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INTRODUCTION

Stony Brook University is proud to host the Research Experiences for Undergraduates (REU) Program in Physics. Sponsored by the National Science Foundation (NSF), this program gives undergraduate students an intensive hands-on research experience and involves them in all phases of the research process. This year, twelve summer researchers from colleges and universities throughout the country were selected from a select pool of approximately two hundred applicants. In carrying out their projects, REU participants worked alongside Stony Brook's faculty, post-docs, graduate students and other undergraduates. The summer activities culminated in a presentation of the students' work in a research symposium and in a written report.

As you read this collection of their abstracts, you will see evidence of their hard work, keen insight and enthusiasm, and be impressed at what they have accomplished in only eight weeks. I have no doubt that these individuals will continue on with successful academic and research careers.

—Erlend Graf, NSF REU Physics Site Director, Stony Brook University

Gabrielle Brochard
The College of New Jersey

BUILDING A HADRON BLIND DETECTOR — THE EVAPORATION PROCESS AND QUANTUM EFFICIENCY TESTS

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The newest upgrade to the PHENIX detector at the Relativistic Heavy Ion Collider is a Hadron Blind Detector (HBD). The HBD detects only high energy electrons by measuring the Cherenkov light they produce. One of the most important features of this detector is that it is photo sensitive without being charge sensitive. This is accomplished by evaporating Cesium Iodide in high vacuum, depositing a thin layer onto a gold-plated GEM substrate. Cesium Iodide is particularly sensitive to UV light and releases electrons when hit by light waves of this range, creating a current that will be measured.

During the evaporation 800 milligrams of CsI is placed in a molybdenum boat under each of four substrates. Once a vacuum on the order of 10^{-7} millibars is established the boats are resistively heated until the CsI evaporates. The CsI is deposited at a rate of ~ 2 nm/s for 3 minutes, creating a final thickness on the substrate of ~ 350 nm. While this process results in an even layer, it is still important to test the sensitivity of each photocathode by measuring its quantum efficiency, the percentage of photons hitting the surface that produce an electron-hole pair. A specialized circuit is used which includes a picoammeter that accurately measures the small (nanoampere) current from each photocathode. After this test the photocathodes are sent on to the next stage of the production process for the HBD. This work was supported by grants from the National Science Foundation (Phy-0552521, Phy-0521536) and a grant from the Department of Energy (DEFG0296ER40988).

Christina Bunker
Stony Brook University

REDSHIFTS CALCULATED FROM OPTICAL AND NEAR-INFRARED DATA IN THE HUBBLE DEEP FIELD

Christina Bunker, *Stony Brook University*; Krish Kotru, *Tufts University*; Stefan Gromoll, Ken Lanzetta, *Department of Physics & Astronomy, Stony Brook University*

The purpose of our project was to investigate the accuracy of the redshifts of galaxies in the Hubble Deep Field that our group is able to calculate using a photometric method. If the redshift we found was more than a couple hundredths off from the expected value, we were to consider them not to agree and figure out why. We were able to compare our work with accepted values from the extensive studies that have been done in the Hubble Deep Field. Using only the optical fluxes we concluded that the code to calculate the redshift works correctly. The near-infrared data did not produce results that agree so nicely, leading us to believe there is some error in the fit or registration of the flux of the near-infrared data. By constructing a Perl program we were able to, for any number of galaxies, quickly match up infrared fluxes from our database and the redshifts they will produce to the widely accepted values. We constructed plots in Super Mongo to see the relation of our values to the correct ones. We then had to find the appropriate grid to register the data for the infrared images. In each case we fit the fluxes and observed sometimes increasing and decreasing accuracy of residuals. Residuals are made to see if our calculations with our models of sources and point spread functions produce a good fit to the data. Our goal was to observe only background noise in this image. By looking at the individual sources we found that sometimes the redshifts would not be correct because our objects were not identified correctly. We sometimes had two or more different galaxies where there should only be one. The other case that causes errors in the redshift of a galaxy would be when there was more than one probable redshift for an object and our programs would choose the incorrect one. We conclude that our photometric method and calculations are correct when the sources are labeled right and the images are registered properly. Funding for this project has been provided by a grant from the National Science Foundation (Phy-0552521).

