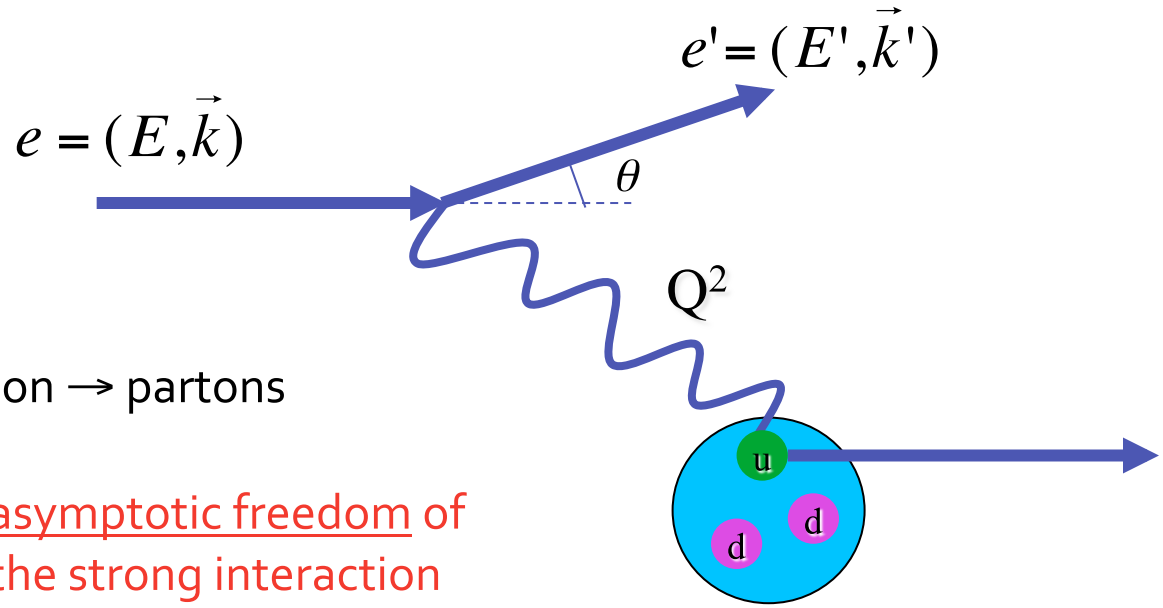
Hall A experiment E12-06-122

Measurement of neutron spin asymmetry A_1^n in the valence quark region using 8.8 and 6.6 GeV beams and Bigbite spectrometer in Hall A

Averett, Cates, Liyanage, Rosner, Wojtsekhowski, Zheng

Deep Inelastic Electron Scattering



High Q^2 and W>2GeV: fine resolution → partons

scaling → asymptotic freedom of the strong interaction

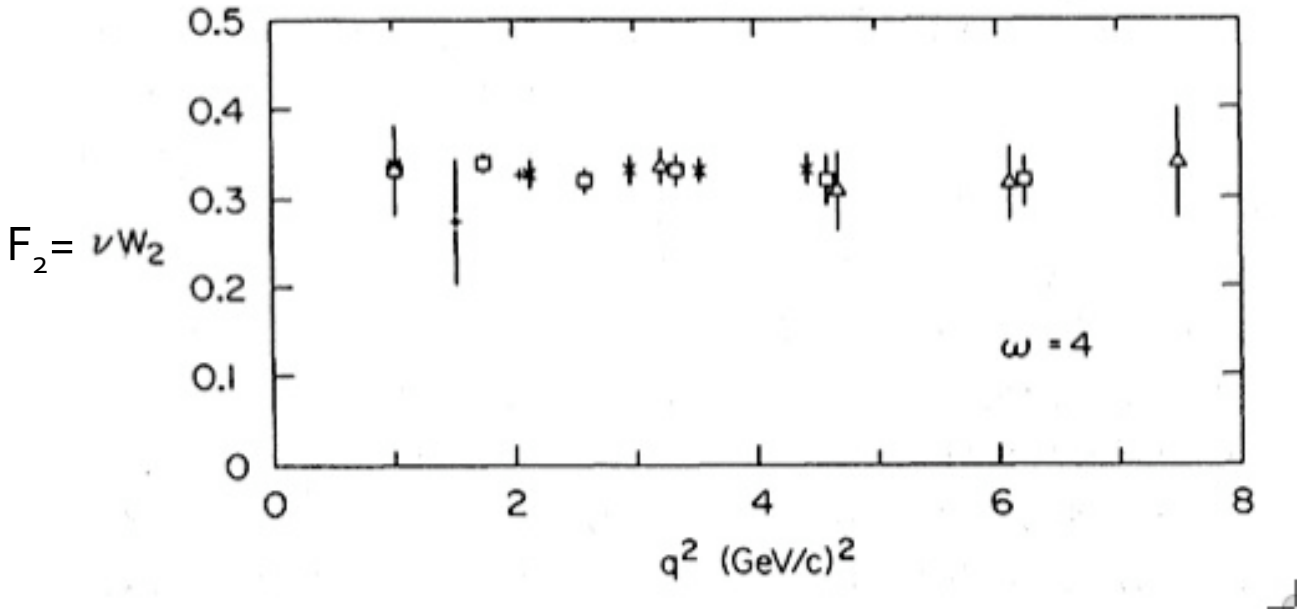
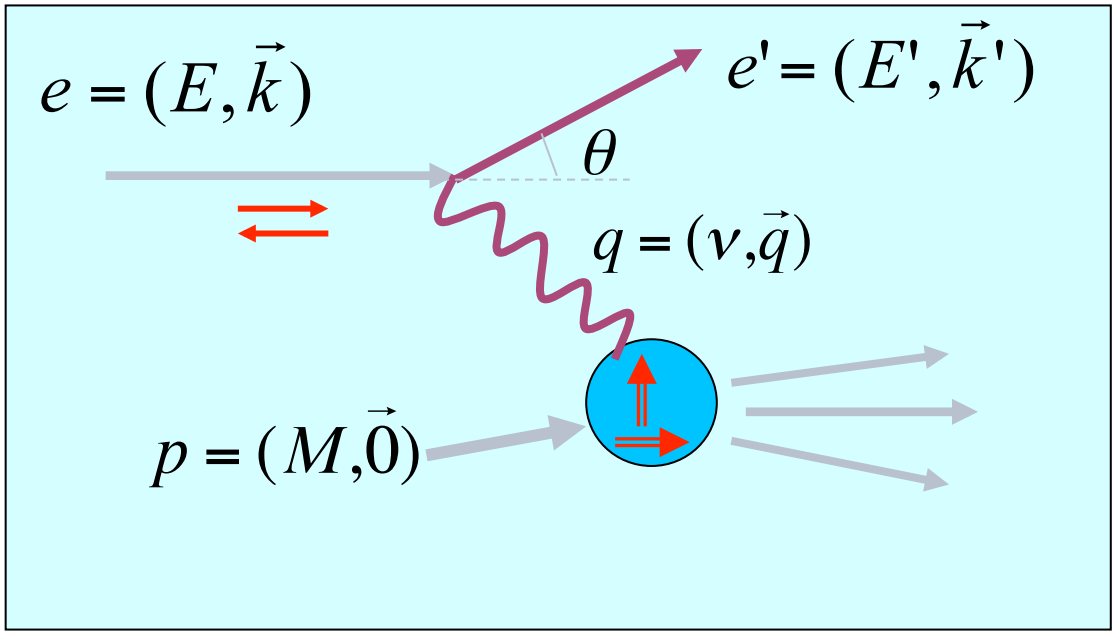


