

# ICHEP2012

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## Book of Abstracts



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**Opening Ceremony / LHC Higgs Search Updates / 3**

## **Official Opening**

**Opening Ceremony / LHC Higgs Search Updates / 4**

## **Higgs - ATLAS**

**Author:** Richard Hawkings<sup>1</sup>

<sup>1</sup> *CERN*

**Corresponding Author:** richard.hawkings@cern.ch

**Opening Ceremony / LHC Higgs Search Updates / 5**

## **Higgs - CMS**

**Author:** Joseph Incandela<sup>1</sup>

<sup>1</sup> *Univ. of California Santa Barbara (US)*

**Corresponding Author:** joseph.incandela@cern.ch

**Opening Ceremony / LHC Higgs Search Updates / 6**

## **Higgs - Tevatron**

**Authors:** Shalhout Shalhout<sup>1</sup>; Shalhout Shalhout<sup>2</sup>

<sup>1</sup> *UCDAVIS*

<sup>2</sup> *University of California Davis (US)*

**Corresponding Authors:** shalhout@gmail.com, shalhout.shalhout@cern.ch

**Tevatron Higgs Search Update / Top Quark Physics / 7**

## **Top Measurements**

**Author:** Thomas Muller<sup>1</sup>

<sup>1</sup> *KIT (DE)*

**Corresponding Author:** thomas.muller@cern.ch

**Tevatron Higgs Search Update / Top Quark Physics / 8**

## Top Quark Physics - Theory

**Author:** Gilad Perez<sup>1</sup>

<sup>1</sup> *CERN (CH) & Weizmann Inst (IL)*

**Corresponding Author:** gilad.perez@cern.ch

EW Physics / SUSY / 9

## Electroweak Physics Results

**Author:** Joao Barreiro Guimaraes Da Costa<sup>1</sup>

<sup>1</sup> *Harvard University (US)*

EW Physics / SUSY / 10

## EWSB - status/directions

**Author:** Alex Pomarol<sup>1</sup>

<sup>1</sup> *Universitat Autònoma de Barcelona (ES)*

EW Physics / SUSY / 11

## SUSY Searches (ATLAS/CMS): the Lady Vanishes

**Author:** Andy Parker<sup>1</sup>

<sup>1</sup> *University of Cambridge (GB)*

**Corresponding Author:** parker@hep.phy.cam.ac.uk

Flavour Physics / 12

## New Physics from Flavour

**Author:** Sheldon Stone<sup>1</sup>

<sup>1</sup> *Syracuse University (US)*

**Corresponding Author:** slstone@syr.edu

Flavour Physics / 14

## Experimental Status of Rare Decays in Charged Leptons and Light Mesons

**Author:** Yoshitaka Kuno<sup>1</sup>

<sup>1</sup> *Osaka University*

**Corresponding Author:** kuno@phys.sci.osaka-u.ac.jp

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## ICFA Report

**Author:** Pier Oddone<sup>1</sup>

<sup>1</sup> *Fermilab*

**Corresponding Author:** pjoddone@fnal.gov

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## Jet Production and QCD at High Energy Colliders

**Author:** Dmitry Bandurin<sup>1</sup>

<sup>1</sup> *Florida State University (US)*

**Corresponding Author:** bandurin@fnal.gov

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## PDF Measurements

**Author:** Alexander Glazov<sup>1</sup>

<sup>1</sup> *DESY (DE)*

**Corresponding Author:** glazov@mail.desy.de

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## Experimental results on Soft Strong Interactions

**Author:** Paul Newman<sup>1</sup>

<sup>1</sup> *Birmingham University (UK)*

**Corresponding Author:** paul.richard.newman@cern.ch

**Heavy Ions / Lattice QCD / 19**

## **Recent Results from Heavy Ion Collisions at the LHC**

**Author:** Johanna Stachel<sup>1</sup>

<sup>1</sup> *Ruprecht-Karls-Universitaet Heidelberg (DE)*

**Corresponding Author:** stachel@physi.uni-heidelberg.de

**Heavy Ions / Lattice QCD / 20**

## **Heavy Ion Theory**

**Author:** Carlos Albert Salgado Lopez<sup>1</sup>

<sup>1</sup> *Universidade de Santiago de Compostela (ES)*

**Corresponding Author:** carlos.salgado@usc.es

**Heavy Ions / Lattice QCD / 21**

## **Progress in Lattice QCD**

**Author:** James Zanotti<sup>1</sup>

<sup>1</sup> *University of Adelaide (AU)*

**Corresponding Author:** james.zanotti@adelaide.edu.au

**BSM / Spectroscopy / IUPAP-C11 Report / 23**

## **BSM Searches**

**Author:** Steven Worm<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** steven.worm@cern.ch

**BSM / Spectroscopy / IUPAP-C11 Report / 24**

## **Beyond the SM: theoretical status**

**Author:** Bogdan Dobrescu<sup>1</sup>

<sup>1</sup> *FNAL*

**Corresponding Author:** bdob@fnal.gov

25

## IUPAP Young Scientist

**Author:** Phillip Urquijo<sup>1</sup>

<sup>1</sup> *Universitaet Bonn (DE)*

**Corresponding Author:** phillip.urquijo@cern.ch

26

## IUPAP Young Scientist

**Author:** Teppei Katori<sup>1</sup>

<sup>1</sup> *Massachusetts Institute of Technology*

**Neutrinos / 29**

## Long Baseline Neutrinos

**Author:** Takashi Kobayashi<sup>1</sup>

<sup>1</sup> *KEK (JP)*

**Corresponding Author:** takashi.kobayashi@kek.jp

**Neutrinos / 30**

## Reactor Neutrino Results

**Author:** Jun Cao<sup>1</sup>

<sup>1</sup> *IHEP (CN)*

**Corresponding Author:** caoj@ihep.ac.cn

**Neutrinos / 31**

## Neutrinos Theory Review

**Author:** Concepcion Gonzalez-Garcia<sup>1</sup>

<sup>1</sup> *YITP-Stony Brook & ICREA-Barcelona (ES)*

**Corresponding Author:** concepcion.gonzalez-garcia@cern.ch

**Cosmology / Theory Developments / 32**

## **DM Direct Searches**

**Author:** lauren hsu<sup>1</sup>

<sup>1</sup> *Fermilab*

**Corresponding Author:** llhsu@fnal.gov

**Cosmology / Theory Developments / 33**

## **Dark Matter and New Physics**

**Author:** Neal Weiner<sup>1</sup>

<sup>1</sup> *New York University (US)*

**Corresponding Author:** neal.weiner@nyu.edu

**Cosmology / Theory Developments / 34**

## **Dark Energy and Cosmology**

**Author:** Mark Trodden<sup>1</sup>

<sup>1</sup> *University of Pennsylvania*

**Corresponding Author:** trodden@physics.upenn.edu

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## **SKA Project (Replace the cancelled Progress in Detector Techniques Talk)**

**Author:** Brian Boyle<sup>None</sup>

**Cosmology / Theory Developments / 37**

## **New Directions in Scattering Theory**

**Author:** LANCE Dixon<sup>1</sup>

<sup>1</sup> *SLAC National Accelerator Laboratory (US)*



**Corresponding Author:** lance@slac.stanford.edu

**Future / Close / 40**

## Closing Talk / Future Machines / Outlook

**Author:** Rolf Heuer<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Author:** rolf.heuer@cern.ch

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 42**

## Radiation from accelerated charges at strong coupling

**Author:** Daniel Fernandez-Fraile<sup>1</sup>

<sup>1</sup> Frankfurt University (DE)

**Corresponding Author:** danfer@th.physik.uni-frankfurt.de

We present our latest results concerning the radiation spectrum emitted by a relativistic charged particle at strong coupling, employing the theoretical techniques provided by the AdS/CFT correspondence. We compare with other recent analyses of this problem with heavy quarks [1,2], and in our case we do find deviations from the (classical) Lienard formula once we take into account all the relevant quantum effects.

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- [2] Y.Hatta, E.Iancu, A.H.Mueller and D.N.Triantafyllopoulos, "Aspects of the UV/IR correspondence: energy broadening and string fluctuations," JHEP 1102, 065 (2011).

**Room 219 - BSM - Non-SUSY - TR3 / 45**

## Discovering Colorons at the Large Hadron Collider

**Author:** Chung Kao<sup>1</sup>

<sup>1</sup> University of Oklahoma (US)

**Corresponding Author:** kao@physics.ou.edu

We investigate the prospects for the discovery of massive hyper-gluons at the CERN Large Hadron Collider with  $\sqrt{s} = 14$  TeV. A phenomenological Lagrangian is adopted to evaluate the cross section of a pair of colored vector bosons (colorons,  $\tilde{\rho}$ ) decaying into four colored scalar resonances (hyper-pions,  $\tilde{\pi}$ ), which then decay into eight gluons. We include the dominant physics background from the production of  $8g, 7g1q, 6g2q$ , and  $5g3q$ , and determine the masses of  $\tilde{\pi}$  and  $\tilde{\rho}$  where discovery is possible. For example, we find that a  $5\sigma$  signal can be established for  $M_{\tilde{\pi}} \text{ alt } 495 \text{ GeV}$  ( $M_{\tilde{\rho}} \text{ alt } 1650 \text{ GeV}$ ). More generally we give the reach of this process for a selection of possible cuts and integrated luminosities.

Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 46

## Top Decays with Flavor Changing Neutral Higgs Interactions at the LHC

**Author:** Chung Kao<sup>1</sup>

<sup>1</sup> *University of Oklahoma (US)*

**Corresponding Author:** kao@physics.ou.edu

We investigate the prospects for the discovery of a top quark decaying into one light Higgs boson along with a charm quark in top quark pair production at the CERN Large Hadron Collider (LHC). A general two Higgs doublet model is adopted to study the signature of flavor changing neutral Higgs interactions for  $t \rightarrow c\phi^0$  or  $\bar{t} \rightarrow \bar{c}\phi^0$  where  $\phi^0$  is a CP-even scalar ( $H^0$ ) or a CP-odd pseudoscalar ( $A^0$ ).

The dominant physics background is evaluated with realistic acceptance cuts as well as tagging and mistagging efficiencies. We have found abundant signal events and that our acceptance cuts reduce the physics background enough to establish a  $5\sigma$  signal for  $M_\phi$

at 130 GeV at the early stage of LHC with  $\sqrt{s} = 7$  TeV and an integrated luminosity of  $10 \text{ fb}^{-1}$ . The discovery potential will be greatly enhanced with the full energy of  $\sqrt{s} = 14$  TeV.

Room 219 - BSM - Non-SUSY - TR3 / 47

## Baryon asymmetry, dark matter and neutrino mass via exotic multiplets

**Author:** Sandy Law<sup>1</sup>

<sup>1</sup> *National Cheng Kung University (TW)*

**Corresponding Author:** slaw@mail.ncku.edu.tw

We demonstrate that by adding three exotic fermion 5-plets and one scalar 6-plet to the standard model, a consistent solution to the problems of baryon asymmetry, dark matter and neutrino mass can be obtained. This is possible because renormalizability and standard model gauge invariance allow the lightest exotic particle in this model to be a dark matter candidate if the new 6-plet scalar does not develop a nonzero vacuum expectation value. Furthermore, light neutrino masses can be generated radiatively at one-loop while the baryon asymmetry is produced by the CP-violating decays of the second lightest exotic particle.

### Financial Support Justification for Early-Stage Researchers:

The ICHEP conference series has established itself as one of the most important events for high energy physicists. Therefore, it is essential that early-stage researchers (like myself, PhD graduated in 2009) will not miss out due to financial difficulties. In Taiwan, funding for postdoc travel has a fixed limit regardless of the destination. As a result, overseas travels are often limited to local Asian areas only. Besides, the weakness of TWD compare to AUD means that there is an extra burden on any costs. Hence, I believe that support in the form of a waived or reduced registration fee would be very helpful given the large amount of spending expected elsewhere for such a distant trip already.

TR 12 - Formal Theory Development & TR 1 - The Standard Model / 48

## Finite Energy One-half Monopole Solutions of the SU(2) Yang-Mills-Higgs Theory.

**Author:** Rosy Teh<sup>1</sup>

**Co-authors:** Ban-Loong Ng<sup>2</sup>; Khai-Ming Wong<sup>3</sup>

<sup>1</sup> *Universiti Sains Malaysia (MY)*

<sup>2</sup> *Universiti Sains Malaysia*

<sup>3</sup> *Universiti Sains Malaysai (MY)*

**Corresponding Author:** rosyteh@usm.my

We would like to show the existence of finite energy SU(2) Yang-Mills-Higgs particles of one-half topological charge. The 't Hooft Abelian magnetic fields of these solutions at spatial infinity correspond to the magnetic field of a positive one-half magnetic monopole located at the origin,  $r = 0$ , and a semi-infinite Dirac string singularity located on one half of the  $z$ -axis which carries a magnetic flux of  $\frac{2\pi}{g}$  going into the center of the sphere at infinity. Hence the net magnetic charge of the configuration is zero. The non-Abelian solutions possess gauge potentials that are singular at only one point, that is, on either the positive or the negative  $z$ -axis at large distances, elsewhere they are regular. There are two distinct different configurations of these particles with different total energies and energy distributions. The total energies of these one-half magnetic monopole solutions are calculated for various strength of the Higgs field self-coupling constant  $\lambda$  and they are found to increase logarithmically with  $\lambda$ . These solutions do not satisfy the first order Bogomol'nyi equations and are non-BPS solutions.

#### Summary:

We have found four different types of one-half monopole charge solutions that we label as Type A1, A2, B1, and B2. The Type B (B1 and B2) solutions seem to be a  $180^\circ$  rotation of the  $z$ -axis about the origin,  $r = 0$ , of the Type A (A1 and A2) solutions. However for a particular value of Higgs self-coupling constant,  $\lambda$ , the Type 1 (A1 and B1) and Type 2 (A2 and B2) solutions possess different total energies as well as energy densities distributions. They also possess different finite Lagrangian and different Lagrangian density distribution in three space.

The gauge potentials of the Type A solutions are singular at only one point at infinity on the negative  $z$ -axis whereas the Type B solutions are singular at only one point at infinity on the positive  $z$ -axis. The 't Hooft magnetic fields of these solutions at spatial infinity correspond to the magnetic field of a positive one-half monopole located at the origin,  $r = 0$ , and a semi-infinite Dirac string singularity located on one-half of the  $z$ -axis which carries a magnetic flux of  $\frac{2\pi}{g}$  going into the center of the sphere at infinity. Hence the net magnetic charge of the configuration is zero. These solutions do not satisfy the first order Bogomol'nyi equations and are non-BPS solutions even in the BPS limit of vanishing Higgs self-coupling as their Lagrangian densities do not vanish over all space and their Lagrangians are finite quantities when  $\lambda = 0$ . When  $\lambda = 0$ , the dimensionless total energy of the one-half monopole located at  $r = 0$  of the Type 1 solutions is 0.51 and the that of the Type 2 solutions is 0.53. Hence the total energies of these one-half monopole solutions are larger than the dimensionless total energy of the BPS solution which is 0.50. The total energies of these one-half monopole solutions are calculated for various strength of the Higgs field self-coupling constant  $\lambda$  from zero to 100 and they are found to increase logarithmically with  $\lambda$ .

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 49**

## Heavy ion collider facility NICA at JINR (Dubna): status and development

**Author:** Grigory Trubnikov<sup>1</sup>

**Co-authors:** Alexander Sorin<sup>2</sup>; Alexandre Kovalenko<sup>3</sup>; Igor Meshkov<sup>4</sup>; Richard Lednicky<sup>5</sup>; Viktor Matveev<sup>6</sup>; Vladimir Kekelidze<sup>7</sup>

<sup>1</sup> *Joint Institute for Nuclear Research (RU)*

<sup>2</sup> *Joint Inst. for Nuclear Research (RU)*

<sup>3</sup> *Institute for Nuclear Research (INR)*

<sup>4</sup> *Joint Institute for Nuclear Research (JINR)*

<sup>5</sup> *Elementary Particle Division*

<sup>6</sup> *Russian Academy of Sciences (RU)*

<sup>7</sup> *Joint Inst. for Nuclear Research (JINR)*

**Corresponding Author:** trubnikov@jinr.ru

New large accelerator complex: heavy ion collider facility NICA (Nuclotron-based Ion Collider Facility) is under active development now at JINR (Dubna).

The main goal of the project is to start in the coming 5 years experimental study of hot and dense strongly interacting baryonic matter and search for possible signs of the mixed phase and critical endpoint in heavy ion collisions (Energy  $\sqrt{s_{NN}} = 4-11$  GeV for Au<sup>79+</sup> nuclei at average luminosity of  $L = 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$ ). Another physics goal of NICA are future experimental studies of spin physics with colliding beams of polarized protons and light nuclei, and also fixed target experiments on ion beams.

The report presents main characteristics of the project: collider facility scheme, operation scenario, proposed methods of accumulation of intense bunched ion beam, application of different RF technique and beam cooling methods to achieve maximal luminosity in the total energy range. Status of R&D and plans of the project development are presented as well.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 50**

## **The case for an excited "Higgs" within the standard model and particle/bound-state duality in the weak interactions**

**Author:** Axel Maas<sup>1</sup>

<sup>1</sup> *Friedrich Schiller University Jena (DE)*

**Corresponding Author:** axelmaas@web.de

It is a remarkable fact that an interaction as weak as QED can sustain bound states. A similar feature naturally can also be expected for the weak interactions. In fact, it has been conjectured in the late seventies that to leading order in an expansion in the Higgs condensate such bound states will have the same mass as the corresponding elementary particle at tree level. Using non-perturbative numerical lattice simulations, evidence will be shown that this holds approximately true even beyond this leading order, provided an adequate renormalization scheme is chosen. This also resolves the apparent paradox that while the Higgs mass itself is both scheme and renormalization point dependent, the peak observed in a cross section is not. Interpreting the actual resonance as a Higgs-Higgs bound state dual to the elementary state gives a physical explanation for the presence of this peak. A similar construction can also be made for the W boson. Such an interpretation of the actually observed resonance peaks as bound states implies necessarily the possibility for excited states. If these should be sufficiently stable, they can show up as 'new particles' in the LHC data, even if they are completely within the standard model. Using once more lattice simulations some ideas are provided for the properties of such an excited "Higgs".

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 51**

## **Onset of deconfinement and search for the critical point of strongly interacting matter at CERN SPS energies**

**Author:** Maciej Rybczynski<sup>1</sup>

<sup>1</sup> *Jan Kochanowski University (PL)*

**Corresponding Author:** maciej.rybczynski@cern.ch

The exploration of the QCD phase diagram particularly the search for a phase transition from hadronic to partonic degrees of freedom and possibly a critical endpoint, is one of the most challenging tasks in present heavy-ion physics. As observed by the NA49 experiment, several hadronic observables in central Pb+Pb collisions at the CERN SPS show qualitative changes in their energy dependence. These features are not observed in elementary interactions and indicate the onset of a phase transition in the SPS energy range [1,2].

The existence of a critical point is expected to result in the increase of event-by-event fluctuations of various hadronic observables [3,4] provided that the freeze-out of the measured hadrons occurs close to its location in the phase diagram and the evolution of the final hadron phase does not erase the fluctuations

signals. A selection of NA49 results on particle multiplicity, transverse momentum, azimuthal angle fluctuations and the proton intermittency from the scan of the phase diagram will be presented and discussed [5,6].

A new technique to study fluctuations of the chemical composition of the hadronic system produced in nuclear collisions, the identity method, will be introduced and its properties will be discussed. Preliminary results from Pb+Pb collisions registered by the NA49 experiment at the CERN SPS will be shown.

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**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 52**

## CP violation in top-quark physics

**Author:** German Valencia<sup>1</sup>

<sup>1</sup> Iowa State University (US)

**Corresponding Author:** valencia@iastate.edu

The LHC will produce large numbers of top anti-top quark pairs providing an excellent opportunity to study in detail the properties of the top-quark. We discuss the use of T-odd correlations to extract information on the CP violating couplings of the top-quark at the LHC. We illustrate our discussion with two examples: CP violating anomalous top quark couplings; and CP violation in extended Higgs sectors, including color octets.

**Poster Session - Board:** 50 / 56

## Dark Energy Field Evolution and Masses of Objects formed by the Gravitational Collapse of Dark Energy Field Configurations

**Author:** Anupam Singh<sup>1</sup>

<sup>1</sup> L.N.Mittal I.I.T. (IN)

**Corresponding Author:** singh@alumni.cmu.edu

Dark Energy is the dominant component of the Energy Density of the Universe. It is imperative to understand the gravitational dynamics of Dark Energy and its implications. The most promising candidate for dark energy is the energy density of fields in curved space-time. We describe the formalism to study the time evolution and gravitational dynamics of dark energy field configurations given any general potential for the dark energy fields. We apply this formalism to models of dark energy motivated by particle physics considerations. We explicitly study the time evolution of the energy density of the fields in addition to studying the dynamics of the fields themselves.

The study of the gravitational dynamics allowed us to demonstrate the gravitational collapse of dark energy field configurations. The study of the time evolution of the energy density allows us to compute the masses of objects formed by the gravitational collapse of dark energy field configurations. We will report on the masses of objects formed by the gravitational collapse of dark energy field configurations.

**Summary:**

I request you to please make an early decision regarding my submission. I need to get approval for funding to travel to ICHEP which can only be granted if my talk is accepted for the conference. Thus my attendance and registration for the conference is pending the acceptance of the abstract for my talk. I had submitted my abstract when submissions opened and I request you to kindly make an early decision in my case for the reasons outlined above.

Thanks and best regards,  
-Anupam.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 58**

## **SUSY Without Prejudice at LHC-7 & -8**

**Author:** Thomas Rizzo<sup>1</sup>

**Co-authors:** Ahmed Ismail<sup>2</sup>; JoAnne Hewett<sup>2</sup>; Matthew Rowley<sup>2</sup>; Stefan Hoeche<sup>2</sup>

<sup>1</sup> SLAC (US)

<sup>2</sup> SLAC

**Corresponding Author:** rizzo@slac.stanford.edu

We will examine the capability of the 7/8 TeV LHC to explore the 19(20) dimensional parameter space of the pMSSM SUSY model following the ATLAS MET analysis suite. Allowing for either a neutralino or gravitino LSP and assuming all sparticle masses lie below 4 TeV, we demonstrate that the LHC searches can cover a large fraction of this space. The importance of non-MET searches, such as those for heavy stable charged particles,  $A \rightarrow \tau\tau$  and  $B_s \rightarrow \mu\mu$  will also be discussed.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 59**

## **The DPHEP Study Group: Data Preservation in High Energy Physics**

**Author:** David South<sup>1</sup>

**Co-author:** Cristinel Diaconu<sup>2</sup>

<sup>1</sup> DESY (DE)

<sup>2</sup> Universite d'Aix - Marseille II (FR)

**Corresponding Author:** david.south@cern.ch

While the current focus is on the LHC at CERN, in the current period several important and unique experimental programs at other facilities are coming to an end, including those at HERA, b-factories and the Tevatron. However, until recently no coherent strategy existed for data preservation and re-use, and many important and complex past data sets have simply been lost. To address this problem, an inter experimental Study Group on HEP data preservation and long-term analysis, DPHEP, was convened in 2009 as a panel of the International Committee for Future Accelerators (ICFA). The group was formed by large collider-based experiments and investigated the technical and organisational aspects of the HEP data preservation. The aims of the study group include to confront the data models, clarify the concepts, set a common language and investigate the technical aspects of data preservation in HEP. The experiments BaBar, Belle, BES-III, CLAS, CLEO, CDF, D0, H1 and ZEUS are all represented in DPHEP, with representatives from the LHC experiments ALICE, ATLAS, CMS and LHCb having joined the study group in 2011. The associated computing centres at CERN (Switzerland/France), DESY (Germany), Fermilab (USA), IHEP (China), JLAB (USA), KEK (Japan) and SLAC (USA) are also represented in DPHEP. An intermediate report was released in November 2009 addressing the general issues of data preservation in HEP. A more complete report is to be released in the first half of 2012, extending and building upon the initial findings. An analysis of the research case for data preservation is provided and a detailed description of the various projects at experiment, laboratory and international levels. In addition, concrete proposal for an international organisation in charge with the data management and policies in high-energy physics are provided.

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## TTbar Spin Correlations at Hadron Colliders

**Author:** Stephen Parke<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Author:** parke@fnal.gov

A theory review of the latest results for TTbar spin correlations for both quark-antiquark annihilation and gluon-gluon fusion production modes will be given with implications for measurements at both the Tevatron and the LHC. I will comment on the recent measurements made by CDF, D0 as well as Atlas and CMS.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 61

## Prospects of measuring the CKM matrix element $V_{ts}$ at the LHC

**Author:** Fernando Barreiro<sup>1</sup>

**Co-authors:** Ahmed Ali<sup>2</sup>; Theodota Lagouri<sup>3</sup>

<sup>1</sup> *Universidad Autonoma De Madrid (ES)*

<sup>2</sup> *DESY, Hamburg, Germany*

<sup>3</sup> *UAM, Madrid, Spain*

**Corresponding Author:** fernando.barreiro@uam.es

We study the prospects of measuring the CKM matrix element  $|V_{ts}|$  at the LHC with the top quarks produced in the processes  $pp \rightarrow t\bar{t}X$  and  $pp \rightarrow t/\bar{t}X$ , and the subsequent decays  $t \rightarrow W^+s$  and

$\bar{t} \rightarrow W^- \bar{s}$ . To reduce the jet activity in top quark decays, we insist on tagging the  $W^\pm$  leptonically,  $W^\pm \rightarrow \ell^\pm \nu_\ell$  ( $\ell = e, \mu, \tau$ ), and analyse the anticipated jet profiles in the signal process  $t \rightarrow Ws$  and the dominant background from the decay  $t \rightarrow Wb$ . To that end, we analyse the  $V0$  ( $K^0$  and  $\Lambda$ ) distributions in the  $s$ - and  $b$ -quark jets concentrating on the energy and transverse momentum distributions of these particles. The  $V0$ s emanating from the  $t \rightarrow Wb$  branch have displaced decay vertexes from the interaction point due to the weak decays  $b \rightarrow c \rightarrow s$  and the  $b$ -quark jets are rich in charged leptons. Hence, the absence of secondary vertexes and of the energetic charged leptons in the jet provide additional ( $b$ -jet vs.  $s$ -jet) discrimination in top quark decays. These distributions are used to train a boosted decision tree (BDT), a technique used successfully in measuring the CKM matrix element  $|V_{tb}|$  in single top production at the Tevatron.

Using the BDT classifier, and a variant of it called BDTD, which makes use of decorrelated variables, we calculate the BDT(D)-response functions corresponding to the signal ( $t \rightarrow Ws$ ) and background ( $t \rightarrow Wb$ ). Detailed simulations undertaken by us with the Monte Carlo generator PYTHIA are used to estimate the background rejection versus signal efficiency for three representative LHC energies  $\sqrt{s} = 7$  TeV, 10 TeV and 14 TeV, of which only the analysis for the  $\sqrt{s} = 14$  TeV case is shown in detail. We argue that a benchmark with 10% accuracy for the signal  $t \rightarrow Ws$  at a background ( $t \rightarrow Wb$ ) rejection by a factor  $10^3$  (required due to the anticipated value of the ratio  $|V_{ts}|^2/|V_{tb}|^2 \simeq 1.6 \times 10^{-3}$ ) can be achieved at the LHC@14 TeV with an integrated luminosity of  $10 \text{ fb}^{-1}$ .

### Plenary3 - The Standard Model -TR1 / 62

## Improved sensitivity to charged Higgs searches un top quark decays $t \rightarrow bH^+ \rightarrow b(\tau^+\nu_\tau)$ at the LHC using $\tau$ polarisation and multivariate techniques

**Author:** Javier Llorente<sup>1</sup>

**Co-authors:** Ahmed Ali<sup>2</sup>; Fernando Barreiro Alonso<sup>3</sup>

<sup>1</sup> Universidad Autónoma De Madrid (ES)

<sup>2</sup> DESY

<sup>3</sup> Universidad Autonoma de Madrid (ES)

**Corresponding Authors:** javier.llorente.merino@cern.ch, fernando.barreiro@uam.es

We present an analysis with improved sensitivity to the light charged Higgs ( $m_{H^+} < m_t - m_b$ ) searches in the top quark decays  $t \rightarrow bH^+ \rightarrow b(\tau^+\nu_\tau) + \text{c.c.}$  in the  $t\bar{t}$  and single  $t/\bar{t}$  production processes at the LHC. In the Minimal Supersymmetric Standard Model (MSSM), one anticipates the branching ratio  $\text{cal}B(H^+ \rightarrow \tau^+\nu_\tau) \simeq 1$  over almost the entire allowed  $\tan\beta$  range. Noting that the  $\tau^+$  arising from the decay  $H^+ \rightarrow \tau^+\nu_\tau$  are predominantly right-polarized, as opposed to the  $\tau^+$  from the dominant background  $W^+ \rightarrow \tau^+\nu_\tau$ , which are left-polarized, a number of  $H^+/W^+ \rightarrow \tau^+\nu_\tau$  discriminators have been proposed and studied in the literature. We consider hadronic decays of the  $\tau^\pm$ , concentrating on the dominant one-prong decay channel  $\tau^\pm \rightarrow \rho^\pm \nu_\tau$ . The energy and  $p_T$  of the charged prongs normalised to the corresponding quantities of the  $\rho^\pm$  are convenient variables which serve as  $\tau^\pm$  polariser. We use the distributions in these variables and several other kinematic quantities to train a boosted decision tree (BDT). Using the BDT classifier, and a variant of it called BDTD, which makes use of decorrelated variables, we have calculated the BDT(D)-response functions to estimate the signal efficiency vs. the rejection of the background. We argue that this chain of analysis has a high sensitivity to light charged Higgs searches up to a mass of 150 GeV in the decays  $t \rightarrow bH^+$  (and charge conjugate) at the LHC. For the case of single top production, we also study the transverse mass of the system determined using Lagrange multipliers.

### Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 63

## Production of the exotic $1^{--}$ hadrons $\phi(2170)$ , $X(4260)$ and $Y_b(10890)$ at the LHC and Tevatron via the Drell-Yan mechanism



**Author:** Ahmed Ali<sup>1</sup>

**Co-author:** Wei Wang<sup>2</sup>

<sup>1</sup> DESY (DE)

<sup>2</sup> DESY, Hamburg, Germany

**Corresponding Author:** ahmed.ali@desy.de

We calculate the Drell-Yan production cross sections and differential distributions in the transverse momentum and rapidity of the  $J^{PC} = 1^{--}$  exotic hadrons  $\phi(2170)$ ,  $X(4260)$  and  $Y_b(10890)$  at the hadron colliders LHC and the Tevatron.

These hadrons are tetraquark (four-quark) candidates, with a hidden  $s\bar{s}$ ,  $c\bar{c}$  and  $b\bar{b}$  quark pair, respectively. In deriving the distributions and cross sections, we include the order  $\alpha_s$  QCD corrections, resum the large logarithms in the small transverse momentum region in the impact-parameter formalism, and use the state of the art parton distribution functions. Taking into account the data on the production and decays of these vector hadrons

from the  $e^+e^-$  experiments, we present the production rates for the processes

$pp(\bar{p}) \rightarrow \phi(2170)(\rightarrow \phi(1020)\pi^+\pi^- \rightarrow K^+K^-\pi^+\pi^-) + \dots$ ,

$pp(\bar{p}) \rightarrow X(4260)(\rightarrow J/\psi\pi^+\pi^- \rightarrow \mu^+\mu^-\pi^+\pi^-) + \dots$ ,

and  $pp(\bar{p}) \rightarrow Y_b(10890)(\rightarrow (\Upsilon(1S), \Upsilon(2S), \Upsilon(3S))\pi^+\pi^- \rightarrow \mu^+\mu^-\pi^+\pi^-) + \dots$ . Their measurements at the hadron colliders will provide new experimental avenues to explore the underlying dynamics of these hadrons.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 64

## Tetraquark interpretation of the charged Bottomonium-like states $Z_b^\pm(10610)$ and $Z_b^\pm(10650)$ and implications

**Author:** Wei Wang<sup>1</sup>

**Co-authors:** Ahmed Ali<sup>2</sup>; Christian Hambrock<sup>3</sup>

<sup>1</sup> DESY (DE)

<sup>2</sup> DESY

<sup>3</sup> Univ. Dortmund, Germany

We present a tetraquark interpretation of the charged bottomonium-like states  $Z_b^\pm(10610)$  and  $Z_b^\pm(10650)$ , observed by the Belle collaboration in the  $\pi^\pm\Upsilon(nS)$  ( $n = 1, 2, 3$ ) and  $\pi^\pm h_b(mP)$  ( $m = 1, 2$ ) invariant mass spectra from the data taken near the peak of the  $\Upsilon(5S)$ . In this framework, the underlying processes involve the production and decays of a vector tetraquark  $Y_b(10890)$ ,  $e^+e^- \rightarrow Y_b(10890) \rightarrow [Z_b^\pm(10610)\pi^\mp, Z_b^\pm(10650)\pi^\mp]$  followed by the decays  $[Z_b^\pm(10610), Z_b^\pm(10650)] \rightarrow \pi^\pm\Upsilon(nS), \pi^\pm h_b(mP)$ . Combining the contributions from the meson loops and an effective Hamiltonian, we are able to reproduce the observed masses of the  $Z_b^\pm(10610)$  and  $Z_b^\pm(10650)$ . The analysis presented here is in agreement with the Belle data and provides crucial tests of the tetraquark hypothesis. We also calculate the corresponding meson loop effects in the charm sector and find them dynamically suppressed. The charged charmonium-like states  $Z_c^\pm(3752)$  and  $Z_c^\pm(3882)$  can be searched for in the decays of the  $J^{PC} = 1^{--}$  tetraquark state  $Y(4260)$  via  $Y(4260) \rightarrow Z_c^\pm(3752)\pi^\mp$  and  $Y(4260) \rightarrow Z_c^\pm(3882)\pi^\mp$ , with the subsequent decays  $(Z_c^\pm(3752), Z_c^\pm(3882)) \rightarrow (J/\psi, h_c)\pi^\pm$ .

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 65

## D+ Purely Leptonic and D0 Semi-leptonic Decays at BESIII

**Author:** Ronald Poling<sup>1</sup>

**Co-authors:** Liaoyuan Dong <sup>2</sup>; Yangheng Zheng <sup>3</sup>

<sup>1</sup> *University of Minnesota (US)*

<sup>2</sup> *Iowa State University*

<sup>3</sup> *GUCAS*

**Corresponding Authors:** poling@umn.edu, zhengyh@gucas.ac.cn, dongly@slac.stanford.edu

With the world largest data sample taken at  $\psi(3770)$  peak with the BESIII detector at the BEPCII e+e- collider, the  $D^+$  purely leptonic and  $D^0$  semi-leptonic decays are studied. We present the preliminary branching fraction measurements of  $D^+ \rightarrow \mu^+ \nu$ ,  $D^0 \rightarrow K^- e^+ \nu$  and  $D^0 \rightarrow \pi^- e^+ \nu$ . We extract pseudoscalar decay constant of  $f_D$  using  $D^+$  purely leptonic decays and the hadronic form factors using the  $D^0$  semi-leptonic decays.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 67

## The charmonium spectroscopy and charmonium decay at BESIII

**Author:** Shan Jin <sup>1</sup>

**Co-authors:** Changzheng YUAN <sup>2</sup>; Yangheng Zheng <sup>3</sup>

<sup>1</sup> *Institute of High Energy Physics*

<sup>2</sup> *IHEP, Beijing*

<sup>3</sup> *GUCAS*

**Corresponding Authors:** jins@mail.ihep.ac.cn, yuancz@ihep.ac.cn, zhengyh@gucas.ac.cn

With the world largest data samples taken at  $J/\psi$ ,  $\psi'$ , and  $\psi''$  peaks with the BESIII detector at the BEPCII e+e- collider. The charmonium spectroscopy and charmonium decay dynamics are studied. We report new measurements of the resonant parameters of the spin-singlet states,  $\eta_c$ ,  $\eta_c'$ , and  $h_c$ , and their production rates in  $\psi'$  transitions; we also report observations of many new decay modes of  $J/\psi$ ,  $\psi'$ ,  $\chi_{cJ}$ , and  $\eta_c$ , and improved measurements of many existing modes.

TR 8 - Neutrinos RM 219 / 71

## Status and plans with the GERDA experiment to probe the nature of neutrinos

**Authors:** Bela Majorovits <sup>1</sup>; Luciano Pandola <sup>2</sup>

<sup>1</sup> *Max-Planck-Institut für Physik (DE)*

<sup>2</sup> *INFN-LNGS*

**Corresponding Authors:** bela@mpp.mpg.de, luciano.pandola@lngs.infn.it

Neutrinoless double-beta decay (DBD) could answer the key question regarding the Majorana or Dirac nature of neutrinos and give an answer to the unknown absolute mass scale as well as on the neutrino mass hierarchy.

High-Purity Germanium (HPGe) detectors are extremely sensitive tools for the search of neutrinoless DBD. This is demonstrated by the GERDA (GERmanium Detector Array) experiment that is currently searching for the DBD of Ge-76 at the Gran Sasso underground Laboratory of INFN, Italy. In its first phase it will scrutinize the claim of observation of neutrinoless DBD in Ge-76 made by a part of the Heidelberg-Moscow Collaboration. The GERDA experiment is designed to minimize the background

by operating HPGe detectors directly immersed in ultra-pure cryogenic liquid. The GERDA physics run started in November 2011 using about 15 kg HPGe detectors isotopically enriched in Ge-76. The status of the data taking and the most relevant results will be presented. The spectrum of the neutrino-accompanied DBD of Ge-76 has been observed with unprecedented signal-to-background ratio. A new measurement of the half-life of the neutrino-accompanied DBD of Ge-76 will be given. For the second phase of GERDA additional ~20 kg of Broad Energy Germanium (BEGe) detectors with favorable properties for improved background recognition are being produced from material enriched in Ge-76. First BEGe detectors with superior energy resolution (1.7 keV at 1.3 MeV) have already been produced and have been characterized. The status of the preparations and further plans for GERDA phase II data taking will be presented.

**TR 8 - Neutrinos RM 219 / 72**

## The ArgoNeuT and MicroBooNE Experiments at Fermi National Accelerator Laboratory

**Author:** Mitchell Soderberg<sup>1</sup>

<sup>1</sup> *Syracuse University (US)*

**Corresponding Author:** msoderbe@syr.edu

Liquid argon time projection chambers provide an extraordinary level of information about the interactions of neutrinos. There are several different efforts ongoing at Fermi National Accelerator Laboratory to develop the liquid argon detector technology and utilize it to study neutrino interactions. Among these are the Argon Neutrino Teststand, or ArgoNeuT, project and the MicroBooNE experiment. ArgoNeuT deployed a relatively small, 170 liter, detector in the NuMI neutrino beamline at Fermilab, and the data collected during that endeavor is now being analyzed and used to measure neutrino interaction cross-sections. MicroBooNE is beginning construction this year of a 100 ton liquid argon detector which will be installed in the Booster neutrino beamline at Fermilab and used to measure a wide variety of cross-sections as well as probing the low-energy excess previously reported by the MiniBooNE experiment. This talk will include discussion of recent results and ongoing analyses from ArgoNeuT, as well as the status of the MicroBooNE experiment and its planned physics program.

**Plenary3 - The Standard Model -TR1 / 74**

## Electroweak corrections to vector-boson pair production at the LHC

**Author:** Tobias Kasprzik<sup>1</sup>

**Co-authors:** Anastasiya Bierweiler<sup>2</sup>; Hans Kuehn<sup>2</sup>; Sandro Uccirati<sup>3</sup>

<sup>1</sup> *KIT (DE)*

<sup>2</sup> *Karlsruhe Institute of Technology*

<sup>3</sup> *Wurzburg University*

**Corresponding Author:** kasprzik@particle.uni-karlsruhe.de

W-boson pair production has been studied extensively during the LEP era, amongst others leading to a precise determination of the W-boson mass and width. At the LHC, vector-boson pair production will be of similar importance. Such processes constitute an important irreducible background to SM-Higgs production in the intermediate-mass region and have already been used to exclude a wide range of mass parameters. Moreover, vector-boson pair production is a perfect candidate to probe

the non-abelian structure of the SM at highest energies, possibly facilitating the discovery of BSM physics. Therefore, it is obvious that theoretical predictions with high accuracy are needed to benefit from the great experimental possibilities provided by the LHC.

In this work, we present the first calculation of the full one-loop electroweak corrections to WW, WZ, and ZZ production at hadron colliders, which give rise to large contributions at high transverse momenta. In addition, photon-induced processes are discussed in detail which contribute significantly to the W-pair production cross section at high invariant masses.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 75**

## Dark Matter Searches with the Fermi Large Area Telescope

**Author:** Aldo Morselli<sup>1</sup>

<sup>1</sup> *INFN Roma Tor Vergata*

**Corresponding Author:** aldo.morselli@roma2.infn.it

Can we learn about New Physics with astronomical and astro-particle data?

Since its launch in the 2008, the Large Area Telescope, onboard of the Fermi Gamma-ray Space Telescope, has detected the largest amount of gamma rays in the 20MeV-300GeV energy range and electrons + positrons in the 7 GeV- 1 TeV range. This impressive statistics allows one to perform a very sensitive indirect experimental search for dark matter. I will present the latest results on these searches and the comparison with LHC searches.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 76**

## Z' signals in polarised top-antitop final states

**Authors:** Ken Mimasu<sup>1</sup>; Lorenzo Basso<sup>2</sup>; Stefano Moretti<sup>2</sup>

<sup>1</sup> *University of Southampton (UK)*

<sup>2</sup> *STFC - Science & Technology Facilities Council (GB)*

**Corresponding Author:** k.mimasu@sussex.ac.uk

We study the sensitivity of top-antitop samples produced at all energy stages of the Large Hadron Collider (LHC) to the nature of an underlying Z' boson, in presence of full tree level standard model (SM) background effects and relative interferences. We concentrate on differential mass spectra as well as both spatial and spin asymmetries thereby demonstrating that exploiting combinations of these observables will enable one to distinguish between sequential Z's and those pertaining to Left-Right symmetric models as well as E6 inspired ones, assuming realistic final state reconstruction efficiencies and error estimates. We go on to discuss other Z' models well suited to such searches in the top-anti top channel.

### Financial Support Justification for Early-Stage Researchers:

I am a PhD student in my second/third year of research in the UK and therefore have limited funds dedicated to international travel. Australia is relatively far for me to travel but I am nonetheless very keen to participate in such a major international conference.

### Summary:

Talk based on paper recently submitted to arXiv:1203.2542

Poster Session - Board: 01 / 77

## Electroweak corrections to vector-boson + jet production at the LHC

**Author:** Tobias Kasprzik<sup>1</sup>

**Co-authors:** Alexander Mueck<sup>2</sup>; Ansgar Denner<sup>3</sup>; Stefan Dittmaier<sup>4</sup>

<sup>1</sup> KIT (DE)

<sup>2</sup> RWTH Aachen

<sup>3</sup> Wuerzburg University

<sup>4</sup> Freiburg University

**Corresponding Author:** kasprzik@particle.uni-karlsruhe.de

A review of the recent progress in the theory predictions for vector-boson plus jet(s) production at the LHC is given, focussing on the discussion of electroweak corrections, where all off-shell effects due to the vector-boson decay are included consistently. The electroweak contributions amount up to several tens of percent at high transverse momenta and thus significantly affect the V+jet production rates. We present new results on the electroweak corrections to single-jet production with missing transverse momentum in the Standard Model, since the corresponding monojet signature is predicted by many new-physics models and therefore needs a reliable SM prediction. In order to further improve the theory prediction for the V+jet cross section, we additionally discuss the correct combination of EW corrections with “standard” QCD Monte Carlo simulations, which is an important issue in view of the high experimental accuracy expected in the future of LHC physics.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 78

## ORKA, The Golden Kaon Experiment: Precision measurement of $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ and other ultra-rare processes

**Authors:** Andreas Kronfeld<sup>1</sup>; Michael Hildreth<sup>2</sup>; Mike Hildreth<sup>2</sup>

**Co-author:** Bob Tschirhart<sup>3</sup>

<sup>1</sup> Fermilab

<sup>2</sup> University of Notre Dame (US)

<sup>3</sup> -

**Corresponding Authors:** mikeh@undhep.hep.nd.edu, ask@fnal.gov, mikeh@omega.hep.nd.edu

Precision measurement of the ultra-rare  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  decay at Fermilab would be one of the most incisive probes of quark flavor physics this decade. Its dramatic reach for uncovering new physics is due to several important factors: The branching ratio is sensitive to most new physics models which extend the Standard Model to solve its considerable problems. The Standard Model prediction for  $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})$  is broadly recognized to be theoretically robust at the 5–10% level. Only a precious few accessible loop-dominated quark processes can be predicted with this level of certainty. The  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  branching ratio is highly suppressed in the Standard Model to the level of  $< 10^{-10}$  ( $< 1$  part in 10 billion). This suppression allows physics beyond the Standard Model to boost the branching fraction with enhancements of up to a factor of five above the Standard Model level. The certainty with which the Standard Model contribution to  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  can be predicted will permit

a 5  $\sigma$  discovery potential for new physics even for enhancements of the branching ratio as small as 35%. This sensitivity is unique in quark flavor physics and allows probing of essentially all models of new physics that couple to quarks within the reach of the LHC. Furthermore, a high precision measurement of  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  is sensitive to many models of new physics with mass scales well beyond the direct reach of the LHC. The ORKA initiative aims to precisely measure the  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  process based on established detector techniques driven with the Fermilab Main Injector high

intensity proton source. In recognition of this exciting opportunity the Fermilab director has recently granted scientific approval to the ORKA proposal. The physics reach and experimental techniques of the ORKA initiative will be discussed, as well as opportunities for collaboration in the ORKA adventure and the longer term Intensity Frontier roadmap at Fermilab.

**Poster Session - Board: 37 / 79**

## **Tetraquark-based analysis and predictions of the cross sections and distributions for the processes $e^+e^- \rightarrow \text{Upsilon}(1S) (\pi^+\pi^-, K^+K^-, \text{eta } \pi^0)$ near $\text{Upsilon}(5S)$**

**Authors:** Ahmed Ali<sup>1</sup>; Christian Hambrock<sup>2</sup>; Satoshi Mishima<sup>3</sup>

<sup>1</sup> *DESY*

<sup>2</sup> *TU Dortmund*

<sup>3</sup> *INFN Rome (IT)*

**Corresponding Author:** [satoshi.mishima@roma1.infn.it](mailto:satoshi.mishima@roma1.infn.it)

We calculate the cross sections and final state distributions for the processes  $e^+e^- \rightarrow \text{Upsilon}(1S) (\pi^+\pi^-, K^+K^-, \text{eta } \pi^0)$  near the  $\text{Upsilon}(5S)$  resonance based on the tetraquark hypothesis. This framework is used to analyse the data on the  $\text{Upsilon}(1S) \pi^+\pi^-$  and  $\text{Upsilon}(1S) K^+K^-$  final states, yielding good fits. Dimeson invariant mass spectra in these processes are shown to be dominated by the corresponding light scalar and tensor states. The resulting correlations among the cross sections are worked out. We also predict  $\sigma(e^+e^- \rightarrow \text{Upsilon}(1S) K^+K^-)/\sigma(e^+e^- \rightarrow \text{Upsilon}(1S) K^0\bar{K}^0) = 1/4$ . These features provide crucial tests of the tetraquark framework and can be searched for in the currently available and forthcoming data from the B factories.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 81**

## **Results from the Telescope Array Experiment**

**Author:** Hisao Tokuno<sup>1</sup>

<sup>1</sup> *Tokyo Institute of Technology (JP)*

**Corresponding Author:** [htokuno@cr.phys.titech.ac.jp](mailto:htokuno@cr.phys.titech.ac.jp)

The Telescope Array (TA) experiment is the largest experiment in the northern hemisphere studying ultra high energy cosmic rays (UHECRs). The Telescope Array is a hybrid detector consists of a surface detector (SD) array and air fluorescence detectors (FDs). This hybrid detector is observing extensive air showers to measure the energy spectrum, anisotropy and composition of ultra high energy cosmic ray (above  $10^{19}\text{eV}$ ).

In this talk, we will report on recent results from TA: the energy spectrum measured by SD array, cosmic ray composition measured with the FDs, and a search for correlations between the pointing directions of cosmic rays, measured by SD array, and possible source distributions.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 82**

## **Gluino pair production at threshold**

**Author:** Peter Marquard<sup>1</sup>

<sup>1</sup> KIT (DE)

We present a next-to-leading order calculation for the production of gluino pairs near threshold at the LHC. We show that threshold effects lead to a characteristic shape of the differential cross section around threshold and an increase of the total cross section.

**TR4 - Top Quark Physics / 83**

## NRQCD matching coefficient at next-to-next-to-next-to-leading order

**Author:** Peter Marquard<sup>1</sup>

<sup>1</sup> KIT (DE)

We present new results for the matching coefficient between the QCD and the non-relativistic QCD (NRQCD) vector current. The matching coefficient constitutes one of the missing ingredients for a complete NNNLO theory prediction of top-quark pair production at a future linear collider. Furthermore, the matching coefficient is an important building block for the analysis of heavy quarkonia, which will allow for the precise determination of the bottom-quark mass from sum rules.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 84**

## Longitudinal Shower Development Studies Near 8 TeV.

**Author:** Paul Doll<sup>1</sup>

<sup>1</sup> KIT (DE)

**Corresponding Author:** paul.doll@kit.edu

(KASCADE-Grande Collaboration).

Muons have never been used up to now to reconstruct the hadron longitudinal development of Extensive-Air-Showers (EAS) induced by Cosmic Rays (CR) with sufficient accuracy, due to the difficulty of building large area ground-based muon telescopes. The Muon Tracking Detector (MTD) in the KASCADE-Grande experiment (128 m<sup>2</sup>,  $E_\mu > 0.8$  GeV) allows to study the angular correlation between muon tracks and the shower axis with high precision and for ‘protons’ in a CM-energy range from 1.4-8.0 TeV or higher. The muon production height allows an almost model independent investigation of the mass composition of the CR flux.

Extensive CR composition studies in KASCADE-Grande based on extensive MC simulations (CORSIKA+Interaction Models) are available for comparison.

A deficit of muons in the data for only the highest CM-energy in the region of the first interactions above 15 km, compared to MC-simulations for proton primaries (CORSIKA, QGSjet-II + FLUKA 2002.4), is observed.

Muon pseudorapidity distributions at all energies are compared to MC simulations. An experimental pseudorapidity gap for muons may support a heavy mass production at 8 TeV.

The deviation from ‘standard’ high energy MC is strongest for the ‘light’ CR primaries at 8 TeV. ‘Heavy’ primaries show little deviation from the MC prediction, which points to a possible threshold effect for the ‘light’ CR primaries. In EAS studies we deal with the pions in the fragmentation region which deliver muons conserving the rapidity of the parent mesons. With respect to the effect of missing muons at the highest energy, the comparison with other type of high energy interaction models is of interest.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 85****The High Intensity Future of Fermilab****Authors:** Bob Tschirhart<sup>1</sup>; Young-Kee Kim<sup>2</sup><sup>1</sup> \_<sup>2</sup> *Fermi National Accelerator Laboratory (US)***Corresponding Authors:** ykkim@fnal.gov, tsch@fnal.gov

Fermilab's high intensity future is "Project-X" which is a US led initiative with strong international participation that aims to realize a next generation proton source that will dramatically extend the reach of Intensity Frontier research. The state of the art in Super-Conducting RF has advanced to a point where it can be considered and implemented as the core enabling technology for a next generation multi-megawatt proton source—reliably delivering unprecedented beam power at duty factors ranging from 0.001% to 100%. The base Super-Conducting RF technology also supports flexible beam-timing configurations among simultaneous experiments, allowing a broad range of experiments to develop and operate in parallel. The US Department Of Energy Office of High Energy Physics and its advisory bodies have recognized this potential and are supporting R&D for Project-X that could lead to a construction start as early as 2017.

Project-X will provide multi-megawatt proton beams from the Fermilab Main Injector over the energy range 60-120 GeV simultaneous with multi-megawatt protons beams 1-3 GeV (kinetic) with very flexible beam-timing characteristics as well as substantial beam power at 8 GeV. The Project-X research program includes world leading sensitivity in long-baseline and short-baseline neutrino experiments, a rich program of ultra-rare muon and kaon decays and opportunities for next-generation electric dipole moment experiments and other nuclear/particle physics probes that reach far beyond the Standard Model. The status and prospects of developing the accelerator complex and the research program will be presented.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 86****Analysis of CCQE Neutrino Interactions in a Liquid Argon Time Projection Chamber (LArTPC)****Author:** Kinga Partyka<sup>1</sup><sup>1</sup> *Yale University***Corresponding Author:** kinga.partyka@yale.edu

The Argon Neutrino Test, ArgoNeuT, is a small scale Liquid Argon Time Projection Chamber(LArTPC). ArgoNeuT, an R&D project paving the way for construction of larger detectors, was located 350 feet underground and ran upstream of the MINOS detector in the NuMI beam at Fermi National Accelerator Laboratory from September 2009 to February 2010. ArgoNeuT provides bubble-chamber-like quality images for excellent particle ID and background rejection. ArgoNeuT provides a sample of neutrino events in a LArTPC for the first time in the U.S. and the first time ever in a low-energy beam of 0.1 to 10 GeV. Analysis of ArgoNeuT's Charged Current Quasi-Elastic (CCQE) neutrino sample, in which a neutrino interacts with a neutron and the final state particles are a proton and a muon, will be presented. Vertex activity and calorimetric reconstruction will be addressed for this class of events.

**Financial Support Justification for Early-Stage Researchers:**

I am a 5th year graduate student working on ArgoNeuT, a small scale Liquid Argon Time Projection Chamber (LArTPC). I am very excited at the prospect of attending ICHEP2012 as I am planning on presenting our newest results on CCQE interactions together with calorimetric reconstruction. Furthermore, this is going to be my first international conference of this scale and importance. This is an excellent opportunity to further develop my presentation skills and to interact with scientists from



all over the world. Furthermore, this conference could also have a great impact on my career as I am currently conducting a post-doctoral search. Unfortunately, I do not have enough funding to cover the total cost of this conference. My attendance and additional support will depend on the amount that I receive from you. Thank you very much for your consideration.

**Poster Session - Board: 38 / 88**

## Electroweak corrections for $W/Z + n$ jet production

**Author:** Sascha Turczyk<sup>1</sup>

**Co-author:** Christian Bauer<sup>2</sup>

<sup>1</sup> *LBNL (US)*

<sup>2</sup> *UC Berkeley*

In the era of the LHC experiments the analysis of vector boson together with  $n$  jet production becomes very important. On the one hand these processes serve as a testing environment for perturbative QCD calculations as well as detector understanding. On the other hand,  $W/Z + n$  jet production is used for new physics searches and thus one has to deal with a huge amount of irreducible Standard Model background. Therefore we need to understand these processes thoroughly. With the increasing center of mass energy  $s$ , electroweak corrections become more important. Especially Sudakov type logarithms of the form  $\alpha_{\text{ew}} \ln^2[M_{W/Z}^2/s]$  can appear and potentially become large in the differential cross section. These logarithms stem from infrared and collinear divergences for  $M \rightarrow 0$ , as e.g. in QCD and QED processes involving a real gluon or photon emission, regularized by the finite gauge boson mass.

I will review the general methods presented in [1-3] and extend them to re-sum the electroweak and QCD logarithms of  $W/Z + 1(2)$  jet production explicitly as well as discuss the necessary input to generalize the computation to  $n$  jets. The starting point for this analysis is the unbroken full Standard Model, which is matched onto a SCET like theory SCET\_EW to describe all particles as collinear fields. At  $M \sim 100\text{--}200$  GeV the electroweak symmetry is broken and SCET\_EW is consequently matched onto SCET\_γ, in which the heavy gauge bosons as well as the top quark are integrated out and remain as static fields. This approach allows to compute the anomalous dimension for the running between the high and low scale as well as low scale matching systematically for each process.

The soft degrees of freedom can interact between different particles and depend on the gauge quantum numbers, only. The collinear degrees of freedom instead do not interact with each other - which actually depends on the regulator choice - and thus depend only on the type of the particle. Therefore we obtain both soft and collinear corrections. In turn we are able to re-sum the logarithms between the high scale at the center of mass energy and the low scale at which the symmetry is broken using the anomalous dimension and additionally obtain the low scale matching corrections at the same time. This correction can be computed analytically as the Wilson coefficient matrix for the operator basis at the low scale up to NLL precision.

I outline the automizable (numerical) calculation as well as necessary input for a general process. Then I will discuss the specific  $W/Z + 1(2)$  jet production and changes to several observables due to this corrections, especially I will mention the importance for distinguished analysis. The possible generalization to more final state vector bosons and jets is discussed. In the end I present an approach to implement these corrections into automatic Monte Carlo generators, at the example of the framework Geneva.

[1] J.-y. Chiu, F. Golf, R. Kelley and A. V. Manohar, Phys. Rev. Lett. **100** (2008) 021802

[2] J.-y. Chiu, F. Golf, R. Kelley and A. V. Manohar, Phys. Rev. D **77** (2008) 053004

[3] J.-y. Chiu, A. Fuhrer, R. Kelley and A. V. Manohar, Phys. Rev. D **81** (2010) 014023

**Plenary3 - The Standard Model -TR1 / 92****HERWIRI2: Exponentiated Electroweak Corrections in a Hadronic Event Generator****Author:** Scott Yost<sup>1</sup>**Co-authors:** Bennie Ward<sup>2</sup>; Miroslav Hejna<sup>3</sup>; Valerie Halyo<sup>4</sup><sup>1</sup> *The Citadel (US)*<sup>2</sup> *Baylor University (US)*<sup>3</sup> *Princeton University*<sup>4</sup> *Princeton University (US)***Corresponding Author:** scott.yost@citadel.edu

Reaching the desired precision level for W and Z processes at the LHC will require a mixture of higher-order QCD and electroweak corrections. HERWIRI2 is a step in implementing QED x QCD exponentiation in a hadronic event generator. This program implements leading electroweak corrections and coherent exclusive exponentiation in a HERWIG environment. We discuss the status of the program, recent tests, and future developments.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 93****A global fit to extract the B->Xs gamma decay rate****Authors:** Florian Bernlochner<sup>1</sup>; Frank Tackmann<sup>2</sup>; Heiko Markus Lacker<sup>3</sup>; Iain Stewart<sup>4</sup>; Kerstin Tackmann<sup>5</sup>; Zoltan Ligeti<sup>6</sup><sup>1</sup> *University of Victoria (CA)*<sup>2</sup> *D*<sup>3</sup> *Humboldt-Universitaet zu Berlin (DE)*<sup>4</sup> *MIT*<sup>5</sup> *Deutsches Elektronen-Synchrotron*<sup>6</sup> *Lawrence Berkeley National Lab. (US)***Corresponding Authors:** florian.bernlochner@cern.ch, kerstin.tackmann@cern.ch, lacker@physik.hu-berlin.de, zoltan.ligeti@cern.ch, iains@mit.edu, frank@mit.edu

The measurements of the total B->Xs gamma decay rate and the determination of the CKM matrix element  $|V_{ub}|$  play important roles in looking for new physics in the flavor sector of the Standard Model, complementary to the ongoing direct searches at the LHC. Their measurements from present and future B-factory data require the precise knowledge of the nonperturbative parts of the parton distribution function for the b quark in the B-meson (called the shape function). We present the state of the art theory and a global fit to BaBar and Belle data to extract the shape function and the B->Xs gamma decay rate using a model-independent framework with reliable theoretical uncertainties for the shape function, based on an expansion in a set of basis functions.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 94****Generalized Galileons for Particle Physics and Cosmology****Author:** Mark Trodden<sup>1</sup>

<sup>1</sup> *University of Pennsylvania (US)*

**Corresponding Author:** trodden@physics.upenn.edu

I describe how to construct new scalar field theories in four dimensions with attractive properties such as nonrenormalization theorems and interesting nonlinear classical dynamics. These generalized galileons are related to extra dimensional gravity models, and have a tight relationship to massive gravity models. Their properties suggest applications in inflation, late-time cosmic acceleration, and perhaps in tackling the hierarchy problem.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 95**

## Strong field effects on physics processes at the Interaction Point of future linear colliders

**Author:** Anthony Hartin<sup>1</sup>

**Co-authors:** Gudrid Moortgat-Pick<sup>2</sup>; Stefano Porto<sup>3</sup>

<sup>1</sup> *DESY (DE)*

<sup>2</sup> *University of Hamburg*

<sup>3</sup> *DESY*

**Corresponding Author:** anthony.hartin@cern.ch

Future linear colliders will be precision machines which, among other things, will closely study the Higgs sector, provide tighter bounds on electroweak observables and look for new physics via polarised beams. The luminosity requirements of such machines entail very intense lepton bunches at the IP with associated strong electromagnetic fields. These strong fields not only lead to obvious phenomena such as beamstrahlung, ISR and FSR, but also affect every particle physics process via virtual exchange with the bunch fields. For precision studies, strong field effects have to be understood to the sub-percent level. Strong external field effects can be taken into account exactly via the Furry interaction Picture. Within this picture, significant theoretical and phenomenological development is in progress and here we summarise the current state of play, presenting new exact solutions for overlapping relativistic charge bunch fields, cross-sections calculations for generic two vertex Furry picture processes, and the generation of processes via a new software package - IPstrong.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 96**

## A rigorous assessment of intrinsic accuracies and uncertainties of NLO+PS matching methods

**Authors:** Frank Martin Krauss<sup>1</sup>; Frank Siegert<sup>2</sup>; Marek Schoenherr<sup>3</sup>; Stefan Hoeche<sup>4</sup>

<sup>1</sup> *University of Durham (GB)*

<sup>2</sup> *Fakultaet fuer Physik*

<sup>3</sup> *University of Durham (UK)*

<sup>4</sup> *SLAC*

**Corresponding Author:** marek.schoenherr@durham.ac.uk

Similarities and differences between the MC@NLO and the POWHEG methods for matching NLO calculations to parton showers are discussed. Particular emphasis is put on their respective formal accuracies. Implementations of both methods in the SHERPA event generator framework are employed to assess their impact on representative observables. Some freedoms in both formulations

will be exploited to quantify the uncertainties for different processes of interest. Further, NLO+PS matched results for complex final states, e.g. the production of a W boson in association with up to 3 jets or a Higgs boson with up to 1 jets will be presented.

**Room 218 - Detectors and Computing for HEP - TR13 / 97**

## Development and Construction of Muon Drift-Tube (sMDT) Chambers for Upgrades of the ATLAS Muon Spectrometer at High LHC Luminosities

**Author:** Hubert Kroha<sup>1</sup>

**Co-authors:** Albert Engl<sup>2</sup>; Alessandro Manfredini<sup>3</sup>; Andre Zibell<sup>2</sup>; Bernhard Bittner<sup>4</sup>; Daniele Zanzi<sup>3</sup>; Joerg Dubbert<sup>3</sup>; Oliver Kortner<sup>3</sup>; Otmar Biebel<sup>2</sup>; Philipp Schwegler<sup>3</sup>; Ralf Hertenberger<sup>2</sup>; Robert Richter<sup>3</sup>; Sebastian Ott<sup>3</sup>

<sup>1</sup> *Max-Planck-Institut für Physik (DE)*

<sup>2</sup> *Ludwig-Maximilians University, Munich, Germany*

<sup>3</sup> *Max-Planck-Institut für Physik, Munich, Germany*

<sup>4</sup> *Max-Planck-Institut fuer Physik, Munich, Germany*

**Corresponding Author:** kroha@mppmu.mpg.de

For the planned high-luminosity upgrades of the Large Hadron Collider (LHC) increasing background rates of neutrons and gamma rays are expected exceed the rate capability of the current ATLAS muon tracking detectors. Drift-tube chambers with a tube diameter of 15 mm have (sMDT chambers) been developed for upgrades of the ATLAS muon spectrometer. A full sMDT prototype chamber has been constructed and tested in a muon beam at CERN and at high gamma and proton irradiation rates. The chamber design and construction procedures are discussed. The test results demonstrate the required track reconstruction efficiency and spatial resolution of the sMDT chambers at background rates far beyond the maximum expected values. The sense wire locations in the prototype chamber have been measured with few micron precision with cosmic rays confirming the required wire positioning accuracy of better than 20 microns. Currently sMDT chambers are under construction for installation in the ATLAS muon spectrometer in the 2013/14 LHC shutdown. Further sMDT chamber construction for subsequent upgrades are in the planning phase. New readout electronics for the chambers with higher bandwidth and better radiation hardness is also under development.

### Summary:

Muon drift-tube (sMDT) chambers have been developed for high-luminosity upgrades of the ATLAS muon spectrometer. The chambers have demonstrated background rate capability far beyond the requirements. Several chambers are under construction for upcoming detector upgrades, others are in the planning phase.

**Room 218 - Detectors and Computing for HEP - TR13 / 98**

## Upgrade project and plans for the ATLAS detector and first level trigger.

**Authors:** Enrico Pasqualucci<sup>1</sup>; Hubert Kroha<sup>2</sup>; Mimmo Della Volpe<sup>3</sup>

**Co-authors:** Oliver Kortner<sup>4</sup>; Philipp Schwegler<sup>4</sup>; Robert Richter<sup>4</sup>

<sup>1</sup> *Universita e INFN, Roma I (IT)*

<sup>2</sup> *Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)*

<sup>3</sup> *Università "Federico II" di Napoli & INFN (IT)*

<sup>4</sup> *Max-Planck-Institut fuer Physik, Munich, Germany*

**Corresponding Authors:** domenico.della.volpe@cern.ch, enrico.pasqualucci@cern.ch, kroha@mppmu.mpg.de

In the coming years, the LHC complex will be upgraded to extend the physics potential of the experiments. The average luminosity will be increased by a factor 5 to 10 above the original design one. The planned upgrades require, among other detector and DAQ system improvements, a significant higher selectivity of the trigger system, to cope with the increased radiation level and particle rates. In this paper we describe the changes to the ATLAS detector and its trigger system currently under study. The calorimetry--based trigger detectors will improve their selectivity by benefiting from the increased granularity available at the trigger level, which will allow for a higher energy resolution. In the muon detector, the momentum resolution of the trigger can be improved by using the precision muon tracking detectors, the Monitored Drift Tube chambers (MDT). An MDT--based trigger scheme has been developed and validated, based on new radiation--hard readout chips currently under development. The use of the inner tracking system in the lower levels of the trigger selection is also discussed. While the second level trigger will be helped by a new fast tracking system, the addition of tracking information at the first level trigger during the last phase of the LHC upgrade is currently under discussion. Different scenarios are compared, having in mind the requirements to achieve the expected physics potential of ATLAS in this high luminosity regime.

#### Summary:

A new Level 1 muon trigger system based on the Monitored Drift Tube (MDT) precision tracking chambers is under development for high-luminosity upgrades of the ATLAS muon spectrometer together with new MDT chamber readout electronics with higher bandwidth and better radiation hardness.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 99

## A proposal to solve some puzzles in semileptonic B decays

**Authors:** Florian Bernlochner<sup>1</sup>; Sascha Turczyk<sup>2</sup>; Zoltan Ligeti<sup>3</sup>

<sup>1</sup> *University of Victoria (CA)*

<sup>2</sup> *LBNL*

<sup>3</sup> *Lawrence Berkeley National Laboratory*

**Corresponding Author:** florian.bernlochner@cern.ch

Some long-standing problems in the experimental data for semileptonic  $b \rightarrow c l \nu$  decay rates have resisted attempts to resolve them, despite substantial efforts. We show that the presence of a relatively large decay rate into radially-excited D-mesons may alleviate several of these tensions simultaneously. In particular, their presence could help explaining the discrepancy between model calculations and experimental results for the first orbitally-excited doublets, known as the "1/2 vs. 3/2 puzzle". In order to substantiate our hypothesis, we estimate the decay rate into the first two radially excited charmed states using a quark-model and light-cone sum-rules, finding that it is not unreasonable to expect O(1%) branching fraction for these decays.

TR 8 - Neutrinos RM 219 / 100

## Status of the Cuore experiment at Gran Sasso

**Author:** Marco Pallavicini<sup>1</sup>

<sup>1</sup> *Universita' di Genova & INFN Genova*

**Corresponding Authors:** sergio.di.domizio@cern.ch, marco.pallavicini@ge.infn.it

Cuore (Cryogenic Underground Observatory for Rare Events) is a second generation neutrino-less double beta decay experiment whose sensitivity is expected to be in the range of 41-95 meV for the electron neutrino effective mass. In Cuore the decay of  $9.6 \cdot 10^{26}$  Te-130 nuclei (206 kg) is observed by means of 988 TeO<sub>2</sub> crystals acting as bolometers at very low temperature (~10 mK).

The experiment is located at the Laboratori Nazionali del Gran Sasso in Italy and is now approaching the final stage of construction. Most of the crystals have been produced, and the final test of the Cuore assembly line (so called Cuore-0 test) is expected to be up and running by June 2012. If successful, the construction of the full

Cuore detector will begin in summer 2012 and is expected to finish by 2014.

The talk will summarize the physics reach of the experiment, the status of the construction, and the expected sensitivity.

## TR 12 - Formal Theory Development & TR 1 - The Standard Model / 101

### Spectrum of a Walking Gauge Theory

**Authors:** L.C. Rohana Wijewardhana<sup>1</sup>; Lilia Anguelova<sup>2</sup>; Peter Suranyi<sup>3</sup>

<sup>1</sup> *University of Cincinnati (US)*

<sup>2</sup> *Perimeter Institute*

<sup>3</sup> *University of Cincinnati*

**Corresponding Authors:** rohana.wijewardhana@gmail.com, peter.suranyi@uc.edu, languelova@perimeterinstitute.ca

We study the spectrum of vector and scalar mesons in the holographic dual of a walking gauge theory, obtained by embedding D7 - anti-D7 probe branes in a certain type IIB background. We show that there is a nontrivial relation that needs to be satisfied in order for axial-vector modes to exist. The scalar mesons arise from fluctuations of the probe flavour branes and complement the (axial-)vector meson spectra. By explicitly finding the spectrum of scalar masses, we show that the nonsupersymmetric D7 - anti-D7 embedding is stable with respect to such fluctuations. Interestingly, it turns out that the mass splitting between the scalar and vector meson spectra is of subleading order in a small parameter expansion. We also estimate the Peskin Takeuchi S parameter of this theory and show that it is positive definite.

#### Summary:

This is joint work of L.Anguelova, P.Suranyi and L.C.R.Wijewardhana.

Will be presented by L.C.R.Wijewardhana.

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and

(2)arXiv:1203.1968 [hep-th].

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## Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 103

### Computing at SuperB

**Author:** Domenico Del Prete<sup>1</sup>

**Co-authors:** Alberto Gianoli <sup>2</sup>; Alejandro Perez <sup>3</sup>; Andrea Di Simone <sup>4</sup>; Armando Fella <sup>5</sup>; Bruno Santeramo <sup>6</sup>; Eleonora Luppi <sup>7</sup>; Fabrizio Bianchi ; Francesco Ciaschini <sup>8</sup>; Francesco Giacomini <sup>9</sup>; Giacinto Donvito <sup>10</sup>; Guido

Russo <sup>11</sup>; Luca Tomassetti <sup>12</sup>; Marco Corvo <sup>13</sup>; Matteo Manzali <sup>12</sup>; Matteo Rama <sup>14</sup>; Paolo Franchini <sup>15</sup>; Roberto Stroili <sup>16</sup>; Silvio Pardi <sup>13</sup>; Stefano Longo <sup>17</sup>; Steffen Luitz <sup>18</sup>

<sup>1</sup> *INFN Napoli (IT)*

<sup>2</sup> *Universita di Ferrara (IT)*

<sup>3</sup> *Laboratoire de l'Accélérateur Linéaire (LAL)*

<sup>4</sup> *Universita degli Studi di Roma Tor Vergata (IT)*

<sup>5</sup> *INFN Pisa*

<sup>6</sup> *INFN Bari*

<sup>7</sup> *Univ of Ferrara & INFN Ferrara*

<sup>8</sup> *CNAF*

<sup>9</sup> *INFN CNAF*

<sup>10</sup> *INFN-Bari*

<sup>11</sup> *Universita e INFN (IT)*

<sup>12</sup> *INFN Ferrara*

<sup>13</sup> *INFN*

<sup>14</sup> *INFN LNF*

<sup>15</sup> *Universita e INFN*

<sup>16</sup> *Univ Padova & INFN Padova*

<sup>17</sup> *INFN Padova*

<sup>18</sup> *SLAC*

**Corresponding Author:** fabrizio.bianchi@to.infn.it

Developing a computing model for the next generation of Super Flavor Factories, like SuperB and SuperKEKB, present significant challenges.

With a nominal luminosity above  $10^{36} \text{ cm}^{-2} \text{ s}^{-1}$ , we estimate that, after few years of operation, the size of the data sample will be of the order of 500 PB and the amount of CPU required to process it will be close to 5000 KHep-Spec06.

The new many and multi core technologies need to be effectively exploited in order to manage very large data set and this has a potential large impact on the computing model for SuperB. In addition, the computing resources available to SuperB, as is already the case for LHC experiments, will be distributed and accessed through a Grid or eventually a cloud infrastructure and a suite of efficient and reliable tools need to be provided to the users. A dedicated R&D program to explore these issues is in progress and it is presented here.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 105**

## Gamma Ray Source Studies Using Muon Tracking.

**Author:** Paul Doll<sup>1</sup>

<sup>1</sup> *KIT (DE)*

**Corresponding Author:** paul.doll@kit.edu

(KASCADE-Grande Collaboration).

High energy gamma rays produce muons in the Earth's atmosphere that can be detected and reconstructed in relatively shallow underground muon detectors such as ICECUBE and MILAGRO. Although muons of such low energy are mostly produced by charged Cosmic Ray (CR) particles, gamma produced muons (via photo-pion production) can be identified provided the detector has sufficient effective area and resolution.

A large area ( $128 \text{ m}^2$ ,  $E_\mu > 0.8 \text{ GeV}$ ) streamer tube detector, located within the KASCADE-Grande detector field has been used for muon tracking studies. We discuss the possibility of observing gamma-ray sources by means of photo-pion produced single isolated muon tracks above the background of CR

muons using a Muon Tracking Detector (MTD).

Properties of the photo-production process in the atmosphere and of the MTD which support the identification of gammas are discussed. The sensitivity of the technique of observing the Crab energy spectrum in the tens of GeV range is discussed. Gamma spectra accumulated from Crab and a flux correlation for Mrk 421 of photo-produced muons with the X-ray flux (RXTE/PCA) are presented. High resolution muon tracking may provide an alternative technique for a wide field of view and large duty cycle observations of gamma sources.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 106**

## Neutrino physics with Borexino

**Author:** Livia Ludhova<sup>1</sup>

<sup>1</sup> *INFN Milano (IT)*

**Corresponding Author:** livia.ludhova@mi.infn.it

Borexino is a large-volume liquid scintillator detector installed in the underground halls of the Laboratori Nazionali del Gran Sasso in Italy. After several years of construction, the Borexino phase I ended after about 3 years of data taking and a period of purification of the scintillator. All Borexino results within its solar neutrino program and their physical implications will be reviewed: the first real time measurement of the  $^7\text{Be}$  solar neutrino interaction rate, obtained with a precision below 5%, and the absence of its day-night asymmetry with 1.4% precision; the first direct evidence of the pep neutrino signal and the strongest experimental constraint of the CNO solar neutrino flux to date; the measurement of the solar  $^8\text{B}$  neutrino rate with 3 MeV energy threshold. Borexino has also made sensitive measurements of antineutrinos, both terrestrial (geoneutrinos) and astrophysical, setting the best limits on a hypothetical antineutrino flux from the Sun assuming undistorted  $^8\text{B}$  spectrum. Along with sensitive searches for exotic processes, Borexino is now preparing to make a precise time-of-flight measurement of neutrinos from the CNGS beam. If available at the time of the ICHEP2012 conference, new results concerning the neutrino speed and/or update of the geoneutrino measurement could be presented.

**Poster Session - Board: 33 / 107**

## Parity of Pions and CP Violation in Neutral Kaon System

**Author:** Brian Robson<sup>1</sup>

<sup>1</sup> *Australian National University (AU)*

**Corresponding Author:** brian.robson@anu.edu.au

The parity of pions will be discussed within the framework of the Generation Model [1] of particle physics and it will be shown that both the 1954 determination [2] of the parity of the charged pions and the 2008 determination [3] of the parity of the neutral pion are compatible with the mixed-parity nature of the pions predicted by a recent composite Generation Model [4]. The development of the Generation Model as an alternative to the Standard Model of particle physics will be discussed. It will be demonstrated how the Generation Model leads to a unified classification of leptons and quarks and how this makes feasible a composite model of the fundamental particles of the Standard Model. In particular it will be shown that the 1964 CP violating experiment of Christenson et al. [5] may be understood without CP violation.

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[2] W. Chinowsky and J. Steinberger, Phys. Rev. 95 (1954) 1561.



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**Poster Session** - Board: 12 / 108

## Large Jet Multiplicities and New Physics at the LHC

**Author:** Jason Kumar<sup>1</sup>

<sup>1</sup> *University of Hawaii (US)*

**Corresponding Author:** jkumar@hawaii.edu

A broad class of scenarios for new physics involving additional strongly-interacting fields predict signatures at hadron colliders which consist solely of large numbers of jets and substantial missing transverse energy. We investigate the prospects for discovery in such scenarios using a search strategy in which jet multiplicity and missing transverse energy are employed as the primary criteria for distinguishing signal from background. We examine the discovery reach this strategy affords in an example theory (a simplified supersymmetric model whose low-energy spectrum consists of a gluino, a light stop, and a light neutralino) and demonstrate that it frequently exceeds the reach obtained via other, alternative strategies.

**TR 8 - Neutrinos RM 219 / 109**

## New results of the OPERA long-baseline experiment in the CNGS neutrino beam

**Author:** Maximiliano Sioli<sup>1</sup>

<sup>1</sup> *INFN (IT)*

**Corresponding Author:** m.sioi@cern.ch

The OPERA neutrino experiment is placed in the CERN Neutrino beam to Gran Sasso (CNGS), 730 km from the beam source at CERN, in the underground Gran Sasso Laboratory. With the aim to measure the neutrino velocity on this baseline with higher accuracy than previous studies using accelerator neutrinos, dedicated upgrades of the CNGS timing system and of the OPERA detector were undertaken, as well as a high precision geodesy campaign to assess the neutrino baseline. With data taken by OPERA from 2009 to 2011, they led to preliminary results in 2011, updated in May 2012. Further verifications and up-to-date results on the neutrino velocity using special short bunch beams will be presented.

