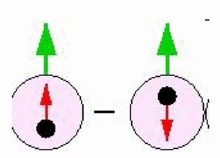
An Integrating Method for Compton Photon Polarimetry

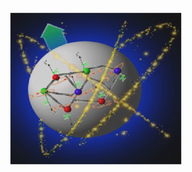
D. Parno, M. Friend, F. Benmokhtar, G. Franklin, B. Quinn, and the Hall A Compton Group

Beam Polarization

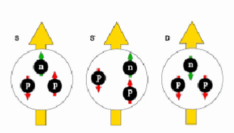
Many experiments in Hall A rely on a highly polarized electron beam:



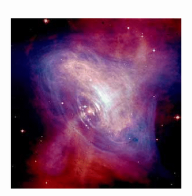
• Transversity (fall 2008 – winter 2009): double spin asymmetry in SIDIS



• d_2^n (spring 2009): neutron spin structure functions



• E05-102 (running experiment): ground-state functions of ^{3}He



• PREx (spring 2010): neutron distribution in a heavy nucleus (i.e. ^{208}Pb)

We need to know the beam polarization, but Møller measurements take away beam-on-target time, so they can't be used for continuous monitoring …

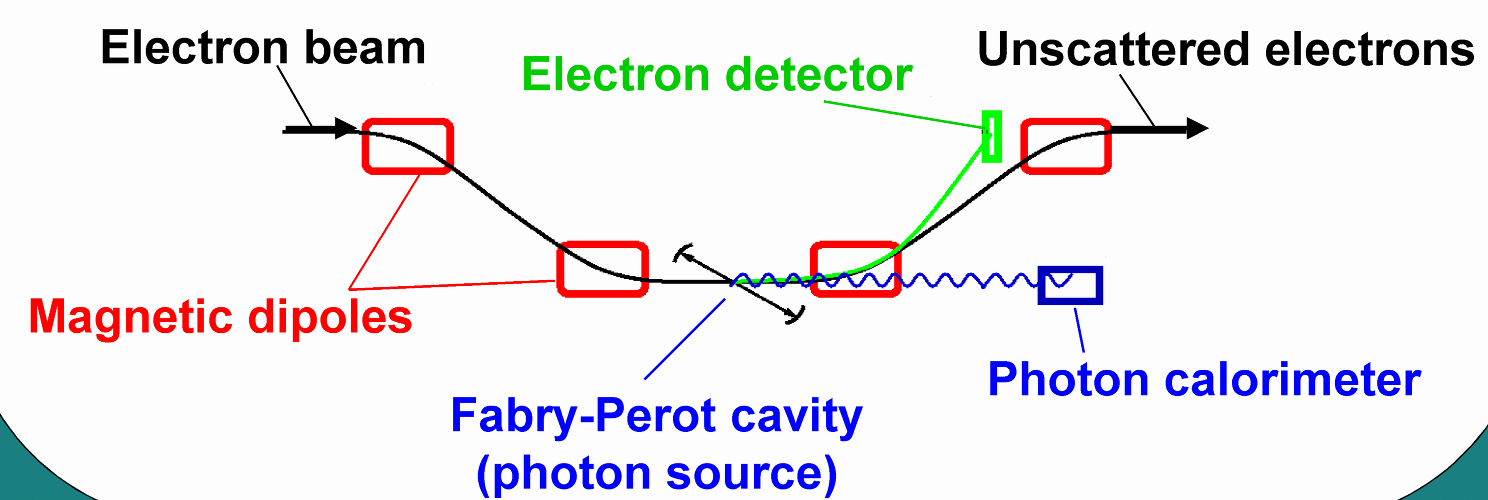
Compton Polarimetry

• The Compton scattering cross section depends on whether the electron and photon have parallel or antiparallel polarizations

• The cross section is very small, so this measurement does not appreciably disturb the electron beam

• Hall A's pre-existing system measures an asymmetry in counting rates

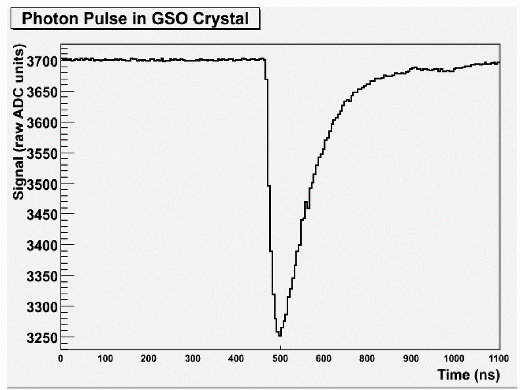
• Our new system measures an asymmetry in energy-weighted integrated signal, which is less sensitive to detector thresholds, response function, etc.



