Annual Report for Period: 09/2009 - 08/2010
Submitted on: 09/15/2010
Principal Investigator: Forest, Tony .
Award ID: 0855661
Organization: Idaho State University
Submitted By:
Forest, Tony - Principal Investigator
Title:
A Program to Study Hadronic Matter using Electromagnetic Probes at Jefferson Lab

Project Participants

Senior Personnel

Name: Forest, Tony
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Dale, Daniel
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Cole, Philip
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Didberidze, Tamar
Worked for more than 160 Hours: Yes
Contribution to Project:
The NSF sponsored this graduate students work on the Qweak experiment and her SIDIS data analysis of EG1 data for her thesis

Name: Parsons, Warren
Worked for more than 160 Hours: Yes
Contribution to Project:
The NSF sponsored part of this students thesis on the Qweak readout system. The student graduated in the summer of 2010.

Name: Martinez, Danny
Worked for more than 160 Hours: Yes
Contribution to Project:
This NSF sponsored graduate student is working on a thesis based on the data collected by the g8 run group from JLab's Hall B. His analysis is on the photoproduction of omega mesons with linearly polarized photons off the proton.

Name: Taylor, Charles
Worked for more than 160 Hours: Yes
Contribution to Project:
The NSF sponsored this students thesis work on the g13 experiment and his start counter calibration for the Frost experiment during their run this year in JLab's Hall B. His PhD thesis project is on extraction of polarization observables in the photoproduction of the K/Lambda channel using both circularly- and linearly-polarized photons off neutrons off unpolarized deuterons.

Name: Salamanca, Julian
Worked for more than 160 Hours: Yes

Contribution to Project:
Julian was an NSF student who finished his thesis on the g8 dataset from JLab's Hall B in December of 2010. His analysis was on the photoproduction of phi mesons with linearly polarized photons off protons.

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings: (See PDF version submitted by PI at the end of the report)

Training and Development:

Outreach Activities:
The physics department also holds a mentoring program for high school teachers and their students during the first month of summer. The group instructed about 14 teachers and students on the operating principles of drift chambers and scintillators. The students were part of an REU program at Idaho State University and were tasked with designing and constructing PMT bases for use in experiments at the Idaho Accelerator Center. The program is a fortuitous example of how research and education can combine efforts and improve the public's understanding of science and technology.

Journal Publications

S.Anefalos Pereira et al., "Differential cross section of gamma n to K+ Sigma- on bound neutrons with incident photons from 1.1 to 3.6 GeV.", Phys. Lett., p. 289-293, vol. B688, (2010). Published,

H. Avakian et al., "Measurement of Single and Double Spin Asymmetries in Deep Inelastic Pion Electroproduction with a Longitudinally Polarized Target", arXiv:1003.4549, p. , vol. , (2010). Submitted,

I.G. Aznauryan et al., "Electroexcitation of nucleon resonances from CLAS data on single pion electroproduction.", Phys.Rev., p. 055203, vol. C80, (2009). Published,

T.E. Rodrigues, et. al., "Nuclear incoherent photoproduction of pi0 and eta from 4 to 12 GeV", Phys.Rev., p. 024608, vol. C82, (2010). Published,

Books or Other One-time Publications

Ricardo Alarcon, Phil Cole, Andres J. Kreiner, Hugo F. Arellano,, "VIII Latin American Symposium on Nuclear Physics and Applications -- Santiago,
Chile 15-19 December 2009", (2010). Book, Published
Editor(s): Ricardo Alarcon, Hugo F. Arellano, Philip L. Cole, Andres J. Kreiner
Collection: VIII Latin American Symposium on Nuclear Physics and Applications -- Santiago,
Chile 15-19 December 2009
Bibliography: AIP Conference Proceedings -- 1265

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

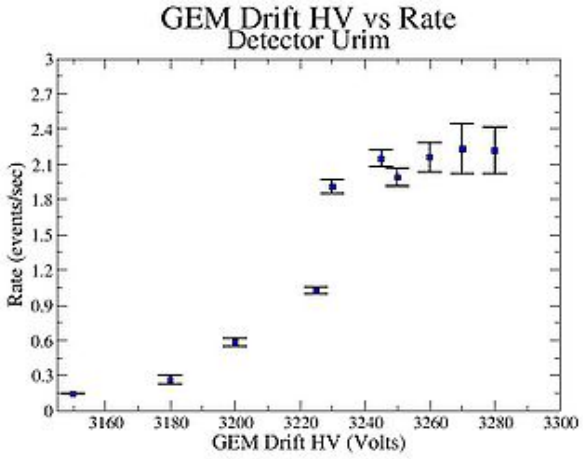
Special reporting requirements: None
Change in Objectives or Scope: None
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Organizational Partners
Activities and Findings: Any Training and Development
Any Web/Internet Site
Any Product
Contributions: To Any within Discipline
Contributions: To Any Other Disciplines
Contributions: To Any Human Resource Development
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering
Any Conference