**Poster Session / 110**

## Static Gravitational Fields at Finite Temperature

**Author:** Fernando T Brandt<sup>1</sup>

**Co-author:** João Bosco Siqueira<sup>1</sup>

<sup>1</sup> *Universidade de São Paulo*

**Corresponding Author:** fbrandt@usp.br

We investigate the two loop contributions to the effective action of static gravitational fields at finite temperature. This allows us to take into account the effects of interactions of the thermal particles and the resulting higher loop contributions to the pressure of thermal matter in a gravitational background.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 111**

## **Precision calculation of the Standard Model $\Delta S=2$ contribution to indirect CP violation in $K \rightarrow \pi\pi$ decays**

**Author:** Thorsten Kurth<sup>1</sup>

**Co-authors:** Antonin Portelli<sup>2</sup>; Christian Holbling<sup>3</sup>; Craig McNeile<sup>4</sup>; Kalman Szabo<sup>5</sup>; Laurent Lellouch<sup>6</sup>; Sandor Katz<sup>7</sup>; Stefan Krieg<sup>8</sup>; Stephan Durr<sup>8</sup>; Thomas Lippert<sup>9</sup>; Zoltan Fodor<sup>10</sup>

<sup>1</sup> *Bergische Universität Wuppertal (DE)*

<sup>2</sup> *CPT Marseille*

<sup>3</sup> *Unknown*

<sup>4</sup> *University of Glasgow*

<sup>5</sup> *Bergische Universität Wuppertal*

<sup>6</sup> *Centre National de la Recherche Scientifique (CNRS)*

<sup>7</sup> *JSC FZ Jülich*

<sup>8</sup> *JSC at FZ Jülich and Wuppertal University*

<sup>9</sup> *JSC, FZ-Jülich*

<sup>10</sup> *BUW*

**Corresponding Author:** thorstenkurth@me.com

Indirect CP violation in  $K \rightarrow \pi\pi$  decays plays a central role in constraining the flavor structure of the Standard Model

and in the search for new physics. For many years the leading uncertainty in the SM prediction of this phenomenon was the one associated with the nonperturbative strong interaction dynamics in this process. I will present a fully nonperturbative lattice QCD calculation of the neutral kaon mixing parameter  $B_K$ , which quantifies the bulk of these effects. Our study involves 21 large-scale simulations with up and down quark masses all the way down to their very small physical value. It additionally involves nonperturbative renormalization. That allows us to gain full control over all sources of error and to determine  $B_K$  with an overall 1.1% uncertainty in the  $\overline{\text{RI}}$  scheme at a scale 3.5 GeV, namely  $B_K^{\overline{\text{RI}}(3.5 \text{ GeV})} = 0.531(6)_{\text{stat}}(2)_{\text{sys}}$ . I will end the talk with a discussion of the phenomenological implications of our result.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 112**

## **J/psi production in NLO NRQCD: A global analysis of yield and polarization**

**Authors:** Bernd Kniehl<sup>1</sup>; Mathias Butenschoen<sup>2</sup>

<sup>1</sup> *University of Hamburg*

<sup>2</sup> *University of Hamburg (DE)*

**Corresponding Author:** mathias.butenschoen@desy.de

We present a rigorous next-to-leading order analysis of  $J/\psi$  yield and polarization within the factorization theorem of nonrelativistic QCD (NRQCD). To the orders considered, this framework depends on the values of three color-octet long-distance matrix elements (LDMEs), which are predicted to be process-independent. We extract their values in a global fit to inclusive  $J/\psi$  production yield data from various hadroproduction, photoproduction, two-photon scattering and electron-positron annihilation experiments. We show that this fit is constrained and stable and describes all data sufficiently well. We then use these values to predict the  $J/\psi$  polarization in photo- and hadroproduction and compare to the currently available data. As for photoproduction, HERA data is not precise enough to draw definite conclusions. But as for hadroproduction, CDF data measured at Tevatron run II is in strong conflict with NRQCD predictions, a feature familiar from the previous Born analyses. With early ALICE data being however compatible with NRQCD, the future, more precise polarization measurements at the LHC will thus have the potential to clearly confirm or dismiss the universality of the LDMEs.

TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 113

## Constraints from direct dark matter searches, rare decays and LHC limits on Supersymmetry

**Author:** Dmitry Kazakov<sup>1</sup>

**Co-author:** Wim de Boer<sup>2</sup>

<sup>1</sup> *JINR (RU)*

<sup>2</sup> *KIT (Karlsruhe)*

**Corresponding Author:** kazakovd@theor.jinr.ru

The direct searches for Supersymmetry can be complemented by direct searches for dark matter, if one assumes the Lightest Supersymmetric Particle (LSP) provides the dark matter of the universe. It is shown that within the CMSSM the direct searches are more sensitive than the direct LHC searches for large values of the squark masses, even if one considers the uncertainties from the local relic density and the form factors. A combined excluded region from LHC, rare decays, WMAP and XENON100 are provided, showing that gluinos below 1 TeV are excluded ( $m_{1/2} > 400\text{GeV}$ ) independent of the squark masses. This limit implies an LSP mass above 160 GeV in the CMSSM.

TR 8 - Neutrinos RM 219 / 114

## The search for CP violation and the determination of the neutrino mass hierarchy in NO $\nu$ A and LBNE

**Author:** Jonathan Paley<sup>1</sup>

<sup>1</sup> *Argonne National Laboratory (US)*

**Corresponding Author:** jpaley@anl.gov

With the recent discovery of a non-zero value of the neutrino mixing angle  $\theta_{13}$ , the NuMI Off-Axis  $\nu_e$  Appearance (NO $\nu$ A) long baseline neutrino oscillation experiment, currently under construction, has unique sensitivity to both the CP-violating neutrino mixing phase and the neutrino mass-hierarchy. Beyond NO $\nu$ A, the proposed Long-Baseline Neutrino Experiment (LBNE) is designed for much greater sensitivity to the CP-violating phase while providing a very rich physics program. I will review the design, capabilities and schedule of both experiments.

**Poster Session - Board: 52 / 115**

## Development of very low threshold detection system for low-background experiments

**Author:** Alexander Akindinov<sup>1</sup>

**Co-authors:** Dmitri Akimov<sup>2</sup>; Ivan Alexandrov<sup>3</sup>

<sup>1</sup> *ITEP Institute for Theoretical and Experimental Physics*

<sup>2</sup> *ITEP, Moscow*

<sup>3</sup> *ITEP (RU)*

**Corresponding Author:** aleksandrov@itep.ru

A concept of readout of noble gas two-phase emission detectors by means of multipixel avalanche Geiger photodiodes (MGPDs or SiPMs) and a THGEM structure is presented.

It is well known that a two-phase emission technique with noble gases is a very sensitive method of detection of very small ionisation signals (down to few or single ionisation electrons). Electroluminescent “amplification” provides the unique possibility to detect reliably even the single ionisation electron extracted from the liquid to the gas phase. Due to this reason such detectors are currently successfully used in the Dark Matter search experiments and are considered for the use in the neutrino experiments: for coherent scattering of reactor antineutrino off atomic nuclei.

To increase the capabilities of a two-phase detector a system of THGEM + WLS (wavelength shifter) +MGPD is used for its readout. Additional amplification of the charge in the THGEM holes gives the large light signal of electroluminescence detected with an array of SiPMs. This readout system provides the mm accuracy for even very low-energy events, that is important for the reliable separation of the rare physical events from the background ones caused by spontaneous emission of the electrons from the liquid noble gas surface. The results of analysis experimental data and comparison MC simulations are present.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 116**

## Progress of MICE, the International Muon Ionization Cooling Experiment

**Authors:** Kenneth Long<sup>1</sup>; Paul Soler Jermyn<sup>2</sup>; Vittorio Palladino<sup>3</sup>

<sup>1</sup> *Imperial College London (UK)*

<sup>2</sup> *University of Glasgow (GB)*

<sup>3</sup> *Universita e INFN (IT)*

**Corresponding Authors:** k.long@imperial.ac.uk, vittorio.palladino@cern.ch, paul.soler@glasgow.ac.uk

Ionization Cooling is the only practical solution to preparing high brilliance muon beams for a neutrino factory or muon collider. The muon ionization cooling experiment (MICE) is under development at the Rutherford Appleton Laboratory (UK) by an international collaboration.

The muon beam line has been commissioned and, for the first time, measurements of beam emittance with particle physics detectors have been performed.

The remaining apparatus is currently under construction. First

results with a liquid-hydrogen absorber will be produced in 2013; a couple of years later a full cell of a representative ionization cooling channel, including RF re-acceleration, will be in operation. The design offers opportunities to observe cooling with various absorbers and several optics configurations. Results will be compared with detailed simulations of cooling channel performance to ensure full understanding of the cooling process.

**Financial Support Justification for Early-Stage Researchers:**

This abstract is being submitted by the chair of the MICE speakers bureau. If accepted an early-stage member of the collaboration will be selected for the mission. It would be surprising from current experience if he/she were not be in need of support for the expensive trip and sejour.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 118**

## **The MICE beamline instrumentation (trackers and PID) for precise emittance measurement.**

**Authors:** Kenneth Long<sup>1</sup>; Paul Soler Jermyn<sup>2</sup>; Vittorio Palladino<sup>3</sup>

<sup>1</sup> *Imperial College London*

<sup>2</sup> *University of Glasgow (UK)*

<sup>3</sup> *Universita e INFN (IT)*

**Corresponding Authors:** paul.soler@glasgow.ac.uk, k.long@imperial.ac.uk, vittorio.palladino@cern.ch

The International Muon Ionization Cooling Experiment (MICE) will carry out a systematic investigation of ionization cooling of a muon beam, for the future Neutrino Factory and the Muon Collider. As the emittance measurement will be done on a particle-by-particle basis, a sophisticated beam instrumentation is needed to measure both particle coordinates and timing vs RF in a harsh environment due to high particle rates, fringe magnetic fields and RF backgrounds. A PID system, based on three time-of-flight stations (with resolutions up to 50-60 ps), two Aerogel Cerenkov counters and a KLOE-like calorimeter (KL) has been constructed and has allowed the commissioning of the MICE muon beamline in 2010. It will be soon followed by an Electron Muon Ranger to determine the muon range at the apparatus downstream end and later by two tracker detectors to trace incoming particles inside two high-field superconducting solenoids. Detector performances will be shown and their use for the beamline characterization fully illustrated.

### **Financial Support Justification for Early-Stage Researchers:**

This abstract is being submitted by the chair of the MICE speakers bureau. If accepted an early-stage member of the collaboration will be selected for the mission. It would be surprising from current experience if he/she were not be in need of support for the expensive trip and sejour.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 119**

## **Flavour violating squark and gluino decays at LHC**

**Author:** Keisho Hidaka<sup>1</sup>

**Co-authors:** Alfred Bartl<sup>2</sup>; Bjoern Herrmann<sup>3</sup>; Elena Ginina<sup>2</sup>; Helmut Eberl<sup>4</sup>; Walter Majerotto<sup>4</sup>; Werner Porod<sup>5</sup>

<sup>1</sup> *Tokyo Gakugei University (JP)*

<sup>2</sup> *University of Wien*

<sup>3</sup> *DESY*

<sup>4</sup> *IHEP, OEAW, Wien*

<sup>5</sup> *University of Wurzburg*

**Corresponding Author:** hidaka@u-gakugei.ac.jp

We study the effect of squark generation mixing on squark and gluino production and decays at LHC in the Minimal Supersymmetric Standard Model (MSSM) with focus on mixing between second and

third generation squarks. Taking into account the constraints from B-physics we show that various regions in parameter space exist where decays of squarks and/or gluinos into flavour violating final states can have large branching ratios of up to  $\sim 40\%$ . Here we consider both fermionic and bosonic final states. Rates of the corresponding signals, e.g.  $pp \rightarrow t \bar{t} \bar{c} b$  missing- $E_T$  X, can be significant at LHC(14 TeV). We find that the inclusion of flavour mixing effects can be important for the search of squarks and gluinos and the determination of the underlying model parameters of the MSSM. (A part of this work is published in Phys. Rev. D84 (2011) 115026; arXiv:1107.2775 [hep-ph].)

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 121**

## Solar neutrino results from Super-Kamiokande

**Author:** Yusuke Koshio<sup>1</sup>

<sup>1</sup> *Kamioka observatory ICRR University of Tokyo (JP)*

Recent results of the Super-Kamiokande (SK) solar neutrino measurements are presented. The main goal of SK's solar analysis is to observe the MSW effect, i.e. a solar neutrino energy spectrum distortion induced by matter in the Sun, and a day/night solar neutrino flux asymmetry induced by matter in the Earth.

Thanks to the improvement of the detector's water circulation system, low energy background levels have been reduced and clear solar neutrino signals are seen even for 4.0-4.5 MeV electron kinetic energy range, along with some indications of a signal even down to 3.5-4.0 MeV.

The combined energy spectrum and day/night solar neutrino flux from phase I to phase IV in SK will be presented. A global oscillation analysis has been carried out using SK-I, II, III, and IV data and combining these results with the results of other solar neutrino experiments as well as the KamLAND reactor experiment. The results of this global analysis will also be presented.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 123**

## Direct Search for Dark Matter with the LUX Experiment

**Authors:** Karen Gibson<sup>1</sup>; Mani Tripathi<sup>2</sup>

<sup>1</sup> *Case Western Reserve University (US)*

<sup>2</sup> *University of California Davis (US)*

**Corresponding Author:** sudhindra.mani.tripathi@cern.ch

The Large Underground Xenon (LUX) experiment consists of a two-phase xenon time projection chamber, which is being deployed at a depth of 4850 feet in the Homestake mine in Lead, South Dakota. When LUX begins operation in Fall 2012 it will be the world's most sensitive dark matter detector, with a fiducial target mass of 100 kg. Results from a surface lab commissioning and calibration run of LUX will be presented. Comparisons will be made to a detailed detector simulation, which is novel for such a class of detectors. Expected sensitivity and physics reach for detecting WIMP dark matter will be discussed, and compared to other contemporary direct search experiments. Plans for an order of magnitude larger detector will be outlined.

**TR 8 - Neutrinos RM 219 / 124**

## The Simplest Neutrino Mass Matrix Revisited

**Authors:** Paul Fraser Harrison<sup>1</sup>; Rama Krishnan<sup>2</sup>; William Scott<sup>3</sup>

<sup>1</sup> *University of Warwick (UK)*

<sup>2</sup> *University of Warwick*

<sup>3</sup> *STFC - Science & Technology Facilities Council (GB)*

**Corresponding Author:** p.f.harrison@warwick.ac.uk

In 2004, two of us published a texture, the “Simplest” neutrino mass matrix, which predicted  $\sin \theta_{13} = \sqrt{2\Delta m_{sol}^2/3\Delta m_{atm}^2}$  and large  $\delta_{CP}$ . Using today’s measured values for neutrino mass-squared differences, this prediction gives  $\sin^2 2\theta_{13} \simeq 0.086_{-0.006}^{+0.003}$ , compared with a measured value, found by averaging the results of the Daya Bay and RENO experiments, of  $\sin^2 2\theta_{13} = 0.097 \pm 0.012$ . Here, we develop that texture separately for the cases of Dirac and Majorana neutrinos. For Dirac neutrinos, we use the measured value of  $\theta_{13}$  to predict the lightest neutrino mass. For the Majorana case, we present a specific model underlying this successful texture, and we explore its phenomenology in the context of the See-saw mechanism. Large  $CP$ -violation is a generic prediction of the texture.

#### Summary:

Successful neutrino mass matrix texture updated and embedded in a full model with Majorana neutrinos. Recent  $\theta_{13}$  values accommodated and large  $CP$  violation predicted.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 125**

## Mirror dark matter interpretations of DAMA, CoGeNT and CRESST-II experiments

**Author:** Robert Foot<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** rfoot@unimelb.edu.au

The DAMA, CoGeNT and CRESST-II experiments have announced evidence for the direct detection of dark matter.

We discuss these results in the context of the mirror dark matter framework. We show that all three experiments can be simultaneously explained via kinetic mixing induced elastic scattering of a mirror metal component off target nuclei. This metal component can be as heavy as  $\text{Fe}'$  if the galactic rotational velocity is relatively low:  $v_{rot} < 220$  km/s. This explanation is consistent with the constraints from the other experiments, such as CDMS/Ge, CDMS/Si and XENON100 when modest  $\sim 20 - 30\%$  uncertainties in energy scale are considered.

**TR 8 - Neutrinos RM 219 / 126**

## Getting the best out of T2K and NOvA

**Author:** Suprabh Prakash<sup>1</sup>

**Co-authors:** Sankagiri Umasankar<sup>2</sup>; Sushant Raut<sup>3</sup>

<sup>1</sup> *Indian Institute of Technology - Bombay (IN)*

<sup>2</sup> *I.I.T. Bombay, Mumbai, India*

<sup>3</sup> *IIT Bombay*

Neutrino oscillation physics stands at an important juncture today. With the reactor experiments having measured a moderately large value of  $\theta_{13}$ , determination of the neutrino mass hierarchy and  $\delta_{CP}$  are the next problems to be solved. In this work, we explore the physics potential of T2K and NOvA, with the aim of extracting as much physics as possible from them before the next generation of experiments.

At these baselines, the hierarchy- $\delta_{CP}$  degeneracy makes it difficult to measure the hierarchy independently of  $\delta_{CP}$ . For

hierarchy determination, we find that the lower half plane (LHP) of  $\delta_{CP}$  is favourable for NH and the upper half plane (UHP) is favourable for IH. If the favourable combinations (NH,LHP) or (IH,UHP) occur, then NOvA by itself can determine the hierarchy. If  $\delta_{CP}$

lies in the unfavourable half plane, NOvA allows a large region with wrong

hierarchy. Combined data from the planned runs of NOvA and T2K cannot determine the hierarchy even for the large  $\theta_{13}$ . However, the situation improves dramatically with a moderate increase in statistics. We demonstrate that the hierarchy can essentially be determined, even for unfavourable values of  $\delta_{CP}$ , if the exposures of NOvA and T2K are increased by a factor of 1.5 and 2 respectively. We find that addition of another experiment with a baseline of 130 km and beam power equivalent to T2K leads to a marginal improvement.

It would seem that an experiment with a shorter baseline (and hence small matter effects) like T2K may be able to measure  $\delta_{CP}$  without knowing the hierarchy. We show that this is not the case. No matter how small the matter effects, for some value of  $\delta_{CP}$ , any single experiment gives a wrong hierarchy-wrong  $\delta_{CP}$  solution. However, combined data from 2T2K+1.5NOvA can determine the correct half plane of  $\delta_{CP}$ .

#### **Financial Support Justification for Early-Stage Researchers:**

I am a fourth year Ph.D. student at the Indian Institute of Technology, Bombay.

My advisor has no project funds and my institute does not provide financial assistance for foreign travel. I have applied to various funding agencies in India for financial assistance. But the assistance provided by them can only cover the air travel. Therefore, I request you to waive the registration fee and provide me with local hospitality.

**TR 8 - Neutrinos RM 219 / 127**

## **First Results of the Daya Bay Reactor Neutrino Experiment**

**Author:** Liangjian Wen<sup>1</sup>

<sup>1</sup> *Institute of High Energy Physics (CN)*

**Corresponding Author:** wenlj@ihep.ac.cn

The neutrino mixing angle  $\theta_{13}$  is the gateway of studying CP violation in lepton sectors and determines the trend of future neutrino experiments. The Daya Bay Reactor Neutrino Experiment aims to precisely determine  $\theta_{13}$ , with the design sensitivity better than 0.01 in  $\sin^2 2\theta_{13}$  at the 90% C.L. The experiment takes a near-far relative measurement by comparing the observed electron-antineutrino rates and spectra at various baselines from the reactors. Functionally identical antineutrino detectors are deployed in water pools underground, in order to minimize the systematic errors and to suppress the cosmogenic backgrounds. The experiment started physics data taking on Dec.24, 2011. An overview of the experiment and the results using data up to May.15, 2012 will be presented.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 128**

## **New insights into soft gluons and gravitons**



**Author:** Chris White<sup>1</sup>

<sup>1</sup> *University of Glasgow (UK)*

**Corresponding Author:** christopher.white@glasgow.ac.uk

The study of gluon radiation in QCD, in the limit of small ("soft") momentum, remains an active research area, with a variety of phenomenological and theoretical applications. Soft gluon emission leads to large logarithms in perturbation theory which have to be summed up to all orders in the coupling, and also governs the structure of infrared singularities. Recently, new techniques and mathematical structures have been discovered, which enhance our understanding of these all-order properties. This talk will review a number of key topics, including: (i) the structure of infrared divergences in multiparton scattering; (ii) constraints from the high energy limit; (iii) intriguing relations between the soft limits of QCD and quantum gravity.

**Room 219 - BSM - Non-SUSY - TR3 / 129**

## Scale invariance and the electroweak symmetry breaking

**Author:** Archil Kobakhidze<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** archilk@unimelb.edu.au

Classical scale invariance maybe responsible for the quantum stability of the electroweak scale. We discuss realistic scale-invariant extensions of the Standard Model and the related phenomenology

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 130**

## High Q<sup>2</sup> Neutral Current new results from ZEUS

The cross sections for neutral current deep inelastic scattering in e+p collisions with a longitudinally polarised positron beam have been measured using the ZEUS detector at HERA. The single-differential cross-sections  $d\sigma/dQ^2$ ,  $d\sigma/dx$  and  $d\sigma/dy$  and the double-differential cross sections in  $Q^2$  and  $x$  are measured in the kinematic region  $Q^2 > 185 \text{ GeV}^2$  for both positively and negatively polarised electron beams and for each polarisation state separately. The measurements are based on an integrated luminosity of  $136 \text{ pb}^{-1}$  taken in 2006 and 2007 at a centre-of-mass energy of 318 GeV. The structure functions  $xF_3$  and  $xF_3^{\gamma Z}$  are determined by combining the e+p results presented in this analysis with previously measured e-p neutral current data. The measured cross sections are compared to the predictions.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 132**

## HERAPDF

**Author:** Ringaile Placakyte<sup>1</sup>

<sup>1</sup> *DESY (DE)*

**Corresponding Author:** ringaileplacakyte@gmail.com

A preliminary global NLO QCD analysis of the HERA data is presented. The following data sets are used in this analysis:

the NC and CC inclusive DIS cross sections obtained from the combination of the measurements from H1 and ZEUS based on HERA I and HERA II data at the nominal proton beam energy, the preliminary combined inclusive NC DIS cross sections at reduced proton beam energies, the inclusive jet cross sections from H1 and ZEUS and the preliminary combined HERA results on the structure function  $F_2(\text{charm})$ .

A NLO QCD PDF fit analysis with simultaneous determination of the strong coupling constant  $\alpha_s(M_Z)$  is presented. The analysis is based on the same combined H1 and ZEUS inclusive DIS measurements as HERAPDF1.5 fit, together with jet measurements provided by both H1 and ZEUS collaborations. The inclusion of jet data in the analysis significantly reduces the correlation between the gluon parton density function and the strong coupling, improving the precision of the gluon PDF and providing an accurate determination of  $\alpha_s(m_Z)$ .

The PDF set HERAPDF1.5 represents the QCD analysis of the combined HERA I including the preliminary combination of the HERA II data. Such, higher precision at high  $Q^2$  and high  $x$  is achieved. The precision of the PDFs at high  $x$  is significantly improved, particularly in the valence sector. The results of the NNLO fit variant are presented: the PDFs and their uncertainties. The fit was performed with 14 free PDF parameters. There are also comparisons to the previous HERAPDF1.0 NNLO PDF, based on HERA I data only, and to the new HERAPDF1.5f, which is a NLO version with also 14 free parameters in the fit.

A next-to-leading order QCD analysis is performed based on the preliminary combination of the H1 and ZEUS F2c measurements together with the published HERA inclusive neutral and charged current cross sections. Different variable flavour number schemes were used for the heavy flavour treatment. The fits are used to estimate the optimal value of the charm quark mass parameter  $m_c^{\text{model}}$  within a given heavy flavour scheme. Depending on the scheme, the optimal values of  $m_c^{\text{model}}$  range between 1.26 GeV and 1.68 GeV, and are determined with a precision of 0.04 GeV including statistical, model and parameterisation uncertainties. The parton distribution functions determined using the above heavy quark schemes at their optimal values of  $m_c^{\text{model}}$  are further used to predict the  $W^\pm$  and Z production cross sections at the LHC. Good agreement between these predictions for the  $W^\pm$  and Z cross sections is observed which allows to reduce the uncertainty due to the heavy flavour treatment, to below 1.0%.

**Poster Session - Board:** 29 / 136

## Search for Single-Top Production in ep Collisions at HERA

**Author:** Katarzyna Wichmann<sup>1</sup>

<sup>1</sup> DESY

**Corresponding Author:** katarzyna.wichmann@desy.de

A search for single-top production,  $ep \rightarrow e\bar{t}X$ , has been performed with the ZEUS detector at HERA using data corresponding to an integrated luminosity of 0.37 fb<sup>-1</sup>. No evidence for top production was found, consistent with the expectation from the Standard Model. Limits were computed for single-top production via flavour changing neutral current transitions. The result was combined with a previous ZEUS result yielding a total luminosity of 0.50 fb<sup>-1</sup>. A 95% credibility level upper limit of 0.13 pb was obtained for the cross section at the centre-of-mass energy of  $\sqrt{s}=315$  GeV.

**Room 219 - BSM - Non-SUSY - TR3 / 137**

## A search for resonance decays to lepton+jet at HERA and limits on leptoquarks

**Author:** Katarzyna Wichmann<sup>1</sup>

<sup>1</sup> DESY

**Corresponding Author:** katarzyna.wichmann@desy.de

A search for first generation leptoquarks was performed in polarized electron-proton collider data recorded with the ZEUS detector at HERA in the years 2003-2007.

They were analyzed for final states with an electron and jets or with missing transverse momentum and jets and a search for resonance structures or other deviations from the Standard Model predictions in the spectra of the invariant mass of lepton and jets was performed. No evidence for leptoquark signals was found. The data were combined with the previously taken data at HERA corresponding to an integrated luminosity of 0.5fb<sup>-1</sup> and limits were set on the Yukawa coupling  $\lambda$  as a function of the leptoquark mass for different leptoquark types within the Buchmueller-Rueckl-Wyler model.

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## Elastic Z0 production at HERA

**Author:** Katarzyna Wichmann<sup>1</sup>

<sup>1</sup> DESY

**Corresponding Author:** katarzyna.wichmann@desy.de

A search for events  $ep \rightarrow ep Z0$  has been performed in ep collisions at HERA using the ZEUS detector. The search is based on the entire HERA-I and HERA-II data set, amounting to 0.49 fb<sup>-1</sup> of integrated luminosity. The Z0 was searched in the di-jet decay mode with elastic condition defined by  $\eta_{\text{max}} < 3$ , where  $\eta_{\text{max}}$  is defined as the pseudorapidity of the energy deposit in the calorimeter closest to the proton beam direction.

A di-jet mass peak is observed at the Z0 mass and the number of signal events is extracted from a fit to the mass spectrum. The elastic Z0 production cross section is determined and compared to the SM prediction.

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## Study of tau-pair production at HERA

**Author:** Masaki Ishitsuka<sup>1</sup>

<sup>1</sup> Tokyo Institute of Technology

**Corresponding Author:** masaki.ishitsuka@cern.ch

A study of events containing two tau leptons with high transverse momentum has been performed with the ZEUS detector at HERA, using a data sample corresponding to an integrated luminosity of 0.33 fb<sup>-1</sup>. The tau candidates were identified from their decays into electrons, muons or hadronic jets. The number of tau-pair candidates has been compared with the prediction from the Standard Model, where the largest contribution is expected from Bethe-Heitler processes. The total visible cross section was extracted. Standard Model expectations agree well with the measured distributions, also at high invariant mass of the tau pair.

## Diffractive cross sections at HERA

**Author:** David Salek<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Author:** david.salek@cern.ch

A combination of the inclusive diffractive cross section measurements made by the H1 and ZEUS Collaborations at HERA is presented. The analysis uses diffractive deep inelastic scattering data measured by means of proton spectrometers. Correlations of systematic uncertainties are taken into account by the combination method, resulting in improved precision. The combined data cover the range  $2.5 < Q^2 < 200 \text{ GeV}^2$  in photon virtualities,  $0.00035 < x_{\text{IP}} < 0.09$  in fractional momentum losses,  $0.09 < |t| < 0.55 \text{ GeV}^2$  in four momentum transfer at the proton vertex and  $0.0018 < \beta < 0.56$  in  $\beta = x/x_{\text{IP}}$ , where  $x$  is the Bjorken scaling variable.

The reduced cross section in diffractive deep inelastic scattering ep events was measured with the ZEUS detector at HERA, using two different centre-of-mass energies, 318 and 225 GeV. The diffractive events,  $\gamma^* p \rightarrow Xp$ , were selected requiring a large rapidity gap between the hadronic system  $X$  and the outgoing proton. The measurement covers an unexplored range of  $y$ , the inelasticity of the interaction.

The diffractive process  $ep \rightarrow eXY$ , where  $Y$  denotes a proton or its low mass excitation with  $M_Y < 1.6 \text{ GeV}$ , is studied with the H1 experiment at HERA. The analysis is restricted to the phase space region of the photon virtuality  $3 \leq Q^2 \leq 1600 \text{ GeV}^2$ , the square of the four-momentum transfer at the proton vertex  $|t| < 1.0 \text{ GeV}^2$  and the longitudinal momentum fraction of the incident proton carried by the colourless exchange  $x_{\text{IP}} < 0.05$ . Triple differential cross sections are measured as a function of  $x_{\text{IP}}$ ,  $Q^2$  and  $\beta = x/x_{\text{IP}}$  where  $x$  is the Bjorken scaling variable. These measurements are made after selecting diffractive events by demanding a large empty rapidity interval separating the final state hadronic systems  $X$  and  $Y$ . High statistics measurements covering the data taking periods 1999-2000 and 2004-2007 are combined with previously published results in order to provide a single set of diffractive cross sections from the H1 experiment using the large rapidity gap selection method. The combined data represent a factor between three and thirty increase in statistics with respect to the previously published results. The measurements are compared with predictions from NLO QCD calculations based on diffractive parton densities and from a dipole model. The proton vertex factorisation hypothesis is tested.

First measurements are presented of the diffractive cross section  $\sigma_{ep \rightarrow eXY}$  at centre-of-mass energies  $\sqrt{s}$  of 225 and 252 GeV, together with a precise new measurement at  $\sqrt{s}$  of 319 GeV, using data taken with the H1 detector in the years 2006 and 2007. Together with previous H1 data at  $\sqrt{s}$  of 301 GeV, the measurements are used to extract the diffractive longitudinal structure function FLD in the range of photon virtualities  $4.0 \leq Q^2 \leq 44.0 \text{ GeV}^2$  and fractional proton longitudinal momentum loss  $5 \cdot 10^{-4} \leq x_{\text{IP}} \leq 3 \cdot 10^{-3}$ . The measured FLD is compared with leading twist predictions based on diffractive parton densities extracted in NLO QCD fits to previous measurements of diffractive Deep-Inelastic Scattering and with a model which additionally includes a higher twist contribution derived from a colour dipole approach. The ratio of the diffractive cross section induced by longitudinally polarised photons to that for transversely polarised photons is extracted and compared with the analogous quantity for inclusive Deep-Inelastic Scattering.

The cross section for the diffractive deep-inelastic scattering process  $ep \rightarrow eXp$  is measured, with the leading final state proton detected in the H1 Forward Proton Spectrometer. The data sample covers the range  $x_{\text{IP}} < 0.1$  in fractional proton longitudinal momentum loss,  $0.1 < |t| < 0.7 \text{ GeV}^2$  in squared four-momentum transfer at the proton vertex and  $4 < Q^2 < 700 \text{ GeV}^2$  in photon virtuality. The cross section is measured four-fold differentially in  $t$ ,  $x_{\text{IP}}$ ,  $Q^2$  and  $\beta = x/x_{\text{IP}}$ , where  $x$  is the Bjorken scaling variable. The  $t$  and  $x_{\text{IP}}$  dependences are interpreted in terms of an effective pomeron trajectory and a sub-leading exchange. The data are compared to perturbative QCD predictions at next-to-leading order based on diffractive parton distribution functions previously extracted from complementary measurements of inclusive diffractive deep-inelastic scattering. The ratio of the diffractive to the inclusive ep cross section is studied as a function of  $Q^2$ ,  $\beta$  and  $x_{\text{IP}}$ .

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## Exclusive VM production at HERA

**Author:** Sampa Bhadra<sup>1</sup>

<sup>1</sup> *York University*

**Corresponding Author:** bhadra@yorku.ca

The exclusive photoproduction reaction  $\gamma p \rightarrow \text{Upsilon}(1S) p$  has been studied with the ZEUS detector in ep collisions at HERA. The exclusive electroproduction of two pions in the mass range  $0.4 < M(\text{p}\pi\text{p}) < 2.5 \text{ GeV}$  has also been studied with the ZEUS detector at HERA. The two-pion invariant-mass distribution is interpreted in terms of the pion electromagnetic form factor,  $|F(M(\text{p}\pi\text{p}))|$ , assuming that the studied mass range includes the contributions of the  $\rho$ ,  $\rho'$  and  $\rho''$  vector-meson states. Results from exclusive diffractive photoproduction of  $J/\psi$  mesons as measured with the H1 detector at the electron-proton collider HERA will be shown. Differential cross sections will be presented as a function of  $t$ , the squared four-momentum transfer at the proton vertex, and of  $W_{\gamma}$  in the kinematical range of low photon virtualities of  $Q^2 < 2.5 \text{ GeV}^2$ .

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## Particle production in DIS at HERA

**Author:** Anastasia Grebenyuk<sup>1</sup>

<sup>1</sup> *DESY (DE)*

**Corresponding Author:** anastasia.grebenyuk@cern.ch

Scaled momentum distributions for the strange hadrons  $K^0$ s and  $\Lambda$ / $\Lambda$ -bar were measured in deep inelastic ep scattering with the ZEUS detector at HERA using an integrated luminosity of 330 pb<sup>-1</sup>. The evolution of these distributions with the photon virtuality,  $Q^2$ , was studied in the kinematic region  $10 < Q^2 < 40000 \text{ GeV}^2$  and  $0.001 < x < 0.75$ , where  $x$  is the Bjorken scaling variable. Clear scaling violations are observed. Predictions based on different approaches to fragmentation were compared to the measurements. Tuned leading-logarithm parton-shower Monte Carlo calculations interfaced to the Lund string fragmentation model describe the data reasonably well in the whole range measured. Next-to-leading-order QCD calculations based on fragmentation functions, FFs, extracted from  $e^+e^-$  data alone, fail to describe the measurements. The calculations based on FFs extracted from a global analysis including  $e^+e^-$ , ep and pA data give an improved description. The measurements presented in this paper have the potential to further constrain the FFs of quarks, anti-quarks and gluons yielding  $K^0$ s and  $\Lambda$ / $\Lambda$ -bar strange hadrons.

The production of neutral strange particles is studied at low  $Q^2$ , using deep-inelastic scattering events recorded with the H1 Detector at HERA. The production cross sections are presented differentially as a function of several kinematical variables in the laboratory and the Breit frame. Moreover, the strangeness production rate is compared to the equivalent rate of charged particles in a similar phase space. The H1 data are compared to theoretical predictions, based on leading order Monte Carlo programs with matched parton showers, with different values of the strangeness suppression factor.

The electron-proton collider HERA allows deep-inelastic scattering (DIS) at very small Bjorken- $x$  of about  $10^{-5}$ . At such small  $x$  new parton dynamics beyond DGLAP are expected to become important. Charged particle spectra are measured in DIS ( $Q^2 > 5 \text{ GeV}^2$ ), in different regions of pseudorapidity, using the increased statistics of HERA-2. The measurements are compared to simulations based on different Monte Carlo generators. It is shown that the region of small transverse momenta is primarily sensitive to hadronisation, whereas the region of large transverse momenta is mainly

driven by perturbative parton radiation. The observed hardness of the transverse momentum spectra, when compared to different model predictions, can be interpreted as supporting the idea of parton dynamics beyond DGLAP.

The production of photons at very small angles with respect to the proton beam direction is studied in deep-inelastic positron-proton scattering at HERA. The data are taken with the H1 detector in the years 2006 and 2007 and correspond to an integrated luminosity of 126 pb<sup>-1</sup>. The analysis covers the range of negative four momentum transfer squared at the positron vertex  $6 < Q^2 < 100 \text{ GeV}^2$  and inelasticity  $0.05 < y < 0.6$ . Cross sections are measured for the most energetic photon with pseudorapidity  $\eta > 7.9$  as a function

of its transverse momentum  $p_{T^{\text{lead}}}$  and longitudinal momentum fraction of the incoming proton  $x_{L^{\text{lead}}}$ . In addition, the cross sections are studied as a function of the sum of the longitudinal momentum fraction  $x_{L^{\text{sum}}}$  of all photons in the pseudorapidity range  $\eta > 7.9$ . The cross sections are normalised to the inclusive deep-inelastic scattering cross section and compared to the predictions of models of deep-inelastic scattering and models of the hadronic interactions of high energy cosmic rays.

## TR 6 - RM 217 - QCD, Jets, Parton Distributions / 145

### Jet Physics at HERA

Isolated-photon+jet production in ep collisions at a centre-of-mass energy of 318 GeV has been measured with the ZEUS detector at HERA using an integrated luminosity of up to 300 pb<sup>-1</sup>. Measurements of prompt-photon+jet cross sections are presented as functions of the photon transverse energy and pseudorapidity in a wide range of exchanged-photon virtuality. In addition, differential gamma+jet cross sections are presented as functions of the jet transverse energy and pseudorapidity. Leading-logarithm parton-shower Monte Carlo predictions and perturbative QCD calculations were compared to the data.

Differential inclusive-jet cross sections have been measured in photoproduction for boson virtualities  $Q^2 < 1 \text{ GeV}^2$  with the ZEUS detector at HERA using an integrated luminosity of 300 pb<sup>-1</sup>. Jets were identified in the laboratory using the kt cluster algorithm in the longitudinally inclusive mode. Cross sections are presented as functions of the jet pseudorapidity,  $\eta_{\text{jet}}$ , and the jet transverse energy,  $E_{T\text{jet}}$ . In addition, measurements of double-differential inclusive-jet cross sections are presented as functions of  $E_{T\text{jet}}$  in different regions of  $\eta_{\text{jet}}$ . These cross sections have the potential to constrain the gluon density in the proton and the photon when included as input to fits to extract the proton parton distribution functions. Next-to-leading-order QCD calculations give a good description of the measurements. A value of  $\alpha_s(M_Z)$  has been extracted from the measurements. The energy-scale dependence of the coupling has also been determined.

Signals of QCD instanton-induced processes are searched for in deep-inelastic scattering (DIS) at the electron-proton collider HERA in the kinematic region defined by the Bjorken-scaling variable  $x > 10^{-3}$ , the inelasticity  $0.2 < y < 0.7$  and the photon virtuality  $150 < Q^2 < 15000 \text{ GeV}^2$ . The search is performed using H1 data corresponding to an integrated luminosity of  $\sim 350 \text{ pb}^{-1}$ . Several observables of the hadronic final state of the events are exploited to identify a potentially instanton-enriched domain. Two Monte Carlo models, RAPGAP and ARIADNE, are used to estimate the background from the standard DIS processes, and the instanton-induced scattering processes are modeled by the program QCDINS. In order to extract the expected signal a multivariate data analysis technique is used.

New results on normalised inclusive jet, di-jet and trijet differential cross sections in neutral current deep-inelastic ep scattering (DIS) based on a regularised unfolding procedure are presented. Detector effects like acceptance and migrations as well as statistical correlations between the multi-jets and the inclusive DIS events are taken into account in this procedure. The DIS phase space of this measurement with the H1 detector is given by the virtuality of the exchanged boson ( $\gamma^*, Z^0$ )  $150 < Q^2 < 15000 \text{ GeV}^2$  and the inelasticity of the interaction  $0.2 < y < 0.7$ . The jets are reconstructed in the Breit frame of reference using the  $k_{T\text{jet}}$  algorithm. In all cases the jet pseudorapidities in the laboratory frame are required to be in the range  $-1.0 < \eta_{\text{lab}} < 2.5$ . For inclusive jets the transverse momenta in the Breit frame are  $7 < p_{T\text{jet}} < 50 \text{ GeV}$ . The di-jet and tri-jet phase space are defined

by requiring  $5 < p_{T,i} < 50$  GeV, and the invariant mass of the two leading jets  $M_{1,2} > 16$  GeV. Compared to a previously published result on normalised multi-jet cross sections, the new features are an extended range in jet pseudorapidity, an improved hadronic energy scale uncertainty of 1% and the adoption of a regularised unfolding procedure. The unfolded normalised jet cross sections are compared to QCD calculations at NLO and values for the strong coupling  $\alpha_s(M_Z)$  are extracted.

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## Charm production in DIS at HERA

**Author:** Achim Geiser<sup>1</sup>

<sup>1</sup> DESY

**Corresponding Author:** achim.geiser@cern.ch

Charm production has been measured with the ZEUS detector in deep inelastic ep scattering at HERA. The measurement is based on the full reconstruction of the decay chain  $D \rightarrow D^0 \pi$ ,  $D^0 \rightarrow K \pi$  and exploits the full HERA II statistics. Differential cross sections have been measured. The kinematic range is  $1.5 \text{ GeV} < p_T(D) < 10 \text{ GeV}$ ,  $|\eta(D)| < 1.5$ ,  $5 < Q^2 < 1000 \text{ GeV}^2$  and  $0.02 < y < 0.7$ . The observed cross sections is extrapolated to the full  $p_T(D)$  and  $\eta(D^*)$  range in order to determine the open-charm contribution,  $F_2^{\text{cc}}(x, Q^2)$  to the proton structure function,  $F_2$ .

Charm production in deep inelastic scattering has been measured with the ZEUS detector using the full HERA II data set. The charm content in events with a jet has been extracted using the decay length significance and invariant mass of secondary vertices. Differential cross sections as a function of  $Q^2$ , Bjorken  $x$ ,  $E_T(\text{jet})$  and  $\eta(\text{jet})$  were measured and compared to theoretical predictions. The open charm contribution to the proton structure function  $F_2$  was extracted from double differential cross sections.

The production of  $D^*$ ,  $D^+$ ,  $D^0$ ,  $D_s$  and  $\Lambda_c$  charm hadrons and their antiparticles in ep scattering at HERA was studied with the ZEUS detector using the full HERA II data set. The measurement has been performed in the photoproduction regime. The fractions of  $c$  quarks hadronising as a particular charm hadron,  $f(c \rightarrow D, \Lambda_c)$ , were derived in the visible kinematic range. The obtained fractions can be compared to previous results from HERA and to measurements from  $e^+e^-$  experiments.

The inclusive photoproduction of  $D^*$  mesons and of  $D^*$ -tagged dijets is investigated with the H1 detector at the ep collider HERA. The kinematic region covers small photon virtualities  $Q^2 < 2 \text{ GeV}^2$  and photon-proton centre-of-mass energies of  $100 < W_{\text{yp}} < 285 \text{ GeV}$ . Inclusive  $D^*$  meson differential cross sections are measured for central rapidities  $|\eta(D^*)| < 1.5$  and transverse momenta  $p_T(D^*) > 1.8 \text{ GeV}$ . The heavy quark production process is further investigated in events with at least two jets with transverse momentum  $p_T(\text{jet}) > 3.5 \text{ GeV}$  each, one containing the  $D^*$  meson. Differential cross sections for  $D^*$ -tagged dijet production and for correlations between the jets are measured in the range  $|\eta(D^*)| < 1.5$  and  $p_T(D^*) > 2.1 \text{ GeV}$ . The results are compared with predictions from Monte Carlo simulations and next-to-leading order perturbative QCD calculations.

Inclusive production of D mesons in deep-inelastic ep scattering at HERA is studied in the range  $5 < Q^2 < 100 \text{ GeV}^2$  of the photon virtuality and  $0.02 < y < 0.7$  of the inelasticity of the scattering process. The observed phase space for the D meson is

$p_T(D) > 1.25 \text{ GeV}$  and  $|\eta(D)| < 1.8$ . The data sample corresponds to an integrated luminosity of  $348 \text{ pb}^{-1}$  collected with the H1 detector. Single and double differential cross sections are measured and the charm contribution  $F_2^{\text{cc}}$  to the proton structure function  $F_2$  is determined. The results are compared to perturbative QCD predictions at next-to-leading order implementing different schemes for the charm mass treatment and with Monte Carlo models based on leading order matrix elements with parton showers.

TR5 &amp; TR7 - Room 220 - B Physics and CP Violation, etc. / 148

## Kaon Physics at CERN: recent results from the NA48/2 experiment

**Author:** Cristina Biino<sup>1</sup>

<sup>1</sup> *Universita e INFN (IT)*

**Corresponding Author:** cristina.biino@cern.ch

Semileptonic kaon decays offer the most precise determination of the CKM matrix element  $|V_{us}|$ . The experimental precision is however limited by the knowledge of the form factors of this decay, since these enter both the phase space integral and the detector acceptances. The NA48/2 experiment presents new high precision measurements of the form factors of the semileptonic decays of charged kaons ( $K^{+-} \rightarrow \pi^0 l^{+-} \nu$ ), based on 4.3 million  $Ke3$  and 3.5 million  $K\mu3$  decays, both with negligible background. The result matches the precision of the current world average on the vector and scalar form factors and allows to significantly reduce the form factor uncertainty on  $|V_{us}|$ . In addition, the comparison of both channels sets tight constraints on lepton flavour violation and other possible new physics.

The NA48/2 collaboration has also accumulated  $\sim 60000$  semi-leptonic  $K$  charged decays  $Ke4(00)$  to  $\pi^0 \pi^0 e$  neutrino, increasing the world available statistics by several orders of magnitude. Background contamination below the percent level and very good  $\pi^0$  reconstruction allow the first accurate measurement of the Branching Fraction and decay Form Factor at the percent level. The achieved precision makes possible the observation of small effects such as  $\pi^+ \pi^-$  to  $\pi^0 \pi^0$  re-scattering below the  $2 m(\pi^+)$  threshold. Concurrently, more than one million  $K$  charged decays  $Ke4(+-)$  to  $\pi^+ \pi^- e$  neutrino has been analyzed, leading to an improved determination of the Branching Fraction by a factor of 3 and detailed Form Factor studies. Both  $Ke4$  modes decay properties bring new precise inputs to Low Energy QCD studies and can provide strong tests of ChPT predictions.

While the above analyses are close to completion and should appear shortly with final results, future prospects include the observation of several 1000 decays in similar muonic modes  $K\mu4(00)$  (never observed) and  $K\mu4(+-)$  (7 events observed). Such poorly known modes could be studied also in the forthcoming NA62 experiment currently under construction.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 152

## Rare kaon decay measurements with NA62/NA48 minimum bias data

**Author:** Vladimir Kekelidze<sup>1</sup>

<sup>1</sup> *Joint Inst. for Nuclear Research (RU)*

**Corresponding Author:** vladimir.kekelidze@cern.ch

The NA62 (phase-I) experiment at CERN collected a large sample of charged kaon decays in 2007-2008, allowing one to study these decays with a high precision. The first result of the helicity-suppressed ratio  $R_K$  of the  $K^{+-} \rightarrow e^{+-} \nu$  and  $K^{+-} \rightarrow \mu^{+-} \nu$  decay measurement based on this sample is presented. The result is in agreement with the Standard Model expectation, and constrains two-Higgs-doublets extension of the Standard Model. The status of analyses of rare decay  $K^{+-} \rightarrow e \nu \gamma$  and very rare decay  $K^+ \rightarrow \pi^+ \pi^0 e^+ e^-$  collected with a low intensity beam and minimum bias trigger conditions in 2007, is presented as well. Using the minimum bias data of NA62 and the data of NA48/2 experiment collected with minimum bias trigger in 2004, a large sample of  $K^{+-} \rightarrow \pi \gamma \gamma$  decays has been selected and analyzed. This analysis led to a precision test of the



Chiral Perturbation Theory. The NA62 experiment at CERN SPS (phase-II) aims to collect of the order of 100  $K^+ \rightarrow \pi^+ \pi^+ \pi^-$  events in two years of data taking, keeping the background at the level of 10%. The physics prospects and the status of the construction of the experiment will be presented.

**Poster Session** - Board: 39 / 153

## Inelastic J/Psi double differential cross sections

**Author:** Alessandro Bertolin<sup>1</sup>

<sup>1</sup> INFN Padova

**Corresponding Author:** alessandro.bertolin@pd.infn.it

The double differential inelastic J/psi photoproduction cross section as function of the squared transverse momentum of the J/psi in bins of the inelasticity  $z$  has been measured in ep collisions with the ZEUS detector at HERA. An integrated luminosity of 468 pb<sup>-1</sup> was used corresponding to the full data sample collected by the ZEUS experiment. The events were required to have  $0.1 < z < 0.9$ ,  $p_T > 1$  GeV and  $60 < W < 240$  GeV, where  $p_T$  is the transverse momentum of the J/psi and  $W$  is the photon-proton centre-of-mass energy. The J/psi mesons were identified through their decay into muon pairs. The double differential cross section measurements are compared to the most recent theoretical predictions.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 154**

## Heavy quark photoproduction at HERA

**Author:** Michel Sauter<sup>1</sup>

<sup>1</sup> Universität Heidelberg (DE)

**Corresponding Author:** michel.sauter@desy.de

Photoproduction of beauty and charm quarks in events with at least two jets has been measured with the ZEUS detector at HERA using an integrated luminosity of 133 pb<sup>-1</sup>. The fractions of jets containing b and c quarks were extracted using the invariant mass of charged tracks associated with secondary vertices and the decay-length significance of these vertices. Differential cross sections as a function of jet transverse momentum,  $p_T$  jet, and pseudorapidity,  $\eta_{\text{jet}}$ , were measured. The data are compared with previous measurements and are well described by next-to leading-order QCD predictions.

The cross section of  $b\bar{b}$  photoproduction in ep collisions is measured with the H1 detector at HERA. Events containing b-quarks are identified through detection of two low momentum electrons in the final state. Semileptonic decays  $b\bar{b} \rightarrow eeX$  are exploited in the kinematic range of the photon virtuality  $Q^2 < 1$  GeV<sup>2</sup>, the inelasticity  $0.2 < y < 0.8$  and the pseudorapidity of the b-quarks  $|\eta(b), \eta(\bar{b})| < 2$ . The differential b-quark production cross section is measured as a function of the transverse b-quark momentum and extends the previously experimentally accessible phase space towards the b-quark production threshold. The results are compared to other b-quark cross section measurements, as well as to QCD predictions.

Measurements of cross sections for beauty and charm events with dijets and a muon in photoproduction at HERA are presented. Events with dijets of transverse momentum  $P_{T^{\text{jet1}}} > 7$  GeV and  $P_{T^{\text{jet2}}} > 6$  GeV in the pseudorapidity range  $-1.5 < \eta_{\text{jet}} < 2.5$  in the laboratory frame are selected in the kinematic region of  $Q^2 < 2.5$  GeV<sup>2</sup> and inelasticity  $0.2 < y < 0.8$ . One of the two selected jets must be associated to a muon with  $P_{T^\mu} > 2.5$  GeV in the pseudorapidity range  $-1.3 < \eta_\mu < 1.5$ . The

data were collected with the H1 detector in the years 2006 and 2007 corresponding to an integrated luminosity of 179 pb<sup>-1</sup>. The fraction of beauty and charm events is determined using variables reconstructed with the H1 vertex detector, which measures the impact parameters of the muon tracks with respect to the primary vertex. In addition, the variable  $P_T^{\text{rel}}$ , the relative transverse momentum of the muon with respect to the axis of the associated jet, is used to determine the beauty and charm content of the events. The measurements are compared with QCD predictions at leading and next-to-leading order and are found to be reasonably well described.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 155**

## Heavy quark production in DIS at HERA

**Author:** Alessandro Bertolin<sup>1</sup>

<sup>1</sup> *INFN Padova (IT)*

**Corresponding Author:** alessandro.bertolin@pd.infn.it

The production of beauty quarks in ep interactions has been studied with the ZEUS detector at HERA for exchanged four-momentum squared  $Q^2 > 10 \text{ GeV}^2$ , using an integrated luminosity of 363 pb<sup>-1</sup>. The beauty events were identified using electrons from semileptonic b decays with a transverse momentum  $0.9 < p_T^e < 8 \text{ GeV}$  and pseudorapidity  $|\eta^e| < 1.5$ . Cross sections for beauty production were measured and compared with next-to-leading-order QCD calculations. The beauty contribution to the proton structure function  $F_2$  was extracted from the double-differential cross section as a function of Bjorken-x and  $Q^2$ .

Measurements of cross sections for events with charm and beauty jets in deep inelastic scattering at HERA are presented. Events with jets of transverse energy  $E_T^{\text{jet}} > 6 \text{ GeV}$  and pseudorapidity  $-1.0 < \eta_{\text{jet}} < 1.5$  in the laboratory frame are selected in the kinematic region of photon virtuality  $Q^2 > 6 \text{ GeV}^2$  and inelasticity variable  $0.07 < y < 0.625$ .

Measurements are also made requiring a jet in the Breit frame with  $E_T^{\text{jet}} > 6 \text{ GeV}$ . The data were collected with the H1 detector in the years 2006 and 2007 corresponding to an integrated luminosity of 189 pb<sup>-1</sup>. The numbers of charm and beauty jets are determined using variables reconstructed using the H1 vertex detector with which the impact parameters of the tracks to the primary vertex and the position of secondary vertices are measured. The measurements are compared with QCD predictions and with previous measurements where heavy flavours are identified using muons.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 158**

## Constrained Supersymmetry after two years of LHC data: a global view with Fittino

**Authors:** Bjorn Sarrazin<sup>1</sup>; Carsten Hensel<sup>2</sup>; Herbert Dreiner<sup>3</sup>; Klaus Desch<sup>4</sup>; Mathias Uhlenbrock<sup>4</sup>; Matthias Hamer<sup>2</sup>; Michael Kramer<sup>5</sup>; Nelly Nguyen<sup>6</sup>; Peter Wienemann<sup>3</sup>; Philip Bechtle<sup>1</sup>; Torsten Bringmann<sup>7</sup>; Werner Porod<sup>8</sup>; Xavier Prudent<sup>9</sup>

<sup>1</sup> *Deutsches Elektronen-Synchrotron (DE)*

<sup>2</sup> *Georg-August-Universitaet Goettingen (DE)*

<sup>3</sup> *University of Bonn*

<sup>4</sup> *Universitaet Bonn (DE)*

<sup>5</sup> *Institut f. Theoretische Physik (E)-Rheinisch-Westfaelische Tec*

<sup>6</sup> *University of Hamburg*

<sup>7</sup> *Hamburg University*

<sup>8</sup> *Uni. Würzburg*<sup>9</sup> *Technische Universität Dresden***Corresponding Authors:** prudent@physik.tu-dresden.de, philip.bechtle@desy.de, desch@physik.uni-bonn.de

We perform global fits to the parameters of the Constrained Minimal Supersymmetric Standard Model (CMSSM) and to a variant with non-universal Higgs masses (NUHM1). In addition to constraints from low-energy precision observables and the cosmological dark matter density, we take into account the LHC exclusions from searches in jets plus missing transverse energy signatures with about  $5\text{ fb}^{-1}$  of integrated luminosity. We also include the most recent upper bound on the branching ratio  $B_s \rightarrow \mu\mu$  from LHCb. Furthermore, constraints from and implications for direct and indirect dark matter searches are discussed. The best fit of the CMSSM prefers a light Higgs boson just above the experimentally excluded mass. We find that the description of the low-energy observables,  $(g-2)_\mu$  in particular, and the non-observation of SUSY at the LHC become more and more incompatible within the CMSSM. A potential SM-like Higgs boson with mass around 126 GeV can barely be accommodated. Values for  $\text{cal}B(B_s \rightarrow \mu\mu)$  just around the Standard Model prediction are naturally expected in the best fit region. The most-preferred region is not yet affected by limits on direct WIMP searches, but the next generation of experiments will probe this region. Finally, we discuss implications from fine-tuning for the best fit regions.

**Plenary 3 - The Standard Model - TR1 / 159****Search for the Higgs boson in the diphoton decay channel with the ATLAS detector****Author:** Kerstin Tackmann<sup>1</sup><sup>1</sup> *Deutsches Elektronen-Synchrotron (DE)***Corresponding Author:** kerstin.tackmann@cern.ch

A search for the Standard Model Higgs boson in the diphoton decay channel in proton-proton collisions using recent data collected with the ATLAS detector at the LHC, over the diphoton mass range 110-150 GeV is reported. Upper limits on the cross-section times branching ratio are derived. Additionally, the results of the search for the fermiophobic Higgs boson are presented, based on the  $4.9\text{ fb}^{-1}$  of data collected in 2011 at a centre-of-mass energy of 7 TeV.

**Plenary 3 - The Standard Model - TR1 / 160****Search for the Standard Model Higgs boson in the  $H \rightarrow ZZ^* \rightarrow 4l$  decay channel with the ATLAS detector****Author:** Konstantinos Nikolopoulos<sup>1</sup><sup>1</sup> *University of Birmingham (GB)***Corresponding Author:** konstantinos.nikolopoulos@cern.ch

A search for the Standard Model Higgs boson in the decay channel  $H \rightarrow ZZ^* \rightarrow 4l$  where  $l = (e, \mu)$  is performed, based on the proton-proton collision data at recorded recently with the ATLAS detector. Upper limits are derived on the cross section of a Standard Model Higgs boson with a mass between 110 GeV and 600 GeV.

**Plenary 3 - The Standard Model - TR1 / 161****Search for the Standard Model Higgs boson through the  $H \rightarrow ZZ \rightarrow (\ell\ell\nu\nu, \ell\ell qq)$  decay channels with the ATLAS detector****Author:** Carl Bryan Gwilliam<sup>1</sup><sup>1</sup> *University of Liverpool (GB)***Corresponding Author:** carl.bryan.gwilliam@cern.ch

The search for the Standard Model Higgs boson via its decays into two Z bosons is presented, based on the proton-proton collisions recorded recently by the ATLAS experiment at the LHC. For Higgs boson masses above 200 GeV, the sensitivity is substantially enhanced by using channels in which one of the Z bosons decays into neutrinos or quarks. With the current integrated luminosity, a wide mass range is excluded at the 95% confidence level.

**Plenary 3 - The Standard Model - TR1 / 162****Search for the Standard Model Higgs boson in the  $H \rightarrow WW \rightarrow \ell\nu\ell\nu, \ell\nu qq$  decay modes with the ATLAS detector****Author:** Biagio Di Micco<sup>1</sup><sup>1</sup> *CERN***Corresponding Author:** biagio.di.micco@cern.ch

A Higgs boson search in the  $H \rightarrow WW (\ell\nu\ell\nu, \ell\nu qq)$  decay mode has been performed using proton-proton collisions recently recorded by the ATLAS detector. The search in the final state with two leptons and two neutrinos covers a broad mass range from 110 - 600 GeV. Upper limits are derived on the cross section of a Standard Model Higgs boson. The semi-leptonic final state with a lepton, neutrino and two or more jets provides additional sensitivity to the fully-leptonic decay mode in the high mass region from 300 to 600 GeV. Upper limits are derived on the cross section of a Standard Model Higgs boson.

**Plenary 3 - The Standard Model - TR1 / 164****Search for the Standard Model Higgs boson produced in association with a vector boson and decaying to a b-quark pair with the ATLAS detector at the LHC****Author:** Giacinto Piacquadio<sup>1</sup><sup>1</sup> *CERN***Corresponding Author:** giacinto.piacquadio@cern.ch

The results of the ATLAS search for the Standard Model Higgs boson in the mass range  $110 < m_H < 130$  GeV with the Higgs boson produced in association with a W or Z boson and decaying to a b-quark pair are presented. The search is performed in a dataset of proton-proton collisions recently recorded by the ATLAS experiment at the LHC.

**Plenary 3 - The Standard Model - TR1 / 165****Search for the Standard Model Higgs boson in the  $H \rightarrow \tau\tau$  decay mode with the ATLAS detector****Author:** Swagato Banerjee<sup>1</sup><sup>1</sup> *University of Wisconsin (US)***Corresponding Author:** swagato.banerjee@louisville.edu

A Higgs boson search in the  $H \rightarrow \tau^+ \tau^-$  decay mode has been performed using proton-proton collision data recently collected with the ATLAS detector at the Large Hadron Collider. The search was performed in the mass range of 100-150 GeV. Upper limits on the cross-section times branching ratio are derived.

**Plenary3 - The Standard Model -TR1 / 167****Search for the neutral MSSM Higgs bosons in the  $H \rightarrow \tau\tau$  and  $H \rightarrow \mu\mu$  decay modes with the ATLAS detector at the LHC****Author:** Sascha Ulrich Thoma<sup>1</sup><sup>1</sup> *Albert-Ludwigs-Universität Freiburg (DE)***Corresponding Author:** sascha.thoma@cern.ch

The Minimal Supersymmetric extension of the Standard Model (MSSM) predicts the existence of three neutral and two charged Higgs bosons. The search for the neutral MSSM Higgs bosons in the  $H \rightarrow \tau^+ \tau^-$  and  $H \rightarrow \mu^+ \mu^-$  decay modes has been performed using proton-proton collision data recently collected with the ATLAS detector at the Large Hadron Collider. The exclusion limits at the 95% confidence level are discussed as a function of the  $m_A$  and  $\tan \beta$  parameters.

**Plenary3 - The Standard Model -TR1 / 168****Search for charged Higgs bosons decaying via  $H^\pm \rightarrow \tau \nu$  in  $t\bar{t}$  events with the ATLAS detector****Author:** Aldo Saavedra<sup>1</sup><sup>1</sup> *University of Sydney (AU)***Corresponding Author:** a.saavedra@physics.usyd.edu.au

The results of a search for charged Higgs bosons are presented. The analysis is based on proton-proton collision data recently collected by the ATLAS experiment at the Large Hadron Collider, using  $t\bar{t}$  events with a tau lepton in the final state. The data are consistent with the background from Standard Model processes. Assuming branching ratio  $BR(H^\pm \rightarrow \tau \nu) = 100\%$ , this leads to upper limits on the branching fraction  $BR(t \rightarrow bH^\pm)$ .

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 169**

## **Inclusive searches for squarks and gluinos with the ATLAS detector**

**Author:** Moritz Backes<sup>1</sup>

<sup>1</sup> *Universite de Geneve (CH)*

**Corresponding Author:** moritz.backes@cern.ch

Despite the absence of experimental evidence, weak scale supersymmetry remains one of the best motivated and studied Standard Model extensions. This talk summarises recent results on inclusive searches for supersymmetric squarks and gluinos in events containing jets, missing transverse momentum with or without leptons. The searches use the full data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC. Results using a  $\sqrt{s}=8$  TeV data sample from the 2012 run may also be presented.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 170**

## **Searches for supersymmetry in events with photons or tau leptons and missing transverse momentum with the ATLAS detector**

**Author:** Steffen Schaepe<sup>1</sup>

<sup>1</sup> *Universität Bonn (DE)*

**Corresponding Author:** steffen.schaepe@cern.ch

Models with gauge-mediated supersymmetry breaking predict that the lightest supersymmetric particle is a gravitino with negligible mass so that the phenomenology of the supersymmetric events produced at the LHC is determined by the next-to-lightest supersymmetric particle (NLSP). Depending on the model parameters, the NLSP can be a neutralino with significant bino admixture that will decay into a photon, or a stau that will decay into a tau lepton. The talk presents results from searches for supersymmetry in events with photons or taus and missing transverse momentum, using the data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 172**

## **Searches for direct pair production of third generation squarks with the ATLAS detector**

**Author:** Martin John White<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** mwhi@unimelb.edu.au

Naturalness arguments for weak-scale supersymmetry favour supersymmetric partners of the third generation quarks with masses not too far from those of their Standard Model counterparts. Scalar top or bottom quarks with masses less than a few hundred GeV 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 results from searches for direct stop and sbottom production using a data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 173**

## **Searches for supersymmetric gaugino production in final states with leptons with the ATLAS detector**

**Author:** Tobias Kruker<sup>1</sup><sup>1</sup> *Universität Bern (CH)***Corresponding Author:** tobias.kruker@cern.ch

Naturalness arguments for weak-scale supersymmetry favour supersymmetric partners of the Higgs and electroweak gauge bosons, so-called gauginos, with masses not too far from those of their Standard Model counterparts. Gauginos with masses less than a few hundred GeV can give rise to direct pair production rates at the LHC that can be observed in the data sample recorded in 2011 by the ATLAS detector. The talk presents results from searches for gaugino production in final states with leptons.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 175**

## **Searches for supersymmetry in resonance production and R-parity violating signatures with the ATLAS detector**

**Author:** Daniel Joseph Pomeroy<sup>1</sup><sup>1</sup> *Brandeis University (US)***Corresponding Author:** daniel.joseph.pomeroy@cern.ch

An extended QCD sector beyond the minimal supersymmetric standard model or the admission of R-parity violation introduces new signatures to the search for supersymmetry at the LHC. Strongly interacting resonances may decay to jets, sleptons may decay via lepton-flavour violating processes and lightest supersymmetric particles may decay into many leptons with or without missing transverse momentum. The talk presents results from searches for scalar gluons and R-parity violation in dijet and multilepton final states using the full data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment.

**Room 219 - BSM - Non-SUSY - TR3 / 176**

## **Searches for monojet events with missing transverse momentum with the ATLAS detector**

**Author:** David Salek<sup>1</sup><sup>1</sup> *CERN***Corresponding Author:** david.salek@cern.ch

Events composed of one high transverse energy jet and large missing transverse momentum represent one of the simplest and most striking signatures that can be observed at a hadron collider. The Standard Model contribution to such ‘monojet’ events is dominated by a Z decaying to a pair of neutrinos plus a recoiling jet. Several new physics models predict monojet events. They can occur via production of a jet in association with an invisible particle or via pair production of invisible particles recoiling against a hard radiative jet. The talk presents results from searches for new physics

in monojet events using the full data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

**Room 219 - BSM - Non-SUSY - TR3 / 177**

## **Search for resonances in lepton pairs and photon pairs with the ATLAS detector**

**Author:** Xabier Anduaga Del Popolo<sup>1</sup>

<sup>1</sup> *Universidad Nacional de La Plata (AR)*

**Corresponding Author:** xabier.anduaga@cern.ch

Resonances decaying into a pair of particles are an obvious place to look for phenomena beyond the Standard Model. This talk summarizes recent results on searches for resonances in lepton pairs, leptons and missing transverse energy and pairs of photons. The models considered are the  $Z'$  and  $W'$ , the Randall-Sundrum gravitons as well as the ADD large extra dimension scenario. The talk presents results from searches for new physics in final states containing pairs of electrons or muons using the full data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC. If ready it will also add a first look at the data collected in early 2012.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 178**

## **Searches for long-lived particles with the ATLAS detector**

**Author:** Andrew Haas<sup>1</sup>

<sup>1</sup> *New York University*

**Corresponding Author:** drandyhaas@gmail.com

Several extensions of the Standard Model predict the existence of massive long-lived particles. We report on searches for weakly-interacting long-lived particles decaying to collimated lepton-jets far away from the interaction point, and for production of highly-ionizing magnetic monopoles. The talk presents results of analyses using data recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 179**

## **Searches for vector-like quarks with the ATLAS detector**

**Author:** Merlin Davies<sup>1</sup>

<sup>1</sup> *Universite de Montreal (CA)*

**Corresponding Author:** merlin.davies@cern.ch

Various extensions of the Standard Model predict the existence of new types of quarks. We report on several search channels such as vector-like quarks that couple to light quarks and Z or W bosons or new quarks decaying to Z boson and b quark. The talk presents results from searches for vector like quarks using the data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.



Room 219 - BSM - Non-SUSY - TR3 / 180

## Search for New Physics in the Dijet and photon+jet angular and mass distributions with the ATLAS detector

**Author:** Dag Gillberg<sup>1</sup>

<sup>1</sup> *Carleton University (CA)*

**Corresponding Author:** dag.gillberg@cern.ch

We study the mass and the angular distributions of pairs of jets and pairs of a photon and a jet to test several new physics hypotheses such as: excited quarks, quantum black holes or quark contact interactions. The most recent results will be presented.

Room 219 - BSM - Non-SUSY - TR3 / 181

## Search for resonant diboson production with the ATLAS detector

**Author:** Giovanni Zevi Della Porta<sup>1</sup>

<sup>1</sup> *Harvard University (US)*

**Corresponding Author:** gzevi@cern.ch

The study of electroweak boson pair production is a powerful test of the spontaneously broken gauge symmetry of the Standard Model (SM) and can be used to search for phenomena beyond the SM. Heavy particles decaying to gauge boson pairs are predicted by many scenarios of new physics, including Extra Dimensions, and Technicolor models. We present generic searches for a heavy particle decaying to a pair of bosons. The talk presents results from searches done in several gauge boson decay channels using the data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 182

## Searches for new Physics in multileptons or like-sign leptons with the ATLAS detector

**Author:** Else Lytken<sup>1</sup>

<sup>1</sup> *Lund University (SE)*

**Corresponding Author:** else.lytken@cern.ch

Events containing several leptons or two like-sign leptons are rarely produced in the Standard Model (SM), but occur with an enhanced rate in many models of new physics. We look for anomalous production of pair of prompt like sign leptons or events with three or more leptons using the full data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

Room 219 - BSM - Non-SUSY - TR3 / 183

## Searches for new Physics in events decaying to tau leptons with the ATLAS detector

**Author:** Peter Wagner<sup>1</sup>

<sup>1</sup> *University of Pennsylvania (US)*

**Corresponding Author:** peter.wagner@cern.ch

We report on searches of heavy particles decay to a pair of taus as well as a search for third-generation leptoquarks decaying to a jet and a tau lepton. The studies reported use the full data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 184**

## 4th generation searches at ATLAS

**Author:** Lorenzo Felgioni<sup>1</sup>

<sup>1</sup> *Universite d'Aix - Marseille II (FR)*

**Corresponding Author:** lorenzo@cppm.in2p3.fr

The top-quark is the heaviest known fundamental particle with unique properties within the Standard Model. Its large couplings to the Higgs boson, and being the only quark that decays before hadronisation make it sensitive to new physics beyond the SM. A potential extension for the SM would be the adjunction a 4th family of heavy chiral fermions that could provide new sources of CP violation to explain the matter-antimatter asymmetry in the Universe, and allow for a heavier Higgs boson while remaining consistent with other precision electroweak studies. We report on searches for 4th generation quarks using the data sample recorded in 2011 at  $\sqrt{s}=7$  TeV centre-of-mass energy by the ATLAS experiment at the LHC.

**TR4 - Top Quark Physics / 185**

## Inclusive top quark pair production cross - section (ATLAS)

**Author:** Frederic Derue<sup>1</sup>

<sup>1</sup> *CNRS IN2P3 UPMC LPNHE (FR)*

**Corresponding Author:** derue@lpnhe.in2p3.fr

We present measurements of the production of top quarks in proton - proton collisions at 7 TeV with the ATLAS detector at the Large Hadron Collider. The cross section of pair - produced top quarks is measured in several channels, including the single lepton, dilepton, all hadronic channel, some using information from b-tagging, as well as channels involving tau leptons.

**TR4 - Top Quark Physics / 186**

## Differential top quark pair production (ATLAS)

**Author:** Taylor Childers<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Author:** john.taylor.childers@cern.ch

After having established the  $t\bar{t}$  production mechanism at LHC, interest is now focused on differential spectra of  $t\bar{t}$ . Latest measurements performed in 7 TeV proton - proton collisions with the ATLAS detector at the Large Hadron Collider will be presented.

**TR4 - Top Quark Physics / 187**

## Measurements of single top quark production (ATLAS)

**Author:** Philipp Sturm<sup>1</sup>

<sup>1</sup> Bergische Universität Wuppertal (DE)

**Corresponding Author:** philipp.sturm@cern.ch

We present the result of measurements of single top - quark production in the  $t$  - and  $Wt$  - channels at 7 TeV proton - proton collisions with the ATLAS detector at the Large Hadron Collider. Information on the CKM matrix element  $|V_{tb}|$  is extracted from these measurements.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 188**

## Searches in s-channel single top quark production at ATLAS

**Author:** Barbara Alvarez Gonzalez<sup>1</sup>

<sup>1</sup> Michigan State University (US)

**Corresponding Author:** barbara.alvarez.gonzalez@cern.ch

We present searches for single top-quark production in the s-channel at 7 TeV proton-proton collisions with the ATLAS detector at the Large Hadron Collider. Limits. The result of a search for an exotic  $W'$  boson production in the single top quark s-channel is also given.

**TR4 - Top Quark Physics / 189**

## Measurement of the top quark mass (ATLAS)

**Author:** Giuseppe Salamanna<sup>1</sup>

<sup>1</sup> University of London (UK)

**Corresponding Author:** giuseppe.salamanna@cern.ch

We present measurements of the top - quark mass in proton - proton collisions at 7 TeV with the ATLAS detector at the Large Hadron Collider. The top mass is determined by making use of a two - dimensional template method in the single lepton channel, and a one - dimensional template method in the all - hadronic channel. An indirect extraction of the top - quark mass from the measurement of the cross - section is also presented.

**TR4 - Top Quark Physics / 190****Other top quark properties in ATLAS****Author:** Antonio Limosani<sup>1</sup><sup>1</sup> *University of Melbourne (AU)***Corresponding Author:** antonio.limosani@cern.ch

Other properties of top quarks as measured with the ATLAS detector, using pp collisions at a center-of-mass energy of 7 TeV, are presented. In particular the charge of the quark is determined to be  $+2/3$  as predicted by the Standard Model, while an exotic charge is excluded. The cross-section of additional photon radiation in top quark pairs is also measured and presented in this talk.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 191****Charge asymmetry in top pairs at ATLAS****Author:** Mario Giordani<sup>1</sup><sup>1</sup> *INFN Trieste (IT)***Corresponding Author:** mario.giordani@cern.ch

In 7 TeV proton - proton collisions at the LHC, pairs of top and anti-top quarks are expected to be mostly produced through gluon fusion, in contrast to production at the Tevatron, where quark annihilation dominates.

The ATLAS experiment has now recorded a large number of top quark pairs, allowing this domain to be explored in detail. We present measurements of top-quark charge asymmetry which constitute important tests of QCD and are sensitive to new physics. Measurements are presented in both, the single lepton and dilepton channel. Also, the lepton based charge asymmetry in top-quark pair events has been measured and will be presented.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 192****Searches for  $t\bar{t}$  resonances (ATLAS)****Author:** Marcel Vos<sup>1</sup><sup>1</sup> *Universidad de Valencia (ES)***Corresponding Author:** marcel.vos@cern.ch

Several extensions of the Standard Model predict the presence of new particles that couple to the top quark. With the dataset of proton - proton collisions collected by the ATLAS detector at the Large Hadron Collider we present searches for resonances decaying to top - quark pairs.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 193****Determination of  $\Delta\Gamma$  and  $\phi_s$  from the decay  $B_s$  to  $J/\psi \Phi$  in ATLAS**

**Author:** Sandro Palestini<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Author:** sandro.palestini@cern.ch

A large sample (20 k) of  $B_s \rightarrow J/\psi \Phi$  decays were collected by ATLAS in year 2011. The transition to states with defined CP eigenvalues have been studied through angular correlations in decays of  $J/\psi$  and  $\Phi$ . Measurement of the lifetimes of the different eigenstates and the CP-violating mixing phase  $\phi_s$  have been recently obtained and are presented.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 194**

## Measurement of mass and lifetime of B-hadrons at ATLAS

**Author:** Konstantin Toms<sup>1</sup>

<sup>1</sup> University of New Mexico (US)

**Corresponding Author:** konstantin.toms@cern.ch

Using data collected in 2011, the ATLAS Collaboration has measured the lifetime and mass of the  $\Lambda_b$ , the lifetimes and masses of the  $B_d$  and  $B_s$  mesons, and the average lifetime for inclusive B production at 7 TeV center of mass energy in proton-proton collisions. The mass of the  $\Lambda_b$  is measured with the precision above the world average. Polarization measurements of the  $\Lambda_b$  are planned.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 195**

## Search for $B_s(B_0) \rightarrow \mu^+ \mu^-$ and other exclusive B decays

**Author:** Paolo Iengo<sup>1</sup>

<sup>1</sup> INFN (IT)

**Corresponding Author:** paolo.iengo@cern.ch

The search for the rare decay  $B_s$  to  $\mu^+ \mu^-$  with the ATLAS detector is discussed. Results from analysis of 2.4fb<sup>-1</sup> of data collected in 2011 are presented. The production of B-mesons has been studied by ATLAS in several exclusive channels containing a  $J/\psi$ . Several analysis are discussed, including the recent observation of  $B_c \rightarrow J/\psi \pi$ .

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 196**

## Production of Quarkonia States at LHC with ATLAS experiment

**Author:** James William Walder<sup>1</sup>

<sup>1</sup> Lancaster University (GB)

**Corresponding Author:** james.william.walder@cern.ch

The production of Quarkonia states at hadron colliders has been the subject of various theoretical approaches, which can now be compared to measurement performed at LHC. In the Charmonium family, the production of  $J/\Psi$  has been studied over wide range of  $p_T$ . In the Bottomonium family, the production of  $Y(1S)$  has been studied by ATLAS. The recent first observation of resonances decaying to  $Y(1S)$  gamma and  $Y(2S)$  gamma, and with mass about 30 MeV below the open-beauty threshold is presented. The signal is consistent with the multiplet of  $\chi_b(3P)$  states predicted by potential models. Comparable studies in the Charmonium sector and plans for future measurements are illustrated.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 202**

## **ATLAS studies of diffraction, soft particle production and double parton scattering**

**Author:** Tim Martin<sup>1</sup>

<sup>1</sup> *University of Birmingham (GB)*

**Corresponding Author:** tim.martin@cern.ch

Soft and semi-hard QCD studies made with ATLAS are presented. These include measurement of the inelastic and diffractive cross sections, mean forward energy flow, forward-backward and azimuthal correlations, azimuthal ordering of hadron production, event shapes, and identified strange particle production. Distributions sensitive to the underlying event are measured in a variety of hard processes. In addition, an explicit study of double-parton scattering using  $W$ +dijet events is presented, along with a measure of the effective cross section. Many of these measurements are used to develop and tune models for soft particle production. An overview of these results is given.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 205**

## **ATLAS jet measurements, and subjet structure for boosted hadronic objects**

**Author:** Bertrand Chapleau<sup>1</sup>

<sup>1</sup> *McGill University (CA)*

**Corresponding Author:** bertrand.chapleau@cern.ch

Comprehensive jet cross section measurements are presented, spanning the dijet mass range from 70 GeV to 5 TeV. In addition, event shapes constructed from jets are measured, as well as measurements of jets containing charm and beauty hadrons. These measurements constitute precision tests of QCD in a new energy regime, and show sensitivity to the parton densities in the proton and to the value of the strong coupling,  $\alpha_s$ . The internal structure of jets is important at the LHC both as a test of perturbative QCD and as a tool for identifying boosted electroweak-scale objects decaying to hadrons. Detailed measurements of jet fragmentation, of subjet variables, single jet masses and jet shapes are presented and compared to the predictions of QCD.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 207**

## ATLAS measurements of jets and heavy flavour produced in association with W and Z bosons

**Author:** Pierre-Hugues Beauchemin<sup>1</sup>

<sup>1</sup> *Tufts University (US)*

**Corresponding Author:** hugo.beauchemin@tufts.edu

The production of jets and/or heavy flavours in association with a W or Z boson represents an important process with which to study QCD in a multi-scale environment. Unprecedented precision is achieved in measurements of differential cross sections and multiplicities, and comparisons are made to state-of-the-art high NLO QCD calculations of high-multiplicity final states. Jets containing b- or c-hadrons are also identified, and correlations are studied.