Karen Cydylo
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CONSTRUCTION OF AN INVERTED OPTICAL TWEEZERS

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While several previous experiments with optical tweezers have been performed in the Laser Teaching Center, this is the first attempt to build an inverted optical tweezers. Optical tweezers trap particles on the size of a micron, and are commonly used in biophysics to study pico-newton forces on, and the motion of, biological molecules and cells. Optical tweezers use the forces associated with the redirection of light to trap particles at the center of a tightly focused laser beam. Incident light rays both reflect and refract when they interact with the particles, resulting in forces due to changes in momentum. The gradient force, which always points towards the point of highest light intensity, is what keeps particles confined in the trap. There is also an undesired radiation pressure force that pushes the particles out of the trap, away from the incident light. In a normal tweezers setup the radiation pressure force and gravity both work against the trapping force. In inverted optical tweezers the laser beam is focused upward onto the particles, so that the radiation pressure force and gravity are opposed. As a result it is much easier to achieve true three-dimensional trapping in an inverted tweezers.

The goal of this project is to create a useful inverted tweezers setup from existing components. The heart of the setup is a donated Nikon inverted microscope that became available during the project. This provides a very stable mechanical system and an effective illumination device (condenser). For the laser we originally used a Sharp LT024 near-infrared (780 nm) diode. The diode laser has an elliptical beam, but this can be circularized using a pair of cylinder lenses. The beam is focused by an 100X oil-immersion objective to create the optical trap. The specimen is illuminated from above and observed with a GBC CCTV camera focused at infinity.

After assembling this setup and achieving an appropriate beam size and shape it was noticed that the laser output power was much lower than expected, only 3 mW versus about 20 mW. Since 3 mW was unlikely to be sufficient power to achieve trapping, the setup was rebuilt using a 19.5 mW red He-Ne laser (632.8 nm). The HeNe beam is already circular, and only has to be enlarged by a pair of spherical lenses with a focal length ratio of 5:1.

We have successfully imaged with this inverted microscope-camera setup, and have observed Brownian motion in yeast cells. The HeNe laser setup is complete and aligned and we hope to achieve trapping soon. In future experiments with this setup a cut transparent plastic film will be placed in the laser beam, thus creating an "optical vortex" beam that can rotate the trapped particles.

This work was supported by a grant from the National Science Foundation (Phy-0243935).

Stephanie Golmon
Principia College

LASER MODE STABILIZATION THROUGH OPTICAL-THERMAL FEEDBACK

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Stabilized lasers are important to science in many ways. They are an essential part of large projects designed to search for gravity waves or trap cesium atoms for setting the world's time standard. An intensity and/or frequency stabilized single-mode laser is also an invaluable general-purpose laboratory tool for diverse experiments such as interferometry, holography, metrology, and atom trapping. The purpose of this project is to stabilize the modes of a HeNe laser using an optical-thermal feedback system.

A given laser can only produce specific frequencies, called modes, which are set by the condition that there must be nodes of the electric field at both ends of the laser cavity. Possible frequencies are given by the equation $\nu_m = mc/2L$, where ν_m is an allowed frequency, m is an integer, and L is the cavity length of the laser. The modes of the HeNe laser used in this project (Siemens LGR7655, 1 mW, $L=14$ cm) are separated by approximately 1.05 GHz. Since this is less than the width of the HeNe gain curve of approximately 1.5 GHz, for this laser at most two modes can lase simultaneously. These modes are alternately orthogonally polarized. As the laser warms up, thermal expansion changes the length of the laser cavity, causing the differing modes to "sweep" under the gain curve. The purpose of the stabilization circuit that was implemented is to "freeze" two modes under the gain curve at positions where their intensities are equal. This assures that the frequency of the two modes will be stable. Theoretically, it is possible to stabilize this laser to an accuracy of seven or more significant digits.

The two lasing modes were separated using a polarizing beam splitter, and their intensities measured using two photodetectors (Thorlabs DET110). The two signals were subtracted in a differential pre-amp box (PAR 113) and the resulting error signal used to control the current through a thermofoil heater (Minco 5459) wrapped around the laser tube. It takes 1-1/2 hours for the laser tube to reach its nominal operating temperature of about 80 C. The heater supplies a maximum of one Watt, which raises the temperature a further 5 - 10 degrees. With this arrangement the error signal (the intensity difference between the two modes) can be locked to within 1% of its maximum value. An earlier version of the circuit in which the two light signals were subtracted in an op-amp failed to produce a lock, possibly due to differences in the time constants between the two circuits. Efforts are underway to complete a usable all op-amp feedback circuit.

