

**Workshop on Tau Neutrinos
from GeV to EeV 2021
(NuTau2021)**

Report of Contributions

Contribution ID: 1

Type: **not specified**

Introduction

Tuesday, 28 September 2021 09:30 (15 minutes)

Presenter: BISHAI, Mary (Brookhaven National Laboratory)

Contribution ID: 3

Type: **not specified**

Theory overview: New Physics in Neutrino Oscillations and role of tau neutrinos

Tuesday, 28 September 2021 09:45 (30 minutes)

I will start motivating and introducing the main New Physics avenues that will be considered in this talk. Then, I will discuss the potential of neutrino oscillation measurements to test these scenarios, paying particular attention to the role of tau neutrino detection. I will also comment on the potential opportunities that tau detection can provide in other related scenarios, as direct searches of Heavy Neutral Leptons in the context of minimal neutrino mass models.

Presenter: LOPEZ-PAVON, Jacobo (Valencia U, IFIC)

Session Classification: Overview

Contribution ID: 4

Type: **not specified**

Experimental overview: artificial sources

Tuesday, 28 September 2021 10:15 (30 minutes)

Artificial neutrino sources are complimentary to natural sources and in many cases have the unique capability that their characteristics can be optimized to specific physics goals. Identifying tau neutrinos from artificial sources is challenging, but has been done successfully by the DoNUT and OPERA experiments. Several experiments using accelerator-based sources of tau neutrinos that are planned or proposed for construction over the next decade. These include for DUNE, FASERnu, SND@LHC, and SHiP. This talk will summarize the status and prospects of these artificial tau neutrino sources.

Presenter: FIELDS, Laura (Fermilab)

Session Classification: Overview

Contribution ID: 5

Type: **not specified**

Experimental overview: natural sources

Tuesday, 28 September 2021 10:45 (30 minutes)

Natural sources produce neutrinos which travel to us over distances ranging from kilometers to gigaparsecs and beyond. Tau neutrinos form a considerable fraction of the neutrino flux, as a result of flavor oscillations. I will review some of the experimental considerations related to detection of atmospheric and cosmological tau neutrinos, and provide a brief overview of the various techniques used, or proposed, to detect these neutrinos at energies ranging from the GeV to the EeV scale.

Presenter: DEYOUNG, Tyce (Michigan State University)

Session Classification: Overview

Contribution ID: 6

Type: **not specified**

Discussion

Tuesday, 28 September 2021 11:15 (15 minutes)

Session Classification: Overview

Contribution ID: 7

Type: **not specified**

Tau neutrinos and 3-flavor model

Tuesday, 28 September 2021 12:30 (45 minutes)

I will review what current measurements tell us about the elements of the PMNS matrix and the importance of the Tau row for the determination of Unitarity.

Presenter: PARKE, Stephen (Fermilab)

Session Classification: Tau neutrinos and SM

Contribution ID: 8

Type: **not specified**

Discussion

Tuesday, 28 September 2021 13:15 (15 minutes)

Session Classification: Tau neutrinos and SM

Contribution ID: 9

Type: **not specified**

Tau neutrinos and lepton flavor at colliders-experiment

Tuesday, 28 September 2021 13:30 (20 minutes)

I review existing collider constraints on lepton universality breaking and lepton flavour violation, and their connection to direct BSM searches.

Presenter: GLIGOROV, Vladimir (CNRS France)

Session Classification: Tau neutrinos and SM

Contribution ID: **10**

Type: **not specified**

Tau neutrinos and lepton flavor at colliders-theory

Tuesday, 28 September 2021 13:50 (20 minutes)

We review the connection between experimental searched for lepton flavor violation and properties of the tau neutrinos.

Presenter: GROSSMAN, Yuval (Cornell)

Session Classification: Tau neutrinos and SM

Contribution ID: **11**

Type: **not specified**

Discussion

Tuesday, 28 September 2021 14:10 (20 minutes)

Session Classification: Tau neutrinos and SM

Contribution ID: 12

Type: **not specified**

Production and detection of tau neutrinos from accelerator sources in DUNE

Wednesday, 29 September 2021 09:30 (20 minutes)

Presenter: MACHADO, Pedro (Fermilab)

Session Classification: Experimental techniques (GeV energies)

Contribution ID: 13

Type: **not specified**

Experimental Detection and Studies of Atmospheric Tau Neutrinos in DUNE

Wednesday, 29 September 2021 09:50 (20 minutes)

Over the last two decades, the experimental understanding of three flavor oscillations has improved dramatically. However, almost all of our understanding of neutrino physics is due to the study of electron and muon neutrinos, and the tau neutrino remains the least well-studied particle in the Standard Model.

