47th Fermilab Users Meeting - Poster Session

Wednesday, June 11, 2014 - Wednesday, June 11, 2014

Fermi National Accelerator Laboratory

Book of Abstracts

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Investigating Surge Protection Devices to Protect Against Transient Over-voltages in Liquid Argon Time Projection Chambers

Author: Jonathan Asaadi[1]

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In this poster we report the investigation of various methods to control transient high voltages that may occur in Liquid Argon Time Projection Chambers (LArTPC's). Recent studies of the electrical properties of a LArTPC's suggest that over-voltages may occur during a spark discharge and damage sensitive components of the detector. Tests of surge protection devices were performed to determine the suitability for their use in the MicroBooNE neutrino experiment , a 170 ton total volume LArTPC, which will begin operations in 2014. Two possible devices which are shown to mitigate transient high voltage conditions in cryogenic temperatures are gas discharge tubes (GDT's) and metal oxide varistors. We report the behavior of both of these devices and their application at liquid argon temperatures.

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The NOvA electron neutrino appearance analysis

Author: Christopher Backhouse[1]

[1] *Caltech*

The NOvA experiment will observe the oscillation of muon neutrinos into electron neutrinos between the Near Detector at Fermilab and the Far Detector at Ash River, Minnesota. With the ability to run neutrino and antineutrino beam, and with the the longest baseline of any accelerator neutrino experiment, NOvA aims to measure the ordering of the neutrino mass states and probe CP violation in the lepton sector. This poster gives an overview of the techniques used in the electron neutrino analysis, and presents sensitivities for the determination of the mass hierarchy and theta23 octant.

Summary:

This poster gives an overview of the techniques used in the NOvA electron neutrino analysis, and presents sensitivities for the determination of the mass hierarchy and theta23 octant.

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Event Reconstruction with the NOvA Experiment

Author: Michael Baird[1]

[1] *Indiana University*

The NOvA experiment is a long-baseline neutrino oscillation experiment based out of Fermilab that uses the newly upgraded NuMI beam line and two functionally identical detectors to measure the neutrino rates at a near location, and 810 km away at a far location. The detector at the far location

has a target mass of 14 kton and is composed of 344,064 cells filled with liquid scintillator each of which is 4 cm x 6 cm x 15 m, which presents a solution to the problem of achieving high granularity with a large target mass. This poster will present the algorithms used to identify particle tracks and showers, locate interaction vertices, and assign particle types and momenta to the final-state particles resulting from neutrino interactions in the detector. The poster will also present performance metrics based on simulations and examples drawn from NuMI neutrino beam events.

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Results from SuperCDMS

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Dark Matter constitutes 84% of the universe's mass content, however, little is known of the fundamental particle properties of Dark Matter. The discovery of the Higgs, coupled with the lack of any confirmed new physics beyond the Standard Model, has made it increasingly important to explore all regions of parameter space in the search for dark matter. Of particular interest is the case of low-mass Dark Matter particles (mass < 10 GeV/c^2), that lie just beyond the standard WIMP paradigm, which the SuperCDMS experiment has a proven track record of exploring.

The SuperCDMS collaboration has operated an array of iZIP detectors at the Soudan Underground Laboratory since March 2012. Each 0.6 kg Ge detector simultaneously measures phonon and ionization energy from particle interactions. Results will be presented from the CDMSlite experiment, which utilizes novel solid-state physics to reach world leading low-thresholds (0.84 keVnr), and explores the mass < 5 GeV/c^2 low-mass WIMP case. Additionally using iZIPs in standard physics operation with high exposure and excellent background rejection capabilities, an analysis was performed with a lower energy threshold (2 keVnr) than the design goal (10 keVnr), with the intent to search for mass < 10 GeV/c^2 WIMPs. Results from this new analysis will also be discussed to show how the SuperCDMS experiment is shedding new light in the low-mass Dark Matter story.

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Muon Neutrino Disappearance Measurements at NOvA

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The NOvA long-baseline neutrino experiment is uniquely positioned to measure a multitude of important neutrino parameters in both the appearance and disappearance channels, including constraints on or even determination of the mass hierarchy. With its 810 km baseline and 14 kton liquid scintillator far detector, study of muon neutrino disappearance will give NOvA competitive sensitivity to θ_{23} and the atmospheric mass squared difference, as well as potential determination of the octant. Numerous analysis techniques are employed to optimize this analysis, including isolation of quasi elastic events and novel algorithms for background reduction and energy estimation. An overview of the entire analysis chain is detailed within.