This work was supported by NSF Grant No. Phy-0243935.

Ben Huang
Harvard University

GAIN ANALYSIS OF CESIUM IODIDE PHOTOCATHODES FOR THE HADRON BLIND DETECTOR

Benedict Shan Yuan Huang, *Harvard University*; Gabrielle Brochard, *The College of New Jersey*; Benjamin Weaver, *Western Washington University*; Jason Kamin, William Anderson, Matthew Durham, *Stony Brook University*; Thomas K. Hemmick, *Department of Physics & Astronomy, Stony Brook University*

One of the most significant sources of background signals in experimental high energy nuclear physics is the production of electron/positron pairs via Dalitz decay. Currently, the PHENIX experiment at RHIC is only able to track electrons and positrons with velocities sufficient to escape the magnetic field and reach the detector. The loss of particles within the field leads to large systematic errors in all resulting calculations. Hence, one of the detector upgrades for PHENIX is the Hadron Blind Detector (HBD), which detects the Cherenkov light produced by high velocity electrons and positrons and will aid in maximizing the signal/background ratio. Situated in a magnetic field-free region close to the beam pipe, the HBD utilizes a novel design that is part phototube and part wire chamber. The evaporation of a thin film of cesium iodide on a gold plated gas electron multiplier (GEM) creates a non-charge sensitive photo-detector. The resulting signal is further amplified by two additional GEM's underneath the primary gold plated GEM.

During production of these "GEM stacks" it is important to verify that all regions of each stack are functional and have approximately the same desired amplification, or gain. These "maps" are accomplished through the use of a specialized gain test box, injected with Argon and CO₂, and a 5.9 keV ⁵⁵Fe x-ray source. The signals are subsequently amplified before being analyzed by multi-channel analyzing software. Overall, we have confirmed that each GEM stack has a saturated gain map approximately equal to the expected mappings derived from the data of each single GEM. However, the behavior of each stack's gain compared to its exposure time is not yet fully understood, and further analyses will be required after installation.

This work was supported by grants from the National Science Foundation (PHY0552521, PHY0521536) and the Department of Energy (DEFG0296ER40988).

Michael Kornhauser
University of Rochester

DEMONSTRATING THE PHOTOREFRACTIVE EFFECT IN LITHIUM NIOBATE BY TWO-WAVE MIXING

Michael Kornhauser, *University of Rochester*; John Noé, Marty Cohen, Harold Metcalf, *Laser Teaching Center, Department of Physics & Astronomy, Stony Brook University*

The photorefractive effect is a nonlinear optical phenomenon in which the local index of refraction of certain transparent materials is changed by the spatial variation of the incident light intensity. In these materials, which include electro-optic crystals and polymers, the local index $n(x,y,z)$ depends on the strength of the electric field at that point. Interference of two light beams in the material creates a standing wave, with alternating regions of high and low light intensity. Electrons freed within the bright regions tend to drift toward dark regions, creating a gradually increasing electric field, which then modifies the local index. Thus these materials provide a way to "modify light with light" similar to the way that a transistor allows one electrical current to modify (amplify) another. The photorefractive effect has many novel and useful applications, including holographic information storage, image amplification and enhancement, and optical computing.

The goal of this project was to demonstrate the photorefractive effect in single-crystal lithium niobate (LiNbO₃) via two-wave mixing. In two-wave mixing the relative intensity of two light beams that intersect inside the crystal changes in response to the photorefractive effect. The originally weaker beam becomes more intense, and vice versa. The setup includes a polarized HeNe laser (632.8 nm, 12 mW), a 50:50 beam splitter, a movable mirror, two lenses ($f = 125$ and 200 mm), the crystal on an adjustable mount, and two photodetectors. The lenses focus each beam to a tiny "waist" no more than a few hundred microns in diameter over the length of the crystal. A key challenge is getting the two tiny crossing beams to actually intersect, by small adjustments to the mirror; a simple knife-edge technique was found very helpful for this task.

LiNbO₃ crystals are expensive, but fortunately a major supplier of these was willing to donate two of them for this project. The first crystal received was 9x9x25 mm with just the two small faces polished. It was determined by observations with crossed polarizers that the optic axis of this crystal is perpendicular to the polished faces. Unfortunately this orientation is not well suited to creating a strong photorefractive effect. The second crystal has the optic axis in the optimum direction, parallel to the polished faces. It is 11 mm wide, but only 1 mm thick and quite long (50 mm), so aligning it with respect to the intersecting laser beams is a challenge. Unfortunately, at the time of submission of this abstract the new crystal had not yet arrived, so we are proceeding with a search for evidence of two-wave mixing in the original crystal.