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 208

## QCD studies with W and Z cross sections measured in ATLAS

**Author:** Maarten Boonekamp<sup>1</sup>

<sup>1</sup> *CEA - Centre d'Etudes de Saclay (FR)*

**Corresponding Author:** maarten.boonekamp@cern.ch

Precise measurements of W and Z production, differential in pT and rapidity, are shown. These provide stringent tests of higher order QCD, resummed calculations and non-perturbative models. They are also used to extract information on the strange quark content of the proton.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 209

## Measurement of boson production in lead-lead collisions at $\sqrt{s_{NN}}=2.76$ TeV with the ATLAS detector

**Author:** Max Klein<sup>1</sup>

<sup>1</sup> *University of Liverpool (UK)*

**Corresponding Author:** mklein@hep.ph.liv.ac.uk

Direct production of bosons are a powerful tool in heavy ion collisions. Their rates provide access to the initial state parton distribution functions, which are expected to be modified by nuclear effects. They also provide a means to calibrate the expected energy of jets that are produced in the medium, and thus are a tool to probe the physics of jet quenching more precisely both through jet rates and fragmentation properties. The ATLAS detector measures photons and  $Z \rightarrow e\bar{e}$  decays with its hermetic, longitudinally segmented calorimeter, which has excellent spatial and energy resolution, providing detailed information about the shower shape of each measured photon. ATLAS also measures the  $Z \rightarrow \mu\mu$  and  $W \rightarrow \mu\nu$  in the same pseudorapidity range using the its muon system. First results on the rates of isolated direct, Z and W from approximately  $140 \mu\text{b}^{-1}$  of lead-lead data will be shown, as a function of transverse momentum, pseudorapidity and centrality, and their rates compared to expectations from perturbative QCD.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 210

## Measurements of Jets and Jet Properties in $\sqrt{s_{NN}}=2.76$ TeV PbPb Collisions with the ATLAS Detector at the LHC

**Author:** Erez Etzion<sup>1</sup>

<sup>1</sup> *Tel Aviv University (IL) & CERN (CH)*

**Corresponding Author:** erez.etzion@cern.ch

Jet quenching in the hot and dense medium created in ultra-relativistic heavy ion collisions is a well-established experimental phenomenon at RHIC. It has long been anticipated that the LHC heavy ion program would substantially advance the study of jet quenching by providing access to highly energetic jets and by measuring fully-reconstructed jets. Immediately following turn-on of the LHC in November, 2010, that expectation was fulfilled through the observation of large di-jet asymmetries that may indicate substantial jet quenching. In this talk we will present recent results from ATLAS aimed to provide further understanding of this phenomenon. Measurements of single jet production, di-jet correlations and jet fragmentation in Pb+Pb collisions at  $\sqrt{s_{NN}} = 2.76$  TeV will be presented. In addition to measurements from the 2010 data, results using the full 2011 run will also be presented, benefiting from a factor of 20 improvement in statistics.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 211

## Measurement of harmonic flow and particle correlations in lead-lead collisions at $\sqrt{s_{NN}}=2.76$ TeV from ATLAS

**Author:** Fabiola Gianotti<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** fabiola.gianotti@cern.ch

This talk will present the results of the azimuthal anisotropy of charged particle production and two particle correlations in Pb + Pb collisions measured with the ATLAS experiment. The results are obtained with multi-particle correlations and compared with the event plane method. A complete set of  $v_n$  harmonics measured from central to peripheral events covers a pseudo-rapidity range of  $|\eta| < 2.5$  and a transverse momentum range  $0.5 < p_T < 20$  GeV. A comparison of the event plane and particle correlation methods allow to uniquely evaluate non-flow effects as well as the size of flow fluctuations. The  $v_1$  flow and scaling of integrated elliptic flow, down to very low- $p_T$ , will be discussed and compared to results of lower energy experiments.

Room 218 - Detectors and Computing for HEP - TR13 / 212

## Study of the performance of the muon and tau identification at ATLAS

**Author:** Mansoor Shamim<sup>1</sup>

<sup>1</sup> *University of Oregon (US)*

**Corresponding Author:** mansoor.shamim@cern.ch



Charged leptons play an important role in the physics programme at the LHC. The performance of identification of charged leptons must be known with high precision. This talk presents the studies of the muon and tau identification performance at the ATLAS experiment.

In 2012 the LHC is operated in a mode leading to up to 40 inelastic pp collisions per bunch crossing, so-called "pile-up", with an average number of 20 inelastic collisions. The high multiplicity of charged tracks in the inner tracking detector makes it difficult to reconstruct and identify muons at high efficiency and low misidentification rate. Di-muon decays of  $J/\psi$  mesons and Z bosons have been used to study the muon reconstruction and identification efficiency as a function of the muon transverse momentum from  $p_T = 4$  GeV to  $p_T = 100$  GeV and the number of inelastic collisions per event. The misidentification rate was determined with Z+jet events.

Optimal identification of hadronically decaying tau leptons is achieved by using detailed information from tracking and calorimeter detector components. Variables describing the properties of calorimeter energy deposits and track reconstruction within tau candidates are combined in multivariate discriminants, to achieve high rejection against backgrounds, which is challenging in high luminosity environments. The identification efficiencies are measured by  $W \rightarrow \tau \nu$  and  $Z \rightarrow \tau \tau$  events. The energy scale uncertainties for tau leptons are determined by investigating single hadron calorimeter response, as well as kinematic distributions in  $Z \rightarrow \tau \tau$  events.

**Room 218 - Detectors and Computing for HEP - TR13 / 214**

## Tracking, vertexing and b-tagging performance in ATLAS

**Author:** Mark James Tibbetts<sup>1</sup>

<sup>1</sup> *Lawrence Berkeley National Laboratory (US)*

**Corresponding Author:** mark.james.tibbetts@cern.ch

ATLAS is a multipurpose experiment at the LHC proton-proton collider. In order to reconstruct trajectories of charged particles, ATLAS is equipped with a tracking system built using different technologies, silicon planar sensors (pixel and micro-strip) and gaseous drift tubes, all embedded in a 2T solenoidal magnetic field. ATLAS physics goals require high resolution, unbiased measurement of all charged particle kinematic parameters in order to assure e.g. accurate interaction and decay vertex finding. The precision on track parameters critically depends on the systematic effects related to the alignment of the tracking system. In particular, small collective deformations due to sudden environmental changes (temperature, magnetic field) have to be identified and corrected in quasi-real time. The reconstruction of the primary interaction vertices is important to identify the hard scattering process and to measure the amount of pile-up interactions, while the reconstruction of so-called secondary vertices is an important ingredient in the identification of jets originating from bottom quarks. The latter, referred to as b-tagging, is of great use in many high-profile physics analyses in e.g. the top quark, Higgs and new phenomena sectors to suppress background processes containing predominantly light-flavour jets. Performance of alignment, track and vertex reconstruction efficiency and resolution achieved in the 2011 and prospects for the 2012 LHC proton-proton collision runs will be discussed. We will present measurements of the b-tag efficiency carried out with jets containing muons as well as with b-jets from top quark decays. A novel measurement of the efficiency to b-tag jets originating from c-quarks, using a sample of jets containing  $D^*$  mesons, will also be presented as well as two complementary measurements of the rate with which jets originating from light-flavour partons are mistakenly tagged as b-jets.

**Room 218 - Detectors and Computing for HEP - TR13 / 215**

## Status of the Atlas Calorimeters: their performances after two years of LHC operation and plans for future upgrades.

**Author:** Carlos Solans Sanchez<sup>1</sup>

<sup>1</sup> *Universidad de Valencia (ES)*

**Corresponding Author:** carlos.solans@cern.ch

The ATLAS experiment is designed to study the proton-proton collisions produced at the Large Hadron Collider (LHC) at CERN. Its calorimeter system measures the energy and direction of final state particles with pseudo rapidity  $|\eta| < 4.9$ . Accurate identification and measurement of the characteristics of electromagnetic objects (electrons/photons) are performed by liquid argon (LAr)-lead sampling calorimeters in the region  $|\eta| < 3.2$ , using an innovative accordion geometry that provides a fast, uniform azimuthal response without gaps. The hadronic calorimeters measure the properties of hadrons, jets, and tau leptons, and also contribute to the measurement of the missing transverse energy and identification of muons. This is done in the region  $|\eta| < 1.7$  with a scintillator-steel sampling calorimeter, and in the region  $1.4 < |\eta| < 3.2$  with a copper-LAr sampling calorimeter. The coverage is extended to  $|\eta| < 4.9$  by an integrated forward calorimeter (FCal) based on LAr with copper and tungsten absorbers.

Following installation in 2004-2006, the calorimeters were extensively commissioned prior to first collisions in 2009. Since then, over  $5 \text{ fb}^{-1}$  of data have been collected. Results on the calorimeters' operation and performance will be presented, including the calibration, stability, absolute energy scale, uniformity, and time resolution. These results demonstrate that the calorimeters are performing well within the design requirements and are giving reliable input to the physics analyses.

Although LHC data-taking is expected to continue for a number of years, plans are already under way for operation at an instantaneous luminosity about 5 times the original design of  $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ , referred to as the HL-LHC. The calorimeter upgrade involves two phases. In the first, upgrades to the LAr calorimeter electronics will provide more granular information to the trigger and hence reduce the effects of the high pile-up noise. The second phase will be devoted to the complete replacement of the readout electronics of both the scintillator and LAr calorimeters. An additional complication may also arise in the case of the liquid argon hadronic calorimeter, where a replacement of the cold preamplifiers may be needed to cope with the radiation levels. Finally, for the FCal, the increased ionization load at the HL-LHC poses a number of problems that may degrade its performance. These include beam heating, space charge effects in the LAr-gaps, and HV losses due to increased current draws through the current-limiting resistors. A number of proposed solutions will be discussed.

**Room 218 - Detectors and Computing for HEP - TR13 / 220**

## Precision tracking at high background rates with the ATLAS muon spectrometer

**Author:** Ralf Hertenberger<sup>1</sup>

<sup>1</sup> *Ludwig-Maximilians-Univ. München (DE)*

**Corresponding Author:** r.hertenberger@lmu.de

The ATLAS muon spectrometer performs to the specs of efficiency, occupancy and spatial resolution at present LHC peak-luminosities of  $4 \times 10^{33} \frac{1}{\text{cm}^2 \text{ s}}$ . Ten times higher peak-luminosities are envisaged after the LHC upgrade by end of this decade. Currently used tracking detectors in the most forward part of the muon spectrometer need to be replaced to cope with the expected huge background hit rates of up to  $15 \text{ kHz/cm}^2$  to ensure muon trigger and precision reconstruction capabilities. Square meter sized micromegas or  $15 \text{ mm}$  diameter drift-tube detectors together with thin gap trigger detectors are under study as replacement. When exposed at our irradiation facility at the Garching Tandem accelerator laboratory, the track reconstruction efficiency and spatial resolution of  $15 \text{ mm}$  drift-tube detectors is robust against up to  $20 \text{ kHz/cm}^2$  highly ionizing background hits. No signs of ageing were observed after accumulating an irradiation dose corresponding to 10 years of high luminosity LHC operation. For the micromegas detectors, which are intrinsically high rate capable, a single hit spatial resolution of  $40 \mu\text{m}$  has been shown. Micromegas using resistive strip technology have been successfully operated under  $10^7 \text{ Neutrons/cm}^2 \text{ s}$  of  $11 \text{ MeV}$ .

For the central part of the muon spectrometer, the installed monitored 30~mm diameter drift-tube detectors remain in place but may be operated using a considerably faster and linear drift-gas mixture. Such gas mixtures have been shown to be marginally sensitive to high photon fluences and do not age due to ionizing radiation.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 221**

## The SiD Detector Concept for the International Linear Collider

**Author:** Andy White<sup>1</sup>

<sup>1</sup> *University of Texas at Arlington (US)*

**Corresponding Author:** awhite@uta.edu

The SiD Detector is one of the two validated concepts for experiments at the future International Linear Collider. The SiD detector concept has been used to perform physics and benchmark studies at a 500 GeV ILC and a 3TeV CLIC electron positron collider. SiD is a highly performant, compact, cost-constrained, detector design. It is designed to make precision measurements and be sensitive to a wide range of new phenomena. The all silicon vertexing and tracking system is the signature component of the design and is immersed in a 5 Tesla field from the superconducting solenoid. Excellent momentum resolution is achieved, as is sensitivity to single bunch crossings. The calorimetry is based on the particle flow approach to achieve excellent jet energy resolution, using a high degree of longitudinal and transverse segmentation. The iron flux return, a component of the SiD self-shielding, is instrumented for muon identification and momentum measurement. The complete detector is designed for rapid push-pull operation. The status of each subsystem of the SiD, the benchmark physics studies, and the machine-detector interface, will be discussed together with completed studies for the ILC LOI, the CLIC CDR and progress towards the ILC Detailed Baseline Design to be completed in late 2012.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 222**

## Inclusive production of Beauty and Charm

**Author:** James Catmore<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** james.catmore@cern.ch

The production of charm and beauty in pp collisions at 7 TeV has been studied with the ATLAS detector using fully reconstructed  $D^*(\bar{D}^*)$  mesons. *The beauty production cross-sections have been obtained using events with a  $D^*$  and a muon in the final state.* The results are compared with the NLO QCD predictions

**Room 218 - Detectors and Computing for HEP - TR13 / 223**

## ATLAS Silicon Microstrip Tracker and Pixel Detector: Status and Performance

**Author:** Kendall Reeves<sup>1</sup>

<sup>1</sup> *University of Texas at Dallas (US)*

**Corresponding Author:** kendall.reeves@utdallas.edu

The Semi-Conductor Tracker (SCT) and the Pixel Detector are the key precision tracking devices in the Inner Detector of the ATLAS experiment at CERN LHC.

The SCT is a silicon strip detector and is constructed of 4088 silicon detector modules for a total of 6.3 million strips. Each module is designed, constructed and tested to operate as a stand-alone unit, mechanically, electrically, optically and thermally. The SCT silicon micro-strip sensors are processed in the planar p-in-n technology. The signals from the strips are processed in the front-end ASICS ABCD3TA, working in the binary readout mode.

The Pixel Detector consists of approximately 80 million pixels that are individually read out via chips bump-bonded to 1744 n-in-n silicon substrates.

In the talk the current status of the SCT and Pixel Detector will be reviewed. We will report on the operation of the detectors including an overview of the issues we encountered and the observation of significant increases in leakage currents (as expected) from bulk damage due to non-ionising radiation.

The main emphasis will be given to monitoring, calibration procedures, timing optimization, detector performance, and the data quality during the many months of data taking (the LHC delivered 47pb<sup>-1</sup> in 2010 and 5.6fb<sup>-1</sup> in 2011 of proton-proton collision data at 7 TeV, and two times one-month periods of heavy ion collisions). The SCT and Pixel Detector have been fully operational throughout all data taking periods.

The running experience will then be used to extract valuable lessons for future silicon strip detector and pixel detector projects.

**Room 218 - Detectors and Computing for HEP - TR13 / 225**

## Overview of the ATLAS Insertable B-Layer (IBL) Project

**Author:** Mario Giordani<sup>1</sup>

<sup>1</sup> *INFN Trieste (IT)*

**Corresponding Author:** mario.giordani@cern.ch

The upgrades for the ATLAS Pixel Detector will be staged in preparation for high luminosity LHC. The first upgrade for the Pixel Detector will be the construction of a new pixel layer which will be installed during the first shutdown of the LHC machine, foreseen in 2013-14. The new detector, called the Insertable B-layer (IBL), will be installed between the existing Pixel Detector and a new, smaller radius beam-pipe at a radius of 3.3 cm. The IBL will require the development of several new technologies to cope with increased radiation and pixel occupancy and also to improve the physics performance through reduction of the pixel size and a more stringent material budget. Two different and promising silicon sensor technologies, planar n-in-n and 3D, are currently under investigation for the IBL. An overview of the IBL project, of the module design and their qualification with particular emphasis on irradiation tests will be presented.

**Room 218 - Detectors and Computing for HEP - TR13 / 227**

## The ATLAS Trigger Performance and Evolution

**Author:** Brian Petersen<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** brian.petersen@cern.ch

During the data taking period from 2009 until 2011, the ATLAS trigger has been very successfully used to collect proton-proton data at LHC centre-of-mass energies between 900 GeV and 7 TeV. The three-level trigger system reduces the event rate from the design bunch-crossing rate of 40 MHz to an average recording rate of about 300 Hz. Using custom electronics with input from the calorimeter and muon detectors, the first level rejects most background collisions in less than 2.5 microseconds. Then follow two levels of software-based triggers. The trigger system is designed to select events by identifying muons, electrons, photons, taus, jets and B hadron candidates, as well as using global event signatures, such as missing transverse energy.

We give an overview of the strategy and performance of the different trigger selections based mainly on the experience during the 2011 LHC run, where the trigger menu needed quick adaptations to the continuous increase of luminosity throughout the year. Examples of trigger efficiencies and resolution with respect to offline reconstructed signals are presented and compared to simulation. These results illustrate that we have achieved a very good level of understanding of both the detector and trigger performance and successfully selected suitable streamed data samples for analysis. Furthermore, we describe how the trigger selections and overall trigger menu (like adding topological triggers, using isolation or using multi-variate techniques) have been re-designed and re-optimized to cope with the increased center-of-mass energy and pileup conditions foreseen in 2012. Initial experience and performance of the trigger running with 8 TeV center-of-mass energy collisions this year will also be described.

**Room 218 - Detectors and Computing for HEP - TR13 / 230**

## **ATLAS Upgrades Towards the High Luminosity LHC: extending the discovery potential**

**Author:** Markus Elsing<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Author:** markus.elsing@cern.ch

After successful LHC operation at 7 TeV in 2011, the LHC is scheduled to deliver even more data in 2012. Meanwhile, plans are actively advancing for a series of upgrades, culminating roughly 10 years from now in the high luminosity LHC (HL-LHC) project, delivering of order five times the LHC nominal instantaneous luminosity along with luminosity levelling. The final goal is to extend the data set from about 300 fb<sup>-1</sup> expected for LHC running to 3000 fb<sup>-1</sup> by around 2030. Current planning in ATLAS also has significant upgrades to the detector during the consolidation of the LHC to reach full LHC energy and further upgrades to accommodate running already beyond nominal luminosity this decade. The challenge of coping with HL-LHC instantaneous and integrated luminosity, along with the associated radiation levels, requires further major changes to the ATLAS detector. The designs are developing rapidly for an all-new inner-tracker, significant upgrades in the calorimeter and muon systems, as well as improved triggers and data acquisition. This presentation summarises the various improvements to the ATLAS detector required to cope with the anticipated evolution of the LHC instantaneous luminosity during this decade and the next.

**Poster Session - Board: 53 / 232**

## **Non-collision backgrounds in ATLAS**

**Author:** Fabiola Gianotti<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Authors:** stephen.gibson@cern.ch, fabiola.gianotti@cern.ch

The proton-proton collision events recorded by the ATLAS experiment are on top of a background that is due to both collision debris and non-collision components. The latter comprises of three types: beam-induced backgrounds, cosmic particles and detector noise. We present studies that focus on the first two of these. We give a detailed description of beam-related and cosmic backgrounds based on the full 2011 ATLAS data set, and present their rates throughout the whole data-taking period. Studies of correlations between tertiary proton halo and muon backgrounds, as well as, residual pressure and resulting beam-gas events seen in beam-condition monitors will be presented. Results of simulations based on the LHC geometry and its parameters will be presented. They help to better understand the features of beam-induced backgrounds in each ATLAS sub-detector. The studies of beam-induced backgrounds in ATLAS reveal their characteristics and serve as a basis for designing rejection tools that can be applied in physics analyses. Basic jet quality criteria are derived which provide high non-collision background suppression while maintaining low-signal rejection. These criteria serve as a baseline for the event cleaning procedure recommended for all ATLAS analyses. Furthermore, beam-background muon and cosmic-muon identification tools are described. They do not utilize jet quantities and therefore provide yet another independent approach to event cleaning. Performance of these tools are demonstrated with the example of the monojet search by ATLAS, where the physics signal topology can be also formed by jets faked by beam-background muons with large radiative energy loss in calorimeters.

**Room 218 - Detectors and Computing for HEP - TR13 / 233**

## **Luminosity determination in p-p collisions at center-of-mass energy of 7 TeV using the ATLAS detector at the LHC**

**Author:** Eric Torrence<sup>1</sup>

<sup>1</sup> *University of Oregon (US)*

**Corresponding Author:** eric.torrence@cern.ch

A precision luminosity measurement is of critical importance for the ATLAS physics program, both for searches for new physics as well as for precision measurements of Standard Model cross-sections. The absolute calibration of the ATLAS luminosity scale is based on beam separation (van der Meer) scans which are used to calibrate a variety of luminosity-sensitive detectors. These detectors then measure the luminosity continuously during regular physics operations. Uncertainties on the luminosity measurement are evaluated based on the calibration procedure itself, plus uncertainties related to extrapolating this calibration to the entire physics data sample. The final luminosity measurement for the ATLAS detector during p-p collisions at center-of-mass energy of 7 TeV in 2010 and 2011 is presented, along with prospects for luminosity measurements in p-p collisions at 8 TeV in 2012.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 236**

## **The Present and Future Challenges of Distributed Computing in the ATLAS experiment**

**Author:** Ikuo Ueda<sup>1</sup>

<sup>1</sup> *University of Tokyo (JP)*

**Corresponding Author:** i.ueda@cern.ch

The ATLAS experiment has collected more than 5 fb<sup>-1</sup> of data in 2011 at the energy of 7 TeV. Several billions of events had been promptly reconstructed and stored in the ATLAS remote data centers spanning tens of petabytes of disk and tape storage. In addition, a similar amount of data has been

simulated on the Grid to study the detector performance and efficiencies. The data processing and distribution on the Grid sites with more than 100.000 computing cores is centrally controlled by the system developed by ATLAS, managing a coherent data processing and analysis of almost one million jobs daily. An increased collision energy of 8 TeV in 2012 and much larger expected data collection rate due to improved LHC operation impose new requirements on the system and suggests a further evolution of the computing model to be able to meet the new challenges in the future. The experience of large-scale data processing and analysis on the Grid is presented through the evolving model and organization of the ATLAS Distributed Computing system.

#### Plenary3 - The Standard Model -TR1 / 238

### ATLAS measurements of WW, WZ and ZZ

**Author:** Chris Hays<sup>1</sup>

<sup>1</sup> *University of Oxford (GB)*

**Corresponding Author:** christopher.paul.hays@cern.ch

ATLAS measurements of diboson production processes involving ZZ, WW and WZ final states are presented. Differential and total visible cross sections are measured for channels involving leptons and neutrinos, and differential distributions are presented. In the  $ZZ \rightarrow 2l2\nu$  and  $WW \rightarrow l\nu l\nu$  channels, jet vetos are applied. Total cross sections are derived, and limits are set on anomalous triple-gauge couplings.

#### Plenary3 - The Standard Model -TR1 / 239

### ATLAS measurements of W/Z+gamma, searches for new physics and constraints on triple-gauge couplings

**Author:** Liang Han<sup>1</sup>

<sup>1</sup> *University of Science & Technology of China (CN)*

**Corresponding Authors:** zhengguo.zhao@cern.ch, liang.han@cern.ch

Differential and total visible cross sections for W+photon and Z+photon production are measured and compared to the predictions of the standard model. Limits on anomalous triple-gauge couplings are derived, and the data are used to search for physics beyond the standard model.

#### Plenary3 - The Standard Model -TR1 / 240

### ATLAS Electroweak measurements from W and Z properties

**Author:** Joshua Moss<sup>1</sup>

<sup>1</sup> *Ohio State University (US)*

**Corresponding Author:** joshua.moss@cern.ch

Precise measurements of W and Z production, including the polarisations of W bosons and of tau leptons produced in W decays are presented. They provide tests of lepton universality and constrain electroweak parameters.

TR 8 - Neutrinos RM 219 / 241

## Renormalization Group Running of Physical Parameters in Neutrino Models and Extra Dimensions

**Author:** Tommy Ohlsson<sup>1</sup>

<sup>1</sup> *KTH Royal Institute of Technology (SE)*

**Corresponding Author:** tohlsson@kth.se

In this talk, we investigate renormalization group running of neutrino parameters such as neutrino masses and leptonic parameters in different models. The models range from the inverse seesaw model to radiative versions of the scotogenic model as well as extra-dimensional models with both one and two extra spatial dimensions. We find that most models lead to large running for  $\theta_{12}$ , whereas the running is negligible for  $\theta_{13}$  and  $\theta_{23}$ . In addition, we show that a bimaximal mixing pattern at high energies (e.g. at the GUT scale) can lead to non-zero values for  $\theta_{13}$  at low energies. Finally, using the running of the Higgs self-coupling constant, we derive bounds on the cutoff scale for one of the extra-dimensional models.

TR 8 - Neutrinos RM 219 / 242

## Results from T2K

**Author:** Ken Sakashita<sup>1</sup>

<sup>1</sup> *KEK (JP)*

**Corresponding Author:** kensh@post.kek.jp

The Tokai to Kamioka (T2K) experiment is a long baseline neutrino oscillation experiment situated in Japan. A high intensity neutrino beam is produced at the Japan Proton Accelerator Research Complex, in Tokai, Japan. A near detector complex, situated 280 m from the neutrino production target, and the far detector at 295 km, are used to detect the neutrinos from this beam. This talk will present T2K results for the neutrino mixing angles  $\theta_{23}$ , and  $\theta_{13}$ , using the data collected up to summer 2012.

TR 8 - Neutrinos RM 219 / 243

## Measurement of the muon neutrino flux and inclusive charged-current cross-section at T2K's near detector

**Author:** Melody Ravonel<sup>1</sup>

<sup>1</sup> *University of Geneva (CH)*

**Corresponding Author:** melody.ravonel@cern.ch

We present the first measurement of the muon neutrino spectrum at the T2K near detector, ND280, using the data collected at the JPARC accelerator facility in Tokai, Japan. ND280 is located 280 meters downstream from the target and 2.5° off-axis from the direction of the beam. The measured spectrum at ND280 constrains the flux and cross section uncertainties in the T2K oscillation analysis. We select inclusive charged-current (CC) events from muon neutrinos in ND280. These are separated into a charged current quasi elastic (CCQE) enhanced sample and a CC non-QE sample. We then fit the muon spectrum for both samples to extract flux and cross section parameters which are used as inputs into T2K's oscillation analysis. We separately produce a flux-averaged



differential inclusive CC cross-section in the 2-dimensional plane of muon momentum and angle. For the cross-section measurement the flux is given by the MC and tuned to data from the NA61 experiment. We present the event selection, detector uncertainties, and final measurement result for both the spectrum measurement and for the cross-section result.

TR 8 - Neutrinos RM 219 / 244

## Measurement of NC $\pi^0$ production and CC interactions using the ND280 P0D.

Author: Glenn Lopez<sup>1</sup>

<sup>1</sup> Stony Brook University (US)

Corresponding Author: glopez@nngroup.physics.sunysb.edu

The T2K experiment is a long baseline neutrino oscillation experiment designed for the primary goal of measuring oscillations of muon neutrinos to electron neutrinos, thereby providing an appearance measurement of  $\theta_{13}$ . One of the major backgrounds of the electron neutrino appearance measurement is from neutral current muon neutrino interactions where a single neutral pion is produced and the photons from the pi-zero decay mimic the electron neutrino appearance signal.

To constrain the uncertainty on this background the T2K near detector facility at 280 meters from the proton beam target was used to measure neutral current pi-zero production by muon neutrinos. Presented is a measurement of the neutral current single pi-zero production cross section using  $8.55 \times 10^{19}$  protons-on-target (POT) of T2K data. We also report the status of an ongoing analysis to measure charged-current interactions in the P0D in which the momentum of the muon is measured in the downstream TPC.

Poster Session - Board: 47 / 245

## Measurement of the electron neutrino component of the T2K beam at ND280

Author: Glenn Lopez<sup>1</sup>

<sup>1</sup> Stony Brook University (US)

Corresponding Author: glopez@nngroup.physics.sunysb.edu

One of the main physics goal of the T2K experiment is the measurement of the angle  $\theta_{13}$  in the neutrino mixing matrix. This is done through the observation of  $\nu_e$  appearance in the  $\nu_\mu$  neutrino beam. The main background to this measurement is the intrinsic  $\nu_e$  beam component that has to be measured before the oscillation at the T2K Near Detector (ND280). We performed two analyses to at ND280 to measure this component, using the data collected during the first two T2K physics runs. One analysis uses the  $\pi^0$  detector (P0D) to select high energy electrons measuring in this way the high energy part of the  $\nu_e$  contamination in the T2K beam mainly coming from the Kaon component. The other analysis selects neutrino interactions in the Fine Grained Detector (FGD) of ND280 and distinguish electrons from muons combining the PID capabilities of three Time Projection Chambers (TPC) and an Electromagnetic Calorimeter (ECAL). The results of these two measurements provide confidence in the understanding of the intrinsic  $\nu_e$  beam component of the T2K beam simulation and in the T2K  $\nu_e$  appearance results.

**Room 218 - Detectors and Computing for HEP - TR13 / 248**

## Radiation-Hard High-Speed Parallel Optical Links

**Author:** Kock Kiam Gan<sup>1</sup>

<sup>1</sup> *Ohio State University (US)*

**Corresponding Author:** gan@mps.ohio-state.edu

We have designed two ASICs for possible applications in the optical links of a new layer of the ATLAS pixel detector for the initial phase of the LHC luminosity upgrade. The ASICs include a high-speed driver for a VCSEL and a receiver/decoder to extract the data and clock from the signal received by a PIN diode. Both ASICs contain 12 channels for operation with a VCSEL or PIN array. Among these channels, the outer four channels are designated as spares to bypass a broken PIN or VCSEL within the inner eight channels. The ASICs were designed using a 130 nm CMOS process to enhance the radiation-hardness. With the spacing of 250  $\mu\text{m}$  between two VCSEL or PIN channels, the width of an optical array is only 3 mm. This allows the fabrication of compact parallel optical engine for installation at a location where space is at a premium. The fabricated receiver/decoder properly decodes the bi-phase marked input stream with no bit error at low PIN current. The performance of the VCSEL driver at 5 Gb/s is satisfactory. We are able to program the ASICs to bypass a broken PIN or VCSEL and the power-on reset circuits have been successfully implemented to set the ASICs to a default configuration in an event of communication failure. We have irradiated the receiver/decoder to high dose and observe no significant degradation and the SEU rate is low. We plan to irradiate the VCSEL drivers in the summer to measure the radiation hardness. We will present results from the study at the conference. In addition, we will briefly present the status of the design of a new VCSEL driver ASIC to operate at 10 Gb/s which will yield an aggregated bandwidth of 120 Gb/s for a fiber ribbon.

### Summary:

The LHC at CERN is now the highest energy and luminosity collider in the world. To enhance the physics potential, the ATLAS experiment plans to add a new pixel layer to the current pixel detector during the 2013 shutdown. The optical data transmission system will also be upgraded to handle the higher data transmission speed. Two ASICs have been prototyped for this new generation of optical links to incorporate the experience gained from the current system. The ASICs include a high-speed driver for a VCSEL and a receiver/decoder to extract the data and clock from the signal received by a PIN diode. Both ASICs contain 12 channels for operation with a VCSEL or PIN array. The outer four channels are designated as spares to bypass a broken PIN or VCSEL within the inner eight channels. The ASICs were designed using a 130 nm CMOS process to enhance the radiation-hardness. With the spacing of 250  $\mu\text{m}$  between two VCSEL or PIN channels, the width of an optical array is only 3 mm. This allows the fabrication of compact parallel optical engine for installation at a location where space is at a premium.

Each of the receiver/decoder circuits includes pre-amplification, a bi-phase mark clock/data recovery circuit, and LVDS outputs for both the clock and data. In order to allow remote control of the chip, the ASIC includes command decoders that have been designed to be single event upset (SEU) tolerant. All latches are based on a dual interlocked storage cell (DICE) latch to enhance the SEU tolerance. The driver ASIC is designed to operate at 5 Gb/s. Each channel has an LVDS receiver, an 8-bit DAC, and a VCSEL driver. The 8-bit DAC is used to set the VCSEL modulation current. Both ASICs contain multiplexer networks to bypass a broken PIN or VCSEL. To enable operation in case of a failure in the communication link to the command decoder, we have included a power on reset circuit that will set the ASICs to its default 1:1 signal routing state and the VCSEL modulation current to 10 mA.

The fabricated receiver/decoder properly decodes the bi-phase marked input stream with no bit error at low PIN current. The performance of the VCSEL driver at 5 Gb/s is satisfactory. We are able to program the ASICs to bypass a broken PIN or VCSEL and the power-on reset circuits have been successfully implemented. We have irradiated the receiver/decoder with 24 GeV/c protons to a dose of  $1.13 \times 10^{15}$  p/cm<sup>2</sup> (30 Mrad) and observe no significant degradation and the SEU rate is low. We plan to irradiate the VCSEL drivers in the summer to measure the radiation hardness. We will present results from the study at the conference. In addition, we will briefly present the status of the design of a new VCSEL driver ASIC to operate at 10 Gb/s which will yield an aggregated bandwidth of 120 Gb/s for a fiber ribbon.

Room 219 - BSM - Non-SUSY - TR3 / 249

## Z' production at LHC in an extended MSSM

**Author:** Simonetta Gentile<sup>1</sup>

**Co-author:** Gennaro Corcella

<sup>1</sup> *Universita e INFN, Roma I (IT)*

**Corresponding Author:** [simonetta.gentile@cern.ch](mailto:simonetta.gentile@cern.ch)

Searching for heavy neutral gauge bosons  $Z'$ , predicted in extensions of the Standard Model based on a  $U'$  gauge symmetry, is among the main new physics investigations undertaken by the experiments at the Tevatron and at the Large Hadron Collider. We study  $Z'$  phenomenology at hadron colliders according to several  $U'$ -based models and in the Sequential Standard Model. In particular, as far as its decay is concerned, we shall include possible  $Z'$  decays into supersymmetric particles, besides the Standard Model modes so far investigated.

We shall point out the new features of the MSSM, once it is extended by means of a  $U'$  group, and consider a few benchmark points in the parameter space. As for  $Z'$  decays into sfermions, we shall account for the D-term contribution, due to the breaking of  $U'$ , to slepton and squark masses. Results on branching ratios and cross sections will be presented, as a function of the MSSM and  $U'$  parameters, which will be varied within suitable ranges. We shall pay special attention to the decay into neutralino and charged-slepton pairs and gauge the feasibility to discover supersymmetry through this channel at the LHC.

Poster Session - Board: 02 / 250

## Production of the heaviest charged Higgs boson in 3-3-1 models

**Author:** Fredy Ochoa<sup>1</sup>

**Co-authors:** Cristina Alvarado<sup>2</sup>; Roberto Martinez<sup>2</sup>

<sup>1</sup> *Universidad Nacional de Colombia Sede Bogota (CO)*

<sup>2</sup> *Universidad Nacional de Colombia Sede Bogota*

In this work we study the production cross section of the heaviest charged Higgs bosons ( $H_{2^\pm}$ ) predicted by the  $SU(3)_c \times SU(3)_L \times U(1)_x$  gauge model (3-3-1 model) without exotic charges. Taking into account intermediate vector bosons, including a new  $Z'$  neutral boson predicted by the model, we calculate the cross section of  $H_{2^\pm}$  pair production in Drell-Yan processes at CERN-LHC hadron collider. For two  $Z'$  masses ( $M_{Z'}=1.8$  and  $2.2$  TeV) we found that the cross section decreases appreciably at the  $H_{2^\pm}$  mass values of  $0.9$  TeV and  $1.1$  TeV, respectively. In order to explore differences with other charged Higgs bosons, we compare our results with the lighter  $H_{1^\pm}$  Higgs of the same model and the charged Higgs boson of the Two Higgs Doublet Model (2HDM), where we found that it is possible to distinguish the  $H_{2^\pm}$  bosons from others charged bosons.

### Summary:

Models with gauge symmetry  $SU(3)_c \times SU(3)_L \times U(1)_x$ , also called 3-3-1 models, arise as an interesting alternative that explains some of the fundamental problems of the Standard Model (SM). For example, introducing a family non-universal  $U(1)$  symmetry, the 3-3-1 models can account for the family replication problem and may generate a hierarchical difference between the heaviest quark family and the two lighter. These models introduce new types of heavy particles, which may be searched at

Hadron Colliders, providing additional information on the nature of the extended gauge structure beyond the SM. In particular, these models extend the scalar sector of the SM into three  $SU(3)_L$  scalar triplets. In the version without exotic charges, after the spontaneous breaking of the gauge symmetry, the model contains 4 massive charged Higgs ( $H_{1\pm}, H_{2\pm}$ ), one neutral CP odd Higgs ( $A^0$ ), 3 neutral CP even Higgs ( $h^0, H^0, H_{2^0}$ ), and one complex neutral Higgs ( $H_{3^0}$ ). In particular, several production and decay channels of the lightest charged Higgs bosons  $H_{1\pm}$  at LHC have been calculated in the literature. In this work, we study the Drell-Yan pair production cross section of the heaviest charged Higgs bosons ( $H_{2\pm}$ ), including the contribution of a new  $Z'$  neutral boson associated to the  $SU(3)_L$  gauge sector.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 251**

## Measurements of High Energy Particle Interaction Properties with the Pierre Auger Cosmic Ray Observatory

**Author:** Jose Bellido<sup>1</sup>

<sup>1</sup> *University of Adelaide (AU)*

**Corresponding Author:** jose.bellidocaceres@adelaide.edu.au

The Pierre Auger Observatory is a cosmic ray detector optimized for the detection of air showers (particle cascades in the atmosphere) created by particles with energies ranging from  $10^{17}$  eV to about  $10^{20}$  eV. The Pierre Auger Observatory is a hybrid detector. It uses a ground array of water Cherenkov tanks (deployed over an area of 3000 square kilometers), and a set of fluorescence telescopes overlooking the atmosphere above the ground array. The ground array measures the density of particles at ground level, while the fluorescence telescopes measure the shower development profile through the atmosphere. In this presentation, I will focus on our recent measurements of the proton-air cross section at  $\sqrt{s} = 57$  TeV, and on our measurements of the muon content in air showers, which appears to be approximately a factor of two larger than predicted by models.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 252**

## Selected results from the ARGO-YBJ experiment

**Author:** Paolo Camarri<sup>1</sup>

<sup>1</sup> *University of Roma Tor Vergata*

**Corresponding Author:** camarri@roma2.infn.it

The ARGO-YBJ experiment is an unconventional air-shower array designed for studying astronomical gamma-ray sources at energy greater than few hundred GeV and cosmic-ray physics at energy greater than about 1 TeV. The detector fulfils the requirements to achieve such goals thanks to its high-altitude location, 4300 meters a.s.l. on the Tibet plateau, and to its structure: a full-coverage layer of Resistive Plate Chambers (RPCs) covering a surface of  $78 \times 74 \text{ m}^2$ , surrounded by a guard ring of RPCs enclosing a total surface of about  $11000 \text{ m}^2$ . ARGO-YBJ has been running with the complete layout since November 2007, collecting about  $4 \times 10^{11}$  events. The main results obtained by ARGO-YBJ, namely the cosmic-ray anisotropy, the monitoring of gamma-ray sources and the limit on the antiproton-proton ratio in the primary cosmic radiation, will be discussed.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 253**

## Scientific Program of NICA @ JINR

**Author:** Vladimir Kekelidze<sup>1</sup>

**Co-authors:** Alexander Kovalenko<sup>2</sup>; Alexander Sorin<sup>2</sup>; Grigori Trubnikov<sup>2</sup>; Igor Meshkov<sup>2</sup>; Richard Lednicky<sup>2</sup>; Victor Matveev<sup>2</sup>

<sup>1</sup> *Joint Institute for Nuclear Research (RU)*

<sup>2</sup> *Joint Institute for Nuclear Research*

**Corresponding Author:** vladimir.kekelidze@cern.ch

Scientific program of NICA (Nuclotron-based Ion Collider fAcility) is now under realization phase at JINR (Dubna). The main goal of the program is an experimental study of hot and dense strongly interacting matter in heavy ion collisions at centre-of-mass energies of  $\sqrt{s_{NN}} = 4\text{--}11$  GeV (NN-equivalent) and at average luminosity of  $10^{27}$  cm<sup>-2</sup> s<sup>-1</sup> for Au (79+) in the collider mode (NICA collider). In parallel, fixed target experiments at the upgraded JINR superconducting synchrotron Nuclotron are carried out in the extracted beams of various nuclei species up to Au (79+) with maximum momenta of 13 GeV/c (for protons). The program also foresees a study of spin physics with extracted and colliding beams of polarized deuterons and protons at the energies up to  $\sqrt{s} = 26$  GeV (for protons). The proposed program allows to search for possible signs of the mixed phase and critical endpoint, and to shed more light on the problem of nucleon spin structure. General design and construction status of the complex is presented.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 254**

## Performance of the CALICE analogue calorimeters and tests of GEANT4

**Author:** Tamaki Yoshioka<sup>1</sup>

<sup>1</sup> *Kyushu University (JP)*

**Corresponding Author:** tyosioka@icepp.s.u-tokyo.ac.jp

The CALICE collaboration has developed highly granular calorimeter prototypes to evaluate technologies for experiments at a future lepton collider, and measured their performance in test beams. One important use of these data is the validation of the physics models in GEANT4, especially those related to hadronic showers. This validation is crucial if Monte Carlo simulations are to be used to optimise the design of detectors for ILC or CLIC.

In this talk we discuss several features of showers recorded in the CALICE calorimeters using analogue readout. These include both a Si-W electromagnetic calorimeter, a tungsten ECAL with scintillator strip readout, and a hadronic calorimeter instrumented with scintillator pads and using either iron or tungsten absorbers. The performance of these different technologies are compared. A common feature of all these designs is their high spatial resolution, optimised for particle flow reconstruction of jets. This granularity permits the investigation of shower shapes in unprecedented detail, and the resolution of detailed substructure within the shower, such as track segments. Many of these features present new challenges to the simulation models. Furthermore, the high level of detail recorded within the showers can be exploited in the form of “software compensation”. A variety of techniques can be used to discriminate between the different components within showers and hence to weight them differently so as to improve the energy resolution. We also report on recent tests of the time-structure of hadronic showers in a tungsten calorimeter - a topic of especial interest for a CLIC detector where accurate time stamping is required.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 257**

## The CLIC project, status and prospects

**Author:** Steinar Stapnes<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** steinar.stapnes@cern.ch

The Compact Linear Collider (CLIC) project explores the possibility of constructing a future multi-TeV linear electron-positron collider. The CLIC-concept is based on high gradient normal-conducting accelerating structures. The RF power for the acceleration of the colliding beams is produced by a novel two beam acceleration scheme, where power is extracted from a high current drive beam that runs parallel with the main linac. In order to establish the feasibility of this concept a number of key issues have been addressed, covering concept verification, accelerator parameters, component development, alignment and stability. The CLIC physics potential and main detector issues, as well as possible implementation stages are being studied in parallel.

A summary of the progress and status of the corresponding studies will be given, as well as an outline of the preparation and work towards developing a CLIC implementation plan by 2016.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 263**

## Measurement of tau polarization in $W \rightarrow \tau \nu$ decays with the ATLAS detector

**Author:** Sarah Marie Demers<sup>1</sup>

<sup>1</sup> *Yale University (US)*

**Corresponding Author:** sarah.marie.demers@cern.ch

A measurement of tau polarization in  $W \rightarrow \tau \nu$  decays is reported with data collected by the ATLAS experiment.

It is measured from the energies of the decay products in hadronic tau decays with a single final state charged particle, and it is found in agreement with the Standard Model prediction.

**Poster Session - Board: 54 / 265**

## Physics and detector studies with the very forward calorimeters at a future linear collider

**Author:** Ivanka Bozovic-Jelisavcic<sup>1</sup>

<sup>1</sup> *Vinca Institute of Nuclear Sciences, University of Belgrade (RS)*

**Corresponding Author:** ivanka.bozovic@cern.ch

The very forward region at a future e+e- collider detector will be instrumented with calorimeters dedicated primarily for precise measurement of the integral luminosity, providing at the same time information for beam-tuning, shielding of the inner detectors and also improving the overall detector hermeticity. Detector designs optimized for the ILC and CLIC colliders are presented, with emphasis on the precise integral luminosity measurement. Physics and machine-related effects are discussed, contributing dominantly to the systematic uncertainty in the luminosity measurement. In addition, recent results of the performance studies of sensor planes for the ILC forward calorimeters assembled with the dedicated FE and ADC ASICs are given.

Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 270

## Dijet Production in Diffractive Deep-Inelastic Scattering using Proton Spectrometers at HERA

**Author:** Richard Polifka<sup>1</sup>

<sup>1</sup> Charles University in Prague (CZ) & University of Toronto (CA)

**Corresponding Author:** richard.polifka@cern.ch

The cross section of diffractive deep-inelastic scattering  $ep \rightarrow eXp$  is measured, where the system  $X$  contains at least two jets and the leading final state proton is detected in the H1 Forward Proton Spectrometer. The measurement is performed for fractional proton longitudinal momentum loss  $x_{IP} < 0.1$  and covers the range  $0.1 < |t| < 0.7 \text{ GeV}^2$  in squared four-momentum transfer at the proton vertex and  $4 < Q^2 < 110 \text{ GeV}^2$  in photon virtuality. The differential cross sections extrapolated to  $|t| < 1 \text{ GeV}^2$  are in agreement with next-to-leading order QCD predictions based on diffractive parton distribution functions extracted from measurements of inclusive and dijet cross sections in diffractive deep-inelastic scattering. The data are also compared with leading order Monte Carlo models.

The production of dijets in diffractive deep inelastic scattering,  $ep \rightarrow e \gamma p \rightarrow e p \text{ jet1 jet2 } X$ , has been measured with the H1 detector at HERA using Very Forward Proton Spectrometer to measure the scattered proton momentum. The data correspond to an integrated luminosity of  $95 \text{ pb}^{-1}$ . This process is sensitive to the partonic structure of the diffractive exchange between the proton and the virtual photon. The scattered proton is measured using the VFPS with an acceptance of about 90% in the range  $0.009 < x_{pom} < 0.025$ , where  $x_{pom}$  is the energy fraction lost by the proton in the interaction. The dijet cross section has been measured for virtualities of the exchanged boson,  $5 < Q^2 < 80 \text{ GeV}^2$  and photon-proton centre-of-mass energies,  $100 < W < 250 \text{ GeV}$  and  $|t| < 1 \text{ GeV}^2$ . The jets were identified using the inclusive  $k_T$  algorithm in the  $\gamma p$  frame. The two highest transverse energy jets identified in each event were required to satisfy  $E^*_T\{\text{jet}\} > 5.5$  and  $4 \text{ GeV}$ , respectively in the pseudorapidity range  $-2.0 < \eta\{\text{jet}\} < 2$ . The cross sections are compared to the predictions from leading-logarithm parton-shower RapGap Monte Carlo and next-to-leading-order QCD calculations based on recent diffractive parton densities extracted from inclusive diffractive deep inelastic scattering data.

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 272

## Measurement and QCD Analysis Deep-Inelastic Scattering at HERA.

**Author:** Zhiqing Philippe Zhang<sup>1</sup>

<sup>1</sup> Laboratoire de l'Accélérateur Linéaire (FR)

**Corresponding Author:** zhangzq@lal.in2p3.fr

The inclusive  $e+p$  single and double differential cross sections for neutral and charged current processes are measured with the H1 detector at HERA. The data were taken at a centre-of-mass energy of  $\sqrt{s} = 319 \text{ GeV}$  with a total integrated luminosity of  $329.1 \text{ pb}^{-1}$  shared between two lepton beam charges and two longitudinal lepton polarisation modes. The differential cross sections are measured in the range of four-momentum transfer squared,  $Q^2$ , between 120 and  $50\,000 \text{ GeV}^2$ , and Bjorken  $x$  between 0.008 and 0.65. The measurements are combined with earlier published H1 data to determine the structure function  $x F_3^{\gamma Z}$ . A measurement of the neutral current parity violating structure function  $F_2^{\gamma Z}$  is presented for the first time. The polarisation dependence of the CC total cross section for  $Q^2 > 400 \text{ GeV}^2$  is found to be consistent with the Standard Model. The new measurements are well described by a next-to-leading order QCD fit using all published H1 inclusive cross section data which is used to extract flavour separated parton densities.

A measurement is presented of the inclusive neutral current  $e\pm p$  scattering cross section using data collected by the H1 experiment at HERA during the years 2003 to 2007 with proton beam energies  $E_p$  of 920, 575, and 460 GeV. The kinematic range of the measurement covers low absolute four-momentum transfers squared,  $1.5 \text{ GeV}^2 < Q^2 < 120 \text{ GeV}^2$ , small values of Bjorken  $x$ ,  $2.9 \cdot 10^{-5} < x < 0.01$ , and extends to high inelasticity up to  $y = 0.85$ . The structure function  $FL$  is measured by combining the new results with previously published H1 data at  $E_p = 920 \text{ GeV}$  and  $E_p = 820 \text{ GeV}$ . The new measurements are used to test several phenomenological and QCD models applicable in this low  $Q^2$  and low  $x$  kinematic domain.

A precise knowledge of the integrated luminosity of the HERA collider is relevant for various types of cross section measurements and for a precise determination of the parton density functions of the proton. At  $ep$  colliders, the integrated luminosity is often measured in the Bethe Heitler process, using dedicated detectors located at small angles. In this paper, an alternative measurement of the integrated luminosity is presented, exploiting the elastic QED Compton process  $ep \rightarrow e \gamma p$ . Both the electron and the photon are detected in the H1 backward calorimeter. The integrated luminosity of the data recorded in 2003 to 2007 is determined with a relative precision of  $\pm 0.85\%(\text{stat}) \pm 2.12\%(\text{sys})$ , where (stat) is the statistical uncertainty and (sys) is the total systematic uncertainty. The measurement is found to be compatible with the corresponding Bethe-Heitler analysis.

**Poster Session - Board: 40 / 284**

## Measurement of the Azimuthal Correlation between the most Forward Jet and the Scattered Positron in Deep-Inelastic Scattering at HERA

**Author:** . H1 Collaboration<sup>1</sup>

<sup>1</sup> DESY

**Corresponding Author:** karin.daum@desy.de

Deep-inelastic positron-proton scattering events at low photon virtuality  $Q^2$  with a forward jet, produced at small angles with respect to the proton beam, are measured with the H1 detector at HERA. A subsample of events with an additional jet in the central region is also studied. For both samples differential cross sections and normalised distributions are measured as a function of the azimuthal angle difference,  $\Delta\phi$ , between the forward jet and the scattered positron. The sensitivity to QCD evolution mechanisms is tested by comparing the data to predictions of Monte Carlo generators based on different evolution approaches as well as to next-to-leading order calculations.

**Room 219 - BSM - Non-SUSY - TR3 / 286**

## Implications of 125 GeV Higgs in composite models

**Author:** Michele (CH) Redi<sup>1</sup>

<sup>1</sup> CERN

**Corresponding Author:** michele.redi@cern.ch

In this talk I will describe the implications of a 125 GeV Higgs in Composite Higgs Models. I will focus on the most relevant scenario where the Higgs is a pseudo-Goldstone boson and Standard Models fields are partially composite. Several models can be constructed characterized by the global symmetries and fermionic content of the composite sector. The Higgs can be light ( $\sim 125 \text{ GeV}$ ) for a moderate tuning of parameters if light fermionic resonances are present. These could be seen at the present LHC run or early LHC14 run.

Based on: arXiv:1110.1613, arXiv: 1205.0232



**Poster Session** - Board: 41 / 287

## Universality of soft hadron spectra in pp and e+e- collisions

**Author:** Olga Driga<sup>1</sup>

<sup>1</sup> SUBATECH (FR)

**Corresponding Author:** olga.driga@cern.ch

The success in understanding dynamics of soft particles inside jets relies on calculations of perturbative QCD, impressive accuracy of which have already been tested experimentally. However, the theory predicts, that the inclusive particle spectrum inside jets is independent of a collision energy in the limiting case of zero momentum ( $p \rightarrow 0$ ). In order to test this prediction, a systematic study of world experimental data from hadron and lepton colliders at the collision energies from tenth of GeV up to the TeV scale at the LHC has been performed. In this work we present the consecutive analysis which confirms these predictions at the momentum region above 0.5 GeV/c. We demonstrate that for the particle momenta lower than 0.5 GeV/c the experimental data break this tendency and show up a new behavior.

### Financial Support Justification for Early-Stage Researchers:

I am a final year PhD student working at the SUBATECH/IN2P3 laboratory, Nantes, France.

I am very interested in participating in ICHEP2012, because the topic of my PhD thesis is widely covered in the scientific program of the Conference.

I would be happy to present, for the benefit of the conference, the results I have obtained on soft hadron production in a form of an oral talk or a poster.

The wide coverage of topics in the scientific program of the Conference makes it very interesting and exciting to listen and participate in discussions.

I find it useful for broadening my general education in high-energy physics and new theoretical developments. This is also a perfect opportunity to discuss the newest results and perspectives with experts which will be gathered together in one place.

Due to limited funding in my laboratory, I would really appreciate any financial support from the Organizing Committee in waiving the conference fee or in covering meals/local stay to be able to attend the conference.

### Summary:

A part of the indicated studies was summarized in the article "Soft Hadron Production at the LHC" published in journal "Progress in Particle and Nuclear Physics" <http://dx.doi.org/10.1016/j.ppnp.2012.01.006>. The complete study is preparing for publication and has not been presented before.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 288**

## Near BPS Skyrmons: Non-shell configurations and Coulomb effects

**Author:** Luc Marleau<sup>1</sup>

<sup>1</sup> Université Laval (CA)

**Corresponding Author:** lmarleau@phy.ulaval.ca

We propose to describe nuclei as near BPS solitons emerging from a generalization of the Skyrme model in the regime where a sixth-order term and a generalized mass term dominate. The mass term is chosen such that the baryon and energy density generated by the solutions do not exhibit the usual shell configuration. Adding contributions from the rotational energy, Coulomb energy and

isospin symmetry breaking, we reproduce the mass of the most abundant isotopes to rather good accuracy.

### Plenary 3 - The Standard Model - TR1 / 290

## Direct searches for the standard model Higgs boson produced in association with a vector boson

**Author:** Wei-Ming Yao<sup>1</sup>

<sup>1</sup> *Lawrence Berkeley National Laboratory (US)*

**Corresponding Author:** weiming.yao@cern.ch

We present the results of searches for the standard model Higgs boson at CDF in final states with bottom quarks. Results are derived from the complete Tevatron Run II dataset, with a measured integrated luminosity of 9.5/fb of proton-antiproton data. The searches are performed for assumed Higgs masses between 90 and 150 GeV, for Higgs bosons produced in association with associated W or Z bosons. Employing several improved techniques, these are currently the most sensitive searches in the world for these processes, surpassing previous CDF results by 30% beyond what would be expected from the addition of new data alone. Combining the search sensitivity of these production modes, 95% upper confidence limits on the standard model cross section times branching fraction are derived, yielding an observed (expected) upper limit of 4.3 (1.8) times the standard model prediction for a 125 GeV Higgs boson. The significance of the data relative to the background-only hypothesis is 2.7 sigma, currently the highest of any Higgs search in a single decay mode.

### Plenary 3 - The Standard Model - TR1 / 291

## Standard Model Higgs boson searches in secondary channels using the full CDF dataset

**Author:** Elisabetta Pianori<sup>1</sup>

<sup>1</sup> *University of Warwick (UK)*

**Corresponding Author:** elisabetta.pianori@cern.ch

Although the sensitivity to a low-mass Standard Model Higgs boson at the Fermilab Tevatron is highest for the primary search channels ( $H \rightarrow b\bar{b}$  decay in association with a vector boson and H-WW), other channels contribute significantly to the combined Higgs search sensitivity. We report the results of searches for the Higgs boson produced in association with a top quark pair with the  $H \rightarrow b\bar{b}$  decay, and also searches in the inclusive diphoton and ditau final states using up to  $10\text{ fb}^{-1}$  of integrated luminosity collected by the CDF detector at  $\sqrt{s} = 1.96\text{ TeV}$ . Despite their challenges, when combined, these secondary channels contribute appreciably to the low-mass Higgs boson sensitivity at the Tevatron.

### Plenary 3 - The Standard Model - TR1 / 292

## Inclusive Search for Standard Model Higgs Boson Production in the WW Decay Channel using the CDF II Detector

**Author:** Massimo Casarsa<sup>1</sup>

<sup>1</sup> INFN - Trieste**Corresponding Author:** massimo.casarsa@cern.ch

The search for the Standard Model (SM) Higgs boson at the Tevatron has been highly successful in driving the first Higgs exclusions since LEP. This search by CDF is performed using the full Run2 dataset and looks specifically in the Higgs to WW final state of two charged leptons ( $e, \mu$ ) and two neutrinos from the collision of  $p - \bar{p}$  pairs at  $\sqrt{s} = 1.96$  TeV. This version of the analysis implements several improvements. Track and calorimeter isolation quantities for the leptons were recalculated to prevent mutual spoilage when two candidates are in close proximity to each other. To maximize signal acceptance, events with same-sign dileptons and trileptons are included as separate regions to account for associated Higgs production with a Z or W boson via vector boson fusion. Additionally, events with low dilepton invariant mass are included in a separate region to further improve acceptance. The search excludes at the 95% C.L. a SM Higgs boson in the mass range between 148 GeV/c<sup>2</sup> and 175 GeV/c<sup>2</sup> and is also one of the main contributors to the Tevatron's sensitivity to the low mass SM Higgs boson.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 293**

## Matter Inflation

**Author:** Stefan Antusch<sup>1</sup><sup>1</sup> University of Basel (CH)**Corresponding Author:** stefan.antusch@unibas.ch

We discuss inflation models in supergravity, where the inflaton resides in the matter sector of the theory. These models, referred to as matter inflation, are based on a tribrid structure in the superpotential and allow for a Heisenberg symmetry or a shift symmetry for solving the eta-problem. Possible close connections to particle physics theories are discussed, such as sneutrino hybrid inflation, or models where a D-flat direction of GUT multiplets acts as the inflaton in SO(10) Grand Unified Theories. Although inflation ends by a waterfall, associated with the breaking of a GUT or family symmetry, the production of topological defects can be avoided by vacuum preselection.

**TR 8 - Neutrinos RM 219 / 294**

## The Neutrino Flavour Puzzle in the Light of Large Theta<sub>13</sub>

**Author:** Stefan Antusch<sup>1</sup><sup>1</sup> University of Basel (CH)**Corresponding Author:** stefan.antusch@unibas.ch

What is the origin of the observed fermion masses and mixing parameters? Neutrinos, with their small mass and large mixing, contribute an important part of this flavour puzzle. We discuss new developments regarding the flavour puzzle in the light of the recent discovery of comparatively large leptonic mixing theta<sub>13</sub>. The new developments include the possibility to explain the observed value of theta<sub>13</sub> from charged lepton corrections in Grand Unified Theories, a new type of Constrained Sequential Dominance models leading to tri-maximal mixing with predicted theta<sub>13</sub> and unsuppressed CP asymmetries for leptogenesis, as well as a new class of models with predicted CP violation in the quark and lepton sectors.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 295

## Hadronic B decays at BaBar

**Author:** Torsten Leddig<sup>1</sup>

<sup>1</sup> *Universität Rostock (DE)*

**Corresponding Author:** leddig@slac.stanford.edu

Baryonic decays account for about 7% of the B-meson width, but are far less studied than decays into meson-only final states. We present new studies of the processes  $B^- \rightarrow \Sigma_c^{++} \bar{p} \pi^-$  and  $B^0 \rightarrow \Lambda_c^+ \bar{p} \pi^-$ . The former decay is a resonant subchannel of the 5-body decay  $B^- \rightarrow \Lambda_c^+ \pi^+ \bar{p} \pi^- \pi^-$ , which is the known baryonic decay mode with the largest branching fraction, which motivates more detailed studies into its substructure. Similarly, the latter decay has the same quark content as the high-branching-fraction modes  $B^0 \rightarrow \Lambda_c^+ \bar{p} \pi^+ \pi^-$  and  $B^- \rightarrow \Lambda_c^+ \pi^+ \bar{p} \pi^- \pi^-$ , shedding further light on baryon production. In addition to measuring the overall branching fractions, we analyze the resonant substructure of these decays.

Decays of B mesons into two charm mesons and a kaon proceed through a number of interfering intermediate states, making them particularly useful for studying charm-strange mesons and  $c\bar{c}$  resonances above the open-charm threshold. We present new studies of these decays based on the full BABAR Upsilon(4S) dataset. We measure the total branching fractions and perform a Dalitz-plot analysis, from which we obtain the properties of intermediate resonances.

Using the full BABAR Upsilon(4S) dataset, we perform amplitude analyses of the decays  $B^+ \rightarrow K^+ K^- K^+$  and  $B^+ \rightarrow K_S K_S K^+$  and measure CP-violating asymmetries and partial branching fractions. For  $B^+ \rightarrow K^+ K^- K^+$ , we find a direct CP asymmetry in  $B^+ \rightarrow \phi(1020) K^+$  of  $(12.8 \pm 4.4 \pm 1.3)\%$ , which differs from zero by 2.8 sigma. The standard model predicts no appreciable asymmetry for this mode. We also perform an angular-moment analysis of these channels. This high-statistics analysis allows us to determine that the  $f_X(1500)$  state, which has been used in previous  $B \rightarrow KKK$  fits, is not needed, and that the data can be adequately described by the sum of the resonances  $f_0(1500)$ ,  $f_2'(1525)$ , and  $f_0(1710)$ .

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 297

## Mixing-induced CP violation at BaBar

**Author:** Riccardo de Sangro<sup>1</sup>

<sup>1</sup> *INFN Frascati (IT)*

**Corresponding Author:** riccardo.desangro@slac.stanford.edu

While CP violation in the B-meson system has been well established by the B factories, there has been no direct observation of time-reversal violation in this system. Using 468 million  $B\bar{B}$  pairs collected by the BABAR detector at SLAC, we measure T-violating parameters in the time evolution of neutral-B mesons by comparing the probabilities of  $B^0$  or anti- $B^0$  transforming into definite CP final states and vice versa. The results lead to the first direct observation of Time Reversal non-invariance, independent of CP violation.

We present a new measurement of the time-dependent CP-asymmetry parameters  $S$  and  $C$  in the decay  $B^0 \rightarrow DD$  decays using 467 million  $B\bar{B}$  pairs collected with the BABAR detector at SLAC. The analysis makes use of the technique of partial reconstruction, resulting in high reconstruction efficiency and high statistics. From  $S$  and  $C$  we extract the CP-even components  $S_+$  and  $C_+$ . Comparison of  $S_+$  to the standard-model prediction based on measurements from  $b \rightarrow c \bar{c} s$  decays constitutes a test for the presence of new physics contributions in this decay.

We present a measurement of the mixing-induced CP asymmetry for  $B^0$  mesons. Semileptonic  $B^0 \rightarrow D^{*\ell}\nu$  decays are selected with a partial reconstruction technique that allows for high selection efficiency and high statistics with precise determination of the background. The resulting precision is comparable with the measurements based on di-lepton tags performed at the B-factories.

B decays that proceed via penguin amplitudes are sensitive to new-physics contributions. Measurements of time-dependent CP violation in such decays have yielded results that were not fully consistent with those from the more precise  $b \rightarrow c \bar{c} s$  decays. This warrants further studies with all possible decay modes, requiring in particular use of decays with multibody final states. We report updated time-dependent CP violation and Dalitz-plot analyses of the decays  $B^0 \rightarrow K_s K_s K_s$  and  $B^0 \rightarrow K^+ K^- K_s$ . The high  $K_s$  multiplicity in the first mode essentially precludes its study at the LHC at this time. We report the total branching fractions, contributions of intermediate resonances, and CP violation parameters. We report the first evidence for CP violation in  $B^0 \rightarrow K_s K_s K_s$ , with CP conservation excluded at 3.8 standard deviations.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 300

## Charm mixing and CP violation at BaBar

**Author:** Giulia Casarosa<sup>1</sup>

<sup>1</sup> SLAC & INFN (IT)

**Corresponding Author:** gcasa@slac.stanford.edu

✉ We present a measurement of the  $D^0$ -anti $D^0$  mixing and CP-violation parameters  $y_{CP}$  and  $\Delta y$  using the full BABAR dataset. We reconstruct samples of  $D^{*-}$ -tagged and untagged  $D^0$  decays to the final states  $K^+K^-$ ,  $K^+/\pi^-/\pi^+$  and  $\pi^+\pi^-$ . From a simultaneous fit to the different channels, we extract the effective lifetimes of the  $D^0$  decaying to the CP-even final states and the flavor-specific final state, and combined them into the mixing parameter  $y_{CP}$  and the CP-violation parameter  $\Delta y$ . Utilizing the full dataset, new track reconstruction, optimized event selection, and the simultaneous fit to both tagged and untagged samples, we improve both the statistical and the systematic errors with respect to all previous measurements.

CP violation in the charm system is predicted to be small, yet evidence for direct CP violation has been reported by the LHCb experiment in 2-body  $D^0$  decays. A full understanding of the effect requires CP measurements in multibody decays as well. Using the full BABAR Upsilon(4S) data set, we investigate CP violation in the decay  $D^+ \rightarrow K^+K^-\pi^+$ . In addition to the overall decay-rate asymmetry, we present CP violation results using model-dependent and model-independent Dalitz-plot analyses.

Recent evidence from LHCb of time integrated asymmetry in 2-body  $D^0$  decays motivates further studies of CP violation in the charm-meson system, which is required for a full understanding of the phenomenon. Charm CP-violation studies at the B factories are competitive with LHCb in particular for decay modes that involve neutral particles, and several such measurements have already been performed by BABAR and Belle. We report here new results of time-integrated CP-violation measurements in the decay modes  $D^+ \rightarrow K_s K^+$ ,  $D_s^- \rightarrow K_s K^+$ , and  $D_s^- \rightarrow K_s \pi^+$ . Our measurements are the most precise to date, due to very efficient  $K_s$  reconstruction and excellent control of systematic errors, including use of a large control sample to reduce the reconstruction asymmetries produced by detector-induced effects. We compare our results with the standard-model prediction, allowing for effects due to  $K^0$ - $\bar{K}^0$  interference.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 303

## Charm decays and spectroscopy at BaBar

**Author:** Romulus Godang<sup>1</sup>

<sup>1</sup> University of South Alabama (US)

**Corresponding Author:** godang@slac.stanford.edu

The flavor-changing neutral-current decays  $D^0 \rightarrow e^+e^-$ ,  $D^0 \rightarrow \mu^+\mu^-$ , and  $D^0 \rightarrow \gamma\gamma$  are highly suppressed in the standard model, well below observable levels. The decay  $D^0 \rightarrow e^+\mu^-$  is further lepton-flavor violating, and thus can occur only through very slow neutrino mixing. Thus, these decays constitute sensitive probes for possible new-physics contributions. We report new limits on the branching fractions of these decays. The electron and di-photon channels, in particular, benefit greatly from the high photon efficiency and clean environment of the B factory.

Charm decays that are very rare or forbidden within the standard model constitute a sensitive search for new physics. We report results of searches for 35 such decays of the  $D^+$ ,  $D^0$ ,  $D_s$ , and  $\Lambda_c$  into final states containing two leptons plus a pion, kaon, or proton. This includes final states involving lepton-number or lepton-flavor violation. We obtain branching-fraction limits of order  $10^{-6}$ . Most of these are the tightest limits to date, in some cases they are the only results published so far, and some cut into the allowed parameter spaces of published new-physics models.

Precision properties of charm mesons help test and provide reference points for many of the tools and approximations used in hadronic calculations, such as lattice QCD computation of hadronic matrix elements. We present a new measurement of the natural line width of the  $D^+$  meson and of the difference between the masses of the  $D^+$  and the  $D^0$  mesons. Using the full BABAR dataset, we reconstruct the decays  $D^+ \rightarrow D^0 \pi^+$ , with the  $D^0$  identified in its decays into  $K\pi^+$ ,  $K\pi^+\pi^-\pi^+$ ,  $K\pi^+\pi^0$ , and  $Ks \pi^+\pi^-$ . We extract the  $D^+$  width and the pole position in the mass difference  $\Delta m$  in each sample by fitting the measured  $\Delta m$  distribution to the sum of background and signal, modeled as a relativistic P-wave Breit-Wigner line shape convolved with a resolution function. Our results are several times more precise than the previous world average.

We report results of measurements of the angular-momentum-excited charmed baryon  $\Lambda_c(2880)^+$  decaying to  $\Lambda_c \pi^+ \pi^-$  using approximately 316 fb<sup>-1</sup> of BaBar  $e^+e^-$  collision data. We reconstruct the  $\Lambda_c^+$  candidates in the decay mode  $p\bar{K}\pi$  and measure the  $\Lambda_c(2880)^+$  mass, width, and production cross section, and study resonances in the  $\Lambda_c^+ \pi^+ \pi^-$  final state. We report the first measurements of the relative branching fractions for decays of the  $\Lambda_c(2880)^+$  into the final states  $\Sigma_c^0(2455) \pi^+$ ,  $\Sigma_c^{++}(2455) \pi^-$ ,  $\Sigma_c^{++}(2520) \pi^-$ ,  $\Sigma_c^0(2520) \pi^+$ , and the non-resonant  $\Lambda_c^+ \pi^+ \pi^-$  contribution.

**Poster Session - Board:** 55 / 309

## The large-angle photon veto system for the NA62 experiment at CERN

**Authors:** Antonella Antonelli<sup>1</sup>; Cristina Biino<sup>2</sup>

<sup>1</sup> INFN (IT)

<sup>2</sup> Universita e INFN (IT)

**Corresponding Authors:** cristina.biino@cern.ch, antonella.antonelli@lnf.infn.it

The branching ratio (BR) for the decay  $K^+ \rightarrow \pi^+ \bar{\nu} \nu$  is a sensitive probe for new physics. The NA62 experiment at the CERN SPS will measure this BR to within about 10%. To reject the dominant background from channels with final state photons, the large-angle vetoes (LAVs) must detect photons with energies as low as 200 MeV with an inefficiency of less than  $10^{-4}$ , as well as provide energy and time measurements with resolutions of  $\sim 10\%$  and 1 ns for 1 GeV photons. The LAV detectors make creative reuse of lead-glass blocks recycled from the OPAL electromagnetic calorimeter barrel. We describe the mechanical design and challenges faced during construction, the development of front-end electronics to allow simultaneous time and energy measurements over an extended dynamic range using the time-over threshold technique, and the development of an in-situ calibration and monitoring system. Our results are based on test beam data collected using prototypes of the LAV detectors.

## TR 6 - RM 217 - QCD, Jets, Parton Distributions / 310

**Transverse Energy Energy Correlations in Next-to-Leading Order in  $\alpha_s$  at the LHC****Author:** Ahmed Ali<sup>1</sup>**Co-authors:** Fernando Barreiro<sup>2</sup>; Wei Wang<sup>3</sup><sup>1</sup> DESY (DE)<sup>2</sup> UAM, Madrid<sup>3</sup> DESY, Hamburg**Corresponding Author:** ahmed.ali@desy.de

We compute the transverse energy-energy correlation (EEC) and its asymmetry (AEEC) in next-to-leading order (NLO) in  $\alpha_s$  in proton-proton collisions at the LHC with the center-of-mass energy  $E_{\text{c.m.}} = 7$  TeV. We show that the transverse EEC and the AEEC distributions are insensitive to the factorization- and renormalization scales, the underlying minimum bias events, and the structure functions. Hence they can be used to precisely test QCD in hadron colliders and determine  $\alpha_s$ . We illustrate this technique by defining jets using the anti- $k_T$  jet algorithm and an event selection procedure typically used in the analysis of jets at the LHC and show the  $\alpha_s$ -dependence of the transverse EEC and the AEEC in the range  $0.11 \leq \alpha_s(M_Z) \leq 0.13$ .

## TR 8 - Neutrinos RM 219 / 311

**Search for Neutrinoless Double Beta Decay in Xenon 136 with the Enriched Xenon Observatory (EXO)****Author:** Peter C. Rowson<sup>1</sup><sup>1</sup> SLAC (US)**Corresponding Author:** rowson@slac.stanford.edu

The EXO collaboration is searching for neutrinoless double beta decay in  $^{136}\text{Xe}$ . Observation of this process would establish the Majorana nature of neutrinos and lepton number violation, while determining an absolute mass scale for neutrinos. The EXO-200 detector is a ultra low background TPC, with an active mass of  $\sim 100$  kg of liquid xenon enriched to 80.6% in the isotope 136. The detector is currently operating at the underground WIPP site in New Mexico, USA and has been collecting data since May 2011. The collaboration has previously reported the first observation of two-neutrino double beta decay in  $^{136}\text{Xe}$ . In our new data, no signal is observed for an exposure of 32.5 kg-yr, with a background of  $\sim 1.5 \times 10^{-3}$  kg-yr $^{-1}$  keV $^{-1}$  in the  $\pm 1$  sigma region of interest. This sets a lower limit on the half-life of the neutrinoless double-beta decay  $T_{1/2}(^{136}\text{Xe}) > 1.6 \times 10^{25}$  yr (90% CL), corresponding to effective Majorana masses of less than 140–380 meV, depending on the matrix element calculation. Current R&D efforts towards a ton-scale experiment will also be discussed.

## Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&amp;7&amp;10 / 313

**Charmless Two-body B decays Involving a Tensor Meson****Author:** Kwei-Chou Yang<sup>1</sup>**Co-author:** Hai-Yang Cheng<sup>2</sup>

<sup>1</sup> Chung Yuan Christian University (TW)

<sup>2</sup> Institute of Physics, Academia Sinica

**Corresponding Author:** kcyang@cycu.edu.tw

We study two-body charmless hadronic  $B$  decays involving a tensor meson in the final state within the framework of QCD factorization (QCDF). Unlike the light vector meson, because of the G-parity of the tensor meson, both the chiral-even and chiral-odd two-parton light-cone distribution amplitudes of the tensor meson are antisymmetric under the interchange of momentum fractions of the quark and antiquark in the SU(3) limit. The factorizable amplitude with a tensor meson emitted vanishes under the factorization hypothesis owing to the fact that a tensor meson cannot be created from the local  $V - A$  and tensor currents. As a result,  $B^- \rightarrow \bar{K}_2^{*0} \pi^-$  and  $\bar{B}^0 \rightarrow K_2^{*-} \pi^+$  vanish in naive factorization. The experimental observation of the former implies the importance of nonfactorizable effects. For penguin-dominated  $B \rightarrow TP$  and  $TV$  decays, the predicted rates in naive factorization are normally too small by one to two orders of magnitude. In QCDF, they are enhanced by the power corrections from penguin annihilation and nonfactorizable contributions. The experimental observation that  $f_T/f_L \ll 1$  for  $B \rightarrow \phi K_2^*(1430)$ , whereas  $f_T/f_L \sim 1$  for  $B \rightarrow \omega K_2^*(1430)$ , can be accommodated in QCDF. More interesting results will be presented in the talk.

H.Y. Cheng and K.C. Yang, "Charmless Hadronic B Decays into a Tensor Meson", Phys. Rev. D 83, 034001 (2011).

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 314

## Multi-jet matching of parton showers to NLO

**Authors:** Leif Ingvar Lönnblad<sup>1</sup>; Stefan Prestel<sup>1</sup>

<sup>1</sup> Lund University (SE)

**Corresponding Author:** leif.lonnblad@thep.lu.se

LHC is now entering a precision era. No striking signals of new phenomena have yet been found, and the searches now have to focus on very small deviations from the Standard Model. This requires an unprecedented precision in our understanding of the Standard Model. Even though the experiments are extremely ingenious in finding model-independent ways of determining the background, this is not always possible and they have to rely event generators. And even if model-independent determinations are possible, they typically need precise event generators to be developed and understood.

During the last years, much effort has gone into increasing the precision of event generators by carefully matching or merging parton shower programs with exact fixed-order matrix elements. The merging of tree-level matrix elements has now become the standard for multi-jet events, but this leading order procedures lacks in precision. For many processes the matching of Next-to-Leading Order (NLO) matrix elements with parton showers has become state-of-the-art, but the standard programs can only handle the lowest possible jet-multiplicities.

In this talk I will briefly review the standard matching and merging procedures, and then present a new algorithm where multi-jet NLO matrix elements can be correctly merged with parton showers. The new algorithm has been implemented in the Pythia8 event generator and will in principle be able to handle any process where multi-jet partonic states can be produced to NLO, however, in this talk I will only present results for W+jets and Higgs+jets observables.

### Summary:

I will briefly review the standard matching and merging procedures, and then present a new algorithm where multi-jet NLO matrix elements can be correctly merged with parton showers.



Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 315

## DIPSY - a new generator for minimum bias and heavy ion collisions

**Authors:** Christoffer Flensburg<sup>1</sup>; Gosta Gustafson<sup>1</sup>; Leif Ingvar Lönnblad<sup>2</sup>

<sup>1</sup> *Lund University*

<sup>2</sup> *Lund University (SE)*

**Corresponding Author:** leif.lonnblad@thep.lu.se

We present a new Monte Carlo event generator based on the Mueller dipole model. The model is equivalent to leading logarithmic BFKL evolution and in our implementation we include several non-leading effects, such as energy-momentum conservation and a so-called swing mechanism to model saturation effects. In the end we can model all kinds of correlations and fluctuations between partons in the initial-state cascade and by adding final-state parton showers and string hadronization we can produce exclusive hadronic final states.

So far the program has given promising results for minimum-bias events in proton collisions, but the main application may be for heavy ion collisions. Here we can again model kinds of correlations and fluctuations not only between partons in individual, but also between partons in different nucleons. This can then be used as the initial state of a hydrodynamical evolution model to better understand how observables are affected by initial-state effects. Alternatively it can be used as in proton collision with parton showers and hadronization to realistically model what heavy-ion collisions would look like in the absence of collective final-state effects.

### Summary:

We present a new Monte Carlo event generator based on the Mueller dipole model, which can be used to model fully exclusive final states in both proton and heavy ion collision.

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## Predictions of Double Parton Scattering at LHC Energies

**Author:** Edmond Berger<sup>1</sup>

<sup>1</sup> *Argonne National Laboratory (US)*

**Corresponding Author:** berger@anl.gov

Next-to-leading order predictions in perturbative QCD are presented of various differential distributions for  $pp \rightarrow Wb\bar{b}X \rightarrow \ell\nu b\bar{b}X$ , and other processes at the CERN Large Hadron Collider. Included are the contributions from both single parton scattering and double parton scattering, as well as relevant backgrounds. Several kinematic variables are proposed for isolating the double parton contribution with the first  $10 \text{ fb}^{-1}$  of integrated luminosity. Smearing associated with next-to-leading order contributions is important for a proper description of some of the observables we compute. Under specified conditions, the double parton process can be identified and measured with signal over background significance  $S/\sqrt{B} \sim 10$ . (The presentation would be based on the work reported in Phys. Rev. D 84 (2011), 074021, arXiv:1107.3150, and subsequent investigations.)

