2011 Fall Meeting of the APS Division of Nuclear Physics
East Lansing, Michigan
http://www.aps.org/meetings/meeting.cfm?name=DNP11
Wednesday, October 26, 2011 8:30AM - 10:00AM – Session 1WA Workshop on New Insights in Nuclear Physics and Astrophysics from Stopped and Reaccelerated Rare Isotopes | 103AB

8:30AM 1WA.00001 Weak interaction and fundamental symmetry studies with laser trapped atoms1, PETER MUELLER, Argonne National Laboratory — Neutral atom laser traps are excellent tools to capture, confine, and manipulate radioactive isotopes. They provide high selectivity and sensitivity and allow preparing a cold sample of the isotope of interest in the center of a vacuum chamber supported only by laser light. In my talk, I will present applications of laser cooling and trapping techniques of radioactive isotopes for precision studies of fundamental symmetries and weak interactions. In particular, I will talk about the progress towards measuring the Schiff moment of 225Ra for searches of time reversal violation beyond the Standard Model and about a new experimental effort to search for possible tensor couplings in the weak decay of 6He.

1This work is supported by the Department of Energy, Office of Nuclear Physics, under contract DEAC02-06CH11357.

9:00AM 1WA.00002 Collinear Laser Spectroscopy Studies of Rare Isotopes at NSCL1, KEI MINAMISONO, NSCL/MSU — The BEam C0oler and LAser spectroscopy (BECOLA) facility is being installed at National Superconducting Cyclotron Laboratory at Michigan State University. BECOLA will make use of low-energy beams generated via projectile-fragmentation reactions and subsequent gas stopping, complementing laser spectroscopy studies for charge radii and nuclear moments at ISOL facilities. Low-energy beams with a maximum energy of 60 keV/q will be transported to a new-generation beam cooler and buncher under development, and then to the collinear laser beam line. The ion beams can be neutralized in a charge exchange cell (CEC) using reactions with alkali vapor. The ion/atom beam will be collinearly overlapped with laser light and fluorescence will be detected in coincidence with the beam bunches to increase the detection sensitivity. The installation of the collinear laser beam line is complete and commissioning tests are underway using stable beams from an offline ion source. On-line operation of BECOLA is foreseen to start in 2012. The earlier science program will start with charge radii measurements of the neutron-deficient K, where the new data are important for revealing single-particle evolution in the pf shell.

1This work was supported in part by NSF Grant PHY 06-06007.

9:00AM 1WA.00003 Nuclear astrophysics at the DRAGON recoil separator1, ULRRIKE HAGER, Colorado School of Mines — The DRAGON recoil separator facility at TRIUMF measures radiative alpha and proton capture reactions of astrophysical importance in inverse kinematics. This is done using radioactive and stable ion beams produced and accelerated using the ISAC (Isotope Separator and ACcelerator) facility in conjunction with a windowless gas target. Over the last few years, the DRAGON collaboration has embarked on a programme to measure a variety of reactions considered vital to the understanding of various astrophysical scenarios. An overview of DRAGON's separation, beam suppression, and detection capabilities will be given. In addition, examples of recent reaction cross section measurements will be discussed, such as the 16O(α,γ)20Ne reaction, which plays an important part in the He-burning in massive stars.

1The authors gratefully acknowledge funding from the NSERC and the DOE Office of Nuclear Physics.

Wednesday, October 26, 2011 8:30AM - 10:00AM – Session 1WB Workshop on Advanced Digital Signal Processing Techniques in Nuclear Science | 104AB

8:30AM 1WB.00001 Gamma ray energy tracking in GRETINA, I.Y. LEE, Lawrence Berkeley National Laboratory — The next generation of stable and exotic beam accelerators will provide physics opportunities to study nuclei farther away from the line of stability. However, these experiments will be more demanding on instrumentation performance. These come from the lower production rate for more exotic beams, worse beam impurities, and large beam velocity from the fragmentation and inverse reactions. Gamma-ray spectroscopy will be one of the most effective tools to study exotic nuclei. However, to fully exploit the physics reach provided by these new facilities, better gamma-ray detector will be needed. In the last 10 years, a new concept, gamma-ray energy tracking array, was developed. Tracking arrays will increase the detection sensitivity by factors of several hundred compared to current arrays used in nuclear physics research. Particularly, the capability of reconstructing the position of the interaction with millimeters resolution is needed to correct the Doppler broadening of gamma rays emitted from high velocity nuclei. GRETINA is a gamma-ray tracking array which uses 28 Ge crystals, each with 36 segments, to cover 1/4 of the 4π solid angle. The gamma ray tracking technique requires detailed pulse shape information from each of the segments. These pulses are digitized using 14-bit 100 MHz flash ADCs, and digital signal analysis algorithms implemented in the on-board FPGAs provides energy, time and select correlation of pulse traces. A digital trigger system, provided flexible trigger functions including a fast trigger output, and also allows complicated trigger decisions to be made up to 20 microseconds. Further analyzed, carried out in a computer cluster, determine the energy, time, and three-dimensional positions of all gamma-ray interactions in the array. This information is then utilized, together with the characteristics of Compton scattering and pair-production processes, to track the scattering sequences of the gamma rays. GRETINA construction is completed in March 2011, and extensive engineering runs were carried out using radioactive sources, and beams from the 88-Inch Cyclotron at LBNL. The data obtained will be used to optimize its performance. Then the first scientific campaign will start in March 2012 at NSCL MSU.

9:00AM 1WB.00002 TBD, W. STOEFFL, LLNL —
9:30AM 1WB.00003 The Upgrade Path From Legacy VME to VXS Dual Star Connectivity For Large Scale Data Acquisition and Trigger Systems, CHRISS CUEVAS, Jefferson Lab — New instrumentation modules have been designed by Jefferson Lab that take advantage of the higher performance and elegant backplane connectivity of the VITA 41 standard of VXS. These new modules are required to meet the 200kHz trigger rates envisioned for the 12GeV experimental program. Upgrading legacy VME designs to the high speed gigabit serial expansions that VXS offers, comes with significant challenges, including electronic engineering design, plus firmware and software development issues. This paper will detail our system design approach including the critical system requirement stages, and explain the pipeline design techniques and selection criteria for the FPGA that require embedded Gigabit serial transceivers. The entire trigger system is synchronous and operates at 250MHz clock with synchronization signals, and the global trigger signals distributed to each front end readout crate via the second switch slot in the 21 slot VXS backplane. The readout of the buffered detector signals relies on 2eSSST over the standard VME64x path at >200MB/s. We have achieved 20Gb/s transfer rate of trigger information within one VXS crate and will present results using production modules in a two crate test configuration with both VXS crates fully populated. The VXS trigger modules that reside in the front end crates will be ready for production orders by the end of the fiscal year. VXS Global trigger modules are in the design stage now, and will be complete to meet the installation schedule for the 12GeV Physics program.

Wednesday, October 26, 2011 8:30AM - 10:00AM – Session 1WC Workshop on the Energy Frontier, Heavy Ions at the LHC I 105AB

8:30AM 1WC.00001 Results from the heavy ion program at RHIC and expectations for the LHC, RENE BELLWIED, University of Houston — I will review the latest results from the heavy ion program at RHIC in light of predictions and expectations for the LHC heavy ion program. New results from STAR and PHENIX will be presented which focus on the features that were also addressed in the first running period of PbPb collisions at the LHC as presented at the Quark Matter 2011 conference. These include particle correlation measurements, flow measurements, quarkonia measurements, jet measurements, the determination of initial conditions, and RHIC beam energy scan results.

9:00AM 1WC.00002 First Results from ALICE, HELEN CAINES, Yale University - on behalf of the ALICE collaboration — After nearly 20 years of preparations, first collisions at the LHC commenced in 2009. Since then proton beams have been collided at sqrt(s) = 0.9, 2.76 and 7 TeV, with the majority of the data being recorded at 7 TeV. In the Fall of 2010 another new era was entered when Pb-Pb collisions at 2.76 TeV were also delivered. ALICE’s (A Large Ion Collider Experiment) main focus is on exploring the physics of strongly interacting matter created in these events. However, the pp data is also being investigated producing both intriguing new results, and serving as a baseline from which to compare the Pb-Pb data. I will present recent results from ALICE (A Large Ion Collider Experiment) from both the 2010 Pb-Pb run and the ongoing physics analyzes of the pp data. These first Pb-Pb results are broadly consistent with expectations based on low energy RHIC and SPS data. They indicate that matter created in these collisions, while initially much larger and hotter, still behaves like a very strongly interacting, almost perfect liquid.

9:30AM 1WC.00003 Soft and Hard Probes of Lead+Lead Collisions at the LHC with the ATLAS Detector, BRIAN COLE, Columbia University — Heavy ion collisions at the LHC provide an opportunity to study the properties of strongly interacting matter at the highest temperatures ever created in the laboratory. The ATLAS detector with its large acceptance calorimetry, extensive silicon tracking, and large-acceptance muon spectrometers is well suited to study both soft/collective observables and high-p_T/hard observables in Lead+Lead collisions. ATLAS accumulated about 8 µb⁻¹ of data during the Fall 2010 LHC heavy ion run. Results will be presented from the analysis of that data set on charged particle multiplicity and pseudo-rapidity distributions, charged particle elliptic and higher harmonic collective flow, single charged particle spectra and single particle suppression at high p_T, single jet and dijet production, and W, Z, and single muon production.

Wednesday, October 26, 2011 10:30AM - 12:30PM – Session 2WA Workshop on New Insights in Nuclear Physics and Astrophysics from Stopped and Reaccelerated Rare Isotopes II 103AB

10:30AM 2WA.00001 Exploring the Nuclear Chart with LeRIBSS and IRIS-2, ROBERT GRZYWACZ, University of Tennessee/ORNL — Exploration of the unknown regions of the chart of the nuclie is essential to both nuclear structure and nuclear astrophysics. Decay spectroscopy studies often provide the first results in previously unexplored areas. The development of new instrumentation dictates the isotopic reach of experiments. New exploratory decay studies have been performed at the Holifield Radioactive Ion Beam Facility on very neutron-rich, medium-mass nuclei produced in the proton induced fission of 238U. A wealth of new data were obtained in the 78Ni region on the r-process path. New nuclear lifetimes, decay schemes and decay branching ratios were measured using the recently developed facilities: Low-energy Radioactive Ion Beam Spectroscopy Station (LeRIBSS) and new Injector for Radioactive Ion Species (IRIS-2). The detailed studies of 76Cu, 83Zn and 85Ga were possible owing to the high production rates, isotopic purity and experimental sensitivities provided by these new devices.

11:00AM 2WA.00002 Measurement of the 25Al(d,n)28Si(p) reaction at RESOLUT: Spectroscopy of l = 0 and l = 1 resonances1, INGO WIEDENHOEVER, Florida State University — Studies of rp-process nucleosynthesis in stellar explosions show that establishing the lowest l = 0 and l = 1 resonances is the most important step to determine reaction rates in the astrophysical rp-process path. In an experiment performed at the RESOLUT radioactive beam facility of Florida State University, we have studied the 25Al(d,n)28Si reaction in inverse kinematics to establish the spectrum of the lowest l = 0 and l = 1 resonances. The spectrum is consistent with a previous experiment using the same reaction at RESOLUT [1] and results obtained from recent stable beam experiments [2].


1This work was supported by the NSF under contract PHY-07-54674 and the U.S. DOE under contract DE-FG02-02ER41220.
11:30AM 2WA.00003 Reaction dynamics near the barrier, W. LOVELAND, Oregon State University — The availability of modest intensity (10^1-10^7 p/s) radioactive nuclear beams has had a significant impact on the study of nuclear reactions near the interaction barrier. The role of isospin in capture reactions is a case in point. Using heavy elements as a laboratory to explore these effects, we note that the cross section for producing an evaporation residue is

$$\sigma_{EVR}(E_{c.m.}) = \sum_{J=0}^{J_{max}} \sigma_{CN}(E_{c.m.}, J) W_{sur}(E_{c.m.}, J)$$

where $\sigma_{CN}$ is the complete fusion cross section and $W_{sur}$ is the survival probability of the completely fused system. The complete fusion cross section can be written as,

$$\sigma_{CN}(E_{c.m.}) = \sum_{J=0}^{J_{max}} \sigma_{capture}(E_{c.m.}) P_{CN}(E_{c.m.}, J)$$

where $\sigma_{capture}(E_{c.m.}, J)$ is the “capture” cross section at center-of mass energy $E_{c.m.}$ and spin $J$ and $P_{CN}$ is the probability that the projectile-target system will evolve inside the fission saddle point to form a completely fused system rather than re-separating (quasi-fission). The systematics of the isospin dependence of the capture cross sections has been developed and the deduced interaction barriers for all known studies of capture cross sections with radioactive beams are in good agreement with recent predictions of an improved QMD model and semi-empirical models. The deduced barriers for these $n$-rich systems are lower than one would expect from the Bass or proximity potentials. In addition to the barrier lowering, there is an enhanced sub-barrier cross section in these $n$-rich systems that is of advantage in the synthesis of new heavy nuclei. Recent studies of the “inverse fission” of uranium ($^{124,132}Sn + ^{109}Mo$) have yielded unexpectedly low upper limits for this process due apparently to low values of the fusion probability, $P_{CN}$. The fusion of halo nuclei, like $^{11}Li$ with heavy nuclei, like $^{208}Pb$, promises to give new information about these and related nuclei and has led/may lead to unusual reaction mechanisms.

1This work was sponsored, in part, by the USDOE Office of Nuclear Physics

12:00PM 2WA.00004 Studies of heavy residues from peripheral collisions near the Fermi energy, SHERRY YENNELLO, Texas A&M University — Neutron-rich nuclei have been produced in peripheral collisions near the Fermi energy. The heavy residues and intermediate mass fragments from the reactions of 86Kr, 64Ni and 136Xe beams with 112,124Sn and 58,64Ni targets have been measured with MARS and BigSol. Additionally the reactions of 86Kr and 64Ni on 208Pb have been studied. These experiments have been designed to study the deep inelastic reaction mechanism. The exchange of nucleons between projectile and target is dependent on the neutron-richness of the reaction partners and has been linked to the nuclear symmetry energy. Experimental results will be presented and compared with predictions of theoretical models.

2This work has been supported by the US Department of Energy and the Robert A. Welch Foundation.

Wednesday, October 26, 2011 10:30AM - 12:30PM –
Session 2WB Workshop on Advanced Digital Signal Processing Techniques in Nuclear Science

10:30AM 2WB.00001 Pulse-Shape Discrimination for Low-Background Proportional Counting, CRAIG AALSETH, Pacific Northwest National Laboratory — Digital pulse-shape discrimination (PSD) is used to improve measurement sensitivity for internal-source gas proportional counters. Because the design of these detectors can be physically simple, they are well-suited for low-background applications where the radiopurity of detector materials must be stringently controlled. After mitigating dominant backgrounds (cosmic rays, external gamma-rays, radioactivity in materials), remaining background events frequently do not arise from ionization of the proportional counter gas. Various PSD methods have exploited the resulting pulse-shape differences. More sophisticated methods can offer better discrimination but may lead to more difficult calibration between model and detector. Variations between modeled and experimental shapes can limit the discriminating power achieved. This work addresses this difficulty by generating a template shape from each individual sample measurement of interest, a “self-calibrating” template. Differences in event topology can also cause differences in pulse shape. In this work the temporal region analyzed is limited to maximize background discrimination while avoiding unwanted sensitivity to event topology. Low-background measurements of tritium, carbon-14, argon-37, and argon-39 are currently being developed at the Pacific Northwest National Laboratory with detectors employing radiopure materials developed for neutrinoless double-beta decay and dark matter searches. The application of self-calibrating template PSD to measurement of these radioisotopes, along with initial measurement results, is described. Applications such as nuclear treaty verification, elucidating the environmental carbon cycle, and the assay of low-background materials for next-generation nuclear physics experiments are presented.

11:00AM 2WB.00002 From Analog Inputs to Physics Results: A Case Study in Using Digital Electronics in Physics Research, CHRIS PERKINS, Lawrence Berkeley National Laboratory — Particle collisions at the Relativistic Heavy Ion Collider (RHIC) can range from grazing collisions to head on collisions and can result in a wide range of physical interactions between the colliding particles. Signals from the full detector suite at a collision point cannot be readout quickly enough to record the full 10 MHz crossing rate. Therefore, to make physics conclusions from these collisions, signatures of specific interactions must be identified using a subset of the full detector to reduce the data acquisition rate to a manageable volume. These signatures must be encoded into a real-time digital pattern recognition system to choose the interactions needed to achieve physics results. This is accomplished using custom built electronics arranged in a tree structure to form a digital trigger system composed of analog-to-digital conversion electronics at the tree inputs and digital electronics throughout the rest of the tree. The trigger system developed for the Solenoidal Tracker at RHIC (STAR) is able to identify a wide array of configurable patterns among thousands of individual detectors at a rate of 10 MHz. The system can be easily programmed to identify new patterns and can be used to look for many different patterns simultaneously. The flexibility of this system allows for a wide range of physical interactions to be explored. This system was recently ported for use at a new experiment at RHIC called AnDY, exhibiting the system’s general utility as a trigger and data acquisition system for physics experiments.
that, together with the continuation of a broad variety of smaller initiatives, will support continued progress well into the next decade.

The dynamics of the strong interaction, and of the relationships between nucleon structure and nuclear structure. The upgrade of CEBAF is now well underway.

Careful plans were laid for the next generation of experiments in the field, with the 12 GeV Upgrade of CEBAF as a major initiative. The research program started and the RHIC Spin program was initiated. In addition, a variety of important smaller initiatives have been supported at other facilities world-wide, and will employ sophisticated background rejection techniques. One such technique, which is key to achieving this background goal, is the ability to distinguish between single-site events from neutrinoless double beta decay and multiple-site events resulting from background gamma rays. This will be achieved through analysis of the digitised signal response of the HPGe detectors. The physics goals of the MAJORANA experiment will be discussed, along with the roles played by digital electronics and digital pulse processing techniques. Details of key background rejection algorithms will also be presented.

Research sponsored by the Office of Nuclear Physics, U.S. Department of Energy.

12:00PM 2WB.00004 Present and Future Applications of Digital Electronics in Nuclear Science - a Commercial Prospective, HUI TAN, XIA LLC — Digital readout electronics instrumenting radiation detectors have experienced significant advancements in the last decade or so. This on one hand can be attributed to the steady improvements in commercial digital processing components such as analog-to-digital converters (ADCs), digital-to-analog converters (DACs), field-programmable-gate-arrays (FPGAs), and digital-signal-processors (DSPs), and on the other hand can also be attributed to the increasing needs for improved time, position, and energy resolution in nuclear physics experiments, which have spurred the rapid development of commercial off-the-shelf high speed, high resolution digitizers or spectrometers. Absent from conventional analog electronics, the capability to record fast decaying pulses from radiation detectors in digital readout electronics has profoundly benefited nuclear physics researchers since they now can perform detailed pulse processing for applications such as gamma-ray tracking and decay-event selection and reconstruction. In this talk, present state-of-the-art digital readout electronics and its applications in a variety of nuclear science fields will be discussed, and future directions in hardware development for digital electronics will also be outlined, all from the prospective of a commercial manufacturer of digital electronics.

Wednesday, October 26, 2011 10:30AM - 12:00PM — Session 2WC Workshop on the Energy Frontier, Heavy Ions at the LHC II 105AB

10:30AM 2WC.00001 First Results from the CMS Heavy Ion Program, JULIA VELKOVSKA, Vanderbilt University — We will present an overview of the CMS results from PbPb collisions at √sNN = 2.76 TeV, probing quark-gluon matter at unprecedented energy density. The CMS apparatus provides calorimeter, muon and tracking systems covering a large range in pseudorapidity, complemented by a flexible two-level trigger system. This allows for the study of the production of jets, photons, charged hadrons, quarkonia and vector bosons at large transverse momenta as a function of collision centrality. Results from the rare probe signals, alongside with measurements of particle correlations and collective flow over a broad kinematic range, would provide the means to characterize the properties of the produced medium.

11:00AM 2WC.00002 Theoretical interpretation of new jet results from the LHC, IVAN VITEV, Los Alamos National Laboratory — Jets physics in heavy ion reactions is an important new area of active research at Relativistic Heavy Ion Collider and at the Large Hadron Collider that paves the way for novel tests of QCD dynamics in dense nuclear matter. Recently, first results on the quenching of leading particles and jets from the LHC lead-lead run at a center-of-mass energy of 2.76 TeV per nucleon-nucleon pair became available. With this motivation, we present a theoretical analysis of the exciting new experimental findings. We emphasize the accuracy that can be achieved in next-to-leading order perturbative calculations and focus on the suppression the single and double inclusive jet cross sections. We demonstrate how the di-jet asymmetry, recently measured by ATLAS and CMS, can be related to these general results. The case of jets tagged by an electroweak boson is exemplified by the Z0 → jet channel. We discuss the constraints that the inclusive Z0 measurements by CMS place on cold nuclear matter effects at the LHC. Finally, we clarify the relation between the suppression of inclusive jets, tagged jets and di-jets and the quenching of inclusive particles on the example of the recent ALICE and CMS hadron attenuation data. We conclude by discussing the insights in the in-medium modification of parton showers that the new LHC data provide and point to future directions and effective theories of QCD that can help improve the accuracy of the tools for jet tomography.

11:30AM 2WC.00003 Flow at the LHC from event-by-event viscous hydrodynamics, BJOERN SCHENKE, BNL — I review recent developments in describing anisotropic flow at the LHC with a relativistic 3+1 dimensional viscous event-by-event hydrodynamic simulation. I present results for elliptic and triangular flow and the comparison to first experimental data. Furthermore, I discuss the potential of the systematic study of higher harmonics and directed flow to pin down the shear viscosity to entropy density ratio of the created quark gluon plasma and the details of the initial state.

Wednesday, October 26, 2011 3:00PM - 6:15PM — Session AA Plenary Session: Dennis Kovar’s Influence on the Past, Present, and Future US Nuclear Physics Program Big Ten A

3:00PM AA.00001 Hadronic Physics in the Kovar Era, LAWRENCE S. CARDMAN, Thomas Jefferson National Accelerator Facility — The period of Dennis Kovar’s leadership of the nuclear physics program at the DOE Office of Science was remarkably productive for the subfield of hadron physics. As it began, research utilizing the newly-constructed Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab started and the RHIC Spin program was initiated. In addition, a variety of important smaller initiatives have been supported at other facilities world-wide, and careful plans were laid for the next generation of experiments in the field, with the 12 GeV Upgrade of CEBAF as a major initiative. The research program has produced a number of surprising discoveries and a substantive refinement of our understanding of the nucleon and its underlying quark structure, of the dynamics of the strong interaction, and of the relationships between nucleon structure and nuclear structure. The upgrade of CEBAF is now well underway that, together with the continuation of a broad variety of smaller initiatives, will support continued progress well into the next decade.

Research sponsored by the Office of Nuclear Physics, U.S. Department of Energy.
3:36PM AA.00002 Relativistic Heavy Ion Collisions: Status and Future, STEVEN VIGDOR, Brookhaven National Laboratory — Dennis Kovar’s critical role in overseeing funding for the construction and early operation years of RHIC helped to launch a new subfield exploring unique quantum many-body manifestations of QCD in quark-gluon matter. In relativistic heavy-ion collisions at RHIC, and now at LHC as well, unanticipated discoveries and remarkable progress have been made in characterizing ultra-hot matter created under conditions akin to those of the early universe about one microsecond after the Big Bang. I will summarize the intellectual advances by presenting highlights of the learning curves (early results, recent developments, open questions) for a few key properties of the matter related to fundamental aspects of QCD. Included will be manifestations of nearly perfect quantum fluid behavior, of jet quenching, of high-temperature quantum fluctuations and of features of the QCD phase diagram. Considerations of the initial states of the colliding nuclei, and of manifestations of gluon proliferation and recombination, will also lead naturally to properties of cold nuclear matter unveiled to date in deuteron-nucleus and polarized proton-proton collisions at RHIC, and to be studied quantitatively at a future Electron-Ion Collider. I will also discuss how ongoing and planned facility upgrades will enhance the unique capabilities RHIC brings to this science and complement QCD matter explorations at LHC.

5:24PM AA.00005 Dennis Kovar and Low-Energy Nuclear Science in the United States at the turn of the century, ROBERT V.F. JANSENS, Physics Division, Argonne National Laboratory — This presentation will retrace aspects of Dennis Kovar’s research career as a staff member within the Physics Division at Argonne National Laboratory. Dennis led pioneering work on understanding how the total cross section in heavy-ion induced reactions is distributed into elastic and inelastic scattering, transfer, incomplete and complete fusion with a focus on the interaction between these different channels. It will also discuss the decisive role Dennis played in stewarding low energy nuclear science, once he joined the Office of Nuclear Physics at the Department of Energy. In particular, this presentation will review Dennis’ role in helping making the case for physics with rare isotopes. Through his many valuable suggestions and probing questions he was instrumental in challenging and stimulating to community into an adventure that ultimately culminated in the proposal for the development of FRIB, the facility for Rare Isotope Beams.

Work supported by DOE (grants DE-SC0004286 and DE-SC0004104 (JET Collaboration)).
9:30AM CA.00004 Analysis of the inclusive differential jet spectrum in pp collisions at \( \sqrt{s} = 2.76 \) TeV with ALICE at the LHC, RONGRONG MA, Yale University — Quantum-Chromodynamics (QCD) predicts that a new state of hot, dense matter, normally referred to as the Quark-Gluon Plasma (QGP), can be created in ultra-relativistic heavy-ion (HI) collisions. Investigating the features of this strongly interacting matter has been the main goal of the field. Full jet reconstruction provides a direct, unbiased probe to study the medium effects. With the advent of the HI run at the Large Hadron Collider (LHC), we are able to measure QGP properties in a new energy domain. In this talk, we present the analysis of the inclusive differential jet spectrum in pp collisions at \( \sqrt{s} = 2.76 \) TeV, which is an essential reference for jet measurements in Pb-Pb collisions at the same energy. The measurement is based on charged particle tracking in the ALICE central tracking system, and neutral energy measured in the Electromagnetic Calorimeter (EMCal). Especially, high tower triggers provided by the EMCal are used to greatly enhance the kinematic reach of the inclusive jet cross section measurement with ALICE.

9:42AM CA.00005 Fluctuation and Correlation Probes of Early Time Dynamics\(^1\), SEAN GWYN, Wayne State University, GEORGE MOSCHELLI, Frankfurt Institute for Advanced Studies, Johann Wolfgang Goethe University — Measurements of two-particle correlations in nuclear collisions exhibit a complex pattern of ridges, peaks, and valleys as functions of relative pseudorapidity and azimuthal angle. The azimuthal dependence of these correlations can be described as anisotropic flow by introducing a novel triangular v3 component comparable to the more familiar elliptic v2 contribution. Triangularity has been attributed to by event-wise fluctuations in the initial shape of the collision volume. We ask two questions: 1) How do shape fluctuations impact other event-by-event observables? 2) Can we disentangle fundamental information on the early time behavior that produces these fluctuations from the complex flow that results? We study correlations and fluctuations in a framework in which an early Glasma stage produces fluctuations in the number of participant and wounded nucleons. We explore this hypothesis with both high and low flow models and show how non-flow contributions can be disentangled. The influence of such factors as choice of distorting potentials and multi-step reaction paths will be explored.

\(^1\)This work was supported in part by U.S. NSF grants PHY-0855369 (SG) and The Alliance Program of the Helmholtz Association (HA216/EMMI) (GM).

9:54AM CA.00006 Measurement of Charge Multiplicity Asymmetry Correlations to Search for Chiral Magnetic Effect in Heavy Ion Collisions, QUAN WANG, Purdue University, STAR AT RHIC COLLABORATION — It has been suggested that local parity violation in QCD would lead to charge separation of quarks by the Chiral Magnetic Effect (CME) in heavy ion collisions. Charge separation could yield a dynamical charge multiplicity asymmetry with respect to the reaction plane. In this talk, we report results on charge multiplicity asymmetry correlations in \( \sqrt{s_{NN}} = 200 \) GeV Au+Au and d+Au collisions by the STAR experiment, as well as from the RHIC beam energy scan. We found that the correlation results could not be explained by CME alone. To gain further insights, we study our results as a function of the measured azimuthal angle range as well as the event-by-event anisotropy parameter \( v_2 \). The results indicate that the charge separation effect appears to be in-plane rather than out-of-plane. We found that the charge separation effect is proportional to the event-by-event \( v_2 \) and consistent with zero in events with \( v_2 \approx 0 \). Our studies suggest that the charge separation effect, within the statistical error, may be a net effect of event anisotropy and correlated particle production. Possible upper limit on the CME imposed by our data will be discussed.

10:06AM CA.00007 Local Parity Violation or Local Charge Conservation/Flow? A Reaction-Plane-Dependent Balance Function Study, HUI WANG, Michigan State University, STAR COLLABORATION — STAR has recently reported charge-dependent azimuthal correlations using a three particle correlator that is sensitive to the charge separation effect in Au+Au collisions at \( \sqrt{s_{NN}} = 200 \) GeV. Qualitatively, these results agree with some of the theoretical predictions for local parity violation in heavy-ion collisions. However, a study using reaction-plane-dependent balance functions shows an alternative origin of this signal. The balance function, which measures the correlation between oppositely charged pairs, is sensitive to the mechanisms of charge formation and the subsequent relative diffusivity of the balancing charges. We report reaction-plane-dependent balance functions for Au+Au collisions at \( \sqrt{s_{NN}} = 200 \) GeV using the STAR detector. The reaction-plane-dependent balance function analysis is consistent with the three particle correlator analysis as expected mathematically. The model of Schlicting and Pratt incorporating local charge conservation and elliptic flow can reproduce most of the three-particle azimuthal correlation results at 200 GeV.

Thursday, October 27, 2011 8:30AM - 10:18AM — Session CB Mini-Symposium on Experimental Advances in Transfer Reactions I Auditorium

8:30AM CB.00001 Perspectives in the Study of Transfer Reactions, SEAN FREEMAN, University of Manchester — The push to study the properties of nuclei far from stability has led to a renewed interest in the use of direct transfer reactions. For example, establishing the single-particle excitations in nuclei is essential to determining a framework within which to properly understand nuclear structure; single-nucleon transfer reactions provide an important experimental probe to accomplish this. In addition, reactions involving the exchange of several nucleons can provide probes of the evolution of pairing and clustering in exotic systems. Recent glimpses into the structure of exotic nuclei have indicated considerable changes in shell structure away from stability and these findings have acted as a spur for both radioactive beam measurements, as well as detailed investigations using stable projectiles. This talk will discuss the experimental requirements for performing transfer-reaction studies. Results from recent experiments will be used to highlight the different experimental techniques that can be adopted to take advantage of the opportunities that will be made available by the new facilities that are currently being designed and constructed.

9:06AM CB.00002 Knockout, Transfer and Spectroscopic Factors, KIRBY KEMPER, Florida State University, NICOLAS KEELEY, The Andrej Sołtan Institute for Nuclear Studies, KRZYSZTOF RUSEK, Heavy Ion Laboratory, University of Warsaw — As derived quantities rather than observables, spectroscopic factors extracted from fits to data are model dependent. The main source of uncertainty is the choice of binding potential, but other factors such as adequate modeling of the reaction mechanism, the Perey effect, choice of distorting nuclear potentials etc. can also play a significant role. Recently, there has been some discussion of apparent discrepancies in spectroscopic factors derived from knockout reactions compared to those obtained from low-energy direct reactions. It should be possible to reconcile these discrepancies and we explore this prospect by attempting to describe the \(^{10}\)Be(d,t)\(^{11}\)Be data of Nucl. Phys. A157, 305 (1970) using the \(^{10}\)Be/\(^{11}\)Be form factors from a recent knockout study, Phys. Rev. Lett. 106, 162502 (2011). The influence of such factors as choice of distorting potentials and multi-step reactions paths will be explored.
9:18AM CB.00003 Study of the $^{19}$O($d,p$) reaction in inverse kinematics with HELIOS\textsuperscript{1}. C.R. HOFFMAN, M. ALCORTA, B.B. BACK, S.I. BAKER, P.F. BERTONE, J.A. CLARK, B. DIGIOVINE, B.P. KAY, R.C. PARDO, K.E. REHM, J.P. SCHIFFER, ANL, C.M. DEIBEL, ANL/JINA, S.T. MARLEY, J.C. LIGHTBULL, ANL/WMU, S. BEDOOR, D.V. SHETTY, A.H. WUOMSAA, WMU, S.J. FREEMAN, D.K. SHARP, J.S. THOMAS, U of Manchester, A. ROJAS, D. SANTIAGO-GONZALEZ, I. WIEDENHÖVER, FSU — The neutron single-particle components of states in $^{20}$O have been probed through the $(d,p)$ reaction in inverse kinematics. The experiment consisted of a 125 MeV radioactive $^{19}$O beam, produced by the ATLAS In-Flight facility at Argonne National Laboratory, impinging on a [$^{12}C_2D_2$]$_n$ target located inside the HELIcal Orbit Spectrometer (HELIOS). A Q-value resolution of ~150 KeV was achieved for states in $^{20}$O. Absolute cross sections and angular distributions have been determined for a number of levels in $^{20}$O up to 7 MeV in excitation energy. A strong candidate for the previously unobserved $\ell = 3$ value at 5.2 MeV has been identified. The extracted spectroscopic factors for $\ell = 2$ (presumably $\nu s_{1/2}$) and $\ell = 0$ ($\nu s_{1/2}$) transitions will be compared to those along the $Z = 8$ isotopic chain and to microscopic calculations.

\textsuperscript{1}Support from US DOE Contract No. DE-AC02-06CH11357 and No. DE-FG-2-04ER41320, NSF Grant No. PHY-0802264, and the UK STFC.

9:30AM CB.00004 The evaluation of a new method to extract spectroscopic factors using asymptotic normalization coefficients and the astrophysical $^{14}$C($n,\gamma$)$^{15}$C reaction rate. M. MCCLESKEY, A.M. MUKHAMEDZHANOV, I. TRACHE, A. BANU, V. GOLDBERG, B.T. ROEDER, E.N. SIMMONS, A. SPIRIDON, R.E. TRIBBLE, Texas A&M Cyclotron Institute — A new method to determine spectroscopic factors (SFs) that utilizes asymptotic normalization coefficients (ANCs) has been tested at Texas A&M, using $^{13}$C as a test case. The method would use the ANC to fix the external contribution to a non-peripheral reaction which would otherwise be free to vary to unphysical values in a traditional approach. The investigation consisted of two parts. First, the ANC for the $^{14}$C+n configuration in $^{15}$C was determined from the heavy ion neutron transfer reaction $^{13}$C($^{14}$C,$^{15}$C)$^{12}$C and the inverse kinematics reaction $d(^{14}$C,p)$^{15}$C. Both of these reactions were measured at sufficiently low energy to be peripheral. Next, a non-peripheral reaction $^{14}$C(d,p)$^{15}$C was measured with an incident deuteron energy of 60 MeV, and this reaction was used along with the previously determined ANC to attempt to find the SF. The ANC was also used to calculate the astrophysical neutron direct capture rate for $^{14}$C($n,\gamma$)$^{15}$C, which was compared with recent direct experimental results.

\textsuperscript{1}Present address: James Madison University

9:42AM CB.00005 One and two-neutron transfer reactions at REX-ISOLDE\textsuperscript{1}. KATHRIN WIMMER, NSCL - MSU, T-REX COLLABORATION — In this contribution we will report on one and two neutron transfer reaction experiments in inverse kinematics at the REX-ISOLDE facility (CERN). Light charged target-like reaction products were detected and identified by the T-REX particle detector [1] while coincident $\gamma$-rays were detected by the MINIBALL Germanium detector array. Recent results on (d,p) as well as (t,p) reactions with radioactive beams ranging from $^{11}$Be to $^{78}$Zn isotopes will be presented. The two-neutron transfer reactions involved for the first time the use of a radioactive tritium target in combination with a radioactive tritium ion beam [2].


\textsuperscript{1}Supported by BMBF 06MT238, 06DA9036I, EURONS (No. 506065), and the DFG cluster of excellence Universe.

9:54AM CB.00006 Measurement of the $^{26}$Al(d,p)$^{27}$Al Reaction to Constraining the $^{26}$Al(p,\gamma) Reaction Rate. STEVEN PAIN, ORNL, OERRUBA/RIBENS COLLABORATION — Detailed observations of the 1809-keV $\gamma$ ray from the beta decay of $^{26}$Al within the galaxy has provided an insight into ongoing nucleosynthesis. Understanding the abundance of $^{26}$Al requires knowledge of the production and destruction rates for $^{26}$Al. For temperatures where the ground-state and metastable state of $^{26}$Al are decoupled, the $^{26}$Al(p,$\gamma$)$^{27}$Si reaction, which is determined by states near the proton threshold in $^{27}$Si, contributes to the destruction rate. Though the strength of many of these resonances have been measured directly, the information there remain uncertainties for the lowest resonances, which are relevant for giant star temperatures. We have measured mirror states in $^{27}$Al within the galaxy has provided an insight into ongoing nucleosynthesis. Understanding the abundance of $^{26}$Al to inform the $^{27}$Al isotopic chain and to microscopic calculations. The energy and angles of light ions emitted from the reactions were measured in the SIDAR and OERRUBA silicon detector arrays. These data are compared with reaction calculations to extract spectroscopic factors. Comparison of analyses using DWBA and more sophisticated reaction theories will be presented as well as several new experimental tools useful for transfer reaction experiments.

\textsuperscript{1}This work was supported in part by the NSF and the U.S. Department of Energy under contract numbers DE-FG52-08NA28552 (Rutgers, ORAU), DE-AO05-00OR22725 (ORNL), DE-FG03-93-ER40789 (UTK), and DE-FG02-96ER40955 (TTU).

Thursday, October 27, 2011 8:30AM - 10:06AM –
Session CC Neutrinos I 101

8:30AM CC.00001 Inclusive neutrino cross section measurements at MINERvA. JASMINE RATCHFORD, University of Texas at Austin, MINERVA COLLABORATION — The MINERvA experiment is a precision neutrino experiment designed to improve our understanding of the neutrino-nucleus interaction. The experiment uses a fully active scintillation detector to allow full event reconstruction and includes passive targets helium, water, carbon, iron and lead. Preliminary measurements of inclusive cross section ratios of lead to iron will be shown.
8:42AM CC.00002 Quasi-Elastic Neutrino Cross Sections with MINERvA {sup 3}. JOE WALDING, William & Mary, MINERvA COLLABORATION — The MINERvA experiment will measure neutrino and antineutrino quasi-elastic scattering on helium, water, carbon, iron, and lead for neutrinos in the few GeV range. We will present preliminary results for quasi-elastic cross sections in the few GeV range on carbon.

{sup 3}Supported in part by the US NSF.

8:54AM CC.00003 Neutrino-nucleus coherent scattering as a probe of neutron density distributions, KELLY PATTON, North Carolina State University, JON ENGEL, University of North Carolina at Chapel Hill, GAIL MCLAUGHLIN, North Carolina State University — Neutrino-nucleus coherent elastic scattering provides a theoretically appealing way to measure the neutron part of the associated form factor. We show, using an expansion of the form factor into moments, that neutrinos from stopped muons can probe not only the second moment of the form factor (the neutron radius) but also the fourth moment. Using simple Monte Carlo techniques for Argon, Germanium, and Xenon detectors of 25 tones, 10 tones, and 3 tones, respectively, we show that the neutron radii could be found with an uncertainty of a few percent. If the luminosity of the neutrino flux is known independently, it is possible to discriminate between the predictions of various Skyrme models as well.

9:06AM CC.00004 SciNOvA: A measurement of neutrino-nucleus scattering in a narrow-band beam, REX TAYLOE, Indiana University — SciNOvA is a proposed project to deploy a fine-grained scintillator detector in front of the NOvA near detector to collect neutrino-nucleus scattering events in the NUMi, off-axis, narrow-band neutrino beam at Fermilab. This detector can make unique contributions to the measurement of charged- and neutral-current quasi-elastic scattering as well as neutral-current {pi}^0 and photon production. These processes are important to understand for fundamental physics and as backgrounds to measurements of electron neutrino appearance oscillations. The talk will present the strategy and science case of the SciNOvA experiment.

9:18AM CC.00005 Status of the SNO+ experiment, JAREK KASPAR, CENPA/University of Washington, SNO+ COLLABORATION — SNO+ is a large liquid scintillator detector following the successful SNO experiment with liquid scintillator replacing the heavy water. Located 2 km underground in Vale nickel mine in Sudbury, Canada, the experiment will detect solar neutrinos including the pep and CNO neutrinos, neutrinos from Earth, reactors, and supernovae. In addition, the experiment will search for neutrino-less double beta decay by adding 150-Nd to the scintillator. I will present the status of the experiment.

{sup 2}The research has been supported under DOE Grant #DE-FG02-97ER41020.

9:30AM CC.00006 Measurement of light yield dependence on electron energy for SNO+ scintillator, HOK SEUM WAN CHAN TSEUNG, University of Washington — SNO+ is a multi-purpose neutrino experiment whose reach extends to the following areas of neutrino physics: neutrinoless double beta decay (with Nd-loaded scintillator), geo-neutrinos, reactor and low-energy solar neutrinos, as well as supernova neutrinos. It is a ~780-tonne liquid scintillator detector currently under construction at the SNOLAB facility in Sudbury, Ontario, Canada. The scintillator to be used in SNO+ is linear alkybenzene (LAB) with ~2 g/L of PPO (2,5-diphenyloxazole). In this talk, we describe an experiment to test the linearity of the response of LAB-PPO with respect to electrons. We find that below ~0.4 MeV, the energy scale of LAB-PPO becomes non-linear. An explanation is given in terms of Cherenkov light absorption and re-emission by the scintillator.

{sup 3}This research has been supported under DOE Grant No. DE-FG02-97ER41020

9:42AM CC.00007 An Improved Apparatus for 2νββ and ECEC Studies to Excited Final States, SEAN FINCH, RAJARSHI RAUT, WERNER TORNOW, Duke University and TUNL — To extend our successful measurements of T_{1/2} for ^{100}\text{Mo} and ^{150}\text{Nd} to the first excited 0^+ state to other nuclei of interest requires an increase in the coincidence efficiency of our two HPGe detector setup, due to low amounts of isotopically enriched target material. Such measurements provide valuable test cases for 2νββ nuclear matrix element calculations, which in turn are used to tune 0νββ nuclear matrix element calculations. Instead of the two previously used 80 mm diameter and 50 mm long crystals sandwiching the target of interest, we now use two HPGe clover detectors. Clover detectors not only provide higher coincidence efficiency for back-to-back gamma rays due to their larger volume, but also allow detection of coincidences from the 0^+ \rightarrow 2^+ \rightarrow 0^+ decay sequence of the daughter nucleus within the four-fold segmented clover detectors themselves. We report results on our coincidence efficiency measurements for the two clover detectors in close geometry and present background spectra taken above ground at TUNL and below ground at the Kimballton Underground Research Facility (KURF). Finally, we will discuss first spectra taken with an isotopically enriched ^{96}\text{Zr} sample.

9:54AM CC.00008 Studies of energy losses in the lithiated layer of p-type point contact germanium detectors in the MAJORANA DEMONSTRATOR project, RYAN MARTIN, Lawrence Berkeley National Laboratory, MAJORANA DEMONSTRATOR COLLABORATION — P-type point contact (PPC) high purity germanium detectors are an emerging technology for neutrinoless double beta decay searches and direct dark matter detection. Understanding their properties is of critical importance for these experiments. This talk will start with a short overview of the PPC detectors in low radioactive background experiments, particularly in the context of the MAJORANA DEMONSTRATOR experiment. A special class of events that take place near the lithiated n+ contact of these detectors will then be discussed. It is shown that there is a partially dead layer near the n+ contact in which gamma-ray interactions can mimic low energy depositions in the crystal. Understanding this source of backgrounds has a direct impact on the sensitivity of these detectors at low energies.

{sup 1}Supported by the U.S. Department of Energy

Thursday, October 27, 2011 8:30AM - 10:06AM – Session CD Instrumentation | Heritage
8:30AM CD.00001 Ion Surfing: A new ion transport method for cryogenic gas catchers, simulations

AMANDA GEHRING, GEORG BOLLEN, MAXIME BRODEUR, DAVE MORRISSEY, NSCL/MSU, GREGORY PANG, LBNL — Gas cells are the tool of choice to thermalize fast rare ion beams produced at projectile fragmentation facilities. After passing through solid degraders, the residual kinetic energy of the ions is dissipated through collisions with the gas atoms and ionization. Previously, ions were directed through a gas cell along a descending electrostatic potential gradient called a “drag field.” Some cells apply a drag field over electrodes with alternating (RF) fields to prevent the rare ions from colliding with the walls. “Ion surfing” is a new method proposed by Bollen [1] which replaces the drag field with a traveling wave superimposed with RF on numerous, thin electrodes. Large potential differences are no longer required for transport over long distances, and the traveling wave can transport ions at a greater speed. This method is being tested for the new cryogenic linear gas cell of the National Superconducting Cyclotron Laboratory at Michigan State University. We will present the concept and simulation results.


*Work supported by the National Science Foundation and Department of Energy.

8:42AM CD.00002 Ion surfing: a new mode for cryogenic gas catchers, experimental results

MAXIME BRODEUR, GEORG BOLLEN, AMANDA GEHRING, DAVID MORRISSEY, GREGORY PANG, MSU/NSCL — A new mode of ion-transport and collection for low-energy precision experiments at projectile fragmentation facilities was recently proposed by Bollen [1]. Present beam thermalization methods use gas-filled linear chambers equipped with sets of electrodes that provide an electrostatic gradient and/or alternating electric fields to transport the ions towards an extraction orifice. A new cryogenic linear gas cell of the National Superconducting Cyclotron Laboratory at Michigan State University will transport ions using only electrodynamic RF fields imposed on a series of linear conductive stripes. Traditionally, the ions migrate along a descending electrostatic potential gradient applied on the individual stripes, called the drag field, which requires a large potential difference to be applied in the gas for transport over long distances. The new method to transport the ions, called “ion surfing,” replaces the drag field with a traveling wave. The new method can transport ions at greater speed while simplifying the overall system. We will present the results of recent measurements for the transport of 85-Rb ions over distances up to 40 cm with various gas pressures at room temperature.


8:54AM CD.00003 A miniature Penning trap for continuous magnetic field monitoring at the LEIBIT Penning trap mass spectrometry facility

MATTHEW REDSHAW, DAVID LINCOLN, RYAN RINGLE, STEFAN SCHWARZ, NSCL, GEORG BOLLEN, NSCL/FRIB — At the LEIBIT Penning trap mass spectrometry facility, the mass to charge ratio of an ion is determined by measuring its cyclotron frequency in a strong magnetic field using a time-of-flight technique, which typically requires at least 50 ions for a single frequency measurement. The magnetic field strength is calibrated by interleaving frequency measurements on the rare isotope with measurements on a stable reference ion. However, this takes up valuable beam time and does not account for non-linear drifts in the magnetic field. These effects become more significant for rare isotopes with low production rates, where a single frequency measurement can take several hours or more. As an alternative scheme for monitoring variations in the magnetic field, we are developing an additional, miniature Penning trap (MiniTrap) to be used as a magnetometer. This MiniTrap can be operated independently from, and simultaneous to, the rare isotope measurement. The cyclotron frequency of a small cloud of ions confined in the MiniTrap will be measured with a Fourier transform technique. In this talk I will present the results of developmental and design studies for MiniTrap, and give an update on the status of the project.

9:06AM CD.00004 Development of tracking detector for transfer reactions with light beams at NSCL

SERGEY ILYUSHKIN, FREDERIC SARAZIN, Colorado School of Mines, Golden, CO, DAN BARDAYAN, Oak Ridge Associated Universities, Oak Ridge, TN, JEFF BLACKMON, Louisiana State University, Baton Rouge, LA, JOEL CIZEWERSKI, Rutgers University, Piscataway, NJ, KATE JONES, University of Tennessee, Knoxville, TN, STEVEN PAINE, Oak Ridge Associated Universities, Oak Ridge, TN, THE CENTER OF EXCELLENCE FOR RADIOACTIVE ION BEAM STUDIES FOR STEWARDSHIP SCIENCE COLLABORATION — We report on the development of new beam tracking detectors to be used at NSCL. The new devices will address the current limitations on position resolution and open up the possibilities for transfer reaction experiments with light (Z<10) beams. The proposed design, likely based on a low pressure multiwire proportional chamber, and possible first experiments to take advantage of these detectors will be discussed.

This work is supported by the Center of Excellence for Radioactive Ion Beam Studies for Stewardship Science.

9:18AM CD.00005 Development of the APOLLO Array

AARON COUTURE, MATTHEW DEVLIN, HYE YOUNG LEE, JOHN O’DONNELL, Los Alamos National Laboratory — The role of neutron capture reactions is critical for nucleosynthesis processes far off of stability. Unfortunately, due to the radioactive nature the target isotopes of interest and the difficulty in producing a neutron target, these reactions will never be amenable to direct measurement. Further, for most astrophysical environments favored for the r-process, the required reaction networks are so large as to make direct experimental treatment of all of the reactions of interest beyond the range of what is feasible. Neutron transfer reactions, such as (d,p), combined with intense beams of radioactive ions can help to elucidate the nuclear physics at play. The HELIOS instrument at Argonne National Laboratory has been successfully used to study a range of reactions in inverse kinematics. To complement this effort, we are designing a scintillator array to be used in conjunction with HELIOS to measure gamma-decay properties following neutron transfer. The design characteristics and optimization of the array, including plans for light collection and readout under the almost 3 T field will be discussed.

1This work was supported by the Department of Energy under Contract No. DE-AC52-06NA25396.

9:30AM CD.00006 Digital acquisition system for superheavy experiments

DAVID MILLER, University of Tennessee, ROBERT GRZYWACZ, University of Tennessee and Oak Ridge National Laboratory, KRZYSZTOF MIERNIK, KRZYSZTOF RYKACZEWSKI, Oak Ridge National Laboratory, DIETER ACKERMANN, SOPHIA HEINZ, SIGURD HOFMANN, FRITZ HEIBBERGER, GSI — The half-lives in the region of Z ∼ 120 are expected to be in the range of several microseconds or shorter. Access to such short decays poses a challenge for traditional analog acquisition systems. A new digital acquisition system has been developed using Pixie digitizers to search for this fast radioactivity. The system was deployed at the decay station following the SHIP separator in parallel with its analog system to detect fast alpha decays following the implantation of fusion residues produced in the 248Cm+84Cr reaction. Its capabilities to detect sub-microsecond radioactivity and future possibilities will be presented.

This work was supported by the Office of Nuclear Physics, U.S. Department of Energy.
9:42AM CD.00007 Status of CHICO2. C.Y. WU, E. KWAN, A. CHYZH, LLNL, D. CLINE, A.B. HAYES, U. of Rochester, I.Y. LEE, LLNL — To fully exploit the potential of GRETINA, the development of auxiliary charged-particle detector arrays with matching position resolution is highly beneficial. CHICO2 is a part of this coordinated effort to improve the position resolution of CHICO for GRETINA by pixelation of the position sensing. Pixels are not readout individually instead interconnected in a checker-board pattern before being coupled to the delay line. The actual position is determined by the time difference between readouts from both ends of delay line. The proof-of-principle work on this technique has been demonstrated successfully in early 2010. Additional tests have been performed to measure the charge distribution for a given avalanche and the correlation between the pixel size and the time resolution, which helps to optimize the design of pixelation. A hybrid pixelation design was proposed to maximize the theta resolution and minimize the impact on the phi resolution. This design together with the results from those tests will be presented. This work is supported by DOE, LLNL Contract DE-AC52-07NA27344 and LLNL Contract DE-AC02-05CH11231 as well as the NSF.

9:54AM CD.00008 Characterization of a 1/2-scale prototype magnet at cryogenic temperatures for the SNS nEDM experiment1. ADRIAN PEREZ GALVAN, BRADLEY FILIPPONE, California Institute of Technology, NEDM COLLABORATION — The observation of a permanent electric dipole moment of the neutron at the current level of experimental sensitivity would indicate new physics beyond the Standard Model of particle interactions. In addition, it might also explain the mystery behind the matter-antimatter asymmetry of the Universe. Given these tantalizing implications, a new multi-institutional effort to measure the neutron electric dipole moment (nEDM) using ultra-cold neutrons and polarized 3He in a bath of superfluid 4He is currently underway at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory. The search for the nEDM asks for stringent requirements on the uniformity of the magnetic environment at cryogenic temperatures. We present measurements of the uniformity of a half-scale version of the coil that will be used for the experiment. The measurements are performed while the coil is at a temperature of ≈ 90 K. The results are in good agreement with previous room temperature measurements which suggest that magnetic non-uniformities due to thermal contraction are under control.

1Supported by NSF and DOE.

Thursday, October 27, 2011 8:30AM - 10:18AM –
Session CE Quark and Gluon Structure of the Nucleon at Large Momentum Fractions 103AB

8:30AM CE.00001 Structure of the free neutron1. SEBASTIAN KUHN, Old Dominion University — Information on the structure of the neutron is indispensable for a full understanding of the static properties, resonance excitations and quark distributions of the nucleon. From elastic form factors over resonance transition amplitudes to deep inelastic structure functions (both unpolarized and polarized), studying both partners of the proton-neutron isospin doublet is necessary to address such fundamental questions as the valence quark structure of the nucleon (in particular the ratio of d/u quark probabilities at large x), higher twist effects and the phenomenon of quark-hadron duality. Measurements on the neutron are hampered by the fact that neutron targets of sufficient densities exist only bound inside nuclei, with the deuteron, the triton and (polarized) 3He being the most often used "ersatz targets." The need to account for binding effects complicates the extraction of free neutron data from these experiments. Progress requires either a way to avoid model uncertainties (e.g., by focusing on kinematics where the PWIA spectator model works reasonably well for the struck nucleus) or a better understanding of these nuclear effects. In either case, one has to also deal with complications like final state interactions and other contributions. On the other hand, detailed studies of the reaction mechanism can yield important new information on the structure of few-body nuclei and the interplay of nuclear and quark degrees of freedom. In my talk, I will present some recent experimental results on neutron structure functions and some new approaches towards a better understanding of nuclear binding effects. I will concentrate on the large and varied program pursued at Jefferson Lab in this area, both from the present 6 GeV program and for the era after the 12 GeV upgrade.

1Research supported by a grant from the U.S. Dept. of Energy.

9:06AM CE.00002 Longitudinal structure of the proton and neutron1. M. ERIC CHRISTY, Hampton University — Lepton scattering has been utilized for more than four decades to study the substructure of protons and neutrons, both free and bound in nuclei. The F2 structure function extracted from such experiments has now been determined over many orders of magnitude in both Bjorken x and the 4-momentum transfer squared, Q2, and such data have been an invaluable tool for the testing and study of Quantum Chromodynamics (QCD) in the perturbative regime. In addition, new precision data on F2 from Jefferson Lab in the region of nuclear resonances has opened up many new studies of the transition from perturbative to non-perturbative QCD. This includes the nature of quark-hadron (Q-H) duality, in which the resonances seem to average to a smooth scaling curve, similar to the that of deep inelastic scattering. In contrast, the longitudinal structure function, FL, has been measured with much poorer precision and over a much more limited kinematic range. This is due to both the high precision required and the need for measurements at fixed x and Q2 with multiple beam energies for the separation of longitudinal and transverse structure. Such measurements are critical for a full picture of nucleon structure. For instance, in deep inelastic scattering F1L is directly sensitive to the gluon content of the nucleon, unlike F2, which is only sensitive through pQCD evolution. We will present the current experimental status of F1L for both free protons and from nucleons in nuclei and discuss some of the physics which can be addressed with such measurements. In particular, studies of Q-H duality and the determination of the structure function moments will be discussed.

1This work is supported in part by research grant 0655308 from the National Science Foundation.

9:42AM CE.00003 Impact of low-energy data on global fits of PDFs. JOSEPH OWENS, Florida State University — Traditional global fits for parton distribution functions (PDFs) use cuts on Q and W in deeply inelastic lepton-nucleon scattering (DIS) to eliminate regions where target mass corrections and higher twist contributions are important. Such cuts typically limit the coverage in x to x < 0.7, which is also the range covered by most high energy DIS experiments. In order to constrain the PDFs at larger values of x, one can relax the cuts imposed on Q and W and make use of lower energy data. This necessitates treating the target mass corrections and higher twist contributions in the fits. Furthermore, the separation of the u and d PDFs requires the use of nuclear targets - typically deuterium - which requires the inclusion of corrections for nuclear effects. This is particularly important in the large-x region. In this talk I will review some recent efforts to include low-energy data in global fits and discuss the resulting PDFs.

Thursday, October 27, 2011 8:30AM - 10:18AM –
Session CF Nuclear Structure I 104AB
8:30AM CF.00001 Determining Neutron-Induced Fission Cross Sections of Picoscound States
R.J. CAPSHER, J.T. BURKE, I.J. THOMPSON, F.S. DIETRICH, J.E. ESCHER, J.J. RESSLER, N.D. SCIHELZO, E. SWANBERG, W. YOUNES, Lawrence Livermore National Laboratory — The first excited state neutron-induced fission cross section of $^{239}\text{Pu}$ is not directly measurable, due to the short lifetime of the $7.86 \text{ keV} 3/2^+$ excited state. We use recent developments in transfer reaction theory to identify the angular momentum distribution of excited states in the pre-fission nucleus $^{239}\text{Pu}^*$. This nucleus will be produced in a (d,p) reaction on $^{239}\text{Pu}$, and the fission probability as a function of outgoing proton angle and energy will be measured. By combining this measurement with (d,p) reaction theory, the fission probability of individual angular momenta can be determined, and recombined into the excited state fission probability. First experimental results will be presented. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

8:42AM CF.00002 Lifetime and proton component of the $2^+_1$ state in $^{16}\text{C}$, MARINA PETRI, Lawrence Berkeley National Laboratory, KÖLN/NSL PLUNGER (NSL EXPERIMENT E07023) COLLABORATION — The lifetime of the $2^+_1$ state in $^{16}\text{C}$ was measured using the Recoil Distance Method with fast radioactive beams at the National Superconducting Cyclotron Laboratory. The lifetime of $11.4 \pm 0.3$ ps, corresponding to a $\beta(2E2; 2^+_1 \rightarrow 0^+_g) = 4.21 \pm 0.11$ e fm$^4$, is in good agreement with previous values [1]. Excited states in $^{16}\text{C}$ were populated via the $^{9}\text{Be}(^{17}\text{N},^{16}\text{C}^*(\gamma,\gamma')X$ one-proton knockout reaction. The one-proton knockout cross section is used to extract the proton component of the $^{16}\text{C} 2^+_1$ state. Gamma branching ratios between excited states were also determined. The $\beta(2E2)$ and branching ratios will be compared with p-d shell model and core shell model (with NN and NN+NNN) calculations.


8:54AM CF.00003 B(E2) Transition Strengths of Neutron-rich Carbon Isotopes in a Seniority Scheme1, A.O. MACCHIAVELLI, M. PETRI, P. FALLON, R.M. CLARK, M. CROMAZ, I-Y. LEE, S. PASCHALIS, Lawrence Berkeley National Laboratory - Berkeley, CA 94720 — Lifetime measurements of $^{16,18,20}\text{C}$ isotopes using the DSAM technique have been recently carried out at NSCL [1,2]. The new data provide unique information about the structure of the Carbon isotopes. In this work we attempt to interpret the derived B(E2) transitions strengths in terms of a seniority inspired scheme. The analysis shows an important role played by proton excitations due to an effective reduction of the p$^3$ to p$^1/2$ spin-orbit splitting. The predicted behavior of spectroscopic factors for proton removal and magnetic moments can be tested experimentally.


1Supported by U.S. DOE under contract DE-AC02-05CH1231.

9:06AM CF.00004 Studies of transitional Gadolinium nuclei by particle-gamma coincidence techniques, T.J. ROSS, R.O. HUGHES, C.W. BEAUSANG, University of Richmond, J.M. ALLMONT, J.T. BURKE, J.E. ESCHER, L.W. PHAIR, N. SCIHELZO, C.T. ANGELL, M.S. BASUNIA, D.L. BLEUEL, R.J. RESSLER, J.M. MONSON, S. PASCHALIS, M. PETRI, J.J. RESSLER, STARS-LIBERACE Collaboration — Nuclei in the N=90 transitional region have been the focus of intense study for a number of years. In spite of this, recent particle-gamma coincidence studies of $^{155}\text{Gd}$ revealed inconsistencies in the present single particle assignments [1]. Expanding on these findings, an experiment was performed using the STARS-LIBERACE array at the 88-Inch Cyclotron in Lawrence Berkeley National Laboratory. A 25 MeV proton beam incident on $^{154}\text{Gd}$ and $^{158}\text{Gd}$ targets was used to populate states in $^{152,153,156,157}\text{Gd}$ via (p,d) and (p,t) reactions. The silicon telescope STARS provided particle identification, residual nucleus energy and angular information. Coincident gamma rays were detected using the LIBERACE clover array. Details of new states identified in $^{155}\text{Gd}$ and $^{157}\text{Gd}$ will be presented as well as a method of extracting the spin distribution imparted to the nucleus via transfer reactions. [1] J.M. Allmond et. al. Phys. Rev. C 81 064316 (2010).

This work supported in part by U.S. DOE grant numbers DE-FG02-05ER41379 & DE-FG52-06NA26206(University of Richmond), DE-AC52 07NA27344(LLNL) and DE-AC02 05CH11231(LBNL).

9:18AM CF.00005 Particle-$\gamma$ Spectroscopy of $^{13}\text{C}(^{134}\text{Te},^{12}\text{C})^{135}\text{Te}$ and $^{9}\text{Be}(^{134}\text{Te},^{8}\text{Be})^{135}\text{Te}$: One-Neutron Transfer Study of $Z=52$, $N=83$ and the $1/2^+_1$ State1, J.M. ALLMONT, D.C. RADFORD, C. BAKTAS, J.R. BEENE, A. GALINDO-URIBARRI, P.A. HAUSLADEN, J.F. LIANG, J. PAVAN, D. SHAPIRA, R.L. VARNER, C.-H. YU, C.R. BINGHAM, M. DANCHEV, J.P. URREGO-BLASCO, L. CHATURVEDI, D. FONG, J.K. HWANG, W. KROLAS, ORNL — A HPGe and CsI array (CLARION+HYBALL @ HRIBF) is used to study the $^{13}\text{C}(^{134}\text{Te},^{12}\text{C})^{135}\text{Te}$ and $^{9}\text{Be}(^{134}\text{Te},^{8}\text{Be})^{135}\text{Te}$ direct reactions by particle-$\gamma$ coincidence measurements. The particle-$\gamma$ technique has several advantages (particularly in inverse kinematics) which include the following: can determine decay paths by particle-$\gamma$-$\gamma$, can determine high-precision level energies, can determine multipolarities of transitions by particle-$\gamma$ angular correlations, and can infer cross sections. The use of one-neutron transfer into Z=52, N=83 is employed to gain selectivity to the single-particle neutron states outside of the N=82 shell closure. Results are presented for $^{135}\text{Te}(Z=52,N=83)$ particularly, results are presented for the new $1/2^+_1$ single-particle state at 2107 keV.

1Research sponsored by the Office of Nuclear Physics, U.S. Department of Energy.

9:30AM CF.00006 Particle-Gamma Coincidence Studies of Uranium Nuclei, R.O. HUGHES, T.J. ROSS, C.W. BEAUSANG, University of Richmond, J.T. BURKE, I.J. THOMPSON, M.S. BASUNIA, C.M. CAMPBELL, R.J. CAPSHER, H.L. CRAWFORD, J.M. MONSON, L. PHAIR, J.J. RESSLER, STARS-LIBERACE Collaboration — The STARS-LIBERACE array at the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory is proving to be an extremely versatile device for probing nuclear structure via (charged) particle-$\gamma$ coincidence spectroscopy. The technique enables the properties of low- and medium-spin states up to and beyond the neutron separation energy to be probed and give rare insights into the high-level density nuclear continuum well above the pair gap. Recently, $^{234}\text{U}$, $^{235}\text{U}$, $^{236}\text{U}$ and $^{237}\text{U}$ were studied via (p,d) and (p,t) reactions on $^{236}\text{U}$ and $^{238}\text{U}$ targets. The exit channel and excitation energy of the residual nucleus are selected by measuring the outgoing charged particle using the STARS silicon telescope array, while coincident gamma rays are detected with the LIBERACE clover array. The subsequent particle spectra show the ensemble of states that were directly populated by the reaction while $\gamma$-$\gamma$ coincidences reveal the decay path from a given level. Results from our recent experiment will be presented. This work was supported by DoE Grant Numbers: DE-FG52-06NA26206 and DE-FG02-05ER41379.
9:42AM CF.00007 Testing the theoretical predictions and affirming chiral behavior in the A \sim 130 region: Chirality in $^{135}$Ce$^1$. A.D. AYANGEAKAA, U. GARG, S. FRAUENDORF, J.T. MATTA, B.K. NAYAK, University of Notre Dame. S.S. GHUGRE, UGC-DAE Consortium for Science Research, Kolkata, India. M.R. CARPENTER, C. CHIARA, C. HOFFMAN, R.V.F. JANSSENS, F. KONDEV, T. LAURITSEN, C. NAIR, D. SEWERYNIK, A. TORKEN, I. STEFANESCU, S. ZHU, Physics Division, Argonne National Laboratory. 60439 — Microscopic calculations based on the three dimensional Tilted Axis Cranking (TAC) model have predicted the existence of a chiral partner band to the $\pi(h_{11/2}/g_{7/2}) \otimes \nu(h_{11/2})$ band in $^{133}$Ce. To test this prediction, high spin states in $^{133}$Ce were populated with the $^{116}$Cd($^{22}$Ne, $^5n$)$^{133}$Ce fusion evaporation reaction at a beam energy of 112MeV using GAMMASPHERE. A $\Delta I = 1$ candidate chiral-band partner built on the $\pi(h_{11/2}/g_{7/2}) \otimes \nu(h_{11/2})$ configuration has been observed. Details of chiral assignment to this pair of bands will be presented.

This work is supported in part by NSF (Grant No. PHY07-58100) and DOE (Contract Nos. DE-FG02-95ER40939 and DE-AC02-06CH11357)

9:54AM CF.00008 2-gamma decay of the 662-keV isomer in $^{137}$Ba$^1$, D.J. MILLENER, R.J. SUTTER, D.E. ALBURGER, Brookhaven National Laboratory — 2-gamma decay of the 662-keV $^{137}$Ba isomer following $^{137}$Cs beta decay has been observed using two 3"x3" NaI detectors, a 20.5-\mu Ci source, and a Pb shielding geometry designed to minimize direct and sequential Compton scattering backgrounds. In runs totaling 144 days, a 662-keV peak has been observed in the profile across the diagonal connecting 662-keV axis points in a 2-dimensional coincidence pulse-height spectrum. A preliminary value of 2.0(6) $\times 10^{-6}$ is derived for the 2-gamma/1-gamma intensity ratio. The distribution of 662-keV events along the 2D diagonal is a continuum centered at 331-331 keV with a shape favoring a double quadrupole E2-M2 or M2-E2 decay sequence. Our result compares with upper limits of $<10^{-5}$, our assessment of the Beusch experiment [1], and $<2.2 \times 10^{-6}$ by Basenko et al. [2]. It will be compared with theoretical estimates.


1Work supported by U.S. D.O.E. contract DE-AC02-98-CH10886

10:06AM CF.00009 Commissioning of GRETINA tracking array, testing of delayed coincidence, AARON SHARPE, University of Richmond, C.W. BEAUSANG, University of Richmond, J.Y. LEE, Lawrence Berkeley National Laboratory, GRETINA COLLABORATION — GRETINA is new a gamma-ray tracking array currently being commissioned at LBNN. When complete, GRETINA will consist of seven quad-modules. Each quad-module in turn consists of four large volume 36 fold segmented Ge crystals. The segmentation of the crystals, together with digital pulse processing techniques allows the position of individual gamma-ray interactions in the detector to be determined. As part of the commissioning process, a series of engineering runs was carried out in the spring at LBNN to check various aspects of the detector performance under "battle conditions." One of these runs involved testing delayed coincidence capability by the measurement of the lifetimes of several high-K isomers in Hafnium-176. Medium/high-spin states in 176Hf were populated following the 176Yb($\alpha$,4$n$) reaction at a beam energy of 41 MeV. Data was taken over a two day period using a variety of trigger conditions. Data analysis is ongoing and initially focused on the 1559 keV and 1333 keV isomers. Preliminary results, which are in agreement with the previously accepted lifetimes, will be presented. This work was partly supported by the US Department of Energy under contract number DE- AC02-05CH11231 and grant numbers DE-FG52-06 NA26206 and DE-FG02-05 ER41379.

Thursday, October 27, 2011 8:30AM - 10:18AM – Session CG Mini-Symposium on Weak Interactions in Astrophysics 105AB

8:30AM CG.00001 Measurement of Gamow-Teller transitions from $^{56}$Ni$^1$, MASAKI SASANO, NSCL, Michigan State University — Electron-capture (EC) and $\beta$-decay play important roles in type-II and type-Ia supernovae. They occur through the Gamow-Teller (GT) and Fermi transitions in nuclei, which are extensively studied to reliably estimate the weak-interactions rates. Experimentally, a powerful probe to study GT transitions has been provided by the charge-exchange reactions at intermediate energies such as the (p,n), (He,t) reactions. They can selectively excite the GT transitions in a wide excitation energy region. Until recently, such studies have been restricted to stable nuclei because of difficulties in inverse-kinematics measurements with rare isotope beams. In this talk, we will present the first study with a rare isotope using the $^{56}$Ni(p,n)$^{56}$Cu reaction at 110 MeV/u in inverse kinematics with a newly developed Low-Energy Neutron Detector Array (LENDA) in combination with the $^{580}$S00 spectrometer. $^{56}$Ni is produced in large abundances during the pre-explosion phase of core-collapse supernovae and considered to be one of the most important contributors to the change in the electron-to-baryon ratio in core-collapse supernovae. In addition, we will discuss how the GT transition in $^{56}$Ni serves as a stringent test of the effects of the N=Z=28 core not being inert on GT transitions for a large number of nearby nuclei in the Fe region.

1This work is supported by the US NSF (PHY-0822648 (JINA) and PHY-0606007).

9:06AM CG.00002 A Long, Cold, Early $r$-process? $\nu$-induced Nucleosynthesis in He Shells Revisited, PROJWAL BANERJEE, School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455, WICK HAXTON, Department of Physics, University of California, and Lawrence Berkeley National Laboratory, Berkeley, CA 94720, YONG-ZHONG QIAN, School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455 — We reexamine a $\nu$-driven $r$-process mechanism in the He core of a core-collapse supernova with low initial metallicity. We use the hydrodynamic code KEPLER to calculate the nucleosynthesis both before and after the passage of shock, in recent pre-supernova models. We find that for an inverted neutrino mass hierarchy, $A \sim 130$ and $195$ abundance peaks can be produced over $\sim 20-50$ s for initial metallicities $\leq 10^{-3}$ the solar value. The mechanism is sensitive to the amount of $^{28}$Si and $^{32}$S present in the He shell in the pre-supernova model, as well as on the $\nu$ emission model and oscillations. We discuss the implications of this early $r$-process which could alter interpretations of abundance data from metal-poor stars.

9:18AM CG.00003 Evidence for an Inverted Neutrino Mass Hierarchy from the T2K $\theta_{13}$ Result and $\nu$-Process Nucleosynthesis Models 1, GRANT MATHews, University of Notre Dame, TOSHIpaka KAJINO, WAKO AOKI, NAOJ, WATaru FUJIYA, Univ. Tokyo — The synthesis of $^{11}$B and $^{7}$Li via neutrino-induced nucleon emission (the $\nu$-process) is sensitive to the neutrino mass hierarchy if the $^{11}$B and $^{7}$Li mixing angle is large enough. This arises because, when there is significant 13 mixing, the average electron neutrino energy for the charged-current neutrino reactions is larger for a normal mass hierarchy than for an inverted hierarchy. This mixing occurs in the carbon shell and hence affects the nucleosynthesis of $^{11}$B and $^{7}$Li in the helium shell of core-collapse supernovae. Recent constraints on $\theta_{13}$ from the T2K collaboration indicates that indeed $\theta_{13}$ is large enough to induce substantial mixing. Moreover, there is also recent recent evidence from SIC X grains in meteorites for the existence of $\nu$-process $^{11}$B and $^{7}$Li encapsulated in some grains. We show here that these two new results hint at a marginal ($1\sigma$) preference for an inverted neutrino mass hierarchy. The analysis of more X grains enriched in Li and B could substantially improve this limit.

1Work at the University of Notre Dame is supported by the U.S. Department of Energy under Nuclear Theory Grant DE-FG02-95-ER40934.

The Thursday, October 27, 2011 8:30AM - 10:18AM – Session CG Mini-Symposium on Weak Interactions in Astrophysics 105AB
9:30AM CG.00004 Probing the origins of $^{19}$F with the $^{19}$F (t, $^3$He) $^{19}$O charge exchange reaction$^1$. AMANDA PRINKE, R.G.T. ZEGERS, SAM M. AUSTIN, D. BAZIN, J.M. DEAVIN, R. MEHARCHAND, K. MEIERBACHTOL, G. PERDIKAKIS, M. SASANO, L.L. VALDEZ, NSCL/MSU, A. COLE, Kalamazoo College, Y. FUJITA, M. NAGASHIMA, Osaka University, C.J. GUESS, UMass Lowell, G.W. HITT, KUSTAR, UAE, Y. SHIMBARA, Niigata University — Nuclear charge-exchange experiments are frequently used to extract Gamow-Teller strengths relevant to astrophysics. This talk will discuss one such recent measurement of the Gamow-Teller strength via the $^{19}$F (t, $^3$He) $^{19}$O* reaction at 115 MeV/u. The experiment was performed at the National Superconducting Cyclotron Laboratory using a secondary triton beam, and the $^3$He ejectiles were momentum-analyzed in the S800 magnetic spectrometer. The extracted Gamow-Teller strength distribution from this experiment can be directly related to $^{19}$O* beta decay to $^{19}$F. This weak interaction rate may contribute to the astrophysical abundance of $^{19}$F. Additionally, the experimental results will be compared to shell-model calculations in the sd-shell.

$^1$This work was supported by the US NSF (PHY-0822648 and PHY-0606007).

9:42AM CG.00005 Computational Resources for Including Nuclear Physics in Astrophysical Simulations, EVAN O’CONNOR, CHRISTIAN D. OTT, TAPIR, Caltech — Simulations of core-collapse supernovae have long included detailed nuclear physics such as finite-temperature equations of state (EOS) and neutrino interactions. Computational simulations of relativistic astrophysical systems such as Black Hole (BH) - Neutron Star (NS) binaries and NS-NS binaries are also beginning to include these nuclear physics inputs. We present a set of open-source, computational tools to aid in the incorporation of nuclear physics into simulations. At stellarcollapse.org, we provide EOS tables and the associated drivers needed to quickly, smoothly, and efficiently integrate all publicly available finite-temperature EOS tables into astrophysical simulations. We also have recently begun compiling, and present here, an open-source library of neutrino interactions relevant for computational simulations of relativistic astrophysical systems. The ultimate goal of NuLib is to provide a computationally efficient and complete resource of neutrino interactions for physics benchmarking and code validation. NuLib will also provide a venue for nuclear theorists to make available to the computational community new or improved neutrino interactions.

9:54AM CG.00006 Nuclear reactions in the crust of an accreting neutron star, KIT YU LAU, A.V. AFANASIEV, M. BEARD, E. BROWN, L.R. GASQUES, S. GUPTA, W.R. HIX, K.L. KRATZ, P. MOLLER, H. SCHATZ, A. STEINER, M. WIESCHER, D.G. YAKOVLEV — Recently there have been many advances in understanding of accreting neutron stars in x-ray binaries. Many of the observed phenomena such as superbursts or the cooling of quasi-persistent transients during their quiescent state are affected by the thermal properties and the composition of the crust. To model the nuclear energy release and crust compositions, we run a consistent nuclear reaction network that follows the evolution of an accreted fluid element from the atmosphere down to the inner crust, where free neutrons exist in beta-equilibrium. We take into account a majority of the most important nuclear processes including electron capture, neutron capture, neutron emissions, $\beta$ decay, and pycnonuclear fusion reactions. Our calculations show that pycnonuclear fusion reactions can occur at a shallower depth than previously thought, depending on the nuclear mass model used.

10:06AM CG.00007 Determining Electron-capture Rates of pf-shell Nuclei in Explosive Stellar Environments$^1$. A.L. COLE, A.C. DOMBOS, Physics Department, Kalamazoo College, R.G.T. ZEGERS, SAM M. AUSTIN, B.A. BROWN, L. VALDEZ, NSCL, JINA, Department of Physics and Astronomy, Michigan State University. S. GUPTA, Indian Institute of Technology Ropar, G.W. HITT, Khalifa University of Science, Technology & Research — The electron-capture rates on pf-shell nuclei are required to model the evolution of core-collapse and thermonuclear supernovae. The majority of these rates are determined from calculated Gamow-Teller strength (B(GT)) distributions, as it's not feasible to measure the B(GT) distributions for all pf-shell nuclei. We present preliminary results of a systematic comparison between the electron-capture rates of 13 pf-shell nuclei determined from experimental B(GT) distribution measurements and the electron-capture rates of nuclei determined only from calculated B(GT) distributions, as measurements do not exist. The B(GT) distribution calculations were performed with the shell model using two different interaction Hamiltonians.