Integrating Method

• For the integrating Compton DAQ, we use a Struck FADC that samples at 200 MHz

• Over a 33-ms helicity window, the FADC integrates all samples in an accumulator



• From each accumulator value, we extract a physics signal for that MPS

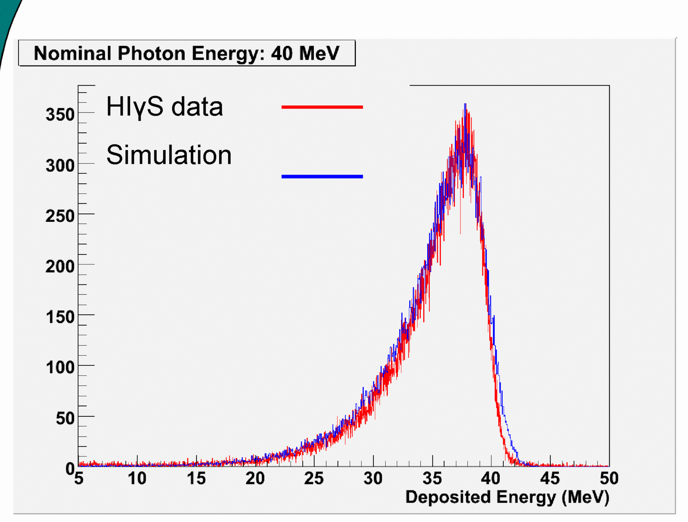
$$S_n = N_n \bar{S}_n = N_n \bar{P} - Acc_n$$

and then a Compton asymmetry proportional to the beam polarization

$$A_n = \frac{1}{D} \frac{S_n^+ - S_n^-}{S_n^+ + S_n^-} = \langle A_l \rangle P_\gamma P_e$$

Dilution factor — Analyzing power — Beam polarization

Analyzing Power



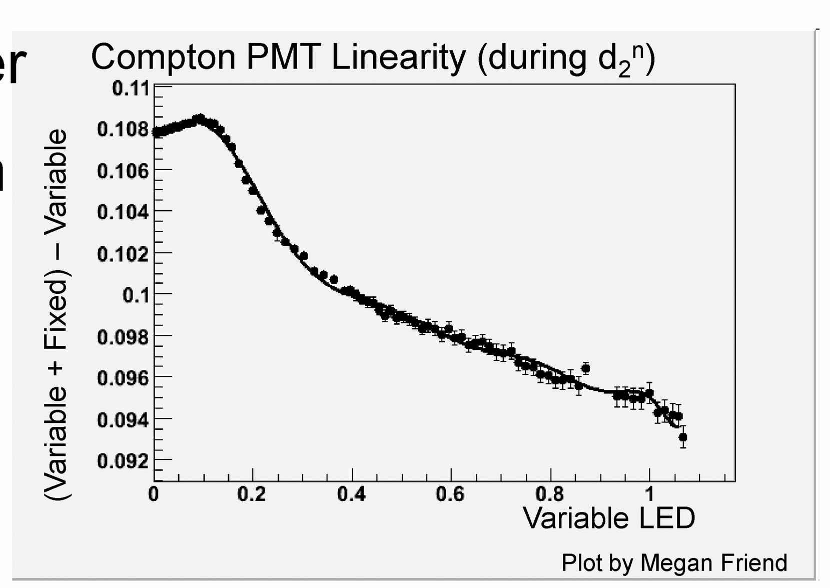
• A large GSO cylinder (6 cm diameter, 15 cm length) has been installed in Hall A as the Compton photon detector

• We combine GEANT4 simulations and HIγS data to understand the detector response function

