A_1 Analysis for E06-014

Diana Parno
for the E06-014 collaboration
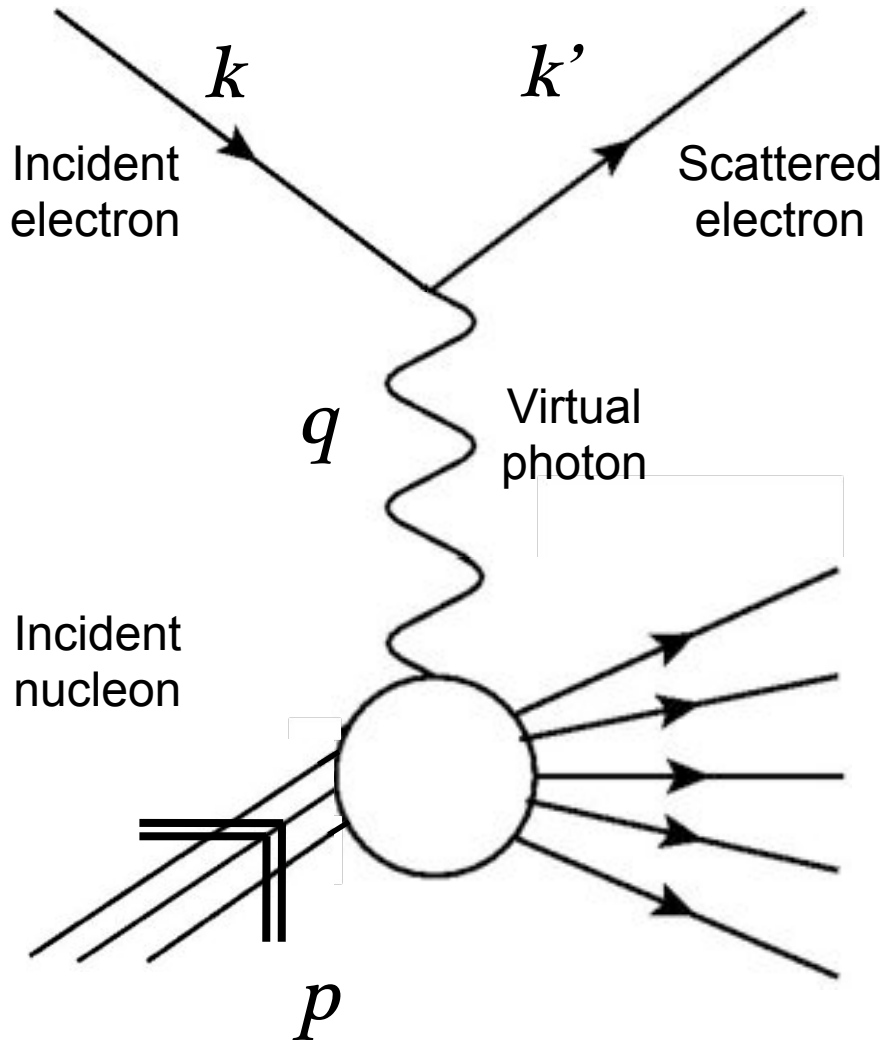
CENPA, University of Washington
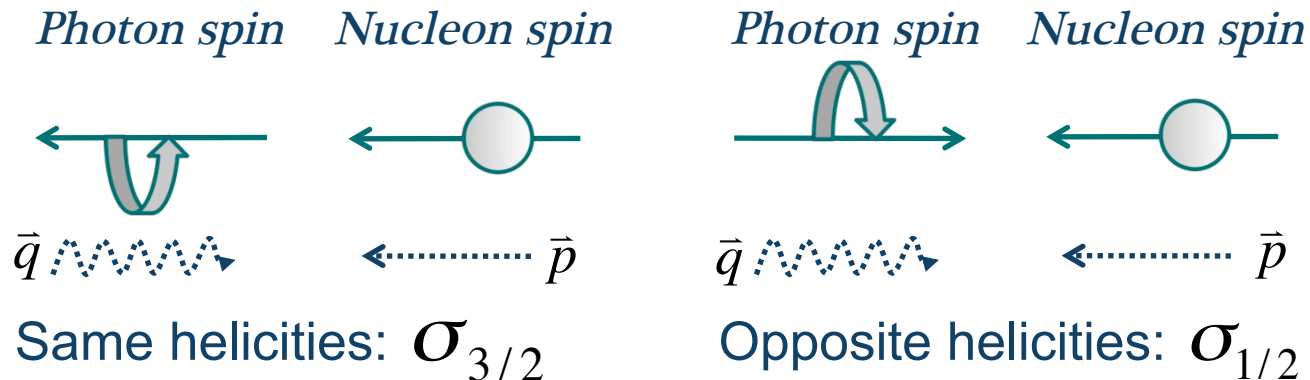*Formerly Carnegie Mellon University*

