International Workshop on Next generation Nucleon Decay and Neutrino Detectors (NNN19)

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Libro de resúmenes

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New constraints on neutrino electric millicharge from elastic neutrino-electron scattering and coherent elastic neutrino-nucleus scattering

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In different extensions of the Standard Model of Particle Physics (SMPP), the neutrino acquire electric millicharge and charge radius, as well as electric and magnetic dipole moments, the latter being the most studied property in the literature. However, the possibility that neutrino be a millicharged particle has also been a subject of study in different theoretical and experimental works. Additionally, several experimental constraints on the neutrino electric millicharge (NEM) have been reported from reactors, accelerators, and astrophysical measurements. In this talk, we will present the results from a statistical analysis using data from reactor neutrino experiments, which include elastic neutrino-electron scattering (ENES) processes, where both individual and combined limits on the neutrino electric millicharge were obtained. Likewise, we will show bounds from several future experimental proposals involving coherent elastic neutrino-nucleus scattering (CEνNS). In the first case, the limit of NEM achieved from the combined results of different experiments is $1.5 \times 10 -12$ e at 90% C.L., and in the second scenario the bound corresponds to $3.5 \times 10 -13$ e (90% C.L.). The outcomes indicate CEνNS experimental proposals might be a suitable alternative to improve the current limits of NEM. https://arxiv.org/abs/1907.04942.

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Texture Zeros for neutrino Mass Matrices

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By assuming Dirac masses for the neutrinos in a model with the Standard Model interactions and particles plus three right-handed neutrinos, we obtain configurations with five texture zeros for the neutrino mass matrices. This matrix is built in such a way that it reproduces the inner angles of the PMNS and the CP-violating phase in the lepton sector. From this work, non-trivial predictions for the neutrino masses are expected.

Poster Session / 7

Mixing angles from five texture zeros of the quark mass matrices

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In the Standard Model, we will deduce a configuration with five texture
zeros for the quark mass matrices that it is not of the Fritzsch type. It is valid and generates all the physical quantities of interest: that includes the quark masses, the inner angles of the Cabibbo-Kobayashi-Maskawa unitary triangle, and the phase responsible for the violation of the charge-parity symmetry. To achieve this, we must include non-physical phases in the unitary matrices that diagonalize the quark mass matrices to bring the Cabibbo-Kobayashi-Maskawa mixing matrix to its standard form.

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Multi-photomultiplier tube module development for the next generation Hyper-Kamiokande neutrino experiment

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Hyper-Kamiokande (Hyper-K) is a next generation, water Cherenkov neutrino detector with 260,000 metric tons of ultra-pure water. It will measure accelerator, cosmic and atmospheric neutrinos to discover CP violation in neutrino oscillations, determine the neutrino mass ordering, as well as potentially discover proton decay. Hyper-K is the far-detector of the 300 km long-baseline neutrino experiment in Japan. We are also proposing a new Intermediate Water Cherenkov Detector (IWCD) located at a baseline of 1-2 km away from the neutrino source at J-PARC to cancel the neutrino flux and cross section uncertainties.

Hyper-K is developing new multi-PMT (mPMT) optical modules, housed in a pressure vessel with an acrylic dome for 19 front-facing 3-inch PMTs. The IWCD requires 500 modules and more are being considered for a portion of the Hyper-K photosensors. The advantages of mPMTs over traditional single 20-inch PMT detector are increased granularity and improved timing resolution. Each of the 19 3-inch PMTs have different orientations with a particular field of view, thus providing information on the direction of each detected photon, which can improve dark hit discrimination and event reconstruction. Each vessel conveniently houses digitization electronics and calibration sources. This work presents the mechanical design and assembly of the first mPMT prototype at TRIUMF,and manufacturing techniques for future mass production.

Poster Session / 9

Forecast on lepton asymmetry from future CMB experiments

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We consider a cosmological lepton asymmetry in the form of neutrinos and impose new expected sensitivities on such asymmetry through the degeneracy parameter (ξ_ν) by using some future CMB experiment configurations, such as CORE and CMB-S4. Taking the default scenario with three neutrino states, we find ⊠⊠=0.05±0.10(±0.04)|, from CORE (CMB-S4) at 95 per cent CL, respectively. Also, within this scenario, we evaluate the neutrino mass scale, obtaining that the normal hierarchy mass scheme is privileged. Our results are an update concerning on the cosmological lepton asymmetry and the neutrino mass scale within this context, from which can bring a perspective on the null hypothesis for ξ_ν (and its effects on ΔN_eff), where perhaps, ξ_ν may take a non-null value up to 95 per cent CL from future experiments such as CMB-S4. Sensitivity results for CMB-S4 obtained here not including all expected systematic errors.

