

**The 17th International  
Workshop on Tau Lepton  
Physics (TAU2023)**

**τ2023**

**Report of Contributions**

Contribution ID: 2

Type: **Plenary Presentation**

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

*Wednesday, December 6, 2023 2:30 PM (20 minutes)*

Many theories beyond the Standard Model predict new phenomena, such as leptoquarks, vector like leptons,  $Z'$ ,  $W'$  bosons, KK gravitons, supersymmetry, new scalars or heavy leptons, in final states with isolated, high- $p_T$  taus. Searches for new physics with such signatures, produced either resonantly or non-resonantly, are performed using the ATLAS experiment at the LHC. The most recent 13 TeV pp results will be reported.

### **Name of collaboration or list of co-authors**

ATLAS collaboration

**Primary authors:** DALLAPICCOLA, Carlo (University of Massachusetts (US)); CARRATTA, Giuseppe (University and INFN, Bologna)

**Presenter:** CARRATTA, Giuseppe (University and INFN, Bologna)

**Session Classification:** Wednesday after lunch

Contribution ID: 3

Type: **Plenary Presentation**

# Measurements of Higgs boson properties in decays to two tau leptons and search for lepton-flavor-violating Higgs boson decays into tau leptons using the ATLAS detector

*Wednesday, December 6, 2023 2:10 PM (20 minutes)*

Detailed measurements of Higgs boson properties can be performed using its decays into fermions, providing in particular a key window into the nature of the Yukawa interactions. This talk presents the latest measurements by the ATLAS experiment of Higgs boson properties in its decays into pairs of tau leptons, using the full Run 2 pp collision dataset collected at 13 TeV. They include in particular measurements of Simplified Template Cross Sections, differential cross sections, and CP properties, as well as its interpretation within the framework of the Standard Model Effective Field Theories. Searches for lepton-flavor-violating Higgs boson decays to  $e\tau$  and  $\mu\tau$  lepton pairs are also presented.

## Name of collaboration or list of co-authors

ATLAS Collaboration

**Primary author:** DALLAPICCOLA, Carlo (University of Massachusetts (US))

**Presenter:** ÖNCEL, Oğul (Albert Ludwigs Universitaet Freiburg)

**Session Classification:** Wednesday after lunch

Contribution ID: 4

Type: **Plenary Presentation**

# The Mu2e Experiment

*Monday, December 4, 2023 4:20 PM (20 minutes)*

The Mu2e experiment, based at Fermilab, will search for the coherent, neutrino-less conversion of a negative muon into an electron in the field of an aluminum nucleus, an example of Charged Lepton Flavor Violation (CLFV). Observation of CLFV at Mu2e would be an unambiguous signal of physics beyond the Standard Model (BSM). Mu2e aims to improve upon the previous upper limit by four orders of magnitude and reach an unprecedented single event sensitivity of  $3 \times 10^{-17}$  on the conversion rate. Mu2e is sensitive to a wide range of BSM models and will indirectly probe effective mass scales up to  $10^4$  TeV/ $c^2$ . To achieve its design goal, Mu2e will utilize an integrated system of solenoids to create an intense muon beam. The background will be kept at a sub-event level through careful detector design choices. The experiment is approaching a very important and exciting stage in its life cycle. Construction is almost complete. Commissioning will begin shortly and physics data-taking is scheduled to begin in early 2026. This talk will explore the theoretical motivations, design, and current status of the Mu2e experiment.

## Name of collaboration or list of co-authors

Mu2e Collaboration

**Primary author:** MIDDLETON, Sophie (Caltech)**Presenter:** MIDDLETON, Sophie (Caltech)**Session Classification:** Monday afternoon

Contribution ID: 5

Type: **Plenary Presentation**

## **Tau Data-Based Evaluation of hadronic vacuum polarization contribution to muon $g-2$**

*Tuesday, December 5, 2023 11:15 AM (25 minutes)*

We compute for the first time the  $\tau$  data-driven Euclidean windows for the hadronic vacuum polarization contribution to the muon  $g-2$ . We show that  $\tau$ -based results agree with the available lattice window evaluations and with the full result. On the intermediate window, where all lattice evaluations are rather precise and agree,  $\tau$ -based results are compatible with them. This is particularly interesting, given that the disagreement of the  $e+e-$  data-driven result with the lattice values in this window is the main cause for their discrepancy, affecting the interpretation of the  $a_\mu$  measurement in terms of possible new physics.

### **Name of collaboration or list of co-authors**

Alejandro Miranda, Pere Masjuan, Pablo Roig

**Primary author:** ROIG GARCÉS, Pablo

**Presenter:** ROIG GARCÉS, Pablo

**Session Classification:** Tuesday before lunch

Contribution ID: 6

Type: **Plenary Presentation**

## Accelerator Search for Dark Matter

*Thursday, December 7, 2023 9:05 AM (25 minutes)*

The search for dark matter with masses below the WIMP regime, that is, in the MeV to GeV range, has aroused a great deal of recent interest. In this mass region, accelerator experiments can explore the production dark matter down to the thermal relic limit. This talk will review the various experimental approaches, with some emphasis on LDMX (the Light Dark Matter eXperiment), a nascent electron-beam fixed-target missing-momentum experiment, planned to run parasitically in the SLAC S30XL beamline, with unique sensitivity to light DM in the sub-GeV range.

### **Name of collaboration or list of co-authors**

LDMX

**Primary author:** HITLIN, David**Presenter:** HITLIN, David**Session Classification:** Thursday morning

Contribution ID: 8

Type: **Plenary Presentation**

## Lepton flavor violation with tau leptons

*Tuesday, December 5, 2023 2:30 PM (20 minutes)*

We review the status and importance of lepton flavor violation with tauons, focusing on well-motivated theoretical models, e.g. connected to neutrino mass, and possible novel signatures involving light new physics.

### **Name of collaboration or list of co-authors**

None

**Primary author:** HEECK, Julian

**Presenter:** HEECK, Julian

**Session Classification:** Tuesday after lunch

Contribution ID: 9

Type: **Plenary Presentation**

## New Physics in Hadronic Tau Decays

*Wednesday, December 6, 2023 11:10 AM (20 minutes)*

This talk is based on the main results of the published article *JHEP* **04** (2022) 152. Model independent bounds on new physics are obtained using hadronic tau decays as observables. To do this, we determine the dependence of several inclusive and exclusive tau observables on the Wilson coefficients of the low-energy effective theory describing charged-current interactions between light quarks and leptons. These results are then combined with inputs from other low-energy precision observables. In particular, with nuclear beta, baryon, pion, and kaon decay data.

### **Name of collaboration or list of co-authors**

Vincenzo Cirigliano, Adam Falkowski, Martín González-Alonso, Antonio Rodríguez-Sánchez

**Primary author:** DÍAZ CALDERÓN, David**Presenter:** DÍAZ CALDERÓN, David**Session Classification:** Wednesday before lunch



Contribution ID: 10

Type: **Plenary Presentation**

## FASER experiment and first results from LHC Run 3

*Friday, December 8, 2023 1:50 PM (20 minutes)*

FASER, the ForwArd Search ExpeRiment, is designed to search for light, extremely weakly-interacting and long-lived beyond standard model particles at the CERN Large Hadron Collider. Such particles, e.g., dark photons, may be produced in the high-energy proton-proton collisions at the ATLAS interaction point and then decay to visible particles in FASER, which is placed 480 m downstream and aligned with the collision axis line-of-sight. The detector covers a previously unexplored range of pseudorapidity  $> 8.8$ , which allows it to have sensitivity to new physics in the far-forward region. FASER also has a sub-detector called FASERv, which is specifically designed to detect and investigate high-energy collider neutrino interactions in the TeV regime, extending current cross-section measurements. In this talk we will introduce the FASER detector and present recent results obtained during LHC Run 3.

### **Name of collaboration or list of co-authors**

FASER Collaboration

**Primary author:** Dr KOSE, Umut (ETH-Zurich)

**Presenter:** Dr KOSE, Umut (ETH-Zurich)

**Session Classification:** Friday after lunch

Contribution ID: 11

Type: **Plenary Presentation**

## Monte Carlo for tau lepton Standard Model and New Physics signatures

*Monday, December 4, 2023 10:25 AM (25 minutes)*

The measurements of heaviest leptons tau, offer window for precision tests of Standard Model electroweak and medium energy strong interactions. They also are expected to be useful for New Physics signatures. The short lived tau leptons are observed through their decay products. The tau neutrinos escape detection. That complicates phenomenological work, but at the same time enables access to the leptons spin state. The Monte Carlo presentation of theoretical prediction is thus very useful and in some cases possibly even indispensable.

We will present recent developments in Monte Carlo programs KKMC TAUOLA and PHOTOS, which can be used for such purposes. Examples of applications for Standard Model and New Physics signatures, in particular in evaluations of observables sensitive to anomalous electric/magnetic dipole moments in tau lepton productions at Belle energies will be given.

### **Name of collaboration or list of co-authors**

Possible list of coauthors will be provided later

**Primary author:** WAS, Zbigniew Andrzej (Polish Academy of Sciences)

**Presenter:** WAS, Zbigniew Andrzej (Polish Academy of Sciences)

**Session Classification:** Monday before lunch

Contribution ID: 12

Type: **Plenary Presentation**

## 3D-Reconstruction of Tau Neutrinos in LArTPC Detectors

*Thursday, December 7, 2023 5:40 PM (20 minutes)*

The Deep Underground Neutrino Experiment (DUNE) is a next-generation neutrino experiment currently under construction. DUNE will consist of two high-resolution neutrino interaction imaging detectors exposed to the world's most intense neutrino beam, with the Near Detector at Fermilab and the Far Detector 1,300 km away in the Sanford Underground Research Facility in South Dakota, US.

The high statistics and excellent resolution capabilities of DUNE's  $^{40}\text{Ar}$  detector will allow us to make precision studies of oscillation parameters capable of searching for CP violation in the lepton sector, testing interaction models, and studying phenomena that have until now, seemed too complex to measure, like  $\nu_\tau$  detection and therefore, providing the completion of the 3-flavor neutrino paradigm. Knowledge of the  $\nu_\tau$  detection can impact a broad spectrum of open questions. Among these include searching for non-standard neutrino interactions, constraining the unitarity of the PMNS matrix, searching the sterile neutrinos, and studying neutrino interactions.

In the case of LArTPC data, the detector hits can be considered nodes in a graph, and the edges represent the spatial and temporal relationships between them. By using graph neural networks, it is possible to exploit these relationships and improve the accuracy of particle identification and reconstruction. During my presentation and specifically for tau neutrino reconstruction, I will show the effectiveness and reliability of our in-house developed graph neural network (GNN), NuGraph2. This GNN classifies detector hits based on the particle type responsible for their production, assuring that the system accurately identifies and categorizes information based on its unique characteristics.

### Name of collaboration or list of co-authors

Danaisis Vargas, V Hewes for the DUNE Collaboration

**Primary author:** YAEGGY ALVAREZ, Barbara

**Presenter:** YAEGGY ALVAREZ, Barbara

**Session Classification:** Thursday afternoon

Contribution ID: 13

Type: **Plenary Presentation**

## Searches for lepton flavor violation in tau-lepton decays at Belle and Belle II

*Tuesday, December 5, 2023 4:00 PM (20 minutes)*

Rates of lepton-flavor violation in charged lepton decays are enhanced in many beyond-the-standard-model theories. The low-background samples of  $e^+e^- \rightarrow \tau^+\tau^-$  events collected by Belle and Belle II allow world-leading searches for such decays with tau leptons. We present results for the decays  $\tau \rightarrow \ell V^0$ , where  $V^0$  is a neutral vector meson,  $\tau \rightarrow \ell\gamma$ , and  $\tau \rightarrow 3\mu$ .

