what predicted by the Standard Model. Direct searches as well as indirect constraints from precision measurements will greatly expand our reach for a variety of candidate Beyond-Standard-Model theories.

Such studies formed the basis of the ATLAS Collaboration input to the recent HL/HE-LHC Yellow-Report. An executive summary of this report was then submitted as input to the European Strategy process.

Primary author: ATLAS COLLABORATION
Presenter: HAYDEN, Daniel (Michigan State University (US))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
The associated production of vector boson with quarkonia is a key observable for understanding the quarkonium production mechanisms, including the separation of single and double parton scattering components. This talk will present the latest measurements from ATLAS on quarkonium production, including associated production.

**Primary author:** ATLAS COLLABORATION

**Presenter:** WALDER, James William (Lancaster University (GB))

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Rare and semi-rare decays in ATLAS

Friday, 12 July 2019 15:10 (20 minutes)

Recent results in the searches for rare processes involving B-mesons are presented. Particular attention will be given to FCNC processes, such as the decay of Bs and Bd into two muons, and the angular analysis of the decay of Bd → K* mu mu, where a number of angular coefficients are measured as a function of the invariant mass squared of the di-muon system. Comparison is made to theoretical predictions, including for the observable P’5, for which there has been recent tension between theory and experiment.

Primary author: ATLAS COLLABORATION

Presenter: IBRAGIMOV, Iskander (Universitaet Siegen (DE))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Measurement of the weak mixing phase $\phi_s$ through time-dependent CP violation in $B_s^0 \rightarrow J/\psi \phi$ decay in ATLAS

Thursday, 11 July 2019 09:40 (15 minutes)

In the Standard Model of particle physics, CP violation arises due to a single complex phase in the Cabibbo–Kobayashi–Maskawa (CKM) quark mixing matrix. Testing the validity of the CKM mechanism as the only source of CP violation is one of the major experimental challenges in particle physics today. Precise measurement of the CKM parameters therefore constrains the Standard Model, and may reveal effects beyond the Standard Model. Measurement of the time–dependent decay rates of $B_s^0 \rightarrow J/\psi \phi$ provides a theoretically clean method for extracting CP–violating weak mixing phase $\phi_s$. The Standard Model predicts $\phi_s$ to be very small and it is very well constrained, while in many new physics models large $\phi_s$ values are expected. $B_s^0 \rightarrow J/\psi \phi$ decay channel is sensitive to the new physics contributions, and already small deviations in a measurement of $\phi_s$ would be hints for the existence of the new particles.

The most recent results from ATLAS are presented in CP-violating mixing phase $\phi_s$ and several other parameters describing the $B_s^0$ meson system.

Primary author: ATLAS COLLABORATION

Presenter: BARTON, Adam Edward (Lancaster University (GB))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
OT-μDTC, a test bench for testing CMS Outer Tracker Phase-2 module prototypes

Monday, 15 July 2019 19:40 (20 minutes)

The CMS Phase-2 Outer Tracker (OT) will be built by using two types of modules (strip-strip modules and pixel-strip modules) both consisting of two silicon sensors with a few millimeter separation. To read out the two types of modules four OT specific custom made chips are required: CBC (CMS Binary Chip [1]), SSA (Short Strip ASIC [2]), MPA (Macro Pixel ASIC [3]) and CIC (Concentrator Integrated Circuit [4]). The CBC and MPA (with SSA input) chips perform a spatial correlation between the hits on the top and bottom sensor to provide data ('stubs') on particles with high transverse momentum. This stub data is sent to CIC, which selects stubs with high transverse momentum. The output stub data from CIC is sent at bunch-crossing rate and the data will be used in the L1 trigger system of CMS. On a reception of a trigger the front-end chips respond by outputting the full event information. A module will thus provide two types of data: synchronous stub data and asynchronous full event data.

All these ASICs need to be qualified: first on stand-alone single-chip carriers, and then on prototype read-out hybrid circuits equipped with different types of ASICs operating together. A firmware project, so called μDTC, was set-up to handle these data streams using a μTCA compatible Advanced Mezzanine Card for generic data acquisition/control applications (the FC7).

This poster will describe the data path of the outer tracker modules, give an overview of the available prototypes, and explain the structure of the firmware framework. Finally, results obtained using this test bench during test beams and lab tests will be presented.


Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: DE CLERCQ, Jarne Theo (Vrije Universiteit Brussel (BE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Search for a $W'$ boson decaying to a tau lepton and a neutrino in proton-proton collisions at 13 TeV with CMS

Monday, 15 July 2019 18:30 (1h 30m)

A search for a new high-mass resonance decaying to a tau lepton and a neutrino will be reported in this poster. The analysis uses proton-proton collision data collected by the CMS experiment at the LHC at 13 TeV, corresponding to an integrated luminosity of 35.9 inverse fb. The search utilizes hadronically decaying tau leptons. An interpretation of results will be shown in the context of $W'$ boson predicted in the sequential standard model (SSM), and also nonuniversal gauge interaction model (NUGIM), in which the $W'$ boson decays preferentially to fermions of the third generation. In addition, a model-independent limit will be shown, allowing the results to be interpreted in other models giving the same final state with similar kinematic distributions.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: MUKHERJEE, Swagata (Rheinisch Westfaelische Tech. Hoch. (DE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Searches for New Physics
BSM Physics from Enlarged Gauge Symmetry: the 331 Model, a case of study.

Thursday, 11 July 2019 18:00 (15 minutes)

We discuss the most relevant features of a BSM model with extra gauge symmetry, the so called 331 model. The gauge group is $SU(3)_c \times SU(3)_L \times U(1)_X$ implying the presence of extra gauge bosons, both charged and neutral, as well as extra/exotic fermions and an enlarged scalar sector. We present the relevant phenomenology of doubly-charged gauge bosons, which are a distinctive feature of a version of the 331 model, and discuss the role of BSM phenomenology as a tool for testing GUT (inspired) theories.

Primary author: COSTANTINI, Antonio (INFN Bologna)
Presenter: COSTANTINI, Antonio (INFN Bologna)
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Impact of magnetic field on beta-processes in partially transparent medium

Monday, 15 July 2019 18:30 (1h 30m)

An influence of a magnetic field on beta-processes is investigated in a partially transparent medium of the inner part of a supernova envelope. Inside this part, an electron-positron plasma is ultra-relativistic. As for neutrinos, they are not in the thermodynamic equilibrium with the medium. We obtain simple analytical expressions for reaction rates of beta-processes as well as energy and momentum transferred from (anti)neutrinos to the medium. In numerical estimations we use results from the spherically-symmetric supernova simulations with the progenitor mass of \(27 \, M_\odot\).

We show that the effect of the magnetic field on the macroscopic quantities mentioned above is relatively small. Therefore, neutrino-transport calculations of the supernova explosion can be performed ignoring the magnetic field.

Primary author: Dr DOBRYNINA, Alexandra (P.G. Demidov Yaroslavl State University)

Co-author: Dr OGNEV, Igor (P.G. Demidov Yaroslavl State University)

Presenter: Dr DOBRYNINA, Alexandra (P.G. Demidov Yaroslavl State University)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Reevaluation of the hadronic vacuum polarisation contributions to the Standard Model predictions of the muon $g$-2 using newest hadronic cross-section data and analyticity and unitarity constraints

Friday, 12 July 2019 15:30 (15 minutes)

The evaluation of the hadronic vacuum polarisation contribution to the muon magnetic anomaly is reappraised using the latest $e^+e^- \to$ hadrons cross-section data. A fit incorporating constraints from analyticity and unitarity of the dominant two-pion form factor allows to significantly reduce the uncertainty in the evaluation at low energy where the measurements are scarce and less precise. The talk discusses the new data and methodical improvements, and presents a new Standard Model prediction of the muon $g$-2.

Primary authors: HOECKER, Andreas (CERN); DAVIER, Michel (LAL-Orsay, Universite Paris--Sud 11); MALAESCU, Bogdan (Centre National de la Recherche Scientifique (FR) & CERN); ZHANG, Zhiqing Philippe (LAL, Orsay (FR))

Presenter: ZHANG, Zhiqing Philippe (LAL, Orsay (FR))

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Constraints on Electromagnetic and Neutral Current Couplings of Dark Vector Boson to Standard Model Fermions by SN1987A

Friday, 12 July 2019 10:00 (20 minutes)

We study SN1987A constraints on the interactions between Standard Model fermions and dark vector boson. We consider a more general scenario that the dark boson mixes with Standard Model (SM) gauge bosons through both kinetic and mass mixing terms in the Lagrangian. Hence dark boson couples to SM fermions via vector and axial-vector couplings. Such couplings induce reactions $N+N \rightarrow N+N+Z_d$ inside the supernova (SN) neutrino-sphere and consequently affect the SN core-collapse dynamics. The emissivity resulting from the above production is calculated and the re-absorption process $N+N+Z_d \rightarrow N+N$, and decays $Z_d \rightarrow l^+l^−, \nu\bar{\nu}$ are also considered. It is shown that the axial-vector couplings between $Z_d$ and nucleons give dominant contributions to the emission and re-absorption processes of $Z_d$ compared to the contributions by vector couplings, assuming that the vector and axial-vector $Z_d \rightarrow N \rightarrow N$ couplings are comparable in magnitudes. The constraints on such couplings are obtained using SN1987A observations. We compare our constraints to those obtained from fixed target experiments, atomic parity violation, and the measurement on coherent elastic neutrino nucleus scattering.

Primary authors: Mr LAI, Wei-Hao (Institute of Physics, National Chiao-Tung University, Taiwan); Prof. LIN, Guey-Lin (Institute of Physics, National Chiao-Tung University, Taiwan); Dr TSAI, Yue-Lin Sming (Institute of Physics, Academia Sinica, Taiwan); Dr WU, Meng-Ru (Institute of Physics, Academia Sinica, Taiwan)

Presenter: Prof. LIN, Guey-Lin (Institute of Physics, National Chiao-Tung University, Taiwan)

Session Classification: Cosmology

Track Classification: Cosmology
Scattering amplitudes in gauge theories display important applications for the calculation of observables in the physics that the LHC delivers and, also, formal properties where mathematical aspects are considered. In this talk we consider relations among scattering amplitudes that are obtained as a consequence of the duality between colour and kinematics. These relations are obtained from Jacobi-like identities of kinematic numerators. Hence, we show that the generation of off-shell currents, with a clever choice of the gauge, allows for finding integral relations as a byproduct of this duality. On top of it, we rely on the loop-tree duality formalism to systematise the derivation of these relations. Analytic examples in QCD are presented.

**Primary authors:** Dr TORRES BOBADILLA, William Javier (IFIC CSIC-UV); RODRIGO, German (IFIC CSIC-UV)

**Presenter:** Dr TORRES BOBADILLA, William Javier (IFIC CSIC-UV)

**Session Classification:** Quantum Field and String Theory

**Track Classification:** Quantum Field and String Theory
Mathematical aspects of the scattering amplitude for $H \rightarrow gg$ within the loop-tree duality

Thursday, 11 July 2019 17:10 (20 minutes)

The phenomenological application of the Higgs boson production via gluon fusion has been extensively studied in the full theory of the standard model and in the effective field theory approach where the Higgs boson couples directly to gluons. The latter is straightforwardly obtained by considering the heavy top mass limit. In this talk, following the ideas of universal dual amplitudes in the loop-tree duality formalism [Eur.Phys.J. C78 (2018) no.3, 231], we analyse the one-loop amplitude $H \rightarrow gg$ in the large top mass limit. In fact, we show that independently of the particles running in the loop (scalar, quarks, vector bosons and gluons), we recover the same functional structure. We present the decay width of $H \rightarrow gg$, in which local UV renormalisation and local IR cancellation are done by means of the four-dimensional-unsubtraction method.

Primary authors: TORRES BOBADILLA, William Javier (IFIC CSIC-UV); RODRIGO, German (IFIC CSIC-UV)

Presenter: TORRES BOBADILLA, William Javier (IFIC CSIC-UV)

Session Classification: Quantum Field and String Theory

Track Classification: Quantum Field and String Theory
Recent advances in the $\mu - e$ scattering amplitude at NNLO in QED

Friday, 12 July 2019 16:45 (15 minutes)

In this talk we review the recent developments of the evaluation of the two-loop virtual correction to the electron-muon scattering, $\mu e \rightarrow \mu e$, at Next-to-Next-to-Leading order in QED. These radiative corrections are relevant for the analysis of the MUonE experiment, recently proposed at CERN. MUonE aims at the high precision determination of the QED running coupling constant in the space-like region from the measurement of the differential cross section of the elastic scattering of high-energy muons on atomic electrons. We focus our discussion on the implementation of the adaptive integrand decomposition algorithm and the interplay with available tools for the reduction and computation of multi-loop integrals. Furthermore, we comment on the progress made towards the renormalisation of the amplitude. Preliminary results are shown.

Primary author: TORRES BOBADILLA, William Javier (IFIC CSIC-UV)
Presenter: TORRES BOBADILLA, William Javier (IFIC CSIC-UV)
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Rank-One Flavor Violation and B-meson anomalies

Friday, 12 July 2019 09:00 (20 minutes)

We assume that the quark-flavor coefficients matrix of the semileptonic operators addressing the neutral-current B-meson anomalies has rank-one, i.e. it can be described by a single vector in quark-flavor space. By correlating the observed anomalies to other flavor and high-pT observables, we constrain its possible directions and we show that a large region of the parameter space of this framework will be explored by flavor data from the NA62, KOTO, LHCb and Belle II experiments.

Primary author: MARZOCCA, David (INFN Trieste)
Presenter: MARZOCCA, David (INFN Trieste)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Measurement of cross sections in Higgs boson decays to two photons with the ATLAS detector

Thursday, 11 July 2019 12:00 (15 minutes)

Higgs boson decays to two photons can be selected with high efficiency, and the very good invariant mass resolution allow a robust subtraction of the backgrounds. This talk will present measurements of differential cross sections, as well as cross section measurements for the different Higgs boson production processes in the simplified template cross section framework using pp collision data collected at 13 TeV.

Primary author: ATLAS COLLABORATION
Presenter: NOMIDIS, Ioannis (Centre National de la Recherche Scientifique (FR))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Measurement of cross sections in Higgs boson decays to four leptons with the ATLAS detector

Thursday, 11 July 2019 12:15 (15 minutes)

Higgs boson decays to four leptons can be selected with a very high purity and are very well suited for measurements of Higgs boson properties, despite the small $H \rightarrow ZZ \rightarrow 4l$ branching ratio. This talk will present measurements of differential cross sections, as well as cross section measurements for the different Higgs boson production processes in the simplified template cross section framework using $pp$ collision data collected at 13 TeV.

Primary author: ATLAS COLLABORATION
Presenter: ODA, Susumu (Kyushu University (JP))
Session Classification: Higgs Physics

Track Classification: Higgs Physics
Measurements of cross sections in Higgs boson decays to two W bosons with the ATLAS detector

Thursday, 11 July 2019 11:30 (15 minutes)

The Higgs boson decay to two W bosons has the largest branching fraction and can be used to perform some of the most precise measurements of the Higgs boson production cross sections. Cross section measurements for Higgs boson production via gluon fusion, vector-boson fusion, and production in association with a vector boson based on pp collision data collected at 13 TeV will be presented.

Primary author: ATLAS COLLABORATION
Presenter: FERRARI, Pamela (Nikhef National institute for subatomic physics (NL))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Measurements of Higgs boson production in decays to two tau leptons with the ATLAS detector

Thursday, 11 July 2019 09:15 (15 minutes)

Testing the couplings of the Higgs boson to leptons is important to understand the origin of lepton masses. This talk presents measurements of Higgs boson production in Higgs boson decays to two tau leptons based on pp collision data collected at 13 TeV, as well as studies of the CP-nature of the HVV coupling in $H\rightarrow\tau\tau\tau$ decays.

Primary author: ATLAS COLLABORATION

Presenter: HOHN, David (Albert Ludwigs Universitaet Freiburg (DE))

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Measurements of Higgs boson production using decays to two b-quarks with the ATLAS detector

Thursday, 11 July 2019 10:00 (15 minutes)

Testing the couplings of the Higgs boson to quarks is important to understand the origin of quark masses. The talk presents simplified template cross section measurements for Higgs boson production in association with a vector boson using decays to two b quarks using pp collision data collected at 13 TeV, along with an interpretation in an effective field theory framework. A search for vector-boson fusion production in the same Higgs decay channel will also be presented.

Primary author: ATLAS COLLABORATION

Presenters: COSTA BATALHA PEDRO, Rute (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part); COSTA BATALHA PEDRO, Rute (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
**Higgs boson production in association with a ttbar pair with the ATLAS detector**

*Thursday, 11 July 2019 14:45 (15 minutes)*

The measurement of Higgs boson production in association with a ttbar pair is essential to understand the top-quark couplings to the Higgs boson. This talk presents the analyses using Higgs boson decays to bbbar pairs, to two Z bosons, to other multi-lepton final states, and to a pair of photons, using pp collision data collected at 13 TeV.

**Primary author:** ATLAS COLLABORATION

**Presenter:** POLICICCHIO, Antonio (Sapienza Università di Roma and INFN ROMA1)

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Combined measurements of Higgs boson production and decays with the ATLAS detector

Friday, 12 July 2019 16:45 (15 minutes)

The most precise measurements of Higgs boson cross sections, using the framework of simplified template cross sections, are obtained from a combination of measurements performed in the different Higgs boson decay channels. This talk presents the combined measurements, as well as their interpretations in terms of Higgs coupling modifiers and their ratios, also taking into account results of searches for H->invisible decays as well as off-shell Higgs boson production. It also presents interpretations in generic 2HDM models and in the hMSSM. Finally, the combined measurements are used to constrain the Higgs boson self-coupling, exploiting higher-order electroweak corrections to single Higgs boson production. The individual measurements use pp collision data with a center-of-mass energy of 13 TeV.

Primary author:  ATLAS COLLABORATION
Presenter:  ZHOU, Chen (University of Wisconsin Madison (US))
Session Classification:  Higgs Physics
Track Classification:  Higgs Physics
Search for rare and lepton flavor violating decays of the Higgs boson with the ATLAS detector

Thursday, 11 July 2019 17:20 (15 minutes)

The Standard Model predicts several rare Higgs boson decay channels, which have not yet been observed, but that could enhanced in theories beyond the Standard Model. Among these are decays to second-generation leptons and quarks, H→mumu and H→cc, as well as decays to a Z boson and a photon, H→Zgamma. In addition, theories beyond the Standard Model may predict lepton-flavor violating decays of the Higgs boson. Results for these searches based on pp collision data collected at 13 TeV will be presented.

Primary author: ATLAS COLLABORATION
Presenter: MARCHIORI, Giovanni (LPNHE Paris)
Session Classification: Higgs Physics
Track Classification: Higgs Physics
Searches for high-mass resonances with the ATLAS detector

Friday, 12 July 2019 15:15 (15 minutes)

Several theories beyond the Standard Model predict the existence of new heavy particles decaying into pairs of gauge bosons. The latest ATLAS results on searches for such resonances in final states with leptons and photons based on pp collision data collected at 13 TeV will be presented.

Primary author: ATLAS COLLABORATION
Presenter: WANG, Hulin (University of Alberta (CA))
Session Classification: Higgs Physics
Track Classification: Higgs Physics
The Higgs to tau tau decay is a considerably important decay channel because it allows to directly measure the Yukawa coupling to fermions and to measure the Higgs boson properties. During the Run 2 of the LHC the energy has increased to $\sqrt{s} = 13$ TeV and the luminosity has increased as well. This improvement leads to more precise measurements and with higher significance, in particular for the $H \rightarrow \tau\tau$ process. In this work the most recent measurements in this channel will be presented, with a focus on the $H \rightarrow \tau\tau$ production cross section measurement using data collected by the ATLAS experiment during 2015 and 2016. Furthermore the separate measurement of the Higgs production through Gluon Fusion and through Vector Boson Fusion has also been possible. The combined measurement with the Run 1 data, which leads to the first observation of $H \rightarrow \tau\tau$ in the ATLAS experiment, will be presented as well.

**Primary author:** ATLAS COLLABORATION  
**Presenter:** MURRONE, Alessia (Università degli Studi e INFN Milano (IT))  
**Session Classification:** Wine & Cheese Poster Session  
**Track Classification:** Higgs Physics
We present LHCb results on quarkonia production in proton-lead collisions, using the data collected at 5.02 and 8.16 TeV nucleon-nucleon centre-of-mass energies, covering forward (pPb configuration) and backward (PbP configuration) rapidities. Measurements include charmonia, where the prompt and from-b-decay components are disentangled, and bottomonia states. The large increase in size of the heavy flavour sample collected at 8.16 TeV with respect to the 5.02 TeV sample allows a remarkable improvement in the accuracy of the studies of nuclear matter effects. Coherent production of J/Psi in PbPb collisions are also presented.

The largely unknown parton distribution functions of nuclei and the similarities observed between high-multiplicity pp and pPb events compared to PbPb, often described by means of hydrodynamic models, are the main motivations for an extended pPb data taking program during LHC Run 3 and Run 4. The future increase in luminosity combined with LHCb’s unique detector capabilities will allow new and precise measurements to be performed. Prospects will be presented on Drell-Yan production down to 5 GeV, DDbar correlations, and fully reconstructed b hadrons.
After the discovery of the Higgs boson, one of the main targets of particle physics is the measurement of the Higgs boson couplings to fermions and vector bosons. Moreover, also of great interest is the observation of the interaction of the Higgs boson with itself, known as the Higgs boson self-coupling. The self-coupling is very loosely constrained by EWK precision measurements therefore new physics effects could induce large deviations from its SM expectation. The self-coupling can be measured directly using the Higgs boson pair production cross section, or indirectly through the measurement of the single-Higgs boson production and decays. In fact, at Next-to-Leading Order in EW interaction the Higgs-decay partial widths and the cross sections of the main single-Higgs production processes depend on the Higgs boson self-coupling via weak loops. Moreover, changes in the Higgs boson self-coupling affect also the Higgs boson differential distribution, like the transverse momentum. In this talk, measurements of the Higgs boson self-coupling using single-Higgs production combining the data of the analyses targeting the γγ, ZZ*, WW*, ττ, bb decay channels and using both inclusive and differential information, will be presented. The results are obtained using ATLAS data corresponding to a luminosity of up to 80 fb⁻¹.
Production of open heavy flavour hadrons in pPb collisions at LHCb

Thursday, 11 July 2019 16:30 (18 minutes)

A rich set of open heavy flavour states is observed by LHCb in pPb collisions collected at 5 and 8.16 TeV nucleon-nucleon centre-of-mass energies. Thanks to the LHCb forward acceptance that is complementary to general purpose detectors, heavy-flavor hadrons can be studied down to zero transverse momentum. This talk presents production measurements of beauty hadrons and open charm states including baryons, through cleanly reconstructed exclusive decays. Results on nuclear effects, quantified by the nuclear modification factors, forward-to-backward production ratios and baryon-to-meson ratios, will be discussed.

Primary author: LHCB COLLABORATION
Presenter: ZHANG, Yanxi (CERN)
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Heavy-Flavour production in fixed-target mode with LHCb

Friday, 12 July 2019 11:30 (20 minutes)

LHCb has the unique capability to study collisions of the LHC beams on fixed targets. Internal gas targets of helium, neon and argon have been used so far to collect samples corresponding to integrated luminosities up to 0.1 pb⁻¹. An upgraded target, allowing a wider choice of target gas species and an increase in the gas density by up to two orders of magnitude, is planned to be installed for the LHC Run 3. Results and prospects on open and hidden charm production measurements will be presented. These measurements can provide crucial constraints on cold nuclear matter effects and nPDF at large x. In addition, production measurements of antiprotons and other light hadrons are of great interest for cosmic-ray physics.

Primary author: LHCb COLLABORATION
Presenter: GARCIA ROSALES, Felipe Andres (Centre National de la Recherche Scientifique (FR))

Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
LHCb inputs to astroparticle physics

Thursday, 11 July 2019 17:30 (20 minutes)

The LHCb experiment has the unique possibility, among the LHC experiments, to be operated in fixed-target mode using its internal gas target. The energy scale achievable at the LHC and the excellent detector capabilities for vertexing, tracking and particle identification allow a wealth of novel measurements of great interest for cosmic ray physics. In particular, using a helium target, the first measurement of antiproton production in proton-helium collisions was achieved using a 6.5 TeV proton beam, for antiproton energies in the range 12-110 GeV. The results are particularly relevant to the interpretation of the recent precise measurements of the antiproton flux in cosmic rays.

Primary author: LHCb COLLABORATION
Presenter: GRAZIANI, Giacomo (INFN, Sezione di Firenze (IT))
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Outreach activities at LHCb

Friday, 12 July 2019 10:30 (15 minutes)

The status of outreach activities of the LHCb experiment at LHC is presented, covering both continuing outreach efforts as well as new projects specific to LHCb. These include the work towards preservation of the subdetectors that are being replaced during the upgrade of the LHCb detector in the Long Shutdown 2, and updates to the surface exhibition above the LHCb interaction point. The latter is being redesigned to display the LHCb Upgrade in greater detail. Finally, a planned overhaul of the successful LHCb masterclass software will be discussed.

Primary author: LHCB COLLABORATION

Presenter: SANTIMARIA, Marco (INFN e Laboratori Nazionali di Frascati (IT))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
The Early Career, Gender & Diversity Office at the LHCb experiment

Friday, 12 July 2019 17:30 (15 minutes)

The mandate of the Early Career, Gender & Diversity (ECGD) office is to oversee the well being and working environment of all LHCb members. The ECGD office was created by the LHCb management in 2014. Since March 2019, the role of the ECGD office is defined in the LHCb constitution and one ECGD officer is invited to attend the LHCb Collaboration Board as a non-voting member. The ECGD officers advise the LHCb management and act as LHCb contacts for all matters related to ECGD. They are available for listening to and advising - in a confidential manner - colleagues who have witnessed or have been subject to harassment, discrimination or other inappropriate behaviour. They help raise awareness in the collaboration for topics related to ECGD, for example by organizing regular meetings within the collaboration and by advertising related activities that are ongoing outside the collaboration. In this talk we briefly introduce the ECGD office, we share the experience gained over the last years, with special emphasis on developments since the last EPS-HEP conference, and we present our vision for the future evolution of the ECGD.

Primary author: LHCB COLLABORATION
Presenter: LISOVSKYI, Vitalii (Centre National de la Recherche Scientifique (FR))
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
Studies of Jet Fragmentation and Hadronisation at LHCb

Friday, 12 July 2019 09:45 (15 minutes)

New results on jet fragmentation measurements at LHCb are presented. LHCb has probed the fragmentation of light and heavy flavour jets, with results showing significant discrepancies with theoretical predictions found using standard Monte Carlo event simulation. These are the first measurements of jet hadronisation and fragmentation at forward rapidities at the LHC. Results from LHCb of J/Psi production inside jets also provide a new handle on long-standing puzzles on accurately predicting J/Psi production in hadronic collisions.

Primary author: LHCB COLLABORATION
Presenter: BLANC, Fred (EPFL - Ecole Polytechnique Federale Lausanne (CH))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Top Physics at LHCb

Friday, 12 July 2019 10:45 (15 minutes)

Results from LHCb on top production in the forward region are presented. LHCb provides unique coverage at forward rapidities at the LHC, and measurements at LHCb probe a unique kinematic range, providing novel constraints on parton distribution functions. The potential for future measurements at LHCb, following major upgrades that will enable the collection of integrated luminosities of at least 300/fb, will also be discussed.

Primary author: LHCB COLLABORATION
Presenter: FARRY, Stephen (University of Liverpool (GB))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Precision electroweak physics at LHCb

Friday, 12 July 2019 17:30 (15 minutes)

The LHCb detector at the LHC offers unique coverage of forward rapidities, allowing the experiment to play an important role in precision measurements of electroweak physics at the LHC. Precision cross-section measurements (from LHC Runs 1 and 2) will be presented. Prospective studies will also be presented, including the potential of a measurement of the W boson mass using the LHCb Run 2 data, where the anti-correlation of theoretical uncertainties with measurements at ATLAS and CMS means that a future measurement offers unique complementarity to the measurements at the other LHC detectors. Also discussed will be prospects for a future measurement of the weak mixing angle at LHCb, building on the existing measurement using Run 1 data. Following major upgrades of the LHCb detector that will enable the collection of integrated luminosities of at least 300/fb, the expected precision in such a measurement is expected to surpass the world average from the LEP and SLD measurements.

Primary author: LHCb COLLABORATION
Presenter: BARTER, William (Imperial College (GB))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
The Sub-TeV transient Gamma-Ray sky: challenges and opportunities

Saturday, 13 July 2019 13:10 (20 minutes)

The detection of gravitational waves and neutrinos from astrophysical sources with gamma-ray counterparts officially started the era of Multi-Messenger Astronomy. Their transient and extreme nature implies that monitoring the VHE sky will be fundamental to investigate the non-electromagnetic signals. However, the limited effective area of space-borne instruments prevents observations above a few hundred GeV, while the small field of view and low duty cycle of IACTs make them unsuited for extensive monitoring activities and prompt response to transients. Extensive Air Shower arrays (EAS) can provide a large field of view, a wide effective area and a very high duty cycle. Their main difficulty is the distinction between gamma-ray and cosmic-ray initiated air showers, especially below the TeV range.

Here we present some case studies stressing the importance that a new EAS array in the Southern hemisphere will be able to survey the sky from below 100 GeV up to several TeV. In the energy domain between 100 and 400 GeV we expect the strongest electro-magnetic signatures of the acceleration of ultra-relativistic particles in sources like SNRs, blazar jets and gamma-ray bursts, as recently proved by IACTs observations. This spectral window is also crucial to understand the Universe opacity to high energy radiation, thus providing constraints on the cosmological parameters. We will discuss the implications of VHE radiation on the mechanisms at work and we will focus on the advantages resulting from the ability to monitor the energy window lying between the domain of space-borne detectors and ground-based facilities.

Primary author: LA MURA, Giovanni (Laboratório de Instrumentação e Física Experimental de Partícul)

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Presenter: LA MURA, Giovanni (Laboratório de Instrumentação e Física Experimental de Partícul)
**Session Classification:** Astroparticle Physics and Gravitational Waves

**Track Classification:** Astroparticle Physics and Gravitational Waves
Studies of Central Exclusive Production and Soft QCD phenomena at LHCb

Friday, 12 July 2019 12:30 (15 minutes)

The LHCb detector at the LHC offers unique coverage of forward rapidities. This enables complementary measurements of soft QCD phenomena to those at the other LHC detectors. Measurements of the inelastic cross-section and of particle production will be presented. Measurements of Central Exclusive Production (CEP) at LHCb will also be presented. These measurements probe QCD, allowing investigation of the nature of pomerons, and provide constraints on low-x gluon phenomenology, probing potential saturation effects. CEP measurements at LHCb in the most recent LHC run have significantly benefited from the installation of new high rapidity shower counters (the "HeRSCHel" subdetector). The performance and use of this new detector for CEP studies will also be discussed.

Primary author: LHCB COLLABORATION
Presenter: FARRY, Stephen (University of Liverpool (GB))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
The LHCb detector at the LHC offers unique coverage of forward rapidities. The detector also offers a flexible trigger that enables low mass states to be recorded with high efficiency, and a precision vertex detector that enables excellent separation of primary interactions from secondary decays. This allows LHCb to make important (and world-best) contributions in these regions of phase space in the search for dark photons and other low-mass resonances that decay to dimuon final states. A selection of results from these searches will be presented, alongside the potential of future measurements that probe the low-mass region using dimuon, dielectron, and diphoton final states.

Primary author: LHCb COLLABORATION

Presenter: VAZQUEZ SIERRA, Carlos (Nikhef National institute for subatomic physics (NL))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Searches for Exotic Higgs-like boson decays at LHCb

Friday, 12 July 2019 11:30 (15 minutes)

LHCb has made a series of searches sensitive to Higgs-like bosons and their decays. These analyses include searches for long-lived particles produced in the decays of such resonances, with these particles decaying to various final states probed in different analyses, and a search for Higgs-like bosons that produce lepton-flavour-violating decays, producing a tau mu final state. The unique design of the LHCb detector, with a flexible trigger and a precision vertex detector, enables competitive and world-best limits, particularly for low mass states, and for states that have a low lifetime. These results, along with future prospects, will be presented.

Primary author: LHCb COLLABORATION
Presenter: SESTINI, Lorenzo (Universita e INFN, Padova (IT))
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Mixing and indirect CPV in Charm decays at LHCb

Thursday, 11 July 2019 16:30 (20 minutes)

The large sample of charmed hadrons collected by LHCb is used to measure $D_0$–$D_0\bar{b}$ mixing and to search for indirect CP violation as well as to measure direct CP violation in $D_0$ mesons and Lambda$_c^+$ baryons. New measurements from several decay modes are presented, including the first observation of CP violation in the charm system. We also discuss prospects for future sensitivities.

Primary author:  LHCb COLLABORATION
Presenter:  KODASSERY PADMALAYAMMADAM, Prasanthkrishnan (Polish Academy of Sciences (PL))
Session Classification:  Flavour Physics and CP Violation
Track Classification:  Flavour Physics and CP Violation
The strong coupling from e+e- to hadrons

Friday, 12 July 2019 16:30 (15 minutes)

We determine the strong coupling, $\alpha_s$, using finite-energy sum rules and a new compilation of the hadronic $R$-ratio from available data for $e^+e^- \rightarrow \text{hadrons}$ below the charm threshold. Quoting our final results at the tau mass to facilitate comparison to the results of analyses of hadronic tau decay data, we find

$$\alpha_s(m^2_{\tau}) = 0.298 \pm 0.017 \text{ in fixed-order perturbation theory}$$

and

$$\alpha_s(m^2_{\tau}) = 0.304 \pm 0.019 \text{ in contour-improved perturbation theory, where the quoted errors are largely dominated by statistics.}$$

At the $Z$ boson mass, we find $\alpha_s(m^2_Z) = 0.1158 \pm 0.0022$ and $\alpha_s(m^2_Z) = 0.1166 \pm 0.0025$, respectively. Our results are in agreement with the world average and with recent extractions from tau decay data. Our method provides an independent and competitive strategy for the extraction of the strong coupling below the charm threshold.

Primary authors: BOITO, Diogo (Universidade de São Paulo); GOLTERMAN, Maarten (San Francisco State University); KESHAVARZI, Alexander; MALTMAN, Kim (York University); NOMURA, Daisuke; TEUBNER, Thomas (University of Liverpool); PERIS, Santiago (Univ. Autonoma de Barcelona)

Presenter: BOITO, Diogo (Universidade de São Paulo)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Rare Charm decays at LHCb

Thursday, 11 July 2019 15:30 (15 minutes)

LHCb is playing a crucial role in the study of rare and forbidden decays of charm hadrons, which are sensitive to effects beyond the Standard Model. New searches for FCNC-mediated processes and asymmetry measurements in multibody final states with two leptons are presented.

Primary author: LHCb COLLABORATION
Presenter: MITZEL, Dominik Stefan (CERN)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Time-integrated measurements of the CKM angle gamma

The tree-level determination of the CKM angle gamma is a standard candle measurement of CP violation in the Standard Model. The latest LHCb results from time-integrated measurements of CP violation using beauty to open charm decays are presented. These include updates to previous Run 1 measurements, and new results from processes that have never been studied before, using the LHCb Run 2 data sample.

Primary author: LHCb COLLABORATION
Presenter: Ms ROLLINGS, Alexandra Paige (University of Oxford (GB))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Time-dependent CP violation measurements from beauty to open charm decays

Thursday, 11 July 2019 10:50 (20 minutes)

The latest time-dependent CP violation measurements using beauty to open charm decays from LHCb are presented. These decays provide sensitivity to important CKM parameters such as the angles beta and gamma from the unitarity triangle. Measurements include the latest results from new decay channels, analysed for the first time, including data from both LHCb Run 1 and Run 2.

Primary author: LHCb COLLABORATION

Presenter: ESEN, Sevda (Nikhef National institute for subatomic physics (NL))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Recent results from LHCb on charged-current decays of b-hadrons

Friday, 12 July 2019 09:20 (15 minutes)

b-hadron decays proceeding via charged-current interactions are excellent tools to study the CKM matrix, b-hadron properties, hadronic form-factors and Lepton Universality. The large branching fractions, coupled with excellent particle identification capability and accurate reconstruction of decay vertices, enable the LHCb experiment to perform high-precision measurements of many key quantities. In this contribution, recent results of charged-current interactions of b-hadrons at LHCb are presented.

Primary author:  LHCB COLLABORATION
Presenter:  LUPATO, Anna (Universita e INFN, Padova (IT))
Session Classification:  Flavour Physics and CP Violation
Track Classification:  Flavour Physics and CP Violation
Heavy flavor production at LHCb

Saturday, 13 July 2019 09:00 (15 minutes)

New results on heavy-flavor production in proton-proton collisions will be presented. The measurements are performed using data collected during 2015-2018 at a centre-of-mass energy of 13 TeV in the forward region. Results from different charmonia states and b-hadrons will be covered in the talk.

Primary author: LHCB COLLABORATION
Presenter: USACHOV, Andrii (Centre National de la Recherche Scientifique (FR))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Spectroscopy using decays of b-hadrons to charmonium at LHCb, including exotic states

Saturday, 13 July 2019 10:30 (15 minutes)

The LHCb detector is an excellent tool for studying b-hadron decays to charmonium, benefiting from a large b-hadron sample, an efficient trigger and good mass resolution. Such decays provide insight into properties of both conventional and exotic charmonium, and can also probe the factorization approach. Recent results in this area are presented.

Primary author: LHCB COLLABORATION
Presenter: DEY, Biplab (CCNU)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Rare $b \to s l \ell$ decays are flavour changing neutral current processes that are forbidden at the lowest perturbative order in the Standard Model (SM). As a consequence, new particles in SM extensions can significantly affect the branching fractions of these decays and their angular distributions. Particularly interesting are extensions of the SM that violate lepton flavour universality. Since rare decays of heavy flavour are heavily suppressed in the SM and new particles can give sizeable contributions to these processes, thus their precise study allows for sensitive tests of lepton flavour universality. The LHCb experiment is ideally suited for the analysis of these decays due to its high trigger efficiency, as well as excellent tracking and particle identification performance. Recent results from the LHCb experiment in the area of $b \to s l \ell$ decays are presented and their interpretation is discussed.

**Primary author:** LHCB COLLABORATION  
**Presenter:** LISOVSKYI, Vitalii (Centre National de la Recherche Scientifique (FR))  
**Session Classification:** Flavour Physics and CP Violation  
**Track Classification:** Flavour Physics and CP Violation
Searches for Lepton Flavour Violating decays at LHCb

Friday, 12 July 2019 16:35 (15 minutes)

Recent hints for lepton-universality violation in $b \rightarrow sll$ transitions could imply the existence of lepton-flavour violating $B$ decays. The LHCb experiment is well suited for the search for these decays due to its large acceptance and trigger efficiency, as well as its excellent invariant mass resolution and particle identification capabilities. Recent results on searches for lepton-flavour violating decays from the LHCb experiment will be presented.

Primary author: LHCB COLLABORATION
Presenter: SANTIMARIA, Marco (INFN e Laboratori Nazionali di Frascati (IT))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
In this talk recent results from LHCb on radiative and very rare decays at LHCb are presented. Radiative b-hadron decays are sensitive probes of New Physics through the study of branching fractions, CP asymmetries and measurements of the polarisation of the photon emitted in the decay. During Run-1 of the LHC, the LHCb experiment has collected large samples of radiative b-hadron decays. The latest measurements will help constrain the size of right-handed currents in extensions of the Standard Model. Flavour-changing neutral-current processes are loop-suppressed in the Standard Model. Since new particles in SM extensions can give significant contributions, they allow for sensitive searches for phenomena beyond the SM. Very rare decays of b-hadrons that are highly suppressed in the SM are particularly clean probes.

Primary author: LHCb COLLABORATION
Presenter: GARCIA MARTIN, Luis Miguel (Univ. of Valencia and CSIC (ES))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Time-dependent CP violation in charmless b decays at LHCb

Thursday, 11 July 2019 11:40 (20 minutes)

In the B meson sector, measurements of weak phases not associated with Vub are obtained through time-dependent, flavour-tagged analyses involving B-Bbar mixing. In addition to new phases that may enter the mixing loop, charmless B decays have an additional mechanism for unknown particles to induce deviations from the Standard Model expectation due to the sizeable contribution to these decays from penguin topologies. We present the most recent studies of time-dependent CP violation in charmless B decays at the LHCb experiment, including Bs -> phi phi, one of the "golden channels" for New Physics searches.

Primary author: LHCb COLLABORATION
Presenter: HENRY, Louis (Instituto de Física Corpuscular (IFIC))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Observation of several sources of CP violation in B⁺ → π⁺ π⁺ π⁻ decays at LHCb

Thursday, 11 July 2019 12:00 (20 minutes)

Very large CP asymmetries in decays of B mesons to final states containing three charged particles have been observed and attracted much interest. We present new results from a Dalitz plot analysis of B⁺ → 3π using a data sample corresponding to an integrated luminosity of 3 fb⁻¹ of pp collisions recorded by the LHCb detector. Significant CP violation from different sources (S-wave, D-wave, S-P wave interference etc.) are established and may shed new light on understanding the underlying dynamics for CP violation in hadronic B decays.

Primary author: LHCB COLLABORATION
Presenter: DALSENO, Jeremy Peter (Universidade de Santiago de Compostela (ES))
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
CP violation in multi-body charmless b-hadron decays at LHCb

Thursday, 11 July 2019 12:20 (20 minutes)

Long-distance resonant dynamics along with a sizeable weak phase present in multi-body charmless b-hadron decays leads to a rich structure of CP violation as a function of the phase space. Amplitude analysis provides a deeper understanding of the mechanisms that generate strong phase variations, which are responsible for this effect. We present the amplitude analyses of $B^+ \rightarrow \pi^+ K^+ K^-$ and $B_s \rightarrow K_s K^\pm \pi^\mp$. For the former, CP asymmetries of the contributing quasi-two-body resonances are measured. Charmless b-baryon decays represent a promising opportunity to make a first observation of CP violation in the baryonic sector. We also present the most recent measurements of four-body charmless b-baryon decays performed by LHCb.

Primary author: LHCB COLLABORATION
Presenter: MORRIS, Adam (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
SciFi - A large Scintillating Fibre Tracker for LHCb

Thursday, 11 July 2019 09:30 (15 minutes)

The LHCb detector is currently being upgraded in order to cope with higher instantaneous luminosities and to read out the data at 40MHz using a trigger-less read-out system. The Run 1 + 2 tracking system, composed of an inner and outer tracking detector, will not be able to cope with the increased particle multiplicities and is being replaced by a single homogenous detector based on scintillating fibres. The new Scintillating Fibre (SciFi) Tracker covers a total detector area of 340 m² and should provide a spatial resolution for charged particles better than 100 µm in the bending direction of the LHCb spectrometer. The detector is being built from individual modules (0.5 m × 4.8 m), each comprising 8 scintillating fibre mats with a length of 2.4 m as active detector material. The fibre mats consist of 6 layers of densely packed blue emitting scintillating fibres with a diameter of 250 µm. The scintillation light is recorded with arrays of state-of-the-art multi-channel silicon photomultipliers (SiPMs). A custom ASIC will be used to digitize the SiPM signals. Subsequent digital electronics performs clustering and data-compression before the data is sent via optical links to the DAQ system. To reduce the thermal noise of the SiPM in particular after being exposed to a neutron fluence of up to 10¹² neq/cm², expected for the lifetime of the detector, the SiPMs arrays are mounted in so called cold-boxes and cooled down by 3D-printed titanium cold-bars to -40°C. Modules together with cold-boxes and readout electronics are mounted on so-called C-frames which provide the mechanical support structure and the necessary services to power, read out and cool the detector elements. After a first proto-type frame has been built and tested the serial assembly of these detector elements has started in March 2019. The first finished and commissioned detector elements will be installed in the experimental cavern at the end of 2019. The talk will give an overview of the detector concept and will present the experience from the series production complemented by most recent test and commissioning results.

Primary author: LHCb COLLABORATION
Presenter: FEO, Mauricio (Nikhef National institute for subatomic physics (NL))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
Flavour Physics at the High Luminosity LHC: LHCb Upgrade II

Monday, 15 July 2019 19:40 (20 minutes)

The LHCb Collaboration is planning an Upgrade II, a flavour physics experiment for the high luminosity era. This will be installed in LS4 (2030) and targets an instantaneous luminosity of $1.5 \times 10^{34}$ cm$^{-2}$ s$^{-1}$, and an integrated luminosity of at least 300 fb$^{-1}$. Modest consolidation of the current experiment will also be introduced in LS3 (2025). Physics goals include probing new physics scenarios in lepton flavour universality, obtaining unprecedented precision on CKM tests, and expanding the LHCb programme into new measurement areas such as Higgs decays to charm. The detector design options include the introduction of timing information, with opportunities in vertexing and tracking, electromagnetic calorimetry, and hadron particle identification. Preliminary studies for the LHC suggest that the luminosity goals will be achievable. Following the issue of a physics case and accelerator note in 2018, the collaboration has been approved by the LHCC to proceed to the preparation of a TDR.

Primary author: LHCB COLLABORATION
Presenter: ESEN, Sevda (Nikhef National institute for subatomic physics (NL))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Integrand reduction for two-loop five-point amplitudes

I will present a framework to compute two-loop five-point amplitudes that combines integrand reduction, integration-by-part identities and finite-field reconstruction techniques. Analytic results for two-loop five parton amplitudes obtained using the framework will also be discussed.

Primary author:  HARTANTO, Heribertus Bayu (Durham University)
Presenter:  HARTANTO, Heribertus Bayu (Durham University)
Session Classification:  QCD and Hadronic Physics
Track Classification:  QCD and Hadronic Physics
Investigation of cross-talk effects in RD53A modules with 100 and 150 um thick n-in-p planar sensors

The CMS and ATLAS detectors will face challenging conditions after the upgrade of the LHC to the High Luminosity LHC. In particular, the granularity of the pixel detectors should increase to mitigate the effect of pile-up. Two possible sensor geometries are being investigated, 50x50 um2 and 25x100 um2, to handle these conditions. One of the main factors in choosing the pixel geometry is cross-talk, defined as the ratio of charge induced on neighboring pixels relative to the total charge. This charge induction will affect the data rates, position resolution, and track reconstruction efficiencies, and therefore should be investigated carefully. The effect of cross-talk is expected to depend on the chosen pixel geometry, threshold of the signal, and readout front-end. The readout chip in this study is RD53A, developed by the RD53 Collaboration, which is a prototype investigated by both CMS and ATLAS collaborations implementing three different analog front-end designs. Cross-talk effects are larger for the 25x100 um2 geometry, given the larger sensor capacitance. They have been studied both in the lab, through direct charge injection, and also at DESY test beam facility, by charge deposition of 5.6 GeV electrons in 150-um thick silicon pixels. The effect of front-end, threshold, and impinging position of electrons on the cross-talk will be presented.

Primary authors: KILMINSTER, Ben (Universitaet Zuerich (CH)); CANELLI, Florencia (Universitaet Zuerich (CH)); MACCHIOLO, Anna (Universitaet Zuerich (CH)); LEONTSINIS, Stefanos (Universitaet Zuerich (CH)); MIKUNI, Vinicius Massami (Universitaet Zuerich (CH)); JOFREHEI, Arash (Universitaet Zuerich (CH))

Presenter: JOFREHEI, Arash (Universitaet Zuerich (CH))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Photonic billiards in ultra-peripheral heavy-ion collisions

Saturday, 13 July 2019 09:18 (18 minutes)

So far light-by-light scattering ($\gamma\gamma \rightarrow \gamma\gamma$) was not accessible for experiments because the corresponding cross section is rather low. Measurements of diphotons in ultra-peripheral collisions (UPCs) of lead-lead have been reported recently by the ATLAS\cite{1} and CMS Collaborations\cite{2}. Our theoretical results based on equivalent photon approximation in the impact parameter space\cite{3} are in agreement with the current data\cite{1, 2}. We will discuss how to extend such studies to lower $\gamma\gamma$ energies where photoproduction of pseudoscalar and scalar resonances contribute to the two-photon final state. In addition, we consider the dominant background that arises from $\gamma\gamma$ fusion into pairs of neutral pions\cite{4}. Such $\pi^0$-pairs contribute to the background when only two of the four decay photons are within the experimental acceptance, the other two photons escape undetected. We will discuss in detail how to reduce the unwanted background. We will present differential distributions and total cross section in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}} = 5.05$ and 5.52 TeV\cite{5} and cross section for Ar-Ar collisions at the energy equal to 6.3 TeV\cite{6}. Results for ALICE and LHCb acceptance will be presented.

\begin{thebibliography}{9}
\bibitem{2} CMS Collaboration, arXiv:1810.04602
\bibitem{3} M.Kłusek-Gawenda, P.Lebiedowicz, A.Szczurek, Phys. Rev. C93 (2016) 044907
\bibitem{4} M.Kłusek-Gawenda, A.Szczurek, Phys. Rev. C87 (2013) 054908
\bibitem{5} M.Kłusek-Gawenda, R.McNulty, R.Schicker, A.Szczurek, 1904.01243 [hep-ph]
\bibitem{6} Z.Citron et al., arXiv:1812.06772
\end{thebibliography}

Primary authors: KLUSEK-GAWENDA, Mariola (IFJ PAS); SZCZUREK, Antoni (Institute of Nuclear Physics)

Presenter: KLUSEK-GAWENDA, Mariola (IFJ PAS)

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Production of $\chi_c(i)\chi_c(j)$ pairs in proton-proton collisions in $k_t$-factorization and collinear approaches

The matrix elements for $g^* g^* \rightarrow \chi_c(J_i)\chi_c(J_j)$ for off-shell gluons were derived [1].

The matrix elements are used then in the $k_t$-factorization approach for the $pp \rightarrow \chi_c(J_i)\chi_c(J_j)$ reaction.

Different combination of the $c\bar{c}$ mesons are considered.

We use the Kimber-Martin-Ryskin (KMR) unintegrated gluon distributions to evaluate cross sections. We concentrate on large rapidity separation between $\chi_c$ mesons.

Several differential distributions for a selected value of the center of mass energy are calculated and shown.

A feed-down from double $\chi_c$ production to the double $J/\psi$ channel is estimated and compared to the dominant direct production of two $J/\psi$ quarkonia.

This mechanism is important in the context of very small $\sigma_{eff}$ found from the analysis of $J/\psi$ production.

Similar analysis is repeated for the collinear factorization approach [2]. The leading order contributions ($2 \rightarrow 2$ processes) are rather small, compared to the $k_t$-factorization result.

We include higher-order contributions of $2 \rightarrow 3$ processes with two $\chi_c$ mesons and one gluon. Several differential distributions will be presented and discussed. Again we will focus on large rapidity distances between the $\chi_c$ mesons.

A comparison to the $k_t$-factorization approach will be made. Conclusions will be formulated.


Primary authors: SZCZUREK, Antoni (Institute of Nuclear Physics); SCHAEFER, Wolfgang (Institute of Nuclear Physics PAN)

Presenter: SCHAEFER, Wolfgang (Institute of Nuclear Physics PAN)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Do electromagnetic effects survive in the production of lepton pairs in nucleus-nucleus collisions?

*Saturday, 13 July 2019 09:54 (18 minutes)*

We calculate cross sections for di-lepton photoproduction in ultrarelativistic heavy-ion collisions from low (SPS) to high (LHC) energy. We study the invariant-mass distributions of dileptons produced in ultrarelativistic heavy-ion collisions at very low pair transverse momenta, $P_T < 0.15$ GeV. Specifically, we investigate the interplay of thermal radiation with initial photon annihilation processes, $\gamma\gamma \rightarrow l^+l^-$, triggered by the coherent electromagnetic fields of the incoming nuclei. For the thermal radiation, we employ the emission from the QGP and hadronic phases with in-medium vector spectral functions which describes the inclusive excess radiation observed over a wide range of collision energies. For the coherent photon fusion processes, whose spectrum is much softer than for thermal radiation, we employ initial fluxes from the Fourier transform of charge distributions of the colliding nuclei in the equivalent-photon approximation.

We first verify that the combination of photon fusion, thermal radiation and final-state hadron decays gives a fair description of the low-$P_T$ invariant-mass as well as $P_T$ spectra as recently measured by the STAR collaboration in $\sqrt{s_{NN}} = 200$ GeV Au+Au collisions for different centrality classes, including experimental acceptance cuts. The coherent contribution dominates in peripheral collisions, while thermal radiation shows a markedly stronger increase with centrality. We extend the calculations to lower collision energies ($\sqrt{s_{NN}} = 17.3$ GeV) and compare to the acceptance-corrected dimuon excess spectra measured by the NA60 experiment at the CERN SPS; the contribution from photoproduction turns out to be subleading. We also provide predictions for the ALICE experiment at the LHC. The resulting excitation function from SPS to LHC energies reveals a nontrivial interplay of photoproduction and thermal radiation. Reasonable results are obtained and open questions are discussed.

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“Dilepton Radiation in Heavy-Ion Collisions at Small Transverse Momentum”
M. Klusek-Gawenda, R. Rapp, W. Schaefer, A. Szczurek

**Primary authors:** SZCZUREK, Antoni (Institute of Nuclear Physics); Dr KLUSEK-GAWENDA, Mariola (Institute of Nuclear Physics Polish Academy of Sciences)

**Presenter:** SZCZUREK, Antoni (Institute of Nuclear Physics)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Production of $W^+W^-$ and $t\bar{t}$ pairs via photon-photon processes in proton-proton scattering and corresponding gap survival factor

Thursday, 11 July 2019 09:45 (15 minutes)

Photon-induced processes in proton-proton interactions have become recently very topical. The large energy at the LHC, when combined with relatively large luminosity at run II, allows starting the exploration of such processes.

We discuss the production of $W^+W^-$ pairs and $t\bar{t}$ quark-antiquark pairs in proton-proton collisions induced by two-photon fusion including, for a first time, transverse momenta of incoming photons. The unintegrated inelastic fluxes (related to proton dissociation) of photons are calculated based on modern parametrizations of deep inelastic structure functions in a broad range of $x$ and $Q^2$.

We focus on processes with single and double proton dissociation. Highly excited remnant systems hadronize producing particles that can be vetoed in the calorimeter. We calculate associated effective gap survival factors. The gap survival factors depend on the process, mass of the remnant system and collision energy. The rapidity gap survival factor due to remnant fragmentation for double dissociative (DD) collisions is smaller than that for single dissociative (SD) process. We observe approximate factorisation: $S_{R,DD} \approx S_{R,SD}^2$ when imposing rapidity veto. For the $W^+W^-$ final state, the remnant fragmentation leads to a taming of the cross section when the rapidity gap requirement is imposed. Also for $t\bar{t}$ quark-antiquark pairs, such a condition reverses the hierarchy observed for the case when such condition is taken into account.

Our results imply that for the production of such heavy objects as $t$ quark and $\bar{t}$ antiquark the virtuality of the photons attached to the dissociative system are very large ($Q^2 < 10^4$ GeV$^2$). A similar effect was observed for the $W^+W^-$ system.

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
The $\gamma^*\gamma^* \rightarrow \eta_c(1S, 2S)$ transition form factor from quarkonium wave functions

On Thursday, 11 July 2019 15:15 (15 minutes)

We discuss $\gamma^*\gamma^* \rightarrow \eta_c(1S), \eta_c(2S)$ transition form factor for both virtual photons. The general formula is given. We use different models for the $c\bar{c}$ wave function obtained from the solution of the Schrödinger equation for different $c\bar{c}$ potentials: harmonic oscillator, Cornell, logarithmic, power-law, Coulomb and Buchmüller-Tye. We compare our results to the BaBar experimental data for $\eta_c(1S)$, for one real and one virtual photon. We discuss approaching of $Q_1^2 F(Q_1^2, 0)$ or $Q_2^2 F(0, Q_2^2)$ to their asymptotic value $g f_{\eta_c}$ predicted by Brodsky and Lepage formalism. We discuss applicability of the collinear and/or massless limit and delayed onset of asymptotic behaviour. We present some examples of two-dimensional distributions for $F_{\gamma^*\gamma^* \rightarrow \eta_c}(Q_1^2, Q_2^2)$. A scaling in $\omega = (Q_1^2 = Q_2^2)/(Q_1^2 + Q_2^2)$ was obtained. A factorization breaking measure is proposed and factorization breaking effects are quantified and shown to be weakly model dependent.

Primary authors: Prof. SZCZUREK, Antoni (Institute of Nuclear Physics, Polish Academy of Sciences); Prof. GONCALVES, Victor P. (Instituto de Física e Matemática –Universidade Federal de Pelotas (UFPel)); Dr PASECHNIK, Roman (Department of Astronomy and Theoretical Physics, Lund University); Dr SCHÄFER, Wolfgang (Institute of Nuclear Physics, Polish Academy of Sciences); Ms BABIARZ, Izabela (Institute of Nuclear Physics, Polish Academy of Sciences)

Presenter: Ms BABIARZ, Izabela (Institute of Nuclear Physics, Polish Academy of Sciences)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Transverse Momentum Dependent splitting kernels from kT-factorization

Friday, 12 July 2019 11:45 (15 minutes)

Transverse Momentum Dependent parton distribution functions allow to take into account apart from the proton momentum fraction also transverse momenta of initial partons in the description of hadronic cross-section. They are therefore a promising tool to obtain a more precise description of kinematics of hadronic observables. In this talk we present our most recent results in the determination of transverse-momentum-dependent splitting kernels, started in refs. [arXiv:1711.04587, arXiv:1607.01507, arXiv:1511.08439]. Our approach is based on a combination of high energy and collinear factorization and aims at the formulation of a generalized TMD framework. So far we obtained a complete set of real-emission kernels (Pgg, Pgq, Pqg and Pqq) at leading order. After introducing the methods used for defining and computing the real contributions, we concentrate on the current effort aiming at the determination of virtual corrections. We further will provide details on the possible relation of our framework to existing QCD operator definitions of TMD distribution.

Primary authors: HENTSCHINSKI, Martin (Universidad de las Americas, Puebla); KUSINA, Aleksander (IFJ PAN); KUTAK, Krzysztof (Instytut Fizyki Jadrowej Polskiej Akademii Nauk); SERINO, Mirko

Presenter: HENTSCHINSKI, Martin (Universidad de las Americas, Puebla)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Study of e+e- annihilation into hadrons with the SND detector at the VEPP-2000 collider

Friday, 12 July 2019 14:30 (15 minutes)

We present recent results on study of exclusive processes of e+e- annihilation into hadrons with the SND detector. Data were collected at the VEPP-2000 e+e- collider in the center-of-mass energy range from 0.3 to 2 GeV. In particular, we have measured the cross sections for e+e- → π+π- and n̅n, studied the radiative decays of excited light vector mesons to π0γ and ηπ0γ, and performed a search for the rare processes of e+e- annihilation into C-even resonances η and f1(1285).

Primary author: DRUZHININ, Vladimir (BINP, Novosibirsk)

Presenter: DRUZHININ, Vladimir (BINP, Novosibirsk)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Measurement from MICE of Coulomb multiple scattering and energy loss

Monday, 15 July 2019 18:30 (1h 30m)

Multiple Coulomb scattering and energy loss are well known phenomena experienced by charged particles as they traverse a material. However, from recent measurements by the MuScat collaboration, it is known that the simulation code (GEANT4) available at the time overestimated the scattering of muons in low Z materials. Updates to GEANT4 have brought the simulations in line with the MuScat data and these new models can be validated over a larger range of momentum, 170-250 MeV/c, with MICE data. This is of particular interest to the Muon Ionization Cooling Experiment (MICE) collaboration which has the goal of measuring the reduction of the emittance of a muon beam induced by energy loss in low Z absorbers. MICE took data without magnetic field suitable for multiple scattering measurements in the spring of 2016 using a lithium hydride absorber and in the fall of 2017 using a liquid hydrogen absorber. The measurement in lithium hydride is reported here along with the preliminary measurements in liquid hydrogen. In the fall of 2016 MICE took data with magnetic fields on and measured the energy loss of muons in a lithium hydride absorber. These data are all compared with the Bethe-Bloch formula and with the predictions of various models, including the default GEANT4 model.

Primary authors: Dr YOUNG, Alan (University of Strathclyde); NUGENT, John Columba (University of Glasgow (GB)); PALLADINO, Vittorio (Universita e sezione INFN di Napoli (IT))

Presenter: Dr YOUNG, Alan (University of Strathclyde)

Session Classification: Wine & Cheese Poster Session

Track Classification: Accelerators for HEP
Learning to pinpoint effective operators at the LHC: a study of the ttbb signature

Friday, 12 July 2019 09:00 (15 minutes)

In the context of the Standard Model effective field theory (SMEFT), we study the LHC sensitivity to four fermion operators involving heavy quarks by employing cross section measurements in the $t\bar{t}b\bar{b}$ final state. Starting from the measurement of total rates, we progressively exploit kinematical information and machine learning techniques to optimize the projected sensitivity at the end of Run III. Indeed, in final states with high multiplicity containing inter-correlated kinematical information, multi-variate methods provide a robust way of isolating the regions of phase space where the SMEFT contribution is enhanced. We also show that training for multiple output classes allows for the discrimination between operators mediating the production of tops in different helicity states. Our projected sensitivities not only constrain a host of new directions in the SMEFT parameter space but also improve on existing limits demonstrating that, on one hand, $t\bar{t}b\bar{b}$ production is an indispensable component in a future global fit for top quark interactions in the SMEFT, and on the other, multi-class machine learning algorithms can be a valuable tool for interpreting LHC data in this framework.

https://doi.org/10.1007/JHEP11(2018)131

Primary authors: MOORTGAT, Seth (Vrije Universiteit Brussel (BE)); MIMASU, Ken (Université Catholique de Louvain); ZHANG, Cen (Institute of High Energy Physics, Chinese Academy Sciences); MARIOTTI, Alberto (VUB Brussels); D’HONDT, Jorgen (Vrije Universiteit Brussel (BE))

Presenter: MOORTGAT, Seth (Vrije Universiteit Brussel (BE))

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Commissioning the SoLid Detector Using Cosmic Ray Muons

*Monday, 15 July 2019 18:30 (1h 30m)*

The SoLid detector was constructed during 2017 and started to take data in December 2017. Commissioning a new detector implies defining and understanding a whole set of new variables. On the one hand the environmental conditions are followed, and on the other hand quantities related to the stability of the detector are monitored.

Cosmic muons are ideal for studying the stability of SoLid, because of their abundance due to the small overburden. Muons can be used to study the timing synchronisation and energy calibration of the detector on a daily timescale. They can be used to monitor the detector stability and to correlate it with the environmental conditions.

Muons also create secondary particles along their trajectory that can be detected and used for commissioning. For instance, spallation neutrons that are thermalized and captured in the detector can be used to verify the thermalisation properties of the detector. Stopping muon decays allow for a check of the muon decay time.

This poster will summarise the experience gained using cosmic ray muons for the detector commissioning.

**Primary author:** VANDIERENDONCK, Giel  
**Presenter:** VANDIERENDONCK, Giel  
**Session Classification:** Wine & Cheese Poster Session  
**Track Classification:** Neutrino Physics
Phase transitions and gravitational waves in models of $Z_N$ scalar dark matter

*Thursday, 11 July 2019 15:50 (20 minutes)*

We study the nature of phase transitions and gravitational wave signals in models of scalar dark matter with $Z_N$ symmetries. The scalar sector comprises the Standard Model Higgs, an Inert Doublet and a complex singlet. In such models, the dark matter relic density can be largely determined by semi-annihilations instead of usual annihilations, which reduces the direct detection signal. We perform a thorough study of the parameter space, investigating the impact of the quartic semi-annihilation couplings on the structure of potential minima, phase transitions, and possible enhancements of the stochastic gravitational wave signal.