$^1$This work is supported in part by NSF grants PHY-0822648, PHY-0606007, PHY-0758099 and by an award from Research Corporation for Science Advancement.

Thursday, October 27, 2011 10:30AM - 12:30PM
Session DA Ultrarelativistic Heavy Ions I 62

10:30AM DA.00001 Chiral and deconfinement transition in QCD, PETER PETRECZKY, BNL, HOTQCD COLLABORATION — I present results on the chiral and deconfinement aspects of the QCD transition at finite temperature. Calculations have been performed using the highly improved staggered quark (HISQ) action with lattices of temporal extent $N_t = 6, 8$ and 12, which allow one to control the approach to the continuum limit. While this action is superior to all previous improved staggered quark actions, it has been demonstrated that in the continuum limit the previously used asqtad action gives consistent results. For the chiral transition temperature we find $T_c = 157 \pm 6$ MeV.

10:42AM DA.00002 Hadron Production and Freeze-Out Dynamics in $\sqrt{s_{NN}}$ Au+Au at RHIC, SAMANTHA BROVKO, University of California, Davis, STAR COLLABORATION — The Beam Energy Scan (BES) program at RHIC was commissioned to search for the critical point and the turn-on of QGP signatures. STAR has collected data from collisions of $Au + Au$ at energies from 7.7 to 62.4 GeV per nucleon. In addition of a full-coverage Time-Of-Flight detector, STAR has extended the momentum range for clean particle identification. The freeze-out parameters can be extracted from the measured hadron spectra. In this talk, we will present STAR preliminary results of particle spectra from $\sqrt{s_{NN}} = 19.6$ GeV $Au + Au$ collisions. Distributions of $\pi, K, p$ and $\bar{p}$ as a function of $m_T - m_0$ will be used to discuss the chemical and kinetic freeze-out properties. In addition, we will compare these results with earlier BES data from STAR.

10:54AM DA.00003 The shapes of the multiplicity distributions in $\sqrt{s_{NN}}=7.7$–200 GeV Au+Au Collisions at STAR$^1$. DANIEL MCDONALD, Rice University. STAR COLLABORATION — A possible signature of the existence of a critical point in the phase diagram of nuclear matter is the non-monotonic behavior of the shape of the multiplicity distributions of particles reflecting the conserved quantities of baryon number, charge, or strangeness. These shapes are characterized with respect to Gaussian distributions via the variance and higher statistical moments, which may reflect the critical fluctuations that may diverge at beam energies near the critical point. The STAR experiment has measured Au+Au collisions at a wide range of beam energies, $\sqrt{s_{NN}}=7.7$–200 GeV, and is well suited for numerous measurements because of its wide, uniform acceptance and the extended particle identification from a newly-installed Time-of-Flight (TOF) system. The measurements of the shapes of the multiplicity distributions of net protons, net kaons, and net charge - via the statistical moments skewness, kurtosis, and the intensive normalized cumulants of Ref. [1] - will be described.


With support from DE-FG02-10ER41666 and the Texas Space Grant Consortium.
11:06AM DA.00004 Strange Baryons Production in RHIC Beam Energy Scan. FENG ZHAO, UCLA, STAR COLLABORATION — Strange baryon production is sensitive to the dynamics of deconfined quark-gluon matter created in heavy ion collisions. We have been investigating the strangeness enhancement and strangeness equilibration as a function of beam energy at RHIC. We have analyzed strange baryon production from Au+Au collision data at 7.7 GeV, 11.5 GeV and 39 GeV that STAR has collected during the RHIC beam energy scan in 2010. In this presentation, the $p_T$ spectra of $Λ$, $Ξ^−$, $Ω^−$ and their antiparticles will be reported. The strangeness enhancement and nuclear modification factor of strange baryons at these energies will also be discussed.

11:18AM DA.00005 Dynamical $K/\pi$, $p/\pi$, and $K/p$ Fluctuations in $\sqrt{s_{\text{NN}}} = 7.7$-200 GeV Au+Au Collisions. TERENCE TARNOWSKY, Michigan State University, STAR COLLABORATION — Dynamical fluctuations in global conserved quantities such as baryon number, strangeness, or charge may be observed near a QCD critical point. Results from new measurements of dynamical $K/\pi$, $p/\pi$, and $K/p$ ratio fluctuations are presented. The commencing of a QCD critical point search at RHIC has extended the reach of possible measurements of dynamical $K/\pi$, $p/\pi$, and $K/p$ ratio fluctuations from Au+Au collisions to lower energies. The STAR experiment has performed a comprehensive study of the energy dependence of these dynamical fluctuations in Au+Au collisions at the energies $\sqrt{s_{\text{NN}}} = 7.7$, 11.5, 39, 62.4, and 200 GeV. New results are compared to previous measurements and to theoretical predictions from several models. The measured dynamical $K/\pi$ fluctuations are found to be independent of collision energy, while dynamical $p/\pi$ and $K/p$ fluctuations have a negative value that increases toward zero at top RHIC energy.

11:30AM DA.00006 Energy dependence of the freeze out eccentricity from azimuthally-dependent HBT analyses at STAR. CHRISTOPHER ANSON, Ohio State University, STAR COLLABORATION — Non-central heavy ion collisions at RHIC create an anisotropic participant zone of QCD matter under extreme conditions of energy and matter density. While this zone is initially out-of-plane-extended, pressure gradients cause the hot, dense medium to expand preferentially in plane. Over time, this expansion makes the shape more spherical, perhaps even becoming extended in the in-plane direction. The change in shape is determined by the expansion and freeze-out time scales which depend, in part, on the early pressure gradients. As a result, the freeze-out shape may provide a sensitive probe of the Equation of State of hot QCD matter.

The recent RHIC Beam Energy Scan, which covered energies from $\sqrt{s_{\text{NN}}} = 7.7$ to 39 GeV provides an opportunity to explore the energy dependence of the freeze out eccentricity. The new low energy data from STAR complements high statistics data sets at $\sqrt{s_{\text{NN}}} = 62.4$ and 200 GeV. The dependence of the HBT radius parameters on azimuthal angle relative to the reaction plane has been extracted. These dependences can be related to the freeze out eccentricity within the context of a blast wave model. We will present STAR’s most recent results from azimuthally-dependent HBT analyses across a wide range of energies.

11:42AM DA.00007 Pion-kaon femtoscopy in 200 GeV collisions in STAR at RHIC. YAN YANG, IOPP/HIT and OSU, STAR COLLABORATION — Correlations between non-identical particles at low relative momentum in the center of mass encode unique information on the space-time structure of the emitting system [1,2], in particular a space-time offset of one particle species (e.g. kaons) with respect to another (e.g. pions). We present new high-statistics measurements of pion-kaon correlations in 200 GeV in the spherical harmonic representation [3,4]. The analysis benefits greatly from the extended particle-identification capabilities of the recently installed STAR Time of Flight detector. In $\sqrt{s_{\text{NN}}} = 200$ GeV Au+Au collisions, we observe an asymmetry similar to that reported at lower energies with poorer statistics. Finally, we present a first similar analysis of $\sqrt{s} = 200$ GeV $p+p$ collisions.

11:54AM DA.00008 Transverse Energy at RHIC in the Forward/Backward Direction using the PHENIX MPC. BRETT FADEM, Muhlenberg College, PHENIX COLLABORATION — Transverse energy has been used to estimate energy density in ultra-relativistic heavy ion collisions and to discriminate between competing models of hadronic interactions. Furthermore, fluctuations in transverse energy might signal the presence of a critical point in the phase diagram of nuclear matter. The PHENIX Muon Piston Calorimeter (MPC) has acceptance in the range $3.1 < \eta < 3.8$. Status of the measurement of transverse energy using the PHENIX MPC at RHIC will be reported.

12:06PM DA.00009 Forward Di-Hadron Correlations and RdA in d+Au Collisions at RHIC. IHNJE A CHOI, University of Illinois at Urbana-Champaign — Measurements using the PHENIX forward detectors in high energy deuteron-gold collisions make it possible to study cold nuclear matter effects in nucleon structure. The high proton densities in nuclei at low-x lead to gluon fusion causing saturation of the gluon distribution and thus suppression of hadron production cross section. This saturation has been described as the formation of the Color Glass Condensate (CGC). A conclusive measurement discriminating between different mechanisms may yet to be carried out. CGC calculations predict significant suppression of conditional yields for rapidity separated hadron pairs with one of the hadrons at forward rapidity. Two new forward electromagnetic calorimeters (Muon Piston Calorimeters, $-3.1 < \eta < -3.7, 3.1 < \eta < 3.9$) allow the PHENIX experiment to further study forward di-hadron correlations and RdA which have been predicted to show dramatic effects due to gluon saturation. Azimuthal correlations of di-hadron pairs at different pseudorapidities and RdA of $p/\pi$, and $K/p$ will be shown. The forward pseudorapidity correlations are especially interesting because it is expected that they provide a test of gluon saturation down to $x < 10^{-3}$ in the Au nucleus. The analysis presented is based on the high integrated luminosity data sample of d+Au collisions at $\sqrt{s_{\text{NN}}} = 200$ GeV taken at RHIC in 2008.

12:18PM DA.00010 Recent Performance of the Resistive Plate Chambers in the PHENIX Forward Trigger Upgrade. MICHAEL DAUGHERITY, Abilene Christian University, PHENIX COLLABORATION — The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory is the world’s only polarized proton-proton collider. The recent $\sqrt{s} = 500$ GeV collisions enable a new W-boson physics program. Since W production is very sensitive to the spin-dependent quark distributions, these measurements will provide new insight into the spin structure of the proton. The PHENIX detector has undergone an extensive upgrade to significantly improve triggering on high-momentum muons produced by W decay at forward rapidity. The upgrade consists of new front-end electronics for the existing muon tracking chambers as well as new resistive plate chambers (RPCs) at two stations in each muon arm. This talk will review the current status and performance of the RPCs in the forward trigger upgrade from recently completed RHIC run 11.

1 Supported by US DOE Grant DE-FG03-94ER40860.

Thursday, October 27, 2011 10:30AM - 12:30PM Session DB Mini-Symposium on Experimental Advances in Transfer Reactions II Auditorium
null
12:06PM DB.00007 Single-neutron levels near the N=82 shell gap. B. MANNING, J.A. CIZEWSKI, S. HARDY, M.E. HOWARD, P.D. O’MALLEY. Rutgers University, S.H. AHN, K.Y. CHAE, K.L. JONES, S.T. PITTMAN, University of Tennessee. D.W. BARDAYAN, C.D. NESARAJA, S.D. PAIN, M.S. SMITH, Oak Ridge National Laboratory, R.L. KOZUB, Tennessee Technological University, K.A. CHIPPS, Colorado School of Mines, W.A. PETERS, Oak Ridge Associated Universities, M. MATOS, Louisiana State University — Nuclei with a few nucleons above and below shell closures are of particular importance to informing the evolution of single-particle structure, which is critical to the benchmarking of nuclear models. Due to increasingly intense beams of radioactive nuclei, studies around the doubly-magic 132Sn shell closure are now possible. While the single-neutron states in tin nuclei in immediate proximity to the N=82 shell gap have recently been verified to be highly pure, fragmentation of the single-neutron strengths in the tellurium isotopes has been observed. The nature of this fragmentation provides a stringent test of shell model effective interactions. In order to study the fragmentation in nuclei close to the N=82 shell gap, a series of (d,p) measurements is being undertaken at the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory, utilizing the superOHRUBA silicon detector array. Motivation, experimental details and preliminary data will be presented. Work supported in part by U.S. Department of Energy and National Science Foundation.

12:18PM DB.00008 Measured and coupled reaction channels analysis of one and two proton transfer reactions for 28Si+,90,94Zr systems. SUNIL KALKAL, S. MANDAL, A. JHINGAN, J. GEHLOT, P. SUGATHAN, K.S. GOLDA, N. MADHAVAN, RITIKA GARG, SAVI GOYAL, GAYATRI MOHANTO, S. VERMA, ROHIT SANDAL, BIVASH BEHERA, G. ELEONORA, H.J. WOLLERSHEIM, R. SINGH — Measurements of angular distributions for one and two proton stripping reactions for 28Si+,90,94Zr systems were performed at lab energy 120 MeV with 90,94Zr beam at Inter University Accelerator Center, New Delhi. Theoretical calculations performed using the quantum mechanical coupled reaction channels code FRESCO (including various intermediate states involving target and projectile excitations before and/or after transfer along with sequential transfer) were able to reproduce one and two proton transfer angular distributions for both the systems reasonably well. It was found that the DWBA calculations could describe the one proton transfer data well for both the systems but failed to reproduce the angular distributions for two proton transfer channels. The present measurements underline the importance of sequential transfer at energies much above the Coulomb barrier. We had also performed transfer reaction measurements for these systems in the sub- and near barrier region using recoil mass separator.

Thursday, October 27, 2011 10:30AM - 12:18PM — Session DC Nuclear Reactions/Rare Isotope Beams

10:30AM DC.00001 Search for Heavy and Superheavy systems in 197Au + 232Th Collisions near the Coulomb Barrier. KRIS HAGEL, MARINA BARBUI, JOSEPH NATOWITZ, MARCIA RODRIGUES, KASIA SCHMIDT, ROY WADA, ZBIG MAJKA, HUA ZHENG, Cyclotron Institute Texas A&M University — The possibility to produce very heavy elements in the reaction 197Au + 232Th at 7.5 MeV/nucleon has been investigated using the BigSol spectrometer at Texas A&M. This experiment indicated the possibility to produce heavy elements of Z about 100, however a combination of the observation is only possible by detecting the high energy alpha particles decayed by the decaying heavy nuclei. In facts very heavy nuclei are expected to decay to stable nuclei through alpha particle chains with energy around or above 10 MeV. A new experiment was performed to search for high energy alpha emission. The heavy reaction products in the angular range from 3° to 45° are implanted in a catcher foil. The particles emitted by the decaying implanted nuclei are detected using ∆E-E telescopes in the backward position. The 7.5 AMeV 197Au beam from the K500 cyclotron at Texas A&M was pulsed at different intervals in order to be able to identify species of different half-life. The events were recorded both in beam-on and beam-off conditions. The preliminary results will be shown.

10:42AM DC.00002 Isospin Dependence of Nucleon Exchange in 78,86Kr + 40,48Ca Reactions at E/A = 10 MeV. ERIC HENRY, WOLF-UDO SCHRODER, JAN TOKE, MICHAEL QUINLAN, HARDEV SINGH, University of Rochester, ISODEC COLLABORATION — Preliminary results are presented of theoretical simulation calculations and experimental data obtained in the ISODEC experiment performed with the CHIMERA multi-detector array at LNS/Catania. One of the main objectives of this experiment was to study the isospin dependence of the flow of energy, mass and charge in damped nuclear reactions involving systems of different initial isospin asymmetries. With a bombarding energy of E/A = 10 MeV the reaction systems approach the limits of an adiabatic nuclear response associated with a separation of relaxation time scales of macroscopic and microscopic degrees of freedom. However, non-equilibrium effects are expected to be still relatively weak, such that the effects of the driving forces underlying isospin relaxation are not masked by pre-equilibrium nuclear disintegration processes.

10:54AM DC.00003 Measurement of emitted tritons and 3Helium from 112,124Sn+112,124Sn collisions at Ebeam=50 MeV/ nucleon and 120 MeV/nucleon1. M. YOUNGS, NSCL/MSU, D.D.S. COUPLAND, W.G. LYNCH, M.B. TSANG, Z. CHAJECKI, R. HODGES, M. KILBURN, FEI LU, J. NOVAK, A. SANETULLAEV, J. WINKELBAUER, NSCL / MSU, JENNY LEE, RIKEN, M.A. FAMIANO, B. GIACHERIO, Western Michigan University, T.K. GHOSH, Variable Energy Cyclotron Centre, P. RUSSOTTO, G. VERDE, C. SFIENTI, INFN — The nuclear symmetry energy affects many aspects of nuclear structure, nuclear astrophysics, and nuclear reactions. The spectral ratio of neutrons to protons from central heavy ion collisions is sensitive to the symmetry energy below saturation density, but previous measurements of the ratio have large uncertainties. In addition, transport model calculations of the ratio using the IBUU04 and ImQMD/05 codes differ greatly, perhaps due to the effective mass splitting in the nuclear medium. A recent experiment at NSCL/MSU measured neutrons and protons emitted from central collisions of 112,124Sn + 112,124Sn at Ebeam = 50 MeV/nucleon to probe the symmetry energy, and at Ebeam = 120 MeV/nucleon to probe the mass splitting. First results will be presented and compared to transport model calculations.

1This work is supported by the National Science Foundation under Grant PHY-0606007.

11:06AM DC.00004 Measurement of emitted neutrons and protons from 112,124Sn + 112,124Sn at Ebeam = 50 MeV/nucleon and 120 MeV/nucleon1. D.D.S. COUPLAND, M. YOUNGS, W.G. LYNCH, M.B. TSANG, Z. CHAJECKI, R. HODGES, M. KILBURN, FEI LU, J. NOVAK, A. SANETULLAEV, J. WINKELBAUER, NSCL / MSU, JENNY LEE, RIKEN, M.A. FAMIANO, B. GIACHERIO, Western Michigan University, T.K. GHOSH, Variable Energy Cyclotron Centre, P. RUSSOTTO, G. VERDE, INFN, C. SFIENTI, GSI — The nuclear symmetry energy affects many aspects of nuclear structure, nuclear astrophysics, and nuclear reactions. The spectral ratio of neutrons to protons from central heavy ion collisions is sensitive to the symmetry energy below saturation density, but previous measurements of the ratio have large uncertainties. In addition, transport model calculations of the ratio using the IBUU04 and ImQMD/05 codes differ greatly, perhaps due to the effective mass splitting in the nuclear medium. A recent experiment at NSCL/MSU measured neutrons and protons emitted from central collisions of 112,124Sn + 112,124Sn at Ebeam = 50 MeV/nucleon to probe the symmetry energy, and at Ebeam = 120 MeV/nucleon to probe the mass splitting. First results will be presented and compared to transport model calculations.

1This work is supported by the National Science Foundation under Grant PHY-0606007.
11:18AM DC.00005 Isospin Observables from Fragment Energy Spectra1. RACHEL HODGES, T.X. LIU, W.G. LYNCH, M.B. TSANG, X.D. LIU, W.P. TAN, M.I. VAN GOETHEM, G. VERDE, A. WAGNER, H.F. XI, H.S. XU, NSCL/MSU, M. FAMIANO, WMI, R.T. DE SOUZA, V.E. VIOLA, IU, R.J. CHARITY, L.G. SOBOTKA, WU — The energy spectra of light charged particles and intermediate mass fragments from 112Sn, 114Sn and 124Sn+ collisions at an incident energy of E/A=50 MeV have been measured with a large array of Silicon strip detectors. We used charged particle multiplicity detected in a near 4pi array to select data from the central collision region. We study isospin observables analogous to ratios of neutron and proton spectra, including double ratios and yield ratios of t/3He and of asymmetries constructed from fragment yields with Z=3-8. Using the energy spectra, we can construct these observables as functions of kinetic energy and observe a large difference in the fragment yields if fragment contributing to sequential decays are included.

1This work has been supported by the U.S. National Science Foundation under Grants PHY 060007 and the Department of Energy under grant numbers DE-FG02-87ER-40316 (WU) and DE-FG02-88ER-40404 (IU).

11:30AM DC.00006 Isotopic trends in dynamical breakup, SYLVIE HUDAN, ROMUALDO DE SOUZA, Indiana University, ALAN MCINTOSH, Texas A&M University — The simultaneous measurement of neutrons and charged particles produced in peripheral and mid-kinetic energy in a heavy-ion cross-bombardment reaction 124,136Xe + 112,124Sn at E/A = 50 MeV is described. Dynamical decay in which the excited projectile-like fragment (PLF) decays on the timescale of its rotation is observed. Specifically, the dependence of the decay timescale on the charge-asymmetry of the binary split of the PLF is extracted. In addition, the correlation between the composition of the lighter fragment, the size of the lighter fragment, the velocity damping and the decay orientation is examined.

11:42AM DC.00007 Precision Measurement of Isospin Diffusion, JACK WINKELBAUER, National Superconducting Cyclotron Laboratory, R. HODGES, M.B. TSANG, W.G. LYNCH, Z. CHAJECKI, D. COUPLAND, M. YOUNGS, F. LU, A. SANETULLAEV, R. SHANE, S. TANGWANCHAROEN, M. FAMIANO, S. GEORGE, T. GHOSH, J. DUNN, S. DYE, S. NIELSEN, A. RAMOS, R. CHARITY, L. SOBOTKA, J. ELSON, T. RANA, M. EL HOUSSENY — In heavy-ion collisions, the tendency for isospin to drift from a neutron (proton) rich region to a neutron (proton) deficient region is sensitive to the density dependence of the symmetry energy. Until recently, most of the isospin diffusion results have been obtained with mid central to central collisions and different isospin observables have been used in experiment and in model simulations. To provide more accurate understanding of the dependence of isospin diffusion on impact parameter and different isospin observables, we have measured isotopic fragment and residue yields for 112,114,124Sn+ collisions measured using the Large Area Silicon Strip Array (LASSA) and heavy residue yields emitted at the forward angles were measured using the S800 Spectrograph. Impact parameter was selected using the MSU Miniball-WU Miniball phoswich array. Preliminary results will be presented. Work supported by the National Science Foundation under Grant PHY-060007.

11:54AM DC.00008 Probing the dynamics of heavy ion collisions via two-particle correlations1. Z. CHAJECKI, V. HENZL, M. KILBURN, D. HENZLOVA, W.G. LYNCH, D. BROWN, D. COUPLAND, P. DANIELIEWICZ, NSCL/MSU, C. HERLITZIUS, NSCL/MSU, A. ROGERS, A. SANETULLAEV, J. LEE, B. TSANG, A. VANDE MOLLEN, M. WALLACE, M. YOUNGS, Y. SUN, NSCL/MSU, G. VERDE, INFN, Catania, Italy. Z.S. HUDAN, Indiana University, M. FAMIANO, Western Michigan University, R. DESOUZA, Indiana University, A. CHBIHI, Gani, S. LUKYANOV, JINR, L. SOBOTKA, Washington University — The angular and rapidity dependence of proton-proton correlations functions is studied in central 40Ca+40Ca and 48Ca+48Ca nuclear reactions at E=80 MeV/c. Measurements were performed with the HIRA detector complemented by the 4π Array at NSCL. A striking angular dependence is found within the lifetime of the system which reflects the different space-time extent of the selected sources. Sources measured at backward angles reflect the participant zone of the reaction, while much larger sources observed at forward angles reflect the expanding, fragmenting and evaporating projectile remnants. The estimate of the time scales of the fragmentation process is presented. The results are compared to the theoretical calculations from BUU transport model. This comparison emphasizes the importance of including the light clusters in the simulations to reproduce the experimental results.

1NSF Grant: PHY-060007; V. Henzl and D. Henzlova currently at LANL; A. Rogers currently at ANL.

12:06PM DC.00009 Towards quantum transport for central collisions of nuclei and of clouds of ultracold quantum gases1. BRENT BARKER, National Superconducting Cyclotron Laboratory, Michigan State University, ARNAU RIOS, University of Surrey, PAWEL DANIELIEWICZ, National Superconducting Cyclotron Laboratory, Michigan State University — Efforts are on the way to develop a practical non-equilibrium Green’s function approach to central nuclear reactions. A truncation of the far off-diagonal elements of the spatial density matrix is implemented, resulting in speedup without affecting the evolution of the system close to the diagonal. The technique is applied to a simulation of collisions between quasi-1D Bose-Einstein condensates, using a modified Gross-Pitaevskii equation that allows inclusion of some transverse degrees of freedom in a one dimensional environment.

1This work was supported in part by US National Science Foundation Grant No. PHY-0800026.

Thursday, October 27, 2011 10:30AM - 12:06PM — Session DD Instrumentation II Heritage

10:30AM DD.00001 Performance Characteristics of the Next Generation Solid-State Photomultipliers. ERIK BJORN JOHNSON, CHRISTOPHER Stapels, XIAO JIE CHEN, CHAD WHITNEY, Radiation Monitoring Devices, MARK HAMMIG, University of Michigan, JOE CAMPBELL, University of Virginia, JAMES CHRISTIAN, Radiation Monitoring Devices — A typical method for detection of radiation consists of using a scintillation material with a photomultiplier tube (PMT), which continues to provide excellent performance in comparison to the solid-state photomultiplier (SSPM). The SSPM has a number of features that makes it a viable alternative, as in being insensitive to magnetic fields, robust, compact, and requiring low voltages for operation, but the major limiting factor associated with a direct replacement for the PMT with SSPMs is the dark current. We will demonstrate a potential, low-cost solution for an upgrade to the PRIMEX experiment at Jefferson Laboratories. We will discuss the characteristics of SSPMs fabricated with commercial and non-commercial CMOS processes. Where the commercial process is reliable but limited in design features, the non-commercial process, which allows for greater control of the design, may have challenges with process control without a dedicated foundry. Fabricated designs show an increase in the ratio of detected photons to dark counts by a factor of 10, and the work will discuss the performance characteristics of the next-generation of solid-state photomultiplier in the context of nuclear and high-energy physics experiments.
10:42AM DD.00002 Timing Resolution tests of Silicon Photomultipliers for use at the Jefferson Lab

A. R. REUSTLE, Georgia Institute of Technology, V. BATURIN, Thomas Jefferson National Accelerator Laboratory, CLAS 12 COLLABORATION — Silicon Photomultipliers are currently under much scrutiny at the Jefferson Lab. Their small size and ability to operate unshielded in strong magnetic fields make them ideal for use in particle accelerators. At the Jefferson Lab these SiPMs are slated for possible use in several detector systems in the new 12GeV upgrade. One such project is the Central Time of Flight (CTOF) detector in CLAS Hall B, whose goal is to identify and distinguish between particle species using Timing and Momentum calculations. The Photomultipliers in this detector will experience magnetic fields of up to 5 T and require timing resolutions of 50ps, the smallest of any detector in the lab. Currently this role is filled by Hamamatsu R2083 PMTs, which require robust magnetic shielding. Resolution tests were performed with direct LED light at various frequencies and intensities. The SiPMs were found to have a resolution of 76ps at usable surface areas, 50% greater than the required maximum of 50ps for CTOF, but well below that necessary for other detector systems, such as the Central Neutron Detector and Photon Tagger arrays.

3Acknowledgments: This work was supported in part by the U.S. Department of Energy under Grant DE-FG02-99ER41110

10:54AM DD.00003 The NIFFTE Data Acquisition System

HAI QU, Abilene Christian University, NIFFTE COLLABORATION — The Neutron Induced Fission Fragment Tracking Experiment (NIFFTE) will employ a novel, high granularity, pressurized Time Projection Chamber to measure fission cross-sections of the major actinides to high precision over a wide incident neutron energy range. These results will improve nuclear data accuracy and benefit the fuel cycle in the future. The NIFFTE data acquisition system (DAQ) has been designed and implemented on the prototype TPC. Lessons learned from engineering runs have been incorporated into some design changes that are being implemented before the next run cycle. A fully instrumented sextant of EtherDAQ cards (16 sectors, 496 channels) will be used for the next run cycle. The Maximum Integrated Data Acquisition System (MIDAS) has been chosen and customized to configure and run the experiment. It also meets the requirement for remote control and monitoring of the system. The integration of the MIDAS online database with the persistent PostgreSQL database has been implemented for experiment usage. The detailed design and current status of the DAQ system will be presented.

11:06AM DD.00004 Implementation of Environmental Monitors for NIFFTE and SeaQuest Experiments

DONALD ISENHOWER, Abilene Christian University, NIFFTE COLLABORATION, SEAQUEST COLLABORATION — The implementation of environmental monitors for the LANSCE NIFFTE and Fermilab SeaQuest experiments will be discussed. The emphasis will be on the use of a single, low cost, general purpose instrument, as opposed to a system of specialized, multiple subsystems. The implementation uses a Keithley™ 2701 Multimeter/Data Acquisition System with a Keithley™ 7710 solid state multiplexer. The system will be set up to work with MIDAS or CODA as the DAQ interface. It can have multiple types of sensors hooked up, as each channel is independent and can measure any parameter ordinarily associated with a DMM. The inputs can be a mixed composition of thermocouples, thermistors, LVDTs, pressure, humidity, and other sensors. The Keithley™ 2701 is easily controlled via the “Standard Commands for Programmable Instrumentation” (SCPI) Ethernet interface in a Linux environment. The different ways in which such a system can be configured as part of the LANSCE NIFFTE and Fermilab SeaQuest slow control systems will be demonstrated.

3Funding for this work was provided in part by the U.S. Department of Energy Office of Science.

11:18AM DD.00005 Analysis Techniques for the Neutron Induced Fission Fragment Tracking Experiment (NIFFTE)

R. BAKER, Cal Poly San Luis Obispo, NIFFTE COLLABORATION — The NIFFTE experiment has developed and tested a Time Projection Chamber (TPC) for the study of neutron induced fission events. The TPC is designed to measure fission cross sections with better than 1% precision. The TPC creates a three dimensional pixelated image of the charge deposited as the fission fragments pass through the gas volume. The analysis of this data requires robust algorithms for reconstructing the tracks of the charged particles and identifying each particle track as either a proton (from n-p scatter), alpha (decays in target) or a fission fragment. This talk will provide a comprehensive overview of the reconstruction and analysis techniques that have been developed for NIFFTE with a discussion of preliminary results from engineering studies.

11:30AM DD.00006 Progress on Data Collection and Analysis with the NIFFTE TPC

LUCAS N. SNYDER, Colorado School of Mines, NIFFTE COLLABORATION — The Neutron Induced Fission Fragment Tracking Experiment (NIFFTE) collaboration has constructed and tested a Time Projection Chamber (TPC) designed to measure fission cross sections to a higher accuracy than has been achieved previously. In this talk I will describe the status of the fission TPC and progress on measuring the alpha decay to spontaneous fission branching ratio of Cf-252.

11:42AM DD.00007 SAMURAI-TPC: A Time Projection Chamber for Constraining the Asymmetry Energy at High Density

A. B. MCINTOSH, N. MAASS, S. J. YENELLO, Texas A&M University Cyclotron Institute, J. BARNEY, Z. CHAJECI, C. F. CHAN, J. W. DUNN, J. ESTEE, J. GILBERT, F. LU, W. G. LYNCH, R. SHANE, M. B. TSANG, NSCL, Michigan State University, M. FAMIANO, Western Michigan University, T. ISOBE, H. SAKURAI, A. TAKETANI, RIKEN, Japan, T. MURAKAMI, Kyoto University, SAMURAI-TPC COLLABORATION — The SAMURAI-TPC is a time projection chamber designed to measure pions and light charged particles. By measuring pion yield ratios and particle flow in heavy ion collisions around E=200A MeV, we expect to constrain the behavior of the nuclear asymmetry energy around twice saturation density. In this talk, the design and construction of the TPC components will be discussed. Upon completion, the SAMURAI-TPC will be installed in the SAMURAI spectrometer at the Radioactive Isotope Beam Facility at RIKEN, Japan. This work is supported by the Department of Energy (DE-SC0004835).

11:54AM DD.00008 SAMURAI-TPC: Field Cage Design and Prototyping

F. LU, J. BARNEY, Z. CHAJECI, C. F. CHAN, J. W. DUNN, J. ESTEE, J. GILBERT, W. G. LYNCH, R. SHANE, M. B. TSANG, NSCL, Michigan State University, A. B. MCINTOSH, S. J. YENELLO, Texas A&M University Cyclotron Institute, M. FAMIANO, Western Michigan University, T. ISOBE, H. SAKURAI, A. TAKETANI, RIKEN, Japan, T. MURAKAMI, Kyoto University, SAMURAI-TPC COLLABORATION — The SAMURAI-TPC is a time projection chamber to be used in conjunction with the SAMURAI spectrometer being built at the Radioactive Isotope Beam Facility at RIKEN, Japan. It will be used to measure charged pions, protons and light ions. The p+-p- ratios from heavy-ion collisions should provide constraints on the asymmetry term in the nuclear equation of state at densities about twice saturation density. In this talk, the design and operation of the field cage, an essential part of the detector, will be discussed, along with the results of prototype testing.

This work is supported by the Department of Energy under Grant DE-SC0004835.

Thursday, October 27, 2011 10:30AM - 12:18PM
Session DE New Results in Fundamental Symmetries 103AB
10:30AM DE.00001 New Results from the emiT Experiment: A Search for Time Reversal Invariance Violation in Neuron Decay1, PIETER MUMM, National Institute of Standards and Technology — The existence of charge-parity (CP) symmetry violation is necessary to explain the preponderance of matter over antimatter in the universe. Thus far, the observed CP violation can be entirely accounted for by a phase in the Cabibbo-Kobayashi- Maskawa matrix, however this phase is insufficient to account for the known baryon asymmetry in the context of Big Bang cosmology and there is good reason to search for CP and the related time-reversal violation in other systems. The emiT experiment tests time reversal symmetry in the β-decay of polarized free neutrons by searching for the T-odd, P-even triple correlation $D\delta_n \times p_x \times p_y$, where $\delta$ and $p$ are the neutron spin and decay product momenta, respectively. The detection of this correlation above the small calculable effect from final state interactions would be a direct indication of time reversal symmetry violation. The $D$ coefficient is the most sensitive probe of the phase, $\delta_{AV}$, between the axial-vector (A) and vector (V) currents and is sensitive to scalar and tensor interactions that could arise due to beyond-Standard-Model physics. A 14-month run in 2002-2003 produced a sample of over 300 million proton- electron coincidence events. A blind analysis and extensive study of systematic effects has recently been completed with the result $D = (-0.96 \pm 1.89\text{(stat)} \pm 1.01\text{(sys)}) \times 10^{-4}$, representing the most sensitive test of time- reversal invariance in beta decay. Within the Standard Model, the result can be interpreted as a measure of the phase $\delta_{AV} = (180.013 \pm 0.228)^{\circ}$.

1This work was supported by the National Institute of Standards and Technology, the US DOE Office of Nuclear Physics, and the NSF Division of Physics.

11:06AM DE.00002 Search for the lepton-flavour violating decay Mu -→ e + gamma – Latest results from the MEG Experiment, PETER-RAYMOND KETTLE, Paul Scherrer Institute PSI — The first search for the lepton-flavour violating (LFV) decay Mu -→ e + gamma, using cosmic rays, dates back some sixty years now. This, together with the diversity of such experiments that have followed, shows that the search for “New Physics” is not restricted to the high-energy frontier of TeV-scale accelerators but that the high-intensity, precision frontier can complement it. The MEG experiment at PSI is a LFV search experiment aiming at a sensitivity of $\mathcal{O}(10^{-11})$ for the decay Mu -→ e + gamma. By using one of the world’s most intense surface muon beams, together with a liquid xenon detector of 900 litres and a gradient-field superconducting positron spectrometer, the two-body decay can be distinguished from the normal Michel and radiative muon decay processes. To resolve the dominant background process of accidental overlapping events, a detector with excellent spatial, temporal and energy resolution is required. The current status of the experiment as well as the latest results will be presented.

11:42AM DE.00003 Prospects for measuring CP violation in the Neutrino Sector, STEPHEN PARKE, Fermi National Accelerator Laboratory — Recent indications that electron neutrino flavor content of the third neutrino mass eigenstate is large ($\theta_{13}$ large) provides the possibility that measuring CP violation in the Neutrino Sector is much easier than expected even a few months ago. I will review our understanding of the Neutrino Sector and how CP violation is a natural consequence of three flavor mixing, and how the next generation of Long Baseline experiments have the real possibility of observing CP violation as well as determination of the mass ordering of the neutrinos. I will also review why we are interested in such CP violation and its consequences for Leptogenesis which may be the answer to the matter antimatter asymmetry observed in the current Universe.

Thursday, October 27, 2011 10:30AM - 12:18PM — Session DF Nuclear Structure II 104AB

10:30AM DF.00001 Seniority, collectivity, and $B(E2)$ enhancement in $^{72}$Ni1, C.J. CHIARA, I. STEFANESCU, U. of Maryland/ANL, W.B. WALTERS, N. SHARP, U. of Maryland, M. ALCORTA, M.P. CARPENTER, G. GÜRDAL, C.R. HOFFMAN, R.V.F. JANSENS, B.P. KAY, F.G. KONDEV, T. LAURITSEN, C.J. LISTER, I. MCCUTCHAN, A.M. ROGERS, D. SEWERYNIAK, S. ZHU, ANL, B. FORNAL, W. KRÓLAS, T. PAWLAT, J. WRZESIŃSKI, Krakow — Gamma rays assigned to $^{72}$Ni have been identified with Gammasphere in deep-inelastic reactions involving a 450-MeV $^{76}$Ge beam and a 1198$^{\text{th}}$Pt target. Using a combination of spectra produced by double gates on the known 454-, 843-, and 1095-keV members of the ground-state cascade, a coincident line at 199 keV has been identified and is tentatively assigned as the $8^+ \rightarrow 6^+$ transition. These $\gamma$-ray coincidences were observed only in prompt events, indicating an $8^+$ half-life below 20 ns and requiring a large $B(E2)$ enhancement compared to that expected from a seniority scheme. This value is consistent with models showing decay to a seniority $\nu=4$, 6$^+$ level that is depressed by the same two-body interaction responsible for the rather low 1095-keV $2^+_1$ energy, as compared to the valence-symmetry counterpart $^{94}$Ruo.

1Supported by the DoE, Office of Nuclear Physics, under Grant No. DE-FG02-94ER40834 and Contract No. DE-AC02-06CH11357, and the Polish Ministry of Science under Contract No. NN2010333.

10:42AM DF.00002 Collectivity of Exotic Silicon Isotopes, A. RATKIEWICZ, A. GADE, T. GLASMACHER, D. WEISSHAAR, G. GRINIER, D. BAZIN, T. BAUGHER, S. BARTHELEMY, B.A. BROWN, C. CAMPBELL, S. MCDANIEL, K. MEIERBACHTOL, R. MEHARCHAND, A. SIGNORACCI, A. Spyrou, P. Stroberg, P. Voss, R. WINKLER, NSCL, P. COTTLE, K. KEMPER, FSU, D. MILLER, UTK, A. GALINDO-URIBARRI, ORNL, T. OTSUKA, RIKEN, Y. UTSONO, JAXA, E. PADILLA-RODAL, ICNM — The determination of the electric quadrupole transition strength between the ground state and first excited state with spin-parity of $J^p=2^+$ (the $B(E2; 0^+ \rightarrow 2^+)$ value) in an even-even nucleus provides a measurement of the low-lying quadrupole collectivity. The $B(E2)$ values for $^{44,46,48,50,52}$Si were measured via intermediate-energy Coulomb excitation at NSCL. The secondary beams were produced by fragmentation of $^{48}$Ca primary beam and guided onto a high-Z target. De-excitation gamma rays indicating the inelastic process were detected around the target position with the high efficiency scintillator array CAESAR-2. The fast, the scattered projectiles traveled on an event-by-event basis in the S800 spectograph. The results comprise the first measurements of the quadrupole collectivity of $^{40,42}$Si and probe the persistence of the $N=28$ magic number. The measured $B(E2)$ values are compared to large-scale shell model calculations and provide insight into the evolution of shell structure and deformation in this region.

10:54AM DF.00003 Collectivity in neutron-rich Mn isotopes, S.N. LIDDICK, S. SUCHYTA, N. LARSON, B. ABROMET, M. BOLLA, (NSCL/MSU), A. AYRES, A. BEY, C. BINGHAM, L. CARTEGNI, M. MADURGA, M. MILLER, M. RAJABALI, R. GRZYWACZ, S. PAULUSKA, S. PADGETT, (UT), H.L. CRAWFORD, (LLBL), I.G. DARBY, (K.U. Leuven), K. RYKACZEWSKI, (ORNL), S. ILYUSHKIN, (Miss S.U.) — The rapid development of collectivity in the N = 40 region as protons are removed from the $T_z=1/2$ single-particle state is suggested by the dramatic drop in energy of the first excited $2^+$ state from $^{60}$Ni to $^{60}$Fe and the increase in B (E2) along the Fe isotopic chain. Recent large-scale shell model calculations which include the $g_{9/2}$ and $d_{5/2}$ single-particle states have attributed the increased collectivity in the Cr and Fe nuclei to the influence of multi- particle neutron excitations across N = 40. While a variety of experiments have focused on even-even nuclei, including Cr and Fe, very little is known about the odd-Z isotopes. To explore the influence of the intruder neutron $g_{9/2}$ and $d_{5/2}$ states, the beta decays of the Cr isotopes into the respective Mn nuclei were studied at the NSCL. Preliminary low-energy level structures for the Mn isotones will be presented.
In parallel to the RDDS measurement, the attenuation coefficients of the angular distributions were measured. The time dependence of these coefficients was scattered Mg ions. Nuclear deorientation effects, due to hyperfine interactions, become increasingly important at the high charge states of the recoiling ions.

2.94 for the Wright Nuclear Structure Laboratory, RAPHAEL CHEVRIER, University of Caen Basse-Normandie, WNSL NUCLEAR STRUCTURE TEAM — The lifetime Recoil Distance Doppler Shift method demonstrated in this nucleus. To rigorously test these predictions, a Coulomb excitation experiment was performed at the ATLAS facility at Argonne. Using a example of the O(6) symmetry of the Interacting Boson Model (IBM). Surprisingly, some of the unique IBM predictions for the O(6) limit have yet to be fully
1. J.M. COOK, D.-C. DINCA, T. GLASMACHER, W.F. MUELLER, A. RATKIEWICZ, D. WEISSHAAR, S. MCDANIEL, G. GRINYER, K. WALSH, NSCL, R.V.F. JANSSSENS, M.P. CARPENTER, F.G. KONDEV, S. ZHU, I. STEFANESCU, E. RICARD-MCUCKETHAN, ANL, S. FREEMAN, A. DEACON, J.F. SMITH, B. KAY, D. SHARP, Manchester — The reduced quadrupole transition probability, \( B(E2) \), provides a way to quantify low-lying collectivity in even-even nuclei. \( B(E2) \) values for \( ^{58,60,62}\text{Cr} \) were extracted using intermediate-energy Coulomb excitation at the NSCL. Cocktail beams containing \( ^{58,60,62}\text{Cr} \) were produced in flight and guided onto a high-Z target. De-excitation gamma-rays tagging the inelastic process were detected in coincidence with the scattered particles using the high-purity germanium array SeGA and the S800 spectrograph. The measurement allowed the \( B(E2) \) values of \( ^{60,62}\text{Cr} \) to be extracted for the first time. Results are compared to large-scale shell-model calculations using a recent effective interaction developed for this region.

1This work was funded by the NSF under contract PHY-0606007; by the US DOE, ONP, under contracts DE- AC02-06CH11357 and DE-FG02-08ER41556 and by the UK Science and Technology Facilities Council (STFC).

11:06AM DF.00004 Collectivity of Cr Isotopes Approaching \( N = 40 \). T. BAUGHER, A. GADE, D. BAZIN, J.M. DOOK, D.C. DINA, T. GLASMACHER, W.F. MUELLER, A. RATKIEWICZ, D. WEISSHAAR, S. MCDANIEL, G. GRINYER, K. WALSH, NSCL, R.V.F. JANSSSENS, M.P. CARPENTER, F.G. KONDEV, S. ZHU, I. STEFANESCU, E. RICARD-MCUCKETHAN, ANL, S. FREEMAN, A. DEACON, J.F. SMITH, B. KAY, D. SHARP, Manchester — The reduced quadrupole transition probability, \( B(E2;0^+ \rightarrow 2^+) \), provides a way to quantify low-lying collectivity in even-even nuclei. \( B(E2) \) values for \(^{58,60,62}\text{Cr} \) were extracted using intermediate-energy Coulomb excitation at the NSCL. Cocktail beams containing \(^{58,60,62}\text{Cr} \) were produced in flight and guided onto a high-Z target. De-excitation gamma-rays tagging the inelastic process were detected in coincidence with the scattered particles using the high-purity germanium array SeGA and the S800 spectrograph. The measurement allowed the \( B(E2) \) values of \(^{60,62}\text{Cr} \) to be extracted for the first time. Results are compared to large-scale shell-model calculations using a recent effective interaction developed for this region.

11:18AM DF.00005 ABSTRACT WITHDRAWN —

11:30AM DF.00006 Isometric levels of nuclei near \( N = 40 \). S. SUCHTYA, S. LIDDICK, H. CRAWFORD, G. GRINYER, A. KLOSE, P. MANTICA, J. PEREIRA, A. SCHNEIDER, S. VINNIKOVA, NSCL/MSU, C. CHIARA, ANL/U. of M., W. WALTERS, U. of M., M. CARPENTER, G. GURDAL, L. MCUCKETHAN, S. ZHU, ANL — The neutron rich nuclei near \( N = 40 \) and \( Z < 28 \) challenge our theoretical understanding of shell structure in this region. As protons are removed from the \( g_{9/2} \) intruder orbital. Even the removal of two protons between \(^{68}\text{Ni} \) and \(^{68}\text{Fe} \) gives rise to a large drop by 1460 keV for the energy of the first excited \( 2^+ \) state from which an increase in collectivity has been inferred. The gamma-ray decay of isomeric states near \( N = 40 \) were studied at the NSCL to investigate nuclear structure in this region. We report the low level structures that were confirmed for \(^{64}\text{Mn} \) and newly proposed for \(^{66}\text{Mn} \) and \(^{68}\text{V} \).

11:42AM DF.00007 Revisiting K-isosmers in \(^{176}\text{Hf} \) via the \(^{176}\text{Yb}(\alpha,4n) \) Reaction\(^1 \), V.S. PRASHER, A.Y. DEO, S. HOTA, S. LAKSHMI, P. CHOWDHURY, C.J. GUESS, E.G. JACKSON, UMass Lowell, V. WERNER, T. AHN, G. ILIE, V. ANAGNOSTATOU, N. COOPER, M. ELVERS, P. GODDARD, A. HEINZ, D. RADECK, E. WILLIAMS, WNSL-Yale U. — High-K bands in \(^{176}\text{Hf} \) have been populated via the \(^{176}\text{Yb}(\alpha,4n)\)\(^{176}\text{Hf} \) reaction at the WNSL tandem accelerator facility at Yale University using \( \alpha \) beam energies of 41, 46 and 51 MeV. For the first time, fast beam pulsing was incorporated and tested with beam on-off periods of a few tens of \( \mu \text{s} \). Known half lives of different high-K isomers in the \( \text{Hf} \) region \(^1 \) were measured to check the reliability of fast beam pulsing at WNSL for heavy ion spectroscopy. The population of \( 2^-, 4^-, \) and \( 6^- \) isomers in \(^{176}\text{Hf} \), with \( T_{1/2} = 9.6, 401 \) and 43 \( \mu \text{s} \), respectively, is compared at different beam energies. The quest for states and isomers above the \( 2^+ \) \( 6^- \) isomer\(^2 \) in \(^{176}\text{Hf} \) will also be discussed.

1Work supported by the U.S. Department of Energy.

11:54AM DF.00008 \(^{196}\text{Pt} \) and the \( O(6) \) Symmetry\(^1 \), E. A. MCUCKETHAN, BNL/ANL, C.J. LISTER, M.P. CARPENTER, G. GURDAL, G. HENNIG, R.V.F. JANSSSENS, T.L. KHOO, T. LAURITSEN, C. NAIR, D. SEWERYNIK, S. ZHU, ANL, G. RAINOVSKI, N. PIETRALLA, V. S. PRASHER, BNL, ANL, C.J. LISTER, M.P. CARPENTER, G. GURDAL, L. MCCUTCHAN, S. ZHU, ANL — The neutron rich nuclei near \( N = 40 \) and \( Z \) known with only 20\% accuracy. In this region, \( \gamma \) decay of isomeric states near \( N = 40 \) were studied at the NSCL to investigate nuclear structure in this region. We report the low level structures that were confirmed for \(^{64}\text{Mn} \) and newly proposed for \(^{66}\text{Mn} \) and \(^{68}\text{V} \).

1Supported by the DOE Office of Nuclear Physics under Contract Nos DE-AC02-06CH11357 and DE-AC02-98CH10946, the National Science Foundation, and the Air Force Office of Scientific Research.

12:06PM DF.00009 Precise measurements of lifetimes and deorientation in \(^{92,94}\text{Zr} \) using the Recoil Distance Doppler Shift method\(^1 \). MATTHEW HINTON, GABRIELA ILIE, VOLKER WERNER, TAN AHN, NATHAN COOPER, Wright Nuclear Structure Laboratory, RAPHAEL CHEVRIER, University of Caen Basse-Normandie, WNSL NUCLEAR STRUCTURE TEAM — The lifetime for the \( 2^+ \) state in \(^{94}\text{Zr} \) is known with only 20\% accuracy. In this region, \( \gamma \) decay of isomeric states near \( N = 40 \) were studied at the NSCL to investigate nuclear structure in this region. We report the low level structures that were confirmed for \(^{64}\text{Mn} \) and newly proposed for \(^{66}\text{Mn} \) and \(^{68}\text{V} \).

1Research supported by U.S. Department of Energy under Grant No. DE-FG02-91ER-40609.

Thursday, October 27, 2011 10:30AM - 12:18PM —
Session DG Astrophysics I: Light Nuclei 105AB
10:30AM DG.00001 8B Breakup, the Longstanding Puzzle1, MUSLEMA PERVIN, NSCL, MSU, FILOMENA NUNES, Dept. of PA, NSCL, MSU — The cross section of 8B breakup reaction provides an indirect estimate of the 7Be(p, γ)8B reaction rate. This reaction is important because of its connection to the solar neutrino problem. At low (stellar) energies the 7Be(p, γ)8B reaction is dominated by the electric dipole transition (E1), while the 8B breakup reaction rate has a significant contribution from the quadrupole transition (E2). To obtain the astrophysical S-factor S(E2) from different 8B breakup experiments we must understand the contribution of E2 to the measured observables. Previous model calculations could not provide an unambiguous estimate of E2. In our present work we use XCDCC (Extended Continuous Discretized Coupled Channel) to explore the impact of the core (7Be) spin, deformation and excitation to 8B breakup.

1This work is supported by DOE DE-FG52-08NA28552 and NSF-0800026.

10:42AM DG.00002 Search for resonant enhancement of the 7Be+d reaction1, P.D.omalley, A. Adekola, J.A. Cizewski, M.E. Howard, S.Y. Strauss, Rutgers University, D.W. Bardayan, K.Y. Chae, C.D. Nesarajah, S.D. Pain, M.S. Smith, Oak Ridge National Laboratory, S. Ahn, K.L. Jones, S.T. Pittman, K.T. Schmitt, University of Tennessee, Knoxville, S. Graves, R.L. Kozub, J.F. Shrirer Jr., J.L. Wheeler, Tennessee Technological University, M. Matos, B.M. Moazen, Louisiana State University, W.A. Peters, I. Spassova, Oak Ridge Associated Universities — Li abundances in the early universe extrapolated from observations are several standard deviations lower than that produced by Big Bang Nucleosynthesis calculations constrained by WMAP. Since most 7Li is produced by the beta decay of 7Be, one proposed solution to this puzzle is a resonant enhancement of the 7Be(d,p)2Be reaction rate via the 5/2+ 16.7 MeV state in 8B. The 7Be(d, d) reaction was done at Oak Ridge National Laboratory to search for such a resonance. This was performed in inverse kinematics using a 10 MeV 7Be beam and a thick Cd target. Experimental data will be shown and results will be discussed.

1Work supported by U.S. DOE, NSF, and NNSA SSGF

10:54AM DG.00003 R-matrix Analysis of 16O Compound Nucleus Reactions1, R.J. deBoer, University of Notre Dame, R.E. Azuma, University of Toronto, University of Notre Dame, J. Goerres, University of Notre Dame, G. Imbriani, Universita degli Studi di Napoli “Federico II” and INFN, P.J. Leblanc, Ethan Uberseder, Michael Wiescher, University of Notre Dame — A large amount of experimental data exists for reactions which probe the 16O compound nucleus near the alpha and proton separation energies, the energy regime most important for nuclear astrophysics. Difficulties and inconsistencies in R-matrix fits of the individual reactions prompt a more complete simultaneous multiple entrance/exit channel analysis of all available reaction channels with the specific aim of attaining a consistent fitting for the 15N(p,γ)16O cross section data. This work was funded by the National Science Foundation through grant number Phys-0758100, and the Joint Institute for Nuclear Astrophysics grant number Phys-0822648.

11:06AM DG.00004 The Cross Section Measurement of the 14N(p, γ)15O Reaction in the CNO Cycle1, Qian Li, Joachim Goerres, Richard Azuma, Richard DeBoer, Gianluca Imbriani, P.J. Leblanc, Ethan Uberseder, Michael Wiescher, University of Notre Dame — The 14N(p, γ)15O reaction is the slowest reaction in the CNO cycle. It also plays an important role in determining the age of globular clusters. Many groups have studied this reaction before yet their measurements and calculations lead to different astrophysical S-factors for the different primary transitions due to the uncertainties in the R-matrix fit of the reaction cross section. To get more precise results, we performed measurements of the reaction cross section over an energy range from 0.28MeV to 3.6MeV. The cross section for the strongest transitions as well as the angular distribution of the ground state were measured using the JN/KN Van de Graaff accelerators in the Nuclear Science Lab at University of Notre Dame. R-matrix calculations have been performed using the code AZURE. The new data provide better constraints for the extrapolation of the astrophysical S-factor towards stellar energies.

1This work was funded in part by National Science Foundation Grant No. 0758100 and Joint Institute for Nuclear Astrophysics Grant No. 0822648.

11:18AM DG.00005 Measurement of the 17O(p, γ)18F nuclear reaction cross section in the energy range E= 360 - 1625 keV, Antonios Kontos, Joachim Görres, Andreas Best, Qian Li, Daniel Schürmann, Ed Stech, Ethan Uberseder, Michael Wiescher, University of Notre Dame, Gianluca Imbriani, Universita di Napoli, Richard Azuma, University of Toronto — The 17O(p, γ)18F reaction influences hydrogen-burning nucleosynthesis in several stellar sites, such as red giants, asymptotic giant branch (AGB) stars, massive stars and classical novae. In the relevant temperature range for these environments (T = 0.01-0.4), the main contributions to the rate of the reaction are the direct capture process, two low lying narrow resonances (E = 70 and 193 keV) and the low energy tails of two broad resonances (E = 587 and 714 keV). Previous measurements and calculations give contradictory results for the direct capture contribution which in turn increases the uncertainty of the reaction rate. In addition, very few published cross section data exist for the high energy region that might affect the interpretation of the direct capture and the broad resonances contributions in the lower energy range. In this work we present a measurement of the reaction at a wide proton energy range (E = 360 – 1625 keV) and at several angles (θ = 10°, 45°, 90°, 135°). All detected primary transitions and all angles were fitted simultaneously and extrapolated to lower energies using the multi-level, multi-channel R-matrix code, AZURE.

11:30AM DG.00006 Measurement of 17F+p reactions with ANASEN1, Launia Linhardt, Milan Matos, B.C. Rasco, Hannah Gardner, Kevin Macos, Jeffrey Blackmon, Louisiana State University, Daniel Santiago-Gonzalez, Lacy Baby, Evgeniy Koschiy, Ingo Wiedenhoever, Grigory Rogachev, Florida State University, ANASEN Collaboration — The Array for Nuclear Astrophysics Studies with Exotic Nuclei (ANASEN) is a charged-particle detector array designed primarily for studies of reactions important in the p- and r-processes with proton-rich exotic nuclei. The first in-beam measurements with a partial implementation of ANASEN have been performed at the RESOLUT radioactive beam facility of FSU. This includes stable beam experiments and measurements of the 17F(p)17F and the 17F(p, alpha)14O reactions that are important for understanding the structure of 15N and the 15O(alpha,p)17F reaction rate. The performance of ANASEN and initial results from the 17F studies will be presented.

1This work is supported by the USDOE and NSF.
computing cluster measurement of five 1-mm thick silicon detectors and a pure beta emitter, 90Sr. The comparison between the experimental and simulated beta-decay spectrum, 1-mm thick silicon detectors. To determine the sensitivity of the system for beta-decay Q value the system was simulated with Geant4 and compared with a decay of neutron-rich nuclei are studied. The beta-decay Q value can be extracted from a measurement of the beta-decay electron energy distribution, providing masses of the isotopes involved. R-process calculations use masses extracted from global theoretical models. To better constrain the r-process path, the beta-
is responsible for the creation of approximately half of the neutron-rich heavy elements above iron. The path of the r-process depends sensitively on the nuclear

11:54AM DG.00008 Studying the 3 alpha reaction in hyperspherical harmonic approach, NGOC NGUYEN, NSCL, Michigan State University, FILÔMENA NUNES COLLABORATION, IAN THOMPSON COLLABORATION — In this work, the 3 alpha reaction is studied by using the Faddeev hyper-spherical harmonic (HH) method [1]. Starting from a three body model, we derive the analytical formulas for the quadrupole strength function B(E2) as well as the reaction rate which is well known for the two particles but not for three particle system. The 2+ state and the 0+ resonance are well reproduced but we consider the contributions of the nonresonant continuum states to the reaction rate in a consistent manner. Considering only Coulomb interaction for the three alpha scattering problem we can obtain analytical continuum wave functions for the 0+ states. At low temperature our calculations agree very well with NACRE and there is an expected increase in the reaction rate at high temperature due to the nuclear contribution (resonant process). A full calculation with the R-matrix method in hyper-spherical coordinate space is being done to include nuclear and coulomb in equal footing. Final results and a detail physical analysis of the reaction mechanism will be presented and compared with [2,3]. [1] I. J. Thompson, F. M. Nunes, B. V. Danilin, Comput.Phys.Comm. 161, 87-107 (2004). [2] K.Ogata, M.Kan, M.Kamimura, Prog. Theor. Phys. 122, 1055 (2009). [3] R. de Diego, E. Garrido, D.V. Fedorov, A.S. Jensen, EPL. 90, 52001(2010).

12:06PM DG.00009 Introduction to the Geometrical Standard Model of Particle Physics, KENNETH STRICKLAND, Owner Rate Change Graph Science, MICHAEL DUVERNOIS, Wrote journal submission — The Geometrical Standard Model (GSM) of Particle Physics is founded on the principles of a new geometrical tool, Rate Change Graph Technology (RCGT). RCGT was specifically designed to model the complexities of universal concepts. The GSM modeling tool parallels the SM with its own Rate Change Graph Mechanics yet is able to duplicate the SM structure and expand on concepts beyond the SM. RCGT uses a new methodology called geometrical intersections to increase the data available for computing and provides valuable clues as to the missing processes in current scientific practices. Forget about size and value, think geometry and in doing so peel back the layers of the physical world to see for the first time a geometrical universe.

Session EA Conference Experience for Undergraduates Poster Session (2:00-4:00PM) Big Ten C

EA.00001 Beta Decay Q value Measurements for Astrophysics, BRITTANY ABROMEIT, SEAN LIDDICK, SCOTT SUCHYTA, NICOLE LARSON, MURÂLÍ BOLLA, National Superconducting Cyclotron Laboratory and Michigan State University — The rapid neutron process is responsible for the creation of approximately half of the neutron-rich heavy elements above iron. The path of the r-process depends sensitively on the nuclear masses of the isotopes involved. R-process calculations use masses extracted from global theoretical models. To better constrain the r-process path, the beta-decay of neutron-rich nuclei are studied. The beta-decay Q value can be extracted from a measurement of the beta-decay electron energy distribution, providing the relative mass between the parent and daughter isotope. The NSCL has a successful beta-decay spectroscopy station consisting of multiple segmented 1-mm thick silicon detectors. To determine the sensitivity of the system for beta-decay Q value the system was simulated with Geant4 and compared with a measurement of five 1-mm thick silicon detectors and a pure beta emitter, 90Sr. The comparison between the experimental and simulated beta-decay spectrum, enabling a simultaneous R-Matrix fit to both the n0 and the n1 channels. The new data were used as input for stellar network calculations and their impact on the weak s process is discussed.

1Supported through NSF grants Phys-0758100 and Phys-0822648.

EA.00002 Optimizing fits of Geant4 simulations to measured gamma-ray spectra on a parallel computing cluster, MICHAEL AGIORGOUSIS — We have developed software to find the best fit between simulated and measured gamma-ray spectra, by varying the energies of the gamma rays and the lifetimes of the states that they de-excite. Using a grid search algorithm based on a chi squared analysis, we identify the energies and lifetimes that provide the best fit. Separate simulations of each energy lifetime pair must be run, each requiring a significant amount of computing resources, so we implemented the Ursinus College parallel computing cluster. The software can be used with simulations of any detector system, but in the present work, we consider Geant4 simulations of the CAESAR array at the NSCL.

1Supported by NSF grant no. PHY-0969002.

EA.00003 A new method to study the resonances in the 12C+12C fusion reaction, ADAM ALONGI, University of Notre Dame — The 12C + 12C nuclear fusion reaction is an important part of the reaction processes which power large stars and create heavier elements. The fused nuclei form an excited 24Mg nucleus which can decay by emitting a proton, neutron, or alpha particle as well as gamma rays. The proton channel was experimentally studied at lab energies of 8.2MeV using a thick target. Preliminary data analysis showed that the Q-value spectrum of the p1 channel is broader than the other proton channel, indicating the existence of a resonance at lower energy. To understand the abnormal shape of the Q-value spectrum, a detailed simulation using the Geant4 code was developed to reproduce the experimental results. By comparing the simulation results with the observed Q-value spectrum, the parameters of the resonance in the p1 channel are determined. This new technique will provide a more efficient way to search for resonances in the 12C + 12C fusion reaction at lower energies.

1This work is supported by the NSF under Grant No. PHY-1068192 and PHY-0822648, and by the Diane and Bryant Hichwa Summer Research Fellowship through the University of Notre Dame Physics Department.
EA.00004 Electronics and Data Acquisition for MiniLENS, M. AMRIT, J. BLACKMON, C. RASCO, L. AFANASIEVA, Louisiana State University — The Low-Energy Neutrino Spectroscopy (LENS) Collaboration aims to precisely measure the entire energy spectrum of solar neutrinos through charged-current neutrino interactions using indium-loaded scintillator in a novel, optically-segmented detector architecture. The collaboration is currently constructing prototype detectors, aiming towards a 1 m$^3$ prototype, miniLENS, that will demonstrate the performance and selectivity of the full-scale instrument. Here we present the electronics and data acquisition system that we are developing for miniLENS. The responses of smaller (up to 15 liter) prototype detectors have been used to characterize the combined response of the scintillator and detector architecture. We have studied various approaches for triggering and for combining signals from multiple photomultipliers to help design an acquisition system best suited to fully characterize the performance of the miniLENS prototype in a cost-effective manner. Analysis of our current prototype measurements and the design of the data acquisition system for miniLENS will be presented.

EA.00005 Development of Veto Detector for MiniCLEAN Experiment to Aid in the Search for Dark Matter, MATTHEW ANTHONY, Massachusetts Institute of Technology — Weakly Interacting Massive Particles (WIMPs), the leading candidate for dark matter, are theorized to comprise approximately 83% of all of the matter in the universe. MiniCLEAN is a single phase liquid argon detector searching for a direct signal from WIMPs elastically scattering in its fiducial volume. These interactions are extremely rare (only several per year) so a high efficiency veto detector must distinguish between dark matter interactions and false positives. These false positives could be caused by other particles such as cosmic ray muons, high energy neutrinos, and low energy neutrinos interacting with the liquid argon detector. A veto detector was constructed and tested for use in the MiniCLEAN detector. Simulations were also run in order to characterize neutron signals in the liquid argon detector.

EA.00006 Thickness Measurements and Isotopic Identification of Cd, Sn, and Te Targets, ANDREW AREND — In preparation for measuring some of the reaction rates relevant to the p-process of stellar nucleosynthesis we characterized a set of 73 thin foil targets of Cd, Sn, or Te. The targets had Al or C backings and Al or Ta frames. Using Particle Induced X-ray Emission, we determined the elemental composition of each target by comparing the observed x-ray emission lines with that of the characteristic emissions of the relevant elements. We concluded that PIXE is not an accurate method of measuring foil thickness. We next used Rutherford Backscattering with 12C3+ beam to determine the isotopic composition and thicknesses of the targets. A Silicon detector was placed at 150 degrees with respect to the beam direction to detect the back-scattered 12C particles. A mixed alpha-source was used to ensure a good energy calibration. Analyzing the energy at the leading edge of the energy spectrum of the scattered particles allowed identification of the specific isotopes of each sample. The width of the scattered 12C peak, indicating the maximum energy loss of 12C in a target, yielded the thickness of the target when compared to calculations. The thicknesses range from about 50 to 650 μg/cm$^2$.

1 This work was supported by the National Science Foundation under contract number PHY0822648.

EA.00007 Truncation and Extrapolation of ab initio Calculations in a Finite Model Space, M. AVETIAN, S.A. COON, M.K.G. KRUSE, U. VAN KOLCK, University of Arizona, P. MARIS, J.P. VARY, Iowa State University — Estimating the errors due to the truncation to a model space is crucial for ab initio calculations which require an extrapolation scheme to obtain a converged result in the full space. Of the calculations done in a harmonic oscillator (HO) basis, the model space is assumed to be characterized by N$_{max}$ which counts the maximum number of shells, above the minimum configuration, kept in the total energy. In the spirit of effective field theory (EFT) we have examined the dependence of the truncated results on two regulators of the model space. The HO ultraviolet (UV) regulator Λ is associated with the minimum momentum included in the calculation. The infrared (IR) regulator λ is associated with the minimum momentum variation allowed. Our investigations are made with different “realistic” $NN$ interactions smooth enough that these calculations, performed with a technology developed for the shell model, are variational in nature. Our energy spectra show a significant tendency towards simple scaling in these two regulators as the calculations approach separately the IR and UV limits. We have established a novel extrapolation parameter composed of the two UV and IR regulators which appears universal (and $NN$ interaction and nucleus independent) and is useful even for modest model spaces.

EA.00008 Characterization of $^{83}$Kr gas source for the Project 8 neutrino mass experiment, ARMAN BALLADO — Measurement of the final state electron energy in tritium beta decay provides a model independent probe of the neutrino mass. However, reaching sufficient electron energy resolution may be beyond the realm of current methods. Project 8 is a new experiment employing a novel, high-resolution non-destructive technique to measure the energy of single electrons via detection of the cyclotron radiation signal emitted by the electron in a magnetic field. The tritium endpoint energy of 18.6 keV in a 1T field corresponds to 26 GHz RF signal, and to test the sensitivity of this method, Project 8 will first attempt to demonstrate RF sensitivity to the 17.8 keV monenergetic electrons as $^{83}$Kr decays to the stable $^{83}$Kr. This project will explore the behavior of the krypton gas around liquid nitrogen temperatures to characterize the formation of a krypton monolayer on the surface of the vacuum chamber. The study hopes to find the optimal conditions to ensure minimal noise due to the electron-krypton scattering while still having enough concentration to produce a detectable signal.

EA.00009 Calibrating the STAR Endcap Electromagnetic Calorimeter Using $^{31}$P $^{16}$O, BENJAMIN BARBER, Valparaiso University, STAR COLLABORATION — Current calibrations of the STAR Endcap Electromagnetic Calorimeter (EEMC) have relied on the energy deposition of minimally-ionizing particles (MIPs). Alternative calibration methods using the energy deposition of the di-photon pairs created by $^{0}$π decays were explored, and used to verify the MIP-based method. Particle interactions with the EEMC result in energy clusters within the detector. Using standard two-body kinematics, the invariant mass spectrum of distinct energy cluster pairs is reconstructed from the 2009 data in the EEMC, resulting in a $^{0}$π peak. Using this peak as the standard $^{0}$π mass, parameters from the energy calibration for each EEMC detector element are varied to minimize the difference between the given and measured $^{0}$π mass and the peak width. Current work has focused on the sensitivity of the resulting mass spectrum to the specific clustering algorithm used. Energy was clustered using K-means methods, fuzzy C-means methods, and a hybrid method of the two. Highlights and preliminary results will be presented.

1 Special thanks to the Department of Energy for their generous support.

EA.00100 Pad Plane Design and Readout for SAMURAI TPC, J. BARNEY, Z. CHAJECKI, C.F. CHAN, J.W. DUNN, J. ESTEE, J. GILBERT, F. LU, W.G. LYNCH, R. SHANE, M.B. TSANG, Michigan State University, A.B. MCINTOSH, S.J. YENELLO, Texas A&M University, M. FAMIANO, Western Michigan University, T. ISOBE, H. SAKURAI, A. TAKETANI, RIKEN, Japan, T. MURAKAMI, Kyoto University, SAMURAI-TPC COLLABORATION — The SAMURAI TPC is being built at Michigan State University to be used in the SAMURAI spectrometer at RIKEN in Japan, as part of the Symmetry Energy project, which focuses on obtaining constraints on the symmetry energy at supra-saturation densities. The presentation will discuss the development of the TPC, as well as design for readout plane design for the TPC. These involve enabling the use of existing and future front end electronics (FEE), making the most of limited space, designing a circuit board for the pad plane, and techniques to glue the pad plane. The pad plane has been designed to work with either STAR or AGET electronics. The pad plane is made of a circuit board designed to minimize crosstalk and capacitance. The board must be built in smaller pieces and tiled, using alignment pins and precision gluing. Prototypes for the pad plane to FEE connection, pad plane gluing and STAR card mounting will be presented.

1 Supported by the Department of Energy under Grant DE-SC0004835.
EA.00011 ABSTRACT WITHDRAWN

EA.00012 Observation of the J/Psi meson in Ultra Peripheral Collisions at STAR , GLEB BATALKIN, Creighton University — Observation of the J/Psi meson in Ultra Peripheral Collisions at STAR Ultra Peripheral Collisions (UPC’s) involve two colliding ions that do not physically overlap but interact electromagnetically. In UPC’s, the exchange of virtual photons can lead to the photoproduction of vector mesons. The 2010 200 GeV Gold-Gold data from STAR contains the first evidence of photoproduction of J/Psi mesons in UPCs at STAR. The J/Psi meson is of particular interest because it probes the gluon distribution function at low-x. This poster will present the measurement of J/psi production in UPCs at STAR, including a Rho to J/psi photoproduction cross section ratio.

EA.00013 Systematic Search for Waiting Points in Nova Explosions , ALEXANDER BENNETT, University of Chicago, 5801 South Ellis Avenue, Chicago, IL 60637, USA, MICHAEL SMITH, RAFAEL HIX, Physics Division, Oak Ridge National Lab, Oak Ridge, TN 37831, USA, TOMOMI SUNAYAMA, Yale University, New Haven, CT 06520, USA — To better understand the element synthesis and energy generation occurring in novae, we have executed a systematic search for waiting point nuclei. We used the waiting point finder tool within the Computational Infrastructure for Nuclear Astrophysics (CINA), an online suite of nuclear astrophysics codes that sets up, executes, and creates visualizations of explosion simulations, to run a series of over five hundred post-processing nova simulations of different models, spatial zones, and time windows. We compiled a database of waiting points complete with a variety of search queries and a visualization tool to graphically aid in understanding nova explosions. We will report on our analysis of this waiting point dataset for trends across mass regions, zones, and time windows, and our searches for waiting points common to a variety of simulations.

EA.00014 Construction of Specialty Guide Field Coils Using an Industrial Robotic Arm1 , WILLIAM BERRY, CHRISTOPHER CRAWFORD, MARIO FUGAL, ELISE MARTIN, DANIEL WAGNER, ROBERT MILBURN, University of Kentucky — Many contemporary nuclear physics experiments require precise control of the magnetic field within key regions of the experimental apparatus. The nEDM experiment, for instance, requires uniform guide fields (produced by guide field coils) to transport neutron spin polarization from the polarizer to the measurement cell. Guide field coils in general are subject to tight geometrical constraints, and must not produce any external fields which would affect the results of the experiment. In order to produce a satisfactory coil in light of these constraints, a systematic design technique is needed. We introduce the magnetic scalar potential technique, which calculates the exact coil windings required on a specified boundary to produce any desired field distribution inside that satisfies Maxwell’s equations. Realizing the designs produced by this technique introduces an additional difficulty: winding many turns according to the exact calculated paths. This is addressed by “printing” our coils onto a copper-plated G10 form using a calibrated robot arm and spindle, resulting in a 3-d printed circuit board. To correct for deviations in the actual shape of the form, we use a laser displacement sensor to capture the actual geometry as input into the calculation of the windings.
1Supported in part by NSF grant PHY-0855584.

EA.00015 Position Sensitivity of the SuN (Summing NaI(Tl)) Scintillation Detector1 , ILYA BESKIN, ARTEMIS SPYROU, STEPHEN QUINN, JESSICA PEACE, ANNA SIMON, NSCL/MSU, SUN TEAM — The astrophysical p-process is responsible for the synthesis of many proton rich nuclei. It involves photo disintegration reactions such as (gamma,alpha), (gamma,n) and (gamma,p) reactions. To try to understand the reaction flow and reproduce the p-nuclei abundances, we will try to study the inverse reactions, namely (p,gamma) and (alpha,gamma). A beam of a heavy nuclei will be impinging on a H or He rich target, and by using the 4\times \sigma parametrized by Abilene Christian University, FERMILAB E-906/SEAQUEST COLLABORATION — The angular differential cross section for the Drell-Yan (DY) process can be written as:

\begin{equation}
\frac{d\sigma}{d\Omega} \propto \Omega \sin^2 \theta \cos^2 \phi \sin^2 \theta \cos 2\phi
\end{equation}

where \( N, Z \) is the atomic number and mass number of each fragment. The purpose of our analysis is to understand if the excess of neutrons leave the system with the gas, liquid or solid. In both cases, we will present separately \( p, t, ^3He, ^4He \) and heavier particles for the gas and the liquid components, respectively. In an equilibrated system the ITD is centered at zero, and its fluctuations are connected to the temperature. Collective effects, such as the Dipole dependence on the symmetry energy and the Coulomb field, may result in a non zero Dipole value. The ITD will be studied for different excitation energies to point out possible phase transitions, similar to those observed in the GDR of high E*. Moreover the study of different reaction systems will give hints on the role of neutrons, protons and heavier fragments in achieving equilibrium.

EA.00016 Dipole Transport in Multi-fragmentation , GIACOMO BONASERA, Texas A&M University — The study of the Giant Dipole Resonance (GDR) in nuclei at low excitation energies (E*) gives access to information on the symmetry energy. Similarly the Isospin Transport Dipole (ITD) can be used to study the migration of protons and neutrons in a heavy ion collision at higher E*. Likewise to the Dipole mode definition used in GDR studies, we define a Dipole mode as:

\begin{equation}
D_z = \sum_{i=1}^{N} m_i p_{z,i} \text{where } m_i = \frac{(N_i-Z_i)}{A_i} \text{ of each fragment } (N,Z)_i.
\end{equation}

The purpose of our analysis is to understand if the excess of neutrons leave the system with the gas, liquid or solid. In both cases, we will present separately \( p, t, ^3He, ^4He \) and heavier particles for the gas and the liquid components, respectively. In an equilibrated system the ITD is centered at zero, and its fluctuations are connected to the temperature. Collective effects, such as the Dipole dependence on the symmetry energy and the Coulomb field, may result in a non zero Dipole value. The ITD will be studied for different excitation energies to point out possible phase transitions, similar to those observed in the GDR of high E*. Moreover the study of different reaction systems will give hints on the role of neutrons, protons and heavier fragments in achieving equilibrium.

EA.00017 Measurement of the Angular Distributions of Drell-Yan Dimuons , BRANDON BOWEN, Abilene Christian University, FERMILAB E-906/SEAQUEST COLLABORATION — The angular differential cross section for the Drell-Yan (DY) process can be parametrized by:

\begin{equation}
\frac{d\sigma}{d\Omega} \propto 1 + \lambda \cos^2 \theta + \mu \sin 2\theta \cos \phi + \nu \sin^2 \theta \cos 2\phi
\end{equation}

where \( \lambda, \mu, \) and \( \nu \) are the angular distribution parameters vs \( p_T, \theta \) and \( \phi \) denote the polar and azimuthal angles, respectively for the positive lepton produced. The Lam-Tung relation, \( 1 - \lambda = 2\mu \), was validated by Fermilab E-866 for proton induced Drell-Yan scattering; However pion induced DY shows a much stronger cos2\theta angular dependence and a violation of the Lam-Tung relation. In pion induced DY the antiquark is a valance quark, whereas in proton induced DY (in a forward acceptance spectrometer) it is a sea quark, so E-866 probed the antiquark sea of the nucleon. The SeaQuest experiment, also using proton induced DY, will improve on the measurement of the angular dependencies at a lower energy (120 GeV), taking advantage lower backgrounds and an increase in Drell-Yan cross section at lower energies. The Boer-Mulders correlates the quark correlates between the quark transverse spin and momentum. Improved data from SeaQuest will help determine the Boer-Mulders function. Funding for this work was provided in part by the U.S. DOE Office of Science.
EA.00018 Germanium Crystal Growth for DUSEL Experiments, LOGAN BREKKE, CUBED COLLABORATION — The Center for Ultra-low Background Experiments at DUSEL (CUBED) is a research center supported by both DOE EPSCoR and the state of South Dakota to grow high-purity germanium crystals for Deep Underground Science and Engineering Laboratory (DUSEL) projects at the Homestake mine in Lead, SD. My specific project within the CUBED program was Germanium Crystal Growth. I assisted in growing Ge crystals using the Czochralski method, along with producing and examining Ge wafers fashioned from the crystals we grew. Our main goal was to perfect the growth process, aiming to eventually grow Ge crystals that meet the strict high-purity and low-dislocation requirements of detector-grade crystals. Throughout the summer, we made significant progress and improvements to our growth equipment and technique. The research and process development performed within the CUBED program are preliminary activities in a much larger project. The ultimate objective is to move the crystal growth and other activities underground to DUSEL, thereby making it the only site in the world where high-purity Ge crystals are grown in a deep underground environment. Through our research and development, we are contributing to the efforts of the DUSEL project by assembling and improving both knowledge and strategy of the crystal growth process and equipment. This groundwork will allow for a “running start” once the activities are moved to the underground site.

