Title	Description	Presenters
Model-independent way to test the CPT violation using NOvA, T2K and INO experiments	Charge-Parity-Time (CPT) symmetry governs that the oscillation parameters for neutrinos and anti-neutrinos are to be identical. Different mass and mixing parameters for these particles may give us a possible hint for CPT violation in the neutrino sector. Using this approach, we discuss the ability of long-baseline and atmospheric neutrino experiments to determine the difference between mass squared splittings ($\Delta m^{2}_{32}-\Delta\bar{m}^{2}_{32}$) and atmospheric mixing angles ($\sin^{2}\theta_{23}-\sin^{2}\bar{\theta}_{23}$) of neutrinos and anti-neutrinos. We show the joint sensitivity of the T2K, NOvA and INO experiments to such CPT violating observables in different possible combinations of octant for neutrinos and anti-neutrinos.	**Daljeet Kaur**
Measurement of space charge effects and Energy calibration in ProtoDUNE-SP	The single-phase liquid argon prototype at CERN (ProtoDUNE-SP) acts as a validation of the design for the DUNE single-phase far detector. With a total mass of 770 tons, it is the largest monolithic liquid argon single-phase time projection chamber in the world. ProtoDUNE-SP collected test-beam in autumn of 2018 and has been collecting cosmic and special calibration data since the end of 2018. The accumulation of positive ions in a LArTPC located on the surface can distort the electric field and the reconstructed particle trajectories. It is critical to understand and correct for the space charge effects in order to achieve the desired spatial and calorimetric resolutions in the LArTPC. This talk will present the measurement of space charge effects and the calorimetric measurements of the detector in ProtoDUNE-SP.	**Mitchell W Mote**
Measurement of the very rare K+→π+νν¯ decay at the NA62 experiment at CERN	The NA62 experiment reports the branching ratio measurement BR(K+→π+νν) at 68% CL, based on the observation of 20 signal candidates with an expected background of 7.0 events from the total data sample collected at the CERN SPS during 2016-2018. This provides evidence for the very rare K+→π+νν decay, observed with a significance of 3.4σ. The experiment achieves a single event sensitivity of (0.839±0.054)×10−11, corresponding to 10.0 events assuming the Standard Model branching ratio of (8.4±1.0)×10−11. The result represents the most accurate measurement achieved so far of this ultra-rare decay. Future prospects and plans for data taking from 2021 will also be presented.	**Renato Fiorenza**

Empowering JUNO physics by means of an ancillary photodetection system	JUNO is a liquid scintillator detector currently under construction in the south of China. JUNO aims to detect the disappearance of reactor antineutrinos at an average baseline of 53 km, with the primary goal of determining the neutrino mass ordering and performing a sub-percent measurement of three of the neutrino oscillation parameters. This physics program is rooted in the detector's unprecedented capability to detect 1200 photoelectrons (PEs) per MeV of deposited energy, yielding a 3% energy resolution at 1 MeV. The main photodetection system comprises 18000 20-inch "large" photomultipliers (LPMTs), each of which experiences an illumination varying over two orders of magnitude. To help calibrating the LPMT response in such a demanding environment, JUNO will be instrumented with additional 25600 custom-made 3-inch "small" photomultipliers (SPMTs). They will operate in photon-counting regime by detecting at most 1 PE per neutrino interaction, hence providing a complementary energy estimator. In addition, the SPMT system is designed to provide a semi-independent measurement of the "solar" oscillation parameters, to aid the measurement of supernova neutrinos, and to improve the muon track reconstruction, whose performance is pivotal for background rejection. The SPMTs, together with their power and readout systems, will have to operate under water for over 20 years, posing challenging constraints on the design, reliability and implementation of this major subsystem of JUNO. In this talk, we will present the innovative design of the JUNO SPMT system, its impact on physics, and the current status of SPMT production and testing.	**Victor LEBRIN, Victor Lebrin**
New Physics with nuSTORM	The Neutrinos from Stored muons (nuSTORM) facility has been proposed to measure neutrino-nucleon cross-sections with percent level precision. It has been shown that nuSTORM with a detector for short baseline oscillation search has excellent capability to search for the existence of light sterile neutrinos that have been postulated to explain the LSND and MiniBooNE results. This analysis used the Charged Current events in a magnetized Iron calorimeter detector. We study if the large number of Neutral Current events at the detector can be used to constrain the sterile neutrino parameter space further. In addition we also study the constraints on non-unitarity of neutrino mixing matrix using both charged and neutral current events at nuSTORM.	**Kaustav Chakraborty**

A Novel Hit-Based Method to Distinguish Tracks and Showers in ProtoDUNE Single Phase	Pandora [1,2] is a pattern recognition software used in liquid argon time projection chamber (LArTPC) experiments such as MicroBooNE, DUNE, SBND, ICARUS, and ProtoDUNE Single Phase (SP). The output of a LArTPC can be considered a high-resolution 2D image and energy depositions, called hits, from particles in a LArTPC create complicated topologies that are broadly classified into tracks and showers. The event reconstruction is particularly challenging when there are multiple overlapping particles and in order to fully harness the imaging capabilities of those experiments, Pandora needs to separate them. A hit-based approach to this problem is presented, which analyses small regions around each hit in data events from ProtoDUNE-SP and from those regions it calculates local variables that are used subsequently in a machine learning approach. After this stage, it is given to each hit a probability to belong to a track or shower-like particle. Results will show the performance of separation between tracks and showers. [1] Eur. Phys. J. C (2018) 78: 82. [2] Eur. Phys. J. C (2015) 75: 439	**Stefano Vergani**

The Mu2e calorimeter	The Mu2e calorimeter consists of 1348 pure CsI crystals coupled to two large area UV-extended Silicon Photomultipliers (SiPMs) organized in two separate annular disks. An intense R & D phase has been pursued to check if this configuration satisfies the Mu2e requirements. In May 2017, a dedicated test has been performed at the Beam Test Facility (BTF) in Frascati (Italy) where a large calorimeter prototype (Module-0) has been exposed to an electron beam in the energy range between 60 and 120 MeV. The prototype consists of 51 crystals, each one readout by two Mu2e SiPMs. We present results for timing and energy resolution both for electrons at normal incidence (0 $^\circ$) and at a grazing impact angle (50 $^{\circ}$) more similar to the experiment configuration. At the moment the calorimeter group is finishing the Quality Control of crystal al SiPMs and the installation of the calorimeter is expected for the summer 2020. A description of all the test stations installed for the Quality Control phase of the crystals and the SiPMs is also reported.	**Eleonora Diociaiuti**
Prospects and challenges of the Muon Collider	Muon Collider is an extremely attractive option for the future energy-frontier machine. It is capable of delivering clean final states of lepton collisions at multi-TeV centre-of-mass energy with the minimal energy consumption. Being a less familiar type of machine compared to e+e- and pp colliders it poses a number of technological challenges that need to be addressed, including the production and acceleration of the muon beams, controlling of the neutrino radiation hazard and mitigation of the beam-induced background with advanced design of both the detector and reconstruction algorithms. In this talk an overview of the mentioned challenges will be presented together with the main solutions studied at the moment. The three main topics that will be covered are: 1. different conceptual designs for obtaining high-energy muon beams; 2. estimated environmental radiation hazard due to neutrinos from the muon beam decays; 3. detector-design considerations and performance studies at a Muon Collider.	**Nazar Bartosik**

