The 43rd International Symposium on Physics in Collision - PIC 2024

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Book of Abstracts

Contents

Parallel Session 3 / 1

Measurements of cross-sections of e+e- annihilation into hidden charm states

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This abstract discusses three recent measurements conducted at BESIII on the cross-sections of electron-positron annihilation into hidden charm final states:
1) The Born cross-section for the reaction e+ e- ⟶ eta hc is measured at center-of-mass energies ranging from 4.129 to 4.600 GeV. A resonant structure in the cross-section line shape near 4.200 GeV is observed with a statistical significance of 7sigma; 2) Using e+e− collision data, corresponding to an integrated luminosity of 892pb−1 collected at center-of-mass energies from 4.84 to 4.95 GeV with the BESIII detector, we search for the process e+ e- ⟶ K+ K- psi(3770) by reconstructing two charged kaons and one D meson from psi(3770). No significant signal of e+ e- ⟶ K+ K- psi(3770) is found, and the upper limits of the Born cross-sections are reported at a 90% confidence level; 3) The energy-dependent cross-section for e+ e- ⟶ eta psi(2S) is measured at eighteen center-of-mass energies from 4.288 GeV to 4.951 GeV using the BESIII detector. Using the same data samples, we also perform the first search for the reaction e+ e−⟶ eta \tilde{X}(3872), but no evidence is found for the \tilde{X} in the pi+ pi- J/psi mass distribution.

Parallel Session 3 / 4

Recent results of Baryon electromagnetic form factors at BESIII

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At BESIII, the electromagnetic form factors (EMFFs) and the pair production cross sections of various baryons have been studied. The proton EMFF ratio |GE/GM| is determined precisely and line-shape of |GE| is obtained for the first time. The recent results of neutron EMFFs at BESIII show great improvement comparing with previous experiments. Cross sections of various baryon pairs (Lambda, Sigma, Xi, Lambdac) are studied from their thresholds. Anomalous enhancement behavior on the Lambda and Lambdac pair are observed. The relative phase of EMFFs for Lambda and Sigma+ are measured for the first time.

Parallel Session 5 / 9

Search for new physics at BESIII

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BESIII is a symmetric e+e- collider operating at c.m. energy from 2.0 to 4.95 GeV. With the world's largest data set of J/psi (10 billion), psi(3686) (2.6 billion), and about 25 fbˆ-1 scan data from 3.77 to

4.95 GeV, various dark sectors and various rare processes can be searched for at BESIII. In this talk, we report the search for invisible dark photon decay using initial state radiation, invisible muonic Z'boson decay, sigma invisible decay, search for axion-like particles with a light scalar or vector particle in the decay of J/psi, and searches for the charged lepton flavor violation, baryon/lepton number violation, FCNC process, and charmonium weak decay processes.

Parallel Session 3 / 11

Hyperon physics at BESIII

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With the large datasets on □+□−-annihilation at the □/□ and □(3686) resonances collected at the BESIII experiment, multi-dimensional analyses making use of polarization and entanglement can shed new light on the production and decay properties hyperon-antihyperon pairs. In a series of recent studies performed at BESIII, significant transverse polarization of the (anti)hyperons has been observed in □/□ or □(3686) to ΛΣ-bar , ΣΣ-bar , ΞΞ-bar .The decay parameters for the most common hadronic weak decay modes were measured, and due to the non-zero polarization, the parameters of hyperon and antihyperon decays could be determined independently of each other for the first time. Comparing the hyperon and antihyperon decay parameters yields precise tests of direct, Δ□ = 1 CP-violation that complement studies performed in the kaon sector. Furthermore, the high production of long-lived baryons in J/ψ decays serves as a novel source of hyperon beams, which open a unique opportunity for exploring the hyperon-nucleon interactions. Recent results, including interactions of Λp, Σp and Ξn, will be presented in this talk.

Parallel Session 8 / 15

Search for CPV in charmless decays of beauty baryons at LHCb

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While CP violation (CPV) has been firmly established in the decays of strange, charm, and beauty mesons, it has not been observed in the baryon sector yet. The charmless decays of beauty baryons offer a promising avenue for investigation, as significant CPV effects could emerge from the interference between tree and penguin topologies, which contribute comparably to the decay amplitudes of these modes. The LHCb experiment is uniquely suited to study these decays thanks to the high production cross-section of beauty baryons in proton-proton collisions at the LHC. This talk presents and discusses the latest LHCb results in the search for CPV in the charmless decays of beauty baryons.

Parallel Session 3 / 16

Recent charmonium decay measurements at BESIII

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This presentation delves into recent experimental measurements of charmonium decays, encompassing four independent measurements conducted at BESIII. 1) Based on 2.7 billion psi(3686) events collected with the BESIII detector at the BEPCII collider, we present the first evidence of chi_c0 → Lambda anti-Lambda phi decays and the first observation of chi_c1,2 → Lambda anti-Lambda phi decays, with significances of 4.5σ, 11.3σ, and 13.0σ, respectively; 2) Using the same data sample, we report the first observation of the decays chi_c0/1/2 → Lambda anti-Lambda omega with statistical significances of 11.7σ, 11.2σ, and 11.8σ. The branching fractions of these decays are determined, with no clear intermediate structures observed in the previous and current measurements; 3) The processes hc → gamma P(eta', eta, pi0) are studied with a sample of 2.7 billion ψ(3686) events collected by the BESIII detector at the BEPCII collider. The branching fractions of hc → gamma eta' and hc → gamma eta are measured, and an upper limit for hc → gamma pi0 is set; 4) Utilizing 9.0 fb−1 of e+e− collision data collected at center-of-mass energies from 4.178 to 4.278 GeV, we conduct the first search for the radiative transition chi_c1(3872) → gamma psi2(3823). No obvious signal is observed, and the upper limit at the 90% confidence level is determined.

Parallel Session 1 / 17

Observation of quantum entanglement in top-quark pair production with the ATLAS detector

Author: Matthew Kevin Kingston[1]

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A new sub-field has emerged in particle physics: borrowing techniques from quantum information science, we can now probe quantum mechanics in collider experiments. The ATLAS Collaboration recently reported the first observation of quantum entanglement between free quarks, in the first dedicated quantum information experiment at a hadron collider. Spin entanglement is observed by selecting ttbar pairs produced close to their invariant mass threshold, and measuring a single angular observable related to the leptonic decay products of the top quarks. The entanglement observable is corrected back to particle-level using simulation; the result constitutes the highest energy measurement of quantum entanglement ever made. Differences between SM predictions and data motivate investigation into current modelling tools. This presentation will introduce the ATLAS measurement and show how it paves the way from further cross-pollination between high-energy physics and quantum information science.

Parallel Session 1 / 18

Highlights on top quark physics with the ATLAS experiment at the LHC

Author: Emily Hampshire[1]

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The large top quark samples collected with the ATLAS experiment at the LHC have yielded measurements of the production cross section of unprecedented precision and in new kinematic regimes. They have also enabled new measurements of top quark properties that were previously inaccessible, enabled the observation of many rare top quark production processes predicted by the Standard Model and boosted searches in the Top sector. In this contribution the highlights of the ATLAS top quark physics program are presented.

Parallel Session 5 / 19

ATLAS searches for non-minimal, compressed and long-lived SUSY scenarios

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Supersymmetry (SUSY) provides elegant solutions to several problems in the Standard Model, and searches for SUSY particles are an important component of the LHC physics program. With increasing mass bounds on more classical MSSM scenarios other variations of supersymmetry, including long-lived particles, compressed states or a non-minimal particle content, become increasingly interesting. This talk will present the latest results of searches conducted by the ATLAS experiment targeting strong and electroweak production in R-parity-violating and long-lived models, as well as compressed and non-minimal models.