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. DUNE is therefore ideally suited to collect a high-statistics, high-purity sample of tau neutrinos to significantly improve our understanding of electroweak interactions and will offer crucial tests of the three-flavor paradigm. This capability can be further improved using a proposed high-energy beam mode.

However, due to the kinematic threshold for producing tau leptons, oscillated beam tau neutrinos occur far from the atmospheric oscillation maximum leading to ambiguity between Δm_{31}^2 and $\sin^2 \theta_{23}$. Since the DUNE Far Detector will be deep underground, it is also ideally suited for collecting a large atmospheric tau neutrino sample. With a rate of 1 charged-current tau neutrinos per kton-year, largely occurring at the first atmospheric oscillation maximum, the DUNE atmospheric tau neutrino sample will provide a critical complement to the beam sample.

In this talk, I will discuss give a brief overview of the atmospheric sensitivity using beam tau neutrinos and the limitation for measuring three flavor parameters. I will present truth-level studies showing the expectations for DUNE's ability to select, reconstruct, and analyze atmospheric tau neutrinos.

Presenter: AURISANO, Adam (University of Cincinnati)

Session Classification: Experimental techniques (GeV energies)

Contribution ID: 14

Type: **not specified**

Experimental techniques: Tau Neutrino Searches at Super-Kamiokande and Hyper-Kamiokande

Wednesday, 29 September 2021 10:10 (20 minutes)

Confirmation of oscillation-induced tau neutrino appearance in atmospheric and accelerator neutrino experiments has been an important piece of establishing the now standard PMNS oscillation paradigm. Though this process has been observed successfully, tau neutrinos continue to play an important role in oscillation physics at these experiments. Further scrutiny of PMNS mixing in order to resolve current open questions, such as the nature of the neutrino mass hierarchy, relies on more detailed knowledge of the tau appearance channel. This talk will focus on measurements of tau neutrinos at Super-Kamiokande to this end and will discuss similar measurement prospects up until and throughout the next-generation experiment, Hyper-Kamiokande.

Presenter: WENDELL, Roger (Kyoto University)

Session Classification: Experimental techniques (GeV energies)

Contribution ID: 15

Type: **not specified**

Experimental techniques: IceCube atmospheric

Wednesday, 29 September 2021 10:30 (20 minutes)

Presenter: KOSKINEN, Jason (NBIA)

Session Classification: Experimental techniques (GeV energies)

Contribution ID: 16

Type: **not specified**

Looking forward to Tau Neutrinos at the LHC - Ideas and Physics Potential

Wednesday, 29 September 2021 11:10 (20 minutes)

As the particle accelerator with the highest energy built thus far, the LHC is also the source of the most energetic human-made neutrinos. Indeed, the LHC produces an intense and strongly collimated beam of TeV-energy neutrinos in the far-forward direction, including a sizable fraction of tau neutrinos. Two neutrino experiments, FASER ν and SND@LHC, are designed to use this opportunity and will start their operation in the upcoming Run of the LHC. For the HL-LHC era, a forward physics facility housing a suite of experiments is being proposed to continue and extend this program. In this talk I will give an overview on ongoing and planned initiatives to detect tau neutrinos at the LHC, and discuss the physics potential that this program offers.

Presenter: KLING, Felix (SLAC)

Session Classification: High energy tau neutrinos at CERN

Contribution ID: 17

Type: **not specified**

Looking Forward to Tau Neutrinos at CERN - Experiments

Wednesday, 29 September 2021 11:30 (20 minutes)

CERN has a number of opportunities to study Tau neutrino physics in the near and more distant future. New experiments recently approved at the LHC will measure neutrinos of all flavours produced in the forward direction produced with energies in the hundreds of GeV to several TeV range. These experiments start data taking in 2022. On the fixed target side the NA65/DsTau experiment will be taking data for physics measurements soon. In the further future the SHiP experiment and the forward physics facility at the LHC will allow for detailed Tau neutrino studies

Presenter: DE ROECK, Albert (CERN)

Session Classification: High energy tau neutrinos at CERN

Contribution ID: **18**

Type: **not specified**

Discussion

Wednesday, 29 September 2021 11:50 (30 minutes)