June 10, 2011

Introduction: Deep Inelastic Scattering

- **+** Start with a polarized electron and a polarized nucleon

- **+** They exchange a virtual photon

- **+** Virtual photon probes single quasi-free quark inside nucleon

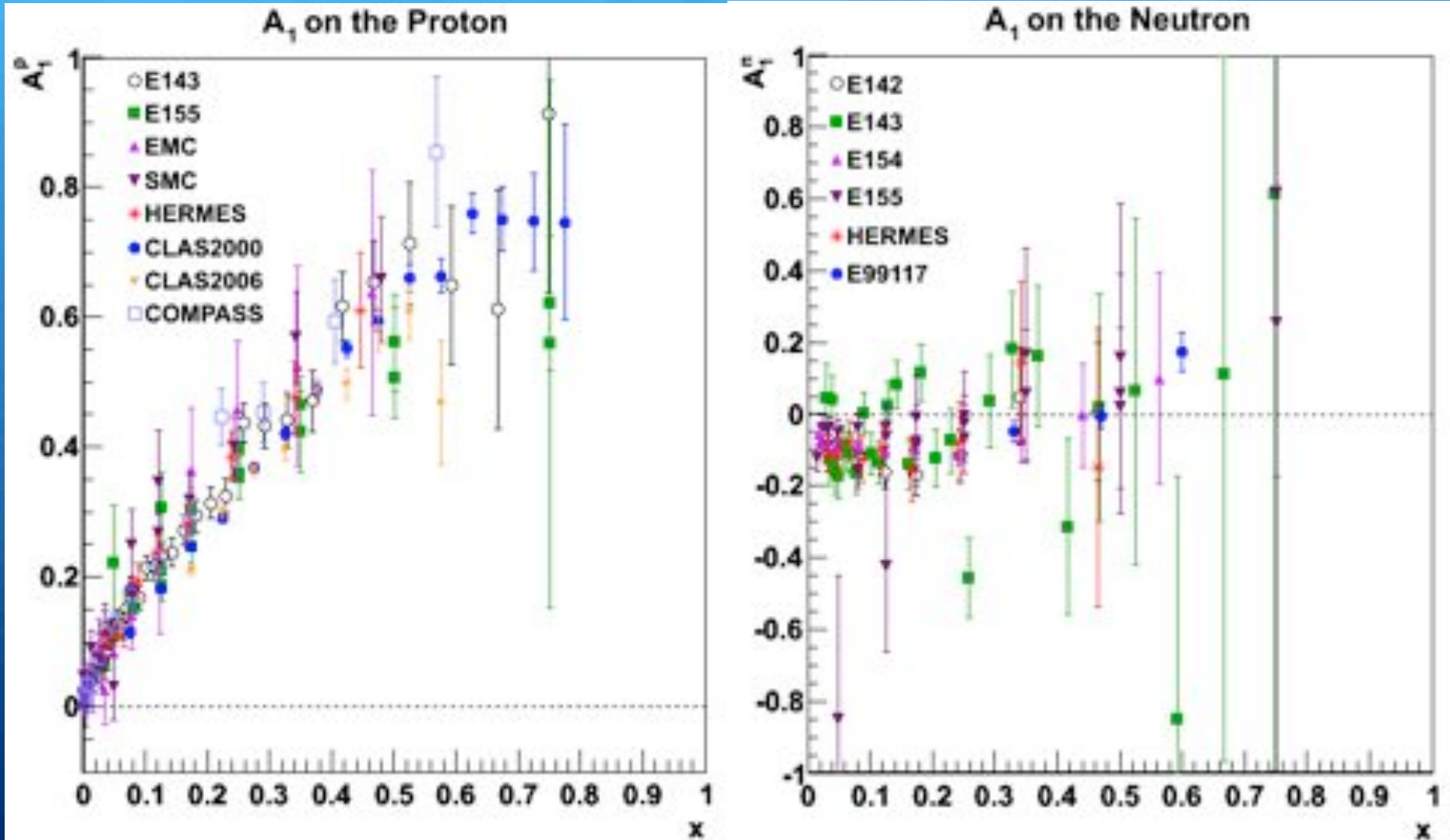- **+** We measure scattered electron

Virtual Photon Asymmetries

+ What spin information do we have at the hadron vertex?

Photon spin   *Nucleon spin*   *Photon spin*   *Nucleon spin*

$\vec{q}$ /\/\/\/\ $\vec{p}$ $\vec{q}$ /\/\/\/\ $\vec{p}$

Same helicities: $\sigma_{3/2}$ Opposite helicities: $\sigma_{1/2}$

+ We can form an asymmetry based on this relationship

$$A_1\left(x,Q^2\right) \equiv \frac{\sigma_{1/2} - \sigma_{3/2}}{\sigma_{1/2} + \sigma_{3/2}} \approx \frac{g_1\left(x,Q^2\right)}{F_1\left(x,Q^2\right)}$$