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The T2K ND280 Upgrade project

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In view of the J-PARC program of upgrades of the beam intensity, the T2K collaboration is preparing towards an increase of the exposure aimed at establishing leptonic CP violation at 3 σ level for a significant fraction of the possible δ_{CP} values. To reach this goal, an upgrade of the T2K near detector ND280 has been launched, with the aim of reducing the overall statistical and systematic uncertainties at the appropriate level of better than 4\%.
We have developed an innovative concept for this neutrino detection system, comprising the totally active Super-Fine-Grained-Detector (SuperFGD), two High Angle TPC (HA-TPC) and six TOF planes.
The SuperFGD, a highly segmented scintillator detector, acting as a fully active target for the neutrino interactions, is a novel device, (JINST 13 (2018) no.02, P02006; NIM A923 (2019) 134), with dimensions of ~2x1.8x0.6 m3 and a total mass of about 2 tons. It consists of about 2x106 small scintillator cubes each of 1 cm3. Each cube is covered by a chemical reflector. The signal readout from each cube is provided by wavelength shifting fibers inserted connected to micro-pixel avalanche photodiodes MPPCs. The total number of channels will be ~60,000. We have demonstrated that this detector, providing three 2D projections, has excellent PID, timing and tracking performance, including a 4π angular acceptance, especially important for short proton and pion tracks.
The HA-TPC will be used for 3D track reconstruction, momentum measurement and particle identification. These TPC, with overall dimensions of 2x2x0.8 m3, will be equipped with 32 resistive Micromegas. The thin field cage (3 cm thickness, 4% rad. length) will be realized with laminated panels of Aramid and honeycomb covered with a kapton foil with copper strips. The 34x42 cm2 resistive bulk Micromegas will use a 500 kOhm/square DLC foil to spread the charge over the pad plane, each pad being appr. 1 cm2. The front-end cards, based on the AFTER chip, will be mounted on the back of the Micromegas and parallel to its plane.
The time-of-flight (TOF) detector will allow to reject events generated in the passive areas of the detector and improve particle identification. The TOF will consist of 6 planes with about 5 m2 surface area surrounding the SuperFGD and the TPCs. Each plane will be assembled with 2.2 m long cast plastic scintillator bars with light collected by arrays of large-area MPPCs from two ends. The time resolution at the bar centre is 150 ps.
In Summer 2018 we have tested prototypes of the SuperFGD, the resistive Micromegas and the TOF in a CERN PS test beam with excellent results.
We have recently completed the detailed TDR describing all the components of the ND280 Upgrade (arXiv:1901.03750). The project has been recently approved by CERN as part of the Neutrino Platform (NP07). In this talk we will report on the design of these detectors, their performance, the results of the test beam and the plan for the construction.

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Taishan Antineutrino Observatory

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Taishan Antineutrino Observatory
Wei Wang,
On behalf of the JUNO collaboration
Abstract:
Many reactor neutrino experiments observed a ~6% deficit in the reactor antineutrino flux compare with the prediction. In addition, Daya Bay confirmed a new anomaly "5-MeV bump" in the spectrum shape. These anomalies require an accurate measurement of the reactor antineutrino spectrum.
The high energy resolution measurement will provide an essential reference spectrum to the JUNO experiment. Taishan Antineutrino Observatory(TAO) will have an energy resolution better than 3%/sqrt(E). It will help to reduce the model dependence for JUNO to determine the mass hierarchy.
Except serve to JUNO, TAO will observe the fine structure of reactor neutrino spectrum, to provide a benchmark to nuclear databases.
TAO will use several tons of Gd-LS as target material to detect antineutrinos via inverse beta decay (IBD). SiPM, with photon detection efficiency ~50%, is used as photon sensor which collects about 4500 photoelectrons at 1MeV energy. The detector including the Gd-LS, container (nylon ball contain, acrylic ball support), SiPM, etc will operate at -50oC to lower the dark noise of SiPM. TAO will be placed at 30m from the reactor core which has a thermal power of 4.6 GW.
This talk will present the simulation of TAO detector and the R&D progress.