Session Classification: High energy tau neutrinos at CERN

Contribution ID: 19

Type: **not specified**

Cross Section Measurement of Tau Neutrinos from GeV to TeV in Ar₄₀

Thursday, 30 September 2021 09:30 (20 minutes)

Experiments such as T2K and NOvA report the calculation of the cross-section (neutrino interactions) as the major contributor of systematic uncertainties in the measurement of oscillations. Determining the energy of neutrinos and neutrino-nucleus interactions relies on reconstruction techniques based on kinematics (T2K/HK) or calorimetric methods (DUNE/NOvA/SBN), and reliable interaction models are required in both. Given the capabilities of new accelerators and detectors, it will be possible to obtain precise interaction models and study phenomena that until now seemed complex to execute. One example is the oscillation of the ν_τ in long-baseline experiments with detectors with Ar_{40} which given their resolution could provide not just higher statistics than previous ones (OPERA/DONUT) but therefore, more accurate insights on how muon neutrinos oscillate into tau neutrinos with nearly maximal mixing or how these results could be used as proof of the properties of neutrinos and their interactions.

This presentation will show a semi-theoretical framework of how it is planned to approach the estimation of the ν_τ cross-section in Ar_{40} and how well we can get the kinematic variables that contribute to it.

Presenter: YAEGGY, Barbara (Cincinnati)

Session Classification: Tau neutrino cross sections

Contribution ID: 20

Type: **not specified**

Cross sections across all energies-theory

Thursday, 30 September 2021 09:50 (20 minutes)

Detection of tau neutrinos from oscillations over distances from terrestrial to cosmic scales require the tau neutrino cross section for energies ranging from GeV to EeV. Tau neutrino flux attenuation and tau neutrino regeneration in the Earth also depends on the cross section.

The theoretical status of the tau neutrino cross section over this broad energy range is reviewed.

Presenter: RENO, Hallsie (U Iowa)

Session Classification: Tau neutrino cross sections

Contribution ID: 21

Type: **not specified**

Neutrino cross-sections from GeV to ZeV energies - experiment

Thursday, 30 September 2021 10:10 (20 minutes)

Neutrino interaction cross-sections have been measured at fixed target experiments and, at higher energies, by neutrino telescopes which observe neutrino absorption in the Earth. In this talk, I will discuss current cross-section measurements and future prospects.

Presenter: KLEIN, Spencer (LBNL)

Session Classification: Tau neutrino cross sections

Contribution ID: 22

Type: **not specified**

Discussion

Thursday, 30 September 2021 10:30 (15 minutes)

Session Classification: Tau neutrino cross sections

Contribution ID: 23

Type: **not specified**

High Energy Tau Neutrino Detection

Thursday, 30 September 2021 10:45 (45 minutes)

The tau neutrino remains the most challenging flavor of neutrino to detect. While tau neutrinos are not generally expected to be produced in significant numbers in cosmic accelerators which produce the high energy neutrinos detected by IceCube, they should appear due to flavor change in flight between the source and the Earth. In this talk I will review methods of tau neutrino identification in existing and planned high energy neutrino detectors.

Presenter: WILLIAMS, Dawn (University of Alabama)

Session Classification: UHE experimental techniques

Contribution ID: 24

Type: **not specified**

The radio technique and UHE tau neutrino searches

Thursday, 30 September 2021 11:30 (45 minutes)

In the last decade the radio technique has experienced a spectacular leap forward, with many different experimental approaches and a diversity of proposals and experiments. Many of them take full advantage of the Earth skimming channel that was proposed soon after oscillations were discovered. After reviewing current understanding of the radio technique in general and the Earth skimming channel, I will give an overview of the main experimental efforts and proposals under consideration to detect Ultra High Energy tau neutrinos.

Presenter: ZAS, Enrique (Santiago de Compostela U.)

Session Classification: UHE experimental techniques

Contribution ID: 26

Type: **not specified**

Reconstruction of multi-GeV tau neutrinos in tracking detectors

Thursday, 30 September 2021 13:40 (30 minutes)

This talk will discuss the reconstruction techniques used in past experiments which performed nutau appearance searches and what can be learned from that experience for future searches.