Findings

At least 2 major findings have been done in the first year of this work. First, the data throughput for the Qweak R1 detector system was measured. The readout system had zero deadtime until after an event rate of 5 kHz. A deadtime of 20% was observed at an event rate of 7 kHz. The Qweak elastic rate is expected to be about 1-3 kHz during the low nano-Amp current runs. The second, major finding was the plateau region for the Qweak R1 detectors. Below is a sample set of measurement indicating that the R1 detector cosmic rate is maximum at a drift HV above 3200 Volts.



Major Research and Education Activities

NSF award #0855661, A Program to Study Hadronic Matter using Electromagnetic Probes at Jefferson Lab, has supported Idaho State University's nuclear physics group. The group is actively engaged in three experiments at Jefferson Lab; Qweak, Primex, and g8/g13. PI Forest and graduate students T. Diberidze and W. Parsons have worked on installing the R1 tracking detector and readout electronics for Qweak. PI Dale, has worked to published the latest results from the Primex experiment and is currently preparing the Primex experiment to take data in Jefferson Lab's Hall B. PI Cole and graduate students D. Martinez, J. Salamanca and C. Taylor have been working with CLAS's g8 and g13 run groups in JLab's Hall B. Two students, W. parsons and J. Salamanca, have graduated this year. The progress of these endeavors is described below.

A. Qweak's Region 1 Tracking System

The testing and installation of the Region 1 tracking system for the Qweak experiment at Jefferson Lab has been a research activity supported by this grant. The Qweak Region 1 tracking system is one of three tracking systems designed to measure the Q^2 profile of elastically scattered electrons as well as background contributions to the parity violating signal. The Region 1 tracking system is located behind the first collimator at a distance of about 550 cm from the main torus magnet (200 cm from the target). The collimator divides the ϕ acceptance into 8 regions, octants, and reduces the azimuthal acceptance by almost 30 percent. Figure 1 shows the simulated elastic scattering profile overlayed on one of the octants. Figure 1 shows the detector mounted on the R1 rotator in preparation for a few tests before the commissioning run. One VFAT card is mounted to the top of the detector so the impact of the high dose on the electronics can be tested before installing all of the readout cards. The Region 1 tracking system will measure the electron scattering angle at only 2 of the octants at a time and will rotate in ϕ to perform measurements in the remaining octants.

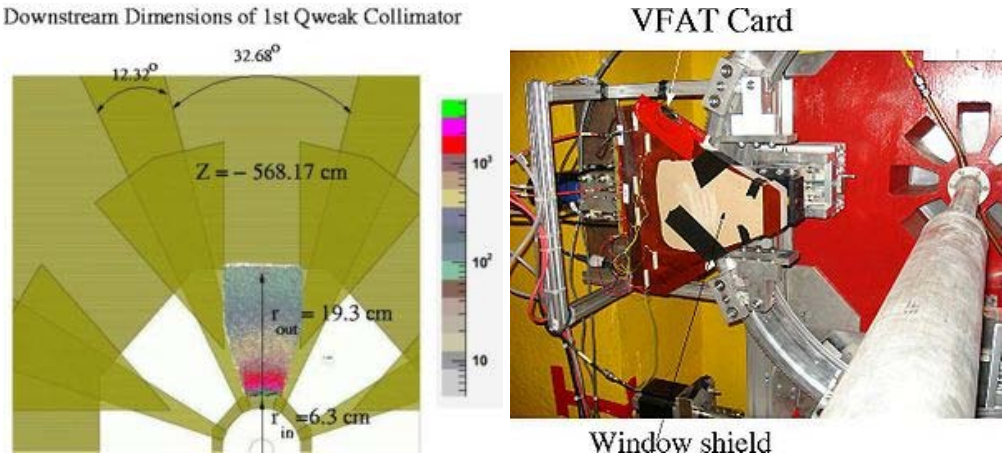


Figure 1. Left: A view of the simulated electron profile overlayed on top of the final collimator design. Right: A picture of the detector installed in Hall C for testing before the commissioning run.

A front end readout system which may be used for Qweak's region 1 tracking system has been under development for the last 3 years. It is based upon a digitization card, known as the VFAT hybrid board, designed at CERN for the TOTEM experiment. The VFAT board has been designed to withstand up to 100 Mrad of radiation and can digitize it's 128 input channels at a sampling frequency of 40 MHz storing up to 128 triggered events. The VFAT card digitizes the analog output of the GEM detector to indicate the presence of a hit on one of the charge collector's copper strips.

