8th International Conference on High Energy Physics in the LHC Era

Monday 9 January 2023 - Friday 13 January 2023

Universidad Técnica Federico Santa María

Book of Abstracts

Contents

Plenary session Monday Morning 1 / 387

Opening talk

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Plenary session Monday Morning 1 / 361

Recent Advances in Soft-Collinear Effective Theory for Collider and Flavor Physics

Author: Matthias Neubert[None]

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I will review recent advances in soft-collinear effective theory, focussing on two frontiers: The derivation of factorization theorems beyond the leading order in the power expansion, and the establishment of a factorization theorem for jet processes at hadron colliders. The main challenge in the first case concerns the treatment of endpoint-divergent convolution integrals, which arise when factorization is applied at next-to-leading power in scale ratios. In the second case, so-called "super-leading logarithms"arise in higher orders of perturbation theory, whose resumption has now been accomplished for the first time, 16 years after their discovery. As concrete examples, I will discuss applications in Higgs physics and rare decays of B mesons.

Plenary session Monday Morning 1 / 293

Highlights of the Pierre Auger Observatory

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The Pierre Auger Observatory, located near Malargüe in the Argentinian province of Mendoza, is the world's largest cosmic ray detector ever built. In operation since 2004, the Pierre Auger Collaboration has published more than a hundred scientific papers covering a wide range of topics regarding the detection, origin, and nature of the most energetic particles of the Universe. In this contribution, we will present our latest results concerning the new feature of the cosmic ray spectrum for energies above 2.5×1018 eV, the anisotropy in the arrival directions of ultrahigh-energy cosmic rays, the determination of the nuclear mass composition, and the measurements of the muon content of extensive air showers. We will also show our results on the searches for ultrahigh-energy photons and neutrinos and our multimessenger studies. Finally, we will describe AugerPrime, the major upgrade of the Pierre Auger Observatory currently underway.

Plenary session Monday Morning 1 / 390

Exclusive physics at JLAB: Overview

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Plenary Session Monday Morning 2 / 391

Overview of Physics results at ATLAS

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Plenary Session Monday Morning 2 / 329

A review of open heavy flavor and quarkonia production measured by STAR and PHENIX Collaborations at RHIC.

Corresponding Author: sonja.kabana@cern.ch

A review of open heavy flavor and quarkonia production measured by STAR and PHENIX Collaborations at RHIC.

Plenary Session Monday Morning 2 / 330

Fragmentation of heavy flavors in a hot environment

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Heavy flavored mesons produced with high [illegible] in heavy ion collisions collisions, reveal several specific features of the production mechanism:
(i) short time of jet formation by a highly virtual heavy quark;
(ii) enhancement of the fragmentation function at large fractional momenta of the heavy meson;
(iii) extremely short time of color neutralization and formation of the heavy flavored meson wave function;
(iv) short mean free path in the medium (no color transparency); (v) the dead-cone effect in gluon radiation, and smallness of the QCD coupling lead to a considerable reduction of the rate of broadening (transport coefficient) of heavy vs light quarks. Non-universality of [illegible] is confirmed by data, which are well described.

Plenary session Monday Afternoon 1 / 327

T2K Results and Plans

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Plenary session Monday Afternoon 1 / 325

Dark Matter from Dark QED

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In this talk, I will present a few novel aspects of dark matter phenomenology, using for illustrative purpose Dark QED, a hidden sector (HS) toy model with fermionic DM interacting with a massive dark photon. I will first discuss a production mechanism valid if the HS interact with the Standard Model with a feeble kinetic mixing parameter. The production mechanism is called sequential freeze-in and is a generalization of freeze-in, but proceeding in two steps, first the production of off-equilibrium dark photons which then produce DM. Next, I will discuss a mapping of thermal DM candidates in the plane T'/T vs mDM, where T'is the temperature of the HS and T that of the Standard Model particles. I will conclude with a brief possible alternative history of the early universe, in which the expansion is dominated by a hot HS.

Plenary session Monday Afternoon 1 / 242

Direct Detection of sub-MeV Dark Matter

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Conventional semiconductor detectors used for light dark matter detection via ionization signals lose sensitivity for dark matter masses below an MeV, for which the energy deposited in a scattering event falls below the bandgap. We propose to overcome this limitation by introducing dopants in the semiconductor target. Dopants have ionization energies that lie orders of magnitude below typical semiconductor bandgaps, and can be used to design detectors with tens of meV thresholds. We show that a doped semiconductor detector has the potential to probe dark matter with masses as small as tens of keV via scattering with electrons, or as small as tens of meV via absorption. In particular, we show that such a detector could test the entire parameter space of sub-MeV dark matter produced via freeze-in, and probe wide regions of parameter space of dark-photon dark matter.

Plenary session Monday Afternoon 2 / 287

Monopoles, Strings and Gravitational Waves

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A variety of interesting topological objects arise in spontaneously broken unified theories. They include monopoles and strings as well as more complex structures with cosmological implications. This talk will focus on magnetic monopoles, cosmic strings and gravitational waves radiated by the latter.

Plenary session Monday Afternoon 2 / 332

Dark photon superradiance: Electrodynamics and multimessenger signals

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Black hole superradiance is a unique mechanism that allows a large cloud of ultralight bosons to grow around spinning black holes, requiring only gravitational interactions. I will focus on superradiance of vector fields around stellar mass black holes and consider a dark photon that kinetically mixes with the Standard Model photon. The dark photon superradiance cloud sources a rotating electromagnetic field around the black hole and initiates a transient phase of electron-positron pair production that populates a plasma inside the cloud. I will discuss the electrodynamics of the system, which shares qualitative features with a neutron star pulsar magnetosphere, and identify the main sources of dissipation and electromagnetic emissions. The result is a new type of very luminous source, comparable to the brightest X-ray sources on the sky, with several unique features that can be looked for with existing and future telescopes. Observational strategies will be presented and include targeted electromagnetic follow-ups of solar-mass black hole mergers and targeted continuous gravitational wave searches of anomalous pulsars.

Plenary session Tuesday Morning 1 / 236

Fully Coherent Energy Loss: from collider to cosmic ray energies

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In high-energy proton-nucleus (pA) collisions, an incoming energetic parton crosses the target nucleus and suffers medium-induced, fully coherent gluon radiation. I will briefly review the theoretical status of this effect, and present the phenomenological consequences of the corresponding fully coherent energy loss (FCEL) on hadron production in pA collisions at the LHC, and on the atmospheric neutrino fluxes induced by semileptonic decays of hadrons produced in the collisions of cosmic rays with light nuclei of the atmosphere.

Plenary session Tuesday Morning 1 / 336

CMS overview Talk

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An overview of selected recent results in heavy-ion collisions from the CMS experiment.

Plenary session Tuesday Morning 1 / 302

Centrality vs event activity in small-on-large collisions

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Determining the collision geometry event-by-event from experimental observables is important in the quantitative study of initial and final state (medium) effects in relativistic heavy ion collisions. When two large ions collide, the mapping between true impact parameter (centrality) and the observable event activity via the Glauber-model is straightforward and uncontroversial. This is true even in events where a hard collision occured and high PT jets were produced, The situation is quite different in so-called small systems (like p+Pb, p+Au, d+Au, 3He+Au). We will discuss data and various models that attempted to explain some controversial results on nuclear modification factors of jets and hadrons, demonstrate the importance of electroweak probes, that are unaffected by the final state (medium) and show how can they be used to derive a purely experimental number of binary collisions. Finally we discuss how the system-size dependence of photon/hadron ratios can differentiate between energy conservation, initial state or possible residual final state effects on the measured nuclear modification factors.

Plenary session Tuesday Morning 2 / 318

S3 as a modular symmetry: consequences in the quark and Higgs sectors

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An open problem in the Standard Model relates to the origin of the mass hierarchy among fermions, and its mixing. Different alternatives have been proposed by adding extra symmetries that relate the three generations of fermions and by extending the Higgs sector. In particular, it has been shown that the S3 symmetry has given good results if two extra Higgs doublets are added to the Standard Model, giving a total of 3 Higgs doublets. The analysis of the scalar invariant potential of S3 was shown to be compatible with the known experimental results on Higgs physics, and to give interesting predictions that can be tested in the LHC pertaining the extra scalar bosons, besides providing one or more candidates to dark matter. However, when taking into account the minimization conditions of the Higgs potential, the resulting VCKM matrix exhibits a residual symmetry with zeros in some entries. Following the success of S3 with 3 Higgs doublets, an extension of the Standard Model is proposed by means of the same group, but obtained from a modular symmetry. A proper assignment of the quark and Higgs fields in S3 and their modular weights allows to write a mass matrix with texture zeroes. By evaluating the modular weights in their symmetric points, and using the results of the minimization of the scalar potential, a VCKM mixing matrix with no zero entries but few free parameters, can be constructed. A likelihood analysis from the theoretical expressions for the mixing matrix is then performed via a χ2 analysis, giving very good agreement with experimental data. On the other hand, with an appropriate assignment of modular weights, the Higgs sector remains unchanged as compared to the usual S3-3H model, and thus the interesting results in this sector are maintained.

Plenary session Tuesday Morning 2 / 130

Nucleon Structure Functions at Large x

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Parton distribution functions at high momentum fraction x continue to be of high interest. On the one hand, they can test predictions from models, effective theories and pQCD in the valence region, where most of the nucleon momentum is carried by a single quark. On the other hand, PDFs at high x and moderate Q2 are linked, via DGLAP evolution, to moderate x and high Q2 kinematics relevant for high-energy colliders like the Tevatron and LHC. In my talk, I will present our current knowledge of both unpolarized and polarized nucleon structure functions in this kinematic region. I will then discuss ongoing and planned experiment at Jefferson Lab that will dramatically improve our understanding of the flavor and spin structure of the nucleon as $x \to 1$.

ACKNOWLEDGMENTS
This work is supported by the Department of Energy under Contract DE-FG02-96ER40960

Plenary session Tuesday Morning 2 / 341

QED Corrections to Azimuthal Asymmetries of SIDIS Cross sections

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We analyze an impact of QED corrections on observables of semi-inclusive deep-inelastic scattering (SIDIS) of electrons and muons on a proton target. It is shown that both the radiative effects and two-photon exchange generate new azimuthal dependent-terms and corresponding ⊠⊠⊠(⊠⊠) moments. A quark-diquark model of a nucleon was used in the calculations of two-photon effects which appear to be essential for both the magnitude and transverse-momentum dependence of ⊠⊠⊠(⊠) and ⊠⊠⊠(2⊠) moments.