EA.00019 Dark Matter Detection with DM-Ice, BENJAMIN BROERMAN, University of Wisconsin-Madison, DM-ICE COLLABORATION — There is strong evidence for the existence of dark matter, theoretically favored to be a weakly interacting and gravitationally influential form of non-baryonic matter. The ΛCDM model delineates 23% of the mass-energy of the Universe to be dark matter, 73% dark energy, and the remaining 4% baryonic matter. However, conclusive evidence as to the direct detection of dark matter has yet to be produced. In December 2010, a new project, named DM-Ice, deployed two prototype NaI detectors in the South Pole ice, testing the feasibility for a future, larger-scale direct detection experiment. The goal is to search for the annual modulation signal expected from interactions between the target nuclei and the weakly interacting massive particle (WIMP), a candidate dark matter particle. I will report on my contributions to data readout and analysis, as well as preparations for the future experiment.

EA.00020 Development of the Silicon Array for Notre Dame (SAND) for the Study of the 12C + 12C Reaction at Sub-Coulomb Energies, CRAIG CAHILLANE, University of Notre Dame - Nuclear Science Lab — The 12C + 12C fusion reaction is an important process in stellar evolution and nucleosynthesis. The energy region of interest lies between 1 and 3 MeV, but studying the reaction at these energies is difficult because of the reaction’s rapidly decaying cross-section a sub-Coulomb energies. Both detector efficiency and beam intensity limit such measurements. As a test run for the future Silicon Array at Notre Dame (SAND), two YY1 Trapezoid Silicon Detectors were used to detect the proton decay of the carbon fusion reaction. The two detectors covered a solid angle of 0.34 steradians. In the construction of SAND, more large surface area silicon detectors will be used to dramatically increase detection efficiency by covering a much larger solid angle. Combined with the new high-intensity 5 MV accelerator also under construction at Notre Dame, SAND could reduce the error on low energy cross sections in the astrophysical region and possibly detect hypothesized resonances at lower energies.

1This work is supported by the NSF under Grant No. PHY-1068192 and PHY-0822648.

EA.00021 Gas Electron Multiplier Tracking Telescopes for OLYMPUS, MILES CAMPBELL, JOSHUA MCMAHON, Hampton University, OLYMPUS COLLABORATION — The OLYMPUS collaboration is conducting an experiment to measure two-photon contributions to elastic electron scattering. The experiment is taking place at the DORIS storage ring at DESY, Hamburg, Germany using the upgraded BLAST detector from the MIT-Bates Linear Accelerator Center. Gas Electron Multiplier (GEM) telescopes are used to detect scattered leptons at a forward angle to monitor the luminosity. The GEM detectors have been commissioned at the test facility at DESY and were installed along with the main detector in the DORIS storage ring. With the testbeam the performance characteristics such as gain, efficiency, multiplicity, and resolution of the GEMs were studied.

EA.00022 Gain Calibrations for the BUNI Large-Volume NaI(Tl) Detector at MAX-lab, OLIVIA CAMPBELL, University of Massachusetts Dartmouth, MAX-TAGG COLLABORATION — One of the most critical questions in nuclear physics today is how to describe the properties of the nucleon in terms of the framework provided by Quantum Chromodynamics. A number of different approaches to solving the QCD calculations at low energies exist. Comparing the results from high quality measurements with the predictions from various quark-based theories provides a way to test the theories. Pion photoproduction near threshold is one fundamental nuclear reaction where both theory and experiment can provide accurate answers. A measurement of $\gamma N \rightarrow \pi N$ is currently being performed using the photon tagging facility located at MAX-lab in Lund, Sweden. Since a $L_D^2$ target was used, the $\pi^-$ cannot escape to be detected directly but are instead captured in the target and produce a nominal 128 MeV gamma-ray. These high-energy gamma-rays were detected in three large-volume NaI(Tl) detectors. The detectors have a core surrounded by a segmented annulus. During the data acquisition period, daily calibration runs were made using a Th-C $\gamma$-ray source to measure the gain of the annulus segments. These calibrations ensured that changes in the detector gains were accurately monitored and corrected for during the analysis of the data.

1Sponsored by NSF OISE/RES award 0553467.

EA.00023 Rate Capability in Bakelite Based Resistive Plate Chambers, MAX CANDOCIA, University of Illinois at Urbana-Champaign — Bakelite-based resistive plate chambers (RPCs) are particle detectors commonly used in muon trigger systems for high-energy physics experiments. Bakelite RPCs combine fast response, sufficient position resolution and low cost, and they can be operated at instantaneous background rates up to about 1.5 kHz/cm². Current and future collider experiments will demand operation of trigger RPCs under background rates higher than what is currently achieved. The rate capability is related to the bulk and surface conductivities of the Bakelite material used for the plates bordering the active gas volume in the RPCs. The inner surface of present Bakelite RPCs used at the LHC and RHIC is coated with linseed oil, lowering the surface resistivity of the raw Bakelite. Methods of increasing the surface conductivity of Bakelite sheets via dispersion of carbon blacks in linseed oil are being developed. Performance tests of prototype RPCs are carried out in a test stand that utilizes cosmic ray muons and radioactive 55Fe sources. In this presentation different dispersion methods and the rate capability of the resulting prototype RPCs will be compared.

EA.00024 ABSTRACT WITHDRAWN —

EA.00025 First Measurement of Statistical Gamma-ray Transitions in $^{88}$Sr at TUNL via Inelastic Neutron Scattering, S. CARTER, BSC and TUNL, G. RUSEV, C. ARNOULD, W. TORNOW, Duke U. and TUNL, M. GOODEN, J.H. KELLEY, NCSU and TUNL, S.L. HAMMOND, UNC and TUNL, L. STEVENS, WFU and TUNL — Predictions of the intensity distribution of $\gamma$ rays emitted by product nuclei of a certain nuclear reaction are of interest for nuclear astrophysics to estimate the photon flux during a supernova as well as for applied physics for calculating shielding, for instance. Furthermore, by knowing the average $\gamma$-ray spectrum for a given isotope we can predict whether the nucleus will transmute if it is exposed to a strong $\gamma$ flux as the “hot supernova-explosion scenario” suggests. We report results for the distribution of $\gamma$ rays following the $^{88}Sr(n,\gamma')$ reaction. This experiment, carried out for the first time at TUNL’s FN 10 tandem, aims at measurement of the statistical $\gamma$ rays and is complementary to our previous experiments on $^{87}Sr(\alpha,\gamma)$ at LANSE and $^{88}Sr(\gamma,\gamma')$ at the High Intensity $\gamma$-Ray Source Facility.

1Work supported by the US Department of Energy under grants DE-FG02-97ER41033, DE-FG02-97ER41042, and DE-FG02-97ER41041 and the National Science Foundation under the grant NSF-PHY-08-51813.
EA.00026 NIFFTE Time Projection Chamber for Fission Cross Section Measurements. Ryan Castillo, Abilene Christian University, Los Alamos National Laboratory, FOR THE NEUTRON INDUCED FISSION FRAGMENT TRACKING EXPERIMENT COLLABORATION — In order to design safer and more efficient Generation IV nuclear reactors, more accurate knowledge of fission cross sections is needed. The goal of the Time Projection Chamber (TPC) used by the Neutron Induced Fission Fragment Tracking Experiment (NIFFTE) collaboration is to measure the cross sections of several fissile materials to within 1% uncertainty. The ability of the TPC to produce 3D “pictures” of charged particle trajectories will eliminate unwanted alpha particles in the data. Another important source of error is the normalization of the data the U-235 standard. NIFFTE will use the H(n,n)H reaction instead, which is known to better than 0.25%. The run control and monitoring system will eventually allow for nearly complete automation and off-site monitoring of the experiment. This presentation will cover the need for precision measurements and an overview of the experiment.

This work was supported by the U.S. Department of Energy Division of Energy Research.

EA.00027 Prototyping a Gas Electron Multiplier For Use At TJNAF. Chris Colvin — I am currently working on, and studying, prototype GEM detectors at the Thomas Jefferson National Accelerator Facility (TJNAF). The goal of this project is to be able to implement a large scale version of this technology into the halls of the accelerator. A GEM (Gas Electron Multiplier) detector is relatively cutting edge technology, first used at CERN in 1997. The models we use receive a constant flow of mixed gas (75% Argon, 25% Carbon Dioxide). The inner workings of the GEMs contain 3 layers of Kapton foil with microscopic engineered holes. Electrons are multiplied inside the holes as they drift along lines created by an external electric field. This charge is collected on two planes of readout strips which are perpendicular to each other, allowing the measurement of the x and y directions. The z-coordinate comes from stacking 3 of these chambers on top of each other. This data is then sent through a costumized data acquisition system for analysis.

EA.00028 Complementary Neutron Efficiency Measurements using VANDLE. P. Copp, University of Wisconsin La Crosse, W.A. Peters, Oak Ridge Associated Universities, R. Grzywacz, M. Madurga, S. Paulauskas, University of Tennessee Knoxville, J.A. Ciezewski, M.E. Howard, P.D. O’Malley, B. Manning, E. Merino, Rutgers University, Piscataway, N.J. T.N. Massey, C. Brune, Ohio University, Athens, OH, F. Sarazin, S. Ilyuskin, D. Walter, Colorado School of Mines, Golden, CO, J. Blackmon, Louisiana State University Baton Rouge, D.W. Bardayan, Oak Ridge National Laboratory, I. Spassova, C. Matei, Oak Ridge Associated Universities — The Versatile Array of Neutron Detectors at Low Energy at the Holifield Radioactive Ion Beam Facility at ORNL is nearly complete for use with a variety of neutron-detection sensors, including (d,n) reactions in inverse kinematics and beta-delayed neutron spectroscopy. The array is comprised of detector modules with two different sizes of scintillating plastic bars. The smaller modules are 60 cm long while the larger ones are 200 cm long. The efficiency of these modules has been measured by comparing to a calibrated 27Al(d,n) reaction performed at Ohio University, and by comparing to a measured 252Cf decay spectrum. Both results will be presented along with the characterization of the light response of elastically scattered low energy carbon recoils below 30 keVee.

This work is supported in part by the US DOE and the NSF.

EA.00029 A Calibration Technique for the ALICE Electromagnetic Calorimeter at the Large Hadron Collider. Karen Cossyleon, Chaan Thomas, Edmundo Garcia-Solis, Chicago State University, Mateusz Ploskon, Peter Jacobs, Lawrence Berkeley National Laboratory — The Large Hadron Collider at CERN is the world’s largest and highest energy, particle and heavy ion collider. The LHC explores the frontiers of particle physics using high energy proton + proton collisions and the properties of the Quark-Gluon Plasma through the collision of heavy nuclei. ALICE is one of the four LHC experiments, specialized for the study of heavy ion collisions. This study presents our work on a detector of ALICE, the Electromagnetic Calorimeter. We are analyzing the proton-proton collision data recorded at 2.76 TeV. The ALICE TPC is used to isolate the tracks of \( e^+e^- \) pairs that originate from the decay of J/\( \Psi \) particle and that fall within the EMCal’s acceptance. The TPC measures the momentum of these electron tracks, which is compared to the energy deposited by them in the EMCal. We therefore use the precise measurement of TPC momentum as the reference to calibrate the EMCal energy measurement. In this presentation we will show the steps taken to analyze the data, how we performed the matching of electron tracks from the J/\( \Psi \) decay with the energy deposited in the EMCal and some preliminary results.

Research funded by NSF grant PHY-0968903.

EA.00030 Measurement of the Background Gamma Spectrum at the SNS FP12. Kayla Craycraft, University of Kentucky, NPDGamma Collaboration — The NPDGamma experiment is running at the Fundamental Neutron Physics Beamline (FP13) of the Spallation Neutron Source (SNS). It will measure the parity violating weak contribution to the long range part of the hadronic interaction in the reaction n + p → d + gamma. We have measured the background gamma-ray spectrum in the FP13 experimental area using a high purity germanium detector. Various sources of background are discussed, including the supermirror polarizer, and materials in the target and detector array, and their projected effect on the NPDGamma experiment.

Supported in part by NSF grant PHY-0855584.

EA.00031 Exploring the EMC Effect and Anti-Shadowing at Fermilab E906/SeaQuest. Mandi Crowder, Abilene Christian University, SeaQuest/FNAL E906 Collaboration — Fermilab E906/SeaQuest will use Fermilab’s 120 GeV Main Injector on the nuclear targets Ca, W, and C to investigate how sea quark distributions differ in nuclear matter. The European Muon Collaboration (EMC) discovered that the quark structure of a nucleon has a different momentum distribution than that of nuclei. SeaQuest is a fixed target experiment designed to extract the sea anti-quark structure of the proton by measuring the Drell-Yan cross-section ratio for proton-proton and proton-deuteron collisions. The data gathered will also aid in understanding parton energy loss in cold nuclear matter, which is a prerequisite to understanding energy loss in hot nuclear matter at RHIC and the LHC. Anti-shadowing causes higher energy loss but was not observed in Fermilab E772 Drell-Yan data. SeaQuest will study these nuclear effects for the anti-quark distributions over the anti-shadowing (0.1 < x < 0.2) and EMC (0.2 < x < 0.5) regions to a much higher precision than E772.

Funding for this work was provided in part by the U.S. DOE Office of Science.
EA.00032 Examination of the validity of statistical models for the $^{12}$C + $^{12}$C fusion reaction at sub-barrier energies\footnote{3}, ERIN DAHLSTROM, Rice University — Previous experimental studies of $^{12}$C + $^{12}$C fusion at sub-barrier energies using gamma spectroscopy have been limited by the use of a single detector. Use of the Gammasphere at the Argonne National Laboratory, however, allows for an array of germanium detectors to pick up the characteristic gamma rays, greatly increasing the information received. These decay products do not give us the total cross section for the fusion reaction though; we rely on statistical models that relate them to how the excited states are originally populated and decay. Using a combination of gamma spectroscopy based on data from the Gammasphere and proton spectroscopy from a recent $^{12}$C + $^{12}$C fusion experiment at Notre Dame, we tested these statistical models. The initial population of excited states for $^{24}$Na predicted by Empire, a standard statistical model for the decay of different $^{24}$Mg spins, was compared with the population determined from the gamma and proton spectroscopy. This comparison will potentially help us more accurately predict the spin population of $^{24}$Mg, further constraining the fusion reaction theory.

\footnote{3}Thanks: NSF grants PHY-1068192, PHY-0822648; ND REU.

EA.00033 Development of CdWO$_4$ Crystal Detectors\footnote{4}, ALYSSA DAY, University of South Dakota — CdWO$_4$ scintillators have been proposed for detecting geo-neutrinos, neutrinoless double-beta decay, and dark matter. Initial research involved an energy resolution comparison of three different sized gamma ray detecting CdWO$_4$ crystals. The three crystals had diameters of 16mm and thicknesses of 5mm, 9mm, and 19mm, respectively. When using the 19mm CdWO$_4$ crystal, the energy resolution of a 137Cs source resulted in 11.4% at 662 keV. A 60Co source used with the same crystal resulted in 6.5% at 1173.2 keV and 8.6% at 1332.5 keV. As the sizes of the crystal decreased, a slight deterioration in energy resolution occurred with more Compton scattering in the energy spectrum. The CdWO$_4$ crystal was beneficial when measuring gamma-ray energy close to 511 keV, which is the primary signature for geo-neutrino detection with $^{106}$Cd. By initially using a number of smaller crystals, small scale experiments can be run to develop and understand the calibration of these crystals. Current experiments involve using a 2 inch CdWO$_4$ crystal. It is predicted that with the use of this larger crystal, energy resolution and detection with be improve. The results of this experiment will be presented.

\footnote{4}Sponsored by DOE EPSCoR

EA.00034 Learning about scalars in the dark sector from generic fifth force searches, ROSS DEVOL, GINTARAS DUDA — To explain the PAMELA/FERMI positron excess through dark matter annihilations, leptophobic dark matter, dark matter that preferentially decays into leptons, is needed. Models such as exciting dark matter (XDM) provide a new annihilation channel for dark matter. $\chi \chi \rightarrow \gamma \gamma$, where $\gamma$ is a new scalar particle. The decay of this scalar into electron-positron or muon-antimuon pairs can explain the PAMELA excess. Since scalar fields generically lead to fifth-force type interactions, this scalar particle and its interactions are constrained by generic fifth force searches. This work will present constraints on the mass of the new scalar particle in the dark sector from fifth force searches.

EA.00035 Fabrication of a Low Radioactive Background Temperature Sensor on a Parylene Substrate, ANKUR DHAR, University of California Berkeley, JAMES LOACH, ALAN POON, Lawrence Berkeley National Lab — Searches for rare nuclear processes are at the center of many research programs in nuclear and particle physics and as these experiments increase in sensitivity there is an growing need for materials that are both technologically complex and chemically pure. A particular need is for low-background electronic circuitry and sensors, an example of which is a temperature sensor for use in neuinetworkless double beta decay and dark matter experiments. In this work a thin-film temperature sensor is fabricated from radio-pure materials to provide a clean alternative to conventional platinum or silicon diode sensors. Parylene is used as a substrate for sputtered gold-titanium traces shaped using photolithography and bonded to parylene-coated copper signal wires; the whole sensor is then sealed with a second layer of parylene. Parylene is a promising substrate material for low-background electronics and this work represents a proof-of-principle and a first step on the road to more complex sensor electronics.

EA.00036 A Microscopic Description of the Elusive Hoyle State\footnote{1}, ALISON DREYFUSS, Keene State College, KRISTINA LAUNEY, Louisiana State University, CAIRO BAHRI, University of Notre Dame, TOMAS DYTRYCH, JERRY DRAAYER, Louisiana State University — Using the symplectic Sp(3,R) symmetry inherent to nuclear dynamics together with a novel many-nucleon interaction, we are able to reproduce low-lying spectral features of $^{12}$C, including the Hoyle state energy, and to gain a further understanding of the underlying physics. We employ a no-core symplectic model for symmetry-preserving interactions—with Sp(3,R) the underpinning symmetry—that offers a microscopic description of nuclei in terms of mixed shape deformations and allows for the inclusion of higher-lying configurations currently inaccessible to ab initio shell models. Our interaction is effectively realized by an exponential dependence on the quadrupole-quadrupole two-body interaction. We were able to reproduce the energies of the ground state rotational band, the Hoyle state, and the next excited $0^+$ state, along with the $B(E2; 2^+ \rightarrow 0^+)$ transition strength for $^{12}$C. The success of this work indicates the importance of alpha-cluster structures in the $^{12}$C nucleus and the inclusion of hierarchical many-body interactions.

\footnote{1}Supported by the National Science Foundation (grant #1004822 and OCI-0904874) and the U.S. Department of Energy (DE-SC0005248).

EA.00037 The SAMURAI Time Projection Chamber, STEVEN DYE, Western Michigan University — The SAMURAI Time Projection Chamber (TPC) will be used to study particle collisions by colliding a beam of particles with a stationary gas which will be contained in a field cage inside the TPC. When the beam collides with the gas, charged particles are accelerated into the pad plane by an electric field. The paths of these particles will be curved by a magnetic field created by the SAMURAI magnet at the RIKEN facility in Japan. The charged particles will then collide with the pad plane which will be located on the bottom of the TPC. The pad plane will take these collisions and create electrical signals and send them to supporting electronics where the data can be interpreted. The TPC will be used to help determine the Equation of State for asymmetric nuclear matter. Measurements of neutron, proton, $^3$H and $^3$He flow will be taken with the NEBULA array which consists of nebula scintillators. The poster will contain information on the laser calibration system and the electronics that will be used for the TPC. The electronics used are the same electronics used in the STAR TPC experiment.

EA.00038 Calibration of the NEXT-1 Time Projection Chamber for Neutrinoless Double Beta Decay Searches, MAXIM EGOROV, Lawrence Berkeley National Laboratory, NEXT-100 COLLABORATION — We propose a high-pressure Xe-136 gas time projection chamber (TPC) for searches of neutrinoless double beta decay. Currently, the prototype NEXT-1 TPC has been constructed at Lawrence Berkeley National Laboratory that uses 1 kilogram of Xe-136. We used a radioactive Am-241, 59.4 keV gamma-ray source for calibration of the TPC, and a GEANT4 Monte Carlo simulation for determining the accuracy of the position and energy reconstructions. The detection mechanism in the TPC relies on the process of electroluminescent amplification that yields a large photon count for signal events. The optical settings were thus optimized to yield accurate position and energy reconstructions to 50% total, fully diffuse, reflectivity. We developed a maximum likelihood estimation method for position reconstruction that demonstrates 90.2% accuracy for simulated events. At full calibration energy, the energy resolution was found to be $\sim$4.6% FWHM, with simulation showing similar results, with an additional inclusion of $\sim$2.6% FWHM. Accurate position reconstruction allows for an accurate radial correction on the energy, which could lead to an improved energy resolution.
EA.00039 Modeling neutron events in MoNa-LISA using MCNPX1, MARGARET KENDRA ELLISTON, ALEXANDER PETERS, KRISTEN STRYKER, SHARON STEPHENSON, Gettysburg College, MoNa Collaboration — The MoNa-LISA collaboration uses time-of-flight techniques and charged particle detectors to determine the structure of exotic nuclei such as 24O and 12Be. To determine the decay energy in particular, a neutron that hits the Modular Neutron Array and the Large multi-Institutional Scintillator Array has its energy, position, and angle of incidence recorded if and only if the charged particle detector system detects an appropriate charged-particle fragment. However, the analysis uses only the first neutron to hit the detector array even in the case of 2n events, since the data acquisition system cannot distinguish between simultaneous but random 2n events and events due to 2n reactions. We are using MCNPX to model the reaction channels possible in the MoNa-LISA detector system in an effort to better improve the resolution on decay energy spectra for events with multiple neutrons.

1This work was supported in part by US National Science Foundation Award 0922335.

EA.00040 Bottomonium in the QGP: Production at RHIC and LHC, ANDREW EMERICK, Cyclotron Institute, Texas A&M University (REU student from University of Minnesota), RALF RAPP, Cyclotron Institute, Texas A&M University — Quantum chromodynamics (QCD) governs the strong interaction, describing the confinement and asymptotic freedom of quarks and gluons. Utilizing ultra-relativistic heavy ion collisions, matter past the critical temperature (Tc ≥ 180 MeV), the region of the quark-gluon plasma (QGP), can be produced. Lattice QCD computations indicate that resonances of heavy quarkonia survive well past the critical temperature: up to 3-4T for bottomonia (Υ). These bound states, such as J/ψ and Υ, are used as essential probes into the phenomenology of the QGP. Euclidean correlator ratios are calculated utilizing in-medium spectral functions for two heavy quarkonia dissociation mechanisms: gluon dissociation (g+Υ → b-b) and quasi-free dissociation (g+q+Υ → g+q+q′ → b-b), corresponding to the strong and weak binding scenarios respectively. These calculations motivate the necessity to reconsider gluon dissociation as the dominant process for Υ in the QGP. Utilizing a kinetic-theory rate-equation approach, the production, suppression, and regeneration of Υ’s in AuAu (PbPb) collisions at RHIC and LHC with √sNN = 200 GeV (2.76 TeV) is calculated and compared to recent STAR (CMS) preliminary data. Treatment is also given to cold nuclear matter effects, simulated by nuclear absorption.

EA.00041 Detection Efficiency of the Clover Array for Recoil Decay Spectroscopy, JOHN ENGEL, MAHAMAD AL-SHUDIFAT, S.V. PAULAUSKAS, MIGUEL MADURGA, ROBERT GRZYWACZ — The Clover Array for Recoil Decay Spectroscopy (CARDS) has been implemented in the newly commissioned facility Low-energy Radioactive Ion Beam Spectroscopy Station at Oak Ridge National Laboratory. Challenging experiments with very neutron rich isotopes near doubly magic 78Ni has been performed. Quantitative analysis of the new data required a thorough measurement of the detection efficiency of the CARDS array using variety of the standard calibration sources. Of particular importance is observed high detection efficiency for gamma rays with energies in the range of 50-200 keV which has been achieved due to implementation of digital electronics. Examples of data from on-line experiments will be presented.

EA.00042 Measurement of the Total Cross Section for γn → pπ− Near Threshold at MAX-lab1, KHAYLA ENGLAND, University of Massachusetts Dartmouth, MAX-TAGG Collaboration — In nuclear science, researchers strive to describe the properties of the nucleons using the framework provided by QCD. A number of theoretical approaches to solving the QCD equations for nuclear processes exist. The predictions of these theories can be compared with the results from accurate experimental measurements for those nuclear reactions where both theory and experiment can provide accurate answers. One such reaction is pion photoproduction near threshold. A measurement of the total cross-section very close to threshold for the γ + n → p + π− reaction is currently being performed using the Tagged Photon Facility at MAX-lab in Lund, Sweden. A LD2 target was used to provide the neutron target. Due to the target thickness, the π− were not detected directly but instead were captured on another nucleus in the target. This capture resulted in a nominal 128 MeV γ-ray approximately 25% of the time. This gamma-ray easily exited the target and was detected using three large NaI(Tl) detectors: CATS, BUNI, and DIANA. An overview of the measurement and preliminary results from the June 2011 run period will be presented.

1Sponsored by NSF OISE/RES award 0553467.

EA.00043 Development of a Polarized He3 Ion Source for RHIC1, CHARLES EPSTEIN, Laboratory for Nuclear Science, MIT, J. ALESSI, E. BEEBE, Collider-Accelerator Division, Brookhaven National Laboratory, W. HEIL, S. KARPUK, Institut für Physik, Universität Mainz, R. MILNER, Laboratory for Nuclear Science, MIT, E. OTTEN, Institut für Physik, Universität Mainz, A. PIKIN, A. ZELENSKI, Collider-Accelerator Division, Brookhaven National Laboratory — A polarized 3He beam in RHIC would enable new, unique, high-energy QCD studies of neutron structure with existing polarized proton beams, as well as important tests of the standard model in a future electron-ion collider (eRHIC). A new polarized 3He ion source using the Electron Beam Ionization Source (EBIS) at BNL is under development. 3He atoms are first polarized using metastability exchange optical pumping (MEOP) and then transferred to EBIS. Fully stripped 3He++ ions would be extracted from EBIS and their polarization measured at low energies before acceleration in RHIC.

1Research supported by DOE Office of Nuclear Physics.

EA.00044 Improving Thick Germanium Detectors: Cryogenic Dark Matter Search1, PAULETTE EPSTEIN2, Cyclotron Institute, Texas A&M University, RUPAK MAHAPATRA, Texas A&M University, CDMS AT TEXAS A&M UNIVERSITY TEAM — Texas A&M University is working on improving the current production rate, quality, and reproducibility of fabricated detectors, specifically for the Cryogenic Dark Matter Search (CDMS) to detect particles called WIMPs (Weakly Interacting Massive Particles). An automated sputtering system is used to deposit amorphous silicon and high quality tungsten and aluminum thin-films on 3 inch by 1 inch germanium substrates to demonstrate repeatable depositions with desired properties, such as, accurate thickness, desirable critical temperature, and good sensitivity at low energy. These techniques can then be used in the future to improve detectors, not only for the search for Dark Matter, but for other areas of research in nuclear and particle physics.

1Funded by DOE and NSF-REU Program.

2REU Student from University of Wisconsin Stevens Point.
EA.00045 (d,n) Proton Transfer Reactions Relevant to Nuclear Astrophysics: The case of $^{17}$O(d,n)$^{18}$F in Inverse Kinematics, EDIZ ERSOY, Michigan State University / National Superconducting Cyclotron Laboratory — The (p,y) process plays an important role in stellar nucleosynthesis and the long term evolution of stars. The (p,y) direct capture process is difficult to observe experimentally due to the low energies and small reaction cross-sections involved, however by comparison, the (d,n) proton transfer process has higher reaction cross-sections in addition to providing insight into the (p,y) process through observations involving neutron kinematics. The particular (d,n) reaction investigated using inverse kinematics was the $^{17}$O(d,n)$^{18}$F reaction. Neutron detection for the $^{17}$O(d,n)$^{18}$F reaction is to be done utilizing the LENDA (Low Energy Neutron Detector Array) detectors. Several calculations were conducted to observe specific excitation levels of astrophysical interest between 5 and 7MeV. These calculations included correlations of neutron and $^{18}$F kinetic energies with their center of mass and scattering angles at different excitation energies. The calculations further included detector placement and coverage for the observation of neutrons and $^{18}$F isotopes. The time-of-flight and angular resolutions of the LENDA detectors were also studied in the calculations.

EA.00046 Non-Uniform Electromagnetic Fields in the SAMURAI TPC, J. ESTEE, J. BARNEY, Z. CHAJECKI, C.F. CHAN, J.W. DUNN, J. GILBERT, F. LU, W.G. LYNNCH, R. SHANE, M.B. TSANG, NSCL, Michigan State University, A.B. MCINTOSH, S.J. YENNELLO, Texas A&M University Cyclotron Institute, M. FAMIANO, Western Michigan University, T. ISOBE, H. SAKURAI, A. TAKETANI, RIKEN, Japan, T. MURAKAMI, Kyoto University, SAMURAI-TPC COLLABORATION — A Time Projection Chamber (TPC) is being developed for the SAMURAI dipole magnet at RIKEN. The main scientific objective for the TPC is to provide constraints on the nuclear symmetry at supra-saturation density. The poster presentation will discuss the design of the TPC field cage and the external electrodes that shape the high electric fields near the cathode. Garfield calculations of the electric field as well as TOSCA calculations of the magnetic field of the SAMURAI dipole will be shown and the impact of the non-uniformity of both fields on electron transport will be discussed. These non-uniformities can introduce components into the electron drift velocity in directions other than the expected vertical direction. This poster presentation will discuss the initial design of a laser calibration system, which will be used to calibrate away the influence of these non-uniformities in the electric and magnetic fields.

3This work is supported by the DOE under Grant DE-SC0004835.

EA.00047 Search for Local Parity Violation in Au+Au collisions at 62.4 GeV at STAR, MIDHAT FAROOQ, UCLA, STAR COLLABORATION — Parity-odd domains are predicted to lead to charge separation of quarks along the orbital momentum of the system created in non-central relativistic heavy ion collisions [1]. A signal consistent with several of the theoretical expectations has been reported by STAR [2]. The measurement is based on a three particle azimuthal correlator, a $P_{L}$- even observable, but sensitive to the charge separation effect. However, the limited statistics of the published results for 62.4 GeV prevented us from a detailed comparison of data between 200 GeV and 62.4 GeV, especially for the more peripheral collisions. In RHIC run2010, high statistics of Au+Au collisions have been taken by STAR, and that enables us to carry out the beam-energy scan of the signal and to revisit 62.4 GeV with much better precision. In this work, we present the measurement of three particle correlator as a function of centrality for Au+Au collisions at 62.4 GeV, and we discuss the energy dependence of the results from 62.4 GeV to 200 GeV.


for STAR Collaboration

EA.00048 Development of Single-Sided Enriched Oxygen-16 and 18 Targets for Exotic Beam Studies, MICHAEL FEBBRARO, FREDERICK BECCHETTI, MITAIRE OJARUEGA, RAMON TORRES-ISEA, University of Michigan, JAMES KOLATA COLLABORATION, AMY ROBERTS COLLABORATION — A technique for the preparation of large reasonably uniform single-sided enriched oxygen targets for radioactive nuclear beam (RNB) experiments using anodization of thin tantalum foils in enriched water is currently being developed. Targets with an active area of 25 mm diameter (and larger) have been prepared using a constant-current source in H$_{2}$O with an additional electrolyte. Currently, work is being done on developing a pulsed-current method for anodization. It is proposed that the pulsed current (a technique used in commercial applications) will increase surface uniformity by replenishing ions locally from the redox reaction, as well as reduce pin-holes in the Ta$_{2}$O$_{5}$ layer by periodic “flushing” of hydrogen gas produced at the surface. The highly exothermic nature of the $^{16}$O ($^{7}$Be, $^{4}$He) reaction planned, allows for single-sided targets on relativity thin supporting foil to be utilized since, the energetic $^{4}$He ions produced will lose minimal energy in the support foil. Testing of the targets will be conducted at the UM-UND TwinSol RNB facility as a joint project between the University of Michigan and the University of Notre Dame funded by grants from the NSF.

EA.00049 A Monte Carlo Simulation for Understanding Energy Measurements of Beta Particles Detected by the UC Nb Experiment, CHI FENG, California Institute of Technology, UC Nb COLLABORATION — It is theorized that contributions to the Fierz interference term from scalar interaction beyond the Standard Model could be detectable in the spectrum of neutron beta-decay. The UC Nb experiment run at the Los Alamos Neutron Science Center aims to accurately measure the neutron beta-decay energy spectrum to detect a nonzero interference term. The experiment consists of a cubic “integrating sphere” calorimeter attached with up to 4 photomultiplier tubes. The inside of the calorimeter is coated with white paint and a thin UV scintillating layer made of deuterated polystyrene to contain the ultracold neutrons. A Monte Carlo simulation using the Geant4 toolkit is developed in order to provide an accurate method of energy reconstruction. Offline calibration with the Kellogg Radiation Laboratory 140 keV electron gun and conversion electron sources will be used to validate the Monte Carlo simulation to give confidence in the energy reconstruction methods and to better understand systematics in the experiment data.

EA.00050 Analysis of the Farmville Meteorite, MEGAN FERM, Keene State College — Meteoroids are objects that are constantly bombarded by cosmic rays in outer space. Through spallation reactions between cosmic rays and meteoroid matter, radioactive nuclides, such as $^{26}$Al, are produced. $^{26}$Al is a positron emitter, meaning that the positron annihilates within a cubic millimeter of the sample. This results in the release of two 511 keV photons, in addition to an 1809 keV gamma ray from the decay to the $^{26}$Mg ground state. This study focuses on the detection of $^{20}$Al in the Farmville meteorite, which fell in North Carolina in 1934. The meteorite has been centered in our sensitive apparatus, and the conditions for detection require a triple gamma coincidence which greatly reduced background. With the radioisotopes measured within the sample, Monte Carlo transport simulations (using the package Geant4) will be performed to determine the amount of $^{20}$Al in the meteorite. With this information, it may be possible to determine the time the meteorite entered Earth’s atmosphere (which should be consistent with the reported find time), the time period that the meteoroid was exposed to the cosmic rays, the pre-atmospheric size of the meteoroid and the intensity of cosmic rays in the inner solar system.
EA.00051 Optimization of a Scintillator for the Measurement of Positrons from Trapped, Polarized $^{37}$K, ERIN FRANCE, Cameron University, DAN MELCONIAN, Texas A&M University — Precision beta decay experiments can be used to test the Standard Model via their value of correlation parameters. The TRINAT collaboration is performing such an experiment using a source of polarized $^{37}$K from a magneto optical trap. The momentum of an emitted positron will be detected using a Silicon strip detector backed by a plastic scintillator. The goal of my research was to optimize the readout of the scintillator by testing different experimental setups. The front face and sides of the scintillator and light guide were wrapped with various reflective materials to find which maximized the light output. We found that one layer of Teflon tape on the front face with a loose wrapping of 3M-ESR (Enhanced Spectral Reflector) on the sides was optimal. We then tested the position dependence of this detector by moving a collimated source of betas across the front face, showing only a $(5.9 \pm 0.5\%)$ reduction in light collection at the edge compared to the center. The product of this work will be used in the upcoming TRINAT experiment measuring the beta asymmetry of $^{37}$K.

EA.00052 Updating the Qweak Database: Maintenance and Accessibility$^1$, MATTHEW GAMMILL, DAMON T. SPAYDE, Hendrix College — The Qweak experiment at Thomas Jefferson National Accelerator Facility is being conducted by a collaboration representing over 25 universities and research institutions, and is an attempt to measure with very low total uncertainty, 4%, the weak nuclear charge of a proton through parity-violating elastic electron-proton scattering. The weak charge can be used to calculate the running Weinberg mixing angle. The Standard Model makes a confident prediction for the mixing angle at low energies, so divergence could point to physics beyond the Standard Model, while agreement will constrain new and existing models. The expected asymmetries are on the order of a few hundred parts per billion, so an exceptional quantity of data (2200 beam-hours) must be gathered. Storing and organizing this data presents a considerable challenge, which the Qweak database aims to satisfy. Tools to improve accessibility for researchers, efforts to improve efficiency, statistical and data quality checks, and ongoing expansion of the database will be discussed.

1Research funded by a grant from the NSF.

EA.00053 Testing a New System for Charged-Particle Nuclear Reactions$^1$, HANNAH GARDINER, JEFFREY BLACKMON, LAURA LINHARDT, KEVIN MACON, MILAN MATOS, CHARLIE RASCO, Louisiana State University, LAGY BABY, YEVEGN KOSHCHEY, GRIGORY ROGACHEV, D. SANTIAGO-GONZALEZ, INGO WIEDENHOVER, Florida State University, DAN BARDAYAN, Oak Ridge National Lab — The Array for Nuclear Astrophysics Studies with Exotic Nuclei (ANASEN) is a charged-particle detector array that is targeted towards reaction studies with radioactive ion beams at FSU and the NSCL primarily to help improve understanding of the nuclear reactions important in stellar explosions. A gas-filled ionization chamber with 10 alternating anode/cathode planes was developed and tested for use with ANASEN to identify the atomic number of recoiling heavy ions by their relative energy loss in the gas. This ionization chamber, in conjunction with high-purity silicon detectors and ASIC electronics, was tested using the $^{170}(p,\alpha)p$ nuclear reaction at FSU. We report on the performance (efficiency and energy resolution) from this test experiment and on plans for improving the ionization counter detector design.

1Supported by the Office of Strategic Initiatives at LSU, the U.S. National Science Foundation, and the U.S. Dept. of Energy.

EA.00054 Simulating Radioactive Decays in Next Generation Geoneutrino Detectors, MEGAN GEEN, Wheaton College, Norton, MA — From analyzing geological samples, the radioactive decays from isotopes $^{238}$U, $^{232}$Th, and $^{40}$K are believed to produce most of the Earth's internal energy. To confirm how much energy these three isotopes are producing, scientists can measure the number of anti-neutrinos (geoneutrinos) which are a product of these decays. While other particles produced by these decays are stopped within the Earth through various interactions and never make it to our detectors, geoneutrinos do not interact and get stopped as frequently making them a good indicator of how many decays actually occur below the Earth's crust. Unlike old geoneutrino detectors, we are developing a new detector that takes advantage of total internal reflection to reduce the number of photomultiplier tubes needed and improve our ability to identify the particle type that reacted within the detector. I will be presenting how we take advantage of total internal reflection in the new detector's design and how we identify when a geoneutrino has reacted within the detector based on Monte Carlo simulations.

EA.00055 Conceptual Design Calculations for the Neutral Pion Hadron Calorimeter (JLab Hall C 12 GeV)$^1$, YEKATERINA GILBO$^2$, Student Intern — The neutral pion’s properties and the additional strange quark in the kaon are opportune to study the proton’s substructure through General Parton Distributions (GPDs), which describe the movements, placements, and momenta of the quarks inside the proton. In pion or kaon electroproduction a neutral pion or kaon is produced. The neutral pion has a short mean lifetime and decays into two real photons. To study the structure of the proton, we have to analyze the neutral pion and the kaon and their decay products, and thus need dedicated detectors. For the neutral pion, a hadronic calorimeter can be placed in the decay photons’ trajectory. For the kaon reaction, the most efficient detection method is an aerogel Cerenkov detector. Both cases rely on detector performance, and thus it is important to evaluate the conceptual design and all components of the detector carefully. In this presentation I will present results of conceptual design studies for the p$^-$ hadron calorimeter and of a new method based on biological techniques to evaluate the aerogel material index of refraction for the kaon detector.

1Supported in part by NSF grants PHY 1019521 and 1039446.

2Junior in High School

EA.00056 Beam characterization and optimization using a tunable Iris Aperture, S.A. GRAVES, R.L. KOZUB, Tenn. Tech. U., D.W. BARDAYAN, ORNL — Successful reaction studies with radioactive beams require optimization of both the beam tune and detector placement. Some experiments require placing detectors close to the beam axis, and thus in potentially harmful positions, while the beam is being tuned. Other experiments benefit from some detector shielding that cannot necessarily be estimated beforehand. A good solution can often be achieved by an appropriate placement of an Iris Aperture (i.e., a circular collimator with a variable diameter) in the target chamber. Although this device is useful for shielding detectors, e.g., while tuning the beam at the beginning of an experiment, it is difficult to determine the exact size of the opening while it is under vacuum. A control module for the motor and screw drive system has been built that allows an operator to open and close the Iris Aperture from outside the vacuum. Using LED indicators, the module also provides information on the size of the aperture opening. Details will be presented. This research is supported by the U. S. Department of Energy.

EA.00057 Table of isotopes as a teaching tool, JOHNATHAN GROSS, ARTEMIS SPYROU, ZACH CONSTAN, MICHAEL THOENNESSEN, National Superconducting Cyclotron Laboratory — A large number of middle and high school science teachers are visiting the National Superconducting Cyclotron Laboratory every year to participate in a variety of available outreach programs. After these visits the teachers often go back to their schools and would like to share their experiences at the laboratory with their students. These efforts are in many cases supported by the laboratory faculty and staff. One of the most requested tools is a convenient and compact version of the Chart of Nuclei, modified to be suitable for a high school classroom. First samples of this work will be presented.
I will talk about the data analysis for the activity of $^{60}$Fe. $^{60}$Fe has an accepted value of $2.62 \times 10^6$ yr. This new value measured at the Technical University of Munich is in contradiction to the previously accepted value of $1.49 \times 10^6$ yr. Our new experiment is to re-measure the half-life of $^{60}$Fe through Accelerated Mass Spectroscopy (AMS) and a low level counting station to eliminate some of the background radiation and other error in the accepted value. In my presentation I would like to thank NSF-PHY97-58100 for this grant.

Work supported by NSF grant PHY-1010745.

This work has been supported in part by the National Science Foundation (Grant Nos. PHY-1068192 and PHY-1062819).

This work was supported in part by the National Science Foundation (Grant Nos. DE-AC02-06CH11357).

This work was supported in part by U.S. Department of Energy, Office of Nuclear Physics, under contract No. DE-AC02-06CH11357.

This work was supported in part by the National Science Foundation (Grant Nos. PHY-1068192 and PHY-1062819).
EA.00065 Modeling the Effects of Mirror Misalignment in a Ring Imaging Cherenkov Detector1
TAWANDA HITCHCOCK, AUSTIN HARTON, EDMUNDO GARCIA-SOLIS, Chicago State University — The Very High Momentum Particle Identification Detector (VHMPID) detector is planned as an upgrade for the ALICE experiment at the LHC. This detector identifies charged hadrons in the range of 5 GeV/c to 25 GeV/c momentum range. The VHMPID uses a Ring Imaging Cherenkov (RICH) detector to determine the particle velocity. This is accomplished by focusing the Cherenkov radiation generated by a relativistic charged particle onto a photon detector using a 24 segment mirror and calculating from that image the Cherenkov angle. This velocity information coupled with the particle momentum allows the particle mass to be calculated. A major issue in the RICH detector is that changes in temperature, humidity and other environmental conditions can cause movements in mirror position leading to errors when determining the Cherenkov angle. In this poster we will model the effects of mirror misalignment using a commercially available optical modeling software package. This will include quantifying the effects of both rotational and translational mirror misalignment for the initial assembly of the module and later on particle identification.

1Research funded by NSF grant PHY-0968903.

EA.00066 Conceptual Design and Data Acquisition Techniques (JLab Hall C 12 GeV Kaon Aerogel Detector)1
NATHANIEL HLAVIN, Catholic University of America — The additional flavor degree of freedom in the \(H(e,e'K^+)\Lambda\) and \(H(e,e'K^+)\Sigma^+\) reactions provides a unique opportunity to study the reaction mechanism underlying strangeness production and the transition from hadronic to partonic degrees of freedom in exclusive processes. However, due to experimental challenges the potential of these reactions has not been fully exploited to date. One such challenge is the separation of kaons from pion and proton backgrounds. At high momenta, a kaon aerogel Cerenkov detector is the simplest and most economical way of addressing this issue. At CU, we are building such a detector for Hall C at the 12 GeV Jefferson Lab. Desirable properties are high light output for kaons, and good efficiency in the collecting and converting the light using cost-effective PMTs. I will present the findings from physics simulations performed for the conceptual design and ongoing component testing, with focus on data acquisition techniques.

1Supported in part by NSF Grants PHY 1019521 and 1039446.

EA.00067 Studying the Light Antiquark Asymmetry in the Nucleon Sea with FNAL E-906/SeaQuest
KRISTIN HOLZ, Abilene Christian University, FNAL E-906/SEAQUEST COLLABORATION — Fermilab’s E-906/SeaQuest experiment will improve our understanding of the structure of the proton using Fermilab’s 120 GeV Main Injector. Protons are collided with liquid hydrogen and liquid deuterium targets to measure the cross section ratio for the Drell-Yan di-muon process. From this ratio, SeaQuest will extract the anti-down to anti-up quark ratio as a function of Bjorken-x up to approximately 0.45. This measurement extends the results of the FNAL E-866/NuSea experiment, that measured the light antiquark asymmetry up to approximately x = 0.3. The momentum of the muons produced in the collisions is measured using a two magnet spectrometer and a four-station detector consisting of hodoscopes and wire chambers. SeaQuest will have greater statistical precision than E-866, in particular in the Bjorken-x region above 0.2, where the past experiment indicated the dbar/ubar ratio approaching unity. This presentation will give an update on the E-906/SeaQuest experiment, including the status of data taking and goals.

EA.00068 Construction, Testing, and Analysis of Radon Mitigation System
DAN JARDIN, RICHARD SCHNEE1, Syracuse University, CDMS COLLABORATION2 — The search for dark matter or other rare events such as neutrinoless double-beta decay is difficult in the presence of background radiation such as the alpha and beta emissions from the 222Rn decay chain. In order to reduce the radioactive background from Rn-daughters, an ultra-low radon clean room is being built at Syracuse University. A vacuum-swing adsorption system is used to mitigate the radon. Air flows through one of two tanks filled with charcoal that the radon absorbs to, allowing the filtered air to pass into the clean room. Computer-controlled valves direct the airflow so that one tank filters the air while the other tank is purged of radon by circulating a small fraction of the cleaned airflow back through the tank at low pressure. The durations, pressures, and flow rates of each stage of building pressure, filtering, releasing pressure, and purging in the tanks are optimized in order to maximize the reduction of radon from the air.

1Professor
2Cryogenic Dark Matter Search

EA.00069 PIXE Analysis of Indoor Aerosols
CHRISTOPHER JOHNSON, COLIN TURLEY, ROBERT MOORE, MARIA BATTAGLIA, SCOTT LABRAKE, MICHAEL VINEYARD — We have performed a proton-induced X-ray emission (PIXE) analysis of aerosol samples collected in academic buildings at Union College to investigate the air quality in these buildings and the effectiveness of their air filtration systems. This is also the commissioning experiment for a new scattering chamber in the Union College Ion-Beam Analysis Laboratory. The aerosol samples were collected on Kapton foils using a nine-stage cascade impactor that separates particles according to their aerodynamic size. The foils were bombarded with beams of 2.2-MeV protons from the Union College 1.1-MV Pelletron Accelerator and the X-ray products were detected with an Amptek silicon drift detector. After subtracting the contribution from background particles, we are leveraging the PIXE software to classify and identify the elements present in the aerosols.

EA.00070 Finding the Incompressibility of Nuclear Matter1
JENNIFER KACHEL, Cyclotron Institute, Texas A&M University (REU student from Marietta College) — The incompressibility coefficient is an important ingredient of nuclear matter’s Equation of State and is significant to understanding neutron stars, supernova explosions and heavy ion collisions. Nuclear matter’s incompressibility \(K_{inm}\) can be determined from the energy of the isoscalar Giant Monopole Resonance theory of nuclei: a collective mode of the nucleus in which the protons and neutrons oscillate in phase. We determined the compressibility coefficients for a set of nuclei using data for the energy of the monopole resonances and the mass radii. Using an \(A^{-1/3}\) expansion analogous to that of the mass formula we extract \(K_{inm}\). Upon examination of the coefficients of the expansion, it becomes evident that more data is needed to deduce an accurate value for \(K_{inm}\).

1Funded by DOE and NSF-REU Program.

EA.00071 Analyzing aCORN Experiment Data
ROBERT KOSAR, Hamilton College, ACORN COLLABORATION — A precise measurement of the electron-antineutrino angular correlation coefficient in neutrino beta decays, parameterized by “a”, can be used to test the standard electroweak model. The aCORN collaboration will measure “a” to 1% uncertainty. aCORN employs a kinematic approach to divide decays into two classes; the relative probability of a decay being in each class is related to “a”. The results of aCORN’s preliminary data run, completed last spring, are being analyzed to prepare for the physics run starting in February 2012. An algorithm to extract “a” from the data and the effects of the experimental parameters on the measured value of “a” are discussed.
EA.00072 Testing and Characterization of Acrylic for the Daya Bay Reactor Neutrino Experiment, MICHAEL KROHN, BRYCE LITTLEJOHN, KARSTEN HEEGER, University of Wisconsin — The Daya Bay reactor antineutrino experiment will determine the last unknown neutrino mixing angle T13 with a sensitivity of 0.1 or better. The measurement of T13 is important for theoretical model building and for possible searches of CP violation in the neutrino sector. Poly(methyl methacrylate), otherwise known as acrylic, is an important component for the construction of the target vessels in the antineutrino detectors and we have performed multiple tests that determined its unique properties. My project has been to understand the properties of acrylic in order to minimize systematic errors and test mechanical and materials compatibility issues in the Daya Bay reactor antineutrino experiment. These tests address both the mechanical and technical issues of the detector as well as the systematic affects introduced by the acrylic.

EA.00073 Calibration of the Sweeper Chamber Charged-Particle Detectors for the LISA Commissioning Experiment, J. KWIATKOWSKI, A. GROVOM, W. ROGERS, Westmont College, MONA COLLABORATION — The new LISA (Large-area multi-Institutional Scintillator Array) neutron detector array, designed to be used in conjunction with MoNA (Modular Neutron Array) was recently commissioned at the NSCL in an experiment designed to investigate excited states of neutron-rich Oxygen isotopes near the neutron drip-line. Charged fragments resulting from the neutron decays were swept out of the beam direction by the Sweeper Magnet after which they passed through a series of charged-particle detectors for fragment trajectory and energy determination. In order to achieve isotope separation and identification at the focal plane, which is then used to reconstruct the invariant mass of the unbound states, precise determinations of the fragment and neutron energies and trajectories are required. To correct for time-shifts in the charge-particle detectors that develop over the entire length of the experiment, Root C++ macros were developed to analyze and precisely correct for these detector drifts to within few tenths of a nanosecond. Root macros were also developed to position calibrate the ion chamber and CRDC’s. Results for the LISA commissioning run will be presented.

EA.00074 A systematic study of the sensitivity of triangular flow to the initial state fluctuations in relativistic heavy-ion collisions, ROLANDO LA PLACA, Harvard University, HANNAH PETERSEN, STEFFEN BASS, Duke University — At sufficiently high temperatures and densities, QCD matter forms a deconfined state called the quark gluon plasma (QGP). This state of matter can be created in collisions of ultra-relativistic heavy-ions, e.g. at the Relativistic Heavy Ion Collider. Due to its short lifetime, many QGP properties can only be inferred indirectly through a comparison of the final state measurements with transport model calculations. For our investigation we use a hybrid transport model based on the Ultra-relativistic Quantum Molecular Dynamics (UrQMD) transport approach using an ideal hydrodynamic expansion for the hot and dense stage. Using UrQMD initial conditions for an Au-Au collision, particles resulting from a collision are mapped into an energy density distribution that is evolved event-by-event with a hydrodynamical calculation. By averaging these distributions over different numbers of events, we studied how the granularity of the distribution affects the initial eccentricity, the initial triangularity, and the resulting flow components. The average elliptic flow in non central collisions is not sensitive to the granularity, while triangular flow is. The triangularity might thus provide a good measure of the amount of initial state fluctuations necessary to reproduce the experimental data.

EA.00075 Monte-Carlo Simulations of Near-Threshold $\gamma + n \rightarrow p + \pi^-$ Measurements at MAX-lab, SAMUEL LIPSCHUTZ, The George Washington University, MAX-TAGG COLLABORATION — Unlike classical regimes of physics, nuclear physics does not yet have a complete theoretical description. To scrutinize the validity of theoretical constructions (such as ChPT) accurate experimental data need to be obtained. Currently, a measurement of the total cross section for $\gamma + n \rightarrow p + \pi^-$ is underway at MAX-lab in Lund, Sweden, using a liquid deuterium target. The resulting $\pi^-$ is detected by its subsequent capture and photoemission by a deuteron through $\pi^- + d \rightarrow 2n + \gamma$. Several large sodium iodide spectrometers detect this emitted photon. Since this experiment deals with an extended target, there are several key quantities that need to be investigated by simulation. The experimental geometry was reproduced in a GEANT simulation where, among other parameters, the fraction of $\pi^-$, which do not undergo recapture in the target and the detector acceptances from the extended target were examined. Preliminary results will be shown.

EA.00076 Simulation of GRETINA Lifetime Experiment, CODY LITTLELEY, HIRONORI IWASAKI, ANTOINE LEMASON — In order to understand properties of exotic atomic nuclei, the research group has developed a method to measure the rate of decay of excited states in certain unstable isotopes, for example $^{66}\text{Fe}$ [1]. By measuring the Doppler shift of gamma rays with a so-called plunger device [1] it is possible to deduce with great accuracy the excited-state lifetime. This technique, which is called the Recoil Distance Doppler-shift Method, has precision on the order of one pico second. I will present the development a simulation software package which will help the research team to quantize and to analyze the data from experimental runs. This software is based upon existing software which was used for simulations of the SeGA project. It has been modified to support the GRETINA detector, which is used in the experimental setup for the lifetime measurements. The software makes use GEANT and ROOT toolkits, which are essential for the calculations of the interactions of particles with the detector and the recording of that data.


EA.00077 Measurements of gamma radiation levels and spectra in the San Francisco Bay Area, B.T. LO, K.P. BROZEK, C.T. ANGELL, E.B. NORMAN, Univ. of California at Berkeley — Much of the radiation received by an average person is emitted by naturally-occurring radioactive isotopes from the thorium, actinium, and uranium decay series, or potassium. In this study, we have measured gamma radiation levels at various locations in the San Francisco Bay Area and the UC Berkeley campus from spectra taken using an ORTEC NOMAD portable data acquisition system and a large-volume coaxial HPGe detector. We have identified a large number of gamma rays originating from natural sources. The most noticeable isotopes are $^{214}\text{Bi}$, $^{40}\text{K}$, and $^{208}\text{Ti}$. We have observed variations in counting rates by factors of two to five between different locations due to differences in local conditions -- such as building, concrete, grass, and soil compositions. In addition, in a number of outdoor locations, we have observed 604-, 662-, and 795-keV gamma rays from $^{137}\text{Cs}$, which we attribute to fallout from the recent Fukushima reactor accident. The implications of these results will be discussed.

This work was greatly supported by a GWU OVPR undergraduate fellowship and DOE grant #DE-FG02-99ER41110.
EA.00078 Study of Energy Resolution of Lead Glass Calorimeter\(^1\), DANIEL LOMBARDO, University of California Los Angeles — In the proposed experiment at Jefferson Lab, Geop(s), the structure of the proton will be studied by measuring the proton elastic form factors. In order to ensure that the scattering events are elastic, the proton angle and energy will be measured with a magnetic spectrometer and the electron angle and energy will be measured with a lead glass calorimeter, called BigCal. An aluminum sheet, 20cm thick, is typically placed in front of BigCal to shield the calorimeter from unwanted radiation, but this causes a loss of resolution in the measured energy. A simulation was carried out to determine whether replacing the shield with radiation hardened lead glass would significantly improve the resolution of the calorimeter. The simulation was run with the aluminum shield in place, and then again with the new radiation hard lead glass shield. Comparing the measured energies between the two different shields it was found that the resolution improved by a factor of 2 with the lead glass shield at an electron energy of 4.6 GeV. The resolution continued to increase at lower values of the electron energy. This improvement in resolution will be useful in isolating elastic scattering events in the trigger for BigCal.

\(^1\)This project was supported by the Department of Defense ASSURE Program, and the National Science Foundation REU Program.

EA.00079 Creation of Thin Deuterated Polyethylene Targets for Inverse Kinematics Transfer Reaction Measurements \(^{1,2}\), K.D. LONG, R.L. KOZUB, Tenn. Tech. U., B. MANNING, Rutgers U., S.D. PAIN, C.D. NESARAJA, M.S. SMITH, D.W. BARDAYAN, ORNL — Transfer reactions are an important tool for the study of single-particle structure of nuclei. Such measurements have many applications to the field of astrophysics, such as study of the rapid neutron capture (\(r\)-) process that is believed to create heavy elements in supernovae. Measurements in inverse kinematics are necessary when studying transfer reactions on unstable nuclei with lifetimes too short to be used as targets. The measurement of deuteron-induced transfer reactions in inverse kinematics requires a target containing a significant quantity of deuterons, such as deuterated polyethylene (\((\text{C}_2\text{D}_4)\text{n}\) or \(\text{CD}_2\)), which can be fabricated into thin foils by dissolving \(\text{CD}_2\) in xylene. A campaign is underway at ORNL to measure \((d,p)\) reactions with unique heavy fission fragment beams. For such measurements, thin targets are favored to minimize peak broadening in the energy spectra of emitted particles. Emphasis has been placed on creation of targets of \(\sim 70\) mg/cm\(^2\) thickness, significantly thinner than previously used at ORNL. Improvements, such as careful control of the temperature of slides covered by the \(\text{CD}_2\)/xylene solution, have been developed to produce such targets. Details will be presented. This research is supported by the Office of Nuclear Physics in the U. S. Department of Energy.

EA.00080 A New 3He-Target Design for Compton Scattering Experiment \(^3\), S. MAHALCHICK, Barnard College, H. GAQ, G. LASKARIS, W. WEIR, Duke University, Q. YE, Oakridge National Laboratory, J.L. YE, Duke University — The neutron spin polarizabilities describe the stiffness of the neutron spin to external electric and magnetic fields. A double-polarized elastic Compton Scattering experiment will try to determine the neutron spin polarizabilities using a new polarized \(^3\)He target and the circularly polarized photon beam of HiS facility at the Duke Free Electron Laser Laboratory (DFELL). To polarize the \(^3\)He target, a newly constructed solenoid is being used which can provide a very uniform magnetic field around the target area and allows to place High Intensity Gamma Source NaI Detector Arrays (HINDA) closer to the target. The ideal target polarization is 40-60% and will be measured using the nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) techniques. A prototype of the polarized \(^3\)He target is being constructed in the Medium Energy Physics Group laboratories at Duke and is currently being tested. The experiment is expected to take place in 2013 after the DFELL upgrade. I will be presenting details of the construction process, including design specifications and data from the magnetic field mapping, as well as preliminary target polarization results. This work is supported by the US Department of Energy, under contract number DE-FG02-03ER41231, and by the National Science Foundation, grant number NSF-PHY-08-51813.

\(^3\)Funded by DOE and NSF-REU Program.

EA.00081 Conductance Control Iris for the K150 Cyclotron H- Ion Source\(^2\), ARMANDO MALDONADO\(^2\), HENRY CLARK, GABRIEL TABACARU, Cyclotron Institute A&M University — A multi-cusp H- ion source has been installed on the K150 cyclotron for the production of high intensity proton beams. These beams will be used to create secondary radioactive ions for the Upgrade Project \([1]\). One of the limiting factors in creating an intense beam comes from poor vacuum along the injection line caused by the ion source itself. A large flow of hydrogen gas is required to make the Hydrogen negative (H-) ions in the ion source. As a result, many of the hydrogen molecules exit the ion source and migrate into the injection line and deteriorate the vacuum. To reduce the flow of these molecules into the injection line, a computer controlled iris will be installed between the ion source and the injection line. With the iris set at the correct diameter, the vacuum in the injection line should improve the transport efficiency of the H- ions to the cyclotron injector should increase. For the project we used an 8” OD Conflat DVM brand iris with an MDrive 17 Plus motor which will be controlled by a Labview software interface.

\(^2\)REU Student from Angelo State University

EA.00082 Study of Hot QCD Matter Using QCD Jets as a Tomographic Probe of the Matter at the LHC \(^1\), SULTAN MALIK, University of California, Berkeley, PETER JACOBS, BO FENTON-OLSON, LBNL — Quantum chromodynamics (QCD) predicts that at very high temperatures, nuclear matter undergoes a phase transition from its normal hadronic gas state to a deconfined partonic phase called the quark-gluon plasma (QGP). This state of matter is generated in high energy collisions of heavy atomic nuclei. QCD jets are correlated sprays of hadrons arising from a hard partonic momentum transfer during the initial phase of the collision. Jets interact strongly with the hot QCD medium, leading to a marked modification of their structure. This phenomenon, known as “jet quenching,” provides unique probes of the QGP. This analysis presents a new approach to jet quenching, utilizing the coincidence of a trigger hadron with a recoil jet. Jets are reconstructed using state-of-the-art tools and the underlying event background, intrinsic to heavy ion collisions, is assessed in detail. This project was supported by the National Science Foundation, grant number NSF-PHY-08-51813.

EA.00083 Simulation of an Apparatus to Measure the Parity-Violating Neutron Spin Rotation in \(^4\)He\(^1\), R.C. MALONE, B.E. CRAWFORD, Gettysburg College, NSR COLLABORATION — In order to better understand the nucleon-nucleon weak interaction, the Neutron Spin Rotation (NSR) collaboration performed an experiment at NIST that measured a parity-violating neutron spin rotation per unit length in liquid helium of \(\sim 1.7\pm1.9\) (stat.)\(^1\)\pm1.4\) (sys.) \times 10^{-7} \text{ rad/m} \([1]\). A second experiment is planned using a more intense neutron beam to reduce the statistical uncertainty, which was the limiting source of uncertainty in the measurement. This project focused on analysis of systematic effects in the experiment using a Monte Carlo computer simulation which traces neutrons down the beamline, calculating scattering from target materials, reflections from neutron waveguides, and rotations due to magnetic fields. Systematic effects resulting from small angle scattering coupled with different target locations and beam geometries were studied.

EA.00084 Investigations of multi-particle exit channels of levels in light nuclei. J.J. MANFREDI, R.J. CHARITY, J.M. ELSON, R. SHANE, L.G. SOBOTKA, Washington University, Z. CHAJECZI, D. COUPLAND, H. IWASAKI, M. KILBURN, J. LEE, W.C. LYNCH, A. SANETULLAEV, M.B. TSANG, J. WINKELBAUER, M. YOUNGS, National Superconducting Cyclotron Laboratory and Michigan State University, S.T. MARLEY, D.V. SHETTY, A.H. WUOSMAA, Western Michigan University, T.K. GHOSH, Variable Energy Cyclotron Centre, M.E. HOWARD, Rutgers University, HIRA COLLABORATION — The HIRA array was used to study the multi-particle exit channels produced from the interactions of an $^{12}C/A = 70$ MeV $\mathrm{\alpha}$ beam with a $^{16}O$ target. Correlations between these particles were studied to analyze the decays, particularly whether they occur in one prompt step or sequentially through long-lived intermediates. The five-body decay of $^{8}$Be is found to occur in two steps of two-proton decay that is $^{6}$Be ground-state. In the first step, the correlations between the protons clearly show the enhanced diphoton character of the decay, and the second step was found to be consistent with the independently measured $^{8}$Be two-proton decay. A new mass and uncertainty for $^{8}$C were deduced from these data and used in a refit of the $A = 8$ data to the isobaric multiplet mass equation (IMME). This fit indicates the need for term corrections beyond quadratic meaning that isospin symmetry is clearly broken for the $A = 8$ multiplet.

EA.00085 Discovery of Isotopes. ERIN MAY, MICHAEL THOENENES. — To date, no comprehensive study has been undertaken regarding the initial detection and identification of isotopes. At NSCL, a project has been initiated to catalog and report the initial observation of every isotope. The conditions characterizing the successful discovery of an isotope include a clear and unambiguous mass and element identification through decay curves, mass spectroscopy, gamma-ray spectra, and/or relationships to other isotopes, as well as the publication of such findings in a refereed journal. I will present the documentation for eight elements: cesium, lanthanum, praseodymium, promethium, samarium, europium, gadolinium, and terbium. The year and author of each initial publication along with the location and methods of production and identification will be shown. A summary and overview of all ~3000 isotopes documented so far as a function of discovery year, method, and place will also be presented.

EA.00086 Nuclear Physics with CLAS12 and the High Threshold Cherenkov Counter. JEFFREY MAZUREK, University of Connecticut — New construction is underway at Thomas Jefferson National Lab for the 12 GeV upgrade to the Continuous Electron Beam Accelerator Facility (CEBAF) and the CEBAF Large Acceptance Spectrometer detector upgrade (CLAS12) at Hall B. This upgrade allows a broad experimental program with the new CLAS12 detector to map the nucleon’s 3-dimensional spin and flavor content through the measurement of deeply exclusive and semi-inclusive processes. During an experiment, CLAS12 will record data when its High Threshold Cherenkov Counter (HTCC) identifies a scattered electron through the generation of Cherenkov Light. Cherenkov Light indicates an event and is created when a charged particle moves faster than the speed of light in a medium. The HTCC uses a system of 48 ellipsoidal mirrors assembled into one circular, 8-ft diameter mirror to capture this light. While both pions and electrons can generate Cherenkov Light, only that from an electron identifies an event. Therefore, the HTCC must distinguish the light of a scattered electron from the light by pion contamination. This paper offers an overview of Jefferson National Lab’s new CLAS12 detector and a detailed presentation of the HTCC.

EA.00087 Gas Electron Multiplier Tracking Telescopes for OLYMPUS. JOSHUA MCMAHON, MILES CAMPBELL, OLYMPUS COLLABORATION — The OLYMPUS collaboration is conducting an experiment to measure two-photon contributions to elastic electron scattering. The experiment is taking place at the DORIS storage ring at DESY, Hamburg, Germany using the upgraded BLAST detector from the MIT-Bates Linear Accelerator Center. Gas Electron Multiplier (GEM) telescopes are used to detect scattered leptons at a forward angle to monitor the luminosity. The GEM detectors have been commissioned at the test facility at DESY and were installed along with the main detector in the DORIS storage ring. With the testbeam the performance characteristics such as gain, efficiency, multiplicity, and resolution of the GEMs were studied.

EA.00088 Analysis of the 4He target density for Jefferson Lab Short Range Correlations (SRC) experiments. NICHOLAS MCMAHON, Christopher Newport University — A series of Short Range Correlations experiments aiming to study the interactions between nucleons inside 4He nuclei ran in Hall A of the Thomas Jefferson National Accelerator Facility (TJNAF) between February and May of 2011. My work consists on the study of the density of the 4He gas target. The Target conditions were set to pressures between 190 and 210 PSI and temperatures between 18 and 20 K. My work shows that virial corrections to the target density taking care of the deviations from an ideal gas model are up to 2%. An additional study showed how slowly target heating increased along with the beam current between 5 and 60 uA.

EA.00089 Analyzing Detector Acceptance for Design Optimization. KATHRYN MEEHAN, DARKLIGHT COLLABORATION — Both the unsolved mystery of 26% of our universe that is dark matter as well as other observed astrophysical anomalies have motivated theories that go beyond the standard model and predict the existence of an $A’$ boson. This particle is theorized as the carrier of a “dark force” that couples with electromagnetism. The Free Electron Laser at Jefferson Laboratory will be used to create an e-p collision that will allow the DarkLight detector to detect the $A’$ boson if it occupies the relevant parameter space. To detect the $A’$ boson, detectors need to be placed at locations that would maximize the signal and minimize background processes such as $e^- + e^- \rightarrow e^+ + e^-$ (Moller scattering) and $e^- + p \rightarrow e^- + p$ (e-p scattering). The computer program ROOT is used to calculate the acceptance and efficiency of the detector for different cuts on the angles of outgoing particles. Efficiency plots were generated for a realistic detector cut.

EA.00090 Production of High-Purity Germanium Ingots for Detector-Grade Crystal growth. HAO MEI, University of South Dakota, CUBED COLLABORATION — The growth of high-purity germanium crystals is needed for planned DUSEL experiments. Many steps are required convert bulk germanium into a germanium-silicon reference The electronic-grade polycrystalline germanium starting material is zone refined in a synthetic silica crucible inside a graphite boat while enclosed within a quartz tube filled with hydrogen. Ingots of impure germanium approximately 60 cm long are held horizontally in a graphite boat as a radio frequency (RF) coil surrounding the quartz tube melts a small vertical section of the ingot. As the ingot is slowly drawn through the fixed coil, the trailing solid is more pure than the adjacent liquid. Therefore, the last liquid to solidify at the ingot’s end contains an increased impurity level. Since the impurities concentrate in the molten section, the repeated and sequential melting from one end towards the final end, sweeps the impurities to the ingot’s final end. This sweeping operation is repeated many times until the impurities are concentrated at one end of the ingot. This final end is then removed to leave the desired higher-purity portion. Production rates can be increased by drawing multiple ingots through multiple coils within one hydrogen-filled quartz tube. Purity is then determined by a Hall Effect measurement.

EA.00091 Development of Testing Equipment for Aerogel and Large-Diameter PMTs. MICHAEL METZ, Catholic University of America — The 12GeV upgrade to the Jefferson Laboratory particle accelerator allows for unique new opportunities to study hadron structure. In particular, the kaon electroproduction reaction provides new insights on the transition from the hadronic to partonic degrees of freedom. To study hadron structure through kaon production in Hall C at JLAB a new detector is needed. A threshold aerogel detector that uses the emission of Cerenkov radiation to separate charged kaons from pions and protons is being built at CUA. In order to distinguish kaons from pions and protons the desired momentum ranges of 2-4 GeV/c and 4-6 GeV/c, aerogel at indices of refraction $n = 1.030$ and 1.020 is required, respectively. Additionally, photomultiplier tubes are required to effectively detect the emitted radiation. In this presentation I will demonstrate the design of the new equipment I developed for testing the detector components and results from commissioning it.
EA.00092 Magnet Construction for Neutron Interferometry1, ROB MILBURN, CHRIS CRAWFORD, University of Kentucky — The study of neutron interferometry highlights some of the essential components of quantum mechanics allowing us to study the wave-like nature of the neutron. The spin of polarized monochromatic neutrons in an interferometer can be flipped by passing through a static B-field perpendicular to the holding field. Constraints on such a magnet are that the field must be constant within a cylindrical volume, but zero everywhere outside the coil. A double cosine theta coil has been designed and is currently undergoing construction. A comparison of the prototype’s results to simulation results will be presented.

1Supported in part by NSF grant PHY-0855584.

EA.00093 Gain-Matching and Efficiency Tests On Double- and Single-Ended Hodoscope Arrays1, ANDREW MILLER, Abilene Christian University, SEAQUEST COLLABORATION — E-906/SeaQuest is a fixed target experiment analyzing the ratio of anti-down to anti-up quarks in the nucleon sea of the proton as well as studying shadowing, anti-shadowing, and energy loss effects using the Drell-Yan process. The muon detector consists of a two-magnet spectrometer and 4 stations of drift chamber and hodoscope combinations. The hodoscopes are used to produce the fast trigger system for the spectrometer. In order to prepare the station 3 and 4 hodoscope arrays for the experiment, the PMTs were initially gain-matched by using a multichannel analyzer to record the spectra from a CsI(37 radiation source and adjusting the voltage so the Compton edge occurred in the same channel. Once this was completed, cosmic ray rate tests were performed using various discriminator thresholds values to verify the chosen PMT voltages. This is critical as each 18-channel discriminator to be used must have a single threshold. Interesting effects observed in these rates due to nearby shielding will also be shown to illustrate the special difficulties in using cosmic ray muons for these tests.

EA.00094 Verification of the Endcap Electromagnetic Calorimeter Implementation into the STAR Simulation Package1, KEVIN MILLER, Valparaiso University, with the STAR Collaboration, STAR COLLABORATION — Spin experiments using the STAR detector at Brookhaven National Laboratory seek to measure the gluon contribution to the proton’s spin. These measurements require the Endcap Electromagnetic Calorimeter (EEMC) to be well-modeled in the STAR simulation package. This analysis will confront simulations and data from proton-proton collision runs taken in 2006. Comparisons of quantities, such as cluster energy, opening angle, particle invariant masses, and hit distributions will be shown.

1Special Thanks to the Department of Energy for Their Generous Support.

EA.00095 Software Implementation for the Characterization of Silicon Pixel Detectors, KYLE MILLER2, Texas A&M University, Cyclotron Institute, RICARDO EUSEBI, Texas A&M University — Pixel and Silicon-strip detectors are now a fundamental component for the detection, identification, and characterization of particles in nuclear and particle physics. They are used for beam diagnostics, for measurements of energy lost by electrons in full-energy measurements of alphas and protons and heavy nuclei. The pixel and strip detectors are usually the most complex, sensitive, and expensive system in multi-million dollar detectors such as the ones in the Relativistic Heavy Ion Collider at Brookhaven. This poster describes the development of a characterization station for pixel and strip detectors in clean room at Texas A&M University. As a first step we describe the quantities to be measured for a full characterization of the pixel sensor, the identification of the needed electronic circuitry and the logic behind the control and readout of the system as a whole. The second stage shows the analysis of the obtained results from a set of next-generation radiation-hard pixel sensors.

1REU student from Florida A&M University

EA.00096 A further measurement to test electron conversion theory: transitions produced following the \( \eta \) decay of \( ^{116} \text{In} \), SONDRA MILLER3, JOHN HARDY, NINEL NICA, JOHN GOODWIN, Texas A&M University, Cyclotron Institute — Precise internal conversion coefficients (ICCs) are vital to the study of nuclear decay schemes, determining transition rates, spin and parity designations, and branching ratios. However, there are very few experimental tests of the calculated ICC’s and in fact there are only ~10 measurements available with errors of less than 1%. Such a paucity of data complicates scientists’ efforts to determine what theoretical calculations should be used to model the ICC. The goal of our present experiment is to determine the \( n_\gamma \) for the 65.7-keV M4 transition in \( ^{119} \text{Sn} \). However, the energy of the \( ^{119} \text{Sn} \) x-rays is below the energy range that our HPGe detector is accurately calibrated for. The \( \eta \) decay of \( ^{116} \text{In} \) populates states in \( ^{116} \text{Sn} \) which produce a few strong transitions with well established conversion coefficients. This allows us to calibrate our detector at the energy of the Sn x-rays, which is an essential requirement for the measurement of the \( ^{115} \text{Sn} \) ICC.

1REU student from Florida A&M University

EA.00097 Trigger Logic using memory bits for SeaQuest E - 906, Prajwal Mohanmurthy, Mississippi State University, JIN-YUAN WU, Fermi National Accelerator Laboratory, SHIQUAN-HAL SHIU, Academia Sinica — The SeaQuest E — 906 at Fermi National Accelerator Laboratory is a fixed target Drell - Yan process experiment to measure the \( \text{ud} \) asymmetry in proton and strip sea using the proton beam from the main injector at 120 GeV. The SeaQuest trigger system consists of four hodoscope stations guided by a coincidence logic to select candidate Drell-Yan dimuon tracks. The trigger electronics involves a CAEN VME 1495 which is a FPGA implementation board. Two basic ways of implementing the trigger logic using FPGA are based either on the gate elements or on the memory bits. The feasibility of using digitized hodoscope signal output wires themselves to address the memory bits, in order to implement the SeaQuest E — 906 trigger logic in the memory, was investigated.