### Name of collaboration or list of co-authors

Belle and Belle II

**Primary authors:** MARTINI, Alberto (DESY); VAHSEN, Sven (University of Hawaii (US))

**Presenter:** MARTINI, Alberto (DESY)

**Session Classification:** Tuesday afternoon

Contribution ID: 14

Type: **Plenary Presentation**

# Precise measurement of the tau-lepton mass at Belle II

*Monday, December 4, 2023 2:10 PM (20 minutes)*

The low-background environment of electron-positron collisions along with the large expected sample size and a hermetic detector make Belle II a premier experiment for studying tau-lepton physics. This talk presents recent world-leading results from Belle II determinations of the tau lepton mass.

## **Name of collaboration or list of co-authors**

Belle II

**Primary author:** VAHSEN, Sven (University of Hawaii (US))

**Presenter:** ZLEBICK, Radek (Deutsches Elektronen-Synchrotron)

**Session Classification:** Monday after lunch

Contribution ID: 15

Type: **Plenary Presentation**

# Measurements of Michel parameters and tests of lepton universality in tau-lepton decays at Belle and Belle II

*Monday, December 4, 2023 1:50 PM (20 minutes)*

Improved measurements of the standard model properties of the tau provide indirect searches for beyond-the-standard-model physics. The low-background samples of  $e^+e^- \rightarrow \tau^+\tau^-$  events collected by Belle and Belle II allow such measurements. We present a test of the V-A structure of  $\tau \rightarrow \mu\nu\nu$  decays through the determination of the Michel parameters. In addition, latest studies of lepton universality in tau decays are presented.

## **Name of collaboration or list of co-authors**

Belle and Belle II

**Primary authors:** FEICHTINGER, Paul (Austrian Academy of Sciences); VAHSEN, Sven (University of Hawaii (US))

**Presenter:** FEICHTINGER, Paul (Austrian Academy of Sciences)

**Session Classification:** Monday after lunch

Contribution ID: 16

Type: **Plenary Presentation**

## Dark sector searches with tau-pair events at Belle and Belle II

*Tuesday, December 5, 2023 4:40 PM (20 minutes)*

The existence and unknown nature of dark matter motivate dark sector searches at accelerators. The Belle and Belle II experiments enable dark sector searches in the sub-GeV mass region. We search for lepton-flavor-violating tau decays of type  $\tau \rightarrow \ell\alpha$ , where  $\ell = e, \mu$  and  $\alpha$  is an invisible particle. We also search for the existence of a heavy neutrino in tau decays. Finally, we present a recent search for a dark, leptophilic scalar particle produced in association with  $\tau^+\tau^-$  pairs at Belle.

### Name of collaboration or list of co-authors

Belle and Belle II

**Primary author:** VAHSEN, Sven (University of Hawaii (US))**Presenter:** DEY, Sourav (KEK)**Session Classification:** Tuesday afternoon

Contribution ID: 17

Type: **Plenary Presentation**

## Partial wave analysis of $\tau^- \rightarrow \pi^- \pi^- \pi^+ \nu$ decays at Belle

*Friday, December 8, 2023 2:30 PM (20 minutes)*

We present a partial-wave analysis of  $\tau^- \rightarrow \pi^- \pi^- \pi^+ \nu$  decays recorded with the Belle experiment at the KEKB  $e^+e^-$  collider. This work provides information on the  $a_1(1420)$  and  $a_1(1640)$  resonances, and aims to improve simulation studies necessary for measuring the electric and magnetic dipole moments and Michel parameters of the tau lepton.

### Name of collaboration or list of co-authors

Belle

**Primary author:** RABUSOV, Andrei (Technical University of Munich)**Co-author:** VAHSEN, Sven (University of Hawaii (US))**Presenter:** RABUSOV, Andrei (Technical University of Munich)**Session Classification:** Friday after lunch



Contribution ID: 18

Type: **Plenary Presentation**

## Searches for lepton flavor violation in meson decays at Belle

*Monday, December 4, 2023 3:10 PM (20 minutes)*

We present searches for the charged lepton-flavor-violating decays  $\Upsilon(1S) \rightarrow \ell\ell'$  and radiative charged lepton-flavour-violating decays  $\Upsilon(1S) \rightarrow \gamma\ell\ell'$  [where  $\ell = e, \mu$  and  $\ell' = e, \mu, \tau$ ] using the 158 million  $\Upsilon(2S)$  sample collected by the Belle detector at the KEKB collider. These searches use  $\Upsilon(1S)$  mesons produced in  $\pi^+\pi^-\Upsilon(1S)$  transitions. We also present Belle searches for the charged lepton-flavor-violating decays  $B_s \rightarrow \ell\tau$  and  $\Upsilon(2S) \rightarrow \ell\tau$ .

### Name of collaboration or list of co-authors

Belle

**Primary author:** VAHSEN, Sven (University of Hawaii (US))

**Presenter:** PATRA, Sourav (University of Louisville affiliated to KEK)

**Session Classification:** Monday after lunch

Contribution ID: 19

Type: **Plenary Presentation**

# Charged Lepton Flavor Violation in Heavy Particle Decays

*Monday, December 4, 2023 11:15 AM (25 minutes)*

Lepton flavor violation (LFV) is one of the cleanest probes of physics beyond the standard model. I will summarize the theoretical and experimental status of the search for charged lepton flavor violation in heavy particle decays, in particular in the decays of the Z and Higgs bosons, and of the top quark. Decays of beyond-Standard-Model particles such as a  $Z'$  or an additional scalar particle are also discussed. I will also review the prospects for such searches at proposed future electron-positron colliders.

## **Name of collaboration or list of co-authors**

based on 2205.10576 with Cecile Caillol, Mogens Dam, Stefania Xella, and Yongchao Zhang

**Primary author:** ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

**Presenter:** ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

**Session Classification:** Monday before lunch

Contribution ID: 21

Type: **Plenary Presentation**

## Probing $\tau$ flavour change with $\mu \rightarrow e$ observables

*Monday, December 4, 2023 4:00 PM (20 minutes)*

Exchanging a virtual  $\tau$  between a  $\mu \rightarrow \tau$  and a  $\tau \rightarrow e$  flavour changing vertex results in  $\mu \rightarrow e$ . This talk will discuss the sensitivity of  $\mu \rightarrow e$  observables to products of  $\mu \rightarrow \tau \times \tau \rightarrow e$  interactions in the Standard Model Effective Field Theory and in a  $Z'$  model. We will show that the exceptional sensitivity of upcoming  $\mu \rightarrow e$  experiments could allow to probe parameter space beyond the reach of upcoming  $\tau \rightarrow l$  searches, providing complementary information on  $\tau$  flavour change.

### Name of collaboration or list of co-authors

Sacha Davidson, Martin Gorbahn, Fiona Kirk

**Primary author:** ARDU, Marco (Univ. Valencia and CNRS, LUPM)**Presenter:** ARDU, Marco (Univ. Valencia and CNRS, LUPM)**Session Classification:** Monday afternoon

Contribution ID: 22

Type: **Plenary Presentation**

## Searching for Heavy Neutral Leptons using tau decays at BABAR

*Monday, December 4, 2023 2:30 PM (20 minutes)*

In the past few years there have been new results on the existence of Heavy Neutral Leptons (HNL) in the  $\mathcal{O}(\text{MeV}/c^2\text{-GeV}/c^2)$  mass range, these results are characterised by new and improved limits on the extended Pontecorvo-Maki-Nakagawa-Sakata (PMNS) matrix element,  $|U_{\tau,4}|^2$ , which describes the mixing of some hypothetical HNL and the Standard Model (SM)  $\nu_\tau$  state. This talk presents a model independent search at BABAR for a mostly sterile HNL, capable of mixing with the SM  $\nu_\tau$  neutrino. A total of  $424 \text{ fb}^{-1}$  of BABAR data has been analyzed. No significant signal is seen and 95 % confidence level upper limits are set:  $2.31 \times 10^{-2} < |U_{\tau,4}|^2 < 5.04 \times 10^{-6}$ , with all uncertainties considered, across the mass range  $100 < m_4 < 1300 \text{ MeV}/c^2$ . More stringent limits are placed at higher masses. The novel technique employed uses only kinematic information and makes no assumptions on the model behind the origins of the HNL, its lifetime or decay modes.

### Name of collaboration or list of co-authors

BABAR Collaboration

**Primary author:** MIDDLETON, Sophie (Caltech)**Presenter:** MIDDLETON, Sophie (Caltech)**Session Classification:** Monday after lunch

Contribution ID: 23

Type: **Plenary Presentation**

## Neutrino & Dark Matter Connections

*Wednesday, December 6, 2023 9:30 AM (25 minutes)*

Tau-flavored neutrinos are, arguably, the least understood particles of the Standard Model. Given the relatively small experimental data considering them, it's natural to ask whether new physics could lie just beneath the surface of our understanding. In this talk, I will discuss how studying tau neutrinos in next-generation facilities may allow us to uncover new physics associated with neutrinos and dark matter.

### **Name of collaboration or list of co-authors**

N/A

**Primary author:** KELLY, Kevin James (Texas A&M University)

**Presenter:** KELLY, Kevin James (Texas A&M University)

**Session Classification:** Wednesday morning

Contribution ID: 24

Type: **Plenary Presentation**

## Tracking Down the Origin of Neutrino Mass

*Wednesday, December 6, 2023 9:05 AM (25 minutes)*

The observation of neutrino oscillations provides striking evidence for physics beyond the Standard Model. While multiple neutrino experiments continue to constrain oscillation rates and mass values, one fundamental question remains unanswered: How do neutrinos get their mass? Many theoretical models exist, but so far none of them have been experimentally confirmed. In this talk I will present several models for neutrino masses and in particular focus on the most testable ones and their predictions.

### **Name of collaboration or list of co-authors**

Theory

**Primary author:** GEHRLEIN, Julia**Presenter:** GEHRLEIN, Julia**Session Classification:** Wednesday morning

Contribution ID: 25

Type: **Plenary Presentation**

# Anomalous Tau Neutrino Appearance from Light Mediators in Short-Baseline Neutrino Experiments

*Thursday, December 7, 2023 1:50 PM (20 minutes)*

This talk will consider a new mechanism to produce anomalous tau neutrino appearance at the near detectors of beam-focused neutrino experiments, without extending the neutrino sector. The charged mesons ( $\pi^\pm, K^\pm$ ) produced and focused in the target-horn system can decay to a neutrino-philic light mediator via the helicity-unsuppressed three-body decays. Such a mediator also can be produced via the bremsstrahlung of the incident proton beam due to the models we consider. The subsequent decay of the mediator to a tau neutrino pair results in tau neutrino detection at the near detectors, which is unexpected under the standard three-flavor neutrino oscillation paradigm. The signal flux from the charged meson decays can be significant enough to discover the light mediator signal at the on-axis liquid-argon near detector of the DUNE experiment, due to the focusing of charged mesons. In this talk, I will also consider ICARUS-NuMI, an off-axis near detector of the NuMI beam to observe the tau neutrino events.

