Polarized Semi-Inclusive Physics Measurements at HERMES and Future Prospects at the Colliders

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Jefferson Lab

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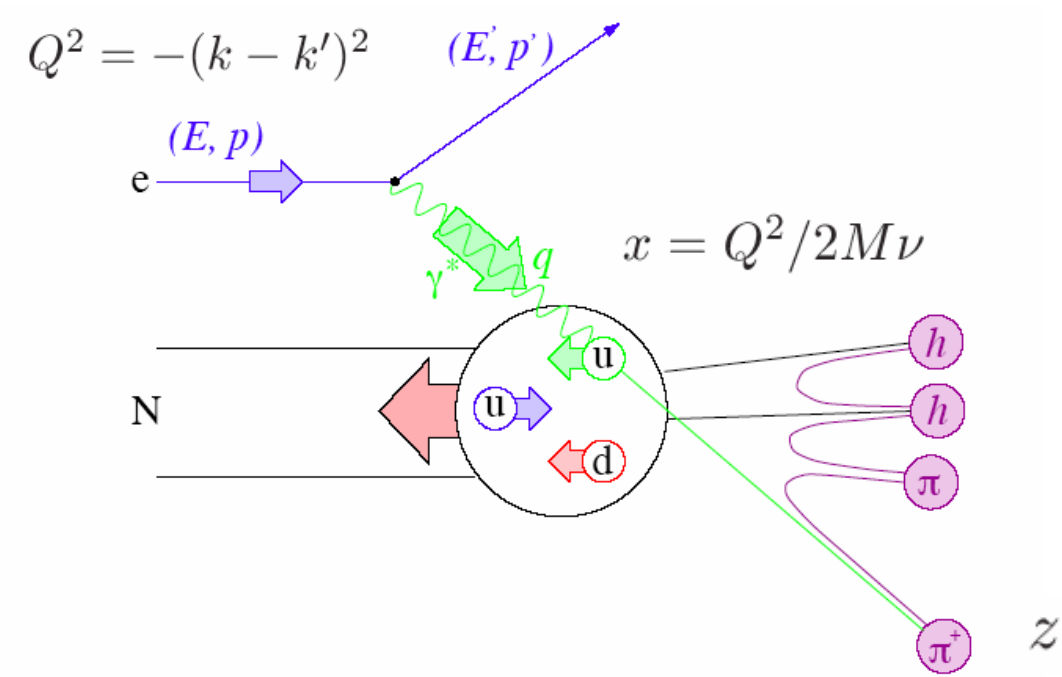
Outline

- Semi-inclusive deep inelastic scattering
- Polarized Hadron Asymmetries
- Flavor Decomposition using Purity Analysis
- HERMES Experiment/Results
- COMPASS Experiment/Results/Expected Results
- RHIC Spin - W Production
- EIC MC Studies/Progress
- Outlook

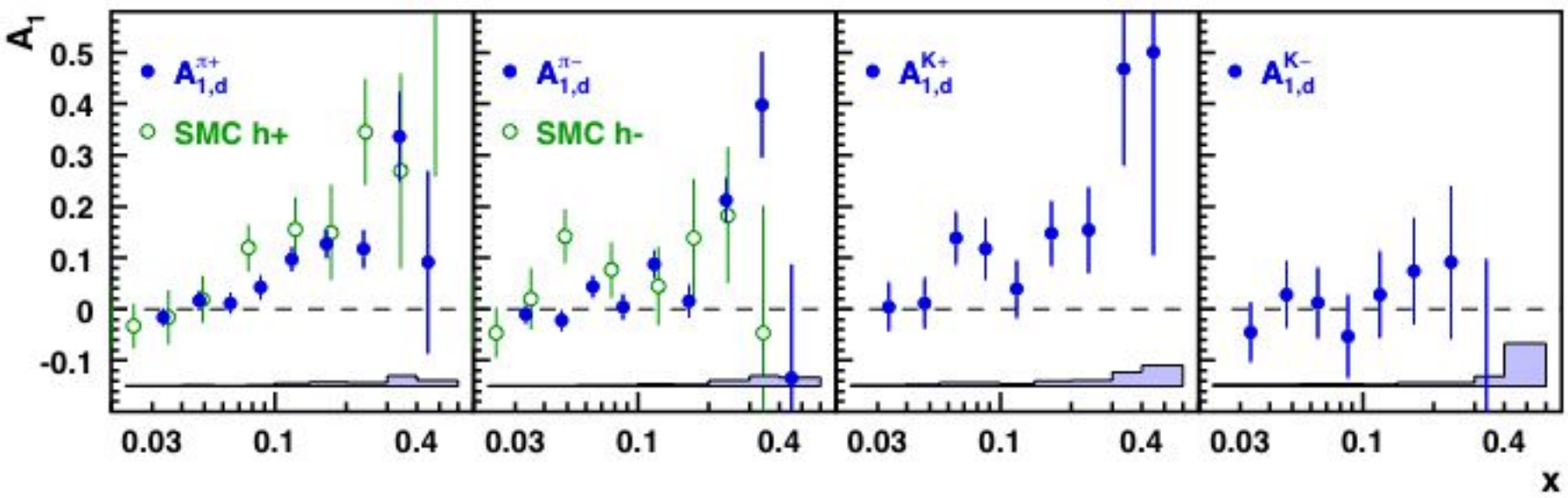
Semi-inclusive DIS Formalism

$$F_1^h(x,Q^2) \propto \int_{z_{min}}^{z_{max}} dz \sum_f e_f^2 q_f(x,Q^2) \cdot D_f^h(z,Q^2)$$



