New Perspectives 2013

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Fermi National Accelerator Laboratory Batavia, IL 60510

Book of Abstracts

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Session 6 / **10**

1D/2D unfolding at MINERvA

Author: Kenyi Paolo Hurtado Anampa[1]

[1] *CBPF*

Corresponding Author: kenaih@gmail.com

Finite detector resolution and limited acceptance require experiments to apply unfolding methods in any particle physics experiment. The MINERvA UnfoldUtils package is an interface to the RooUnfold Framework [1] used to apply different unfolding algorithms for this purpose and incorporates the ability to use specific MINERvA classes for handling the different systematic errors in the experiment correctly.

[1] http://hepunx.rl.ac.uk/~adye/software/unfold/RooUnfold.html

Session 4 / **5**

Beam Instrumentation for High Pressure RF Cavity Experiment at Fermilab MuCool Test Area

Author: Mukti Jana[1]

[1] *Fermilab*

Corresponding Author: mukti@fnal.gov

At MuCool Test Area (MTA) of Fermilab, an experiment has been performed with an RF cavity filled with high pressure hydrogen gas to study beam loading effects. In this experiment a 400 MeV proton beam is used with an external magnetic field of B=3 T. Quantitative information about the number of protons passing through the cavity is an essential requirement of the beam test. We have developed beam diagnostic instrumentation using a combination of a Chromox-6 scintillation screen and CCD camera. This paper describes quantitative measurements of the beam size and transmission efficiency through a collimator with B=0 T and B=3 T, and for high and low intensity proton beams.

Session 5 / **31**

Calibrating the MicroBooNE Photomultiplier Tube (PMT) Array with Michel Electrons from Cosmic Ray Muons

Author: Amy Greene[1]

[1] *MIT*

Corresponding Author: greenea@mit.edu

MicroBooNE is a neutrino experiment at Fermilab designed to investigate the 3 sigma low-energy electron candidate events measured by the MiniBooNE experiment. Neutrinos from the Booster Neutrino Beam are detected by a 170-ton (total) liquid argon time projection chamber, which is expected to start taking data in 2014. MicroBooNE measures both the ionization electrons and scintillation light produced by neutrino interactions in the liquid argon. The scintillation light is collected by an array of 30 PMTs located at one side of the detector. This array can be calibrated using Michel electrons from stopping cosmic ray muons, by fitting the measured PMT response with the theoretical

expectation. I will report on the progress of the PMT calibration software that has been developed using the MicroBooNE Monte Carlo.

Session 4 / **32**

Charge Current Quasi-Elastic Neutral Hyperon Production with ArgoNeuT

Author: Saima Farooq[1]

[1] *KSU*

Corresponding Author: saima@ksu.edu

ArgoNeuT is a small scale (170 liter) Liquid Argon Time Projection Chamber (LArTPC) which collected data at Fermi National Accelerator Laboratory in Batavia, Illinois (2009 2010). ArgoNeuT was located 100 meters underground, upstream of the MINOS near detector, exposed to the on-axis NUMI neutrino beamline. It is an R&D project paving the way for bigger LArTPCs such as MicroBooNE and multi-kiloton scale devices. The detector takes neutrino interactions in the 0.1 to 10 GeV range, providing the first ever low energy neutrino interactions data within a LArTPC. ArgoNeuT provides bubble-chamber-quality images with high quality particle identification through dE/dx that results in excellent background rejection and high sensitivity for detecting rare event types. As an example, ArgoNeuT can observe the CKM-suppressed analog to quasi-elastic scattering where a neutral strange particle is produced instead of a nucleon in the final state. Its ability to 'see' the detached vertex of a neutral hyperon decay, makes it stand out among other experiments. There are very few studies on neutral hyperon production via charge current quasi-elastic (CCQE) neutrino interaction. Among other measurements, ArgoNeuT will allow for a study comparing CCQE neutral hyperon production and CCQE neutron production at low energy.

Session 6 / **7**

Charged Current Coherent Pion Production by Neutrinos.