## Name of collaboration or list of co-authors

Bhupal Dev, Tao Han, Doojin Kim

**Primary author:** Prof. DUTTA, Bhaskar**Presenter:** Prof. DUTTA, Bhaskar**Session Classification:** Thursday after lunch

Contribution ID: 26

Type: **Plenary Presentation**

## Charged lepton flavor violation at circular e+e- colliders

*Monday, December 4, 2023 11:40 AM (25 minutes)*

Lepton flavor violation is one of the cleanest probes of physics beyond the standard model. In this work, we explore the sensitivity of the process  $e^+e^- \rightarrow \tau\mu$  to new physics above the TeV scale at the proposed circular electron-positron colliders FCC-ee and CEPC. We compute the  $e^+e^- \rightarrow \tau\mu$  cross-section in the Standard Model Effective Field Theory and assess the relevant backgrounds. We compare our sensitivity projections to existing and expected constraints from tau decays and  $Z$  decays and find that the future electron-positron colliders provide competitive probes of new physics. We highlight the complementarity of searches for resonant  $e^+e^- \rightarrow Z \rightarrow \tau\mu$  production on the  $Z$  pole and searches for non resonant  $e^+e^- \rightarrow \tau\mu$  at higher center-of-mass energies.

### Name of collaboration or list of co-authors

Wolfgang Altmannshofer, Pankaj Munbodh and Talise Oh.

**Primary authors:** MUNBODH, Pankaj (University of California Santa Cruz); Ms OH, Talise; ALTMANNSHOFER, Wolfgang (UC Santa Cruz)

**Presenter:** MUNBODH, Pankaj (University of California Santa Cruz)

**Session Classification:** Monday before lunch



Contribution ID: 27

Type: **Plenary Presentation**

## Data-driven determinations of light-quark-connected and strange-plus-disconnected window contributions to $a_\mu$

*Tuesday, December 5, 2023 10:50 AM (25 minutes)*

As part of an ongoing effort to understand the source of the discrepancy between data-driven and lattice determinations of the HVP contribution to  $a_\mu$ , the anomalous magnetic moment of the muon, we perform data-driven determinations of the light-quark-connected and strange-plus-disconnected contributions to a number of “window” contributions to  $a_\mu$ , including the RBC/UKQCD intermediate window contribution, and compare these to recent lattice determinations of the same quantities, where available. We find a large discrepancy with 8 recent high-precision lattice determinations of the RBC/UKQCD intermediate window quantity. We also discuss the potential impact of recent CMD-3 2-pion cross-section measurements, which differ significantly from those of earlier experiments, on the observed discrepancies between lattice determinations and our data-driven results.

### **Name of collaboration or list of co-authors**

Genessa Benton, Diogo Boito, Maarten Golterman, Alex Keshavarzi and Santiago Peris

**Primary author:** MALTMAN, Kim

**Presenter:** MALTMAN, Kim

**Session Classification:** Tuesday before lunch

Contribution ID: 28

Type: **Plenary Presentation**

## New Physics in Neutrino Oscillations

*Wednesday, December 6, 2023 9:55 AM (25 minutes)*

The discovery that neutrinos oscillate was one of the first indications of physics beyond the Standard Model. That is, the addition of neutrino masses to the Standard Model requires, at minimum, three new sterile states. Furthermore, models seeking to explain the smallness of neutrino masses lead to a direct connection between observed neutrino masses and physics at very high mass scales. Therefore, neutrino oscillations are an excellent target for exploring new physics.

Upcoming oscillation experiments are expected to achieve levels of precision which will allow for searches for new physics through their imprint on observed oscillation patterns. In this talk, I will give a survey of new physics possibilities and the prospects of upcoming experiments to shed light on them.

### **Name of collaboration or list of co-authors**

None

**Primary author:** AURISANO, Adam Jude (University of Cincinnati)**Presenter:** AURISANO, Adam Jude (University of Cincinnati)**Session Classification:** Wednesday morning

Contribution ID: 29

Type: **Plenary Presentation**

## The Pacific Ocean Neutrino Experiment (P-ONE)

*Thursday, December 7, 2023 4:40 PM (20 minutes)*

The Pacific Ocean Neutrino Experiment (P-ONE) Collaboration is currently developing a new cubic-kilometre neutrino telescope in the Northern Pacific Ocean. With a focus on detecting TeV-PeV high-energy astrophysical neutrinos, P-ONE will expand the sky coverage of other neutrino telescopes like IceCube, KM3NeT, and Baikal-GVD. Its unique combination of water properties and detector technology make P-ONE especially well-suited for detecting the characteristic double-cascade signal of astrophysical tau neutrinos. We present the current status and show first results from a tau neutrino sensitivity study.

### **Name of collaboration or list of co-authors**

P-ONE

**Primary author:** GAERTNER, Andreas

**Presenter:** GAERTNER, Andreas

**Session Classification:** Thursday afternoon

Contribution ID: 30

Type: **Plenary Presentation**

## Update on $\alpha_s$ from hadronic tau decays

*Wednesday, December 6, 2023 11:50 AM (20 minutes)*

We discuss recent work on the methodology for determining the strong coupling,  $\alpha_s$ , from hadronic tau decays. In particular, we address a number of concerns that have been raised with regard to the method we employ, showing that all of these concerns are unfounded.

### **Name of collaboration or list of co-authors**

Diogo Boito, Maarten Golterman, Kim Maltman, Santiago Peris

**Primary author:** GOLTERMAN, Maarten

**Co-authors:** BOITO, Diogo; MALTMAN, Kim; PERIS, Santi

**Presenter:** GOLTERMAN, Maarten

**Session Classification:** Wednesday before lunch

Contribution ID: 31

Type: **Plenary Presentation**

## TAMBO: Searching for Tau Neutrinos in the Peruvian Andes

*Thursday, December 7, 2023 3:10 PM (20 minutes)*

The detection of high-energy astrophysical neutrinos by IceCube has opened a new window on our Universe. While IceCube has measured the flux of these neutrinos at energies up to several PeV, much remains to be discovered regarding their origin and nature. Currently, measurements are limited by the small sample size of astrophysical neutrinos and by the difficulty of discriminating between electron and tau neutrinos.

TAMBO is a next-generation neutrino observatory specifically designed to detect tau neutrinos in the 1-100 PeV energy range, enabling tests of neutrino physics at high energies and the characterization of astrophysical neutrino sources. The observatory will comprise an array of water Cherenkov and plastic scintillator detectors deployed on the face of the Colca Canyon in the Peruvian Andes. This unique geometry will facilitate a high-purity measurement of astrophysical tau neutrino properties. In this talk, I will present the prospects of TAMBO in the context of next-generation neutrino observatories and provide an overview of its current status.

### **Name of collaboration or list of co-authors**

TAMBO Collaboration

**Primary author:** THOMPSON, Will (Harvard University)**Presenter:** THOMPSON, Will (Harvard University)**Session Classification:** Thursday after lunch

Contribution ID: 32

Type: **Plenary Presentation**

## Neutrino Mixing Parameters

*Thursday, December 7, 2023 1:30 PM (20 minutes)*

Six parameters enable us to compute all neutrino oscillations in the standard three-flavor neutrino mixing paradigm. Our measurements of these parameters have been steadily improving over time. With the unprecedented precision promised by the next-generation experiments, we re-evaluate our understanding of neutrino mixing by relaxing the three-flavor assumption, i.e., testing the unitarity of the PMNS matrix. This highlights the complementarity of future experiments DUNE, T2HK, JUNO, and IceCube Upgrade.

### **Name of collaboration or list of co-authors**

Sebastian Ellis, Kevin Kelly

**Primary author:** LI, Shirley (UC Irvine)**Presenter:** LI, Shirley (UC Irvine)**Session Classification:** Thursday after lunch

Contribution ID: 33

Type: **Plenary Presentation**

# Global analysis of Lepton Flavor Violating Operators

*Friday, December 8, 2023 12:00 PM (25 minutes)*

Processes involving charged lepton flavor violation (CLFV) are very powerful tools to search for new physics beyond the Standard Model and their observation could provide important insight onto the origin of neutrino masses. Probes of CLFV exist across a broad spectrum of energy scales, from low-energy experiments looking for CLFV decays of the muon, of the tau lepton and of a variety of mesons, to high-energy colliders. In this talk, I will give an overview of existing bounds on CLFV operators in the framework of the Standard Model Effective Field Theory, highlighting the complementarity between low- and high-energy probes. I will then discuss the directions in parameter space that are least constrained by existing experiments, and discuss future opportunities at the Electron-Ion Collider.

## Name of collaboration or list of co-authors

Kaori Fuyuto, Bin Yan, Sergi Gonzalez-Solis, Vincenzo Cirigliano, Christopher Lee

**Primary author:** MEREGHETTI, emanuele**Presenter:** MEREGHETTI, emanuele**Session Classification:** Friday before lunch

Contribution ID: 35

Type: **Plenary Presentation**

## The FLArE Experiment for High Energy Neutrino and Dark Matter Searches at LHC

*Thursday, December 7, 2023 5:20 PM (20 minutes)*

The Forward Physics Facility (FPF) is a proposed program to build an underground cavern with the space and infrastructure to support a suite of far-forward experiments at the Large Hadron Collider in the High Luminosity era (HL-LHC). The Forward Liquid Argon Experiment (FLArE) is a Liquid Argon Time Projection Chamber (LArTPC)-based experiment designed to detect very high energy neutrinos and search for dark matter in FPF, 620 m from the ATLAS interaction point in the far-forward direction, and will collect data during HL-LHC. With a fiducial mass of ~10 tons, FLArE will detect millions of high-energy tau neutrinos at the highest energies ever detected from a human source, and will also search for dark matter particles with world-leading sensitivity in the MeV to GeV mass range. In this talk, I will give an overview of the physical reach, preliminary design and status of FPF and FLArE. The reconstruction and identification of high-energy tau neutrinos at FLArE will also be discussed.

### **Name of collaboration or list of co-authors**

Jianming Bian, Jonathan Feng, Milind Diwan

**Primary author:** Prof. BIAN, Jianming (University of California Irvine)

**Presenter:** Prof. BIAN, Jianming (University of California Irvine)

**Session Classification:** Thursday afternoon



Contribution ID: 36

Type: **Plenary Presentation**

## Measurement of the Muon Magnetic anomaly to 0.20 ppm by the Muon g-2 experiment at Fermilab

*Tuesday, December 5, 2023 9:05 AM (25 minutes)*

The Muon  $g - 2$  experiment at Fermilab aims to measure the muon magnetic moment anomaly,  $a_\mu = (g - 2)/2$ , with a final accuracy of 0.14 parts per million. The experiment's first result published in 2021, based on Run-1 data collected in 2018, confirmed the previous result obtained at Brookhaven National Laboratory with a similar sensitivity. In 2023, the experiment published new results based on the 2019 and 2020 datasets, Run-2 and Run-3, which contain a factor of four more data than in Run-1, thus entering a new sensitivity regime to  $g - 2$ . In this talk, I will discuss the improvements in the accuracy of  $a_\mu$  with respect to the Run-1 result, which allowed for a factor 2 improvement on both the statistical and systematic uncertainties, and the future prospects for the experiment. and for the Standard Model prediction for muon  $g - 2$ . I will then discuss the implications of the comparison of the new measurement with the last Standard Model predictions for muon  $g - 2$ .

### Name of collaboration or list of co-authors

E989 (Muon g-2) collaboration at Fermilab

**Primary author:** COTROZZI, Lorenzo**Presenter:** COTROZZI, Lorenzo**Session Classification:** Tuesday morning

Contribution ID: 37

Type: **Plenary Presentation**

## Measurement of beam polarization at an $e^+e^-$ $B$ -Factory with a new tau polarimetry technique

*Tuesday, December 5, 2023 5:40 PM (20 minutes)*

Belle II is considering upgrading SuperKEKB with a polarized electron beam. The introduction of beam polarization to the experiment would significantly expand the physics program of Belle II in the electroweak, dark , and lepton flavor universality sectors. For all of these future measurements a robust method of determining the average beam polarization is required to maximize the level of precision. The *BABAR* experiment has developed a new beam polarimetry technique, Tau Polarimetry, which exploits the  $\tau$  decay kinematics to measure the average beam polarization to better than half a percent. We present the results obtained by *BABAR*, including details of the studies of systematic uncertainties, using  $420 \text{ fb}^{-1}$  collected at the  $e^+e^-$  PEP-II collider, which demonstrates the feasibility of using Tau Polarimetry at future colliders such as an upgraded Belle II or the ILC.