Poster Session / 20

Measurement of Jet Track Functions and their Renormalization Group Flows in ATLAS Run 2 Data

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Measurements of jet substructure are key to probing the energy frontier at colliders, and many of them use track-based observables which take advantage of the angular precision of tracking detectors. Theoretical calculations of track-based observables require "track functions", which characterize the transverse momentum fraction r_q carried by charged hadrons from a fragmenting quark or gluon. This work presents a direct measurement of r_q distributions in dijet events from the 140 fb^{-1} of $\sqrt{s} = 13$ TeV proton-proton collisions collected by the ATLAS detector. The data are corrected for detector effects using a machine learning-based method. The scale evolution of the moments of the r_q distribution provides direct access to non-linear renormalization group evolution equations of QCD, and is compared with analytic predictions. When incorporated into future theoretical calculations, these results will enable a precision program of theory-data comparison for track-based jet substructure observables.

Poster Session / 21

Measurement of Isolated-Photon Production at 13 TeV with the ATLAS Detector

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Measurements of the differential cross section for isolated-photon production in proton-proton collisions at a centre of mass energy of 13 TeV are presented. The analysis uses data collected by the ATLAS detector at the LHC, corresponding to an integrated luminosity of 139 fb-1. Cross sections

are measured as a function of the photon transverse energy in various regions of photon pseudorapidity. Additionally, we examine how the production cross section varies with two different photon isolation radii.

Parallel Session 1 / 22

Measurements of jet cross-section ratios with ATLAS

Author: Kristin Lohwasser[1]

[1] *University of Sheffield*

Jet cross-section ratios between inclusive bins of jet multiplicity are measured differentially in variables that are sensitive to either the energy-scale or angular distribution of hadronic energy flow in the final state. Several improvements to the jet energy scale uncertainties are described, which result in significant improvements of the overall ATLAS jet energy scale uncertainty. The measurements are compared to state-of-the-art NLO and NNLO predictions.

Parallel Session 5 / 23

Searches for new physics with leptons using the ATLAS detector

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Many different theories beyond the Standard Model (SM) predict that new physics will manifest itself by decaying into final states involving leptons. Leptoquarks are predicted by many new physics theories to describe the similarities between the lepton and quark sectors of the SM. Right-handed Ws and heavy-neutrinos are also predicted by many extensions of the SM in the gauge sector, and lepton flavour violation could manifest itself by decays of new gauge bosons into leptons of different flavours. This talk will present the most recent 13 TeV results on the searches for leptoquarks with the ATLAS detector, covering flavour-diagonal and cross-generational final states, as well as the latest searches for lepton-flavour violating Z' and heavy neutrinos arising from left-right symmetric models.

Parallel Session 4 / 25

Probing the nature of electroweak symmetry breaking with Higgs boson pairs in ATLAS

Author: Ang Li[1]

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In the Standard Model, the ground state of the Higgs field is not found at zero but instead corresponds to one of the degenerate solutions minimising the Higgs potential. In turn, this spontaneous electroweak symmetry breaking provides a mechanism for the mass generation of nearly all fundamental particles. The Standard Model makes a definite prediction for the Higgs boson self-coupling and thereby the shape of the Higgs potential. Experimentally, both can be probed through the production of Higgs boson pairs (HH), a rare process that presently receives a lot of attention at the

LHC. In this talk, the latest HH searches by the ATLAS experiment are reported, with emphasis on the results obtained with the full LHC Run 2 dataset at 13 TeV. Non-resonant HH search results are interpreted both in terms of sensitivity to the Standard Model and as limits on the Higgs boson self-coupling and the quartic VVHH coupling. The Higgs boson self-coupling can be also constrained by exploiting higher-order electroweak corrections to single Higgs boson production. A combined measurement of both results yields the overall highest precision, and reduces model dependence by allowing for the simultaneous determination of the single Higgs boson couplings. Results for this combined measurement are also presented. Finally, extrapolations of recent HH results towards the High Luminosity LHC upgrade are also discussed.

Parallel Session 4 / 26

Searching for additional Higgs bosons at ATLAS

Author: Kevin Michael Nelson[1]

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The discovery of the Higgs boson with the mass of about 125 GeV completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many measurements, it is not capable to solely explain some observations. Many extensions of the Standard Model addressing such shortcomings introduce additional Higgs-like bosons which can be either neutral or charged. The current status of searches for additional low- and high-mass Higgs bosons based on the full LHC Run 2 dataset of the ATLAS experiment at 13 TeV are presented.

Parallel Session 4 / 27

Measurements of Higgs boson properties with the ATLAS detector

Author: Luca Franco[1]

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This talk presents precise measurement of the properties of the Higgs boson, including its mass, total width, spin, and CP quantum number. The measurements are performed in various Higgs boson production and decay modes, as well as their combinations. Observation of deviations between these measurements and Standard Model (SM) predictions would be a sign of possible new phenomena beyond the SM

Parallel Session 4 / 28

Measurements of Higgs boson production and decay rates with the ATLAS experiment

Author: Rabia Shaheen[1]

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The event rates and kinematics of Higgs boson production and decay processes at the LHC are sensitive probes of possible new phenomena beyond the Standard Model (BSM). This talk presents precise measurements of Higgs boson production and decay rates, obtained using the full Run 2 and partial

Run 3 pp collision dataset collected by the ATLAS experiment at 13 TeV and 13.6 TeV. These include total and fiducial cross-sections for the main Higgs boson processes as well as branching ratios into final states with bosons and fermions. Differential cross-sections in a variety of observables are also reported, as well as a fine-grained description of the Higgs boson production kinematics within the Simplified Template Cross-section (STXS) framework.

Parallel Session 4 / 30

Search for additional Higgs bosons at CMS

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Results are presented on searches for additional Higgs bosons using the CMS Run 2 data. The search covers both low mass (below 125 GeV), in the diphoton and ditau channel, and higher masses in the decays into b jets and a top pair. Additionally, exotic decays of the SM Higgs boson in psedoscalar states are presented. The results constrain a wide range of the parameter space of (N)MSSM and 2HDM models.

Parallel Session 1 / 31

Entanglement of top quarks at CMS

Author: Didar Dobur[1]

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Present the observation of entanglement in top quark pairs using data collected with the CMS detector in the Run II of the LHC. Event signatures are selected only when two high pT leptons are present consistent with the dileptonic decay channel. An entanglement proxy D is used to determine whether the top quark pairs are entangled in the production threshold with D < -⅓ signaling entanglement. D is observed (expected) to be −0.480ˆ{+0.026}{−0.029} (−0.467ˆ{+0.026}{−0.029}) at the parton level. The observed significance is 5.1 standard deviations with respect to the non-entangled hypothesis. This measurement provides a new probe of quantum mechanics at the highest energies ever produced.

Parallel Session 1 / 32

Searches for Heavy Resonances Decaying into Bosons at CMS

Author: Antonios Agapitos[1]

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This presentation will cover the latest results from the CMS experiment on searches for heavy resonances decaying into bosons using data from Run 2. The analysis focuses on various final states, including those involving γ, g, W, Z, and H bosons. These searches aim to identify potential new particles predicted by theories beyond the Standard Model, such as Higgs sector extensions and extra dimensions. The findings place stringent limits on the production cross-sections and masses of these hypothetical resonances, narrowing down the parameter space for new physics.

Parallel Session 2 / 33

The latest results from Daya Bay

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The Daya Bay reactor neutrino experiment, operated from December 2011 to December 2020, has gathered a record amount of statistical data on reactor neutrino interactions. Antineutrinos from 6 reactor cores were detected through inverse beta decay and identified through neutron capture on gadolinium or hydrogen using eight functionally identical detectors located in three experiment halls. Thanks to the high statistics, well-controlled systematic errors, effective background suppression and precise evaluation, Daya Bay has been providing the most precise measurements of the neutrino mixing angle theta13 in the world. This talk will present the latest results using the full dataset from Daya Bay, spanning from the measurement of neutrino oscillation parameters within the three-neutrino oscillation framework, the search for sterile neutrinos, and measurements of reactor flux and spectra.