Author: Aaron Higuera[1]

[1] *Universidad de Guanajuato*

MINERvA (Main Injector Experiment for v-A) is a neutrino scattering
experiment in the 1-10 GeV energy range in the NuMI high-intensity neutrino beam at
Fermi National Accelerator Laboratory. MINERvA is measuring neutrino/antineutrino
scattering off a variety of different nuclear materials (C, Fe, Pb, He, H2O). This talk
will describe the current analysis on charged current coherent pion production by neutrinos.

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Dielectrics, Lasers, and Electron Acceleration

Author: Francois Lemery[1]

[1] *NIU Accelerator Physics*

Corresponding Author: francois.lemery@gmail.com

Dielectric lined waveguides (dlw) are an attractive alternative for particle acceleration due to their relative high acceleration gradients and low cost. We discuss work related toward the demonstration of wakefield acceleration in the THz regime at Fermilab's new ASTA, including the possibility of an energy doubler. Lastly we report on the an ongoing experiment using high-efficiency THz generation from optical rectification to drive modes in a slab-symmetric dlw.

Session 3 / **24**

Electroluminescence studies for DarkSide

Author: Alden Fan[1]

[1] *UCLA*

Corresponding Author: aldenf@physics.ucla.edu

Dual phase liquid argon dark matter detectors, such as the DarkSide experiment, rely on a detailed understanding of secondary scintillation light (S2) produced by electroluminescence in the gas phase. The formation of S2 is not well understood, especially for high electric field cryogenic detectors. This talk will present an R&D effort at UCLA to fully map the space of parameters that affect S2. This effort will inform design parameters and operating conditions for future dual phase liquid argon detectors, particularly the next generation experiments and beyond in the DarkSide dark matter search program.

Session 6 / **6**

Electron-neutrino charged-current quasi-elastic cross-section at MINERvA

Author: Jeremy Wolcott[1]

[1] *University of Rochester*

The electron-neutrino charged-current quasi-elastic (CCQE) cross-section on nuclei is an important input parameter to appearance-type neutrino oscillation experiments, where it affects both the signal and predicted background rates. Current experiments typically work from the muon neutrino cross-section and apply corrections from theoretical arguments to obtain a prediction for the electron neutrino cross-section, but to date there has been no experimental verification of these estimates in energy ranges applicable to oscillation searches. MINERvA intends to directly measure the electron neutrino differential cross-section vs. Q^{2} on scintillator using electron neutrinos of energies up to 10 GeV. We present the current status of this work, including event selection and early indications of the flux prediction used to compute the cross-section.

Session 3 / **8**

How Many Galaxies? Checking the Accuracy of a Method for Extrapolating Galaxy Cluster Richness

Author: Matthew Wiesner[1]

Co-author: Huan Lin [2]

[1] *Northern Illinois University*

[2] *Fermilab*

Corresponding Author: matthewwiesner@aol.com

In order to study a sample of galaxy clusters exhibiting strong gravitational lensing, we took images of ten galaxy clusters at Kitt Peak National Observatory. In our analysis, we extrapolated the total number of galaxies in the outer regions of the clusters because some sections of the clusters were outside of our original images. In early 2012, we took new observations of some of these clusters at Apache Point Observatory with the goal of imaging the previously missing area. We then determined how many cluster galaxies were present in this area and compared this to the extrapolated number to check the accuracy of our extrapolation method. We describe our results. We also describe new imaging of a foreground galaxy cluster obtained during these observations.