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Channeling Radiation as a Source for High-Brightness X-rays at the Advanced Superconducting Test Accelerator

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Co-authors: Daniel Mihalcea [2]; Philippe Piot [3]

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Channeling radiation (CR) is emitted from charged particles that are accelerated into a crystal target and channel through the crystal emitting radiation as they oscillate about the crystal planes. Fermilab's new user facility the Advanced Superconducting Test Accelerator (ASTA) will be used to accelerate electrons up to 40-MeV and focus the beam to a sub-micron spot on a crystal target for production of CR. Our study focuses on the production of x-rays with high average brightness; this is made possible by ASTA's long pulse train capabilities and ability to preserve beam quality. Our end goal is the development of an x-ray source that is tunable, compact, and has a high average brightness.

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NOvA ND Assembly and Installation

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NOvA is a long baseline neutrino experiment with a 300-ton near detector on the Fermilab site and a 14,000-ton far detector in northern Minnesota. The NOvA experiment will study neutrino and antineutrino oscillations in both disappearance and appearance channels to determine the neutrino mass hierarchy, to constrain the CP phase, and more.
The near detector plays a critical role in understanding the composition of the unoscillated beam and helping reducing systematic uncertainties.
The poster will present the procedures of assembly and installation of the NOvA near detector at Fermilab, including the detector assembly and transportation, mechanical installation, electronics installation and first data event display.

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Using Variability to search for Lensed Quasars in the Dark Energy Survey

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The Dark Energy Survey (DES) has just started its first season of a 5 year program using the DE-Cam instrument on the Blanco 4m telescope at CTIO. Over the course of the 5 year survey we expect to discover about 120 lensed quasars brighter than i=21, including 20 high information-content quads (third brightest image required to be i<21). Strongly lensed quasars can be used to measure cosmological parameters. The time delays between the multiple images can be measured via dedicated monitoring campaigns, while the gravitational potential of the lensing galaxy and of structures along the line of sight can be modeled and measured using deep high resolution imaging and spectroscopy. The combination of these observables enables a distance, known as the time-delay distance (a combination of angular diameter distances) to be measured, which in turn can be converted into a measurement of cosmological parameters including those describing the Dark Energy equation of state.

The first step in this measurement is to identify the lensed quasars. Traditionally, quasar candidates have been identified by their blue u-g color which allows them to be separated from the much more numerous stellar contaminants. However, the Dark Energy Survey does not take data in the u-band so other techniques must be employed. One such technique is based on the instrinsic variability of quasars (Schmidt et al, 2010, ApJ 714 1194). We have simulated what we would expect for the DES observing cadence in the first two seasons where we expect four visits to a given patch of sky spread over the two years. We will show results from the simulations as well as a first look at the data from the Science Verification phase of DES.

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Using Fast Photosensors in Massive Water Cherenkov Neutrino Detectors

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Future experiments rely on the precision measurements of rare events with low cross section, such as neutrino interactions and proton decay. Using very large detectors and new advances in photosensor technology are both important towards the achievement of high sensitivity to these measurements. New photodetectors based on micro-channel plates are being developed by the Large-Area Picosecond Photo Detector (LAPPD) Collaboration. These photosensors have been shown to have excellent spatial and timing resolution. Using these devices can enable better capabilities in massive megaton-scale water Cherenkov detectors by resolving track features to within a few centimeters and enhancing background rejection for neutrino oscillation experiments. We present preliminary results on the reconstruction capabilities for single particles in water Cherenkov detectors using fast photosensors.

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The Coherent Elastic Neutrino Nucleus Scattering (CENNS) Experiment at Fermilab

Author: Robert Cooper[1]

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Low energy neutrinos (< 50 MeV) with a wavelength larger than target nuclei can en- gage in coherent elastic scattering with low momentum transfer. Coherent scattering is important in supernovae, low-Q^2 weak nuclear form factors, and low-energy tests of the Standard Model. Despite a large interaction cross section, it has remained unobserved because of its low energy deposition and neutron backgrounds. The CENNS collaboration is proposing to deploy a 1-ton, single-phase, liquid argon detector for a first measurement of coherent neutrino scattering near the booster neutrino beam (BNB) at Fermilab. By placing the detector near the beam target in a far off-axis position, a flux of low-energy neutrinos from stopped pions is produced. The proximity to the BNB introduces a high flux of beam-correlated neutrons whose elastic scatters are indistinguishable from the neutrino scattering signal. We have recently completed a measurement of 10-200 MeV neutrons near the BNB with the 70-kg, Indiana-built, SciBath detector [1]. We will return later this summer to measure the neutron fluxes and energy and direction spectra at a candidate site for the CENNS detector. We will improve upon the earlier measurement by systematically configuring a concrete shielding structure around SciBath to modulate the neutron back- ground. These results will be used to validate difficult neutron shielding and transport simulations.