We are indebted to John Kump from Crystal Technologies, Inc. for providing the donated lithium niobate crystals. This work was supported by a grant from the National Science Foundation (Phy-0243935).

Krish Kotru
Tufts University

**TESTING A NEW PHOTOMETRIC REDSHIFT PROGRAM WITH OPTICAL AND NEAR-
INFRARED DATA**

Krish Kotru, *Tufts University*; Christina Bunker, *Stony Brook University*; Stefan Gromoll and Ken Lanzetta, *Department of Physics & Astronomy, Stony Brook University*

Three years ago, Prof. Ken Lanzetta of Stony Brook University and Alberto Fernandez-Soto of the University of New South Wales photometrically measured the redshifts of 1,067 galaxies in the Hubble Deep Field (HDF) with optical and near-infrared bandpasses. A majority of their results either closely matched or corrected previous spectroscopic measurements. Currently, Lanzetta and Stony Brook graduate student, Stefan Gromoll, are working on a more sophisticated program that uses photometry to calculate redshifts from the same part of the electromagnetic spectrum. The improvement comes in the form of a more precise model for the data. To produce this model, data from several bandpasses are deconvolved using point-spread functions, and then recombined, translated, and rotated to fit the HDF image. In addition, the new program uses mid-infrared data taken by the Spitzer Space Telescope (SST) to constrain some aspects of galaxy formation.

Our role in this large-scale endeavor is to test the new program and help with the debugging process. The program should, in principle, work with optical and near-infrared light as it does with mid-infrared light from SST. If we can use it to measure the redshifts of HDF galaxies in the same bandpasses that Fernandez-Soto used, and then match the old results, we should be able to trust our new measurements of the SST data.

The portion of the new program that calculates redshifts from a given set of fluxes very nearly reproduces previous results. Our problems lie in our ability to correctly measure fluxes from the data. Specifically, the registration, or positional match up, of the model tends to stray far enough from the data to create significant errors. Flux measurements are thereby inaccurate, as are redshifts. On the occasion where the model and the data are registered within tolerable error, our redshifts match those of Soto.

This study was funded by NSF Grant Phy-0552521

Andrew Lingenfelter
Worcester Polytechnic Institute

THE DAQ SETUP AND USE OF COMPUTER INTERFACING TO PROCESS RADIO SIGNALS FOR DETECTION OF ATMOSPHERIC PHENOMENON

Andrew Lingenfelter, *Worcester Polytechnic Institute*; Zejie Zhang, Michael Marx, *Stony Brook University, Department of Physics & Astronomy*

With computer interfacing, we developed a data acquisition (DAQ) setup for the radio detection of atmospheric phenomenon and for the possible future detection of cosmic rays. Mixed Apparatus for Radar Investigation of Cosmic-rays of High Ionization, or MARIACHI, is an experiment that has the goal of a unified system for detection of these phenomena. MARIACHI involves many components including the use of an array of many ground scintillators and several radio antennas dispersed throughout Long Island. The DAQ system must be able to synchronize data from all the sites. Radio Cosmic Ray Scatter (RCRS) is a way to detect the ionization trail left by cosmic rays. With the use of a dipole antenna, PC, antenna receiver, sound card, GPS, and MATLAB we were able to set up two RCRS stations at Stony Brook University and Brookhaven National Lab.

We recorded signals in computer software called Spectrum Laboratory (SpecLab). We learned how to do basic operations in MATLAB and eventually how to process these signals. We faced many timing and synchronization issues, some of which were solved. By implementing the GPS pulse per second and event time tag with the signal, we created a MATLAB program that sets the antenna data on the appropriate time scale. Although receiver-GPS synchronization was achieved, sound card synchronization was not possible with the equipment available. Although radio data can be analyzed with the use of SpecLab and MATLAB, we determined that LabView would be the best DAQ method for the future of the MARIACHI project. We created numerous manuals and setup instructions, along with an online journal, to facilitate the continuation of this work by others. This work was funded by NSF grant number Phy-0552521.

