

CONTENTS

INTRODUCTION.....	2
PRODUCING OPTICAL VORTICES WITH AN ADJUSTABLE SPIRAL PHASE PLATE GREGORY CARAVELLI, AMOL JAIN, JOHN NOÉ AND HAROLD METCALF	3
SINGLE BUBBLE SONOLUMINESCENCE MAANELI DERAKHSHANI, JOHN NOÉ AND HAROLD METCALF.....	4
INTERPOLATING EVOLUTIONARY TRACKS OF RAPIDLY ROTATING STARS DANIELLE KUMPULANIAN AND DEANE PETERSON	5
ANALYSIS OF DEEP MULTI-BAND IMAGING DATA FROM THE SPITZER SPACE TELESCOPE AND THE HUBBLE SPACE TELESCOPE MICHAEL SCHAUBER, KENNETH M. LANZETTA AND STEPHAN GROMOLL	6
ARBITRARY SHAPING OF FEMTOSECOND LASER PULSES NATHAN CHANDLER-SMITH; DAVID CARDOZA, SARAH NICHOLS, CARLOS TRALLERO, DANIEL FLICKINGER, BRETT PEARSON AND THOMAS WEINACHT.....	7
PHYSICS AND DATA ANALYSIS IN ELECTRON ENERGY-LOSS SPECTROSCOPY DMITRY MEYERSON AND CHRIS JACOBSEN	8
USING THE ELECTRIC TUNNEL EFFECT TO DETERMINE THE QUANTUM BARRIER HEIGHTS OF SIMILAR ELECTRODES SEPARATED BY A THIN INSULATING FILM COLUMBINE ROBINSON AND EMILIO MENDEZ	9
DETECTING MAGNETIC MONOPOLES WITH THE CERENKOV EFFECT DANIEL P. HOGAN AND ALFRED S. GOLDBERGER	10
EXPERIMENTAL AND THEORETICAL ANALYSIS OF THE “JUMPING RING” APPARATUS ROBERT P. NOWICKI AND ERLEND GRAF	11
SCATTERING OF BENJAMIN-ONO SOLITONS ON IMPURITIES ABHINAV GULIANI AND ALEXANDRE ABANOV.....	12
SILICON VERTEX TRACKER (SVTX) AND THE CAEN SY1527 UNIVERSAL MULTICHANNEL POWER SUPPLY SYSTEM FOOK CHIN CHIANG, HARRY THEMANN AND AXEL DREES	13
PHOTOCATHODE PRODUCTION USING CESIUM IODIDE EVAPORATION IN HIGH VACUUM ARTHUR EVANS, MEGAN LINZEY, THOMAS HEMMICK, JASON KAMIN, RICHARD LEFFERTS.....	14
FITTING (P_T) SINGLE-SPECTRA IN CU+CU SYSTEMS AT PHENIX EVAN KORNACKI; NATHAN EMERSON AND THOMAS K. HEMMICK.....	15
DESIGN AND CONSTRUCTION OF A SPARK CHAMBER MICHAEL ASSIS, EUGENE VAYNBERG, MICHAEL RIJSSENBEEK AND JACK STEFFENS.....	16
A GENERAL PURPOSE LASER SCANNING PROGRAM BUILT WITH “LABVIEW” CHRISTOPHER MILLER AND GENE SPROUSE.....	17
INDEX OF UNDERGRADUATE CONTRIBUTORS.....	18

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, fifteen summer researchers from fourteen 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. Our symposium also features the work of SBU and/or visiting undergraduates funded outside of the REU program.

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

Greg Caravelli
John Hopkins University

PRODUCING OPTICAL VORTICES WITH AN ADJUSTABLE SPIRAL PHASE PLATE

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John Noé and Harold Metcalf, Laser Teaching Center, Department of Physics & Astronomy,
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An optical vortex (OV) is an example of a phase singularity in a wavefield, that is, a point in space where the phase of the field is undefined and the amplitude is necessarily zero. A loosely related but more familiar example would be trying to identify directions such as East or West while standing on the earth's North Pole. In recent years the study of such optical singularities has emerged as an exciting new discipline, both on account of its inherent theoretical interest and applications in diverse fields such as optical manipulation (laser tweezers), quantum computing and encryption. The most common type of OV is characterized by a spiral phase distribution in which the phase of the light field steadily increases in proportion to the azimuthal angle ϕ as one moves around the vortex center (phase = $\exp\{im\phi\}$). After one complete revolution the phase has advanced by an integer multiple m times 2π ; this integer is called the topological charge of the vortex. OV's are commonly created by passing a laser beam through a type of diffraction pattern called a computer-generated hologram (CGH). A more effective method is to directly impose a spiral phase-shift distribution on the light beam by varying the thickness of a transparent material through which it passes. A fixed spiral phase plate can be made by micro-lithography, a technically difficult process. Such a device is also limited to a specific wavelength. A variable (computer controlled) phase plate can be created using a spatial-light modulator (SLM), but such devices are quite expensive.

