E97-110 Status Report

Hall A Collaboration Meeting

December 11^{th}, 2003

Vincent Sulkosky

The College of William and Mary

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Graduate Students: J. Singh, V. Sulkosky, J. Yuan

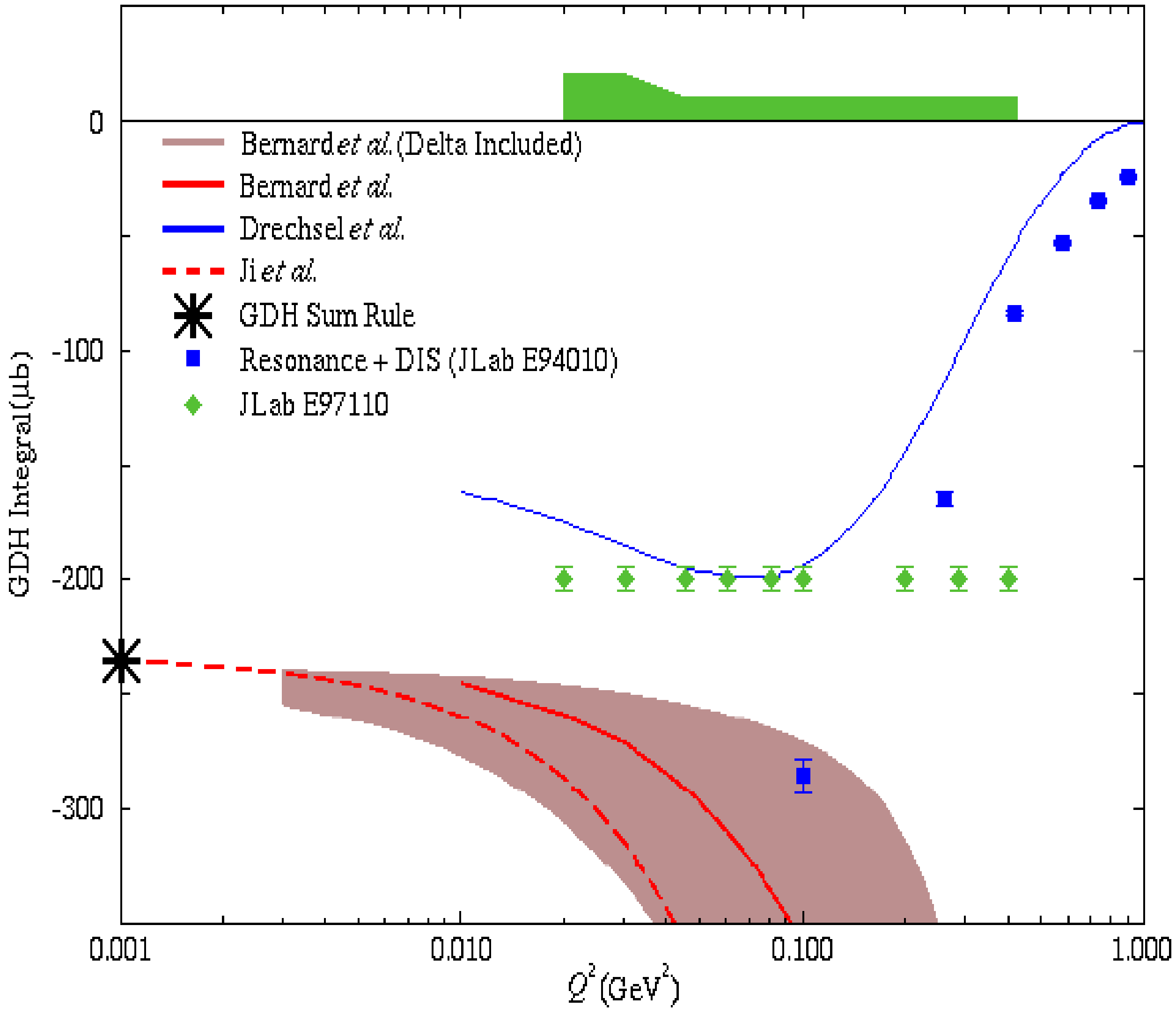
A Hall A collaboration experiment

Goals of the Experiment

Experiment E97-110: The GDH Sum Rule and the Spin Structure of the Neutron and ^{3}He using Nearly Real Photons

- Precise measurement of generalized GDH integral at low Q^2 (0.02 to 0.3 $(\text{GeV})^2$)
- Slope of the GDH sum rule at $Q^2 \sim 0$ (check χ PT)
- Extrapolation to the real photon point
- Constraints on the resonance structure of the nucleon
- Overlap with previous Hall A GDH experiment (E94-010, PRL **89**, 242301 (2002))
- Second PRL on the moments of g_1^n and g_2^n accepted for publication (hep-ex/0310003)

E97110 Expected Results



GDH Sum Rule

GDH Sum Rule

- Scattering of circularly polarized photon beam on longitudinally polarized target