[1] S.J. Brice et al., Phys. Rev. D 89, 072004 (2014).

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Performance of b-tagging at CMS with pp collision data at √s=8 TeV

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The identification of jets originating from b-quarks is crucial both for the searches for new physics and for the measurement of standard model processes. CMS has developed a variety of algorithms to select b-quark jets based on variables such as impact parameter of charged particle tracks, properties of reconstructed decay vertices, and the presence or absence of a lepton, or combinations thereof. The studies on these algorithms and their performances are presented, using multijet events and ttbar events recorded in proton-proton collision data at √s=8 TeV with the CMS detector in the LHC Run 1.

2

Dynamical Stability of Slip-stacking

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Slip-stacking is an acceleration configuration that has been used at Fermilab to nearly double proton intensity since 2004. Our analysis provides a new look at the dynamics, calculating for the first time the stable-phase space area and the injection efficiency as a function of aspect ratio. We also find the first complete perturbative solutions and parametric resonances from slip-stacking. We've also shown that is directly corresponds to the driven pendulum and may have applications for standing-wave traps used in optical and acoustic physics.

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Testing and Assembly of the High Density Interconnect Circuits for the CMS Forward Pixel Detector Upgrade

Authors: Andrew Godshalk[1]; Ashish Kumar[2]; James Dolen[3]; Maral Alyari[1]; Matthew Gordon[1]

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The CMS pixel detector is the innermost component of the all-silicon tracking system located closest to the interaction point. The foreseen increase of the instantaneous and integrated luminosities at the LHC necessitate an upgrade of the pixel detector in order to maintain the excellent tracking performance of the CMS detector. The main new features of the upgraded pixel detector would be ultra-light mechanical design with four barrel layers and three end-caps on either side of the interaction region, and a digital readout chip with higher rate capability and a new cooling system. The forward pixel detector will have 672 detector modules with 44 million pixels of the size 100 x 150 micrometers. The modules consist of silicon sensors bumb-bonded to readout chips. A high-density-interconnect (HDI) circuit is glued on top of the sensor and is wire-bonded to 2x8 array of readout chips. HDI provide signal and power distribution for the readout circuitry. The group from SUNY at Buffalo group is responsible for the detailed testing and assembly of the HDIs at Fermilab. The poster will present our contribution to the testing and assembly of the HDI circuit boards.

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Observation and studies of the double J/ψ production at the Tevatron

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We present measurements of the production cross section of prompt J/ψ mesons, as well as the cross section of simultaneous production of two prompt J/ψ mesons, in proton-antiproton collisions at s√=1.96 TeV using 8.1 fb−1 of Tevatron data collected by the D0 experiment. The latter cross section is separated into contributions due to single parton and double parton scatterings. The J/ψ mesons are fully reconstructed in the muonic final states. Using these measurements, the effective cross section, a parameter characterizing an effective spatial area of parton-parton interaction and tightly related to the parton spatial density inside the nucleon, is also measured.

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Liquid Argon Time Projection Chambers: MicroBooNE and Future Prospects for Neutrino Oscillation Physics

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MicroBooNE—the latest in a series of Booster Beam experiments located at Fermilab—is a Liquid Argon Time Projection Chamber (LArTPC). Using the high precision reconstruction capabilities of a LArTPC, MicroBooNE will be able to determine with high statistical certainty whether electrons or photons caused the anomalous MiniBooNE low energy excess. Of further interest to MicroBooNE are neutrino-nucleon cross-sections. Cross sections have accounted for much of the uncertainty in recent results from a variety of neutrino experiments, and sensitive measurements by MicroBooNE will lead to improved nuclear models and rate predictions. Beyond MicroBooNE, LArTPCs will continue to play a notable role in oscillation physics. LAr1-ND will act as a baseline for improving systematic uncertainties in MicroBooNE and investigating the nature of the MiniBooNE excess, while also acting a small-scale phase experiment for future, bigger LArTPCs such as LBNF.

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Charged Current Coherent Pion Production at MINERvA

Author: Aaron Higuera[1]

Co-author: Aaron Mislivec [2]

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MINERvA is a neutrino scattering experiment in the 1-10 GeV range using the NuMI neutrino beam at Fermilab. MINERvA will constrain neutrino-nucleus interaction cross sections which are a significant source of uncertainty in neutrino oscillation measurements. This poster presents the analysis of neutrino and antineutrino Charged Current Coherent Pion Production in MINERvA including the methods used to differentiate signal from background and distributions from the candidate event samples.