Poster Session / 13

Design and Implementation of a Photon Detector using SiPM Sensors and Data Processing Based on Artdaq

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Co-autor: Diego Aranda [1]

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In this work, was designed a signal amplification system generated by SiPM sensors to detect photons created by the interaction of muons with plastic scintillators. The Corsi model was used to analyze different electronic topologies for data reading and noise filter using operational amplifiers. Two types of configurations were considered: Transimpedance and Charge Integrator, which were compared according to the requirements of the experiment.

Poster Session / 14

Design of a SiPM Signal Conditioning System for the DUNE Photon Detection System

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Co-autor: Carlos B. Montiel [2]

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In this work we study the design of three stages used to read and amplifly the signals coming from 48 SiPM detectors connected in parallel. In the pre amplification stage, the charge integrator circuit and the trans-amplifier circuit are proposed, in the addition stage, a simple adder circuit; and, in the final stage, a low pass Sallen Key filter. A circuit analysis of the stages was done taking into account the different noise sources, obtaining their respective tranfer functions in order to simulate the behavior of system. Finally, a set of values that meets the system requirements was found and a comparison beetween the circuits perfomances of the pre amplification stage was done.

Poster Session / 15

Probing non-standard neutrino properties by using the Earth matter effects on supernova neutrinos

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Co-autor: Hiroshi Nunokawa [1]

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The observation of Earth matter effects in the spectrum of neutrinos coming from a next galactic supernova could, in principle, reveal if neutrino mass ordering is normal or inverted. A way to identify these effects is through the observation of the modulations that appear in the spectrum when neutrinos travel through the Earth before they arrive at the detector. These features in the neutrino spectrum depend on two factors, the average neutrino energies, and the difference between the primary neutrino fluxes of electron and other flavors produced inside the supernova. However, recent studies indicate that the Earth matter effect is expected to be rather small and difficult to be observed because of the similarity of average energies between electron and other flavors of neutrinos. Here, we are looking towards the possibility if the non-standard neutrino properties can enhance the Earth matter effect. In this poster we focus on possibility of invisible neutrino decay which can lead to situations where the difference between these primary fluxes is large enough to make the Earth matter effect observable.

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Machine learning techniques to enhance water Cherenkov reconstruction

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Machine learning has the potential to enhance the sensitivities of water Cherenkov detectors by improving the event reconstruction, suppressing backgrounds and reducing systematic uncertainties. These improvements will be vital in achieving the precision measurements that current and next-generation detectors are now aiming to perform.
This talk covers several areas where machine learning architectures are being explored as part of the WatChMaL organisation for event reconstruction in the Super-Kamiokande and Hyper-Kamiokande projects. Specific physics motivations are discussed, including applications for accelerator, atmospheric and low energy neutrino measurements, followed by an overview of the plans, progress, and challenges of ongoing efforts to use machine learning techniques in these areas.

Poster Session / 17

Rewriting the probability of large compactified extra dimension

Autor: Victor Saul Basto-Gonzalez[1]

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In a model where the right-handed neutrinos can propagate in a large compactified extra dimension and where the left-handed neutrinos are confined to a 4-dimensional spacetime, the oscillation probability in this model is $P_{\alpha\beta} = |\sum_{k=1}^{3} U^{\alpha k} U^{\beta k*} A_k|^2$, where $A_k = A_k(L, E_\nu, R_{LED}) = \sum_{n=0}^{\infty} (L_k^{0n})^2 \exp(iL\lambda_k^{(n)2}/2E_\nu R^2)$. In this poster, I will show an approximation of this probability and, through figures, I will compare it with the probability of standard oscillation for different baselines to understand the different terms that make up this approximation.

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Recent Cross-section Measurements from MicroBooNE

Autor: Joshua Spitz[1]

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MicroBooNE is a liquid argon time projection chamber in the Booster Neutrino Beam at Fermilab. The large event rate and 3 mm wire spacing of the detector provide high-statistics, precise-resolution imaging of neutrino interactions leading to low-threshold, high-efficiency event reconstruction with full angular coverage. As such, this is an ideal place to probe neutrino-argon interactions in the hundreds-of-MeV to few-GeV energy range, and to study the impact of nuclear effects through detailed measurements of hadronic final states. This talk will present recent measurements of neutrino interactions in MicroBooNE, including inclusive charged-current interactions, neutral-pion production, and measurements of low-energy protons.