Hadron Asymmetries

$$A_1^h \approx \frac{g_1^h}{F_1^h}(x,Q^2) = \frac{\int_{z_{min}}^{z_{max}} dz \sum_f e_f^2 \Delta q_f(x,Q^2) \cdot D_f^h(z,Q^2)}{\int_{z_{min}}^{z_{max}} dz \sum_f e_f^2 q_f(x,Q^2) \cdot D_f^h(z,Q^2)}$$



Purity Analysis

$$A_1^h = \sum_q \frac{e_q^2 q(x) \int_{z_{min}}^{z_{max}} dz D_{q'}^h(z)}{\sum_{q'} e_{q'}^2 q'(x) \int_{z_{min}}^{z_{max}} dz D_{q'}^h(z)} \frac{\Delta q(x)}{q(x)}$$

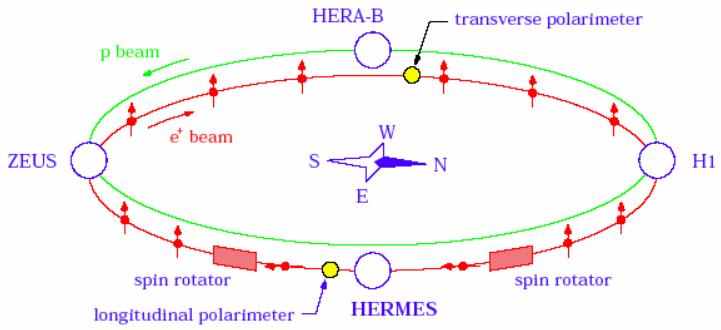
$$= \sum_q P_q^h \frac{\Delta q}{q}$$

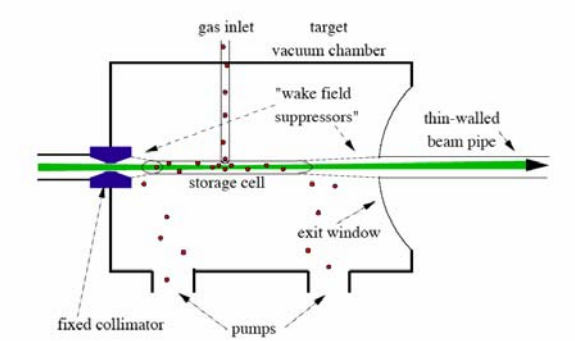
- Purities calculated using q(x) + Lund FF + Acceptance
- Matrix equation used to perform fit to data:

