An Integrating Method for Compton Photon Polarimetry at Jefferson Lab

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Outline

- Compton polarimetry in Hall A
- Data acquisition
- Simulation results
- Preliminary polarization measurements
Compton Polarimetry

- Spin-dependent asymmetry in Compton cross section gives access to electron beam polarization

\[ A_{\text{exp}} = \frac{S^+ - S^-}{S^+ + S^-} = P_\gamma \times P_e \times \langle A_l \rangle \]

- Measured experimentally
- Calculated theoretically

- Parallel polarization counted in \( S^+ \)
- Anti-parallel polarization counted in \( S^- \)
• Route incoming electron beam through a magnetic chicane and into Fabry-Perot cavity for Compton scattering

• Detect scattered photons and electrons

• Unscattered electrons continue downstream
Integrating DAQ

- 16-bit FADC samples signal every 5 ns, writes to disk every 1/30 second
  - Integrated signal from photon detector
  - Peaks, areas of individual pulses
  - Occasional waveforms from individual pulses
- Ancillary data from other DAQ elements
  - Rates in photon detector
  - Beam current, power in Fabry-Perot cavity, photon polarization, ...
Integrating Method

- Integrate energy-weighted photon signal over 1/30 second
- With programmable thresholds, we can cut out pedestal noise, large background pulses, etc
- We can compute the asymmetry over
  - A single electron helicity pair or quadruplet
  - An entire Compton laser cycle
Simulation Results

- We need to understand analyzing power, detector response
  - GEANT4 simulations of beamline, detector

- Test against spectra measured in data from individual photon pulses

- Impressive agreement at several electron energies
Preliminary Results

- Compton polarization measurements from HAPPEx (Fall 2009), compared to Møller measurements
Conclusion

- Integrating Compton photon polarimetry has performed well in Hall A during several experiments
  - $d_2^n$: Neutron quark-gluon correlations (Spring `09)
  - HAPPEx-III: Nucleon strange form factors (Fall `09)
  - PVDIS: Parity violation in deep inelastic scattering (Fall `09)

- Measurements agree well with other polarimetry methods over a range of electron beam energies (3.5 GeV-5.9 GeV) and photon rates (5-100 kHz)

- We’re looking forward to low-energy polarimetry during PREx next month
Thank you!

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