Annual Review Report

Vincent Sulkosky
College of William and Mary
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For my Ph. D. research, I have been working with the Polarized ^{3}He Collaboration at Jefferson Lab (JLab). Polarized ^{3}He is used as an effective neutron target, since approximately 87% of the nuclear polarization comes from the S-state. In this state, the two proton spins are anti-aligned, which effectively cancels their spin contribution to the ^{3}He nucleus. The polarized ^{3}He target will be used for the Hall A experiment E97-110, the GDH Sum Rule and the Spin Structure of ^{3}He and the Neutron using Nearly Real Photons. The Gerasimov-Drell-Hearn (GDH) sum rule is a Quantum Chromodynamics (QCD) sum rule that is used to understand the transition from the quark-gluon picture to the hadronic picture: The GDH sum rule is only valid at the real photon point ($Q^2 = 0$); however, physicists have extended the GDH sum rule to virtual photons. The dependence of the generalized GDH sum rule at low four-momentum transfer squared (Q^2), the slope of the GDH sum rule at $Q^2 \sim 0$, and the extrapolation of the sum rule to the real photon point will be examined by measuring cross section differences and asymmetries. For the experiment, the standard right High Resolution Spectrometer (HRS) will be used with an additional septum magnet, which will allow scattered electrons with angles of 6° and 9° to be detected. Since the septum magnet for the left HRS will not be available, this spectrometer will be used to monitor the beam luminosity and false asymmetries.

In the past year, I have been learning the intricacies of the polarized ^{3}He target at JLab. My responsibilities at JLab include the NMR system, optics and laser alignment, system calibrations, cell characterization, and analysis. The purpose of my work on the ^{3}He target system is to prepare the system for the upcoming experiment and address any issues that may affect the smooth operation of the system. To that end, my colleague Patricia Solvignon from Temple University and I have tested over a dozen ^{3}He cells. These tests involve polarization, cell lifetime, and systematic studies. Some of the systematic studies include: calibrations, polarization loss, and field gradients.

Besides polarization tests, I have been working on a few modifications to the ^{3}He target system. To determine the polarization of the various target cells, two methods of polarimetry are used: standard NMR and Electron Paramagnetic Resonance (EPR). EPR polarimetry utilizes a small increase in the Zeeman splitting of the sublevels of the Rubidium ground state in the presence of polarized ^{3}He. This increase is proportional to the ^{3}He polarization and is measured by detecting an increase in fluorescence with a photodiode. For previous experiments, a complicated optics system was used to detect the fluorescence from the cell. I have created a design that will use a fiber coupler and optical fiber that will eliminate most of the optics. A second modification to the target system involves an important concern for the

experiment. Field gradients due to the close proximity of the septum magnet to the target system can destroy cell polarization. I have been working with others to understand the field gradients and compensate for the gradients using correction coils. I have also designed a field mapping device that will aid in mapping the target system Helmholtz coils in the presence of the septum magnet.

Throughout the year, I have also been taking shifts on experiments in Hall A to learn about that standard Hall A equipment and data analysis. For the experiment, I have also been working on calibrating and determining the efficiency of the HRS detectors. For the experiment, the primary detectors that will be used are the particle identification (PID) detectors such as the gas cherenkov and total absorption shower counter to control the pion contamination. Before the experiment, I will check these detectors with existing data from recent experiments. I will do periodic checks to monitor the detector efficiencies throughout the experiment.

In the next few months, I will continue to work on the polarized ^{3}He target system and prepare for the upcoming running period for E97-110. In mid November, I will aid in the installation of the target system into Hall A, and I will also help with the commissioning run of the septum magnet in mid-December. Then in early January, the production running for Small Angle GDH (SAGDH) will begin. Once the experiment is completed, I will work on the data analysis and begin to write my dissertation. I plan on defending for my Ph. D. in the Fall of 2004.