E07-013 Update

Target SSA in the Inclusive DIS reaction $n^{\uparrow}\left(e,e'\right)$
from a Vertically Polarized ^3He Target

Joe Katich

Hall A Update

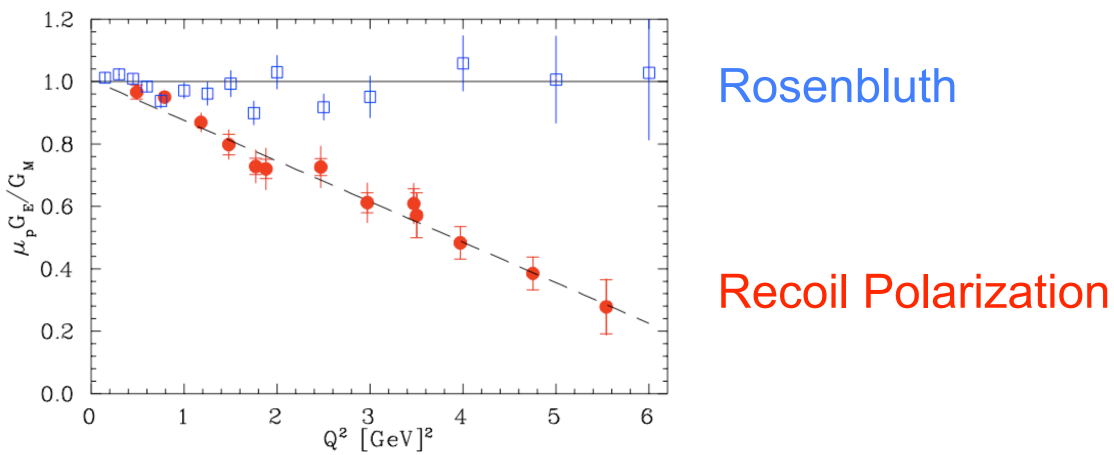
December 15th, 2009

Physics Motivation

Two-photon physics has generated recent interest because…

Radiative corrections are becoming more important:

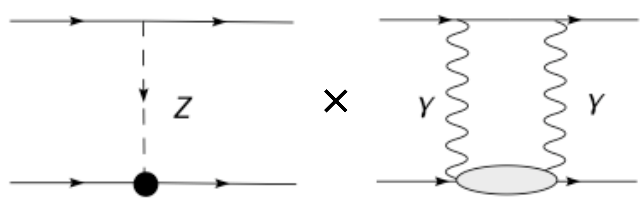
- best candidate to explain G_E/G_M discrepancy



- can affect parity violating in elastic $\vec{e}^-p$ scattering by with few percent correction

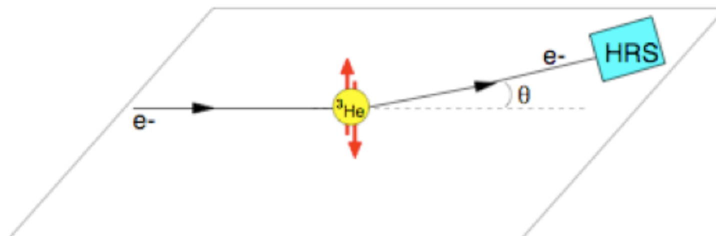
A. Afanasev and C. Carlson, PRL 94, 212301 (2005)

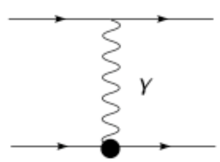
$A_{PV} \propto$



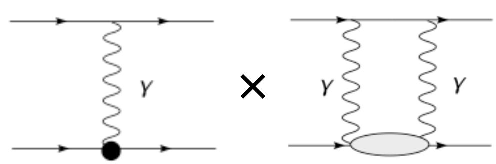
Physics Motivation

What observables allow us to isolate two-photon effect?



Born Approx: 

$\Leftrightarrow$ $A = \frac{\sigma_{UT}^{\uparrow} - \sigma_{UT}^{\downarrow}}{\sigma_{UT}^{\uparrow} + \sigma_{UT}^{\downarrow}} = 0$ Time Reversal Invariance (Christ-Lee Theorem)

Interference Term: 