Poster Session / 21

Open hardware at big detectors

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The relationship between open source culture and the great physics experiments in the world has always brought great benefits for both sides. However, the challenges to achieving high-performance instrumentation and time development constrain, makes the labor harder in terms of hardware. A method to use and share information in this context is mandatory to achieve experimental designs in which open and closed code can cohabit, without penalizing the reliability or the reusability of technology developed in the process. In this talk, I will share an example where fast FPGA circuitry

development turns into a reliable task for big and budget-sensitive projects such as the detectors at the DUNE experiment in FERMILAB.

Poster Session / **22**

Assessment performance of newly installed Basler Optical diagnostic digital system against the standard BTV system at CLEAR for future LHC upgrades.

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In this work, the new digital system installed at CLEAR was analyzed. To measure its efficiency, beam Emittance and Twiss parameters were tested by comparing the results of the Basler digital camera with the results of the traditional BTV system. The new digital system presented better results regarding the quality and resolution of the beam images obtained. In addition, this digital system presented a smaller standard error of the mean beam size, which led to a lower final error of the emittance and Twiss parameters. Besides, Monte Carlos was used to propagate errors. In general, these results appear to be in agreement with the BTV camera, especially in current ranges near and equidistant to the minimum point of the parabola obtained after the Quadrupole Scan. In the horizontal plane, beam size values for current ranges far from the minimum point tend to create slightly different parabolas in both cameras, which leads to different results. In the vertical plane, this issue was not observed. In the horizontal plane, a normalized emittance of 17.163 $\pm$ 0.14 mm.mrad and 13.91 $\pm$ 0.18 mm.mrad and in the vertical plane were obtained for the Basler camera. On the other hand, a normalized emittance of 17.167 $\pm$ 0.12 mm.mrad in the horizontal plane and 13.84 $\pm$ 0.077 mm.mrad in the vertical plane for the BTV camera were obtained. All these calculation were done with an energy of 200 MeV.

Poster Session / **23**

Supernova Remnant W28 observed by Fermi-LAT

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We present a long term analysis of temporal evolution of the gamma-ray source W28, which is a supernova remnant (SNR) observed by the Large Area Telescope (LAT) on board of the Fermi Gamma-Ray Space Telescope since 2008. W28 is an old (3.5 - 4.5x104 yr) galactic diffuse gamma-ray source, located ~2kpc away from us, at (l:6.71, b:0.05) . Observed for more than 10 years, W28 is a interesting target of study because of its good spectral and spatial data resolution. We studied the 10 years data (04/August/2008 - 04/August/2018) between the energy range 100MeV to 300GeV, this study takes a longer observation time allowing us to have good statistics and confidence in our results. SNR W28, a verified hadronic gamma-ray source, is an example of interaction of the supernovae ejecta with the ISM. For this work we performed an extended source binned likelihood analysis, through FermiTools software. We obtained light curves, flux and spectral parameters. Our results are in agreement with parameters obtained from a simulation of the source region (10 degrees radii) considering the contribution of gamma-ray nearby sources, due to large point spread function (PSF) at low energies, and background, through Galactic diffuse and isotropic emission models. We found an excess of gamma-ray emission in the time period between 2014 and 2015, with a significance of more the 8σ. We reproduce previous results, the increase in gamma emission was produced by the interaction of the shock front with a dense region within a molecular cloud (MC). After this emission episode we found another emission episode in 2016, and we studied its characteristics. Finally, we

discuss the potential physical processes responsible for the gamma emission of the SNR.

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New constraints on neutrino electric millicharge from elastic neutrino-electron scattering and coherent elastic neutrino-nucleus scattering

Autor: Alexander Parada Valencia[1]

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In different extensions of the Standard Model of Particle Physics (SMPP), the neutrino acquire electric millicharge and charge radius, as well as electric and magnetic dipole moments, the latter being the most studied property in the literature. However, the possibility that neutrino be a millicharged particle has also been a subject of study in different theoretical and experimental works. Additionally, several experimental constraints on the neutrino electric millicharge (NEM) have been reported from reactors, accelerators, and astrophysical measurements. In this talk, we will present the results from a statistical analysis using data from reactor neutrino experiments, which include elastic neutrino-electron scattering (ENES) processes, where both individual and combined limits on the neutrino electric millicharge were obtained. Likewise, we will show bounds from several future experimental proposals involving coherent elastic neutrino-nucleus scattering (CEνNS). In the first case, the limit of NEM achieved from the combined results of different experiments is 1.5×10^{-12} e at 90% C.L., and in the second scenario the bound corresponds to 3.5×10^{-13} e (90% C.L.). The outcomes indicate CEνNS experimental proposals might be a suitable alternative to improve the current limits of NEM. https://arxiv.org/abs/1907.04942.