Muon reconstruction with waveform information in JUNO	On behalf of the JUNO Collaboration The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector currently being built in a dedicated underground laboratory in China. It is a multi-purpose underground experiment with a physics program including neutrino mass hierarchy determination, precision measurement of neutrino oscillation parameters, measurement of solar, atmospheric, geo-neutrinos and other unsolved physical problems. Electron anti-neutrinos are detected via the inverse beta decay by measuring the correlated positron and neutron signals. In this detection channel cosmic ray muon induced radioactive isotopes are the main background, especially ^{9}Li/^{8}He. They are predominantly produced by showing muons which account for about 10% of all muons. Considering that the ^{9}Li/^{8}He background is correlated with the parent muon in time and space, the vertex reconstruction of showers along the muon track is helpful to reject the backgrounds of ^{9}Li/^{8}He and other isotopes. Based on the waveform analysis of Toy MC, we know that the multi-peaks in waveform output by PMTs are caused by these showers. Waveform analysis of muon events and preliminary results of shower vertex reconstruction based on detector simulation will be presented in the poster.	**Yongpeng Zhang**
The HyperMu experiment: measuring the Zemach radius of the proton	The HyperMu experiment is planning to measure the hyperfine splitting of the muonic hydrogen 1S level to extract the Zemach radius of the proton. A DC muon beam will be stopped in a cryogenic hydrogen target placed inside a laser cavity. After thermalisation and de-excitation, on resonance a powerful 6.8 um laser pulse triggered by the incoming muon will excite the muonic atom to the 1S(F=1) level. The subsequent de-excitation provides enough kinetic energy for the atom to diffuse to the target wall, which is coated with a thin gold layer. The muon quickly transfers to a gold atom, the high energy X-rays from the muonic gold cascade are detected as the resonance signal. Last fall, a first test measurement with the detector system was performed at the Paul Scherrer Institute, providing valuable input for the final design of the apparatus. This year, the laser system is being further developed	**Frederik Wauters**

Status of the Short-Baseline Near Detector at Fermilab	The Short-Baseline Near Detector (SBND) will be one of three liquid Argon Time Projection Chamber (LArTPC) neutrino detectors positioned along the axis of the Booster Neutrino Beam (BNB) at Fermilab, as part of the Short-Baseline Neutrino (SBN) Program. The detector is currently in the construction phase and is anticipated to begin operation in the second half of 2022. SBND is characterised by superb imaging capabilities and will record over a million neutrino interactions per year. Thanks to its unique combination of measurement resolution and statistics, SBND will carry out a rich program of neutrino interaction measurements and novel searches for physics beyond the Standard Model (BSM). It will enable the potential of the overall SBN sterile neutrino program by performing a precise characterisation of the unoscillated event rate, and by constraining BNB flux and neutrino-Argon cross-section systematic uncertainties. In this talk, the physics reach, current status, and future prospects of SBND are discussed.	**Valdiviesso Gustavo**
Testing the neutrino mass generation mechanism at the colliders	The neutrino mass generation mechanism is a mystery so far which explains the possible origin of the tiny observed neutrino masses and the flavor mixings over the decades- which indicates the existence of the beyond the Standard Model (BSM) physics, however, there is no observation of such BSM physics so far. Among the plethora of scenarios, the simple tree level mass generation mechanism with heavy fermions are the interesting ones which are tested at the Large Hadron Collider for the years. In this talk we will discuss briefly about the current status of these models and their prospects in the near future.	**Arindam Das**

Physics studies for ND280 upgrade in T2K experiment	Neutrino oscillation physics has now entered the precision era. In parallel with needing larger detectors to collect more data with, future experiments further require a significant reduction of systematic uncertainties with respect to what is currently available. In the neutrino oscillation measurements from the T2K experiment the systematic uncertainties related to neutrino interaction cross sections are currently the most dominant. To reduce this uncertainty a much improved understanding of neutrino-nucleus interactions is required. In particular, it is crucial to better understand the nuclear effects which can alter the final state topology and kinematics of neutrino interactions in such a way which can bias neutrino energy reconstruction and therefore bias measurements of neutrino oscillations. The upgraded ND280 near detector of T2K will directly confront our naivety of neutrino interactions using a new detector configuration with full polar angle acceptance and a much lower proton tracking threshold. Furthermore, neutron tagging capabilities in addition to precision timing information will allow the upgraded detector to estimate neutron kinematics from neutrino interactions. Such improvements permit access to a much larger kinematic phase space which correspondingly allows techniques such as the analysis of transverse kinematic imbalances (TKI) to offer remarkable constraints of the pertinent nuclear physics for T2K analyses. In this talk we quantitatively demonstrate ND280's upgraded sensitivity to key nuclear effects such as removal energy and 2p2h. To this end, we present a fit of a parameterised interaction and flux model to simulated measurements of TKI and neutrino energy from the upgraded ND280.	**Viet Nguyen**

Heavy Neutrinos at Future Linear e+e- Colliders	With the Standard Model being unable to describe the observed baryon asymmetry or dark matter density in the universe, many models of the New Physics introduce heavy neutrino species as a possible explanation for these effects. Dirac or Majorana neutrinos with masses above the EW scale could be produced at future linear e+e- colliders, like the Compact LInear Collider (CLIC) or the International Linear Collider (ILC). We studied the possibility of observing production and decays of heavy neutrinos in qql final state at the ILC running at 500 GeV and 1 TeV and the CLIC running at 3 TeV. The analysis is based on the WHIZARD event generation and fast simulation of the detector response with DELPHES. Dirac and Majorana neutrinos with masses from 200 GeV to 3.2 TeV are considered. Estimated limits on the production cross sections and on the neutrino-lepton coupling are compared with the current limits coming from the LHC running at 13 TeV, as well as the expected future limits from hadron colliders. Impact of the gamma-induced backgrounds on the experimental sensitivity is also discussed. Obtained results are stricter than any other limit estimates published so far.	**Krzysztof Mekala**
Low emittance muon beam in the 2 to 40 GeV energy range for muon and neutrino experiments	I present a scheme to obtain a 2 to 40 GeV low emittance muon beam, not requiring cooling and within today's technological resources, to be used for early commissioning of muon accelerator projects, or alternatively dedicated muon and neutrino parameter measurements. In particular, a muon rate of 5x10^4 mu/s in a normalized transverse emittance of 5 um at 22 GeV, and energy spread of 1 GeV obtained from O(10^11) e+/s on target at 44 GeV. This emittance is below the expected results of advanced emittance cooling techniques for muons produced from protons-on-target, and represents an alternative for the duration of complete muon cooling studies. The scheme has beam designed to adjust the muon beam energy in the GeV energy range to the needs for precise parameter measurements of muons and neutrinos. Although the rate is small compared to other muon sources, it does not seem to represent a big limitation for its usage. Furthermore, the muon rate could be in principle increased proportionally to the availability of higher positron rates, already foreseen for future collider projects.	**Oscar Blanco Garcia**

First Measurement of Differential Charged Current Quasi-Elastic-Like Muon Neutrino Argon Scattering Cross Sections with the MicroBooNE Detector	Current and future generation neutrino oscillation experiments aim towards a high-precision measurement of the oscillation parameters, which requires an unprecedented understanding of neutrino-nucleus scattering. Charged-current quasi-elastic (CCQE) scattering is the process in which the neutrino produces a charged lepton and removes a single intact nucleon from the nucleus without producing any additional particles. For existing and forthcoming accelerator–based neutrino experiments, CCQE interactions are either the dominant process or part of the signal. MicroBooNE is the first liquid argon time projection chamber (LArTPC) commissioned as part of the Short Baseline Neutrino (SBN) program at Fermilab and its excellent particle reconstruction capabilities allow the detection of neutrino interactions using exclusive final states, which will play a crucial role in the success of future kiloton LArTPC detectors such as DUNE. This talk will present the first measurement of exclusive ν_μ -Ar CCQE–like flux integrated total and differential cross sections using single proton knock–out interactions recorded by the MicroBooNE LArTPC detector, which has comparable acceptance to deuterium Bubble Chambers.	**Afroditi Papadopoulou**
Extraction of the Inclusive Muon Neutrino Charged Current Cross Section at MicroBooNE	The MicroBooNE detector has an active mass of 85 tons of liquid argon and is located along the Booster Neutrino Beam (BNB) at Fermilab. It has a rich physics program including the search for a low-energy excess observed at MiniBooNE and measurements of neutrino-Argon interaction cross sections. In this talk, we present a procedure, using the Wiener-SVD unfolding method, to extract the nominal neutrino flux-averaged total and differential cross sections of the inclusive muon neutrino charged-current interaction on argon. This procedure relies on a minimal set of assumptions while maximizing the power in comparing data results with predictions from theory and event generators. Taking advantage of the excellent resolution of a Liquid Argon Time Projection Chamber (LArTPC) and the Wire-Cell tomographic event reconstruction paradigm, this procedure enables a new round of cross section measurements at MicroBooNE.	**Wenqiang Gu**