### Name of collaboration or list of co-authors

on behalf of the BaBar collaboration

**Primary author:** MILLER, Caleb**Presenter:** MILLER, Caleb**Session Classification:** Tuesday afternoon

Contribution ID: 38

Type: **Plenary Presentation**

## The Euclidean Adler function and its interplay with low-energy data and $\alpha_s$

*Wednesday, December 6, 2023 10:50 AM (20 minutes)*

Perturbative QCD gives a precise description of the Euclidean Adler function at large momenta. A comprehensive study of the perturbative approach is presented for momenta of the order of the tau mass, including the different expansions at all known orders. We then compare to the corresponding Adler functions obtained from experimental data and lattice simulations and comment on the phenomenological implications. This talk is mostly based on JHEP 04 (2023) 067.

### Name of collaboration or list of co-authors

Davier, Díaz-Calderon, Malaescu, Pich, Rodríguez-Sánchez, Zhang

**Primary authors:** RODRIGUEZ SANCHEZ, Antonio; DAVIER, Michel; DÍAZ CALDERÓN, David; MALAESCU, Bogdan (LPNHE-Paris CNRS/IN2P3 (FR)); PICH, Antonio (IFIC); ZHANG, Zhiqing Philippe (IJCLab, Orsay (FR))

**Presenter:** RODRIGUEZ SANCHEZ, Antonio

**Session Classification:** Wednesday before lunch

Contribution ID: 39

Type: **Plenary Presentation**

## Tau Neutrinos with IceCube

*Friday, December 8, 2023 9:50 AM (25 minutes)*

The IceCube experiment is sensitive to tau neutrinos spanning over six orders of magnitude in energy, from atmospheric and astrophysical sources. We report on IceCube results, focusing on atmospheric tau neutrino appearance and our recent astrophysical tau neutrino detection. We also provide estimated sensitivities for future analyses, including those to be performed with the approved IceCube Upgrade.

### **Name of collaboration or list of co-authors**

IceCube Collaboration

**Primary author:** COWEN, Douglas

**Presenter:** COWEN, Douglas

**Session Classification:** Friday morning

Contribution ID: 40

Type: **Plenary Presentation**

## Status and Prospects of the JUNO Experiment

*Thursday, December 7, 2023 11:40 AM (25 minutes)*

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment currently under construction in South China. It is located 53 kilometers away from two nuclear power plants in a 700-meter-deep underground laboratory.

JUNO will be the largest liquid scintillator (LS) detector in the world, comprising 20,000 tons of ultra-pure LS filled in a 35.4-meter-diameter acrylic sphere. The vast volume will be monitored by 17,612 20-inch and 25,600 3-inch photomultiplier tubes, ensuring a photocathode coverage of 78% and providing an unprecedented energy resolution of better than 3% at 1 MeV with an absolute energy scale uncertainty lower than 1%.

The main physics goal of JUNO is the determination of the neutrino mass ordering.

The unique location of JUNO allows for the detection of oscillated electron antineutrinos from reactors at medium-baselines and enables the first-time precision measurement of two oscillation patterns in one energy spectrum. A significance of mass ordering determination exceeding  $3\sigma$  is expected after six years of data taking. Simultaneously, JUNO will achieve sub-percent precision in measuring several neutrino oscillation parameters.

In addition, neutrinos from several sources, including the Sun, the Earth's interior, the atmosphere, and galactic core-collapse supernovae, can be studied. Furthermore, JUNO is in a great position to discover the diffuse supernova neutrino background, as well as to search for proton decay and other new physics beyond the Standard Model.

In this talk, I will present the current status of JUNO and discuss its physics prospects.

### **Name of collaboration or list of co-authors**

JUNO Collaboration

**Primary author:** Mr STOCK, Matthias Raphael (Technische Universität München)

**Presenter:** Mr STOCK, Matthias Raphael (Technische Universität München)

**Session Classification:** Thursday before lunch

Contribution ID: 42

Type: **Plenary Presentation**

# LHCb measurements on semileptonic decays of **b**-hadrons

*Monday, December 4, 2023 5:20 PM (20 minutes)*

Semileptonic  $b$ -hadron decays proceed via charged-current interactions and provide powerful probes for testing the Standard Model and for searching for New Physics effects. The advantages of studying such decays include the large branching fractions and reliable calculations of the hadron matrix elements. In this contribution, LHCb measurements on CKM parameters and test of new physics will be presented.

## **Name of collaboration or list of co-authors**

LHCb

**Primary authors:** LUPATO, Anna (Università di Padova & INFN); VOS, Keri (Nikhef National institute for subatomic physics (NL))

**Presenter:** LUPATO, Anna (Università di Padova & INFN)

**Session Classification:** Monday afternoon

Contribution ID: 43

Type: **Plenary Presentation**

# Lepton Flavour Universality tests using semileptonic $b$ -hadron decays

*Monday, December 4, 2023 5:40 PM (20 minutes)*

In the SM, the electroweak bosons couple to the three lepton families with the same strength, the only difference in their behaviour being due to the difference in mass. In recent years, some deviations have been found in measurements of the ratios of branching fractions for  $b$ -hadrons decaying into final states with different lepton flavours. This talk presents recent results of lepton flavour universality tests in  $b \rightarrow c\ell\nu$  decays, using hadronic or muonic  $\tau$  decays, performed at LHCb.

## Name of collaboration or list of co-authors

LHCb, speaker to be determined

**Primary authors:** BROSSA GONZALO, Arnau (Universidade de Santiago de Compostela); VOS, Keri (Nikhef National institute for subatomic physics (NL))

**Presenter:** BROSSA GONZALO, Arnau (Universidade de Santiago de Compostela)

**Session Classification:** Monday afternoon

Contribution ID: 44

Type: **Plenary Presentation**

## Difference between fixed-order and contour-improved perturbation theory

*Wednesday, December 6, 2023 12:10 PM (20 minutes)*

Using standard mathematical methods for asymptotic series and the large- $\beta_0$  approximation, we define a Minimum Distance between the Fixed-Order perturbative series and the Contour-Improved perturbative series in the strong coupling  $\alpha_s$  for finite-energy sum rules as applied to hadronic  $\tau$  decays. This distance is similar, but not identical, to the Asymptotic Separation of Hoang and Regner, which is defined in terms of the difference of the two series after Borel resummation. Our results confirm a nonzero nonperturbative result in  $\alpha_s$  for this Minimum Distance as a measure of the intrinsic difference between the two series, as well as a conflict with the Operator Product Expansion for Contour-Improved Perturbation Theory.

### Name of collaboration or list of co-authors

M. Golterman, K. Maltman

**Primary author:** PERIS, Santi**Co-authors:** Prof. MALTMAN, Kim (Univ. of Adelaide and York Univ.); Prof. GOLTERMAN, Maarten (SFSU)**Presenter:** PERIS, Santi**Session Classification:** Wednesday before lunch



Contribution ID: 46

Type: **Plenary Presentation**

## A data-driven method to estimate the antiproton background in Mu2e

*Monday, December 4, 2023 4:40 PM (20 minutes)*

The Mu2e experiment at Fermilab will search for the CLFV neutrinoless coherent conversion of muon to electron, in the field of an Al nucleus. The experimental signature of the process is a monochromatic conversion electron (CE) with 104.97 MeV/c energy. CE-like electrons could also come from background processes like the cosmic muons, Decay in Orbit (DIO) of muons stopped in the Stopping Target (ST) or antiprotons produced by the proton beam at the Production Target and annihilating in the ST. The background induced by antiprotons is low but highly uncertain. This background cannot be efficiently suppressed by the time window cut used to reduce the prompt background because antiprotons are significantly slower than the other beam particles. We are developing a method for the in-situ measurement of this background.  $p\bar{p}$  annihilation in the ST is the only source of events in Mu2e with multiple tracks, simultaneous in time, each with a momentum in the signal window region. We plan to exploit this unique feature. The idea is to identify and reconstruct events with multiple tracks and use them to estimate the antiproton background. The Mu2e detector and event reconstruction are optimised for efficient single-track event reconstruction, we are developing algorithms to reconstruct multi-track events. The talk will present its status and discuss the prospects of the in-situ estimate of the antiproton background.

### Name of collaboration or list of co-authors

Mu2e Collaboration

**Primary author:** CHITHIRASREEMADAM, Namitha (University of Pisa)

**Presenter:** CHITHIRASREEMADAM, Namitha (University of Pisa)

**Session Classification:** Monday afternoon

Contribution ID: 48

Type: **Plenary Presentation**

## **Non-standard and secret neutrino interactions at future tau neutrino experiments**

*Thursday, December 7, 2023 2:50 PM (20 minutes)*

In this talk, we investigate the excellent potential of future tau neutrino experiments in probing non-standard interactions and secret interactions of neutrino. Due to its ability identifying tau lepton, DUNE far detector could have superior sensitivity in probing the secret neutrino interactions by observing downward-going atmospheric neutrinos, compared to the short-baseline experiments in Forward Physics Facility (FPF) at CERN. In probing the non-standard interactions, the large volume experiments such as HK, KNO, or ORCA could provide the dominant sensitivities. However, the inclusion of tau neutrino observation of DUNE could raise its sensitivity comparable to those larger volume experiments. Hence we point out the importance of increasing the tau lepton identification efficiencies in future experiments.

### **Name of collaboration or list of co-authors**

Pouya Bakhti, Meshkat Rajae

**Primary author:** Prof. SHIN, Seodong (Jeonbuk National University)**Co-authors:** Dr RAJAE, Meshkat (Jeonbuk National University); Dr BAKHTI, Pouya (Jeonbuk National University)**Presenter:** Prof. SHIN, Seodong (Jeonbuk National University)**Session Classification:** Thursday after lunch

Contribution ID: 49

Type: **Plenary Presentation**

## **Status and prospects of measuring Electric Dipole Moment of tau lepton**

*Tuesday, December 5, 2023 12:05 PM (25 minutes)*

The electric dipole moment (EDM) of the tau lepton is a good probe for new physics. The measurement has been and will be performed based on the huge amount of tau-pair production data collected with the high-luminosity colliders. The status of the measurement and prospects for future experiment will be presented.

### **Name of collaboration or list of co-authors**

None

**Primary author:** INAMI, Kenji

**Presenter:** INAMI, Kenji

**Session Classification:** Tuesday before lunch

Contribution ID: 50

Type: **Plenary Presentation**

## Measurement of muon $g-2$ and EDM at J-PARC

*Tuesday, December 5, 2023 9:30 AM (25 minutes)*

Physics of lepton dipole moment is receiving great attentions after the results of the muon  $g-2$  experiment at Fermi National Laboratory indicated the measured value of muon  $g-2$  was larger than that from the standard model of particle physics. Upcoming experiments as well as theoretical research are supposed to provide crucial information if this anomaly is owing to new physics beyond the standard model of particle physics. A new experiment is under preparation at J-PARC to measure muon  $g-2$  as well as EDM with novel muon beam by using muon cooling followed by acceleration with LINAC. In this contribution, status and prospects of the experiment will be presented.