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The Dichroicon: Spectral Photon Sorting For Large-Scale Cherenkov and Scintillation Detectors

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Large-scale monolithic water and scintillator neutrino detectors have, for decades, successfully used photons to detect neutrino interactions. Liquid scintillator detectors, due to their high light yields, have far better energy and position resolutions than achievable in a water Cherenkov detector. The most notable advantage of a water Cherenkov detector is the excellent direction reconstruction, which is not possible with isotropic scintillation light. Ideally, one would like to design a detector with both the advantages of the scintillation light as well as direction reconstruction. Future large-scale scintillation experiments like THEIA plan to detect both Cherenkov and scintillation light as a way of providing a very broad range of physics with a single detector. I will present a novel approach for discriminating Cherenkov from scintillation light, by building a Winston cone from dichroic filters. With this 'dichroicon' we expect to be able to sort photons by their wavelength and achieve scintillation and Cherenkov separation in a liquid scintillator or WbLS based detector. Bench-top results demonstrating this new technology will be presented.

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LiquidO: a Novel Neutrino Detection Concept

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Liquid Scintillator (LS) detectors have been a workhorse for low energy neutrino physics ever since the discovery of these elusive particles in the late fifties. In the traditional implementation of these detectors, the light produced by particle interactions propagates across transparent scintillator volumes to surrounding photo-sensors. This talk introduces a new concept for LS detection called LiquidO that departs from the conventional transparency-based approach in at least two significant ways: the use of an opaque liquid scintillator that confines light near its creation point, and the collection of light from within the LS volume through a dense fiber array. The result is a detector that has a high affinity for loading and that, by preserving the precious topological information of particle interactions lost in conventional LS detectors, has unprecedented capabilities for event identification and background rejection. A small prototype called micro-LiquidO was recently built and tested with a 1 MeV monochromatic electron beam, validating the basic principles behind the new paradigm. A proto-collaboration is coming together to develop and exploit this promising new technology whose main features, R&D status and possible applications will be discussed in this talk.

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Neutrino Overview

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Neutrino Overview

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Theoretical Overview of Neutrino Oscillations

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Plenary Session 1 / 30

Conference LOC information

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Review of ev-sterile neutrino and short baseline anomalies

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Poster Session / 32

Probing neutrino decay scenarios by Hyper-Kamiokande and its second detector in Korea

Autores: Alexander Quiroga[1]; Arman Esmaili[1]; Francesco Pessina[1]; Hiroshi Nunokawa[1]

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We study the signatures of decaying neutrino scenario in T2HKK experiment. Considering a combination of disappearance and appearance channels, for a normal mass ordering and assuming that the heaviest neutrino eigenstate decays, we show by performing an χ^2 analysis, that the ν_3 lifetime divided by its mass can be constrained to $\tau_3/m_3 > 9.4 \times 10^{-11}$ s/eV at 95% CL (preliminary result). We also perform a combined analysis of T2HKK and T2HK experiments, aiming to obtain an stronger bound. The effect of neutrino decay on the determination of oscillation parameters, $\sin^2\theta_{23}$ and Δm^2_{31}, will be discussed.

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The 3DST Spectrometer as part of the DUNE Near Detector

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The main purpose of the Deep Underground Neutrino Experiment (DUNE) is to observe the violation of the charge-parity symmetry in neutrino oscillations, proton decay and supernova neutrinos with a liquid-argon far detector of unprecedented size.
In the near detector complex, a spectrometer system called 3DST-S centered by a 3D projection scintillator tracker (3DST) is proposed and being studied. It consists of a large 3D matrix of 1 cm3 scintillator cubes, optically isolated, for a total weight of approximately 11 tons. A gas tracker measures the momentum of particles exiting the 3DST, while an electromagnetic calorimeter reconstructs the energy of electrons and neutral pions. The whole system is placed in a 0.6 T magnetic field.

3DST-S, located downstream of a liquid-argon TPC and a magnetized high pressure gaseous-argon TPC, will be the only detector complex always on the neutrino beam axis and will precisely monitor the neutrino beam spectrum, rate and profile.
Thanks to its unprecedented capability of neutron detection and energy measurement, it will provide comprehensive measurements on a fully active scintillator target, allowing further constraints of neutrino interaction models.
Moreover, promising methods for the measure of the neutrino and antineutrino flux have been tested, showing strong potential.