The DUNE Photon Detection System	DUNE is an underground neutrino oscillation experiment that will be performing precision measurements of the PMNS matrix to determine unambiguously the mass ordering and the leptonic CP violation. It also comprises a rich non-accelerator physics program for the detection of supernova neutrinos, nucleon decay, and BSM physics. DUNE employs a high-power neutrino beam under construction at Fermilab together with the DUNE Near Detector, and four Liquid Argon TPCs (Far Detector) that will be installed at the Sanford Underground Research Facility in South Dakota, 1300 km away from the neutrino source. The photon detection system (PDS) – which records the 128 nm scintillation light of argon and provides the time of interaction of the beam neutrinos in the Far Detector - is critical for studying nucleon decay and detecting Supernove Neutrino Bursts. The PDS also complements the calorimetric measurement performed by the TPC (i.e. the charge readout) and contributes to the energy calibration and time performance of the Far Detector. In the talk, we will overview the design of the Photon Detection System for the first DUNE far detector module, with special emphasis on VUV light trapping in a cryogenic environment, its technical challenges, and the expected physics performance. We will also discuss the status of the construction of the PDS and its validation in the Run II of ProtoDUNE-SP.	**Andrea Falcone**

Measuring the proton-argon cross-section at ProtoDUNE-SP	The Deep UndergroundNeutrino Experiment (DUNE) is a next generation long-baseline neutrino experiment hosted by the Fermilab. DUNE will be able to unambiguously determine the neutrino mass hierarchy and measure the value of the CP-violating phase. The single-phase liquid argon far-detector prototype (ProtoDUNE-SP) at the CERN neutrino platform serves as a prototype to validate the technology for the 10-kton fiducial mass liquid argon detectors for the DUNE experiment. The primary physics goal of ProtoDUNE-SP is to measure the hadron-argon cross-sections to unprecedented precision. ProtoDUNE-SP was exposed to a variety of test-beam particles (protons, pions, kaons, muons, and electrons) in a broad range of momenta (from 0.3 - 7 GeV/c). ProtoDUNE-SP has successfully collected over 4 million high-quality beam events. This provides rich data to study the hadron-argon interactions in a liquid argon detector. In this talk, I will present our progress on the proton-argon cross-section measurement, including the selection of beam protons, energy calibration, and the preliminary result of the proton-argon cross-section.	**Heng-Ye Liao**

Development, construction and qualification tests of the Mu2e electromagnetic calorimeter mechanical structures	Charged Lepton Flavour Violating neutrino-less coherent conversion of a muon into an electron in the field of an aluminum nucleus. The observation of this process would be the unambiguous evidence of physics beyond the Standard Model. Mu2e detectors comprise a straw-tracker, an electromagnetic calorimeter and an external veto for cosmic rays. The calorimeter provides excellent electron identification, complementary information to aid pattern recognition and track reconstruction, and a fast calorimetric online trigger. The detector has been designed as a state-of-the-art crystal calorimeter and employs 1340 pure Cesium Iodide (CsI) crystals readout by UV-extended silicon photosensors and fast front-end and digitization electronics. A design consisting of two identical annular matrices (named “disks”) positioned at the relative distance of 70 cm downstream the aluminum target along the muon beamline satisfies the Mu2e physics requirements. The hostile Mu2e operational conditions, in terms of radiation levels (total ionizing dose of 12 krad and a neutron fluence of 5x1010 n/cm2 @ 1 MeVeq (Si)/y), magnetic field intensity (1 T) and vacuum level (10^-4 Torr) have posed tight constraints on the design of the detector mechanical structures and materials choice. The support structure of the two 670 crystal matrices employs two aluminum hollow rings and parts made of open-cell vacuum-compatible carbon fiber. The photosensors and service front-end electronics for each crystal are assembled in a unique mechanical unit inserted in a machined copper holder. The 670 units are supported by a machined plate made of vacuum-compatible plastic material. The plate also integrates the cooling system made of a network of copper lines flowing a low temperature radiation-hard fluid and placed in thermal contact with the copper holders to constitute a low resistance thermal bridge. The data acquisition electronics is hosted in aluminum custom crates positioned on the external lateral surface of the two disks. The crates also integrate the electronics cooling system as lines running in parallel to the front-end system. In this talk we will review the constraints on the calorimeter mechanical structures design, the development from the conceptual design to the specifications of all the structural	**Daniele Pasciuto**

A Plan for Decay at Rest $\nu_e+{\rm Pb}$ Cross Section Measurement at J-PARC MLF; D@RveX	D@RveX stands for Decay at Rest $\nu_e+{\rm Pb}$ Cross(X) section measurement. So far there has not been good low energy ν_e detection technique. Lead is expected to be an excellent low energy ν_e target because the cross section is expected to be very large and the delayed coincidence technique can be used to reduce the backgrounds. If decay at rest $\nu_e+{\rm Pb} \to e^-+n+{\rm Bi}$ cross section is measured, it brings new possibilities to the future neutrino experiments, such as low energy ν_e oscillation measurements, flavor specific measurement of the supernova explosion ν_e and understanding of ν_e-nucleus interactions. We are preparing an experiment to measure the cross section, energy spectrum and direction of the emitted electron, at J-PARC MLF. The beam pulse is very narrow in time and the duty cycle is low at MLF, which help further to reduce the backgrounds significantly. In this presentation, we will explain about conceptual idea of the experiment and status of the preparation.	**Fumihiko Suekane**

Muon beamline design on EMuS	China Spallation Neutron Source (CSNS) at Dongguan, China, has been in operation since August 2018. Its accelerator complex delivers a proton beam of 100 kW in beam power, 1.6 GeV in kinetic energy and 25 Hz in repetition rate. The Experimental Muon Source (EMuS) is planned to be constructed from 2022 as a part of the CSNS-II project, and will utilize a proton beam of 25 kW in a standalone mode. Two different schemes for EMuS have been studied, with the Phase-I based on a conventional thick target and side collection, and the future upgrade or the baseline scheme based on a conical target and capture superconducting solenoid. The baseline scheme will provide both surface muon beams and high energy decay muon beams for μSR, muon imaging and muonic X-ray, etc. The muon beam momentum is tunable and covers a wide range from 28 MeV/c to 450 MeV/c. The complex muon beamlines are based on superconducting solenoids, superferric dipoles and room-temperature magnets, and divided into five areas: trunk beamline, surface muon area, decay muon area and low-energy muon area, as well as a vertical beamline from a tandem thin target to provide surface muons. The surface muon area can provide beam for three μSR spectrometers simultaneously with an electrostatic separator, by using the spatial beam splitting method. Three spectrometers or experimental setups in the decay muon area, for muon imaging, μSR, and muonic X-ray, respectively, can share the beam in the beam switch mode. The vertical beamline that offers high polarization surface muons serves only one spectrometer in the platform. The area for slow muons and potential particle physics experiments is also planned. For the Phase-I scheme or simplified scheme, the beamlines are relatively simple, and based on only room-temperature magnets. Only surface muons and cloud negative muons are provided to four endstations with focus on μSR applications and also muonic X-ray analysis. The beam delivery system employs a combined spatial beam splitting and switching method. This presentation will be about the design study of the above two schemes for EMuS.	**Yang Hong**