**Primary authors:** Mr BENINCASA, Nico; KANNIKE, Kristjan (National Institute of Chemical Physics and Biophysics (EE)); HEKTOR, Andi (National Institute of Chemical Physics and Biophysics (EE)); HRYCZUK, Andrzej (University of Oslo)

**Presenter:** Mr BENINCASA, Nico

**Session Classification:** Dark Matter

**Track Classification:** Dark Matter
Latest results of the LHCf experiment

Thursday, 11 July 2019 17:50 (20 minutes)

The main aim of the LHC forward (LHCf) experiment is to precisely measure very forward particle production in high energy p-p and p-ion collisions. These experimental results are necessary for the tuning of hadronic interaction models used to simulate the Extensive Air Showers (EAS) generated from the interaction of Ultra High Energy Cosmic Rays (UHECR) with the Earth atmosphere. The two main analysis targets of the experiment are: $\pi^0$/photons, important to understand the evolution of the electromagnetic component of EAS; neutrons, important to derive the process inelasticity and to understand the muon component of EAS. During LHC Run II, the experiment acquired data relative to p-p collisions at $\sqrt{s} = 13$ TeV, which allows us to study particle production in $\eta > 8.4$ at the highest energy ever available. In this talk, we would like to present the analysis results relative to forward photons and neutrons produced in p-p collisions at $\sqrt{s} = 13$ TeV, two recently published measurements that highlighted a significant model-data discrepancy. We will also show the first results relative to the ATLAS-LHCf joint analysis, which is a very powerful tool to study forward particle production distinguishing between different production mechanisms, like diffractive and non-diffractive processes. Finally, we will discuss about the analysis and operation prospects of the LHCf experiment in the incoming years.

Primary author: BERTI, Eugenio (Universita e INFN, Firenze (IT))
Presenter: BERTI, Eugenio (Universita e INFN, Firenze (IT))
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Precision Higgs Physics at the International Linear Collider

*Thursday, 11 July 2019 17:35 (15 minutes)*

The precision study of the 125 GeV Higgs boson offers a new window into the search for new physics beyond the Standard Model. To confront the predictions of models with new interactions, it is important that the experimental program be designed to achieve 1% precision over the full spectrum of Higgs boson couplings, with minimal model-dependence in the analysis and with tight control of systematic errors. This talk will explain how a precision Higgs program with these capabilities can be achieved at the proposed International Linear Collider. We will compare the capabilities of the ILC to those of the high-luminosity LHC and to those of other $e^+e^-$ Higgs factory proposals.

**Primary authors:** EIGEN, Gerald (University of Bergen (NO)); Dr KAWADA, Shin-ichi (DESY)

**Presenter:** Dr KAWADA, Shin-ichi (DESY)

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Particle Discovery Opportunities at the International Linear Collider

Friday, 12 July 2019 17:30 (15 minutes)

Future $e^+e^-$ colliders will offer possibilities to search for new particles in a manner very complementary to the searches planned for HL-LHC. ILC, in particular, will operate triggerlessly, with sensitivity to very small energy depositions, and with beam polarization to both control and measure crucial backgrounds. In this contribution we will discuss the potential of ILC to discover new particles both in $e^+e^-$ pair production and in Higgs boson decays. Examples will be given for models of dark matter, SUSY, and extended Higgs sectors, as well as for general light particle searches.

**Primary authors:** EIGEN, Gerald (University of Bergen (NO)); HABERMEHL, Moritz (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** HABERMEHL, Moritz (Deutsches Elektronen-Synchrotron (DE))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
DAΦNE as Test Facility for future colliders

Friday, 12 July 2019 18:10 (20 minutes)

DAΦNE is an lepton collider becoming operational in 2000. It has been providing data in consecutive data-taking periods for the KLOE, DEAR and FINUDA experiments until 2006, for Siddharta in 2009, and again for the upgraded KLOE between November 2014 and March 2018. It will continue operating for PADME (just using the upgraded Linac) and for Siddharta-2 in 2019. DAΦNE is the only existing phi-factory on which starting from 2007 the crab-waist collision scheme has been successfully implemented with and without the experiment solenoid.

Currently only few accelerator test facilities exists: the ATF2 (KEK), a top-class facility designed for the development of the International Linear Collider, CLASSE(Cornell Laboratory for Accelerator Based Science and Education), a centre of excellence in the development of accelerator technologies located in university campus, and ANKA (Karlsruhe), devoted to R&D of machines and applied research.

The proposal of DAΦNE as a test facility (DAΦNE-TF) for accelerator physics and technology development has been presented as an open call for ideas culminated in the organization of a topical workshop in December 2018.

The lines of technological research identified so far for DAΦNE-TF are the following: i) Study of low SEY (Secondary Electron Yield) elements and impedances, graphitization of chambers and other surface treatment technologies; ii) New components for accelerators (vacuum chambers, collimators, masks, kickers) and innovative beam diagnostic techniques; iii) Accelerator components realized with 3D printers; iv) High power solid state RF amplifiers; v) Wide-excursion adjustable permanent magnets; vi) High-power positron sources; vii) Components for future SLED and pulse flatness compensation; viii) Emittance manipulators; ix) Beams interacting with amorphous materials, crystals, lasers, plasma; x) Testing new methods to generate terahertz coherent radiation.

In this contribution a selection of the proposed activities will be summarized and a temptative plan for the future of the DAΦNE-TF proposal will be presented.

Primary author: DE SANTIS, Antonio (INFN - LNF)
Presenter: DE SANTIS, Antonio (INFN - LNF)
Session Classification: Accelerators for HEP
Track Classification: Accelerators for HEP
Light Yukawa couplings from double Higgs production

Thursday, 11 July 2019 09:45 (15 minutes)

One of the puzzles of the SM is the large hierarchy between the Yukawa couplings of different flavours. Yukawa couplings of the first and the second generation are constrained only very weakly so far. However, one can obtain large deviations in the Yukawa couplings in several New Physics (NP) models, such as e.g new vector-like quarks, or new Higgs bosons that couple naturally to individual fermion families. In this talk, we investigate the potential bounds on the NP Higgs Yukawa couplings modification $\kappa_f$ for light quarks from double-Higgs at the LHC. We start discussing model-independent bounds and then we investigate specific models. We have looked at the Higgses’ final states $b\bar{b}\gamma\gamma$, and the relevant experimental cuts to reduce backgrounds and estimated the potential exclusion bounds for $\kappa_f$ and $\kappa_\lambda$ that can be achieved at the LHC for some models.

Primary author: Ms ALASFAR, Lina (Humboldt Universität zu Berlin)

Co-author: Prof. GRÖBER, Ramona (Humboldt-Universität zu Berlin)

Presenters: Ms ALASFAR, Lina (Humboldt Universität zu Berlin); ALASFAR, Lina (Max-Planck-Gesellschaft (DE)); ALASFAR, Lina (HU-Berlin)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Searching for odderon exchange in exclusive $pp \rightarrow pp\phi\phi$ and $pp \rightarrow pp\phi$ reactions

Monday, 15 July 2019 18:30 (1h 30m)

Last year results of the TOTEM collaboration \cite{1} suggest that the odderon exchange can be responsible for a disagreement of theoretical calculations and the TOTEM data \cite{2} for elastic proton-proton scattering. Similar conclusion can be drawn when comparing recent result for $\sqrt{s} \approx 2.76$ TeV with the Tevatron data \cite{3}. It is premature to draw definite conclusion. Here we present some recent studies for two related processes where the odderon exchange may show up. We apply recently proposed tensor-pomeron and vector-odderon model for soft high-energy processes \cite{4}.

The first one is central exclusive production of pairs of $\phi$ mesons. Here odderon exchange is not excluded by the WA102 experimental data \cite{5} for high $\phi\phi$ invariant masses. The process is advantageous \cite{6} as here odderon does not couple to protons (the corresponding coupling constant is probably small). Predictions for the LHC will be presented. The observation of $M_{\phi\phi}$ and the rapidity difference $Y_{\phi\phi}$ seems well suited to identify odderon exchange.

Finally we discuss a possibility to search for odderon exchange for the $pp \rightarrow pp\phi$ reaction \cite{7}. At high energies probably the photon-pomeron fusion is the dominant process. The odderon-pomeron fusion is an interesting alternative. Adding odderon exchange with parameters adjusted for the $\phi\phi$ production improves considerably description of the $pp$ angular correlations measured in the past by the WA102 collaboration \cite{8}. At the low energy we consider also some other sub-leading processes that turned out to be rather small. Predictions for the LHC will be presented.

\begin{itemize}
  \item \cite{1} TOTEM Collaboration, arXiv:1812.04732 [hep-ex]
  \item E. Martynov, B. Niculescu, Phys. Lett. B786 (2018) 207
  \item \cite{2} C. Ewerz, M. Maniatis, O. Nachtmann, Annals Phys. 342 (2014) 31
  \item \cite{3} P. Lebiedowicz, O. Nachtmann, A. Szczurek, arXiv:1901.11490 [hep-ph]
  \item P. Lebiedowicz, O. Nachtmann, A. Szczurek, in preparation
  \item \cite{5} WA102 Collaboration, Phys. Lett. B432 (1998) 436
  \item \cite{8} A. Kirk, Phys. Lett. B489 (2000) 29
\end{itemize}
The LHC Top Working Group was established to perform combinations of top-quark related measurements from the LHC experiments, and provides a forum to discuss interpretation of LHC measurements in the light of the most recent theory developments. In this talk the challenges and the progress in such combinations are presented together with the latest results, including the recently published combination of single-top-quark production cross-section measurements and determination of Vtb.

**Primary authors:** MULDERS, Martijn (CERN); SCHWIENHORST, Reinhard (Michigan State University (US)); MANGANO, Michelangelo (CERN)

**Presenters:** MULDERS, Martijn (CERN); SCHWIENHORST, Reinhard (Michigan State University (US)); MANGANO, Michelangelo (CERN)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Measurement of hadronic cross sections at CMD-3

Friday, 12 July 2019 15:00 (15 minutes)

The CMD-3 experiment at the VEPP-2000 collider in Novosibirsk carries out a comprehensive study of the exclusive cross-sections of $e^+e^- \rightarrow \text{hadrons}$ in the center-of-mass energy range from the threshold to $\sqrt{s} < 2$ GeV. The energy scan of the whole energy range was performed in 2011-2013 and, after detector and collider upgrade and increase in luminosity by factor 2-3, in 2017-2019. The total luminosity integral collected so far is $200 \text{ pb}^{-1}$.

Measurement of the total cross-section of $e^+e^- \rightarrow \text{hadrons}$, derived as the sum of exclusive channels, provides an important input for the calculation of the hadronic contribution to the muon anomalous magnetic moment. The calculation is strongly dominated by low-energy data, in particular, by data at $\sqrt{s} < 2$ GeV. The largest contribution comes from $e^+e^- \rightarrow \pi^+\pi^-$ channel, therefore the corresponding cross-section should be measured with sub-percent precision. The new results from CMD-3 are essential for improvement of the reliability of the Standard model calculation, whose accuracy should match the expected precision of the new experiment for measurement of muon $(g - 2)$ taking data at Fermilab.

Other interesting topic of the CMD-3 physics program is the detailed study of the hadron cross-sections at the nucleon-antinucleon threshold.

Here we present the survey of results of data analysis, including various modes of electron-positron annihilation with up to seven pions or two kaons and pions in the final state.

**Primary author:** LOGASHENKO, Ivan (BINP)

**Presenter:** IVANOV, Vyacheslav (BINP)

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Atmospheric neutrino spectrum reconstruction with JUNO

Thursday, 11 July 2019 12:10 (20 minutes)

The atmospheric neutrino flux represents a continuous source that can be exploited to infer properties about Cosmic Rays and neutrino oscillation physics. The JUNO observatory, a 20 kt liquid scintillator currently under construction in China, will be able to detect the atmospheric flux, given the large fiducial volume and the excellent energy resolution. The light produced in neutrino interactions will be collected by a double-system of photosensors: 18,000 x 20" PMTs and 25,000 x 3" PMTs. The rock overburden above the experimental hall is around 700 m and the experiment is expected to start the data-taking in 2021.

In this study, a sample of Monte Carlo events has been generated from theoretical models of the atmospheric neutrino flux, through the Genie software. To evaluate the JUNO performances, the events have been processed by a full Geant4 - based simulation, which propagates all the particles and the light inside the detector. The different time evolution of light on the PMTs allows to discriminate the flavor of the primary neutrinos. To reconstruct the time pattern of events, the signals from 3" PMTs only have been used, because of the small time resolution. A probabilistic unfolding method has been used, in order to infer the primary neutrino energy spectrum by looking at the detector output. JUNO will be particularly sensitive in the energy range (100-1000) MeV, where neutrino-induced events can be fully contained within the instrumented volume.

Primary author: SETTANTA, Giulio (INFN - National Institute for Nuclear Physics)

Co-authors: MARI, Stefano Maria (INFN - National Institute for Nuclear Physics); Ms MARTELLINI, Cristina (INFN - National Institute for Nuclear Physics); MONTINI, Paolo (INFN - National Institute for Nuclear Physics)

Presenter: SETTANTA, Giulio (INFN - National Institute for Nuclear Physics)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Recent measurements of electroweak boson properties at D0

Friday, 12 July 2019 15:15 (15 minutes)

We present a measurement of the shape of the Z boson rapidity for $Z/\gamma^* \rightarrow \mu^+\mu^-$ produced in $p\bar{p}$ collision at $\sqrt{s} = 1.96$ TeV. We use 8.6 fb$^{-1}$ of $p\bar{p}$ data collected by the D0 detector at the Tevatron collider. The results are compared to NNLO QCD predictions using different sets of Parton Density Functions. We also present a measurement of the shape of the transverse momentum distribution for W boson in the $W \rightarrow e\nu$ decay channel using 4.2 fb$^{-1}$ of $p\bar{p}$ data at $\sqrt{s} = 1.96$ TeV.

**Primary authors:** TUCHMING, Boris (Université Paris-Saclay (FR)); HIROSKY, Bob (University of Virginia (US)); D0, Collaboration

**Presenter:** WANG, Chen (University of Science and Technology of China (CN))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
High-$p_T$ Lepton Tails at the LHC and Flavour Physics

Thursday, 11 July 2019 16:45 (15 minutes)

Large Hadron Collider (LHC) is delivering an unprecedented amount of data which enables ATLAS and CMS detectors to perform the most precise measurements of the Drell-Yan and mono-lepton high-$p_T$ tails. One the one hand, the LHC is a collider of five-quark flavors and several excellent methods of heavy flavor tagging in the final state have recently been developed, while on the other hand, a short distance new physics effects are enhanced at high-$p_T$. Having this in mind, we explore the opportunities and challenges for studying heavy flavour physics in the high-$p_T$ tails in years to come.

Primary author: GRELJO, Admir
Presenter: GRELJO, Admir
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Cosmic-Ray Lithium Isotopes with the Alpha Magnetic Spectrometer

Measurement of the lithium isotopes $^6\text{Li}$ and $^7\text{Li}$ fluxes and ratios based on data collected by AMS during the first 7 years of operation are presented. Prospects for measurement of beryllium and boron isotopic ratios with AMS will be also discussed.

**Primary authors:** DEROME, Laurent Yves Marie (Centre National de la Recherche Scientifique (FR)); ALI CAVASONZA, Leila (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** DEROME, Laurent Yves Marie (Centre National de la Recherche Scientifique (FR))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Astroparticle Physics and Gravitational Waves
Antimatter in High Schools

Friday, 12 July 2019 16:45 (15 minutes)

In the context of a national general public event on antimatter (called Nuit de l’antimatière, https://www.sfpnet.fr/nuit-de-l-antimatiere) that has been organized under the aegis of CNRS (French National Center for Scientific Research), SFP (French Physical Society) and CEA (French Alternative Energies and Atomic Energy Commission), we initiated a pedagogical project to visit high schools with an antimatter detection setup. Over the first half of 2019, we had the opportunity to deliver these lectures in 20 high schools, located in the French region Auvergne-Rhône-Alpes. The setup consisted of two gamma ray NaI detectors recording positron-electron annihilations originating from a $^{22}$Na source. The whole device was made easily portable and did not require any particular transportation authorization from the French Nuclear Safety Agency (ASN) ($^{22}$Na activity < 1 MBq). The experiment and the pedagogical material accompanying the interventions were prepared in a language adapted to the physics program of the final two years of high school in France. This class provided a perfectly suitable pedagogical tool to experimentally touch upon several notions of radioactivity, relativity, particle physics, quantum mechanics, collision kinematics, as well as the principle of positron emission tomography. An outlook on contemporary research activities on antimatter at CERN as well as in cosmology and astrophysics was a natural extension, arousing further interest from the students. The speaker will briefly describe the experiment and the subjects covered during the lectures, and present the perspectives for extending the initiative to more participants at the national and international level.

Primary author: COLLOT, Johann (university Grenoble Alpes (FR))

Co-authors: CLEMÉNT, Benoît; Ms PÉRIGOIS, Carole (LAPP); FURGET, Christophe (Centre National de la Recherche Scientifique (FR)); Mr GALLOT, Laurent (LAPTh); REBOUD, Meril (Centre National de la Recherche Scientifique (FR)); DEL AMO SANCHEZ, Pablo (LAPP - Université de Savoie - IN2P3 - CNRS); SERPICO, Pasquale (LAPTh - CNRS & Univ. Savoie (FR)); GHEZ, Philippe (Centre National de la Recherche Scientifique (FR)); KARYOTAKIS, Yannis (LAPP CNRS/IN2P3)

Presenter: COLLOT, Johann (university Grenoble Alpes (FR))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
The goal of the NEXT (Neutrino Experiment with a Xenon TPC) collaboration is the sensitive search of the neutrino-less double beta decay ($\beta\beta_{0\nu}$) of $^{136}\text{Xe}$ at the Laboratorio Subterraneo de Canfranc (LSC). The observation of such a lepton-number-violation process would prove the Majorana nature of neutrinos, providing also handles for an eventual measurement of the neutrino absolute mass. After a successful R&D phase, a first large-scale prototype of a high-pressure gas-Xenon electroluminescent TPC is being operated at the LSC since 2016. NEXT-White is a 5-kg radiopure detector meant to understand the relevant backgrounds for the $\beta\beta_{0\nu}$ search and to perform a measurement of the two neutrino mode of the double beta decay ($\beta\beta_{2\nu}$). The operation of NEXT-White is setting the grounds for the construction of the NEXT-100 detector: a TPC holding 100 kg of $^{136}\text{Xe}$ and reaching a sensitivity to the $\beta\beta_{0\nu}$ half-life of $6\times10^{25}$ y after 3 years of data taking. In this talk, the latest results from the NEXT-White detector will be presented. The calibration data have allowed to evaluate the performance of the NEXT technology in terms of the topology-based background rejection capabilities and the energy resolution. In particular, a world-leading resolution for a Xe TPC has been achieved ($<1\%$ FWHM at 2.6 MeV). The radioactivity-induced backgrounds have also been measured using the data collected operating the detector with depleted xenon. These results validate the background model of the NEXT experiment, estimating less than $5\times10^{-4}$ counts/keV/kg/year in the NEXT-100 detector. As NEXT-White is currently taking data with $^{136}\text{Xe}$, preliminary results on the measurement of the $\beta\beta_{2\nu}$ half-life will be released in this talk. Finally, the status of NEXT-100 and future upgrades, like the Ba$^{2+}$ tagging R&D, will also be addressed.

**Primary author:** NOVELLA GARIJO, Pau (Univ. of Valencia and CSIC (ES))

**Co-author:** FOR THE NEXT COLLABORATION

**Presenter:** NOVELLA GARIJO, Pau (Univ. of Valencia and CSIC (ES))

**Session Classification:** Neutrino Physics

**Track Classification:** Neutrino Physics
Progress on Muon Ionization Cooling Demonstration with MICE

Monday, 15 July 2019 18:30 (1h 30m)

The Muon Ionization Cooling Experiment (MICE) at RAL has collected extensive data to study the ionization cooling of muons. Several million individual particle tracks have been recorded passing through a series of focusing magnets in a number of different configurations and a liquid hydrogen or lithium hydride absorber. Measurement of the tracks upstream and downstream of the absorber has shown the expected effects of the 4D emittance reduction. Further studies are providing now more and deeper insight.

Primary authors:  PALLADINO, Vittorio (Universita e sezione INFN di Napoli (IT)); HUNT, Christopher (Imperial College); Mr JURJ, Paul (Imperial College London)
Presenter:  Mr JURJ, Paul (Imperial College London)
Session Classification:  Wine & Cheese Poster Session
Track Classification:  Accelerators for HEP
Emittance exchange in MICE

Monday, 15 July 2019 18:30 (1h 30m)

The Muon Ionization Cooling Experiment, MICE, has demonstrated transverse emittance reduction through ionization cooling. Transverse ionization cooling can be used either to prepare a beam for acceleration in a neutrino factory or for the initial stages of beam cooling in a muon collider. Later stages of ionization cooling in the muon collider require the longitudinal emittance to be manipulated using emittance exchange and reverse emittance exchange, where emittance is exchanged from and to longitudinal phase space respectively. A wedge absorber within the MICE cooling channel has been used to experimentally demonstrate reverse emittance exchange in ionization cooling. Parameters for this test have been explored in simulation and applied to experimental configurations using a wedge absorber when collecting data in the MICE beam. This analysis of reverse emittance exchange is presented in detail.

Primary authors: PALLADINO, Vittorio (Università e sezione INFN di Napoli (IT)); BONESINI, Maurizio; BROWN, Craig; ROGERS, Chris (STFC)

Presenter: BONESINI, Maurizio

Session Classification: Wine & Cheese Poster Session

Track Classification: Accelerators for HEP
Pseudoscalar current transition form factors of the delta in baryon chiral perturbation theory

*Thursday, 11 July 2019 15:00 (15 minutes)*

We present the chiral corrections to the pseudoscalar current transition form factors of the delta in relativistic baryon chiral perturbation theory up to third chiral order using the complex-mass renormalization scheme (CMS) to generate a systematic power counting. We analyze the form factors $\tilde{g}(q^2)$ and $\tilde{h}(q^2)$ which are relevant to address the $\pi\Delta\Delta$ coupling constants at $q^2 = 0$. Knowledge on these form factors are necessary as there is no clear available experimental data for the pseudoscalar current-delta transition form factors which makes the topic still up to date for both experimental and theoretical studies.

This study was supported by Canakkale Onsekiz Mart University Scientific Research Projects Commission under the grant no: FBA-2018-2666.

**Keywords:** Baryon chiral perturbation theory, CMS, delta resonance, form factors.

**Primary author:** Dr ÜNAL, Yasemin (Çanakkale Onsekiz Mart University)

**Presenter:** Dr ÜNAL, Yasemin (Çanakkale Onsekiz Mart University)

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
The DAMPE experiment: performances and first results

Thursday, 11 July 2019 16:30 (20 minutes)

The DAMPE (DArk Matter Particle Explorer) experiment, in orbit since December 17th 2015, is a space mission whose main purpose is the detection of cosmic electrons and photons up to energies of 10 TeV, in order to identify possible evidence of Dark Matter in their spectra. Furthermore it aims to measure the fluxes and the elemental composition of the galactic cosmic rays nuclei up to 100 TeV, in order to get a better understanding of the galactic sources, acceleration mechanisms and propagation processes in the Galaxy. The DAMPE detector consists of: a double layer of Plastic Scintillator Detector; a Silicon-tungsten Tracker-converter; an electromagnetic calorimeter (composed by BGO crystals) and a Neutron Detector. We intend to present and discuss the performances of the detector and the main scientific results obtained after three years of data taking.

**Primary author:** Mr DE BENEDITTIS, Antonio (Università del Salento and INFN Lecce)

**Presenter:** Mr DE BENEDITTIS, Antonio (Università del Salento and INFN Lecce)

**Session Classification:** Astroparticle Physics and Gravitational Waves

**Track Classification:** Astroparticle Physics and Gravitational Waves
The High Intensity Muon Beam (HiMB) project at PSI

Saturday, 13 July 2019 12:40 (20 minutes)

Meson factories are powerful drivers of diverse physics programs and play a major role in particle physics at intensity frontiers.

Currently PSI delivers the most intense continuous muon beam in the world up to $5 \times 10^8 \mu^+/s$. The High Intensity Muon Beam (HiMB) project at PSI aims at develop new muon beam lines able to provide up to $10^{10} \mu^+/s$. While next generation of proton drivers with beam powers in excess of the current limit of 1.4 MW still requires significant research, the focus of HiMB is the optimisation of existing target stations and beam lines. Detailed Monte Carlo simulations show that geometrical target optimisations would imply beam intensity gains in the range of 30-60%, that could be further increased by using novel target materials such as boron carbide. Higher muon capture and transmission beam line efficiencies can be obtained with a design of a beam line optics based on pure solenoid elements. The expectation is to increase the total fraction of captured and transmitted muons by more than one order of magnitude with respect to the current hybrid beam lines.

Putting into perspective the target optimisation only, corresponding to O(50%) of muon beam intensity gain, would corresponds to effectively raising the proton beam power at PSI by 650 kW, equivalent to a proton beam power of almost 2 MW without additional complications such an increased energy and radiation deposition into the target and its surroundings. Taking also into account the beam line optimisation the equivalent proton beam power would be of order of several tens of MW, an outstanding value and out of present technological capabilities.

This year the new production target prototype will be installed and tested along the primary beam line at PSI. The status of the project will be reported in detail.

Primary authors: PAPA, Angela (PSI and UniPi/INFN); KETTLE, Peter-Raymond (PSI); KNECHT, Andreas (PSI)

Presenter: PAPA, Angela (PSI and UniPi/INFN)

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
4D particle tracking with Resistive AC-Coupled Silicon Detectors

Thursday, 11 July 2019 16:45 (15 minutes)

In this contribution we present the advantages of performing 4D particle tracking with Resistive AC-Coupled Silicon Detectors (RSD), a new paradigm in silicon detectors with moderate internal multiplication. Their design is an evolution of the standard LGAD (Low-Gain Avalanche Diode) technology, and is based on the combination of a resistive $n$-implant, freezing the multiplied charges, and a capacitive oxide layer, coupling the signal with the readout pads. Having a homogeneous gain layer throughout the detector, the spatial granularity is realized through the segmentation of pads, while the timing information directly benefits from the good performances given by the internal multiplication. Such scheme will allow to completely eliminate the signal loss between active areas (or pixels) proper of LGAD-based silicon trackers and to fully exploit the potentialities of high-luminosity scenarios foreseen in near-future colliders, thanks to their intrinsic 100% fill-factor (the ratio between the active and the total area).

After reviewing the RSD working principle and their design through numerical simulations, also a set of laboratory characterizations performed on the first production run RSD1 at Fondazione Bruno Kessler (FBK) will be presented, both before and after irradiation.

Primary authors: MANDURRINO, Marco (INFN); ARCIDIACONO, Roberta; BOSCARDIN, Maurizio; CARTIGLIA, Nicolò (INFN); DALLA BETTA, Gian Franco; FERRERO, Marco; FICORELLA, Francesco; PANCHERI, Lucio; PATERNOSTER, Giovanni; SIVIERO, Federico; SOLA, Valentina; STAiano, Amedeo; VIGNATI, Anna

Presenter: MANDURRINO, Marco (INFN)

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
Strong gravitational radiation from a simple dark matter model

*Thursday, 11 July 2019 15:30 (20 minutes)*

A rather minimal possibility is that dark matter consists of the gauge bosons of a spontaneously broken symmetry. Here we explore the possibility of detecting the gravitational waves produced by the phase transition associated with such breaking. Concretely, we focus on the scenario based on a dark SU(2) group and argue that it is a case study for the sensitivity of future gravitational wave observatories to phase transitions associated with dark matter. This is because there are few parameters and those fixing the relic density also determine the effective potential establishing the strength of the phase transition. Particularly promising for LISA is the super-cool dark matter regime, with DM masses above 100 TeV, for which we find that the gravitational wave signal is notably strong. In our analysis, we include the effect of astrophysical foregrounds, which are often ignored in the context of phase transitions.

**Primary author:** Dr BALDES, Iason (ULB)  
**Co-author:** Dr GARCIA CELY, Camilo (DESY)  
**Presenter:** Dr BALDES, Iason (ULB)  
**Session Classification:** Dark Matter  
**Track Classification:** Dark Matter
Probing the dark sector via searches for invisible decays of the Higgs boson at the ILC

Thursday, 11 July 2019 17:50 (15 minutes)

To unravel the nature of dark matter is one of the most important goals in particle physics today. The Higgs field may well be the portal that couples to a whole new dark sector in which the dark matter candidate particle is accommodated. Searches for invisible decays of the Higgs boson, which may originate from the Higgs boson decaying to dark matter directly or via some mediator, would give us a clear signal of new physics. At $e^+e^-$ colliders, taking advantage of the recoil mass technique, the 4-momentum of the Higgs boson can be fully reconstructed even though it decays invisibly. A specific advantage of the ILC are the polarized beams which help to suppress the background significantly. We will report our studies based on the full simulation of the ILD detector concept, using the $e^+e^- \to ZH$ with $Z \to qq/ll$ channels. We obtain a sensitivity to $\text{BR}(H^{-}\to\text{invisible})$ of $0.3\%$ (95\% C.L. upper limit) at the ILC 250 GeV with an integrated luminosity of 2 ab$^{-1}$. We will also discuss the impact of center-of-mass energy, beam spectrum, ISR, and detector performance for the Higgs to invisible measurement.

**Primary authors:** Dr TIAN, Junping (The University of Tokyo); Mr KATO, Yu (The University of Tokyo); KAWAGOE, Kiyotomo (Kyushu University (JP))

**Presenter:** Mr KATO, Yu (The University of Tokyo)

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Production and electroweak couplings of 3rd generation quarks at the ILC

Saturday, 13 July 2019 12:30 (15 minutes)

The 3rd generation quarks are, due to their large mass, highly sensitive probes for new physics connected to the electroweak symmetry breaking. Linear e+e- colliders allow for clean measurements of heavy quark final states between the Z-Pole and the TeV scale with sensitivities to different aspects of the manifestations of new physics in the extracted electroweak couplings. At the same time these processes are ideal benchmarks for the optimisation of detectors at linear colliders. This includes for example the event-by-event distinction between b and anti-b quarks indispensable for the proper measurement of differential observables. The contribution will outline with full simulation studies the capabilities of the ILD concept. An efficiency of 30% has been achieved for the charge measurements in bb final states, which is about a factor three better than presented earlier. We will also present new results using the fully hadronic tt final state. Finally quantitative estimations of the reach in detecting the onset of new physics will be given.

Primary authors: POESCHL, Roman (Centre National de la Recherche Scientifique (FR)); KAWAGO, Kiyotomo (Kyushu University (JP)); IRLES, Adrian (LAL-CNRS/IN2P3)

Presenter: IRLES, Adrian (LAL-CNRS/IN2P3)

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
The ILC as a natural SUSY discovery machine and precision microscope: From light higgsinos to tests of unification

Thursday, 11 July 2019 12:15 (15 minutes)

The requirement of electroweak naturalness in simple supersymmetric models motivates the existence of a cluster of four light higgsinos with mass 100-300 GeV, the lighter the better. While such light compressed spectra may be challenging to observe at LHC, future e+e- colliders with \( \sqrt{s} > 2m(\text{higgsino}) \) would serve as both a SUSY discovery machine and a precision microscope.

We study higgsino pair production signatures at the ILC based on full, Geant4-based simulation of the ILD detector concept. We examine several benchmark scenarios that may or may not be accessible to HL-LHC searches, with mass differences between the higgsino states between 20 and 4 GeV. Assuming \( \sqrt{s} = 500 \text{ GeV} \) and 1000 fb\(^{-1}\) of integrated luminosity, the individual higgsino masses can be measured to 1-2% precision in case of the larger mass differences, and still at the level of 5% for the smallest mass difference case. The higgsino mass splittings are sensitive to the electroweak gaugino masses and can allow extraction of gaugino masses to 3 - 20% (depending on the model). Extrapolation of gaugino masses via renormalization group running can test the hypothesis of gaugino mass unication. We also examine a case with natural generalized mirage mediation where the unication of gaugino masses at an intermediate scale apparently gives rise to a natural SUSY spectrum somewhat beyond the reach of HL-LHC.

**Primary authors:** LIST, Jenny (Deutsches Elektronen-Synchrotron (DE)); KAWAGOE, Kiyotomo (Kyushu University (JP)); SASIKUMAR, Swathi (DESY)

**Presenter:** SASIKUMAR, Swathi (DESY)

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
Latest three-flavor neutrino oscillation results from NOvA

Friday, 12 July 2019 09:45 (20 minutes)

The NOvA experiment is a long-baseline neutrino oscillation experiment that uses the upgraded NuMI beam from Fermilab to detect both electron appearance and muon disappearance. NOvA employs two functionally identical detectors: a Near Detector, located at Fermilab, and a Far Detector, located at Ash River, Minnesota over an 810 km baseline. NOvA's primary physics goals include precision measurements of neutrino oscillation parameters, such as $\theta_{23}$ and the atmospheric mass-squared splitting, along with probes of the mass hierarchy and the CP violating phase. This talk will present the latest NOvA measurements of the neutrino oscillation parameters using neutrino and antineutrino disappearance and appearance.

Primary author: KOLUPAEVA, Liudmila
Presenter: KOLUPAEVA, Liudmila
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Sterile neutrino searches with the Icarus detector

Saturday, 13 July 2019 10:10 (15 minutes)

The ICARUS collaboration employed the 760-ton T600 detector in a successful three-year physics run at the underground LNGS laboratory studying neutrino oscillations with the CNGS neutrino beam from CERN and searching for atmospheric neutrino interactions. ICARUS performed a sensitive search for LSND-like anomalous $\nu_e$ appearance in the CNGS beam, contributing to constraint the allowed parameters to a narrow region around $\Delta m^2 \sim eV^2$, where all the experimental results can be coherently accommodated at 90% CL. After a significant overhauling at CERN, the T600 detector has now been placed in its experimental hall at Fermilab where installation activities are in progress. It will be soon exposed to the Booster Neutrino Beam to search for sterile neutrino within the Short Baseline Neutrino (SBN) program, devoted to clarify in a definitive way the open questions of the presently observed neutrino anomalies. The contribution will address ICARUS achievements and plans for the sterile neutrino search at Fermilab.

Primary authors: MENEGOLLI, Alessandro (University of Pavia and INFN Pavia); ON BEHALF OF THE ICARUS COLLABORATION

Presenter: MENEGOLLI, Alessandro (University of Pavia and INFN Pavia)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
The FAMU experiment at RIKEN RAL for a precise measure of the proton radius

Thursday, 11 July 2019 12:45 (15 minutes)

The FAMU (Fisica degli Atomi Muonici) experiment has the goal to measure precisely the proton Zemach radius, thus contributing to the solution of the so-called proton radius "puzzle", consisting in a 6 sigmas discrepancy between measurements with electrons and with muons of the charge proton radius. This discrepancy may point to new physics or violation of the lepton universality. To this aim, the FAMU experiment makes use of a high-intensity pulsed muon beam at RIKEN-RAL impinging on a cryogenic hydrogen target with an high-Z gas admixture and a tunable mid-IR high power laser, to measure the hyperfine (HFS) splitting of the 1S state of the muonic hydrogen. From the value of the exciting laser frequency, the energy of the HFS transition may be derived with high precision ($\sim 10^{-5}$) and thus, via QED calculations, the Zemach radius of the proton. The experimental signature of the process will be the emission of characteristic X-rays ($\sim 100$ keV) from the de-excitation of the high-Z muonic atoms formed when the muon is transferred from $\mu p$ to $\mu Z$. Preliminary studies have provided indications on the most suitable high-Z elements to be used. The experimental apparatus includes a system of precise fiber-SiPM beam hodoscopes, a crown of eight 1" $LaBr_3$ crystals read by photomultipliers complemented by additional 1/2" $LaBr_3$ crystals read by SiPM arrays with temperature control and a few HPGe detectors for detection of the emitted characteristic X-rays around 100 keV. The system is in condition to detect the signal in a very noisy environment and has been used for preliminary runs. The experimental apparatus and the innovative method to determine the Zemach proton radius with high precision will be described in detail.

Primary author: ON BEHALF OF THYE FAMU COLLABORATION

Presenters: BONESINI, Maurizio; BONESINI, Maurizio (Università & INFN, Milano-Bicocca (IT)); BONESINI, Maurizio

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
The Matrix Element Method as a tool for precision and accuracy

*Thursday, 11 July 2019 09:30 (15 minutes)*

The Matrix Element Method is a promising multi-variate analysis method which offers an optimal approach to compare theory and experiment. However, until recently its usage has been limited by the fact that only leading-order predictions could be employed. This rather crude approximation of the underlying probability distribution can introduce a significant bias into the analysis which requires a major calibration for the method to be accurate. Moreover, the estimation of the theoretical uncertainties by scale variation in the Born-level calculation may yield unreliable results. We present the extension of the Matrix Element Method to the next-to-leading order in QCD readily applicable to LHC data. The accuracy gain is illustrated by determining the top-quark mass from single top-quark events generated with POWHEG+Pythia. Additionally, the method’s potential for BSM parameter determination is demonstrated by extracting a CP-violating Top-Yukawa coupling from events of single top-quarks in association with a Higgs boson.

**Primary author:** MARTINI, Till (HU Berlin)

**Co-authors:** Dr KRAUS, Manfred (HU Berlin); UWER, Peter (Humboldt-Universität zu Berlin); PEITZSCH, Sascha (HU Berlin)

**Presenter:** MARTINI, Till (HU Berlin)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Rapidity distributions of pions in p+p and Pb+Pb collisions at CERN SPS energies

Thursday, 11 July 2019 12:06 (18 minutes)

Our presentation will be largely based on our recent paper [1].

The centrality and energy dependence of rapidity distributions of pions in Pb+Pb reactions can be understood by imposing local energy-momentum conservation in the longitudinal "fire-streaks" of excited matter. With no tuning nor adjustment to the experimental data, the rapidity distribution of pions produced by the fire-streak which we obtained from Pb+Pb collisions reproduces the shape of the experimental pion rapidity distribution in p+p interactions, measured by the NA49 Collaboration at the same energy per nucleon. The observed difference in the absolute normalization of this distribution can be explained by the difference in the overall energy balance, induced by baryon stopping and strangeness enhancement phenomena occurring in heavy ion collisions. We estimate the latter effects using a collection of CERN SPS experimental data on $\pi^\pm$, $K^\pm$, net $p$, and $n$ production in p+p and Pb+Pb reactions. We discuss the implications of the above findings for the understanding of particle production phenomena in both hadron-hadron and nucleus-nucleus collisions. In addition, we comment on the excellent accuracy in the determination of the energy balance at the CERN SPS, which can be used as an independent tool to test different models for hadronic or nuclear reactions.

A complete update of \( \varepsilon' / \varepsilon \) in the Standard Model

Thursday, 11 July 2019 17:10 (20 minutes)

The recent release of improved lattice data has revived again the interest on precise theoretical predictions for the direct CP-violation ratio \( \varepsilon' / \varepsilon \). We present a complete update of the Standard Model prediction, including a new re-analysis of isospin-breaking corrections which are of vital importance in the theoretical determination of this observable. Contrary to recent claims, the Standard Model prediction turns out to be in good agreement with the experimental measurement. In addition, we analyse the prospects for future improvements on the current uncertainty, which is dominated by our current ignorance about \( 1/N_C \)-suppressed contributions to some chiral-perturbation theory low-energy constants.

Primary authors:  PICH, Antonio (IFIC, U. Valencia -); CIRIGLIANO, Vincenzo (Los Alamos National Laboratory); RODRÍGUEZ, Antonio (IFIC (UV-CSIC)); GISBERT MULLOR, Hector (University of Valencia - IFIC)

Presenter:  GISBERT MULLOR, Hector (University of Valencia - IFIC)

Session Classification:  Flavour Physics and CP Violation

Track Classification:  Flavour Physics and CP Violation
Tagging Top in Leptonic Decay

Friday, 12 July 2019 11:45 (15 minutes)

We have performed an object tagging approach to identify boosted top quark decaying to electron or muon final state without an explicit use of the lepton. When top quark is produced with large transverse momentum, its daughter lepton has a hadronic activity in its neighborhood, and hence standard lepton identification and isolation criteria are affected. We have come up with novel observables and used jet substructure information to tag the top quark in this scenario. We have also developed new variables which can distinguish the top quark from its supersymmetric partner stop, when both of them decay to the same final state consisting of lepton, b quark and missing energy. The performance of our tagger is evaluated using multivariate analysis at detector level.

Primary authors: Mr CHATTERJEE, Suman (Tata Inst. of Fundamental Research (IN)); ROY, Tuhin (Boston University); GODBOLE, Rohini Madhusudan (Indian Institute of science (IN))

Presenter: Mr CHATTERJEE, Suman (Tata Inst. of Fundamental Research (IN))

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
LHC constraints on the minimal Dirac gaugino model.

*Thursday, 11 July 2019 11:30 (15 minutes)*

Most SUSY searches at the LHC are optimised for the MSSM, where gauginos are Majorana particles. By introducing Dirac gauginos, we obtain an enriched phenomenology, from which considerable differences in the LHC signatures and limits are expected as compared to the MSSM. Concretely, in the minimal Dirac gaugino model (MDGSSM) we have six neutralino and three chargino states. Moreover, production cross sections are enhanced for gluinos, while for squarks they are suppressed. In this talk, we explore the consequences for the current LHC limits on gluinos and squarks. This is based on the recent paper arXiv:1812.09293. We also comment on ongoing work regarding electroweak-ino phenomenology in the MDGSSM.

**Primary authors:** CHALONS, Guillaume (CNRS); GOODSELL, Mark Dayvon (Sorbonne Université (FR)); KRAML, Sabine (LPSC Grenoble); REYES-GONZÁLEZ, Humberto (LPSC Grenoble); WILLIAMSON, Sophie (LPTHE, Sorbonne Université)

**Presenter:** REYES-GONZÁLEZ, Humberto (LPSC Grenoble)

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
The Belle II experiment at the SuperKEKB energy-asymmetric $e^+e^-$ collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and the Belle II experiment aims to record 50 ab$^{-1}$ of data, a factor of 50 more than its predecessor. From February to July 2018, the machine has completed a commissioning run, achieved a peak luminosity of $5.5 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$, and Belle II has recorded a data sample of about 0.5 fb$^{-1}$. Main operation of SuperKEKB has started in March 2019.

We use the early Belle II data to characterize the performance of the detector regarding the tracking of charged particles, the reconstruction of known resonances, and the capability of identifying displaced decay vertices.

A first benchmark towards analysing time-dependent CP violation consists in the measurement of the lifetime of $B$ mesons and of the $B^0 - \bar{B}^0$ mixing frequency. We present the first results, based on samples of $B$ mesons that decay to hadronic and semileptonic final states. We further present estimates of the sensitivity to $\beta$ in the golden channels $B \to c\bar{c} s$ and in the penguin-dominated modes $B^0 \to \eta' K^0, \phi K^0, K_S \pi^0(\gamma)$. A study of the time-dependent analysis of $B^0 \to \pi^0\pi^0$, relevant for the measurement of $\alpha$, and feasible only in the clean environment of an $e^+e^-$ collider, will also be given.

Belle II can also measure $\gamma$, the third and least well known CKM angle, through the interference between $B^+ \to D^0 K^+$ and $B^+ \to \bar{D}^0 K^+$ decays, which occurs if the final state of the charm-meson decay is accessible to both the $D^0$ and $\bar{D}^0$ mesons. We will also discuss the precision that Belle II will be achieved in this measurement.
We present fits to determine parton distribution functions (PDFs) using top-antitop, inclusive $W/Z$-boson, as well as $W^+$ and $W^-$ boson production measurements in association with jets from ATLAS, in combination with deep-inelastic scattering data from HERA. The ATLAS $W$ and $Z$ boson data exhibit sensitivity to the valence quark distributions and the light quark sea composition, whereas the top-quark pair production data have sensitivity to the gluon distribution. The impact of the top-antitop production data is increased by fitting several distributions simultaneously, with the full information on the systematic and statistical correlations between data points. The parton distribution functions extracted using $W$+jets data show an improved determination of the high-$x$ sea-quark densities, while confirming the unsuppressed strange-quark density at lower $x<0.02$ found by previous ATLAS analyses.

**Primary author:** ATLAS COLLABORATION  
**Presenter:** GIULI, Francesco (INFN e Universita Roma Tor Vergata (IT))  
**Session Classification:** QCD and Hadronic Physics  
**Track Classification:** QCD and Hadronic Physics
Measurement of jet substructure observables using the ATLAS detector

Theoretical calculations for jet substructure observables with accuracy beyond leading-logarithm have recently become available. Such observables are significant not only for probing a new regime of QCD at a hadron collider, but also for improving the understanding of jet substructure properties that are used in many searches for physics beyond the Standard Model. In this talk, we discuss a first measurement of such jet substructure quantities. The soft drop mass is measured in dijet events with the ATLAS detector at $\sqrt{s}=13$ TeV, unfolded to particle-level and compared to Monte Carlo simulations. We also present a measurement of substructure variables in $t\bar{t}$ and inclusive jet events, using data collected by the ATLAS experiment at $\sqrt{s} = 13$ TeV. The measurements are performed with large-radius jets. They are corrected for detector effects, represented as particle-level distributions and are compared to the predictions of various Monte Carlo event generators. If available, a measurement of jet substructure observables performed using charged particles, at $\sqrt{s} = 13$ TeV, is also presented. New event generator configurations for the modelling of jet production, derived using ATLAS data will also be presented.

Primary author: ATLAS COLLABORATION
Presenter: VILLAPLANA, Miguel (Università degli Studi e INFN Milano (IT))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Gluon splitting to b-quark pairs is a unique probe of the properties of gluon fragmentation, as the identified b-tagged jets provide a proxy for the quark daughters of the initial gluon. We present a measurement of key differential distributions related to $g\to b\bar{b}$ using data collected with the ATLAS detector at $\sqrt{s}=13$ TeV. Track jets are used to probe angular scales below the standard $R=0.4$ jet radius. The observables are unfolded to particle level in order to facilitate direct comparison with predictions from simulations and provide an important constraint to hadronization models. A measurement of the properties of jet fragmentation performed with proton-proton collision data collected with the ATLAS detector at $\sqrt{s}=13$ TeV will also be presented. Charged particle tracks are used to measure charged particle multiplicity, the jet charge, the summed fragmentation function, the momentum transverse to the jet axis, and the radial profile of the jet. Each observable is unfolded to correct for acceptance and detector effects. Exclusive interpretations in terms of quarks and gluons are provided in order to directly compare with state-of-the-art calculations.

**Primary author:** ATLAS COLLABORATION  
**Presenter:** VILLAPLANA, Miguel (Università degli Studi e INFN Milano (IT))  
**Session Classification:** QCD and Hadronic Physics  
**Track Classification:** QCD and Hadronic Physics
Observation and measurements of vector-boson scattering with ATLAS

Saturday, 13 July 2019 10:00 (15 minutes)

The scattering of electroweak bosons tests the gauge structure of the Standard Model and is sensitive to anomalous quartic gauge couplings. In this talk, we present recent results on vector-boson scattering from the ATLAS experiment using proton-proton collisions at \( \sqrt{s} = 13 \) TeV. This includes the observation of WZ and same-sign-WW production via vector-boson scattering along with a measurement of VV production in semileptonic final states. If available, measurements of ZZ and ZZ production via vector-boson scattering will also be presented. The results can be used to constrain new physics that manifests as anomalous electroweak-boson self interactions. Predicted cross sections for electroweak scattering of two same-sign W bosons in association with two jets are compared for a number of Monte Carlo configurations. The sensitivity to the choices of renormalisation and factorisation scales, the Parton Distribution Functions and showering models are studied into detail.

Primary author: ATLAS COLLABORATION

Presenter: SOMMER, Philip (University of Sheffield (GB))

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Measurements of inclusive WW and WZ production with ATLAS

Saturday, 13 July 2019 09:30 (15 minutes)

Measurements of electroweak boson pair production at the LHC constitute a stringent test of the electroweak sector and provide a model-independent means to search for new physics at the TeV scale. In this talk, we present recent results for inclusive WW and WZ production in proton-proton collisions at $\sqrt{s}=13$ TeV, including polarisation studies in the WZ final state. The precision measurements are compared to theoretical predictions at NLO (and NNLO) in perturbative QCD. The data are sensitive to anomalous triple gauge couplings and are reinterpreted in terms of an effective field theory to constrain new physics beyond the Standard Model.

Primary author: ATLAS COLLABORATION

Presenter: CALFAYAN, Philippe (Indiana University)

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Measurements of inclusive neutral diboson production with ATLAS

Saturday, 13 July 2019 09:45 (15 minutes)

In this talk, we present a number of recent measurements of inclusive ZZ and Z\(\bar{Z}\) production in proton-proton collisions at \(\sqrt{s}=13\) TeV at ATLAS. The unfolded differential cross section for ZZ-\(>4l\) as a function of the four-lepton invariant mass is presented and compared to state-of-the-art Standard Model calculations. If available, an additional measurement of ZZ production will be presented for events in which the ZZ system decays to two charged leptons and two neutrinos. We also report measurements of Z-boson production in association with a high-energy photon, using the Z-boson decay to neutrinos and (if available) the Z boson decay to b-quarks and respectively to charged leptons. The data in all these measurements can be used to search for triple- and quartic-neutral gauge boson interactions, which are forbidden at tree-level in the Standard Model. No excess is observed relative to the Standard Model expectation, and upper limits are set on the strength of ZZ\(\gamma\) and Z\(\gamma\gamma\) couplings.

Primary author: ATLAS COLLABORATION
Presenter: RICHTER, Stefan (DESY)
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurement of photon production at ATLAS

Friday, 12 July 2019 15:00 (15 minutes)

The production of prompt isolated photons at hadron colliders provides stringent tests of perturbative QCD and can be used to evaluate probability density functions of partons in the proton. In this talk, we present the measurements of the isolated-photon plus two jets and the inclusive isolated-photons cross sections, both measured using proton-proton collision data collected by the ATLAS experiment at $\sqrt{s}=13$ TeV. A ratio of photon cross sections at $\sqrt{s}=8$ and $\sqrt{s}=13$ TeV will also be presented. The results are compared with state-of-the-art theory predictions, indicating several interesting discrepancies.

Primary author: ATLAS COLLABORATION

Presenter: CANTERO, Josu (Oklahoma State University (US))

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
Measurement of W and Z boson production at ATLAS

Friday, 12 July 2019 14:45 (15 minutes)

Precision measurements of the production cross sections of W and Z bosons in proton-proton collisions provide stringent tests of perturbative QCD and yield important information about the parton distribution functions (PDFs) for quarks within the proton. We report measurements of fiducial integrated and differential cross sections for inclusive W+, W− and Z boson production, analysed in the electron and muon decay channels, using data collected at center-of-mass energies of 2.76 and 5.02 TeV. The measurement of the W+ and W− cross sections, in bins of the absolute lepton rapidity, and the associated charge asymmetry are also presented. The study is performed using data collected at √s = 8 TeV. If available, measurements of the transverse momentum distribution of Drell-Yan lepton pairs will be presented, including for low-mass Drell-Yan pairs. The measurements are compared with state-of-the-art QCD cross-section calculations.

Primary author: ATLAS COLLABORATION
Presenter: YANG, Siqi (University of Iowa (US))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurement of V+jets production at ATLAS

Friday, 12 July 2019 15:45 (15 minutes)

Measurements of weak boson production in association with jets are presented. First, differential cross sections for Z-boson and W-boson production in association with jets are presented, with the measurements performed using proton-proton collisions at $\sqrt{s} = 8$ TeV. The data are compared to next-to-leading order QCD calculations and predictions from a variety of different parton distribution functions. In addition, if available, differential cross sections are presented for Z-boson production in association with heavy-flavour jets at $\sqrt{s} = 13$ TeV. The data are compared to theoretical predictions provided by various Monte Carlo event generators.

Primary author: ATLAS COLLABORATION
Presenter: MEONI, Evelin (Universita della Calabria e INFN (IT))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Evidence of the production of three massive vector bosons using the ATLAS detector

Saturday, 13 July 2019 10:15 (15 minutes)

A search for the production of three massive vector bosons in WWW, WWZ and WZZ final states is presented, using proton-proton collision data collected by the ATLAS experiment at $\sqrt{s}=13$ TeV. The analysis utilises multiple search channels. WWW production is probed using a fully-leptonic decay channel, with three-charged leptons and missing transverse momentum, and a semi-leptonic decay channel with two-charged leptons and two hadronic jets. WWZ production is probed in both a fully leptonic decay channel (four charged leptons) and a semi-leptonic decay channel (three leptons and two hadronic jets), whereas WZZ production is probed using a semi-leptonic decay channel (four charged leptons and two hadronic jets). The signal strengths in each channel are extracted and combined in a global fit. The data are found to be in good agreement with the SM expectations.

Primary author: ATLAS COLLABORATION
Presenter: TUNA, Alexander Naip (Harvard University (US))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurements of multiparton interactions at ATLAS

Thursday, 11 July 2019 17:30 (15 minutes)

Measurements of multiple parton scattering in proton-proton collisions provide insight into the structure and long-range low-momentum scale interactions of the proton. In this talk we present two recent measurements using proton-proton collision data collected by the ATLAS experiment. The first measurement determines the double-parton scattering contribution to four-lepton events at $\sqrt{s}=8$ TeV. An artificial neural net is used to optimise the analysis and an upper limit on the double-parton scattering fraction is set at 0.042, which corresponds to an effective cross section of 1mb. In the second measurement, the underlying event activity is studied in events containing a Z-boson in $\sqrt{s}=13$ TeV data. Unfolded differential cross sections are presented for charged particle multiplicity and charged particle transverse momentum in regions of azimuth measured with respect to the Z-boson direction. The data are compared to a wide variety of predictions from Monte Carlo event generators.

**Primary author:** ATLAS COLLABORATION

**Presenter:** MARTIN, Tim (University of Warwick (GB))

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Precision electroweak measurements with ATLAS

Friday, 12 July 2019 17:00 (15 minutes)

The electroweak sector of the Standard Model can be tested via precision measurements of fundamental observables. Measurements of the Drell-Yan production of Z bosons at the LHC provide a benchmark of our understanding of perturbative QCD and electroweak processes. The ATLAS collaboration has recently used such measurements to evaluate the effective leptonic weak mixing angle using data collected during the Run-1 of the LHC at a centre-of-mass energy of 8 TeV. The result is $\sin^2\theta_{\text{eff}}^l = 0.23140 \pm 0.00036$, yielding a precision similar to that of the recently published Tevatron legacy result and to the most precise individual observable measurements from lepton colliders. If available, measurements useful for a precise determination of the W boson mass will also be presented.

Primary author: ATLAS COLLABORATION
Presenter: ANDARI, Nansi (Université Paris-Saclay (FR))
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
Measurements of single diffraction using forward proton tagging at ATLAS

Friday, 12 July 2019 12:15 (15 minutes)

Inclusive single diffractive dissociation (pp->pX) is studied using data collected by the ATLAS experiment at the LHC. The intact proton is reconstructed and measured in the ALFA forward spectrometer, while charged particles from the dissociative system (X) are reconstructed and measured using the ATLAS inner tracking detector and calorimeters. Differential cross sections are presented as a function of the proton fractional momentum loss, the four-momentum transfer squared, and the size of a rapidity gap measured from the edge of the ATLAS calorimeters. The results are interpreted in the framework of Regge phenomenology.

Primary author: ATLAS COLLABORATION
Presenter: SYKORA, Tomas (Charles University (CZ))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Measurements of dijet azimuthal decorrelations and extraction of alpha_S at ATLAS

Friday, 12 July 2019 18:15 (15 minutes)

The production of jets at hadron colliders provides stringent tests of perturbative QCD. We present a measurement of the rapidity and transverse momentum dependence of dijet azimuthal decorrelations, using the quantity $R\Delta\phi$. This quantity specifies the fraction of the inclusive dijet events in which the azimuthal opening angle of the two jets with the highest transverse momenta is less than a given value of the parameter $\Delta\phi_{\text{max}}$. $R\Delta\phi$ is measured in proton-proton collisions at $\sqrt{s}=8$ TeV as a function of the dijet rapidity interval, the event total scalar transverse momentum, and $\Delta\phi_{\text{max}}$. Predictions of a perturbative QCD calculation at next-to-leading order in the strong coupling with corrections for non-perturbative effects describe the data well in the whole kinematic region. The data are used to determine the strong coupling $\alpha_S$ and to study its running for momentum transfers from 260 GeV to above 1.6 TeV. An analysis that combines data at all momentum transfers results in $\alpha_S(m_Z)=0.1127\pm0.0027\pm0.0063$.

Primary author: ATLAS COLLABORATION

Presenter: RIZVI, Eram Syed (Queen Mary, University of London)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Global study of effective Higgs portal dark matter models using GAMBIT

Thursday, 11 July 2019 17:20 (15 minutes)

In this talk, I’ll present results from a global analysis of effective Higgs portal dark matter (DM) models in the frequentist and Bayesian statistical frameworks. In particular, we use the GAMBIT software to determine the preferred mass and coupling ranges for vector, Majorana and Dirac fermion DM models. We also assess the relative plausibility of all four (including scalar DM) models using Bayesian model comparison. Our analysis includes up-to-date likelihood functions for the DM relic density, invisible Higgs decays, and direct and indirect searches for weakly-interacting DM, including the latest XENON1T data. We also account for important systematic uncertainties arising from the local density and velocity distribution of DM, nuclear matrix elements relevant for direct detection, and Standard Model masses and couplings. From our global study, we find the parameter regions that can explain all of the DM and give a good fit to the observed data. The case of vector DM requires the most tuning and is therefore slightly disfavoured from a Bayesian point of view, whereas the fermionic DM case requires a strong preference for including a CP-violating phase which allows for a suppression of direct detection limits. Finally, we present DDCalc 2.0.0, a tool for calculating direct detection observables and likelihoods for arbitrary non-relativistic effective operators. All of our results and samples are publicly available via Zenodo.

Primary author: Dr BENIWAL, Ankit (CP3, Université catholique de Louvain)
Presenter: Dr BENIWAL, Ankit (CP3, Université catholique de Louvain)
Session Classification: Dark Matter
Track Classification: Dark Matter
Interference effects in semileptonic decays from heavy Majorana neutrinos

Saturday, 13 July 2019 12:45 (15 minutes)

Several Beyond the Standard Model scenarios introduce new heavy neutrinos, whose Dirac or Majorana nature could be tested by comparing the rates of lepton number violating and conserving processes: a Dirac fermion induces only the latter, while a Majorana one predicts the same ratio for both of them. Nevertheless, in presence of more than one Majorana fermion, this picture may change drastically due to interference effects. In this talk, we will focus on LNV and LFV semileptonic meson decays induced by two heavy Majorana fermions, exploring the necessary conditions to have sizable interference effects and discussing its implications for current experimental constraints and possible future observations. In particular, we show how the CP violating phases may lead to have an enhancement of the lepton number violating modes and suppression of the lepton number conserving ones, and vice-versa.

Primary authors: TEIXEIRA, Ana M. (LPC Clermont); ABADA, Asmaa; HATI, Chandan (LPC Clermont); Dr MARCANO, Xabier (LPT Orsay)

Presenter: Dr MARCANO, Xabier (LPT Orsay)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Time-dependent CP violation in B decays at Belle

*Thursday, 11 July 2019 12:40 (20 minutes)*

Using the entire Belle dataset collected at the Upsilon(4S) resonance containing 772 million B-meson pairs, measurements of time-dependent CP violation in neutral B meson decays are performed for the decay channels governed by, or sensitive to, the $b \to s$ penguin (loop) transitions. In this presentation, we report a new measurement of CP violation parameters in $B \to K_s K_s K_s$ and few other channels.

**Primary author:** NISHIDA, Shohei (KEK)

**Presenter:** YUSA, Yosuke

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Color-allowed Bottom Baryon to $s$-wave and $p$-wave Charmed Baryon non-leptonic Decays

Thursday, 11 July 2019 15:45 (15 minutes)

We study color allowed $\Lambda_b \to \Lambda_c^{(s,**)}\pi^-$, $\Xi_b \to \Xi_c^{(s,**)}\rho^-$ and $\Omega_b \to \Omega_c^{(s,**)}\rho^-$ decays with $M = \pi, K, D, D_s, \rho, K^*, D^*, D_s^*, a_1$ and $s$-wave and $p$-wave charmed baryons, including $\Lambda_c^{(s,**)} = \Lambda_c, \Lambda_c(2595), \Lambda_c(2625), \Lambda_c(2765), \Lambda_c(2940)$, $\Xi_c^{(s,**)} = \Xi_c, \Xi_c(2815), \Xi_c(2790)$ and $\Omega_c^{(s,**)} = \Omega_c, \Omega_c(2770), \Omega_c(3050), \Omega_c(3070), \Omega_c(3120)$, in this work. There are six types of transitions, namely (i) $calB_b(3_f, 1/2^+) \to calB_c(3_f, 1/2^+)$, (ii) $calB_b(6_f, 1/2^+) \to calB_c(6_f, 1/2^+)$, (iii) $calB_b(6_f, 1/2^+) \to calB_c(6_f, 3/2^-)$, (iv) $calB_b(6_f, 1/2^+) \to calB_c(6_f, 3/2^-)$, and (vi) $calB_b(3_f, 1/2^+) \to calB_c(6_f, 3/2^-)$ transitions. The light diquarks are spectating in these transitions.

The bottom baryon to charmed baryon form factors are calculated using the light-front quark model. All of the form factors in the $1/2 \to 1/2$ and $1/2 \to 3/2$ transitions are extracted. They are found to reasonably satisfy the relations obtained in the heavy quark limit, as we are using heavy but finite $m_b$ and $m_c$. Decay rates and up-down asymmetries are predicted using naive factorization and can be checked experimentally. The study on these decay modes may shed light on the quantum numbers of some of the charmed baryons.

**Primary author:** CHUA, Chun-Khiang

**Presenters:** CHUA, Chun-Khiang; CHUA, Chung Tah (Nanyang Technological University)

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
New results on the magnitudes of the CKM elements $|V_{cb}|$ and $|V_{ub}|$ from Belle

Friday, 12 July 2019 09:35 (20 minutes)

The magnitudes of the Cabibbo-Kobayashi-Maskawa (CKM) matrix elements, in combination with the angles of the Unitarity Triangle, are crucial for testing the standard model. We report a new determination of $|V_{cb}|$ based on $B \rightarrow D^* l^+ \nu$ decays in untagged events. Different parameterizations of the semileptonic form factor are used in the extraction of this CKM matrix element. Finally, we also cover the new Belle search for the purely leptonic decay $B \rightarrow \mu^+ \nu$, which will allow to determine $|V_{ub}|$. The analyses are based on the full data set recorded by the Belle detector at the KEKB $e^+e^-$ collider containing 772 million $B\bar{B}$ pairs.

Primary author: NISHIDA, Shohei (KEK)

Presenter: BERNLOCHNER, Florian Urs (KIT - Karlsruhe Institute of Technology (DE))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Measurement of Lepton Flavor Universality in B decays at Belle

Friday, 12 July 2019 14:50 (20 minutes)

Recent anomalies of lepton flavor universality violation (LFUV) in B decays could be a hint of new physics. We report new measurements of LFUV observable $R(K)$ and $R(K^*)$, the branching fraction of $B \rightarrow K^{(*)}\mu^+\mu^-$ to $B \rightarrow K^{(*)}e^+e^-$, at Belle. The analyses are based on the full data set recorded by the Belle detector at the $\Upsilon(4S)$ resonance containing 772 million $B\bar{B}$ pairs from $e^+e^-$ collisions produced by the KEKB collider.

Primary author: NISHIDA, Shohei (KEK)
Presenter: CHOU DHURY, Seema (IIT Hyderabad)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Search for Dark Sector at Belle

Monday, 15 July 2019 18:30 (1h 30m)

Dark sector models can explain the relic abundance of universe and thus constitute attractive scenarios. We present the searches for dark sector particles in B decays at Belle. We also search for the dark Gauge boson $Z'$ and light dark matter $\chi$, in the process $e^+ e^- \rightarrow \mu^+ \mu^- Z'$ and $e^+ e^- \rightarrow \mu^+ \mu^- \chi \bar{\chi}$. Other analyses related to dark sector are also covered. The analyses are based on the full data set recorded by the Belle detector at the KEKB $e^+ e^-$ collider.