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Design, simulation and preliminary testing results of prototype Vertically Integrated Pattern Recognition Associative Memory

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The challenge of the Vertically Integrated Pattern Recognition Associative Memory (VIPRAM) Project is to increase pattern density through aggressive Vertical Integration. Our first step is to implement

in conventional VLSI the building blocks that can be used in 3D stacking. We are reporting on the first successful implementation of a conventional 2D demonstrator of the VIPRAM chip (protoVIPRAM2D). Measurements achieved with a dedicated test card benchmark the design in terms of functionality and performance are promising for Level 1 Tracking Trigger applications in LHC experiments. The results show that these building blocks are ready for 3D stacking.

Summary:

An associative memory based track finding approach has been proposed for a Level 1 Tracking Trigger to cope with increased luminosity at the LHC. The VIPRAM (Vertically Integrated Pattern Recognition Associative Memory) Project exploits emerging 3D Vertical Integration technology to build faster and denser Associative Memory devices.

From the beginning, our design methodology has been to develop concepts and circuitry in 2D to confirm functionality and then translate those ideas into 3D. The first step taken by the VIPRAM Project was the development of a 2D prototype (protoVIPRAM2D) in which the associative memory building blocks were designed with an eye toward future, aggressive Vertical Integration. In fact, the associative memory building blocks were laid out as if this was a 3D design. Room was left for as yet non-existent Through Silicon Vias and routing was performed to avoid these areas. To mimic a 3D approach the PRAM array was composed of protoLegs which were created from four identical CAM cells and a Control Cell resulting in the ability to recognize 4-layer road matches. The readout circuitry was deliberately simplified to allow direct performance studies of the CAM and Control cells.

protoVIPRAM2D was designed and fabricated in a 130nm Low Power CMOS process that has been used previously in High-Energy Physics 3D designs. The layout was implemented such that in future designs all cells can be hosted on different 3D tiers and also extended in layer depth to enable more sophisticated tracking. The design has been thoroughly simulated at all levels and the prototype has been tested for functionality using a custom test setup. The design of the chip will be presented and detailed simulations dealing with timing will be shown. This poster will clearly show that the building blocks that comprise protoVIPRAM2D are ready for vertical integration.

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Measurement of differential production cross-section of γ +2b-jets at √s=1.96 in ppbar colisions

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The study of prompt photons produced in association with heavy quarks provides a crucial test of perturbative QCD predictions as well as constraints on parton distribution functions. We present the first measurements of the differential cross section
for the production of an isolated photon in association with at least two b-quark jets. The ratio of differential production cross sections for photon with at least two b-quark jets to photon with at least one b-quark jets is also presented. The results are based on the proton-antiproton collision data at √s=1.96 collected with the D0 detector at the Fermilab Tevatron Collider. The measured cross sections and their ratios are compared to the
next-to-leading order perturbative QCD calculations as well as predictions
based on the kt-factorization approach and those from the SHERPA and
PYTHIA Monte Carlo event generators.

Summary:

In summary, we have presented the first measurement of the differential cross section
of inclusive production of a photon in association with two b-quark jets as a function of photon transverse momentum at the Fermilab Tevatron ppbar Collider.
The measured cross sections are in agreement with the NLO QCD calculations and

predictions from the kT-factorization approach. We have also measured the ratio of differential production cross sections for photon with at least two b-quark jets to photon with at least one b-quark jets. The ratio agrees with the predictions from NLO QCD and kT-factorization approach within the theoretical and experimental uncertainties. These results can be used to further tune theory, MC event generators and improve the description of background processes in studies of the Higgs boson and searches for new phenomena beyond the Standard Model at the Tevatron and the LHC in final states involving the production of vector bosons in association with two b-quark jets.

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Tracking down scattered light in the DES Dark Energy Camera

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Co-author: Thomas Diehl [2]

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Scattered light from bright stars outside the field of view afflicts about 1% of DES data. Tracking down the causes of scattering was a lengthy exercise, but all major causes have now been eliminated.

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Measurement of electroweak vector boson pair productions in pp collision at CMS detector, LHC.

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We present an overview of measurements of electroweak vector boson pair production, decaying to semileptonic and fully leptonic final states. The data analysed were taken at centre of mass energy of 7 & 8 TeV by the CMS detector at the Large Hadron Collider. The cross-section measurements are important because they are a test of the Standard Model predictions, while the processes serve as a background for Higgs searches and various other processes.

