2003 Annual Review Report

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For my Ph. D. research, I have been working with the Polarized ^{3}He Collaboration at Jefferson Lab (JLab) to study the spin structure of the neutron. The Gerasimov-Drell-Hearn (GDH) sum rule is one method used to study the nucleon spin structure. This sum rule strictly pertains to real photon absorption (corresponding to Q^2=0) but has been extended to finite Q^2. The polarized ^{3}He target was used for Hall A experiment E97-110, the GDH Sum Rule and the Spin Structure of ^{3}He and the Neutron using Nearly Real Photons, to measure the generalized GDH integral. The goals of the experiment were to study the Q^2 dependence of the generalized GDH integral between 0.02 and 0.3 $(GeV/c)^2$, measure the slope of the GDH integral at $Q^2 \sim 0$, and obtain an extrapolation to the real photon point for ^{3}He and the neutron. The data acquisition was completed in August using the JLab polarized ^{3}He target and high polarization continuous electron beam. The low Q^2 range was achieved by using the new Hall A Septum magnet, which allows the detection of scattered electrons at forward angles of 6°and 9°. The measurement of the extended GDH integral tests Chiral Perturbation Theory and checks the limits of its applicability at low Q^2. The data also provide constraints on understanding the ^{3}He and neutron spin structure and enable a better understanding of the resonances.

In the past year, I helped to setup the polarized ^{3}He target system in Hall A in preparation for the experiment. Due to the continued delay of the Septum magnets, experiment E01-012, Measurement of neutron (^{3}He) spin structure functions in the resonance region, took data from January to Mid-February 2003. During this experiment, I was responsible for the NMR and general target systems, plus I also contributed to the experiment by working on the scaler analysis. Before the end of January, the first Septum magnet arrived, and after the experimental run completed, I began preparations for the E97-110 run period. The preparations included field mapping the field gradients in the target region due to the Septum, Septum magnet training, and installing correction coils to compensate for the gradients. The run period began in Mid-April, however the commissioning of the Septum magnet was difficult due to large background issues, and after approximately two weeks, it was concluded that the Septum magnet was miswired. Due to beam energy considerations and the probability that the experiment would not finish running this year, data was taken using the skewed Septum magnet. The first run period ended May 23^{rd}, so that the Septum magnet could be fixed.

In early June, the scheduling committee concluded that the second Septum magnet would not arrive until August, which was too late to run the next HAPPEX experiment, so E97-110 was given beam time from Mid-July until the end of August to finish the experiment.

Between the two run periods, I began work on the High Resolution Spectrometer (HRS) optics data base optimization for the first run period. The optics matrix elements are used to reconstruct the interaction vertex in the target from the coordinates of the detected particles at the focal plane via a transport tensor. Optics matrix elements have been optimized over the full ranges of both HRS's. However the Septum magnet is a new optical element, so the effect of the Septum on the optics needs to be carefully studied. After the magnet was repaired, I performed another field map of the target holding field to check the field gradients. In Mid-July, the second run period began. The commissioning of the Septum went smoothly, and I began working on the optics optimization for the second run period for 6°and 9°. For the experiment I was also responsible for the NMR and general target systems. The run period ended successfully on August 29^{th} with $\sim 80\%$ of the second period data taken. After the run period, I finished the necessary calibration tests needed and helped to disassemble and move the target system back to the Target lab at JLab.

Since the experiment run ended, I have continued to work on the optics optimization. After completing the optimization for the second run period, I will go back to finish the work on the first period data base. After the data bases have been optimized, I will work on the Septum+spectrometer acceptance calculations as well as the target polarization analysis for E97-110 and E01-012. Finally I will also work on the production data analysis for the GDH integral, which includes simulations and radiative corrections. Besides the above analysis, I have been advising the new students that are working with the polarized ^{3}He target for the next experiment. Plus I will aid in starting the database optimization for the experiment E94-107, a hypernuclear spectroscopy experiment. In the next few months, I plan to begin work on writing my dissertation with a defense date for my Ph. D. in the Fall of 2005.