Slow control and data acquisition development in the Mu2e experiment	The muon campus program at Fermilab includes the Mu2e experiment that will search for a charged-lepton flavor violating processes where a negative muon converts into an electron in the field of an aluminum nucleus, improving by four orders of magnitude the search sensitivity reached so far. Mu2e's Trigger and Data Acquisition System (TDAQ) uses {\it otsdaq} solution. Developed at Fermilab, {\it otsdaq} uses the {\it artdaq} DAQ framework and {\it art} analysis framework, for event transfer, filtering, and processing. {\it otsdaq} is an online DAQ software suite with a focus on flexibility and scalability, and provides a multi-user interface accessible through a web browser. A Detector Control System (DCS) for monitoring, controlling, alarming, and archiving has been developed using the Experimental Physics and Industrial Control System (EPICS) open source Platform. The DCS System has also been integrated into {\it otsdaq}, providing a GUI multi-user, web-based control, and monitoring dashboard.	**Antonio Gioiosa**

Measurement of the Production of Λ Baryons in Muon Anti-Neutrino-Ar Interactions with the MicroBooNE Detector	The MicroBooNE detector is a liquid argon time projection chamber (LArTPC) with an 85 ton active mass that receives flux from the Booster Neutrino and the Neutrinos Main Injector (NuMI) beams, providing excellent spatial resolution of the reconstructed final state particles. Since 2015 MicroBooNE has accumulated many neutrino and anti-neutrino scatterings with argon nuclei allowing for searches of rare interaction channels. The Cabibbo suppressed production of hyperons in anti-neutrino-nucleus interactions provides sensitivity to a range of effects, including second class currents, SU(3) symmetry violations and reinteractions between the hyperon and the nuclear remnant. This channel exclusively involves anti-neutrinos, offering an unambiguous constraint on wrong sign contamination. The effects of nucleon structure and final state interactions are distinct from those affecting the quasielastic channel and modify the Λ and Σ production cross sections in different ways, providing new information that could help to break their degeneracy. Few measurements of this channel have been made, primarily in older experiments such as Gargamelle [1,2]. This talk will cover the selection of candidate Λ events for the measurement of their production cross-section from Ar nuclei using the MicroBooNE detector. [1] O. Erriquez et al., Nucl. Phys. B140, 123 (1978) [2] O. Erriquez et al., Phys. Lett. B 70, 383 (1977)	**Christopher Thorpe**

Expanding T2K near detector fit by adding proton information	T2K (Tokai to Kamioka) is a long-baseline neutrino oscillation experiment located in Japan. One of the most challenging tasks of T2K is to determine whether CP is violated in the lepton sector, which is suggested by recent T2K results. By utilizing the near detector (ND280) data, T2K can constrain neutrino interaction and flux uncertainties by fitting a parametrised model to data. This allows for a significant reduction of the systematic uncertainties in neutrino oscillation analyses. The fit to ND280 data currently uses several samples which are based on muon kinematics and pion multiplicity. There is ongoing work to expand these samples by incorporating the reconstructed proton multiplicity in order to enhance ND280 sensitivity to neutrino cross-section modelling that drive current systematic uncertainties. The poster presents the properties of new ND280 samples and how they enhance the sensitivities to nuclear effects that are dominant at the energy range relevant for T2K. The addition of the proton multiplicity will also help to reduce systematics uncertainties that affect neutrino oscillation measurements at T2K.	**Kamil Janusz Skwarczynski**
Explaining the MiniBooNE Excess Through a Mixed Model of Oscillation and Decay	This talk presents a model of the electron-like excess observed by the MiniBooNE experiment comprising of oscillations involving two new mass states: ν_4, at $\mathcal{O}(1)$ eV, that participates in oscillations, and $\mathcal{N}$, at $\mathcal{O}(100)$ MeV, that decays to $\nu+\gamma$ via a dipole interaction. Short-baseline oscillation data sets, omitting MiniBooNE appearance data, are used to predict the oscillation parameters. We simulate the production of $\mathcal{N}$ along the Booster Neutrino Beamline via both Primakoff upscattering ($\nu A \to \mathcal{N} A$) and Dalitz-like neutral pion decays ($\pi^0 \to \mathcal{N} \nu \gamma$). The simulated events are fit to the MiniBooNE neutrino energy and visible scattering angle data separately to find a joint allowed region at 95\% CL. A point in this region with a coupling of 3.6×10^{-7} GeV^{-1}, $\mathcal{N}$ mass of 394 MeV, oscillation mixing angle of 6×10^{-4} and mass splitting of 1.3 eV^2 has $\Delta \chi^2/dof$ for the energy fit of 15.23/2 and 37.80/2. This model represents a significant improvement over the traditional single neutrino oscillation model.	**Stefano Vergani**

First detection of solar neutrinos from the CNO fusion cycle with the Borexino experiment	Borexino is a large-volume liquid-scintillator experiment designed for real-time detection of low energy solar neutrinos. It is located at Laboratori Nazionali del Gran Sasso (INFN) and started taking data in May 2007. This talk will report about the latest results of Borexino: the direct observation of neutrinos produced in the carbon-nitrogen-oxygen (CNO) fusion cycle in the Sun. The measurement was possible only after a dedicated campaign of hardware improvement aimed at stabilizing the thermal condition of the detector and at reducing the intrinsic radioactive backgrounds.The CNO cycle is the main nuclear engine in massive stars: this result is therefore crucial for the modeling of solar physics and confirms the existence of this process in the Universe. The details of the detector stabilization and the analysis strategy used by the Borexino collaboration for disentangling the spectral component of the CNO neutrinos from the residual backgrounds will be presented.	**Riccardo Biondi**
First Data from the Commissioned ICARUS Side Cosmic Ray Tagger	The ICARUS detector will operate at shallow depth and therefore it will be exposed to the full surface flux of cosmic rays. This poses a problematic background to the electron neutrino appearance analysis. A direct way to suppress this background is to surround the cryostat with a detector capable of tagging incident cosmic muons with high efficiency (~95\%). A cosmic ray tagger (CRT) consists of an organic plastic scintillator, wavelength-shifting fibers, readout by silicon photomultipliers and multi-anode photomultiplier tubes. The installation of the ICARUS Cosmic Ray Tagger (CRT) side wall hardware is complete and commissioning of the system is underway. In this talk, I will present the status of the integration of the CRT readout and analysis of first data from the commissioned side CRT system.	**Biswaranjan Behera**
Measurement of pion-argon inelastic cross section in ProtoDUNE-SP	The Deep Underground Neutrino Experiment (DUNE) is a leading-edge, international experiment for neutrino science and proton decay studies. ProtoDUNE-SP is one of two liquid argon time projection chambers (LArTPCs) built at CERN using the single phase technology to test the design and robustness of the detector components for DUNE. ProtoDUNE-SP accumulated over 4 million beam events in the H4-VLE beam line at CERN, including pions, protons, kaons and electrons from 0.3 to 7 GeV/c, which are being used to study the detector response to different particles and to measure the hadron-argon cross sections. This talk will discuss the progress on the measurement of the pion-argon inelastic cross section using ProtoDUNE-SP data.	**Tingjun Yang**

The role of leptonic CPV phases in cLFV observables	In models where the Standard Model is extended by Majorana fermions, interference effects due to the presence of CP violating phases have been shown to play a crucial role in lepton number violating processes. However, important interference effects can also arise in lepton number conserving, but charged lepton flavour violating (cLFV) transitions and decays. In this work we show that in the presence of CP violating (Dirac and Majorana) phases important interference effects might arise, with a striking impact for the predicted rates of cLFV observables. We explore the interference effects in several cLFV observables, carrying for the first time a thorough analysis of the different observables and the implications for future observation. We show in this talk how the presence of leptonic CP violating phases might lead to a loss of correlation between observables (typically present in simple SM extensions via heavy sterile fermions), or even to the suppression of certain channels; these effects can be interpreted as suggestive of non-vanishing phases.	**Jonathan Kriewald**
Measurements of Neutrino Interactions with Electrons in the Final State in the NOvA Near Detector	NOvA is a long-baseline accelerator neutrino experiment primarily designed to measure neutrino oscillations. NOvA utilizes two functionally-identical detectors that lie 14.6 mrad off-axis from the NuMI neutrino beam. The near detector, positioned 1 km downstream of the beam target, provides an excellent platform to perform high-statistics measurements of neutrino cross sections and associated physics. There are few measurements of electron neutrino and electron antineutrino charged current interactions at the GeV scale. Furthermore one of the dominant sources of systematic uncertainties in all neutrino cross section measurements arises from the flux prediction, for which the neutrino-electron elastic scattering can provide an in-situ constraint benefiting from its accurately calculated cross section. We present the first-ever measurement of a double-differential electron neutrino charged-current cross section, and the status of the measurement of the neutrino-electron elastic scattering in the NOvA near detector. Plans for future measurements with electron antineutrinos are also presented.	**Wenjie Wu**

