Introduction to High Precision Polarimetry working group

Kent Paschke

University of Virginia

Outline

Goals:

- Establish common view of goals, challenges, and expected capabilities
- Identify possible pitfalls
- Flag areas requiring near-term activity

Outline:

- Plan for high precision polarimetry
- Moller, general issues
- Compton, general issues.
- Comparison between polarimeters

Credibility for 0.4% accuracy

- **Two independent measurements which can be cross-checked**
- Continuous monitoring **during production (protects against drifts, precession...)**
- **Statistical power to facilitate** cross-normalization **(get to systematics limit in about 1 hour)**

Schedule for high precision:
- PREX2/CREX Fall 2018: 1% at 1 GeV and 2 GeV
- MOLLER 2020: 0.5% at 11 GeV (for phases 2 & 3)
- SOLID 2024(?): 0.4% at 11 GeV and 6.6 GeV

Møller

Upgraded “high field” polarimeter

JLab, Temple, SBU, Kharkov/UVa

Atomic hydrogen gas target polarimeter
- expected accuracy to better than 0.4%
- non-invasive, continuous measurement
- Requires significant R&D
- backup plan, if needed

Mainz, W&M

Mott

Upgraded for precise asymmetry measurement

Techniques for limiting Sherman function uncertainty

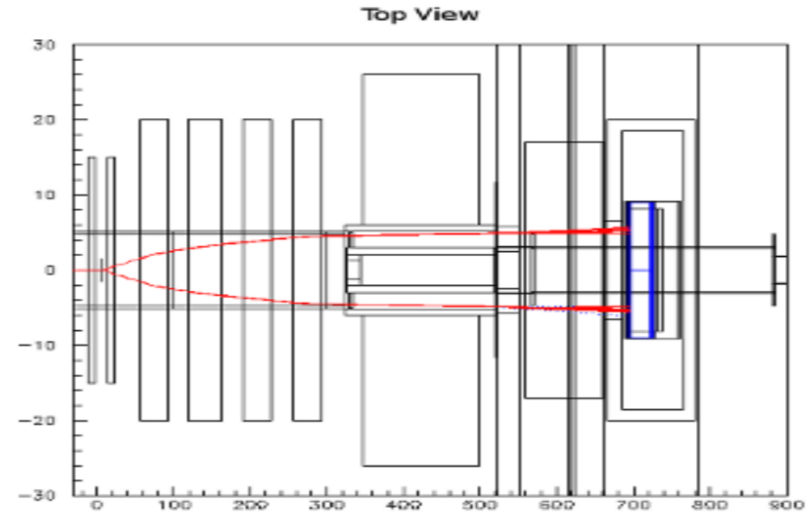
Compton

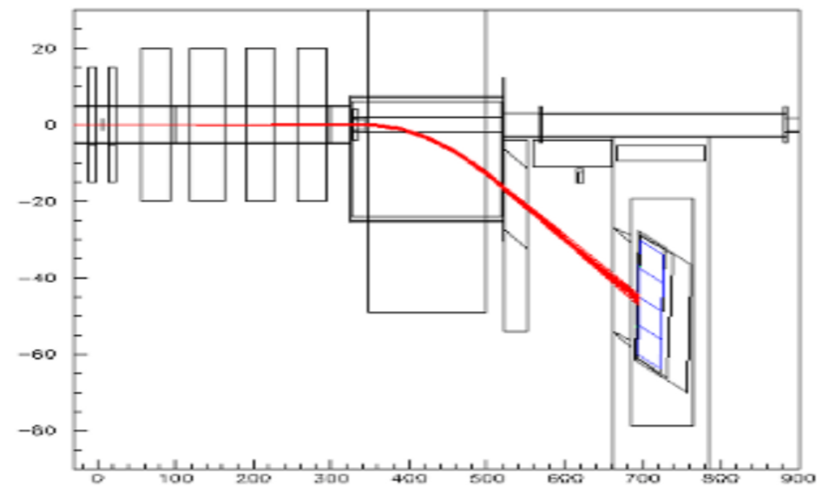
11 GeV baseline may meet goals
- significant independence in photon vs electron measurements
- continuous measurement with high precision

JLab, CMU, UVa, Manitoba, MSU, SBU

Moller Polarimetry Goals

- "high field" iron target
  - well-known magnetization at saturation
  - ultimately rests on empirical spin polarization from force/torque measurements
- QQQQD spectrometer
  - Open acceptance minimizes Levchuk correction
- Detect coincidence of identical particles
  - low background measurement





Can be (in principle) well understood:
spectrometer acceptance, magnetic saturation, target heating, radiative corrections, dead time, backgrounds…

Same techniques in Hall C ~ 0.7% polarimetry

Rebuilt for 12 GeV and high field.
- Commissioned at high energy
- Needs low energy commissioning
- Target apparatus being improved

