# ICHEP2018 SEOUL

Wednesday 04 July 2018 - Wednesday 11 July 2018

COEX, SEOUL

# Book of Abstracts

PoS(ICHEP2018)930

**Quark and Lepton Flavor Physics / 12**

# Search for Muon to Electron Conversion at J-PARC - COMET Experiment

MyeongJae Lee[1] ; Yoshitaka Kuno[2] ; Dmitry Grigoriev[None]

[1] *Institute for Basic Science (Korea)*
[2] *Osaka University*

**Corresponding Author(s):** dngrigorev@gmail.com, kuno@phys.sci.osaka-u.ac.jp, myeongjaelee@ibs.re.kr

Muon to electron conversion in a muonic atom is a process of charged lepton flavor violation (CLFV). It is not allowed in the Standard Model (SM) and known to be one of the best processes to search for new physics beyond the SM. The COMET experiment aims to search for this process at J-PARC with single-event sensitivity of $3\times10^{-17}$, which is about 10,000 improvement over the current limit. Recently the COMET experiment has taken a staged approach. COMET Phase-I, as the first phase, aims at a single-event sensitivity of $3\times10^{-15}$ with a partial muon beam line and a Phase-I dedicated detector. The construction of COMET Phase-I has started in 2013 and its physics run is expected to start in 2018/2019. The COMET Phase-II will follow immediately afterwards. In this talk, we will describe the physics motivation of CLFV, and the details of COMET Phase-I / Phase-II together with the current status of the experiment preparation.

**Heavy Ions / 14**

# The Critical Point and Random Fluctuation Walk

Gennady Kozlov[1]

[1] *Joint Institute for Nuclear Research (RU)*

**Corresponding Author(s):** gennady.kozlov@cern.ch

The critical phenomena of strongly interacting matter are presented in the random fluctuation walk model at finite temperature. The phase transitions are considered in systems where the Critical Point (CP) is a distinct singular one existence of which is dictated by the dynamics of conformal symmetry breaking.
The physical approach to the effective CP is predicted through the influence fluctuations of two-particle quantum correlations to which the critical mode couples. The finite size scaling effects are used to extract the vicinity of deconfinement phase transition.
We obtain the size of the particle emission source affected by the stochastic forces in thermal medium characterized by the Ginzburg-Landau parameter which is defined by the correlation length of characteristic dual gauge field. The size above mentioned blows up when the temperature approaches the critical value as correlation length becomes large enough. The results are the subject to the physical programs at accelerators to search the hadronic matter produced at extreme conditions.

**Dark Matter Detection / 16**

# Dark photons in the decay of a scalar

Gennady Kozlov[1]

[1] *JINR*

**Corresponding Author(s):** kozlov@jinr.ru

PoS(ICHEP2018)930

The couplings of the Standard Model sector to the scale invariant degrees of freedom can open the possibility to study dark photons (DP). The model for the DP particle solvable in 4-dimensional space-time is studied at the lowest order of perturbative theory using canonical quantization. The model is gauge and scale invariant and these symmetries are spontaneously broken with the following properties: the DP field is massive. The Dalitz-like decay of the (Higgs-like) scalar boson into a single photon and DP is studied. The interaction between DP and quarks is mediated by the derivative of the scalar field - the dilaton. The mass of the dilaton does not enter the final solutions. The limits are set on the DP mass, the mixing strength between the standard photon and DP. This study can be used to probe the DP sector since the emitted energy of the single photon is encoded with measuring of the missing of the recoil DP.

**Quark and Lepton Flavor Physics / 22**

## The MEGII experiment at PSI and the quest for $\mu \to e\gamma$ and its experimental limiting factors at future high intensity muon beams

Francesco Renga[None] ; Gianluca Cavoto[1] ; Angela Papa[None] ; Emanuele Ripiccini[2] ; Cecilia Voena[1]

[1] *Sapienza Universita e INFN, Roma I (IT)*
[2] *UNIGE*

**Corresponding Author(s):** francesco.renga@roma1.infn.it, emanuele.ripiccini@cern.ch, gianluca.cavoto@roma1.infn.it, angela.papa@psi.ch, cecilia.voena@roma1.infn.it

The search for the Lepton Flavor Violating decay $\mu \to e\gamma$ exploits the most intense continuous muon beams, which can currently deliver $\sim 10^8$ muons per second. In the next decade, accelerator upgrades are expected in various facilities, making it feasible to have continuous beams with an intensity of $10^9$ or even $10^{10}$ muons per second. We investigate the experimental limiting factors that will define the ultimate performances, and hence the sensitivity, in the search for $\mu \to e\gamma$ with a continuous beam at these extremely high rates. We then consider some conceptual detector designs and evaluate the corresponding sensitivity as a function of the beam intensity.

**POSTER / 23**

## Construction and prototype modules testing of HT-KZ Ultra-high energy cosmic rays detector system for cosmic rays with energies above 10^17 eV

Dmitriy Beznosko[1] ; Ayan Batyrkhanov[1] ; Alexander Iakovlev[1] ; Shotan Jakupov[1] ; Tileubek Uakhitov[1] ; Alikhan Yeltokov[1] ; Kanat Baigarin[2]

[1] *Nazarbayev University*
[2] *Nazarbayev University*

**Corresponding Author(s):** dmitriy.beznosko@nu.edu.kz, ayan.batyrkhanov@gmail.com, tileubek.uakhitov@nu.edu.kz, alikhan.yeltokov@nu.edu.kz, k.baigarin@nu.edu.kz, shotan.jakupov@nu.edu.kz, aleksandr.iakovlev@nu.edu.kz

The HT-KZ is an ultra-high energy cosmic rays detector system that is currently under construction at Nazarbayev University (NU), Kazakhstan. It is designed to study the spatial and temporal structure of Extensive Air Showers with the energy of the primary above ~10 17 eV, and with high time resolution of the shower disk profile and timing synchronization between the detection points (both ~1 ns). Detector system construction at NU is conducted in collaboration with the Tien Shan high-altitude Science Station (TSHSS).
Based on computer simulations, several prototype designs were created, constructed and tested. This poster will

PoS(ICHEP2018)930

present the design features and testing data from prototype modules currently in operation at NU.

**Neutrino Physics / 24**

## Discovery of Massive Sterile Neutrinos at the LHC

Choong Sun Kim[1]

[1] *Yonsei Uiversity*

**Corresponding Author(s):** cskim@yonsei.ac.kr

We will discuss all the possibilities of discovering the massive sterile neutrinos at the LHC.

**Beyond the Standard Model / 26**

## Dilaton-Assisted composite Higgs model at LHC

Deog Ki Hong[1]

[1] *Pusan National University (KR)*

**Corresponding Author(s):** d.hong@cern.ch

We study a recently proposed dilaton-assisted composite Higgs model, which addresses a new solution to the Higgs naturalness problem, relying the scale symmetry of the dilator-Higgs effective theory. The model predicts a heavy U(1) axial vector boson and two massive, oppositely charged, pseudo Nambu-Goldstone bosons. We discuss the phenomenology of new particles, which might be accessible at LHC.

**Dark Matter Detection / 28**

## Directional Search for Dark Matter Using Nuclear Emulsion

Murat Ali Guler[1] ; NEWSdm Collaboration[None] ; NEWSdm Collaboration[None] ; Tatsuhiro Naka[2]

[1] *Middle East Technical University (TR)*
[2] *Nagoya University*

**Corresponding Author(s):** naka@flab.phys.nagoya-u.ac.jp, ali.murat.guler@cern.ch

A variety of experiments have been developed over the past decades, aiming at the detection of Weakly Interactive Massive Particles (WIMPs) via their scattering in an instrumented medium. The sensitivity of these experiments has improved with a tremendous speed, thanks to a constant development of detectors and analysis methods. Detectors capable of reconstructing the direction of the nuclear recoil induced by the WIMP scattering are opening a new frontier to possibly extend Dark Matter searches beyond the neutrino background. Exploiting directionality would also give a proof of the galactic origin of dark matter making it possible to have a clear and unambiguous signal to background separation. The NEWSdm experiment, based on nuclear emulsions, is a new experiment proposal intended to measure the direction of WIMP-induced nuclear recoils with a solid-state de- tector, thus with a high sensitivity. We discuss the discovery potential of a directional experiment based on the use of a solid target made of newly developed nuclear emulsions and novel read-out systems achieving nanometric resolution. We also report results of a technical test conducted in Gran Sasso.

PoS(ICHEP2018)930

# Search for Rotational Cross-Correlations in Emergent Space-Time with the Holometer

Ohkyung Kwon[1] ; Craig Hogan[2]

[1] *KAIST*
[2] *U. Chicago and Fermilab*

**Corresponding Author(s):** o.kwon@kaist.ac.kr, cjhogan@fnal.gov

We present a new phenomenology for the Fermilab Holometer, a pair of 39m-long, co-located but independent high-power Michelson interferometers. The differential position signals are cross-correlated over a broad frequency band exceeding the inverse light crossing time, attaining sensitivity to both timelike and spacelike correlations across the physical system. The second-generation experiment employs a unique bent-arm configuration to search for rotational correlations associated with the emergence of flat space-time and local inertial frames from a quantum system. A Planck density spectrum in dimensionless strain units is shown to be consistent with causal diamonds of 4-position whose degrees of freedom scale with the holographic information content of black hole event horizons.
A Lorentz invariant framework is constructed to interpret data. Nonlocal entanglements among states in *relational* space-time are statistically modeled as antisymmetric cross-covariances on past and future light cones between world lines of Planck bandwidth in proper time, motivating a distinctive signature: an imaginary broad-band cross-spectrum that is acausal in standard physics, with a frequency response derived from the optical layout and its causal structure.



# IceCube's astrophysical neutrino energy spectrum from CPT violation

Danny Marfatia[1] ; D M[None]

[1] *University of Hawaii*

**Corresponding Author(s):** dmarf8@hawaii.edu

The 6-year dataset of high-energy starting events (HESE) at IceCube indicates a spectrum of astro-physical neutrinos much softer than expected from the Fermi shock acceleration mechanism. On the other hand, IceCube's up-going muon neutrino dataset and Fermi-LAT's gamma-ray spectrum point to an $E^{-2}$ neutrino spectrum. If the HESE data above 200 TeV are fit with the latter flux, an excess at lower energies ensues, which then suggests a multicomponent spectrum. We show that the HESE dataset can be explained by a single $E^{-2}$ power-law neutrino flux from a muon-damped $p\gamma$ source if neutrino interactions are modified by CPT violation. The low-energy excess is naturally explained by the pileup of events from superluminal neutrino decay, and there is no cutoff at high energies due to the contribution of subluminal antineutrinos. The best-fit scenario with CPT violation also predicts the observation of Glashow resonance events in the near future.



PoS(ICHEP2018)930

# Background study of HW production with the Higgs decaying to a b-quark pair

Fernando Febres Cordero[1]

[1] *University of Freiburg*

**Corresponding Author(s):** ffebres@physik.uni-freiburg.de

We present next-to-leading order QCD predictions for $W b\bar{b} + n$-jet ($n = 0, 1, 2, 3$) production at the Large Hadron Collider with $\sqrt{s} = 13$ TeV. We work in the four-flavor number scheme with a non-vanishing bottom-quark mass and include all subprocesses at leading electroweak order as well as all heavy-fermion-loop effects. We show the impact of QCD corrections for total as well as differential cross sections and make an assessment of theoretical uncertainties of $Wbb$ production viewed as an irreducible background to $H(\to b\bar{b})W$ studies. For the calculations we have employed an upgraded version of the BlackHat library which can handle massive fermions in combination with SHERPA. Our results can be explored through publicly available n-tuple sets.

**Neutrino Physics / 36**

# First Measurement of Monoenergetic Muon Neutrino Charged Current Interactions

Joshua Spitz[1] ; Johnathon Jordan[1]

[1] *University of Michigan*

**Corresponding Author(s):** jrlowery@umich.edu, spitzj@umich.edu

We report the first measurement of monoenergetic muon neutrino charged current interactions. MiniBooNE has isolated 236 MeV muon neutrino events originating from charged kaon decay at rest ($K^+ \to \mu^+$) at the NuMI beamline absorber. These signal-carbon events are distinguished from primarily pion decay in flight and backgrounds produced at the target station and decay pipe using their arrival time and reconstructed muon energy. The significance of the signal observation is at the 3.9σ level. The muon kinetic energy, neutrino-nucleus energy transfer ($= E - E'$), and total cross section for these events is extracted. This result is the first known-energy, weak-interaction- only probe of the nucleus to yield a measurement of ω using neutrinos, a quantity thus far only accessible through electron scattering.

**Beyond the Standard Model / 37**

# CP violation in B –> D** tau nu

Abi Soffer[1] ; Yuval Grossman[2] ; Daniel Aloni[3]

[1] *Tel Aviv University (IL)*
[2] *Cornell*
[3] *Weizmann Institute of Science*

**Corresponding Author(s):** yg73@cornell.edu, abner.soffer@cern.ch, daniel.aloni@weizmann.ac.il

Current measurements of the branching fractions for b –> c tau nu processes yield results that are more

PoS(ICHEP2018)930

than 4 standard deviations higher than the standard-model expectations. This motivates exploration of potential new physics in these decays, including searches for CP violation. A CP-violating asymmetry requires interference between amplitudes with different CP-violating and CP-conserving phases. We show that these conditions can be satisfied in B –> D** tau nu in the presence of new physics, and describe a new method for measuring the asymmetry at Belle II or LHCb.

**Higgs Physics / 38**

## Sensitive study of the Higgs-strange coupling at FCC-ee

Abi Soffer[1] ; Jordi Duarte Campderros[2] ; Matthias Schlaffer[3] ; Gilad Perez[4]

[1] *Tel Aviv University (IL)*
[2] *Universidad de Cantabria (ES)* [3] *Weizmann Institute of Science* [4] *CERN & Weizmann*

**Corresponding Author(s):** gilad.perez@cern.ch, matthias.j.schlaffer@gmail.com, jorge.duarte.campderros@cern.ch, abner.soffer@cern.ch

Precise measurment of the Higgs couplings is a central part of the energy-frontier physics program. Obtaining the small couplings to light states is particularly difficult. We describe a new technique for studying the Higgs coupling to the strange quark using H –> ssbar events at a 250 GeV e+e- collider. With this method, the sensitivity of the proposed FCC-ee collider is at a level of only a few times the standard-model expectation. This is a large improvement over previous proposals, yielding sensitivity to a variety of new-physics scenarios.

**Neutrino Physics / 43**

## Neutrino Oscillation Probabilities in Matter

**Author(s):** Peter Denton[1]
**Co-author(s):** Stephen Parke [2]

[1] *Niels Bohr International Academy*
[2] *Fermi National Accelerator Lab. (US)*

**Corresponding Author(s):** peterbd1@gmail.com, parke@fnal.gov

Recent advances in ways to calculate the neutrino oscillation probabilities in matter will be present as well as their utility for long baseline oscillation experiments. These methods are not only numerically accurate enough for all current and future experiments but provide better analytic understanding then other methods. How accurate an oscillation probability is needed for long baseline experiments will also be discussed as well as the significance of variations in the matter density along the neutrino path line.

**POSTER / 44**

## Development of profiling system for low energy physics

**Author(s):** Insung Yeo[1]
**Co-author(s):** Kihyeon Cho [1]

[1] *KISTI*

**Corresponding Author(s):** cho@kisti.re.kr, madjjang150@kisti.re.kr

The Standard Model in particle physics is refined. However, new physics beyond the standard model, such as dark matter, requires thousand to million times of simulation events compared to those of the Standard Model. Thus, the development of software is required, especially for the development of simulation tool kits. In addition, computing is evolving. It requires the development of the simulation tool kit to accommodate the evolving computing architecture. Therefore, an efficient simulation tool kit is needed. Then, a profiling system is required to confirm it. In Geant4, a typical simulation tool kit, a profiling system in higher-energy physics areas such as the LHC experiment is well developed, contributing to the development of the software. However, profiling systems in the low-energy physics domain are in the beginning stage. Therefore, we develop it and show performances using it. In addition, profiling is performed depending on the development of soft- ware. These profiling systems could be used to confirm the development of software for evolving computing architecture.



**Detector: R&D for Present and Future Facilities / 46**

# Status of DUNE experiment

Jianming Bian[1]

[1] *University of California Irvine (US)*

**Corresponding Author(s):** bianjm@uci.edu

The Deep Underground Neutrino Experiment (DUNE) provides a rich science program with the focus on the neutrino oscillation physics, proton decay studies and Supernova explosions. The high-intensity wide-band neutrino beam will be produced at Fermilab and will be directed to the 40 kt Liquid Argon far detector at the Sanford Underground Research Facility (SURF), 1300 km from Fermilab. One of the most important goals of the experiment is to determine the neutrino mass ordering and the measurement of the CP violating phase. The underground location of the large DUNE far detector and its excellent energy and spatial resolution will allow also conducting non-accelerator physics programs predicted by GUT models, such as nucleon decay or n-nbar oscillations. Moreover, it will be sensitive to measure of the electron neutrino flux from a core-collapse supernova providing valuable information on the mechanism of a supernova. This ambitious project involves worldwide contribution and extensive prototyping and testing program to guarantee that all parts of the technology are fully understood and well tested. Two such prototypes, in both single phase (ProtoDUNE-SP) and dual phase (ProtoDUNE-DP) technologies, are under construction and will be operated at the CERN Neutrino Platform (NP) starting in 2018.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 48**

# LBNF Beamline

Heidi Marie Schellman[1]

[1] *Oregon State University (US)*

**Corresponding Author(s):** heidi.schellman@science.oregonstate.edu, heidi.schellman@oregonstate.edu

The Long Baseline Neutrino Facility (LBNF) will utilize a beamline located at Fermilab to provide and aim a neutrino beam of sufficient intensity and appropriate energy range toward DUNE detectors, placed deep underground at the Sanford Underground Research Facility (SURF) in South Dakota. LBNF is designed for approximately twenty years of operation, to provide adequate exposure for the DUNE experiment. During its lifetime, the facility must be able to accommodate various target and focusing configurations to enable tuning of the neutrino energy spectrum.
The primary proton beam (60-120 GeV) will be extracted from the MI-10 section of Fermilab's Main Injector.

Neutrinos are produced after the protons hit a solid target and produce mesons, which are subsequently focused by magnetic horns into a 194m long decay pipe where they decay into muons and neutrinos. The parameters of the facility were determined by taking into account the physics goals, spatial and radiological constraints and the experience gained by operating the NuMI facility at Fermilab. The Beamline facility is designed for initial operation at a proton-beam power of 1.2 MW, with the capability to support an upgrade to about 2.4 MW. LBNF/DUNE obtained CD-1 approval in November 2015. We discuss here the design status and the associated challenges as well as the R&D and plans for improvements before baselining the facility, and we will present results of a beam optimization algorithm developed to maximize DUNE's sensitivity to neutrino CP violation, yielding substantial improvements to the neutrino flux and physics sensitivities.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 50**

## CEPC Accelerator CDR and R&D towards TDR

Jie Gao[1]

[1] *Institute of High Energy Physics, China*

**Corresponding Author(s):** gaoj@ihep.ac.cn

In this talk, CEPC CDR status will be reported which relects the CEPC accelerator baeline design status with Higgs, W, and Z operation modes, which includes parameters, collider ring, booster and injection linac designs, including SCRF system, civil engeneering design, cost breakdown and Ac power consumption analysis.
As for CEPC TDR phase, the key R&D issues are addressed with CEPC project timeline.

**Beyond the Standard Model / 55**

## Loop Induced Single Top Partner Production and Decay at the LHC

Ian Lewis[1] ; Jeong Han Kim[2] ; K.C. Kong[2] ; Haider Alhazmi[None]

[1] *The University of Kansas*
[2] *University of Kansas*

**Corresponding Author(s):** jeonghan.kim@ku.edu, kckong@ku.edu, ian.lewis@ku.edu

Most searches for top partners, T, are concerned with top partner pair production. However, as these bounds become increasingly stringent, the LHC energy will saturate and single top partner production will become more important. We study the LHC sensitivity to single top partner production in a model where the Standard Model (SM) is extended by an SU(2) singlet top partner and a SM gauge singlet scalar, S. In this model, it is possible that the scalar singlet can mediate loop induced $gg \to T\,t$ production, where t is the SM top quark. In fact, we find that the production rate of this channel can be comparable to top partner pair production at top partner masses of $M_T > 1.5$ TeV. In addition, while most current searches focus on the decays $T \to tZ$, $T \to th$, $T \to Wb$ decays, in this model the decay pattern of the top partner can be significantly altered with new decay modes $T \to gt$, $T \to \gamma t$, and $T \to St$. We give an overview of the various production and decay channels of the top partner in this model and classify which modes are dominant in which regions of parameter space. We then project the the sensitivity of the high luminosity LHC to $gg \to T\,t$.

**Beyond the Standard Model / 60**

## The MoEDAL Experiment at the LHC - a New Light on the High Energy Frontier

James Pinfold[1]

[1] *University of Alberta (CA)*

**Corresponding Author(s):** james.pinfold@cern.ch

MoEDAL, is a pioneering LHC experiment designed to search for anomalously ionizing messengers of new physics such as magnetic monopoles or massive (pseudo-)stable charged particles, that are predicted to existing a plethora of models beyond the Standard Model. It started data taking at the LHC at a centre-of-mass energy of 13 TeV, in 2015. Its ground breaking physics program defines a number of scenarios that yield potentially revolutionary insights into such foundational questions as: are there extra dimensions or new symmetries; what is the mechanism for the generation of mass; does magnetic charge exist; and what is the nature of dark matter. MoEDAL purpose is to meet such far-reaching challenges at the frontier of the field. We will present the results from the MoEDAL detector on Magnetic Monopole and highly ionizing electrically charged particle production that are the world's best. In conclusion, progress on the installation of MoEDAL's MAPP (MoEDAL Apparatus for the detection of Penetrating Particles) sub-detector prototype will be very briefly be discussed.

PoS(ICHEP2018)930

**Beyond the Standard Model / 62**

# The unexplored landscape of top-partner decays

Ian Lewis[1] ; Jeong Han Kim[2] ; Haider Alhazmi[None] ; K.C. Kong[2]

[1] *The University of Kansas*
[2] *University of Kansas*

**Corresponding Author(s):** kckong@ku.edu, ian.lewis@ku.edu, jeonghan.kim@ku.edu

We discuss the LHC sensitivity to top partner production in a model where the Standard Model (SM) is extended by an SU(2) singlet top partner and a SM gauge singlet scalar.
Unlike most searches for top partners which are concerned with three conventional decay modes, Wb, tZ and tH, the decay pattern of the top partner in this model can be significantly altered with new decay modes, gluon + top, photon + top and singlet scalar + top.
We present a new approach to search for a pair-produced top partner that decays to a top quark and a gluon (photon). We give an overview of the various production and decay channels of the top partner and project the sensitivity of the high luminosity LHC.

**Detector: R&D for Present and Future Facilities / 67**

# Ultra-Fast Hadronic Calorimetry

Dmitri Denisov[1] ; Strahinja Lukic[2] ; Nikolai Mokhov[1] ; Sergei Striganov[3] ; Predrag Ujic[4]

[1] *Fermi National Accelerator Lab. (US)*
[2] *University of Belgrade (RS)*
[3] *Fermilab*
[4] *University of Belgrade*

**Corresponding Author(s):** strahinja.lukic@cern.ch, strigano@fnal.gov, mokhov@fnal.gov, denisovd@fnal.gov

Calorimeters for particle physics experiments with integration time of a few ns will substantially improve the capability of the experiment to resolve event pileup and to reject backgrounds. In this paper time development of hadronic showers induced by 30 and 60 GeV positive pions and 120 GeV protons is studied using Monte Carlo

simulation and beam tests with a prototype of a sampling steel- scintillator hadronic calorimeter. In the beam tests, scintillator signals induced by hadronic showers in steel are sampled with a period of 0.2 ns and precisely time-aligned in order to study the average signal waveform at various locations w.r.t. the beam particle impact. Simulations of the same setup are performed using the MARS15 code. Both simulation and test beam results suggest that energy deposition in steel calorimeters develop over a time shorter than 3 ns providing opportunity for ultra- fast calorimetry. Simulation results for an ideal calorimeter consisting exclusively of bulk tungsten or copper are presented to establish the lower limit of the signal integration window.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 72**

## Fermilab Accelerator Complex: Status, Progress, and Near-and Far- Future Upgrade Plans

Vladimir Shiltsev[None] ; Sergei Nagaitsev[None] ; Mary Convery[None] ; Michael Lindgren[None] ; Ioanis Kourbanis[None] ; Alexander Valishev[None] ; Phil Adamson[1]

[1] *Fermi National Accelerator Laboratory*

**Corresponding Author(s):** pa@fnal.gov, nsergei@fnal.gov, shiltsev@fnal.gov

We present status of operation and recent progress of the Fermilab proton accelerators, and discuss in our activities toward their near- and far-future upgrades. We also present the spectrum of related accelerator physics and technology R&D activities, including those at the US-leading FAST/IOTA research facility for the intensity frontier beam studies.

**Astro-particle Physics and Cosmology / 76**

## Ultralight Axion Dark Matter and Structure Formation

Kingman Cheung[1]

[1] *National Tsing Hua University (TW)*

**Corresponding Author(s):** kingman.cheung@cern.ch

The Ultra-Light Axion (ULA) is a dark matter candidate with mass 10^{-22} eV and de-Broglie wavelength of order kpc. Such an axion, also called the Fuzzy Dark Matter (FDM), thermalizes via the gravitational force and forms a Bose-Einstein condensate. The quantum pressure from FDM can significantly affect the structure formation in small scales, thus alleviating the so-called "small-scale crisis." We develop a new technique to discretize the quantum pressure and use N-body simulations to show the formation of the dark matter halo and its inner structure. We find a constant density solitonic core, which potentially solves the problems of small-scale crisis.
We also investigate the effects of quantum pressure (QP) in cosmological simulations and find that QP leads to further suppression of the matter power spectrum at small scales. We then estimate the flux power spectrum of Lyman-alpha forest, and compare it to the data from BOSS and XQ-100 to set the lower bound on the FDM particle mass to 10^{−23} eV.

**Astro-particle Physics and Cosmology / 79**

## First Results from the DAMPE Mission

PoS(ICHEP2018)930

Xin Wu[1] ; for DAMPE Collaboration[None] ; Andrii Tykhonov[1]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** andrii.tykhonov@cern.ch, xin.wu@cern.ch

DAMPE (DArk Matter Particle Explorer) is a satellite mission of the Chinese Academy of Sciences (CAS) dedicated to high energy cosmic ray detections. Since its successful launch on December 17th, 2015 a large amount of cosmic ray data has been collected. With relatively large acceptance, DAMPE is designed to detect electrons (and positrons) up to 10 TeV with unprecedented energy resolution to search for new features in the cosmic ray electron plus positron (CRE) spectrum. It will also study cosmic ray nuclei up to 100 TeV with good precision, which will bring new input to the study of their still unknown origin and their propagation through the Galaxy.
In this talk, the DAMPE mission will be introduced, together with some details of the construction and on-ground calibration of the detector subsystems. The in-orbit detector commissioning, calibra- tion and operation will be described. First data analysis results will be presented.

**Strong Interactions and Hadron Physics / 80**

# First-principles lattice QCD calculation of the neutron lifetime

**Author(s):** Enrico Rinaldi[1] ; Enrico Rinaldi[2]
**Co-author(s):** C. C. Chang ; A. Nicholson ; E. Berkowitz ; N. Garron ; D. Brantley ; H. Monge-Camacho ; C. Monahan ; C. Bouchard ; M. Clark ; B. Joo ; T. Kurth ; K. Orginos ; P. Vranas ; A. Walker-Loud

[1] *RIKEN BNL Research Center*
[2] *Lawrence Livermore National Laboratory*

**Corresponding Author(s):** rinaldi2@llnl.gov, erinaldi.work@gmail.com

There is an intriguing discrepancy in the measurements of the neutron lifetime. The almost $4\sigma$ difference has recently been highlighted due to new high-precision experiments using ultra cold trapped neutrons and it could indicate the existence of new physics.
Thanks to the Standard Model relation between the lifetime and the axial coupling $g_A$ of the neutron, which governs it's transition to a proton, a first-principle QCD calculation of $g_A$ could shed light on the experimental discrepancy and new physics.
Lattice QCD provides a robust framework to numerically compute inherently non-perturbative quantities from first principles. Starting only from the Lagrangian of QCD and owing to new improved numerical algorithms, we calculate the axial coupling of the neutron with unprecedented precision and thus obtain the neutron lifetime: $\tau_n = 885(15)$ seconds.
This calculation is challenging and the outcome is very promising: it paves the way to understanding nuclear observables directly from QCD degrees of freedom with high accuracy.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 83**

# CEPC injector linac design

Cai Meng[1]

[1] *Institute of High Energy Physics, CAS*

**Corresponding Author(s):** lxp@ihep.ac.cn, mengc@ihep.ac.cn

PoS(ICHEP2018)930

Circular Electron-Positron Collider (CEPC) is a 100 km ring e+ e- collider for a Higgs factory. The injector of CEPC is composed of linac and booster. The linac is a normal conducting S-band linac and provide electron and positron beam at an energy up to 10 GeV with repetition frequency in 100 Hz. The linac consideration and design will be detailed discussed, including electron linac, positron linac, positron source and damping ring.

**Higgs Physics / 84**

## Prospects for measuring Higgs triscalar coupling at the HL-LHC and HL-100 TeV hadron collider

**Author(s):** Chih-Ting Lu[None]
**Co-author(s):** Jae Sik Lee [1] ; Jubin Park [1] ; Jung Chang [2] ; Kingman Cheung [3]

[1] *Chonnam National University*
[2] *National Center for Theoretical Sciences, Physics Division*
[3] *National Tsing Hua University (TW)*

**Corresponding Author(s):** timluyu@yahoo.com.tw,honolov77@gmail.com,chang.jung@mx.nthu.edu.tw,jslee@jnu.ac.kr, kingman.cheung@cern.ch

We perform the most up-to-date comprehensive signal-background analysis for Higgs-pair production in $HH \to bb\gamma\gamma$ channel at the HL-LHC with the goal of probing the self-coupling $\lambda_{3\mathrm{H}}$ of the Higgs boson. We simulate all the standard-model signal and background processes with the simulation tools almost as sophisticated as what experimentalists are using. At the HL-LHC, the Higgs boson self-coupling would be constrained to $-1.0\lambda_{3\mathrm{H}} < 7.6$ at 95 \% confidence level after considering the uncertainties associated with the top-Yukawa coupling and the estimation of backgrouds. Some crucial kinematic distributions and significance performances are also shown to display our analysis informaitons. Here we also extend the study to the HL-100 TeV hadron collider. We find that, at the SM value, the coupling can be measured with about 20 (7) \% accuracy assuming 3 (30) $ab^{-1}$.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 85**

## Recent ILC R&D status

Shinichiro MICHIZONO[1]

[1] *KEK*

**Corresponding Author(s):** shinichiro.michizono@kek.jp

Key technologies for the ILC are nano-beam and superconducing rf system (SRF). The final beam size at 250GeV ILC, which was announced at ICFA on last November, is ~8nm. In case of 250 GeV ILC, the number of SRF cavities becomes half (compared with 500 GeV). However, the cost of the SRF is still dominant in the ILC accelerator cost. We have started the cost reduction R&D at SRF since last year. The recent progress of these key technologies will be reported.

**Strong Interactions and Hadron Physics / 88**

## Measurement of Jet Production Cross Sections in Deep-inelastic ep Scattering at HERA

Stefan Schmitt[1] ; H1 Collaboration[2] ; Daniel Britzger[3]

[1] *Deutsches Elektronen-Synchrotron (DE)*
[2] *DESY*
[3] *Ruprecht Karls Universitaet Heidelberg (DE)*

**Corresponding Author(s):** daniel.britzger@cern.ch, stefan.schmitt@desy.de, stefan.schmitt@cern.ch

A precision measurement of jet cross sections in neutral current deep-inelastic scattering for photon virtualities $5.5 < Q^2 < 80$ GeV$^2$ and inelasticities $0.2 < y < 0.6$ is presented, using data taken with the H1 detector at HERA, corresponding to an integrated luminosity of 290 pb$^{-1}$. Double-differential inclusive jet, dijet and trijet cross sections are measured simultaneously and are presented as a function of jet transverse momentum observables and as a function of $Q^2$. Jet cross sections normalised to the inclusive neutral current DIS cross section in the respective $Q^2$-interval are also determined. Previous results of inclusive jet cross sections in the range $150 < Q^2 < 15000$ GeV$^2$ are extended to low transverse jet momenta $5 < P_T < 7$ GeV. The data are compared to predictions from perturbative QCD in next-to-leading order in the strong coupling, in approximate next-to-next-to-leading order and in full next-to-next-to-leading order. Using also the recently published H1 jet data at high values of $Q^2$, the strong coupling constant $\alpha_s(M_Z)$ is determined in next-to-leading order.
Eur.Phys.J.C77 (2017) 4, 215 [arxiv:1611.03421]

**POSTER / 92**

## Exclusive Photoproduction of $2\pi+2\pi-$ Final State at HERA

Stefan Schmitt[1]; H1 Collaboration[2]; Arthur Bolz[3]

[1] *Deutsches Elektronen-Synchrotron (DE)*
[2] *DESY*
[3] *Ruprecht Karls Universitaet Heidelberg (DE)*

**Corresponding Author(s):** arthur.bolz@cern.ch, stefan.schmitt@desy.de, stefan.schmitt@cern.ch

Exclusive production of four charged pions at the ep collider HERA is studied at small photon virtualities $Q^2 < 2$GeV$^2$. The data were taken with the H1 detector in the years 2006 and 2007 at a centre-of-mass energy of $\sqrt{s} = 319$ GeV and correspond to an integrated luminosity of $7.6$ pb$^{-1}$. The cross section of the reaction $\gamma p \to 2(\pi^+\pi^-)Y$ is determined in the phase space of $45 < W_{\gamma p} < 100$ GeV, $|t| < 1$ GeV$^2$ and $M_Y < 1.6$ GeV. The $4\pi$ mass spectra indicate that the reaction proceeds predominatly via production and decay of $\rho'(1450)$ and $\rho''(1700)$ resonances. Parameters of these resonances as well as production cross sections times branching ratio into four charged pions are estimated from the mass fit, which includes contributions from non-resonant $4\pi$ channel and inter- ference terms.

**Strong Interactions and Hadron Physics / 96**

## QCD analysis of the ATLAS and CMS W and Z cross-section measurements and implications for the strange sea density

Amanda Cooper-Sarkar[None]; Katarzyna Wichmann[1]; Oleksii Turkot[1]

[1] *Deutsches Elektronen-Synchrotron (DE)*

**Corresponding Author(s):** oleksii.turkot@cern.ch, katarzyna.wichmann@desy.de, a.cooper-sarkar@physics.ox.ac.uk

In the present paper, the ATLAS inclusive $W^\pm$ and $Z$ boson production data are analysed together with the CMS inclusive $W^\pm$ and $Z$ boson production data to investigate any possible tensions be- tween the data sets and to determine the strange sea fraction, within the framework of a parton distribution function fit at next-

PoS(ICHEP2018)930

to next-to leading order in perturbative QCD.

**Neutrino Physics / 98**

## Results from the CUORE experiment

CUORE Collaboration[1] ; Stefano Pozzi[2]

[1] *CUORE*
[2] *INFN - National Institute for Nuclear Physics*

**Corresponding Author(s):** stefano.pozzi@mib.infn.it

The Cryogenic Underground Observatory for Rare Events (CUORE) is the first bolometric experiment searching for neutrinoless double beta decay that has been able to reach the 1-ton scale. The detector consists of an array of 988 TeO2 crystals arranged in a cylindrical compact structure of 19 towers. The construction of the experiment and, in particular, the installation of all towers in the cryostat was completed in August 2016 and data taking started in spring 2017. In this talk we present the neutrinoless double beta decay results of CUORE from examining a total TeO2 exposure of 86.3 kg yr, characterized by an effective energy resolution of 7.7 keV FWHM and a background in the region of interest of 0.014 counts/(keV kg yr). In this physics run, CUORE placed a lower limit on the decay half-life of 130Te > 1.3 10^25 yr (90% C.L.). We then discuss the improvements in the detector performance achieved in 2018, the new results on the background model and the latest update on the study of rare processes in Tellurium.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 101**

## HTS Technology R&D for Future High Energy Accelerators

Qingjin XU[1]

[1] *IHEP*

**Corresponding Author(s):** xuqj@ihep.ac.cn

R&D of high field HTS magnet technology is ongoing at IHEP (Beijing, China) for future high energy accelerators. A hybrid twin-aperture dipole magnet is under development for SPPC pre-study. The magnet is designed with Common-coil configuration and will be fabricated with Nb3Sn and HTS superconductors. The main field is 12 T with 20% operating margin at 4.2 K. The aperture diameter is 30 mm. The fabrication and experimental test is divided into 3 steps: 1) 4 flat racetrack NbTi coils and 2 flat racetrack Nb3Sn coils are firstly fabricated and tested, to evaluate the fabrication process and stress management of Nb3Sn coils. 2) 2 more Nb3Sn coils are fabricated and tested together with the 1st 2 Nb3Sn coils, to provide 12 T main field in the top and bottom apertures with the diameter of 20 mm. 3) 2 racetrack HTS coils with flared ends are fabricated and inserted into the 4 Nb3Sn coils, to provide 12 T main field in the top and bottom apertures with the diameter of 30 mm. The main design parameters, fabrication process and test results of the magnet will be presented. The R&D plan and steps for next years will also be discussed.

**POSTER / 104**

## Advancements of THGEM in IHEP, China

Yuguang Xie[1]

[1] *Institute of High Energy Physics, CAS, Beijing, China*

**Corresponding Author(s):** ygxie@ihep.ac.cn

Thick Gaseous Electron Multiplier (THGEM) is one of the promising Micro-pattern Gaseous Detectors. It can be applied to Digital Hadron Calorimeter (DHCAL), TPC tracker readout, Muon detector, single photon detector, neutron imaging and so on. The attractive advantages of THGEM are high gain, robust and low cost. The moderate spacial resolution limits its applications but it is acceptable in many cases as listed above. In recent years, we have made continuous effort to improve THGEM performances, develop new types of THGEMs and. The hole pitch and hole diameter can be reached 400 μm and 150 μm by mechanical drilling and 300 μm and 100 μm by laser sputtering respectively. The sensitive area of a single film can be reached 1.0×0.5m^2. The laser sputtering is hopeful to overcome the mass production difficulty of THGEM. Our test results indicated that better substrate, better performance. The specified FR4 substrate for high performance THGEM was made according to more than 10 types of FR4s. Besides FR4 THGEM, the PTFE, Ceramic and Kapton (PI) THGEMs were also developed for low background experiments and neutron imaging. Another attractive direction is the new structure THGEMs, such as Multi-layer THGEM (M-THGEM), Well-THGEM and so on. M-THGEM shows excellent gain performance within a single thin film. The newly progresses will be also presented.

**POSTER / 105**

## Calibration of the CMS preshower detector in LHC Run2

Long Hoa Cao Phuc[1]

[1] *National Central University (TW)*

**Corresponding Author(s):** cplhoa89@gmail.com

The preshower detector, part of the CMS endcap electromagnetic calorimeter, is designed to have good spatial resolution to distinguish between different types of incoming particles. The preshower is a sampling detector with two layers of lead absorber, each followed by 1.9mm pitch silicon strip sensors. Each of the 4288 DC-coupled sensors has an active area of 61x61mm^2, making a total sur- face of around 16m^2. The in-situ calibration is performed using isolated charged hadrons, which are close to minimum-ionizing. The precision required for the calibration of the preshower is largely determined by the fraction of energy deposited in the preshower with respect to that in the CMS end-cap crystal calorimeter. The required channel-to-channel calibration precision is 5%. The achieved precision is better than 5%. In this poster, the calibration strategy and results with LHC Run2 data will be described.

**POSTER / 106**

## Performance Measurements of B-tagging Algorithms in CMS

Joshuha Thomas-Wilsker[1]

[1] *Institute Of High Energy Physics, Beijing*

**Corresponding Author(s):** joshuha.thomas-wilsker@cern.ch

The identification of jets originating from b-quarks is of great importance to many physics analyses. For this reason, a great deal of effort has been put into developing several algorithms that can efficiently distinguish b-jets from light and c-jets. These algorithms typically use information re- garding reconstructed objects such as the jet's tracks, secondary vertices and jet-associated leptons. This information is then fed into a multivariate classifier to distinguish whether or not the jet originated from a b-quark. The efficiency with which an algorithm can identify b-jets can differ between simulation and data and therefore correction factors are derived from the ratio of these efficiencies. Several methods have been developed to correct the b-tagging

efficiences in MC from the analysis of data events. This poster will focus on the results from techniques that use multijet and ttbar events for the CMS b-tagging algorithms using data collected from 13TeV proton-proton collisions.

**Neutrino Physics / 107**

## Long-range interactions at current and future neutrino oscillation experiments

Sushant Raut[1] ; Hye-Sung Lee[2] ; Hooman Davoudiasl[3] ; William Marciano[None]

[1] *IBS CTPU, Daejeon, South Korea*
[2] *Institute for Basic Science*
[3] *BNL*

**Corresponding Author(s):** hooman@bnl.gov, leeprime@gmail.com, sushantkr@gmail.com

The presence of flavoured symmetries like $U(1)_{L_e - L_\mu}$, etc. can affect the propagation of neutrinos by introducing new interactions. If the mediating gauge bosons corresponding to these symmetries are ultra light, then the nucleons and electrons in the sun can generate a long-range potential that can modify the neutrino oscillation probabilities for earth-based experiments. We study the effect of these long-range interactions on long-baseline and atmospheric neutrino experiments. We constrain the parameter space of these new physics scenarios using current oscillation data. We discuss the effect that these interactions can have on future data, and calculate the projected bounds from future experiments. We also discuss the smoking-gun signatures that can distinguish these scenarios from other non-standard interactions.

**POSTER / 116**

## A Search for Vector-Like Quark Pair Production using a New Multiclassification Machine Learning Algorithm for Boosted Final State at CMS

Justin Pilot[1]

[1] *University of California Davis (US)*

**Corresponding Author(s):** justin.pilot@cern.ch

We present a unique search for vector-like T quark pair production, targeting all possible decay modes tH, tZ, and bW, of the T quark at once. We use data collected from the CMS experiment at center of mass energy of 13 TeV. We use a multivariate algorithm, the 'boosted event shape tagger' (BEST), to classify candidate jets as originating from top quarks, W, Z, or Higgs bosons. BEST uses kinematic distributions evaluated in several hypothesized reference frames of the candidate jet as inputs to a neural network-based machine-learning algorithm, to better determine consistency with the decay products of a heavy standard model particle. With this multiclassification algorithm, we categorize candidate events according to multiplicities of heavy objects observed in the final state, and use the sum of all observed jet momenta to better discriminate signal events from the expected QCD multijet backgrounds. With this strategy, we increase signal acceptance relative to standard search techniques, and obtain sensitivities competitive with existing VLQ searches, optimized for specific final states.

**Beyond the Standard Model / 118**

# Searches for electroweakly produced supersymmetry with CMS

Valentina Dutta[1]

[1] *Univ. of California Santa Barbara (US)*

**Corresponding Author(s):** valentina.dutta@cern.ch

In supersymmetric models where colored sparticles are beyond the reach of the LHC, the electroweak production of SUSY particles may constitute the dominant SUSY processes that could be observed at the LHC. In this talk, I will discuss the results of CMS searches for electroweakinos and sleptons. These searches are challenging because of the low production cross sections, however the growing LHC dataset allows us to improve our sensitivity to these signal processes.



**Neutrino Physics / 122**

# New Results from Double Chooz

Achim Stahl[1] ; Anatael Cabrera[2]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[2] *IN2P3/CNRS*

**Corresponding Author(s):** anatael.cabrera@gmail.com, stahl@physik.rwth-aachen.de

The reactor neutrino experiment Double Chooz observes electron-antineutrinos from two French power plants at Chooz with two identical detectors at different baselines. From the observed neutrino deficit the mixing angle theta_13 can be determined within the three flavour-scenario and signatures from further generations can be searched for. We will report the status of the experiment and present new results.

**Detector: R&D for Present and Future Facilities / 126**

# The CMS Tracker Upgrade for the High Luminosity LHC

Martin Delcourt[1]

[1] *Universite Catholique de Louvain (UCL) (BE)*

**Corresponding Author(s):** martin.delcourt@cern.ch

The LHC machine is planning an upgrade program which will smoothly bring the luminosity at about 5*10^34cm-2s-1 in 2028, to possibly reach an integrated luminosity of 3000fb-1 by the end of 2037. This High Luminosity LHC scenario, HL-LHC, will require a preparation program of the LHC detectors known as Phase-2 upgrade. The current CMS Outer Tracker, already running beyond design specifications, and CMS Phase1 Pixel Detector will not be able to survive HL-LHC radiation conditions and CMS will need completely new devices, in order to fully exploit the high-demanding operating conditions and the delivered luminosity. The new Outer Tracker should have also trigger capabilities. To achieve such goals, R&D activities are ongoing to explore options either for the Outer Tracker, either for the pixel Inner Tracker. Solutions are being developed that would allow including tracking information at Level-1. The design choices for the Tracker upgrades are discussed along with some highlights of the R&D activities.

**Higgs Physics / 128**

# Fiducial inclusive and differential Higgs boson cross sections at CMS

Vittorio Raoul Tavolaro[1]

[1] *ETH Zurich (CH)*

**Corresponding Author(s):** vittorio.tavolaro@cern.ch

The measurement of fiducial inclusive and differential Higgs boson cross sections allows the study of its properties under a minimal set of assumptions. By defining a fiducial phase-space, the uncertainties due to model dependence and extrapolations are minimized. A new, extended set of measurements performed using 35.9/fb of pp collisions collected by the CMS experiment at LHC in 2016 is presented. The measurements, obtained in the diphoton and ZZ decay channels, cover a wide range of differential observables, describing the kinematic properties of the Higgs boson, of its decay products and of particles produced in association with it. Fiducial measurements targeting individual production mechanisms are also presented.

**Beyond the Standard Model / 133**

# Searches for SUSY with boosted objects at CMS

Arnd Meyer[1] ; Rishi Gautam Patel[2]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[2] *University of Colorado Boulder (US)*

**Corresponding Author(s):** rpatel@cern.ch

Searches for supersymmetry at the LHC have pushed the mass limits for strongly-produced sparticles to the TeV level and make the reconstruction and identification of boosted objects to an essential tool for current and future searches for supersymmetry. These objects can originate from the final stage of a short decay chain, or arise heavy gauge or Higgs bosons produced in a decay chain. The talk summaries the use of large-radius jets and substructure techniques in searches such as the ones for the pair production of gluinos or third generation squarks in proton-proton collisions at 13 TeV.

**Beyond the Standard Model / 137**

# Searches for new physics in dijet and multijet final states

Arnd Meyer[1] ; Sung Won Lee[2]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[2] *Texas Tech University (US)*

**Corresponding Author(s):** sungwon.lee@cern.ch

Results of searches for new physics in the dijet and multijet final states are presented. These include model-independent and model-specific searches using the dijet invariant mass spectrum and the dijet angular distributions, searches for black holes, quantum and microscopic, in multijet events, as well as searches for RPV SUSY in events with paired dijets. This talk focuses on the recent results obtained using data collected at Run-

PoS(ICHEP2018)930

II of the LHC.

**Heavy Ions / 145**

## Bottomonium production in PbPb collisions from CMS

Jaebeom Park[1]

[1] *Korea University (KR)*

**Corresponding Author(s):** jaebeom.park@cern.ch

The relative yields and the nuclear modification factors of the ground and excited Upsilon states were measured via dimuon channels in PbPb collisions at 5.02 TeV. The analysis was performed as functions of collision centrality, rapidity, and transverse momentum. The results in PbPb are com- pared with the previous ones in pPb collisions. The results are discussed in terms of the sequential melting scenario in dense partonic matter.

**Heavy Ions / 147**

## Open charm measurements in heavy ion collisions with the CMS detector

Hyunchul Kim[1]

[1] *Chonnam National University (KR)*

**Corresponding Author(s):** hyunchul.kim@cern.ch

Charm mesons are excellent probes for studying the properties of the hot and dense medium created in heavy-ion collisions. The measurement of their nuclear modification factor, elliptic and triangular flow can provide strong constraints for the mechanisms of in-medium energy loss. In this talk, the latest measurements of the $D^0$ in PbPb collisions at 5.02 TeV will be presented.

**Quark and Lepton Flavor Physics / 152**

## Angular analyses at CMS

Geng Chen[1]

[1] *Peking University (CN)*

**Corresponding Author(s):** normanaachen@gmail.com

Angular analyses of penguin B hadron decays such as B0->Kll constitute one of the main indirect probes of new physics at LHC, due to the clean theoretical predictions and precise experimental results that can be obtained. In this report we present the most recent results of the CMS experiment on this subject,including the measurement of the P1 and P5' angular variables in B0->Kmumu decays and the angular analysis of the B+->K+mumu process.

**Top Quark and Electroweak Physics / 159**

# Anomalous top quark couplings, FCNC, and EFT interpretations in CMS

**Corresponding Author(s):** alexander.grohsjean@desy.de

Top quark production can probe physics beyond the SM in different ways. Some processes, and especially certain angular correlations, are sensitive to the existence of anomalous top quark couplings. In the SM, flavour-changing neutral currents (FCNC) are forbidden at tree level and are strongly suppressed in loop corrections. Several extensions of the SM incorporate significantly enhanced FCNC behaviour that can be directly probed in top quark processes. Current approaches adopting an EFT framework allow describing effects of new physics in a model independent way. This talks reviews the current limits on possible anomalous couplings of the top quark, FCNC searches in the top sector, and EFT interpretations.



**Strong Interactions and Hadron Physics / 160**

# Measurement of the Minimum Bias, Underlying Events and Double-Parton Scatterings at CMS

Arnd Meyer[1]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*

**Corresponding Author(s):** ankita.mehta@cern.ch, ed.scott@cern.ch

We present recent results on Minimum Bias, Underlying Events and Double Parton Scattering using data recorded by CMS detector at the LHC. The results on the measurement of the underlying event using leading tracks, jets, and Drell-Yan processes are presented. Double parton scattering is investigated in several final states including vector bosons and multi-jets, and the results are com- pared to other experiments and to MPI models tuned to recent underlying event measurements at CMS.

**Higgs Physics / 162**

# Constraints on CP-violating couplings of the Higgs boson using its decay to fermions in the CMS experiment

Senka Duric[1]

[1] *Kansas State University (US)*

**Corresponding Author(s):** senka.duric@cern.ch

A study of anomalous Higgs boson couplings and CP violation is presented using the Higgs boson decay mode with a pair of fermions in the final state. Associated production of the Higgs boson with two jets is used in this analysis, which is driven by the VBF, VH, and gluon fusion production mechanisms. Constraints on the anomalous couplings and CP-violating parameters are obtained by the CMS experiment with the Run-II data.

**Higgs Physics / 165**

# The latest results of the measurement of the Higgs boson decaying to tau lepton pairs at CMS

Abdollah Mohammadi[1]

[1] *Kansas State University (US)*

**Corresponding Author(s):** abdollah.mohammadi@cern.ch

The latest results of the measurement of the Higgs boson decaying to tau lepton pairs will be presented. The analysis is performed using data collected with the CMS experiment in 2016 and 2017 at the LHC from pp collisions at centre-of-mass energies of 13 TeV.

**Higgs Physics / 166**

# Measurements of the Higgs boson mass, production and decay rates and constraints on its couplings at CMS

Nicholas Wardle[1]

[1] *Imperial College (GB)*

**Corresponding Author(s):** nicholas.wardle@cern.ch

Combined measurements of the Higgs boson mass, production and decay rates, as well its couplings to vector bosons and fermions, are presented. The analysis uses the LHC pp collisions recorded by the CMS detector in 2016 at centre-of-mass energies of 13 TeV.

**Higgs Physics / 171**

# Searches of double Higgs boson production with CMS

Devdatta Majumder[1]

[1] *University of Kansas (KU)*

**Corresponding Author(s):** devdatta.majumder@cern.ch

The search for standard model (SM) double Higgs boson (HH) production using data collected by the CMS detector at the CERN LHC will be presented, using final states from various decay channels: HH->bbbb, bbVV, bbtautau, and bbgammagamma. The HH production serves to measure the self- coupling of the Higgs boson, the rate of which is small in the SM. However, contributions from beyond standard models can significantly enhance the rate. Furthermore, many BSM particles may decay to HH, which are then manifested as a resonance in the HH invariant mass spectrum. Also final state topologies are considered with highly Lorentz-boosted H bosons, which occur for high mass resonance decays, and for large non-SM contributions to the top quark-Higgs boson coupling strength. In this case, jet substructure-based H tagging techniques are used to identify H bosons in the hadronic decay channel. The results showcase the latest upper limits on the production cross sections of the double Higgs boson production, assuming SM and several non-SM Higgs boson self- coupling values. Upper limits are also placed on the production cross sections of massive spin-0 and spin-2 resonances decaying to a HH.

PoS(ICHEP2018)930

**Heavy Ions / 172**

# nPDF studies with electroweak bosons in pPb collisions with the CMS detector

Andre Govinda Stahl Leiton[1]

[1] *Centre National de la Recherche Scientifique (FR)*

**Corresponding Author(s):** andre.govinda.stahl.leiton@cern.ch

Yields of W and Z bosons can be used to probe the nuclear parton distribution functions of quarks and antiquarks. Results on W boson and Drell-Yan production in pPb collisions using the CMS detector will be presented. The lepton decay channel is used to study both positive and negative W bosons as a function of lepton pseudorapidity. Rapidity and charge asymmetries in the W yield are studied. The Drell-Yan cross section is extracted as functions of the dimuon mass for the first time in pPb collisions, and both as a function of dimuon transverse momentum and rapidity, in the Z boson mass region.

**Higgs Physics / 174**

# Prospects for Higgs Boson Measurements at the High-Luminosity LHC with CMS

Sylvie Braibant-Giacomelli[1]

[1] *Universita e INFN, Bologna (IT)*

**Corresponding Author(s):** sylvie.braibant@cern.ch

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

**Beyond the Standard Model / 178**

# Search for new resonances coupling to third generation quarks at CMS

Arnd Meyer[1] ; Kevin Connor Nash[2]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[2] *Rutgers State Univ. of New Jersey (US)*

**Corresponding Author(s):** knash201@gmail.com

We present an overview of searches for new physics with top and bottom quarks in the final state, using proton-proton collision data collected with the CMS detector at the CERN LHC at a center-of-mass energy of 13 TeV. The results cover non-SUSY based extensions of the SM, including heavy gauge bosons or excited third

generation quarks. Decay channels to vector-like top partner quarks, such as T', are also considered. We explore the use of jet substructure techniques to reconstruct highly boosted objects in events, enhancing the sensitivity of these searches.