In the current project an extremely simple and inexpensive method [1] for creating a spiral phase plate was investigated experimentally. The device can be easily adjusted to produce OV's of varying topological charge at any laser wavelength. (We observed vortices up to charge 7 with a HeNe laser.) Our version consists of a 22 mm square, 0.25 mm thick, plastic microscope cover slip which has been cut along a line running radially outwards from the center to one corner. It is "tuned" by inserting a thin plastic wedge part way into the cut; this causes the material on either side of the cut to curve smoothly outwards in opposite directions. The resulting surface tilt creates a spatially varying optical path length distribution and hence a varying phase shift. It is of great interest to know what the tilt angle distribution is, as this information can be used to model and refine the device. A simple optical-lever method was developed to accurately measure the surface tilt at 441 points on a 500 micron grid. The spot diameter of the scanning HeNe laser beam was estimated to be 200 microns. Analysis of the data to extract the tilt distribution is in progress.

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

1) See C. Rotschild, et al. "Adjustable Spiral Phase Plate," *Applied Optics*, April 2004.

Maaneli Derakhshani Stony Brook University

SINGLE BUBBLE SONOLUMINESCENCE

Maaneli Derakhshani, Stony Brook University; John Noé, Harold Metcalf, Laser Teaching Center, Department of Physics & Astronomy, Stony Brook University

Single bubble sonoluminescence (SBSL) is the process whereby ultrasonic sound waves cause the growth and collapse of micron-size air bubbles, the consequence of which is the emission of energy in the form of picosecond-long flashes of light. The phenomenon is of considerable interest due to the production of temperatures exceeding 10,000 Kelvin on the surface of the bubble, and the lack of consensus among researchers on the details of the physical mechanism. The conventional method by which SBSL is produced involves injecting a gas bubble into a small spherical flask of degassed water that is oscillating at its fundamental resonant frequency of ~26 kHz; two piezoelectric transducers (PZTs) on opposite sides of the flask create the standing wave pattern. The bubble is attracted to the pressure anti-node at the center of the flask, where it repeatedly expands and contracts as a result of the changing sound pressure in the surrounding liquid. The rapid collapse of the bubble causes it to emit photons which peak in the ultraviolet.

To date this study has focused on getting an existing dormant setup back into operation and developing a quantitative understanding of key experimental parameters in SBSL, such as producing sufficiently intense sound waves and achieving the optimum concentration of dissolved gas in water. In addition, a number of connections between SBSL and other fields of study have been explored, such as the use of SBSL as a black hole analogue model, and the discovery and use of acoustical (as opposed to optical) vortices to induce a torque on a sonoluminescing bubble. Laser-induced cavitation was also studied for its potential use as a means of investigating claims of "bubble fusion." One of us (MD) even toured a large sonoluminescence display set up at an art gallery in New York City.

The PZT's used to produce sound waves in our setup are driven by a series resonant circuit connected to a voltage-to-current amplifier. The op-amp circuit was analyzed and an equation was derived to model its behavior. Several components of the SL apparatus were also repaired, such as the microphone transducer, the vacuum pump valves and gauge meter, and one of the PZT drivers. Experiments related to quantifying the amount of air dissolved in water were more time consuming. The goal was to use the pressure rise in a closed vacuum system holding the degassed water as an indicator, but the dissolved gas was found to be released unexpectedly slowly, over many days. Alternative techniques for measuring dissolved air are being explored.

The current work will continue here in the fall, with the initial goal of consistently producing SBSL and enhancing visible light output by using additives such as glycerin or the wavelength-shifter luminol. Further studies will attempt to measure bubble size through Mie scattering and investigate the effects of magnetic fields on bubble stability.

This study was supported by NSF Grant No. PHY-0243935.