Frank Modica
Stony Brook University

STAR CLUSTER AGES OF THE IC883 GALAXY BY PHOTOMETRIC ANALYSIS

Frank Modica; *Stony Brook University* and Aaron Evans, *Department of Physics & Astronomy, Stony Brook University*

The objective of this project was to perform a multi-wavelength study of star clusters in the IC883 starburst galaxy. This galaxy is the result of a collision between two galaxies, as is evident from its ultraluminous infrared properties and distinct tails that arise from tidal forces. High resolution images of the target come from the NICMOS and ACS cameras of the Hubble Space Telescope, with filters in the I-band, H-band, 110μ , 160μ , and 200μ . The purpose of imaging in different bands is that different features of the galaxy reflect some wavelengths more efficiently than others. For example, the dust that accumulates within galaxy mergers can hide the galaxy nuclei but can be penetrated at longer wavelengths. This is demonstrated by the considerably larger number of visible star clusters at B and I band. CO data will also be used as a tracer for the molecular gas in the galaxy to show where stars are forming. Fixed aperture photometry of the star clusters was computed by combining the Interactive Data Language (IDL) with Source Extractor. The latter smooths and median-filters the background of the images. However, it cannot perform fixed circular aperture photometry at the current time, so IDL code was written to do this on the resultant images. For the most accurate photometric results, the PSF of the point sources need to be taken into account. Plots of flux versus aperture size for a sample star showed that the flux kept increasing all the way to the end of the frame of the image. Aperture correction was then accomplished with the TinyTim program which simulates PSF for different camera-filter combinations. By converting the flux to color magnitudes we plot relative colors and compare them with theoretical models. Specifically, the Worthy population model was used to compute the statistics/properties of a starburst galaxy with a continuous starburst with a 0.1 – 120 solar mass range. Plots such as B-I vs. I-H will be used to constrain the ages of the star clusters in order to learn the details of how and when stars form due to galaxy collisions.

Benjamin Moeller
University at Buffalo

**DATA ACQUISITION AND SYNCHRONIZATION FOR FORWARD SCATTERING OF
COSMIC RAYS USING LABVIEW**

*Benjamin Moeller, University at Buffalo, Zejie Zhang, Helio Takai, Michael Marx, Department of
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As cosmic rays enter the atmosphere, they strike particles with higher energies than any man-made collision. These collisions create particle showers, which then leave distinct ionization trails. The MARIACHI Project involves using forward scattering of radio signals to detect these ionization trails. This would allow for larger detection area at a lower cost than conventional scintillator ground detectors. The eventual goal of the project is to have many radio receiver sites, all acquiring data simultaneously. These are to be synchronized using GPS and networked using linux. This report summarizes the incorporation of LabView software in the data acquisition and processing method in the MARIACHI project. It includes the initial development of a new program for synchronization and storage. This program allows access to the data stream directly from the GPS, rather than just a pulse per second, allowing direct time tag of the data. Direct data streaming simplifies the process by saving the data as an array, rather than a music file as in Speclab, the original software used for data collection. Labview's flexible language also allows for future development. An online journal (wiki) was kept to allow others in the future to continue our work seamlessly. This work was funded by NSF grant Phy-0552521.

Xin (Flora) Wang
Columbia University

CONSTRUCTION AND RADIATION DAMAGE TESTING OF AN INTEGRATING SILICON DETECTOR WITH SEGMENTATION FOR SCANNING TRANSMISSION X-RAY MICROSCOPY

Xin Wang, Columbia University; Benjamin Hornberger, Chris Jacobsen, Department of Physics & Astronomy, Stony Brook University