Presenter: AUTIERO, Dario (Lyon, IPN)

Session Classification: Tau neutrino reconstruction techniques

Contribution ID: 27

Type: **not specified**

Reconstruction, Flavor Identification and Future Prospects at High Energies

Thursday, 30 September 2021 14:10 (20 minutes)

There are many challenges for high-energy tau-neutrino reconstruction with sparse detectors: The falling spectrum limits the number of expected events with high enough tau decay lengths, while the reconstructions themselves are prone to systematic uncertainties. I will discuss recent improvements and near-future prospects to overcome statistical and systematic limitations and improve flavor identification and flavor measurements.

Presenter: STACHURSKA, Juliana (MIT)

Session Classification: Tau neutrino reconstruction techniques

Contribution ID: **28**

Type: **not specified**

Discussion

Thursday, 30 September 2021 14:30 (15 minutes)

Session Classification: Tau neutrino reconstruction techniques

Contribution ID: 29

Type: **not specified**

Tau neutrinos and BSM

Friday, 1 October 2021 09:00 (20 minutes)

Light sterile neutrinos have been put forward as an explanation of the anomalous measurements obtained in short-baseline neutrino experiments. In this talk I will review the status and discuss recent results in the search for light sterile neutrinos. Additionally, I will present extensions of the light sterile neutrino model that aim to explanations of these anomalous observations and resolve tensions in the global neutrino data set.

Presenter: ARGUELLES, Carlos (Harvard)

Session Classification: Tau neutrinos and BSM

Contribution ID: 30

Type: **not specified**

Physics with Atmospheric Tau Neutrino at ICAL-INO

Friday, 1 October 2021 09:20 (20 minutes)

In this talk, I discuss the possibility of detecting tau events in the multi-GeV energy range originated via atmospheric muon neutrino to tau neutrino oscillation in the context of 50 kt magnetized Iron Calorimeter (ICAL) detector under the India-based Neutrino Observatory (INO) collaboration. I also discuss the possibility of exploring some interesting beyond the Standard Model (BSM) scenarios using this facility.

Presenter: AGARWALLA, Sanjib (Institute of Physics, Bhubaneswar)

Session Classification: Tau neutrinos and BSM

Contribution ID: 31

Type: **not specified**

High-energy and ultra-high-energy tau neutrinos and BSM

Friday, 1 October 2021 09:40 (20 minutes)

High-energy (TeV-PeV) and ultra-high-energy (> 100 PeV) tau neutrinos of cosmic origin offer great potential to test a wide variety of BSM scenarios. Because the tau sector in BSM searches is often the least constrained, measuring high-energy tau neutrinos represents an opportunity to make substantial progress. Today, we perform BSM tests using the IceCube TeV-PeV neutrinos, based on their spectrum and flavor composition. Ongoing improvements in statistics and techniques to identify tau neutrinos will sharpen these tests. In the coming decade, a host of planned neutrino telescopes, some sensitive mostly to tau neutrinos may finally discover the long-sought ultra-high-energy neutrinos, and open up a new energy regime wherein to test BSM. I will survey the present and near-future BSM opportunities, point out what are the most promising ones, and comment on dealing with prevailing astrophysical uncertainties.

Presenter: BUSTAMANTE, Mauricio (Niels Bohr Institute)

Session Classification: Tau neutrinos and BSM

Contribution ID: **32**

Type: **not specified**

Discussion

Friday, 1 October 2021 10:00 (15 minutes)

Session Classification: Tau neutrinos and BSM

Contribution ID: 33

Type: **not specified**

Prompt atmospheric tau neutrino flux

Friday, 1 October 2021 10:15 (20 minutes)

I will talk about the prompt component of atmospheric neutrinos, which are from the heavy flavor hadron decays, focusing on tau neutrinos. For the energy above ~ 10 TeV, the flux of prompt atmospheric tau neutrinos dominates over the conventional tau neutrino flux, produced from oscillation of conventional muon neutrinos, and at lower energies, it can be a background to the conventional tau neutrino flux. Unlike the conventional neutrinos, the prompt neutrino flux has large uncertainty. In this talk, I will discuss main components for evaluating the prompt neutrino flux and its theoretical uncertainties.

Presenter: JEONG, Yu Seon (CERN)

Session Classification: Tau neutrinos in astrophysics

Contribution ID: **34**

Type: **not specified**

Discussion

Friday, 1 October 2021 10:35 (15 minutes)

Session Classification: Tau neutrinos in astrophysics

Contribution ID: 36

Type: **not specified**

On the reliability of present predictions for tau neutrino fluxes

Wednesday, 29 September 2021 13:20 (15 minutes)

Tau neutrino fluxes in the atmosphere and at the Large Hadron Collider arise from heavy-flavour production and decay. The reliability of their predictions is therefore deeply connected to the reliability of present predictions for charm and bottom production in hadronic collisions. I plan to discuss this subject, presenting the various sources of uncertainties affecting these predictions and considering different frameworks, corresponding to different system of cuts and center-of-mass energies.

