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The Structure of the Nucleon from Helicity-Dependent Experiments at LEGS

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Beamline(s): X5A

The LEGS Spin Collaboration working at X5A has developed the equipment and techniques necessary to determine fundamental properties of the proton and the neutron involving measurements of the spin-dependent reaction amplitude for the nucleon. In particular, the helicity $\frac{1}{2}$ and $\frac{3}{2}$ reaction cross sections will be measured, with target and photon-beam spins parallel and anti-parallel, to determine the forward spin-polarizability and Gerasimov Drell-Hearn sum rule integrals for both the proton and neutron using the same target and the same detection system. This project at LEGS will also measure the double polarization differential cross sections for both neutral and charged pion production, i.e. the explicit channels contributing to the sum rule integrals. These data will place stringent tests on QCD-inspired models that are used to calculate the nucleon spin structure.

In FY'2002, the first data were taken with linearly and circularly polarized photon beams on a longitudinally polarized frozen-spin HD ice target. The proton polarization was $(30\pm 3)\%$ and that of the deuteron was $(6\pm 1)\%$ at the beginning of the run. The total data taking time was approximately 3.5 days. The data were obtained by randomly flipping through six different polarization states of the beam, $0^\circ/90^\circ$ linear, $+45^\circ/-45^\circ$ linear and left/right circular.

These experiments required the development of the frozen-spin HD target, a detector system capable of detecting in coincidence particles emitted over a wide angular range, and a backscattered gamma-ray beam with well determined circular as well as linear polarizations.