Measurement of Neutral Current Elastic Cross Section in MicroBooNE	The MicroBooNE experiment is an 85 ton active volume liquid-argon time projection chamber located in the Fermilab Booster Neutrino Beamline. MicroBooNE's ability to detect low-energy protons allows us to study single proton events with a four-momentum transfer squared, Q^2, as low as 0.10 GeV^2. We present a measurement of the flux-averaged neutral-current elastic differential cross section for neutrinos scattering on argon as a function of Q^2, as well as our plan to extract the strange quark contribution to the axial form factor. This is not only the least-constrained contribution to the neutral-current elastic scattering cross section but is also crucial for understanding the strange quark contribution to the proton spin.	**Lu Ren**
ESSnuSB detector performance	ESSnuSB is a design study for a high precision future experiment at ESS, which will measure CP violation in the lepton sector at the second neutrino oscillation maximum. The experiment is based on a neutrino superbeam and will feature both near and far detectors. This talk will report on the baseline configuration of the near and far detectors. The progress of design and simulation of the far Cherenkov detectors will be presented in more detail, focusing on the migration matrices and detector efficiencies for detecting relevant neutrino flavors.	**Olga Zormpa**
NuMI Beam Monitoring Simulation and Data Analysis Status and Progress	With the Main Injector Neutrino Oscillation Search (MINOS) experiment decommissioned, muon and hadron monitors became an important diagnostic tool for the NuMI Off-axis ν_μ Appearance (NOvA) experiment at Fermilab to monitor the Neutrinos at the Main Injector (NuMI) beam. The goal of this study is to establish correlations between muon monitor and other beamline detector signals and upstream and downstream beam and lattice parameters in order to monitor and improve neutrino beam quality. We report on the progress of the beam data analysis and comparison with the simulation results.	**Yiding Yu**

Exploring Earth's Matter Effect in High-Precision Long-Baseline Experiments	from the upcoming high-precision long-baseline experiments to resolve the remaining fundamental unknowns such as neutrino mass ordering, leptonic CP violation and precision measurements of the oscillation parameters. In this paper, for the first time, we explore in detail the capability of Deep Underground Neutrino Experiment (DUNE) to establish the matter oscillation as a function of δ_{CP} and θ_{23} by excluding the vacuum oscillation. We find that DUNE is sensitive to Earth’s matter effect at more than 2σ C.L. irrespective of the choice of the oscillation parameters. The relative 1σ precision in the measurement of line-averaged constant Earth matter density (ρ_{avg}) for maximal CP-violating choices of δ_{CP} is around 10% to 15% depending on the choice of neutrino mass ordering. If δ_{CP} turns out to be around -90° or 90° , the precision in measuring ρavg is better in DUNE as compared to what are achievable from the Super-K atmospheric data, combined data from Solar and KamLand, and full exposure of T2K and NOνA. We also observe new interesting degeneracies among ρ_{avg} , δ_{CP} , and θ_{23} and notice that the present uncertainty in δ_{CP} dilutes more the measurement of ρ_{avg} compared to θ_{23} . To lift these degeneracies, we incorporate the prospective data from the upcoming Tokai to Hyper-Kamiokande (T2HK) and T2HK with a second detector in Korea (T2HKK) experiments. With a relatively shorter baseline and high statistics at first oscillation maximum, T2HK offers unprecedented sensitivity to establish genuine CP violation and to measure δ_{CP}, whereas in the T2HKK setup, the second detector in Korea with a roughly four times longer baseline is more sensitive to Earth's matter effect and provides crucial information on δ_{CP} working at second oscillation maximum. We explore interesting complementarities among these possible setups and find that the combined data from DUNE and T2HKK can establish Earth’s matter effect at more than 5σ C.L. irrespective of the choices of mass ordering, δ_{CP}, and θ_{23}.	**Masoom Singh**

Study of hierarchy-independent determination of leptonic δ_{CP} at sub-GeV energies with long baseline neutrinos	The value of leptonic CP violation phase δ_{CP} and neutrino mass hierarchy are two of the current major open problems in neutrino oscillation physics. The quest to find the former is spearheaded by various accelerator-based long-baseline neutrino experiments sensitive to δ_{CP}. It is known that hierarchy-δ_{CP} ambiguity can affect the measurement of both parameters, and experiments are usually designed to have baselines and energies to eliminate this ambiguity. It is known from studies of sub-GeV atmospheric neutrinos that δ_{CP} can be determined irrespective of neutrino mass ordering at these energies. Here we explore the possibility of obtaining hierarchy independent measurement of δ_{CP} with sub-GeV ν and $\bar{\nu}$ events in accelerator based long-baseline experiments. Event rates are studied as a function of the energy (E_ℓ) and direction ($\cos\theta_\ell$) of the final state lepton produced during charged current ν and $\bar{\nu}$ interactions.	**Yashwanth S Prabhu**
Exploring environmentally induced decoherence effect on neutrino oscillation probabilities	We discuss the effect of environmental decoherence on matter-effective neutrino oscillation probabilities. Decoherence is a phenomenon observed in systems interacting with the environment. We treat the neutrinos as an open quantum system and by using the Lindblad Master equation we study the evolution of neutrino states. The matter effect is incorporated for neutrinos passing through matter with the help of the Cayley-Hamilton formalism. In this work, we have developed a general algorithm that attempts to solve the Lindblad Master Equation to compute the neutrino oscillation probabilities in presence of environmental decoherence. We extensively validate the algorithm and explore how environmentally induced decoherence can potentially affect the oscillation probabilities, particularly in the long-baseline sector.	**Arnab Sarker**

JUNO Detector Design and Status	The Jiangmen Underground Neutrino Observatory (JUNO) is a next generation multipurpose liquid scintillator being built in China. It will address a wide range of topics in neutrino physics: the determination of the neutrino mass ordering and the sub-percent measurement of three oscillation parameters from reactor neutrino oscillations, detection of solar, atmospheric and supernova neutrinos as well as the search for physics beyond the Standard Model. The JUNO detector design is optimised towards the determination of the neutrino mass ordering by reaching an unprecedented energy resolution and a low background. The over 50-meter wide experimental hall, which was recently successfully dug out, is located under about 700 m of granite overburden. The center of the instrument consists of a 35.4-meter diameter acrylic vessel containing 22 kt of LAB-based liquid scintillator, making it the largest liquid scintillator detector in the world. The spherical detector is submerged in a water pool shielding doubling as a water Cherenkov detector which, along with a top tracker above it, serves to precisely reconstruct and veto atmospheric muons. Surrounding the vessel are 17612 20” photomultiplier tubes (PMTs) and 25600 3” PMTs, which will collect the light induced by neutrinos interacting in the detector. This talk presents the detector design and construction status of JUNO, which is expected to start taking data in 2023.	**Marta Colomer Molla**