Presenter: GARZELLI, Maria Vittoria (University of Hamburg)

Session Classification: Contributed talks I

Contribution ID: 37

Type: **not specified**

Appearance of tau neutrinos in the near detectors due to the oscillations involving sterile neutrinos

Wednesday, 29 September 2021 13:35 (15 minutes)

In the long-baseline neutrino experiments, an interesting signature of sterile neutrinos could be the anomalous appearance of tau neutrinos in the near detectors, not expected in case of three-flavour oscillations. The sensitivities in the $(\sin^2 2\theta_{\mu\tau}, \Delta m_{41}^2)$ parameter space, based on full MINOS+ Monte Carlo simulation and reconstruction, for total statistics of MINOS+ experiment will be presented [1]. Based on this example, the possible modifications of sensitivity for the anomalous appearance of tau neutrinos in the near detectors in the future long-baseline experiments will be discussed [1] <https://zenodo.org/record/1300962>

Presenter: GRZELAK, Katarzyna (University of Warsaw)

Session Classification: Contributed talks I

Contribution ID: 38

Type: **not specified**

Constraining tau neutrino transition magnetic moments at DUNE

Wednesday, 29 September 2021 13:50 (15 minutes)

We consider the sensitivity of the DUNE experiment to a heavy neutral lepton, HNL (also known as sterile neutrino) in the mass range from a few MeV to a few GeV, interacting with the Standard Model via a transition magnetic moment to the active neutrinos, the so-called dipole portal. The HNL is produced via the up-scattering of active neutrinos, and the subsequent decay inside the detector provides a single-photon signal. We show the tau-neutrino dipole portal can be efficiently probed at DUNE.

Presenter: ZHU, Jingyu (Karlsruhe Institute of Technology)

Session Classification: Contributed talks I

Contribution ID: 39

Type: **not specified**

Kinematic Tau neutrino search at DUNE far detectors

Wednesday, 29 September 2021 14:05 (15 minutes)

DUNE will be a long baseline neutrino experiment utilizing liquid Argon TPC technology. As well as a rich program of neutrino oscillation and BSM physics studies, DUNE will have an unprecedented sensitivity to the tau neutrino appearance with an event rate of approximately 30 events per year and far detector module. Their study will improve the understanding of neutrino interactions and provide a test for the 3-flavour neutrino paradigm. Moreover an alternative high energy neutrino beam configuration would increase the tau neutrino statistics at the far detectors by a factor of 6. However, the DUNE far detectors will not resolve the topology of the prompt decay of the charged lepton tau, so the isolation of a tau neutrino sample requires a non-trivial treatment. I will present an analysis to search for tau neutrinos in the DUNE experiment based on kinematic criteria, exploiting the precise tracking and calorimetric performance of the liquid argon time projection chambers technology. Three tau decay modes are studied, and for each of them, a dedicated analysis is deployed to isolate tau neutrinos and reject the associated backgrounds. Semi-realistic significances are calculated.

Presenter: KOSC, Thomas (Institut de Physique des 1 Infinis (Lyon, France))

Session Classification: Contributed talks I

Contribution ID: 40

Type: **not specified**

Learning from Tau Neutrino Appearance at Long Baselines

Wednesday, 29 September 2021 14:30 (15 minutes)

Excitingly, the DUNE experiment will have access to the world's largest sample of well-identified tau-neutrino scattering events arising from oscillations of muon-neutrinos. Since such a sample has yet to be analyzed, it is prudent to ask "what can we learn from it?" In this talk, I will walk through the benefits of such a sample, in the framework of three-neutrino oscillations and beyond.

