Looking Ahead to 22 GeV: A1n in Hall C

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Outline

- Motivation
- Simulation for HMS/SHMS
- From He3 Measurement to A1n
- Projected A1n Results
- Conclusion

Motivation

- While CEBAF is currently running at a maximum beam energy of 12 GeV, the facilities' tunnel is designed to accommodate an electron beam with energies up to 24 GeV.
- Through inclusive DIS measurements in Hall C, an increase in the maximum beam energy to 24 GeV will allow for the first measurement of the neutron spin asymmetry (A1n) above Bjorken x = 0.75, providing data up to x = 0.91.

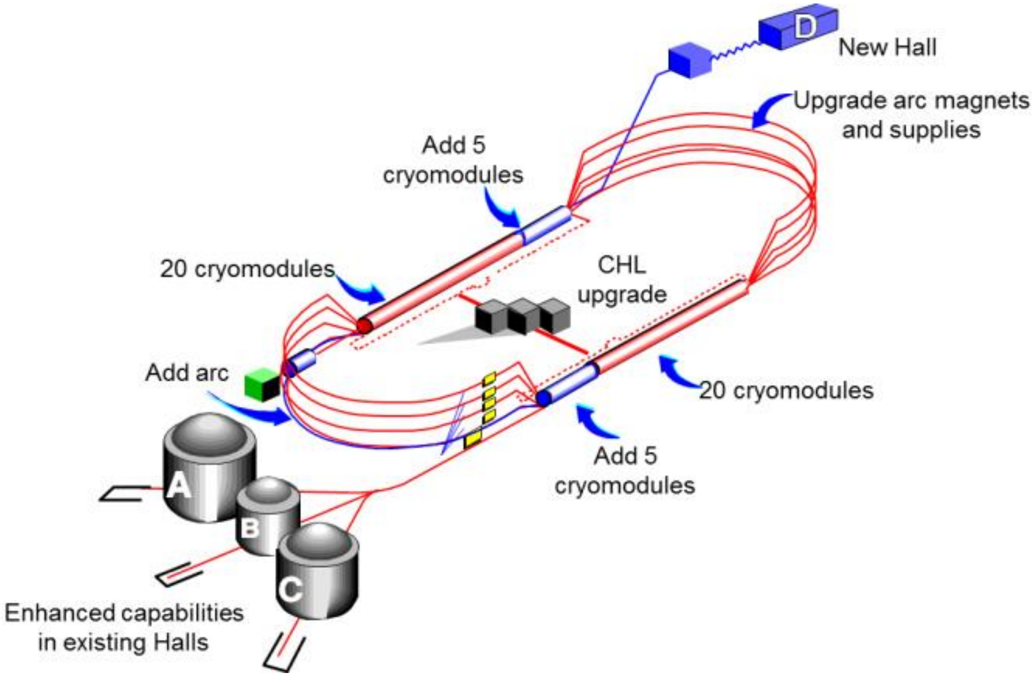
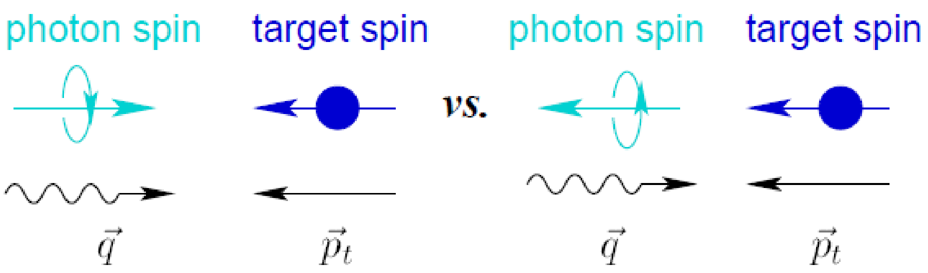


Diagram of CEBAF Summarizing the Completed 12 GeV Upgrade

Motivation

- The results of a 22 GeV A1n experiment will test predictions of A1n at large x made by several models such pQCD and relativistic CQM. It will also provide a precise determination of the polarized valence parton distributions Δd and Δu.
- My work will look at the ability of such an experiment to make precise measurements of A1n at large x, assuming a reasonable amount of beam time.