$$\vec{A}(x) = \mathcal{P}(x) \cdot \vec{Q}(x)$$

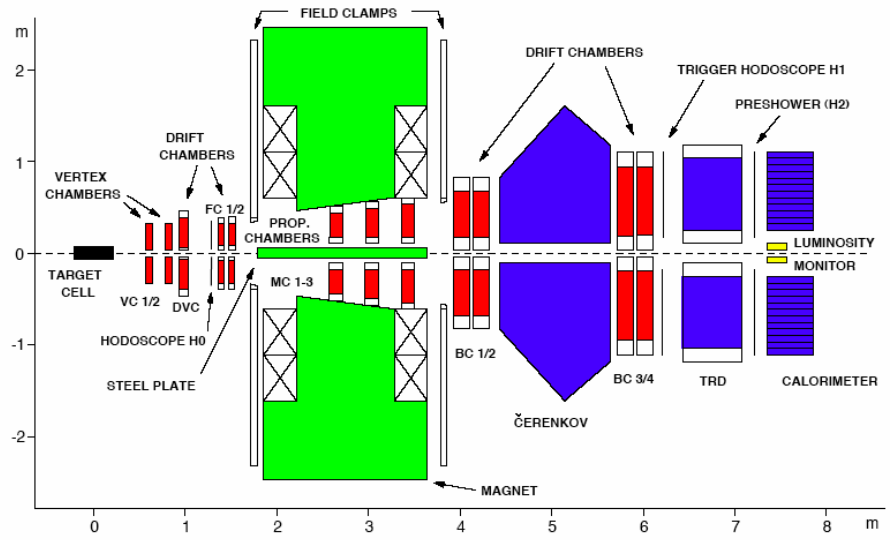
HERMES Experiment

Current $\approx$ 30 mA
$\langle$Beam Polarization$\rangle \approx 50\%$



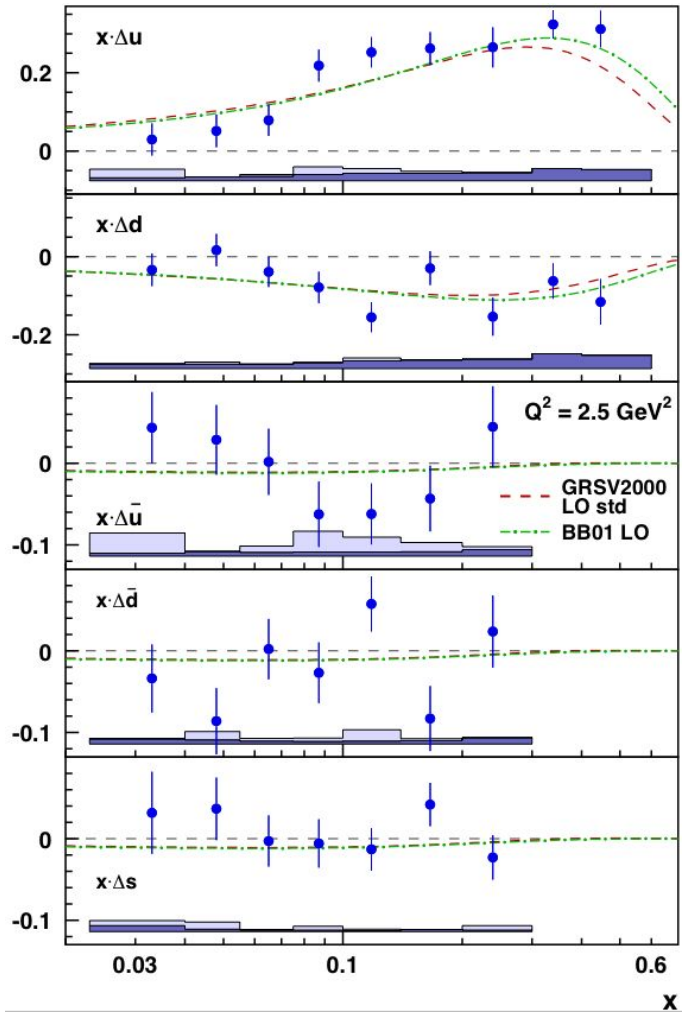


Polarized: H, D, ^{3}He
Unpolarized: H_2, D_2, ^{3,4}He, Ne, N_2, Kr
$\langle$Target Thickness $\rangle \approx 10^{13} - 10^{15}$atoms/cm^2



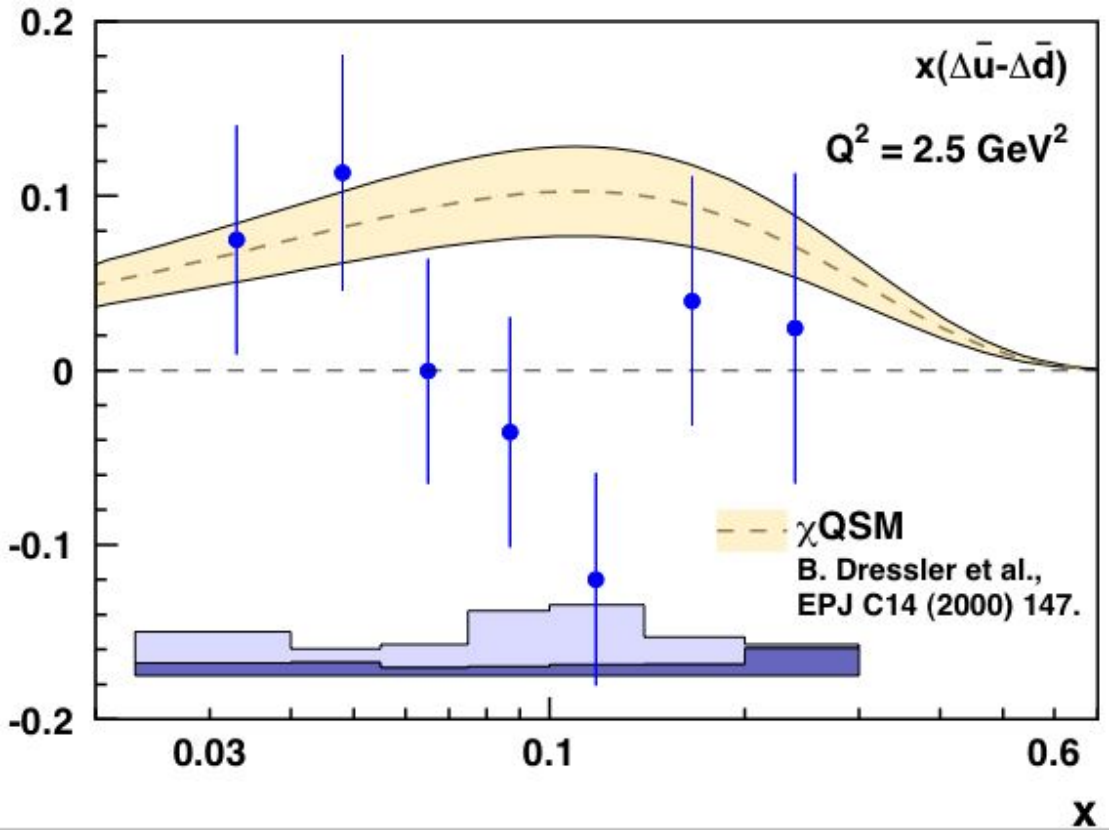
- large solid angle: $|\theta_x| < 170$ mrad
  $40 < \theta_y < 140$ mrad
- momentum resolution $\sim$ 1% from 1 to 27 GeV
- hadron/lepton contamination $<$ 1% (with high efficiency)
- calo energy resolution $\sim 2\% + 5.1\%/\sqrt{E} + 10\%/E$