### Name of collaboration or list of co-authors

The J-PARC muon  $g-2$ /EDM collaboration**Primary author:** MIBE, Tsutomu**Presenter:** MIBE, Tsutomu**Session Classification:** Tuesday morning

Contribution ID: 51

Type: **Plenary Presentation**

## Flavor-changing neutral currents in tau decays

*Monday, December 4, 2023 10:50 AM (25 minutes)*

We discuss constraints on the flavor-changing neutral current transitions of taus with photons and gluons.

### **Name of collaboration or list of co-authors**

N/A

**Primary author:** PETROV, Alexey (University of South Carolina)

**Presenter:** PETROV, Alexey (University of South Carolina)

**Session Classification:** Monday before lunch

Contribution ID: 52

Type: **Plenary Presentation**

## Latest results from the MicroBooNE experiment

*Thursday, December 7, 2023 11:15 AM (25 minutes)*

The MicroBooNE experiment employs an 85-ton active volume liquid argon time projection chamber to detect neutrinos from both the on-axis Booster Neutrino Beam (BNB) and off-axis Neutrinos at the Main Injector (NuMI) beam. The goals of the experiment are to investigate the short baseline neutrino anomalies, to measure neutrino cross sections and to probe BSM physics with neutrino beams. In this presentation, we will present our most recent physics results and give an overview of the planned future analyses.

### **Name of collaboration or list of co-authors**

MicroBooNE

**Primary author:** GRAMELLINI, Elena

**Presenter:** MOHAYAI, Tanaz (Indiana University)

**Session Classification:** Thursday before lunch

Contribution ID: 53

Type: **Plenary Presentation**

# Heavy neutral leptons and beyond at the electron-ion collider

*Monday, December 4, 2023 2:50 PM (20 minutes)*

The future Electron-Ion Collider (EIC) at Brookhaven National Laboratory, along with its primary capacity to elucidate the nuclear structure, will offer new opportunities to probe physics beyond the Standard Model coupled to the electroweak sector. Among the best-motivated examples of such new physics are new heavy-neutral leptons (HNLs), which are likely to play a key role in neutrino mass generation and lepton number violation. We study the capability of the EIC to search for HNLs, which can be produced in electron-proton collisions through charged current interactions as a consequence of their mixing with light neutrinos. We find that, with the EIC design energy and integrated luminosity, one is able to probe HNLs in the mass range of 1 –100 GeV with mixing angles down to the order of  $10^{-4} \sim 10^{-3}$  through the prompt decay signatures, and in the mass range of 1–10 GeV with  $10^{-6} \sim 10^{-4}$  via the displaced decay signatures. We also consider the invisible mode where an HNL is undetected or decaying to dark sector particles. One could potentially probe heavy HNLs for mixing angles in the window  $10^{-3} \sim 10^{-2}$ , provided SM background systematics can be brought under control. These searches are complementary to other probes of HNLs, such as neutrino-less double- $\beta$  decay, meson decay, fixed-target, and high-energy collider experiments.

## Name of collaboration or list of co-authors

Brian Batell, Tao Han, Tatha Gosh

**Primary author:** XIE, Keping (University of Pittsburgh)**Presenter:** XIE, Keping (University of Pittsburgh)**Session Classification:** Monday after lunch

Contribution ID: 54

Type: **not specified**

## Measurement of the tau-lepton pair production from photons and tau $g-2$

*Wednesday, December 6, 2023 2:50 PM (20 minutes)*

Relativistic heavy-ion beams at the LHC are accompanied by a large flux of equivalent photons, leading to photon-induced processes. In this talk, the observation of tau-lepton pair production in ultraperipheral lead-lead collisions recorded by the ATLAS experiment at the LHC in 2018 is reported. The measurement is used to constrain the tau lepton's anomalous magnetic dipole moment.

### Name of collaboration or list of co-authors

ATLAS Collaboration

**Primary authors:** DALLAPICCOLA, Carlo (University of Massachusetts (US)); BUAT, Quentin (University of Washington)

**Presenter:** BUAT, Quentin (University of Washington)

**Session Classification:** Wednesday after lunch



Contribution ID: 55

Type: **Plenary Presentation**

## Wishlist of neutrino results for Tau2025

*Friday, December 8, 2023 3:40 PM (30 minutes)*

I provide an overview of neutrino physics including outstanding questions and how we hope to get answers. I will spend a little more time talking about lepton number violation and the nature of neutrinos.

### **Name of collaboration or list of co-authors**

NA

**Primary author:** DE GOUVEA, Andre

**Presenter:** DE GOUVEA, Andre

**Session Classification:** Friday afternoon

Contribution ID: 56

Type: **Plenary Presentation**

## Searches for Neutrinoless Double Beta Decay

*Thursday, December 7, 2023 9:55 AM (25 minutes)*

Observation of neutrinoless double beta decay would profoundly impact our understanding of the neutrino. This lepton-number violating process requires new beyond Standard Model physics, would imply that neutrinos are Majorana particles, and provide insight into the nature of neutrino mass. It is thus a highly-sensitive and promising probe of new physics. In this talk, I will present the status of the experimental field, particularly highlighting the recent achievements. The future is bright, with next-generation experimental concepts proposed to leverage these advances and drive the discovery sensitivity of the field down to the  $m_{\beta\beta} \sim 10$  meV scale.

### Name of collaboration or list of co-authors

N/A

**Primary author:** PETTUS, Walter (Indiana University)**Presenter:** PETTUS, Walter (Indiana University)**Session Classification:** Thursday morning

Contribution ID: 57

Type: **Plenary Presentation**

# Measurement of the anomalous magnetic moment in ultraperipheral collisions with ALICE at the LHC

*Wednesday, December 6, 2023 3:10 PM (20 minutes)*

The measurement of the anomalous magnetic moment of leptons  $a_l$  provides a sensitive test of QED and allows one to test for the existence of New Physics (NP) beyond the Standard Model. Since the NP effect is expected to scale with  $m_l^2$ , the tauon with its heavy mass promises to be the most suitable lepton for such a test. However, due to its short lifetime, the spin precessing methods used to determine  $a_{e,\mu}$  with high accuracy cannot be applied in this case. Alternatively, one can exploit the fact that the  $\gamma - \tau$  vertex is sensitive to  $a_\tau$ , such as in the  $\gamma + \gamma \rightarrow \tau + \tau$  process. Ultraperipheral PbPb collisions (UPCs) at the LHC provide a clean environment to study two-photon induced processes. In this talk, we discuss the prospects of measuring  $a_\tau$  in UPCs with ALICE at the LHC with data from the ongoing Run 3 data campaign.

## Name of collaboration or list of co-authors

ALICE

**Primary author:** BUHLER, Paul Alois (Stefan Meyer Institute for Subatomic Physics (SMI), Austrian Academy of Sciences)

**Presenter:** BUHLER, Paul Alois (Stefan Meyer Institute for Subatomic Physics (SMI), Austrian Academy of Sciences)

**Session Classification:** Wednesday after lunch

Contribution ID: 58

Type: **Plenary Presentation**

## Search for Baryogenesis and Dark Matter in *B*-meson decays at *BABAR*.

*Tuesday, December 5, 2023 5:00 PM (20 minutes)*

We present the most recent *BABAR* searches for reactions that could simultaneously explain the presence of dark matter and the matter-antimatter asymmetry in the Universe. This scenario predicts exotic *B*-meson decays into an ordinary-matter baryon and a dark-sector anti-baryon  $\psi_D$  with branching fractions accessible at the *B* factories.

The results are based on the full data set of about  $430 \text{ fb}^{-1}$  collected at the  $\Upsilon(4S)$  resonance by the *BABAR* detector at the PEP-II collider.

We search, in particular, for decays like  $B^0 \rightarrow \psi_D \text{ cal}B$  where

*calB* is a baryon (proton or  $\Lambda$ ). The hadronic recoil method has been applied with one of the *B* mesons from  $\Upsilon(4S)$  decay fully reconstructed, while only one baryon is present in the signal *B*-meson side. The missing mass of signal *B* meson is considered as the mass of the dark particle  $\psi_D$ . Stringent upper limits on the decay branching fraction are derived for  $\psi_D$  masses between 1.0 and 4.3  $\text{GeV}/c^2$ .

### Name of collaboration or list of co-authors

BABAR

**Primary author:** ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT))

**Presenter:** BROWN, David Norvil (Western Kentucky University)

**Session Classification:** Tuesday afternoon

Contribution ID: 59

Type: **Plenary Presentation**

## Charged Lepton Flavor Violation at the EIC

*Tuesday, December 5, 2023 4:20 PM (20 minutes)*

The discovery of neutrino oscillations provided conclusive evidence for lepton flavor violation (LFV). LFV in the neutrino sector is expected to induce charged lepton flavor violation (CLFV), although it is highly suppressed by the small neutrino masses. However, a wide variety of new physics beyond the Standard Model can lead to enhanced rates for CLFV processes within the reach of current experiments. CLFV can arise in Deep Inelastic Scattering (DIS) processes, such as  $ep \rightarrow \tau X$ , that can be searched for at the EIC in a manner that complements CLFV searches in other experiments. The high luminosity, wide kinematic range, and the availability of polarized beams at the EIC allows for improved sensitivity to different underlying CLFV mechanisms, providing complementary information to other low energy probes and constrains from the LHC. It could also lead to an improvement by an order of magnitude or more compared to previous limits set at HERA. In this talk, I will provide an overview of the impact the EIC can have in constraining CLFV physics. I will also discuss the possibility of probing CLFV between the first two generations of charged leptons at JLAB.

### **Name of collaboration or list of co-authors**

Yulia Furletova, Jinlong Zhang, Xiaochao Zheng, and the ECCE collaboration

**Primary author:** MANTRY, Sonny (University of North Georgia)

**Presenter:** MANTRY, Sonny (University of North Georgia)

**Session Classification:** Tuesday afternoon

Contribution ID: 60

Type: **Plenary Presentation**

## Matter effects in the muon to tau neutrino probability ( $P_{\mu\tau}$ ) at long baselines

*Thursday, December 7, 2023 2:10 PM (20 minutes)*

In the simple two-generation case the probability  $P_{\mu\tau}$  is not affected by interactions of neutrinos in matter. But for three generation case at baselines of the order of 9000 km matter effects become important for this channel. This is a genuine three flavour effect. We study how the presence of non-standard interactions alters the  $P_{\mu\tau}$  probability at these baselines. We observe large deviations from standard matter effect. In particular we find energies and baselines for which the phases governing the non-standard interactions do not play any role. This may facilitate a better determination of NSI parameters if tau neutrinos can be detected.

### Name of collaboration or list of co-authors

Animesh Chatterjee and Supriya Pan

**Primary author:** GOSWAMI, Srubabati (Northwestern University)

**Co-authors:** Dr CHATTERJEE, Animesh (CERN); Mr PAN, Supriya (Physical Research Laboratory)

**Presenter:** GOSWAMI, Srubabati (Northwestern University)

**Session Classification:** Thursday after lunch

Contribution ID: 61

Type: **Plenary Presentation**

# The Hyper-Kamiokande Experiment: Status and Prospect

*Thursday, December 7, 2023 4:20 PM (20 minutes)*

Hyper-Kamiokande is the next generation neutrino observatory with broad physics programs: searching for leptonic CP violation in long baseline accelerator neutrino oscillations, neutrino mass ordering, potentially discovering the proton decay, observing supernova burst neutrinos, supernova relic neutrinos as well as another type of astrophysical neutrinos and solar neutrinos. It will be the world largest underground Cherenkov detector, with an eight times larger fiducial volume than its predecessor, Super-Kamiokande, filled with 258 kton of ultrapure water, starting its operation in 2027 at Kamioka, Japan.