The infrastructure to readout a detector contains of four basic elements. First, a VFAT readout board converts the analog charge observed on a charge collector strip to a digital signal. Then, a Gumstick unix micro-controller is used to program the VFAT card and set parameters such as the amplifier gain and discriminator thresholds. A third component is known as the breakout board which serves as a branch highway to deliver control input and data output signals. Finally, a VME I/O board, the CAEN V1495, receives LVDS digital signals from the VFAT via the breakout board and stores the signals for readout by a single board computer located in a VME crate.

Implementation of the breakout board and the programming of the CAEN V1495 FPGA were the subject of W. Parson's graduate thesis. The lines of communication between the VFAT readout board, the Gumstick controller, and the VME FPGA I/O module are managed by the breakout board. W. parson's thesis describes the design of this board. A conceptual block diagram and a picture of the finished board are shown below in Figure 2. The thesis also describes the software developed for the V1495. Also shown in the Figure 2 is a NIM module design by T. Didberidze used to distribute power and the I2C micro-controller signals to the readout system.

Figure 3. The VFAT readout system. Left: a block diagram of the control system. Middle: A breakout board designed at ISU to direct control and data signals. Right: A NIM bin module built at ISU to power the readout electronics and house the slow controls computer.

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B. Primex

The PrimEx Collaboration is in the final stages of editing a paper to be submitted to Physical Review Letters in the next couple of weeks. In this paper, we report a radiative neutral pion decay width, $\Gamma(\pi 0 \rightarrow \gamma\gamma)$ of 7.82 +/- 0.14 (stat) +/- (0.17) (syst) eV. This result is considerably more precise than the current Particle Data Book average (2.5 times more precise), and is consistent with current chiral perturbation calculations including next-to-leading order. In addition to this paper, substantial progress has been made on a paper describing high precision photon flux measurements for tagged photon experiments. Publication of this paper is expected during year two of this grant.

For the upcoming PrimEx run, the ISU group has taken primary responsibility for the pair spectrometer online luminosity monitor. During this period, considerable work was performed on the pair spectrometer including electronics checkout, upgrading and calibrating the scintillator detectors, and development of the run plan as it impacts the luminosity monitoring. As spokesperson for the experiment, Dr. Dale has also written the relevant safety documentation for the experiment which is required by the Laboratory, and has been involved in the preparation for the run at all levels.

C. CLAS g8 and g13

The g8b dataset"' will measure the beam asymmetry (and other polarization observables) using polarized photons interacting with protons and deuterons which result in the final states ηp, KY (Y=Λ,Σ0, Σ+), ρ0p, (ρ+n), ωp, and φp from Eγ=1.1 GeV to 2.1 GeV. This is to be compared to higher energy measured asymmetries at GRAAL (Eγ < 1.5GeV) which observed the final states ηp, K+Λ . For φp ,g8b will afford an extension of the measured asymmetry at SPring8 (Eγ >1.7GeV) to lower energy and higher "t". Julian Salamanca has completed his Ph.D. thesis titled: THE PHOTOPRODUCTION OF φ-MESONS OFF PROTONS BY USING A BEAM OF LINEARLY POLARIZED PHOTONS AT THRESHOLD ENERGIES on October, 2009 (see http://www.jlab.org/~salamanc/phd_thesis_new-5-ds-v3.pdf). Danny Martinez is currently working on his thesis titled: THE PHOTOPRODUCTION OF ω-MESONS OFF PROTONS BY USING A BEAM OF LINEARLY POLARIZED PHOTONS AT THRESHOLD ENERGIES.

Similarly, "'the g13a/b datasets"' will yield the measurement of beam asymmetry (and other polarizeation observables) in ηp, ηn, KY (Y=Λ,Σ0, Σ+,Σ-), ρ0p, ρ0n,(ρ+n & ρ-p), ωp, and φp from Eγ=1.1 GeV to 2.3 GeV. Charles Taylor is currently working on his thesis title: THE PHOTOPRODUCTION OF THE ΚΛ OFF NEUTRONS BY USING A BEAM OF LINEARLY AND CIRCULARLY POLARIZED PHOTONS.

II. Physics Analysis

Graduate students T. Didberidze, D. Martinez, and C. Taylor are analyzing Jefferson Lab data sets taken in Hall B. T. Didberidze is currently analyzing data from Hall B's EG1 run group which will test independent fragmentation for SIDIS. D. Martinez is has completed calibrating the time-of-flight system for the g13 experiment and is now searching for omega mesons in g8 data set for his thesis. C. Taylor used his calibration work on g13 to calibrate the start counter for the FROST experiment at Jlab as a collaborative service task.