Session 2 / **19**

KS0 production at the Main Injector Particle production experiment at Fermilab

Author: Amandeep Singh[1]

[1] *Punjab University, Chandigarh*

Corresponding Author: amandeep@fnal.gov

The Main Injector Particle Production (MIPP) experiment at Fermilab is a full acceptance spectrometer to measure hadronic particle production using beams of $\pi^{\pm}$, $K^{\pm}$, p and $\bar{p}$ ranging in momentum from 5 to 120 GeV/c incident on Liquid-Hydrogen, Beryllium, Carbon, Bismuth, Uranium and NuMI targets. The experiment has excellent charged particle identification using Time Projection Chamber (TPC), Time of Flight (ToF), multicell Cherenkov, RICH detector and Calorimeters. A technique to reconstruct K^0_S has been developed and will be described. We present the preliminary inclusive cross-section result for the production of K^0_S from the interaction of 84 GeV/c protons with Liquid-Hydrogen target and 120 GeV/c protons with Carbon, Beryllium, Bismuth targets.

Session 5 / **1**

Long Term Performance of the MINOS Calibration Procedure

Author: Navaneeth Poonthottathil Poonthottathil[1]

[1] *CUSAT/Fermilab*

Corresponding Author: nav@fnal.gov

The MINOS experiment uses two detectors separated by 734 km to study neutrino oscillations between Fermilab and the Soudan Underground Laboratory. The MINOS detectors are steel-scintillator sampling tracking calorimeters and are calibrated based on the information obtained from an in-situ light injection system and cosmic ray muons.The Stability of the detectors monitored during the entire data collection period.The Calibration procedure corrects for the response variation of the scintillator, WLS fiber, photomultiplier tubes .In this talk I will discuss the calibration procedure and its implication on detector performance.

Session 3 / **22**

Low-mass WIMP searches with SuperCDMS

Author: Ritoban Basu Thakur[1]

[1] *Fermilab/ UIUC*

Corresponding Author: basutha1@illinois.edu

I will discuss the new Silicon results from the CDMS experiment. I will primarily talk about the observed events and their statistical significance as light WIMP candidates. In the paradigm of light WIMPs we will see how the SuperCDMS experiment intends to search for light WIMP dark matter using the CDMSlite experiment.

Session 1 / **28**

Measurement of Lorentz Angle for the CMS Pixel Detector

Author: Andrew Godshalk[1]

Co-authors: Ashish Kumar [2] ; Avto Kharchilava [1]

[1] *SUNY at Buffalo*

[2] *State University of New York at Buffalo*

Corresponding Author: godshalk@buffalo.edu

At the core of the CMS all-silicon tracking system is the silicon pixel detector, comprising three barrel layers and two pixel disks in the forward and backward regions, accounting for a total of 66 million channels. The pixel detector provides high-resolution 3D coordinates of the tracks produced in high energy pp collisions. Under the combined action of electric and magnetic fields, the charged carriers traversing the pixel sensors experience the Lorentz force. It causes charge sharing among neighboring pixels which is crucial in enhancing the spatial resolution. In the barrel pixels, the electric and magnetic fields are perpendicular resulting in maximum Lorentz drift, while, in the disks, the fields are oriented at 20 degrees resulting in much smaller Lorentz drift. We present the results of Lorentz angle measurement for the pixel detector using two independent methods.

Session 5 / **17**

Measurement of Neutrino and Antineutrino Oscillation Parameters Using the Complete Atmospheric and Beam Data Sets from MINOS

Author: Michelle Mesquita de Medeiros[1]

[1] *Federal University of Goias*

Corresponding Author: medeiros@fnal.gov

The MINOS detectors are used to collect data from the NuMI neutrino beam as well as atmospheric neutrino data. The atmospheric data taken by the Far Detector, located underground at a depth of 2070 meters-water-equivalent and at 735 km from the neutrino production target, is combined with beam data from both Near and Far Detectors to measure the neutrino and antineutrino mixing parameters. Because our detectors are magnetized, we are able to separate neutrinos and antineutrinos on an event-by-event basis. This allows us to analyze the complete MINOS data set under two possible scenarios: assuming neutrinos and antineutrinos have different oscillation parameters; and assuming these parameters are identical. We report the world-leading measurement of the neutrino and antineutrino atmospheric mass splitting parameter along with the most precise comparison to date of neutrino and antineutrino oscillation parameters.