Parallel Session 6 / 34

The buzz of b→sll decays and why it still matters.

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Rare b→sll decays serve as a valuable laboratory for probing the Standard Model (SM) flavour universality. These decays are sensitive to potential contributions from heavy mediators that are not accessible through direct searches. The LHCb detector plays a crucial role in this sector, as it is specifically designed to study hadrons containing b or c quarks. LHCb has conducted various analyses focusing on b→sll decays, including branching ratio and angular measurements. Comparing decays to electrons and muons can potentially reveal differences between lepton families. This talk presents the latest LHCb results on b→sll analyses, with a particular focus on the rare B0→K*0ee angular analysis.

Parallel Session 8 / 35

Analysis of local and non-local amplitudes in the B0 → K0*μ+μ−

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The B0 → K0*μ+μ− decay occurs via the rare flavor-changing neutral current (FCNC) transition b → sl+l−, making it a sensitive probe for New Physics (NP) since FCNC is forbidden at tree level in the Standard Model (SM). Virtual NP contributions can significantly influence this decay, and previous LHCb measurements have shown notable discrepancies with SM predictions at a 3σ level. Interpreting these anomalies is challenging due to uncertainties in non-local SM contributions, such

as charm-loops, which can mimic NP effects. This presentation covers results from a data-driven approach aimed at determining the size of charm-loops and other non-local contributions to the B0 ⟶ K0*μ+μ− amplitude. This is the first measurement to parameterise the full di-muon invariant mass spectrum, using an integrated luminosity of 8.4 1/fb collected by the LHCb experiment.

Parallel Session 6 / **36**

Search for coherent neutrino-nucleus scattering in the NEON experiment

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Since the COHERENT collaboration first observed coherent elastic neutrino-nucleus scattering (CEνNS) in 2017, interest in this phenomenon has surged, leading to numerous global efforts to detect reactor neutrinos via CEνNS. Launched in 2019, the NEON (Neutrino Elastic Scattering Observation with NaI(Tl)) experiment aims to observe CEνNS from reactor neutrinos. Following the successful development of a high-light-yield NaI(Tl) detector, data acquisition began in 2022 with the detector installed in the tendon gallery of Hanbit Nuclear Power Plant Unit 6 in Yeonggwang, South Korea. This presentation will provide an overview of the NEON experiment, detailing the detector configuration and operation, as well as its performance and the latest analysis results.

Poster Session / **37**

Resolving the DAMA/LIBRA Anomaly with the Full COSINE-100 Dataset

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The event rate from dark matter interactions is expected to exhibit an annual modulation due to the galactic halo distribution of dark matter. However, this signature has only been observed in the DAMA/LIBRA experiment, which used NaI(Tl) scintillators. While their results could suggest dark matter scattering, no other experiment has successfully replicated these findings. To address this anomaly, the COSINE-100 experiment was established as a direct, model-independent test of the DAMA result, utilizing 106 kg of the same NaI(Tl) material. Operating from September 2016 to March 2023 at the Y2L underground laboratory in South Korea, COSINE-100 has collected high-quality data to rigorously test DAMA's claims. This presentation will cover the recent model-independent annual modulation search results from the full COSINE-100 dataset. Additionally, various other physics searches conducted by COSINE-100 will be discussed. Having completed its initial mission phase last year, COSINE-100 is now undergoing upgrades to transition into COSINE-100U. With its new, deeper location at Yemilab and improved encapsulation techniques, the experiment will continue its dark matter search efforts. The talk will also outline the status and prospects of the upgrade program, along with plans for the next-generation experiment, COSINE-200.

Plenary Session / **38**

Status and perspectives of coherent elastic neutrino nucleus scattering

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The talk will cover the status of coherent elastic neutrino nucleus scattering experiments and a brief outlook on the physics potential.

Plenary Session / **39**

Review of Solar and Geo Neutrino Experiments

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This talk will review the status of experiments measuring solar and geo neutrinos, including recent results and prospects for the near future.

Plenary Session / **41**

The Virgo experiment and the hunt for gravitational waves: status, recent results and prospects.

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Since the first discovery in 2015, the field of gravitational-wave searches has strongly developed, with a total of 90 confirmed detections during the first three observing runs of the Advanced LIGO/Virgo detectors. In this talk, I will present the current status of the Virgo detector and its contribution in the global network of Earth-based detectors. Then, I will discuss the various searches that are currently carried on, along with the recent findings and their scientific implications. Finally, I will discuss future upgrades of the detector and the prospects for the coming decades.

Plenary Session / **42**

Review of recent Heavy Ion Physics results at the LHC

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Heavy-ion collisions at the Large Hadron Collider (LHC) offer a unique laboratory for probing the quark-gluon plasma (QGP), a novel state of matter believed to have existed shortly after the Big Bang.
This talk will present the latest findings from the LHC, focusing on key observables that shed light on various aspects of the QGP. Heavy-flavor hadrons and jet observables, such as jet quenching and de-correlation, provide crucial insights into the interactions between high-energy partons and the QGP, probing the medium energy density and transport properties. The study of quarkonia suppression and regeneration reveals the binding dynamics of heavy quarks within the plasma, while collective flow patterns offer evidence of the thermalization of the QGP and of collective behavior. Additionally, direct photons serve as penetrating probes, delivering unaltered information from the early stages of the collision, and allowing for the determination of the medium initial temperature and fundamental characteristics.
The talk will also explore emerging similarities between heavy-ion and small-system collisions, contributing to a broader understanding of QGP phenomena. By integrating these diverse findings, this presentation aims to provide a comprehensive overview of the current state of heavy-ion physics research at the LHC.

Plenary Session / **43**

New measurement of K -> π ν νbar branching ratio

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The $K \to \pi\nu\bar{\nu}$ decay is a "golden mode" for flavour physics. Its branching ratio is predicted with high precision by the Standard Model to be less than 10^{-10}, and this decay mode is highly sensitive to indirect effects of new physics up to the highest mass scales. The NA62 experiment at the CERN SPS is designed to study the $K^+ \to \pi^+\nu\bar{\nu}$ decay, and provided the world's most precise investigation of this decay using 2016–18 data. Building on this success, the first results from a significantly improved analysis of new data, taken in 2021–22 after beam-line and detector upgrades, are presented, along with the combination with the 2016–18 results.

Parallel Session 2 / **44**

Borexino and the Sun

Author: Marco Giammarchi[1]

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I will review the story of Borexino at Gran Sasso in the light of our understanding of the working principle of the Sun with the original hypotesis put forth by Bethe, Gamow and von Weiszacker in 1938. From the design to the radiopurity tests and the evolution of the project, the solution of several technical challenges led to a thorough real-time understanding of the nuclear reactions taking place inside the core of our star, both for the pp and the CNO cycles. This constitutes the final experimental confirmation of the 1938 predictions, which also applies for all the stars in the Main Sequence.

Plenary Session / **45**

Direct neutrino mass measurement

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The neutrino mass is deeply connected to physics of and beyond the Standard Model and to the evolution of the universe. Direct neutrino mass experiments provide the most model-independent approach to measure the absolute mass scale of neutrinos. In this talk the focus is on the latest results of the KATRIN experiment. In addition I will give an overview on the status and prospects of the field of direct neutrino mass experiments.

Plenary Session / **46**

Recent progress on charmed hadron decays at BESIII

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BESIII has collected 7.93, 7.33, and 4.5 fb^{-1} of e^+e^- collision data samples at 3.773, 4.128-4.226, and 4.6-4.7 GeV, which provide the largest dataset of charmed hadron pairs in the world, respectively, and present a unique opportunity to investigate charm decays.