Plenary session Tuesday Morning 2 / 405

GlueX –looking for exotic mesons with polarized photons

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Parallel session B / 165

ATLAS results in hadron spectroscopy and production

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The ATLAS experiment has investigated strong force dynamics via searches for exotic hadron states and measurements of production rates. Studies of potential pentaquark and tetraquark candidates will be discussed, as will measurements of charmonium and B hadron differential cross sections.

Parallel session A / 162

A renormalizable left-right symmetric model with low scale seesaw mechanisms

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I will describe a low scale renormalizable extended left-right symmetric theory where the observed SM fermion mass hierarchy arises from a seesaw-like mechanism and the light active neutrino masses are generated from a radiative inverse seesaw. I will discuss its implications in charged lepton flavour violation, in the lepton and baryon asymmetries of the Universe, in the muon and electron anomalous magnetic moments as well as the constraints arising from the Higgs diphoton decay rate and meson oscillations. I will also discuss the Z'and heavy scalar production at a proton-proton collider.

Parallel session C / 169

Study of high-energy hadronic interactions with the Pierre Auger Observatory

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The Pierre Auger Observatory is the largest facility in the world to observe ultra-high-energy cosmic rays. Its hybrid detection technique combines the observation of the longitudinal development of the shower in the atmosphere and the measurement of the lateral distribution of particles that arrive at the ground. This has allowed the Auger Collaboration to test hadronic interactions that occur at energies well beyond those accessible by human-made accelerators. The proton-air inelastic cross section for particle interactions was measured and post-LHC hadronic interaction models were probed by means of correlations between different air shower observables. In this contribution, we review the tension between model predictions and data from the muonic component of air showers from the Pierre Auger Observatory, over three decades at the highest energies.

Parallel session A / 16

Supersymmetry in the adjoint representation of the conformal superalgebra

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We present a model based on an implementation of supersymmetry where matter fields are in the adjoint representation. We will discuss some of the details of the construction. We present a GUT model based on the conformal superalgebra. We present exact black-hole solutions, gravitating spinor solutions and non-trivial gauge configurations. We discuss the issue of anomalies in the context of GUT models.

Parallel session B / 166

Lepton Flavour Universality tests using semileptonic b-hadron decays

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According to SM, the electroweak bosons couple to the three lepton families with the same strength, the only difference in their behaviour being due to the difference in mass. In recent years, some deviations from the SM predictions have been observed in $b \to c\ell\nu\ell$ transitions. These measurements have been made by calculating R-values, which represent the ratio of branching fractions for b decays into different lepton flavours. These semileptonic measurements are ideally suited to study the weak interaction and the effects of the strong interaction in B-meson decays. In particular, decays involving a τ- lepton are sensitive to new physics and provide insight into third-generation physics. In this talk, we present results from lepton universality tests in $b \to c\ell\nu\ell$ decays at LHCb.

Parallel session C / 172

Anisotropy studies of the arrival directions of cosmic rays at the highest energies with the Pierre Auger Observatory

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The distribution of arrival directions of high-energy cosmic rays carries major clues to understanding their origin. The Pierre Auger Observatory, the largest cosmic-ray observatory in the world, collected an unprecedentedly large data set over 17 years of operation. In this work, we describe anisotropy-related results obtained by using such events. These are the large-scale searches in the arrival direction of events detected with energies above 4 EeV and the analysis of arrival directions of the highest-energy events exceeding 32 EeV. A remarkable dipolar modulation in right ascension for energies above 8 EeV is observed, as previously reported, with a statistical significance of 6.6σ as well as evidence of anisotropy at intermediate angular scale with ~15∘ Gaussian spread at 4σ significance level for cosmic-ray energies above ~40 EeV.

Parallel session A / 161

Searches for leptoquarks with the ATLAS detector

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Leptoquarks are predicted by many new physics theories to describe the similarities between the lepton and quark sectors of the Standard Model and offer an attractive potential explanation for the B-physics anomalies observed at LHCb and flavour factories. The ATLAS experiment has a broad program of direct searches for leptoquarks, coupling to the first-, second- or third-generation particles. 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.

Parallel session B / 167

Latest results from Kaon experiments at CERN

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An overview of the latest NA62 results and the future prospect of the experiment are presented. The NA62 experiment at CERN collected the world's largest dataset of charged kaon decays in 2016-2018, leading to the first measurement of the branching ratio of the ultra-rare □+→□+□□̄ decay, based on 20 candidates.
The radiative kaon decay □+→□0□+□□ (Ke3g) was studied with a data sample of O(100k) Ke3g candidates with sub-percent background contaminations recorded in 2017-2018. The most precise measurements of the branching ratio and of T-asymmetry are achieved.
An analysis of the flavour-changing neutral current □+→□+□+□− decay, based on about 27k signal events with negligible background contamination collected in 2017 and 2018 with a dedicated pre-scaled di-muon trigger, leads to the most precise determination of the branching ratio and of the form factor.
New preliminary results are obtained from an analysis of the □+→□+□□ decay using data collected in 2016-2018 with a minimum-bias trigger. The sample, about 15 times larger than the previous largest one, leads to an unprecedented sensitivity. This analysis can be naturally extended to search for the □+→□, □→□□ process, where a is a short-lived axion-like particle.
Dedicated trigger lines were employed to collect di-lepton final states, which allowed establishing new stringent upper limits on the rates of lepton flavour and lepton number violating kaon decays.
NA62 can also be run as a beam-dump experiment, by removing the kaon production target and moving the upstream collimators into a "closed"position. Analyses of the data taken in beam-dump mode were performed to search for visible decays of exotic mediators, with a particular emphasis on Dark Photon models.
The first observation of the decay □±→□0□0□±□ (K00μ4) by the NA48/2 experiment at the CERN

and the preliminary measurement of the branching ratio are also presented. The result is converted into a first measurement of the R form factor in Kl4 decays and compared with the prediction from 1-loop Chiral Perturbation Theory.

Parallel session C / 170

Search for dark photons in heavy-ion collisions

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Search for the dark matter (DM) candidates is one of the growing direction of the experimental and theoretical research in heavy-ion physics [1]. The vector ⊠-bosons, or so called 'dark photons', are one of the possible candidates for the dark matter mediators. They are supposed to interact with the standard matter via a 'vector portal' due to the ⊠(1)−⊠(1)′ symmetry group mixing which might make them visible in particle and heavy-ion experiments. While there is no confirmed observation of dark photons, the detailed analysis of different experimental data allows to estimate the upper limit for the kinetic mixing parameter ⊠2 depending on the mass ⊠⊠ of ⊠-bosons which is also unknown.

In Ref. [2] we have introduced a procedure to define theoretical constraints on the upper limit of ⊠2(⊠⊠) from heavy-ion (as well as ⊠+⊠ and ⊠+⊠) dilepton data. Our analysis is based on the microscopic Parton-Hadron-String Dynamics (PHSD) transport approach which reproduces well the measured dilepton spectra in ⊠+⊠, ⊠+⊠ and ⊠+⊠ collisions. Additionally to the different dilepton channels originating from interactions and decays of ordinary (Standard Model) matter particles (mesons and baryons), we incorporate in the microscopic transport approach - for the first time - the decay of hypothetical ⊠-bosons to dileptons, ⊠⟶⊠+⊠−, where the ⊠-bosons themselves are produced by the Dalitz decay of pions ⊠0⟶⊠⊠, ⊠-mesons ⊠⟶⊠⊠ and Delta resonances Δ⟶⊠⊠.

Using the fact that dark photons are not observed in dilepton experiments so far one can require that their contribution can not exceed some limit which would make them visible in experimental data. By varying the parameter ⊠2(⊠⊠) in the model calculations, one can obtain upper constraints on ⊠2(⊠⊠) based on pure theoretical results for dilepton spectra under the constraint that the 'surplus' of the DM contribution doesn't overshine the SM contributions (which is equivalent to the measured dilepton spectra) with any requested accuracy. We confront our results with the analysis from the HADES Collaboration \cite{HADES:2013nab} at SIS18 energies where the dark photons are not observed as well as with the world data collection, including the LHC experimental results.

Our theoretical analysis can help to estimate the requested accuracy for future experimental searches of 'light' dark photons by dilepton experiments. Moreover, the extension of our procedure to other dark matter candidates - as axions - is foreseen.

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Parallel session B / 168

J/psi production at NLO + timelike parton shower

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We discuss the behavior of the Jpsi transverse-momentum distribution in the color evaporation

model (CEM) at NLO. Our calculations use transverse-momentum-dependent PDFs and include a timelike parton shower. The latter solves the issue of the too-hard spectrum at NLO in the CEM. Finally, we will present the consequence of the present study for the NRQCD's LDME.

Parallel session C / 173

Dark sector of an extended 2HDM with Q4 symmetric matter

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We describe the phenomenology of the scalar and dark matter sectors of an extended 2HDM with Q4 symmetry among the SM fermions. The model features a Higgs portal to a dark sector comprised of heavy right handed neutrinos. We discuss relic abundance as well as direct detection constraints on the DM candidate.

Parallel session A / 363

RGE in semileptonic decays of mesons

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Parallel session C / 171

Searches for Dark Matter with the ATLAS Experiment at the LHC

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The presence of a non-baryonic Dark Matter (DM) component in the Universe is inferred from the observation of its gravitational interaction. If Dark Matter interacts weakly with the Standard Model (SM) it could be produced at the LHC. The ATLAS Collaboration has developed a broad search program for DM candidates in final states with large missing transverse momentum produced in association with other SM particles (light and heavy quarks, photons, Z and H bosons, as well as additional heavy scalar particles) and searches where the Higgs boson provides a portal to Dark Matter, leading to invisible Higgs decays. The results of recent searches on 13 TeV pp data from the LHC, their interplay and interpretation will be presented.