5 Flavor Analysis Results

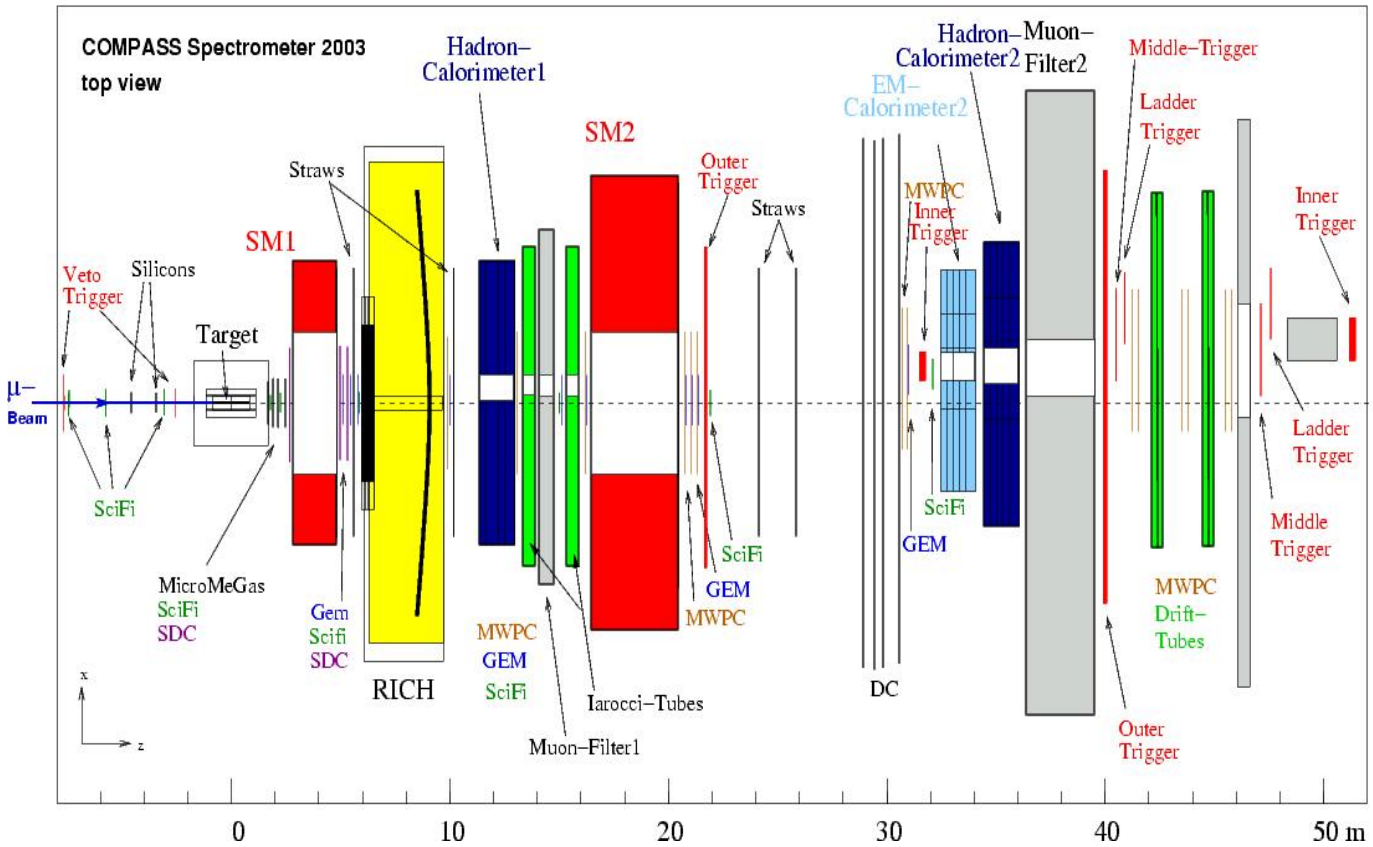


- Asymmetries from p and d targets
- Systematic uncertainty dominated by FF dependence
- Consistent with PDF parameterizations
- Sea polarizations set to 0 above x = 0.3
- Anti-strange sea pol = 0
- Low Q2 - NLO analysis necessary?
- *Sea polarizations consistent with zero*