1Fermi National Accelerator Laboratory and DOE DE-FG02-07ER41528

EA.00098 Monte Carlo Studies: Tagging Heavy Quark Initialized Jets, ALYSSA MONTALBANO, Rensselaer Polytechnic Institute — Quark-Gluon-Plasma (QGP), a new quantum chromodynamic phase of matter made in heavy ion collisions composed of deconfined quarks and gluons, is studied at the Relativistic Heavy Ion Collider and its experiment PHENIX has plans to upgrade its detectors to study QGP properties in greater detail. Detailed measurements of modifications of heavy and light jets are needed to develop a coherent understanding of how different partons interact with QGP. Jets, hadrons resulting from high energy quarks or gluons, are used since they are color and energy calibrated probes of QGP. Leading order Monte Carlo event generator PYTHIA was used to generate p+p collisions and resulting charm and beauty jets. Realistic detector performance was accounted for using Geant4 based simulations. Tagging methods of distance of closest approach and determining secondary vertices were used to study tagging efficiency and rejection of light jets. Probability distributions of jets originating at the collision vertex were plotted. Results will lead to further development of tagging heavy flavor jets in high multiplicity Au+Au collisions and a new understanding of fundamental energy loss mechanisms within QGP.
EA.00099 Optimizing Position Sensitivity of the Detection System for the St. George Recoil Mass Separator¹, LUIS MORALES, JERRY HINNEFELD, Indiana Univ. South Bend, MANOEL COUDER, Univ. of Notre Dame, SUNIL KALKAL, Indiana Univ. South Bend — The St. George recoil mass separator at the University of Notre Dame will be used to study (p,γ) reactions of astrophysical interest. A detection system for use with St. George, which utilizes energy and time-of-flight to identify detected particles, is being developed at Indiana University South Bend. An electrostatic mirror assembly is used to deflect secondary electrons produced by the passage of an ion through a thin foil onto a microchannel plate (MCP) detector, which registers the start time for the time-of-flight measurement. Simulations of the transport of the secondary electrons from the foil to the MCP detector have been carried out using SIMION, in order to determine how well the position of the ion at the foil is preserved by the electrostatic mirror. The effective position resolution of the electrostatic mirror assembly has been found to be sensitive to the pitch of a wire grid that accelerates the secondary electrons away from the foil. Position sensitivity for both the start detector and the stop detectors of the time-of-flight system will allow corrections based on the ion trajectory.

¹Supported by NSF Grant: PHY-0959816

EA.00100 Study of charged pion elliptic flow and search for Electric Quadrupole Effect in Au+Au collisions at 39 GeV from STAR¹, LYNN MORMINO, Kalamazoo College / UCLA, STAR COLLABORATION — It is predicted that Chiral Magnetic Wave (CMW) at finite baryon density can induce an electric quadrupole moment of the quark-gluon plasma produced in heavy ion collisions. [1] This electric quadrupole deformation lifts the degeneracy between the elliptic flow ($v_2$) of positive and negative pions leading to $v_2(\pi^+) < v_2(\pi^-)$. We study the difference between $v_2(\pi^+) \text{ and } v_2(\pi^-)$ measurements from STAR for Au+Au collisions at 39 GeV, and investigate the dependence of the $v_2$ difference on the measured net-proton number of the data sample. Here the net-proton number is used to approximate the conserved net-baryon number, and the $v_2$ difference is expected to be proportional to the baryon number asymmetry in the presence of an Electric Quadrupole Effect. In this work, we present pion elliptic flow as a function of transverse momentum and centrality for Au+Au collisions at 39 GeV, and we will discuss the dependence of the $v_2$ difference on net-proton numbers.


³Supported by STAR Collaboration

EA.00101 Characterization of P-Type Point-Contact Detectors for the Majorana Demonstrator Project¹, JAMES MULLIGAN, Undergraduate (University of Washington) — The Majorana Demonstrator is an experiment that will search for neutrinoless double beta decay in 76-Ge. Canberra’s Broad Energy Germanium Detectors (BEGes) are commercial high purity germanium p-type point contact detectors that are of interest to the Majorana Demonstrator experiment. Point contact detectors have the ability to distinguish single-site events from multiple-site events and can use this capability to reject gamma-ray backgrounds in the detectors. Several detailed characterizations were performed on modified BEGe detectors, including analysis of multi-site interactions and investigation of performance as a function of bias voltage. Coincidence data were also taken using a scintillation detector in order to characterize the drift time of pulses from the germanium detector.

¹This research was completed through an internship funded by the Department of Energy.

EA.00102 Simulation of the CLAS12 dual hydrogen-deuteron target, CHRISTOPHER MUSALO, GERARD GILFOYLE, University of Richmond — The primary mission of Jefferson Lab (Jlab) is to reveal the quark and gluon structure of nucleons and nuclei and to deepen our understanding of matter and quark confinement. This mission will be done using a 12-GeV electron beam incident on nuclear targets. One approved experiment E12-07-104 will measure the elastic scattering of electrons from deuterium to extract the neutron magnetic form factor ($G_n^e$) using the CLAS12 detector. Calibrations will be done with a dual, co-linear target consisting of liquid hydrogen (LH$_2$) and liquid deuterium (LD$_2$) cells. The hydrogen target is used for calibration, and the deuterium one provides the data for the physics analysis. A CLAS12 simulation has been developed called gmc, where Geant4 is used to simulate the components of CLAS12. We have added the dual LH$_2$ — LD$_2$ target to the gmc simulation. The targets parameters are stored in a mysql database and then read into the simulation at run time. Simulated particles start at a random point in the target volume and are propagated through the CLAS12 detector. We will present initial results showing the effect of target size and position on the distribution of hits in CLAS12.

EA.00103 Efficiency of PHENIX Resistive Plate Chambers in RHIC √s = 500 GeV p+p Collisions, ANDREW NEDERLOF, BREET FADEM, Muhlenberg College, PHENIX COLLABORATION — The PHENIX collaboration studies polarized proton proton collisions created by the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory to better understand the spin structure of nuclei. The PHENIX collaboration has recently added stations of Resistive Plate Chambers (RPCs) to the north and south forward arms of the detector. An additional set of stations closer to the CLAS12 detector. We will present initial results showing the effect of target size and position on the distribution of hits in CLAS12.

EA.00104 Search for induced depletion of $^{108}$Ag with 6 MeV bremsstrahlung, KAATRIN NETHERTON, ARL, Drexel University, STANLEY HENRIQUEZ, NINO PEREIRA, MARC LITZ, JAMES CARROLL, ARL, ALTERNATIVE ENERGY TEAM — The nuclide $^{108}$Ag has a complicated and not yet well understood energy structure with numerous excited states. One of these, $^{108}$Ag, is a metastable state with a half-life of 418 years and a significantly higher energy than the ground state. The ground state has a 2.37 min half-life and a large $\beta$- decay branch with $Q_{\beta^-} = 1.649$ MeV. While these traits make the isomer a good candidate for energy storage, the rarity of its natural decays makes it difficult to utilize its stored energy. Through irradiation of a $^{108}$Ag source, it might be possible to bypass the natural decay path and induce an energy release by transferring population from the isomer to the ground state. The poster will describe the implementation of an automated system by which to perform repeated tests of $^{108}$Ag depletion with 6 MeV bremsstrahlung and preliminary results will be given.

EA.00105 ABSTRACT WITHDRAWN —
EA.00106 Resistive Plate Chamber Assembly for the PHENIX Forward Trigger Upgrade, WALKER NIKOLAUS, Abilene Christian University, PHENIX COLLABORATION — Measuring the contributions of sea quarks to the total spin of the proton is a prominent goal of the PHENIX collaboration at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Lab (BNL). To enable PHENIX to measure these contributions, a trigger upgrade is needed to select the single high transverse momentum muons events. These events are common in the decay of a W-boson. Studying particles created during proton collisions is the process being used to find spin contributions through the W-boson. A trigger upgrade is needed that can meet these requirements: high time resolution, high position resolution, cheap construction, and thin form. A Resistive Plate Chamber (RPC) fits the requirements. These RPCs are high rate detectors assembled meticulously to minimize noise and cross signals. These detectors are made up of multiple layers. Within an aluminum frame sits a readout plane between two layers of gas gaps both of which are covered with copper. There are short analog wires that connect to the side of the RPCs from the readout plane. This presentation will discuss in detail the overall assembly process of RPCs and the purpose of each component.

EA.00107 Effective Boson Number- A New Approach for Predicting Separation Energies with the IBM1, Applied to Zr, Kr, Sr isotopes near A=100. NANCY PAUL, University of Notre Dame, GANIL, PIETER VAN ISACKER, GANIL, CEA/DSM-CNRS/IN2P3, JOSE ENRIQUE GARCIA RAMOS, Universidad de Huelva, ANI APRAHAMIAN, University of Notre Dame — This work uses effective boson numbers in the Interacting Boson Model (IBM1) to predict two neutron separation energies for neutron-rich zirconium, strontium, and krypton isotopes. We determine the functional forms of binding energy and excitation energies as a function of boson number for a given choice of IBM parameters that give a good overall description of the experimental spectra of the isotopic chain. The energy of the first excited 2+ level is then used to extract an effective boson number for a given nucleus, which is in turn used to calculate the separation energies. This method accounts for complex interactions among valence nucleons around magic and semi-magic nuclei and successfully predicts the phase transitional signature in separation energies around A=100 for 92-108Zr, 90-104Sr, and 86-96Kr [1]. References: [1] Ame2011-preview as downloaded from http://amdc.in2p3.fr/mastables/Ame2011int/filel.html.

1Supported by the NSF under contract PHY0758100, the Joint Institute for Nuclear Astrophysics grant PHY0822648, University of Notre Dame Nanovic Institute, Glynn Family Honors Program, Center for Undergraduate Scholarly Engagement.

EA.00108 Energy Loss Calculations for Target Thickness Determinations using SRIM and Excel, A.S. PAWLAK, J.P. GREENE, Argonne National Laboratory — The thickness of a thin target foil can be determined by measuring the energy loss of alpha particles that travel through it. In the Target Laboratory of the Physics Division at Argonne National Laboratory (ANL), this is accomplished by measuring the energy loss of the 5812 keV alpha particles emitted by a 40Ca source using a silicon detector set-up [1]. The energy loss is translated into the target foil thickness using the stopping power for 4He in the target material obtained from the stopping/range tables provided by SRIM. This calculation has until recently been carried out using a program developed for this purpose, “ENELOSS.” This program uses the stopping/range tables from the original work published by Ziegler [2]. Additionally, due to its design, ENELOSS is unable to easily accommodate targets made from compounds. In order to perform these measurements using the most recent SRIM data, and to better calculate the thickness of compound targets, we have developed a “Thickness Calculation” spreadsheet using Microsoft Excel. This spreadsheet approach is not limited to elemental targets and employs stopping/range tables from the most recent edition of SRIM available on the web. The calculations obtained allow for more accurate target thicknesses and automates the process conveniently for repetitive measurements. This work was supported by the U.S. DoE, Nuclear Physics Division, under Contract No. W-31-109-Eng-38. [1] G.E. Thomas and J.P. Greene, NIMA 199 (1995) 201. [2] J.F. Ziegler, The Stopping and Range of Ions in Matter, vols. 2-6, Pergamon Press, New York, USA, 1977-1980.

EA.00109 Characterization and development of photocathodes using laser induced time-of-flight spectroscopy, E. RAMIREZ-HOMS, University of Texas at El Paso, D. VELAZQUEZ, L. SPENTZOURIS, J. TERRY, Illinois Institute of Technology — The emittance of a beam generated for use in particle accelerators is a critical performance parameter. In order to achieve peak performance, intrinsic transverse emittance on the order of 0.1mm-mrad is required. This initial emittance is about an order of magnitude lower than provided by today’s sources. Several important efforts are being made to reach this lower emittance with cathode design modifications. A photocathode design study and implementation of experimental techniques for the characterization is proposed and discussed.

EA.00110 Determining the Impact Parameter and Cross-Section in Heavy-Ion Collisions, ANDIRA RAMOS, Florida International University, WILLIAM LYNCH, BETTY TSANG, RACHEL HODGES, National Superconducting Cyclotron Laboratory, Michigan State University, Physics and Astronomy Department, HIGH RESOLUTION ARRAY (HIRA) TEAM — The collisions of Tin isotopes, 112,118,124Sn + 112,118,124Sn at E/A= 70MeV will be used to constrain the nuclear Equation of State at low densities. To identify central and peripheral collisions, the impact parameters and cross-sections for each reaction were calculated using charged particle multiplicities measured with the MSU Miniball/WU Miniball array. The array consists of 160 CsI crystals covering around 72% of the solid angle around the target. Each Miniball/Miniwall detector consists of a layer of thin plastic scintillator, followed by a CsI (Tl) scintillator, which is 3 cm thick for the Miniwall and 2 cm thick for the Miniball detectors. The number of charged particles from a collision that hit the Miniwall/Miniwall array is defined as the multiplicity for that collision. The methodology for extracting the impact parameter from the multiplicity and the results of the Miniball/Miniwall analysis will be presented in this poster.

3This work is supported by the Summer Research Opportunity Program (SROP) at Michigan State University and the National Science Foundation Grant #PHY-0606007.

EA.00111 Accelerator and cosmological constraints on low mass WIMP models compatible with DAMA and CoGeNT searches, CLYDE REDGER, GINTARAS DUDA, Creighton University — Recent dark matter experiments have generated much interest in light (m_{DM} < 15 GeV) dark matter particles. The DAMA/LIBRA and CoGeNT direct detection experiments have detected signals that could be interpreted as a Weakly Interacting Massive Particle (WIMP) with a mass range of m_{DM} ~ 5 – 10 GeV and a WIMP-nucleon cross section of approximately $\sigma \sim 7 \times 10^{-41}$ cm$^2$. In addition, the Fermi Gamma Ray Space Telescope has detected gamma rays from the Galactic Center that, if interpreted as dark matter annihilations, imply a mass range of mDM ~ 7 – 10 GeV. There are several dark matter models that can produce WIMPs in this region. We determine the viability of these models by subjecting them to current constraints from colliders and other direct detection experiments.
EA.00112 Optical Attenuation in MoNA and LISA Detector Elements\textsuperscript{1}, LOGAN RICE, JONATHAN WONG, Wabash College, MoNA \textsc{Collaboration} — The MoNA collaboration is a research group of students and faculty from 13 primarily undergraduate institutions, with detectors at the NSCL: MoNA (Modular Neutron Array) and the newly-built LISA (Large multi-Institutional Scintillating Array). These arrays each have 144 plastic scintillating bars. When a neutron collides with a hydrogen nucleus within the plastic, photomultiplier tubes at either end of the bar detect the scintillation photons. Their arrival times are used to determine the position of the event, but as the light travels through the detector it loses intensity exponentially. How dramatic this loss is can be described by a parameter called the attenuation length, with larger attenuation lengths corresponding to lower loss. Recently the MoNA collaboration conducted its LISA commissioning experiment investigating two-neutron decay states of \textsuperscript{23}O. As a part of LISA’s commissioning, we measured the attenuation lengths of the individual detector bars that make up the LISA array and compared these lengths with those of the older MoNA array. We found that the LISA bars had a larger attenuation length on average with impacts on detector efficiency and effective threshold.

\textsuperscript{1}The authors wish to acknowledge the contributions of the members of the MoNA collaboration.

EA.00113 \textsuperscript{26}Al Beam Production and its Application to Nuclear Astrophysics, B. RICHARD, Cyclotron Institute, Texas A&M University (REU student from Arkansas Tech University), R. TRIBBLE, L. TRACHE, G. PIZZONE, B. ROEDER, Cyclotron Institute, Texas A&M University — Presumably produced during the supernova stage of stellar evolution, \textsuperscript{26}Al offers unique opportunities to better understand the processes of nucleosynthesis occurring in pre-SN phases of stellar evolution and within the Galactic disk. When decaying to \textsuperscript{26}Mg, \textsuperscript{26}Al emits a unique 1.8 MeV gamma ray, detectable by satellite telescopes. Understanding the production and destruction pathways of \textsuperscript{26}Al is a key portion of understanding the on-going stellar nucleosynthesis. In order to measure the cross-section of \textsuperscript{26}Al(\alpha, p)\textsuperscript{26}Mg at the astrophysically relevant energies, an indirect method, called the Trojan Horse Method (THM), is utilized. The THM allows the study of neutron induced reactions at astrophysical energies via the d-break-up. This method requires the three-body cross section for the \textsuperscript{26}Al(d, p \textsuperscript{26}Mg)H reaction to be measured at a beam of 60 MeV. The \textsuperscript{26}Al secondary beam is produced by MARS at Cyclotron Institute of Texas A&M University from a primary \textsuperscript{26}Mg beam (E\textsubscript{beam} = 16 MeV/u) impinging on a H\textsubscript{2} target, and was then degraded to 2.25 MeV/u energy by means of a Be foil. The results will be shown and discussed in detail together with the features of the obtained intense and pure beam of \textsuperscript{26}Al (0.5 cm x 0.5 cm beamspot, >97% pure, 10\textsuperscript{6} pps). This later will be used for many applications in nuclear astrophysics using both direct and indirect methods.

EA.00114 Slow Control System for the NIFFTE Collaboration TPC\textsuperscript{1}, ERIK RINGLE, Abilene Christian University, NIFFTE \textsc{Collaboration} \textsc{Collaboration} — As world energy concerns continue to dominate public policy in the 21st century, the need for cleaner and more efficient nuclear power is necessary. In order to effectively design and implement plans for generation IV nuclear reactors, more accurate fission cross-section measurements are necessary. The Neutron Induced Fission Fragment Tracking Experiment (NIFFTE) collaboration, in an effort to meet this need, has constructed a Time Projection Chamber (TPC) which aims to reduce the uncertainty of the fission cross-section to less than 1\%. Using the Maximum Integration Data Acquisition System (MIDAS) framework, slow control measurements are integrated into a single interface to facilitate off-site monitoring. The Hart Scientific 1560 Black Stack will be used with two 2564 Thermistor Scanner Modules to monitor internal temperature of the TPC. A Prologix GPIB to Ethernet controller will be used to interface the hardware with MIDAS. This presentation will detail the design and implementation of the slow control system for the TPC.

\textsuperscript{1}This work was supported by the U.S. Department of Energy Division of Energy Research.

EA.00115 Locating a Radioactive High Voltage Nut for the Majorana Project, BENJAMIN ROSE, Whitworth U., TUNL, MAJORANA \textsc{Collaboration} — Majorana is looking for a neutrinoless double beta decay in \textsuperscript{76}Ge. Due to the necessity of low background radiation in Majorana, we wanted to see if one could locate a radioactive hot spot, by analyzing GEANT4-generated Monte Carlo data. We used the data to determine the probabilities that a crystal will be hit given a source location. Our source were the high voltage indicator nuts (HV nuts) spread through out the detector. We looked at their \textsuperscript{222}Ra decay series, especially the \textsuperscript{208}Tl peak with a region of interest (ROI) from 2.58 – 2.65 MeV. We studied the distribution of crystals that have events with energies in the ROI. We call this distribution the “hit” distribution. We created randomly filled hit distributions based on the probabilities obtained from simulation and used the Kolmogorov-Smirnov test to compare the random fill to all the possible source distributions. The source distribution with the best KS value is used to determine the location of the source. The results show that with approximately 200 counts from a HV nut and no background you can resolve the source to the exact HV nut to within 90\% accuracy.

EA.00116 Simulations for Light Collection Efficiency (Jlab Hall C 12 GeV Kaon Aerogel Detector)\textsuperscript{1}, LAURA ROTHGEB, Catholic University of America — Studying the additional flavor degree of freedom in charged kaon production allows for an unexamined insight into the transition from hadronic to partonic degrees of freedom in exclusive processes and specifically the reaction mechanism underlying strangeness production. This unique opportunity has gone greatly unexplored, however, because of the challenges posed by the experimental factors. One of these challenges is determining a method of separation for kaons from pion and proton backgrounds at high momenta. The simplest and most cost-effective solution is the implementation of a kaon aerogel Cherenkov detector. At the Catholic University of America, we are building such a detector for use in the 12GeV Hall C Super High Momentum Spectrometer at Jefferson Lab. The detector will use photo multiplier tubes to collect the Cherenkov radiation given off by the aerogel and convert that signal into analyzable data that will be used to determine the form factor of the kaon, which will yield a greater understanding of the internal structure of the proton. In this presentation I will present the results from the simulations carried out to optimize the aerogel coverage and study the effect of light guides on the efficiency of the detector.

\textsuperscript{1}Supported in part by NSF grants PHY 1019521 and 1039416

EA.00117 Performance of Aerogels as Cherenkov Light Radiators, ISAAC SALDIVAR, DAVID BLYTH, MATT GIBSON, RICARDO ALARCON, Arizona State University — Aerogels with indexes of refraction ranging approximately from 1.01 to 1.05 can fill an important need as high-yield Cherenkov light radiators and they are widely used by the scientific community, particularly in the experimental nuclear and particle physics arena. We have designed, constructed, and operated equipment to measure the Cherenkov light produced by the passage of relativistic charged particles through different aerogel samples. The samples come from Matsushita Electric Works (Japan) and Aspen Aerogels (USA). The measurements were conducted using a light-tight box, which housed the aerogel samples, two photomultiplier tubes (to measure Cherenkov radiation), and a pair of scintillators to count the number of particles through the aerogel. The photon yields from the samples have been analyzed and results will be presented in terms of the detected number of photoelectrons.
EA.00118 Photon Beam Monitors at MAX-lab1, CHRISSPER CYBERSEYMOUR, University of Massachusetts Dartmouth, MAX-TAGG COLLABORATION — An important objective for nuclear scientists is to describe the properties of nucleons in terms of the framework provided by QCD. The various theoretical approaches can be tested by comparing the predictions from the theories with the results from accurate measurements. The Photon Tagging Facility at MAX-lab in Lund, Sweden is capable of tagging photons with energies up to 200 MeV, which is ideal for testing fundamental nuclear processes in the low-energy region. Exploring the pion photoproduction reaction near threshold will provide new high-quality data to compare with the predictions from various QCD-based theories. Careful monitoring of the photon beam characteristics is paramount to the success and accuracy of the experiment. Two beam monitoring systems are now in use with the tagged photon beam at MAX-lab. One system, the x-y Beam Monitor provides a way to detect horizontal or vertical shifts in the photon beam position. The second device, the In-Beam Monitor, is used to keep track of the photon flux and to monitor the tagging efficiency during the data acquisition. These measurements are crucial for the overall experiment. An overview of these two beam monitor systems, and their performance will be provided.

1Sponsored by NSF OISE/IRES award 0553467.

EA.00119 Light Collection Efficiency in Thin Strip Plastic Scintillator for the Study of ISGMR in Unstable Nuclei1, JACOB SHAFFER, Texas A&M University Cyclotron Institute — The compressibility of nuclear matter (K$^A$) is one of the constituent of the equation of state for nuclear matter which is important in the study Neutron Stars and Super Novae. The K$^A$ is proportional to the Giant Monopole Resonance (GMR) energy and is related by the equation $E_{\text{GMR}} = a (\hbar/ m) ^{1/2} (AK^A)^{1/2}$, where $a$ is the mass of a nucleon and the $A$ is the radius of the nucleus. The GMR in unstable nuclei is important because the K$^A$ is related to the ratio of protons to neutrons. For this reason, it is desirable to study unstable nuclei as well as stable nuclei. The study of the GMR in unstable nuclei will be done using inverse kinematics on a target of Lithium ($^{6}\text{Li}$). A detector composed of two layers of thin strip scintillators and one layer of large block scintillators has been designed and constructed to give adequate energy and angular distribution over a large portion of the solid angle where decay particles from the ISGMR can be found. Attenuation of the light signal in the strip scintillators was measured using an Americium ($^{241}\text{Am}$) alpha source. Gains in light collection efficiency due to various wrapping techniques were also measured. The thin strip scintillators are connected to the photomultiplier tube (PMT) via bundles of optical fiber. Losses in light calculation efficiency due to fiber bundles were measured as well.

1Funded by DOE and NSF-REU.

EA.00120 M1 width of the $2^+_1$ state in $^{22}\text{Na}$ and searches for tensor contributions to beta decays1, DEVIN SHORT, ALEJANDRO GARCIA, University of Washington, SMARAJIT TRIAMBAK, TRIUMF, STEVEN SENERING, DAVID WILLIAMS, University of Washington — A determination of the $\beta-\gamma$ angular correlation from $^{22}\text{Na}$ beta decay has been used to extract induced tensor current contributions to the weak interaction. The result, combined with other available data, yielded an unexpectedly large breaking of the Conservation of the Vector Current, a fundamental assumption of the Standard Model. A weak link in the data used for this analysis is the weak magnetism form factor, which is extracted from an independent unpublished determination of the analog isovector magnetic dipole ($2^+ \rightarrow 3^+$) $\gamma$-ray transition strength to the ground state of $^{22}\text{Na}$ which was limited by low statistics. We have run an experiment seeking to improve on those results by using a $^{21}\text{Ne}(p,\gamma)$ resonance at $E_p = 1112$ keV, leading to a $E_\gamma = 7800 \rightarrow 1952 \rightarrow 0$ keV $\gamma$ cascade in $^{22}\text{Na}$. Angular correlation data were acquired using coincidence $\gamma$-rays in order to extract the M1-E2 mixing ratio. This, in conjunction with the 1952 keV branching ratio, will allow for a reliable determination of the M1 width. We are presently running Monte Carlo simulations that will help determine the absolute efficiency of our apparatus in order to extract the needed information.

1Supported by the DOE and by CENPA at the University of Washington.

EA.00121 Dark Current in PHENIX Resistive Plate Chambers, MARIANNE SKOLNIK, BRETT FADEM, Muhlenberg College — The PHENIX collaboration studies polarized proton collisions at the Relativistic Heavy Ion Collider (RHIC) in hopes of eventually understanding the source of angular momentum in the proton. In particular, the antiquark contribution to the “spin” can be ascertained via single spin asymmetries of muons that result from the decay of W bosons. Such muons typically have high momentum. A new subsystem in PHENIX consisting of resistive plate chambers (RPCs) enhances the muon trigger by allowing discrimination of high momentum muons and increases our chances of recording these rare events. In preparing the RPC modules, we conduct many quality assurance tests that require monitoring dark current in the modules. Analysis of this dark current will reveal its dependence on temperature, humidity, and gas gap geometry.

EA.00122 Study of the crystal transparency changes of the CMS ECAL, CAROLINE SOFIATTI, University of Massachusetts Boston, CMS-CALTECH COLLABORATION — The Compact Muon Solenoid (CMS) is a general purpose detector installed at the Large Hadron Collider (LHC) at CERN, Geneva. Detection and precise energy measurement of photons and electrons is a key to new physics that is expected at the 100 GeV - TeV scale. Additionally, the discovery of the postulated Higgs boson is a primary goal at LHC and $\gamma-\gamma$ is the most promising discovery channel if the mass is between 114 and 130 GeV. In this mass range the Higgs decay width is very narrow, but the signal will lie above an irreducible background and so good energy resolution is crucial. A photon energy resolution of 0.5% above 100 GeV has therefore been set as a requirement for the CMS performance. Light monitoring the transparency changes in the lead tungstate crystal plays a crucial role in maintaining the energy resolution for the CMS ECAL at LHC. This work presents the preliminary studies of the transient transparency changes of the CMS ECAL. Ultimately, this study will be used to implement an upgraded correction algorithm that will optimize the CMS discovery potential, particularly in the di-photon search channels.

EA.00123 PHENIX Silicon Vertex Detector Software and Kalman Fitting, MICHAEL STONE, J. NAGLE, University of Colorado, PHENIX COLLABORATION — The PHENIX experiment at the Relativistic Heavy Ion Collider recently took data in p+p and Au+Au collisions with a new detector called the “Silicon Vertex Detector.” The main purpose of the detector is to measure heavy flavor meson decay electrons near the collision vertex and will thus allow for refined measurement of these processes, in particular the separation of charm and beauty contributions. Part of the work necessary to make this possible is the development of an offline software framework capable of reconstructing hit clusters, tracks, and, as follows, entire events. This project covers the C++ objects and methods written to go from the raw data format, to clusters, and then to tracks. Specifically, the process of using Kalman fitting algorithms through a real magnetic field map for track reconstruction will be described. Initial tracking efficiency, momentum resolution, and computation speed will be detailed.
EA.00124 Automating the Data Acquisition Process with Scripts¹, ALEXEY STRAKOVSKY². Student, BAYA OUSSENA. Mentor, A2 COLLABORATION. — This poster describes work done with the A2 Collaboration at the Johannes Gutenberg Universitaet (JGU) located in Mainz, Germany. The data acquisition system used by the A2 collaboration primarily gathers data from the Crystal Ball particle detector, Tagger Microscope, and the TAPS detector, all of which are housed at the Mainzer Mikrotron facility (MAMI) at JGU. There are many components to the software controlling the acquisition of data from these detectors, many of which are scripts. Currently, each script must be started manually and in a specific order by the system operator to perform a specific task or series of tasks. The purpose of this project is to reduce the dependency on the user to correctly run the necessary scripts, replacing the complex manual workflow with a simple user interface, through which the user can give the system a procedure to carry out without worrying about most of the details of the procedure. When this project is completed, it will be much easier for system operators to effectively run the data acquisition system.

¹Sponsored in part by USDOE and USNSF
²Sponsored in part by USDOE and USNSF
³Sponsored in part by SFB 443

EA.00125 Spin Assignments of excited states in $^{23}\text{Mg}$ through a $^{24}\text{Mg}(p,d)^{23}\text{Mg}$ reaction. SABRINA STRAUSS, Rutgers, D.W. BARADANYAN, J.C. BLACKMON, ORNL, K.Y. CHAE, ORNL, U of TN, K.A. CHIPPS, CO School of Mines, J.A. CIZEWSKI, R. HATARIK, Rutgers, K.L. JONES, U of TN, R.L. KOZUB, TTU, J.F. LIANG, ORNL, C.D. NESARAJA, ORNL, U of TN, P.D. O’MALLEY, Rutgers, C. MATEI, ORAU, B.H. MOAZEN, U of TN, S.D. PAIN, Rutgers, S.T. PITTMAN, U of TN, M.S. SMITH, ORNL. — The $^{22}\text{Na}(p,\gamma)^{23}\text{Mg}$ reaction is part of the hot NeNa cycle, which is important for the nucleosynthesis of Ne and Na isotopes in stellar explosions such as novae. Observation of the characteristic $\gamma$-ray line at 1275 keV from the decay of $^{22}\text{Na}$ is a promising mechanism to constrain nova models. As the reaction proceeds through resonances in $^{23}\text{Mg}$, the properties of $^{23}\text{Mg}$ levels above the proton threshold are important. We measured the $^{24}\text{Mg}(p,d)^{23}\text{Mg}$ reaction using 41 and 41.5 MeV proton beams and a 500 $\mu$g/cm$^2$ $^{24}\text{Mg}$ target at the Holifield Radioactive Ion Beam Facility to better constrain the spins of important levels. Reaction deuterons were detected and identified in the segmented 16-strip silicon detector array SIDAR. By comparing the angular distributions and DWBA calculations, we are able to constrain the spins and parities of levels in $^{24}\text{Mg}$. Experimental details and a status report on the analysis will be presented.

EA.00126 A Study of the Ionization of Deuterium Gas by Pyroelectric Crystals. BRYCE TAYLOR, NCSSM, STEPHEN SHAFOORTH, UNC, WERNER TORNOW, Duke/TUNL. — Pyroelectric crystals produce a stream of electrons or positive ions when heated or cooled in a near-vacuum environment. We studied the behavior of these crystals in deuterium gas. We look at what portion of the positive ion beam consists of $D^+$ and what portion is $D^-$. Since $D_2^+$ contains only half the energy of $D^+$ per deuterium atom after traversing a given potential difference, it has a notably lower cross-section for fusing than $D^+$ does, which lowers neutron yield. Looking at the equivalent dissociation question for $H_2$ gas, we find that <0.1% is ionized as $H^+$ based on magnetic deflection of the ions. Analogous results are assumed for $D_2$. Furthermore, we present a new phenomenon in which groups of positive ions arrive at the detector at the same time similar to multiple peaks present in electron spectra reported by Brownridge and Shafroth. We provide a new theory on the workings of pyroelectric crystals based on the expulsion of gas trapped inside the crystal to explain these findings and other results. Funding provided by grant DOE DE-FG52-09NA29465.


EA.00127 Recent Augmentations of the Functionality of the Thermonuclear Reaction Rate Calculator (TReRaC). KYLE THOMSEN, Tennessee Technological University, MICHAEL SMITH, ORNL. — The chemical variety of our universe can be explained by stellar nucleosynthesis. Many thermonuclear reactions are studied by reproducing them in accelerator experiments and determining their rates. One such program is the Thermonuclear Reaction Rate Calculator (TReRaC), which uses various experimental inputs including resonant energies, strengths, channel widths, and information on non-resonant contributions to calculate reaction rates. Presently, TReRaC is capable of quickly generating accurate rates which closely match those given in a number of publications. This adds to CINA capabilities by enabling a wider variety of nuclear information to generate reaction rates. The next step in TReRaC’s evolution is integration into the existing CINA complex so that it can be used by researchers worldwide.

EA.00128 Ratio of Kaon and Pion valence-quark parton distributions¹. JEFFREY TIBBALS, Seattle University. — The $K^+$ and $\pi^+$ are composed of two valence quarks each, $u\bar{u}$ and $u\bar{d}$, respectively. The ratio of momentum fractions carried by the up valence quarks, $u_K/u_\pi$, has been measured by Badier et al. [1], and found to decrease with increasing Bjorken $x$. I extend the statistical model of Zhang et al. [2] to calculate the parton distribution functions for the $K^+$ meson and the $\pi^+$ meson. I consider the $\pi^+$ and $K^+$ as an infinite series expansion of quark-gluon Fock states. The probabilities of each state were calculated using detailed balance and the three processes $g \leftrightarrow q\bar{q}$, $g \leftrightarrow gg$ and $g \leftrightarrow gg$. I find a sea asymmetry of $\bar{d} - \bar{u} \approx 0.255$ in the $K^+$, but no sea asymmetry in the $\pi^+$. I used the RAMBO program to produce a Monte Carlo simulation for the momentum distributions of the $n$-parton Fock states of both $K^+$ and $\pi^+$, which determine the momentum distribution functions of the mesons. I compare the ratio of momentum fractions carried by the up valence quarks in each meson, $u_K/u_\pi$, to the experimental results, and to other theoretical calculations.


¹This research has been supported in part by the Research in Undergraduate Institutions program of the National Science Foundation, Grant No. 0855656.

EA.00129 A Transverse Resonant Neutron Spin Flipper¹, JUSTIN TOMEY, University of Kentucky. — A radio frequency spin flipper (RFSF) was designed to quickly and efficiently reverse the polarization of a neutron beam. Pulsing the RFSF on and off makes it possible to compare reactions with spin “up” neutrons versus spin “down” on a pulse-by-pulse basis to reduce systematic errors associated with drifts in beam current and detector efficiency. It will be used in an experiment to measure the parity violating neutron spin asymmetry in the reaction $n^+\text{He} = \text{H}^+ + p$ with longitudinally polarized neutrons. The RFSF coil is designed with a double cos-theta pattern with current-carrying wire running down its length and end-caps. The transverse field allows for the manipulation of either transverse or longitudinal polarizations with almost 100% polarization, since the neutron sees no fringe field. It is a resonant spin flipper, based on the principle of nuclear magnetic resonance (NMR). It creates an oscillating magnetic field at the exact Larmor frequency of the neutron. In the rotating frame of the neutron’s spin, it views the transverse magnetic field as static and precesses at exactly the rate needed to reverse direction entirely upon exit of the spin flipper.

¹Supported in part by NSF grant PHY-0855584.
EA.00130 Efficiency Studies of the Resistive Plate Chambers for PHENIX Trigger Upgrade

RAMSEY TOWELL, ACU, PHENIX COLLABORATION — The PHENIX experiment at RHIC studies polarized proton-proton collisions to learn more about the spin structure of the proton. PHENIX can only record a few thousand collisions of the millions that occur every second. A trigger upgrade is required to select rare events. The trigger upgrade includes two sets of Resistive Plate Chambers (RPCs) that will be installed in both muon arms. The smaller RPCs will be installed closer to the collision point and will be constructed and installed before the next run. One of the many quality assurance tests that are performed on the RPCs is an efficiency measurement. In addition to the normal efficiency test that is ran on each module, some long-term tests are being performed to see how environmental factors (e.g., temperature, humidity, and pressure) cause a change in the performance of the chambers. This test is being performed on the chambers in a specially designed cosmic ray test stand using hodoscopes to trigger on cosmic muons that are tracked through the RPCs. These tests accumulate data for an extended period of time while the environmental conditions are continuously monitored. The results from these tests will be presented.

EA.00131 Optimization and Expansion of the Qweak Database

GRACE TREES, DAMON SPAYDE, Hendrix College — Weak interactions have been found to violate parity conservation and can be observed in electron-proton scattering. The results of the scattering reveal an asymmetry in the scattering-rate of electrons in the detectors as the helicity of the beam is flipped. By measuring this asymmetry, the Qweak experiment at RHIC can check the weak charge of the proton. That value can then be used to calculate the weak mixing angle. The weak mixing angle can indicate if there is physics beyond the Standard Model. The experiment will be collecting data for approximately 2200 hours at the Thomas Jefferson Lab National Accelerator Facility. A database has been implemented to allow for storage and organization of the collected data so it can be analyzed at a future time. This database must be optimized in order to allow quick and easy access for every member of the collaboration. This optimization can be accomplished through speed tests to weigh different techniques that can be used in the database as well as altering and expanding the database for improved data procurement.

EA.00132 Development of Water Target for Radioisotope Production

NATHAN TRIPP — Ongoing studies of plant physiology at TUNL require a supply of nitrogen-13 for use as a radiotracer. Production of nitrogen-13 using a water target and a proton beam follows the nuclear reaction 18-O(p, n)18-F. The presence of this second nuclear reaction reduces the efficacy of nitrogen-13 as a radiotracer. Designing a natural water target for nitrogen-13 production at TUNL required the design of several new systems to address the problems inherent in nitrogen-13 production. A heat exchanger cools the target water after irradiation within the target cell. The resulting improved thermal regulation of the target water prevents the system from overheating and minimizes the effect of the cavitations occurring within the target. Alumina pellets within a scrubbing unit remove the fluorine-18 contamination from the irradiated water. The modular design of the water target apparatus makes the system highly adaptable, allowing for easy reuse and adaptation of the different components into future projects. The newly designed and constructed water target should meet the current and future needs of TUNL researchers in the production of nitrogen-13.

1 This TUNL REU project was funded in part by a grant from the National Science Foundation (NSF) NSF-PHY-08-51813.

EA.00133 Construction and Commissioning of a New Scattering Chamber at the Union College Ion Beam Analysis Laboratory

COLIN TURLEY, ROBERT MOORE, CHRISTOPHER JOHNSON, MARIA BATTAGLIA, MICHAEL VINEYARD, SCOTT LABRAKE, Union College — We have constructed a new scattering chamber in the Union College Ion Beam Analysis Laboratory to improve our experimental capabilities. The new chamber was constructed from a ten-inch, conflat, multi-way cross. We fitted the chamber with an eight-inch, Leybold turbomolecular pump so that it can be evacuated quickly. A target manipulator with stepper motors that provide x, y, and z- positioning of the target with micron precision is mounted atop the chamber. A target ladder was constructed for the manipulator that allows us to analyze multiple samples without breaking the vacuum. The chamber has a door with an O-ring seal mounted on one of the ten-inch ports that provides easy access to the interior of the chamber. An Amptek silicon-drift X-ray detector is mounted close to the target ladder, inside the vacuum so that low-energy X-rays can be detected. A new Faraday cup was also installed to provide more accurate current measurements. Finally, a new collimator system was developed and installed in the beam-line to the scattering chamber to provide a well-defined beam spot. A proton induced X-ray emission analysis of aerosol samples has been performed as the commissioning experiment for the chamber. Here, we report on the construction and commissioning of this new chamber.

EA.00134 Fast beam optics simulation of low-energy beam transport systems with a matrix method

ADRIAN VALVERDE, Michigan State University, GEORG BOLLEN, RYAN RINGLE — The Low Energy Beam and Ion Trap (LEBIT) facility at the NSCL utilizes thermalized rare isotope beams produced via projectile fragmentation for high-precision Penning trap mass measurements. Ions are transported between the different components using an electrostatic ion optical system. Optimizing ion transport can be difficult as the parameter space is large and it is not immediately obvious what effect changing a parameter has on the beam. SIMION is a program that provides a very accurate way to model the paths of these ions; however, it can take considerable time, so to quickly calculate the effect of minor adjustments to the potentials, a different method is desirable. Matrix ion optics provides such a method; like in matrix optics for light, matrices are created to model the focusing effect of the elements in the system. A specific method for the modeling of certain electrostatic elements can be found in papers by G.H. Gillespie and T.A. Brown. The purpose of this project was to create an implementation of the matrix methods for einzel lenses and acceleration columns in python, and test the results from the program against those produced by SIMION. Thus far, the comparison between SIMION values and those calculated through this method has shown good agreement; as it provides a good approximation of the actual path, it can be used to predict the path of the beam.

EA.00135 Testing and Installation of a High Efficiency CsI Scintillator Array

NATALIE VISCARIOLI, STUART CASAROTTO, NATHAN FRANK, Augusta College, JENNA SMITH, MICHAEL THOENNESSEN, NSCL/MSU — Experiments on neutron-rich nuclei have identified changes to the structure of nuclei far from stability. The Sweeper-MoNA- LISA facility at the National Superconducting Cyclotron Laboratory (NSCL), located at Michigan State University, is used for performing experiments on neutron-rich nuclei. Currently, these experiments are limited to the mass region below neon due to the resolution of the charged fragment detectors, which limit the isotope separation. The resolution of the system will be improved with changes to the setup, primarily due to a new scintillator array. The new array will consist of twenty-five sodium-doped CsI crystals arranged in a 5 x 5 configuration. The array will be used to measure the kinetic energy of charged fragments with energies in the GeV range. The improved resolution will allow experiments of unbound systems above neon. The testing and assembly of the detector array will be presented.

EA.00136 GEANT4 Implementation of Calorimeters for a Medium-energy Electron Ion Collider

JAMES WALKER, University of NC at Chapel Hill — Detector designs for an Electron-Ion Collider (EIC) require detection of the scattered lepton and hadronic debris with high precision as well as all the particles involved in the reaction. GEANT4 simulations will be used in order to optimize the Medium-energy EIC (MEIC) detector design to these requirements. Before simulating detector efficiencies, hadronic and electromagnetic calorimeter models must be incorporated into a full detector geometry. Electromagnetic calorimeter models were constructed as a mixture of lead tungsten and lead glass. Hadronic calorimeter models are still in design. The models are at a low stage of complexity currently, but can be developed further. The models can be used in further research to maximize efficiencies of detector designs and minimize cost.

1 National Science Foundation
EA.00137 Photonuclear Production of Medical Isotopes, NICK WEINANDT, University of South Dakota — Every year, more than 20 million people in the United States receive a nuclear medicine procedure. Many of the isotopes needed for these procedures are under-produced. Suppliers of the isotopes are usually located outside the United States, which presents a problem when the desired isotopes have short half-lives. Linear accelerators were investigated as a possible method of meeting isotope demand. Linear accelerators are cheaper, safer, and have lower decommissioning costs compared to nuclear reactors. By using (γ,p) reactions, the desired isotope can be separated from the target material due to the different chemical nature of each isotope. Isotopes investigated were Cu-67, In-111, and Lu-111. Using the results the photon flux Monte Carlo simulations, the expected activity of isotopes can be calculated. After samples were irradiated, a high purity germanium detector and signal processing apparatus were used to count the samples. The activity at the time of irradiation stop was then calculated. The uses of medical isotopes will also be presented.

1 Thanks to Idaho State University, the Idaho Accelerator Center, and the National Science Foundation for supporting the research.

EA.00138 Targets for Inverse (3He,d) Reaction Studies with Radioactive Ion Beams, J.L. WHEELEER, R.L. KOZUB, S.A. GRAVES, D.J. SISSOM, Tenn. Tech. U., D.W. STRACENER, D.W. BARDAYAN, ORNL, C. JOST, U. Tenn.-Knoxville, P.D. O’MALLEY, Rutgers U. — Proton transfer reactions, such as (3He,d), are extremely important for measuring the properties of single particle states and resonances. Many such resonances are used in the rp process of explosive nucleosynthesis, but cannot be measured via resonance scattering directly. For the (3He,d) reaction, it is necessary to use localized 3He targets, and gas jet targets are expensive and difficult to construct. We are continuing an alternate approach - implanting 3He into 0.65 μm thick aluminum foils at the On-Line Test Facility (OLT) at ORNL. Target profiles are analyzed using Rutherford backscattering to determine the concentration and distribution of the implanted 3He. An update of these results and a detailed description of new procedures will be presented. This research is supported by the U. S. Department of Energy.

EA.00139 Simulations of the In-Beam Performance of the CAESAR and Gretina Arrays With Liquid-Hydrogen and Solid Targets, SAMANTHA WILDONGER, Ursinus College — In order to plan gamma-ray spectroscopy experiments at the National Superconducting Cyclotron Laboratory (NSCL), we used Geant4 simulations of the CAESAR and Gretina arrays with the Ursinus College Liquid Hydrogen Target and a solid 9Be target. Analysis of the simulated data allows us to evaluate the precision of measured gamma-ray intensities, photopeak efficiencies, and the in-beam energy resolution of each array. The relative advantages of each array will be discussed.

1 Ursinus College, Supported by NSF grant no. PHY-0969002

EA.00140 Optimization of MCMC algorithm for the calculation of interaction and reaction cross sections in the Glauber Theory framework, JOHN WILSON, IVAN NOVIKOV, Western Kentucky University — To extract various parameters of a nuclear density distribution, the experimentally measured interaction cross-section is compared to cross-sections calculated in various theoretical approaches. The calculation of the interaction and reaction cross-section in the Glauber Theory framework are usually performed using a Monte Carlo technique. In the presented paper, we discuss the accuracy of the Markov Chain Monte Carlo (MCMC) approach to calculating the interaction and reaction cross-sections. Using various statistical diagnostics, we evaluate the “quality” of the random numbers generated by the Metropolis-Hastings algorithm which are utilized to calculate the cross-sections. The dependence of the accuracy of the determined nuclear density parameters on the “quality” of the Markov chains was obtained for the Woods-Saxon density distribution and the harmonic oscillator (OH) density distribution.

EA.00141 Characterization of aerogel and Photomultiplier Tubes for the 12-GeV Hall C Kaon Aerogel Detector at Jefferson Lab, KEVIN WOOD, University of South Carolina — Thomas Jefferson National Accelerator Facility’s upgrade from 6-GeV to 12-GeV beam energy requires a new magnetic spectrometer for Hall C. At 6 GeV the High Momentum Spectrometer (HMS) made use of an aerogel threshold Cherenkov detector for particle identification of p/K/p. The HMS is not designed to operate at momenta greater than 7 GeV/c, instead a Super High Momentum Spectrometer (SHMS) will be constructed. An aerogel threshold Cherenkov detector needs to be included in the new spectrometer as well. Pions, kaons and protons of sufficient velocity produce Cherenkov radiation when passing through media with low indices of refraction. Aerogels with n = 1.020 and n = 1.030 will be used for p/K/p separation. A diffusion box, lined with millipore, will collect the light from the Cherenkov radiation. Photomultiplier tubes (PMTs) will then detect the light and convert the photons into an electrical signal that electronics will then be able to interpret. This presentation will show the dependence of the aerogel’s signal strength on thickness of stack as well as the PMTs’ gain dependence on high voltage.

1 Supported in part by NSF grant PHY 1039446.

EA.00142 Study of Rescattering Effects in (azimuthal angle)-dependent asymmetry distributions. Since for the elementary process 7d→K+Λ through Helicity Asymmetries, WEIZHI XIONG, University of South Carolina, CLAS COLLABORATION — Here we present our experimental study of rescattering effects in the reaction 7d→K+Λn through the (azimuthal angle)-dependent asymmetry distributions. The data were collected with the CLAS detector at Jefferson Lab. The goal of this project is to identify kinematics at which final-state interactions are maximal. Our investigations of the hyperon-nucleon interaction through rescattering between the lambda (Λ) and the neutron in 7d→K+Λn will construct and study φ (azimuthal angle)-dependent asymmetry distributions. Since for the (azimuthal angle)-dependent asymmetry the large asymmetries would indicate large rescattering effects in the final state. In this presentation we show the reaction of interest, and will give very preliminary estimates for the beam-helicity asymmetry for 7d→K+Λn through Helicity Asymmetries.

1 This work is supported by the US National Science Foundation under grant PHY-0856010.

EA.00143 Noise studies on the PHENIX RPC1 prototype, EMILY ZARNDT, University of Illinois Urbana-Champaign — An important goal of the PHENIX collaboration at the Relativistic Heavy Ion Collider is to measure the spin contributions of sea quarks to the overall spin of the proton. The detection of W-bosons resulting from polarized p-p collisions enables us to directly probe and separate by flavor the spin dependent quark and anti-quark distributions in the proton. In order to improve the trigger efficiency for final state muons with high transverse momentum from W-boson decay, the muon spectrometers in PHENIX are being upgraded with fast front-end electronics for the cathode strip tracking chambers and with two stations of Resistive Plate Chambers (RPCs). A prototype of RPC1, the RPC station near the collision point upstream of the muon tracking magnet, was tested in a cosmic ray test stand including detailed studies of the signal noise: we have carried out an optimization of the threshold used in the RPC pre-amplifier, characterized the noise for different high voltage settings and front-end shielding configurations, and measured the average noise rates. These studies have led to the final techniques used for the RPC1 detector assembly and to the choice of operating parameters for the detector.
EA.00144 Radiation Hardness of Trigger Electronics¹, IRENE ZAWISZA, Cyclotron Institute, Texas A&M University, ALEXEI SAFONOV, JASON GILMORE, VADIM KHOTILOVICH, Dept. of Physics & Astronomy, Texas A&M University — As the maximum intensity of particle accelerators increases, probing the most basic questions of the Universe, detectors and electronics must be designed to ensure reliability in high-radiation environments. As the Large Hadron Collider (LHC) beam intensity is increased, it is necessary to upgrade the electronics in the Compact Muon Solenoid (CMS). To select interesting events, CMS utilizes fast electronics, which are installed in the experimental cavern. However, much higher post-upgrade levels of radiation in the cavern set tight requirements on the radiation hardness of the new electronics. Damaging effects of high and low energy radiation leads to disruption of digital circuits and accumulated degradation of silicon components. Quantifying the radiation exposure is required for the design of a radiation-tolerant system, but current simulation studies suffer from large uncertainties. We compare simulation predictions with measured performance in two different experimental studies, which evaluate component performance for pre and post irradiation determining the survivability of electronics in the harsh CMS environment.

Thursady, October 27, 2011 4:00PM - 6:00PM Session FA Mini-Symposium on EIC Physics 62

4:00PM FA.00001 The Electron-Ion Collider: Tackling QCD from the Inside (of Nucleons and Nuclei) Out. CHRISTINE AIDALA, Los Alamos National Laboratory — After the development of quantum chromodynamics in the last quarter of the 20th century, the 21st century as it extends before us holds great promise for reaching a new era in understanding QCD’s rich complexities, in particular confinement and asymptotic freedom. While there will be more than one front along which to advance our understanding, a key experimental facility, capable of colliding beams of electrons with a wide range of nuclei as well as polarized protons and light ions, has been proposed. This versatile facility will for example allow us to perform precision spatial and momentum mapping of the structure of the nucleons and nuclei of everyday matter, study the physics of strong color fields in nuclei, explore in detail the effects of soft scales on hard partonic processes, and confront the question of the transition from scattered quarks and gluons to final-state hadrons observable in the laboratory. An overview of the proposed Electron-Ion Collider will be presented.

4:36PM FA.00002 Quark and Gluon Imaging with Meson Electroproduction at an EIC. TANJA HORN, Catholic University of America — Hadrons in QCD are relativistic many-body systems with a fluctuating number of elementary quark and gluon constituents. With the 12 GeV energy upgrade at Jefferson Lab we will probe the valence quark structure of these strongly interacting systems. Beyond the valence quark region, the nucleon is expected to contain a “sea” of quark-antiquark pairs. The Electron-Ion Collider (EIC) as a frontier QCD facility would for the first time provide the kinematic reach and precision to study the fundamental structure of matter by directly probing the sea quarks and the virtual force carriers of QCD, the gluons. Information on the sea quarks and gluon structure is obtained from exclusive scattering. Measurements of, for instance, J/Ψ production would allow for mapping the transverse spatial distribution of gluons in the nucleon, including the unexplored “valence-like” gluons. Production of light mesons with charge/isospin would map the transverse distributions of sea quarks and provide additional insight into their dynamical origin. In this talk I will discuss the exciting prospects of studying the transverse spatial landscape of nucleon structure using production of various vector and pseudoscalar exclusive channels.

4:48PM FA.00003 The EIC: Precision tool to explore & understand the role of gluons in QCD², ABHAY DESHPANDE, Stony Brook University — While it is known for decades that QCD is the correct theory that describes Strong Interactions, our understanding of the role of the gluons in QCD still remains largely unknown at extreme low and high energy, where large number of gluons (and quarks) interact with each other coherently. The high energy, polarized Electron Ion Collider (EIC) will provide a unique opportunity to systematically study and understand this as no other machine will. I will summarize the physics goals of the EIC, and present the status of the project, including anticipated steps needed to realize the project in the US.

5:00PM FA.00004 e+A physics at an Electron-Ion Collider³, LIANG ZHENG, Brookhaven National Lab and IOPP/CUNY, THE EIC SCIENCE TASK FORCE TEAM — The probing of nuclei via deep-inelastic and diffraective processes in the high-energy (low-x) regime will open a new precision window for the investigation of the gluonic structure of matter. Studies of e+p collisions at HERA and especially d+Au collisions at RHIC have found tantalizing hints of saturated gluon densities, a phenomenon with substantial impact on the physics of heavy-ion collisions. With well controlled kinematics and a reduced source of background compared to d+Au, deep inelastic scattering on nuclear targets (e+A) at an Electron-Ion Collider (EIC) would allow one for the first time to precisely explore the collective behavior of densely packed gluons deep into the saturation regime. Being sensitive to the gluon distribution, di-hadron correlations provide a key measurement to study saturation. In this talk, I am going to discuss the capabilities of the proposed EIC at Brookhaven National Lab with a special emphasis on the aspirations of di-hadron correlation measurements in e+Au collisions.

5:12PM FA.00005 High Luminosity Electron-Hadron Collider eRHIC¹, NICHOLAOS TSOPAS², BNL — The design of future high-energy high-luminosity electron-hadron collider at RHIC called eRHIC is presented. The design employs two energy recovery linacs (ERL’s) to accelerate the electron beam bunches to 20 (potentially 30) GeV and to collide these electron bunches with the circulating hadrons bunches in RHIC. After the collision the electron bunches will be decelerated by the two ERL linacs down to 10 MeV and dumped to a target. The center-of-mass energy of eRHIC will range from 30 to 200 GeV. The luminosity exceeding 10^{34}cm^{-2}s^{-1} can be achieved in eRHIC using the low-beta interaction region (IR) with a 10 mrad beam crossing. The (IR) will utilize 5 mrad crab cavities for both the hadrons and the electron bunches. The important eRHIC R&D items include: a) the high-current polarized electron source, b) the coherent electron cooling and c) the compact magnets for recirculating passes. We will present a staged scenario of step-by-step, increase of the electron beam energy to the top energy of 30 GeV, by building-up the eRHIC’s SRF linacs.

5:24PM FA.00006 Status Report on the Tungsten Powder/Fiber Calorimetry Program for EIC, JAY DUNKELBERGER, UCLA — We report the current status of an EIC detector R&D project for a new sampling calorimeter technology using tungsten powder and scintillating fibers. Detector construction techniques and bench test results will be presented. We will show results of Geant4 simulations for a proposed tungsten-fiber calorimeter envisioned for both a STAR forward calorimeter upgrade and an electromagnetic calorimeter for EIC with emphasis on the performance characteristics of the detector (energy and position resolution, pT-gamma separation and e/h rejection, pT reconstruction etc.). Finally, future plans for our R&D effort will be discussed.

¹Supported by the US Department of Energy

²On behalf of the eRHIC accelerator design team
5:36PM FA.00007 Physics Opportunities with STAR in the EIC Era, ERNST SICHTERMANN, Lawrence Berkeley National Laboratory, FOR THE STAR COLLABORATION — A future high-energy polarized Electron-Ion Collider (EIC) would enable precision measurements of the partonic structure of nucleons and nuclei, yielding unique insights in the momentum, spin, and spatial substructure of nucleons and nuclei. An upgrade of the Relativistic Heavy Ion Collider, RHIC, at Brookhaven National Laboratory (BNL) with a high-intensity electron beam in stages with increasing electron beam energies is one several possibilities worldwide that are being investigated to realize an EIC. Its concept allows, with suitable redesign of the interaction regions, collisions at the existing RHIC experiments. Selected physics opportunities with, limitations of, and upgrade paths for the STAR experiment at RHIC in the early stages of such an EIC will be discussed.

5:48PM FA.00008 The extraction of the \( F_2 \) and \( F_L \) structure functions from inclusive \( e+p \) and \( e+\Lambda \) scatterings at the EIC, RAMIRO DEBBE, Brookhaven National Laboratory, EIC SCIENCE TASKFORCE TEAM — Among the many measurements projected to study the nucleon and nuclei structure at the eRHIC, the extraction of the longitudinal structure function \( F_L \) stands prominently. This is so because this measurement provides a unique tool to study the gluon distribution in the nucleus and nuclei and allows to test saturation effects in gluons at low \( x \) and low \( Q^2 \). In preparation for these measurements, simulations are being performed to estimate the effects of detector resolution, radiative corrections and the presence of systematic uncertainties which in turn determine the quality of extracted physics. The extraction of the \( F_L \) structure function will be done from a combination of inclusive measurements at different electron beam energies each with at least three values of the hadron beam energy. The selected electron and hadron beam energies will allow the extraction of the \( F_L \) and \( F_2 \) structure functions down to \( x \) values of \( 10^{-3} \) and the virtuality of the exchanged photon \( Q^2 \), ranging from 1 to 1000 GeV/c\(^2\). The kinematic coverage of these measurements as well as the effects of the detector resolution and systematic uncertainties on both \( F_L \) and \( F_2 \) will be discussed.

Thursday, October 27, 2011 4:00PM - 5:48PM –
Session FB Mini-Symposium on Experimental Advances in Transfer Reactions III, Auditorium

4:00PM FB.00001 The \((7Be,3He)\) Reaction: A New Tool for Alpha Spectroscopy\(^1\), F.D. BECCETTI, H. AMRO, HAO JIANG, A.N. VILLANO, M. OJARUEGA, U. Michigan-Ann Arbor, J.J. KOLATA, A. ROBERTS, U. Notre Dame, TWIN SOL COLLABORATION — Recent experiments done at the UM-UND low-energy RNB facility TwinSol have shown that the \((7Be,3He)\) reaction selectively populates alpha-cluster states (in the case studied,\(^{16}O\)) with relatively large cross sections [1]. As will be discussed, this reaction has a number of advantages over both \((6Li,d)\) and \((7Li,t)\) as an alpha-transfer reaction and in particular this reaction for various reasons is not a direct analog of \((7Li,t)\). Thus it can be considered to be a new tool (among few available) for identifying alpha-cluster states in nuclei. Further experiments are planned both at the TwinSol facility as well as the new ReA facility at MSU. To facilitate experiments at UND, a new large (ca.1 m dia.) chamber has been built to accommodate large area position-sensitive detectors and improved time-of-flight. Also, a new technique for making single-sided enriched oxygen targets suitable for low-energy (\(7Be,3He\)) studies has been developed and will be reported elsewhere (M. Febraro et al., this conference).

1Supported by U.S. National Science Foundation.

182PM FB.00002 Experimental techniques to use the \((d,n)\) reaction for spectroscopy of low-lying proton-resonances\(^1\), INGO WIENENHOEVER, ALEXANDER ROJAS, LAGY T. BABY, JESSICA BAKER, SEAN KUVIN, PATRICK PEPLOWSKI, DANIEL SANTIAGO-GONZALEZ, Florida State University, GEORGIOS PERDIKAKIS, National Superconducting Cyclotron Lab, Michigan State University, DENNIS L. GAY, University of North Florida, Jacksonville — Studies of rp-process nucleosynthesis in stellar explosions show that establishing the lowest \( l = 0 \) and \( l = 1 \) resonances is the most important step to determine reaction rates in the astrophysical rp-process path. At the RENSOL facility, we have used the \((d,n)\) reaction to populate the lowest \( p\)-resonances in \(^{16}O\), and demonstrated the usefulness of this approach to populate the resonances of astrophysical interest[1]. In order to establish the \((d,n)\) reaction as a standard technique for the spectroscopy of astrophysical resonances, we have developed a compact setup of low-energy Neutron-detectors, resonant and tested it with the steady beam reaction \(^{12}C(d,n)\(^{15}N\)) in inverse kinematics. Performance data from this test-experiment and future plans for this setup will be presented.

1Supported by U.S. National Science Foundation.

4:24PM FB.00003 First use of HELIOS at forward laboratory angles, B.P. KAY, York, M. ALCORBA, B.B. BACK, J.A. CLARK, C.R. HOFFMAN, K.E. REHM, J.P. SCHIFFER, S. ZHU, Argonne, C.M. DEIBEL, JINA/Argonne — The HELIOS spectrometer eliminates the problem of kinematic compression when performing transfer reactions in inverse kinematics, typically resulting in a factor of \( \sim 3 \) improvement in excitation-energy resolution over conventional approaches. To date the instrument has been used primarily for \((d,p)\) reaction studies with both stable and radioactive ion beams, where the outgoing protons are detected at backwards laboratory angles. Here we report on the first use of HELIOS with negative-Q-value reactions, the \((d,t)\) and \((d,^3He)\) reactions induced by a 14-MeV/u \(^{26}Si\) beam on a CD\(_2\) target. For these reactions, outgoing tritons and \(^3He\) ions are detected at forward laboratory angles along with a range of unwanted reactions products. In HELIOS, particle identification by means of the cyclotron period of the outgoing ion allows unique selection of the low-energy branch of \(^3He\) or \(^4He\), separating them from the dominant background of protons and alpha particles that arise from fusion-evaporation of the beam with \(^{12}C\). This work was supported by the US Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357 and Grant No. DE-FG-2-04ER414320, and NSF Grant No. PHY-0802268, and the UK Science and Technology Facilities Council.

4:36PM FB.00004 Low-threshold neutron detection for proton-transfer reactions with VANDLE\(^1\), WILLIAM PETERS, Oak Ridge Associated Universities, R. GRZYWACZ, M. MADURGA, S. PAULAUSKAS, U. Tenn., J.A. CIZEWSKI, M.E. HOWARD, P.D. O’MALLEY, B. MANNING, E. MERINO, Rutgers, T.N. MASSEY, C. BRUNE, Ohio U., F. SARAZIN, S. ILYUSKIN, D. WALTER, Col. Sch. of Mines, J. BLACKMON, Louisiana St. U., D.W. BARDAYAN, Oak Ridge Nat. Lab. I. SPASSOVA, C. MATEI, O.R.A.U. — Proton-transfer studies with radioactive beams are a useful tool for constraining astrophysical proton-capture rates and probing the single-particle structure of exotic nuclei. Measurements from \((d,n)\) reactions on radioactive beams require an efficient large- area neutron detector array. The Versatile Array of Neutron Detectors at Low Energy (VANDLE) is being developed at ORNL for both \((d,n)\) and beta-delayed neutron spectroscopy measurements. Digital electronics and optimized materials make VANDLE sensitive to neutron–proton scattering for neutrons above 100 keV, and also to elastically scattered carbon from neutrons above 1 MeV. This carbon sensitivity supplements the detection efficiency at those energies. Measured efficiencies from an \(^{252}Cf\) source will be presented, along with plans and simulated responses for \((d,n)\) measurements of astrophysically important proton-capture reactions.

1Supported in part by the U.S. DOE and NSF.
4:48PM FB.00005 Coupling the ORRUBA and Gammasphere Arrays1. STEVEN HARDY, A. ADEKOLA, J.A. CIZEWESKI, M.E. HOWARD, P.D. O’MALLEY, B. MANNING, Rutgers University, D.W. BARDayAN, S.D. VAIN, ORAU, C.J. LISTER, D. SEWERYNIK, Argonne National Laboratory, J.C. BlackMon, M. MATOS, Louisiana State University, K.A. CHIPPS, Colorado School Of Mines, K.L. JONES, University of Tennessee, R.L. KOZUB, Tennessee Technological University, W.A. PETERS, ORAU — The coincident detection of charged particles and gamma rays with high resolution facilitates the performance of numerous nuclear physics measurements. These include the study of the fragmentation of single-particle strengths close to shell closures, surrogate measurements to inform neutron capture, heavy-ion transfer reactions and inelastic scattering measurements to probe collective states. The large internal geometry of Gammasphere is ideally suited to coupling to a large solid-angle silicon detector array, maximizing gamma ray efficiency without compromising charged particle angular resolution. The upcoming coupling of the ORRUBA and Gammasphere arrays for the coincident measurement of charged particles and gamma rays with high-efficiency and high-resolution will be discussed.

1Work supported in part by U.S. Department of Energy and National Science Foundation

5:00PM FB.00006 Deuterated Liquid Scintillators: A New Tool for Neutrons without ToF for RNB Reaction Studies, MITAIRE OJARUEGA, FRED BECCHETTI, Department of Physics, University of Michigan, Ann Arbor, MI 48109, J.J. KOLATA, AMY ROBERTS, Department of Physics, University of Notre Dame, Notre Dame, IN 46556, RAMON TORRES-ISEA, MICHAEL FEFRBARO, Department of Physics, University of Michigan, Ann Arbor, MI 48109 — An array of 6 large deuterated neutron detectors ((100mm x 150mm) has been developed at the University of Michigan. These detectors will make it possible to carry out RNB measurements with neutrons as the outgoing particle. The ability of this detector to obtain neutron energy spectra from nuclear reactions without the use of time of flight (ToF) has been verified and will be utilized. Typical data collected with these detectors showing optimized pulse-shape-discrimination, some using digital pulse analysis from this detector will be presented. This work is supported by the U.S. National Science Foundation under Contracts PHY-0652591, CMMI 0936649, PHY-0969456 and PHY-0758100.

5:12PM FB.00007 Prototype AT-TPC: a new active target time projection chamber for low-energy reactions, D. SUZUKI, D. BAZIN, W. MITTIG, M. FORD, W.G. LYNCH, A. FRITSCH, E. GALYAERV, National Superconducting Cyclotron Laboratory, J.J. KOLATA, J. BROWNE, B. BUCHER, X. FANG, A. HOWARD, A.L. ROBERTS, X.D. TANG, University of Notre Dame, F.D. BECCHETTI, M. FEFRBARO, M. OJARUEGA, University of Michigan, D. BEN ALI, Universite Paris Sud — An active target time projection chamber (AT-TPC) is being developed at the National Superconducting Cyclotron Laboratory. The detector will be coupled to the forthcoming ReA3 accelerator complex, providing a powerful tool for reaction studies with low-energy radioactive beams. The Prototype AT-TPC, a half scale version of the future AT-TPC, has recently been completed. The first in-beam experiment was performed at the University of Notre Dame in April. The elastic and inelastic alpha scattering on radioactive 4He beams were measured at low energy to study the neutron transfer or resonant processes. The 4He beam at 14 MeV was produced by the Twinsol device, and directed to the Prototype AT-TPC operated with He:CO2 gas mixtures. The design and the performances of the detector, and the results from the Notre Dame experiment will be presented.

5:24PM FB.00008 A Gas Jet Target for Radioactive Ion Beam Experiments1, K.A. CHIPPS, Colorado School of Mines, JENSA COLLABORATION — With the development of new radioactive ion beam (RIB) facilities such as FRIB, which will push further away from stability, the need for improved RIB targets is more crucial than ever. Important scattering, transfer and capture reaction measurements of rare, exotic, and unstable nuclei on hydrogen and helium require targets that are dense (∼1 x 10^{15} nuclei/cm^{2}), highly localized, and pure. Conventional targets suffer too many drawbacks to allow for such measurements. Targets must also accommodate the use of novel detector arrays. To this end, a collaboration led by the Colorado School of Mines (CSM) is designing, building and testing a supersonic gas jet target for use at existing and future RIB facilities. The gas jet target allows for a high density and purity of target nuclei (such as 4He) within a highly confined region, without the use of windows or backing materials, and will also enable the use of state-of-the-art detection systems. Motivation, specifications and status of the CSM gas jet target system will be discussed.

1Work funded by DOE Office of Science and the NSF.

5:36PM FB.00009 The $^{12}$C($^3$He,$^4$He) transfer reaction at 5 MeV per nucleon at the ISAC-II TRIUMF facility1, DUANE SMALLEY, FRED SARAZIN, ULRIKE HAGER, Colorado School of Mines, SHARC AND TIGRESS COLLABORATION — The $^{12}$C($^3$He,$^4$He)$^{14}$C transfer reaction was studied using the Silicon Highly-segmented Array for Reactions and Coulex (SHARC), a compact charged particle silicon detector array, and the TRIUMF-ISAC Gamma-ray Escape Suppressed Spectrometer (TIGRESS), a high-efficiency γ-ray detector, at the TRIUMF-ISAC-II facility. The goal of the experiment is to compare the two-neutron transfer cross sections using ($^3$He,$^4$He) to the more traditional (p,t) on $^{12}$C. The study requires good angular resolution coupled with particle identification, both of which are provided by SHARC with its 10,000 Si pixels instrumented by over 800 DAQ channels including a number of ΔE-E telescopes. Since the identification of the individual $^{12}$C excited states requires coincident detection of γ events, the HPGe BGO-suppressed TIGRESS detectors contribute γ detection over a large solid angle. The combination of the two detector arrays allows accurate reconstruction of reaction kinematics, including Doppler correction. Preliminary results of the experiment will be presented.

1funding supported by DOE

Thursday, October 27, 2011 4:00PM - 5:48PM – Session FC Trends in Nuclear Physics 101

4:00PM FC.00001 Prize for a Faculty Member for Research in an Undergraduate Institution: Undergraduate Participation in the Study of Ultrapertipheral Collisions at RHIC1, JANET SEGEB. Creighton University — In ultraperipheral nuclear collisions, with impact parameters larger than twice the nuclear radius, the nuclei do not physically overlap, but instead interact via intense long-range electromagnetic fields. Heavy-ion colliders are therefore powerful tools to study photonuclear and two-photon interactions. These interactions typically produce final states with only a few particles and leave the colliding nuclei intact. Undergraduate students at Creighton University have been heavily involved in this physics program within the STAR (Solenoidal Tracker at RHIC) Collaboration for the last decade. We present recent STAR results on vector meson production in AuAu collisions at various energies, including the observation of coherent photoproduction of the J/ψ meson, as well as a g-9 final state which may be associated with excited ρ states that are not yet well understood. An emphasis will be placed on the contributions of undergraduate students.

1This work supported in part by the U. S. Department of Energy

2(for the STAR Collaboration)
4:36PM FC.00002 New Applications of Renormalization Group Methods in Nuclear Physics. KAI HEBELER, The Ohio State University — Renewed interest in the physics of nuclei is stimulated by experiments at rare isotope facilities, which open the way to new regions of exotic nuclei, and by astrophysical observations and simulations of neutron stars and supernovae, which require controlled constraints on the equation of state of nucleonic matter. The use of Renormalization Group methods to lower the characteristic resolution of inter-nucleon interactions is opening new avenues for calculations of low-energy nuclear structure and reactions. In this presentation I will give an overview over recent developments and discuss various results for the nuclear equation of state and the consequences for the structure of neutron stars, short-range correlations and the role of many-body forces in nuclear systems.

5:12PM FC.00003 Hypernuclear physics via γ-ray spectroscopy. HIROKAZU TAMURA, Department of Physics, Tohoku University — A series of hypernuclear γ-ray spectroscopy experiments performed at KEK-PS and BNL-AGS using a germanium detector array, Hyperball, have accumulated precise data on various p-shell Λ hypernuclei. We observed “hypernuclear fine structure” in various hypernuclei and extracted the strengths of all the spin-dependent parts (spin-spin, spin-orbit, and tensor terms) of the Λ-N interaction. The obtained strengths reproduced structure of most of the p-shell Λ hypernuclei quite well, and also played important roles in testing and improving baryon-baryon interaction models. We also measured a B(E2) value of 2^+\textsubscript{Li} and confirmed “shrinking effect” of a Λ hyperon. In the J-PARC facility, further experiments of hypernuclear γ-ray spectroscopy are planned to be performed. In the first experiment (E13), we will extend our study to s-shell and sd-shell hypernuclei and investigate the Λ-N interaction more in detail. We also plan to study the g factor of a Λ hyperon in a nucleus by measuring a B(M1) value of Λ-spin-flip transitions in hypernuclei in order to study possible modification of baryon properties in nuclear matter. In future, we will also investigate “impurity effect” of nuclear structure induced by a Λ, such as the shrinking effect and a possible change of nuclear deformation.

Thursday, October 27, 2011 4:00PM - 5:36PM – Session FD Instrumentation III  Heritage

4:00PM FD.00001 Facilitating Precision Mass Measurements at CARIBU\textsuperscript{1}, DANIEL LASCAR, Northwestern University, U. JON VAN SCHELT, U of Chicago, GUY SAVARD, ANL, RALPH SEGEL, Northwestern U, JASON CLARK, ANL, KUMAR SHARMA, U of Manitoba, SHANE CALDWELL, U of Chicago, LI GANG, McGill U, MATTHEW STERNBERG, U of Chicago, JOHN GREENE, ANTHONY LEVAND, BRUCE ZABRANSKY, ANL — The Canadian Penning Trap Mass Spectrometer (CPT) has begun a campaign of precision mass measurements of neutron-rich nuclei produced via spontaneous fission of 252\textsubscript{Cf} as part of the CALifornium Rare Isotope Breeder Upgrade (CARIBU) to the ATLAS facility at Argonne National Laboratory. At the time of submission of this abstract, we have measured neutron rich isotopes of Cs, I, Te, Sb, and Sn. CARIBU is currently running with a 60 mCi source of 252\textsubscript{Cf} which will be upgraded to a 1 Ci source in the future. In order to make this campaign possible, several upgrades to the CARIBU and CPT system were required including a new Radio Frequency Quadrupole (RFQ) ion buncher to CARIBU's low energy beamline, cryogenic cooling of the RFQ Paul trap below the CPT, and an electrostatic elevator to allow for transport of ion bunches from a 50 kV platform to the CPT system's 2 kV beamline. Construction and commissioning of the buncher and modified Paul Trap will be discussed as well as their impact on the measurements in this campaign.

\textsuperscript{1}Support from U.S. DOE, Nucl Phys Div and NSERC Canada.

4:12PM FD.00002 Commissioning a Tape Transport System for Decay Studies and Beam Diagnostics at CARIBU\textsuperscript{1}, P.F. BERTONE, B. DIGIOVINE, C.J. LISTER, K. TEH, Physics Division, Argonne National Laboratory, F.G. KONDEV, C. NAIR, Nuclear Engineering Division, Argonne National Laboratory, P. CHOWDHURY, A.Y. DEO, S. LAKSHMI, Department of Physics and Applied Physics, University of Massachusetts Lowell — The CALifornium Rare Isotope Breeder Upgrade (CARIBU) to the ATLAS facility at Argonne utilizes the spontaneous fission of 252\textsubscript{Cf} for producing neutron-rich radioactive nuclei. CARIBU will be used for a wide variety of experiments, involving both reaccelerated and stopped beams, in nuclear structure, nuclear astrophysics and applications. Many of these experiments will require a means of transporting radioactivity to and from detector counting stations for the purpose of assaying beam content, measuring half-lives, β-γ spectroscopy and determining Gamow-Teller strength distributions. We have commissioned the first of several tape transport systems that will perform these functions. An overview of the design and deployment of the system will be given along with preliminary test results.

\textsuperscript{1}Supported by the U.S. DOE Office of Nuclear Physics DE-AC02-06CH11357.

4:24PM FD.00003 New detector array - the HRIBF Modular Total Absorption Spectrometer\textsuperscript{1}. MARZENA WOLINSKA-CICHOCKA, ORNL, ORAU, KRZYSZTOF RYKACZEWSKI, ORNL, MAREK KARNY, ORNL, ORAU, UW, ALEKSANDRA KUZNIACKA, UTK, UW, ROBERT GRZYWACZ, UTK, ORNL, CHARLIE RASCO, LSU, DAVID MILLER, UTK, CARL J. GROSS, JIM JOHNSON, ORNL — The construction of a new Modular Total Absorption Spectrometer (MTAS) at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory will be presented. The total absorption gamma spectra measured with MTAS will be used to derive a true beta-feeding pattern and resulting beta strength function of a new Modular Total Absorption Spectrometer (MTAS) at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory. At the time of submission of this abstract, we have measured neutron rich isotopes of Cs, I, Te, Sb, and Sn. CARIBU is currently running with a 60 mCi source of 252\textsubscript{Cf} which will be upgraded to a 1 Ci source in the future. In order to make this campaign possible, several upgrades to the CARIBU and CPT system were required including a new Radio Frequency Quadrupole (RFQ) ion buncher to CARIBU's low energy beamline, cryogenic cooling of the RFQ Paul trap below the CPT, and an electrostatic elevator to allow for transport of ion bunches from a 50 kV platform to the CPT system's 2 kV beamline. Construction and commissioning of the buncher and modified Paul Trap will be discussed as well as their impact on the measurements in this campaign.

\textsuperscript{1}Research supported by the DOE Office of Nuclear Physics.