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Dark Matter Detector Prototype testing area Underground

Author: Bill Lee[1]

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Located 350 feet beneath the surface the MINOS Underground Areas, at Fermilab provide a useful shallow testing site for Dark Matter Detector R&D. It is accessible 24hrs/day, 365 days/year, under normal circumstances, with minimal training. The area is fully supported by Fermilab staff and resources, including network capabilities and other utilities. It has been used by the DAMIC and COUPP experiments to trouble shoot problems before moving to the deeper and less accessible SNOLAB. Other notable test experiments include DM-Ice, Sci-Bath, Peanut, and ArgoNeuT.

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Dielectric-Lined Waveguides for Dynamic Beam Manipulation

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We discuss several new possible applications of dielectric-lined waveguides (DLW) to low-energy (<10MeV) photo-injected electron bunches.

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Charged kaon production at MINERvA

Author: Chris Marshall[1]

[1] *University of Rochester*

Supersymmetric Grand Unified Theories predict proton decay with $p \rightarrow K^+\bar{\nu}$ as the dominant channel. Backgrounds arise from K^+ production by atmospheric neutrinos where other final-state particles are not detected. MINERvA identifies K^+ events by reconstructing the time difference between the kaon and its decay products, and expects to be able to constrain the rate of such neutrino-induced backgrounds. The current status of this analysis is presented.

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Non Oscillation Physics in NOvA

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The NOvA experiment will illuminate aspects of neutrino oscillation parameters which are currently unknown, including the octant of θ_{23}, the Dirac CP phase, and the neutrino mass hierarchy. However NOvA also has capabilities for clarifying other properties and scattering phenomena involving neutrinos. This Poster will describe two such measurements to be carried out using the NOvA Near Detector which illustrate the latter capabilities of the experiment. These measurements are: 1) limit-setting or determination of the ν_μ magnetic moment using ν_μ-electron scattering; and 2) measurement of charged- current neutrino-carbon cross sections into final states of low hadronic

multiplicity. In particular, quasi-elastic scattering on carbon can be examined for evidence of nuclear medium effects such as meson exchange currents and multi-nucleon correlations.

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Measurement of the Lambda_b cross section

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The Lambda_b differential production cross section are measured as functions of their corresponding transverse momentum and rapidity in proton-proton collisions as centre-of-mass energy of 7 TeV using data collected by the Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider (LHC). Measurements are based on Lambda_b reconstructed decays in the J/psi meson and Lambda^0 baryon final state where the J/psi decays into an opposite charged muon pair and Lambda_0 decays into a proton and a pion meson. This work uses a data sample corresponding to an integrated luminosity of 1.9/fb.

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The Double Chooz Time Projection Chamber

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The Double Chooz Time Projection Chamber (DCTPC) is a directional fast neutron detector with sensitivity to 0.1-30 MeV neutron-induced nuclear recoils. DCTPC is currently measuring background neutron production at the Double Chooz near (120 mwe) and far (300 mwe) halls. DCTPC will make neutron measurements as a function of depth, direction, energy, and rainfall. I will discuss bringing DCTPC to MicroBooNE.

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Charged Current Inclusive Neutrino Scattering with MINERvA

Author: Joel Mousseau[1]

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"MINERvA is a precision neutrino cross section measurement experiment. The
detector is equipped with nuclear targets of C, Fe, and Pb followed
downstream by a high granularity tracker.
This configuration has allowed MINERvA to make high statistics
measurements of inclusive
cross sections. This poster presents the results of these measurements

which include
the ratios of the total inclusive and differential cross sections.

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Monitoring and Commissioning the NOvA Far Detector

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Early performance results and first neutrino events from the NOvA Far Detector will be presented.

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Time Synchronization and Energy Calibration in the NOvA Detector

Author: Evan Niner[1]

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The NuMI Off-Axis nu_e Appearance (NOvA) experiment has been commissioning and operating its Far Detector in Ash River, MN for over a year. Upon completion this summer, the 14 kT detector will consist of more than 340,000 4x6 cm^2 x 15 m cells of extruded PVC plastic filled with liquid scintillator and read out through avalanche photo-diodes (APDs). NOvA's neutrino oscillation analyses require precise correlation of events in the detector with the narrow 10 µs NuMI neutrino beam pulses. The technique to calibrate the timing system uses the abundant cosmic-ray muon flux at the detector's surface location to establish a precise network of timing offsets between the detector components spread over the 64 m spatial extent of the detector. Cosmic-rays are also used to measure the light yield and attenuation length within the detector cells and to establish the absolute energy scale of the detector. This poster will discuss results from the time synchronization and energy calibration performed with the cosmic-ray flux.