Parallel session B / 174

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

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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 for flavour- changing-neutral-current interactions of the top quark, that are heavily suppressed in the SM. In this contribution the highlights of the ATLAS top quark physics program are presented. ATLAS presents in particular new measurements of the production cross section and production asymmetries in different tt+X final states as well as new measurements of top quark properties. The recent observation of associated production of a single top quark with a photon completes the list of processes and adds sensitivity to the electroweak couplings of the top quark. A first look into top production in Run 3 data is also given. ATLAS furthermore reports strong evidence for the four-top-production process. Strict bounds are also presented of searches for flavour-changing-neutral-current processes involving top quarks.

Parallel session A / 176

Searches for resonances decaying to pairs of heavy bosons in ATLAS

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Many new physics models predict the existence of resonances decaying into two bosons (W, Z, photon, or Higgs bosons) making these important signatures in the search for new physics. Searches for Vγ, VV, and VH resonances have been performed in various final states. In some of these searches, jet substructure techniques are used to disentangle the hadronic decay products in highly boosted configurations. This talk summarises recent ATLAS searches with Run 2 data collected at the LHC and explains the experimental methods used, including vector- and Higgs-boson-tagging techniques.

Parallel session A / 175

Searches for supersymmetric particles with prompt decays with with the ATLAS detector

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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. This talk will present the latest results from SUSY searches conducted by the ATLAS experiment. The searches target multiple final states and different assumptions about the decay mode of the produced SUSY particles, including searches for both R-parity conserving models and R-parity violating models and their possible connections with the recent observation of the favour and muon g-2 anomalies. The talk will also highlight the employment of novel analysis techniques, including advanced machine learning techniques and special object reconstruction, that are necessary for many of these analyses to extend the sensitivity reach to challenging regions of the phase space.

Parallel session B / 180

The LHC Run II top quark data legacy on global PDF and SMEFT analyses

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We assess the impact of the full luminosity LHC Run II top quark measurements on global PDF and SMEFT analyses as well as on their mutual interplay. Starting from the widest LHC top quark dataset considered to date, we first assess the constraints it provides on the gluon PDF in the NNPDF4.0 framework and study its consistency with other gluon-sensitive measurements. We then carry out an extensive SMEFT interpretation of the same dataset to provide bounds on more than 20 Wilson coefficients, demonstrating the significant new information provided by Run II measurements. Subsequently we combine the two analyses within the SIMUnet approach to achieve a simultaneous extraction of the SMEFT PDFs and the Wilson coefficients from the LHC Run II top quark data and identify the regions of the parameter space where their interplay is most phenomenologically relevant. We also propose strategies to separate EFT corrections from QCD effects in the interpretation of the LHC top quark data.

Parallel Session D / 200

ATLAS ITk Pixel Detector Overview

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In the high-luminosity era of the Large Hadron Collider, the instantaneous luminosity is expected to reach unprecedented values, resulting in up to 200 proton-proton interactions in a typical bunch crossing. To cope with the resulting increase in occupancy, bandwidth and radiation damage, the ATLAS Inner Detector will be replaced by an all-silicon system, the Inner Tracker (ITk). The innermost part of the ITk will consist of a pixel detector, with an active area of about 13 m2. To deal with the changing requirements in terms of radiation hardness, power dissipation and production yield, several silicon sensor technologies will be employed in the five barrel and endcap layers. Prototype modules assembled with RD53A readout chips have been built to evaluate their production rate. Irradiation campaigns were done to evaluate their thermal and electrical performance before and after irradiation. A new powering scheme –serial –will be employed in the ITk pixel detector, helping to reduce the material budget of the detector as well as power dissipation. This contribution presents the status of the ITk-pixel project focusing on the lessons learned and the biggest challenges towards production, from mechanics structures to sensors, and it will summarize the latest results on closest-to-real demonstrators built using module, electric and cooling services prototypes.

Parallel session A / 177

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

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Various theories beyond the Standard Model predict new, long-lived particles with unique signatures which are difficult to reconstruct and for which estimating the background rates is also a challenge. Signatures from displaced and/or delayed decays anywhere from the inner detector to the muon spectrometer, as well as those of new particles with fractional or multiple values of the charge of the electron or high mass stable charged particles are all examples of experimentally demanding signatures. The talk will focus on the most recent results using 13 TeV pp collision data collected by the ATLAS detector.

Parallel session B / 181

Exclusive photoproduction of quarkonia pairs as a probe of gluon GPDs.

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In this talk we analyze exclusive photoproduction of heavy quarkonia pairs in the kinematics of moderate values of Bjorken variable ⊠⊠. We discuss the relation of various observables to gluonic generalized parton distributions (GPDs) of the target. We demonstrate that the largest cross-section has exclusive production of ⊠/⊠⊠⊠ pairs, which gets the dominant contribution from the unpolarized gluon GPDs ⊠⊠, ⊠⊠. We provide numerical estimates for the cross-section in the kinematics of the future Electron Ion Collider.

Parallel Session D / 369

Bent crystal extraction from lepton storage rings: the SHERPA experiment

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The SHERPA ("Slow High-efficiency Extraction from Ring Positron Accelerator") project aim is to develop an efficient technique to extract a positron beam from one of the accelerator rings composing the DAΦNE accelerator complex at the Frascati National Laboratory of INFN, setting up a new beam line able to deliver positron spills of O(ms) length, excellent beam energy spread and emittance.
The most common approach to slowly extract from a ring is to increase betatron oscillations approaching a tune resonance in order to gradually eject particles from the circulating beam.
SHERPA proposes a paradigm change using coherent processes in bent crystals to kick out positrons from the ring, a cheaper and less complex alternative [1]. This non-resonant technique, already successfully used and still developed mainly in hadron accelerators, will provide a continuous multi-turn extraction of a high quality beam [2, 3, 4, 5].
Realizing this for sub-GeV leptons is challenging, however would provide the world's first primary positron beam obtained with crystal extraction. An immediate application of this new extracted beam line would be the PADME ("Positron Annihilation into Dark Matter Experiment") experiment [6], currently strongly limited by the duty cycle. Using the proposed extraction, PADME could increase the statistics by a factor 104 and its sensitivity by a factor 102.
This technology can be applied in general for both negative and positive leptons, including muons, providing a know how that can be applied for several accelerating machine aspects in the next future, as collimation, extraction and beam splitting, contributing to a general improvement in the particle accelerator field.
In the talk will be given an overview of the whole experiment, describing in particular the crystal extraction principle, the accelerator optics studies [7], the crystal prototype and the characterization apparatus. Simulation and experimental results will be reported, together with new future applications.

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Parallel session B / 182

ATLAS results on weak decays of B mesons

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The ATLAS experiment is able to probe potential beyond the Standard Model physics by performing precise measurements of B meson decays. In particular this talk will highlight the branching fractions of rare decays B_s and B -> mu mu and CP violation in B_s -> J/psi phi, which can both be altered by new physics.

Parallel Session D / 370

Redefining Performance: New Techniques for ATLAS Jet & MET Calibration

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Experimental uncertainties related to hadronic object reconstruction can limit the precision of physics analyses at the LHC, and so improvements in performance have the potential to broadly increase the impact of results. Recent refinements to reconstruction and calibration procedures for ATLAS jets and MET result in reduced uncertainties, improved pileup stability and other performance gains. In this contribution, selected highlights of these developments will be presented.

Parallel session A / 448

Radiative neutrino masses

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I will present two models where light active neutrino masses are radiatively generated. In the first one the light active neutrino masses are generated at one loop level via a radiative seesaw mechanism mediated by the neutral components of the SU(3)L leptonic Octet and electrically neutral scalars. These SU(3)L leptonic Octet is crucial for achieving successful gauge coupling unification. The second theory is a minimally extended inert doublet model where the tiny neutrino masses are generated through a three-loop seesaw. The model leads to a rich phenomenology while satisfying all the current constraints imposed by neutrinoless double-beta decay, charged-lepton flavor violation, and electroweak precision observables. The model could also successfully explain the W mass anomaly and provides viable fermionic or scalar dark matter candidates.

Parallel session B / 183

Observation of new structures in the J/ψJ/ψ mass spectrum in pp collisions at s√=13 TeV

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A search is reported for low-mass structures in the J/ψJ/ψ mass spectrum produced by proton-proton collisions at s√=13TeV. The data sample corresponds to an integrated luminosity of 135 fb−1 collected by the CMS experiment at the LHC. Modelling signals with relativistic Breit-Wigner shapes, and under the assumption of the absence of interference between signal components, and between signal

and background, three structures are identified. Two structures are observed with local significances well above 5 standard deviations at masses of 6927±9(stat)±5(syst)MeV and 6552±10(stat)±12(syst)MeV. The first one is consistent with the previously observed X(6900). Evidence for a third structure is found at a mass of 7287±19(stat)±5(syst)MeV with a local significance of 4.1 standard deviations.

Parallel Session D / 371

Depth sensing for automatic detector construction and quality control

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The LHC at CERN will soon be upgraded to the high-luminosity LHC (HL-LHC) that will deliver larger scattering rates. Along with the increased data rate, the HL-LHC will produce a more challenging environment that current detectors used in CMS cannot cope with. To address this issue, a new calorimeter will be built and used to measure the energy of particles. The TTU HEP group is responsible for building roughly 5 thousand silicon modules for the new CMS calorimeter. This work involves laminating components with high precision alignment and bonding around 700 wires per module. Performing quality control tests of mechanics, sensors, and electronics is key to producing high-performance detectors. Manual inspection is not practical and together with the limited timelines it intensifies the assembly and quality control work generating a need for robust and efficient automation tools. We developed a high precision automatic depth sensing algorithm, which is incredibly useful for integration of the assembly and quality control protocols in a single robot, since it only requires a camera, making the process faster and more efficient. Other methods such as stereo vision are needed while working with a larger field of view. For this method object recognition is necessary so the robot knows the location of its points of reference. Machine Learning tools are being developed in the context of quality control, object detection and depth sensing so that these tasks can be performed by the same instrument in an efficient way.

Parallel session A / 447

Revisiting the scotogenic model with scalar dark matter

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There are many models trying to explain some of the main current questions in physics. The scotogenic model presents both an explanation to neutrino masses and provides a dark matter candidate that can be a scalar or a fermion. In this work we focus on a real scalar as the dark matter candidate which is generated in a thermal freeze-out scenario. We study the parameter space of the model contrasting our results with the most recent signatures presented by the experiments for dark matter relic abundance, direct and indirect detection. We find regions in the parameter space that explain the total dark matter abundance below 500 GeV for the mass of the dark matter that are correlated with the presence of long-lived particle signals at colliders and we discuss different signatures for its detection.