Danielle Kumpulanian
Rensselaer Polytechnic Institute (RPI)

INTERPOLATING EVOLUTIONARY TRACKS OF RAPIDLY ROTATING STARS

Danielle Kumpulanian, Rensselaer Polytechnic Institute; Deane Peterson, Department of Physics & Astronomy, Stony Brook University

This project has two purposes: to provide an accurate method of interpolating data from published evolutionary models grids, and to solve the problem of inferring the mass or range of possible mass values of a star given its radius and luminosity. The first is necessary because the grids only cover a limited set of mass values, and studying an object of an arbitrary mass requires data for that mass to be interpolated and used.

In this case, the stellar models grids were those published by A. Claret in 2004. These tracks were plotted on a $\log(\text{radius})$ vs. $\log(\text{luminosity})$ diagram. The interpolation method was tested by using the existing tracks and linearly interpolating one intermediate track. This test showed that this interpolation method could be used, accurate to better than 1%, for any $\log(\text{mass})$ in the range of the $\log(\text{mass})$ values given in the grid, and therefore, new models grids could be accurately generated using existing ones.

The evolutionary tracks plotted on the $\log(\text{radius})$ vs. $\log(\text{luminosity})$ plot are complicated and include loops. Because of this, the tracks are divided into three sections, with the middle section being the loop area. In this area, multiple values for $\log(\text{mass})$ can exist, and a range of values can be determined. In the other areas, one value can be found. So the process requires finding first which area the $[\log(\text{radius}), \log(\text{luminosity})]$ point in question occupies and, if it is in the loop region, finding the range of $\log(\text{mass})$ involved.

This project fits into a larger context. Two properties of stars, radius and luminosity, are known to remain unchanged when the stars rotate. These can be found using observational techniques, and using these two quantities, other properties of the star can be deduced. This allows for study of the star's evolutionary state and how rotation affects stellar evolution. This work was supported by a grant from the National Science Foundation (Phy-0243935).

Michael Schauber
Binghamton University

ANALYSIS OF DEEP MULTI-BAND IMAGING DATA FROM THE SPITZER SPACE TELESCOPE AND THE HUBBLE SPACE TELESCOPE: JUNE 13 TO AUGUST 5, 2005

Michael Schauber, Binghamton University; Kenneth M. Lanzetta, Stephan Gromoll, Department of Physics & Astronomy, Stony Brook University

Our group's major focus is to measure photometry to within great enough precision that the comoving mass density of the Universe can be determined. With this known the time derivative can be taken to produce an accurate measurement of the star formation rate as a function of redshift. This project uses data acquired mostly from the Spitzer Space Telescope (SST) and Hubble Space Telescope (HST), however also incorporates various ground-based observations. We used the high resolution data of the HST to build a model for the lower resolution data of the SST, which we then use to fit for fluxes across all of the low resolution images. By using our method, we can fit for the fluxes of sources which are blurred together and indistinguishable in the low resolution data. Because of the procedure used, it is necessary to register the data at the sub-pixel level and thus we implemented code to convert between various astrometric systems. We created tests that found the accuracy of the data registration to be on the order of one thousandth of a pixel (for the specific images tested). In order to better interface with our code library, we rewrote various C scripts into PERL. Near infrared data taken from the NICMOS camera of the HST (wavelengths between 1.1 and 2.1 microns) were fixed using code we developed to remove various sources of error, such as cosmic rays and bad pixels. Once these images are registered and the fluxes of the sources are measured, we will incorporate them into a measurement of the comoving mass density. This work was supported by a grant from the National Science Foundation (Phy-0243935).

Nathan Chandler-Smith
University of Nebraska at Lincoln

ARBITRARY SHAPING OF FEMTOSECOND LASER PULSES

Nathan Chandler-Smith, University of Nebraska at Lincoln; David Cardoza, Sarah Nichols, Carlos Trallero, Daniel Flickinger, Brett Pearson, and Thomas Weinacht, Department of Physics & Astronomy, Stony Brook University