Primary author: NISHIDA, Shohei (KEK)
Presenter: PARK, Seokhee (Yonsei University)
Session Classification: Wine & Cheese Poster Session
Track Classification: Dark Matter
Inclusive Bs to Ds X decay at Belle

Monday, 15 July 2019 19:40 (20 minutes)

We present an analysis of the inclusive decay Bs -> DsX tagged with semi-inclusive decay Bs -> DsXl, where X denotes a final state that may consist of additional hadrons or photons and l is an electron or muon. Our Bs decays are contained in the 121.4 fb^{-1} Y(5S) data sample collected by the Belle detector at the KEKB asymmetric-energy e+e- collider.

Primary author:  NISHIDA, Shohei (KEK)

Presenter:  WANG, Boqun (Max Planck Institute for Physics)

Session Classification:  Wine & Cheese Poster Session

Track Classification:  Flavour Physics and CP Violation
Quarkonium production measured by the STAR experiment

Friday, 12 July 2019 09:54 (18 minutes)

Quark-gluon plasma and it’s properties can be studied with quarkonium states used as a probe. Both $J/\psi$ and $\Upsilon$ states dissociate if a sufficiently high temperature is reached in the plasma. Since these quarkonium states have different binding energies, they are expected to dissociate at different temperatures, which is expected to lead to the so-called sequential suppression phenomenon. There are also other effects, which contribute to the suppression such as nuclear absorption, shadowing or comover interactions. In addition, an enhancement of $J/\psi$ yield due to possible regeneration may contribute. Furthermore, by studying the quarkonium spectra and charged particle multiplicity dependence in p+p collisions important information can be gained on quarkonium production mechanism and it’s relation with soft particle production.

This presentation will include both $J/\psi$ and $\Upsilon$ production cross section measurements in p+p collisions at $\sqrt{s} = 200$ GeV and $\sqrt{s} = 500$ GeV. Normalized quarkonium yield vs. normalized charged particle multiplicity will be shown. The nuclear modification factor in p+Au collisions at $\sqrt{s_{NN}} = 200$ GeV, $R_{pA}$, will also be presented. Finally, the nuclear modification factors $R_{AA}$ in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV will be shown. All the results will be compared to measurements by other experiments and model calculations.

Primary author: Dr KOSARZEWSKI, Leszek (Czech Technical University in Prague)

Presenter: Dr KOSARZEWSKI, Leszek (Czech Technical University in Prague)

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Reactor Neutrino Spectrum Uncertainty and Mass Hierarchy Determination

Monday, 15 July 2019 18:30 (1h 30m)

In the next years, several experiments will try to perform a precise measurement of the neutrino mass hierarchy, among these there are also reactor neutrino experiments, such as JUNO and RENO 50. One of the challenges that must be overcome in this kind of experiment is the uncertainty on the reactor neutrino spectrum: as became clear with the discovery of the "5 MeV bump", the theoretical models that describe the reactor neutrino spectrum are not very reliable, and tension between the expected and measured spectrum is significantly larger than the difference between the two hierarchies; moreover the only experimental data currently available on the reactor neutrino spectrum are obtained with a worse energy resolution than the one needed in order to determine the hierarchy: I will discuss a model-independent way to treat the errors due to the uncertainty on the spectrum. The uncertainty on the spectrum is one of the reason why the JUNO collaboration announced that a near detector will be build (JUNO-TAU). However there is an additional complication: the far detector will receive neutrinos from two power plants of different model and generation, each of them with multiple reactors, while the near detector can see only the spectrum from one core; this means that the (unoscilated) spectrum at the near and far detector will be different. I will show that, by studying the time evolution of the spectrum at the near detector, it will be possible to reconstruct the spectrum at the far; I will discuss how it is possible to take into account this kind of systematic error in the measurement of the mass hierarchy, how it will affect the sensitivity and the effects of different methods of reconstructing the spectrum.

Primary author:  Prof. CIUFFOLI, Emilio (IMP, CAS)
Presenter:  Prof. CIUFFOLI, Emilio (IMP, CAS)
Session Classification:  Wine & Cheese Poster Session
Track Classification:  Neutrino Physics
A general framework for modeling the small-scale power in non-standard cosmologies

Friday, 12 July 2019 16:30 (20 minutes)

Structure formation at small cosmological scales provides an important frontier for Dark Matter (DM) research. So far, many non-cold DM (nCDM) candidates have been proposed in order to give a better description of the structure formation and distribution at small scales, with respect to the standard cold DM (CDM) model. The details of the small-scale power suppression depend on the DM particle nature, allowing for a direct link between DM models and astrophysical observations. However, most of the constraints currently available refer to a very specific shape of the power suppression, corresponding to thermal warm DM. Nonetheless, most of the viable particle DM candidates are not characterised by a thermal momentum distribution.

In this talk, I will discuss an efficient method for constraining both thermal and non-thermal DM scenarios with the Lyman-alpha forest, based on a simple and flexible parametrisation capable to reproduce the small-scale clustering signal of a large set of nCDM models. I will present the first astrophysical constraints on such parametrisation, easily translatable to bounds on the fundamental nCDM properties without the need to run any specific numerical simulations.

Primary author: MURGIA, Riccardo (SISSA)
Presenter: MURGIA, Riccardo (SISSA)
Session Classification: Cosmology
Track Classification: Cosmology
New Observables in Inclusive Production of Quarkonia

Monday, 15 July 2019 18:30 (1h 30m)

I will review the relevance of new quarkonium observables such as the associated production along with a Standard Model boson (γ, W and Z), with another quarkonium, with another heavy quark as well as with light hadrons or jets in order to improve our understanding of the mechanisms underlying quarkonium production as well as the physics of multi-parton interactions, in particular the double parton scatterings. I will discuss existing results from the LHC and the Tevatron and discuss prospects for future measurements.

Primary author:  LANSBERG, Jean-Philippe (Centre National de la Recherche Scientifique (FR))

Presenter:  LANSBERG, Jean-Philippe (Centre National de la Recherche Scientifique (FR))

Session Classification:  Wine & Cheese Poster Session

Track Classification:  QCD and Hadronic Physics
Measurement of open-charmed hadron production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment

Thursday, 11 July 2019 17:06 (18 minutes)

In ultrarelativistic heavy-ion collisions at RHIC energies, the charm quarks are predominantly produced in initial hard partonic scatterings. Therefore, they experience the entire evolution of the hot and dense medium produced in these collisions, known as the Quark-Gluon Plasma (QGP), and make a very valuable probe. The STAR experiment is capable of studying the production of charm quarks and their interactions with the QGP through the reconstruction of the hadronic decays of $D^0$, $D^\pm$, $D_s$, and $\Lambda_c^\pm$ hadrons. These measurements were enabled thanks to the excellent pointing resolution of the Heavy Flavor Tracker (HFT). In this talk, we will present recent results of open-charmed hadron measurements in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV with the STAR experiment. In particular, we will discuss the nuclear modification factors of $D^\pm$ and $D^0$ mesons, which imply significant energy loss of charm quarks in the QGP, and $D^0$ elliptic and triangular flow coefficients which probe the charm quark transport in the QGP. We will also present the $D_s/D^0$ and $\Lambda_c/D^0$ yield ratios as functions of transverse momentum and collision centrality which help us better understand the charm quark hadronization process in heavy-ion collisions. Finally, we will show the rapidity-odd directed flow of $D^0$ mesons, which is sensitive to the initial tilt of the QGP bulk and can also probe the effects of the initial magnetic field in heavy-ion collisions.

**Primary author:** Mr LICENIK, Robert (Nuclear Physics Institute, Czech Academy of Sciences)

**Presenter:** Mr LICENIK, Robert (Nuclear Physics Institute, Czech Academy of Sciences)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
We investigate the prospects for discovering a top quark decaying into one light Higgs boson ($h^0$) along with a charm quark in top quark pair production at the CERN Large Hadron Collider (LHC) and future hadron colliders.

A general two Higgs doublet model is adopted to study the signature of flavor changing neutral Higgs (FCNH) interactions with $t \rightarrow c h^0$, followed by $h^0 \rightarrow WW^*$ and $\tau^+\tau^-$. We study the discovery potential for the FCNH signal and physics background from dominant processes with realistic acceptance cuts and tagging efficiencies.

Promising results are found for the LHC running at 13 or 14 TeV collision energies as well as future pp colliders at 27 or 100 TeV.

**Primary author:** Prof. KAO, Chung (University of Oklahoma)

**Presenter:** Prof. KAO, Chung (University of Oklahoma)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Conclusions from TrackML the HEP Tracking Machine Learning challenge

Friday, 12 July 2019 12:45 (15 minutes)

The HL-LHC will see ATLAS and CMS see proton bunch collisions reaching track multiplicity up to 10,000 charged tracks per event. Algorithms need to be developed to harness the increased combinatorial complexity. To engage the Computer Science community to contribute new ideas, we have organized a Tracking Machine Learning challenge (TrackML). Participants are provided events with 100k 3D points, and are asked to group the points into tracks; they are also given a 100GB training dataset including the ground truth. The challenge is run in two phases. The first “Accuracy” phase has run on Kaggle platform from May to August 2018; algorithms were judged only on a score related to the fraction of correctly assigned hits. The second “Throughput” phase ran Sep 2018 to March 2019 on Codalab, required code submission; algorithms were then ranked by combining accuracy and speed. The first phase has seen 653 participants, with top performers with innovative approaches (see arXiv:1904.06778). The second phase has recently finished and featured some astonishingly fast solutions. The talk will report on the lessons from the TrackML challenge and perspectives.
We construct the Barut-Girardello coherent states for charge carriers in 2D-Dirac-Weyl materials immersed in a constant homogeneous magnetic field which is orthogonal to the sample surface. We consider the situation in which the membrane is deformed uniformly and uniaxially, avoiding the generation of pseudo-magnetic fields. For that purpose, we solve the Dirac-Weyl equation with an anisotropic Fermi velocity and identify the appropriate arising and lowering operators. Working in a Landau-like gauge, we explicitly construct nonlinear coherent states as eigenstates of a generalized annihilation operator with complex eigenvalues which depends on an arbitrary function $f$ of the number operator. In order to describe the anisotropy effects on these states, we obtain the Heisenberg uncertainty relation, the probability density and mean energy value for three different functions $f$. In particular, for strained graphene we obtain that, when a stress is applied along the $x$-axis of the material surface, the probability density for the nonlinear coherent states is smaller compared to when the material is compressed along the same axis.

Keywords: nonlinear coherent states, Dirac-Weyl fermions, graphene, magnetic field

**Primary author:** Dr CONCHA-SÁNCHEZ, Yajaira (Michoacana University, Mexico)

**Co-authors:** Dr DÍAZ-BAUTISTA, Erik (Physics Department, Cinvestav, Mexico); Dr RAYA, Alfredo (Michoacana University, Mexico)

**Presenter:** Dr CONCHA-SÁNCHEZ, Yajaira (Michoacana University, Mexico)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Quantum Field and String Theory
Recent Cross-section Measurements from MicroBooNE

Saturday, 13 July 2019 12:30 (15 minutes)

MicroBooNE is a liquid argon time projection chamber in the Booster Neutrino Beam at Fermilab. The large event rate and 3 mm wire spacing of the detector provide high-statistics, precise-resolution imaging of neutrino interactions leading to low-threshold, high-efficiency event reconstruction with full angular coverage. As such, this is an ideal place to probe neutrino-argon interactions in the hundreds-of-MeV to few-GeV energy range, and to study the impact of nuclear effects through detailed measurements of hadronic final states. This talk will present recent measurements of neutrino interactions in MicroBooNE, including inclusive charged-current interactions, neutral-pion production, and measurements of low-energy protons.

Primary authors: COLLABORATION, MicroBooNE; ESCUDERO SANCHEZ, Lorena
Presenter: ESCUDERO SANCHEZ, Lorena
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Studies of the ISR process $e^+e^- \rightarrow \pi^+\pi^-\pi^0\gamma$ at the phi mass with the KLOE detector

Monday, 15 July 2019 18:30 (1h 30m)

Experimental measured value of the muon magnetic moment $a_\mu = \frac{g_\mu - 2}{2}$ has a long-standing and well known discrepancy comparing with Standard Model prediction that has been narrowed down within a range $3.2 - 3.6\,\sigma$ after years of efforts made by experimentalists and theorists. Previous results of dipion cross section $\sigma_{\pi\pi} = \sigma(e^+e^- \rightarrow \pi^+\pi^-)$ from KLOE have provided comprehensive and substantial studies on the largest experimental input from hadronic contribution. In order to deepen the understand of theoretical uncertainty for $a_\mu$, it is natural to extent the studies to three pion cross section, which is the second largest hardronic contribution to $a_\mu$.

The initial state radiation (ISR) process $e^+e^- \rightarrow 3\pi$ has been studied at a center-of-mass energy $\sqrt{s} \approx 1.019$ GeV close to the $\phi$ resonance using a 1.7 fb$^{-1}$ data sample collected with KLOE detector at the DAΦNE year 2004/2005. In this analysis, we have studied the visible section $\sigma_{\text{vis}}^{3\pi}$ of process $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ for the effective center-of-mass energy $\sqrt{s'}$ corresponds to omega mass range $M_{3\pi} \in [720, 900]$ MeV/c$^2$. With the same dataset, a further study of C-violating decay $e^+e^- \rightarrow \phi \rightarrow \omega\gamma$ is being performed based on a careful investigation of the ISR process, which is the major background with identical $3\pi$ final state.

Primary author: GIOVANNELLA, Simona (INFN)

Presenter: Dr BO, Cao

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
Low energy hadron physics at KLOE/KLOE-2

Friday, 12 July 2019 14:45 (15 minutes)

The KLOE-2 experiment completed its data-taking at the e+e- DAPHNE collider in Frascati, achieving the integrated luminosity goal of more than 5 fb-1 at the phi peak. KLOE-2 represents the continuation of KLOE with an upgraded detector and an extended physics program, which includes the study of light meson properties and decay dynamics with unprecedented statistics. The new data sample, together with the KLOE one, corresponds to more than 3x10^8 eta meson events. This statistics has been used to search for the P, CP violating decay eta->pi+pi-, obtaining the most stringent upper limit for this decay.

The eta -> pi0 gamma gamma decay is an important test of ChPT because of its sensitivity to the p^6 term on both the branching ratio and the M(gg) spectrum. A preliminary KLOE measurement, based on 450 pb-1, provided a 4 sigma’s lower value w.r.t. the most accurate determination of the BR from Crystal Ball. A new analysis with a larger data sample is in progress to confirm this result. The same five photon final state is used to search for the B boson, a postulated leptophobic mediator of dark forces.

The new four stations installed in KLOE-2 to tag electrons and positrons from the reaction e+e- -> e+e-gamma gamma -> e+e-X, will give the opportunity to investigate gamma-gamma physics at the phi resonance. Single pseudoscalar production will improve the determination of the two-photon decay widths of these mesons. The analysis for the pi0 final state is in progress, aiming to achieve an accuracy of O(1%). Preliminary results will be presented.

Primary author: GIOVANNELLA, Simona (INFN)
Presenter: KANG, xiaolin (LNF)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
The study of top-quark production and decay is central in the LHC physics programme, allowing to test the Standard Model and offering a window on possible new physics. Precise theoretical predictions are crucial for these analysis.

In this talk, we report on a new calculation of the next-to-next-to-leading order QCD radiative corrections to the inclusive production of top-quark pairs at hadron colliders. The calculation is performed by using the $q_T$-subtraction formalism to handle and cancel infrared singular contributions at intermediate stages of the computation, and represents its first complete application to the hadroproduction of a colorful high-mass system at next-to-next-to-leading order. The numerical results are also presented and discussed.

**Primary authors:** MAZZITELLI, Javier; CATANI, Stefano (Universita e INFN, Firenze (IT)); DEVOTO, Simone; GRAZZINI, Massimiliano (Universitaet Zuerich (CH)); KALLWEIT, Stefan (Universita & INFN, Milano-Bicocca (IT)); SARGSYAN, Hayk (University of Zurich)

**Presenter:** MAZZITELLI, Javier

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
First measurements of the $\phi_3$ sensitive decay $B^+ \rightarrow D(K_S\pi^+\pi^-\pi^0)K^+$ with Belle

We present the first model-independent measurement of the CKM angle $\phi_3$ using $B^{\pm} \rightarrow D(K_S^0\pi^+\pi^0)K^{\pm}$ decays. The GGSZ method is used by binning the a five-dimensional phase space of the $D$ decay. This analysis uses the measurement of the average strong-phase differences across the phase space in $D \rightarrow K_S^0\pi^+\pi^-\pi^0$ decays from CLEO-c, as input. The results are obtained from the full Belle data set with an integrated luminosity of 711 fb$^{-1}$ collected at the $\Upsilon(4S)$ resonance.

Primary authors:  P K, Resmi (IIT Madras); NISHIDA, Shohei (KEK)
Presenter:  P K, Resmi (IIT Madras)
Session Classification:  Flavour Physics and CP Violation
Track Classification:  Flavour Physics and CP Violation
Baryon spectroscopy at Belle

Saturday, 13 July 2019 10:15 (15 minutes)

The large data sample accumulated by the Belle experiment at KEKB asymmetric energy $e^+ e^-$ collider provides a unique opportunity to perform studies of charmed strange baryons. In this presentation, we report a measurement of the absolute branching fraction of $\Xi_c^0$ and $\Xi_c^+$. We present observation of $\Xi(1620)^0$ and evidence for $\Xi(1690)^0$ found in the decay $\Xi_c^+ \rightarrow \Xi^0 \pi^+ \pi^-$, and observation of excited Omega- baryons. Other measurements related to baryons will also be covered in this presentation.

**Primary author:** NISHIDA, Shohei (KEK)

**Presenter:** KATO, Yuji

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
An overview of CALET observations after three years on the International Space Station

Thursday, 11 July 2019 16:50 (20 minutes)

The CALorimetric Electron Telescope CALET is a space instrument designed to carry out precision measurements of high energy cosmic-rays on the JEM-EF external platform of the ISS where it has been collecting science data continuously since mid October 2015. Equipped with a thick (30 X0, 1.3 λI) calorimeter with an imaging pre-shower and with two independent subsystems to identify the charge of the incident particle, CALET has the depth, tracking capability, electron/proton discrimination and energy resolution to study hadrons, electrons and gamma rays.

An overview of CALET observations is presented, based on the data taken during the first three years. It includes a direct measurement of the electron+positron energy spectrum from 11 GeV to 4.8 TeV in good agreement with AMS-02 data in the region below 1 TeV and suggesting a flux suppression above 1 TeV. In the energy region below ∼300 GeV, CALET’s spectral index is consistent with AMS-02, Fermi-LAT and DAMPE, while from 300 GeV to 600 GeV the spectrum is significantly softer than the spectra from the latter two experiments.

The proton spectrum has been measured from 50 GeV to 10 TeV covering, for the first time with a single space-borne instrument, the whole energy interval previously investigated in separate sub-ranges by magnetic spectrometers and calorimetric instruments. The observed spectrum is consistent with AMS-02 but it extends by nearly one order of magnitude higher in energy, showing a smooth transition of the power-law spectral index from -2.81 ± 0.03 (50–500 GeV) to -2.56 ± 0.04 (1–10 TeV), thereby providing evidence of a deviation from a single power law by more than 3 sigma.

In addition to its primary goal of identifying nearby sources of high-energy electrons and possible signatures of dark matter in the electron spectrum, CALET is carrying out extensive measurements of the energy spectra, relative abundances and secondary-to-primary ratios of elements from proton to iron and above (up to Z=40) studying the details of galactic particle propagation and acceleration.

Preliminary spectra of cosmic-ray nuclei are presented, together with gamma-ray observations and searches of an e.m. counterpart of LIGO/Virgo GW events.

**Primary authors:** Prof. MARROCCHESI, Pier Simone (Univ. of Siena and INFN Pisa); CALET COLLABORATION

**Presenter:** Prof. MARROCCHESI, Pier Simone (Univ. of Siena and INFN Pisa)

**Session Classification:** Astroparticle Physics and Gravitational Waves

**Track Classification:** Astroparticle Physics and Gravitational Waves
A general two Higgs doublet model is employed to study flavor changing neutral Higgs (FCNH) interactions in pp collisions. We investigate the discovery potential of (a) a flavor changing neutral Higgs boson decays into leptons, 
\[ pp \rightarrow \phi^0 \rightarrow \tau^\pm \mu^\mp + X \] 
from gluon fusion, and 
(b) production of a flavor changing neutral Higgs boson associated with a top quark 
\[ pp \rightarrow t\phi^0 + X, \] 
where \( \phi^0 \) could be a CP-even scalar (\( h^0, H^0 \)) or a CP-odd pseudoscalar (\( A^0 \)).

The light Higgs boson \( h^0 \) is found to resemble closely the standard Higgs boson at the Large Hadron Collider (LHC). In the alignment limit of \( \cos(\beta - \alpha) \approx 0 \), for \( h^0-H^0 \) mixing, FCNH couplings of \( h^0 \) are naturally suppressed, but such couplings of the heavier \( H^0, A^0 \) are sustained by \( \sin(\beta - \alpha) \approx 1 \). We evaluate physics backgrounds from dominant processes with realistic acceptance cuts and tagging efficiencies. We find promising results for the LHC with \( \sqrt{s} = 14 \text{ TeV} \), and future pp colliders with \( \sqrt{s} = 27 \text{ TeV} \) and 100 TeV.
New physics at T2HKK with new asymmetries

Monday, 15 July 2019 18:30 (1h 30m)

The proposed T2HKK experiment involves placing a neutrino detector in Korea in the path of the T2HK beam, to collect data at an additional baseline of 1100 km. This setup will allow the measurement of neutrino oscillation probabilities at two different baselines with the same beam. In addition the detectors are also well suited to observe atmospheric neutrinos. In this work, we explore the role of asymmetries in determining the unknown neutrino parameters at T2HKK. In particular we consider the measurement of the neutrino mass hierarchy, CP-violating phase delta_CP and non-standard interactions (NSIs) in neutrino propagation. We also discuss the possibility of distinguishing between classes of NSIs with different interaction ranges at T2HKK.

Primary author: Dr RAUT, Sushant (IBS CTPU, Daejeon, South Korea)
Presenter: Dr RAUT, Sushant (IBS CTPU, Daejeon, South Korea)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
Probing non-standard interactions with a muon decay-at-rest source

Saturday, 13 July 2019 10:40 (20 minutes)

The hybrid setup of T2HK (neutrino) in conjunction with a muon decay-at-rest (muDAR) source (antineutrinos) has been shown to have very good sensitivity to the standard oscillation parameters. We now explore the ability of this setup to observe charged-current non-standard interactions (NSIs) of neutrinos that can affect the production and detection of neutrinos. We discuss the interplay between the detector NSI parameters and standard oscillation parameters, which affects the sensitivity of the setup. We demonstrate the robustness of the hybrid setup in measuring the standard CP phase even in the presence of NSIs, as well its ability to measure the non-standard phases. Finally we discuss correlations between the phases. The treatment of source NSIs at a muDAR setup is different since there are two neutrino flavours involved. We highlight the sensitivity reach of this setup to measure the NSI parameters, which is comparable to the current sensitivity.

Primary author: RAUT, Sushant (IBS CTPU, Daejeon, South Korea)
Presenter: RAUT, Sushant (IBS CTPU, Daejeon, South Korea)
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Recent results of the ANTARES neutrino telescope.

Saturday, 13 July 2019 10:40 (20 minutes)

The ANTARES detector is the first Cherenkov neutrino telescope realised in the Mediterranean sea. It is continuously taking data since 2007, with the primary aim to detect astrophysical neutrinos in the TeV-PeV range. A very good angular resolution in all flavour neutrino interaction channels, together with the depth of the abyssal site (2500 m below the sea level) led to an unprecedented sensitivity in the searches for neutrino sources in the Southern Sky and in the energy range below 100 TeV. This has allowed constraining on the origin of the cosmic neutrino flux discovered by the IceCube detector. ANTARES is also focussed on a rich multi-messenger program, providing with both online and offline actions or feedbacks. Among these, the searches triggered by gravitational wave observations are of prominent interest. Other physics topics are also covered: searches of dark matter annihilation or decay in massive objects; the search for relic massive magnetic monopoles and nuclearites; the study of atmospheric neutrinos and neutrino oscillations.

Primary authors: CHIARUSI, Tommaso (INFN - Sezione di Bologna); ON BEHALF OF THE ANTARES COLLABORATION

Presenter: CHIARUSI, Tommaso (INFN - Sezione di Bologna)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Recent results on hadronic cross sections measurements at BABAR for the g-2 calculation

A program of measuring the light hadrons production in exclusive $e^+e^- \rightarrow$ hadrons processes is in place at BABAR with the aim to improve the calculation of the hadronic contribution to the muon $g - 2$. We present the most recent results obtained by using the full data set of about 470 fb$^{-1}$ collected by the BABAR experiment at the PEP-II $e^+e^-$ collider at a center-of-mass energy of about 10.6 GeV. In particular, we report the results on the channels $e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0$, $e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0(\eta)$ and $e^+e^- \rightarrow \pi^+\pi^-\eta$. The first reaction, in particular, presently gives the main uncertainty on the total hadronic cross section in the energy region between 1 and 2 GeV.

**Primary authors:** ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); DRUZHININ, Vladimir (BINP, Novosibirsk)

**Presenter:** DRUZHININ, Vladimir (BINP, Novosibirsk)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** QCD and Hadronic Physics
Study of $e^+e^- \rightarrow e^+e^-\eta'$ in double-tag mode at BABAR and measurement of the $\gamma^*\gamma^* \rightarrow \eta'$ Transition Form Factor.

Monday, 15 July 2019 18:30 (1h 30m)

We study the process $e^+e^- \rightarrow e^+e^-\eta'$ in the double-tag mode and measure for the first time the $\gamma^*\gamma^* \rightarrow \eta'$ transition form factor $F_{\eta'}(Q^2_1,Q^2_2)$ in the momentum-transfer range $2 < Q^2_{1,2} < 60$ GeV$^2$. The analysis is based on data with an integrated luminosity of about 470 fb$^{-1}$ collected at the PEP-II $e^+e^-$ collider with the BABAR detector at center-of-mass energies near 10.6 GeV. The results for the form factor are compared with the predictions based on pQCD and VMD.

Primary authors: ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); KOZYREV, Evgeny (Budker Institute of Nuclear Physics)

Presenter: KOZYREV, Evgeny (Budker Institute of Nuclear Physics)

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
The Phase-II upgrade of the ATLAS Muon Spectrometer

Monday, 15 July 2019 19:40 (20 minutes)

The muon spectrometer of the ATLAS detector will undergo a major upgrade during the Long Shutdown 3, in order to cope with the operational conditions at the high-luminosity LHC. The trigger and readout electronics for the Resistive Plate Chambers (RPC), Thin Gap Chambers (TGC), and Monitored Drift Tube (MDT) chambers will be replaced to make them compatible with a new trigger scheme with higher trigger rates and longer latencies. MDT precision chambers, that at the moment are not included in the hardware trigger, will be integrated into the level-0 trigger in order to sharpen the momentum threshold. The MDT front-end electronics will also be replaced. New-generation RPC chambers will be installed in the inner barrel layer to increase the acceptance and robustness of the trigger. Some of the MDT chambers in the inner barrel layer will be replaced with new small-diameter MDTs. New TGC triplet chambers in the barrel-endcap transition region will replace the current TGC doublets to suppress the high trigger rate from random coincidences in this region. A major upgrade of the power system is also planned. The Phase-II upgrade concludes the process of adapting the muon spectrometer to the ever increasing performance of the LHC, which started with the Phase-I upgrade New Small Wheel (NSW) project that will replace the innermost endcap wheels.

Primary author: ATLAS COLLABORATION
Presenter: POLICICCHIO, Antonio (Sapienza Università di Roma and INFN ROMA1)
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Detecting Gravitational Waves by Twisted Light - Dipole Interaction of Photons and Gravitational Waves

Saturday, 13 July 2019 10:00 (20 minutes)

Motivated by the next generation of gravitational wave (GW) detectors, we study the wave mechanics of a twisted light beam in the GW perturbed spacetime. We found a new gravitational dipole interaction of photons and gravitational waves. Physically, this interaction is due to coupling between the angular momentum of twisted light and the GW polarizations. We demonstrate that for the higher-order Laguerre-Gauss (LG) modes, this coupling effect makes photons undergoing dipole transitions between different orbital-angular-momentum (OAM) eigenstates, and leads to some measurable optical features in the 2-D intensity pattern. It offers an alternative way to realize precision measurements of the gravitational waves, and enables us to extract more information about the physical properties of gravitational waves than the current interferometry. With a well-designed optical setup, this dipole interaction is expected to be justified in laboratories.

Primary authors: Prof. FENG, Longlong (Sun Yat-Sen University); Mr WU, Qianfan

Presenter: Prof. FENG, Longlong (Sun Yat-Sen University)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
The Phase-II upgrade of the ATLAS Monitored Drift Tube Detector and Frontend electronics

Monday, 15 July 2019 19:40 (20 minutes)

ATLAS plans to replace the present barrel innermost station of Monitored Drift Tube (MDT) chambers with an integrated system of thin-gap Resistive Plate Chambers (RPC) and small diameter muon drift-tube (sMDT) chambers to improve the muon trigger efficiency in the barrel region. In addition, to cope with large amount of data and high event rate expected from the planned LHC upgrades, the present MDT readout electronics will be replaced and the MDT detector will be used at the first-level trigger. For chambers, we will present the design, construction, and tests of the new sMDT and RPC chambers as well as the status of series production. For electronics, we will show present the overall trigger and readout design and focus on latest results from prototypes of ASICs and frontend boards.

Primary author: ATLAS COLLABORATION
Presenter: XIAO, Xiong (University of Michigan)
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Performance of the ATLAS RPC detector and L1 Muon Barrel trigger at 13 TeV

Monday, 15 July 2019 19:40 (20 minutes)

The ATLAS experiment at LHC uses a trigger system consisting of a first level hardware trigger and a higher level software trigger. The Level-1 muon trigger system selects muon candidates with six transverse momentum thresholds and associates them with a correct LHC bunch crossing. The Level-1 Muon Barrel Trigger uses Resistive Plate Chambers (RPC) detectors to generate trigger signals for selecting muon candidates within the pseudorapidity range of up to 1.05. The RPC detectors are arranged in three concentric double layers and consist of 3600 gas volumes, with a total surface of more than 4000 square meters, that operate in a toroidal magnetic field. This contribution will discuss performance of the RPC detector system and of the Level-1 Muon Barrel trigger during the 2018 data taking period. Measurements of RPC detector response obtained using muon candidates produced in LHC collisions will be presented. Trigger performance and efficiency measurements that are obtained using Z boson decays to a muon pair will be also discussed. Finally, studies of the RPC detector response at different high voltage and threshold settings will be discussed, in the context of expected detector response after the High Luminosity LHC upgrades.

Primary author: ATLAS COLLABORATION
Presenter: HADEF, Asma (University of Science and Technology of China (CN))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
The Micromegas chambers for the upgrade of the forward muon detector of ATLAS

Monday, 15 July 2019 19:40 (20 minutes)

The ATLAS collaboration at LHC has chosen the resistive Micromegas technology, along with the small-strip Thin Gap Chambers (sTGC), for the high luminosity upgrade of the first muon station in the high-rapidity region, the so called New Small Wheel (NSW) project. After the R&D, design and prototyping phase, the first series production Micromegas quadruplets are being constructed at the involved construction sites in France, Germany, Italy, Russia and Greece. This is a big step forward towards the installation of the NSW foreseen for the LHC long shutdown in 2019 and 2020. The construction of the four types of large size quadruplets, all having trapezoidal shapes with surface areas between 2 and 3 m², will be reviewed. The achievement of the requirements for these detectors revealed to be even more challenging than expected, when scaling from the small prototypes to the large dimensions. We will describe the encountered problems, to a large extent common to other micro-pattern gaseous detectors, and the adopted solutions. Final quality assessment and validation results on the achieved mechanical precision, on the High-Voltage stability during operation with and without irradiation will be presented together with results from test-beam studies with the first production chambers.

Primary author:   ATLAS COLLABORATION
Presenter:       SAMARATI, Jerome (CERN)
Session Classification:  Wine & Cheese Poster Session
Track Classification:  Detector R&D and Data Handling
Small-Strip Thin Gap Chambers for the Muon Spectrometer Upgrade of the ATLAS Experiment

The instantaneous luminosity of the Large Hadron Collider at CERN will be increased by about a factor of five with respect to the design value by undergoing an extensive upgrade program over the coming decade. The largest phase-1 upgrade project for the ATLAS Muon System is the replacement of the present first station in the forward regions with the New Small Wheels (NSWs) during the long-LHC shutdown in 2019/20. Along with Micromegas, the NSWs will be equipped with eight layers of small-strip thin gap chambers (sTGC) arranged in multilayers of two quadruplets, for a total active surface of more than 2500 m$^2$. To retain the good precision tracking and trigger capabilities in the high background environment of the high luminosity LHC, each sTGC plane must achieve a spatial resolution better than 100 μm to allow the Level-1 trigger track segments to be reconstructed with an angular resolution of approximately 1 mrad. The basic sTGC structure consists of a grid of gold-plated tungsten wires sandwiched between two resistive cathode planes at a small distance from the wire plane. The precision cathode plane has strips with a 3.2mm pitch for precision readout and the cathode plane on the other side has pads for triggering. The sTGC design, performance, construction and integration status will be discussed, along with results from tests of the chambers with nearly final electronics with beams, cosmic rays and high-intensity radiation sources.

Primary author: ATLAS COLLABORATION
Presenter: ABREU AGUILAR, Henso Javier (Technion- Israel Institute of Technology (IL))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Frontend and backend electronics for the ATLAS New Small Wheel Upgrade

Thursday, 11 July 2019 12:00 (15 minutes)

The Phase-I and Phase-II upgrades of the LHC accelerator will increase the LHC instantaneous luminosity to $2 \times 10^{34}$ cm$^{-2}$s$^{-1}$ and $7.5 \times 10^{34}$ cm$^{-2}$s$^{-1}$, respectively. The luminosity increase drastically impacts the ATLAS trigger and readout data rates. The present ATLAS small wheel muon detector will be replaced with a New Small Wheel (NSW) detector in 2019. The NSW will feature two new detector technologies, Resistive Micromegas (MM) and small strip Thin Gap Chambers (sTGC) conforming a system of ~2.4 million readout channels. Both detectors will be used for muon triggering and precision tracking. A common readout path and two separate trigger paths are developed for these two detector technologies. The frontend electronics will be implemented in about 8000 boards including the design of 4 custom ASICs capable of driving trigger and tracking primitives to the backend trigger processor and readout system. The readout data flow is designed through a high-throughput network approach. The large number of readout channels, short time available to prepare and transmit trigger data, large volume of output data, harsh radiation environment, and the need of low power consumption all impose great challenges on the system design. We will present the overall design along with the status of all ASIC and board prototypes.

Primary author: ATLAS COLLABORATION
Presenter: WANG, Ann Miao (Harvard University (US))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
We perform a general model-independent analysis of $b \to c \tau \bar{\nu}$ transitions, including measurements of $R_D$, $R_{D^*}$, their $q^2$ differential distributions, the recently measured longitudinal $D^*$ polarization $F_{L}^{D^*}$, and constraints on the $B_c \to \tau \bar{\nu}$ lifetime. A global fit to a general set of Wilson coefficients of an effective low-energy Hamiltonian is presented, assuming CP-invariance and linear electroweak symmetry breaking. The fitted solutions are interpreted in terms of hypothetical new-physics mediators. From the results obtained, we analyze the predictions for additional $b \to c$ observables such as the baryonic transition $\Lambda_b \to \Lambda_c \tau \bar{\nu}$, the ratio $R_{J/\psi}$, the forward-backward asymmetry $\mathcal{A}_{FB}^{D^*}$, the $\tau$ polarization $P_{L}^{D^*}$, and the longitudinal $D^*$ polarization $F_{L}^{D^*}$. At the $1\sigma$ level, one observes clear tensions among the current experimental inputs, independently of any new-physics hypothesis, which suggests that the reported anomalies could be partly driven by underestimated systematic uncertainties.
Design and performance of the LHCb trigger and full real-time reconstruction in Run 2 of the LHC

Friday, 12 July 2019 12:15 (15 minutes)

The LHCb collaboration has redesigned its trigger to enable the full offline detector reconstruction to be performed in real time. Together with the real-time alignment and calibration of the detector, and a software infrastructure for persisting the high-level physics objects produced during real-time processing, this redesign enabled the widespread deployment of real-time analysis during Run 2. We will describe the design of the Run 2 trigger and real-time reconstruction, and present data-driven performance measurements for a representative sample of LHCb’s physics programme.

Primary author: LHCb COLLABORATION
Presenter: DE CIAN, Michel (EPFL - Ecole Polytechnique Federale Lausanne (CH))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
A comprehensive real-time analysis model in Run 2 at the LHCb experiment

Friday, 12 July 2019 09:00 (15 minutes)

An evolved real-time data processing strategy is proposed for high-energy physics experiments, and its implementation at the LHCb experiment is presented. The reduced event model allows not only the signal candidate firing the trigger to be persisted, as previously available, but also an arbitrary set of other reconstructed or raw objects from the event. This allows for higher trigger rates for a given output data bandwidth, when compared to the traditional model of saving the full raw detector data for each trigger, whilst accommodating inclusive triggers and preserving data mining capabilities. The gains in physics reach and savings in computing resources already made possible by the model during Run 2 of the experiment are discussed.

Primary author: LHCb COLLABORATION
Presenter: MITRESKA, Biljana (University of Manchester (GB))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
Particle identification performance of the LHCb experiment in Run 2

Monday, 15 July 2019 19:40 (20 minutes)

The LHCb particle identification (PID) system is composed of two ring-imaging Cherenkov detectors, a series of muon chambers and a calorimeter system. A novel strategy has been introduced in Run 2, where the selection of PID calibration samples for charged particles and neutrals is implemented in the LHCb software trigger. A further processing of the data is required in order to provide samples for the determination of PID performance, which is achieved through a centralised production that makes highly efficient use of computing resources. This talk covers the major steps of the implementation, and highlights the PID performance achieved in Run 2.

Primary author: LHCb COLLABORATION
Presenter: DE CIAN, Michel (EPFL - Ecole Polytechnique Federale Lausanne (CH))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Real-time alignment and temperature dependency of the LHCb Vertex Detector

Monday, 15 July 2019 19:40 (20 minutes)

The accuracy of the LHCb Vertex Locator (VELO) has ensured excellent detector performance, with a track reconstruction efficiency above 98%, and a vertex resolution along the beam axis of about 70 microns. The real-time alignment and calibration procedure developed by the LHCb experiment for Run 2 (2015-2018) for the full detector, including the VELO, provided extremely stable conditions during the full data taking period. In 2010, a significant shrinkage of the VELO modules was observed at the operating temperature of -30 degrees with respect to survey measurements made at ambient temperature. This has been confirmed by laboratory measurements on a single module. In a recent study, using a dedicated LHCb data sample taken over a range of VELO temperatures, the variation of the detector position as a function of temperature has been evaluated. An overview of the VELO alignment procedure and its performance during Run 2 will be presented, with an emphasis on the study of the temperature dependence.

Primary author: LHCb COLLABORATION
Presenter: MITRESKA, Biljana (University of Manchester (GB))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
We report the measurements of the branching fractions of the decays \( \tau \rightarrow K n\pi^0\nu \), \( n = 0, 1, 2, 3 \), and \( \tau \rightarrow \pi n\pi^0\nu \), \( n = 3, 4 \). The measurements are based on a data sample of 435 million tau pairs produced in \( e^+e^- \) collisions at and near the \( Y(4S) \) peak and collected with the BABAR detector in 1999 – 2008. Additional systematic studies have been completed after the presentation of the preliminary results. Most measurements are substantial improvements over previous measurements and \( \text{calB}(\tau \rightarrow \pi 4\pi^0\nu) \), is measured for the first time. These measurements improve the determination of \( |V_{us}| \) from the branching fraction \( \tau^- \rightarrow X_s^\nu_{\tau} \) computed as the sum of all measured exclusive modes, with a method based on finite-energy QCD sum rules.

**Primary authors**: ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

**Presenter**: LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

**Session Classification**: Flavour Physics and CP Violation

**Track Classification**: Flavour Physics and CP Violation
Recent results on production and decay of quarkonium states at BABAR

Friday, 12 July 2019 15:15 (15 minutes)

We present measurements of absolute branching fractions of the two-body decays of $B$ mesons $Br(B \to K + X)$, where $X$ is a charmonium state, by using a data set corresponding to about 470 fb$^{-1}$ collected by the BABAR detector at the PEP-II $e^+e^-$ collider. For events in which one $B$ is fully reconstructed, the charmonium spectrum can be observed in an unbiased way by looking at the distribution of the $K$ momentum in the rest frame of the recoiling $B$. The same data set is used to study the radiative decays of the $\Upsilon(1S)$ to $\pi^+\pi^-\gamma$ and $K^+K^-\gamma$ final states, performed on the data samples collected at the peak of the $\Upsilon(2S)$ and $\Upsilon(3S)$ resonances. The $\Upsilon(1S)$ is reconstructed from the decay chains $\Upsilon(nS) \to \pi^+\pi^-\Upsilon(1S)$, with $n = 2, 3$. Branching fractions measurements and spin-parity analysis are reported for the $\Upsilon(1S)$ radiative decays to intermediate resonances observed in the $\pi^+\pi^-$ and $K^+K^-$ mass spectra.

**Primary authors:** ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); WORMSER, Guy (LAL Orsay)

**Presenters:** WORMSER, Guy (LAL Orsay); WORMSER, Guy Henri Maurice (Centre National de la Recherche Scientifique (FR)); WORMSER, Guy

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Study of $B \to D^{(*)} l \nu$ decays with a full angular analysis at BABAR

Friday, 12 July 2019 10:15 (20 minutes)

We present results on the first full 4-dimensional angular analysis of $B \to D^{(*)} l \nu$, using the $e^+e^-$ collision dataset collected by the BABAR experiment at the $\Upsilon(4S)$ resonance. One $B$ meson from the $\Upsilon(4S) \to BB$ decay is fully reconstructed in a hadronic decay mode which constrains the kinematics and provides a precise determination of the neutrino momentum vector. We extract the underlying hadronic form-factors employing the model-independent BGL approach and a value for the $CKM$ matrix element $|V_{cb}|$. Last, employing our measured BGL form-factors, we provide new predictions within the Standard Model, for observables related to the the semi-tauonic decay $B \to D^{(*)}\tau\nu$.

**Primary authors:** ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); DEY, Biplab (CCNU)

**Presenter:** DEY, Biplab (CCNU)

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Search for the forbidden charm meson decays

\[ D^0 \to hh' ll' \]

*Monday, 15 July 2019 19:40 (20 minutes)*

Decay modes with two oppositely charged leptons of different flavor correspond to lepton flavor violating (LFV) decays and are essentially forbidden in the Standard Model (SM) because they can occur only through lepton mixing. Decay modes with two leptons of the same charge are lepton-number violating (LNV) decays and are forbidden in the SM. Hence, decays of the form \( D^0 \to hh' ll' \) provide sensitive tools to investigate new mediators or couplings in physics beyond the SM. Charmed mesons were copiously produced in \( e^+ e^- \to c\bar{c} \) continuum events at the PEP-II \( e^+ e^- \) collider at the SLAC National Accelerator Laboratory. In this talk, we report on a search for the three LFV and nine LNV decays of the type \( D^0 \to hh' ll' \) (with \( h, h' = K/\pi \) and \( l, l' = e/\mu \)) using data taken by the BABAR experiment which had comparable sensitivity to both muons and electrons in the final state. Upper limits on the branching fractions are improved by up to two orders of magnitude.

**Primary authors:** ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); WILSON, Fergus (Science and Technology Facilities Council STFC (GB))

**Presenter:** WILSON, Fergus (Science and Technology Facilities Council STFC (GB))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Flavour Physics and CP Violation
Probing pseudo-Dirac mass splittings by observing the high-energy astrophysical neutrinos from blazars

*Friday, 12 July 2019 09:20 (20 minutes)*

Pseudo-Dirac neutrinos are pairs of maximally-mixed Majorana neutrinos with tiny mass difference between the active and the sterile states in each pair. Their oscillation phenomenology is different from that of active neutrinos. Assuming blazars to be the source of astrophysical neutrinos, we construct all-sky maps of neutrino flavor compositions resulting from oscillations of pseudo-Dirac neutrinos originated from different redshifts. Using terrestrial measurements of neutrino flavor composition and the redshift distributions of blazars, we can constrain the mass splittings of pseudo-Dirac neutrinos.

**Primary authors:** Dr LIU, tsugche (LeCosPA, national taiwan university); Prof. LIN, GUEY-LIN (Institute of Physics, National Chiao-Tung University); Prof. LAI, KWANG-CHANG (Physics Group, Center for General Education, Chang Gung University)

**Presenter:** Dr LIU, tsugche (LeCosPA, national taiwan university)

**Session Classification:** Cosmology

**Track Classification:** Cosmology
Observation of the rare decay $D^0 \rightarrow K^-\pi^+e^+e^-$

$\text{Thursday, 11 July 2019 15:45 (15 minutes)}$

Flavor-changing neutral current (FCNC) processes are rare within the Standard Model (SM) as they cannot occur at tree level and are suppressed at loop level by the Glashow-Iliopoulos-Maiani (GIM) mechanism. In $D$-meson decays, the GIM cancellation is almost exact, leading to expected branching fractions for $c \rightarrow ul^-l^+$ processes of order $\mathcal{O}(10^{-9})$. However, long-distance effects can raise this to $\mathcal{O}(10^{-6})$. In this talk, we report on the observation of the $D^0 \rightarrow K^-\pi^+e^+e^-$ decay, based on a sample of about $470 \text{ fb}^{-1}$ of data collected at or near the $\Upsilon(4S)$ resonance, with the $BABAR$ detector at the PEP II $e^+e^-$ collider.

We measure $B(D^0 \rightarrow K^-\pi^+e^-e^+) = (4.0 \pm 0.5) \times 10^{-6}$ in the di-lepton mass range $0.675 < m(e^+e^-) < 0.875 \text{ GeV}/c^2$, where the production of the intermediate state $\rho \rightarrow e^+e^-$ dominates, and set upper limits for decays outside this interval where long-distance effects are expected to be small. The result in the $\rho \rightarrow e^+e^-$ region is consistent with the recent observation of the analogous $D^0 \rightarrow K^-\pi^+\mu^+\mu^-$ decay, reported by the LHCb Collaboration.

**Primary authors:** ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); WILSON, Fergus (Science and Technology Facilities Council STFC (GB))

**Presenter:** WILSON, Fergus (Science and Technology Facilities Council STFC (GB))

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Search for a stable six-quark state in $\Upsilon$ decays at BABAR

Thursday, 11 July 2019 14:30 (20 minutes)

Recent investigations have suggested that the six-quark combination $uuddss$ could be a deeply bound state ($S$) that has eluded detection so far, and a potential dark matter candidate. We report the first search for a stable, doubly strange six-quark state in $\Upsilon \rightarrow S\bar{\Lambda}\bar{\Lambda}$ decays with the BABAR experiment. No signal is observed, and limits on the combined $\Upsilon(2S,3S) \rightarrow S\bar{\Lambda}\bar{\Lambda}$ branching fraction set stringent limits on the existence of such exotic particles.

Primary authors: ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); EIGEN, Gerald (University of Bergen (NO))

Presenter: EIGEN, Gerald (University of Bergen (NO))

Session Classification: Dark Matter

Track Classification: Dark Matter
Search for low-mass New Physics states at BABAR

Friday, 12 July 2019 09:15 (15 minutes)

Many extensions of the Standard Model include the possibility of light new particles, such as axions or dark matter candidates. These scenarios can be probed using the large data sets collected by the B-factories, complementing measurements performed at the LHC. The BABAR collaboration has conducted an extensive program to search for axions in B decays and for self-interacting or non-mimimal dark forces. In this talk, we’ll report on the most recent results.

Primary authors: ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); FORTI, Francesco (INFN Sezione di Pisa, Universita’ e Scuola Normale Superiore, P)

Presenter: FORTI, Francesco (INFN Sezione di Pisa, Universita’ e Scuola Normale Superiore, P)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Recent KLOE-2 results on kaon physics and discrete symmetries tests

Thursday, 11 July 2019 16:50 (20 minutes)

The KLOE-2 experiment at the Frascati Laboratories of INFN collected at the DAΦNE collider an integrated luminosity of 5.5 fb$^{-1}$ that together with the 2.5 fb$^{-1}$ collected by its predecessor KLOE corresponds to $\sim 8 \times 10^9 K_S K_L$ entangled pairs produced. This is the world largest available data sample of this typology and represents a unique tool to improve the precision in the study of the kaon properties and the fundamental discrete symmetries of nature.

The latest results on $K_S$ semileptonic decays, the measurement of their charge asymmetry - recently improved by about a factor of two with respect to the previous result - and related CP and CPT tests will be presented, together with the results of the latest ongoing analyses on tests of Time reversal and CPT in kaon transitions, and the search for the CP violating $K_S \rightarrow 3\pi^0$ decay.

**Primary author:** DI DOMENICO, Antonio (Sapienza Universita e INFN, Roma I (IT))

**Presenter:** Dr KISIELEWSKA, Daria (Jagiellonian University)

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Welcome and Prize ceremony

Monday, 15 July 2019 09:00 (1h 30m)

Session Classification:  Plenary session
LHC collider status and future

Presenter: BRUNING, Oliver (CERN)
Session Classification: Plenary session
Highlights from the ATLAS Experiment

Monday, 15 July 2019 11:30 (30 minutes)

**Presenter:** HOECKER, Andreas (CERN)

**Session Classification:** Plenary session
Highlights from the CMS Experiment

Monday, 15 July 2019 12:00 (30 minutes)

Presenters: ADAM, Wolfgang (Austrian Academy of Sciences (AT)); ADAM, Wolfgang (HEPHY-Vienna)

Session Classification: Plenary session
Higgs measurements

Monday, 15 July 2019 12:30 (30 minutes)

Presenter: SALERNO, Roberto (Centre National de la Recherche Scientifique (FR))
Session Classification: Plenary session
Contribution ID: 498

Higgs Theory

Monday, 15 July 2019 14:00 (30 minutes)

**Presenter:** RIVA, Francesco

**Session Classification:** Plenary session
Standard Model Measurements

Monday, 15 July 2019 14:30 (30 minutes)

Presenter:  DI CIACCIO, Lucia (Universite de Savoie Mont-Blanc (FR))
Session Classification:  Plenary session
Standard Model Theory

Monday, 15 July 2019 15:00 (30 minutes)

Presenter: ZANDERIGHI, Giulia
Session Classification: Plenary session
Calculational Techniques

*Monday, 15 July 2019 15:30 (30 minutes)*

**Presenter:** DUHR, Claude (CERN)

**Session Classification:** Plenary session

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**Contribution ID:** 501

**Type:** not specified
Searches for Supersymmetry

Monday, 15 July 2019 16:30 (30 minutes)

Presenter: MELZER-PELLMANN, Isabell (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Plenary session
Searches for Exotica

Monday, 15 July 2019 17:00 (30 minutes)

Presenter: GENEST, Marie-Helene (LPSC-Grenoble, CNRS/UGA (FR))
Session Classification: Plenary session
Beyond Standard Model Theory

Monday, 15 July 2019 17:30 (30 minutes)

Presenter: PANICO, Giuliano (The Barcelona Institute of Science and Technology (BIST) (ES))

Session Classification: Plenary session
Quantum Field and String Theory

Monday, 15 July 2019 18:00 (30 minutes)

Presenters: OOGURI, Hirosi (Caltech); OOGURI, Hirosi

Session Classification: Plenary session
Highlights from the LHCb Experiment

Tuesday, 16 July 2019 09:00 (30 minutes)

Presenter: MUELLER, Katharina (Universitaet Zuerich (CH))

Session Classification: Plenary session
Rare decays, exotica and CP Violation

Tuesday, 16 July 2019 09:30 (30 minutes)

Presenter:  ALBRECHT, Johannes (Technische Universitaet Dortmund (DE))
Session Classification:  Plenary session
BELLE II and flavor physics in e+e-

Tuesday, 16 July 2019 10:00 (30 minutes)

**Presenter:** FORTI, Francesco (INFN Sezione di Pisa, Universita' e Scuola Normale Superiore, P)

**Session Classification:** Plenary session
Contribution ID: 509

Flavour physics theory

Tuesday, 16 July 2019 10:30 (30 minutes)

Presenters: NARDECHIA, Marco; NARDECHIA, Marco (Sapienza Universita e INFN, Roma I (IT)); NARDECHIA, Marco (SISSA/ISAS)

Session Classification: Plenary session
Gravitational Waves Observations

Tuesday, 16 July 2019 11:30 (30 minutes)

Presenter: SCHMIDT, Patricia (Nijmegen)
Session Classification: Plenary session
Multimessenger astroparticle physics observations

Tuesday, 16 July 2019 12:00 (30 minutes)

Presenter: BERNARDINI, Elisa (Laboratorio Nazionale del Gran Sasso (LNGS))

Session Classification: Plenary session
High-energy Cosmic Rays

Tuesday, 16 July 2019 12:30 (30 minutes)

Presenters:  DE LOTTO, Barbara (Università degli Studi di Udine (IT)); DE LOTTO, Barbara (INFN Udine)

Session Classification:  Plenary session
Broadening and saturation effects in dijet azimuthal correlations in p-p and p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

*Thursday, 11 July 2019 09:38 (18 minutes)*

We demonstrate that the recent forward-forward dijet correlation data measured by the ATLAS collaboration for proton-proton and proton-lead collisions are consistent with the broadening effects due to both the gluon saturation and the resummation of large logarithms of the hard scale (the so-called Sudakov logarithms). We find that both effects are necessary to describe the experimental results.

**Primary authors:** KUTAK, Krzysztof (Instytut Fizyki Jadrowej Polskiej Akademii Nauk); KOTKO, Piotr; SAPETA, Sebastian (IFJ PAN); VAN HAMEREN, Andreas (IFJ PAN)

**Presenter:** KUTAK, Krzysztof (Instytut Fizyki Jadrowej Polskiej Akademii Nauk)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Neutrino Physics from Natural and Reactor Beams

Tuesday, 16 July 2019 14:30 (30 minutes)

Presenter: RANUCCI, Gioacchino (Istituto Nazionale di Fisica Nucleare)
Session Classification: Plenary session
Neutrino physics from Particle Beam

Tuesday, 16 July 2019 15:00 (30 minutes)

Presenter: DI LODOVICO, Francesca (University of London (GB))

Session Classification: Plenary session
Neutrino theory

*Tuesday, 16 July 2019 15:30 (30 minutes)*

**Presenter:** PASCOLI, Silvia (University of Durham (GB))

**Session Classification:** Plenary session
Direct and Indirect Dark Matter Searches

*Tuesday, 16 July 2019 16:30 (30 minutes)*

**Presenter:** DE LOS HEROS, Carlos (Uppsala University)

**Session Classification:** Plenary session
Axion Searches

Tuesday, 16 July 2019 17:00 (30 minutes)

Presenter: GARCIA IRASTORZA, Igor (Universidad de Zaragoza (ES))
Session Classification: Plenary session
Dark Matter Theory

Tuesday, 16 July 2019 17:30 (30 minutes)

Presenter: BLUM, Kfir (CERN)

Session Classification: Plenary session
Highlights from the ALICE experiment

*Wednesday, 17 July 2019 09:00 (30 minutes)*

**Presenter:** VAN LEEUWEN, Marco (Nikhef National institute for subatomic physics (NL))

**Session Classification:** Plenary session
Emergence of Quark-Gluon Plasma Phenomena

Wednesday, 17 July 2019 09:30 (30 minutes)

Presenter:  GROSSE-OETRINGHAUS, Jan Fiete (CERN)
Session Classification:  Plenary session
High-density QCD Matter

Wednesday, 17 July 2019 10:00 (30 minutes)

Presenter: PEREPELITSA, Dennis (University of Colorado Boulder)
Session Classification: Plenary session
Dense QCD Matter in Heavy Ion collisions and Neutron Stars

Wednesday, 17 July 2019 10:30 (30 minutes)

Presenter: SALGADO LOPEZ, Carlos Albert (Universidade de Santiago de Compostela (ES))
Session Classification: Plenary session
Observational Cosmology

Wednesday, 17 July 2019 11:30 (30 minutes)

Presenter: BOUCHET, Francois (Paris)

Session Classification: Plenary session
Cosmology Theory

Wednesday, 17 July 2019 12:00 (30 minutes)

Presenter: SENATORE, Leonardo (Stanford University)
Session Classification: Plenary session
Future Astroparticle Facilities

Wednesday, 17 July 2019 12:30 (30 minutes)

Presenter: KOWALSKI, Marek (Polish Academy of Sciences (PL))

Session Classification: Plenary session
Novel Data-Analysis Techniques

Wednesday, 17 July 2019 14:30 (30 minutes)

Presenter: ROUSSEAU, David (LAL-Orsay, FR)
Session Classification: Plenary session
Detector R&D Collider Experiments

Wednesday, 17 July 2019 15:00 (30 minutes)

Presenter: CONTARDO, Didier Claude (Centre National de la Recherche Scientifique (FR))

Session Classification: Plenary session
Detector R&D non-Collider Experiments

*Wednesday, 17 July 2019 15:30 (30 minutes)*

**Presenter:** PREVITALI, Ezio (INFN - National Institute for Nuclear Physics)

**Session Classification:** Plenary session
Future Accelerator R&D

Wednesday, 17 July 2019 16:00 (30 minutes)

Presenter: ASSMANN, Ralph Wolfgang (Deutsches Elektronen-Synchrotron (DE))
Session Classification: Plenary session
Highlights

Wednesday, 17 July 2019 16:30 (30 minutes)

Presenter: BUTTERWORTH, Jonathan (University College London (UK))

Session Classification: Plenary session
Announcement of EPS-HEP 2021 and Closing

Wednesday, 17 July 2019 17:00 (30 minutes)

**Primary authors:** SCHWANENBERGER, Christian (Deutsches Elektronen-Synchrotron (DE)); TYTGAT, Michael (Ghent University (BE))

**Presenters:** SCHWANENBERGER, Christian (Deutsches Elektronen-Synchrotron (DE)); TYTGAT, Michael (Ghent University (BE))

**Session Classification:** Plenary session
On Anomaly-Free Dark Matter Models

Gamma lines provide a clean and distinctive signature, and hence, they represent a smoking gun for the discovery of the dark matter. Unfortunately, for many well-known dark matter models it is not possible to observe them, either because they are not predicted by the theory or they are overcome by the background. I will provide a simple guide to classify abelian dark matter models according to their potential to predict gamma lines. As an example, a very attractive and simple SM extension will be discussed: local baryon number with Majorana dark matter. In the context of this model, anomaly cancellation predicts the existence of dark matter and gamma lines, and interesting phenomenological features arise as a consequence of their leptophobic behaviour.

Primary author:  Mrs MURGUI GALVEZ, Clara
Presenter:  Mrs MURGUI GALVEZ, Clara
Session Classification:  Dark Matter
Track Classification:  Dark Matter
The NOvA experiment, which uses two functionally identical liquid scintillator detectors over an 810 km baseline in the Fermilab NuMI beam, has the potential to set world-leading limits on the $\theta_{24}$ and $\theta_{34}$ parameters governing sterile neutrino oscillations by searching for a deficit of neutral current interactions compared to that predicted at the two detectors. An updated analysis with the NOvA antineutrino beam dataset will be presented. Limits on the sterile neutrino mixing parameters will be shown and plans for future analyses, including a two-detector joint fit utilizing a covariance matrix to constrain systematics, will be discussed.
SOME QUANTUM-MECHANICAL RELATIONS IN CASE OF SINGULAR OPERATORS

Thursday, 11 July 2019 16:30 (20 minutes)

Elaboration of some fundamental relations in 3-dimensional quantum mechanics is considered taking into account the restricted character of areas in radial distance. In such cases the boundary behavior of the radial wave function and singularity of operators at the origin of coordinates contribute to these relations. We derive the relation between the average value of the operator’s time derivative and the time derivative of the mean value of this operator, which is usually considered to be the same by definition. The deviation from the known result is deduced and manifested by extra term, which depends on the boundary behavior mentioned above. The general form for this extra term takes place in the hypervirial-like theorems. As a particular case, the virial theorem for Coulomb and oscillator potentials is considered and correction to the Kramers’ sum rule is derived. Moreover the corrected Ehrenfest theorem is deduced and its consistency with real physical picture is demonstrated.

Primary authors: Prof. NADAREISHVILI, Teimuraz (Iv.Javakhishvili Tbilisi State University); Prof. KHELASHVILI, Anzor (St.Andrea the First-called Georgian University of Patriarchate of Georgia)

Presenter: Prof. NADAREISHVILI, Teimuraz (Iv.Javakhishvili Tbilisi State University)

Session Classification: Quantum Field and String Theory

Track Classification: Quantum Field and String Theory
The onset of spin rotation effects in electroproduction of heavy quarkonia

Thursday, 11 July 2019 15:30 (15 minutes)

We study manifestations of the Melosh spin rotation effects in diffractive electroproduction of heavy quarkonia off a nucleon target.

The quarkonia wave functions are determined within the Schroedinger equation based formalism using realistic potentials, which describe the interaction between heavy quark and antiquark.

The large importance of the Melosh spin transformation is analysed within the color dipole approach using several popular parametrizations of the dipole cross section.

We find that a strong onset of spin rotation effects in 1S charmonium photoproduction, obviously neglected in present calculations, contributes to obtaining a reasonable agreement with available data.

For the photoproduction of radially excited 2S (3S) quarkonia these effects are even stronger as a direct manifestation of the nodal structure of their wave functions (the node effect).

They lead to a rise of the $\Psi'(2S)$ photoproduction cross section by a factor of 2-3 causing so a substantial enhancement of the $\Psi'(2S)$-to-$J/\Psi(1S)$ ratio of the photoproduction cross sections to the values close to experimental data.

However, for the radially excited bottomonia $\Upsilon'(2S)$ and $\Upsilon''(3S)$, they enhance the corresponding photoproduction cross sections by a smaller factor of 1.2-1.3 due to a weaker node effect.

Finally, we predict that the spin effects vanish gradually with photon virtuality $Q^2$ with the universal onset in the production of different heavy quarkonia at the same fixed values of $Q^2 + M_V^2$.

Primary author: Dr KRELINA, Michal (FNSPE, Czech Technical University)

Co-authors: NEMCHIK, Jan (Czech Technical University in Prague (CZ) and Institute of Experimental Physics, Kosice (SK)); PASECHNIK, Roman (Lund university); CEPILA, Jan (Czech Technical University (CZ))

Presenter: Dr KRELINA, Michal (FNSPE, Czech Technical University)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Search for Additional Heavy Neutral Higgs Bosons in the Ditau Final State with the ATLAS Detector

Monday, 15 July 2019 18:30 (1h 30m)

A search for heavy neutral Higgs bosons is performed using a data from proton–proton collisions at \( \sqrt{s} = 13 \text{ TeV} \) recorded by the ATLAS detector at the LHC. The heavy resonance is assumed to decay to \( \tau^+ \tau^- \) with at least one tau lepton decaying to final states with hadrons and a neutrino. Results are interpreted in the hMSSM benchmark scenario.

Primary author: ATLAS COLLABORATION

Presenter: KRZYSIAK, Janina Anna (Polish Academy of Sciences (PL))

Session Classification: Wine & Cheese Poster Session

Track Classification: Searches for New Physics
Reactor antineutrino flux and spectrum measurement of Daya Bay Experiment

Thursday, 11 July 2019 10:40 (20 minutes)

The Daya Bay Reactor Neutrino Experiment utilizes eight functionally identical detectors with large target volume to measure the antineutrino flux emitted from three pairs of powerful nuclear reactors at different baselines. The detectors are placed underground to provide enough shielding against cosmic rays induced backgrounds. The experiment can perform a high-statistics determination of the absolute reactor antineutrino flux and spectrum. It’s found that a deviation in the measured positron prompt energy spectrum with the comparison to model predictions. It’s observed a local discrepancy in the energy range of 4-6 MeV. The experiment gave the first measurement of individual spectra from 235U and 239Pu. This talk will report the latest measurements of antineutrino flux, spectral shape and evolution of these two quantities with nuclear fuel at Daya Bay.