Session 2 / **35**

Measurement of Z boson production in association with heavy flavor jets at D0

Author: Joseph Zennamo[1]

[1] *SUNY at Buffalo, D0*

Associated production of a Z boson with a charm or bottom quark
can serve as an important test of perturbative quantum chromodynamic
calculations. The ratios of cross sections,
\sigma(Z+c-jet)/\sigma(Z+jet) and \sigma(Z+c-jet)/\sigma(Z+b-jet)
are measured for associated production of a Z boson with jets
as a function of the jet and Z boson transverse momentum.
Measurements use data collected by the D0 experiment in Run˜II
of the Tevatron ppbar collisions at a center-of-mass energy of 1.96 TeV,
and correspond to an integrated luminosity of 9.7 fbˆ{-1}.
Results are compared to predictions from next-to-leading order
calculations and various Monte Carlo event generators.

Session 5 / **9**

Measuring Neutrino Oscillations with the MINOS Experiment

Author: Alexander Radovic[1]

[1] *University College London*

Corresponding Author: a.radovic@gmail.com

"The observation of neutrino oscillation provided the first evidence for physics beyond the standard model. MINOS has been one of the foremost experiments in the field. Pioneering the two-detector technique, the MINOS long-baseline oscillation experiment has made several world-class neutrino oscillation measurements, not only making the most precise measure of the largest neutrino mass splitting, but also the first direct measurement of the antineutrino oscillation parameters. This presentation provides a definitive summary of the contribution MINOS has made to the world's knowledge of theta_23 and delta mˆ2_32 through the observation of muon neutrino and antineutrino disappearance."

Session 5 / **18**

MicroBooNE Electronics: Triggering and Readout

Author: David Kaleko[1]

[1] *Columbia University/Nevis Labs*

Corresponding Author: kaleko@nevis.columbia.edu

MicroBooNE is a neutrino experiment under construction at Fermi National Lab. It employs a 10m*2.6m*(2.5m drift length) 86 ton liquid argon time projection chamber (TPC) active volume to record ionization signals from particles produced in neutrino interactions, and uses scintillation light detected by a PMT array to provide precise interaction timing information. The MicroBooNE readout electronics system includes both TPC and PMT readout electronics which digitize neutrino interaction signals at 2MHz and 64MHz, respectively. The TPC electronics readout system processes

ionization signals from the three wire planes to two readout streams: one for triggered neutrino events, and a second one for continuous readout. The PMT readout system generates the trigger. Triggering schemes have been designed to study beam neutrino events as well as fully characterize background cosmic rays. In addition, exploration of important physics applications including "late" scintillation light in Argon and Michel electrons will be possible. This talk will describe the MicroBooNE readout system, its physics requirements, and specifications.

Session 4 / **25**

MicroBooNE: Physics Overview and Detector Assembly

Author: Ryan Grosso[1]

[1] *University of Cincinnati*

Corresponding Author: grossora@mail.uc.edu

The MicroBooNE Experiment is a 170-ton Liquid Argon Time Projection Chamber (LArTPC) that will commence
running in the Booster Neutrino Beam at Fermilab in early 2014. LArTPC detectors provide powerful electron/photon discrimination and will allow MicroBooNE to investigate low energy electron-like events. The
experiment will also improve neutrino cross section measurements and serve as an R&D platform for future large
liquid Argon detectors. This talk summarizes the main physics goals of the MicroBooNE Experiment as well as
addresses the progress of detector construction.

Session 6 / **14**

Muon Neutrino Charged Current Quasi-Elastic Scattering in MINERvA

Author: Tammy Walton[1]

[1] *Hampton University*

Corresponding Author: twalton@jlab.org

MINERvA is a few-GeV neutrino-nucleus scattering experiment, stationed in the high intensity NuMI beam line at Fermilab. It has been taking data since November 2009 and completed construction in March 2010. MINERvA aims to make precision cross section measurements of both the electron neutrino and muon neutrino interactions, both in support of neutrino oscillation experiments and as a pure weak probe of the nuclear medium. This presentation will focus on the preliminary results for charged current quasi-elastic scattering on the active scintillator target and the passive nuclear targets, carbon, iron, and lead.