Light Sea Asymmetry



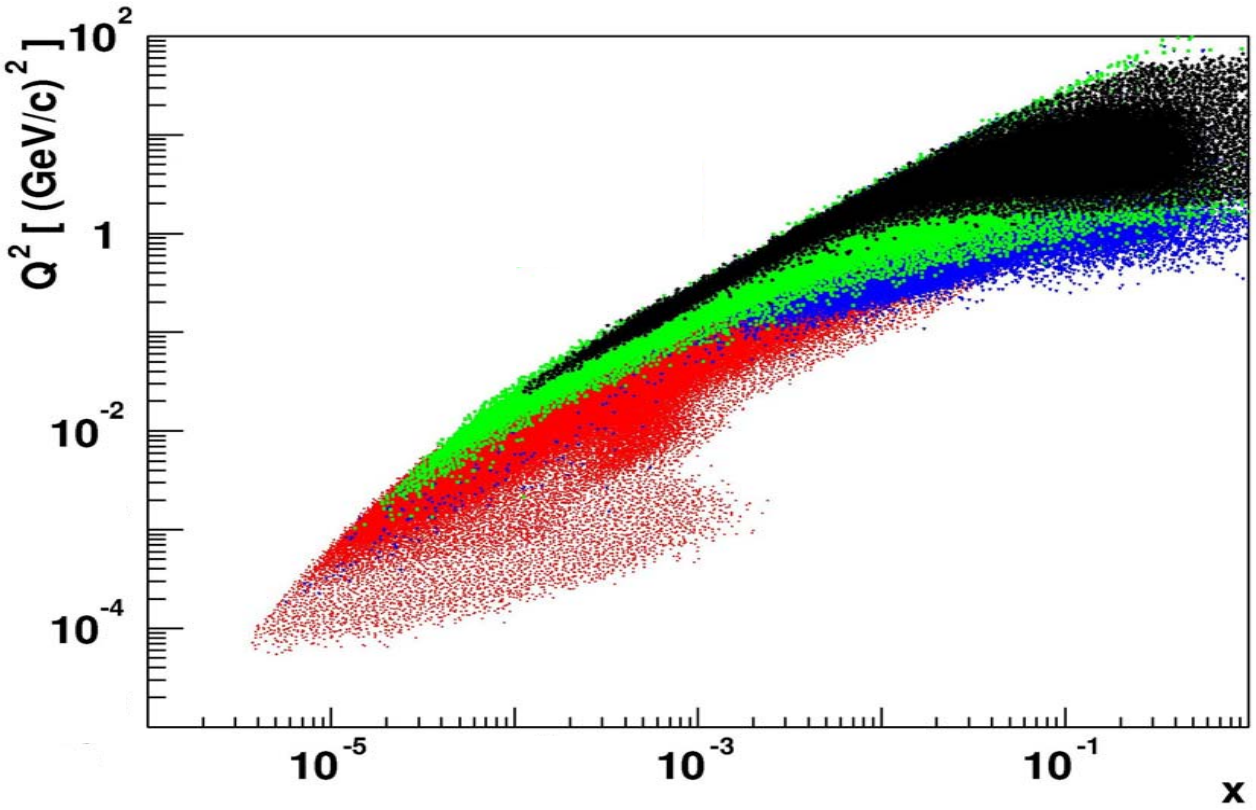
COMPASS at CERN



Beam: $2 \cdot 10^8$ μ^+/ spill (4.8s / 16.2s) **Beam momentum:** 160 GeV/c

Luminosity: ~$5 \cdot 10^{32}$ cm^{-2} s^{-1} **Beam polarization:** -76%

COMPASS Acceptance



Preliminary Inclusive Results