Plenary session Wednesday Morning 1 / 89

Status of SND@LHC

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SND@LHC is a compact and stand-alone experiment to perform measurements with neutrinos produced at the LHC in a hitherto unexplored pseudo-rapidity region of 7.2 < ⊠ < 8.6, complementary to all the other experiments at the LHC. The experiment is located 480 m downstream of IP1 in the unused TI18 tunnel. The detector is composed of a hybrid system based on an 800 kg target mass of tungsten plates, interleaved with emulsion and electronic trackers, followed downstream by a calorimeter and a muon system. The configuration allows efficiently distinguishing between all three neutrino flavours, opening a unique opportunity to probe physics of heavy flavour production at the LHC in the region that is not accessible to ATLAS, CMS and LHCb. This region is of particular interest also for future circular colliders and for predictions of very high-energy atmospheric neutrinos. The detector concept is also well suited to searching for Feebly Interacting Particles via signatures of scattering in the detector target. The first phase aims at operating the detector throughout LHC Run 3 to collect a total of 290 fb−1. The experiment was recently installed in the TI18 tunnel at CERN and has seen its first data. A new era of collider neutrino physics is just starting.

Plenary session Wednesday Morning 1 / 296

Direct Detection of Dark Matter at SNOLAB

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The SNOLAB laboratory is two kilometers underground in Sudbury, Ontario, Canada. I will describe the overall scientific program with emphasis on the experiments focused on the direct detection of dark matter, one of the primary scientific thrusts at SNOLAB. There are currently eight active dark matter experiments running, in design, or in construction: SuperCDMS, PICO-40, PICO-500, DEAP-3600, DAMIC, SENSEI, OSCURA, and NEWS-G. I will include short descriptions of the technology and status of these projects.

Plenary session Wednesday Morning 1 / 347

PHENIX overview

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The wealth of data and an optimized detector configuration has enabled PHENIX to perform an extensive study on the evolution of medium effects from small to large systems. An insight into the properties of Quark-Gluon Plasma (QGP) is obtained through detailed measurements of the direct photons, ⊠0-hadron correlation, non-photonic electrons, and ⊠/⊠ flow with a large statistics of data collected in 2014. A search for droplets of QGP in small system collisions continue with the measurements of collective flow, modification of light hadron and quarkonia production, and jet substructure. In this talk, we will report the recent results from the PHENIX experiment from various collision systems.

Plenary session Wednesday Morning 2 / 352

Overview of the LHCb experiment

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Plenary session Wednesday Morning 2 / 419

A new Microscopic Model for J/ψ Production in Heavy Ion Collisions

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The experimental observation ofJ/ψ and Bc mesons multiplicities, distributions and azimuthal flows plays a key role in understanding the properties of the quark gluon plasma (QGP) which is formed in ultra relativistic heavy ion collisions. This is due to the fact that the heavy quarks can come from different vertices in the initial stage and that the J/ψ are not stable when the QGP is produced with a temperature above the J/ψ dissociation temperature while resonant states can be achieved before the transition to the hadronic phase, offering the possibility to probe directly these high temperatures. In our recently developed approach [1], the hidden heavy flavor mesons production rate is described by solving the von Neumann equation of the two body density matrix in the expanding N-body system, following a method introduced by Remler et al. to predict deuteron production in HIC at lower energies [2]. In this formalism, the rate of mesons formation is based on the semi-classical trajectories of c and b quarks, what naturally encodes possible off-equilibrium effects of these quarks.The trajectories are based on the description of the expanding QGP by the EPOS event generator, supplemented by the Nantes energy loss model which have demonstrated successful agreement with the data for open heavy flavor mesons.This allows for the prediction of the hidden heavy flavor observables (J/ψ and Bc) which are confronted with the experimental results on multiplicity, RAA and v2. We discuss what we can learn from the hidden heavy flavor mesons about the expanding QGP, in particular the time at which the mesons appear to be dynamically produced.

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Plenary session Thursday Morning 1 / 351

Vector Dark Matter via a Fermionic Portal from a New Gauge Sector

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We suggest a new class of models - Fermionic Portal Vector Dark Matter (FPVDM) which extends the Standard Model (SM) with SU(2)D dark gauge sector. While FPVDM does not require kinetic mixing and Higgs portal, It is based on the Vector-Like (VL) fermionic doublet which couples the dark sector with the SM sector through the Yukawa interaction. The FPVDM model provides a vector Dark Matter (DM) with Z2 odd parity ensuring its stability. Multiple realizations are allowed depending on the VL partner and scalar potential. The FPVDM realization with only a VL top partner and no mixing between SM and new scalar sectors will be discussed as an example together with its implications for DM direct and indirect detection experiments, relic density and collider searches. The talk is based on 2203.04681 and 2204.03510 arXiv papers.

Plenary session Thursday Morning 1 / 440

SWGO: The Southern Wide-field of view Gamma-ray Observatory

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Abstract:
The Southern Wide-field Gamma-ray Observatory (SWGO) will be a new extensive air shower array in South America for the observation of VHE (very high energy) to UHE (ultra high energy) gamma rays. The SWGO Collaboration is currently engaged in the design work and the site selection towards the construction of this future facility. SWGO will use an array of water Cherenkov-based particle detectors to provide a wide field and high duty cycle view of the southern sky in Gamma Rays, complementing CTA and the existing particle arrays of the Northern Hemisphere, such as HAWC and LHAASO. In this talk, we will give an overview of the status of the project, which has a strong contingent of Latin American participation, with candidate sites in Argentina, Chile, Peru and Bolivia. We will also talk about performance expectations and the science goals of the Observatory.

Plenary session Thursday Morning 1 / 349

Daya Bay talk

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Plenary session Thursday Morning 2 / 94

Diagrammatica: Systematic deconstruction of EFT operators

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The matching of specific new physics scenarios onto the standard model effective field theory (SMEFT) framework is a well-understood procedure. The inverse problem, the matching of the SMEFT to UV scenarios, is more difficult and requires the development of new methods to perform a systematic exploration of models. In this talk I discuss a diagrammatic technique to construct in an automated way a complete set of possible UV models that can produce specific groups of SMEFT operators. The simplest example for an application of these techniques is the Weinberg operator (which yields Majorana neutrino mass models), but the method is much more general. As a demonstration, I will present results of this approach for (d=6) four-fermion operators at 1-loop level.

Plenary session Thursday Morning 2 / 437

Some novel QCD results

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Plenary session Thursday Morning 2 / 297

Probing the non-standard neutrino interactions using quantum statistics

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We present a completely general, model-independent formalism to probe the possible nonstandard couplings of (Dirac and Majorana) neutrinos. The proposed methodology is based on the different quantum statistical properties of the Dirac and Majorana neutrinos which, contrary to neutrinomediated processes of lepton number violation, could lead to observable effects not suppressed by the small ratios of neutrino and heavier particle masses. For processes with a neutrino-antineutrino pair of the same flavor in the final state, we formulate the "Dirac Majorana confusion theorem (DMCT)" showing why it is normally very difficult to observe the different behaviour of both kinds of neutrinos in experiments if they have only the standard model (SM)-like left-handed vector couplings to gauge bosons. We discuss deviations from the confusion theorem in the presence of non-standard neutrino interactions, allowing to discover or constrain such novel couplings. We illustrate the general results with two chosen examples of neutral current processes, Z → ν ν and Pi → Pf ν ν (with Pi,f denoting pseudoscalar mesons, such as B,K,π). Our analysis shows that using 3-body decays the presence of non-standard interactions can not only be constrained but one can also distinguish between Dirac and Majorana neutrino possibilities.

Plenary session Thursday Morning 2 / 356

COMPASS physics programme: highlights and recent results

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Parallel Session E / 377

Neutrino decoupling in standard and non-standard scenarios

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We discuss the phenomenology of neutrino decoupling in the early universe, by summarising the details of the calculation in standard and non-standard scenarios. We present the state-of-the-art calculation of the effective number of neutrino species in the early universe (Neff) in the three-neutrino case, which gives Neff=3.044, and show how the result can change when additional particles (such as sterile neutrinos or decoupled scalar fields) or non-standard cosmological scenarios (low reheating models) are considered. Implications for Big Bang Nucleosynthesis are also briefly discussed.

Parallel Session D / 426

Results from muon reconstruction performance with ATLAS at Run-3

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Muon reconstruction performance plays a crucial role in the precision and sensitivity of the Large Hadron Collider (LHC) data analysis of the ATLAS experiment. Using di-muon Resonances we are able to calibrate to per-mil accuracy the detector response for muons. Innovative techniques developed throughout the Run-2 period and during the collider's shut-down significantly improve the measurement of muon reconstruction, identification and calibration performance with these preliminary data. New analysis techniques are exploited which involve multivariate analyses for rejecting background hadrons from prompt leptons from the hard interactions as well as innovative in-situ corrections on data that reduce biases in muon momenta induced from residual detector displacements. We measure the reconstruction efficiencies and momentum performance measured with these methods. The results achieved are fundamental for improving the reach of measurements and searches involving leptons, such as Higgs decays to dimuons and ZZ or the first low mass and high mass searches in the beyond-the-standard model sector. This talk will present the recently released results on the muon reconstruction performance using the Run-3 data collected in 2022 by the ATLAS detector.