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## Fermiophobic Higgs Boson in Associated Production with a Massive Vector Boson

**Author:** Edmond Berger<sup>1</sup>

<sup>1</sup> *Argonne National Laboratory (US)*

**Corresponding Author:** berger@anl.gov

Production in association with a vector boson  $V$  is a distinctive mode of production for a Higgs boson  $H$  without tree-level couplings to fermions, known as a fermiophobic Higgs boson. We focus on  $HV$  associated production with  $H$  decay into a pair of photons, and  $V$  into a pair of jets, with the goal of distinguishing a fermiophobic Higgs boson from the standard model Higgs boson. Performing a simulation of the signal and pertinent QCD backgrounds, and using the same event selection cuts employed by the LHC ATLAS collaboration, we argue that existing LHC data at 7 TeV with  $4.9\text{fb}^{-1}$  of integrated luminosity may contain evidence for a fermiophobic Higgs boson near 125 GeV at about 1.9 standard deviation signal significance  $1.9\sigma$ . At 8 TeV the same analysis shows that associated production could yield  $3\sigma$  significance with  $10\text{fb}^{-1}$  of data.

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## Dynamical Origin of the Correlation between the Top Quark Production Asymmetries $A_{FB}^t$ and $A_{FB}^\ell$

**Author:** Edmond Berger<sup>1</sup>

<sup>1</sup> *Argonne National Laboratory (US)*

**Corresponding Author:** berger@anl.gov

A larger than expected forward-backward asymmetry in rapidity is observed in top quark pairs produced in proton-antiproton collisions at the Tevatron. The asymmetry is seen in both the top quark rapidity distribution  $A_{FB}^t$  and in the distribution of charged leptons  $A_{FB}^\ell$  from top quark decay. We explore the kinematic and dynamic aspects of the tight relationship of the two observables arising from the spin correlation between the charged lepton and the top quark with different polarization states. We also consider two benchmark new physics models, an axigluon model and a flavor-changing  $W'$  model. These models could explain the values of both  $A_{FB}^t$  and  $A_{FB}^\ell$ . We emphasize the value of both measurements, and we conclude that a model which produces more right-handed than left-handed top quarks is favored by the present data. (The presentation would be based on the material in Phys Rev Lett. 108, 072002 (2012) [arXiv:1201.1790] and subsequent work.)

Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 319

## Opportunities to Learn Scientific Literacy

**Author:** Marjorie Bardeen<sup>1</sup>

<sup>1</sup> *Fermilab Friends for Science Education (US)*

**Corresponding Author:** mbardeen@fnal.gov

Support for “big science” must come from a society that is scientifically literate. We get few chances to develop scientific literacy for students who do not study science formally in university or college. QuarkNet provides activities in which high school students work with particle physics data and do scientific investigations. Evaluation data show that participants broaden their frame of reference for

science, learning how scientists discover new knowledge and talk about their work. We will provide brief descriptions of three activities—masterclasses, e-Labs and student research teams, methods and results of the evaluation and some effective practices based our work.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 320**

## **Development of beam-collision feedback systems for future lepton colliders**

**Author:** Philip Burrows<sup>1</sup>

<sup>1</sup> *University of Oxford (UK)*

**Corresponding Author:** p.burrows@physics.ox.ac.uk

Future lepton colliders such as the International Linear Collider (ILC), and the Compact Linear Collider (CLIC) require nanometer-sized beams at the interaction point (IP). We report on the design, prototyping and testing of beam-based feedback systems for steering the beams into collision at the IP so as to maximise the luminosity performance of the colliders. Both all-analogue and digital feedback prototypes have been built and tested for CLIC and ILC, respectively. The latency of such systems needs to be very low so as to match the bunch spacing and bunch-train length. We report on the achievement of systems with 130ns and 23ns latency that meet the beam position resolution and beam kick requirements of both ILC and CLIC, respectively; the prototypes were tested with ILC- and CLIC-like beams at the Accelerator Test Facility at KEK. We have simulated the measured performance and demonstrated the potential of the feedbacks to compensate for ground-motion disruption and recover almost all of the design luminosity.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 321**

## **A 125 GeV Higgs in the PQ violating minimal Supergravity model**

**Author:** Sudhir Kumar Gupta<sup>1</sup>

**Co-author:** Csaba Balazs<sup>1</sup>

<sup>1</sup> *Monash University (AU)*

**Corresponding Author:** sudhir.gupta@monash.edu

Motivated by the recent hints from ATLAS and CMS we consider a minimal supersymmetric model which, due to its approximate Peccei-Quinn symmetry, naturally accommodates a 125 GeV Higgs boson. This model can also explain the potentially anomalous branching ratios of such a Higgs. We examine whether other experimental evidence supports this scenario.

**Poster Session - Board: 17 / 322**

## Tau-lepton Charge asymmetry at the LHC: A probe to new physics models

**Author:** Sudhir Kumar Gupta<sup>1</sup>

**Co-author:** German Valencia

<sup>1</sup> *Monash University (AU)*

**Corresponding Author:** sudhir.gupta@monash.edu

Lepton charge asymmetry, LHC analog of the forward-backward asymmetry of the Tevatron, can be an useful tool to probe new physics that “hides-out” from the dilepton invariant mass distribution due to large SM background in the tail region. To demonstrate how sensitive it can be to the new physics models, we will consider example of models which may or “may not” leave their imprints in the dilepton invariant mass distribution.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 323**

## Ultra-High Energy Neutrinos at the Pierre Auger Observatory

**Author:** Roger Clay<sup>1</sup>

<sup>1</sup> *University of Adelaide (AU)*

**Corresponding Author:** roger.clay@adelaide.edu.au

The observation of ultra-high energy neutrinos (UHEVs) is a priority in experimental astroparticle physics. This follows from the expectation that energetic cosmic ray particles are likely to be produced with an associated flux of neutrinos, and the belief that UHE cosmic ray interactions will produce neutrinos as the parent particles travel to us through various astrophysical radiation fields.

UHEVs can be detected with a variety of techniques, and the Surface Detector array of the Pierre Auger Observatory is suited to detecting cascades produced when such neutrinos interact in the atmosphere (downward-going  $\nu$ ) or in the Earth's crust (Earth-skimming  $\nu$ ). This presentation will review the signatures of neutrino events and the procedure and criteria established to search for UHEVs in the Pierre Auger Observatory dataset.

**Room 218 - Detectors and Computing for HEP - TR13 / 324**

## Exploring physics beyond the Standard Model with a Muon Acceleration Facility

**Author:** Donald Hartill<sup>1</sup>

<sup>1</sup> *Cornell University (US)*

**Corresponding Author:** donald.hartill@cern.ch

An accelerator complex that can produce ultra-intense beams of muons presents many opportunities to explore new physics. A facility of this type is unique in that, in a relatively straightforward way, it can present a physics program that can be staged and thus move forward incrementally, addressing exciting new physics at each step. An intense cooled low-energy muon source can be used to perform extraordinarily precise lepton flavor violating experiments. These same muons can be accelerated and then stored in a race track-like storage ring to produce neutrinos for experiments

to explore neutrino mixing with unprecedented precision, creating the so-called Neutrino Factory. Finally, these muons could be accelerated to very-high energy to do energy-frontier physics with a muon collider. In this talk I will give an introduction to muon accelerator facilities and their physics capabilities and then will discuss some of the limiting technologies that must be developed in order to make these concepts a reality and the US Muon Accelerator Program that aims to address these technical challenges.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 325**

## Charmless B decays and CP violation at BABAR

**Author:** Eli Ben Haim<sup>1</sup>

<sup>1</sup> LPNHE, IN2P3-CNRS, Universities of Paris VI (FR)

**Corresponding Author:** benhaim@in2p3.fr

We report a measurement of CP violation in the decay  $B^0 \rightarrow \pi^+ \pi^- \pi^0$  using the full Upsilon(4S) sample of the BABAR experiment. We perform a full time-dependent Dalitz-plot analysis sensitivity to the interference between  $B^0$  and  $B^0$ bar decays, as well as between the intermediate  $\rho \rightarrow \pi \pi$  resonances. This allows us to extract the CKM unitarity-triangle angle  $\alpha$  with reduced ambiguity and improved precision. Precise measurement of  $\alpha$  serves to test the standard model and constrain new physics in  $B^0$ - $B^0$ bar mixing.

We search for decays of the  $B^0$  meson to the final states  $\omega \omega$  and  $\omega \phi$ . These flavor-changing-neutral-current decays are sensitive to physics beyond the standard model and thus provide constraints on potential new-physics effects. They may also shed light on the unexpectedly low longitudinal-polarization fraction in the SU(3)-related decay  $B \rightarrow K^* \phi$ .

We report studies of B-meson decays to the  $K^* \rho$  and  $K^* f_0$  final states, where the  $K$  and  $\rho$  may be charged or neutral. We distinguish between the vector  $K(892)$ , the tensor  $K^*_2(1430)$ , and the resonant and nonresonant scalar components. We report first observation or first evidence for some of the modes and analyze the polarization of the vector-vector and vector-tensor components for the observed signals.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 328**

## Measurement of Collins asymmetries in inclusive production of pion pairs in $e^+e^-$ collisions at BABAR

**Authors:** (A. Soffer) babar collaboration<sup>1</sup>; Isabella Garzia<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> SLAC & INFN (IT)

**Corresponding Author:** garzia@fe.infn.it

The transversity distribution function, which describes the quark transverse polarization inside a transversely polarized nucleon, is the least known leading-twist component of the QCD description of the partonic structure of the nucleon. Transversity can be extracted from semi-inclusive deep-inelastic-scattering data where, however, it couples to a new fragmentation function, called the Collins function. We present a measurement of the azimuthal asymmetries in the process  $e^+e^- \rightarrow q \bar{q} \pi \pi X$ , where the two pions are produced in opposite hemispheres, based on data collected by the BABAR experiment at a center-of-mass energy of about 10 GeV. The Collins function is extracted from the measured asymmetries.

Room 217 - Education &amp; Outreach - QCD, Jet, Parton Distributions - TR15&amp;6 / 330

## Hadron production in $e^+e^-$ collisions at BABAR and implications for the muon anomalous magnetic moment

**Authors:** (A. Soffer) babar collaboration<sup>1</sup>; Andreas Martin Hafner<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> Mainz University (DE)

**Corresponding Authors:** andreas.martin.hafner@cern.ch, hafner@slac.stanford.edu

The BABAR Collaboration has an intensive program of studying hadronic cross sections at low-energy  $e^+e^-$  collisions, accessible at BaBar via initial-state radiation. Our measurements allow significant improvements in the precision of the predicted value of the muon anomalous magnetic moment. These improvements are necessary for shedding light on the current  $\sim 3.5$  sigma difference between the predicted and the experimental values. We have published results on a number of processes with two to six hadrons in the final state. We report here the results of recent studies with the final states  $2(\pi^+\pi^-)$ ,  $K^+K^-\pi^+\pi^-$ ,  $K^+K^-\pi^0\pi^0$ , and  $2(K^+K^-)$ , which constitute the main contribution to the hadronic cross section in the energy region between 1 and 3 GeV. We also report measurements of inclusive hadron production cross sections and angular distributions in  $e^+e^-$  collisions at around 10 GeV. These measurements shed light on fundamental questions of hadronization and fragmentation processes and help test cross-section scaling properties.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 331

## Rare and forbidden B decays at BaBar

**Author:** Steven Robertson<sup>1</sup>

<sup>1</sup> McGill University (CA)

**Corresponding Author:** steven.robertson@cern.ch

Lepton-flavor violation in the standard model occurs only via neutrino mixing, and is thus suppressed by powers of  $(m_\nu / m_W)^2$  to far below observable levels. However, in many extensions of the standard model, lepton-flavor violation involving third-generation fermions may be highly enhanced. Study of B decays involving a tau lepton in the final state is complicated by the presence of final-state neutrinos. At an  $e^+e^-$  B factory, this difficulty is handled by reconstructing both B mesons in the event, taking advantage of the high luminosity and clean event environment. Using this technique, we set the first upper limits on the branching fractions of  $B \rightarrow K \tau e$ ,  $B \rightarrow \pi \tau e$ , and  $B \rightarrow \pi \tau \mu$ , and improve our previous limit on  $B \rightarrow K \tau \mu$ , at the level of a few times  $10^{-5}$ .

The decay of a  $B^0$  meson into two neutrinos is suppressed by a helicity factor of order  $(m_\nu / m_B)^2$  in the standard model. The same decay with an additional photon in the final state is also predicted to be unobservably rare, with a branching fraction at the level of  $10^{-9}$ . Thus, observation of such decays would constitute evidence for new physics, and several scenarios beyond the standard model predict branching fractions as high as  $10^{-6}$ . The search for invisible (+ photon) decays of the  $B^0$  requires fully reconstructing the entire event and tagging the presence of the  $B^0$ , and so can be performed only at an  $e^+e^-$  B factory. We present the results of a new analysis based on the full BABAR dataset and improved reconstruction, obtaining limits several times tighter than the previous results, at the level of  $10^{-5}$ .

The decays  $B \rightarrow K^{(*)} \nu \bar{\nu}$  are flavor-changing neutral-current (FCNC) processes that proceed via a box or penguin diagram. FCNC decays are suppressed in the standard model, with branching-fraction predictions in the  $10^{-6}$  range, but they may be enhanced by new-physics contributions. Due to the final-state neutrinos and the small decay rate, study of these decays can currently be

performed only at an  $e^+e^-$  B factory, where reconstruction of the other B in the event (the “tag B”) is possible. We report the results of a new search for these decays using hadronic decays to identify the tag B in the full BABAR data set. We also use our data to search for invisible decays of the  $J/\psi$ .

Lepton number is conserved in the standard model, but may occur in scenarios beyond the standard model, for example, due to the existence of Majorana neutrinos. We report the results of a new search for lepton-number violation in the decays  $B^+ \rightarrow K^- e^+ e^+$ ,  $B^+ \rightarrow \pi^- e^+ e^+$ ,  $B^+ \rightarrow K^- \mu^+ \mu^+$ ,  $B^+ \rightarrow \pi^- \mu^+ \mu^+$ , and set upper limits on the branching fractions at a few times  $10^{-8}$ . Study of the di-electron modes has been performed only in  $e^+e^-$  B factories, and in these modes we improve on previous limits by two orders of magnitude.

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## Leptonic and semileptonic B decays with tau at BaBar

**Authors:** (A. Soffer) babar collaboration<sup>1</sup>; Guglielmo De Nardo<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> Napoli University and INFN (IT)

**Corresponding Author:** denardo@na.infn.it

Within the standard model, the decay  $B^+ \rightarrow \tau^+ \nu$  has the largest branching fraction of any leptonic B decay, yet its reconstruction is made complicated by the multiple final-state neutrinos. The study of this decay is made possible by the ability to reconstruct the other B in the event, unique to the  $e^+e^-$  environment of the B factories. We present the result of an improved analysis using the full BABAR dataset, where the other B is tagged with a large number of hadronic decays. We observe evidence for  $B^+ \rightarrow \tau^+ \nu$  at more than 3 standard deviations, and discuss the implied constraints on models of new physics.

The exclusive semileptonic transitions  $b \rightarrow c \tau \bar{\nu}$  are sensitive to physics beyond the standard model. For example, in type-II two-Higgs-doublet models, the  $B \rightarrow D(\tau) \tau \bar{\nu}$  branching fractions are functions of the ratio between  $\tan(\beta)$  and the charged Higgs mass. Using the full BABAR data set, we present measurements of the branching fractions of these decays, normalized relative to those of the decays  $B \rightarrow D(\tau) l \bar{\nu}$ , where  $l$  is an electron or a muon. The measurements are performed using a reconstructed  $D(\tau)$  and an electron, muon, or tau recoiling against a fully-reconstructed B meson, taking advantage of the clean B-factory environment and high luminosity. The branching-fraction ratios are extracted from a simultaneous two-dimensional fit to the measured lepton spectrum and the reconstructed missing mass squared. The experimentally challenging background contributions from decays involving  $D^*$  states are estimated using a control sample. We report the first observation of the semileptonic  $B \rightarrow D \tau \bar{\nu}$  decay and discuss implications of our results for scenarios of physics beyond the standard model.

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## Charmonium-like states at BaBar

**Authors:** (A. Soffer) BABAR Collaboration<sup>1</sup>; Valentina Santoro<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> INFN Ferrara (IT)

**Corresponding Author:** santoro@fe.infn.it

In the past few years, several new charmonium-like states have been observed above the open-charm threshold, with properties that disfavor their interpretation as conventional charmonium states. It

is not clear whether all these states are unique. Specifically, it has been suggested that the  $X(3915)$ , observed in  $\gamma\gamma \rightarrow J/\psi \omega$ , and the  $Y(3940)$ , observed in  $B \rightarrow J/\psi \omega K$ , may be one and the same as the  $\chi_{c2}(2P)$ , which was discovered in  $\gamma\gamma \rightarrow D \bar{D}$ . We use the full BABAR dataset to study the process  $\gamma\gamma \rightarrow J/\psi \omega$ . We measure the mass and width of the  $X(3915)$  and conduct the first assessment of its spin to determine whether it is the  $\chi_{c2}(2P)$  or a new state. We also search for the  $X(3872)$ , which should be produced in  $\gamma\gamma$  events if it has spin and parity  $2^+$ , while the alternative  $J^P = 1^+$  assignment would preclude  $X(3872)$  production via this mechanism.

Di-pion transitions are well known for vector charmonium states. However, they have not been studied for non-vector states, where they may shed light on the nature of some of the new charmonium-like resonances, which are not well understood and whose properties often disfavor interpretation as conventional charmonium. In particular, it has been suggested that the decay  $X(3872) \rightarrow \eta_c(1S) \pi^+ \pi^-$  will favor identification of the  $X(3872)$  as the  $\eta_c$ . In addition, measurement of di-pion transition rates for well-understood charmonium states serves to test charmonium-model predictions. Using two-photon-fusion events, we perform the first search for the decays of the  $\chi_{c2}(1S)$ ,  $\eta_c(2S)$ ,  $X(3872)$ ,  $X(3915)$ , and  $\chi_{c2}(2P)$  into the final state  $\eta_c(1S) \pi^+ \pi^-$ , and report limits on the branching fractions for these decays or on the products of the branching fractions and 2-photon widths.

In recent years, several new Charmonium-like states have been discovered, which cannot be fully explained by a simple charmonium model. The  $Y(4260)$  was discovered by BABAR via its decay into  $J/\psi \pi \pi$ . Its production in initial-state-radiation events determines its quantum numbers to be  $J^{PC}=1^-$ , so the fact that it has not been observed decaying into  $D \bar{D}$  is in contradiction to the charmonium-model expectation. Other interpretations are also not in good agreement with the data. We use the full BABAR dataset to improve determination of the parameters of the  $Y(4260)$  and to study the  $\pi^+\pi^-$  system, which we find to be predominantly in an S-wave state, with a  $f_0(980)$  component. We do not confirm the report from Belle of a broad structure around 4.01 GeV.

A number of new charmonium-like states have been discovered recently, with properties that disfavor their identification as charmonium states. An understanding of the nature of these states requires precision measurements of their properties. Several of the new states are produced in initial-state-radiation events, indicating the quantum numbers  $J^{PC}=1^-$ . Of these, the  $Y(4660)$  has been observed only in the Belle experiment, and still requires independent confirmation. We report a new study of the final state  $\psi(2S) \pi^+ \pi^-$  in initial-state-radiation events using the entire BABAR dataset. We measure the masses and widths of the  $Y(4360)$  and  $Y(4660)$ , and study the di-pion mass spectrum distributions.

Recent discoveries of new charmonium-like states have prompted development of various models to explain them. None of the models, including the standard charmonium interpretation, account well for all the properties of these states. A clear prediction of the 4-quark interpretation is the existence of charged charmonium-like states. Such states are the  $Z_1(4050)^+$  and  $Z_2(4250)^+$ , which is been reported by Belle to be produced in  $B \rightarrow ZK$  and to decay into  $\chi_{c1} \pi^+$ . We search for these states in the decays  $B^0 \rightarrow \chi_{c1} \pi^- K^+$  and  $B^- \rightarrow \chi_{c1} \pi^- K_s$ . We show that adequate treatment of the background requires addressing the angular distribution of the  $K\pi$  system, which produces features in the  $\chi_{c1} \pi^+$  invariant-mass distribution if not properly handled. Once this is done, we see no evidence for the  $Z_1(4050)^+$  and  $Z_2(4250)^+$  states, and set upper limits on the branching fractions of the decays  $B \rightarrow ZK$ . We also report the total branching fractions of the decays  $B^0 \rightarrow \chi_{c1} \pi^- K^+$  and  $B^- \rightarrow \chi_{c1} \pi^- K_s$ .

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## **$b \rightarrow s \gamma$ and $b \rightarrow s l^+ l^-$ at BaBar**

**Authors:** (A. Soffer) BABAR Collaboration<sup>1</sup>; Gerald Eigen<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> University of Bergen (NO)

**Corresponding Author:** gerald.eigen@cern.ch



The inclusive decay  $b \rightarrow s \gamma$ , which in the standard model proceeds via the electroweak penguin process, is sensitive to contributions from physics beyond the standard model. Extensive theoretical literature discusses the contributions of new physics to the decay rate and CP asymmetry. While predictions for the exclusive decays such as  $B \rightarrow K^* \gamma$  suffer from large hadronic uncertainties associated with form factors of the final-state hadrons, the inclusive decays are theoretically better understood, with partonic rates calculated to a precision of a few percent. We present new results of the inclusive decay  $b \rightarrow s \gamma$  using both a fully inclusive technique and the sum of 38 exclusive modes. In both techniques we take advantage of the clean  $e^+e^-$  environment. We report the branching fraction, CP asymmetry, and photon energy spectrum for these decays.

In the standard model, the flavor-changing-neutral-current decays  $b \rightarrow d l^+ l^-$  are suppressed by the electromagnetic coupling relative to the decay  $b \rightarrow d \gamma$  and Cabibbo suppressed with respect to the decays  $b \rightarrow s l^+ l^-$ . Being very rare and proceeding via an electroweak penguin or box diagram, these decays are sensitive probes of new physics, which may significantly increase the branching fraction. Using the full BABAR data set, we study the decays  $B^+ \rightarrow \pi^+ l^+ l^-$ ,  $B^0 \rightarrow \pi^0 l^+ l^-$ , and  $B^0 \rightarrow \eta l^+ l^-$ , where  $l = e$  or  $\mu$ . We present updated branching-fraction upper limits for the individual pion modes and for the combined  $B \rightarrow \pi l^+ l^-$  decay. We also present the first upper limit on the branching fraction of the decay  $B^0 \rightarrow \eta l^+ l^-$ .

We study the rare decays  $B \rightarrow K(e^+e^-)$  and  $B \rightarrow K(\mu^+\mu^-)$  in a sample of 471 million BB events collected with the BABAR detector. We report measurements of the partial branching fractions, isospin asymmetry,  $K^*$  polarization, and lepton forward-backward asymmetry in seven bins of dilepton mass squared. We also present the CP and lepton-flavor asymmetries for dilepton mass below and above the  $J/\psi$  resonance. Our results are compared with the standard-model predictions and those of other experiments.

The inclusive, flavor-changing-neutral-current decay  $b \rightarrow s l^+ l^-$  provides a probe of new physics and stringent tests of the standard model, as it is theoretically better understood than individual exclusive decays. We present new measurements of the inclusive decay  $B \rightarrow X_s l^+ l^-$ , where  $X_s$  is a hadronic system consisting of one charged or neutral  $K$  and 0-3 pions with at most one  $\pi^0$ , and  $l$  is an electron or muon. The measurement is based on the full BABAR Upsilon(4S) data set. We report the total branching fraction, partial branching fractions and CP asymmetries in five regions of dilepton mass using a sum-of-exclusive-modes technique.

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## Charmless semileptonic B decays at BaBar

**Authors:** Abner Soffer<sup>1</sup>; Florian Urs Bernlochner<sup>2</sup>

<sup>1</sup> Tel Aviv University (IL)

<sup>2</sup> University of Victoria (CA)

**Corresponding Author:** florian.bernlochner@cern.ch

The  $q^2$  dependence of exclusive semileptonic form factors may be used to test standard-model theoretical calculations, and the total branching fractions provide a measure of the CKM matrix element  $V_{ub}$ . We report on measurements of the differential branching fractions of the exclusive semileptonic decays  $B \rightarrow \pi l \text{ nubar}$ ,  $B \rightarrow \eta l \text{ nubar}$ ,  $B \rightarrow \eta' l \text{ nubar}$ , and  $B \rightarrow \omega l \text{ nubar}$  as a function of  $q^2$ . We report the branching fractions for these decays and determine  $|V_{ub}|$  using theoretical predictions from sum-rule and unquenched-lattice QCD calculations.

We report a comprehensive study of the partial branching fractions for inclusive  $b \rightarrow u l \text{ nubar}$  transitions using decays recoiling against a fully reconstructed B meson performed with the full BABAR data sample. The partial branching fractions are measured in seven overlapping regions of phase space using different kinematic cuts to suppress the much more abundant  $b \rightarrow c l \text{ nubar}$  decays. Values of the CKM element  $|V_{ub}|$  are determined using four independent calculations of the partial decay rates. The most precise result is obtained from a two-dimensional fit to the  $m_X$  vs.  $q^2$  distributions, with no kinematic restriction other than requiring the lepton momentum to be greater

than 1 GeV. Furthermore, we report a new limit on weak annihilation, studied using the isospin conjugated decays of the neutral and charged B mesons.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 349**

## Tau decays at BaBar

**Authors:** (A. Soffer) BABAR Collaboration<sup>1</sup>; Soeren Andre Prell<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> Iowa State University (US)

**Corresponding Author:** prell@iastate.edu

We present a set of new results in tau-lepton physics using the full BABAR data set. This includes a new limit on the branching fraction of the isospin-forbidden, second-class-current decay  $\tau \rightarrow \pi \eta' (958) \nu_\tau$ ; a first study of high-multiplicity tau decays with charged kaons; and measurements of the branching fractions of 3- and 5-prong tau decays.

Using the full BABAR dataset, we measure the branching fractions of the decays  $\tau \rightarrow h (n\pi^0)$  and  $h K_s K_s (\pi^0)$ , where  $h$  indicates a charged kaon or pion and  $n$  may be up to 3. We also report the invariant-mass distributions of the decays  $\tau \rightarrow \pi \pi \pi \nu$ ,  $\tau \rightarrow K \pi \pi \nu$ ,  $\tau \rightarrow K K \pi \nu$ , and  $\tau \rightarrow K K K \nu$ , where events with  $K_s \rightarrow \pi^+ \pi^-$  decays are excluded. We use these measurements to update the value of the magnitude of the CKM matrix element  $V_{us}$ .

Within the standard model, tau-lepton decays conserve CP, so searches for CP violation in this system are sensitive to new physics. We report the results of a search for CP violation in the decay  $\tau^- \rightarrow \pi^- K_s \nu$  using the full BABAR data set. In this mode a decay-rate asymmetry of  $(0.36 \pm 0.01)\%$  is expected within the standard model due to CP violation in the neutral kaon system. After accounting for effects due to the different interaction cross sections of  $K^0$  and anti- $K^0$  mesons with the detector material, we find a decay-rate asymmetry of  $(-0.36 \pm 0.23 \pm 0.11)\%$ , approximately 2.8 standard deviations from the standard model expectation.

**Room 219 - BSM - Non-SUSY - TR3 / 352**

## Search for dark-sector Higgs and gauge bosons at BABAR

**Authors:** (A. Soffer) BABAR Collaboration<sup>1</sup>; Adrian Bevan<sup>2</sup>

<sup>1</sup> SLAC

<sup>2</sup> Queen Mary University of London (UK)

**Corresponding Author:** a.j.bevan@qmul.ac.uk

Recent astrophysical observations have motivated interest in models with a new, dark sector containing GeV-scale gauge and Higgs bosons. In such models, dark-sector photons typically mix with the standard-model photon, enabling their detection in  $e^+e^-$  collisions at BABAR, with very little background in many of the channels. We present searches for a dark-sector photon and a dark-sector Higgs boson and set stringent limits on the parameters of the model. One way to present our results is that if the dark-sector  $U(1)$  coupling is similar to the standard-model electromagnetic coupling, our limits on the mixing between the standard model and the dark sector are tighter than previous limits by up to two orders of magnitude, depending on the masses of the dark Higgs and dark boson.

**Plenary3 - The Standard Model -TR1 / 353****Search for light Higgs bosons in radiative Upsilon(1S) decays at BABAR****Authors:** (A. Soffer) BABAR Collaboration<sup>1</sup>; Yury Kolomensky<sup>2</sup><sup>1</sup> SLAC<sup>2</sup> UC Berkeley & LBNL (US)**Corresponding Author:** yury@physics.berkeley.edu

We search for a light CP-odd Higgs boson ( $A_0$ ) that arises in non-minimal supersymmetric extensions of the Standard Model and naturally couples strongly to bottom quarks. The search is conducted using radiative di-muon and di-tau decays of the Upsilon(1S) meson. We use BABAR's large data sets of  $(92.8 \pm 0.8)$  million Upsilon(2S) and  $(116.8 \pm 1.0)$  million Upsilon(3S) decays to identify Upsilon(1S) production via the decay  $\text{Upsilon}(2S,3S) \rightarrow \pi^+\pi^-\text{Upsilon}(1S)$ . This yields a high-purity sample with a Higgs-search sensitivity similar to that of radiative Upsilon(2S) and Upsilon(3S) decays. We set stringent limits on the product of branching ratios  $\text{Br}(\text{Upsilon}(1S) \rightarrow \gamma A_0) \times \text{Br}(A_0 \rightarrow l^+l^-)$  where  $l = \mu$  or  $\tau$ , as well as on the effective coupling of the b-quark to the  $A_0$ . Depending on the parameters of the model, the Higgs may decay predominantly into hadrons. We also present results of a search for a CP-odd Higgs boson produced in radiative Upsilon(2S) or Upsilon(3S) decays and decaying into hadrons. Our results severely restrict the available parameter space for models predicting light Higgs states.

**Plenary 3 - The Standard Model - TR1 / 355****Combination of CDF's Higgs boson Searches with up to 10 fb-1 of data****Author:** Azeddine Kasmi<sup>1</sup><sup>1</sup> Baylor University (US)**Corresponding Author:** kasmi@fnal.gov

A combination of the results of searches for the standard model Higgs boson is presented. The searches use up to 10 fb-1 of Tevatron collider Run II data. We present upper bounds at the 95% CL on the production rate of a SM-like Higgs boson in the mass range 90-200 GeV. We further present measurements of the cross section times branching ratio for Higgs bosons decaying to  $b\bar{b}$ , tau pairs, W pairs, and photon pairs. We evaluate the significance of observed excesses over the standard model background predictions.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 356****The Dark Energy Survey: status and science prospects****Author:** Marcelle Soares-Santos<sup>1</sup><sup>1</sup> Fermi National Accelerator Laboratory (US)**Corresponding Author:** marcelle@fnal.gov

The Dark Energy Survey Collaboration will soon begin a 5000 sq. deg. imaging survey of the southern galactic cap using a new 3 sq. deg., 520 Megapixel CCD camera, the Dark Energy Camera

(DECam), with 5 filters (g,r,i,z and Y) mounted on the Blanco 4-meter telescope at the Cerro-Tololo Inter-American Observatory. Construction of DECam is complete, and installation and commissioning on the telescope are taking place in spring and summer 2012, with the expectation that the survey will begin in fall 2012. The survey data will be used to place new and tight constraints on the nature of dark energy via the history of the cosmic expansion rate and the growth of large-scale structure, using the four complementary techniques recommended by the Dark Energy Task Force: weak gravitational lensing, galaxy cluster counts, large-scale structure including baryon acoustic oscillations, and Type Ia supernovae. The science projections and prospects will be described, together with the status of the DECam installation and commissioning.

**TR 8 - Neutrinos RM 219 / 357**

## Double Chooz: new results on the $\theta_{13}$ mixing angle

**Author:** Pau Novella Garijo<sup>1</sup>

<sup>1</sup> CIEMAT (ES)

**Corresponding Author:** pau.novella@ciemat.es

The Double Chooz experiment presented in November 2011 a first indication of reactor electron antineutrino disappearance consistent with neutrino oscillations. The observed deficit in the neutrino rate, along with the distortion of the neutrino energy spectrum, is interpreted as a consequence of the oscillation driven by the mixing angle  $\theta_{13}$ . In 2012, a second analysis has been performed by the Double Chooz collaboration after 250 days of data taking confirming the oscillation effect and providing a more accurate best-fit value for the  $\theta_{13}$  angle. A detailed description of the Double Chooz latest results will be given in the talk.

**Poster Session - Board: 48 / 358**

## Optimization of neutrino fluxes for future long baseline neutrino oscillation experiment

**Author:** Silvestro Di Luise<sup>1</sup>

**Co-author:** Andrea Longhin<sup>2</sup>

<sup>1</sup> Eidgenössische Tech. Hochschule Zuerich (CH)

<sup>2</sup> Università degli Studi di Padova

**Corresponding Author:** silvestro.di.luise@cern.ch

We present an optimization of the neutrino beam which could be produced at CERN and aimed to the newly proposed deep-underground neutrino observatory LAGUNA-LBNO located at distance of about 2300 km (Phyasalmi mine, Finland). Specific scenarios for the proton driver and the far detectors have been investigated. In particular, the flux predictions have been obtained by means of a full GEANT4 simulation of the primary proton beam interaction in the target, the secondary hadrons focusing system (e.g. horn-reflector layout) and the decay pipe. A dedicated algorithm has been then developed to search for the optimal configuration of the beam line by scanning the multidimensional space of the design parameters. The aim is to maximize the LAGUNA-LBNO physics performance in terms of the discovery potential for both the CP violation phase  $\delta_{CP}$  and the mass hierarchy. For different CERN SPS proton beam energies sensitivity limits will be presented as a function of the beam exposure and the far detector fiducial mass.

## TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 359

**NLO corrections to squark-squark production and decay at the LHC****Authors:** Davide Pagani<sup>1</sup>; Hollik Wolfgang<sup>2</sup>; Jonas Lindert<sup>None</sup><sup>1</sup> *Max-Planck-Institut für Physik (DE)*<sup>2</sup> *MPI Munchen***Corresponding Author:** pagani@mppmu.mpg.de

We present the analysis of the signature  $jj+\text{missing-ET}(+X)$  via squark-squark production and direct decay into the lightest neutralino in next-to-leading order QCD within the framework of the minimal supersymmetric Standard Model. We provide a consistent, fully differential calculation of NLO QCD factorizable corrections to the given processes with on-shell squarks. Clustering final states into partonic jets, we investigate the experimental inclusive signature  $jj+\text{missing-ET}$  and we choose for illustration several benchmark scenarios. We compare resulting differential distributions with leading-order approximation rescaled by a flat K-factor and examine a possible impact for cut-and-count searches for supersymmetry at the LHC.

## Room 216 - Particle Astrophysics and Cosmology -TR11 / 360

**STUDY OF THE  $2\text{H}(\alpha,\gamma)6\text{Li}$  REACTION PRODUCING  $6\text{Li}$  IN STANDARD BIG BANG NUCLEOSYNTHESIS****Author:** Carlo Gustavino<sup>1</sup><sup>1</sup> *INFN (IT)*

LUNA (Laboratory for Underground Nuclear Astrophysics) is devoted to measure nuclear cross sections relevant in astroparticle physics. The LUNA measurements are performed at the “Laboratori Nazionali del Gran Sasso” (LNGS), with the unique accelerator in the world operating underground. Here, the background induced by cosmic rays is orders of magnitude lower than outside. As a consequence, with the LUNA facility it is possible to make direct measurements at energies well below the coulomb barrier, thus giving a solid experimental footing on several field of astrophysics and particle physics, such as the solar neutrino flux, the stellar evolution and the primordial abundance of isotopes after BBN. The presentation is centered on the measurement of the  $2\text{H}(\alpha,\gamma)6\text{Li}$  reaction, that is the leading process to produce the primordial  $6\text{Li}$ . Recent observations of a high abundance of  $6\text{Li}$  in metal-poor stars (Asplund et al. 2006) are debated. However, because of the very low cross section, direct measurements exists only for energies greater than 700 keV, making the  $6\text{Li}$  abundance calculation affected by a large uncertainty.

For the first time, a direct measurement has been performed at energies around  $E_{\text{cm}}=100$  keV, i.e. well inside the BBN region of interest ( $40 \text{ keV} < E_{\text{cm}} < 300 \text{ keV}$ ). The innovative experimental technique and the preliminary results will be shown.

## Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 361

**Recent results and future plans form the NA61/SHINE experiment****Author:** Silvestro Di Luise<sup>1</sup><sup>1</sup> *Eidgenössische Tech. Hochschule Zürich (CH)*

**Corresponding Author:** silvestro.di.luise@cern.ch

The NA61/SHINE (SPS Heavy Ion and Neutrino Experiment) is a fixed-target experiment to study hadron production in hadron-nucleus and nucleus-nucleus collisions at the CERN SPS.

The experimental apparatus is a large acceptance Magnetic Spectrometer complemented with Time-Of-Flight detectors and a Projectile Spectator Detector. Its excellent capability for particle identification and momentum determination, even in complex events, makes the NA61/SHINE experiment well suited for pursuing a reach physics program which consists of three main topics:

- i) hadron-nucleus interactions: hadron production measurements for neutrino (T2K) and cosmic-ray (Pierre Auger Observatory) experiments
- ii) nucleus-nucleus interactions: hadron production measurements to search for the critical point of strongly interacting matter and to study the properties of the onset of the deconfinement
- iii) proton-proton and proton-nucleus interactions: measurement of inclusive and correlated yields of high pT hadrons to study their in-medium modifications

i) Second generation long baseline neutrino oscillation experiments, like T2K, do require a very good knowledge of neutrino fluxes which means a more precise measurements of the production cross sections of pions and kaons.

NA61/SHINE thanks to the large acceptance and particle identification in the forward region covers most of the phase space region of interest for T2K.

So far  $\pi^+$  and  $K^+$  differential cross section in p+C interaction at 31 GeV/c have been measured and published. Such measurements contributed significantly to the T2K measurement of electron neutrino appearance ( $\nu_\mu \rightarrow \nu_e$ ) which led to the first indication of a non zero mixing angle  $\theta_{13}$  and to the measurement of muon neutrino disappearance ( $\nu_\mu \rightarrow \nu_\mu$ ).

Preliminary results on  $K^0_S$  production have been released as well. Precise knowledge of the neutral kaons cross section is in fact required for the accurate calculation of the  $\nu_e$  and  $\nu_\mu$  fluxes from  $K^0_L \rightarrow \pi^\pm e \nu_e$  decays.

Measured charged pions and kaons data provide also important input to improve hadron production models prediction needed for the study of air shower initiated by ultra-high-energy cosmic particles.

ii) and iii) NA61/SHINE aims to extend the NA49 ion program exploring a wider region of the phase diagram of strongly interacting matter within the range of thermodynamical variables (e.g. temperature and baryon chemical potential).

Profiting from the successful increase in the data taking rate after the detector upgrade, NA61/SHINE is performing a scan the QCD phase diagram by varying both the energy (beam momentum 13A-158A GeV/c) and the

size of the colliding nuclear system (p+p, p+Pb, Be+Be, Ar+Ca, Xe+La).

The main goal is to find signatures of the critical point and to study the onset of the QGP formation by measuring the dynamical fluctuations, the azimuthal anisotropy and the identified hadron spectra and yields.

Moreover, high statistics data will make possible the measurement of high pT hadron spectra.

Successful data taking for p+p (13 to 158 GeV/c) and of Be+Be (40A, 75A and 150A GeV/c) interactions have been completed.

From the analysis of p+p data

at 20A, 31A, 40A, 80A and 158A GeV/c preliminary results are available on the energy dependence of the inclusive pion production, the transverse momentum fluctuations and the azimuthal angle fluctuations.

All the achieved results and the analysis techniques will be described in detail with particular emphasis on the impact on the related physics measurements.

Future data taking plans and the foreseen program of measurements will be presented as well.

## Signatures of Dark Matter Annihilation in the Cosmic Microwave Background

**Author:** Tracy Slatyer<sup>1</sup>

<sup>1</sup> *Institute for Advanced Study (US)*

**Corresponding Author:** tslatyer@ias.edu

The annihilation or decay of dark matter (DM), or other new physics, could inject high-energy electrons and photons into the universe during the cosmic dark ages. The resulting modification to the cosmic ionization history induces a characteristic perturbation to the anisotropies of the cosmic microwave background (CMB) radiation. I will show how to describe an arbitrary energy injection history in terms of a few parameters that efficiently characterize the possible effects on the CMB, and how to apply the resulting constraints to assorted DM models.

### Financial Support Justification for Early-Stage Researchers:

I am a postdoc at the Institute for Advanced Study in Princeton; I received my PhD in May 2010. Traveling to ICHEP from the East Coast of the US appears likely to cost ~2000; *combined with the conference registration fee of 750*, this exceeds the remainder of my travel budget for the year. I expect to be able to cover the bulk of the travel costs from my own institution's funding (although of course any support would be much appreciated), but a waiver or reduction of the registration fee would be very helpful in allowing me to attend ICHEP. (Equivalently, if travel support is available but registration support is not, up to \$1000 of travel support would help cover the shortfall between my financial support and the travel+registration costs.)

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 363**

## New measurements of forward physics in the TOTEM experiment at the LHC

**Author:** Hubert Niewiadomski<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** hubert.niewiadomski@cern.ch

The TOTEM experiment recently measured the elastic proton rates  $dN/dt$  down to  $-t=0.02 \text{ GeV}^2$  at the LHC energy of  $\sqrt{s} = 7 \text{ TeV}$ . In addition, the accompanying inelastic rates were recorded with the forward telescopes for  $5.3 < |\eta| < 6.4$ . The optical theorem allowed for first luminosity independent total cross-section measurement at  $\sqrt{s} = 7 \text{ TeV}$  energy. Moreover, the total pp cross-section was obtained in two additional ways, as a quantity dependent on the CMS luminosity. It was calculated with optical theorem solely from the differential elastic cross-section as well as expressed as a direct sum of the elastic and inelastic contributions.

Finally, the estimates of total cross-section obtained from data with small and large bunch populations were compared. The different methods agree very well within their errors. Attempts are made to identify the individual components of the inelastic cross-section.

Moreover, TOTEM measured the very forward charged particle distributions  $dN/d\eta$  for  $5.3 < |\eta| < 6.4$ , which significantly extend the measurements of the other LHC experiments. The obtained results disagree with the key Monte Carlo generators.

**TR 8 - Neutrinos RM 219 / 364**

## LAGUNA-LBNO: a very long baseline neutrino oscillation experiment

**Author:** Silvestro Di Luise<sup>1</sup>

<sup>1</sup> *ETH-Zurich Institute for Particle Physics (CH)*

**Corresponding Author:** silvestro.di.luise@cern.ch

LAGUNA (Large Apparatus for Grand Unification and Neutrino Astrophysics)-LBNO(Long-Baseline Neutrino Oscillation)\* is the proposal for a long baseline neutrino oscillation experiment with a new conventional neutrino beam aimed at a next generation deep-underground neutrino observatory composed of a double phase liquid Argon detector and a magnetized iron calorimeter located at the Pyhsalami mine, 2300 km from CERN.

The design of experimental apparatus is mainly driven by the successful phase of of R&D and prototyping on small scale setups:

i) higher signal efficiency along with high background rejection are attainable with the double phase LAr LEM TPC tracking-calorimeter technology thanks to the three-dimensional mm-scale spatial resolution and the excellent energy resolution capabilities.

ii) the detector will be complemented with a magnetized calorimeter for the muon detection in order to improve the reconstruction of events occurring in the LAr target.

The Phyasalmi mine, the deepest in Europe (4000 m.w.e.), represents a unique experimental location to observe new rare phenomena, both accelerator and non-accelerator based.

An unprecedented rich physics program can be pursued.

i) neutrino oscillations can be studied in detail fully exploiting, for the first time, the energy spectrum information of the oscillation probability (L/E method) in appearance and disappearance mode at long baseline.

An exposure of  $2.25 \times 10^{20}$  protons on target (p.o.t.) from the CERN SPS at 400 GeV would allow for a definitive determination ( $> 5$  sigma C.L.) of the neutrino mass hierarchy for any value of the CP violation phase  $\delta_{CP}$ . The CP violation can be instead discovered at 3 sigma, through the L/E method, with a coverage of the 70% of the  $\delta_{CP}$  parameter space, providing  $1.5 \times 10^{21}$  p.o.t., which is achievable possibly in 10 years of exposure.

ii) Grand Unified Theories (GUT) can be investigated with searches for several nucleon decay signatures and with unprecedented sensitivities thanks to the very large detector mass and the extremely clean cosmological background.

iii) atmospheric neutrinos, as well as unknown astrophysical neutrinos (e.g. from D.M. annihilation) can be studied for the first time over a wide range of energies and final states

iv) the explosion of a galactic Supernova (SN) will be detected with large statistics, in neutrino and antineutrino modes and in all flavors allowing to constrain both the astrophysics of the SN and the neutrino flavor oscillations.

Main achievements of the R&D phase will be illustrated along with the future plan.

The status of the LAGUNA-LBNO project proposal will be discussed along with the possible realization schedules.

It will be highlighted the physics reach of a CERN-Pyhasalmi long baseline conventional beam coupled to one or more

experiment(s), based on an incremental approach, initially starting from the existing CERN SPS performance and far detector(s) with mass ranges in the 20 kton-scale, and gradually increasing the far detector masses and/or the SPS beam power.

- European Commission Framework Programme 7 Design Study LAGUNA (Project Number 212343).

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 365**

## Status of the SuperB project



**Author:** Guy Wormser<sup>1</sup>

<sup>1</sup> *LAL Orsay (FR)*

**Corresponding Authors:** dosselli@padova.infn.it, wormser@lal.in2p3.fr

The SuperB experiment is a next generation Super Flavour Factory expected to accumulate  $75\text{ab}^{-1}$  of data at the  $Y(4S)$  in five years of nominal running. This facility will be constructed at the Cabibbo Lab in the Rome Tor Vergata Campus and will be operational later this decade. In addition to running at the  $Y(4S)$ , SuperB will be able to accumulate data at the  $\psi(3770)$  and above and below the  $Y(4S)$ . A polarized electron beam enables unique physics opportunities at SuperB. The main physics goal of SuperB is to unravel the detailed structure physics BSM likely to be discovered soon at the LHC, or to indirectly extend this search well beyond the TeV scale.

**Plenary3 - The Standard Model -TR1 / 367**

## **Precision electroweak measurements at SuperB with polarised beams**

**Author:** Michael Roney<sup>1</sup>

<sup>1</sup> *University of Victoria (CA)*

**Corresponding Author:** roney@slac.stanford.edu

SuperB has a programme of precision electroweak measurements made possible using data at the  $Y(4S)$  by virtue of beam polarisation. These measurements include  $\sin^2 \theta_W$  obtained via left-right asymmetry measurements of  $e^+e^-$  transitions to pairs of fermions. The precision obtainable at SuperB is expected to match that of the LEP/SLC world average at the center of mass energy of  $10.58\text{GeV}$ . Once the Higgs mass is known the SuperB precision electroweak programme will become a search for physics BSM

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 368**

## **The role of SuperB in unraveling the nature of physics beyond the SM**

**Author:** David Hitlin<sup>1</sup>

<sup>1</sup> *California Institute of Technology*

**Corresponding Author:** hitlin@hep.caltech.edu

Energy frontier searches are continuing to search for signs that set a scale for physics BSM. SuperB is able to measure a broad spectrum of observables that can be used to constrain parameters in the theory of any physics BSM found in the coming years at the LHC. In the event that no discoveries are made, one can use the same observables to constrain both parameter and model space. Deviations from SM expectations, or observation of forbidden processes at SuperB could point the way to new physics at scales beyond the reach of the LHC.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 369**

## **B physics at SuperB**

**Author:** Claudia Cecchi<sup>1</sup>

<sup>1</sup> *Universita e INFN (IT)*

**Corresponding Author:** claudia.cecchi@cern.ch

SuperB will collect  $75\text{ab}^{-1}$  of data at the  $Y(4S)$ . Using this data, the experiment will be able to study rare B decays such as  $B \rightarrow l \nu$  and  $K^{(*)}\nu$  nubar as well as perform precision measurements of the angles of the unitarity triangle and improving measurements of  $|V_{ub}|$  and  $|V_{cb}|$ . A few  $\text{ab}^{-1}$  run at the  $Y(5S)$  will allow this experiment to search for rare decays of the  $B_s$  meson as well as measuring  $a_{SL}$ .

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 372**

## **J/Psi and Upsilon production in proton-nucleus collisions: lessons from RHIC for the 2012 proton-lead LHC run**

**Authors:** Andry Rakotozafindrabe<sup>1</sup>; Elena Ferreiro<sup>2</sup>; Frederic Fleuret<sup>3</sup>; Jean-Philippe Lansberg<sup>4</sup>

<sup>1</sup> *SPhN, CEA, Saclay, France*

<sup>2</sup> *Universidad Santiago de Compostela, Spain*

<sup>3</sup> *Ecole Polytechnique, France*

<sup>4</sup> *Institut de Physique Nucléaire d'Orsay / IN2P3-CNRS (FR)*

**Corresponding Authors:** lansberg@ipno.in2p3.fr, lansberg@in2p3.fr, jean-philippe.lansberg@cpht.polytechnique.fr, lansberg@cpht.polytechnique.fr, elena@fpaxp1.usc.es

We will discuss the nuclear-matter effects on J/Psi and Upsilon production at RHIC and the LHC in proton-nucleus and, by extension, in nucleus-nucleus collisions. In the Upsilon case, we will argue that (i) the Upsilon break-up probability can be neglected in a first approximation, (ii) the gluon shadowing and antishadowing are not strong enough to describe forward RHIC data, (iii) the backward data hints at a gluon EMC effect, possibly stronger than the quark one, (iv) fractional energy loss provides a very convincing explanation for the Upsilon suppression seen by PHENIX in the forward region. Following these discussions, predictions for the LHC pPb run will be presented. In the J/Psi case, we will show that the fractional energy loss needed to explain the forward Upsilon suppression provides an alternative explanation to a strong gluon saturation for the strong forward J/Psi suppression at RHIC. We will discuss how this also affects J/Psi production in pA collisions at LHC energies. We will present results for J/Psi production in dAu at RHIC as function of rapidity, centrality and transverse momentum as well as for pA and AA collisions at the LHC. We will also pay special attention to two potential experimental issues in the interpretation of the LHC data, namely the absence of pp measurements at the same energy as for pPb and the difference in the transverse-momentum region accessed by the different detectors, i.e. ALICE vs. CMS and ATLAS.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 373**

## **Implications of a SM like Higgs for a natural NMSSM with low cutoff**

**Authors:** Anibal Medina<sup>1</sup>; Benedict Harling<sup>1</sup>; Michael Schmidt<sup>2</sup>; Tony Gherghetta<sup>3</sup>

<sup>1</sup> *The University of Melbourne*

<sup>2</sup> *University of Melbourne (AU)*

<sup>3</sup> *University of Melbourne*

We will present a study of the NMSSM with a low cutoff in the light of the recent experimental hints for a (close to) SM like Higgs at 125 GeV. The introduction of a singlet with a large value of  $\lambda$  reduces the fine tuning in comparison to the MSSM and provides a solution to the  $\mu$ -problem. We determine the natural region in parameter space with a fine tuning better than 10% which satisfies electroweak constraints and study its implications for phenomenology.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 374**

## Status of the Gadolinium project for Super-Kamiokande

**Author:** Yano Takatomi<sup>1</sup>

<sup>1</sup> *Okayama University (JP)*

**Corresponding Author:** tyano@phys.sci.kobe-u.ac.jp

EGADS (Evaluating Gadolinium's Action on Detector Systems) is a test facility for a new neutrino detection method using a gadolinium-loaded water Cherenkov detector. In this method, events due to anti-neutrino charged-current interactions on protons (i.e., inverse beta decay) are identified by the coincident detection of a prompt positron signal and a delayed gamma-ray signal from neutron capture on gadolinium [Gd] sulfate which is dissolved in the water. By introducing this method to a large water Cherenkov detector such as Super-Kamiokande we expect to achieve the first detection of the supernova relic neutrinos.

EGADS consists of a cylindrical stainless steel tank holding 200 tons of dissolved Gd solution (0.2% by mass), two hundred forty 20-inch PMTs, and special water circulation systems for pre-treatment, filtration, and gadolinium recovery. It is designed to evaluate the impact of dissolving Gd sulfate on water transparency and detector materials. In 2011 and 2012, we tested the performance of water circulation system with a 15 ton buffer tank. In the second half of 2012 we will install PMTs in the 200 ton tank and start detector commissioning with our DAQ. The current status of EGADS will be presented.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 375**

## The LHCf experiment to verify UHECR interactions at LHC

**Author:** Yoshitaka Ito<sup>1</sup>

**Co-authors:** Alessia Tricomi<sup>2</sup>; Anne-Laure Perrot<sup>3</sup>; Gaku Mitsuka<sup>1</sup>; Hiroaki Menjo<sup>1</sup>; Katsuaki Kasahara<sup>4</sup>; Koji Noda<sup>2</sup>; Lel D'Alessandro<sup>2</sup>; Lorenzo Bonechi<sup>5</sup>; Massimo Bongi<sup>6</sup>; Oscar Adriani<sup>7</sup>; Shoji Torii<sup>4</sup>; Takashi Sako<sup>1</sup>; Yasushi Muraki<sup>8</sup>

<sup>1</sup> *Nagoya University (JP)*

<sup>2</sup> *Universita e INFN (IT)*

<sup>3</sup> *CERN*

<sup>4</sup> *Waseda University (JP)*

<sup>5</sup> *Istituto Nazionale di Fisica Nucleare (INFN)*

<sup>6</sup> *Universita & INFN, Firenze*

<sup>7</sup> *Dipartimento di Fisica*

<sup>8</sup> *Konan University*

**Corresponding Author:** itow@stelab.nagoya-u.ac.jp

The LHCf experiment has performed dedicated measurement of neutral particles in the very forward of LHC p-p collisions. The results in inclusive single photon spectra at 7TeV and 900GeV p-p collisions, and the  $\pi^0$  transverse spectra at 7TeV p-p are presented with comparison of various hadron

interaction models used for UHECR shower simulations. Also prospects in the 2012 p-Pb runs at LHC and possible future A-A runs are discussed.

**Summary:**

The single photon spectra at 7TeV and 900GeV p-p collisions are compared with various cosmic ray interaction models such as QGSJET-II, DPMJET3, SYBILL, EPOS and PYTHIA in the very forward. The results show most of models predict too hard spectra. Similarly  $\pi^0$  PT spectra in the very forward region are compared and we found EPOS shows pretty good agreement. These results will be soon feed-back to UHECR experiments to refine their MC.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 376**

## Search for Squarks in R-parity Violating Supersymmetry in ep Collisions at HERA

**Author:** Gerhard Immanuel Brandt<sup>1</sup>

<sup>1</sup> *University of Oxford (UK)*

**Corresponding Author:** gerhard.immanuel.brandt@cern.ch

A search for squarks in R-parity violating supersymmetry is performed in  $e^+p$  collisions at HERA using the H1 detector. The full data sample taken at a centre-of-mass energy  $\sqrt{s} = 319$  GeV is used for the analysis, corresponding to an integrated luminosity of  $255 \text{ pb}^{-1}$  of  $e^+p$  and  $183 \text{ pb}^{-1}$  of  $e^-p$  collision data. The resonant production of squarks via a Yukawa coupling  $\lambda$  is considered, taking into account direct and indirect R-parity violating decay modes. Final states with jets and leptons are investigated. No evidence for squark production is found and mass dependent limits on  $\lambda$  are obtained in the framework of the Minimal Supersymmetric Standard Model and in the Minimal Supergravity Model. In the considered part of the parameter space, for a Yukawa coupling of electromagnetic strength  $\lambda = 0.3$ , squarks of all flavours are excluded up to masses of 275 GeV at 95% confidence level, with down-type squarks further excluded up to masses of 290 GeV.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 377**

## Search for Lepton Flavour Violation at HERA

**Author:** David South<sup>1</sup>

<sup>1</sup> *DESY (DE)*

**Corresponding Author:** david.south@cern.ch

A search for second and third generation scalar and vector leptoquarks produced in ep collisions via the lepton flavour violating processes  $ep \rightarrow \mu X$  and  $ep \rightarrow \tau X$  is performed by the H1 experiment at HERA. The full data sample taken at a centre-of-mass energy  $\sqrt{s} = 319$  GeV is used for the analysis, corresponding to an integrated luminosity of  $245 \text{ pb}^{-1}$  of  $e^+p$  and  $166 \text{ pb}^{-1}$  of  $e^-p$  collision data. No evidence for the production of such leptoquarks is observed in the H1 data. Leptoquarks produced in  $e^+p$  collisions with a coupling strength of  $\lambda = 0.3$  and decaying with the same coupling strength to a muon-quark pair or a tau-quark pair are excluded at 95% confidence level up to leptoquark masses of 712 GeV and 479 GeV, respectively.

Room 219 - BSM - Non-SUSY - TR3 - Board: 18 / 378

## Search for Contact Interactions in $e^+p$ Collisions at HERA

**Author:** Eram Syed Rizvi<sup>1</sup>

<sup>1</sup> *Queen Mary, University of London*

**Corresponding Author:** e.rizvi@qmul.ac.uk

A search for physics beyond the Standard Model in neutral current deep inelastic scattering at high negative four-momentum transfer squared  $Q^2$  is performed in  $ep$  collisions at HERA. The differential cross section  $d\sigma/dQ^2$ , measured using the full H1 data sample corresponding to an integrated luminosity of 446 pb<sup>-1</sup>, is compared to the Standard Model prediction. No significant deviation is observed. Limits on various models predicting new phenomena at high  $Q^2$  are derived. For general four-fermion  $eeqq$  contact interaction models, lower limits on the compositeness scale  $\Lambda$  are set in the range 3.6 TeV to 7.2 TeV. Leptoquarks with masses  $M_{LQ}$  and couplings  $\lambda$  are constrained to  $M_{LQ}/\lambda > 0.41-1.86$  TeV and limits on squarks in R-parity violating supersymmetric models are derived. A lower limit on the gravitational scale in  $(4+n)$  dimensions of  $M_S > 0.9$  TeV is established for low-scale quantum gravity effects in models with large extra dimensions. For the light quark radius an upper bound of  $R_q < 0.65 \times 10^{-18}$  m is determined.

Room 219 - BSM - Non-SUSY - TR3 / 379

## Search for First Generation Leptoquarks in $ep$ Collisions at HERA

**Author:** Jenny List<sup>1</sup>

<sup>1</sup> *Deutsches Elektronen-Synchrotron (DE)*

**Corresponding Authors:** david.south@cern.ch, jenny.list@cern.ch

A search for first generation scalar and vector leptoquarks produced in  $ep$  collisions is performed by the H1 experiment at HERA. The full H1 data sample is used in the analysis, corresponding to an integrated luminosity of 446 pb<sup>-1</sup>. No evidence for the production of leptoquarks is observed in final states with a large transverse momentum electron or with large missing transverse momentum, and constraints on leptoquark models are derived. For leptoquark couplings of electromagnetic strength  $\lambda = 0.3$ , first generation leptoquarks with masses up to 800 GeV are excluded at 95% confidence level.

TR 12 - Formal Theory Development & TR 1 - The Standard Model / 380

## Calculating repetitively

**Author:** Gopinath Kamath<sup>1</sup>

<sup>1</sup> *Indian Institute of Technology-Madras (IN)*

**Corresponding Author:** kamath@iitm.ac.in

The Antonsen –Bormann idea was originally proposed by these authors for the computation of the heat kernel in curved space; it was also used by the author recently with the same objective but for the Lagrangian density for a real massive scalar field in  $2 + 1$  dimensional stationary curved

space, the metric being defined by the rotating solution of Deser et al. Ann.Phys.120,220(1984) and Clement, Int.J.Theor.Phys.24,267(1985) of the Einstein field equations associated with a single massless spinning particle located at the origin. It is now reworked here with a different purpose –namely, to determine the zeta function for the said model using the Schwinger operator expansion. The repetitive nature of this calculation at all higher orders ( $\geq 3$ ) in the gravitational constant  $G$  suggests the use of the Dirac delta-function and one of its integral representations –in that it is convenient to obtain answers. The vierbeins presented by the author at FFP10 –arXiv: 1003.0260 [hep-th] –and published in Kamath, AIP Conf.Proc.1246: 174-177, 2010 play a pivotal role in this exercise, with the pair displayed in eq.(12) therein being distinguished for the simplicity of the calculation reported here.

## TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 381

### One-loop effects on MSSM parameter determination via chargino production at the LC

**Authors:** Aoife Bharucha<sup>1</sup>; Georg Weiglein<sup>2</sup>; Gudrid Moortgat-Pick<sup>3</sup>; Jan Kalinowski<sup>4</sup>; Krzysztof Rolbiecki<sup>2</sup>

<sup>1</sup> *University of Hamburg (DE)*

<sup>2</sup> *DESY*

<sup>3</sup> *Hamburg University/DESY*

<sup>4</sup> *University of Warsaw*

**Corresponding Author:** aoife.bharucha@cpt.univ-mrs.fr

Very precise measurements of masses and cross sections are expected to be achievable with a future linear collider. With such an accuracy one is even sensitive to quantum correction, which therefore must be incorporated in order to make meaningful predictions for the underlying new physics parameters. For the chargino–neutralino sector, this involves fitting one-loop predictions to expected measurements of the cross section and forward-backward asymmetry for chargino pair production and of the accessible chargino and neutralino masses. We consider three scenarios, each with characteristic features, chosen taking recent LHC SUSY and Higgs searches into account. Our analysis allows the accurate determination of the desired parameters and, additionally, access to the mass of the lighter stop that enters via loop corrections.

## Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 382

### Suppression of high-pt heavy-flavour particles in Pb-Pb collisions at the LHC, measured with the ALICE detector

**Author:** Andrea Dainese<sup>1</sup>

<sup>1</sup> *INFN Padova (IT)*

**Corresponding Author:** andrea.dainese@pd.infn.it

The ALICE experiment studies nucleus-nucleus collisions at the LHC in order to investigate the properties of QCD matter at extreme energy densities. The measurement of open charm and open beauty production allows to probe the mechanisms of heavy-quark propagation, energy loss and hadronization in the hot and dense medium formed in high-energy nucleus-nucleus collisions. In particular, in-medium energy loss is predicted to be different for massless partons (light quarks and gluons) and heavy quarks at moderate momentum. The ALICE apparatus allows us to measure open heavy-flavour particles in several decay channels and with a wide phase-space coverage.

We present the results on the nuclear modification factors for heavy flavour particle production in Pb-Pb collisions at  $\sqrt{s_{NN}} = 2.76$  TeV.

Using proton-proton and lead-lead collision samples at  $\sqrt{s} = 2.76$  and 7 TeV and at  $\sqrt{s_{NN}} = 2.76$  TeV, respectively, nuclear modification factors  $R_{AA}(p_t)$  were measured for D mesons at central rapidity (via displaced decay vertex reconstruction), and for electrons and muons from heavy flavour decays, at central and forward rapidity, respectively.

The large suppression observed in the high  $p_t$  region, by a factor 2.5-4 in central Pb-Pb collisions with respect to the pp reference, indicates a strong in-medium energy loss of heavy quarks.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 383**

## The DEPFET pixel vertex detector for the Belle II experiment at SuperKEKB

**Author:** Stefan; on behalf of the DEPFET collaboration Rummel<sup>1</sup>

<sup>1</sup> *LMU Munich (DE)*

**Corresponding Author:** stefan.rummel@lmu.de

The luminosity upgrade of the KEKB accelerator towards SuperKEKB opens up new possibilities for physics at the intensity frontier. SuperKEKB will provide an instantaneous luminosity of  $8 \times 10^{35}$  1/cm<sup>2</sup>/s which allows to increase the integrated luminosity of 1ab<sup>-1</sup> achieved at the BELLE detector towards 50 ab<sup>-1</sup> at BELLE II.

The increased luminosity poses challenges to all subsystems like DAQ, trigger and sub detectors. Especially the innermost detector will be faced with a significant background due to two-photon pair production, synchrotron radiation, and intra-beam scattering.

For precise vertex reconstruction, this requires using pixel detector technologies capable to deal with these issues while maintaining physics performance adequate for a precision detector.

The DEPFET technology offers a unique set of advantages as low power dissipation in the active area, large device size, radiation tolerance and a thinning procedure which allows tailoring the thickness of the device over a wide range. Using this technology the impact parameter resolution of the combined silicon detector of Belle II can be improved significantly compared to the previous experiment even in the challenging high luminosity environment.

The DEPFET pixel detector (PXD) will offer a granularity of 8MPix and a frame time of 20 $\mu$ s, this requires a sophisticated scheme to handle the data flow. I will give an overview how the data is processed from the zero suppression on the module till the online pattern recognition to reject background.

As the first physics runs of SuperKEKB are foreseen for 2015 the PXD project currently moves from the R&D- into the construction phase. This means that many engineering tasks are close to finalization. I will present an overview of the electro-mechanical integration of the DEPFET PXD into the BELLE II experiment, as well as the cooling scheme and the power distribution.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 384**

## Particle production in Pb-Pb collisions with the ALICE experiment at LHC

**Author:** Francesca Bellini<sup>1</sup>

<sup>1</sup> *Universita e INFN & University of Bologna (IT)*

**Corresponding Author:** francesca.bellini@cern.ch

The ALICE experiment can benefit from its excellent particle identification capabilities to study hadron production in Pb-Pb collisions at  $\sqrt{s_{NN}} = 2.76$  TeV, over a wide range of momenta. This allows one to probe different stages of the medium evolution. Transverse momentum spectra of identified particle and resonances characterize the bulk freeze-out properties and the dynamical evolution of the system. Results from hydrodynamics-motivated blast-wave model fits to the data are shown, while production yields and ratios are discussed from a thermodynamical point of view. Since the colliding nuclei have no net strangeness content, the study of strange and multi-strange particle production is an important probe of the early partonic stages of the collision. The enhancement of strangeness production in relativistic heavy-ion collisions relative to proton-induced reactions was one of the predicted signatures of the formation of the deconfined medium known as Quark-Gluon Plasma. ALICE results are presented. Moreover, high-pT particle production can be used to investigate the energy loss of the fast partons produced in early hard scatterings, while traversing the medium. To this purpose, measurements of the nuclear modification factor ( $R_{AA}$ ) of identified particles have been performed and are discussed. Pb-Pb results are finally compared to measurements at lower energies and predictions for the LHC.

TR 8 - Neutrinos RM 219 / 385

## The Hyper-Kamiokande Experiment

**Author:** Hiroyuki Sekiya<sup>1</sup>

<sup>1</sup> *Kamioka Observatory ICRR University of Tokyo*

**Corresponding Author:** sekiya@icrr.u-tokyo.ac.jp

We propose the Hyper-Kamiokande (Hyper-K) detector as a next generation underground water Cherenkov detector. It will serve as a far detector of a long baseline neutrino oscillation experiment envisioned for the upgraded J-PARC, and as a detector capable of observing – far beyond the sensitivity of the Super-Kamiokande (Super-K) detector – proton decays, atmospheric neutrinos, and neutrinos from astronomical origins. The baseline design of Hyper-K is based on the highly successful Super-K, taking full advantage of a well-proven technology.

Hyper-K consists of two cylindrical tanks lying side-by-side, the outer dimensions of each tank being 48 m (W) x 54 m (H) x 250 m (L). The total (fiducial) mass of the detector is 0.99 (0.56) million metric tons, which is about 20 (25) times larger than that of Super-K. A proposed location for Hyper-K is about 8 km south of Super-K (and 295 km away from J-PARC) at an underground depth of 1,750 meters water equivalent (m.w.e.). The inner detector region of the Hyper-K detector is viewed by 99,000 20-inch PMTs, corresponding to the PMT density of 20% photo-cathode coverage (one half of that of Super-K).

Hyper-K presents the potential for determination of the CP phase  $\delta$  in the 3-flavor framework and therefore has discovery reach for CP violation in the lepton sector. With a total exposure of 5 years (one year being equal to  $10^7$  sec) to a 2.5 degree off-axis neutrino beam produced by the 1.66 MW J-PARC proton synchrotron, it is expected that the CP phase  $\delta$  can be determined to better than 18 degrees for all possible  $\delta$  values and CP violation can be established with a statistical significance of  $3\sigma$  for 70% of the  $\delta$  parameter space assuming the recent measured  $\theta_{13}$  by T2K, Daya Bay, and RENO, and a known mass hierarchy. The mass hierarchy itself can be determined with more than  $3\sigma$  statistical significance for 46% of the  $\delta$  parameter space. Furthermore, Hyper-K's high statistics data sample of atmospheric neutrinos will allow us to extract additional information on the mass hierarchy and the octant of  $\theta_{23}$ . With a full 10 year duration of data taking, the significance for the mass hierarchy determination is expected to reach  $3\sigma$  or greater if  $\sin^2\theta_{23} > 0.4$ .

Hyper-K will extend the sensitivity to nucleon decays beyond what can be achieved by Super-K by an order of magnitude or more. The sensitivities to the partial lifetime of protons for the decay modes  $p \rightarrow e^+ \pi^0$  and  $p \rightarrow \nu K^+$  are expected to exceed  $1 \times 10^{35}$  years and  $2 \times 10^{34}$  years, respectively. This is the only known, realistic detector option capable of reaching such a sensitivity for the  $p \rightarrow e^+ \pi^0$  mode.



The scope of studies at Hyper-K also covers high precision measurements of solar neutrinos, observation of both supernova burst neutrinos and supernova relic neutrinos, and dark matter searches.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 386**

## Recent results from HERMES

**Author:** Delia Hasch<sup>1</sup>

<sup>1</sup> *INFN-Frascati (IT)*

**Corresponding Author:** delia.hasch@lnf.infn.it

The main focus of the HERMES experiment at DESY was the detailed investigation of the spin structure of the nucleon, mainly its decomposition into contributions from quarks and gluon spins and their orbital angular momenta. Many exciting, unexpected results have been obtained by measuring semi-inclusive and exclusive processes in deep-inelastic scattering.

Over recent years, pioneering measurements of observables carrying information about the three-dimensional nucleon structure were performed. We will present an overview about recent results from HERMES, relate them with our current understanding of the spin and three-dimensional structure of the nucleon, and discuss their relevance for other physics fields.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 388**

## Recent results of the ANTARES neutrino telescope

**Author:** Juan de Dios Zornoza<sup>1</sup>

<sup>1</sup> *IFIC (ES)*

**Corresponding Author:** zornoza@ific.uv.es

The ANTARES collaboration completed in 2008 the construction of the largest neutrino telescope in the Northern hemisphere. Neutrinos, being neutral, stable and weakly-interacting have unique advantages with respect to other more traditional probes to study the high energy Universe. The scientific scope of ANTARES is very broad, including the observation of astrophysical neutrino sources, the indirect detection of dark matter and more exotic searches like monopoles or nuclearites. The data gathered in the last years has provided a rich output. In this talk I will overview the most relevant results: the skymap of the Southern neutrino sky, with the best flux limits up to date for most of that region; the limits for dark matter searches in the Sun, which are interpreted in the frameworks of MSSM and mUED; an extensive multi-messenger program, which includes search for correlations with GRBs, micro-quasars, UHE cosmic rays of Auger and gravitational waves; searches for monopoles and nuclearites, and the observation of neutrino oscillations (the first time this is measured with a neutrino telescope).

### Summary:

The ANTARES detector, completed in 2008, is the largest neutrino telescope in the Northern hemisphere. Neutrinos are unique probes to study the high energy Universe. Contrary to photons or cosmic rays, they can travel long distances without being absorbed. Moreover, they pinpoint back to their sources since they are neutral. Being located in the Northern hemisphere, ANTARES enjoys a great visibility of the Galactic Center and most of the Galactic plane. For some of the hottest topics in astroparticles, like the origin of cosmic rays or the mechanisms underlying in some gamma ray sources, neutrinos could provide key information. For the search of dark matter, neutrino telescopes also have unique potential. In particular, a potential signal of high energy neutrinos from the Sun would have a natural interpretation as dark matter, contrary to other indirect searches like those with gamma rays or cosmic rays,

where astrophysical interpretations are usually possible. The multi-messenger studies have also a great weight in our scientific program. Results on the search for correlations with GRBs, micro-quasars, Auger UHE CRs or gravitational waves have been made. Other results related to particle physics include the best limits up to date for nuclearites and monopoles. Finally, ANTARES has also measured neutrino oscillations for the first time with a neutrino telescope.

TR 8 - Neutrinos RM 219 / 389

## Latest results from the NEMO-3 experiment and status of SuperNEMO

**Author:** Karol Lang<sup>1</sup>

<sup>1</sup> *University of Texas at Austin (US)*

**Corresponding Author:** lang@physics.utexas.edu

The NEMO-3 experiment, designed to search for neutrinoless double beta decay, was carried out from 2003 to 2011 in the Modane Underground Laboratory in the Frejus Tunnel. The detector employed thin isotopic foils surrounded by a drift chamber and scintillator blocks to reconstruct topology, energy, and timing features of nuclear decays. This multi-observable technique offers a powerful means not only to identify double beta decays but also to reject background events mostly due to natural radioactivity. NEMO-3 employed seven different isotopes to construct foils, with most notable mass of Mo-100 of 6.9kg and Se-82 of 0.93kg. Data from the entire running period are currently being analyzed but NEMO-3 has already achieved the best-to-date results on half-lives of all seven isotopes and has reported lower limits on neutrinoless double beta half-lives which can be translated to the most stringent upper limit on the effective neutrino mass.

The next generation experiment, SuperNEMO, will employ the technique pioneered by NEMO-3 but will ultimately house about 100kg of an isotopic source distributed in 20 detector modules. SuperNEMO's goal is to reach half-life sensitivity of about  $10^{26}$  years and thus about 50meV for an upper limit for the effective neutrino mass. The collaboration has conducted an extensive R&D program to improve detector performance and lower backgrounds in the new detector and the construction of the first "demonstrator" module has commenced. The module will be commissioned in 2014 and remaining modules will be built later in the decade. The baseline choice for an isotope is Se-82 but this technique has flexibility to use any other source. The collaboration also considers Ca-48 and Nd-150 if sufficient amounts of these isotopes can be enriched, currently viewed as an extremely challenging task of its own.

### Summary:

NEMO-3 has already achieved the best-to-date results on neutrinoless double beta decay half-lives of seven isotopes and produces the most competitive constraints on the neutrino mass. Future analysis of all collected data will further improve these results.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 390

## The Standard Model confronts CP violation in $D^0 \rightarrow \pi^+ \pi^-$ and $D^0 \rightarrow K^+ K^-$

**Authors:** Enrico Franco<sup>1</sup>; Luca Silvestrini<sup>1</sup>; Satoshi Mishima<sup>2</sup>

<sup>1</sup> *INFN Rome*

<sup>2</sup> *INFN Rome (IT)*

**Corresponding Author:** satoshi.mishima@roma1.infn.it

The recently measured direct CP asymmetries in the processes  $D^0 \rightarrow \pi^+ \pi^-$  and  $D^0 \rightarrow K^+ K^-$  show a significant deviation from the naive Standard Model expectation. Using a general parameterization of the decay amplitudes, we show that the measured branching ratios imply large SU(3) breaking and large violations of the naive  $1/N_c$  counting. Furthermore, rescattering constrains the  $I=0$  amplitudes in the  $\pi\pi$  and  $KK$  channels. Combining all this information, we show that, with present errors, the observed asymmetries are marginally compatible with the Standard Model. Improving the experimental accuracy could lead to an indirect signal of new physics.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 391**

## New results on the 3-loop Heavy Flavor Wilson Coefficients in Deep-Inelastic Scattering

**Authors:** Abilio De Freitas<sup>1</sup>; Alexander Hasselhuhn<sup>2</sup>; Carsten Schneider<sup>3</sup>; Fabian Wissbrock<sup>4</sup>; Jakob Ablinger<sup>3</sup>; Johannes Bluemlein<sup>5</sup>; Sebastian Klein<sup>6</sup>

<sup>1</sup> DESY Zeuthen (DE)

<sup>2</sup> DESY Zeuthen

<sup>3</sup> Johannes Kepler University - RISC

<sup>4</sup> DESY - Zeuthen

<sup>5</sup> DESY

<sup>6</sup> DESY, Zeuthen

**Corresponding Author:** abilio.de.freitas@desy.de

We report on recent results obtained for the 3-loop heavy flavor Wilson coefficients in deep-inelastic scattering at general values of the Mellin variable  $N$  at large scales of  $Q^2$ . These concern contributions to the gluonic ladder-topologies, the transition matrix elements in the variable flavor scheme, and first results on higher topologies. The knowledge of the heavy flavor Wilson coefficients in 3-loop order is of importance to carry out complete NNLO QCD analyses of the world precision data on the structure function  $F_2(x, Q^2)$ .

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 392**

## SUSY fits: Implications of LHC data on Constrained SUSY Models

**Author:** Albert De Roeck<sup>1</sup>

<sup>1</sup> CERN (CH)

**Corresponding Author:** albert.de.roeck@cern.ch

We present the latest results of the MasterCode collaboration on global SUSY fits.

Currently available experimental data are used to determine the preferred SUSY and Higgs boson mass scales. The data comprise a combination of high-energy SUSY searches, low-energy precision measurements and astrophysical data. We include all relevant LHC searches for SUSY, electroweak precision observables such as the  $W$  boson mass and the anomalous magnetic moment of the muon,  $B$  physics observables such as  $BR(b \rightarrow s \gamma)$ , as well as the cold dark matter density in the Universe.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 393****|Vub| determination in Lattice QCD**

**Authors:** Alberto Ramos<sup>1</sup>; Antoine Gerardin<sup>2</sup>; Benoit Blossier<sup>3</sup>; Fabio Bernardoni<sup>4</sup>; Felix Bahr<sup>5</sup>; Georg Matthias Von Hippel<sup>None</sup>; Hubert Simma<sup>3</sup>; Jochen Heitger<sup>6</sup>; John Merritt Bulava<sup>7</sup>; Michele Della Morte<sup>8</sup>; Michele Della Morte<sup>None</sup>; Nicolas Garron<sup>None</sup>; Patrick Fritzsch<sup>9</sup>; Rainer Sommer<sup>None</sup>

<sup>1</sup> CNRS

<sup>2</sup> *Laboratoire de Physique Théorique, Université Paris*

<sup>3</sup> DESY

<sup>4</sup> DESY (DE)

<sup>5</sup> DESY Zeuthen

<sup>6</sup> Munster University

<sup>7</sup> CERN

<sup>8</sup> Unknown

<sup>9</sup> H

**Corresponding Authors:** fabio.bernardoni@desy.de, benoit.blossier@desy.de, john.bulava@cern.ch, michele.della.morte@cern.ch, morte@kph.uni-mainz.de, ngarron@staffmail.ed.ac.uk, georg.von.hippel@desy.de, alberto.ramos@cpt.univ-mrs.fr, sommer@ifh.de, felix.tobias.bahr@desy.de, fritzsch@physik.hu-berlin.de, hubert.simma@desy.de, antoine.gerardin@th.u-psud.fr, heitger@uni-muenster.de

At present there is a tension at the level of 3  $\sigma$  between two exclusive determinations of  $|V_{ub}|$ . They are obtained combining the experimental branching ratios of  $B \rightarrow \tau \nu$  and  $B \rightarrow \pi l \nu$  (respectively) with a theoretical computation of the hadronic matrix elements  $f_B$  and the  $B$  to  $\pi$  form factor  $f_+(q^2)$ . To understand the tension, improved precision and a careful analysis of the systematics involved are necessary. We report the results of the ALPHA collaboration for  $f_B$  from the Lattice with  $N_f=2$  O(a) improved Wilson fermions. We employ HQET, including  $1/m_b$  corrections, with pion masses ranging down to  $\sim 250$  MeV. Renormalization and matching were performed non-perturbatively, and three lattice spacings reaching  $a^{-1} \sim 4.1$  GeV are used in the continuum extrapolation.