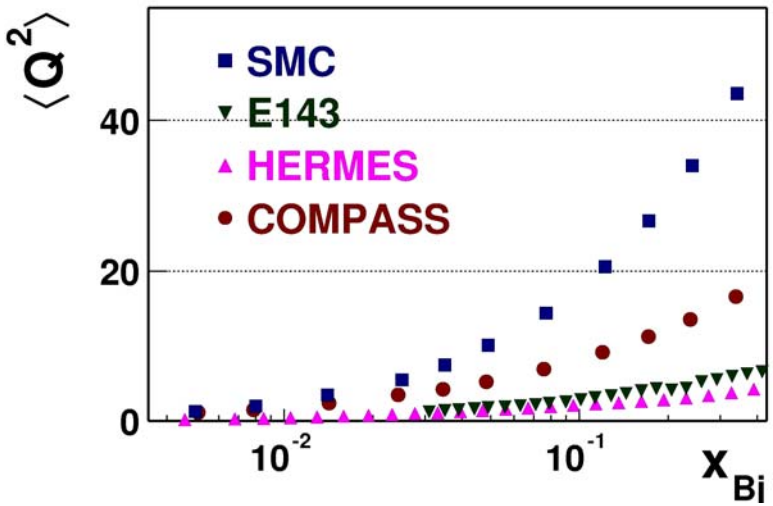
- 2002 data only

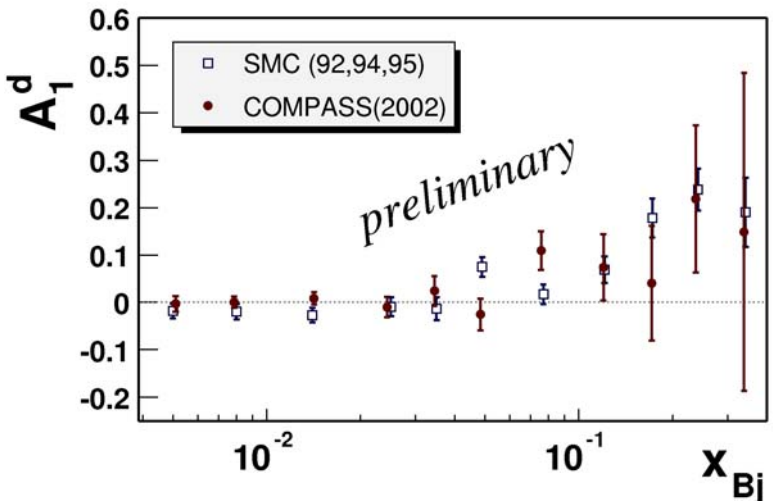
  6.5 Million DIS events

  $Q^2 > 1\ (GeV/c)^2$

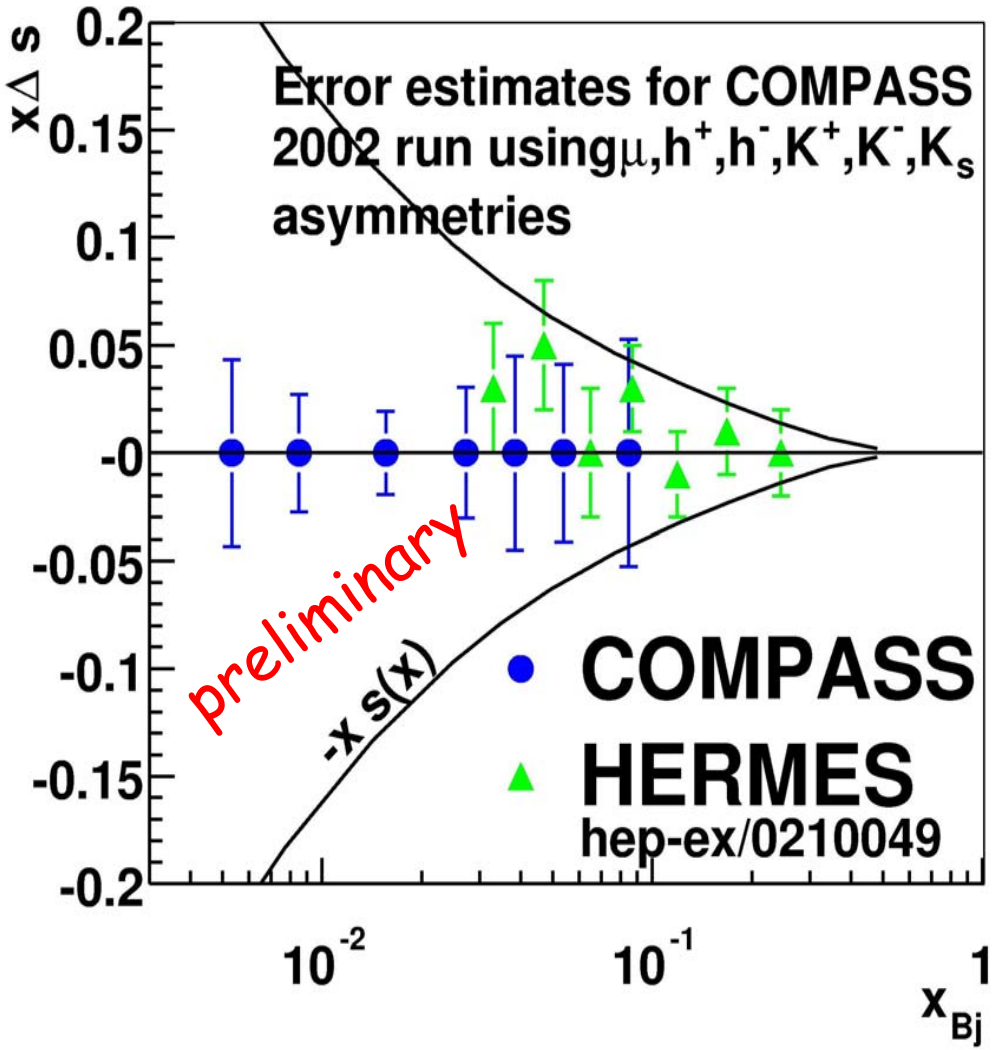
  $0.1 < y < 0.9$

expect *4 statistics
by end of 2004