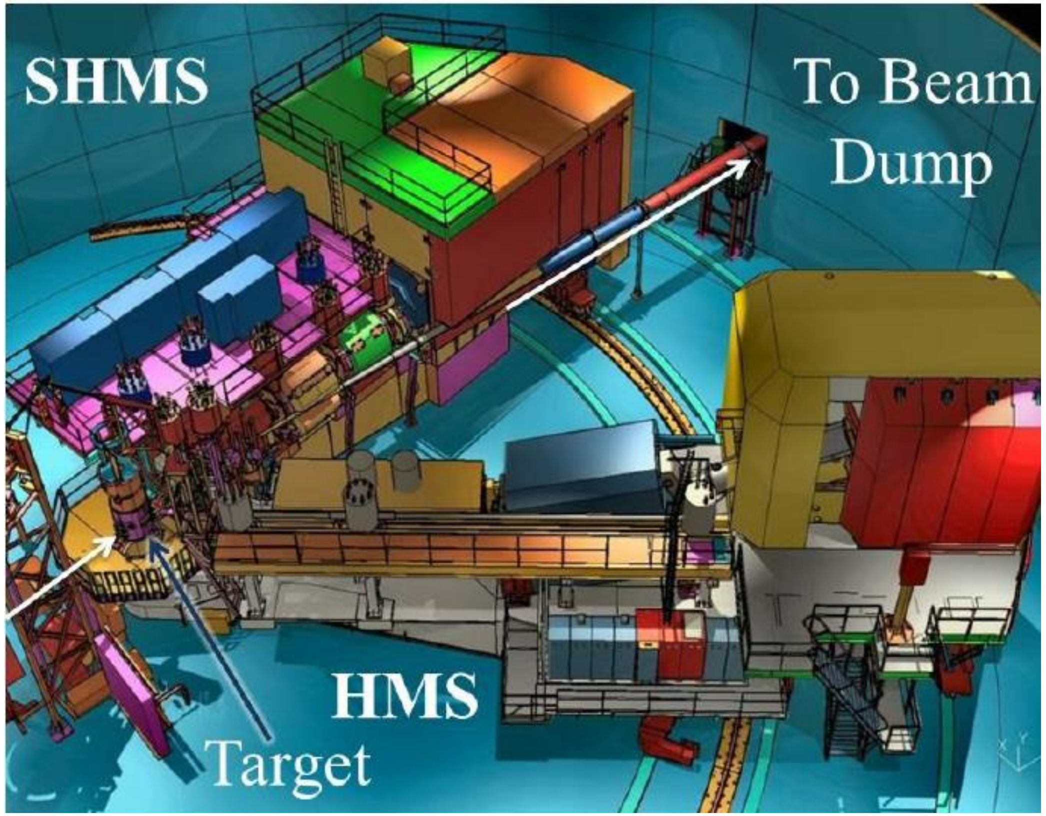


Definition of Virtual Photon Asymmetry A1

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

Simulation

- First, I estimated the highest value in x we could reach for DIS and reasonably low Q2 assuming a beam energy of 22 GeV (x = .91).
- I then used the mc-single-arm Monte-Carlo simulation code to generate event rates at SHMS using the F1F2IN21 model, assuming a 30uA beam current (Pbeam = 85%) on a 40cm polarized He3 target (Ptar = 50%).
- From the event rate, I can then estimate the statistical error bar of A1n assuming 30 days of beam time.



Data Analysis Procedure

- From the parallel and perpendicularly polarized Helium-3 cross sections, we can define the electron asymmetries in the usual way:

$$A_{\parallel} \equiv \frac{\sigma_{\downarrow\Uparrow} - \sigma_{\uparrow\Uparrow}}{\sigma_{\downarrow\Uparrow} + \sigma_{\uparrow\Uparrow}} \qquad A_{\perp} \equiv \frac{\sigma_{\downarrow\Rightarrow} - \sigma_{\uparrow\Rightarrow}}{\sigma_{\downarrow\Rightarrow} + \sigma_{\uparrow\Rightarrow}}$$

- I can form the Helium-3 virtual photon asymmetry A1(He3) using the following linear combination of parallel and perpendicular electron asymmetries:

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

- I then optimize the runtime split between parallel and perpendicular polarizations to minimize the error, dA1(He3) (25/5), where the error in the electron asymmetries is simply 1/sqrt(N).

Data Analysis Procedure

- I convert from the “raw” dA1(He3) to the true “physics” dA1(He3), taking into account the beam and target polarizations (Pb=0.5, Pt=0.85), and the nitrogen dilution (f=0.9).

