# PRECISION MEASUREMENT OF THE NUCLEON SPIN STRUCTURE FUNCTIONS IN THE REGION OF THE NUCLEON RESONANCES

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Nucleon spin asymmetreis have been measured in the resonance region at Jefferson Lab's Hall C using longitudinally polarized electron beam and longitudinally and transversely polarized $NH_3$ and $ND_3$ targets. The proton and deuteron spin asymmetries $A_1(\nu,\ Q^2)$ and $A_2(\nu,\ Q^2)$ will be extracted from the $A_\parallel$ and $A_\perp$ asymmetries measured at $Q^2 \approx 1.3$ GeV$^2$. An overview of the status of the experiment, data analysis and an outlook of what we can expect from our program will be discussed in this proceeding.

## 1. Introduction

Spin structure functions of the nucleon have been measured since the late 1970's. Most of the experimental studies at SLAC [1], CERN [2], and DESY [3] have been concentrated on the high $Q^2$ region where electrons scatter essentially from a free constituent and perturbative QCD works well. The Thomas Jefferson National Accelerator Facility (TJNAF) provides a low and intermediate energy range (up to 6 GeV) polarized electron beam and gives us a unique opportunity to study the nucleon spin structure at lower energy region where quarks are not simple free particle anymore and pQCD is not applicable. The spin structure measurements in the low and intermediate $Q^2$ region will allow us to study the contribution of individual nucleon resonances to the spin structure function.

One of the measurable quantities in polarized electron-nucleon scattering is the asymmetry, simply a normalized cross section difference between scattering with the electron and nucleon spin parallel and anti-parallel. The virtual photon asymmetries $A_1$ and $A_2$ describe the quark contribution to the nucleon spin. Experiment E01-006 at Jefferson Laboratory has measured the asymmetries $A_\parallel$ and $A_\perp$ at $Q^2 \approx 1.3$ GeV from proton and deuteron targets. This high precision measurement on both $A_\parallel$ and $A_\perp$ will allow us to extract the spin asymmetries $A_1\left(\nu, Q^2\right)$ and $A_2\left(\nu, Q^2\right)$ without using any assumption or models. The nucleon spin structure in the resonance region as well as the connection to the DIS measurements can be studied. Also, the effects of the quark-gluon interactions, twist-3, and the local duality for the polarized case can be explored from this measurement.

## 2. Experiment

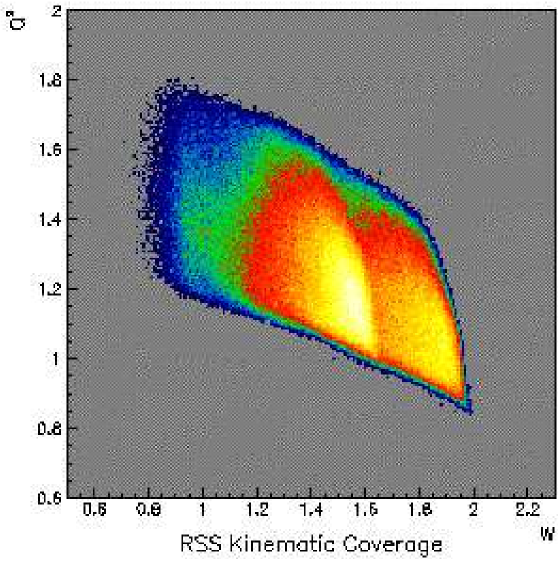


Figure 1. RSS kinematic coverage for the longitudinal $NH_3$

The experiment was conducted at Hall C, Jefferson Lab for two months in early 2002 using a continuous polarized electron beam of 5.7 GeV beam energy. The beam polarization was measured by a Moller polarimeter installed at the entrance to the Hall C and the average beam polarization was about 70 %. The beam helicity was flipped at 30 Hz on a pseudo-random basis. The beam charge asymmetry was measured online every five minutes and fedback to the helicity control device at the injector to minimize the false asymmetry.

Frozen $^{15}NH_3$ and $^{15}ND_3$ were used as a target material for proton and deuteron. The target polarization was achieved via Dynamic Nuclear

Polarization technique and measured by an NMR system using pickup coils embeded in the material. The average target polarization for $^{15}NH_3$ was around 80 %, and for $^{15}ND_3$ around 20 %. For the $A_\perp$ measurement, the whole target was rotated 90 degree from its norminal position.