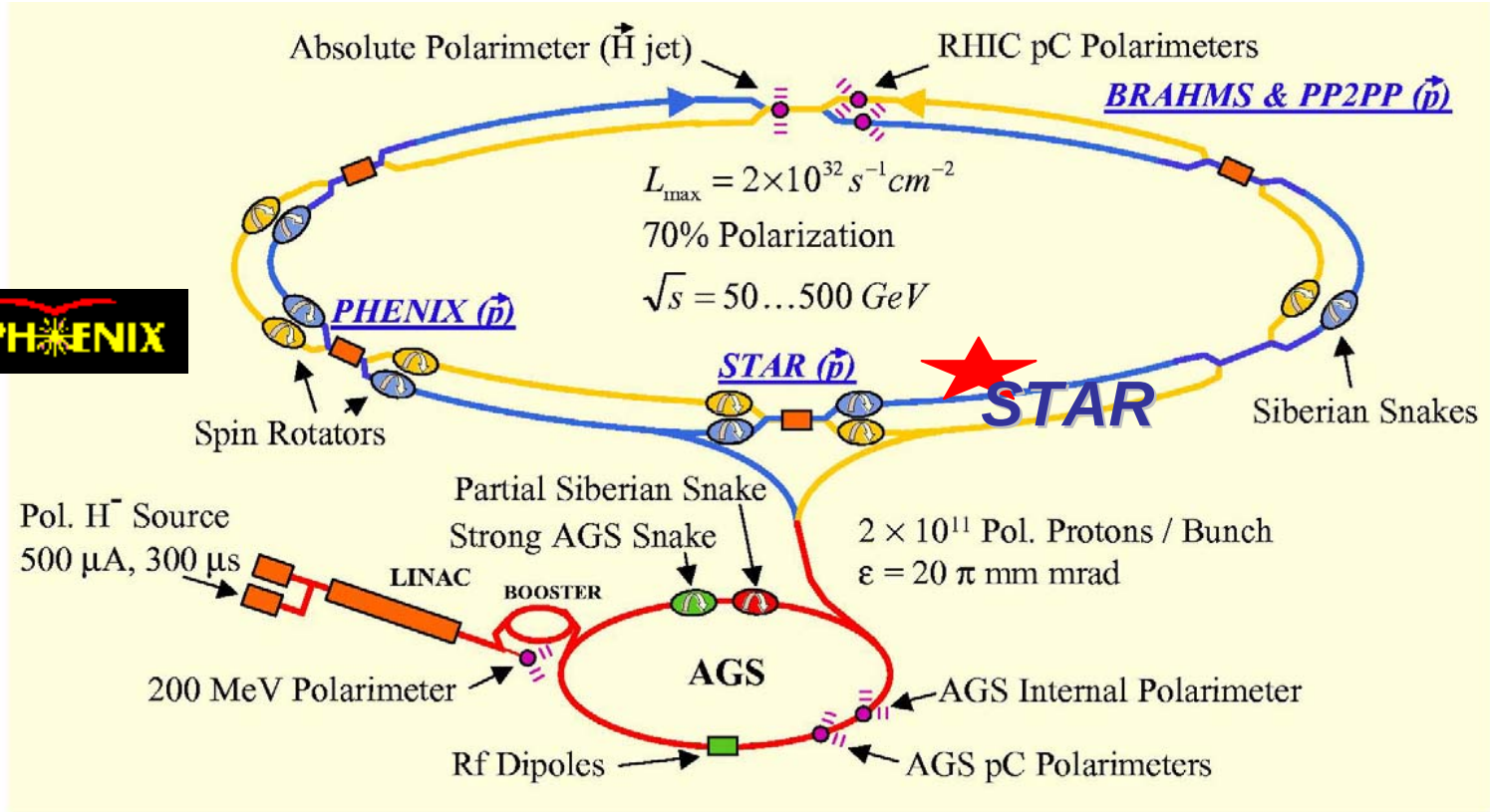




Expected Accuracies for Δq



Δq from Polarized pp at RHIC



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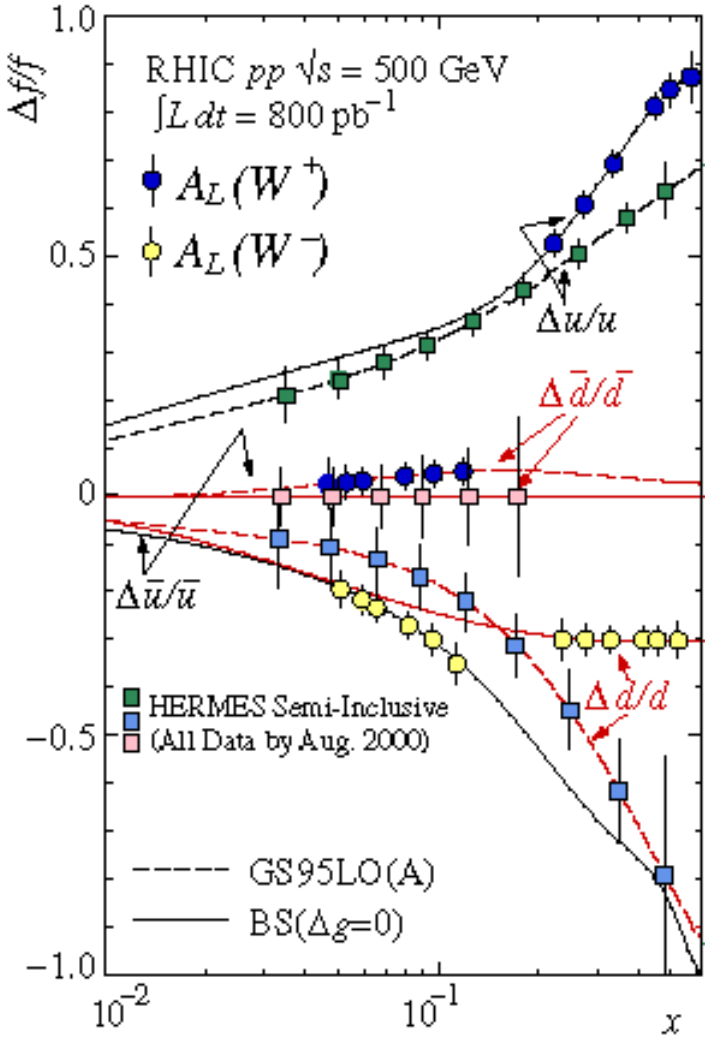
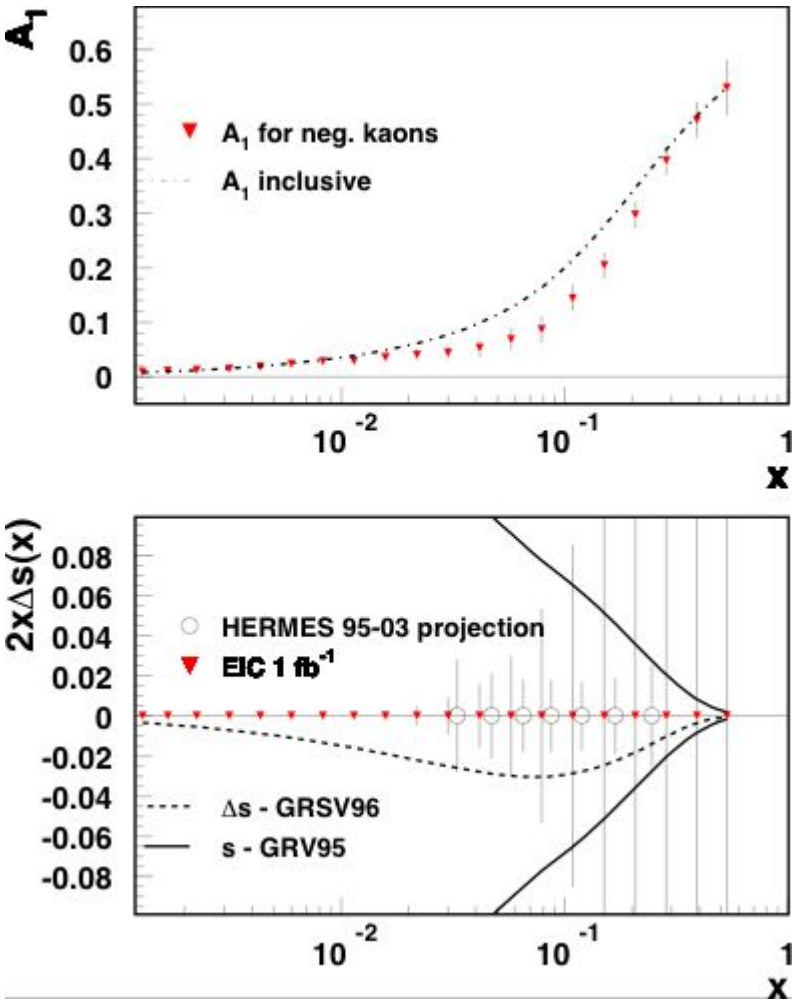
Single Spin Asymmetries from W Production