Existing DIS Data on Nucleon A_1

Measurement Strategy
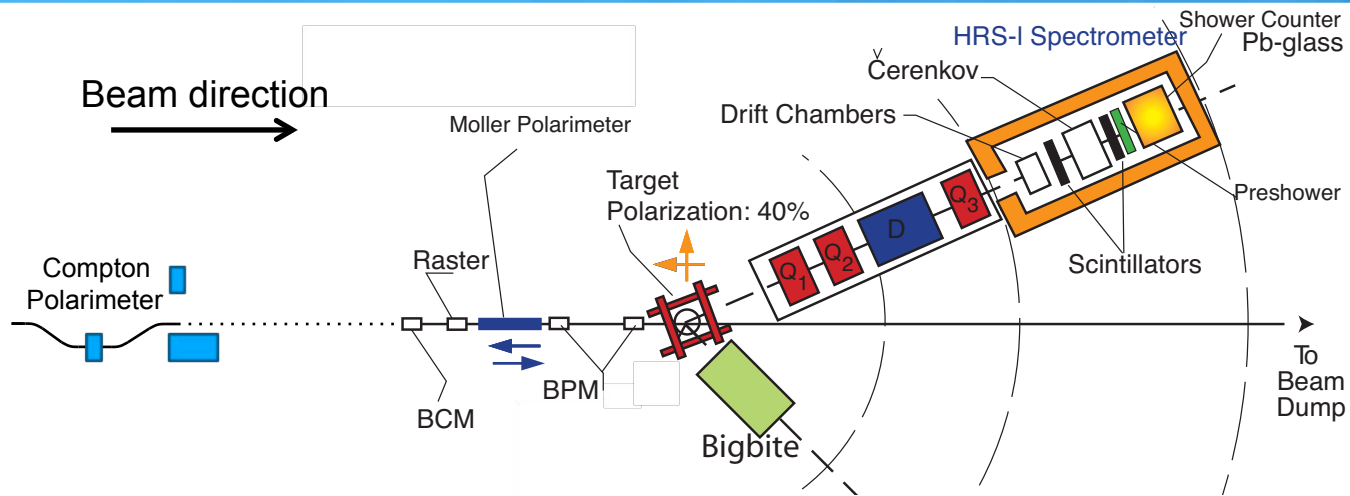
+ E06-014 ran in February-March 2009

+ Large *x* range from BigBite

+ Form double-spin asymmetries (parallel and perpendicular target spin) corrected for polarization

$$A = \frac{N^{\downarrow\Uparrow} - N^{\uparrow\Uparrow}}{N^{\downarrow\Uparrow} + N^{\uparrow\Uparrow}} \cdot \frac{1}{P_e P_{^3\text{He}} D_{\text{N}_2}}$$
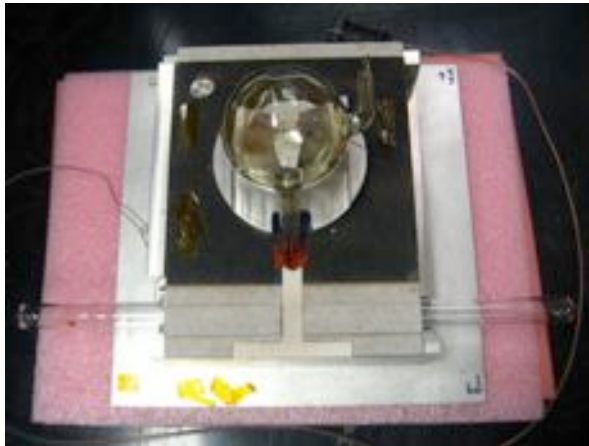
+ Kinematics, world F_2 data then give us A1

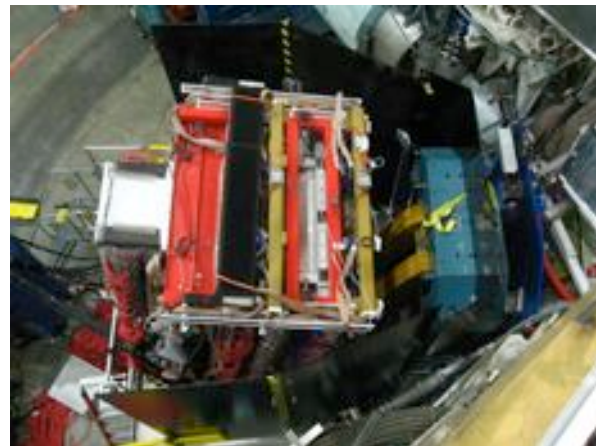$$A_1 = \frac{1}{D(1+\eta\xi)} A_{\parallel} - \frac{\eta}{d(1+\eta\xi)} A_{\perp}$$