Session 6 / **16**

NuMI Beam Flux Study for MINERvA

Author: Leonidas Aliaga Soplin[1]

[1] *College of William and Mary*

The Neutrinos at the Main Injector (NuMI) delivers an intense muon neutrino beam in an energy range of 2-20 GeV. A well known neutrino flux is crucial to make absolute cross sections in experiments like Minerva. Several techniques are currently using to constraint the flux and one of then is to use the existing external hadron production data to reduce the NuMI hadron production uncertainties by tuning our Monte Carlo. In this presentation I will be focused on our current effort on this topic.

Session 1 / **46**

Particle Flow Superclustering and the CMS Hcal Upgrade

Author: Josh Kaisen[1]

[1] *CMS*

Corresponding Author: jkkaisen@buffalo.edu

The CMS Hadron Calorimeter (Hcal) is an integral part of the particle flow and tracking of the CMS detector. A new design is to be implemented which will implement multiple layers of read out to the Hcal in order to reveal various physical properties of the incoming tracks of jets. These layers bring new challenges to the framework of the DAQ and analysis from the Hcal / PF portion of the CMS detector that will be presented on, along with the new design, its physical significance, and the superclustering method

Session 2 / **30**

Particle Production Measurements using the MIPP Detector at Fermilab

Author: Sonam Mahajan[1]

Co-author: Rajendran Raja [2]

[1] *Panjab University, Chandigarh, India*

[2] *Fermi National Accelerator Laboratory, Batavia, IL, USA*

Corresponding Author: sonam@fnal.gov

The Main Injector Particle Production (MIPP) experiment at Fermilab is a fixed target hadron production experiment. It measures particle production in interactions of 120 GeV/c primary protons from the Main Injector and secondary beams of $\pi^{\pm}$, $K^{\pm}$, p and $\bar{p}$ from 5 to 90 GeV/c on nuclear targets which include H, Be, C, Bi and U, and a dedicated run with the NuMI target. MIPP is a high acceptance spectrometer which provides excellent charged particle identification using Time Projection Chamber (TPC), Time of Flight (ToF), multicell Cherenkov (CKOV), Ring Imaging Cherenkov (RICH) detectors, and Calorimeter for neutrons. We present inelastic cross section measurements for 58 and 85 GeV/c p-H interactions, and 58 and 120 GeV/c p-C interactions. The MIPP data are compared with the Monte Carlo predictions and previous measurements. We also describe an algorithm to identify charged particles ($\pi^{\pm}/p/p$ etc.), and present the charged pion and kaon spectra from the interactions of protons with NuMI target.

Session 1 / **48**

Phase 1 CMS Pixel Detector Upgrade

Author: Sarah Freed[1]

[1] *SUNY at Buffalo*

Corresponding Author: smfreed@buffalo.edu

The CMS pixel detector is a tracking device located closest to the interaction point. The present detector was designed for a maximum luminosity of 1×10ˆ34 cmˆ−2sˆ−1. Following the Phase 1 upgrade of the LHC, the peak luminosity is foreseen to reach 2×10ˆ34 cmˆ−2sˆ−1 or higher. Due to the radiation damage and significant data losses in the readout chip, the present pixel system must be replaced by a new one in order to maintain the excellent tracking and physics performance of the detector. The main new features of the upgraded pixel detector would be ultra-light mechanical design with four barrel layers and three end-cap disks, digital readout chip with higher rate capability and new cooling system. Motivations for the upgrade of the pixel detector as well as the features of the proposed detector will be presented.