For the hadronic decays, we will present the observation of D^+ to $K_s\ a_0(980)+$ and D to $a_0(980)^+\pi$, and the determination of U-spin breaking parameters of the decay D^0 to $K_L\ \pi^+\ \pi^-$, and recent progress on amplitude analyses, including $D_s^+ \to \pi^+\pi^+\pi^-\pi^0$, Λ_c^+ to $\Lambda\pi^+\pi^0$, and Λ_c^+ to $\Lambda\pi^+\eta$, along with the measurement of branching fractions of fifteen D_s^+ hadronic decays using a global fit. Futhermore, our talk will also includes the branching fraction measurements of the singly and doubly Cabibbo-suppressed decays of charmed hadrons and the measurement of the decay asymmetry in the Λ_c^+ decays.

For the (semi-)leptonic decays, we will present the first experimental study of $D_{(s)}^{*+}$ to $l^+\ \nu$ and the inclusive $\Lambda_c \to Xe\nu$ decays, and the improved measurements of $|V_{cs}|$ and D_s decay constant in $D_s^+ \to \mu^+\nu$ and $\tau^+\nu$. Finally, we will summarize the form factor studies in the decays of D_s to $\eta^{(\prime)}$, D_s to $f_0(980)$, D_s to ϕ, and D to $f_0(500)$, D to K^*.

Plenary Session / **47**

Unraveling Neutrinos with KM3NeT

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Neutrinos are interesting elusive particles that can provide significant insights into our Universe. Their neutral, stable, and weakly interacting nature, make them ideal messengers to explore the deep

Universe. However, the flux of high energy neutrinos is quite low, necessitating the development of large detectors. The KM3NeT collaboration addresses this challenge by building two undersea neutrino telescopes to investigate phenomena across the GeV to the PeV energy ranges. These experiments, named ARCA (Astroparticle Research with Cosmics in the Abyss) and ORCA (Oscillation Research with Cosmics in the Abyss), are located in Sicily at a depth of 3500m and in Toulon at a depth of 2500m, respectively. ARCA is tailored for detecting high-energy astrophysical neutrinos, while ORCA focuses on the study of the atmospheric neutrino flux to measure neutrino properties. The Physics program covered by KM3NeT is very broad and includes the study of cosmic neutrinos, the measurement of neutrino properties (oscillation parameters, mass ordering, etc), the detection of supernovae, the search for dark matter, among others.
Both ARCA and ORCA are composed of multi-PMT modules that had been designed and assembled in several integration sites across Europe and Morocco. The module design ensures excellent resolution capabilities, position and time calibration.
This talk aims to give an overview of KM3NeT telescopes technology, construction, goals, current status and preliminary results.

Plenary Session / **48**

Overview of the sterile neutrino searches and status of SBN/ICARUS experiment

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The results of short-baseline oscillation experiments have raised the possibility of the existence of light sterile neutrino states in the eV mass range. As a result, there has been a surge in new experimental efforts to definitively approve or disapprove the oscillations between active and sterile neutrino states. This new neutrino, if confirmed, would be a Standard Model gauge singlet, hence dubbed “sterile.” The discovery or exclusion of this sterile neutrino could have far-reaching implications for particle physics, as well as astrophysics and cosmology. In this presentation, I will provide an overview of the ongoing searches for sterile neutrinos and discuss the progress and plans for the ICARUS and SBND experiments as part of the Short-Baseline Neutrino program at Fermilab.

Parallel Session 1 / **49**

Measurement of the W boson mass at CMS

Author: Rajarshi Bhattacharya[1]

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The W boson mass is measured using proton-proton collision data at sqrt(s)=13 TeV corresponding to an integrated luminosity of 16.8 inverse fb recorded during 2016 by the CMS experiment. The W boson mass is extracted using single-muon events via a highly granular maximum likelihood fit of the transverse momentum, pseudorapidity, and charge distribution of the selected muons, yielding one of the most precise measurements of the W mass to date

Parallel Session 6 / **50**

Recent advances in the search for 0νββ decay of 76Ge with LEGEND-200

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The LEGEND collaboration aims to detect neutrinoless double-beta (0νββ) decay in ^{76}Ge using enriched high-purity germanium (HPGe) detectors. In its first phase, LEGEND-200, the experiment has been collecting physics data for over a year using 140 kg of HPGe detectors deployed in a liquid argon cryostat, with plans to add more detectors in the near future. In this talk, we present the results of the 0νββ analysis based on this data set. We will discuss the experiment's performance in terms of background suppression, signal acceptance, and bounds on the 0νββ decay half-life. In addition, we present the combined analysis of LEGEND-200 and the previous ^{76}Ge-based experiments GERDA and Majorana Demonstrator. Finally, we give an overview of the current planning for LEGEND-1000, the next phase of the experiment.

Parallel Session 2 / 51

Latest NOvA Oscillation Results from 10 Years of Data

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NOvA is a long-baseline, accelerator-based neutrino oscillation experiment, optimized for electron neutrino measurements. It utilizes the upgraded, Megawatt-capable NuMI beam from Fermilab to measure electron-neutrino appearance and muon-neutrino disappearance at its Far Detector in Ash River, Minnesota. NOvA's goals include resolving the neutrino mass hierarchy problem, constraining the CP-violating phase, and determining the octant of theta23. This talk will present the latest results on muon (anti-)neutrino disappearance and electron (anti-)neutrino appearance from NOvA. These measurements are based on 10 years of NOvA data collected between 2013 and 2023. The new NOvA results suggest a preference for the normal mass hierarchy with a credence level of 87%.

Parallel Session 2 / 52

Search for neutrinoless double beta decay at AMoRE

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Observation of neutrinoless double beta ($0\nu\beta\beta$) decay can reveal the neutrino properties beyond the Standard Model. AMoRE searches for the $0\nu\beta\beta$ decay of molybdenum-100 using the isotope in the form of scintillation crystals equipped with the cryogenic detector system in the underground laboratory. In the first two phases of AMoRE using $^{48\mathrm{depl}}\mathrm{Ca}^{100}\mathrm{MoO}_4$ and $\mathrm{Li}_2{}^{100}\mathrm{MoO}_4$ crystals, working principles and stability for a long-term operation of the detector have been demonstrated, and the half-life of Mo-100 $0\nu\beta\beta$ decay have been constrained at $T^{0\nu}_{1/2} > 2.9 \times 10^{24}$ years at 90% confidence level. The AMoRE-II detector is under preparation for its data taking to be started in 2025. AMoRE-II will be conducted using 157 kg of ^{100}Mo-based crystals for longer than 5 years. With a background level below 2×10^{-4} count/keV/kg/year at the energy around the Q-value at 3.034 MEV, we expect the experimental sensitivity about $T^{0\nu}_{1/2} \sim 4 \times 10^{26}$ years, or in terms of the effective Majorana mass $m_{\beta\beta} \sim 25-73$ meV for the exclusion limit at 90% confidence level, covering most parameter space in the inverse mass ordering scenario.

Parallel Session 2 / **53**

Recent results from MicroBooNE

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Modelling and reconstructing neutrino-nucleus scattering is difficult, but it is crucial to do it precisely to enable next-generation oscillation measurements. Liquid argon time projection chambers (LArTPCs), such as MicroBooNE, can be the tool for this job as they are excellent precision neutrino detectors with their ability to produce detailed three-dimensional interaction images and precise energy and spatial resolution. MicroBooNE currently possesses the world's largest neutrino-argon scattering data set collected over five years using the BNB and NuMI neutrino beams at Fermilab. The experiment has performed measurements over a broad range of physics topics including neutrino-argon cross sections, searches for BSM physics, and investigations of the MiniBooNE LEE excess. Many of these measurements are essential for improving the modelling of nuclear effects for both MicroBooNE and future LArTPC neutrino experiments, such as DUNE. This talk will give an overview of recent MicroBooNE results, the analysis techniques that enable them, and prospects for future measurements.