Primary author: Mr LU, Haoqi (Institute of High Energy Physics, CAS, China)
Presenter: Mr LU, Haoqi (Institute of High Energy Physics, CAS, China)
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
ZICOS – Neutrinoless double beta decay experiment using Zr-96 in organic liquid scintillator-

Monday, 15 July 2019 18:30 (1h 30m)

A liquid scintillator containing a tetrakis (isopropyl acetoacetato) zirconium (Zr(iPrac)₄) has been developed for new experiment of neutrinoless double beta decay (0νββ) search using ⁹⁶Zr isotope. The liquid scintillator has 10wt.% concentration of Zr(iPrac)₄, which corresponds to 1.4wt.% of natural zirconium, a light yield of 48.7 ± 7.1% for BC505, and an energy resolution of 2.6 ± 0.5% at 3.35MeV assuming 64% photo coverage of the photomultiplier.

In order to investigate a half-life of 0νββ over 10⁻²⁷ years, which corresponds to neutrino mass less than 0.01eV/c², we have to use tons scale of ⁹⁶Zr isotope. At present, we are planning to construct a spherical detector similar to KamLAND-Zen, however we have to reduce 95% of backgrounds from ²⁰⁸Tl decay which should be adhere on the surface of inner balloon as observed by KamLAND-Zen.

For this purpose, we have developed new technique to use Cherenkov light in order to reduce those backgrounds using the topology of location for photomultipliers received Cherenkov light, and have obtained the results of Monte Carlo simulation that 93% of ²⁰⁸Tl decay events could be reduced with 78% efficiency for 0νββ events using the topological information. In this points of view, we have to use the pulse shape for the discrimination to extract Cherenkov lights, and have to demonstrate the topological information using actual low energy electrons.

Here we will report recent developments and the prototype ZICOS detector, which is approved by JSPS, to demonstrate the topological information.

Primary authors: Prof. FUKUDA, Yoshiyuki (Miyagi University of Educartion); Prof. MORIYAMA, Shigetaka (Kamioka Observatory, Institute for Cosmic Ray Research, The University of Tokyo); Prof. OGAWA, Izumi (Faculty of Engineering, University of Fukui); Prof. GUNJI, Takahiro (Faculty of Science and Technology, Tokyo University of Science); Dr HIRAIDE, Katsuki (Kamioka Observatory, Institute for Cosmic Ray Research, The University of Tokyo); Prof. KUROSAWA, Shunsuke (Institute for Material Research, Tohoku University)

Presenter: Prof. FUKUDA, Yoshiyuki (Miyagi University of Educartion)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Recent developments and applications of crystal channeling at the CERN Large Hadron Collider

Friday, 12 July 2019 16:50 (20 minutes)

A unique experimental apparatus with 4 bent crystals is installed in the betatron collimation insertion of the Large Hadron Collider (LHC) at CERN. This setup is designed to study experimentally the crystal-assisted collimation of high-energy hadron beams and it has been used, with various improvements throughout the years, since 2015. After the first observation of channeling of proton and heavy-ion beams at the unprecedented energy of 6.5 Z TeV, various systematic studies were carried out. With the main focus to demonstrate the feasibility of crystal collimation at the LHC, other applications were studied. In 2018, this apparatus was also used for a low-background run at 450 GeV, where crystals were integrated as a part of the LHC collimation system to optimize loss rates at Roman pots, for the first time in a physics run. The good observed performance motivated studies for other applications of bent crystals with the LHC beams, like possible implementations of fixed-target experiments with 7 TeV beams that are addressed in the framework of the Physics Beyond Collide study at CERN. This paper reviews the status of recent developments on bent crystal applications at the LHC.

Primary author: REDAELLI, Stefano (CERN)

Co-authors: MIRARCHI, Daniele (University of Manchester (GB)); BRUCE, Roderik (CERN); D’ANDREA, Marco (Università e INFN, Padova (IT)); GARCIA MORALES, Hector (University of Oxford)

Presenter: REDAELLI, Stefano (CERN)

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
The Gamma Factory (GF) initiative proposes to use partially stripped ion (PSI) beams as drivers of a new type of high intensity and high energy (1-400 MeV) photon source. As part of the ongoing Physics Beyond Collider studies, initial beam tests with PSI beams have been carried out in 2017 and 2018 at the SPS and LHC with partially stripped xenon and lead beams. This contribution discusses the results of these tests and the preparations for the next GF R&D step — the proof-of-principle experiment at the SPS to study collisions of PSI beams with the laser pulses.
Track Classification: Accelerators for HEP
DarkSide-50 Results and the Future Liquid Argon Dark Matter Program

Thursday, 11 July 2019 12:20 (20 minutes)

DarkSide uses a dual-phase Liquid Argon Time Projection Chamber to search for WIMP dark matter. The talk will present the latest result on the search for low mass ($M_{WIMP} < 20\text{GeV}/c^2$) and high mass ($M_{WIMP} > 100\text{GeV}/c^2$) WIMPs from the current experiment, DarkSide-50, running since mid 2015 a 50-kg-active-mass TPC, filled with argon from an underground source. The next stage of the DarkSide program will be a new generation experiment involving a global collaboration from all the current Argon based experiments. DarkSide-20k, is designed as a 20-tonne fiducial mass TPC with SiPM based photosensors, expected to be free of any instrumental background for an exposure of $>100\text{ton} \times \text{yr}$. Like its predecessor DarkSide-20k will be housed at the Gran Sasso (LNGS) underground laboratory, and it is expected to attain a WIMP-nucleon cross section exclusion sensitivity of $10^{-47}\text{cm}^2$ for a WIMP mass of $1\text{TeV}/c^2$ in a 5 yr run.

A subsequent objective, towards the end of the next decade, will be the construction of the ultimate detector, ARGO, with a 300 t fiducial mass to push the sensitivity to the neutrino floor region for high mass WIMPs.

The combination of the three experiments, part of a single family, will cover completely the WIMP hypothesis from $1\text{GeV}/c^2$ to several hundreds of $\text{TeV}/c^2$ masses.

Primary authors: DARKSIDE COLLABORATION; CAMINATA, Alessio (INFN e Universita Genova (IT))

Presenter: CAMINATA, Alessio (INFN e Universita Genova (IT))

Session Classification: Dark Matter

Track Classification: Dark Matter
Due to the current gap between the electroweak scale and the scale of New Physics, the use of electroweak effective approaches is justified. A linear realization of the electroweak symmetry breaking with the Higgs forming a doublet is a first possibility (SMEFT), but we prefer to use the more general non-linear realization, being the Higgs a scalar singlet with independent couplings (EWET or HEFT). Note that the EWET includes the SMEFT as a particular case. We construct the effective Lagrangians at low energies (including only the SM fields) and at high energies (including also a set of resonances). Considering the high scales of these resonances, a good way to handle with them is by searching for their imprints in the Low Energy Constants (LECs) of the EWET at energies lower that the resonances masses. We also relate our general approach with specific examples present in the literature.

**Primary author:** ROSELL, Ignasi (Universidad CEU Cardenal Herrera, Valencia)

**Presenter:** ROSELL, Ignasi (Universidad CEU Cardenal Herrera, Valencia)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Vetoing Tops without B-Tagging

Friday, 12 July 2019 12:00 (15 minutes)

At TeV-scale hadron colliders, such as the CERN LHC and proposed future facilities at $\sqrt{s} = 28 - 100$ TeV, single and pair production of top quarks invariably constitute a major background in multi-lepton searches for new, TeV-scale particles, such as $W'$ gauge bosons, smuons ($\tilde{\mu}$), and heavy neutrinos ($N$). Due to imperfect tagging efficiencies, however, vetoing events according to the presence of $b$-jets has limitations. A newly proposed (dynamic) jet veto scheme, one where the veto threshold is set on an event-by-event basis and is capable of rejecting a majority of top quark events while retaining a high ($> 90 - 95\%$) signal efficiency without invoking heavy quark flavor-tagging, is presented. Impact on heavy neutrino and smuon searches will be discussed.

Primary author: RUIZ, Richard (Universite Catholique de Louvain)
Presenter: RUIZ, Richard (Universite Catholique de Louvain)
Session Classification: Top and Electroweak Physics
Track Classification: Top and Electroweak Physics
A primary electron beam facility is proposed at CERN with main motivations; (i) dark sector experiments, and (ii), enabling a suite of development projects in accelerator technology.

The facility consists of a 3.5 GeV X-band linac injecting electrons into the SPS where the electron beam can be accelerated to around 16 GeV. This presentation will cover the design studies for the 3.5 GeV linac and the re-introduction of an electron beam in the SPS.

The potential of such beams for particle physics studies (e.g. Light Dark Matter Searches) and accelerator R&D will also be reviewed, with emphasis on the latter. The accelerator R&D possibilities cover linear collider studies, studies with relevance for circular electron-positron accelerators, plasma acceleration studied and general accelerator R&D (impedance studies, instrumentation, electron guns, positron production, irradiation studies, and more).

**Primary author:** STAPNES, Steinar (CERN)

**Presenter:** STAPNES, Steinar (CERN)

**Session Classification:** Accelerators for HEP

**Track Classification:** Accelerators for HEP
Measurement of long-range correlations in pp collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC

Saturday, 13 July 2019 10:32 (18 minutes)

The observed azimuthal modulations of long-range correlations in pseudorapidity in small systems like pp or p-Pb collisions show strikingly similar features to those seen in heavy ion collisions. Many theoretical approaches to interpreting this effect have been developed. However, it is still unclear whether these long-range correlations are due to final or initial state effects. To further investigate these effects, we studied long-range correlations as a function of transverse momentum in very high multiplicity pp collisions at $\sqrt{s} = 13$ TeV, collected with the high multiplicity event trigger during 2016 and 2017 with ALICE. In this talk, we present the near-side per-trigger yield at large pseudorapidity separation (ridge yield) as a function of transverse momentum in pp collisions at $\sqrt{s} = 13$ TeV. The results will be compared to previous measurements from CMS and ATLAS. In addition, we present the ridge yield in events where harder fragmentation processes are present, to explore possible physical origins of long range correlations.

Primary author: KIM, Junlee (Chonbuk National University (KR))

Presenter: KIM, Junlee (Chonbuk National University (KR))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Where do AMS-02 anti-helium events come from?

Friday, 12 July 2019 12:30 (20 minutes)

In this talk, I will discuss consequences of the potential detection of anti-helium-3 and -4 events by AMS-02. After showing that spallation from primary hydrogen and helium nuclei onto the ISM cannot account for the measured fluxes, I will argue that dark matter annihilation or decay face similar difficulties in explaining these events. I will then entertain the possibility that these events originate from anti-matter-dominated regions in the form of anti-clouds or anti-stars. I will finally discuss constraints due to annihilation onto normal matter that apply on such scenario.

Primary authors:  Dr POULIN, Vivian (LUPM, CNRS, France);  SALATI, PIERRE (LAPTh & Université de Savoie Mont Blanc);  KAMIONKOWSKI, Marc (Johns Hopkins University);  CHOLIS, ILIAS (Johns Hopkins University);  SILK, joseph (IAP)

Presenter:  Dr POULIN, Vivian (LUPM, CNRS, France)

Session Classification:  Cosmology

Track Classification:  Cosmology
FCC-hh detector concept

Monday, 15 July 2019 19:40 (20 minutes)

The physics reach and feasibility of the Future Circular Collider (FCC) with centre of mass energies up to 100\,TeV and unprecedented luminosity have been studied and published in a Conceptual Design Report (CERN-ACC-2018-0058). The new energy regime of the FCC-hh opens the opportunity for the discovery of physics beyond the standard model.

In order to exploit the full physics potential of such a collider, a conceptual design of a possible reference detector has been developed. Proton-proton collisions at 100\,TeV will produce very high energetic particle showers in the calorimeters from both, light jets and boosted bosons and top quarks. The reconstruction of such objects sets the calorimeter performance requirements in terms of shower containment, energy resolution and granularity. Furthermore, high-precision measurements of photons and electrons over a wide energy range are crucial to fully exploit the FCC-hh physics potential, especially given the large amount of collisions per bunch crossing the detectors will have to face (pile-up of up to $\langle \mu \rangle = 1000$).

This talk, on behalf of the FCC-hh detector group, will give a more detailed description of the design considerations. The benchmark physics channels used in the design will be introduced and a detailed description of the detector conceptual choices in terms of technology, geometry, granularity etc... will be given.

**Primary authors:** HELSENS, Clement (CERN); ALEKSA, Martin (CERN); NEUBUSER, Coralie (CERN); HENRIQUES CORREIA, Ana Maria (CERN); VOLKL, Valentin (University of Innsbruck (AT)); ZABOROWSKA, Anna (CERN)

**Presenter:** HELSENS, Clement (CERN)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
FCC-hh detector performance

Monday, 15 July 2019 19:40 (20 minutes)

The physics reach and feasibility of the Future Circular Collider (FCC) with centre of mass energies up to 100\,TeV and unprecedented luminosity have been studied and published in a Conceptual Design Report (CERN-ACC-2018-0058). In order to exploit the full physics potential of such a collider, a conceptual design of a possible reference detector has been developed. Proton-proton collisions at 100\,TeV will produce very high energetic particle showers in the calorimeters from both light jets and boosted bosons/top. The reconstruction of such objects sets the calorimeter performance requirements in terms of shower containment, energy resolution and granularity. Furthermore, high-precision measurements of photons and electrons over a wide energy range are crucial to fully exploit the FCC-hh physics potential, especially given the large amount of collisions per bunch crossing the detectors will have to face (pile-up of up to $\langle \mu \rangle = 1000$).

This talk, on behalf of the FCC-hh detector group, will give a more detailed description of the detector performances, introducing the benchmark physics channels of the FCC-hh, and presenting simulation studies that have been performed in order to give a realistic estimate of the detectors performance. While the focus will lay on the calorimetric systems, the tracker design as well as the muon system requirements will also be discussed.

Primary authors: HELSENS, Clement (CERN); ALEKSA, Martin (CERN); HENRIQUES CORREIA, Ana Maria (CERN); NEUBUSER, Coralie (CERN); VOLKL, Valentin (University of Innsbruck (AT)); ZABOROWSKA, Anna (CERN)

Presenter: HELSENS, Clement (CERN)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Dissociative production of vector mesons as a new tool to study gluon saturation at electron-ion colliders

Saturday, 13 July 2019 12:30 (15 minutes)

We present a model with which we predict the cross sections for exclusive and dissociative photo and electroproduction of light and heavy vector mesons off protons; the model describes correctly available experimental data. The model is based on the color-dipole approach and incorporates geometric fluctuations of the target-proton partonic structure. The fluctuations are generated as randomly placed areas of high gluonic density, so-called hot spots, in the proton impact-parameter plane, with the number of hot spots being energy-dependent. A striking feature of the model is the prediction of a maximum of the dissociative cross section as a function of the centre-of-mass energy $W_{\gamma p}$, followed by a steep decrease as the hot spots start to overlap with increasing energy. We use these maxima to define a geometrical saturation scale and find that it grows linearly with energy as a function of the scale of the process. This phenomenon can be studied at the proposed electron-ion colliders, JLEIC, eRHIC, and LHeC. We present a comparison of their envisioned kinematic reach with the geometrical saturation scale.

Primary author: BENDOVA, Dagmar (Czech Technical University in Prague (FNSPE))

Co-authors: CONTRERAS NUNO, Jesus Guillermo (Czech Technical University (CZ)); CEPILA, Jan (Czech Technical University (CZ))

Presenter: BENDOVA, Dagmar (Czech Technical University in Prague (FNSPE))

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Recent results from STEREO

Saturday, 13 July 2019 09:40 (15 minutes)

STEREO is a coarsely segmented, Gd-loaded liquid scintillator calorimeter studying anti-neutrinos produced by the compact, nearly pure $^{235}\text{U}$ nuclear reactor core of the Institut Laue-Langevin at Grenoble (France). The experiment has been designed to test the light sterile neutrino explanation of the Reactor Antineutrino Anomaly (RAA) by comparing the neutrino energy spectra recorded by its six detector cells. The cells are located between 9 and 11 m away from the centre of the reactor core.

Using data collected since 2016, the STEREO experiment excludes a significant fraction of the RAA favoured region in the $\Delta m^2_{41} - \sin^2(2\theta_{ee})$ parameter space, rejecting the RAA best-fit point at >99.8 % C.L. We also measure the total anti-neutrino flux coming from the reactor. Finally, we present our first measurement of the energy spectrum of the reactor anti-neutrinos. A good agreement with the predicted spectrum is observed up to 6 MeV.

Primary author: DEL AMO SANCHEZ, Pablo (LAPP - Université de Savoie - IN2P3 - CNRS)
Co-author: THE STEREO COLLABORATION
Presenter: DEL AMO SANCHEZ, Pablo (LAPP - Université de Savoie - IN2P3 - CNRS)
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
DARWIN – a next-generation liquid xenon observatory for dark matter and neutrino physics

Thursday, 11 July 2019 12:40 (20 minutes)

Benefiting from more than a decade of experience in WIMP search with liquid xenon time projection chambers, the DARWIN (DARK matter WImp search with liquid xenoN) collaboration intends to build an observatory involving 50 tonnes of xenon. The primary goal of the experiment is to explore the entire experimentally accessible parameter space for WIMP masses above \(5 \text{ GeV}/c^2\) down to the irreducible neutrino floor. With its low energy threshold and ultra-low background level, DARWIN will provide an excellent platform to search for various other rare interactions, including the neutrinoless double beta decay of \(^{136}\text{Xe}\), solar axions and axion-like particles. Furthermore, it will measure the low-energy solar neutrino flux with high precision, observe coherent neutrino-nucleus interactions and detect galactic supernovae. In this talk, we will present the detector concept, the sensitivity to the various science channels, and ongoing R&D efforts.

**Primary author:** Mr THIEME, Kevin (University of Zurich)

**Presenter:** Mr THIEME, Kevin (University of Zurich)

**Session Classification:** Dark Matter

**Track Classification:** Dark Matter
Inert Doublet Model signatures at future e+e- colliders

Friday, 12 July 2019 10:45 (15 minutes)

The Inert Doublet Model (IDM) is one of the simplest extensions of the Standard Model (SM), providing a dark matter candidate. It is a two Higgs doublet model with a discrete Z2 symmetry, that prevents the scalars of the second doublet (inert scalars) from coupling to the SM fermions and makes the lightest of them stable. We study a large statistics of IDM scenarios, which are consistent with current constraints on direct detection, including the most recent bounds from XENON1T experiment and relic density of dark matter, as well as with all collider and low-energy limits. We propose a set of benchmark points with different kinematic features, that promise detectable signals at future e+e- colliders. Two inert scalar pair-production processes are considered, \( e^+e^- \rightarrow H^+H^- \) and \( e^+e^- \rightarrow A \), followed by decays of \( H^+/^- \) and \( A \) into the final states which include the lightest and stable neutral scalar dark matter candidate \( H \). Significance of the expected observations is studied for different benchmark models and different running scenarios, for center of mass energies up to 3 TeV. Numerical results are presented for the signal signatures with two muons or an electron and a muon in the final state. For high mass scenarios, when the significance is too low for the leptonic signatures, the semi-leptonic one can be used as the discovery channel.

Primary authors: SOKOLOWSKA, Dorota (UFRN Natal); KALINOWSKI, Jan Henryk (University of Warsaw (PL)); KLAMKA, Jan (University of Warsaw); Dr KOTLARSKI, Wojciech (TU - Dresden); ROBENS, Tania Natalie (Rudjer Boskovic Institute (HR)); SOPICKI, Pawel (University of Warsaw (PL)); ZARNECKI, Aleksander Filip (University of Warsaw)

Presenter: SOKOLOWSKA, Dorota (UFRN Natal)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Status and Results from the XENON Dark Matter Project

Thursday, 11 July 2019 11:40 (20 minutes)

XENON1T, the first tonne-scale dual-phase xenon time projection chamber, took data at the Laboratori Nazionali del Gran Sasso in Italy between 2016 and 2018. The experiment was sensitive to the scattering of weakly interacting massive particle (WIMP) dark matter within a 2 t target volume. By using both the scintillation and ionisation signals induced by an interaction it is possible to discriminate WIMP-induced events from the main electronic recoil background. The electronic-recoil background rate of 82 ev / (t yr keV) is the lowest ever achieved in such a detector. Work is now underway to upgrade the detector to XENONnT. Using much of the same infrastructure, this will have a three-times larger target. At the same time XENONnT will have a significantly reduced background rate, largely due to a new radon distillation column. This talk will present the latest results from XENON1T as well as the status of the XENONnT work currently being performed.

Primary author:  BROWN, Adam (University of Zurich)
Presenter:  BROWN, Adam (University of Zurich)
Session Classification:  Dark Matter
Track Classification:  Dark Matter
Constraining the gluon nuclear content with heavy-flavour production at the LHC

Friday, 12 July 2019 11:50 (18 minutes)

We report on our study showing that heavy-flavour production at the LHC can strongly improve our knowledge of the gluon content of the heavy nuclei. We have indeed observed that the nuclear effects encoded in both most recent global fits of nuclear parton densities at next-to-leading order (nCTEQ15 and EPPS16) gives a good account of the LHC proton-lead data. Thanks to a Bayesian-reweighting analysis for each particle data sample, we have shown that the existing data on $D^0$, prompt and nonprompt $J/\psi$, and $\Upsilon$ mesons clearly points, with a minimal statistical significance of $7\sigma$, to a gluon distribution which is shadowed at small $x$ in the lead. As such, the inclusion of such heavy-flavour data in a global fit is expected to drastically reduce the gluon-density uncertainty down to $x \simeq 7 \times 10^{-6}$, where no other data exist, while keeping an agreement with the other data of the global fits. We also address the issue of the factorisation-scale uncertainties which is particularly relevant for the charm(onium) sector.

References:

Gluon Shadowing in Heavy-Flavor Production at the LHC
By Aleksander Kusina, Jean-Philippe Lansberg, Ingo Schienbein, Hua-Sheng Shao.

Towards an automated tool to evaluate the impact of the nuclear modification of the gluon density on quarkonium, D and B meson production in proton–nucleus collisions
By Jean-Philippe Lansberg, Hua-Sheng Shao.

Primary authors: KUSINA, Aleksander (IFJ PAN); LANSBERG, Jean-Philippe (IPN Orsay, Paris Saclay U. / IN2P3-CNRS); SHAO, Huasheng (Centre National de la Recherche Scientifique (FR)); SCHIENBEIN, Ingo (Universite Grenoble Alpes)

Presenter: LANSBERG, Jean-Philippe (IPN Orsay, Paris Saclay U. / IN2P3-CNRS)

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Design of Radiation Tolerant Electronics for StrECal System in COMET Experiment

Monday, 15 July 2019 19:40 (20 minutes)

The COMET experiment at J-PARC aims to search for the charged lepton flavor violating process of neutrinoless muon to electron (mu-e) conversion with an improvement of a sensitivity by a factor of 10000 to the current limit. When the mu-e conversion occurs, almost all the energy of the muon mass is carried out by the electron which is expected to have the monochromatic energy of about 105 MeV. In order to achieve the goal sensitivity, we plan to use a StrECal system as an electron detector, which consists of straw tube tracker (Str) with an excellent momentum resolution and electron calorimeter (ECal) which is used for trigger generation, particle identification and so on. To read out the signals from StrECal system precisely, optimal front-end electronics are needed. We have developed the readout electronics boards for Str and ECal called ROESTI and EROS, respectively. These boards have the same components except for the front-end part. Fundamental performance evaluation of ROESTI and EROS was almost done using the prototype boards and it was already found that the performance satisfied the physics requirements. However, those had not satisfied the requirements of radiation tolerance.

According to the simulation study, neutron fluence of $10^{12}$ n/cm$^2$ and gamma-ray absorbed dose of $1 \text{kGy}$ with the safety factor of 5 are expected at the places where the boards are located. Radiation tolerant parts has to be selected and countermeasure against single event upset (SEU) in FPGA has to be considered. Thus, we had parts selection with many times of neutron and gamma-ray irradiation tests. In the results, we found the candidates which satisfied our requirements. Development of new FPGA firmware with the function of SEU detection and correction was also done and its test was done with neutron irradiation. In the result, it was found that the function was powerful for the SEU and it satisfied our requirements. Based on those results, we have designed and developed final version of ROESTI and EROS. The performance evaluation of those is ongoing. In this presentation, we describe the details of irradiation tests and those results. The details of the design and performance evaluation of the boards based on the irradiation tests are also reported.

Primary author: Dr UENO, Kazuki (KEK)

Co-authors: FUJII, Yuki (Monash University); HAMADA, Eitaro (KEK); IKENO, Masahiro (KEK); KAWASHIMA, Ryosuke (Kyushu University); MIHARA, Satoshi (KEK); NAKAZAWA, Yu (Osaka University); NISHIGUCHI, Hajime (KEK); OISHI, Kou (Kyushu University); SHOJI, Masayoshi (KEK); TOJO, Junji (Kyushu University); UCHIDA, Tomohisa (KEK); YOSHIDA, Hisataka (Osaka University)

Presenter: Dr UENO, Kazuki (KEK)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
We study dimuon events in 2.11/fb of 7 TeV pp collisions, using CMS Open Data, and search for a narrow dimuon resonance with moderate mass (14-66 GeV) and substantial transverse momentum (p_T). Applying dimuon p_T cuts of 25 GeV and 60 GeV, we explore two overlapping samples: one with isolated muons, and one with prompt muons without an isolation requirement. Using the latter sample requires information about detector effects and QCD backgrounds, which we obtain directly from the CMS Open Data. We present model-independent limits on the product of cross section, branching fraction, acceptance, and efficiencies. These limits are stronger, relative to a corresponding inclusive search without a p_T cut, by factors of as much as nine. Our "p_T-enhanced" dimuon search strategy provides improved sensitivity to models in which a new particle is produced mainly in the decay of something heavier, as could occur, for example, in decays of the Higgs boson or of a TeV-scale top partner. An implementation of this method with the current 13 TeV data should improve the sensitivity to such signals further by roughly an order of magnitude.

**Primary author:** Dr XUE, Wei  
**Presenter:** Dr XUE, Wei  
**Session Classification:** Searches for New Physics  
**Track Classification:** Searches for New Physics
High time resolution, two-dimensional position sensitive MSMGRPC for high energy physics experiments

Thursday, 11 July 2019 17:00 (15 minutes)

We will report our intense R&D activity focused on the development of a Multi-Strip readout, Multi-Gap Resistive Plate Chamber (MSMGRPC), aiming to fulfil performance requirements of high energy physics experiments with high counting rate and high multiplicity environment.

Triggerless mode operation needed in a high interaction rate experiment requires a negligible noise or spurious signals from detectors and front-end electronics. Therefore, a close to perfect impedance matching between the detector and the electronics is mandatory and challenging for the counter design.

An innovative chamber design based on a method which gives the possibility to tune the characteristic impedance of the signal transmission line to the one of the FEE channel will be reported. The optimized design of the MGMSRCP prototype fulfils simultaneously two main, but antagonist, requirements for strip readout MRPCs: the granularity and the impedance matching to the front-end electronics.

The results obtained with such a prototype in heavy ions in-beam tests (SIS18 - GSI Darmstadt and SPS - CERN), in triggered mode as well as in a free streaming readout operation, will be reported. The detector performance (i.e. efficiency, time resolution, cluster size) in conditions of exposure of the whole active area of the chamber to high flux and high multiplicity reaction products are going to be discussed.

Based on the obtained performance, a layout of a small polar angle region of a fix target experiment, (e.g. CBM@FAIR TOF inner wall zone) was designed. A modular structure based on 12 modules of 4 types fit the uniform coverage of the active area. For a given strip pitch, the strip length can be adjusted in order to fulfil the required granularity as a function of polar angle. For this reason, each module contains up to three types of MRPCs. Module design, module integration and counter integration inside each module will be discussed.

Primary authors: Dr PETRIS, Mariana (IFIN-HH); Mr BARTOS, Daniel (IFIN-HH); Prof. PETROVICI, Mihai (IFIN-HH); Dr RADULESCU, Laura (IFIN-HH); Dr SIMION, Victor (IFIN-HH); Mr FRUENHAUF, Jochen (GSI Darmstadt); Dr DEPPNER, Ingo (Universität Heidelberg); Prof. HERRMANN, Norbert (Universität Heidelberg)

Presenter: Dr PETRIS, Mariana (IFIN-HH)

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
Towards Understanding the Origin of Cosmic-Ray Positrons

Thursday, 11 July 2019 09:45 (20 minutes)

Precision measurements of cosmic ray positrons are presented up to 1 TeV based on 1.9 million positrons collected by the Alpha Magnetic Spectrometer on the International Space Station. The positron flux exhibits complex energy dependence. Its distinctive properties are: (a) a significant excess starting from 25.2 GeV compared to the lower-energy, power-law trend; (b) a sharp drop-off above 284 GeV; (c) in the entire energy range the positron flux is well described by the sum of a term associated with the positrons produced in the collision of cosmic rays, which dominates at low energies, and a new source term of positrons, which dominates at high energies; and (d) a finite energy cutoff of the source term at 810 GeV is established with a significance of more than 4σ. These experimental data on cosmic ray positrons show that, at high energies, they predominantly originate either from dark matter annihilation or from other astrophysical sources.

Primary authors:  WENG, Zhili (Massachusetts Inst. of Technology (US)); DURANTI, Matteo (Universita e INFN, Perugia (IT)); XU, Weiwei (Massachusetts Inst. of Technology (US)); LI, Zuhao (Chinese Academy of Sciences (CN)); KOUNINE, Andrei (Massachusetts Inst. of Technology (US)); ZIMMERMANN, Nikolas (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter:  ZIMMERMANN, Nikolas (Rheinisch Westfaelische Tech. Hoch. (DE))

Session Classification:  Dark Matter

Track Classification:  Dark Matter
Towards Understanding the Origin of Cosmic-Ray Electrons

Friday, 12 July 2019 12:10 (20 minutes)

Precision results on cosmic-ray electrons are presented in the energy range from 0.5 GeV to 1.4 TeV based on 28.1 million electrons collected by the Alpha Magnetic Spectrometer on the International Space Station. In the entire energy range the electron and positron spectra have distinctly different magnitudes and energy dependences. The electron flux exhibits a significant excess starting from 41.2 GeV compared to the lower energy trends, but the nature of this excess is different from the positron flux excess above 25.2 GeV. Contrary to the positron flux, which has an exponential energy cutoff of 810 GeV, at the 5σ level the electron flux does not have an energy cutoff below 1.9 TeV. In the entire energy range the electron flux is well described by the sum of two power law components. The different behavior of the cosmic-ray electrons and positrons measured by AMS is clear evidence that most high energy electrons originate from different sources than high energy positrons.

Primary authors: XU, Weiwei (Massachusetts Inst. of Technology (US)); ZIMMERMANN, Nikolas (Rheinisch Westfaelische Tech. Hoch. (DE)); ZHANG, Cheng (Chinese Academy of Sciences (CN)); WENG, Zhili (Massachusetts Inst. of Technology (US)); KOUNINE, Andrei (Massachusetts Inst. of Technology (US)); DURANTI, Matteo (Universita e INFN, Perugia (IT))

Presenter: ZHANG, Cheng (Chinese Academy of Sciences (CN))

Session Classification: Cosmology

Track Classification: Cosmology
The Compact Linear Collider (CLIC) collaboration has submitted to the European Strategy Update a Project Implementation Plan for construction of a 380 GeV e+e- linear collider at CERN. The machine is upgradeable in stages to 3 TeV. The CLIC design is based on high-gradient normal-conducting accelerating structures operating at X-band (12 GHz) frequency.

We present the CLIC accelerator concept and the current status of the project. We report on high-power tests of X-band structures using test facilities across the collaboration, as well as CLIC system verification studies and the technical development of key components of the accelerator. We present updated estimates of the cost, and of the power budget which is substantially reduced relative to the CDR, for both the baseline design and a klystron-based alternative at 380 GeV.

We present plans and developments for the next project phase, which would lead to readiness for construction around 2026 and first physics by 2035.

**Primary author:** BURROWS, Philip Nicholas (University of Oxford (GB))

**Presenter:** BURROWS, Philip Nicholas (University of Oxford (GB))

**Session Classification:** Accelerators for HEP

**Track Classification:** Accelerators for HEP
Generic Loop Effects of New Scalars and Fermions in $b \to s\ell^+\ell^-$ and a Vector-like $4^{\text{th}}$ Generation

Saturday, 13 July 2019 11:40 (20 minutes)

We investigate the possibility of accounting for the $b \to s\ell^+\ell^-$ anomalies via box contributions involving with new scalars and fermions. For this purpose we extend previous analysis by allowing that the new particles can also couple to right-handed Standard Model (SM) fermions as preferred by recent $b \to s\ell^+\ell^-$ data and the anomalous magnetic moment of the muon.

In the second part of the talk we illustrate this generic approach for a UV complete model in which we supplement the Standard Model by a $4^{\text{th}}$ generation of vector-like fermions and a real scalar field. This model allows one to coherently address the observed anomalies in $b \to s\ell^+\ell^-$ transitions and in $a_u$ without violating the bounds from other observables (in particular $B_s - \bar{B}_s$ mixing) or LHC searches. In fact, we find that our global fit to this model, after the recent experimental updates, is very good and prefers couplings to right-handed SM fermions.

Primary authors: Dr CRIVELLIN, Andreas; Dr MESCIA, Federico; Dr FEDELE, Marco; ARNAN, Pere (ICCUB)

Presenter: ARNAN, Pere (ICCUB)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Dark matter search results from 231 live-days of DEAP-3600

Thursday, 11 July 2019 12:00 (20 minutes)

DEAP-3600 is a dark matter detector located 2 km underground at SNOLAB. The DEAP-3600 detector is sensitive to the scintillation signal from the scattering of dark matter particles on argon nuclei, using a single-phase (scintillation-only) design. The 3279 kg LAr target is contained in a spherical acrylic vessel and viewed by 255 photomultiplier tubes. The background from Ar-39 beta decays is strongly suppressed by the best pulse-shape discrimination in a LAr detector demonstrated so far. This talk will highlight the recent analysis and results from 231 live-days of data in DEAP-3600, currently representing the most sensitive WIMP search above a mass of 30 GeV/c² using argon.

Primary author: Dr POLLMANN, Tina (Technische Universität München)
Presenter: Dr POLLMANN, Tina (Technische Universität München)
Session Classification: Dark Matter
Track Classification: Dark Matter
The determination of $|V_{cb}|$ from $B\rightarrow D(*)\nu\bar{\nu}$

Friday, 12 July 2019 12:05 (20 minutes)

The precision determination of the CKM matrix element $|V_{cb}|$ from semileptonic $B \rightarrow D^*$ and $B \rightarrow D$ decays provides an important input to test the unitarity of the CKM matrix and search for new physics. In recent analyses, higher values of $|V_{cb}|$ were extracted using (the so-called BGL) form factor parametrization, which allows more freedom to describe the experimental spectra. We develop a systematic approach to assess the role of the truncation order of the form factor parametrization, and study its impact on the extracted value of $|V_{cb}|$. In addition, we survey the current status of $|V_{cb}|$ extractions and their compatibility with heavy quark symmetry.

Primary authors: BERNLOCHNER, Florian Urs (KIT - Karlsruhe Institute of Technology (DE)); LIGETI, Zoltan (Lawrence Berkeley National Lab. (US)); ROBINSON, Dean (UC Santa Cruz/ LBL)

Presenter: BERNLOCHNER, Florian Urs (KIT - Karlsruhe Institute of Technology (DE))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Analysis of b jets in p-Pb collisions at √sNN = 5 TeV with ALICE

Monday, 15 July 2019 18:30 (1h 30m)

Beauty quarks are considered to be effective probes of the Quark-Gluon Plasma (QGP) produced in ultra-relativistic heavy-ion collisions. Since the b quark has a large mass, its production takes place mostly in initial hard scatterings, and it is calculable using perturbative QCD. Thus, beauty quarks can be considered as ideal self-generated penetrating probes of the created medium and utilized to investigate mass-dependent properties of in-medium parton energy loss or cold nuclear matter (CNM). The measurement of beauty-jet production in p-Pb collisions is fundamental for the investigation of CNM effects, like the modification of gluon Parton Distribution Functions in nuclei with respect to protons or energy loss in CNM. Understanding these effects is necessary for the proper interpretation of results in Pb-Pb collisions.

The ALICE experiment at the LHC exploits excellent particle tracking capabilities, that allow for a precise jet reconstruction and for the identification of B-hadron decay vertices, displaced hundreds of micrometers from the primary interaction vertex. The large statistics of events have been collected in p-Pb collisions at √sNN=5.02 TeV in the LHC Run-II allows us to measure beauty-jet production down to relatively low transverse momenta, constraining CNM effects in a range relevant for testing different energy loss models in Pb-Pb collisions. The poster will present the inclusive pT spectrum of charged b-jets in the range from 10 to 100 GeV/c measured in p-Pb collisions by ALICE.

Primary author: ISAKOV, Artem (Acad. of Sciences of the Czech Rep. (CZ))
Presenter: ISAKOV, Artem (Acad. of Sciences of the Czech Rep. (CZ))
Session Classification: Wine & Cheese Poster Session
Track Classification: Heavy Ion Physics
New predictions for $\Lambda_b \rightarrow \Lambda_c$ semileptonic decays

Friday, 12 July 2019 12:25 (15 minutes)

The heavy quark effective theory makes model independent predictions for semileptonic $\Lambda_b$ baryon decays in terms of a small set of parameters. No subleading Isgur-Wise function occurs at order $\Lambda_{QCD}/m_{c,b}$, and only two sub-subleading functions enter at order $(\Lambda_{QCD}/m_c)^2$. These features allow us to fit the form factors and decay rates calculated up to order $(\Lambda_{QCD}/m_c)^2$ to LHCb data and lattice QCD calculations. We derive a significantly more precise standard model prediction than prior results for the ratio of the rates for semi-tauonic vs. light-lepton decays. In addition, we investigate the influence of all possible beyond standard model four-Fermi interactions and present model independent predictions for them.

Primary authors: LIGETI, Zoltan (Lawrence Berkeley National Lab. (US)); BERNLOCHNER, Florian Urs (KIT - Karlsruhe Institute of Technology (DE)); SUTCLIFFE, William (Karlsruhe Institute of Technology (KIT)); ROBINSON, Dean (UC Santa Cruz/ LBL)

Presenter: SUTCLIFFE, William (Karlsruhe Institute of Technology (KIT))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
The design and layout of the Phase-II upgrade of the Inner tracker of the ATLAS experiment

Monday, 15 July 2019 19:40 (20 minutes)

In the high luminosity era of the Large Hadron Collider (HL-LHC), the instantaneous luminosity is expected to reach unprecedented values, resulting in about 200 proton-proton interactions in a typical bunch crossing. To cope with the resultant increase in occupancy, bandwidth and radiation damage, the ATLAS Inner Detector will be replaced by an all-silicon system, the Inner Tracker (ITk), aiming to provide tracking coverage up to |η|<4. The Technical Design Reports (TDR) for the strip and pixel subsystems were published in 2017 and 2018 respectively. Since their publication, the ITk design has undergone further refinement, in particular for the pixel subsystem, addressing the then-pending design choices in several areas and accommodating updated engineering requirements. In addition, the simulation model of the detector has become more realistic, leading to updated estimates of the material budget. In this presentation an overview of the updated layout is presented and the resultant expected tracking performance discussed.

Primary authors: HAYWARD, Helen (University of Liverpool (GB)); BRUERS, Ben (Deutsches Elektronen-Synchrotron (DE))

Presenter: BRUERS, Ben (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Muon Collider: A path to the future?

Saturday, 13 July 2019 12:00 (20 minutes)

Muon colliders potentially offer a road to very high energy lepton colliders in the multi-TeV regime. Therefore the interest in this technology has increased during the preparation of the update of the European Strategy for Particle Physics.

In the talk the status of the research will be presented and the potential path forward will be highlighted.

Primary authors: SCHULTE, Daniel (CERN); PASTRONE, Nadia (INFN); DELAHAYE, Jean-Pierre; LONG, Kenneth Richard (Imperial College (GB)); RIVKIN, Lenny (Paul Scherrer Institut (CH)); MANSOULIE, Bruno (Université Paris-Saclay (FR)); WULZER, Andrea (CERN and EPFL); DIEMOZ, Marcella (Istituto Nazionale di Fisica Nucleare Sezione di Roma 1); SKRINSKY, Alexander (BINP)

Presenter: SCHULTE, Daniel (CERN)

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
Color propagation in eA from CLAS at Jefferson Lab

The studies on the propagation of the color charge and hadron formation in nuclear medium allow to explore mechanisms intimately related to confinement and asymptotic freedom. This fundamental topic has been of interest to multiple communities: Drell-Yan, heavy-ion collisions and Semi-Inclusive DIS, all of which contribute different but complimentary information. A unique feature of SIDIS is its ability to investigate time-dependence of color propagation and hadronization processes by embedding it in well understood nuclear medium of increasing size.

In this talk I will present preliminary results on many fold π+, π- and π0 multiplicity ratios measured from SIDIS reaction on C, Fe, Pb normalized to D. The series of measurements were performed at Jefferson Lab with 5.014 GeV electron beam incident on a double-target system in which liquid deuterium and one of the solid targets were exposed simultaneously to the beam. In future, these measurements will continue with approved experiment at CLAS12 with 11 GeV electron beam and with color propagation program accessible with the Electron Ion Collider.

Primary author: TAISIYA, Mineeva (UTFSM)
Presenter: TAISIYA, Mineeva (UTFSM)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Charm-loop effect in rare $B \to K(*)l\bar{l}$ decays beyond leading twist

Saturday, 13 July 2019 10:30 (20 minutes)

We revisit soft gluon contributions to the “charm loop” effect in rare $B \to K(*)l\bar{l}$ decays, which is a large systematic uncertainty in the interpretation of the $b$-anomalies. Since these contributions are dominated by long-distance effects and are resistant to factorization attempts, we employ the method of light-cone sum rules to compute the relevant hadronic matrix elements. Our calculation extends previous works by considering the full set of the three-particle $B$-meson distribution amplitudes. We provide first numerical results, and discuss qualitatively their impact on the extraction of the Wilson coefficient $C_9$.

Primary authors: GUBERNARI, Nico (technische universität münchen); VIRTO, Javier (Massachusetts Institute of Technology); VAN DYK, Danny (TU München)

Presenter: GUBERNARI, Nico (technische universität münchen)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Towards two-loop computations in four dimensions with the Loop-Tree Duality

Thursday, 11 July 2019 17:30 (20 minutes)

We propose a new algorithm based on the Loop-Tree Duality theorem to renormalise and calculate two-loop diagrams. The ultraviolet singularities are locally cancelled in a systematic way and at the integrand level, allowing for a full four-dimensional numerical implementation of the method. In particular, we apply the method to calculate the $H \rightarrow \gamma\gamma$ amplitude at two-loop level, and find an excellent agreement with already available literature results. We also present other advantages of the Loop-Tree Duality formalism, such as the possibility to write unintegrated amplitudes in a universal way, regardless of the particle running inside the loop.

Primary author: DRIENCOURT-MANGIN, Félix (IFIC, UV-CSIC)

Co-authors: RODRIGO, German (IFIC CSIC-UV); SBORLINI, German (Università di Milano, INFN Milano and IFIC-Valencia); TORRES BOBADILLA, William Javier (IFIC CSIC-UV)

Presenter: DRIENCOURT-MANGIN, Félix (IFIC, UV-CSIC)

Session Classification: Quantum Field and String Theory

Track Classification: Quantum Field and String Theory
Toward realistic implementation of large imaging calorimeters

*Monday, 15 July 2019 19:40 (20 minutes)*

The next generation of collider detectors will most likely make full use of Particle Flow algorithms, requiring precision tracking and imaging calorimeters. The latter, with granularity 2 to 3 orders of magnitude above existing devices, have been developed during the last 15 years by the CALICE collaboration and are now approaching maturity. The state-of-the-art and the remaining challenges will be presented for all the investigated readouts: silicon diodes and scintillator for a tungsten electromagnetic calorimeter, gaseous with semi-digital readout and scintillator with SiPM readout for a hadronic one. We will describe the commissioning, including beam tests, of large scale technological prototypes and where applicable, raw performances such as energy resolution and linearity and studies exploiting the distinct features of granular calorimeters regarding pattern recognition. Beyond these prototypes, the design of experiments addressing the requirements and potential of imaging calorimetry will be commented on. In addition, less established but promising techniques for dedicated devices will also be highlighted.

**Primary author:** CALICE COLLABORATION

**Presenter:** EMBERGER, Lorenz Konrad (Max-Planck-Institut fur Physik (DE))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Exploring the structure of hadronic showers and hadronic energy reconstruction with highly granular calorimeters

Thursday, 11 July 2019 18:15 (15 minutes)

Prototype imaging electromagnetic and hadronic calorimeters developed and operated by the CALICE collaboration provide an unprecedented wealth of highly granular data of hadronic showers for a variety of active sensor elements and different absorber materials. In this presentation, we discuss detailed measurements of the spatial and the time structure of hadronic showers to characterise the different stages of hadronic cascades in the calorimeters, which are confronted with GEANT4-based simulations using different hadronic physics models. These studies also make use of the two different absorber materials, steel and tungsten, used in the prototypes. The high granularity of the detectors is also exploited in the reconstruction of hadronic energy, both in individual detectors and combined electromagnetic and hadronic systems, making use software compensation and semi-digital energy reconstruction. We will report on the performance of these reconstruction techniques for different electromagnetic and hadronic calorimeters, with silicon, scintillator and gaseous active elements.

Primary author: CALICE COLLABORATION
Presenter: LAKTINEH, Imad (Centre National de la Recherche Scientifique (FR))
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The PADME experiment

Thursday, 11 July 2019 14:30 (15 minutes)

The PADME experiment at the Laboratori Nazionali di Frascati of INFN is designed to search for the gauge boson, $A'$, of a $U(1)$ symmetry holding in a hidden sector of particles neutral under the Standard Model interactions.

The design performance of the experimental apparatus allows exploring the $A'$ mass range $m < 23.7$ MeV for values of the effective coupling between $A'$ and the photon $\epsilon > 10^{-3}$ using a positron beam impacting on a thin diamond target.

The PADME experiment has been in operation from October 2018 to February 2019 for a first detector and beam commissioning run. The statistics of the data sample collected could also allow the extraction of preliminary physics results.

The talk will review the experience gained with the detector and beam operation. In addition, the status of the understanding of the data in terms of detector performance, beam induced and physics background and, finally, the physics potential of PADME will be discussed.

**Primary authors**: PADME, Collaboration; Dr CHIODINI, Gabriele (INFN Lecce & Università del Salento (IT))

**Presenter**: Dr CHIODINI, Gabriele (INFN Lecce & Università del Salento (IT))

**Session Classification**: Detector R&D and Data Handling

**Track Classification**: Detector R&D and Data Handling
Review of the results from the Pierre Auger Observatory

Saturday, 13 July 2019 11:30 (20 minutes)

This year marks 20 years since the founding of the Pierre Auger Observatory. The Pierre Auger collaboration provided answers to some of the fundamental questions on the most energetic particles known to us, the ultra high energy cosmic rays (UHECRs). These particles, some of them exceeding 100 EeV, are messengers of the most violent phenomena in the Universe, nevertheless exactly which objects are producing them is still a mystery. We review some of the relevant results that have lead to the progress in the understanding of the nature, arrival direction and energy spectrum of the UHECRs. We will address also the remaining open questions about UHECRs, their relation to particle physics at accelerators, and multi-messenger astrophysics.

Primary author: FOR THE PIERRE AUGER COLLABORATION

Presenters: MARIS, Ioana Codrina (Univ. P. et Marie Curie (Paris VI) (FR)); MARIS, Ioana Codrina; MARIS, Ioana; MARIS, Ioana; MARIS, Ioana

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
This talk presents the latest jet measurements in 5.02 TeV Pb+Pb collisions with the ATLAS Experiment at the LHC. Jets are direct probes of the quark-gluon plasma produced in heavy-ion collisions and studying how they are modified in the heavy-ion collisions compared to the pp collisions provides insight into their interactions with this QCD medium. The latest jet results from ATLAS shown in this talk include measurements of nuclear modification factor of jets, jet fragmentation functions, the momentum and angular dependence of charged particle yields within and around jets, and the correlations of jets with direct photons. The presented measurements are also directly compared to state of the art theoretical models and provide important information to understand the strength and mechanism of the jet quenching. Further, this talk presents ATLAS results on dijet production in p+Pb collision that help to understand the partonic structure of heavy nuclei, and serve as a constraint on the initial state of Pb+Pb collisions.

Primary author: ATLAS COLLABORATION
Presenter: SANTOS, Helena (LIP - Lisbon)
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Combining theory inputs for $B \rightarrow D^{(*)}\ell\nu$ and extracting $|V_{cb}|$

Recent theory results for the full set of hadronic matrix elements arising in $B \rightarrow D^{(*)}\ell\nu$ decays have triggered our interest. We investigate if and how various pieces of theory information on these hadronic matrix elements fit together. As a consequence, we obtain precise theory predictions for the full angular distribution of these decays in the SM and beyond. Finally, we challenge the experimental data available from the BaBar and Belle collaborations. We discuss the compatibility between our results for $|V_{cb}|$ and the inclusive determination.

Primary author: BORDONE, Marzia (Universitaet Zuerich)

Co-authors: VAN DYK, Danny (TU Munchen); JUNG, Martin (TUM IAS / Excellence Cluster Universe)

Presenter: BORDONE, Marzia (Universitaet Zuerich)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Bridging mathematics and physics: models of the evolution of dynamic aperture in hadron colliders and applications to LHC

Monday, 15 July 2019 18:30 (1h 30m)

When designing a high-energy, circular accelerator, like the upcoming High-Luminosity LHC or the future FCC, it is essential to have a reliable estimate of the expected beam losses and beam lifetime. A good prediction of the beam losses is essential to anticipate potential issues leading to quenches of the superconducting magnets or damage to the collimation system, while the beam lifetime is in direct relation to luminosity and, hence, to the overall performance of the accelerator. It is customary to make these estimations by means of the so-called dynamic aperture, which gives the extent of phase space in which the beam motion remains bounded for a given amount of time. The computational time for the evaluation of dynamic aperture has reached challenging levels, and as result the dynamic aperture can only be computed over a lapse of time that is too short with respect to the actual physical time scales. In this framework, intense efforts have been devoted to finding means of extrapolating the results of numerical simulations to more realistic time scales. The proposed approach is based on the Nekhoroshev theorem and Kolmogorov-Arnold-Moser theory of dynamical systems. This approach has provided the solid ground of well-established mathematical results to tackle a long-standing problem in accelerator physics. The technique has since been studied and tested in detail, both in numerical simulations and in experiments at the CERN Large Hadron collider with very encouraging results.

Primary authors:  VAN DER VEKEN, Frederik (University of Malta (MT)); GIOVANNOZZI, Massimo (CERN); MACLEAN, Ewen Hamish (University of Malta (MT)); MONTANARI, Carlo Emilio; Prof. BAZZANI, A.; Mr VAN GOETHEM, Wietse

Presenter:  VAN DER VEKEN, Frederik (University of Malta (MT))

Session Classification:  Wine & Cheese Poster Session

Track Classification:  Accelerators for HEP
Application of machine learning techniques at the CERN Large Hadron Collider

Friday, 12 July 2019 17:30 (20 minutes)

Machine learning techniques have been used extensively in several domains of Science and Engineering for decades. These powerful tools have been applied also to the domain of high-energy physics, in the analysis of the data from particle collisions, for years already. Accelerator physics, however, has not started exploiting machine learning until very recently. Several activities are flourishing in this domain, in view of providing new insights to beam dynamics in circular accelerators, in different laboratories worldwide. This is, for instance, the case for the CERN Large Hadron Collider, where since a few years exploratory studies are being carried out. A broad range of topics have been addressed, such as anomaly detection of beam position monitors, analysis of optimal correction tools for linear optics, optimisation of the collimation system, lifetime and performance optimisation, and detection of hidden correlations in the huge data set of beam dynamics observables collected during the LHC Run 2. Furthermore, very recently, machine learning techniques are being scrutinised for the advanced analysis of numerical simulations data, in view of improving our models of dynamic aperture evolution.

Primary authors: VAN DER VEKEN, Frederik (University of Malta (MT)); GIOVANNOZZI, Massimo (CERN); AZZOPARDI, Gabriella (University of Malta (MT)); COYLE, Loic Thomas Davies (EPFL - Ecole Polytechnique Federale Lausanne (CH)); FOL, Elena (Johann-Wolfgang-Goethe Univ. (DE)); Dr PIELONI, Tatiana (EPF Lausanne); REDAELLI, Stefano (CERN); RIVKIN, Lenny (Paul Scherrer Institut (CH)); SALVACHUA FERRANDO, Belen Maria (CERN); TOMAS GARCIA, Rogelio (CERN); VALENTINO, Gianluca (University of Malta (MT)); BLANC, Fred (EPFL - Ecole Polytechnique Federale Lausanne (CH)); SCHENK, Michael

Presenter: VAN DER VEKEN, Frederik (University of Malta (MT))

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
New Einstein-Hilbert type action for space-time and matter - Nonlinear-supersymmetric general relativity (NLSUSYGR)

Friday, 12 July 2019 17:30 (20 minutes)

We can perform the geometric argument of general relativity principle on (unstable) Riemann space-time just inspired by nonlinear representation of supersymmetry (NLSUSY), whose tangent space is specified by Grassmann degrees of freedom $\psi$ of $\text{SL}(2,\mathbb{C})$ besides the ordinary Minkowski one $x^a$ of $\text{SO}(1,3)$ and obtain straightforwardly new Einstein-Hilbert (EH)-type action with global NLSUSY invariance (NLSUSYGR) equipped with the cosmological term. Due to the NLSUSY nature of space-time NLSUSYGR would breaks down (Big Collapse) spontaneously to ordinary EH action of graviton, NLSUSY action of Nambu-Goldstone fermion $\psi$ and their gravitational interaction. Simultaneously the attractive gravitational force would constitute the NG fermion-composites corresponding to the eigenstates of linear-SUSY (LSUSY) super-Poincare space-time symmetry, which gives a new paradigm for the unification of space-time and matter.

By linearizing NLSUSY we show that the standard model (SM) of the low energy particle physics can emerge in the true vacuum of NLSUSYGR as the NG fermion-composite massless eigenstates of LSUSY super-Poincare algebra of space-time symmetry, which can be understood as the ignition of the Big Bang and continues naturally to the standard Big Bang model of the universe.

NLSUSYGR paradigm can bridge naturally the cosmology and the low energy particle physics and provides new insights into unsolved problems of cosmology, SM and mysterious relations between them, e.g. the space-time dimension four, the origin of SUSY breaking, the dark energy and dark matter, the dark energy density ($\nu$ mass), the tiny neutrino mass, the three-generations structure of quarks and leptons, the rapid expansion of space-time, the magnitude of bare gauge coupling constant, etc..


Primary author: Prof. SHIMA, Kazunari (Saitama Institute of Technology)

Presenter: Prof. SHIMA, Kazunari (Saitama Institute of Technology)

Session Classification: Cosmology

Track Classification: Cosmology
Cosmology with the Dark Energy Survey

The Dark Energy Survey (DES) is a large galaxy survey designed to address the fundamental question of the accelerating expansion of the universe and uncover the nature of the dark energy. It has mapped 1/8 of the sky in the southern hemisphere to an unprecedented depth for such a wide area. The talk will present the most recent measurements of the cosmological parameters from this project, including the exhaustive analysis for the control of systematics effects that has been performed.

Primary author: SANCHEZ, Eusebio (CIEMAT)
Presenter: SANCHEZ, Eusebio (CIEMAT)
Session Classification: Cosmology
Track Classification: Cosmology
Fermion mass and mixing hierarchies from E8-inspired left-right-color-family Grand-unification

Monday, 15 July 2019 18:30 (1h 30m)

We present a Grand Unified Theory where the usual E6 gauge coupling unification is supplemented by a local SU(2)×U(1) family symmetry. We discuss its origin inspiring our model by an embedding into E8 which can be seen as an unifying force. We argue that the presence of such a family symmetry has remarkable implications for both high-scale and low scale physics: First, while the usual 273 cubic interactions in the superpotential are forbidden, tree-level Yukawa terms are generated via dimension-four operators upon the breaking of E6 down to its trinification maximal subgroup. Such a breaking will also induce sizable threshold corrections to the gauge couplings at the E6 scale which modifies their running in such a way that it becomes possible to attain a low scale unification picture not far from the reach of a Future 100 TeV Circular Collider. On the other hand we demonstrate that the masses of leptons and first generation quarks are of radiative origin whereas second and third quark families are tree-level generated. This results in a CKM-mixing with the Cabibbo where deviations from unitarity are induced via mixing with down-type vector-like quarks as well as radiative corrections.

Primary author:  PASECHNIK, Roman (Lund university)
Co-authors: Dr MORAIS, Antonio (Aveiro university); Prof. POROD, Werner (Wurzburg university)
Presenter:  PASECHNIK, Roman (Lund university)
Session Classification:  Wine & Cheese Poster Session
Track Classification:  Searches for New Physics
Primordial gravitational waves from sequential electroweak phase transitions

Saturday, 13 July 2019 10:20 (20 minutes)

The first-order electroweak phase transition in the early universe could occur in multiple steps leading to specific multi-peaked signatures in the primordial gravitational wave (GW) spectrum. We argue that these signatures are generic phenomena in multi-scalar extensions of the Standard Model particularly relevant for electroweak baryogenesis. In a simple example of such an extension, we have studied the emergence of reoccurring and nested vacuum bubble configurations and their role in the formation of multiple peaks in the GW spectrum. The conditions for potential detectability of these features by the forthcoming generation of interferometers have been studied.

Primary author: PASECHNIK, Roman (Lund university)
Co-author: Dr MORAIS, Antonio (Aveiro university)
Presenter: PASECHNIK, Roman (Lund university)

Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Cosmological constant as a quantum gravity correction to the QCD vacuum density

Friday, 12 July 2019 17:10 (20 minutes)

To the zeroth order in gravitational interactions, the averaged QCD (quark-gluon) vacuum condensate density is dynamically self-screened and is eliminated at macroscopic space-time separations. We argue that the observable cosmological constant can then be generated as a quantum gravity correction to QCD vacuum energy density after the QCD phase transition epoch. In order to incorporate the latter, we compute the leading-order quantum correction to the classical Einstein equations due to metric fluctuations induced by the non-perturbative vacuum fluctuations of the gluon and quark fields in the quasi classical approximation (valid at the considered energy scales). The resulting contribution to the cosmological constant is positive and approaches the observed value within a factor of few.

Primary author: PASECHNIK, Roman (Lund university)
Presenter: PASECHNIK, Roman (Lund university)
Session Classification: Cosmology
Track Classification: Cosmology
Quantum Yang-Mills vacua in expanding Universe:
Do we live in a time crystal?

Thursday, 11 July 2019 14:53 (22 minutes)

The dynamical cancellation of the vacuum energy of the QCD sector in the infrared regime is a relevant problem for both particle physics and cosmology. We find an argument related to the existence of $Z_2$-symmetry for the renormalization group flow derived from the bare Yang-Mills Lagrangian, and show that the cancellation of the vacuum energy may arise motivated both from the renormalization group flow solutions and the effective Yang-Mills action. At the cosmological level, we explore the stability of the electric and magnetic attractor solutions, both within and beyond the perturbation theory, and find that thanks these latter the cancellation between the electric and the magnetic vacua components is achieved at macroscopic space and time separations. This implies the disappearance of the conformal anomaly in the classical limit of an effective Yang-Mills theory while a local breakdown of time-translation invariance highlights the formation of a time-crystal grounds-state as a result of the QCD phase transition. A new type of non-perturbative non-local configurations in the Yang-Mills vacua, space-time instanton-like objects separated by domain walls, is emerged and their properties and implications (e.g. for gravitational-wave echoes of the QCD transition) are discussed.

Primary author:  PASECHNIK, Roman (Lund university)

Co-authors:  Dr MARCIANO, Antonino (Fudan U.); Dr ADDAZI, Andrea (Fudan U.)

Presenter:  PASECHNIK, Roman (Lund university)

Session Classification:  Quantum Field and String Theory

Track Classification:  Quantum Field and String Theory
The quark-gluon plasma production from the QCD ground state in the Hamiltonian picture

Thursday, 11 July 2019 12:24 (18 minutes)

A semi-classical Hamiltonian approach can be used to describe the quark-gluon plasma (QGP) production mechanism in heavy-ion collisions in real physical time based upon the existence of a homogeneous initial state being a non-trivial QCD ground-state. An effect ala parametric resonance leading to a decay of the homogeneous gluon condensate into inhomogeneous gluon plasma can be thought as a possible driver of QGP production in QCD as well as its hadronisation. I will elaborate on physical significance and the possible new signatures of this mechanism relevant for heavy-ion phenomenology.

Primary author: PASECHNIK, Roman (Lund university)
Presenter: PASECHNIK, Roman (Lund university)
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
A new model-independent imaging method, the Lévy expansion, plays an important role in the analysis of the differential cross section of elastic hadron-hadron scattering. It enables for the first time to quantify simultaneously the signatures of the Odderon, internal substructures in the proton, as well as a subtle emergence of its hollowness at ultra-high collision energies directly from the existing precision data sets in a model-independent way. I will present the basic properties of the Levy method and a selected set of new and most significant results of the Levy analysis, with a perspective into the future.

Primary author: PASECHNIK, Roman (Lund university)

Co-authors: Mr STER, Andras (Wigner Research Centre for Physics of the Hungarian Academy of Sciences, Budapest XII, HU); Prof. CSORGO, Tamas (Wigner Research Centre for Physics of the Hungarian Academy of Sciences, Budapest XII, HU)

Presenter: PASECHNIK, Roman (Lund university)

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
Analysis of singularities and the four-dimensional representation of physical observables within the LTD formalism

Thursday, 11 July 2019 17:50 (20 minutes)

In the past years, we have been developing a novel technique, called Four-Dimensional Unsubtraction (FDU) which aims to obtain purely four-dimensional representations of the matrix elements contributing to physical observables. In this talk, we describe the application of the loop-tree duality (LTD) theorem to represent loop amplitudes in terms of tree-level like objects, focusing on the origin of possible singularities of scattering amplitudes. In particular, we analyse the regions responsible of infrared and threshold singularities. With this information, we aim to extend the FDU formalism to NNLO and beyond.

Primary authors: DRIENCOURT-MANGIN, Félix (IFIC CSIC-UV); RODRIGO, German (IFIC CSIC-UV); SBORLINI, German (IFIC CSIC-UV); TORRES BOBADILLA, William Javier (IFIC CSIC-UV)

Presenter: SBORLINI, German (IFIC CSIC-UV)

Session Classification: Quantum Field and String Theory

Track Classification: Quantum Field and String Theory
NICA accelerator complex project at JINR

Friday, 12 July 2019 15:35 (25 minutes)

Status of the project of NICA (Nuclotron-based Ion Collider fAcility) accelerator complex, which is under construction at JINR (Dubna, Russia), is presented. The main goal of the project is to provide ion beams for experimental studies of hot and dense baryonic matter and spin physics.

The NICA collider will provide heavy ion collisions in the energy range of $\sqrt{s_{NN}}=4\div11$ GeV at average luminosity of $L=1\cdot10^{27}\text{cm}^{-2}\cdot\text{s}^{-1}$ for $^{197}\text{Au}^{79+}$ nuclei and polarized proton collisions in energy range of $\sqrt{s_{NN}}=12\div27$ GeV at luminosity of $L \geq 10^{31}\text{cm}^{-2}\cdot\text{s}^{-1}$.

NICA accelerator complex will consist of two injector chains, 578 MeV/u superconducting (SC) booster synchrotron, the existing SC synchrotron (Nuclotron), and the new SC collider that has two storage rings each of 503 m circumference.

Constructing facility is based on “Nuclotron”-technology of SC magnets with iron yoke. Both stochastic and electron cooling methods are used for the beam accumulation and its stability maintenance.