4:36PM FC.00004 Vertical Charge Exchange Cell for Collinear Laser Spectroscopy at NSCL\textsuperscript{1}. ANDREW KLOSE, Dept. of Chemistry and NSCL, Michigan State University, East Lansing, MI 48824, USA, KEI MINAMISONO, NSCL, Michigan State University, East Lansing, MI 48824, USA, NADJA FROEMMGEN, CHRISTOPHER GEPPERT, MICHAEL HAMMEN, JOERG KRAEMER, ANDREAS KRIEGER, University of Mainz, D-55099 Mainz, DE, PHIL LEVY, TRIUMF, Vancouver, BC, CA V6T 2A3, PAUL MANTICA, Dept. of Chemistry and NSCL, Michigan State University, East Lansing, MI 48824, USA, WILFRIED NOERTERSHAUSEN, University of Mainz, D-55099 Mainz, DE, SOPHIA VINKINNOVA, Dept. of Chemistry and NSCL, Michigan State University, East Lansing, MI 48824, USA — A vertical charge exchange cell (CEC), originally developed at TRIUMF/ISAC, has been constructed at NSCL for the Beam Cooling and Laser Spectroscopy (BECOLA) system. The CEC was initially commissioned at the TRIGA-Laser Chemistry and NSCL, Michigan State University, East Lansing, MI 48824, USA, NADJA FROEMMGEN, CHRISTOPHER GEPPERT, MICHAEL HAMMEN, JOERG KRAEMER, ANDREAS KRIEGER, ANDREW KLOSE, Dept. of Chemistry and NSCL, Michigan State University, East Lansing, MI 48824, USA, KEI MINAMISONO, NSCL, Michigan State University, East Lansing, MI 48824, USA — The Canadian Penning Trap Mass Spectrometer (CPT) has begun a campaign of precision mass measurements of neutron-rich nuclei produced via spontaneous fission of 252\textsubscript{Cf} as part of the CALifornium Rare Isotope Breeder Upgrade (CARIBU) to the ATLAS facility at Argonne National Laboratory. As of the time of submission of this abstract, we have measured neutron rich isotopes of Cs, I, Te, Sb, and Sn. CARIBU is currently running with a 60 mCi source of 252\textsubscript{Cf} which will be upgraded to a 1 Ci source in the future. In order to make this campaign possible, several upgrades to the CARIBU and CPT system were required including a new Radio Frequency Quadrupole (RFQ) ion buncher to CARIBU’s low energy beamline, cryogenic cooling of the RFQ Paul trap below the CPT, and an electrostatic elevator to allow for transport of ion bunches from a 50 kV platform to the CPT system’s 2 kV beamline. Construction and commissioning of the buncher and modified Paul Trap will be discussed as well as their impact on the measurements in this campaign.

\textsuperscript{1}This work was supported in part by NSF Grant PHY 06-06007.
4:48PM FD.00005 Status of the ReAccelerator Facility ReA for Rare Isotopes, DANIELA LEITNER, MSU/FRIB, JOHN POPIELARSKI, FRIB, ALAIN LAPIERRE, FERNANDO MONTES, GEORGIOS PERDIKAKIS, STEFAN SCHWARZ, MSU, WALTER WITTMER, XIAOHONG WU, FRIB — The Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU) is currently in the preliminary design phase. FRIB consists of a heavy ion driver LINAC, followed by a fragmentation target station, a fragment separator, a gas stopping area, experimental areas for fast and stopped beams, and a ReAccelerator facility (ReA). In its final configuration, ReA will provide heavy ion beams from 0.3 MeV/u to 12 MeV/u for heaviest ions and up to 20 MeV/u for light ions. The first stage of ReA is already under commissioning and will be connected to the Coupled Cyclotron Facility at MSU by the end of 2012. The front end of the accelerator consists of a gas stopper, an Electron Beam Ion Source Trap (EBIT) charge state booster, a room temperature RFQ, followed by a short SRF LINAC. An overview and status of the ReA facility will be presented and will be focused on the testing and ongoing beam commissioning. A schedule for the completion of the first stage and proposed energy upgrades will be described. In addition, the beam line layout of the experimental hall will be described.

5:00PM FD.00006 Summing NaI(Tl) detector (SuN) for radioactive beam experiments relevant for the $p$-process, ANNA SIMON, ILYA BESKIN, SEAN LIDDICK, KARTHIK PADMANABHAN, JESSICA PEACE, STEPHEN QUINN, ARTEMIS Spyrou, BENJAMIN STEFANEK, NSCL/MSU — P-process refers to $\gamma(p, \gamma, p)$ and $(\gamma, n)$ reactions producing nuclei on the neutron-deficient side of the valley of stability that cannot be reached by $s$- and $r$-processes. This process can be investigated via inverse reactions, i.e., proton or alpha capture with gamma emission. Gamma spectra resulting from capture reactions, may be complicated in structure and as such difficult to analyze. However, this difficulty may be omitted by implementing a summing technique, for which all gamma rays emitted during the decay cascade are summed into one peak, so called “sum peak.” Thus, in ideal case, the resulting spectrum will comprise of one peak of the energy $E=E_{\text{sum}}$. This technique has already been successfully tested during stable beam experiments. In order to apply this technique to radioactive beam experiments a new Summing NaI(Tl) (SuN) detector was designed at NSCL. It is a 16x16 inch cylindrical barrel divided into eight optically separated segments, each of them read by three photomultipliers. Each of the PMTs is read independently by a digital data acquisition system (DDAS) and the final sum spectrum is obtained by software summing of the individual spectra. Here, first results obtained with the SuN detector as well as its possible future applications will be presented.

5:12PM FD.00007 Designing Magnetic Coils From the Inside Out, DANIEL WAGNER, University of Kentucky — Traditionally the design cycle for magnetic fields involves guessing at a reasonable conductor and magnetic material configuration, using finite element analysis (FEA) software to calculate the resulting field, modifying the configuration, and iterating to produce the desired results. We take the opposite approach of specifying the required magnetic field, imposing it as a boundary condition on the region of interest, and then solving the Laplace equation to determine the field outside that region. The exact conductor configuration along the boundaries is extracted from the magnetic scalar potential in a trivial manner. This method is being applied to design a coils for the neutron EDM experiment, and an RF waveguide in a new design of a neutron resonant spin flipper for the n-3He experiment. Both experiments will run at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory.

5:24PM FD.00008 Simulation of the NSCL Cyclotron Gas Stopper, NINAD JOSHI, NSCL, GEORG BOLLEN, SHAILENDRA CHOUHAN, DAVID MORRISSEY, STEFAN SCHWARZ, NSCL — Thermalization in a buffer gas is becoming the method of choice for converting beams of rare isotopes produced via projectile fragmentation after in-flight separation into low-energy beams. These beams allow ISOL-type experiments to be conducted on projectile fragmentation products, such as precision mass measurements with traps or laser spectroscopy, and further transport for reacceleration. Currently available systems for high-energy beams employ a linear gas cell design filled with 0.1-1 bar of helium. A new device is being constructed at the NSCL/MSU. The new system is based on slowing down the fast ions in a sector-focusing cyclotron magnet in a chamber filled with helium buffer gas at low pressure. RF-guiding techniques are used to extract the ions. Comparison to linear gas stopper systems such a device promises higher efficiencies and faster extraction in particular for light ions and higher beam rate capability. This contribution will summarize the status of the ongoing design of the cyclotron gas stopper, with emphasis on detailed simulations with an optimized magnetic field including simulations of beam injection and stopping in the full 3D magnetic field.

Thursday, October 27, 2011 4:00PM - 6:00PM – Session FE Electroweak Interactions I 103AB

4:00PM FE.00001 High-precision digital $\beta$ counting for superallowed $\beta$-decay studies, LIXIN CHEN, JOHN C. HARDY, Cyclotron Institute, Texas A&M University, College Station, TX 77843, USA — Superallowed $\beta$-decay ft values must be measured to high precision in order to test the Electroweak Standard Model and probe new physics beyond it. To establish a more robust $\beta$ counting system for high precision half-life measurements, we have implemented a new digital $\beta$ counting system, which we have now tested on-line. An 8-bit digitizer with 1 GS/s sampling rate was used to record the waveforms from our gas proportional counter, and a software filter applied to discriminate and count genuine decay events. The software filter uses pulse shape analysis to separate genuine $\beta$-decay events from proportional-counter spurious pulses. The digital counting method and the results obtained from our recent on-line test experiments will be presented in detail. This work demonstrates the first successful application of a high-speed digitizer and off-line digital signal-processing techniques to high precision nuclear $\beta$-decay lifetime measurements.

4:12PM FE.00002 Superallowed Branching Ratio in the $\beta$ Decay of $^{34}$Ar, V.E. IACOB, J.C. HARDY, Cyclotron Institute at Texas A&M University — Precise $ft$-values for superallowed $^{0+} \rightarrow ^{0+}$ $\beta^+\bar{\nu}$-decays contribute to the most demanding unitarity test of the Cabibbo-Kobayashi-Maskawa matrix. The decays from $T_{1/2}=1$ nuclei, like $^{34}$Ar, are particularly valuable because they can constrain the isovector symmetry-breaking corrections that must be applied to the measured $ft$-values. This requires their branching ratios to be determined to ~0.1% or better. We report here on our continuing quest to reach this goal, which most recently has involved better control of our detection geometry (with laser ranging) and continuous monitoring of dead-time. We used a pure $^{34}$Ar beam at the exit of the MARS recoil separator using a 25A MeV $^{32}$Cl beam from the Texas A&M cyclotron to bombard a hydrogen gas target. The $^{34}$Ar beam was extracted into air, degraded and implanted into the Mylar tape of our fast transport system. In repeated cycles, each $^{34}$Ar sample was collected for 2s and then moved in 175 ms to the center of a well-shielded $\beta-\gamma$ counting station, where $\beta$ singles and $\beta-\gamma$ coincidences were recorded for 2s. The $\beta$'s were detected in a 1-mm-thick plastic scintillator, while the $\gamma$'s were detected by our precisely efficiency-calibrated HPGe detector. With the laser sensor we read the tape-to-HPGe distance to a precision better than 0.1mm and recorded it for each cycle. Branching-ratio results will be reported.
4:24PM FE.00003 High-Precision Branching Ratio Measurement for the Superallowed $\beta^+$ emitter $^{74}$Rb, Ryan Dunlop, University of Guelph — Precision measurements of superallowed Fermi beta decay allow for tests of the Cabibbo-Kobayashi-Maskawa matrix (CKM) unitarity, the conserved vector current hypothesis, and the magnitude of isospin-symmetry-breaking effects in nuclei. A high-precision measurement of the branching ratio for the $\beta^+$ decay of $^{74}$Rb has been performed at the Isotope Separator and Accelerator (ISAC) facility at TRIUMF. The $\pi^0$ spectrometer, an array of 20 close-packed HPGe detectors, was used to detect gamma rays emitted following the decay of $^{74}$Rb. PACEs, an array of Si(Li) detectors, was used to detect emitted conversion electrons, while SCEPTAR, an array of plastic scintillators, was used to detect emitted beta particles. In this talk, the importance of the branching ratio measurement of the $^{74}$Rb superallowed decay will be discussed and preliminary results from the recent measurements at ISAC will be presented.

4:36PM FE.00004 High Precision Determination of the $^6$He Half-life, A. Knecht, B.G. Delbridge, A. Garcia, G.C. Harper, R. Hong, R.G.H. Robertson, H.E. Swanson, S. Utsuno, D.I. Will, C. Wrede, D.W. Zumwalt, University of Washington, P. Mueller, W. Will, Argonne National Laboratory — We performed a high precision measurement of the half-life of $^6$He. The motivation for this experiment lied not only in resolving a long-standing discrepancy between the previous most precise measured values of $806.7 \pm 1.5$ ms and $798.1 \pm 1$ ms, respectively, but also in serving as a solid basis for the extraction of the axial coupling constant $g_A$ by comparing the result to ab initio calculations. The measurement took place at the tandem accelerator of the Center for Experimental Nuclear Physics and Astrophysics of the University of Washington where we used the $^7$Li($^3$H,$^3$He)$^6$He reaction to produce $^6$He. We impinge a 10 $\mu$A, 18 MeV deuterium beam on a liquid lithium target station that delivers $\sim10^9$ atoms/s to a low-background experimental area. Here we present the design of the lithium target station and the results of the $^6$He half-life determination.

This work was supported by DOE under grant DE-FG02-97ER41020.

4:48PM FE.00005 High Precision Measurement of the Lifetime of $^{19}$Ne, Leah Broissard, Duke University — The $T=\frac{1}{2}$ mirror transitions, such as the $\beta^+$ decay of $^{14}$Ne, have been identified as excellent candidates for high precision studies of the weak interaction in the Standard Model, complementary to the well-studied $0^- \rightarrow 0^+$ decays and neutron decay measurements. The Triangle Universities Nuclear Laboratory (TUNL) has developed an experiment to perform high precision lifetime measurements using the Trapped Radioactive Isotopes Microlaboratories for fundamental Physics (TRIP) facility at the Kernfysisch Versneller Instituut (KVI) in Groningen, the Netherlands. We use a custom tape drive system to collect and transport the purified isotope from the TRIP isotope separator to the HPGe clover detector array, where annihilation radiation is detected in coincidence. We will discuss analysis of systematic uncertainties due to contamination, diffusion, and rate-dependent effects and present measurement results.

5:00PM FE.00006 A Magneto-Gravitational Trap for the Measurement of the Free Neutron Lifetime, Daniel Salvat, Indiana University, UCNTAU COLLABORATION — Recent measurements of the free neutron beta-decay lifetime using trapped Ultra-Cold Neutrons (UCN) have yielded results with high precision ($\sim 1$ s), but with central values significantly lower than the previous world average. To resolve this controversy, we initiated a new effort to measure the neutron beta-decay lifetime using UCN in a magneto-gravitational trap at the Los Alamos Neutron Science Center. The trap eliminates wall interactions which lead to additional UCN loss. We will present the design of the trap, and R&D results. Extensive Monte Carlo techniques are in development to investigate the time dependence of the neutron phase space within the trap, and systematically study marginally trapped UCN. We also investigate a novel method for UCN detection, wherein a vanadium foil absorbs neutrons within the trap, and the foil activation is measured using a beta-gamma coincidence technique. This provides a clean signal proportional to the number of trapped UCN, and avoids the process of emptying UCN from the trap. The current experimental status, and plans for a proof-of-principle 1 second measurement of the lifetime will be discussed.

5:12PM FE.00007 A T-odd Momentum Correlation in Radiative Beta Decay, Susan Gardner, Dahan H. He, University of Kentucky — A triple-product momentum correlation in the neutron or nuclear radiative $\beta$-decay rate isolates the pseudo-Chern-Simons term found by Harvey, Hill, and Hill as a consequence of the baryon vector current anomaly and SU(2)$_\chi$ x U(1)$_Y$ gauge invariance at low energies. The correlation appears if the imaginary part of the coupling constant is nonzero, so that its observation potentially probes sources of CP violation beyond the Standard Model. The effect can be mimicked by electromagnetic final-state interactions in the Standard Model; we have computed the induced T-odd triplet correlator in radiative $\beta$-decays as well. We discuss the role nuclear processes can play in discovering the effect.

5:24PM FE.00008 Status of the Neutron Radiative Decay Experiment, Benjamin Oneill, Arizona State University, RDK II COLLABORATION — The theory of quantum electrodynamics predicts that beta decay of the neutron into a proton, electron, and antineutrino should be accompanied by a continuous spectrum of photons. We previously reported detection of photons from neutron beta decay with a branching ratio of (3.09±: 0.32) x 10^{-3} in the energy range of 15keV to 340keV. This was achieved by prompt coincident detection of an electron and photon, in delayed coincidence with a proton. The photons were detected using a single bar of bismuth germanate scintillating crystal coupled to an avalanche photodiode (APD). Our most recent experiment employs an array of twelve of these detectors, as well as three large area APD detectors. We anticipate that our improved measurement of the branching ratio will have an uncertainty of 1 percent. In addition, we have extended the detectable energy range down to $\approx$250 eV and up to the endpoint. We will present an overview of the apparatus and an update of the status of the analysis on the branching ratio and the photon energy spectrum with a focus on the large area APDs.

5:36PM FE.00009 The $\tau$-He Parity Violation Experiment, Christopher Crawford, University of Kentucky, N3HE COLLABORATION — We are proposing an experiment at the SNS Fundamental Neutron Physics Beamline to measure the parity violating longitudinal neutron spin asymmetry from the reaction $n + ^{3}$He $\rightarrow p + ^{3}$H. Recent calculations of 4-body wave functions and P-odd operators have shown that this observable is sensitive to both the I=1 long range and I=0 components of the hadronic weak interaction. The experimental setup and expected sensitivity will be discussed.

5:48PM FE.00010 ABSTRACT WITHDRAWN –

Thursday, October 27, 2011 4:00PM - 6:00PM —
Session FF Nuclear Structure III 104AB
Consequently, we do not have three coexisting shapes in deformation originates in a neutron configuration which is fundamentally different from the “intruder” configuration producing the ground state deformation. The study of excitations of $^{44}$Ca, $^{46}$Ar at the NSCL using the SeGA gamma-array at the S800 spectrograph. We analyzed the gamma-recoil and gamma-gamma-recoil coincidence events to determine the isotensor decay matrix element from the unbound analog transition in $^{10}$B. We populated the 5164 keV state in $^{10}$B using the $^{10}$B(p,$\gamma$) reaction at 10 MeV using a proton beam from the ESTU accelerator at Yale University. Gamma decays were detected in the “YrastBall” array. We determined the branch for this transition to be 0.16(4)%. This indicates a significant isotensor term.

$^{10}$B, $^{12}$Cd Populated via the Beta Decay of $^{124,126}$Ag: J.C. Batchelder, S.-H. Liu, UNIRIB/ORAU, N.T. Brewer, J.H. Hamilton, A.V. Ramayya, Vanderbilt University, C.J. Gross, ORNL, M. KARNY, A.J. MENDEZ II, K. MIERNIK, K.P. RYKACEWSKI, D.W. STRACENER, ORNL, R. GRZYWACZ, M. MADURGA, D.T. MILLER, U. Tennessee, S.W. PADGETT, S.V. PAULASKAS, U. Tennessee, A. KUZNIAK, M. WOLINSKA-CICHOCKA, ORAU. The lowest lying levels in the neutron-rich even-even Cd isotopes have structures that resemble an anharmonic vibrator coupled to 2-proton intruder states. Deviations from this picture have been shown to occur in $^{112-116}$Cd isotopes. To determine the systematics of these states across the neutron shell we have begun to measure the beta decays of the heavier even-mass Ag isotopes. $^{124,126}$Ag ions were produced via the proton-induced fission of U at the HRIBF at ORNL. 15 microA of 50 MeV p bombarded on a UCx target, and the fission products were then separated by a high-resolution magnetic isobar separator and deposited on a moving tape collector directly in the center of the LeRIBSS (Low-Energy RIB Spectroscopy) array. Many new levels in $^{124,126}$Cd have been observed. These results and the systematics of the even-even Cd isotopes will be presented and discussed.

The logitudinal momentum distribution of reaction residues was used to find angular momentum assignment to the excited states. The logitudinal momentum distribution of reaction residues was used to find angular momentum assignment to the excited states. The logitudinal momentum distribution of reaction residues was used to find angular momentum assignment to the excited states.

The logitudinal momentum distribution of reaction residues was used to find angular momentum assignment to the excited states.
5:12PM FF.00007 Coulomb Excitation of 78.80Se and the radioactive 84Se (N=50) isotopes 1. A. GALINDO-URIBARRI, ORNL, E. PADILLA-RODAL, R.F. GARCIA-RUIZ, ICN-UNAM, J.M. ALLMOND, JIHIR, J.C. BATELDER, URIBARRI, J.R. BEENE, ORNL, K.B. LAGERGREN, JIHIR, P.E. MUELLER, D.C. RADFORD, D.W. STRACENER, ORNL, J.P. URREGO-BLANCO, UTK, R.L. VARNER, C.-H. YU, ORNL — Coulomb excitation is a purely electromagnetic excitation process of nuclear states due to the Coulomb field of two colliding nuclei. It is a very precise tool to measure excitation probabilities and provide insight on the collectivity of nuclear excitations and in particular on nuclear shapes. We have measured the Be(22) value of various nuclei in the mass A=80 region using particle-gamma coincidences with the HyBall and Clarion arrays at HIRIF. The Coulomb excitation of various projectile-target combinations (As on 12C, 24Mg, 27Al and 50Ti) allow the use of consistency cross checks and the systematic study of isotopic and isotonic chains using both stable and radioactive nuclei under almost identical experimental conditions. We present new results for 78Se, 80Se and the radioactive nucleus 84Se (N=50).

1Research sponsored by the Office of Nuclear Physics, U.S. Department of Energy and CONACyT Grant 103366.

5:24PM FF.00008 α-Clustering in 18O. MELINA AVILA, GRIGORY ROGACHEV, ERIC JOHNSON, AMY CRISP, J. GILES, Florida State University, BERT GREEN, KIRBY KEMPÆR, K. LEE, DONALD ROBSON, BRIAN ROEDER, Florida State University, VLADILEN GOLDBERG, CHANGBO FU, ROBERT TRIBBLE, Cyclotron Institute, Texas A&M University, SIMON BROWN, University of Surrey — The α-cluster structure of N ≠ Z nuclei is poorly known and is a subject of intense theoretical discussion. α-clusters have been used to explain various nuclear effects including quasi-rotational bands of states with large α-particle widths, which were observed in light 4N nuclei, 12Be, 14C, 19O and 20Ne. We report on the observation of the α-cluster structure in the N ≠ Z nucleus 18O. The α-cluster structure of 18O was studied through α→14C elastic scattering using the Thick Target Inverse Kinematics (TTIK) technique. The analysis was performed using a multi-level, multi-channel R-Matrix approach. It was found that 18O has an elaborate α-cluster structure, including two unusual states with α widths exceeding the formal single particle limit. A comparison of the observed 18O structure with the predictions of potential model approach was performed. A more detailed description of the very two stable states can be given using this potential model approach.

5:36PM FF.00009 In-beam and decay properties of the proton-rich nucleus 179Tl. C. NAIR, F.G. KONDEV, M.P. CARPENTER, S. ZHU, I. AHMAD, B.B. BACK, P.F. BERTONE, C.J. CHIARA, C.A. COPOS, J.P. GREENE, G. GURDAL, G. HENNING, C.R. HOFFMAN, R.V.F. JANSSENS, B.P. KAY, T.L. KOHO, T. LAURITSEN, C.J. LISTER, E.A. MCCUTCCHAN, A. ROGERS, D. SEWERYNIKA, M.L. SMITH, Argonne National Laboratory, D.J. HARTLEY, U.S. Naval Academy — Nuclear structure studies of proton-rich Tl nuclei are important in order to elucidate their shape evolution with neutron number as well as to better interpret the rare decay modes in this region, such as electron-capture delayed fission. The 179Tl nucleus was produced via the symmetric 92Mo(89Y, 2n) reaction using a 375 MeV beam delivered by the ATLAS accelerator at Argonne National Laboratory. The recoiling nuclei were implanted into a double-sided silicon strip detector, located at the focal plane of the Argonne Fragment Mass Analyzer. The Recoil Decay Tagging technique in conjunction with the Gammasphere spectrometer helped identify the decays of the 179Tl ground state (Ig=1/2+) and a shorter-lived isomeric state (Ig=11/2+). The observed α-decay correlations allowed an unambiguous identification of the previously unassigned ground state of the daughter nucleus 175Au.

1This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

5:48PM FF.00010 Model-Independent Calculation of Radiative Neutron Capture on Lithium-7. GAUTAM RUPAK, LAKMA FERNANDO, Mississippi State University, RENATO HIGA, KVI Groningen — The radiative neutron capture on lithium-7 is calculated model independently using a low energy halo effective field theory. The cross section is expressed in terms of scattering parameters directly related to the S-matrix element. The capture through E1 and M1 transitions is considered. At low energy the cross section depends on the poorly known p-wave effective range parameter r1. This constitutes the leading order uncertainty in traditional model calculations. It is explicitly demonstrated by comparing with potential model calculations. A single parameter fit describes the low energy data extremely well and yields r1 = 1.5 fm-1. The contribution from two-body currents is also discussed.

Thursday, October 27, 2011 4:00PM - 5:48PM — Session FG Astrophysics II: s-d Shell 105AB

4:00PM FG.00001 Studying the αp-process waiting points using Radioactive Ion Beams. C.M. DEIBEL, JINA/ANL, M. ALCORTA, P. BERTONE, J. CLARK, C.R. HOFFMAN, C.L. JIANG, B.P. KAY, H.Y. LEE, R. PARDO, K.E. REHM, A.M. ROGERS, ANL, J.M. FIGUEIRA, Laboratorio TANDAR, S. BEDOOR, D. SHETTY, A.H. WUOSMAA, WMU, J.C. LIGHTHALL, S.T. MARLEY, WMU/ANL, M. PAUL, Hebrew University, C. UGALDE, ANL/JINA/U. Chicago — The nucleosynthetic flow in type I X-ray Bursts (XRBs) is driven by the triple-α, αp and αp processes. Several intermediate mass nuclei, 22Mg, 26Si, 30S, and 34Ar, have been identified as possible candidates for waiting points in XRBs. When such a nucleus is reached, the flow stalls due to (p, α) equilibrium and must await decay unless the (α, p) reaction is fast enough to break out of the waiting point first. A method to study these α-process reactions has been developed wherein the time- inverse reaction is studied in inverse kinematics using radioactive ion beams produced by the in-flight method at the Argonne National Laboratory ATLAS facility. The reactions p(29P, 29Si)α, p(33Cl, 33S)α, and p(37K, 34Ar)α have been studied to determine reaction rates for 26Si(α, p)29P, 30S(α, p)33Cl, and 32Ar(α, p)35K, respectively. The results and possible implications for nucleosynthesis in XRBs will be discussed.

1This work was supported under JINA NSF grant No. PHY0822648 and U.S. DOE contract DE-AC02-06CH11357.

4:12PM FG.00002 Asymptotic normalization of mirror states and the effect of couplings. LUKE TITUS, NSCL, Michigan State University, East Lansing, MI 48824, USA, PIERRE CAPEL, Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz, D-55128 Mainz, Germany, FILOMENA NUNES, NSCL, Michigan State University, East Lansing, MI 48824, USA — Assuming that the ratio between asymptotic normalization coefficients (ANCs) of mirror states is model independent, charge symmetry can be used to indirectly extract astrophysically relevant proton capture reactions on proton-rich nuclei based on information on stable isotopes. In this work we explore the Hamiltonian independence of the ratio between ANCs of mirror states when deformation and core excitation is introduced in the system. We apply the model to 6Li/8B, 13C/14N, 17O/17F, 20Ne/20Al, and 27Mg/27P. Our results show that for most studied cases, the ratio between ANCs of mirror states is independent of the strength and multipolarity of the couplings involved. The exception is for cases in which there is an s-wave coupled to the ground state of the core, the proton system is loosely bound, and the states have large admixture with other configurations. We discuss the implications of our results for novae.
4:24PM FG.00003 High Precision Measurement of Resonance States in $^{18}$Ne, $^{30}$S, and $^{38}$Ca Nuclei using the (p,t) Reaction, and Reaction Rates in the αp- and rp-Processes1, T. ADACHI, KVI Univ. of Groningen, G.P.A. BERG, Univ. of Notre Dame, E.Z. BUTHELEZI, iTHEMBA LABS, J. CARTER, Univ. of Witwatersrand, M. COUNDER, Univ. of Notre Dame, R. FEARICK, Univ. of Cape Town, S.V. FÖRTSCH, iTHEMBA LABS, J. GÖRRES, Univ. of Notre Dame, Y. KHESWA, J. MIRA, M. MURRAY, R. H. SELVEN, iTHEMBA LABS, P. PAPKA, iTHEMBA LABS, E. SIDERAS-HADDAD, Univ. of Witwatersrand, F.D. SMIT, J.A. SWARTZ, iTHEMBA LABS, R. TALWAR, Univ. of Notre Dame, I. USMAN, iTHEMBA LABS, J.J. VAN ZYL, Univ. of Stellenbosch, M. WIESCHER, S. O’BRIEN, Univ. of Notre Dame — Thermonuclear runaway reactions in type I X-ray burst are triggered by the breakout from the hot CNO cycles and is subsequently driven by αp- and rp-processes. These time scales for the αp- and rp-process are determined by the associated reaction rates, which depend exponentially on the associated resonance energies. High precision (p,t) measurement were performed at iTHEMBA LABS to examine resonance states in $^{18}$Ne, $^{30}$S, and $^{38}$Ca nuclei using the K600 spectrometer with a dispersion matched beam. Preliminary analysis will be presented.

4:36PM FG.00004 Resonance strengths in $^{20}$Ne(p, γ)$^{22}$Na and $^{22}$Ne(p, γ)$^{23}$Na and the NeNa cycle1, STEPHANIE LYONS2. JOACHIM GOERRES, ANTONIOS KONTOS, ED STECH, MICHAEL WIESCHER, University of Notre Dame — In second-generation stars whose stellar temperature T is greater than 0.05 GK, Hydrogen burning can proceed also via the NeNa cycle which is important for the nucleosynthesis of the Ne and Na isotopes. The stellar reaction rate for $^{20}$Ne(p, γ)$^{22}$Na is dominated by the Direct Capture and the high energy tail of a subthreshold resonance. The strength of these nonresonant contributions was measured [1] relative to the strength of the resonance at 1.17 MeV. Because of conflicting results for this reference [2], we have remeasured the strength of this resonance relative to the well-known 1.28 MeV resonance in $^{22}$Ne(p, γ)$^{23}$Na using implanted Neon targets. In addition, we also performed an independent measurement of the γ branching ratios and the strength of the $^{22}$Ne(γ, pγ) resonance. 


1 This project is funded by the NSF through grant PHY0822648 and the Universities of JINA. 
2 DOE NNSA Stewardship Science Graduate Fellow

4:48PM FG.00005 Measurement of $^{26}$Si+p resonant elastic scattering for studying the $^{26}$Si(p,γ)$^{27}$P reaction1, HYO SOON JUNG, Y.K. KWON, J.Y. MOON, J.H. LEE, C.C. YUN, C.S. LEE, Chung-Ang U., SEOHNO CHO, M.J. KIM, Y.H. KIM, Seoul Natl. U., Y.K. KIM, J.S. PARK, Hanyang U., E.J. KIM, Chonbuk Natl. U., C.B. MOON, Hoeso U., S. KUBONO, H. YAMAGUCHI, D. KAHL, CNS, U of Tokyo, T. TERANISHI, Kyushu U., Y. WAKABAYSHI, JIAE, N. IWASHA, Tohoku U., Y. TOGANO, RIKEN, S. CHERUBINI, INFN-LNS — Proton resonant states in $^{27}$P have been studied by the resonant elastic scattering of $^{26}$Si+p with a $^{26}$Si radioactive ion beam at 3.039 MeV/u bombarding a thick H2 gas target with the inverse kinematics method at the low-energy RI beam facility CRIB at CNS, University of Tokyo. The properties of these resonance states are important to better determine the production rates of $^{26}$Si(p,γ)$^{27}$P reaction which is one of the atrophysically important reactions to understand the production of the ground state of $^{26}$Al under the explosive stellar environments at higher temperature. In this work, some new states have been observed with a high statistics and background free through a covered range of excitation energies from $E_x \sim$ 2.3 to 3.8 MeV. The resonant parameters of those states, were determined by an R-matrix analysis of the excitation functions.

5:00PM FG.00006 Beta-Delayed Proton- and Gamma-Decay of $^{27}$P for Nuclear Astrophysics1, E. SIMMONS, L. TRACHE, A. BANU, M. MCCLESKEY, B. ROEDER, A. SPIRIDON, R.E. TRIBBLE, Cyclotron Institute, Texas A&M University, Texas, United States, T. ADACHI, KVI, Univ. of Groningen, F.G. OBERHOLZER, School of Physics, University of Edinburgh, Edinburgh, United Kingdom, A. SAASTAMOINEN, Department of Physics, University of Jyväskyla, Finland — The creation site of cosmic $^{26}$Al is still under debate. It is thought to be produced in hydrogen burning and in explosive helium burning in novae and supernovae, and possibly also in the H-burning in outer shells of red giant stars. Also, the reactions for its creation or destruction are not completely known. When $^{26}$Al is created in novae, the reaction chain is: $^{26}$Mg(p, γ)$^{27}$Al, $^{27}$Al(α + γ)$^{30}$Si, $^{30}$Si(p, γ)$^{31}$P, but it can be by-passed by another chain: $^{25}$Al(p, γ)$^{26}$Si(p, γ)$^{27}$P and it can also be destroyed directly. The reaction $^{26}$Al(α, γ)$^{30}$Si is another avenue to bypass the production of $^{26}$Al and is dominated by neutron capture. We study these reactions by an indirect method, through the β−delayed decay of $^{27}$P. We use $^{27}$P produced and separated with MARS and a setup which allows increased efficiency for low energy protons and for high-energy gamma-rays. We measure gamma-rays and β−delayed protons emitted from states above the proton threshold in the daughter nucleus $^{25}$Si ($S_p = 7.463$ MeV) to identify and characterize the resonances. Its lifetime was also measured with accuracy under 1%.

1 US Department of Energy under Grant No. DE-FG02-03ER41073

5:12PM FG.00007 A new method of measuring the $^{12}$C+$^{12}$C fusion cross sections towards astrophysical energies1, X. FANG, C.L. JIANG, M. ALCORTA, B.B. BACK, C.M. DEIBEL2, B. DIGIOVINE, J.P. GREENE, D.J. HENDERSON, R.V.F. JANSENS, C.J. LISTER, S.T. MARLEY, R.C. PARDO, K.E. REHM, D. SEWERYNIK, C. UGALDE, S. ZHU, Argonne National Laboratory, A. ALONGI, B. BUCHER, C. CAHILLANE, P. COLLON, X.T. TANG, University of Notre Dame, E. DAHLSTROM, Rice University — The $^{12}$C+$^{12}$C fusion reaction plays a crucial role in a number of important astrophysical scenarios. The past studies of carbon fusion reactions at sub-barrier energies were limited by the usage of small detectors with low efficiency. A new measurement method, particle-γ coincidence, has been tested using Gammasphere at ANL in the center-of-mass energy range 4.0-5.0 MeV. We are building a large area silicon-detector array and a new Ge-detector array (GEORGINA) which will be coupled with the forthcoming high-current accelerator at the University of Notre Dame. Preliminary results from our test experiment will be presented.

1 This work's supported by NSF under Grant No. PHY-0758100 and PHY-0822648, DOE office of Science through DE-AC02-06CH11357, NNSF of China under Grant No.11021504. 
2 Michigan State University 
3 Western Michigan University

5:24PM FG.00008 A new source of neutrons for weak s-process nucleosynthesis, BRIAN BUCHER, University of Notre Dame, JUSTIN BROWNE, SERGIO ALMARAZ-CALDERON, ADAM ALONGI, AKAA AYANGAEKAA, ANDREAS BEST, MANOEL COUDER, JAMES DEBOER, XIAO FANG, WENTING LU, MASAHIRO NOTANI, DARSHANA PATEL, NANCY PAUL, AMY ROBERTS, RASHI TALWAR, WANPENG TAN, XIAODONG TANG — $^{12}$C($^{12}$C, n) is a potential neutron source for the weak s-process occurring in convective shell carbon burning of massive stars. This reaction has been measured only twice previously and at high energy relative to the astrophysical energy range. Recent studies at the University of Notre Dame indicate the existence of a low-energy resonance which could drastically affect the astrophysical reaction rate. The precise location of this resonance is critically important for the rate determination. A summary of our findings will be presented and the astrophysical implications will be discussed.
5:36PM FG.00009 Quarkeosynthesis – Concise New Laws of Nuclear Physics, WILLIAM WEBB, Energy Control Engineering — Assume an alternate synthesis. Assume that in the building of more massive nuclei the quarks do the combining (quarkeosynthesis). Quarkeosynthesis provides concise new laws of nuclear physics. One of quarkeosynthesis’ new laws is detailed. In the “Law of Nuclear Electron Emission” the absolute magnitude of the fractional charge ratio between outer quarks and center quark is shown to determine the electron emission decay and/or stability of a group of 183 isotopes. The Law concisely demonstrates: Isotopes with charge ratio less than 0.77 decay by emitting an electron. Isotopes with charge ratio more than 0.77 are stable. This law allows 183 simple calculations all of which unerringly lead to perfect agreement with factual nuclear data. Nuclear science has never before encountered so concise a systematic arrangement of truths showing the operation of general law. Quarkeosynthesis, the alternate synthesis, provides concise new laws of nuclear physics.

Friday, October 28, 2011 8:30AM - 10:06AM – Session GA Nuclear Theory I: RHI, EMC, Beta-decay 62

8:30AM GA.00001 Medium Induced Collinear Radiation via Soft Collinear Effective Theory (SCET), FRANCESCO D’ERAMO, HONG LIU, KRISHNA RAJAGOPAL, MIT — The propagation of hard partons through the strongly interacting matter created in high energy heavy-ion collisions involves widely separated scales. The methods of Effective Field Theories (EFT) can provide a factorized description at lowest nontrivial order, and a formalism where the correction to this factorization are calculable systematically order by order in the small ratios between the different scales. In this talk I will present our preliminary results on the medium induced collinear radiation by using the methods of Soft Collinear Effective Theory (SCET). The radiated gluon is collinear with the incoming hard parton and gets and arbitrary fraction of its energy.

8:42AM GA.00002 Transverse Momentum Broadening in Weakly Coupled Quark-Gluon Plasma, MINDAUGAS LEKAVECKAS, KRISHNA RAJAGOPAL, HONG LIU, FRANCESCO D’ERAMO, CHRISTOPHER LEE — Jet quenching parameter or, equivalently, transverse momentum broadening distribution function is an important quantity which helps to understand energy losses in heavy ion collisions and get insights into the properties of the de-confined quark-gluon plasma. Soft Collinear Effective Theory (SCET) provides framework to calculate jet quenching parameter at weak coupling using expectation value of two space-like separated light-like Wilson lines which can be evaluated for desired medium. In this work we obtain transverse momentum broadening distribution function for the quark-gluon plasma in equilibrium using full Thermal Field Theory formalism and recover its limiting behavior in the HTL regime.

8:54AM GA.00003 ABSTRACT WITHDRAWN —

9:06AM GA.00004 Nuclear Scaling at Low Resolution1, E.R. ANDERSON, Ohio State Univ., S.K. BOGNER, Michigan State Univ., R.J. FURNSTAH, K. HEBELE, R.J. PERRY, Ohio State Univ. — Nuclear scaling is observed in the ratios of inclusive electron scattering on different nuclei for 1.5 ≤ x_F ≤ 2.0 at large momentum transfer Q^2. The ratios depend on the nucleus but are independent of Q^2, and have been understood to be a result of strong short-range correlations induced by the nucleon-nucleon interaction. Recent calculations of nuclear structure make use of the similarity renormalization group to soften the nuclear potential through a series of unitary transformations, which suppress short range correlations. However, we can now understand and calculate this scaling ratio as an effect of low momentum nuclear structure via factorization of operator expectation values. We also add this framework to an observed correlation with the EMC effect.2

1Supported in part by the NSF under Grants No. PHY-1002478 and the UNEDF SciDAC Collaboration under DOE Grant DE-FC02-09ER41586.

9:18AM GA.00005 The onset of proton-neutron correlations in nuclei1, MIHAI HOROI, Department of Physics, Central Michigan University, Mount Pleasant, MI 48859 — Proton-neutron correlations in nuclei can be explained in part by isoscalar and isovector pairing. Shell model techniques reveal additional strong proton-neutron correlations that were recently observed in neutron transfer reactions. I will discuss the pieces of the effective interaction that contribute to these strong correlations. I will also show the the observed 1^+0 and 0^+1 low-lying states in odd-odd nuclei are geometrically favored in the two-body random ensemble model.

1Support from NSF grant PHY-0758099 and DOE grant DF-FC02-09ER41584 is acknowledged.

9:30AM GA.00006 Spectroscopy of the hadronic atoms and superheavy isotopes: Energy shifts and strong K, pi- N interaction corrections, OLGA KHETSELIUS, INGA SERGA, ANASTASIYA SHAKHMAN, Odessa University — Ab initio many-body perturbation theory approach with an accurate account of relativistic, nuclear, radiative effects is used in calculating spectra of some hadronic (pion, kaon) atoms. One of the main purposes is establishment a quantitative link between quality of nucleus structure modeling and accuracy of calculating energy and spectral properties. The wave functions zeroth basis is found from the Klein-Gordon-Fock equation for hadronic system and the Dirac-Fock equation for usual atom. The potential includes the SCF ab initio potential, the electric and polarization potentials of a nucleus (the RMF and Fermi models for a charge distribution in a nucleus are considered). For low orbits there are the important effects due to the strong hadron-nuclear interaction. We present the data on: the energy levels for superheavy isotopes Z=113,114 and the shifts and widths of transitions (2p-1s,3d-2p, 4f-3d etc) in some pionic and kaonic atoms (H, He, N, W, U). The calculated X-ray transitions spectrum for kaonic He and estimate of 2p level shift due to the strong K-N interaction 1.57 eV are in the reasonable agreement with experiment (the shift 1.9eV) by Okada et al (2008; E570; KEK 12GeV, RIKEN Nishina Centre, JAPAN) and differ (about order) of other experimental data by Wiegand-Pehl (1971), Batty et al (1979), Baird et al (1983).
9:42AM GA.00007 Advances in the calculation of double beta decay, J. KOTILA, F. IACHELLO, Center for Theoretical Physics, Sloane Physics Laboratory, Yale University, New Haven, CT 06520-8120, USA — The fundamental nature and the absolute mass scale of the neutrino is a subject of great interest at the present. In order to study these issues the nuclear ββ-decay is utilized. For an extraction of the neutrino mass and for estimates of the half-life, besides the involved nuclear matrix elements, one also needs the phase-space factors \( G_{0\nu} \) and \( G_{2\nu} \). A general formulation was given by Doi et al. [1]. However, in previous calculations an approximate expression for the electron wave function at the nucleus is used. We have done an independent calculation with exact Dirac electron wave functions including screening by the electron cloud [2]. The influence to the phase-space factors is especially for the heavier \( \nu_3 \)-decaying nuclei. This is an extremely important observation since, judging by the expected lifetime, \(^{150}\text{Nd}\) is one of the most prominent candidates where the 0/\(2\nu_3\)-decay could be seen. Furthermore, we have calculated the phase-space factors to the first excited 0\(^+\) state both in 0\(\nu\) and 2\(\nu\) mode. All the above mentioned results are combined with recently calculated IBM-2 nuclear matrix elements [3] leading to a more reliable prediction for neutrino mass and estimates of the half-life in both modes. [1] M. Doi et al., Prog. Theor. Phys. 66 (1981) 1739. [2] J. Kotila and F. Iachello, to be published. [3] J. Barea and F. Iachello, Phys. Rev. C 79 (2009) 044301 and to be published.

9:54AM GA.00008 The beta-decay properties in the vicinity of \(^{78}\text{Ni}\)\(^\text{+}\), IVAN N. BORZOV, JIHIR (Oak Ridge) and IPPE (Obninsk) — The beta-decay properties of neutron-rich Cu to Ga nuclei in the vicinity of the doubly magic \(^{78}\text{Ni}\) have been calculated within the density-functional approach plus continuum approximation (DF+CQPA) [1]. The framework allows for a fully microscopic description of the Gamow-Teller (GT) and first forbidden (FF) transitions between \( dsgh \) and \( fpfp \) shells. The new theoretical predictions are compared with our previous ones, with the standard FRDM calculations [2] and recent experimental data. Of particular importance are new high quality gamma ray spectroscopy data obtained for \( Z \geq 50 \) at Halfield Radioactive Ion Beam Facility (HRIBF). In \(^{78}\text{Ni}\) region, the half-lives calculated with blocking of the odd-proton on the 1p\(s_{1/2}\)-orbit with the data better than the ones with no blocking as well as the ones from standard FRDM calculations used for the r-process modeling. The high-energy first forbidden transitions in the nuclei with \( N > 50 \) populating low lying excited levels in the daughter nuclei produce a strong impact on the total half-lives and especially on the delayed neutron emission. The effect of reduction of the \( \nu_n \)-values compared to the pure GT- approximation in \( N > 50 \) isotopes [1] will be discussed. [1] I.N. Borzov, Phys. Rev. C 67, 025802 (2003); Phys. Rev. C 71, 065801 (2003). [2] P. Moeller, B. Pfeiffer and K-L Kratz, Phys. Rev. C 67, 055802 (2003).

Friday, October 28, 2011 8:30AM - 10:18AM – Session GB Exotic Correlated Decays - Auditorium

8:30AM GB.00001 Multiple proton decays of \(^{6}\text{Be}, \, ^{8}\text{C}, \, ^{8}\text{B}(\text{IAS})\) and excited states in \(^{10}\text{C}\), LEE SOBOTKA, Washington University — Recent technical advances have allowed for high-order correlation experiments to be done. We have primarily focused on experiments in which the final channels are composed of only alphas and protons. Four cases we have studied are: \(^{6}\text{Be}, \, ^{10}\text{C}, \, ^{8}\text{C}, \) and \(^{8}\text{B}(\text{IAS})\) via 3, 4, 5, and 3-particle correlation measurements, respectively. While the first case had been studied before, our work presents very high statistics in the full Jacobi coordinates (the coordinates needed to describe 3-body decay.) Our study of \(^{10}\text{C}\) excited states provides isolatable examples of correlated 2p decay from one state, and the decay of another which is unusually highly correlated, a “ménage a quatre.” \(^{8}\text{C}\) decay presents the only case of sequential 3-body 2p decay steps (i.e. 2p-2p). The intermediate in this 2-step process is the first example \((^{6}\text{Be})\) mentioned above. Unlike the well-studied second step \((^{6}\text{Be}\) decay\), the first step in this 2p-2p process provides another example of correlated 2p emission. The decay of \(^{8}\text{B}(\text{IAS})\), the isobaric analog of \(^{8}\text{C}\), also decays overwhelmingly by 2p emission, in this case to \(^{8}\text{Li}(\text{IAS})\). This IAS-to-IAS 2p decay is one for which decay to the potential 1p intermediates is energetically allowed but isospin forbidden. This represents an expansion, over that originally envisioned by Goldanski, of the conceivable nuclear territory for 2p decay.

9:06AM GB.00002 Two-proton radioactivity of \(^{48}\text{Ni}\)\(^\text{+}\), KRZYSZTOF MIERNIK, Oak Ridge National Laboratory — In experiment performed at NSCL facility we studied the decay of extremely neutron deficient isotope of \(^{48}\text{Ni}\)\(^\text{+}\). Ions were implanted into a gaseous detector, the Optical Time Projection Chamber which allows to record tracks of charged particles. Six events of \(^{48}\text{Ni}\)\(^\text{+}\) were observed, the two-proton radioactivity (four events) and the \(\beta\)-decay (two events) channels were clearly identified. The half-life of \(^{48}\text{Ni}\)\(^\text{+}\) is determined to be \(T_{1/2} = 2.1^{+1.4}_{-0.4}\) ms. The results of three-dimensional events reconstruction as well as comparison of results with theoretical models will be presented.

Friday, October 28, 2011 8:30AM - 10:30AM – Session GC Electroweak Interactions II – 101

8:30AM GC.00001 The Qweak Experiment: A Search for New Physics at the TeV Scale via a Measurement of the Proton’s Weak Charge, RAKITHA BEMINIWATTHA, Ohio University, QWEAK COLLABORATION — The Qweak experiment at Jefferson Lab will measure the parity-violating elastic electron-proton scattering asymmetry at \(Q^2 = 0.03\) (GeV/c)\(^2\) to obtain the weak charge of the proton, \(Q_W^p\), to an accuracy of 4%. The result will test the Standard Model prediction of the running of \(\sin^2 \theta_W\) and will provide an indirect probe of new physics at TeV scale. An overview and the performance of the experiment after the first data taking run will be provided.

This research was supported by the US NSF under grant PHY-0854912 and by the US DOE under grant DE-FG02-04ER41338.

This work was supported by JIHIR (ORNL, Oak Ridge).

Eugen P. Wigner Fellow and staff member at the Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U.S. Department of Energy under Contract DE-AC05-00OR22725.

My work is supported by the National Science Foundation under Grant No 0969788 and No 0653422.

3This work was supported by JIHIR (ORNL, Oak Ridge).

4Research performed as a Eugene P. Wigner Fellow and staff member at the Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U.S. Department of Energy under Contract DE-AC05-00OR22725.

3Research was supported by the US NSF under grant PHY-0854912 and by the US DOE under grant DE-FG02-04ER41338.
8:54AM GC.00003 Measuring the Parity-Violating Asymmetry of Aluminum in the $Q_{\text{weak}}$ Experiment 1, KATHERINE MYERS, George Washington University, QWEAK COLLABORATION — The $Q_{\text{weak}}$ Collaboration at Jefferson Lab will perform the first direct measurement of the proton’s weak charge, $Q_{\text{wp}}$, to a precision of 4% by measuring the parity-violating asymmetry in elastic electron-proton scattering. At tree level, the weak mixing angle is related to the weak charge of the proton by $Q_{\text{wp}}^{2} = 1 - 4 \sin^{2} \theta_{W}$, leading to a 0.3% measurement of $\sin^{2} \theta_{W}$ at low energy. To achieve these goals, systematic effects must be well understood and measured precisely. One of the largest corrections to the experimental asymmetry comes from elastic electron-Aluminum scattering in the target windows. This asymmetry must be measured directly in dedicated thick Aluminum target runs and measured to a relative precision of a few percent. The measurement of this asymmetry will provide the first extraction of the parity-violating elastic electron-Aluminum asymmetry. To extract this asymmetry, corrections for target contaminants (other nuclei present in the Aluminum alloy used), quasielastic scattering, and inelastic transitions must be considered. A discussion of the data quality from the first production run of the experiment as well as the mentioned corrections will be presented.

1This work supported by the NSF.

9:06AM GC.00004 A Diamond Micro-strip Electron Detector for Compton Polarimetry 1, AMRENDRANARAYAN, Mississippi State University — The Qweak experiment in Hall C at Jefferson Lab aims to measure the weak charge of the proton with a precision of 4.1% by measuring the parity violating asymmetry in polarized electron-proton elastic scattering. Beam polarimetry is the largest experimental contribution to the error budget. A new Compton polarimeter was installed for a non-invasive and continuous monitoring of the electron beam polarization with a goal of 1% systematic and 1% per hour statistical precision. The Compton-scattered electrons are detected in four planes of diamond micro-strip detectors. These detectors are read out using custom built electronic modules that include a pre-amplifier, a pulse shaping amplifier and a discriminator for each detector micro-strip. We use Field Programmable Gate Array based general purpose logic modules for event selection and histogramming. The polarimeter was commissioned during the first run period of the Qweak experiment. We will show the preliminary results from the electron detector obtained during the first run period of Qweak experiment.

1Grant Number: DE-FG02-07ER41528: Precision Measurements at Medium Energy

9:18AM GC.00005 Simulation and Measurement of the Qweak Main Detector Energy Sensitivity, ADESUBEDI, Mississippi State University — The Qweak experiment in Hall C at Jefferson Lab aims to make the first direct measurement of the weak charge of the proton with about 4% overall uncertainty by measuring the parity violating asymmetry in elastic electron-proton scattering. Changes in helicity correlated beam properties create false asymmetries, particularly if the apparatus is misaligned. We measure and correct such false asymmetries, but also try to understand and reduce them where possible. This talk will emphasize simulations of the sensitivity of the main detector to energy jitter (the single largest correction!) and what the comparison to data tells us about our detector alignment.

9:30AM GC.00006 Results from UCNA 2010 1, ROBERT PATTIE, North Carolina State University, UCNA COLLABORATION — We will present the results of a $\approx 0.7\%$ measurement of the electron momentum neutron spin angular correlation coefficient “A” using polarized ultracold neutrons (UCN) during the 2010 beam cycle at the Los Alamos Neutron Science Center (LANSCE) by the UCNA collaboration. Improvements made to the solid deuterium ultracold neutron source and the neutron guide system allowed us to achieve the a factor of two increase in the decay rate and overall statistics. Major systematic uncertainties, including detector calibration and linearity, electron backscattering, and neutron polarimetry, were reduced, bringing the full systematic uncertainty to below $0.6\%$ based on the investigations during the 2008-2009 beam cycles.

1NSF Grant no: 1005233

9:42AM GC.00007 UCN Transport, BRITTNEY VORNDICK, UCNA COLLABORATION — The UCNA experiment utilizes ultracold neutrons (UCN) to measure angular correlations in beta-decay. UCN are produced in a solid deuterium source and then coupled to the experimental decay volume through a sequence of guide tubes. Requirements for the guides typically include smooth surfaces, high Fermi potentials, and often a very low depolarization probability per bounce. We review the UCNA guide geometry and characterize the effectiveness of recently developed diamond-like carbon coatings produced by pulsed laser deposition on Cu and quartz tubing. We also describe the development of a UCN shutter to be used to monitor UCN polarization. Finally we present research and development towards new coating processes and materials for UCN guides.

9:54AM GC.00008 Precision Polariometry with UCN in the UCNA Experiment, A.T. HOLLEY 1, North Carolina State University — The UCNA experiment, which uses ultracold neutrons (UCN) to determine the angular correlation between the electron momentum and the neutron spin (the beta-asymmetry) in free polarized neutron decay, was developed to provide a complementary technique to cold neutron beam measurements. Neutron polarization is an important systematic in both approaches, especially since neutron spin flipper are generally required to reduce detector-related asymmetries. Traditionally neutron polarimetry in such experiments was performed in situ determination of both the polarizing efficiency and the spin flipping efficiency using, for example, a crossed polarizer analyzer apparatus. This technique was applied to the UCNA polarization system, but the use of UCN in the experiment allows for a second in situ method of performing polarimetry which serves as the primary monitor of neutron polarization for UCNA. Results from both polarimetry techniques will be compared, and polarimetry data collected during UCNA running through the 2010 run cycle will be presented.

1for the UCNA Collaboration

10:06AM GC.00009 The future of UCNA: towards a sub-0.4% measurement of the neutron beta decay asymmetry using ultracold neutrons, MICHAEL MENDEHNALL, California Institute of Technology, UCNA COLLABORATION — The UCNA experiment uses trapped ultracold neutrons (UCN) to measure the neutron beta decay asymmetry “A”. Since publication of a proof-of-principle result in 2009, a series of improvements have increased the statistical and systematic sensitivity of the experiment, from an initial 4% determination of “A” to the 1.4% result published in 2010 and the soon-to-be-published $\sim 0.7\%$ measurement. This talk describes plans for pushing the UCNA experiment towards the limits of its sensitivity (below 0.4%), including higher precision polarimetry and energy calibrations, thinner windows to decrease backscattering and monte carlo corrections, and improvements in UCN production and transport.
10:18 AM GC.00010 Fierz Interference in Beta Decay of Ultracold Neutrons

KEVIN HICKERSON, California Institute of Technology, UCBB COLLABORATION — We discuss the status of the UCNb experiment that uses the ultracold neutron (UCN) source at LANSE. The UCNb apparatus is being designed to test contributions to scalar and tensor interactions from physics beyond the Standard Model, manifest as a nonzero value for the neutron Fierz interference parameter, $b_N = (b_p - 3b_{b_T})(1 + 3\lambda^2)$, in the $\beta$ energy spectrum of neutron decay. Some models may have $b_{b_T}$ as large as $10^{-3}$, but below the current limits on the Fermi component, $b_F$, set by superallowed $0+ \rightarrow 0+$ nuclear $\beta$ decays. Neutron decay has the advantage of sensitivity to the Gamow-Teller component of $b_{b_T}$. We present data from UCN test runs from 2010 that help set limits on systematic backgrounds from $\beta$ decay of spallation produced 6He and from UCN generated $\gamma$ backgrounds. We also discuss test plans and upgrades for 2011 and beyond.

1LANSE LDRD

Friday, October 28, 2011 8:30AM - 10:06AM  
Session GD Instrumentation IV Heritage

8:30 AM GD.00001 Developing a fast ionization chamber for transfer reaction studies

K.Y. CHAE, D.W. BARDAYAN, M.S. SMITH, Oak Ridge National Laboratory, K.T. SCHMITT, S.H. AHN, University of Tennessee, W.A. PETERS, Oak Ridge Associated Universities, S. STRAUSS, Rutgers University — Detection of beam and beam like recoils at far forward angles is often critical for radioactive beam measurements in inverse kinematics. Gas-filled ionization chambers are well suited for these applications, since they have moderately good energy resolution and can take long exposure times. Conventional ion counters using a Frisch grid, however, have slow response times because the ionized electrons must travel long distances to the anodes. To reduce response times, a fast ion counter using a tilted window and tilted electrodes was developed and tested at ORNL’s Holifield Radioactive Ion Beam Facility, modified from an original design by Kimura et al. [1]. The maximum counting rate and energy resolution, along with future plans for using the new ion counter, will be presented.


This work was sponsored by the Office of Nuclear Physics, U.S. Department of Energy.

8:42 AM GD.00002 Photon Detection System for Collinear Laser Spectroscopy at NSCL

SOPHIA VINNIKOVA, Michigan State University, NSCL. CHRISTOPHER GEPPERT, University of Mainz, GSI. MICHAEL HAMMEN, University of Mainz, ANDREW KLOSE, Argonne National Laboratory, Argonne National University, NSCL. JORG KRAMER, WILFRIED NORTERSHAUSER, University of Mainz, GSI. PAUL MANTICA, Michigan State University, NSCL. KEI MINAMISONO, NSCL, ANTHONY SCHNEIDER, Michigan State University, NSCL — A photon detection system has been designed and fabricated for the BEam C0oler and COllinear Laser spectroscopy (BECOLA) facility at NSCL to work over the wavelength ranges of 350-500 nm and 700-1000 nm. The detection system is based on a design from the University of Mainz and relies on an ellipsoidal reflector to focus fluorescence from the atom/ion beam passing through the first focal point to a photomultiplier tube located at the second focal point. An aperture system will be used to reduce background caused by stray laser light. Ray trace simulations and measurement of stray light characteristics will be discussed. This research is funded in part by NSF grant PHY 06-0067.

8:54 AM GD.00003 Performance of the X-ARRAY at ANL

A.Y. DEO, U. Massachusetts Lowell, C.J. LISTER, Argonne National Lab., P. CHOWDHURY, U. Massachusetts Lowell, F.G. KONDEV, P.F. BERTONE, K. TEH, Argonne National Lab., S. ZHU, Argonne National Lab., G.J. LANE, Australian National Univ., E. MCCUTCCHAN, C. NAIR, D. SEWERYNIK, Argonne National Lab., M.L. SMITH, Australian National Univ., S. ZHU, Argonne National Lab. — The X-ARRAY is a versatile and efficient HpGe array consisting of a Eurysys Supercooler made of four 70 mm diameter n-type germanium crystals and 4 regular clover detectors based on 60 mm technology. Both the array and its electronics are compact and can be easily moved. It has been used extensively at the Argonne Fragment Mass Analyzer (FMA) and will be an integral part of the CARIBU decay station for beta-gamma spectroscopy of neutron-rich nuclei. In order to process signals from the array, a CAMAC-based data acquisition system, SCARLET, is used. The overall performance of the array and SCARLET will be discussed.

Work supported by the U.S. Department of Energy.

9:06 AM GD.00004 Digital Data Acquisition System for Gammasphere

M.P. CARPENTER, M. ALCORTA, J.T. ANDERSON, C.R. HOFMAN, R.V.F. JANSSENS, T.L. KHOO, A. KREPS, T. LAURITSEN, C.J. LISTER, D. SEWERYNIK, P. WILT, S. ZHU, Argonne National Laboratory, M. CROMAZ, C. LIONBERGER, I.Y. LEE, Lawrence Berkeley National Laboratory — A new digital-based data acquisition system for Gammasphere is under development. This system leverages the electronics designed for the GRETINA collaboration. At the center of this development are the GRETINA 10-channel digitizer modules which digitize the Ge preamp signals at a 100MHz rate [1]. The new DAQ will increase event throughput significantly over the existing system while addressing multiple repair and maintenance issues. New hardware and firmware to integrate the GRETINA electronics with Gammasphere is under development. The capabilities of digital electronics have been tested using CAEN V1720 VME digitizers (12 bit, 250MS/s). Analogue RC/CR emulation filters have been developed to perform neutron/$\gamma$ discrimination: zero crossing technique as well as gate integrated method have been implemented. Signal interpolation routines allowed to obtain also ~1 ns timing performances. During June 2011 a subset of 8 detectors was successfully used to perform an in-beam experiment to measure neutron production cross sections. This required the use of 2 VME synchronized acquisition boards and the development of a specific on-line analysis software. We will present a short description of the RIPEN apparatus at LNL and the digital electronic setup. Specifically developed pulse shape algorithms will also be illustrated, as well as the results obtained in calibration and in-beam measurements.

9:18 AM GD.00005 Digital Electronics Equipment for the RIPEN Apparatus

TOMMASO MARCHI, FABIANA GRAMEGNA, MARCO CINAUSERO, VLADIMIR KRAVCHUK, INFN - Legnaro, GIANMARIA COLLAZUOL, INFN Padova and Padova University, NUCX-EX COLLABORATION — The RIPEN apparatus is a neutron detector array composed of BC501 liquid scintillators specifically suited for neutron detection and time of flight measurement. It was installed at Legnaro National Laboratory in early '90s, while the last measurement campaign was performed in 2007. At present the apparatus is undergoing a process of complete substitution of readout/acquisition electronics. The capabilities of digital electronics have been tested using CAEN V1720 VME digitizers (12 bit, 250MS/s). Analogue RC/CR emulation filters have been developed to perform neutron/$\gamma$ discrimination: zero crossing technique as well as gate integrated method have been implemented. Signal interpolation routines allowed to obtain also ~1 ns timing performances. During June 2011 a subset of 8 detectors was successfully used to perform an in-beam experiment to measure neutron production cross sections. This required the use of 2 VME synchronized acquisition boards and the development of a specific on-line analysis software. We will present a short description of the RIPEN apparatus at LNL and the digital electronic setup. Specifically developed pulse shape algorithms will also be illustrated, as well as the results obtained in calibration and in-beam measurements.
9:30AM GD.00006 Monte-Carlo simulation and acceptance calculation on NSCL charge breeder electron beam ion trap, KRITSADA KITTIMANAPUN, GEORG BOLLEN, ALAIN LAPIERRE, STEFAN SCHWARZ, National Superconducting Cyclotron Laboratory, Michigan State University, ANTHONY SCHNEIDER, Duke University and TUNL, ANTHONY SCHNEIDER, Duke University and TUNL, GEORGE WOLFF, University of Kentucky — We have measured the Compton scattering cross section from \(\gamma p\) for the first time using the High Intensity Gamma Source (HI\textsubscript{S}) at the Triangle Universities Nuclear Laboratory (TUNL). This measurement is intended to provide a new method for obtaining the electric and magnetic polarizabilities of the proton using the framework provided by QCD. Pion photoproduction is one process where both experiment and theory can produce valid and useful results. Consequently, high-quality measurements of this fundamental process can be used to test the predictions of approaches such as chiral effective-field theories and dispersion relations, as well as provide additional data for the SAI\textsubscript{D} and MAID partial-wave analyses. The Photon Tagging Facility at MAX-lab in Lund, Sweden is uniquely suited to perform measurements of pion photoproduction at energies below threshold and the \(\Delta\)-resonance. The MAX-TAGG collaboration is undertaking a comprehensive program to investigate the \(\gamma p\to p\pi^+\) channel. The first measurement of the \(\gamma n\to p\pi^-\) channel has just been completed. Using a LD\textsubscript{S} target and the reaction \(\gamma d\to ppm^-\), the \(\pi^-\) is captured on another deuteron creating a high-energy \(\gamma\)-ray. These \(\gamma\)-rays were detected using three very large NaI spectrometers. These new near-threshold measurements will be used to better evaluate the threshold \(E_{\text{th}}(\pi^-)\) amplitude, which can be compared with the predictions from Chiral Perturbation Theory and other quark-based theories. Initial results from this measurement will be presented.

9:42AM GD.00007 The EBIT charge breeder at NSCL, ALAIN LAPIERRE, STEFAN SCHWARZ, KRITSADA KITTIMANAPUN, GEORG BOLLEN, NSCL, OLIVER KESTER, NSCL/GSI — The National Superconducting Cyclotron Laboratory (NSCL) is finalizing ReA to reaccelerate rare-isotope beams to energies of \(\sim 0.3-20\) MeV/u. ReA consists of an electron-beam ion source / trap (EBIS/T), a mass separator, a radio-frequency quadrupole (RFQ) pre-accelerator, and a superconducting radio-frequency linear accelerator (SRF-LINAC). By increasing the charge of ions injected into the RFQ and SRF-LINAC, this charge breeder is a key component to provide a compact and cost-efficient reaccelerator. The ReA EBIT has started producing highly charged ion beams. It is equipped with an electron gun yielding a few amperes and a magnet configuration made of Helmholtz coils and a solenoid, providing a maximum magnetic field strength of 6 T. The solenoid magnet configuration will guarantee high beam acceptance. The combination of a high-current gun and strong magnetic field will allow this EBIS/T to reach high electron current densities suitable to rapidly increase the charge of short-lived isotopes within tens of milliseconds. The status of the EBIT will be presented.

9:54AM GD.00008 Collinear Laser Spectroscopy at the BECOLA Facility, ANDREW KLOSE, PAUL MANTICA, SOPHIA VINNIKOVA, Michigan State University, KEI MINAMISONO, NSCL, BECOLA TEAM — The BEam COoler and LASer spectroscopy (BECOLA) facility has been constructed at NSCL to measure the hyperfine structure of nuclei and deduce moments and charge radii. A Colutron off-line ion source is being used to produce stable isotope beams to commission the collinear laser beam line. Laser light is transported to the beam line via fiber optic cable and is collinearly aligned with the stable, low-energy (< 60 keV) beam. The hyperfine structure is extracted by observing the fluorescence as a function of the acceleration voltage of the beam, which is equivalent to scanning the laser frequencies due to the Doppler Effect. The operational characteristics and controls of the off-line source and collinear beam line will be discussed. This work is supported in part by NSF grant PHY-06-06007.

Friday, October 28, 2011 8:30AM - 10:06AM – Session GE Electromagnetic Interactions 103AB

8:30AM GE.00001 Near-Threshold Measurement of \(\gamma n\to p\pi^-\) at MAX-lab, GRANT O’RIELLY, University of Massachusetts Dartmouth, MAX-TAGG COLLABORATION — One of the important questions in nuclear science is to describe the properties of the nucleon using the framework provided by QCD. Pion photoproduction is one process where both experiment and theory can produce valid and useful results. Consequently, high-quality measurements of this fundamental process can be used to test the predictions of approaches such as chiral effective-field theories and dispersion relations, as well as provide additional data for the SAI\textsubscript{D} and MAID partial-wave analyses. The Photon Tagging Facility at MAX-lab in Lund, Sweden is uniquely suited to perform measurements of pion photoproduction at energies below threshold and the \(\Delta\)-resonance. The MAX-TAGG collaboration is undertaking a comprehensive program to investigate the \(\gamma p\to p\pi^+\) channel and, eventually, \(\gamma n\to n\pi^0\) channels to complement the existing large data set on the \(\gamma p\to p\pi^0\) channel. The first measurement of the \(\gamma n\to p\pi^-\) channel has just been completed. Using a LD\textsubscript{S} target and the reaction \(\gamma d\to ppm^-\), the \(\pi^-\) is captured on another deuteron creating a high-energy \(\gamma\)-ray. These \(\gamma\)-rays were detected using three very large NaI spectrometers. These new near-threshold measurements will be used to better evaluate the threshold \(E_{\text{th}}(\pi^-)\) amplitude, which can be compared with the predictions from Chiral Perturbation Theory and other quark-based theories. Initial results from this measurement will be presented.

8:42AM GE.00002 Compton Scattering on \(^6\text{Li}\) at 60 MeV, L. MYERS, M.W. AHMED, S.S. HENSHAW, J.M. MUELLER, H.R. WELLER, Duke University and TUNL, G. FELDMAN, T. BALINT, K. SYKORA, George Washington University, M.A. KOVASH, University of Kentucky — We have measured the Compton scattering cross section from \(\gamma^6\text{Li}\) for the first time using the High Intensity Gamma Source (HI\textsubscript{S}) at the Triangle Universities Nuclear Laboratory (TUNL). This measurement is intended to provide a new method for obtaining the electric and magnetic polarizabilities of the lithium (\(\alpha\) and \(\beta\)) of the nucleus. The \(Z=3\) target gives a higher Compton cross section compared to a proton or deuterion target, and as long as nuclear effects can be theoretically modeled, it should be feasible to extract information about \(\alpha\) and \(\beta\). The experiment was conducted using a 60 MeV \(\gamma\)-ray beam with an intensity of \(10^8\) Hz and the eight-element HI\textsubscript{S} NaI Detector Array (HINDA) covering an angular range of \(35^\circ\) to \(159^\circ\). A phenomenological Compton scattering model has been developed [1] which utilizes known photoabsorption data to infer the Compton scattering amplitudes — with these fixed inputs, \(\alpha\) and \(\beta\) are free parameters that can be fit to the angular distribution of the scattering data. Our preliminary data will be presented and compared to initial calculations using the phenomenological model which includes nuclear electric and magnetic polarizabilities. Partially supported by the USDOE under grant numbers DG-FG02-97ER41033 and DE-FG02-06ER41422. [1] D.H. Wright et al., Phys. Rev. C 32, 1174 (1985).

8:54AM GE.00003 Measuring Proton Spin Polarizabilities with Polarized Compton Scattering, PHILIPPE MARTEL, WILLIAM BARNES, RÔMY MISKIMEN, ALEXANDER MUSHKARENKO, University of Massachusetts, MAMI A2 COLLABORATION — An important test of low-energy QCD theories is the extraction of the proton spin polarizabilities (SPs), which describe the response of the proton spin to a polarized photon. The SPs arise as third order terms in the energy expansion of the Compton scattering amplitude, with theoretical values provided by dispersion and effective field theories, and in the future by lattice calculations. Extraction of these values is possible by measuring two beam-target asymmetries of a circularly polarized photon beam on a transversely polarized target, \(\Sigma_{x\gamma}\); and on a longitudinally polarized target, \(\Sigma_{z\gamma}\), and a beam asymmetry of a linearly polarized photon beam on an unpolarized target, \(\Sigma_{3}\), at photon energies between \(\pi\) and \(2\pi\) threshold. The MAMI A2 Bremsstrahlung beam is used in conjunction with either a frozen-spin butanol or an unpolarized hydrogen gas, and the Crystal Ball and TAPS detectors which combined provide 97% coverage of \(\pi\). We will report on \(\Sigma_{x\gamma}\) measurements, supplemented by initial \(\Sigma_{z\gamma}\) measurements, both just below and above \(2\pi\) threshold.

1DE-FG02-88ER410415
9:06AM GE.00004 Study of dimensional scaling in two-body photodisintegration of 3He\(^3\), YORDANKA ILIEVA, University of South Carolina, THE CLAS COLLABORATION — Ever since their formulation in 1973, dimensional scaling laws have been extensively exploited to probe short-distance dynamics in nuclear processes. Despite their overwhelming empirical success in describing a large number of nuclear reactions, many of which were measured at low energies, there has been a longstanding controversy in the interpretation of scaling. Recent theoretical developments within the AdS/CFT approach suggest that in the non-perturbative regime of QCD, scaling is due to the near constancy of the strong coupling constant at very low momentum transfer. Thus, probing exclusive processes in this kinematic regime is instrumental to test the validity of the AdS/CFT approach. In this talk I will present our novel experimental studies of dimensional scaling using two-body photodisintegration of 3He in which we have mapped the invariant cross section of this process over photon-energy range from 0.4 GeV to 1.4 GeV and center-of-mass angles from 40° to 140°. The data have been taken with the CLAS at Jefferson Lab. The results of our study support a non-perturbative interpretation of scaling at low momentum transfer.

3This work is supported in part by the US National Science Foundation under grant PHY-0856010.

9:18AM GE.00005 Short-Range Nucleon-Nucleon Correlations, DOUGLAS HIGINBOTHAM, Jefferson Lab — For short periods of time, the nucleons in the nucleus can form strongly correlated pairs. By probing the nucleus with electrons in xB > 1 and Q2 > 2 [GeV/c]² kinematics, it seems that researchers have finally clearly observed the effects of a correlated initial-state and suppressed the other reaction mechanisms which dominated experiments which were done in less extreme kinematics. Recent experimental results in these kinematics, both inclusive and exclusive, will be presented along with a discussion of what the data has taught us.

9:30AM GE.00006 ABSTRACT WITHDRAWN —

9:42AM GE.00007 Discharge of metastable nuclei during negative muon capture: Energy approach, ALEXANDER GLUSHKOV, Odessa University and Troitsk ISAN, Russian Acad.Sci. — A negative muon captured by a metastable nucleus may accelerate the discharge of the latter by many orders of magnitude. For a certain relation between the energy range of the nuclear and muonic levels a discharge may be followed by muon ejection and muon participates in discharge of other nuclei. We present relativistic energy approach to description of a discharge of nucleus with emission of gamma quantum and further muon conversion. Besides, the external laser (graser) effect on cited processes is studied. The decay probability is linked with imaginary part of the “nucleons subsystem-photon-muon” system energy. One should consider 3 channels: 1). radiative purely nuclear 2j-poled transition (probability P1); 2). Non-radiative decay, when a proton transits into the ground state and muon leaves a nucleus with energy E=E(p-N1J1)-E(i), where E(p-N1J1) is an energy of nuclear transition, E(i) is the bond energy of muon in 1s state (P2); 3). A transition of proton to the ground state with muon excitation and emission of gamma quantum with energy E(p-N1J1)-E(n) (P3). As example, the probabilities for different channels in a case of the Sc, Ti nuclei are presented. The Dirac-Wood-Saxon model is used. The key features of the possible high-power monochromatic gamma radiation sources on the studied processes basis are analyzed.

9:54AM GE.00008 The Charge Radius of the Proton, a 5 Sigma Discrepancy?, GIL PAZ, The University of Chicago — Recently, the charge radius of the proton was extracted, for the first time, from muonic hydrogen. The value was 5 sigma away from similar measurement of regular hydrogen. The extraction of the charge radius depends on a theoretical input. Together with Richard J. Hill, we are studying the hadronic uncertainty in the theoretical prediction, using the tool of an effective field theory, namely NRQED. In the talk I will report on the results of this study. I will also report on a previous study of the model-independent extraction of the charge radius from electron-proton scattering, which found that previous extractions have typically underestimated their errors.

Friday, October 28, 2011 8:30AM - 10:18AM —
Session GG Astrophysics III: r-process, s-process 105AB

8:30AM GG.00001 First experimental determination of the ⁵⁹Fe(n,γ)⁶⁰Fe reaction via Coulomb dissociation, E. UBERSEDER, University of Notre Dame, T. HEFTRICHT, M. HEIL, J. MARGANIEC, R. REIFARTH, GSI Helmholtzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany, M. WIESCHER, University of Notre Dame, S389 COLLABORATION — The nucleosynthesis of ⁶⁰Fe is one of the current outstanding problems in nuclear astrophysics. Observations of galactic radioactivity by γ-ray telescopes have provided a direct measurement of the ⁵⁹Fe/⁶⁰Fe ratio dispersed across the galactic plane. As the two isotopes are produced in similar stellar environments, the ratio provides a unique constraint on current stellar models. Specifically, ⁶⁰Fe is created and destroyed by neutron capture on stable iron isotopes. A recent measurement of the ⁶⁰Fe(n,γ)⁶¹Fe reaction has provided a first experimental quantification of the destruction rate. Currently, no experimental data exist for the ⁵⁹Fe(n,γ)⁶⁰Fe production rate. To address this void, a Coulomb dissociation experiment has been performed at GSI to indirectly measure the ground state neutron capture cross section of ⁵⁹Fe. The ⁶⁰Fe beam was produced by fragmentation of a 660 AMeV primary ⁶⁴Ni beam by a Be target. The ⁶⁰Fe fragments were separated using the FRS and impinged on a lead target. The experimental setup provides for an event-by-event reconstruction of the four-momenta of all incoming particles and reaction products. The analysis is currently ongoing, and preliminary results will be discussed.

8:42AM GG.00002 Neutron Capture from ⁸⁷Sr\(^1\), G. RUSEV, Duke University and TUNL, R. RAUT, A.P. TONCHEV, W. TORNOW, Duke U. and TUNL, B. BARAMSAI, J.H. KELLEY, G. MITCHELL, NCSU and TUNL, T. BREDEWEG, A. COUTURE, M. JANDEL, J. O’DONNELL, R. RUNDBERG, J.L. ULLMANN, LANL, A. CHYZH, E. KWAN, LLNL — The neutron-capture resonances of the reaction ⁸⁷Sr(n,γ)⁸⁸Sr are significant to nuclear astrophysics to estimate the neutron density during the s process, whose path is split by the branching nucleus ⁸⁶Kr, and for a possible use of the ⁸⁷Rb-⁸⁷Sr chronometric pair to measure the age of our Galaxy. In addition, the γ rays of the product nucleus ⁸⁸Sr are of importance to nuclear structure and the study of the pygmy resonance observed earlier in (γ,γ′) measurements. We report results from a neutron-capture experiment on ⁸⁷Sr carried out with the 4× BaF₂ array, DANCE, at LANL. Spin values of neutron resonances have been deduced using the multiplicity and angular distributions of the cascade γ rays following the neutron capture.