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Detector Control System (DCS)

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The Detector Control Systems group is an integral part of NOvA experimental operations. We have a novel system for monitoring approximately 3,000 environmental, structural, and power channels, as well as nearly 13,000 Front-End-Board channels. We provide a comprehensive readout of all parameters from this diverse array of technologies and present them in simple graphical interfaces. We have developed operational guidelines for the channels to be monitored, logged, included in alarm logic, and presented to shifters. We also train collaboration physicists in the systems as needed by the experiment. An overview of the most important systems are described herein.

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Bright Electron Beams: A Comprehensive Research at Fermilab

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High brightness electron beams have countless applications from simple to most complicated. We follow up on 2013-2014 new experimental results on the generation, characterization and application of high brightness electron beams at the HBESL facility at Fermilab. HBESL was built by our group over the last three years by transforming the previous A0 facility into a more compact facility, with relevant upgrades made as necessary - all of which have been presented previously. This year we present the diverse results we obtained after a successful construction of HBESL.

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Prospects for a Sterile Neutrino Search at MINOS+

Authors: Adam Aurisano[1]; Navaneeth Poonthottathil Poonthottathil[2]

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The MINOS+ experiment operates the MINOS detector in the recently upgraded NuMI muon neutrino beam. The increased beam intensity and energy will enable the MINOS+ experiment to collect high statistics in the 4–10GeV energy range, which is particularly useful for new physics searches. We present the prospects for a search for sterile neutrinos with mass splittings in the range from ~10-2eV^2 to ~10eV^2 using beam in both the muon neutrino mode and the anti-neutrino enhance mode. In addition, we present the MINOS+ sensitivity combined with that of the disappearance reactor experiment Bugey. This combined sensitivity will be compared to the LSND and MiniBooNE appearance signal.

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Charged Pion Cross section measurement at MINERvA

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The charged pion production by neutrinos interacting on heavy nuclei
is of great interest to high energy and nuclear physics and
increasingly important for neutrino oscillation experiments. MINERvA
is a few GeV neutrino-nucleus scattering experiment that employs a
fine grained detector running in the NuMi neutrino beam at Fermilab.
We present a measurement of the differential cross-sections for
muon-neutrino charged current charged pion production in the MINERvA
active plastic target.

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Low-nu flux Flux and Total Charged-current Cross section in MINERvA

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The MINERvA measures neutrino and antineutrino interaction cross sections on carbon and nuclear targets which are of interest to ongoing and future accelerator oscillation experiments. Cross section measurements require accurate knowledge of incident neutrino flux. The low-nu flux technique uses a standard-candle cross section for events with low energy transfer to the hadronic system to determine the incident flux. MINERvA will use low-nu fluxes to tune production models in beam simulations and to extract total charged-current interaction cross sections. This poster will present the low-nu flux technique adapted for the MINERvA data samples and present prospects for low energy total charged-current cross section measurements from MINERvA.

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NuMI-X: An Inter-Collaboration NuMI Beam Working Group

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NuMI-X is a consortium comprising Fermilab neutrino experiments collaborating on the modeling of NuMI beam. Its goal is to develop and maintain the best knowledge about NuMI neutrino fluxes relevant to all NuMI experiments. In this poster, we describe the upgraded NuMI facility. The full NuMI beam modelling chain using Monte Carlo generators is outlined. Finally, we discuss the general plans to constrain hadron production across the different NuMI experiments.

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MWPC Tracking System Upgrade

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The Multiwire Proportional Chamber Tracking System at the Fermilab Test Beam Facility has been upgraded. Improvements include a renovation of the chambers themselves to vastly improve noise on the signals. An extensive study was done to find the most efficient gas for operation, and a completely new electronics read-out system has been created to improve reliability, and system compatibility. Users can now have an ASCII file for each run to merge into their DAQ system, and an event display.

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New High Rate Tracking area

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A new area for beam tests of high rate tracking devices is being commissioned at the Fermilab Test Beam Facility. The new area is in the MTest beam line upstream of the pinhole collimator in the MT3 Alcove. This area is suitable for tests of detectors with modest transverse dimensions. High rate tests will use 120 GeV protons. The maximum rate available is approximately 2.5 GHz/cm2(1E10 particles/spill). A Patch panel for signal and high voltage cables links the enclosure alcove area with the MS3 service building, where experimenters can monitor their apparatus. Network fiber is installed between the two areas, with capabilities for general network access and private network capabilities. A remotely controllable motion table is available so users can perform beam scans, and move detectors completely into and out of the beam, without making accesses to the beam enclosure.