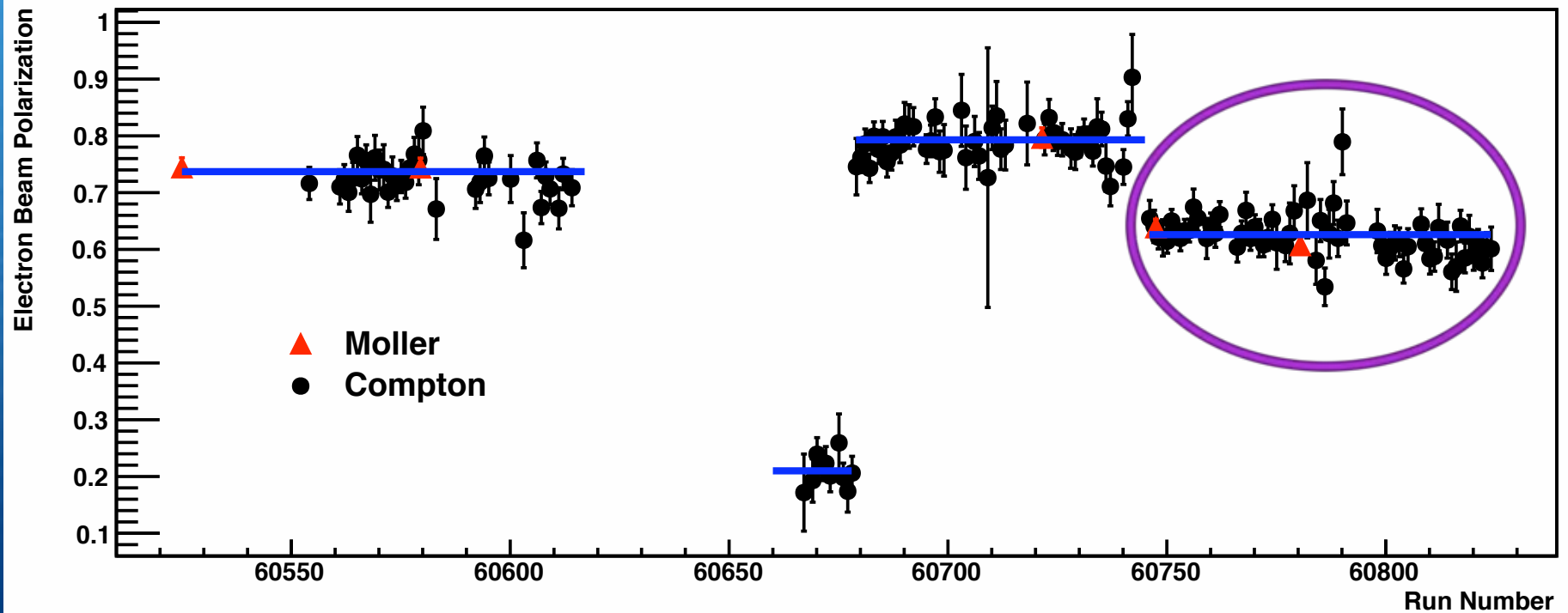# E06-014 Setup in Hall A

Polarized ^{3}He target

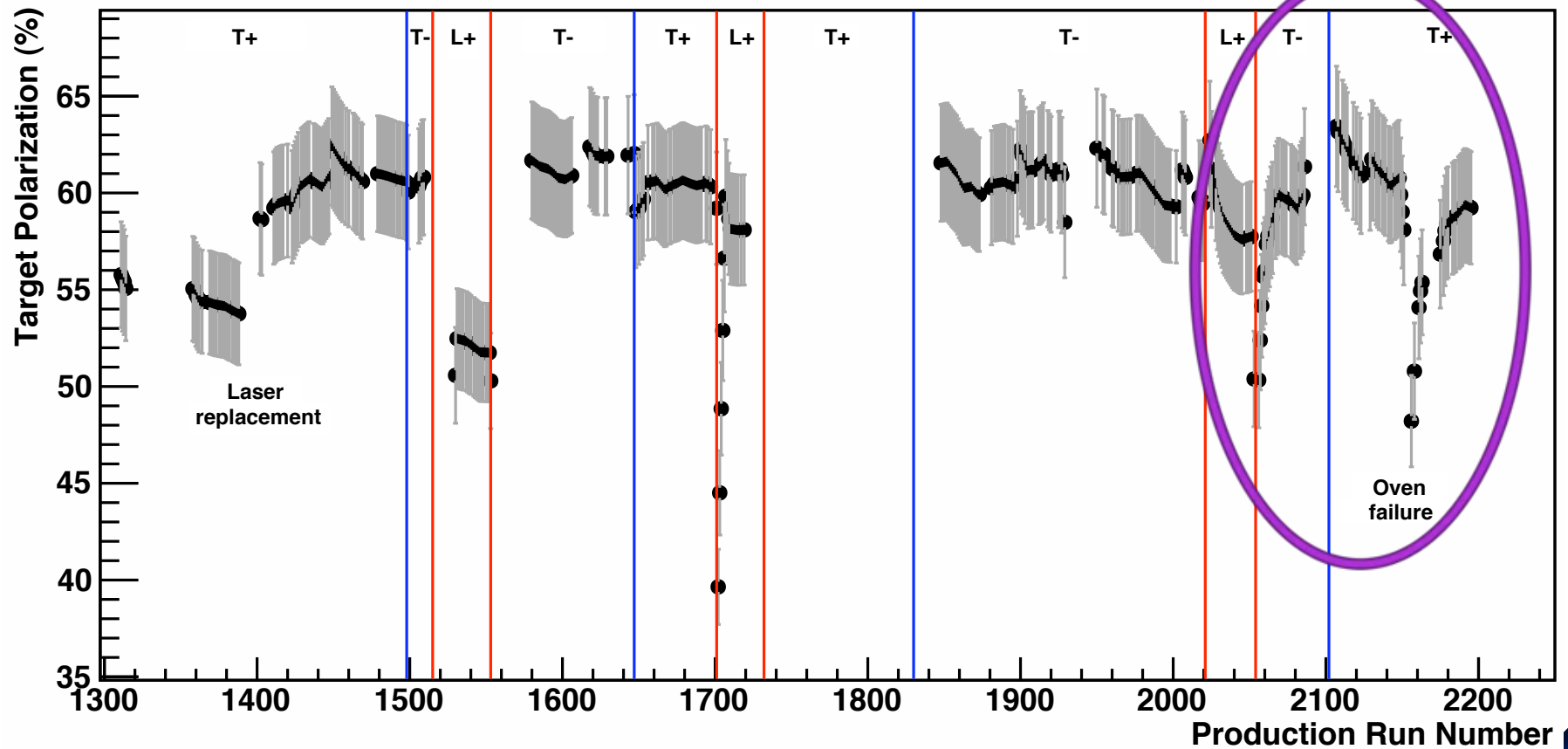BigBite spectrometer

Final Beam Polarization Results

+ Combine Compton and Møller results to achieve error of ~1.6%