Parallel Session G / 433

DiHiggs Production Searches with ATLAS

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Parallel Session D / 374

On the possibility of measuring the polarization of a 3He beam at EIC by the HJET polarimeter

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The requirements for hadron polarimetry at the future Electron Ion Collider (EIC) include measurements of the absolute helion (3He, *h*) beam polarization with systematic uncertainties better than ⊠syst⊠/⊠≤1%. Here, we consider a possibility to utilize the Polarized Atomic Hydrogen Gas Jet Target (HJET) for precision measurement of polarization of the ~100\,GeV/n helion beam. HJET, which serves to determine absolute proton beam polarization at the Relativistic Heavy Ion Collider, provides the accuracy of about ⊠syst⊠/⊠~0.5%. To adapt the HJET method for the EIC helion beam, the experimentally determined ratio of the beam and target (jet) spin correlated asymmetries should be adjusted by the ratio of ⊠↑*h* and *h*↑⊠ analyzing powers ⊠⊠*h*N(⊠)/⊠*h*⊠N(⊠) which, in the leading order approximation, is predefined by magnetic moments of the proton and helion, (⊠⊠−1)/(⊠*h*/2−1/3). However, to achieve the required accuracy in the measured polarization, the corrections due to hadronic spin-flip amplitudes and due to possible beam 3He breakup should be considered. Preliminary results of an analysis discussed here indicate that (i) the proton-helion hadronic spin-flip amplitudes can be related, with sufficient precision, to the proton-proton one and (ii) the breakup corrections are small and cancel in the ratio. So, the EIC helion beam absolute polarization can be measured by HJET with the required accuracy.

Parallel Session E / 378

Long-lived Multi-charged particles and neutrino mass models

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We will discuss multi-lepton signals of LNV that can arise with experimentally interesting rates in certain loop models of neutrino mass generation. Interestingly, in such models the observed smallness of the active neutrino masses, together with the high-multiplicity of the final states, leads in large parts of the viable parameter space to the prediction of long-lived charged particles. We focus on one particular 1-loop neutrino mass model in this class and discuss its LHC phenomenology.

Parallel Session G / 434

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

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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 pp collision dataset collected by the ATLAS experiment at 13 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. Combinations of such measurements are also presented, as well as their interpretation in terme of Higgs boson couplings and in the context of Effective Field Theory (EFT) frameworks and specific BSM models.

Parallel Session D / 375

Double-Target for Nuclear Medium Hadronization studies with CLASI2 at JLab

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In 2003, an experiment with a Double-Target (liquid deuterium and solid target simultaneously exposed to an electron beam) dedicated to better understanding the hadronization process in a nuclear medium was conducted in the CLAS spectrometer in Jefferson Lab's Hall B. To detect a wider variety of higher energy hadrons with higher luminosity at the upgraded CLAS12, a new experiment will be conducted using a new Double Target design. The new experiment is scheduled for 2024. The environmental conditions of the CLAS12 detector bring new engineering challenges that must be addressed. These challenges include temperature extremes, from low cryogenic to room temperatures, routine operation in strong magnetic fields, up to 5 T, significantly constrained space for a motorized exchange of different target types, high radiation, and high vacuum. Experiments and designs were made by a multidisciplinary group of engineers (informatics, electronics, design, and mechanics) and physicists that work at CCTVal to ensure the proper and reliable functioning of Double Target. A report summarizing these experiments' results was submitted to Jefferson Lab in 2022. The system is ready for commissioning in 2023.

Parallel Session E / 379

Latest results on neutrino oscillation parameters from Daya Bay

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The Daya Bay Reactor Neutrino Experiment discovered a non-zero value for the neutrino mixing angle 13 in 2012. Since then, Daya Bay continues to provide leading determination of this small mixing angle. This is accomplished by comparing the measured rate and energy spectrum of electron antineutrinos coming from three pairs of reactors between multiple identical-designed detectors installed in three underground experimental halls located at different distances from the reactors. After a total of about nine years of operation, Daya Bay has amassed a record-breaking number of electron antineutrino events via their inverse beta-decay (IBD) interactions in the gadolinium-doped liquid scintillator inside the detectors. Based on about 5.6 million IBD candidates with the final-state neutron captured on gadolinium obtained from the full data set, Daya Bay has further improved the precision of determining 13 and the mass-square difference Δm232. These latest results will be presented.

Parallel Session G / 444

Measurements of Higgs boson properties with the ATLAS detector

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This talk presents precise measurement of the properties of the Higgs boson, including its mass, total width, spin, couplings 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 G / 178

Searching for additional Higgs bosons at ATLAS

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The discovery of the Higgs boson with the mass of 125 GeV confirmed the mass generation mechanism via spontaneous electroweak symmetry breaking and completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many experimental measurements, it is not capable of solely explaining some observations. Many extensions of the Standard Model introduce additional scalar fields to account for the electroweak symmetry breaking and thereby extra Higgs-like bosons, which can be either neutral or charged. This talk presents recent searches for additional low- and high-mass Higgs bosons, as well as decays of the 125 GeV Higgs boson to new light scalar particles, using LHC collision data at 13 TeV collected by the ATLAS experiment in Run 2.

Parallel Session D / 376

Improving ATLAS Hadronic Object Performance with ML/Al Algorithms

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Hadronic object reconstruction is one of the most promising settings for cutting-edge machine learning and artificial intelligence algorithms at the LHC. In this contribution, selected highlights of ML/AI applications by ATLAS to particle and boosted-object identification, MET reconstruction and other tasks will be presented.

Parallel Session E / 380

Low-scale Seesaw Mechanism in a U(1) extension of the Standard Mode with classical scale invariance

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The Standard Model (SM) of particle physics has been very successful in explaining a wide range of experimental observations. However, it still can not address certain issues such as the non-zero neutrino masses, existence of dark matter and the baryon asymmetry of the Universe. This motivates studies beyond the SM. Among the various scenarios that have been proposed in the literature, the models in which the SM is extended by a U(1) gauge group has received some attention. I will first briefly talk about a class of gauged U(1) extensions of the SM, where active light neutrino masses are generated by an inverse seesaw mechanism. Then I will motivate the conformal symmetric models with classical scale invariance (CSI) and discuss a scenario where one can incorporate both CSI and low-scale seesaw in the context of U(1) extensions. Some of the phenomenological aspects of this model, such as, the recent W boson mass anomaly, leptogenesis, etc., will also be discussed.

poster Session / 449

Phenomenological aspects of the fermion and scalar sectors of a S_4 flavored 3-3-1 model

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We propose a predictive model based on the $SU(3)_C \times SU(3)_L \times U(1)_X \times U(1)_{Lg}$ gauge symmetry, supplemented by the S_4 family symmetry and auxiliary cyclic symmetries whose spontaneous breaking produces the observed SM fermion mass and mixing pattern. The masses of the neutrinos are produced by an inverse seesaw mechanism mediated by the right-handed Majorana neutrinos. Our proposed model successfully accommodates the experimental values of the SM fermion mass and mixing parameters as well as the Higgs di-photon decay rate.

poster Session / 86

Superposing and Decay Process of Mass-Massless Type Two Identical Wave Potentials

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Assumed a test magnetic dipole (MD) moment contains positive magnetic charge on its North Pole. Laws of physics tell that an accelerating object can lose applied (external) energy. In the case of a test MD-moment undergone free fall, its mass keeping constant in allowing to pass through the region B1B1 of a positively diverged magnetic (PDM) field contained 1d box on condition that Δv/Δt = g⊥ΔB, where g gravitational acceleration vector perpendicular to the positively changing magnetic flux density vector ΔB, there are appeared two positive valued changes at the same time causing superposed velocity squared (SVS) on the test MD-moment. It loosed internal energy equivalent to the magnetic charge time spatial length dependent magnetic voltage, when the SVS of the test MD-moment slowed down in the region B1B1 where probability of finding particle is 1. De Broglie's matter-wave potential energy which is external (applied) energy appears in superposed (additional) form with internal potential energy. Experiment had been conducted many times. The result obtained tells us—for perfect superposing, applied energy and superposed energy should be in the ratio '1 : 2'. The ratio for semi-superposing was found '1:1.39'in the experiment. Superposed energy is released in mechanical form. I would like to show the test report prepared on the basis of superposing of "mass-massless"type two identical wave potentials. I would like to explain internal source which is responsible for internal potential energy.

poster Session / 105

The renormalization scale-setting problem in QCD

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A vital issue in making accurate predictions in QCD is establishing the renormalization scale μ_r to determine the correct running coupling in the perturbative expansion. In conventional scaling, the renormalization scale is set to the typical process scale Q, and errors are estimated by scaling over a range of two $[Q/2, 2Q]$. This procedure introduces a considerable ambiguity in the scheme and renormalization scale in the final results to a fixed order. Therefore, this dependency directly impacts the predictions of several high-energy processes.

Currently, some strategies for scale setting optimization have been proposed in the literature, such as the Fastest Apparent Convergence (FAC), the Principle Minimal Sensitivity (PMS), the BLM method and the Principle of Maximum Conformity (PMC). Because the renormalization group imposes self-incidence properties such as singularity, reflexivity, symmetry, and transitivity, we see that FAC and PMS can lead to incorrect results in particular kinematic regions. Furthermore, they do not solve the problem presented by the ambiguity generated by the adjustment. Of conventional scale since they were designed to find an optimal renormalization. While BLM and PMC satisfies the theoretical requirements for the scale setting procedure based on the standard invariance of the renormalization group, it eliminates a systematic error in the pQCD predictions.

The principle of maximum conformality is used to remove uncertainties from the renormalization scale and scheme through a systematic way to absorb the non-conformal terms in the running coupling, obtaining an effective coupling $\alpha_s\,(Q_{\text{PMC}})$, and determine an optimal effective scale as a result of the setting, PMC gives us a completely conformal perturbative observable. This method is based on the standard renormalization group invariance, and it succeeds in removing unnecessary systematic errors for high-precision pQCD predictions. It can be applied to virtually all high-energy hadronic processes, including multiscale problems.