Figure from: H. W. Kendall, Rev. Mod. Phys. 63 (1991) 597

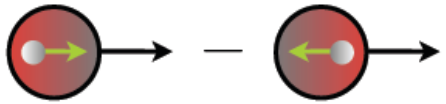
Deep Inelastic Electron Scattering



In the quark-parton model

$$F_1(x) = \frac{1}{2}\Sigma e_i^2 (q_i(x) + \bar{q}_i(x))$$

$$g_1(x) = \frac{1}{2}\Sigma e_i^2 (\Delta q_i(x) + \Delta \bar{q}_i(x))$$

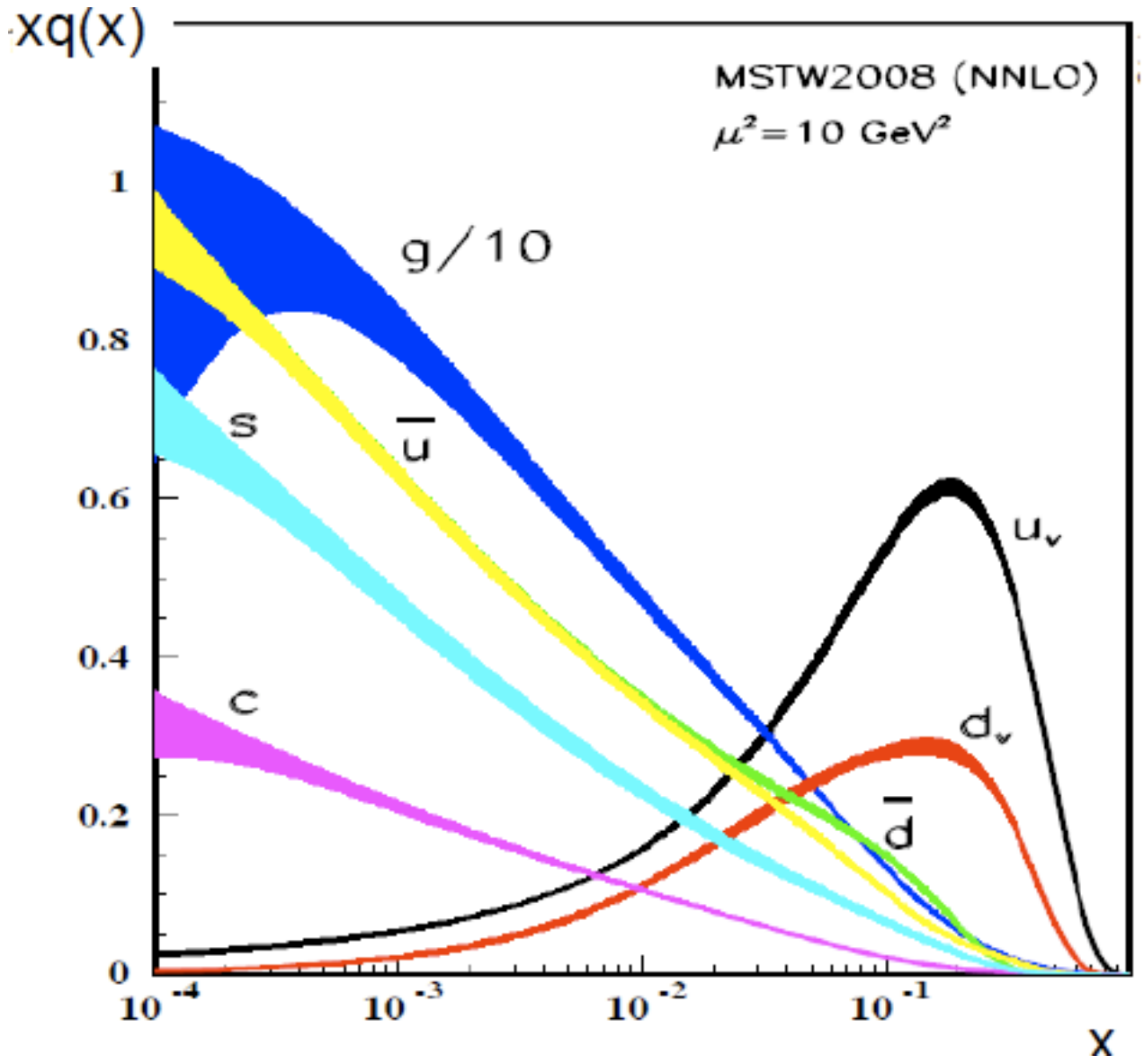
$\Delta q_i(x) =$ 

Unpolarized case

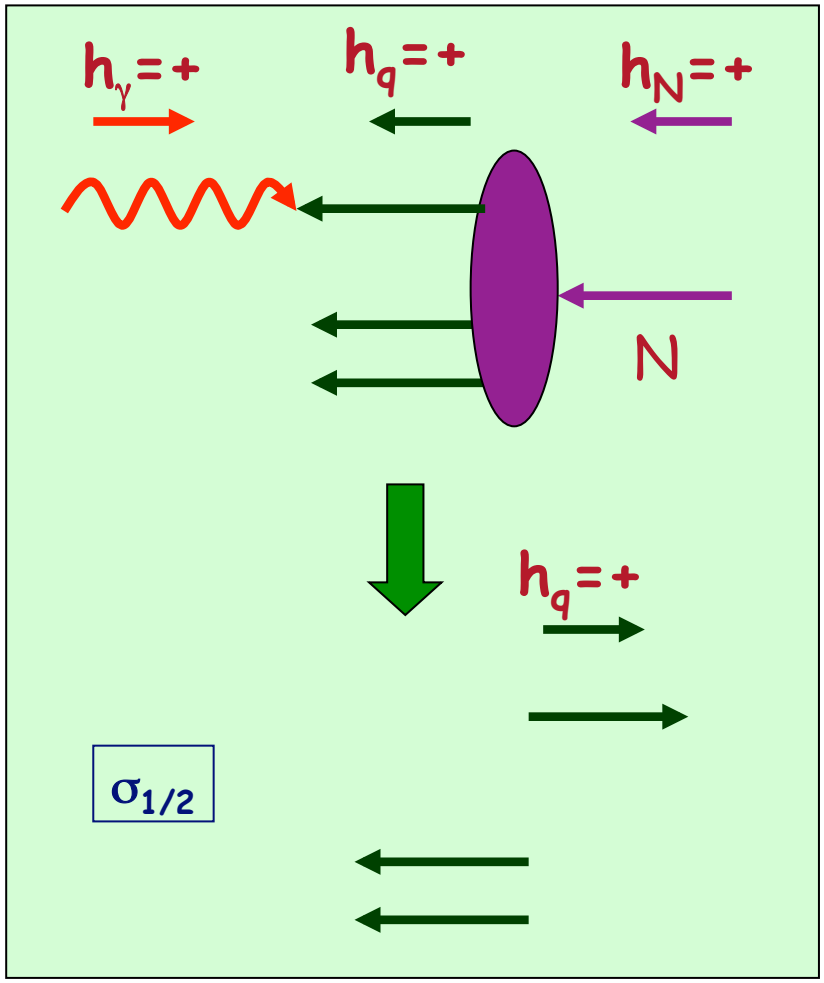