Observing the interaction of specific laser pulse shapes with a sample is one way of studying molecular dynamics. In this application, the phase and amplitude of the many frequency components that make up the short laser pulses are the parameters. Equivalently, a laser pulse will need to be produced with an arbitrary shape. To generate arbitrary waveforms in our experiment, the frequency components of the laser pulse are separated spatially through diffraction. Then, this spatially separated laser pulse is sent into an acousto-optic modulator (AOM). The AOM diffracts the laser pulse via an acoustic wave in the acousto-optic crystal. By shaping the phase and amplitude of the acoustic wave in the AOM crystal, one can shape the phase and amplitude of the diffracted light. A voltage into the AOM controls acoustic wave on the acousto-optic crystal. In this way, the shape of the laser pulse is controlled by the voltage signal into the piezoelectric. Production of the voltage signal is not straight-forward. Due to limitations of Bragg scattering efficiency, the carrier frequency of the voltage signal must be 150 MHz—in the radio frequency range. In the past, an arbitrary waveform was output from two arbitrary waveform generators and mixed with a 150MHz signal from a voltage controlled oscillator (VCO) using an in-phase and quadrature (I&Q) mixer. The voltage output from this system is not what was desired. In the absence of an explanation, it was not possible to create many pulse shapes that were required for some molecular dynamics experiments. In the last few weeks new arbitrary waveform generators have become available that can write at 1 billion samples per second. It was shown that this sampling rate was fast enough to write a 150 MHz directly from a single board. Additionally, linearly increasing frequencies with a 10 MHz bandwidth centered at 150 MHz with pulse duration of 8.5 micro seconds have been produced with negligible amplitude shaping. Also, an 8.5 micro second 150MHz pulse with a randomly sampled phase and a 85pi final phase has been produced with only 1% amplitude shaping. These new boards are likely to be used alongside of, if not replacing, the old PCI cards. Funding for this project has been provided by the National Science Foundation REU Grant (Phy-0243935), National Science Foundation Research Grant, and the Office of Naval Research.

Dmitry Meyerson
Cornell University

PHYSICS AND DATA ANALYSIS IN ELECTRON ENERGY-LOSS SPECTROSCOPY,
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Stony Brook University

Electron energy-loss spectroscopy is briefly reviewed, with particular emphasis placed on plural scattering. A review of Fourier-log deconvolution methods as applied to plural scattering follows. Several diagrams to illustrate problems (aliasing, ringing) and solutions characteristic of the finite approach are presented. Finally a single scatter spectrum is shown along side the original convoluted spectrum.

Clustering and its applicability is explained and followed by a more in-depth look at the clustering algorithm and analysis program (pca gui) of Lerotic et al.[1, 2]. The clustering algorithm was originally used to perform cluster analysis on soft x-ray spectromicroscopy data, but it is neutral as to the physics of the imaging method. A major portion of this project was devoted to writing software to convert electron energy-loss data to a format compatible with pca gui. Once this was accomplished, applying these well-tested x-ray analysis tools yielded good results. Specifically different structural isotopes of TiO₂ were successfully identified in EELS data (or not still pending confirmation). I thank Chris Jacobsen, Bjorg Larson, and Mirna Lerotic of Stony Brook, and Robert Klie of Brookhaven National Laboratory, for helpful discussions and assistance. This project was supported by a grant from the National Science Foundation (Phy-0243935).

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Columbine Robinson
University of California, San Diego (UCSD)

USING THE ELECTRIC TUNNEL EFFECT TO DETERMINE THE QUANTUM BARRIER HEIGHTS OF SIMILAR ELECTRODES SEPARATED BY A THIN INSULATING FILM: JUNE 12TH-AUGUST 5TH 2005

Columbine Robinson, University of California, San Diego, and Emilio Mendez,
Department of Physics & Astronomy, Stony Brook University

The goal of my project was to test the experimental method proposed by John G. Simmons to determine the quantum barrier height of a thin film insulator. This thin film insulator is placed between two electrodes in the form of a diode. I was working with diodes with electrodes of the same composition. I focused on diodes with electrodes made of Gallium Arsenide with a thin layer of Gallium Aluminum Arsenide in between, approximately 125 Angstroms thick. The concentration of Aluminum for SB200 was $x=0.35$ and SB207 $x=0.30$, with a potential barrier of approximately $.30 \pm .05\text{eV}$.

The quantum barrier of Gallium Aluminum Arsenide impeded electrons from flowing through the electrodes. By applying a voltage to the diode, one is able to offset their energies, hence more electrons can flow through the barrier. By studying the Current-Voltage characteristics, it is apparent that the more voltage applied, the more current is able to tunnel through the barrier. The I-V characteristics however are not linear, they present a symmetric parabola with a positive concavity to the right of the origin, and a negative concavity to the left of the origin. By cooling down the diode, the resistance increases, hence the I-V curve is lowered. By finding the difference between the current at difference temperatures, we could determine a Voltage at which this was a maximum. This maximum was also dependent upon the current at the lowest temperature, therefore by finding $T(77\text{K})-T(0\text{K})/T(0\text{K})$ we could determine the barrier height. For 77K we used liquid nitrogen and used liquid helium for a temperature of 0K, however it is at 4K.