Poster Session / 35

Gaussian Process Accelerated Feldman-Cousins Approach for Physical Parameter Inference

Autor: Lingge Li[None]

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The unified approach of Feldman and Cousins allows for exact statistical inference of small signals that commonly arise in high energy physics. For instance, the Feldman-Cousins approach has been the gold standard for studying neutrino oscillations. However, the approach relies on the Neyman construction of the classical confidence interval and is computationally intensive as it is typically done in a grid-based fashion over the entire parameter space. In this letter, we propose an efficient algorithm for the Feldman-Cousins approach using Gaussian processes to construct confidence intervals iteratively. We show that in the neutrino oscillation context, one can obtain confidence intervals 5 times faster in one dimension and 10 times faster in two dimensions, while maintaining an accuracy above 99.5%.

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Status of the MicroBooNE Low-energy Excess Search

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The primary goal of MicroBooNE is to address the origin of the excess of low energy electromagnetic-like events observed by MiniBooNE. This talk will present MicroBooNE's progress towards a low-energy excess result, including the status of targeted searches for both single-photon-like and electron-like events.

Poster Session / 38

FIVE COIL HELMHOLTZ CONFIGURATION OF DUNE NEAR DETECTOR SUPERCONDUCTING MAGNET

Autores: UDAI GIRI PRATAP SINGH SACHAN[1]; S. SUNDAR RAJAN[1]; SANJAY MALHOTRA[1]; VIJAY HARAD[1]

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Deep Underground Neutrino Experiment (DUNE) is a facility to carry out studies related to neutrino science and proton decays. The proposed DUNE facility will consist of two neutrino detectors. The near detector is adjacent to beam source whereas far detector is 1300 Km downstream of the source in South Dakota. In near detector, interaction of Neutrinos with High Pressure Gas Time Projection

Chamber (HPgTPC) in presence of magnetic field is aimed to be studied. In HPgTPC chamber 10 bar pressure of Argon gas is maintained. After neutrino interaction in multipurpose detector (MPD) muons are generated which are deflected by the magnetic field. The magnetic field requirement is 0.5 Tesla with a uniformity better than 20 % in a diameter of spherical volume (DSV) 5.2 m. DUNE near detector magnet inner diameter is 7.2 meters in order to encapsulate HPgTPC Pressure Vessel & ECAL. The length of the magnet is restricted to 12 meters. The neutrino, beam shall directly pass from Liquid Argon detector to HPgTPC along radial direction.
In this paper, the proposed magnet design is five coil Helmholtz configuration in which each superconducting coil will be housed in a separate cryostat. Design optimizations have been carried out to achieve the required field uniformity and reduction of stray fields. In order to improve quench performance of the magnet, it is proposed to use NbTi superconductor Rutherford cable extruded with high purity Aluminium. Quench Analysis of the magnet coils have also been carried to estimate maximum temperature reached in coils and voltage developed.

Poster Session / 39

"Design and analysis of Pressure vessel for DUNE HPgTPC Detector"

Autor: PRASHANT KUMAR[1]

Co-autores: VIKAS TEOTIA [1]; SANJAY MALHOTRA [1]; RAJESH CHIMURKAR [1]

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Abstract:
A Deep Underground Neutrino Experiment (DUNE) facility is being set up at Fermi National Accelerator Laboratory. DUNE consisting of two massive particle detectors, one at Fermilab known as Near Detector (ND) and a much larger one to be constructed a mile underneath surface at the Sanford Underground Research Facility in South Dakota (Known as 'Far Detector'). In the Near Detector, high-pressure Ar gas (1 MPa) TPC (HPgTPC) is a tracker with an active size approximately 5.7 m in diameter by 6 m in length. HPgTPC is housed inside a pressure vessel, which supports the ECAL detector and is surrounded by a superconducting magnet. Superconducting magnet has its own support structure, but ECAL has to be supported on the pressure vessel. The weight of ECAL is about 300 Ton.
Keeping in view the above requirements, structural design and analysis of pressure vessel are carried out as per ASME code Section VIII Div-I and II. Material of construction has been chosen to minimize radiation length, while complying with the codal requirements. The pressure vessel will be kept on saddle supports which have been designed to meet load requirements. Design and analysis include shell thickness calculations for competitive materials as per UG-27 of ASME, design parameters calculations of Ellipsoidal head (Appendix 1). Stresses such as circumferential bending, longitudinal bending, tangential shear, bolt size calculations and flange design have been calculated as per ASME Section VIII Div II, 3D FEM Analysis.
Key Words: DUNE, HPgTPC, Pressure Vessel, ASME, Stress, Deflection