$$\frac{d^2\sigma}{d\Omega dE'} = \sigma_{Mott}\left[\frac{1}{\nu}F_2(x,Q^2) + \frac{2}{M}F_1(x,Q^2)\tan^2\frac{\theta}{2}\right]$$

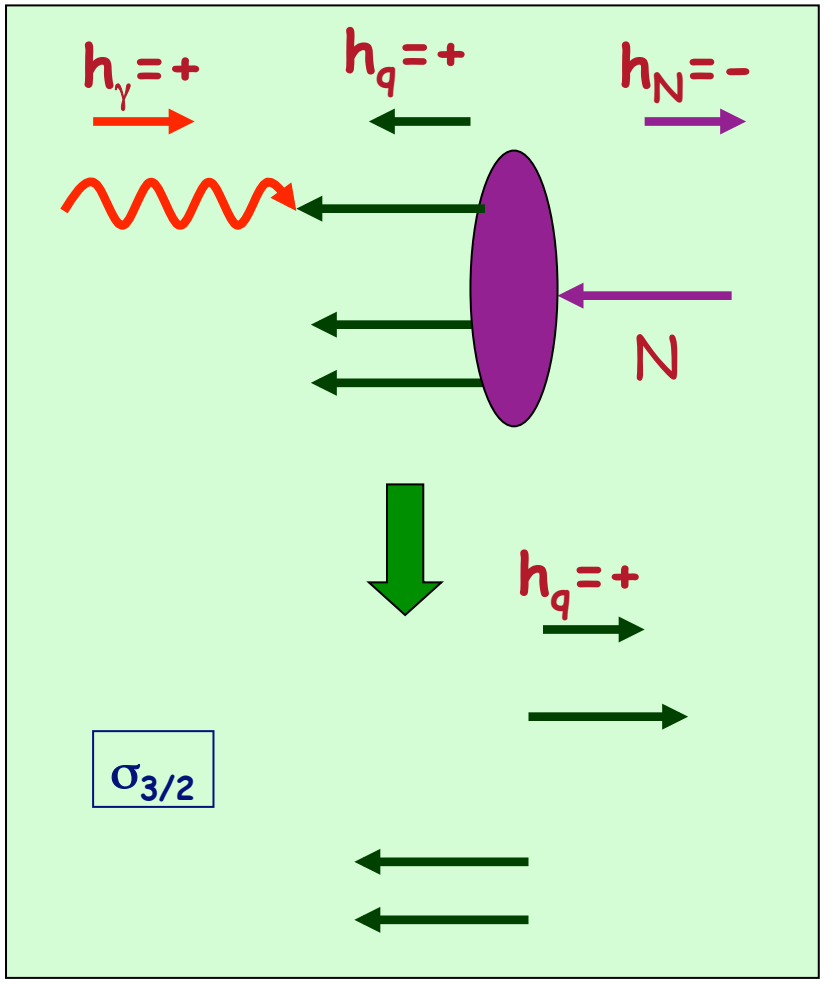
Polarized case

$$\frac{d^2\sigma^{\uparrow\Uparrow}}{d\Omega dE'} - \frac{d^2\sigma^{\downarrow\Uparrow}}{d\Omega dE'} = \frac{4\alpha^2 E'}{\nu E Q^2}\left[(E + E'\cos\theta)g_1(x,Q^2) - 2Mxg_2(x,Q^2)\right]$$


xq(x)
MSTW2008 (NNLO)
$\mu^2 = 10$ GeV^2
g/10
s
$\bar{u}$
c
u_v
d_v
$\bar{d}$
1
0.8
0.6
0.4
0.2
0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
x