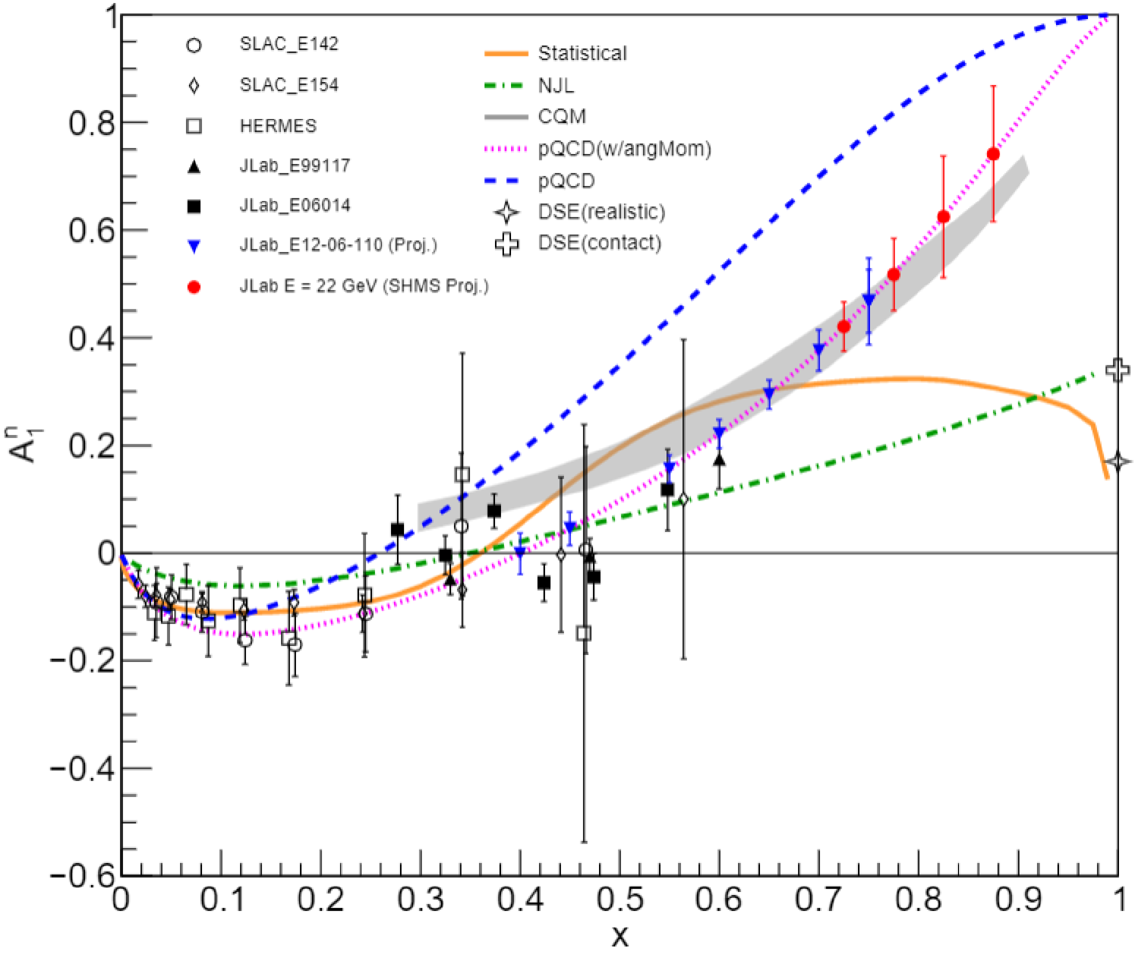
$$dA_{1,phys} = \frac{dA_{1,raw}}{P_b P_t f}$$

- We can relate A1(He3) to A1n by the following equation, where F2’s are provided by the fit (F1F2IN21). Structure functions are not well known at large-x. While this is another motivation to perform a large-x A1n experiment, this also introduces a some uncertainty in this analysis.

$$A_1^n \;=\; \frac{F_2^{^3\mathrm{He}}}{P_n F_2^n \left(1 + \frac{0.056}{P_n}\right)} \left(A_1^{^3\mathrm{He}} - 2 \frac{F_2^p}{F_2^{^3\mathrm{He}}} P_p \left(1 - \frac{0.014}{2P_p}\right) A_1^p \right)$$

Results

- Red points are projected results from this work. Only SHMS has been studied so far, so we will expect error bars to shrink once HMS data is included. 22 GeV A1n extends existing measurements of A1n from x=0.75 to x= 0.91 with reasonable precision.
- Blue points are projected results from the 11 GeV A1n experiment, which has run and is currently being analyzed.