Session 3 / **20**

Probing Quantum Space-Time with Interferometers

Author: Jonathan Richardson[1]

[1] *University of Chicago*

Corresponding Author: jonathan.richardson@uchicago.edu

The standard model of particle physics has been remarkably successful in accounting for every experimental result to date, with the exception of the acceleration of the universe. However, this theory becomes inconsistent at intervals shorter than the Planck scale, where quantum mechanics and general relativity collide, unless the geometry of space-time itself also acquires some quantum character. Some ideas of quantum geometry, based only on general principles of covariance and quantum mechanics, predict correlated quantum position fluctuations detectable with current technology. The Fermilab Holometer is the first experiment designed to measure transverse position fluctuations, expressed in spectral density units, smaller than a Planck time. This precision is achieved by cross-correlating the anti-symmetric signals of two 40-meter power-recycled Michelson interferometers. When operating at its design sensitivity, the Holometer will either detect or conclusively rule out candidate forms of holographic quantum geometry. In this talk I will provide an overview of the Holometer experiment and an update on its current operational status.

Session 1 / **29**

Production of channeling radiation at the HBESL and ASTA facilities

Author: Ben Blomberg[1]

[1] *Northern Illinois University*

Corresponding Author: bblomberg@niu.edu

Channeling radiation is an appealing radiation process to produce X-ray radiation with low energy electron beams. We plan to use our novel photo and field emission cathodes to generate very small emittance electron beams to make channeling radiation X-ray sources. In this contribution we discuss the anticipated performance and construction status of a channeling radiation experiment to produce ˜2.5 keV radiation from a 4-MeV electron beam at Fermilab's High-Brightness Electron

Source Lab (HBESL) and plans to produce X-ray (˜100 keV) radiation at Fermilab's Advanced Superconducting Test Accelerator (ASTA).

Session 4 / **27**

Results from the Bo Argon Scintillation Test Stand at Fermilab

Author: Benjamin Jones[1]

[1] *MIT*

Corresponding Author: bjpjones@mit.edu

In this talk I will discuss some recent results from the Bo test stand at the Proton Assembly Building, Fermilab. This test stand has been used to characterize elements of the MicroBooNE optical system as well as to perform studies of processes affecting argon scintillation light such as scintillation quenching and optical absorption by impurities. The results of these studies are important for the design and operation of liquid argon TPC detectors such as MicroBooNE and LBNE.

Session 2 / **15**

Search for W' production in the single top channel with the ATLAS detector

Author: Patrick True[1]

[1] *Michigan State University*

Corresponding Author: truepatr@msu.edu

We present the search for W' -> tb using the LHC pp collision data collected with the ATLAS detector at a center-of- mass energy of 8 TeV. The primary backgrounds to this search are ttbar, W+jets, and multijets processes. To reduce the contributions of these backgrounds we require a leptonic final state and use Boosted Decision Trees to discriminate against background-like events. This measurement gives the latest limits on the W' -> tb cross section times branching ratio and the ratio of coupling constants g'/g as functions of the W' mass.

Session 2 / **26**

Search for heavy resonances decaying into tau pair with CMS detector at the LHC

Author: Nitish Dhingra[1]

[1] *Panjab University, Chandigarh (India)*

Corresponding Author: nitishdhingra87@gmail.com

A search for heavy resonances decaying into $\tau^+\tau^-$ is performed using 4.94 fb^{-1} of proton-proton collision data at 7 TeV recorded by the CMS detector during LHC Run2011. The estimation of major backgrounds is performed using data-driven methods wherever possible. A cut and count approach is followed to look for excess of observed events over the Standard Model background prediction.

In the absence of any excess, an upper limit on the product of the resonance cross-section and branching fraction into τ-lepton pair has been calculated as a function of the resonance mass. Using the Sequential Standard Model resonance Z'_{SSM} and the Superstring inspired E6 Model resonance Z'_{ψ} as benchmarks, resonances with Standard Model couplings with masses below 1.4 and 1.1 TeV, respectively, are excluded at 95% confidence level.