Parallel Session 6 / **54**

Analysis and Validation of PMT's Waveforms in ICARUS LArTPC Using Monte Carlo Simulations

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ICARUS (Imaging Cosmic and Rare Underground Signals), will operate as the Far Detector in the Short Baseline Neutrino (SBN) program at Fermilab. It plays a key role in detecting the potential existence of sterile neutrinos in the eV mass region. The ICARUS detector consists of two large liquid Argon time projection chambers (LArTPCs), each holding 760 tons of liquid Argon. A crucial component of the detector is its array of 360 photomultiplier tubes (PMTs), which detect the scintillation light produced by charged particles in liquid Argon.
The light scintillation signal is fast enough for accurate event timing, triggering, and reconstruction in the detector. Specifically, the PMTs, together with TPC and CRT, allow precise determination of the interaction time, which is important for distinguishing between neutrino events and cosmic-ray background.
The PMTs used in ICARUS are Hamamatsu R5912-MOD tubes, 8 inches in diameter, optimized for cryogenic temperatures. These PMTs have a high quantum efficiency, and also feature excellent timing resolution and a low dark current (around 10 nA at 1500 V). The PMTs'sensitivity spans from 300 to 650 nm, making them efficient at detecting scintillation light over a broad spectrum.
In my research, I analyze the waveforms of the light signals detected by the PMTs to ensure that the experimental data aligns with Monte Carlo simulations. This comparison is crucial for validating the accuracy of the experimental data and enhancing our understanding of the detector's performance. By improving this comparison, we aim to refine the reconstruction of neutrino events and ensure that the detector is properly calibrated for ongoing and future operations.

Parallel Session 7 / **55**

Prospects for Neutrinos from Natural Sources in JUNO

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The Jiangmen Underground Neutrino Observatory (JUNO) is a 20-kiloton liquid scintillator detector nearing completion in southern China. JUNO is designed to achieve an energy resolution of 3% at 1 MeV, with its primary goal being the determination of the neutrino mass ordering by resolving fine structure in the antineutrino energy spectrum from nearby nuclear reactors. Additionally, with its large scale, extensive PMT coverage, and low background, JUNO will carry on a broad physics program, detecting neutrinos with energies from keV to GeV. JUNO will perform neutrino oscillation measurements using atmospheric neutrinos, increasing its sensitivity to mass ordering. It will further investigate solar neutrinos, geoneutrinos, and neutrinos from supernova bursts, contributing to the study of the physics of their sources. This talk will focus on JUNO's physics potential with neutrinos from natural sources.

Parallel Session 6 / 56

MoEDAL-MAPP and the lifetime frontier

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The unprecedented collision energy of the LHC has opened up a new discovery regime. The first LHC dedicated search experiment, MoEDAL, has inaugurated the lifetime frontier being optimised for searches of long-lived particles. MoEDAL is designed to search highly ionising particle avatars of new physics using proton and heavy-ion collisions at the LHC. The upgrade for MoEDAL at Run 3 - the MAPP detector (MoEDAL Apparatus for Penetrating Particles) - will extend the physics reach to include feebly interacting, long-lived messengers of physics beyond the Standard Model. This will allow us to explore a number of models of new physics, including dark sector models, in a complementary way to that of the main LHC detectors. The presentation will focus on recently published results and plans for the Run 3 and HL-LHC.

B Acharya et al [MoEDAL Collaboration], "MoEDAL search in the CMS beam pipe for magnetic monopoles produced via the Schwinger effect,"
Phys.Rev.Lett. 133 (2024) 071803
→ Editors' Suggestion

B Acharya et al [MoEDAL Collaboration], "Search for highly ionizing particles in pp collisions during LHC Run-2 using the full MoEDAL detector,"
Phys.Rev.Lett., to appear[\arXiv:2311.06509 [hep-ex]]

M Kalliokoski, V A Mitsou, M de Montigny, A Mukhopadhyay, P-P A Ouimet, J Pinfold, A Shaa, M Staelens, "Searching for Minicharged Particles at the Energy Frontier with the MoEDAL-MAPP Experiment at the LHC,"
JHEP 04 (2024) 137

Parallel Session 7 / 57

JUNO's Physics with Reactor Antineutrinos

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The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector with a 650 m overburden that is currently under construction in the southern China. The experiment has two main goals: determining the neutrino mass ordering and precisely measuring the oscillation parameters Δm^2_{31}, Δm^2_{21}, and $\sin^2\theta_{12}$. JUNO will have an energy resolution of 3% at 1 MeV, an optimized baseline of 52.5 km, and will use electron antineutrinos emitted by eight nuclear reactors. Given these features, JUNO can determine the neutrino mass ordering with a sensitivity of 3σ with an exposure of about 6.5 years × 26.6 $\mathrm{GW_{th}}$, which corresponds to about 7 years of data-taking. Additionally, it can measure the oscillation parameters with a precision better than 1% during the first two years of data taking. This talk will cover the physics results that JUNO can achieve using reactor antineutrinos.

Plenary Session / **58**

Top measurements from ATLAS and CMS

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The top quark, the heaviest known elementary particle, plays a crucial role in advancing our understanding of fundamental physics. In this talk, the latest measurements of top quark production and properties from the ATLAS and CMS experiments at the LHC will be discussed. Key results include precise cross section measurements of top quark pair production, single top quark production, and associated production channels at different center-of-mass energies, providing valuable insights into QCD and electroweak interactions. A recent highlight is the observation of quantum entanglement between top quark pairs, offering a unique perspective on quantum mechanics at the highest energies. The talk will also cover the most precise measurements of the top quark mass, a parameter that is essential for testing the internal consistency of the standard model.

Parallel Session 5 / **59**

Search for the critical point in NA61/SHINE

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The NA61/SHINE experiment at the CERN SPS is a multipurpose fixed-target spectrometer for charged and neutral hadron measurements. Its research program includes studies of strong interactions as well as reference measurements for neutrino and cosmic-ray physics. One major goal of its strong interaction program is to determine the existence and pinpoint the location of the QCD critical point, an object of both experimental and theoretical studies.

This contribution will summarize the current status of NA61/SHINE critical point searches in nucleus-nucleus collisions, in the collision energy range $\sqrt{s_{NN}}$ = 5 - 17 GeV. The review will include studies of multiplicity and multiplicity-transverse momentum fluctuations, fluctuations of net-electric

charge, Bose-Einstein (HBT) correlations in femtoscopy analysis, as well as proton and h^- intermittency. Particular focus will be devoted to the development of novel methods aimed at solving the long-standing problem of bin-by-bin correlations in experimental intermittency analysis, and for a more accurate handling of systematics and uncertainties. Although no clear indication of the critical point has been observed so far, exclusion plots for the parameters of Monte Carlo models will be presented.

Plenary Session / 61

Current status of neutrino oscillation physics with neutrinos from accelerators

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In the last years, experiments with neutrinos from accelerators have been instrumental for our knowledge of neutrino oscillations.
Long baseline neutrino experiments (T2K and NOVA), combining a high-intensity neutrino beam, sophisticated near detectors and massive far detectors, have established a non zero theta13 angle and measured with precision the theta23 angle and the Dm*2_32 mass difference.
After a description of the experimental setup, recent results from these long baseline experiments will be showed with emphasis on the T2K experiment.
T2K decided to launch a major upgrade of its near detector that has been recently installed, featuring a novel highly segmented Fine Grained Detector and two new TPCs. Moreover, the accelerator complex has been upgraded to reach a proton beam power on target of 800 kW.
I will briefly mention the future of the field : new experiments (DUNE and HyperKamiokande) are in construction to complete the picture with measurements of the CP violation phase delta and the mass ordering.
The challenges facing this program will be presented, in particular the uncertainties in the neutrino nucleus cross-sections.