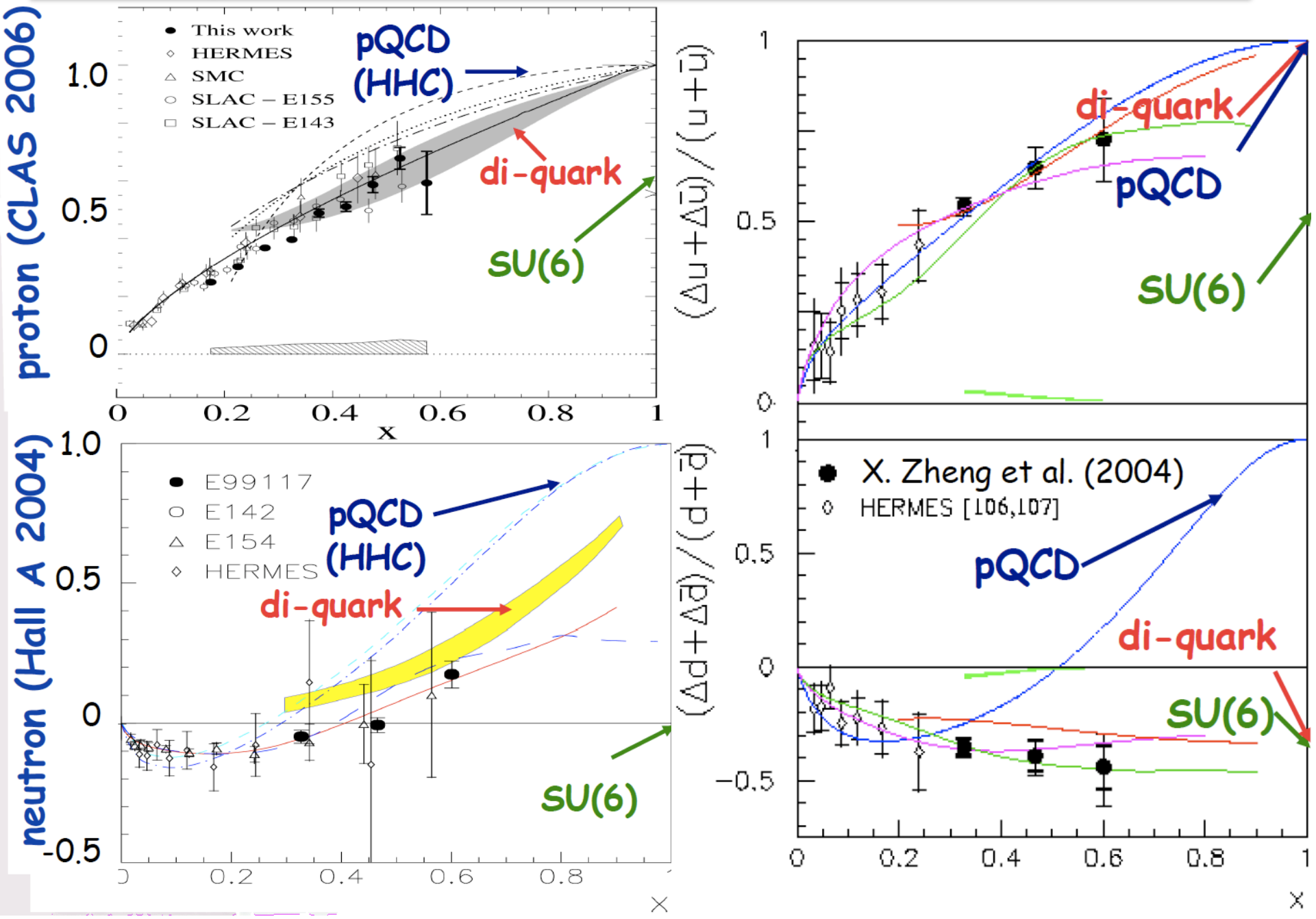
Virtual Photon Asymmetry





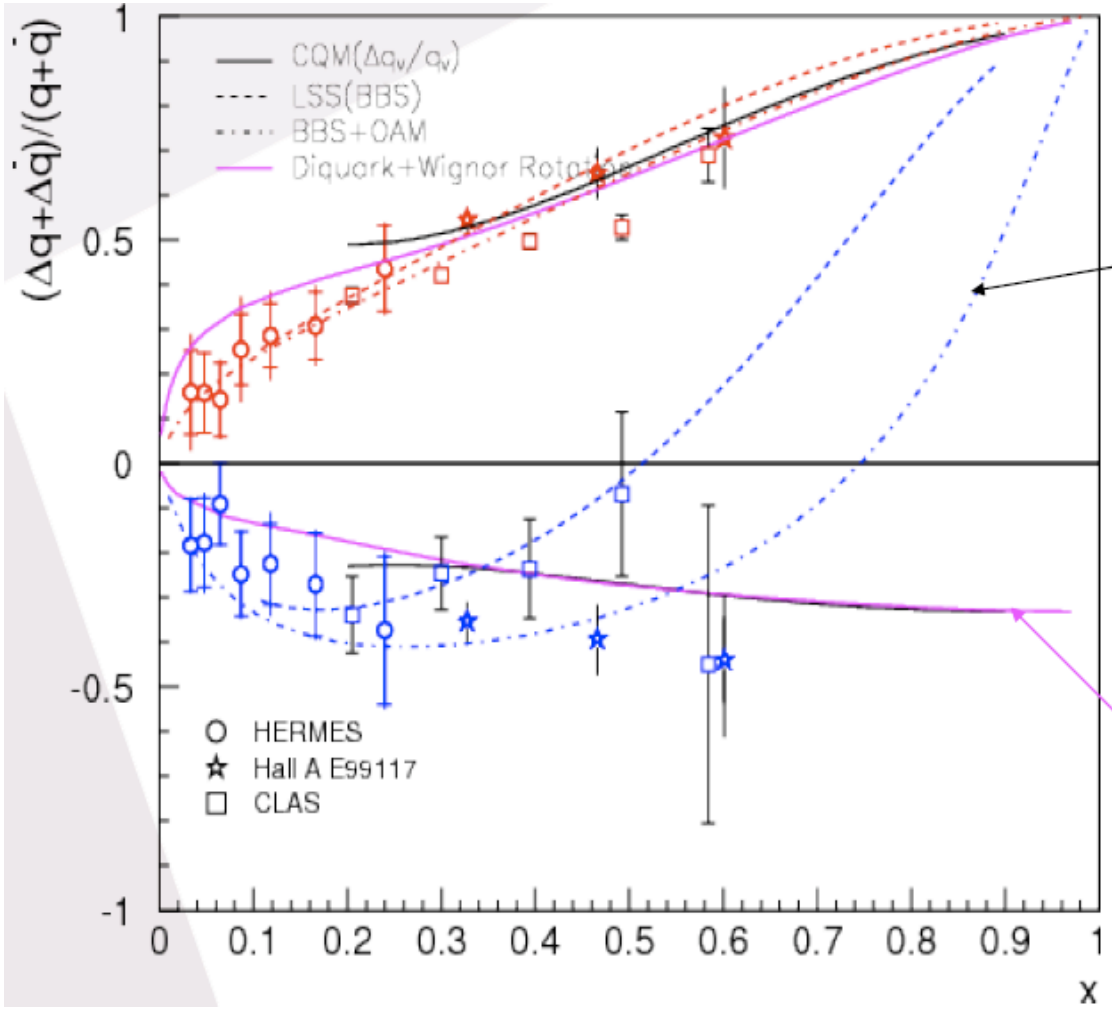
$$A_1 = \frac{\sigma_{1/2} - \sigma_{3/2}}{\sigma_{1/2} + \sigma_{3/2}} \approx \frac{g_1}{F_1}$$