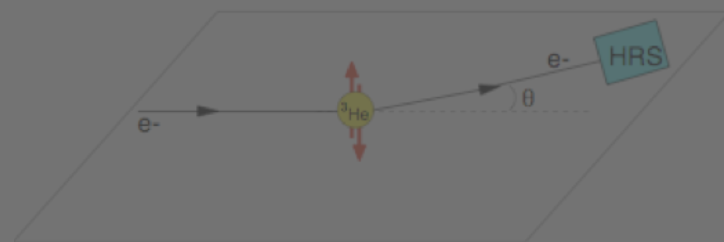
$\Leftrightarrow$ $A = \frac{\sigma_{UT}^{\uparrow} - \sigma_{UT}^{\downarrow}}{\sigma_{UT}^{\uparrow} + \sigma_{UT}^{\downarrow}} \neq 0$

$$\sigma_{UT} \propto e_l \alpha_{em} \frac{M}{Q} \varepsilon_{\mu\nu\rho\sigma} S^{\mu} p^{\nu} k^{\rho} k'^{\sigma}$$

A. Metz, M. Schlegel, K. Goeke, Phys. Lett. B643, 319 (2006)

Physics Motivation

What observables allow us to isolate two-photon effect?



Born Approx:

$A = \frac{\sigma_{UT}^{\uparrow} - \sigma_{UT}^{\downarrow}}{\ldots} = 0$

Time Reversal Invariance

n)

$$\varepsilon_{\mu\nu\rho\sigma} S^{\mu} p^{\nu} k^{\rho} k'^{\sigma} \propto \vec{S} \cdot \left(\vec{k} \times \vec{k}' \right)$$

Interference Term:

$\Leftrightarrow$

$$A = \frac{\sigma_{UT}^{\uparrow} - \sigma_{UT}^{\downarrow}}{\sigma_{UT}^{\uparrow} + \sigma_{UT}^{\downarrow}} \neq 0$$

$$\sigma_{UT} \propto e_l \alpha_{em} \frac{M}{Q} \varepsilon_{\mu\nu\rho\sigma} S^{\mu} p^{\nu} k^{\rho} k'^{\sigma}$$

A. Metz, M. Schlegel, K. Goeke, Phys. Lett. B643, 319 (2006)

Physics Motivation

What observables allow us to isolate two-photon effect?

Form SSA from the process: $l(k) + \vec{N}(p) \to l'(k') + X(p')$

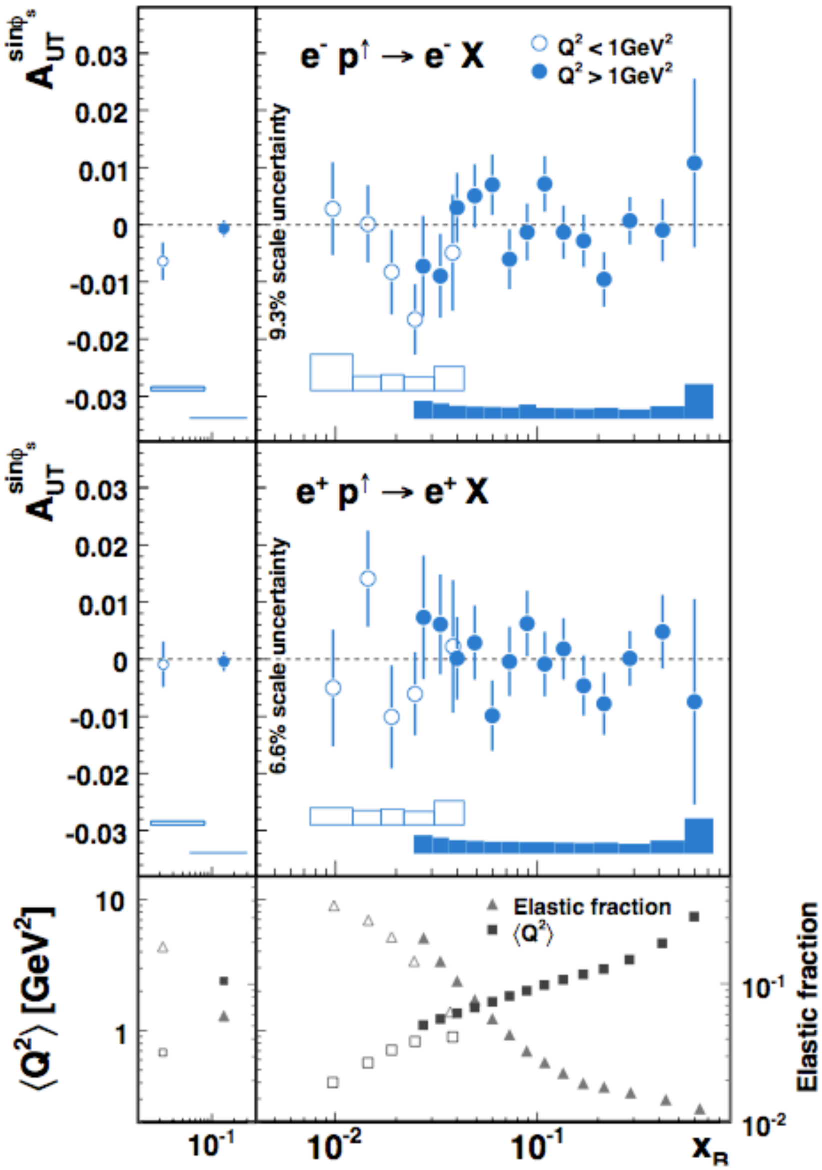
$$T_{\lambda_h,\lambda'_N\lambda_N} = \frac{e^2}{Q^2}\bar{u}(k',\lambda_h)\gamma_\mu u(k,\lambda_h) \times \bar{u}(p',\lambda'_N)\left(\tilde{G}_M\gamma^\mu - \tilde{F}_2\frac{P^\mu}{M} + \tilde{F}_3\frac{\gamma\cdot KP^\mu}{M^2}\right)u(p,\lambda_N)$$