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ArgonCube: A Modular LArTPC with Pixelated Charge Readout

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ArgonCube is a novel, modular approach to Liquid Argon Time Projection Chambers (LArTPCs). ArgonCube segments the total detector volume into an number of electrically and optically isolated TPCs sharing a common cryostat, providing improved performance while also mitigating technical risks with LAr purity and
electric field. The field shaping uses a continuous resistive plane, a field-shell, instead of mechanical cage, minimising dead material near the active volume and reducing power dissipation in the case of HV breakdown.
For the charge readout a pixelated anode plane is employed, with bespoke readout electronics providing cold amplification and digitisation, enabaling unambiguous true 3D event reconstruction with a flat efficiency as function of track angle. The light readout is achieved with large dielectric planes inside the field-shell, this minimises effects of Rayleigh scattering, allowing for the efficient detection of contained prompt scintillation, thus improving trigger efficiency. ArgonCube has already found application in the high multiplicity environment of the Deep Underground Neutrino Experiment (DUNE) Near Detector (ND). An ArgonCube prototype will be deployed as the core component of ProtoDUNE-ND at Fermilab in 2020.

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The importance of LAr TPC in neutrino experiments

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Presently, neutrinos are one of the most mysterious and interesting particles in physics, they seem to be the ones that can explain different processes of high energy physics, antimatter, conservation of energy and momentum in radioactive decay, and contribute with important data for cosmology and astrophysics. To better understand their different properties such as mass, parity, oscillations, among others, there are several experiments such as ICARUS, MicroBoone, NEXT, T2K and currently under construction the Deep Underground Neutrino Experiment (DUNE). The liquid Argon Time Projection Chamber (LAr TPC) is common in these experiments, particularly important for DUNE. A LAr TPC allows to obtain an exact three-dimensional reconstruction of neutrino interactions, provides precise time of each event, has a large sensitive area,a high operational stability, and good light detection systems, among other important performance qualities that make it almost indispensable for neutrino detection. The importance and functioning of LAr TPC in neutrino experiments are summarized in this poster in particular its application in DUNE.

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Convolutional Neural Networks for Energy and Vertex Reconstruction in DUNE

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Measuring neutrino CP violation and mass hierarchy is currently one of the biggest challenges in particle physics. The DUNE neutrino experiment is the next-generation flagship neutrino program

in the US designed to solve these problems. The DUNE detector uses liquid argon time projection chamber (LArTPC) technology, considerably improving the spatial resolution, neutrino detection efficiency and background rejection. However, reconstructing neutrino events with DUNE presents many challenges due to missing energy caused by argon impurities, nonlinear detector energy responses, invisible energy, hadron identities (mass), and overlaps between lepton and hadron interactions. One way of approaching this problem is using machine learning to reconstruct the neutrino events from pixel map images of interactions in the detectors. Here we present a regression convolutional neural network with a custom architecture to reconstruct neutrino energy and interaction vertices. For neutrino energy, we show considerable performance improvements in Monte Carlo simulations, compared with previous traditional energy reconstruction methods and initial results in interaction vertices.

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Overview of neutrino nucleus interactions

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Review of double beta decay experiments

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Solar and Supernova Neutrinos

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High Power Neutrino Beams

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Short Baseline Neutrino Experiments at FNAL

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Systematics Uncertainties in Future Neutrino Oscillation Experiments

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IceCube

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ProtoDUNE

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Summary Talk: Neutrino Detectors

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Summary talk: Systematics and Analysis Techniques

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Report from Steering Committee

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Next NNN

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Temperature Control for SiPM characterization setup

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SiPM are devices widely used in great experiments on high energy physics to measure the energy related to a specific phenomenon and establish its characteristics. Now, an international collaboration leaded by Fermilab and CERN is working on DUNE project, which use high quantities of SiPM organized in structures; these structures operate as transduction paths for response of photon detection devices called ARAPUCA to investigate nature of neutrinos. SiPMs must be characterized and we must begin for their temperature dependence, because DUNE will operate to cryogenic temperature (90°F) and is necessary to know SiPM operation in these conditions. Therefore, in Universidad Antonio Nariño (UAN-Villavicencio), we are developing an SiPM characterization setup to acquire capabilities and experiences to strengthen UAN participation on DUNE developing with Fermilab and other Latin-American universities.

