New Results on Testing Duality in Spin Structure from Jefferson lab Hall A

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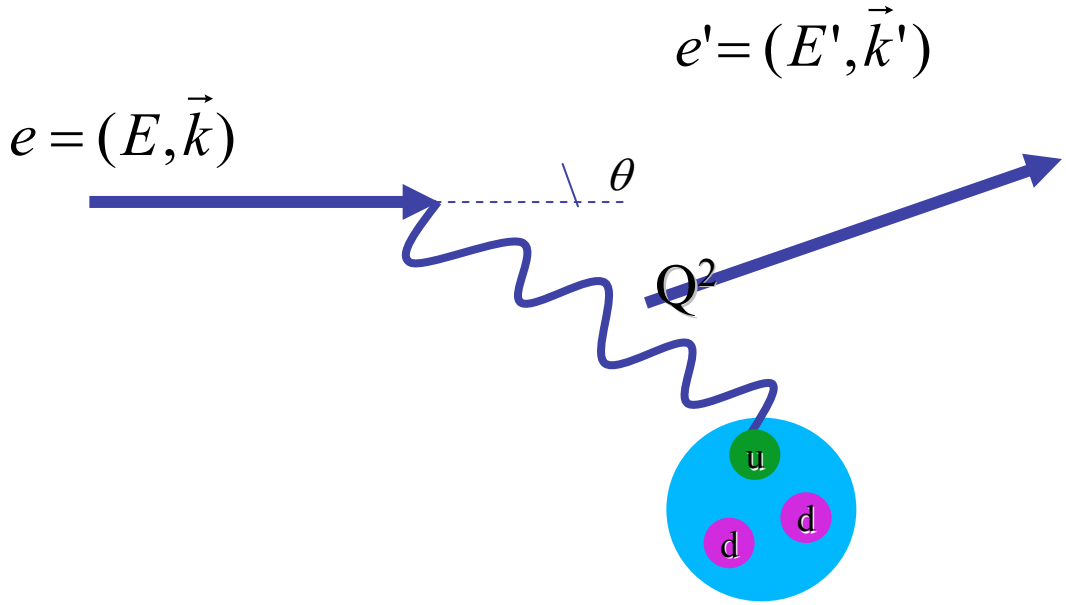
Jefferson Lab Hall A Collaboration

- DoF in the QCD Lagrangian are current quarks and gluons
- But the DoF observed in nature are Hadrons
- To understand hadron structure in QCD -in the confinement region - vital to understand the transition from partonic DoF to Hadronic DoF

Important clues from Quark-Hadron duality

Deep Inelastic Scattering



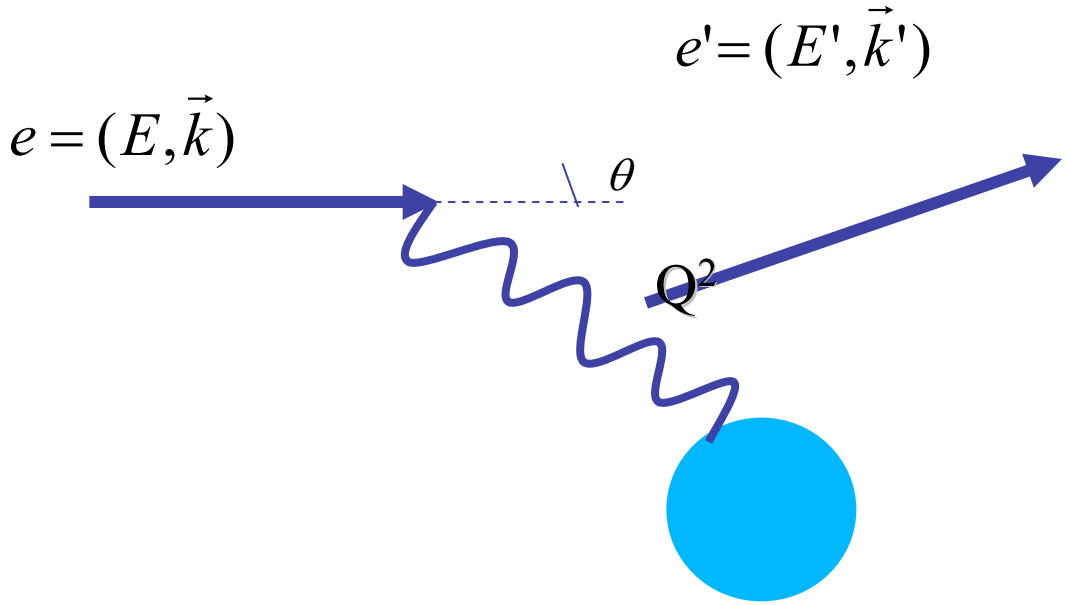
High Q^2 and W>2GeV: fine resolution → we see partons

→ scaling → asymptotic freedom of the strong interaction

→ 2004 Nobel Prize

D. J. Gross, H. D. Politzer and F. Wilczek

Resonance region



Low Q^2 and W<2 GeV : coarse resolution → we don't see partons.