Presenter: KELLY, Kevin J (Fermilab)

Session Classification: Contributed talks I

Contribution ID: 41

Type: **not specified**

Prospects for anomalous tau neutrino appearance searches at the DUNE Near Detector

Wednesday, 29 September 2021 14:45 (15 minutes)

The DUNE Near Detector, with a LAr TPC (Liquid Argon Time Projection Chamber) as its primary detector, enables DUNE to probe for new physics beyond the Standard Model, such as short-baseline tau neutrino appearance mediated by sterile neutrino oscillations. Due to the high energy production threshold of the tau lepton and its very short lifetime, detection of tau neutrinos is very challenging, but the large statistics expected (especially in high-energy configuration) for the LBNF beam, as well as the excellent spatial resolution of the DUNE ND detectors, present an opportunity to search for this unique signature. This study is focused on charged-current tau neutrino interactions, identified using multivariate methods based on kinematic variables. In this talk, I will review the tau neutrino selection strategy for the DUNE ND, and present DUNE's expected sensitivities to short-baseline tau neutrino appearance, assuming mixing between active and sterile neutrinos.

Presenter: RAJAOALISOA, Miriama (University of Cincinnati)

Session Classification: Contributed talks I

Contribution ID: 42

Type: **not specified**

New tau neutrino oscillation constraints on unitary violation

Wednesday, 29 September 2021 15:00 (15 minutes)

Testing the unitarity of the PMNS matrix can give insights into the existence of additional neutrino generations which would render the 3x3 leptonic mixing matrix non-unitarity. Current oscillation data mostly constrains the electron and muon row of the mixing matrix whereas the tau row still allows for large unitarity violation. Here we will focus on new unitary constraints on the tau row coming from previously overlooked experimental data.

Presenter: GEHRLEIN, Julia (Brookhaven National Laboratory)

Session Classification: Contributed talks I

Contribution ID: 43

Type: **not specified**

Constraining neutrino magnetic moments at the LHC

Wednesday, 29 September 2021 15:15 (15 minutes)

The significant neutrino flux at high rapidity at the LHC motivates dedicated forward detectors to study the properties of neutrinos at TeV energies. We investigate magnetic dipole interactions between different flavors of active neutrinos, and between the active neutrinos and new sterile states at emulsion and liquid argon experiments that could be located in a future Forward Physics Facility (FPF) downstream of the ATLAS interaction point. The scattering of neutrinos off electrons produces an electron recoil signature that can probe new regions of parameter space at the High Luminosity LHC, particularly for liquid argon detectors due to low momentum thresholds. In the presence of a sterile neutrino we also consider its decay through the dipole operator, which leads to a photon that could be displaced from the production vertex. FPF detectors can test the magnetic properties of neutrinos, highlighting the use of high energy LHC neutrinos as probes of new physics.

Presenter: MAMMEN ABRAHAM, Roshan (Oklahoma State University)

Session Classification: Contributed talks I

Contribution ID: 46

Type: **not specified**

Axial and pseudoscalar form factor with tau neutrinos

Friday, 1 October 2021 13:30 (15 minutes)

We study the sensitivity to axial nucleon structure of single-spin asymmetries in (anti)neutrino charged current quasielastic scattering on free nucleons. The weak interaction gives rise to relatively large single-spin asymmetries at leading order. Besides the axial form factor, the pseudoscalar form factor can be accessed with tau (anti)neutrinos measuring recoil and target transverse asymmetries without additional assumptions.

Presenter: TOMALAK, Oleksandr (Los Alamos National Laboratory)

Session Classification: Contributed talks II

Contribution ID: 47

Type: **not specified**

The Giant Radio Array for Neutrino Detection - the experimental status and plans

Friday, 1 October 2021 12:35 (15 minutes)

The Giant Radio Array for Neutrino Detection (GRAND) project aims to find the sources of Ultra-High Energy Cosmic Rays (UHECRs) in the Universe. This would be achieved by deploying 200,000 radio antennas over 200,000 km², gathering enough UHE neutrino, cosmic ray and gamma-ray events to pinpoint UHECRs origin. The use of a sparse array of antennas would allow achieving statistics far beyond what is accessible to the current experiments at an affordable cost. However, GRAND faces significant challenges: developing a fully autonomous system of triggering on the radio signals, and reconstructing parameters of very inclined air showers from the radio data only. Solving them is the main aim of GRANDProto300 - an array of 300 antennas, which should take the first data still in 2021. We present preliminary designs and simulation results, plans for construction, deployment, and the detection methods that will allow us for a rich research program, spanning beyond the UHE particles detection.