I set up a voltage source which ran current through the diode and through a known resistance. Because both the diode and the resistor were in series, the current was the equal in both the diode and the resistor. The current equals the voltage drop across the diode divided by the resistance of the diode and the voltage drop across the resistor divided by the known resistance. The voltage drop across the resistor was simply the source voltage minus the voltage across the diode. I set up a voltmeter across both the diode and the resistor to measure voltage. However just the voltmeter across the second voltmeter would suffice to find the current. Labview was used to control the voltage source to sweep from approximately -700mV to 700mV with increments of 5mV and then read and record the respective voltages. With my data I found the relative change in current between $T=77\text{K}$ and $T=0\text{K}$ as well as the double derivative or bias.

In conclusion, the barrier height calculations I found were not significantly different enough to draw a conclusion to whether this method works. To further investigate I would like to characterize diodes with various compositions so that I could study a more complete range.

Daniel Hogan
University of Kansas

DETECTING MAGNETIC MONOPOLES WITH THE CERENKOV EFFECT

Daniel P. Hogan, University of Kansas; and Alfred S. Goldhaber, Department of Physics & Astronomy, Stony Brook University

In 1931, Paul Dirac showed that the existence of a magnetic monopole, a particle with net magnetic charge, could explain electric charge quantization, and he thereby predicted the (large) quantum unit of magnetic charge. Despite numerous attempts in the 74 years since then, no magnetic monopole has ever been confirmed experimentally. The Radio Ice Čerenkov Experiment (RICE), a ~200m diameter, .008km³ array of radio antennae buried in the Antarctic ice, represents one more opportunity to seek a particle that has eluded so many.

In this talk I discuss the first step in implementing that search, a simple analysis of the electromagnetic energy loss and resulting Čerenkov radiation of a relativistic magnetic monopole traveling through ice. Čerenkov radiation is light produced by a transparent medium due to a charged particle passing at a velocity greater than the local velocity of light. A relativistic monopole would produce Čerenkov radiation polarized differently from radiation produced by an electric charge. As a secondary detection mechanism dominating at higher velocities, a relativistic monopole can also trigger electromagnetic cascades containing electrically charged particles that create Čerenkov radiation of their own. Using the Weizsäcker-Williams method to model the monopole's electromagnetic field as a spectrum of virtual quanta, it is found that monopoles with values of gamma (the relativistic factor) above 10^5 will trigger more than three 10^{15} eV electromagnetic showers per 100 meters of travel. However, for a broad range of potential monopole masses and gamma factors, the electromagnetic energy loss over distances on the order of 200m is insignificant compared to the total monopole energy. By looking for direct and indirect Čerenkov radiation, RICE might feasibly constrain the flux of relativistic magnetic monopoles. An additional energy loss, still to be explored, might come from direct interactions of a magnetic monopole with atomic nuclei.

This study was sponsored by NSF Grant Phy-0243935.

Robert Nowicki
Susquehanna University

EXPERIMENTAL AND THEORETICAL ANALYSIS OF THE “JUMPING RING”

APPARATUS:

Robert P. Nowicki, Susquehanna University; and Erlend Graf, Department of Physics & Astronomy, Stony Brook University

A jumping ring apparatus is a solenoid with a ferromagnetic rod protruding from the center of the solenoid. When an AC current is applied to the solenoid as a conducting ring rests on top of the solenoid and around the core, the ring jumps.

Typically, college electricity and magnetism courses qualitatively explain this phenomenon with Lenz's Law. However, the detailed reason for this jump is due to the interaction of the radial component of the magnetic field generated by the solenoid with the current induced in the ring. This interaction depends critically on both the magnitudes and relative phase of these quantities.

The height of the ring's jump was predicted by two different methods, one method using direct force measurements on the ring, and the other using magnetic field and current measurements. These measurements each predicted the height with approximately 5% uncertainty, and both agreed with the experimental measurements of the height, given their respective uncertainties. Studies were made to maximize the height of the jump, including connecting a capacitor in series with the power source, cooling the ring in liquid nitrogen, and applying maximum voltage to the system. This work was supported by National Science Foundation grant # Phy-0243935.