Evolution of Neutrino Mass-Mixing Parameters in Matter with Non-Standard Interactions	We explore the role of matter effect in the evolution of neutrino oscillation parameters in the presence of lepton-flavor-conserving and lepton-flavor-violating neutral-current non-standard interactions (NSI) of the neutrino. We derive simple approximate analytical expressions showing the evolution/running of mass-mixing parameters in matter in the presence of standard interactions (SI) and SI+NSI. We observe that only the NSI parameters in the (2,3) block, namely $\varepsilon_{\mu\tau}$and $(\gamma - \beta) \equiv (\varepsilon_{\tau\tau}-\varepsilon_{\mu\mu})$ affect the running of θ_{23}. Though all the NSI parameters influence the evolution of θ_{13}, $\varepsilon_{e\mu}$ and $\varepsilon_{e\tau}$ show a stronger impact at the energies relevant for DUNE. The solar mixing angle θ_{12} quickly approaches to $\sim$ 90° with increasing energy in both SI and SI+NSI cases.The change in $\Delta m^2_{21,m}$ is quite significant as compared to $\Delta m^2_{31,m}$ both in SI and SI+NSI frameworks for the energies relevant for DUNE baseline. Flipping the signs of the NSI parameters alters the way in which mass-mixing parameters run with energy. We demonstrate the utility of our approach in addressing several important features related to neutrino oscillation such as: a) unraveling interesting degeneracies between θ_{23} and NSI parameters, b) estimating the resonance energy in presence of NSI when θ_{13} in matter becomes maximal, c) figuring out the required baselines and energies to have maximal matter effect in ν_{μ} $\rightarrow$ ν_{e} transition in the presence of different NSI parameters, and d) studying the impact of NSI parameters $\varepsilon_{\mu\tau}$ and $(\gamma - \beta)$ on the $\nu_{\mu} \to \nu_{\mu}$ survival probability.	**Sudipta Das**

Muon Precision Measurements with a Penning Trap	Muon, which has a mass of about 200 times greater than that of an electron, is expected to be a good probe to search for new physics beyond the Standard Model. There is a 4.2σ discrepancy between the theoretical value of the Standard Model and the experimental value observed from muon $g-2$ experiments [1, 2, 3]. At J-PARC, precision measurements of muon $g-2$ and muonium hyperfine structure are planned [4, 5]. In addition, by combining the ultra-slow muon technology at J-PARC with the Penning trap technology, we plan to measure the mass, lifetime, and magnetic moment of a rest muon with the precision of 1 ppb, 1 ppm, and 1 ppb, respectively. In this talk, we will present the conceptual design and progress of the muon Penning trap project. [1] B. Abi ${\it et\ al}$., (Muon $g–2$ Collaboration), Phys. Rev. Lett. ${\bf 126}$, 141801 [2] T. Albahri ${\it et\ al}$., (Muon $g–2$ Collaboration), Phys. Rev. D ${\bf 103}$, 072002 [3] T. Albahri ${\it et\ al}$., (The Muon $g–2$ Collaboration) Phys. Rev. A ${\bf 103}$, 042208 [4] M. Abe ${\it et\ al}$., Prog. Theor. Exp. Phys. 2019, 053C02. [5] S. Kanda ${\it et\ al}$., Phys. Lett. B ${\bf 815}$ 136154.	**Shoichiro Nishimura**

Validating the Earth's Core using Atmospheric Neutrinos with ICAL at INO	The Iron Calorimeter (ICAL) detector at the proposed India-based Neutrino Observatory (INO) aims to detect atmospheric neutrinos and antineutrinos separately in the multi-GeV range of energies and over a wide range of baselines. By utilizing its charge identification capability, ICAL can efficiently distinguish μ^- and μ^+ events. Atmospheric neutrinos passing long distances through Earth can be detected at ICAL with good resolution in energy and direction, which enables ICAL to see the density-dependent matter oscillations experienced by upward-going neutrinos in the multi-GeV range of energies. In this work, we explore the possibility of utilizing neutrino oscillations in the presence of matter to extract information about the internal structure of Earth complementary to seismic studies. Using good directional resolution, ICAL would be able to observe 331 μ^- and 146 μ^+ core-passing events with 500 kt$\cdot$yr exposure. With this exposure, we show for the first time that the presence of Earth's core can be independently confirmed at ICAL with a median $\Delta \chi^2$ of 7.45 (4.83) assuming normal (inverted) mass ordering by ruling out the simple two-layered mantle-crust profile in theory while generating the prospective data with the PREM profile. We observe that in the absence of charge identification capability of ICAL, this sensitivity deteriorates significantly to 3.76 (1.59) for normal (inverted) mass ordering.	**Anil Kumar**

Toward high-precision measurement of muon lifetime with an intense pulsed muon beam at J-PARC	Precise measurements of the muon lifetime can determine the Fermi constant, which is the coupling constant for the weak interaction. The Fermi constant is an essential parameter of the Standard Model that should be determined experimentally, as well as the fine structure constant and the mass of the weak boson. In the 2000s, the FAST [1] and MuLan [2] experiments were performed using continuous muon beams at PSI. The former obtained the muon lifetime with a precision of 16 ppm and the latter with a precision of 1 ppm. An experiment using a pulsed muon beam was also conducted at RIKEN-RAL [3]. We have studied the feasibility of further high-prevision measurement using an intense pulsed muon beam at J-PARC MLF MUSE to revisit this topic. A segmented scintillation counter with SiPM readout will be employed in a proposed experiment to obtain a muon lifetime spectrum with pileup correction. We will report on an overview of the experiment, detector prototype development, and pileup correction modeling in this contribution. [1] A. Barczyk et al. (FAST Collaboration), Phys. Lett. B 663, 172 (2008). [2] V. Tishchenko et al. (MuLan Collaboration), Phys. Rev. D 87, 052003 (2013). [3] D. Tomono et al, Nucl. Phys. B, Proc. Suppl. 149, 341 (2005).	**Sohtaro Kanda**

Detector Systems Development for Inter-Bunch Extinction Measurements at the 8 GeV Slow-Extracted Pulsed Proton Beam for the COMET Experiment at J-PARC	The COMET experiment will search for the muon-to-electron conversion process in aluminium with a high single event sensitivity of 10^{-17}. We use the high-intensity proton beam at 8 GeV slowly extracted from the main synchrotron accelerator of Japan Proton Accelerator Research Complex (J-PARC). The beam must form in a pulsed structure with a distance of 1.2 μsec, and the extinction value, the proton-number ratio outside and inside of the bunch, should be less than 10^{-10}. We measured the extinction by counting proton-induced pions at the K1.8BR secondary beamline at the Hadron Experimental Facility in J-PARC, and the analysis is ongoing. For the measurement, we developed a hodoscope to measure the pion-hitting timings with 132-channel segmented plastic scintillators, read out by silicon photomultipliers and photomultiplier tubes, and its surrounding system, including an amplifier and digitiser electronics and data acquisition (DAQ) software. We prepared three different FPGA-based TDC modules with time resolutions of 1, 5, and 7.5 nsec and optimised their firmware to have distinct advantages for redundancy. The amplifier boards also discriminate signals and distribute them to all three TDC modules. The DAQ software was designed not to limit the data transfer speed and not be suppressed by disk access. The system worked as expected at a hit rate of 12Mπ/beam spill, the maximally allowed beam intensity. The detail and performance of the developed detector system will be presented.	**Kou Oishi**

Status on the construction of the straw tube tracker for the COMET experiment Phase-I	The COMET experiment at J-PARC aims to search for the charged lepton flavor violating process of neutrinoless muon to electron conversion with an improvement of a sensitivity by a factor of 10000 to the current limit. When the muon to electron conversion occurs, almost all the energy of the muon mass is carried out by the electron which is expected to have the monochromatic energy of about 105 MeV. The experiment requires detecting such electron with an excellent momentum resolution, better than 200 keV/c, to achieve the goal sensitivity. Thus, the very light material detector which is operational in vacuum is indispensable. Based on the requirement, we have developed the thin-wall straw-tube tracker which is operational in the vacuum and constructed by the extremely light material. The straw-tube tracker consists of 9.8 mm diameter tube, longer than 1 m length, with 20 μm thickness Mylar foil and 70 nm aluminum deposition. Recently, we started the assembly of the final straw tube tracker for COMET phase-I. In this presentation, we report the status on the construction of the straw tube tracker. The prospect of the development of the straw tracker towards the COMET phase-II is also described.	**Kazuki Ueno**
Muon and electron g-2, proton and cesium weak charges implications on dark $\mathbf{Zd}$ models	The 4.2σ deviation of the anomalous muon magnetic moment measurements recently performed at Fermilab with respect to the state of the art theory prediction has strengthened the motivation for standard model extensions. In this talk, we analyse a model involving an additional Zd mediator and we show the constraints obtained considering the muon and electron magnetic moment determinations and the proton and cesium weak charge measurements. We will also explain the procedure used to revise the cesium weak charge determination from atomic parity violation, exploiting a practically model-independent extrapolation from the recent neutron radius of lead nuclei performed by PREX. A combined fit suggests an appealing evidence of the existence of a Zd boson, particularly intriguing in light of other increasing evidences for the incompleteness of the standard model.	**Nicola Cargioli**