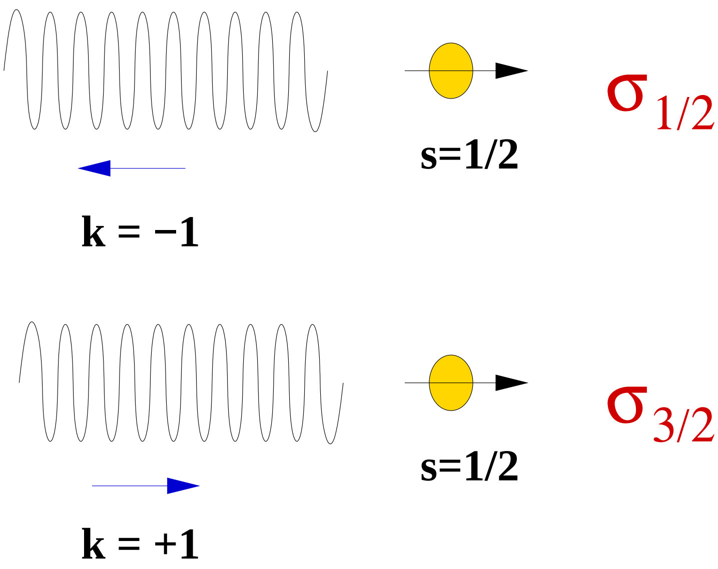
$$I_{GDH} = \int_{\nu_{thr}}^{\infty}(\sigma_{1/2} - \sigma_{3/2})\frac{d\nu}{\nu} = -\left(\frac{2\pi^2\alpha}{M_N^2}\right)\kappa_N^2$$

$$= -496\mu b$$

$$(^3He)$$

$$= -232.8\mu b$$

$$(neutron)$$



GDH at Finite Q^2

Extended GDH Integral ($Q^2 > 0$)

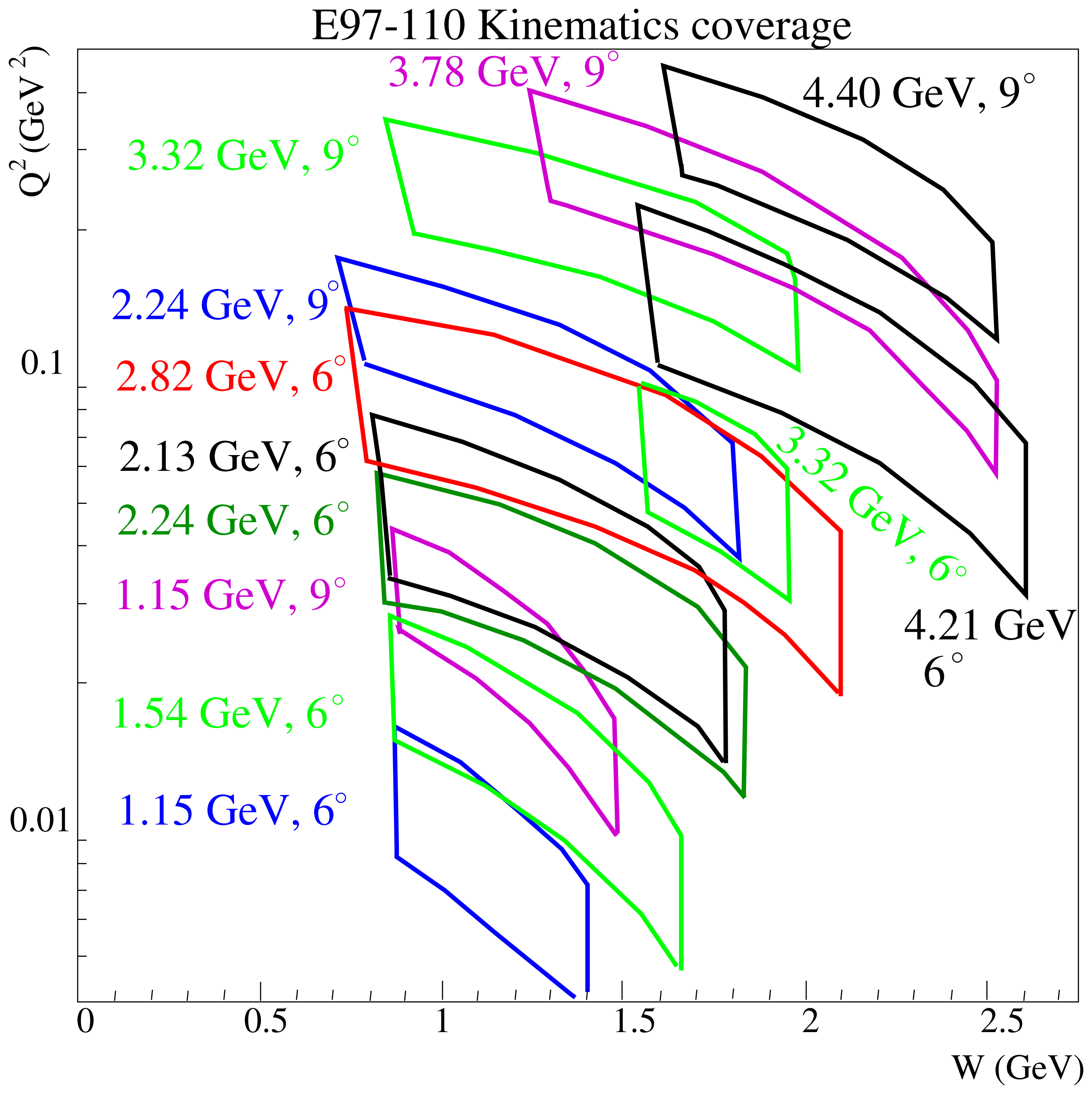
$$I(Q^2) \;=\; \int_{thr}^{\infty} [\sigma_{1/2}(\nu, Q^2) - \sigma_{3/2}(\nu, Q^2)] \frac{d\nu}{\nu}$$

$$Q^2 \rightarrow 0 \text{ or } \infty, \mathrm{I}(\mathrm{Q}^2) \rightarrow \frac{16\pi^2\alpha\Gamma_1}{\mathrm{Q}^2}, \Gamma_1 = \int_0^1 \mathrm{g}_1 \mathrm{dx}$$

