Report on Target Analysis Progress For E02-013

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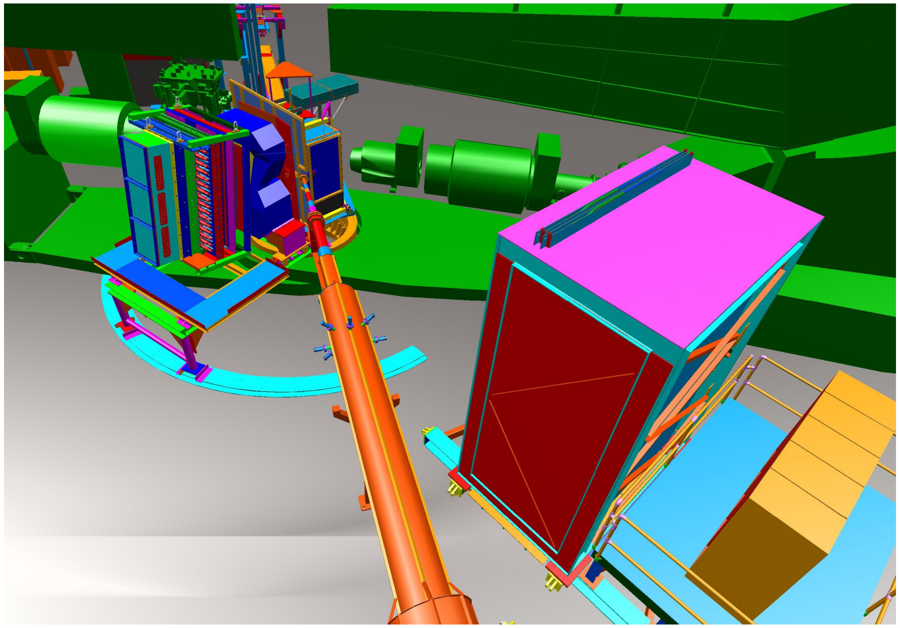
Outline

1. Experiment Reminder
2. Laser Light
3. Hybrid Cell
   - Polarization Results
4. Special Holding Field
5. Pion Asymmetry Monitor
6. G_E^n at 12 GeV

G_E^n at High Q^2: E02-013

Used the exclusive reaction $\overrightarrow{^3He}(\vec{e}, e'n)$ to extract G_E^n from the double polarized asymmetry: $A_\perp = -\frac{G_E^n}{G_M^n} \frac{2\sqrt{\tau(\tau+1)}\tan(\theta/2)}{(G_E^n/G_M^n)^2+(\tau+2\tau(1+\tau)\tan^2(\theta/2))}$