The purpose of this paper is to present the main ideas of the Principle of Maximum Conformality and to show some applications under a single-scale and multi-scale PMC setting.

poster Session / 109

Search for Magnetic Monopoles produced via the Schwinger Mechanism at the LHC

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The Schwinger mechanism predicts the production of an electron-positron pair through the decay of an extremely strong electric field. The electro-magnetic dual of this process would produce magnetic monopoles (MMs) - if they exist - in sufficiently strong magnetic fields. The 2018 lead ion collisions at the LHC produced the strongest magnetic fields in the known Universe. The MoEDAL detectors –Magnetic Monopole trappers (MMTs) and Nuclear Track Detectors (NTDs) were exposed to 0.235 nbˆ(−1) of Pb-Pb collisions with 5.02 TeV center-of-mass energy per collision. The analysis excluded the presence of MMs with Dirac charges 1gD ≤ g ≤ 3gD and masses up to 75 GeV/cˆ(2) at 95% confidence level. Uniquely, the MM production rate can be calculated by semi-classical methods without the use of perturbative calculation. This search, thus, provides the first reliable lower mass bound for the finite-size magnetic monopoles from a collider search while significantly extending previous bounds. This poster would describe the results of this study and the ongoing searches to expand the sensitivity of MoEDAL detectors to higher magnetic charges.

poster Session / 132

Sensitivity of direct detection experiments to neutrino magnetic dipole moments

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With large active volume sizes dark matter direct detection experiments are sensitive to solar neutrino fluxes. Nuclear recoil signals are induced by ^8B neutrinos, while electron recoils are mainly generated by the pp flux. Measurements of both processes offer an opportunity to test neutrino properties at low thresholds with fairly low backgrounds. In this work we study the sensitivity of these experiments to neutrino magnetic dipole moments assuming 1, 10 and 40 tonne active volumes (representative of XENON1T, XENONnT and DARWIN), 0.3 keV and 1 keV thresholds. We show that with nuclear recoil measurements alone a 40 tonne detector could be as competitive as Borexino, TEXONO and GEMMA, with sensitivities of order 8.0×10^{-11} μ_B at the 90% CL after one year of data taking. Electron recoil measurements will increase sensitivities way below these values allowing to test regions not excluded by astrophysical arguments. Using electron recoil data and depending on performance, the same detector will be able to explore values down to 4.0×10^{-12} μ_B at the 90% CL in one year of data taking. By assuming a 200-tonne liquid xenon detector operating during 10 years, we conclude that sensitivities in this type of detectors will be of order 10^{-12} μ_B. Reducing statistical uncertainties may enable improving sensitivities below these values.

poster Session / 288

Gamma ray signals from primordial black hole evaporation

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In this work, we study the photon spectrum produced by the Hawking radiation from a primordial black hole (PBH). We focus on the last stages before full evaporation. The spectrum is estimated using the black body approach and Hawking's emission formula. The connection between both descriptions is discussed. Furthermore, through analytical approximations for the greybody factors at the high and low energy limits, we time-integrate the primary spectrum along the PBH lifetime. As a result, we obtain a correction to the primary photon time-integrated spectrum commonly used in the literature. In addition, due to the BH emission of free quarks, we estimate, under rough approximations, the pion production from quark hadronization. As a consequence, a secondary photon spectrum is obtained through $\pi^0 \to \gamma\gamma$ decay. These calculations for the spectral emission are compared with spectra obtained with simulations using `BlackHawk`. Based on the previous analysis, we estimate the number of photons per km^2, within a certain detection energy interval, and during a fixed observation time, that eventually reach the Earth's atmosphere. Finally, with the help of `Corsika`, we run simulations of very high energy gamma rays to study the basic features of the electromagnetic showers that are produced in the atmosphere.

poster Session / 291

Predictive extended 3HDM with S_4 family symmetry.

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We propose two extended 3HDM theories where the SM gauge symmetry is enlarged by the inclusion of the spontaneously broken S_4 discrete symmetry group, supplemented by the preserved Z_2 and broken Z_4 cyclic symmetries. The first one has an extra inert scalar singlet field, whereas the second one has an inert scalar doublet. Both models yield the same structure of the mass matrices for the fermion sector, where a radiative seesaw generates the tiny light active neutrinos masses at one-loop level. The presence of flavor changing neutral currents mediated by heavy scalars allowed us to study the $(K^0 - \overline{K}^0)$ and $(B^0_{d,s} - \overline{B}^0_{d,s})$ meson mixings, in the parameter space that currently satisfy the experimental constraints. The extra scalars in our model provide radiative corrections to the oblique parameters, where due to the presence of the scalar inert doublet, model 2 is less restrictive than model 1. Due to the preserved Z_2 symmetry, our proposed models has stable scalar and fermionic dark matter candidates. Furthermore, these models are consistent with the current pattern of SM fermion masses and mixings, with the measured dark matter relic abundance and successfully accommodate the constraints arising from meson oscillations, oblique parameters and W mass anomaly.

poster Session / 295

Production of Mono-Higgs and Mono-Z in the Minimal Spin-one Isotriplet Dark Matter Model in pp Collisions

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One of the current topics in Particle Physics is the attempt to understand the nature of dark matter, through the predictions of simplified but realistic models. In this case we will focus on the Minimal Vectorial Dark Matter Model [1], where dark matter is the neutral component of a massive spin 1 field that transforms into the adjoint representation of $SU(2)_L$. The model has two free parameters: the mass of the vector at tree level and the coupling constant between the massive vector field and the Higgs field. Using the CalcHep package [2], this presentation will show production at tree level of a Z boson and a Higgs boson in the context of the vector model, which in principle, can be put to the test in future hadronic accelerators (such as HL-LHC). We will present our cross-section predictions and them with the Standard Model .

The lagrangian of VDTM is described by:

\begin{align}
\mathcal{L}=&\mathcal{L}{SM}-Tr\{D\mu V_\nu D^\mu V^\nu\}+Tr\{D_\mu V_\nu D^\nu V^\mu\}-\dfrac{g^2}{2}Tr\{[V_\mu,V_\nu]
&-igTr\{W_{\mu\nu}[V^\mu,V^\nu]\}+M^2Tr\{V_\nu V^\nu\}+a(\Phi^\dagger\Phi)Tr\{V_\nu V^\nu\}
\end{align}

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Parallel Session E / 427

The Mach3 Bayesian oscillation Analysis framework of the T2K experiment

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The Tokai-to-Kamioka (T2K) long-baseline neutrino experiment measures neutrino-flavor oscillation parameters using the three-flavor oscillation model parameterized by the PMNS matrix. This measurement is performed by sampling the JPARC (anti)neutrino beam by various detectors: once at a near detector complex before oscillations take place and once at a far detector after oscillations. A critical part of the data analysis is the fit machinery that needs to find the best compatibility of a large number of parameters (neutrino interaction, flux, detector, and oscillation model parameters) with the neutrino scattering data. T2K uses several approaches to fit the data that are frequently cross-checked against each other. In this talk, the Bayesian analysis approach is presented, which performs a joint near and far detector fit and uses a Markov Chain Monte Carlo sampling

Parallel Session F / 428

Recent heavy ion results from CMS

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An overview of selected recent results in heavy-ion collisions from the CMS experiment.

Parallel Session H / 324

Using Machine Learning to control the GlueX Central Drift Chamber

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Machine learning (ML) is becoming more widely used in nuclear physics, often used to complement or replace conventional data analysis, eg for detector calibration, track reconstruction and particle identification, but it is rarely used for detector control. We developed a ML model and incorporated it into software to control the anode voltage of the GlueX Central Drift Chamber in order to stabilize its gain, which would otherwise vary considerably with the atmospheric pressure. This system has been used for recent experiments in Hall D at Jefferson Lab. Its development and deployment will be described.

Parallel Session E / 382

IceCube Upgrade and -Gen2 - The future of neutrino astronomy at the South Pole

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The IceCube observatory at the South Pole, with its 1km3 of instrumented ice, is one of the largest neutrino detectors worldwide. The observatory has detected the first high-energy astrophysical neutrinos and has shown compelling evidence for the first neutrino point source. The success of IceCube has matured plans for the extension of its energy range of 10GeV to PeV towards both lower and higher energies. The first stage of this expansion is IceCube Upgrade, with a dense infill of seven additional strings to be deployed in the 2025/26 Antarctic summer season. The strings will be instrumented with around 700 novel optical sensors with increased sensitivity to detect low-energy neutrinos in the range of 1 to 100GeV. This will significantly enhance IceCube's capabilities to measure oscillation parameters and improve its already competitive results. Also, state-of-the-art calibration devices will be deployed, aiming to improve the current calibration of the IceCube detector, which will enhance the reconstruction of archival data taken in the last decade. A successful deployment of IceCube Upgrade will also pave the way for IceCube-Gen2, the next-generation high-energy neutrino telescope at the South Pole.

IceCube-Gen2 will enlarge the detector's volume to eight cubic kilometres increasing the detection rate of cosmic neutrinos by a factor of ten. The extension consists of three sub-arrays taking advantage of neutrino signals in the optical and radio range and a surface detector measuring atmospheric particle showers. This presentation will focus on the optical arrays of these extensions, addressing the R&D activities towards the Upgrade and Gen2 and the resulting physics potential.

Parallel Session H / 431

Two-Pion Bose-Einstein Correlation measurements with CLAS detector

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We have studied Bose-Einstein correlations for positive pions produced in DIS events with data from experiments carried out during the run period EG2 in Jefferson Lab, Virginia using different targets, such as D2, C, Fe and Pb, exposed to a 5.014 GeV electron beam. By comparing the pairs of $\pi+$ from same events to uncorrelated pairs, we can obtain information of the space-time structure and dynamics of the source of the produced bosons. The goal of the study was to measure the size of the $\pi+$ production source and its degree of coherence in one and two-dimensional approaches. No significant differences have been found, regarding the size of the pion source along solid targets and clear elongation of the source was found for all nuclear targets with dependence in nuclear number A.

Parallel Session F / 429

Quarkonium transport in weakly and strongly coupled plasmas

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Suppression of open heavy flavors and quarkonia in heavy-ion collisions is among the most informative probes of the quark-gluon plasma. Interpreting the full wealth of data obtained from the collision events requires a precise understanding of the evolution of heavy quarks and quarkonia as they propagate through the nearly thermal and strongly coupled plasma. Only in the past few years, systematic theoretical studies of quarkonium time evolution in the QGP have been carried out in the regime where the temperature of the QGP is much smaller than the inverse of quarkonium size.

Such calculations require the evaluation of a gauge-invariant correlator of chromoelectric fields dressed with Wilson lines, which is similar to, but different from, the correlation used to define the well-known [1] heavy quark diffusion coefficient. In this talk, we will describe its calculation at weak coupling in QCD up to next-to-leading order [2] and at strong coupling in $\mathcal{N}$=4 SYM using the AdS/CFT correspondence [3]. At first sight, the calculations are similar to those of the open heavy quark case, but a closer inspection reveals that they have crucial differences that highlight the relevance of quantum color correlations. Crucial insights are obtained by studying them in temporal axial gauge, where these correlators would naively be equal [4]. Finally, we give a prescription to evaluate this correlation function from lattice QCD [5], which, at present, is the only tool we have to study QCD in the non-perturbative regime.