$$\tilde{G}_M(\nu,Q^2) = G_M(Q^2) + \delta\tilde{G}_M(\nu,Q^2)$$

$$\tilde{F}_2(\nu,Q^2) = F_2(Q^2) + \delta\tilde{F}_2(\nu,Q^2)$$

$$\tilde{F}_3(\nu,Q^2) = \textit{0 in Born Scattering}$$

Summary of HERMES Data



Open Circles:
$Q^2 < 1 GeV^2$

Closed Circles:
$Q^2 > 1 GeV^2$

Error bars show statistical uncertainty,
Error boxes show systematic

Bottom Panel: average Q^2 vs x_b from data (squares) and the fraction of elastic Background events to the total event Sample from a MC simulation (triangles)

The asymmetries integrated over x_b are shown on the left

All are consistent with zero except low Q2 electron data, which is 1.9 sigma away

Jefferson Lab E07-013

Goal is to make the first precision (non-zero?) measurement of the transverse SSA from a **neutron** target

Some Highlights:

- Ran parasitically to Transversity: late October 2008 to early February 2009

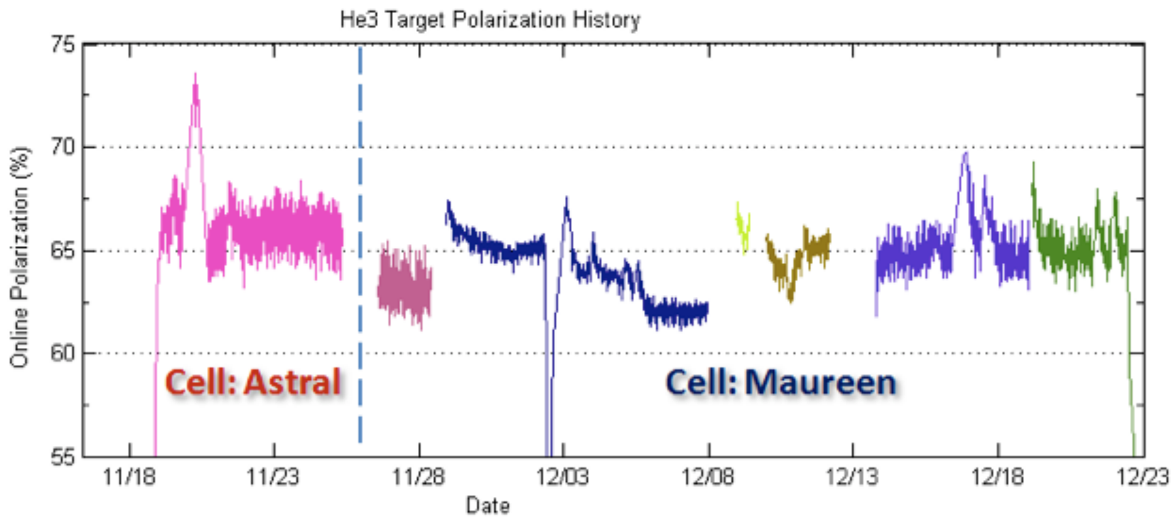
- No Cherenkov, but still achieving good PID with BB preshower/shower

- More than 16 coulombs of ‘good’ vertical-target production data

- Made use of a drastically modified polarized ^{3}He target

Polarized ^{3}He Target

- Hybrid cells combined with new narrow-band lasers allowed for >60% polarization