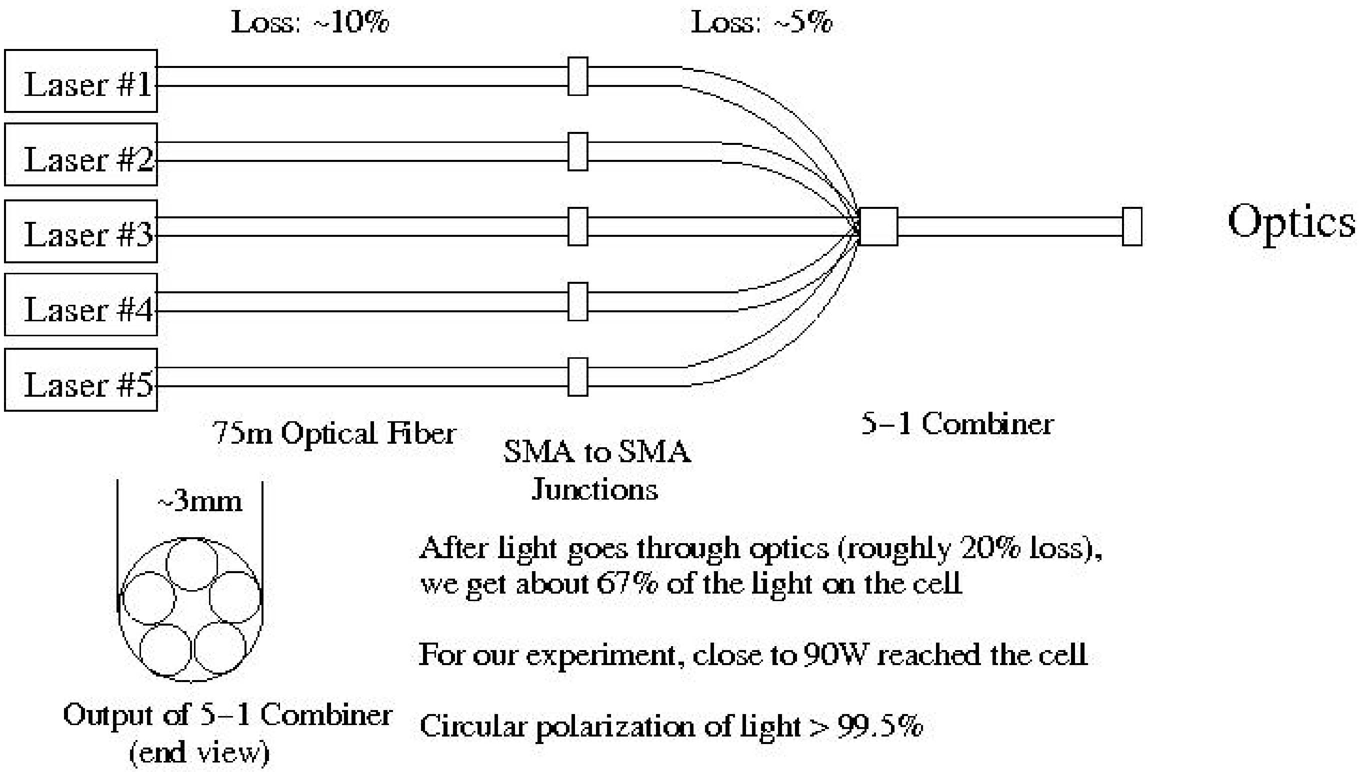


Polarized ^{3}He

- Standard set-up covered in other talks during this meeting
- What You Need to Know
  - Polarized ^{3}He as effective neutron target
  - ^{3}He is polarized by
    - Magnetic Field
    - Polarized Laser Light
    - Alkali Metal Vapor
  - Polarization Measured by
    - Nuclear Magnetic Resonance
    - Electron Paramagnetic Resonance