In this presentation, we will describe the physics program of Hyper-Kamiokande, as well as present the status of the experiment.

## **Name of collaboration or list of co-authors**

Hyper Kamiokande

**Primary author:** Dr KOSE, Umut (ETH-Zurich)

**Presenter:** Dr KOSE, Umut (ETH-Zurich)

**Session Classification:** Thursday afternoon

Contribution ID: 62

Type: **Plenary Presentation**

## Magnetic and Electric Tau Dipole Moments Revisited

*Tuesday, December 5, 2023 11:40 AM (25 minutes)*

Precise measurements of magnetic and electric dipole moments are important tests of the standard model and beyond standard model physics, in particular for the electron and the muon. However, when dealing with the tau lepton, the situation presents distinctive challenges due to its very short lifetime and relatively high mass. In this talk, we review the theoretical predictions and the experimental measurements of both the anomalous magnetic and electric dipole moments of the tau lepton.

### **Name of collaboration or list of co-authors**

no list

**Primary author:** Prof. GONZÁLEZ-SPRINBERG, Gabriel (Faculty of Sciences-Uruguay)

**Presenter:** Prof. GONZÁLEZ-SPRINBERG, Gabriel (Faculty of Sciences-Uruguay)

**Session Classification:** Tuesday before lunch



Contribution ID: 63

Type: **Plenary Presentation**

## NOvA Status and Prospects

*Thursday, December 7, 2023 4:00 PM (20 minutes)*

NOvA is a two detector, long baseline, neutrino oscillation experiment utilizing the NuMI beamline at Fermilab to study neutrino oscillations through muon (anti)neutrino disappearance and electron (anti)neutrino appearance. NOvA's primary goals are to make determinations of the neutrino mass hierarchy and the octant of  $\theta_{23}$ , and to measure possible CP violation. Along with standard three flavor neutrino oscillations, NOvA data is used to study cross sections in the near detector, neutrino oscillations beyond the three flavor framework such as sterile neutrinos and non-standard interactions, along with other exotic neutrino interactions from astrophysical sources including supernovae. I will provide an overview of the NOvA detectors, share some current results from the experiment, and discuss the future of NOvA operations and analyses.

### **Name of collaboration or list of co-authors**

NOvA

**Primary author:** LACKEY, Teresa (Fermilab)**Presenter:** LACKEY, Teresa (Fermilab)**Session Classification:** Thursday afternoon

Contribution ID: 64

Type: **Plenary Presentation**

## Current Status and Future Prospects of the ICARUS Experiment

*Thursday, December 7, 2023 12:05 PM (25 minutes)*

The ICARUS T600 LArTPC detector successfully ran for three years at the underground LNGS laboratories, providing a first sensitive search for LSND-like anomalous electron neutrino appearance in the CNGS beam. After a significant overhauling at CERN, the T600 detector has been placed in its experimental hall at Fermilab, fully commissioned, and the first events observed with full detector readout. Regular data taking began in May 2021 with neutrinos from the Booster Neutrino Beam (BNB) and neutrinos 6 degrees off-axis from the Neutrinos at the Main Injector (NuMI). As the far detector of the Short-Baseline Neutrino (SBN) Program, the ICARUS experiment's capability in searching for both muon neutrino disappearance and electron neutrino appearance will allow for unprecedented sensitivity to light sterile neutrinos with eV-scale mass. Exposure to both the BNB and NuMI beams provides a broad program of neutrino interaction measurements and searches for physics beyond the Standard Model. This talk will summarize the current status and future prospects of the ICARUS experiment.

### Name of collaboration or list of co-authors

ICARUS Collaboration

**Primary author:** MUELLER, Justin

**Presenter:** MUELLER, Justin

**Session Classification:** Thursday before lunch

Contribution ID: 65

Type: **Plenary Presentation**

## Mu2e-II Experiment

*Monday, December 4, 2023 5:00 PM (20 minutes)*

Mu2e-II experiment is a proposed upgrade to the Mu2e experiment (currently in its construction phase) for the purpose of discovering charge lepton flavor violation (CLFV) through muon to electron conversion. The upgrade will use the increased beam capabilities of Fermilab's PIP-II project to achieve another order of magnitude improvement over the existing Mu2e goal of  $10^4$  to the previous limit set on the conversion. This improvement will also require R&D on the existing detector and accelerator technologies. I will discuss the physics goal, necessary R&D and the latest sensitivity projections.

### **Name of collaboration or list of co-authors**

Mu2e-II collaboration

**Primary author:** YUCEL, Mete (Fermilab)**Presenter:** YUCEL, Mete (Fermilab)**Session Classification:** Monday afternoon

Contribution ID: 66

Type: **Plenary Presentation**

## Chiral Belle: e- Beam Polarization Upgrade of SuperKEKB

*Friday, December 8, 2023 10:15 AM (25 minutes)*

Recent R&D work associated with upgrading the SuperKEKB e+e- collider with polarized electron beams is presented. The Chiral Belle physics program enables a set of unique precision measurements using the Belle II detector. It includes a set of measurements of  $\sin^2 \theta_W$  via separate left-right asymmetry ( $A_{LR}$ ) measurements in annihilations to pairs of electrons, muons, taus, charm and b-quarks that yield precisions matching or exceeding those of the current world averages from measurements at the  $Z^0$ , but at 10GeV. Consequently these measurements provide unique probes the running of  $\sin^2 \theta_W$  with high precision. Chiral Belle will also probe for new physics via the highest precision measurements of neutral current universality ratios and precision measurements of tau lepton properties, including the tau magnetic moment. After reviewing developments on the physics potential, this presentation will report on developments related to provision of the polarized source, the new components of the accelerator lattice that rotate the electron spin from transverse to longitudinal at the interaction point, and polarimetry of the electron beam.

### Name of collaboration or list of co-authors

Belle II &amp; SuperKEKB e- Polarization Upgrade Working Group

**Primary author:** RONEY, Michael**Presenter:** RONEY, Michael**Session Classification:** Friday morning

Contribution ID: 67

Type: **Plenary Presentation**

# **Tau Polarization and Correlated Decays in Neutrino Experiments**

*Thursday, December 7, 2023 2:30 PM (20 minutes)*

We present the first fully differential predictions for tau neutrino scattering in the energy region relevant to the DUNE experiment, including all spin correlations and all tau lepton decay channels. The calculation is performed using a generic interface between the neutrino event generator Achilles and the publicly available, general-purpose collider event simulation framework Sherpa.

## **Name of collaboration or list of co-authors**

Listed above

**Primary author:** ISAACSON, Joshua

**Co-authors:** SIEGERT, Frank (Technische Universitaet Dresden (DE)); WANG, Sherry; HOECHE, Stefan (Fermilab)

**Presenter:** ISAACSON, Joshua

**Session Classification:** Thursday after lunch

Contribution ID: 68

Type: **Plenary Presentation**

# The Deep Underground Neutrino Experiment

*Thursday, December 7, 2023 10:50 AM (25 minutes)*

The Deep Underground Neutrino Experiment, DUNE, is a next-generation long-baseline neutrino oscillation experiment with the main goal of precisely measuring the neutrino oscillation parameters. DUNE will employ the most intense beam of neutrinos produced at the Fermi National Accelerator Laboratory, FNAL, in Batavia, Illinois and aimed at the far detector complex located 1300km away and 1.5km below the surface in the Sanford Underground Research Facility, SURF, in Lead, South Dakota. The baseline for the far detector complex features a set of liquid argon time projection chambers, LArTPC, with a total volume of 70 ktons, which will record the neutrino interactions, while a near detector complex at FNAL will analyze the content of the neutrino beam. Furthermore, the scientific reach of this US flagship project spans the range from proton decay to the observation of neutron stars and black holes. The DUNE collaboration is an international team of 1000+ scientists and engineers who are working on achieving those goals. This presentation will discuss the current status of DUNE.

## Name of collaboration or list of co-authors

The DUNE Collaboration

**Primary author:** TZANOV, Martin (Louisiana State University)**Presenter:** TZANOV, Martin (Louisiana State University)**Session Classification:** Thursday before lunch

Contribution ID: 70

Type: **Plenary Presentation**

## Neutrino-nuclear interactions, beyond-standard-model physics, and accelerator-produced dark matter

*Thursday, December 7, 2023 9:30 AM (25 minutes)*

Neutrino-nuclear interactions have been crucial from the discovery of neutrinos through the flagship neutrino oscillation experiments of today. At low energy, knowledge of weak form factors and nuclear structure are intertwined with ongoing studies of coherent elastic neutrino-nucleus scattering, and for the detection of supernova neutrinos. For high energy neutrino sources, deep inelastic scattering and the hadronization of target nuclei shape complex event topologies in detectors. Further, accelerator neutrino sources offer fertile ground for beyond-standard-model physics such as searches for accelerator-produced dark matter. In this talk, I provide a brief overview of experiments which can both benefit from and contribute to our knowledge of neutrino-nuclear interactions, and survey searches for accelerator-produced dark matter and other BSM signatures at accelerator-based neutrino sources.

### **Name of collaboration or list of co-authors**

COHERENT

**Primary author:** SALVAT, Daniel (Indiana University)**Presenter:** SALVAT, Daniel (Indiana University)**Session Classification:** Thursday morning

Contribution ID: 71

Type: **Plenary Presentation**

## Status and Prospects of SNO+ Experiment

*Tuesday, December 5, 2023 3:10 PM (20 minutes)*

SNO+ aims to detect the neutrinoless double beta decay ( $0\nu\beta\beta$ ) signals of Te130, which, if observed, would prove neutrinos are Majorana particles that violate lepton number, providing strong evidence for physics beyond the Standard Model, and shed light on the origin of matter over anti-matter in the Universe. Between 2017 - 2019, SNO+ took data in the water phase, during which it obtained world-leading limits on invisible nucleon decay and achieved the first detection of reactor antineutrinos using pure water. Currently, SNO+ is running its liquid scintillator phase, which allows us to measure the internal radioactivity of the scintillator and external backgrounds for the search of  $0\nu\beta\beta$ , and enables us to measure geoneutrinos, reactor neutrinos, solar neutrinos, atmospheric neutrinos and potential supernova neutrinos in a wide energy range. Loading Te in the liquid scintillator is in preparation, and the exciting Te data taking will start in 2025. Sensitivity for the effective Majorana neutrino mass near or into the parameter space allowed by inverted neutrino mass ordering can be expected.

### Name of collaboration or list of co-authors

SNO+ Collaboration

**Primary author:** YE, Ziping**Presenter:** YE, Ziping**Session Classification:** Tuesday after lunch



Contribution ID: 72

Type: **Plenary Presentation**

## Status and plans of tau fits for HFLAV/PDG

*Friday, December 8, 2023 12:25 PM (25 minutes)*

HFLAV performs a global fit of the tau branching fractions measurements and, for several tau decay modes searches, a combination of the measured upper limits. The status and prospects of these fits are presented.

### **Name of collaboration or list of co-authors**

Heavy Flavour Averaging Group

**Primary authors:** LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa); SHWARTZ, Boris; Prof. HAYASAKA, Kiyoshi (Niigata University); CHRZASZCZ, Marcin (Polish Academy of Sciences (PL)); RONEY, Michael; BANERJEE, Swagato (University of Louisville (US))

**Presenter:** LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

**Session Classification:** Friday before lunch

Contribution ID: 73

Type: **Plenary Presentation**

## Neutrinos in modern astrophysics and cosmology

*Friday, December 8, 2023 9:25 AM (25 minutes)*

Neutrinos are some of the most abundant elementary particles in our universe. They play important, even dominant, roles in many of the most extreme astrophysical phenomena, while also serving as unique messengers from the deep stellar interiors. Historically, studies of solar neutrinos gave us the first observation of physics beyond the Standard Model, while also providing an important probe of the solar core. I will focus on the physics that can be learned from the detection of the next supernova neutrino burst and the analysis of modern cosmological data.