1Work supported by the US Department of Energy under grants DE-FG02-97ER41033, DE-FG02-97ER41042, DE-FG02-97ER41041, and DE-FG52-06NA26155.
8:54AM GG.00003 Stearル Neutral Sources and s-Process in Massive Stars. R. TALWAR, G.P.A. BERG, T. ADACHI, M. COUVER, H. FUJITA, J. GORES, M.N. HARAKEH, K. HATANAKA, T. ITO, A. LONG, A. MATIC, H. MATSUBARA, J. MATTA, M. NAGASHIMA, T. OGURA, D. PATEL, Y. SAKEMI, H. SCHATZ, Y. SHIMBARA, Y. SHIMIZU, T. SUZUKI, A. TAMII, T. WAKASA, M. WIESCHER, M. YOSO — Potential stearル neutral sources for the s-process in massive stars are associated with α-capture reactions on light nuclei. The capture-reaction rates provide the reaction flow for the buildup of the neutron sources 22Ne, and 74Mg during the helium-burning phase in stars. A critical influence on these rates is expected to come from low-energy resonances at stellar energies between 300 keV and 1500 keV. These resonances are characterized by a pronounced cluster structure near the α-threshold. Direct measurements of capture reactions to study the cluster structure are handicapped by the Coulomb barrier and limited detector resolutions. Hence, inelastic α-scattering on these nuclei has been used as an alternative tool to probe into the level structure. In reference to this, the experiment performed using the Grand Raiden Spectrometer at RCNP, Osaka will be discussed and preliminary results will be presented.

9:06AM GG.00004 Impact of beta-decay rate uncertainties on the slow neutron capture process in massive stars1. MARCO PIGNATARI, University of Basel, MARY BEARD, MICHAEL WIESCHER, University of Notre Dame, RAPHAEL HIRSCH, University of Keele — The slow neutron capture process in massive stars is mostly activated during He-burning and C-burning phases. Most of the abundances of elements such as copper or germanium, which have been observed in both the Solar System and Galaxy, are produced in these conditions, together with most of the s-process isotopes between iron and strontium (60 < A < 90). Nucleosynthesis predictions from stellar models depend on the nuclear physics networks used in simulations. A key ingredient in these simulations are the beta-decay and electron capture rates. In particular, the s-process yields beyond iron are affected by the present uncertainties associated with these rates. We aim to present the impact of these rate uncertainties on s-process calculations, focusing the discussion on a few examples relevant for their astrophysical impact.

1For a complete acknowledgement we refer to http://forum.astro.keele.ac.uk:8080/nugrid

9:18AM GG.00005 Development of AMS procedure for measurement of 93Zr. WENTING LU, PHILIPPE COLLON, YOAV KASHIV, MATTHEW BOWERS, DANIEL ROBERTSON, CHRISTOPHER SCHMITT — The procedure for measuring 93Zr (t1/2 = 1.5 Ma) by AMS is currently being developed at the Nuclear Science Lab at the University of Notre Dame and we report on first experiments performed in this direction. AMS detection of 93Zr can potentially be applied to address astrophysical and environmental issues: (1) the measurement of the 93Zr(n,γ)94Zr reaction cross-section at nucleosynthesis s-process relevant temperatures, (2) the search for potential live 93Zr from a supernova in deep sea sediments, (3) hydrological and radioactive waste tracing. The measurement of 93Zr requires adequate separation from its stable isobar 93Nb. We are currently working on optimizing this separation by using the Gas-Filled Magnet technique with additional multiple dE measurements in a focal plane ionization chamber.

9:30AM GG.00006 Double magicity of N=Z nuclei near the rp-process path discerned. MADAN M. SHARMA, Kuwait University, Kuwait, JAGDISH K. SHARMA, St. Johns College, Agra, India — We have investigated the experimental isotope shifts in Kr nuclei near the proton drip-line within the framework of the deformed relativistic Hartree-Bogoliubov theory. In this work, we have attempted to answer the question as to why the charge radius of 72Kr shrinks significantly as against its expected swelling in approaching the proton drip line. It is shown that due to the spin-orbit interaction N=Z=36 in deformed space, which compacts the charge radius of 72Kr. Consequently, we have discerned that N=Z rp-process nuclei 68Se, 72Kr, 75Sr and 80Zr exhibit shell closures both at the proton and neutron numbers in the deformed space with the consequence that pairing correlations for protons and neutrons vanish. This lends a double magicity to these nuclei. Thus, N=Z rp-process waiting-point nuclei are shown to exhibit a magic character similar to that shown by the r-process waiting-point nuclei in the neutron-rich region. A significant number of nuclei in rp-process region are also shown to exhibit neutron magicity at N= 34, 36, 38, and 40 in the deformed space.

9:42AM GG.00007 Formation of the Rare Earth Peak: Gaining Insight Into Late-Time r-Process Dynamics1. MATTHEW MUMPPOWER, GAIL MLAUCHLAN, North Carolina State University, REBECCA SURMAN, Union College — The theoretical r-process is thought to be responsible for approximately half of the neutron-rich elements above iron. While many studies of r-process environments have focused on early time behavior, e.g. conditions for sufficient neutron-to-seed ratio, less effort has been made studying late-time r-process dynamics. We study the formation and evolution of the rare earth peak which occurs as matter decays back to stability. We show that the rare earth peak is sensitive to the interplay between thermodynamic evolution and nuclear physics input. We highlight the late-time dynamical behavior which is critical for peak formation and show that the final structure of the rare earth abundances depends most strongly on the nuclear physics input. We identify neutron capture rates which are critical to rare earth peak formation. These nuclei lie within 10-15 neutrons from stability.

1We thank North Carolina State University for providing the high performance computational resources necessary for this project. Funding for this project was provided by U.S. DOE Grant No. DE-FG02-02ER41216.

9:54AM GG.00008 β-decay and neutron emission studies of r-process nuclei near 137Sr. KARL SMITH, Univ. of Notre Dame, F. ATTALLAH, Helmholtzzentrum fur Schwerionenforschung (GSI), T. FAESTERMANN, Technische Universitat Muenchen, U. GIESEN, Univ. of Notre Dame, H. GEISSEL, GSI, M. HANNAIWALD, Universitat Mainz, M. HAUSMANN, M. HELSTROEM, GSI, R. KESSLER, K.-L. KRATZ, Univ. Mainz, Y. LITVINOV, GSI, H. MAHMUD, Univ. of Edinburgh, M.N. MINEVA, Lund Univ., F. MONTES, National Superconducting Cyclotron Laboratory (NSCL), G. MUENZENBERG, GSI, B. PFEIFFER, Univ. Mainz, J. PEREIRA CONCA, NSCL, P. SANTI, Los Alamos National Laboratory, H. SCHATZ, Michigan State Univ., C. SCHNEIDER, K. SCHMIDT, GSI, R. SCHNEIDER, TU München, A. STOLZ, NSCL, K. SUEMMERER, GSI, J. STADLMANN, Universitat Giessen — The β-decays of very neutron rich nuclei in the A=130 region, including the astrophysically relevant nucleus 137Sr, were studied experimentally at the Helmholtzcentrum für Schwerionenforschung (GSI) using a stack of four 500 µm thick double-sided silicon strip detectors in conjunction with the Mainz 4π neutron long counter detector. The system allows the time correlation of ion implant and decay events and the detection of neutrons emitted during the decay. We measured half-lives and branchings for β-decays and neutron emission studies of r-process nuclei in the region of the rare earth peak. The impact of our results on various types of models for the astrophysical rapid neutron capture process (r-process) is explored.

10:06AM GG.00009 Results of precision mass measurements from CARIBU with the CPT. J. VAN SCHETT, U. of Chicago, D. LASCAR, Northwestern U., G. SAVARD, J.A. CLARK, J.P. GREENE, A.F. LEVAND, T. SUN, B.J. ZABRANSKY, ANL, S. CALDWELL, M.G. STERNBERG, U. of Chicago, A. CHAUDHURI, K.S. SHARMA, U. of Manitoba, G. LI, McGill U. — An array of neutron-rich nuclides from the Californium Rare Isotope Breeder Upgrade (CARIBU) at ANL beyond 132Sn has been subjected to precision mass measurements with the Canadian Penning Trap mass spectrometer, including many never-before-measured nuclides. Neutron-separation energies calculated directly from these results provide essential input to models of the astrophysical r-process. Trends in binding energies far from stability provide input to nuclear mass models and identify regions of deformation. Additional nuclear structure information can be extracted from symmetry energy and observations of isomeric states. Implications for all of these topics will be discussed as well as future plans with the more intense CARIBU source.

2This work performed under the auspices of NSERC, Canada, application number 216974, and the U.S. DOE, Office of Nuclear Physics, under Contract Nos. DE-AC02- 06CH11357, DE-FG02-91ER-40609, DE-FG02-98ER41086 and DE-AC52-07NA27344.
10:42AM HA.00002 Two particle number and momentum correlations for $\sqrt{s_{NN}}=200$ GeV Au+Au collisions at STAR

LARRY TARINI, Wayne State University, STAR COLLABORATION — Recent two-particle correlation measurements of Au+Au collisions at $\sqrt{s_{NN}}=200$ GeV at STAR differ from previous p+p correlation results due to the appearance of strong long-range correlations in relative pseudorapidity, a phenomenon known as "the ridge." Using different number and transverse momentum pair correlation observables, we investigate the ridge and related phenomena as a function of collision centrality and charge dependence. Parameters for a Gaussian fit in $\Delta \eta$ and harmonic coefficients in $\Delta \phi$ are extracted for number correlations.

10:54AM HA.00003 Incident Energy Dependence of $p_t$ Correlations at RHIC

JOHN NOVAK, Michigan State University, STAR COLLABORATION — We present results for two-particle transverse momentum correlations $\langle \Delta p_t, \Delta p_t \rangle$ as a function of event centrality for Au+Au collisions at $\sqrt{s_{NN}} = 7.7, 11.5, 39, \text{ and } 200 \text{ GeV at RHIC}$. Correlations were observed to decrease with centrality. The correlations multiplied by the multiplicity density increase with incident energy, and the centrality dependence may be indicative of physics. The square root of the correlations divided by the event-wise average transverse momentum per event shows little beam energy dependence for beam energies from 39 GeV up to LHC energies, but decreases at lower beam energies. This result differs with previous results from CERES [1], but is replicated by UrQMD.

11:06AM HA.00004 Comparing correlation predictions from a glasma flux-tube model with measurements

LANNY RAY, The University of Texas at Austin, THOMAS TRAINOR, University of Washington — A Glasma flux-tube model has been proposed to explain strong elongation on relative pseudorapidity ($\eta$) of the same-side 2D peak in minimum-bias angular correlations from $\sqrt{s_{NN}}=200$ GeV Au+Au collisions. In this model the same-side peak, or "soft ridge," is said to arise from coupling of the flux tubes to radial flow. Gluons radiated transversely from the flux tubes are boosted by radial flow to form a narrow structure or ridge on azimuth. We have tested this conjecture by comparing predictions for particle production, spectra and transverse momentum correlations [1] from the Glasma model and conventional fragmentation processes with measurements. We conclude that the Glasma model is not relevant for understanding the same-side $\eta$-elongated correlations in Au-Au collisions at RHIC. A two-component model (soft plus hard) of hadron production, including minimum-bias parton fragmentation, provides a quantitative description of most data although the $\eta$ elongation remains unexplained.

11:18AM HA.00005 Viscous Diffusion and Transverse Momentum Correlations at RHIC and LHC

RAJENDRA POKHAREL, SEAN GAVIN, Wayne State University, GEORGE MOSCHELLI, J.W. Goethe Universität — RHIC experiments indicated that the matter formed in relativistic nuclear collisions flows like a nearly perfect fluid, with a small viscosity to entropy density ratio. Various estimates from elliptic flow measurements give 1-2 times the Koltsov-Ons-Starinets bound. However, there is theoretical uncertainty resulting from our incomplete knowledge of initial conditions, equation of state and the role of the mini-jets. Recently, the STAR collaboration reported measurements of transverse momentum correlations. The idea behind this method is that shear viscosity diffuses the distribution of transverse momentum fluctuations reducing the peak value of the correlation function while broadening its rapidity distributions and thus relating the viscosity to evolution of the width. This approach to viscosity is different from those involving elliptic flow. Here we present the theory using the second order viscous hydrodynamics and compare the calculations with recent STAR data.

11:30AM HA.00006 Estimates of the non-flow contribution in Pb-Pb flow analysis using two-particle correlations in $pp$ with the ALICE detector at the LHC

VERA LOGGINS, Wayne State University — Two-particle azimuthal correlations are statistically the most precise method for measuring anisotropic flow in heavy-ion collisions. The main drawback of this method is its strong sensitivity to non-flow correlations which, unlike real flow, do not have a geometrical origin. Non-flow contributions can be estimated from two-particle azimuthal correlations using $pp$ data. We report measurements using the $<u^*Q>$ method applied to $pp$ collisions at $\sqrt{s}=2.76$ TeV and $\sqrt{s}=7$ TeV. We study the dependence of correlations on two-particle separation in pseudorapidity in order to find the separation which minimizes the correction without sacrificing the statistics too much. Measurements are performed for first to fifth harmonics.

11:42AM HA.00007 Number and Transverse Momentum Two-Particle Correlation Studies in Pb+Pb Collisions at the LHC

CLAUDE PRUNEAU, Wayne State University, ALICE COLLABORATION — Observations of a ridge on the near-side, and a dip on the away-side of two-particle correlations measured in central Au+Au collisions have generated considerable interest at RHIC. Are the two phenomena connected? Do they result from jet interactions with the medium, or do they naturally arise from the rapid thermalization and hydrodynamic expansion of collision systems subject to large initial fluctuations? We present measurements, carried with the ALICE detector, of number ($R_2$) and transverse momentum ($\Delta p_t, \Delta p_t$) correlation functions in Pb + Pb collisions. The two correlation functions are studied as a function of collision centrality for $++, --,$ and $++$ charged particle pairs in various momentum ranges. The like-sign and unlike-sign correlations exhibit different evolution with collision centrality. We combine these correlations to study charge dependent (CD) and charge independent (CI) correlation functions. We characterize these distributions by studying Fourier decompositions of $\Delta \phi$ projections of the $R_2$ and $\Delta p_t, \Delta p_t$ correlation functions for different ranges of $\Delta \eta$. Of particular interest are the evolution of the ratios of 3rd, and 4th harmonics to the 2nd harmonics with number of participants. We will discuss these results in light of a MC Glauber model of the initial eccentricity of collision nucleon participants.

1Research supported in part by The U.S. Dept. of Energy.

2Research supported in part by the U.S. Dept. of Energy.
11:54AM HA.00008 Illuminating nuclei with Vector Mesons in the STAR Ultra Peripheral Collision Program , RAMIRO DEBBE, Brookhaven National Laboratory; STAR COLLABORATION — The Ultra Peripheral Collision (UPC) program of the STAR Collaboration at RHIC has collected a substantial set of events where \( p + J/\Psi \) vector mesons are detected with no other hadronic activity between the colliding nuclei. The vector meson production in heavy ion ultra peripheral interactions is well described as quark-antiquark dipole fluctuating out of the strong electric fields of the ions. These dipoles then strongly interact with the other nucleus via color-singlet exchange. We will present the distribution of the momentum transfer of the detected vector meson in UPC \( Au+Au \) events at \( 200 \text{ GeV} \), around mid-rapidity. This distribution is connected to the partonic form factor of the nuclei as these interactions are seen as diffraction of beams of vector mesons on the hadronic component of nuclei. STAR’s Zero Degree Calorimeters, designed to detect neutrons with beam momentum produced by weak excitations of the nuclei, can be used to separate events where the vector meson interacts coherently with the entire nucleus or incoherently with individual nucleons. The STAR UPC data sample is composed mainly of events with \( \rho \) mesons, but last year’s extensive run produced a good sample of events with \( J/\Psi \) and we expect to be able to get a first glimpse of the “imaging” of nuclei with two wave lengths; the \( J/\Psi \) is considered a small object as opposed to the more extended nature of the \( \rho \) meson.

12:06PM HA.00009 Ultrapерipheral Pb+Pb reactions at LHC energies , EDWIN NORBECK, YASAR ONEL, University of Iowa — The magnetic field midway between two \( \text{Pb} \) nuclei passes at 20 fm is \( 2 \times 10^{20} \) gauss at LHC energies (\( 1144 \text{ TeV} \) in \( \text{PbPb} \) center of mass). At these energies the Coulomb field of a passing \( \text{Pb} \) nucleus can be regarded as a cloud of real photons. The cross sections for \( \gamma \gamma \) and \( \gamma \pi \) reactions are huge compared to 7 b for two \( \text{Pb} \) nuclei actually colliding. The reaction rate is limited by the 323 b cross section for breaking up the \( \text{Pb} \) nucleus or for the capture by a \( \text{Pb} \) ion of an \( e^+ \) or \( e^- \) from the many \( e^+ e^- \) pairs that are formed. These products go down the beam pipe and eventually hit superconducting magnets. The \( \gamma \gamma \) reactions can produce particles with \( mc^2 \) up to 100 GeV. The \( \gamma \pi \) reactions can produce particles with \( mc^2 \) more than 900 GeV. These ultraperipheral reactions are particularly clean. In proton-proton reactions, the reaction between two partons to produce something of interest is accompanied by a large background caused by many other parton-parton reactions. When \( \gamma \) breaks up a \( \text{Pb} \) nucleus, the transverse energy is small so that the fragments continue in the original beam direction. A single neutron in the original beam direction provides a useful flag that shows that an ultraperipheral reaction has occurred.

12:18PM HA.00010 Macroscopic Anomalous Effects in Hot QCD Fluid: A Status Report , JINFENG LIAO, BNL & Rice University & RBRC — Two fundamental features of QCD, the nontrivial topological nature of gauge fields together with the anomaly of light fermions, have been recently shown to lead to macroscopic anomalous effects in the hot QCD fluid created in relativistic heavy ion collisions. A number of recent exciting progresses will be reported here: (1) the Chiral Magnetic Effect (as a local P- and CP-odd phenomenon) predicts charge asymmetry fluctuations and particular patterns of charged hadron correlations, and progresses toward an accurate interpretation of the full data set, from most recent RHIC Beam Energy Scan all the way to LHC results, will be critically evaluated; (2) for fireballs with nonzero vector densities (e.g. in low-beam energy collisions), the Chiral Magnetic Wave induces an electric quadrupole of quark-gluon plasma and we predict the charge-dependent elliptic flow with \( v_2(\text{p}) \propto v_2(\pi^-); \) (3) for rotating hot fluid (i.e. QGP with angular momentum) in non-central collisions, a new class of anomalous hydrodynamic phenomena (Anomalous Magneto-Hydrodynamics) will also be presented, including the helical sound and the acoustic analog of the Faraday rotation in optics. Reference: PRC81:031901, PRC82:054902, PRC83:014905 (with Bzdak, Koch); In preparation (with Kharzeev); arXiv:1103.1307 to appear in PRL (with Burnier, Kharzeev, Yee).

11:06AM HB.00002 New Results from Long Baseline Experiments , KATE SCHOLBERG, Duke University — Experiments using high-energy beams of neutrinos detected after they have propagated hundreds of kilometres aim to improve knowledge of neutrino mixing. The current physics emphasis of long baseline beam neutrino oscillation experiments is on the measurement of the 0\( \theta \), mixing angle and on muon neutrino disappearance. This talk will review new results from the current long baseline experiments T2K, MINOS and OPERA (and the implications of these results), and will also cover prospects for future measurements with experiments in the US, Europe and Asia.

11:42AM HB.00003 What can geo-neutrinos tell us about the Earth? , NIKOLAI TOLICH, University of Washington — The principal source of energy for dynamic processes of the earth, such as plate tectonics, is thought to come from the radioactive decays of \( ^{238}\text{U}, ^{232}\text{Th}, \) and \( ^{40}\text{K} \) within the earth. These decays produce electron-antineutrinos, so-called geo-neutrinos, the measurement of which near the earth’s surface allows for a direct measure of the total radiogenic heat generation in the earth. The KamLAND and Borexino experiments have both recently measured a geo-neutrino flux significantly greater than zero. I will discuss how these and future measurements can constrain our knowledge of the earth.

Friday, October 28, 2011 10:30AM - 12:18PM — Session HB Neutrinos From Heaven and Earth Auditorium

10:30AM HB.00001 Recent Results in Solar Neutrinos , RICHARD SALDANHA, Princeton University — Solar neutrinos are an invaluable tool for studying neutrino oscillations in matter as well as probing the nuclear reactions that fuel the Sun. In this talk I will give an overview of solar neutrinos and discuss the latest results in the field. I will highlight the recent precision measurement of the \( ^{7}\text{Be} \) solar neutrino interaction rate with the Borexino solar neutrino detector and present the status of the analysis of pep and CNO neutrinos. I will also briefly describe future experiments and their potential to detect low energy solar neutrinos.

10:30AM HC.00001 Forward Single Spin Asymmetries in Transversely Polarized Proton Collisions at STAR , YUXI PAN, University of California, Los Angeles, STAR COLLABORATION — In transversely polarized proton collisions, single spin asymmetries of particle production at forward rapidity are known to be sensitive to the polarized quark degrees of freedom. Large asymmetries for \( ^{11}\text{B} \) mesons in the region \( 0 < x_F < 0.5 \) observed at energies up to \( \sqrt{s} = 200 \text{ GeV} \) continue to attract theoretical attention due to speculation about their exact origins, and subsequent predictions for different proposed mechanisms. Recently STAR has taken approximately \( 28 \mu \text{b}^{-1} \) of transversely polarized proton collision data at \( \sqrt{s} = 500 \text{ GeV} \) with an average polarization in excess of 45\%. Neutral mesons, single photons and jets were observed in the Forward Meson Spectrometer for the rapidity range \( 2.5 < y < 4 \). We present an update on the analysis for \( ^{11}\text{B} \) and D mesons for this data, especially the prospects of extending the transverse momentum and \( x_F \) range of the previous measurements.
10:42AM HC.00002 Asymmetries in Forward-rapidity $π^0$-Charged Particle Correlations at STAR from $p^1 + p$ Collisions at $\sqrt{s} = 200$ GeV. JAMES DRACHENBERG, Texas A&M University, STAR COLLABORATION — RHIC experiments have observed large transverse single-spin asymmetries, $A_{NL}$, in inclusive hadron production at forward rapidity. Extending the analysis beyond inclusive measurements provides the opportunity to decipher between dynamical contributions to $A_{NL}$. Asymmetries in two-particle correlations provide access to so-called interference fragmentation functions and proton transversity. Recent analysis at STAR investigates single-spin asymmetries in high-pseudorapidity $π^0$-charged particle correlations from $\sqrt{s} = 200$ GeV polarized-proton collisions recorded during 2008 with average fill polarization of 48%. The $π^0$s are detected at $2.5 < \eta < 4$ with a Pb-Glass calorimeter known as the Forward Meson Spectrometer, and the charged particles are detected in the same pseudorapidity region with the Forward Time Projection Chamber. The status of the analysis will be discussed.

10:54AM HC.00003 Transverse Single Spin Asymmetry for Forward Direct Photon Production in $\sqrt{s} = 200$ GeV $p^1 + p$ Collisions at STAR. LEN K. EUN, Lawrence Berkeley National Lab, STAR COLLABORATION — Experimental results for large transverse single spin asymmetries, $A_{NL}$, continue to challenge our understanding of QCD. One important test of the current theoretical framework is the sign reversal of $A_{NL}$ from SIDIS to Drell-Yan channels, a topic closely linked to QCD factorization. Theoretical models based on initial state effects predict the sign of $A_{NL}$ for jets and prompt photons in hadron collisions to be the same as Drell-Yan, but opposite of what is observed for mesonic final states, such as previous STAR results for $π^0$ and $η$. The $A_{NL}$ for direct photons (prompt + fragmentation) may serve as an indirect test of this model, especially if final state effects (Collins asymmetry) are small for fragmentation photons. We present the status update for the STAR measurement of $A_{NL}$ for direct photon production at average pseudorapidity of 3.65. All data were collected for polarized $p + p$ collisions at RHIC energies of $\sqrt{s} = 200$ GeV. The integrated luminosity was $6.8 \text{ pb}^{-1}$, and the average polarization was 56%.

11:06AM HC.00004 Collins Asymmetry Contributions to Quark Transversity Constraints in Mid-Rapidity Jets in $p^1 + p$ Collisions at STAR. ROBERT FERSCH, University of Kentucky, STAR COLLABORATION — Proton quark transverse spin distributions ($δg(x,Q^2)$) are less well-constrained than longitudinal spin distributions ($Δg(x,Q^2)$) due to the limited amount of transverse spin data available to separate Collins and Sivers effects. Measurement of the azimuthal asymmetry of $π^0$ mesons within reconstructed jets in $p^1 + p$→jet($π^0$) + X reactions observed in the Solenoidal Tracker at RHIC (STAR) at midrapidity ($|y| < 1.0$) enables isolation of the Collins effect, and thus offers additional constraints to $δg(x,Q^2)$ parametrizations, which currently include Belle measurements of Collins fragmentation in $e^+ e^−$ collisions and HERMES and COMPASS measurements of the Collins asymmetry in deep-inelastic lepton-nucleon scattering. We present progress toward asymmetry measurements from $\sqrt{s} = 200$ GeV transversely polarized ($\sim 58\%$) proton collision data (totaling $\sim 1 \text{ pb}^{-1}$), for average quark momentum fraction ($x$) $\sim 0.2$.

11:18AM HC.00005 Single Spin Asymmetry Measurement for $W$-Boson Production in Longitudinally Polarized $p^1 + p$ Collisions at PHENIX. YOUNG JIN KIM, University of Illinois at Urbana Champaign, PHENIX COLLABORATION — One of main physics thrusts at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) is to understand the origin of proton spin structure. Parity violating single spin asymmetries for $W^{\pm}$-bosons in longitudinally polarized $p + p$ collisions at $\sqrt{s} = 500$ GeV will access to the flavor separated quark and anti-quark polarizations in the proton. The PHENIX experiment has measured $A_{2}$ for electrons from $W$-decay with its central arm spectrometers and will measure muons from $W$-decay with its forward muon spectrometers. Cross sections for $W^{\pm}$-bosons and the corresponding single spin asymmetries for $e^\pm$ in the central arms will be shown for the run 2009 data sample. The current status of the muon measurements from $W^\pm$ decays in muon arms during RHIC Run-11 will be presented.

11:30AM HC.00006 Constraining $ΔG$ at Low-$x$ with Double Longitudinal Spin Asymmetries for Forward Hadron and Di-Hadron Pairs in PHENIX. SCOTT WOLIN, University of Illinois at Urbana-Champaign, PHENIX COLLABORATION — The gluon polarization, $ΔG = \int_0^1 g(x)dx$, is constrained in the region $0.05 < x < 0.2$ from measurements of double spin asymmetries, $A_{LL}$, for inclusive hadron and jet production at mid-rapidity at RHIC. Theoretical analysis of experimental results shows that $0.02 \Delta g(x)dx = 0.013^{+0.106}_{-0.120}$. This is not large enough to account for the missing proton spin. However, $Δg(x)$ is unconstrained at low-$x$, and a measurement sensitive to this region will provide important insight for future analyses. The measurement of $A_{LL}$ for inclusive hadrons and di-hadrons with the Muon Piston Calorimeter (MPC) at PHENIX, we aim to probe the structure of $Δg(x)$ at $x < 0.05$. The di-hadron measurement is especially interesting as it is sensitive to the sign of $ΔG$ and best constrains the parton kinematics giving the most precise access to $xg_{\perp \perp}$. The inclusive measurement provides a looser constraint on the event kinematics but has a higher yield. We will present the status of these measurements for the 2009 dataset at $\sqrt{s} = 500$ GeV and $\sqrt{s} = 200$GeV.

11:42AM HC.00007 Constraining $ΔG$ at low-$x$ with Double Longitudinal Spin Asymmetries for Forward Hadrons in PHENIX. CAMERON MCKINNEY, University of Illinois, PHENIX COLLABORATION — Currently, global fits of the gluon polarization $Δg(x)$ are constrained by PHENIX and STAR data from polarized $p + p$ collisions at RHIC in the range $0.03 < x < 0.3$. These fits yield a first moment of the gluon polarization, $ΔG$, consistent with zero, but they are not sensitive to possible contributions to $ΔG$ from the low-$x$ region. By measuring $A_{LL}$ for forward ($3.1 < \eta < 3.9$) $π^0$ production in the Muon Piston Calorimeter (MPC) at PHENIX, we aim to probe the structure of $Δg(x)$ in this low-$x$ region. Production of hadrons at large pseudo-rapidities is favored in asymmetric collisions between a high-$x$ quark and a low-$x$ gluon that give the center of momentum frame a large forward boost. Simulations using the event generator PYTHIA have shown that measuring forward $π^0$s can access $Δg(x)$ for $x \sim 10^{-3}$. Here, we present the analysis status of $A_{LL}$ for merged $π^0$s in the MPC at $\sqrt{s} = 500$ GeV from the 2009 dataset. This data along with data from polarized-$p + p$ runs at PHENIX through 2015 will help to provide stronger constraints on the form of $Δg(x)$ for ongoing global analyses.

11:54AM HC.00008 HERMES Measurements of the Nucleon Transverse Spin Structure. FRANCESCA GIORDANO, University of Illinois at Urbana-Champaign, HERMES COLLABORATION — Azimuthal modulations appearing in the Semi-Inclusive Deep-Inelastic Scattering (SIDIS) cross section for hadrons are sensitive to the transverse degrees of freedom of quarks within the nucleon. Such modulations can be related to combinations of Transverse Momentum Dependent (TMD) parton distribution functions and fragmentation functions, which describe correlations between the quark or the nucleon spin with the quark transverse momentum (spin-orbit correlations), and could provide insights into the yet unmeasured quark orbital angular momentum. At HERMES, TMDs are probed for various hadron types through the analysis of specific azimuthal modulations of the SIDIS cross section. An overview of recent results obtained using transversely polarized target protons as well as using unpolarized beam and targets will be presented.

1 On behalf of the HERMES collaboration
12:06PM HC.00009 The MPC-EX Upgrade to the PHENIX Forward Spectrometers. ARBIN TIMILSINA — The PHENIX detector has been one of the primary experimental tools at the Relativistic Heavy Ion Collider (RHIC). The MPC-EX upgrade to PHENIX will complement the existing Muon Piston Calorimeter (MPC) for measurements of inclusive direct photon and hadron production at forward rapidities. The MPC-EX will make possible a study of gluon distributions in cold nuclear matter via direct photon and neutral pion measurements, and direct measurements of spin-dependent fragmentation in polarized proton-proton collisions. The detector will cover pseudorapidity from 3.8 to 3.1 and consists of a novel Si+W preshower device with pad and strip readout. In this presentation I will discuss the design of the MPC-EX detector and the latest simulation results.

Friday, October 28, 2011 10:30AM - 12:06PM – Session HD Instrumentation V

10:30AM HD.00001 Astrobox - a novel detector for nuclear astrophysics studies with low-energy protons1, B.T. ROEDER, E. SIMMONS, M. MCCLESKY, A. SPIRIDON, L. TRACHE, R.E. TRIBBLE, Texas A&M University, E. POL-LACCO, DSO/IRfu/SPPhN, CEA-Saclay, G. PASCOVICI, IKP, University of Cologne — In many radiative proton capture reactions on sd-shell nuclei or heavier, resonances dominate. One way these resonances can be studied is by measuring very-low energy protons from β-delayed proton decays. In the past, we produced and separated chosen exotic nuclei with MARS, implanted them in thin silicon strip detectors and observed the β-delayed protons while pulsing the beam. With this technique, we measured protons with low background for $E_p = 400$-1500 keV. However, to measure lower-energy protons, careful subtraction of a substantial background from the positrons was needed. To reduce this background, we have developed Astrobox, a gas detector using micromegas electron amplifiers. In the first in-beam test of this gas detector at Texas A&M University, it was found to be more transparent to positrons than the thin silicon detectors, and we were able to measure low-energy protons down to 200 keV with no positron background. The design of Astrobox and the results of the first test measurement of the device, which observed low-energy protons from the β-delayed proton decay of $^{23}$Al with very-low positron background for the first time, will be presented.

1Work supported by the US Department of Energy under grant no. DE-FG02-93ER40773.

10:42AM HD.00002 Fast Timing Measurements Using CeBr$_3$ Scintillators1, N. D'OLYMPIA, S. LAKSHMI, P. CHOWDHURY, E. JACKSON, UMass Lowell, J. GLODÖ, U. SHIRWADKAR, K. SHAH, RMD Inc. — Continued research in advancing scintillation detector technology for both basic and applied nuclear science has recently focused on novel alkali halides. One candidate, CeBr$_3$, is capable of achieving ≈120 ps timing resolution, and has also been found to have an energy resolution on the order of 3-5%. In this work, the utility of CeBr$_3$ detectors for research in basic nuclear physics has been investigated through fast-timing measurements of nanosecond and sub-nanosecond isomer half-lives. A $t_{1/2}=1.4$ ns $^{214}$Po state in $^{135}$Sm was populated in the decay of a $^{152}$Eu γ-calibration source, and a $t_{1/2}=537$ ps 9/2$^-$ state in $^{177}$Hf in the decay of $^{177}$Lu, produced through thermal neutron activation of a natural Lu foil in the UMass Lowell Research Reactor. Half-lives were measured using a multi-parameter data acquisition setup to obtain energy gated time spectra. Results of these measurements with CeBr$_3$ detectors will be discussed in the context of next generation nuclear science research.

1This work was supported by the U.S. Department of Energy

10:54AM HD.00003 Resistive Plate Chamber Rate Capability Studies, DANIEL JUMPER, University of Illinois Urbana-Champaign, PHENIX COLLABORATION — Bakelite RPCs have been used in first level muon trigger applications in the CMS and ATLAS experiments at LHC and in the PHENIX experiment at RHIC. In hadron colliders RPCs have to withstand high levels of background rates. Using a novel method to test rate capability with a radioactive source, we have studied the possibility to further increase the rate capability of bakelite RPCs by changing the resistivity of the bakelite surface coating.

11:06AM HD.00004 Nuclear Spectroscopy using Novel, Position-Sensitive Detectors1, S. LAKSHMI, P. CHOWDHURY, E.G. JACKSON, S. HOTA, University of Massachusetts Lowell, C.J. LISTER, S. GROS, Argonne National Laboratory, M. MCCLISH, R. FARREL, K. SHAH, Radiation Monitoring Devices Inc. — Novel, position-sensitive particle and gamma detectors were tested for applications in nuclear physics experiments. An efficient compact setup was used to measure angular correlation between the alpha particle decay of $^{220}$Ra to an excited state in $^{220}$Rn, and the subsequent gamma decay to the ground state in $^{220}$Rn. A 1” X 1” position-sensitive avalanche photo-diode (PSAPD) was used for detecting the alpha particles and a planar germanium double-sided strip detector (GeDSSD) for detecting the gamma rays. Significant solid angle coverage is achieved in a single, fixed geometry, due to the excellent position resolutions of the PSAPD (400 microns) and the GeDSSD (5 mm) by positioning the detectors close to the source. Distortion correction algorithms for the PSAPD, pixel efficiencies, method of angle reconstruction and the measured angular correlation have been improved iteratively. Latest results will be presented.

1Work supported by the U.S. Department of Energy.

11:18AM HD.00005 Gamma Ray Interactions in Planar Germanium Strip Detectors1, E.G. JACKSON, S. LAKSHMI, P. CHOWDHURY, A.Y. DEO, C.J. GUESS, S. HOTA, UMass Lowell, C.J. LISTER, Argonne National Laboratory — The position resolution of the interaction point of a gamma ray within the volume of a planar germanium crystal is under investigation. A 16x16 planar double-sided strip detector of high-purity germanium, measuring 92x92x20mm, with 16 horizontal strips on one face and 16 vertical strips on the other, is used. Comparing the strongest strip signal from each side of the detector allows for a X-Y pixelation of the gamma ray interaction in the crystal. Energy and efficiency calibrations are performed with standard $^{152}$Eu and $^{133}$Ba sources placed at fixed distances from the detector face. The measured efficiency of each pixel is compared to calculated geometric efficiencies. Next steps involve the analysis of two-pixel events which pick out Compton scatters within the planar crystal. Results and status report will be presented.

1Work supported by the U.S. Department of Energy
11:30AM HD.00006 Depth of Gamma Ray Interaction in a Planar Ge Double-sided Strip Detector via Digital Signal Processing  
T. HARRINGTON, J. THOMAS, S. LAKSHMI, P. CHOWDHURY, U. Mass. Lowell, C.J. LISTER, Argonne National Lab — Using a 1 GHz Lecroy Digital Oscilloscope to digitize waveforms, C++ programs and analysis software were developed for various digital signal processing (DSP) applications. In this research, we have focused on the DSP applications using a 16x16 planar high purity germanium double-sided strip detector, which measures 92x92x20mm. Using a $^{137}$Cs source, electron and hole current signals were collected for photopeak events using one strip from both the front and back of the detector. The time resolution was measured by performing a custom constant fraction discrimination (CFD) routine on the waveforms and histogramming the time differences. The optimum time resolution was investigated by adjusting the CFD parameters. By analyzing the time differences between the electron and hole current signals, the possibility of determining the depth of a gamma ray's interaction point within the germanium detector was examined. The method used to determine time resolution, the optimization of the constant fraction discrimination parameters, and analysis techniques will be presented.

1 Work Supported by the Department of Energy.

11:42AM HD.00007 Upgrading the PHENIX Muon Trigger using Resistive Plate Chambers to Enhance Proton Spin Measurements  
RUSTY TOWELL, Abilene Christian University, PHENIX COLLABORATION — Determining the contributions of the sea quarks and other partons to the spin structure of the proton is important to our understanding of QCD. Collisions of longitudinally polarized protons at high energies provide a measurement of the flavor dependent contributions. In particular, the production of W-bosons at forward rapidity is sensitive to the flavor dependent spin contributions. The PHENIX detector at RHIC is well designed to make this measurement but required an upgrade to the forward trigger. The new PHENIX Muon Trigger will help select W-bosons events that can be detected through the appearance of a high-energy muon in one of the two existing muon spectrometers. The trigger upgrade is based on new front-end electronics for the muon tracking chambers and the addition of two stations of Resistive Plate Chambers in both muon arms. The stations of RPCs closest to the interaction point have recently been assembled and installed. The design and performance of these chambers will be reviewed along with the measurements possible in the next polarized proton run.

11:54AM HD.00008 Improved Timing Resolution using digital pulse shape processing  
NICOLE LARSON, SEAN LIDDICK, ANDREAS STOLZ, SCOTT SUCHYTA, NSCL/MSU — At fragmentation facilities radioactive isotopes are identified using a combination of energy loss and time-of-flight measurements. At the NSCL, the time-of-flight is measured between a scintillator placed at the intermediate dispersive image plane and a detector placed a large distance from the experimental station. To increase the rates of radioactive isotopes delivered to the experimental station the momentum acceptance of the A1900 is increased. Maintaining satisfactory particle identification with larger momentum acceptance requires correcting the time-of-flight of the radioactive isotope based on their position at the intermediate dispersive image. The correction is currently derived from standard analog circuits using timing filter amplifiers, constant fraction discriminators, and TAC modules. Digital pulse-shape processing may offer the possibility to reduce the timing uncertainty in the position determination thus improving the sensitivity of the particle identification. Preliminary results will be presented.

Friday, October 28, 2011 10:30AM - 12:18PM

Session HE Nuclear Structure IV 103AB

10:30AM HE.00001 Possible excited deformed rotational bands in $^{82}$Ge  
J.K. HWANG, J.H. HAMILTON, A.V. RAMAYYA, N.T. BREWER, Vanderbilt University, Y.X. LUQ, LBNL/Vanderbilt University, J.O. RASMUSSEN, LBNL, S.J. ZHU, Tsinghua University — Excited states of neutron-rich nuclei $^{82}$Ge were studied from the spontaneous fission of $^{252}$Cf. Eleven new transitions and seven new levels in $^{82}$Ge were identified by using X(Dy)-γ and γ-γ-γ-γ triple coincidences. Possible excited deformed rotational bands are observed, for the first time, in this nuclear region. Coexistence of the spherical ground and deformed excited shapes is proposed in $^{82}$Ge. These deformed rotational bands can be formed by 2-particle, 2-hole excitations with 0+ pairing energy of r9/2[404]−2x1/2[431] across the N=50 closed shell.

10:42AM HE.00002 Band Structures in $^{230}$Th  
R.V.F. JANSSENS, S. ZHU, M.P. CARPENTER, I. AHMAD, C.R. HOFFMAN, T.L. KHOO, B.P. KAY, F.G. KONEDEV, S. LALIKOVSKI, University of Sofia — Experimenting the evidence for the recently proposed phenomenon of condensation of rotational-aligned octupole phonons [1] has been observed in $^{240}$Pu [2] and $^{238}$U [3]. In order to study this phenomenon in $^{230}$Th, an experiment has been carried out at ATLAS. The octupole band was extended up to spin 29. In addition, three positive-parity bands were observed for the first time. With increasing spin, the octupole band and the ground state band (gsb) start forming a smooth sequence of states with alternating spin and parity. Furthermore, the Routhian of the octupole band becomes lower than that of the gsb at rotational frequencies above 0.24 MeV. A band built on the second 0+ spin, the octupole band and the ground state band (gsb) start forming a smooth sequence of states with alternating spin and parity. Furthermore, the Routhian of the octupole band becomes lower than that of the gsb at rotational frequencies above 0.24 MeV. A band built on the second 0+ spin, the octupole band and the ground state band (gsb) start forming a smooth sequence of states with alternating spin and parity. Furthermore, the Routhian of the octupole band becomes lower than that of the gsb at rotational frequencies above 0.24 MeV.
11:18AM HE.00005 First identification of high-spin states in $^{152}$Pr. SSHAHUA LIU, UNIRIB/ORAU and Vanderbilt University, J.H. HAMILTON, A.V. RAMAYYA, J.K. HWANG, N.T. BREWER, Vanderbilt University, S. YUE, F.R. XIU, Peking University, Y.X. LUO, Vanderbilt University and Lawrence Berkeley National Laboratory, J.O. RASMUSSEN, Lawrence Berkeley National Laboratory, S.J. ZHU, Tsinghua University, W.C. MA, Mississippi State University — The odd-odd neutron-rich nucleus $^{152}$Pr has been studied from the spontaneous fission of $^{252}$Cf with the Gammasphere detector array at Lawrence Berkeley National Laboratory. A high-spin level scheme of $^{152}$Pr has been established for the first time. Angular correlation and internal conversion coefficient measurements are used to determine level spins and parities in the yrast band of $^{152}$Pr relative to the band head. The possible configurations of the band head have been discussed based on systematics and total Routhian surface calculations. The results will be presented.

11:30AM HE.00006 Investigating High Spin States in Transplutonium nuclei with Ultimate Cranker$^1$, Y. QIU, P. CHOWDHURY, S. HOTA, S. LAKSHMI, University of Massachusetts Lowell — Total Routhian Surface calculations have been performed with the Ultimate Cranker program (modified harmonic oscillator potential) as a function of epsilon2, epsilon4 and gamma deformation parameters on actinide nuclei with $94 \leq Z \leq 98$ and $150 \leq N \leq 152$. The equilibrium deformation trend is investigated with increasing frequencies. Nucleon alignments as a function of rotational frequency deduced from the calculations are compared with previous results reported in literature, both experimental as well as theoretical (Woods-Saxon potential). Results from the calculations will be presented and discussed in the context of new spectroscopic information in this region.

$^1$Work supported by U.S. Department of Energy.

11:42AM HE.00007 Spectroscopy of $^{244,245,246}$Pu$^1$, S. HOTA, P. CHOWDHURY, S. LAKSHMI, S.K. TANDEL, T. HARRINGTON, E.G. JACKSON, K. MORAN, U. SHIRWADKAR, University of Massachusetts Lowell, I. AHMAD, M.P. CARPENTER, C.J. CHIARA, J. GREENE, C.R. HOFFMAN, R.V.F. JANSENS, T.L. KHOO, F.G. KONDEV, T. LAURITSEN, C.J. LISTER, E.A. MCCUTCCHAN, D. SEWERYNIK, I. STEFANESCU, S. ZHU, Argonne National Laboratory — In continuation of high-spin studies in the A~250 region via inelastic and transfer reactions, new spectroscopic measurements have been performed in the neutron rich $^{244,245,246}$Pu. High-spin states in these $N=150,151,152$ nuclei were populated using a $^{208}$Pb beam incident on a $^{244}$Pu target, with gamma rays detected by the Gammasphere array. In $^{245}$Pu, two new bands are observed which follow vibrational characteristics. In $^{246}$Pu, new rotational bands are observed through coincidences with the binary reaction partner $^{208}$Pb as well as transitions identified in light-ion transfer reactions. The ground state band in $^{244}$Pu is extended to $J^* = 20^+$. The new results will be discussed in the context of emerging systematics of high-spin spectroscopic data in the Z<100 Cd@1 and Cf@2 isotones. 1. U. Shiriwadkar, Ph.D. Thesis, U. Massachusetts Lowell, 2009. 2. S. K. Tandel et. al., Phys. Rev. C 82, 041301(R) (2010).

$^1$Supported by USDOE Grants DE-FG02-94ER40848 and DE-AC02-06CH11357.

11:54AM HE.00008 New level schemes and excitation modes of $^{117,118,119,120,122}$Cd, Y.X. LUO, Vanderbilt Univ./LBNL, J.O. RASMUSSEN, LBNL, C.S. NELSON, J.H. HAMILTON, A.V. RAMAYYA, S.H. LlIU, N.T. BREWER, J.K. HWANG, C. GOODIN, Vanderbilt Univ., S.J. ZHU, Tsinghua Univ., G.M. TER-AKOPIAN, A.V. DANIEL, JINR, I.Y. LEE, LBNL — Analysis of high statistics triple coincidence fission data from $^{252}$Cf at Gammasphere including angular correlations yielded well-expanded high-spin level schemes with more complete and reliable spin/parity assignments for $^{117-120,122}$Cd. Both the quasi-particle/hole couplings and quasi-rotational degrees of freedom are implied to play roles in these Cd isotopes. Evidence for triaxial shapes and octupole components in the Cd isotopes is presented. TRS calculations show an evolution from prolate shapes for mass number 115-118 to triaxial for 119-122. The model-independent spin – $\hbar$ $\omega$ plots of the yrast bands indicate the role of quasi-rotational alignment of the ($\hbar\nu_1/2\hbar\nu_2$) neutron pair and the blocking effect of the odd $\hbar_1/2\hbar_2$ neutron.

12:06PM HE.00009 Nuclear Structure in Neutron Rich Gd, NATHAN BREWER, Vanderbilt, J.C. BATCHELDER, UNIRIB/ORAU, J.H. HAMILTON, A.V. RAMAYYA, Vanderbilt, C.J. CROSS, ORNL, K.P. RYKACZEWSKI, ORNL, Warsaw Univ., R. GRZYBacz, M. MADURAG, D. MILLER, U. Tennessee, D. STRACENER, C. JOST, ORNL, E. ZGANJAR, Louisiana State, J.A. WINGER, Mississippi State, M. KARNY, ORNL, ORAU, Warsaw University, S.V. PAULAKUSKA, U. Tennessee, S.H. LlIU, ORNL, M. WOLINSKA-CICHOCKA, ORNL, ORAU, S. PADGETT, U. Tennessee, T. MENDEZ, K. MIERNIK, ORNL, A. KUZNIK, U. Tennessee, Warsaw Univ. — Deformed nuclei at midpoints between closed spherical shells form some of the best nuclear rotors known. Only a few nucleons away from the exact midshell in Z=66 and N=104, these nuclei have been shown to have very consistent (I(I+1)) spacing in the yrast band. By studying the energy systematics of the non-yrast and parent ground states we can further probe the structure of these nuclei. Nuclei for this study were produced via proton induced fission of $^{238}$U at HRIBF at ORNL. They were measured at the Low-energy RIB Spectroscopy Station (LeRIBSS) which utilizes beta and gamma detection as well as a MTC (Moving Tape Collector) which allows for parent lifetime measurements. In addition to 5 new levels in $^{162}$Gd, levels in $^{162,164}$Gd are both populated via beta- decay up to the 8$^+$ yrast levels. We will present and discuss new results from the beta decay of these isotopes.

Friday, October 28, 2011 10:30AM - 12:18PM – Session HF Nuclear Structure V 104AB

10:30AM HF.00001 The polariser beamline at TRIUMF for nuclear structure physics, A. VOSS, M.R. PEARSON, C.D.P. LEVY, J. BILLOWES, F. BUCHINGER, K.H. CHOW, J.E. CRAWFORD, M.D. HOSSEIN, R.F. KIEFL, W.A. MACPARLANE, E. MANE, G.D. MORRIS, T.J. PAROLIN, H. SADAOUI, Z. SALMAN, O.T.J. SHELBYA, M. SMADELLA, Q. SONG, D. WANG — Originally built to provide polarised ion beams for condensed matter experiments, the polariser beamline at TRIUMF is coupled to both beta-NMR and beta-NQR spectrometers. In addition, the beam can be passed through a radio-frequency quadrupole cooler and buncher (RFQ) providing bunched beams. Originally, a laser spectroscopy and beta-NQR program was started to investigate the ground state structure of exotic nuclei. Results from recent experiments including zero-field beta-NQR studies to determine the quadrupole moment of the halo nucleus Li-11 and laser spectroscopy to determine the charge radius of Rb-74.

10:42AM HF.00002 Precision Neutron Scattering Length Measurements with Nucleon Interferometry, M.G. HUBER, M. ARIF, D.L. JACOBSON, NIST, D.A. PUSHIN, Waterloo U., M.O. ABUTALEB, MIT, C.B. SHAHI, F.E. WIETFELDT, Tulane U., T.C. BLACK, UNC-Wilmington — Since its inception, single-crystal neutron interferometry has often been utilized for precise neutron scattering length, $b$, measurements. Scattering length data of light nuclei is particularly important in the study of few nucleon interactions as $b$ can be predicted by two – three nucleon interaction (NI) models. As such they provide a critical test of the accuracy of 2+3 NI models. Nuclear effective field theories also make use of light nuclei $b$ in parameterizing mean-field behavior. The NIST neutron interferometer and optics facility has measured $b$ to less than 0.8% relative uncertainty in polarized $^4$He and to less than 0.1% relative uncertainty in $^4$H, D, and unpolarized $^4$He. A neutron interferometer consists of a perfect silicon crystal machined such that there are three separate slits on a common base. Neutrons are Bragg diffracted in the slits to produce two spatially separate (yet coherent) beam paths much like an optical Mach-Zehnder interferometer. A gas sample placed in one of the beam paths of the interferometer causes a phase difference between the two paths which is proportional to $b$. This talk will focus on the latest scattering length measurement for $^4$He which ran at NIST in Fall/Winter 2010 and is currently being analyzed.
10:54AM HF.00003 High-Performance Algorithm for Calculating Non-Spurious Nuclear Level Densities, ROMAN SENKOV, MIHAI HOROI, JAGJEET KAUR, Central Michigan University, VLADIMIR ZELEVINSKY, Michigan State University. A new high-performance algorithm was recently proposed for calculating spin- and parity-dependent shell model nuclear level densities using methods of statistical spectroscopy in the proton-neutron formalism. When used in valence spaces that cover more than one major harmonic oscillator shell, this algorithm mixes the genuine intrinsic states with spurious center-of-mass excitations. We construct an advanced algorithm based on the method of statistical moments that eliminates the spurious states. Results for states of unnatural parity in several sd-shell nuclei are presented and compared with exact shell model calculations and experimental data. The new algorithm is applied to calculation of reaction rates for nuclei on the rp-process path.

11:06AM HF.00004 An algorithm for the removal of spurious states and calculations of nuclear level densities, JAGJEET KAUR, MIHAI HOROI, ROMAN SENKOV, Central Michigan University. An algorithm was developed for the calculation of nuclear level densities in proton-neutron formalism using the moments method. This method was further improved to discard the contributions of spurious states related to the center-of-mass excitations. We present nuclear level densities for some nuclei in comparison with the shell model calculations and experimental data. Applications of this algorithm such as calculations of the reaction rates for the nuclei in the rp-process will be also presented.

11:18AM HF.00005 Simulations of the HRLIBF Modular Total Absorption Spectrometer (MTAS), CHARLES RASCO, LSU, MAREK KARNEY, ORNL, ORAU, U Warszaw, KRZYSZTOF RYKACZEWSKI, ORNL, ALEKSANDRA KUZNIAK, UTK, U Warszaw, MARZENA WOLINSKA-CICHOCKA, ORNL, ORAU, ROBERT GRZYWACZ, UTK, ORNL. We will present calculations of the simulated performance of the MTAS detector at the Holifield Radioactive Ion Beam Facility (HRLIBF) at Oak Ridge National Laboratory. The total absorption gamma spectra measured with MTAS will be used to derive improved beta-feeding patterns and the resulting beta strength functions for fission products. In particular, measurements of decay heat released by radioactive nuclei produced in nuclear fuel reactors will be performed. The MTAS is made up of 19 large NaI(Tl) hexagonal detectors and this geometry was simulated using the GEANT4 toolkit. The energy resolution depends crucially on the non-linearity response of the optical light production of the NaI crystals. We developed a light production curve based on the dE/dx of the electrons generated by all incoming particles and this curve was used to generate the amount of light produced independent of the incoming particle type. Simulation results of the energy resolution compared with several measurements will be presented.

11:30AM HF.00006 Progress towards the search for the permanent electric dipole moment of Ra-225, JAIDEEP SINGH, KEVIN BAILEY, MATT R. DIETRICH, JOHN P. GREENE, ROY J. HOLT, MUKUT R. KALITA, Argonne National Laboratory, WOLFGANG KORSCH, University of Kentucky, ZHENG-TIAN LU, PETER MUELLER, THOMAS O'CONNOR, Argonne National Laboratory, RICHARD H. PARKER, IBRAHIM A. SULAI, University of Chicago. We will report on progress towards measurements of atomic properties necessary for the EDM search and the EDM search itself. This work is supported by DOE, Office of Nuclear Physics, under contract No. DE-AC02-06CH11357.

11:42AM HF.00007 Challenges and opportunities in the search for electric dipole moment (EDM) in $^{225}$Ra atom, MUKUT RANJAN KALITA, University of Kentucky, KEVIN BAILEY, MATTHEW DIETRICH, JOHN GREENE, ROY HOLT, Argonne National Laboratory, WOLFGANG KORSCH, University of Kentucky, ZHENG-TIAN LU, PETER MUELLER, THOMAS O'CONNOR, Argonne National Laboratory, RICHARD PARKER, IBRAHIM SULAI, University of Chicago. We will discuss our recent progress on manipulation of ultra cold Ra atoms in the ODT, efforts in improving our laser systems and generation of electric and magnetic fields required for the measurement.

12:06PM HF.00009 Reconciliation of Values for Bohr Radius and Empirical Radius of H-Atom Using Nuclear Vibration Factor, STEWART BREKKE, Northeastern Illinois University (former grad student). The value for the calculated H-atom radius, the Bohr value, is $5.29 \times 10^{-11} \text{m}$ and the empirical value is $2.52 \times 10^{-11} \text{m}$. Since the nucleus is vibrating, the distance relation, $d$, between the nucleus and the electron is $r + x \cos(2\pi ft) = d$, due to a slight lag time between nuclear vibration and orbiting electron. Repeatedly changing the distance between the vibrating nucleus and the electron, therefore, the distance between vibrating nucleus and orbiting electron must only be an average distance. The average value for the cosine is the RMS value of 0.707. Substituting the calculated distance for $r$ and the empirical distance for $d$, the equation becomes $5.29 \times 10^{-11} m + (0.707) A = 2.52 \times 10^{-11} m$. Solving for the average amplitude of nuclear vibration, $A$, $A = 3.95 \times 10^{-11}m$. 

Friday, October 28, 2011 10:30AM - 12:06PM – Session HG Astrophysics IV: alpha-Reactions, Capture Rates, etc. 105AB
10:30AM HG.00001 First experimental results of the $^{33}\text{S}(\alpha,p)^{36}\text{Cl}$ cross section for production in the early Solar System, MATTHEW BOWERS, University of Notre Dame, PHILIPPE COLLON, YOAV KASHIV, WILLIAM BAUDER, KAREN CHAMBLIN, WENTING LU, DANIEL ROBERTSON, CHRISTOPHER SCHMITT — The existence in the early Solar System (ESS) of the now extinct $^{36}\text{Cl}$ ($t_{1/2} = 3.01 \times 10^7$ yr) has been determined from correlation between isotopic enrichment of its daughter isotope, $^{32}\text{S}$, and Cl abundance in meteorites. The relatively high inferred initial Solar System $^{36}\text{Cl}/^{32}\text{S}$ ratio strongly suggests that $^{36}\text{Cl}$ was produced in the ESS by bombardment of solar energetic particles on gas and dust in the protoplanetary disc. However, no experimental data are currently available for the relevant production reactions cross sections. Instead, models of ESS production use Hauser-Feshbach approximations. The $^{35}\text{S}(\alpha,p)^{38}\text{Cl}$ reaction is calculated to have the largest cross section at bombarding energies $< 5$ MeV/A. Here we report first results of a measurement of the averaged reaction cross section in the energy range 1.93-1.95 MeV/A. Our result, 191 ± 33 mb (1σ), is significantly higher than results of previous calculations, 102 and 34 mb.

10:42AM HG.00002 Experimental results for studies of the $^{40}\text{Ca}(\alpha,\gamma)^{44}\text{Ti}$ reaction rates, DANIEL ROBERTSON, University of Notre Dame, HANS-WERNER BECKER, Ruhr-Universität Bochum, MATT BOWERS, PHILIPPE COLLON, JOACHIM GOERRES, WENTING LU, CHRIS SCHMITT, MICHAEL WIESCHER, University of Notre Dame — Observational studies of galactic $\gamma$ emitters such as $^{44}\text{Ti}$ have highlighted their use in nucleosynthesis studies of massive stars in their late stage stellar evolution and final explosive demise in core collapse supernova events. Models used in the simulation of such $\gamma$ emitters rely heavily upon reliable reaction rates for both the creation and annihilation of these isotopes over large temperature ranges. The production of $^{44}\text{Ti}$ is currently through the reaction $^{40}\text{Ca}(\gamma,\gamma')^{44}\text{Ti}$. It is thought to take place primarily in the $\alpha$-rich freeze out phase of a core collapse supernova. However, current supernova models predict lower $^{44}\text{Ti}$ to $^{56}\text{Ni}$ ratios than observed, creating a need for more information about its production mechanism. A number of previous studies include prompt $\gamma$-ray measurements, recoil mass separator experiments and the use of AMS, all giving greatly different reaction rates. Aiding in the refinement of these needed rates, the results of experiments at the DTL, Bochum and NSL, Notre Dame will be presented against the backdrop of these previous measurements.

1Supported by the US Department of Energy, Office of Nuclear Physics, under contract DE-AC02-06CH11357.

10:54AM HG.00003 Effects of Initial Composition on A=28-48 Reaction Flows in Thermonuclear Supernovae, DAVID A. CHAMULAK, Argonne National Laboratory, EDWARD F. BROWN, Michigan State University, ALAN C. CALDER, SUNY Stony Brook, AARON P. JACKSON, United States Naval Research Laboratory, BRENDAN K. KRUEGER, SUNY Stony Brook, F.X. TIMMES, Arizona State University, DEAN M. TOWNSLEY, The University of Alabama — Type Ia supernovae (SNe Ia) are the main distance indicator for cosmological studies and a primary source of the iron peak elements in the solar system. However the progenitor systems for this type of supernovae remain loosely understood. Numerical modeling can now probe the connection between the properties of the progenitor and the outcome of the explosion. We have performed numerical calculations to examine the nucleosynthesis in SNe Ia. Detailed yields resulting from explosive burning of the carbon/oxygen plasma in our models are examined using post-processing through a 532-nuclide reaction network. We explore how the production of elements from silicon to titanium varies with the composition of the progenitor star. Our calculations identify the reactions that most effect the final yields. These yields may be observable, allowing nuclear physics to constrain the astrophysical scenario.

1Supported by the NSF under grant No. PHY0758100 and the Joint Institute for Nuclear Astrophysics, NSF-PFC under grant No. PHY0822648.

11:06AM HG.00004 Systematic study of alpha-optical potential near the Z=50 region for p-process, WANPENG TAN, A. PALUMBO, A. BEST, M. COUDER, J. DEBOER, S. FALAHAT, J. GÖRRES, P. LEBLANC, H. LEE, S. O'BRIEN, E. STRANDBERG, M. WIESCHER, University of Notre Dame, J. GREENE, Argonne National Laboratory, ZS. FÜLÖP, GY. GYÜRKY, G. KISS, E. SOMORJAI, ATOMKI, Hungary, G. EFE, R. GURAY, N. ÖZKAN, Kocaeli University, Turkey — Production of proton-rich elements beyond iron in stars proceeds via a-p-process, i.e., a sequence of photo-disintegration reactions, $(\gamma,\gamma')$, $(\alpha,\beta)$, and $(\gamma,\alpha)$ on heavy elements at temperatures of 2-3 $\times 10^9$ K. The involved reaction rates are typically calculated with the statistical Hauser-Feshbach (HF) model. However, the HF model performs poorly in calculating the critical $(\gamma,\alpha)$ rates due to the uncertainty of the alpha optical potentials applied. To test the reliability of the HF calculations and provide a systematic understanding of the alpha optical potential at energies of astrophysical interest, a series of precision alpha scattering measurements were carried out at the Notre Dame FN tandem accelerator. Specifically, $^{108}\text{Cd}$, $^{114}\text{Sn}$, and $^{120,124,126,128,130}\text{Te}$ were studied at energies both below and above the Coulomb barrier. The derived potential was applied for calculating the $\alpha$-induced reaction rates on these nuclei using the CIGAR code. The results were compared to the corresponding experimental rates obtained via activation experiments at Notre Dame and other places.

1Supported by the NSF under grant No. PHY0758100 and the Joint Institute for Nuclear Astrophysics, NSF-PFC under grant No. PHY0822648.

11:18AM HG.00005 Correcting for $\beta$-Summing in $\beta$-delayed Proton Detection with Double-Sided Silicon Strip Detectors, ZACHARY MEISEL, Michigan State /NSCL, H. CRAWFORD, TRIUMF, G. GRINYER, GANIL, G. LORUSSO, RIKEN, P. MANTICA, M. DEL SANTO, H. SCHATZ, NSCL, JOINT INSTITUTE FOR NUCLEAR ASTROPHYSICS COLLABORATION — In studies of $\beta$-delayed proton emission, detection of the proton energy is often of primary interest. However, once deposited in a thick double-sided silicon strip detector, the parent nucleus emits a positron and proton nearly simultaneously. Simulations must be used to determine the amount of energy the positron contributed to the overall energy detected to allow an accurate extraction of the proton energy. We solve this issue, which we call the $\beta$-summing effect using GEANT4 for the parent nuclei Mg-20, Sr-23, and Ba-69. We find the positron’s contribution can significantly impact peak energy for a decay event, leading to an incorrect determination of proton energy. The $\beta$-summing primarily depends on implantation depth and weakly on the $\beta$-decay’s Q-value. We also find the shape of the summing peak can be used to constrain the parent nucleus’s implantation depth.

This project is funded by the NSF through grants PHY-0822648 PHY-0600607 and Michigan State University.

11:30AM HG.00006 Photoneutron and radiative capture reaction rates for Nuclear Astrophysics, MARY BEARD, S. FRAUENDORF, University of Notre Dame, B KAEMPFEER, Institut fuer Strahlenphysik, Helmholtz-Zentrum Dresden-Rossendorf & Institut fuer Theoretische Physik, Technische Universität Dresden, R. SCHWENGNER, Institut fuer Strahlenphysik, Helmholtz-Zentrum Dresden-Rossendorf, M. WIESCHER, University of Notre Dame — The vast majority of nuclei heavier than iron are synthesisized via the capture of neutrons. There are however 35 naturally occurring nuclei, including isotopes of Mo and La, located on the neutron-deficient size of the valley of stability. It has been proposed that these nuclei, referred to as p-nuclei, are produced via sequential photo-dissociation reactions in the oxygen-neon shell burning regions of a pre-supernova star. As such, cross sections for p-nuclei production are particularly sensitive to the gamma-ray strength function, which, though dominated by the giant dipole resonance, may contain extra strength contributions near to the neutron threshold. Recently new $(\gamma,\gamma')$ cross section measurements have been performed at the ELBE facility at Helmholtz-Zentrum Dresden-Rossendorf for the nuclei $^{92,100}\text{Mo}$, $^{90,92}\text{Sr}$, $^{86}\text{Zr}$ and $^{130}\text{La}$ probing the photo-absorption cross section over an energy range 4.5 - 6 MeV up to the neutron separation threshold. The use of these measurements as a test of existing gamma-ray strength function models, and the consequent impact on p-nuclei production rates, will be discussed.
The tendency of producing less governing the pre-equilibrium stage. We also find that the initial conditions for the viscous hydrodynamic evolution are sensitive to the specific mechanisms this has important consequences for the starting values of the flow profile and shear stress tensor of the subsequent hydrodynamic evolution. By examining study the effect of different pre-equilibrium scenarios on late-time observables. We explain how our algorithm differs from what was used in [1,2], and that initial conditions, but this begs the question whether the parameters used are a realistic reflection of the (largely unknown) pre-equilibrium dynamics. We dynamics can generate collective flow before hydrodynamics becomes applicable. Most applications of hydrodynamics to heavy ion collisions use parametrized

Hydrodynamics

1

Collision Energy Dependent Gradual Breakdown of Longitudinal Boost-Invariance Near Midrapidity When Going from Higher to Lower Collision Energies. By comparing (2+1)-d with (3+1)-d viscous hydrodynamics we explore to what extend these different tendencies may indicate a cascade model of heavy ion collisions to the key soft observables (HBT, elliptic flow, spectra) measured at RHIC and the LHC. Within this framework the data representing multiple different measurements from different experiments are compiled into single format. One of the unique features of CHIMERA is, that in addition to taking into account statistical errors, it also treats different types of systematic uncertainties. The hydrodynamics/hadron cascade model used in the framework incorporates different initial state conditions, pre-equilibrium flow, the UVH2+1 viscous hydro model, Cooper-Frye freezeout, and the UrQMD hadronic cascade model. The sensitivity of the observables to the equation of state (EoS) is explored using several EoS's in the hydrodynamic evolution. The latest results from CHIMERA, including data from the LHC, will be presented.

2:24PM JA.00003 (2+1)-d vs. (3+1)-d viscous hydrodynamics from RHIC and LHC1 CHUN SHEN, The Ohio State University, BJOERN SCHENKE, Brookhaven National Laboratory, ULRICH HEINZ, The Ohio State University — Using (2+1)-d viscous hydrodynamics with a state-of-the-art equation of state (s95p-PCE), we present comparisons with recent ALICE measurements of the charged hadron spectra and elliptic flow, as well as successful predictions of the differential elliptic flow coefficient vsch/(pT) for identified pions, kaons and protons from 2.76 A GeV Pb+Pb collisions at the Large Hadron Collider (LHC) [1]. We also study how the “universal” curves describing the dependence of the eccentricity-scaled charged elliptic flow vch/(pT) on the charged multiplicity density per unit area (1/S)(dNch/dy) change from RHIC to LHC energies. In (2+1)-d viscous hydrodynamics we find a tendency of reducing less vch/(pT) at higher collision energies, which contradicts the opposite tendency found by Hirano et al.[2] for (3+1)-d ideal hydrodynamics coupled to a hadron cascade. By comparing (2+1)-d with (3+1)-d viscous hydrodynamics we explore to what extend these different tendencies may indicate a collision energy dependent gradual breakdown of longitudinal boost-invariance near midrapidity when going from higher to lower collision energies.

1Supported by the U.S. Department of Energy.

2:36PM JA.00004 Early Flow from Matching Pre-Equilibrium Dynamics to Viscous Hydrodynamics1 DANIEL WHITE, ULRICH HEINZ, Ohio State University — In the earliest stage of relativistic heavy-ion collisions, pre-equilibrium dynamics can generate collective flow before hydrodynamics becomes applicable. Most applications of hydrodynamics to heavy ion collisions use parametrized initial conditions, but this begs the question whether the parameters used are a realistic reflection of the (largely unknown) pre-equilibrium dynamics. We present an algorithm that allows to match any pre-equilibrium model for the energy-momentum tensor to relativistic viscous fluid dynamics and thus allows to study the effect of different pre-equilibrium scenarios on late-time observables. We explain how our algorithm differs from what was used in [1,2], and that this has important consequences for the starting values of the flow profile and shear stress tensor of the subsequent hydrodynamic evolution. By examining three specific models of early dynamics, we also find that the initial conditions for the viscous hydrodynamic evolution are sensitive to the specific mechanisms governing the pre-equilibrium stage.

1Supported by DoE.
Finally, the impact of this accident on design and deployment of nuclear generating stations in the future will be discussed. Locally and at large, will also be discussed. An assessment of radiological health risk for the plant workers as well as the general public will also be presented. Radioactivity will be presented, along with likely scenarios for stabilization and site cleanup in the future. Some aspects of the isotope monitoring programs, both explosions. Resultant releases of fission product isotopes in air were significant and have been estimated to be in the 3×10^17 MCi.

1 Work supported by U.S. Department of Energy under Grants No. DE-SC0004286 and (within the JET Collaboration) DE-SC0004104.

3:00PM JA.00006 Triangular flow and nonflow by 2-, 4-, and 6-particle cumulants1, LI YI, Purdue University, STAR COLLABORATION — Triangular flow (v3) can arise from event-by-event fluctuations. Its connection to fluctuations in the initial state collision geometry may reveal hydrodynamic information of the collision system. Theoretical studies suggest its sensitivity to hydrodynamic evolution may even be stronger than elliptic flow (v2). We present v3 measurement by the 2-, 4-, and 6-particle cumulant method at √sNN = 200 GeV in Au+Au collisions by STAR. We compare our v3 results to v2, also from the multiparticle cumulant method. The 2-particle cumulant result contains nonflow contribution. We assess the nonflow effect by separating charges as well as applying a pseudo-rapidity gap. The 4- and 6-particle v3 results are strongly affected (perhaps dominated) by v3 fluctuations. Assuming Gaussian flow fluctuation, we further attempt to distinguish flow, flow fluctuation, and nonflow.

1 Li Yi for the STAR Collaboration

3:12PM JA.00007 Measurement of higher order flow harmonics in PbPb collisions at 2.76 TeV by CMS1, YUTING BAI, University of Illinois at Chicago, CMS COLLABORATION — Collective flow is an important probe of the earliest stages in the expansion of the hot and dense matter created in relativistic heavy-ion collisions. Higher harmonics of the azimuthal distribution of emitted particles, in particular v2 and v3, complement v2 measurements in elucidating the dynamical evolution of the bulk medium and providing constraints on its transport properties and initial conditions. With its large acceptance and broad rapidity coverage, the CMS detector is ideally suited to provide detailed analyses of higher order harmonic flow at the LHC. Measurements of higher order flow harmonics, v_n, in PbPb collisions at 2.76 TeV from the CMS detector will be presented as a function of p_T and centrality. Connections of the results to the properties of the medium will be discussed.

1 This work was partially supported by US DOE Grant DE-FG02-94ER40865.

3:24PM JA.00008 Study of flow factorization with two particle azimuthal correlation, DANIEL KIKOLA, FUQIANG WANG, Purdue University — Elliptic flow (v2) provides information about initial expansion of the medium created in non-central heavy ion collisions. However, non-flow effects, such as jet correlation, can contribute significantly to the measured v2. In this talk we investigate the possibility of separating flow and non-flow components of v2 (v_n, in general) measured via two particle azimuthal correlations. If the observed azimuthal anisotropy is due to global flow, then coefficients v_n,n(p_a,p_b) in Fourier decomposition of two particle correlation function dN/dΔφ factorize into product of single particle flow coefficients: v_n,n(p_a,p_b) = v_n(p_a) v_n(p_b). Deviation from v_n,n factorization indicates a significant non-flow contribution. We investigate the flow and non-flow contributions to two particle azimuthal correlations with model of heavy ion dynamics which includes particles from hydro medium (with a given anisotropic flow) and jet correlations simulated with Pythia. We discuss the feasibility of separation of flow and nonflow in the real data based on the hypothesis of v_n,n factorization for a global flow.

3:36PM JA.00009 Higher-order flow harmonics: implications for initial-eccentricity models and the “viscous horizon”1, ROY LACEY, Stony Brook University — Flow measurements continue to play an essential role for characterization of the transport properties of the quark gluon plasma produced in heavy ion collisions at both the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC). The scaling properties of recent higher order flow measurements will be presented and shown to be compatible with the expected growth of viscous damping for sound propagation in the plasma produced in RHIC and LHC collisions. I will also show that these measurements provide a constraint for distinguishing between the two leading eccentricity models, as well as new estimates for the ratio of viscosity to entropy density η/s, the sound horizon and the “viscous horizon” or length-scale which characterizes the highest harmonic that survives viscous damping.

1 This research is supported by the US DOE.

Friday, October 28, 2011 2:00PM - 3:48PM –
Session JB The Fukushima Nuclear Plant: Assessment and Future Alternatives Auditorium

2:00PM JB.00001 Fukushima Accident: Sequence of Events and Lessons Learned, EDWARD C. MORSE, University of California, Berkeley, Department of Nuclear Engineering — The Fukushima Dai-Ichi nuclear power station suffered a devastating Richter 9.0 earthquake followed by a 140 m tsunami on 11 March 2011. The subsequent loss of power for emergency core cooling systems resulted in damage to the fuel in the cores of three reactors. The relief of pressure from the containment in these three reactors led to sufficient hydrogen gas release to cause explosions in the buildings housing the reactors. There was probably subsequent damage to a spent fuel pool of a fourth reactor caused by debris from one of these explosions. Resultant releases of fission product isotopes in air were significant and have been estimated to be in the 3.7 × 6.3 × 10^17 Bq range (~ 10 MCi) for 131I and 137Cs combined, or approximately one tenth that of the Chernobyl accident. A synopsis of the sequence of events leading up to this large release of radioactivity will be presented, along with likely scenarios for stabilization and site cleanup in the future. Some aspects of the isotope monitoring programs, both locally and at large, will also be discussed. An assessment of radiological health risk for the plant workers as well as the general public will also be presented. Finally, the impact of this accident on design and deployment of nuclear generating stations in the future will be discussed.
has been recently measured up to high missing momenta and missing energies; during the first running period of FROST using the CLAS detector at Jefferson Lab with photon energies ranging from 329 to 2,350 MeV. We present data for the proton, BRIAN MORRISON

Search for N-N Short Range Correlations — The bare mass of the three valence quarks only makes \( \sim 1\% \) of the proton mass, the rest is gluons and a sea of quarks and anti-quarks dominated by the light up, down and strange stark flavors. From a naive interpretation of the quark model, one might expect that the electromagnetic form factors are determined only by the distribution of valence quarks. But, existing data suggesting a no-zero strange quark contribution to these form factors at high \( Q^2 \) would have important implications for the understanding of nuclear structure, and be a powerful constraint on the symmetry energy \( S_\pi(n) \) of neutron-rich nuclear matter, including neutron stars. The PREX collaboration has completed a first run, measuring \( R_n \) to a precision of \( \sim 2.5\% \) and providing the first electroweak evidence for the neutron skin of a heavy nucleus. Results from this measurement, and prospects for more precise future measurements, will be discussed.

FRIDAY, October 28, 2011 2:00PM - 3:48PM
Session JC Hadronic Physics II 101

2:00PM JC.00001 HAPPEX-III results: measurement of nucleon strange form factors at high \( Q^2 \) — RUPESH SILWAL, University of Virginia, HAPPEX-III COLLABORATION — The bare mass of the three valence quarks only makes \( \sim 1\% \) of the proton mass, the rest is gluons and a sea of quarks and anti-quarks dominated by the light up, down and strange stark flavors. From a naive interpretation of the quark model, one might expect that the electromagnetic form factors are determined only by the distribution of valence quarks. But, existing data suggesting a no-zero strange quark contribution to these form factors at high \( Q^2 \) would have important implications for the understanding of nuclear structure, and be a powerful constraint on the symmetry energy \( S_\pi(n) \) of neutron-rich nuclear matter, including neutron stars. The PREX collaboration has completed a first run, measuring \( R_n \) to a precision of \( \sim 2.5\% \) and providing the first electroweak evidence for the neutron skin of a heavy nucleus. Results from this measurement, and prospects for more precise future measurements, will be discussed.

2:12PM JC.00002 Recent Results in Parity-Violating Electron Scattering at Jefferson Lab: PREX and HAPPEX-III — CHUN-MIN JEN, Syracuse University, PREX COLLABORATION — The parity-violating asymmetry \( A_{PV} \) in electron scattering from the \(^{208}\text{Pb}\) nucleus is clearly sensitive to the neutron radius \( R_n \). A precision measurement of \( R_n \) would have important implications for the understanding of nuclear structure, and be a powerful constraint on the symmetry energy \( S_\pi(n) \) of neutron-rich nuclear matter, including neutron stars. The PREX collaboration has completed a first run, measuring \( R_n \) to a precision of \( \sim 2.5\% \) and providing the first electroweak evidence for the neutron skin of a heavy nucleus. Results from this measurement, and prospects for more precise future measurements, will be discussed.