Presenter: PIOTROWSKI, Lech W (University of Warsaw)

Session Classification: Contributed talks II

Contribution ID: 48

Type: **not specified**

Prospects for EeV tau-neutrino physics with in-ice radio detectors

Friday, 1 October 2021 12:50 (15 minutes)

The detection of the radio emission following a neutrino interaction in ice is a promising technique to obtain significant sensitivities to neutrinos with energies above 10 PeV. The detectable radio emission stems from particle showers in the ice. With the RNO-G detector being under construction in Greenland, and the plans for an order-of-magnitude more sensitive radio detector as part of IceCube-Gen2, the detection of UHE neutrinos becomes a realistic option in the next years. This contribution explores the sensitivity of identifying tau neutrinos. Taus, created by an interaction of the corresponding neutrino, create several additional detectable showers during their propagation through the ice. If multiple of these showers are detected, it provides a signature for the neutrino flavor. Using NuRadioMC, the signatures of secondary interactions were simulated for RNO-G and IceCube-Gen2 which are used to quantify the fraction of detectable tau neutrinos.

Presenter: GLASER, Christian (Uppsala University, Sweden)

Session Classification: Contributed talks II

Contribution ID: 49

Type: **not specified**

Looking for HNLs via Double Bang signals

Friday, 1 October 2021 13:45 (15 minutes)

Heavier neutral leptons are predicted in many extensions of the SM as a solution of several fundamental questions like the origin of the neutrino masses. In this talk, we will consider the detection of HNLs using “double-bang” signals. Several models can explain this type of event, here we will consider two: the production of HNLs via mixing with the light neutrinos and through a transition magnetic moment. We will explore the present a future sensitivity of neutrino detectors to this signal.

Presenter: MARTINEZ-SOLER, Ivan (Fermilab and Northwestern University)

Session Classification: Contributed talks II

Contribution ID: 50

Type: **not specified**

Tau neutrino propagation with NuPropEarth

Friday, 1 October 2021 14:00 (15 minutes)

Understanding the propagation of neutrinos through matter is fundamental to quantify the sensitivity to detect high-energy tau neutrinos. NuPropEarth is a simulation framework with the structure of a general-purpose Monte Carlo event generator and therefore allows following the path and interactions of individual neutrinos as they travel through Earth on an event-by-event basis. In this talk, we will present the main details of the framework and quantify the tau neutrino attenuation rates.

Presenter: GARCIA, Alfonso (Harvard University)

Session Classification: Contributed talks II

Contribution ID: 51

Type: **not specified**

Probing Secret Interactions of Tau Neutrinos in the High-Statistics Era

Friday, 1 October 2021 14:15 (15 minutes)

Do neutrinos have sizable self-interactions? They might. Laboratory constraints are weak, so strong effects are possible in astrophysical environments and the early universe. Observations with neutrino telescopes can provide an independent probe of neutrino self (“secret”) interactions, as the sources are distant and the cosmic neutrino background intervenes. We define a roadmap for making decisive progress on testing secret neutrino interactions governed by a light mediator, using IceCube-Gen2.

Presenter: ESTEBAN, Ivan (CCAPP, Ohio State University)

Session Classification: Contributed talks II

Contribution ID: 52

Type: **not specified**

Discussion

Wednesday, 29 September 2021 10:50 (20 minutes)

Session Classification: Experimental techniques (GeV energies)

Contribution ID: 53

Type: **not specified**

Discussion

Thursday, 30 September 2021 12:15 (25 minutes)

Session Classification: UHE experimental techniques

Contribution ID: 54

Type: **not specified**

Break

Wednesday, 29 September 2021 14:20 (10 minutes)

Session Classification: Contributed talks I

Contribution ID: 55

Type: **not specified**

nutau-nucleon/nucleus deep inelastic scattering in the multi-GeV energy region

Friday, 1 October 2021 10:50 (15 minutes)

We shall present the results for a study of some perturbative and nonperturbative effects on the evaluation of the nutau(nutabar)-nucleon scattering cross sections. The free nucleon structure functions have been obtained by using the evolution of parton distribution functions at the next-to leading order and taking the effects of kinematical and dynamical higher twists. These free nucleon structure functions are then convoluted with the nucleon spectral function in the nucleus to obtain the nuclear structure functions $F_{iA}(x, Q^2)$; ($i=1-5$), by taking into account Fermi motion, binding energy and nucleon correlations. We also include the contribution of π and ρ mesons and the corrections due to shadowing and obtain the results for $F_{iA}(x, Q^2)$; ($i=1-5$) and the cross sections. This is the first theoretical study, which includes nuclear medium effects in the evaluation of nutau(nutabar)-nucleus differential and total scattering cross sections.