### **Name of collaboration or list of co-authors**

none

**Primary author:** FRIEDLAND, Alexander

**Presenter:** FRIEDLAND, Alexander

**Session Classification:** Friday morning

Contribution ID: 74

Type: **Plenary Presentation**

## The sensitivity and discovery potential of nEXO

*Thursday, December 7, 2023 5:00 PM (20 minutes)*

Neutrinoless double beta decay ( $0\nu\beta\beta$ ) is a hypothetical nuclear process which, if observed, would have far-reaching implications in particle physics. Being a lepton number violating process, the observation of  $0\nu\beta\beta$  is direct evidence for physics beyond the Standard Model. In addition, it would prove that neutrinos are Majorana particles, and contribute to the determination of the neutrino mass scale. nEXO is a proposed next-generation experiment that will search for  $0\nu\beta\beta$  of  $^{136}\text{Xe}$ . nEXO plans to use a liquid xenon time projection chamber that employs 5 tonnes of xenon, isotopically enriched to 90% in Xe-136. Ionization electrons and scintillation photons will be detected by segmented anode tiles and silicon photomultipliers, respectively. These will enable event-by-event reconstruction of event energy, position, and topology which will be used in a multi-parameter analysis to search for  $0\nu\beta\beta$  events. The projected sensitivity of nEXO to the Xe-136  $0\nu\beta\beta$  half-life is  $1.35 \times 10^{28}$  years after 10 years of data-taking. The nEXO project is being developed by a collaboration of 34 institutions from 9 countries. In this talk, an overview of nEXO will be presented followed by a description of the conceptual design.

### Name of collaboration or list of co-authors

nEXO Collaboration

**Primary author:** Prof. MACLELLAN, Ryan (University of Kentucky)**Presenter:** Prof. MACLELLAN, Ryan (University of Kentucky)**Session Classification:** Thursday afternoon

Contribution ID: 75

Type: **Plenary Presentation**

## Wishlist of Tau results for 2025

*Friday, December 8, 2023 4:40 PM (30 minutes)*

In this talk, I will briefly review the status of tau lepton physics after Tau 2023 and provide a wishlist of topics and results that would be welcome in the field in the next years, particularly at Tau 2025.

### **Name of collaboration or list of co-authors**

no co-authors

**Primary author:** INGUGLIA, Gianluca (Austrian Academy of Sciences)

**Presenter:** INGUGLIA, Gianluca (Austrian Academy of Sciences)

**Session Classification:** Friday afternoon

Contribution ID: 76

Type: **Plenary Presentation**

## **Study of additional radiation in the initial-state-radiation processes $e^+e^- \rightarrow \mu^+\mu^-\gamma$ and $e^+e^- \rightarrow \pi^+\pi^-\gamma$ in the BABAR experiment**

*Friday, December 8, 2023 2:10 PM (20 minutes)*

A dedicated study of additional radiation in  $e^+e^- \rightarrow \mu^+\mu^-\gamma$  and  $e^+e^- \rightarrow \pi^+\pi^-\gamma$  initial-state-radiation events is presented using the full BABAR data sample. Results are presented at next-to- and next-to-next-to-leading order, with one and two additional photons, respectively, for radiation from the initial and final states. Comparison with predictions from Phokhara and AfkQed Monte Carlo generators is performed, revealing discrepancies in the one-photon rates and angular distributions for the former. This disagreement has a negligible effect on the BABAR measurement of the  $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$  cross section, but may affect other measurements significantly.

### **Name of collaboration or list of co-authors**

BaBar collaboration

**Primary author:** LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)**Presenter:** LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)**Session Classification:** Friday after lunch

Contribution ID: 77

Type: **Plenary Presentation**

## Tau-LFUV Tests at Future Lepton Colliders

*Tuesday, December 5, 2023 2:50 PM (20 minutes)*

As one of the hypothetical principles in the Standard Model (SM), lepton flavor universality (LFU) should be tested with a precision as high as possible such that the physics violating this principle can be fully examined. The run of  $Z$  factory at a future  $e^+e^-$  collider such as CEPC or FCC- $ee$  provides a great opportunity to perform this task because of the large statistics and high reconstruction efficiencies for  $b$ -hadrons at  $Z$  pole. In this paper, we present a systematic study on the LFU test in the future  $Z$  factories. The goal is three-fold. Firstly, we study the sensitivities of measuring the LFU-violating observables of  $b \rightarrow c\tau\nu$ ,  $\{ \text{it i.e.}, R_{J/\psi}, R_{D_s}, R_{D_s^*} \text{ and } R_{\Lambda_c} \}$ , where  $\tau$  decays muonically. For this purpose, we develop the strategies for event reconstruction, based on the track information significantly. Secondly, we explore the sensitivity robustness against detector performance and its potential improvement with the message of event shape or beyond the  $b$ -hadron decays. A picture is drawn on the variation of analysis sensitivities with the detector tracking resolution and soft photon detectability, and the impact of Fox-Wolfram moments is studied on the measurement of relevant flavor events. Finally, we interpret the projected sensitivities in the SM effective field theory, by combining the LFU tests of  $b \rightarrow c\tau\nu$  and the measurements of  $b \rightarrow s\tau^+\tau^-$  and  $b \rightarrow s\bar{\nu}\nu$ . We show that the limits on the LFU-violating energy scale can be pushed up to  $\sim \mathcal{O}(10)$  TeV for  $\text{less sim } \mathcal{O}(1)$  Wilson coefficients at Tera- $Z$ .

### Name of collaboration or list of co-authors

Anson Kwok, Xuhui Jiang, Tao Liu

**Primary author:** LI, LINGFENG (Brown U.)

**Presenter:** LI, LINGFENG (Brown U.)

**Session Classification:** Tuesday after lunch

Contribution ID: 78

Type: **not specified**

## Summary of Tau2023

*Friday, December 8, 2023 5:10 PM (30 minutes)*

We will give a summary of the conference highlights.

### **Name of collaboration or list of co-authors**

None

**Primary author:** PRELL, Soeren Andre (Iowa State University)

**Presenter:** PRELL, Soeren Andre (Iowa State University)

**Session Classification:** Friday afternoon

Contribution ID: 79

Type: **Plenary Presentation**

## Electromagnetic corrections in hadronic tau decays

*Monday, December 4, 2023 1:30 PM (20 minutes)*

We study the isospin-breaking and electromagnetic corrections of hadronic tau decays, which can also be utilized to extract the CKM matrix element  $V_{us}$ . Our analysis extends previous work by Antonelli et al. using ChPT with resonances. Our findings show the importance of these corrections in distinguishing between the  $\pi^- \bar{K}^0$  and  $K^- \pi^0$  modes, beyond the Low approximation. The  $K^- K^0$  channel is also discussed.

### Name of collaboration or list of co-authors

Rafel Escribano and Pablo Roig

**Primary authors:** MIRANDA, Alejandro (IFAE); ROIG GARCÉS, Pablo; ESCRIBANO, Rafel**Presenter:** MIRANDA, Alejandro (IFAE)**Session Classification:** Monday after lunch



Contribution ID: 80

Type: **Plenary Presentation**

# An alternative evaluation of the leading-order hadronic contribution to the muon g-2 with MUonE

*Tuesday, December 5, 2023 9:55 AM (25 minutes)*

We propose an alternative method to extract the leading-order hadronic contribution to the muon g-2,  $a_\mu^{\text{HLO}}$ , with the MUonE experiment. In contrast to the traditional method based on the integral of the hadronic contribution to the running of the electromagnetic coupling,  $\Delta\alpha_{\text{had}}$ , in the space-like region, our approach relies on the computation of the derivatives of  $\Delta\alpha_{\text{had}}(t)$  at zero squared momentum transfer  $t$ . We show that this approach allows to extract  $\sim 99\%$  of the total value of  $a_\mu^{\text{HLO}}$  from the MUonE data, while the remaining  $\sim 1\%$  can be computed combining perturbative QCD and data on  $e^+e^-$  annihilation to hadrons. This leads to a competitive evaluation of  $a_\mu^{\text{HLO}}$  which is robust against the parameterization used to model  $\Delta\alpha_{\text{had}}(t)$  in the MUonE kinematic region, thanks to the analyticity properties of  $\Delta\alpha_{\text{had}}(t)$ , which can be expanded as a polynomial at  $t \sim 0$ .

## Name of collaboration or list of co-authors

Riccardo Nunzio Pilato (speaker), Fedor Ignatov, Thomas Teubner, Graziano Venanzoni

**Primary author:** PILATO, Riccardo (University of Liverpool)**Co-authors:** Dr IGNATOV, Fedor (University of Liverpool); VENANZONI, Graziano (INFN); TEUBNER, Thomas**Presenter:** PILATO, Riccardo (University of Liverpool)**Session Classification:** Tuesday morning

Contribution ID: 81

Type: **Plenary Presentation**

## Renormalon subtraction in hadronic tau decays

*Wednesday, December 6, 2023 11:30 AM (20 minutes)*

The hadronic tau decay width is regarded as an important observable from which the strong coupling can be extracted precisely. However, the inconsistency in the calculations between two perturbative methods, known as FOPT and CIPT, had been a long standing problem until recently. We propose a new method to remove the renormalon divergence, which has turned out to cause the problem, by utilizing the gradient flow. Compared with the previously proposed method, our method can skip estimate of the renormalon normalization and can give the unambiguous gluon condensate by lattice simulations. In this talk, I will explain the idea and show that the FOPT and CIPT calculations exhibit mutually consistent results.

### **Name of collaboration or list of co-authors**

Martin Beneke, Hiromasa Takaura

**Primary author:** Dr TAKAURA, Hiromasa

**Presenter:** Dr TAKAURA, Hiromasa

**Session Classification:** Wednesday before lunch

Contribution ID: 83

Type: **Plenary Presentation**

## Search for LFV with tau leptons in the final state

*Wednesday, December 6, 2023 1:50 PM (20 minutes)*

In the Standard Model (SM) lepton flavour numbers are exactly conserved. The observation of neutrino oscillations, however, proves that neutrinos are massive particles and allows for Lepton Flavour Violating (LFV) processes. Nevertheless, these processes are predicted with very low branching ratios and are sensitive to new physics effects, which could manifest as an enhancement in the decay probability. Similarly, Lepton Flavour Universality Violating (LFUV) observables allows for the test of the SM and the study of beyond the SM theories. The latest CMS results from the Higgs, B-physics and exotica groups are presented on the search for LFV and LFUV with tau leptons in the final state. The results are based on data collected in proton-proton collisions at the centre of mass energy of 13 TeV.

### Name of collaboration or list of co-authors

CMS

**Primary author:** GUZZI, Luca (Universita & INFN, Milano-Bicocca)

**Presenter:** GUZZI, Luca (Universita & INFN, Milano-Bicocca)

**Session Classification:** Wednesday after lunch

Contribution ID: 84

Type: **Plenary Presentation**

## Searches for New Physics that couple with third generation fermions

*Wednesday, December 6, 2023 1:30 PM (20 minutes)*

The tau lepton is the only one kinematically allowed to decay into hadrons and a tau neutrino. Semi-leptonic tau decays (indicated as hadronic decays) occur about the 65% of times in a combination of charged and neutral hadrons, and a tau neutrino. The remaining times, tau leptons decay into a lighter charged lepton which can be identified and reconstructed by detectors, and two neutrinos, which escape undetected. The Tau leptons play a key role for many analyses involving Standard Model (SM) phenomena, like the leptonic Higgs decays, or searches for New Physics that couple with third generation fermions. Therefore a correct identification of taus, especially hadronic ones, is crucial at the CMS experiment. The major challenge is to discriminate hadronically decaying taus against the backgrounds originated from quark or gluon jets, which are copiously produced in QCD multijet processes; moreover, also electrons or muons that can be produced by Drell-Yan, leptonic W decays and other SM processes. The tau reconstruction at CMS starts at L1-Trigger, the hardware based trigger, where the seeds for the HLT objects reconstruction are defined, then it is reconstructed at the High Level Trigger (offline) through different steps, depending on the tau decay channel.