62

Registration

Welcome Address / 66

Opening and welcome address by the President of NCSR Demokritos

Welcome Address / 67

Welcome by the Chair on behalf of the IAC

Parallel Session 3 / **77**

Studying chiral partner resonances K^* and K_1 to investigate chiral symmetry restoration with ALICE

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In the relativistic heavy-ion collisions at the LHC, the quark-gluon plasma (QGP) is produced during the deconfinement phase transition, when the system reaches a specific temperature (T_{ch}) and energy density.
Lattice QCD calculations indicate that chiral symmetry (CS) restoration occurs around T_{ch} as well (~ 156 MeV). CS restoration can be investigated using parity partner resonances, particles that have the same quantum numbers except parity, such as $\mathrm{K}^*(892)^0$ and $\mathrm{K}_1(1270)$. In the vacuum these resonances exhibit different masses, decay lengths, and production yields. However, at a temperature near those associated with CS restoration, these discrepancies are expected to diminish, resulting in a K_1 to K^* production ratio higher than the one predicted by the statistical hadronization model.
The ALICE Collaboration has already measured K^* production spectra using LHC Run 2 data, evaluating the K^*/K yield ratios in pp, p-Pb and Pb-Pb collisions, providing an experimental evidence that $\mathrm{K}^*(892)^0$ decay products undergo rescattering during the hadronic phase of the QGP evolution. However, the reconstruction of the K_1 resonance has not been achieved.

Thanks to its excellent tracking and particle identification capabilities, the ALICE Collaboration has measured a comprehensive set of mesonic and baryonic resonances. In this contribution, recent results on resonance production in pp, p–Pb, Xe–Xe and Pb–Pb collisions at various centre-of-mass energies, including new feasibility studies on $\mathrm{K}^*(892)^0$ using LHC Run 3 data, will be presented and compared to state-of-the-art models. Furthermore, the feasibility study of the K_1 measurement with ALICE and plans for investigating CS restoration will be discussed.

Plenary Session / **82**

Exotics searches at the LHC

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Plenary Session / **83**

Overview of dark matter searches

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Parallel Session 3 / **84**

Hypercontractivity and factorial moment scaling in the symmetry broken phase

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We perform a theoretical interpretation of the results on intermittency analysis recently presented by the STAR collaboration at RHIC (Phys. Lett. B 845, 138165 (2023), arXiv:2301.11062v1 [nucl-ex]). The main task in this analysis was the search for the scaling law relating higher order factorial moments in transverse momentum space with the second order one. In a more general context, such a scaling, as well as the associated power-law exponent $\nu \approx 1.304$, have been proposed as a signal for the approach to criticality from the hadronic phase (Phys. Rev. Lett. 69, 741 (1992)). Here we show that hypercontractivity, a general property of independent random variables in a higher dimensional space, dictates that such a scaling behaviour is prohibited in the asymptotic limit $q \to \infty$. Thus, the proposed scaling behaviour can only hold for q
$lesssim q_{max}$. However, in such a case there is a wide class of distributions, not related to criticality, leading to this behaviour with exactly the same ν-value. We provide examples supporting this statement. Then, we explain the origin of ν-values less than one, measured in STAR for all analysed data sets. We demonstrate that they emerge naturally when the observed power-law behaviour refers to the factorial moment difference ΔF_q after the subtraction of the corresponding background, providing also some sufficient condition leading to $\nu < 1$.

Parallel Session 7 / **85**

DUNE: science and status

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The Deep Underground Neutrino Experiment (DUNE) is a next-generation long-baseline neutrino oscillation experiment. Its primary goal is the determination of the neutrino mass hierarchy and the CP-violating phase. The DUNE physics program also includes the detection of astrophysical neutrinos and the search for beyond the Standard Model phenomena, such as nucleon decays. DUNE will consist of a near detector complex placed at Fermilab, several hundred meters downstream of the neutrino production point, and 17-kton Liquid Argon Time Projection Chamber (LArTPC) far detector modules to be built in the Sanford Underground Research Facility (SURF), approximately 1.5 km underground and 1300 km away. The detectors will be exposed to a wide-band neutrino beam generated by a 1.2 MW proton beam, with a planned upgrade to 2.4 MW. Two prototypes of the FD technology, the ProtoDUNE 700 ton LArTPCs, have been operated at CERN for over 2 years, and have been recently optimised to take new data in 2024-2025. Additionally, the 2x2 Demonstrator, a prototype of the LAr component of the near detector, has recently started operations in the NuMI beam at Fermilab. This talk will present the science programme, as well as recent progress of DUNE and its different prototyping efforts.

Poster Session / **86**

Measurement of the atmospheric muon neutrino flux with KM3NeT/ORCA6

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The KM3NeT/ORCA detector (Oscillation Research with Cosmics in the Abyss) is an underwater array of Digital Optical Modules. These are spheres that host 31 photomultiplier tubes each, and they are tied together in vertical structures (the Detection Units-DUs) anchored on the seabed. This configuration allows the detection of neutrino events using the Cherenkov radiation emitted by secondary particles originating from neutrino interactions in the abyssal depths of the Mediterranean Sea. The KM3NeT/ORCA detector is being deployed at a depth of 2450m, approximately 40 km South of Toulon, France with the determination of the Neutrino Mass Ordering being the main physics goal of the detector.

in this work, we present a measurement of the atmospheric muon neutrino flux between 1 GeV and 100 GeV, using data collected with the 6-DU configuration of KM3NeT/ORCA (KM3NeT/ORCA6). The data analyzed corresponds to a time period of one and a half years. A high-purity atmospheric neutrino sample is selected using a Machine Learning classifier (Boosted Decision Tree). Subsequently, an unfolding scheme is used to obtain an estimation of the atmospheric muon neutrino flux in bins of energy in the region of interest. Finally, a detailed study of the impact of the systematic uncertainty sources in the measurement is also presented. This measurement illustrates the ability of the KM3NeT/ORCA detector to provide experimental information, even with an early-stage detector configuration, at an energy region in which only few measurements exist by other experiments.

Plenary Session / **87**

JUNO Experiment: Advancing the Next Generation of Reactor Neutrino Research

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Abstract: Since the discovery of neutrinos, nuclear reactor has played a major role in understanding neutrino physics, from the observation of neutrino oscillations with the precise measurement of Δm_{21} and θ_{12}, to the more recent breakthrough precise measurement of θ_{13} by the Daya Bay, Double Chooz and RENO. With the Jiangmen Underground Neutrino Observatory (JUNO), reactor neutrino physics is entering a new era in terms of precision and physics reach. Situated 52.5 km from two nuclear power plants within a newly established 700-meter-deep underground laboratory, JUNO aims to determine neutrinos mass ordering by precisely measuring the energy spectrum of reactor neutrinos. In addition, it will measure, with sub-percent precision, most of the neutrino oscillation parameters. Thanks to its excellent characteristics in terms of an unprecedented active mass and excellent energy resolution, the JUNO physics program comprises also solar neutrinos, atmospheric neutrinos, supernova neutrinos, and geoneutrinos, as well as beyond standard model physics topics such as nucleon decay.
This talk will present the JUNO experiment in the context of current reactor neutrino experiments and upcoming long-baseline neutrino oscillation programs, highlighting the complementarity and synergies between JUNO and these initiatives in understanding the fundamental properties of neutrinos.

Plenary Session / **88**

PHENIX Overview

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PHENIX Overview highlights recent results in pp collisions, such as the sensitivity of direct photons to gluon spin (510 GeV), jet cross section and dilepton production (200 GeV) and J/ψ yield multiplicity dependence.
In small systems (dAu) the direct photon yield multiplicity dependence and pi0 supression in central collision, in AuAu collisions the new results of direct photon scaling, the v2 measurements of heavy flavors and J/ψ at forward rapidity
and the medium's response to jets will be presented.