High-x spin structure at the end of 6 GeV Jlab



•Initial prediction for $\Delta d/d$ from the pQCD inspired model assumes that the quarks in the lowest Fock state are in a relative s state -> Hadron Helicity Conservation (HHC)

• But OAM can provide a logarithmic enhancement of helicity-flip amplitudes.

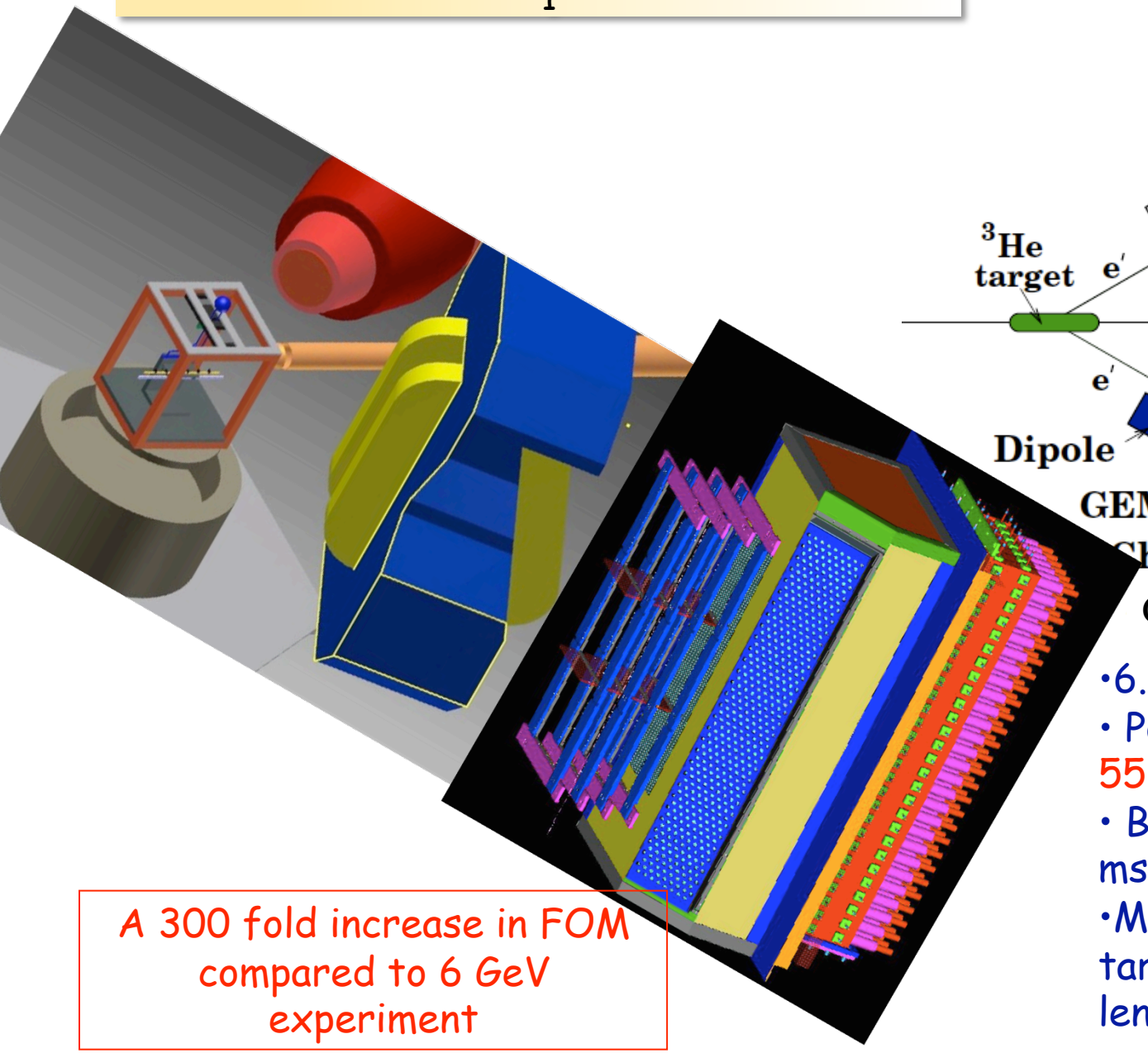


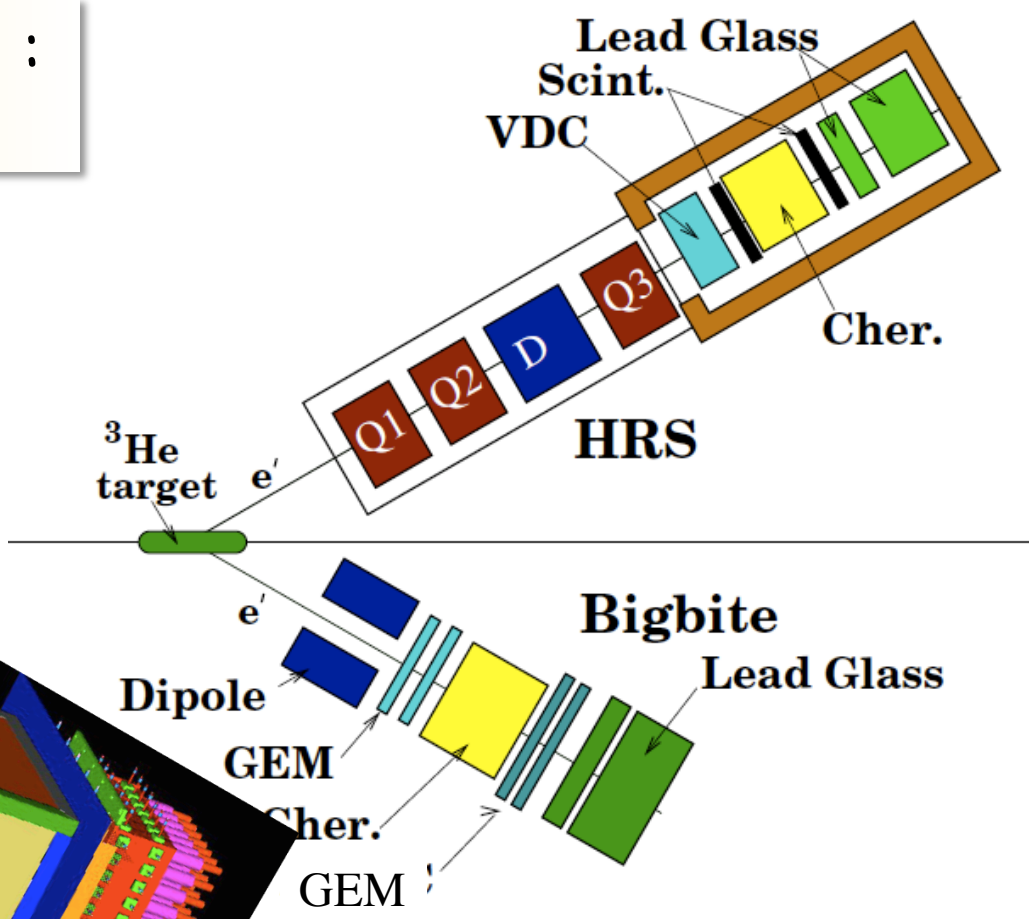