We also present progress towards a computation of  $f_+(q^2)$ , to directly compare two independent exclusive determinations of  $|V_{ub}|$  with each other and with inclusive determinations. Additionally, we report on preliminary results for  $f_B$ s, which is needed to determine  $|V_{td}|$  and  $|V_{ts}|$ .

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 394****The ILD detector concept for the ILC**

**Author:** Tomohiko Tanabe<sup>1</sup>

**Co-authors:** Georgios Voutsinas<sup>2</sup>; Marc Winter<sup>2</sup>

<sup>1</sup> ICEPP University of Tokyo (JP)

<sup>2</sup> IPHC Strasbourg

**Corresponding Author:** tomohiko@icepp.s.u-tokyo.ac.jp

The ILD detector concept is a proposal for a detector at an electron –positron linear collider, in particular the international linear collider, ILC. It has been conceived as an experiment optimized for precision physics in the comparatively clean environment of electron positron collisions. The particle flow concept has played a central role in the overall optimization of the concept, which is reflected in the proposal of a highly granular calorimeter with exceptional performance. ILD in

addition has put special emphasis on excellent vertexing capabilities, and a highly integrated efficient tracking system, build around a large volume advanced time projection chamber.

Over the last years the ILD concept has been developed to a point where not only a concept of the detector has been developed, but where through a series of prototyping experiments and detailed simulation a solid understanding of the overall system has been established. Realistic technologies are proposed for each sub-detector, and are validated through test experiments and simulation. A detailed model of the integrated detector has been developed and has been used to study and understand the behavior of the complete system. A series of benchmark physics reactions have been studied in full simulation to illustrate the power of the proposed detector concept. In this talk the philosophy of the ILD detector concept, its implementation and its anticipated performance are discussed.

In this presentation the overall concept of the detector is developed. Special emphasis is given to demonstrate that the key components of the system have passed stringent performance tests and have demonstrated their performance. Results from recent work on most system, in particular the vertex detector and the time projection chamber, are presented.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 395**

## **A metric theory of gravity with torsion in extra-dimension**

**Author:** Kameshwar Wali<sup>1</sup>

**Co-author:** Karthik Shankar K<sup>2</sup>

<sup>1</sup> *Syracuse University (US)*

<sup>2</sup> *Boston University*

**Corresponding Author:** wali@physics.syr.edu

Present a theory of gravity with an extra-dimension and metric-dependent torsion. A set of constraints imposed on the geometry confine torsion components to the extra-dimension and determine all the connection coefficients in terms of the metric. At the kinematic level, the theory maps on to 4D General Relativity. keeping the extra-dimension hidden. But the dynamical field equations that follow from the action principle deviate markedly for the standard Einstein equations.

### **Summary:**

Investigations of spherically symmetric vacuum solutions and homogeneous-isotropic cosmological within the framework lead to solutions of significant physical interest. In the first case, positive mass solutions with naked singularity that match Schwarzschild solutions at large distances without an event horizon. In the cosmological context, an oscillatory scenario of the universe emerges in contrast to the inevitable big bang of the standard cosmology

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 396**

## **NLO Assistance to LHC Searches with Complex Final States using BlackHat and Sherpa**

**Author:** Lance Dixon<sup>1</sup>

<sup>1</sup> *SLAC National Accelerator Laboratory (US)*

**Corresponding Author:** lance@slac.stanford.edu

The prediction of backgrounds to new physics signals in topologies with large missing transverse energy and jets is important to new physics searches at the LHC. The BlackHat collaboration has investigated theoretical issues in extrapolating backgrounds from experimental control regions to signal regions. For example, we compute, ratios of gamma + n-jet to Z + n-jet production rates and kinematic distributions in NLO QCD, and compare with a parton shower matched to leading-order matrix elements. These predictions validate uncertainty estimates used by CMS for the irreducible Z + n-jet component of MET+jets searches. We also describe the phenomenon of left-handed W polarization at large transverse momentum, its theoretical prediction and recent measurement by CMS and ATLAS, and its potential role in background separation.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 397**

## Scattering in Planar N=4 Super-Yang-Mills Theory and the Multi-Regge Limit

**Author:** Lance Dixon<sup>1</sup>

<sup>1</sup> *SLAC National Accelerator Laboratory (US)*

**Corresponding Author:** lance@slac.stanford.edu

Scattering amplitudes in N=4 Super-Yang-Mills theory are tightly constrained by several general principles: Dual (super)conformal invariance, an operator product expansion for the leading singularity, discrete symmetries, the properties of transcendental functions, and various kinematic limits. Remarkably, these constraints can be combined to almost completely determine the six-gluon scattering amplitude at three loops, as well as provide important information beyond three loops, without ever directly evaluating any loop integrands or loop integrals. The general constraints work in synergy with those arising in a specific limit — multi-Regge-kinematics for high-energy scattering — and shed new light on this limit.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 398**

## Latest Results on Searches for Dark Matter from IceCube

**Author:** Matthias Danninger<sup>1</sup>

**Co-author:** Collaboration The IceCube<sup>2</sup>

<sup>1</sup> *Stockholm University (SE)*

<sup>2</sup> *see author list*

**Corresponding Author:** danning@fysik.su.se

Construction of the IceCube neutrino observatory was completed in early 2011, including a low-energy in-fill extension. This DeepCore sub-detector offers exciting opportunities for neutrino physics in the energy range of 10 GeV to 1 TeV. IceCube searches indirectly for dark matter via neutrinos from dark matter self-annihilations and has a high discovery potential through striking signatures. We report on the latest results from searches for dark matter self-annihilations in the Milky Way and nearby Galaxy clusters, as well as the search for signals from the Sun and Earth. Furthermore, a formalism for quickly and directly comparing event-level IceCube data with arbitrary annihilation spectra in detailed model scans, considering not only total event counts, but also event directions and energy estimators is presented. We show an application of this formalism to both model exclusion and parameter estimation in models of supersymmetry.

**Financial Support Justification for Early-Stage Researchers:**

I am a Ph.D student at Stockholm University and was invited by the co-convenor personally to present this talk. The flight costs from Europe are already very hard on the budget of a Ph.D student. It would be great help to get financial support by having not to pay the also rather high conference fees. I assume, asking for additional support towards the flight costs will not be possible? Such financial support will make the trip financially more feasible for me.

I sincerely hope that support towards me travel is possible.

Thanks a lot, Matthias

## TR 12 - Formal Theory Development & TR 1 - The Standard Model / 399

### NLO and NNLO EWC for PV Møller Scattering

**Authors:** Aleksandrs Aleksejevs<sup>1</sup>; Svetlana Barkanova<sup>2</sup>

<sup>1</sup> *Memorial University of Newfoundland*

<sup>2</sup> *Acadia University (CA)*

**Corresponding Author:** svetlana.barkanova@acadiau.ca

High-precision electroweak experiments such as parity-violating Møller scattering can provide indirect access to physics at multi-TeV scales and play an important complementary role to the LHC research program. However, before physics of interest can be extracted from experimental data, electroweak radiative corrections, which can significantly reduce the cross-section asymmetry, must be calculated with an unprecedented completeness and accuracy. Although the two-loop corrections are strongly suppressed relative to the one-loop corrections, they can no longer be dismissed. We evaluate a full gauge-invariant set of one-loop and several types of the two-loop radiative corrections for the Møller asymmetry by combining two distinct but mutually-reinforcing techniques: semiautomatic, precise, with FeynArts and FormCalc as base languages, and “by hand”, with some approximations. For 11 GeV relevant for the MOLLER experiment planned at JLab, the results obtained by two approaches are in excellent agreement, which gives us assurance that our calculations are error-free. A possible way to incorporate new physics particles into theoretical predictions for the Møller asymmetry is briefly discussed at the end.

## TR 12 - Formal Theory Development & TR 1 - The Standard Model / 400

### Electric, Magnetic and Spin-Dependent Dynamical Polarizabilities of Hadrons

**Authors:** Aleksandrs Aleksejevs<sup>1</sup>; Svetlana Barkanova<sup>2</sup>

<sup>1</sup> *Memorial University of Newfoundland (CA)*

<sup>2</sup> *Acadia University*

**Corresponding Author:** aaleksejevs@grenfell.mun.ca

Compton scattering offers a unique opportunity to study the dynamical structure of hadrons over a wide kinematic range, with polarizabilities characterizing the hadron’s active internal degrees of freedom.

We present calculations and detailed analysis of electric and magnetic and the spin-dependent dynamical polarizabilities for the lowest in mass SU(3) octet of baryons.

These extensive calculations are made possible by the recent implementation of semi-automatized calculations in chiral perturbation theory which allows evaluating polarizabilities from Compton

scattering up to next-to-the-leading order. The dependences for the range of photon energies covering the majority of the meson photoproduction channels are analyzed.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 401**

## The status of the cosmic $e^+/e^-$ anomaly

**Author:** Csaba Balazs<sup>1</sup>

<sup>1</sup> *Monash University (AU)*

**Corresponding Author:** csaba.balazs@monash.edu

The anomalous part of the cosmic electron-positron flux can be isolated within a Bayesian likelihood analysis. From the cosmic ray data the values of relevant cosmic ray propagation parameters can be also be inferred. I show how a tension arises between various cosmic ray datasets indicating an  $e^+/e^-$  anomaly. Then I show how to calculate the anomalous part of the PAMELA and Fermi-LAT measurements. I focus on the uncertainty of this 'signal'. Finally, I briefly compare this signal to some theoretical results predicting such an anomaly.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 402**

## Constraining CP violation in neutral meson mixing with theory input

**Author:** Sascha Turczyk<sup>1</sup>

**Co-authors:** Marat Freytsis<sup>2</sup>; Zoltan Ligeti<sup>2</sup>

<sup>1</sup> *Lawrence Berkeley National Laboratory (US)*

<sup>2</sup> *Lawrence Berkeley National Laboratory*

There has been a lot of recent interest in experimental hints of CP violation in  $B_{d,s}^0$  mixing. The  $D_0$  measurement of the semileptonic CP asymmetry would - with higher significance - be a clear signal of beyond the standard model physics. In this talk I present a relation [arXiv:1203.3545] for the mixing parameters, which allows clearer interpretation of the data in models in which new physics enters in  $M_{12}$  and/or  $\Gamma_{12}$ . This result implies that the central value of the  $D_0$  measurement in  $B_{d,s}^0$  decay is not only in conflict with the standard model, but in a stronger tension with data on  $|\Delta\Gamma_s|$  than previously appreciated. After I derive the relation between the theoretical prediction of  $|\Gamma_{12}|$  and the measurements of  $\Delta M$ ,  $\Delta\Gamma$  and  $A_{\text{SL}}$ , I will explain how this result can help to better constrain  $\Delta\Gamma$  or  $A_{\text{SL}}$ , whichever is less precisely measured.

**Financial Support Justification for Early-Stage Researchers:**

Due to the large travel, accommodation, and registration costs, I would like to ask for financial help.

**Poster Session - Board: 42 / 403**

## Evidence for a pion condensate formation in pp interactions at U-70



**Author:** Elena Kokoulina<sup>1</sup>

<sup>1</sup> *Joint Institute for Nuclear Research (RU)*

**Corresponding Author:** kokoulin@sunse.jinr.ru

Experiments at LHC give evidence of similarity of multiple production mechanisms in proton interactions at high multiplicities [1] and central collisions of relativistic heavy ions (RHIC). Studies at high multiplicity (more than mean value) region are carried out at U-70 accelerator at IHEP (Protvino). They are aimed at the search for collective phenomena.

It is known that mainly pions are produced at U-70 energies. Their mean energy decreases with multiplicity increase. In that system Bose-Einstein condensate (BEC) [2] can be formed. The theoretical and experimental studies of BEC are continuing from 70es. M. Gorenstein and V. Begun [3] have shown within the framework of an ideal pion gas model that sharp growth of the neutral pion number fluctuations will be a signal of BEC formation with the increase of total multiplicity (a sum of neutral and charged particles). They proposed to measure scaled variance,  $\omega$ . It is defined as the ratio of variance of neutral pion number distribution to mean multiplicity. In the thermodynamic limit  $\omega$  approaches to infinity. This value reached the finite quantity for the restricted system formed in the collisions of two protons.

SVD Collaboration (JINR, IHEP and SINP MSU) [4] investigated neutral pion number fluctuations in pp interactions at 50 GeV/c incident beam at U-70 versus total multiplicity and has revealed noticeable growth of  $\omega$  with the total multiplicity increase. This work was carried out in two stages. At the first stage the charged-particle multiplicity distribution was measured. At the second stage the neutral pion number distributions were restored. We could go down three orders on topological cross sections up to  $\sim 10$  nb. Events with high multiplicity are extremely rare therefore we have designed a sophisticated trigger to suppress the recording of events with the multiplicity smaller than the given value, called a trigger level. The measured topological cross sections have been corrected with taking into account trigger conditions, a detector acceptance, the detection efficiency of setup and the reconstruction algorithm. The measurements have been fulfilled with the silicon vertex detector.

#### Summary:

Comparison of the topological cross sections with models has shown that the negative binomial distribution (NBD) overestimates experimental data at high multiplicity region,  $N_{ch} > 20$ , but describes well the region of a small multiplicity. Good agreement has been received using the gluon dominance model with including the gluon sources fission.

To restore neutral pion multiplicity, the electromagnetic calorimeter (EMCal) is used. Owing to its restricted aperture and threshold energy of a gamma-quantum registration, the restoration of a  $\pi^0$ -meson number in every single event is impossible. This multiplicity is restored by means of simulation of EMCal work. For this purpose we have used Monte Carlo event generator PYTHIA5.6. For 10 mil simulated inelastic events the linear dependence between the mean multiplicity of  $\pi^0$ -mesons and the number of EMCal registered photons has been revealed. Besides, the next procedure was carried out. The simulated events were broken up into samples according to charged particle number,  $N_{ch}$ . Every sample was divided into groups of events by EMCal registered photon number,  $N_{\gamma}$ . In each group the  $\pi^0$ -meson number distribution was restored. This distribution determines the share of events with a possible number of neutral mesons. By means of these distributions the multiplicity distributions of neutral mesons,  $N_0$ , has been received from experimental data for photons.

To analyze neutral pion number fluctuations versus total multiplicity,  $N_{tot} = N_{ch} + N_0$ , the variable  $n_0 = N_0 / N_{tot}$ , (a region of change  $[0, 1]$ ) is used. These distributions were parameterized by Gauss function to restore the missing regions. The found values of scaled variance are agreed well with the magnitude of  $\omega$  defined on simulated events at  $N_{tot} < 22$ . At the same time we reveal the significant growth of  $\omega$ , reachable by more than 7 standard deviations at  $N_{tot} \sim 30$  as opposed to the tendency for the simulated events. This growth has been observed both registered photons ( $N_{tot} = N_{ch} + N_{\gamma}$ ), and restored neutral pions.

Critical point of pion condensation is determined in statistical physics by an expression [2]. The density,  $\rho$ , is equal to  $0.2 \text{ fm}^{-3}$  at interaction region size for two protons  $\sim 3 \text{ fm}$ . In this case the critical energy is resulted to  $E_{crit} = 100 \text{ MeV}$ . At 50-GeV proton beam and  $N_{tot} = 30$  the mean energy of pion,  $E_{\pi} = (E_{cms} - 2 m_N - N_{tot} m_{\pi}) / N_{\pi}$ , is equal to  $120 \text{ MeV}$ . This value is compatible with  $E_{crit}$ . Thus the experimental observable growth of scaled variance at U-70 for registered gamma-quanta and restored neutral pion multiplicity can testify to BEC formation in the pion system at high multiplicity events.

At present we are planning to study soft photon ( $E_{\gamma} < 100 \text{ MeV}$ ) yield versus neutral, charged and total multiplicities. Experiments carried out in last year's point to the excess its yield in comparison with theoretical estimations. The exhaustive explanation of this collective phenomenon is absent. In the approach developed by S. Barshay [6] the excess of soft photon yield is connected with BEC formation in

the pion system. Also we will increase statistics to move forward to a totally much higher multiplicity region.

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**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 404**

## Studies of the $\psi(2S)$ and $\psi(3770)$ at KEDR

**Author:** Korneliy Todyshev<sup>1</sup>

<sup>1</sup> *Budker Institute of Nuclear Physics (RU)*

**Corresponding Author:** todyshev@inp.nsk.su

We present a measurement of the main parameters of the  $\psi(2S)$  and  $\psi(3770)$  resonances, which has been performed with the KEDR detector at the VEPP-4M  $e^+e^-$  collider.

Fitting the energy dependence of the multihadron cross section in the vicinity of the  $\psi(2S)$  we obtained the mass value and the product of the electron partial width by the branching fraction into hadrons. These results are significantly precisely than any of the previous experiments.

We present a measurement of the mass, total width and electron partial width of the  $\psi(3770)$  meson. Interference of resonant and nonresonant  $D\bar{D}$  production essential in the near-threshold region has been taken into account. We got two possible solutions for the  $\psi(3770)$  electron partial width and the radiatively corrected nonresonant  $D\bar{D}$  cross section at the mass of  $\psi(3770)$ .

### Financial Support Justification for Early-Stage Researchers:

I would be grateful to receive any financial support due to the significant costs required for the trip to Melbourne from Novosibirsk, if it is possible, of course.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 405**

## Recent results of the atmospheric neutrino analysis in SK

**Author:** Yoshinari Hayato<sup>1</sup>

<sup>1</sup> *Kamioka observatory ICRR University of Tokyo (JP)*

**Corresponding Author:** hayato@icrr.u-tokyo.ac.jp

Super-Kamiokande started its operation in 1996. Since then, more than 3000 days of atmospheric neutrino data has been collected. In the beginning, we have obtained  $\Delta m^2_{23}$  and  $\theta_{23}$  with two flavor oscillation using the zenith angle distribution of observed leptons. Afterwards, we have extracted L/E distribution from observed quantities to deduce the oscillation parameters. Continuous efforts to understand the data samples, it is possible for us to use not only the single ring events but multiple ring events and energetic events. Also, electronics upgrade in 2008 expands the dynamic range of charge measurements and improves the detection efficiency of electrons from the muon decays. As a result, we can perform more precise analysis of neutrino oscillation parameters,

like three flavor oscillation analyses to study the value of  $\theta_{13}$ , mass hierarchy problem, CP violation, possible non-standard interactions of neutrino and so on. Especially, recent measurements of  $\theta_{13}$  from the accelerator and reactor experiments are complementary to the results from the atmospheric neutrino analysis. In this presentation, we will report the latest results from the oscillation analysis using the atmospheric neutrino samples in Super-Kamiokande.

**Poster Session - Board: 31 / 406**

## Single top production from diquark resonance at the LHC

**Author:** Satyanarayan Nandi<sup>1</sup>

**Co-authors:** Durmus Karabacak<sup>2</sup>; Santosh Rai<sup>2</sup>

<sup>1</sup> *Oklahoma State University (US)*

<sup>2</sup> *Oklahoma State University*

**Corresponding Author:** s.nandi@okstate.edu

New physics at the TeV scale is highly anticipated at the LHC. New particles with color, if within the LHC energy reach, will be copiously produced. One such particle is a diquark, having the quantum numbers of two quarks, and can be a scalar or a vector. It will decay to two light quarks, or two top quarks, or a top and a light quark, (up or down type depending on the quantum number of the produced diquark). If singly produced, it can be looked for as a dijet resonance, or as giving extra contribution to the single top production or tt production. In this talk, we consider a diquark having the quantum number of (ud) type, its resonance production, and the subsequent decay to tb, giving rise to excess contribution to the single top production. Even though the diquark mass is large, its strong resonance production dominates the weak production of tb for a wide range of the diquark mass. Also its subsequent decay to tb produces a very hard b-jet compared to the usual electroweak production. In addition, the missing energy in the final state event is much larger from the massive diquark decays. Thus, with suitable cuts, the final state with b,  $\bar{b}$  and a charged lepton together with large missing energy stands out compared to the Standard Model background. We make a detailed study of both the signal and the background. We find that such a diquark is accessible at the 7 TeV LHC up to a mass of about 3.3 TeV with the luminosity  $1 \text{ fb}^{-1}$ , while the reach goes up to about 4.3 TeV with a luminosity of  $10 \text{ fb}^{-1}$ . I will also briefly review the other aspects of diquark production, such as top pair production (tt) and the associated signal at the LHC.

### Summary:

Detailed study of top physics at the LHC, and any deviation from the Standard Model expectation can give us hint for new physics. One such possibility is the existence of a diquark state accessible at the LHC energy. Its production leads to significant deviation in the single top and tt productions which can be isolated with suitable cuts on the final state particles. In this talk, I will review the work of our group, as well as other works on the diquark effects on the top physics. Our work is contained in arXiv:1201.2917v1 [hep-ph].

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 407**

## Probing Flavor Transition Mechanisms with High Energy Astrophysical Neutrinos

**Author:** Kwang-Chang Lai<sup>1</sup>

**Co-authors:** Guey-Lin Lin<sup>2</sup>; TsungChe Liu<sup>3</sup>

<sup>1</sup> *Chang Gung University (TW)*

<sup>2</sup> *National Chiao Tung University*

<sup>3</sup> *National Taiwan University*

**Corresponding Author:** kclai1893@gmail.com

The determination of neutrino flavor transition mechanisms by neutrino telescopes is discussed. We parametrize these mechanisms in a basis which is very convenient for classifying flavor transition models. At very high energies ( $>10\text{PeV}$ ), It is investigated that the electron neutrino fraction can be extracted without identifying muon and tau neutrinos by the neutrino telescope, such as ARA. We demonstrate how this observation, the electron neutrino fraction at very high energies, can probe the flavor transition mechanism.

**Poster Session - Board: 51 / 408**

## Galactic Dark Matter in the Phantom Dark Energy Background

**Authors:** Kwei-Chou Yang<sup>1</sup>; Ming-Hsun Li<sup>2</sup>

<sup>1</sup> *Chung Yuan Christian University*

<sup>2</sup> *Chung Yuan Christian University (TW)*

**Corresponding Authors:** mxli@cycu.org.tw, kcyang@cycu.edu.tw

We study the possibility that the galactic dark matter exists in the phantom field responsible for the dark energy. The statically and spherically exact solution for this kind of the galaxy system with a supermassive black hole at its center is obtained. The solution of the metric functions is satisfied with  $g_{tt} = -g_{rr}^{-1}$ . In a galaxy, the background of the phantom field, which is spatially inhomogeneous, has an exponential potential. The absorption cross section of the low-energy  $S$ -wave excitations, arising from the phantom dark energy background, into the central black hole is shown to be the horizontal area of the central black hole. The accretion of the phantom energy is accompanied with the decrease of the black hole mass, which is estimated to be much less than a solar mass in the lifetime of the Universe. Using a simple model with the cold dark matters very weakly coupled to the excited phantom particles, we show that these two densities can be stable in the galaxy.

M.H. Li and K.C. Yang, "Galactic Dark Matter in the Phantom Field", ArXiv:1204.3178 [astro-ph.CO].

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 409**

## NNLL resummation for W-boson production at large $p_T$

**Author:** Nikolaos Kidonakis<sup>1</sup>

<sup>1</sup> *Kennesaw State University (US)*

**Corresponding Author:** nkidonak@kennesaw.edu

I present new results for W-boson production at large transverse momentum at the LHC and the Tevatron. The contribution of soft-gluon corrections is derived from NNLL resummation and added to the exact NLO result.

Numerical results for the approximate NNLO W-boson transverse momentum distributions are derived. The scale and PDF uncertainties are discussed.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 410****Detecting Dark Matter at the LHC with Electroweak Bremsstrahlung****Author:** Galea Ahmad<sup>1</sup>**Co-authors:** James Dent <sup>2</sup>; Lawrence Krauss <sup>2</sup>; Nicole Bell <sup>3</sup>; Thomas Jacques <sup>2</sup>; Thomas Weiler <sup>4</sup><sup>1</sup> *University of Melbourne (AU)*<sup>2</sup> *Arizona State University*<sup>3</sup> *University of Melbourne*<sup>4</sup> *Vanderbilt University*

We investigate electroweak bremsstrahlung as a potential search channel for dark matter at the LHC. For illustrative purposes we consider a typical quarkphilic model with a Majorana dark matter candidate. We focus on the emission of a  $Z$  boson from either the initial state particles or the internal propagator during annihilation of quarks into dark matter. Among the signatures of such processes will be a pair of high  $p_T$  muons that reconstruct to the invariant mass of the  $m_Z$ , and large amounts of missing energy. We compare this signal to Standard Model backgrounds at the generator level, as a proof of principle for this search channel. We find that in certain regions of the model parameter space, up to 50% signal to background can be achieved, for 14TeV centre of momentum energy.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 411****Light stop phenomenology****Author:** Jong Soo Kim<sup>1</sup><sup>1</sup> *University of Adelaide (AU)*

We discuss the phenomenology of light scalar tops (stops) in the minimal supersymmetric standard model (MSSM). We analyse the discovery potential of stops in the co-annihilation region at the Large Hadron Collider (LHC). The bino-like neutralino is the lightest supersymmetric particle (LSP) and the lighter stop is the next-to-LSP. Such scenarios can be consistent with electroweak baryogenesis and also with dark matter constraints. Provided, the mass difference between LSP and NLSP is small enough, we exploit the opportunity of a light and long-lived stop. We investigate the prospects to extract supersymmetric couplings from a decay length measurement at the LHC. Finally, we discuss the prospects to test relations of the superpotential. So far, no such tests have been proposed for the LHC.

**Summary:**

arxiv references:

1201.5714

1112.5324

1011.5508

0910.2124

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 412****Physics and Detectors at CLIC**

**Author:** Frank Simon<sup>1</sup>

<sup>1</sup> *Max-Planck-Institut für Physik (DE)*

**Corresponding Author:** frank.simon@cern.ch

The Compact Linear Collider CLIC with e+e- collisions up to 3 TeV in energy is designed to precisely explore New Physics at the TeV scale as well as Standard Model Physics such as the Higgs Mechanism. It will be capable of precisely measuring the masses and couplings of new particles, the mass, decay branching ratios and the self-coupling of the Higgs Boson as well as the parameters of the top quark. The detector systems at this collider have to provide highly efficient tracking and excellent jet energy resolution and hermeticity for multi-TeV final states with multiple jets and leptons as well as precise flavor tagging. In addition, the detector systems have to be capable of performing in an environment of large beam-induced backgrounds at a bunch crossing frequency of 2 GHz. Based on the ILC detector concepts, the CLIC detectors are adapted to meet this challenges with precise timing, dense calorimeter systems using Tungsten absorbers and sophisticated event reconstruction techniques based on particle flow algorithms with the inclusion of timing information. We will discuss the physics program of CLIC in view of a realistic implementation in a staged construction, and present highlights of the detectors and reconstruction algorithms developed during the recently completed conceptual design phase of CLIC.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 413**

## Exploring Supersymmetry with future e+e- Linear Colliders

**Author:** Taikan Suehara<sup>1</sup>

<sup>1</sup> *The University of Tokyo (JP)*

**Corresponding Author:** suehara.ch@kblack.icepp.s.u-tokyo.ac.jp

Proposed e+e- linear colliders with center-of-mass energy from 250 GeV to 3 TeV (International Linear Collider, ILC and Compact Linear Collider, CLIC) are ideal tools for exploring supersymmetry, in addition to precision Higgs, top, W and Z physics and more generic searches for BSM phenomena. These machines cover a wide range of possible mass spectra of sparticles from 100 GeV to 1.5 TeV, and can explore the slepton and gaugino sectors as well as colored sparticles accessible by pair production. The excellent measurement performance of linear colliders for masses, spins, couplings, etc. provides the possibility to identify the underlying mechanisms after the discovery of SUSY-like particles. In this presentation we will focus on experimental studies of various SUSY models and particles, mainly with realistic detector simulations of ILD, SiD and CLIC geometries.

**Poster Session - Board: 43 / 414**

## Structure function with higher twist contribution in the thermodynamical Bag Model

**Author:** Krishna Kumar Singh<sup>1</sup>

**Co-author:** karthiyayini Sridharan<sup>2</sup>

<sup>1</sup> *Bits Pilani Dubai Campus (AE)*

<sup>2</sup> *Bits Pilani Dubai Campus*

**Corresponding Author:** singh@bits-dubai.ac.ae

In the Thermodynamical Model the quarks and gluons are treated as Fermi and Bose gases. The nucleon structure functions calculated using this model agree well with the experimental values. Hence

we now propose to use this model to calculate the nucleon structure functions including the higher twist contributions and compare with the corresponding experimental data. This throws more light on the quark structure function of the nucleon.

**Poster Session** - Board: 44 / 415

## Longitudinal structure function using Thermodynamical Bag model

**Authors:** Krishna Kumar Singh<sup>1</sup>; karthiyayini Sridharan<sup>2</sup>

<sup>1</sup> *Bits Pilani Dubai Campus (AE)*

<sup>2</sup> *Bits Pilani Dubai Campus*

**Corresponding Author:** singh@bits-dubai.ac.ae

A thermodynamical bag model is used to calculate the nucleon structure function by treating the quarks and gluons as Fermi and Bose gases. It is found to agree well with the experimental data. In this article this model is used to calculate the longitudinal structure function which is related to the ratio of absorption cross section for longitudinally and transversely polarized virtual photons. This can then be compared with the corresponding experimental values and other models.

**Poster Session** - Board: 34 / 416

## B to Kstar and Bs to phi form factors at low recoil from lattice QCD

**Author:** Matthew Wingate<sup>1</sup>

**Co-authors:** Ronald Horgan<sup>2</sup>; Stefan Meinel<sup>3</sup>; Zhaofeng Liu<sup>4</sup>

<sup>1</sup> *University of Cambridge (UK)*

<sup>2</sup> *University of Cambridge*

<sup>3</sup> *College of William and Mary*

<sup>4</sup> *IHEP, Beijing*

**Corresponding Author:** m.wingate@damtp.cam.ac.uk

We present our calculation of B to Kstar and Bs to phi form factors (and those for B to rho and Bs to Kstar). These are obtained from lattice QCD calculations which include the effects of up, down, and strange sea quarks and use the nonrelativistic formulation for the bottom quark. Results are obtained directly in the low recoil (large q-squared) kinematic range, complementing results obtained using light-cone sum rules. The ability to determine these form factors accurately is a key ingredient in searches for and constraints on the types of BSM physics which can contribute to rare B decays.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 418**

## Precision Polarimetry for Electron Positron Linear Colliders

**Author:** Jenny List<sup>1</sup>

<sup>1</sup> DESY (DE)

**Corresponding Author:** jenny.list@cern.ch

Beam polarisation is an important ingredient of the physics program of future Electron Positron Linear Colliders. In order to fully exploit the benefits of the polarised beams, the luminosity weighted average polarisation needs to be known to 0.25% or even 0.1% at the ILC, while a few percent seem achievable at CLIC. We will present the polarimetry concept for the Beam Delivery Systems of both machines, including the design of the Compton polarimeters and recent progress in their calibration strategies, the possibilities to calibrate the absolute scale of the polarimeters against e+e- collision data and the necessary simulations of spin dynamics in the BDS and at the e+e- interaction point.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 419**

## SUSY prospects for Linear Colliders in view of LHC results

**Authors:** Howard Baer<sup>1</sup>; Jenny List<sup>2</sup>

<sup>1</sup> University of Oklahoma

<sup>2</sup> DESY (DE)

**Corresponding Author:** jenny.list@cern.ch

We re-evaluate prospects for Supersymmetry at a future Electron Positron Linear Collider in light of the first  $5 \text{ fb}^{-1}$  of data taken at LHC with  $\sqrt{s} = 7 \text{ TeV}$  proton proton collisions. Strong new limits from LHC SUSY searches, along with a hint of a Higgs boson signal around  $m_h \sim 125 \text{ GeV}$ , suggest a paradigm shift from previously popular models to ones with new and compelling signatures. We present a variety interesting Linear Collider benchmark points in scenarios including: natural SUSY, hidden SUSY, the Kallosh-Linde model, NUHM2 with low  $m_A$ , as well as the remaining phase space of mSUGRA/CMSSM. While all proposed benchmark points at present elude LHC limits - and some will at least for a long time - they are compatible with electroweak precision and flavour observables and do offer intriguing case studies for a Linear Collider operating at  $\sqrt{s} = 0.25 - 1 \text{ TeV}$ .

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 420**

## Pangogenesis: visible and dark matter from a common origin

**Author:** Kalliopi Petraki<sup>1</sup>

<sup>1</sup> University of Melbourne (AU)

**Corresponding Author:** kallia.petraki@gmail.com

The similarity of the visible and the dark matter relic abundances suggests related production mechanisms. This is possible if the dark matter density is -analogously to the visible matter- due to an asymmetry in a dark particle number which is conserved at low energies. In pangogenesis, the visible and dark asymmetries are produced jointly via Affleck-Dine dynamics, and they compensate each other under an always conserved generalised baryon number. Supersymmetry, GeV-scale dark-matter mass (favoured by current direct detection experiments) and a  $Z'$  boson with a significant invisible width into the dark sector would constitute evidence for this mechanism.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 421**



## Heavy-quarkonium theory in the LHC era

**Author:** Bernd Kniehl<sup>1</sup>

**Co-author:** Mathias Butenschoen<sup>2</sup>

<sup>1</sup> *University of Hamburg (DE)*

<sup>2</sup> *University of Hamburg*

**Corresponding Author:** kniehl@desy.de

We review the present landscape of heavy-quarkonium theory, its tests by worldwide collider and fixed-target experiments, and the future perspectives offered by the LHC. Special emphasis is placed on the effective quantum field theory of nonrelativistic QCD (NRQCD), endowed with the factorization theorem conjectured by Bodwin, Braaten, and Lepage, which arguably constitutes the most probable candidate theory at the present time. Being impressively consolidated at the next-to-leading order (NLO) by the world's data on unpolarized J/psi production, NRQCD factorization has now reached the crossroads. In fact, NLO NRQCD exhibits encouraging agreement with the first J/psi polarization measurement at the LHC, performed by ALICE at 7 TeV (cf. the cover story of the current issue of CERN Courier), while it severely disagrees, by 10-20 experimental standard deviations, with a similar measurement by CDF at Tevatron's Run II, with 1.96 TeV. In this tantalizing situation, we eagerly await final clarification by the wealth of LHC data to come.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 422**

## Prospective for A Fixed-Target Experiment at the LHC: AFTER @ LHC

**Authors:** Andry Malala Rakotozafindrabe<sup>1</sup>; Bernard Genolini<sup>2</sup>; Cynthia Hadjidakis<sup>2</sup>; Elena Gonzalez Ferreiro<sup>3</sup>; Enrico Scomparin<sup>4</sup>; Frédéric Fleuret<sup>5</sup>; Jean-Philippe Lansberg<sup>6</sup>; Jean-Pierre Didelez<sup>2</sup>; Philippe Rosier<sup>2</sup>; Roberta Arnaldi<sup>4</sup>; Stanley J. Brodsky<sup>7</sup>; Ulrik I. Uggerhøj<sup>8</sup>; Valerie Chambert<sup>2</sup>

<sup>1</sup> *CEA - Centre d'Etudes de Saclay (FR)*

<sup>2</sup> *IPN Orsay - Paris Sud U. / IN2P3-CNRS*

<sup>3</sup> *Universidad de Santiago de Compostela*

<sup>4</sup> *Universita e INFN (IT)*

<sup>5</sup> *LLR Ecole Polytechnique, IN2P3/CNRS*

<sup>6</sup> *Institut de Physique Nucléaire d'Orsay / IN2P3-CNRS (FR)*

<sup>7</sup> *SLAC*

<sup>8</sup> *University of Aarhus*

**Corresponding Authors:** lansberg@in2p3.fr, arnaldi@to.infn.it, sjbth@slac.stanford.edu, rosierph@ipno.in2p3.fr, enrico.scomparin@cern.ch, ulrik@phys.au.dk, chambert@ipno.in2p3.fr, didelez@ipno.in2p3.fr, genolini@ipno.in2p3.fr, elena@fpaxp1.usc.es, frederic.fleuret@cern.ch, cynthia.hadjidakis@cern.ch, andry.malala.rakotozafindrabe@cern.ch

We discuss the possibility of the conception of a multi-purpose fixed-target experiment with the proton or lead ion LHC beams extracted by bent a crystal. This mature extraction technique offers an ideal way to obtain a clean and very collimated high-energy beam, without altering at all the performance of the LHC [1,2,3]. It has been successfully tested at SPS (450 GeV) and at the Tevatron (900 GeV) and future tests at the LHC are planned (7 TeV).

As simple as it seems, the multi-TeV LHC beams will allow for the most energetic fixed-target experiments ever performed. Such an experiment, tentatively named AFTER for "A Fixed-Target Experiment", gives access to new domains of particle and nuclear physics complementing that of collider experiments [4], in particular that of Brookhaven's Relativistic Heavy Ion Collider (RHIC) and the projects of Electron-ion colliders (EIC). We have already evaluated that the instantaneous luminosity achievable with AFTER using typical targets would surpass that of RHIC by more than 3 orders of magnitude. This provides a quarkonium and heavy-flavour observatory [5] in pp and pA collisions where, by instrumenting the target-rapidity region, gluon and heavy-quark distributions

of the proton, the neutron and the nuclei can be accessed at large  $x$  and even at  $x$  larger than unity in the nuclear case. The fixed-target mode also has the advantage to allow for spin measurements with polarized target and for an access over the full backward rapidity domain up to  $x_F \sim -1$ . The nuclear target-species versatility provides a unique opportunity to study nuclear matter versus the features of the hot and dense matter formed in heavy-ion collisions, including the formation of the quark-gluon plasma. During the one-month lead runs, PbA collisions can be studied at a luminosity comparable to that of RHIC and the LHC over the full range of target-rapidity domain with a large variety of nuclei. Modern detection technology should allow for the study of quarkonium excited states, in particular the  $\chi(c)$  and  $\chi(b)$  resonances, even in the challenging high-multiplicity environment of pA and PbA collisions, thanks to the boost of the fixed-target mode. We will discuss a tentative design for AFTER, and report the projected detector performances from the first preliminary simulations.

### Plenary 3 - The Standard Model - TR1 / 423

## Prospects for Precision Higgs Physics at Linear Colliders

**Author:** Frank Simon<sup>1</sup>

<sup>1</sup> *Max-Planck-Institut für Physik (DE)*

**Corresponding Author:** frank.simon@cern.ch

A linear  $e^+e^-$  collider provides excellent possibilities for precision measurements of the properties of the Higgs boson. At energies close to the Z-Higgs threshold, the Higgs boson can be studied in recoil against a Z boson, to obtain not only a precision mass measurement but also direct measurements of the branching ratios for all important decay modes, including possible decay to invisible species. At higher energies, the Higgs boson coupling to top quarks and the Higgs boson self-coupling can also be measured. At energies approaching 1 TeV and above, the rising cross section for Higgs production in WW fusion allows the measurement of very small branching ratios, including the branching ratio to muon pairs. These experiments make it possible to determine the complete profile of the Higgs boson in a model-independent way. This contribution will report the prospects for these measurements, based on the results of detailed full simulation studies performed within the frameworks of the CLIC conceptual design report and the ILC technical design report.

### TR4 - Top Quark Physics / 424

## Top Precision Studies at Linear Colliders

**Author:** Marcel Vos<sup>1</sup>

<sup>1</sup> *Universidad de Valencia (ES)*

**Corresponding Author:** marcel.vos@cern.ch

The top quark is the heaviest particle of the Standard Model and, thus, the particle most strongly coupled to the physics of electroweak symmetry breaking. A future linear  $e^+e^-$  collider will be able to make precision measurements of the top quark mass and width, of the detailed QCD physics of the top quark threshold, and of the top quark production and decay asymmetries. Both measurements at the top quark threshold and measurements in continuum production at 500 GeV have been analyzed with detailed full simulation studies performed within the frameworks of the CLIC conceptual design report and the ILC technical design report. Experiments at an  $e^+e^-$  linear collider have the capability of measuring the top quark mass with unprecedented accuracy, below 100 MeV, and making a direct precision measurement of the top quark width. Further, by using all properties of the  $e^+e^-$  environment – the electroweak production mechanism, the ability for full event reconstruction, the excellent jet energy measurement, and the excellent b and c identification capabilities – they make it possible to make precision measurements of the weak and electromagnetic couplings of the top

quark, quantities that are directly sensitive to composite Higgs and extra-dimensional models of new physics.

**Poster Session** - Board: 56 / 425

## Automatic Lagrangian Generation

**Author:** Nicholas Setzer<sup>1</sup>

<sup>1</sup> *Universidad de Granada (ES)*

**Corresponding Author:** nsetzer@ugr.es

In particle physics, after specifying the symmetries of a theory, the field content and their transformations under the symmetries, the resulting procedure for obtaining physical results is well-defined and algorithmic. This talk presents a program that permits the user to simply specify the relevant content and automatically generate a Lagrangian.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 426**

## CMB Polarization Results from the QUIET Experiment

**Author:** Masaya Hasegawa<sup>1</sup>

**Co-author:** Collaboration QUIET <sup>2</sup>

<sup>1</sup> *KEK (JP)*

<sup>2</sup> *Bonn, Chicago, Caltech, Columbia, Fermilab, JPL, KEK, Stanford, Manchester, Miami, Michigan, Oslo, Oxford, Princeton*

**Corresponding Author:** masaya.hasegawa@kek.jp

QUIET is a ground-based CMB Polarization experiment, which aims to detect the degree-scale B-modes (curl components) induced by primordial gravitational waves. The existence of the primordial gravitational wave is a generic prediction of inflationary universe, therefore the detection of the B-modes is a “smoking-gun” signature of the inflation. The B-mode signal is expected to be orders of magnitude smaller than the temperature anisotropy so having a large detector array with precise control and mitigation of systematic effects is essential.

QUIET employs the world largest coherent receiver arrays in 43 GHz and 95 GHz frequency bands, and had accumulated CMB data for over 10000 hours at 5,000m altitude in Chile: the Chajnantor plateau. Our unique instruments design and the calibration strategy lead to the lowest levels of systematic errors to date. Those advantages enable us to begin to prove the B-modes.

In this talk, I will describe the QUIET experiment and the results for the CMB polarization measurements.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 429**

## Quarkonium production in the LHC era: QCD corrections and new observables

**Author:** Jean-Philippe Lansberg<sup>1</sup>

<sup>1</sup> *Institut de Physique Nucléaire d'Orsay (FR)*

**Corresponding Author:** lansberg@in2p3.fr

I will discuss the impact of QCD corrections on the  $P_T$  differential cross section for quarkonium production at RHIC [1], Tevatron and LHC energies [2], as well as the contributions from charm-gluon fusion [3]. I will discuss the promising agreement between the parameter-free predictions of the Colour-Singlet Model –up to  $\alpha_s^5$  in some cases– and the first LHC data for  $J/\psi$  and Upsilon (see e.g. [4-7]), especially in the region of low transverse momenta and thus for the  $P_T$  integrated yields. I will also show predictions for the polarisation to be compared with the (forthcoming) LHC results [8]. Additionally, I will justify the introduction of new observables meant to better discriminate between the different mechanisms at work in quarkonium production at high energies. Finally, I will touch upon the issue of the extraction of gluon PDF using quarkonium yields [9] as it was done in pioneer works in the late eighties [10,11].

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 430**

## Implications of LHC Higgs and SUSY searches for MSSM

**Author:** Nazila Mahmoudi<sup>1</sup>

**Co-authors:** Alexandre Arbey<sup>2</sup>; Marco Battaglia<sup>3</sup>

<sup>1</sup> CERN (CH) & Clermont Ferrand University (FR)

<sup>2</sup> Lyon U.

<sup>3</sup> University of California, Santa Cruz (US)

The implications of a discovery, or a non-discovery, of the lightest Higgs boson will be discussed in terms of constrained and general MSSM scenarios. Exploring the MSSM through the Higgs sector is an alternative and complementary path to direct searches, and tight constraints on the parameter space can be obtained. Such constraints will be discussed in addition to, very briefly, the interplay with other sectors.

### Financial Support Justification for Early-Stage Researchers:

Since this conference is very expensive for European participants, I would very much appreciate a partial support to cover (at least partly) the local expenses.

**Plenary 3 - The Standard Model - TR1 / 431**

## Search for SM Higgs decaying to two photons at CMS

**Author:** Serguei Ganjour<sup>1</sup>

<sup>1</sup> CEA - Centre d'Etudes de Saclay (FR)

**Corresponding Author:** serguei.ganjour@cern.ch

Results are presented on the search for the standard model Higgs bosons decaying into two photons, and into a photon and a Z boson. Multivariate techniques are used to enhance the sensitivity. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 at a CM energy of 7 TeV with the CMS experiment have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new CM energy of 8 TeV.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 432**

## Flavour data constraints on supersymmetry and SuperIso

**Author:** Nazila Mahmoudi<sup>1</sup>

<sup>1</sup> CERN (CH) & Clermont Ferrand University (FR)

I will review flavour physics constraints on supersymmetric models and in particular those from  $b \rightarrow s \gamma$ ,  $B_s \rightarrow \mu^+ \mu^-$  and  $B \rightarrow K^* \mu^+ \mu^-$  (with an emphasis on the new LHCb results). These rare transitions provide valuable information in the quest for new physics and are complementary to the direct searches. The SuperIso program will also be described.

### Plenary 3 - The Standard Model - TR1 / 433

## Search for SM Higgs decaying to ZZ to four leptons at CMS

**Author:** Markus Klute<sup>1</sup>

<sup>1</sup> Massachusetts Institute of Technology

**Corresponding Author:** markus.klute@cern.ch

Results are presented on the search for the standard model Higgs boson decaying into two Z bosons, with each boson decaying into a pair of charged leptons, either muons, electrons or taus. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 at a CM energy of 7 TeV with the CMS experiment have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

### Plenary 3 - The Standard Model - TR1 / 434

## Search for SM Higgs decaying to ZZ to ll qq or ll vv at CMS

**Author:** Francesco Pandolfi<sup>1</sup>

<sup>1</sup> ETH Zürich (CH)

**Corresponding Author:** francesco.pandolfi@cern.ch

Results are presented on the search for the standard model Higgs boson decaying into two Z bosons, with one boson decaying into a pair of charged leptons, either muons or electrons, and the other boson decaying in neutrinos or jets. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 at a CM energy of 7 TeV with the CMS experiment have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

### Plenary 3 - The Standard Model - TR1 / 436

## Search for SM Higgs decaying to tau tau at CMS

**Author:** Joshua James Swanson<sup>1</sup>

<sup>1</sup> University of Wisconsin (US)

**Corresponding Author:** jjswan33@gmail.com

Results are presented on the search for the standard model Higgs boson decaying into two tau leptons, using both leptonic and hadronic decays of the tau. The sample are split into various categories to enhance the search sensitivity. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Plenary 3 - The Standard Model - TR1 / 437**

## Search for SM Higgs decaying to bb at CMS

**Author:** David Lopes-Pegna<sup>1</sup>

<sup>1</sup> *Princeton University (US)*

**Corresponding Author:** david.lopes-pegna@cern.ch

Results are presented on the search for the standard model Higgs decaying into two b-quark jets, using associated production of the Higgs with W and Z bosons decaying to leptons. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Plenary3 - The Standard Model -TR1 / 438**

## Search for a fermiophobic Higgs particle

**Author:** Matteo Sani<sup>1</sup>

<sup>1</sup> *University of California (US)*

**Corresponding Author:** matteo.sani@cern.ch

Vector boson fusion and associate production of Higgs bosons are searched for, with the Higgs decaying into vector bosons. The results are interpreted in a model for a fermiophobic Higgs. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 440**

## Light neutralino dark matter in MSSM

**Author:** Nazila Mahmoudi<sup>1</sup>

**Co-authors:** Alexandre Arbey<sup>2</sup>; Marco Battaglia<sup>3</sup>

<sup>1</sup> *CERN (CH) & Clermont Ferrand University (FR)*

<sup>2</sup> *Lyon U.*

<sup>3</sup> *University of California,Santa Cruz (US)*

Three dark matter direct detection experiments (DAMA, COGENT and CRESST) have reported a possible signal of WIMP interaction corresponding to very light particles, close to the edge of the XENON-100 and CDMS sensitivity. Imposing the latest constraints from colliders, flavour physics, electroweak precision tests and dark matter searches, we show that viable MSSM scenarios with a light neutralino, in agreement with all the present data, are feasible. An analysis of the characteristics of the resulting scenarios will be presented.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 441**

## **An Explicit SU(12) Family and Flavor Unification Model**

**Authors:** Carl Albright<sup>1</sup>; Robert Feger<sup>2</sup>; Thomas Kephart<sup>2</sup>

<sup>1</sup> *Northern Illinois University & Fermi National Accelerator Laboratory (US)*

<sup>2</sup> *Vanderbilt University*

**Corresponding Author:** albright@fnal.gov

An explicit SU(12) unification model with three light chiral families is presented which avoids any external flavor symmetries. The hierarchy of quark and lepton masses and mixings is explained by higher dimensional Yukawa interactions involving Higgs bosons containing SU(5) singlet fields with VEVs appearing at a scale 50 times smaller than the  $3 \times 10^{16}$  GeV SU(12) unification scale. The model has been found to be in very good agreement with the observed quark and lepton masses and mixings.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 442**

## **Natural Supersymmetry**

**Author:** Xerxes Tata<sup>1</sup>

<sup>1</sup> *University of Hawaii (US)*

**Corresponding Author:** tata@phys.hawaii.edu

The non-observation of signals for supersymmetry in the LHC data appears to have led to questions about the viability of supersymmetry in nature. We delineate clear criteria for SUSY models which stabilize the electroweak scale, and show that these models are not in conflict with the non-appearance of SUSY in the 2011 LHC data. Finally, we discuss some phenomenological implications of these Natural SUSY scenarios.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 443**

## **A charged Z' to explain the apparent disagreement in top-antitop asymmetries between Tevatron and LHC**

**Authors:** Estefania Coluccio Leskow<sup>1</sup>; Ezequiel Álvarez<sup>2</sup>

<sup>1</sup> *Buenos Aires University (AR)*

<sup>2</sup> *Buenos Aires University (UBA)*

**Corresponding Author:** ecolucciol@gmail.com

We propose a phenomenological model with a flavour changing electrically-neutral but not self-conjugated  $Z'$  to simultaneously explain the large Tevatron  $t\bar{t}b\bar{b}$  forward-backward asymmetry and the compatible with zero LHC charge asymmetry. We find that the model produces a natural cancellation in  $pp$  collisions which is suppressed in Tevatron's  $p\bar{p}$  collisions, leading to a large forward-backward asymmetry. Being not self-conjugated, the model is not affected by same-sign top pair production. We find the region in parameter space compatible with the mentioned observables in addition to the measured cross-sections. We propose easy distinctive features of the model which can be tested in differential charge asymmetry measurements.

**Financial Support Justification for Early-Stage Researchers:**

I'm a first year PhD student at Buenos Aires University (UBA) under the supervision of Ezequiel Álvarez and Daniel de Florian. My research group has already paid for the airfare, but the conference fee still presents a serious financial challenge for me to participate. I'm a young researcher from Argentina, and do not have access to the economic resources to attend this kind of conference. Participating in such an important event as ICHEP2012 would be very relevant for my career as I could have the opportunity to meet colleagues from all over the world working in my field, something that is difficult to accomplish living in this country, not only due to our economic situation as a developing country but also because of our geographical distance from much of the centres of scientific research. Working on phenomenology requires constant contact with experimental results and conferences such as these are crucial in developing relationships with scientists actively involved in my area of research. Furthermore, since I'm in the first year of my PhD, giving a presentation could be a very enriching opportunity to showcase my work and exchange knowledge with the scientific community engaged in this field.

**Plenary 3 - The Standard Model - TR1 / 444**

**Search for the associated production of W/Z and Higgs bosons in final states with b quark pairs in  $p\bar{p}$  collisions at  $\sqrt{s}=1.96$  TeV**

**Author:** Satish Desai<sup>1</sup>

<sup>1</sup> *Fermilab*

**Corresponding Author:** satish@fnal.gov

We present searches for a low mass standard model Higgs boson produced in association with a W or a Z boson at a center of mass energy  $\sqrt{s}=1.96$  TeV with the D0 detector at the Fermilab Tevatron collider. The search is performed in the full D0 Run2 data sample using the leptonic decay channels of the W and the Z boson ( $W \rightarrow l\nu$ ,  $Z \rightarrow l\bar{l}$  and  $Z \rightarrow \nu\bar{\nu}$ ) leading to signatures with one lepton and an imbalance in the transverse energy, or two leptons, or just a large imbalance in the transverse energy, in association with one or two b-tagged jets.

We present a search for a low mass Standard Model Higgs boson produced in association with a Z boson decaying invisibly into a pair of neutrinos at a center-of-mass energy of  $\sqrt{s}=1.96$  TeV with the D0 detector at the Fermilab Tevatron collider. A significant signal contribution also arises from associated WH production with a leptonic W boson decay in which the charged lepton is not identified. The search is performed in events containing a large imbalance in the transverse energy, and one or two b-tagged jets and uses the full D0 Run 2 dataset. This channel is one of the most powerful ones in the search for a low mass Higgs boson at the Tevatron, but it is experimentally challenging due to the large QCD backgrounds and absence of visible leptons in the final state.

We present a search for a low mass Standard Model Higgs boson produced in association with a Z boson decaying to charged leptons at a center-of-mass energy of  $\sqrt{s}=1.96$  TeV with the D0 detector at the Fermilab Tevatron collider. The search is performed in events containing two opposite-sign leptons (electron or muon) and one or two b-tagged jets and uses the full D0 Run 2 dataset. The



reconstruction of a leptonic Z boson and the fully constrained kinematics provide powerful experimental handles to both suppress backgrounds and improve the dijet mass reconstruction, making this a very important channel in the search for a low mass Higgs boson at the Tevatron.

**Poster Session** - Board: 35 / 446

## Global fits of the unitarity triangle and search for new physics in pseudoscalar-pseudoscalar final states

**Author:** Eigen Gerald<sup>1</sup>

**Co-authors:** David Hitlin<sup>2</sup>; Frank Porter<sup>2</sup>; Gregory Dubois-Felsmann<sup>3</sup>

<sup>1</sup> *University of Bergen (NO)*

<sup>2</sup> *Caltech*

<sup>3</sup> *SLAC*

**Corresponding Author:** gerald.eigen@ift.uib.no

We have updated our unitary triangle fitting program based on the scan method{Global fits of the CKM matrix. G. Eigen, G.P. Dubois-Felsmann, D.G. Hitlin, F.C. Porter. Eur.Phys.J. C33 (2004) S644, e-Print: hep-ex/0312062.} to constrain the  $\bar{\rho}-\bar{\eta}$  plane using the standard input measurements (CKM matrix elements,  $\sin 2\beta$ ,  $B_{d(s)}^0$  mixing, and  $\epsilon_K$ ) as well as branching fraction and  $CP$  asymmetry measurements of  $B$  decays to all light pseudoscalar-pseudoscalar, pseudoscalar-vector, vector-vector, and  $a_1$  pseudoscalar mesons to determine  $\alpha$ ,  $D^{(*)}K^{(*)}$  mode to determine  $\gamma$ , and  $D^{(*)}\pi$  and  $D\rho$  decays to determine  $2\beta + \gamma$ . We parameterize the individual decay amplitudes in terms of color-allowed tree, color-suppressed tree, penguin, singlet penguin, electroweak penguin, as well as the  $W$ -exchange and  $W$ -annihilation amplitudes. With this parameterization, we obtain a good fit to the measured branching fractions and  $CP$  asymmetries of all  $B$  decays to pseudoscalar-pseudoscalar mesons without any New Physics contributions. This simultaneous fit allows us to determine the correlation between  $\alpha$  and  $\beta$ .

**Plenary 3 - The Standard Model - TR1 / 448**

## Searches for the Higgs boson decay in W boson pairs in ppbar collisions at sqrt(s)=1.96 TeV

**Author:** Abid Patwa<sup>1</sup>

<sup>1</sup> *Brookhaven National Laboratory (BNL)*

**Corresponding Author:** abid@fnal.gov

We present searches for a standard model Higgs boson decaying into W boson pairs and produced either via the gluon fusion process or in association with an additional W or Z boson. Different decay topologies are considered, exploiting both leptonic and hadronic decays of the W boson. The final states considered are two leptons, both with equal and opposite charges, final states with three or more leptons, and final states in which one or two of the W bosons decay into jet pairs. These decay channels are used to cover the entire mass region between 120 and 200 GeV. Data corresponding to the entire Run 2 sample collected with the D0 detector at the Fermilab Tevatron collider are used in these searches.

**TR 8 - Neutrinos RM 219 / 451**

## The KATRIN neutrino mass experiment

**Author:** Volker Hannen<sup>1</sup>

<sup>1</sup> *University of Münster (DE)*

**Corresponding Author:** hannen@uni-muenster.de

The KATRIN experiment aims at a direct and model independent determination of the neutrino mass with 200 meV sensitivity (90% C.L.) via a measurement of the endpoint region of the tritium beta-decay spectrum. The main components of the experiment are a windowless gaseous tritium source (WGTS), differential and cryogenic pumping sections and a tandem of a pre- and a main-spectrometer, applying the concept of magnetic adiabatic collimation with an electrostatic retardation potential to analyze the energy of beta decay electrons and to guide electrons passing the filter onto a segmented silicon PIN detector.

At present the experiment is being installed at the Karlsruhe Institute of Technology and many components are undergoing extensive testing. In the Tritium Laboratory Karlsruhe the demonstrator of the WGTS has been set up. The differential pumping section DPS2F has been installed and initial tests have been completed. A large range of test experiments and background studies have been performed at the pre-spectrometer. The main spectrometer with its air coil system and inner wire electrode is currently in the process of being closed up for bake-out of the system, after which the commissioning of this major component can take place. The 148 pixel silicon detector, required for spectrometer operation, is in place and currently undergoes a refinement of its readout electronics.

The talk will present an overview of the experimental status and give an outlook on the commissioning activities.

The project is supported by the german ministry of research and education (BMBF) under contract number 05A11PM2.

**Poster Session - Board:** 49 / 452

## Parametrizing the Neutrino sector of the seesaw extension in tau decays

**Author:** Darius Jurciukonis<sup>1</sup>

**Co-authors:** Andrius Juodagalvis<sup>1</sup>; Thomas Gajdosik<sup>1</sup>; Tomas Sabonis<sup>1</sup>

<sup>1</sup> *Vilnius University (LT)*

**Corresponding Author:** darius.jurciukonis@cern.ch

The Standard Model includes neutrinos as massless particles, but neutrino oscillations showed, that neutrinos are not massless. A simple extension of adding gauge singlet fermions to the particle spectrum allows normal Yukawa mass terms for neutrinos. Then smallness of the neutrino masses can be well understood within the seesaw mechanism (type I). After spontaneous symmetry breaking of the Standard Model gauge group one obtains a  $(n_L + n_R) \times (n_L + n_R)$  Majorana mass matrix  $M_\nu$  for neutrinos. The mixing between the  $n_R$  right-handed neutrino singlets and the neutral parts of the  $n_L$  lepton doublets gives masses for the neutrinos which are of the size expected from neutrino oscillations.

The diagonalization of the mass matrix gives rise to a split spectrum consisting of heavy and light states of neutrinos given by  $U^T M_\nu U = \text{diag}(m_{n_L}^{\text{light}}, m_{n_R}^{\text{heavy}})$ . For the case  $n_R = 1$  we diagonalize the neutral fermion mass matrix with a rotation matrix  $U$  determined by two complex angles, two masses, and two Majorana phases. For the case  $n_R = 2$  we parametrize the mass matrix with a rotation matrix  $U$  determined by two complex angles, four masses, and four Majorana phases. In both cases we take  $n_L = 3$ .

We calculate the 1-loop radiative corrections to the mass parameters of the neutrino sector of the seesaw extension of the Standard Model which produce mass terms for the neutral leptons. With these ingredients we plan to look at the process  $W^\pm \rightarrow \tau^\pm + \nu \rightarrow h_1^\pm + h_2^\mp + h_3^\pm + \nu + \nu$ . In the future we plan to apply our parametrization to study the  $\tau$  polarization coming from the decay of a  $W$  boson in the data of the CMS experiment at LHC and thus determine restrictions to the parameters of the neutrino sector.

**Plenary 3 - The Standard Model - TR1 / 455**

## Searches for the Higgs boson in final states with photons or taus in ppbar

**Author:** Paul Grannis<sup>1</sup>

<sup>1</sup> *Stony Brook University*

**Corresponding Author:** pgrannis@sunysb.edu

We present the result of two searches for the standard model Higgs boson using the Run 2 data sample collected with the D0 detector at the Fermilab Tevatron collider at a center of mass energy  $\sqrt{s}=1.96$  TeV. In the first search the Higgs boson is searched for in final states with two high transverse momentum photons, exploiting in addition to the diphoton invariant mass spectrum a large number of other kinematic variables via a multivariate technique. This search is also interpreted in the framework of fermiophobic Higgs boson models. In the second search we consider final states with a lepton (e or mu), a tau (identified via its hadronic decays), and analyze separately events with no jets, exactly one jet and two or more jets. These different final states are sensitive to all dominant Higgs boson production modes and probe the Higgs coupling to tau leptons.

**Plenary3 - The Standard Model -TR1 / 457**

## Search for Neutral Supersymmetric Higgs Bosons in bbb(b) Final States in ppbar Collisions at $\sqrt{s}=1.96$ TeV

**Author:** Avto Kharchilava<sup>1</sup>

<sup>1</sup> *State University of New York (US)*

**Corresponding Author:** avto.kharchilava@cern.ch

We present a search for Higgs bosons in the  $b\bar{b}(h \rightarrow b\bar{b})$  and  $b\bar{b}b(h \rightarrow b\bar{b})$  channels at a center-of-mass energy of  $\sqrt{s}=1.96$  TeV with the D0 detector at the Fermilab Tevatron collider. In many Supersymmetric models the cross-section for production of neutral Higgs bosons in association with bottom quarks is greatly enhanced compared to the Standard Model, and over much of the parameter space the dominant decay mode is into a pair of bottom quarks. The search is performed in events with 3 and 4 identified b jets and uses the full D0 Run 2 dataset. Currently this search is only performed at the Tevatron and thus provides unique complementary information to searches for Supersymmetric Higgs bosons decaying into tau pairs at the LHC. The sophisticated techniques to model the dominant multijet background, as well as the multivariate techniques used to both efficiently select the signal and suppress the background, will be discussed in detail.

**Plenary 3 - The Standard Model - TR1 / 458**

## Combined Search for the Standard Model Higgs Boson at D0 in ppbar Collisions at $\sqrt{s}=1.96$ TeV

**Author:** Kenneth Richard Herner<sup>1</sup>

<sup>1</sup> *University of Michigan (US)*

**Corresponding Author:** kenneth.richard.herner@cern.ch

We present the combination of the searches for the Standard Model Higgs boson at a center-of-mass energy of  $\sqrt{s}=1.96$  TeV, using the full Run 2 dataset collected with the D0 detector at the Fermilab Tevatron collider. The major contributing processes include associated production ( $WH \rightarrow \nu b \bar{b}$ ,  $ZH \rightarrow \nu \nu b \bar{b}$ ,  $ZH \rightarrow l l b \bar{b}$ , and  $WH \rightarrow WW()$ ) and *gluon fusion* ( $gg \rightarrow H \rightarrow WW()$ ). The significant improvements across the full mass range resulting from the larger data sets, improved analyses and inclusion of additional channels are discussed. The combination of all channels results in significantly improved sensitivity across the 100-200 GeV mass range.

**Plenary3 - The Standard Model -TR1 / 460**

## Measurement of the $WZ/ZZ(Z \rightarrow b \bar{b})$ Production Cross Section at D0 in ppbar Collisions at $\sqrt{s}=1.96$ TeV

**Author:** Bjorn Penning<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory*

**Corresponding Author:** bjoern.penning@cern.ch

We present a combined measurement of the cross section for the simultaneous production of two vector bosons ( $WZ, ZZ$ ), where one of the bosons decays leptonically ( $W \rightarrow \nu l$ ,  $Z \rightarrow l l$  or  $Z \rightarrow \nu \nu$ ) and the other Z boson decays to  $b \bar{b}$ . The measurement uses the complete Run 2 dataset collected with the D0 detector in ppbar collisions at  $\sqrt{s}=1.96$  TeV, and combines the three leptonic decay modes mentioned above. This final state is a direct analog to SM Higgs searches in final states of leptons plus bottom quark pairs, and thus provides a crucial validation benchmark of the Higgs boson signal isolation techniques involved.

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## Measurement of b-quark production in association with W or Z bosons in ppbar collisions at $\sqrt{s}=1.96$ TeV

**Author:** Avto Kharchilava<sup>1</sup>

<sup>1</sup> *State University of New York (US)*

**Corresponding Author:** avto.kharchilava@cern.ch

Measurements of the total and differential cross section for the production of b-quarks in association with either W or Z bosons in ppbar collisions at  $\sqrt{s}=1.96$  TeV are presented using data collected with the D0 detector at the Fermilab Tevatron collider. The W and Z bosons are identified via their leptonic decays, while the fraction of b-jets is determined via an algorithm that employs the kinematic properties of the tracks associated to jets. Results are compared to NLO theoretical predictions and to MC event generators.

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 463

## Measurements of differential cross sections for W+jets and for multijet production and determination of the strong coupling constant in ppbar collisions at $\sqrt{s}=1.96$ TeV

**Author:** Michael Strauss<sup>1</sup>

<sup>1</sup> *University of Oklahoma (US)*

**Corresponding Author:** mike.strauss@cern.ch

We present two sets of measurements based on data collected with the D0 detector at the Fermilab Tevatron collider running at  $\sqrt{s}=1.96$  TeV. First we present a comprehensive study of the differential cross sections for the production of W bosons in association with up to four hadronic jets. Results are compared with the latest NLO and resummation theoretical predictions as well as with models implemented in event generators. We then present measurements of differential cross sections sensitive to multijet production, which are then interpreted in the framework of QCD to determine the evolution of the strong coupling constant in the energy range between 200 and 450 GeV, which has not been investigated yet in these type of studies.

Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 464

## Measurements of the elastic cross section and of the single diffractive cross section in ppbar scattering at $\sqrt{s}=1.96$ TeV

**Author:** Vladislav Simak<sup>1</sup>

<sup>1</sup> *Czech Technical University Prague (CZ)*

**Corresponding Author:** vladislav.simak@cern.ch

We present two measurements of cross sections using the data recorded at the Fermilab Tevatron collider with the forward proton spectrometer(s) of the D0 detector. First we discuss a measurement of the differential distribution  $d\sigma/dt$  for the elastic cross section in the range  $0.26 < |t| < 1.2$  GeV<sup>2</sup>. Next we discuss a measurement of the differential cross section for the single diffractive process in a similar range of  $|t|$ .

Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 466

## Measurements of the diphoton and of the photon + b-jet differential production cross sections in ppbar collisions at $\sqrt{s}=1.96$ TeV

**Author:** Peter Svoisky<sup>1</sup>

<sup>1</sup> *University of Oklahoma (US)*

**Corresponding Author:** psvoisky@fnal.gov

We present measurements of the differential cross sections for the production of photon pairs and for the production of b-jets in association with photons in ppbar collisions at  $\sqrt{s}=1.96$  TeV using data recorded with the D0 detector at the Fermilab Tevatron collider and corresponding to an integrated luminosity of 8.7 fb<sup>-1</sup>. Results are compared with the prediction of NLO QCD calculations and with the predictions of Monte Carlo event generators.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 471****NLO Vector+Jets Predictions with BlackHat & Sherpa****Author:** David Kosower<sup>1</sup>**Co-authors:** Daniel Maitre <sup>2</sup>; Fernando Febres Cordero <sup>3</sup>; Harald Ita <sup>4</sup>; Kemal Ozeren <sup>4</sup>; Lance Dixon <sup>5</sup>; Stefan Hoeche <sup>5</sup>; Zvi Bern <sup>4</sup><sup>1</sup> *CEA - Centre d'Etudes de Saclay (FR)*<sup>2</sup> *Univ Durham*<sup>3</sup> *Univ. Simon Bolivar, Caracas*<sup>4</sup> *UCLA*<sup>5</sup> *SLAC***Corresponding Author:** david.kosower@cea.fr

Calculations to next-to-leading order in QCD of Standard-Model processes provide the leading quantitatively reliable predictions. They are a prerequisite for comparisons to experimental data. The BlackHat collaboration has been pushing the high-multiplicity frontier in such calculations. In this talk, representing the BlackHat collaboration, I present the next-to-leading predictions for W and Z production in association with three and four jets at the LHC, results for W production in association with five jets; and results for pure four-jet production. I also show comparisons to available Atlas and CMS data.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 472****Maximal Unitarity at Two Loops****Author:** David Kosower<sup>1</sup>**Co-author:** Kasper Larsen <sup>2</sup><sup>1</sup> *CEA - Centre d'Etudes de Saclay (FR)*<sup>2</sup> *Univ Uppsala***Corresponding Author:** david.kosower@cea.fr

The unitarity method is a key part of the set of on-shell methods for calculating gauge-theory amplitudes both analytically and numerically. These methods have been used successfully to obtain the one-loop amplitudes needed for a variety of cutting-edge high-multiplicity next-to-leading order calculations for LHC physics. They have been applied both to analytic calculations, and in the framework of numerical codes such as BlackHat. In this talk, I discuss the first steps in extending maximal unitarity to a computation of two loop amplitudes, needed for precision LHC calculations.

**Plenary 3 - The Standard Model - TR1 / 473****Determination of properties of a Higgs-like resonance at LHC****Author:** Sara Bolognesi<sup>1</sup>**Co-authors:** Andrei Gritsan <sup>1</sup>; Andrew James Whitbeck <sup>1</sup>; Kirill Melnikov <sup>2</sup>; Markus Schulze <sup>2</sup>; Nhan Viet Tran <sup>3</sup>; Yanyan Gao <sup>3</sup><sup>1</sup> *Johns Hopkins University (US)*

<sup>2</sup> *Johns Hopkins University*

<sup>3</sup> *Fermi National Accelerator Lab. (US)*

**Corresponding Author:** sara.bolognesi@cern.ch

With the luminosity expected from the 2012 LHC run, the CMS and ATLAS experiments may reach the discovery sensitivity for the Higgs search in the low-mass region. If a new resonance is observed on LHC, it will be crucial to determine the spin and quantum numbers of the new particle and its couplings to Standard Model fields as accurately as possible. We study the production of a single resonance at the LHC and its decay into a pair of vector bosons. The simulation of the production and decay chain includes all spin correlations and the most general couplings of a spin-zero, -one, and -two resonance to Standard Model matter and gauge fields. Angular analysis is illustrated with an example of a resonance with mass around 125 GeV and expectations are given for various LHC luminosity scenarios.

#### **Financial Support Justification for Early-Stage Researchers:**

The speaker will be supported by the CMS LPC fellowship

#### **Summary:**

This work is a new development of what has been published in Phys.Rev. D81 (2010) 075022  
New results will be shown.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 474**

## **Top quark forward-backward asymmetry from gauged flavor symmetry**

**Author:** Kaladi S. Babu<sup>1</sup>

<sup>1</sup> *Oklahoma State University (US)*

**Corresponding Author:** babu@okstate.edu

The CDF and D0 experiments have reported measurements of the top quark forward-backward asymmetry  $A_{\text{FB}}$  which are (2.5-3.5) sigma away from the standard model predictions. In this talk it will be shown that this anomaly can be explained by new physics that arises when the flavor symmetry of the standard model is gauged in a maximal way. The flavor gauge symmetry would provide an understanding of the three family structure and the pattern of fermion masses. The Higgs doublets needed for generating the fermion masses contribute to  $A_{\text{FB}}$  in the right amount, while being consistent with all flavor changing constraints. The recent measurements of the top quark charge asymmetry  $A_C$  at the LHC by CMS and ATLAS provide additional constraints on these models. Interestingly, these constraints are compatible with models with extra Higgs doublets. Sharper predictions for  $A_C$  will be given, and the possibility of explaining an excess in the dijet invariant mass in the  $Wjj$  channel observed by CDF will be noted. New Higgs scalars in the mass range (150-400) GeV are predicted.

#### **Summary:**

The anomaly in  $A_{\text{FB}}$  observed by the CDF and D0 experiments can be explained via new Higgs scalar exchange arising from flavor gauge symmetries. Sharp predictions for the charge asymmetry  $A_C$  at the LHC will be given. New scalars in the mass range (150-400) GeV are predicted by these models.

**TR 8 - Neutrinos RM 219 / 475**

## Large $\theta_{13}$ from minimal SO(10) unification

**Author:** Kaladi S. Babu<sup>1</sup>

<sup>1</sup> *Oklahoma State University (US)*

**Corresponding Author:** babu@okstate.edu

Unified theories based on SO(10) are ideal settings to address the masses and mixings of neutrinos. In minimal SO(10) models there are just two Yukawa coupling matrices, one associated with a 10 and one with a 126 of Higgs bosons (as opposed to five such matrices in the standard model). This results in a predictive framework for the neutrinos: all neutrino mixing angles and mass ratios can be computed in terms of the quark and lepton mass parameters. Even though quarks and leptons are unified, large neutrino mixing angles emerge simultaneously with small quark mixing angles. The prediction for the reactor neutrino mixing angle is  $\sin^2(2\theta_{13}) = (0.08 - 0.095)$ , which is nicely consistent with recent results from Daya Bay and RENO experiments. This talk will present the minimal model and its predictions, including the expectations for the neutrino CP violation parameter  $\delta$ . A new mechanism that connects neutrino masses with the baryon asymmetry of the universe will be presented, which relies on the B-L violating decays of GUT scale scalars.

### Summary:

Recent measurements of the reactor neutrino mixing angle  $\theta_{13}$  by Daya Bay and RENO experiments are nicely consistent with the prediction for this angle made some years ago based on minimal SO(10) unified theories. The long baseline experiments will test CP violation in neutrino oscillations, for which the minimal SO(10) models make sharp predictions. The neutrino masses are directly linked to a new way of generating baryon asymmetry of the universe.

TR 12 - Formal Theory Development & TR 1 - The Standard Model / 476

## Supersymmetry breaking from monopole condensation

**Authors:** Csaba Csaki<sup>1</sup>; David Curtin<sup>2</sup>; John Terning<sup>3</sup>; Vikram Rentina<sup>4</sup>; Yuri Shirman<sup>5</sup>

<sup>1</sup> *Cornell University*

<sup>2</sup> *Cornell*

<sup>3</sup> *UC Davis*

<sup>4</sup> *U. Arizona*

<sup>5</sup> *University of California-Irvine (US)*

**Corresponding Author:** yshirman@uci.edu

I will describe models where dynamical supersymmetry breaking is triggered by monopole condensation. Low energy theory is described by O'Raifeartaigh models with spontaneously broken R-symmetry.

Poster Session - Board: 13 / 477

## Should we still believe in constrained supersymmetry?

**Authors:** Andy Buckley<sup>1</sup>; Benjamin Farmer<sup>2</sup>; Csaba Balazs<sup>3</sup>; Martin John White<sup>4</sup>

<sup>1</sup> *University of Edinburgh (GB)*

<sup>2</sup> *Monash University (AU)*



<sup>3</sup> *Monash University*

<sup>4</sup> *University of Melbourne (AU)*

**Corresponding Author:** benjamin.farmer@monash.edu

We calculate Bayes factors to quantify how the feasibility of the constrained minimal supersymmetric model (CMSSM) has changed in the light of a series of observations. This is done in the subjective Bayesian spirit where probability reflects a degree of belief in a proposition and Bayes' theorem tells us how to update it after acquiring new information. Our experimental baseline is the approximate knowledge that was available before LEP, and our comparison model is the Standard Model with a simple dark matter candidate. To quantify the amount by which experiments have altered our relative belief in the CMSSM since the baseline data we compute the Bayes factors that arise from learning in sequence the LEP Higgs constraints, the XENON100 dark matter constraints, the 2011  $1 \text{ fb}^{-1}$  LHC supersymmetry search results, and the early 2012 LHC Higgs search results. We find that LEP and the LHC strongly shatter our trust in the CMSSM (with  $M_0$  and  $M_{1/2}$  below 2 TeV), reducing its posterior odds by a factor of approximately three orders of magnitude. This reduction is largely due to the substantial Occam factors induced by the LEP and LHC Higgs searches and the poor maximum likelihood fit to the LHC Higgs search results.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 478**

## A Seiberg Dual for the MSSM: Partially Composite W and Z

**Authors:** Csaba Csaki<sup>1</sup>; John Terning<sup>2</sup>; Yuri Shirman<sup>3</sup>

<sup>1</sup> *Cornell University*

<sup>2</sup> *UC Davis*

<sup>3</sup> *University of California Irvine*

**Corresponding Author:** yshirman@uci.edu

We examine the possibility that the SU(2) gauge group of the standard model appears as the dual “magnetic” gauge group of a supersymmetric gauge theory, thus the W and Z (and through mixing, the photon) are composite (or partially composite) gauge bosons.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 479**

## GUT-less mSUGRA

**Author:** Pearl Sandick<sup>1</sup>

**Co-authors:** Jonathan R. Ellis<sup>2</sup>; Keith Olive<sup>3</sup>

<sup>1</sup> *University of Utah (US)*

<sup>2</sup> *CERN*

<sup>3</sup> *University of Minnesota*

**Corresponding Author:** sandick@physics.umn.edu

In this talk we consider the phenomenology of minimal supergravity (mSUGRA) models in which the supersymmetry-breaking parameters are unified at a scale below the GUT scale. After a brief review of the so-called GUT-less constrained MSSM (CMSSM), we turn to a GUT-less version of mSUGRA. Of particular interest are GUT-less Polonyi models. The possibility that the recent ATLAS and CMS results may be compatible with a Standard Model-like Higgs boson with a mass of approximately 125 GeV is addressed. The dark matter candidate may be either the gravitino or the lightest neutralino. In the latter case, we discuss the prospects for direct detection via elastic scattering on nuclei.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 480**

## **Lattice hadron spectroscopy with the stochastic LapH algorithm**

**Author:** Keisuke Juge<sup>1</sup>

**Co-authors:** Brendan Fahy<sup>2</sup>; Chik-Him Wong<sup>3</sup>; Colin Morningstar<sup>2</sup>; David Lenkner<sup>2</sup>; Jhang You-Cyuan<sup>2</sup>; John Merritt Bulava<sup>4</sup>; Justin Foley<sup>5</sup>

<sup>1</sup> *University of the Pacific (US)*

<sup>2</sup> *Carnegie Mellon University*

<sup>3</sup> *U.C. San Diego*

<sup>4</sup> *CERN*

<sup>5</sup> *University of Utah*

**Corresponding Author:** kjudge@pacific.edu

We present some preliminary results for single-particle and multi-particle states obtained on anisotropic, dynamical 2+1 lattices ( $24^3$ ) generated by the Hadron Spectrum Collaboration. We use the Stochastic LapH algorithm to generate the all-to-all quark propagators.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 481**

## **LHC Status and Future Upgrade Plans**

**Author:** Ralph Steinhagen<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** ralph.steinhagen@cern.ch

The Large-Hadron-Collider (LHC) operated at CERN has been re-commissioned after a short scheduled technical maintenance stop and reached its previous peak performance safely and after only about a month in the beginning of 2012.