**Dark Matter Detection / 183**

## New Physics searches at BESIII

BESIII Collaboration[None] ; Shenjian Chen[1]

[1] *Nanjing University (CN)*

**Corresponding Author(s):** shenjian.chen@cern.ch, fabrizio.bianchi@to.infn.it

Many models of physics beyond the SM, motivated by the recent astrophysical anomalies, include the possibility of a new types of weak-interacting degrees of freedom. Typical models, such as Next-to-Minimal Supersymmetric SM and Light Hidden Dark-sector model, predict a low-mass Higgs and a Dark Bosons, respectively. The masses and decay modes of these particles are expected to be accessible at the BESIII experiment. BESIII has recently performed searches of light Higgs and Dark Bosons in several decay modes using the data collected at $J/\psi$, $\psi(2S)$ and $\psi(3770)$ resonances. In the data sample at the $J/\psi$ a search of possible invisible decays of light vector mesons V and pseudo- scalar mesons via $J/\psi \to VP$ decays ($V = \omega, \phi$ and $P = \eta, \eta'$) has also been performed. This talk will summarize BESIII recent results on these searches for new physics.

**Detector: R&D for Present and Future Facilities / 187**

## The Belle II Experiment: Status and Prospects

Shuji Tanaka[1]

[1] *KEK*

**Corresponding Author(s):** shuji.tanaka@kek.jp

The Belle II experiment is a substantial upgrade of the Belle detector and will operate at the SuperKEKB energy-asymmetric $e^+e^-$ collider. The accelerator has already successfully completed the first phase of commissioning in 2016. First electron positron collisions in Belle II are expected for April 2018. The design luminosity of SuperKEKB is $8 \times 10^{35}$ cm$^{-2}$s$^{-1}$ and the Belle II experiment aims to record 50 ab$^{-1}$ of data, a factor of 50 more than the Belle experiment. This large data set will be accumulated with low backgrounds and high trigger efficiencies in a clean $e^+e^-$ environment. This talk will review the detector upgrade, the achieved detector performance and the plans for the commissioning of Belle II

**Quark and Lepton Flavor Physics / 191**

## Determination of the CKM matrix elements $|V_{ub}|$ and $|V_{cb}|$ at Belle II

Ida Peruzzi[1] ; Thomas Lueck[2]

[1] *Laboratori Nazionali di Frascati dell'INFN*
[2] *INFN - National Institute for Nuclear Physics*

**Corresponding Author(s):** thomas.lueck@pi.infn.it, peruzzi@slac.stanford.edu

The Belle II experiment is a substantial upgrade of the Belle detector and will operate at the SuperKEKB

energy-asymmetric $e^+e^-$ collider. The accelerator has already successfully completed the first phase of commissioning in 2016 and first electron positron collisions in Belle II are expected for April 2018. The design luminosity of SuperKEKB is $8 \times 10^{35}$ cm$^{-2}$s$^{-1}$ and the Belle II experiment aims to record 50 ab$^{-1}$ of data, a factor of 50 more than the Belle experiment. In this presentation we report our prospects for CKM favoured and suppressed semileptonic $B$ meson decays (with a light lepton) and how they can be used to better understand the CKM matrix element magnitudes $|V_{ub}|$ and $|V_{cb}|$.

**Strong Interactions and Hadron Physics / 193**

## Exotic and Conventional Quarkonium Physics Prospects at Belle II

Ida Peruzzi[1] ; Youngjoon Kwon[2]

[1] *Laboratori Nazionali di Frascati dell'INFN*
[2] *Yonsei University*

**Corresponding Author(s):** yjkwon63@yonsei.ac.kr, peruzzi@slac.stanford.edu

The Belle II experiment, now operating at the KEK laboratory in Japan, is a substantial upgrade of both the Belle detector and the KEKB $e^+e^-$accelerator. It aims to collect 50 times more data than existing B-Factory samples. Belle II is uniquely capable to study the so-called "XYZ" particles: heavy exotic hadrons consisting of more than three quarks. First discovered by Belle, these now number in the dozens, and represent the emergence of a new category within quantum chromodynamics. This talk will present the capabilities of Belle II to explore both exotic and conventional quarkonium physics.

**Quark and Lepton Flavor Physics / 200**

## $\Lambda^+_c$ physics with BESIII threshold data

BESIII Collaboration[None] ; Haiping Peng[1]

[1] *University of Science and Technology of China (CN)*

**Corresponding Author(s):** haiping.peng@cern.ch, fabrizio.bianchi@to.infn.it

The BESIII detector accumulated 567 pb$^{-1}$ of data at the center-of-mass energy of 4.6 GeV, which is the world's largest $e^+e^-$ sample at the $\Lambda_c$ pair threshold. By analyzing this data sample, we report the determinations of the absolute branching fractions of the semi-leptonic decays of $\Lambda^+_c \to \Lambda e^+\nu$ and $\Lambda\mu^+\nu$, the hadronic decays of $\Lambda^+_c \to pK_S$, $pK^-\pi^+$, $pK_S\pi^0$, $pK_S\pi^+\pi^-$, $\Lambda\pi^+$, $\Lambda\pi^+\pi^0$, $\Lambda\pi^+\pi^+\pi^-$, $pK^-\pi^+\pi^0$, $\Sigma^0$ and $\Sigma^-\pi^+\pi^+\pi^0$, as well as the inclusive $\Lambda$ and electron decays. The accurancies of the absolute branching fractions for most decays are improved significantly compared to the previous measurements. We will aslo report cross section measurement of $e^+e^- \to \Lambda^+_c\Lambda^-_c$ near threshold at BESIII.

**Strong Interactions and Hadron Physics / 202**

## Baryonic Decays of Charmonium at BESIII

BESIII Collaboration[None] ; Hao Cai[1]

[1] *Wuhan University (CN)*

**Corresponding Author(s):** hao.cai@cern.ch, fabrizio.bianchi@to.infn.it

For the first time the branching ratio and the angular distribution of the decay $\psi(3686) \to n\bar{n}$ have been measured. At the same time also the branching ratio and angular distribution of the decay $\psi(3686) \to p\bar{p}$ have been measured with unprecedented precision. It turns out that the two branching ratio are quite close, implying that the phase between strong and electromagnetic part is close to 90 degrees for the "magnetic" part, while since the angular distributions are different very likely the "electric" part behaves in a different way.

**POSTER / 204**

## Measurement of ttbb production at 13 TeV with the CMS experiment

Chanwook Hwang[1]

[1] *Sungkyunkwan University (KR)*

**Corresponding Author(s):** chanwook.hwang@cern.ch

The measurement of the cross section ratio $\sigma_{t\bar{t}b\bar{b}} / \sigma_{t\bar{t}jj}$ is performed in pp collisions at $\sqrt{s} = 13$ TeV with the CMS detector at the LHC. Events with two leptons (e or μ) and at least four reconstructed jets, including at least two identified as b quark jets, in the final state are selected. The ratio is measured at the particle in visible phase space and the parton level in the full phase space. The measurement is compatible with the expectation obtained from the POWHEG simulation interfaced with PYTHIA.

**POSTER / 213**

## Search for additional Higgs Bosons in Final States with b-Quarks with the LHC Run II data at CMS

Arnd Meyer[1] ; Chayanit Asawatangtrakuldee[2]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[2] *Deutsches Elektronen-Synchrotron (DESY)*

**Corresponding Author(s):** chayanit.asawatangtrakuldee@cern.ch

Properties of the discovered 125 GeV Higgs boson are in good agreement with the predictions of the Standard Model (SM). However, the current precision of these measurements, allows models, such as Supersymmetry, with extended Higgs sectors, in which the discovered Higgs boson is only one of several Higgs bosons. The work focuses on the search for high mass Higgs bosons in a final state with b-quarks will be presented. The analysis was performed with data collected by the CMS experiment at a center-of-mass energy of 13 TeV in the year 2016, corresponding to an integrated luminosity of 36.9 fb-1. Results of this analysis, as well as they interpretation within models, including the Minimal Supersymmetric Standard Model and Two Higgs Doublets Model, will be shown.

**POSTER / 214**

## Study of hadronic processes in the energy interval from 2 GeV up to 3.08 GeV at BESIII.

PoS(ICHEP2018)930

BESIII Collaboration[None] ; Guangshun Huang[1]

[1] *University of Science and Technology of China (CN)*

**Corresponding Author(s):** hgs@ustc.edu.cn, fabrizio.bianchi@to.infn.it

500 pb$^{-1}$ of data have been collected by BESIII between 2.0GeV and 3.08 GeV. Recent results on the line-shape of $e^+e^- \to \phi\pi\pi$, $K^+K^-$, $2(K^+K^-)$, $\phi\eta$, $\phi\eta'$, $\omega\pi^0$, $\omega\eta$ are reported. Possible new resonances in these channels are studied, in particular the $\phi(2170)$, that may be the strange partner of the Y(4260).

**POSTER / 216**

## ttH(bb) in leptonic final state with CMS

Marcel Rieger[1]

[1] *RWTH Aachen University (DE)*

**Corresponding Author(s):** marcel.rieger@cern.ch

We present a search for the standard model Higgs boson decaying into b quarks and produced in association with a pair of top quarks in the leptonic final states. This search has been performed on the full 13-TeV dataset of proton-proton collisions collected by the CMS experiment at the LHC in 2016. To separate the $t\bar{t}H$ signal from the irreducible $t\bar{t}$ + $b\bar{b}$ background, this analysis takes advantage of several different innovative methods that are a Deep Neural Network (DNN), a Matrix Element Method (MEM), and a Boosted Decision Tree (BDT).

**Top Quark and Electroweak Physics / 217**

## Direct and indirect measurements of the top quark mass in $p\bar{p}$ collisions

**Corresponding Author(s):** stefan.soldner-rembold@cern.ch

We discuss extractions of the pole mass of the top quark based on measurements of the inclusive and unfolded differential $p\bar{p} \to t\bar{t}$ production cross section as a function of $p_T(t)$ and $M(t\bar{t})$. We use the full Run II (2001–2011) data set of $p\bar{p}$ collisions at $\sqrt{s} = 1.96$TeV collected by the D0 experiment, corresponding to an integrated luminosity of $9.7$ fb$^{-1}$. We compare the indirect extraction to the final combination of direct measurements of the top quark mass at D0 and to the preliminary D0+CDF combination.

**POSTER / 218**

## Search for the Standard Model Higgs boson in the dilepton plus a photon channel at 13 TeV with CMS

Ming-Yan Lee[1]

[1] *National Central University (TW)*

**Corresponding Author(s):** a342545@gmail.com

This poster presents the search for a Higgs boson decaying into dileptons plus a photon. This topology has contributions from Z boson and a photon or two photons, one of which has an internal conversion into a lepton pair. This is one of the important rare Higgs decay channels and can be used to probe new physics as well. The results with the data collected by the CMS detector at the LHC from proton-proton collisions at 13TeV in 2016 will be shown.

**Top Quark and Electroweak Physics / 219**

## Forward-backward asymmetry in $p\bar{p} \to t\bar{t}$ events at the Tevatron

Bob Hirosky[1]

[1] *University of Virginia (US)*

**Corresponding Author(s):** bob.hirosky@cern.ch

We discuss the asymmetry between yields of forward- and backward-produced top and antitop quarks in $p\bar{p} \to t\bar{t}$ events at the Tevatron collider. These measurements use the full Run II data set in lepton plus jets and dilepton channels, recorded in the D0 and CDF detectors, corresponding to an integrated luminosity of $\approx 2 \times 10$ fb$^{-1}$. The combinations of inclusive and differential asymmetries are presented and compared with recent standard model predictions.

**Top Quark and Electroweak Physics / 220**

## Measurements of the effective weak mixing angle in at D0

**Corresponding Author(s):** siqi.yang@cern.ch

We present the measurements of forward-backward charge asymmetry AFB in pp¯ → Z/γ∗ → μ+μ− events using 9.7 fb−1 of pp¯data collected at √s = 1.96 TeV by the D0 detector at the Fermilab Tevatron collider. AFB is measured as a function of the invariant mass of the dimuon system to extract the effective weak mixing angle sin2 θefflep . This measurement is combined with a previous measurement performed in the pp¯ → Z/γ∗ → e+e− channel at D0. In the context of the2 2 2 standard model, using the on-shell renormalization scheme where sin θW = 1 − MW/MZ, the measurement of yields an indirect extraction of the W.

**Top Quark and Electroweak Physics / 221**

## Measurements and combination of the weak mixing angle at the Tevatron and extraction of the W mass

**Corresponding Author(s):** liang.han@cern.ch

We combine four measurements of the forward-backward charge asymmetry AFB in pp¯ → Z/γ∗ → e+e−/μ+μ− + X events using ∼ 10 fb−1 of pp¯ data collected at √s = 1.96 TeV by the CDF and D0 detectors at the Fermilab Tevatron collider. AFB is measured as a function of the invariant mass of the dilepton system to extract the effective weak mixing angle sin2 θefflep . We discuss the combination of these measurements and present the indirect extraction of the W mass in the context of the standard model.

PoS(ICHEP2018)930

**Strong Interactions and Hadron Physics / 223**

# Studies of the $X^{\pm}(5568)$ state and Evidence for Zc±(3900) in b-flavored Hadron Decays at D0

Bob Hirosky[1] ; Boris Tuchming[2] ; D0 Collaboration[None] ; Dmitri Denisov[3]

[1] *University of Virginia (US)*
[2] *CEA Saclay*
[3] *Fermi National Accelerator Lab. (US)*

**Corresponding Author(s):** denisovd@fnal.gov, bob.hirosky@cern.ch, tuchming@cea.fr

We study the production of a narrow structure X±(5568) decaying to Bs0π± produced in 10.4 fb−1 of pp¯collisions recorded by the D0 detector at the Fermilab Tevatron collider at √s = 1.96 TeV. We report evidence for the production of X±(5568) using the semileptonic mode Bs0 → μ∓Ds±X with Ds± → ϕπ±. The results are consistent with the previous measurements by D0 of the production of X±(5568) using the hadronic decay Bs0 → J/ψϕ. The mass and width of this state are measured using a combined fit of the hadronic and semileptonic data.

**POSTER / 228**

# Search for high mass resonances decaying into four lepton final state at 13 TeV with the CMS detector

Arnd Meyer[1]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*

**Corresponding Author(s):** ed.scott@cern.ch

A search for heavy resonances decaying into four-lepton final states in pp collisions is performed. This search is based on the data collected in CMS detector at the LHC. The full 2016 dataset corresponding to an integrated luminosity of 36 /fb at the center-of-mass energy of 13 TeV is used. Benchmark signal samples are generated using Monte Carlo simulation. Event selection takes into account the inefficiency arising from the boosted signature. Data-driven method is used to determine backgrounds with respect to fake muons. Upper limits on the cross section times branching ratio as a function of resonance mass are presented.

**POSTER / 230**

# Searches for dark matter in CMS in non-hadronic final states

Arnd Meyer[1]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*

**Corresponding Author(s):** ed.scott@cern.ch

Searches for a weakly interacting particle candidate (WIMP) for dark matter at the Large hadron Collider complement the WIMP direct detection experiments and is one of the major physics goals of the LHC. A series of analyses in CMS (and ATLAS) are aimed at detecting events where a pair of WIMPs may have been produced and recoiled against a visible particle. Such events give rise to final states with large Missing ET and a high pT object, e.g. a jet, a photon, or a weakly interacting gauge boson. Searches for dark matter in final states with

PoS(ICHEP2018)930

invisible particles recoiling against leptons and photons are presented in this talk. Various topologies are explored where several dark-matter pro- duction modes are covered. The talk focuses on the recent results obtained using the data collected during 2016 run of the LHC.

**Diversity and Inclusion / 236**

## Strategies to improve diversity and inclusion in physics

Brian Beckford[1]

[1] *University of Michigan*

**Corresponding Author(s):** bobeck@umich.edu

The number of physics and astronomy bachelor's and doctoral degrees earned in the US continues to increase. However, the degrees earned by underrepresented minority (URM) groups continues to be a small percentage and is on a downward trend for Black/African American students.
National societies such as the American Physical Society (APS) and the American Institute of Physics (AIP) have acknowledged there must be action taken to improve the situation. APS has started the National Mentoring Network, the APS Bridge Program, sponsored the CUWiP conferences, and published the LGBT climate in physics report. AIP has recently launched the TEAM-UP Task Force to investigate the reasons for the persistent underrepresentation of African American undergraduate students in physics and astronomy.
In this talk, I will recap levels of representation in physical sciences, discuss current national efforts and outline some initiatives at the University of Michigan aimed to improve diversity and inclusion in physics.

**Formal Theory Development / 239**

## Casimir scaling and Yang-Mills glueballs

Deog Ki Hong[1]

[1] *Pusan National University (KR)*

**Corresponding Author(s):** d.hong@cern.ch

We conjecture that in Yang-Mills theories the ratio between the ground-state glueball mass squared and the string tension is proportional to the ratio of the eigenvalues of quadratic Casimir operators in the adjoint and the fundamental representations. The proportionality constant depends on the dimension of the space-time only, and is henceforth universal. We argue that this universality, which is supported by available lattice results, is a direct consequence of area-law confinement. In order to explain this universal behaviour, we provide three analytical arguments, based respectively on a Bethe-Salpeter analysis, on the saturation of the scale anomaly by the lightest scalar glueball and on QCD sum rules, commenting on the underlying assumptions that they entail and on their physical implications.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 245**

## Machine-Detector Interface at the CEPC

Hongbo Zhu[1] ; Jie Gao[2] ; Xinchou Lou[3] ; Ke LI[None] ; Xiongfei Wang[1] ; Wei Xu[None] ; Sha Bai[4] ; Yiwei WANG[None]

[1] *Chinese Academy of Sciences (CN)*
[2] *Institute of High Energy Physics, China*
[3] *University of Texas at Dallas (US)*
[4] *IHEP*

**Corresponding Author(s):** wangyw@ihep.ac.cn, gaoj@ihep.ac.cn, xuwei@ihep.ac.cn, xinchou.lou@cern.ch, like@ihep.ac.cn, xiongfei.wang@cern.ch, baisha@ihep.ac.cn, hongbo.zhu@cern.ch

Machine-Detector Interface (MDI) represents one of the most challenging topics for the Circular Electron Positron Collider (CEPC), which is proposed as a Higgs Factory to measure Higgs properties with unprecedented precision. MDI involves critical machine and detector components in the constrained interaction region. Performance optimization, often along with considerable trade-offs, can be only achieved with thorough understandings of machine and detector designs and their impacts on each other. In this talk, design progress on the interaction region (IR) layout, the IR superconducting magnets and the luminosity calorimeter will be presented. Predicted radiation backgrounds and their potential impacts will be also discussed.

PoS(ICHEP2018)930

**Accelerators: Physics, Performance, and R&D for Future Facilities / 246**

# Progress on the 650MHz/800kW CW klystron development at IHEP

Zusheng Zhou[1] ; Jianli Wang[None] ; Shengchang Wang[None] ; Yunlong Chi[None] ; Yuan Chen[None] ; Zhijun Lu[None] ; Ouzheng Xiao[None] ; Guan Shu[None] ; Ningchuang Zhou[None] ; Xiang He[None] ; Dong Dong[None] ; Fukuda Shikegi[None] ; Shilun Pei[None] ; Guoxi Pei[None] ; Zaib Nisa[None] ; Shengchang Wang[1]

[1] *IHEP*

**Corresponding Author(s):** wangsc@ihep.ac.cn, zhouzs@ihep.ac.cn

The configurations of the CEPC and the SPPC were proposed in September, 2012. To reduce the costs of the construction and the operation, high efficiency klystrons is preferred for the Collider ring. In this scenario, the plan to develop the high efficiency 650MHz/800kW CW klystron with an ultimate goal of 80% is initialized. Since there are no any experiences and infrastructures such as the large baking furnace and the high power testing stand to develop these kind of high power CW klystrons in China, the 1st klystron prototype is based on the conventional 2nd harmonic bunching technology, then more klystron prototypes will be made with steady improvement of the efficiency. In this paper, the progress on the 1st 650MHz/800kW CW klystron prototype development at IHEP is presented. Till now, the mechanical design of the 1st klystron prototype has been finished; the fabrication will be started soon. In addition, the design of the 2nd klystron prototype and the strategic plan to progressively increase the klystron efficiency will also be shown.

**Strong Interactions and Hadron Physics / 249**

# Strong coupling from a nonperturbative determination of the QCD Λ-parameter

Patrick Fritzsch[1] ; Mattia Bruno[2] ; Mattia Dalla Brida[3] ; Tomasz Korzec[4] ; Alberto Ramos[5] ; Stefan Schaefer[6] ; Hubert Simma[6] ; Stefan Sint[5] ; Rainer Sommer[7]

[1] *CERN*
[2] *BNL*
[3] *INFN*
[4] *Wuppertal University*
[5] *Trinity College Dublin*
[6] *DESY*
[7] *DESY & HU Berlin*

**Corresponding Author(s):** patrick.fritzsch@cern.ch

We present a first-principle determination of the Λ parameter and the strong coupling at the Z pole mass. Computing the nonperturbative running of the coupling in the range from 200 MeV to 70 GeV, and using experimental input values for the masses and decay constants of the pion and the kaon, we obtain α(mZ)=0.11852(84). The nonperturbative running up to very high energies guarantees that systematic effects associated with perturbation theory are well under control.

**POSTER / 250**

# Interesting Models unifying Neutrino Mass, Dark Matter, Origin of PMNS and CKM, and GUT

Alexander Natale[1] ; Arnab Dasgupta[2] ; Oleg Popov[3] ; Sin Kyu Kang[4]

[1] *Korea Institute for Advanced Study*
[2] *Jamia Millia Islamia*
[3] *UC Riverside*
[4] *Seoul-Tech*

**Corresponding Author(s):** arnabdasgupta28@gmail.com, skkang@snut.ac.kr, opopo001@ucr.edu, alex.anderson.natale@gmail.com

The Standard Model of particle physics have been extremely successful so far, but there are still many unanswered questions like the origin of neutrino mass, nature of dark matter, the source of quark and lepton flavor mixing and their possible correlation, the theory of grand unification of all SM interactions. In this talk I will focus on some interesting models that attempt to answer these questions and possible correlation between them. Embedding a Pati-Salam quark-lepton unification symmetry, $SU(4)_c \otimes SU(2)_L \otimes U(1)_R$, into SU(7) GUT with a Scotogenic radiate neutrino mass and LHC phenomenology will be discussed. I will also touch on $G_{SM} \otimes U(1)_{B-L}$ with residual $Z_4$ symmetry leading to Scotogenic radiative Dirac neutrino masses with dark matter, $0\nu4\beta$ and absence of $0\nu2\beta$ signal and phenomenology of related rare processes. Possible common origin of CKM and PMNS mixings in a complete model. Other possible topics will include chiral dark sector with composite dark matter leading to Scotogenic two loop neutrino mass and neutrino portal to SM.

**Neutrino Physics / 254**

# Updated MiniBooNE Neutrino Oscillation Results within the Context of Global Fits to Short-Baseline Neutrino Data

Alejandro Diaz[1]

[1] *Massachusetts Institute of Technology*

**Corresponding Author(s):** diaza@mit.edu

In its original 2002-2007 run, MiniBooNE observed an anomalous and yet-unexplained excess of electromagnetic events at low energy neutrino energies. This observation is one of several that has pushed the discussion and search for sterile neutrinos. Since 2016, MiniBooNE has been collecting new neutrino-mode data, doubling the statistics from the original 2002-2007 run. We will revisit the originally observed excess, with one analysis treating the new data as stand alone, and another anal- ysis looking at the combined data. We will then discuss the global fits to the world's short-baseline neutrino data, focusing on models with sterile neutrinos and including the updated MiniBooNE results.

PoS(ICHEP2018)930

**Strong Interactions and Hadron Physics / 257**

# Quark jet fraction in multi-jet final states and quark gluon discrimination

Yasuhito Sakaki[1]

[1] *KAIST*

**Corresponding Author(s):** yasuhito.sakaki@kaist.ac.kr

We calculate quark and gluon jet fraction in multi-jet final states at the LHC, which is based on perturbative QCD at next-to-double logarithmic accuracy. We find a measurable scaling pattern of the fraction. This is related to a performance of new physics searches using quark-gluon jet discrimination in multi-jet final states, and would be useful for more understanding of QCD and tuning of Monte-Carlo generators. We also introduce a variable which is related to jet flavors in multi-jet final states, and propose a data-driven method using the variable to reduce systematic uncertainties of the analysis. We show how the background rejection using the method increase for signals which produce many quark jets.

**POSTER / 261**

# Upgrade plan for RENO

hyungi lee[1]

[1] *SNU*

**Corresponding Author(s):** physilhg@gmail.com

The more precise measurement of theta13 is valuable for determining the CP violating phase if combined with an accelerator neutrino beam experimental result. We plan to upgrade the RENO facility to make a precise measurement of theta13 and dm_ee^2 and to solve the problem of the 5 MeV excess in the measured reactor neutrino spectrum. We propose to add more identical near and far detectors and to construct further far detectors located at 1.7 km away from the center of reactor array. In this talk, we present the uprade plan for RENO with expected sensitivities.

**Heavy Ions / 262**

# A Fixed-Target Program at the LHC (AFTER@LHC): where do we stand ?

Jean-Philippe Lansberg[1] ; Zhenwei Yang[2]

[1] *IPN Orsay, Paris Sud U. / IN2P3-CNRS*
[2] *Tsinghua University (CN)*

**Corresponding Author(s):** zhenwei.yang@cern.ch, lansberg@in2p3.fr

We review the physics opportunities 1 which are offered by a next generation and multi-purpose fixed-target program exploiting the LHC beams in order to study pp, pd and pA collisions at $\sqrt{s_{NN}} \sim 115$GeV as as well as Pbp and PbA collisions at $\sqrt{s_{NN}} \sim 72$ GeV. These opportunities span spin, heavy-ion, nucleon-structure and astroparticle physics.

We propose two possible implementations, namely with an internal (polarised) gas target or with a "splitted" beam by a bent crystal which both provide typical instantaneous luminosities [1,2] for pp and pA collisions which surpass that of RHIC by more than 3 orders of magnitude and are comparable to those of the LHC collider mode.
We also discuss our most recent figures of merit [3,4,5] based on two already existing detector set-ups, the LHCb and the ALICE detectors.

**Astro-particle Physics and Cosmology / 263**

## Dark matter in the early matter dominated Universe

Ki-Young Choi[1]

[1] *Sungkyunkwan University (KR)*

**Corresponding Author(s):** ki-young.choi@cern.ch

In the early Universe, there exists a matter-dominated era, that is driven by inflaton oscillation, curvaton, moduli or long-lived heavy particles. In this early matter domination, dark matter exists and show different behavior from the standard one during radiation domination, from the relics density to the density perturbation, constraints on the reheating temperature and baryogengesis. In this talk, I will present the recent developments.

**Detector: R&D for Present and Future Facilities / 264**

## Electron and photon identification with the ATLAS detector

Nadezda Proklova[1]

[1] *National Research Nuclear University MEPhI (RU)*

**Corresponding Author(s):** nadezda.proklova@cern.ch

Excellent electron and photon identification capabilities are crucial for many aspects of the ATLAS physics program, from standard model measurements (including Higgs boson) to new physics searches. The identification of prompt photons and the rejection of backgrounds, mostly coming from photons from hadron decays, relies on the high granularity of the ATLAS calorimeter. Electron identification is based on a likelihood discrimination to separate isolated electron candidates from candidates originating from photon conversions, hadron misidentification and heavy flavor decays. Isolation variables are used as further handles to extract the signal. The measurement of the efficiencies of the identification and isolation cuts are performed using several high-statistics data samples, including Z->ee and J/psi->ee decays, radiative Z decays, and inclusive high energy photon samples. The results of these measurements, performed with pp collision data recorded at sqrt(s)=13 TeV during 2015-2017 and corresponding to an integrated luminosity of 80 fb-1, are presented. The impact of the pile-up, especially large in the second part of 2017 data taking, is discussed.

**Computing and Data Handling / 267**

## Performance of tau and muon leptons reconstruction and identification in the ATLAS experiment using pp collisions at sqrt(s)=13 TeV and their prospects for the HL-LHC

David Kirchmeier[1]

[1] *Technische Universitaet Dresden (DE)*

**Corresponding Author(s):** david.kirchmeier@mailbox.tu-dresden.de

The ATLAS experiment is a multi-purpose experiment installed at the Large Hadron Collider (LHC) at CERN, designed to study elementary particles and their interactions in high-energy collisions of proton and heavy ion beams.
Muon and Tau leptons play an important role in many physics processes that are being investigated at the LHC. Hadronic decays of the taus are reconstructed from the combined analysis of the calorimeter and inner tracker informations. This contribution details the performance of the identification, trigger, energy calibration and decay mode classification of hadronic decays of the tau leptons with the ATLAS detector using the Run 2 dataset of pp collisions collected at the LHC at a centre-of-mass energy $s$=13 TeV. The algorithms and the criteria used in ATLAS for the reconstruction and identification of muons with transverse momentum from a few GeV to the TeV scale will also be presented. Their performance is measured with data based on the decays of Z and J/$\psi$ to pairs of muons, that provide a large calibration sample.
Reconstruction and identification efficiencies are evaluated, as well as momentum scales and resolutions, and the results are used to derive precise corrections for the MC simulation of ATLAS events. Isolation selection criteria and their performances in presence of high pileup will also be presented.
For the high-luminosity phase of the LHC (HL-LHC), the instantaneous luminosity will increase up to $L \simeq 7.5\times10^{34}cm^{-2}s^{-1}$ leading to an average interactions per bunch crossing of up to 200 and the ATLAS detector will undergo a significant upgrade of its sub-systems, including a complete re- placement of its inner tracker.
The prospects of the reconstruction and identification of tau leptons for the HL-LHC are discussed.

**POSTER / 269**

## Measurement of the tau lepton reconstruction and identification performance in the ATLAS experiment using pp collisions at sqrt(s)=13 TeV

ATLAS Collaboration[None] ; Samuel Dezso Dysch[1]

[1] *University of Manchester (GB)*

**Corresponding Author(s):** samuel.dysch@cern.ch

Tau leptons play an important role in many Standard Model and Beyond the Standard Model physics processes that are being investigated at the LHC. This poster details measurements of the performance of the reconstruction and identification of hadronic tau lepton decays using the ATLAS detector. The measurements include the performance of the identification, trigger, energy calibration and decay mode classification algorithms for reconstructed tau candidates. The performance of these algorithms is measured with Z bosons and top quark decays to tau leptons and uses the Run 2 dataset of pp collisions collected at the LHC at a centre-of-mass energy sqrt(s)=13 TeV.

**Computing and Data Handling / 270**

## Identification of Jets, Missing energy and Boosted Hadronic Resonances in high pile-up conditions with ATLAS

Jeff Dandoy[1]

PoS(ICHEP2018)930

[1] *University of Pennsylvania (US)*

**Corresponding Author(s):** jeff.dandoy@cern.ch

Accurate measurements and identification of jets, missing energy and boosted hadronic resonances are crucial to most of the ATLAS physics programme both in domain of Standard Model precision measurements and search for beyond the SM physics. The ever increasing LHC luminosity while providing higher statistical sensitivity to rare processes, also leads to more challenging experimental conditions due to multiple simultaneous collisions (pile-up). Additional energy falling inside a jet cone can affect both the jet energy scale and resolution leading to performance which depends on the amount of pile-up. Missing Transverse Momentum, formed from all reconstructed objects, is particularly affected by high pile-up. New techniques are developed and presented to improve immunity to the effects of pile-up and maintain or improve resolution and identification capabilities despite more challenging conditions.



**Detector: R&D for Present and Future Facilities / 275**

# The ATLAS FastTracker: Pioneering the next era of hardware track triggers

Tova Ray Holmes[1]

[1] *University of Chicago (US)*

**Corresponding Author(s):** tova.ray.holmes@cern.ch

Though hardware-based trackers were a crucial element of the triggering systems for both D0 and CDF, no such system has yet been incorporated into either ATLAS or CMS. The ATLAS FastTracKer (FTK) is a first step towards this goal, and will soon provide full tracking information for all events passing ATLAS's Level-1 trigger. This system massively reduces the CPU required to identify track- based signatures like b-jets and taus, and allows for the suppression of pile-up effects on missing energy and jet triggers. This talk will present an overview of FTK commissioning and future plans, along with updated projections for FTK performance.

**Detector: R&D for Present and Future Facilities / 278**

# The upgraded trigger system and di-τ trigger strategies of the ATLAS detector at the HL-LHC

Stephanie Majewski[1]

[1] *University of Oregon (US)*

**Corresponding Author(s):** smajewsk@uoregon.edu

When LHC enters the High Luminosity (HL-LHC) phase, the instantaneous luminosity will increase from the current 2 x 10^34 cm-2 s-1 (Run II) to a maximum expected value of 7.5 x 10^34 cm-2 s-1, equivalent to 200 interactions per bunch crossing, and the estimated integrated luminosity will reach 3000 fb-1.
New strategies are needed in order to make triggers more selective and to keep pT thresholds for leptons close to the current ones.
The current trigger system is based on a Level-1 hardware trigger plus a High Level Trigger (HLT) implemented in software, two scenarios are being considered for the HL-LHC phase.
The first one is a single Level-0 which will do a preliminary selection of data to reduce the rate to 1 MHz with a latency of 6 μs followed by a High Level Trigger. This corresponds to a 200 kHz target for a di-τ trigger.
The second scenario would reduce the event rate to 2-4 MHz at Level-0, then a Level-1 trigger will further reduce it to 600-800 kHz, followed again by a High Level Trigger.

The new trigger system will rely on better spatial resolution of the LAr calorimeter of ATLAS, whose granularity will be 4 times improved at Level-0 and 16 times at Level-1. This will improve the turn-on curves and the matching between tracks and clusters, it will make transverse energy measurements of reconstructed objects more accurate and it will allow the use of more sophisticated jet algorithms. Physics motivations for the trigger upgrade at HL-LHC together with an overview of the new trigger system will be given.
The current status of the di-τ trigger at the future HL-LHC Level-0 will then be shown. This study has been performed through simulations of the hadronic decay of the Higgs boson into two taus at a center of mass energy of 14 TeV under a pile-up conditions corresponding to 200 interactions per bunch crossing.
In particular, results on the performance (in terms of turn-on curves and rejection power of the algorithm) will be shown along with the challenges related to the development of this trigger in such a very high pile-up environment.



**Detector: R&D for Present and Future Facilities / 280**

# ATLAS level-1 calorimeter trigger: Phase-I Upgrade Performance

Chiao-Ying Lin[1]

[1] *University of Cambridge (GB)*

**Corresponding Author(s):** chiao-ying.lin@cern.ch

Following the Run 2 LHC data taking, the ATLAS experiment at CERN will enter the first phase (Phase-I) of the planned detector subsystem upgrades. Several systems, in particular, the hardware- based Level-1 calorimeter trigger (L1Calo) will be significantly enhanced to provide improved selectivity at the higher expected pileup in Run 3. During the second long shutdown (LS2) in 2019-2020, the existing L1Calo
electronic processor modules will be replaced with new, advanced boards, called feature extractors, which will receive higher-granularity information from the calorimeters and will support the implementation of more sophisticated algorithms to select electrons or photons, jets, met and large-radius jets. This presentation will summarise the anticipated functionality of the upgraded L1Calo trigger system. In particular, the performance of the preliminary trigger-level algorithms and a comparison to the operation of the Run 2 L1Calo system will be described.

**Detector: R&D for Present and Future Facilities / 282**

# Expected performance of the upgraded ATLAS experiment for HL-LHC

Hector De La Torre Perez[1]

[1] *Michigan State University (US)*

**Corresponding Author(s):** hector.de.la.torre.perez@cern.ch

The Large Hadron Collider (LHC) has been successfully delivering proton-proton collision data at the unprecedented center of mass energy of 13 TeV. An upgrade is planned to increase the instantaneous luminosity delivered by LHC in what is called HL-LHC, aiming to deliver a total of up 3000/fb to 4000/fb of data per experiment. To cope with the expected data-taking conditions ATLAS is planning major upgrades of the detector.
It is now a critical time for these upgrade projects and during the last year and half ATLAS six Technical Design Reports (TDR) were produced by the ATLAS Collaboration. In these TDRs the physics motivation and benefits of such upgrades are discussed together with details on the upgrade project itself.
In this contribution we review the expected performance of the upgraded ATLAS detector and the expected reach for physics measurements as well as the discovery potential for new physics that is expected by the

end of the HL-LHC data-taking. Performance of object reconstruction under the expected pile-up conditions will be shown, including a fully re-optimized b-tagging algorithm. Important benchmark physics projections including di-Higgs boson production sensitivity will be discussed.

**POSTER / 285**

## Measurement of Single Event Upset rates in single pixels of ATLAS IBL

ATLAS Collaboration[None] ; Peilian Liu[1]

[1] *University of California Berkeley (US)*

**Corresponding Author(s):** peilian.liu@cern.ch

Techniques have been developed to determine the single upset rates in individual pixels in the inner- most layer of the ATLAS pixel detector, called IBL. SIngle pixel SEU cannot be observed directly through error reporting of the pixels as there is no such function, nor is there real time monitoring of configuration during operation. Through analysis of cluster data from physics running and time-over-threshold value distributions the upset rates of individual bits have been extracted and compared to expectation from early beam tests of individual devices. The upset rate is large enough to impact precision measurements, such as luminosity determination from cluster rates, which has a 1% target precision. Corrections for SEU must be developed in order to make such measurements.

**POSTER / 286**

## Modeling Radiation Damage to Pixel Sensors in the ATLAS Detector

Marcello Bindi[1]

[1] *Georg August Universitaet Goettingen (DE)*

**Corresponding Author(s):** marcello.bindi@cern.ch

Silicon pixel detectors are at the core of the current and planned upgrade of the ATLAS detector at the Large Hadron Collider (LHC). As the closest detector component to the interaction point, these detectors will be subjected to a significant amount of radiation over their lifetime: prior to the High-Luminosity LHC (HL-LHC), the innermost layers will receive a fluence in excess of 10^15 neq/cm2 and the HL-HLC detector upgrades must cope with an order of magnitude higher fluence integrated over their lifetimes. Simulating radiation damage is critical in order to make accurate predictions for current future detector performance that will enable searches for new particles and forces as well as precision measurements of Standard Model particles such as the Higgs boson. We present a digitization model that includes radiation damage effects to the ATLAS pixel sensors for the first time and considers both planar and 3D sensor designs. In addition to thoroughly describing the setup, we compare predictions for basic pixel cluster properties on leakage currents, depletion voltage, charge collection efficiency, Lorentz angle etc. with real data collected at LHC proton-proton collisions.

**POSTER / 287**

## Single Event Upsets in the ATLAS IBL Frontend ASICs

ATLAS Collaboration[None] ; Pierfrancesco Butti[1]

PoS(ICHEP2018)930

[1] *CERN*

**Corresponding Author(s):** pierfrancesco.butti@cern.ch

During operation at instantaneous luminosities of up to 1.5 /s/cm^2 the frontend chips of the ATLAS innermost pixel layer (IBL) experienced single event upsets affecting its global registers as well as the settings for the individual pixels, causing, amongst other things loss of occupancy, noisy pixels, and silent pixels. A quantitative analysis of the single event upsets as well as the operational issues and mitigation techniques will be presented.

**Detector: R&D for Present and Future Facilities / 291**

# The upgrade of the ATLAS Muon System for High-Luminosity LHC

Yasuyuki Horii[1]

[1] *Nagoya University (JP)*

**Corresponding Author(s):** yasuyuki.horii@cern.ch

The muon spectrometer of the ATLAS detector will undergo a major upgrade during the Long Shut-down 3, in order to cope with the operational conditions at the high-luminosity LHC. The trigger and readout system will be completely redesigned, to support Level-0 trigger rates of 1–4 MHz and a latency of 10 us.
To do so, the readout electronics of all the trigger and precision chambers will be replaced and the precision chambers, that at the moment are not included in the hardware trigger, will be integrated into the Level-0 trigger in order to sharpen the momentum threshold and increase the system redundancy. New-generation RPC chambers will be installed in the inner barrel layer to increase the acceptance and robustness of the trigger. Some of the MDT chambers in the inner barrel layer will be replaced with new small-diameter MDTs. New TGC triplet chambers in the barrel-endcap transition region will replace the current TGC doublets to suppress the high trigger rate from random coincidences in this region. A major upgrade of the power system is also planned. The Phase-II upgrade concludes the process of adapting the muon spectrometer to the ever increasing performance of the LHC, which started with the Phase-I upgrade New Small Wheel (NSW) project that will replace the innermost endcap wheels.

**Detector: R&D for Present and Future Facilities / 295**

# Small-Strip Thin Gap Chambers for the Muon Spectrometer Upgrade of the ATLAS Experiment

Jesse Alan Heilman[1]

[1] *Carleton University (CA)*

**Corresponding Author(s):** jesse.heilman@cern.ch

The instantaneous luminosity of the Large Hadron Collider at CERN will be increased up to a factor of five with respect to the design value by undergoing an extensive upgrade program over the coming decade. Such increase will allow for precise measurements of Higgs boson properties and extend the search for new physics phenomena beyond the Standard Model. The largest phase-1 upgrade project for the ATLAS Muon System is the replacement of the present first station in the forward regions with the so-called New Small Wheels (NSWs) during the long-LHC shutdown in 2019/20. Along with Micromegas, the NSWs will be equipped with eight layers of small-strip thin gap chambers (sTGC) arranged in multilayers of two quadruplets, for a total active surface of more than 2500 $m^2$. All quadruplets have trapezoidal shapes with surface areas up to 2 $m^2$. To retain the good precision tracking and trigger capabilities in the high background environment of the high luminosity LHC, each sTGC plane must achieve a spatial resolution better than 100 μm to allow the Level-1

trigger track segments to be reconstructed with an angular resolution of approximately 1mrad. The basic sTGC structure consists of a grid of gold-plated tungsten wires sandwiched between two resistive cathode planes at a small distance from the wire plane. The precision cathode plane has strips with a 3.2mm pitch for precision readout and the cathode plane on the other side has pads for triggering. The position of each strip must be known with an accuracy of 30 μm along the precision coordinate and 80 μm along the beam. The mechanical precision is a key point and must be controlled and monitored all along the process of construction and integration. The sTGC detectors are currently being produced and tested in five countries and assembled into wedges at CERN for integration into ATLAS. The sTGC design, performance, construction and integration status will be discussed, along with results from tests of the chambers with nearly final electronics with beams and cosmic rays.

**Diversity and Inclusion / 298**

## Regional, Age and Gender Demographics in the ATLAS Collaboration

Luis Roberto Flores Castillo[1]

[1] *The Chinese University of Hong Kong (HK)*

**Corresponding Author(s):** luis.flores.castillo@cern.ch

The ATLAS Collaboration consists of more than 5000 members, with nearly 100 different nationalities. This study presents updated data showing aspects of the regional, age and gender demographics of the collaboration. In particular the relative fraction of women is discussed, including their share of contributions, recognition and positions of responsibility, and showing how this depends on other demographic measures.

**Neutrino Physics / 302**

## An overview of the neutrino interaction cross-section measurements in the T2K experiment

Marat Khabibullin[1]; Callum David Wilkinson[2]

[1] *Russian Academy of Sciences (RU)*
[2] *Universitaet Bern (CH)*

**Corresponding Author(s):** callum.wilkinson@lhep.unibe.ch, marat.khabibullin@cern.ch

In addition to its contributions to our understanding of neutrino oscillation parameters, the T2K long-baseline neutrino oscillation experiment has a complementary program of neutrino interaction cross-section measurements with its near detector complex. With multiple targets (carbon, water, argon, iron), and with on- and off-axis detectors which sample different neutrino spectra from the same beamline, T2K is able to investigate atomic number and energy dependent behavior in a single experiment.
This talk presents an overview of the T2K neutrino cross sections, focusing on the latest results.

**Neutrino Physics / 303**

## Probing neutrino cross-section models with T2K near-detector data

David Hadley[1]

[1] *University Of Warwick*

**Corresponding Author(s):** d.r.hadley@warwick.ac.uk

The T2K long-baseline neutrino oscillation experiment has been running since January 2010 and collected thousands of neutrino-interaction events at the near detectors (ND280 and INGRID) with different targets. The data collected allow us not only to measure the neutrino-interaction cross sections, but also to probe different nuclear models. T2K is developing new tools for unfolding the data in order to infer unbiased cross sections and exploring new variables which probe ambiguities in the modeling of nuclear effects in neutrino interactions at the energies most relevant for current and future neutrino oscillation experiments. An overview of methods probing cross-section models which could be used in other neutrino experiments will be presented in this talk. The impact of nuclear effects on the oscillation analysis will be also outlined.

**Neutrino Physics / 304**

# Search for sterile neutrinos with the T2K far detector

Marat Khabibullin[1] ; Ka Ming Tsui[2]

[1] *Russian Academy of Sciences (RU)*
[2] *University of Tokyo*

**Corresponding Author(s):** kmtsui@icrr.u-tokyo.ac.jp, marat.khabibullin@cern.ch

T2K is a long baseline accelerator neutrino experiment in Japan which studies neutrino oscillations with a narrow-band muon neutrino beam peaked at 0.6 GeV. The large water Cherenkov detector Super-Kamiokande (SK) located 295 km away from the proton target acts as a far detector and provides high quality samples for oscillation analysis. In the present study the T2K setup is used to search for light sterile neutrinos.
Sterile neutrinos are hypothetical particles that do not interact via weak interactions and couple with active neutrinos only through mixing. They are present in many extensions of the Standard Model and can have any masses from 0 to the GUT scale. Light sterile neutrinos of eV masses could modify the standard 3-flavour oscillation pattern and explain anomalies observed in some oscillation experiments.
A sterile neutrino analysis at T2K was developed to constrain $\theta_{24}$ and $\theta_{34}$ mixing elements in the 3+1 sterile neutrino model. This is the first study of sterile neutrinos at T2K which is based on SK data. To enhance the sensitivity to the effects related to the presence of sterile neutrinos, a joint analysis is done using both charged-current and the newly implemented neutral-current (NC) oscillation samples (NC$\pi^0$ with 2 rings observed and NC gamma de-excitation) at the far detector. The primary sensitivity for this sterile search comes from NC samples where we are looking for a deficit due to the oscillations to the sterile neutrino.
The analysis strategy and the results obtained for the current T2K data (2010-2017 data taking) are presented.

**Neutrino Physics / 305**

# Search for heavy neutrinos with the near detector ND280 of the T2K experiment

Marat Khabibullin[1] ; Mathieu Lamoureux[2]

[1] *Russian Academy of Sciences (RU)*
[2] *Université Paris-Saclay (FR)*

**Corresponding Author(s):** mathieu.lamoureux@cern.ch, marat.khabibullin@cern.ch

Heavy Neutral Leptons (HNLs, heavy neutrinos) with masses below the electroweak scale are introduced in some extensions of the Standard Model to address consistently such effects as neutrino oscillations, light neutrino masses, dark matter and baryon asymmetry. In the mass range below 500 MeV/$c^2$ these heavy

neutrinos can be produced in pion or kaon decays, and further decay themselves into charged particles, hence giving a possibility for their detection.
The T2K long-baseline neutrino oscillation experiment utilises an intense neutrino beam, originating mainly from $\pi$ and K parents. Usage of the K flux allows the study of a wider mass range of heavy neutrinos. The near detector complex ND280, located 280 m from the target and composed of various sub-modules operated inside a magnetic field, provides the tracking capabilities to identify the products of HNLs' decays.
A selection aimed to search for heavy neutrino events in the gas-filled ND280 TPCs was developed and optimised to significantly reduce the background from active neutrino interactions down to few events for the current dataset. After applying the selection to the T2K ND280 data $(12.34\nu + 6.29\bar{\nu}) \times 10^{20}$ protons- on-target, 2010-2017 statistics), no events in the signal region were observed. The results were used to extract limits on the mixing parameters between heavy neutrino and electron-, muon- and tau- flavoured currents in the mass range of $140 < M_{\mathrm{HNL}} < 493$ MeV/$c^2$. The T2K data allow an improvement of the limits provided by the previous experiments such as the CERN PS191 which, together with the BNL E949 data, put the most stringent constraints in the mass region studied by T2K.



**Higgs Physics / 307**

# Flavor Changing Neutral Higgs Interactions with Top and Tau at Hadron Colliders

Chung Kao[1]

[1] *University of Oklahoma*

**Corresponding Author(s):** chung.kao@ou.edu

A general two Higgs doublet model (2HDM) is adopted to study the signature of flavor changing neutral Higgs (FCNH) decay $\phi^0 \to t\bar{c} + tc$ and $\phi^0 \to \tau\mu$, where $\phi^0$ could be a CP-even scalar ($H^0$) or a CP-odd pseudoscalar ($A^0$) as well as $t \to ch^0$.
Measurement of the light 125 GeV neutral Higgs boson ($h^0$) couplings at the Large Hadron Collider (LHC) favor the decoupling limit or the alignment limit of a 2HDM, in which gauge boson and diagonal fermion couplings of $h^0$ approach Standard Model values.
In such limit, FCNH couplings of $h^0$ are naturally suppressed by a small mixing parameter $\cos(\beta - \alpha)$, while the off-diagonal couplings of heavier neutral scalars $\phi^0$ are sustained by $\sin(\beta - \alpha) \sim 1$.
We study physics background from dominant processes with realistic acceptance cuts and tagging efficiencies. Promising results are found for the LHC running at 13 or 14 TeV collision energies as well as future pp colliders at 27 TeV, or 100 TeV.

**Top Quark and Electroweak Physics / 310**

# Charming Top Decays with Flavor Changing Neutral Higgs Interactions at Hadron Colliders

Chung Kao[1]

[1] *University of Oklahoma*

**Corresponding Author(s):** chung.kao@ou.edu

We investigate the prospects for discovering a top quark decaying into one light Higgs boson along with a charm quark in top quark pair production at the CERN Large Hadron Collider (LHC) and future hadron colliers.
A general two Higgs doublet model is adopted to study the signature of flavor changing neutral Higgs (FCNH) interactions with $t \to c\phi^0$, followed by $\phi^0 \to bb, ZZ^*$, and $WW^*$, where $\phi^0$ could be CP-even ($h^0$) or CP-odd

($A^0$).
We study the discovery potential for the FCNH signal and physics background from dominant processes with realistic acceptance cuts and tagging efficiencies.
Promising results are found for the LHC running at 13 or 14 TeV collision energies as well as future pp colliders at 28 TeV, 33 TeV, or 100 TeV.

**Formal Theory Development / 312**

## SSB in tensor theories and matrices

Pablo Diaz Benito[1]

[1] *IBS*

**Corresponding Author(s):** pablodiazbe@gmail.com

Counting observables in tensor and in matrix theories reveals a non-trivial relation between them. By means of a SSB mechanism, we explore the connection between tensor theories with symmetry group U(N)^d and symmetrized tensor theories which transform under U(N). We see that, in such a case, the Goldstone boson space precisely organizes itself into a collection of d-1 matrices transforming in the adjoint.

**Beyond the Standard Model / 315**

## The Reach of Thermal Supersymmetric Dark Matter

John Ellis[1] ; Keith Alison Olive[None] ; Feng Luo[1] ; Jiaming Zheng[2] ; Jason Evans[3]

[1] *CERN*
[2] *University of Tokyo*
[3] *University of Minnesota*

**Corresponding Author(s):** f.luo@cern.ch, keith.olive@cern.ch, john.ellis@cern.ch, jasonevans27@gmail.com

The three main successes of supernumerary are: naturlaness, gauge coupling unification, and a thermal dark matter candidate. Although experimental constraints on supersymmetry has pushed it to a region of parameter space which is less natural, the other two motivations for supersymmetry are still in tact. I will discuss under what conditions can we still get a good thermal dark matter candidate. The two main ways being gluino coannihilation and stop coannihilation. These methods of generating a thermal dark matter candidate will persist for dark matter masses up to of order 8 TeV, well beyond the reach of the LHC.

**Neutrino Physics / 317**

## Spectroscopy of the first electrons from the KATRIN tritium source

Magnus Schlösser[1] ; KATRIN Collaboration[None]

[1] *Karlsruhe Institute of Technology, Insitute of Technical Physics, Tritium Laboratory Karlsruhe*

**Corresponding Author(s):** magnus.schloesser@kit.edu

Neutrinos are by far the lightest particles in the Universe. According to the Standard Model of Particle Physics neutrinos should be massless. However, the existence of their mass has been proven experimentally by the observation of neutrino mass oscillations. The KArlsruhe TRitium Neutrino (KATRIN) experiment at the Karlsruhe Institute of Technology aims for a direct neutrino mass determination with a sensitivity of 200 meV/$c^2$ (90% C.L.).
The measurement will be performed by precise spectroscopy of the tritium-β-decay electrons near the kinematic endpoint of 18.6 keV. That is achieved by employing a high-resolution (ΔE < 1 eV) MAC-E-type high-pass energy filter coupled to a high-luminosity ($10^{11}$ Bq) windowless gaseous tritium source which is supplied by the closed gas processing loop of the Tritium Laboratory Karlsruhe (TLK) at throughput of 40 g of $T_2$ per day.
In autumn 2016, the First Light commissioning campaign took place, in which photoelectrons generated from KATRIN's rear wall were guided through the complete beamline (source and spectrometers) and were detected successfully on the detector. During the subsequent experimental stage in summer 2018, gaseous metastable Kr-83m was injected into the KATRIN source section. Furthermore, a condensed Kr-83m source was deployed in the transport section. By using both sources, first high-resolution spectroscopy of electrons from radioactive origin has been performed with KATRIN (arXiv:1802.04167). From this campaign, we could demonstrate many aspects of the high-resolution spectroscopy capability of the KATRIN setup and perform a highly accurate calibration of the energy scale of KATRIN from the mono-energetic conversion electrons from Kr-83m (arXiv:1802.05227).
After the demonstration of the high-resolution performance of the KATRIN spectrometers, in spring 2018, the first injection of tritium into the KATRIN source section is scheduled. The principal aim of this campaign is to demonstrate the stability of the tritium source at an activity of about 1% (~$10^9$ Bq) of the nominal level, which is maintained by a complex tritium loop at the TLK. This stability investigation is crucial in order to operate the tritium source at high isotopic purity (>95%) and a stability of 0.1% during upcoming neutrino mass runs (with a total measurement time of three years).
This talk presents the ambitious goals of KATRIN and the complex setup designed to reach them. The fruitful achievements of the successful Krypton campaign will be summarized and an insight into the results from the first ever high-resolution spectroscopy with tritium beta-decay electrons by KATRIN is given.