X-ray microscopy is a valuable tool for studies in fields such as biology, chemistry, and environmental science. X-rays undergo both absorption and refraction in materials; while most microscope systems are sensitive only to absorption contrast, segmented detectors can be used to deliver phase contrast images provided they have adequate efficiency, dynamic range, and signal-to-noise characteristics. A first generation of detectors had been developed a few years ago for application in a soft X-ray (250 - 800 eV) scanning transmission microscope at the National Synchrotron Light Source (NSLS). More recently, a new version has been built for use with hard (4 - 12 keV) X-ray microprobes at the Advanced Photon Source (APS). Both use the same silicon chip, but different electronics to accommodate the different signal rates. The detectors we are currently working on are designed for hard x-ray microprobes at Argonne National Laboratory. As the specimen is scanned through a focused x-ray beam, images are formed by collecting the transmitted photon flux at each pixel. In the chip, charges are created from the incident photons (3.6eV creates one electron hole pair). Since photon counting becomes increasingly difficult at high flux rates due to dead time limitations, our detector uses charge integration to measure the signal transmitted in each image pixel. The detector chip is a photodiode made of high resistivity n-type silicon with rectifying junctions implanted with p-type material to form segments in an annular geometry matched to the symmetry of the microscope. A low leakage current in the detector chip is crucial for low-noise measurements of small signal currents. When the first detector chips were developed at Brookhaven National Laboratory by Michael Feser, Pavel Rehak et al.; they found radiation damage to be a big problem for frontside illumination. Just a few hours of radiation increased the leakage current of the detector chips by a factor of 100. In the case of backside illumination, the detector chip must be fully depleted, and this creates more natural leakage current--about 10 times as that of frontside illumination. Luckily, this leakage current is relatively stable over time, and is relatively small compared to the total current generated by hard x-rays though for soft x-rays it is on the same order of magnitude as our incoming signal. We are not completely sure as to what causes the radiation damage and different responses to radiation on the two sides of the silicon. One hypothesis is that the silicon oxide which forms on the surface of the chip when exposed to air causes the chip to be more vulnerable to leakage current. The chips we are working with now were developed at the Max Planck Institute with a different surface treatment. We assembled the new chip for frontside illumination onto the detector box for our beamline at the National Synchrotron Light Source, and set it to work under normal operating conditions for 10 hours. Despite our hope however, the new chip did not show any improvement in resistance to radiation. At this point, we are still unclear about the factors that cause radiation damage to the detector. Therefore, while backside illumination is being used at both Argonne and Brookhaven Labs, the search for a more radiation hard chip continues.

This work was supported by the National Science Foundation.

Benjamin Weaver
West Washington University

ASSEMBLING A HADRON BLIND DETECTOR

Benjamin Weaver, *Western Washington University*; B. Huang, *Harvard University*; G. Brochard, *The College of New Jersey*; W. Anderson, J. Kamin, J.M. Durham, *Stony Brook University*; T.K. Hemmick, *Stony Brook University, Department of Physics & Astronomy*

The Hadron Blind Detector (HBD) is an upgrade being assembled for the PHENIX experiment at the Relativistic Heavy Ion Collider (RHIC), BNL. The role of this detector is to identify electron-positron pair decays from low-mass vector mesons produced in heavy ion collisions. The HBD is the first detector of its kind, performing charged particle detection with minimal absorption of energy. The novelty of such a device is its capacity to detect the charged particle's Cherenkov light, while remaining "blind" to the charged particle's ionization trail. The HBD is a windowless Cherenkov detector utilizing a triple Gas Electron Multiplier (GEM) stack. The vessel is ~60 cm in Z and is filled with pure CF₄. The functionality of the HBD is based on the production of Cherenkov light created by the $e^+ e^-$ pairs traveling through the CF₄. The top (gold plated) GEM is evaporated with a CsI photocathode sensitive to this Cherenkov light. The voltage bias on a cathode grid above the GEM stack is such that very nearly all electrons produced from the ionization flow to the grid acting as an anode. The Cherenkov light, however, produces photoelectrons off the CsI photocathode, which follow electric field lines through the GEM, and this current is multiplied by the second and third GEMs. Current signal to background without the HBD is around 1:100. This background signal, owing primarily to photon conversions and Dalitz decay, has less than ideal electron identification. A distinguishing characteristic of this background signal is the very small opening angles of $e^+ e^-$ pairs due to the light or zero mass of its parent particle as opposed to the wide opening angles of pairs from heavy signal particles. The HBD will recognize this distinction and is expected to tag the background signal with greater than 90% efficiency. The tendency for only one of the pair's charged particles to escape the magnetic field for detection will also be eliminated, as the HBD will be installed directly around the collision point in a magnetic field-free region. With the implementation of the HBD, electron identification is expected to improve by a factor of 10 to 30 according to MC simulations. This will dramatically decrease errors in signal analysis.

Challenges of the construction and assembly of the vessel include a CsI evaporation onto the (top) gold-plated GEM, a quantum efficiency measurement as a test of photosensitivity, a GEM stack gain test, and installation of GEMs into the vessel. This work was funded by National Science Foundation grants (PHY-0552521 and PHY-0521536) and Department of Energy Grant (DEFG0296ER40988).

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