Abhinav Guliani
Stony Brook University

SCATTERING OF BENJAMIN-ONO SOLITONS ON IMPURITIES

Abhinav Guliani, Stony Brook University; Alexandre Abanov, Department of Physics & Astronomy, Stony Brook University

Solitary waves that propagate through medium without any change in the form are called *Solitons*. Solitons were first observed by Sir J. Scott Russell in the 19th century as waves propagating through a narrow channel of water. Korteweg and deVries later derived an equation, known as the famous KdV equation, which governs moderately small, shallow-water waves. This was the first example of an *integrable* nonlinear partial differential equation having soliton solutions. The aim of this work is to study the Benjamin-Ono equation (BO)– the relative of KdV equation which governs internal waves of deep stratified fluids. The equation has a form

$$\frac{\delta U}{\delta t} + U \frac{\delta U}{\delta x} + H \frac{\partial^2 U}{\partial x^2} = 0$$

where H is the Hilbert Transform Operator defined as

$$Hf(x) = \frac{1}{\pi} P \int_{-\infty}^{\infty} \frac{f(y)}{y-x} dy$$

We studied the multiple soliton solutions of BO using Pole Ansatz method. The aim of the research was to see how BO solitons scatter in presence of impurities. According to a recent conjecture the solitons of BO equation correspond to free quantum one-dimensional particles-Fermions. Such analysis can hence allow us check the conjecture and to establish the relation between the collective hydrodynamics of quantum fermions and classical BO equation. We are still in the process of using Numerical Methods to model the scattering process of solitons that are governed by the BO equation. The research was supported by NSF-REU grant no. Phy-0243935 and NSF grant DMR-0348358.

Fook Chin Chiang Stony Brook University

SILICON VERTEX TRACKER (SVTX) AND THE CAEN SY1527 UNIVERSAL MULTICHANNEL POWER SUPPLY SYSTEM

Fook Chin Chiang, Harry Themann and Axel Drees, Department of Physics & Astronomy, Stony Brook University

PHENIX or Pioneering High Energy Nuclear Interaction eXperiment is a detector located at RHIC or Relativistic Heavy Ion Collider. It was built to detect and measure the position of a charged particle and its momentum in the highest matter energy and density. PHENIX was designed mainly for measuring probes of electron, muon and photon and for studying the Quark-Gluon Plasma and Au-Au collisions. The finest tracking is at the Drift Chamber (DC) which was built by SUNY-SB and is one meter away from the collision. The Beam Beam Counter (BBC) tells us about Z vertex with uncertainty of +/-10 cm and together they give us a resolution at the primary vertex on the order of centimeters. Secondary vertices that we are interested in resulting from the decays of particles after the initial collision was approximately 400 μm away from the primary vertex and is way too small to be detected by drift chamber and beam-beam counter. Therefore, SVTX was proposed for PHENIX to facilitate the vertex tracking of a charged particle in highly reliable accuracy and precision near the collision point. It has four concentric cylinders (or tracking layers); the two outer layers are the silicon strip ($80\mu\text{m} \times 3\text{cm}$) detector developed by BNL whereas the two inner layers are the silicon pixel detectors with $50\mu\text{m} \times 425\mu\text{m}$ pixel, 4.6×10^6 channels, $\sim 1800\text{cm}^2$ surface areas and huge tracking ability. The pixel detectors were developed for the ALICE experiment at CERN LHC in Europe and were adapted by us. Stony Brook University contributes in designing and building the Front End Modules (FEM's). We use the silicon pixel detector without modification to their data output (40 MHz, 25 ns) except that FEM must translate the data output to PHENIX form (10 MHz, 100 ns). Furthermore, FEM must supply six different voltages to the pixel chips. The CAEN SY1527 Universal Multichannel Power Supply System has been proposed for SVTX pixel layers. My task is to explore operation of the system which consisted of one Low Voltage (LV, 7V) module with six outputs and one High Voltage (HV, 250V) module with 12 outputs. I control the channels from the remote location and customize the interface & voltage control on the main frame by using Graphical User's Interface (GUI) and Gimp Tool Kit (GTK+) in order to simplify the system for users who have unprecedented training (for example, random user can click on the buttons to signal the system instead of typing the commands). Since CAEN provides C subroutines that can be called by a GUI and thus an attempt was made to write a GUI to control the mainframe. This project was funded by National Science Foundation Grant Phy-0243935.