<table>
<tr><td>Measurement of neutrino oscillation parameters $\sin^{2}2\theta_{13}$ and Δm^2_{ee} at Daya Bay, and joint sterile neutrino limits with MINOS/MINOS+ and Bugey-3</td><td>measurements of the mixing angle θ_{13} and the effective mass splitting Δm^2_{ee}, while also shedding light on various other topics in neutrino physics. At Daya Bay, electron antineutrinos are provided by six nuclear reactors in southern China, totaling 17.4 GW$_{\mathrm{th}}$, and they are observed by eight identically designed liquid scintillator detectors divided among two near sites and one far site. By measuring the relative antineutrino rates and spectral shapes at the near and far sites, Daya Bay benefits from a virtually complete cancellation of all systematic uncertainties related to the reactor flux and absolute detection efficiency.

In addition to the measurement of θ_{13}-driven oscillation, Daya Bay is also well-positioned to search for hypothetical "θ_{14}-driven" oscillation caused by a light sterile neutrino with a sub-eV^2 mass-squared splitting. Such a particle could potentially explain, first, the anomalous electron (anti)neutrino excess in muon (anti)neutrino beams observed by the LSND and MiniBooNE collaborations, and second, the global deficit observed in the reactor neutrino flux compared to model predictions. With the addition of data from the shorter-baseline Bugey-3 experiment, sensitivity can be extended to higher values of Δm^2_{41}. Going further, the data from the two reactor experiments can be combined with that from the MINOS/MINOS+ accelerator experiments, allowing limits to be set on the ν_μ-to-ν_e effective mixing angle $\sin^2 2\theta_{\mu e} \equiv 4|U_{e4}|^2|U_{\mu4}|^2$.

In this talk, we describe Daya Bay's measurements using our primary data sample, in which electron antineutrinos are identified via the inverse beta decay interaction, with subsequent neutron capture on gadolinium. From a 1958-day data sample, we obtain $\sin^2 2\theta_{13} = 0.0856 \pm 0.0029$ and $\Delta m^2_{ee} = (2.522^{+0.068}_{-0.070}) \times 10^{-3}$ eV^2. In addition, from a 1230-day sample, we set 90% CL limits of $\sin^{2}2\theta_{14} \, < 0.01$ for approximately $4 \times 10^{-3} \, < \Delta m^2_{41} <</td><td>Matt Kramer</td></tr>
<tr><td>Simulating the ARAPUCA - DUNE's next generation light sensors</td><td>Arapuca is "bird trap" built by Brazil's natives. On the other hand, our ARAPUCA is a light trap that increases the collection area of regular SiPMs and it is the sensitive element upon which DUNE's whole photon detection system is based upon. Here we present the journey to build a reliable state-of-the-art simulation of such device, highlighting the process of modeling its dichronic filters, wavelength-shifting wave guides, and silicon photo-multipliers. As a result we obtain its efficiency and are able to study how its performance could be affected by small changes, either intended or not.</td><td>Gustavo Valdiviesso</td></tr>
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Improved Neutrino Energy Estimation in Neutral Current Interactions with Liquid Argon Time Projection Chambers	Large liquid argon time projection chambers (LAr TPCs) at SBN and DUNE will provide an unprecedented amount of information about GeV-scale neutrino interactions. By taking advantage of the excellent tracking and calorimetric performance of LAr TPCs, we present a novel method for estimating the neutrino energy in neutral current interactions that significantly improves upon conventional methods in terms of energy resolution and bias. We present a toy study exploring the application of this new method to the sterile neutrino search at SBN under a 3+1 model.	**Andrew Furmanski, Christopher Hilgenberg**
Flavour dependence and Coulomb corrections for charged current neutrino-nucleus scattering	QED effects are controllable and calculable corrections that must be understood for percent-level neutrino cross section inputs. Of particular importance are ``enhanced" corrections stemming from either large-logs or coherent effects. Of particular importance are corrections that depend on lepton mass, or the sign of the charged lepton that is produced. In the former case, the mass dependence inherited from the charged lepton results in a neutrino-flavour dependent correction, while in the latter case it introduces an additional discrepancy between neutrino and antineutrino cross sections. In this talk I will discuss recent progress towards a rigorous treatment of Coulomb corrections that stem from the coherent exchange of soft-photons between the outgoing lepton and the final nuclear state (of charge Z). I will outline the construction of an effective field theory that is appropriate for high-energy lepton kinematics and that can capture all-order behaviour in Z\alpha via high energy expansion. A power-counting scheme for the computation of distorted-wave matrix elements in the high energy limit will be presented, which allows for an analytic description of Coulomb corrections. Useful phenomenological examples will be highlighted.	**Ryan Plestid**
Search for Tau -> 3mu decays with CMS experimentat LHC	New results are presented for the search for charged lepton flavor violating decays of tau leptons to three muons with the CMS detector. The search employs tau leptons produced in decays of heavy flavor B/D mesons and W bosons.	**Caterina Aruta**

Hyperfine Splitting in Muonic Hydrogen (CREMA collaboration)	Energy levels of muonic hydrogen, the bound state of proton and muon, are very sensitive to the inner structure of the proton. The two-photon exchange contribution can be inferred from the ground-state hyperfine splitting (1S-HFS), the energy separation of the singlet (F = 0) and triplet (F = 1) spin states. The CREMA collaboration at the Paul Scherrer Institute aims to measure the 1S-HFS with an accuracy of 1-2 ppm to extract the two-photon exchange contribution with a relative accuracy of about 100 ppm by means of laser spectroscopy. A custom pulsed laser system is being built, producing 5 mJ pulses at a tunable wavelength around 6.8 µm and a bandwidth of less than 100 MHz. We will present the measurement principle, and show details of our laser and detection system.	**Lukas Affolter**
The Power Distribution System for the Mu3e Experiment	The Mu3e experiment under construction at the Paul Scherrer Institute, Switzerland, aims to search for the lepton flavour violating decay of a muon into one electron and two positrons with an ultimate sensitivity of one in 10^{16} muon decays. The detector for the Mu3e experiment consists of High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) combined with scintillating tiles and fibres for precise timing measurements. The entire detector and front-end electronics are located in the 1m diameter bore of a 1T superconducting magnet. A compact power distribution system based on custom DC-DC converters provide the detector ASICs and readout FPGAs with supply voltages of 1.1V to 3.3V with currents up to 30A per channel. These converters are placed as close as possible to the detector and provide 10kW of power in total. For the whole experiment a total of 126 DC-DC converters is required. The poster presents the results of recent prototype tests and the path to the production of the full power system.	**Sophie Gagneur**

Development of the pre-Supernova Alert System for Super-Kamiokande	The current phase of the Super-Kamiokande experiment, SK-Gd, is characterized by the addition of gadolinium sulfate to the water Cherenkov detector, which improves the detection capability of thermal neutrons. For low energy events, the main detection channel for electron anti-neutrinos is the Inverse Beta Decay interaction, which has, in its final state, a positron and a neutron. The neutron thermal capture by gadolinium emits gamma-ray cascades with energies about 8 MeV, improving the identification of the products of this process, which reduces the background for low energy events and allows the analysis of neutrinos with energies below the usual Super-Kamiokande thresholds. One possible detection by SK-Gd is the neutrinos coming from massive stars at the last evolutionary stage before core-collapse Supernova, known as pre-Supernova stars. During this stage, pair annihilation and beta decay processes are the main cooling mechanisms of the stars, emitting high fluxes of electron anti-neutrinos. Their detection could provide an early warning for core-collapse Supernovae. In this poster it is presented the techniques for the development of a Supernova alert system for Super-Kamiokande based on the detection of pre-Supernova neutrinos and the expected sensitivity.	**Lucas N Machado**