Primary authors: KOSTROMIN, Sergei (JINR); MESHKOV, Igor (Joint Institute for Nuclear Research (JINR)); KAZINOVA, Olha (JINR)

Presenter: KAZINOVA, Olha (JINR)

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
Challenges of the LEMMA positron-driven muon collider design

*Saturday, 13 July 2019 12:20 (20 minutes)*

The Low EMittance Muon Accelerator (LEMMA) concept uses a positron-driven muon source, providing an attractive path to very high energy lepton colliders with improved particle backgrounds. The recent developments of the LEMMA overall layout will be described, together with its main challenges. The positron beam is stored in a ring with high energy acceptance and low emittance and then extracted into a multi-IP beamline to produce muon pairs at threshold on the target’s electrons. The muon target is being optimized in terms of material and thickness. The produced muon beam is being characterized from the source through the accumulator rings up to the accelerating sections, with the final goal of a start-to-end simulation for the muon beams up to the collider.

**Primary authors:** BOSCOLO, Manuela (INFN e Laboratori Nazionali di Frascati (IT)); THE LEMMA TEAM; PASTRONE, Nadia (INFN)

**Presenter:** PASTRONE, Nadia (INFN)

**Session Classification:** Accelerators for HEP

**Track Classification:** Accelerators for HEP
Status of the Virgo gravitational-wave detector and the O3 Observing Run

Saturday, 13 July 2019 09:00 (20 minutes)

On April 1st 2019 the Virgo gravitational-wave detector, jointly with the two US-based LIGO detectors in Hanford and Livingston, entered the O3 Observing Run, which is foreseen to last one calendar year. After the past O2 Run, which was characterized by the first ever revelation of gravitational waves emitted by the coalescence of a binary neutron star system, all three detectors underwent an intense, one-year-long Upgrade & Commissioning phase, aimed at the improvement of the sensitivity and at the increase of the duty cycle. An important difference with respect to the prior Observing Run is the introduction of the “Open Public Alert” system, which is automatically providing low-latency information for events and superevents to the EM partners, increasing the possibility of a joint detection of events of astrophysical importance in the framework of multimessenger astronomy.

This talk will present an overview of the Upgrade & Commissioning phase of the Virgo detector which preceded the O3 Observing Run, and the detector’s current status during the first part of the Run. An overview of the scientific results obtained so far will also be presented. Finally, the current plans and expectations for the remaining part of the Run will be described, followed by a short overview of the future plans for the Virgo detector in the post-O3 phase.

Primary author: Dr BERSANETTI, Diego (INFN - National Institute for Nuclear Physics)
Presenter: Dr BERSANETTI, Diego (INFN - National Institute for Nuclear Physics)
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Neutrino oscillation and CPT violation due to quantum decoherence at DUNE

Friday, 12 July 2019 11:50 (15 minutes)

We study the feasibility of observing deviations from the CPT symmetry owing to quantum decoherence and in the framework of the neutrino oscillations. Taking into account the open system approach, and considering non-diagonal decoherence matrices, we study all the cases in which CPT violation (CPTV) terms that could be arising in the neutrino oscillation probabilities. Considering the vacuum case, we find exact solutions for the CPT asymmetry function. Moreover, in order to show tangible results, to make predictions of this model for the future Long-Baseline experiment and based on the information from the $\nu_\mu \rightarrow \nu_\mu$ and $\bar{\nu}_\mu \rightarrow \bar{\nu}_\mu$ channels, we define an observable $R$ and we put on trial all the CPTV cases using the DUNE experiment. We found values of the decoherence parameters with $5\sigma$ of discrepancy to standard physics which are allowed by the current experimental limits suggesting hints for new physics by this model in the context of future experiments.

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Presenter: Mr DÍAZ DESPOSORIO, Félix Napoleón (Pontificia Universidad Católica del Perú)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
First Experiences with the Novel Time of Propagation (TOP) Barrel PID Detector in the Belle II Experiment

Thursday, 11 July 2019 11:30 (15 minutes)

The Time of Propagation (TOP) detector is a novel particle identification system developed for the barrel region of the Belle II experiment at the SuperKEKB collider at KEK in Tsukuba, Japan. The detector is based on reconstructing the emission angle of Cherenkov photons generated in its quartz radiator bars by measuring the propagation time of individual photons to the Micro-Channel Plate PMT sensor plane. The readout electronics for the 8192 channels of the TOP system are built around a switched capacitor array waveform sampling ASIC operating at 2.7GSa/s. Acquired waveforms are processed in real time in the front end electronics, extracting the individual timing of detected photons to better than 100 ps.

After a commissioning run with first beam collisions starting in spring 2018, the final inner tracking system is now installed in the Belle II detector, and the physics programme and luminosity rampup is underway since March 2019.

This talk presents the current experiences and results from commissioning, calibration and operation of the Belle II TOP detector in the first Belle II physics runs up until now.

**Primary author:** HARTBRICH, Oskar (University of Hawaii at Manoa)

**Presenter:** HARTBRICH, Oskar (University of Hawaii at Manoa)

**Session Classification:** Detector R&D and Data Handling

**Track Classification:** Detector R&D and Data Handling
Investigating charm and beauty production and elliptic flow with leptons in Pb–Pb with ALICE

Thursday, 11 July 2019 16:48 (18 minutes)

Heavy quarks (charm and beauty) constitute unique probes for the hot and dense QCD medium produced in heavy-ion collisions: the Quark-Gluon Plasma (QGP). They are mainly produced in hard scattering processes among partons, which occur immediately after the nuclei crossing with a time-scale shorter than the QGP formation time. Therefore, they witness the full evolution of the medium loosing energy while interacting with its constituents.

The measurement of the nuclear modification factor ($R_{AA}$) of open heavy-flavour hadrons can provide important information about the properties of the parton in-medium energy loss. In this regard, of particular interest is the study of charm and beauty production separately so to assess the expected mass effect on the in-medium energy loss. Moreover, the measurement of the azimuthal anisotropies at low transverse momentum, quantified by the elliptic flow ($v_2$), gives insight into the participation of the heavy quarks in the collective expansion of the system and their possible thermalisation in the medium.

The ALICE detector is well suited to measure the production of leptons from heavy-flavour hadrons decays at mid- and forward rapidities. In particular, thanks to the excellent tracking and particle identification capabilities, at mid-rapidity ALICE can study electrons from beauty hadron decays. In this contribution, we report the latest measurements of the $v_2$ and $R_{AA}$ of electrons from beauty hadron decays at mid rapidity in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. In addition the $v_2$ and $R_{AA}$ of heavy-flavour hadrons decay muons at forward rapidity will be shown.

The experimental results will be compared with theoretical models.

**Primary authors:** ANONYMOUS, submission (ALICE Collaboration); VOLKL, Martin Andreas (Eberhards Karls Universiy Tubingen (DE))

**Presenter:** VOLKL, Martin Andreas (Eberhards Karls Universiy Tubingen (DE))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
D mesons and charmed baryon production in small systems with ALICE

Heavy quarks (charm and beauty) are effective probes of the Quark-Gluon Plasma (QGP) formed in high-energy nuclear collisions. They are produced in the initial hard partonic scatterings of the collisions, propagate through the medium, and interact with its constituents, thus probing the entire evolution of the system.

Heavy-flavour measurements in pp and p–Pb collisions not only provide the reference for heavy-ion collisions, but are also of prime interest, respectively, to test of pQCD calculations and to study the cold nuclear matter (CNM) effects, such as the modification of parton densities in nuclei and $k_T$-broadening or parton energy loss. In recent years, effects ascribed to the collective expansion of the QGP, such as long-range flow-like correlations and the enhancement of baryon production, have also been observed at high multiplicity in pp and p–Pb collisions. The study of open heavy flavours in high-multiplicity p–Pb collisions provides important information to understand how the possible presence of collective effects could modify the production of heavy-flavour hadrons. The study of the baryon-to-meson ratio, sensitive to the hadronisation mechanisms in the charm sector, can give further insight into the production processes in small systems and be useful as a reference for Pb–Pb collisions.

In this talk, we will present production of $D^0$, $D^+$, $D^{*+}$ and $D_s^+$ mesons and $Λ_c$ baryons measured with the ALICE detector via their hadronic decays at mid-rapidity in pp collisions at $\sqrt{s} = 5.02$ TeV and 7 TeV and p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. We will show the D-meson cross sections down to $p_T = 0$ and the nuclear modification factors. The $Λ_c/D^0$ ratio measured in pp and p–Pb collisions will be also discussed. The results will be compared with predictions from pQCD calculations and Monte Carlo event generators in the pp system, and with models including CNM effects as well as ones assuming the formation of a QGP in p–Pb collisions.

Primary author: ANONYMOUS, submission (ALICE Collaboration)

Presenter: WILKINSON, Jeremy (Universita e INFN, Bologna (IT))

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Measurement of $\Lambda_c$ baryons and $D_s^+$ mesons in Pb–Pb collisions with ALICE

Friday, 12 July 2019 09:00 (18 minutes)

The study of heavy-flavour (charm and beauty) production is important to understand the properties of the Quark-Gluon Plasma (QGP) formed in ultra-relativistic heavy-ion collisions, since heavy quarks are produced in the initial stages of the collisions and subsequently interact with the medium throughout its evolution.

In the QGP, strange quarks are expected to be abundantly produced and may recombine with charm quarks leading to an enhancement of the nuclear modification factor ($R_{AA}$) of $D_s^+$ mesons over other charmed meson states at low and intermediate $p_T$. The measurement of elliptic flow ($v_2$) of $D_s^+$ mesons is useful to determine the degree of thermalization of charm quarks in the collective expansion of the QGP. In addition, charm quarks could recombine with light di-quark states in the medium, which would lead to an enhancement of the production of the $\Lambda_c/D^0$ baryon-to-meson ratio as compared to that in pp collisions. Precise measurements of these particle species in Pb–Pb collisions, therefore, give a deeper insight into the hadronisation mechanisms that heavy quarks undergo in the strongly-interacting medium.

In this talk, we will discuss the latest results measured with ALICE for $\Lambda_c$-baryon and $D_s^+$-meson production in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, using data from Run 2 of the LHC. The nuclear modification of $\Lambda_c$ yield and the $\Lambda_c$-to-$D^0$ ratio will be presented, along with the $R_{AA}$ and $v_2$ of $D_s^+$ mesons.

**Primary author:** VERMUNT, Lucas Anne (Utrecht University (NL))

**Presenter:** VERMUNT, Lucas Anne (Utrecht University (NL))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Investigating collective-like effects in small systems with heavy flavour with ALICE

Monday, 15 July 2019 18:30 (1h 30m)

In heavy-ion physics, the interest on heavy-flavour measurements in small hadronic systems, like p-Pb and pp, has been for a long time limited to the possibility of providing tests of perturbative QCD, measurements of cold-matter effects in the nuclear medium, and the baseline for observations of hot-medium effects in heavy-ion collisions. However, such measurements have recently gained additional interest due to the possibility of observing, in pp and p-Pb systems, collective-like effects similar to those expected and measured in heavy-ion collisions. In particular, measurements of angular correlations of heavy-flavour particles with charged particles in pp and p-Pb collisions allow one to investigate the existence of collective behaviour involving heavy flavours, with the particle multiplicity acting as an effective scaling parameter driving the strength of such effects.

In this contribution, ALICE results on open heavy-flavour production in p-Pb collisions at $\sqrt{s_{\text{NN}}}$ = 5.02 and 8.16 TeV will be discussed, in both the single-electron and single-muon channels. The elliptic flow coefficient will be shown at central rapidity for electrons from heavy-flavour hadrons decays and at forward rapidity for muons from heavy-flavour hadron decays. In addition, the latest measurements on charm particle ratios and on the multiplicity dependence of charm particle production in pp and p-Pb collisions will be discussed. The results will be compared with similar measurements in the light-flavour sector and to theoretical models.

Primary author: ANONYMOUS, submission (ALICE Collaboration)
Presenter: GAL, Arthur Willem Jean (Centre National de la Recherche Scientifique (FR))
Session Classification: Wine & Cheese Poster Session
Track Classification: QCD and Hadronic Physics
Study of $R_{AA}$ and $v_2$ of non-strange D mesons and D-jet production in Pb–Pb collisions with ALICE

Thursday, 11 July 2019 18:02 (18 minutes)

The LHC heavy-ion physics program aims at investigating the properties of the Quark-Gluon Plasma (QGP) formed in such collisions. Heavy quarks (charm and beauty) are regarded as efficient probes to study and characterize the QGP, as they are created on a very short time scale in initial hard processes and subsequently experience the entire system evolution interacting with the medium constituents.

The measurement of the nuclear modification factor, $R_{AA}$, of heavy-flavour particles gives important information about the colour-charge and parton-mass dependence of the energy loss as well as about possible modifications of heavy-quark hadronization in the medium. The heavy-flavour elliptic flow, $v_2$, provides insights on the degree of thermalization of heavy quarks in the medium at low $p_T$ and the path-length dependence of parton energy loss at high $p_T$, respectively. In addition, the study of heavy-flavour jets gives more direct access to the initial parton kinematics and can provide further constraints for heavy-quark energy loss mechanisms, in particular concerning the dissipation of the radiated energy in the medium.

In this talk, the latest results on the $p_T$-differential $R_{AA}$ and $v_2$ of non-strange D mesons in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV performed with ALICE will be presented for different centrality classes and compared with theoretical model predictions. The results obtained with the Event-Shape Engineering (ESE) technique applied to the D-meson elliptic flow in semi-central Pb–Pb events to investigate the influence of initial geometry fluctuations on heavy-flavour production will be shown. Finally, the measurements of D-tagged jets in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be discussed.

Primary author: ANONYMOUS, submission (ALICE Collaboration)

Presenter: GROSA, Fabrizio (Politecnico di Torino (IT))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Quarkonium measurements at forward rapidity with ALICE at the LHC

Friday, 12 July 2019 10:12 (18 minutes)

Heavy quarks are produced at the first instant of a nucleus-nucleus collision and therefore are an important tool to study the subsequent high energy-density medium formed in ultra-relativistic heavy-ion collisions. A series of experimental efforts for understanding the properties of the Quark-Gluon Plasma (QGP), a medium consisting of a deconfined state of quarks and gluons, are based on measuring the bound states of heavy quark-antiquark pairs known as quarkonia. However, the medium modification of heavy-flavour hadron production includes also the contribution of cold nuclear matter effects such as shadowing or nuclear break-up in addition to the QGP effects. Proton-nucleus collisions, where no QGP is expected, are used to measure cold nuclear matter effects on quarkonium production. Finally, quarkonium measurements in proton-proton collisions are used as reference for both heavy-ion and proton-ion collisions.

ALICE measurements of quarkonia at forward rapidity for various energies and colliding systems (pp, p–Pb, Pb–Pb and Xe–Xe) during the LHC Run-1 and Run-2 periods will be discussed. Recent ALICE results of quarkonium nuclear modification factor, elliptic flow and polarization using the 2018 Pb–Pb data sample will be specially highlighted. A comparison of the results among the LHC experiments and theoretical models will be also presented.

Primary author: ANONYMOUS, submission (ALICE Collaboration)
Presenter: DAMAS, Florian (Centre National de la Recherche Scientifique (FR))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
European School of Instrumentation in Particle and Astroparticle Physics: ESIPAP

Friday, 12 July 2019 17:00 (15 minutes)

Teaching instrumentation to students and early-stage scientists is not an easy task, when one considers the inherent difficulties to both gathering specialists and accessing latest-generation equipment on a unique site. However, this was the challenge we decided to take up in 2014, when we initiated ESIPAP in Archamps next to CERN, one of the very few places in the world where such an initiative could be attempted at an affordable cost.

Thanks to ENIGMASS (a French consortium of excellence gathering LAPP, LAPTh in Annecy and LPSC in Grenoble), to CERN and to several participating universities (University of Strasbourg, University of Tsukuba, University Grenoble Alpes, Grenoble INP, University Savoie Mont-Blanc, University of Tangier), ESIPAP now offers master, PhD students and early-stage scientists two high-level intensive four-week courses that can be entirely followed in a row, or week by week depending on participants’ needs.

ESIPAP lectures are given by some 50 world experts from academia, research facilities and laboratories. Course 1 deals with the physics of particle and astroparticle detectors, while course 2 covers detector technology and applications. Both courses are validated by exams so that partner universities may attribute ECTS and/or doctoral credits to participating students.

At ESIPAP, students have the opportunity to follow hands-on classes (detectors, electronics, 3D-printing, programming, Arduino handling, carbon fiber lab, data management, project management...) in Archamps, at CERN, in Grenoble at ILL and at Institut Néel, that, when considered all together, are quite unique.

ESIPAP is progressively becoming a reference school in its field. About 80 alumni from 26 countries have already attended the school, some coming from developing countries where the access to high-technology experimental equipment is almost impossible.

The speaker will briefly present the school, the diversity of students that already attended, and discuss its evolution that is being considered for the next five years.

Primary author: COLLOT, Johann (university Grenoble Alpes (FR))

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Presenter: COLLOT, Johann (university Grenoble Alpes (FR))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
The HIBEAM/NNBAR Experiment at the ESS

Friday, 12 July 2019 12:00 (15 minutes)

The HIBEAM/NNBAR experiment is a two stage experiment for the European Spallation Source (ESS) to search for baryon number violation. The experiment would make high sensitivity searches for baryon number violating processes: \( n \rightarrow n\bar{\nu} \) and \( n \rightarrow n^* \) (neutron to sterile neutron), corresponding to the selection rules in baryon number \( \Delta B = 2, 1 \), respectively. The experiment addresses topical open questions such as baryogenesis and dark matter, and is sensitive to a scale of new physics substantially in excess of that available at colliders. This is a cross-disciplinary experiment with a clear particle physics goal. The community encompasses physicists from large collider experiments and low energy nuclear physics experiments, together with scientists specialising in neutronics and magnetics. European, US and Asian communities are represented. The experiment would increase the sensitivity to neutron conversion probabilities by three orders of magnitude compared with previous searches. The opportunity to make such a leap in sensitivity in tests of a global symmetry is a rare one.

**Primary author:** MILSTEAD, David Anthony (Stockholm University (SE))

**Presenter:** MILSTEAD, David Anthony (Stockholm University (SE))

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
We analyze constraints on anomalous tWb couplings that parameterize the possible contribution of New Physics to the weak tWb vertex. We take into account indirect constraints obtained from B-physics ($B \rightarrow X_s \gamma$, $B \rightarrow X_s l^+ l^-$, $B$-$\bar{B}$ oscillations) and direct constraints from the t-channel single top quark production. In two-dimensional scenarios when different pairs of the anomalous couplings can vary whereas others are set to their SM values, the indirect and direct constraints are shown to nicely agree with each other. Combining both types of constraints narrows down the allowed ranges of the anomalous couplings.
Optics Corrections and Emittance Tuning for FCC-ee

The FCC-ee project studies the design of a future 100 km e+/e circular collider for precision studies and rare decay observations in the range of 90 to 350 GeV center of mass energy with luminosities in the order of $10^{35} \text{ cm}^{-2} \text{ s}^{-1}$. In order to reach this high luminosity, extreme focusing is required in the interaction regions, with the beta function values range from 0.8 mm to 7736 m (for the Z lattice). This makes FCC-ee particularly susceptible to misalignments and field errors, and therefore presents an appreciable challenge for emittance tuning. We describe a comprehensive correction strategy used for the low emittance tuning. The strategy includes programs that have been developed to optimise the lattice based on Dispersion Free Steering, linear coupling compensation based on Resonant Driving Terms and beta beat correction utilising response matrices. Hundreds of lattices with different random seeds for the misalignment and field errors were introduced in MAD-X and the final corrected lattices are presented.

Primary author: Dr CHARLES, Tessa

Co-authors: ZIMMERMANN, Frank (CERN); Dr OIDE, Katsunobu (High Energy Accelerator Research Organization (JP)); HOLZER, Bernhard (CERN); AUMON, Sandra

Presenters: Dr CHARLES, Tessa; CHARLES, Tessa (University of Melbourne (AU))

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
Measurement of electroweak-boson production in p–Pb and Pb–Pb collisions at the LHC with ALICE

Friday, 12 July 2019 16:30 (15 minutes)

Electroweak bosons are created in the hard scattering processes at the initial stage of heavy-ion collisions and they are insensitive to the presence of the strongly-interacting medium. This makes them clean probes of the initial-state effects in heavy-ion collisions, such as the nuclear modification of the Parton Distribution Functions (nPDFs). Furthermore, their measurement in heavy-ion collisions is a powerful test of the binary scaling of hard processes as well as a reference for hot-matter effects on other probes.

The measurement of electroweak-boson production in p-Pb and Pb-Pb collisions at the LHC provides constraints on the nPDFs of (anti)quarks in phase-space regions which are poorly constrained from previous experiments.

At forward rapidity ($2.5 < y < 4$), ALICE can measure W and Z bosons via their muon decay in all collisions systems provided by the LHC. These measurements are complementary to those by ATLAS and CMS at central rapidity.

In this contribution, focus will be given to the most recent ALICE electroweak-boson measurements. Centrality and rapidity-differential measurements of the Z-boson production yield in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ will be discussed and the status of the analysis of the 2018 data sample will be presented. The first measurement of the Z-boson production cross-section in p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV will also be shown as a function of rapidity. The status of ongoing W-boson analyses in various collision systems will also be reported. All the presented results will be compared to theoretical calculations including nPDFs.

Primary author: ANONYMOUS, submission (ALICE Collaboration)

Presenter: TAILLEPIED, Guillaume (Université Clermont Auvergne (FR))

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
$J/\psi$ production measurements in pp, p-Pb and Pb-Pb collisions at mid-rapidity using the ALICE detector at LHC

Friday, 12 July 2019 10:30 (18 minutes)

$J/\psi$ production provides a particular sensitivity to the medium which can be produced in heavy-ion collisions at ultrarelativistic energies as delivered by the LHC. The vacuum production is modelled by a reference measured in proton-proton collisions and potential initial-state effects can be constrained using p–Pb collisions in the same collision-energy regime.

In this contribution $J/\psi$ production measured at mid-rapidity ($|y| < 0.9$) with the ALICE detector down to zero transverse momentum is presented. Final results of the proton-proton collisions at $\sqrt{s} = 5.02$ TeV collected in 2017 are presented which serve also as a high-precision reference for the nuclear modification factors in p–Pb and Pb–Pb collisions at the corresponding centre-of-mass collision energy. The status of the analysis of the nuclear modification factor and the separation of the prompt and non-prompt components of $J/\psi$ production in p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV is shown. The status of the $p_T$-differential $J/\psi$ cross section measurement in pp at $\sqrt{s} = 13$ TeV is also discussed. Available models are confronted with the data.

**Primary author:** ANONYMOUS, submission (ALICE Collaboration)

**Presenter:** LOFNES, Ingrid Mckibben (University of Bergen (NO))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Measurement of heavy-quark production via dielectrons in pp and p-Pb collisions with ALICE at the LHC

Heavy quarks are particularly useful probes to investigate the properties of the Quark-Gluon Plasma produced in heavy-ion collisions at the LHC, since they are produced on a shorter timescale than that of the hot fireball. To single out the signals that are characteristic of the QGP, it is nevertheless crucial to understand the primordial heavy-quark production in vacuum, i.e. in inelastic proton-proton collisions, and to disentangle hot from cold-nuclear matter effects with p-Pb collisions. Moreover, observations of collective effects in high-multiplicity pp and p-Pb collisions show surprising similarities with those in heavy-ion collisions. The measurement of heavy-flavour production in such collisions could give further insight into the underlying physics processes.

The heavy-flavour production can be studied with electron-positron pairs from correlated semileptonic decays of heavy-flavour hadrons. Compared to single heavy-flavour measurements, the dielectron yield contains information about the initial kinematical correlations between the charm and anti-charm quarks, which is otherwise not accessible, and is sensitive to soft heavy-flavour production. Therefore dielectron measurements can give further constraints on Monte-Carlo (MC) event generators and models aiming to reproduce the heavy-flavour production.

In this talk, we will present results on correlated $e^+e^−$ pairs in pp collisions recorded by ALICE at different energies. The production of heavy quarks will be discussed by comparing the yield of dielectrons from heavy-flavour hadron decays as a function of invariant mass, pair transverse momentum and distance of closest approach to the primary vertex with different MC event generators. The heavy-flavour production cross sections, extracted from the data, will be presented. Results from high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV and the status of the p-Pb analysis at $\sqrt{s_{NN}} = 5.02$ TeV will be reported as well.

Primary author: ANONYMOUS, submission (ALICE Collaboration)
Presenter: SCHEID, Horst Sebastian (Johann-Wolfgang-Goethe Univ. (DE))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Low-mass dielectron measurements Pb–Pb collisions with ALICE at the LHC

The production of low-mass dielectrons is the most promising tools for the understanding of the chiral symmetry restoration and of the thermodynamical properties of the Quark-Gluon Plasma (QGP) created in ultra-relativistic heavy-ion collisions. Since dielectrons are unaffected by strong final-state interactions and emitted during all stages of the collision, they carry information about the whole space-time evolution of the medium. The dielectron invariant mass allows for an approximate chronological view on this evolution. At low invariant mass ($m_{ee} < 1.1 \text{ GeV}/c^2$), the dielectron spectrum is sensitive to in-medium modification of the spectral function of the rho meson and effects related to the chiral symmetry restoration. In the intermediate-mass region ($1.1 < m_{ee} < 2.8 \text{ GeV}/c^2$), the dominant contribution of correlated pairs from semileptonic decays of charm and beauty hadrons is sensitive to in-medium effects on heavy-flavour production. Thermal radiation emitted by the system, both during the partonic and hadronic phase, contributes as well to the dielectron yield over a broad mass range and gives insight into the temperature of the medium. Finally, at very low pair transverse momenta initial photon annihilation processes, triggered by the coherent electromagnetic fields of the incoming nuclei, are expected to play a role in more peripheral collisions.

In this talk, we will present dielectron measurements with ALICE in Pb-Pb collisions at two energies, $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV. The results will be compared to the expected dielectron yield from know hadronic sources and several predictions for the thermal radiation from the hadron gas and QGP phases. The study of virtual-photon production will be shown as well.

Primary author: ANONYMOUS, submission (ALICE Collaboration)
Presenter: BAILHACHE, Raphaëlle (Johann-Wolfgang-Goethe Univ. (DE))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
MUON Spectrometry at forward rapidities in ALICE

Thursday, 11 July 2019 11:45 (15 minutes)

ALICE is the experiment specifically designed for the study of the Quark-Gluon Plasma in heavy-ion collisions at the CERN LHC. The forward Muon Spectrometer of ALICE is devoted to the study of muon production in the pseudo-rapidity interval between 2.5 and 4. During Run 1 and 2, the spectrometer produced an impressive amount of results concerning the Quarkonia ($J/\Psi$ and $\Upsilon$ families), Heavy flavor and low mass vector mesons. The present spectrometer is composed of two systems: the muon tracking based on 10 planes of Cathode Pad Chambers (CPC) and the muon trigger based on 4 planes of Resistive Plate Chambers (RPC). For Run 3 and 4, an ambitious upgrade program is ongoing for both systems, consisting of the replacement of the front-end and the back-end readout electronics in order to cope with an increased rate by an order of magnitude in Pb-Pb collisions compared to run 2. An additional detector, the Muon Forward Tracker (MFT), will be installed in front of the spectrometer absorber. It consists of planes of high resolution CMOS pixel sensors and it will bring precise vertexing capabilities to the Muon Spectrometer. The technical challenges and construction status related to the muon spectrometer upgrade and the addition of the MFT will be presented.

Primary author:  FERRERO, Andrea (Université Paris-Saclay (FR))
Presenter:  FERRERO, Andrea (Université Paris-Saclay (FR))
Session Classification:  Detector R&D and Data Handling
Track Classification:  Detector R&D and Data Handling
Upgrade of the ALICE Time Projection Chamber for the LHC Run3

Thursday, 11 July 2019 10:30 (15 minutes)

One of the experiments at the Large Hadron Collider (CERN), ALICE, is undergoing ambitious upgrades during the ongoing second long shutdown. The main goal of this project is to access rare events and previously inaccessible physics observables. The increased Pb-Pb and p-p collision rates need a correspondingly higher TPC operation rate in the next Run 3 of the LHC.

The operational gated MWPC readout used so far cannot be used at such fast rates. Therefore a new readout chamber is needed with a novel technology and without any compromise on the momentum and energy resolution. As a solution the Gas Electron Multiplier (GEM) technology is applied, which is a thin, metal-clad polymer foil with a high density of holes etched chemically. This new readout chamber consists of inner- (IROC) and outer (OROC) readout chambers with a 4 stage GEM cascade in order to reduce back-drifting ion space charges. These quadruple stacks have proven to provide sufficient ion blocking capabilities. This structure also preserves the intrinsic energy resolution and keeps the space-charge distortions at a tolerable level. At the nominal working point, the gain of one stack is around 2000.

We will present the status of the ongoing ALICE TPC upgrade project: (i) The recently completed quality assurance (QA) and calibration of the 720 GEM foils. This included basic QA tests performed at CERN, a high definition optical and gain scan. (ii) The disassembly and re-build of the ALICE TPC. (iii) The new data acquisition with continuous readout system for the 50kHz Pb-Pb performance.

Primary author: ANONYMOUS, submission (ALICE Collaboration)

Presenter: GERA, Adam Laszlo (Hungarian Academy of Sciences (HU))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
The new Inner Tracking System for the ALICE Upgrade

Thursday, 11 July 2019 09:45 (15 minutes)

ALICE (A Large Ion Collider Experiment) is the CERN LHC experiment optimized for the study of the strongly interacting matter produced in heavy-ion collisions, in particular the characterization of the quark-gluon plasma. ALICE is preparing a major upgrade of its detector to be installed during the second long LHC shutdown (LS2). The main objective is to increase the readout capabilities to allow the readout and recording of Pb–Pb minimum bias events at rates in excess of 50 kHz, the expected Pb–Pb interaction rate at the LHC after LS2. This increase in readout speed, together with the deployment of a new data acquisition system capable of recording all collisions, will imply an increase by about two orders of magnitude in the collectible minimum-bias statistics compared to the present ALICE set-up. One of the key components of the LS2 upgrade programme is the replacement of the current Inner Tracking System (ITS) with an entirely new one (ITS2) which will bring about an increased vertexing and tracking performance, especially for particles with low transverse momentum ($p_T < 1$ GeV/c). The new ITS consists of seven approximately-cylindrical detector layers based on CMOS Monolithic Active Pixel Sensors (MAPS) with the sensor matrix and readout integrated in a single chip, named ALPIDE (ALice PIxel DEtector), covering a 10 m$^2$ area with about 12.5 billion pixels. This talk will present the motivations, the requirements and the overall layout of the ITS2 as well as the construction and commissioning status.

Primary author: ANONYMOUS, submission (ALICE Collaboration)

Presenter: Dr CORRALES MORALES, Yasser (Los Alamos National Laboratory (US))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
A feeble window on leptophilic dark matter

Friday, 12 July 2019 10:40 (20 minutes)

In this talk, I will discuss a leptophilic dark matter scenario involving feeble dark matter coupling to the Standard Model (SM) and compressed dark matter-mediator mass spectrum. I will consider a simplified model where the SM is extended with one Majorana fermion, the dark matter, and one charged scalar, the mediator, coupling to the SM leptons through a Yukawa interaction. I will first discuss the dependence of the dark matter relic abundance on the Yukawa coupling going continuously from freeze-in to freeze-out with an intermediate stage of conversion driven freeze-out. Focusing on the latter, I will then exploit the macroscopic decay length of the charged scalar to study the resulting long-lived-particle signatures at collider and to explore the experimental reach on the viable portion of the parameter space.

Primary author: JUNIUS, Sam (ULB/VUB)
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Presenter: JUNIUS, Sam (ULB/VUB)
Session Classification: Cosmology
Track Classification: Cosmology
The commissioning of the ICARUS LAr detector on the short baseline (SBN) neutrino beam at FNAL

Monday, 15 July 2019 19:40 (20 minutes)

The ICARUS T600 cryogenic detector is made of two identical modules for a total mass of \( \sim 760 \) tons of Liquid Argon, representing the biggest detector of this kind in operation. Each module is equipped with two readout chambers on the long sides, with planes of wires at \( 0^\circ, \pm 60^\circ \) for a total of \( 54000 \) readout wires. The LAr TPC’s have been refurbished at CERN, in the framework of the WA104 project, and have been recently installed in the SBN Far Detector Building at FNAL. While during previous operations at LNGS, due to the deep rock overburden, a single prompt trigger has always ensured the unique timing connection of the main image of the event for the T600 detector, at FNAL, due to installation at shallow depth, several additional cosmic muons will be present in the 1 ms drift time, giving problems for track reconstruction. To handle this problem, in addition to a \( 4\pi \) cosmic ray tagger (CTS), a system based on 360 large area PMTs for the detection of the emitted scintillation light at \( \sim 128 \) nm has been implemented. This light readout system will allow both a precise event timing and localization and the exploitation of the SBN beam bunched structure (1.15 ns every 19 ns) to reject out-of-bunch cosmics. The timing measurements will rely on a fast laser based calibration system for time monitoring.

The refurbishment at CERN and installation and first commissioning at FNAL of the ICARUS detector will be reviewed, with emphasis on future perspectives.

**Primary authors:** BONESINI, Maurizio; ON BEHALF OF THE ICARUS COLLABORATION

**Presenter:** BONESINI, Maurizio

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Machine Learning based jet momentum reconstruction in Pb-Pb collisions measured with ALICE

Thursday, 11 July 2019 10:52 (18 minutes)

The precise reconstruction of jet transverse momenta in heavy-ion collisions is a challenging task. A major obstacle is the large number of uncorrelated (mainly) low-$p_T$ particles overlaying the jets. Strong region-to-region fluctuations of this background complicate the jet measurement and lead to significant uncertainties.

We developed a novel approach to correct jet momenta (or energies) for the underlying background in heavy-ion collisions. The approach allows the measurement of jets down to extremely low transverse momenta and for large resolution $R$ by making use of common Machine Learning techniques to estimate the jet transverse momentum based on several parameters.

In this talk, we will present transverse momentum spectra and nuclear modification factors of track-based jets that have been corrected by this Machine Learning approach and comparisons to published results where possible. The analysis was performed on Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV recorded with the ALICE detector and measures jets with large resolution parameters for low momenta, unprecedented thus far in data on heavy-ion collisions.

Primary author: ALICE COLLABORATION

Presenter: HAAKE, Rudiger (Yale University (US))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
System and event activity dependences of inclusive jet production with ALICE

Thursday, 11 July 2019 09:00 (18 minutes)

Jets are produced by a high momentum transfer of initial partons at high energies. Comparing jet production in pp and nucleus-nucleus collisions will allow us to study the jet-quenching effect caused by the hot and dense QCD medium produced in nucleus-nucleus collisions when energetic partons traverse the medium. In particular, systematic studies of jet production in different multiplicity environments will provide in-depth understanding of the medium properties and its evolution from small to large systems. In small systems and high multiplicity events, the particle bulk behaves as if a hot QCD medium was created, but such behavior is not observed with hard probes. Therefore, a detailed study of the jet production in different collision systems and different event activity with various jet resolution parameters will help us to investigate further the existence of medium effects on jets in small systems with high multiplicity. In this presentation, the jet cross section measurements in different collision systems using the data taken by ALICE during the LHC RUN 2 will be presented. The jet nuclear modification factor, which characterizes the jet-quenching effect, will be presented using different jet resolution parameters. In order to study the jet collimation properties, the jet cross section ratio for different jet resolution parameters will be also measured and compared to different theoretical models.

Primary author: ALICE COLLABORATION

Presenters: ZHOU, Daicui (Central China Normal University CCNU (CN)); HOU, Yongzhen (Central China Normal University CCNU (CN))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Measurements of $p_T$-differential $v_2$ and $v_3$ using multi-particle cumulants in Pb-Pb and Xe-Xe collisions

Saturday, 13 July 2019 12:08 (18 minutes)

Anisotropic flow coefficients $v_n$ have been used as a tool to probe the initial conditions and transport properties of the strongly interacting matter produced in heavy-ion collisions. In this talk we report on the measurements of $p_T$-differential $v_2$ and $v_3$ coefficients for charged hadrons using two- and multi-particle cumulants in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV and Xe-Xe collisions at $\sqrt{s_{NN}} = 5.44$ TeV. In order to discuss the non-flow effects, we also present results obtained using a novel 2-subevent technique. We observe that the $v_2\{6\}$ and $v_2\{8\}$ deviate from $v_2\{4\}$, indicating that the underlying probability density distribution of $v_n$ coefficients is not well-described by the Bessel-Gaussian distribution. This provides new constraints on the initial geometry and its event-by-event fluctuations of heavy-ion collisions. Moreover, the non-trivial evolution of $v_2\{6\}/v_2\{4\}$ and $v_2\{8\}/v_2\{4\}$ ratios with $p_T$ suggests that the transport properties of the expanding medium play an important role to the azimuthal distributions of charged hadrons.

Primary author: ALICE COLLABORATION
Presenter: VISLAVICIUS, Vytautas (University of Copenhagen (DK))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Pseudorapidity dependence of anisotropic flow in heavy ion collisions with ALICE

Saturday, 13 July 2019 12:26 (18 minutes)

Anisotropic flow, characterised by the flow coefficients $v_n$, is one of the probes used to study the properties of the strongly interacting Quark-Gluon Plasma formed in ultra-relativistic heavy-ion collisions. These flow coefficients are usually measured by correlations between two or more particles.

We present results on the pseudorapidity ($\eta$) dependence of $v_2(2)$, $v_3(2)$, $v_4(2)$ and $v_2(4)$ in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The measurements presented in this talk exploit the largest possible separation in $\eta$ with the ALICE detectors. The Generic Framework with a $\Delta \eta$-gap is used to suppress non-flow effects originating from correlations not related to the common symmetry plane, e.g. jets and resonance decays. In addition, four particle cumulants with an $\eta$-gap are used to further suppress non-flow effects. The $\eta$-dependent flow coefficients are presented within the range $-3.4 \leq \eta \leq 5$ at different centralities. A new method is also presented for eliminating flow contributions from secondary particles applied at forward pseudorapidity, giving further insight into non-flow effects. The collisions energy dependence of $v_n(\eta)$, as well as the comparison to theoretical model calculations will be discussed.

Primary author: ALICE COLLABORATION
Presenter: THORESEN, Freja (University of Copenhagen (DK))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Non-linear flow modes of identified particles in Pb-Pb collisions at 5.02 TeV

Saturday, 13 July 2019 12:44 (18 minutes)

The study of flow coefficients and in particular their higher orders, provides important constraints on the initial conditions and transport properties of the QGP. It has been shown that higher order flow coefficients \((n > 3)\) have significant contribution from lower order initial spatial anisotropies giving rise to non-linear flow modes. Thus, these non-linear observables probe the contribution of the lower order initial spatial anisotropies, e.g. \(\varepsilon_2\) and \(\varepsilon_3\), to higher order flow coefficients.

In this talk, we present the first ever measurements of \(p_T\)-differential non-linear flow modes, \(v_{4,22}, v_{5,32}, v_{6,33}\) and \(v_{6,222}\) of \(\pi^\pm, K^\pm, p + p, \Lambda, K_0^0\) and \(\phi\) in Pb-Pb collisions at \(\sqrt{s_{NN}} = 5.02\) TeV recorded with the ALICE detector. Interestingly, all the characteristic features observed in previous \(p_T\)-differential \(v_n\) measurements for various particle species are also present in the measurement of the non-linear flow modes, i.e. increase of magnitude with increasing centrality percentile, mass ordering and particle type grouping at the low and intermediate \(p_T\) regions, respectively.

Hydrodynamical calculations (iEBE-VISHNU) that use different initial conditions and values of shear and bulk viscosity to entropy density ratios are confronted with the data at low transverse momenta. This comparison provides increased discriminatory power in the study of initial conditions as well as a new stringent constraint to hydrodynamical calculations.

**Primary author:** ALICE COLLABORATION  
**Presenter:** MOHAMMADI, Naghmeh (CERN)  
**Session Classification:** Heavy Ion Physics  
**Track Classification:** Heavy Ion Physics
Studies of the production of light- and heavy-flavour baryons are of prominent importance to characterise the partonic phase created in ultrarelativistic heavy ion collisions and to investigate hadronisation mechanisms at the LHC. Studies performed in p–Pb and pp collisions have revealed unexpected features, qualitatively similar to what is observed in larger collision systems and, in the charm sector, not in line with the expectations from $e^+e^-$ and $e^-p$ interactions. The ALICE experiment has exploited its excellent tracking and PID capabilities down to low transverse momentum to perform an extensive study of protons, hyperons and charmed baryons. A critical discussion of the most recent results on light (protons and hyperons) and heavy-flavour ($\Lambda_c$ and $\Xi_c$) baryon production will be presented, together with a comparison to phenomenological models. Emphasis will be given to the discussion of the impact of these studies on our understanding of hadronisation processes.

**Primary author:** ALICE COLLABORATION  
**Presenter:** VAZQUEZ RUEDA, Omar (Lund University (SE))  
**Session Classification:** Heavy Ion Physics  
**Track Classification:** Heavy Ion Physics
Particle production as a function of system size and underlying-event activity measured with ALICE at the LHC

Saturday, 13 July 2019 11:45 (15 minutes)

ALICE has performed several measurements aimed at understanding the heavy-ion-like patterns observed in small collision systems. New approaches can be helpful to clarify particle production mechanisms in pp collisions, as well as the similarities observed among the systems created in pp, p-A and A-A collisions.

In this talk we report on charged-particle transverse momentum distributions as a function of event multiplicity. The distributions are obtained using a 2D-unfolding procedure. We compare unidentified charged-particle production at different collision energies, as well as that for pp, p-Pb and Pb-Pb collisions at the same energy. In order to understand the role of autocorrelations in small systems, it has been proposed to exploit the usage of the underlying event as a multiplicity estimator to factorize the hardest and the softer components of the events. This approach can also be used to study collective effects in events with exceptionally large activity in the underlying-event region with respect to the event-averaged mean. For this purpose, in this talk we also present the charged particle transverse momentum distributions as a function of underlying-event activity in pp collisions. All results will be compared with QCD-inspired event generators, as well as with existing measurements adopting the mid- and forward-pseudorapidity multiplicity estimators.

Primary author: ALICE COLLABORATION
Presenter: KRUGER, Mario (Johann-Wolfgang-Goethe Univ. (DE))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
The hypertriton lifetime presents one of the key open questions of hypernuclear physics. The separation energy of the $\Lambda$ inside the hypertriton is only 130 keV and it implies a small change of the $\Lambda$ wave function inside the nucleus and hence the lifetime of the hypertriton is expected to be close to that of the free $\Lambda$ hyperon.

The average value of the results obtained with different experimental technique and available up to a couple of years ago, was much lower than the theoretical prediction and this disagreement is referred to as the hypertriton lifetime puzzle.

The measurement of the hyper-triton lifetime performed with the ALICE detector at the LHC will help to address such a question.

The dataset collected with Pb-Pb collisions during the LHC Run 2 at $\sqrt{s_{NN}} = 5.02$ TeV allows one to systematically study the production of light (anti-)hypernuclei in heavy-ion collisions. In particular, owing to the large statistics available with respect to the dataset collected at lower energy ($\sqrt{s_{NN}} = 2.76$ TeV), the hypertriton lifetime can be determined with higher accuracy.

The analysis has been carried out by exploiting the excellent particle identification performance by measuring the energy loss in the Time Projection Chamber. In addition, the Inner Tracking System is used to discriminate secondary vertices, originating from weak decays, from the primary vertex. This is of particular importance for the measurement of (anti-)hypertriton, which decays weakly with a decay length of several centimetres.

The study of (anti-)hypertriton production in Pb-Pb collisions at both energies available at the LHC will be discussed and compared to model predictions and to the experimental results obtained at lower energies. Special emphasis will be put on the latest measurement of the hypertriton lifetime via its 2-body decay channel. This result is in agreement with the free $\Lambda$ lifetime as supported by most of the theoretical calculations which predict similar lifetimes.

A detailed discussion of the experimental results and the effort needed on both the experimental and the theoretical side in this sector will be presented with an overview of the performance achievable with ALICE during Run 3 and Run 4 of the LHC.
High energy pp, p-Pb, and Pb-Pb collisions at the LHC offer a unique opportunity to study the production of light (anti-)nuclei. The study of the production yield of (anti-)nuclei in heavy-ion collisions at LHC energies probes the late stages in the evolution of the hot, dense nuclear matter created in the collision and serves as baseline in the search for exotic multi-baryon states. Measurements performed in smaller collision systems are crucial to understand how the production mechanism evolves going from small to large systems. The results on the determination of the (anti-)nuclei yields will be complemented by the measurement of their azimuthal anisotropic production. This is a powerful tool to gain insight into the production mechanism of light nuclei in heavy-ion collisions: in particular, it will help to distinguish between coalescence and hydrodynamic models. The coalescence approach predicts light nuclei formation as the result of coalescence of nucleons which are close enough in the phase space, thus the elliptic and triangular flow are expected to scale with the number of constituent hadrons. On the other hand, if light nuclei are produced thermally at the phase boundary in heavy-ion collisions together with all the other hadrons, the evolution with transverse momentum of both elliptic and triangular flow can be described by hydrodynamic models. Results on the production yields of light (anti-)nuclei in pp, p-Pb, and Pb-Pb collisions at energies going from 5.02 TeV to 13 TeV will be presented. In addition, new results on the measurement of the elliptic and the triangular flow of deuterons and 3He produced in Pb–Pb collisions at 5.02 TeV will be discussed. A critical comparison of the experimental results with the predictions of statistical (thermal) models and the baryon coalescence approach will be given.
Production and modification of hadronic resonances measured with ALICE

Saturday, 13 July 2019 12:15 (15 minutes)

Measurements of the production of short-lived hadronic resonances are used to probe the properties of the late hadronic phase in ultra-relativistic heavy-ion collisions. Since these resonances have lifetimes comparable to that of the produced fireball, they are sensitive to the competing effects of particle re-scattering and regeneration in the hadronic gas, which modify the observed particle momentum distributions and yields after hadronisation. Having different masses, quantum numbers and quark content, hadronic resonances carry a wealth of information on different aspects of ion-ion collisions, including the processes that determine the shapes of particle momentum spectra, strangeness production, and the possible onset of collective effects in small systems. We present the most recent ALICE results on $\rho(770)^0$, $K^*(892)$, $\phi(1020)$, $\Sigma(1385)^\pm$, $\Lambda(1520)$, $\Xi(1530)^0$ and $\Xi(1820)$ production at the LHC. They include measurements performed in pp, p–Pb and Pb–Pb collisions at different energies, as well as the results from the LHC Run 2 with Xe–Xe collisions at $\sqrt{s_{NN}} = 5.44$ TeV. Collision energy and multiplicity differential measurements of transverse momentum spectra, integrated yields, mean transverse momenta and particle yield ratios are discussed in detail. A critical overview of these results will be given through comparisons to measurements from other experiments and theoretical models.

Primary author: ALICE COLLABORATION
Presenter: SONG, Jihye (University of Houston (US))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Multiplicity and centre-of-mass energy dependence of light-flavor hadron production in pp, p-Pb, and Pb-Pb collisions with ALICE

Thursday, 11 July 2019 14:48 (18 minutes)

The study of identified hadron production as a function of event multiplicity is a key tool for understanding the similarities and differences between large and small colliding systems. The multiplicity-dependence of the total yields of identified hadrons as a function of event activity shows a remarkable scaling that covers all the collision systems considered.

The production rates of strange and multi-strange hadrons show enhancement patterns, which are not consistently captured by commonly-used Monte Carlo generators. To isolate the center-of-mass energy dependence, pp and Pb–Pb collisions have been measured at two different energies. We find that hadrochemistry is dominantly driven by the multiplicity in hadronic collisions at LHC energies, and not the colliding system or the center-of-mass energy.

We report on the production of pions, kaons, protons, $K^0_S$, $\Lambda$, $\Xi$ and $\Omega$ measured in pp ($\sqrt{s} = 7$ and 13 TeV), p–Pb ($\sqrt{s_{NN}} = 5.02$ TeV) and Pb–Pb ($\sqrt{s_{NN}} = 2.76$ and 5.02 TeV) collisions at the LHC. Results will be compared to predictions from hydrodynamic and statistical hadronization models.

Primary author: ALICE COLLABORATION
Presenter: RAVASENGA, Ivan (National Academy of Sciences of Ukraine (UA))
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
The High Energy cosmic-Radiation Detection (HERD): a probe for high-energy cosmic rays’ physics and multimessenger astronomy

Thursday, 11 July 2019 17:10 (20 minutes)

The High Energy cosmic-Radiation Detection (HERD) facility has been proposed as one of several space astronomy payloads onboard the future China’s Space Station (CSS) aimed to detect charged cosmic-rays and gamma-rays from few GeV to PeV energies. The main science objectives of HERD are searching dark matter particle, the study of cosmic ray chemical composition up to the knee and high energy gamma-ray observations. HERD consists of a very thick (3 lambda, 55 X0) cubic calorimeter made of small LYSO cubic crystals allowing 3D reconstruction, a tracker consisting of silicon microstrip detectors and thin converter foils for gamma conversion and plastic scintillator plates for veto and charge measurements. HERD will extend high precision and high statistics measurement of cosmic ray spectra up to 1 PeV. It will also observe the gamma-ray sky from a few GeV up to 1 TeV contributing to multi-messenger astronomy together with ground-based high energy gamma-ray telescope (CTA, HAWC) and neutrino and gravitational waves detectors.

Primary author:  GARGANO, Fabio (Universita e INFN, Bari (IT))
Presenter:  GARGANO, Fabio (Universita e INFN, Bari (IT))
Session Classification:  Astroparticle Physics and Gravitational Waves
Track Classification:  Astroparticle Physics and Gravitational Waves
High rate performance of Small-pad Resistive Micromegas. Comparison of different resistive protection concepts.

Monday, 15 July 2019 19:40 (20 minutes)

Motivated mainly by future upgrades at high-luminosity LHC (HL-LHC) and detectors at future colliders, most of the HEP R&D collaborations are focusing on the design of new particle detectors for operation under very high particle flow. In the field of Micro-Pattern- Gaseous-Detectors, the small-pad resistive Micromegas prototypes were designed to overcome the actual limitations of standard resistive strip Micromegas chambers. In these new prototypes, pads with 1x3 mm² area replace the readout strips to reduce the occupancy, and the spark protection resistive layer has been redesigned and optimized with different techniques to permit a safe behaviour of the detector, without efficiency loss, at rates of the order of tens MHz/cm² over large surfaces. The firstly-developed design exploits a pad-patterned embedded resistor layout by screen-printing, while the most recent technique involves uniform sputtered DLC (Diamond Like Carbon structure) layers, where the charge evacuates through the several vias connected to the ground. Comparative studies have been conducted on the performances of the detectors with two resistive layouts, and between two (DLC) prototypes with different pitch of vias and DLC resistivity. The results of the tests performed with high intensity X-rays and with high energy charged particle beams will be presented.

Primary authors: ALVIGGI, Mariagrazia (Naples University and INFN); CAMERLINGO, Maria Teresa (Universita e INFN Roma Tre (IT)); CANALE, Vincenzo (Universita e sezione INFN di Napoli (IT)); DELLA PIETRA, Massimo (Universita e sezione INFN di Napoli (IT)); DI DONATO, Camilla (Universita e sezione INFN di Napoli (IT)); IENGO, Paolo (CERN); IODICE, Mauro (INFN - Sezione di Roma Tre); PETRUCCI, Fabrizio (Universita e INFN Roma Tre (IT)); SEKHNIAIDZE, Givi (Universita e sezione INFN di Napoli (IT))

Presenter: ALVIGGI, Mariagrazia (Naples University and INFN)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
New Physics implications of the B-physics anomalies

Saturday, 13 July 2019 10:10 (20 minutes)

Recent experimental measurements hint for possible new physics effects in B-meson decays, the so-called B-anomalies. New physics explanations of the anomalies generically imply large effects also in other observables, both at low-energies and at high-pT. I will review new physics scenarios able to address these anomalies and discuss their smoking-gun signatures. The possible connection of these anomalies with the SM flavor puzzle will also be addressed.

Primary author: FUENTES-MARTIN, Javier (University of Zurich)
Presenter: FUENTES-MARTIN, Javier (University of Zurich)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Recent results on spectator-induced electromagnetic effects in ultrarelativistic light- and heavy-ion collisions

We review our studies of spectator-induced electromagnetic (EM) effects on charged pion emission. For heavy-ion Pb+Pb and Au+Au reactions, we formulate a model which associates the size of EM effect with the space-time properties of the system of hot and dense matter formed in the collision. As a result we obtain an estimate for the pion decoupling time which agrees with pion decoupling times obtained from standard femtoscopy [1].

The first observation of the spectator-induced EM distortion of the $\pi^+ / \pi^-$ ratio in small systems at the CERN SPS [2] allows the extension of our study to Ar+Sc collisions at $\sqrt{s_{NN}} = 17.3$ GeV. We improve our model description to take into account spectator fragmentation as well as the possible influence of the net positive participant charge close to the spectator system. This brings new information on the space-time evolution of pion production in small systems, and on the other hand allows us to study the interplay between spectator fragmentation and electromagnetic phenomena also in ultrarelativistic heavy-ion collisions.

A consistent picture of the space-time evolution of all the studied systems emerges, where the longitudinal evolution of the hot and dense matter created in the participant zone results in faster pions being produced closer to the spectator system.


Primary authors: MARCINEK, Antoni (Polish Academy of Sciences (PL)); RYBICKI, Andrzej (Polish Academy of Sciences (PL)); SZCZUREK, Antoni (Institute of Nuclear Physics); SPUTOWSKA, Iwona Anna (Polish Academy of Sciences (PL)); DAVIS, Nikolaos (Polish Academy of Sciences (PL))

Presenter: SPUTOWSKA, Iwona Anna (Polish Academy of Sciences (PL))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Kaon Isospin Fluctuations in Pb-Pb Collisions at $\sqrt{s_{NN}} = 2.76$ TeV with ALICE at the LHC

Thursday, 11 July 2019 15:24 (18 minutes)

The first measurements of event-by-event correlated fluctuations of neutral and charged kaons are reported in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, which are proposed to be related to isospin fluctuations in the kaon sector. These dynamic fluctuations affect the mechanism of correlated productions of neutral and charged kaons in heavy ion collisions. In this work we have used the robust statistical observable, $\nu_{\text{dyn}}$, to study the dynamical fluctuations in strangeness sector using charged and neutral kaons. A statistically significant signal of dynamical fluctuations is observed in the data which is underestimated by HIJING and AMPT model predictions, when moments of neutral and charged kaons are calculated as a function of centrality. We observed that $K_0^0 - K^\pm$ fluctuations is not dominated by the correlation from particle decay like $K^+ - K^-$. 

Primary author: NAYAK, Ranjit (IIT- Indian Institute of Technology (IN))

Presenter: NAYAK, Ranjit (IIT- Indian Institute of Technology (IN))

Session Classification: Heavy Ion Physics

Track Classification: Heavy Ion Physics
Forward-backward correlations and multiplicity fluctuations in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV from ALICE at the LHC

Monday, 15 July 2019 19:40 (20 minutes)

Forward-backward (FB) multiplicity correlations carry important information on the early dynamics of ultra-relativistic heavy ion collisions. In this talk, new data on forward-backward charged particle correlations and multiplicity fluctuations in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV are presented. The data are recorded with the ALICE detector at the LHC. We focus on the evolution of the correlation coefficient $b_{corr}$ and the strongly-intensive quantity $\Sigma$ as a function of the distance between forward and backward pseudo rapidity intervals ($\eta$ gap), the centrality of the collision and the width of the centrality bin. Both observables are studied by means of two different centrality estimators: charged-particle multiplicity and spectator energy.

At the moment, the strong dependence of the measured magnitude of forward-backward correlations ($b_{corr}$) on the applied centrality estimator, and as a function of the width of the centrality bin, are well-established facts. In this presentation, we substantiate that the correlation strength, measured with the ALICE detector, appears to be dominated by geometrical fluctuations for wider centrality windows. This effect decreases significantly when narrowing the width of the centrality bin.

On the other hand, the most recent studies of the $\Sigma$ variable indicate that this observable exhibits the properties of a strongly intensive quantity in terms of the Independent Source Model for Pb–Pb collisions at LHC energies. As such, it is independent of the centrality bin width and centrality estimator. The usage of $\Sigma$ makes the measurement independent of effects such as fluctuations in the initial state geometry. Therefore it provides information on the early collision dynamics which is more direct than that obtained from other observables.

Primary author: ALICE COLLABORATION

Presenter: SPUTOWSKA, Iwona Anna (Polish Academy of Sciences (PL))

Session Classification: Wine & Cheese Poster Session

Track Classification: Heavy Ion Physics
Relic neutrinos: local clustering and consequences for direct detection

Friday, 12 July 2019 09:00 (20 minutes)

The Cosmic Neutrino Background is a prediction of the standard cosmological model, but it has been never observed directly. Experiments with the aim of detecting relic CNB neutrinos are under development. For such experiments, the expected event rate depends on the local number density of relic neutrinos. Since massive neutrinos can be attracted by the gravitational potential of our galaxy and cluster locally, a local overdensity of relic neutrinos should exist at Earth. We report the status of our knowledge of neutrino clustering and the consequences for future direct detection experiments.

Primary author: Dr GARIAZZO, Stefano (IFIC-CSIC/University of Valencia)
Presenter: Dr GARIAZZO, Stefano (IFIC-CSIC/University of Valencia)
Session Classification: Cosmology
Track Classification: Cosmology
Latest Results from Double Chooz

Thursday, 11 July 2019 11:30 (20 minutes)

On behalf of the Double Chooz (DC) collaboration, we’d like to propose a talk to report our latest results as of the latest publication (arXiv:1901.09445). We hereby report our latest measurement of Theta13. Special emphasis has been done for the validation of the systematics accuracy by the articulation of redundant measurements while DC exploits its unique simpler geometry to cancel almost completely the impact of questioned reactor flux model. Our Theta13 measurement continues to exhibit an inconclusive slightly higher value within an acceptable $\pm 2\sigma$ effect of the latest Daya Bay and RENO results. Additionally, we also report the world most precise mean cross-section per fission ($\langle \sigma f \rangle$) in good agreement to all experiments so far, thus superseding Bugey4 results for the first time. DC also scrutinises the reactor model prediction discrepancies in terms of both rate and shape, including inter-experiment comparison and addressing the possible impact to the accuracy of Theta13 measurement. DC thus concludes that the reactor prediction model uncertainties are likely underestimated and we quantify using an empirical neutrino data driven approach. Also, an empirical prescription for a new reactor model systematics is presented as temporary empirical solution for as long as the prediction accuracy appears questioned and compromised.

Primary author: SOLDIN, Philipp (RWTH Aachen University)

Presenter: SOLDIN, Philipp (RWTH Aachen University)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Highly Efficient RF Power Sources

Saturday, 13 July 2019 10:30 (20 minutes)

The klystron based high RF power system is a core element of the particle accelerator. The large-scale future accelerator projects such as FCC, CLIC and ILC will consume RF power at a level of hundred MW. Thus, the economical aspects of the machine operation, the environmental issues and the installation cost strongly depend on the efficiency performance of the RF power sources. The klystron technology has been developed for almost eight decades. For majority of the devices used in accelerator science it was established that the cost effective limit for the RF power production efficiency shall stay below 65%. In 2014, the dedicated study was initiated at CERN in attempt to improve the efficiency figure up to 80% and above through the thorough investigations of the physical process in the klystrons and understanding the limiting factors. As an outcome, a number of the new klystron bunching technologies have been developed and/or evaluated at CERN in collaboration with industry. These new technologies have been implemented into the klystron designs at different frequencies and power levels and predicted for some of them the efficiency reach as high as 80% (FCC CSM klystron for example). The general aspects of the new klystron technologies and their impact on the accelerators operation performance will be reviewed.

Primary author: SYRATCHEV, Igor (CERN)
Presenter: SYRATCHEV, Igor (CERN)
Session Classification: Accelerators for HEP
Track Classification: Accelerators for HEP
The Higgs self-coupling at CLIC

Thursday, 11 July 2019 15:45 (15 minutes)

The Compact Linear Collider (CLIC) is a mature option for a future electron-positron collider operating at centre-of-mass energies of up to 3 TeV. CLIC will be built and operated in a staged approach with three centre-of-mass energy stages currently assumed to be 380 GeV, 1.5 TeV, and 3 TeV. The Higgs self-coupling is of particular interest: for determining the shape of the Higgs potential, and due to its sensitivity to a variety of BSM physics scenarios. At the higher-energy stages CLIC will produce Higgs boson pairs both via double Higgsstrahlung and via vector-boson fusion. Recent results will be presented showing that measurements of these processes lead to a determination of the Higgs self-coupling with a precision of around 10%.

Primary authors: CLICDP COLLABORATION; SCHNOOR, Ulrike (CERN)
Presenter: SCHNOOR, Ulrike (CERN)
Session Classification: Higgs Physics
Track Classification: Higgs Physics
The CLIC potential for new physics

Friday, 12 July 2019 18:00 (15 minutes)

The Compact Linear Collider (CLIC) is a mature option for a future electron-positron collider operating at centre-of-mass energies of up to 3 TeV. CLIC will be built and operated in a staged approach with three centre-of-mass energy stages currently assumed to be 380 GeV, 1.5 TeV, and 3 TeV. A selection of results from recent studies will be presented showing that CLIC has excellent sensitivity to many BSM physics scenarios, both through direct observation and precision measurements of SM processes. New particles can be discovered in a model-independent way almost up to the kinematic limit. Compared with hadron colliders, the low background conditions at CLIC provide extended discovery potential. In addition to studying new particles directly, BSM models can be probed up to scales of tens of TeV through precision measurements. Beam polarisation allows further constraints on the underlying theory in many cases.

Primary authors: CLICDP COLLABORATION; ROBSON, Aidan (University of Glasgow (GB))

Presenter: ROBSON, Aidan (University of Glasgow (GB))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Top-quark physics at CLIC

The Compact Linear Collider (CLIC) is a mature option for a future electron-positron collider operating at centre-of-mass energies of up to 3 TeV. CLIC will be built and operated in a staged approach with three centre-of-mass energy stages currently assumed to be 380 GeV, 1.5 TeV, and 3 TeV. This contribution discusses the prospects for precision measurements of top-quark production and properties at CLIC, including a top-quark mass measurement with a precision of around 50 MeV, top-quark couplings to the electroweak gauge bosons, forward-backward and polarisation asymmetries, the top Yukawa coupling and CP properties in the ttH coupling, and top-quark pair production through vector-boson fusion. At the high-energy stages new studies have been undertaken using jet-substructure techniques originally developed for the LHC, and the BSM sensitivity provided by the top physics program at CLIC is illustrated using Effective Field Theory (EFT) approaches.

Primary authors: CLICDP COLLABORATION; ZARNECKI, Aleksander Filip (University of Warsaw)

Presenter: ZARNECKI, Aleksander Filip (University of Warsaw)

Session Classification: Top and Electroweak Physics

Track Classification: Top and Electroweak Physics
The proposed Compact Linear Collider (CLIC) will provide electron-positron collisions at centre-of-mass energies from a few hundred GeV up to 3 TeV. CLIC offers a rich precision physics program, and a high sensitivity to a wide range of possible new phenomena. The precision required for such measurements and the specific conditions imposed by the CLIC beam structure put strict requirements on the detector design and technology developments. This includes ultra-low mass vertexing and tracking systems with small cells, highly granular imaging calorimeters, and a precise hit-timing resolution for all subsystems. Ambitious R&D programs for silicon tracking detectors and calorimeters are being pursued, addressing the challenging detector requirements with innovative new technologies. A variety of detector optimisation studies have been carried out to establish the overall detector performance and to assess the impact of different technology options. This contribution reviews the CLIC detector concept, presents the detector performance achieved in full-detector simulations, and gives an overview of the ongoing hardware R&D.