Art Evans
California Polytechnic State University, San Luis Obispo

Megan Linzey
Drew University

PHOTOCATHODE PRODUCTION USING CESIUM IODIDE EVAPORATION IN HIGH VACUUM

Arthur Evans, California Polytechnic State University at San Luis Obispo; Megan Linzey, Drew University; Thomas K. Hemmick, Department of Physics & Astronomy, Stony Brook University; Jason Kamin; Richard Lefferts, Nuclear Structures Laboratory, Stony Brook University

One of the detector upgrades planned for the PHENIX experiment is the Hadron Blind Detector (HBD). The HBD detects the Cherenkov light produced only by high-velocity electrons, hence the term “hadron blind”. The light detector uses a novel technique that is part phototube and part wire chamber. By evaporating a thin film of cesium iodide onto a gas electron multiplier (GEM), a non-charge sensitive photo-detector will have been created. The major difficulties in creating such a detector involve maintaining a clean environment, evaporating under the proper vacuum conditions, transport from evaporation area to detector assembly, and mass production. In order to produce the quantities necessary, and in order to ensure that the proper conditions are upheld, the “Big Mac” scattering chamber in the Nuclear Structures Laboratory will be converted into a multi-purpose evaporation and quantum efficiency test station. As a preliminary measure a small scale apparatus was developed to test the feasibility of achieving high quantum efficiency in such a large vessel. The overall purpose for this small system is to provide proof of principle for the larger apparatus. The quantum efficiency of small test samples were measured at Brookhaven National Laboratory and adjustments to the system were made as found necessary. This work was supported by a grant from the National Science Foundation (Phy-0243935) and the Department of Energy (DEFG0296ER40988).

Evan Kornacki
University of North Texas (UNT)

FITTING (ρ_t) SINGLE-SPECTRA IN CU+CU SYSTEMS AT PHENIX

Evan Kornacki, University of North Texas; Nathan Emerson, and Thomas K. Hemmick,
Department of Physics & Astronomy, Stony Brook University

The PHENIX experiment during RHIC Run5 collected data on the collisions of Copper ions at High Energies. In an effort to demonstrate the existence of a phase transition to Strongly Coupled Quark-Gluon Plasma (sQGP) above 175MeV at RHIC, physicists compare the Pion, Kaon, and Proton/Anti-Proton yields, hadronic emissions of varying mass. Previously, PHENIX produced a Single-Spectrum Fit for Au+Au collisions, with maximum freeze-out temperatures in the ~140MeV range [1]. Models for sQGP predict a plateau in temperature with increased mass, caused by the isentropic expansion of the source after a phase transition. Finding such evidence of a maximum temperature with lighter and heavier systems is a necessary, but not sufficient, condition that would support the statement that sQGP is produced at RHIC energies. We performed a transverse momentum (ρ_t) fit on PHENIX preliminary Single-Spectra of the Cu+Cu system. By adapting blastwave code for Gold systems to Copper, and fitting temperature-flow velocity with Schnedermann-Heinz [2], we find a maximum freeze-out temperature near that of a Gold system. This research is funded in part by grants from the National Science Foundation (Phy-0243935) and US Department of Energy (DEFG0296ERA0988).

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Michael Assis
Taylor University

Eugene Vaynberg
University of Rochester

DESIGN AND CONSTRUCTION OF A SPARK CHAMBER

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The project is the design and construction of a spark chamber for a visual demonstration of cosmic ray particles to Stony Brook University physics students. Every second, hundreds of cosmic rays pass through every square meter of the atmosphere at sea level. The majority these cosmic rays consist of hydrogen and helium nuclei as well as muons. At higher altitudes, x-rays, alpha, beta, and gamma rays can also be seen. The spark chamber is able to show evidence of the passing particles by creating sparks along their paths between aluminum plates in a gas-filled chamber. The cosmic ray ionizes the gas along its path, and the plates will discharge along the path of least resistance, which happens to be the path of the cosmic ray. The physical chamber is constructed of $\frac{3}{4}$ " Plexiglas with dimensions 12" x 17" x 6.5". The inside walls of the chamber contain grooves for the eleven .0625" aluminum plates, each separated by 1cm. The chamber is filled with a mixture of 70% neon to 30% helium gas, and sealed using a Nitril O-ring. There is a scintillator above and below the chamber able to detect passing cosmic rays. Once a particle is detected, photomultiplier tubes connected to the scintillator sends a signal to a discriminator, which creates a digital signal of a fixed width. Signals from both counters are presented to an AND logic gate, which signals a coincidence whenever the scintillators detect the same cosmic ray. The coincidence signal is then converted from a NIM logic pulse to a TTL logic pulse by a converter circuit. To prevent hundreds of sparks from happening each second, a timing circuit disables the detection signal for 1 second in between pulses. The TTL pulse is further amplified by a pulse generator, which outputs the necessary high voltage trigger to a thyatron high-voltage switch. A high-voltage supply inputs 5,000 volts into the thyatron, which outputs this voltage to alternating plates of the chamber upon reception of the pulse from the generator. At this point, a spark will occur inside the chamber between alternating charged and grounded plates as they discharge along the path of the cosmic ray. This work was supported by a grant from the National Science Foundation (Phy—0243935) as well as the US Department of Energy (DEFG0292ER40697).