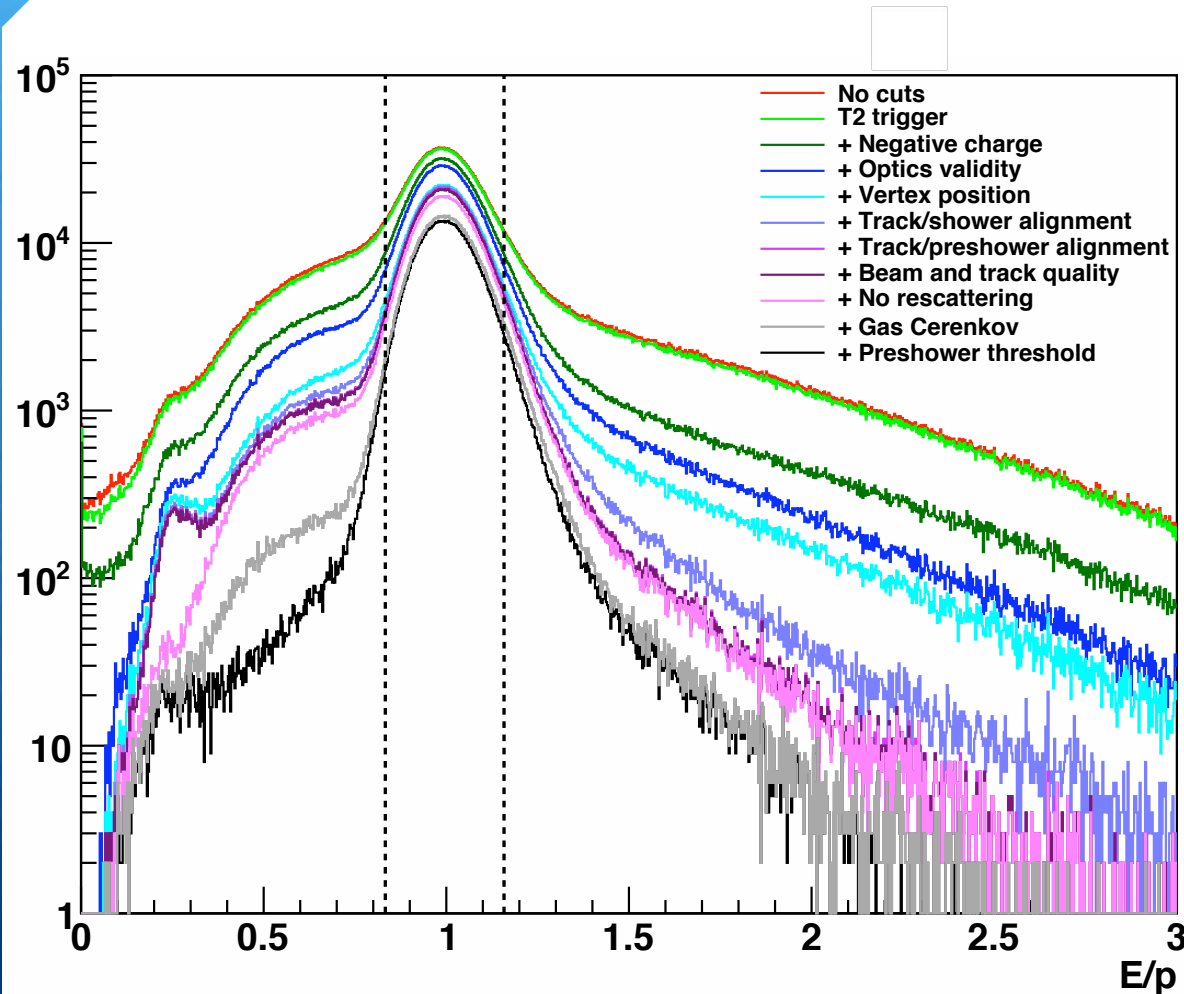
Beam Polarization During E06-014

Measuring ³He Polarization

+ NMR every four hours (target chamber)

+ EPR every spin rotation (pumping chamber)