- Related to the forward virtual Compton scattering amplitude
- Provides a bridge from the the non-perturbative region to the perturbative region of QCD
- Compares an experimental quantity to a theoretical calculation over the whole Q^2 range

Experiment E97-110

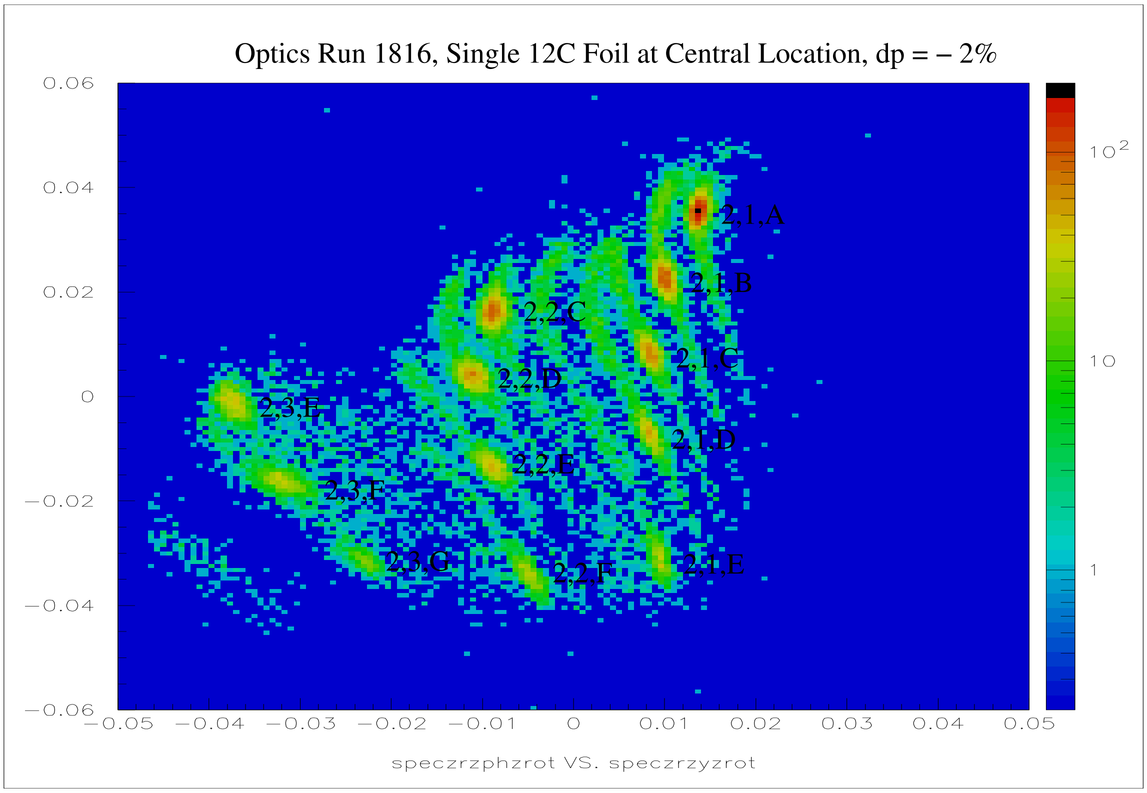
- Measurements:
  - $^3\overrightarrow{\mathrm{He}}(\vec{e},e')X$ reaction
  - Polarized cross sections and asymmetries
- Aspects of the experiment:
  - Newly commissioned Right Septum magnet at 6° and 9°
  - Special cone shaped cell for low beam energy (1-2 GeV) at 6°
  - High DAQ rate (4kHz, single arm DAQ)



E97-110 Kinematics coverage
Q^2 (GeV^2)
W (GeV)
0.1
0.01
0
0.5
1
1.5
2
2.5
3.78 GeV, 9°
4.40 GeV, 9°
3.32 GeV, 9°
2.24 GeV, 9°
2.82 GeV, 6°
2.13 GeV, 6°
2.24 GeV, 6°
1.15 GeV, 9°
1.54 GeV, 6°
1.15 GeV, 6°
3.32 GeV, 6°
4.21 GeV
6°