The operational experience gained during the previous year and additional analysis of the robustness of the magnet interconnections as well as the measured available triplet aperture allowed further performance improvements, pushing the hadron-hadron centre-of-mass energy to 8 TeV, reduced final focus beta-functions of 0.6 m in the two high-luminosity insertions. In combination with the significantly reduced and consistently produced transverse beam emittances delivered by the LHC injector chain, these allowed new peak luminosity records beyond  $0.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$  necessary to achieve the challenging integrated luminosity targets for 2012.

This contribution summarises the status of the ongoing accelerator and beam optimisations, the planned first long shut-down (LS1) in 2013-2014 to improve the magnet interconnection and protection system in view of safely reaching the LHC design collision energy, as well as the already approved upgrade targeting the modification of the existing high-luminosity insertions. In addition, depending on the outcome of the multitude of ongoing HEP studies – notably the Higgs search, future upgrade options are being discussed that may require more substantial modifications to the existing accelerator or go beyond the present LHC design.

**Summary:**

Summary on behalf of the LHC Team.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 482****Dynamical Dark Matter: An Explicit Model****Author:** Brooks Thomas<sup>1</sup>**Co-author:** Keith Dienes<sup>2</sup><sup>1</sup> *University of Hawaii (US)*<sup>2</sup> *University of Arizona***Corresponding Author:** thomasbd@phys.hawaii.edu

In this talk, we provide an explicit realization of the DDM framework in which the constituent fields of the dark-matter ensemble are the mixed KK excitations of an axion propagating in the bulk of large extra spacetime dimensions. Mixing between these KK excitations, induced by a brane mass term, leads to a suppression of the interactions between the light mass eigenstates in the KK tower and the Standard-Model fields on the brane. Largely as a result of this suppression, the DDM ensemble in this model satisfies all collider, astrophysical, and cosmological constraints while at the same time providing the observed dark-matter relic abundance. This model therefore serves as an existence proof that the DDM framework is a viable alternative to traditional models of dark matter.

**Financial Support Justification for Early-Stage Researchers:**

I am a postdoctoral fellow at the University of Hawaii. My travel budget is very limited, and because of the geographical location of my institution, travel costs are particularly high for me no matter where the location happens to be. For this reason, I am typically required to dip into my own personal savings in order to pay travel expenses. My travel to and participation at ICHEP will therefore be funded entirely out of my own pocket. In order to make such travel feasible for me and not financially burdensome, I am hoping that the ICHEP organizers could provide support to cover the registrations cost for the conference, as well as some of the travel expenses (airfare is approximately \$1600.00 USD round-trip from Honolulu). However, regardless of the amount of support available, I would greatly appreciate any financial help you can provide, and am hoping that such support will make it feasible for me to participate in what I am expecting to be an engaging and productive conference.

**Summary:**

In this talk, we provide an explicit realization of the DDM framework in which the constituent fields of the dark-matter ensemble are the mixed KK excitations of an axion propagating in the bulk of large extra spacetime dimensions. Mixing between these KK excitations, induced by a brane mass term, leads to a suppression of the interactions between the light mass eigenstates in the KK tower and the Standard-Model fields on the brane. Largely as a result of this suppression, the DDM ensemble in this model satisfies all collider, astrophysical, and cosmological constraints while at the same time providing the observed dark-matter relic abundance. This model therefore serves as an existence proof that the DDM framework is a viable alternative to traditional models of dark matter.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 483****Measurements of flavor specific mixing asymmetries in B<sub>0</sub>d and B<sub>0</sub>s mesons and of the like-sign dimuon charge asymmetry****Author:** Iain Bertram<sup>1</sup><sup>1</sup> *Lancaster University***Corresponding Author:** iain.bertram@cern.ch

We present measurements of the flavor-specific semileptonic asymmetry for B<sub>0</sub>d and B<sub>0</sub>s mesons using the full Run II data sample collected with the D0 detector at the Fermilab Tevatron collider.

Three different decay channels are analysed:  $B^0 \rightarrow \mu + D + X$ , with  $D \rightarrow K\pi\pi$ ,  $B^0 \rightarrow \mu + D + X$  with  $D \rightarrow D^0\pi$ ,  $D^0 \rightarrow K\pi$ , and  $B^0_s \rightarrow D_s + \mu + X$ , with  $D_s \rightarrow \phi\pi$ ,  $\phi \rightarrow KK$ .

We extract the charge asymmetries as a function of the proper decay length in the case of the  $B^0$  mesons, while in the case of the  $B^0_s$  mesons the time integrated asymmetries are obtained. Detector related asymmetries are corrected for using data driven methods and corrections are applied using Monte Carlo simulations for the contributions from charge symmetric processes. Results with a precision comparable to the current world average are obtained and compared to the measurements obtained from the study of the dependence of the like-sign dimuon charge asymmetry as a function of the muon impact parameter.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 486**

## Updated measurements of the $B^0$ s and $\Lambda_b$ lifetimes

**Author:** Peter Ratoff<sup>1</sup>

<sup>1</sup> *Lancaster University (UK)*

**Corresponding Author:** p.ratoff@lancaster.ac.uk

Updated measurements of the lifetimes of the  $\Lambda_b$  and of the  $B^0$ s are obtained using the full data sample collected with the D0 detector in Run II of the Tevatron collider. For the  $B^0$ s the lifetime measurement is obtained from a study of a sample of semileptonic decays,  $B^0_s \rightarrow D_s + \mu + X$ , while in the case of the  $\Lambda_b$  the fully reconstructed decay  $\Lambda_b \rightarrow J/\psi + \Lambda^0$  is used.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 487**

## Study of dimuon final states in the decay of B and Y mesons.

**Authors:** Claus Buszello<sup>1</sup>; Claus Buszello<sup>2</sup>; Claus Buszello<sup>3</sup>

<sup>1</sup> *Uppsala University*

<sup>2</sup> *Uppsala University (SE)*

<sup>3</sup> *Department of Physics and Astronomy-University of Uppsala*

**Corresponding Authors:** claus.buszello@cern.ch, buszello@hep.phy.cam.ac.uk, claus.peter.buszello@cern.ch

We present the observation of a narrow mass state decaying into  $Y(1s) + \text{photon}$ , where the  $Y(1s)$  is detected by its decay into a pair of oppositely charged muons and the photon is identified through its conversion into an electron-positron pair. The significance of this observation is 5.6 standard deviation. The mass of the state is centered at  $10.551 \pm 0.014(\text{stat}) \pm 0.017 \text{ GeV}$ , which is consistent with that of the state recently observed by the ATLAS Collaboration. We also present an update of the search for the decay  $B^0_s \rightarrow \mu + \mu^-$  using the full D0 data sample of about  $10.4 \text{ fb}^{-1}$  of integrated luminosity. In this analysis, backgrounds have been significantly reduced compared to earlier D0 measurements by addition isolation variables, by reconstructing additional vertices near the  $B^0$ s decay vertex and by employing multivariate techniques to discriminate between signal and background.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 488**

## Search for $Z + \text{photon}$ events with Large Missing Transverse Energy in ppbar Collisions at 1.96 TeV

**Author:** James Kraus<sup>1</sup>

<sup>1</sup> *University of Mississippi*

**Corresponding Authors:** james.alexander.kraus@cern.ch, jakraus@fnal.gov

We present the first search for supersymmetry (SUSY) in  $Z\gamma$  final states with large missing transverse energy using data corresponding to an integrated luminosity of  $6.2 \text{ fb}^{-1}$  collected with the D0 experiment in  $p\bar{p}$  collisions at  $\sqrt{s}=1.96 \text{ TeV}$ . This signature is predicted in gauge-mediated SUSY-breaking models, where the lightest neutralino is the next-to-lightest supersymmetric particle (NLSP) and is produced in pairs, possibly through decay from heavier supersymmetric particles. The NLSP can decay either to a Z boson or a photon and an associated gravitino that escapes detection. We exclude this model at the 95% C.L. for SUSY breaking scales of  $\Lambda < 87 \text{ TeV}$ , corresponding to neutralino masses of  $< 151 \text{ GeV}$ .

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 489**

## Search for Pair Production of the Scalar Top Quark in $\mu^+\tau$ Final States

**Author:** James Kraus<sup>1</sup>

<sup>1</sup> *University of Mississippi (US)*

**Corresponding Authors:** james.alexander.kraus@cern.ch, jakraus@fnal.gov

We present a search for the pair production of scalar top quarks ( $\text{stop}_1$ ), the lightest supersymmetric partners of the top quarks, in  $p\bar{p}$  collisions at a center-of-mass energy of  $1.96 \text{ TeV}$ , using data corresponding to an integrated luminosity of  $7.3 \text{ fb}^{-1}$  collected with the D0 experiment at the Fermilab Tevatron Collider. Each scalar top quark is assumed to decay into a b quark, a charged lepton, and a scalar neutrino (snu). We investigate final states arising from  $\text{stop}_1 \bar{\text{stop}}_1 \rightarrow b \bar{b} \mu^+ \tau^- \text{snu} \text{snu}$  and  $\text{stop}_1 \bar{\text{stop}}_1 \rightarrow b \bar{b} \tau^+ \tau^- \text{snu} \text{snu}$ . With no significant excess of events observed above the background expected from the standard model, we set exclusion limits on this production process in the  $(m_{\text{stop}_1}, m_{\text{snu}})$  plane.

**Room 219 - BSM - Non-SUSY - TR3 / 490**

## Search for Universal Extra Dimensions in $p\bar{p}$ Collisions

**Author:** Souza Santos Angelo<sup>1</sup>

<sup>1</sup> *LAFEX, Centro Brasileiro de Pesquisas Físicas (BR)*

**Corresponding Author:** angelift@ift.unesp.br

We present a search for Kaluza-Klein (KK) particles predicted by models with universal extra dimensions (UED) using a data set corresponding to an integrated luminosity of  $7.3 \text{ fb}^{-1}$ , collected by the D0 detector at a  $pp$  center of mass energy of  $1.96 \text{ TeV}$ . The decay chain of KK particles can lead to a final state with two muons of the same charge. This signature is used to set a lower limit on the compactification scale of  $R^{-1} > 260 \text{ GeV}$  in a minimal UED model.

**Poster Session - Board: 19 / 491**

## Model Independent Search for New Phenomena in ppbar Collisions at $\sqrt{s} = 1.96$ TeV

**Author:** James Kraus<sup>1</sup>

<sup>1</sup> *Michigan State University*

**Corresponding Authors:** jakraus@fnal.gov, james.alexander.kraus@cern.ch

We describe a model independent search for physics beyond the standard model in lepton final states. We examine 117 final states using 1.1 fb<sup>-1</sup> of ppbar collisions data at  $\sqrt{s} = 1.96$  TeV collected with the D0 detector. We conclude that all observed discrepancies between data and model can be attributed to uncertainties in the standard model background modeling, and hence we do not see any evidence for physics beyond the standard model.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 492**

## High Resolution Hadron Calorimetry

**Author:** Adam Para<sup>1</sup>

**Co-author:** Hans Wenzel<sup>2</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

<sup>2</sup> *Fermilab*

**Corresponding Author:** para@fnal.gov

We review the physics foundations of hadron calorimetry with the help of detailed simulation based on GEANT5. Detailed studies of spatial and temporal development of hadronic showers are presented and the contributions of various particles species to the observed signals are evaluated.

We identify the principal contributions to the energy resolutions and demonstrate the importance of the total absorption and calorimetry in attaining high energy resolution. Furthermore we demonstrate that the additional information provided by Cherenkov light in addition to the scintillation light makes it possible to correct, on the event-by-event basis, for the loss of the energy for particles production and nuclear binding energy and to attain the energy resolution of the order of 10%/sqrt(E).

We present the performance of a dual readout total absorption calorimeter for single particles of different kinds and energies as well as for the jets.

We discuss the practical implementation of a calorimeter in a colliding beam experiment. Leakage of energy due to the finite thickness of the calorimeter is likely to be the dominant contribution to the energy resolution and we discuss possible ways to mitigate this contribution.

We present a program of a studies of various systematic effects potentially relevant to the energy resolution, like the non-linearity of response of inorganic scintillators to heavily ionizing particles.

**Room 219 - BSM - Non-SUSY - TR3 / 493**

## Search for First Generation Leptoquark Pair Production in the Electron + Missing Energy + Jets Final State

**Author:** Bjorn Penning<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Author:** bjoern.penning@cern.ch

We present a search for the pair production of first generation scalar leptoquarks (LQ) in data corresponding to an integrated luminosity of  $5.4 \text{ fb}^{-1}$  collected with the D0 detector at the Fermilab Tevatron Collider in ppbar collisions at  $\sqrt{s}=1.96 \text{ TeV}$ . In the channel  $LQ \bar{LQ} \rightarrow e \nu_e q q'$ , where  $q, q'$  are u or d quarks, no significant excess of data over background is observed, and we set a 95% C.L. lower limit of 326 GeV on the leptoquark mass, assuming equal probabilities of leptoquark decays to  $e q$  and  $\nu_e q'$ .

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 494**

## Search for Charged Massive Long-Lived Particles

**Author:** Yuri Gershtein<sup>1</sup>

<sup>1</sup> *Rutgers University (US)*

**Corresponding Author:** gershtein@physics.rutgers.edu

We report on a search for charged massive long-lived particles (CMLLPs), based on data collected with the D0 detector at the Fermilab Tevatron ppbar collider. We search for events in which one or more particles are reconstructed as muons but have speed and ionization energy loss ( $dE/dx$ ) inconsistent with muons produced in beam collisions. CMLLPs are predicted in several theories of physics beyond the standard model. We present limits on massive long-lived particles in several supersymmetric theories.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 495**

## Search for a Narrow $t\bar{t}$ Resonance in ppbar Collisions at $\sqrt{s} = 1.96 \text{ TeV}$ (Combined D0, CDF)

**Author:** Erich Varnes<sup>1</sup>

<sup>1</sup> *University of Arizona (US)*

**Corresponding Authors:** kasmi@fnal.gov, varnes@fnal.gov

We report a search for a narrow  $t\bar{t}$  resonance that decays into a lepton+jets final state based on an integrated luminosity of 5.3/fb of proton-antiproton collisions at  $\sqrt{s}=1.96 \text{ TeV}$  collected by the D0 Collaboration at the Fermilab Tevatron Collider. We set upper limits on the production cross section of such a resonance multiplied by its branching fraction to  $t\bar{t}$  which we compare to predictions for a leptophobic topcolor  $Z'$  boson. We exclude such a resonance at the 95% confidence level for masses below 835 GeV.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 496**

## LHC Signatures Inspired by Yukawa-bound Mesons: Double Resonant $WW + \text{jet}$

**Authors:** George Wei-Shu Hou<sup>1</sup>; Hiroshi Yokoya<sup>1</sup>; Johan Alwall<sup>2</sup>; Tsedenbaljir Enkhbat<sup>3</sup>

<sup>1</sup> *National Taiwan University (TW)*

<sup>2</sup> *Fermilab*<sup>3</sup> *National Taiwan University***Corresponding Author:** hyokoya@gmail.com

With  $5\text{ fb}^{-1}$  LHC data at 7 TeV collected in 2011, current mass limits of the chiral 4th generation quarks have reached 600 GeV, nominally entering the regime of perturbative unitarity violation. The very large Yukawa couplings of these quarks may require nonperturbative treatment, including the possible formation of tightly Yukawa-bound “mesons”. Assuming an almost degenerate 4th generation quark doublet (heavy Isospin) and large Higgs-boson mass as required to be consistent with the electroweak precision observables, the spectrum of Yukawa-bound mesons would likely be  $M(\pi_1) < [M(\pi_8), M(\omega_1)] < M(\omega_8)$ , where  $\pi$  and  $\omega$  copy from isospin notation, while 1 and 8 in subscript reflect the color of these mesons. The leading production is  $q\bar{q} \rightarrow \omega_8$ , with a rather rich decay phenomenology. A possible “double resonance” final state appears where  $\omega_8$  decays predominantly into a  $\pi_8$  plus a weak boson, followed by the decay of the  $\pi_8$  into a weak boson plus a gluon. This unusual final state is realized when the mixing of 4th generation quarks with SM quarks is small, which is consistent with absence of new physics signals from flavor physics. We perform a phenomenological study for the signature at the LHC using the W-jet tagging method, including SM background estimation and demonstration of resonance mass determination. This study also serves as a precursor study for the search for other resonances with the same final state, such as technicolor models with QCD-colored techniquarks.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 497**

## Cosmological neutrino mass constraint from the WiggleZ Dark Energy Survey

**Author:** Signe Riemer-Sorensen<sup>1</sup><sup>1</sup> *University of Queensland***Corresponding Author:** signe.riemer@gmail.com

The absolute neutrino mass scale is currently unknown, but can be constrained from cosmology. We use the large-scale structure information from the WiggleZ Dark Energy Survey to constrain the sum of neutrino masses. The WiggleZ high redshift star-forming blue galaxy sample is less sensitive to systematic effects from non-linear structure formation, pairwise galaxy velocities, redshift-space distortions, and galaxy bias than previous surveys. Through exhaustive tests using numerical dark-matter simulations of the WiggleZ survey, we demonstrate that at small scales common modelling approaches lead to systematic errors in the recovered cosmological parameters, and we use the simulations to calibrate a new non-linear fitting formula extending to small scales ( $k=0.3h/\text{Mpc}$ ). We obtain an upper limit on the sum of neutrino masses of 0.60eV (95% confidence) for WiggleZ+Wilkinson Microwave Anisotropy Probe. Combining with priors on the Hubble Parameter and the baryon acoustic oscillation scale gives an upper limit of 0.29eV, which is the strongest neutrino mass constraint derived from spectroscopic galaxy redshift surveys.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 498**

## CP violation in charm decays: Standard Model and Beyond

**Author:** Amarjit Soni<sup>1</sup><sup>1</sup> *Brookhaven National Laboratory (US)***Corresponding Author:** adlersoni@gmail.com



CP violation in charm decays is studied in light of recent experimental findings of LHCb and CDF. Flavor symmetry violations as manifestly displayed in the data are incorporated without theoretical assumptions. Repercussions for CP asymmetries for some of the B (Bs) -decays are incorporated. Range of expectations from the Standard Model are quantified. Further directions to pursue to isolate potential contributions from new physics are pointed out. This talk is based in part on work done in collaboration with Thorsten Feldman and Soumitra Nandi.

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 499

## Interplay of IR-Improved DGLAP-CS Theory and NLO Parton Shower MC Precision

**Author:** Bennie Ward<sup>1</sup>

**Co-authors:** Scott Yost<sup>2</sup>; Swapan Majhi<sup>3</sup>

<sup>1</sup> *Baylor University (US)*

<sup>2</sup> *The Citadel*

<sup>3</sup> *IACS, Calcutta*

**Corresponding Author:** bfl\_ward@baylor.edu

We present the interplay between the new IR-improved DGLAP-CS theory and the precision of NLO parton shower/ME matched MC's as it is realized by the new MC Herwiir1.031 in interface to MC@NLO. We discuss phenomenological implications using comparisons with recent LHC data on single heavy gauge boson production.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 500

## Measurements of CP violation in charm decays at CDF

**Author:** Diego Tonelli<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** diego.tonelli@cern.ch

Measurements of CP violation in charm meson decays are presented using the complete 10/fb dataset collected by the CDF experiment at the Tevatron. The difference between CP-violating asymmetries in  $D^0 \rightarrow K^+ K^-$  and  $D^0 \rightarrow \pi^+ \pi^-$  decays is observed to be 2.8 sigma different from zero, supporting evidence of CP violation in charm reported by other experiments. In addition, world's most precise measurements of individual asymmetries in  $D^0 \rightarrow h h$  and  $D^0 \rightarrow K_S \pi \pi$  are reported.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 501

## CDF results on CP violation in hadronic B decays

**Author:** Mirco Dorigo<sup>1</sup>

<sup>1</sup> *INFN Trieste & University of Trieste (IT)*

**Corresponding Author:** mirco.dorigo@ts.infn.it

Using the complete 10/fb dataset, the CDF experiment has studied CP violation in several hadronic decay modes of bottom hadrons.

In the decays of  $B_d$ ,  $B_s$ , and  $\Lambda_b$  hadrons into charmless two-body final states, we present results including improved measurements of the branching ratios and time-integrated CP-violating asymmetries of known decays and tightened constraints on these quantities for the as yet unobserved modes. In flavor-tagged  $B_s \rightarrow J/\psi \Phi$  decays, we have measured the  $B_s$  mixing phase, lifetime, and width-difference. We also present world's best results on the  $B_s \rightarrow J/\psi \Phi$  and  $D_s D_s$  branching fractions.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 502**

## **CDF results on the search for rare $B_d$ , $B_s \rightarrow \mu^+ \mu^-$ and $X_s \mu^+ \mu^-$ decays**

**Author:** Hideki Miyake<sup>1</sup>

<sup>1</sup> KEK (JP)

**Corresponding Author:** hideki@post.kek.jp

Results of a CDF search for  $B \rightarrow \mu^+ \mu^-$  decays and the angular analysis of  $B \rightarrow X_s \mu^+ \mu^-$  decay are presented using the complete 10/fb dataset collected by the CDF experiment. The  $B \rightarrow \mu^+ \mu^-$  analysis is unchanged with respect to the last iteration and 30% more data allow to reach 95% expected upper limits for the branching ratio of  $4.2 \times 10^{-9}$  in the  $B_d$  decay and  $1.3 \times 10^{-8}$  in the  $B_s$  decay. The results show no evidence for the  $B_d$  decay and an indication for a moderate excess of signal-like events over background in the  $B_s$  channel, compatible with standard model expectations and other experimental results. The  $b \rightarrow s \mu^+ \mu^-$  results include updated measurements of branching fractions, polarization, and muon forward-backward asymmetry in  $B \rightarrow K^* \mu^+ \mu^-$  and  $\Lambda_b \rightarrow \Lambda \mu^+ \mu^-$  decays.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 503**

## **An Estimate of $\Lambda$ in Resummed Quantum Gravity in the Context of Asymptotic Safety and Planck Scale Cosmology: Constraints on SUSY GUTS**

**Author:** Bennie Ward<sup>1</sup>

<sup>1</sup> Baylor University (US)

**Corresponding Author:** bfl\_ward@baylor.edu

We use the amplitude-based resummation of Feynman's formulation of Einstein's theory to arrive at a UV finite approach to quantum gravity. We show that we recover the UV fixed point recently claimed by the exact field-space renormalization group approach. We use our approach in the context of the attendant Planck scale cosmology formulation of Bonanno and Reuter to estimate the value of the cosmological constant as  $\rho_\Lambda = (0.0024 \text{ eV})^4$ . We show that the closeness of this estimate to experiment constrains SUSY GUT models.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 506**

## Production and properties of heavy flavors at CDF

**Author:** Sinead Farrington<sup>1</sup>

<sup>1</sup> *University of Warwick (UK)*

**Corresponding Author:** sinead.farrington@cern.ch

We present new results on the measurements of properties of heavy hadron production and decay at CDF. These include the first three-dimensional determination of the Upsilon meson spin alignment, the first measurement of the Bc meson lifetime in an exclusive final state, and a study of the phenomenology of charged charmed meson fragmentation.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 507

## Results on Bottom Baryons with the CDF II Detector

**Author:** Igor Gorelov<sup>1</sup>

<sup>1</sup> *University of New Mexico (US)*

**Corresponding Author:** igor.gorelov@cern.ch

We present the latest results on the search for excited bottom baryon states *Lambda<sub>b</sub> proton-antiproton collisions with a center of mass energy of 1.96 TeV. Using a 10/fb data sample, we study the Lambda<sub>b</sub> resonance states in the Lambda<sub>b</sub>0 pi+ pi- decay mode in events collected by the CDF II detector with a displaced vertex trigger.*

TR 12 - Formal Theory Development & TR 1 - The Standard Model / 509

## Classical geometry to quantum behavior correspondence in a Virtual Extra Dimension

**Author:** Donatello Dolce<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** dolce@fi.infn.it

In the Lorentz invariant formalism of compact space-time dimensions the assumption of periodic boundary conditions represents a consistent semi-classical quantization condition for relativistic fields. In [arXiv:1110.0315, Ann. Phys. (2012)] we have shown, for instance, that the ordinary Feynman path integral is obtained as interference between the classical paths with different winding numbers associated to the cyclic dynamics of the field solutions. Through the boundary conditions, the kinematical information of interaction is encoded on the relativistic geometrodynamics of the boundary. Furthermore, such a purely four-dimensional theory is manifestly dual to an extra-dimensional field theory. The resulting correspondence between extra-dimensional geometrodynamics and ordinary quantum behavior yields an unconventional interpretation of the AdS/CFT correspondence in terms of wave-particle duality. By applying this approach to a simple Quark-Gluon-Plasma freeze-out model we retrieve basic aspects of AdS/QCD phenomenology.

Room 216 - Particle Astrophysics and Cosmology -TR11 / 510

## The Affleck-Dine dynamics of pangenesis

**Authors:** Benedict von Harling<sup>1</sup>; Kalliopi Petraki<sup>2</sup>; Raymond Volkas<sup>3</sup>

<sup>1</sup> *University of Melbourne (AU)*

<sup>2</sup> *U*

<sup>3</sup> *The University of Melbourne*

In pangenesis, the baryon asymmetry of the universe and the dark matter abundance are generated simultaneously via the Affleck-Dine mechanism. This talk will discuss the Affleck-Dine dynamics, both for the case of gravity- and gauge-mediated supersymmetry breaking. Cosmological constraints on the scenario, in particular arising from the production of gravitinos and the formation of Q-balls, will be considered and the viable regions of parameter space for successful pangenesis presented. The results are also applicable to other scenarios involving the Affleck-Dine mechanism.

**Financial Support Justification for Early-Stage Researchers:**

not needed

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 512**

## Higgs boson mass in GMSB with messenger-matter mixing

**Author:** Kaladi S. Babu<sup>1</sup>

<sup>1</sup> *Oklahoma State University (US)*

**Corresponding Author:** babu@okstate.edu

In minimal models of gauge mediated SUSY breaking the mass of the lightest neutral Higgs boson cannot exceed about 118 GeV, provided that the SUSY particle masses are below 2 TeV. This work investigates the Higgs boson mass in the presence of messenger-matter mixing. Such mixing would generate a non-zero A-term (trilinear soft SUSY braking term) at the messenger scale, which enhances the Higgs mass to about 126 GeV, even when all superparticle masses are below a TeV. Such a spectrum is shown to be consistent with recent LHC limits. The increase in  $m_h$  is maximal in the case of messengers belonging to  $10+10^*$  of SU(5). The embedding of these models in SU(5), along with a flavor U(1) symmetry, addresses the fermion mass hierarchy problem and generates naturally large neutrino mixing angles, while being consistent with all flavor changing processes.

**Summary:**

LHC experiments have provided rather stringent limits on the SUSY particle masses within minimal supergravity. Such limits are not easily obtained for the class of gauge mediated SUSY breaking models, primarily because these models predict rather low Higgs boson mass ( $m_h < 118$  GeV for SUSY particles below 2 TeV). The present work gives a consistent scenario where  $m_h$  is raised to about 126 GeV within minimal GMSB, even with sub-TeV SUSY particles.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 513**

## Diagnosing top-quark Forward-Backward Asymmetry

**Author:** Sudhir Kumar Gupta<sup>1</sup>

**Co-authors:** Amarjit Soni <sup>2</sup>; David Atwood <sup>3</sup>

<sup>1</sup> *Monash University (AU)*

<sup>2</sup> *BNL*

<sup>3</sup> *Iowa State University*

**Corresponding Author:** sudhir.gupta@monash.edu

Recent measurements on the top-quark forward-backward asymmetry ( $A_{FB}$ ) by the two (CDF & D0) Tevatron experiments show a more than 3 sigma deviation from the Standard Model prediction from the SM expectation of  $5.2 \pm 0.6\%$ . Later about 3.1sigma enhancement was established on the basis of considering top-pairs only from the large  $t\bar{t}$  invariant mass region. In this talk, we will discuss about the diagnostic tests performed by us for the the aforementioned observation and provide some detail on the nature of the correct BSM model that causes such a large deviation.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 515**

## Searches for CP violation in the $B_0$ s system using $B_0 \rightarrow J/\psi + (\phi/f_0/f_2)$ decays

**Author:** Dmitri Tsybychev<sup>1</sup>

<sup>1</sup> *Stony Brook University (US)*

**Corresponding Author:** tsybych@fnal.gov

We report updated measurement of the CP-violating phase  $\phi_s$  and of the decay width differences for the two mass eigenstates  $\Delta\Gamma_s$  from the flavor-tagged decay  $B_0 \rightarrow J/\psi + \phi$ . We also present measurements of the branching ratios for the decays  $B_0 \rightarrow J/\psi + f_0$  and  $B_0 \rightarrow J/\psi + f_2$ , a study of the angular distribution for the latter decay and improve the determination of the CP violation parameters using the  $B_0 \rightarrow J/\psi + f_0$  decay.

**TR 8 - Neutrinos RM 219 / 522**

## Recent Cross Section Measurements from MiniBooNE

**Authors:** Heather Ray<sup>1</sup>; Martin Tzanov<sup>2</sup>

<sup>1</sup> *University of Florida (US)*

<sup>2</sup> *L*

**Corresponding Author:** hray@fnal.gov

A precise knowledge of the neutrino cross sections at  $\sim 1$  GeV on nuclear targets is required to determine the remaining neutrino oscillation parameters accurately. Until recently, our knowledge of neutrino interactions was based on measurements from 20-year old bubble chamber experiments on hydrogen and deuterium targets. As a result, the systematic uncertainties due to neutrino cross sections are large. In order to reduce these uncertainties neutrino oscillation experiments had to constrain and measure the cross sections. The MiniBooNE experiment at Fermilab was a short baseline neutrino oscillation experiment designed to confirm or refute the LSND signal. MiniBooNE has collected the largest sample of neutrino and anti-neutrino interactions in the  $\sim 1$  GeV region. The latest neutrino cross section results from MiniBooNE are presented.

**Poster Session** - Board: 14 / 523

## Finding Stop with Azimuthal angle in 2jet+MET at the LHC

**Author:** Doyoun Kim<sup>1</sup>

<sup>1</sup> *Monash University (AU)*

**Corresponding Author:** abistp00@phy.snu.ac.kr

Suppressing the bunch of top quark background is essential in finding the top squark at the LHC. Currently we are not optimized in the discrimination of them. We suggest the azimuthal angle around the beam axis be a good discriminator and show its utility in the dijet+Missing Energy channel at the LHC with 14 TeV center of energy.

**Plenary3 - The Standard Model -TR1 / 524**

## Measurement of W/Z+gamma production and limits on triple gauge couplings in ppbar collisions at sqrt(s)=1.96 TeV

**Author:** Heidi Schellman<sup>1</sup>

<sup>1</sup> *Northwestern University*

**Corresponding Author:** h-schellman@northwestern.edu

We measure the cross section and differential distributions for the production of a weak bosons (W or Z) in association with a photon in data collected with the D0 detector at the Fermilab Tevatron ppbar collider at sqrt(s)=1.96 TeV and corresponding to integrated luminosities of up to 6.2 fb<sup>-1</sup>. The W and Z bosons are identified via their leptonic decays to electrons or muons. The results obtained are consistent with the standard model predictions for from next-to-leading order calculations. The differential distributions are used to set limits on possible anomalous couplings in the triple gauge boson vertices.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 526**

## Dynamical Dark Matter: A Theoretical Overview

**Author:** Keith Dienes<sup>1</sup>

**Co-author:** Brooks Thomas<sup>2</sup>

<sup>1</sup> *NSF & University of Arizona & University of Maryland (US)*

<sup>2</sup> *University of Hawaii*

**Corresponding Author:** dienes@physics.arizona.edu

In this talk, we introduce a new framework for dark-matter physics which we call “Dynamical Dark Matter”. Rather than focus on one or more stable dark-matter particles, we instead consider a multi-component framework in which the dark matter of the universe comprises a vast ensemble of interacting fields with a variety of different masses, mixings, and abundances. Moreover, rather than impose stability for each field individually, we ensure the phenomenological viability of such a scenario by requiring that those states with larger masses and Standard-Model decay widths have correspondingly smaller relic abundances, and vice versa. In other words, dark-matter stability is not an absolute requirement in such a framework, but is balanced against abundance. This leads to a

highly dynamical scenario in which cosmological quantities such as  $\Omega_{\text{CDM}}$  experience non-trivial time-dependences beyond those associated with the expansion of the universe. Although it may seem difficult to arrange an ensemble of states which have the required decay widths and relic abundances, we present one particular example in which this balancing act occurs naturally: an infinite tower of Kaluza-Klein (KK) states living in the bulk of large extra spacetime dimensions. Remarkably, this remains true even if the stability of the KK tower itself is entirely unprotected. Thus theories with large extra dimensions — and by extension, certain limits of string theory — naturally give rise to dynamical dark matter. Such scenarios also generically give rise to a rich set of collider and astrophysical phenomena which transcend those usually associated with dark matter.

### Plenary3 - The Standard Model -TR1 / 527

## Measurements of WW and WZ production in W + jets final states in ppbar collisions

**Author:** Gregorio Bernardi<sup>1</sup>

<sup>1</sup> LPNHE University of Paris (FR)

We study WW and WZ production with  $l \nu q \bar{q}$  ( $l=e,\mu$ ) final states using data collected by the D0 detector at the Fermilab Tevatron Collider corresponding to 4.3 fb<sup>-1</sup> of integrated luminosity from ppbar collisions at  $\sqrt{s}=1.96$  TeV. Assuming the ratio between the production cross sections  $\sigma(WW)$  and  $\sigma(WZ)$  as predicted by the standard model, we measure the total WW ( $V=W,Z$ ) cross section to be  $\sigma(WV) = 19.6^{+3.2}_{-3.0}$  pb, and reject the background-only hypothesis at a level of 7.9 standard deviations. We also use  $b$ -jet discrimination to separate the WZ component from the dominant WW component. Simultaneously fitting WW and WZ contributions, we measure  $\sigma(WW) = 15.9^{+3.7}_{-3.2}$  pb and  $\sigma(WZ) = 3.3^{+4.1}_{-3.3}$  pb, which is consistent with the standard model predictions.

### TR 12 - Formal Theory Development & TR 1 - The Standard Model / 529

## Measurement of the W boson mass with the D0 detector and combination of the CDF and D0 results for the W boson mass

**Author:** Jan Stark<sup>1</sup>

<sup>1</sup> Laboratoire de Physique Subatomique et de Cosmologie

**Corresponding Author:** stark@in2p3.fr

We present a measurement of the W boson mass using data corresponding to an integrated luminosity of 4.3 fb<sup>-1</sup> collected with the D0 detector during Run 2 at the Fermilab Tevatron ppbar collider. With a sample of 1,677,394  $W \rightarrow e \nu$  candidate events, we measure  $M_W = 80.367 \pm 0.026$  GeV. This result is combined with an earlier D0 result determined using an independent Run 2 data sample, corresponding to 1 fb<sup>-1</sup> of integrated luminosity, to yield  $M_W = 80.375 \pm 0.023$  GeV. We also present the combination of all the Tevatron measurements of the W boson mass, including the results from CDF and from Run I, to obtain the Tevatron average for the mass of the W boson of  $80.387 \pm 0.016$  GeV and the new world average, including the data from LEP II,  $M_W = 80.385 \pm 0.015$  GeV.

### Room 216 - Particle Astrophysics and Cosmology -TR11 / 531

## Low-Mass Dark Matter Searches with Sub-keV Germanium Detectors

**Author:** Hau-Bin Li<sup>1</sup>

**Co-author:** Henry Wong<sup>2</sup>

<sup>1</sup> *Academia Sinica (TW)*

<sup>2</sup> *Academia Sinica*

**Corresponding Authors:** lihb@phys.sinica.edu.tw, htwong@phys.sinica.edu.tw

Germanium detectors with sub-keV sensitivities offer a unique opportunity to probe low-mass WIMP Dark Matter, where there is an intense interest inspired by possible allowed regions indicated by the CoGeNT experiment. The TEXONO-CDEX Collaboration has been pursuing such research program at the Kuo-Sheng Neutrino Laboratory (KSNL) in Taiwan and in the China Jinping Underground Laboratory (CJPL) in China. In this presentation, we will focus on commissioning of the 1-kg-class experiments at CJPL, as well as the latest status, results and plans of the analysis.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 532**

## Measurement of the forward-backward charge asymmetry in top quark pair production (D0)

**Author:** Alexander Josef Grohsjean<sup>1</sup>

<sup>1</sup> *DESY (DE) & Centre d'Etudes de Saclay (FR)*

**Corresponding Author:** alexander.grohsjean@desy.de

We present measurements of the forward-backward asymmetry and the lepton charge asymmetry in lepton plus jets and dilepton final states in top antitop quark pair production in proton antiproton collisions, using up to 10 fb<sup>-1</sup> of data collected by D0 in Run II. We present unfolded results corrected for acceptance and resolution effects. In case of the lepton plus jets channel the analysis is also performed as function of the invariant mass of the ttbar pair. Furthermore, we give the combination of both channels and present first distributions sensitive to the top quark polarization.

**TR4 - Top Quark Physics / 533**

## Measurement of top quark properties - electric charge and width (D0)

**Author:** Christian Schwanenberger<sup>1</sup>

<sup>1</sup> *University of Manchester (UK)*

**Corresponding Author:** schwanen@fnal.gov

We present a measurement of the electric charge of the top quark and an improved determination of the total width of the top quark,  $\Gamma_t$ , using 5.3 fb<sup>-1</sup> of integrated luminosity collected by the D0 Collaboration at the Tevatron ppbar Collider. The top quark charge is reconstructed from the top quark decay products in events which have an isolated high-pT charged lepton, large missing transverse momentum, and at least four high-pT jets, at least two of which identified as b-quark jets by a neural network. We exclude the hypothesis that the top quark is an exotic quark of charge  $-4e/3$  at a confidence level greater than six standard deviations and conclude that the observed top quark charge is in good agreement with the standard model value of  $2e/3$ . The total width  $\Gamma_t$  is extracted from the partial decay width  $\Gamma(t \rightarrow Wb)$ , obtained from the t-channel single top quark production cross section, and the branching fraction  $B(t \rightarrow Wb)$  measured in ttbar events. For



a top mass of 172.5 GeV, the resulting width is  $\Gamma_t = 2.00^{+0.47-0.43}$  GeV which translates to a top-quark lifetime of  $\tau_t = (3.29^{+0.90-0.63}) \cdot 10^{-25}$  s.

TR4 - Top Quark Physics / 534

## Measurements of the inclusive cross section and of differential distributions in top quark pair production (D0)

**Author:** Christian Schwanenberger<sup>1</sup>

<sup>1</sup> *University of Manchester*

**Corresponding Author:** schwanen@fnal.gov

We present measurements of the inclusive top quark pair production cross section in various final states including electrons, muons, tau leptons, large missing transverse energy, b-tagged and light flavor jets. We also show measurements of differential distributions of top quarks produced in pairs which provides a unique test of the dynamics of a heavy diquark system at large scales and represents a powerful search for new physics. The measured spectra, binned in several observables, are compared to simulations from different Monte Carlo generators. The measurements use up to  $10 \text{ fb}^{-1}$  of data collected with the D0 detector at the proton-antiproton Tevatron collider at a center-of-mass energy of 1.96 TeV.

TR4 - Top Quark Physics / 536

## Tevatron and LHC top mass combinations

**Author:** Frederic Deliot<sup>1</sup>

<sup>1</sup> *CEA - Centre d'Etudes de Saclay (FR)*

**Corresponding Author:** frederic.deliot@cern.ch

The top quark is the heaviest known elementary particle and its mass is a free parameter of the Standard Model. The CDF and D0 collaborations have previously measured the top quark's mass using the top quark pairs produced at the Tevatron proton-antiproton collider in many decay channels. We present here the combination of all published measurements with an integrated luminosity up to  $5.8 \text{ fb}^{-1}$  using a proper treatment of the uncertainty correlations between different measurements. This combination leads to the most precise top quark mass determination with a relative precision of 0.54%.

TR4 - Top Quark Physics / 538

## Measurements of single top quark production cross sections and $|\text{V}_{tb}|$ in ppbar collisions at $\sqrt{s}=1.96$ TeV (D0 and CDF)

**Author:** Yvonne Peters<sup>1</sup>

<sup>1</sup> *University of Göttingen & DESY (DE)*

**Corresponding Author:** reinhild.peters@cern.ch

We present measurements of production cross sections of single top quarks in ppbar collisions at  $\sqrt{s} = 1.96$  TeV using data collected with the CDF and D0 experiments with integrated luminosities of up to 9.7 fb<sup>-1</sup>. Measurements of the total production cross section and of the t-channel cross section are presented, as well as searches for the s-channel production process. These measurements are also used to extract the  $V_{tb}$  element of the CKM mixing matrix

Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 540

## Search for anomalous $Wtb$ couplings in ppbar collisions at $\sqrt{s} = 1.96$ TeV (D0)

**Author:** Kenneth Bloom<sup>1</sup>

<sup>1</sup> *University of Nebraska-Lincoln (US)*

**Corresponding Author:** kenbloom@unl.edu

We present new direct constraints on a general  $Wtb$  interaction using data corresponding to an integrated luminosity of 5.4 fb<sup>-1</sup> collected by the D0 detector at the Tevatron ppbar collider. The standard model provides a purely left-handed vector coupling at the  $Wtb$  vertex, while the most general, lowest dimension Lagrangian allows right-handed vector and left- or right-handed tensor couplings as well. We obtain precise limits on these anomalous couplings by comparing the data to the expectations from different assumptions on the  $Wtb$  coupling using information from electroweak single top quark production. We combine this with results studying the helicity of W bosons from top quark decays in  $t\bar{t}$  events.

TR4 - Top Quark Physics / 541

## Spin correlation in $t\bar{t}$ production (D0)

**Authors:** Yvonne Peters<sup>1</sup>; Yvonne Peters<sup>None</sup>

<sup>1</sup> *University of Göttingen & DESY*

**Corresponding Author:** reinhild.peters@cern.ch

We present a measurement of the ratio of events with correlated t and  $\bar{t}$  spins to the total number of  $t\bar{t}$  events. This ratio  $f$  is evaluated using a matrix-element-based approach in events with a single lepton (electron or muon) and at least four jets and in events with two leptons (ee, emu, mumu) and at least two jets. We analyze ppbar collisions data corresponding to an integrated luminosity of 5.3-5.4 fb<sup>-1</sup> collected with the D0 detector at the Fermilab Tevatron collider operating at a center of mass energy  $\sqrt{s}=1.96$  TeV. Combining the results of the single lepton and dilepton final states, we find  $f$  in agreement with the standard model. In addition, the combination provides evidence for the presence of spin correlation in  $t\bar{t}$  events with a significance of more than three standard deviations.

TR4 - Top Quark Physics / 543

## Measurement of the top quark mass in ppbar collisions using events with two leptons (D0)

**Authors:** Oleg Brandt<sup>1</sup>; Oleg Brandt<sup>2</sup>

<sup>1</sup> *University of Göttingen (DE)*

<sup>2</sup> *University of Oxford*

**Corresponding Author:** oleg.brandt@cern.ch

The mass of the top quark is a fundamental parameter of the standard model and has to be determined experimentally. The D0 experiment at the Fermilab Tevatron proton-antiproton collider with a centre-of-mass energy of 1.96 TeV has measured the top quark in various channels. We present the most recent measurements of the top quark mass in the dilepton and lepton+jets channels with up to 5.3 fb<sup>-1</sup> as well as their combination and give an outlook on the final, most precise measurement of the top quark mass at D0.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 544**

## Spin tracking at Future e+e- Colliders

**Author:** Anthony Hartin<sup>1</sup>

**Co-author:** Gudrid Moortgat-Pick<sup>2</sup>

<sup>1</sup> *DESY (DE)*

<sup>2</sup> *University of Hamburg*

**Corresponding Author:** anthony.hartin@cern.ch

In order to exploit the full potential of proposed future high-energy electron-positron colliders, precise knowledge of the beam polarization is required as it evolves throughout the entire machine. Here we discuss global spin tracking efforts in the ILC design from source to Interaction Point. Numerical results are presented for the latest International Linear Collider (ILC) and Compact Linear Collider (CLIC) machine parameters. A GEANT model that transports spin is used for the positron sources.

Depolarisation studies in the ring and through the spin rotators shows that polarization is maintained within budget. Spin tracking simulations through the Beam Delivery System reveals the importance of orbit correction and nanometer stabilization of final focus quadrupoles. Interaction Point beam-beam effects lead to significant depolarisation, the knowledge of which is obtained through a combination of custom designed polarimeters and analysis of W pair production data. Progress towards a global simulation package which incorporates specific spin tracking codes is discussed.

**TR4 - Top Quark Physics / 545**

## Combination of CDF and D0 measurements of the W boson helicity in top quark decays

**Author:** Erich Ward Varnes<sup>1</sup>

<sup>1</sup> *University of Arizona (US)*

**Corresponding Author:** erich.varnes@cern.ch

We report the combination of recent measurements of the helicity of the W boson from top quark decay by the CDF and D0 collaborations, based on data samples corresponding to integrated luminosities of 2.7–5.4 fb<sup>-1</sup> of ppbar collisions collected during Run II of the Fermilab Tevatron Collider. Combining measurements that simultaneously determine the fractions of W bosons with longitudinal (f<sub>0</sub>) and right-handed (f<sub>+</sub>) helicities, we find  $f_0 = 0.722 \pm 0.081$  [ $\pm 0.062$  (stat.)  $\pm 0.052$  (syst.)] and  $f_+ = -0.033 \pm 0.046$  [ $\pm 0.034$  (stat.)  $\pm 0.031$  (syst.)]. Combining measurements where one of the helicity fractions is fixed to the value expected in the standard model, we find  $f_0 = 0.682 \pm 0.057$  [ $\pm 0.035$

(stat.) $\pm$ 0.046 (syst.)] and  $f_+ = -0.015 \pm 0.035$  [ $\pm 0.018$  (stat.) $\pm$ 0.030 (syst.)]. The results are consistent with standard model expectations.

**Poster Session** - Board: 32 / 546

## Search for violation of Lorentz invariance in top quark pair production and decay

**Author:** Physics Coordinators D0<sup>None</sup>

**Corresponding Author:** d0\_physics\_coordinators@listserv.fnal.gov

Using data collected with the D0 detector at the Fermilab Tevatron Collider, corresponding to 5.3 fb<sup>-1</sup> of integrated luminosity, we search for violation of Lorentz invariance by examining the  $t\bar{t}$  production cross section in lepton+jets final states. We quantify this violation using the standard-model extension framework, which predicts a dependence of the  $t\bar{t}$  production cross section on sidereal time as the orientation of the detector changes with the rotation of the Earth. Within this framework, we measure components of the matrices  $(c_Q)_{\mu\nu}$  and  $(c_U)_{\mu\nu}$  containing coefficients used to parametrize violation of Lorentz invariance in the top quark sector. Within uncertainties, these coefficients are found to be consistent with zero.

**Poster Session** - Board: 57 / 547

## Antineutrino Detector for On-Line Monitoring of Nuclear Reactor Parameters and search for short range neutrino oscillations

**Authors:** A.S. Kobayakin<sup>1</sup>; A.S. Starostin<sup>1</sup>; E.I. Tarkovsky<sup>1</sup>; E.V. Demidova<sup>1</sup>; I.N. Tikhomirov<sup>1</sup>; M.V. Shirchenko<sup>2</sup>; Mikhail Danilov<sup>3</sup>; R. Mizuk<sup>1</sup>; R.V. Vasil'ev<sup>2</sup>; V.B. Brudanin<sup>2</sup>; V.G. Egorov<sup>2</sup>; V.V. Sinev<sup>4</sup>; V.Yu. Rusinov<sup>1</sup>

<sup>1</sup> ITEP

<sup>2</sup> JINR

<sup>3</sup> Institute for Theoretical and Experimental Physics (RU)

<sup>4</sup> INR

**Corresponding Author:** danilov@itep.ru

A solid scintillator detector DANSS (Detector of Anti-Neutrino based on Solid Scintillator) designed for remote on-line diagnostics of nuclear reactor parameters and a search for short range neutrino oscillation is under construction now. It will be installed at the Kalinin Nuclear Power Plant next year. DANSS is a 1 m<sup>3</sup> plastic scintillator detector divided into 2500 cells and surrounded with combined passive and active shielding to suppress external radiation backgrounds. The basic element of the detector is the scintillator strip 4×1×100 cm<sup>3</sup> in size with thin gadolinium coating. Light from the strip is collected by wave length shifting fibers 1.2 mm in diameter and transported to small-size photomultipliers and multipixel photodiodes operated in the Geiger mode (SiPMs) used to read out scintillation signals. The estimates of the DANSS parameters are presented: efficiency (~70%), counting rate of neutrino events (~8500 per day), and expected background level (below 1%). We demonstrate that a detector with such properties is capable to measure the nuclear reactor thermal power with an accuracy of about 1.3% in one day and to determine the fuel composition and <sup>239</sup>Pu production with an accuracy of ~4%. In addition, the antineutrino detector allows monitoring the <sup>239</sup>Pu-enriched rod extraction procedure. DANSS is placed on a movable platform. It can change the distance from the detector to the reactor core from 12 to 17 meters. The detector can be also placed at larger distances from the reactor core but this requires reassembling of the detector in a different hall. Measurements of the neutrino flux and energy spectrum at different distances should allow to study a large fraction of a sterile neutrino parameter space indicated by recent experiments and reanalysis of the reactor neutrino fluxes.

**Summary:**

Design and sensitivity of a solid scintillator antineutrino detector are presented. The sensitivity is sufficient to measure the fuel composition and to study a large fraction of a sterile neutrino parameters discussed for the explanation of recent experiments and neutrino reactor flux reanalysis.

**Poster Session** - Board: 20 / 549

## Recent result on search for nucleon decay and neutron-antineutron oscillation in Super-Kamiokande

**Author:** Jun Kameda<sup>1</sup>

<sup>1</sup> ICRR, University of Tokyo (JP)

**Corresponding Author:** kameda@suketto.icrr.u-tokyo.ac.jp

We present recent results of the search for baryon number violating phenomena predicted by GUTs in Super-Kamiokande covering nucleon decay and neutron-antineutron oscillation.

Grand Unified Theories (GUTs) seek to unify the strong and electroweak forces, and a unique prediction of the GUTs is baryon number violation. Two quarks in a nucleon can transform into a lepton and an antiquark resulting in a lepton plus meson final state.

Super-Kamiokande (SK) is ring imaging water Cherenkov detector, containing 50 ktons of ultra-pure water, located in Kamioka-town in Gifu prefecture, Japan.

The Super-Kamiokande experiment had started observation in 1996, and we collected data in four periods: SK-I (91.7kton year exposure), II (49.2 kton yr), III (31.9kton yr) and IV (on-going).

We present the results on search for  $p$

$\rightarrow e^+ + \pi^0$ ,  $p$

$\rightarrow \mu^+ + \pi^0$ , and  $p$

$\rightarrow \nu +$

$K^+$  based on SK-I to SK-IV data (219.8 kton yr exposure).

The other nucleon decay modes to meson plus anti-leptons are also presented based on SK-I, SK-I+II, or SK-I+II+III data.

Another possibility allowed by some of GUTs and Super Symmetric models is that neutron spontaneously changes to antineutron (called neutron-antineutron oscillation).

We plan to present the final result of neutron-antineutron oscillation search in SK-I.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 550**

## Measurements with electroweak gauge bosons at LHCb

**Author:** Jonathan Anderson<sup>1</sup>

<sup>1</sup> Universität Zürich (CH)

**Corresponding Author:** jonathan.anderson@cern.ch

We report the results of several analyses based on the reconstruction of electroweak gauge bosons at LHCb. The forward coverage of the LHCb detector provides unique sensitivity to various different observables that can be used to test the Standard Model predictions. The results include those on  $W$  and  $Z$  production,  $Z$  production with associated jets, and low-mass Drell-Yan production.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 551**

## Studies of soft QCD at LHCb

**Author:** Raluca Muresan<sup>1</sup>

<sup>1</sup> *Horia Hulubei National Institute of Physics and Nuclear Engineering (RO)*

**Corresponding Author:** raluca.muresan@cern.ch

Due to its unique pseudorapidity coverage and the possibility of extending the measurements to low transverse momenta, LHCb provides important input to the understanding of particle production and energy flow in a kinematical range where QCD models have large uncertainties. Measurements of charged, strange and charmed particle production are compared to predictions. In addition, studies of the energy flow probe the underlying event which is modeled in different ways by several Monte Carlo event generators.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 553**

## Onia production and polarisation at LHCb

**Author:** Valerie Gibson<sup>1</sup>

<sup>1</sup> *University of Cambridge (GB)*

**Corresponding Author:** gibson@hep.phy.cam.ac.uk

Studies of quarkonia production in the forward region provide important tests of perturbative QCD. We present studies of the production of charmonia and bottomonia in the LHCb detector, using data from proton-proton collisions at a range of centre-of-mass energies. The results are compared to recent theoretical predictions. Absolute and relative production cross-sections are presented for both S-wave and P-wave onia states. We also present studies of onia polarisation and double charm production, the latter performed for the first time at a hadron collider.

**Poster Session - Board: 36 / 554**

## The light pseudoscalar meson transition form factor

**Author:** Chong Chung Lih<sup>1</sup>

**Co-author:** Chao-Qiang Geng<sup>2</sup>

<sup>1</sup> *Department of Optometry, Shu-Zen College of Medicine and Management (TW)*

<sup>2</sup> *Department of Physics, National Tsing-Hua University*

**Corresponding Author:** cclih@phys.nthu.edu.tw

We use the light front quark model in order to improve the theoretical prediction of the transition form factor of  $\pi^0(\eta)$  to  $\gamma^*\gamma$  as a function of the momentum transfer  $Q^2$ . We compare our result with the experimental data by BaBar as well as other calculations based on the LFQM. We show that our predicted form factor fits well with the experimental data, particularly those at the large  $Q^2$  region.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 555

## Heavy flavour spectroscopy at LHCb

**Author:** Raphael Märki<sup>1</sup>

<sup>1</sup> *Ecole Polytechnique Federale de Lausanne (CH)*

**Corresponding Author:** raphael.marki@epfl.ch

LHCb is a dedicated B physics experiment at the LHC. During the 2011 run the experiment collected 1.0 fb<sup>-1</sup> of data. This large data sample allows to explore the b baryon sector with unprecedented precision. We will present the first observation of the  $\Lambda_b^*$  baryons and measurements of the properties of  $\Xi_b$  and  $\Omega_b$  baryons. In addition we will present results on the production and properties of the Bc meson, including searches for previously unobserved decay modes.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 556

## B meson decays to final states containing charmonia at LHCb

**Author:** Christian Peter Linn<sup>1</sup>

<sup>1</sup> *Ruprecht-Karls-Universitaet Heidelberg (DE)*

**Corresponding Author:** linn@physi.uni-heidelberg.de

The LHCb experiment is a forward arm spectrometer designed to make high precision measurements of b hadron decays at the LHC. During 2011 a total luminosity of 1.0 fb<sup>-1</sup> of data was collected at  $\sqrt{s}=7$  TeV. LHCb's efficient dimuon trigger allows to perform studies of B mesons decaying to charmonia with high precision. We will present new measurements of the relative branching ratios of exclusive b decays to final states involving J/psi and psi(2S) mesons, together with other studies of B-decays into J/psi and light hadrons. In addition, we will discuss results for exotic states such as the X(3872) and X(4140).

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 557

## Charm production and rare charm decays at LHCb

**Author:** Walter Bonivento<sup>1</sup>

<sup>1</sup> *INFN Cagliari (IT)*

**Corresponding Author:** walter.bonivento@cern.ch

Flavour-changing neutral current decays such as  $c \rightarrow u l^+ l^-$  are highly suppressed in the Standard Model (SM), but may be enhanced by New Physics. For  $D^0 \rightarrow \mu^+ \mu^-$ , the SM decay rate is dominated by long distance contributions but is still a few order of magnitudes below the current experimental limit. In decays such as  $D^+ \rightarrow \pi^+ \mu^+ \mu^-$ , measuring the differential branching ratio as a function of the  $\mu^+ \mu^-$ -invariant mass is a sensitive probe for New Physics contributions. We present results of searches for rare charm decays with the 2011 LHCb data sample, corresponding to an integrated luminosity of 1.0 fb<sup>-1</sup>.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 558

## Studies of charm mixing and CP violation at LHCb

**Author:** Jordi Garra Tico<sup>1</sup>

<sup>1</sup> *University of Cambridge (UK)*

**Corresponding Author:** jordi.garra.tico@cern.ch

LHCb collected 1.0 fb<sup>-1</sup> of data in 2011, corresponding to O(10<sup>8</sup>) fully reconstructed decays of open charm hadrons. This data provides unprecedented samples of charmed hadrons, allowing precise measurements of mixing and CP violation parameters. We report the results of searches for mixing and CP violation in 2-body and multi-body decays, with analyses using part or all of the 2011 data.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 559

## Searches for very rare decays to purely leptonic final states at LHCb

**Author:** Mathieu Perrin-Terrin<sup>1</sup>

<sup>1</sup> *Centre de Physique des Particules de Marseille, Université d'Aix-Marseille (FR)*

**Corresponding Author:** perrin-terrin@cppm.in2p3.fr

We present a review of the searches for very rare decays to muon final states performed at LHCb using 1.0 fb<sup>-1</sup> of pp collisions at 7 TeV centre of mass energy. Flavour changing neutral current processes, such as B<sup>0</sup>s → μ<sup>+</sup> μ<sup>-</sup> are highly suppressed in the Standard Model (SM). Such decays therefore allow the contributions from new processes or new heavy particles to significantly modify the expected SM rates. Charged lepton flavour violating processes (LFV), such as the neutrinoless τ<sup>+</sup> → μ<sup>+</sup> μ<sup>-</sup> μ<sup>+</sup> decay, have vanishingly small decay rates in the SM, but can be significantly enhanced in extended models. We report the latest results on these channels from the LHCb dataset.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 560

## Studies of the electroweak penguin transitions b → s μ<sup>+</sup> μ<sup>-</sup> and b → d μ<sup>+</sup> μ<sup>-</sup> at LHCb

**Author:** Abraham Antonio Gallas Torreira<sup>1</sup>

<sup>1</sup> *Universidade de Santiago de Compostela (ES)*

**Corresponding Author:** abraham.gallas@cern.ch

Rare b → s μ<sup>+</sup> μ<sup>-</sup> transitions that proceed via flavour changing neutral currents are suppressed in the SM and provide a sensitive probe of new physics contributions entering in competing diagrams. The dataset collected with the LHCb experiment has enabled measurements to be made in decays such as B<sup>0</sup> → K<sup>0</sup> μ<sup>+</sup> μ<sup>-</sup>, B<sup>+</sup> → K<sup>+</sup> μ<sup>+</sup> μ<sup>-</sup> and B<sup>0</sup>s → φ μ<sup>+</sup> μ<sup>-</sup>. Particularly interesting are the angular and isospin asymmetries in the decay B<sup>0</sup> → K<sup>0</sup> μ<sup>+</sup> μ<sup>-</sup>, which are sensitive probes of new physics. The large statistics of reconstructed B mesons allow, for the first time, experimental access to b → d μ<sup>+</sup> μ<sup>-</sup> transitions, such as B<sup>+</sup> → π<sup>+</sup> μ<sup>+</sup> μ<sup>-</sup>, which are further suppressed in the SM. The latest results on these decay modes will be presented.



Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 561

## Radiative B decays at LHCb

**Author:** Olivier Deschamps<sup>1</sup>

<sup>1</sup> *Laboratoire De Physique Corpusculaire (FR)*

**Corresponding Author:** olivier.deschamps@cern.ch

Radiative B decays are sensitive probes of New Physics. We present the first results on these decays from the LHCb experiment, which are obtained with 1.0 fb<sup>-1</sup> of proton-proton collision data collected in 2011. Results include the measurements of the branching fraction of  $B^0 \rightarrow \phi \gamma$  and the CP asymmetry in  $B^0 \rightarrow K^{*0} \gamma$ .

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 562

## Measurement of $\phi$ s at LHCb

**Author:** Greig Cowan<sup>1</sup>

<sup>1</sup> *EPFL (CH)*

**Corresponding Author:** greig.cowan@cern.ch

The determination of the CP-violating phase  $\phi$ s in  $B^0 \rightarrow J/\psi \phi$  decays is one of the key goals of the LHCb experiment. Its value is predicted to be very small in the Standard Model but can be significantly enhanced in many models of new physics. We present the world's best measurement of  $\phi$ s and the first observation of a non-zero  $\Delta\Gamma$ s based upon 1.0 fb<sup>-1</sup> of data collected at LHCb during 2011.  $\phi$ s can also be measured using the  $B^0 \rightarrow J/\psi \pi \pi$  decay mode, which has been shown to be predominantly CP-odd. We present this measurement and the combination of  $\phi$ s from both decay modes.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 563

## Measurements of b hadron lifetimes and effective lifetimes at LHCb

**Author:** Anna Phan<sup>1</sup>

<sup>1</sup> *Syracuse University (US)*

**Corresponding Author:** anna.phan@cern.ch

Precision measurements of b-hadron lifetimes are a key goal of the LHCb experiment. In the  $B^0$ s sector, the measurement of the effective lifetimes for  $B^0$ s mesons decaying to CP-odd, CP-even and flavour specific final states are essential for constraining the  $B^0$ s mixing parameters,  $\Delta\Gamma$ s, the average width  $\Gamma$ s and the CP-violating phase,  $\phi$ s. We present measurements of the effective lifetimes of  $B^0 \rightarrow K^+ K^-$ ,  $B^0 \rightarrow J/\psi f_0(980)$  and  $B^0 \rightarrow J/\psi \phi$  using 1.0 fb<sup>-1</sup> of data collected by LHCb in 2011.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 564

## Flavour tagging at LHCb and measurements of B meson oscillations

**Author:** Stefania Vecchi<sup>1</sup>

<sup>1</sup> *INFN Ferrara*

**Corresponding Author:** stefania.vecchi@fe.infn.it

The identification of the flavour of reconstructed B<sup>0</sup> and B<sup>0s</sup> mesons at production is necessary for the measurements of oscillations and time-dependent CP asymmetries. We report on the techniques developed by the LHCb experiment for flavor tagging and on the procedures used to optimize and calibrate its performance using data samples of different flavour-specific B decays. We also describe the latest results on B meson oscillations obtained using flavour tagging, including the updated determination of the B<sup>0</sup> and B<sup>0s</sup> mixing frequencies  $\Delta m_d$  and  $\Delta m_s$ .

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 565

## Measurements of B → D K(\*) decays to constrain the CKM unitarity triangle angle $\gamma$ at LHCb

**Author:** Andrew Stephen Powell<sup>1</sup>

<sup>1</sup> *University of Oxford (GB)*

**Corresponding Author:** a.powell1@physics.ox.ac.uk

The LHCb experiment is a general purpose forward spectrometer operating at the Large Hadron Collider, optimized for the study of B and D hadrons. LHCb collected 1.0 fb<sup>-1</sup> of integrated luminosity during 2011 data taking, collecting unprecedented large samples of B hadron decays to final states involving charmed hadrons. These decays offer many complementary measurements of CP violation, in particular measurements which are sensitive to the angle  $\gamma$  of the CKM unitarity triangle. We present here world best measurements of these decays.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 566

## Studies of hadronic B decays to final states containing open charm mesons at LHCb

**Author:** Alexandra Martin Sanchez<sup>1</sup>

<sup>1</sup> *Universite de Paris-Sud 11 (FR)*

**Corresponding Author:** sanchez@lal.in2p3.fr

The LHCb experiment is a general purpose forward spectrometer operating at the Large Hadron Collider, optimized for the study of B and D hadrons. LHCb collected 1.0 fb<sup>-1</sup> of integrated luminosity during 2011 data taking, collecting unprecedented large samples of B hadron decays to final states involving charmed hadrons. These decays offer many complementary measurements of CP violation and CKM matrix parameters, and serve as a laboratory for testing effective theories of hadron decays. We present a selection of new world leading results in these types of decays, including first observations of new decay modes, world best branching ratio measurements and studies of resonant structure.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 568

## Measurements of CP violation in charmless two-body B decays at LHCb

**Author:** Paul Soler Jermyn<sup>1</sup>

<sup>1</sup> *University of Glasgow (GB)*

**Corresponding Author:** paul.soler@glasgow.ac.uk

Direct and mixing-induced CP violation observables in charmless charged two-body B decays may provide valuable information in the quest for physics beyond the Standard Model. Owing to the large beauty production cross-section at the LHC and to the unique characteristics of the LHCb detector and trigger, unprecedented samples of such decays are becoming available. We present updated measurements of direct CP violation in  $B^0(s) \rightarrow K \pi$  decays as well as of direct and mixing-induced CP violation in  $B^0 \rightarrow \pi^+ \pi^-$  and  $B^0_s \rightarrow K^+ K^-$  decays. Furthermore, we report measurements of the branching fractions of these decays, notably including those of the annihilation modes  $B^0 \rightarrow K^+ K^-$  and  $B^0_s \rightarrow \pi^+ \pi^-$ .

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 569

## Studies of multibody charmless B decays at LHCb

**Author:** Fernando Luiz Ferreira Rodrigues<sup>1</sup>

<sup>1</sup> *CBPF - Brazilian Center for Physics Research (BR)*

**Corresponding Author:** frodrigu@cbpf.br

Charmless multibody B decays proceeding through the quark transitions  $b \rightarrow q \bar{q} s(d)$  are relevant laboratories to study both direct and mixing-induced CP violation effects and to search for deviations from Standard Model expectations. The  $1.0 \text{ fb}^{-1}$  of data recorded by the LHCb experiment in 2011 have been analyzed to reconstruct  $B^+$ ,  $B^0$  and  $B^0_s$  decays in various multibody final states. We report direct CP-violation studies in three-body charged B decays, reconstruction of neutral B mesons in three-body decays with a  $K^0_S$  meson in the final state and amplitude analyses of B decays into two intermediate vector particles such as  $B^0 \rightarrow \varphi K^{*0}$  or  $B^0_s \rightarrow \varphi \varphi$ .

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 570

## Studies of asymmetries in semileptonic B decays at LHCb

**Author:** Marina Artuso<sup>1</sup>

<sup>1</sup> *Syracuse University (US)*

**Corresponding Author:** marina.artuso@cern.ch

During 2011 data taking, LHCb has recorded large samples of semileptonic B decays. These provide potential to study CP violation effects in all of the  $D^0$ ,  $B^0$  and  $B^0_s$  systems. For the former, the charge of the muon in  $B \rightarrow D^0 \mu^\pm \nu X$  decays provides a novel procedure to tag the flavour of the neutral D meson at production, allowing competitive sensitivity for the measurement of the difference of CP violation asymmetries in  $D^0 \rightarrow h^+ h^-$  ( $h = K, \pi$ ). For the latter, integrated or time-dependent asymmetries between charge-conjugate final states probe CP violation in  $B^0(s)$  mixing through the measurement of the parameter  $A_{\text{fs}}$  (sometimes referred to as  $A_{\text{sl}}$ ). All of these measurements rely

on data-driven techniques to obtain excellent control of systematic uncertainties. We present the status of the analyses.

**Room 218 - Detectors and Computing for HEP - TR13 / 571**

## The LHCb upgrade

**Author:** Franz Muheim<sup>1</sup>

<sup>1</sup> *University of Edinburgh (UK)*

**Corresponding Author:** muheim@ph.ed.ac.uk

The LHCb experiment is designed to perform high-precision measurements of CP violation and search for New Physics using the enormous flux of beauty and charmed hadrons produced at the LHC. The operation and the results obtained from the data collected in 2010 and 2011 demonstrate that the detector is robust and functioning very well. However, the limit of  $\sim 1 \text{ fb}^{-1}$  of data per year cannot be overcome without improving the detector. We therefore plan for an upgraded spectrometer by 2018 with a 40 MHz readout and a much more flexible software-based triggering system that will increase the data rate as well as the efficiency specially in the hadronic channels. Here we present the LHCb detector upgrade plans.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 572**

## Dark Matter Relic and Its Implications on the Underground Laboratory and LHC Search

**Author:** Ho-Chin Tsai<sup>1</sup>

**Co-author:** Kwei-Chou Yang<sup>2</sup>

<sup>1</sup> *Chung Yuan Christian University (TW)*

<sup>2</sup> *Chung Yuan Christian University*

**Corresponding Author:** tsaihochin@gmail.com

Dark matter (DM) search is one of the major goals in the modern physics. An eligible dark matter candidate may reproduce the correct relic inferred from astrophysical observations, e.g. WMAP experiment. It may also be compatible with the null results on dark matter direct detection performed in the underground laboratories by measuring events of nuclei recoil as scattered by the halo dark matter, e.g. XENON experiment. Due to weakly interacting, dark matter particles produced at colliders involve missing momentum and this increase the mono-jet plus missing  $E_T$  events. But so far there is no deviation from SM prediction found with the now accumulated luminosity, e.g. LHC experiment. Alternative to the recent effective operator study shows it is hard to compatible with relic and collider search simultaneously. Here we study a dark sector consists of DM fermion and scalar mediator with a mediator kinematics details kept. We display viable parameter space in terms of these two exotic particle masses which satisfy various experimental data.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 573**

## Leptonic and semileptonic B decays at Belle

**Author:** Youngmin Yook<sup>1</sup>

<sup>1</sup> *Yonsei University*

**Corresponding Author:** yookym@gmail.com

We present a measurement of the decay  $B \rightarrow \tau\nu$  using the full Belle data set including  $772 \times 10^6$   $B\bar{B}$  collected at the KEKB asymmetric-energy  $e^+e^-$  collider. The  $B\bar{B}$  pair events are tagged by fully reconstructing one B meson decaying in a hadronic mode and detecting the  $B \rightarrow \tau\nu$  candidate in the recoil. We obtain the branching fraction for  $B \rightarrow \tau\nu$  and present a direct determination of the product of the B meson decay constant  $f_B$  and the magnitude of the Cabibbo-Kobayashi-Maskawa matrix element  $|V_{ub}|$ . The resulting constraints on the charged Higgs boson are also discussed.

**Plenary3 - The Standard Model -TR1 / 574**

## Search for Higgs Particles in MSSM SUSY

**Author:** Christian Veelken<sup>1</sup>

<sup>1</sup> *Ecole Polytechnique (FR)*

**Corresponding Author:** christian.veelken@cern.ch

Results are presented on the search for MSSM SUSY Higgs production and decays, including a neutral Higgs decaying to a pair of tau leptons, and a charged Higgs decaying in tau neutrino. The full data sample of 4.7 fb-1 of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Plenary3 - The Standard Model -TR1 / 576**

## Search for the Higgs particle in models beyond the MSSM

**Author:** James Olsen<sup>1</sup>

<sup>1</sup> *Princeton University (US)*

**Corresponding Author:** jim.olsen@cern.ch

Results are presented on the search for the non standard-model Higgs production and decays, beyond MSSM SUSY, including the production of a doubly charged Higgs boson decaying onto a pair of like sign charged leptons and a search for a low mass neutral  $a_0$  decaying into a pair of muons. The full data sample of 4.7 fb-1 of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 577**

## Jet Measurements in CMS

**Author:** Sanmay Ganguly<sup>1</sup>

<sup>1</sup> *Tata Institute of Fundamental Research*

**Corresponding Author:** sanmay.ganguly@cern.ch

We present studies of the substructure in multijet and V+jets events at CMS. Several jet grooming techniques are investigated, and we present measurements of jet properties and jet production rates at CMS with pp collisions at 7 TeV. Inclusive jet and dijet differential cross sections are compared to NLO QCD predictions with various PDF sets. We also present studies of the jet substructure in QCD multijet and V+jets events. Several jet grooming techniques are investigated, and predictions from MC generators are compared to collision data.

**Room 218 - Detectors and Computing for HEP - TR13 / 581**

## The status of the CMS pixel upgrade detector

**Author:** Ferdinando Giordano<sup>1</sup>

<sup>1</sup> *University of California Riverside (US)*

**Corresponding Author:** ferdinando.giordano@cern.ch

The present CMS pixel detector was designed for a maximum luminosity of  $1 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ . Following the Phase 1 upgrade of the LHC, the peak luminosity is foreseen to reach  $2 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ . Due to the radiation damage and large data losses in the readout chip the present pixel system must be replaced by a new one in the long shutdown of 2016. The current status of the CMS pixel detector upgrade project will be presented. The new features of the proposed detector that will be discussed are ultra-light mechanical design with four barrel layers and 3 end-cap disks, digital readout chip with higher rate capability and new cooling system.

**TR4 - Top Quark Physics / 582**

## Top quark pair production cross section at CMS

**Author:** Ana Rodriguez Marrero<sup>1</sup>

<sup>1</sup> *Universidad de Cantabria (ES)*

**Corresponding Author:** ana.rodriquez.marrero@cern.ch

Precision measurements are presented of the top-pair production cross section in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV. The data are collected with the CMS experiment during the year 2011. The measurements are performed in several decay channels, the lepton+jets, the dilepton and the fully hadronic channels, including the tau-dilepton and tau+jets modes. B-jet identification is used to increase the purity of the selection. The backgrounds are determined using data-driven techniques. The results are combined with each other and compared with theory predictions.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 585**

## Measurement of the top pair invariant mass distribution and search for New Physics (CMS)

**Author:** Freya Blekman<sup>1</sup>

<sup>1</sup> *Inter-University Institute for High Energies (BE)*

**Corresponding Author:** freya.blekman@cern.ch

A measurement of the top-pair mass distribution in  $t\bar{t}$  events is presented using proton-proton collision events at the LHC at a centre-of-mass energy of 7 TeV. The data are collected with the CMS experiment during the year 2011. The analysis is performed using several final states originating from top-pair production. The measurement is then used to search for massive resonances decaying into top-pairs. No significant deviations from the QCD expectations are observed, and upper limits on the new physics production cross-section as a function of the particle mass is determined

TR4 - Top Quark Physics / 586

## Differential cross sections in top pair events at CMS

**Author:** Maria Aldaya Martin<sup>1</sup>

<sup>1</sup> *Deutsches Elektronen-Synchrotron (DE)*

**Corresponding Author:** maria.aldaya.martin@cern.ch

We present measurements of various differential cross sections in top pair production in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV. The data are collected by the CMS experiment during the year 2011. Cross sections are measured differentially as a function of various variables, including the transverse momentum and rapidity of the (anti)top quark and the top-antitop system, as well as multiplicity and transverse momenta of jets produced in addition to the top pair. The cross sections are corrected for detector effects to the level of stable particles. The results are compared with various Monte Carlo models, as well as with theory predictions. The overall consistency of the features of top pair production with expectations from the standard model is investigated.

Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 587

## Measurement of the charge asymmetry in top quark pair production in pp collisions (CMS)

**Author:** Thorsten Chwalek<sup>1</sup>

<sup>1</sup> *KIT - Karlsruhe Institute of Technology (DE)*

**Corresponding Author:** thorsten.chwalek@cern.ch

A measurement is presented of the charge asymmetry in top-pair production in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV. The data are collected by the CMS experiment during the year 2011. The analysis uses events with one charged lepton and at least four jets. In order to measure the charge asymmetry in charge-symmetric initial state processes, the difference of absolute pseudo-rapidities of top and anti-top is used. The asymmetry is measured inclusively and differentially, as functions of the invariant mass, the rapidity and the transverse momentum of the  $t\bar{t}$  system. The results are compared with various theory predictions, and discussed in the context of forward-backward asymmetry measurements at Tevatron.

TR4 - Top Quark Physics / 588

## Measurements of the top quark mass (CMS)

**Author:** Hartmut Stadie<sup>1</sup>

<sup>1</sup> *Hamburg University (DE)*

**Corresponding Author:** hartmut.stadie@cern.ch

The mass of the top quark is a fundamental parameter of the Standard Model. Measurements of the top quark mass are presented using data collected by the CMS experiment during the year 2011, in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV. Different reconstruction methods to extract the top quark mass are employed. The results of the various channels are combined and compared to the world average. The top mass is also extracted from the top pair cross section measured at CMS, including a determination of  $m_{\text{top}}$  in the  $\overline{\text{MS}}$  scheme.

**TR4 - Top Quark Physics / 590**

## Measurement of the top-antitop mass difference (CMS)

**Author:** Gerrit Van Onsem<sup>1</sup>

<sup>1</sup> *Vrije Universiteit Brussel (BE)*

**Corresponding Author:** gerrit.patrick.van.onsem@cern.ch

A measurement of the difference between the masses of top and anti-top quarks is presented using data collected by the CMS experiment during the year 2011, in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV. Events from the 1+jets channel are selected by requiring one lepton and at least four jets in the final state. The measured value is compared with the prediction from the Standard Model, where no difference in mass between the top quark and the antitop quark is expected.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 591**

## Semileptonic B/Bs decays at Belle

**Author:** Christian Oswald<sup>1</sup>

<sup>1</sup> *Universität Bonn*

**Corresponding Author:** oswald@ipnp.troja.mff.cuni.cz

We present a search for the four-body semileptonic baryonic decay  $B^- \rightarrow p\bar{p}\ell^-\bar{\nu}_\ell$  ( $\ell = e, \mu$ ) based on a data sample of 772 million  $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy electron-positron collider. In this study, a new neural-network based hadronic  $B$ -meson tagging method is applied. The theoretical expectation of the decay branching fraction is  $\sim 1 \times 10^{-4}$ , which is within the experimental sensitivity of this search.

**TR4 - Top Quark Physics / 592**

## Spin correlations and W helicity in top events with CMS

**Author:** Suharyo Sumowidagdo<sup>1</sup>

<sup>1</sup> *University of California Riverside (US)*



**Corresponding Author:** suharyo.sumowidagdo@cern.ch

Measurement of the polarisation of W bosons and top anti-top spin correlations in top-quark decays are presented. The analysis makes use of top-pair events in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV using data collected by the CMS experiment during the year 2011. Final states are selected where one of the two W bosons decays into electron-neutrino or muon-neutrino, and the other into quarks. From these events the W-boson helicity fractions and angular asymmetries are extracted. The spin information is extracted from the the angular distributions of the top quark decay products. The results, in agreement with the expectations from the Standard Model, are presented and used to set limits on anomalous contributions to the Wtb vertex.