Scattered Electron Sample

Legend:
- No cuts
- T2 trigger
- + Negative charge
- + Optics validity
- + Vertex position
- + Track/shower alignment
- + Track/preshower alignment
- + Beam and track quality
- + No rescattering
- + Gas Cerenkov
- + Preshower threshold
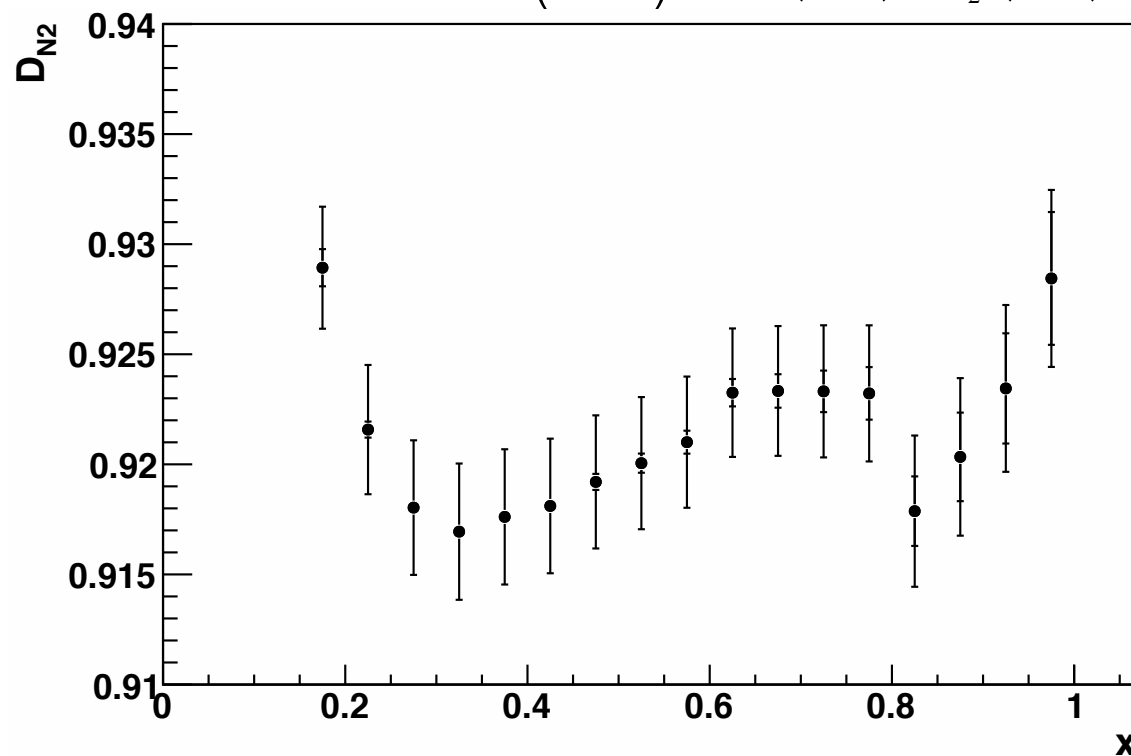
x-axis: E/p

+ Negligible pion contamination

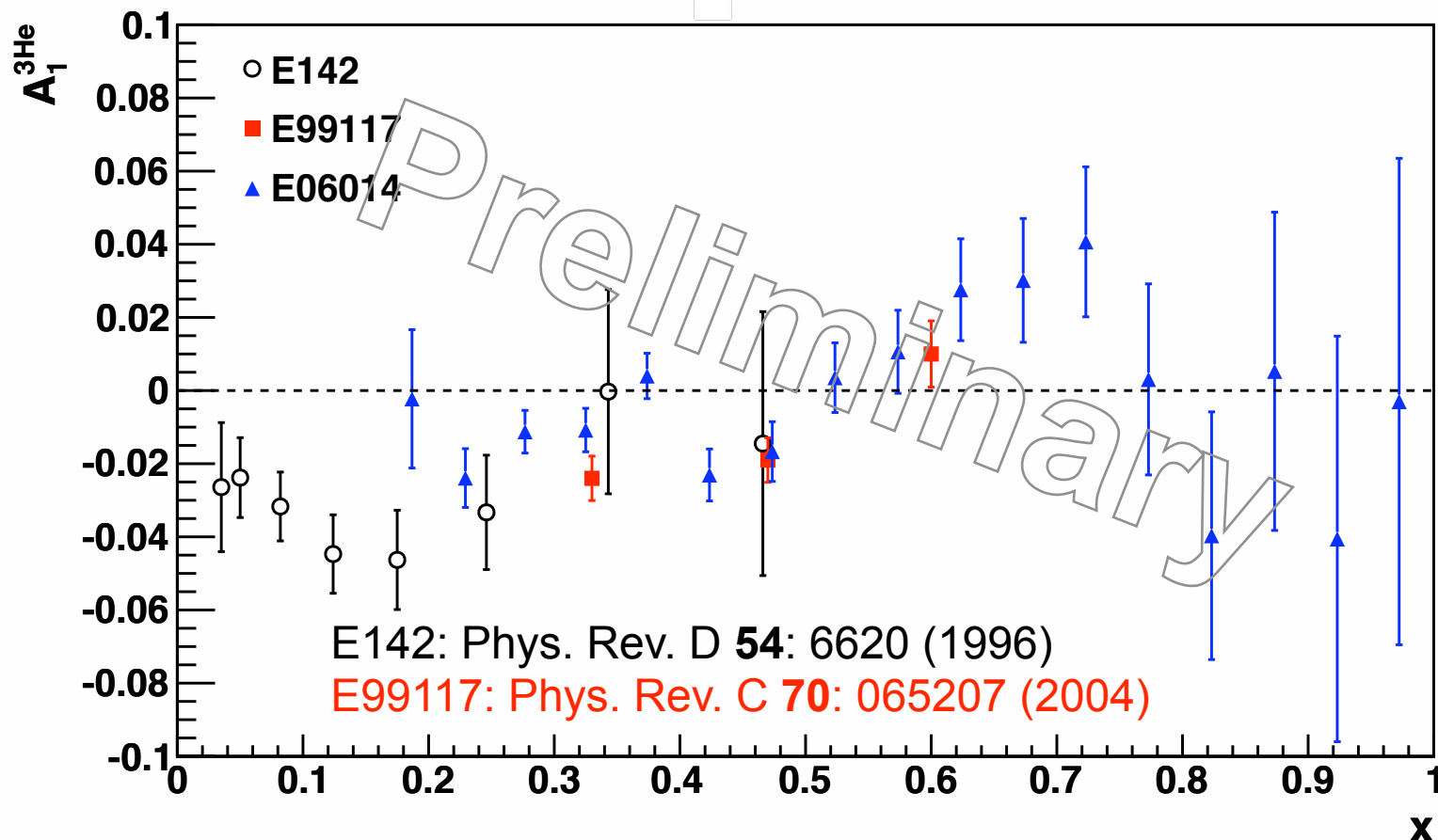**+** Errors in momentum reconstruction form primary background