Primary authors: CLICDP COLLABORATION; LEOGRANDE, Emilia (CERN)

Presenter: LEOGRANDE, Emilia (CERN)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Top-quark electroweak interactions at high energy

*Thursday, 11 July 2019 09:00 (15 minutes)*

Modified interactions in the electroweak sector may lead to scattering amplitudes that grow with energy compared to their Standard Model (SM) counterparts. We present a detailed study of all $2\to2$ scattering amplitudes involving at least one top quark and a pair of EW bosons. We analyse the high energy behaviour of the amplitudes using the Standard Model Effective Field Theory (SMEFT) to parametrise the departures from the SM. We discuss the origin of the energy growth that arise from effective contact interactions by appealing to the Goldstone equivalence theorem and find that the amplitudes obey expected patterns of (non-)interference. The results are connected to unitary-violating behaviour in the framework of anomalous SM interactions. Therein, we identify the appearance of additional growth due to the violation of SU(2) gauge symmetry that leads to substantial differences between the SMEFT and the anomalous couplings approaches. We also discuss the embeddings of the scattering amplitudes into physical collider processes, presenting the parametric SMEFT sensitivity to relevant top quark operators and paying special attention to the extent to which the high energy behaviour of the $2\to2$ amplitude is retained in the actual processes accessible at colliders. The effective W approximation is exploited to gain analytical insight into the embeddings of the $2\to2$ helicity amplitudes. Finally, we provide a compendium of processes detailing numerous directions in which the SMEFT parameter space can be accessed through high energy top quark processes in current and future colliders.

**Primary author:** Mr MANTANI, Luca (UCLouvain)

**Presenter:** Mr MANTANI, Luca (UCLouvain)

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Attenuation of heavy flavors in a dense medium

Thursday, 11 July 2019 17:44 (18 minutes)

Unexpectedly strong suppression of heavy flavored mesons, produced with high transverse momenta in heavy ion collisions, is caused by final state interactions in the created dense medium. Gluon bremsstrahlung by a highly virtual heavy quark ceases shortly after the hard collision in accordance with perturbative QCD calculations and LEP measurements of the fragmentation function. Nevertheless, within a dense medium hadronization lasts a much longer time than in vacuum, due to prompt multiple breakups of a large-size heavy-light meson, which has a very short mean free pass in the dense medium. This and the specific shape of the heavy quark fragmentation function explains the observed strong suppression of D and B mesons produced in heavy ion collisions.

Primary author: KOPELIOVICH, Boris (UTFSM)
Presenter: KOPELIOVICH, Boris (UTFSM)
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Vector-like leptonic dark matter, neutrino mass and collider signature

Friday, 12 July 2019 10:20 (20 minutes)

We study a class of models in which the Standard Model (SM) is augmented by vector-like leptons: one doublet and a singlet, which are odd under an unbroken discrete $Z_2$ symmetry. As a result, the neutral component of these additional vector-like leptons are stable and behave as dark matter. We study the phenomenological constraints on the model parameters and elucidate the parameter space for relic density, direct detection and collider signatures of dark matter. In such models, we further add a scalar triplet of hypercharge two and study the consequences. In particular, after electroweak symmetry breaking (EWSB), the triplet scalar gets an induced vacuum expectation value (vev), which yield Majorana masses not only to the light neutrinos but also to vector-like leptonic doublet DM. Due to the Majorana mass of DM, the $Z$-boson mediated elastic scattering with nucleon is forbidden and hence allowing the model to survive from stringent direct search bound. 

The DM without scalar triplet lives in a small singlet-doublet leptonic mixing region ($\sin \theta \lesssim 0.1$) due to large contribution from singlet component and have small mass difference ($\Delta m \sim 10$ GeV) with charged companion, the NLSP (next to lightest stable particle), to aid co-annihilation for yielding correct relic density. Both these observations change to certain extent in presence of scalar triplet to aid observability of hadronically quiet leptonic final states at LHC, while one may also confirm/rule-out the model through displaced vertex signal of NLSP, a characteristic signature of the model in relic density and direct search allowed parameter space.

**Primary author:** Dr SAHU, Narendra (Department of Physics, IIT Hyderabad, India)

**Presenter:** Dr SAHU, Narendra (Department of Physics, IIT Hyderabad, India)

**Session Classification:** Cosmology

**Track Classification:** Astroparticle Physics and Gravitational Waves
SoLid is a short baseline neutrino experiment, which is currently operating a 1.6 tons detector at the SCK-CEN BR2 research reactor in Belgium. SoLid will address the study of the so-called Reactor Antineutrino Anomaly (RAA), whose origin could be the existence of a light sterile neutrino state with a mass around the eV scale. In addition, it will perform a new measurement of the antineutrino energy spectrum produced by the 235-U isotope, which will help in the understanding of the 5-MeV distortion observed in previous reactor antineutrino experiments.

SoLid leverages a novel technology, combining PVT cubes of $5 \times 5 \times 5 \text{ cm}^3$ dimensions and $^{6}\text{LiF}:\text{ZnS(Ag)}$ screens of $\sim 250 \mu\text{m}$ thickness. To detect antineutrino interactions, signals are readout by a network of wavelength shifting fibers and SiPMs. The fine granularity (12800 cells) provides powerful tools to distinguish signal from background, but presents a challenge in ensuring homogeneous detector response and calibrating the energy scale and neutron detection efficiency. In this poster, the methods that have been developed for the calibration of such a segmented detector will be described. In addition, the calibration results will be presented.

**Primary author:** MANZANILLAS, Luis (Centre National de la Recherche Scientifique (FR))

**Presenter:** MANZANILLAS, Luis (Centre National de la Recherche Scientifique (FR))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Current status of JUNO Top Tracker

Monday, 15 July 2019 18:30 (1h 30m)

The JUNO experiment is a multi-purpose anti-neutrino oscillation experiment with the main objective of determining the neutrino mass ordering ($\nu$MO). The baselines to its two major reactors are both 53 km. JUNO’s goal is to achieve $3\sigma$ sensitivity of $\nu$MO with 6-year of data taking, so it is critical to obtain an unprecedented energy resolution, better than 3% at 1 MeV. The JUNO Central Detector (CD), a 20 kton liquid scintillator detector, will be built with high PMT photocathode coverage and good transparency for this purpose.

Despite the 700m overburden, the atmospheric muon-induced background is still estimated to be non negligible compared to the expected signal for the $\nu$MO determination. A veto system was designed for muon detection to further suppress muon-induced background. Two subsystems are used for the muon veto strategy: the Top Tracker (TT) and the Water Cherenkov Detector (WCD). The TT is a 3-layer muon tracker covering about 60% of the surface above the WCD and will provide precise atmospheric muon tracking. These well reconstructed muons are essential in the JUNO veto strategy for rejecting cosmogenic isotopes ($^9$Li and $^8$He). Combining the muon information from the TT and the WCD, our veto strategy will remove most of the atmospheric muon-induced background.

This poster will discuss the current status and the expected performance of the JUNO Top Tracker.

Primary authors: Mr HUANG, Qinhua (IPHC/LLR IN2P3); Dr ATHAYDE MARCONDES DE ANDRE, Joao Pedro (IPHC)

Presenter: Mr HUANG, Qinhua (IPHC/LLR IN2P3)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Status and perspectives of the Euclid mission

Friday, 12 July 2019 15:30 (30 minutes)

Euclid is the M2 mission of ESA’s Cosmic Vision program dedicated to the study of the dark universe: Dark Matter and Dark Energy, with launch scheduled for 2022. Euclid will observe 15,000 square degrees of extragalactic sky in the visible band with resolution of 0.1arcsec (VIS), in IR photometry for the Y, J, H bands and in slitless spectroscopy between 1 and 2 microns (NISP). Euclid will be able to measure the gravitationally induced distortion of the apparent shapes of about one billion of galaxies (Weak Lensing), and Galaxy Clustering (BAO and RSD), using several tens of millions of spectroscopic redshift determinations and billions of photometric redshifts.

After a short introduction to the problem of the accelerated expansion of the Universe and Dark Energy the talk will illustrate the scientific objectives of Euclid and give an update of its current status, along with the expected results and foreseen precision and accuracy.

Primary author:  RENZI, Alessandro (INFN Padova)

Presenter:  RENZI, Alessandro (INFN Padova)

Session Classification:  Cosmology

Track Classification:  Cosmology
Neutrino astronomy uses large volume detectors to search for astrophysical neutrinos. Detectors such as IceCube at the Geographic South Pole and the Gigaton Volume Detector (GVD) at Lake Baikal instrument up to a cubic kilometer of fresh water or ice for measuring Cherenkov radiation created in neutrino-matter interactions. Using the clear water of the deep sea as the Cherenkov medium has so far always posed severe difficulties in deploying and maintaining the offshore infrastructure, although KM3NeT currently develops a detector of this type in the Mediterranean.

A collaboration of the Ocean Networks Canada (ONC), the University of Victoria, the University of Alberta, and the Technical University of Munich (TUM) is currently exploring possibilities for a future neutrino telescope located in the Pacific. 300km westerly of Victoria, the Cascadia Basin is a promising position for a cubic scale detector with a depth of 2600m. In June 2018, the collaboration deployed the Strings for Absorption Length in Water (STRAW) which monitor the optical conditions at the Cascadian Basin since then. In 2020, the deployment of STRAW-b, one 500m long string with 10 modules, is scheduled to test hardware and strategies for the 10-string array Pacific Ocean Neutrino Explorer.

We will give a brief overview and outlook of the three missions and present first results on the measurements at Cascadia Basin.

Primary authors: HOLZAPFEL, Kilian (Technical University of Munich (TUM)); RESCONI, Elisa (Technical University Munich)

Presenter: HOLZAPFEL, Kilian (Technical University of Munich (TUM))

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Search for narrow resonance in the Dijet Mass spectrum with the Run II dataset at CMS

Monday, 15 July 2019 18:30 (1h 30m)

The results for searches of narrow dijet resonances at high masses (above 1.8 TeV) will be presented with the full Run II dataset. The model independent cross section limits, as well as the interpretations under a variety of new physics models will be shown.

Primary authors: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE)); DIAMANTOPOULOU, Melpomeni (National and Kapodistrian University of Athens (GR))

Presenter: DIAMANTOPOULOU, Melpomeni (National and Kapodistrian University of Athens (GR))

Session Classification: Wine & Cheese Poster Session

Track Classification: Searches for New Physics
Search for wide resonances in the Dijet Mass spectrum with the Run II dataset at CMS

Monday, 15 July 2019 18:30 (1h 30m)

The results for searches of broad dijet resonances at high masses (above 1.8 TeV) will be presented with the full Run II dataset. The cross section limits for generic spin1 and spin2 quark-quark and gluon-gluon resonances will be presented. The coupling vs mediator mass limits will be also shown for a leptophobic $Z'$ that couples to quarks as well as DM particles.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: KARASAVVAS, Dimitrios (National and Kapodistrian University of Athens (GR))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Searching for Dark Matter with PICO-40L

Thursday, 11 July 2019 18:15 (15 minutes)

PICO is an experiment using bubble chambers with superheated $\text{C}_3\text{F}_8$ to detect nuclear recoils caused by WIMP dark matter. Due to their inherent electron recoil rejection and ability to probe spin-dependent interactions using fluorocarbon targets, bubble chambers have an established niche in the field of dark matter direct detection. PICO-60 set world-leading limits on the WIMP-proton interaction cross section, though was background limited and saw excess events at the interface between the water buffer and active fluid. PICO-40L is the next phase of the experiment employing a new "right-side-up" design to eliminate the buffer and thereby remove these backgrounds, in addition to providing a proof-of-concept for the future PICO-500 detector. PICO-40L is being installed in the spring of 2019 and is expected to be collecting data during the summer. This talk will provide an overview of the experiment and discuss the current status of PICO-40L.

Primary author:  Mr HARDY, Clarke (Queen’s University)
Presenter:  Mr HARDY, Clarke (Queen’s University)
Session Classification:  Dark Matter
Track Classification:  Dark Matter
New Outreach Initiatives in Canada with the McDonald Institute

Friday, 12 July 2019 10:15 (15 minutes)

Named after the 2015 Nobel Laureate in physics, the Arthur B. McDonald Canadian Astroparticle Physics Research Institute is a new initiative to create a network of Canadian astroparticle physics research talent through its home base at Queen’s University, 7 partner institutions, and 5 research facilities. Following the success of Art McDonald and the SNO collaboration, Canada recognized the value of forging deep collaboration between researchers and more effectively harnessing scientific knowledge creation for greater impact. In addition to establishing a research network across Canada, one of the primary objectives of the McDonald Institute is to inspire students and the general public through dynamic educational programs and captivating outreach activities. This talk will discuss these initiatives and describe the recent progress in bringing the latest research to the attention of the wider Canadian public through regular local events and live-streamed public talks.

Primary author: HARDY, Clarke (Queen’s University)
Presenter: HARDY, Clarke (Queen’s University)
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
The presence of a hot and dense medium, produced in ultra-relativistic heavy-ion collisions, is known to modify the parton shower evolution. Several observations of the resulting intra-jet activity show significant modifications of what can be considered as a medium-modified jet from a "vacuum" (proton-proton) reference. These modifications, generically known as jet quenching effects, are the result of the multiple interactions of the parton shower with the produced fast evolving quark-gluon plasma (QGP). Recent efforts have tried to assess the time dependence of jet quenching effects, with particular focus on late or early dynamics. In this talk, we show a novel tool that evaluates the full-time evolution of the jet, by applying jet grooming techniques to a fully re-clustered jet. The result can bring novel insights into the QGP expansion as well as shed some light on how to re-sum, in a consistent way, vacuum-like and medium-like emissions into a single parton shower evolution equation.


**Primary author:** APOLINARIO, Liliana (LIP (PT))

**Presenter:** APOLINARIO, Liliana (LIP (PT))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Performance of the SoLid reactor neutrino detector

Thursday, 11 July 2019 15:30 (15 minutes)

Submitted for the SoLid Collaboration

**Presenter:** MANZANILLAS, Luis (Centre National de la Recherche Scientifique (FR))

**Session Classification:** Detector R&D and Data Handling

**Track Classification:** Detector R&D and Data Handling
Results from the SoLid Experiment at the BR2 Reactor

Saturday, 13 July 2019 09:55 (15 minutes)

Submitted for the SoLid collaboration

Presenter:  MICHIELS, Ianthe (Universiteit Gent)
Session Classification:  Neutrino Physics
Track Classification:  Neutrino Physics
The Jiangmen Underground Neutrino Observatory (JUNO) is a neutrino medium baseline experiment in construction in China, with the main goal to determine the neutrino mass hierarchy and to measure several neutrino mass and mixing parameters with a precision at the sub-percent level. The JUNO detector consists of 20 ktons of liquid scintillator contained in a 35 m diameter acrylic sphere, instrumented by more than 18000 20-inch photomultiplier tubes (PMTs), and about 25600 3-inch small PMTs. The required energy resolution to discriminate between the normal and inverted neutrino mass hierarchies at a 3-4 sigma CL for about 6 years of data taking is 3% at an energy of 1 MeV. This puts strong constraints on the detector component quality.

The JUNO electronics system can be separated into mainly two parts: the front-end electronics system performing analog signal processing (the underwater electronics), and after 100 meters Ethernet cables, the backend electronics system, sitting outside water, consisting of the DAQ and the trigger. For the front-end part, the electronics are located very close to the PMTs in order to minimize the length of cables and maximize the signal to noise ratio. The incoming analog signals from the PMTs are digitized in the Global Control Unit (GCU), contained in a water-tight box. Each underwater box is connected to three PMTs. The GCU is a custom Field Programmable Gate Array (FPGA) board with 3 ADU and 3 HV units. The digital signal and trigger informations are forwarded to the dry electronics by means of 100 m CAT5 Ethernet cable. For the back-end electronics part, back-end cards (BEC) are used as concentrators to collect and compensate the incoming trigger request signals and an FPGA mezzanine card handles all trigger request signals. The signals from the various BECs are sent to 21 RMU (Reorganise&Multiplex Unit) cards, and their sum is forwarded to the CTU (Central Trigger Unit). The main challenge of the whole electronics system is the very strict criteria on reliability: a maximum of 0.5% failure over 6 years for the PMT full readout chain.

The overall picture of the main parts of the JUNO detector, as well as its electronics readout system will be presented in this talk.

**Primary authors:** YANG, Yifan (ULB); CLERBAUX, Barbara (ULB)

**Presenter:** CLERBAUX, Barbara (Universite Libre de Bruxelles (BE))

**Session Classification:** Detector R&D and Data Handling

**Track Classification:** Detector R&D and Data Handling
THE BACKEND ELECTRONICS CARDS OF THE JUNO EXPERIMENT

Monday, 15 July 2019 19:40 (20 minutes)

The Jiangmen Underground Neutrino Observatory (JUNO) is a next generation multi-purpose antineutrino detector currently under construction in Jiangmen, in China, with the main goal to determine the neutrino mass hierarchy, as well as several neutrino mass and mixing parameters with a precision at the sub-percent level. The reactor electron antineutrinos of two power plants at a baseline of 53 km will be detected in the central part of the detector, which consists of 20 kt of liquid scintillator contained in a 35 m diameter acrylic sphere. The central detector is instrumented by more than 18000 20-inch photomultiplier tubes (PMTs), and about 25600 3-inch small PMTs. Two veto systems are added to reduce the backgrounds. Data taking is expected to start at the end of 2021.

The JUNO electronics system is separated into mainly two parts: the front-end electronics system performing analog signal processing (the underwater electronics), and after 100 meters Ethernet cables, the backend electronics system, sitting outside water, consisting of the Back-End Cards (BEC), the DAQ and the trigger. For the front-end electronics, global control units (GCU) digitize the incoming analog signals, then store the data in a large local memory waiting for trigger decision, and send out event data corresponding to a certain trigger acknowledgement as well as trigger requests to the outside-water system.

The BECs are used as concentrators to collect and compensate the incoming trigger request signals. The FPGA mezzanine cards handle all trigger request signals, and send their sum to the trigger system over an optical fiber. In order to test all the communication channels of the BECs in an efficient and fast way, a common baseboard with interfaces to different mezzanine boards is designed. The common baseboard is built to monitor and control the bit error rate of a loop connecting two channels of the BEC through a 100 m Ethernet cable.

The poster presents the JUNO electronics system, with an emphasis of the backend electronics system and on the BECs: their design, the various prototypes built, the tests already performed.

Primary authors: PETITJEAN, Pierre-Alexandre (ULB); YANG, Yifan (ULB); CLERBAUX, Barbara (ULB)

Presenter: PETITJEAN, Pierre-Alexandre (ULB)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Non-reactor neutrino physics with the JUNO experiment

Monday, 15 July 2019 18:30 (1h 30m)

The Jiangmen Underground Neutrino Observatory (JUNO) is a next generation multi-purpose antineutrino detector currently under construction in Jiangmen, in China. The reactor electron antineutrinos of two power plants at a baseline of 53 km will be detected in the central part of the detector, which consists of 20 ktons of liquid scintillator contained in a 35 m diameter acrylic sphere. The central detector is instrumented by more than 18000 20-inch photomultiplier tubes (PMTs), and about 25600 3-inch small PMTs, with a total cathode coverage of about 77%. The required neutrino energy resolution is 3% at an energy of 1 MeV. This puts strong constraints on the detector component quality. Data taking is expected to start at the end of 2021.

The main goal of the JUNO experiment is to determine the neutrino mass hierarchy, as well as to measure several neutrino mass and mixing parameters with a precision at the sub-percent level, using reactor electron antineutrinos events. However, thanks to its large volume and precise neutrino energy measurement, JUNO will be able to tackle a wide range of neutrino physics topics and provides an ideal place to perform non-reactor neutrino measurements. This includes the study of solar neutrinos to improve our knowledge of matter effects on the oscillation processes and of the solar metallicity, and atmospheric neutrinos, to perform a complementary measurement of the neutrino mass hierarchy. A measurement of the flux of geoneutrinos will also be performed to shed light on the earth composition and formation, as well as the study of potential near-by supernovae explosions to contribute to characterize the supernovae explosion mechanism. Last but not least, a search for nucleon decays in a complementary way to the Cherenkov-based experiments will be performed.

The JUNO’s physics potential with the latest expectations for these non-reactor analyses will be described comprehensively in the talk.

Primary author: Prof. CLERBAUX, Barbara (ULB)
Presenter: Prof. CLERBAUX, Barbara (ULB)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
PDF Profiling Using the Forward-Backward Asymmetry in Neutral Current Drell-Yan

Thursday, 11 July 2019 18:00 (15 minutes)

Non-perturbative QCD effects from Parton Distribution Functions (PDF) at hadron colliders may be constrained by using high statistics Large Hadron Collider (LHC) data. Drell-Yan (DY) measurements in the Charged Current (CC) case provide one of the primary channels to do this, in the form of the lepton charge asymmetry. We investigate here the impact of measurements in Neutral Current (NC) DY data mapped in the Forward-Backward Asymmetry ($A_{FB}$) on PDF determinations, by using the open source fit platform xFitter. We find that $A_{FB}$ enables new PDF sensitivity and present results showing this in presence of a thorough uncertainty analysis.

**Primary authors:** ACCOMANDO, Elena (Università e INFN (IT)); Dr BERTONE, Valerio (Università degli studi di Pavia); FIASCHI, Juri (Westfälische Wilhelms-Universität Münster); Dr GIULI, Francesco (INFN e Universita Roma Tor Vergata (IT)); GLAZOV, Alexander (Deutsches Elektronen-Synchrotron (DE)); HAUTMANN, Francesco (Institute of Theoretical Physics); MORETTI, Stefano (Science and Technology Facilities Council STFC (GB)); ZENAIEV, Oleksandr (Hamburg University)

**Presenter:** Dr GIULI, Francesco (INFN e Universita Roma Tor Vergata (IT))

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Coherent Meson Production in the NOMAD Experiment

Friday, 12 July 2019 17:45 (15 minutes)

We present recent NOMAD measurements on neutrino-induced coherent production of $\pi^0$, $\rho^+$ and $\rho^0$ mesons. The NOMAD detector is based upon a low density design (0.1 g/cm$^3$) offering excellent momentum, energy and angular resolutions, which are well suited for the measurement of the coherent production processes.

The new NOMAD measurements are compared with different models for the coherent scattering off nuclei, in which all nucleons participate in the interaction and the nucleus recoils intact. These measurements can also provide a test of our understanding of the weak current at small momentum transfer, namely the PCAC and CVC hypotheses, which are used to model the processes. As a utilitarian application of the measurements, we will discuss the use of coherent $\pi$ and $\rho$ to provide constraints on neutrino fluxes and energy scales.

Primary authors: KULLENBERG, Chris (JINR (Joint Institute for Nuclear Research)); Prof. MISHRA, Sanjib (University of South Carolina)

Presenter: KULLENBERG, Chris (JINR (Joint Institute for Nuclear Research))

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Analysis framework for sensitivity studies of the SoLid experiment

Monday, 15 July 2019 18:30 (1h 30m)

The observation of the Reactor Antineutrino Anomaly, at the beginning of this decade, has revived the interest in short-baseline experiments that probe the disappearance of electron antineutrinos. In addition, the recent evidence for a distortion in the reactor antineutrino energy spectrum, seen by some of those short-baseline experiments, has questioned our current models even more.\n
The SoLid experiment is a reactor neutrino experiment that aims to resolve the anomaly and perform a precise spectral measurement using a novel detector design. Installed at a very short distance of \( \sim 6 - 10 \) m from the BR2 research reactor at SCK·CEN in Belgium, it will be able to search for sterile neutrino oscillations through the detection of low energy \( \bar{\nu}_e \). It will also exploit the high purity in \(^{235}\text{U}\) of the BR2 reactor fuel, to increase our knowledge on reactor flux models and trace the origin of the spectral distortion.\n
The first phase of SoLid has reached one year of data taking and the experiment will soon be able to present some initial results.\n
To fulfil its challenging goals, the SoLid collaboration needs to perform detailed reactor calculations and develop a dedicated analysis framework. This poster aims to review the simulation chain and analysis techniques needed to predict the measured antineutrino rates and spectra, to build the detector response matrix and to determine the experimental sensitivity and confidence limits using several fitting methods.

Primary author: Ms MICHIELS, Ianthe (Universiteit Gent)
Presenter: Ms MICHIELS, Ianthe (Universiteit Gent)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
The role of angular ordering condition in Parton Branching transverse momentum dependent (TMD) PDFs and DY transverse momentum spectrum at LHC

Thursday, 11 July 2019 14:30 (15 minutes)

We discuss the parton branching (PB) evolution equation for transverse momentum dependent (TMD) parton distribution functions (PDFs), especially we concentrate on the angular ordering constrain and its effect on the TMD distributions.

We discuss application of the PB TMDs to precise prediction of Drell-Yan transverse momentum spectrum at LHC, especially we stress the role of angular ordering in the low transverse momentum region.

We compare the PB implementation of the angular ordering condition with the Kimber-Martin-Ryskin-Watt (KMRW) and the Collins-Soper-Sterman (CSS) approaches, both at the analytical and numerical level.

Primary authors: HAUTMANN, Francesco (Institute of Theoretical Physics); KEERSMAEKERS, Lissa (University of Antwerp); VAN KAMPEN, Aron Mees (University of Antwerp); LELEK, Aleksandra (University of Antwerp (BE))

Presenter: LELEK, Aleksandra (University of Antwerp (BE))

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
A search for dark matter (DM) particles produced in association with a Higgs Boson, where the Higgs boson decays to pair of Z bosons and each Z decays to two leptons (e, μ) is presented. The experimental signature includes a Higgs boson produced together with large missing transverse energy. The study is performed using data collected in proton-proton collisions during 2016 with an integrated luminosity of 35.9 fb−1 at a center of mass energy of 13 TeV with the CMS experiment. Two simplified benchmark models are used for interpreting the results.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** ALY, Reham (Bari University - Italy)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
Distinguishing black hole microstates: bulk and boundary perspectives

Thursday, 11 July 2019 15:15 (22 minutes)

Within supergravity (the low energy effective theory of string theory) there exist non-singular, horizonless solutions, called fuzzballs, with asymptotic charges $M$, $J$, $Q$ coincident with the charges of a black hole. Two immediate questions arise: 1) Are these solutions viable candidates for microstates that make up the black hole entropy? 2) Can humans (asymptotic observers) distinguish between these solutions? In this talk I will report on our recent progress to answering these questions within the framework of AdS/CFT for a toy model for such microstate: an AdS generalization of the Damour-Solodukhin wormhole. In particular we calculate the quasi-normal modes in that geometry and relate them to poles of CFT correlators via the AdS/CFT dictionary. Then we study how close are these correlators to the thermal correlator (that is the standard black hole result) and comment on whether thermality bounds such as the eigenstate thermalization hypothesis allow for these solutions to enter in the black hole ensemble.

Primary authors:  Mr DIMITROV, Vasil (KU Leuven); Prof. VERCNOCKE, Bert (KU Leuven); Mr MIN, Vincent (KU Leuven); Dr MAYERSON, Daniel (CEA Saclay); Mr LEMMENS, Tom (KU Leuven)

Presenter:  Mr DIMITROV, Vasil (KU Leuven)

Session Classification:  Quantum Field and String Theory

Track Classification:  Quantum Field and String Theory
The legacy of the OPERA experiment on neutrino oscillations

Friday, 12 July 2019 17:25 (20 minutes)

The OPERA experiment has conclusively observed the appearance of tau neutrinos in the muon neutrino CNGS beam. High purity samples of nu-e, nu-mu and nu-tau charged current weak neutrino interactions, as well as neutral current weak interactions were isolated. In this talk recent results obtained using the full dataset to test the three-flavor neutrino oscillation model are discussed. Constraints on the existence of a light sterile neutrino, derived using for the first time tau and electron neutrino appearance channels, are also presented. A significant fraction of the sterile neutrino parameter space allowed by LSND and MiniBooNE experiments is excluded at 90% C.L. In particular, the best-fit oscillation parameter values obtained by MiniBooNE are excluded at 3.3 significance.

Primary author: OPERA COLLABORATION, (t.b.a.)
Presenter: GALATI, Giuliana
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Performance of Jets at the Higgs Factory, CEPC

After the Higgs discovery, precise measurements become vital for the experimental particle physics. A powerful Higgs factory, the Circular electron-positron Collider (CEPC), is proposed. The Particle Flow Oriented Detector Design and Reconstruction have been chosen as the Baseline for the CEPC CDR study. Our work reports the physics performance on jet reconstruction of the CEPC baseline design.

Primary author: LAI, Pei-Zhu (National Central University (TW))

Co-authors: RUAN, Manqi (Chinese Academy of Sciences (CN)); Dr LI, Gang (Institute of high energy physics); KUO, Chia-Ming (National Central University (TW))

Presenter: LAI, Pei-Zhu (National Central University (TW))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
In top quark production, the polarization of top quarks, decided by the chiral structure of couplings, is likely to be modified in the presence of any new physics contribution to the production. Hence the same is a good discriminator for those new physics models wherein the couplings have a chiral structure different than that in the Standard Model (SM). In this note we construct probes of the polarization of a top quark decaying hadronically, using easily accessible kinematic variables such as the energy fraction or angular correlations of the decay products. Tagging the boosted top quark using the usual jet sub structure technique we study robustness of these observables for a benchmark process, $W' \rightarrow t\bar{b}$. We demonstrate that the energy fraction of b-jet in the laboratory frame and a new angular variable, constructed by us in the top rest frame, are both very powerful tools to discriminate between the left and right polarized top quarks. Based on the polarization sensitive angular variables, we construct asymmetries which reflect the polarization. We study the efficiency of these variables for two new physics processes where which give rise to boosted top quarks:

(i) decay of the top squark in the context of supersymmetry searches, and
(ii) decays of the Kaluza-Klein (KK) graviton and KK gluon, in Randall Sundrum (RS) model.

Remarkably, it is found that the asymmetry can vary over a wide range about $+20\%$ to $-20\%$. The dependence of asymmetry on top quark couplings of the new particles present in these models beyond the SM (BSM) is also investigated in detail.

**Primary authors:** HOLUR VIJAY, Aravind; GUCHAIT, Monoranjan (Tata Institute of Fundamental Research (TIFR)); Dr LAHIRI, Jayita (Regional Centre for Accelerator-based Particle Physics); Dr K. KHOSA, Charanjit (Department of Physics and Astronomy, University of Sussex); GODBOLE, Rohini (Centre for Theoretical Studies (CTS)); SHARMA, Seema (Indian Institute of Science Education and Research (IN))

**Presenter:** HOLUR VIJAY, Aravind

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
CAPP-8TB: Search for Axion Dark Matter in a Mass Range of 6.62 to 7.04 μeV

Monday, 15 July 2019 18:30 (1h 30m)

The axion is a hypothetical particle proposed to solve the strong $CP$ problem, and also a candidate for dark matter. Galactic halo axions which are non-relativistic can be converted into photons under a strong magnetic field and detected with a microwave resonant cavity. Since P. Sikivie had proposed this experimental method, many experiments have excluded some mass regions with certain sensitivities in terms of axion-photon coupling ($g_{a\gamma\gamma}$) for decades, but no axion dark matter has been discovered to date. CAPP-8TB is yet another axion haloscope experiment at IBS/CAPP designed to search for the axion in a mass range of 6.62 to 7.04 μeV. The experiment aims for the most sensitive axion dark matter search in this particular mass range with its first-phase sensitivity reaching the QCD axion band. In this presentation, we discuss the overview of the experiment, and present the first result. We also discuss an upgrade of the experiment to achieve higher sensitivity.

Primary authors: Dr LEE, Soohyung (Institute for basic Science (KR)); Mr AHN, Saebyeok (Korea Institute of Science and Technology (KAIST)); Dr CHOI, Jihoon (Institute for Basic Science); Dr KO, Byeong Rok (Institute for Basic Science); Prof. SEMERTZIDIS, Yannis (IBS/CAPP and KAIST in Republic of Korea)

Presenter: Dr LEE, Soohyung (Institute for basic Science (KR))

Session Classification: Wine & Cheese Poster Session

Track Classification: Dark Matter
Status of the TORCH time-of-flight detector

Thursday, 11 July 2019 10:45 (15 minutes)

TORCH is a novel time-of-flight detector, designed to provide π/K particle identification up to 10 GeV/c momentum over a 10 m flight path. Based on the DIRC principle, Cherenkov photons are produced in a quartz plate of 10 mm thickness, where they propagate to the periphery of the plate by total-internal reflection. There the photons are focused onto an array of micro-channel plate photomultipliers (MCP-PMTs) which measure their arrival times and spatial positions. A time resolution of 70 ps per detected Cherenkov photon is expected, which results in a time-of-flight resolution of 15 ps, given typically 30 detected photons per track. To demonstrate the principle, a half-scale (660 × 1250 × 10 mm³) TORCH prototype module has been tested in a 5 GeV/c mixed proton-pion beam at the CERN PS. Customised 53 × 53 mm² MCP-PMTs of effective granularity 128 × 8 pixels have been employed, which have been developed in collaboration with an industrial partner. The single-photon timing performance and photon yields have been measured and are close to specification, demonstrating the TORCH concept. For a future application, a full-scale TORCH detector has been proposed for the LHCb Phase II Upgrade, which comprises 18 modules with 198 MCP-PMTs. Results will be reported on the simulated performance of the detector for high luminosity LHCb running in terms of π/K/p discrimination.

Primary authors: HADAVIZADEH, Tom (University of Oxford (GB)); BHASIN, Srishti (University of Bristol (GB)); BLAKE, Thomas (University of Warwick); Prof. BROOK, Nick (University of Bath); CONNEELY, Thomas (Photek LTD); CUSSANS, David (University of Bristol (GB)); FORTY, Roger (CERN); FREI, Christoph (CERN); GABRIEL, Emmy Pauline Maria (The University of Edinburgh (GB)); GAO, Rui (University of Oxford (GB)); GERSHON, Timothy (University of Warwick (GB)); GYS, Thierry (CERN); HANCOCK, Thomas Henry (University of Oxford (GB)); HARNEW, Neville (University of Oxford (GB)); KREPS, Michal (University of Warwick (GB)); MILNES, James (Photek Ltd); PIEDIGROSSI, Didier (CERN); RADEMACKER, Jonas (University of Bristol (GB)); VAN DIJK, Maarten (CERN)

Presenter: HADAVIZADEH, Tom (University of Oxford (GB))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
I present a viable two leptoquark model based on $SU(5)$ gauge symmetry that addresses the $B$-physics anomalies. The entire low-energy flavor structure of the set-up originates from two $SU(5)$ operators that relate Yukawa couplings of the two leptoquarks. The proposed scenario accommodates all measured lepton flavor universality ratios in $B$-meson decays, is consistent with related flavor observables, and is compatible with direct searches at the LHC. The model is self-consistently perturbative, provides gauge coupling unification, and predicts several yet-to-be-measured flavor observables. I also discuss prospects for future discoveries of the two leptoquarks at the LHC.
Searching for the stochastic background with Advanced LIGO and Virgo

Saturday, 13 July 2019 09:20 (20 minutes)

Detecting and characterizing the stochastic gravitational-wave background is a target for future ground-based gravitational-wave detectors. In this talk I will present an overview of a cross-correlation based analysis that has been applied to gravitational-wave data. I will then present upper limits obtained by Advanced LIGO and Advanced Virgo in the most recent observing run on isotropic and anisotropic stochastic backgrounds. I will discuss the implications of these results for models of the background from compact binaries and cosmic strings. Finally, I will discuss upper limits on correlated magnetic noise due to geophysical Schumann resonances, and comment on strategies to mitigate the effects of this noise in future runs.

Primary author: Dr MATAS, Andrew (Albert Einstein Institute, Potsdam-Golm)

Presenter: Dr MATAS, Andrew (Albert Einstein Institute, Potsdam-Golm)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Recent progress of the Baikal-GVD project

Thursday, 11 July 2019 10:40 (20 minutes)

Cubic kilometer scale neutrino telescope Baikal-GVD is currently under construction in Lake Baikal. The detector is specially designed for search for high energies neutrinos whose sources are not yet reliably identified. Since April 2019 the telescope has been successfully operated in complex of five functionally independent clusters i.e. sub-arrays of optical modules (OMs) where now are hosted 1440 OMs on 40 vertical strings. Each cluster is connected to shore by individual electro-optical cables. The effective volume of the detector for neutrino initiated cascades of relativistic particles with energy above 100 TeV has been increased up to about 0.25 km$^3$. Preliminary results in data analysis are discussed.

**Primary author:** SUVOROVA, Olga (Russian Academy of Sciences (RU))

**Presenter:** SUVOROVA, Olga (Russian Academy of Sciences (RU))

**Session Classification:** Astroparticle Physics and Gravitational Waves

**Track Classification:** Astroparticle Physics and Gravitational Waves
Soft drop thrust in lepton collisions

*Friday, 12 July 2019 16:45 (15 minutes)*

We discuss the status of determinations of the strong coupling with special attention to using event shape observables based on data collected at the Large Electron Positron collider and theoretical predictions at highest accuracy available at present. We argue that such extractions can be competitive with lattice determinations if the observables are selected carefully such that both higher order perturbative as well as non-perturbative contributions are suppressed. We give a list of such observables and study one particular class—the soft groomed event shapes—in detail. We present predictions for the soft drop thrust and study the scale dependence as a function of the grooming parameters.

**Primary authors:** Prof. TROCSANYI, Zoltan Laszlo (Eotvos Lorand University (HU)); KARDOS, Adam (University of Debrecen)

**Presenter:** Prof. TROCSANYI, Zoltan Laszlo (Eotvos Lorand University (HU))

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Superweak force

Monday, 15 July 2019 18:30 (1h 30m)

We summarize the current status of particle physics, collecting the established deviations from the standard model of particle interactions both at the energy and the intensity frontier as well as in cosmology. We propose a specific U(1) extension of the standard model of particle interactions and discuss the possible consequences of the model concerning the observed deviations. We present ways to constrain the parameter space of the model.

**Primary author:** Prof. TROCSANYI, Zoltan Laszlo (Eotvos Lorand University (HU))

**Presenter:** Prof. TROCSANYI, Zoltan Laszlo (Eotvos Lorand University (HU))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
Reconstruction of Physics Objects at the Circular Electron Positron Collider with Arbor

Monday, 15 July 2019 19:40 (20 minutes)

After the Higgs discovery, precise measurements become vital for the experimental particle physics. A powerful Higgs factory, the Circular electron-positron Collider (CEPC), is proposed. Adequate detector design and reconstruction algorithm are fundamental to this project. The Particle Flow oriented detector design is proposed to the CEPC and a Particle Flow algorithm, Arbor, is optimized accordingly. The performance of physics object reconstruction with Arbor algorithm and how this combination fulfills the physics requirement of CEPC will be presented.

Primary author: LAI, Pei-Zhu (National Central University (TW))
Co-authors: RUAN, Manqi (Chinese Academy of Sciences (CN)); LI, Gang (Institute of high energy physics); KUO, Chia-Ming (National Central University (TW))
Presenter: LAI, Pei-Zhu (National Central University (TW))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Evolution of Regional, Age and Gender Demographics in the ATLAS Collaboration

Friday, 12 July 2019 15:00 (15 minutes)

The ATLAS Collaboration consists of more than 5000 members, from about 100 different countries. This study presents data showing aspects of the regional, age and gender demographics of the collaboration, including the time evolution over the lifetime of the experiment. In particular the relative fraction of women is discussed, including their share of contributions, recognition and positions of responsibility, and showing how this depends on other demographic measures.

Primary author: WELLS, Pippa (CERN)
Presenter: SHAW, Kate (University of Sussex (GB))
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
Communicating ATLAS: adapting to an ever-changing media landscape

Friday, 12 July 2019 10:00 (15 minutes)

Communicating the status and achievements of the ATLAS Experiment has been a core objective of the ATLAS Collaboration since its founding. To match an ever-changing media landscape, ATLAS has tailored its communication strategy to produce content that effectively targets key audiences. The comprehensive approach of ATLAS communications is explored, with a focus on strategic themes, effective distribution channels, and message. The success of this approach is examined and the effect on user experience is evaluated.

Primary author: ANTHONY, Katarina (Università degli Studi di Udine (IT))
Presenter: ANTHONY, Katarina (Università degli Studi di Udine (IT))
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
Perform data analysis and visualisation on your own computer? Yes, you can! Commodity computers are now very powerful in comparison to only a few years ago. On top of that, the performance of today’s software and data development techniques facilitates complex computation with fewer resources. Cloud computing is not always the solution, and reliability or even privacy is regularly a concern. While the Infrastructure as a Service (IaaS) and Software as a Service (SaaS) philosophies are a key part of current scientific endeavours, there is a misleading feeling that we need to have remote computers to do any kind of data analysis. One of the aims of the ATLAS Open Data project is to provide resources — data, software and documents — that can be stored and executed in computers with minimal or non-internet access, and in as many different operating systems as possible. This approach is viewed as complementary to the IaaS/SaaS approach, where local university, students and trainers’ resources can be used in an effective and reproducible way — making the HEP and Computer Sciences fields accessible to more people. We present the latest developments in the production and use of local Virtual Machines and Docker Containers for the development of physics data analysis. We also discuss example software and Jupyter notebooks, which are in constant development for use in classrooms, and students’ and teachers’ computers around the world.

Primary author: SANCHEZ PINEDA, Arturo (Abdus Salam Int. Cent. Theor. Phys. (IT))

Presenter: HAALAND, Even Simonsen (University of Oslo (NO))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
Analytical results for hadronic contributions to the muon g-2

Friday, 12 July 2019 15:45 (15 minutes)

I will present a number of calculations relevant for hadronic contributions to the muon $g - 2$. These include issues relevant for the Light-by-light part, i.e. proper constraints on the short-distance part and understanding a number of aspects of pion-exchange, here with regards to the cancellation between connected and disconnected parts in lattice QCD, and the two-pion contribution. For the hadronic-vacuum-polarization part we present results at the two-loop order for connected/disconnected contributions and purely hadronic as well as electromagnetic finite volume corrections.


Primary author: Prof. BIJNENS, Johan (Lund University)
Presenter: Prof. BIJNENS, Johan (Lund University)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Probing the flavor of New Physics with dipoles

Friday, 12 July 2019 18:10 (20 minutes)

Dipole operators encode a rich variety of phenomena, such as radiative decays and electric dipole moments in both quark and lepton sectors, which probe physics beyond the Standard Model up to very high energy scales. Through renormalization, non-dipole operators mix into dipole ones, thus possibly generating observable effects that can be investigated by those same phenomena. I will discuss the calculation of this mixing in cases where the leading order effect happens at two-loops (i.e., when one-loop effects vanish), and the phenomenological consequences for flavor and CP violation coming from New Physics described by operators of dimension six.

Primary authors: VALE SILVA, Luiz; JAGER, Sebastian (Unknown); Ms LESLIE, Kirsten (University of Sussex)

Presenter: VALE SILVA, Luiz

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Latest measurement of $K^+ \to \pi^+ \bar{\pi}$ with the NA62 experiment at CERN

Thursday, 11 July 2019 17:30 (20 minutes)

The decay $K^+ \to \pi^+ \bar{\pi}$, with a very precisely predicted branching ratio of less than $10^{-10}$, is one of the best candidates to reveal indirect effects of new physics at the highest mass scales. The NA62 experiment at the CERN SPS is designed to measure the branching ratio of the $K^+ \to \pi^+ \bar{\pi}$ with a decay-in-flight technique. NA62 took data so far in 2016-2018. Statistics collected in 2016 allowed NA62 to reach the Standard Model sensitivity for $K^+ \to \pi^+ \bar{\pi}$, entering the domain of $10^{-10}$ single event sensitivity and showing the proof of principle of the experiment. Thanks to the statistics collected in 2017, NA62 surpasses the present best sensitivity. The analysis strategy is reviewed and the preliminary result from the 2017 data set is presented.

**Primary authors:** CENCI, Patrizia (INFN Perugia (IT)); RUGGIERO, Giuseppe (Lancaster University (GB))

**Presenter:** LURKIN, Nicolas (University of Birmingham (GB))

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Searches for lepton flavour and lepton number violation in K+ decays

Thursday, 11 July 2019 17:50 (20 minutes)

The NA62 experiment at CERN collected a large sample of charged kaon decays into final states with multiple charged particles in 2016-2018. The sensitivity to a range of lepton flavour and lepton number violating kaon decays provided by this data set improves over the previously reported measurements. Results from the searches for these processes with a partial NA62 data sample are presented.

Primary authors: CENCI, Patrizia (INFN Perugia (IT)); ROMANO, Angela (University of Birmingham (GB))

Presenter: ROMANO, Angela (University of Birmingham (GB))

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Search for an invisible vector boson from $\pi^0$ decays at NA62

Friday, 12 July 2019 10:15 (15 minutes)

The high-intensity setup, trigger system flexibility, and detector performance – high-frequency tracking of beam particles, redundant PID, ultra-high-efficiency photon vetoes – make NA62 particularly suitable for searching for new-physics effects from different scenarios. We report the results of a search for $\pi^0$ decays to one photon and an invisible massive dark photon. From a total of about 400 million $\pi^0$ decays, no signal is observed beyond the expected fluctuation of the background and limits are set in the plane of the dark photon coupling to ordinary photon versus dark photon mass. The analysis has been also interpreted in terms of the branching ratio (BR) for the electro-weak decay $\pi^0 \rightarrow \gamma vv^\dagger$: the null result implies a limit on the BR at the level of $2 \times 10^{-7}$.

The latest results and the NA62 sensitivity for production and decay searches of Dark Photons, Heavy Neutral Lepton and Axion-Like Particles will be reviewed, together with prospects for future data taking at the NA62 experiment.

Primary authors: CENCI, Patrizia (INFN Perugia (IT)); MINUCCI, Elisa (INFN e Laboratori Nazionali di Frascati (IT))

Presenter: MINUCCI, Elisa (INFN e Laboratori Nazionali di Frascati (IT))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
First observation and study of the $K^\pm \rightarrow \pi^\pm \pi^0 e^+ e^-$ decay with the NA48/2 experiment at CERN

Thursday, 11 July 2019 18:10 (20 minutes)

The NA48/2 experiment at CERN reports the first observation of the $K^\pm \rightarrow \pi^\pm \pi^0 e^+ e^-$ decay from an exposure of $1.7 \times 10^{11}$ charged kaon decays recorded in 2003–2004. A sample of 4919 candidates with 4.9% background contamination allows the determination of the branching ratio in the full kinematic region. The study of the kinematic space shows evidence for a structure dependent contribution in agreement with predictions based on chiral perturbation theory. Several P- and CP-violating asymmetries are also evaluated.

**Primary authors:** CENCI, Patrizia (INFN Perugia (IT)); ANZIVINO, Giuseppina (INFN and University of Perugia)

**Presenter:** ANZIVINO, Giuseppina (INFN and University of Perugia)

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
Searching for the critical point of strongly interacting matter in nucleus-nucleus collisions at CERN SPS

Saturday, 13 July 2019 11:30 (18 minutes)

One of the primary goals of the NA61/SHINE experiment at CERN SPS is the detection of the critical point (CP) of strongly interacting matter. In the interests of this search, an energy (beam momentum 13A – 150A GeV/c) and system size (p+p, p+Pb, Be+Be, Ar+Sc, Xe+La) scan is being performed.

A number of observables are being considered as possible signatures of the CP. These include non-monotonic fluctuations of strongly intensive variables ($\Delta[p_T, N]$, $\Sigma[p_T, N]$), which so far show no prominent CP-related structures; and local fluctuations of the proton density, which are especially suited for the task, being connected to the critical behavior of the chiral phase transition order parameter in the neighborhood of the CP. In particular, proton density fluctuations are probed by means of an intermittency analysis of the proton second scaled factorial moments (SSFMs) in transverse momentum space, expected by universality theory to scale as a power-law in the vicinity of the CP.

A previous analysis of this sort probed a number of NA49 heavy ion collisions of different size \[T.\] significant power-law fluctuations were observed in "Si"+Si collisions at 158A GeV/c, with a power-law exponent consistent with the theoretically expected critical value, within uncertainties. Recently, NA61/SHINE Be+Be collisions at 150A GeV/c were similarly probed, yielding a negative result.

We now extend the analysis to NA61/SHINE Ar+Sc collisions at 150A GeV/c. The system size and freeze-out baryochemical potential are similar to NA49 "Si"+Si, and preliminary analysis suggests the presence of intermittency. We employ statistical techniques in order to subtract non-critical background present in factorial moments and enhance the signal in cases of low statistics. Through combined use of critical and background Monte Carlo simulations, we assess the quality and statistical significance of the observed intermittency effect.


**Primary author:** Dr DAVIS, Nikolaos (Polish Academy of Sciences (PL))

**Presenter:** Dr DAVIS, Nikolaos (Polish Academy of Sciences (PL))

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Improved Measurement of the Reactor Antineutrino Flux at Daya Bay

Monday, 15 July 2019 18:30 (1h 30m)

Using four near and four far functionally identical antineutrino detectors, the Daya Bay Reactor Neutrino Experiment measures the antineutrino flux and spectrum from six commercial reactor cores. I will report a new precise measurement of the reactor antineutrino flux using 2.2 million inverse beta decay (IBD) events collected with the Daya Bay near detectors in 1230 days. The dominant uncertainty on the neutron detection efficiency is reduced by 56% with respect to the previous measurement through a comprehensive neutron calibration and detailed data and simulation analysis. The new average IBD yield is determined to be \((5.91 \pm 0.09) \times 10^{-43} \text{ cm}^2/\text{fission}\), which is \(0.952 \pm 0.014 \text{ (exp.) } \pm 0.023 \text{ (model)}\) of the Huber-Mueller model prediction, confirming the discrepancy between the world average of reactor antineutrino flux and the Huber-Mueller model. The mean fission fractions from the four main fission isotopes \(^{235}\text{U}, \, ^{238}\text{U}, \, ^{239}\text{Pu}, \, \text{and} \, ^{241}\text{Pu}\) will also be presented.

**Primary author:** Prof. CHU, Ming-chung (The Chinese University of Hong Kong)

**Presenter:** Prof. CHU, Ming-chung (The Chinese University of Hong Kong)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Neutrino Physics
We consider in this work a Slotheon scalar field for Dark Energy. A Slotheon field is inspired by extra dimensional models of Dvali, Gabadadze and Porrati (DGP) related to brane world. In the decoupling limit of this model, the DGP theory in Minkowski space-time is described by a scalar field that obeys a shift symmetry. When extended to curved space time this scalar field is termed as Slotheon field. In this work we calculate general relativistic perturbations by deriving the Dark Energy and matter perturbation equations and solve them numerically. The results are then compared with similar quantities derived from LambdaCDM model. It appears that the Slotheon field model for Dark Energy is more akin to Dark energy in LambdaCDM model than that in standard Quintessence model. A comparison has also been made between the matter power spectra obtained from Slotheon model and LambdaCDM model.
New Physics interpretations with GAMBIT

Thursday, 11 July 2019 12:00 (15 minutes)

I will present recent results from the Global and Modular Beyond-the-Standard-Model Inference Tool (GAMBIT) collaboration. Global fits with GAMBIT have been carried out on many models including supersymmetric models, scalar singlet dark matter, fermionic and vector Higgs portal dark matter and axions. In this talk I will focus on our most recent study interpreting collider constraints on electroweakinos (arXiv:1809.02097). First we show that when the neutralinos and charginos are the only light states of the MSSM, there are scenarios which evade LHC constraints for any mass of the lightest neutralino and the lightest chargino, i.e. the profile likelihood shows no constraint in this plane when one only considers the possibility of excluding new physics. Intriguingly, in addition we also find that excesses in the data can lead to closed contours, indicating a preference for light neutralinos and charginos over the standard model. We find the excess has a local significance of 3.3 sigma when combining ATLAS and CMS 13 TeV searches, which drops to 2.9 sigma when including 8 TeV searches as well.

Primary authors:  ATHRON, Peter; GAMBIT COLLABORATION

Presenter:  ATHRON, Peter

Session Classification:  Searches for New Physics

Track Classification:  Searches for New Physics
A Novel Approach to Calorimeter-based Particle Identification at the Belle II Experiment using Scintillator Pulse Shape Discrimination

We present an innovative new approach to calorimeter-based particle identification at the Belle II experiment through the application of CsI(Tl) Pulse Shape Discrimination. By instrumenting the 8736 CsI(Tl) crystals in the Belle II calorimeter with new electronics that enable online CsI(Tl) waveform digitization and readout, during the first run of SuperKEKB collision data-taking in summer 2018 Belle II was the first B-Factory experiment to apply CsI(Tl) pulse shape discrimination to improve particle identification. With control samples of $e^\pm$, $\mu^\pm$, $\pi^\pm$, $K^\pm$ and $p/\bar{p}$ selected from collision data, we demonstrate through offline analysis of the waveform pulse shapes that hadronic interactions in the calorimeter crystals can be identified and distinguished from energy deposits produced by electromagnetic showers and minimum-ionizing particles. By applying pulse shape discrimination we are able to improve challenging and important areas of charged particle identification such as low momentum ($0.3 - 1$ GeV/c) $\mu$ vs $\pi$ separation. In addition with control samples of photon’s and $K^0_L$’s isolated from Belle II collision data, we demonstrate that high efficiency $K^0_L$ identification with low photon fake-rates can be achieved through the unique information provided by pulse shape discrimination. The potential impact of pulse shape discrimination on improving planned physics analysis at Belle II will also be discussed.

Primary authors: LONGO, Savino (University of Victoria); RONEY, Michael (University of Victoria)
Presenter: LONGO, Savino (University of Victoria)
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
Deformed relativistic kinematics, expected to emerge in a flat-spacetime limit of quantum gravity, predicts the Planck-scale violation of discrete symmetries, in particular the CPT symmetry. Momentum-dependent deformations of the action of CPT are derived from the kappa-deformed Poincare algebra.

In this approach, deformation of CPT symmetry leads to a subtle violation of Lorentz symmetry. This entails some small but measurable phenomenological consequences, as corrections to characteristics of time evolution: particle lifetimes or oscillations in two-particle states at high energy. We argue that using current experimental precisions on the muon lifetime or quark flavour oscillations in systems of neutral mesons we can bound kappa > $10^{14}$ GeV at LHC energy and move this limit to $10^{16}$ GeV at Future Circular Collider.

**Primary author:** Prof. WISLICKI, Wojciech (National Centre for Nuclear Research)

**Presenter:** Prof. WISLICKI, Wojciech (National Centre for Nuclear Research)

**Session Classification:** Cosmology

**Track Classification:** Astroparticle Physics and Gravitational Waves
DANAE – Evaluating the potential to directly search for Dark Matter-electron scattering with a DEPFET-RNDR matrix

Monday, 15 July 2019 18:30 (1h 30m)

The direct search for dark matter (DM) at the sub-GeV/c² mass scale gained special interest during the last years, mainly motivated by various theoretical models. To search for individual DM-electron interactions in Si-semiconductor devices a readout noise level of less than 1e⁻ RMS is required.

One possible technique which promise a sub-electron noise level is the Depleted P-channel Field Effect Transistor (DEPFET) with Repetitive Non Destructive Readout (RNDR). Such a low noise level was successfully demonstrated with a single pixel DEPFET-RNDR prototype [1]. The follow-up project DANAE aims to apply the DEPFET-RNDR technique to the direct search for DM-electron interactions.

A prototype detector matrix of 64x64 pixels was developed at the Semiconductor Laboratory of the Max Plank Society (HLL) in Munich. The specially designed control and readout electronic for the matrix were successfully tested. A dedicated test stand, which is able to cool down the detector to around -100°C and provide a simple shielding against ambient background, was assembled at HLL.

It is envisage to finish the currently ongoing integration until end of May 2019.

With an operational DANAE prototype, we plan to evaluate the performance of the DEPFET-RNDR matrix in comparison with the previous published performance of a single DEPFET-RNDR pixel [1].

A further objective it to optimize the operation conditions of the detector matrix. A special focus will be the study of the temperature dependence of the leakage count rate and its minimization via an optimal operation temperature.

In this contribution, we will introduce the DEPFET-RNDR technique and the DANAE project. Afterwards, the status of the ongoing R&D work will be reported and latest results from the ongoing test measurements will be presented. Finally, we will discuss future prospects of DANAE.


Primary author: KLUCK, Holger (Technische Universität Wien)

Co-authors: BÄHR, Alexander (Halbleiterlabor der Max-Planck-Gesellschaft); NINKOVIC, Jelena (Halbleiterlabor der Max-Planck-Gesellschaft); SCHIECK, Jochen (Austrian Academy of Sciences (AT)); SHI, Hexi (Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften); TREIS, Johannes (Halbleiterlabor der Max-Planck-Gesellschaft)

Presenter: SCHIECK, Jochen (Austrian Academy of Sciences (AT))

Session Classification: Wine & Cheese Poster Session

Track Classification: Dark Matter
Improved determination of Vus with tau decays

Saturday, 13 July 2019 12:40 (20 minutes)

We present improved determinations of |Vus| with tau decays relying on the HFLAV tau branching fractions global fit results. The HFLAV results are to be included in the 2019 HFLAV report and use the recent new BaBar measurements of:

- the branching fractions of the processes \( \tau^- \to K^- n\pi^0 \nu_{\tau} \) with \( n=1,2,3 \) and \( \tau^- \to \pi^- n\pi^0 \nu_{\tau} \) with \( n=3,4 \);
- the branching fraction \( \tau^- \to K^- \bar{K}_S^0 \nu_{\tau} \);

which were not included in the Spring 2017 HFLAV report.

**Primary author:** LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

**Presenter:** LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

**Session Classification:** Flavour Physics and CP Violation

**Track Classification:** Flavour Physics and CP Violation
MSW effects on the time evolution of the supernova neutrino event rates

Monday, 15 July 2019 18:30 (1h 30m)

The flavour transition mechanisms of supernova neutrinos as they propagate outward from the deep inside of the supernova are yet to be determined. We study the time-evolution patterns of different neutrino flavours in various flavour transition scenarios. With simulation data of supernova neutrinos, we calculate the neutrino event rates at different kinds of detectors for different flavour transition scenarios. Using the calculated event rates of electron neutrinos in liquid argon detectors, event rates of electron anti-neutrinos (IBD) and proton elastic scatterings in liquid scintillation detectors, we calculate two ratios by dividing the first two flavour dependent event rates by the flavour blind proton elastic scatterings event rates for the entire duration of the supernova explosion. We find that in different flavour transition scenarios, the time evolution of these ratios exhibits different patterns, which can be clearly distinguished from one another.

Primary authors: Mr LEUNG, Chun Sing Jason (National Chiao Tung University, Taiwan); Prof. LIN, Guey-Lin (National Chiao Tung University, Taiwan); Prof. LAI, Kwang-Chang (Chang Gung University, Taiwan)

Presenter: Mr LEUNG, Chun Sing Jason (National Chiao Tung University, Taiwan)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Water Cherenkov detector of the JUNO Veto System

Monday, 15 July 2019 19:40 (20 minutes)

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector with primary physics goal of neutrino mass hierarchy determination and other measurements, including precise neutrino oscillation parameters, solar neutrino, geo-neutrino, supernova neutrinos and the diffuse supernova neutrinos background. The detector will be built in 700m deep underground laboratory. A multi-veto system will be built for cosmic muon detection and background reduction. The outer of the central detector is filled with water and equipped with ~2400 MCP-PMTs (20 inches) to form a Water Cherenkov Detector for muon tagging. Both around the water Cherenkov detector and the central detector external surface are coated with Tyvek reflector to increase the light collection efficiency. The muon detection efficiency is >95% for Water Cherenkov Detector. With this veto system, the cosmic muon induced fast neutron background can be reduced at the level of ~0.1/day.

Primary authors: Prof. WANG, Ruiguang (IHEP); Mr LU, Haoqi (IHEP); Prof. YANG, Changgen (IHEP)

Presenter: Prof. WANG, Ruiguang (IHEP)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
Beam-Beam Effects and Parameter Optimization for FCC-ee

Saturday, 13 July 2019 09:45 (25 minutes)

FCC-ee is a double-ring $e^+e^-$ collider to be operated in the range of collision energies from Z-pole (91 GeV) to $t\bar{t}$ (up to 365 GeV). The design of FCC-ee aims to achieve a very high luminosity, which only a crab waist collision scheme can provide. Simulations for the FCC-ee revealed new types of beam instability associated with large Piwinski angle and beamstrahlung, that may limit the collider performance. A dedicated parameter optimization allows to solve these problems. We will discuss the features of beam-beam interaction for the FCC-ee and the choice of main parameters for maximum luminosity at different energies.

Primary author:  Dr SHATILOV, Dmitry (Budker Institute of Nuclear Physics (RU))
Presenter:  Dr SHATILOV, Dmitry (Budker Institute of Nuclear Physics (RU))
Session Classification:  Accelerators for HEP
Track Classification:  Accelerators for HEP
On the correlations of polarizations in the system of two photons produced in hadronic decays

Monday, 15 July 2019 18:30 (1h 30m)

The theoretical study of correlations of the linear and circular polarizations in the system of two photons has been performed. The polarization of a two-photon state is described by the one-photon Stokes parameters and by the components of the correlation "tensor" in the Stokes space. It is shown that the correlations between the Stokes parameters in the case of the two-photon decays $\pi^0 \rightarrow 2\gamma$, $\eta \rightarrow 2\gamma$, $K_L^0 \rightarrow 2\gamma$, $K_S^0 \rightarrow 2\gamma$ and the cascade process $|0\rangle \rightarrow |1\rangle + \gamma \rightarrow |0\rangle + 2\gamma$ ($|0\rangle$ and $|1\rangle$ are states with the spin 0 and 1, respectively) have the purely quantum character: the incoherence inequalities of the Bell type for the components of the correlation "tensor", established previously for the case of classical "mixtures", are violated (i.e. there is always one case when the modulus of sum of two diagonal components of the correlation "tensor" exceeds unity). The general analysis of the registration procedure for the system of two correlated photons by two one-photon detectors is performed.

Primary author: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)

Co-author: Dr LYUBOSHITZ, Vladimir (Joint Institute for Nuclear Research, Dubna)

Presenter: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
Spectrum of relative momenta of the neutron and proton at the deuteron peripheral breakup in the limit of very low momentum transfer

In the limit of very low momentum transfer to one of the nucleons, the analytical expression for the spectrum $dW(k)$ of relative momenta $k$ of the neutron and proton, produced at the deuteron peripheral breakup, is obtained taking into account the $S$-wave function of the deuteron. It should be stressed that namely this formula for $dW(k)$ describes the spectrum of relative momenta of nucleons at the deuteron dissociation in the Coulomb field of charged particles (in particular – heavy nuclei). Using the well-known Hulthen form of the deuteron $S$-wave function, the explicit calculation of the spectrum $dW(k)$ has been performed. Finally, corrections due to the deuteron $D$-wave state are briefly analyzed.

Primary author: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)
Co-author: Dr LYUBOSHITZ, Vladimir (Joint Institute for Nuclear Research, Dubna)
Presenter: Dr LYUBOSHITZ, Valery (Joint Institute for Nuclear Research, Dubna)
Session Classification: Wine & Cheese Poster Session
Track Classification: QCD and Hadronic Physics
Implications for New Physics in $b \to s\mu\mu$ transitions after recent measurements by Belle and LHCb

Saturday, 13 July 2019 11:20 (20 minutes)

We present a Bayesian analysis of the implications for new physics in semileptonic $b \to s$ transitions after including new measurements of $R_K$ at LHCb and new determinations of $R_{K^*}$ and $R_{K^{*+}}$ at Belle. We perform global fits with 1, 2, 4, and 8 input Wilson coefficients, plus one CKM nuisance parameter to take into account uncertainties that are not factorizable. We infer the 68\% and 95.4\% credibility regions of the marginalized posterior probability density for all scenarios and perform comparisons of models in pairs by calculating the Bayes factor given a common data set. We then proceed to analyzing a few well-known BSM models that can provide a high energy framework for the EFT analysis. These include the exchange of a heavy $Z'$ boson in models with heavy vector-like fermions and a scalar field, and a model with scalar leptoquarks. We provide predictions for the BSM couplings and expected mass values.