H. Avakian, S. Brodsky, A. Deur, F. Yuan, Phys. Rev. Lett.99:082001(2007)

Including $L_z = 1$ term.

light-cone quark/diquark model
X. Chen, Y. Mao, B.-Q. Ma, Nucl. Phys. A 759, 188 (2005)

Hall A experiment E12-06-122 : A_1^n



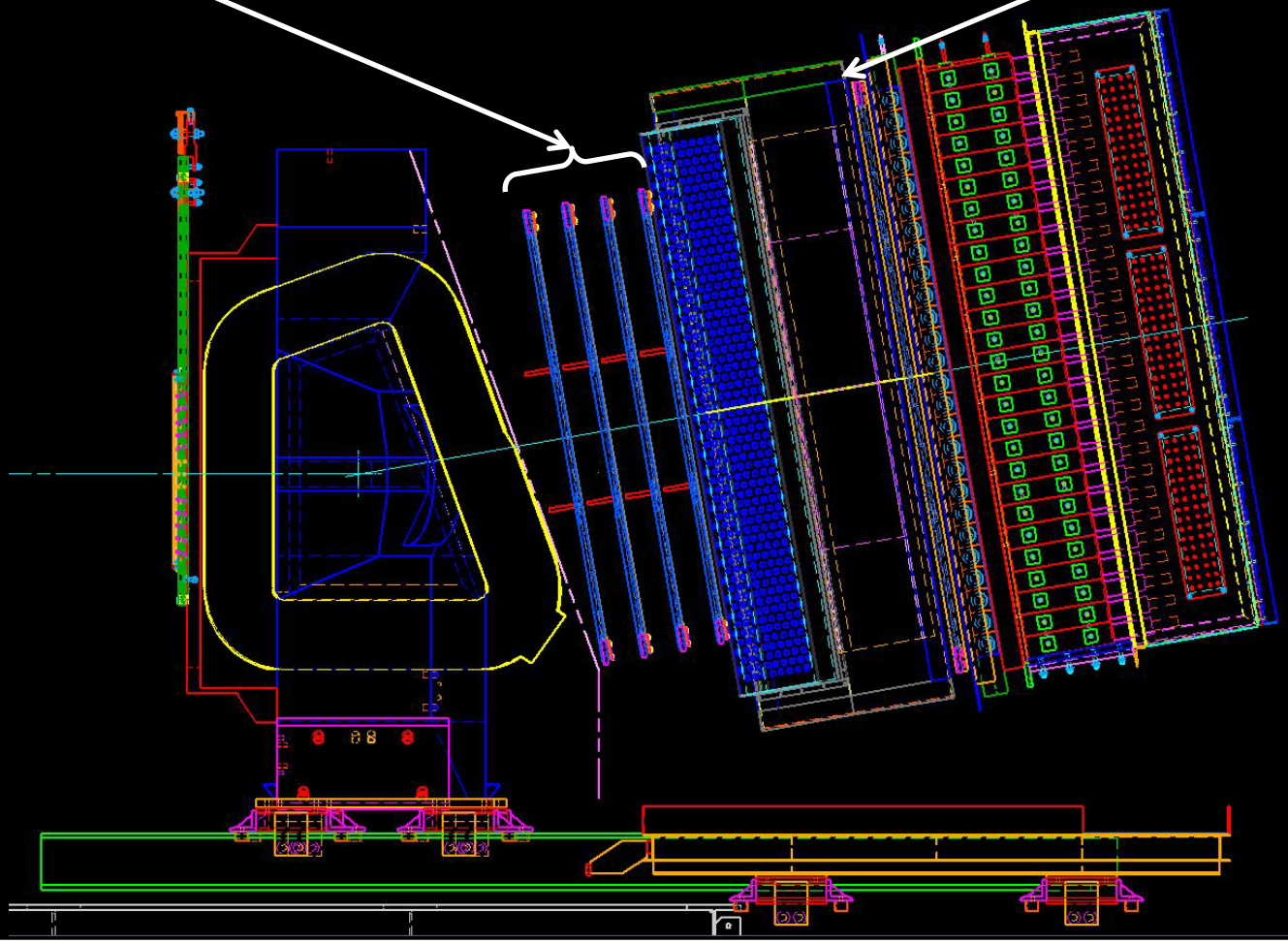


- 6.6 and 8.8 GeV beam 30 μA
- Polarized ^{3}He target 55-60% polarization
- BigBite spectrometer: 45 msr over 50 cm of target:
- Most likely would be a 40 cm target; 30 cm of useful length