Semi-inclusive charged-current neutrino-nucleus reactions: Analysis of Data in the relativistic Plane-Wave Impulse Approximation	Nuclear effects in neutrino-nucleus scattering is one of the main sources of uncertainty in the analysis of neutrino oscillation experiments. At present most of these studies have been focused on inclusive scattering processes where only the scattered lepton is detected in the final state. This implies, due to the extended neutrino energy distribution (flux), that very different reaction mechanisms can contribute to the cross section. Hence the determination of the neutrino energy, required in the analysis of neutrino oscillations, presents a high uncertainty due to effects associated to the nuclear dynamics. This difficulty can be solved significantly by considering semi-inclusive scattering processes in which, in addition to the charged lepton, one hadron is also detected in the final state. We have presented a detailed description of this process using different nuclear models in [1]. Moreover, in the last years different neutrino collaborations have provided semi-inclusive data given in terms of several different kinematical variables linked to the detection of an ejected nucleon from the nucleus. In this work we provide a systematic study comparing our theoretical predictions with all available semi-inclusive data measured by the T2K, MINERνA and MicroBooNE collaborations. Although being aware of the important limitations of the model, we are confident that the present results will help to better understand the nuclear dynamics, providing a more precise knowledge of neutrino oscillation parameters. [1] "Semi-inclusive charged-current neutrino-nucleus cross sections in the relativistic plane wave impulse approximation". J.M. Franco-Patino, J. Gonzalez-Rosa, J.A. Caballero, M.B. Barbaro. Phys.Rev. C102 6, 064626 (2020)	**Juan Manuel Franco Patino**

Inelastic neutrino-nucleus scattering in the superscaling model	The superscaling SuSAv2 model, that was successfully used to explain electron scattering data in the quasielastic (QE) as well as in the high inelastic regions (see [1] and refs. therein), is here extended to charged-current neutrino scattering processes on nuclei. We provide a detailed description of the Delta nucleon resonance and compare our predictions based on the pure Relativistic Fermi Gas (RFG) and SuSAv2 scaling functions with previous results obtained using a Delta scaling function fitted to the analysis of (e,e') data. The model is extended to the complete neutrino inelastic spectrum, resonant, non-resonant and deep inelastic scattering (DIS), by considering different parametrizations of the weak inelastic single-nucleon structure functions and a Parton Distribution Function (PDF) model. Our predictions, including also two-particle two-hole contributions, are compared with data taken by the T2K collaboration. [1] "Electron- versus neutrino-nucleus scattering". J.E. Amaro, M.B. Barbaro, J.A. Caballero, R. Gonzalez-Jimenez, G.D. Megias, I. Ruiz Simo. J. of Phys. G47, 124001 (2020).	**Jesús Gonzalez Rosa**
Status of the KDAR Neutrino measurement with JSNS2.	The The J-PARC Sterile Neutrino Search at the J-PARC Spallation Neutron Source (JSNS2) experiment has the unique ability to precisely measure monoenergetic 236 MeV neutrinos from charged kaon decay-at-rest (KDAR). J-PARC's Material and Life Science Facility (MLF) 3 GeV primary proton beam incident on a mercury target generates the world's most intense source of KDAR which can be used to make neutrino cross-section measurements using known-energy neutrinos. In this poster, I will describe the analysis status for the KDAR neutrino measurement at JSNS2 using the first long-term physics run data set obtained during this year.	**Hyoungku Jeon**

Simulation study of electron energy resolution and reconstruction with thinner iron plates using plastic scintillators in ICAL	The proposed magnetized Iron Calorimeter (ICAL) detector to study atmospheric neutrinos and anti–neutrinos at the India based Neutrino Observatory (INO) is a 51 K ton detector which will have a magnetic field of 1.3 T. The default geometry of ICAL has 56 mm thick iron plates as the interaction material (target), separated by 40 mm gaps in which the active detectors the resistive plate chamberes (RPCs) will be placed. This makes ICAL sensitive to muons with energy in the range ~0.5–25 GeV, produced in charged current (CC) interactions of atmospheric ν_μ and $\bar{\nu}_\mu$ with iron. It was shown that sub–GeV ν_e and $\bar{\nu}_e$ charged current events are sensitive to the leptonic CP phase δ CP irrespective of the neutrino mass hierarchy. In our new study we explore the possibility of detecting sub–GeV ν_e and $\bar{\nu}_e$ in ICAL for different combinations of iron plate thickness, air gaps and different types of active detectors. Energy resolutions for electrons with energy < 1 GeV were obtained for cases with RPC and scintillator as active detectors with 18 mm thick iron and 40 mm thick air gap and compared with each other and also the resolutions for DUNE experiment. In this case, number of hits per layer can be used to reject pion background from electron events. Further studies with 18 mm thick iron plate and a decreased air gap of 12 mm (10 mm scintillator and 2 mm air gap) to improve the energy resolutions for low energy electrons and identification of more variables for background rejection are being performed.	**Honey Khindri**
DUNE experiment physics	The Deep Underground Neutrino Experiment (DUNE) will feature a 40-kton liquid argon TPC detector situated a mile below the surface at the Sanford Underground Research Facility. A new broadband high-intensity neutrino source and Near Detector complex will be located at Fermilab, 1300 kilometers away. This arrangement will provide unprecedented sensitivity in the search for neutrino CP violation, determination of the neutrino mass ordering, and precision measurements of neutrino mixing parameters. The underground Far Detector also allows for low background, low threshold observations of supernova neutrinos, with a unique sensitivity to the electron neutrino flux. Further, DUNE will conduct a wide range of searches for physics beyond the Standard Model, including baryon number violation, rare scattering processes, and non-standard flavor transitions. In this talk, we review DUNE's extensive physics program and show updated sensitivities.	**Miquel Nebot Guinot**

Charged current interactions on carbon with a single positively charged pion in the final state at the T2K off-axis near detector with 4π solid angle acceptance	The long-baseline neutrino experiment Tokai-to-Kamiokande (T2K) is located in Japan and is measuring neutrino oscillation parameters. The muon neutrino charged current interactions in the near detector (ND280) are used to predict the event rate at the far detector, in particular constraining the neutrino flux and neutrino-nucleus interaction cross-sections, which are the dominant systematic uncertainties in the oscillation analysis. This poster presents a study of charged current interactions on carbon with a muon and a single positively charged pion in the final state (CC1π+) at the T2K off-axis near detector with a 4π solid angle acceptance. This channel constitutes the main background for the muon neutrino disappearance measurement when the charged pion is not observed in the SuperKamiokande water Cherenkov detector, and a precise understanding of it is relevant for all current and planned neutrino oscillation experiments. Single positive pion production is primarily sensitive to resonant processes but also to non-resonant contributions as well as coherent pion production. Additionally, final-state interactions in the nuclear target have to be taken into account. A particularly interesting characterization of CC1π interactions through the measurement of Adler Angles is presented. These observables carrying information about the polarization of the Delta resonance and the interference with the non-resonant single pion production.	**Danaisis Vargas**

Mu3e Integration Run 2021	The Mu3e experiment at the Paul Scherrer Institute searches for the lepton flavour violating decay $\mu^+ \rightarrow e^+ e^+ e^-$. The experiment aims for an ultimate sensitivity of one in 10^{16} μ decays. The first phase of the experiment, currently under construction, will reach a branching ratio sensitivity of $2\cdot10^{-15}$ by observing 10^{8} μ decays per second over a year of data taking. The highly granular detector based on thin high-voltage monolithic active pixel sensors (HV-MAPS) and scintillating timing detectors will produce about 100 GB/s of data at these rates. The Field Programmable Gate Array based Mu3e Data Acquisition System will read out this data from the detector and identify interesting events using a farm of graphics processing units. The poster presents the status of the DAQ and first results from the 2021 integration run, which for the first time operated a slice of the Mu3e detector with the muon beam at PSI.	**Marius Köppel**