Conclusion

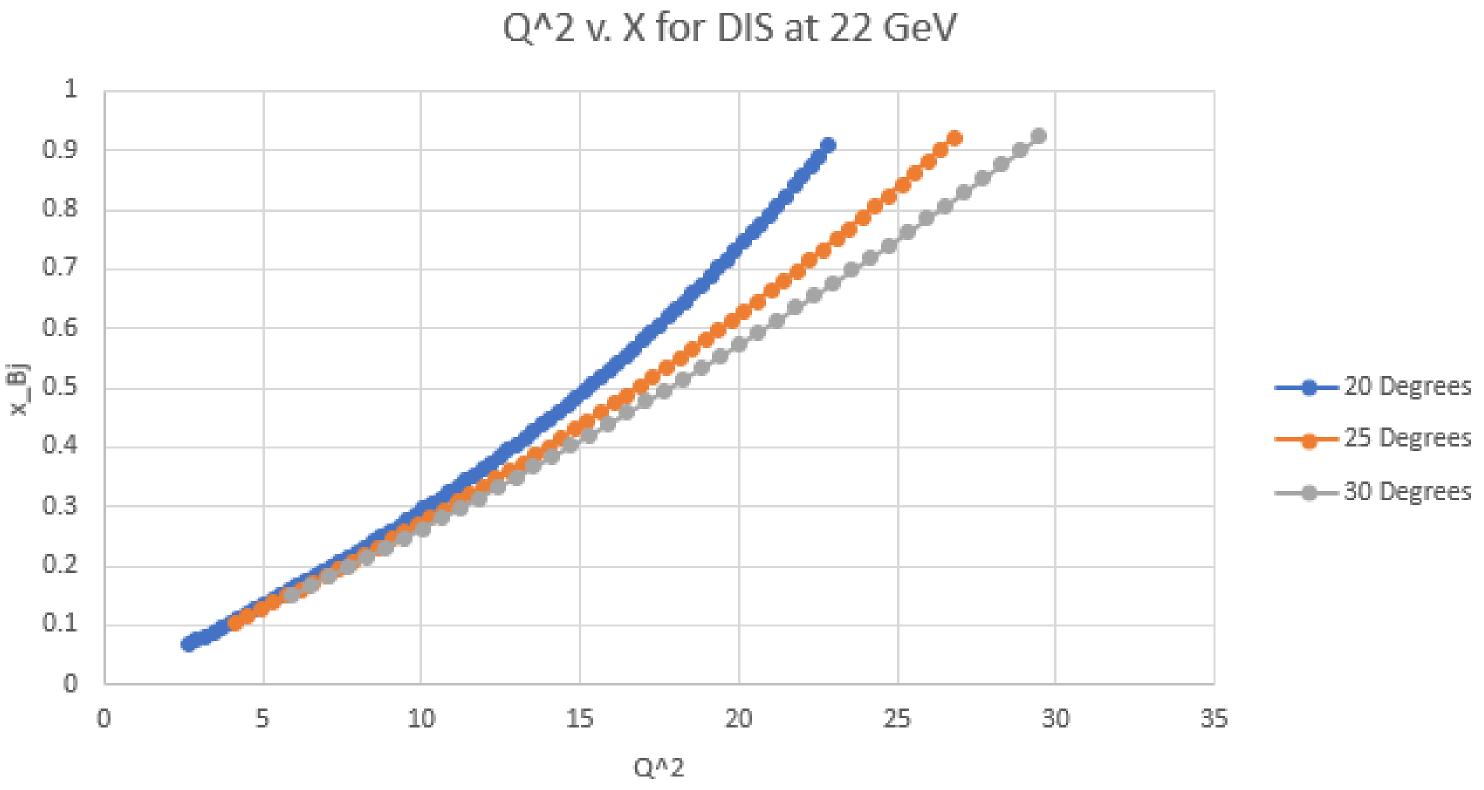
- From my preliminary study, we have found that we can push measurements of A1n all the way up to x=0.91, probing into the valence quark region more than ever. In addition, the statistical uncertainty we expect to achieve looks promising for a future A1n experiment.

- Moving forward, I will look into adding HMS data to reduce the statistical uncertainty of measurements. The HMS has a maximum E’ of 7.5 GeV, which is too low to reach x = 0.91 at low Q2 like the SHMS. However, we can still reach x = 0.91 at larger Q2 (and lower event rates).