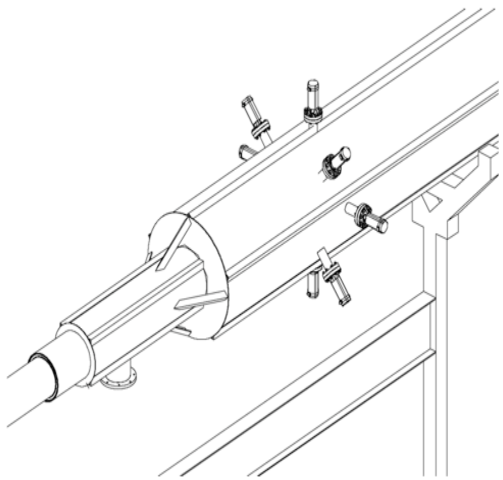
- Polarization along x,y and z axis allows for systematic checks

- Advances in polarimetry lead to more accurate and more frequent measurements

- Rapid spin flip gives target polarization every 20 minutes while reducing systematics

Analysis Progress

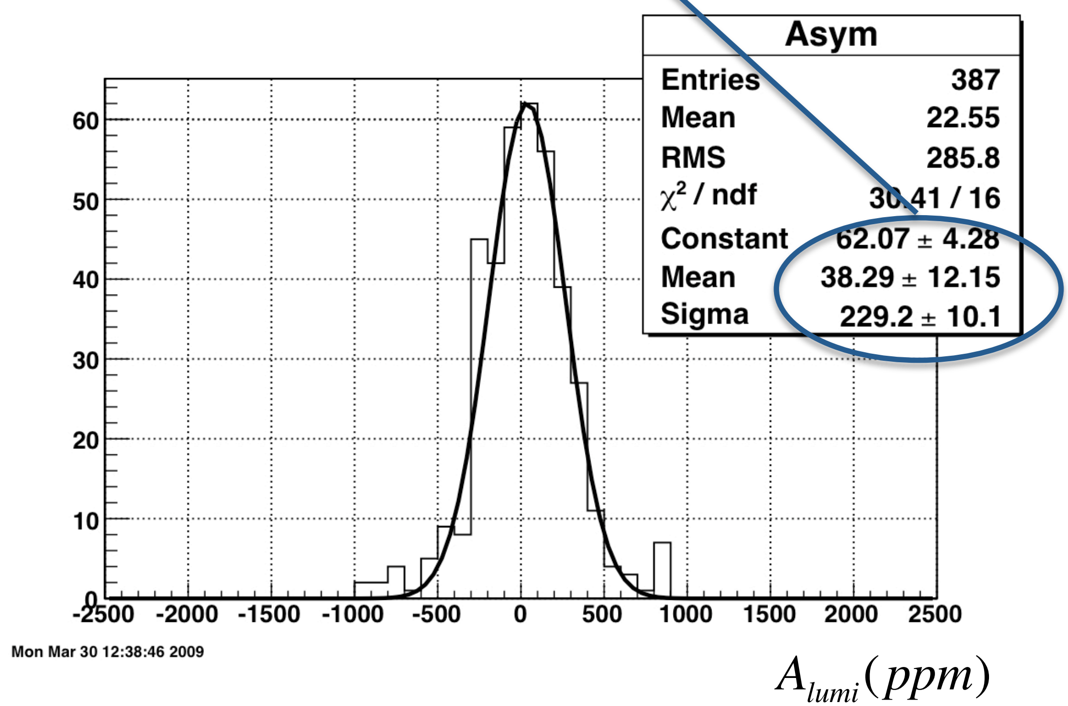
-Hall A Luminosity Monitors provide a means of auditing target fluctuation



-Sum over all 8 lumis to remove any physics effects

- Each entry is made of 40 minutes of data, split equally between target up and down