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A GENERAL PURPOSE LASER SCANNING PROGRAM BUILT WITH "LABVIEW"

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When an atom is illuminated with a tunable laser, certain wavelengths of the light will be very strongly absorbed, and then emitted in all directions. This emitted light can be detected with a photomultiplier at right angles to the laser beam, and recorded with a computer. The Francium research group in the Nuclear Structure Laboratory needs to measure the exact position and width of these atomic resonance for many experiments. My project was to develop a computer program to scan the wavelength of a laser, and record the photomultiplier counting rate at each wavelength, along with other important parameters that can be represented by analog voltages.

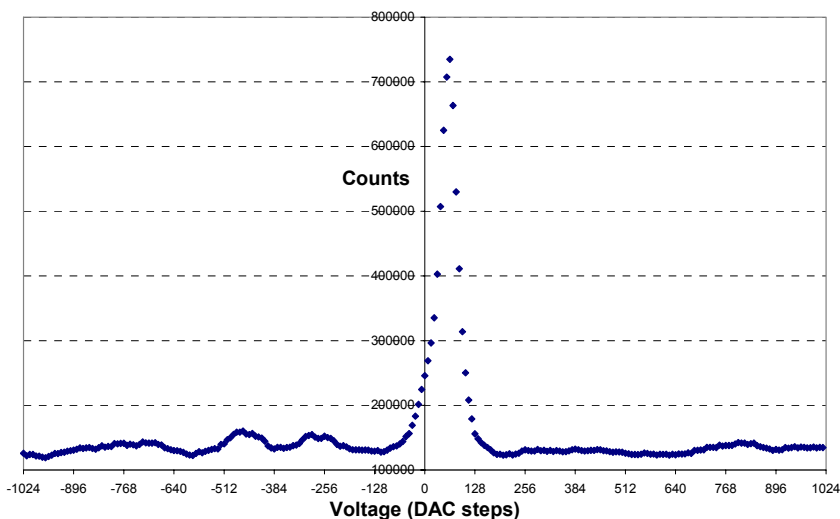
The scanning program that I built is able to increment a digital to analog converter (DAC) that controls the laser, read a counter, record the wavelength, and save the data onto disk. When the program runs, counts are accumulated for a specified time interval, read out, and then reset back to zero. Immediately after this, the voltage output is incremented (The applied voltage on the ring laser is proportional to the emitted wavelength) and an analog input notes the wavelength

reading. In addition, two real time graphs display the relationship between the wavelength, counts, and the voltage output. The data from a scan is continuously saved into an excel file and all of the data points from the program pauses and previous scans are automatically deleted.

This scanner is programmed in a language called LabView, which is unlike traditional text-based programming languages such as FORTRAN or Java. In LabView, various symbolic objects act as the source code instead of actual text. In addition, the concept of data flow controls the execution of the virtual instrument. In a traditional programming language, the data flow is linear since the code executes line by line. However, the data flow in LabView is nonlinear because the code follows a user-defined path. Incorporating the idea of data flow between the symbolic objects was vital in developing this application.

This virtual instrument has already shown an atomic resonance for rubidium, which is shown in the diagram above. This same scanner can also look for atomic resonances in Francium without being reprogrammed. In addition, this program can easily encompass more counters and analog output/inputs, which future experiments will need.

Rubidium Atomic Resonance



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INDEX OF UNDERGRADUATE CONTRIBUTORS

A

Assis, Michael · 16

C

Caravelli, Gregory · 3
Chandler-Smith, Nathan · 7
Chiang, Fook Chin · 13

D

Derakhshani, Maaneli · 4

E

Evans, Arthur · 14

G

Guliani, Abhinav · 12

H

Hogan, Daniel · 10

K

Kornacki, Evan · 15
Kumpulanian, Danielle · 5

L

Linzey, Megan · 14

M

Meyerson, Dmitry · 8
Miller, Chris · 17

N

Nowicki, Robert · 11

R

Robinson, Columbine · 9

S

Schauber, Michael · 6

V

Vaynberg, Eugene · 16