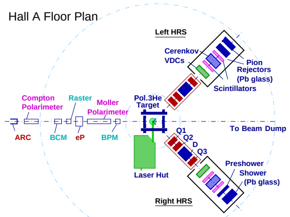
Precision Measurement of Neutron Spin Asymmetry A_1^n in the Large x_{Bj} Region

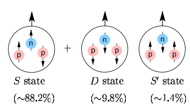
X. Zheng, W. Bertozzi, M.I.T. (For The Jefferson Lab Hall A Collaboration)

Experimental Setup

- Jefferson Lab polarized e^- beam 5.734 GeV, $P_{beam} = 81\%$
- Hall A polarized ^{3}He target
  - Based on spin exchange between optically pumped Rb and ^{3}He
  - 25cm, $\sim$ 10 atm
  - $P_{targ} = 40\%$ with 12μA beam
  - Two independent polarimetries: NMR, EPR
- Scattered e^-'s detected by two standard Hall A High Resolution Spectrometers
- Highest polarized luminosity of the world: 1×10^{36} s^{-1}



Why Polarized ^{3}He?

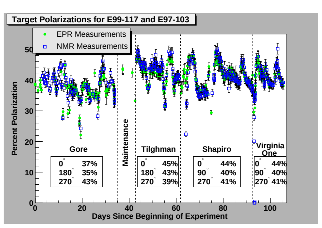


Effective nucleon polarizations:

$P_n = 86\%, P_p = -2.8\%$

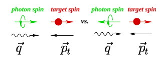
$\vec{^3He} \approx \vec{n}$ Effective Neutron Target

Target performance



Virtual photon asymmetry A_1^n

$$A_1^n = \frac{\sigma_{\frac{1}{2}} - \sigma_{\frac{3}{2}}}{\sigma_{\frac{1}{2}} + \sigma_{\frac{3}{2}}}$$



$$A_1^n = \frac{g_1^n(x,Q^2) - \gamma^2 g_2^n(x,Q^2)}{F_1^n(x,Q^2)}$$

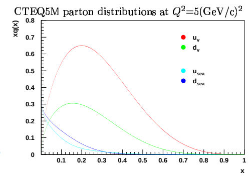
How did we measure A_1^n?

Measure asymmetries $A_\parallel$ and $A_\perp$ in inclusive $\vec{e}^- - ^3\vec{He}$ DIS

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

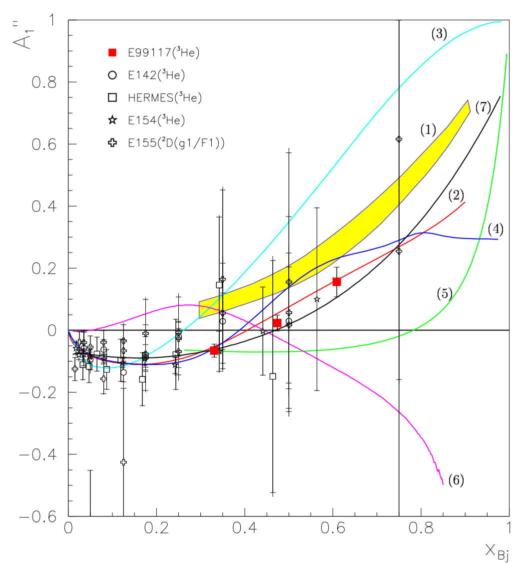
x_{Bj}	0.331	0.474	0.609
Q^2 (GeV/c)^2	2.738	3.567	4.887
W^2 (GeV)^2	6.426	4.846	4.023

Why at high x_{Bj}?



- Valence quarks dominate;
- Constituent quark models:
  $A_1^n \to 1$ at $x \to 1$
  - Is our understanding of valence quark picture correct?
- pQCD: $A_1^n = 1$ at $x = 1$
  - how solid it is
  - to how low x it can apply;
- QCD vacuum:
  - $A_1^n < 0$ at high x possible
  - chiral soliton, instanton.

Preliminary Results



Conclusion

- Provide the first precise data of A_1^n in the region $x > 0.4$
- Data on g_1^n, A_n^2, g_2^n are also available
- Provide valuable input to theories

More Thoughts: A_1^n and $\Delta q/q$

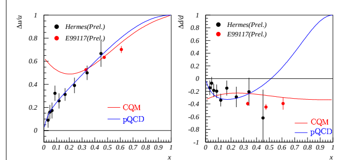
- From world data of $A_1^{n,p}$, and

$$A_1^n = \frac{\Delta u + 4\Delta d}{u + 4d}, \quad A_1^p = \frac{4\Delta u + \Delta d}{4u + d}$$

- Can extract $\Delta q/q$ as:

$$\frac{\Delta u}{u} = \frac{4}{15}A_1^p(4 + \frac{d}{u}) - \frac{1}{15}A_1^n(1 + 4\frac{d}{u})$$
$$\frac{\Delta d}{d} = \frac{4}{15}A_1^n(4 + 1/\frac{d}{u}) - \frac{1}{15}A_1^p(1 + 4/\frac{d}{u})$$

- d/u from *Phys.Lett.***B377**, 11-17 (1996)



Future of A_1^n

- A_1^n at high x_{Bj} is also a key program at Jefferson Lab 12 GeV upgrade, after which A_1^n will be measured up to $x \sim 0.8$ within $2 < Q^2 < 10$(GeV/c)^2.

References

^{3}He Nuclear Correction:
F. Bissey *et al.* hep-ph/0109069.

1. Constituent Quark Model (N. Isgur);
2. pQCD based LSS parameterization (LSS);
3. pQCD based BBS parameterization (LSS);
4. statistical model (J. Soffer);
5. local duality (W. Melnitchouk);
6. chiral soliton model (H. Weigel);
7. E155 experimental fit.