PoS(ICHEP2018)930

**Detector: R&D for Present and Future Facilities / 318**

# Construction and performance of the Top and Bottom Counting Detectors for the ISS-CREAM experiment

HongJoo Kim[1]

[1] *Kyungpook National University*

**Corresponding Author(s):** hongjooknu@gmail.com

The Cosmic Ray Energetics And Mass experiment for the International Space Station, ISS-CREAM, aims to study the origin, acceleration and propagation mechanisms of high-energy cosmic rays. The ISS-CREAM detector was launched in August 2017 to the ISS aboard the SpaceX-12 Dragon space-craft. The Top Counting Detector (TCD) and Bottom Counting Detector (BCD) are parts of the ISS- CREAM instrument and they are designed for electron and gamma-ray physics. The TCD/BCD can distinguish electrons from protons using differences in shape between electromagnetic and hadronic showers. In addition, the TCD/BCD can provide a complementary trigger to that from the calorimeter and a low energy trigger to the ISS-CREAM instrument. For these purposes, the TCD/BCD are designed as 2-dimensional detectors, which consist of a plastic scintillator attached to 20 x 20 photodiodes. The sizes of the TCD and BCD detectors are 500 mm × 500 mm × 5 mm and 600 mm × 600 mm × 10 mm, respectively. The ISS-CREAM experiment has many critical requirements for space launch qualification. Thus the mechanical safety and performance in response to vibration and thermal vacuum tests have been studied under various conditions prior to launch. In this presentation, we report the design and construction of the TCD/BCD and the performance of the detector before and after launch.

**Quark and Lepton Flavor Physics / 329**

# Measurement of cos2beta = cos2phi_1 in B^0 to D^{(*)0} h^0 with D to K^0_S pi^+ pi^- decays by a time-dependent Dalitz analysis using BaBar and Belle combined data

Shohei Nishida[1]; Vitaly Vorobyev[2]

[1] *KEK*
[2] *Budker Institute of Nuclear Physics (RU)*

**Corresponding Author(s):** vitaly.vorobyev@cern.ch, shohei.nishida@kek.jp

We report measurements of sin2beta = sin2phi_1 and cos2beta = cos2phi_1 from a time-dependent Dalitz analysis in B^0 to D^{(*)0} h^0 with D to K^0_S pi^+ pi^- decays using BaBar and Belle combined data sample containing 471 + 772 million B meson pairs collected at the Upsilon(4S) resonance. The measurement gives a confirmation of the CP violation in this B decay mode and solves the two- fold ambiguity of the angle beta=phi_1 that can not solely be fixed by the sin2beta = sin2phi_1 measurements in B^0 to charmonium K^0 decays.

**Quark and Lepton Flavor Physics / 334**

# Electroweak Penguin B Decays at Belle

Shohei Nishida[1]; Milind Vasant Purohit[2]

[1] *KEK*
[2] *University of South Carolina (US)*

**Corresponding Author(s):** purohit@sc.edu, shohei.nishida@kek.jp

The electroweak penguin B decay process b → s *l*+ *l*- is a sensitive probe to New Physics (NP) Recent measurements of angular variable of B → K*l*+ *l*- by LHCb and Belle indicate a deviation from the standard model, and further measurements on these process are of interest in the search of NP. In this presentation, we report on the measurements of lepton flavor non universality tests and search for the lepton flavor violating decays in B→K *l*+ *l*- and B→Xs *l*+ *l*-. The analyses are based on the full data set recorded by the Belle detector at the Υ(4S) resonance containing 772 million BBbar pairs from e+ e- collisions produced by the KEKB collider.

**Strong Interactions and Hadron Physics / 339**

# Recent results on charmonium(-like) states and search for pentaquark at Belle

Shohei Nishida[1]; Pavel Krokovny[2]

[1] *KEK*
[2] *Budker Institute of Nuclear Physics (RU)*

**Corresponding Author(s):** pavel.krokovny@cern.ch, shohei.nishida@kek.jp

Study of the processes e+e- →J/ψDD and D(*)+-*D*-+ by Belle is updated, where a new charmonium(- like) state

X(3860) is observed with a significance of 6.5σ using full amplitude analysis in J/ψDD, and the first angular analysis is performed in $D^{(*)}+$- D-+. We present the measurement of the absolute branching fractions of B+→*Xcc K*+ and $B+\to D^{(*)}0\pi+$ decays. Here, Xcc denotes ηc, J/ψ, χc0, χc1, ηc(2S), ψ(2S), ψ(3770), X(3872), and X(3915). We also perform first search for hidden-strangeness penta-quark decay Ps+→φp in the Cabibbo-suppressed decay Λc→φpπ0. All the results presented here exploit the full data set of Belle.

**Quark and Lepton Flavor Physics / 341**

## Study of the Lorentz structure of tau decays and the rare tau decays from Belle

Shohei Nishida[1] ; Kiyoshi Hayasaka[None]

[1] *KEK*

**Corresponding Author(s):** hayasaka@hepl.phys.nagoya-u.ac.jp, shohei.nishida@kek.jp

We evaluate the Michel parameters of τ decays using the full data sample of Belle. This is important to reveal the Lorentz structure of τ leptonic decays, which includes not only the V - A interaction but also contributions from scalar, tensor and others that may arise from New Physics, thus testing lepton universality as well. We use both tau+ → l+ nu nu and tau+ → l+ gamma nu nu. We also measure branching fractions of τ decays into three charged leptons and two neutrinos as well as charged pion, lepton-pairs and a neutrino. Recently, their precise theoretical prediction of the branching fractions are given (O(10^-5 .. -7)) and the statistics of the Belle data allows us to achieve the first observation for them.

**Strong Interactions and Hadron Physics / 343**

## Measurement of Bs and Y(5S) Decays with Belle

Shohei Nishida[1] ; Leo Piilonen[2]

[1] *KEK*
[2] *Virginia Tech*

**Corresponding Author(s):** piilonen@vt.edu, shohei.nishida@kek.jp

The branching fraction of the decay Bs → Ds X has been measured by Belle and other experiments, but with indirect methods which have model-dependent limitations. We report a direct measurement of this decay by tagging one Bs from Y(5S) with semi-leptonic decay (Bs → Ds l nu), where several Ds decay modes are combined to increase the total statics. We also report a search for eta and eta' transitions from Y(5S) resonance to the lower bottomonia. These results are based on data sample of 121 /fb collected at the Y(5S) resonance by the Belle detector at the KEKB asymmetric-energy e+ e- collider. Other analyses on Bs and Y(5S) decays are also covered in this talk.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 354**

## First Ever Ionization Cooling Demonstration in MICE

Vittorio Palladino[1] ; Chris Rogers[2]

[1] *Universita e sezione INFN di Napoli (IT)*
[2] *STFC*

**Corresponding Author(s):** chris.rogers@stfc.ac.uk, vittorio.palladino@cern.ch

The Muon Ionization Cooling Experiment (MICE) at RAL has studied the ionization cooling of muons. Several million individual particle tracks have been recorded passing through a series of focusing magnets in a number of different configurations and a liquid hydrogen or lithium hydride absorber. Measurement of the tracks upstream and downstream of the absorber has shown the expected effects of the 4D emittance reduction. This invited talk presents and discusses these results, and projects the future of ionization cooling.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 356**

# Recent results from MICE on multiple Coulomb scattering and energy loss

Vittorio Palladino[1] ; Scott Wilbur[2]

[1] *Universita e sezione INFN di Napoli (IT)*
[2] *University of Sheffield*

**Corresponding Author(s):** s.h.wilbur@sheffield.ac.uk, vittorio.palladino@cern.ch

Multiple Coulomb scattering and energy loss are well known phenomena experienced by charged particles as they traverse a material. However, from recent measurements by the MuScat collaboration, it is known that the available simulation codes (GEANT4, for example) overestimate the scattering of muons in low Z materials. This is of particular interest to the Muon Ionization Cooling Experiment (MICE) collaboration which has the goal of measuring the reduction of the emittance of a muon beam induced by energy loss in low Z absorbers. MICE took data without magnetic field suitable for multiple scattering measurements in the fall of 2015 with the absorber vessel filled with xenon and in the spring of 2016 using a lithium hydride absorber. In the fall of 2016 MICE took data with magnetic fields on and measured the energy loss of muons in a lithium hydride absorber. These data are all compared with the Bethe-Bloch formula and with the predictions of various models, including the default GEANT4 model.

**POSTER / 357**

# Recent results from the study of emittance evolution in MICE

Vittorio Palladino[1] ; Chris Rogers[2]

[1] *Universita e sezione INFN di Napoli (IT)*
[2] *STFC*

**Corresponding Author(s):** chris.rogers@stfc.ac.uk, vittorio.palladino@cern.ch

The Muon Ionization Cooling Experiment (MICE) has measured the evolution of beam emittance due to ionization cooling. In MICE, a muon beam is focused onto an absorber using a large aperture solenoid. Lithium hydride and liquid hydrogen absorbers have been studied. Diagnostic devices are placed upstream and downstream of the focus, enabling the phase space coordinates of individual muons to be reconstructed. By observing the properties of ensembles of muons, the change in beam emittance can be measured.
Data taken during 2016 and 2017 are currently under study to evaluate the change in emittance due to the absorber for muon beams with various initial emittances, momenta, and settings of the magnetic lattice. Simulations have been used to estimate the regimes in which heating and cooling are expected and to evaluate the equilibrium emittance, at which neither heating nor cooling is observed. The results of the simulations have been compared to the measured emittance changes. The current status and the most recent results of these

analyses will be presented.

**POSTER / 362**

## High speed trigger system with 4.8Gbps rate for COMET Phase-I experiment

MyeongJae Lee[1]

[1] *Institute for Basic Science (Korea)*

**Corresponding Author(s):** myeongjaelee@ibs.re.kr

We report the design and construction of the trigger system for COMET Phase-I experiment of searching for cLFV of muon-electron conversion. A robust, intelligent and flexible trigger system of COMET Phase-I experiment is critical to cope with background hits rating a few MHz in Cylindrical Drift Chamber detector of COMET experiment. To establish robust links between central trigger and timing system with detector readout system, custom serial link rating 4.8Gbps and the receiver board for trigger and timing information are designed and produced. The primary trigger signal will be generated and processed to make intelligent decision using decision tree on conversion signal, through custom-made processing system. The performance of the central trigger system and its test results under beam condition will be reported also.

**Neutrino Physics / 363**

## Quasi-elastic-like anti-neutrino production at MINERvA

Heidi Schellman[1]; MINERvA Collaboration[2]

[1] *Oregon State University*
[2] *Fermilab*

**Corresponding Author(s):** heidi.schellman@science.oregonstate.edu

Next-generation neutrino oscillation experiments, such as DUNE and Hyper-Kamiokande, hope to measure charge-parity (CP) violation in the lepton sector. In order to do this, they must dramatically reduce their current levels of uncertainty, particularly those due to neutrino-nucleus interaction models. As CP violation is a measure of the difference between the oscillation properties of neutrinos and antineutrinos, data about how the less-studied antineutrinos interact is especially valuable. We present the MINERvA experiment's first double-differential scattering cross sections for antineutrinos on scintillator, in the few-GeV range relevant to experiments such as DUNE and NovA. We also present total antineutrino-scintillator quasi-elastic cross sections as a function of energy, which we compare to measurements from previous experiments. As well as being useful to help reduce oscillation experiments' uncertainty, our data can also be used to study the prevalence of various correlation and final-state interaction effects within the nucleus. We compare to models produced by different model generators, and are able to draw first conclusions about the predictions of these models.

**Dark Matter Detection / 369**

## PICO Bubble Chambers for Dark Matter Searches

**Author(s):** Eric Vázquez-Jáuregui[1]

PoS(ICHEP2018)930

**Co-author(s):** PICO collaboration

[1] *Instituto de Física UNAM*

**Corresponding Author(s):** ericvj@fisica.unam.mx

The PICO collaboration uses bubble chambers to search for dark matter, with world-leading sensitivity to spin-dependent (SD) WIMP-proton couplings via direct detection. The bubble chambers are operated in a moderately superheated state, providing excellent rejection of the dominant gamma background, and are located in the deep underground facility SNOLAB in Canada. The PICO-60 detector has set the most stringent limits to date for SD WIMP-proton couplings using C3F8. The collaboration is currently installing PICO-40L, a new detector that will incorporate several design improvements to reduce backgrounds from neutrons and particulate contamination; and is also preparing PICO-500L, a ton-scale bubble chamber designed to cover a large range of mass and cross section parameter space, proving a variety of theoretical models. The PICO collaboration has built a well established technology, easily scalable and relatively inexpensive with flexibility to easily exchange targets following a discovery. The technology, latest results from the PICO-60 detector, recent progress in PICO-40L and future plans towards PICO-500L will be presented in this talk.



**POSTER / 371**

## Electroweakinos with GAMBIT

Are Raklev[1]

[1] *University of Oslo (NO)*

**Corresponding Author(s):** are.rachlow@cern.ch

We introduce the GAMBIT framework for global scans and its collider physics module ColliderBit, and show results from a recent scan of the electroweak fermion sector of the Minimal Supersymmetric Standard Model (MSSM) in light of LHC searches at 13 TeV and older LEP results. We take particular care to avoid assumptions from specific realizations of the MSSM that automatically prohibit very light neutralinos, and remain agnostic on its relationship with dark matter, in order to focus on the collider implications for the sector. We find that the strict bounds seemingly implied by simplified model interpretations of the LHC data are not borne out in the scan.

**Beyond the Standard Model / 372**

## Limits on non-Newtonian gravity at 10 $\mu$m scale by precision force measurements with optically-levitated microspheres

**Author(s):** Akio Kawasaki[1]
**Co-author(s):** Alexander Rider [1] ; Charles Blakemore [1] ; Giorgio Gratta [1]

[1] *Stanford University*

**Corresponding Author(s):** twilight.hf@gmail.com, cblakemo@stanford.edu, arider@stanford.edu, gratta@stanford.edu

The universal law of gravity has undergone stringent tests for a long time over a significant range of length scale, from an atomic scale to a planetary scale 1. Of particular interest is the short distance regime, where modifications to Newtonian gravity may arise from axion-like particles [2] and extra dimensions 1. We have constructed a precision force sensor based on optically-levitated micro-spheres with a force sensitivity of $\sim 10^{-17}$ N/$\sqrt{\text{Hz}}$ [3] for the purpose of increasing the sensitivity of searches for non-Newtonian forces in the 1-100 $\mu$m range. In our scheme, the microsphere interacts with a variable-density attractor mass made by alternating

silicon and gold segments with periodicity on the order of 10 $\mu$m, which is the same as the distance between the microsphere and the attractor. We report on the performance of this technique, its sensitivity, and some initial results. Further technological developments to reduce background are expected to provide orders of magnitude improvement in the sensitivity, going beyond current constraints [4-8].

**POSTER / 375**

## Track reconstruction in high-multiplicity environments with the ATLAS Detector at the LHC

ATLAS Collaboration[None] ; Pierfrancesco Butti[1]

[1] *CERN*

**Corresponding Author(s):** pierfrancesco.butti@cern.ch

During 2017, the Large Hadron Collider provided record-breaking integrated and instantaneous luminosities, resulting in huge amounts of data being provided with numbers of interaction per bunch crossing significantly beyond initial projections. In spite of these challenging conditions, the ATLAS Inner Detector (ID) track reconstruction continued to perform excellently, and this contribution will discuss the latest performance results covering the key aspects of track reconstruction. Potential areas for improvement will also be highlighted, and planned improvements to track reconstruction techniques for future data-taking periods, in areas such as track ambiguity solving and vertex reconstruction, will be outlined.

**Strong Interactions and Hadron Physics / 377**

## Measuring jet substructure observables at the ATLAS Experiment

ATLAS Collaboration[None]

**Corresponding Author(s):** deepak.kar@cern.ch

Jet substructure observables have significantly extended the search program for physics beyond the Standard Model at the Large Hadron Collider. The state-of-the-art tools have been motivated by theoretical calculations, but there has never been a direct comparison between data and calculations of jet substructure observables that are accurate beyond leading-logarithm approximation. Such observables are significant not only for probing the collinear regime of QCD that is largely unexplored at a hadron collider, but also for improving the understanding of jet substructure properties that are used in many studies at the Large Hadron Collider. The ATLAS collaboration has recently per- formed several measurements of precision jet substructure at 13 TeV that will significantly extend our understanding of both the perturbative and non-perturbative aspects of jet formation. These measurements of jet mass in various topologies as well as other properties of jet fragmentation such as charged-particle multiplicity and the properties of gluon splitting to bottom quarks are unfolded to correct for detector effects and compared with a variety of predictions.

**Strong Interactions and Hadron Physics / 378**

## Probing perturbative QCD at the ATLAS Experiment

Jeff Dandoy[1]

[1] *University of Pennsylvania (US)*

**Corresponding Author(s):** jeff.dandoy@cern.ch

Perturbative QCD calculations at next-to-leading order are available for the jet production in pp collisions since several years and next-to-next-to leading order calculations also became available recently. In this talk, we present the latest results from the ATLAS collaboration for inclusive jets and dijets, measured at center of mass energies of 8 and 13 TeV. All measured cross-sections are compared to state-of-the art theory predictions. Moreover, we present two measurements of dijet correlations allowing to test the renormalization group equation and to extract the strong coupling constant.

**Strong Interactions and Hadron Physics / 381**

# Constraints on the Parton Density Functions of the Proton by Measurements with the ATLAS Detector

Claire Gwenlan[1]

[1] *University of Oxford (GB)*

**Corresponding Author(s):** c.gwenlan1@physics.ox.ac.uk

Parton distribution functions (PDFs) are crucial ingredients for measurements at hadron colliders, since they describe the initial states and therefore critically impact the precision of cross section predictions for observables. This talk will review recent precision analyses, where the PDFs play an important role and discuss the impact of several new ATLAS cross-section measurements on PDFs of the proton.

**Strong Interactions and Hadron Physics / 382**

# New Results on the W Boson Production and Multi-lepton Cross Sections with the ATLAS Detector

Zara Jane Grout[1]

[1] *University of London (GB)*

**Corresponding Author(s):** zara.jane.grout@cern.ch

We report on the latest measurement on the production of W bosons in association with jets at 8 TeV and compare our results to the latest theoretical predictions. Differential cross sections for events with one or two jets are presented for a range of observables, including jet transverse momenta and rapidities, the scalar sum of transverse momenta of the visible particles in the event, and the transverse momentum of the W boson. For a subset of the observables, the differential cross sections of positively and negatively charged W bosons are measured separately.
Moreover, the exclusive muon pair production measurement at 13 TeV is presented and the results are compared to theoretical predictions. The integrated cross-section is determined within a fiducial acceptance region of the ATLAS detector and differential cross-sections are measured as a function of the dimuon invariant mass.
If available, a study of the W and Z boson production in association with 1 or 2 b-jets will be presented.

**Beyond the Standard Model / 385**

PoS(ICHEP2018)930

# Complementarity of ATLAS Searches for s-channel Resonance Production in Bosonic an Leptonic Final States

Stephane Yves G Willocq[1]

[1] *University of Massachusetts (US)*

**Corresponding Author(s):** stephane.willocq@cern.ch

Many theories beyond the Standard Model predict new s-channel resonances decaying into two bosons (WW,ZZ,WZ,WH,ZH) and possibly leptons (ll, lv), such as a new heavy scalar singlet, a new heavy vector-boson triplet, or a heavy spin-2 graviton in the bulk Randall-Sundrum model. This talk will summarize relevant ATLAS searches at the LHC using proton-proton collision data collected at a centre-of-mass energy of 13 TeV and show their complementarity.

**Beyond the Standard Model / 387**

# Searches for New Phenomena in Dijet Events with the ATLAS Detector

Andrea Coccaro[1]

[1] *Genova*

**Corresponding Author(s):** andrea.coccaro@cern.ch, coccaro@cern.ch

Events with two hadronic jets in the final state are of particular interest in the search for physics beyond the Standard Model: new phenomena produced in parton collisions are likely to produce final states with (at least) two partons. In this talk several searches performed by the ATLAS collaboration are presented. The very high mass and the low mass regions have both been investigated, by exploiting dedicated signatures and, in case of the latter, new techniques to overcome trigger limitations. Final states with b-jets have also been explored.

**Beyond the Standard Model / 389**

# Searches for new phenomena in leptonic final states using the ATLAS detector

Borut Paul Kersevan[1]

[1] *Ljubljana*

**Corresponding Author(s):** borut.kersevan@cern.ch

Many theories beyond the Standard Model predict new phenomena which decay to well isolated, high-pt leptons. Searches for new physics models with these signatures are performed using the ATLAS experiment at the LHC. The results reported here use the pp collision data sample collected by the ATLAS detector at the LHC with a centre-of-mass energy of 13 TeV.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 391**

# Magnet design studies for future hardon colliders

Vadim Kashikhin[1] ; Igor Novitski[2] ; Alexander Zlobin[1]

PoS(ICHEP2018)930

[1] *Fermilab*
[2] *FERMILAB*

**Corresponding Author(s):** zlobin@fnal.gov, vadim@fnal.gov, novitski@fnal.gov

Fermilab in collaboration with other members of the US Magnet Development Program (MDP) is working on the development of accelerator magnets for future hadron colliders. A 4-layer, 15-T dipole with 60 mm bore based on Nb3Sn superconductor is under construction with the testing foreseen at the end of the year. At the same time, there are conceptual design studies to evaluate the feasibility of reaching even higher fields with the help of HTS materials. This paper presents the results of these studies and discusses possible options towards higher fields.

PoS(ICHEP2018)930

**Beyond the Standard Model / 397**

## Searches for direct pair production of stops and sbottoms with the ATLAS detector

Giacomo Polesello[1 1] *Pavia*

**Corresponding Author(s):** giacomo.polesello@cern.ch

Naturalness arguments for weak-scale supersymmetry favour supersymmetric partners of the third generation quarks with masses not too far from those of their Standard Model counterparts. The phenomenology ranges from final states of top or bottom quark pairs and two dark matter candidates, to more complex scenarios involving non-prompt sparticle decays or R-parity violating signatures. This talk presents recent ATLAS results from searches for direct sbottom and stop pair production focusing on the less conventional scenarios.

**Beyond the Standard Model / 398**

## Searches for electroweak production of supersymmetric particles involving the Higgs boson and the higgsino with ATLAS

Anyes Taffard[1]

[1] *UCI*

**Corresponding Author(s):** anyes.taffard@cern.ch

Fine-tuning arguments suggest the mass of the supersymmetric partner of the Higgs boson, the higgsino, is not too far from the weak scale. The search for higgsinos represents an experimental challenge due to the near mass-degeneracy resulting in soft decay products, and the low production cross section. This talk presents recent ATLAS results of analyses explicitly targeting the higgsino with a variety of experimental techniques, as well as searches for electroweak production of super- symmetric particles in final states involving the Higgs boson.

**POSTER / 402**

## Innovative Strategies in the Search for Electroweak Production of Compressed SUSY States with the ATLAS Detector

ATLAS Collaboration[None] ; Jesse Liu[1]

[1] *University of Oxford*

**Corresponding Author(s):** jesse.liu@cern.ch

The search for electroweakinos and sleptons is a key component of the supersymmetry program at the LHC. In particular, natural SUSY models motivate small mass splittings between the lightest charginos and neutralinos, known as a compressed mass spectrum. Such a scenario presents several experimental challenges, since the decay products are very soft and there is little final state missing energy. In order to build a sensitive analysis around these difficulties, a variety of new techniques are applied, including improvements with ISR-assisted topologies and lepton reconstruction. Here, some of these new strategies are described, and recent results from the search using data at $\sqrt{s} = 13$ TeV from the ATLAS detector are presented.



**POSTER / 403**

## Search for top squarks with ATLAS at √s = 13TeV in fully hadronic and semi-leptonic final states

ATLAS Collaboration[None] ; Philipp Mogg[1]

[1] *Albert Ludwigs Universitaet Freiburg (DE)*

**Corresponding Author(s):** philipp.mogg@cern.ch

Looking for supersymmetry, the search for a scalar partner of the top quark plays a major part due to its role in stabilising the Higgs boson mass. In the parameter space where a decay of a top squark into a top quark and the neutralino, a Dark Matter candidate, is possible, searches asking for either zero or one charged lepton are most sensitive. Events with an isolated electron or muon simplify event classification, whereas the branching fraction into fully hadronic final states is higher. In both cases b-jets are produced and missing transverse momentum is observed due to undetectable neutralinos. This contribution presents methods used by these searches and the results obtained with data taken in 2015 and 2016 with the ATLAS detector at $\sqrt{s} = 13$ TeV

**POSTER / 412**

## Hough transform based low momentum track finding for the BESIII drift chamber

**Author(s):** Yao Zhang[1] ; Huaimin Liu[1]
**Co-author(s):** Ye Yuan [1]

[1] *Institute of High Energy Physics, CAS*

**Corresponding Author(s):** liuhm@ihep.ac.cn, yuany@ihep.ac.cn

A Hough transform based tracking method is introduced for curling track finding of BESIII drift chamber. This track finding algorithm is implemented in the BESIII offline software system and its performance has been checked. The results show that this algorithm improves the reconstruction efficiency for the low transverse momentum tracks.

**Beyond the Standard Model / 414**

# Light Dark Matter Showering under Broken U(1) – Revisited

Pyungwon Ko[1] ; Hsiang-nan Li[2] ; Jinmian Li[1] ; Hiroshi Yokoya[1] ; Junmou Chen[3]

[1] *KIAS*
[2] *Academia Sinica*
[3] *Korean Institute for Advanced Study*

**Corresponding Author(s):** jmchen@kias.re.kr

The scenario of light dark matter fermion under a massive U(1) group has attracted some attention lately. It was proposed recently that different chiralities of the DM can lead to different showering patterns, resulting in distinguishable signatures in LHC. This can be helpful in understanding the origin of the dark photon mass and the DM mass. Here we study this subject further by examining the dark shower of two simplified models – named Chiral Model and Vector Model. We derive a more complete set of collinear splitting functions by specifying the helicities of the fermion, incorporating all degrees of freedom and splittings arising from symmetry breaking. We implement dark shower with those splitting functions in the two models and analyze the jet profiles after the dark photons decay back the SM particles. The effects of different aspects of splitting functions are demonstrated and discussed.

PoS(ICHEP2018)930

**Neutrino Physics / 415**

# Neutrino mixing in a rephasing invariant parametrization

**Author(s):** Shao-Hsuan Chiu[1]
**Co-author(s):** T. K. Kuo [2]

[1] *Chang Gung University*
[2] *Purdue University*

**Corresponding Author(s):** schiu@mail.cgu.edu.tw

Six rephasing invariant combinations can be constructed from elements of the neutrino mixing matrix $V$: $\Gamma_{ijk} = V_{1i}V_{2j}V_{3k} = R_{ijk} - iJ$, where $(i, j, k)$ is cyclic permutation of $(1, 2, 3)$, $R_{ijk}$ is the real part, and the common imaginary part $J$ is identified with the Jarlskog invariant. In terms of this rephasing invariant parametrization, the squared elements of the neutrino mixing matrix are found to satisfy, as functions of the induced mass, a set of differential equations. They show clearly the dominance of pole terms when the neutrino induced masses cross. Using the known vacuum mixing parameters as initial conditions, it is found that these equations have very good approximate solutions, for all values of the induced mass. The results may be applicable to Long Baseline Experiments (LBL).

**POSTER / 425**

# Measurement of theta13 in the reactor neutrino events with neutron captures on Hydrogen at RENO

ChangDong Shin[None]

**Corresponding Author(s):** scd0211@gmail.com

RENO has been taking data since August, 2011 and successfully measured the smallest neutrino mixing angle, theta13. The measurement values are obtained from the observed reactor antineutrino events with neutron captures on gadolinium (n-Gd) in the target detector region. In addition, RENO has successfully measured the mixing angle as well, using an independent sample with neutron captures on hydrogen (n-H). Because of a large

accidental background in the n-H sample, the analysis requires additional reduction of backgrounds. This independent measurement provides a valuable systematic cross-check of the theta13 measurement using the n-Gd sample. In this talk, we will present the results from the 1500 days of n-H data sample.

**POSTER / 428**

## A Study on the Shielding Ability of Current Aerospace Materials of a Detector against High Energy Cosmic Rays

DONG LIU[1] ; Jong-Kwan WOO[2]

[1] *Jeju National University*
[2] *Jeju Naitonal University*

**Corresponding Author(s):** liudongcn@jejunu.ac.kr, w00jk@jejunu.ac.kr

High energy cosmic rays are one of the biggest concerns for a detector used in space and manned spaceflight, along with the swift development of the high energy experiments in space and space-flight enterprise, the research of shielding materials against high energy cosmic rays has become increasingly important. In this study, by using Monte Carlo method, firstly we defined a simple detector in the form of human body, and then we designed the geometry of shielding structures with various shielding materials. At last we comprehensively considered the radiation shielding properties of various materials together with the consideration of mass problems of shielding materials. The radiological protection capability of materials against certain higher energy cosmic ray was appraised from the perspectives of radiation dose. The results concluded that under the same level of mass of shielding materials, it is advantageous to employ the composites and non-metal materials as shielding materials than using metal or alloy. For practical application, the shielding structure is usually consisted with multi-layers. The calculation result shows that a multi-layers shielding structure that has low density layer-high density layer-low density layers structure has a more ideal shielding effect.

**Higgs Physics / 436**

## Evidence for Higgs boson production in decays to two b-quarks using the ATLAS detector

Yuji Enari[1]

[1] *University of Tokyo (JP)*

**Corresponding Author(s):** yuji.enari@cern.ch

The analysis that studies VH process with H->bb decays is presented based on the 13 TeV pp collision data. A clear excess of the VH with H->bb process over the predicted background is shown providing evidence for such a process. In addition a search for VBF production in the same decay channel is presented.

**Higgs Physics / 437**

## Evidence for Higgs boson production in association with a ttbar pair

Yasuyuki Horii[1]

PoS(ICHEP2018)930

[1] *Nagoya University (JP)*

**Corresponding Author(s):** yasuyuki.horii@cern.ch

The search for the production of the Higgs Boson with a pair of top-anti-top quarks is both very important and very challenging. This talks presents the analyses using Higgs boson decays to bbbar pairs, to multi-lepton final states using pp collision data collected at 13 TeV, as well as their combined results including also Higgs boson decays to two photons or Z bosons.

**Higgs Physics / 440**

## Search for rare decays of the Higgs boson

Haifeng Li[1]

[1] *Shandong*

**Corresponding Author(s):** haifeng.li@cern.ch

The Standard Model predicts decay channels of the Higgs boson that are rare and have not yet been seen. Searches for Higgs boson decays to two muons or to a Z boson and a photon based on pp collision data collected at 13 TeV are presented.

**Higgs Physics / 441**

## Searches for non-Standard Model decays to a light meson and a photon of the Higgs boson

Andrew Chisholm[1]

[1] *CERN*

**Corresponding Author(s):** andrew.chisholm@cern.ch

Theories beyond the Standard Model predict Higgs boson decays at a much enhanced rate compared to the Standard Model, e.g. for decays to Z+photon or a meson and a photon. This talk presents recent results based pp collision data collected at 13 TeV.

**Higgs Physics / 443**

## Search for di-Higgs production

ATLAS Collaboration[None] ; Andrew Mehta[1]

[1] *University of Liverpool (GB)*

**Corresponding Author(s):** andrew.mehta@cern.ch

Di-Higgs final states can arise through non-resonant production of two Higgs bosons and through potential heavy states decaying to two Higgs boson. This talk presents searches in several Higgs boson decay channels using 36 fb-1 of pp collision data recorded at 13 TeV.

PoS(ICHEP2018)930

**Top Quark and Electroweak Physics / 450**

## Measurements of ttbar+X using the ATLAS detector

**Corresponding Author(s):** marisa.sandhoff@cern.ch

The large centre-of-mass energy available at the proton-proton collider LHC allows for the copious production of top quark pairs in association with other final state particles at high transverse momenta. The ATLAS experiment has measured several final state observables that are sensitive to additional radiation in top anti-top quark final states. Results on the top production in association with W and Z bosons are presented as well as top pair production with a photon or with b quarks. These measurements are compared to modern Monte Carlo generators based on NLO QCD matrix elements.

**Top Quark and Electroweak Physics / 452**

## Single Top quark production and properties measurements using the ATLAS detector

**Corresponding Author(s):** h73@nikhef.nl

Measurements of single top-quark production in proton-proton collisions and of angular correlations in single top-quark events are presented based on the 8 TeV and 13 TeV ATLAS datasets. For the production of single top quarks in the t-channel and the tW-channel, measurements of inclusive and differential cross-sections are included. Evidence for s-channel production using 8 TeV data and the measurement of single top quark production in association with a Z boson at 13 TeV are also presented. All measurements are compared to state-of-the-art theoretical calculations. Differential cross-sections are measured as a function of angular variables that are sensitive to anomalous contributions to the Wtb vertex and the top quark polarization.

**Top Quark and Electroweak Physics / 453**

## Searches for rare top quark couplings with the ATLAS detector

**Corresponding Author(s):** ligang.xia@cern.ch

The top quark is the heaviest known fundamental particle and probing its couplings with the other fundamental particle may open a window to physics beyond the Standard Model. Searches for flavour-changing neutral current top-quark interactions are discussed based on the 13 TeV ATLAS dataset. Searches for rare top quark decays to Higgs and Z bosons are presented in top quark pair production, and searches for rare top quark interactions with gluons and Z bosons are presented in single top quark production.

**Beyond the Standard Model / 454**

## Spectral Decomposition of Missing Transverse Energy at Hadron Colliders

Tae Hyun Jung[1] ; Kyu Jung Bae[2] ; Myeonghun Park[3]

PoS(ICHEP2018)930

[1] *Institute for Basic Science*
[2] *Univ. of Oklahoma*
[3] *Institute for basic Science (KR)*

**Corresponding Author(s):** myeonghun.park@cern.ch, thjung0720@ibs.re.kr, baekj81@gmail.com

We propose a spectral decomposition to systematically extract information of dark matter at hadron colliders. The differential cross section of events with missing transverse energy (MET) can be expressed by a linear combination of basis functions. In the case of s-channel mediator models for dark matter particle production, basis functions are identified with the differential cross sections of subprocesses of virtual mediator and visible particle production while the coefficients of basis functions correspond to dark matter invariant mass distribution in the manner of the Källén-Lehmann spectral decomposition. For a given MET dataset and mediator model, we show that one can differentiate a certain dark matter–mediator interaction from another through spectral decomposition.

PoS(ICHEP2018)930

**Top Quark and Electroweak Physics / 455**

# New Results on Z Boson Production with the ATLAS Detector

**Corresponding Author(s):** manuella.greta.vincter@cern.ch

Precision measurements of the Drell-Yan production of Z bosons at the LHC provide a benchmark of our understanding of perturbative QCD and electroweak processes and probe the proton structure in a unique way. ATLAS performed a precise triple differential Drell-Yan cross-section measurement as a function of Mll, dilepton rapidity and cosθ∗ defined in the Collins-Soper frame at a center of mass energy of 8 TeV. We report on this measurement which provides sensitivity to PDFs and the Z forward-backward asymmetry, AFB. In order to test the electroweak sector with single Z boson final states, ATLAS has published a first measurement of the tau-polarization in Z events as well as the cross-section of the electroweak production of Z bosons at 13 TeV. These results will be presented and discussed.

**Top Quark and Electroweak Physics / 456**

# Tests of the electroweak sector sector with Diboson final states at the ATLAS Experiment

**Corresponding Author(s):** rustem.ospanov@cern.ch

Measurements of the cross sections of the production of pairs of electroweak gauge bosons at the LHC constitute stringent tests of the electroweak sector and provide model-independent means to search for new physics at the TeV scale. Similarly, the electroweak production of vector bosons in proton-proton collisions tests the gauge structure of the Standard Model. The ATLAS collaboration has performed detailed measurements of integrated and differential cross sections of the production of ZZ di-boson pairs as well as WZ and WW di-boson pairs at 8 and 13 TeV. The results will be presented and compared to predictions at NLO (and NNLO) in pQCD. Constraints on new physics are provided by setting limits on anomalous triple gauge couplings. If available, a measurement of the unfolded 4-lepton mass at 13 TeV will be presented.

**Top Quark and Electroweak Physics / 457**

# New Results on Multi-Boson Production with the ATLAS Detector

Marc-Andre Pleier[1]

[1] *Brookhaven National Laboratory (US)*

**Corresponding Author(s):** pleier@fnal.gov, marc-andre.pleier@cern.ch

Measurements of the cross sections of the production of three electroweak gauge bosons and of vector-boson scattering processes at the LHC constitute stringent tests of the electroweak sector of the Standard Model and provide a model-independent means to search for new physics at the TeV scale. The ATLAS collaboration searched for the production of three W bosons or of a W boson and a photon together with a Z or W boson at a center of mass energy of 8 TeV. ATLAS also searches for the electroweak production of diboson final states, where evidence was found for the exclusive production of W boson pairs. If available also further results on the electroweak production of diboson pairs will be presented. All results have been used to constrain anomalous gauge couplings and have been compared to the latest theory predictions.

PoS(ICHEP2018)930

**Strong Interactions and Hadron Physics / 460**

# Open heavy-flavour measurements in proton-proton collisions with ALICE at the LHC.

Julien Charles Hamon[1] ; Andrea Rossi[2]

[1] *Institut Pluridisciplinaire Hubert Curien (FR)*
[2] *Universita e INFN, Padova (IT)*

**Corresponding Author(s):** andrea.rossi@cern.ch, julien.hamon@cern.ch

In proton-proton (pp) collisions, open heavy-flavour hadrons are valuable tools for testing perturba- tive Quantum Chromo-Dynamics (pQCD) calculations. Indeed, the large heavy-quark masses (with respect to the QCD scale parameter) allow to calculate the heavy-quark production cross section, as perturbation series in $\alpha_S$ down to $p_T = 0$.
The ALICE experiment has measured D mesons in pp collisions, via the reconstruction of hadronic decay channels at central rapidity, as well as muons (electrons) from semi-leptonic decay of heavy-flavour hadrons at forward (mid) rapidity. These measurements, performed over a wide range of transverse momentum, in several rapidity regions and for different collision energies, have much smaller uncertainties than the typical theoretical ones. Thus, ALICE results challenge state-of-the-art pQCD calculations such as FONLL and GM-VFNS and, besides, add sensitivity to gluon PDF.
More differential measurements help studying further charm production: the analysis of D-meson-tagged jets allows measuring charm jet production, and addressing charm-quark production processes and charm fragmentation properties. Additionally, multiplicity-dependent measurements of heavy-flavour production provide insight into multi-parton interactions and the possible interplay of soft and hard processes.
In this talk, new and most recent ALICE results on open heavy-flavours in pp collisions at $\sqrt{s} = 2.76$, 5, 7, 8 and 13 TeV will be presented and compared with theoretical and model predictions.

**POSTER / 461**

# Performance of Jets at CEPC

**Author(s):** Pei-Zhu Lai[1]
**Co-author(s):** Bo Liu [2] ; Manqi Ruan [3] ; LI Gang [4] ; Chia-Ming Kuo [1]

[1] *National Central University (TW)*

[2] *Institute of High Energy Physics*
[3] *Chinese Academy of Sciences (CN)*
[4] *IHEP*

**Corresponding Author(s):** manqi.ruan@cern.ch, ligang@ihep.ac.cn, boliu@ihep.ac.cn, ht910155@gmail.com, chia-ming.kuo@cern.ch

After the Higgs discovery, precise measurements become vital for the experimental particle physics. A powerful Higgs/Z factory, the Circular electron-positron Collider is proposed. Adequate reconstruction and detector design are fundamental to this project. Arbor algorithm has been optimized to fulfill the CEPC physics requirements and is used as the core for the CEPC physics reconstruction. With a particle flow algorithm oriented detector design, we will present the current performance of jets at CEPC. Crucial studies to be covered in the future will also be discussed in this poster.



**Astro-particle Physics and Cosmology / 464**

# The ISS-CREAM Silicon Charge Detector for identification of the charge of cosmic rays up to Z = 26

Jik Lee[1] ; on behalf of the ISS-CREAM collaboration[None]

[1] *Sungkyunkwan University*

**Corresponding Author(s):** jiklee999@gmail.com

The Cosmic Ray Energetics And Mass experiment for the International Space Station (ISS-CREAM) is a space-borne mission designed for the precision measurement of energy and elemental composition of cosmic rays. It was launched and installed on the ISS in August 2017. The Silicon Charge Detector (SCD), placed at the top of the ISS-CREAM payload, consists of 4 layers. Each layer has 2688 silicon pixels and associated electronics arranged in such a fashion that its active detection area of 78 x 74 cm2 is free of any dead area. The 4-layer configuration was chosen to achieve the best precision in measuring the charge of cosmic rays within the constraints on the mass, volume and power allotted to it. The amount of material used for its support structure was minimized as well to reduce the chance of interactions of the cosmic ray within the structure. Given the placement of the SCD, its 4-layer configuration and the minimal amount of material in the cosmic-ray trajectory, the SCD is capable of measuring the charge of cosmic rays ranging from protons to iron nuclei with excellent detection efficiency and charge resolution. We present the design and fabrication of the SCD, and its performance during various ground tests before launch including a heavy-ion beam test. We also present the operation and performance of the SCD on the ISS.

**POSTER / 468**

# Physics performance of the Particle Flow Oriented detector at the CEPC

Manqi Ruan[1] ; Xinchou Lou[2] ; Yaquan Fang[1] ; Gang LI[3]

[1] *Chinese Academy of Sciences (CN)*
[2] *University of Texas at Dallas (US)*
[3] *Institute of high energy physics*

**Corresponding Author(s):** yaquan.fang@cern.ch, xinchou.lou@cern.ch, li.gang@mail.ihep.ac.cn, manqi.ruan@cern.ch

After the Higgs discovery, precise measurements of the Higgs properties and the electroweak observables

become vital for the experimental particle physics. A powerful Higgs/Z factory, the Circular Electron Positron Collider (CEPC) is proposed. The Particle Flow oriented detector design is proposed to the CEPC and a Particle Flow algorithm, Arbor has been designed and optimized accordingly.
In this talk, we would like to report the status and progress of the detector design and performance study of the PFA oriented CEPC detector.

**Education and Outreach / 472**

## The "social content" strategy of the ATLAS Experiment

Katarina Anthony[1]

[1] *Universita degli Studi di Udine (IT)*

**Corresponding Author(s):** katarina.anthony-kittelsen@cern.ch

Social media is an essential tool for communicating particle physics results to a wide audience. This presentation will explore how the nature of social media platforms has impacted the content being shared across them, and the subsequent effect this has had on the user experience. The ATLAS Experiment has adapted its communication strategy to match this social media evolution, producing content specifically targeting this emerging audience. The success of this approach is examined and the effect on user experience is evaluated.

**Education and Outreach / 473**

## Taking science to festivals: engaging the public where they least expect it

ATLAS Collaboration[None]; Roger Jones[1] [1] *Lancaster University (GB)*

**Corresponding Author(s):** roger.jones@cern.ch

Over the past several years, a team based around the ATLAS Experiment at CERN in Geneva has organised public engagement and education activities at a variety of non-scientific venues. These have included the Montreux Jazz Festival (Montreux, Switzerland), the Bluedot Festival (Jodrell Bank, UK), the WOMAD Festival (Charlton Park, UK), Moogfest (Durham, NC, USA), and the Sofia Music Weeks in Bulgaria, with discussions on-going with a major European music festival as well as a festival in the United States. The goal of this effort is to engage new audiences who normally would not be drawn to science festivals and to investigate our ability to communicate scientific messages to broad, diverse audiences.
The results have been impressive, as measured through attendance (example: the first Physics Pavilion at WOMAD received 4500 visitors over 3 days and such was the success that a return invitation was received immediately for 2017 with additional space, resulting in an increased footfall of ~5500), and enthusiasm of the audience and the scientists hosting the activities. We describe the presentation material and format, the hands-on workshops, and other methods employed, as well as lessons learned on how to best optimise audience engagement. The concept can be reproduced for other festival-type environments, and adapted to suit the particular audience demographic and format of the festival.

**Heavy Ions / 479**

## Recent results on correlations and fluctuations in pp, p+Pb, and Pb+Pb collisions from the ATLAS Experiment at the LHC

The ATLAS Collaboration[None] ; Mariusz Przybycien[1]

[1] *AGH University of Science and Technology (PL)*

**Corresponding Author(s):** mariusz.przybycien@agh.edu.pl, pmariusz@cern.ch

The azimuthal anisotropies of particle yields observed in relativistic heavy-ion collisions have been traditionally considered as a strong evidence of the formation on a deconfined quark-gluon plasma produced in these collisions. However multiple recent measurements from the ATLAS Collaboration in pp and p+Pb systems show similar features as those observed in Pb+Pb collisions, indicating the possibility of the production of such a deconfined medium in smaller collision systems.
This talk presents a comprehensive summary of ATLAS measurements in pp collisions at 2.76, 5.02 and 13~TeV and in p+Pb collisions at 5.02 and 8.16 TeV. It includes measurements of two-particle hadron-hadron and muon-hadron correlations in $\Delta\phi$ and $\Delta\eta$, with a template fitting procedure used to subtract the dijet contributions. Measurements of multi-particle cumulants c_n{2−8} are also presented. The standard cumulant measurements confirm presence of collective phenomena in p+Pb collisions, but are biased by non-flow correlations and are not able to provide evidence for collectivity in pp collisions. To address this, measurements from a new sub-event cumulant method that suppresses the contribution of non-flow effects are presented. More detailed studies of longitudinal flow decorrelations, and higher-order cumulants in ultra-central Pb+Pb collisions are also presented to provide deeper insight into the details of the geometry of the initial state.

**Heavy Ions / 481**

# Low mass dielectron measurements in pp, p-Pb and Pb-Pb collisions with ALICE at the LHC

Ivan Vorobyev[1]

[1] *Technische Universitaet Muenchen (DE)*

**Corresponding Author(s):** ivan.vorobyev@cern.ch

Low-mass dielectron pairs are unique experimental tool for the studies of the Quark-Gluon Plasma (QGP) created in ultra-relativistic heavy-ion collisions at the LHC. Such pairs are produced during all stages of the collision and carry the information about the whole space-time evolution of the system unperturbed by final-state interactions. The dielectron continuum is very rich in physics sources: on top of ordinary Dalitz and resonance decays of pseudo-scalar and vector mesons, thermal black- body radiation is of particular interest as it contains the information about the temperature of the hot and dense system created in such collisions. The dielectron invariant-mass distribution is also sensitive to medium modifications of the spectral function of short-lived vector mesons that are linked to the potential restoration of chiral symmetry at high temperatures. Correlated electron pairs from semi-leptonic charm and beauty decays provide complementary information about the heavy-quark energy loss. Such pairs dominate in the intermediate mass region ($1.2 < m_{ee} < 2.8$ GeV/$c^2$) and can be used for a complementary measurement of the heavy-flavour production cross-section. The studies of the minimum-bias proton-proton and proton-ion collisions provide crucial vacuum and cold-nuclear matter references needed for the interpretation of the heavy-ion results. Recent observations of collective effects in high-multiplicity pp and p-Pb collisions show surprising similarities with those in heavy-ion collisions. Measurements of low-mass dielectrons in such events could provide additional information regarding the underlying physics processes. In this talk, we present the latest results from the ALICE experiment in all three collisions systems: in pp at $\sqrt{s}$ = 7 TeV and 13 TeV, in p-Pb at $\sqrt{s_{NN}}$ = 5.02 TeV and Pb-Pb at $\sqrt{s_{NN}}$ = 2.76 TeV and 5.02 TeV. This includes analyses making use of impact parameter information to identify dielectrons from heavy-flavour decays as well as machine learning techniques to improve electron identification and combinatorial background rejection. To single out the interesting phenomena, the dielectron spectra are compared to the expectations from known hadronic sources. The implications for the heavy-flavour and direct photon production will be discussed. Furthermore, the results will be shown as a function of the charged-particle event multiplicity and of the centrality of the collision.

PoS(ICHEP2018)930

**Astro-particle Physics and Cosmology / 482**

# In between the Observation Runs 2 and 3, a status report on the Advanced LIGO and Advanced Virgo gravitational-wave detectors

The LIGO Scientific Collaboration and the Virgo Collaboration[None]; Nicolas Arnaud[1]

[1] *LAL (CNRS/IN2P3 and Université Paris-Sud)*

**Corresponding Author(s):** narnaud@lal.in2p3.fr

Following a fruitful Observation Run 2 (O2, November 2016 - August 2017) marked by the first three-detector observation of a binary black hole merger and the first ever detection of a binary neutron merger followed by the discovery of the optical counterpart of the gravitational-wave signal, the LIGO and Virgo giant interferometers started a new upgrade phase with a twofold goal: to improve the sensitivity and the duty cycle of the three instruments before starting the Observation Run 3 (O3) next fall, which should last about a year. After a brief review of the O2 data taking period and a summary of the main results achieved, including the successes of multi-messenger astronomy, we will describe the current upgrade campaign, review the performance achieved to date and conclude by presenting some prospects for O3.

**Neutrino Physics / 486**

# Hadron Production Measurements for Neutrino Oscillation Experiments with NA61/SHINE

Scott Robert Johnson[1]

[1] *University of Colorado Boulder (US)*

**Corresponding Author(s):** scott.robert.johnson@cern.ch

The uncertainty in the flux of neutrino beams is dominated by our understanding of both the primary interactions of protons and the secondary interactions of protons, kaons and pions with target and beamline material. Hadron production measurements from a comprehensive set of interactions will allow modern neutrino experiments to make more precise neutrino cross section and oscillation measurements. Measurements of charged hadron spectra and total cross sections have recently been obtained by NA61/SHINE, a fixed target experiment at the CERN SPS, for a variety of beam particles, beam momenta and target materials. From the 2010 dataset of 31 GeV/$c$ protons interacting with a T2K replica target, multiplicities of $\pi^+$, $\pi^-$, $K^+$, $K^-$ and protons have been obtained. These measurements supplement the results from the 2009 thin target measurements, which have been used to constrain the T2K neutrino flux prediction. The application of the replica target results is ongoing and is expected to further reduce the uncertainties in the flux prediction. Starting in 2015 and continuing through 2018, NA61/SHINE has been recording interactions relevant to the neutrino beams at NuMI and LBNF located at FNAL. These beams are used by the ongoing experiments NO$\nu$A and MINER$\nu$A and the future experiment DUNE. In 2015, total inelastic and production cross section measurements have been obtained from interactions of $K^+$ at 60 GeV/$c$ and $\pi^+$ at 31 and 60 GeV/$c$ with carbon and aluminum targets. In 2016 and 2017, NA61/SHINE recorded interactions of $\pi^+$, $\pi^-$ and protons with momenta ranging from 31 to 120 GeV/$c$ with carbon, aluminum and beryllium targets. The first of these interactions to be analyzed is 60 GeV/$c$ $\pi^+$ with thin carbon and beryllium targets, where multiplicities of $\pi^+$, $\pi^-$, $K^+$, $K^-$ and protons are being measured. In the summer of 2018, NA61/SHINE will resume data taking including interactions of 60 GeV/$c$ $K^+$ with carbon and 120 GeV/$c$ protons on a NO$\nu$A replica target.

**Education and Outreach / 487**

PoS(ICHEP2018)930

# Public analysis of Belle II Data

Leo Piilonen[1]

[1] *Virginia Tech*

**Corresponding Author(s):** piilonen@vt.edu

A small Belle II data sample will be available to the general public through an interactive graphical application which includes basic particle selection tools for reconstructed particles. The application is using an open source library Blockly running in an HTML5 capable browser. In the application, different particle decays can be described by selecting and combining particles from the data file. The application includes easy histogramming and cutting tools and enables display of the ROOT his- tograms. After submission, a pseudocode is generated by the user interface. The code is interpreted by the server which then runs back-end analysis and sends back the resolution histograms to the client. The browser app also enables for the interactive fitting of the histograms, thus enabling even more complex analyses. The application can be run on a single public web server aimed at a single access or in a virtual appliance for use in a classroom consisting. The virtual appliance consists of a Linux OS, data sample, an analysis framework and a private web server. In the presentation, I will describe the application, demonstrate its use and outline our plans for future development.

**Dark Matter Detection / 488**

# Dark Matter Search with the DEAP-3600 experiment

**Author(s):** Eric Vázquez-Jáuregui[1]
**Co-author(s):** DEAP collaboration

[1] *Instituto de Física UNAM*

**Corresponding Author(s):** ericvj@fisica.unam.mx

DEAP-3600 is a single-phase liquid argon (LAr) dark matter direct detection experiment sensitive to spin-independent scattering of Weakly Interacting Massive Particles (WIMPs) on nucleons. The experiment is located two kilometres underground at SNOLAB, in Canada, with a sensitivity of 10^-46 cm^2 for a spin-independent WIMP-nucleon cross section at 100 GeV/c^2 WIMP mass for a background-free exposure of 3 tonne-year. The LAr is contained in an acrylic vessel (85 cm radius) viewed by 255 HQE 8 inches Hamamatsu PMTs, separated by 50 cm acrylic light guides. The detector was designed and built to reach a background level of less than 0.6 events in 3 tonne-year exposure. DEAP-3600 has been taking physics data since late 2016 and first results were recently published which demonstrated stable detector operations and the power of pulse shape discrimination to distinguish electron recoil backgrounds from nuclear recoils, leading to the most sensitive WIMP search to date using a LAr target. Results from the current analysis and future plans will be presented in this talk.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 489**

# Superconducting RF Cavities R&D Towards Future High Energy Accelerators

Mattia Checchin[1]

[1] *FNAL - IIT*

**Corresponding Author(s):** checchin@fnal.gov

Modern accelerators for High Energy Physics (ILC, FCC-ee, FCC-he, CEPC) demand efficient operation of SRF cavities. Since low cryogenic losses and high quench fields are essential to save in both capital and operational cost, basic SRF R&D on niobium cavities is focused on increasing the quality factor at the highest accelerating gradient.
The talk will be focused on the description of the strategies adopted to increase quality factor and accelerating gradient in SRF cavities. Innovative surface preparations can allow for future SRF-based accelerators that wouldn't otherwise be feasible, by cutting the capital cost of their realization.
Layered SRF surfaces and smart engineering of the impurities profile at the RF surface are promising technologies that may substantially decrease the cost of accelerators and possibly allow for higher duty cycle operation. The physics behind these new technologies will be described and the impact their application would bring in the accelerator world will be analyzed in detail.
Part of the talk will also address the description of new directions being explored in the SRF community to further increase accelerating gradients beyond the current limitations and on the cost savings they might allow.



**Astro-particle Physics and Cosmology / 490**

# Statistical Analyses of Higgs- and Z-Portal Dark Matter Models

Andrew Fowlie[1] ; John Ellis[2] ; Luca Marzola[3] ; Martti Raidal[4]

[1] *Monash University*
[2] *CERN*
[3] *University Of Tartu*
[4] *National Institute of Chemical Physics and Biophysics (EE)*

**Corresponding Author(s):** martti.raidal@cern.ch, luca.marzola@ut.ee, johnellis@fastmail.fm, andrew.fowlie@monash.edu

I present results from 1711.09912 of frequentist and Bayesian statistical analyses of Higgs- and Z- portal models of dark matter particles with spin 0, 1/2 and 1. Our analyses incorporate data from direct detection and indirect detection experiments, as well as LHC searches for monojet and monophoton events. We find acceptable regions of the parameter spaces for Higgs-portal models with real scalar, neutral vector, Majorana or Dirac fermion dark matter particles, and Z-portal models with Majorana or Dirac fermion dark matter particles.