After DVCS
- move target system to test lab for development
- Reinstall, commission for PREX in 2018

Potential Moller Polarimetry Challenges

Accuracy of Asymmetry Measurement

- Rate dependence / deadtime
- Background - dilution?
- Background asymmetry - iron pipe and new beam optics quadrupole

Analyzing power normalization

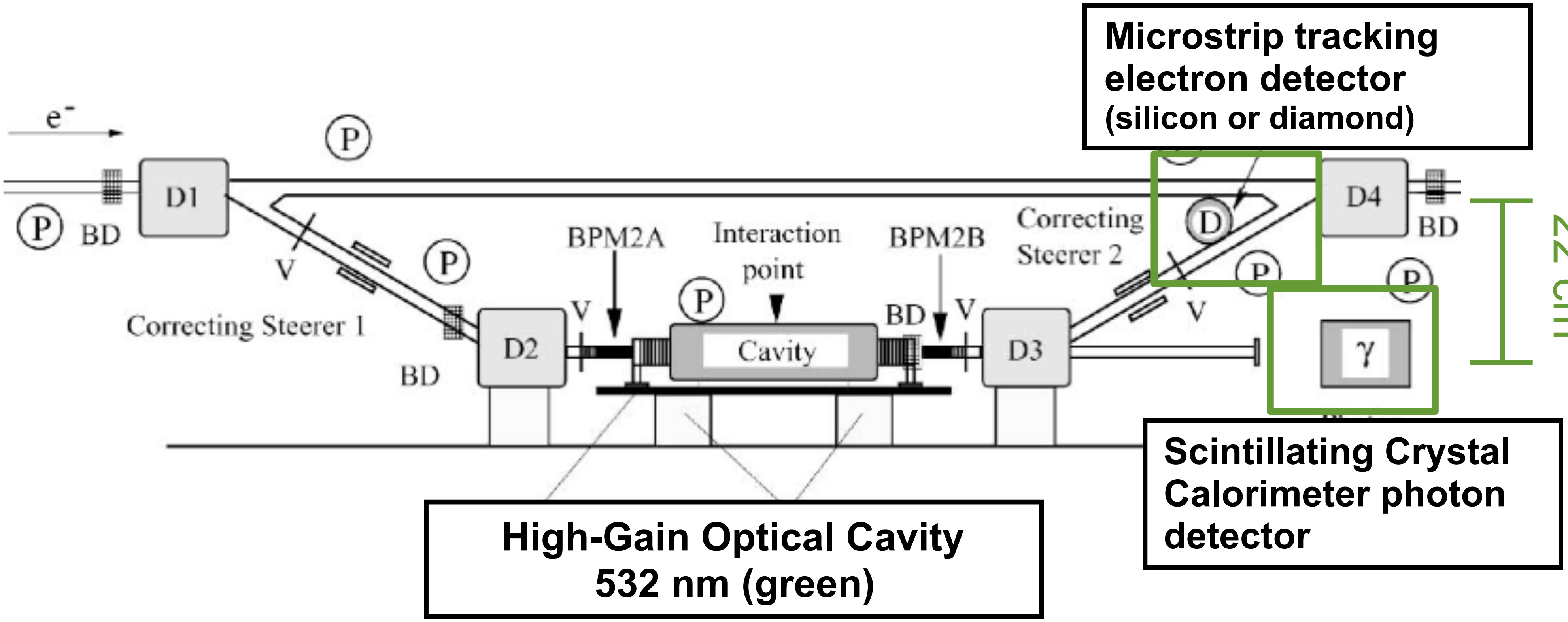
- Optics / acceptance (distorted by target field?)
- Levchuk correction
- Quality of saturation
- Target heating
- Electron spin polarization in magnetized material

Extrapolation to running conditions

- Polarization vs. Cathode current
- Polarization vs. slit width, etc…

Other issues?