$$A_{lumi} \approx 40\,ppm$$
$$\sigma \approx 230\,ppm$$

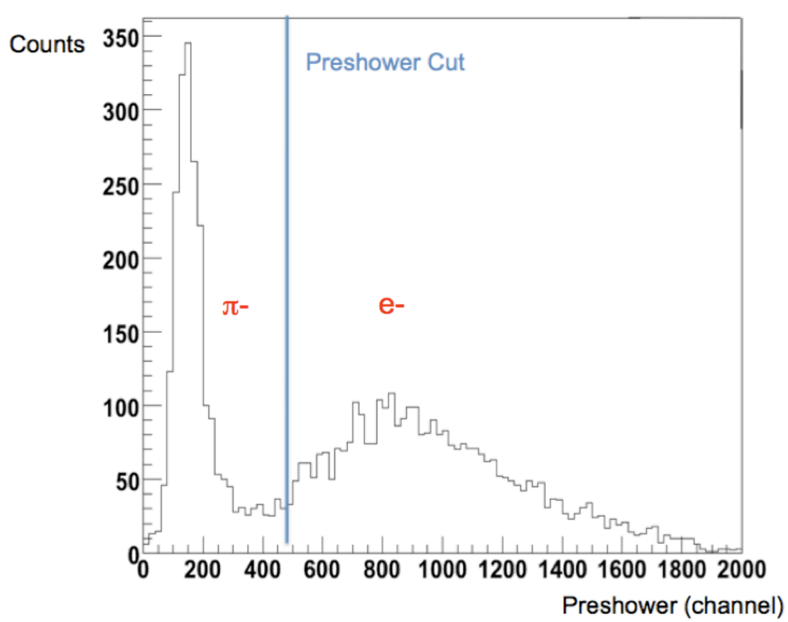


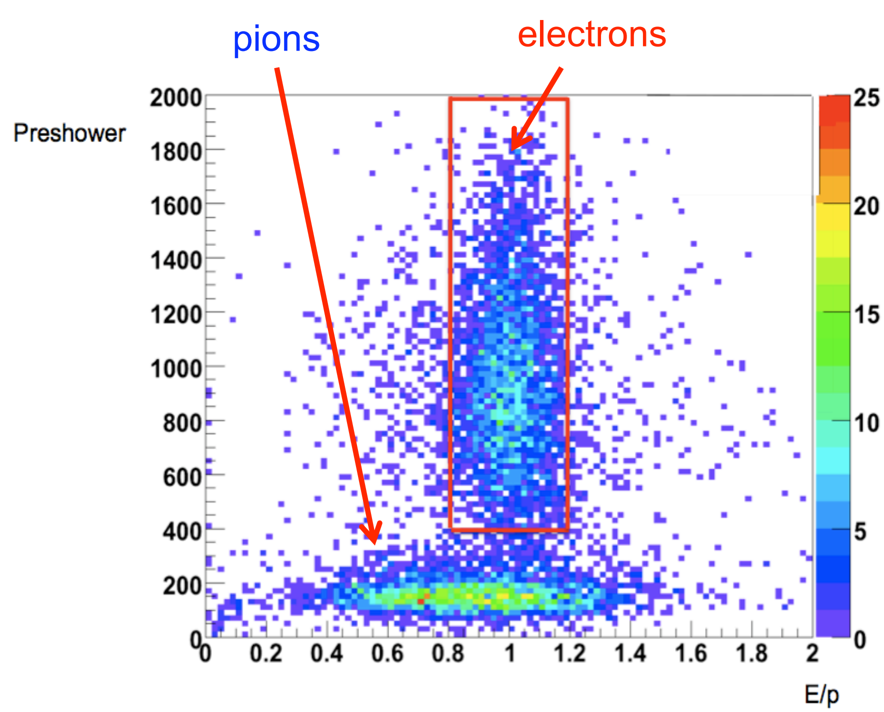
Analysis Progress

-Biggest challenge is electron PID in BigBite

-Use a combination of cuts to separate e^- from π^-

- track and optics cuts
- preshower
- E/p
- momentum

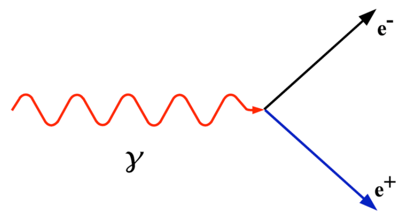




Analysis Progress

Other Background

More than likely, ‘pair-produced’ electrons contribute the largest amount of background



- Due to the short lifetime of the π^0 (~ 8.4×10^{-17} sec), pair-produced electrons could appear to be ‘good’ electrons events, passing all PID cuts and leaving a good track

- Fortunately, have 12 ‘positron’ data runs (reverse BB polarity) to help sort out this issue:
  - apply same cuts to positron runs, compare good event rate to the usual production data. Assume a 1:1 correspondence between detected positrons and contaminating electrons

- Recent development, so more thought is needed; % contamination could potentially be on the order of a few 10s

Analysis Progress

Preliminary Asymmetries:

- Asymmetries are normalized to average of BCM3, as well as detector live time
- Error bars are statistical error ONLY!
- No target polarization or dilution factors
- No corrections for contamination, etc…

What is Next?

- Finalize target polarization and dilution factors

- Reliable estimate of pair-produced electron background

- Radiative corrections

- Systematic error bars

End of Slides