**TR4 - Top Quark Physics / 594**

## Single top production in CMS

**Author:** Gabriele Benelli<sup>1</sup>

<sup>1</sup> *University of Kansas (US)*

**Corresponding Author:** gabriele.benelli@cern.ch

We present measurements of single top quark production, performed using CMS data collected in 2010-2011 at a centre-of-mass energy of 7 TeV. The cross section for the electroweak production of single top quarks is measured in the t-channel using various methods. The combined result is used to place a constraint on the CKM matrix element  $V_{tb}$ . The data sample analyzed allows to study also differential distributions. For the first time, single top production is measured in the tW channel.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 595**

## Design Concepts for a Large Hadron Electron Collider

**Author:** Max Klein<sup>1</sup>

<sup>1</sup> *CERN*

**Corresponding Author:** mklein@hep.ph.liv.ac.uk

A Conceptual Design Report has been completed for a new electron-proton and electron-ion collider, which achieves a cms energy of 1.3 TeV in ep using the high energy beams of the LHC. Designed for synchronous ep and pp operation, the LHeC will be a high luminosity collider with a wide ranging physics program on high precision deep inelastic scattering and new physics. The electron beam is designed as an energy recovery linac in a racetrack configuration with triple return arcs. As well as a summary of the Conceptual Design, the next steps towards a technical design of the LHeC are presented.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 597**

## Partons, QCD and Low x Physics at the Large Hadron electron Collider (LHeC Study Group)

**Author:** Claudia Beatriz Glasman Kuguel<sup>1</sup>

<sup>1</sup> *Universidad Autonoma de Madrid (ES)*

**Corresponding Author:** claudia.beatriz.glasman.kuguel@cern.ch

The Large Hadron electron Collider (LHeC) is a proposed facility which will exploit the new world of energy and intensity offered by the LHC through collisions with a new 60 GeV electron beam. This contribution summarises the detailed simulation studies on QCD-related topics included in the recently released Conceptual Design Report. Highlights include a new level of precision and flavour decomposition for the extraction of parton densities and a much extended kinematic range towards low Bjorken- $x$  in which novel saturation effects are expected.

In addition to inclusive neutral and charged current cross sections, more exclusive processes such as jet and heavy flavour production are included, as well as diffractive observables.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 599**

## Search for FCNC in top pair events in pp collisions (CMS)

**Author:** Yuan Chao<sup>1</sup>

<sup>1</sup> *National Taiwan University (TW)*

**Corresponding Author:** yuan.chao@cern.ch

A search for flavor changing neutral currents in top quark decays is presented using a sample of top quark pair event candidates decaying via  $Wb$  and  $Zq$  into  $lvb$  and  $llq$  events. The search is performed at the CMS experiment at the LHC, using a data sample recorded in proton-proton collisions at a center-of-mass energy of 7 TeV. The observed number of events agrees with the standard model prediction, and no evidence of flavor changing neutral currents in top decays is found.

**TR4 - Top Quark Physics / 601**

## Other top quark properties in CMS

**Author:** Yvonne Küssel<sup>1</sup>

<sup>1</sup> *RWTH-Aachen (DE)*

**Corresponding Author:** yvonne.kuessel@cern.ch

Measurement of top quark properties, such as the top quark charge and the flavour contents in top quark pair events is presented using proton-proton collision data recorded with the CMS Experiment at the LHC at a centre-of-mass energy of 7 TeV. For the measurement of the top quark charge, the top quark pair events are reconstructed in the muon+jets final state and different top quark charge hypotheses ( $2/3e$  or  $-4/3e$ ) are discriminated by use of the charge correlations between high- $p_T$  muons from  $W$  boson decays and soft muons from  $B$ -hadron decays in  $b$  jets. A normalised asymmetry of events categorised with a charge of either  $+2/3e$  or  $-4/3e$  is calculated. The fraction of top quarks decaying into a  $W$ -boson and a  $b$ -quark relative to all top quark decays,  $R = BR(t \rightarrow Wb) / \text{Sum}(BR(t \rightarrow Wq))$ , is determined by counting the jets identified as  $b$ -jets, using a model that relies on the  $b$ -tagging and mistagging efficiencies. The results are found consistent with SM predictions.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 603**

## Electron-Ion Collisions at a Large Hadron electron Collider (LHeC Study Group)

**Author:** Paul Newman<sup>1</sup>

<sup>1</sup> *University of Birmingham (UK)*

**Corresponding Author:** paul.richard.newman@cern.ch

The Large Hadron electron Collider (LHeC) is a proposed facility which will exploit the LHC heavy ion beam for electron-nucleus scattering, using a new 60 GeV electron accelerator. This contribution, which is derived from the detailed simulations in the recently released Conceptual Design report, addresses the expected physics impact of the LHeC for heavy ion physics and nuclear parton density determinations. The kinematic coverage extends beyond previous deep inelastic lepton-ion experiments by nearly four orders of magnitude at low Bjorken  $x$  (from  $x \sim 10^{-2}$  to  $x \sim 10^{-6}$ ) and is expected to be sufficient to reveal the non-linear dynamics which tame the low  $x$  growth of parton densities. The inclusive electron-lead cross section, as well as exclusive and diffractive channels, are explored as means of probing this new region of very high parton densities.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 605**

## The Large Hadron electron Collider Detector Design Concept (LHeC Study Group)

**Authors:** Alessandro Polini<sup>1</sup>; Paul Newman<sup>2</sup>; Peter Kostka<sup>3</sup>; Peter Kostka<sup>4</sup>

<sup>1</sup> *DESY (DE) & CERN (CH)*

<sup>2</sup> *Birmingham University*

<sup>3</sup> *DESY, Zeuthen*

<sup>4</sup> *Deutsches Elektronen-Synchrotron (DE)*

**Corresponding Authors:** alessandro.polini@cern.ch, paul.richard.newman@cern.ch, kostka@mail.desy.de, peter.kostka@desy.de

The Conceptual Design Report for the Large Hadron Electron Collider has recently been released. This contribution summarises the part of the report covering design concepts for a new detector, which combines the demands of very high precision with those of large acceptance into a novel device for electron-proton physics at TeV energies. The physics and technical requirements, choices of detector techniques and the integration of the detector with the 3 beam interaction region including its magnet designs are presented.

**Plenary 3 - The Standard Model - TR1 / 607**

## Prospects for Higgs Physics at a Large Hadron Electron Collider (LHeC Study Group)

**Authors:** , LHeC Study Group<sup>1</sup>; Uta Klein<sup>2</sup>

<sup>1</sup> *CERN*

<sup>2</sup> *University of Liverpool (UK)*

**Corresponding Authors:** uta.klein@cern.ch, paul.newman@cern.ch

The Large Hadron electron Collider (LHeC) is a proposed facility which will collide an LHC proton beam with a new 60 GeV electron beam. This contribution summarises the LHeC prospects for Higgs physics, as documented in the recently released Conceptual Design Report. Assuming a light Higgs boson, the dominant  $b\text{-}b\bar{b}$  coupling can be measured and other Standard model properties of the decay can be tested. The dominant Standard Model production mechanism via  $WW$  fusion yields a

clean final state signature with missing transverse momentum and one high transverse momentum jet in addition to the Higgs decay products and also contains two rapidity gaps. Isolating this channel will allow sensitive tests of the CP structure and other properties of the HWW vertex, which lies at the heart of electroweak symmetry breaking.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 608**

## **Forward Physics Results from CMS.**

**Author:** Gilvan Augusto Alves<sup>1</sup>

<sup>1</sup> *Centro Brasileiro de Pesquisas Físicas (BR)*

**Corresponding Author:** gilvan.augusto.alves@cern.ch

We report on the latest soft and semi-hard QCD measurements in p-p collisions at the LHC including: (i) measurement of the total inelastic cross section, (ii) inclusive identified charged-hadron pT spectra, (iii) underlying event and constraints on models of multi-parton interactions, and (iv) characteristics of jet radiation as a function of pseudorapidity.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 610**

## **Exclusive and diffractive physics results from CMS**

**Author:** Robert Ciesielski<sup>1</sup>

<sup>1</sup> *Rockefeller University (US)*

**Corresponding Author:** rciesielsk@rockefeller.edu

We report on the latest CMS measurements of exclusive and diffractive production of dijets, dimuons, dielectrons and diphotons in pomeron- and photon-induced collisions in p-p at 7 TeV. The data are compared to various theoretical predictions.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 616**

## **Searches for SUSY in hadronic final states at CMS**

**Author:** Seema Sharma<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Lab. (US)*

**Corresponding Author:** seema.sharma@cern.ch

We present results of searches for SUSY production at CMS in events containing hadronic jets and missing energy. Various discriminants based on the event kinematics are employed to suppress standard-model backgrounds. The results are interpreted in the context of the Constrained Minimal Supersymmetric Standard Model, and of a number of “simplified models”.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 617**

## Searches for SUSY in final states with single leptons at CMS

**Author:** Kajari Mazumdar<sup>1</sup>

<sup>1</sup> *Tata Institute of Fundamental Research*

**Corresponding Author:** mazumdar@tifr.res.in

We search for evidence of Supersymmetry in events with a single lepton, multijets and missing energy. The search is done with proton-proton collision data collected by the CMS detector at the CERN Large Hadron Collider. The backgrounds, which are primarily from W+jet and top quark production, are predicted with control samples in the data. The results are interpreted in terms of the constrained minimal supersymmetric extension of the standard model as well as more generic Simplified Model Spectra (SMS) topologies.

TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 618

## Searches for SUSY in events with two or more leptons at CMS

**Author:** Pablo Martinez Ruiz Del Arbol<sup>1</sup>

<sup>1</sup> *Eidgenoessische Tech. Hochschule Zuerich (CH)*

**Corresponding Author:** pablo.martinez@cern.ch

We present results of searches for SUSY production at CMS in events with multiple lepton production. These include final states with Z bosons decaying to lepton pairs, non-resonant same- and opposite-sign lepton pairs, and three or more isolated leptons. The results are used to exclude previously unexplored regions of the supersymmetric parameter space assuming R-parity conservation with the lightest supersymmetric particle being either a neutralino or gravitino.

TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 619

## Searches for SUSY in final states with photons at CMS

**Author:** Mike Hildreth<sup>1</sup>

<sup>1</sup> *University of Notre Dame (US)*

**Corresponding Author:** mikeh@omega.hep.nd.edu

We present results of searches for SUSY production at CMS in events with one or two isolated photons. The results are interpreted in terms of gauge-mediation models, with the gravitino as the lightest supersymmetric particle.

TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 620

## Searches for SUSY in events with third-generation particles at CMS

**Author:** Altan Cakir<sup>1</sup>

<sup>1</sup> *Deutsches Elektronen-Synchrotron (DE)*

**Corresponding Author:** altan.cakir@cern.ch

We present results of searches for SUSY production at CMS in events with third-generation signatures. Along with missing energy, the final states may include hadronic jets with or without b-quark tag, light leptons, and tau leptons. These features serve both to distinguish standard-model components, and for sensitivity to those SUSY models that lead to final states rich in heavy-flavored particles.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 622**

## Heavy flavor and vector bosons associate production

**Author:** Simon Marie E De Visscher<sup>1</sup>

<sup>1</sup> *Universität Zürich (CH)*

**Corresponding Author:** simon.de.visscher@cern.ch

The mechanism of production of heavy-flavoured mesons, containing b or c quarks, in association with vector bosons, W or Z, in the Standard Model is only partially understood. The study of events with one or two well-identified and isolated leptons accompanied by b-jets or secondary vertices is therefore crucial to refine the theoretical calculations in perturbative QCD, as well as validate associated Monte Carlo techniques. The deep understanding of these processes is furthermore required by Higgs and BSM analyses with similar final states. Using the LHC proton-proton collision data collected in 2010 and 2011 at a centre of mass energy of 7 TeV by the CMS detector, preliminary measurements of the Z+b(b) cross sections and angular correlations are presented. Finally, the study of the W+c production rate with respect to the W charge and W+light jets rates allows to probe the strange quark content of the proton. These results are also presented.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 624**

## Jet production in association with vector bosons

**Author:** Piergiulio Lenzi<sup>1</sup>

<sup>1</sup> *CERN*

**Corresponding Author:** piergiulio.lenzi@cern.ch

The associated production of jets and vector bosons allows for stringent tests of perturbative QCD calculations and is sensitive to the possible presence of new physics beyond the Standard Model. A measurement of jet production rates in association with W and Z bosons, or photons, in proton-proton collisions at a 7 TeV center-of-mass energy is presented, using data collected with the CMS detector. The measured jet multiplicity distributions corrected for efficiency and unfolded for detector effects are compared with theoretical predictions. Results for the W charge asymmetry as a function of the number of jets and a test of Berends–Giele scaling are also presented.

**Plenary3 - The Standard Model -TR1 / 625**

## WW, WZ and ZZ production at CMS

**Author:** Kalanand Mishra<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Lab. (US)*

**Corresponding Author:** kalanand.mishra@cern.ch

We present studies of WW, WZ and ZZ diboson production in pp collisions based on data recorded by the CMS detector at the LHC. These include precise measurements the production cross section of these processes at center-of-mass energies of 7 and 8TeV . The leptonic decay modes of the W and Z bosons are used. The results are interpreted in terms of constraints on anomalous triple gauge couplings. In addition the first observation of the decay Z to 4 charged leptons is reported.

**Plenary3 - The Standard Model -TR1 / 626**

## Wgamma and Zgamma Production in 7TeV pp collisions

**Author:** Syue-Wei Li<sup>1</sup>

<sup>1</sup> *National Central University (TW)*

**Corresponding Author:** potter@cern.ch

We present the measurement of Wgamma and Zgamma production cross sections using data corresponding to the full 2010 and 2011 periods of the LHC run. For charged lepton decay modes of W and Z bosons the total cross sections are measured for photon transverse energy greater than 15 GeV. We also present the first measurement of Zgamma production cross section using the nunugamma final state for photon transverse energy greater than 145 GeV. The results are also interpreted in terms of limits of anomalous trilinear gauge couplings.

**Plenary3 - The Standard Model -TR1 / 627**

## W and Z studies at 8 TeV at CMS

**Author:** Anna Kropivnitskaya<sup>1</sup>

<sup>1</sup> *University of Florida (US)*

**Corresponding Author:** anna.kropivnitskaya@cern.ch

The production of W and Z bosons has been observed in pp collisions at a center-of-mass energy of 8 TeV using data collected in the CMS experiment. W events were selected containing an isolated, energetic electron or muon. Z events were selected containing a pair of isolated, energetic electrons or muons. Data-driven methods are used to estimate reconstruction and triggering efficiencies, and well as the main backgrounds. We present the W and Z signal yields and the extracted cross-sections at  $\sqrt{s}=8$  TeV, as well as the ratio of 8 TeV / 7 TeV cross sections.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 630**

## Measurements of Y(nS) polarization with the CMS experiment

**Author:** Valentin Knunz<sup>1</sup>

<sup>1</sup> *Austrian Academy of Sciences (AT)*

**Corresponding Author:** valentin.karl.knunuz@cern.ch

The polarizations of the Upsilon(1S), Upsilon(2S) and Upsilon(3S) mesons produced in proton-proton collisions at  $\sqrt{s} = 7$  TeV are measured using a data sample collected with the CMS detector at the LHC, corresponding to an integrated luminosity of around  $5 \text{ fb}^{-1}$ . The measurements are based on the analysis of the dimuon decay angular distributions, analyzed in three different polarization frames, and are presented as a function of the Upsilon transverse momentum, in two rapidity ranges. The measurement of the polarization parameters,  $\lambda_{\theta}$ ,  $\lambda_{\phi}$  and  $\lambda_{\theta\phi}$  is complemented by the determination of the frame-invariant quantity  $\lambda_{\tilde{}}$ , which provides a very useful intrinsic test of the reliability of the whole analysis chain and supplementary physical information.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 631**

## Studies of exotic charmonium and bottomonium states with the CMS experiment

**Author:** Kai Yi<sup>1</sup>

<sup>1</sup> *University of Iowa (US)*

**Corresponding Authors:** keith.ulmer@cern.ch, yik@fnal.gov

CMS has searched for exotic charmonium states in the data sample collected in proton-proton collisions at 7 TeV in 2011. The X(3872) state is reconstructed in the  $J/\psi \pi^+ \pi^-$  decay channel and the production cross-section is computed by determining the ratio to  $\psi(2S)$  production in the same decay channel. For the first time, prompt and non-prompt contributions to the X(3872) cross section are disentangled by looking at secondary vertices. Furthermore, we also report on searches for other exotic quarkonium states.

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 632**

## Prospects of investigating reactor neutrino anomaly with 3-16 m baseline

**Author:** Jelena Maricic<sup>1</sup>

<sup>1</sup> *Drexel University (US)*

**Corresponding Author:** jelena@physics.drexel.edu

Results from reactor neutrino experiments show a repeating pattern of a small constant deficit at baselines between 16 m and 1-2 km as described in the paper by Mention et al. Proposed explanation of the deficit is so called reactor neutrino anomaly that requires existence of a non-standard neutrino oscillation with a very short baseline. Convincing independent confirmation of this result can come from the observation of the same pattern in the large liquid scintillator detector with the radioactive anti-neutrino source in the 100 kCi range as suggested by Cribier et al. In this talk we will investigate potential for the reactor neutrino anomaly measurement with the highly radioactive anti-neutrino source deployed in the veto region of the KamLAND detector with oscillation baseline between 3 and 16 m.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 634**



## Studies of rare beauty and charm decays with the CMS experiment

**Author:** Keith Ulmer<sup>1</sup>

<sup>1</sup> *University of Colorado at Boulder (US)*

**Corresponding Author:** keith.ulmer@cern.ch

The rare decays  $B_s(B^0) \rightarrow \mu^+\mu^-$ ,  $B^0 \rightarrow K^*\mu^+\mu^-$  and  $D^0 \rightarrow \mu^+\mu^-$  are excellent tests of the flavor sector of the Standard Model and are sensitive to new physics. We report on studies of these decays performed with the CMS experiment using pp collisions data collected in 2011 at a centre-of-mass energy of 7 TeV.

We present the first observation of the excited B baryon  $\Xi_b^*$  in the strong decays to  $\Xi_b^-$  and a charged pion, performed with the CMS experiment at  $\sqrt{s}=7$  TeV. In addition, we present measurements of B hadron lifetimes.

TR 12 - Formal Theory Development & TR 1 - The Standard Model / 635

## Holographic calculation of hadronic contributions to muon $g-2$

**Authors:** Doyoun Kim<sup>1</sup>; deog-ki hong<sup>2</sup>

<sup>1</sup> *Monash University (AU)*

<sup>2</sup> *pusan national university*

**Corresponding Author:** abistp00@phya.snu.ac.kr

We have performed a holographic calculation of the hadronic contributions to the anomalous magnetic moment of the muon, using the gauge/gravity duality. We compute the leading order hadronic (HLO) contribution to the anomalous magnetic moment of muon,  $a_\mu(\text{HLO})$ , and find  $a_\mu(\text{HLO}) = 470.5 \times 10^{-10}$  in AdS/QCD with two light flavors, which is compared with the currently revised BABAR data estimated from  $e^+e^- \rightarrow \pi^+\pi^-$  events,  $a_\mu(\text{HLO})[\text{p}\pi] = (514.1 \pm 3.8) \times 10^{-10}$ . Calculating the light-by-light contribution, both 5D SU(2) and U(3) flavor gauge symmetries are considered for the neutral pion, eta and eta' contributions to the hadronic corrections. We find the total light-by-light contributions of pseudo scalars to the muon anomalous magnetic moment,  $a_\mu = 10.7 \times 10^{-10}$ , which is consistent with previous estimates, based on other approaches.

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 637

## Quarkonia production in 2.76 TeV PbPb collisions in CMS

**Author:** Nuno Viegas Guerreiro Leonardo<sup>1</sup>

<sup>1</sup> *Purdue University (US)*

**Corresponding Author:** nuno.leonardo@cern.ch

The Compact Muon Solenoid (CMS) is fully equipped to measure hard probes in the di-muon decay channel in the high multiplicity environment of nucleus-nucleus collisions. Such probes are especially relevant for studying the quark-gluon plasma since they are produced at early times and propagate through the medium, mapping its evolution. CMS has measured the nuclear modification factors of non-prompt  $J/\psi$  (from b-hadron decays), prompt  $J/\psi$ , and  $Y(1S)$  in PbPb collisions at

$\sqrt{s_{NN}} = 2.76$  TeV. Suppression of the excited Y-states is also studied in comparison to the Y(1S) state.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 638**

## Collective flow and charged hadron correlations in 2.76 TeV PbPb collisions at CMS

**Author:** Sandra Padula<sup>1</sup>

<sup>1</sup> *UNESP - Universidade Estadual Paulista (BR)*

**Corresponding Author:** sandra.padula@cern.ch

We report on the CMS measurements of charged hadron anisotropic azimuthal distributions from PbPb collisions at  $\sqrt{s_{NN}} = 2.76$  TeV. The results are presented as a function of transverse momentum, centrality and pseudorapidity and cover a broad kinematic range. Long range in pseudorapidity di-hadron azimuthal correlations are also studied and discussed in terms of the possible influence of the initial collision geometry. These results can provide constraints on the theoretical description of the early dynamics in the hot and dense medium created at the LHC and the transport properties through this medium.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 639**

## Dijet imbalance in 2.76 TeV PbPb collisions in CMS

**Author:** David Krofcheck<sup>1</sup>

<sup>1</sup> *University of Auckland (NZ)*

**Corresponding Author:** david.krofcheck@cern.ch

Jet production in PbPb collisions at a nucleon-nucleon center-of-mass energy of 2.76 TeV is studied with the CMS detector at the LHC. Jets are reconstructed using the energy deposited in the CMS calorimeters. A large dijet imbalance is observed in central PbPb collisions, which reduces in the more peripheral collisions. This observation is consistent with a jet quenching scenario, where the parton loose energy propagating through the hot and dense QCD medium. Detailed studies of the jet properties and jet-hadron correlations will be presented.

**Room 219 - BSM - Non-SUSY - TR3 / 640**

## Search for compositeness and contact interactions in CMS

**Author:** Kerstin Hoepfner<sup>1</sup>

<sup>1</sup> *Rheinisch-Westfaelische Tech. Hoch. Aachen (DE)*

**Corresponding Author:** hoepfner@physik.rwth-aachen.de

We present results of searches for compositeness and contact interactions in decays of excited quarks and leptons and inclusive spectra. The full data sample of 5 fb<sup>-1</sup> of pp collisions collected in 2011 at a center-of-mass energy of 7 TeV with the CMS experiment have been used.

**Room 219 - BSM - Non-SUSY - TR3 / 641**

## **Search for hadronic resonances at CMS**

**Author:** Andreas Hinzmann<sup>1</sup>

<sup>1</sup> *CERN*

**Corresponding Author:** andreas.hinzmann@cern.ch

We present results of searches for new heavy resonances decaying in hadronic final states. A variety of final states ranging from 2 jets up to 8 jets have been analyzed using the sample of 5 fb<sup>-1</sup> of pp collisions at 7 TeV collected with CMS in 2011.

**Room 219 - BSM - Non-SUSY - TR3 / 642**

## **Search for new heavy gauge bosons at CMS**

**Author:** Claudia Wulz<sup>1</sup>

<sup>1</sup> *Austrian Academy of Sciences (AT)*

**Corresponding Author:** claudia.wulz@cern.ch

We present results of searches for new heavy gauge bosons decaying to dilepton, diphoton, lepton+MET, WZ, and ZZ final states. The full sample of 5 fb<sup>-1</sup> of pp collisions at 7 TeV collected with CMS in 2011 have been analyzed as well as the new collisions recorded at 8 TeV in 2012.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 643**

## **Indirect CP violation at Belle**

**Author:** Bastian Kronenbitter<sup>1</sup>

<sup>1</sup> *KIT*

**Corresponding Author:** kronenbitter@ekp.uni-karlsruhe.de

We present a precise measurement of time-dependent CP violation in the neutral  $B$  decays into charmonium and  $K^0$  with a large data sample containing 772 million  $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

**Room 219 - BSM - Non-SUSY - TR3 / 644**

## **Search for extra dimensions at CMS**

**Author:** Alessio Bonato<sup>1</sup>

<sup>1</sup> *CERN*

**Corresponding Author:** alessio.bonato@cern.ch

We present results for searches of the existence of large extra spatial dimensions. A variety of final states sensitive to both resonant and non-resonant enhancement of expected events have been analyzed. The full sample of 5 fb<sup>-1</sup> of pp collisions recorded with CMS in 2011 at the center-of-mass-energy of 7 TeV has been used.

**Plenary3 - The Standard Model -TR1 / 645**

## **CDF searches for diboson production in final states with heavy flavor jets**

**Author:** Marco Trovato<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Author:** mtrovato@fnal.gov

We present the results of CDF searches for diboson production in final states with jets identified as originating from heavy flavor quark decays. In particular, searches for WZ/ZZ production where the first W or Z boson decays leptonically and the second Z decays into a pair of bottom or charm quarks mimic primary Tevatron searches for a low mass Higgs with subsequent decay into a pair of bottom quarks produced in association with a W or Z boson. CDF's ability to observe diboson production in these final states provides a critical validation of the tools, techniques, and background modeling used in our H→bb searches.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 647**

## **Search for new massive stable particles at CMS**

**Author:** Fedor Ratnikov<sup>1</sup>

<sup>1</sup> *KIT (DE)*

Several models of new physics, including split supersymmetry, predict the existence of heavy particles which are long-lived on timescales of the bunch spacing of the LHC. We present the results three dedicated searches using the measurement of the energy loss dE/dx in the tracking system, the time-of-flight and special jet triggers. The full sample of 5 fb<sup>-1</sup> of pp collisions recorded with CMS in 2011 at the center-of-mass-energy of 7 TeV has been used

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 648**

## **Search for new physics with displaced leptons, jets, and photon at CMS**

**Author:** Valerie Halyo<sup>1</sup>

<sup>1</sup> *Princeton University (US)*

**Corresponding Author:** valerieh@princeton.edu

We present results of searches for new long-lived particles with a distinctive signature of decay products far from the primary event vertex. Dedicated trigger and reconstruction algorithms have been developed to identify such displaced particles. The full sample of 5 fb<sup>-1</sup> of pp collisions recorded with CMS in 2011 at the center-of-mass energy of 7 TeV has been used.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 649**

## Studies related to the CKM angles $\phi_2$ and $\phi_3$ at Belle

**Author:** Jeremy Dalseno<sup>1</sup>

<sup>1</sup> *Max-Planck-Institut für Physik*

**Corresponding Author:** j.dalseno@bristol.ac.uk

We present a time-dependent measurement of CP violation parameters in  $B^0 \rightarrow \pi^+ \pi^-$  decays. These results are obtained from the full data sample that contains 772 million  $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 650**

## Search for 4th generation quarks

**Author:** Sadia Khalil<sup>1</sup>

<sup>1</sup> *Kansas State University (US)*

**Corresponding Author:** skhalil@cern.ch

We present results of searches for a new heavy 4th generation quark using leptonic, semileptonic and hadronic final states. The full sample of 5 fb<sup>-1</sup> of pp collisions recorded with CMS in 2011 at the center-of-mass energy of 7 TeV has been used.

**Room 219 - BSM - Non-SUSY - TR3 / 652**

## Search for leptoquarks and heavy neutrino

**Author:** James Francis Hirschauer<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Author:** james.francis.hirschauer@cern.ch

We present results of searches with leptons, jets and missing transverse energy in the final state sensitive to the existence of leptoquarks and heavy right majorana neutrinos. The full sample of 5 fb<sup>-1</sup> of pp collisions recorded with CMS in 2011 at the center-of-mass energy of 7 TeV has been used.

**Room 218 - Detectors and Computing for HEP - TR13 / 653**

## Performance and Upgrade plans for the CMS Hadron Calorimeter at the LHC

**Author:** Sudarshan Paramesvaran<sup>1</sup>

<sup>1</sup> *University of California Riverside (US)*

**Corresponding Author:** sudarshan.paramesvaran@cern.ch

The hadron calorimeters of the CMS experiment have successfully recorded data at 7 TeV and 8 TeV center-of-mass energy during 2011 and 2012 LHC operation. The performance of all systems (barrel, end-cap, forward and the outer calorimeters) are discussed and results from the full 2011 dataset are shown on noise rejection, calibration, collision timing, and identification of jet candidates and for other salient features. In addition, the CMS collaboration is planning improvements to the hadron calorimeters which include the replacement of the HPD photodetectors with SiPMs, increased depth segmentation in the calorimeter, and the inclusion of TDC capability. The status of the R&D for these upgrades will be discussed, including the testing of the upgraded microTCA readout electronics during current LHC data taking.

**Poster Session - Board:** 45 / 655

## Identification of b-quark jets in the CMS experiment

**Author:** Sudhir Malik<sup>1</sup>

<sup>1</sup> *University of Nebraska-Lincoln (US)*

**Corresponding Author:** sudhir.malik@cern.ch

The identification of jets associated with the production of b quarks is an essential tool both for the measurement of standard-model processes and in the search for physics beyond this model at the Large Hadron Collider. The CMS experiment has developed a variety of algorithms that use the impact parameters of charged-particle tracks, the properties of reconstructed decay vertices, the presence of a lepton or combinations of these quantities to select samples of jets with different b purities. Proton-proton collisions recorded in 2011 and corresponding to an integrated luminosity of 5.0 fb<sup>-1</sup> have been used to compare the quality of the reconstruction with expectations from simulation. The performance of the algorithms in terms of efficiency and misidentification probability has been measured from multi jet events and from top-quark pair events.

**Poster Session - Board:** 22 / 658

## Heavy QQ(bar) "Fireball" Annihilation to Multi-Vector Bosons

**Author:** George W.-S. Hou<sup>1</sup>

<sup>1</sup> *National Taiwan University (TW)*

**Corresponding Author:** wshou@phys.ntu.edu.tw

Drawing an analogy of replacing the nucleon by heavy (chiral) quark Q, the pion by longitudinal weak boson (i.e. Goldstone boson G), and the pi-N-N coupling by G-Q-Q Yukawa coupling, we construct a statistical model for annihilation of QQ(bar) into multi-Goldstone bosons, i.e. n longitudinal weak bosons. This analogy is becoming prescient since the LHC direct bound on heavy chiral quark (the 4th generation!) masses has reached above 600 GeV, hence entered the regime of perturbative unitarity violation, or strong coupling, much like the case for pion-nucleon coupling. Taking  $M_Q \sim \text{TeV}$ , the mean number of produced Goldstone bosons is of order 10 or more, with two or three boson

production occupying only a very tiny fraction, hence would affect search strategy. This “fireball” process is controlled by a temperature of order  $v$ , the electroweak symmetry breaking scale. But this is no “blackhole”, as only longitudinal weak bosons, plus perhaps one or two gluons, are emitted. Although we cannot estimate the  $QQ(\text{bar})$  annihilation rate since the Yukawa coupling is now nonperturbative, but given that individual  $t'$  or  $b'$  decays are either suppressed by phase space ( $t' \rightarrow b'$  or  $b' \rightarrow t'$ ) or quark mixing, we view  $QQ(\text{bar}) \rightarrow nV$  as the likely outcome for ultra heavy  $QQ(\text{bar})$  production at the LHC and beyond, which should be taken into account by the experiments.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 659**

## New results using the razor at the LHC

**Author:** Will Reece<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** will@reece.org.uk

The “razor” at the LHC refers to a set of kinematical variables used to discriminate heavy new physics against standard model processes. The empirical modeling of the variables and their correlation leads to good sensitivity to new physics. In this talk we present some of the latest results obtained with the razor technique in CMS, ranging from SUSY to more exotic searches.

**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 661**

## Interpretations of CMS SUSY analyses in the simplified model space (SMS)

**Author:** Christopher Rogan<sup>1</sup>

<sup>1</sup> *California Institute of Technology (US)*

**Corresponding Author:** crogan@cern.ch

This talk we will present a compilation of all CMS new physics search results in the simplified model space and discuss the advantages and limitations of such interpretations.

**Room 219 - BSM - Non-SUSY - TR3 / 662**

## Search for new physics in events with two photons, many jets, and low missing transverse energy

**Author:** Marc Gabriel Weinberg<sup>1</sup>

<sup>1</sup> *Florida State University (US)*

**Corresponding Author:** marc.gabriel.weinberg@cern.ch

Many supersymmetric and exotic models of new physics predict high-multiplicity events with leptons or electroweak gauge bosons and low missing transverse energy in the final state. We present results of a search for new physics at CMS in events with two photons and many hadronic jets with no requirement for large missing transverse energy.

**Room 219 - BSM - Non-SUSY - TR3 / 664**

## **Searches for the pair production of dark matter particles at CMS**

**Author:** Jean-Roch Vlimant<sup>1</sup><sup>1</sup> CERN**Corresponding Authors:** smalik@hep.ucl.ac.uk, sarah.alam.malik@cern.ch, jean-roch.vlimant@cern.ch

We present the results of searches for dark matter performed using data collected by the CMS experiment at the LHC in pp-collisions at a center-of-mass energy of 8 TeV. Searches for dark matter candidates are performed in events with missing transverse energy. Traditionally, searches for supersymmetry (SUSY), where the lightest SUSY particle is a good candidate for dark matter, have been performed. We present more model independent searches for the production of a pair of dark matter particles without making assumptions on the new physics model. The results are translated to bounds on the dark matter-nucleon scattering cross-section which can be directly compared to those from the direct detection and the indirect detection experiments, showing that the collider bounds are competitive and complementary to those from the other approaches.

**Room 218 - Detectors and Computing for HEP - TR13 / 665**

## **Operation and Performance of the CMS Silicon Tracker**

**Author:** Erik Butz<sup>1</sup><sup>1</sup> Massachusetts Inst. of Technology (US)**Corresponding Author:** erik.butz@cern.ch

The CMS silicon tracker is the largest silicon detector ever built. It consists of a hybrid pixel detector with 66 million channels and a 200 m<sup>2</sup> silicon strip detector with 10 million read out channels. The presentation describes the operation of this detector during the first three year of LHC both during proton-proton as well as heavy ion collisions. Results on the operational performance are presented including alignment, calibration, S/N, timing, etc. Reconstructed photon conversions and nuclear interactions are used to evaluate the material in the tracker. The resolution and efficiency of the track and vertex reconstruction are measured with data and compared to the results from simulation. With increasing integrated luminosity, monitoring of radiation-induced effects becomes more and more important. Our methods for measuring the evolution of full depletion voltage and leakage current will be presented and the results discussed.

**Room 218 - Detectors and Computing for HEP - TR13 / 667**

## **Performance of the CMS electromagnetic calorimeter at the LHC and role in the hunt for the Higgs boson**

**Author:** Riccardo Paramatti<sup>1</sup><sup>1</sup> INFN - Rome I (IT)**Corresponding Author:** riccardo.paramatti@cern.ch

The Electromagnetic Calorimeter (ECAL) of the Compact Muon Solenoid (CMS) experiment at the LHC is a hermetic, fine grained, homogeneous calorimeter, comprising 75,848 lead tungstate (PbWO<sub>4</sub>) scintillating crystals, located inside the CMS superconducting solenoidal magnet. The scintillation



light is detected by avalanche photodiodes (APDs) in the barrel section and by vacuum phototriodes (VPTs) in the two endcap sections. A silicon/lead pre-shower detector is installed in front of the endcaps in order to improve  $\gamma/\pi^0$  discrimination. Precise calibration of the ECAL detector is required. This includes inter-calibration, to account for the differing response of channels, and calibration of the energy scale. The performance obtained during the first LHC physics runs in 2010 and 2011 is presented and the role of the ECAL in the hunt for the Higgs boson, through the 2-gamma decay mode, is discussed.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 669**

## Data Preparation for the CMS detector at 8TeV at the LHC.

**Author:** Jean-Roch Vlimant<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Author:** jean-roch.vlimant@cern.ch

The CMS detector, currently taking data at the LHC in Geneva, is a very complex apparatus composed of more than 70 million acquisition channels. Fast and efficient methods for the calibration and the alignment of the detector are a key asset to exploit its full physics potential. Moreover, a reliable infrastructure for the monitoring of the data quality and for their validation are instrumental to ensure timely preparation of results for conferences and publications.

The CMS experiment has set up a powerful framework in order to cope with all these requirements and in 2012 it had to consolidate and optimize all the workflows to withstand the higher luminosity and energy delivered by the LHC machine. The reconstruction algorithms have been optimized for the higher occupancies without compromising the physics performance. A MonteCarlo production with a statistic comparable to the collision data has been prepared and fully validated.

This contribution will cover the development and operational aspects of the offline workflows reporting about the CMS performance and the experience gained during the data taking.

**Room 218 - Detectors and Computing for HEP - TR13 / 673**

## Performance of the CMS Level-1 Trigger

**Author:** Jim Brooke<sup>1</sup>

<sup>1</sup> *University of Bristol (UK)*

**Corresponding Author:** jim.brooke@cern.ch

The first level trigger of the CMS experiment is comprised of custom electronics that process data from the calorimeters and muon detectors in order to select the most interesting events from LHC collisions. The rate of events selected by this Level-1 trigger must be reduced from the beam crossing frequency to no more than 100 kHz before detector digitization and High Level Trigger processing can occur. Here we report on the efficiencies, resolution, and trigger rates of the Level-1 trigger as measured from LHC proton collisions at 7 and 8 TeV center-of-mass energies. Example trigger menus used to select events for physics analysis by the CMS experiment also will be discussed.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 679**

## Bootstrap Dynamical Symmetry Breaking with New Heavy Chiral Quarks

**Author:** George Wei-Shu Hou<sup>1</sup>

**Co-authors:** Hiroaki Kohyama<sup>2</sup>; Yukihiro Mimura<sup>3</sup>

<sup>1</sup> *National Taiwan University (TW)*

<sup>2</sup> *Chung Yuan Christian University*

<sup>3</sup> *National Taiwan University*

**Corresponding Author:** wshou@phys.ntu.edu.tw

Despite the hint for a 125 GeV Higgs boson, we consider the other option of  $M_H > 600$  GeV, noting that the existence of the Higgs boson itself is not yet an established fact. What we do know is that the Goldstone bosons of electroweak symmetry breaking exist as longitudinal components of the weak bosons. The Goldstone boson coupling to a new heavy chiral quark doublet  $Q$  (assuming it exist), the  $G$ - $Q$ - $Q(\text{bar})$  Yukawa coupling, would now be in the strong coupling regime, given the LHC limit of  $M_Q > 600$  GeV is already beyond the perturbative partial-wave unitarity bound. Such strong Yukawa couplings could induce  $Q$ - $Q(\text{bar})$  condensation, which might take the role of the Higgs condensate. Guided by a Bethe-Salpeter equation approach, we identify the leading “collapsed state”, the (heavy) isotriplet, color singlet “meson”, as the Goldstone boson  $G$  itself. Viewing  $G$  as a very deeply bound state, a “bootstrap” gap equation without a Higgs particle is constructed. Electroweak symmetry breaking via strong Yukawa coupling generates both heavy mass for  $Q$ , while self-consistently justifying the keeping of  $G$  as a massless Goldstone particle in the loop. We solve such a gap equation, and investigate the mass of heavy quarks in this bootstrap picture, which is found to be not less than a TeV. We consider also a scale-invariant model by Hung and Xiong, in which a massless scalar doublet  $\phi$  couples strongly with  $Q$ , which induces electroweak symmetry breaking. Although a gap equation similar to the one in the bootstrap picture can be written down, we discuss differences with the results of Hung and Xiong, as well as offer a brief critique.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 681**

## Any data, any time, any where

**Author:** Sudhir Malik<sup>1</sup>

<sup>1</sup> *University of Nebraska-Lincoln (US)*

**Corresponding Author:** sudhir.malik@cern.ch

In this presentation we will discuss progress on providing access to CMS experiment data through the use of wide area transfer protocols directly from remote storage to a running application. This program of work has involved the deployment of infrastructure on facilities in both the US and in Europe, the optimization of the application to make more efficient use of a higher latency connection, and the demonstration of a variety of use cases to showcase the value of this functionality. The project is at the level where several of the intended applications are used in production running, and several of the more ambitious techniques are in the prototype phase.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 682**

## Common Solutions to LHC Computing Problems

**Author:** Maria Girone<sup>1</sup>

<sup>1</sup> *CERN (CH)*

**Corresponding Authors:** ian.fisk@cern.ch, maria.girone@cern.ch

In this presentation we will discuss the process and some examples of the development of common solutions that face the LHC experiments. The LHC experiments have relied on common grid components since the design of the computing models. Recently there have been efforts to develop and support higher-level services that provide solutions to problems common to several experiments. We will discuss the process used to select prospective common solutions, some examples of successful common services, and some planning for future common development activities.

**Room 218 - Detectors and Computing for HEP - TR13 / 683**

## The CMS High Level Trigger

**Author:** Stéphanie Beauceron<sup>1</sup>

<sup>1</sup> *Universite Claude Bernard-Lyon I (FR)*

**Corresponding Author:** stephanie.beauceron@cern.ch

The CMS experiment has been designed with a 2-level trigger system: the Level 1 Trigger, implemented using FPGA and custom ASIC technology, and the High Level Trigger (HLT), implemented running a streamlined version of the CMS offline reconstruction software on a cluster of commercial rack-mounted computers, comprising thousands of CPUs. The design of a software trigger system requires a tradeoff between the complexity of the algorithms running online, the output rate, and the selection efficiency. The complexity is limited by the available computing power, while the rate is constrained by the offline storage and processing capabilities. The main challenge faces during 2012 is the fine-tuning and optimisation of the algorithms, in order to cope with the increasing LHC pile-up without impacting the physics performance.

Here we will present a review of the performance of the main triggers uses during the 2012 data taking, ranging from simpler single-object selections to more complex algorithms combining different objects, and applying analysis-level reconstruction and selection. We will discuss how the increasing LHC pile-up is affecting their performance, and how these effects is being mitigated.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 684**

## Asymmetry measurements in $t\text{-}\bar{t}$ at CDF

**Author:** Chris Hays<sup>1</sup>

<sup>1</sup> *University of Oxford (UK)*

**Corresponding Author:** christopher.paul.hays@cern.ch

The most intriguing property of top-quark physics observed so far is the forward-backward asymmetry in the production of top-quark pairs in proton anti-proton collisions at the Fermilab Tevatron. An unexpectedly sizable effect has observed in both the semi-leptonic and the all-leptonic decay channels of top-quark pairs, exceeding significantly the standard model predictions, and has motivated intensive theoretical investigations. Several models have already been proposed so far to explain the data, none of them fully successful. We present measurements of the asymmetry in both decay channels and studies of the asymmetry as a function of various kinematics variables, as well as related measurements of the top-quark pair production cross section differential in sensitive variables.

We also present, for the first time, measurements of the asymmetry in bottom-quark pair production, which allows for exploring the asymmetry production mechanism in both the top and the bottom flavor sectors. All measurements are using the full CDF Run II sample.

Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 685

## Implications of $\text{Br}(\mu \rightarrow e \gamma)$ and $\Delta a_\mu$ on Muonic Lepton Flavor Violating Processes

**Author:** Chun-Khiang Chua<sup>1</sup>

<sup>1</sup> *Chung Yuan Christian University (TW)*

**Corresponding Author:** ckchua@cycu.edu.tw

We study the implications of the experimental results on the  $\mu \rightarrow e \gamma$  decay rate and the muon anomalous magnetic moment on muonic lepton flavor violating processes, such as  $\mu \rightarrow 3e$  and  $\mu N \rightarrow e N$ . We use a model independent approach in this analysis, where these processes are considered to be loop induced by exchanging spin 1/2 and spin 0 particles. We explore two complementary cases, which has no or has internal (built-in) cancellation mechanism in amplitudes. Our main results are as following.

- (a) Bounds from rates are used to constrain parameters, such as coupling constants and masses. These constraints can be easily updated by simple scalings, if the experimental situations change.
- (b) The muon  $g-2$  data favors non-chiral interactions.
- (c) In  $\mu \rightarrow 3e$  and  $\mu N \rightarrow e N$  processes, Z-penguin diagrams may play some role, while box diagrams contributions are highly constrained.
- (d) In the first case (without any built-in cancellation mechanism), using the recent  $\mu \rightarrow e \gamma$  bound, we find that  $\mu \rightarrow 3e$  and  $\mu N \rightarrow e N$  rates are bounded below the present experimental limits by two to three orders of magnitudes in general. Furthermore, by comparing  $\Delta a_\mu$  and  $\text{Br}(\mu \rightarrow e \gamma)$  data, the couplings of  $\mu$  and  $e$  are found to be highly hierarchical. Additional suppression mechanism should be called for.
- (e) In the second case (with a built-in cancellation mechanism), the  $\mu \rightarrow 3e$  rate remains suppressed, but the bounds on  $\mu N \rightarrow e N$  rates, implicated from the  $\mu \rightarrow e \gamma$  bound, can be relaxed significantly and can be just below the present experimental bounds.

Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 687

## Searches for New Physics with CDF Detector

**Author:** Adam Aurisano<sup>1</sup>

<sup>1</sup> *Texas A&M University*

**Corresponding Authors:** aurisano@fnal.gov, jude@hep.uchicago.edu, adam.aurisano@gmail.com

Searches for physics beyond the standard model are intensively pursued using the full CDF Run II sample. Many among them are pursued in the top-quark sector because it is believed that the top-quark, due to its very large mass, may play a special role in the spontaneous breaking of the electroweak symmetry of the standard model as well as in possible new physics. We present searches for a heavy  $Z'$  boson decaying into a top-quark pair in the semi-leptonic decay channel as well as in semi-leptonic decays associated with one and two additional jets; a search for a dark matter candidate particle associated with a single top-quark decaying into the neutrino+jets decay channel and a search of a dark matter candidate particle in events with one jet and large missing transverse energy; and a search for new physics in events with a delayed photon and large missing transverse energy.

Room 218 - Detectors and Computing for HEP - TR13 / 688

## Alignment procedures for the CMS Silicon Tracker detector

**Author:** Roberto Castello<sup>1</sup>

<sup>1</sup> *Universite Catholique de Louvain (BE)*

**Corresponding Author:** roberto.castello@cern.ch

The CMS all-silicon tracker consists of 16588 modules: aligning them with the desired precision of a few micrometers is only feasible using track based alignment procedures. Ultimate precision is now achieved by the determination of sensor curvatures in addition to the local translation and rotation of modules in space. This challenges the alignment algorithms to determine about 200k parameters simultaneously. This is achieved using the Millepede II program, interfaced with CMS software. The alignment of the detector is also monitored using its built in Laser Alignment System. For this, 3% of the silicon strip modules are illuminated by the laser beams, assuring a continuous surveillance during data taking. The system allows to monitor the alignment changes with a precision better than 10 micron and to measure the absolute alignment parameters better than 100 microns. The main remaining challenge for the alignment are global distortions that systematically bias the track parameters and thus physics measurements. These distortions are controlled by adding further information into the alignment workflow, e.g. the mass of decaying resonances. The orientation of the tracker with respect to the magnetic field of CMS is determined with a stand-alone chi-square minimization procedure. The resulting geometry is finally carefully validated: the monitored quantities include the basic track quantities for tracks from both collisions and cosmic muons and physics observables like resonance masses.

#### TR4 - Top Quark Physics / 689

### Cross section measurements of top quark production at CDF

**Author:** Matteo Corbo<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Author:** corbeo@gmail.com

The cross section for top-quark production, either in pairs through chromo-dynamical mechanisms or in single top-quarks through electro-weak based mechanisms, is a topic of great interest for testing theoretical predictions and constraining standard model parameters, as well as for searching for new physics in the top-quark sector. We present recent measurements of the top-quark pair production cross section in the all-leptonic channel and of the single top-quark production cross sections in the s- and t-channels. The combined s+t-channel single top-quark production cross section is also used to measure the  $|V_{tb}|$  matrix element of the CKM matrix. We also present a measurements of the top-quark pair production cross section and branching ratio in the all-leptonic channel where one of the two leptons defining the decay channel is required to be a reconstructed tau channel. The pair production cross section measurements are using the full CDF Run II sample.

#### TR4 - Top Quark Physics / 690

### Top quark properties at CDF

**Author:** Youngdo Oh<sup>1</sup>

<sup>1</sup> *Kyungpook National University (KR)*

**Corresponding Author:** ydoh500@gmail.com

The top-quark properties are of special interest for testing standard model predictions and for indirect searches for new physics due to the large mass of the top-quark, probing very short distances,

and its uniquely short life time, eliminating hadronization complexities. We present recent measurements of the top-quark decay branching ratio, constraining the  $|V_{tb}|$  matrix element of the CKM matrix; of the helicity fractions of the W boson in the top-quark pair decays in the semi-leptonic channel; of the spin correlation of the top-quark pair in the all-leptonic decay channel; and of the top-quark charge in the all-leptonic decay channel. All measurements are using the full CDF Run II sample.

**Poster Session - Board: 03 / 691**

## Search for MSSM Higgs decaying to $\mu\mu$ at CMS

**Authors:** Adrian Perieanu<sup>1</sup>; Adrian Perieanu<sup>2</sup>; Adrian Perieanu<sup>3</sup>

<sup>1</sup> RWTH Aachen (DE)

<sup>2</sup> Rheinisch-Westfälische Tech. Hoch. (DE)

<sup>3</sup> Physikalisches Institut - Ruprecht-Karls-Universität Heidelberg

**Corresponding Authors:** perieanu@physik.rwth-aachen.de, adrian.perieanu@cern.ch, perieanu@physi.uni-heidelberg.de

The search for the neutral Higgs bosons decaying via the  $\mu\mu$  channel in the MSSM  $m_{\text{max}_h}$  scenario is presented. The analysed data were recorded in 2011 with the CMS detector at 7 TeV centre of mass energy. The 95% C.L. exclusion limits on the cross section times branching ratio and the  $(m_{A^0}, \tan\beta)$  limits are presented.

**Room 219 - BSM - Non-SUSY - TR3 / 692**

## Large lepton mixing angles from a 4+1-dimensional $SU(5) \times A_4$ domain-wall braneworld model

**Authors:** Callen Benjamin<sup>1</sup>; Raymond Volkas<sup>2</sup>

<sup>1</sup> University of Melbourne (AU)

<sup>2</sup> University of Melbourne

**Corresponding Author:** bdcallen@student.unimelb.edu.au

We propose an extension of the 4+1D  $SU(5)$  domain-wall braneworld of Davies, George and Volkas which includes the addition of a discrete  $A_4$  flavor symmetry. We show that lepton mixing and light Majorana neutrino masses can be generated from the additional  $A_4$  physics while at the same time sufficient parameter freedom can be maintained in the charged fermion sector to produce charged fermion masses and quark mixing naturally from the split fermion mechanism of Arkani-Hamed and Schmalz. Importantly, we show that the vacuum realignment problem typical of discrete flavor symmetry models of quark and lepton mixing can be solved by separating the appropriate flavons in the extra dimension, leading to exponentially sensitive suppression of the operators responsible for vacuum realignment.

**TR4 - Top Quark Physics / 693**

## Top quark mass measurements at CDF

**Author:** Hyun Su Lee<sup>1</sup>

<sup>1</sup> Ewha Womans University

**Corresponding Author:** hslee@fnal.gov

The top-quark mass is an important parameter of the standard model. It is used, along with the W boson mass, to constrain the mass of the predicted Higgs boson. We present measurements of the top-quark mass and of the top-antitop mass difference, which tests the CPT symmetry, in the semi-leptonic top-quark pair decay channel using the template method and the full CDF Run II sample. These are currently the world's most precise top mass and mass difference single measurements.

**Poster Session - Board: 04 / 694**

## Search for SM Higgs boson in 2l2tau final state

**Author:** Gobinda Majumder<sup>1</sup>

<sup>1</sup> Tata Inst. of Fundamental Research (IN)

**Corresponding Author:** gobinda@tifr.res.in

Results are presented on the search for the standard model Higgs boson decaying into two Z bosons, with one boson decaying into a pair of charged leptons, either muons or electrons, and the other boson decaying into a pair of taus which taus decay both hadronically and leptonically. This analysis is mainly sensitive for Higgs masses higher than 180 GeV where both Z's are on-shell. For low mass Higgs boson with the same final state, the Z associated Higgs production with Higgs decay into tau tau and WW have been investigated. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 at a CM energy of 7 TeV with the CMS experiment have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Poster Session - Board: 58 / 696**

## Muon fast Track Tag : A muon trigger upgrade for CMS at the HL-LHC

**Author:** Oliver Pooth<sup>1</sup>

<sup>1</sup> Rheinisch-Westfaelische Tech. Hoch. (DE)

**Corresponding Author:** oliver.pooth@cern.ch

In the high luminosity LHC scenario (HL-LHC) with a luminosity up to ten times higher than at LHC and running at 14 TeV centre-of-mass energy, it will be important to rely on a more accurate transverse momentum resolution in order to keep the trigger rate under control and reach low p<sub>T</sub> thresholds. In order to improve the transverse momentum resolution the idea is to combine the high precision tracking information from the inner Tracker detector with a reliable muon trigger. An additional detector layer behind the CMS magnet and in front of the first muon stations could be realized by fast plastic scintillator tiles read out by silicon photomultipliers (SiPMs), possibly via wave length shifting fibres. In addition to tag a selective Tracker readout region, the MTT layer helps to resolve ambiguities at high muon rates in the innermost muon stations. The poster will discuss the development of a MTT prototype module and concentrates on the characterization of SiPMs in combination with fast plastic scintillators. Different possible scenarios are presented.

**Poster Session - Board: 59 / 697**

## Tau reconstruction and identification at CMS

**Author:** Raman Khurana<sup>1</sup>

<sup>1</sup> *Saha Institute of Nuclear Physics (IN)*

**Corresponding Author:** raman.khurana@cern.ch

CMS has developed sophisticated tau identification algorithms for tau hadronic decay modes. Production of tau lepton decaying to hadrons are studied at 8 TeV centre of mass energy with 2012 collision data collected by CMS detector and has been used to measure the performance of tau identification algorithms by measuring identification efficiency and mis-identification rates from electrons, muons, and hadronic jets.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 699**

## Anisotropic Flow of Charged Particles at High Transverse Momentum in 2.76 TeV Pb-Pb Collisions at the LHC from ALICE experiment

**Author:** Anitha Nyatha<sup>1</sup>

<sup>1</sup> *Indian Institute of Technology Bombay (IN)*

**Corresponding Author:** anithaiitb@gmail.com

Anisotropic flow is sensitive to the properties of the deconfined state of matter produced during the course of a heavy-ion collision. We report on the inclusive photons anisotropic flow at forward rapidity,  $2.3 < \eta < 3.9$ , measured for Pb-Pb collisions at 2.76 TeV with ALICE at the LHC. Photons are reconstructed with ALICE Photon Multiplicity Detector (PMD), and the collision symmetry plane is estimated with charged particles produced at midrapidity  $|\eta| < 0.8$ , which introduce large rapidity gap to reduce non-flow effects in the correlation analysis.

### Financial Support Justification for Early-Stage Researchers:

Dear Conference committee,

I am a research scholar working on anisotropic flow of inclusive photons from Photon Multiplicity detector in ALICE experiment at LHC. I am in 3rd year of my PhD from Indian Institute of Technology Bombay, India. It will be very helpful if you can arrange financial support for me to attend the conference.

Thank you,  
Anitha Nyatha

### Summary:

I would like to attend the conference and present my results on anisotropic flow of inclusive photons for ALICE Collaboration.

**Room 218 - Detectors and Computing for HEP - TR13 / 705**

## Operations and Performance of the CMS DT and RPC muon systems

**Author:** Gabriella Pugliese<sup>1</sup>



<sup>1</sup> *Universita e INFN & Politecnico di Bari (IT)*

**Corresponding Author:** gabriella.pugliese@ba.infn.it

The Drift Tubes (DT) detector in the CMS experiment triggered and recorded high quality data during the LHC run in 2011, observing muons from pp collisions at a center of mass energy of 7 TeV. More than 99% of the detector channels participated in data taking with very good performances in terms of up-time and efficiency. Prompt data were monitored in order to evaluate noise and backgrounds and to determine calibrations. The DT system showed excellent performance: at the trigger level, with excellent bunch crossing identification capability, despite long drift times intrinsic to the detector technology; and at the reconstruction level, reaching very good spatial and temporal resolution. Weak points of the current detector and electronics were also identified, and actions to mitigate their possible impact were taken during the run where possible. Future developments were planned in view of upgrade campaigns during the accelerator shutdowns. The first results of the 2012 run at 8 TeV center of mass energy will also be presented. The Resistive Plate Chambers are used in CMS as dedicated muon trigger in both barrel and endcap region. They also contribute to the identification of the muons together with Drift tube in the barrel and Cathod Strip Chambers in the endcaps. We will report the operations and performance of the system after two years of LHC activities with increasing instantaneous luminosity. Special attention will be given to the stability of the system and to the working point calibration procedures.

**Room 218 - Detectors and Computing for HEP - TR13 / 706**

## Performance of Jets and Missing Transverse Energy in CMS

**Co-author:** Joram Berger <sup>1</sup>

<sup>1</sup> *KIT (DE)*

**Corresponding Author:** joram.berger@cern.ch

A summary of the measurements of the jet energy calibration in CMS is presented, performed with data samples collected in proton-proton collisions at a centre-of-mass energy of 8 TeV corresponding to an integrated luminosity of 1.6/fb. The final jet energy calibration is based on dijet,  $\gamma$ +jet and Z+jet events. The results are presented for the “Particle Flow” approach, which attempts to reconstruct individually table particles in the event, prior to the jet clustering, based on information from all relevant subdetectors. We discuss the effect of pile-up interactions and the state of the art mitigation techniques used in CMS and we describe the main sources of uncertainty on the jet energy calibration. Finally, the results of comprehensive studies of missing transverse energy are presented.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 708**

## Hadronic B decays at Belle

**Author:** T’Mir Julius<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** danger@physics.unimelb.edu.au

The measurement of  $B^0 \rightarrow \pi^0 \pi^0$  plays a vital role in the extraction of the UT angle  $\phi_2 = \arg[-V_{td}V_{tb}^*/V_{ud}V_{ub}^*]$  from time-dependent CP analyses of the  $B \rightarrow \pi\pi$  decays. This process is also expected to exhibit direct CP violation, a measurement of which would place additional constraints on  $\phi_2$ . Furthermore, an improved analysis of  $B^0 \rightarrow \pi^0 \pi^0$  would help resolve the significant disagreement in the Belle and BaBar measurements of this mode. We present a new measurement of this mode using the full

data set of  $772 \times 10^6$   $B\bar{B}$  pairs collected by the Belle experiment at the KEKB asymmetric-energy  $e^+e^-$  collider.

We present improved measurements of the branching fraction,  $CP$  asymmetry and longitudinal polarization fraction for the  $B^+ \rightarrow \rho^+ \rho^0$  decay based on a data sample corresponding to  $772 \times 10^6$   $B\bar{B}$  pairs, collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

We report the results of a search for the  $B^+ \rightarrow K^{*+} \bar{K}^{*0}$  decay based on a data sample of  $772 \times 10^6$   $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

Decays of  $B$  mesons to the final states with an even number of kaons, such as  $B^0 \rightarrow K^+ K^- \pi^0$ , are suppressed within the Standard Model (SM). Therefore, they provide a unique probe to test the SM predictions. We present a first search of this decay using the full data set of  $772 \times 10^6$   $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

We search for  $B \rightarrow K^+ K^-$  decay based on the full data sample of  $772 \times 10^6$   $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 715**

## Direct CP violation in charm at Belle

**Author:** Byeong Rok Ko<sup>1</sup>

<sup>1</sup> Korea University (KR)

**Corresponding Author:** brko@hep.korea.ac.kr

We measure the time-integrated rate  $R_{WS}$  of the wrong-sign decay  $D^0 \rightarrow K^+ \pi^- \pi^+ \pi^-$  relative to the Cabibbo-favored right-sign process. The data was recorded with the Belle detector and corresponds to an integrated luminosity of  $800 \text{ fb}^{-1}$  at the  $\Upsilon(4S)$  resonance. We also report a measurement of the  $CP$  asymmetry factor  $A_{CP}$  by fitting the  $D^0$  and  $\bar{D}^0$  samples separately.

We observe evidence for  $CP$  violation in the decay  $D^+ \rightarrow K_S^0 \pi^+$  using a data set corresponding to an integrated luminosity of  $977 \text{ fb}^{-1}$  collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. The  $CP$  asymmetry in the decay is measured to be  $(-0.363 \pm 0.094 \pm 0.067)\%$ , which is 3.2 standard deviations away from zero. This is consistent with the expected  $CP$  violation due to neutral kaons in the final state.

Using data from the Belle experiment at KEKB asymmetric-energy  $e^+e^-$  collider, we present a measurement of the weak-decay asymmetry parameter  $\alpha_{\Lambda_c}$  in the decay  $\Lambda_c^+ \rightarrow \Lambda \pi^+$ . By comparing the results for particle and antiparticle decays, we also present a measurement of the  $CP$  violating asymmetry parameter  $A_{CP} = (\alpha_{\Lambda_c} \alpha_{\Lambda} - \alpha_{\bar{\Lambda}_c} \alpha_{\bar{\Lambda}}) / (\alpha_{\Lambda_c} \alpha_{\Lambda} + \alpha_{\bar{\Lambda}_c} \alpha_{\bar{\Lambda}})$ .

We report preliminary results on the time-integrated  $CP$  asymmetry  $A_{CP}$  in the decay  $D^0 \rightarrow \pi^+ \pi^- \pi^0$  using a  $673 \text{ fb}^{-1}$  data sample collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. We set an upper limit on the rate of the Dalitz-distribution-dependent asymmetry between two flavor samples:  $D^0$  and  $\bar{D}^0$ .

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 718**

## Charm decays at Belle

**Author:** Min-Zu Wang<sup>1</sup>

<sup>1</sup> *National Taiwan University (TW)*

**Corresponding Author:** mwan@phys.ntu.edu.tw

We present new branching fraction measurements of rare radiative  $D$  decays and compare these measurements with the theoretical predictions. The results are obtained from a large data sample collected near the  $\Upsilon(4S)$  and  $\Upsilon(5S)$  resonances with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

**Room 218 - Detectors and Computing for HEP - TR13 / 721**

## Measurements of the luminosity and normalised beam-induced background using the CMS Fast Beam Condition Monitor

**Author:** Nathaniel Jay Odell<sup>1</sup>

<sup>1</sup> *Northwestern University (US)*

**Corresponding Author:** nathaniel.jay.odell@cern.ch

The CMS Beam Conditions and Radiation Monitoring system (BRM) is installed to protect the CMS detector from high beam losses and to provide feedback to the LHC and CMS on the beam conditions. The Fast Beam Condition Monitor (BCM1F), one of the sub-detectors in the BRM system, is installed inside the pixel volume close to the beam pipe and consists of two planes of 4 modules each located 1.8 m away from the IP, on both ends. It uses single-crystal CVD diamond sensors, radiation hard front-end electronics and an optical transmission of the signal. It is designed for single particle rate measurements, detecting both machine induced beam background and collision products on a bunch-by-bunch basis.

Presented is the implementation of the normalized online beam-induced background measurement and the online instantaneous luminosity measurement. The method for determining the luminosity from the measured rates, including the absolute calibration using the Van der Meer scan, and the measurement performance will be described.

**Poster Session - Board: 05 / 722**

## Boost-invariant Leptonic Observables and Reconstruction of Parent Particle Mass

**Author:** Yasuhiro Shimizu<sup>1</sup>

<sup>1</sup> *Tohoku Univ. (JP)*

**Corresponding Author:** shimizu@tuhep.phys.tohoku.ac.jp

We propose a class of observables constructed from lepton energy distribution, which are independent of the velocity of the parent particle if it is scalar or unpolarized. These observables may be used to measure properties of various particles in the LHC experiments. We demonstrate their usage in a determination of the Higgs boson mass.

**TR 8 - Neutrinos RM 219 / 723**

## Neutrino cross section measurements at MINERvA

**Author:** Vittorio Paolone<sup>1</sup>

<sup>1</sup> *University of Pittsburgh (US)*

MINERvA (Main INjector Experiment for  $\nu$ -A) is a neutrino scattering experiment, employing a fine-grained detector with an eight ton active target region, located in the NuMI high-intensity neutrino beam at the Fermi National Accelerator Laboratory. MINERvA was designed to make precision measurements of low energy neutrino and antineutrino cross sections on a variety of different materials (plastic scintillator, C, Fe, Pb, He and H<sub>2</sub>O). The experiment will provide important inputs, both in support of neutrino oscillation searches and as a pure weak probe of the nuclear medium.

We present the current status of the analyses of the charge current quasi-elastic scattering in plastic scintillator, for both the neutrinos and antineutrinos. In addition We present the current status of the charge current inclusive analyses in the plastic scintillator and in the nuclear targets of carbon, iron and lead.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 727

## Charmonium and exotic particles at Belle

**Author:** Bruce Yabsley<sup>1</sup>

<sup>1</sup> *University of Sydney (AU)*

**Corresponding Author:** b.yabsley@physics.usyd.edu.au

We present the study of narrow charmonium(-like) resonances by  $\chi_{c1,c2}\gamma$  final states in  $B \rightarrow \chi_{c1,c2}\gamma K$  decays at Belle. The results are based on the full  $\Upsilon(4S)$  data sample corresponding to  $772 \times 10^6$   $B\bar{B}$  pairs recorded by the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

We present the study of  $B^\pm \rightarrow J/\psi \eta K^\pm$  decays at Belle. Along with the branching fraction measurement, we search for narrow charmonium-like resonances in the  $J/\psi \eta$  final state. The analysis is based on the full  $\Upsilon(4S)$  data set corresponding to  $772 \times 10^6$   $B\bar{B}$  pairs collected by the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

We present the results of an amplitude analysis of the decay  $\bar{B}^0 \rightarrow J/\psi K^- \pi^+$ . A search for charged charmonium-like states in the  $J/\psi \pi^+$  system has been performed. The analysis is based on a  $711 \text{ fb}^{-1}$  data sample collected by the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

The cross section for  $e^+e^- \rightarrow J/\psi \eta$  between  $\sqrt{s} = 3.8 \text{ GeV}$  and  $5.3 \text{ GeV}$  is measured using  $980 \text{ fb}^{-1}$  of data on and off the  $\Upsilon(nS)$  resonances collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. Two resonant structures at the  $\psi(4040)$  and  $\psi(4160)$  are observed in the  $J/\psi \eta$  invariant mass distribution. The transition rates of  $\psi(4040)$  and  $\psi(4160)$  to the  $J/\psi \eta$  final state are measured. This is the first measurement of this hadronic transition mode. No significant signals of the  $Y(4008)$ ,  $Y(4260)$ ,  $Y(4360)$ , or  $Y(4660)$  are observed in the  $J/\psi \eta$  final state.

We search for a doubly charmed tetraquark ( $T_{cc}$ ) using a large data sample collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. Various hadronic models, which are in good agreement in the baryon and meson sectors, show different results for tetraquarks. The production of  $T_{cc}$  plays a crucial role for discriminating among these models.

We report preliminary results of a search for decays of an exotic state  $X$  to various modes with the  $\eta_c$  meson:  $\eta_c \pi^+ \pi^-$ ,  $\eta_c \omega$ ,  $\eta_c \eta$ , and  $\eta_c \pi^0$ . The analysis is based on a data sample of  $772 \times 10^6$   $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 729

## Charm mixing at Belle

**Author:** Tao Peng<sup>1</sup>

<sup>1</sup> *University of Science & Technology of China*

**Corresponding Author:** ptd8606@mail.ustc.edu.cn

We present an updated measurement of the mixing parameter  $y_{CP}$  in the decays  $D^0 \rightarrow K^+ K^-$  and  $D^0 \rightarrow \pi^+ \pi^-$ . The results are obtained from the full data set of  $1 \text{ ab}^{-1}$  collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

We report a measurement of  $D^0 - \bar{D}^0$  mixing in  $D^0 \rightarrow K_S^0 \pi^+ \pi^-$  decays using a time-dependent Dalitz plot analysis. The results are obtained from a large data sample collected on the  $\Upsilon(4S)$  and  $\Upsilon(5S)$  resonances with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 736**

## Study of QCD in gamma gamma to pseudoscalar meson pair processes

**Author:** Hideyuki Nakazawa<sup>1</sup>

<sup>1</sup> *National Central University (JP)*

**Corresponding Author:** nkzw@post.kek.jp

We report QCD studies of pseudoscalar meson pair production in two-photon collisions at the Belle experiment. Differential cross sections have been measured for  $\pi^+ \pi^-$ ,  $\pi^0 \pi^0$ ,  $K^+ K^-$ ,  $K_S K_S$ ,  $\eta \pi^0$  and  $\eta \eta$  final states. Their  $W$  dependence and angular distributions are compared with perturbative and non-perturbative QCD predictions at  $(2.4 - 3.1) \text{ GeV} < W < (3.3 - 4.1) \text{ GeV}$ , where  $W$  is the invariant mass of the two-photon system. Existing predictions fail systematically to describe our measurements.

**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 737**

## Two-photon collisions at Belle

**Author:** Hideyuki Nakazawa<sup>1</sup>

<sup>1</sup> *National Central University*

**Corresponding Author:** nkzw@post.kek.jp

The invariant mass spectrum of the  $\eta' \pi^+ \pi^-$  final state produced in two-photon collisions is obtained using  $673 \text{ fb}^{-1}$  of data on and off the  $\Upsilon(4S)$  collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. The  $\eta_c$  mass, width and the product of the two-photon width and the branching fraction of the decay into  $\eta' \pi^+ \pi^-$  are measured. We also report the first evidence for the  $\eta(1760)$  decays to  $\eta' \pi^+ \pi^-$ . From a fit of the mass spectrum with the coherent  $X(1835)$  and  $\eta(1760)$  resonances, we set a 90% confidence level upper limit on the product  $\Gamma_{\gamma\gamma} \text{calB}$  for the  $X(1835)$ .

**Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 738**

## Photon results from CDF.

**Corresponding Author:** konstantinos.vellidis@cern.ch

Prompt isolated photon pairs production cross sections, as well as direct photon production in association with a heavy (b or c) quark jets are presented. Differential cross sections are presented as a function of several variables. The results are compared with a next-to-leading order perturbative QCD calculations.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 742**

## Search for $\tau \rightarrow \mu/e \gamma$ with the full data sample of Belle

**Author:** Kiyoshi Hayasaka<sup>1</sup>

<sup>1</sup> *Nagoya University (JP)*

**Corresponding Author:** hayasaka@hepl.phys.nagoya-u.ac.jp

We search for a lepton flavor violating  $\tau$  decay into  $\mu/e$  and  $\gamma$  using the full data sample of approximately  $1000 \text{ fb}^{-1}$  collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 743**

## Precise measurement of the W boson mass at CDF II

**Author:** Ashutosh Kotwal<sup>1</sup>

<sup>1</sup> *Duke University (US)*

**Corresponding Author:** kotwal@phy.duke.edu

The mass of the W boson is sensitive to radiative corrections from the top quark and the Higgs boson. We present a new measurement of mW using  $2.2/\text{fb}$  of  $\sqrt{s}=1.96 \text{ TeV}$  ppbar collision data collected with the CDF II detector. Utilizing 470126  $W \rightarrow e\nu$  candidates and 624708  $W \rightarrow \mu\nu$  candidates, we measure  $mW = 80387 \pm 19 \text{ MeV}$ . This is the most precise measurement of mW, more precise than all previous measurements of mW combined.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 744**

## Bs decays at Belle

**Author:** Felicitas Thorne<sup>1</sup>

<sup>1</sup> *Institute of High Energy Physics (AT)*

**Corresponding Author:** felicitas.thorne@oeaw.ac.at

We study the decays  $B_s^0 \rightarrow J/\psi\phi$  and  $B_s^0 \rightarrow J/\psi K^+ K^-$  using a  $121.4 \text{ fb}^{-1}$  data sample collected at the  $\Upsilon(5S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. The decay  $B_s^0 \rightarrow J/\psi\phi$  is an important mode for measuring the CP violating phase  $\beta_s$  in the  $B_s \bar{B}_s$

mixing, which is of particular interest as it is sensitive to physics beyond the Standard Model. Therefore, regarding the current PDG value with a relative error of 36%, a precise measurement of this branching fraction is essential. Furthermore, in this analysis the branching fraction of the decay  $B_s^0 \rightarrow J/\psi K^+ K^-$ , which has not been measured so far, is determined simultaneously with the branching fraction of the  $B_s^0 \rightarrow J/\psi \phi$ . By separating these two final states, it is also possible to calculate the  $S$ -wave contribution within the  $\phi$  mass region.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 745**

## Z+Jets results from CDF

**Author:** Konstantinos Vellidis<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Author:** konstantinos.vellidis@cern.ch

Inclusive Z boson plus jets cross sections, as well as bottom jet production in association with a Z-boson cross sections, are measured in a final state where the Z boson has decayed in two muons or electrons. Results are based on the full data sample collected with the CDF detector in Run II, corresponding to  $\sim 9.4 \text{ fb}^{-1}$  of pp collisions at  $\sqrt{s} = 1.96 \text{ TeV}$ . Differential cross sections are measured as a function of several variables, among which jet transverse momentum, jet rapidity and jets multiplicity. Measurements are compared to results from different next-to-leading order perturbative QCD predictions and event generators.

**Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&7&10 / 746**

## Y(5S) spectroscopy at Belle

**Author:** Alexander Bondar<sup>1</sup>

<sup>1</sup> *Novosibirsk State University (RU)*

**Corresponding Author:** bondar@inp.nsk.su

We report the results of the  $R_b$  scan in the region from 10750 MeV to 11020 MeV in steps of 5 MeV. The scan data were collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. This result can be used to map the shape of the  $\Upsilon(10860)$  and  $\Upsilon(11020)$  resonances. The search for the tetraquark candidate  $Y(10900)$  is also reported.

We report on the study of the hadronic transitions from the  $\Upsilon(5S)$  to lower bottomonia using 121.4  $\text{fb}^{-1}$  data collected at the  $\Upsilon(5S)$  resonance by the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. Decays of the  $\Upsilon(5S)$  to the  $\Upsilon(1D)\pi^+\pi^-$  and  $\Upsilon(1,2S)\eta$  final states have been observed for the first time.

Recently, Belle observed the spin-singlet bottomonium states  $h_b(1P)$  and  $h_b(2P)$ . Radiative transitions to the  $\eta_b(1S)$  and  $\eta_b(2S)$  are expected to account for a large fraction of the  $h_b(nP)$  decays. We report on the measurement of the  $\eta_b(1S)$  and  $\eta_b(2S)$  parameters using these radiative transitions. We report the most precise measurement of the  $\eta_b(1S)$  mass, first measurement of its width, first measurement of the  $\eta_b(2S)$  mass, and first measurement of the branching fractions of the radiative transitions  $h_b(nP) \rightarrow \eta_b(mS)\gamma$ .

Recently, Belle observed two exotic resonances  $Z_b(10510)$  and  $Z_b(10560)$  produced in the  $\Upsilon(5S) \rightarrow Z_b^+\pi^-$  transitions and decaying into the  $\Upsilon(1S)\pi^+$ ,  $\Upsilon(2S)\pi^+$ ,  $\Upsilon(3S)\pi^+$ ,  $h_b(1P)\pi^+$  and  $h_b(2P)\pi^+$  final states. We report on further studies of these resonances.

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 750

## The Energy Dependence of the Underlying Event in Hadron-Hadron Collisions

**Author:** Richard Dryden Field<sup>1</sup>

<sup>1</sup> *University of Florida (US)*

**Corresponding Author:** rfield@phys.ufl.edu

We study the behavior of the underlying event in proton-antiproton collisions at 300 GeV, 900 GeV, and 1.96 TeV using charged particles measured by the CDF detector. The charged particle density and the scalar PTsum density in the transverse region as defined by the leading charged particle, PTmax, are examined as a function of PTmax at the three center-of-mass energies. The data at 300 GeV and 900 GeV were taken just before the shutdown of the Tevatron. The 900 GeV results are compared directly with similar studies at the LHC and combining Tevatron and LHC results allows for a mapping out of the energy dependence of the underlying event at 300 GeV, 900 GeV, 1.96 TeV, and 7 TeV. We also examine the ability of the QCD Monte-Carlo models to simultaneously describe the behavior of the underlying event at all four center-of-mass energies.

Plenary3 - The Standard Model -TR1 / 756

## Search for Light Higgs Bosons in $\Upsilon(1S)$ and $\Upsilon(2S)$ decays

**Author:** Paoti Chang<sup>1</sup>

<sup>1</sup> *National Taiwan University (TW)*

**Corresponding Author:** pchang@phys.ntu.edu.tw

A light  $CP$ -odd Higgs boson ( $A^0$ ) is predicted in some extensions of the Standard Model; such a particle would be evident in decays of the  $\Upsilon(nS)$  resonance. Using a data sample of 102 million  $\Upsilon(1S)$  events and 158 million  $\Upsilon(2S)$  events collected by the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider, we search for light Higgs boson decays  $A^0 \rightarrow \tau^+\tau^-$  and  $A^0 \rightarrow \mu^+\mu^-$  in the processes  $\Upsilon(1S) \rightarrow \gamma A^0$  and  $\Upsilon(2S) \rightarrow \gamma A^0$ .

Room 219 - BSM - Non-SUSY - TR3 / 760

## “Light” Higgs and warped models : Possible clues for future directions in HEP

**Author:** Amarjit Soni<sup>1</sup>

<sup>1</sup> *Brookhaven National Laboratory (US)*

**Corresponding Author:** adlersoni@gmail.com

Taking the indications for the lightish Higgs from the LHC experiments along with no signs of anything else new to about the TeV scale seriously and focusing on warped models, it'd appear that except for a radion/dilaton all other manifestations of KK-modes are a lot heavier in simplest models. Implications of such a radion will be discussed and what this scenario may mean for the frontiers



of high energy physics will be explored. This talk is partly based on work done in collaboration with Hooman Davoudiasl and Tom McElmurry.

TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 761

## Decays and spectroscopy at $\Upsilon(1S,2S)$ at Belle

**Authors:** Matthew Barrett<sup>1</sup>; Matthew Barrett<sup>2</sup>

<sup>1</sup> University of Hawai'i at Manoa

<sup>2</sup> Brunel University

**Corresponding Authors:** mattb@phys.hawaii.edu, mattb@slac.stanford.edu

Using samples of 102 million  $\Upsilon(1S)$  and 158 million  $\Upsilon(2S)$  events collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider, we study hadronic exclusive decays of these two bottomonium resonances to the three-body final states  $\phi KK$ ,  $\omega\pi\pi$  and  $K^{*0}(892)K^-\pi^+ + \text{c.c.}$ , as well as two-body processes including the Vector-Tensor ( $\phi f_2'(1525)$ ,  $\omega f_2(1270)$ ,  $\rho a_2(1320)$ ,  $K^{*0}(892)\bar{K}_2^{*0}(1430) + \text{c.c.}$ ) and Axial-vector-Pseudoscalar ( $K_1(1270)^+K^- + \text{c.c.}$ ,  $K_1(1400)^+K^- + \text{c.c.}$ ,  $b_1(1235)^+\pi^- + \text{c.c.}$ ) modes. Branching fractions are determined for processes with a statistical significance greater than  $3\sigma$ ; otherwise, the upper limits on the branching fractions are set at 90% confidence level. The ratios of the branching fractions of  $\Upsilon(2S)$  and  $\Upsilon(1S)$  decay into the same final state are used to test the perturbative QCD prediction.