Presenter: ANSARI, VANIYA (ALIGARH MUSLIM UNIVERSITY)

Session Classification: Contributed talks II

Contribution ID: 56

Type: **not specified**

On the Tau flavor of the cosmic neutrino flux

Friday, 1 October 2021 11:05 (15 minutes)

We show how the detection of the tau events by ICECUBE constrains the interaction of the neutrinos with ultralight dark matter and discuss the implications of this interaction for even higher energy cosmic neutrinos detectable by future radio telescopes such as ARA, ARIANNA and GRAND. We also revisit the $3 + 1$ neutrino scheme and clarify a misconception about the evolution of high energy neutrinos in matter within the $3 + 1$ scheme with a possibility of scattering off nuclei.

Presenter: FARZAN, Yasaman (IPM)

Session Classification: Contributed talks II

Contribution ID: 57

Type: **not specified**

KM3NeT/ORCA sensitivity to atmospheric tau-neutrino appearance

Friday, 1 October 2021 12:20 (15 minutes)

ORCA is the low-energy branch of the KM3NeT neutrino facility under construction in the Mediterranean Sea and optimised to study oscillations of atmospheric neutrinos in the few-GeV energy range. Using the first six (out of a final 115) deployed detection units, ORCA is already now able to confirm the disappearance of muon neutrino charged-current events with 5σ . Once completed, an unprecedented statistics of 3k tau neutrinos per year that have oscillated from a purely muon- and electron-neutrino initial atmospheric flux will be detected within the instrumented volume. ORCA will be able to determine the normalisation of the tau-neutrino flux as a statistical excess of shower-like events in the event sample. The contribution will present the sensitivity of ORCA to measure tau-neutrino appearance on a statistical basis.

Presenter: HALLMANN, Steffen (DESY)

Session Classification: Contributed talks II

Contribution ID: 58

Type: **not specified**

POEMMA: Probe Of Extreme Multi-Messenger Astrophysics

Friday, 1 October 2021 13:05 (15 minutes)

The Probe Of Extreme Multi-Messenger Astrophysics (POEMMA) is designed to observe cosmic neutrinos and to identify the sources of ultra-high energy cosmic rays (UHECRs). POEMMA consists of two spacecraft flying in a loose formation at 525 km altitudes with each spacecraft hosting a large Schmidt telescope with a focal plane optimized to observe both the optical Cherenkov signals and the near-UV fluorescence signals from extensive air showers. POEMMA will be sensitive to cosmic tau neutrinos above 20 PeV by observing the upward-moving EASs induced from tau neutrino interactions in the Earth. POEMMA can quickly slew to the neutrino limb-viewing mode to follow Target-of-Opportunity (ToO) transient astrophysical sources with exceptional neutrino flux sensitivity over the full-sky. POEMMA will also have remarkable sensitivity to UHE neutrinos above 20 EeV using EAS fluorescence measurements.

Presenter: KRIZMANIC, John F (UMBC/CRESST/NASA/GSFC)

Session Classification: Contributed talks II

Contribution ID: 59

Type: **not specified**

Break

Friday, 1 October 2021 13:20 (10 minutes)

Session Classification: Contributed talks II

Contribution ID: **60**Type: **not specified**

Fermilab W&C from MicroBooNE

Friday, 1 October 2021 17:00 (1 hour)

Search for anomalous single-photon production in MicroBooNE as a first test of the MiniBooNE low-energy excess

Oct. 1, 2021, 4:00 pm US/Central

Mark Ross-Lonergan, Columbia University

We report first results from a search for neutrino-induced neutral current (NC) resonant $\Delta(1232)$ baryon production followed by Δ radiative decay. Data corresponding to MicroBooNE's first three years of operations (6.80×10^{20} protons on target) are used to select single-photon events with one or zero protons and without charged leptons in the final state. The background is constrained via an in-situ high-purity measurement of NC π^0 events. This provides the world's most sensitive search for NC $\Delta \rightarrow \text{N}\gamma$ below 1 GeV, and a first test of the MiniBooNE low-energy excess under a single photon hypothesis.

Please click the link below to join the webinar:

<https://fnal.zoom.us/j/96005592607?pwd=UnpjUmZaQ295Nm00U25RVnpJRjByZz09>

Passcode: 054691

<https://theory.fnal.gov/events/event/search-for-anomalous-single-photon-production-in-microboone-as-a-first-test-of-the-miniboone-low-energy-excess/>