Laser Light

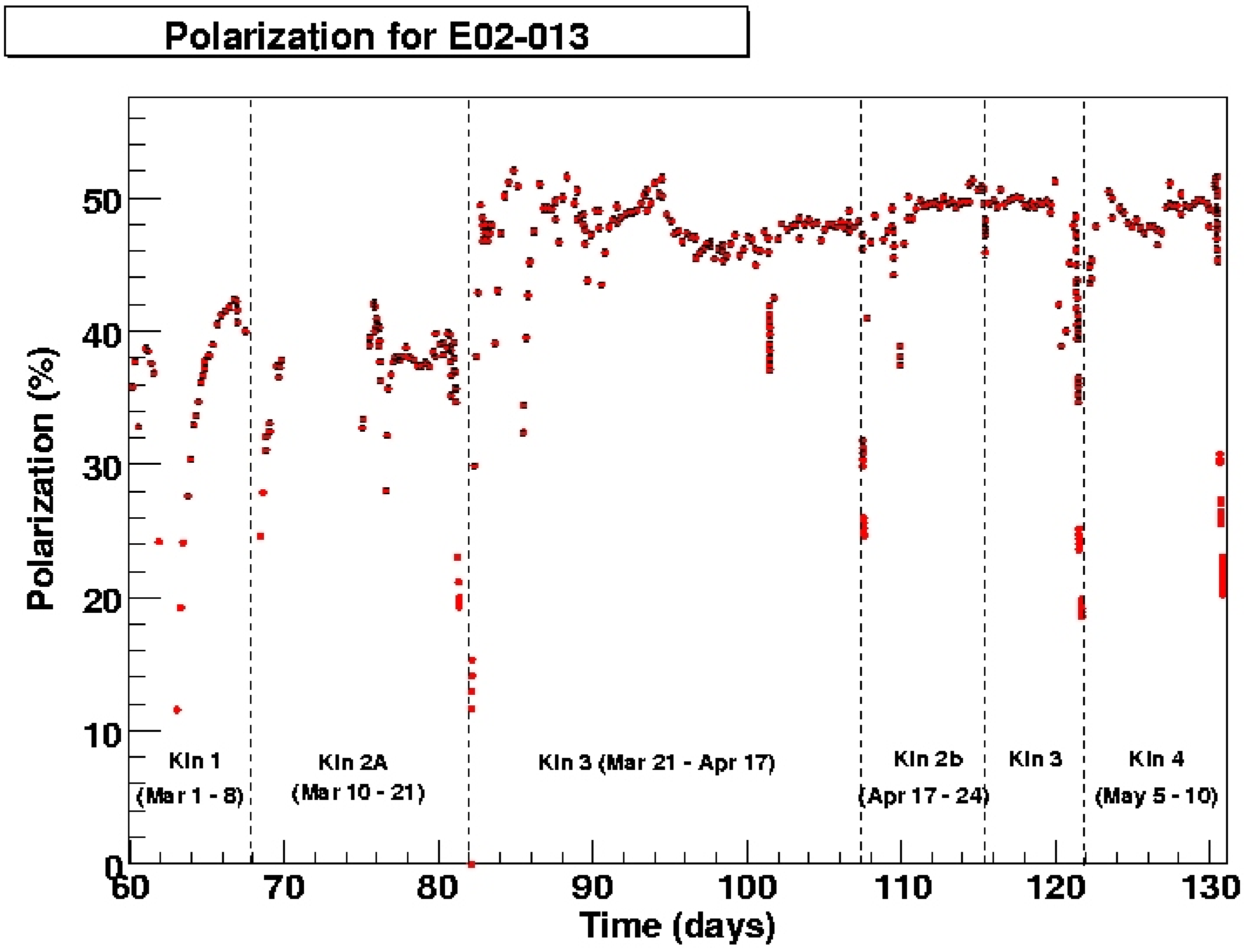
E02-013 was the first experiment to use improved fiber technology.



Alkali Metal – Hybrid Cells

- First Experiment to Use Polarized Cell Breakthrough – Hybrid Cells
  - Mixture of Rb and K vapors
  - Optically pump Rb, transfers spin to K, which transfers to ^{3}He
- Great results:
  - Fast Polarization Time
  - High Maximum Polarization (record $\approx 50\%$ in beam)
- Experience from E02-013 applied to next round of ^{3}He
  - Can "tune" hybrid mixture to achieve even better results.

Hybrid Cell Performance



Systematic Errors

	Barbara	Dolly	Edna
κ_0	1.47%	4.07%	4.11%
EPR Measurement	2.00%	0.87%	1.32%
Flux and Density	2.17%	1.00%	1.00%
NMR Fit	$\approx 0.6\%$	$\approx 0.6\%$	$\approx 0.6\%$
Other temperature	1.79%	0.89%	0.25%
Overall	**3.80%**	**4.41%**	**4.47%**
Days in use	8	14	48