Poster Session / 89

Diffuse astrophysical neutrino flux searches with KM3NeT/ARCA

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In this contribution the most recent results of an all-flavour search for diffuse astrophysical neutrino fluxes, using the full dataset obtained with the first KM3NeT/ARCA configurations, will be presented. KM3NeT/ARCA is part of the KM3NeT research infrastructure and focuses on the detection of high energy neutrinos (>TeV) from astrophysical sources. The KM3NeT/ARCA detection units are deployed offshore Capo Passero, Italy at a depth of 3500 m, delivering data as the construction of the detector is ongoing. The two search cases considered here are an all-sky diffuse flux and a flux coming from the Galactic Ridge, namely $|b| < 2^{\circ}$ and $|l| < 30^{\circ}$, in Galactic coordinates. The event selection is based on machine learning techniques and a bayesian method for the statistical analysis is employed.

Parallel Session 6 / 90

Mitigating Parametric Instabilities with Mechanical Dampers in Current and Future Gravitational Wave Detectors

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To enhance the sensitivity of gravitational wave detectors, it is crucial to reduce noise within the 10 Hz to 10 kHz frequency range.
One effective method is to decrease shot noise by increasing the laser power.
This allows the achievement of noise specifications expected for the upcoming observation runs of Advanced Virgo and Advanced LIGO detectors, as well as for third generation detectors.

However, employing a high power laser may result in undesirable effects known as Parametric Instabilities (PI), impacting the instrument's efficiency.
These instabilities occur in an optical cavity due to the interaction between some optical and mechanical modes of the mirrors with very high quality factors and when the light power is very high (hundreds of kW).
To mitigate the effect, a system has been developed to prevent the triggering of instabilities.
Small oscillators resonating at the critical frequencies and with a low quality factor are attached to the lateral surface of the mirrors.
Due to coupling effect between the damper's mode and mirror's mode, the quality factor of the mirror's mode is reduced, and so allows for the reduction of the risk of triggering instabilities.
We present the latest results of various types of dampers tested on a suspended small fused silica substrate placed in a vacuum chamber at room temperature, as part of the effort to set up dampers for the Advanced Virgo interferometer.

Plenary Session / **91**

Current State of Neutrino Astronomy - IceCube and Beyond

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A decade ago, the IceCube Neutrino Observatory at the South Pole opened a new window into the universe by detecting an astrophysical neutrino flux in the TeV - PeV range. Since then, the field has rapidly evolved. The energy spectrum of astrophysical neutrinos has been measured with ever-increasing precision in multiple detection channels. The first point sources are emerging, with the blazar TXS 0506+056 and the Seyfert Galaxy NGC 1068. Adding to the complexity of the neutrino sky, IceCube has recently measured neutrino emission from the Galactic Plane, which offers valuable new information to the study of galactic cosmic ray production and transport. In the meantime, the instrumented volumes of next-generation telescopes, such as KM3NeT and Baikal-GVD, are becoming comparable to IceCube. As they are located in the Northern Hemisphere, these instruments complement IceCube's field of view, promising exciting results in the following years.
In this talk, I will present IceCube's recent results on astrophysical neutrinos and highlights from the next-generation instruments.

Poster Session / **92**

Impact of using the data-driven daemonflux model on CORSIKA simulations of atmospheric muons in KM3NeT

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Muons, created in interactions of cosmic rays with the Earth's atmosphere, are the main component of cosmic ray air showers which reach underwater or in-ice neutrino telescopes such as KM3NeT and IceCube. Measurements of such muons provide crucial information about the properties of cosmic rays, and their interactions with the atmosphere. The KM3NeT research infrastructure includes two telescopes in the Mediterranean Sea which are partially installed and operational. The

KM3NeT/ORCA detector is deployed at 2450 m depth near Toulon, France. The KM3NeT/ARCA telescope is located at 3500 m depth off-shore Capo Passero, Italy. Previous comparisons of the atmospheric muon flux between the data collected by ORCA (ARCA) and CORSIKA simulations performed using the Sibyll2.3d model for high-energy hadronic interactions and the GSF model for mass composition show a 40% (up to 80%) disagreement, with the simulation underestimating the data. Recently, a data-driven model derived from cosmic ray, accelerator, and surface muon data was proposed to help ameliorate the disagreement. In this study, we estimate the impact of correcting the simulations using the muon flux obtained from the daemonflux model. We show that these corrections significantly increase the atmospheric muon flux in CORSIKA simulations and can potentially alleviate the disagreement seen in previous comparisons between KM3NeT data and CORSIKA simulations.

Parallel Session 2 / 93

Latest Results and Future Prospects of the KamLAND-Zen Experiment

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The search for neutrinoless double-beta decay ($0\nu\beta\beta$) is a critical probe for testing the Majorana nature of neutrinos, a key question in particle physics. In this presentation, I will provide an overview of the KamLAND-Zen experiment, one of the leading efforts in this search. I will focus on the data analysis of our latest results, which offer new insights into the $0\nu\beta\beta$ decay search. Additionally, I will report the future directions of the experiment, including the planned KamLAND2 and KamLAND2-Zen projects. These next-generation experiments aim to further improve sensitivity and reduce background, advancing our understanding of neutrino physics. Progress on the technical developments and timelines of these experiments will also be reported.

Parallel Session 7 / 94

Long baseline neutrino project in Europe: ESSnuSB project

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ESSnuSB is a design study for a long-baseline neutrino experiment to precisely measure the CP violation in the leptonic sector, at the second neutrino oscillation maximum, using a beam driven by the uniquely powerful ESS linear accelerator. The ESSnuSB CDR showed that after 10 years, about 72% of the possible CP-violating phase, δCP, range will be covered with 5σ C.L. to reject the no-CP-violation hypothesis. The expected precision for δCP is better than 8° for all δCP values, making it the most precise proposed experiment in the field. The recently started extension project, the ESSnuSB+, aims in designing two new facilities, a Low Energy nuSTORM and a Low Energy Monitored Neutrino Beam to use them to precisely measure the neutrino-nucleus cross-section in the energy range of 0.2 –0.6 GeV. A new water Cherenkov detector will also be designed to measure cross sections and serve to explore the sterile neutrino case. An overall status of the project will be presented together with the ESSnuSB+ additions.

Parallel Session 8 / **95**

Heavy-flavor and quarkonia measurements from RHIC

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Open heavy-flavor hadrons and quarkonia production are considered among the most valuable tools for the investigation of the dense and hot matter produced in relativitstic heavy ion collisions and to study the properties of sQGP.
We will present recent open flavor and quarkonia measurements in p+p and A+A collisions from the experiments at the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory and discuss them in the context of theoretical models.

Plenary Session / **96**

Neutrinoless Double Beta Decay: The Current Status and Future Prospects

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This talk will explore the current landscape of neutrinoless double beta decay ($0\nu\beta\beta$) searches, a phenomenon that, if observed, would provide direct evidence that neutrinos are their own antiparticles (Majorana fermions). The implications of such a discovery extend beyond the realm of particle physics, potentially offering insights into the origin of neutrino mass and the matter-antimatter asymmetry in the Universe.
The talk will then present a comprehensive survey of the experimental landscape, showcasing the diverse approaches employed to detect $0\nu\beta\beta$, including the use of high-purity germanium detectors, liquid scintillators, and bolometric techniques. I will highlight recent experimental results, including the most stringent limits on the $0\nu\beta\beta$ half-life for various isotopes. The challenges and future prospects of $0\nu\beta\beta$ searches will also be discussed, with a focus on the next-generation experiments that aim to significantly improve sensitivity and explore new regions of parameter space. This talk will underscore the crucial role of $0\nu\beta\beta$ searches in advancing our understanding of neutrinos and their place within the broader framework of particle physics and cosmology.