Nitrogen Dilution Factor

+ Target's nitrogen content dilutes asymmetry

$$D_{N_2} = 1 - \frac{\Sigma_{N_2}(N_2)}{\Sigma_{total}(^3He)} \cdot \frac{Q(^3He)\rho_{N_2}(^3He)}{Q(N_2)\rho_{N_2}(N_2)}$$

A_1 on ^{3}He with 4.74-GeV electrons

+ Low-*x* bins will be more affected by radiative corrections and pair-production (not yet applied)
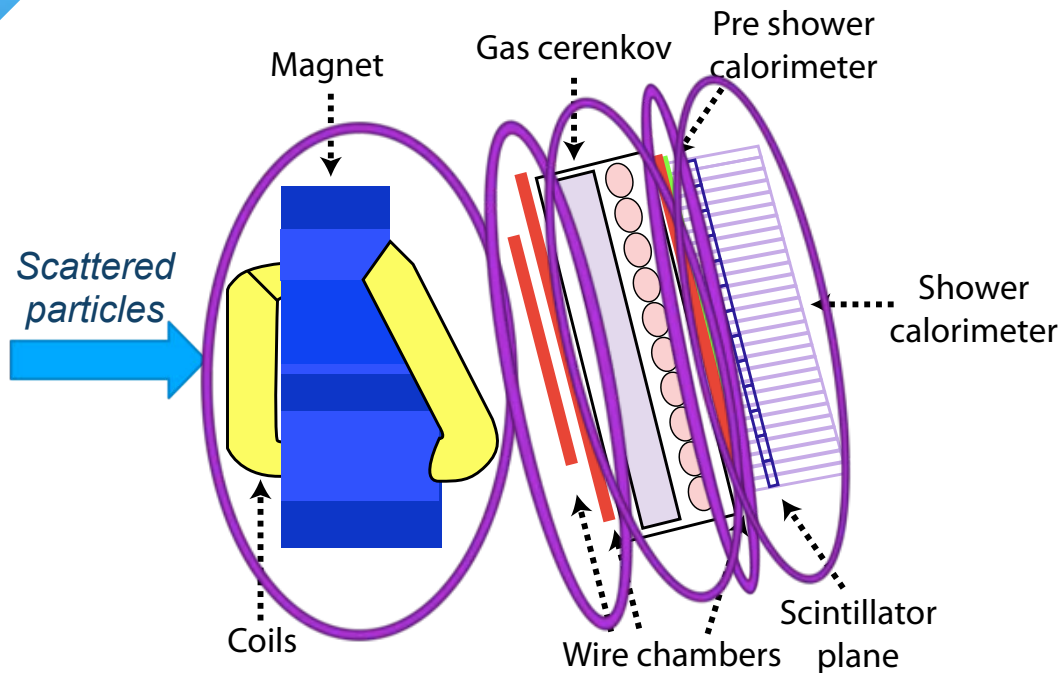

E142: Phys. Rev. D **54**: 6620 (1996)
E99117: Phys. Rev. C **70**: 065207 (2004)

Conclusion

+ We've measured A_1 on ^{3}He from part of the E06-014 dataset
  + Wide x range (0.15 ≤ x ≤ 0.55 DIS, 0.60≤x≤1.0 resonance)
  + Support for previous measurements

+ Future work
  + Analysis tweaks
  + Radiative corrections, pair-production corrections
  + New dataset: E_e = 5.9 GeV
  + Extraction of neutron A_1

Thank you!

+ Thanks go to the Hall A collaboration and staff who made this experiment possible