Session 2 / **21**

Search for the standard model Higgs boson produced in association with W or Z bosons, and decaying to bottom quarks

Author: Jia Fu Low[1]

[1] *University of Florida*

Corresponding Author: jiafu@fnal.gov

One of the most important decay channels of the standard model Higgs is its decay into a pair of bottom quarks. For the highest signal significance, the associated production of the Higgs with a W or Z boson is investigated. Six different channels are used: $W(\mu\nu)H, W(e\nu)H, W(\tau\nu)H, Z(\mu\mu)H, Z(ee)H$ and Z(\nu\nu)H.$Adatasample, recordedbytheCMSdetectorattheLHC, correspondingtointegratedluminositiesof5.1fb$ 1}at\sqrt{s} = 7$TeV and$19fb^{-1}at$\sqrt{s} = 8$TeV isanalyzed. Exclusionlimitsatthe95\%confidencelevelandsignificance$ \to b{\bar b}$inthemassrange$110-135$ GeV are reported.

Session 6 / **33**

Study of Quasi-Elastic interactions using the NOvA Detector Prototype

Author: Minerba Betancourt[1]

[1] *University of Minnesota*

NOvA is a 14 KTon long-baseline neutrino oscillation experiment currently being installed in the NUMI off-axis neutrino beam produced at Fermilab. A 222 Ton prototype NOvA detector (NDOS) was built and operated in the neutrino beam for over a year to understand the the response of the detector and its construction. Muon neutrino interaction data collected in this test are being analyzed to identify quasi-elastic charge-current interactions and measure the behavior of the Quasi-elastic muon neutrino cross section. The status of these quasi-elastic studies in NDOS will be shown.

Session 4 / **2**

TRANSVERSE-TO-LONGITUDINAL EMITTANCE EXCHANGE AT THE FERMILAB ADVANCED SUPERCONDUCTING TEST ACCELERATOR

Author: Chris Prokop[1]

[1] *Fermilab*

Corresponding Author: cprokop@gmail.com

A variable-dispersion bunch compressor chicane with a transverse-deflecting cavity (TDC) may serve as a transverse-to-longitudinal emittance exchangers (EEX). In this paper, we present a design and simulations of a chicane-based EEX for eventual implementation at Fermilab's Advanced Superconducting Test Accelerator (ASTA). Such a beamline is foreseen to enable bunch current profile shaping, bunch compression, and emittance repartioning to tailor the beam per user's requirements.

Session 1 / **47**

Testing of the HDI's to be installed during Phase 1 Upgrades of the LHC

Author: Brendan Smith[1]

[1] *University at Buffalo SUNY*

Corresponding Author: bmsmith5@buffalo.edu

The CMS pixel detector is an all-silicon tracking device located closest to the interaction point. Following the first long shut down of the LHC, in order to maintain the high performance of the tracker, the pixel detectors must be upgraded to handle the increased amounts of event pileup. One of the components of the upgrade is the forward pixel detector, which uses a High Density Interconnect (HDI) to connect the pixels and the readout chip. During the shutdown, a pilot system will be installed in the forward pixels to test the performance of the new design. In addition to this pilot program, 50 HDI's are currently being visually and electrically tested by a team from the University at Buffalo, located on-site at Fermilab. The current results of these tests will be presented.

Session 3 / **3**

The NRQED Lagrangian at order $1/M^4$

Authors: Gabriel Lee[1] ; Richard Hill[1]

[1] *University of Chicago*

Corresponding Author: leeg@uchicago.edu

The parity and time-reversal invariant effective Lagrangian
for a heavy fermion interacting with an Abelian gauge field, i.e.,
NRQED, is constructed through order $1/M^4$. The implementation of
Lorentz invariance in the effective theory becomes nontrivial at this order,
and a complete solution for Wilson coefficient constraints is obtained. Matching
conditions in the one-fermion sector are presented in terms of form
factors and two-photon matrix elements of the nucleon.
The extension of NRQED to describe interactions of the heavy fermion with a
light fermion is introduced.
Sample applications are discussed; these include
the computation of nuclear structure effects in atomic bound
states, the model-independent analysis of radiative corrections to
low-energy lepton-nucleon scattering, and the study of static
electromagnetic properties of nucleons.