A 300 fold increase in FOM compared to 6 GeV experiment

GEM Trackers For BigBite Upgrade

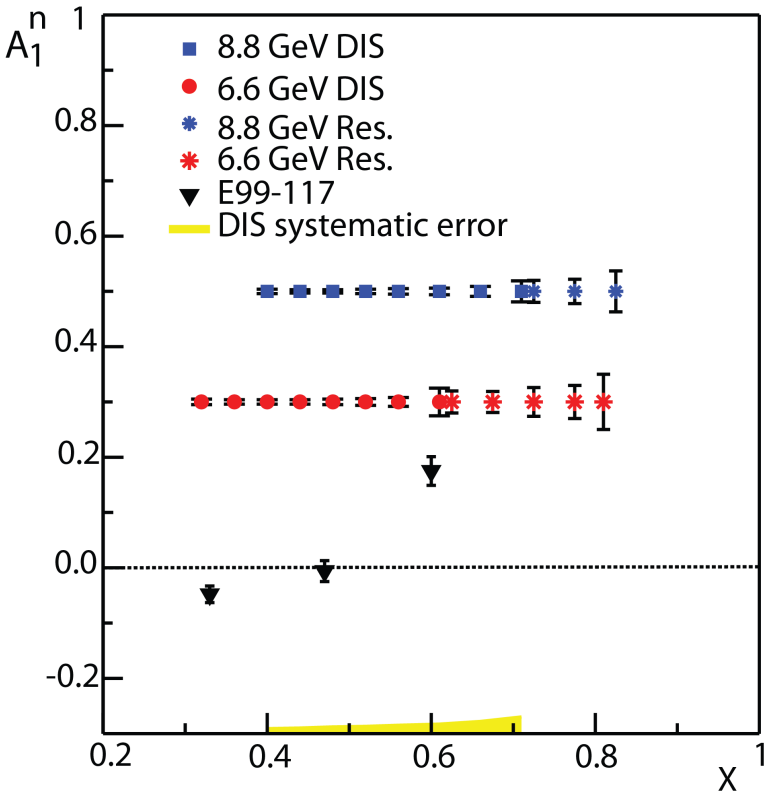
- Front Tracker: 4 chambers 40 × 150 cm^2
  - 12 INFN modules (40 × 50 cm^2)
- Back Tracker: One chamber 50 × 200 cm^2
  - 4 UVa modules (50 × 50 cm^2)