2:24PM JC.00003 ABSTRACT WITHDRAWN —

2:36PM JC.00004 Study of the \(^{4}\text{He}(e,e'p)\) reaction up to high missing momenta and energies. Search for N-N Short Range Correlations — FATIHA BENMOHTAR, Christopher Newport University — The \(^{4}\text{He}(e,e'p)\) reaction has been recently measured up to high missing momenta and missing energies; \( p_{\text{min}} \) of 1 GeV/c and \( E_\text{min} \) of 200 MeV, respectively, in Hall A of Jefferson Lab., part of a rich short range correlation experimental program. The continuum region is under study in order to investigate high-nucleon-momenta components in the \(^{4}\text{He}\) wave function with the absorption of virtual photons on nucleons correlated in pairs in the \(^{4}\text{He}\) ground state. The measurements were performed at \( x_B = 1.25 \) and at a fixed transferred four-momentum \( Q^2 = 2(\text{GeV}/c)^2 \). Physics goals will be discussed and analysis status and strategy will be presented.

For the Jefferson Lab Hall-A Collaboration

2:48PM JC.00005 Measurements of the helicity asymmetry \( E \) for eta meson photoproduction on the proton — BRIAN MORRISON, Arizona State University, FOR THE CLAS COLLABORATION — The nucleon resonance spectrum consists of many overlapping excitations. Polarization observables are an important tool for understanding and clarifying these spectra. While there is a large data base of differential cross sections for the process, there are no published data for eta double polarization asymmetries. A program of double polarization experiments has been conducted at Jefferson Lab using a tagged polarized photon beam and a frozen spin polarized target (FROST). The results to be presented were taken during the first running period of FROST using the CLAS detector at Jefferson Lab with photon energies ranging from 329 to 2,350 MeV. We present data for the \( E \) polarization observable for eta meson photoproduction at threshold and above, along with comparisons to several theoretical predictions.

\(^1\)For the Jefferson Lab Hall-A Collaboration

\(^2\)Work at ASU is supported by the U.S. National Science Foundation.
3:00PM JC.00006 Transverse Polarization of $\Sigma^+(1189)$ in Photoproduction on Hydrogen Target with CLAS, CHANDRA S. NEPALI, MOSKOV AMARYAN, Old Dominion University, CLAS COLLABORATION — Experimental results on the measurement of $\Sigma^+(1189)$ hyperon transverse polarization in photoproduction on a hydrogen target with CLAS are presented for the first time. The $\Sigma^+(1189)$ is reconstructed in the exclusive reaction $\gamma+p \rightarrow \Sigma^+ p$ via the decay $\Sigma^+ \rightarrow p\pi^+$. The $K_S$ is reconstructed in the invariant mass of two oppositely charged pions and $\pi^+$ is identified in the missing mass of detected proton, $\pi^+$ and $\pi^-$. We observe significant negative polarization of as much as 60%. Experimental data are collected in the photon energy range 1-3.5 GeV. As the mechanism of large transverse polarization of hyperons produced in unpolarized hadro-, and photo production experiments is still not well understood, these results will help to distinguish between different theoretical models on hyperon production. Current status of the analysis and future prospects are discussed.

3:12PM JC.00007 Light Anti-quark Asymmetry in E906 Drell-Yan $(p + p(d) \rightarrow \mu^+ + \mu^-)$ and prospects of polarized Drell-Yan at Fermilab Main Injector, CHIRANJIB DUTTA, University of Michigan, Ann Arbor, E906/SEAQUEST COLLABORATION — The E-906/SeaQuest experiment will measure the Drell-Yan cross section in p-p and p-d scattering and will determine hadro-, and photo production. Current status of the analysis and future prospects are discussed.

3:24PM JC.00008 Comparison of kaon and pion valence quark distributions in a statistical model1, MARY ALBERG, Seattle University, University of Washington — We have calculated the Bjorken-x dependence of the kaon and pion valence quark distributions in a statistical model. Each meson is described by a Fock state expansion in terms of quarks, antiquarks and gluons. Although the pion valence quark distributions have been determined by Drell-Yan experiments, the kaon valence quark distributions have only been deduced from the measurement of the ratio $n_K(x)/u(x)$ by Badier et al. [1]. We show that, using no free parameters, our model is in good agreement with the decrease of this ratio with increasing x.

1This research has been supported in part by the Research in Undergraduate Institutions program of the National Science Foundation, Grant No. 0855666.

3:36PM JC.00009 Precision Measurement of Charged Hadron Multiplicities in $e^+e^-$ Annihilation at Belle, MARTIN LEITGAB, University of Illinois at Urbana-Champaign — Fragmentation functions describe the formation of final state particles from a partonic initial state. Precise knowledge of these functions is a key ingredient in accessing quantities such as the nucleon spin structure in semi-inclusive deep inelastic scattering and proton proton collisions. However, fragmentation functions can currently not be determined from first principles Quantum Chromodynamics and have to be extracted from experimental data. The Belle experiment at KEK, Japan, provides a large data sample at a low energy scale for high precision measurements of hadron multiplicities allowing for first-time or more precise extractions of fragmentation functions. The current status of the measurement will be presented.

Friday, October 28, 2011 2:00PM - 4:00PM —
Session JD Nuclear Theory II: Heavy Nuclei  Heritage

2:00PM JD.00001 New microscopic theory of low-energy collective motion in soft spherical nuclei1, LIYUAN JIA, VLADIMIR ZELEVINSKY, Michigan State University and NSCL — Many medium and heavy spherical nuclei clearly manifest strong collective motion of low frequency, mainly of quadrupole symmetry. In the absence of static deformation, this motion has a character of large amplitude collective vibrations. While the shell-model diagonalization is usually impossible in such cases, and anharmonic effects are crucial, we develop a method to go beyond standard Hartree-Fock-Bogoliubov mean field and random phase approximation. Considering typical frequencies of collective motion smaller than the pair breaking energy, we map the exact operator equations of motion onto the dynamics governed by the collective Hamiltonian. The parameters of this Hamiltonian (cubic and quartic anharmonicity) are determined self-consistently. After checking the approach by simple cases (Lipkin model and the model with factorizable forces), we discuss the realistic applications.

1Support from the NSF grant PHY-0758099 is acknowledged

2:12PM JD.00002 Exploring the fission barrier of superheavy nuclei in covariant density functional theory1, HAZEM ABUSARA, Mississippi State University, ANATOLI AFANASJEV, Mississippi State University, PETER RING, Technische Universität München — Systematic calculations of the fission barriers with allowance of triaxial deformation have been performed within the covariant density functional theory for the super heavy region of the nuclear chart. Pairing is treated within the BCS approximation using seniority zero forces adjusted to empirical values of the pairing gap parameters. The analysis of the results showed that triaxiality doesn’t lower the height of the inner fission barrier. The height of the inner fission barrier increases with increasing magic Z=120 N=172 nucleus has the largest value of the height of the inner fission barrier indicating its increased stability.

1This work was supported by the US Department of Energy under Grant No. DE-FG02-07ER41459 and by the DFG cluster of excellence “Origin and Structure of the Universe” (www.universe-cluster.de)
2:24PM JD.00003 Brownian shape motion: Fission fragment mass distributions\(^1\). J. RANDRUP, BNL. P. MOLLER, LANL — Exploiting the expected strongly damped character of nuclear dynamics, we treat the nuclear shape evolution in analogy with Brownian motion and perform random walks on five-dimensional fission potential-energy surfaces which were calculated previously and are the most comprehensive available. Test applications give good reproduction of a selection of diverse experimental mass yields. This novel general approach requires only a single new global parameter, the critical neck size at which the mass partition is frozen in, and the results are remarkably insensitive to its specific value. A deeper understanding of these results can be achieved by including the friction tensor for the shape motion which appears to have only a minor effect on the resulting mass partition. Relative to previously employed models, the present approach represents a significant advance with regard to predictive power. It can be readily employed in regions of the neck chart that are of special astrophysical interest and it may, for example, help to clarify the importance of fission recycling for the r-process. Taking explicit account of the equilibration process, the treatment extends in a natural way the compound nuclear concept and it builds directly on the general picture of low-energy nuclear dynamics as being dissipation dominated. [PRL 106 (2011) 132503]

\(^1\)DOE contracts AC02-05CH12311 (JR) AC52-06NA25396 (PM)

2:36PM JD.00004 Microscopic dynamic study of giant resonance excitation and fusion in \(^{122}\text{Sn}^{+}\text{Ca}\). VOLKER OBERACKER, A.S. UMAR, Vanderbilt University — In connection with experiments at Radioactive Ion Beam Facilities, we study pre-compound giant resonance excitation and fusion in heavy-ion reactions within a microscopic dynamic theory. Calculations are carried out on a 3-D lattice using the density-constrained Time-Dependent Hartree-Fock (TD-DHF) method [1,2]. For \(^{122}\text{Sn}^{+}\text{Ca}\), we calculate the time-evolution of giant resonance excitation and associated gamma-ray yield. Also, we calculate the heavy-ion interaction potential and total fusion cross section and compare the results to \(^{122}\text{Sn}^{40}\text{Ca}\). A comparison with recently measured fusion cross sections will be given.


Supported by DOE grant DE-FG02-96ER40963.

2:48PM JD.00005 Novel Indication for Non-Locality of the Optical Model for \(^{12}\text{C}\). GEORGE RAWITSCHER, Physics Department, University of Connecticut, Storrs., MOHAMMED HASSAN, MAHMOUD JAGHOUB, Physics Department, University of Jordan — In this work we consider the n - \(^{12}\text{C}\) elastic scattering data and fit the angular distributions in the energy range 12 to 20 MeV. Our fits are obtained by adding to the conventional optical model a new term which is real, velocity dependent and is assumed to represent the nuclear density. The fits reproduce well the detailed structure of the angular distributions including the prominent backscattering minima which depend sensitively on the incident energies. A sign of the presence of non-locality is manifested a) by the pronounced motion of the peak of the spin-orbit potential towards the nuclear interior as the incident energy increases, and b) by the necessary presence of velocity-dependent term, which is nearly stationary as the incident energy increases. All our potentials have the form of the conventional Woods-Saxon potential or its derivative. Possible explanations of the non-locality in terms of physical processes will be attempted.

Non-localities in the nucleon - \(^{16}\text{O}\) optical potential were also previously found by Cooper [1] in the form of parity dependent potentials.


3:00PM JD.00006 Do We Understand Physics of Non-Exponential Decay?\(^1\). VLADIMIR ZELEVINSKY, Michigan State University, ALEXANDER VOLYA, Florida State University — In practical evaluations of the mean lifetime the exponential behavior of the survival probability is assumed. Quantum mechanics, however, predicts that the survival probability of the decaying state, given by the squared overlap of the initial wave function and the evolved wave function at a later time, cannot be strictly exponential. Although it is hard to observe experimentally, in a quantum system with the finite expectation values of energy and its mean square fluctuation, both the initial stage of decay and its long-time limit are non- exponential. Using an exactly solvable quantum model we show that even at intermediate times the decay is not strictly exponential. This could be due to interfering components in the decay wave function, interfering decay channels, recurrent returns of the system to the quasi-bound states including those different from the original one, and due to exchange terms in cluster decays. In the presence of intrinsic degrees of freedom coupled to different decay channels we observe the oscillations superimposed on the power tail in the long-time limit, which is similar to the so-called GSI oscillations.

\(^1\)We thank M. Peshkin who initiated this work.

3:12PM JD.00007 Random Matrix Theory Approach for Unstable Nuclei\(^1\). GAVRIIL SHCHEDRIN, VLADIMIR ZELEVINSKY, Michigan State University — Random Matrix Theory as a statistical approach for exploring energy spectra of complex quantum systems was pioneered by Wigner and Dyson in 1950’s. This theory was successfully applied to excited states of complex nuclei and other mesoscopic systems evaluating statistical fluctuations and correlations in energy levels and corresponding wave functions. The standard random matrix approach was formulated only for closed systems with no coupling to the outside world. Later it was generalized for decaying systems with energies of unstable states in the complex plane. Recent precise experiments showed that the centroid width distribution in low-energy neutron resonances cannot be described by the standard Porter-Thomas distribution that follows from standard random matrix theory. We analyze the combined distribution function of resonance widths and energies in an unstable quantum system that follows from the statistical assumptions which agree with the general quantum requirements, such as unitarity of the scattering matrix. We show that such statistical theory indeed leads to the trend observed experimentally.

\(^1\)Support from the NSF grant PHY-0758099 is acknowledged.

3:24PM JD.00008 Random matrices, symmetries, and many-body states\(^1\). CALVIN JOHNSON, San Diego State University — All nuclei with even numbers of protons and of neutrons have ground states with zero angular momentum. This is ascribed to the pairing force between nucleons, but simulations with random interactions suggest a much broader many-body phenomenon. I discuss how to project out random Hermitian matrices that have good quantum numbers and, computing the width of the Hamiltonian in subspaces, find ground states dominated by low quantum numbers, e.g. J = 0.

\(^1\)Supported by US DOE grant DE-FG02-96ER40985
An improved nuclear mass model: FRDM (2012)¹, PETER MOLLER, Los Alamos National Laboratory — We have developed an improved nuclear mass model which we plan to finalize in 2012; so we designate it FRDM(2012). Relative to our previous mass table in 1995 [1] we do a full four-dimensional variation of the shape coordinates EPS2, EPS3, EPS4, and EPS6, we consider axial asymmetric shape degrees of freedom and we vary the density symmetry parameter L. Other additional features are also implemented. With respect to the Audi 2003 data base we now have an accuracy of 0.57 MeV. We have carefully tested the extrapolation properties of the new mass table by adjusting model parameters to limited data sets and testing on extended data sets and find it is highly reliable in new regions of nuclei. We discuss what the remaining differences between model calculations and experiment tell us about the limitations of the currently used effective single-particle potential and possible extensions.

¹DOE No. DE-AC52-06NA25396

Energy Released from Nuclear Radiation, HAN YONGQUAN — If temperature is not taken into consideration (in fact, atomic nucleus temperature is far beyond the atom temperature), energy released from visible light—electromagnetic wave radiated by atomic nuclei can be calculated as follows: \[ \frac{4}{3}m \times v^2 - m_1 \times c^2 = \frac{1}{2} \times 0.91 \times 10^{-30} \times (2.14 \times 10^{14})^2 - 4.04 \times 10^{-36} \times (3 \times 10^9) \approx 0.8 \times 10^{-2}. \] Ignoring electromagnetic’s whole movement velocity in interior part of the object, we only calculate the revolving velocity of its electron pair and assume that both the revolving velocity of electromagnetic electron pair of visible light and its transmission velocity equal \(3 \times 10^7\) in the above calculation formula. If the influence of temperature is taken into consideration, the energy released from radiation is more than \(0.8 \times 10^{-2}\). Therefore, the energy released from nuclear radiation must be far beyond this value. It can easily explain why international prototype kilogram has lessened about 50 micrograms, which is a cylindrical casting made of platinum and iridium and having a history of 118 years.

Friday, October 28, 2011 2:00PM - 4:00PM – Session JE Nuclear Reactions/Rare Isotope Beams II 103AB

2:00PM JE.00001 Measuring Cluster Fusion Plasma Temperature and Density from \(^3\)He(D,p)\(^4\)He and D(D,p)T Reactions, MARINA BARBUI, A. BONASERA, K. HAGEL, J.B. NATOWITZ, K. SCHMIDT, H. ZHENG, M. BARBARINO, W. BANG, T. DITMIRE, G. DYER, H. QUEVEDO, A. BERNSTEIN — The interaction of intense ultrafast laser pulses with molecular clusters produces the explosion of the clusters with enough kinetic energy to drive nuclear reactions. If we assume the thermalization of the plasma, the ratio of the yields from two different nuclear reactions occurring simultaneously will allow the determination of the ion temperature at the time when the reaction occurred. We performed two experiments: one using pure deuterium to drive the D(D,p)T and D(D,n)\(^4\)He reactions, another mixing D\(_2\) and \(^3\)He in the gas jet target to allow us to measure simultaneously yields from the \(^3\)He(D,p)\(^4\)He and the D-D reactions. We detected both the 2.45 MeV neutrons and 3.02 MeV protons from the D-D reactions and the 14.7 MeV protons from the \(^3\)He(D,p)\(^4\)He reaction. Preliminary results will be shown.

2:12PM JE.00002 Elastic Scattering of \(^6\)He based on a Cluster Description, STEPHEN WEPPNER, Eckerd College, CHARLOTTE ELSTER, Ohio University — Recently elastic scattering of \(^6\)He off a polarized proton target has been measured for the first time at an energy of 71 MeV/nucleon. The experiment finds that the analyzing power becomes negative around 50°, a feature which can not be described by simple folding models for the optical potential, which do not take into account the halo character of the \(^6\)He nucleus. In this work, the cluster structure of \(^6\)He is incorporated in an optical potential for the reaction \(p+\(^6\)He\) in the framework of the Watson ansatz for the multiple scattering theory. We find that the analyzing power at 71 MeV/nucleon is sensitive to the cluster structure of \(^6\)He, whereas the differential cross section is not. We also present predictions for higher energies which also show a lack of sensitivity.

1Supported by Eckerd College and the U.S. DOE DE-SC0004084 (Torus Collaboration) and DE-FG02-93ER40756 and Ohio U.

2:24PM JE.00003 Testing formalisms for deuteron breakup and transfer reactions, NEELAM UPADHYAY, NSCL, Michigan State University, USA; ARNOLDAS DELTUVAS, Centro de Física Nuclear, Universidade de Lisboa, Portugal; FILOMENA Nunes, NSCL, Michigan State University, USA — The Continuum Discretized Coupled Channels (CDCC) [1] method is a well established theory for the direct nuclear reactions which includes breakup to all orders. In CDCC, the 3-body problem is solved by expanding the full wave function in terms of a complete basis of the projectile’s bound and continuum states. Alternatively, the 3-body problem can be solved exactly within the Faddeev formalism [2] which explicitly includes breakup and transfer channels to all orders. Thus with the aim to understand how the CDCC compares with the exact 3-body Faddeev formulation, we study scattering of deuterons on \(^{10}\)Be, \(^{12}\)C, and \(^{64}\)Cu at low and intermediate energies. We calculate elastic, breakup and transfer observables. Results indicate that for transfer cross sections at low energy, CDCC is in better agreement with the Faddeev formalism. The discrepancy in two methods increases with beam energy. [1] N. Austern et al., Phys. Rep. 154, 125 (1987). [2] L. D. Faddeev, Zh. Eksp. Teor. Fiz. 39, 1459 (1960). [3] E. O. Alt, P. Grassberger, and W. Sandhas, Nucl. Phys. B2, 167 (1967).

This work is done within the TORUS collaboration and supported by the U.S. Department of Energy under the grant number DE-SC0004087.

2:36PM JE.00004 Knockout reactions from p-shell nuclei: tests of ab initio structure models, DANIEL BAZIN, Michigan State University, GEOFF GRINBERG, GANIL, SOFIA QUAGLIONI, LNL, JAMES TERRY, LANL, DIRK WEISSHAAR, ALEXANDRA GADE, NSCL/MSU, JEFF TOSTEVIN, Surrey, ALEX BROWN, CHRIS CAMPBELL, NSCL/MSU, THOMAS GLASMACHER, FRIB/MSU, SEAN MC DANIEL, NSCL/MSU, PETR NAVRATIL, TRIUMF, ALEXANDRE OBERTELLI, CEA-Saclay, ROBERT WIRINGA, ANL — Absolute cross section measurements have been performed at the level of 5% precision following single neutron knockout reactions from \(^{10}\)Be and \(^{12}\)C at intermediate beam energy. Theoretical nucleon densities and bound-state wavefunction overlaps obtained from Variational Monte-Carlo (VMC) and No-Core Shell Model (NCSM) ab initio calculations have been incorporated into the theoretical description of knockout reactions. Comparison to experimental cross sections demonstrates that the VMC approach provides the best agreement while the NCSM and conventional shell-model calculations both over-predict the cross section for \(^{10}\)Be by 20 to 30% and \(^{12}\)C by 40 to 50%, respectively. This study provides new insight into the importance of nucleon correlations and 3-body forces in light nuclei and the accuracy of the VMC and NCSM structure models for describing these effects at the microscopic level.
2:48PM JE.00005 Analysis of Fusion Reactions with Carbon Isotopes, HENNING ESBENSEN, Argonne National Laboratory, CHENG-LIE JIANG, Argonne National Laboratory, XIAO-DONG TANG, University of Notre Dame — Fusion data for $^{13}\text{C}+\text{C}$ are analyzed by coupled-channels calculations that are based on the M3Y+repulsion, double-folding potential. Quadrupole and octupole transitions to low-lying states in projectile and target are included, as well as mutual excitations of these states. The one-neutron transfer to the $^{12}\text{C}+\text{C}$ mass partition is also considered. By adjusting the parameters of the M3Y+repulsion interaction it is possible to obtain an excellent fit to the data. This requires, however, that the absolute normalization of the calculation is adjusted, and justifications for doing that are discussed. The calibrated M3Y+repulsion interaction is applied to predict the fusion cross section for $^{12}\text{C}+^{12}\text{C}$ and good agreement with the data is achieved. The prediction for $^{12}\text{C}+^{12}\text{C}$ is in reasonable agreement with the maximum peak cross sections that have been measured, and provides an upper limit for the extrapolation to the low energies that are of interest to astrophysics.

3:00PM JE.00006 Developing a technique for measuring the fusion of neutron-rich nuclei at near barrier energies, KYLE BROWN, M.J. RUDOLPH, Z.Q. GOSSTER, S. HUDAN, R.T. DESOUZA, Indiana University, M. FAMIANO, Western Michigan University — Enhancement of the fusion cross-section for neutron-rich light nuclei has been postulated as a heat source that triggers X-ray superbursts in the crust of an accreting neutron star. To investigate this question, one has begun an experimental program to measure near-barrier fusion of $^{20,22}\text{O}$ ions incident with $^{12}\text{C}$ nuclei. Fusion in $^{16}\text{O}+^{12}\text{C}$ provides a necessary reference reaction. While this reference reaction has already been extensively studied, measuring the excitation function with the same experimental setup used for radioactive beam experiments will allow us to both demonstrate the feasibility of the experimental technique, as well as account for experimental uncertainties. Near and sub-barrier fusion cross-sections were measured for $^{16}\text{O}+^{12}\text{C}$ at Western Michigan University for $20\text{ MeV} < \text{E}_{\text{lab}} < 31\text{ MeV}$. The time-of-flight between two micro-channel plate detectors, spaced by approximately 80 cm, allows selection of the incident particle’s time-of-flight on an event-by-event basis. The carbon foil of the second MCP acts as the target and provides a start signal. Fusion residues are identified by energy and time-of-flight ($\delta = 425\text{ps}$ for $\text{E}_{\text{c.m.}} = 7.687\text{ MeV}$) between the active target and two segmented, annular silicon detectors which cover the angular range, $3^\circ < \theta_{\text{lab}} < 20^\circ$. Results will be compared with established cross-sections.

3:12PM JE.00007 Fusion of neutron-rich O ions on a carbon target at near-barrier energies, RUMIUALDO DESOUZA, M.J. RUDOLPH, Z.Q. GOSSTER, K. BROWN, S. HUDAN, Indiana University, A. CHIBIHI, B. JACQUOT, GANIL, M. FAMIANO, Western Michigan University, F. LIANG, D. SHAPIRA, ORNL, D. MERCIER, CNRS — Experimental investigation of the sub-barrier fusion of neutron-rich light nuclei is important in understanding the structure of neutron-rich nuclei, and fusion dynamics of neutron-rich nuclei. It has recently been proposed that X-ray superbursts may originate from carbon burning ignited by heat from the fusion of neutron-rich oxygen nuclei in the crust of an accreting neutron stars [1]. An enhancement in the fusion probability, pronounced at energies near and below the Coulomb barrier, may signal the presence of different fusion dynamics as compared to the fusion of less neutron-rich nuclei. To assess if the fusion probability is enhanced for neutron-rich nuclei, we performed the first fusion excitation measurement for $^{16}\text{O} + ^{12}\text{C}$ for $\text{E}_{\text{lab}}/A = 1-2\text{ MeV}$. Initial results of this experimental measurements will be presented.

3:24PM JE.00008 Influence of neutron excess on fusion hindrance in neutron-rich radioactive Sn induced reactions, J.F. LIANG, J.M. ALLMOND, C.J. GROSS, Z. KOHLEY, K. LARGERGREEN, P.E. MUELLER, D. SHAPIRA, R.L. VARNER, Physics Division, Oak Ridge National Laboratory, A.L. CARALEY, Department of Physics, State University of New York at Oswego — Fusion enhancement has been observed in reactions induced by neutron-rich radioactive beams at energies near the Coulomb barrier. In heavier systems, fusion is hindered because of quasifission. Whether the hindrance will cancel out the enhancement brought by neutron-rich radioactive nuclei is an open question. We have measured evaporation residue cross sections for neutron-rich radioactive Sn on Ni targets to study the influence of neutron excess on the amalgamation process. A model independent comparison between $^{132}\text{Sn}+^{58}\text{Ni}$ and $^{128}\text{Sn}+^{64}\text{Ni}$ will be made. The isotope dependence of fusion hindrance in $^{124,126,127,128}\text{Sn}$ on $^{64}\text{Ni}$ will be examined.

3:36PM JE.00009 The role of transfer couplings in the fusion of Sn+Ni and Te+Ni systems, Z. KOHLEY, J.F. LIANG, D. SHAPIRA, R.L. VARNER, C.J. GROSS, J.M. ALLMOND, Oak Ridge National Laboratory, A.L. CARALEY, State Univ. of New York at Oswego, E.A. COELLO, F. FAVELA, Universidad Nacional Autonoma de Mexico, K. LAGERGREEN, P.E. MUELLER, Oak Ridge National Laboratory — Evaporation residue and fusion cross sections have been measured for the radioactive $^{132}\text{Sn}+^{58}\text{Ni}$ and stable $^{130}\text{Te}+^{58,64}\text{Ni}$ systems at energies near the Coulomb barrier. Through a comparison with previous Sn+Ni measurements, the role of transfer couplings on the heavy-ion fusion has been examined. The number of positive Q-value neutron transfer channels varied widely between the different Sn+Ni and Te+Ni systems, the reduced excitation functions were equivalent. This is in contrast to a number of previous studies where large enhancements in the sub-barrier fusion cross sections were observed in systems with positive Q-value neutron transfer channels. The present results suggest a significant change in the influence of transfer couplings on the fusion process for the Sn+Ni and Te+Ni systems. This work was supported by DOE Office of Nuclear Physics.

3:48PM JE.00010 Fusion reactions with the halo nucleus $^{15}\text{C}$, M. ALCORTA, K.E. REHM, B.B. BACK, P.F. BERTONE, B. DIGIOVINE, H. ESSENSEN, J.P. GREENE, C.R. HOFFMAN, C.L. JIANG, R.C. PARDO, A.M. ROGERS, Argonne National Laboratory, S. BEDOOR, A.H. WUOSMAA, Western Michigan University, C.M. DEIBEL, Argonne National Laboratory and JINA, J.C. LIGHTHALL, S.T. MARLEY, Argonne National Laboratory and Western Michigan University, M. PAUL, Hebrew University, C. UGALDE, Argonne National Laboratory and University of Chicago and JINA — We have for the first time studied the fusion-fission excitation functions for the systems $^{14,15}\text{C}+^{208}\text{Pb}$ at energies in the vicinity of the Coulomb barrier. A radioactive $^{15}\text{C}$ beam was produced using the ATLAS In-Flight Technique at Argonne National Laboratory. The intensity of the $^{15}\text{C}$ beam was on the order of $1 \times 10^6$ ions/s at the highest energy with a $^{14}\text{C}$ contamination of only 3%. The results of the experiment show that at energies below the barrier, the fusion cross section of the halo nucleus $^{15}\text{C}$, with an $n_{1/2}$ neutron weakly bound to the closed neutron shell nucleus $^{14}\text{C}$, is enhanced by a factor of 2-5, while the fusion cross section for $^{14}\text{C}$ follows a trend similar to that of $^{12,13}\text{C}$. The experimental results will be presented and compared to various theoretical models.

Friday, October 28, 2011 2:00PM - 3:48PM — Session JF Nuclear Structure VI 104AB
2:00PM JF.00001 Spectroscopy of neutron-unbound $^{15}$Be, JESSE SNYDER, MICHAEL THOENENNESSEN, THOMAS BAUMAN, ARTEMIS SPRYOL, GREG CHRISTIAN, SHEA MOSBY, MICHELLE MOSBY, JENNA SMITH, ANNA SIMON, NSCL/MSU, BRYAN LUTHER, Concordia College, SHARON STEPHENSON, ALEX PETERS, Gettysburg College, PAUL DEYOUNG, ERIC LUNDERBERG, Hope College, JOSEPH FINCK, Central Michigan University — $^{15}$Be was populated via a $(p,n)$ reaction, and a $^{14}$Be population was used as a reference. The decay energy spectra were measured at the Modular Neutron Array at Michigan State University (MNA). The decay energy spectrum was measured using the Modular Neutron Array (MoNA) and Sweeper superconducting dipole magnet experimental setup. The $^{15}$Li decays via two-neutron emission and Geant4 simulations will be shown. The results will also be compared to the experiment.

2:12PM JF.00002 Spectroscopy of Neutron Unbound Carbon Isotopes, MOSBY, M. THOENENNESSEN, NSCL / MSU, P. DEYOUNG, Hope College, MONA COLLABORATION — Neutron-unbound states were populated in reactions with $^{14}$Be at 15 MeV/u. The decay energy spectrum was measured with the Modular Neutron Array (MoNA) and Sweeper superconducting dipole magnet experimental setup. The $^{15}$Li decays via two-neutron emission and Geant4 simulations will be shown. The results will also be compared to the experiment.

2:24PM JF.00003 Spectroscopy of $^{12}$Li, E.M. LUNDERBERG, C.C. HALL, P.A. DEYOUNG, Hope College Department of Physics, M. THOENENNESSEN, J. SNYDER, National Superconducting Cyclotron Laboratory, Michigan State University, MONA COLLABORATION — The properties of neutron-unbound levels in $^{12}$Li are presented. The $^{12}$Li levels were populated via a $(p,n)$ reaction, and the decay energy spectrum was measured with the Modular Neutron Array (MoNA) and Sweeper superconducting dipole magnet experimental setup. The $^{12}$Li decays via two-neutron emission and Geant4 simulations will be shown. The results will also be compared to the experiment.

2:36PM JF.00004 The search for nuclear molecules in isobaric analog states of $^{13}$B, ANTHONY KUCHERA, GRIGORY ROGACHEV, Florida State University, VLADILEN GOLDBERG, Texas A&M University, ERIC JOHNSON, LANIECE MILLER, Florida State University, SILVIO CHERUBINI, MARISA GULINO, Istituto Nazionale Fisica Nucleare Laboratori Nazionali del Sud, JOHN HARDY, Texas A&M University, MARCO LA COGNATA, MARCELLO LATTAUDA, ROSARIO GIANLUCA PIZZONE, STEFANO ROMANO, CLAUDIO SPITALIERI, Istituto Nazionale Fisica Nucleare Laboratori Nazionali del Sud, ROBERT TIBBLES, Texas A&M University, WALDEK TRZASKA, University of Jyväskyla, AURORA TUMINO, Istituto Nazionale Fisica Nucleare Laboratori Nazionali del Sud — The low-lying levels of the $^{13}$B nucleus were measured using the angular distribution of observed protons. Details of the experimental setup and a status report on the analysis will be discussed.


3:00PM JF.00006 Nuclear Structure Studies of $^{76}$Se and $^{76}$Ge with the $(n, n’)$ Reaction, B.P. CRIDER, A. CHAKRABORTY, A. KUMAR, E.E. PETERS, F.M. PRADOS-ESTEVEZ, M.T. MCELLESTREM, S.W. YATES, Departments of Chemistry and Physics and Astronomy, University of Kentucky, Lexington, KY 40506-0055 — A prominent nucleus which may undergo neutrinoless double beta decay is $^{76}$Ge, which decays to $^{76}$Se. While an unambiguous observation of this lepton-number-violating decay mode has not been made, much progress is in progress to obtain the decay properties required for an accurate calculation of the nuclear matrix element (NME), which is vital to extracting the absolute mass scale of the neutrino. In order to provide more information for calculation of the NME, the $^{76}$Ge($n,n’$) reaction will be discussed.

3:00PM JF.00007 Full distribution of dipole states below 9 MeV in $^{76}$Se, N. COOPER, V. WERNER, M.K. SMITH, Yale University, P.M. GODDARD, Yale, SURREY, FRIEDHELM, J. BELLER, M. FRITZSCHEN, N. PIETRALLA, C. ROMIG, D. SAVRAN, M. SCHRACK, J. SONNABEND, J. WAGNER, TU-Darmstadt, A. CHAKRABORTY, B.P. CRIDER, E. PETERS, S.W. YATES, University of Kentucky, J. KELLY, R. RAUT, G. RUSEV, A.P. TONCHEV, W. TORNOW, TUNL, D. DELAUNAU, D. FILIPESCU, T. GLODARIU, IFIN-HH — Systematics of photoexcitation strength near the particle emission threshold have been of great interest in recent years due to its importance in stellar nucleosynthesis of certain heavy nuclei. Theories such as the RPA and its variants are currently used to calculate photoexcitation strength in this energy region, as well as the nuclear matrix element of the hypothetical 0s2-3-2 decay modes, such as $^{76}$Ge$^{+2}$ and $^{76}$Se$^{+2}$. Dipole states between 2 and 4 MeV in $^{76}$Se have been studied using linearly polarized, nearly monoenergetic photons produced by Compton-backscattering at the HI7S facility. The experiment completes a series of photon scattering experiments performed on this nucleus in the energy region below 9 MeV, both at the S-DALINAC and at HI7S. Collecting dipole excitations will be discussed.

3:12PM JF.00008 Support for the National Science Foundation under Grant No. PHY-096058.
3:24PM JG.00008 Intermediate States in the Photoexcitation of $^{176}$Lu 1, J.J. CARROLL, US Army Research Laboratory, T. HENRY, University of Surrey, T. BALINT, Youngstown State University, H.-H. PITZ, F. STEDILE, U. KNEISSL, University of Stuttgart — The photoexcitation of $^{176}$Lu has been studied experimentally using a high-intensity DYNAMITRON accelerator at the University of Stuttgart. Enriched samples of $^{176}$Lu (72.5%) were irradiated with bremsstrahlung having endpoint energies between 700 – 2,200 keV. Several intermediate states were identified by which the 3.64 hour isomer was populated, and their energy-integrated cross sections were measured. The results and implications for stellar nucleosynthesis of this odd-odd nuclide will be discussed.

1Supported in part by DTRA grant HDTRA1-08-1-0014.

3:36PM JG.00009 Testing the Mutually Enhanced Magicity (MEM) effect in the Giant Monopole Resonance (GMR) in the $^{204-208}$Pb isotopes 1, D. PATEL, Univ. of Notre Dame(UND), U. GARG, G.P.A. BERG, UND, T. ADACHI, KVI, H. AKIMUNE, Konan U., Y. FUJITA, M. FUJIWARA, Osaka U., M. HARAKEH, KVI, M. ITOH, Tohoku U., C. IWAMOTO, Konan U., A. LONG, J. MATTA, UND, T. MURAKAMI, Kyoto U., A. OKAMOTO, Konan U., K. SAULT, R. TALWAR, UND, M. UCHIDA, Tokyo Inst. of Tech., M. YOSOI, Osaka U. — Recent study of the giant monopole resonance (GMR) in the even $^{204-208}$Pb and $^{196-198}$Cd isotopes showed discrepancy in the centroid energy of GMR peak when compared with the theoretical calculations. It has been suggested [2] that this discrepancy might result from the MEM effect [3]. A consequence of this hypothesis would be significantly high GMR energy in the doubly-magic $^{208}$Pb nucleus when compared with the nearby Pb isotopes. We have investigated GMR in $^{204-208}$Pb isotopes in an experiment performed at RCNP, Osaka University, Japan. Measurements were taken at forward angles, including $0^\circ$, using a 400 MeV $\alpha$ beam. Preliminary results indicate that this hypothesis does not hold.


Friday, October 28, 2011 2:00PM - 3:24PM –
Session JG Astrophysics V: Dark Matter and Unification 105AB

2:00PM JG.00001 Argon Depletion for a Large Scale Dark Matter Detector 1, DANA BYRAM, DONGMING MEI, DUSTIN NOWOTNY, University of South Dakota, JASON SPAANS — A system of Thermal Diffusion columns is being built and tested at the University of South Dakota for the purposes of providing argon depleted of $^{39}$Ar. Thermal diffusion is a well-known technique in isotope separation, which introduces a radial temperature gradient in a gas column to produce a vertical concentration gradient via convective currents. In this concentration gradient, the heavier isotopes accumulate at the bottom of the column and the lighter isotopes at the top. The test system under development will allow us to deplete 1 kg of natural argon by a factor of 10 for over two months. This would lead to the full-scale production of depleted argon by using more columns that are longer in length. In addition, recycling depleted argon through the column yields further depletion up to a theoretical maximum factor of about 1000. This highly depleted argon could then be used as a target material for next generation dark matter detectors. Preliminary depletion results in 3 meter columns will be reported utilizing the more abundant isotope $^{36}$Ar and progress toward an automated gas collection system will be discussed.

1CUBED

2:12PM JG.00002 The MiniCLEAN Dark Matter Experiment, RICHARD SCHNEE, Syracuse University, DEAP/CLEAN COLLABORATION — The MiniCLEAN dark matter experiment exploits a single-phase liquid argon (LAr) detector, instrumented with photomultiplier tube submersed in the cryogen with nearly 1$\sigma$ coverage of a 500 kg target (150 kg fiducial) mass. The high light yield and large difference in singlet/triplet scintillation time-profiles in LAr provide effective defense against radioactive backgrounds through pulse-shape discrimination and event position reconstruction. The detector is also designed for a liquid neon target which, in the event of a positive signal in LAr, will enable an independent verification of backgrounds and provide a unique test of the expected $A^2$ dependence of the WIMP interaction rate. The conceptually simple design can be scaled to target masses in excess of 10 tons in a relatively straightforward and economic manner. The experimental technique and current status of MiniCLEAN will be summarized.

2:24PM JG.00003 Photomultiplier tube characterization for MiniCLEAN, STEPHEN JADITZ, LNL/MIT. MINICLEAN COLLABORATION — MiniCLEAN is a single-phase dark matter experiment which uses liquid argon (87 K) or neon (27 K) as an active medium. Photomultiplier tubes (PMTs) submersed in the cryogen detect light emitted by tetraphenyl butadiene, which fluoresces at short optical wavelengths when excited by the primary ultraviolet scintillation of the argon or neon. The collaboration has chosen to use 8” Hamamatsu R5912-02MOD PMTs, the low-temperature successor of the R1408-R5912 lineages. The bialkali photocathode of the R5912-02MOD has a platinum underlayer which increases electron mobility, enabling operation at temperatures lower than 150 K where traditional bialkali cathodes fail. The number of dynodes in the tube has also been increased to 14, which lowers the bias required to attain reasonable gain and saves heat load in the voltage divider chain of the base. This talk describes characterization of the tube and base for use in MiniCLEAN. I present gain and dark rate measurements as a function of temperature, considerations that inform the base design, and implications of using this tube in a low-background experiment.

2:36PM JG.00004 Simulation and Analysis for the MiniCLEAN Dark Matter Experiment, STANLEY SEIBERT, University of Pennsylvania, MINICLEAN COLLABORATION — The MiniCLEAN dark matter experiment is an ultra-low background liquid argon and neon detector at SNOLAB with a fiducial volume of 150 kg. The ability of the experiment to exchange the target material gives MiniCLEAN both competitive sensitivity to WIMP dark matter and also the opportunity to demonstrate the technologies required to build the multi-ton detectors necessary for dark matter and precision measurements of low energy solar neutrinos. I will discuss the current status of the MiniCLEAN simulation and analysis package, called RAT. RAT is a GEANT4-based full optical simulation, which includes a complete model of the data acquisition system in order to mimic the real detector data stream for development of event-level analysis algorithms. In addition, I will report on projected performance of position reconstruction in RAT and improved timing-based techniques for particle identification.

2:48PM JG.00005 C4: Prospects for an expanded search for light-mass WIMPs, JOHN ORRELL, Pacific Northwest National Laboratory, JUAN COLLAR, NICOLE FIELDS, University of Chicago, ERIN FULLER, TODD HOSSBACH, MAREK KOS, CORY OVERMAN, DOUG REID, BRENT VAN DEVENDER, Pacific Northwest National Laboratory, C4 DARK MATTER EXPERIMENT COLLABORATION — The CoGeNT experiment located at the Soudan Underground Laboratory has reported an excess of events below an electron scattering equivalent of 1 keV. This result may be interpreted alternatively as either an unidentified background contribution or a signature of light-mass (5-10 GeV/c2) weakly interacting massive particle (WIMP) dark matter. The initial CoGeNT results were produced using a single 440 gram high-purity germanium radiation detector operated at liquid nitrogen temperature. To further test these unexpected results, an expanded CoGeNT-4 experimental design is under development. The shield design concept is presented and the science impact of a four-detector experiment is explored. Of particular interest is the sensitivity to a hypothesis for light-mass WIMP dark matter particles in the 5-10 GeV/c2 mass range that could potentially explain the initial CoGeNT results as well as the results of the DAMA/LIBRA experiment.
9:06AM MA.00002 Calculation of Maxwellian-averaged cross sections and their uncertainties using ENDF/B-VII.1 evaluated neutron library, BORIS PRITYCHENKO, National Nuclear Data Center, Brookhaven National Laboratory — Present contribution represents a first application of ENDF/B-VII.1 neutron library for calculation of Maxwellian-averaged cross sections and astrophysical reaction rates. Recent improvements in neutron cross section evaluations and more extensive utilization of covariance files, by the CSEWG collaboration, allowed us to perform complete calculations and provide additional insights on all currently available neutron-induced reaction data. Nuclear reaction calculations using ENDF libraries and current Java technologies will be discussed and new results will be presented. This work was sponsored by the Office of Nuclear Physics, Office of Science of the U.S. Department of Energy, under Contract No. DE-AC02-98CH10886 with Brookhaven Science Associates, LLC.

9:18AM MA.00003 New Features in the Computational Infrastructure for Nuclear Astrophysics, MICHAEL S. SMITH, ERIC J. LINGERFELT, W. RAPHAEL HIX, CAROLINE D. NESARAJA, ORNL, KYLE THOMSEN, Tenn. Tech. Univ. — The Computational Infrastructure for Nuclear Astrophysics (CINA) is a platform-independent suite of computer codes that are freely available online at http://nucastrodata.org. The system enhances the utilization of nuclear data by streamlining the process to include the latest data into astrophysics simulations. Users can upload measured or calculated cross sections, process them into reaction rates, incorporate rates into libraries, run simulations with these custom libraries, and store and visualize the results—all with a simple graphical user interface. New features in CINA include: automated studies of the sensitivity of astrophysical predictions on nuclear input; calculation of thermonuclear reaction rates from resonance information; and the ability to extract information from several additional international databases. Several utilizations of, and future plans for, this software suite will be given.

9:30AM MA.00004 Fission product $^{87}$Kr studied with Modular Total Absorption Spectrometer at the HRIBF, A. KUŹNIAK, UTK, UW, M. KARNY, ORNL, ORAU, UW, K. RYKACZEWSKI, C.J. GROSS, J. JOHNSON, ORNL, M. WOLINSKA-CICHOCKA, ORNL, ORAU, R. GRZYWACZ, UTK, ORNL, D. MILLER, UTK, B.C. RASCO, LSU — Modeling of the decay heat of uranium and plutonium fission products is one of the main challenges of contemporary applied nuclear physics. The differences between measured and calculated values are believed to be due to the incorrect or incomplete decay schemes measured with low efficiency detectors. Recently, a very efficient Modular Total Absorption Spectrometer, has been constructed at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory. Its full energy peak efficiency reaches 90% for 300 keV and over 75% for 5 MeV gamma rays. Results of the first test measurements of the 238-Uranium fission product $^{87}$Kr will be presented.

9:42AM MA.00005 Nuclear Data Needs for Research at the Facility for Rare Isotope Beams, BRADLEY SHERRELL, Facility for Rare Isotope Beams — Estimates indicate that the Facility for Rare Isotope Beams, FRIB, could produce 1000 new isotopes and allow the detailed study of in total nearly 4500 isotopes. With this potential for discovery, one of the main scientific goals of the facility is to make the series of measurements that will allow a comprehensive model of atomic nuclei to be developed. Evaluation and interpretation of nuclear data will be one of the key steps in reaching this goal. Hence, research at FRIB will both require and generate large amounts of nuclear data. This makes a close connection to the US Nuclear Data Program essential. A connection could also be useful to identify the new measurements that should be made to fill in missing, important data for applied programs as well as basic research. The talk will provide an overview of these issues and the projected capabilities of FRIB.

3:00PM JG.00006 Considerations Concerning the Overall Unification, SHANTILAL GORADIA, Gravity Research Institute, Inc. — The direction of the century old search, based on non-probabilistic gravity, for the unification of forces blockades the search for consciousness at a fundamental level. Probabilistic gravity deriving strong coupling from a quantum mechanically modified inverse square law of gravity, and derivation of the fine structure constant’s 137 by a computational route throw light on the quantum source of consciousness as explained in the book by this author (Quantum Consciousness - The Road to Reality) containing more details. Spooky action is a natural consequence of non local probabilistic gravity. I will show how this constitutes a play on the shoulders of the giants.

3:12PM JG.00007 ABSTRACT WITHDRAWN —
9:54AM MA.00006 Nuclear Science with Thermal and Fast Neutrons at UMass Lowell
C.J. GUESS, P. CHOWDHURY, N. BORGES, N. D’OLYMPIA, A.Y. DEO, T. HARRINGTON, S. HOTA, E.G. JACKSON, G. KEGEL, S. LAKSHMI, G. PARKER, V.S. PRASHER, K. RECCA, T. REGAN, J. THOMAS, Q. YUAN, UMass Lowell — Increased interest in improving nuclear data for applied nuclear science has prompted new research activity at the UMass Lowell Radiation Laboratory. At the 5.5-MV CN Van de Graaff accelerator facility, the beamline for precision $(n,\gamma)$ and $(n,n')$ measurements with sub-nanosecond proton beam bunches is being refurbished. A proton microbeam facility is being installed for interdisciplinary studies of materials using applied nuclear techniques. In addition, the thermal column of the 1-MW research reactor will be fitted with a new shielded area for thermal $(n,\gamma)$ measurements. Neutron flux measurements, shielding calculations, and simulations are underway. Progress, status and research plans with these facilities will be discussed.

3This work is supported by the US Department of Energy.

10:06AM MA.00007 Putting it all together: Nuclear Data as input for Nuclear Astrophysics
RICHARD CYBURT, JINA — The Joint Institute for Nuclear Astrophysics (JINA) main goal is to open and maintain close ties within the nuclear astrophysics community. A recurring theme throughout nuclear astrophysics is the need for and use of the best available nuclear data as input for astrophysics calculations. I will discuss how one can use JINA Online Tools to augment their research and how that research can facilitate new efforts gathering data. I will discuss the JINA Virtual Journal, REACLIB reaction rate and NUCDATA LIB nuclide property databases.

Saturday, October 29, 2011 8:30AM - 10:18AM –
Session MB First Results from Heavy-Ions at LHC Auditorium

8:30AM MB.00001 Recent Heavy Ion results from the ATLAS detector at the LHC
PETER STEINBERG, Brookhaven National Laboratory — A broad program of measurements using heavy ion collisions is underway in ATLAS, with the aim of studying the properties of QCD matter at high temperatures and densities. This talk describes measurements performed using up to 9 μb-1 of lead-lead collision data provided at a nucleon-nucleon center-of-mass energy of 2.76 GeV by the Large Hadron Collider and collected by the ATLAS Detector during November and December 2010. We will be presenting results on inclusive charged particle multiplicities and elliptic flow to study the global features of the collisions as a function of centrality, pseudorapidity and transverse energy. Higher order Fourier coefficients will also be shown to assess the importance of more complicated event-wise geometric fluctuations. The study of the microscopic properties of the system will be addressed with high pT probes. Muon measurements provide access to W and Z bosons which are potentially sensitive to modifications of the nuclear PDFs, as well as heavy flavor. Charged particle spectra, particularly at high pT, are sensitive to the overall suppression of jets and their modified fragmentation. Finally, jet rates, asymmetries and fragmentation properties offer a more direct look at the physics of jet quenching than has been available at previous facilities.

9:06AM MB.00002 ALICE results from the first Pb-Pb run at the LHC
CONSTANTIN LOIZIDES, Lawrence Berkeley National Laboratory — ALICE (A Large Ion Collider Experiment) is a general-purpose detector specifically designed to measure the properties of strongly-interacting matter created in nucleus-nucleus collisions at the LHC. Results from the first LHC Pb-Pb run at center-of-mass energy of 2.76 TeV per nucleon pair will be presented, and discussed in the context of pp collisions at the same center-of-mass energy and of nucleus-nucleus collisions at lower energies.

3On behalf of the ALICE collaboration.

9:42AM MB.00003 Overview of Pb+Pb results from CMS
GUNTHER ROLAND, Massachusetts Institute of Technology — We will present an overview of CMS results on Pb+Pb collisions and p+p reference data at $\sqrt{s} = 2.76$ TeV. In addition to results on quarkonium suppression, the talk will in particular focus on long-range azimuthal correlations observed in p+p and Pb+Pb collisions and their connection to hydrodynamic flow and on measurements related to parton propagation in the QCD medium. For the latter topic, measurements of charged hadron and photon momentum distributions, as well as detailed studies of dijet final states will be discussed.

Saturday, October 29, 2011 8:30AM - 10:06AM –
Session MC Neutrinos II

8:30AM MC.00001 Radon Monitoring and Emanation Studies at the Sanford Underground Laboratory at Homestake
KEENAN THOMAS, The University of South Dakota, DONGMING MEI, USD, JARET HEISE, Sanford Lab, DAN DURBEN, BHSU, HOMESTAKE BACKGROUND CHAR. TEAM — In anticipation of low-background nuclear and particle astrophysics experiments to be situated underground at the Sanford Underground Laboratory at Homestake our group has been researching factors relevant to radon underground at the Homestake Mine in Lead, SD. Continuous airborne monitoring of radon concentrations have been performed along the primary ventilation routes underground. Such measurements are useful for understanding the behavior of radon underground with respect to various ventilation conditions and will be of use in the design of experiments and underground laboratory infrastructure. In addition, iron oxide has been found to enhance the emanation of radon due to the co-precipitation of radium in the oxide layer. After decommissioning in 2003, the lower levels of the mine were allowed to fill with water, which prompted the formation of iron oxide upon submerged rock surfaces. A series of measurements including radon emanation tests have been performed upon rock and iron oxide samples to demonstrate this effect upon the airborne radon underground at Homestake.

1Supported by NSF PHY-0758120 and 0919278.

8:42AM MC.00002 Cross-section measurements for neutron activation of long-lived radioisotopes in TeO₂
B.S. WANG, E.B. NORMAN, Univ. of California at Berkeley, N.D. SCIELZIO, Lawrence Livermore National Lab., S.A. WENDER, M. DEVLIN, Los Alamos National Lab., A.R. SMITH, Lawrence Berkeley National Lab. — CUORE (Cryogenic Underground Observatory for Rare Events) is an experiment that will search for neutrinoless double-beta $(0\nu\beta\beta)$ decay. In CUORE, an array of 988 high-resolution, low-background TeO₂ bolometers will be operated at a temperature of 10 mK and will serve as both the source and the detector of $0\nu\beta\beta$ decay. All sources of background that can obscure the $0\nu\beta\beta$ decay signature must be characterized and well-understood. One of these sources is activation by cosmic ray neutrons. This process can produce long-lived radioisotopes in the TeO₂ bolometers. A reliable estimation of this background is essential but difficult to obtain because of the lack of cross-section data. Therefore, cross-section measurements have been carried out at LANSE (Los Alamos Neutron Science Center). In these measurements, TeO₂ crystals have been exposed to a spectrum of neutrons mimicking the cosmic ray neutron spectrum. The cross-sections, which have been extracted using gamma-ray counting, will be used to obtain an estimate of the cosmogenic activation background that will be present in CUORE.

3This work was supported in part by grants from the U. S. Depts. of Energy and Homeland Security.
9:06AM MC.00004 Surface Performance of a Big Liquid Scintillation Detector for Measuring Neutrons\textsuperscript{1}. DONGMING MEI, CHAO ZHANG, University of South Dakota, FRED GRAY. Regis University — Characterizing neutron background is extremely important to the success of rare event physics research such as neutrinoless double beta decay and dark matter search. We developed a neutron detector that is built with an aluminum tube filled with 12 liter liquid scintillators. The detector is about one meter in length and five inches in diameter. The inner surface of the detector is painted with specular reflector and there are two 5" PMTs (Hamamatsu H4144) attached at both ends. The detector is well calibrated with cosmic muons and radioactive sources. Good neutron/gamma discrimination is found from few MeV to 20MeVs. We report the measured result for room neutrons at the surface.

\textsuperscript{1}This project is supported by NSF PHY-0758120 and 0919278.

9:18AM MC.00005 Simulation of Cosmogenic Background for Davis Cavern at Homestake Mine\textsuperscript{1}. CHAO ZHANG, DONGMING MEI, University of South Dakota — Davis Cavern at Homestake Mine is selected as the site for LUX and Majorana experiments. The local cosmogenic background will directly affect their target sensitivity. Detailed mountain profile and averaged rock composition are considered for muon attenuation from surface to the Davis Cavern. The muon energy spectrum is then used in a full Monte Carlo simulation to understand the cosmic ray muon induced background in the Cavern. We will present the simulated results in detail.

\textsuperscript{1}This project is supported by NSF PHY-0758120 and 0919278.

9:30AM MC.00006 LENS Prototyping Status Report\textsuperscript{1}. S. DEREK ROUNTREE, Virginia Tech, LENS COLLABORATION — The LENS collaboration’s goal is the construction of a low energy neutrino spectrometer (LENS) that will measure the entire solar neutrino spectrum above 114keV. In an effort to reach this goal we have developed a two phase prototype program. The first of these is microLENS, a small prototype to study the light transmission in the as built LENS scintillation lattice—a novel detector method of high segmentation in a large liquid scintillator detector. The microLENS prototype is currently being finished and deployed at the Kimballton Underground Research Facility (KURF) near Virginia Tech. This prototype will be the main topic of this talk. I will discuss the methods and schemes of the program during the first phases of running with minimal channels instrumented (~41 compared to full coverage 216). After construction of the microLENS detector we will finalize designs for the miniLENS prototype and have the miniLENS prototype running shortly thereafter.

\textsuperscript{1}This work is supported by the National Science Foundation and Department of Energy.

9:42AM MC.00007 KATRIN: Measuring the Mass Scale of Neutrinos. NOAH OBLATH, MIT, KATRIN COLLABORATION — Over the past decade, experiments studying neutrinos from atmospheric, solar, and reactor sources have shown conclusively that neutrinos change flavor and, as a consequence, have a small but finite mass. However, the scale of neutrino masses remains an open question that is of great importance for many areas of physics. The most direct method to measure the neutrino mass scale is still via beta decay. The talk will focus primarily on the status of the KArlsruhe TRItium Neutrino experiment (KATRIN), currently under construction. KATRIN combines an ultra-luminous molecular windowless gaseous tritium source with a high-resolution integrating spectrometer to gain sensitivity to the absolute mass scale of neutrinos. The projected sensitivity of the experiment on the neutrino mass is 0.2 eV at 90\% C.L. In this talk I will discuss the status of the KATRIN experiment.

9:54AM MC.00008 Project 8: Toward a radio frequency based measurement of Neutrino Mass. JARED KOFRON, University of Washington, PROJECT 8 COLLABORATION — Efforts to measure the electron neutrino mass require measuring a distortion in the beta decay spectrum produced by the kinematics of the 3 body decay. The Project 8 experiment employs a novel approach to electron energy measurement using radio frequency techniques which promises a unique combination of scalability, superb resolution, and low background. A beta decay electron trapped in a strong magnetic field will emit cyclotron radiation (27 Ghz at B=1T), where the frequency of that cyclotron radiation depends on the total energy of the electron due to relativistic effects. Therefore, observing the emitted radiation provides a non-destructive method for measuring the total electron energy and therefore determining the neutrino mass. A prototype experiment is under construction, and current status and results will be presented. The results of the prototype construction are expected to be of value in estimating the ultimate sensitivity of such a measurement technique.

Saturday, October 29, 2011 8:30AM - 10:18AM — Session MD Nuclear Theory III: Ab Initio and Density Functionals

8:30AM MD.00001 Ab initio studies of light nuclei\textsuperscript{1}. CHRISTIAN FORSSÉN, Chalmers University of Technology — The ab initio no-core shell model (NCSM) is a well-established theoretical framework aimed at an exact description of nuclear structure starting from high-precision interactions between the nucleons. We consider realistic two- and three-nucleon interactions and will also discuss techniques based on unitary transformations that provide many-body Hamiltonians with superior convergence properties. The performance of the NCSM within nuclear physics will be exemplified by showing results from studies of light nuclei.

\textsuperscript{1}This work was supported by the Swedish Research Council and the European Research Council under the FP7.

8:42AM MD.00002 Ab Initio No Core Full Configuration Calculations for Lithium Isotopes. ROBERT COCKRELL, Iowa State University — Ab Initio No Core Full Configuration methods are employed to obtain nuclear densities for several light nuclei with a realistic NN interaction, JISP16. We calculate binding energies for various states of interest as well as dipole and quadrupole moments and select M1 and E2 transitions. The One Body Density Matrix is used to determine the densities and shapes of the ground state and various excited states of these Lithium isotopes. We discuss the opportunities to use these densities to construct Nuclear Energy Density Functionals.
8:54AM MD.00003 Importance truncation and the further development of the No-Core Shell Model1, MICHAEL KRUSE, University of Arizona, PETR NAVRATIL, TRIUMF, BRUCE BARRETT, University of Arizona — The No-Core Shell Model, an ab-initio approach to calculating observables of light nuclei, has been shown to be successful in describing p-shell nuclei properties. With the inclusion of the resonating group method, the approach can be extended to describe nuclear reactions. However, the calculations require a large number of basis states for full convergence. By using perturbation theory, one can formulate a procedure, for selecting only those states that one considers “important.” This selection procedure is able to drastically reduce the size of the basis, yet captures enough of the physics present, comparing well with full space calculations. I will show calculations in which we calculate the wave functions of Helium-8 (in an importance truncation setting), which are used as input for the n+He-8 scattering calculations. Those theoretical calculations are then compared to recent experiments.

1M.K and B.B supported in part by NSF grant number PHY0854912.

9:06AM MD.00004 Ab initio calculation of the optical model1, HELBER DUSSAN, SETH WALDECKER, WILLEM DICKHOFF, HERBERT MÜTHER, ARTUR POLLS — We explore the effects of short-range correlations in nuclei for positive and negative energies starting from a microscopically generated irreducible self-energy. This approach is an attempt to develop an optical potential obtained from a realistic nucleon-nucleon interaction. In this first study we use a CD Bonn self-energy obtained for 40Ca. Our results are compared with the ones found using the dispersive optical model (DOM) and with experimental data available for 40Ca. Finally we outline further necessary developments to obtain a purely ab initio optical potential that can reproduce experimental data.

9:18AM MD.00005 Ab Initio Configuration-Interaction Calculations in SU(3)-scheme Basis1, TOMAS DYTRYCH, Louisiana State University — The predictive power of ab initio no-core shell model (NCSM) depends critically on the choice of a realistic nuclear interaction, and on the adequacy of basis to describe a system of strongly interacting nucleons. To include many-body correlations important for the description of nuclear collective dynamics and geometry, we embedded the SU(3) coupling scheme of the Elliot SU(3) model into the NCSM framework. The SU(3)-scheme basis provides a microscopic description of nuclei in terms of mixed shape configurations, and offers a symmetry-guided framework for winnowing a model space while retaining the ability to remove center-of-mass spurious excitations exactly. The resulting SU(3) no-core shell model (SU3-NCSM) harnesses powerful computational techniques of the group theory while taking the advantage of massively parallel computing systems. The foundation principles of SU(3)-NCSM will be discussed and the results for some p-shell nuclei will be presented.

1Supported by the U.S. National Science Foundation (PHY-0500291 and OCI-0904874), the U.S. Department of Energy (DE-SC0005248), and the Southeastern Universities Research Association.

9:30AM MD.00006 Properties of trapped neutrons interacting with realistic nuclear Hamiltonians1, PIETER MARIS, JAMES VARY, Iowa State University — Neutron drops can provide useful microscopic input to a universal nuclear energy density functional. We have computed the ground state energy of neutrons trapped in harmonic wells of different strengths and compare results from different Hamiltonians, including realistic two-body interactions as well as different three-body forces. In addition to the total energy of the system, we also compute the internal energies and radii. Excitation energies for different spin states provides information about spin-orbit splittings. These results can be used as a benchmark for different many-body techniques, test different nuclear interactions far from stability, and to constrain properties of nuclear energy-density functionals.

1This work was supported, in part, by US DOE Grants DE-FG02-87ER40371, and DE-FG02-09ER41582 (SciDAC UNEDF Collaboration).

9:42AM MD.00007 Fission Barriers of Actinide Nuclei with New Nuclear Density Functionals, JORDAN MCDONNELL, MARKUS KORTELAINEN, WITOLD NAZAREWICZ, J.A. SHEIKH, MARIO STOITSOV, University of Tennessee, Knoxville, NICOLAS SCHUNCK, Lawrence Livermore National Laboratory — We survey the fission of isotopes of Ra, Th, U, and Pu through nuclear density functional theory. We compare the fission barriers predicted by new universal nuclear energy density functionals (UNEDF) to the predictions of previous Skyrme functionals within such an approach.

9:54AM MD.00008 Widths of nuclear states from ab initio calculations1, KENNETH NOLLETT, Physics Division, Argonne National Laboratory — Ab initio calculations of nuclear structure from the bare nucleon-nucleon interaction describe the energy spectra of light nuclei quite accurately, but the usual pseudobound calculations do not yield widths when those levels are unbound. Computing widths from scattering wave functions is difficult and computationally expensive, but one can also compute widths directly from the pseudobound calculations using an integral relation. The integral is short-ranged and thus well-suited to quantum Monte Carlo methods. I will show calculations in which we calculate the wave functions of Helium-8 (in an importance truncation setting), which are used as input for the n+He-8 scattering calculations. Those theoretical calculations are then compared to recent experiments.

1Supported by U.S. Department of Energy, Office of Nuclear Physics, under contract No. DE-AC02-06CH11357.

10:06AM MD.00009 Ab initio DFT for nuclear physics, LUCAS PLATTER, Chalmers University of Technology — The description of heavy nuclei using a microscopic Hamiltonian that describes the nucleon-nucleon interaction is one of the ultimate challenges in nuclear theory. I will discuss recent progress towards this goal made with ab initio density functional theory (ADFT). ADFT aims at obtaining a density functional from many-body perturbation theory and using modern methods borrowed form chemical physics to solve for ground state observables of large nuclei. In particular, I will highlight the density matrix expansion [1] and the optimized effective potential [2] method as tools to deal with non-local functionals that appear naturally within such an approach.


Saturday, October 29, 2011 8:30AM - 10:06AM – Session ME Nuclear Reactions/Rare Isotope Beams III 103AB
8:30AM ME.00001 Interaction and reaction cross sections calculations in the Glauber theory framework, IVAN NOVIKOV, Western Kentucky University, YULI SHABELSKI, Petersburg Nuclear Physics Institute — The parameters of nuclear densities can be extracted from the comparison between experimentally measured interaction cross sections and reaction or interaction cross sections calculated in optical approximation or using exact expressions of the Glauber theory. The difference between reaction and interaction cross sections between stable isotopes with atomic weight \( A < 40 \) was calculated in various approximations as well as using exact expressions. In addition, the cross sections of the processes with excitation or disintegration of one or both nuclei were calculated in the same approximations. Lastly, we will discuss the accuracy of the obtained results.

8:42AM ME.00002 Exploration of the possible new island of inversion with the production of neutron rich nuclei, T. BAUMANN, O.B. TARASOV, A.M. AMTHOR, L. BANDURA, D. BAZIN, J.S. BERRYMAN, A. GADE, T.N. GINTER, M. HAUSMANN, D.J. MORRISSEY, A. NETTL ETION, J. PEREIRA, M. PORTILLO, B.M. SHERRILL, A. STOLZ, C. SUMITHRACHARCHI, M. THOENENNES, D. WEISSHAAR, NSCL/MSU, N. FUKUDA, N. INABE, T. KUBO, RIKEN, Japan, G. CHUBARIAN, TA&MU — Recent experiments at the NSCL have demonstrated that fragmentation coupled with two-stage separation technique can be used to explore the properties of very neutron-rich nuclei. Production cross sections for a large number of neutron-rich nuclei produced from the fragmentation of a 76Ge beam at 132 MeV/u with beryllium and tungsten targets were measured, including 15 new isotopes of the elements 17 ≤ Z ≤ 25. The higher cross sections of several new nuclei relative to a simple thermal evaporation framework, previously shown to describe similar production cross sections, indicate that nuclei in the region around 62Ti might be more stable than predicted by current mass models. This could indicate the existence of a new island of inversion. This year, a newly-developed primary beam of 82Se at 140 MeV/u has been used to extend these measurements of production cross sections to even more neutron-rich isotopes for elements from calcium to cobalt.

8:54AM ME.00003 Evolution of fragmentation momentum distributions with mass, K. MEIERBACHTOL, D.J. MORRISSEY, M. MOSBY, D. BAZIN, NSCL/MSU — Parallel momentum distributions of fragmentation products as a function of fragment mass have been used extensively to understand the fragmentation mechanism. Mass dependencies of the perpendicular momentum distributions, however, are much less well-understood. Complete momentum distributions of projectile-like fragments produced in \(^{76}\text{Ge} + ^{19}\text{Be}\) and \(^{76}\text{Ge} + ^{197}\text{Au}\) reactions have been measured using a 130 MeV/nucleon beam. Parallel distributions of all fragments follow established mass systematics, regardless of target species. However, the perpendicular distributions of fragments produced with the \(^{197}\text{Au}\) target that are near the projectile mass contain a clear peak near the grazing momentum that diminishes in significance as fragment mass decreases, a deviation from predictions. In addition, proton-pickup fragments were also observed to peak away from zero degrees. The results of this peak and its systematic variation will be discussed in the context of fragmentation reaction mechanisms.

9:06AM ME.00004 Measurement of Excitation Energy of Neon Prefragments, M. MOSBY, D.J. MORRISSEY, M. THOENENNES, NSCL/MSU, MONA COLLABORATION — Projectile fragmentation forms the basis for beam production at radioactive beam facilities such as the National Superconducting Cyclotron Laboratory (NSCL), yet uncertainties remain about the specifics of the production mechanism. For example, very little is known about the excitation energy of the precursors of the observed final fragments. In the present work, neon isotopes produced in the fragmentation of a \(^{32}\text{Mg}\) beam at 86 MeV/nucleon on a Beryllium target, ranging in mass loss from \(\Delta A = 3-10\), were observed and the coincident neutrons were detected using the Modular Neutron Array (MoNA). A strong correlation between the neutron multiplicities and fragmentation mass loss was observed, and the variation compares well to that from a statistical evaporation model.

9:18AM ME.00005 A feasibility study on the production of \(^{235}\text{U}\) by nuclear excitation by electronic transition, PERRY CHODASH, ERIC NORMAN, ERIK SWANBERG, UC Berkeley, JASON BURKE, MAU CHEN, MARK FOORD, LLNL — Nuclear excitation by electronic transition (NEET) is predicted to occur in nuclei where a nuclear transition closely matches the energy and multipolarity of an electronic transition. NEET is considered to be the inverse of bound internal conversion. This rare form of excitation is predicted to occur in many nuclei. In \(^{235}\text{U}\), the \(1/2^+\) isomeric state decays to the \(7/2^-\) ground state with a transition energy of 77 eV and a half life of 26 minutes. This decay proceeds by internal conversion emitting a low energy electron. In order for NEET to occur in uranium, it must be partially ionized to create an electronic configuration that has a transition that matches the nuclear transition. Numerous experiments have been performed to search for this excitation mechanism in \(^{235}\text{U}\) by creating a plasma using either a laser or an electron beam. The difficulty in finding this excitation is due to the low excitation rates, \(10^{-7} - 10^{-9}\) s\(^{-1}\), as well as the ability to detect the low energy internal conversion electrons. The results of previous experiments as well as the current experimental plan will be discussed.

9:30AM ME.00006 Search for the inverse fission of uranium, W. LOVELAND, R. YANEZ, J. BECKERMAN, M. LEONARD, G. PETTERSSON, Oregon State University, C.J. GROSS, D. SHAPIRA, J.F. LIANG, Z. KOHLEY, R.L. VARNER, Oak Ridge National Laboratory — A search for the “inverse fission” of uranium has been made. Two “inverse fission” reactions were studied, the reaction of \(^{132}\text{Sn} + ^{150}\text{Mo}\) and the reaction of \(^{132}\text{Sn} + ^{150}\text{Mo}\). In the former case, evaporation residues were searched for using (a) in-beam \(\alpha\)-spectroscopy, (b) post-irradiation \(\alpha\)-spectroscopy and (c) in-beam detection of recoiling evaporation residues while in the latter case, the evaporation residue, \(^{230}\text{U}\) was searched for using post irradiation radio-analytical techniques. Data acquisition and analysis is on-going with expected upper limits or production cross sections of \(< 1\) microbarn. The implications of these results for determining the fusion probability, \(P_{\text{CN}}\), in the collisions of massive nuclei are discussed.

9:42AM ME.00007 The ratio technique: a new way to study exotic nuclei, PIERRE CAPEL, Helmholtz-Institut Mainz, RON JOHNSON, University of Surrey, FILOMENA NUNES, Michigan State University — The study of exotic nuclear structures, like halo nuclei, is usually performed through indirect techniques, such as reactions. Unfortunately, the complexity of the reaction mechanism renders the analysis of measurements more difficult than initially thought. Here, we present a new way to extract information about the structure of halo nuclei through reactions. The basic idea of this new technique is to perform the ratio of angular distributions for breakup and scattering. The recoil excitation and breakup (REB) model predicts this observable to be independent of the projectile-target interaction, and hence to reveal detailed information on the structure of these nuclei. We have checked the validity of this approach within the dynamical eikonal approximation. Our calculations show this ratio to be fairly independent of the reaction mechanism and thus to provide a unique way to measure halo wave functions.

1This work was performed under the auspices of the U.S. DOE under contract No. DE-AC52-07NA27344 and is supported in part by the NNIS Graduate Fellowship from the U.S. DOE.

2This work was supported in part by the USDOE Office of Nuclear Physics under Grant DE-FG06-97ER41026 and Contract No. DE-AC02-06CH11357.
9:54AM ME.00008 Investigation of the Affect of a Coulomb Force on Velocity Distributions in Multifragmentation, L. HEILBORN, G. SOULIOTIS, S. SOISSON, P. CAMMARATA, P. MARINI, L.W. MAY, A. MCINTOSH, A. RAPHELT, B. STEIN, S. YENNELLO, Texas A&M University — The relationship between the N/Z of the fragmenting source and the nature of its subsequent fragmentation was studied in the reaction of $^{125}$S with $^{112}$Sn at 45 MeV/nucleon. Isotopically resolved Light Charged Particles (LCPs) Intermediate Mass Fragments (IMFs) were measured with the FAUST Array. The velocity distribution of $^7$Li was observed to be asymmetric and backward peaked in the frame of the moving quasiprojectile (QP). We observed a clear peak in the peak of the velocity distributions of the emitted towards the quasitarget (QT) as the particles of a given Z become more neutron-rich. In order to investigate the velocity distributions of the emitted fragments, a theoretical simulation consisting of Deep Inelastic Transfer followed by Statistical Multifragmentation for the system was run for different distances between the QP and the QT at the time of breakup. The proximity of the QP to the QT at the time of breakup in SM does affect the distribution of fragments in the QP frame. However, the effect is diminished when an experimental filter is applied.

Saturday, October 29, 2011 8:30AM - 10:18AM – Session MF Nuclear Structure VII 104AB

8:30AM MF.00001 The $g$ factor of the $2^+_1$ state in $^{126}$Sn, G.J. KUMBARTZKI, N. BENZCER-KOLLER, D.A. TORRES, Rutgers University, G. GÜRDAL, Argonne National Lab., C.J. GROSS, A. GALINDO-URIBARRI, Oak Ridge National Lab., C. BINGHAM, N. STONE, University of Tennessee, A.E. STUCHBERRY, Australian National University, K.-H. SPEIDEL, University Bonn — In the quest to develop the necessary tools and gather experience in using the transient field technique to measure $g$ factors of low-lying short-lived nuclear states in radioactive beam experiments, the $^{126}$Sn ($t_{1/2} = 2.3 \times 10^5$ years) will be measured at the HRIBF, ORNL. Each radioactive beam experiment presents its own set of problems and challenges due to the radioactive background from the beam and beam contaminants and their life times, and the low beam intensity. This experiment is a test with a very long lived, nearly stable beam. The target is designed to stop the reaction products in the backing of the target but to allow the bulk of the beam to pass through and stop in a foil placed between the target and the particle detector. This foil can be changed in the course of the experiment, should it become too radioactive. The experiment is scheduled to run in July 2011. Success or failure will provide a wealth of information on working in different radioactive environments and will extend the spectroscopic information on $g$ factors of $2^+_1$ states in Sn isotopes. The transient field measurement will provide the sign of the $g$ factor.

8:42AM MF.00002 Measuring $g$ factors of $4^+_1$ and $6^+_1$ states in even-even nuclei with $80<A<100$, D. RADECK, T. AHN, V. WERNER, Yale University, S.J.Q. ROBINSON, Millisaps College — The measurement of $g$ factors of the low lying excited states in even-even nuclei with lifetimes of the order of 1 to 50 picoseconds presents challenging questions for both theory and experiment. The experimental determination of accurate $g$ factor values uses the transient field technique in inverse kinematics and requires an understanding of the reaction mechanism used to populate the final states. So far, the main method of excitation has been Coulomb excitation. More recently, alpha transfer from a $^{12}$C target to selected beams made it possible to populate states in nuclei not available as stable beams. This method has been successful for lighter nuclei up to $^{A-70}[1]$. A comparison between Coulomb excitation and alpha transfer reactions will be presented. The experiments used the Tandem at the Wright Nuclear Structure Laboratory at Yale University. Preliminary results for the $^{100}$Pd, $^{96}$Ru and $^{86}$Sr nuclei will be presented. Experimental challenges for future experiments will be discussed.

1Supported in part by the DOE and the NSF.

8:54AM MF.00003 Lifetime and relative $g$ factor measurements in $^{104,106,108}$Pd isotopes, G. ILIE, V. WERNER, D. RADECK, T. AHN, C.W. BEALISANG, L. BETTERMANN, R.J. CASPERSON, R. CHEVRIER, N. COOPER, T.C. BONNIWELL, A. HEINZ, E. HOLLAND, D. MCCARTHY, B. PAUERSTEIN, M.K. SMITH, J.R. TERRY, E. WILLIAMS — The purpose of this research was the proof-of-principle for the new $g$-plunger technique to measure the deoriantation and the lifetime of a state after an inverse kinematics reaction. The deorientation effect is due to the hyperfine interaction between the nuclear spin and the surrounding electron configurations. The attenuation of $\gamma$-ray angular distributions has been measured for the $2^+_1$, $4^+_1$ and $4^+_2$ states of $^{104}$Pd, $^{106}$Pd and $^{108}$Pd. The beams with energies of 324 MeV, 330 MeV and 336 MeV, respectively, were Coulomb excited into their $2^+_1$ state on a $^{24}$Mg target. Forward scattered Mg was detected after passing a Cu foil, which served as a stopper for the beam. We measured the time-dependence of the attenuation as a function of distance, in parallel to measuring the lifetimes of the $2^+_1$ and $4^+_1$ states. This attenuation is used to measure the g factor of the decaying states relative to each other. In this work, hyperfine parameters have been calibrated for the Pd isotopes. The results of this work and a discussion of the parameterization used to fit the data in this work will be presented. Research was supported by the U.S. Department of Energy under Grant No. DE-FG02-01ER40609.

9:06AM MF.00004 Connecting the Super-Heavy Island to the Nuclear Mainland1, K. RYKACZEWSKI, K. MIERNIK, ORNL, R. GRZYWACZ, UTK and ORNL, D. MILLER, UTK — The reactions between radioactive actinide targets and doubly-magic $^{48}$Ca beam led the identification of 6 new super-heavy elements (SHE) and 48 nuclei. Since the observed decay chains are ended by a fission process, these super-heavy nuclei are forming an isolated island in the nuclear chart. The HRIBF development of new detector system and digital data acquisition sensitive to very short-lived $\alpha$-emitters made possible to attempt the studies extending the SHE island. The experiments aiming in new nuclei produced in the reactions with $^{148}$Cm and $^{239,240}$Pu targets and $^{40,44,48}$Ca projectiles and connecting the SHE island to the known nuclear mainland will be discussed.

1Research sponsored by the Office of Nuclear Physics, U.S. Department of Energy.