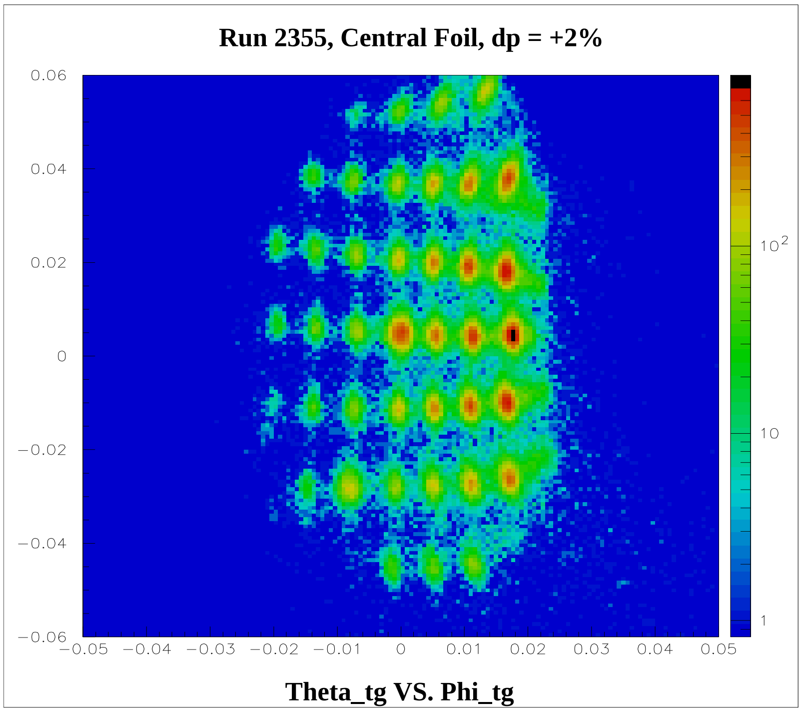
First Run Period

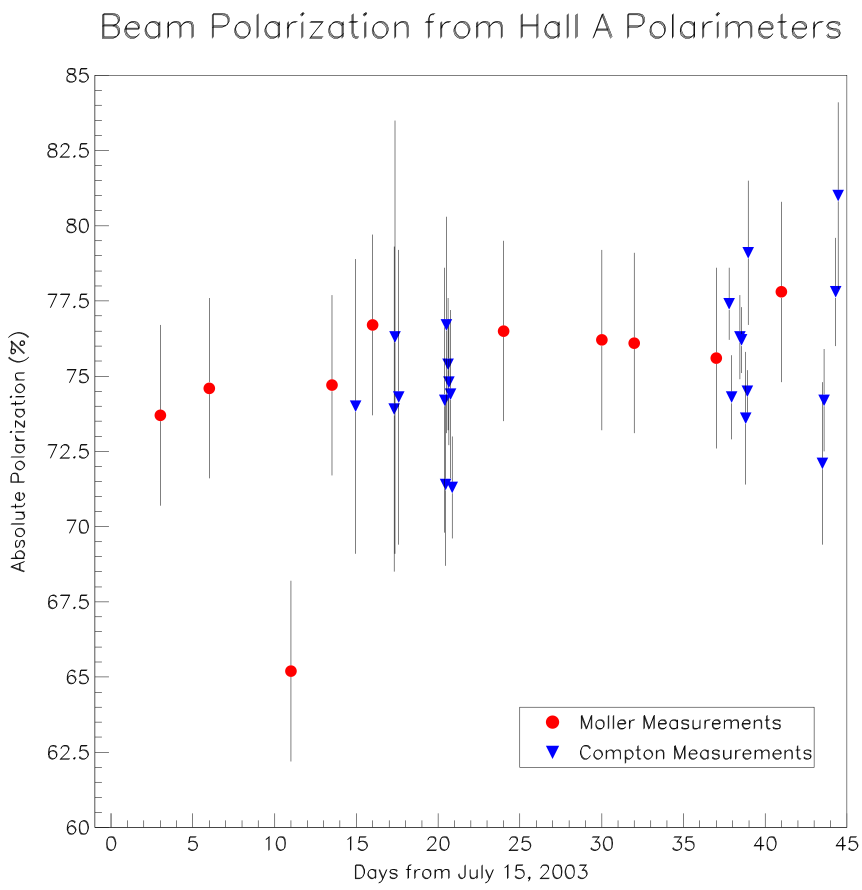
- April 21st to May 23rd
- Large Background (Added collimators around sieve slit)
- Septum miswired (skewed quad)
- Ice on Septum entrance
- Target polarimetry losses due to large field gradients from the Septum ($\sim$ 100 mG/cm at 300 A)