Scattered electrons were measured inclusively using the High Momentum Spectrometer (HMS) at the scattering angle of 13.15 degree with the average $Q^2 = 1.3$ GeV. Particles are detected and identified by a combination of hodoscope planes, wire chambers, a Cerenkov counter and a lead glass calorimeter. Two different HMS momentum setting were used to cover wider kinematic range: 4.095 GeV for $W$ from 1.48 GeV to 1.95 GeV and 4.723 GeV for 0.83 GeV $< W <$ 1.59 GeV.

## 3. Results

Approximately 160 million triggers were collected on the proton target, 350 million triggers on deuteron. Data analysis is currently underway including calibration of the spectrometer optics, tracking and particle identification and extracting beam and target polarization. The preliminary results on the count asymmetries, Fig.2 and Fig.3 from the first pass analysis are very promising.

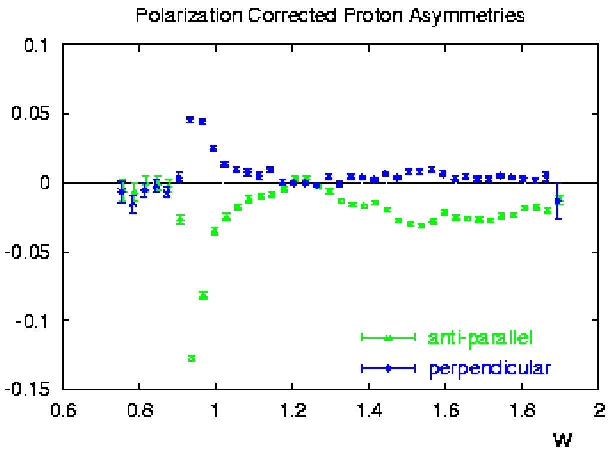


Figure 2. Preliminary result on $NH_{3]}$ asymmetry, for beam and target polarization parallel and perpendicular. The sign of the parallel asymmetry was reversed for better view and marked as anti-parallel.

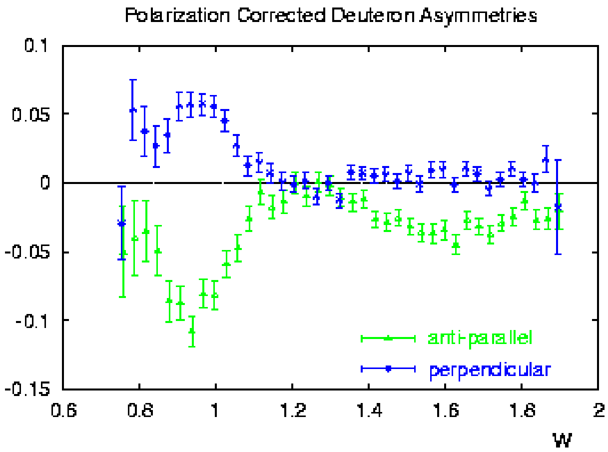


Figure 3. Preliminary result on $ND_{3]}$ asymmetry, for beam and target polarization parallel and perpendicular. The sign of the parallel asymmetry was reversed for better view and marked as anti-parallel.

## 4. Outlook

One of main physics goals of the program is to study $W$ dependence of the transverse and longitudinal polarized structure functions of the proton and deuteron in the resonance region. The RSS measurement will provide the first precision measurement of the transverse asymmetry for the proton and deuteron. This will give us an opportunity to study the effects of twist-3 to the structure functions. The RSS kinematic region was chosen that the data connect very well with other polarized DIS experiments for direct comparison with extrapolated DIS data with our data in the resonance region to study local duality for the polarized structure functions. Also, these data can be used to test the extended Gerasimov-Drell-Hearn [4] sum rule with a minimum of interpolations or use of fits to the world data on the structure function $g_1$. Along with other programs at Jefferson Lab [5] [6] [7], this measurement will contribute significantly to the world data on the spin structure functions.

## 5. Acknowledgments

This work was supported by Department of Energy contract DE-FG02-96ER40950, and by the Institute of Nuclear and Particle Physics of the University of Virginia. The Southern Universities Research Association

(SURA) operates the Thomas Jefferson National Accelerator Facility for the United States Department of Energy under contract DE-AC05-84ER40140.

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