Hall A Compton Polarimeter



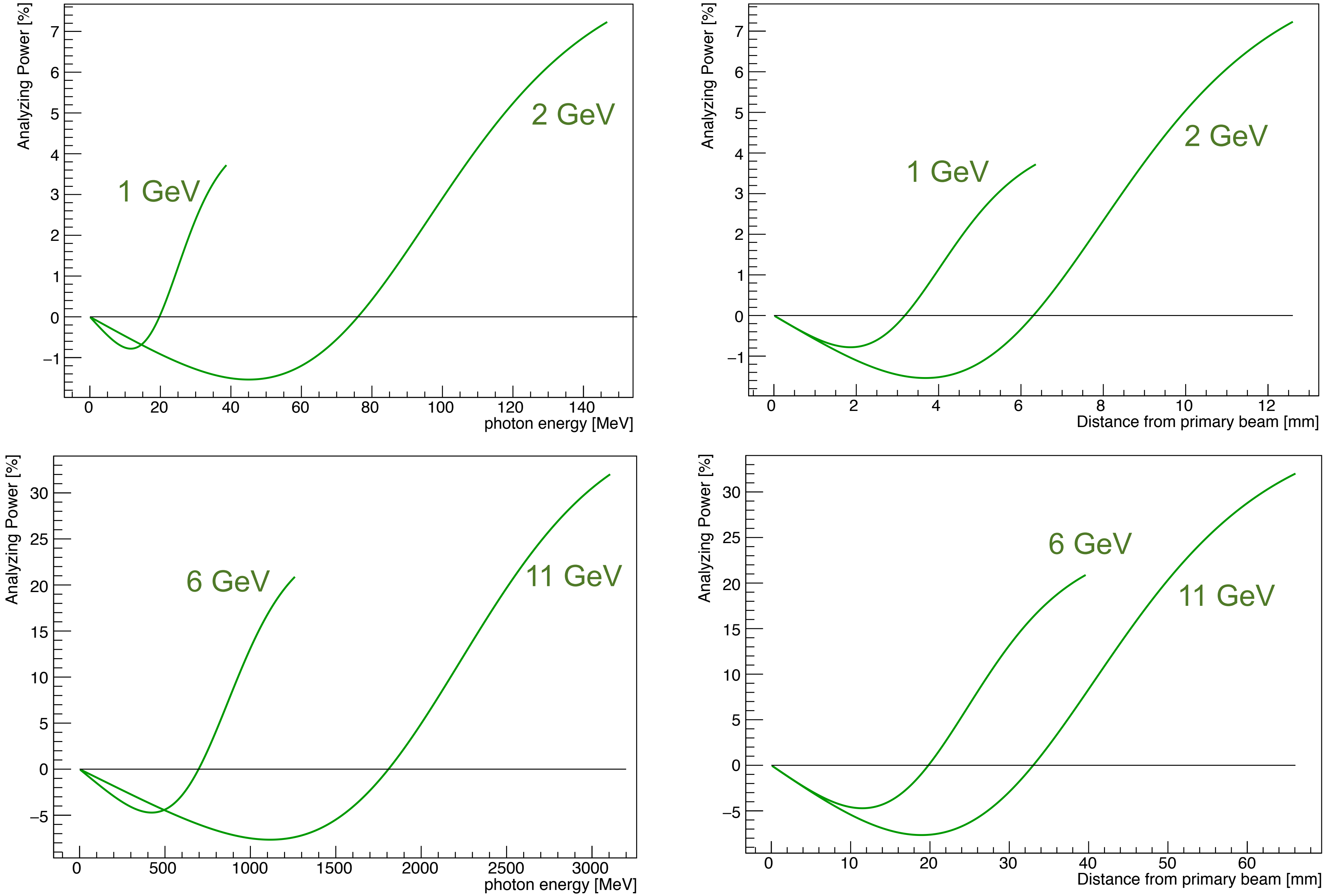
Operation at lower energy (1-2 GeV) is a very different set of challenges

<1% at 1 GeV is important proving ground for 0.4% at 11 GeV

Past Achievement

- HAPPEX-3 (2009): 0.8% at 3 GeV
- PREX-2 (2010): 1.0% at 1.06 GeV
- Qweak (2012): 0.8% at 1 GeV

PREX / CREX vs. MOLLER/SOLID



Potential Compton Polarimetry Challenges

Photon

Accuracy of Asymmetry Measurement
- Detector baseline shifts (integration)
- Detector rate linearity (integration, counting)
- Synchrotron radiation
- background magnitude / stability
- electronics noise (integrating)

Analyzing power normalization
- Energy calibration (counting)
- Response function linearity (integrating)
- Laser polarization

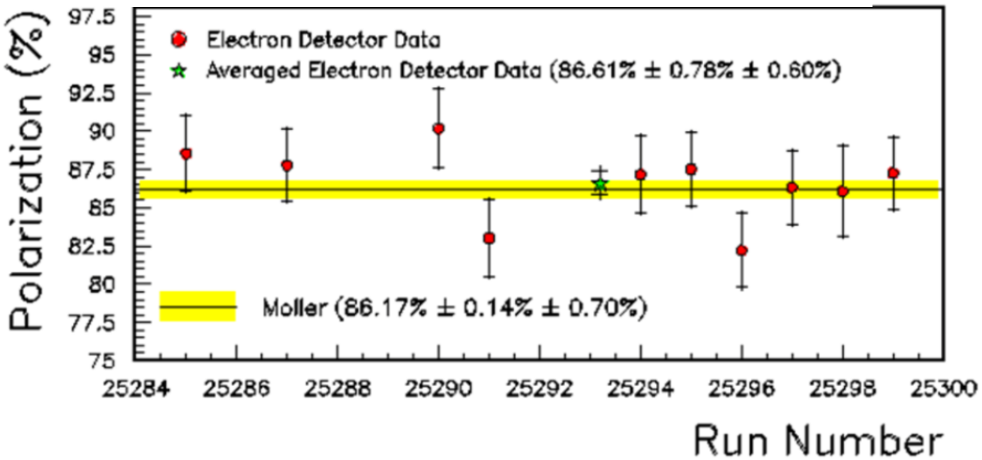
Electron

Detector
- no Hall A detector since 2007
- Efficiency? Geometry? Radiation resistance? Light sensitivity? Thickness?
- DAQ
- Most useful at high-E. At 2 GeV (CREX in 2018) probably would be useful