This SiPM characterization setup with temperature control is the first stage of a medium-term program which aim is obtain capabilities and human resources in Colombia focusing IDI+i developing to modern technologies of particle and radiation detectors. The medium-term program consists of

a second stage for analog signal conditioning, and third stage for signal acquisition using a multi-channel card, finally, the fourth stage is the software required to analyze data from photon detector system. These stages are planned to be thesis for electronics engineering students and will be the basis to become highly qualified engineers with researching capabilities.

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Registration and Welcome to NNN2019

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Review of ev-sterile neutrino and short baseline anomalies

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Review of double beta decay experiments

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Solar and Supernova Neutrinos

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Phenomenology of the Two Higgs doublets on noncommutative geometry

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Connes' noncommutative geometry (NCG) provides a rigorous framework to build the full Lagrangian of the Standard Model (SM) of particle physics. In this framework, there is an underlying finite space associated with each space-time point. Here, the Higgs field appears naturally as the "connection" linked with this new (dimensionless) space. Despite this achievement, in the minimal NCG SM version, the estimate Higgs boson mass is of 170 GeV, which differs from its actual experimental value. It can be shown that the addition of an extra (singlet) scalar field is a single solution to this shortcoming. In this work, we show a reinterpretation of the fluctuated Dirac operator on NCG which

induces an extended Higgs sector. In particular, we present an analysis of the scalar mass spectrum for models with two Higgs doublets (2HDM) on NCG with and without extra singlet scalar fields.

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Multi-photomultiplier tube module development for the next generation Hyper-Kamiokande neutrino experiment

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The Dichroicon: Spectral Photon Sorting For Large-Scale Cherenkov and Scintillation Detectors

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JUNO PMT 20-inch

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The T2K ND280 Upgrade project

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DUNE Single Phase Photon Detection System

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ARIADNE, optical readout in LAr TPC

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ArgonCube: A Modular LArTPC with Pixelated Charge Readout

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The 3DST Spectrometer as part of the DUNE Near Detector

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LiquidO: a Novel Neutrino Detection Concept

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Parallel session: Systematics and Analysis Techniques / 92

Machine Learning and Computer Vision for Modern Particle Imaging Neutrino Detectors

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Parallel session: Systematics and Analysis Techniques / 93

Convolutional Neural Networks for Energy and Vertex Reconstruction in DUNE

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Machine learning techniques to enhance water Cherenkov reconstruction

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New constraints on neutrino electric millicharge from elastic neutrino-electron scattering and coherent elastic neutrino-nucleus scattering

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Parallel session: Systematics and Analysis Techniques / 96

ICARUS

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Recent Cross-section Measurements from MicroBooNE

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Parallel session: Systematics and Analysis Techniques / 98

Status of the MicroBooNE Low-energy Excess Search

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MeV-Scale Physics in LArTPCs

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A modern fit of the electroweak parameters from all the available low energy ν_μ-hadron scattering data

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We present an updated fit of the model independent electroweak~(EW) parameters by using all the available low energy data for neutrino scattering from nuclei. For the theoretical expressions we make use of the CTQ10 set of Parton Distribution Functions~(PDFs) taking into account the corresponding uncertainties coming from the charm mass and the PDF parameters. We find that that these uncertainties have an sizable effect in determining EW parameters.

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Dirac neutrino mass generation from Majorana messenger

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The radiative type-I seesaw has been already implemented to explain the lightness of Majorana neutrinos with both Majorana and Dirac heavy fermions, and the lightness of Dirac neutrinos with Dirac heavy fermions. In this work we present a minimal implementation of the radiative type-I seesaw with light Dirac neutrinos and heavy Majorana fermions. An inert doublet and a complex singlet scalar complete the dark sector which is protected by an Abelian fermiophobic gauge symmetry that also forbids tree level mass contributions for the full set of light neutrinos. A fermion vector-like extension of the model is also proposed where the light right-handed neutrinos can thermalize in the primordial plasma and the extra gauge boson can be directly produced at colliders.
In particular, the current upper bound on ΔN_{eff} reported by PLANCK points to large ratios $M_{Z'}/g' > 40$ TeV which can be competitive with collider constraint for g' sufficiently large in the ballpark of the Standard Model values, while future cosmic microwave background experiments may probe all the no minimal models presented here.