**Strong Interactions and Hadron Physics / 493**

# Spectroscopy, production and exotica in HF states in ATLAS

The ATLAS collaboration[None] ; Roger Jones[1]

[1] *Lancaster University (GB)*

**Corresponding Author(s):** roger.jones@cern.ch

Searches for, and measurements of exotic states are studied with the ATLAS detector. The latest results from ATLAS on exotic (tetra- / pentaquark) states are presented. In addition, recent results on heavy flavour production measurements are reported in the Bu and Bc systems.

**Neutrino Physics / 494**

# Searching for a Light Sterile Neutrino at Daya Bay

Ming-chung Chu[1]

[1] *The Chinese University of Hong Kong*

**Corresponding Author(s):** mcchu@phy.cuhk.edu.hk

Additional generations of neutrinos that do not participate in standard V-A interactions - hence called "sterile" - arise in many extensions of the Standard Model. The existence of light sterile neutrino, with masses at eV or sub-eV scale, could explain several anomalies in short neutrino oscillation experiments as well as discrepancy in cosmological measurements of the Hubble parameter. I will report a search for light sterile neutrino mixing in the electron antineutrino disappearance channel by the Daya Bay Reactor Neutrino Experiment in the $2x10^{-4}$ $|\Delta m^2|$ 0.3 eV$^2$ range. The resulting limits on $sin^2 2_{14}$ constitute the most stringent constraints to date in the $|\Delta m^2|$ 0.2 eV$^2$ region. A joint analysis with electron antineutrino disappearance measurements from the Daya Bay and Bugey-3 experiments and the measurement of muon (anti)neutrino disappearance by the MINOS experiment will also be presented. The combined results place stringent constraints on electron neutrino and antineutrino appearance driven by sterile neutrino. The sterile-neutrino mixing parameter space allowed by the LSND and MiniBooNE experiments is excluded for $^2$ < 0.8 eV$^2$ at 95% CLs.

**Quark and Lepton Flavor Physics / 495**

# CP asymmetries in charm decays into neutral kaons

Fu-Sheng Yu[None]

**Corresponding Author(s):** yufsh@lzu.edu.cn

We find a new CP-violation effect in charm decays into neutral kaons, which results from the interference between two tree (Cabibbo-favored and doubly Cabibbo-suppressed) amplitudes with the mixing of final-state mesons. This effect, estimated to be of an order of 10−3, is much larger than the direct CP asymmetries in these decays, but missed in the literature. It can be revealed by measuring the difference of the time-dependent CP asymmetries in the D+ → π+KS0 and Ds+ → K+KS0 modes, which are accessible at the LHCb and Belle II experiments. If confirmed, the new effect has to be taken into account, as the above direct CP asymmetries are used to search for new physics.
This work has been published in Phys.Rev.Lett 119.181802(2017).

**Higgs Physics / 500**

# Deep learning approaches to the Higgs boson self coupling

Jung Chang[1] ; Kingman Cheung[2] ; Jae Sik Lee[3] ; Chih-Ting Lu[4] ; Jubin Park[3]

[1] *National Center for Theoretical Sciences, Physics Division*
[2] *National Tsing Hua University/Konkuk University*
[3] *Chonnam National University*
[4] *National Tsing Hua University*

**Corresponding Author(s):** jslee@jnu.ac.kr, timluyu@hotmail.com, chang.jung@mx.nthu.edu.tw, kingman8cheung@gmail.com, honolov77@gmail.com

Deep learning has been applied to many studies in high energy physics with substantial improvement over the traditional selection-cut methods. Based on deep-learning approaches, we perform a comprehensive signal-

background analysis for Higgs-pair production in $HH \to b\bar{b}\gamma\gamma$ channel at the HL-LHC, with the goal of probing the self-coupling $\lambda_{3H}$ of the Higgs boson. We show that the multi- class classification using Deep Neural Network can indeed give better performance in disentangling signal and backgrounds.

**Astro-particle Physics and Cosmology / 501**

## Revisiting electroweak phase transitions in SM with a singlet scalar: gauge artifact issue

**Author(s):** Eibun Senaha[1]
**Co-author(s):** Cheng-Wei Chiang [2] ; Yen-Ting Lee [3]

[1] *IBS*
[2] *National Taiwan University*
[3] *National Taiwan Univerisity*

**Corresponding Author(s):** rch0421@gmail.com, eibunsenaha@gmail.com, chengwei@phys.ntu.edu.tw

First-order electroweak phase transition plays a central role in electroweak baryogenesis.
However, it is known that unwanted gauge dependence exists in critical temperature and Higgs vacuum expectation value in an ordinary perturbative calculation scheme. In this talk, we revisit the electroweak phase transition in the SM with a singlet scalar utilizing a gauge-independent method proposed by Patel and Ramsey-Musolf and make a comparison with previous results. Impact on deviation of triple Higgs coupling from the standard model is also discussed.

**Detector: R&D for Present and Future Facilities / 502**

## Status of CEPC-ECAL R&D

Yazhou Niu[1]

[1] *USTC*

**Corresponding Author(s):** niuyz@mail.ustc.edu.cn

Circular Electron Position Collider (CEPC) is proposed as a Higgs or Z factory. One option of CEPC-ECAL(Electromagnetic calorimeter), designed based on the Particles Flow Algorithm(PFA), consists of tungsten and scintillator coupling with SiPM as active sensor. A advanced study of the gain with single photon and the responding curve of SiPM will be presented. Scintillator module also had be studied, different degrees of polishing and different ways of coupling with SiPM, to make light yield meet the dynamic range requirements and improve the uniformity of output light. A 20×20 single layer prototype had be produced and the cosmic-ray test results also will be presented.

**POSTER / 506**

## Search for dark matter candidates in the channel of Mono-H($\to\gamma\gamma$) at the ATLAS experiment

ATLAS Collaboration[None] ; Renjie Wang[1]

[1] *LPNHE-Paris, CNRS/IN2P3 (FR)*

**Corresponding Author(s):** renjie.wang@cern.ch

A search for a dark matter candidate in association with a Higgs boson decaying to two photons based on 36.1 $fb^{-1}$ data collected with the ATLAS detector at the LHC at the energy of 13 TeV will be presented. The results are interpreted in in different benchmark models: a baryonic Z' model and a two-Higgs-doublet-model with a Z' boson.

**POSTER / 507**

## Search for SM H→μμ production in pp collisions with the ATLAS detector at the LHC

ATLAS Collaboration[None] ; Aaron White[1]

[1] *University of Michigan*

**Corresponding Author(s):** aaronsw@umich.edu

The detection of the SM H→μμ decay is important to study the Higgs boson Yukawa couplings to the 2nd generation fermions. Discovering the signal of Higgs boson decay to dimuon is extremely challenging due to the small decay branching fraction (2.2x10-4) and very large irreducible background from Drell-Yan production at the LHC. The search for the H→μμ decay has been a high profile analysis in Higgs physics study program. This poster presents the latest search method and results at the time of the conference. Using the combined data sets from LHC Run 1 to Run 2, we present the limit on the signal strength of H→μμ.

**POSTER / 508**

## Search for Higgs boson production in association with a pair of top-quarks with the Atlas detector

ATLAS Collaboration[None] ; Tim Michael Heinz Wolf[1]

[1] *Nikhef National institute for subatomic physics (NL)*

**Corresponding Author(s):** tim.michael.heinz.wolf@cern.ch

A great success of the Standard Model (SM) was the discovery of a Higgs boson in 2012. Measuring its properties and yet unobserved production and decay modes provides a test of the validity of the SM. The process of Higgs production in association with a pair of top-quarks ($t\bar{t}H$) is still unobserved. Further interest arises from the fact that it provides direct access to the top Yukawa coupling which is possibly sensitive to new physics and therefore provides a crucial test of the SM.
In order to maximize the statistics of the data sample of the $t\bar{t}H$ process the final state of the Higgs decay with the highest branching ratio into a pair of $b$-quarks has been chosen for this search. This summary is based on the recently published results using $36.1 fb^{-1}$ in pp collisions collected with the Atlas detector in 2015 and 2016. Especially the reconstruction techniques to correctly match the jets originating from $b$-quarks to their origin, are reviewed. The measurement in the $t\bar{t}H(b\bar{b})$ final state is put in context with the combination of the other Higgs decay modes, resulting in evidence for this process.

**Astro-particle Physics and Cosmology / 513**

# Non-thermal WIMP baryogenesis

Jongkuk Kim[1] ; Ki Young Choi[1] ; Sin Kyu Kang[2]

[1] *Sungkyunkwan University*
[2] *Seoul-Tech*

**Corresponding Author(s):** jongkuk.kim927@gmail.com, skkang@snut.ac.kr, kiyoung.choi@uam.es

We propose a WIMP baryogensis achieved by the annihilation of non-thermally produced WIMPs from decay of heavy particles, which can result in low reheating temerature. Dark matter (DM) can be produced non-thermally during a reheating period created by the decay of long-lived heavy particle, and subsequently re-annihilate to lighter particles even after the thermal freeze-out. The re-annihilation of DM provides the observed baryon asymmetry as well as the correct relic density of DM. We investigate how wahout effects can affect the generation of the baryon asymmetry and study a model suppressing them. In this scenario, we find that DM can be heavy enough and its annihilation cross section also can be larger than that adopted in the usual thermal WIMP baryogenesis.

**Heavy Ions / 515**

# Open heavy-flavour production in Pb-Pb and Xe-Xe collisions measured with ALICE at the LHC

Andrea Rossi[1] ; on behalf of ALICE Collaboration[None]

[1] *Universita e INFN, Padova (IT)*

**Corresponding Author(s):** andrea.rossi@cern.ch

Heavy quarks (charm and beauty) are effective probes of the properties of the Quark-Gluon Plasma (QGP) formed in high-energy heavy-ion collisions at the LHC. Produced mainly in initial hard parton scatterings on shorter time scales compared to the QGP formation time, they witness the full evolution of the system, interacting with the medium constituents and losing energy. The measurement of open-heavy-flavour hadron and jet production in heavy-ion collisions and the comparison (nuclear modification factor, $R_{AA}$) with what expected from pp collisions give insight into the microscopic processes behind parton in-medium energy loss, in particular on its dependence on quark mass and colour charge, and on the interplay of elastic and radiative processes. At low transverse momentum the measurement of the relative abundances of different particle species, in particular non-strange D mesons, $D_s^+$ mesons, and $\Lambda_c^+$ baryons, is fundamental to address the possible formation of hadrons via coalescence of charm quarks with medium quarks. The study of the heavy-flavour azimuthal anisotropy (elliptic flow, $v_2$) allows to constrain the path-length dependence of energy loss and, also thanks to the "Event-Shape Engineering" technique, the level of heavy-quark thermalisation and coupling to the system.

Open-heavy-flavour production is measured with ALICE over a wide rapidity range: at mid-rapidity via the full reconstruction of hadronic decay channels of non-strange D mesons, $D_s^+$ mesons, and $\Lambda_c^+$ baryons, and via the identification of electrons from charm and beauty semi-leptonic decays. At forward rapidity heavy-flavour hadron decay muons are detected. The properties of heavy-flavour jets are investigated with angular correlation of heavy-flavour hadron decay electrons with charged particles, as well as by directly reconstruct charm jets tagged by the presence of a D meson among its constituents.

In this contribution new and most recent ALICE measurements of open heavy-flavour $R_{AA}$ and $v_2$ in Pb-Pb and Xe-Xe collisions at the LHC will be presented. The comparison with measurements at different collision energies and with available theoretical calculations will be also discussed.

**Neutrino Physics / 519**

# Latest Results from MicroBooNE

Pip Hamilton[1]

[1] *Syracuse University*

**Corresponding Author(s):** phhamilt@syr.edu

The MicroBooNE experiment has been taking data in a LArTPC detector at Fermilab since late 2015. This talk will present initial cross-section results from MicroBooNE, alongside our progress on a short-baseline neutrino oscillation analysis in the region of the MiniBooNE low-energy excess. These results will be discussed in the wider context of MicroBooNE's long-term physics goals of neutrino interaction rates, neutrino oscillations, exotic searches and detector research and development.



**Formal Theory Development / 521**

# Supersymmetrizing the map between W symmetry and affine Yangian

**Author(s):** Wei Li[1]
**Co-author(s):** Matthias Gaberdiel [2] ; Cheng Peng [3] ; Hong Zhang [1]

[1] *Institute of Theoretical Physics, Chinese Academy of Sciences*
[2] *ETH Zurich*
[3] *Brown University*

**Corresponding Author(s):** u.duality@gmail.com

Higher spin symmetry and integrability are two different types of symmetry structures with strong constraining power. I will explain an interesting and useful map between the two in the example of the W symmetry and affine Yangian of gl(1). Then I will explain how to supersymmetrize this map via gluing. This method then allows us to construct new types of affine Yangian algebras.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 523**

# R&D status of CEPC Accelerator key technologies

YUNLONG CHI[1]

[1] *IHEP, CAS*

**Corresponding Author(s):** chiyl@ihep.ac.cn

CEPC is a 100 km circular electron-positron collider operating at 90-240 GeV center-of-mass energy of Z-pole, WW pair production threshold and Higgs resonance. CEPC and its successor SPPC, a 100 TeV center-of-mass super proton-proton collider, will ensure the elementary particle physics a vibrant field for decades to come. To reduce the overall cost, partial double ring scheme was proposed as the alternative, which has a significant impact on the cavity operation and beam dynamics. The conceptual design report (CDR) of CEPC will be completed by the end of 2017 as an important step to move the project forward. In this presentation, the status of CEPC accelerator key technology R&D status will be shown, including SRF system, High efficiency klystron etc.

**Detector: R&D for Present and Future Facilities / 528**

# The CLIC detector

Eva Sicking[1]

[1] *CERN*

**Corresponding Author(s):** eva.sicking@cern.ch

The proposed Compact Linear Collider (CLIC) will provide electron-positron collisions at centre-of-mass energies from a few hundred GeV up to 3 TeV. CLIC offers a rich precision physics program, and a high sensitivity to a wide range of possible new phenomena. The precision required for such measurements and the specific conditions imposed by the CLIC beam structure put strict requirements on the detector design and technology developments. This includes ultra-low mass vertexing and tracking systems with small cells, highly granular imaging calorimeters, and a precise hit-timing resolution for all subsystems. Ambitious R&D programs for silicon tracking detectors and calorimeters are pursued, addressing the challenging detector requirements with innovative new technologies. A variety of detector optimisation studies have been carried out to establish the overall detector performance and to assess the impact of different technology options. The resulting optimised detector model has been integrated in the CLIC full-detector simulation framework. This contribution reviews the optimisation studies performed for critical parameters of the CLIC detector, presents the detector performance achieved in full-detector simulations, and gives an overview of the ongoing hardware R&D.

**POSTER / 530**

# Design study of a Split-Coaxial RFQ for IsoDAR

Jungbae Bahng[1] ; Janet Conrad[2] ; Daniel Winklehner[2]

[1] *Korea University*
[2] *Massachusetts Institute of Technology*

**Corresponding Author(s):** conrad@mit.edu, winklehn@mit.edu, bahngjb@korea.ac.kr

The Isotope Decay-At-Rest experiment (IsoDAR) is a proposed experiment to search for sterile neutrinos by measuring neutrino oscillations. The electron-antineutrino generation requires a high intensity primary proton beam impinging on a beryllium target surrounded by lithium . In IsoDAR, H2+ ions are generated and accelerated to avoid space charge effects in the low energy region, which will be stripped into protons after extraction from a cyclotron. As part of the IsoDAR injection system, an RFQ buncher with 32.8 MHz of operation frequency provides 70 keV acceleration and strong bunching of the H2+ beam. The RFQ will be installed halfway inside the iron yoke of the cyclotron to be very close to the median plane. Because the beam starts diverging after the RFQ in both trans- verse and longitudinal direction, a re-buncher is employed in the end transition cell to re-focus the beam longitudinally. In this paper, we describe in detail the beam dynamics study and RF analysis of the IsoDAR RFQ for direct injection into a compact cyclotron.

**Beyond the Standard Model / 531**

# Improved studies of B—>D(*) tau nu with vertexing at Belle II

Ida Peruzzi[1] ; Abi Soffer[2]

[1] *Laboratori Nazionali di Frascati dell'INFN*

[2] *Tel Aviv University (IL)*

**Corresponding Author(s):** abner.soffer@cern.ch, peruzzi@slac.stanford.edu

BABAR, Belle, and LHCb measure the rates for the decays $B \to D^{(*)}\tau\nu$ and $B_c \to J/\psi\tau\nu$ to be higher than the SM expectations, with a combined discrepancy of $4.1\sigma$ (for $B \to D^{(*)}\tau\nu$ only) or $\sim 4.3\sigma$ (including all modes). In the coming years, Belle II and LHCb will greatly improve the measurement precision, to the level that systematic uncertainties associated with the background $B \to D^{**}\ell\nu$ become critical. We show how to utilize Belle II's high spatial resolution to obtain a model-independent handle on this background and improve the overall signal-backgroud. We also study the impact of vertexing on Belle II's capability to perform this measurement with the decay $\tau \to 3\pi\nu$, as already demonstrated by LHCb.



**Top Quark and Electroweak Physics / 536**

## Results of vector boson scattering from CMS

**Corresponding Author(s):** kdlong@wisc.edu

The production of massive vector boson pairs is a key process for the understanding of the non-abelian gauge structure of the standard model and for the comprehension of the electroweak symmetry breaking mechanism. The study of the production of vector boson pairs with the presence of two jets in the event allows to measure the electroweak production of vector bosons in association with jets, in particular made up through vector boson scattering (VBS) processes. In this presentation, we will report the recent results of the production of diboson in association with two jets. The constraints on anomalous quartic couplings will be presented as well.

**Top Quark and Electroweak Physics / 539**

## W/Z boson production cross sections with the CMS detector

**Corresponding Author(s):** ilya.gorbunov@cern.ch

Measurements of single W and Z boson inclusive and differential production cross sections with the CMS detector are presented. Measurements of Drell-Yan cross sections in the mass range of 15 to 3000 GeV are also reported. The results are compared to predictions from different Monte Carlo generators.

**POSTER / 542**

## Search for Z and Higgs boson decaying into J/psi + photon in pp collisions at 13 TeV with CMS

Arnd Meyer[1]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*

**Corresponding Author(s):** ed.scott@cern.ch

Search for the Standard Model Z and Higgs boson decaying into a J/psi and a photon, with subsequent decay of the J/psi into dimuon pair will be presented. The analysis is performed using data recorded by CMS detector from proton-proton collisions at 13 TeV in 2016. The latest results of the limits on the Z/Higgs -> J/psi+photon decay branching fraction will be shown in this poster.

**Neutrino Physics / 546**

# The Short Baseline Neutrino Program at Fermilab

Jaroslaw Nowak[1] ; Diego Garcia-Gamez[None]

[1] *Lancaster University*

**Corresponding Author(s):** diego.garciagamez@manchester.ac.uk, j.nowak@lancaster.ac.uk

The Fermilab Short-Baseline Neutrino (SBN) program, with three liquid argon time projection chamber (LAr-TPC) detectors located along the Booster Neutrino Beam, presents a rich physics and R&D opportunity. SBN will perform sensitive searches for neutrino oscillations in both appearance and disappearance channels at the 1 eV^2 mass- splitting scale, thereby testing the sterile neutrino interpretation of the anomalous excesses of electron (anti)neutrinos observed by LSND and MiniBooNE. Also, the SBN detectors play a major role in on-going R&D efforts aimed at realizing multi-kiloton- scale LAr-TPC detectors in the next generation long-baseline neutrino oscillation experiment DUNE. To form the SBN program, two additional detectors will join MicroBooNE (currently operational at 470m along the beam); the new Short-Baseline Near Detector (SBND) will be installed at 110m, and the largest existing LAr-TPC, the ICARUST600, will be placed at 600m. In this talk, we present the current status of the SBND and ICARUS detectors and review the physics reach of the full three- detector SBN program.

**Detector: R&D for Present and Future Facilities / 547**

# Upgrades of the CMS muon system in preparation of HL-LHC

Anna Colaleo[1]

[1] *Universita e INFN, Bari (IT)*

**Corresponding Author(s):** anna.colaleo@cern.ch

The present CMS muon system operates three different detector types: in the barrel drift tubes (DT) and resistive plate chambers (RPC), cathode strip chambers (CSC) and RPCs in the forward regions. In order to cope with the challenging conditions of increasing luminosity, several upgrades are planned to the trigger and muon systems. For the existing DT and CSC detectors, the electronics will be upgraded to handle higher rates. Accelerated ageing tests are being performed to study the behaviour of these detectors under conditions which are one order of magitude beyond the design values. New micro-pattern gas detectors will be added to improve the performance in the critical forward region. Those detectors - large-area triple-foil gas electron multiplier (GEM) detectors - will already be installed in upcoming long shutdown in the pseudo-rapidity region 1.6 < eta < 2.4. Only with those additional high resolution detectors, the rate of background triggers can be controlled while maintaining high trigger efficiency for low transverse momentum muons. For the HL-LHC operation the muon forward region should be enhanced with another large area GEM based station, called GE2/1, and with two new generation RPC stations, called RE3/1 and RE4/1, having low resis- tivity electrodes. These detectors will combine tracking and triggering capabilities and can stand particle rates up to few kHz/cm2. In addition to take advantage of the pixel tracking coverage exten- sion a new detector, ME0 station, behind the new forward calorimeter, covering up to |η| = 3.

**Detector: R&D for Present and Future Facilities / 553**

PoS(ICHEP2018)930

# Flavour Physics at the High Luminosity LHC: LHCb Upgrade II

Katharina Mueller[1] ; Chris Parkes[2]

[1] *Universitaet Zuerich (CH)*
[2] *University of Manchester (GB)*

**Corresponding Author(s):** chris.parkes@cern.ch

The LHCb Collaboration is planning an Upgrade II, a flavour physics experiment for the high luminosity era. This will be installed in LS4 (2030) and targets an instantaneous luminosity of 1 to 2 x10^34 cm-2 s-1, and an integrated luminosity of at least 300fb-1. Modest consolidation of the current experiment will also be introduced in LS3 (2025). Physics goals include probing new physics scenarios in lepton flavour universality, obtaining unprecedented precision on CKM tests, and expanding the LHCb programme into new measurement areas such as Higgs decays to charm. The detector design options include the introduction of timing information, with opportunities in vertexing and tracking, electromagnetic calorimetery, and RICH particle identification. Preliminary studies for the LHC suggest that the luminosity goals will be achievable. The collaboration produced an Expression of Interest in 2017 and will issue a physics case document in May 2018, with Technical Design Reports planned for 2020.

**Diversity and Inclusion / 554**

# ECGD: Supporting early-career physicists, gender equality, and diversity at LHCb

Simon Akar[1]

[1] *University of Cincinnati (US)*

**Corresponding Author(s):** simon.akar@cern.ch

LHCb is a collaboration of over 800 scientists from 72 institutions based in 16 countries, and representing many more nationalities. We aim to work together on experimental high energy physics, and to do so in the best and most productive and collaborative conditions. The ECGD office exists to support this goal, and in particular has a mandate to support early-career physicists, and to work towards gender equality and support diversity in the collaboration. In this talk we discuss what we have learned from analysis of the collaboration's demographics and survey responses, share our experiences from efforts to achieve these aims, and consider the broader context and challenges facing the field.

**Computing and Data Handling / 557**

# Turbo: the flexible reduced data format for real-time analysis at the LHCb experiment

Alex Pearce[1]

[1] *CERN*

**Corresponding Author(s):** alex.pearce@cern.ch

In 2015, the LHCb experiment implemented a unique data processing model that allows for reconstructed objects created in the trigger to be persisted and analysed offline, without a loss in physics performance. This model has recently evolved such that arbitrary additional objects, in addition to those used in the trigger decision, can also be persisted. This allows for a more inclusive approach, where persisted objects may or may

PoS(ICHEP2018)930

not be required for present analyses but are available for future study, whilst still reducing the average event size with respect to saving the raw detector data. This talk motivates and describes the updated data model, and presents a study on the performance of this triggering technique in the context of the LHCb upgrade detector, running from 2021, where it is expected to be the de facto trigger strategy.

**Detector: R&D for Present and Future Facilities / 558**

# LHCb Upgrade Detector

Katharina Mueller[1] ; Giovanni Passaleva[2]

[1] *Universitaet Zuerich (CH)*
[2] *INFN Florence (IT)*

**Corresponding Author(s):** giovanni.passaleva@fi.infn.it

This year, at the end of LHC Run 2, LHCb will start replacing major parts of the detector and installing new detector components in the underground cavern of LHC Interaction Point 8, thus realizing the long-planned upgrade I of the LHCb experiment. The new detector is designed to operate at the instantaneous luminosity of 2·10^33 cm-2s-1, more than five times higher than in Run 2. All sub- detectors are in production, some close to completion. This talk will present a status overview of the new detector and highlight performance results of a few key sub-systems, such as the silicon pixel vertex detector, the silicon-strip tracker, the scintillating-fibre tracker and the ring-imaging Cherenkov system. A crucial part of the upgrade lies in the software-only trigger, which is facing the extreme challenge to select the desired events at 30MHz input rate with around five to six visible interactions per bunch crossing. Recent R&D progress on the trigger strategy and benchmarking will be presented. In addition, the continuous expansion of the LHCb physics programme (in particular, using fixed targets) and preparation for future challenges will be briefly outlined.

**Detector: R&D for Present and Future Facilities / 560**

# SciFi - A large Scintillating Fibre Tracker for LHCb

Katharina Mueller[1] ; Janine Müller[2]

[1] *Universitaet Zuerich (CH)*
[2] *Technische Universitaet Dortmund (DE)*

**Corresponding Author(s):** janine.muller@cern.ch, jihyun.bohm@cern.ch

The LHCb detector will be upgraded during the Long Shutdown 2 (LS2) of the LHC in order to cope with higher instantaneous luminosities and to read out the data at 40MHz using a trigger-less read-out system. The current LHCb main tracking system, composed of an inner and outer tracking detector, will not be able to cope with the increased particle multiplicities and will be replaced by a single homogenous detector based on scintillating fibres. The new Scintillating Fibre (SciFi) Tracker covers a total detector area of 340 m2 and should provide a spatial resolution for charged particles better than 100 μm in the bending direction of the LHCb spectrometer. The detector will be built from individual modules (0.5 m × 4.8 m), each comprising 8 scintillating fibre mats with a length of 2.4 m as active detector material. The fibre mats consist of 6 layers of densely packed blue emitting scintillating fibres with a diameter of 250 μm. The scintillation light is recorded with arrays of state-of-the-art multi-channel silicon photomultipliers (SiPMs). A custom ASIC will be used to digitize the SiPM signals. Subsequent digital electronics performs clustering and data-compression before the data is sent via optical links to the DAQ system. To reduce the thermal noise of the SiPM in particular after being exposed to a neutron fluence of up to 10^{12} neq /cm^2, expected for the lifetime of the detector, the SiPMs arrays are mounted in so called cold-boxes and cooled down by 3D-printed titanium cold-bars to -40o C. Modules together with cold-boxes and readout electronics are mounted on so-called C-frames which will

PoS(ICHEP2018)930

provide the mechanical support structure and the necessary services to power, read out and cool the detector elements. A proto-type frame is currently being built. The serial assembly of these detector elements will start in summer 2018. The detector installation is foreseen to start end of 2019. The talk will give an overview of the detector concept and will present the experience from the series production complemented by most recent test and quality assurance results.

**Computing and Data Handling / 564**

## Particle identification at LHCb: new calibration techniques and machine learning classification algorithms

Anton Poluektov[1]

[1] *University of Warwick (GB)*

**Corresponding Author(s):** anton.poluektov@cern.ch

Particle identification (PID) plays a crucial role in LHCb analyses. Combining information from LHCb subdetectors allows one to distinguish between various species of long-lived charged and neutral particles. PID performance directly affects the sensitivity of most LHCb measurements. Advanced multivariate approaches are used at LHCb to obtain the best PID performance and control systematic uncertainties. This talk highlights recent developments in PID that use innovative machine learning techniques, as well as novel data-driven approaches which ensure that PID performance is well reproduced in simulation.

**Detector: R&D for Present and Future Facilities / 565**

## The LHCb Velo Upgrade

Katharina Mueller[1] ; Stefano De Capua[2]

[1] *Universitaet Zuerich (CH)*
[2] *University of Manchester (GB)*

**Corresponding Author(s):** decapua.stefano@gmail.com

The Large Hadron Collider Beauty detector is a flavour physics detector, designed to detect decays of b- and c-hadrons for the study of CP violation and rare decays. At the end of Run-II, many of the LHCb measurements will remain statistically dominated. In order to increase the trigger yield for purely hadronic channels, the hardware trigger will be removed and the detector will operate at 40 MHz. This, in combination with the five-fold increase in luminosity necessitates radical changes to LHCb's electronics with entire subdetector replacements required in some cases. The Vertex Locator (VELO) surrounding the interaction region is used to reconstruct the collision points (primary vertices) and decay vertices of long-lived particles (secondary vertices). The upgraded VELO modules will each be equipped with 4 silicon hybrid pixel tiles, each read out with by 3 VeloPix ASICs. The silicon sensors must withstand an integrated fluence of up to $8\times10^{15} 1MeV\, n_{eq}/cm^2$, a roughly equivalent dose of 400 MRad. The highest occupancy ASICs will have pixel hit rates of 900 Mhit/s and produce an output data rate of over 15 Gbit/s, with a total rate of 1.6 Tbit/s anticipated for the whole detector. The detectors are located in vacuum, separated from the beam vacuum by a thin custom made foil. The foil will be manufactured through a novel milling process and possibly thinned further by chemical etching.
An additional challenge is the non uniform nature of the radiation damage, which results in requiring a guard ring design with excellent high voltage control. In addition, the n-in-p design requires the guard ring to be on the chip side making the high voltage reach the vicinity of the ground plane (about 30 $\mu$m apart). This requires a high voltage tolerant setup for irradiated assemblies which can be achieved using a vacuum

PoS(ICHEP2018)930

chamber. The performance of the prototype sensors has been investigated in a test beam in which a dedicated telescope system was created read out by Timepix3 ASICs. Several different tests of the of the sensor prototypes were performed before and after irradiation. A collection of preliminary results will be presented, as well as a comparison of the performance of the different sensor prototypes.
The VELO upgrade modules are composed of the detector assemblies and electronics hybrid circuits mounted onto a cooling substrate, which is composed of thin silicon plates with embedded micro-channels that allow the circulation of liquid $CO_2$. This technique was selected due to the excellent thermal efficiency, the absence of thermal expansion mismatch with silicon ASIC's and sensors, radiation hardness of CO2, and very low contribution to the material budget. An alternative and more conservative approach is also under development. The front-end hybrid hosts the VeloPix ASICs and a GBTx ASIC for control and communication. The hybrid is linked to the opto- and-power board (OPB) by 60 cm electrical data tapes running at 5 Gb/s. The tapes must be vacuum compatible and radiation hard and are required to have enough flexibility to allow the VELO to retract during LHC beam injection. The OPB is situated immediately outside the VELO vacuum tank and performs the opto-electrical conversion of control signals going to the front-end and of serial data going off-detector. The board is designed around the Versatile Link components developed for high-luminosity LHC applications. From the OPB the detector data are sent through 300 m of optical fibre to LHCb's common readout board (PCIe40). The PCIe40 is an Altera Arria10-based PCI-express control and readout card capable of 100 Gb/s data throughput. The PCIe40 firmware is designed as a series of common components with the option for user-specific data processing. The common components deal with accepting the input data from the detector over the GBT protocol, error-checking, dealing with reset signals, and preparing the data for the computing farm. The VELO-specific code would, for example, perform clustering of hits and time reordering of the events scrambled during the readout.
The design of the complete VELO upgrade system will be presented with the latest results from the R&D. The LHCb upgrade detector will be the first detector to read out at full LHC rate of 40 MHz. The VELO upgrade will utilise the latest detector technologies to read out at this rate using while maintaining the necessary radiation hard profile and minimising the detector material.

**POSTER / 569**

# Precise measurement of theta13 and dm^2_ee at RENO

Dongha Lee[1] ; [2] ; Serguey[2] ;
; [6] ; [6] ; [6] ; [6] ; [6] ; 3 . 3 . 4 . 5 . 5 . 5 . 5 . 5 . 5 . 5 . 5 . 6
9 ; 9 Rott Carsten[6] ; [7] ; 7 . 7 . 7 . 7 . 7 . 7 . 7 . 8 .
;

[1] *Seoul National University*
2
3
4
5
6
7
[8] *GIST*
[9] *KAIST*

**Corresponding Author(s):** summerofeast@snu.ac.kr, wooyoung@knu.ac.kr

The RENO experiment has measured the neutrino mixing angle θ_13 and dm^2_ee, using reactor antineutrinos from the reactors at Hanbit Nuclear Power Plant since Aug. 2011. In 2016, RENO published results on sin^2(2θ_13) and dm^2_ee using the energy dependent oscillation of reactor antineutrinos in the 500days of data. RENO has accumulated roughly ~2000 days of data with reduced backgrounds and thus decreased systematic uncertainties. Due to the improved statistics and systematic uncertainties we measured sin^2(2θ_13) and dm^2_ee more precisely. In this talk we will present new results from the ~2000 days data.

PoS(ICHEP2018)930

**Detector: R&D for Present and Future Facilities / 571**

# Overview talk on detector performances at CMS

Lucia Silvestris[1]

[1] *Universita e INFN, Bari (IT)*

**Corresponding Author(s):** lucia.silvestris@cern.ch

The performance of CMS detector on early 2018 data will be presented. Special attention will be given to the performance of the recently upgraded components, and in particular to the silicon pixel detector and hadronic calorimeters.



**Education and Outreach / 574**

# A MOOC on HEP for French high schools

Nicolas Arnaud[None] ; Sebastien Descotes-Genon[1]

[1] *Laboratoire de Physique Théorique d'Orsay*

**Corresponding Author(s):** narnaud@lal.in2p3.fr, sebastien.descotes-genon@th.u-psud.fr

"Voyages de l'infiniment grand à l'infiniment petit" ("Journeys from the infinitely large to the in- finitely small") is a French Massive Online Open Course aimed at promoting nuclear and particle physics as well as astrophysics and cosmology to high-school teachers and pupils. Designed by an editorial team of physicists from CNRS and CEA and edited with the pedagogical and technical sup- port from Ecole Polytechnique, this MOOC is composed of 4 courses (Physics of the infinitely small, physics of the infinitely large, The links between the two, The connections with everyday life), con- sisting in 10 modules of 10 minutes each, and a dozen of speakers have contributed in the writing of the modules. The MOOC students can follow the 4 courses and test their knowledge through a series of quizzes on the Coursera platform. This MOOC aims at providing an overview of high-energy physics to interested students with a high-school level in physics, and also at giving video and text resources to high-school teachers willing to include high-energy physics in their lectures.

**Heavy Ions / 579**

# Quarkonia production in pPb collisions with LHCb

Shanzhen Chen[1]

[1] *Universita e INFN, Cagliari (IT)*

**Corresponding Author(s):** shanzhen.chen@cern.ch

We present new results on quarkonia production in pPb collisions, using the data collected in 2016 at 8.16 TeV nucleon-nucleon centre-of-mass energy, in the unique forward region (pseudorapidity between 2 and 5) covered by the LHCb detector. Both forward and backward rapidities are covered thanks to the possibility of beam reversal. Measurements include the vector bottomonia states and the J/psi and psi(2S), where the prompt and from-b-decay components can be disentangled. The large increase in size of the heavy flavour sample, compared to 5 TeV sample collected in 2013, allows a re- markable improvement in the accuracy of the determination of nuclear modification factors.

**Beyond the Standard Model / 582**

# Searches for Long Lived Particles at LHCb

Carlos Vazquez Sierra[1]

[1] *Nikhef National institute for subatomic physics (NL)*

**Corresponding Author(s):** carlos.vazquez@cern.ch

A flexible trigger system, excellent vertex locator, particle identification detectors, and forward acceptance allow unique searches for long-lived particles to be performed at LHC energies using data collected with the LHCb detector. A summary of results will be presented, including searches for long-lived particles decaying into lepton or jets or coming from B meson decays.

**Top Quark and Electroweak Physics / 585**

# Top physics at LHCb

**Corresponding Author(s):** carlos.vazquez@cern.ch

LHCb, while purpose built for b-physics, also functions as a general purpose forward detector, covering the pseudo-rapidity range 2.0 to 5.0. Measurements of top production in the LHCb acceptance have particular sensitivity to high values of Bjorken-x, and offer complementary PDF constraints to measurements at the central detectors. In addition, the higher contribution from quark-initiated production to top pair production in the forward region leads to a larger expected charge asymmetry at LHCb than at the other experiments. The first Run 2 measurement of top pair production at LHCb at 13 TeV will be presented, along with previous Run 1 measurements in final states accessible to both single top and top pair production.

**Top Quark and Electroweak Physics / 586**

# EW physics at LHCb

**Corresponding Author(s):** pavel.krokovny@cern.ch

A variety of vector boson measurements have been performed at LHCb with Run 1 data, including inclusive Z/W cross-sections, the Z forward-backward asymmetry, Z/W production with jets (including heavy flavor). Additionally, the inclusive Z cross-sections have been measured with Run 2 data. A variety of these results will be presented.

**Strong Interactions and Hadron Physics / 587**

# Soft QCD at LHCb

Chris Parkes[1]

PoS(ICHEP2018)930

[1] *University of Manchester (GB)*

**Corresponding Author(s):** chris.parkes@cern.ch

The forward acceptance of LHCb, 2.0 < y < 5.0, provides a complementary reach to the general purpose detectors at the LHC. LHCb measurements of the pp inelastic cross-section, J/psi production in jets, kinematic correlations between b and b-bar hadrons, and Bose Einstein correlations are discussed. Prompt J/psi production is found to be less isolated than predicted in LO NRQCD.

**Strong Interactions and Hadron Physics / 593**

## Heavy quark(onia) spectroscopy at LHCb

Daniel Johnson[1]

[1] *CERN*

**Corresponding Author(s):** daniel.johnson@cern.ch

The spectroscopy of excited hadronic states in the beauty sector, double heavy hadrons and quarkonia provides a rich proofing ground for effective theories of the strong interaction. The unique data set collected during runs 1 and 2 of the LHC have lead to the observation of several new states, interesting decay modes and has enabled precision mass measurements of known resonances. Here we present recent results from LHCb.

**Quark and Lepton Flavor Physics / 597**

## CP violation in b-hadron decays to charmless charged two-body final states at LHCb

**Corresponding Author(s):** stefano.perazzini@cern.ch

The amplitudes governing the decays of neutral b-hadrons to charmless charged two-body final states receive relevant contribution from both b->u tree-level and b->d,s penguin topologies. Hence, these decays are sensitive probes of the CKM paradigm, but also have the potential to reveal new physics beyond the Standard Model. Relevant quantities to measure are time-dependent and time-integrated CP asymmetries, and branching ratios. We present the most recent measurements of these quantities performed by the LHCb experiment.

**Quark and Lepton Flavor Physics / 598**

## CP violation and polarisation amplitudes in B->VV decays at LHCb

**Corresponding Author(s):** j.dalseno@bristol.ac.uk

Decays of b-mesons to charmless multi-body final states are CKM suppressed in the Standard Model, which brings the tree amplitudes to levels comparable with corresponding loop amplitudes. New particles not foreseen in the SM that appear in the loops may alter not only the CP asymmetries of these decays, but also the polarisation fractions and triple-product asymmetries. The latest measurements of these quantities performed by the LHCb experiments are presented, with particular emphasis on B->VV decays, where V indicates a light vector meson.

PoS(ICHEP2018)930

**Quark and Lepton Flavor Physics / 601**

## CP violation in b-baryon decays to multibody final states at LHCb

**Corresponding Author(s):** j.fu@cern.ch

The violation of CP symmetry is well established nowadays in the K- and B-mesons sectors. However CPV has not been observed in the baryonic sector. Charmless b-baryon decays represent a promising opportunity in this respect since their amplitudes receive both contributions from tree level diagrams where the CKM element Vub appears and loop level diagrams which have comparable contirbutions. In addition, these decays are sensitive to possible physics beyond the SM, entering from penguin topologies. We present the most recent measurements of CP violation in charmless b-baryon decays performed by LHCb, including branching ratios and triple-product asymmetries.

**Quark and Lepton Flavor Physics / 603**

## Direct CP violation in B decays at LHCb

**Corresponding Author(s):** grabowski@physi.uni-heidelberg.de

Measurements of charge CP asymmetries in the decays of b hadrons with charmonia in the final state are powerful probes to search for physics effects beyond the Standard Model. Recent results in the measurement of direct CP violation of B mesons performed by the LHCb collaboration using Run 1 data will be presented.

**Quark and Lepton Flavor Physics / 605**

## B meson mixing parameters and branching fractions at LHCb

**Corresponding Author(s):** veronika.chobanova@cern.ch

New LHCb results in the measurement of B meson mixing parameters and branching fractions will be presented. The results are obtained using pp collisions collected in Run 1 and Run 2 of the LHC and include a new and world's most precise determination of the decay width difference in the Bs system and the ratio between the decay width of the Bs and Bd mesons.

**Quark and Lepton Flavor Physics / 606**

## Recent improvements and prospects with flavour tagging at LHCb

**Corresponding Author(s):** simon.akar@cern.ch

Precision measurements of time-dependent CP violation and of mixing parameters in the neutral B meson systems are bound to the ability to identify the production flavour of reconstructed b hadrons. The harsh environment of proton-proton collisions at LHC constitutes a challenging environment for flavour tagging and demand for novel and improved strategies. We present recent progress and new developments in

PoS(ICHEP2018)930

flavour tagging at the LHCb experiment, which will allow for a further improvement of CP violation measurements in decays of B0 and Bs0 mesons.

**Quark and Lepton Flavor Physics / 610**

## Mixing and indirect CPV in Charm decays at LHCb

**Corresponding Author(s):** maurizio.martinelli@cern.ch

LHCb has collected the world's largest sample of charmed hadrons. This sample is used to measure $D^0 - \bar{D}^0$ mixing and to search for indirect CP violation. New measurements from several decay modes are presented, as well as prospects for future sensitivities.

**Quark and Lepton Flavor Physics / 616**

## Radiative B decays at LHCb

**Corresponding Author(s):** fedor.ratnikov@gmail.com

Radiative b-hadron decays are sensitive probes of New Physics through the study of branching fractions, CP asymmetries and measurements of the polarisation of the photon emitted in the decay. During Run-1 of the LHC, the LHCb experiment has collected large samples of radiative b-hadron decays. We present here the latest LHCb measurements, which help constrain the size of right-handed currents in extensions of the Standard Model.

**Detector: R&D for Present and Future Facilities / 627**

## Characteristics of MCP-PMTs in magnetic field

Michael Foley[1]

[1] *Incom Inc.*

**Corresponding Author(s):** mrf@incomusa.com

Performance of the microchannel plate photomultiplier (MCP-PMT) in magnetic field is an important aspect for its application in the proposed electron ion collider (EIC). The motivation of this paper is to explore the critical parameters that affect the performance of MCP-PMT in magnetic field, and to guide the design optimization of MCP-PMTs for high magnetic field tolerance. MCP-PMTs with two different designs were examined in magnetic field and the results were compared. The magnetic field tolerance of MCP-PMT with new independent biased voltage design shows significant improvement (up to 0.8 T) compared to that of the MCP-PMT with resistor chain design (up to
0.2 T), indicating that optimization of the individual MCP voltage is an important parameter for magnetic field tolerance improvement. The effects of other parameters such as the rotation angle relative to the magnetic field direction and the bias voltage between photocathode and entrance MCP were thoroughly studied with the independent biased voltage design. The gain of the MCP-PMT exhibits enhanced performance at ± 8 degree tilt angle due to the original MCP 8 degree bias angle. Maximum gain values are observed dependent on the optimal bias voltages in different magnetic field strength.

PoS(ICHEP2018)930

**Dark Matter Detection / 628**

# A dark matter search with NaI(Tl) crystals by using a pulse shape discrimination analysis

Kyungwon Kim[1]

[1] *Center for Underground Physics, IBS*

**Corresponding Author(s):** kwkim@ibs.re.kr

KIMS-NaI is an experiment aimed at directly detecting Weakly Interacting Massive Particle (WIMP) via weak interactions with the nuclei in low-background NaI(Tl) crystals. Underground data for the WIMP search were obtained in the Yangyang underground laboratory with two NaI(Tl) crystals that have unprecedentedly high light-output. Since the scintillation characteristics of nuclear recoils from WIMP interactions and electron recoils produced by many background processes are different, it is possible to distinguish between the two types of events by means of pulse shape discrimination (PSD) methods. We characterized the pulse shapes produced in an NaI(Tl) test crystal by neutrons from a deuteron-based generator and gamma rays from a radioactive source. Surface nuclear recoils that could be misidentified as candidates for WIMP-induced events were also investigated and taken into account in the analysis. Preliminary results based on a PSD analysis of a 2967 kg*day data exposure will be presented.

**POSTER / 629**

# Reduction of the radioactive impurities in NaI powder by recrystallization method

**Author(s):** Keon Ah SHIN[1]
**Co-author(s):** Olga Gileva [2] ; HyangKyu Park [3]

[1] *IBS*
[2] *IBS, CUP*
[3] *Institute for Basic Science*

**Corresponding Author(s):** sinh4230@gmail.com, lelyum1986@yandex.ru, hyangkyu.park@gmail.com

The COSINE project is aimed at direct detection of dark matter experiment1. WIMPs(Weakly Interacting Massive Particles) are one of the most attractive candidates of dark matter[2, 3] but, only DAMA/LIBRA experiment has claimed the detection of a WIMPs[4]. To confirm or exclude the DAMA/LIBRA's modulation results, COSINE is going to achieve ultra-low background and lower energy threshold than DAMA/LIBRA experiment. The NaI scintillating crystal is very suitable material for dark matter searching. In this experiment, radioactive impurities make noise on the peaks and high background. To manufacture the ultra-low background crystal, this presentation will be focused on purification of the NaI powder.
NaI powder was purified by fractional recrystallization from water. The concentration of K, Pb, Th, U and other impurities was measured by ICP-MS. As a result, the recrystallization effectively reduced the concentration of radioactive impurities such as K, Pb, Sr, Ba, Th, and U. Furthermore, based on these experimental methods and results, pilot scale of process were designed and manufactured for COSINE project. It is a recrystallization purify system that can purify 70 kg of NaI powder at one cycle and it takes 3~4 days from purification to drying. This process and result also will be presented.

References:
[1] Adhikari P et al (2016) Understanding internal backgrounds in NaI(T1) crystals toward a 200 Kg array for the KIMS-NaI experiment. Eur Phys J C 76(4):1-9
[2]Bertone G, Hooper D, Silk J (2005) Particle dark matter: evidence, candidates and constraints. Phys Rept 405:279-390
[3] Jungman G, Kamionkowski M, Griest K (1996) Supersymmetric dark matter. Phys. Rept 267:195- 373

PoS(ICHEP2018)930

[4] Bernabei R et al (2010) New results from DAMA/LIBRA. Eur Phys J C 67:39-49

**Computing and Data Handling / 633**

# New approaches using machine learning for fast shower simulation in ATLAS

Hasib Ahmed[1]

[1] *The University of Edinburgh (GB)*

**Corresponding Author(s):** a.hasib@cern.ch

Modeling the detector response to collisions is one of the most CPU expensive and time-consuming aspects in the LHC. The current ATLAS baseline, GEANT4, is highly CPU intensive. With the large collision dataset expected in the future, CPU usage becomes critical. During the LHC Run-1, a fast calorimeter simulation (FastCaloSim) was successfully used by ATLAS. FastCaloSim parametrizes the energy response of particles in the calorimeter cells, accounting for the lateral shower profile and the correlation of the energy deposition among various calorimeter layers. It significantly speeds up the calorimeter simulation. An improved version of FastCaloSim is currently under develop- ment to reduce CPU and memory requirements and to improve the physics description. The new FastCaloSim implements machine learning techniques, such as principal component analysis and neural networks. Other new ideas being investigated include using deep generative models such as Variational Auto-Encoders (VAEs) and Generative Adversarial Networks (GANs). These models take into account the complex geometry of the ATLAS calorimeter and reproduce the shower characteris- tics. They are enhanced to handle different particle types and energy level variations simultaneously. This talk will describe these fast simulation methods, quantify the performance and discuss physics applications.

**Beyond the Standard Model / 635**

# Search for a heavy dark photon at future e^+e^− colliders

Min He[1] ; Xiao-Gang He[2] ; Cheng-Kai Huang[2] ; Gang Li[None]

[1] *Shanghai Jiao Tong University*
[2] *National Taiwan University*

**Corresponding Author(s):** gangli@phys.ntu.edu.tw

A coupling of a dark photon $A'$ from a $U(1)_{A'}$ with the standard model (SM) particles can be generated through kinetic mixing represented by a parameter $\epsilon$. A non-zero $\epsilon$ also induces a mixing between $A'$ and $Z$ if dark photon mass $m_{A'}$ is not zero. This mixing can be large when $m_{A'}$ is close to $m_Z$ even if the parameter $\epsilon$ is small. Many efforts have been made to constrain the parameter $\epsilon$ for a low dark photon mass $m_{A'}$ compared with the $Z$ boson mass $m_Z$. We study the search for dark photon in $e^+e^- \to \gamma A' \to \gamma\mu^+\mu^-$ for a dark photon mass $m_{A'}$ as large as kinematically allowed at future $e^+e^-$ colliders. For large $m_{A'}$, care should be taken to properly treat possible large mixing between $A'$ and $Z$. We obtain sensitivities to the parameter $\epsilon$ for a wide range of dark photon mass at planed $e^+e^-$ colliders, such as Circular Electron Positron Collider (CEPC), International Linear Collider (ILC) and Future Circular Collider (FCC-ee). For the dark photon mass $20$ GeV $\lesssim m_{A'} \lesssim 330$ GeV, the $2\sigma$ exclusion limits on the mixing parameter are $\epsilon \lesssim 10^{-3} - 10^{-2}$. The CEPC with $\sqrt{s} = 240$ GeV and FCC-ee with $\sqrt{s} = 160$ GeV are more sensitive than the constraint from current LHCb measurement once the dark photon mass $m_{A'} \gtrsim 50$ GeV. For $m_{A'} \gtrsim 220$ GeV, the sensitivity at the FCC-ee with $\sqrt{s} = 350$ GeV and $1.5$ ab$^{-1}$ is better than that at the 13~TeV LHC with $300$ fb$^{-1}$, while the sensitivity at the CEPC with $\sqrt{s} = 240$ GeV and $5$ ab$^{-1}$ can be even better than that at 13~TeV LHC with $3$ ab$^{-1}$ for $m_{A'} \gtrsim 180$ GeV. We also comment on sensitivities of $e^+e^- \to \gamma A'$ with dark photon decay into several other channels at future $e^+e^-$ colliders.

**Neutrino Physics / 638**

# Prospects for CP violation measurement with Hyper-Kamiokande

**Author(s):** Masaki Ishitsuka[1]
**Co-author(s):** Masaki Ishitsuka [2]

[1] *Tokyo University of Science*
[2] *Tokyo Institute of Technology (JP)*

**Corresponding Author(s):** masaki.ishitsuka@gmail.com, masaki.ishitsuka@cern.ch

Three flavor neutrino mixing has been established by the continuous studies of neutrino oscillations since its discovery. Large mixing angles and small neutrino masses, in contrast to those in quark sector, imply new physics at ultra-high energy. In addition, as- yet unmeasured CP violation in neutrino sector is considered as a clue to investigate the origin of matter-antimatter asymmetry of the universe. Hyper-Kamiokande is a next generation large-scale water Cherenkov detector. With the baseline design, its fiducial volume is about an order of magnitude larger than Super-Kamiokande and the detector performance is significantly improved with newly developed photo-sensors. Com- bination of the Hyper-Kamiokande detector with the upgraded J-PARC neutrino beam will provide unprecedented high statistics of the neutrino and antineutrino signals to measure the CP violation and reveal a full picture of neutrino mixing with high precision. Prospects for the CP violation measurements by the Hyper-Kamiokande
long baseline project will be presented.

**Neutrino Physics / 639**

# Oscillation Physics with Atmospheric Neutrinos at Hyper-Kamiokande

Sandro Bravar[1]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** alessandro.bravar@unige.ch

After the initial observation of neutrino oscillations using atmospheric neutrinos, considerable progress has been made in the understanding of the mixing paradigm using long-baseline and reactor neutrinos. Despite these successes, there are several open questions remaining, including the ordering of the neutrino masses, the octant of the atmospheric mixing angle, and whether or not neutrino oscillations violate CP. Hyper-Kamiokande is next-generation water Cherenkov experiment that will observe long-baseline neutrinos from J-PARC as well as atmospheric neutrinos with its 187~kton fiducial volume. While its atmospheric sample is subject to considerable matter effects and pro- vides sensitivity primarily to the neutrino mass hierarchy, its accelerator neutrino sample provides a clean measurement of the CP phase in the PMNS mixing framework, especially when the hierarchy is known.
This talk will discuss Hyper-Kamiokande's oscillation sensitivity using atmospheric neutrinos and demonstrate the power of their combination with the beam sample to realize early resolutions to the open questions in oscillation physics.

**Astro-particle Physics and Cosmology / 640**

PoS(ICHEP2018)930

# Searches for Nucleon Decay at Hyper-Kamiokande

Gabriella Catanesi[1] ; Masashi Yokoyama[2]

[1] *INFN, Sezione di Bari-Universita & INFN, Bari*
[2] *University of Tokyo (JP)*

**Corresponding Author(s):** masashi@phys.s.u-tokyo.ac.jp

While grand unified theories offer potential solutions to problems with the Standard Model, such as the origins of charge quantization, their signature prediction, proton decay, has not been observed experimentally. Hyper-Kamiokande is a next-generation water Cherenkov experiment with a 187~kton target volume that will provide unprecedented sensitivity to a variety of nucleon decay modes, including many beyond the so-called flagship modes, $p \to e^+\pi^0$ and $p \to \bar{\nu}K^+$. With improved detector technologies to enhance signal efficiencies and reject backgrounds, Hyper-Kamiokande is expected to search for these processes with sensitivities to proton lifetimes of 10^{35} years and longer, providing opportunities for a discoveries for lifetimes exceeding existing limits by an order of magnitude. This presentation will describe the complete Hyper-Kamiokande nucleon decay physics program and its expected sensitivities.

**Neutrino Physics / 641**

# Astrophysical Neutrinos at Hyper-Kamiokande

Itaru Shimizu[None]

**Corresponding Author(s):** shimizu@awa.tohoku.ac.jp

Hyper-Kamiokande (Hyper-K) is a proposed next generation underground large water Cherenkov detector with 260 kton of water and 40% photo coverage.
With about 10 times larger fiducial volume than Super-Kamiokande, the sensitivities for astrophysical neutrinos, like solar neutrinos or supernova neutrinos, will be greatly improved in Hyper-K. In this presentation, we will discuss the physics potential of Hyper- K on astrophysical neutrinos and expected performance of the detector.