Poster Session / **97**

ANNIE: Overview and Physics goals

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The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton Gd-doped water Cherenkov detector installed in the Booster Neutrino Beam (BNB) at Fermilab. The main physics goal of the experiment is to measure the final state neutron multiplicity of neutrino-nucleus interactions to improve the systematic uncertainties in oscillation experiments. Complementing this goal,

ANNIE tests novel technologies such as water-based liquid scintillator (WbLS) and Large Area Picosecond PhotoDetectors (LAPPDs). This poster provides an overview of the experiment describing the status and physics goals.

Plenary Session / **98**

Recent progress on heavy hadron spectroscopy in LHCb

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Spectroscopy of heavy hadrons offers a powerful tool for exploring the intricacies of quantum chromodynamics. In traditional hadron spectroscopy, experimental studies—particularly the discovery of new hadronic states—are essential for understanding the nature of exotic hadrons. The extensive flavor dataset collected by the LHCb experiment during the periods 2011-2012 and 2015-2018 presents a unique opportunity to investigate the internal structure of hadrons and deepen our understanding of strong interactions. This talk will highlight the latest advancements in hadron spectroscopy, leveraging insights gained from these comprehensive datasets.

Parallel Session 8 / **99**

Recent measurements of the CKM angle gamma at LHCb

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The Cabibbo-Kobayashi-Maskawa (CKM) γ angle can be determined by exploiting the interference between favoured b —> c and suppressed b —> u transition. It is the only angle that is directly measured at the tree level with negligible theoretical uncertainties. It provides a benchmark for the SM of the particle physics to explain the CP violation and to test the new physics contribution Beyond the Standard Model (BSM). The LHCb experiment performs the combination of the measurements sensitive to the CKM angle γ and obtained the most precise measurement of the γ angle which is a central topic in flavour physics. This talk presents the latest γ combination using measurements of tree-level decays at LHCb.

Plenary Session / **100**

Rare B decays

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Rare B decays, mediated by flavor-changing neutral currents, are sensitive probes for new physics beyond the Standard Model. LHCb at CERN and Belle II at KEK focus on high-precision measurements of these decays. In this talk, we will discuss recent measurements from both experiments and highlight why they are ideal detectors for studying such decays.

Parallel Session 5 / **101**

Searches for BSM physics using challenging and long-lived signatures with the ATLAS detector

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Many Beyond the Standard Model (BSM) theories predict the existence of long-lived particles (LLPs), which can exhibit unusual experimental signatures. Standard reconstruction algorithms may inadvertently reject events or objects containing LLPs. Therefore, dedicated searches are essential to uncover LLP signals. This presentation will discuss the recent results from LLP searches with the ATLAS detector.

Plenary Session / **102**

Higgs measurements from CMS and ATLAS

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The standard model (SM) of particle physics is a widely successful theoretical model, as it agrees with the vast majority of measurements in particle physics. However, the SM is not able to explain certain physical observations, leaving it unable to answer some open questions in particle physics. Among the particles predicted by the SM is the Higgs boson: a fundamental scalar boson, central to the SM and many of its predicted interactions. Because the Higgs interacts with most SM particles either directly or indirectly, it is an excellent tool for simultaneously validating the SM, and probing for physics beyond the SM (BSM). This motivates a substantial Higgs physics program at the ATLAS and CMS detectors based at the Large Hadron Collider (LHC) in Geneva, Switzerland. This talk will cover recent Higgs measurements from the ATLAS and CMS collaboration from Runs 2 and 3 of the LHC, and their comparisons to SM predictions.

Plenary Session / **103**

Precision EWK and QCD measurements from ATLAS, CMS, LHCb

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This talk will highlight the latest results from CMS, ATLAS, and LHCb on precision electroweak measurements, including the W boson mass, sin2thetaW, and the g-2 from tau leptons, as well as recent determinations of the strong coupling constant, alphaS, in quantum chromodynamics (QCD).

Plenary Session / **106**

Announcement of PIC2025

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Plenary Session / **107**

Closing remarks and Farewell on behalf of the IAC and LOC

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Plenary Session / **108**

Run-2/3 measurement of the muon anomalous magnetic moment by the Muon g-2 experiment at Fermilab

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The Muon g-2 experiment at Fermilab seeks to measure the muon magnetic moment anomaly, $a_\mu = (g-2)/2$, with a final target precision of 0.14 parts per million (ppm). The experiment's initial result, published in 2021 using Run-1 data from 2018, confirmed the previous measurement at Brookhaven National Laboratory with a comparable sensitivity of 0.46 ppm. In 2023, new results from Run-2 and Run-3, based on data collected in 2019 and 2020, were released. These datasets contain four times the data from Run-1, significantly enhancing sensitivity and achieving an unprecedented uncertainty of 0.20 ppm. This advancement resulted in a two-fold improvement in both statistical and systematic uncertainties. In this talk, we will discuss the increased precision relative to the Run-1 result, provide an outlook on future measurements, and highlight the projected uncertainties for the final analysis, which will incorporate datasets from 2021 to 2023. Additionally, we will explore the implications of comparing the new measurements with the latest Standard Model predictions for muon g-2.

Plenary Session / **109**

Charm: Rare, CPV, Mixing

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LHCb has collected the world's largest sample of charmed hadrons. This sample is used to search for charm rare decays and to measure *CP* violation and the $D^0 - \overline{D}^0$ mixing. New measurements of several decay modes are presented, along with prospects for the sensitivity at the LHCb upgrades.

Plenary Session / **110**

Light QCD exotics at BESIII

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Charmonium decays offer a promising hunting ground for the investigation of light QCD exotics, particularly gluonic excitations such as glueballs and hybrids. These particles are expected to be copiously produced in the gluon-rich environment characteristic of charmonium decays. In this talk, we will report on the discovery of a glueball-like state, X(2370). Additionally, we will present recent advancements in the study of spin-exotic 1-+ states, eta(1855) and pi1(1600). Furthermore, the observation of the anomalous shape of X(1840) in J/psi->gamma 3(pi+pi-) will be presented as well.

Plenary Session / **111**

Direct dark matter searches: recent results and prospects

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The nature of Dark Matter is one of modern physics' most intriguing mysteries. Direct search experiments aim to reveal its secret by studying its potential interactions with "visible" matter. This talk will overview the experimental landscape, focusing on promising Dark Matter candidates investigated in labs. In line with the theme of "physics in collision," it will highlight the search for Weakly Interacting Massive Particles (WIMPs) and other particles that might collide with detector media. I will present recent findings from noble gas time projection chambers, with a focus on the XENONnT experiment, and briefly discuss future detectors and their potential to advance our understanding.

Plenary Session / **113**

Neutrinos at the LHC

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Two neutrino detectors have been in operation at the LHC interaction point 1 since the start of Run 3 in 2022. The SND@LHC and FASER experiments perform measurements with neutrinos produced at the LHC. These are the highest-energy human-made neutrinos and they are produced in a hitherto unexplored pseudo-rapidity range, inaccessible to other LHC experiments. Their configurations allow efficiently distinguishing between all three neutrino flavours, opening a unique opportunity to probe physics of heavy flavour production at the LHC, as well as measuring TeV scale neutrino cross sections and test lepton flavour universality. This talk will focus on the results obtained by the experiments with the first two years of data taking at the LHC, as well as the plans for the high-luminosity phase of the collider.

Plenary Session / **114**

High-statistics B decays

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LHCb and Belle II are two frontier experiments in flavor physics that operate at the complementary setting of proton-proton and electron-positron collisions, respectively. We report new results from these experiments on the angles of the CKM Unitarity Triangle and the anomalies surrounding decays mediated by b-to-c tree-level transitions.