9:18AM MF.00005 Internal conversion electron study of excited states in $^{76}$As, F.M. PRADOS-ESTÉVEZ, S.W. YATES, Dept. of Physics & Astronomy and Chemistry, University of Kentucky, USA, B.P. CRIDER, Dept. of Physics and Astronomy, University of Kentucky, USA, E.E. PETERS, Dept. Chemistry, University of Kentucky, USA, T. KIBEDI, G.D. DRACOULIS, R.F. LESLIE, A.E. STUCHBERRY, Dept. of Nucl. Physics, Australian National University (ANU), Australia, N.M. COOPER, V. WERNER, T. WILLIAMS, Wright Nucl. Structure Lab., Yale University, USA, A.P. TONCHEV, Dept. of Physics (TUNL), Duke University, USA — Experiments on $^{76}$Ge and $^{76}$Se are revealing new information about double beta decay and giving better insight into whether or not the neutrino is Majorana particle. New data on intermediate mass $^{76}$As, which is virtually populated by double beta decay modes ($2\beta/3\beta$, $0\beta/3\beta$), should lead to important constraints on the theoretical models that allow the determination of the neutrino mass. We carried out the $^{76}$Ge($p,e^-$)$^{76}$As reaction at 6.0 MeV at the ANU. Internal conversion coefficients have been obtained, giving better insight into the level structure of $^{76}$As. First results of the ongoing data analysis will be presented.

1This Work is supported by the U.S. NSF under Grant No. PHY-0956310.
9:30AM MF.00006 Proof-of-principle measurement of beta-delayed neutron precursor 89Br using VANDLE\textsuperscript{1}, STANLEY PAULUSKAS, R. GRZYWACZ, M. MADURGA, S. PADGETT, The University of Tennessee at Knoxville, VANDLE COLLABORATION — The Versatile Array of Neutron Detectors at Low Energy (VANDLE) uses the time of flight technique to measure the energy of neutrons from various nuclear processes. Beta delayed neutrons from fission fragments typically have an energy below 1 MeV, making measurements of their energy challenging. This has led to the use of a reliable off-the-shelf digital electronics system to instrument VANDLE. However, the timing resolution and neutron energy threshold of the system required investigation. Timing resolutions better than 1 ns have been obtained. The digital system can be operated with low thresholds to obtain high detection efficiency for low energy neutrons ($E \geq 150$ keV). A proof-of-principle experiment using 89Br was conducted at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory (ORNL). 89Br is produced in proton induced fission of 235U and was chosen because its neutron energy spectrum has been measured by G. Ewan et. al. (Z. Phys. A. 318, 309-314, 1984).

\textsuperscript{1}This research was sponsored by the National Nuclear Security Administration under the Stewardship Science Academic Alliance program through DOE Cooperative Agreement No. DE-FG02-08NA28552.

9:42AM MF.00007 Partitioning the double $\beta$ decay of $^{116}$Cd: Electron-capture on $^{116}$In\textsuperscript{1}, C. WREDE, CENPA, U. Washington, NSCL, Michigan State University, U. AHMAD, Argonne Nat. Lab., A. ALGORA, IFIC, CSIC-Univ. Valencia, V.-V. ELOMAA, T. ERONEN, U. Jyväskylä, A. GARCÍA, CENPA, U. Washington, J. HAKALA, V.S. KOLHINEN, I.D. MOORE, H. PENTTILÄ, M. REPONEN, J. RISSANEN, A. SAASTAMOINEN, U. Jyväskylä, S. SJUE, TRIUMF, H.E. SWANSON, CENPA, U. Washington, J. ÄYSTÖ, U. Jyväskylä — $^{116}$Cd undergoes double $\beta$ decay to $^{116}$Sn. This rare process may be described by virtual transitions through states in the intermediate nucleus $^{116}$In and there could be a major contribution from the $^{116}$In ground state. It is, therefore, valuable to determine the matrix elements for the decays of $^{116}$In to $^{116}$Cd and $^{116}$Sn in order to provide benchmarks for nuclear models that may be used to describe double $\beta$ decay matrix elements. We have experimentally constrained the small decay branch for electron capture on the ground state of $^{116}$In. Samples of $^{116}$In were produced using the IGISOL facility at the University of Jyväskylä, isobarically purified using the JYFLTRAP double- Penning trap, and delivered to a counting station consisting of a high-purity Ge x-ray detector and a 4π scintillator to discriminate $\beta$-decay events. Our result sheds light on discrepancies between past values for the Gamow-Teller strength obtained via electron capture and charge-exchange, providing a more consistent benchmark in the $A=116$ system for nuclear models of double $\beta$ decay.

\textsuperscript{1}This work is supported in part by the U. S. Department of Energy under grant Nos. DE-FG02-97ER41020 and DE-AC02-06CH11357.

9:54AM MF.00008 $^{69}$Kr $\beta$-delayed proton emission\textsuperscript{1}, A.M. ROGERS, C.J. LISTER, J.A. CLARK, S.M. FISCHER, S. GROS, E.A. MCCUTCHEAN, G. SAVARD, D. SEVERYNIAK, ANL, J. GIOVINAZZO, B. BLANK, G. CANCEL, CENBG/CNRS/IN2P3, G. DE FRANCE, S. GREVY, F. DE OLIVEIRA, I. STEFAN, J.-C. THOMAS, GANIL — Proton-rich nuclei beyond the $N=Z$ line play a key role in our understanding of astrophysics, weak-interaction physics, and nuclear structure tests. In particular, the decay of $^{69}$Kr populates states in the proton-unbound nucleus $^{69}$Br. While recent measurements of $^{65}$As and $^{69}$Br have constrained key $rp$-process waiting points, spectroscopic and structural information remains elusive. An experiment was conducted at GANIL which utilized implant-$\beta$-p and $\beta$-y correlations to study physics related to the $\beta$ decays of $^{69,70}$Kr. Isotopes were implanted into a Si-DSSD, also used to detect decay protons, located at the end of the USE spectrometer. Coincident $\gamma$-rays were measured in surrounding HpGe EXOGAM clovers. We identified 212 $^{69}$Kr implantation-decay events and observed a dominant superallowed $\beta$-decay branch ($T_{1/2}=27(3)$ ms) to the isobaric analog state which decays via $2.97(5)$ MeV protons to the first excited state in $^{68}$Se. This decay path strongly constrains the spin and mass of $^{69}$Kr.

\textsuperscript{1}This work is supported by the U.S. DOE Office of Nuclear Physics, Contract No. DE-AC02-06CH11357.

10:06AM MF.00009 Beta-decay of $^{122}$Ag and structure of $^{122}$Cd\textsuperscript{1}, A.V. RAMAYYA, Vanderbilt Univ., Y.X. LUO, Vanderbilt Univ./LEBLN, N.T. BREWER, Vanderbilt Univ., J.C. BATECHLER, UNRIB/ORIAU, J.H. HAMILTON, Vanderbilt Univ., J.C. GROSS, ORNL, K.P. RYKACZEWSKI, ORNL/Warsaw Univ., R. GRZYWACZ, M. MADURGA, D. MILLER, Univ. Tennessee, D. STRACENER, C. JOST, ORNL, E. ZGANJAR, Louisiana State Univ., J.A. WINGER, Mississippi State Univ., M. KARNY, ORNL/ORIAU/Warsaw Univ., S.V. PAULUSKAS, Univ. Tennessee, S.H. LIU, ORNL, M. WOLINSKA-CICHOCKA, ORNL/ORIAU, S. PADGETT, Univ. Tennessee, T. MENDEZ, K. MIERNIK, ORNL, A. KUZNIK, Univ. Tennessee/Warsaw Univ. — The structures of even-even Cd nuclei are considered to be an important testing ground for vibrational states coupled to intruder states with rotational degrees of freedom. In addition, there may be up to 3 isomeric states in $^{122}$Ag. Two of them are very similar in their adopted values for lifetime. We produced a $^{122}$Ag nucleus via proton induced fission of $^{237}$U. Subsequent decay of $^{122}$Ag to $^{122}$Cd is investigated at the Low-energy RIB Spectroscopy Station (LERIBSS) at the HRIBF. Many new levels and new gamma transitions in $^{122}$Cd were observed. The parent half-life was also observed. The structure of this isotope will be discussed.

\textsuperscript{1}This work is supported by the U.S. DOE Office of Nuclear Physics, Contract No. DE-AC02-06CH11357.

Saturday, October 29, 2011 8:30AM – 9:30AM Session MG: Astrophysics VI: EoS and Neutron Stars 105AB

8:30AM MG.00001 Quark matter in neutron stars and core-collapse supernovae\textsuperscript{1}, IRINA SAGERT, Department of Physics and Astronomy, Michigan State University. TOBIAS FISCHER, MATTHIAS HEMPEL, GIUSEPPE PAGLIARA, JUERGEN SCHAFFNER-BIELICH, THOMAS RAUSCHER, FRIEDRICH-K. THIELEMANN, ROGER KAEPPELI, GABRIEL MARTINEZ-PINEDO, MATTHIAS LIEBENDOERFER — Recent neutron star mass measurements point to compact star maximum masses of at least 1.97 $\pm$ 0.04 solar masses and represent thereby a challenge for soft nuclear equations of state, which often go hand in hand with the presence of hyperons or quarks. In this talk I will discuss such high neutron star masses regarding the nuclear equation of state from heavy ion experiments. Furthermore, I will introduce equations of state for core-collapse supernova and binary merger simulations, which include a phase transition to strange quark matter. As was recently shown, neutrino signals from supernova explosions can provide a probe for the low density appearance of quark matter. The compatibility of the latter with high neutron star masses is an interesting and important question and will be addressed in the talk.

\textsuperscript{1}Submitting author is supported by the Alexander von Humboldt foundation via the Feodor-Lynen fellowship.

8:42AM MG.00002 Laboratory Tests of Low Density Astrophysical Equations of State\textsuperscript{1}, JOSEPH NATOWITZ, Texas A&M University. — Clustering in low density nuclear matter has been investigated using the NIMROD multi-detector at Texas A&M University. Thermal coalescence models were employed to extract densities, $\rho$, and temperatures, $T$, for evolving systems formed in collisions of 47A MeV $^{40}$Ar + $^{112}$Sn, $^{124}$Sn and $^{40}$Zn + $^{112}$Sn, $^{124}$Sn. The yields of $d$, $t$, $^3$He and $^4$He have been determined at $\rho = 0.002$ to 0.32 nucleons/fm$^3$ and $T = 5$ to 10 MeV. Symmetry energy coefficients and equilibrium constants for alpha production have been derived from these data. The data provide an important constraint on astrophysical equation of state models at low density.

\textsuperscript{1}This research was sponsored by the National Nuclear Security Administration under the Stewardship Science Academic Alliance program through DOE Cooperative Agreement No. DE-FG02-08NA28552.
8:54AM MG.00003 Bulk viscosity for high amplitude oscillations and its effect on spin-down evolution of compact stars, SIMIN MAHMOODIFAR, MARK G. ALFORD, KAI SCHWENZER, Washington University in St. Louis — I will present our results for the bulk viscosity of dense matter taking into account non-linear effects that arise in the supra-thermal regime. $\mu > T$, where the bulk viscosity grows with the oscillation amplitude. This regime is relevant to unstable modes such as $r$-modes in neutron stars, which grow in amplitude until saturated by non-linear effects. Then I will discuss the effects of the high amplitude bulk viscosity on damping of the $r$-modes and spin-down evolution of rapidly rotating compact stars. I will present our results for different cases of hadronic stars and strange stars.

9:06AM MG.00004 An Updated Nuclear Equation of State for Neutron Stars and Supernova Simulations, M.A. MEIXNER, G.J. MATHEWS, University of Notre Dame, H.E. DALHED, N.Q. LAN — We present an updated and improved Equation of State based upon the framework originally developed by Bowers & Wilson. The details of the EoS and improvements are described along with a description of how to access this EOS for numerical simulations. Among the improvements are an updated compressibility based upon recent measurements, the possibility of the formation of proton excess ($Y_p > 0.5$) material and an improved treatment of the nuclear statistical equilibrium and the transition to pasta nuclei as the density approaches nuclear matter density. The possibility of a QCD chiral phase transition is also included at densities above nuclear matter density. We show comparisons of this EOS with the other two publicly available equations of state used in supernova collapse simulations. The advantages of the present EoS is that it is easily amenable to phenomenological parameterization to fit observed explosion properties and to accommodate new physical parameters.

9:18AM MG.00005 Chemical separation in accreting Neutron Stars, ANDRE DA SILVA SCHNEIDER, JOE HUGHTO, CHARLES HOROWITZ, DON BERRY, Indiana University — Matter accreted by a Neutron star in a binary system undergoes a variety of nuclear reactions. The ash left over from these nuclear reactions include a complex range of chemical elements which form the ocean and crust of the neutron star. Amongst the elements produced are heavy elements such as Selenium and light elements such as Oxygen. We used large molecular dynamics simulations to study Oxygen Selenium mixtures and the chemical separation that occurs when the ash freezes. We found that the liquid ocean is enriched in light elements while the crust, solid phase, is greatly enriched in heavier elements. Understanding this phase separation is important to determine the thermal conductivity and temperature profile of the star.

Saturday, October 29, 2011 10:30AM - 12:30PM
Session NA Mini-Symposium on Emerging Needs for Nuclear Data II

10:30AM NA.00001 STARLIB: A Next-Generation Reaction-Rate Library for Nuclear Astrophysics, A.L. SALLASKA, C. ILIADIS, A.E. CHAMPAGNE, UNC/TUNL, F.X. TIMMES, S. STARRFIELD, ASU — One of the major inadequacies of current reaction-rate libraries is the absence of information on uncertainties. Although estimates have been attempted, these uncertainties are generally not based on rigorous statistical definitions. Clearly, a common standard for deriving uncertainties is warranted. STARLIB is a new, next-generation reaction-rate library that addresses this deficiency by providing a tabular, up-to-date database that supplies not only the recommended rate but also its factor uncertainty. The foundation of this library rests on an entirely new method for calculating reaction rates: Monte-Carlo simulation, which utilizes experimental nuclear physics quantities as inputs, yields a probability-density function for the reaction rate at a given temperature [1]. From the cumulative distribution of rate probability densities, the low, median, and high rates are naturally defined. In addition, quantities with upper limits are seamlessly included. This library attempts to bridge the gap between experimental nuclear physics data and stellar modelers by providing a convenient tabular format with reliable uncertainties for use in the simulation of astrophysical phenomena. We expect to submit STARLIB for publication by year’s end, which will coincide with the unveiling of a webpage for ease of dissemination and updating.


10:42AM NA.00002 Comments from DOE regarding Nuclear Data, TED BARNES, DOE/NP — In this presentation I will briefly discuss some present and future aspects of the Nuclear Data program from the perspective of the DOE Office of Nuclear Physics.

11:06AM NA.00003 Hadron Analyses Data Repository Online Project, MICHAEL PENNINGTON, Jefferson Laboratory — The study of excited states of the nucleon is a major effort of present day nuclear physics. The spectrum reflects the internal dynamics of QCD. The past decade has seen a dramatic increase in the precision and range of experimental measurements from MAMI@Mainz and CEBAF@JLab. The analyses of these data, both in Europe and the US, have reached a level of robustness and sophistication that the results on the production of $N^*$'s demand to be shared openly in the nuclear reaction community and beyond. Indeed, there is a demand for such information in fields beyond hadron spectroscopy, such as Heavy Ion collisions. Reaction calculations demand amplitudes and not just simple representations in terms of resonances. The aim of this project is to set up a publicly accessible database to archive (a) the full range of data on cross-sections and polarization asymmetries measured in hadro and photo-production of baryon resonances, (b) for each excited baryon its mass, width, couplings and transition formfactors, (c) for each analysis, the partial wave amplitudes with a detailed exposition of the methods used, (e) where appropriate these will be compared with the detailed predictions of QCD.

11:18AM NA.00004 GW Data Analysis Center and Database Development, W.J. BRISCOE, H. HABERZETTL, M.W. PARIS, I.I. STRAKOVSKY, R.L. WORKMAN, Institute for Nuclear Studies & Department of Physics, The George Washington University, Washington, DC 20052, USA — The Data Analysis Center (DAC) of the Institute for Nuclear Studies (formerly the Center for Nuclear Studies) at The George Washington University houses the SAID facility. It constitutes a dedicated center that joins experimental, theoretical, and phenomenological efforts to support the national physics program for a variety of reactions of importance to nucleon-nucleon phenomena and nuclear physics generally. A renaissance in light-hadron spectroscopy is underway as a continuous stream of precision polarization data issues from existing and planned precision electromagnetic facilities, including the coming Jefferson Lab 12-GeV upgrade. Additionally, neutron-proton scattering, the primary standard in measurements involving neutron-induced nuclear reactions, is under continual analysis and refinement. Through the ongoing maintenance of SAID, the DAC is making significant progress in its program to enhance and expand the partial-wave analyses of fundamental two- and three-body reactions (pion-nucleon, gamma-nucleon, and nucleon-nucleon) by maintaining and augmenting the analysis codes and databases associated with these reactions. These efforts provide guidance to experimental groups both nationally and internationally.

1Supported in part by the US DOE Grant DE-FG02-99ER41110.
11:30AM NA.00005 Leadership Class Configuration Interaction Code - Status and Opportunities1, JAMES VARY, Iowa State University — With support from SciDAC-UNEDF (www.unedf.org) nuclear theorists have developed and are continuously improving a Leadership Class Configuration Interaction Code (LCCI) for forefront nuclear structure calculations. The aim of this project is to make state-of-the-art nuclear structure tools available to the entire community of researchers including graduate students. The project includes codes such as NuSheix, MFDn and BIGSTICK that run a range of computers from laptops to leadership class supercomputers. Codes, scripts, test cases and documentation have been assembled, are under continuous development and are scheduled for release to the entire research community in November 2011. A covering script that accesses the appropriate code and supporting files is under development. In addition, a Data Base Management System (DBMS) that records key information from large production runs and archived results of these runs has been developed (http://nuclear.physics.iastate.edu/info/) and will be released. Following an outline of the project, the code structure, capabilities, the DBMS and current efforts, I will suggest a path forward that would benefit greatly from a significant partnership between researchers who use the codes, code developers and the National Nuclear Data efforts.

1This research is supported in part by DOE under grant DE-FG02-87ER40371 and grant DE-FC02-09ER41582 (SciDAC-UNEDF).

11:42AM NA.00006 New Directions for Nuclear Data2, RICHARD FIRESTONE, Lawrence Berkeley National Laboratory — The evaluation of nuclear data has gone on for over 75 years. After WWII it was realized that the rate of accumulation of nuclear data had become too rapid for individual scientists and engineers to scan to literature so the modern nuclear data program was funded in the US by an act of Congress under the leadership of Katherine Way. In the 1970’s at Oak Ridge National Laboratory the Nuclear Data Sheets ENSDf file format was designed and continues to be used, largely unchanged, today. Although originally envisioned to support nuclear applications, ENSDf today now largely supports basic nuclear structure research. As data evaluation became a specialized field, the Nuclear Data Sheets has not kept pace with these important developments. We have built an online, dedicated suite of tools to address this problem — the Nuclear Mass Toolkit at nuclearmasses.org. This free, platform-independent system enables researchers to quickly and efficiently share, manage, visualize, access, manipulate, compare, and analyze nuclear mass datasets. With our system, researchers can upload their own mass datasets, store them, share them with colleagues, quickly and easily visualize them in customizable 1D and 2D plots, and calculate and plot RMS differences. We will demonstrate the utility of our site by comparing the RMS deviations of a variety of different theoretical mass models from the AME2003 evaluated masses, over a variety of mass ranges.

2This work was supported under U.S DOE Contract No. DE-AC02-05CH11231.

11:54AM NA.00007 Comparison of Nuclear Mass Models with the Nuclear Mass Toolkit online at nuclearmasses.org1, CAROLINE D. NESARAJA, MICHAEL S. SMITH, ERIC J. LINGERFELT, ORNL, HIROYUKI KOURA, JAEA, FILIP G. KONDEV, ANL — Nuclear masses are crucial in many areas of basic and applied nuclear science, ranging from r-process nucleosynthesis in supernovae to developing new models of superheavy nuclei. There is significant international effort in new mass measurements, new theoretical mass models, and new mass evaluations — but the dissemination of mass information has not kept pace with these important developments. We have kept an online, dedicated suite of tools to address this problem — the Nuclear Mass Toolkit at nuclearmasses.org. This free, platform-independent system enables researchers to quickly and efficiently share, manage, visualize, access, manipulate, compare, and analyze nuclear mass datasets. With our system, researchers can upload their own mass datasets, store them, share them with colleagues, quickly and easily visualize them in customizable 1D and 2D plots, and calculate and plot RMS differences. We will demonstrate the utility of our site by comparing the RMS deviations of a variety of different theoretical mass models from the AME2003 evaluated masses, over a variety of mass ranges.

1Research sponsored by the Office of Nuclear Physics, U.S. Dept. of Energy.

12:06PM NA.00008 Decay Heat Calculations for 235U1, T.D. JOHNSON, A. SONZOGNI, E. MCCUTCCHAN, NNDC — Following a nuclear reactor shutdown, a major issue is the decay heat due to radioactive decay of fission products and actinides. Contributing to this are light particles (e.g., β- electrons), heavy particles (e.g., delayed neutrons), and electromagnetic radiation. Sources of uncertainty include probabilities for the formation of specific fission products, and incomplete knowledge of the levels of daughter nuclei. The latter is partially addressed by using Total Absorption Gamma Spectroscopy (TAGS). Earlier calculations are based on older decay schemes and sometimes less precise, mass measurements. In part to facilitate these calculations, the decay sub-library for the Evaluated Nuclear Data File was updated using the Evaluated Nuclear Structure Data Files with the latest mass measurements. The update includes electron conversion coefficients calculated using the Band-Raman Internal Conversion and “Frozen Orbital” approximation. The updated library was used in conjunction with available TAGS data to obtain preliminary updated decay heat calculations for 235U. 

1Work was supported by the Office of Nuclear Physics, Office of Science, US Department of Energy, under contract DE-AC02-98CH10946.

12:18PM NA.00009 Measurement of the Absolute Elastic and Inelastic Differential Neutron Cross Sections for 23Na between 2 and 4 MeV1, AJAY KUMAR, M.T. MCCELLSTREM, B.P. CRIDER, E.E. PETERS, F.M. PRADOS-ESTEVEZ, A. CHAKRABORTY, S.W. YATES, University of Kentucky, USA, A. SIGLITTO, P.J. MCDONOUGH, L.J. KERSTING, C.J. LUKE, S.F. HICKS, University of Dallas, USA, J.R. VANHOY, United States Naval Academy, Annapolis, USA — Elastic and inelastic neutron scattering angular distributions for 23Na sample were measured at the University of Kentucky using the time-of-flight (ToF) technique, between 2 and 4 MeV incident neutron energies. Normalization of yields into scattering cross sections was accomplished by comparison of Na yields to the yields obtained from hydrogen in polyethylene samples via the well-known n-p scattering cross sections. The H(p,n) differential cross sections are used to determine the energy-dependent efficiency of the main detector. Because the efficiency of this detector appears as a ratio in the comparison of scattered yields from different samples, the absolute values of the H(p,n) cross sections are not critical, but their energy dependence is.

1This work is supported by the U.S. DOE contract no. DE-AC07-05ID14517.

Saturday, October 29, 2011 10:30AM - 12:18PM – Session NB Neutron Rich Nuclei at the Extremes Auditorium

10:30AM NB.00001 Nuclear structure at the limits of stability, MORTEN HJORTH-JENSEN, University of Oslo — The aim of this talk is to shed light on our understanding of many-body correlations in nuclei. Since all theoretical calculations involve effective Hamiltonians and effective Hilbert spaces, it is crucial to have a handle on the role many-body correlations play in complex many-particle systems like nuclei. This means that a sound theory should provide error estimates on the importance of neglected many-body effects. To understand these and develop mathematically rigorous error estimates is mandatory if one wants to have a predictive theory. In order to achieve the above, I will present several challenges to nuclear many-body theory and our understanding of the stability of nuclear matter. In particular, I will focus on our current understanding of many-body correlations, and how they evolve as function of the number of particles. This is of fundamental importance if we wish to use theoretical results in analyzing properties of nuclei close to the drip lines. In particular, I will report on studies of weakly bound nuclei, focusing on properties like binding energies and spectroscopic factors as functions of proton-neutron asymmetry.
done by simulating the gamma cascade emitted from the excited experimental setup. The results are compared with a theoretical calculation of the capture of polarized cold neutrons in the Al vessel of the hydrogen target the parity-violating photon asymmetry from the capture of polarized cold neutrons on an Al target using the SNS pulsed cold neutron beam and the NPDGamma parity-violating asymmetry from Al to quantify it and then correct the measured asymmetry obtained from the hydrogen target accordingly. We have measured a liquid hydrogen target and about 15% of the measured photon yield is from the Al target vessel. It is therefore necessary to independently measure the rays emitted in the capture of polarized cold neutrons on protons. The photons are detected in an array of 48 CsI detectors cylindrically arranged around 11:06AM NB.00002 First results from CARIBU \(^1\), GUY SAVARD, Argonne National Laboratory — The Californium Rare Ion Breeder Upgrade (CARIBU) of the ATLAS superconducting linac facility aims at providing low energy and reaccelerated neutron-rich radioactive beams to address key nuclear physics, astrophysics and application issues. These beams are obtained from fission fragments of a 1 Ci 252Cf source, thermalized and collected into a low-energy particle beam by a helium gas catcher, mass analyzed by an isobar separator, and charge bred to higher charge states for acceleration in ATLAS. The method described is fast and universal and short-lived isotope yield scale essentially with Californium fission yields. The facility is now commissioned and operating with a 100 mCi source which has yielded extracted low-energy mass separated radioactive beams at intensities in excess of 100000 ions per second. Radioactive beams have been charge bred with an efficiency of up to 12\% and reaccelerated to 6 MeV/u. Commissioning results, together with the results from first astrophysics experiments at CARIBU using the beams from the 100 mCi source will be presented. The final 1 Ci source is currently under fabrication and is expected to be installed by the end of the year.

\(^1\)This work was supported by the US DOE, Office of Nuclear Physics, under contract DE-AC02-06CH11357.

11:42AM NB.00003 Experimental challenges to explore neutron-rich nuclei: progress and perspective of lifetime measurements with RI beams, HIRONORI IWASAKI, NSCL/MSU — Studies of neutron-rich nuclei lying at the limits of stability are of great importance for understanding nuclear structure at extreme isospin, correlations of halo neutrons, as well as their impacts on astrophysical phenomena. Applications of Doppler-shift techniques to rare-isotope (RI) beam experiments have enabled level lifetime measurements of neutron-rich nuclei far from stability, offering new opportunities to investigate the evolution of nuclear shell structure and examine symmetries of nuclear many-body system. In this talk, recent progresses in lifetime measurement programs at National Superconducting Cyclotron Laboratory (NSCL) will be introduced. Experimental results on neutron-rich carbon and iron isotopes will be discussed in terms of suppressed or enhanced collectivity associated with unique shell structure of these isotopes. Future perspectives of lifetime measurements with re-accelerated RI beams and gamma-ray tracking detector arrays will also be presented.

Saturday, October 29, 2011 10:30AM - 12:18PM Session NC Electroweak Interactions III 101

10:30AM NC.00001 First Calculation of Nuclear Parity Violation from Lattice QCD, JOSEPH WASEM, Lawrence Livermore National Laboratory — While parity violating phenomena have been known and observed for several decades little is known about the flavor-conserving, parity violating interaction between quarks. The primary example of this interaction is the small parity violating interaction between nucleons. The large QCD background for this interaction makes both experimental extractions and theoretical predictions difficult. Here we report on results from a lattice QCD calculation of $h_{\gamma NN}$, the leading-order momentum-independent parity violating coupling between pions and nucleons. This is the first calculation of this quantity directly from QCD.

10:42AM NC.00002 Hadronic parity violation in pionless effective field theory, MATTHIAS SCHINDLER, University of South Carolina — The weak interaction between quarks induces a parity-violating component in the low-energy interaction between nucleons. Due to the nonperturbative nature of QCD at these energies, an understanding of how the weak quark-quark interactions manifest themselves in nucleon interactions remains elusive. Few-nucleon experiments utilizing polarized neutrons are being performed at the SNS, NIST, and other neutron facilities to map out this weak component of the nuclear force. I will describe a theoretical program to analyze and interpret the obtained data based on effective field theory. This approach allows for a systematic and model-independent description of few-nucleon observables. Results for parity-violating observables in the two- and three-nucleon sectors will be presented, including a discussion of the relevance of parity-violating three-nucleon interactions. Recent progress in the application of effective field theory methods in few-nucleon systems will allow us to extend these calculations to observables involving four and more nucleons.

10:54AM NC.00003 First Results from the NPDGamma Experiment at the Spallation Neutron Source, NADIA FOMIN, Los Alamos National Laboratory, NPDGAMMA COLLABORATION — The NPDGamma experiment aims to measure the parity-odd correlation between the neutron spin and the direction of the emitted photon in neutron-proton capture. A parity violating asymmetry from this process can be directly related to the strength of the hadronic weak interaction between nucleons. The methodology and results from the first run of this experiment, completed at LANSCE in 2006, will be summarized. The next phase of the experiment has finished a very successful commissioning on the Fundamental Neutron Physics Beamline of the Spallation Neutron Source at ORNL. We will discuss the improvements in the apparatus and show results from the commissioning data. The upcoming run is expected to yield a measurement with a projected statistical error of 1x10\(^{-8}\) as well as negligible systematic errors. This result will finally test the theoretical predictions.

11:06AM NC.00004 Parity-violating asymmetry from the capture of polarized neutrons on \(^{27}\)Al, SEPTIMIU BALASCUTA, RICARDO ALARCON, Arizona State University, JAMES D. BOWMAN, SEppo PENTTILA, Oak Ridge National Laboratory, NPDGAMMA COLLABORATION — The NPDGamma experiment at the Fundamental Neutron Physics Beamline at the Spallation Neutron Source seeks to determine the strength of the hadronic weak interaction by measuring the parity-violating asymmetry in the angular distribution of the gamma rays emitted in the capture of polarized cold neutrons on protons. The photons are detected in an array of 48 CsI detectors cylindrically arranged around a liquid hydrogen target and about 15\% of the measured photon yield is from the Al target vessel. It is therefore necessary to independently measure the parity-violating asymmetry from Al to quantify it and then correct the measured asymmetry obtained from the hydrogen target accordingly. We have measured the parity-violating asymmetry from the capture of polarized cold neutrons on an Al target using the SNS pulsed cold neutron beam and the NPDGamma experimental setup. The results are compared with a theoretical calculation of the capture of polarized cold neutrons in the Al vessel of the hydrogen target done by simulating the gamma cascade emitted from the excited \(^{28}\)Al nucleus and of the bremsstrahlung radiation of the electrons emitted in the nuclear beta decay of \(^{28}\)Al.

11:18AM NC.00005 A Liquid parahydrogen target for the NPDGamma experiment \(^1\), ZHAOWEN TANG, Indiana University, NPDGAMMA COLLABORATION — The goal of NPDGamma experiment is to measure the parity-odd directional gamma-ray asymmetry from the polarized neutron-proton capture reaction. This reaction is sensitive to the $\Delta I = 1$ part of the hadronic weak interaction between nucleons, where contributions from quark-quark neutral currents are expected to dominate. Our goal is to measure $A_\gamma$ to a sensitivity of $10^{-8}$ of the newly commissioned fundamental neutron physics beamline (FNPB) at the Spallation Neutron Source at Oak Ridge National Lab. The target has to meet strict requirements set by this sensitive measurement. It is operated in the para-hydrogen state at 17K to avoid depolarization of cold neutrons. The design of the target has to meet SNS hydrogen safety requirements and minimize background from neutron capture in aluminum. The previous version of the target was successfully operated at LANSCE, where a parahydrogen fraction of 99.98\% was measured [1]. We will describe the target along with its installation and testing.

\(^1\)Zhaowen Tang for the NPDGamma Collaboration
3

11:30AM NC.00006 GEANT4 Simulation of Empty Target for the NPDGamma Experiment

ANDREW MCNAMARA, University of Kentucky, NPDGAMMA COLLABORATION — The NPDGamma experiment was designed to detect a very small parity violating asymmetry (∼10−8) in the n+p→d+γ reaction. Background rates will be modeled to determine the dilution of the asymmetry. To validate these models, data were taken with the detector array fitted with a mock-up version of the liquid hydrogen target in the neutron beam. Rates were measured from four targets: empty, water, and two concentrations of MgCl, which has a large parity violating asymmetry. A comparison of these results with a Geant4 simulation of this simple target will be used to tune the simulation of the real hydrogen target.

1Supported in part by NSF grant PHY-0855584.

11:42AM NC.00007 Determining the Neutron Polarization of the Fundamental Neutron Physics Beamline at the Spallation Neutron Source with a 3He Spin Filter

MATTHEW MUSGRAVE, University of Tennessee, NPDGAMMA COLLABORATION — The Fundamental Neutron Physics Beamline (FNPB) at the Spallation Neutron Source (SNS) provides a pulsed beam of polarized cold neutrons for several experiments including NPDGamma and n3He. The neutrons are polarized by a multi-channel super mirror polarizer. The polarization of the neutron beam was measured at several points across the beam cross section by utilizing the spin dependent capture cross section of the neutron on polarized 3He. The neutron beam is incident on a series of 6Li loaded collimators and a 3He spin filter. The transmitted neutrons are detected in a 3He monitor operating in current mode. An RF spin rotator reverses the spin of the neutrons on successive accelerator pulses enabling the transmission of different neutron spin states to be measured, and the 3He spin is reversed by adiabatic fast passage to enable the transmission through different 3He spin states. The neutron polarization can be determined in a redundant fashion using these two independent spin reversals.

11:54AM NC.00008 3He multi-wire proportional counters for the FNPB at the SNS

MARK MCCREA, University of Minnesota, NPDGAMMA COLLABORATION, N3HE COLLABORATION — We have constructed a set of beam monitors for the Fundamental Neutron Physics Beam Line (FNPB), at the Spallation Neutron Source, Oak Ridge National Laboratory. The beam monitors are 3He multi-wire proportional counters. A 3He nucleus that captures a neutron will break up by the reaction n+3He→p+T+765keV. The 765keV is released as kinetic energy of the proton and triton which will ionize the chamber gas, giving a consistent signal from each capture. The chamber gas is a mix of N2 and 3He at 750 Torr. The 3He fraction used determines the fraction of the beam that is captured. The 3He chambers are used to monitor the neutron flux along the neutron beam, and are currently used for the NPDGamma experiment, but will also be used for beam line diagnostics in future experiments. I will report on the monitor design, construction, and beam data obtained during the commissioning of the NPDGamma experiment. I will also report on the design, and simulation of a 3He wire chamber to be used in the n3He experiment, which runs after the NPDGamma experiment. It uses the same neutron detection process as described above, but will be black to neutrons (high 3He content) with a small amount of ionization gas, to allow the protons to range out over as long a distance as possible to measure the parity violating longitudinal asymmetry in the number of protons emitted in the capture reaction.

12:06PM NC.00009 Parity-Violating Gamma-ray Asymmetry in Polarized Neutron Capture on 35Cl

ELISE MARTIN, University of Kentucky, NPDGAMMA COLLABORATION — As part of the commissioning of the NPDGamma experiment at the Fundamental Neutron Beamline at the Spallation Neutron Source at Oak Ridge National Lab, we measured the gamma-ray asymmetry from the parity-violating interaction of polarized cold neutron capture on chlorine. Previous measurements result in a chlorine asymmetry on the order of 10−6. We expect to improve the precision of this value. For the NPDGamma experiment we will measure the gamma-ray asymmetry of hydrogen. Since the asymmetry of chlorine is two orders of magnitude larger than the predicted hydrogen asymmetry, we gain insight into the systematic effects and statistical error introduced by our experimental apparatus. The chlorine measurement, data, and preliminary results will be presented.

Saturday, October 29, 2011 10:30AM - 12:30PM –
Session ND Nuclear Theory IV: For Theorists

10:30AM ND.00001 Renormalization and Power Counting of Chiral Nuclear Forces

BINGWEI LONG, Jefferson Laboratory, CHIEH-JEN YANG, University of Arizona — We study renormalization of chiral nuclear forces by examining the cutoff dependence of the solution to the Lippmann-Schwinger equation for nucleon-nucleon scattering. In particular, we are interested in the interplay between renormalization and power counting of nucleon-nucleon contact interactions, leading to necessary modifications to Weinberg’s original power counting scheme. We also discuss the difference between the conclusions of the previous investigations and ours.

1This work is coauthored by Jefferson Science Associates, LLC under U.S. DOE Contract No. DE-AC05-06OR23177.

10:42AM ND.00002 Two nucleons in a harmonic-oscillator trap with chiral potential

CHIEHJEN YANG, JIMMY ROTUREAU, U. VAN KOLCK, BRUCE BARRETT, The Ohio State University — We establish the connection between the bound-state energy spectrum for two nucleons in a harmonic-oscillator trap and their scattering phase shifts in the continuum with potentials derived from chiral effective field theory (EFT). We compare our results for the 2S0 and 1S1 → 1D2 channels to those obtained with pionless EFT. Our results extend the EFT approach to the no-core shell model to a higher-energy region.

1Work supported by NSF under grant PHYS-0854912 and DOE under grant DE-FG02-04ER41438.

10:54AM ND.00003 Understanding the Evolution of Three-Body Forces via Similarity Renormalization Group

KYLE WENDT, RICHARD FURNSTAHL, ROBERT PERRY, The Ohio State University — The Similarity Renormalization Group (SRG) is a continuous series of unitary transformations. When the relative kinetic energy (Trel) is used in the SRG generator, high- and low-momentum scales are decoupled, but at a cost of induced many-body forces. For few-body nuclei or when including only short-range initial three-body forces, the four-body (and possibly higher) forces have been kept small. However, recent evolutions with long-range initial three-body forces, indicate that induced many-body forces gain significant strength for larger nuclei. We present some novel methods for examining the SRG evolution as well as results from model calculations where we have attempted to control these induced forces.

1Support in part by NSF Grants PHY-0653312 and PHY-1002478, UNEDF SciDAC Collaboration under DOE Grant DE-FC02-07ER41415, and DOE SCGF Program under contract number DE-AC05-06OR23100.
11:06AM ND.00004 Behavior of SRG evolved interactions into the p-shell\textsuperscript{1}, ERIC JURGENSON, Lawrence Livermore Natl Lab, PIETER MARIS, Iowa State U, RICHARD FURNSTAHL, Ohio State U, PETR NAVRATIL, TRIUMF, ERICH ORMAND, Lawrence Livermore Natl Lab, JAMES VARY, Iowa State U — We introduce a formulation of relativistic quantum mechanics where the dynamical input is Euclidean generating functionals or Green functions. We discuss how dynamical calculations can be performed without analytic continuation. We discuss the structure of model generating functionals, the construction of the Hilbert space, the Poincaré Lie Algebra, one particle eigenstates, and representations of finite Poincaré transformations.

\textsuperscript{1}Supported by NSF Grant No. PHY-0653312, UNEDF SciDAC Collaboration under DOE Grant DE-FC02-07ER41457, and LLNL under Contract DE-AC52-07NA27344.

11:18AM ND.00005 Euclidean relativistic quantum mechanics I\textsuperscript{1}, WAYNE POLYZOU, PHILIP KOPP, University of Iowa — We introduce a formulation of relativistic quantum mechanics where the dynamical input is Euclidean generating functionals or Green functions. We discuss how dynamical calculations can be performed without analytic continuation. We discuss the structure of model generating functionals, the construction of the Hilbert space, the Poincaré Lie Algebra, one particle eigenstates, and representations of finite Poincaré transformations.

\textsuperscript{1}This work supported the U.S. Department of Energy, under contract DE-FG02-86ER40286.

11:30AM ND.00006 Euclidean relativistic quantum mechanics II\textsuperscript{1}, PHILIP KOPP, WAYNE POLYZOU, The University of Iowa — We discuss the calculation of scattering amplitudes in relativistic Euclidean quantum mechanics. We discuss the general formulation of the scattering problem in terms of the existence of wave operators and formal methods for computing scattering amplitudes without analytic continuation. Two models are discussed to illustrate the method and the accuracy of the computations.

\textsuperscript{1}This work supported the U.S. Department of Energy, under contract DE-FG02-93ER40756 with Ohio University.

11:42AM ND.00007 Effective field theory for the Helium-6 halo nucleus\textsuperscript{1}, CHEN JI, CHARLOTTE ELSTER, DANIEL PHILLIPS, Ohio University — The ground-state of Helium-6 can be treated as a two-neutron halo with an alpha-particle core. This bound state is generated by the resonant \( nn \) and \( na \) interactions. The latter is dominated by a shallow p-wave resonance, where both the scattering length and effective range appear at leading order [1]. Here we first study a separable-potential model which fits the \( nn \) and \( na \) scattering parameters [c.f., e.g. [2]]. This reproduces known properties of He-6 moderately well for a specific choice of interaction ranges. We then show that the He-6 binding energy diverges in the limit that the range of the \( nn \) and \( na \) forces goes to zero. This indicates that within Halo EFT this three-body system needs an \( na \) contact interaction to be properly renormalized at leading order. We adjust the coefficient of this \( na \) force to reproduce the Helium-6 ground-state energy, and present its running as a function of the cutoff. The correlations amongst Helium-6 properties that result from this successful renormalization of the leading-order three-body problem in halo EFT with p-wave resonant interactions will be discussed.

\textsuperscript{1}Work supported by the US DOE (Office of Nuclear Physics, under contract No. DE-FG02-93ER40756 with Ohio University).

11:54AM ND.00008 Vector variable solution of the N-N scattering problem using the momentum-space Argonne V18 interaction\textsuperscript{1}, SARAVANAN VEERASAMY, ELSTER CHARLOTTE, Ohio University, WAYNE POLYZOU, The University of Iowa — We discuss the formulation and solution of the nucleon-nucleon scattering problem using a vector-variable approach in momentum space. We take the Argonne V18 potential as input potential. The operator form of this potential is represented by the sum of a complete set of spin-isospin operators multiplied by functions of the momentum transfer, which are accurately approximated using Chebyshev polynomials. This representation makes it easy to compute Wolfenstein parameters directly from the solution of the Lippmann-Schwinger equation. The Wolfenstein parameters are then used to calculate the experimental observables. This approach overcomes some of the difficulties in using partial wave expansions to represent smooth scattering amplitudes at medium energies. Wolfenstein parameters and a representative set of observables will be presented and compared to calculations based on partial waves.

\textsuperscript{1}This work is supported by National Science Foundation, NSF-PHY-1005578 , NSF-PHY-1005501 and DOE grant DE-FG02-86ER40286.

12:06PM ND.00009 Low Density Matter and Bose Einstein Condensates in Nuclei , KATARZYNA SCHMIDT, Cyclotron Institute, Texas A&M University — The ability to isolate low density matter in near Fermi Energy collisions and the high degree of alpha clustering at such low densities suggest that we search for evidence of Bose Condensates which are predicted to occur in the density and temperature range which we are exploring [1-3]. A natural way to pursue this question experimentally appears to be to apply our techniques of low density gas investigations to collisions of “alpha-conjugate” nuclei expected to have significant initial alpha cluster character. Such nuclei might show a more natural predilection to evolve into a Bose Condensate. We have initiated searches for Bose Condensates using the NIMROD array. Our first experiments, carried out at the end of 2008 employed 10, 25, 35 MeV/u beams of \( ^{40}\text{Ca} \) and \( ^{28}\text{Si} \) incident on \( ^{40}\text{Ca} \), \( ^{28}\text{Si} \), \( ^{12}\text{C} \) and \( ^{180}\text{Ta} \) targets. The data are currently being analyzed. It is our expectation that a Bose Condensate would manifest itself as an assembly of alpha conjugate products with particular kinematic correlations. References: [1] Y. Funakiet al., Phys. Rev. C 80, 064326 (2009). [2] G. Roepeke et al., Phys. Rev. Lett. 80, 3177(1998). [3] T. Sogo et al., Phys. Rev. C 81, 064310 (2010).

12:18PM ND.00010 Neutron Matter as a Composite Bose-Fermi Superfluid\textsuperscript{1}, GORAN ARBANAS, Oak Ridge National Laboratory, ARTHUR KERMAN\textsuperscript{2}, Massachusetts Institute of Technology, HAI AH NAM, Oak Ridge National Laboratory, JIRINA STONE\textsuperscript{3}, University of Oxford — We model infinite neutron matter as an interacting Bose-Fermi superfluid consisting of superconducting neutrons and a Bose-Einstein condensate of a six-quark Feshbach state. The interaction term in the many-body grand canonical Hamiltonian is defined by a coupling form-factor and a coupling strength that are determined by fitting an expression for neutron-neutron scattering (via the same Feshbach state) to the \( ^{1}S_{0} \) phase shift. Extremization of the expectation value of the grand canonical Hamiltonian in the ground state yields an equation of state for infinite neutron matter that we numerically solve for particle-number densities between \( 10^{-7} \) and 0.5 fm\(^{-3}\). In the unitary limit (i.e., infinite scattering length and a zero effective range), we find the energy per particle to be 0.6 that of a free Fermi gas. The effect of random-phase-approximation corrections to our equation of state is addressed.

\textsuperscript{1}This manuscript has been authored by UT-Battelle, LLC, under contract DE-AC05-00OR22725 with the U.S. Department of Energy.

\textsuperscript{2}Other affiliations: U. of Tennessee at Knoxville, and the Oak Ridge National Laboratory

\textsuperscript{3}Other affiliation: U. of Tennessee at Knoxville
10:30AM NE.00001 New Results and Future Experiments on Double Spin Asymmetry $A_{LT}$ in DIS Pion Electroproduction on $^3$He . JIN HUANG, MIT, JEFFERSON LAB HALL A COLLABORATION, E06-010 COLLABORATION — We report the final results for the first measurement of the double-spin asymmetry $A_{LT}$ of charged pion electroproduction in deep inelastic electron scattering on a transversely polarized $^3$He target, obtained by reversing the electron beam helicity at 30 Hz. The corresponding neutron $A_{LT}$ asymmetries were extracted. The kinematics were focused on the valence quark region, $x \leq 0.16-0.35$, with $Q^2 \sim 1.4-2.7 \text{GeV}^2$. These new data probe the transverse momentum dependent parton distribution $g_{1T}$ and therefore provide direct access to quark spin-orbit correlations. This experiment has laid the foundation for future high-precision measurements using an approved large acceptance spectrometer, which will also be discussed in this talk.

10:42AM NE.00002 Results from Single Spin Asymmetries Measurement in Semi-Inclusive DIS Reaction on a Transversely Polarized $^3$He Target . KALYAN ALLADA, Thomas Jefferson National Accelerator Facility, E06-010 COLLABORATION, JEFFERSON LAB HALL A COLLABORATION — Jefferson Lab experiment E06-010 measured the target single spin asymmetries in semi-inclusive deep inelastic $^3$He($e,\pi^+ K^{+})X$ reactions on a transversely polarized $^3$He target. The measured asymmetry ($A_{UT}$) is sensitive to nucleon transversity and Sivers distribution functions. The kinematics were chosen to be in the valence quark region with $x \sim 0.16-0.35$ and $Q^2 \sim 1.4 - 2.7 \text{GeV}^2$. The Collins moment, which is sensitive to the transversity, and the Sivers moment, which is sensitive to the orbital motion of the quarks, were extracted using the azimuthal angular dependence of the measured asymmetries. This data, when combined with the data from other experiments on the transversely polarized proton and deuteron targets, will help in extracting the nucleon transversity and Sivers distribution functions through a global analysis. We will present the results of pion asymmetries from this experiments and future plans for high precision experiments in Hall-A.

10:54AM NE.00003 Pair-Symmetric Background of Spin Asymmetries of the Nucleon Experiment (Jefferson Lab E07-003) . LUWANI NDUKUM, Mississippi State University — The Spin Asymmetries of the Nucleon Experiment (SANE) at the Thomas Jefferson National Lab Accelerator Facility measured inclusive double spin asymmetries by scattering longitudinally polarized electrons on a longitudinally and transversely polarized NH$_3$ target. The measurements were done at momentum transfer of $2.5 < Q^2 < 6.5 \text{GeV}^2$ and Bjorken $x$ of $0.3 < x < 0.8$. Data were also taken at $0.2 < x < 0.3$. Preliminary analysis of the pair-symmetric background used to extract asymmetries from this low $x$ data will be discussed.

11:06AM NE.00004 The Spin Asymmetries of the Nucleon Experiment . WHITNEY ARMSTRONG, Temple University, SANE COLLABORATION — The Spin Asymmetries of the Nucleon Experiment (SANE) measured the virtual Compton scattering asymmetries, $A_1$ and $A_2$, and $A_1$ and $A_2$, from which the spin structure functions of the proton, $g_1$ and $g_2$, can be obtained. The kinematics for these measurements are in a range of Bjorken $x$, $0.3 < x < 0.8$, where extraction of the twist three matrix element $d_3^\perp$ (an integral with respect to $x$ of $2g_1 + 3g_2$ weighted by $x^2$) is most sensitive. The observable, $d_2$, is a measure of the average restoring Lorentz color force experienced by a quark inside a polarized nucleon after it is struck by a virtual photon in electron Deep Inelastic Scattering (DIS)[1]. The data was taken at the Thomas Jefferson National Accelerator Facility’s Hall C, using beam energies of 4.7 and 5.9 GeV, probing the nucleon at scales ranging from $Q^2 = 2.5 \text{GeV}^2$ up to $Q^2 = 6.5 \text{GeV}^2$. In this polarized electron scattering off a polarized proton target experiment two inclusive double spin asymmetries, $A_1$ and $A_2$, were measured using the BETA detector. BETA is a device without magnetic momentum dispersion that consists of a front scintillator hodoscope followed by a threshold gas Cherenkov counter, a Lucite hodoscope and a large array of lead glass detectors. In addition to motivating the physics of the proton’s spin structure we shall discuss the analysis and present preliminary results.


11:18AM NE.00005 Extracting the photoproduction cross section off the neutron $\gamma N \rightarrow \pi^+ \pi^-$ from deuteron data with FSI effects$^1$ . IGOR STRAKOVSKY, GWU, VLADIMIR E. TARASOV, ITEP, WILLIAM BRISCOE, GWU, HAIYAN GAO, Duke U., ALEXANDER E. KUDRYAVTSEV, ITEP — The incoherent pion photoproduction $\gamma N \rightarrow \pi^+ \pi^-$ is considered theoretically in a wide energy region below 2.7 GeV. The model applied contains the impulse approximation (IA) as well as the NN- and NA-FSI. The aim of the project is to study a reliable way for getting the information on elementary $\gamma N \rightarrow \pi^+ \pi^-$ cross section beyond the IA for $\gamma N \rightarrow \pi^+ \pi^-$. For the elementary $\gamma N \rightarrow \pi^+ \pi^-$ amplitudes, the results of the GW DAC are used. There are no additional theoretical constraints. The calculated $d^2 \sigma / d\Omega (\gamma N \rightarrow \pi^+ \pi^-)$ are compared with existing data. The procedure used to extract information on the $d^2 \sigma / d\Omega (\gamma N \rightarrow \pi^+ \pi^-)$ from the neutron data using the FSI correction factor R is discussed. The results show a sizeable FSI effect $R \geq 1$ from S-wave part of $p$-FSI at small angles close to $\theta_\pi \sim 0$: this region narrows as the photon energy increases. At larger angles, the effect is small ($|R-I| < 1$) and agrees with estimations of FSI in the Glauber approach.

$^1$This work was supported in part by the US DOE Grants DE-FG02-99ER41110 and DE-FG02-03ER41231, by the Russian RFBR Grant No. 02-02-1645, and by the Italian INFN.

11:30AM NE.00006 Single and double polarization asymmetries from deeply virtual $\pi^0$ production with a longitudinally polarized proton target . ANDREY KIM, Kyungpook National University, CLAS COLLABORATION — Deeply virtual exclusive reactions such as $\pi^0$ meson production with large $\gamma$ virtuality $Q^2$ offer an opportunity to explore the nucleon structure and access information about quark position and angular momentum distribution in nucleon, as described in terms of the Generalized Parton Distributions (GPDs). Cross-section measurements of $\pi^0$ production recently have been carried out at Jefferson Lab in the DIS regime. Measurements of polarization observables provide additional information of the production mechanism due to interference effects. Preliminary results will be discussed on single and double polarization asymmetries from the data recently obtained using the highly polarized CEBAF electron beam, a longitudinally polarized NH$_3$, and the CEBAF Large Acceptance Spectrometer (CLAS) equipped with a high granularity electromagnetic calorimeter. The asymmetries are highly sensitive to the different kinematics covered in the measurement. Preliminary results for different $Q^2$, $x_B$ and $t$ ranges will be presented.

11:42AM NE.00007 Quark Propagation and Hadron Formation in Cold Nuclear Matter . RAPHAEL DUPRE, Argonne National Laboratory, CLAS COLLABORATION — After four decades of dedicated experiments, knowledge on the hadronization dynamic remain very limited, this is due to both the model and measurement uncertainties. The question is whether the hadron attenuation observed is due to gluon emission by the colored parton or due to the absorption of colorless prehadron or both. Clarifying this issue is the main goal of several recent experiments. In this talk, I will present recent results from a Jefferson Lab experiment, data were taken using a 5 GeV electron beam on various nuclear targets (deuterium, carbon, aluminum, iron, tin and lead). The large acceptance spectrometer, CLAS in Hall B, permits to detect the scattered electron in coincidence with produced hadrons over a large kinematic range. The focus of the talk will be on semi-inclusive negative pion measurement and their implications on various existing hadronization model. I will conclude with the opportunities these data offers to extract information on the time scale of hadronization and on the gluon content of nuclei.
11:54AM NE.00008 Target Single Spin Asymmetry in DVCS

ERIN SEDER, University of Connecticut, CLAS COLLABORATION — The target single spin asymmetry in the reaction ep → epγ is directly proportional to the imaginary part of the Deeply Virtual Compton Scattering (DVCS) amplitude and gives access to a combination of the Generalized Parton Distributions (GPDs) H, H, and E. We present the preliminary single spin asymmetry studies from the eg1-dvcs experiment conducted in Hall B of Jefferson Lab using the Continuous Electron Beam Accelerator Facility’s (CEBAF) 6 GeV electron beam, a polarized solid-state 14N H3 target, and the CEBAF Large Acceptance Spectrometer (CLAS) equipped with an additionally built Inner Calorimeter (IC). The high statistics collected allow for detailed studies of the Q2, xF and t dependences of the DVCS amplitude over a wide range of kinematics.

12:06PM NE.00009 Investigation of Angular Distributions of Drell-Yan Dimuons in p+p and p+d Interactions with the E906/SeaQuest Experiment

CHRISTINE AIDALA, Los Alamos National Laboratory, FNAL E906/SEAQUEST COLLABORATION — Striking cos2θ dependences in pion-induced Drell-Yan measurements were first observed in the 1980s, and proton-induced Drell-Yan measurements by the Fermilab E66 experiment on deuterium and hydrogen targets published in 2007 and 2009 reported smaller but non-zero azimuthal dependences of the Drell-Yan pairs. These azimuthal effects have been attributed to a correlation between the spin and transverse momentum of transversely polarized quarks within an unpolarized nucleon, parametrized by the Boer-Mulders transverse-momentum-dependent distribution function, with additional contributions from QCD effects. With data taking planned to start in the summer of 2011, the E906/SeaQuest experiment will use a 120 GeV/c proton beam extracted from the Fermilab Main Injector on liquid hydrogen and deuterium targets, extending the kinematic coverage of its predecessor experiment E66 to higher proton momentum fraction. Measurement of the dimuon angular distributions will also allow the Lam-Tung relation to be tested in an extended kinematic range compared to E866. The status of data taking and prospects for measurement of the angular distributions of Drell-Yan pairs will be presented.

Saturday, October 29, 2011 10:30AM - 12:30PM
Session NF Applications in Nuclear Physics 104AB

10:30AM NF.00001 Photonuclear Physics Applications for Isotopic Detection and Assay

M.S. JOHNSON, LLNL, SJSU, J.M. HALL, D.P. MCNABB, LLNL, J.J. GONZALEZ, SJU — National security and international safeguards programs are interested in new technologies that utilize gamma-ray sources to detect special nuclear materials (SNM) and/or assay isotopes of interest in a variety of shielded configurations. There are many constraints and caveats that must be addressed such as fast scan times to avoid commercial backlogs. Other challenges include determining the total mass of minute traces of certain isotopes in thick, highly radioactive, nuclear fuel assemblies. This presentation will focus on a high-altitude view of how processes such as nuclear resonance fluorescence (NRF) and photo-fission can function in a variety of applications. We will present an overview of performance estimates for a wide-range of applications. We will also present results from recent validation measurements.

1 This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

10:42AM NF.00002 NUCFRG3: Light ion improvements to the nuclear fragmentation model

ANNE ADAMCZYK, University of Tennessee, RYAN NORMAN, NASA Langley Research Center, SIRIKUL SRIPRISAN, Prairie View A&M University, LAWRENCE TOWNSEND, University of Tennessee, JOHN NORBURY, STEVE BLATTNIG, TONY SLABA, NASA Langley Research Center — Light ion improvements to the nuclear fragmentation model NUCFRG are reported. Improvements include the replacement of the simple light ion production model with a light ion coalescence model and an improved electromagnetic dissociation (EMD) formalism. Prior versions of the model provide reasonable overall agreement with measured data; however, those versions lack a physics-based description for coalescence and EMD. The NUCFRG3 model has improved theoretical descriptions of these mechanisms and offers additional benefits. Previous work established the improved EMD formalism to be more accurate than the predecessor. The predictive capability of NUCFRG has been improved and strengthened by the light ion physics-based changes. Based on increased capability and better theoretical grounding of NUCFRG3, it is recommended that it replace NUCFRG2 for space radiation assessments and other applications.

10:54AM NF.00003 Neutron Capture and Fission Measurements on Actinides at DANCE

ANDRII CHYZH, CHING-YEN WU, ELAINE KWAN, RODGER HENDERSON, JULIE GOSTIC, LLNL, JOHN ULLMANN, MARIAN JANDEL, TODD BREDEWEG, AARON COUTURE, HYE YOUNG LEE, ROBERT HAIT, JOHN O’DONNELL, LANL — Neutron capture and fission measurements on actinides are important in nuclear engineering and physics. DANCE (Detector for Advanced Neutron Capture Measurement) built at LANL) together with PPAC (avalanche technique based fission tagging detector designed and fabricated at LLNL) were used to measure the prompt γ-ray energy and multiplicity distributions in the spontaneous fission of 252Cf. These measured spectra together with the unfolded ones will be presented. The unfolding technique will be described. In addition the 238Pu(n,γ) cross section will be presented, which was measured using DANCE alone and also is the first such measurement in a laboratory environment.

1 This work was performed under the auspices of the US Department of Energy by Los Alamos National Laboratory under Contract DE-AC52-07NA27344 and Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

11:06AM NF.00004 Gamma-Ray Output Spectra from 239Pu Fission

JOHN ULLMANN, MARIAN JANDEL, TODD BREDEWEG, AARON COUTURE, ROBERT HAIT, JOHN O’DONNELL, DAVID VIEIRA, Los Alamos National Laboratory, CHING-YEN WU, ANDRII CHYZH, JULIE GOSTIC, ROGER HENDERSON, ELAINE KWAN, Lawrence Livermore National Laboratory — A new measurement of the gamma-ray energy spectrum and multiplicity following neutron-induced fission of 239Pu has been made using DANCE, a highly-segmented, nearly 4π BaF2 array at the Los Alamos Neutron Science Center. The 239Pu target consisted of an approximately 2 mg/cm2 deposit mounted in a small parallel-plate avalanche chamber inserted into the DANCE in order to tag fission events. The gamma-ray spectra were measured for several strong neutron resonances below 100 eV. The measured spectra were corrected for detector response by using simple parameterizations of the actual fission gamma-ray emission coupled with a GANE model of the DANCE array.

This research was supported by funding from the American Recovery and Reinvestment Act of 2009.
11:18AM NF.00005 Prompt \(\gamma\) rays and neutrons from fission\(^1\). E. KWAN, C.Y. WU, A. CHYZH, J. GOSTIC, R. HENDERSON, Lawrence Livermore National Laboratory, R.C. HAIGHT, H.Y. LEE, J.M. O’DONNELL, B.A. PERDUE, T.N. TADDEUCCI, Los Alamos National Laboratory — Nuclear data are needed to test the accuracy of calculations from nuclear reaction codes. Information on the prompt \(\gamma\)-ray distributions from fission is sparse and only a handful of published experiments data that measured the prompt \(\gamma\)-ray distribution above incident neutron energies of 1 MeV can be found. In addition, improvement on the accuracy and shape of neutron spectrum from the fission of actinides has been requested by the nuclear data community\(^2\). An investigation on the shapes of the neutron and \(\gamma\)-ray distributions from the spontaneous fission of \(^{252}\text{Cf}\) and the neutron-induced fission of \(^{235}\text{U}\) was undertaken using the Chi-Nu detector array at the Weapons Neutron Research Facility of the Los Alamos Neutron Science Center. Preliminary results will be presented.

\(^1\)This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 and the Los Alamos National Laboratory under Contract DE-AC52-06NA25396.


11:30AM NF.00006 Surrogate measurements of the \(^{241,242}\text{Am}(n, f)\) cross sections\(^1\). J.J. RESSLER, LLNL, J.T. BURKE, J.E. ESCHER, A. ADEKOLA, R.E.A. AUSTIN, M.S. BASUNIA, C.W. BEAUSANG, L.A. BERNSTEIN, D. BLEUEL, J. GOSTIC, R.H. HENDERSON, R.O. HURST, A. KRICTHER, C.M. MATTOON, J. MUNSON, L.W. PHAIR, T. ROSS, N.D. SCIELZO, M.A. STOYER — New reactor designs and materials, reprocessing efforts, and transmutation of nuclear waste play significant roles in the future of nuclear energy. New or improved neutron measurements on a number of isotopes are needed to determine feasibility, effectiveness, and safety issues for the novel engineering efforts. Data collection is often hampered by the need for radioactive targets; the use of such targets is limited to longer-lived isotopes due to the large background induced by the decay of the material. However, cross sections for isotopes of interest can be obtained indirectly using light-ion reactions on long-lived neighbors. Decay from the compound state is assumed to be independent of the production reaction, allowing reactions with the neighboring isotopes to be used as a surrogate for the reaction of interest. Results from the neutron-induced fission cross sections of \(^{241}\text{Am}\) and \(^{242}\text{Am}\), performed via surrogates \(^{243}\text{Am}(^{4}\text{He}, \alpha'f)\) and \(^{243}\text{Am}(^{4}\text{He}, \text{He}'f)\), respectively, will be shown.

\(^1\)This work was performed under the auspices of the U.S. DOE by LLNL under contract DE-AC52-07NA27344.

11:42AM NF.00007 A Measurement of Neutron Polarization Asymmetries in Photofission of Actinides Using Polarized Gamma Rays at Hi\(\gamma\)S\(^1\). J.M. MUELLER, M.W. AHMED, S.S. HENSHAW, H.J. KARWOSKI, L. MYERS, B.A. PERDUE, S. STAVE, J.R. TOMPKINS, H.R. WELLER, Triangle Universities Nuclear Laboratory (TUNL), B. DAVIS, D. MARKOFF, North Carolina Central U. (NCCU) — Photofission of \(^{235}\text{U}\), \(^{238}\text{U}\), \(^{232}\text{Th}\), and \(^{236}\text{Pu}\) has been studied using 100% linearly polarized, high intensity (\(\sim 10^8\) \(\gamma/s\)), and nearly-monenergetic gamma-ray beams of energies between 5.6 and 7.0 MeV at the High Intensity Gamma-ray Source (Hi\(\gamma\)S). An array of 18 liquid scintillating detectors was used to measure prompt fission neutron angular distributions. The ratio of prompt neutron yields parallel to the plane of beam polarization to those perpendicular to this plane was measured as a function of beam and neutron energies. A ratio close to unity was found for \(^{232}\text{U}\) and \(^{236}\text{Pu}\) while a significant ratio (\(\sim 3\)) was found for \(^{238}\text{U}\) and \(^{232}\text{Th}\) at a scattering angle of 90°. A phenomenological model of near threshold photofission is being developed in an attempt to explain this large difference for these isotopes. A simulation, based on our model and using previous measurements of fission fragment angular distributions, is being used to interpret our experimental results.

\(^1\)Partially supported by DHS (2010-DN-077-AR046-02) and the DOE Office of Science Graduate Fellowship Program (DOE SCGF).

11:54AM NF.00008 ABSTRACT WITHDRAWN —

12:06PM NF.00009 Observations of Fallout from the Fukushima Reactor Accident in San Francisco Bay Area Rainwater\(^1\), ERIC NORMAN, CHRISTOPHER ANGELL, PERRY CHODASH, Univ. of California at Berkeley — We observed fallout from the Fukushima Dai-ichi reactor accident in samples of rainwater collected in the San Francisco Bay area beginning approximately 1 week after the earthquake. Gamma-ray spectra measured from these samples show clear evidence of fission products – \(^{131}\text{I}\), \(^{132}\text{Te}\), and \(^{134,137}\text{Cs}\). The activity levels we have measured for these isotopes are very low and pose no health risk to the public. Soon after the observation of fallout in rainwater, we also observed low levels of Fukushima fallout in plant and food specimens collected in the the San Francisco area.

\(^1\)This work was supported in part by the US Dept. of Homeland Security and by a Nuclear Non-Proliferation International Safeguards Graduate Fellowship (PAC) from the US Dept. of Energy.

12:18PM NF.00010 Nuclear Physics of DNA: Evidence for Mutations of Free DNA Nucleotides in Nuclear Inelastic Scattering with 14 MeV Neutrons and Applications\(^1\), BOGDAN C. MAGLICH, LUZ MARIE AQUINO, CHRIS DRUEY, CALSEC California Science & Engineering Corp., ANNA Z. RADOVIC, UC — First experimental study of interactions of nuclear particles whose \(\lambda_{\text{DeBroglie}} \sim 10^{-15}\) m and nanoparticles (\(r \sim 10^{-9}\) m) of free DNA nucleotides is presented. Each collision knocks out 1 atom and creates mutated DNA or DNA breakup. Targets: dAdenosine (\(\text{C}_{10}\text{O}_7\text{N}_2\text{H}_{15}\text{P}\)), dCytidine (\(\text{C}_9\text{O}_7\text{N}_2\text{H}_{14}\text{P}\)) and dThymidine (\(\text{C}_{10}\text{O}_8\text{N}_2\text{H}_{15}\text{S}\)), differing by 1 O or 1 C atom. We measured high-resolution prompt \(\gamma\) spectra of \(\sim 10^7\) inelastic scatterings of 14 MeV n’s: \(n+O \rightarrow n+\gamma\) (6.128 MeV) and \(n+C \rightarrow C+n' + \gamma\) (4.44 MeV). C or O ejection from 3 DNA’s should manifest itself as 3 (2) \(\gamma\) peaks corresponding to 6, 7, 8 O (9, 10 C). We observed 3 O \(\gamma\) peaks containing 8,526±400, 10,495±402, 11,448±405 each; and 2 C peaks, as expected; and decoded stoichiometry of 3 DNA’s with 3-5 \(\sigma\) in 30°, signal/background \(\sim 2\%\). Applications of femtoatometry to genomics, genetic engineering and noninvasive cancer diagnostics will be presented… (maglich@calsec.com)

\(^1\)ICBP 7th International Conference on Biological Physics, 2011.
Wayne State University, ALICE COLLABORATION — We report results of the $\pi^0$ reconstruction in p+p and Pb+Pb collisions at 2.76 TeV collisions at the LHC, using invariant mass and shower shape analysis based on signals from the ALICE EMcal and PHOS electromagnetic calorimeters, and $e^+e^-$ conversion pair reconstruction with the central tracking system. We present measurements of the $\pi^0$ production cross section as a function of transverse momentum and the neutral pion elliptic flow compared with the $v_2$ of charged pions. We use the measured spectra to determine the nuclear modification factor, $R_{AA}$, of Pb+Pb collisions which we compare to theoretical predictions, results from RHIC as well as from the charged pion analysis, showing a strong suppression of the $\pi^0$ spectrum at high-$p_T$.

10:42AM NG.00002 Jet-underlying event studies with ALICE detector at the LHC, BETTY ABELEV1, LBNL — Relativistic heavy ion collisions produce a state of strongly interacting matter of quarks and gluons, called the Quark Gluon Plasma (QGP). Measuring particle production via fragmentation (specifically in jets) and understanding parton energy loss in the QGP enables one to directly probe the medium. One of the necessary components in studying jets in heavy ion events is the ability to isolate jets from the soft physics background, i.e., the underlying event. Thus it is important to understand the underlying event properties, in particular, energy fluctuations. This presentation will address the initial studies done to map out the underlying event in $\sqrt{s} = 7$ TeV pp collisions measured with the ALICE detector at the LHC, as preparation for extending these studies to Pb-Pb collisions. The focus will be on the analyses performed with the ALICE Electro-Magnetic Calorimeter (EMCal). EMCal is especially well-suited for the measurement of high-momentum particles which are produced predominantly in jets and therefore is a useful tool in subtracting the jet cone from the underlying event.

1For the ALICE Collaboration

10:54AM NG.00003 Electrons from B-meson semileptonic decay in 2.76 TeV p-p collisions identified by the ALICE EMCal, TOMAS ARONSSON, Yale University, ALICE COLLABORATION — High-energy heavy ion (HI) collisions at the LHC allow physicists to study the properties of the quark-gluon plasma (QGP). Heavy quarks produced in the hard-scattering of the HI collision are excellent probes of the QGP. When they traverse the QGP the heavy quarks are expected, according to pQCD, to suffer an energy loss per unit distance proportional to the inverse of the quark mass. Experimental data from RHIC indicate small or no such mass dependence. Beauty quarks, which are considered heavy quarks, produce hadrons with a relatively long lifetime ($\tau_e \sim 100 - 500 \mu$m). The semileptonic decay of these hadrons can be identified against the background by secondary vertex reconstruction from high momentum electrons and associated hadrons. The ALICE EMCal detector possesses outstanding particle identification for electrons at high transverse momentum $p_T$. In combination with the ALICE central tracking detectors provides identification of secondary vertices from semileptonic decay of beauty mesons. The electron associated with the secondary vertex is then tagged as a B-electron and the resulting electron from the semileptonic decays of heavy quarks can be used to extract information on the transport properties of the QGP.

11:06AM NG.00004 Heavy flavor electrons in $\sqrt{s} = 2.76$ TeV p-p collisions using the ALICE detector1, BERNARD HICKS, Yale University — Recent measurements from RHIC and the LHC seem to confirm T.D.Lee’s hypothesis that a hot and dense strongly interacting medium, the quark-gluon plasma (QGP), could be formed in heavy-ion collisions at high energies. Perturbative QCD predicts that high energy partons passing through a QGP will lose a fraction of their energy (jet quenching) proportional to the density and the traversed distance in the medium. Moreover, for quarks, the amount of the energy lost to the medium depends on their flavor and is inversely proportional to their mass. Heavy quarks (b and c) being formed in the early stages of heavy-ion collisions, are a good probe for the properties of the QGP and allow to study the predicted flavor dependence of jet quenching. Consequently, the spectrum of electrons from the semileptonic decays of heavy quarks at intermediate/high $p_T$ can provide additional constraints to the theoretical descriptions of the energy loss mechanism. Electrons are identified using the ALICE Electro-Magnetic Calorimeter (EMCal) in conjunction with the mid-rapidity tracking detectors, the Inner Silicon Tracker (ITS) and the Time Projection Chamber (TPC). The major sources of background electrons, such as those from photonic decays, are identified and then subtracted to produce a non-photonic electron spectrum. We present studies towards the crucial reference measurement of the production cross-sections of electrons from b and c decays from pp collisions at $\sqrt{s}=2.76$ TeV at the LHC reconstructed in ALICE.

1on behalf of the ALICE collaboration

11:18AM NG.00005 Heavy flavor electron $v_2$ in Au+Au Collisions at $\sqrt{s_{NN}}=62.4$ GeV, LEI DING, Iowa State University, PHENIX COLLABORATION — Heavy quarks are produced early in relativistic heavy ion collisions and propagate through and interact with the medium created in the collisions. The measurement of azimuthal anisotropy $v_2$ of single electrons from semi-leptonic decay of open heavy flavor mesons in PHENIX experiment has provided important understanding of the geometrical dependence of partonic energy loss. PHENIX results of $v_2$ in Au+Au collision at $\sqrt{s_{NN}}=200$GeV for heavy-flavor decays are comparable to the $v_2$ measurements of other hadrons, which is not well understood. We extend the PHENIX systematic study of azimuthal anisotropy by reducing the beam energy to $\sqrt{s_{NN}}=62.4$GeV. We will present $v_2$ of heavy flavor electrons at 62.4GeV.

11:30AM NG.00006 Measurement of Upsilon suppression in Au+Au collisions at 200 GeV, SHAWN WHITAKER, Iowa State University, PHENIX COLLABORATION — Understanding the quarkonium suppression mechanisms of the QGP is one of the outstanding challenges for theorists and experimentalists at RHIC. Measuring several states in the charmonium and bottomonium families is predicted to provide an indication of the temperature of the plasma since in a hot medium less tightly bound states are predicted to dissociate at lower temperatures than the more tightly bound ground states. A large sample of Au+Au collisions at $\sqrt{s_{NN}}=200$ GeV was collected during 2010 data taking run with the PHENIX detector at RHIC. From this sample $\Upsilon$ yields at mid-rapidity from the di-electron decay channel were determined and used to calculate its nuclear modification factor.

11:42AM NG.00007 The elliptic flow of di-leptons in 200 GeV Au+Au collisions at STAR1, XIANGLI CUI, University of Science and Technology of China (USTC) — Di-leptons are ideal probes of the strongly interacting hot, dense medium created at RHIC. They are not affected by the strong interaction once produced, therefore they can probe the whole evolution of the collision. The di-lepton spectra in the intermediate mass range are directly related to thermal radiation of the QGP. In the low mass range, we can study the vector meson in-medium properties through their di-lepton decays, the observable of possible chiral symmetry restoration. In addition to the spectrum, the elliptic flow of di-leptons, which is sensitive to the early time dynamics, might also shed light on the properties of the medium. In year 2010, a large amount of data were taken in 200 GeV Au+Au collisions with the full time-of-flight detector in operation, which enables the elliptic flow measurements of di-leptons. In this poster, we will present the details of the analysis including background subtraction and elliptic flow methodology.

1STAR Physics Group
11:54AM NG.00008 Tagging Jets with Heavy Flavor using the PHENIX VTX Detector. ALEXANDER SHAVER, Iowa State University, PHENIX COLLABORATION — To better understand the behavior of hadron jets containing heavy flavor (charm, beauty), measurements by a silicon vertex detector (VTX) will be used to tag jets reconstructed by the anti-$k_T$ algorithm. The VTX provides precise measurements of particle tracks near the vertex, and allows us to determine quantities such as reconstructed secondary vertices, and the distance of closest approach of each track to the collision vertex. By taking advantage of the longer lifetimes of hadrons with heavy flavor (D and B mesons, for example), we can preferentially select jets containing heavy flavor for further study. I will show results from simulated data of the predicted VTX capabilities for tagging jets containing heavy flavor. The status of performing such measurements in p+p and Au+Au data collected in the RHIC 2011 run will be discussed.

12:06PM NG.00009 A Novel and Compact Muon Telescope Detector at STAR for Midrapidity Di-lepton Physics at RHIC, LIJUAN RUAN, Brookhaven National Laboratory — Data taken over the last decade have demonstrated that RHIC has created a hot, dense medium with partonic degrees of freedom. One of the physics goals for the next decade is to study the fundamental properties of this medium such as temperature, density profile, and color screening length via electro-magnetic probes such as di-leptons. Muons have a clear advantage over electrons due to reduced Bremsstrahlung radiation in the detector material. This is essential for separating the ground state (1S) of the Upsilon from its excited states (2S+3S) which are predicted to melt at very different temperatures. We propose a novel and compact Muon Telescope Detector (MTD) in the Solenoidal Tracker at RHIC (STAR) at mid-rapidity to measure different Upsilon states, J/psi over a broad transverse momentum range through di-muon decays to study color screening features, and muon-e correlations to distinguish heavy flavor correlations from initial lepton pair production. In this talk, we will present the physics cases for the proposed MTD. We will report the R&D results including simulations and MTD prototype performance at STAR.

12:18PM NG.00010 The PHENIX MuTrig Local Level One Trigger Upgrade at PHENIX. JOSHUA PERRY, PHENIX — The PHENIX detector at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory has had robust forward muon tracking and identification from the MuTracker and MuID detector systems for many years. The addition of the resistive plate chamber (RPC) detectors in the forward region as well as the upgrade of the muon tracker (MuTr) front-end electronics allows for greater rejection of both collision related and non-collision related backgrounds at the trigger level. The MuTrig Local Level One (LL1) trigger system allows for the rejection of events without high momentum muons originating from the collision; this allows for collision event selection (such as W boson production). This updated trigger system will ultimately increase the trigger rejection factor from a few hundred to over 9,000. The LL1 trigger system is a very sensitive system which requires active monitoring. This presentation focuses on commissioning of the MuTrig LL1 and the implementation and monitoring of the trigger system during its installation in 2011.