**Detector: R&D for Present and Future Facilities / 644**

# Development of 50 cm Photo-Detectors for Hyper-Kamiokande

Yasuhiro NISHIMURA[1]

[1] *The University of Tokyo*

**Corresponding Author(s):** ynisi@icrr.u-tokyo.ac.jp

Hyper-Kamiokande is a large water Cherenkov detector planned in Japan. It requires a large aperture photo-detector with a high photon detection efficiency to explore various neutrino physics and discover a nucleon decay. A photomultiplier tube (PMT), R12860 by Hamamatsu Photonics K.K., was developed with a box-and-line dynode to achieve high resolutions of charge and timing, compared with an R3600 PMT for Super-Kamiokande. Compared with the R3600 PMT, a single photon detection efficiency of the new R12860 PMT is doubled due to the high collection efficiency of 95% and a higher quantum efficiency of 30% at 390 nm wavelength. Recently the output dynamic range was improved and a dark count rate is being reduced. We evaluated an individual difference of the performance measuring 140 PMTs. Using an avalanche diode with a single structure inside of the bulb, we developed a 50 cm hybrid photo-detector (HPD), R12850 by Hamamatsu. The timing resolution was improved to be 3.6 ns (FWHM) by developing a preamplifier with a fast time response. A waterproofed HPD was pre- pared and installed into a 200-ton water Cherenkov detector at Kamioka, Japan.

PoS(ICHEP2018)930

Several designs of a shockwave prevention cover by an implosion of the PMT in deep water were developed and tested. It enables a light weight or low cost. The recent development and improved performance of the 50 cm photo-detectors will be presented.

**Detector: R&D for Present and Future Facilities / 645**

# A multi-PMT photodetector system for the Hyper-Kamiokande experiment

Vincenzo Berardi[1]

[1] *Universita e INFN, Bari (IT)*

**Corresponding Author(s):** vincenzo.berardi@cern.ch

Hyper-Kamiokande (Hyper-K), a proposed one-megaton water Cherenkov detector to be built in Japan, is the logical continuation of the highly successful Super-Kamiokande experiment. Its broad physics programme includes neutrinos from astronomical sources, nucleon decay, with the main focus the determination of leptonic CP violation.
To detect the weak Cherenkov light generated by neutrino interactions or proton decay, the employment of the multi-PMT concept, first introduced in the KM3NeT detector, is considered as possible solution. A multi-PMT Optical Module based on a pressure vessel instrumented with multiple small diameter photosensors, readout electronics and power, offers several advantages as higher sensitive surface, weaker sensitivity to Earth's magnetic field, increased granularity and directional information with an almost isotropic field of view. In this contribution the development of a multi-PMT module for Hyper-K is discussed.

**Detector: R&D for Present and Future Facilities / 649**

# Near Detectors for Hyper-Kamiokande

Stephen Michael Playfer[1]

[1] *University of Edinburgh (GB)*

**Corresponding Author(s):** playfer@ph.ed.ac.uk

The proposed Hyper-Kamiokande experiment (Hyper-K) is a next generation large water Cherenkov (WD) detector with a broad physics program consisting of neutrino beam measurements in search of leptonic CP violation, astrophysical measurements and a search for proton decay. Hyper-K will act as the far detector to measure the oscillated neutrino flux from the long-baseline beam of 0.6 GeV neutrinos/anti-neutrinos produced by a 1.3 MW proton beam at J-PARC in Japan. To minimize systematic uncertainties, particularly due to flux and cross-section uncertainties, detailed measurements of the unoscillated flux are required with a suite of near detectors. This talk will review the challenges, and present the planned components of the near detector measurement suite, including a new intermediate Water Cherenkov Detector.

**Higgs Physics / 652**

# Partially Composite Higgs Models

Martin Rosenlyst Jørgensen[1]

[1] *University of Southern Denmark*

**Corresponding Author(s):** mrosenlyst@sdu.dk

We study the phenomenology of partially composite-Higgs models where electroweak symmetry breaking is dynamically induced, and the Higgs is a mixture of a composite and an elementary state. The models considered have explicit realizations in terms of gauge-Yukawa theories and allow for a very SM-like Higgs state.

**Detector: R&D for Present and Future Facilities / 654**

## the 20-inch PMT system for the JUNO experiment

Zhonghua Qin[1]

[1] *Institute of High Energy Physics, China*

**Corresponding Author(s):** qinzh@ihep.ac.cn

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment under construction. The primary goal is to determine the neutrino mass hierarchy and precisely measure the oscillation parameters by detecting reactor anti-neutrinos. There will be around 20000 PMTs with a large photo-cathode of 20-inch equipped for the JUNO experiment, which includes 15000 MCP PMTs from a Chinese company and 5000 Dynode PMTs from Hamamatsu company. To achieve the designed 3% energy resolution, the PMTs are required to have high detection efficiency as well as very tight positioning in the JUNO detector. The 20-inch PMT system for JUNO includes PMT performance testing, design of high voltage divider, waterproof potting, chain implosion protection, and installation on the detector. Testing of the PMTs will use a device developed in a container for batch test and a scanning station for sampling test. Since the PMTs are required to work for 20 years in water with a depth up to 45 m, the PMTs need to be potted to keep the high voltage divider away from water. And in a situation that the PMTs will be closest possible arranged with the spacing only a few mm to achieve a coverage larger than 75%, the protection for chain implosion and also the installation are very challenging. In this talk, all aspects mentioned above for the JUNO 20-inch PMT system will be addressed.

**Quark and Lepton Flavor Physics / 656**

## Study of the normalization modes in search the rare decay of K0 → $\pi^0\nu\bar{\nu}$ with the KOTO detector

Brian Beckford[1]

[1] *University of Michigan*

**Corresponding Author(s):** bobeck@umich.edu

The KOTO experiment aims to observe the K0L → π0νν¯ decay and measure the branching rate. The Standard Model (SM) prediction for the mode is 2.4 x 10−11 with a small theoretical uncertainty. An experimental upper limit of 2.6 x 10−8 was set by the KEK E391a collaboration 1. A comparison of experimentally obtained results with SM calculations permits a test of the quark flavor region and a search for physics beyond the SM. The experimental method lies in the detection of two photons and nothing else. KOTO uses a Cesium Iodide (CSI) electromagnetic calorimeter to measure the photon positions and energies. All other detectors compose a hermetic veto system to confirm no extra detectable particle.
A critical part of the blind analysis includes a detailed study of the normalization modes, K0L → π0π0π0, K0L →

π0π0, and K0L → γγ. These modes are used to calculate the KL flux and efficiencies of kinematic and veto cut requirements. This talk will discuss the analysis results of the normalization modes and provide the framework for our anticipated final branching ratio result which is expected to surpass the sensitivity of the Grossman-Nir limit 2.

**Education and Outreach / 657**

## Phantom of the Universe: A State-of-the-Art Planetarium Show on Dark Matter

Michael Barnett[1]; Kaushik De[2]; Reinhard Schwienhorst[3]; Uta Bilow[4]

[1] *LBNL*
[2] *University of Texas at Arlington*
[3] *Michigan State University*
[4] *Technische Universitaet Dresden (DE)*

**Corresponding Author(s):** uta.bilow@tu-dresden.de, rmbarnett@lbl.gov, schwier@pa.msu.edu, kaushik@uta.edu

*Phantom of the Universe* is a planetarium show that showcases an exciting exploration of dark matter, from the Big Bang to the Large Hadron Collider. The show reveals the first hints of its existence through the eyes of Fritz Zwicky. Viewers see the astral choreography witnessed by Vera Rubin in the Andromeda galaxy. They plummet deep underground to see a very sensitive dark matter detector. From there, they end the journey at the Large Hadron Collider, speeding alongside particles before they collide in visually stunning explosions of light and sound, and learning how scientists around the world are collaborating to track down the constituent of dark matter. The show is offered to planetariums worldwide free of charge, and is currently in more than 300 planetariums in 56 countries in 17 languages. It features sound by Skywalker Sound and narration by Academy-Award winning actress Tilda Swinton, as well as the writing and producing talents of award-winning filmmaker, Carey Ann Strelecki. Michael Barnett, Kaushik De, and Reinhard Schwienhorst were the Executive Producers.

**Beyond the Standard Model / 658**

## Hunting Z/H-resonant Neutralino Dark Mater at High-Luminosity LHC

Yang Zhang[1]; Giancarlo Pozzo[1]

[1] *Monash University*

**Corresponding Author(s):** zhangyang@itp.ac.cn

In Supersymmetric Standard Models, bino-like or singlino-like neautralino dark matter (DM) can achieve the right thermal relic density through Z boson or Higgs boson resonant annihilations with tiny higgsino component, which makes it very hard to be detected. In this work we focus on the reach for such scenarios at High-Luminosity LHC and their interplay with DM direct detection experiments. We first find that Bino-like DM with $m_{\tilde{\chi}^0} \in [41, 46]$ or $[58, 63]$ GeV and $m_{\tilde{\chi}^\pm} \in [300, 1500]$ GeV can avoid all current constraints. Then we investigate the searches of such samples at 14 TeV High-Luminosity LHC by chargino neutalino pair production in final states of $3l + E^{\text{miss}}$, $1l + 2b + E^{\text{miss}}$ and also two boost jet $+E^{\text{miss}}$ to make use of the large mass spitting between higgsino and bino. Our simulations indicate that each search mode can exclude higgsino with mass smaller than 800 GeV, and the combination can further push the limit to 1 TeV. Together with expected DM-neutron scattering limit from LUX-ZEPLIN, all the Z/H-resonant DM can be explored.

PoS(ICHEP2018)930

**Dark Matter Detection / 659**

# Recent results in the COSINE-100 experiment

Chang Hyon Ha[1]

[1] *IBS*

**Corresponding Author(s):** changhyon.ha@gmail.com

The COSINE-100 experiment searches for dark-matter interactions using an array of scintillating NaI(Tl) crystals, that serve both as a WIMP-interaction target and detector, in the low-background environment of the Yangyang underground laboratory. The main goal is to check the annual modulation signal observed by DAMA/LIBRA in an NaI(Tl) crystal array. The experiment has been running for more than 1.5 years stably and several analyses were performed based on the current energy threshold of ~2 keV with a background rate of roughly 3 counts/day/kg/keV in the energy region between 2 and 6 keV. The performance of the detector and recent results will be presented.

**POSTER / 660**

# Asymmetry realization of p-Carbon interactions in Geant4 for the storage ring proton EDM experiment

Hoyong Jeong[1] ; Seongtae Park[2] ; Edward Stephenson[3] ; Eunil Won[4] ; Yannis Semertzidis[5]

[1] *Center for Axion and Precision Physics Research*
[2] *CAPP/IBS*
[3] *Indiana University*
[4] *Korea University*
[5] *CAPP/IBS and KAIST in South Korea*

**Corresponding Author(s):** semertzidis@bnl.gov, stephene@indiana.edu, eunil@hep.korea.ac.kr, hyjeong@hep.korea.ac.kr, stpark@ibs.re.kr

Our universe appears to break the CP symmetry in the strong interaction within the paradigm of the elementary particle physics. However, no violation has been discovered so far by experiments. To address this question further, a storage ring experiment has been proposed to search for a permanent intrinsic electric dipole moment of proton (pEDM) with the target sensitivity of $10^{-29}$ e.cm within a year of measurement time. A polarimeter for the proposed storage ring proton EDM (SR pEDM) experiment is being under development using gas electron multiplier (GEM) technology. For an efficient polarimeter design study, we wrote a computer simulation code in the Geant4 frame, which makes the spin-dependent proton-carbon elastic hadronic scattering possible. The cross sec- tion of the scattering was implemented with reference from experimental data. The new algorithm of Geant4, its operation, and more details are introduced in this report. Furthermore, the performance of the GEM detector has been demonstrated at Forshungszentrum Juelich (FZJ) in Germany using Deuteron beam generated by Cooler Synctrotron (COSY). (This work was supported by IBS- R017-D1-2018-a00.)

**POSTER / 665**

# A Cosmic Ray Detector for the Mu2e Experiment at Fermilab

Robert Bernstein[None] ; Eleonora Diociaiuti[1]

[1] *LNF-INFN*

PoS(ICHEP2018)930

**Corresponding Author(s):** eleonora.diociaiuti@lnf.infn.it, rhbob@fnal.gov

The Mu2e experiment is designed to search for the charged-lepton flavor-violating process, μ− to a e−, with unprecedented sensitivity. The single 105-MeV electron that results from this process can be mimicked by electrons produced by cosmic-ray muons traversing the detector. An active veto detector surrounding the apparatus is used to detect incoming cosmic-ray muons. To reduce the backgrounds to the required level it must have an efficiency of about 99.99% as well as excellent hermeticity.
The detector consists of four layers of scintillator counters, each with two embedded wavelength-shifting fibers, whose light is detected by silicon photomultipliers. The design and expected performance of the cosmic ray veto detector will be described.



**Dark Matter Detection / 667**

# Lastest results from the XENON Dark Matter Project

Michael Murra[None]

**Corresponding Author(s):** michaelmurra89@gmail.com

The XENON1T experiment for the direct detection of dark matter is located at the Laboratori Nazionali del Gran Sasso in Italy. The detector uses 3.2 tons of liquid xenon with ∼2 tons being inside the dual phase time projection chamber (TPC).
A first dark matter search conducted between November 2016 and January 2017 in a 5-40 $keV_{nr}$ energy window did not yield evidence for dark matter interactions within the 35.6 (ton × day) exposure. This allowed to set the most stringent limits so far on the spin-independent scattering cross section of Weakly Interacting Massive Particles (WIMP) on nucleons for WIMP masses above 10 $GeV/c^2$. The limit features a minimum of $7.7 \times 10^{-47} cm^2$ for 35 $GeV/c^2$ WIMPs at 90% confidence level. Since this science run 0 result a total exposure of 1 (ton×year) has been acquired allowing a significant step in sensitivity of direct dark matter search. Additionally to the large expo- sure, XENON1T's sensitivity relies on an electronic recoil background below $2 \times 10^{-4}$ events/(kg × day × $keV_{ee}$) - the lowest ever achieved for a dark matter detector.
This talk will describe the XENON1T detector, the data analysis and the results of the new science run 1.

**POSTER / 668**

# Dark matter research platform with deep learning

Kihyeon Cho[1] ; Insung Yeo[1]

[1] *KISTI*

**Corresponding Author(s):** madjjang150@kisti.re.kr, cho@kisti.re.kr

Theoretical and experimental studies have been consistently performed to search for dark matter. The project of "dark matter research cluster" supported by National Research Council of Science and Technology in Korea has done successfully to collaborate between indirect and accelerator search. Therefore, so-called "dark matter research cluster season II' has been again approved to expand it to including Information and Communication Technology (ICT) based on deep learning.
Through it, we propose to research and develop intellectual information platform and provide a theoretical template to identify the foundation of dark matters. We also propose to perform astronomical and particle experiment-theory-simulation data utilizing integrated research. We also would like to develop a deep-learning software algorithm on dark matter research.
This could enable us to research and develop an intelligent information platform that combines deep- learning-based astronomical and particle experimental data. It could lead in developing ICT, which makes efficient

research to search for dark matter.

**Detector: R&D for Present and Future Facilities / 674**

## Detector status of AMoRE-Pilot Experiment

**Author(s):** Inwook Kim[1]
**Co-author(s):** Yong-Hamb Kim [2]

[1] *Institute of Basic Science*
[2] *Institute for Basic Science*

**Corresponding Author(s):** yhk@ibs.re.kr, tirstrike@snu.ac.kr

Advanced Molybdenum-based Rare-process Experiment (AMoRE) aims to search for the neutrino-less double beta decay (0nbb) of Mo-100 in scintillating molybdenum-based crystals using cryogenic metallic magnetic calorimeters (MMCs) at millikelvin temperature. Its commissioning phase, the AMoRE-Pilot, is currently running in the 700-meter-deep Yangyang underground laboratory (Y2L) with six 40Ca100MoO4 crystals weighing in total 1.9 kg. Throughout the pilot phase, the vibrational noise coming from the pulse tube refrigerator, which is the main source of the noise, has been reduced by installing vibration dampers in the dilution refrigerator. The origins of the main background have also been tentatively identified, and the highly contaminated components have been replaced. Detector modules for AMoRE-I, the first phase of AMoRE experiment, is currently in preparation using the results of AMoRE-Pilot. In this presentation, we describe the current status of AMoRE experiment.

**POSTER / 675**

## Measurement of nuclear recoil responses of NaI(Tl) crystal for dark matter search

**Author(s):** Hanwool Joo[1]
**Co-author(s):** Hyeonseo Park [2]

[1] *Seoul National University*
[2] *Korea Research Institute of Standards and Science*

**Corresponding Author(s):** hwjoo1240@gmail.com, hyeonseo.park@gmail.com

In direct detection of WIMP dark matter particles, scintillation crystals such as NaI(Tl) are commonly used as targets/detectors. Interactions between WIMP and the crystal are expected to produce nu- clear recoils, while energy calibrations for the crystal are done with gamma sources that produce electron recoils. Since the light yields from electron and nuclear recoils of the same energy are different due to their different fraction of energy transferred to electrons, measurements of these light yield ratios -the so-called quenching factors- are necessary to obtain recoil energies from the light yields from WIMP interactions.
On the other hand, nuclear recoil events and beta/gamma-induced events can be discriminated based on their differences in scintillation characteristics. By using a pulse shape discrimination(PSD) analysis, discrimination between WIMP-induced recoils and the background beta/gamma events can be achived.
In this measurement, the quenching factor of a NaI(Tl) crystal (2 cm x 2 cm x 1.5 cm) were measured from the responses of the crystal to nuclear recoils. The nuclear recoils are produced by 2.43 MeV mono-energetic neutrons from D-D fusion reactions in a neutron generator. Neutron-induced events were selected by the time coincidence of signals in BC501a liquid scintillator neutron detectors and the NaI crystal.
In measurements of the quenching factor for sodium and iodine recoils, energies of the recoiling ions range from

PoS(ICHEP2018)930

6 to 150 keVnr for sodium and 10 to 75 keVnr for iodine. In these ranges, the quenching factors for sodium are measured at 10 points and vary from 10% to 22% and for iodine are measured at 6 points and vary from 5~6%. The PSD power of the NaI(Tl) crystal was characterized using quality factors and measured from 1 keVnr to 10 keVee. To measure the quality factor, the responses to nuclear recoils are compared to the response to electron recoils produced by Compton scattering of 662 keV gamma-rays from a 137Cs source.

**Neutrino Physics / 677**

## Recent results of the AMoRE-pilot experiment, a search for neutrinoless double beta decay of Mo-100

YoungSoo Yoon[1]

[1] *Institute for Basic Science*

**Corresponding Author(s):** ysy@ibs.re.kr

The Advanced Mo-based Rare process Experiment (AMoRE) is a search for neutrinoless double beta decay of 100Mo in calcium molybdate (CaMoO4) crystals by using cryogenic detectors at a temperature range of tens of millikelvin. The crystals are made of Molybdenum enriched on 100Mo (≥95%) and Calcium depleted on 48Ca isotopes (≤0.002%). The ongoing pilot experiment at the YangYang underground laboratory consists of a number of commissioning runs using six 40Ca100MoO4 crystals of a total mass 1.9 kg. At the same time, the fist phase of the AMoRE experiment with about 5 kg of CaMoO4 crystals is in preparation. The physics data of the AMoRE-pilot were analyzed and fitted with Monte Carlo simulation results to identify their background sources. In this presentation, the fit results will be presented and discussed.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 680**

## Status of the FCC-hh design studies

Daniel Schulte[1]

[1] *CERN*

**Corresponding Author(s):** daniel.schulte@cern.ch

The Future Circular Collider (FCC) Study aims at developing a large-scale accelerator research infrastructure based on a 100 km tunnel. While the ultimate goal is a proton-proton collider, with 100 TeV centre-of-mass collision energy and unprecedented direct discovery potential. Also ion-ion and ion-proton collisions are possible. The initial project stage could consist of an electron-positron collider.
The talk describes the status of the hadron collider design.

**POSTER / 683**

## Top quark pair production in association with a photon

ATLAS Collaboration[1] ; Joshua Wyatt Smith[2]

[1] *CERN*
[2] *Georg August Universitaet Goettingen (DE)*

**Corresponding Author(s):** joshua.wyatt.smith@cern.ch

Top quark pairs in association with final state particles are produced in large quantities at the LHC due to the high centre-of-mass energy available in proton-proton collisions. One such topology is that of a prompt photon radiated from the top-quark in addition to the final state particles from the top-quark decay. Presented are the results from the ATLAS experiment, which measured the fiducial cross section as well as differential cross sections with respect to kinematic variables of the photon.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 687**

## Super Charm-Tau Factory in Novosibirsk

Eugene Levichev[1]

[1] *Budker INP*

**Corresponding Author(s):** levichev@inp.nsk.su

A Crab-Waist e+e- collider with the beam energy from 1 GeV to 3 GeV is under development at Budker INP (Novosibirsk, Russia) to study physics in charmonium and tau-lepton sectors. The talk reviews realisation principles, configuration and features of the collider including extremely high luminosity of 10^35 cm^-2s^-1 and longitudinal polarization of electron beam.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 688**

## Low energy e+e- collider to search and study of mu+mu- bound state (dimuonium)

Eugene Levichev[1]

[1] *Budker INP*

**Corresponding Author(s):** levichev@inp.nsk.su

To discover and study a mu+mu- atom (dimuonium) we propose a low energy (410 MeV per beam) e+e- collider with extremely large crossing angle to boost the dimuonium atoms from the collision area and reduce a background. A report describes the collider status and its parameters.

**Astro-particle Physics and Cosmology / 689**

## Status of a 3D Imaging Calorimeter of DAMPE for Cosmic Ray Physics on Orbit

Libo Wu[1]

[1] *University of Science and Technology of China*

**Corresponding Author(s):** wulibo11@gmail.com

The space experiment of DArk Matter Particle Explorer (DAMPE) developed in China is designed to find the evidence of dark matter particle by observing primary cosmic rays and gamma rays in energy range from 5

PoS(ICHEP2018)930

GeV to 10 TeV. Since its launch in December 2015, a large quantity of data has been recorded.
The BGO Electromagnetic Calorimeter (BGO ECAL) of the DAMPE is a total absorption calorimeter consisted of 308 BGO crystal bars that allows for a precise three-dimensional imaging of the shower shape. It provides a good energy resolution (<1%@200 GeV) and high electron/hadron discrimination (>10^5). The ECAL also provides a trigger capability for DAMPE. With the data set acquired more than two years of operation in space, a precise time-dependent calibration for energy, shower topologies measured by the BGO calorimeter had been developed.
In this report, the instrumentation and development of the BGO ECAL is briefly described. The calibration on orbit, including the pedestal, minimum ionizing particle (MIP) peak, dynode ratio, and etc. is discussed, and more details about calibration methods and the performance in space are presented.

**POSTER / 692**

## Status of Korean Neutrino Observatory

Sangyong KIM[1]

[1] *SNU*

**Corresponding Author(s):** sfc5302@gmail.com

The Korean Neutrino Observatory(KNO) is proposed as a next generation underground neutrino observatory in Korea consisting of 260 ton water Cherenkov detector and can serve as the second detector of Hyper-Kamiokande experiment.
By detecting J-PARC neutrino beam in these two detectors at the same time, neutrino oscillation parameters such as leptonic CP violation phase and the neutrino mass ordering can be definitively measured and the sensitivities are expected to be better than locating the two detectors in Japan. Measuring these oscillation parameters are very important questions to be answered in neutrino physics.
In this work we present such sensitivity studies for various detector configurations as a function of beam exposure time and study of geological candidate sites.

**POSTER / 693**

## Research of the 20-inch Microchannel Plate Photomultiplier with Transit Time Spread Improved

**Author(s):** Ling Ren[1]
**Co-author(s):** Jianning Sun [2] ; Haiyang Xu [2] ; Shuguang Si [2] ; Guorui Huang [2] ; Xingchao Wang [2] ; Shulin Liu [3] ; Sen Qian [3] ; Muchun Jin [2] ; Fei Xie [2] ; Kai Ruan [2] ; Dong Li [2]

[1] *North night vision technology Co., Ltd.*
[2] *North Night Vision Technology Co., LTD*
[3] *Institute of High Energy Physics, Chinese Academy of Sciences*

**Corresponding Author(s):** sjn@nvt.com.cn, lingren198511@163.com

Abstract: The transit time spread (TTS) is an important parameter of photomultiplier tube in the high energy physics field. By the software of CST and Matlab, the theoretical model of the photo- multiplier tube structure was established, and the particle sources theoretical model was established according to the M-C integral sampling method of cosine distribution. Based on the establishment of theoretical models, the trajectories of photoelectrons in the 20-inch microchannel plate photo- multiplier were simulated. The influence of the focusing electrode structure and the divided voltage ratio between the photocathode and the surface of the first microchannel plate on the TTS was analyzed. The simulation results were that, the transit time spread was improved greatly by adjust- ing the focusing electrode structure and the divided voltage, and the focusing electrode structure looked like flower. According to the theoretical simulation results, the 20-inch

PoS(ICHEP2018)930

microchannel plate photomultiplier with TTS improved was produced. The TTS of the new 20-inch microchannel plate photomultiplier with the flower-like focusing electrode was about 5 ns (FWHM), and the TTS of the initial 20-inch microchannel plate photomultiplier was about 20ns. The TTS of the new 20-inch microchannel plate photomultiplier was much better than the initial one. The research of improving the TTS was in favor of enlarging the application of 20-inch microchannel plate photomultiplier in the high energy physics field.

Keywords: transit time spread, microchannel plate, photomultiplier tube, focusing electrode.

**Higgs Physics / 698**

## Learning from Higgs Physics at Future Higgs Factories

Shufang Su[1]

[1] *University of Arizona*

**Corresponding Author(s):** shufang@email.arizona.edu

Future Higgs factories can reach impressive precision on Higgs property measurements. In this talk, we explore its sensitivity to new physics models at the electron-positron colliders. In particular, we study two categories of new physics models, Standard Model with a real scalar singlet extension, and Two Higgs Double Model as examples of weakly-interacting models, Minimal Composite Higgs Model and three typical patterns of the more general operator counting for strong interacting models as examples of strong dynamics. We perform a global fit to various Higgs search channels to obtain the 95 C.L. constraints on the model parameter space. We also compare the sensitivity of various future Higgs factories, namely Circular Electron Positron Collider, Future Circular Collider-ee and International Linear Collider.

**POSTER / 703**

## High precision tracking for J-PARC (g-2)/EDM experiment.

**Author(s):** Zhanibek Omarov[1]
**Co-author(s):** Soohyung Lee [2] ; Yannis Semertzidis [3]

[1] *KAIST, IBS/CAPP*
[2] *Institute for Basic Science*
[3] *CAPP/IBS and KAIST in South Korea*

**Corresponding Author(s):** semertzidis@bnl.gov, zhanik@kaist.ac.kr, soohyunglee@ibs.re.kr

The J-PARC (g-2)/EDM experiment features a novel experimental idea of the anomalous magnetic and electric dipole moments of the muon. The goals of the experiment are to improve the precision of the previous measurement of the E821 experiment at BNL that sets the measurement significantly away from theory; therefore, providing an evidence for new physics. The systematic uncertainties of the experiment vastly differ from E821; thus, it will provide an independent result of the discovered anomaly. In this study, we use a high precision beam and spin dynamics tracking to assess possible systematic uncertainties and relevant corrections for the experiment. We demonstrate the power of the simulation tracking tool and possible areas of using it to further enhance the sensitivity of the experiment. A specific application on so-called pitch effect and momenta distribution will be shown.

**Beyond the Standard Model / 704**

# Monojet signatures at the High-Luminosity and High-Energy LHC

Mihoko Nojiri[1]

[1] *Theory Center, IPNS, KEK*

**Corresponding Author(s):** nojiri@post.kek.jp

In some class of BSM models, such as SUSY , DM may be searched using high pT jets + missing ET, where DM (X) may be produced from the decay of a heavy particle H. If mH is close to mX, the signature is ISR , and may be monojet like, and there are much information on the nature of H and X. I will discuss leading jet distribution contains the information of both mH, color representation and spin of the particles, but to extract the information fully, one need to predict the distribution with less than 10% accuracy for the parameter region that may be studied at HL-or HE-LHC. Then I turn into the theoretical error in the current best NLO MC based on MC@NLO scheme, such as MG5 and Sherpa, and discuss if such accuracy can be achieved.



**POSTER / 705**

# A non-destructive beam profile monitor for a muon beam of g-2/EDM experiment at J-PARC

**Author(s):** Chang-Kyu Sung[1]
**Co-author(s):** Moses Chung [1] ; Selcuk Haciomeroglu [2]

[1] *UNIST*
[2] *CAPP/IBS*

**Corresponding Author(s):** mchung@unist.ac.kr, csung@unist.ac.kr, selcuk@ibs.re.kr

At J-PARC, g-2/EDM experiment will be prepared to measure the anomalous magnetic moment of muon with high precision by producing the ultra-cold muon. The ultra-cold muon beam will be injected into the solenoidal storage magnet after acceleration to 300 MeV/c.
At the injection, it is required for the muon beam to have axisymmetric distribution for a reduction of a systematic error on the precision. The muon spin orientation could be disturbed by the non-symmetric distribution. Therefore, the beam profile monitoring is crucial to enhance the precision by reducing the systematic error.
The non-destructive beam profile monitor has been chosen for the online monitoring to keep the amount of particles where it has to measure the pretty low intensity (~ uA). In this paper a design status of the monitoring system and a reconstruction procedure for transverse profile will be presented.

**POSTER / 706**

# Recent progress of the ARIADNE experiment

**Author(s):** Younggeun Kim[1]
**Co-author(s):** Dongok Kim [1] ; Yun Chang Shin [2]

[1] *Center for Axion and Precision Physics (IBS), KAIST*
[2] *Center for Axion and Precision Physics (IBS)*

**Corresponding Author(s):** yunshin@ibs.re.kr, physicist@kaist.ac.kr, dkkimsun@kaist.ac.kr

The purpose of the Axion Resonant InterAction DetectioN Experiment (ARIADNE)1 is to detect axion

mediated macroscopic interactions between polarized and unpolarized masses using NMR techniques. This experiment is a collaboration among institutes in Korea, IBS/CAPP and KRISS, and US institutes, Northwestern, Stanford, and Indiana University. Wilczek and Moody2 predicted the possible existence of symmetry violating forces that would be mediated by exotic particles with a very light mass like axions[3]. ARIADNE employs a rotating mass to source the interactions, and a polarized 3He gas as NMR sample to detect axion mediated spin-dependent interactions in sub mm range with high precision. This experiment will investigate a broad mass range of QCD axion from 0.1~10meV. We report the recent progress of this work at IBS/CAPP as well as the other institutes[4].

**POSTER / 707**

## The IBS/CAPP magnetometer station for the GNOME experiment is running

**Author(s):** Kim DongOk[1]
**Co-author(s):** Kim Younggeun [1] ; Shin Yun Chang [2] ; Yannis K. Semertzidis [1]

[1] *Center for Axion and Precision Physics (IBS), KAIST*
[2] *Center for Axion and Precision Physics (IBS)*

**Corresponding Author(s):** semertzidis@bnl.gov, yunshin@ibs.re.kr, dkkimsun@kaist.ac.kr, physicist@kaist.ac.kr

The Global Network of Optical Magnetometers to search for Exotic physics (GNOME) is an experiment looking for transient events of axion domain walls from the gradient coupling of axion field with atomic spins 1. GNOME is based on synchronized measurements from multiple GPS-timed magnetometer stations located in geographically separated places on the Earth [3]. While a single magnetometer could detect spin signalsfrom such terrestrial events, it would not be possible to distinguish real physic events from false ones caused by environmental noise sources. GNOME can effectively veto false events by arraying magnetometer stations. One of those stations located at IBS/CAPP in Daejeon, South Korea employs cesium alkali atoms as a primary magnetometer. We present the optimization and characterization of the Cs magnetometer at IBS/CAPP as well as the first preliminary test run results.

**POSTER / 708**

## DAQ Design and Implementation for the HEPS-BPIX 1M Detector

**Author(s):** Xiaolu Ji[1]
**Co-author(s):** Yang Li [1]

[1] *Institute of High Energy Physics, CAS*

**Corresponding Author(s):** jixl@ihep.ac.cn, liyang616@ihep.ac.cn

HEPS-BPIX 1M is a silicon detector with 1 million pixels, which is designed for the High Energy Photon Sources (HEPS) in Beijing, China. It is a high-frame-rate pixel detector working in the single-photon-counting mode. The frame rate is designed to 1 kHz, which leads to ~ 2GB/s high data bandwidth. The data acquisition (DAQ) system need to read out data efficiently. Meanwhile it should provide the functionalities including run control, data transmission, event building, lossless compression, data storage, real-time image display and so on. The DAQ system is deployed in a high performance server, using open source QT framework to develop the user interface. The test results show that the DAQ system is stable and reliable, and the required data bandwidth has been achieved. The detailed design and implementation will be presented, and the results of the performance test will be shown.

PoS(ICHEP2018)930

POSTER / 710

# Flavor physics in the multi-Higgs doublet models induced by the Left-Right symmetry

Yuji Omura[1] ; Syuhei Iguro[2] ; Yoshihiro Shigekami[2] ; Yu Muramatsu[3]

[1] *KMI, Nagoya University*
[2] *Nagoya University*
[3] *Central China Normal University*

**Corresponding Author(s):** yumura@kias.re.kr, sigekami@eken.phys.nagoya-u.ac.jp, yujiomur@kmi.nagoya-u.ac.jp, iguro@eken.phys.nagoya-u.ac.jp

The matter unification, that is proposed by the Grand Unified theory (GUT), predicts extra fields that couple to quarks and leptons, in order to realize the realistic Yukawa couplings. In a simple setup, many fields, in which Higgs $SU(2)_L$ doublets are built, are introduced and the realistic Yukawa couplings consist of the many Yukawa couplings between the Standard Model (SM) fermions and the lightest mode among the Higgs doubles. The GUT symmetry breaks down at the very high scale, and we can expect that the heavier Higgs fields do not also gain masses from the GUT symmetry breaking and survive up to the EW scale. Then, we could find the predictions of the matter unification for the low-energy observables. In this talk, we discuss the multi-Higgs doublet models, that could be effectively induced by the extended SM with the matter unification. In particular, we focus on the predictions in the supersymmetric left-right (LR) model. In this model, the down-type and the up-type Yukawa couplings are unified and the Yukawa couplings are expected to be hermitian. Besides, the heavy Higgs doublets have flavor changing couplings with quarks and leptons corresponding to the realization of the realistic fermion mass matrices. The LR symmetry is assumed to break down at high energy, to realize the Type-I seesaw mechanism, and the EW symmetry breaking is radiatively realized. In this case, the flavor-dependent interaction of the Higgs fields is one promising prediction, so that we especially discuss the flavor physics induced by the heavy Higgs fields in my talk.

POSTER / 714

# Study on the Secondary Electron Emission Coefficient of aluminum oxide

**Author(s):** kaile wen[1]
**Co-author(s):** shulin Liu ; baojun yan [2]

[1] *IHEP CAS*
[2] *IHEP*

**Corresponding Author(s):** yanbj@ihep.ac.cn, wenkaile@126.com, liusl@ihep.ac.cn

Using the spherical secondary electron emission coefficient measuring device, the primary current and the secondary current of the secondary electron emission process are simultaneously measured by the collection method and the principle of charge conservation, and the surface of the sample is neutralized by charge during the measurement process. Under the small error, the secondary electron emission coefficient of the insulation sample under different incident energy and incident angle was measured, and the result obtained by this measurement method was proved to be stable and reliable. At the same time, the secondary electron emission coefficients of aluminum oxide films with different thicknesses at different incident energies and incident angles were measured by this method, and the energy distribution of the secondary electrons emitted was measured by the grid screening method. Thus, a film having a better secondary electron emission characteristic as a coating solution for an electron multiplier device can be selected and used to enhance the performance of the electron multiplier device.

PoS(ICHEP2018)930

**POSTER / 716**

# Spectral measurement of sinSq(2theta13) via neutron capture on hydrogen at Daya Bay

Chao Li[1]

[1] *Shandong University*

**Corresponding Author(s):** 245062490@qq.com

The Daya Bay experiment has measured sinSq(2theta13) and Delta(mSq32) with better than 4% precision using an IBD sample tagged via neutron capture on gadolinium (nGd). A precise and independent measurement of the oscillation parameters can be done with IBDs tagged via neutron capture on Hydrogen (nH), a statistically distinct sample with largely different systematic uncertainties. Ef- fort has gone into developing an energy model that properly handles the extra energy leakage in nH events and that enables a spectral measurement of reactor antineutrino disappearance with this sample. Data-driven methods to precisely estimate the backgrounds and to better control the systematic uncertainties have also been developed. This work will be presented in this poster,alongside the latest nH oscillation results from Daya Bay.

**Dark Matter Detection / 717**

# Ultra-light dark matter in NEWS-G experiment using a gaseous spherical detector

ioannis giomataris[1] ; et al.[None]

[1] *CEA-Saclay*

**Corresponding Author(s):** ioannis.giomataris@cea.fr

NEWS-G experiment is using a new type of radiation detector based on the spherical proportional counter. The detector consists of a large spherical gas volume with a central electrode forming a radial electric field. A small spherical sensor located at the center is acting as a proportional amplification structure.
Combination of sub-keV energy threshold and versatility of the target (Ne, He, H) opens the way to search for ultra light dark matter WIMPs down to 100 MeV. Recent results obtained with a low radioactivity detector, 60 cm in diameter operated in LSM underground laboratory will be presented. First NEWS-G results with Ne as target nuclei, exclude above 4.4 1037 cm2 for a 0.5 GeV/c2 WIMP. The next project NEWS-G, under study, is a larger detector that consists in a selected pure copper sphere of 1.4 meter of diameter to be installed at SNOLAB. This will allow benefiting from a larger volume, relative to the current detector and a much lower background level.
I will discuss the status of the project and prospects for the future.

**Astro-particle Physics and Cosmology / 722**

# Measurements of Light Nuclear Isotopic Composition in Cosmic Rays with the Alpha Magnetic Spectrometer on the International Space Station

Alberto Oliva[1] ; Alexandre Ghelfi[2] ; Amaresh Datta[3] ; Andrea Contin[4] ; Andreas Bachlechner[5] ; Andrei Kounine[6] ; Bastian Beischer[5] ; Benoit Jean-Albert Coste[7] ; Bilge Demirkoz[8] ; Bruna Bertucci[9] ; Carlos Delgado Mendez[1] ; Cen Zhang[10] ; Chan

Hoon Chung[5] ; Claudio Corti[3] ; Corinne Goy[2] ; Cristina Consolandi[3] ; Davide Grandi[11] ; Domenico D'Urso[9] ; Fernando De Carvalho Barao[12] ; Francesca Giovacchini[1] ; Francesco Dimiccoli[7] ; Giovanni Ambrosi[9] ; Giuseppe La Vacca[11] ; Henning Gast[5] ; Hesheng Chen[13] ; Hsin-Yi Chou[14] ; Hu Liu[6] ; Iris Gebauer[15] ; Javier Berdugo Perez[1] ; Jie Feng[16] ; Jorge Casaus[1] ; Laurent Yves Marie Derome[2] ; Manuel Aguilar-Benitez[17] ; Manuela Vecchi[18] ; Marco Incagli[19] ; Matteo Boschini[20] ; Matteo Duranti[9] ; Matthew Daniel Behlmann[6] ; Maura Graziani[15] ; Melanie Heil[6] ; Mercedes Paniccia[21] ; Miguel Angel Velasco Frutos[1] ; Mike Capell[6] ; Nikolas Zimmermann[5] ; Paolo Zuccon[6] ; Philip Von Doetinchem[22] ; Qi Yan[6] ; Roberto Battiston[23] ; Sadakazu Haino[16] ; Senquan Lu[16] ; Stefan Schael[5] ; Stefan Zeissler[15] ; Stefano Della Torre[11] ; Stefano Di Falco[24] ; Travis Gordon Nelson[None] ; Ulrich Becker[6] ; Valerio Formato[9] ; Veronica Bindi[3] ; Weiwei Xu[6] ; Wim De Boer[15] ; Xudong Cai[6] ; Yuan-Hann Chang[14] ; Zhicheng Tang[13] ; Zhili Weng[6] ; Zuhao Li[13] ; Vitaly Choutko[6]

[1] *Centro de Investigaciones Energéti cas Medioambientales y Tecno*
[2] *Centre National de la Recherche Scientifique (FR)*
[3] *University of Hawai'i at Manoa (US)*
[4] *Universita e INFN, Bologna (IT)*
[5] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[6] *Massachusetts Inst. of Technology (US)*
[7] *Universita e INFN, Padova (IT)*
[8] *Middle East Technical University (TR)*
[9] *Universita e INFN, Perugia (IT)*
[10] *Institute of High Energy Physics, Chinese Academy Sciences*
[11] *Universita & INFN, Milano-Bicocca (IT)*
[12] *LIP Laboratorio de Instrumentacao e Fisica Experimental de Part*
[13] *Chinese Academy of Sciences (CN)*
[14] *National Central University (TW)*
[15] *KIT - Karlsruhe Institute of Technology (DE)*
[16] *Academia Sinica (TW)*
[17] *Cent.de Investigac.Energeticas Medioambientales y Tecnol. (CIEMAT)*
[18] *Universidade de Sao Paulo (BR)*
[19] *INFN Sezione di Pisa, Universita' e Scuola Normale Superiore, P*
[20] *Univ. degli Studi Milano-Bicocca (IT)*
[21] *Universite de Geneve (CH)*
[22] *University of Hawaii at Manoa*
[23] *Univ + INFN*
[24] *Universita & INFN Pisa (IT)*

**Corresponding Author(s):** yuan-hann.chang@cern.ch, hsin-yi.chou@cern.ch, alberto.oliva@cern.ch, sadakazu.haino@cern.ch, veronica.bindi@cern.ch, jorge.casaus@cern.ch, di.falco.stefano@cern.ch, stefan.zeissler@cern.ch, nikolas.zimmermann@cern.ch, stefan.schael@physik.rwth-aachen.de, michael.capell@cern.ch, iris.gebauer@cern.ch, ulrich.becker@cern.ch, zuhao.li@cern.ch, francesca.giovacchini@cern.ch, xudong.cai@cern.ch, javier.berdugo@ciemat.es, laurent.derome@lpsc.in2p3.fr, manuel.aguilar@ciemat.es, zhicheng.tang@cern.ch, bilge.demirkoz@cern.ch, wim.de.boer@kit.edu, giuseppe.la.vacca@cern.ch, stefano.della.torre@cern.ch, philip.doetinchem@cern.ch, matteo.duranti@cern.ch, giovanni.ambrosi@cern.ch, amaresh.datta@cern.ch, paolo.zuccon@cern.ch, henning.gast@cern.ch, matteo.boschini@cern.ch, maura.graziani@cern.ch, qi.yan@cern.ch, jie.feng@cern.ch, claudio.corti@cern.ch, manuela.vecchi@cern.ch, weiwei.xu@cern.ch, mercedes.paniccia@cern.ch, cristina.consolandi@cern.ch, valerio.formato@cern.ch, fernando.barao@cern.ch, hu.liu@cern.ch, miguel.angel.velasco.frutos@cern.ch, andrei.kounine@cern.ch, andrea.contin@cern.ch, cenzhang@ihep.ac.cn, andreas.bachlechner@cern.ch, davide.grandi@cern.ch, corinne.goy@cern.ch, vitaly.choutko@cern.ch, chenhs@ihep.ac.cn, travis.gordon.nelson@cern.ch, francesco.dimiccoli@cern.ch, senquan.lu@cern.ch, domenico.d'urso@cern.ch, carlos.jose.delgado.mendez@cern.ch, alexandre.ghefli@cern.ch, m.behlmann@cern.ch, zhili.weng@cern.ch, chan.hoon.chung@cern.ch, r.battiston@tiscali.it, bruna.bertucci@cern.ch, benoit.coste@cern.ch, melanie.heil@cern.ch, bastian.beischer@cern.ch, marco.incagli@cern.ch

The spectral shape of the secondary isotopes in cosmic rays is completely determined by the source spectrum of the parent elements and by the propagation process. In particular, 3He in cosmic rays is believed to result from the interaction of primary 4He with the interstellar medium, providing a powerful tool to constrain the parameters of the galactic cosmic rays propagation models. A precise measurement of the helium isotopes ratio (3He/4He) and the individual 3He and 4He fluxes in the kinetic energy per nucleon range from 1.0 GeV/nucl to 10 GeV/nucl based on data collected by AMS during the first 5 years of operation are presented.
The 6Li/7Li ratio, as both isotopes are secondary and stable, is expected to reflect the ratio between the production cross sections and therefore constitute a good check of the reconstruction method. Measurement of the lithium isotopes ratio (6Li/7Li) as a function of the kinetic energy per nucleon from 0.5 GeV/nucl to 10

PoS(ICHEP2018)930

GeV/nucl based on data collected by AMS during the first 5 years of operation is presented.

**Astro-particle Physics and Cosmology / 724**

# Precision Measurement of the positron fraction and the combined electron and positron flux in Primary Cosmic Rays with the Alpha Magnetic Spectrometer on the International Space Station

Alberto Oliva[1] ; Alexandre Ghelfi[2] ; Amaresh Datta[3] ; Andrea Contin[4] ; Andreas Bachlechner[5] ; Andrei Kounine[6] ; Bastian Beischer[5] ; Benoit Jean-Albert Coste[7] ; Bilge Demirkoz[8] ; Bruna Bertucci[9] ; Carlos Delgado Mendez[1] ; Cen Zhang[10] ; Chan Hoon Chung[5] ; Claudio Corti[3] ; Corinne Goy[2] ; Cristina Consolandi[3] ; Davide Grandi[11] ; Domenico D'Urso[9] ; Fernando De Carvalho Barao[12] ; Francesca Giovacchini[1] ; Francesco Dimiccoli[7] ; Giovanni Ambrosi[9] ; Giuseppe La Vacca[11] ; Henning Gast[5] ; Hesheng Chen[13] ; Hsin-Yi Chou[14] ; Hu Liu[6] ; Iris Gebauer[15] ; Javier Berdugo Perez[1] ; Jie Feng[16] ; Jorge Casaus[1] ; Laurent Yves Marie Derome[2] ; Manuel Aguilar-Benitez[17] ; Manuela Vecchi[18] ; Marco Incagli[19] ; Matteo Boschini[20] ; Matteo Duranti[9] ; Matthew Daniel Behlmann[6] ; Maura Graziani[15] ; Melanie Heil[6] ; Mercedes Paniccia[21] ; Miguel Angel Velasco Frutos[1] ; Mike Capell[6] ; Nikolas Zimmermann[5] ; Paolo Zuccon[6] ; Philip Von Doetinchem[22] ; Qi Yan[6] ; Roberto Battiston[23] ; Sadakazu Haino[16] ; Senquan Lu[16] ; Stefan Schael[5] ; Stefan Zeissler[15] ; Stefano Della Torre[11] ; Stefano Di Falco[24] ; Travis Gordon Nelson[None] ; Ulrich Becker[6] ; Valerio Formato[9] ; Veronica Bindi[3] ; Weiwei Xu[6] ; Wim De Boer[15] ; Xudong Cai[6] ; Yuan-Hann Chang[14] ; Zhicheng Tang[13] ; Zhili Weng[6] ; Zuhao Li[13] ; Vitaly Choutko[6]

[1] *Centro de Investigaciones Energéti cas Medioambientales y Tecno*
[2] *Centre National de la Recherche Scientifique (FR)*
[3] *University of Hawai'i at Manoa (US)*
[4] *Universita e INFN, Bologna (IT)*
[5] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[6] *Massachusetts Inst. of Technology (US)*
[7] *Universita e INFN, Padova (IT)*
[8] *Middle East Technical University (TR)*
[9] *Universita e INFN, Perugia (IT)*
[10] *Institute of High Energy Physics, Chinese Academy Sciences*
[11] *Universita & INFN, Milano-Bicocca (IT)*
[12] *LIP Laboratorio de Instrumentacao e Fisica Experimental de Part*
[13] *Chinese Academy of Sciences (CN)*
[14] *National Central University (TW)*
[15] *KIT - Karlsruhe Institute of Technology (DE)*
[16] *Academia Sinica (TW)*
[17] *Cent.de Investigac.Energeticas Medioambientales y Tecnol. (CIEMAT)*
[18] *Universidade de Sao Paulo (BR)*
[19] *INFN Sezione di Pisa, Universita' e Scuola Normale Superiore, P*
[20] *Univ. degli Studi Milano-Bicocca (IT)*
[21] *Universite de Geneve (CH)*
[22] *University of Hawaii at Manoa*
[23] *Univ + INFN*
[24] *Universita & INFN Pisa (IT)*

**Corresponding Author(s):** nikolas.zimmermann@cern.ch, zhili.weng@cern.ch, jorge.casaus@cern.ch, veronica.bindi@cern.ch, francesco.dimiccoli@cern.ch, ulrich.becker@cern.ch, alberto.oliva@cern.ch, bruna.bertucci@cern.ch, stefan.schael@physik.rwth- aachen.de, r.battiston@tiscali.it, vitaly.choutko@cern.ch, travis.gordon.nelson@cern.ch, miguel.angel.velasco.frutos@cern.ch, m.behlmann@cern.ch, andreas.bachlechner@cern.ch, bilge.demirkoz@cern.ch, amaresh.datta@cern.ch, chan.hoon.chung@cern.ch, senquan.lu@cern.ch, michael.capell@cern.ch, marco.incagli@cern.ch, iris.gebauer@cern.ch, manuel.aguilar@ciemat.es, wim.de.boer@kit.edu, di.falco.stefano@cern.ch, maura.graziani@cern.ch, carlos.jose.delgado.mendez@cern.ch, xudong.cai@cern.ch, cristina.consolandi@cern.ch, bastian.beischer@cern.ch, stefan.zeissler@cern.ch, manuela.vecchi@cern.ch, paolo.zuccon@cern.ch, jie.feng@cern.ch, benoit.coste@cern.ch, laurent.derome@lpsc.in2p3.fr, alexandre.ghefli@cern.ch, andrea.contin@cern.ch, yuan-hann.chang@cern.ch, zuhao.li@cern.ch, henning.gast@cern.ch, cenzhang@ihep.ac.cn, hsin-yi.chou@cern.ch,

PoS(ICHEP2018)930

zhicheng.tang@cern.ch, philip.doetinchem@cern.ch, andrei.kounine@cern.ch, weiwei.xu@cern.ch, giovanni.ambrosi@cern.ch, francesca.giovacchini@cern.ch, qi.yan@cern.ch, chenhs@ihep.ac.cn, melanie.heil@cern.ch, fernando.barao@cern.ch, valerio.formato@cern.ch, mercedes.paniccia@cern.ch, matteo.duranti@cern.ch, davide.grandi@cern.ch, hu.liu@cern.ch, matteo.boschini@cern.ch, sadakazu.haino@cern.ch, stefano.della.torre@cern.ch, corinne.goy@cern.ch, claudio.corti@cern.ch, javier.berdugo@ciemat.es, domenico.d'urso@cern.ch, giuseppe.la.vacca@cern.ch

Precision measurements by AMS of the positron fraction and the combined electron and positron flux in primary cosmic rays in the energy range from up to 1000 GeV based on 25 million positron and electron events is presented. This measurement extends the energy range of our previous observation and increases its precision. The new results show that at ~300 GeV the positron fraction reaches its maximum. This behavior is consistent with a new source of high energy electrons and positrons.

**Astro-particle Physics and Cosmology / 726**

# Properties of Elementary Particle Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station

Alberto Oliva[1] ; Alexandre Ghelfi[2] ; Amaresh Datta[3] ; Andrea Contin[4] ; Andreas Bachlechner[5] ; Andrei Kounine[6] ; Bastian Beischer[5] ; Benoit Jean-Albert Coste[7] ; Bilge Demirkoz[8] ; Bruna Bertucci[9] ; Carlos Delgado Mendez[1] ; Cen Zhang[10] ; Chan Hoon Chung[5] ; Claudio Corti[3] ; Corinne Goy[2] ; Cristina Consolandi[3] ; Davide Grandi[11] ; Domenico D'Urso[9] ; Fernando De Carvalho Barao[12] ; Francesca Giovacchini[1] ; Francesco Dimiccoli[7] ; Giovanni Ambrosi[9] ; Giuseppe La Vacca[11] ; Henning Gast[5] ; Hesheng Chen[13] ; Hsin-Yi Chou[14] ; Hu Liu[6] ; Iris Gebauer[15] ; Javier Berdugo Perez[1] ; Jie Feng[16] ; Jorge Casaus[1] ; Laurent Yves Marie Derome[2] ; Manuel Aguilar-Benitez[17] ; Manuela Vecchi[18] ; Marco Incagli[19] ; Matteo Boschini[20] ; Matteo Duranti[9] ; Matthew Daniel Behlmann[6] ; Maura Graziani[15] ; Melanie Heil[6] ; Mercedes Paniccia[21] ; Miguel Angel Velasco Frutos[1] ; Mike Capell[6] ; Nikolas Zimmermann[5] ; Paolo Zuccon[6] ; Philip Von Doetinchem[22] ; Qi Yan[6] ; Roberto Battiston[23] ; Sadakazu Haino[16] ; Senquan Lu[16] ; Stefan Schael[5] ; Stefan Zeissler[15] ; Stefano Della Torre[11] ; Stefano Di Falco[24] ; Travis Gordon Nelson[None] ; Ulrich Becker[6] ; Valerio Formato[9] ; Veronica Bindi[3] ; Weiwei Xu[6] ; Wim De Boer[15] ; Xudong Cai[6] ; Yuan-Hann Chang[14] ; Zhicheng Tang[13] ; Zhili Weng[6] ; Zuhao Li[13] ; Vitaly Choutko[6]

[1] *Centro de Investigaciones Energéti cas Medioambientales y Tecno*
[2] *Centre National de la Recherche Scientifique (FR)*
[3] *University of Hawai'i at Manoa (US)*
[4] *Universita e INFN, Bologna (IT)*
[5] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[6] *Massachusetts Inst. of Technology (US)*
[7] *Universita e INFN, Padova (IT)*
[8] *Middle East Technical University (TR)*
[9] *Universita e INFN, Perugia (IT)*
[10] *Institute of High Energy Physics, Chinese Academy Sciences*
[11] *Universita & INFN, Milano-Bicocca (IT)*
[12] *LIP Laboratorio de Instrumentacao e Fisica Experimental de Part*
[13] *Chinese Academy of Sciences (CN)*
[14] *National Central University (TW)*
[15] *KIT - Karlsruhe Institute of Technology (DE)*
[16] *Academia Sinica (TW)*
[17] *Cent.de Investigac.Energeticas Medioambientales y Tecnol. (CIEMAT)*
[18] *Universidade de Sao Paulo (BR)*
[19] *INFN Sezione di Pisa, Universita' e Scuola Normale Superiore, P*
[20] *Univ. degli Studi Milano-Bicocca (IT)*
[21] *Universite de Geneve (CH)*
[22] *University of Hawaii at Manoa*
[23] *Univ + INFN*
[24] *Universita & INFN Pisa (IT)*

**Corresponding Author(s):** zhili.weng@cern.ch, philip.doetinchem@cern.ch, andreas.bachlechner@cern.ch,

amaresh.datta@cern.ch, senquan.lu@cern.ch, jie.feng@cern.ch, andrea.contin@cern.ch, marco.incagli@cern.ch, hsin-yi.chou@cern.ch, m.behlmann@cern.ch, qi.yan@cern.ch, wim.de.boer@kit.edu, paolo.zuccon@cern.ch, chenhs@ihep.ac.cn, vitaly.choutko@cern.ch, cristina.consolandi@cern. stefan.schael@physik.rwth-aachen.de, jorge.casaus@cern.ch, r.battiston@tiscali.it, zuhao.li@cern.ch, ulrich.becker@cern.ch, giuseppe.la.vacca@cern.ch, bilge.demirkoz@cern.ch, yuan-hann.chang@cern.ch, xudong.cai@cern.ch, weiwei.xu@cern.ch, hu.liu@cern.ch, manuel.aguilar@ciemat.es, javier.berdugo@ciemat.es, carlos.jose.delgado.mendez@cern.ch, vale- rio.formato@cern.ch, stefan.zeissler@cern.ch, domenico.d'urso@cern.ch, iris.gebauer@cern.ch, fernando.barao@cern.ch, zhicheng.tang@cern.ch, manuela.vecchi@cern.ch, veronica.bindi@cern.ch, michael.capell@cern.ch, giovanni.ambrosi@cern.ch, francesca.giovacchini@cern.ch, matteo.boschini@cern.ch, melanie.heil@cern.ch, stefano.della.torre@cern.ch, niko-las.zimmermann@cern.ch, alberto.oliva@cern.ch, mercedes.paniccia@cern.ch, sadakazu.haino@cern.ch, maura.graziani@cern.ch, travis.gordon.nelson@cern.ch, corinne.goy@cern.ch, henning.gast@cern.ch, davide.grandi@cern.ch, cenzhang@ihep.ac.cn, di.falco.stefano@cern.ch, alexandre.ghefli@cern.ch, andrei.kounine@cern.ch, miguel.angel.velasco.frutos@cern.ch, laurent.derome@lpsc.in2p3.fr, matteo.duranti@cern.ch, francesco.dimiccoli@cern.ch, claudio.corti@cern.ch, chan.hoon.chung@cern.c bruna.bertucci@cern.ch, bastian.beischer@cern.ch, benoit.coste@cern.ch

The fluxes and flux ratios of charged elementary particles in cosmic rays are presented in the absolute rigidity range from 1 to 1000 GV. In the absolute rigidity range ~60 to ~500 GV, the antiproton, proton, and positron fluxes are found to have nearly identical rigidity dependence and the electron flux exhibits different rigidity dependence. Below 60 GV, the antiproton-to-proton, antiproton-to-positron, and proton-to-positron flux ratios each reaches a maximum. Particular emphasis is made on new observations of the properties of elementary particles in the rigidity range above 500 GV.