Magnetic Field

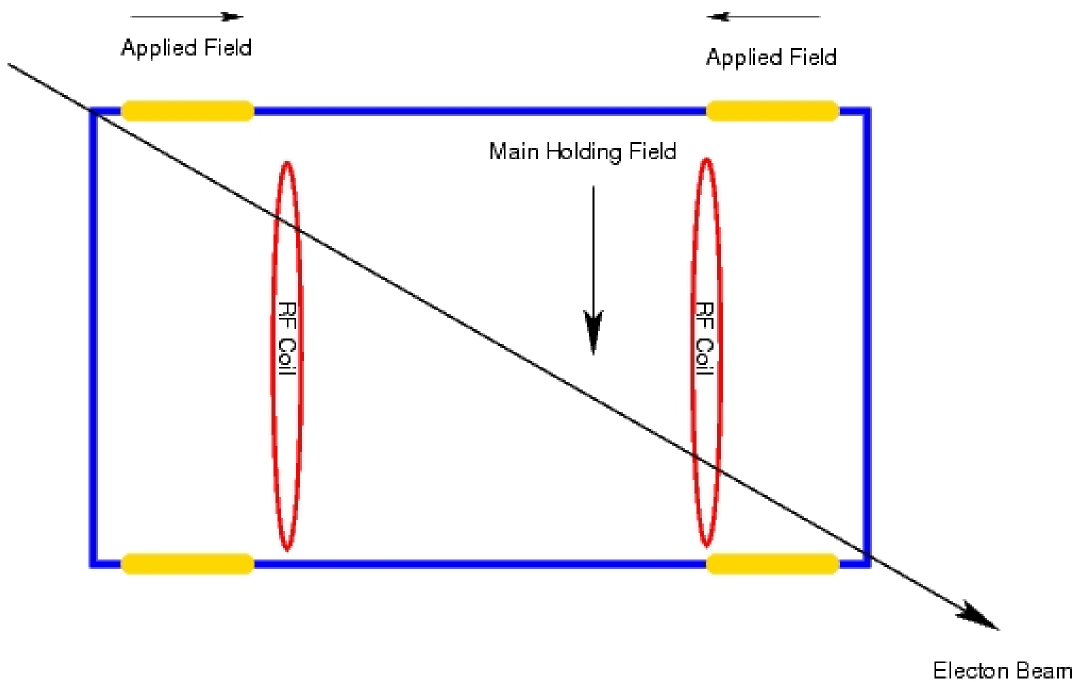
Big Bite Dipole

- Placed Close to Target for Maximum Acceptance
- Large Open Dipole $\rightarrow$ Large Fringe Fields $\rightarrow$ Field Inhomogeneity

Magnetic Box

- Provides a uniform magnetic field
- Not shielding, it produces the field
- Polarization loss during NMR due to field gradients acceptable ($\approx 2\%$).