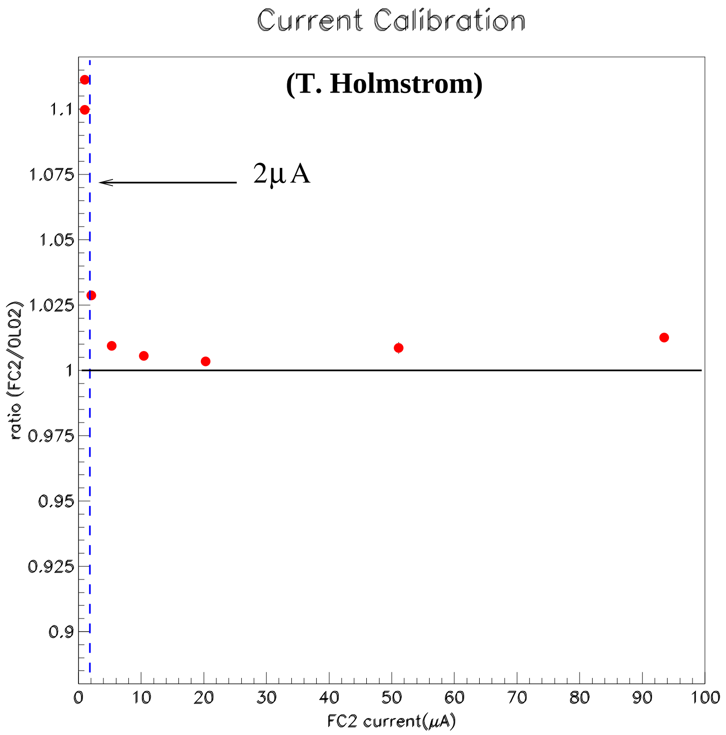
Second Run Period

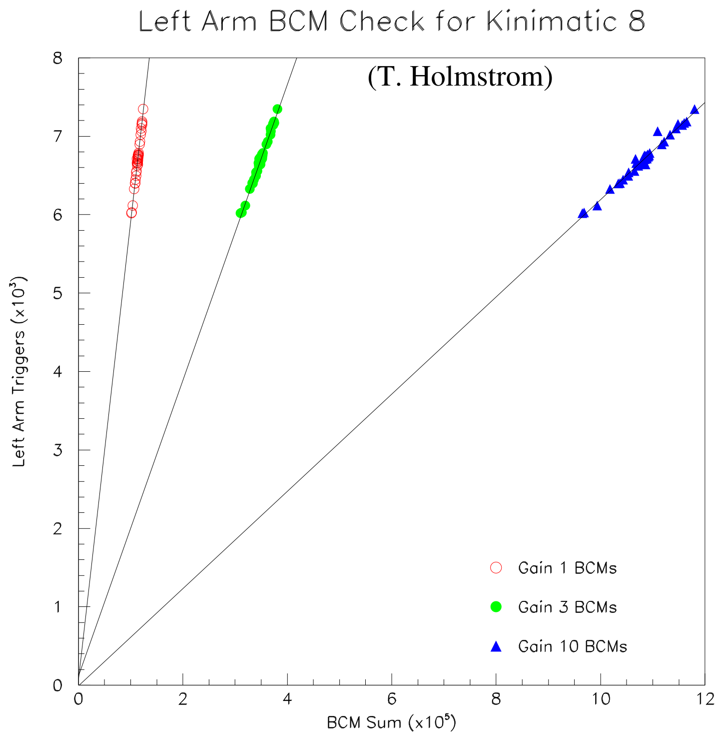
- July 15^{th} to August 29^{th}
- Septum Repaired (June)
- Successful commissioning
- Two standard 40 cm target cells used
  - Penelope lost after one week of running
  - Priapus lasted for the rest of the experiment
- No significant ice build up on Septum entrance
- Target pol. $\sim$ 40%, (gradients $\sim$ 30 mG/cm, 400 A)





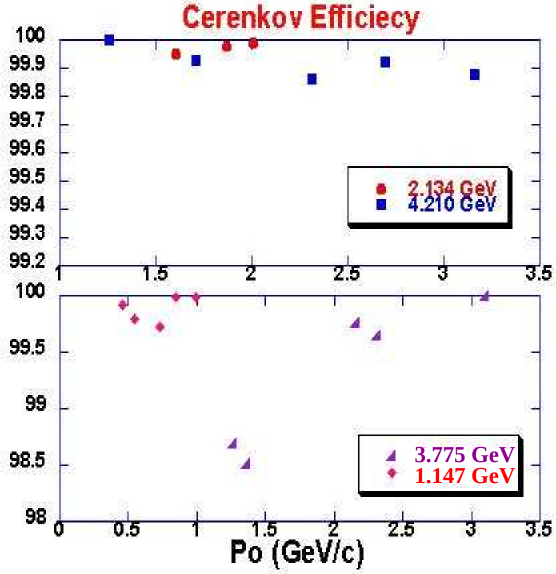
- Plot provided by T. Holmstrom
- Moller Measurements (E. Chudakov)
- Compton Measurements (S. Nanda)


Current Calibration
(T. Holmstrom)
$2\mu A$
ratio (FC2/OLO2)
FC2 current(μA)

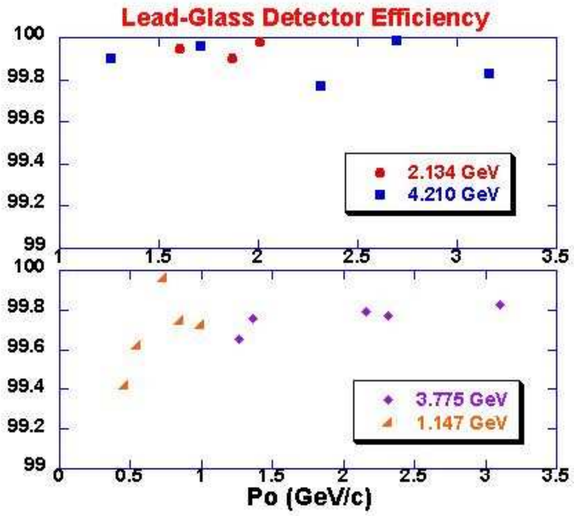

Left Arm BCM Check for Kinimatic 8
(T. Holmstrom)
Left Arm Triggers ($\times10^3$)
BCM Sum ($\times10^5$)
Gain 1 BCMs
Gain 3 BCMs
Gain 10 BCMs

Detector Efficiency (J. Yuan)