**Astro-particle Physics and Cosmology / 728**

# Precision Measurement of the Monthly Cosmic Ray Fluxes with the Alpha Magnetic Spectrometer on the ISS

Alberto Oliva[1] ; Alexandre Ghelfi[2] ; Amaresh Datta[3] ; Andrea Contin[4] ; Andreas Bachlechner[5] ; Andrei Kounine[6] ; Bastian Beischer[5] ; Benoit Jean-Albert Coste[7] ; Bilge Demirkoz[8] ; Bruna Bertucci[9] ; Carlos Delgado Mendez[1] ; Cen Zhang[10] ; Chan Hoon Chung[5] ; Claudio Corti[3] ; Corinne Goy[2] ; Cristina Consolandi[3] ; Davide Grandi[11] ; Domenico D'Urso[9] ; Fernando De Carvalho Barao[12] ; Francesca Giovacchini[1] ; Francesco Dimiccoli[7] ; Giovanni Ambrosi[9] ; Giuseppe La Vacca[11] ; Henning Gast[5] ; Hesheng Chen[13] ; Hsin-Yi Chou[14] ; Hu Liu[6] ; Iris Gebauer[15] ; Javier Berdugo Perez[1] ; Jie Feng[16] ; Jorge Casaus[1] ; Laurent Yves Marie Derome[2] ; Manuel Aguilar-Benitez[17] ; Manuela Vecchi[18] ; Marco Incagli[19] ; Matteo Boschini[20] ; Matteo Duranti[9] ; Matthew Daniel Behlmann[6] ; Maura Graziani[15] ; Melanie Heil[6] ; Mercedes Paniccia[21] ; Miguel Angel Velasco Frutos[1] ; Mike Capell[6] ; Nikolas Zimmermann[5] ; Paolo Zuccon[6] ; Philip Von Doetinchem[22] ; Qi Yan[6] ; Roberto Battiston[23] ; Sadakazu Haino[16] ; Senquan Lu[16] ; Stefan Schael[5] ; Stefan Zeissler[15] ; Stefano Della Torre[11] ; Stefano Di Falco[24] ; Travis Gordon Nelson[None] ; Ulrich Becker[6] ; Valerio Formato[9] ; Veronica Bindi[3] ; Weiwei Xu[6] ; Wim De Boer[15] ; Xudong Cai[6] ; Yuan-Hann Chang[14] ; Zhicheng Tang[13] ; Zhili Weng[6] ; Zuhao Li[13] ; Vitaly Choutko[6]

[1] *Centro de Investigaciones Energéti cas Medioambientales y Tecno*
[2] *Centre National de la Recherche Scientifique (FR)*
[3] *University of Hawai'i at Manoa (US)*
[4] *Universita e INFN, Bologna (IT)*
[5] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[6] *Massachusetts Inst. of Technology (US)*
[7] *Universita e INFN, Padova (IT)*
[8] *Middle East Technical University (TR)*
[9] *Universita e INFN, Perugia (IT)*
[10] *Institute of High Energy Physics, Chinese Academy Sciences*
[11] *Universita & INFN, Milano-Bicocca (IT)*
[12] *LIP Laboratorio de Instrumentacao e Fisica Experimental de Part*
[13] *Chinese Academy of Sciences (CN)*
[14] *National Central University (TW)*
[15] *KIT - Karlsruhe Institute of Technology (DE)*
[16] *Academia Sinica (TW)*
[17] *Cent.de Investigac.Energeticas Medioambientales y Tecnol. (CIEMAT)*
[18] *Universidade de Sao Paulo (BR)*

PoS(ICHEP2018)930

[19] *INFN Sezione di Pisa, Universita' e Scuola Normale Superiore, P*
[20] *Univ. degli Studi Milano-Bicocca (IT)*
[21] *Universite de Geneve (CH)*
[22] *University of Hawaii at Manoa*
[23] *Univ + INFN*
[24] *Universita & INFN Pisa (IT)*

**Corresponding Author(s):** veronica.bindi@cern.ch, nikolas.zimmermann@cern.ch, valerio.formato@cern.ch, vitaly.choutko@cern.ch, manuela.vecchi@cern.ch, michael.capell@cern.ch, philip.doetinchem@cern.ch, maura.graziani@cern.ch, jorge.casaus@cern.ch, marco.incagli@cern.ch, zhicheng.tang@cern.ch, yuan-hann.chang@cern.ch, manuel.aguilar@ciemat.es, hsin-yi.chou@cern.ch, xudong.cai@cern.ch, senquan.lu@cern.ch, zuhao.li@cern.ch, hu.liu@cern.ch, stefan.zeissler@cern.ch, bilge.demirkoz@cern.ch, sadakazu.haino@cern.ch, paolo.zuccon@cern.ch, andreas.bachlechner@cern.ch, benoit.coste@cern.ch, carlos.jose.delgado.mendez@cern.ch, giovanni.ambrosi@cern.ch, mercedes.paniccia@cern.ch, r.battiston@tiscali.it, bruna.bertucci@cern.ch, weiwei.xu@cern.ch, wim.de.boer@kit.edu, travis.gordon.nelson@cern.ch, jie.feng@cern.ch, stefan.schael@physik.rwth-aachen.de, qi.yan@cern.ch, miguel.angel.velasco.frutos@cern.ch, henning.gast@cern.ch, bastian.beischer@cern.ch, andrea.contin@cern.ch, cenzhang@ihep.ac.cn, giuseppe.la.vacca@cern.ch, cristina.consolandi@cern.ch, francesca.giovacchini@cern.ch, fernando.barao@cern.ch, chan.hoon.chung@cern.ch, matteo.boschini@cern.ch, zhili.weng@cern.ch, melanie.heil@cern.ch, iris.gebauer@cern.ch, alexandre.ghefli@cern.ch, davide.grandi@cern.ch, ulrich.becker@cern.ch, laurent.derome@lpsc.in2p3.fr, m.behlmann@cern.ch, chenhs@ihep.ac.cn, stefano.della.torre@cern.ch, francesco.dimiccoli@cern.ch, corinne.goy@cern.ch, claudio.corti@cern.ch, domenico.d'urso@cern.ch, amaresh.datta@cern.ch, alberto.oliva@cern.ch, di.falco.stefano@cern.ch, matteo.duranti@cern.ch, javier.berdugo@ciemat.es, andrei.kounine@cern.ch

The precision measurements of the monthly cosmic ray fluxes for the period from May 2011 to May 2017 with Alpha Magnetic Spectrometer on the International Space Station are presented. This period covers the ascending phase of solar cycle # 24 together with the reversal of the Sun's magnetic field polarity through the minimum. The detailed variations with time of the fluxes are shown up to rigidities of 60 GV. Impact of the solar polarity reversal is discussed in details.

**Astro-particle Physics and Cosmology / 730**

# Precision Measurement of Nitrogen flux by AMS

Alberto Oliva[1] ; Alexandre Ghelfi[2] ; Amaresh Datta[3] ; Andrea Contin[4] ; Andreas Bachlechner[5] ; Andrei Kounine[6] ; Bastian Beischer[5] ; Benoit Jean-Albert Coste[7] ; Bilge Demirkoz[8] ; Bruna Bertucci[9] ; Carlos Delgado Mendez[1] ; Cen Zhang[10] ; Chan Hoon Chung[5] ; Claudio Corti[3] ; Corinne Goy[2] ; Cristina Consolandi[3] ; Davide Grandi[11] ; Domenico D'Urso[9] ; Fernando De Carvalho Barao[12] ; Francesca Giovacchini[1] ; Francesco Dimiccoli[7] ; Giovanni Ambrosi[9] ; Giuseppe La Vacca[11] ; Henning Gast[5] ; Hesheng Chen[13] ; Hsin-Yi Chou[14] ; Hu Liu[6] ; Iris Gebauer[15] ; Javier Berdugo Perez[1] ; Jie Feng[16] ; Jorge Casaus[1] ; Laurent Yves Marie Derome[2] ; Manuel Aguilar-Benitez[17] ; Manuela Vecchi[18] ; Marco Incagli[19] ; Matteo Boschini[20] ; Matteo Duranti[9] ; Matthew Daniel Behlmann[6] ; Maura Graziani[15] ; Melanie Heil[6] ; Mercedes Paniccia[21] ; Miguel Angel Velasco Frutos[1] ; Mike Capell[6] ; Nikolas Zimmermann[5] ; Paolo Zuccon[6] ; Philip Von Doetinchem[22] ; Qi Yan[6] ; Roberto Battiston[23] ; Sadakazu Haino[16] ; Senquan Lu[16] ; Stefan Schael[5] ; Stefan Zeissler[15] ; Stefano Della Torre[11] ; Stefano Di Falco[24] ; Travis Gordon Nelson[None] ; Ulrich Becker[6] ; Valerio Formato[9] ; Veronica Bindi[3] ; Weiwei Xu[6] ; Wim De Boer[15] ; Xudong Cai[6] ; Yuan-Hann Chang[14] ; Zhicheng Tang[13] ; Zhili Weng[6] ; Zuhao Li[13] ; Vitaly Choutko[6]

[1] *Centro de Investigaciones Energéti cas Medioambientales y Tecno*
[2] *Centre National de la Recherche Scientifique (FR)*
[3] *University of Hawai'i at Manoa (US)*
[4] *Universita e INFN, Bologna (IT)*
[5] *Rheinisch Westfaelische Tech. Hoch. (DE)*
[6] *Massachusetts Inst. of Technology (US)*
[7] *Universita e INFN, Padova (IT)*
[8] *Middle East Technical University (TR)*
[9] *Universita e INFN, Perugia (IT)*
[10] *Institute of High Energy Physics, Chinese Academy Sciences*
[11] *Universita & INFN, Milano-Bicocca (IT)*

PoS(ICHEP2018)930

[12] *LIP Laboratorio de Instrumentacao e Fisica Experimental de Part*
[13] *Chinese Academy of Sciences (CN)*
[14] *National Central University (TW)*
[15] *KIT - Karlsruhe Institute of Technology (DE)*
[16] *Academia Sinica (TW)*
[17] *Cent.de Investigac.Energeticas Medioambientales y Tecnol. (CIEMAT)*
[18] *Universidade de Sao Paulo (BR)*
[19] *INFN Sezione di Pisa, Universita' e Scuola Normale Superiore, P*
[20] *Univ. degli Studi Milano-Bicocca (IT)*
[21] *Universite de Geneve (CH)*
[22] *University of Hawaii at Manoa*
[23] *Univ + INFN*
[24] *Universita & INFN Pisa (IT)*

**Corresponding Author(s):** matteo.duranti@cern.ch, andreas.bachlechner@cern.ch, yuan-hann.chang@cern.ch, manuel.aguilar@ciemat.es, javier.berdugo@ciemat.es, bastian.beischer@cern.ch, stefan.zeissler@cern.ch, benoit.coste@cern.ch, nikolas.zimmermann@cern.ch, stefan.schael@physik.rwth-aachen.de, di.falco.stefano@cern.ch, giovanni.ambrosi@cern.ch, miguel.angel.velasco.frutos@cern.ch, ulrich.becker@cern.ch, mercedes.paniccia@cern.ch, jorge.casaus@cern.ch, sadakazu.haino@cer francesca.giovacchini@cern.ch, marco.incagli@cern.ch, qi.yan@cern.ch, vitaly.choutko@cern.ch, r.battiston@tiscali.it, michael.capell@cern.ch, xudong.cai@cern.ch, philip.doetinchem@cern.ch, hu.liu@cern.ch, jie.feng@cern.ch, da- vide.grandi@cern.ch, henning.gast@cern.ch, laurent.derome@lpsc.in2p3.fr, chenhs@ihep.ac.cn, iris.gebauer@cern.ch, travis.gordon.nelson@cern.ch, m.behlmann@cern.ch, wim.de.boer@kit.edu, maura.graziani@cern.ch, senquan.lu@cern.ch, hsin-yi.chou@cern.ch, manuela.vecchi@cern.ch, domenico.d'urso@cern.ch, veronica.bindi@cern.ch, cristina.consolandi@cern.ch, weiwei.xu@cern.ch, carlos.jose.delgado.mendez@cern.ch, stefano.della.torre@cern.ch, claudio.corti@cern.ch, bruna.bertucci@cern.ch francesco.dimiccoli@cern.ch, valerio.formato@cern.ch, zhicheng.tang@cern.ch, cenzhang@ihep.ac.cn, giuseppe.la.vacca@cern.ch, andrei.kounine@cern.ch, melanie.heil@cern.ch, amaresh.datta@cern.ch, corinne.goy@cern.ch, alexandre.ghefli@cern.ch, fernando.barao@cern.ch, bilge.demirkoz@cern.ch, matteo.boschini@cern.ch, andrea.contin@cern.ch, paolo.zuccon@cern.ch, zhili.weng@cern.ch, chan.hoon.chung@cern.ch, zuhao.li@cern.ch, alberto.oliva@cern.ch

The nitrogen flux in cosmic rays is expected to contain both primary and secondary components, so the knowledge of their relative contributions is important in understanding the origin, acceleration, and propagation of cosmic rays. A precise measurement of the nitrogen flux with rigidity from 2 GV to 3 TV based on 2 million nuclei collected by AMS during first 5 years of operation is presented.

**Detector: R&D for Present and Future Facilities / 732**

# Scalability of technologies for highly granular calorimeters

Frank Simon[1]; Yuji Sudo[2]

[1] *Max-Planck-Institut fuer Physik*
[2] *Deutsches Elektronen-Synchrotron (DE)*

**Corresponding Author(s):** yuji.sudo@cern.ch, frank.simon@cern.ch

After the successful demonstration of the performance of highly granular electromagnetic and hadronic calorimeters by the CALICE collaboration, emphasis has shifted to system issues and large scale production. These are addressed by varied technological prototypes currently in production. We present work on silicon, scintillator, and gas-detector based imaging calorimeters for future electron-positron colliders, pointing out the relevance also for LHC upgrades and other applications. Emphasis will be placed on techniques developed for mass production, such as automatic testing of active detector elements; packaging, wrapping, and mounting of scintillators; and automatised assembly chains as well as on solutions for large-size detector components, precision mechanics and ser- vices. We also report results from recent laboratory and beam tests of electromagnetic and hadronic calorimeter prototypes using these production and testing techniques.

PoS(ICHEP2018)930

**Computing and Data Handling / 735**

# ALICE Analysis Framework for the LHC Run III

Markus Bernhard Zimmermann[1]

[1] *CERN*

**Corresponding Author(s):** markus.bernhard.zimmermann@cern.ch

In LHC Run 3, the ALICE experiment will record 100 times more events than in the runs before. This is achieved with a continuous detector readout. To cope with such a huge amount of data, a new integrated Online-Offline (O2) computing infrastructure is created. Part of this development is a new analysis framework. In Run 1 and Run 2 a large fraction of the time to analyze a dataset has been used to read the data from disk and to deserialize it. Consequently a main focus of the new development is on this step. A new flat data structure is developed which supports growing, skimming and pruning of the data. Only the absolutely necessary information for an analysis will be read. Uninteresting event or track information should not be processed. The important parts of the dataset will be read at dedicated analysis facilities which are themselves optimized for a quick data access.
The new framework should be built on open source implementations to reduce the required work within ALICE and to benefit from synergies with industry. By using open source implementations, new code can be contributed and no dependency on proprietary software is created.

**Top Quark and Electroweak Physics / 743**

# Electroweak Physics at CEPC

**Author(s):** Zhijun Liang[1]
**Co-author(s):** Manqi Ruan [1] ; gang Li [1] ; Yaquan Fang [1]

[1] *Chinese Academy of Sciences (CN)*

**Corresponding Author(s):** zhijun.liang@cern.ch, yaquan.fang@cern.ch, li.gang@mail.ihep.ac.cn, manqi.ruan@cern.ch

Abstract: The Circular Electron Positron Collider (CEPC) project aims to build a circular electron-positron collider capable of precision physics measurements at center-of-mass energies ranging from 90 GeV to 240GeV. The CEPC has a total circumference of at least one hundred kilometers and at least two interaction points. In its 10 years operation at 240 GeV, it will collect more than one million Higgs events. CEPC will also run at Z pole for two years, producing more than 100 billion Z bosons in two year. It will also collect data around WW threshold for one year, in order to perform the W boson mass measurement with high precision. These datasets will boost the precision of electroweak measurements by orders of magnitude. An overview is presented of the potential of CEPC to advance precision studies of electroweak physics with an emphasis on the opportunities in W and Z physics.

**Astro-particle Physics and Cosmology / 746**

# Cosmological search of light dark matter

kenji kadota[None]

**Corresponding Author(s):** kadotak@gmail.com

PoS(ICHEP2018)930

A few examples for the light dark matter will be presented along with their cosmological (e.g. radio astronomy search) and the particle physics (dark matter search experiments) constraints to illustrate the complementarity between the particle physics and cosmology probes.

**POSTER / 747**

## Study of PMT saturation for JSNS2 experiment

J.Y. Yang[1] ; S.Y. Kim[1] ; J.S. Jang[2]

[1] *Seoul National University*
[2] *Gwangju Institute of Science and Technology*

**Corresponding Author(s):** jsjang@chonnam.ac.kr, sfc5302@gamil.com, x0109@snu.ac.kr

The JSNS2 experiment will search for a sterile neutrino with short baseline (~24m) using a high intensity neutrino beam produced from muon decays at rest at J-PARC MLF (Material and Life science experimental Facility). The experiment considers use of 10-inch Hamamatsu PMTs that are also used by RENO and Double Chooz. A study has been made to understand the PMT saturation behavior with various gains, in order to find a linear-response region of the PMT for the JSNS2. In this presentation, we report the results of the PMT saturation study.

**Neutrino Physics / 749**

## CANDLES project to search for neutrino-less double beta decay of $^{48}$Ca

Saori Umehara[1] ; Yasuhiro Takemoto[2] ; for CANDLES collaboration[None]

[1] *Osaka University*
[2] *Osaka Unversity*

**Corresponding Author(s):** takemoto@km.phys.sci.osaka-u.ac.jp, umehara@rcnp.osaka-u.ac.jp

Neutrino-less double beta decay($0\nu\beta\beta$) is acquiring great interest after the confirmation of neutrino oscillation which demonstrated nonzero neutrino mass. Measurement of $0\nu\beta\beta$ provides a test for the Majorana nature of neutrinos and gives an absolute scale of the effective neutrino mass.
In order to search for $0\nu\beta\beta$ of $^{48}$Ca, we proposed CANDLES project and a detector system by using $CaF_2$(pure). The CANDLES III system, which is one of the CANDLES project, aims at a high sensitive measurement by a characteristic detector system. The system realizes a complete $4\pi$ active shield by immersion of the $CaF_2$ scintillators in liquid scintillator. The active shield leads to a low background condition for the measurement. Now we have developed the CANDLES III system, which contained 350 g of $^{48}$Ca at the Kamioka underground laboratory. In 2016, we have installed a shielding system in the CANDLES III system to reduce background events by the high energy $\gamma$-rays, which were emitted from neutron capture reaction on surround materials. By the system, we reduced the background events from neutron capture by two orders of magnitude. After this upgrade, we started a double beta decay measurement and obtained result.
Furthermore, we started development of next detector system. In this system, we will use a $CaF_2$ scintillating bolometer and enriched $^{48}$Ca. In this paper, we will report result of $^{48}$Ca double beta decay measurement by using the CANDLES III system and current status of the $CaF_2$ scintillating bolometer and enrichment of $^{48}$Ca.

PoS(ICHEP2018)930

**POSTER / 751**

# Data reconstruction and analysis for the 3x1x1 m^3 dual phase Liquid Argon Time Projection Chamber prototype

Christoph Alt[1] ; Laura Amelie Zambelli[2]

[1] *ETH Zurich*
[2] *Centre National de la Recherche Scientifique (FR)*

**Corresponding Author(s):** laura.zambelli@cern.ch, christoph.alt@cern.ch

Combining high precision calorimetry with scalability to the multi-kiloton level, the Liquid Argon Time Projection Chamber (LAr TPC) has proven to be an attractive technology for long baseline neutrino oscillation experiments. An extensive R&D program for LAr TPCs at the ten-kiloton level is currently underway in the context of the Deep Underground Neutrino Experiment (DUNE). The DUNE far detector, located at the Sanford Underground Research Facility in South Dakota, USA, will measure the oscillated neutrino flux at a baseline of 1300 km with four 10 kiloton LAr TPC modules. Two different technologies are being explored for this purpose: single phase and dual phase LAr TPCs. The dual phase technology allows to amplify the charge signal in gas argon, offering several advantages over the single phase. The first large scale dual phase LAr TPC with an active volume of 3x1x1 m3 has been operated at CERN in 2017. Another prototype with an active volume of 6x6x6 m3 will be commissioned by the end of 2018, paving the way for DUNE. This poster will give a detailed overview of the different reconstruction stages for dual phase LAr TPC data. Furthermore, results on the liquid argon purity, charge readout uniformity and charge-light matching for the 3x1x1 m3 detector are presented.

**Diversity and Inclusion / 752**

# Broadening access to STEM via Gender inclusive teaching

**Author(s):** Genevieve Guinot[1]
**Co-author(s):** Jeff Wiener [1] ; Ioanna Koutava [1]

[1] *CERN*

**Corresponding Author(s):** ioanna.koutava@cern.ch, genevieve.guinot@cern.ch, jeff.wiener@cern.ch

Various studies have demonstrated that girls are less likely than boys to take up science subjects in high schools, in most countries. This has later repercussions on professional choices. A 2015 study by the OECD demonstrates that the main reason for boys' and girls' education choices is less related to ability than self-perception.
Three years ago, with the initial support of an education researcher, CERN launched an awareness-raising initiative on gender equality in the science classroom within its International High School Teacher Programme. The objective of the initiative is to equip teachers with an understanding of concepts used in diversity management, and explore how they apply to science teaching. This trans- lates into helping them design actions that they will put in place in their classroom, and possibly disseminate in their local education professionals' network. Sharing experience, addressing stereo-types reproduced in physics classes and other aspects that may influence students' motivation are part of the programme, as well as the exploration of collaborative tools to disseminate the lessons learnt. Gender inclusive teaching has been acclaimed by the programme's participants and has be- come one of its yearly features. The presentation will explain why and how the programme was set up, and draw an assessment of what was achieved so far. It will also touch on the limits of the initiative and explain its possible dis- semination towards a broader network actively developing and promoting ideas and tools.

PoS(ICHEP2018)930

**Diversity and Inclusion / 753**

# Advancing inclusion through work-life balance policies.

Genevieve Guinot[1]

[1] *CERN*

**Corresponding Author(s):** genevieve.guinot@cern.ch

CERN, as an intergovernmental organisation with twenty-two Member States mainly from across Europe, operates in a very particular environment. Complying with the necessity to promote the geographical representation of Member States among its 4000 employees and students inevitably engenders talent attraction challenges. As a research performing organisation in high-energy physics and related fields, fostering gender diversity also proves to be rather complex.
To remain an attractive employer, CERN regularly updates its financial and social conditions taking into account the prevailing social trends and expectations from the new generation of internationally mobile scientists. However, taking action at the time of recruitment is not sufficient to efficiently promote diversity amongst personnel: long-term support policies covering the different stages of life are necessary to help individuals shape their life with equal opportunities, while overcoming the difficulties that may arise from their career and life choices.
To that aim, CERN has recently upgraded its employment policies through a review of its measures enabling a better balance between professional and personal life, and developing an inclusive approach of family structures. Rather than working on pure gender equality plans, CERN has invested in work-life balance policies. The presentation will give an overview of the policies, questioning whether they can help demanding institutions like CERN re-think the work environment and change a normative work culture into a more inclusive one.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 762**

# The FCC-ee Lepton Collider: Design Status and Operation Concept

**Author(s):** Dmitry Shatilov[1] ; Evgeny Levichev[1]
**Co-author(s):** Erk Jensen [2] ; Frank Zimmermann [2] ; Katsunobu Oide [3] ; Michael Benedikt [2] ; Olivier Brunner[2]

[1] *Budker Institute of Nuclear Physics (RU)*
[2] *CERN*
[3] *High Energy Accelerator Research Organization (JP)*

**Corresponding Author(s):** frank.zimmermann@cern.ch, erk.jensen@cern.ch, olivier.brunner@cern.ch, dimitry.shatilov@cern.ch, katsunobu.oide@cern.ch, levichev@inp.nsk.su, michael.benedikt@cern.ch

The Future Circular Collider (FCC) Study aims at developing a large-scale accelerator research infrastructure based on a 100 km tunnel. While the ultimate goal is a proton-proton collider, with 100 TeV centre-of-mass collision energy and unprecedented direct discovery potential, the initial project stage could consist of an electron-positron collider, with highest luminosities at collision energies up to 380 GeV, for indirect exploration of the energy scale up to 100 TeV via precision measurements. The talk provides an overview on the lepton collider design. Special emphasis is given to the parameter and luminosity optimisation, the operation phases and the corresponding evolution of the machine in terms of RF staging for the different physics working points, and the overall duration of the physics program.

**Diversity and Inclusion / 763**

# Moving towards diversity and inclusion in science: Why it is essential for Physics in Africa

PoS(ICHEP2018)930

Azwinndini Muronga[1] ; Azwinndini Muronga[None]

[1] *Nelson Mandela University*

**Corresponding Author(s):** azwinndini.muronga@gmail.com, azwinndini.muronga@mandela.ac.za

The challenge of diversity and inclusion in science is not solely about demographics. And although improving the numbers is a necessary start, it is not enough to truly address the challenge. Many institutions in South Africa, for example, are making concerted efforts to recruit students and staff from historically marginalized groups, but this approach will only succeed if academics, administrators, and the scientific community at large also consider the environment that the students and new staff are being recruited into, and how to make those spaces truly inclusive arenas where a diverse group of scholars can thrive.
For an environment to be inclusive, students and staff also need spaces to openly and honestly vocalize their feelings and anxieties related to broader social issues. At the Nelson Mandela University, for example, such spaces are created under the theme of 'Courageous Conversations'.
Creating an inclusive scientific community, particularly within the context of South African academic science, is a challenging and multidimensional issue. Nonetheless, there are efforts that are being championed by the South African Institute of Physics and the physics community of South Africa and Africa as a whole.
This report will highlight efforts aimed at addressing the diversity and inclusion in science challenge. The focus will be on physics as a discipline where the diversity and inclusion challenge is most experienced. Physics, and in particular a diverse programme joining nuclear and particle physics with astrophysics, astronomy, cosmology and theoretical physics, offers a model for driving diversity and inclusion in science.

**Higgs Physics / 766**

## An Improved Model-Independent Higgs Precision Analysis

Sunghoon Jung[None]

**Corresponding Author(s):** nejsh21@gmail.com

We discuss an improved model-independent Higg precision analysis of d=6 effective operators based on measurements of future lepton colliders. In particular, we focus on how to improve single Higgs couplings and Higgs triple coupling precisions. We identify main obstacles on obtaining sub-percent precisions on them and provide insights on how we may overcome them.

**Astro-particle Physics and Cosmology / 776**

## Combined search for dark matter in the Galactic center with ANTARES and IceCube

Christoph Tönnis[1]

[1] *SKKU Suwon*

**Corresponding Author(s):** christoph.toennis@gmx.de

To date the neutrino telescopes IceCube and ANTARES have been generating strong limits on the thermally averaged annihilation cross-secttion of WIMP dark matter in the galactic center, with ANTARES yeilding the currently strongest limits at WIMP masses exceeding 30 TeV. At a WIMP mass range of 50 GeV to a few hundred GeV the current limitss from IceCube surpass those of ANTARES offering a good opportunity for a combined analysis. In this presentation the results of a first combined search for dark matter in the galactic center using the data of both these experiments is presented. As a first step to a combined analysis using both detectors full datasets the 79-string data sample taken from 2012 to 2014 was used from IceCube, while from

PoS(ICHEP2018)930

ANTARES the data sample collected from 2007 to 2015 was taken. The analysis considered dark matter with particle masses between 50 and 100 GeV and a variety of different dark matter halo models and annihilation channels.

**POSTER / 777**

## A search for secluded dark matter in the Sun using the IceCube neutrino telescope

Christoph Tönnis[1]

[1] *SKKU Suwon*

**Corresponding Author(s):** christoph.toennis@gmx.de

Secluded dark matter is a model for dark matter in which dark matter particles annihilate into baryonic matter via a metastable mediator. In the case of annihilations in the sun sufficiently long-lived mediator particles can escape the solar plasma before decaying, avoiding the absorption of signal particles. This results in significantly amplified neutrino signals at energies beyond 1 TeV promising a high sensitivity for indirect searches using neutrino telescopes. In this talk the results of a search for secluded dark matter in the sun with the IceCube neutrino observatory will be presented. WIMP masses ranging from 100 GeV to 10 TeV and mediators between 1 ns and 10 s decaying directly into neutrinos are considered. The data taken by IceCube in the in the years from 2011 to 2015 in the 86 string configuration is used in the analysis.

**Computing and Data Handling / 779**

## Exploitation of heterogeneous resources for ATLAS Computing

Jiri Chudoba[1]

[1] *Acad. of Sciences of the Czech Rep. (CZ)*

**Corresponding Author(s):** jiri.chudoba@cern.ch

LHC experiments require significant computational resources for Monte Carlo simulations and real data processing and the ATLAS experiment is not an exception. In 2017, ATLAS exploited steadily almost 3M HS06 units, which corresponds to about 300 000 standard CPU cores. The total disk and tape capacity managed by the Rucio data management system exceeded 350 PB.

Resources are provided mostly by Grid computing centers distributed in geographically separated locations and connected by the Grid middleware. The ATLAS collaboration developed several systems to manage computational jobs, data files and network transfers. ATLAS solutions for job and data management (PanDA and Rucio) were generalized and now are used also by other collaborations.

More components are needed to include new resources such as private and public clouds, volunteers' desktop computers and primarily supercomputers in major HPC centers.

Workflows and data flows significantly differ for these less traditional resources and extensive software redesign was needed for some components of the ATLAS distributed computing software stack. High Performance Computers might not allow internet connection directly from/to computing nodes. Some provide hundreds of thousands cores each several times slower than a standard Grid core, others require jobs running in parallel on many cores using MPI, still others allow ATLAS jobs only as a backfill.

The newly developed and commissioned ATLAS software framework called Event Service has been put in place to exploit these highly volatile resources.

The volunteer computing project ATLAS@Home is based on the BOINC platform. Virtualization technologies enabled usage of various platforms and simplified installation. The project adds up to several tens of thousands

PoS(ICHEP2018)930

computing cores used for ATLAS simulations and serves as a unique tool for outreach activities. Not only desktop computers are used; servers from computing clusters too can increase total utilization by running ATLAS@Home on top of standard jobs.
We will discuss current usage of ATLAS pledged and opportunistic resources, evolution of the soft- ware used for the management of the huge number of distributed jobs and need for a significant upgrade of computational infrastructure for HL-LHC.

**Neutrino Physics / 780**

## DOUBLE BETA DECAY WITH NEMO-3 AND SUPERNEMO

Ruben Saakyan[None]; NEMO-3 and SuperNEMO Collaborations[None]

**Corresponding Author(s):** rrsaakyan@gmail.com

Neutrinoless double beta decay ($0\nu\beta\beta$) is the only practical way to understand the neutrino nature (Dirac or Majorana particle) and to observe full lepton number violation required by most beyond the standard model scenarios. The goal of the SuperNEMO experiment is to search for $0\nu\beta\beta$ decay. Its technology is based on a successful design approach of the NEMO-3 experiment which was running at the Modane Underground Laboratory in the Frejus Tunnel under the French-Italian Alps in 2003 − 2011. The unique features of this approach are the ability to study almost any $\beta\beta$ isotope and reconstruction of the event topology which produces a "smoking gun" evidence for the process and may allow the underlying physics mechanism to be disentangled. The latest updates on the final NEMO-3 results obtained with 7 different $\beta\beta$ isotopes are presented. The physics reach of the SuperNEMO project is discussed and the status of the integration and commissioning of its first module, the Demonstrator, as well as its physics sensitivity are presented.

**Strong Interactions and Hadron Physics / 781**

## Measurement of hadronic cross sections with the BABAR detector

Fabio Anulli[1]; Korneliy Todyshev[2]

[1] *Sapienza Universita e INFN, Roma I (IT)*
[2] *BINP*

**Corresponding Author(s):** todyshev@inp.nsk.su, fabio.anulli@roma1.infn.it

A program of measuring the light hadrons production in exclusive e+e− → hadrons processes is in place at BABAR, with the aim to improve the calculation of the hadronic contribution to the muon g − 2. We present the most recent results obtained by using the full data set of about 470 fb−1 collected by the BABAR experiment at the PEP-II e+e− collider at a center-of-mass energy of about 10.6 GeV. In particular, we report the results on the channels e+e− → π+π−π0π0, e+e− → π+π−η, KS0K+π−π0, K¯0K0π0, K¯0K0π0π0, and K¯0K0η.
The first reaction is the main source of uncertainty on the total hadronic cross section in the energy region between 1 and 2 GeV, while the other processes, together with previous BABAR results, complete the studies of the final states with two neutral or charged kaons.

**Strong Interactions and Hadron Physics / 784**

## Precise measurement of the $D^*(2010)^+ - D^+$ mass difference

Fabio Anulli[1] ; Liang Sun[2]

[1] *Sapienza Universita e INFN, Roma I (IT)*
[2] *Wuhan University (CN)*

**Corresponding Author(s):** liang.sun@cern.ch, fabio.anulli@roma1.infn.it

We measure the mass difference, $\Delta m_+$, between the $D^*(2010)^+$ and the $D^+$, using the decay chain $D^*(2010)^+ \to D^+\pi^0$ with $D^+ \to K^-\pi^+\pi^+$. The data were recorded with the BABAR detector at center-of-mass energies at and near the $\Upsilon(4S)$ resonance, and correspond to an integrated luminosity of approximately $468\ \text{fb}^{-1}$. We measure $\Delta m_+ = (140\,601.0 \pm 6.8\ [\text{stat}] \pm 12.9\ [\text{syst}])$ keV.
We combine this result with a previous BaBar measurement of $\Delta m_0 \equiv m(D^*(2010)^+) - m(D^0)$ to obtain $\Delta m_D = m(D^+) - m(D^0) = (4\,824.9 \pm 6.8\ [\text{stat}] \pm 12.9\ [\text{syst}])$ keV.
These results are compatible with, and approximately five times more precise than, previous world averages.

**Strong Interactions and Hadron Physics / 785**

## Study of radiative decays of the $\Upsilon(1S)$ and of three-body decays of the $J/\psi$

Fabio Anulli[1] ; Nicolas Arnaud[2]

[1] *Sapienza Universita e INFN, Roma I (IT)*
[2] *LAL (CNRS/IN2P3 and Université Paris-Sud)*

**Corresponding Author(s):** narnaud@lal.in2p3.fr, fabio.anulli@roma1.infn.it

We report on recent studies of quarkonium decays performed with the data collected by the BaBar experiment at the PEP-II $e^+e^-$ collider.
In particular, we use the entire BaBar dataset to study the reaction $e^+e^- \to \gamma_{\text{ISR}} J/\psi$, with $J/\psi \to \pi^+\pi^-\pi^0$, $J/\psi \to K^+K^-\pi^0$, or $J/\psi \to K_S K^\pm\pi^\mp$, and the photon $\gamma_{\text{ISR}}$ is produced via Initial- State-Radiation. We measure the relative $J/\psi$ branching fractions and perform a Dalitz plot analysis of each $J/\psi$ decay mode using an isobar model and a Veneziano model.
We also present a study of the radiative decays of the $\Upsilon(1S)$ to $\pi^+\pi^-\gamma$ and $K^+K^-\gamma$ final states, performed on the data samples collected at the peak of the $\Upsilon(2S)$ and $\Upsilon(3S)$ resonances. The $\Upsilon(1S)$ is reconstructed from the decay chains $\Upsilon(nS) \to \pi^+\pi^-\Upsilon(1S)$, with $n = 2, 3$. Branching fractions measurements and spin-parity analysis are reported for the $\Upsilon(1S)$ radiative decays to intermediate resonances observed in the $\pi^+\pi^-$ and $K^+K^-$ mass spectra.

**POSTER / 790**

## Signal optimization and study of the JUNO 20-inch PMT with high-voltage divider

fengjiao Luo[1]

[1] *Institute of High Energy Physics, CAS*

**Corresponding Author(s):** luofj@ihep.ac.cn

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector with primary physics goal of neutrino mass hierarchy determination. One of the key parameters is that the energy resolution of the JUNO should reach 3%@1MeV, totally 20,000 20" PMTs will be used, including 15000 MCP-

PMTs from NNVT and 5000 dynode PMTs from Hamamatsu. For better performances and higher stability, the PMT will be optimized with high-voltage divider. In this work, we will show the design and study of the PMT high-voltage divider and the optimized signal about the overshoot and ringing following the positive HV scheme. We have controlled the overshoot to less than ~1% of the signal amplitude; especially, for MCP-PMTs, we have optimized the HV divider for the collection efficiency, and the time properties of the waveform. More other related parameters also will be presented.

**Detector: R&D for Present and Future Facilities / 795**

# Development of the Silicon Tracker for CEPC

Qun Ouyang[1] ; Meng Wang[2] ; Xiangming Sun[3] ; Hongbo Zhu[4] ; Yunpeng Lu[4]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences*
[2] *Shandong University*
[3] *Central China Normal University*
[4] *IHEP, CAS*

**Corresponding Author(s):** yunpeng.lu@cern.ch, sphy2007@126.com, zhuhb@ihep.ac.cn, yplu@ihep.ac.cn, ouyq@ihep.ac.cn, mwang@sdu.edu.cn

The Circular Electron Positron Collider (CEPC) has been proposed as a Higgs/Z0 (flavor) factory, which would allow precision measurements of the Higgs boson properties, as well as of W±/Z0 bosons. The baseline design of CEPC tracking system consists of a vertex detector with three concentric double-sided pixel layers and a silicon tracker with some layers on both barrel and end-cap regions, besides a large volume time projection chamber (TPC). Driven by physics studies and experimental conditions, the silicon tracking system has similar performance requirements to the ILC detectors, such as a single point resolution of a few micrometers, very low material budget (0.15%X0 per layer for the vertex region and <1%X0 per layer for the outer tracker) and power consumption, but without power-pulsing, which leads to significantly additional constrains on detector specifications, especially for the case of machine operating at Z-pole energy region with high luminosity. In this presentation, I will give an overview of the CEPC tracker design, the requirements and challenges for each sub-system with possible technologies. The on-going R&D activities will also be reported on silicon pixel detector, based on monolithic CMOS pixel sensor (CPS) and Silicon on Insulator (SOI) technologies.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 796**

# Status and prospects of the AWAKE experiment

Fearghus Keeble[1]

[1] *University College London*

**Corresponding Author(s):** f.k@cern.ch

AWAKE is a plasma wakefield acceleration experiment at CERN, using the 400 GeV proton bunch of the SPS to drive an accelerating gradient in the GV $m^{-1}$ range. AWAKE aims to inject 15–20 MeV electrons into this plasma wakefield and accelerate them to GeV energies over 10 metres. An introduction to AWAKE and its physics will be presented, as well as an overview of the experimental apparatus and the most recent results. Longer term plans, including the future of the AWAKE facility and possible applications of the technology to HEP, will be discussed.

PoS(ICHEP2018)930

**Detector: R&D for Present and Future Facilities / 798**

# Development of TPC detector module and prototype with laser calibration for CEPC

Huirong QI[1] ; Haiyun WANG[1] ; Zhiwen WEN[1] ; Ling LIU[1] ; Yulian ZHANG[1] ; QUN OUYANG[1] ; Jian Zhang[1]

[1] *Institute of High Energy Physics, CAS*

**Corresponding Author(s):** zhangyl@ihep.ac.cn, wanghy91@ihep.ac.cn, zhangj@ihep.ac.cn, wenzhw@ihep.ac.cn, qihr@ihep.ac.cn, ouyq@ihep.ac.cn, liuling@ihep.ac.cn

In the baseline design of the Circular Electron Positron Collider (CEPC) tracking system, the high position resolution(~100μm) Time Projection Chamber(TPC) would be as the main tracker detector integrated with silicon tracker and ECAL. Unlike the detector at International Linear Collider (ILC), the beam structure of CEPC is the continous mode, which determines the detector's operation with- out the 'power-pulsing', on both Higgs and Z-pole energy regions with the high rating.
To meet the critical physics requirements of the tracker, the new concept structure gaseous detector module as one option for the tracer detector has been developed and tested. In this talk, the deviation of position resolution was calculated by the space charge causing the track distortions in the drift chamber at Z pole run in CEPC, and the value was less than 10μm in the inner diameter of TPC detector. Some performance of the conceptual detector module was obtained. The energy resolution is better than 20% for 5.9 keV X-rays and it indicates that the continuous suppression of ions backflow ratio about 0.1% can be reached at the gas gain of about 5000. Aimed to the calibration and alignment of TPC module, the TPC prototype integrated with laser calibration system has been designed with 5000mm drift length and 200mm*200mm active readout. The on-going R&D activities and some preliminary results will also be briefly reported.

**Quark and Lepton Flavor Physics / 809**

# Recent results on $\tau$-lepton decays with the BABAR detector

Fabio Anulli[1] ; Thomas Lueck[2]

[1] *Sapienza Universita e INFN, Roma I (IT)*
[2] *INFN - National Institute for Nuclear Physics*

**Corresponding Author(s):** thomas.lueck@pi.infn.it, fabio.anulli@roma1.infn.it

We report on the most recent results of studies of tau-lepton decays, relying on about $430 \times 10^6$ $e^+e^- \to \tau^+\tau^-$ events produced at a center-of-mass energy near 10.6 GeV with the BABAR detector at the PEP-II $e^+e^-$ collider.
We present measurements of the branching fractions and the spectral functions for the processes $\tau^- \to K^- K_S (\pi^0)\nu_\tau$, which can be used to determine the hadronic contribution to the muon $g-2$ due to the vacuum polarization.
We present also measurements of the branching fractions of the processes $\tau^- \to K^- n\pi^0 \nu_\tau$, with n=1,2,3, which can be used to improve the determination of $|V_{us}|$ from the branching fraction $\tau^- \to X_s \nu_\tau$ computed as the sum of all measured exclusive modes with a method based on finite-energy QCD sum rules.

**Education and Outreach / 812**

# The role of nuclear and particle physics, astrophysics, and cosmology in building capacity for Physics in Africa

Azwinndini Muronga[None] ; Azwinndini Muronga[None]

**Corresponding Author(s):** azwinndini.muronga@gmail.com, azwinndini.muronga@mandela.ac.za

In Africa particle physics, nuclear physics, astrophysics, and cosmology have been grabbing our attention, and that of our students for years. In the last decade, the field of a diverse research programme joining nuclear and particle physics with astrophysics, astronomy, cosmology and the enticing 'new worlds' imagined in theoretical physics has become particularly exciting due to the unprecedented scale of modern machinery and the discoveries that come with it. There are so many opportunities for students, teachers, and the public to learn about modern science such as the value of blue-skies research to society and everyday applications. For teachers, students, and academics this is also an opportunity to rethink the African science curriculum.
The South African Institute of Physics has created opportunities for the physics community in Africa to engage in physics education and outreach. The nuclear and particle physics community participates through iThemba LABS and the South Africa-CERN Consortium while the astrophysics and cosmology community participates in the astronomy facilities such as the Southern African Large Telescope (SALT) and the Square Kilometre Array (SKA) and its precursor MeerKAT. Teachers, re- searchers in education and science communication, professionals who work in engagement and out- reach in particle physics, nuclear physics, astrophysics, and cosmology, as well as academics across both areas, collaborate in physics education and outreach programmes.
The aim of this report is to highlight the challenges Africa faces in building capacity in physics and the positive impact particle physics, nuclear physics, astrophysics, and cosmology has on physics education, communication, and outreach in Africa.

**Astro-particle Physics and Cosmology / 813**

# Relaxion: A Landscape Without Anthropics

**Author(s):** Chanda Prescod-Weinstein[1]
**Co-author(s):** Ann Nelson [1]

[1] *University of Washington*

**Corresponding Author(s):** cprescod@uw.edu, anelson@phys.washington.edu

The relaxion mechanism provides a potentially elegant solution to the hierarchy problem without resorting to anthropic or other fine-tuning arguments. This mechanism introduces an axion-like field, dubbed the relaxion, whose expectation value determines the electroweak hierarchy as well as the QCD strong CP violating θ parameter. However, in the original model proposed by Graham, Kaplan and Rajendran (2015), the relaxion does not solve the strong CP problem, and in fact contributes to it, as the coupling of the relaxion to the Higgs field and the introduction of a linear potential for the relaxion produces large strong CP violation. We resolve this tension by considering inflation with a Hubble scale which is above the QCD scale but below the weak scale, and estimating the Hubble temperature dependence of the axion mass. The relaxion potential is thus very different during inflation than it is today. We find that provided the inflationary Hubble scale is between the weak scale and about 3 GeV, the relaxion resolves the hierarchy, strong CP, and dark matter problems in a way that is technically natural.

**POSTER / 816**

# Lattice calculation of form factors for semi-leptonic decays B \to D^(\ast) using improved heavy quark action

Yong-Chull Jang[1] ; Rajan Gupta[2] ; Tanmoy Bhattacharya[3] ; Jon Bailey[4] ; Jaehoon Leem[4] ; Sungwoo Park[4] ; Weonjong Lee[4]

[1] *Brookhaven National Laboratory*

PoS(ICHEP2018)930

[2] *Los Alamos National Lab*
[3] *T-2*
[4] *Seoul National University*

**Corresponding Author(s):** rg@lanl.gov,kunsung5@gmail.com,tanmoy@lanl.gov,jonbailey@snu.ac.kr,leemjae-hoon@gmail.com, wlee000@gmail.com, ypj@quark.phy.bnl.gov

The semileptonic form factors, at zero and non-zero recoil, of B → D(∗)ℓν decays are needed to determine the Vcb, a Cabibbo-Kobayashi-Maskawa (CKM) matrix element. Typically in the Unitarity Triangle (UT) analysis for the quark flavor mixing angles and the CP violating phase, Vcb enters as a normalization of |Vub|/|Vcb| or with εK ∝ |Vcb|4. More precise determination of Vcb will make the UT constraints tighter and possibly can reveal a new physics. Other interesting quantity is the ratios of R(D(∗)) = Γ(B → D(∗)τν)/Γ(B → D(∗)ℓν) which can provide a precision test of lepton-flavor universality. A lattice calculation with a non-zero recoils can be used to diagnose the current HQET parameterization of the form factors, which are argued by many of recent articles. We will present a recent progress in a lattice calculation of these B → D(∗)ℓν decays form factors. The calculation has been carried out with the MILC HISQ ensemble which simulates 2+1+1-flavor of dynamical quarks. A preliminary results from two different lattice spacings a = 0.12,0.09 fm with heavy pion mass 310 MeV will be presented. The valence charm and bottom quarks are simulated with the Oktay-Kronfeld (OK) action 1 by which a highly improved lattice heavy quark action reducing discretization errors with O(λ3QCD/m3b,c) matching to continuum QCD at tree-level. Capturing the loop corrections with a tadpole prescription in a numerical simulation, we reported that this tree-level matched OK action, in practice, shows a significant improvement in the heavy quark discretization errors. 2 Anticipating improved measurements of the decay rates from Belle II experiment, our projected error on the Vcb is below 1%. Such an improvement will tighten the constraints on the UT analysis, and help resolve the approximate 3σ discrepancy between estimates using exclusive and inclusive B decays.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 817**

# Storage ring proton Electric Dipole Moment Experiment with $10^{-29}$ $e$·cm sensitivity

Yannis Semertzidis[1]

[1] *CAPP/IBS and KAIST in South Korea*

**Corresponding Author(s):** semertzidis@bnl.gov

The electric dipole moment (EDM) of fundamental particles, when induced by the particle internal spin, violates separately the parity (P) and time (T) reversal symmetries. Due to CPT conservation,T-violation also means CP-violation and it is a sensitive probe of Physics beyond the standard model (SM). The storage ring EDM (srEDM) collaboration and the Juelich electric dipole investigations (JEDI) collaboration joined forces together with CERN scientists as part of the CERN initiative of Physics Beyond Colliders (PBC) to put together a study of the storage ring proton EDM method under the combined name charged particle EDM (CPEDM). The goal is to evaluate its feasibility, as well as to come up with a cost estimate for a ring with a goal of $10^{-29}$ $e$·cm, making it the best sensitivity hadronic EDM experiment, with a mass-scale reach for new, SUSY-like Physics of order $10^3$ TeV. The method requires an all-electric storage ring between 400m-500m in circumference, simultaneous storage of counter-rotating, longitudinally polarized proton beams, magnetic field shielding below 10nT, state of the art SQUID-based beam position monitors, high efficiency with high analyzing power proton polarimeters, high precision beam/spin dynamics tracking simulators, and the devel- opment of reliable and cost effective electric field plates capable of sustaining 10MV/m with 3cm plate separation. Several polarimeter and beam polarization concepts have already been tested us- ing polarized beams at the COSY ring in Juelich/Germany. I will present the current status towards the realization of this experiment.

**POSTER / 822**

# Probing BSM physics with Recursive Jigsaw Reconstruction

Paul Douglas Jackson[1]

[1] *University of Adelaide*

**Corresponding Author(s):** paul.douglas.jackson@cern.ch

The recursive jigsaw reconstruction technique provides a powerful way to tackle challenging SUSY final states with multiple missing particles. By altering the input "decay tree" we demonstrate a new approach to considering compressed SUSY signatures from a variety of different sources. The imposition of this decay tree provides a clear way to define which objects are associated with decay states and to partition the visible an invisible objects in a given system. From the imposition of a series of rules, a set of variables emerge, providing a method to distinguish BSM physics cases from the pernicious standard model backgrounds present. These allow sensitivity to signals without having to apply harsh cuts on object momenta or invisible momenta leading to selecting events in unique regions of phase-space.
We introduce this new approach, comparing it briefly to other methods used to probe for BSM physics and demonstrate it's power through application to several final states sensitive to new physics. We will further touch on the applicability of this same method to other physics processes where the use of conventional kinematic handles is challenging.

**POSTER / 827**

# 3-inch PMT system of JUNO experiment

Jilei Xu[1]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences*

**Corresponding Author(s):** xujl@ihep.ac.cn

The JUNO experiment will install 25k 3-inch PMTs (SPMTs) in the gaps between 18k closely packed 20-inch PMTs (LPMTs). Both systems will detect the same IBD signals, but the SPMTs will almost always work in single photoelectron mode. As a result, they will help constrain some of the systematics in the LPMT energy reconstruction, improving the energy resolution and the sensitivity of neutrino mass hierarchy measurement. They will also improve the muon reconstruction resolution, help reduce muon-related isotope backgrounds, provide an independent measurement of the θ12 and Delta_m^{2}_{21} solar parameters with unprecedented precision, and improve the measurement of supernova neutrinos.
SPMT production started in 2018 at a rate of 1000/month by the HZC Company. Performance test data so far indicate that the SPMTs perform as expected. A first version of the electronics has been done and is working well.Testing of the integration will be done at the end of this year. Other areas like the high voltage divider, SPMT potting, cabling, connector and underwater box are all making good progress.

**POSTER / 831**

# Axion dark matter search experiment with 18T high temperature superconducting magnet at CAPP/IBS in KAIST

**Author(s):** Jongkuk Kim[1]
**Co-author(s):** YoungJae Lee [1] ; Byeonghun Min [2] ; DongLak Kim [2] ; JinGeun Kim [2] ; Moohyun Ahn [3] ; JiYoung Lee[2] ; HeeJun

Park [2] ; JONGHEE YOO [1]

[1] *KAIST*
[2] *IBS*
[3] *Seoul National University*

**Corresponding Author(s):** djfldlshs@kaist.ac.kr, bhmin90@ibs.re.kr, yoo.jonghee@gmail.com, phjun1010@naver.com, jylee0124@ibs.re.kr, donglkim@ibs.re.kr, moohyun@gmail.com, inquirer1109@kaist.ac.kr, handbookofphysics@gmail.com

The axion is a hypothetical particle that was introduced to solve the strong CP problem. The U(1) Peccie-Quinn symmetry is spontaneously broken and dynamically produce a slowly oscillating par- ticle axion field. The axion is also a strong candidate for dark matter. In order to search for the axionic dark matter, we use a haloscope technology which is equipped with a strong solenoid mag- net and a frequency-tuned resonant cavity system. Our detector is designed to be sensitive to the axion mass range of 14.88-26.88 ueV (3.7-6.5 GHz). In this presentation, we report the CAPP18T axion dark matter search experiment setup which utilizes a 18T High Temperature Superconducting solenoid magnet, resonant cavity, dilution refrigerator and linear amplifier system.