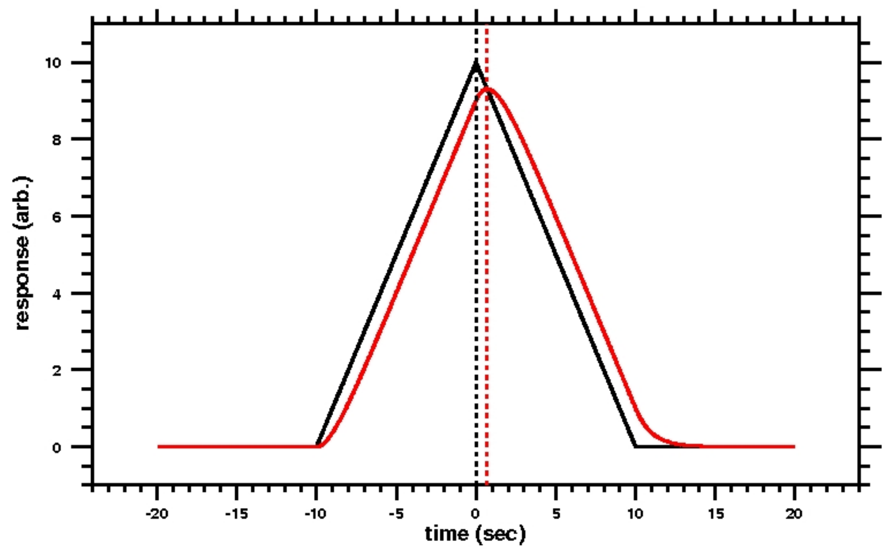
Magnet Box



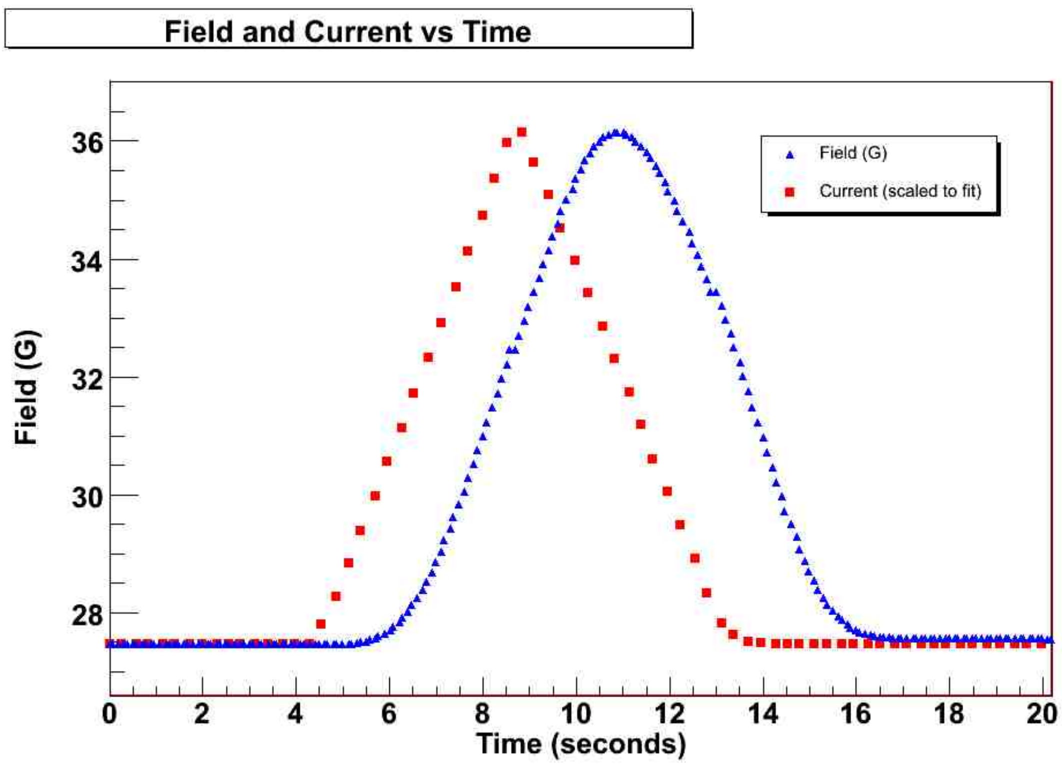
Coil Orientation (Top View)