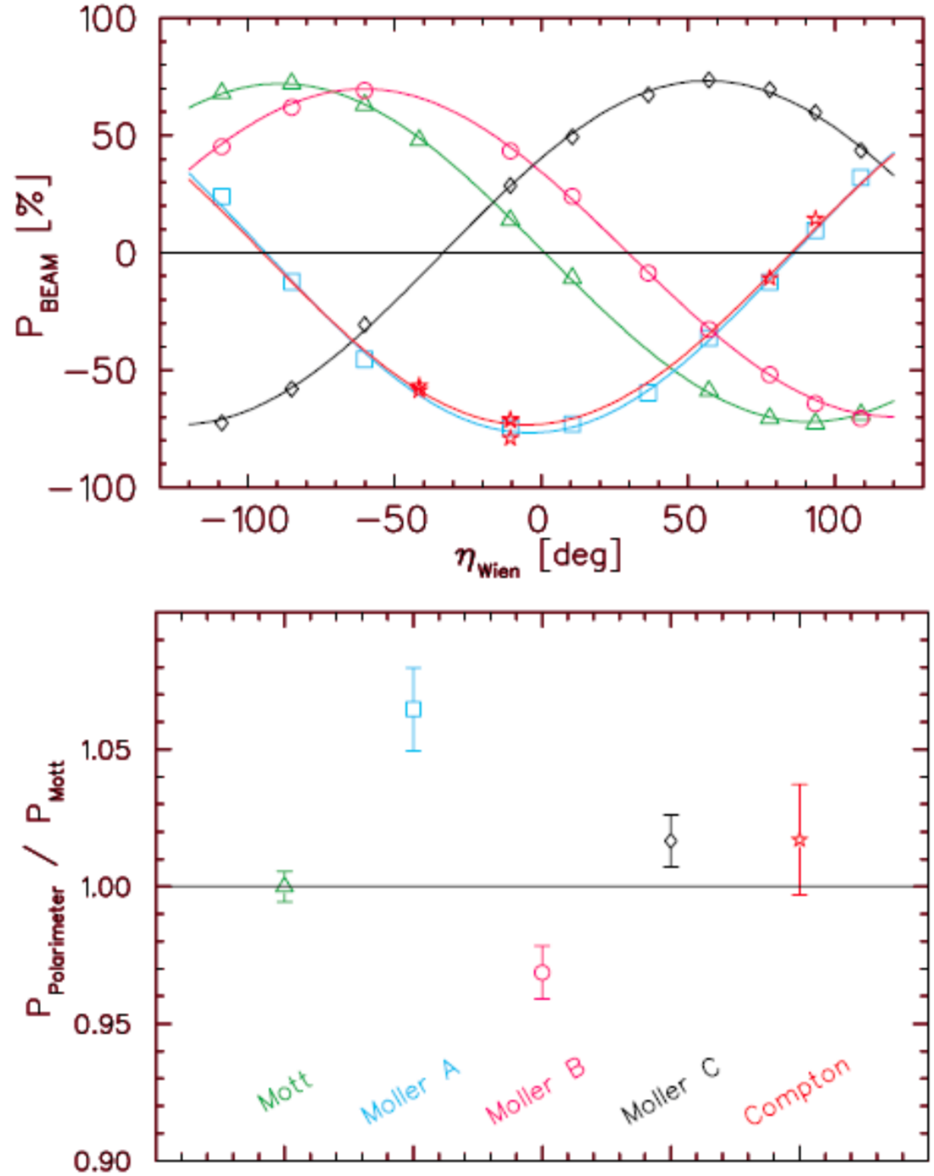
Analysis
- Qweak-style fit - well defined set of possible errors, cross-checks
- Cross-checks (“zero-slope”)

Spin Dance / Cross-Comparison

Qweak Moller-Compton-Moller (2012)



JLab Spin Dance (2000)



Direct Comparison between polarimeters is crucial benchmark

PREX should have
- high precision Moller and Compton in Hall A
- maybe can be compared to Moller in Hall C?
- Mott in injector?

Will Hall C Compton be ready for high precision again (no Hall C physics driver)?