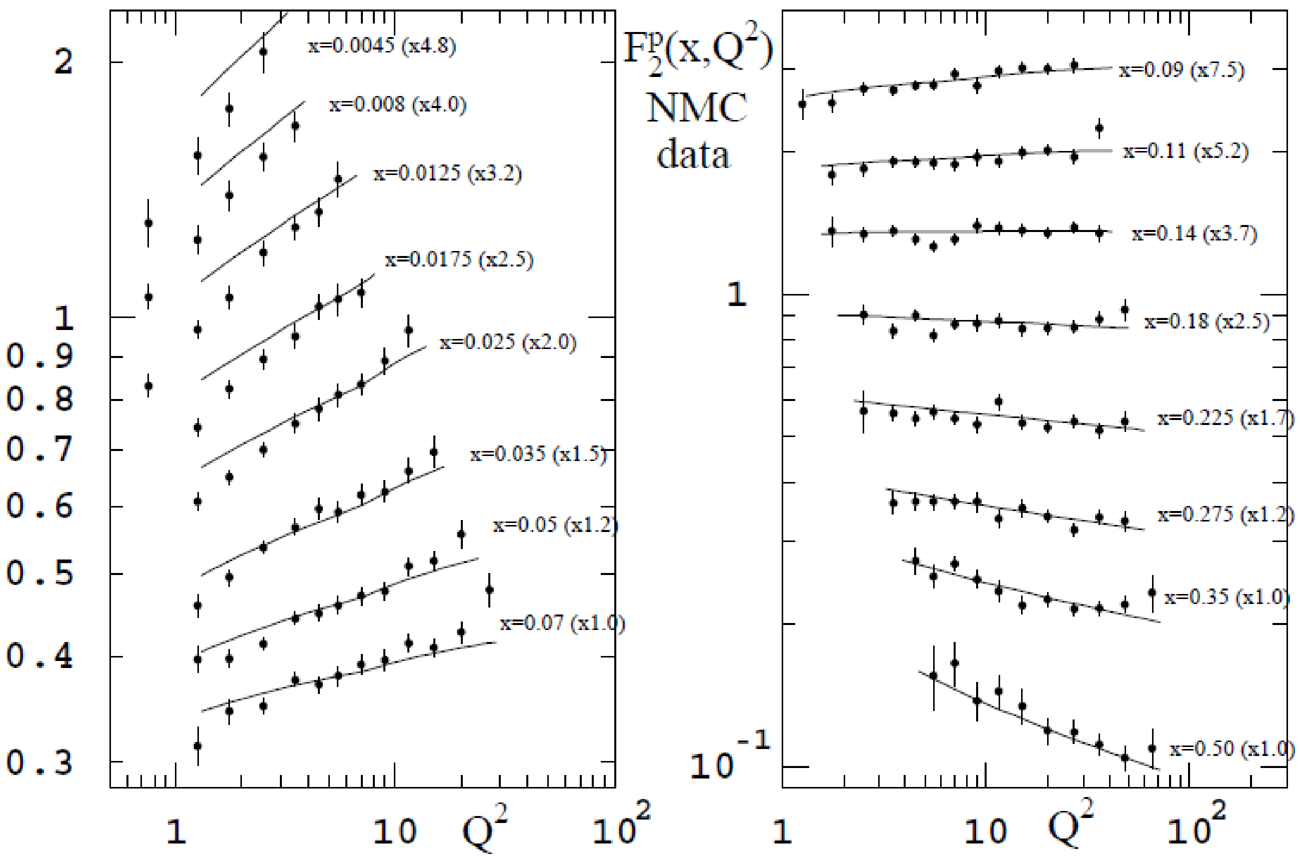
Questions?

Back Up Slides

Q2 v. X for DIS – Angular Comparison



Cross Section v. Q2



Convolution Model+

$$g_1^{^3\mathrm{He}}(x,Q^2) \;=\; \int_x^3 \frac{\mathrm{d}y}{y}\Delta f_{n/^3\mathrm{He}}(y)\tilde{g}_1^n(x/y,Q^2) + \int_x^3 \frac{\mathrm{d}y}{y}\Delta f_{p/^3\mathrm{He}}(y)\tilde{g}_1^p(x/y,Q^2)$$

$$-0.014(\tilde{g}_1^p(x) - 4\tilde{g}_1^n(x) + a(x)g_1^n(x) + b(x)g_1^p(x)$$

This model is an improvement upon the Convolution Model of the He3 Spin Structure Function. It takes into account the off-shellness of the nucleons, non-nucleonic degrees of freedom, and nuclear shadowing/anti-shadowing.