The hadronic decays of the narrow  $\Upsilon(nS)$  resonances ( $n = 1, 2$ , or  $3$ ) produce large numbers of  $u\bar{u}, d\bar{d}$ , and  $s\bar{s}$  pairs concentrated in a limited phase-space volume, which makes them ideal for searching for multi-quark states with zero strangeness. Here we report on high sensitivity searches for inclusive production of the predicted  $S=-2$  pentaquark baryon  $\Xi^{--}$  and six-quark  $H$  dibaryon using the 102 million event  $\Upsilon(1S)$  and 158 million event  $\Upsilon(2S)$  data samples collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. The  $\Xi^{--}$  search concentrates on the  $\Xi \rightarrow \Xi^-\pi^+$  decay mode and has a branching fraction sensitivity at the  $10^{-5}$  level; the  $H$ -dibaryon search includes the  $H \rightarrow \Xi^-\pi^+$ ,  $\Lambda\Lambda$  and  $\Lambda p\pi^-$  decay channels with branching fraction sensitivities approaching  $10^{-6}$ . Decay branching fractions and momentum distributions for topologically similar inclusive processes  $\Upsilon(nS) \rightarrow \Xi^0(1530)X$  and  $\Xi_c^0 X$  are measured for the first time.

Using samples of 102 million  $\Upsilon(1S)$  and 158 million  $\Upsilon(2S)$  events collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider, we search for the first time for double charmonium decays from  $\chi_{bJ}$ ,  $\Upsilon(1S)$  and  $\Upsilon(2S)$  states. No significant signal is observed in these modes and the upper limits on the decay rates are obtained at the 90% confidence level. These limits are consistent with calculations using the NRQCD factorization approach.

Using samples of 158 million  $\Upsilon(2S)$  events collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider, we study the hadronic exclusive decays of  $\Upsilon(1,2S)$  to baryon-antibaryon ( $p\bar{p}$ ,  $\Lambda\bar{\Lambda}$ ,  $\Sigma\bar{\Sigma}$ ,  $\Xi\bar{\Xi}$ ) and 0, 1, or 2 mesons ( $\pi^0$ ,  $\eta$ , and  $\pi^\pm$ ). Branching fractions are determined for processes with statistical significance greater than  $3\sigma$ ; otherwise, the upper limits on the branching fractions are set at 90% confidence level. The ratios of the branching fractions of  $\Upsilon(2S)$  and  $\Upsilon(1S)$  decay into the same final state are used to test the perturbative QCD prediction.

The double cascade radiative transitions  $\Upsilon(2S) \rightarrow \gamma\chi_{bJ} \rightarrow \gamma\gamma\Upsilon(1S)$  have been studied using a sample of 158 million  $\Upsilon(2S)$  decays recorded with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. These provide the most precise measurement to date of the branching ratios  $\text{cal}B(\chi_{b0,1,2}(1P) \rightarrow \gamma\Upsilon(1S))$  and limits on the total widths of the  $\chi_b$  states. Results are compared with potential models and recent NRQCD predictions.

## Study of inclusive production of $S = 0, 1, 2$ , or 3 baryons from $\Upsilon(1, 2S)$ at Belle

**Author:** Youngjoon Kwon<sup>1</sup>

<sup>1</sup> *Yonsei University*

**Corresponding Author:** yjkwon63@yonsei.ac.kr

Using samples of 102 million  $\Upsilon(1S)$  and 158 million  $\Upsilon(2S)$  events and about  $70 \text{ fb}^{-1}$  of data taken in the nearby continuum with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider, we compare the inclusive production rates of baryons in 3-gluon vs. quark fragmentation processes. The spectra of  $p$ ,  $\Lambda$ ,  $\Sigma$ ,  $\Xi$ , and  $\Omega$  baryons are compared, and we quantify the enhanced production in 3-gluon mechanisms by studying their dependence on strange quark content. Experimental results are compared with Monte Carlo predictions.

Room 219 - BSM - Non-SUSY - TR3 / 767

## Search for the dark photon at Belle

**Author:** Ming-Chuan Chang<sup>1</sup>

<sup>1</sup> *Fu Jen Catholic University (TW)*

**Corresponding Author:** 068190@mail.fju.edu.tw

Many extensions of the Standard Model introduce additional Higgs fields that include one or more dark Higgs bosons to the interactions. Such a gauge boson, also known as a dark photon, typically has very weak coupling to Standard Model particles. Experimental results from direct dark matter searches (e.g., DAMA/LIBRA) and other experimental anomalies (e.g.,  $g - 2$ ) can be explained by such an additional interaction. Dark gauge bosons are typically of low mass, of order MeV to GeV. The ideal tools to discover such particles are therefore not high-energy collider experiments but lower-energy high-luminosity collider experiments like Belle and BaBar or dedicated fixed target experiments, several of which are planned or already under construction: at JLAB (Newport News, USA) and MAMI (Mainz, Germany), for example. In Belle, the search for the dark photon focuses on the so-called Higgs-strahlung channel, as proposed by Batell et al., where a dark photon and a dark Higgs are produced. Preliminary results will be presented and discussed.

Room 216 - Particle Astrophysics and Cosmology -TR11 / 768

## Status and Prospects for SuperCDMS

**Authors:** Collaboration SCDMS<sup>1</sup>; Lauren Hsu<sup>2</sup>

<sup>1</sup> *SuperCDMS*

<sup>2</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Authors:** llhsu@fnal.gov, cooley@physics.smu.edu

Direct searches for dark matter are one of the most promising ways to discover new particles and fields. For over a decade, the Cryogenic Dark Matter Search has been a leader in searches for dark matter. CDMS has pioneered the use of athermal phonon and ionization sensors to achieve world-leading sensitivity to a theoretically-favored dark matter candidate, the Weakly Interacting Massive Particle. This endeavor is far from complete, however. The next generation of the experiment, SuperCDMS, will take place in two phases. The first phase of the experiment, SuperCDMS Soudan, is now in operation in Northern Minnesota. The dark matter detector consists of a 9-kg array of Ge

crystals. The second phase, SuperCDMS SNOLAB, is under active development. This phase will consist of ~200 kg of Ge crystals and will be deployed in SNOLAB, the deepest underground laboratory in the Western Hemisphere. This is a busy and exciting time as we work to turn these plans into reality. I will describe the SuperCDMS projects and report on their present status.

TR 8 - Neutrinos RM 219 / 769

## Status of the OPERA search for muon-neutrino to tau-neutrino oscillations

**Authors:** Collaboration OPERA<sup>1</sup>; Marilisa De Serio<sup>2</sup>

<sup>1</sup> *Publications and talks Board*

<sup>2</sup> *INFN (IT)*

**Corresponding Author:** marilisa.de.serio@cern.ch

The OPERA neutrino detector built in the underground Gran Sasso Laboratory is designed to detect muon-neutrino to tau-neutrino oscillations in direct appearance mode. The hybrid apparatus consists of an emulsion/lead target complemented by electronic detectors. It is placed in the long-baseline CERN to Gran Sasso neutrino beam (CNGS) 730 km away from the source.

The running of the experiment and the extraction of data recorded in the emulsion will be described, with the special procedures used to locate the interactions vertices and detect short decay topologies. OPERA is taking data since 2008 and a first nu-tau interaction candidate has been published in 2010. After publication of the results of the nu-tau search in the 2008 and 2009 data, a much larger amount of new data has been accumulated and the analysis scheme was improved including more detailed simulations at the emulsion level. New results with increased statistics will be presented.

TR 6 - RM 217 - QCD, Jets, Parton Distributions / 771

## Momentum space dipole amplitude for DIS and inclusive hadron production

**Author:** M. Beatriz Gay Ducati<sup>1</sup>

**Co-authors:** Eduardo Basso<sup>2</sup>; Emmanuel de Oliveira<sup>3</sup>

<sup>1</sup> *Universidade Federal do Rio Grande do Sul (BR)*

<sup>2</sup> *Universidade Federal do Rio Grande do Sul*

<sup>3</sup> *USP*

**Corresponding Author:** beatriz.gay@cern.ch

We show how the AGBS model, originally developed for deep inelastic scattering applied to HERA data on the proton structure function, can also describe the RHIC data on single inclusive hadron yield for  $d+Au$  and  $p+p$  collisions through a new simultaneous fit. The single inclusive hadron production is modeled through the color glass condensate, which uses the quark(and gluon)-condensate amplitudes in momentum space. The AGBS model is also a momentum space model based on the asymptotic solutions of the BK equation, although a different definition of the Fourier transform is used. This description entirely in transverse momentum of both processes arises for the first time. The small difference between the simultaneous fit and the one for HERA data alone suggests that the AGBS model describes very well both kind of processes and thus emerges as a good tool to investigate the inclusive hadron production data. We use this model for predictions at LHC energies, which agree quite well with available experimental data.

TR 8 - Neutrinos RM 219 / 772

## CP Violation at a Neutrino Factory

**Authors:** Kenneth Long<sup>1</sup>; Paul Soler Jermyn<sup>2</sup>

<sup>1</sup> *Imperial College London (UK)*

<sup>2</sup> *University of Glasgow (GB)*

**Corresponding Authors:** k.long@imperial.ac.uk, paul.soler@glasgow.ac.uk

Exciting prospects for the discovery of CP violation in the neutrino sector have recently been made more likely by the measurement of the neutrino mixing angle  $\theta_{13}$ . CP violation is a necessary condition for leptogenesis to be at the origin of the matter-antimatter asymmetry of the universe. A number of future options for establishing CP violation in neutrinos are possible, but the Neutrino Factory, in which beams of neutrinos are created from the decays of muons in a storage ring, offers the best sensitivity for this discovery and the most precise measurements of the mixing parameters and CP phase in the leptonic sector, which is related to the problem of flavour, the existence of three generations in nature and leptogenesis.

The International Design Study for the Neutrino Factory (the IDS-NF) was established to deliver a Reference Design Report (RDR). The baseline design has been revised in the light of the new  $\theta_{13}$  results. The facility will provide  $10^{21}$  muon decays per year from 10 GeV stored muon beams pointing at a large (100 kton) Magnetised Iron Neutrino Detector (MIND) at a distance between 2000—2500 km. A description of the facility and a new upgraded neutrino oscillation analysis will be used to determine the CP sensitivities and the measurement of the CP phase  $\delta$ . A compelling case for a Neutrino Factory will be made, based on the unprecedented precision in  $\delta$  and the prospects of new physics in the neutrino sector that such a Neutrino Factory will be able to establish.

Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&amp;13 / 773

## The Accelerator Complex from the International Design Study of the Neutrino Factory

**Author:** Paul Soler Jermyn<sup>1</sup>

<sup>1</sup> *University of Glasgow (UK)*

**Corresponding Author:** paul.soler@glasgow.ac.uk

The Neutrino Factory produces high-energy neutrino beams with a well-defined flavour content and energy spectrum from the decay of intense, high-energy, stored muon beams to establish CP violation in the neutrino sector. The International Design Study for the Neutrino Factory (the IDS-NF) will provide a Reference Design Report (RDR) for the facility. The present baseline design has been re-evaluated to take into account the recent measurements of  $\theta_{13}$ . This talk describes the status of the accelerator facility and the accelerator subsystems of which it is comprised. This is a modification of the facility described in the Interim Design Report (IDR) completed in 2011. The accelerator facility will deliver  $10^{21}$  muon decays per year from 10 GeV stored muon beams. The straight sections of the storage ring point to a 100 kton Magnetised Iron Neutrino Detector (MIND) at a distance of 2000—2500 km from the source. The accelerator-physics challenges, and the R&D underway to meet them, will be described together with alternative designs that are being developed to mitigate the technical risks that some of the subsystems present.

Poster Session - Board: 65 / 774

## Forward Calorimeters Test Beam Results for Future Linear Colliders

**Author:** Olga Novgorodova<sup>1</sup>

<sup>1</sup> DESY (DE)

**Corresponding Author:** olga.novgorodova@cern.ch

In detectors at Future Linear Colliders a Beam Calorimeter (BeamCal) is foreseen. The main BeamCal goals are coverage of low polar angles for new physics searches and beam tuning. The challenges are radiation hardness of sensors due to a large amount of beamstrahlung remnants, fast readout, fine granularity and compactness. A prototype of a BeamCal sensor made of GaAs with pad structures was assembled and successfully tested in the laboratory and on the 4,5 GeV electron beam (DESY II, Hamburg). Two test beams results are present 2010-2011. The sensor was connected to a fan-out, and specially developed front-end ASICs and flash ADC. Multichannel read out was shown working with recently developed DAQ. Results are obtained for signal-to-noise and the response as a function of the position on and between the pads.

In addition, results of the sensor characterization are presented: the leakage current measured as a function of temperature and the charge collection efficiency as a function of the operation voltage.

#### **Financial Support Justification for Early-Stage Researchers:**

A PhD student of DESY I would like to ask for support to go to ICHEP. My Mary Curie contract finishes in May and new DESY contract does not include travel money.

#### **Summary:**

FCAL collaboration is doing for last two years test beams for the Luminosity and Beam Calorimeters prototypes.

**TR 8 - Neutrinos RM 219 / 775**

## **Short baseline neutrino and anti-neutrino oscillation studies at the CERN-SPS.**

**Author:** Maximiliano Sioli<sup>1</sup>

<sup>1</sup> INFN (IT)

**Corresponding Author:** m.siolli@cern.ch

The possibility of mixing between standard active neutrinos and neutrino fields which are singlets under the gauge symmetries of the Standard Model was proposed a long time ago. Recent tensions between world-wide experimental data renewed the possibility of at least a sterile neutrino state to explain the observations. While a huge effort is being devoted to resolve the standard three-neutrino mixing paradigm at present no resolute experimental setup was carried out or proposed to unambiguously settle these anomalies. Here we present the proposal for an experimental search for sterile neutrinos with a new CERN-SPS neutrino beam using muon spectrometers and large LAr detectors. To definitively clarify the physics issue the proposed experiment will study oscillations in a muon neutrino/antineutrino beam both in appearance and disappearance modes in the  $eV^2$  square mass difference region.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 776**

## **Flow of strange and charm particles in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV measured with ALICE**

**Author:** Carlos Eugenio Perez Lara<sup>1</sup>

<sup>1</sup> *NIKHEF (NL)*

**Corresponding Author:** carlos.eugenio.perez.lara@cern.ch

The ALICE experiment studies Pb-Pb collisions at the LHC in order to investigate the properties of the hot and dense QCD matter at extreme energy densities. Recent results from ALICE in identified particle flow allow for the exploration of the collective properties of the medium created in heavy-ion collisions. Due to their difference in mass, the strange and charm quarks are expected to couple differently to the system in the deconfined phase. In this talk, special attention is given to strange and charm particles which probe the medium differently and thus provide new constraints for the study of its properties. The talk will cover results on elliptic flow for  $K^+$ ,  $K_s^0$ ,  $\Lambda$ ,  $\Xi$ ,  $\Omega$ ,  $\Phi$ ,  $D^0$  and  $D^{*+}$  measured at midrapidity by ALICE in Pb-Pb collisions at  $\sqrt{s_{NN}} = 2.76$  TeV. The comparison with available models will also be shown.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 777**

## European and global networks for high-energy physics communications and outreach

**Author:** Arnaud Marsollier<sup>1</sup>

<sup>1</sup> *CERN*

**Corresponding Author:** arnaud.marsollier@cern.ch

As High-Energy physics is going global, high-energy physicists and their organizations collaborate more and more not only into science but also in communicating about it.

Communications play an increasing role in our society, and we face big challenges as the visibility of our field is becoming high. Networks for outreach and communications are then crucial to promote the field in a coherent way at the global level, to coordinate activities and develop common actions. We will present networks that developed mainly around CERN such as EPPCN, Interactions, IP-POG... with a focus on two key questions:

How can physicists benefit from these networks? What can they do to help these networks?

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 778**

## International Particle Physics Masterclasses - Bringing LHC data into the classroom

**Author:** Farid Ould-Saada<sup>1</sup>

<sup>1</sup> *Oslo University (NO)*

**Corresponding Author:** farid.ould-saada@fys.uio.no

The International Particle Physics Outreach Group (IPPOG) has developed an educational activity that brings the excitement of cutting-edge particle physics research into the classroom.

Each year, since 2005, thousands of high school students in many countries all over the world come to nearby universities or research centres for one day in order to unravel the mysteries of particle physics and be “scientists for a day”. In 2012, 10000 students from 130 institutions in 31 countries took part in the popular event over 4 weeks.

Lectures from active scientists give insight on topics and methods of fundamental research on the

building blocks of matter and the forces between them, enabling the students to perform measurements on real data from particle physics experiments themselves.

The last two years featured the use of fresh LHC data from the ALICE, ATLAS and CMS experiments. Event display programs, software tools and analysis methods are quickly mastered by students who then measure various properties of some known particles, such as the weak gauge bosons W and Z and a number of hadrons (Jpsi, Upsilon, Lambda, K-short). The fractions of W+ and W- events are interpreted in terms of quark structure of the proton (not just the simple view of uud quarks). The concept of invariant mass is first used to identify and measure masses and widths of short-lived particles, before it is applied to look for new particles.

At the end of each day, with tools used in our international research collaborations, the participants join in a videoconference with CERN or Fermilab for discussion and combination of their results.

The latter are then compared to recent results published by the experiments.

We will describe the methodology employed for the IPPOG International Masterclasses, summarise the measurements performed and report on the impact of the day on young students. We will show how you (the particle physicist) can become involved in this activity and develop your own initiatives based around the samples of LHC data and associated tools.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 779**

## IR-Improved Operator Product Expansions in non-Abelian Gauge Theory

**Author:** Bennie Ward<sup>1</sup>

<sup>1</sup> *Baylor University (US)*

**Corresponding Author:** bfl\_ward@baylor.edu

We present a formulation of the operator product expansion that is infrared finite to all orders in the attendant massless non-Abelian gauge theory coupling constant, which we will often-times associate with the QCD theory, the theory that we actually have as our primary objective in view of the operation of the LHC at CERN. We make contact in this way with the recently introduced IR-improved DGLAP-CS theory and point-out phenomenological implications accordingly, with an eye toward the precision QCD theory for LHC physics.

**Room 218 - Detectors and Computing for HEP - TR13 / 780**

## Diamond sensors in HEP

**Author:** Marko Mikuz<sup>1</sup>

**Co-authors:** Harris Kagan<sup>2</sup>; William Trischuk<sup>3</sup>

<sup>1</sup> *University of Ljubljana, Jozef Stefan Institute (SI)*

<sup>2</sup> *Ohio State University*

<sup>3</sup> *University of Toronto (CA)*

**Corresponding Authors:** marko.mikuz@cern.ch, william.trischuk@cern.ch

Progress in experimental particle physics in the coming decade depends crucially upon the ability to carry out experiments at high energies and high luminosities. These conditions imply that future experiments will take place in very high radiation areas. In order to perform these complex and expensive experiments new radiation hard technologies will have to be developed. Chemical Vapour Deposition (CVD) diamond is being developed as a radiation tolerant material for use very close to the interaction region where detectors may have to operate in extreme radiation conditions. During the past few years many CVD diamond devices have been manufactured and tested. As a detector for high radiation environments CVD diamond benefits substantially from its radiation hardness, very

low leakage current, low dielectric constant, fast signal collection and ability to operate at room temperature. As a result CVD diamond now has been used extensively in beam conditions monitors as the innermost detectors in the highest radiation areas of colliders. CVD diamond is being considered as a sensor material for the particle tracking detectors closest to the interaction region where the most extreme radiation conditions exist. We will present the state-of-the-art of the radiation tolerance of the highest quality CVD diamond material for a range of proton energies, pions and neutrons obtained from strip detectors constructed with this material. Recently single crystal CVD diamond material has been developed which resolves many of the issues associated with polycrystalline material. We will also present recent results on radiation tolerance obtained from strip detectors constructed from this new diamond material. We will discuss the use of diamond detectors and their survivability in the highest radiation environments.

Currently diamond is deployed in HEP experiments for two tasks: for beam conditions monitoring and measurement of luminosity. Beam conditions can be deduced either from beam induced current measurements replacing the commonly used ionization chambers by CVD diamond pad detectors (e.g. ATLAS BLM; CMS BCM1, BCM2) or by particle counting (ATLAS BCM; CMS BCMF). Due to its fast response and insensitivity to pile-up, ATLAS BCM also serves as the preferred luminosity monitor. As a result of positive experience with the ATLAS BCM an upgraded Diamond Beam Monitor (DBM) is being prepared for installation during the 2013-14 LHC shutdown. This detector will consist of 8 three-layer telescopes of pixelated diamond detectors. Each plane will have ~27k active pixels. The telescopes will provide sub-mm impact parameter resolution adding spatial information on the origin of backgrounds to the already precise (sub-ns) timing information from the BCM. This talk will describe the design and construction of both the ATLAS BCM and DBM systems as well as showing results from the first two years of BCM operation and test-beam studies of the DBM modules.

**Poster Session** - Board: 23 / 782

## Search for muon to electron conversion at J-PARC

**Author:** Yoshitaka Kuno<sup>1</sup>

<sup>1</sup> *Osaka University (JP)*

**Corresponding Author:** kuno@phys.sci.osaka-u.ac.jp

The COMET experiment at J-PARC is an experiment to search for muon to electron conversion at a single event sensitivity of  $3 \times 10^{-16}$ . This process is charged-lepton flavor violating. We are planning to stage the COMET experiment. The staging approach is endorsed by J-PARC PAC and KEK. We will present the details of COMET Phase-I.

**TR 8 - Neutrinos RM 219 / 783**

## Results from KamLAND-Zen double-beta decay experiment with <sup>136</sup>Xe

**Author:** Satoru Yamada<sup>1</sup>

<sup>1</sup> *Tohoku University (JP)*

**Corresponding Author:** yamada6@awa.tohoku.ac.jp

KamLAND-Zen is an experiment for neutrino-less double-beta decay search with <sup>136</sup>Xe. A newly constructed balloon was installed inside the current 13m diameter KamLAND balloon and filled with <sup>136</sup>Xe loaded liquid scintillator in 2011. The data taking was started in October 2011 and the first physics results were obtained with an exposure of 77.6 days with 129 kg of <sup>136</sup>Xe. We measured the two neutrino beta-decay half-life of <sup>136</sup>Xe,  $T_{1/2}(2\nu) = 2.38 \pm 0.02(\text{stat}) \pm 0.14(\text{syst}) \times 10^{21}$



yr and obtained an improved lower limit for the neutrino-less double-beta decay half-life,  $T_{1/2}(0\nu) > 5.7 \times 10^{24}$  yr at 90% confidence level.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 785**

## A new intense DC muon beam from a pion capture solenoid, MuSIC

**Author:** Yuko Hino<sup>1</sup>

**Co-authors:** Akira Sato<sup>2</sup>; Akira Yamamoto<sup>3</sup>; Hideyuki Sakamoto<sup>2</sup>; Kichiji Hatanaka<sup>4</sup>; Makoto YOSHIDA<sup>5</sup>; Mark Lancaster<sup>6</sup>; Matthew Wing<sup>6</sup>; Mitsuhiro Fukuda<sup>4</sup>; Nam Tran Hoai<sup>7</sup>; Richard D'Arcy<sup>8</sup>; Sam Cook<sup>8</sup>; Toru Ogitsu<sup>5</sup>; Truong Ming<sup>2</sup>; Yoshiharu Mori<sup>9</sup>; Yoshitaka Kuno<sup>2</sup>

<sup>1</sup> *Osaka University (JP)*

<sup>2</sup> *Osaka University*

<sup>3</sup> *High Energy Accelerator Research Organization (JP)*

<sup>4</sup> *RCNP*

<sup>5</sup> *KEK*

<sup>6</sup> *UCL*

<sup>7</sup> *Osaka University*

<sup>8</sup> *University College London*

<sup>9</sup> *KURRI*

**Corresponding Author:** sato@phys.sci.osaka-u.ac.jp

MuSIC is a project to provide the world's highest-intensity muon beam with continuous time structure at Research Center of Nuclear Physics (RCNP) of Osaka University, Japan. A pion capture system using a superconducting solenoid magnet and a part of superconducting muon transport solenoid channel have been built in 2010. The highest muon production efficiency was demonstrated by the beam test carried out in February 2011. The result concludes that the MuSIC can provide more than  $10^9$  muons/sec using a 400W proton beam. The pion capture system is one of very important technologies for future muon programs such as muon to electron conversion searches, neutrino factories, and a muon collider. The MuSIC built the first pion capture system and demonstrate its potential to provide an intense muon beam. The construction on the entire beam channel of the MuSIC will be finished in five years. We plan to carry out not only an experiment to search the lepton flavor violating process but also other experiments for muon science and their applications using the intense muon beam at RCNP.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 786**

## Cosmology and particle physics with POLARBEAR

**Author:** Adrian Lee<sup>1</sup>

**Co-authors:** Collaboration POLARBEAR<sup>2</sup>; Masaya Hasegawa<sup>3</sup>

<sup>1</sup> *University of California, Berkeley*

<sup>2</sup> *UC Berkeley, UCSD, KEK, McGill, Austin, Cardiff, Colorado, Dalhousie, Imperial C., LAC, LBNL, Tsukuba*

<sup>3</sup> *KEK (JP)*

**Corresponding Authors:** masaya.hasegawa@kek.jp, masashi.hazumi@kek.jp

Cosmic inflation predicts that primordial gravitational waves were created during the inflationary era. Measurements of polarization of the Cosmic Microwave Background (CMB) radiation are known

as the best probe to detect the primordial gravitational waves.

POLARBEAR is a telescope designed to detect the CMB B-mode with very sensitive polarimeters based on superconductive transition edge sensor (TES) detector technology. Its large primary mirror with a diameter of 3.5m also allows us to constrain or measure the sum of neutrino masses beyond the limit obtained so far.

POLARBEAR is located on the Chajnantor plateau in the Atacama desert in northern Chile at an altitude of 5,200m. We received the first light in January 2012 and are taking CMB data at 150 GHz. In this presentation we will describe the current status and prospect of POLARBEAR.

**Room 218 - Detectors and Computing for HEP - TR13 / 787**

## Evolution of the CMS Trigger System

**Author:** Ivan Kresimir Furic<sup>1</sup>

<sup>1</sup> *University of Florida (US)*

**Corresponding Authors:** ivan.kresimir.furic@cern.ch, ikfuric@hep.uchicago.edu

A key challenge at high luminosity hadron colliders is the selection of sufficiently pure event samples against large QCD backgrounds, whilst keeping data rates within practical bounds. The CMS trigger system performs the first step in event selection, and its performance dictates the physics reach of the experiment in many areas. As LHC luminosity continues to increase over the next decade, both the trigger strategy and systems must evolve. We describe the upgrade plans for the CMS trigger, including the possible use of tracking information at level-1, and explore the impact for the high-luminosity physics programme.

**Poster Session - Board: 24 / 789**

## Search for exotic VZ resonances decaying into a jet and dileptons with CMS

**Author:** Flavia De Almeida Dias<sup>1</sup>

<sup>1</sup> *UNESP - Universidade Estadual Paulista (BR)*

**Corresponding Author:** flavia.dias@cern.ch

We present a search by the CMS experiment for new exotic particles decaying to the VZ final state, where V is either a W or a Z decaying hadronically and the Z decays to dielectrons or dimuons. The analysis uses the full 2011 dataset at  $\sqrt{s} = 7$  TeV.

**Poster Session - Board: 25 / 790**

## Search for RS Gravitons decaying into a Jet plus Missing ET with CMS

**Author:** Thiago Fernandez Perez Tomei<sup>1</sup>

<sup>1</sup> *UNESP - Universidade Estadual Paulista (BR)*

**Corresponding Author:** thiago.tomei@cern.ch

We search for the production of heavy resonances in proton-proton collisions at  $\sqrt{s} = 7$  TeV, with the Randall-Sundrum graviton as a benchmark model. We focus on the  $G$  to  $ZZ$  to  $q\bar{q}$  reaction with boosted  $Z$  bosons. We look for the jet plus missing transverse energy signature in the  $4.7 \text{ fb}^{-1}$  of data collected by the CMS detector during 2011. Since the event yield is compatible with what would be expected solely from Standard Model processes, we are able to derive limits on the cross-section for the RS graviton production, and hence on the parameters of the Warped Extra Dimensions model. The cross-section 95% confidence upper limits are found to be in the range  $[0.047, 0.021] \text{ pb}$  for resonance masses ranging between 1000 and 1500 GeV. We extend the  $k/\text{MPI}$  search range to values up to 0.3, and translate the cross-section limits to the  $(m_G, k/\text{MPI})$  parameter space. In that way, we set 95% confidence upper limits on the coupling parameter  $k/\text{MPI}$  in the range 0.11 to 0.29, for the aforementioned resonance mass range.

**Poster Session** - Board: 26 / 791

## Searches for vector-like quarks

**Author:** Kai-Feng Chen<sup>1</sup>

<sup>1</sup> *National Taiwan University (TW)*

**Corresponding Author:** kai-feng.chen@cern.ch

We present results from searches for heavy exotic vector-like quarks performed using 5 fb-1 data sample of pp collisions at the center-of-mass energy of 7 TeV collected by the CMS detector at LHC.

**Poster Session** - Board: 27 / 793

## Search for a Heavy Exotic partner of the top quark with charge 5/3

**Author:** Saptaparna Bhattacharya<sup>1</sup>

<sup>1</sup> *Brown University (US)*

**Corresponding Author:** saptaparna.bhattacharya@cern.ch

Presented is a study of searches for two exotic particles - a heavy top quark partner with a fractional charge of  $5/3$ ,  $T_{5/3}$ , and its partner, the heavy  $B$  quark with charge  $-1/3$ . These particles decay to a top quark and a  $W$  boson, leading to very busy events with multi-leptons and multi-jets. Processes where same-sign dileptons are produced are considered. The backgrounds are predominantly from  $t\bar{t}$ , QCD multi-jets,  $Z$ +jets,  $t\bar{t}WW$ ,  $t\bar{t}W$  and multiple- $W$ +jets production. A study using the data collected by the CMS detector at the LHC during 2011 has been performed.

Speakers

**Poster Session** - Board: 28 / 794

## Search for large extra dimensions in dielectron events in pp collisions at $\sqrt{s} = 7$ TeV at CMS

**Author:** Seyed Mohsen Etesami<sup>1</sup>

<sup>1</sup> *Institute f. Studies in Theoretical Physics and Mathematics (IR)*

**Corresponding Author:** sm.etesami@ipm.ir

We present a poster to report the results of a search for large extra dimensions in events with two isolated electrons using the whole 5 fb<sup>-1</sup> of data collected with the CMS detector at the LHC in 2011. The exclusion limits on the parameters of different models with different assumptions on the validity range of the model are shown

**Poster Session - Board: 06 / 795**

## Search for Higgs decaying to tau tau at CMS

**Author:** Agni Bethani<sup>1</sup>

<sup>1</sup> *DESY (DE)*

**Corresponding Author:** agni.bethani@cern.ch

Results are presented on the search for the standard model Higgs boson decaying into two tau leptons, using both leptonic and hadronic decays of the tau. The sample are split into various categories to enhance the search sensitivity. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Poster Session - Board: 07 / 796**

## Search for Standard Model Higgs boson decaying into 4 leptons with CMS detector

**Author:** Christian Veelken<sup>1</sup>

<sup>1</sup> *Ecole Polytechnique (FR)*

**Corresponding Author:** christian.veelken@cern.ch

A search for a Higgs boson in the four-lepton decay channel Higgs to ZZ(\*), with each Z boson decaying to an electron or muon pair, is presented using 4.7 fb<sup>-1</sup> of integrated luminosity collected during 2011 as well as considerable fraction of 2012 integrated luminosity recorded by the CMS detector in pp collisions from the LHC at CM energy of 7 TeV. The search covers Higgs boson mass hypotheses of 110 < m<sub>H</sub> < 135 GeV/c<sup>2</sup> and 305 < m<sub>H</sub> < 340 GeV/c<sup>2</sup>. Upper limits at 95% CL on the product of the cross section and branching ratio as well as the p-value for the Standard Model Higgs boson are presented.

**Poster Session - Board: 46 / 797**

## Measurement of the inclusive production cross sections for forward jets and forward - central dijets in CMS at sqrt{s} = 7 TeV

**Author:** Salim Cerci<sup>1</sup>

<sup>1</sup> *Cukurova University (TR)*

**Corresponding Author:** salim.cerci@cern.ch

We present the measurements of inclusive production cross sections for forward jets, as well for jets in dijet events with at least one jet emitted at central and the other at forward pseudorapidities in proton-proton collisions at  $\sqrt{s} = 7$  TeV. The measurements were performed in the range of transverse momenta  $p_T = 35 - 150$  GeV/c within pseudorapidities  $3.2 < |\eta| < 4.7$ , and central jets within the  $|\eta| < 2.8$  range. The differential cross sections  $d^2\sigma/dp_T d\eta$  are compared to predictions from three approaches in perturbative quantum chromodynamics: (i) next- to-leading-order calculations obtained with and without matching to parton-shower Monte Carlo simulations, (ii) PYTHIA and HERWIG parton-shower event generators with different tunes of parameters, and (iii) CASCADE and HEJ models, including different non-collinear corrections to standard single-parton radiation.

**Room 219 - BSM - Non-SUSY - TR3 / 800**

## Quantum corrections to broken N=8 supergravity

**Author:** Fabio Zwirner<sup>1</sup>

**Co-author:** Gianguido Dall'Agata<sup>2</sup>

<sup>1</sup> *University of Padova and INFN (IT)*

<sup>2</sup> *University and INFN, Padova*

**Corresponding Author:** fabio.zwirner@pd.infn.it

We show that, for all tachyon-free classical Minkowski vacua with four-dimensional spontaneously broken N=8 supergravity, the one-loop effective potential is calculable and finite. We also find that, in all presently known examples, it is negative-definite.

**Room 218 - Future Accelerators - Detectors and Computing for HEP - TR14&13 / 801**

## Belle II at SuperKEKB

**Author:** Martin Sevior<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** martines@unimelb.edu.au

The next generation of B factories (so called super B factories) are designed to accumulate a 50 times larger data sample, corresponding to an integrated luminosity of  $50 \text{ ab}^{-1}$ . To achieve the necessary increase of event rates by a factor of 40, a substantial upgrade is required both of the accelerator complex as well as of the detector. To maintain the excellent performance of the detector, the critical issue will be to mitigate the effects of higher backgrounds (by a factor of 10 to 20), leading to an increase in occupancy and radiation damage, as well as fake hits and pile-up noise in the electromagnetic calorimeter. Higher event rates require substantial modifications in the trigger scheme, DAQ and computing relative to the current experiments. In addition, improved vertex detection and hadron identification are needed, and similarly good (or better) hermeticity is required. We will discuss the requirements for the SuperKEKB accelerator and for the Belle II detector, both under construction at KEK, and review several innovative approaches in detector design. Finally, the status of the project will be presented together with the plans for the future.

**Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 802**

## Physics with the Belle II experiment

**Author:** Mikhail Danilov<sup>1</sup>

<sup>1</sup> *ITEP Institute for Theoretical and Experimental Physics (RU)*

**Corresponding Author:** danilov@itep.ru

The B factories —the Belle detector at the KEKB collider in KEK and the BaBar detector at the PEP II in SLAC —have, in more than a decade of data taking, outreached the initial expectations on the physics results. They pointed out few hints of discrepancies between the Standard Model (SM) predictions and the results of the measurements. To experimentally verify the current hints of possible new particles and processes often addressed as the New Physics(NP) a new generation of B factories - the Super B factories - are planned to start operation around 2015. The so-called precision frontier represented by the machines requires the achieved luminosities of the B factories to be raised by  $O(10^2)$ . We will present the planned measurements and some of the expected precisions on various physics observables which will be reached by the Belle II detector currently being built at KEK. We will comment on the tests of various NP models that will be possible with the upgraded detector.

**TR 6 - RM 217 - QCD, Jets, Parton Distributions / 805**

## MBR Monte Carlo Simulation in PYTHIA8

**Authors:** Konstantin Goulianos<sup>1</sup>; Robert Ciesielski<sup>2</sup>

<sup>1</sup> *The Rockefeller University*

<sup>2</sup> *Rockefeller University (US)*

**Corresponding Author:** rciesielsk@rockefeller.edu

We present the MBR (Minimum Bias Rockefeller) Monte Carlo simulation of (anti)proton-proton interactions and its implementation in the PYTHIA8 event generator. We discuss the total, elastic, and total-inelastic cross sections, and three contributions from diffraction dissociation processes that contribute to the latter: single diffraction, double diffraction, and central diffraction or double-Pomeron exchange. The event generation follows a renormalized-Regge-theory model, successfully tested using CDF data. Based on the MBR-enhanced PYTHIA8 simulation, we present cross-section predictions for the LHC and beyond, up to collision energies of 50 TeV.

**TR 12 - Formal Theory Development & TR 1 - The Standard Model / 806**

## Higher Spins and Strings

**Author:** Dario Francia<sup>1</sup>

<sup>1</sup> *Centro E. Fermi and Scuola Normale Superiore (IT)*

**Corresponding Author:** dario.francia@sns.it

The formulation of consistent theories involving particles with arbitrary spin represents an old open theoretical challenge. In the massless case the corresponding gauge theories provide far-reaching generalisations of Yang-Mills theory and General Relativity, while massive higher-spin states are known to represent essential ingredients of the spectrum of String Theory. I will describe the basics of higher-spin constructions in flat and (Anti-) de Sitter backgrounds and review some recent

progress on the subject, aiming to better frame the question of how to provide a bridge between the massless regime and its possible broken phases.

**BSM / Spectroscopy / IUPAP-C11 Report / 809**

## **IUPAP-C11 Report**

**Authors:** Hiroaki Aihara<sup>1</sup>; Pier Oddone<sup>2</sup>

<sup>1</sup> *University of Tokyo*

<sup>2</sup> *Fermi National Accelerator Laboratory (US)*

**Corresponding Authors:** aihara@phys.s.u-tokyo.ac.jp, pjoddone@fnal.gov

**Flavour Physics / 811**

## **Flavour Physics Theory Overview**

**Author:** cecilia tarantino<sup>1</sup>

<sup>1</sup> *University Roma Tre*

**Corresponding Author:** tarantino@fis.uniroma3.it

**QCD / 812**

## **Perturbative QCD Status**

**Author:** John Campbell<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Laboratory*

**Corresponding Author:** johnmc@fnal.gov

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## **CP Violation / CKM Measurements**

**Author:** Mikihiro Nakao<sup>1</sup>

<sup>1</sup> *KEK*

**Corresponding Author:** mikihiro.nakao@kek.jp

**BSM / Spectroscopy / IUPAP-C11 Report / 814**

## **Spectroscopy Update**

**Author:** Roman Mizuk<sup>1</sup>

<sup>1</sup> *Inst. f. Theor. and Exp. Physics (RU)*

**Corresponding Author:** mizuk@itep.ru

**Plenary3 - The Standard Model -TR1 / 818**

## One-Loop Calculation of the Oblique S Parameter in Higgsless Electroweak Models

**Author:** Ignasi Rosell<sup>1</sup>

<sup>1</sup> *Universidad CEU Cardenal Herrera and IFIC (ES)*

**Corresponding Author:** rosell@uch.ceu.es

If the Higgs boson does not show up soon, we should look for alternative mechanisms of mass generation, satisfying the many experimental constraints which the Standard Model (SM) has successfully fulfilled so far. Following this aim, we present a one-loop calculation of the oblique S parameter within Higgsless models of Electroweak Symmetry Breaking (EWSB) and analyze the phenomenological implications of the available electroweak precision data. Within an effective Lagrangian we implement the chiral symmetry breaking  $SU(2)_L \times SU(2)_R \rightarrow SU(2)_{L+R}$  with Goldstones, gauge bosons and one multiplet of vector and axial-vector massive resonance states. Using the dispersive representation of Peskin and Takeuchi and imposing the short-distance constraints dictated by the operator product expansion, we obtain S at the next-to-leading order in terms of a few resonance parameters. We have found that, in order to match the experimental determination of the S parameter, the resonance masses are required to be over the TeV scale in this kind of strongly-coupled EWSB scenarios.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 819**

## Universal behavior in the scattering of heavy, weakly interacting dark matter on nuclear targets

**Author:** Richard Hill<sup>1</sup>

**Co-author:** Mikhail Solon<sup>2</sup>

<sup>1</sup> *University of Chicago (US)*

<sup>2</sup> *University of Chicago*

**Corresponding Author:** richardhill@uchicago.edu

We introduce heavy particle effective field theory techniques to isolate universal properties and to systematically study the QCD anatomy of dark matter direct detection.

In particular: Particles that are heavy compared to the electroweak scale ( $M \gg m_W$ ), and that are charged under electroweak  $SU(2)$  gauge interactions display universal properties such as a characteristic fine structure in the mass spectrum induced by electroweak symmetry breaking, and an approximately universal cross section for scattering on nuclear targets. The heavy particle effective theory framework is developed to compute these properties. As illustration, the spin independent cross section for low-velocity scattering on a nucleon is evaluated in the limit  $M \gg m_W$ , including complete leading-order matching onto quark and gluon operators, renormalization analysis, and systematic treatment of perturbative and hadronic-input uncertainties.



TR 8 - Neutrinos RM 219 / 820

## Model independent determination of the axial mass parameter in quasielastic neutrino-nucleon scattering

**Author:** Richard Hill<sup>1</sup>

**Co-authors:** Bhubanjyoti Bhattacharya<sup>2</sup>; Gil Paz<sup>3</sup>

<sup>1</sup> *University of Chicago (US)*

<sup>2</sup> *University of Montreal*

<sup>3</sup> *Wayne State University*

**Corresponding Author:** richardhill@uchicago.edu

Quasielastic neutrino-nucleon scattering is a basic signal process for neutrino oscillation studies. At accelerator energies, the corresponding cross section is subject to significant uncertainty due to the poorly constrained axial-vector form factor of the nucleon. A model-independent description of the axial-vector form factor is presented. Data from the MiniBooNE experiment for quasielastic neutrino scattering on carbon are analyzed under the assumption of a definite nuclear model. The value of the axial mass parameter,  $m_A = 0.85^{+0.22}_{-0.07}$   $\pm$  0.09 GeV, is found to differ significantly from extractions based on traditional form factor models. Implications for future neutrino scattering and pion electroproduction measurements are discussed.

Room 220 Lattice QCD / B-Physics / CP Violation, etc -TR5&amp;7&amp;10 / 821

## B-physics from lattice QCD...with a twist

**Author:** Andrea Shindler<sup>1</sup>

**Co-authors:** Benoit Blossier<sup>2</sup>; Chris Michael<sup>3</sup>; David Palao<sup>4</sup>; Francesco Sanfilippo<sup>5</sup>; Giancarlo Rossi<sup>6</sup>; Gregorio Herdoiza<sup>7</sup>; Nuria Carrasco Vela<sup>8</sup>; Petros Dimopoulos<sup>9</sup>; Roberto Frezzotti<sup>9</sup>; Silvano Simula<sup>10</sup>; Vicent Gimenez Gomez<sup>11</sup>; Vittorio Lubicz<sup>12</sup>; cecilia tarantino<sup>13</sup>

<sup>1</sup> *Humboldt University (DE)*

<sup>2</sup> *Université de Paris XI, Centre d'Orsay*

<sup>3</sup> *University of Liverpool*

<sup>4</sup> *Università di Tor Vergata*

<sup>5</sup> *Université de Paris XI, Centre d'Orsay*

<sup>6</sup> *Università di Tor Vergata and INFN*

<sup>7</sup> *Universidad Autónoma de Madrid*

<sup>8</sup> *Instituto de Fisica Corpuscular (IFIC)-Universitat de Valencia-U*

<sup>9</sup> *Università di Roma Tor Vergata and INFN*

<sup>10</sup> *Università di Roma Tre*

<sup>11</sup> *Universitat de Valencia-CSIC*

<sup>12</sup> *Università di Roma Tre and INFN*

<sup>13</sup> *University Roma Tre*

**Corresponding Author:** andrea.shindler@physik.hu-berlin.de

Present and future experiments will reach unprecedented precision in the measurements of physical quantities related to B-physics. Therefore an accurate theoretical determination of intrinsically non-perturbative parameters, relevant for studies of B-physics, is required in many phenomenological analyses to further constrain the Standard Model and to explore New Physics scenarios. The goal of lattice QCD calculations is to provide the required non-perturbative information with competitive statistical and systematic errors. Despite the intrinsic difficulties in simulating the non-perturbative

dynamic of the b-quark with currently numerically affordable lattice spacings, B-physics quantities can nevertheless be calculated with high precision. I will present results for selected physical quantities obtained employing a well tested, though recently developed, method.

**Physics Highlights / Detectors & Computing / 822**

## ICHEP2012 Physics Highlights

**Author:** Riccardo Barbieri<sup>1</sup>

<sup>1</sup> *Scuola Normale Superiore & INFN (IT)*

**Corresponding Author:** barbierr@cibs.sns.it

**Physics Highlights / Detectors & Computing / 823**

## Progress in HEP Computing

**Author:** Ian Fisk<sup>1</sup>

<sup>1</sup> *Fermi National Accelerator Lab. (US)*

**Corresponding Author:** ian.fisk@cern.ch

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 824**

## Status of the AMS-02 detector after one year of operation on the International Space Station

**Author:** Veronica Bindi<sup>1</sup>

<sup>1</sup> *University of Hawaii at Manoa (US)*

The Alpha Magnetic Spectrometer AMS-02 has been installed in May 19th 2011 on the International Space Station where it will detect cosmic rays for the next decades. AMS-02 with its accurate measurements up to the TeV scale will contribute to our knowledge of the Universe providing the most sensitive search for the existence of primordial anti matter and indirect search for dark matter.

Nine layers of silicon micro-strip constitute the core of the spectrometer, allowing the simultaneous measurement of the sign and charge of impinging particles and reconstructing their rigidity up to the TV. The 3D imaging calorimeter, with a depth of 17 radiation lengths, and the TRD detector provide an accurate measurement of the electron and positron components, rejecting the protons background. Velocity and charge measurements are performed by the scintillator planes of the Time of Flight system and by the Ring Imaging Cherenkov detector. During the first year in Space several billion events have been recorded: the AMS-02 flight operations, performance and perspective for physics measurements will be reported.

**TR 8 - Neutrinos RM 219 / 825**

## MINOS neutrino oscillation results

**Author:** Giles Barr<sup>1</sup>

<sup>1</sup> *Oxford University (UK)*

**Corresponding Author:** giles.barr@physics.ox.ac.uk

The MINOS experiment finished data collection in April this year. We have made precision measurements of the oscillation parameters using both neutrino (10.7e20pot) and anti-neutrino (3.3e20pot) enhanced beams and with atmospheric neutrinos (37.9 kt.y). The atmospheric neutrino sample can also be separated into neutrino and antineutrino samples with the magnetic field in the far detector. Updated results of measurements in the 23-mixing sector and the sub-dominant 13-mixing sector will be presented including combined fits from beam and atmospheric data to the separate neutrino and antineutrino mixing parameters. The MINOS+ experiment (the MINOS detector in the ME NOVA beam) will commence running in April 2013.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 826**

## Dark matter search results from the COUPP 4 kg bubble chamber

**Author:** Russell Neilson<sup>1</sup>

<sup>1</sup> *University of Chicago (US)*

**Corresponding Author:** rneilson@uchicago.edu

Data will be reported from the operation of a 4.0 kg CF3I bubble chamber in the 6800 foot deep SNOLAB underground laboratory. The effectiveness of ultrasound analysis in discriminating alpha decay background events from single nuclear recoils has been confirmed. The total exposure was 553 kg-days distributed over three different bubble nucleation thresholds. This observation provides world best direct detection constraints on WIMP-proton spin-dependent scattering for WIMP masses  $>20 \text{ GeV}/c^2$  and demonstrates significant sensitivity for spin-independent interactions. Updates on progress towards operation of larger scale bubble chambers will also be presented.

### Financial Support Justification for Early-Stage Researchers:

Due to the high cost and long travel time from Chicago to Melbourne, some financial support would be greatly appreciated.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 828**

## The status of KIMS experiment

**Author:** Yeongduk Kim<sup>1</sup>

<sup>1</sup> *Sejong University (KR)*

**Corresponding Author:** ydkim@sejong.ac.kr

KIMS (Korea Invisible Mass Search) experiment has run its 100kg setup for last three years. We have given a new WIMP interaction rates for spin-independent and spin-dependent limits with 24524 kgdays data. We have further analyzed for the annual modulation amplitude with the last 3 years data. An analysis will be presented which has a limit comparable to DAMA's modulation amplitude. We have recently studied in detail and identified for the major internal and external background sources. Perspectives for KIMS experiment will be presented.

**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 829**

## **Up-to-date results and upgrade plans of the MEG experiment**

**Authors:** Giovanni Signorelli<sup>1</sup>; Hajime Nishiguchi<sup>2</sup>

<sup>1</sup> *INFN*

<sup>2</sup> *KEK (JP)*

**Corresponding Authors:** hajime.nishiguchi@kek.jp, giovanni.signorelli@pi.infn.it

The MEG experiment at the Paul Scherrer Institut (Switzerland) aims at searching for the Lepton-Flavour Violating (LFV) muon decay,  $\mu^+ \rightarrow e^+ \gamma$ , with unprecedented sensitivity. Such decay is forbidden within the Standard Model, nevertheless all its viable extensions predict a branching ratio for this decay in the  $10^{-14}$  to  $10^{-12}$  range. Data collected in 2009 and 2010, which corresponds to a total of  $1.8 \times 10^{14}$  muon decays, allowed us to set the most stringent limit to date on charged LFV ( $\text{BR}(\mu^+ \rightarrow e^+ \gamma) < 2.4 \times 10^{-12}$  at 90% C.L.). The status of the experiment during the last data taking will be presented together with preliminary analysis of 2011 data.

In parallel with the data-taking, the MEG collaboration has recently started to discuss the upgrade plan in order to perform the experiment with three times higher beam intensity and better measurement resolutions, and already started several associated R&D. In addition to the future prospects, the detailed studies of upgrade will also be presented.

**EW Physics / SUSY / 830**

## **SUSY - What's left?**

**Author:** Raman Sundrum<sup>1</sup>

<sup>1</sup> *University of Maryland (US)*

**Corresponding Author:** sundrum@pha.jhu.edu

**IUPAP Prize Winners / CKM / 831**

## **Semileptonic B(s) Decays**

**Corresponding Author:** phillip.urquijo@cern.ch

**IUPAP Prize Winners / CKM / 832**

## **Tests of Lorentz and CPT violation with neutrinos.**

**IUPAP Prize Winners / CKM / 833**

## **CP Violation/CKM Measurements**

**Corresponding Author:** mikiyiko.nakao@kek.jp

Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9 / 834

## Rare or forbidden B decays at Belle

**Author:** Oksana Brovchenko<sup>1</sup>

<sup>1</sup> KIT - Karlsruhe Institute of Technology (DE)

**Corresponding Author:** oksana.brovchenko@kit.edu

The quark transition  $b \rightarrow s\nu\bar{\nu}$  is only possible within the Standard Model (SM) through higher order processes, which are highly suppressed compared to tree-level processes. The theoretical predictions of the decays where this quark process occurs are very precise because there is only one hadron in the final state and no charged lepton. However, in models beyond the Standard Model, these decays can be enhanced by orders of magnitude. The very small SM branching fractions and two undetectable neutrinos in the final state are the main challenges of this analysis. To be able to reconstruct these channels despite the missing neutrinos, the full reconstruction method is used.

We present the results of the search for  $B \rightarrow h^{(*)}\nu\bar{\nu}$  decays based on the full data set collected at the  $\Upsilon(4S)$  resonance with the Belle detector operating at the KEKB asymmetric-energy  $e^+e^-$  collider.

We report on a search for heavy neutral leptons in  $B$ -meson decays. The results are obtained using a data sample that contains  $772 \times 10^6$   $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. No signal is observed and upper limits are set on mixing of heavy neutral leptons with left-handed neutrino of the SM in the mass range  $0.5 - 5.0 \text{ GeV}/c^2$ .

We report a search for  $B$  decays into invisible final states using a data sample of 656.7 million  $B\bar{B}$  pairs collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. The signals of invisible final states are identified by fully reconstructing the accompanying  $B$  meson and requiring no other charged particles and no extra energy deposited in the calorimeter. The measured upper limits are reported and the corresponding physics are discussed.

The HyperCP experiment at Fermilab reported the observation of three events for  $\Sigma^+ \rightarrow p\mu^+\mu^-$  decay. The dimuon masses of the observed events are clustered around  $214.3 \text{ MeV}/c^2$  within the detector resolution of  $1 \text{ MeV}/c^2$ . These decays might be interpreted as a two-body decay,  $\Sigma^+ \rightarrow pX^0(214)$ , with  $X^0(214) \rightarrow \mu^+\mu^-$ . Several hypotheses are suggested to interpret  $X^0(214)$  including a sgoldstino in SUSY, a light Higgs boson in NMSSM, and a  $U$  boson. We report on a search for  $X^0$  in  $B^0 \rightarrow K^+(\pi^+)\pi^-X^0$  decays using 772 million  $B$  meson pairs collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. We extend the search to a larger mass region between  $212 \text{ MeV}/c^2$  and  $1.8 \text{ GeV}/c^2$  with different values of the  $X^0$  lifetime.

We study the charmless  $B^0$  decays with final state particles  $p\bar{\Lambda}\pi^-\gamma$  using the full data sample collected at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. This decay is believed to proceed via the  $b \rightarrow s\gamma$  electro-weak penguin process at the quark level. We also search for the intermediate three-body decays using the same final state particles. Observed branching fractions or upper limits are reported.

We present a study of  $B$  decays to  $K^{(*)}$  and two leptons ( $e, \mu$ ) in the full Belle  $\Upsilon(4S)$  data set containing  $771 \times 10^6$   $B\bar{B}$  pairs. The flavor-changing neutral-current process responsible for this decay,  $b \rightarrow s\ell^+\ell^-$ , proceeds via electro-weak penguin diagrams in the Standard Model. However, this process is sensitive to new physics due to contributions from Beyond the Standard Model particles in these diagrams. We report the differential branching fraction, isospin asymmetry,  $K^*$  polarization, and forward-backward asymmetry ( $A_{FB}$ ) as a function of  $q^2 = M_{\ell\ell}^2 c^2$ .

The flavor-changing-neutral-current decays such as  $B \rightarrow X_s\gamma$  are sensitive to new physics beyond the Standard Model as particles of new physics may enter the loop and affect the decay process. While the branching fraction of the inclusive  $B \rightarrow X_s\gamma$  decays has been measured by several experiments with good precision, other quantities such as the  $CP$  and isospin asymmetries of the inclusive  $B \rightarrow X_s\gamma$  are less well determined. To facilitate the precise measurements of such quantities, we study inclusive  $B \rightarrow X_s\gamma$  decays using a hadronic tagging method, where one of the  $B$  mesons in a  $B\bar{B}$  event is fully reconstructed in the hadronic final state. In this paper, we show preliminary

results of this study using the full Belle data sample of  $711 \text{ fb}^{-1}$  integrated luminosity recorded by the Belle detector at the  $\Upsilon(4S)$  resonance at the KEKB asymmetric-energy  $e^+e^-$  collider.

**Poster Session** - Board: 60 / 836

## The ATLAS Muon Trigger Performance in pp collisions

**Author:** Takashi Kubota<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

**Corresponding Author:** takashi.kubota@cern.ch

Events with muons in the final state are an important signature for many physics topics at Large Hadron Collider (LHC), for instance, searches for Higgs boson production or new phenomena, measurements on the standard model processes like top-quark, W, Z production.

Thus, efficient trigger on muons in data taking and understanding its performance are crucial to perform these physics studies. At LHC high rejection power against large backgrounds, while maintaining high efficiency for rare signal events, is required already at such online trigger stage.

The ATLAS experiment employs a multi-level trigger architecture that selects the events in three sequential steps of increasing complexity and accuracy to cope with this challenging task.

This poster reports about efficiency and general performance of the ATLAS muon trigger in proton-proton collisions at  $\sqrt{s}=7$  TeV in 2011 runs and also at  $\sqrt{s}=8$  TeV in 2012 runs.

**Poster Session** - Board: 61 / 837

## Measuring the b-jet tagging efficiency using top quark pairs events with ATLAS data

**Author:** Agnieszka Leyko<sup>1</sup>

<sup>1</sup> *Universitaet Bonn (DE)*

**Corresponding Author:** agnieszka.leyko@cern.ch

Many physics analyses with the ATLAS detector expect to have jets originating from b-quarks in the final state. Algorithms that allow to identify such jets are thus of great importance and it is crucial to study their performance directly in data by measuring the tagging efficiencies and fake rates.

Since the top quark almost exclusively decays to a W boson and a b-quark, a sample of top quark pairs events is ideal for studying the b-tagging performance. Final states containing one or two leptons have been used to measure the b-tagging efficiency, either by counting the number of b-tagged jets, by exploiting the kinematics of top quark pairs decays and flavor composition of studied sample or by applying kinematical fit to extract sample rich in b-jets.

**Poster Session** - Board: 62 / 838

## Performance of the ATLAS Transition Radiation Tracker

**Author:** Kevin Daniel Finelli<sup>1</sup>

<sup>1</sup> *Duke University (US)*

**Corresponding Author:** kevin.finelli@cern.ch

The ATLAS Transition Radiation Tracker (TRT) is an integral subsystem for precision tracking at ATLAS. In addition, transition radiation signatures allow for particle identification capabilities. Monitoring the performance of the TRT helps establish the necessary foundation for understanding higher level tracking reconstruction and particle identification. We present our current studies on how the TRT is performing, in particular as the number of interactions per bunch crossing increases.

**Room 218 - Detectors and Computing for HEP - TR13 / 839**

## Performance of Jets and Missing Transverse Energy in ATLAS

**Author:** Ariel Gustavo Schwartzman<sup>1</sup>

<sup>1</sup> *SLAC National Accelerator Laboratory (US)*

**Corresponding Author:** ariel.gustavo.schwartzman@cern.ch

After the analysis of the 2010 proton proton collision data provided by LHC, the ATLAS experiment has achieved an accuracy of the jet energy measurement between 2-4% for jet transverse momenta from 20 GeV to about 2 TeV in the pseudo-rapidity range up to  $|\eta|=4.5$ . The jet energy scale uncertainty is derived from in-situ single hadron response measurements along with systematic variations in the Monte Carlo simulation. In addition, several in situ techniques exploiting transverse momentum balance are exploited. Preliminary results from the 2011 run based on an integrated luminosity of 5/fb reducing further the uncertainties on the jet energy scale will also be presented.

Results on the energy scale and resolution of the reconstructed missing transverse momentum (ET<sub>miss</sub>) from 2010 and 2011 collision data will be presented. The uncertainty evaluation mainly relies on events with a Z-boson. Special attention will be given to the influence of the large number of interactions produced in addition to the event of interest (pile-up). Techniques to mitigate pile-up effects for jets and ET<sub>miss</sub> will be discussed.

Advanced approaches to jet reconstruction using jet grooming algorithms such as filtering, trimming, and pruning are compared. Such techniques aim to reconstruct the jet mass and jet substructure with special focus on highly boosted particles

**Poster Session - Board: 08 / 840**

## Higgs boson coupling measurements at the LHC using H $\rightarrow$ tau tau decays.

**Author:** Sinead Farrington<sup>1</sup>

<sup>1</sup> *University of Oxford (UK)*

**Corresponding Author:** sinead.farrington@cern.ch

We investigate the potential for measuring the relative couplings of a low-mass Higgs boson at the Large Hadron Collider using W H, ZH, and ttH production, where the Higgs boson decays to tau-lepton pairs. With 100 fb<sup>-1</sup> of  $\sqrt{s} = 14$  TeV pp collision data we find that these modes can improve coupling-ratio sensitivity for a Higgs boson mass between 115 and 135 GeV/c<sup>2</sup>.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 841**

## Prospects of direct dark matter detection with DarkSide experiment

**Author:** Jelena Maricic<sup>1</sup>

<sup>1</sup> *Drexel University (US)*

**Corresponding Author:** jelena@physics.drexel.edu

DarkSide represents a staged program for direct detection of dark matter utilizing two-phase argon time projection chamber with the goal of achieving a high sensitivity limit or convincing detection of dark matter.

The first stage in the program is DarkSide-10, a 10 kg prototype detector that was running in Laboratori Nazionali del Gran Sasso Counting Test Facility (CTF) during summer of 2011. The prototype was used to test argon light yield and other features necessary to achieve high sensitivity in the physics detector. The DarkSide-10 will be followed DarkSide-50 detector featuring a 50 kg active mass depleted argon target that is designed to reach sensitivity of  $10^{-45}$  cm<sup>2</sup> and will also be deployed in CTF. Besides the use of depleted argon that will allow use of pulse shape discrimination, other unique features such as neutron veto and muon veto along with active detector calibration will result in a detector capable of achieving background-free conditions. Construction of the neutron veto has been finished and DarkSide-50 is expected to start taking data in the Fall of 2012. The third stage of the program is DarkSide-G2, a second generation detector with 5 ton active mass of liquid argon reaching  $10^{-47}$

cm<sup>2</sup> sensitivity level, currently going into an R&D phase. In my talk, I will present DarkSide program, R&D activities and steps toward high sensitivity background-free measurement.

**Room 218 - Detectors and Computing for HEP - TR13 / 842**

## The ATLAS Data Acquisition and High Level Trigger Systems: Experience and Upgrade Plans

**Authors:** Reiner Hauser<sup>1</sup>; Reiner Hauser<sup>2</sup>

<sup>1</sup> *Michigan State University (US)*

<sup>2</sup> *MSU*

**Corresponding Authors:** reiner.hauser@cern.ch, rhauser@fnal.gov

The ATLAS DAQ/HLT system reduces the Level 1 rate of 75 kHz to a few kHz event build rate after Level 2 and a few hundred Hz output rate to disk. It has operated with an average data taking efficiency of about 94% during the recent years. The performance has far exceeded the initial requirements, with about 5 kHz event building rate and 500 Hz of output rate in 2012, driven mostly by physics requirements.

Several improvements and upgrades are foreseen in the upcoming long shutdowns, both to simplify the existing architecture and improve the performance. On the network side new core switches will be deployed and possible use of 10Gbit Ethernet links for critical areas is foreseen. An improved read-out system to replace the existing solution based on PCI is under development. A major evolution of the high level trigger system foresees a merging of the Level 2 and Event Filter functionality on a single node, including the event building. This will represent a big simplification of the existing system, while still maintaining the flexibility of the Region of Interest based approach. It will furthermore open up new optimizations and simplifications in the existing HLT code.

**Poster Session - Board: 63 / 843**



## The ATLAS hadronic tau trigger

**Author:** Curtis William Black<sup>1</sup>

<sup>1</sup> *University of Sydney (AU)*

**Corresponding Author:** curtis.black@cern.ch

With the high luminosities of proton-proton collisions achieved at the LHC, the strategies for triggering have become more important than ever for physics analysis. The naïve inclusive single tau lepton triggers now suffer from severe rate limitations. To allow for a large program of physics analyses with taus, the development of topological triggers that combine tau signatures with other measured quantities in the event is required. These combined triggers open many opportunities to study new physics beyond the Standard Model and to search for the Standard Model Higgs.

We present the status and performance of the hadronic tau trigger in ATLAS. We demonstrate that the ATLAS tau trigger ran remarkably well over 2011, and how the lessons learned from 2011 led to numerous improvements in the preparation of the 2012 run. These improvements include the introduction of tau selection criteria that are robust against varying pileup scenarios, and the implementation of multivariate selection techniques in the tau trigger. First results from the improved 2012 tau trigger will be shown. Measurements of the trigger efficiency using the  $Z \rightarrow \tau\tau$  and  $W \rightarrow \tau\nu$  events are also presented.

**Poster Session - Board:** 64 / 844

## The ATLAS Tau Reconstruction and Identification Algorithms and Performance at ATLAS

**Author:** Kong Guan Tan<sup>1</sup>

<sup>1</sup> *University of Melbourne (AU)*

Tau leptons play an important role in the physics program at the LHC.

They are used not only in searches for new phenomena like the Higgs boson or Supersymmetry and electroweak measurements but also in detector related studies like the determination of the missing transverse energy scale.

Optimal identification of hadronically decaying tau leptons is achieved by using detailed information from tracking and calorimeter detector components. Variables describing the properties of calorimeter energy deposits and track reconstruction within tau candidates are combined in multivariate discriminants, to achieve high rejection against backgrounds, which is challenging in high luminosity environments.

The identification efficiencies are measured by  $W \rightarrow \tau\nu$  and  $Z \rightarrow \tau\tau$  events, and compared with the prediction of the Monte Carlo simulation. The energy scale uncertainties for tau leptons are determined by investigating single hadron calorimeter response, as well as kinematic distributions in  $Z \rightarrow \tau\tau$  events.

**Plenary 3 - The Standard Model - TR1 / 845**

## Search for SM Higgs decaying to $WW$ to $l\nu l\nu$ and $lvqq$ at CMS

**Author:** Emanuele Di Marco<sup>1</sup>

<sup>1</sup> *California Institute of Technology (US)*

**Corresponding Author:** emanuele.di.marco@cern.ch

Results are presented on the search for the standard model Higgs boson decaying into two W bosons, with at least one W boson decaying into a charged lepton and a neutrino. Several classes of events with zero to two or more jets are analysed separately. Associated production of the Higgs with a Z or W is discussed as well. The full data sample of 4.7 fb<sup>-1</sup> of pp collisions collected in 2011 with the CMS experiment at a CM energy of 7 TeV have been analyzed, as well as a significant fraction of the 2012 luminosity delivered so far at the new energy of 8 TeV.

**Poster Session - Board: 09 / 846**

## Measurement of the Z to tau tau cross section with the ATLAS detector

**Author:** Jana Novakova<sup>1</sup>

<sup>1</sup> Charles University (CZ)

**Corresponding Author:** jana.novakova@cern.ch

The Z to tau tau cross section has been recently measured using data collected with the ATLAS detector corresponding to the integrated luminosity of 1.34 – 1.55 fb<sup>-1</sup>. The analysis is performed in three different final states determined by decay modes of the tau leptons - so-called electron + hadronic tau, muon + hadronic tau and electron + muon channels. Cross sections are measured separately in each final state in a fiducial kinematic phase space, and also extrapolated to the full phase space in the invariant mass region 66 – 116 GeV. The individual cross sections are combined together and the product of the total Z boson production cross section and Z to tau tau branching fraction is measured to be 0.92 +/- 0.20(stat) +/- 0.08(syst) +/- 0.03(lumi) nb, in agreement with the NNLO theoretical expectation.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 847**

## Dark matter searches with the ANTARES neutrino telescope: constraints to CMSSM and mUED models

**Author:** Juan de Dios Zornoza Gomez<sup>1</sup>

<sup>1</sup> IFIC (ES)

**Corresponding Author:** zornoza@ific.uv.es

ANTARES is the largest neutrino telescope Northern hemisphere. It consists of a three-dimensional array of 885 photomultipliers to collect the Cherenkov light induced by relativistic muons produced in CC interactions of high energy neutrinos. One of the main scientific goals of the experiment is the search for dark matter. We present here the analysis of the recently unblinded data taken during 2007 and 2008 to look for a WIMP signal in the Sun. WIMPs are one of the most popular scenarios to explain the dark matter content of the Universe. They would accumulate in massive objects like the Sun or the Galactic Center and their self-annihilation would produce (directly or indirectly) high energy neutrinos detectable by neutrino telescopes. Contrary to other indirect searches (like with gamma rays or positrons), the search for neutrinos in the Sun is free from other astrophysical contributions, so the explanation of a potential signal in terms of dark matter is much more robust. The results are interpreted within two theoretical frameworks: CMSSM and mUED.

Dark matter searches with neutrino telescopes has specific advantages with respect to other indirect searches. On the other hand, neutrino telescopes are particularly sensitive to spin-dependent cross-section, in contrast to direct search experiments. In particular, a potential signal from the Sun would

can safely be interpreted as dark matter, contrary to excesses observed in cosmic rays or gamma rays, since there is no likely astrophysical alternative. We will present the results of the search for WIMPs in the Sun, using the recently unblinded data of 2007-2008. These results include limits in the muon and neutrino flux and also limits in the spin dependent cross section in the CMSSM and mUED frameworks. Moreover, an overview of the capabilities of other on-going analysis (Galactic Center, Sun with 2007-2011 data) will be also presented.

**Poster Session** - Board: 15 / 848

## Search for supersymmetry in events with a Z boson, jets and missing energy using the JZB method

**Author:** Marco Andrea Buchmann<sup>1</sup>

<sup>1</sup> *Eidgenössische Tech. Hochschule Zuerich (CH)*

**Corresponding Author:** marco-andrea.buchmann@cern.ch

We present a search for Physics beyond the Standard Model (SM) in final states with a Z boson, jets and missing transverse energy, using the full data sample collected in 2011 by the CMS detector at the Large Hadron Collider corresponding to an integrated luminosity of 4.7 /fb. This final state is predicted in several models of Physics beyond the SM, including supersymmetry. The Jet-Z Balance method is used and a precise determination of the total SM background is obtained using control samples from data. In the absence of any significant excess beyond the SM background, upper limits are set on simple models of supersymmetry, and further information is provided to allow confrontation of other models to these results.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 849**

## Social Media in Science Communication

**Authors:** Achintya Rao<sup>1</sup>; Claudia Marcelloni De Oliveira<sup>2</sup>

<sup>1</sup> *Fermi National Accelerator Lab. (US)*

<sup>2</sup> *Lawrence Berkeley National Lab. (US)*

We demonstrate social media in action along with a panel discussion on how you could benefit from using these platforms to better engage with your audiences. Social media are increasingly used as tools for science communication by science journalists and writers, by scientific organisations and laboratories, as well as by scientists themselves. These media offer many advantages over traditional methods of communicating, which are usually unidirectional. Social networks encourage dialogue and allow the general public as well as members of the press to have an open and personal conversation with scientists at the forefront of human knowledge.

### Summary:

**Goal:** Inspire physicists to use social media to engage with the general public, teachers and students, and members of the press.

**Format:**

- 1) Intro: presentation including the activities on the “outreach corner”(5’)
- 2) Panel: The panel will be a virtual panel, with participants connecting via Google+ and the Hangout being broadcast publicly (5’each panelist)
- 3) Discussion: Questions will also be taken via Twitter. (10’) or more if the session can be longer

**Plenary3 - The Standard Model -TR1 / 850****Light Higgs Scenario in BMSSM and LEP Precision Data****Authors:** DOYOUN Kim<sup>1</sup>; Hyung Do Kim<sup>2</sup>; Jihun Kim<sup>3</sup>; Kyu Jung Bae<sup>4</sup>; Radovan Dermisek<sup>None</sup><sup>1</sup> *Monash University*<sup>2</sup> *Unknown*<sup>3</sup> *Seoul National University*<sup>4</sup> *Korea Advanced Institute of Science and Technology***Corresponding Author:** abistp00@phy.snu.ac.kr

In this talk we consider very light Higgs fields in BMSSM(Beyond MSSM). The spectrum below TeV scale is the same as the MSSM but the Higgs potential is modified and is well described in terms of effective dimension five and six operators. A correction from the BMSSM operators allows us to consider new parameter space of Higgs sector which is not allowed in the MSSM. It can be regarded as a constrained version of general 2 Higgs doublet model (2HDM) as long as Higgs sector is concerned. We focus on the possibility that CP odd Higgs (A) mass is about 7 or 8 GeV and charged Higgs mass is comparable to W mass. At the same time one of the CP even Higgs (h) is light enough such that h and A production at the Z pole is kinematically allowed. The tension between forward backward asymmetry of bottom quark  $A_{FB}$  measured at LEP and the Standard Model prediction can be ameliorated if bottom quark pair produced from light CP even Higgs is taken into account.

**Poster Session - Board: 16 / 851****Search for charged long-lived heavy particles with the ATLAS experiment at the LHC****Authors:** Elisa Guido<sup>1</sup>; Elisa Guido<sup>2</sup><sup>1</sup> *INFN-Genova (IT)*<sup>2</sup> *INFN Genova***Corresponding Author:** elisa.guido@cern.ch

We report on a search for charged long-lived heavy particles, as predicted by several beyond the Standard Model theories. Such particles can be detected in ATLAS through anomalous specific ionisation measured in the Pixel detector; their slow motion ( $\beta < 1$ ) measured in the calorimeter, and also through their possible muon-likeness in the Muon Spectrometer. Results of this search on the full data sample collected by ATLAS during 2011 are shown, both with a Pixel detector based approach and by combining the information from various subdetectors.

**TR4 - Top Quark Physics / 852****Spin correlation and W helicity in top quark events with ATLAS****Author:** Markus Jüngst<sup>1</sup><sup>1</sup> *CERN*

**Corresponding Author:** ralph.markus.jungst@cern.ch

In 7 TeV proton - proton collisions at the LHC, pairs of top and anti-top quarks are expected to be mostly produced through gluon fusion, in contrast to production at the Tevatron, where quark annihilation dominates. The ATLAS experiment has now recorded a large number of top quark pairs, allowing this domain to be explored in detail. We present measurements of the spin correlation between top and anti-top quarks. The helicity fractions of W bosons from top quark decays are precisely predicted by the Standard Model and a deviation could reveal the presence of new physics. We also present a measurement of the W helicity fractions from top quark decays in ATLAS.

**Room 216 - Top Quark Physics / Particle Astrophysics & Cosmology - TR4 & TR11 / 853**

## FCNC in top quark production and decay at ATLAS

**Author:** Markus Cristinziani<sup>1</sup>

<sup>1</sup> *Universitaet Bonn (DE) & CERN*

**Corresponding Author:** markus.cristinziani@cern.ch

Results on the search for flavor-changing neutral-currents (FCNC) in top-quark production and decay are reported, with data collected with the ATLAS detector at a center-of-mass energy of  $\sqrt{s} = 7$  TeV. The single top quark topology is used to place limits on  $\sigma(q\bar{q} \rightarrow t) \times B(t \rightarrow Wb)$  ( $q=u,c$ ). A search is also performed for top-quark pair events, with one top quark decaying through the  $t \rightarrow Zq$  FCNC channel, and the other through the Standard Model dominant mode  $t \rightarrow Wb$ . An upper limit on the  $t \rightarrow Zq$  is set.

**Room 216 - Particle Astrophysics and Cosmology -TR11 / 854**

## The Fermi Large Area Telescope at 4: the Surprising Gamma-Ray Sky.

**Author:** Eric Charles<sup>1</sup>

<sup>1</sup> *SLAC (US)*

The Fermi Large Area Telescope (LAT) has been operating since June 2008 and observes the gamma-ray sky from 20 MeV to over 300 GeV. The first four years of the LAT era have seen numerous exciting scientific results, some expected and others unexpected. In this talk I will discuss the current state of our understanding of the gamma-ray sky. In particular, I will describe how the Fermi-LAT has improved our accounting of the contributions from known astrophysical source classes, including some previously undiscovered, and how we can disentangle such contributions from signatures of particle dark matter interactions and other possible signatures for new physics.

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 856**

## The importance of Science Communication Now

**Corresponding Author:** rolf.heuer@cern.ch

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 857**

## **Great Moments in Science**

**Author:** Karl Kruszelnicki<sup>1</sup>

<sup>1</sup> *University of Sydney (AU)*

**Room 217 - Education & Outreach - QCD, Jet, Parton Distributions - TR15&6 / 858**

## **Q&A to the Public**

**Poster Session - Board: 10 / 859**

## **Search for SM Higgs decaying to WW and WW production cross section measurement at CMS**

**Author:** Lara Lloret Iglesias<sup>1</sup>

<sup>1</sup> *Universidad de Oviedo (ES)*

**Corresponding Author:** lara.lloret.iglesias@cern.ch

Results are presented on the search for the standard model Higgs boson decaying into two W bosons, with each W boson decaying into a charged lepton and a neutrino. The full data sample of 2012 luminosity delivered so far at the new energy of 8 TeV has been analyzed. WW production cross section is also presented.

**860**

## **Higgs - Tevatron**

**Corresponding Authors:** shalhout@gmail.com, shalhout.shalhout@cern.ch

**861**

## **Refreshment Break**

**862**

## **High School Masterclass**

**863**

## Teacher Development Day

864

### Public Lecture

865

### Refreshment Break

Room 218 - Detectors and Computing for HEP - TR13 / 866

## Status and Plans for the Upgrades of the CMS Detector

**Author:** Jeremy Mans<sup>1</sup>

<sup>1</sup> *University of Minnesota (US)*

**Corresponding Author:** jeremy.mans@cern.ch

The LHC has successfully delivered more than 12 /fb of data through operations from 2009-2012, which CMS has used for wide range of physics analyses. CMS is planning a set of detector upgrades beginning in 2013 and continuing to support physics in the HL-LHC era, which will extend the delivered luminosity up to 3000 /fb by 2030. The projects already in the technical design phase in planned improvements include an improved pixel tracker, enhancements to the hadronic calorimeters, and a more-powerful Level-1 trigger. For HL-LHC, designs for a trigger-capable tracker and extremely radiation-hard forward calorimeters are under study. This presentation summarizes the various improvements to the CMS detector planned to optimize the physics yield from LHC data over the next 20 years.

TR4 - Top Quark Physics / 867

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**Corresponding Author:** jodielling@gmail.com

TR 12 - Formal Theory Development & TR 1 - The Standard Model / 868

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TR 6 - RM 217 - QCD, Jets, Parton Distributions / 869

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**TR2 - Plenary 3 - Beyond the Standard Model - SUSY / 870**

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**TR5 & TR7 - Room 220 - B Physics and CP Violation, etc. / 871**

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**High School Masterclass / 872****High School Masterclass****High School Masterclass / 873****Public Lecture****Room 220 - Neutrinos / QCD, Jets, Parton Distributions - TR6 / 874**

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**Room 219 - Beyond the Standard Model SUSY / Non-SUSY - TR2&3 / 875****Illuminating the 130 GeV Gamma Line with Continuum Photons****Author:** Jacob Wacker<sup>1</sup><sup>1</sup> *SLAC (US)***Corresponding Author:** jgwacker@stanford.edu

There is evidence for a 130 GeV  $\gamma$ -ray line at the Galactic Center in the \emph{Fermi} Large Area Telescope data. Dark matter candidates that explain this feature should also annihilate to Standard Model particles, resulting in a continuous spectrum of photons. To study this continuum, we analyze the \emph{Fermi} data down to 5 GeV, restricted to the inner  $3^\circ$  of the Galaxy. We place a strong bound on the ratio of continuum photons to monochromatic line photons that is independent of uncertainties in the dark matter density profile. Neutralino dark matter is excluded by the derived constraints.

**Poster Session / 876**



## **MINERvA: CC Inclusive Cross Section Ratio**

**Author:** Heather Ray<sup>1</sup>

<sup>1</sup> *University of Florida*

This poster presents preliminary results from the MINERvA experiment. We present the muon neutrino CC inclusive cross section measurement, performed as a ratio across different nuclear materials.

**Plenary3 - The Standard Model -TR1 / 877**

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