**Dark Matter Detection / 833**

# Dark matter axion search experiments using 18T HTS magnet at CAPP/IBS in KAIST

Byeonghun Min[1] ; DongLak Kim[2] ; Jiyoung Lee[2] ; Heejun Park[2] ; Jongkuk Kim[3] ; Lee Youngjae [3] ; Ahn Moohyun [4]; Jonghee Yoo[3]

[1] *Institute for Basic Science (IBS)*
[2] *Institute for Basic Science (IBS)*
[3] *Department of Physics, Korea Advanced Institute of Science and Technology (KAIST)*
[4] *Department of Physics, Seoul National University*

**Corresponding Author(s):** yoo.jonghee@gmail.co, moohyun@gmail.com, jongkuk.kim@kaist.ac.kr, phjun1010@naver.com, bhmin90@ibs.re.kr, djfldlshs@kaist.ac.kr, donglkim@ibs.re.kr, jylee0124@ibs.re.kr

The presence of dark matter had profound consequences on the evolution of the Universe. The Standard Model does not accommodate a suitable dark matter candidate. Therefore, the existence of dark matter is a crucial phenomenological evidence for physics Beyond the Standard Model. The pressing goal of current and future dark matter experiments is to answer the question of whether dark matter interacts with normal matter other than gravity; i.e. if dark matter is detectable. Among the plethora of dark matter candidate particles, the Weakly Interacting Massive Particles (WIMPs) and the Axions are the most outstanding contender. In this talk, we will discuss about the dark matter axion search projects at the Center for Axions and Precision Physics Research at CAPP/IBS in KAIST, especially focused on the CAPP18T axion dark matter search experiment which utilizes a 18T High Temperature Superconducting solenoid magnet, resonant cavity, dilution refrigerator and linear amplifier system.

**Detector: R&D for Present and Future Facilities / 840**

# A new particle identification method with the Belle II calorimeter using pulse shape discrimination in CsI(Tl)

Savino Longo[1] ; Michael Roney[1] ; Claudia Cecchi[2] ; Torben Ferber[3] ; Andrea Fodor[4] ; Christopher Hearty[5] ; Alexan- der Kuzmin[6] ; Frank Meier[7] ; Kenkichi Miyabayashi[8] ; Isamu Nakamura[9] ; Mikhail Remnev[10] ; Vasily Shebalin[11] ; Alexei Sibidanov[1] ; Yuji Unno[12] ; Vladimir Zhulanov[13]

[1] *University of Victoria*
[2] *Universita e INFN, Perugia (IT)* [3] *University Of British Columbia* [4] *McGill University*
[5] *University of British Columbia*
[6] *Budker Institute for Nuclear Physics (INP)*
[7] *University of Sydney*
[8] *Nara Women's University*
[9] *Department of Physics*
[10] *Budker Institute of Nuclear Physics* [11] *Budker Institute of Nuclear Physics* [12] *Hanyang University*
[13] *Budker Institute of Nuclear Physics (RU)*

**Corresponding Author(s):** isamu.nakamura@kek.jp, vladimir.zhulanov@cern.ch, longos@uvic.ca, miyabaya@cc.nara-wu.ac.jp, ferber@physics.ubc.ca, mroney@uvic.ca, akuzmin@inp.nsk.su, hearty@physics.ubc.ca, frank.meier@sydney.edu.au, claudia.cecchi@cern.ch

We will present studies on the development and first implementation of a novel technique to improve particle identification at high energy physics experiments through the use of pulse shape discrimination (PSD) with CsI(Tl) scintillators used for electromagnetic calorimeters. Using $5 \times 5 \times 30$ cm$^3$ CsI(Tl) crystals, such as those used in the electromagnetic calorimeter of the Belle II experiment, we will discuss a new method 1 for characterizing and simulating the CsI(Tl) scintillation response for hadronic energy deposits developed with neutron and proton testbeam data collected at the TRIUMF Proton Irradiation Facility. By implementing the measured pulse shape differences between electromagnetic and hadronic energy depositions into GEANT4 simulations of an array of CsI(Tl) crystals, we demonstrate the potential for PSD to separate electromagnetic and hadronic showers in CsI(Tl) calorimeters. In particular we show the potential for using PSD to distinguish between calorimeter clusters originating from high energy photons and $K^0$ mesons or neutrons. In addition, progress on the implementation of PSD for the Belle II experiment's CsI(Tl) calorimeter will be outlined and initial performance results using first Belle II collision data will be reported.

**Astro-particle Physics and Cosmology / 841**

## Search for decaying dark matter with IceCube

Hrvoje Dujmovic[1]

[1] *SKKU*

**Corresponding Author(s):** hrvoje.dujmovic@gmail.com

Dark matter particles may be metastable. If they decay into neutrinos, directly or indirectly, the signal is detectable with a neutrino telescope like IceCube, located at the geographic South Pole. IceCube instruments a cubic kilometre of ice with over 5000 optical sensors which detect the Cherenkov light emitted by particles produced in neutrino interactions in the ice. This talk will present recent searches for a decaying dark matter signal. For dark matter mass above 100 TeV, lifetimes below ~10^28 s are excluded for various decay channels, providing the strongest constraints to date.

**Dark Matter Detection / 842**

## On the Calibration of the DEAP-3600 Experiment

Pietro Giampa[None]

**Corresponding Author(s):** giampapietro@gmail.com

The DEAP-3600 experiment is a single phase liquid argon (LAr) dark matter detector, capable of holding up to 3,6 tonnes of LAr. The target material is contained within an ultra-radiopure acrylic vessel 85 cm in radius. Particle interactions within the active volume are observed via 255 HQE 8 inches Hamamatsu room-

temperature PMTs, which are coupled to the detector via 50 cm long acrylic light guides (LGs). The inner detector is sealed inside a stainless steel vessel, which is immersed in a 400 meter-cube water tank that functions as a muon veto. The experiment has been operational since May 2016 and stable physics trigger data-taking has been underway since November 2016. In this talk, we will report on the full (multi-year) calibration campaign completed for the PMTs response, the energy response, and the pulse-shape discrimination, all necessary to achieve the ultimate WIMP- nucleus sensitivity.

**Neutrino Physics / 843**

## Status of NEOS

**Author(s):** Yoomin Oh[1]
**Co-author(s):** Youngju Ko [2] ; NEOS Collaboration

[1] *Institute for Basic Science*
[2] *Institute for Basic Science (IBS)*

**Corresponding Author(s):** ohyoumean@gmail.com

The NEOS experiment has successfully measured the reactor antineutrino energy spectrum at 24 m distance from Hanbit reactor unit 5 for 180 days of reactor operation and constrained the active-to-sterile oscillation parameters. An extended measurement for a whole burnup cycle by the NEOS Phase-II will be a unique probe for the dependence of the reactor antineutrino flux and spectrum on the fuel composition. Physics goal and schedule of the NEOS-II will be presented in this talk.

**POSTER / 844**

## Study on the noise temperature of Josephson Parametric Amplifier (JPA) used in the axion dark matter search experiment at CAPP/IBS in KAIST

Ji-Young Lee[1] ; Byeonghun Min[2] ; DongLak Kim[2] ; JinGeun Kim[2] ; HeeJun Park[2] ; Jongkuk Kim[3] ; YoungJae Lee[4] ; Moohyun Ahn[5] ; JONGHEE YOO[4]

[1] *Institute for Basic Science*
[2] *IBS*
[3] *Korea Advanced Institute for Science and Technology*
[4] *KAIST*
[5] *Seoul National University*

**Corresponding Author(s):** yoo.jonghee@gmail.com, djfldlshs@kaist.ac.kr, donglkim@ibs.re.kr, handbookofphysics@gmail.com, jylee0124@ibs.re.kr, moohyun@gmail.com, jongkuk.kim@kaist.ac.kr, bhmin90@ibs.re.kr, phjun1010@naver.com

In an axion dark matter search haloscope experiment, the noise temperature of a linear amplifier is a crucial component that seriously affects the sensitivity of the dark matter axion search. In the CAPP18T experiment at CAPP/IBS in KAIST, we use a cryogenically cooled Josephson Parametric Amplifier (JPA) in order to amplify weak RF signals from a resonant cavity. In this presentation, we describe a method to obtain an accurate and repeatable input noise temperature of the JPA: We use a device with a cryogenic attenuator co-located with the amplifier. A dilution refrigerator (~20mK) and a cryogenic High Electron Mobility Transistor are used for this measurement. We will also discuss the calibration techniques.

**Astro-particle Physics and Cosmology / 848**

# Highlights from the Telescope Array Experiment

IL H. PARK[1] ; on behalf of the Telescope Array collaboration[None]

[1] *Sungkyunkwan University (SKKU)*

**Corresponding Author(s):** ilpark@skku.edu

Telescope Array (TA) is the largest cosmic ray detector in the Northern hemisphere, constructed to study ultra high energy cosmic rays (UHECRs) with energies above 10^18 eV. The TA consists of an array of scintillation counters with 1200 m spacing and three fluorescence detectors, each viewing 3 to 30 degrees in elevation. The TA has also added a facility (TALE) to extend the energy threshold down to 10^15.8 eV, by addition of 10 additional fluorescence telescopes increasing the elevation angle up to 59 degrees, and an infill array of plastic scintillation counters with spacing of 400 and 600 m. The TA has accumulated a large UHECR data set which allows us to determine the energy spectrum and chemical composition of the primary particles, and search for anisotropy of UHECR arrival directions and thus sources of cosmic rays. We discuss findings with the latest data about the localized excess of events known as the TA "hotspot". The experiment and its most recent measurements - spectrum, composition, and anisotropy - will be presented.

**POSTER / 851**

# Lightweight Dark Matter search in a neutrino beam with the NOvA Near Detector

Filip Jediny[1]

[1] *Czech Technical University in Prague*

**Corresponding Author(s):** filip.jediny@gmail.com

Beyond the Standard Model ideas include lightweight (sub-GeV) Dark Matter candidates. We postulate that they could be produced within the NuMI beam at Fermilab. The NOvA neutrino experiment has recorded ~10e20 protons on target, which correspond to millions of neutrino interaction events in its low-Z, 300-ton, off-axis Near Detector. Among these neutrinos, we search, in a model agnostic way, for EM showers signatures from DM candidates scattering or decaying within the detector. We present here the techniques we use to process these events, involving sophisticated particle ID algorithms. We also discuss the progress in understanding the NOvA sensitivity to them as well as projections for the capabilities and sensitivity of the DUNE Near Detector to these models.

**POSTER / 857**

# The tunable microwave cavity for pilot axion experiment at IBS/CAPP

**Author(s):** Ohjoon Kwon[1]
**Co-author(s):** Woohyun Chung [2] ; Doyu Lee [2] ; Jinsu Kim [3] ; Danho Ahn [3]

[1] *Institute for Basic Science*
[2] *Center for Axion and Precision Physics Research, IBS*
[3] *KAIST*

**Corresponding Author(s):** kjs098@kaist.ac.kr, lion99999@kaist.ac.kr, du5698@kaist.ac.kr, o1tough@gmail.com, gnuhcw@ibs.re.kr

A Pilot experiment of CULTASK (CAPP's Ultra Low Temperature Axion Search in Korea) started to take axion data in the frequency range between 2.45~2.75GHz with a specially designed microwave cavity. The conventional design, i.e., the open cylinder with two disk shaped endcaps, creates critical reduction on quality factor (Q factor) of the cavity due to the perpendicular crossing between the discontinuity of cavity and the current flow of TM010 mode. We have fabricated the cavity by cutting the copper rod vertically and digging the inside of two halves of the cylinder. The Q factor measurements perfectly agree with the finite difference time domain (FDTD) simulation results whereas conventional horizontal cut cavities have shown near 10% degradation. We have tuned the resonant frequency of the cavity with ~ 1 kHz resolution by changing horizontal position of sapphire or copper rod which is controlled by Attocube piezoelectric actuators. The geometrical factor was more than 0.55 over all frequency range and the Q factor was more than 80,000 with copper rod and more than 100,000 with sapphire rod. I will present the details of the resonant cavity R&D and discuss the future plans.



**POSTER / 860**

## Signal Processing Methods for CAPP's Axion Data

**Author(s):** Caglar Kutlu[1]
**Co-author(s):** Woohyun Chung [2] ; Yannis Semertzidis [3] ; Jinsu Kim [1] ; Danho Ahn [1] ; Doyu Lee [1] ; Ohjoon Kwon [4]

[1] *IBS/CAPP, KAIST*
[2] *Center for Axion and Precision Physics Research, IBS*
[3] *CAPP/IBS and KAIST in South Korea*
[4] *Institute for Basic Science*

**Corresponding Author(s):** gnuhcw@ibs.re.kr, o1tough@gmail.com, semertzidis@bnl.gov, doyulee1@gmail.com

The IBS center for axion and precision physics research (CAPP) conducts haloscope axion search whose method uses a cavity resonator capable of scanning a range of frequencies using a special tuning system. The relic axions passing through the detector are converted into microwave photons inside the resonator via Primakoff effect. The converted photons are coupled to an RF transmission line from the cavity. The RF signal is transferred through the receiver chain and recorded as an averaged spectrum in a predetermined processing frequency band. This study focuses on the processing aspects of the data obtained from the pilot axion experiments at CAPP (CAPP-PACE) covering the 2.45 - 2.75 GHz frequency range. In this poster, the employed methods of data processing for maxi- mum SNR output are considered.

**POSTER / 861**

## Simulation Studies on Supernova Neutrino Detections in JUNO

Chin-Wei Wu[1] ; Kuo-Lun Jen[1] ; Guey-Lin Lin[1]

[1] *National Chiao Tung University*

**Corresponding Author(s):** gueylin.lin@gmail.com, kljen.py01g@g2.nctu.edu.tw

Supernova(SN) 1987A was the first detected neutrino burst in neutrino experiment. The Jiangmen Underground Neutrino Observatory(JUNO) is an upcoming large liquid scintillator detector experiment with an expected 3% energy resolution at 1 MeV and abundant light yield. These properties make JUNO a powerful SN neutrino detector. In this poster, we present our simulation studies on SN neutrino event selection efficiencies and purities for different detection channels involving different flavours of SN neutrinos. We demonstrate that pulse shape discrimination (PSD) technique is effective in JUNO detector for separating different SN neutrino

detection channels.

**Dark Matter Detection / 862**

## The LUX-ZEPLIN Dark-Matter Experiment

S. Douglas LEONARD[1]

[1] *CUP, IBS*

**Corresponding Author(s):** douglas.s.leonard@gmail.com

Cosmological and astrophysical evidence for the existence of dark matter in the universe and in the Milky Way itself is compelling, with weakly interacting massive particles (WIMPs) being a leading dark-matter candidate. The LUX-ZEPLIN experiment will search for nuclear recoils from dark matter particles incident on 5.6 tonnes of liquid xenon contained within the fiducial volume of a two-phase time projection chamber. The detector will operate at the Davis Cavern at 4850 ft depth at the Sanford Underground Research Facility in Lead, South Dakota. The baseline spin-independent cross-section sensitivity for 40 GeV WIMPs is 1.6 x 10^{-48} cm^2 in 1000 days of livetime. An overview and the status of the project will be presented.

**Detector: R&D for Present and Future Facilities / 863**

## Belle II iTOP Particle Identification Detector: Construction, Operation and Commissioning

Hulya Atmacan[1] ; On Behalf of the Belle II iTOP Group[None]

[1] *University of Cincinnati*

**Corresponding Author(s):** hulya.atmacan@gmail.com

The imaging Time Of Propagation (iTOP) counter is the primary Particle IDentification (PID) system in the barrel region of Belle II. It contains 16 identical modules between the tracking detectors and the calorimeter. The key elements of each module are the quartz radiator, the Micro-Channel Plate PhotoMultiplier Tubes (MCP-PMTs), and the front end readout electronics. The Cherenkov photons produced by the passage of charged particles through the quartz propagate through the quartz ra- diator. After multiple internal reflections they reach the MCP-PMTs. Multi-gigasample per second (GSa/s) waveform sampling Application Specific Integrated Circuits (ASICs) are used in readout to provide precise photon timing. Arrival times and positions of the photons are used to identify parti- cles. The construction and installation of the iTOP detector was completed successfully in 2016. The iTOP counter has been in the Phase 2 commissioning together with the other Belle II sub-detectors since February 2018. This talk presents the construction, general principles of operation, and com- missioning of the Belle II iTOP detector.

**Astro-particle Physics and Cosmology / 866**

## Leptogenesis in Cosmological Relaxation with Particle Production

Fang Ye[1] ; Tevong You[2] ; Minho Son[1]

[1] *KAIST*
[2] *University of Cambridge*

**Corresponding Author(s):** shivaandalice@gmail.com, minho.son@kaist.ac.kr, tty20@cam.ac.uk, fangye@kaist.ac.kr

Among cosmological relaxation solutions to the weak-scale hierarchy problem, gauge boson production is a particularly efficient backreaction mechanism for trapping the relaxion. In these models, scanning can even happen after inflation and the relaxion field range can be sub-Planckian, with no extremely small parameters or large e-foldings involved. We consider a model where particle production by the relaxion also reheats the universe and generates the baryonic matter-antimatter asymmetry. Out-of-equilibrium leptons scatter with the thermal bath through interactions that violate CP and lepton number via higher-dimensional operators. Such an effective field theory setup, with no new physics below the cut-off, is sufficient to achieve successful leptogenesis. The baryon asymmetry is thus intrinsically tied to a weak-scale hierarchy.

PoS(ICHEP2018)930

**Beyond the Standard Model / 870**

# Indirect detection of (Late-decoupling) Semi-Annihilating Dark Matter

**Author(s):** Andrew Spray[1]
**Co-author(s):** Yi Cai [2]

[1] *Institute for Basic Science*
[2] *The University of Melbourne*

**Corresponding Author(s):** aps37@triumf.ca, andrew.spray@coepp.org.au, aspray@unimelb.edu.au, caiyi.pku@gmail.com

Semi-annihilation describes processes with an initial state of two dark matter particles, and a final state of one plus standard model states. It is a generic feature of dark matter whenever the symmetry group enforcing stability is not a discrete $Z_2$. Semi-annihilation changes the expected signals in current dark matter searches, weakening limits from direct and collider searches, but can still be probed using cosmic ray observations. We discuss generic features of semi-annihilating searches and derive model-independent bounds using effective operators. We additionally discuss the relation between semi-annihilation and kinetic decoupling of the dark and visible sectors. The scattering processes that maintain thermal contact are related by crossing symmetry to dark matter annihilation, which can have an important effect on thermal freeze out. However, interesting parameter space remains where the indirect signals today can be significantly enhanced. We illustrate this general feature using a specific example, a dark matter explanation of the AMS positron flux.

**POSTER / 876**

# Phonon simulation of low temperature acoustic waves for rare event detector

Jin Li[1]

[1] *Institute for Basic Science*

**Corresponding Author(s):** lijin1201@gmail.com

We present a simulation to calculate heat signal spectrum from low temperature bolometer attached to a crystal. This implementation is based on the elementary acoustic wave theory at low temperature, and has been developed using modern Monte Carlo techniques by tracking individual phonon's polarization, wave, and group velocity vectors in anisotropic media. Physical processes include phonon transmission and absorption at the interface, scattering in the bulk, and reflection on the surface. The obtained time dependence of signal is compared against real experimental data to validate our simulation process. Development of this simulation can be used to understand and predict signals from low temperature rare event detector for astro-particle and neutrino physics experiments.

**POSTER / 878**

# Implosion protection and waterproof potting for the JUNO 20-inch PMTs

meihang xu[1]

[1] *IHEP*

**Corresponding Author(s):** xumh@ihep.ac.cn

The Jiangmen Underground Neutrino Observatory (JUNO), its primary goal is to determine the neutrino mass hierarchy and precisely measure the oscillation parameters by detecting reactor anti- neutrinos, is under construction. 20000 PMTs , including 5000 Hamamatsu dynode PMTs and 15000 NNVT MCP PMTs, are designed to capture photos emitting from the central detector, where the neutrinos enter and react with the liquid scintillator. To reach the physics goal of JUNO, on the one hand, the PMTs should be arranged as close as possible to achieve highest cover rate, so the PMTs should be protected to avoid suffering from chain implosion; On the other hand, the failure rate of the PMT waterproofing should be below than 0.5% for the first 6 years. Design and test of the PMT implosion and waterproof potting have been made and will be shown in this poster.

**POSTER / 879**

# The Top Tracker detector of the JUNO experiment

Joao Pedro Athayde Marcondes de Andre[1] ; Marcos Dracos[2] ; Yuri Gornushkin[3]

[1] *Michigan State University/IceCube*
[2] *Institut Pluridisciplinaire Hubert Curien (FR)*
[3] *Joint Institute for Nuclear Research (RU)*

**Corresponding Author(s):** marcos.dracos@cern.ch, yuri.gornouchkine@cern.ch, jp_cern@m4x.org

The JUNO (Jiangmen Underground Neutrino Observatory) experiment is under preparation in China. The project's main goal is to determine the neutrino mass ordering via the precise measurement of the energy spectrum of antineutrinos emitted from nuclear reactors located 53km from the JUNO detector. Data taking is expected to begin in 2021.

In order to achieve JUNO's goals, it is essential to be able to measure the reactor neutrino spectrum with an energy resolution better than 3%. It is also essential to be able to suppress or control the background processes rate, as these processes may produce events with the same signature as those from the neutrino interactions in the central detector. While there are several sources of background, the most dangerous one is the cosmogenic isotopes produced in nuclear spallation processes by atmospheric muons in the detector volume. The Veto system of the JUNO detector is designed to measure, and characterize the muon flux in the detector as well as to reduce the cosmogenic isotopes' contribution to the antineutrino spectrum. This system consists of the Top Tracker and the Water Cherenkov detector surrounding the Central Detector which is responsible for measuring the antineutrino energy spectrum. The Top Tracker consists of three layers of two-dimensional detectors made of scintillator strips and will cover about 1/3 of the surface above the Central and Water Cherenkov detectors. The role of the Top Tracker will be to detect atmospheric muons and to reconstruct precisely their trajectory in JUNO in order to study the cosmogenic background production and to supress its contribution.

This poster will discuss the JUNO detector's Top Tracker current design and expected performance.

PoS(ICHEP2018)930

**POSTER / 880**

# R&D on superconducting cavity at IBS/CAPP

**Author(s):** Danho Ahn[1]
**Co-author(s):** Ohjoon Kwon [2] ; Woohyun Chung [3] ; Dojun Youm [4] ; Wonjun Jang [5] ; Jhinhwan Lee [4] ; Doyu Lee [3] ; Jinsu KIM [6] ; Yannis Semertzidis [7]

[1] *IBS, KAIST*
[2] *Institute for Basic Science*
[3] *Center for Axion and Precision Physics Research, IBS*
[4] *KAIST*
[5] *Center for Quantum Nanoscience, IBS*
[6] *CAPP@IBS, KAIST*
[7] *CAPP/IBS and KAIST in South Korea*

**Corresponding Author(s):** jhinhwan@kaist.ac.kr, semertzidis@bnl.gov, kjs098qazzz@gmail.com, dojunyoum@kaist.ac.kr, gnuhcw@ibs.re.kr, lion99999@kaist.ac.kr, du5698@kaist.ac.kr, jwj8125@gmail.com, o1tough@gmail.com

The IBS Center for Axion and Precision Physics Research (CAPP) explores for dark matter axions with tunable resonant cavities immersed in a strong magnetic field to boost the axion-to-photon conversion when a cavity mode resonates with the axion mass. Deposition of superconducting thin films on the inner surface of the cavity increases Q factor of the cavity and thereby enhances the conversion power. However, in the presence of high magnetic fields, Type II superconductors with high critical regions (> 10 T) should be used. In this study, we present various RF characteristics related to superconducting thin films using cylindrical cavities with NbTi coated using the RF magnetron sputtering method; and with YBCO tapes on the inner surface.

**Astro-particle Physics and Cosmology / 881**

# Search for Solar atmospheric neutrinos with the IceCube Neutrino Telescope

Jin In[None] ; Carsten Rott[1]

[1] *Sungkyunkwan University*

**Corresponding Author(s):** carsten.rott@gmail.com, seongjin.in@gmail.com

Cosmic ray interactions with the solar atmosphere are expected to generate energetic neutrinos that might be observable with the neutrino telescopes. These so called solar atmospheric neutrinos are expected to have a distinguishable shape in the energy spectrum compared with atmospheric neutrinos generated in the Earth. The difference originates from the lower atmospheric density on the Sun, which allows secondary particles to decay rather than interact with the medium and lose energy. We present the first search for a signal of solar atmospheric neutrinos, using 8 years of data collected with the worlds largest neutrino telescope IceCube, which shows optimal sensitivity for the energetic neutrinos. To distinguish signal from backgrounds we perform a likelihood analysis using directional and energy spectral information. The analysis method and optimization will be introduced and sensitivities presented.

**POSTER / 882**

# NaI(Tl) crystal encapsulation with liquid scintillator

PoS(ICHEP2018)930

**Author(s):** Nam Young Kim[1]
**Co-author(s):** Gwangsoo Kim [2] ; Hong Joo Kim [2] ; Yeongduk Kim [1] ; Jooyoung Lee [2] ; Hyunsu Lee [1] ; Changhyon Ha [1]

[1] *Institute for Basic Science*
[2] *Kyungpook National University*

**Corresponding Author(s):** nykim@ibs.re.kr

Because of hygroscopic property of NaI(Tl) crystal, meticulous care should be taken when handling and encapsulating the crystal. Encapsulation with little surface radioactive background is critical in building low-background rare search experiment.
One of possible method for the background reduction is encapsulation with active veto counter, such as liquid scintillator. Alpha events from surface of NaI(Tl) crystal and gamma events from external backgrounds are tagged in the liquid scintillator and then such background events can be rejected.
In this poster, we will present the performance a of NaI(Tl) crystal detector encapsulated with liquid scintillator.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 884**

# The CLIC accelerator project status and plans

Daniel Schulte[1] ; Steinar Stapnes[1]

[1] *CERN*

**Corresponding Author(s):** steinar.stapnes@cern.ch, daniel.schulte@cern.ch

The Compact Linear Collider (CLIC) collaboration will present a project implementation plan for construction of a 380 GeV e+e- linear collider for the European Strategy update by the end of 2018. The machine is upgradable in stages to 3 TeV. The CLIC concept is based on high-gradient normal-conducting accelerating structures operating at X-band (12 GHz) frequency.
We present the CLIC accelerator concept and the current status of the project. We report on high-power tests of X-band structures using test facilities across the collaboration, as well as CLIC system verification studies and the technical development of key components of the accelerator, in many cases with the goal of reducing the energy consumption and/or cost of the machine.
We will also summarise developments for application of the X-band technology to more compact accelerators for use e.g. as X-ray FELs and in medicine. A rapidly increasing number of installations are taking the technology in use opening up co-ordinated programmes for further industrial developments in the next phase of the project.

**Strong Interactions and Hadron Physics / 885**

# Studies of HERA deep inelastic scattering data at low Q^2 and low x_Bj

Matthew Wing[1] ; Katarzyna Wichmann[2] ; Volodymyr Myronenko[3] ; Brian Foster[4] ; Amanda Sarkar[4] ; Iris Abt[5]

[1] *University College London*
[2] *Deutsches Elektronen-Synchrotron (DE)*
[3] *Deutsches Elektronen-Synchrotron*
[4] *University of Oxford (GB)*
[5] *MPI*

**Corresponding Author(s):** volodymyr.myronenko@cern.ch, katarzyna.wichmann@desy.de, amanda.cooper-sarkar@physics.ox.ac.u isa@mpp.mpg.de, b.foster1@physics.ox.ac.uk, mw@hep.ucl.ac.uk

A phenomenological study of the final combined HERA data on inclusive deep inelastic scattering (DIS) has been performed. The data are presented and investigated for a kinematic range extending from values of the four-momentum transfer, $Q^2$, above $10^4$ GeV$^2$ down to the lowest values observable at HERA of $Q^2 = 0.045$ GeV$^2$ and Bjorken $x$, $x_{\mathrm{Bj}} = 6 \times 10^{-7}$. The data are well described by fits based on perturbative quantum chromodynamics (QCD) using collinear factorisation and evolution of the parton densities encompassed in the DGLAP formalism from the highest $Q^2$ down to $Q^2$ of a few GeV$^2$. The standard DGLAP evolution was augmented by including an additional higher-twist term in the description of the longitudinal structure function, $F_{\mathrm{L}}$. This additional term, $F_{\mathrm{L}} A^{\mathrm{HT}}/Q^2$, im- proves the description of the reduced cross sections significantly. The resulting predictions for F_L suggest that further corrections are required for $Q^2$ less than about 2 GeV$^2$. The Regge formalism can describe the data up to $Q^2 \sim 0.65$ GeV$^2$. The complete data set can be described by a new fit using the ALLM parameterisation. The region between the Regge and the perturbative QCD regimes is of particular interest.



**Accelerators: Physics, Performance, and R&D for Future Facilities / 886**

# An 3-15 GeV electron beam facility at CERN for particle physics and accelerator R&D

Steinar Stapnes[1]

[1] *CERN*

**Corresponding Author(s):** steinar.stapnes@cern.ch

CERN today operates a small ~200 MeV electron test-facility for accelerator R&D (CLEAR). This facility was put into operation in 2017 and a number of R&D activities were started. The results for accelerator R&D at the CLEAR facility will be reviewed including the plans for 2018-20.
Longer term and in the framework of the Beyond Collider Physics studies at CERN at 3.5 GeV electron linac is proposed. This linac will be used at injector to the SPS where the electron beam can be accelerated to around 15 GeV. This presentation will cover the studies for the 3.5 GeV linac and re-introduction of an electron beam in the SPS.
The potential of such beams for particle physics studies (e.g. Light Dark Matter Searches) and accelerator R&D will be reviewed. The accelerator R&D possibilities cover linear collider studies, general accelerator component R&D (impedance studies, instrumentation, electron guns), novel accelerator technology and more.

**Dark Matter Detection / 888**

# Direct dark matter search with the CRESST-III experiment

Michele Mancuso[1]

[1] *Max-Planck-Institut für Physik*

**Corresponding Author(s):** mancuso@mpp.mpg.de

Detecting dark matter particles is one of the most exciting experimental challenges in modern astroparticle physics. Despite many naturally motivated theoretical models for light dark matter, a large part of the parameter space for spin-independent scattering off nuclei remains untested for dark matter particles with masses below few GeV/c^{2}. The CRESST-III experiment (Cryogenic Rare Events Search with Superconducting Thermometers), located at the underground facility Laboratori Nazionali del Gran Sasso in Italy, uses detectors designed to probe the dark matter low-mass region of the parameter space with a sensitivity never achieved before.
The CRESST-III experiment employs scintillating CaWO_{4} crystals as target material for dark matter interaction.

Each detector consists of one ~25 g CaWO_{4} crystal coupled with a smaller crystal made of Silicon-On-Sapphire for the detection of the scintillating light. Both crystals are equipped with Transition Edge Sensors (TES) and operated as cryogenic calorimeters down to temperatures of ~10 mK. The double read-out of scintillating light and total energy deposition allows an event-by-event particle identification, which is used for background suppression.
CRESST-III, whose Phase 1 started data taking in August 2016, extends further the reach of a direct search to the sub-GeV/c^{2} mass region.
In this contribution the achievements of the CRESST-III will be discussed focusing on the latest results and the perspectives of future stages of the experiment.

**POSTER / 890**

# Photo production of dijets in ultra-peripheral PbPb collisions at 5.02 TeV

Samuel Steed Boren[1] ; James Lee Smith Bowen[1] ; Daniel Tapia Takaki[2] ; Beomgon Kim[3] ; Michael Murray[1] ; Quan Wang[1] ; Yongsun Kim[4]

[1] *The University of Kansas (US)*
[2] *University of Kansas*
[3] *Korea University (KR)*
[4] *Univ. Illinois at Urbana Champaign (US)*

**Corresponding Author(s):** quan.wang@cern.ch, beomgon.kim@cern.ch, j294b619@ku.edu, yongsun.kim@cern.ch, sboren@cern.ch, daniel.tapia.takaki@cern.ch, mjmurray@ku.edu

Ultra-peripheral collisions (UPCs) of heavy ions involve long-range interactions at impact parameters larger than the sum of their radii. Therefore, the hadronic interactions are largely suppressed in UPC. Though there are no hadronic processes in UPC, the jets can be produced via some other ways, such as gamma-nucleus interactions. The study of di-jet photoproduction by gamma-nucleus interactions at high energy offer a unique opportunity to study hadron structure and low Bjorken-x gluon dynamics. This presentation shows the first observation of the photonuclear jets analyzed by CMS at the LHC. The CMS experiment has excellent capabilities for the measurements of jets and charged tracks, which are definite advantages for this analysis. The primary result of di-jet photoproduction in ultra-peripheral PbPb collisions using the data taken in 2015 will be presented.

**POSTER / 892**

# Temperature dependent study of NaI(Tl) scintillator and PMT

**Author(s):** Gwangsoo Kim[1] ; Namyoung Kim[2]
**Co-author(s):** jooyoung Lee [1] ; Hongjoo Kim [1] ; Chang Hyon Ha [3] ; Yeongduk Kim [4] ; Hyunsoo Kim [5]

[1] *Kyungpook National University*
[2] *Institute for Basic Science*
[3] *IBS*
[4] *Sejong University*
[5] *Sejong University (KR)*

**Corresponding Author(s):** hongjoo@knu.ac.kr, ydkim@sejong.ac.kr, jylee8875@gmail.com, nykim@ibs.re.kr, hyunsoo.kim@cern.ch, rhkdtn94214@gmail.com, changhyon.ha@gmail.com

The COSINE-100 experiment is searching for the direct detection of weakly interacting massive particles (WIMP) using an array of ultra-low background NaI(Tl) scintillation crystals attached with the PMTs. The next phase of

the experiment, COSINE-200, requires crystal background levels that are well below, and light yields are well above, the DAMA/LIBRA detector. Thus, the study of temperature dependent NaI(Tl) light yield and photomultiplier tube(PMT) noise are called to improve confidential level of WIMP detection. The light output of the scintillator and the PMT properties have investigated in the temperature range of -25 C to 30 C. Single photoelectron (SPE) was measured by using LED light source which is independent from the refrigerator. The results of temperature dependent properties of this detector will be presented.

**POSTER / 893**

## AMoRE-Pilot background simulation

**Author(s):** Daehoon Ha[None] ; Eunju Jeon[1] ; Young Soo Yoon[1]
**Co-author(s):** hongjoo Kim [2] ; on behalf of the AMoRE Collaboration [3]

[1] *Institute for Basic Science*
[2] *Kyungpook National University*
[3] *AMoRE Collaboration*

**Corresponding Author(s):** ysy@ibs.re.kr, hongjooknu@gmail.com, ejjeon@ibs.re.kr, dicedh2@gmail.com

The AMoRE (Advanced Mo Rare process Experiment) project is the experiment searching for neutrino-less double beta decay of $^{100}$Mo.
Monte Carlo simulation using the Geant4 toolkit was performed to understand background level of detector configuration.
Decays of radioactive isotopes such as $^{232}$Th, $^{238}$U, $^{40}$k, $^{235}$U and their daughter nuclei were simulated in six $CaMoO_4$ crystals, and in near-by detector materials.
Background spectra of crystals from the recent pilot measurements were fitted with simulation results to identify dominant background sources.
In this poster, the simulation results and fitting results will be presented.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 896**

## An Energy Recovery Linac for energy-frontier DIS at CERN: the LHeC and the FCC-eh

Nestor Armesto Perez[1]

[1] *Universidade de Santiago de Compostela (ES)*

**Corresponding Author(s):** daniel.schulte@cern.ch

Energy-frontier DIS can be realised at CERN through an energy recovery linac that would produce 60 GeV electrons to collide with the HL-LHC or later HE-LHC (LHeC) or eventually the FCC hadron beams (FCC-eh). This would create a new laboratory for energy frontier particle and nuclear physics. It provided electron-proton/nucleus collisions with centre-of-mass energies in the range 0.3-3.5 TeV per nucleon, and luminosities exceeding $10^{34}$ cm$^{-2}$s$^{-1}$ in ep scattering. Such machine would provide a huge physics programme, as the highest resolution microscope for hadron substructure, through high precision Higgs, top and precision EW physics, and with unique possibilities for BSM searches. With a high luminosity of $5\times10^{32}$ cm$^{-2}$s$^{-1}$ in ePb scattering, both LHeC and FCC-eh are unique top-energy nuclear physics facilities with eventual access to a new regime of QCD at high partonic densities. All these aspects have strong complementarities with the respective, concurrent pp and AA programmes. In this talk we review the recent accelerator and infrastructure aspects of the LHeC and FCC-eh proposals at CERN, as will be presented to the next European Strategy for Particle Physics in 2019/2020. We also review the progress on the corresponding ERL demonstrator, PERLE, under preparation to be built at LAL Orsay.

**Higgs Physics / 898**

# SM and BSM Higgs physics at the LHeC and the FCC-eh

Chen Zhang[1]

[1] *Peking, China*

**Corresponding Author(s):** larry@pku.edu.cn

Energy-frontier DIS can be realised at CERN through an energy recovery linac that would produce 60 GeV electrons to collide with the HL-LHC or later HE-LHC (LHeC) or eventually the FCC hadron beams (FCC-eh). It would deliver electron-proton collisions with centre-of-mass energies of 1.2 and 3.5 TeV, respectively, at luminosities exceeding $10^{34}$ $cm^{-2}s^{-1}$. The SM cross section for charged current (CC) Higgs production in polarised $e^-p$ scattering is 0.2 (1) pb, respectively, which offers a unique potential for high precision and novel Higgs physics. A summary will be given on the CC, as well as NC, SM decay fraction and resulting coupling measurements, and different possibilities are presented on BSM Higgs physics, both regarding exotic H decays, such as into DM, and extended Higgs theories.

**Beyond the Standard Model / 899**

# BSM physics in energy-frontier DIS with the LHeC and the FCC- eh

Nestor Armesto Perez[1] ; Daniel Britzger[2]

[1] *Universidade de Santiago de Compostela (ES)*
[2] *Ruprecht Karls Universitaet Heidelberg (DE)*

**Corresponding Author(s):** daniel.britzger@cern.ch

Energy-frontier DIS can be realised at CERN through an energy recovery linac that would produce 60 GeV electrons to collide with the HL-LHC or later HE-LHC (LHeC) or eventually the FCC hadron beams (FCC-eh). It would deliver electron-proton collisions with centre-of-mass energies in the range 1.2-3.5 TeV, and luminosities exceeding $10^{34}$ $cm^{-2}s^{-1}$. In this talk we present new studies on the possibilities that the LHeC and FCC-eh offer for BSM physics. Among other aspects, we will discuss anomalous top couplings, searches for heavy and sterile neutrinos, contact interactions, FCNC and EWK SUSY particles. We will also demonstrate how the precision PDF and QCD information from ep will empower the search potential of the associated pp facilities, LHC and FCC-hh.

**POSTER / 900**

# Measurements of internal alpha activities in the AMoRE-pilot CaMoO4 crystals

Young Soo Yoon[1] ; Yoomin Oh[1] ; Yeongduk Kim[1] ; Hyunsoo Kim[2] ; Kyungmin Seo[1]

[1] *Institute for Basic Science*
[2] *Sejong University (KR)*

**Corresponding Author(s):** ysy@ibs.re.kr, hyunsoo.kim@cern.ch, sukm2000@gmail.com, ohyoumean@gmail.com

PoS(ICHEP2018)930

AMoRE (Advanced Mo-based Rare process Experiment) is an experimental search for neutrino-less double beta decay of Mo-100. A pilot experiment, AMoRE-Pilot, has been operating with six 40Ca100MoO4 (CMO) crystals, total mass 1.9 kg, in a cryostat at the Yangyang underground laboratory (Y2L), with an overburden of 700 m. It is unavoidable that the materials of the crystals suffer from some contaminations of radioactive isotopes such as U-238, Th232, U-235, and their decay particles. They can originate from the chemical powders that were used to grow the crystals and/or may be introduced during the crystal growing and polishing procedures. From fits to the measured energy spectra for background alpha decay events, the levels of contamination from U-238, Th-232, U-235, and their decay particles can be estimated. The estimated information can be used to provide important input to the development strategies for reducing backgrounds in the future crystals. We will present preliminary results of internal alpha activity measurements in the AMoRE-Pilot crystals.



**Strong Interactions and Hadron Physics / 901**

# Parton Distributions, QCD and small-$x$ physics in energy-frontier DIS with the LHeC and the FCC-eh

Nestor Armesto Perez[1]

[1] *Universidade de Santiago de Compostela (ES)*

**Corresponding Author(s):** c.gwenlan1@physics.ox.ac.uk

Energy-frontier DIS can be realised at CERN through an energy recovery linac that would produce 60 GeV electrons to collide with the HL-LHC or later HE-LHC (LHeC) or eventually the FCC hadron beams (FCC-eh). It would deliver electron-proton collisions with centre-of-mass energies in the range 0.3-3.5 TeV, and luminosities exceeding $10^{34}$ cm$^{-2}$s$^{-1}$. In this talk we will present new studies on the prospects for the precise and complete determination of parton distributions in the proton, both inclusively and in diffractive deep inelastic scattering. We discuss electroweak physics at high scales in ep. We will then embark on the most promising way for establishing the existence of new QCD physics at small $x$, of BFKL type, through the discovery of a new regime beyond the dilute one described by fixed-order perturbation theory.

**POSTER / 903**

# AMoRE Muon Veto Counter and Event Selection

Young Soo Yoon[1] ; Yoomin Oh[1] ; Jaison Lee[2] ; Jooyoung Lee[3] ; Hongjoo Kim[3] ; Yeongduk Kim[1] ; Hyunsoo Kim[4] ; Kyungmin Seo[1]

[1] *Institute for Basic Science*
[2] *CUP/IBS*
[3] *Kyungpook National University*
[4] *Sejong University (KR)*

**Corresponding Author(s):** hyunsoo.kim@cern.ch, hongjoo@knu.ac.kr, jsahnlee@gmail.com, sukm2000@gmail.com, ysy@ibs.re.kr, ohyoumean@gmail.com

The AMoRE (Advanced Mo-based Rare process Experiment) is an experiment searching for a neutrinoless double beta decay of Mo-100. A pilot experiment, AMoRE Pilot, has been running with a total of ~1.8 kg of six 40Mo100MoO4 (CMO) crystals in a cryostat at the Yangyang underground laboratory (Y2L, 700 m overburden from the surface). The AMoRE muon veto counter covers the AMoRE cryostat with 10 plastic scintillator counters (28 PMTs). We have developed several methods to select the muon events in the muon counter and checked the coincident background signals from the crystals. We will present on how to select muons, the muon rate at the AMoRE experiment, and the background level of the crystals by the muons.

**Beyond the Standard Model / 906**

# Recent progress with Muon g-2 Experiment at Fermilab

Liang Li[1]

[1] *Shanghai Jiao Tong University*

**Corresponding Author(s):** liangliphy@sjtu.edu.cn

The muon anomalous magnetic moment can be both measured and computed with high precision, providinga sharp tool in testing the robustness of the Standard Model and searching for new physics. The previous measurement by the Brookhaven E821 experiment found a 3.6 standard deviation discrepancy from the predicted value. The new generation Muon g-2 experiment at Fermi National Laboratory has started to take physics data since early this year. The first physics result is coming soon with expected improvements in both the measurement precision and theory calculation.

**POSTER / 908**

# A study of cryogenic Li2MoO4 phonon-scintillation detectors for AMoRE-II

Hyelim Kim[1] ; Yong-Hamb Kim[2] ; HongJoo Kim[3] ; Jungho So[None] ; Moohyun LEE[4] ; Minkyu Lee[5] ; Dohyung Kwon[6] ; Inwook Kim[7] ; JinA Jeon[None] ; Hyejin Lee[6] ; Seung-Yoon Oh[None] ; Sora Kim[2] ; Hyunsuk Jo[6] ; Chang Lee[6] ; Chanseok Kang[6] ; Seuncheon Kim[6] ; Kyungrea Woo[6]

[1] *Institute for Basic Science, Kyungpook National University*
[2] *Institute for Basic Science*
[3] *Kyungpook National University*
[4] *CUP, IBS*
[5] *KRISS*
[6] *IBS*
[7] *Institute of Basic Science*

**Corresponding Author(s):** hjlee@ibs.re.kr, sora24840@gmail.com, irem1215@gmail.com, tiankim@gmail.com, hongjooknu@gmail.com, kwon8688@naver.com, sugisa1987@naver.com, tirstrike@snu.ac.kr, hyonsuk@ibs.re.kr, feynubrick@gmail.com, jhso50@gmail.com, yhk@ibs.re.kr, khl7984@gmail.com, jina8407@gmail.com, minkyu@kriss.re.kr, moohyun.lee@gmail.com, clee21@ibs.re.kr

We studied phonon and scintillation properties of $Li_2MoO_4$ crystals for the AMoRE-II (Advance Molybdenum based Rare process Experiment - phase II), an experiment aiming at detecting neutrinoless double beta decay of $^{100}Mo$. The $Li_2MoO_4$ is one of promising crystal candidates among molybdate crystals containing Mo element for a simultaneous detection of heat and light signals at mK temperatures. It is advantageous to use the crystal in terms of crystal growth and internal background control. We tested $Li_2MoO_4$ crystals in a low-temperature detection system for high resolution phonon-scintillation measurement based on a metallic magnetic calorimeter (MMC) read-out technology. We will present tests results of the $Li_2MoO_4$ crystals as target material and discuss a feasibility for the large scale experiment, AMoRE-II, with about 200 kg of molybdate crystals.

**Neutrino Physics / 911**

# Recent EXO-200 results

Michal Tarka[None]

**Corresponding Author(s):** michal.tarka@stonybrook.edu

The EXO-200 experiment consists of a time projection chamber filled with ~150 kg of liquid xenon enriched at 80.7% of the 136Xe isotope. The low background level reached within the detector made possible the detection of the two neutrinos double decay of 136Xe, set the most precise measurement of a double beta decay half life to date and provided one of the most sensitive search for the neutrinoless double beta decay. After a brief hiatus in operations, the experiment restarted data taking with upgrades to its front-end electronics and a Rn suppression system. This presentation will cover the recent results of the EXO-200 collaboration published last year,including one year of data with the upgraded detector.

**Education and Outreach / 913**

# Belle2VR – An Interactive Virtual Reality Visualization of Particle Physics

Leo Piilonen[1]

[1] *Virginia Tech*

**Corresponding Author(s):** piilonen@vt.edu

I describe a novel interactive virtual reality visualization of particle physics, designed as an educational tool for learning about and exploring the electron-positron collision events in the Belle II experiment at the SuperKEKB colliding-beam facility at KEK in Japan. The visualization is designed for untethered, locomotive virtual reality, allowing multiple simultaneous users to walk naturally through a virtual model of the Belle II detector and interact with and gather information about the particles that result from collisions. Belle2VR displays the detailed GEANT4-simulated history of each collision event superimposed on the complete detector geometry; the user can move freely through the scalable detector geometry and manipulate the history timeline with handheld controllers. Developed by an interdisciplinary team of researchers in physics, education, and virtual environments, the simulation will be integrated into the undergraduate physics curriculum at Virginia Tech. I describe the tool, including visualization features and design decisions, and outline our plans for future development.

**Neutrino Physics / 914**

# Resolving DUNE oscillation parameter ambiguities in the 3+1 sterile neutrino scenario using SBN

Davio Cianci[1] ; Georgia Karagiorgi[1] ; Yeon-Jae Jwa[2] ; mark ross-lonergan[3]

[1] *University of Manchester*
[2] *Seoul National University (KR)*
[3] *IPPP, Durham University*

**Corresponding Author(s):** davio.cianci@postgrad.manchester.ac.uk, mark.ross-lonergan@durham.ac.uk, yeon-jae.jwa@cern.ch, georgia.karagiorgi@manchester.ac.uk

There has been significant interest in the possible effect that one or more light sterile neutrinos, hinted by

several short-baseline neutrino oscillation experiments, can have on the measurement of the three-neutrino mixing parameters at the future long-baseline Deep Underground Neutrino Experiment (DUNE), with a particular focus on their effect on CP-violation measurements. By the time DUNE is operational, however, the Short-Baseline Neutrino (SBN) program at Fermilab will have performed high-precision measurements of possible light sterile neutrino oscillations, or will have provided stringent constraints to such scenarios. In this work we will present results on a joint SBN+DUNE light sterile neutrino oscillation analysis, combining both $\nu_e$ appearance and $\nu_\mu$ disappearance oscillation measurements at both long and short baselines. By utilizing a fast MonteCarlo simulation of all SBN and DUNE detectors, we estimate the effects that either a positive or a null observation at SBN could have on DUNE sensitivities.

**POSTER / 916**

## An R&D of Molybdate scintillating crystals for the AMoRE phase-II

**Author(s):** Jungho So[1]
**Co-author(s):** Chulho Lee [1] ; Daehoon Ha [2] ; Daeyeon Kim [1] ; Douglas Leonard [1] ; Eunju Jeon [1] ; Eunkyung Lee [1] ; Hongjoo Kim [2] ; Hyangkyu Park [3] ; Hyelim Kim [2] ; Jooyoung Lee [2] ; Jukyung Son [1] ; Junseok Choi [1] ; Keonah Shin [1] ; Moohyun Lee [1] ; Olga Gileva [1] ; Sejin Ra [1] ; Woongu Kang [1] ; Yeongduk Kim [1] ; Yonghamb Kim [1] ; Youngsoo Yoon [1]

[1] *Center for Underground Physics*
[2] *Kyungpook National University*
[3] *Korea University*

**Corresponding Author(s):** jhso50@gmail.com

The AMoRE (Advanced Molybdenum based Rare process Experiment) project is an experiment aiming for searching the neutrinoless double beta decay of $^{100}$Mo. The planned technique is a combination of 200 kg of X-Molybdates (~100 kg of $^{100}$Mo and X candidates are Ca, Li, Na, and Pb.) scintillating crystals as an absorber and metallic magnetic calorimeter (MMC) sensor as a heat and light signal detector at mK temperatures.
1.8 kg of $^{40}Ca^{100}MoO_4$ ($^{48}$Ca depleted, $^{100}$Mo enriched) scintillating crystals are currently installed in the AMoRE-pilot experiment and two candidate crystals, $Na_2MoO_7$ and $Li_2MoO_4$, have been being investigated for the large scale experiment with their easiness in crystal growth and internal background control.
The AMoRE phase-II with 200 kg of molybdate crystals aims to reach the range of the inverted neutrino mass hierarchy for an effective Majorana neutrino mass sensitivity of 10~30 meV which can be obtained by a zero background (~$1 \times 10^{-4}$ count/keV/kg/y in total) experiment. In order to obtain the mass sensitivity, the internal background levels of the crystal are estimated to be less than 15 $\mu$Bq/kg for $^{226}$Ra and 1.5 $\mu$Bq/kg for $^{228}$Th.
We will report the current status of the R&D of molybdate crystals for the AMoRE phase-II.

**Dark Matter Detection / 917**

## Search for Boosted Dark Matter at ProtoDUNE

Animesh Chatterjee[1] ; Albert De Roeck[2] ; Doojin Kim[2] ; Zahra Ghorbani Moghaddam[2] ; Jong-Chul Park[3] ; Seodong Shin[4] ; Leigh Howard Whitehead[2] ; Jaehoon Yu[1]

[1] *University of Texas at Arlington (US)*
[2] *CERN*
[3] *Chungnam National University*
[4] *Yonsei University/University of Chicago*

**Corresponding Author(s):** jaehoonyu@uta.edu, shinseod@indiana.edu, leigh.howard.whitehead@cern.ch, ani-

mesh.chatterjee@uta.edu, log1079@gmail.com, albert.de.roeck@cern.ch, doojin.kim@cern.ch, z.gh.moghaddam@gmail.com

We propose, for the first time, the potential of beyond the standard model opportunities at the Proto-DUNE experiment in the context of dark matter physics. We explore various experimental signatures at the cosmic frontier, arising in boosted dark matter scenarios, i.e., inelastic scattering of a relativistic dark matter particle often created by the annihilation of its heavier component which usually constitutes the dominant relic density. Although signal features are unique enough to isolate signal events from potential backgrounds, vetoing an enormous amount of cosmic background is rather challenging as the detectors are located on the ground. Nevertheless, we argue, with a careful estimate, that such backgrounds can be well under control via performing dedicated analyses after data acquisition. We then discuss some phenomenological studies which can be achieved with the Proto-DUNE detectors, employing a dark photon scenario as our benchmark dark-sector model.



**Education and Outreach / 921**

# 8 Hours of the NicoNico live webcast from the Belle II experimental hall

Shota Takahashi[1]

[1] *KEK*

**Corresponding Author(s):** shotakah@post.kek.jp

Phase 2 of the Belle II experiment is about to begin. A new super-B factory facility, utilizing the SuperKEKB accelerator and the Belle II detector, is designed to search for as yet unknown "New Physics".
The outreach teams of KEK and the Belle II collaboration worked together for more than a year to make the Belle II/SuperKEKB project better known in Japan as well as in the world.
Significant milestones in our roadmap are:
(1) the start of Phase 1 in Feb. 2016 and first turns in the SuperKEKB accelerator,
(2) "the Belle II roll-in", integration of the detector and the accelerator in Apr. 2017, and
(3) Phase2 and first collisions in the coming months,
the list will go on as the project develops towards its design luminosity.
In this talk, we will focus on "the Belle II roll-in" .
We cooperated with the "Niconico" livestreaming service in Japan and live-casted the roll-in event from the Belle II experimental hall for over 8 hours.
We would like to share know-how on how we collaborated, how we risk-hedged , and how impressive it was, and exchange opinions with other institutions who have tried livecasting important events.