Magnet Box – Concerns About Iron

- Hysteresis Effects
- Time Dependent Effects

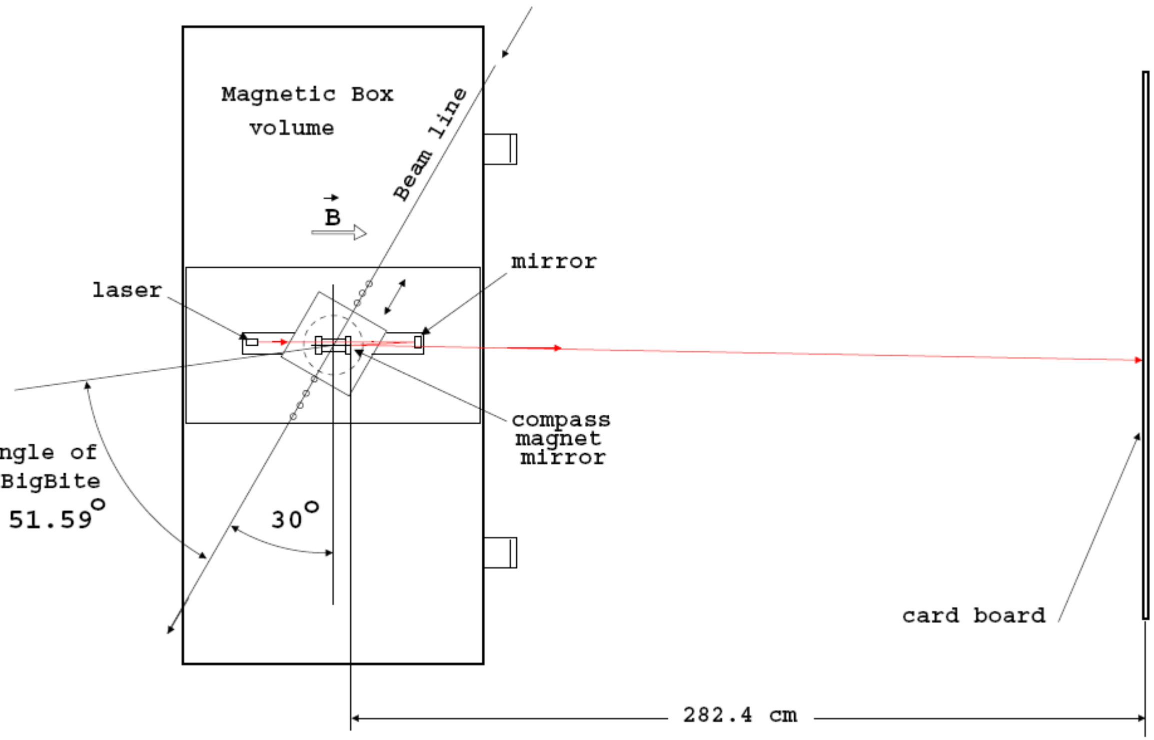


Magnet Box – Measured Induction



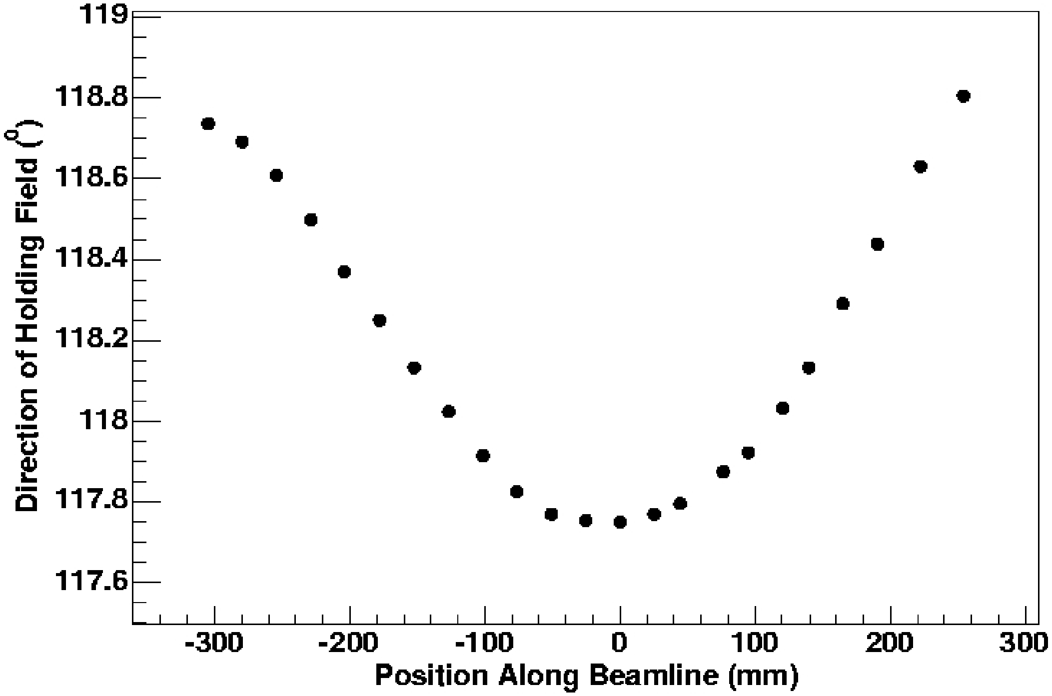
Magnet Box – Field Direction

New magnetic field compass developed for this experiment



Magnet Box – Field Direction

Magnetic field measured with an accuracy of 2mrad

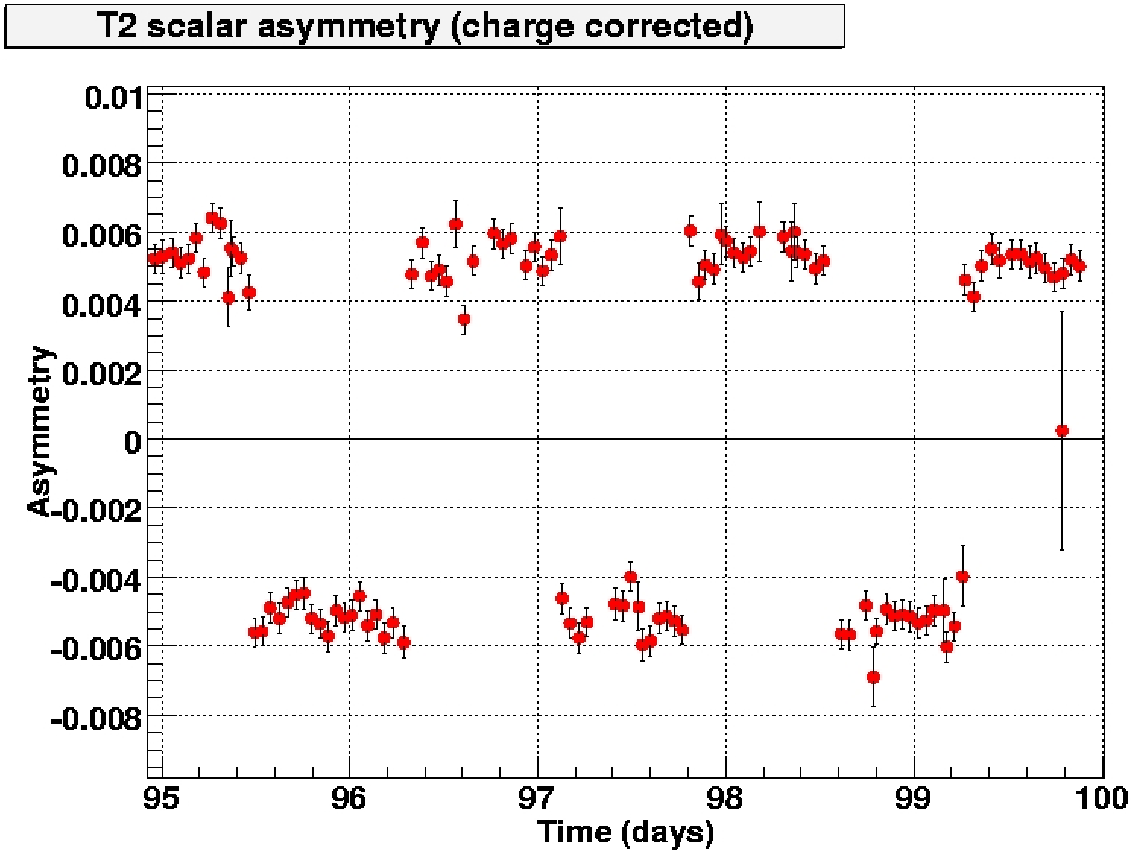


Pion Asymmetry Monitor

Technique to monitor drastic changes in the beam and target polarizations as well as helicity changes to the beam

- Use scaler BigBite singles counts
- Correct for beam asymmetry
- Dominant remaining detected asymmetry from electro-production of pions ($\gamma^* \vec{n} \rightarrow \pi^\circ n$)
- Useful for selecting and inspecting runs

Pion Asymmetry Monitor



Extension to Future $\overrightarrow{^3He}$ Experiments

Technique can be improved and expanded

- Dedicated detector
- Include photo-production pions (use lower threshhold)
  - Make use of much larger photo-production asymmetry
  - Small, dedicated detector could be located in unused space in the hall
  - Single helicity gated scaler channel is all that is required
  - Could possibly use the luminosity monitors

G_E^n (and A_1^n and nDVCS) at 12 GeV

Requirements (G_E^n): 30μA (8μA) beam, 70% (50%)Polarization

- Improvements in optics and hybrid cells have already achieved significantly higher polarization (after E02-013 running)
- Developments at UVA (Cates) and UNH (Hersman)
  - Higher density
  - Faster polarization mixing allows high beam current
  - Robust cell materials
- Continued investment of intellect (and money) for $\overrightarrow{^3\mathrm{He}}$ is a high priority

Conclusions

E02-013 created an innovative target, based on the Hall A $\overrightarrow{^3\mathrm{He}}$ target

- Commissioned 75m fiber and 5–1 fiber combiner technology
- Achieved a high polarization ($> 50\%$) target
- First use of hybrid cell
- Precise field direction measurement using new compass
- Developed a new technique to monitor beam and target polarization
- Exciting developments for future experiments