- Independent method of decomposition
- Large integrated luminosity required, with high polarization
- Studies underway to understand realistic detector/background effects

Δq at an Electron-Ion Collider



- From EIC White Paper
- 5 GeV e on 50 GeV p
- 70% polarizations
- "Perfect" detection outside 5 degrees

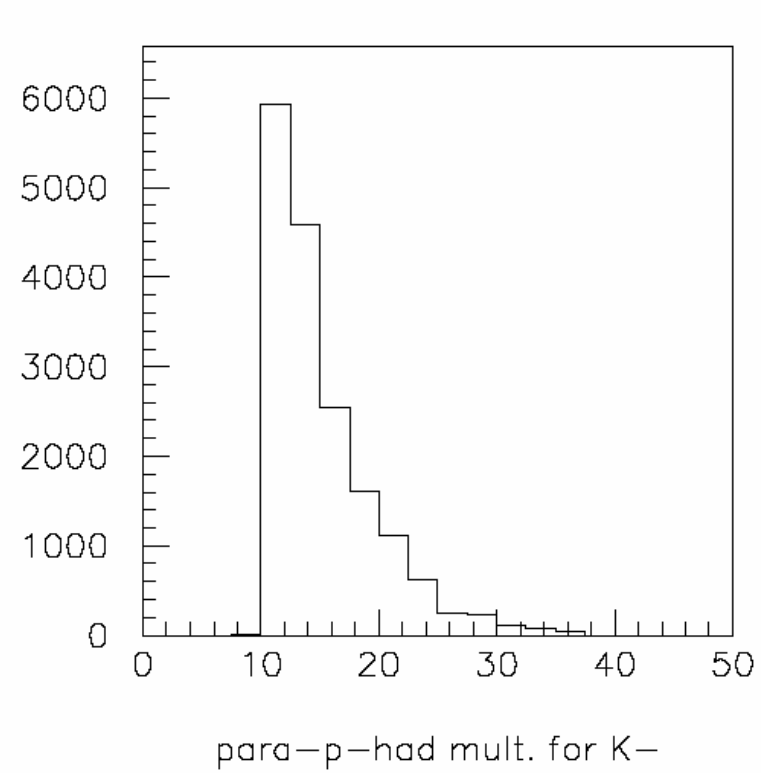
U. Stoesslein

Recent Studies at Colorado

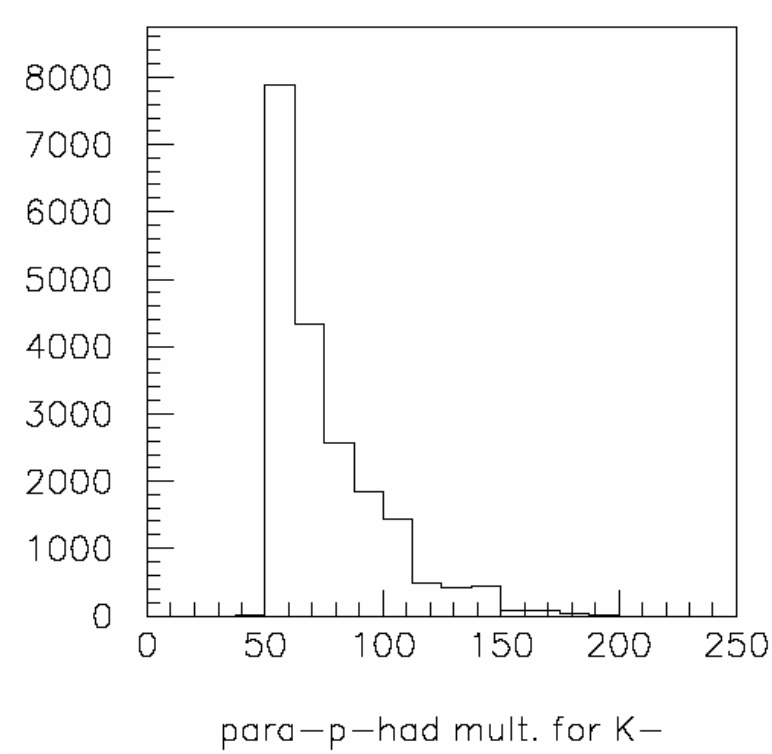
- Optimize energies: 10 GeV electrons on 50, 150, 250 GeV protons
- Study requirements for spectrometer acceptance and pid
- Study luminosity requirements
- Just started, so no conclusions yet…

K- Multiplicities

10 on 50



10 on 250



J. Seele

Conclusions/Outlook

- After HERMES, new measurements at COMPASS and RHIC will significantly improve our knowledge of Δq's in particular regimes
- New measurements at an EIC will have big impact at low x
- Optimization Studies underway
- Other experiments (Minerva, g5 at EIC)
- Will non-perturbative QCD theorists rise to the challenge of a precise flavor-spin decomposition?