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Near to Far extrapolation for the NOvA muon neutrino disappearance analysis

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The soon-to-be completed NOvA long-baseline neutrino experiment consists of two highly active, finely segmented, liquid scintillator detectors located 14 mrad off Fermilab's NuMI beam axis. A Near Detector is located at Fermilab and a Far Detector is located 810 km at Ash River, MI.
I will present the methods developed to predict the Far Detector spectra as extrapolated from the observed Near Detector data

and its application to the NOvA measurements of theta(23) and delta m^2_(32) through the observation of muon neutrino and muon antineutrino disappearance.

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Dark Matter Search using MiniBooNE

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Cosmology observations indicate that our universe is composed of 25\% dark matter (DM), yet we know little about its microscopic properties. Whereas the gravitational interaction of DM is well understood, its interaction with the standard model is not. Direct detection experiments, the current standard, have a nuclear recoil interaction low mass sensitivity edge of order 1 GeV. To detect DM masses below 1 GeV, either the sensitivity of the experiments needs to be upgraded or use of accelerators producing DM are needed. Since the signature in the detector is similar to the ν neutral current elastic scattering events, it is logical to use neutrino detectors to search for DM being produced by high–intensity proton accelerators. The MiniBooNE experiment, located at Fermilab on the Booster Neutrino Beamline, has produced the world's largest collection of ν and $\overline{\nu}$ samples and is already well understood, making it desirable to search for accelerated–produced DM. A search for DM produced by 8.9 GeV/c protons hitting the beam dump is underway. Analysis techniques along with predicted sensitivity will be presented.

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Searching for Sterile Neutrinos with MINOS

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MINOS is a two-detector on-axis experiment based at Fermilab. The NuMI neutrino beam encounters the MINOS Near Detector 1 km downstream before travelling 734 km through the Earth's crust, to reach the Far Detector located at the Soudan Underground Laboratory in Northern Minnesota. By searching for oscillations driven by a large mass splitting, MINOS is sensitive to the existence of sterile neutrinos. This talk will present results of a search for sterile neutrinos that is sensitive to the parameter space suggested by LSND and MiniBooNE. Both charged current numu and neutral current neutrino interactions are analysed in a 3+1 model. This MINOS search for numu disappearance complements other previous experimental searches for sterile neutrinos in the nue appearance channel

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Fermilab T1041: CMS Forward Calorimetry R&D

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Fermilab T1041 collaboration focuses on developing new technologies for CMS Forward Calorimetry (FCAL) in Phase II Upgrade of the CMS detector. The main objective of the R&D program is to search for high sensitive materials such as scintillators/crystals, capillaries and wavelength shifting/quartz fibers, as well as new readout techniques such as precision timing detectors and radiation hard photodetectors. For this purpose, T1041 collaboration conducted beam tests at the Fermilab Test Beam Facility (FTBF) in 2013-14 to study performances of several prototype detectors such as Shashlik electromagnetic calorimeter, Hadronic Endcap (HE) Calorimeter, Resistive Plate Chambers (RPCs) and Secondary Emission (SE) Calorimetry. The preliminary test results of this small-large scale of design improvements along with the future test plans will be presented.

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Neutrino Electron Scattering at Minerva

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This poster demostrates a tool to constrain the muon neutrino flux using neutrino electron scattering studies at the MINERvA Experiment in the medium energy era. Neutrino electron scattering helps to reduce flux normalization uncertainties on MINERvA's absolute cross-section measurements. It is detected via an electromagnetic shower, produced by a single outgoing electron with a very forward angle. We will describe how we will isolate the single electron, and the expected signal events using a simulation of neutrinos produced by the medium energy beam.

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Measurement of the scintillator quenching factor for DAMIC's energy calibration

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The measurement of nuclear recoil quenching factor at low energies has become very important in the last years due to various theoretical hints of low mass WIMPs as Dark Matter (DM) candidates. In order to do this measurement, the DAMIC collaboration has set up a neutron scattering experiment on a silicon target, with scintillator bars to measure the angular distribution of the scattered neutrons. This experiment will also allow us to measure the quenching factor of the scintillator bars. To test the experimental setup, we have already used as beam electrons from a ruthenium (Ru) source and 120GeV protons from the Fermilab Test Beam Facility (TB). The preliminary results of the analysis of the data will be reported in this poster.

