

2005 Annual Review Report

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In partial fulfillment of the requirement for my Ph. D. to conduct original research, I have collaborated with the Polarized ^3He Collaboration at Jefferson Lab (JLab) to study the spin structure of the neutron. The spin structure of the nucleon has been of great interest over the past few decades. Sum rules, including the Gerasimov-Drell-Hearn (GDH) [1], and moments of the spin structure functions are powerful tools for understanding nucleon structure. The GDH sum rule was originally derived for real photon absorption and has been generalized to nonzero Q^2 [2, 3, 4]. The Hall A polarized ^3He target was used for experiment E97-110 [5] to measure the ^3He and neutron generalized GDH integrals. The goal of the experiment is to perform a precise measurement of the Q^2 dependence of the generalized GDH integral and of the moments of the neutron and ^3He spin structure functions between 0.02 and 0.3 GeV^2 . This Q^2 range will allow us to test predictions of Chiral Perturbation Theory [6, 7], and verify the GDH sum rule by extrapolating the integral to the real photon point. The measurement will also contribute to the understanding of nucleon resonances. During the summer of 2003, the data were taken in Hall A using a high resolution spectrometer with the addition of a septum magnet, which allowed us to access the low Q^2 region.

During the past year, significant progress has been made in the analysis for experiment E97-110. The calibration of the particle identification detectors (PID) has been completed. The spectrometer optics calibration has been completed and thoroughly tested for all the kinematics. In addition, a significant amount of time has been spent to understand the spectrometer acceptance and wire chamber efficiency. Analysis code is currently being prepared in anticipation of replaying the production data and extracting physics quantities.

The progress in my work for the past year has been to complete the spectrometer optics and to study the spectrometer acceptance. There were a few remaining issues that needed to be solved for the optics calibration. The optics matrix elements are used to reconstruct the target variables from the coordinates of the detected particles at the focal plane via a transport matrix. The addition of the septum magnet required a careful study of the target reconstruction. The optimization of the transport matrix was completed over a year ago. However shifts were discovered in the reconstructed transverse position and in-plane angle. These shifts are caused by septum saturation effects, which produced a mismatch between the septum magnet current and the spectrometer momentum setting. The shifts have to be corrected in order to obtain the correct target coordinates. For the 6° data, a fit was used to interpolate between optimized momentum settings. At 9° , the septum current was corrected during the experimental run period, though a separate correction was needed for a few cases where the magnet current was set incorrectly. The corrections have been tested using ^{12}C

foil data and were found to work reasonably well. They have since been incorporated into the analysis code.

For the past few months, I have spent a considerably amount of time studying the acceptance of the Hall A spectrometer with the addition of the septum magnet. An accurate determination of the spectrometer acceptance is crucial for extracting the absolute cross sections for the experiment. The acceptance is a geometrical concept, and in the absence of an electromagnetic field, it is defined by the geometrical boundaries of the spectrometer. The presence of an electromagnetic field alters the acceptance so that it doesn't necessarily coincide with the geometrically defined apertures. The acceptance depends on the particle momentum, interaction vertex and trajectory. The complicated shape of the acceptance is modeled with a simulation.

My work has involved modifying the existing simulation to include the septum magnet. Initially tests showed the spectrometer model with septum agreed considerably well with elastic data. I have made some minor improvements to obtain better agreement with the data. Comparing data near the deep inelastic region (white spectrum), I have obtained good agreement between the 6° data and the simulation weighted by the Mott cross section. Remaining tasks for the acceptance include obtaining a quantitative measure of the acceptance model, checking the simulation with the 9° data, and performing a full Monte Carlo for the 6° and 9° polarized ^3He data.

Though the majority of the past year was spent completing work on the spectrometer optics and acceptance, I have also finished the NMR analysis for experiment E01-012, which ran before E97-110. I have attended and presented my work at the JLab User Group Meeting and the Gordon Research Conference in Nuclear Physics. At the moment I am currently finishing checks on the spectrometer acceptance model and plan to finish this work in about a month. I am also in charge of setting up the analysis code for the experiment. Once the acceptance is finished, my work will proceed to the data analysis for the GDH integral, which includes forming the raw cross sections and asymmetries, calculating the polarized cross sections, and extracting physics quantities (g_1 , g_2 and I_{GDH}). I have also started writing my dissertation. A chapter on the spectrometer optics calibration has been written in the form of a technical report. The third version is available for the committee to read over and provide comments at their leisure. I have also started to write a report on the E01-012 target analysis. I plan to defend my Ph. D. in the summer of 2006.

References

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