- Cerenkov detectors
  - Right arm efficiency average: 99.78%

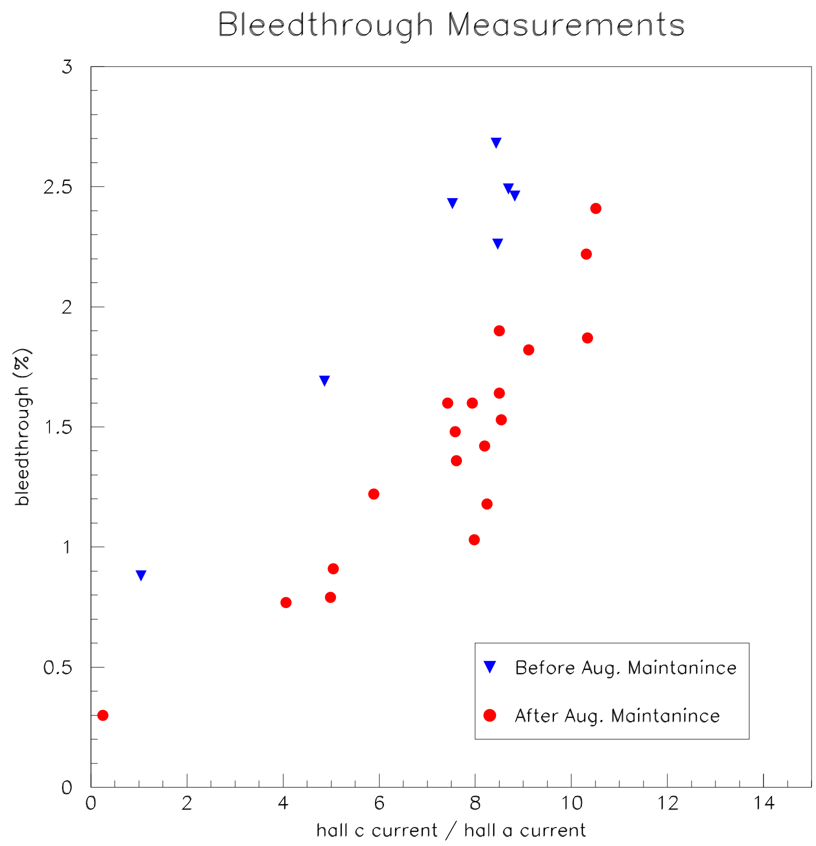


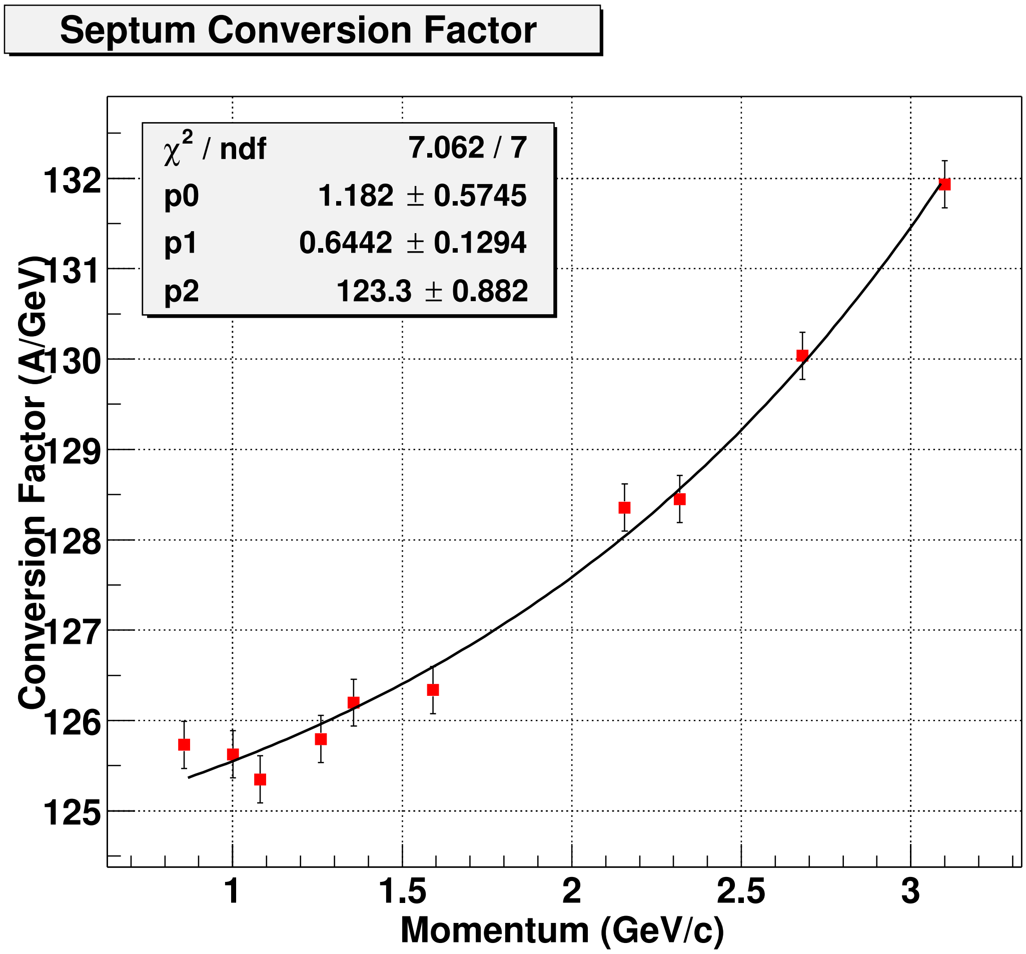
- Lead-Glass detectors
  - Right arm efficiency average: 99.72%