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Search for magnetic monopoles with the NOvA far detector

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Magnetic monopole, which may be predicted by too many physics models, is becoming more and more mysterious to us, with its large uncertainty in mass (10^{4} ~ 10^{18}GeV). The NOvA far detector due to its surface proximity, large size, good timing resolution, and large energy dynamic range, is sensitive to the detection of magnetic monopoles over a large range of velocities and masses. Two different algorithms have been developed for the monopole trigger: one targeting on relativistic, highly ionizing monopoles, the other on non-relativistic monopoles. Both have been tested using a detailed Monte Carlo simulation of the detector with simulated monopoles overlaid with cosmic-ray background events. We present the detector's response to simulated monopoles, the trigger efficiencies of both algorithms, background rejection algorithms and the expected sensitivity for the full NOvA far detector exposure.

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The Atmospheric Neutrino Neutron Interaction Experiment (ANNIE)

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Neutron tagging in Gadolinium-doped water may play a significant role in reducing backgrounds from atmospheric neutrinos in next generation proton-decay searches using megaton-scale Water Cherenkov detectors. Similar techniques might also be useful in the detection of supernova neutrinos. Accurate determination of neutron tagging efficiencies will require a detailed understanding of the number of neutrons produced by neutrino interactions in water as a function of momentum transferred. We propose an experiment to be built on the Fermilab Booster Neutrino Beam, the Atmospheric Neutrino Neutron Interaction Experiment (ANNIE). It is designed to measure the neutron yield of atmospheric neutrino interactions in gadolinium-doped water. An innovative aspect of the ANNIE design is the use of precision timing to localize interaction vertices in the small fiducial volume of the detector. We plan to achieve this by using early production of the Large Area Picosecond Photodetectors (LAPPDs). This experiment will be a first application of these devices demonstrating their feasibility for Water Cherenkov neutrino detectors.

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HARP targets π+ production cross section and yield measurements for MiniBooNE

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The prediction of the muon neutrino flux from a 71.0 cm long beryllium target for the MiniBooNE experiment is based on a measured pion production cross section which were taken from a 2.0 cm (5% nuclear interaction length) thin beryllium target in the HARP experiment at CERN. To verify the extrapolation to our longer target, HARP also measured the pion production from 20.0 cm and 40.0 cm beryllium targets. The measured production yields on targets of 5%, 50% and 100% nuclear interaction lengths are presented. These measurements are also compared with that from the Monte Carlo prediction in the MiniBooNE experiment. Results are presented in the kinematic rage of momentum from 0.75 GeV/c to 6.5 GeV/c and the range of angle from 30 mrad to 210 mrad.

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Cosmic ray rates at the Fermilab Liquid Argon Test Facility

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The MicroBooNE neutrino detector is currently being installed in the Liquid Argon Test Facility at Fermi National Accelerator Lab. The liquid-argon, time-projection chamber has an event-readout time of about 5 milliseconds, during which many cosmic-ray muons will cross the large active volume. We present an estimate for this rate, based on a combination of measurements made in the experimental hall and a CRY/GEANT4 simulation.

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Cosmic Ray Muon Data in the NOvA Far Detector

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NOvA is a next generation long-baseline experiment optimized for the detection of electron neutrino appearance. The Far Detector (FD) is located on the surface under 14 radiation lengths of barite and concrete overburden. Cosmic rays passing through the FD present a unique challenge in cosmic ray background rejection. These cosmic ray events must be rejected at the 1 in 100M level to achieve NOvA's oscillation physics goals. In this poster, we show initial cosmic ray data representing approximately 30 minutes of live time and collected with 4 out of 14 kilotons of the FD. Using these data, recorded out of time with respect to the neutrino beam, we demonstrate that we achieve the necessary level of cosmic rejection in the electron neutrino signal region.

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Muon Neutrino Disappearance with the Fermilab Short-baseline Neutrino Program

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LAr1-ND (the Liquid Argon Near Detector) is a proposed near detector for the short-baseline neutrino oscillation program on the Fermilab Booster Neutrino Beam. Located 100m from the target, LAr1-ND will run concurrent with the MicroBooNE detector and will provide a detailed characterization of the intrinsic beam content, allowing for a near-to-far extrapolation between the two detectors and precision measurements of neutrino appearance and disappearance. We will present the expected sensitivities for the observation of eV mass-scale sterile neutrinos through the disappearance of muon neutrinos for this two-detector setup.