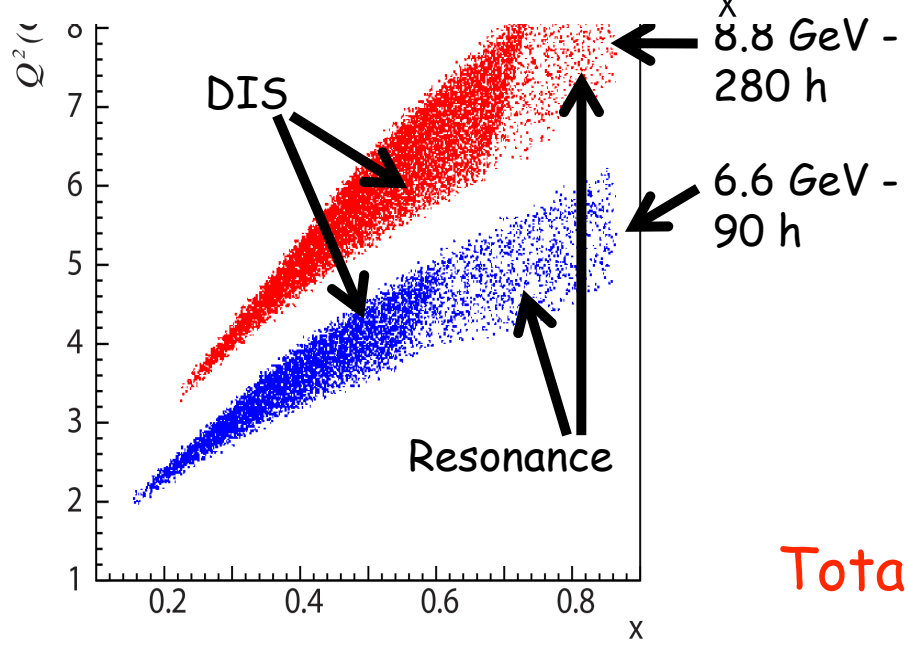


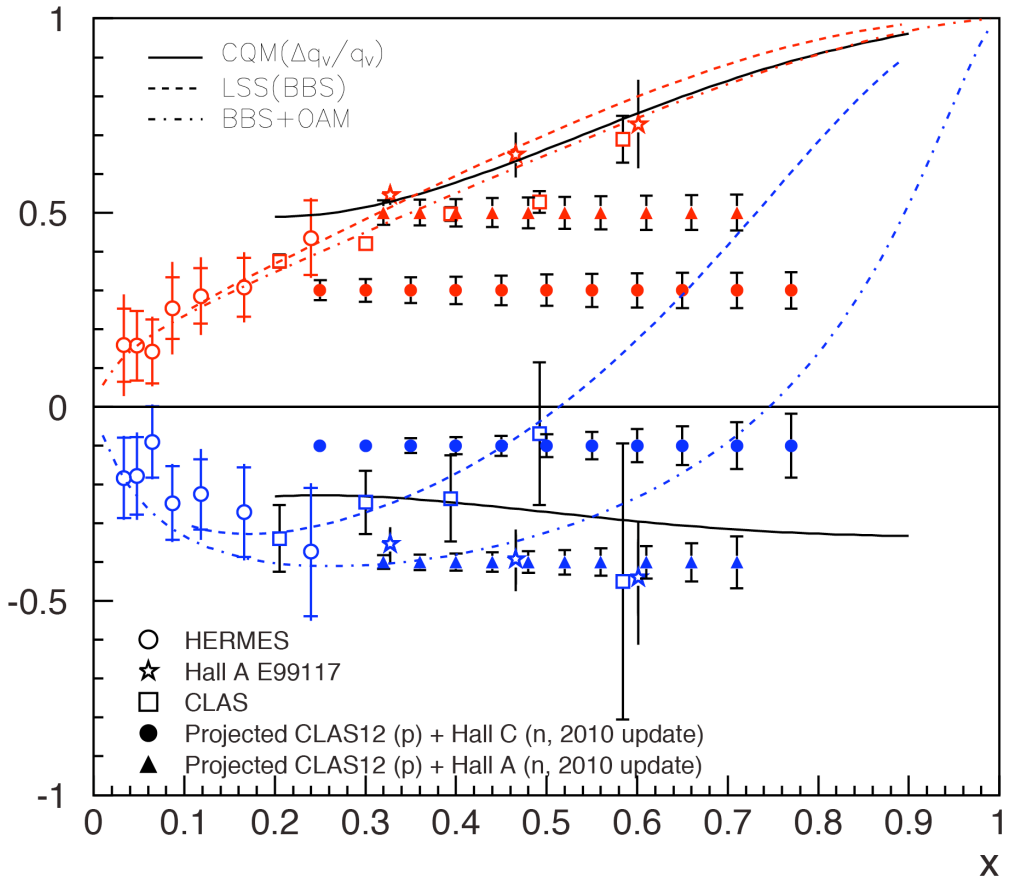
University of Virginia

Jefferson Lab

Projected data for A_1^n

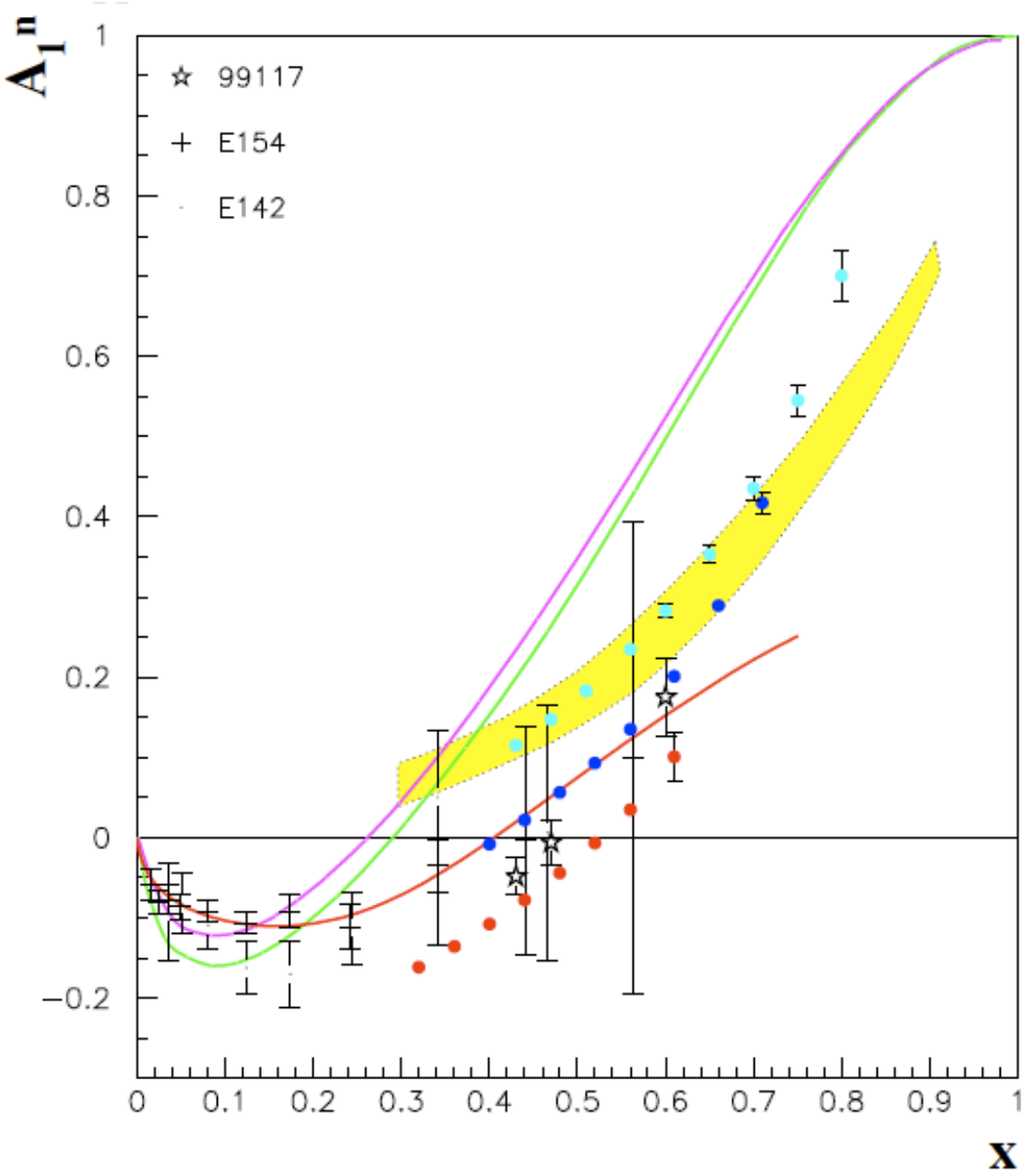






Total : 480 h

Possibilities with Super-Bigbite

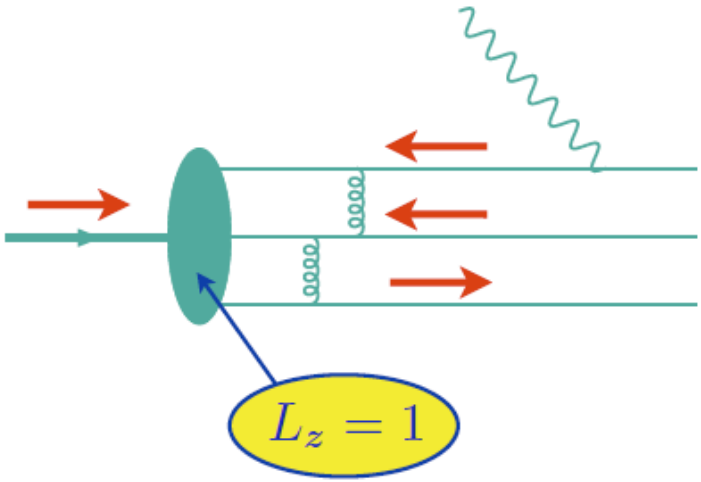


All of this in 500 h

pQCD prediction for Δd/d and quark OAM

- For $L_z = 1$ Fock state, expand hard scattering amplitude in powers of $k_\perp$ ("collinear expansion")

→ logarithmic singularities arise when integrating over longitudinal momentum fractions x_i of soft quarks



→ leads to additional $\log^2(1-x)$ enhancement of $q^\downarrow$

$$q^\downarrow \sim (1-x)^5 \log^2(1-x)$$

*Avakian, Brodsky, Deur, Yuan, PRL **99**, 082001 (2007)*

(similar contributions to positive helicity $q^\uparrow$ are power-suppressed)