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Parallel Session E / 383

Constraints on Very Special Relativity from the Electron's gyromagnetic factor

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In 2006, A. Cohen and S. Glashow presented for the first time the idea of Very Special Relativity (VSR), where they imagined to restrict space-time invariance to a subgroup of the full Lorentz group, usually the subgroup $SIM(2)$. The advantage of this theory is that, while it does not affect kinematic predictions of Special Relativity, it is able to explain the existence of neutrino masses without the addition of new exotic particles or tiny twisted space dimensions, which until now have not been observed in experiments yet.
Furthermore, the addition of either P, CP or T invariance to $SIM(2)$ symmetry enlarges the total symmetry group again to the full Lorentz group, implying a natural explanation of the smallness of neutrino's masses in the framework of the CP-violating Standard Model.
Consequences of VSR have already been considered in a large variety of fields, starting from Supersymmetric extensions and getting to the Gravitational sector, Quantum Electrodynamics and much more.
The final goal of this work is to put bounds on some specific Very Special Relativity (VSR) parameters by using the extremely accurate measurement of the Electron's g-factor in Penning trap's experiments.
To do that, we start by considering the corrections arising from the SIM(2) invariant realization of Very Special Relativity to the energy spectrum of a T–invariant Dirac Fermion in a static and homogeneous magnetic field $\vec{B}$. First, we analyze the case of $\vec{B}$ parallel to the spatial VSR preferred direction $\vec{n}$, finding that the expression for the energy spectrum stays the same, except for a mass shift arising from the VSR contribution. Then, we relax the parallelism condition, finding a new equation for the energy spectrum. We solve this equation perturbatively.
Aiming at comparison with Penning trap's experiment, we derive the first order VSR corrections to the electron's $g-2$ factor. Finally, using the most accurate electron's g-factor measurements in these experiments, we obtain an upper bound to the VSR electron mass parameter, and therefore also to the VSR electronic neutrino mass, of $1eV$. This result does not contradict the possibility for VSR to be the origin of neutrino masses.

Parallel Session H / 432

Transverse Momentum Broadening in Nuclear Media at Jefferson Lab's CLAS

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Transverse momentum broadening is one of the observables measured to study the hadronization process. This process is directly related to the space-time development of a deconfined quark in the nuclear medium before it evolves into a hadron [1, 2, 3]. I'll show the preliminary results for the first experimental measurements of the transverse momentum broadening for positive pions, produced by lepton-nucleon deep inelastic scattering, in carbon, iron, and lead targets at Jefferson Lab's CLAS detector with a 5.014GeV unpolarized electron beam. We used the particle identification scheme developed during the charged pions'multiplicity ratio analysis measurements [4]. In addition, we applied detector acceptance and radiative corrections.

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Parallel Session F / 430

Recent ATLAS measurements in heavy-ion collisions

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This talk presents an overview of recent ATLAS measurements in heavy ion collision systems. These include multiple measurements of jet production and structure, which probe the dynamics of the hot, dense Quark-Gluon Plasma formed in relativistic nucleus-nucleus collisions, and measurements of quarkonia and heavy flavor production to probe the QGP medium properties. The final measurement of charged-hadron production in Xe+Xe and Pb+Pb collisions will be discussed. Furthermore, the photo-nuclear events can provide a clean probe of the partonic structure of the nucleus analogous to deep inelastic scattering. This talk will present a new measurement of dijet production in ultra-peripheral Pb+Pb collisions.

Parallel Session E / 350

Latest results from new physics searches in MicroBooNE

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MicroBooNE is a liquid argon time projection chamber (LArTPC) neutrino detector located in Fermilab. Operating from 2015 to 2020 it collected the largest number of neutrino interactions in liquid-argon to date. Its primary physics goal is to clarify the origins of the low-energy excess of electromagnetic activity observed by MiniBooNE; the first set of results on this were released during 2021. In addition, MicroBooNE has a rich program of neutrino-liquid argon cross section measurements, other Beyond the Standard Model physics searches, and pioneering research and development of LArTPC detector technology, all of which will be key to the success of the Fermilab Short-Baseline Neutrino Program (SBN) and the DUNE experiment. This talk will focus on our latest results of new physics searches: a search for eV-scale sterile neutrino oscillations, and a search for heavy neutral leptons and Higgs portal scalars decaying in the detector.

Parallel Session H / 438

Machine Learning for Real-Time Processing of ATLAS Liquid Argon Calorimeter Signals with FPGAs

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The ATLAS Liquid Argon (LAr) calorimeter measures the energy of particles produced in LHC collisions. This calorimeter has also trigger capabilities to identify interesting events. In order to enhance the ATLAS detector physics discovery potential, in the blurred environment created by the pileup, an excellent resolution of the deposited energy and an accurate detection of the deposited time is crucial.

The computation of the deposited energy is performed in real-time using dedicated data acquisition electronic boards based on FPGAs. FPGAs are chosen for their capacity to treat large amount of data with very low latency. The computation of the deposited energy is currently done using optimal filtering algorithms that assume a nominal pulse shape of the electronic signal. These filter algorithms are adapted to the ideal situation with very limited pileup and no overlap of the electronic pulses in the detector. However, with the increased luminosity and pileup, the performance of the optimal filter algorithms decreases significantly and no further extension nor tuning of these algorithms could recover the lost performance.

The back-end electronic boards for the Phase-II upgrade of the LAr calorimeter will use the next high-end generation of INTEL FPGAs with increased processing power and memory. This is a unique

opportunity to develop the necessary tools, enabling the use of more complex algorithms on these boards. We developed several neural networks (NNs) with significant performance improvements with respect to the optimal filtering algorithms. The main challenge is to efficiently implement these NNs into the dedicated data acquisition electronics. Special effort was dedicated to minimising the needed computational power while optimising the NNs architectures.
Five NN algorithms based on CNN, RNN, and LSTM architectures will be presented. The improvement of the energy resolution and the accuracy on the deposited time compared to the legacy filter algorithms, especially for overlapping pulses, will be discussed. The implementation of these networks in firmware will be shown. Two implementation categories in VHDL and Quartus HLS code are considered. The implementation results on Stratix 10 INTEL FPGAs, including the resource usage, the latency, and operation frequency will be reported. Approximations in the firmware implementations, including the use of fixed-point precision arithmetic and lookup tables for activation functions, will be discussed. Implementations including time multiplexing to reduce resource usage will be presented. We will show that two of these NNs implementations are viable solutions that fit the stringent data processing requirements on the latency (O(100ns)) and bandwidth (O(1Tb/s) per FPGA) needed for the ATLAS detector operation.

Plenary session Friday Morning 1 / 308

QED Fermions in a noisy magnetic field background

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We consider the effects of a noisy magnetic field background over the fermion propagator in QED, as an approximation to the spatial inhomogeneities that would naturally arise in certain physical scenarios, such as heavy ion collisions or the quark gluon plasma in the early stages of the evolution of the universe. We consider a classical, finite and uniform magnetic field background ⟨⊠(⊠)⟩=⊠, subject to white-noise spatial fluctuations with auto-correlation of magnitude Δ⊠. By means of the Schwinger representation of the propagator in the average magnetic field as a reference system, we used the replica formalism to study the effects of the magnetic noise in the form of renormalized quasi-particle parameters, leading to an effective charge and an effective refraction index, that depend not only on the energy scale, as usual, but also on the magnitude of the noise Δ⊠ and the average field ⊠.

Plenary session Friday Morning 1 / 358

neutrino physics update

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In this talk I will briefly review the status of neutrino physics and describe symmetry-based approaches to some of the main drawbacks of in particle physics

Plenary session Friday Morning 1 / 163

Long-lived Heavy Neutral Leptons at the LHC

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Long-lived particles are predicted in several beyond the Standard Model theories. Their signatures

can be tested at the LHC main detectors (such as ATLAS or CMS), current and proposed far detectors (such as FASER or MATHUSLA), as well as other experimental facilities. I will comment on the phenomenology of displaced signatures and sensitivity reach of models predicting long-lived Heavy Neutral Leptons (HNLs), focusing on the minimal scenario as well as prospects within effective field theory.

Plenary session Friday Morning 2 / 303

The sPHENIX experiment at RHIC

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The sPHENIX detector at the BNL Relativistic Heavy Ion Collider (RHIC) is currently under construction and on schedule for first data in summer 2023. Built around the excellent BaBar superconducting solenoid, the central detector consists of a silicon pixel vertexer adapted from the ALICE ITS design, a silicon strip detector with single event timing resolution, a compact TPC, novel EM calorimetry, and two layers of hadronic calorimetry. The plan is to use the combination of electromagnetic calorimetry, hermetic hadronic calorimetry, precision tracking, and the ability to record data at high rates without trigger bias to make precision measurements of Heavy Flavor, Upsilon and jets to probe of the Quark Gluon Plasma (QGP) formed in heavy-ion collisions. These measurements will have a kinematic reach that not only overlaps those performed at the LHC, but extends them into a new, low-pT regime. sPHENIX will significantly expand the observables and kinematic reaches of these measurements at RHIC and provide a comparison with the LHC measurements in the overlapping kinematic region. The physics program, its potential impact, and recent detector development will be discussed in this talk.

Plenary session Friday Morning 2 / 366

Fermion mass and width in QED in a magnetic field

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We revisit the calculation of the fermion self-energy in QED in the presence of a magnetic field[1] . We show that, after carrying out the renormalization procedure and identifying the most general perturbative tensor structure for the modified fermion mass operator in the large field limit, the mass develops an imaginary part. This happens when account is made of the subleading contributions associated to Landau levels other than the lowest one. The imaginary part is associated to a spectral density describing the spread of the mass function in momentum. The center of the distribution corresponds to the magnetic-field modified mass. The width becomes small as the field intensity increases in such a way that for asymptotically large values of the field, when the separation between Landau levels becomes also large, the mass function describes a stable particle occupying only the lowest Landau level. For large but finite values of the magnetic field, the spectral density represents a finite probability for the fermion to occupy Landau levels other than the lowest Landau level.