Issues

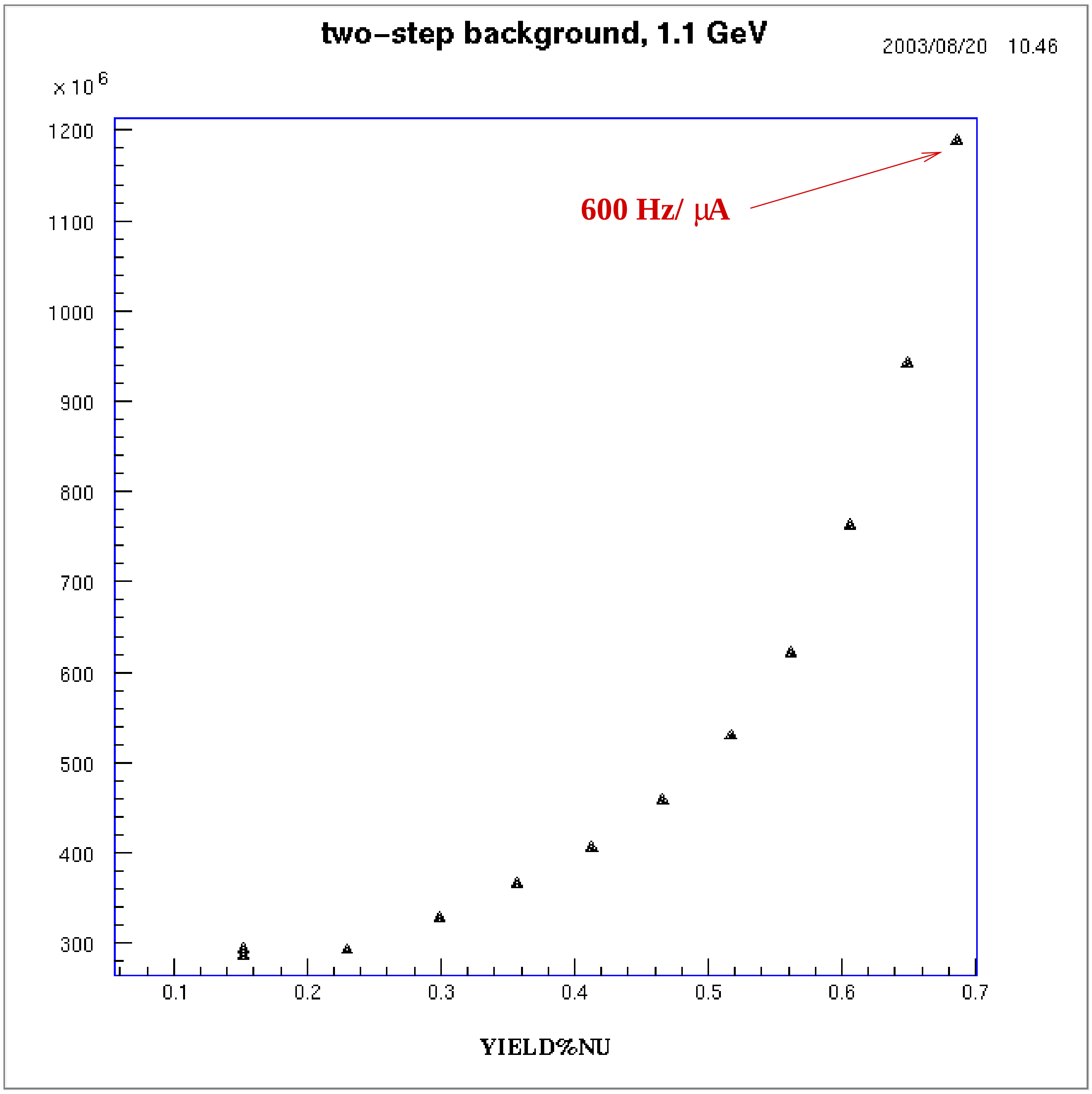
- A few elastic runs lost due to disk failure
- Bleedthrough from Hall C monitored and kept at the % level (T. Holmstrom)
- 80% of data taken: CHL crashes, beam aspect ratio, cell replacement





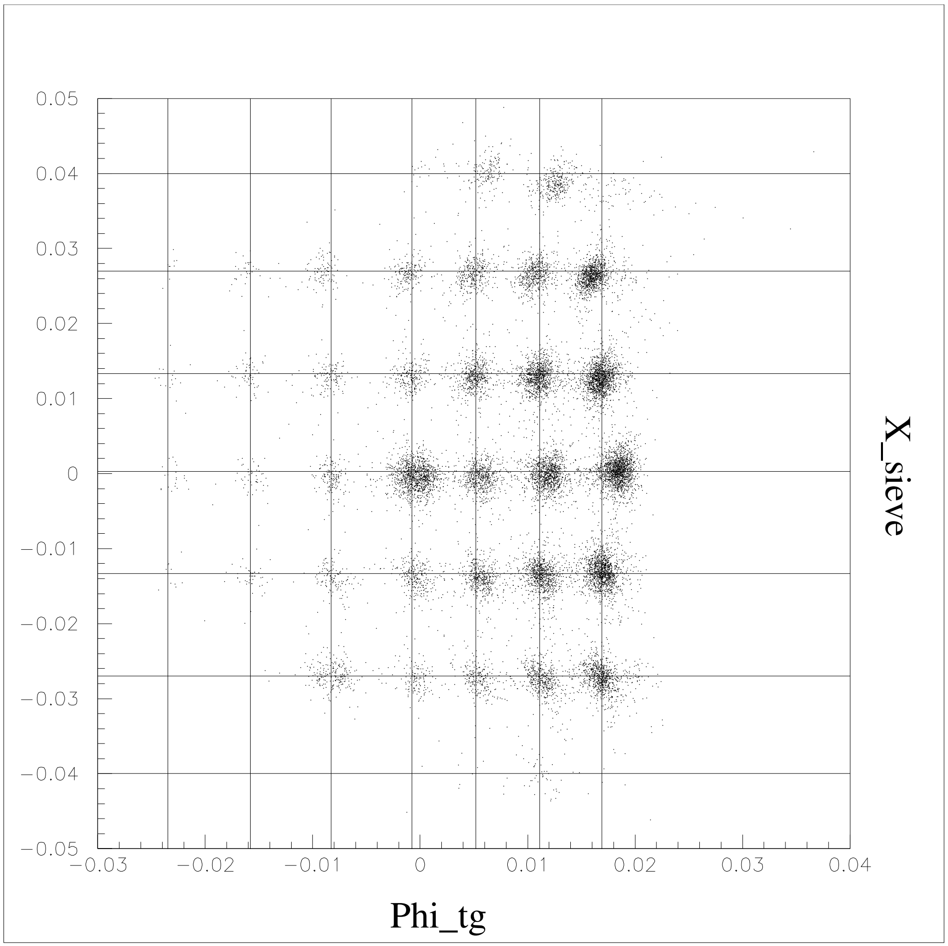
- For 9° high current (200 A to 410 A) running, Septum saturation curve
- For 6°, a constant factor was used

$$\mathrm{I_{read}} = (\mathrm{p0} * \exp(\mathrm{p1} * \mathrm{P_{HRS}}) + \mathrm{p2}) * \mathrm{P_{HRS}}$$