Primary author: Dr KUMAR, Dinesh (National Centre for Nuclear Research, Warsaw)

Co-authors: SESSOLO, Enrico Maria (NCBJ, Warsaw); Dr KOWALSKA, Kamila (National Centre for Nuclear Research, Warsaw, Poland)

Presenter: Dr KUMAR, Dinesh (National Centre for Nuclear Research, Warsaw)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Measurement of top-Higgs Yukawa coupling in tHq process with CMS

Probing the top-Higgs Yukawa coupling precisely is currently one of the important mandates of the LHC experiments. While the magnitude of this coupling can be determined by studying the Higgs production with top anti-top pair, the sign can be estimated using production of Higgs boson in association with a single top quark. The data collected at the LHC is not yet sensitive to the process, since, in Standard Model the rate is very low. However an anomalous coupling can enhance the production rate. Results will be presented from the analysis performed so far with LHC data by CMS collaboration along with the future prediction for constraining the coupling.

Primary author: MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))
Presenter: DAS, Pallabi (Tata Inst. of Fundamental Research (IN))
Session Classification: Wine & Cheese Poster Session
Track Classification: Higgs Physics
Unravelling Cosmic Acceleration with Gravitational Waves and Large-Scale Structure

Identifying the nature of the late-time accelerated expansion of our Universe remains a difficult puzzle to cosmology. Scalar-tensor modifications of gravity have long been considered as an alternative explanation to the cosmological constant. I will first discuss how the direct detection of gravitational waves and the measurement of electromagnetic counterparts, confirming a luminal speed of gravity, in combination with observations of the large-scale structure brought the anticipated challenge to the concept of cosmic self-acceleration from scalar-tensor gravity. I will then provide an outlook of how a more general model space will ultimately only be exhaustively probed by Standard Sirens. In a second part, I will show how a simple additional variation of the standard Einstein-Hilbert action with respect to the Planck mass may solve both the old and new cosmological constant problems. The additional variation yields a topological constraint that prevents vacuum energy from gravitating and when accounting for the nonlinear structure formation predicts a current energy density parameter of the cosmological constant of $\Omega_\Lambda = 0.704$, in good agreement with observations.

**Primary author:** Prof. LOMBRISER, Lucas (University of Geneva)

**Presenter:** Prof. LOMBRISER, Lucas (University of Geneva)

**Session Classification:** Cosmology

**Track Classification:** Cosmology
Orbital angular momentum in photon-photon scattering

Thursday, 11 July 2019 16:50 (20 minutes)

Photon-photon scattering in vacuum is one of the oldest and most intriguing predictions of quantum electrodynamics, as it would confirm what is called "vacuum polarization" and change our perception of the electromagnetic vacuum. However, experimental verification of scattering between real photons in vacuum hasn’t materialized yet. This is due, in part, to the relative weakness of this interaction. Several proposals have been put forth to attempt to detect this effect, including using high-power lasers which compensate the relatively low energy of their photons with the ultra-high intensities they can achieve. With the advent of new multi-petawatt laser facilities, such as ELI and APOLLON, an experiment to detect photon-photon scattering using high-power lasers is looking increasingly feasible. However, these types of experiments still need to find a way to increase the relatively low signal-to-noise ratio caused by the large amount of background radiation coming from unwanted effects such as inverse Compton scattering. To this end, we have investigated the effect of orbital angular momentum (OAM) on elastic photon-photon scattering in vacuum for the first time. We defined exact solutions to the vacuum electromagnetic wave equation which carry OAM. Using those, the expected coupling between three initial waves has been derived in the framework of an effective field theory based on the Euler-Heisenberg Lagrangian which has shown that OAM adds a signature to the generated photons thereby greatly improving the signal-to-noise ratio. This forms the basis for a proposed high-power laser experiment utilizing quantum optics techniques to filter the generated photons based on their OAM state. This would allow the detection of these rare scattering events on the previously mentioned multi-petawatt systems thereby finally providing experimental proof for elastic photon-photon scattering in vacuum.

Primary author: Mr ABOUSHELBAHA, Ramy (Ramy)

Co-authors: Dr GLIZE, Kevin (Central Laser Facility); Mr SAVIN, Alexander (University of Oxford); Mr MAYR, Marko (University of Oxford); Mr SPIERS, Benjamin (University of Oxford); Mr WANG, Robin (University of Oxford); Dr TRINES, Raoul (Central Laser Facility); Dr COLLIER, John (Central Laser Facility); Prof. MARKLUND, Mattias (Chalmers University); Prof. BINGHAM, Robert (Strathclyde University); Prof. NORREYS, Peter (University of Oxford)

Presenter: Mr ABOUSHELBAHA, Ramy (Ramy)

Session Classification: Quantum Field and String Theory

Track Classification: Quantum Field and String Theory
Snapshots of fireballs at freeze-out from heavy-ion collisions at different energies

*Thursday, 11 July 2019 15:42 (18 minutes)*

Identified hadron spectra from relativistic heavy-ion collisions allow one to reconstruct the final state of the fireball. In principle, one could deduce its previous evolution from a back extrapolation of the final state. It is also important to study the collisions at different energies, since hot matter at different energy and baryon densities is created that way. One is then interested in any irregularities of the collision energy dependence that might indicate the onset of deconfinement or the vicinity of the critical point.

We reconstruct the freeze-out state of the fireball produced in central Au+Au or Pb+Pb collisions in the energy range from 7.7 GeV up to 2760 GeV per colliding nucleon pair. The data stem from the RHIC beam energy scan programme and from the LHC. Transverse momentum spectra of protons, antiprotons, charged pions and kaons have been fitted with the blast-wave model that includes production via resonance decay. We present how the composition of spectra looks at different energies as a function of the transverse momentum. The freeze-out temperature decreases with increasing collision energy, while the transverse expansion velocity grows. The decrease of the freeze-out temperature seems to stop at the collision energy of 130 GeV; afterwards the temperature stays constant or grows slightly.

**Primary authors:** Prof. TOMÁŠIK, Boris (Matej Bel University); Dr MELO, Ivan (University of Žilina)

**Presenter:** Dr MELO, Ivan (University of Žilina)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Beauty in Particle Physics

Friday, 12 July 2019 12:45 (15 minutes)

Particle physicists are sometimes described as Platonists, referring to their belief that the ultimate explanation of the Universe must possess beauty. Since scientists in other fields are more sceptical about the role of beauty in science, HEP physicists are in a unique position: we know there is beauty in the fundamental laws that we discovered and this is a great message that we could share with the public. I will give a short sample of ideas of renown physicists about relation of truth and beauty, discuss beauty criteria and show examples that could appeal to young generation. I also compare scientific and artistic beauty. This topic was inspired by the panel discussions on beauty in physics the author coordinated during IPPOG meetings. A short talk on this topic was well received by the high school audience at the 2019 International Masterclasses.

Primary author: Dr MELO, Ivan (University of Žilina)
Presenter: Dr MELO, Ivan (University of Žilina)
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
KaTie is a parton level event generator that can deal with space-like initial-state partons, which occur in factorization prescriptions for hadron scattering that involve non-vanishing momentum components transverse to scattering hadrons. Improved transverse momentum dependent factorization (ITMD) is such a prescription. It allows to include saturation effects into hadron collisions in a consistent and gauge invariant manner, and for a large range of values for the transverse momentum. It requires a non-trivial treatment of the color structure of hard matrix elements, the implementation of which into KaTie is presented.
Understanding charm CP

Thursday, 11 July 2019 15:10 (20 minutes)

Recently LHCb announced the exciting discovery of direct CP asymmetry in D0 decays to K-pairs and pion pairs around 15×10⁻⁴. It is extremely difficult to do reliable calculations for the expectations from the SM for these asymmetries because of large non-perturbative effects. However, a novel mechanism is proposed to help us understand roughly the size of the asymmetry and the key idea readily leads to several testable predictions. Moreover, even though the original amplitudes for D⁰ → h⁺ h⁻ are extremely difficult to handle on the lattice using known techniques, a class of reactions with sizeable direct CP asymmetries where precise tests of the SM are possible will be discussed.

Primary author: SONI, AMARJIT (BNL)
Presenter: SONI, AMARJIT (BNL)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Performance of the Belle II Silicon Vertex Detector

Monday, 15 July 2019 19:40 (20 minutes)

The Belle II experiment at the SuperKEKB collider of KEK (Japan) will accumulate 50 ab\(^{-1}\) of \(e^+e^-\) collision data at an unprecedented instantaneous luminosity of \(8 \cdot 10^{35}\) cm\(^{-2}\)s\(^{-1}\), about 40 times larger than its predecessor. The Belle II vertex detector plays a crucial role in the rich Belle II physics program, especially for time-dependent measurements. It consists of two layers of DEPFET-based pixels and four layers of double sided silicon strip detectors (SVD). The vertex detector has been recently completed and installed in Belle II for the physics run started in spring 2019. We report here results on the commissioning of the SVD and its performance measured with the first collision data set.

Primary author: SCHWANDA, Christoph (Austrian Academy of Sciences (AT))
Presenter: PALADINO, Antonio (INFN - National Institute for Nuclear Physics)
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
The Aerogel RICH detector of the Belle II experiment

In the forward end-cap of the Belle II spectrometer, an innovative proximity focusing Ring Imaging Cherenkov counter with a multilayer focusing aerogel radiator has been installed. The detector is designed to be operated in a B field of 1.5 T, and consists of a double layer aerogel radiator, an expansion volume and a photon detector. In total 420 Hamamatsu hybrid avalanche photo sensors with 144 channels each are used to read out single Cherenkov photons with high efficiency. The device will allow a better than 4σ separation of pions from kaons in the experiment kinematic region from 0.5 GeV/c to 4 GeV/c.

The detector components have been successfully produced and installed in the spectrometer. After a commissioning phase in 2018 (so called Phase 2), the detector is now included in the Belle II data taking, and is expected to contribute substantially to the performance of the spectrometer in looking for rare decays of B and D mesons, and of tau leptons. In the proposed contribution we will review some interesting design and construction points, discuss the commissioning experience, and report on the results of data taking in the 2019 campaign.

Primary author: KORPAR, Samo (University of Maribor and JSI)

Presenter: SANTELJ, Luka (Jozef Stefan Institute)

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Robust limits on dark matter annihilation from the high latitude γ-ray sky

Thursday, 11 July 2019 09:25 (20 minutes)

The Milky Way halo is the densest source of dark matter on the sky. As a matter of facts, the dark matter signals are expected to be stronger with a J-factor of ∼ 10^{22} GeV2.cm−5 than those coming from objects such as dwarf galaxies (J ∼ 10^{17} −10^{19} GeV2.cm−5) or galaxy groups, even in regions away from the Galactic center. We present the results of an indirect search for dark matter annihilation signals in the gamma-ray data of Fermi-LAT. Our analysis is performed using 536 weeks of Pass 8 data within the energy range of 0.1 GeV - 1 TeV in the smooth Milky Way halo for the region |b|>20° and r<50° and for several annihilation channels. These results are obtained with SkyFACT, a new method of gamma-ray fitting which combines template fitting and image reconstruction and accounts for model background uncertainties. We expect to provide the most robust constraints on the annihilation cross section of dark matter at 95% C.L.

Primary authors:  Ms ARMAND, Celine (LAPTh); CALORE, Francesca (LAPTh, CNRS); WENIGER, Christoph (University of Amsterdam)

Presenter:  Ms ARMAND, Celine (LAPTh)

Session Classification:  Dark Matter

Track Classification:  Dark Matter
Some breakthroughs in charmed-baryon experiments, including singly charmed baryons and doubly charmed baryons, have been made in recent years. In this talk, I will introduce the new calculated branching fractions and spin asymmetry of typical two-body weak decays for both singly and doubly charmed baryons. Both factorizable and nonfactorizable contributions are incorporated in the study. For the nonfactorizable contribution, generated from W-exchange and internal W-emission, we resort to pole model and the current algebra technique. Our prediction for some modes of $\Lambda_c^+$ decays are in excellent agreement with BESIII measurement. The ongoing Belle-II and LHCb experiments are anticipant to further check our prediction for decays of $\Xi_c^0, \Xi_c^+$ as well as doubly charmed baryons $\Xi_{cc}^{(-+)}$, $\Xi_{cc}^{+}$ and $\Omega_{cc}^-$. 

**Primary author:** Prof. XU, Fanrong (Jinan University)  
**Co-author:** CHENG, Hai-Yang (Academia Sinica)  
**Presenter:** Prof. XU, Fanrong (Jinan University)  
**Session Classification:** Wine & Cheese Poster Session  
**Track Classification:** Flavour Physics and CP Violation
Future Challenges in Particle Physics Education and Outreach

Friday, 12 July 2019 09:00 (15 minutes)

The European Particle Physics Strategy Update 2020 discusses what Europe, taking into account the worldwide particle physics landscape, sees as the highest priorities for particle physics research in the coming decades. A wide spectrum of proposals and opportunities are examined to explore the basic building blocks of matter, the structure of time and space, and with it the origins of our Universe. Large-scale facilities will be required to deepen our understanding and to open new paths for future research. The duration of the planning, construction, commissioning, and operation stages of these facilities, regardless of which candidates are selected and prioritised, will span many decades.

The execution of these programmes thus relies heavily on support from key stakeholders and decision makers, including politicians, funding agencies and, underlying all, the public. Furthermore, the success of such large-scale projects depends heavily on the talents of a skilled, enthusiastic, and diverse new generation of physicists, engineers, and developers.

The International Particle Physics Outreach Group (IPPOG), a collaboration of 30 countries, major experiments in the field, and CERN, has built a world-wide education and outreach programme that is uniquely situated to address and inspire the current, and more importantly, the next generation of scientific talent, stakeholders, and the public. This talk will highlight the challenges particle physics education and outreach will need to address to ensure that these future projects are not only technically possible, but that they become global collaborative endeavours with the full support of society.

Primary authors: IPPOG COLLABORATION; BECK, Hans Peter (Universitaet Bern (CH)); GOLD-FARB, Steven (University of Melbourne (AU))

Presenter: BECK, Hans Peter (Universitaet Bern (CH))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
Studies of RPC operations with ecological gas mixture under irradiation at GIF++

Monday, 15 July 2019 19:40 (20 minutes)

Resistive Plate Chambers working at the LHC experiments are operated with large fractions of Tetrafluoroethane (C2H2F4) commonly known as R-134a that has a high Global Warming Power (GWP) and has been recently banned by the European community. Many studies are ongoing to find a good replacement for such component for RPCs working in avalanche mode at the LHC. One interesting alternative is the Tetrafluoropropane (C3H2F4) called HFO1234ze that has a GWP of 6 and that has been shown to have reasonable performance with respect to the R134a. Past tests have been performed with cosmic rays and no data are available at present showing the long term impact of high background to the RPCs operated with this new component.

A joint collaboration between ALICE, ATLAS, CMS and CERN groups has been set-up at the GIF++ facility in order to study the performance under irradiation of RPCs operated with a HFO1234ze based gas mixture. Preliminary results of the detector operation stability and of the gas contamination due to the irradiation will be presented along with the future plans.

Primary authors: PICCOLO, Davide (INFN e Laboratori Nazionali di Frascati (IT)); PUGLIESE, Gabriella (Universita e INFN, Bari (IT)); ZAGANIDIS, Nikolaos (Ghent University (BE)); TYTGAT, Michael (Ghent University (BE)); RIGOLETTI, Gianluca (Universite Claude Bernard Lyon I (FR))

Presenter: RIGOLETTI, Gianluca (Universite Claude Bernard Lyon I (FR))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Over the past 10 years, a new type of live-action team-based game became extremely popular all over the world, so-called escape (or adventure) games. Escape games are fun and engaging activities that require teamwork, communication and delegation skills, as well as critical thinking while fully absorbing players in a different reality. However, if adapted to specific learning content, the different puzzles of an escape game can also provide rich and engaging learning activities. What makes educational games special is their potential to have players reach an optimal experience (flow state) while at the same time supporting learning. However, these goals are seldom evaluated. Little is known about students’ experiences of the activity, in particular, if and how many of them really reach a flow state and how individual differences can be explained.

In this study, the game experience of high-school students (aged 16-19) is measured during and after taking part in an antimatter-themed physics escape game involving advanced level puzzles (e.g. on Feynman diagrams, magnets, UV LEDs, and electric circuits) and advanced equipment (such as X-ray machines, digital sundials, and semiconductors). The game has been developed in an iterative process following the escapED framework which suggests a 6-level approach focusing step by step on participants, learning objectives, game mode and theme, puzzles, equipment, and evaluation. First results confirm that most students reach a high state of flow while learning more about particle physics independent of their gender or their prior interest in physics. Perceived mental flow shows high correlations with students’ feeling of competence, immersion and positive team experience. The next steps of this project include a detailed analysis of the game experience and their perceived learning. In this talk, we will present the development of the game and discuss participants’ game experience.

Primary authors: WOITHE, Julia (CERN); JANSKY, Alexandra (University of Vienna (AT))

Presenters: WOITHE, Julia (CERN); JANSKY, Alexandra (University of Vienna (AT))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
Multi-messenger astroparticle physics through hierarchical modelling

Saturday, 13 July 2019 12:10 (20 minutes)

The goal of multi-messenger astroparticle physics is to bring together observations and constraints from different messengers into a consistent physical picture, allowing us to test theoretical predictions and deepen our understanding. This is no easy task, with data from very different instruments, possible explanations from a range of complex models, unknown source populations and selection effects at play. I will show how we can leverage Bayesian hierarchical modelling as a statistical technique to address these challenges and use data to constrain models with more of what we know about the problem built in. As a concrete example, I will present a hierarchical model for the association of ultra-high-energy cosmic rays to potential astrophysical sources. This demonstrates that the inclusion of more information (energies as well as arrival directions) has a strong impact on the results. Coming back to the multi-messenger problem, I will also mention current work on the extension of these ideas to neutrino and gamma-ray data and how such a framework can help us to ask the right questions for the data we have.

Primary author: Ms CAPEL, Francesca (KTH Royal Institute of Technology)
Presenter: Ms CAPEL, Francesca (KTH Royal Institute of Technology)
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Upper Limits on Very-High-Energy Gamma-ray Emission from Core-Collapse Supernovae Observed with H.E.S.S.

Thursday, 11 July 2019 18:10 (20 minutes)

The sources of cosmic-rays beyond the knee of the cosmic-ray spectrum $10^{15}$eV (= 1 PeV) are not firmly discovered yet. Supernovae remnants (SNR) have been proven to be able to accelerate cosmic-rays up to $\sim 10^{14}$eV, but not beyond. Supernovae (SNe), the precursor phase of SNRs, are good candidates for PeV acceleration as some recent theoretical studies indicate that particles with PeV energies and beyond shall be produced as the SN shock propagates in a very dense environment and this may result in measurable gamma-ray emission.

In that context, we searched for gamma-ray emission from ten supernovae observed with the High Energy Stereoscopic System (H.E.S.S.) within a year of the supernova event. No significant gamma-ray emission was detected for any of the objects, and upper limits on the $> 1$ TeV gamma-ray flux of the order of $10^{-13}$cm$^{-2}$s$^{-1}$ are derived. These values are used to place model-dependent constraints on the mass-loss rates of the progenitor stars, implying upper limits between $2 \times 10^{-5}$ and $2 \times 10^{-3}$ M$\odot$yr$^{-1}$, under reasonable assumptions on the particle acceleration parameters. Furthermore, the prospect of a future $> 1$ TeV gamma-ray detection of a young supernova is investigated and found to be a distinct possibility with H.E.S.S. or the Cherenkov Telescope Array (CTA).

Primary authors: SIMONI, Rachel (Rachel); H.E.S.S. COLLABORATION

Co-authors: MAXTED, Nigel; RENAUD, Matthieu; VINK, Jacco

Presenter: SIMONI, Rachel (Rachel)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Detector Performances Studies at Muon Collider

Thursday, 11 July 2019 14:45 (15 minutes)

The Muon Collider is a possible option for the next generation of high energy collider machines. It would permit to achieve the energy frontier in leptons collisions, without occurring in significative synchrotron radiation losses as in electrons rings.

Among the technological challenges in the realization of such machine, the treatment of the beam-induced background is one of the most critical issues for the detectors.

Beams with intensity spanning from $10^9$ up to $10^{11}$ muons per bunch are necessary to obtain the desired luminosity, therefore the muons decay rate is very high. Beam decay products and subsequent particles from secondary interactions with the machine elements can reach the interaction point, limiting the physical performances of the detector. This talk presents a study of the beam induced background for two beam energies and discuss possible strategies for its reduction in the light of new detectors technologies. A reconstruction strategy for a benchmark process, $H \rightarrow \sqrt{b}$-bar, including the beam-induced background will be also illustrated as demonstration of the facility feasibility.

Primary author: LUCCHESI, Donatella (INFN Padova)

Presenters: LUCCHESI, Donatella (INFN Padova); LUCCHESI, Donatella (Universita e INFN, Padova (IT))

Session Classification: Detector R&D and Data Handling

Track Classification: Detector R&D and Data Handling
The main physics goal of the MEGII experiment is to search for the ultra-rare muon decay into a photon and a positron (μ⁺ → e⁺ ν), a sensitive tool for probing physics beyond standard model and exploring new energy scale (up few thousands TeV). The MEG experiment has set the best upper limit on the branching ratio B.R. of the μ⁺ → e⁺ ν decay (B.R.(μ⁺ → e⁺ ν) < 4.2 × 10⁻¹³ at 90% C.L.) and a major upgrade of the experiment (MEGII experiment), aiming at improving the sensitivity on the μ⁺ → e⁺ ν decay search by one order of magnitude, is now well advanced.

In this contribution we would like to discuss the key elements of the MEGII experiment design, from MEG to MEGII.

The detector is able to sustain the most intense continuous muon beam in the world. It includes a large 900 liters LXe calorimeter based only on scintillation light, a spectrometer based on a non-uniform magnetic field map, an innovative TDAQ able to digitize waveforms up to 5 GSample/s, a lot of complementary calibration and monitoring methods and auxiliary tools.

**Primary authors:** PAPA, Angela (PSI and UniPi/INFN); MEGII COLLABORATION

**Presenter:** PAPA, Angela (PSI and UniPi/INFN)

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Liquid argon (LAr) sampling calorimeters are employed by ATLAS for all electromagnetic calorimetry in the pseudo-rapidity region $|\eta| < 3.2$, and for hadronic and forward calorimetry in the region from $|\eta| = 1.5$ to $|\eta| = 4.9$. In the first LHC run a total luminosity of 27 fb$^{-1}$ has been collected at center-of-mass energies of 7-8 TeV. After detector consolidation during a long shutdown, Run-2 started in 2015 and about 150 fb$^{-1}$ of data at a center-of-mass energy of 13 TeV have been recorded.

In order to realize the level-1 acceptance rate of 100 kHz in Run-2 data taking, the number of readout samples recorded and used for the energy and the time measurement has been modified from five to four while keeping the expected performance. The well calibrated and highly granular LAr Calorimeter reached its design values both in energy measurement as well as in direction resolution.

This contribution will give an overview of the detector operation, hardware improvements, changes in the monitoring and data quality procedures, to cope with increased pileup, as well as the achieved performance, including the calibration and stability of the electromagnetic scale, noise level, response uniformity and time resolution.
A High-Granularity Timing Detector for the Phase-II upgrade of the ATLAS Calorimeter system: detector concept, description and R&D and first beam test results

Thursday, 11 July 2019 09:15 (15 minutes)

The increase of the particle flux (pile-up) at the HL-LHC with luminosities of $L \approx 7.5 \times 10^{34}$ cm$^{-2}$ s$^{-1}$ will have a severe impact on the ATLAS detector reconstruction and trigger performance. The end-cap and forward region where the liquid Argon calorimeter has coarser granularity and the inner tracker has poorer momentum resolution will be particularly affected. A High Granularity Timing Detector (HGTD) is proposed in front of the LAr end-cap calorimeters for pile-up mitigation and for luminosity measurement.

It will cover the pseudo-rapidity range from 2.4 to 4.0. Two Silicon sensors double sided layers will provide precision timing information for MIPs with a resolution better than 30 ps per track in order to assign each particle to the correct vertex. Readout cells have a size of 1.3 mm $\times$ 1.3 mm, leading to a highly granular detector with 3 millions of channels. Low Gain Avalanche Detectors (LGAD) technology has been chosen as it provides enough gain to reach the large signal over noise ratio needed.

The requirements and overall specifications of the HGTD will be presented as well as the technical proposal. LGAD R&D campaigns are carried out to study the sensors, the related ASICs, and the radiation hardness. Laboratory and test beam results will be presented.

Primary author: ATLAS COLLABORATION
Presenter: LEOPOLD, Alexander (LPNHE Paris)
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The Phase-I Trigger Readout Electronics Upgrade of the ATLAS Liquid Argon Calorimeters

Electronics developments are pursued for the trigger readout of the ATLAS Liquid-Argon Calorimeter towards the Phase-I upgrade scheduled in the LHC shut-down period of 2019-2020. Trigger signals with higher spatial granularity and higher precision are needed in order to improve the identification efficiencies of electrons, photons, tau, jets and missing energy, at high background rejection rates, already at the Level-1 trigger. The LAr Trigger Digitizer system will digitize the 34,000 channels (SuperCells) at a 40 MHz sampling frequency with 12 bit precision after the bipolar shaping of the front-end system. The data will be transmitted to the LAr Digital Processing system in the back-end to extract the transverse energies and perform the bunch-crossing identification. A demonstrator has been installed during Run-2, and the results of the data-taking have helped to validate the chosen technology. Results of ASIC developments including QA/QC and radiation hardness evaluations, performances of the pre-production boards and results of the system integration tests, progress of QA/QC of final production boards will be presented along with the overall system design.

Primary author: ATLAS COLLABORATION
Presenter: IGUCHI, Ryunosuke (University of Tokyo (JP))
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
Netzwerk Teilchenwelt: Where High School Students Participate in HEP Research and Young Talents are Promoted

Friday, 12 July 2019 15:45 (15 minutes)

To enable high school students to participate in the fascinating research in HEP physics, 30 universities in Germany have joined forces to form Netzwerk Teilchenwelt. About 150 researchers are active in the outreach program and bring cutting edge physics research into the classroom, for example with Masterclasses. They inform high school students about current findings, open questions and research methods in particle and astroparticle physics. Every year about 4000 students are reached and work with original data from CERN or study cosmic particles with particle detectors. In the advanced stages of Netzwerk Teilchenwelt, motivated pupils continue to engage in research and attend workshops at CERN. The most committed students can spend two weeks at CERN doing their own research projects. Preparation and follow-up of this work takes place close to home. The finished projects are usually taken to the Abitur (university entrance qualification) or competition entries, e.g. Jugend forscht, and are often awarded prestigious prizes.

Through a fellow program, young people who found their way to particle physics via Netzwerk Teilchenwelt are further supported as students. The program offers students early contact with research at their place of study, personal support and further education, as well as nationwide networking opportunities. Through the fellow program, research groups can attract highly motivated and educated young scientists who can take on future research and development tasks, but also help with scientific activities such as conferences or outreach events.

Since 2019, Netzwerk Teilchenwelt has joined forces with other players in the BMBF-funded KONTAKT project, e.g. Weltmaschine, in order to expand the range of programs to include topics of hadrons and nuclear physics on the one hand and to address other target groups such as the general public and journalists on the other.

Primary authors: BILOW, Uta (Technische Universitaet Dresden (DE)); KOBEL, Michael (Technische Universitaet Dresden (DE))

Presenter: BILOW, Uta (Technische Universitaet Dresden (DE))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
Charged lepton flavour violation search with the Mu3e experiment

Friday, 12 July 2019 17:10 (20 minutes)

The Mu3e experiment searches for the charged lepton flavour violating $\mu^+ \rightarrow e^+ \mu^+ \bar{\nu}_e$ decay and it aims at reaching an ultimate sensitivity of $10^{-16}$ on the branching fraction of the $\mu^+ \rightarrow e^+ \mu^+ \bar{\nu}_e$ decay, four orders of magnitude better than the current limit $B(\mu^+ \rightarrow e^+ \mu^+ \bar{\nu}_e) < 10^{-12}$ set by the SINDRUM experiment. The experiment will be hosted at the Paul Scherrer Institute (Villigen, Switzerland) which delivers the most intense low momentum continuous muon beam in the world (up to few $\times 10^8 \mu^+/s$).

In order to be sensitive to the signal at this so high level, to reject the background and to run at the intensity beam frontier excellent detector performances are needed. To match those requests the experiment has been design based on completely new technologies. Extensive test beams have been performed to validate the detector design. The collaboration is concluding the detector R&D phase and is approaching the pre-engineering phase. A pre-engineering run is foreseen next year with sub-modules of each sub-detector followed by a full assembled pre-engineering run for 2021. The physics runs is expected to follow and will take at least three years of data taking. A review of the Mu3e experiment and its physics case will be given.

Primary authors: PAPA, Angela (PSI and UniPi/INFN); MU3E COLLABORATION
Presenter: PAPA, Angela (PSI and UniPi/INFN)
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
The Gigatracker of the NA62 experiment at CERN

Thursday, 11 July 2019 10:00 (15 minutes)

NA62 is a fixed-target experiment at the CERN SPS designed to measure the branching ratio of the very rare kaon decay $K^+ \rightarrow \pi^+\nu\bar{\nu}$ with 10% precision. Measurements of time, momentum and direction of incoming beam particles are provided by a beam spectrometer called GigaTracKer.

The GigaTracKer is made of three stations of hybrid silicon pixel detector installed in vacuum ($\sim 10^{-6}$mbar). Each station consists of 18000 pixels of $300 \times 300 \mu$m$^2$ area each, arranged in a matrix of $200 \times 90$ elements corresponding to a total area of $62.8 \times 27 mm^2$. The beam particles, flowing at 750 MHz, are tracked in 4-dimensions by means of time-stamping pixels with the single hit time resolution reaching 115ps. This performance has to be maintained despite the beam irradiation amounting to a yearly fluence of $4.5 \times 10^{14} MeV n_{eq}/cm^2/200$ days. In order to limit multiple scattering and beam hadronic interactions, the station material budget is reduced to 0.5%X0 by using micro channel cooling (first application in HEP).

We will present the detector design and performances during the NA62 data taking periods.

**Primary authors:** GIANOLI, Alberto (Universita e INFN, Ferrara (IT)); MAPELLI, Alessandro (CERN); KLUGE, Alex (CERN); KLEIMENNOVA, Alina (Universite Catholique de Louvain (UCL) (BE)); COTTA RAMUSINO, Angelo (Universita e INFN, Ferrara (IT)); CECCUCCI, Augusto (CERN); VELGHE, Bob (TRIUMF (CA)); BIINO, Cristina (INFN Torino (IT)); ALVAREZ FEITO, Diego (CERN); CORTINA GIL, Eduardo (Universite Catholique de Louvain (UCL) (BE)); MINUCCI, Elisa (INFN e Laboratori Nazionali di Frascati (IT)); GAMBERINI, Enrico (CERN); MIGLIORE, Ernesto (Universita e INFN Torino (IT)); PETRUCCI, Ferruccio (Universita di Ferrara); MARCHETTO, Flavio (Universita and INFN-Torino(IT)); AGLieri RINELLA, Gianluca (CERN); ROMAGNOLI, Giulia (CERN); RUGGIERO, Giuseppe (Lancaster University (GB)); WAHL, Heiner (Universita e INFN, Ferrara (IT)); KAPLON, Jan (CERN); NOEL, Jerome (CERN); DEGRANGE, Jordan (CERN); POLTORAK, Karolina (AGH University of Science and Technology (PL)); FEDERICI, Luca (CERN); PERKTOLD, Lukas (Graz University of Technology (AT)); FIORINI, Massimiliano (Universita e INFN, Ferrara (IT)); PERRIN-TERRIN, Mathieu (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France); NOY, Matthew (CERN); MOREL, Michel (CERN); PETAGNA, Paolo (CERN); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); BONACINI, Sandro (CERN); CHIOZZI, Stefano (Universita e INFN, Ferrara (IT))

**Presenter:** KLEIMENNOVA, Alina (Universite Catholique de Louvain (UCL) (BE))

**Session Classification:** Detector R&D and Data Handling

**Track Classification:** Detector R&D and Data Handling
Precision QCD with the LHeC and the FCC-eh

Thursday, 11 July 2019 17:00 (15 minutes)

The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an ERL providing electrons to collide with the HL-LHC, HE-LHC and the FCC-hh proton beams. These ep configurations will achieve centre-of-mass energies 1.3-3.5 TeV and luminosities $\sim 10^{34}$ cm$^{-2}$ s$^{-1}$ which extends the HERA kinematic coverage by more than one order of magnitude towards smaller $x$ and larger $Q^2$. DIS measurements in such machines will greatly enlarge our knowledge on parton densities through a complete unfolding of all flavours in a single experimental setup, to be compared with data from hadron colliders as an independent input and as a test of factorisation. They will also allow a very precise determination of $\alpha_s$. In this talk we review the most recent developments on these subjects.

Primary author: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))
Presenter: SARKAR, Amanda (University of Oxford (GB))
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Determination of diffractive parton densities at the LHeC and the FCC-eh

Monday, 15 July 2019 18:30 (1h 30m)

The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an ERL providing electrons to collide with the HL-LHC, HE-LHC and the FCC-hh proton (ion) beams achieving per nucleon centre-of-mass energies 1.3-3.5 (0.8-2.2) TeV and luminosities $\sim 10^{34(33)} \, \text{cm}^{-2} \, \text{s}^{-1}$, respectively. These three configurations will enlarge the HERA kinematic coverage by more than one order of magnitude towards smaller $x$ and larger $Q^2$, which translates into a range of available momentum fraction of the diffractive exchange with respect to the hadron down to $10^{-4}$ for a wide range of the momentum fraction of the parton with respect to the diffractive exchange. Here we show the large possibilities that they offer for the determination of diffractive parton densities DPDFs in proton and nuclei. Using the same framework and methodology previously employed at HERA and under very conservative assumptions for the luminosities and systematic errors, we find an immense improvement in the extraction of DPDFs from fits to reduced cross sections for inclusive coherent diffraction in $ep$ by about an order of magnitude. We analyse the sensitivity to kinematic cuts and variations of the fit framework. We also note unprecedented sensitivity to the shape of the gluon distribution, and to physics beyond linear twist-2 DGLAP evolution at moderate $Q^2$. For $eA$, we find that an extraction of the currently unmeasured nuclear DPDFs is possible with similar accuracy to that in $ep$, in a kinematic range extended by $\sim 4$ orders of magnitude as compared to available lepton-nuclear DIS data.


Primary authors: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES)); STASTO, Anna (Penn State)

Presenter: STASTO, Anna (Penn State)

Session Classification: Wine & Cheese Poster Session

Track Classification: QCD and Hadronic Physics
Prospects for CP violation measurement with Hyper-Kamiokande

Three flavor neutrino mixing has been established by the continuous studies of neutrino oscillations since its discovery. Large mixing angles and small neutrino masses, in contrast to those in quark sector, imply new physics at ultra-high energy. In addition, as-yet unmeasured CP violation in neutrino sector is considered as a clue to investigate the origin of matter-antimatter asymmetry of the universe. Hyper-Kamiokande is a next generation large-scale water Cherenkov detector. With the baseline design, its fiducial volume is about an order of magnitude larger than Super-Kamiokande and the detector performance is significantly improved with newly developed photosensors. Combination of the Hyper-Kamiokande detector with the upgraded J-PARC neutrino beam will provide unprecedented high statistics of the neutrino and antineutrino signals to measure the CP violation and reveal a full picture of neutrino mixing with high precision. Prospects for the CP violation measurements by the Hyper-Kamiokande long baseline project will be presented.

Presenter: QUILAIN, Benjamin

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an ERL providing electrons to collide with the HL-LHC, HE-LHC and the FCC-hh proton beams achieving centre-of-mass energies 1.3-3.5 TeV and luminosities $\sim 10^{34}$ cm$^{-2}$ s$^{-1}$, respectively. These large energies and luminosities lead to charged current Higgs production cross sections which are comparable (LHeC) or 3-4 times larger (FCC-eh) than those of $Z$-Higgs-strahlung at $e^+e^-$ colliders. In this talk we present the latest results on the determination of Higgs couplings, both in $ep$ at the LHeC and the FCC-eh, and in combination with their hadronic counterparts HL-LHC/HE-LHC and FCC-hh, exhibiting a strong $ep + pp$ synergy and very interesting complementarity to $e^+e^-$ Higgs prospects. We also show the implication that a precise determination of PDFs in $ep$ has for precision Higgs measurements at hadron colliders.

**Primary author:** ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

**Presenter:** KLEIN, Uta (University of Liverpool (GB))

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
Near Detectors for the Hyper-K Neutrino Experiment

Monday, 15 July 2019 18:30 (1h 30m)

The neutrino oscillation measurement program of Hyper-K requires unprecedented accuracy for the modeling of neutrino fluxes and neutrino-nucleus interaction cross sections. The Hyper-K experiment will include a suite of near detectors to control systematic uncertainties on neutrino flux and interaction models. In this talk we will describe the baseline Hyper-K near detector suite, which includes beam direction measurement detectors, a magnetized tracking detector, and a kilo-ton scale water Cherenkov detector. We will discuss the measurements these detectors will make to control systematic errors for the accelerator-based neutrino oscillation program, as well as the atmospheric neutrino and nucleon decay programs of Hyper-K.

Primary author: ETAM, Noah Messomo (Université Geneve, CH)
Presenter: ETAM, Noah Messomo (Université Geneve, CH)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
BSM physics at the LHeC and the FCC-eh

Friday, 12 July 2019 18:15 (15 minutes)

The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an ERL providing electrons to collide with the HL-LHC, HE-LHC and the FCC-hh proton beams achieving centre-of-mass energies 1.3-3.5 TeV, respectively, at very high luminosities $\sim 10^{34}$ cm$^{-2}$ s$^{-1}$. These large luminosities and energies provide most interesting possibilities for discoveries of new physics, beyond the SM. In this talk we present the latest results on the prospective determination of anomalous couplings involving top, Higgs and $W$, $Z$ bosons in high-energy DIS at the LHeC and the FCC-eh, on studies on sterile neutrinos and other new physics models. We also show the complementarity with corresponding studies at the HL-LHC.

Primary author: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Presenter: SCHWANENBERGER, Christian (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Astrophysical Neutrinos at Hyper-Kamiokande

Thursday, 11 July 2019 11:30 (20 minutes)

Hyper-Kamiokande (Hyper-K) is a proposed next generation underground large water Cherenkov detector with a 187 kton target volume of water and 40% photo coverage. With about 10 times larger fiducial volume than Super-Kamiokande, the sensitivities for astrophysical neutrinos, like solar neutrinos or supernova neutrinos, will be greatly improved in Hyper-K. In this presentation, we will discuss the physics potential of Hyper-K on astrophysical neutrinos and expected performance of the detector.

Primary author: CATANESI, Gabriella (Universita e INFN, Bari (IT))
Presenter: BRAVO BERGUNO, David (Universidad Autónoma de Madrid)
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Searches for Nucleon Decay at Hyper-Kamiokande

Thursday, 11 July 2019 11:50 (20 minutes)

While grand unified theories offer potential solutions to problems with the Standard Model, such as the origins of charge quantization, their signature prediction, proton decay, has not been observed experimentally. Hyper-Kamiokande is a next-generation water Cherenkov experiment with a 187 kton target volume that will provide unprecedented sensitivity to a variety of nucleon decay modes, including many beyond the so-called flagship modes, $p \rightarrow e^+ \pi^0$ and $p \rightarrow \bar{\nu}K^+$. With improved detector technologies to enhance signal efficiencies and reject backgrounds, Hyper-Kamiokande is expected to search for these processes with sensitivities to proton lifetimes of $10^{35}$ years and longer, providing opportunities for discoveries for lifetimes exceeding existing limits by an order of magnitude. This presentation will describe the complete Hyper-Kamiokande nucleon decay physics program and its expected sensitivities.
A detector for the LHeC and the FCC-eh

Monday, 15 July 2019 19:40 (20 minutes)

The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an energy recovery linac (ERL) in racetrack configuration providing an intense electron beam to collide with the HL-LHC, HE-LHC and the FCC-hh proton (ion) beams achieving per nucleon centre-of-mass energies $1.3-3.5$ ($0.8-2.2$) TeV and luminosities $\sim 10^{34(33)}$ cm$^{-2}$ s$^{-1}$, respectively. Such a machine offers the opportunity to build a state-of-the-art HEP detector to be operative in the 2030s. The present design of the detectors for the three configurations will be discussed, i.e. the detector configuration, acceptance and resolution, technology choices and integration with the beams.

Primary author: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Presenter: KLEIN, Max (University of Liverpool (GB))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
Performances of multi-PMT photodetector for the Hyper-Kamiokande experiment

Thursday, 11 July 2019 15:15 (15 minutes)

Hyper-Kamiokande, a 187 kton fiducial volume water Cherenkov detector to be built in Japan, is the next generation of the Super-Kamiokande experiment. Its broad physics program includes nucleon decay, neutrinos from astronomical and human-made beam, with the main focus to determine the leptonic CP violation. To detect the weak Cherenkov light generated by neutrino interactions or proton decay, the primary photo-detector candidate are 20-inch PMTs. In order to enhance the Hyper-Kamiokande physics sensitivity, the use of a smaller amount of mPMTs to be integrated in the 20” PMT configuration, is considered. A multi-PMT Optical Module based on a pressure vessel instrumented with multiple small diameter photosensors, readout electronics and power, offers several advantages as increased granularity, reduced dark rate, weaker sensitivity to Earth’s magnetic field, improved timing resolution and directional information with an almost isotropic field of view. In the first part of this talk, we will briefly present the multi-PMT modules developed for Hyper-Kamiokande. We will then show their positive impact on the sensitivity of the Hyper-Kamiokande Intermediate Water Cherenkov detector, which motivated their choice as the primary photosensor candidate. We will finally conclude by presenting the impact of these modules on the physics of the Hyper-Kamiokande far detector.

Primary author: CATANESI, Gabriella (Università e INFN, Bari (IT))
Presenter: QUILAIN, Benjamin
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
The Large Hadron-electron Collider: status and plans

*Friday, 12 July 2019 17:50 (20 minutes)*

The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. An Energy Recovery Linac (ERL) in racetrack configuration will provide an intense electron beam of up to 60 GeV energy to collide with the HL-LHC proton and ion beams. This configuration is also foreseen to be achieve higher energy $ep/eA$ collisions eventually with those from the HE-LHC and the FCC-hh. Such configurations will yield electron-proton (nucleus) collisions with per nucleon centre-of-mass energies 1.3-3.5 (0.8-2.2) TeV and luminosities $\sim 10^{34(33)} \text{ cm}^{-2} \text{ s}^{-1}$, respectively.

The talk describes the recent accelerator developments, an up-to-date configuration following optimisations of cost vs. energy, updates on the interaction region design and as well present the status of the 802 MHz, multi-turn ERL demonstrator facility PERLE at Orsay.

**Primary author:** KLEIN, Max (University of Liverpool (GB))

**Co-author:** ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

**Presenter:** KLEIN, Max (University of Liverpool (GB))

**Session Classification:** Accelerators for HEP

**Track Classification:** Accelerators for HEP
Recent T2K Neutrino Oscillation Results

Friday, 12 July 2019 09:20 (25 minutes)

T2K is a long baseline neutrino experiment producing a beam of muon neutrinos at the Japan Particle Accelerator Research Centre on the East coast of Japan and measuring their oscillated state 295 km away at the Super Kamiokande detector. Since 2016 T2K has doubled its data in both neutrino and antineutrino beam modes. Coupled with improvements in analysis techniques this has enabled the experiment to make world leading measurements of the PMNS oscillation parameters $\Delta m^2_{32}$, $\sin^2(\theta_{23})$ and the CP violating phase $\delta_{\text{CP}}$. In particular the CP conserving values of $\delta_{\text{CP}}$ now appear to be disfavoured at the 95\% CL and there are regions of parameter space excluded at the 99.7\% CL. This talk will describe these results and the analysis improvements that have enabled them.

Presenter: KORMOS, Laura

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Performances of multi-PMT photodetectors for the Hyper-Kamiokande experiment

Monday, 15 July 2019 18:30 (1h 30m)

Hyper-Kamiokande, a 187 kton fiducial volume water Cherenkov detector to be built in Japan, is the next generation of the Super-Kamiokande experiment. Its broad physics program includes nucleon decay, neutrinos from astronomical and human-made beam, with the main focus to determine the leptonic CP violation. To detect the weak Cherenkov light generated by neutrino interactions or proton decay, the primary photo-detector candidate are 20-inch PMTs. In order to enhance the Hyper-Kamiokande physics sensitivity, the use of multi-PMT modules is considered as a complement of the primary candidates. A multi-PMT Optical Module based on a pressure vessel instrumented with multiple small diameter photosensors, readout electronics and power, offers several advantages as increased granularity, reduced dark rate, weaker sensitivity to Earth’s magnetic field, improved timing resolution and directional information with an almost isotropic field of view. In this talk, we will present the recent development of the mechanical design and electronics of these modules in order to both maximize the physics sensitivity of Hyper-Kamiokande and comply with the detector requirements. We will then show the exhaustive tests of the individual 3-inch PMTs that constitute these modules before to present the incoming perspectives of testing the assembled modules in a test beam.

Presenters: NASCIMENTO MACHADO, Lucas (INFN - National Institute for Nuclear Physics); NASCIMENTO MACHADO, Lucas (Purdue University Calumet (US))

Session Classification: Wine & Cheese Poster Session

Track Classification: Detector R&D and Data Handling
First Sub-Percent Exploration of PMNS Unitarity with LiquidO?

Thursday, 11 July 2019 12:05 (15 minutes)

The last decade has witnessed a remarkable progress in the knowledge of the Pontecorvo-Maki-Nakagawa-Sakata (PMNS) neutrino mixing matrix upon the first observation and today’s precision (\(\sim 3\%\)) measurement of the \(\theta_{13}\) mixing angle by the reactor experiments; i.e. Daya Bay (China), Double Chooz (France) and RENO (South Korea). However, only the JUNO experiment (China) will open, for the first time, the sub-percent precision era. The measurement of the ("solar") \(\theta_{12}\) mixing angle is expected to reach \(<1\%\) precision (today: \(\sim 4\%\)) soon upon data taking in 2022. The ("atmospheric") \(\theta_{23}\) mixing angle ultimate knowledge depends on the DUNE (USA) and Hyper-Kamiokande (Japan) next generation beam experiments. The ultimate precision is expected to reach the \(\sim 1\%\) level, despite the so called "octant" ambiguity. These same experiments are expected to provide the most precise knowledge on CP-Violation. Hence, sub-percent precision across the entire PMNS matrix is reachable within the forthcoming 2030 decade, only if a sub-percent \(\theta_{13}\) measurement was possible. If so, the unprecedented opportunity for competitive unitarity exploration will open, including sensitivity to hypothetical evidence for physics beyond 3 neutrino families — a critical building block of the Standard Model. However, none of the running or proposed experiments can yield such a precision on \(\theta_{13}\). In this talk, we shall describe the necessary experimental steps needed to yield "the missing experiment" to reach the world best knowledge on PMNS unitarity. The new hypothetical experiment relies on a novel methodology and a new detection technique, called LiquidO, in active R&D demonstration. Both will be described as well as full systematics uncertainty feasibility for the first time. One of the most powerful sites is in Europe, which is to be highlighted too. A publication in preparation, this talk will be the first release.

Primary author: Dr CABRERA, Anatael (LAL/LNCA - IN2P3/CNRS)

Presenter: Dr CABRERA, Anatael (LAL/LNCA - IN2P3/CNRS)

Session Classification: Neutrino Physics

Track Classification: Neutrino Physics
Neutrino-Nucleus Interaction Cross-Section Measurements at T2K

Saturday, 13 July 2019 11:30 (25 minutes)

A detailed understanding of neutrino(ν)-nucleus interactions is essential for the precise measurement of neutrino oscillations at long baseline experiments, such as T2K. The T2K ND complex, designed to constrain the T2K flux and cross section models, also provides a complementary program of neutrino interaction cross-section measurements. Given the neutrino energy range of the T2K flux, the T2K near detector is in a unique position to make precision measurements of CC0πi processes. Combining multiple CC0πi samples into a single analysis produces relatively high-precision results that can validate new cross-section models and resolve modelling ambiguities. This strategy, which is vital for the future of the field, and recent results will be presented.

Primary author: CHRISTODOULOU, Georgios (CERN)
Presenter: CHRISTODOULOU, Georgios (CERN)
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an ERL providing electrons to collide with the HL-LHC, HE-LHC and the FCC-hh ion beams. It will achieve per nucleon centre-of-mass energies 0.8-2.2 TeV, respectively, and luminosities about $10^{33}$ cm$^{-2}$ s$^{-1}$. The LHeC and its possible successors will extend the kinematic plane in nuclear DIS by about four orders of magnitude towards smaller $x$ and larger $Q^2$ and therefore be the highest energy electron-ion colliders we can possibly build. DIS measurements in such configurations offer the unique opportunity to completely resolve the partonic content and dynamics inside nuclei, including observations of flavour dependent shadowing, non-linear parton interactions and similarly unresolved phenomena. Nuclear PDFs can be determined to very high precision and the relation to proton structure be established for each quark flavour and the gluon deep into an unknown range and independently of any proton PDF basis. This programme has the unique potential to completely change the view on nuclear structure and dynamics and resolve many phenomena at the heart of deconfinement and the Quark Gluon Plasma.

**Primary authors:** ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES)); STASTO, Anna (Penn State)

**Presenter:** STASTO, Anna (Penn State)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
Measurement of the charged-current electron (anti-)neutrino cross-section on plastic with the T2K neutrino beam in the off-axis near detector ND280

Monday, 15 July 2019 18:30 (1h 30m)

The intrinsic electron neutrino contamination of the T2K neutrino beam provides the single largest background in the measurement of electron neutrino appearance at the far detector. These electron neutrinos can be measured directly in the T2K near detector, ND280. With the transition to antineutrino running the selection of both electron neutrinos and electron anti-neutrinos are important. Measurements of the intrinsic electron (anti-)neutrino backgrounds from both neutrino and antineutrino beam mode will be presented with details on the event selection and rejection of the large backgrounds of muons, photons, protons and pions. The selected events are used to measure the inclusive charged-current electron neutrino and electron anti-neutrino cross-sections, the latter being the first measurement since 1979.

Primary author: CHRISTODOULOU, Georgios (CERN)
Presenter: CHRISTODOULOU, Georgios (CERN)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
Top and Electro-Weak physics at the LHeC and the FCC-eh

Saturday, 13 July 2019 12:45 (15 minutes)

The Large Hadron-electron Collider (LHeC) is a proposed upgrade of the LHC at CERN. It consists of an ERL providing electrons to collide with the HL-LHC, HE-LHC and the FCC-hh proton beams achieving centre-of-mass energies 1.3-3.5 TeV, respectively, and luminosities $\sim 10^{34}$ cm$^{-2}$ s$^{-1}$. These large luminosities and the corresponding cross sections provide huge possibilities for precision measurements of top couplings and EW parameters. In this talk we present the latest results on the determination of SM and anomalous top couplings in top-energy DIS at the LHeC and the FCC-eh, and compare them with the results at LHC and the prospects at the HL-LHC. We also show the implications that a precise determination of PDFs at the LHeC and FCC-eh has on the extraction of EW parameters at hadronic colliders.

**Primary author:** SCHWANENBERGER, Christian (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** SCHWANENBERGER, Christian (Deutsches Elektronen-Synchrotron (DE))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
First physics run of the WAGASCI-BabyMIND detector with full setup

Saturday, 13 July 2019 11:55 (15 minutes)

WAGASCI-BabyMIND is a set of new neutrino detectors to measure the neutrino cross-section with the T2K neutrino beam. It is composed of neutrino detectors made of water and scintillator surrounded by muon range detectors made of iron and scintillator. The downstream muon range detector is magnetized to discriminate the charge of the muons. It is located in the same building as ND280 but at the different off-axis angle from ND280. The WAGASCI experiment has just completed in summer 2018 its commissioning run with a reduced setup. The next physics run with the full setup is scheduled to start at the end of May 2019 and will last approximately a month. More physics runs are scheduled later this year and in the next years. In this talk, we will present the preliminary results of the first full setup run and the future prospect of the neutrino cross section measurement with the WAGASCI-BabyMIND detector.

Presenter:  NOAH, Etam (Université de Genève)

Session Classification:  Neutrino Physics

Track Classification:  Neutrino Physics
Measurement of Charged Current anti-neutrino cross section on water and hydrocarbon with limited acceptance at 1.5 deg off axis with the T2K beam

Monday, 15 July 2019 18:30 (1h 30m)

A detailed understanding of neutrino and antineutrino interactions with nuclei is essential for the precise measurement of neutrino oscillations at long-baseline experiments, such as T2K. Moreover, since T2K utilises a water Cherenkov far detector, the study of neutrino cross sections on water is imperative. The T2K experiment has recently been equipped with a new additional near detector, WAGASCI, located 1.5 degrees off-axes with respect to the beam center. Composed of 80% of water and 20% of plastic scintillator, WAGASCI offers unique opportunity to characterize (anti-)neutrino interactions on water with a 4pi acceptance. In this talk, we will present the first WAGASCI analysis, using antineutrino data taken with the detector in its preliminary configuration. The differential charged current cross sections of antineutrinos on water and hydrocarbon will be shown, as well as their ratio, in a restricted phase space, as a function of the reconstructed muon angle. The signal selection, the analysis technique, as well as the precautions taken to reduce possible model dependence, will be described in detail.

Primary author: KIN, Kenichi (Osaka City University)
Presenter: KIN, Kenichi (Osaka City University)
Session Classification: Wine & Cheese Poster Session
Track Classification: Neutrino Physics
Event Generation and Statistical Sampling with Deep Generative Models and a Density Information Buffer

Friday, 12 July 2019 09:00 (15 minutes)

We present a study for the generation of events from a physical process with generative deep learning. To simulate physical processes it is not only important to produce physical events, but also to produce the events with the right frequency of occurrence (density). We investigate the feasibility to learn the event generation and the frequency of occurrence with Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) to produce events like Monte Carlo generators. We study three toy models from high energy physics, i.e. a simple two-body decay, the processes $e^+e^-\rightarrow Z\rightarrow l^+l^-$ and $pp\rightarrow tj$ including the decay of the top quarks and a simulation of the detector response. We show that GANs and the standard VAE do not produce the right distributions. By buffering density information of Monte Carlo events in latent space given the encoder of a VAE we are able to construct a prior for the sampling of new events from the decoder that yields distributions that are in very good agreement with real Monte Carlo events and are generated $O(10^8)$ times faster. Applications of this work include generic density estimation and sampling, targeted event generation via a principal component analysis of encoded events in the latent space and the possibility to generate better random numbers for importance sampling, e.g. for the phase space integration of matrix elements in quantum perturbation theories. The method also allows to build event generators directly from real data events.

Primary authors: OTTEN, Sydney (Radboud Universiteit Nijmegen); CARON, Sascha (Nikhef National institute for subatomic physics (NL)); Ms DE SWART, Wieske (Radboud University Nijmegen); VAN BEEKVELD, Melissa Corona (Nikhef National institute for subatomic physics (NL)); HENDRIKS, Luc (Nikhef); Mr VAN LEEUWEN, Caspar (SURFsara); Mr PODAREANU, Damian (SURFsara); RUIZ DE AUSTRI, Roberto; VERHEYEN, Rob (Radboud University Nijmegen)

Presenter: OTTEN, Sydney (Radboud Universiteit Nijmegen)

Session Classification: QCD and Hadronic Physics

Track Classification: QCD and Hadronic Physics
Spin component of the Pomeron from data on Coulomb-nuclear interference

Monday, 15 July 2019 18:30 (1h 30m)

Small-angle polarized elastic pp scattering dominated by Coulomb-nuclear interference (CNI) open a unique chance to access the spin component of the Pomeron. Our analysis of data on single-spin asymmetry at $\sqrt{s} = 200$ GeV reveals a considerable spin-flip component, missed in the previous analyses because of lack of absorptive corrections. Analogous, much more precise measurements at lower energies also demonstrate large hadronic spin-flip, which might partially related to the contribution of Reggeons. We performed a global Regge analysis of CNI data at different energies and disentangle spin-flip parts of the Pomeron and Reggeons. We observe a faster rise of the Pomeron spin-flip with energy in comparison with the non-flip amplitude in accordance with theoretical expectations.

Primary author: KRELINA, Michal (FNSPE, Czech Technical University)
Co-author: KOPELIOVICH, Boris (UTFSM)
Presenter: KRELINA, Michal (FNSPE, Czech Technical University)
Session Classification: Wine & Cheese Poster Session
Track Classification: QCD and Hadronic Physics
Physics Beyond Colliders at CERN

Physics Beyond Colliders is an exploratory study aimed at exploiting the full scientific potential of CERN’s accelerator complex and its scientific infrastructure in the next two decades through projects complementary to the LHC, HL-LHC and other possible future colliders. These projects should target fundamental physics questions that are similar in spirit to those addressed by high-energy colliders, but that require different types of beams and experiments.

A kick-off workshop held in September 2016 identified a number of areas of interest and working groups have been set-up to study and develop these proposals. The projects currently under consideration are briefly presented including their physics motivation.

Primary author: LAMONT, Mike (CERN)
Presenter: LAMONT, Mike (CERN)
Session Classification: Accelerators for HEP
Track Classification: Accelerators for HEP
Top-Higgs Associated Production involving $m_{A^0}$, $m_{H^0} \sim 300$ GeV

Thursday, 11 July 2019 15:00 (15 minutes)

We revisit an old proposal where a pseudoscalar $A^0$ has mass between $t\bar{c}$ and $tt$ thresholds, but possess extra Yukawa couplings by absence of $Z_2$ symmetry. With $\rho_{tt}$ small, it evades $gg \to A^0 \to h^0(125)Z$ constraints, where approximate alignment also helps. We find this scenario with relatively light $A^0$ is not yet ruled out, and $cg \to tA^0 \to t\bar{c}c$ can probe sizable $\rho_{tc}$ at the LHC. In a similar vein, we find that discovery is possible for $m_{H^0} \sim 300$ GeV for $cg \to tH^0 \to thh$, but would need finite $h-H$ mixing angle $\cos \gamma$ to allow for finite $\lambda_{Hhh}$ coupling, and $\rho_{tc}$ also needs to be not too small. The latter could drive electroweak baryogenesis, which further motivates the search.

Primary author: Prof. HOU, George W.S. (National Taiwan University)

Presenters: Prof. HOU, George W.S. (National Taiwan University); HOU, George Wei-Shu (National Taiwan University (TW))

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Searches for right-handed neutrinos at accelerators

Friday, 12 July 2019 16:15 (15 minutes)

Extensions to the SM featuring a low-scale seesaw can be used to explain the observation of neutrino oscillations, baryogenesis and dark matter. I present the potential to search for right-handed neutrinos using current experiments. I compare the reach of the main detectors at the LHC when a displaced vertex signature in proton collisions is used. Additionally, I show the potential to improve on that using heavy ion collisions. Finally, I present the reach of the fixed target experiment NA62.

Primary author: Dr HAJER, Jan (Université catholique de Louvain)
Presenter: Dr HAJER, Jan (Université catholique de Louvain)
Session Classification: Searches for New Physics
Track Classification: Searches for New Physics
Detection of a Neutrino Event at the Glashow Resonance Energy in IceCube

Thursday, 11 July 2019 10:00 (20 minutes)

The IceCube Neutrino Observatory has measured the astrophysical neutrino flux from tens of TeV up to PeV energies, with no significant indication of a cutoff at the highest energies. At these energies, the neutrino event-rates quickly drop and spectral measurements are statistically limited.

However, at an energy of $\approx 6.3$ PeV, anti-electron neutrinos are expected to resonantly interact with atomic electrons via the Glashow resonance mechanism creating $W^-$-bosons, and thereby increasing the total neutrino interaction probability by two orders of magnitude. This process has so far never been experimentally observed.

Observation of Glashow resonance events would provide a unique possibility to measure the ratio of neutrinos and anti-neutrinos, which is an important input for the theoretical modelling of astrophysical accelerators.

In this talk, I will present our finding of a single partially-contained shower-like neutrino event with deposited energy $E_{\text{dep}} = 6.04^{+0.63}_{-0.61}$ PeV, consistent with a neutrino interacting via the Glashow resonance.

The event shows a clear signature of relativistic muon production, consistent with a hadronic origin of the particle shower. The leading muon energy is estimated to $E_\mu = 20^{+44}_{-5}$ GeV and consistent with expectations for a hadronic W-decay with $\approx 6$ PeV lab-energy.

Furthermore, such an event topology is highly unlikely to arise from atmospheric background. With an estimated background rate of $10^{-7}$ in the 4.6 year search period, this strongly suggests an astrophysical origin of the neutrino.

**Primary authors:** HAACK, Christian (RWTH Aachen University); LU, Lu (Chiba University); YUAN, Tianlu (UW Madison)

**Presenter:** HAACK, Christian (RWTH Aachen University)

**Session Classification:** Astroparticle Physics and Gravitational Waves

**Track Classification:** Astroparticle Physics and Gravitational Waves
Relating CGC and TMD factorization frameworks beyond leading twist

Thursday, 11 July 2019 10:34 (18 minutes)

It is known already for some time that the leading power limit of the Color Glass Condensate (CGC) expressions for dijet production can be identified with the (generalized) Transverse Momentum Dependent (TMD) factorization in the small $x$ regime. In the latter formalism, there are several TMD gluon distributions containing distinct Wilson line operators, and corresponding on-shell hard factors. There is a natural extension of this formalism, which generalizes the on-shell hard factors to the off-shell case in a gauge invariant way – the so-called small-$x$ improved TMD factorization (ITMD) [JHEP 1509 (2015) 106], which allows to study the kinematic regime beyond back-to-back configuration, and thus beyond the leading twist. In a recent work [arXiv:1901.01175] we studied the relation of the ITMD approach and the CGC theory in detail. We have shown that the ITMD framework corresponds to isolated and resummed all kinematic twists in the CGC theory.

Primary author: KOTKO, Piotr (Penn State University)
Presenter: KOTKO, Piotr (Penn State University)
Session Classification: Heavy Ion Physics
Track Classification: Heavy Ion Physics
Particle Physics in a Common Language

Friday, 12 July 2019 15:15 (15 minutes)

Ten years ago, the CERN Portuguese Teachers Program was extended to include also teachers from the other Portuguese speaking countries. This has allowed large numbers of teachers from Portugal and Brazil to come together with teachers from several African nations, and from East Timor in Asia. In addition to enlarging the reach of the CERN programs to other non-member countries, in developing regions, this increases the opportunity for sharing experiences among teachers of very different countries.

In May 2019, an Association of Physicists sharing the Portuguese language will be launched in São Tomé e Príncipe, and it is probable that other common training initiatives will follow from there. Students of São Tomé e Príncipe, a relatively small island country next to the equator, are already participating in the IPPOG masterclasses for many years, for example. The engagement with particle physics of teachers and students of these countries can be quite different, and there are several things each can learn from the others.

Primary authors: ANDRINGA, Sofia (LIP); ABREU, Pedro (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Presenter: ANDRINGA, Sofia (LIP)

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
Commissioning of the Belle II Pixel Vertex Detector

Thursday, 11 July 2019 10:15 (15 minutes)

As an upgrade of the asymmetric e⁺e⁻ collider KEKB, SuperKEKB aims to increase the peak luminosity by a factor of 40 to $8 \times 10^{35}$ cm⁻²s⁻¹. The upgraded Belle II detector allows the experiment to handle the much increased data rates, with the goal to explore new physics beyond the Standard Model at the intensity frontier. Belle II is expected to accumulate a dataset of 50 ab⁻¹ by 2027. The Belle II pixel detector (PXD) has been developed using the DEpleted P-channel Field Effect Transistor (DEPFET) technology, which combines low power consumption in the active pixel area and low intrinsic noise with a very small material budget. In this talk commissioning and performance of this novel detector measured with first collision data will be presented.