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Plenary session Friday Morning 2 / 164

Searching for Magnetic Monopoles and other Exotics with MoEDAL

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MoEDAL is an experiment at the LHC that is dedicated to searches for magnetic monopoles (MM) and other exotic particles. In Run 2, MoEDAL established best current laboratory constraints for point-like MM with magnetic charges ranging from 2 to 5 Dirac charges, surpassing the results of ATLAS in this range. MoEDAL also performed the first search for Dyons, particles with both electric and magnetic charge. More recently, MoEDAL performed a pioneering search for MM production in Pb-Pb collisions via the Schwinger mechanism, establishing first reliable mass limits on composite MMs in a collider experiment. Apart from particles with magnetic charge, MoEDAL is sensitive to highly electrically charged objects (which may include aggregates of quark matter, Q-balls, or micro black hole remnants) and long-lived particles (having a particularly competitive sensitivity to doubly charged fermions). A recently approved addition of a new sub-detector –MoEDAL Apparatus for Penetrating Particles, or MAPP –will also allow MoEDAL to have competitive sensitivity to milli-charged particles, which are predicted within the framework of vector portal dark sector models. This talk will introduce the MoEDAL experiment, describe its recent results, and present plans for the LHC Run 3 and beyond.

Plenary session Friday Morning 2 / 364

HEP Statistics in Latin America

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81

ATLAS LAr Calorimeter Commissioning for LHC Run-3

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The Liquid Argon Calorimeters are employed by ATLAS for all electromagnetic calorimetry in the pseudo-rapidity region $|\eta| < 3.2$, and for hadronic and forward calorimetry in the region from $|\eta| = 1.5$ to $|\eta| = 4.9$. They also provide inputs to the first level of the ATLAS trigger. After successful period of data taking during the LHC Run-2 between 2015 and 2018 the ATLAS detector entered into the a long period of shutdown. In 2022 the LHC will restart and the Run-3 period should see an increase of luminosity and pile-up up to 80 interaction per bunch crossing.

To cope with this harsher conditions, a new trigger readout path has been installed during the long shutdown. This new path should improve significantly the triggering performances on electromagnetic objects. This will be achieved by increasing the granularity of the objects available at trigger level by up to a factor of ten.

The installation of this new trigger readout chain required also the update of the legacy system. More than 1500 boards of the precision readout have been extracted from the ATLAS pit, refurbished and re-installed. The legacy analog trigger readout that will remain during the LHC Run-3 as a backup of the new digital trigger system has also been updated.

For the new system 124 new on-detector boards have been added. Those boards that are operating in a radiative environment are digitizing the calorimeter trigger signals at 40MHz. The digital signal is sent to the off-detector system and processed online to provide the measured energy value for each unit of readout. In total up to 31Tbps are analyzed by the processing system and more than 62Tbps are generated for downstream reconstruction. To minimize the triggering latency the processing system had to be installed underground. The limited available space imposed a very compact hardware structure. To achieve a compact system, large FPGAs with high throughput have been mounted on ATCA mezzanines cards. In total no more than 3 ATCA shelves are used to process the signal from approximately 34000 channels.

Given that modern technologies have been used compared to the previous system, all the monitoring and control infrastructure is being adapted and commissioned as well.

This contribution will present the challenges of the installation, the commissioning and the milestones still to be completed towards the full operation of both the legacy and the new readout paths for the LHC Run-3.

82

Development of the ATLAS Liquid Argon Calorimeter Readout Electronics for the HL-LHC

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A new era of hadron collisions will start around 2029 with the High-Luminosity LHC which will allow to collect ten times more data than what has been collected during 10 years of operation at LHC. This will be achieved by higher instantaneous luminosity at the price of higher number of collisions per bunch crossing.

In order to withstand the high expected radiation doses and the harsher data taking conditions, the ATLAS Liquid Argon Calorimeter readout electronics will be upgraded.

The electronic readout chain is composed of four main components.
1: New front-end boards will allow to amplify, shape and digitise the calorimeter's ionisation signal on two gains over a dynamic range of 16 bits and 11 bit precision. Low noise below Minimum Ionising Particle (MIP), i.e. below 120 nA for 45 ns peaking time, and maximum non-linearity of two per mille are required. Custom preamplifiers and shapers are being developed to meet these requirements using 65 nm and 130 nm CMOS technologies. They shall be stable under irradiation until 1.4kGy (TID) and 4.1×10^{13} new/cm^2 (NIEL). Two concurrent preamp-shaper ASICs were developed and, "ALFE", the best one has been chosen. The test results of the latest version of this ASIC will be presented. "COLUTA", a new ADC chip is also being designed. A production test setup is being prepared and integration tests of the different components (including lpGBT links developed by CERN) on a 32-channels front-end board are ongoing, and results of this integration will be shown.
2: New calibration boards will allow the precise calibration of all 182468 channels of the calorimeter over a 16 bits dynamic range. A non-linearity of one per mille and non-uniformity between channels of 0.25% with a pulse rise time smaller than 1ns shall be achieved. In addition, the custom calibration ASICs shall be stable under irradiation with same levels as preamp-shaper and ADC chips. The HV SOI CMOS XFAB 180nm technology is used for the pulser ASIC, "CLAROC", while the TSMC 130 nm technology is used for the DAC part, "LADOC". The latest versions of those 2 ASICs which recently passed the production readiness review (PDR) with their respective performances will be presented.
3: New ATCA compliant signal processing boards ("LASP") will receive the detector data at 40 MHz where FPGAs connected through lpGBT high-speed links will perform energy and time reconstruction. In total, the off-detector electronics receive 345 Tbps of data via 33000 links at 10 Gbps. For the first time, online machine learning techniques are considered to be used in these FPGAs. A subset of the original data is sent with low latency to the hardware trigger system, while the full data are buffered until the reception of trigger accept signals. The latest development status of the board as well as the firmware will be shown.

4: A new timing and control system, "LATS", will synchronise to the aforementioned components. Its current design status will also be shown.

113

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

Author: ATLAS speaker to be selected[None]

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.

129

High precision TPC detection technology R&D for Tera Z at e+e- collider

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The Circular Electron Positron Collider (CEPC) and Future Electron Position Circular Collider (FC-Cee) were been proposed as a Higgs and high luminosity Z factory in last few years. The detector conceptual design of a updated detector consists of a tracking system, which is a high precision (about 100μm) spatial resolution Time Projection Chamber (TPC) detector as the main track device in very large 3D volume. The tracking system required the high precision performance requirements, but without power-pulsing not likely as the International Linear Collider (ILC), which leads to additional constraints on detector specifications, especially for the case of the machine operating at the high luminosity Z pole (Tera Z). TPC detection technology requires longitudinal time resolution of about 100ns and the physics goals require Particle Identification Detection (PID) resolution of very good separation power with cluster counting to be considered. A number of critical issues are still remaining regarding the TPC research. The simulation and PID resolution show TPC technology potential to extend Tera Z at the future e+e- collider.
In this talk, I will present the feasibility and status of high precision TPC as the main track detector for e+e- collider. The traditional pad readout is designed about 1mm x 6mm and the pixelated readout is designed about 55μm x 5μm or bigger size. Compared with the pad readout, the pixelated readout option will obtain the better spatial resolution of single electrons, the very high detection efficiency in excellent tracking and good dE/dx performance. A smaller prototype TPC has been developed with a drift length of 500 mm, gaseous chamber, 20000V field-cage, the low power consumption FEE electronics and DAQ have been commissioned and some studies have been finished.

Some updated experimental results including the spatial resolution, the gas gain, the laser track reconstruction and dE/dx will be reported. The track performance results and summarize the next steps of the pad/pixelated TPC technology for e+e- collider will presented in this talk.

239

Overview of ATLAS Upgrades projects for HL-LHC

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With the restart of the proton-proton collision program in 2022 (Run-3) at the Large Hadron Collider (LHC), the ATLAS detector aims to double the integrated luminosity accumulated during the ten previous years of operation. After this data-taking period the LHC will undergo an ambitious upgrade program to be able to deliver an instantaneous luminosity of 7.5×10^{34} cm^{-2} s^{-1}, allowing the collection of more than 3 ab^{-1} of data at $\sqrt{s}$ =14 TeV. This unprecedented data sample will allow ATLAS to perform several precision measurements to constrain the Standard Model Theory (SM) in yet unexplored phase-spaces, in particular in the Higgs sector, a phase-space only accessible at the LHC. To benefit from such a rich data-sample it is fundamental to upgrade the detector to cope with the challenging experimental conditions that include huge levels of radiation and pile-up events. The ATLAS upgrade comprises a completely new all-silicon tracker with extended rapidity coverage that will replace the current inner tracker detector; a redesigned trigger and data acquisition system for the calorimeters and muon systems allowing the implementation
of a free-running readout system. Finally, a new subsystem called High Granularity Timing Detector, will aid the track-vertex association in the forward region by incorporating timing information into the reconstructed tracks. A final ingredient, relevant to almost all measurements, is a precise determination of the delivered luminosity with systematic uncertainties below the percent level. This challenging task will be achieved by collecting the information from several detector systems using different and complementary techniques.
This presentation will describe the ongoing ATLAS detector upgrade status and the main results obtained with the prototypes, giving a synthetic, yet global, view of the whole upgrade project.

299

Search for new physics via compressed mass spectra SUSY in VBF topology with one-lepton final states using LHC Run II data

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A search for supersymmetric particles produced in the Vector Boson Fusion (VBF) topology using LHC Run II data at $\sqrt{s}$ = 13 TeV collected with the CMS detector is performed. The search focuses on the final states involving a single low-pT lepton, large missing transverse momentum, and two widely separated jets having large invariant mass. Such a dijet system is the peculiar signature of VBF topology and plays a crucial role in background reduction. The event selection criteria are designed to maximize the SUSY signal acceptance under a compressed mass scenario where the wino-like electroweakino masses are nearly degenerate to the bino-like lightest SUSY particle ($\tilde{\chi}_1^0$). The benchmark model for this search is the R-parity conserving Minimal Supersymmetric Standard Model (MSSM), where the lightest neutralino is the canonical dark matter candidate. The dominant standard model background processes are estimated using data-driven techniques. This talk will focus on the overall search strategy, methodology, and background estimation using various data-driven control regions along with their validation.