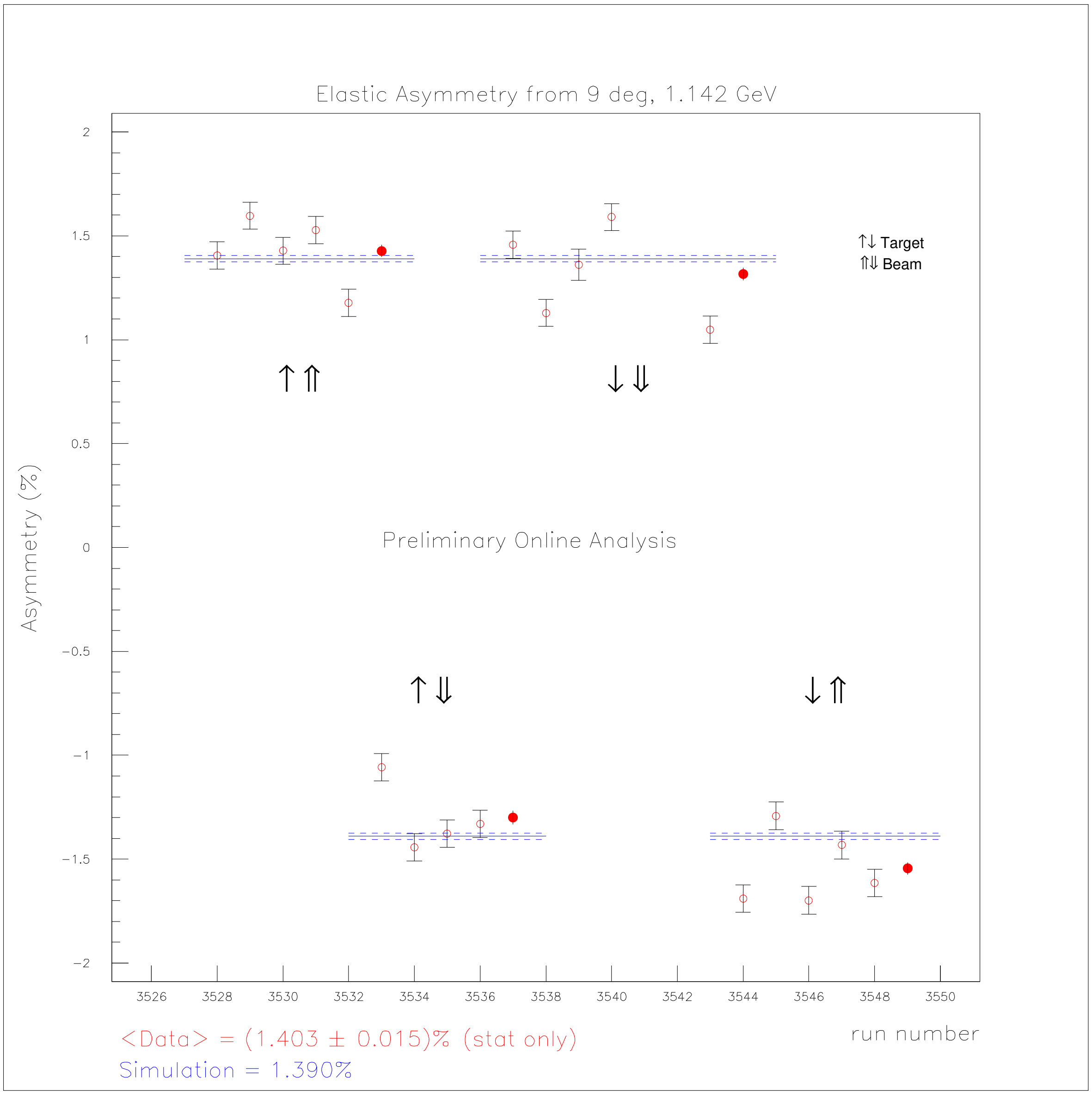
- 2-step process
  - Data from empty reference cell (should be 0)
  - Exponential rise follows calculation (A. Deur)
  - Should not be an issue for the experiment

Optics Calibration



- Angular optimization almost completed at 6°
- ytg in progress
- dp needs to be done
- 9° optimization
- First period optimization

Elastic Asymmetry



- Preliminary analysis (J. Singh) agrees well with prediction
- Four target and beam configurations

Summary and Plan

Summary

- Data acquisition completed and analysis is underway
- First run data are tractable, but will be a more delicate and longer analysis
- Successful commissioning of right Septum magnet at 6° and 9°
- Low Q^2 data will check Chiral Perturbation Theory
- Data complements E94010 data set above Q^2 of 0.10 with improved precision

Near Term Plan

- Beamline, e.g. beam pol. and BCM calibration (T. Holmstrom)
- Optics and Acceptance (V. Sulkosky, N. Liyanage/X. Jiang)
- Elastic, VDC, and scintillators (J. Singh)
- PID and scalers (J. Yuan)