• PMT nonlinearities also affect the analyzing power

• We use a pulser system with multiple LEDs for precise measurements

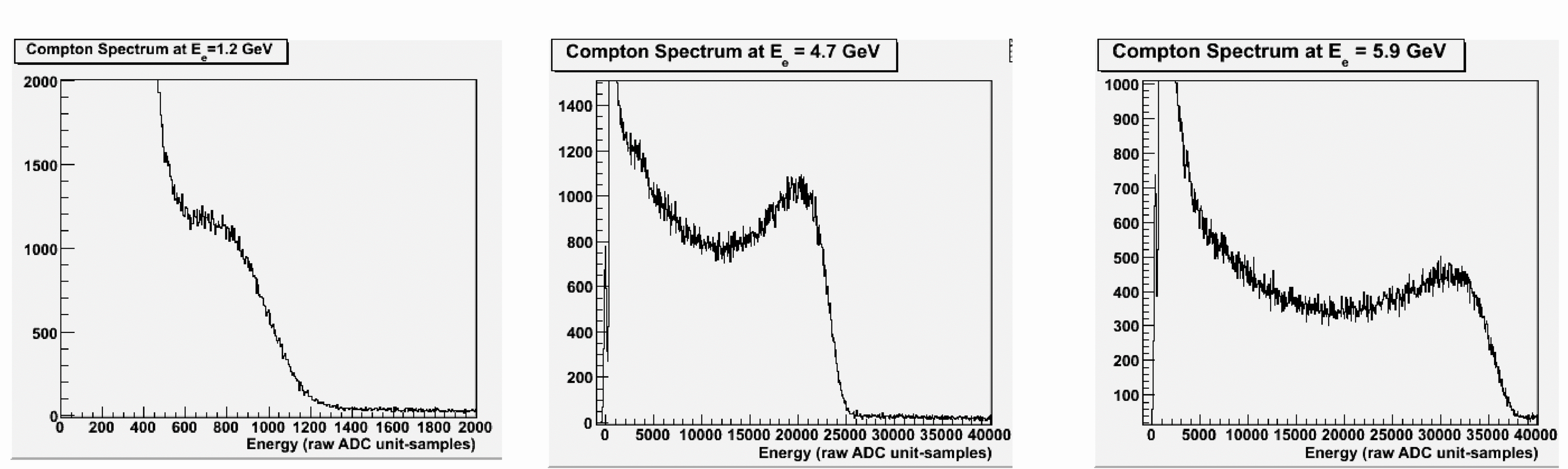
• This can be installed in the Hall for regular monitoring



Preliminary Results from d_2^n Running

• To confirm that we have good Compton signal, we take sampling data to measure Compton spectra

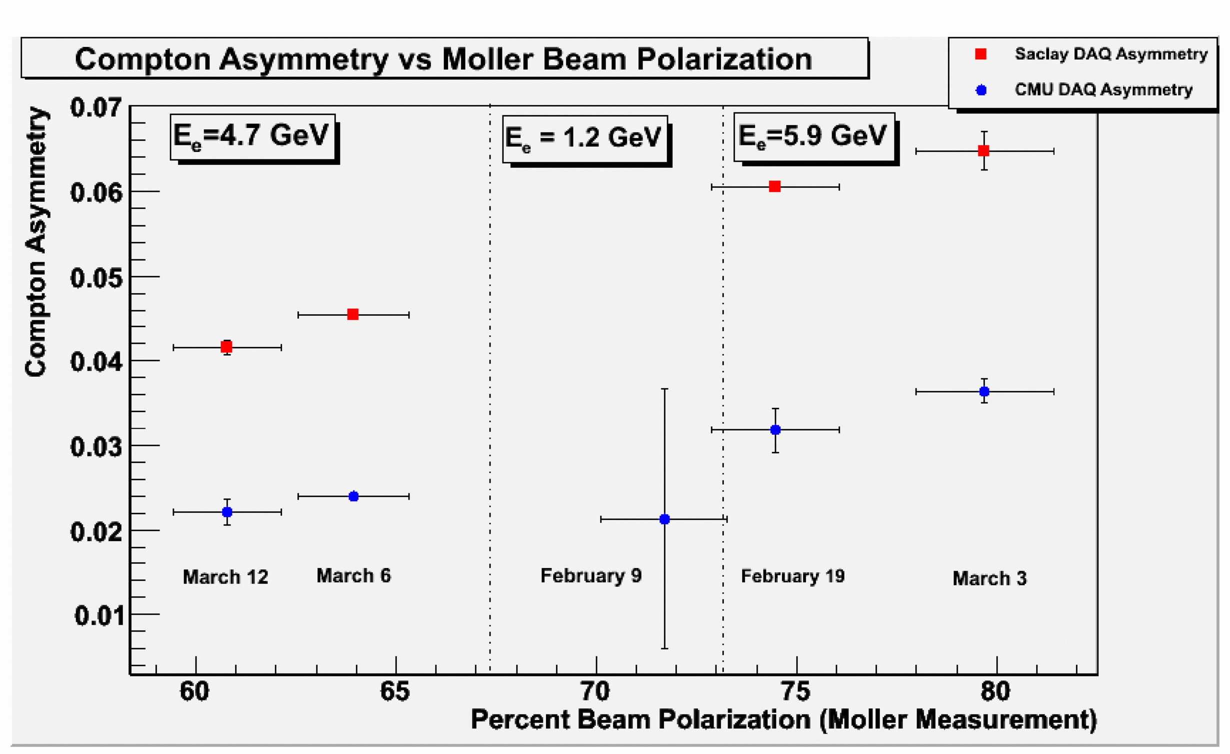
• The spectrum should have a distinctive parabolic shape with a sharp edge on the high-energy side



• Planned upgrade to a green Compton laser (double the incident photon energy) will give us access to more of the spectrum at one-pass

• To go from a Compton asymmetry to a beam polarization, we can begin by comparing Compton results to Møller measurements

• We have both integrated data from the new CMU DAQ and counting data from the original Saclay DAQ



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