**Beyond the Standard Model / 925**

# (In)dependence of various LFV observables in the non-minimal SUSY

Hyejung Stoeckinger-Kim[1] ; Dominik Stoeckinger[1] ; Wojciech Kotlarski[1] ; Jae-hyeon Park[2]

[1] *TU - Dresden*
[2] *KIAS*

**Corresponding Author(s):** dominik.stoeckinger@tu-dresden.de, jhpark@kias.re.kr, wojciech.kotlarski@tu-dresden.de, hyejung.stoeckinger-kim@tu-dresden.de

We investigate the muon anomalous magnetic moment, the $\mu \to e\gamma$ branching ratio and the $\mu \to e$ conversion

rate in the nuclei from the point of view of the planned $\mu \to e$ conversion experi- ments. In the MSSM these processes are strongly correlated through $\tan\beta$ enhanced contributions. We demonstrate how in the Minimal R-symmetric Supersymmetric Standard Model the $\mu \to e\gamma$ branch- ing ratio and the $\mu \to e$ conversion rate in the nuclei give distinct bounds on the parameter space. We also consider the supersymmetric contributions to the muon anomalous magnetic moment, gen- erated by a subset of topologies contributing to the LFV observables. We briefly discuss the generic implementation of the aforementioned observables into the FlexibleSUSY spectrum-generator gen- erator. Looking at the current $\mu \to e\gamma$ searches, the analysis points to the need of constructing a dedicated $\mu \to e$ conversion experiment to cover as large parameter space as possible in the non-minimal supersymmetric models.



**Neutrino Physics / 926**

# Measuring Neutrino Oscillations with KM3NeT/ORCA

Marco Circella[1]

[1] *INFN Bari*

**Corresponding Author(s):** marco.circella@ba.infn.it

ORCA is the low-energy detector of KM3NeT, the next generation underwater Cherenkov neutrino observatory in the Mediterranean Sea. With ORCA, the primary goal is to resolve the long-standing unsolved question of whether the neutrino mass ordering is normal or inverted, by measuring matter oscillation effects with atmospheric neutrinos. The ORCA design foresees a dense configuration of KM3NeT detection units, optimised for studying the interactions of neutrinos in seawater at energies < 100 GeV. The detector will be deployed at the French KM3NeT site, at 2500 m depth ~40 km offshore Toulon. The excellent optical properties of deep seawater will be exploited by the ORCA's multi-PMT optical modules to accurately reconstruct both cascade events (mostly induced by electron neutrinos) and track events (mostly from muon neutrinos). The construction of the detector has started. In this contribution we will report on the progress of the construction plan and will discuss the potentialities of the ORCA detector both in neutrino mass hierarchy studies and in obtaining new constraints on other key oscillation parameters.

**Higgs Physics / 927**

# Global constraints on the dimension-6 Standard Model Effective Field Theory

Jorge de Blas[1] ; Marco Ciuchini[2] ; Enrico Franco[3] ; Satoshi Mishima[4] ; Maurizio Pierini[5] ; Laura Reina[6] ; Luca Silvestrini[7] ; Otto Eberhardt[8]

[1] *INFN-Padova*
[2] *INFN*
[3] *INFN (Istituto Nazionale Fisica Nucleare)*
[4] *KEK*
[5] *CERN*
[6] *Florida State University (US)*
[7] *INFN Rome*
[8] *Istituto Nazionale di Fisica Nucleare*

**Corresponding Author(s):** otto.eberhardt@roma1.infn.it, enrico.franco@roma1.infn.it, jorge.deblasmateo@pd.infn.it, maurizio.pierini@cern.ch, reina@hep.fsu.edu, marco.ciuchini@roma3.infn.it, satoshi.mishima@kek.jp, luca.silvestrini@roma1.infn.it

We derive global constraints on new physics within the framework of the dimension-6 Standard Model

Effective Field Theory. Our results include the latest theoretical and experimental updates on the electroweak precision observables, as well as the latest Higgs results from the LHC run 2. We also include in the combination the limits from diboson measurements. The results are presented as limits on the Wilson coefficients of the dimension-6 interactions, discussing the complementarities between the different types of observables. All the results have been obtained using the HEPfit code.

**Computing and Data Handling / 928**

## HEPfit: The Analysis Toolkit

HEPfit Collaboration[None] ; Ayan Paul[1] ; Otto Eberhardt[2]

[1] *INFN, Sezione di Roma*
[2] *Istituto Nazionale di Fisica Nucleare*

**Corresponding Author(s):** otto.eberhardt@roma1.infn.it, apaul2@alumni.nd.edu

HEPfit is a computational tool for the combination of indirect and direct constraints on High Energy Physics models. The code is built in a modular structure so that one can select observables and models of interest. It can be used to build customized models and customized observables. It has a statistical framework based on Markov Chain Monte Carlo (MCMC) driven Bayesian analysis. However, any statistical framework can be used as an option. The goal of HEPfit is to implement electroweak, Higgs and flavour physics observables to the highest degree of precision with minimum theoretical assumptions built in. This has been done in the Standard Model and in several models beyond the Standard Model, such as MSSM, THDM, L-R symmetric models, and several EFTs. Since the statistical treatment in HEPfit is based on MCMC, optimized computational time is of utmost importance, HEPfit is massively parallelized to run over a large number of CPUs using openMPI.

**Detector: R&D for Present and Future Facilities / 934**

## Characterization of the 20-inch Photomultiplier Tubes for the JUNO Central Detector

Wei Wang[1]

[1] *Sun Yat-Sen University*

**Corresponding Author(s):** wenlj@ihep.ac.cn

The primary physics goal of the Jiangmen Underground Neutrino Observatory (JUNO) is to resolve neutrino mass hierarchy, taking the advantage of the copious antineutrinos from two powerful nuclear power plants at distances of ~53 km in Guangdong Province, China. To meet this goal, JUNO has designed a 20 kt underground liquid scintillator (LS) detector which deploys 20,000 high quantum efficiency (HQE) photomultiplier tubes(PMTs) to reach an energy resolution of $3\%/\sqrt{(E/MeV)}$ and an energy scale uncertainty better than 1%. Such performance numbers on such a massive LS detector are unprecedented, which places stringent requirements on the two types of the 20-in PMTs used by JUNO, the Hamamatsu HQE PMT and the newly developed micro-channel plate (MCP) PMT. To select qualified PMTs and to supply the detector simulation with precise PMT performance data, we have developed two PMT characterization systems, an industrial container-based mass PMT testing system and a PMT photocathode uniformity scanning station. This talk will explain the requirements on the two types of JUNO PMTs in connection to its physical goals, the technical designs of the two PMT evaluation systems, the PMT testing strategy and the preliminary JUNO 20-inch PMT characterization results.

PoS(ICHEP2018)930

**Detector: R&D for Present and Future Facilities / 937**

# Status of the PTOLEMY project for CNB detection and directional direct detection of MeV dark matter

Chris Tully[1] ; Alfredo Cocco[2] ; Marcello Messina[3]

[1] *Princeton University (US)*
[2] *Universita e sezione INFN di Napoli (IT)*
[3] *Universitaet Bern (CH)*

**Corresponding Author(s):** alfredo.cocco@cern.ch, marcello.messina@cern.ch, chris.tully@cern.ch

The PTOLEMY project aims to develop a scalable design for a Cosmic Neutrino Telescope, the first of its kind and the only telescope conceived that can look directly at the image encoded in neutrino density fluctuations of the Universe in the first second after the Big Bang. The past two years of developments have established a compelling case to proceed to telescope design. The cryogenic calorimeters aim to reach 0.05eV energy resolution, an order of magnitude beyond the original target and the highest resolution of any calorimeter. The graphene substrate is stable under 40% loading fraction of hydrogen, the highest on record. The Simons prototype at Princeton has become the basis of a new world-wide collaboration consisting of seven countries (Netherlands, Spain, Sweden, Israel, Italy, UAE, USA) and 29 institutions. The scope of work for the next three years is to complete the design of the Cosmic Neutrino Telescope and to to validate with direct measurement that the non-neutrino backgrounds are below the expected signal from the Big Bang by extrapolating broad backgrounds that span over keV into the 0.1eV window of the signal under the operation of a newly designed high stability HV system with MAC-E filter and TES calorimeter. A proposal to install the PTOLEMY prototype at the LNGS is currently under review. By implementing high radio-pure carbon-12 graphene, we will exploit a concurrent program in directional MeV dark matter searches with 2D targets and CNTs. The number and deployment of CNB telescopes around the world will depend on the next phase of PTOLEMY developments.

**Detector: R&D for Present and Future Facilities / 941**

# Prototype Production of Large Area Picosecond Photodetectors

Michael Minot[1] ; Bernhard Adams[2] ; Melvin Aviles[1] ; Justin Bond[2] ; Till Cremer[2] ; Michael Foley[2] ; Alexey Lyashenko[1] ; Mark Popecki[2] ; Michael Stochaj[2] ; William Worstell[2] ; Jeffrey Elam[3] ; Anil Mane[None] ; Oswald Siegmund[4] ; Camden Ertley[5] ; Henry Frisch[6] ; Andrey Elagin[7]

[1] *Incom Inc.*
[2] *Incom Inc.*
[3] *Argonne National Laboratory*
[4] *University of California, Berkeley*
[5] *UC Berkeley, SSL*
[6] *university of Chicago*
[7] *University of Chicago*

**Corresponding Author(s):** mjm@incomusa.com, amane@anl.gov, mes@incomusa.com, ossy@ssl.berkeley.edu, frisch@hep.uchicago.edu, elagin@hep.uchicago.edu, camden.ertley@ssl.berkeley.edu, map@incomusa.com, mrf@incomusa.com, alyashenko@incomusa.com, jelam@anl.gov, badams@incomusa.com, jlb@incomusa.com, maviles@incomusa.com, bworstell@incomusa.com, tcremer@incomusa.com

We report prototype production results achieved for fully functional sealed Large Area Picosecond Photodetectors (LAPPD™). The LAPPD™ is a microchannel plate (MCP) based photodetector, capable of imaging with single-photon sensitivity at high spatial and temporal resolutions in a hermetic package with an active area of 400 square centimeters. In December 2015, Incom Inc. completed installation of equipment and facilities for demonstration of early stage pilot production of LAPPD™. Initial fabrication trials commenced in

PoS(ICHEP2018)930

January 2016. The "baseline" LAPPD™ employs an all-glass hermetic package with top and bottom plates and sidewalls made of borosilicate float glass. Signals are generated by a bi-alkali Na2KSb photocathode, amplified with a stacked chevron pair of "next generation" MCPs produced by applying resistive and emissive atomic layer deposition coatings to glass capillary array (GCA) substrates. Signals are collected on RF strip-line anodes applied to the bottom plates which exit the detector via pin-free hermetic seals under the side walls. Fully functional, sealed LAPPD™s tested to date have shown electron gains > 7.5 x10^6 @ 850/950 V (entry/exit), low dark rates (9.5 Cts/s cm^2 ), space resolution along strips of 2.9 mm RMS for single photoelectrons, cross strip spatial resolutions of 1.6 mm RMS, and along-strip time difference resolutions of 33.4 psec RMS. Many of these devices also had very high QE photocathodes that were uniform over the full 8"X8" window area (#15 QE% @ 365nm Max/Avg/Min = 25.8/22.3±3/15.7). LAPPD™ performance results and test methods for product produced and delivered to early adopter customers during the first half of 2018 will be reviewed. In addition, recent advances in the development of LAPPD™ will also be reviewed as the baseline design is adapted to meet the requirements for a wide range of emerging applications including DOE-supported R&D for the Deep Underground Neutrino Experiment (DUNE), nuclear physics applications such as EIC, homeland security, medical imaging applications including for proton therapy and astronomical applications for direct and indirect photon detection.



**POSTER / 947**

# The Minkowskian dynamics of hadrons

Jorge Henrique Alvarenga Nogueira[1] ; Emanuel Ydrefors[2] ; Tobias Frederico[2] ; Giovanni Salmè[3] ; Wayne de Paula[2]

[1] *Instituto Tecnológico de Aeronáutica & 'La Sapienza' Università di Roma & INFN, Sezione di Roma*
[2] *Instituto Tecnologico de Aeronautica*
[3] *Istituto Nazionale di Fisica Nucleare, Sezione di Roma, Piazzale Moro 2, I-00185 Roma, Italy*

**Corresponding Author(s):** giovanni.salme@roma1.infn.it, wayne@ita.br, e.ydrefors@gmail.com, tobias@ita.br, dealvare@roma1.infn.it

The advent of approaches based on the Euclidean space for studying hadron observables, as e.g. by lattice QCD and Schwinger-Dyson equations, has been remarkable and responsible to produce important understanding on non-perturbative physical systems.
However, the quantum field theory formulation in Minkowski space has subtle essential signatures as, for instance, related with spin degrees of freedom, that requires deep understanding by a theoretical framework developed in that space. One important example is the Fock space expansion, which allows one to construct a probabilistic description of the hadron and to explore purely relativistic effects on the dynamics as, for example, through the EM form factors 1.
In recent years, studies based on actual solutions of the homogeneous Bethe-Salpeter equation directly in Minkowski space are becoming available. This makes feasible to start phenomenological investigations of the hadron structure, shedding light on the intrinsic dynamics that is formally and conceptually connected with the physical space, i.e. the Minkowski one [2,3].
Obtaining information on the internal dynamics of the hadrons relies on achieving realistic Bethe-Salpeter amplitudes, making it a necessary step for the calculation of observables. The new framework for solving the Bethe-Salpeter equation has a main ingredient given by the the so-called Nakanishi Integral Representation of the Bethe-Salpeter amplitude, that allows to compute the amplitude for the bound state fully in Minkowski space.
In order to illustrate the phenomenological potential of the approach based on the aforementioned framework, we explore the dynamical observables of the recently observed doubly charmed baryon$_{cc}$ [4], by means of a quark-diquark bound state model. By taking the constituents and exchanged-boson masses from lattice calculations, the predicted momentum distributions are shown.
The possibility of understanding the dynamical features also of other possible baryons composed by two-heavy and one-light quarks within the model is another exciting prospect.
The Minkowskian framework is also developed for a quark-antiquark bound state, which is applied for a mock pion. The peculiar features related to the spin degrees of freedom are shown through its Bethe-Salpeter amplitude. That enables the calculation of the EM form factor, the parton distribution functions (PDFs) and transverse amplitudes for the pion, where the comparison with the available data is feasible.

[1] V. Gigante, J. H. Alvarenga Nogueira, E. Ydrefors, C. Gutierrez, V. A. Karmanov and T. Frederico, Phys. Rev. D 95, 056012 (2017).
[2] J. H. Alvarenga Nogueira, Chueng-Ryong Ji, E. Ydrefors and T. Frederico, Phys. Lett. B 777, 207-211,(2018).
[3] W. de Paula, T. Frederico, G. Salmè, M. Viviani, R. Pimentel,
%Fermionic bound states in Minkowski space: light-cone singularities and structure, Eur. Phys. J. C 77, 764 (2017)
[4] R. Aaij et al. (LHCb Collaboration), Phys. Rev. Lett. 119, 112001 (2017).

**Neutrino Physics / 955**

## New results from GERDA Phase II

Matteo Agostini[1]

[1] *Technical University Munich*

**Corresponding Author(s):** matteo.agostini@ph.tum.de

GERDA is performing a background-free search for neutrinoless double-beta decay of Ge-76. An observation of this nuclear transition would unambiguously prove that neutrinos are Majorana particles and that the lepton number is violated. Thanks to a factor two increase in statistics, the experimental sensitivity doubled compared to the last data release making GERDA the first experiment exploring neutrinoless double beta decay half-lives at the order of 1e26 years. First results and prospects of this pioneering exploration will be presented.

**POSTER / 957**

## Snowball Chamber: A Super-cooled Approach to Dark Matter Detection

Corwin Knight[1]

[1] *SUNY Albany*

**Corresponding Author(s):** knight.corwin@gmail.com

As higher mass particles are eliminated as possibilities in the search for dark matter, it is important to explore new types of detectors that are more specialized at looking for lower mass particles. For this purpose, I've been exploring super-cooled water as a target material for future detectors. This talk will go over the motivations for a detector of this type, the evidence that has been collected—including the first evidence of radiation induced nucleation of super cooled water, and additional applications beyond searching for dark matter.

**POSTER / 959**

## Search for black holes and sphalerons in high-multiplicity final states in proton-proton collisions at sqrt(s) = 13 TeV with CMS

Arnd Meyer[1]

[1] *Rheinisch Westfaelische Tech. Hoch. (DE)*

**Corresponding Author(s):** ed.scott@cern.ch

A search for new-physics signals resulting in energetic, high-multiplicity final states, such as black holes, string balls, and electroweak sphalerons, is presented using a data sample corresponding to an integrated luminosity of 35.9 $fb^{-1}$ collected with the CMS experiment at the LHC in proton-proton collisions at a center-of-mass energy of 13 TeV in 2016. Standard model backgrounds, dominated by multijet production, were determined from control regions in data. No excesses characteristic of new-physics signals resulting in such final states were observed. Model-independent 95% confidence level upper limits on the cross section of new-physics signals in these final states are set and further interpreted in terms of limits on semiclassical black hole, string ball, and sphaleron production.



**POSTER / 960**

# Fast Calorimeter Simulation in ATLAS

ATLAS Collaboration[None] ; Stefan Gadatsch[1]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** stefan.gadatsch@cern.ch

Successful physics and performance studies of the ATLAS detector at the Large Hadron Collider rely on a large number of simulated events. The production of these simulated events with the precise detector description using GEANT4 is highly CPU intensive. With the large collision dataset expected to be collected by the ATLAS detector, the development of a simulation tool to reduce CPU requirements is imperative. During the LHC Run-1, a fast calorimeter simulation (FastCaloSim) was successfully used by ATLAS. FastCaloSim utilizes a parametrization of the energy response of particles at the calorimeter read-out cell level, taking into account the lateral shower profile and the correlation of the energy deposition among various calorimeter layers. The tool is interfaced to AT- LAS digitization and reconstruction software and provides a calorimeter simulation approximately 500 times faster than GEANT4. An improved version of FastCaloSim is currently under development to further optimize the CPU and memory requirements and to improve the physics description. The new FastCaloSim implements machine learning techniques, such as principal component analysis and neural networks to optimize the amount of information stored in the ATLAS simulation infrastructure. These techniques improve the physics modeling and enhance the performance by reducing the I/O time and the memory usage during simulation. In this talk, the new FastCaloSim parameterization will be described, its performance will be quantified and its physics applications discussed.

**Astro-particle Physics and Cosmology / 963**

# Cosmic Ray Energetics And Mass (CREAM) Launch and On-Orbit Performance

Eun Suk Seo[1]

[1] *University of Maryland (US)*

**Corresponding Author(s):** eun.suk.seo@cern.ch

The CREAM experiment was launched on a SpaceX Falcon 9 rocket to the International Space Station (ISS) from NASA's Kennedy Space Center on August 14, 2017. The instrument was successfully installed and activated on the ISS Japanese Experiment Module Exposed Facility as an attached payload on August 22, 2017. The CREAM instrument was initially developed to measure cosmic ray elemental spectra using a series of ultra-long-duration balloon flights. The balloon-borne CREAM experiment was flown seven times (12/15/04 - 12/28/16) over Antarctica accumulating ~191 days of flight time, the longest known exposure for a single

balloon project. Building on the success of the balloon flights, the payload was transformed for accommodation on the ISS. This version of CREAM, aka ISS-CREAM, is configured with redundant and complementary particle detectors capable of precise measurements of elemental spectra for Z = 1 - 26 nuclei, as well as electrons. The four layers of its finely segmented Silicon Charge Detector provide precise charge measurements, and its ionization calorimeter provides energy measurements. In addition, scintillator-based Top and Bottom Counting Detectors and Boronated Scintillator Detector distinguish electrons from nuclei. At least an order of magnitude increase in data collecting power is expected by utilizing the ISS to reach the highest energies practical with direct measurements. On-orbit performance of the instrument and preliminary results from the ongoing analysis will be presented.

**Dark Matter Detection / 966**

# Darkside latest results and future prospects

Alfredo Cocco[1]

[1] *INFN/Na*

**Corresponding Author(s):** alfredo.cocco@cern.ch, alfredo.cocco@na.infn.it

DarkSide uses a dual-phase Liquid Argon Time Projection Chamber to search for WIMP dark matter. The talk will present the latest result on the search for low mass ($M_{\mathrm{WIMP}} < 20\,GeV/c^2$) and high mass ($M_{\mathrm{WIMP}} > 100\,GeV/c^2$) WIMPs from the current experiment, DarkSide-50, running since mid 2015 a 50-kg-active-mass TPC, filled with argon from an underground source. The next stage of the Darkside program will be a new generation experiment involving a global collaboration from all the current Argon based experiments. DarkSide-20k, based on a >20-tonne fiducial mass TPC with SiPM based photosensors, is designed to have a background well below that from coherent scattering of solar and atmospheric neutrinos. Like its predecessor DarkSide-20k will be housed at the Gran Sasso (LNGS) underground laboratory, and it is expected to attain a WIMP-nucleon cross section exclusion sensitivity of $10^{-47}$ cm$^2$ for a WIMP mass of 1TeV/$c^2$ in a 5 yr run.

**Neutrino Physics / 967**

# Progress on the IsoDAR Antielectron Neutrino Experiment

Alejandro Diaz[1]

[1] *Massachusetts Institute of Technology*

**Corresponding Author(s):** diaza@mit.edu

IsoDAR is a compact, accelerator-based source for anti-electron neutrinos produced through $^8$Li decay. When paired with a large scintillator-based detector, IsoDAR allows for a high-precision investigation of the reactor and source-based neutrino oscillation anomalies. This talk will discuss this physics, as well as other beyond Standard Model precision measurements that can be performed. We will also briefly review recent technical developments on the source.

**Dark Matter Detection / 969**

# The DarkSide-20k Experiment and the future of Dark Matter Liquid Argon Program

Pietro Giampa[None]

**Corresponding Author(s):** giampapietro@gmail.com

DarkSide-20k is a proposed 20 tonne fiducial mass liquid argon TPC that will perform an instrumental background-free search for WIMP dark matter. The TPC will be outfitted with more than 100,000 specifically designed silicon photomultipliers (SiPM) grouped into several thousands single-channel, 25 $cm^2$ photosensors that are sensitive to single photoelectrons. We will present the recently achieved performances of the photosensor and associated low-noise electronics at liquid argon temperature and discuss the strategy for the mass production for DarkSide-20k.

**Top Quark and Electroweak Physics / 970**

# Electroweak Physics at FCC-ee

Tadeusz Lesiak[1]

[1] *Polish Academy of Sciences (PL)*

**Corresponding Author(s):** tadeusz.lesiak@cern.ch

The Future Circular Collider with electron-positron beams (FCC-ee) should provide improvements of the electroweak precision measurement concerning Z, W, H and their masses by a large factor over the present status.
The unparalleled experimental precision would open, via Electroweak loop corrections, a broad discovery potential for new, at least weakly interacting particles up to high energy scales.
The Z boson mass and width, as well as the Z → bb partial width, and the forward-backward asymmetries for leptons and quarks can be measured with high precision with the run at the Z pole, where the instantaneous luminosity is expected to be five to six orders of magnitude larger than LEP. As a result, a precise determination of the effective weak mixing angle, as well as of the running electro-magnetic coupling αQED(mZ2) can be extracted directly from the data.
At centre-of-mass energies around 160 GeV, corresponding to the WW production threshold, the W boson mass and width can be determined precisely with high-statistics cross section measurements at several energy points. The key breakthrough for this exceptional performance is the continuous beam energy determination by resonant depolarization of the beams. Considerable improvements of the strong coupling constant determination down to a precision of Δαs(mZ) ±0.0001 will be possible with the measurements of the hadronic widths of the Z and W bosons.

**Strong Interactions and Hadron Physics / 973**

# QCD and gamma-gamma Physics at FCC-ee

Alain Blondel[1]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** alain.blondel@cern.ch

e+e- collisions at a Future Circular Collider with tens of ab^-1 integrated luminosities provide un-paralleled conditions to carry out unique high-precision QCD and two-photon-fusion studies. The QCD and gamma-gamma physics perspectives at the FCC-ee will be summarized focusing on high-accuracy measurements of 1) the QCD coupling alpha_s 1, 2) parton radiation and fragmentation 2, and 3) SM and BSM studies in photon-photon collisions [3].
[1] http://arxiv.org/abs/arXiv:1512.05194

[2] http://arxiv.org/abs/arXiv:1702.01329
[3] http://arxiv.org/abs/arXiv:1510.08141

**Accelerators: Physics, Performance, and R&D for Future Facilities / 976**

# Physics at the FCC: a story of synergy and complementarit

Alain Blondel[1]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** alain.blondel@cern.ch

CERN has launched in 2014 the design study of Future Circular Colliders, including a High Luminosity e+e- collider (FCC-ee) running from the Z pole to above the top pair production threshold. Follow a 100 TeV pp and heavy ion collider (FCC-hh) able to reach an unprecedented energy scale and possibly an e-p collider. The FCC-ee offers a broad discovery potential based on a combination of precision Electroweak Measurements, high statistics quark and lepton flavour physics, searches for rare phenomena and new particles, and Higgs model-independent coupling measurements. The FCC-hh can observe the production new particles with Standard Model couplings up to ~30 TeV, but is also an extremely abundant factory for W, Z top and Higgs, allowing searches for rare phenomena and a number of precision measurements including those of the triple Higgs and ttH couplings. The ep option would offer unprecedented reach in structure functions and high statistics of Higgs production. The synergy and complementarity of the FCC machines making the FCC complex a compelling option for the future of Collider Physics.

**Neutrino Physics / 977**

# Right-Handed neutrino searches at the FCC

Alain Blondel[1]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** alain.blondel@cern.ch

CERN has launched in 2014 the design study of Future Circular Colliders, including a High Luminosity e+e- collider (FCC-ee) running from the Z pole to above the top pair production threshold. Follow a 100 TeV pp and heavy ion collider (FCC-hh) able to reach an unprecedented energy scale and an e-p collider option. The FCC-ee offers a broad discovery potential based on a combination of precision Electroweak Measurements, high statistics quark and lepton flavour physics, searches for rare phenomena and new particles, and Higgs model-independent coupling measurements. The FCC-hh can observe the production new particles with Standard Model couplings up to ~30 TeV, but is also an extremely abundant factory for W, Z top and Higgs, allowing searches for rare phenomena and a number of precision measurements including those of the triple Higgs and ttH couplings. The ep option would offer unprecedented reach in structure functions and high statistics of Higgs production.
The complementarity of the FCC machines can be illustrated in a spectacular way for particular example of heavy neutral leptons (Right Handed neutrinos), which constitute today one of the most compelling extensions of the Standard Model, if their masses are around the Electroweak scale. While the FCC-ee offers the largest discovery domain by either the very clean observation of long lived particles in Z→ νN decays, or by a typical pattern of deviations in a series of precision observables, the FCC-hh (or ep) could detect them in W→l N (or e→ N Charged current transition) followed by the semileptonic decay of the Heavy Neutral lepton, thus able to observe possible change of lepton flavour or even leptonic number.

PoS(ICHEP2018)930

**Beyond the Standard Model / 982**

# Search for a Long-Lived Heavy Photon with the Heavy Photon Search Experiment

Matthew Solt[1]

[1] *SLAC National Accelerator Laboratory*

**Corresponding Author(s):** mrsolt@slac.stanford.edu

The Heavy Photon Search experiment (HPS) at Jefferson Lab seeks to discover evidence for a new dark-force mediator. A new U(1) vector boson could couple to the Standard Model photon through kinetic mixing and could be produced by an electron beam in a dense target in a process similar to bremsstrahlung. Subsequent decays into e+e- pairs, if kinematically allowed, would enable discovery either as a resonance peak on a large Standard Model continuum distribution or as vertices displaced from the target. Small couplings would lead to longer decay times, but also reduced cross sections, requiring high currents (to produce any signal) and large detector acceptance, especially close to the beam (to capture the boosted decay products). The HPS detector is a compact, large acceptance, forward spectrometer consisting of a silicon vertex tracker and lead-tungstate electro- magnetic calorimeter. Installed at the Jefferson Lab electron beam facility, it conducted successful engineering runs in the spring of 2015 using a 1.056 GeV, 50 nA beam, and in 2016 using a 2.3 GeV, 200 nA beam. In this talk we will discuss the motivation for this heavy photon search, the detector and its performance during these two engineering runs, as well as present details of the displaced vertex analysis and prospects for discovery in the upcoming physics runs. A separate talk at this conference will present details of a complementary analysis searching for peaks in the invariant mass spectrum of the final-state electron-positron pairs

**Beyond the Standard Model / 985**

# The Light Dark Matter eXperiment

Omar Moreno[1]

[1] *SLAC National Accelerator Laboratory*

**Corresponding Author(s):** omoreno@slac.stanford.edu

The Light Dark Matter eXperiment (LDMX) proposes a high-statistics search for low-mass dark matter in fixed-target electron-nucleus collisions. Ultimately, LDMX will explore thermal relic dark matter over most of the viable sub-GeV mass range to a decisive level of sensitivity. To achieve this goal, LDMX employs the missing momentum technique, where electrons scattering in a thin target can produce dark matter via "dark bremsstrahlung" giving rise to significant missing momentum and energy in the detector. To identify these rare signal events, LDMX individually tags incoming beam-energy electrons, unambiguously associates them with low energy, moderate transverse-momentum recoils of the incoming electron, and establishes the absence of any additional forward-recoiling charged particles or neutral hadrons. LDMX will employ low mass tracking to tag incoming beam-energy electrons with high purity and cleanly reconstruct recoils. A high-speed, granular calorimeter with MIP sensitivity is used to reject the high rate of bremsstrahlung background at trigger level while working in tandem with a hadronic calorimeter to veto rare photonuclear reactions. This talk will summarize the small-scale detector concept for LDMX, ongoing performance studies, and near future prospects.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 991**

PoS(ICHEP2018)930

# Status of the Fermilab Muon g-2 experiment

Selcuk Haciomeroglu[1]

[1] *CAPP/IBS*

**Corresponding Author(s):** selcuk.haciomeroglu@gmail.com

Previous Muon g-2 experiment at BNL measured the anomalous magnetic moment of muon which is $\approx 3\sigma$ away from the Standard Model value. The Fermilab Muon g-2 Collaboration started commissioning runs with an upgraded version of the storage ring. In the first phase, the new experiment aims 4 times more sensitivity thanks to several improvements including muons statistics, pileup reduction, gain changes, lost muons and coherent betatron oscillations. A physics run with significant statistics is expected to take place in 2018.

**Strong Interactions and Hadron Physics / 996**

# Deeply Virtual Compton Scattering at Jefferson Lab

Carlos MUNOZ CAMACHO[1]

[1] *CNRS*

**Corresponding Author(s):** munoz@ipno.in2p3.fr

Exclusive processes at high momentum transfer, such as Deeply Virtual Compton Scattering (DVCS) access the Generalized Parton Distributions (GPDs) of the nucleon. GPDs offer the exciting possibility of mapping the 3-D internal structure of protons and neutrons by providing a transverse image of the constituents as a function of their longitudinal momentum.
A vigorous experimental program is currently pursued at Jefferson Lab (JLab) to study GPDs through DVCS and meson production. New results from Hall A will be shown and discussed. Special attention will be devoted to the applicability of the GPD formalism at the moderate values of momentum transfer. In addition, we will report on results for L/T separated pi0 electroproduction cross sections off the proton, the neutron and the deuteron. A large transverse response for both the proton and neutron cases is found, pointing to a possible dominance of higher-twist transversity GPD contributions. For the first time, a flavor decomposition of the u and d quark contributions to the cross section will be shown.
We will conclude with a brief overview of additional DVCS experiments under analysis and planned with the future Upgrade of JLab to 12 GeV.

**Accelerators: Physics, Performance, and R&D for Future Facilities / 1004**

# Progress on stabilising relativistic lepton beams for future colliders

Philip Nicholas Burrows[1]

[1] *University of Oxford (GB)*

**Corresponding Author(s):** philip.burrows@cern.ch

We report progress on stabilising relativistic electron beams, in terms of their position and arrival time, for achieving high luminosity at future lepton colliders such as the International Linear Collider (ILC) and the Compact Linear Collider (CLIC). Hardware has been developed and deployed at the Accelerator Test Facility (ATF) at KEK for measuring and stabilising the beam position at the final focus to the nanometre level. We report latest closed-loop feedback tests in which the beam position was stabilised to c. 40 nm. In addition, a beam phase feed-forward system was deployed at the CLIC Test Facility (CTF3) at CERN. We report the results

of recent beam tests in which the beam arrival time was stabilised to c. 50 femtoseconds, which meets the requirement for efficient power transfer between the CLIC drive and main beams in the two-beam accelerator complex.

**Detector: R&D for Present and Future Facilities / 1010**

## Test Beam Results of 3D Detectors in CVD Diamond

Harris Kagan[1] ; William Trischuk[2]

[1] *Ohio State University (US)*
[2] *University of Toronto (CA)*

**Corresponding Author(s):** william.trischuk@cern.ch, harris.kagan@cern.ch

Detectors based on Chemical Vapor Deposition (CVD) diamond have been used extensively and successfully in beam conditions/beam loss monitors as the innermost detectors in the highest radiation areas of Large Hadron Collider (LHC) experiments. Over the last two years the RD42 collaboration has constructed a series of 3D detectors using CVD diamond as the active material and laser fabricated columns in the bulk and characterized them in test beams. As a result, the 3D geometry in diamond has been measured to collect more than two times the charge of a standard planar diamond device. 3D cell sizes from 100um x 150um down to 50um x 50um have been tested. The electrical properties and beam test results of the latest 3D devices will be presented.

**Detector: R&D for Present and Future Facilities / 1017**

## Commissioning of the Baby MIND detector

Alain Blondel[1]

[1] *University of Geneva*

**Corresponding Author(s):** alain.blondel@cern.ch

The Baby MIND (Magentized Iron Neutrino Detector) is characterized by its original magentization design, as well as by the presence of air gaps allowing muons to be reconstructed down to 300 MeV/c and their charge identified. The detector was completed, assembled and tested at the neutrino platform at CERN, and delivered to the T2K ND280 pit in December 2017. First results from test beam at CERN and commissionning in the neutrino beam at T2K will be presented.

**Neutrino Physics / 1018**

## Neutrino scattering at nuSTORM

Kenneth Richard Long[1] ; Patrick Huber[2]

[1] *Imperial College (GB)*
[2] *Virginia Tech*

**Corresponding Author(s):** pahuber@vt.edu, k.long@imperial.ac.uk

PoS(ICHEP2018)930

The nuSTORM facility will provide \nu_e and \nu_\mu beams from the decay of low energy muons confined within a storage ring. The instrumentation of the ring, combined with the excellent knowledge of muon decay, will make it possible to determine the neutrino flux at the %-level or better. The neutrino and anti-neutrino event rates are such that the nuSTORM facility serving a suite of near detectors will be able to measure \nu_eN and \nu_\muN cross sections with the %-level precision required to allow the next generation of long-baseline neutrino-oscillation experiments to fulfil their potential. By delivering precise cross section measurements with a pure weak probe nuSTORM may have the potential to make measurements important to understanding the physics of nucleii. The precise knowledge of the initial neutrino flux also makes it possible to deliver uniquely sensitive sterile-neutrino searches. The concept for the nuSTORM facility will be presented together with an evaluation of its performance. The status of the planned consideration of nuSTORM at CERN in the context of the Physics Beyond Colliders workshop will be summarised.



**Dark Matter Detection / 1020**

# Recent PandaX-II Results on Dark Matter Search and PandaX-4T Upgrade Status

Ning Zhou[1]

[1] *Shanghai Jiao Tong University (CN)*

**Corresponding Author(s):** nzhou@sjtu.edu.cn

PandaX experiment, located at China JinPing underground Laboratory (CJPL), is a 500kg scale liquid xenon dark matter direct detection experiment. With recent data, PandaX-II experiment obtained stringent upper limits on the spin-independent (SI) and spin-dependent (SD) WIMP-nucleon elastic scattering cross sections. Alternative models of dark matter are also explored using this data. Meanwhile, PandaX collaboration has launched an upgrade plan to build PandaX-4T detector with 4-ton liquid xenon in the active volume. The PandaX-4T experiment will be relocated to CJPL-II and is expected to run after 2020. Detailed simulation indicates that the sensitivity on SI WIMP-nucleon scattering cross section could reach 10^{-47} cm^2 after two-year's running.

**Detector: R&D for Present and Future Facilities / 1023**

# The Mu3e scintillating fiber tracker R&D

Sandro Bravar[1] ; Angela Papa[None]

[1] *Universite de Geneve (CH)*

**Corresponding Author(s):** angela.papa@psi.ch, alessandro.bravar@unige.ch

The Mu3e experiment searches for a rare lepton flavour violating μ+ → e+e+e− decay and it aims at reaching an ultimate sensitivity of 10^−16 on the branching fraction of the μ+ → e+e+e− decay, four orders of magnitude better than the current limit B(μ+ → e+e+e−) < 10^−12. The experiment will be hosted at the Paul Scherrer Institute (Villigen, Switzerland) which delivers the most intense low momentum continuous muon beam in the world (up to few ×10^8 μ/s). In order to be sensitive to the signal at this so high level, to reject the background and to run at the intensity beam frontier excellent detector performances are needed. To match those requests the experiment has been design based on completely new technologies, one of that given by a tracker made of the thinnest available scintillating fibers coupled to silicon photomultipliers (SiPMs).
We will report in detail the status of the scintillating fiber tracker R&D, from the fiber through the photosensors up to the electronics and the data acquisition, and we will discuss the results obtained with our current prototypes. The final aim would be to provide a fiber tracker detecting minimum ionizing particles (m.i.p.) with a minimal amount of material (the detector thickness below 0.4 % of radiation length X0) with full detection efficiency, timing resolutions below 1 ns and spatial resolution below 100 μm. While expertise on

scintillating fibers and SiPMs has been around for a while, nobody has ever built a detector that matches these demands. Current measurements show very promising results: a very high detection efficiency for m.i.p. with a single fiber layer (≥ 95%), and a full efficiency for multilayer configurations (≥ 99%); timing resolutions of the order of 500 ps (multi- layer configuration); optical cross-talk between coated fibers at a negligible level (< 1%), for which spatial resolutions < 50 μm are foreseen (multilayer configuration). We will also discuss the very good agreement between data and Monte Carlo simulation predictions.

**Computing and Data Handling / 1025**

## Applying deep learning methods to HEP data

Su Yong Choi[1]

[1] *Korea University (KR)*

**Corresponding Author(s):** su.yong.choi@cern.ch

We apply deep learning methods to various aspects of high energy physics problems, from jet reconstruction to top quark reconstruction at hadron colliders. Various supervised and unsupervised learning method use cases and failure cases are discussed. We describe our setup to make deep learning methods easier for users who are used to analyzing with ROOT data formats.

**Computing and Data Handling / 1027**

## Machine Learning on Datacenter Operations

Jeongheon Kim[1]

[1] *Korea Institute of Science and Technology Information*

**Corresponding Author(s):** jh.kim@kisti.re.kr

Google said it has reduced electricity bills by introducing machine learning into its data center operations. And what else is there?

**Quark and Lepton Flavor Physics / 1028**

## Status of the Mu3e experiment

The Mu3e Collaboration[None]; Angela Papa[None]

**Corresponding Author(s):** angela.papa@psi.ch

The Mu3e experiment searches for the charged lepton flavour violating μ+ → e+e+e− decay and it aims at reaching an ultimate sensitivity of 10^−16 on the branching frac- tion of the μ+ → e+e+e− decay, four orders of magnitude better than the current limit B(μ+ → e+e+e−) < 10^−12. The experiment will be hosted at the Paul Scherrer Institute (Villigen, Switzerland) which delivers the most intense low momentum continuous muon beam in the world (up to few ×10^8 μ/s). In order to be sensitive to the signal at this so high level, to reject the background and to run at the intensity beam frontier excellent detector performances are needed. To match those requests the experiment has been design based on completely new technologies. Extensive test beams have been performed to validate the detector design. The collaboration is concluding the detector R&D phase

and is ap- proaching the pre-engineering phase. A pre-engineering run is foreseen next year with sub-modules of each sub-detector followed by a full assembled pre-engineering run for 2020. The physics runs is expected to start in 2021 followed by at least three years of data taking. A review of the Mu3e experiment and its physics case will be given.

**POSTER / 1030**

## EFT for new physics in multi-Higgs final states in hadron colliders

Sichun Sun[1]

[1] *National Taiwan University*

**Corresponding Author(s):** sichunssun@gmail.com

I will show how to parametrize the Standard Model and generic new-physics contributions by an effective Lagrangian that includes higher-dimensional operators and discuss the constraints from the unitarity of scattering amplitudes for 2 to 2 and 2 to 3 processes. The selected subset of operators is motivated by composite-Higgs and Higgs-inflation models. The new physics effect can be potentially discovered in multi-Higgs final states in both 14 and future 100 TeV colliders.
We study the gluon fusion and vector boson fusion processes at the hadron colliders. The sizable contributions from new effective operators can largely increase the cross section and/or modify the kinematics of the Higgs bosons in the final state. Taking into account the projected constraints from single and double Higgs-boson production, we propose benchmark points in the new physics models for the measurement of the triple-Higgs boson final state for future collider projects.

**Neutrino Physics / 1032**

## First observation of coherent elastic neutrino-nucleus scattering and continued efforts of the COHERENT Collaboration

Grayson Rich[1]

[1] *U of Chicago*

**Corresponding Author(s):** gcrich@uchicago.edu

More than 40 years after its theoretical description, the process of coherent elastic neutrino-nucleus scattering (CEvNS) has been observed for the first time by the COHERENT Collaboration, using a 14.6-kg CsI[Na] detector at the Spallation Neutron Source of Oak Ridge National Lab. COHERENT and other groups continue to work towards additional CEvNS measurements because of the breadth of physics sensitivity shown by the process, including connections to nuclear structure, astrophysics, dark sector physics, and other physics beyond the Standard Model. Details of the initial observation of CEvNS will be presented along with an overview of the physics program within the COHERENT Collaboration, comprised of measurements of both CEvNS on other target nuclei as well as additional neutrino processes, including charged-current interactions on iodine and neutrino-induced neutron production on lead. The complementarity of additional CEvNS measurements will be explored, emphasizing the importance of additional, diverse experimental efforts.

**Detector: R&D for Present and Future Facilities / 1033**

## Large Area SiPM Readout and Signal Processing for nEXO

Jonathan Manoah Echevers[1]

[1] *Univ. Illinois at Urbana Champaign (US)*

**Corresponding Author(s):** jonathan.manoah.echevers@cern.ch

The EXO programme is a two-phase experiment to search for neutrinoless double beta decay. The first phase, EXO-200, yielded the first measurement of two neutrino double beta decay in Xenon and one of the most sensitive searches for neutrinoless double beta decay. The second phase, nEXO, is a proposed 5 tonne liquid xenon time projection chamber (TPC) that will implement several improvements over EXO-200. One such improvement is the usage of silicon photomultipliers (SiPMs) instead of avalanche photodiodes (APDs) as scintillation light detectors. By optimizing the light collection, reducing electronic noise and improving the SiPM performance, we can achieve a 1% energy resolution at the Xe-136 double beta decay end point. In this presentation, I will discuss the electronics readout of large area FBK UV sensitive SiPMs at liquid xenon temperatures and the digital filtering of SiPM waveforms.

**Computing and Data Handling / 1035**

## Automated Monitoring Tools for the CMS Muon System Based on Machine Learning Algorithms

Junghwan Goh[1]

[1] *Hanyang University (KR)*

**Corresponding Author(s):** junghwan.goh@cern.ch

Monitoring the quality of the data being collected by the CMS Muon system to ensure that it fulfills the requirements needed to be used for physics analyses is a time-consuming and labor-intensive task. The CMS Muon group is developing a reliable and robust tool that will make use of automated statistical tests and modern machine learning algorithms to reduce the resources needed to run and monitor the muon sub-detectors. The challenge in the development of such a tool is that the running conditions of the LHC experiments are not static, causing the quantities used for data monitoring to evolve. Furthermore, the tool must be applicable to the monitoring of all four muon sub-detectors (Cathode Strip Chambers, Drift Tube chambers, Gas Electron Multiplier chambers, Resistive Plate Chambers), which all depend on different detector technologies and are located in different geometrical areas of the detector. We will present an overview of the current tools and workflows used for monitoring, together with the status of the state-of-the-art developments towards the automated monitoring that we will implement for the future LHC runs.

**Neutrino Physics / 1036**

## Recent Results from the NOvA experiment

Jianming Bian[1]

[1] *University of California Irvine (US)*

**Corresponding Author(s):** bianjm@uci.edu

NOvA is a long-baseline neutrino experiment that uses an upgraded NuMI neutrino source at Fermilab and a 14-kton detector at Ash River, Minnesota. The detector has a highly active, finely segmented design that offers superb event identification capability. The latest results on muon (anti-)neutrino disappearance and electron (anti-)neutrino appearance will be shown, as well as neutral current measurements. The results will include the implications for neutrino oscillation mixing parameters, CP violation and the mass ordering.

PoS(ICHEP2018)930

**Formal Theory Development / 1038**

# On Geometric classification of 5d SCFTs

Heechoel Kim[1]

[1] *Postech*

**Corresponding Author(s):** heecheol1@gmail.com

We formulate geometric conditions necessary for engineering 5d superconformal field theories (SCFTs) via M-theory compactification on a local Calabi-Yau 3-fold. Extending the classification of the rank 1 cases, which are realized geometrically as shrinking del Pezzo surfaces embedded in a 3-fold, we propose an exhaustive classification of local 3-folds engineering rank 2 SCFTs in 5d. This systematic classification confirms that all rank 2 SCFTs predicted using gauge theoretic arguments can be realized as consistent theories, with the exception of one family which is shown to be non-perturbatively inconsistent and thereby ruled out by geometric considerations. We find that all rank 2 SCFTs descend from 6d (1,0) SCFTs compactified on a circle possibly twisted with an automorphism together with holonomies for global symmetries around the Kaluza-Klein circle.

**Computing and Data Handling / 1039**

# Machine learning at CERN: ALICE, CMS, and other developments

Markus Stoye[1]

[1] *Imperial College (GB)*

**Corresponding Author(s):** markus.stoye@cern.ch

Machine learning is of increasing importance to high energy physics as dataset sizes and data rates grow, while sensitivity to standard model and new physics signals are continually pushed to new extremes. Machine learning has proven to be advantageous in many contexts, and applications now span areas as diverse as triggering, monitoring, reconstruction, simulation, and data analysis. This talk will discuss a subset of the applications of machine learning in the ALICE and CMS experiments, as well as other areas of more general use in high energy physics at CERN.

**Dark Matter Detection / 1045**

# First Results from the ADMX G2 dark matter axion search

Gray Rybka[None]

**Corresponding Author(s):** grybka@uw.edu

The axion is a well-motivated dark matter candidate inspired by the Peccei-Quinn solution to the Strong-CP problem. After decades of work, the US DOE flagship axion dark matter search, ADMX G2, is the first experiment to be sensitive to dark matter axions from the plausible DFSZ coupling model, and has begun to search the theoretically-favored axion mass region 2-40 micro-eV. ADMX G2 could now discover dark matter at any time. I will report the first results from exploring the range around 2.7 micro-eV last year, discuss this

PoS(ICHEP2018)930

year's operations and review the ADMX G2 plans to continue the search to cover the entire mass range.

**Technology Applications and Industrial Opportunities / 1049**

## Case Study for the Socio-economic Impact of large Scientific Projects on the Technology Transfer and Technology-driven Startups in KOREA

**Corresponding Author(s):** kwonm@nfri.re.kr

In Korea, large scientific facilities started to build in parallel with the economic growth from late 1980s. The 3rd generation synchrotron-based, 2 GeV electron accelerator, the Pohang Light Source (PLS), was the biggest scientific endeavor in Korean history at that time. Few heavy industries for nuclear power with decent technical level, large ship building industries, semiconductor chip makers and a steel company were all engineering and technological resources from the industrial sector. After PLS, consecutive large science projects have been deployed with bigger scales in cost and technical complexities. A few of those are KSTAR, KOMAC, RAON, KSLV, KHIMA and ITER. During the rapid expansion period of last 30 years, there have been a noticeable change in the industrial sector. New startups driven by the advanced technology development have emerged and networked with laboratories as well as themselves, establishing new industrial clusters of companies for developing new and advanced technologies. This change definitely give impacts to the policy and strategy on the large science facilities deployment.
In this presentation, few cases will be shown as an example and some insight will be drawn for the future.

**Technology Applications and Industrial Opportunities / 1050**

## Chinese industries in technology developments related to high energy physics facilities: Introduction to CIPC

Jie Gao[1]

[1] *Institute of High Energy Physics, China*

**Corresponding Author(s):** gaoj@ihep.ac.cn

Facing to future high energy physics large science projects, CEPC-SppC, CEPC Industrial Promotion Consortium (CIPC) has been established in Nov 7, 2018 , with companies working in different key technology domains, such as superconducting cavities, cryo-module, klystron, high field super-conducting magnet, civil engineering, etc. Previously, these companies have worked closely with Chinese academic institutions and Universities in ILC collaboration,JUNO, and Jinping Dark matter experiment, European XFEL, LCLSII, FRIB-MSU, and C-ADS, etc.

**Technology Applications and Industrial Opportunities / 1051**

## Convergence: HPC + AI

**Corresponding Author(s):** sml@nvidia.com

Introducing a new era for innovation in the Exascale timeframe

**Technology Applications and Industrial Opportunities / 1055**

# ALICE ITS production with Korean industry - Status and Outlook

**Corresponding Author(s):** youngil.kwon@cern.ch

The ITS (Inner Tracking System) upgrade for the ALICE experiment at the LHC consists of novel monolithic CMOS pixel senosors with a total surface of 10^2. It is foreseen to be installed in the experiment during LS2 in 2019/20. The ITS upgrade encompasses highly advanced industrial technologies, such as CMOS sensor processing, post processing of silicon wafers, custom electronics and precision robotics. This contribution will give and overview of the R&D development carried out with industrial partners in Korea and present the current status of the production as well as an outlook for the future.

**Neutrino Physics / 1056**

# COHERENT constraints on generalized neutrino-quark interactions

Diego ARISTIZABAL[1]

[1] *Universite de Liege*

**Corresponding Author(s):** daristizabal@ulg.ac.be

Generalized neutrino-quark interactions can be studied in a fairly model-independent way by considering dimension-six effective operators constructed by only requiring Lorentz invariance. In this talk, following such approach, I will discuss the constraints on generalized neutrino-quark couplings implied by COHERENT data. I will show that some of these interactions can still be sizeable, and that when included provide a better fit to the data that the standard model alone.

**Technology Applications and Industrial Opportunities / 1054**

# Mass Production of GEM foils in Korea

MECARO has invested great efforts to produce the large size GEM foils since 2012. The company developed their original production methods including new chemicals for etching and high-tech lithography machine. In this talk, we will overview the current status for the large size GEM foil production and review our future plan.

**Detector: R&D for Present and Future Facilities / 1057**

# Status Report on Inner Tracking System Upgrade of ALICE

In Kwon Yoo[1]

[1] *Pusan National University (KR)*

**Corresponding Author(s):** yoo@pusan.ac.kr

PoS(ICHEP2018)930

The ALICE Collaboration is preparing a major upgrade of the ALICE detector, planned for installation during the second long LHC shutdown. The construction is expected to be completed by 2020 for data taking until 2029. A key element of the ALICE upgrade is the construction of a new, ultra- light, high-resolution Inner Tracking System (ITS).
With respect to the current ITS, this upgrade is aiming at a better position resolution (5 micron), a lower material budget (0.3% X0 for the three innermost layers) and a faster readout (up to 100 kHz in Pb-Pb collisions). This will be obtained by seven concentric detector layers based on an advanced Monolithic Active Pixel Sensor (MAPS) chip, with a pixel pitch of 30x30um^2.
I will present the general layout and main components of the new ITS, a summary of the R&D activities, the current status and outlook.

**Plenary / 1065**

## CMS+ LHCb highlights

Shahram Rahatlou[1]

[1] *Sapienza Universita e INFN, Roma I (IT)*

**Plenary / 1068**

## Short baseline experiments

Michele Weber[1]

[1] *Universitaet Bern (CH)*

**Corresponding Author(s):** michele.weber@cern.ch

**Plenary / 1069**

## non-accelerator-based experiment

Ruben Saakyan[None]

**Corresponding Author(s):** rrsaakyan@gmail.com

**Plenary / 1073**

## Future e+e- (CEPC, FCC, ILC, CLIC)

Xinchou Lou[1]

[1] *University of Texas at Dallas (US)*

**Corresponding Author(s):** xinchou.lou@cern.ch

PoS(ICHEP2018)930

**Plenary / 1076**

# Industry activities

Petra Riedler[1]

[1] *CERN*

**Corresponding Author(s):** petra.riedler@cern.ch

**Plenary / 1077**

# Higgs, experimental

Giacinto Piacquadio[1]

[1] *State University of New York (US)*

**Corresponding Author(s):** giacinto.piacquadio@cern.ch

**Plenary / 1079**

# Theory (SM Higgs, top, EW)

Matthew Dolan[1]

[1] *University of Melbourne*

**Corresponding Author(s):** maitiu.o.dolain@gmail.com

**Plenary / 1080**

# SUSY

Sara Strandberg[1]

[1] *Stockholm University (SE)*

**Corresponding Author(s):** sara.strandberg@cern.ch

**Plenary / 1083**

# CPV and CKM, experimental

Phillip Urquijo[1]

[1] *University of Melbourne (AU)*

**Corresponding Author(s):** phillip.urquijo@cern.ch

**Plenary / 1088**

## Outreach & Education

Kate Shaw[1]

[1] *University of Sussex (GB)*

**Corresponding Author(s):** kate.shaw@cern.ch

**Plenary / 1089**

## Diversity

Sahal Yacoob[1]

[1] *University of Cape Town (ZA)*

**Corresponding Author(s):** sahal.yacoob@cern.ch

**Plenary / 1091**

## 2nd Public Lecture

Michael Turner[None]

**Corresponding Author(s):** mturner@uchicago.edu

**Plenary / 1092**

## Strong interactions and hadrons, theory including lattice

**Corresponding Author(s):** pshana@mit.edu, phiala.shanahan@adelaide.edu.au

**Plenary / 1093**

## Strong interactions and hadron physics, experimental

latifa Elouadrhiri[1]

[1] *Jefferson Lab*

PoS(ICHEP2018)930

**Corresponding Author(s):** latifa@jlab.org

**Plenary / 1094**

## Exotic hadrons

Shuangshi Fang[1]

[1] *Instittute of High Energy physics*

**Corresponding Author(s):** fangss@ihep.ac.cn

**Plenary / 1096**

## Heavy ions, theory

Tetsufumi Hirano[1]

[1] *Sophia Univ*

**Corresponding Author(s):** hirano@sophia.ac.jp

**Plenary / 1103**

## CMB, cosmology, other astroparticle physics

Masashi Hazumi[1]

[1] *KEK*

**Corresponding Author(s):** masashi.hazumi@kek.jp

**Plenary / 1133**

## Industry Keynote speech by a Senior VP of Samsung Electronics

Eunsoo Shim[1]

[1] *Samsung Electronics (Senior Vice President)*

**Neutrino Physics / 1148**

## NSI @LBL

Danny Marfatia[1]

PoS(ICHEP2018)930

[1] *University of Hawaii*

I will describe nonstandard matter effects in the next generation long-baseline experiments, DUNE, T2HK and T2HKK.