The talk will cover the techniques adopted at the CMS experiment to identify tau leptons, with a specific focus on hadronic decays, at the High Level Trigger during the current ongoing data taking (Run 3), which started in 2022.

### Name of collaboration or list of co-authors

CMS Collaboration

**Primary author:** D'AMANTE, Valeria (Universita & INFN Pisa)**Presenter:** D'AMANTE, Valeria (Universita & INFN Pisa)**Session Classification:** Wednesday after lunch

Contribution ID: 85

Type: **Plenary Presentation**

## Neutrino Portals to the Dark Sector

*Tuesday, December 5, 2023 2:10 PM (20 minutes)*

Dark sectors that communicate with the visible sector via SM neutrinos are well-motivated benchmarks for current and future experimental searches. However, they are much more elusive than the typical minimal portal scenarios (e.g dark photon, dark Higgs portals). In this talk, we will discuss some models of neutrino portal dark matter that become increasingly more invisible, and describe strategies to search for these dark matter candidates at experiments such as Belle II and at the Forward Physics Facility. In particular, I will focus on two models: heavy neutral leptons that decay invisibly to dark matter, and purely neutrinophilic dark matter.

### **Name of collaboration or list of co-authors**

Kevin J. Kelly, Felix Kling, and Yue Zhang;  
Wolfgang Altmannshofer, Akshay Galsasi, and David McKeen

**Primary author:** TUCKLER, Douglas (TRIUMF and Simon Fraser University)

**Presenter:** TUCKLER, Douglas (TRIUMF and Simon Fraser University)

**Session Classification:** Tuesday after lunch

Contribution ID: 87

Type: **Plenary Presentation**

## Overview of Tau Physics

*Monday, December 4, 2023 9:15 AM (40 minutes)*

I will review the recent status relating tau physics as well as other leptons.

### **Name of collaboration or list of co-authors**

None

**Primary author:** HAYASAKA, Kiyoshi (Niigata University)

**Presenter:** HAYASAKA, Kiyoshi (Niigata University)

**Session Classification:** Monday morning

Contribution ID: 90

Type: **Plenary Presentation**

## What if cLFV was only detectable in tau decays?

*Monday, December 4, 2023 12:05 PM (25 minutes)*

The observation of massive neutrino oscillations indicate that lepton flavour is violated beyond the renormalizable standard model (SM). However, extending the SM by merely the existence of neutrino oscillations does not predict an observably large signal in charged lepton flavour violating (cLFV) searches. Therefore, a detection of cLFV would represent a genuine signal of new physics effects in the lepton sector —perhaps the same underlying physics which generates nonzero neutrino masses. Many precision searches for cLFV have focussed on the muon-electron transition, and they have thus far set strong limits but not detected any events. Motivated by flavour symmetry models, we may construct theories based on a low-energy limit featuring lepton flavour triality that have flavour-violating tau decays as the main phenomenological signatures of BSM physics. These decay modes are expected to be probed in the near future with increased sensitivity by the Belle II experiment. In this talk I will discuss the motivation, model-building and phenomenology of simple extensions to the SM featuring doubly-charged scalars, for which the smoking-gun would be a detection of cLFV in these tau decay channels. This talk will be based around the work in arXiv 2212.09760 .

### Name of collaboration or list of co-authors

As indicated above

**Primary author:** Dr BIGARAN, Innes (Fermilab and Northwestern University)**Co-authors:** VALENCIA, German (Monash University (AU)); SCHMIDT, Michael (UNSW Sydney); Prof. VOLKAS, Raymond (The University of Melbourne); HE, Xiao-Gang**Presenter:** Dr BIGARAN, Innes (Fermilab and Northwestern University)**Session Classification:** Monday before lunch

Contribution ID: 91

Type: **Plenary Presentation**

## Hadronic vacuum polarization contribution to the muon $g-2$ from lattice QCD

*Friday, December 8, 2023 11:10 AM (25 minutes)*

The experimental uncertainty on the anomalous magnetic moment of the muon has been significantly reduced with the recent results of the Fermilab  $g-2$  experiment, and a further reduction is expected in the near future. The precision of the Standard Model prediction needs to improve correspondingly to increase the sensitivity of tests for physics beyond the Standard Model. The largest uncertainty is due to the strong interaction, in particular the hadronic vacuum polarization (HVP) contribution.

Lattice QCD calculations have the potential to provide precise predictions of the HVP contribution with systematically improvable uncertainties. We will review the current state of lattice QCD calculations, focusing on the dominant sources of uncertainty that need to be controlled to provide results with sub-percent precision. We will also address recently emerging tensions with data-driven estimates.

### Name of collaboration or list of co-authors

.

**Primary author:** KUBERSKI, Simon**Presenter:** KUBERSKI, Simon**Session Classification:** Friday before lunch



Contribution ID: 92

Type: **Plenary Presentation**

## **Tau hadronic decay input for Muon $g-2$**

*Friday, December 8, 2023 11:35 AM (25 minutes)*

Hadronic tau decay experiments provide an alternative determination of the Hadronic Vacuum Polarization for Muon  $g-2$ . The difference in the hadronic cross section between tau-decay and electron-positron collision must be corrected. We review our strategies for such isospin-breaking correction using first-principle Lattice QED+QCD predictions.

### **Name of collaboration or list of co-authors**

RBC / UKQCD Collaboration

**Primary authors:** MEYER, Aaron (University of California Berkeley); LEHNER, Christoph (University of Regensburg); BRUNO, Mattia (CERN); IZUBUCHI, Taku

**Presenter:** IZUBUCHI, Taku

**Session Classification:** Friday before lunch

Contribution ID: 93

Type: **Plenary Presentation**

## Leptophilic Dark Portals

*Tuesday, December 5, 2023 1:50 PM (20 minutes)*

We will discuss some recent anomalies in the LHC data, which are tantalizing hints of leptophilic dark scalars. Implications for lepton flavor violation and neutrino mass will also be discussed.

### **Name of collaboration or list of co-authors**

Yoav Afik, Anil Thapa

**Primary author:** DEV, Bhupal (Washington University in St. Louis)

**Presenter:** DEV, Bhupal (Washington University in St. Louis)

**Session Classification:** Tuesday after lunch

Contribution ID: 96

Type: **Plenary Presentation**

## **Wishlist of G-2 results for Tau2025**

*Friday, December 8, 2023 4:10 PM (30 minutes)*

Wishlist of G-2 results for Tau2025

### **Name of collaboration or list of co-authors**

G-2

**Presenter:** KIBURG, Brendan (Fermilab)

**Session Classification:** Friday afternoon

Contribution ID: 99

Type: **Plenary Presentation**

## Measurement of the tau lepton polarisation in Z boson decays by CMS detector

*Tuesday, December 5, 2023 5:20 PM (20 minutes)*

We report on a measurement of the tau lepton polarisation using leptonic and hadronic tau lepton decays in  $Z \rightarrow \text{di-tau}$  events. A sample of pp collisions corresponding to an integrated luminosity of  $36.3 \text{ fb}^{-1}$  at a centre of mass energy of 13 TeV is used. The analysis method using template fitting techniques will be described for different decay modes. The measured average polarisation corrected to the Z-pol is in good agreement with the Standard Model value of the lepton asymmetry parameter. The tau-polarisation determines the ratio of the neutral-current vector to axial-vector coupling of the tau lepton and the weak mixing angle independently of the production process of the Z resonance. The result and perspectives are discussed.

### Name of collaboration or list of co-authors

CMS

**Primary author:** MOHAMMADI, Abdollah (University of Wisconsin Madison)

**Presenter:** MOHAMMADI, Abdollah (University of Wisconsin Madison)

**Session Classification:** Tuesday afternoon

Contribution ID: **100**

Type: **not specified**

## Welcome

*Monday, December 4, 2023 9:00 AM (5 minutes)*

Welcome address by Dr. Dayna R. Touron, Dean of College of Arts & Sciences

### **Name of collaboration or list of co-authors**

**Presenter:** TOURON, Dayna (University of Louisville)

**Session Classification:** Welcome by Dean of College of Arts & Sciences

Contribution ID: **101**

Type: **not specified**

## Announcements

*Monday, December 4, 2023 9:05 AM (10 minutes)*

Announcements

### **Name of collaboration or list of co-authors**

**Presenter:** BANERJEE, Swagato (University of Louisville)

**Session Classification:** Monday

Contribution ID: **102**

Type: **not specified**

## Announcements

*Tuesday, December 5, 2023 9:00 AM (5 minutes)*

Announcements

**Name of collaboration or list of co-authors**

**Presenter:** BANERJEE, Swagato (University of Louisville)

**Session Classification:** Tuesday

Contribution ID: **103**

Type: **not specified**

## Announcements

*Wednesday, December 6, 2023 9:00 AM (5 minutes)*

Announcements

**Name of collaboration or list of co-authors**

**Presenter:** BANERJEE, Swagato (University of Louisville)

**Session Classification:** Wednesday



Contribution ID: **104**

Type: **not specified**

## Announcements

*Thursday, December 7, 2023 9:00 AM (5 minutes)*

Announcements

**Name of collaboration or list of co-authors**

**Presenter:** BANERJEE, Swagato (University of Louisville)

**Session Classification:** Thursday

Contribution ID: **105**

Type: **not specified**

## Announcements

*Friday, December 8, 2023 9:20 AM (5 minutes)*

Announcements

### **Name of collaboration or list of co-authors**

**Presenter:** BANERJEE, Swagato (University of Louisville)

**Session Classification:** Friday

Contribution ID: 106

Type: **Plenary Presentation**

## Search for charged lepton flavor violation in $J/\psi$ decays at BESIII

*Friday, December 8, 2023 2:50 PM (20 minutes)*

In the Standard Model (SM), charged Lepton Flavor Violation (cLFV) is highly suppressed to a negligible level by the finite but tiny neutrino masses. The BESIII experiment is a symmetric  $e^+e^-$  collider operating at c.m. energy from 2.0 to 4.95 GeV and has collected the world's largest data set of  $J/\psi$  (10 Billion),  $\psi(2S)$  (2.7 Billion) on production threshold, and about  $25 \text{ fb}^{-1}$  scan data from 3.77 to 4.95 GeV. This talk presents the cLFV searches at BESIII. The  $J/\psi \rightarrow e \tau / e \mu$  is searched for with 10 Billion  $J/\psi$  events and the result improves the previously published limit by two orders of magnitude.

### Name of collaboration or list of co-authors

BESIII

**Primary author:** YU, Xudong (Peking University)

**Presenter:** YU, Xudong (Peking University)

**Session Classification:** Friday after lunch

Contribution ID: **107**

Type: **Plenary Presentation**

## Photos

*Tuesday, December 5, 2023 12:30 PM (20 minutes)*

**Name of collaboration or list of co-authors**

**Presenter:** BANERJEE, Swagato (University of Louisville (US))

**Session Classification:** Photo session