**A high precision Mott polarimeter operating at 5 MeV**

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**Abstract:** We report on the design and performance of a Mott polarimeter optimized for operation at a nominal 5 MeV electron beam energy. Using beam with a 31.1875 MHz time structure from the 1497 MHz CEBAF electron injector, and incorporating time-of-flight in the electron detection, we can isolate the detected electrons that originate from the scattering foil. This background elimination results in very stable asymmetry measurements over a wide range of beam conditions and foil thicknesses. We have measured the scattering asymmetry produced by a ~ 85% transversely polarized electron beam incident on a range of gold foil thicknesses from 96 g/cm2 to 1.93 mg/cm2. The statistical uncertainty of each measurement was below 0.25%. We confirmed that within this statistical precision, the measured asymmetry was unaffected by +/- 2 mm shifts in the beam position on the target, by beam current changes, and by dead time effects over a wide range of beam currents.

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Introduction/Motivation

Photocathodes

Users

Polarimeter Comparisons

Beam Energy Measurement

Spin at 11 GeV

The physical construction of the polarimeter (Sinclair, Grames)

The scattering chamber, optimized for 5 MeV (i.e. 172.6o scattering angle)

Internal collimation

Target ladder and foils

OTR viewport

Beam dump, including long channel and dump magnet

The detector packages (four ports)

Shielding

vacuum

Data acquisition : Signal to Disk (Sulieman)

The laser, source, injector (Sinclair, Poelker)

The gun, cathode, (including laser spot size at cathode and QE map?), and 130 kV operation (vs. original design at 100 kV?)

Wien filters and solenoids

The laser system, including details of 31.1875 (and 62.375) MHz operation and the IHWP

Chopping, bunching, capture, and quarter cryomodule

Beam monitoring and transport to polarimeter and spectrometer (including BPMs), and measured beam properties (emittance, E, dE, spot size at foil)

Beam current measurements (F. cups, BCM)

The experiment

setup of polarization with Wien and solenoids

data collection

Analysis and

offline analysis, including complete details of E counter spectra and TOF, event selection, etc. (Poelker, Sulieman, Moser)

Systematic studies (deadtime, PITA, IHWP, position change, sign of dump dipole, ultimate elimination of dump dipole, polarization stability measurements during run) (Sinclair, Grames)

Details of foils used and their thickness measurements by Lebow, FESEM, and singles rates (Stutzman, Mamun, Gay)

Target thickness calibration – measured asymmetry versus measured foil thickness and hyperbolic fit to data (Moser)

GEANT model of the polarimeter and its performance, including generation of a fit to the data from first principles (McHugh)

**Theory:** Xavier has submitted his theory paper. We can either use sub-section or see if he wants to publish the work separately.

Calculated Sherman function and its uncertainties, and comparison with model and experimental data

(Roca-Maza, Sinclair)

**Conclusion** (Grames, Sinclair, Gay)

**Future plans** (measurement with different Z foils, and at different energies, allowing some bounds to be placed on systematic uncertainties of the Sherman function calculations; precision polarimetry with a different polarimeter to allow extraction of the Sherman function from our results) (Sinclair, Poelker, Grames, Gay)

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## References