+ Special thanks go to the primary analysis team:
    + Brad Sawatzky
    + David Flay
    + Matt Posik
    + Yawei Zhang
    + Gregg Franklin
    + Zein-Eddine Meziani
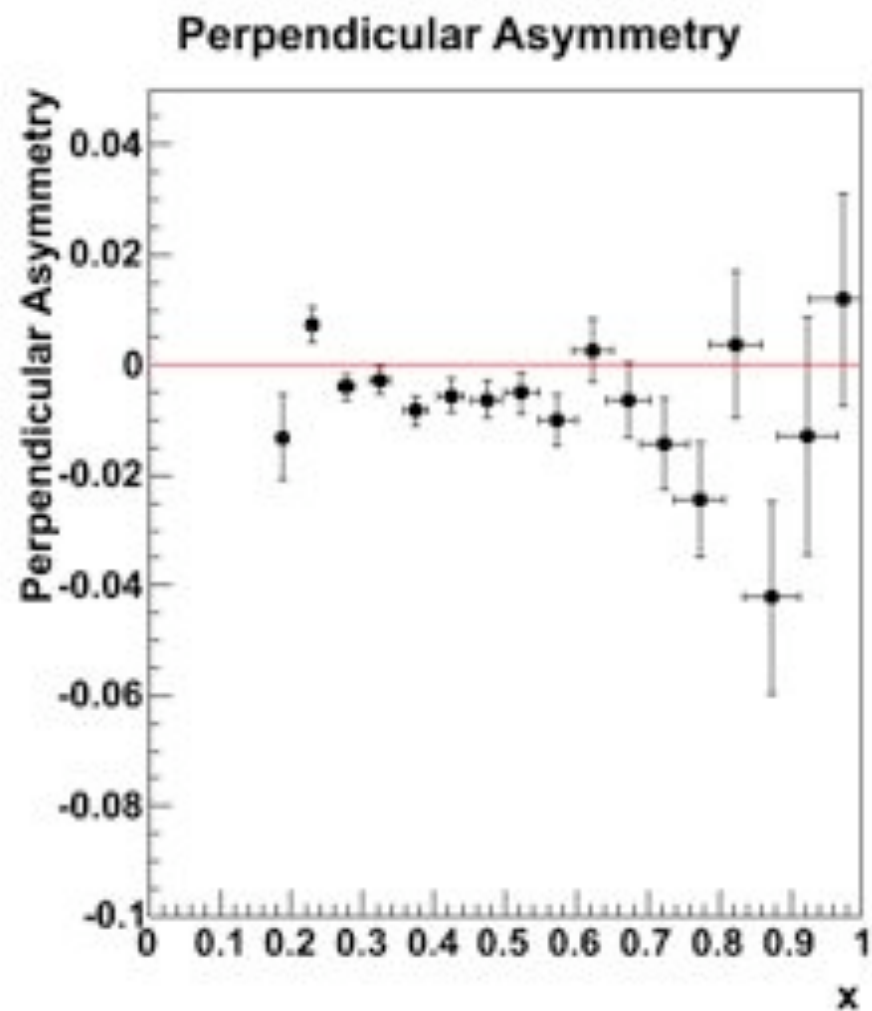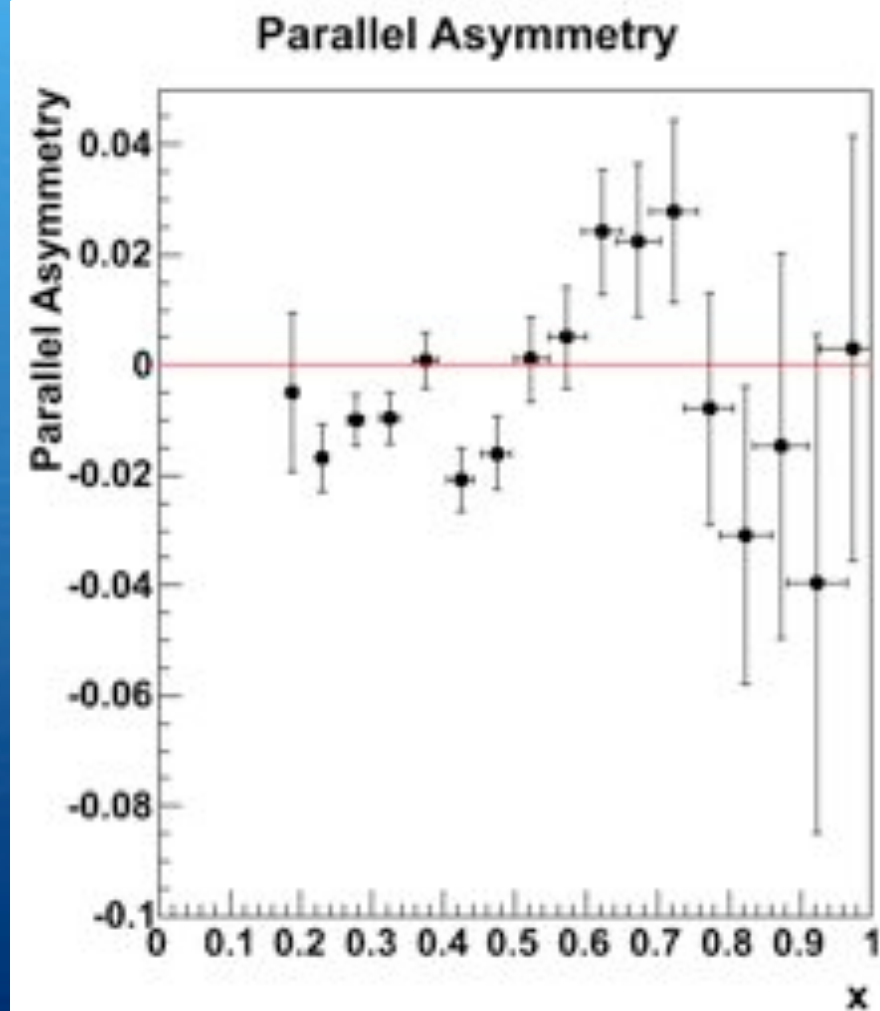
BigBite Spectrometer

Magnet

Gas cerenkov

Pre shower calorimeter

Scattered particles

Shower calorimeter

Coils

Wire chambers

Scintillator plane

Adapted from Xin Qian, PhD thesis, 2010

+ **Magnet**
  + Separates by charge and momentum
+ **MWDCs**
  + Reconstruct trajectory, forward and back
+ **Gas Čerenkov**
  + Removes pions from online trigger
+ **Calorimeter**
  + Measures energy
  + Particle identification

Electron-³He Asymmetries

A_1 and A_2 on ^{3}He