Primary author: Dr YE, Hua
Co-author: PXD-DEPFET COLLABORATION
Presenters: Dr YE, Hua; PXD-DEPFET COLLABORATION
Session Classification: Detector R&D and Data Handling
Track Classification: Detector R&D and Data Handling
Crystal-assisted HEP

Monday, 15 July 2019 18:30 (1h 30m)

In a crystal, atoms arranged in a precise and periodic pattern interact together as planes or axes with incoming charged particles. Thus, it is possible to substitute the random incoherent scattering of each atom with continuum potentials and fields. These planar and axial fields are extremely intense (up to $10^9$ V/cm for Si, up to $10^{12}$ V/cm for heavier elements) and exceed artificial ones. Several phenomena could be efficiently exploited to assist HEP application.

Planar channeling occurs when charged particles impinges crystal planes within a critic angle: positive charged particles are confined between planes away from nuclei and undergo strongly reduced scattering. When a crystal is bent, the particles channeled along the planes follow the curvature and change trajectory accordingly. This is a powerful mean for beam steering: a silicon bent crystal can achieve in few millimeters the effect of hundreds tesla magnetic dipole. A bent crystal could efficiently separate the beam particle halo from the primary beam in a controlled manner, increasing collimation efficiency. The same deflected particles could be exploited as an extracted beam instead of being lost. Recently it has been proposed to exploit the bent trajectory inside crystal to induce precession of MDM and EDM in fast decay particles, whose short life do not allow use of magnetic dipole. In case of axial alignment, the stronger effect of stochastic deflection is possible. In this case is possible to deflect also negative particles.

Crystal can be unique sources of radiation as well. A sinusoidally bent crystal can perform as free electron laser crystalline undulator, similar to traditional one but with period reduced of 2-3 order of magnitude. Either undulator or synchrotron radiation is emitted by channeling radiation, while the particle is channeled.

Axial potential exceeds the planar case, so much that in some cases critical field condition is achieved, which results in enhanced emission of hard radiation or emission of $e^+/e^-$ couples. Such effects are Lorentz-boosted, hence intensify as projectile momentum increases. This effect enables novel design of gamma sources for hybrid positron production, “smart” gamma converter to clean photons from a neutral beam, compact electromagnetic calorimeters for forward detectors or satellites.

Primary authors: ROMAGNONI, Marco (Università e INFN, Ferrara (IT)); MAZZOLARI, Andrea (Università e INFN, Ferrara (IT)); BANDIERA, Laura (Università e INFN, Ferrara (IT)); GUIDI, Vincenzo Guidi (University of Ferrara and INFN); CAMATTARI, Riccardo (Università e INFN, Ferrara (IT)); SYTOV, Alexei (Università e INFN, Ferrara (IT)); TIKHOMIROV, Victor (BSU); Dr TAMISARI, Melissa (University of Ferrara); Dr CASOTTI, Davide (INFN Ferrara); CAVOTO, Gianluca (Sapienza Università e INFN, Roma I (IT)); HAURYLAVETS, Viktar (Institut for Nuclear Problems, Belarusian State University)

Presenter: ROMAGNONI, Marco (Università e INFN, Ferrara (IT))

Session Classification: Wine & Cheese Poster Session

Track Classification: Accelerators for HEP
Search for a Higgs boson produced in association with a Z or W boson, where H decays to b-bbar and the Z/W to leptons at CMS.

In 2012, the ATLAS and CMS Collaborations announced the discovery of a new state with a mass around 125 GeV, compatible with the Standard Model Higgs boson. The measurements of this new particle’s properties are important to test the predictions of the Standard Model.

A measurement of the Higgs-beauty quark coupling through the Higgs boson production associated with a Z or W boson in the dilepton + beauty final state is presented. The analysis is based on 41.3/ fb data from p-p collisions at 13 TeV center-of-mass energy, collected by CMS in 2017. When combining with previous versions of the analysis on the 7, 8 and 13 TeV center-of-mass energy, a 125.09 GeV Standard Model Higgs is measured with a significance of 4.8 sigma. The combination of this measurement with other CMS analyses of a Higgs boson decaying in the beauty quarks yields a significance of 5.6 sigma. This is the first observation of a Higgs boson decaying into bottom quarks at CMS.

The poster gives an overview of the analysis strategy and results on the 2017 dataset. Results of the combination with other Higgs search will be presented as well.

**Primary author:** GEDIA, Krunal Bipin (ETH Zurich (CH))

**Presenter:** GEDIA, Krunal Bipin (ETH Zurich (CH))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Higgs Physics
Majorana and pseudo-Dirac Neutrinos at the ILC

Monday, 15 July 2019 18:30 (1h 30m)

In the extension of the standard model with two right hand neutrinos and considering an approximate lepton number symmetry, we can have these neutrinos with masses in the scale of the GeV and with large mixing. We found that splitting in the masses of the right handed neutrinos could be connected to a lepton number violation (LNV) parameter, and that therefore we will have important contributions from LNV processes.

We consider the production of heavy neutrinos in electron-positron colliders, where its displaced vertex can be a golden signal for experimental searches. We analyze a forward-backward asymmetry that will depend on the mass splitting of heavy neutrinos. With this asymmetry, we can put restrictions on the mass difference, and find that they can be much lower than the known limits.

Primary authors: Dr JONES PÉREZ, Joel (Pontificia Universidad Católica del Perú); Mr SUAREZ NAVARRO, Omar (Pontificia Universidad Católica del Perú); Dr HERNÁNDEZ, Pilar (Instituto de Física Corpuscular (IFIC), CSIC-Universitat de Valencia.)

Presenter: Mr SUAREZ NAVARRO, Omar (Pontificia Universidad Católica del Perú)

Session Classification: Wine & Cheese Poster Session

Track Classification: Neutrino Physics
In this presentation we discuss the contribution of the three-pomeron configurations to quarkonia production in proton-proton collisions. This mechanism provides a natural explanation of the elevated multiplicities of the produced charged hadrons in the events with production of charmonia. The suggested mechanism gets dominant contribution from the region which can be theoretically described by CGC/Saturation approach, and numerically gives a substantial contribution to the $J/\psi$ production. It is able to describe the experimentally observable shapes of the rapidity, momenta and multiplicity distributions. This implies that contribution of multipomeron (multigluon) mechanisms might be numerically substantial and should be analyzed in more detail.

**Primary authors:** SIDDIKOV, Marat (Universidad Santa Maria); Prof. LEVIN, Eugene (Tel Aviv University/UTFSM)

**Presenter:** SIDDIKOV, Marat (Universidad Santa Maria)

**Session Classification:** Heavy Ion Physics

**Track Classification:** Heavy Ion Physics
As the experimental precision at the LHC keeps improving, next-to-next-to leading order (NNLO) corrections for scattering processes have become crucial for providing theoretical predictions of comparable accuracy. The scattering amplitudes are a fundamental ingredient of these theoretical predictions, and the perturbative analytic calculations are extremely valuable. While NNLO calculations for two-to-two scattering processes are becoming the new standard, analytic results for two-to-three processes are rather scarce and are usually restricted to the planar approximation. Many of the processes appearing in the latest Les Houches “wish list” involve yet unknown two-to-three scattering amplitudes. In particular, the three-jet production, which offers unique opportunities for precision measurements, is of great interest. In order to tackle high-multiplicity scattering processes in NNLO approximation analytically, a dramatic revolution in the tools and techniques is necessary. In my talk I will present analytic results for all master integrals (including the non-planar sector) that describe the NNLO virtual corrections for the three-jet production; in other words, these are two-loop master integrals for five-particle massless scattering. The calculation relies on the cutting-edge mathematical techniques: symbol alphabets, leading singularity analysis, the method of differential equations in their canonical form. I will describe the relevant functional space for the five-particle scattering, and then I will explain how to extract arbitrarily high precision numerical values of the master integrals. Finally, I will show some applications of the master integrals for calculating gauge-theory two-loop scattering amplitudes. The talk is based on arXiv:1812.11160; PRL 122, 121602; JHEP 1903 (2019) 115.

**Primary author:** CHICHERIN, Dmitry (Max Planck Institute for Physics)

**Presenter:** CHICHERIN, Dmitry (Max Planck Institute for Physics)

**Session Classification:** QCD and Hadronic Physics

**Track Classification:** QCD and Hadronic Physics
Charm and tau loop effects in $B^+ \rightarrow K^+ \mu^- \mu^+$

Saturday, 13 July 2019 09:55 (15 minutes)

I will present an improved parametrisation of the contribution of $\bar{c}c$ real intermediate states in the $B^+ \rightarrow K^+ \mu^- \mu^+$ decay, aimed at improving the description of the dilepton spectrum and, possibly, the extraction of short-distance information from this process. Motivated by $B$-anomalies, whose combined explanations calls for large NP in the $b \rightarrow s\tau^-\tau^+$ transition, I will also comment on the possibility of extracting bounds on this contribution from the $B^+ \rightarrow K^+ \mu^- \mu^+$ dilepton spectrum.

Primary author: CORNELLA, Claudia (University of Zurich )
Presenter: CORNELLA, Claudia (University of Zurich )
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
HAMMER: a tool for new physics searches in semileptonic decays at Belle II and LHCb

Friday, 12 July 2019 11:45 (20 minutes)

The search for new physics (NP) involving semileptonic $b$-hadron decays requires large, dedicated Monte Carlo data sets, in order to properly model acceptance and selection efficiencies. We present the Hammer reweighting tool, developed for and in conjunction with the LHCb and Belle II experiments, that makes use of an efficient event and histogram reweighting strategy, permitting computationally inexpensive exploration of NP effects in the fully differential phase space. The Hammer approach also permits study of the effects of different choices for hadronic form-factor parametrizations, crucial for the measurement of the CKM elements $|V_{cb}|$ and $|V_{ub}|$. In this talk we show various example applications of this tool, both for NP and CKM matrix studies.

Primary authors: ROBINSON, Dean (UC Santa Cruz/ LBL); BERNLOCHNER, Florian Urs (KIT - Karlsruhe Institute of Technology (DE)); DUELL, Stephan (University of Bonn); PAPUCCI, Michele (Lawrence Berkeley National Laboratory); PAPUCCI, Michele (Lawrence Berkeley National Laboratory (LBNL)); LIGETI, Zoltan (Lawrence Berkeley National Lab. (US))

Presenter: DUELL, Stephan (University of Bonn)

Session Classification: Flavour Physics and CP Violation

Track Classification: Flavour Physics and CP Violation
Generalized Parton Distributions from charged current meson production

Friday, 12 July 2019 11:30 (15 minutes)

We suggest that generalized parton distributions can be probed in charged current meson production process, like $e p \rightarrow e \pi^- p$ and $e p \rightarrow e \rho^- p$. In contrast to pion photoproduction, this process is sensitive to the unpolarized GPDs $H, E$, and for this reason has a very small contamination by higher twist and Bethe-Heitler type contributions. We prove that the simultaneous study of both $\rho$- and $\pi$-meson production by charged currents in Bjorken kinematics allows for a very clean extraction of the leading twist Generalized Parton Distributions of the target, with inherent control of the contribution of higher-twist corrections. Also, it might provide target-independent constraints on the distribution amplitudes of the produced mesons. We expect that such processes might be studied either in neutrino-induced or in electron-induced processes. According to our numerical estimates, the cross-sections of these processes are within the reach of JLab and EIC experiments.

Primary authors: SIDIJKOV, Marat (Universidad Santa Maria); SCHMIDT, Ivan
Presenter: SIDIJKOV, Marat (Universidad Santa Maria)
Session Classification: QCD and Hadronic Physics
Track Classification: QCD and Hadronic Physics
Developments in International Masterclasses

Friday, 12 July 2019 09:30 (15 minutes)

International Masterclasses (IMC) have grown in a number of ways. World Wide Data Day (W2D2) and special masterclasses for International Day of Women and Girls in Science (IDWGS) are innovations that began two years ago and have taken root. W2D2 establishes new ways for high school students and teachers to engage in masterclass activities from their own classrooms. For IDWGS, a new pathway has been opened for high school girls to be encouraged in physics. New masterclass measurements beyond those for the LHC have been developed and tested, notably the MINERvA Neutrino Masterclass, which is the first IMC offering in neutrino physics and the first based on a Fermilab experiment. In the MINERvA measurement, students are able to study interactions of a neutrino beam with carbon nuclei, using conservation of momentum to draw conclusions. Other masterclass measurements related to Belle II and medical imaging are also in the testing stage. More neutrino masterclasses are in development as well, especially for MicroBooNE. A longer-term goal is the creation of a DUNE masterclass measurement as that facility reaches the data-taking stage.

Primary authors: CECIRE, Kenneth William (University of Notre Dame (US)); BILOW, Uta (Technische Universitaet Dresden (DE))

Presenter: BILOW, Uta (Technische Universitaet Dresden (DE))

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
THE USE OF NARRATION AND ART IN THE PUBLIC COMMUNICATION OF SCIENCE

Friday, 12 July 2019 12:15 (15 minutes)

As a laboratory for unconventional scientific communication, the experimentation of different ways to communicating science have led the INFN Communications Office to carry out, in the last decade, innovative formats for public events, in which performing arts intertwine with the narrative of science. Since the structure of the story is intrinsically connected with the process of knowledge building, the basic idea for these events relies on the belief that the use of narratives can help unveiling invisible connections in the interpretation of reality. Indeed, it and can open unexpected scenarios for the acquisition of knowledge, also offering greater understanding, interest and involvement. If well designed and verified in their contents, these innovative communication formats can offer tactics to involve different audiences of non-experts, correctly and ethically.

Examples are offered by public events like "Cosmic Tale", a conference-show about the universe birth and evolution, offered to more than 6000 people in the period 2016-19 (7 live replicas). The narrative structure of CT is based on the interweaving among dialogues, videos, readings and music, with a main thread given by a cartoon story, whose texts follow a well defined storyboard. More recently, the INFN and the Italian Space Agency (ASI) experimented with a new format, in which three scientists are invited to perform monologues, by telling the same story - that of the discovery of gravitational waves from the coalescence of neutron stars - from three different points of view (space satellites, terrestrial telescopes and gravitational wave detectors). In "Lights & Waves Rhapsody" jazz plays a dominant role, giving rhythm to the speech and underlining suspensions and climaxes, taking sometimes the scene to create a suitable environment for the public perception of ideas, as if the music staged its own monologue.

If conceived appropriately and evaluated in their impact on the audience, such scientific narratives can open unprecedented synthesis windows between science and art, giving rise to unexpected insights on abstract concepts of physics.

Primary author:  Mrs SCIANITTI, Francesca (INFN Communications Office)

Presenter:  Mrs SCIANITTI, Francesca (INFN Communications Office)

Session Classification:  Outreach, Education, and Diversity

Track Classification:  Outreach, Education, and Diversity
ART AS A LANGUAGE TO REPRESENT SCIENCE: A PROJECT FOR SCHOOLS

Creativity is something common to many disciplines and is certainly involved in artistic and scientific thought and work. Scientists and artists are asked to see and think beyond the perceivable reality. They can imagine aspects of things and phenomena, which can only be seen from an unusual perspective: they possess vision and creativity. We found it interesting to explore similarities and differences in the way art and science move, using the artistic language to talk about science. This is the goal of "Art&Science across Italy", a European project organized by the Italian National Institute for Nuclear Physics (INFN) and CERN: the use of the artistic language to capture the interest in the science of all students, regardless of their attitude towards scientific subjects or their initial knowledge, in order to represent scientific ideas and research topics through artworks. The artistic tools used by students to communicate science can be painting, sculpture, photography, filmmaking, storytelling or other artistic languages that can be useful to tell the story they have in mind.

The first step of the "Art&Science across Italy" project is aimed at training students on science and art, while in a second phase students are asked to design and implement an artwork inspired at a specific scientific topic, chosen among the ones approached during the first phase. All artworks will take part to a local exhibition, established in either a historical-cultural centre or a museum, in each participating city. The first 10 artworks of each local competition will pass to the national phase.

Selected by an international committee of experts (scientists, artists, science communicators), the winners of the national Art&Science competition will be invited to attend a school on art and science at CERN, in Geneva, and in other laboratories in Italy. The first edition of the project (2016-2018) involved 3000 students, who took part in scientific seminars and worked on artistic ideas inspired by science and research. The second edition of the project involves more than 4000 high school students from Florence, Genoa, Milan, Naples, Padua, Venice, Potenza, Matera, Pisa, Rome and Turin and will end in May 2020.
Outlook for Nuclear Collisions in the LHC after Run 2

Friday, 12 July 2019 15:15 (20 minutes)

LHC Run 2 ended with the 2018 Pb-Pb collision run, during which a luminosity 6 times beyond the design was achieved by further exploiting mitigations of the phenomena limiting luminosity that had been established in the 2015 run. Similar records were achieved with p-Pb collisions in 2016, a complex run, within a tight time frame, providing data sets at different energies, both in minimum-bias and high-luminosity modes. In 2017 a short Xe-Xe collision run demonstrated the collider’s flexibility with new species and further extended the physics programme. We discuss the prospects for achieving the luminosity goals defined for Runs 3 and 4 and the potential for colliding lighter nuclei.

Primary author:  JOWETT, John (CERN)
Presenter:  JOWETT, John (CERN)
Session Classification:  Accelerators for HEP
Track Classification:  Accelerators for HEP
Landau Damping of coherent beam instabilities: challenges at future high-energy hadron colliders

Friday, 12 July 2019 17:10 (20 minutes)

High energy hadron colliders are powerful tools for high energy physics research. The later experience at the Large Hadron Collider showed the fundamental need of strong Landau damping to keep the beams on stable orbits and achieve the luminosity goals needed for studying rare physics events. In the LHC the Landau damping is ensured by Landau octupole magnets that provide the necessary detuning with amplitude. For future higher energy colliders (i.e. FCC-hh or HE-LHC) these devices are limited due to the energy and intensity steps foreseen. For these reasons other mechanism are explored to provide the necessary Landau damping for transverse beam stability. In this study we highlight the physics mechanism and challenges of the different methods explored over the years (i.e. Landau octupoles, Radio frequency Quadrupoles, Electron-lens, second order chromaticity). Details on how the design of future higher energy colliders is modified by the presence of strong Landau damping devises is covered showing the challenges and improvements in the collider performances.

Primary author: PIELONI, Tatiana (EPF Lausanne)

Co-authors: TAMBASCO, Claudia (EPFL - Ecole Polytechnique Federale Lausanne (CH)); METRAL, Elias (CERN); LI, Kevin Shing Bruce (CERN); RIVKIN, Lenny (Paul Scherrer Institut (CH)); SCHENK, Michael; BUFFAT, Xavier (CERN)

Presenter: PIELONI, Tatiana (EPF Lausanne)

Session Classification: Accelerators for HEP

Track Classification: Accelerators for HEP
Art and Physics

Friday, 12 July 2019 11:30 (15 minutes)

Science and art define the culture of a society, through intention to understand the world around us. Both, art and science develop the ability of abstract thinking, the most powerful tool of knowledge, and the strongest force in the universe. Creativity is common to both science and art, science teaches us to think in a new way, and art teaches us to observe and perceive the world differently. Art seeks to understand what is that govern us human and science what is that govern the natural phenomena. The lecture will point out that the knowledge of physics about the nature of space and time and the new scientific paradigm influenced the artistic expression. Future will be shaped by new emerging technology advances in an fast and unpredictable way so that deep emotion is replaced by a superficial impression and deep reflection is reduced to the use of “smart” applications. The science and art are the only guarantee of preserving those values of which our humanity and uniqueness of human beings are weaved. The purpose of education should not be a mere acquiring of skills need bu labor market, the main purpose of education to learn how to think and make conclusion which leads to the new knowledge.

Primary author: Prof. GODINOVIC, Nikola (University of Split)

Presenter: Prof. GODINOVIC, Nikola (University of Split)

Session Classification: Outreach, Education, and Diversity

Track Classification: Outreach, Education, and Diversity
The Circular Electron Positron Collider (CEPC) project aims to build a circular electron-positron collider capable of precision physics measurements at center-of-mass energies ranging from 90 GeV to 240 GeV. The CEPC has a total circumference of at least one hundred kilometers and at least two interaction points. In its 10 years operation at 240 GeV, it will collect more than one million Higgs events. CEPC will also run at Z pole for two years, producing more than 100 billion Z bosons in two year. It will also collect data around WW threshold for one year, in order to perform the W boson mass measurement with high precision. These datasets will boost the precision of electroweak measurements by orders of magnitude. An overview is presented of the potential of CEPC to advance precision studies of electroweak physics with an emphasis on the opportunities in W and Z physics.

**Primary author:** Prof. LIANG, Zhijun (Chinese Academy of Sciences (CN))

**Presenter:** Prof. LIANG, Zhijun (Chinese Academy of Sciences (CN))

**Session Classification:** Top and Electroweak Physics

**Track Classification:** Top and Electroweak Physics
Status of the CODEX-b experiment to search for long-lived particles in LHCb

Friday, 12 July 2019 14:30 (15 minutes)

CODEX-b is a novel proposal to extend LHCb’s physics reach in long-lived particle searches by placing a 10X10X10m3 tracking volume around 25m from IP8, inside the LHCb cavern. The potential sensitivity probes not only high center of mass energy portals such as the Higgs invisible width to dark photons, but also low-scale vector, scalar or fermion mixing portals, such as heavy neutral leptons and new Higgs-mixed scalars. While the full proposal aims for the HL-LHC era, a smaller 2X2X2m3 demonstrator is being planned to be installed during 2021, to enable data-taking during Run3. An overview and current status of the project will be presented.

Primary authors: DEY, Biplab (CCNU); GLIGOROV, Vladimir (Centre National de la Recherche Scientifique (FR)); Dr ROBINSON, Dean; KNAPEN, Simon (Institute for Advanced Study); PAPUCCI, Michele (Lawrence Berkeley National Laboratory)

Presenter: DEY, Biplab (CCNU)

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
Cultural Collisions, a cross disciplinary science engagement and networking programme

Friday, 12 July 2019 12:00 (15 minutes)

“Cultural Collisions” is an interdisciplinary science/art engagement and networking programme. It is designed to trigger curiosity, creativity, and foster critical thinking in school students to help them overcome the scientific and technological challenges of the 21st century.

It was developed and evaluated within the EU funded project CREATIONS and supported by the international particle physics collaboration of the CMS experiment at CERN. The Cultural Collisions format has been implemented and tested in several European countries - Austria, Germany, Switzerland and Montenegro. Furthermore it was the key component of a research project sponsored by the Ontario Ministry of Education, Canada, which assessed the educational impact on participating students.

In the presentation, cross-disciplinary methodologies will be discussed and the results of the European and Canadian exercises will be presented showing that the programme has demonstrated its capacity to increase motivation and interest in science. In particular, the evaluation has also determined that there is a significant relationship between the creative presentation approach of the programme and the increased educational outcomes.

Primary author: Dr HOCH, Michael (Austrian Academy of Sciences (AT))
Presenter: Dr HOCH, Michael (Austrian Academy of Sciences (AT))
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
Digging deeper: Removal of astrophysical foreground from black hole and neutron star binaries to reveal the cosmological background

Saturday, 13 July 2019 09:40 (20 minutes)

In addition to the loud and nearby sources of gravitational waves from black hole-black hole or neutron star-neutron star binaries that are seen as isolated transient events, there is a population of weak, unresolved sources at higher redshifts. The superposition of these sources is expected to be the main contributor to the astrophysical stochastic background which may be detected in the next few years as the Advanced LIGO and Virgo detectors reach their design sensitivity. The astrophysical background contains a wealth of information about the history and evolution of point sources but it is a confusion background that obscures the observation of the primordial gravitational-wave background produced during the early stages of the Universe. In this talk, I will discuss the possibility of subtracting the astrophysical background with the third generation ground based detectors, such as the Einstein Telescope and Cosmic Explorer in order to observe the primordial background.

Primary authors: SACHDEV, Surabhi (Penn State University); Prof. REGIMBAU, Tania (Laboratoire D’annecy Le Vieux De Physique Des Particules); Prof. SATHYAPRAKASH, Bangalore (Penn State University)

Presenter: SACHDEV, Surabhi (Penn State University)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Anomaly-free model building: algebraic geometry and the Froggatt-Nielsen mechanism

Saturday, 13 July 2019 09:20 (15 minutes)

We present a method to find anomaly-free gauged U(1) Froggatt-Nielsen type models using results from algebraic geometry. These methods should be of general interest for model building beyond the Standard Model when rational charges are required. We consider models with a gauged U(1) flavour symmetry with one flavon and provide several model examples based on different physical assumptions. The models we study are; anomaly-free with all fermions being Dirac particles, anomaly-free with seesaw mechanism for neutrino masses and minimal supersymmetric model where the anomalies cancel via the Green-Schwarz mechanism. With these different models we show how algebraic methods may be used in model building; both to reduce the charge constraints by calculation of Gröbner bases, and to find rational solutions to cubic equations using Mordell-Weil generators.

Moreover, we show that the UV-behaviour of these models are in general plagued by Landau poles. Two different UV-completions are considered; through vector-like fermions and through Higgs doublets. In the fermion completion, the gauge couplings are in general plagued with Landau poles while in a scalar completion this may be avoided, but instead the quartic couplings generally blow up. Thus, the generic case is that neither completion works, but the scalar completion might be saved by appropriate choice of parameters in the scalar potential. This conclusion does not change if we allow U(1) to be anomalous or global.

Primary author: TELLANDER, Felix
Presenter: TELLANDER, Felix
Session Classification: Flavour Physics and CP Violation
Track Classification: Flavour Physics and CP Violation
Fat Jet Signature of a Heavy Neutrino at Lepton Collider

Friday, 12 July 2019 10:30 (15 minutes)

In this work, we study the discovery prospect of a heavy neutrino in the intermediate to very high mass range at $e^+e^-$ collider. We consider two different c.m. energies $\sqrt{s} = 1.4$ TeV and 3 TeV, respectively, that are relevant for CLIC. Contrary to the LHC, the production cross-section of a heavy neutrino at $e^+e^-$ collider is fairly large. We consider two different mass ranges $M_N = 600 - 1200$ GeV, that can be probed at 1.4 TeV run of CLIC, and $M_N = 1300 - 2700$ GeV, that can be discovered with 3 TeV c.m. energy. We consider the production mode $e^+e^- \rightarrow \nu_eN$, and the subsequent decays of $N$ into an electron $e^\pm$ and $W^\pm$ gauge boson. We further consider the hadronic decay modes of $W^\pm$. For such a heavy $N$, the $W^\pm$'s are highly boosted. Hence, the quarks from $W^\pm$ are collimated, leading to a single fat-jet. Therefore, the final state is $e^\pm + j_{\text{fat}} + \text{Missing momentum}$. We pursue an in-depth study for this final state, with both cut-based and multivariate analysis (MVA). We show that a heavy neutrino with mass $600 - 2700$ GeV and mixing $|V_{eN}|^2 \sim 10^{-5} - 10^{-6}$ can be discovered with $5\sigma$ significance at $e^+e^-$ collider with $L \sim 500$ fb$^{-1}$ luminosity, which is an order of magnitude betterment as opposed to the LHC limit.

**Primary author:** SHIL, SUJAY (INSTITUTE OF PHYSICS, BHUBANESWAR, INDIA)

**Presenter:** SHIL, SUJAY (INSTITUTE OF PHYSICS, BHUBANESWAR, INDIA)

**Session Classification:** Searches for New Physics

**Track Classification:** Searches for New Physics
A viable Two Higgs Doublet Model with CP violation of spontaneous origin is presented. In this model, based on a flavoured $Z_2$ symmetry, the lagrangian respects CP invariance, while the vacuum has a CP violating phase, which is able to generate a complex CKM matrix. Scalar mediated flavour changing neutral couplings are analysed, stressing the connection between the generation of a complex CKM matrix and the unavoidable presence of scalar FCNC. The scalar sector is also presented in detail, showing that the new scalars are necessarily lighter than 1 TeV. Finally, a phenomenological analysis of the model including the most relevant constraints is discussed, exploring, in particular, definite implications for the observation of New Physics signals.
High-Energy Neutrino Astronomy: Current Status and Prospects

Thursday, 11 July 2019 09:00 (30 minutes)

In the last decade, neutrino astronomy has taken off and collected two major breakthroughs, the first observation of high-energy astrophysical neutrinos in 2013 and the first joint observation of gamma-rays and neutrinos (from TXS0506+056) announced last summer. In this talk, we will review these important milestones as well as the other noteworthy achievements reached by the community. We will emphasize the interest of neutrino searches in the multi-messenger era and describe the current efforts carried out in the large neutrino telescopes, with a focus on the IceCube Neutrino Observatory and KM3NeT. We will conclude presenting an outlook for the coming years.

Primary author:  DE WASSEIGE, Gwenhaël (APC, CNRS)
Presenter:  DE WASSEIGE, Gwenhaël (APC, CNRS)
Session Classification:  Astroparticle Physics and Gravitational Waves
Track Classification:  Astroparticle Physics and Gravitational Waves
Discussion

Thursday, 11 July 2019 10:45 (15 minutes)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Contribution ID: 803  
Type: not specified

**Discussion**

**Session Classification:** Higgs Physics

**Track Classification:** Higgs Physics
TrackML : the roller coaster of organizing a HEP challenge on Kaggle and Codalab

Friday, 12 July 2019 09:45 (15 minutes)

The HL-LHC will see ATLAS and CMS see proton bunch collisions reaching track multiplicity up to 10,000 charged tracks per event. Algorithms need to be developed to harness the increased combinatorial complexity. To engage the Computer Science community to contribute new ideas, we have organized a Tracking Machine Learning challenge (TrackML), running first on Kaggle platform, then on Codalab platform. Participants are provided events with 100k 3D points, and are asked to group the points into tracks; they are also given a 100GB training dataset including the ground truth. This talk will describe the challenges within the challenge, and the lessons drawn from this adventure to engage the machine learning community on a specific HEP problem.

Primary author: ROUSSEAU, David (LAL-Orsay, FR)
Presenter: ROUSSEAU, David (LAL-Orsay, FR)
Session Classification: Outreach, Education, and Diversity
Track Classification: Outreach, Education, and Diversity
Latest Daya Bay neutrino oscillation results

Monday, 15 July 2019 18:30 (1h 30m)

The Daya Bay Reactor Neutrino Experiment was designed to measure $\theta_{13}$, the smallest mixing angle in the three-neutrino mixing framework, with unprecedented precision. The experiment consists of eight identically designed detectors placed underground at different baselines from three pairs of nuclear reactors in South China. Since Dec. 2011, the experiment has been running stably for more than 7 years, and has collected the largest reactor anti-neutrino sample to date. Daya Bay greatly improved the precision on $\theta_{13}$ and made an independent measurement of the effective mass splitting in the electron antineutrino disappearance channel. Daya Bay also performed a number of other precise measurements, such as a high-statistics determination of the absolute reactor antineutrino flux and spectrum evolution, as well as a search for sterile neutrino mixing, among others. The most recent neutrino oscillation results from Daya Bay are discussed in this talk, as well as the current status and future prospects of the experiment.

**Primary author:** VOROBEL, Vit (Charles University (CZ))

**Presenter:** VOROBEL, Vit (Charles University (CZ))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Neutrino Physics
We consider unfavoured light quark/antiquark to D meson fragmentation. We discuss nonperturbative effects for small transverse momenta. The asymmetry for $D^+$ and $D^-$ production measured by the LHCb collaboration provides natural constraints on the parton (quark/antiquark) fragmentation functions. We find that already a fraction of fragmentation probability is sufficient to account for the measured asymmetry. Large D-meson production asymmetries are found for large $x_F$ which is related to dominance of light quark/antiquark fragmentation over the standard $c \to D$ fragmentation. As a consequence, prompt atmospheric neutrino flux at high neutrino energies can be much larger than for the conventional $c \to D$ fragmentation. The latter can constitute a sizeable background for the cosmic neutrinos claimed to be observed recently by the IceCube Observatory.

2. V.P. Goncalves, R. Maciula and A. Szczurek,”From $D^{\pm}$ production asymmetry at the LHC to prompt $\nu_{\tau}$ at IceCube,” arXiv:1809.05424 [hep-ph]
Prospects for Higgs and precision SM physics with the ATLAS detector at the HL-LHC

Thursday, 11 July 2019 16:45 (20 minutes)

The Large Hadron Collider (LHC) has been successfully delivering proton-proton collision data at the unprecedented center of mass energy of 13 TeV. An upgrade is planned to increase the instantaneous luminosity delivered by LHC in what is called HL-LHC, aiming to deliver a total of about 3000/fb of data to the ATLAS detector at a center of mass energy of 14 TeV. To cope with the expected data-taking conditions ATLAS is planning major upgrades of the detector.

In this contribution we present an overview of the precision physics measurement of the Standard Model, with particular focus on the electro-weak and Higgs sectors. Prospects for precision determination of Standard Model fundamental parameters, as the weak mixing angle, the Higgs couplings, di-Higgs observation, vector boson scattering processes, as well as measurement for rare Higgs decays are presented.

Such studies formed the basis of the ATLAS Collaboration input to the recent HL/HE-LHC Yellow-Report. An executive summary of this report was then submitted as input to the European Strategy process.

Primary author:  WOSIEK, Barbara Krystyna (Institute of Nuclear Physics Polish Academy of Sciences (PL))

Presenter:  MCFAYDEN, Josh (CERN)

Session Classification:  Higgs Physics

Track Classification:  Higgs Physics
Resonances in unitarized HEFT at the LHC

Monday, 15 July 2019 18:30 (1h 30m)

Higgs Effective Field Theory (HEFT) can be used to study vector-boson elastic scattering at the high energies relevant for the LHC. For most of the parameter space, the scattering is strongly interacting, with the minimal Standard Model being a remarkable exception. From its one-loop treatment complemented with dispersion relations and the Equivalence Theorem, we derive two different unitarization methods which produce analytical amplitudes corresponding to different approximate solutions to the dispersion relations: the Inverse Amplitude method (IAM) and the N/D method. The partial waves obtained can show poles in the second Riemann sheet whose natural interpretation is that of dynamical resonances with masses and widths a function of the starting HEFT parameters. We compare the different unitarizations and we find that they are qualitatively, and in many cases quantitatively, very similar. However, for different reason it is more interesting to use one of the two methods depending on the particular channel for WW, ZZ, W Z, Zh, W h or hh scattering. Here we briefly describe the possible I and J channels for these reactions and give the unitarization method of choice in each case. The amplitudes obtained provide realistic resonant and nonresonant cross sections to be compared with and to be used for a proper interpretation of the LHC data.

Primary authors: DOBADO, Antonio (Universidad Complutense (ES)); LLANES-ESTRADA, Felipe J.

Presenter: DOBADO, Antonio (Universidad Complutense (ES))

Session Classification: Wine & Cheese Poster Session

Track Classification: Higgs Physics
The Latest Results from the Alpha Magnetic Spectrometer on the ISS

Thursday, 11 July 2019 14:30 (30 minutes)

Precision measurements by AMS of the fluxes of cosmic ray positrons, electrons, antiprotons, protons and light nuclei as well as their ratios reveal several unexpected and intriguing features. The presented measurements extend the energy range of the previous observations with much increased precision. The new results show that the positron flux rises from ~10 GeV above the rate expected from cosmic ray collisions with interstellar gas and at energies ~300 GeV exhibits behavior consistent with a new source of high energy positrons. Surprisingly, at similar rigidities the spectra of cosmic ray nuclei show progressive hardening over the interval of few hundred GV. Most importantly, AMS continues studies of complex antimatter candidates with stringent detector verification and collection of additional data.

Primary author: KOUNINE, Andrei (Massachusetts Inst. of Technology (US))
Presenter: KOUNINE, Andrei (Massachusetts Inst. of Technology (US))
Session Classification: Astroparticle Physics and Gravitational Waves
Track Classification: Astroparticle Physics and Gravitational Waves
Properties of Primary and Secondary Cosmic Ray Nuclei Measured with the Alpha Magnetic Spectrometer on the ISS

Thursday, 11 July 2019 15:00 (20 minutes)

We present precision measurements of primary and secondary cosmic rays by Alpha Magnetic Spectrometer in the rigidity range up to several TV. These measurements are based on high statistics nuclei samples collected by AMS during the first 7 years of operation aboard the International Space Station. Surprisingly, at ~200 GV all the measured nuclei spectra experience progressive hardening over the rigidity interval of few hundred GV. This hardening is more pronounced for the secondary nuclei such as lithium, beryllium, and boron than for the primary nuclei as helium, carbon and oxygen. The properties of cosmic ray nuclei isotopes will also be discussed.

Primary author: DEROME, Laurent Yves Marie (LPSC Laboratoire de Physique Subatomique et de Cosmologie (LPSC))

Presenter: DEROME, Laurent Yves Marie (LPSC Laboratoire de Physique Subatomique et de Cosmologie (LPSC))

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Anisotropy of Cosmic Ray Fluxes Measured with the Alpha Magnetic Spectrometer on the ISS

*Thursday, 11 July 2019 15:20 (20 minutes)*

Analysis of anisotropy of the arrival directions of galactic protons, electrons and positrons has been performed with the Alpha Magnetic Spectrometer on the International Space Station. These results allow to differentiate between point-like and diffuse sources of cosmic rays for the explanation of the observed excess of high energy positrons. The AMS results on the dipole anisotropy are presented along with the discussion of implications of these measurements.

**Primary author:** CASAUS, Jorge (Centro de Investigaciones Energéticas Medioambientales y Tecno)

**Presenter:** CASAUS, Jorge (Centro de Investigaciones Energéticas Medioambientales y Tecno)

**Session Classification:** Astroparticle Physics and Gravitational Waves

**Track Classification:** Astroparticle Physics and Gravitational Waves
Search for anomalous triple gauge couplings in semileptonic WW and WZ decays with CMS

Monday, 15 July 2019 18:30 (1h 30m)

The LHC Run II with a center-of-mass energy of 13 TeV has opened new doors for searching possible effects of physics beyond the standard model. New physics can be parametrized by the addition of higher dimensional operators to the Standard Model Lagrangian in the so called Effective Field Theory approach.

In this poster we summarize an analysis which focuses on operators in the electroweak sector which lead to anomalous triple gauge couplings (aTGC). The analysis deals with the WW/WZ final states in the semileptonic decay channel where boosted topology is used for the hadronic decay. We present 1-D and 2-D limits on aTGC parameters, with the limits being the most stringent experimental limits to date.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))
Presenter: IQBAL, Muhammad Ansar (KIT - Karlsruhe Institute of Technology (DE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
QCD couplings probed with top quark pairs at CMS

Monday, 15 July 2019 18:30 (1h 30m)

A measurement of the inclusive top quark-antiquark pair production cross section in proton proton collisions at a centre-of-mass energy of 13 TeV is used by the CMS experiment, together with the theoretical prediction at next-to-next-to-leading order, to determine the top quark mass and to extract a value of the strong coupling constant with different sets of parton distribution functions. Dilepton events are selected and the cross section is measured from a likelihood fit to the final state distributions. The dependence of the measured cross section on the assumption on the top quark mass parameter in the POWHEG simulation is mitigated by including this parameter in the fit. The top quark mass is extracted in the pole and running mass schemes.

Primary author: MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

Presenter: DEFRANCHIS, Matteo (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Wine & Cheese Poster Session

Track Classification: Top and Electroweak Physics
Observation of single top quark production in association with a Z boson from CMS

*Monday, 15 July 2019 18:30 (1h 30m)*

The observation of single top quark production in association with a Z boson and a quark (tZq) is presented. Events from proton-proton collisions at a center-of-mass energy of 13 TeV containing three charged leptons (either electrons or muons) and at least two jets are analyzed. The data were collected with the CMS detector in 2016 and 2017, and correspond to an integrated luminosity of 77.4 fb⁻¹. The increased integrated luminosity, a multivariate lepton identification, and a redesigned analysis strategy improve significantly the sensitivity of the analysis compared to previous searches for tZq production. The tZq signal is observed with a significance well over five standard deviations, and its production cross section is measured with an uncertainty more than twice smaller than that in any previous measurement.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** VERBEKE, Willem (Ghent University (BE))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Top and Electroweak Physics
Water phase results and $0\nu\beta\beta$ prospects of the SNO+ experiment

Friday, 12 July 2019 18:00 (15 minutes)

SNO+ is a multipurpose neutrino detector located in 2km underground in Sudbury, Canada. The experiment is taking data and the first results from water phase on invisible nucleon decay search and solar neutrino analysis will be presented. The ultra-pure water inside the detector is currently being replaced by liquid scintillator, which will then be loaded with tellurium-130 to provide high sensitivity for neutrinoless double beta decay search starting next year. Further substantial improvements to the sensitivity could be achieved in an economical and straightforward manner by increasing the loading. The nature of the tellurium loading technique, projected $0\nu\beta\beta$ sensitivities and future prospects will also be presented.

Primary author: KROUPOVA, Tereza (University of Oxford (GB))
Presenter: KROUPOVA, Tereza (University of Oxford (GB))
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
The smallness of neutrino masses provides a tantalizing allusion to physics beyond the standard model (SM). Heavy neutral leptons (HNL), such as hypothetical sterile neutrinos, accommodate a way to explain this observation, through the see-saw mechanism. If they exist, HNL could also provide answers about the dark matter nature, and baryon asymmetry of the universe. A search for the production of HNL at the LHC, originating from leptonic W boson decays through the mixing of the HNL with SM neutrinos, is presented. The search focuses on signatures with three leptons, providing a clean signal for probing the production of the HNL in a wide mass range never explored before at the LHC: down to 1 GeV, and up to 1.2 TeV. The sample of pp collisions collected by the CMS detector throughout 2016 is used, amounting to a volume of 35.9/ fb.

**Primary author:** MEYER, Arnd (Rheinisch Westfaelische Tech. Hoch. (DE))

**Presenter:** VIT, Martina (Ghent University (BE))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Searches for New Physics
A measurement of the top quark Yukawa coupling from differential cross sections of top quark pairs with CMS

A measurement of the top quark Yukawa coupling from the top quark-antiquark production as function of the mass of the top quark pair and the rapidity difference is presented. Corrections due to weak boson exchange, including the Higgs boson, between the top quarks can produce large distortions of differential distributions near the energy threshold of top quark pair production and at high invariant masses. Therefore, precise measurements of these distributions are sensitive to the Yukawa coupling.

**Primary author:** MEYER, Arnd (Rheinisch Westfälische Tech. Hoch. (DE))

**Presenter:** HINDRICHS, Otto Heinz (University of Rochester (US))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Top and Electroweak Physics
Disentangling Higgs and Electroweak Physics at Future Lepton Colliders

Thursday, 11 July 2019 12:30 (15 minutes)

With Higgs couplings measurement prospects reaching the per-mille level at future lepton colliders, their interplay with the electroweak sector is expected to become relevant. We perform the first comprehensive Standard Model Effective Field Theory analysis covering jointly the Higgs and electroweak sectors. It allows us to investigate the impact of electroweak parameter uncertainties in Higgs couplings determination; to examine what electroweak measurements are needed to achieve the full potential of the precision Higgs physics program at future lepton colliders; and conversely to discuss the possible improvement to measurements electroweak parameters otherwise brought by Higgs measurements. For this we systematically compare reaches for circular and linear colliders with several proposed energies and polarization configurations.

Primary author: Dr PAUL, Ayan (INFN, Sezione di Roma)

Presenter: Dr PAUL, Ayan (INFN, Sezione di Roma)

Session Classification: Higgs Physics

Track Classification: Higgs Physics
Search for chargino and neutralino production with three leptons and missing transverse momentum in the final states at $\sqrt{s} = 13$ TeV with the ATLAS detector

A search is presented for the direct pair production of a chargino and a neutralino $pp \rightarrow \tilde{\chi}^\pm_1 \tilde{\chi}^0_2$, where the chargino decays to the lightest neutralino and the $W$ boson, $\tilde{\chi}^\pm_1 \rightarrow \tilde{\chi}^0_1 (W^\pm \rightarrow \ell^\pm \nu)$, while the neutralino decays to the lightest neutralino and either the $Z$ boson $\tilde{\chi}^0_2 \rightarrow \tilde{\chi}^0_1 (Z \rightarrow \ell^\ell)$ or the 125 GeV Higgs boson, $\tilde{\chi}^0_2 \rightarrow \tilde{\chi}^0_1 (h \rightarrow \ell^\ell)$. The final states considered for the search have large missing transverse momentum and three isolated light leptons (electrons and muons). The analysis is based on $\sqrt{s} = 13$ TeV proton-proton collision data delivered by the Large Hadron Collider and recorded with the ATLAS detector.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))

Presenter: TROVATO, Fabrizio (University of Sussex (GB))

Session Classification: Wine & Cheese Poster Session

Track Classification: Searches for New Physics
Search for supersymmetric partners of third-generation quarks in 139 fb−1 of pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector.

Monday, 15 July 2019 19:40 (20 minutes)

This poster presents the latest results on searches for pair production of supersymmetric partners of the top and bottom quarks using the LHC proton-proton collision data, recorded by the ATLAS detector at a center of mass energy of $\sqrt{s}=13$ TeV from 2015 to 2018, corresponding to an integrated luminosity of 139 fb−1. Different final states and models are considered for each search.

Primary author: JUSTE ROZAS, Aurelio (ICREA and IFAE (ES))
Presenter: PEREIRA SANCHEZ, Laura (Stockholm University (SE))
Session Classification: Wine & Cheese Poster Session
Track Classification: Searches for New Physics
Scrutinizing the evidence for dark matter in cosmic-ray antiprotons

Global fits of primary and secondary cosmic-ray (CR) fluxes measured by AMS-02 have great potential to study CR propagation models and search for exotic sources of antimatter such as annihilating dark matter (DM). Previous studies of AMS-02 antiprotons revealed a possible hint for a DM signal which, however, could be affected by systematic uncertainties. To test the robustness of such a DM signal, in this work we systematically study two important sources of uncertainties: the antiproton production cross sections needed to calculate the source spectra of secondary antiprotons and the potential correlations in the experimental data, so far not provided by the AMS-02 collaboration. To investigate the impact of cross-section uncertainties we perform global fits of CR spectra including a covariance matrix determined from nuclear cross-section measurements. As an alternative approach, we perform a joint fit to both the CR and cross-section data. The two methods agree and show that cross-section uncertainties have a small effect on the CR fits and on the significance of a potential DM signal, which we find to be at the level of 3 sigma. Correlations in the data can have a much larger impact. To illustrate this effect, we determine possible benchmark models for the correlations in a data-driven method. The inclusion of correlations strongly improves the constraints on the propagation model and, furthermore, enhances the significance of the DM signal up to above 5 sigma. Our analysis demonstrates the importance of providing the covariance of the experimental data, which is needed to fully exploit their potential.

Primary author: Dr HEISIG, Jan (Université catholique de Louvain (UCL))
Presenter: Dr HEISIG, Jan (Université catholique de Louvain (UCL))
Session Classification: Cosmology
Track Classification: Cosmology
Data Quality Evaluation in ATLAS during LHC Run 2

The LHC delivered more than 150/fb of collision data to ATLAS between 2015-2018. In order to produce reliable physics results of high quality, the data is subject to intense scrutiny to ensure detector conditions are well understood and to eliminate any detector-related problems affecting the dataset. This talk discusses the data quality (DQ) monitoring procedures in place to guarantee the integrity of all ATLAS collision data, from the point at which the data is recorded up until the delivery of an analysis-ready dataset to physics groups. During Run-2 ATLAS recorded a total integrated luminosity of 139/fb good for physics pp collision data with a data quality efficiency of about 95%.

**Primary author:** FERRANDO, James Edward (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** MOCHIZUKI, Kazuya (Universite de Montreal (CA))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Luminosity determination in pp collisions at sqrt(s)=13 TeV using the ATLAS detector at the LHC

Monday, 15 July 2019 18:30 (1h 30m)

The preliminary calibration of the integrated luminosity for the Run-2 ATLAS data sample of pp collisions at sqrt(s)=13 TeV is described. The absolute luminosity scale is determined using van der Meer scans during dedicated running periods in year, and extrapolated to the physics data-taking regime using complementary measurements from several ATLAS subdetectors. The total uncertainties on the integrated luminosities are 2.0-2.4% for each individual year, and 1.7% on the full Run-2 data sample.

Primary author:  FERRANDO, James Edward (Deutsches Elektronen-Synchrotron (DE))
Presenter:  WANG, Hulin (University of Alberta (CA))
Session Classification:  Wine & Cheese Poster Session
Track Classification:  Detector R&D and Data Handling
AWAKE: the proton-driven plasma wakefield accelerator experiment at CERN

Monday, 15 July 2019 18:30 (1h 30m)

In order to achieve affordable and compact high-energy particle accelerators, machines with high accelerating gradients are necessary. The beam-driven plasma wakefield accelerator is a novel accelerator technique being developed for this purpose. The AWAKE experiment at CERN is the first proton-driven plasma wakefield accelerator experiment. The experiment relies on seeded self-modulation to transform the 12 cm long, 400 GeV proton bunch from the SPS into a train of bunches spaced by the plasma wavelength (~ 1mm). The train can then resonantly drive GV/m fields that can be used to accelerate electrons over 10s to 100s of meters. We present experimental results from the first experimental run, including measurements of the proton bunch self-modulation and of 2 GeV energy gain in a 10 meter long plasma cell.

Primary author: ADLI, Erik (University of Oslo (NO))
Presenter: ADLI, Erik (University of Oslo (NO))
Session Classification: Wine & Cheese Poster Session
Track Classification: Accelerators for HEP
Identification and calibration of high-rapidity electrons with the ATLAS detector

Monday, 15 July 2019 18:30 (1h 30m)

Drell-Yan events with high-rapidity electrons provide strong constraints on the proton parton density functions, and the highest sensitivity for the measurement of the electroweak mixing angle. Optimal electron identification and energy calibration are crucial to exploit these features. The identification relies on a multi-variate likelihood technique to separate prompt electrons from hadrons. Measurements of the forward electron identification efficiency are performed using the tag-and-probe technique and large samples of Z boson decays. A new method is used to perform the energy calibration, accounting for possible non-linearities in the energy response. The identification efficiency and energy calibration results are obtained with pp collision data recorded at $\sqrt{s}=13$ TeV in 2015-2016, and corresponding to an integrated luminosity of 36 fb$^{-1}$.

**Primary author:** FERRANDO, James Edward (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** GAO, Jun (University of Science and Technology of China (CN))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
The identification of b-hadrons at low-pT can play a crucial role in a variety of analyses, such as those where soft b-hadrons are produced by new physics signals as in compressed SUSY searches for stop/sbottom production or in analyses that require heavy flavour jet vetos. Such b-hadron identification is a particularly challenging task, owing to the relatively short decay length of such b-hadrons and difficulties identifying hadronic jets, and current flavour tagging algorithms are often not tuned to identify such b-hadron decays. This [talk/poster] presents new developments for soft b-hadron tagging techniques based either on the presence of jets composed only of tracks, or on the identification of secondary vertices from the b-hadron decay seeded without requiring the presence of a jet. The techniques will be described and their performance reviewed.
Expected tracking performance with the HL-LHC ATLAS detector

Monday, 15 July 2019 18:30 (1h 30m)

The High Luminosity LHC (HL-LHC) aims to increase the LHC data-set by an order of magnitude in order to increase its potential for discoveries and precision measurements. Starting approximately in 2026, the HL-LHC is expected to reach the peak luminosity of $7.5 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$ which corresponds to conditions where up to 200 inelastic proton-proton collisions can occur per bunch crossing which is approximately five times the current number of collisions per bunch crossing. To cope with the large radiation doses and high pileup, the current ATLAS Inner Detector will be replaced with a new all-silicon Inner Tracker which will cover up to $|\eta| < 4$. This poster presents recent results regarding the expected tracking performance of the Inner Tracker. The impact of tracking on reconstruction of selected physics objects is shown.

**Primary author:** FERRANDO, James Edward (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** ABELING, Kira (Georg August Universitaet Goettingen (DE))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Detector R&D and Data Handling
Neutrino Oscillations in IceCube

Friday, 12 July 2019 16:30 (20 minutes)

The DeepCore low energy extension of the IceCube Neutrino Observatory allows us to study atmospheric neutrino oscillations. With the ability to distinguish between track- and shower-like events, we can statistically look for the disappearance of muon neutrinos and simultaneously the appearance of tau neutrinos. At the same time we can use this data to test the neutrino mass ordering or search for oscillation phenomena beyond the standard picture. Latest oscillation physics results from our collaboration will be presented.

Primary author: ELLER, Philipp David (ETH Zurich (CH))
Presenter: ELLER, Philipp David (ETH Zurich (CH))
Session Classification: Neutrino Physics
Track Classification: Neutrino Physics
Mechanical properties of the thin-walled welded straws for the COMET experiment

Monday, 15 July 2019 18:30 (1h 30m)

In the technique of modern experiment on accelerators coordinate gas-filled wire detectors based on thin-walled tubes, straws, made of polyethylene terephthalate film are increasingly used. This type of detectors has numerous of advantages. To ensure high coordinate accuracy of the straw detector, the material from which the straw is made is also required to preserve its basic physical properties in time, as well as to be homogeneous throughout the length. The most important mechanical properties of the straw material are the area of elastic deformation, the value of the elastic modulus, which characterizes the straw strength, the rate of stress relaxation. Knowledge of the Poisson’s ratio is required to select the straw initial tension, since its tension changes when operating in a vacuum.

The purpose of this work was to investigate the most important mechanical properties of the thin-walled welded straws developed by JINR (Joint Institute for Nuclear Research) COMET (COherent Muon to Electron Transition, J-PARK) group and to estimate straws lifetime as the main part of the COMET experiment tracking system. The design of the stand for studying the straw characteristics as well as the results of the measurements are given.

Primary author: Mr KRAVCHENKO, Michail (Joint Institute for Nuclear Research)
Presenter: Mr KRAVCHENKO, Michail (Joint Institute for Nuclear Research)
Session Classification: Wine & Cheese Poster Session
Track Classification: Detector R&D and Data Handling
ANDES: the future Latin American deep underground laboratory

Thursday, 11 July 2019 12:30 (20 minutes)

In this talk I will present the project of creation of the first deep underground laboratory in the tunnel Agua Negra that will be connecting Argentina and Chile. This project profits from the construction of the highway linking two countries under the Los Andes mountain range. The depth of the tunnel provides an important cosmic ray shielding which opens vast possibilities to perform experiments in fundamental physics. The ANDES laboratory, planned as the first deep underground site in the Southern Hemisphere, will have a particular merit of providing complementary information to what is currently being learned from the existing laboratories in the Northern Hemisphere.

Primary author: MINEEVA, Taisiya (Universidad Técnica Federico Santa Maria)

Presenter: MINEEVA, Taisiya (Universidad Técnica Federico Santa Maria)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Contribution ID: 832
Type: not specified

Discussion

Friday, 12 July 2019 15:45 (30 minutes)

Session Classification: Higgs Physics
Track Classification: Higgs Physics
Welcome

Saturday, 13 July 2019 14:30 (5 minutes)

Primary author:  D’HONDT, Jorgen (Vrije Universiteit Brussel (BE))
Presenter:  D’HONDT, Jorgen (Vrije Universiteit Brussel (BE))
Session Classification:  ECFA-EPS Special Session
Overview of the ESPP Open Symposium

Saturday, 13 July 2019 14:35 (30 minutes)

Presenter: ABRAMOWICZ, Halina (Tel Aviv University (IL))
Session Classification: ECFA-EPS Special Session
Technology path towards future colliders

Saturday, 13 July 2019 15:05 (30 minutes)

Presenters:  BISCARI, Caterina (Istituto Nazionale di Fisica Nucleare (INFN));  BISCARI, Caterina (ALBA Synchrotron)

Session Classification:  ECFA-EPS Special Session
Community challenges and opportunities for detector R&D

Saturday, 13 July 2019 15:35 (30 minutes)

Presenter: CATTAI, Ariella (CERN)

Session Classification: ECFA-EPS Special Session
Higgs at Future Colliders

Saturday, 13 July 2019 16:05 (30 minutes)

Presenter: GROJEAN, Christophe (DESY (Hamburg) and Humboldt University (Berlin))

Session Classification: ECFA-EPS Special Session
Physics Beyond Colliders

Saturday, 13 July 2019 17:00 (30 minutes)

Presenter: VALLEE, Claude (Centre de Physique des Particules de Marseille)

Session Classification: ECFA-EPS Special Session
Synergies between astroparticle, particle and nuclear physics

Saturday, 13 July 2019 17:30 (30 minutes)

Presenter: DOGLIONI, Caterina (Lund University (SE))
Session Classification: ECFA-EPS Special Session
Computing and Software challenges

Saturday, 13 July 2019 18:00 (30 minutes)

Primary author: STEWART, Graeme A (CERN)
Presenter: STEWART, Graeme A (CERN)
Session Classification: ECFA-EPS Special Session
Dark compact objects as a probe of Dark Matter existence in the inner parsecs from Galactic Centre

Monday, 15 July 2019 18:30 (1h 30m)

We study the structure of compact objects that contain non-self annihilating, self-interacting dark matter admixed with ordinary matter made of neutron star and white dwarf materials. We find that the total mass of the compact objects increases with decreasing dark matter particle mass. In the strong interacting case and for dark matter particle masses in the range 1-10 GeV, the total mass of the compact objects largely exceeds the 2M\text{sun} constraint for neutron star masses and the nominal 1M\text{sun} for white dwarfs, while for larger dark matter particle masses or in the weakly interacting case the compact objects show masses in agreement or smaller than these constraints, thus hinting at the exclusion of strongly self-interacting dark matter of masses 1-10 GeV in the interior of these compact objects.

Moreover, we observe that the smaller the dark matter particle mass, the larger the quantity of dark matter captured is, putting constraints on the dark matter mass trapped in the compact objects so as to fulfill 2M\text{sun} observations. Finally, the inhomogeneity of distribution of dark matter in the Galaxy implies a mass dependence of compact objects from the environment which can be used to put constraints on the characteristics of the Galaxy halo DM profile and on particle mass. In view of the these results, we discuss the formation of the dark compact objects in an homogeneous and non-homogeneous dark matter environment. This in turn, leads us to conclusion that the pulsar masses should decreases going towards the center of the Milky Way due to dark matter capture by those stars. This feature be used as a probe for the existence and nature of dark matter. We thus propose that the evolution of the pulsar mass in a dark matter rich environment can be used to put constraints, when combined with future experiments, on the characteristics of our Galaxy halo dark matter profile, on the dark matter particle mass and on the dark matter self-interaction strength.

**Primary author:** DELIYERGIYEV, Maksym (Jan Kochanowski University (PL))

**Presenter:** DELIYERGIYEV, Maksym (Jan Kochanowski University (PL))

**Session Classification:** Wine & Cheese Poster Session

**Track Classification:** Dark Matter
Recent highlights in high-energy-neutrino and ultra-high-energy-cosmic-ray research and implications for astrophysical candidate sources

Thursday, 11 July 2019 09:30 (30 minutes)

The origin of ultra-high energy cosmic rays (UHECRs) is a long-standing mystery. In 2013 the IceCube experiment announced the observation of an astrophysical high-energy neutrino flux, adding the question of the origin of high-energy neutrinos to the mysteries in astroparticle physics. Recent highlights from the quest for the sources of UHECRs and high-energy neutrinos include the discovery of a dipole anisotropy in the arrival directions of UHECRs and the observation of high-energy neutrinos in the direction of the blazar TXS 0506+056. In this talk, I will review the implications of the most recent observations for astrophysical source models. One point of focus will be models of the origin of high-energy neutrinos in blazar flares, motivated by the first plausible association of a high-energy neutrino with an astrophysical source.

Presenter: OIKONOMOU, Foteini (Penn State University)

Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves
Recent Results and Future Plans of the MoEDAL Experiment

Friday, 12 July 2019 12:45 (15 minutes)

MoEDAL is an LHC experiment designed to search for anomalously ionizing messengers of new physics such as magnetic monopoles or massive (pseudo-)stable charged particles, which are predicted to exist in many models beyond the Standard Model. It started data taking at the LHC at a centre-of-mass energy of 13 TeV in 2015. Its physics program yields insights into such foundational questions as: are there extra dimensions or new symmetries; what is the mechanism for the generation of mass; does magnetic charge exist; and what is the nature of dark matter. We will present the results from the MoEDAL detector on magnetic monopole and highly ionizing electrically charged particle production. In conclusion, progress on the installation of MoEDAL’s MAPP (MoEDAL Apparatus for the detection of Penetrating Particles) sub-detector prototype will be briefly be discussed.

Presenter: SANTRA, Arka (Univ. of Valencia and CSIC (ES))

Session Classification: Searches for New Physics

Track Classification: Searches for New Physics
European Research Council - Funding opportunities for frontier science. Ensuring equal treatment of applicants

Friday, 12 July 2019 14:30 (15 minutes)

This session will present European Research Council (ERC) funding opportunities, available for both early career researchers and senior research leaders. The ERC operates according to a «bottom-up», approach, allowing researchers to identify new opportunities in any field of research. It encourages competition for funding between the very best, creative researchers of any nationality and age. An update will be given on the calls, deadlines and budgets, applicants’ suitable profiles and other relevant information. The presentation will be addressing equally all fields of science and scholarship.

The ERC monitors closely gender figures on every call and has taken actions to tackle imbalances and potential unconscious biases. Efforts made to understand and ensure equal treatment of all candidates, with particular focus on gender balance and with specific attention to fundamental physics, as well as data and statistics collected in running these highly competitive and internationally recognised funding schemes will be presented.

**Presenter:** LUIS, Fariña Busto

**Session Classification:** Outreach, Education, and Diversity

**Track Classification:** Outreach, Education, and Diversity
Seminar: The Solvay Councils and the Beginning of Modern Physics

Friday, 12 July 2019 18:45 (45 minutes)

Primary author: MARAGE, Pierre (Universite Libre de Bruxelles (BE))

Presenter: MARAGE, Pierre (Universite Libre de Bruxelles (BE))
First Result for a Full Two-Loop Five-Gluon Amplitude

Monday, 15 July 2019 18:30 (1h 30m)

The physics exploitation of the precision data to be collected in future runs of the LHC requires highly accurate theory predictions, which are obtained through the calculation of higher orders in perturbation theory. For many processes of interest, Next-to-Next-to-Leading-Order results are required. At present, only observables involving up to four particles are available at this order. The main bottleneck towards higher multiplicity observables is the analytic calculation of the required two-loop scattering amplitudes. We present the first fully analytic result for a full-color two-loop five-particle amplitude: the five-gluon amplitude in the all-plus helicity configuration. We express it in a remarkably compact form containing only logarithms, dilogarithms, and rational functions, which exhibit surprising signs of conformal symmetry.

Primary author: CHICHERIN, Dmitry (Max Planck Institute for Physics)
Presenter: CHICHERIN, Dmitry (Max Planck Institute for Physics)
Session Classification: Wine & Cheese Poster Session
Track Classification: QCD and Hadronic Physics
Welcome & introduction

Saturday, 13 July 2019 19:30 (5 minutes)

Presenter:  HOCH, Michael (Austrian Academy of Sciences (AT))

Session Classification:  art@CMS: ORIGIN Poetics 2019 event
Why Art & Science

Saturday, 13 July 2019 19:35 (15 minutes)

Presenter: CHARALAMBOUS, Andrew (Departm.of Physics and Astronomy Univ.Coll.London)

Session Classification: art@CMS: ORIGIN Poetics 2019 event
Suratomica – an art science collaboration with Colombia

Saturday, 13 July 2019 19:50 (10 minutes)

**Presenter:** BRILL, Daniela (Quantico Co)

**Session Classification:** art@CMS: ORIGIN Poetics 2019 event
The Arscientic Adism – My Romantic Manifesto

Saturday, 13 July 2019 20:00 (15 minutes)

Presenter: SCHELLMANN, Denise (Applied Arts University Vienna/ AT)

Session Classification: art@CMS: ORIGIN Poetics 2019 event
Art Science Collaborations in Montenegro’

Saturday, 13 July 2019 20:15 (5 minutes)

Presenter: KASALICA, Iva (Art University Montenegro/ Mo)

Session Classification: art@CMS: ORIGIN Poetics 2019 event
EPS-HEP2019 / Report of Contributions

Contribution ID: 852

Type: not specified

ORIGIN Poetics 2019

Tuesday, 16 July 2019 13:00 (5 minutes)

Session Classification: Plenary session
Proceedings Announcement

Wednesday, 17 July 2019 13:00 (5 minutes)

Session Classification:  Plenary session