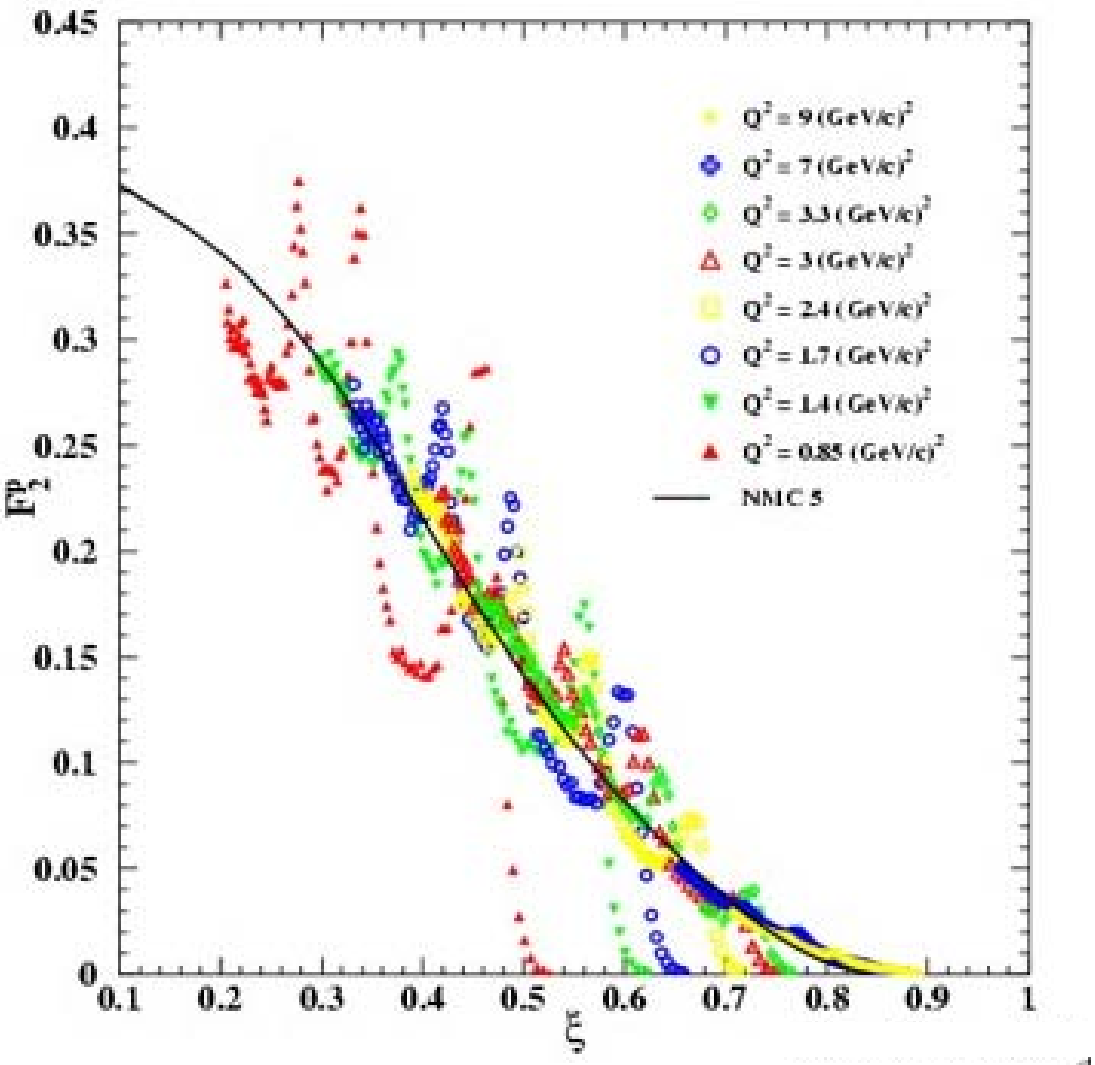
→ The nucleon goes through different excited states: the resonances

DIS versus resonance:

two very different pictures of the nucleon.

Quark-hadron duality

- First observed by Bloom and Gilman in the 1970's on F_2
- Scaling curve seen at high Q^2 is an accurate average over the resonance region at lower Q^2
- Global and Local duality are observed for unpolarized structure functions: F_2



I. Niculescu et al., PRL 85 (2000) 1182

Was duality seen in F^2_p an accident or a global phenomena ?

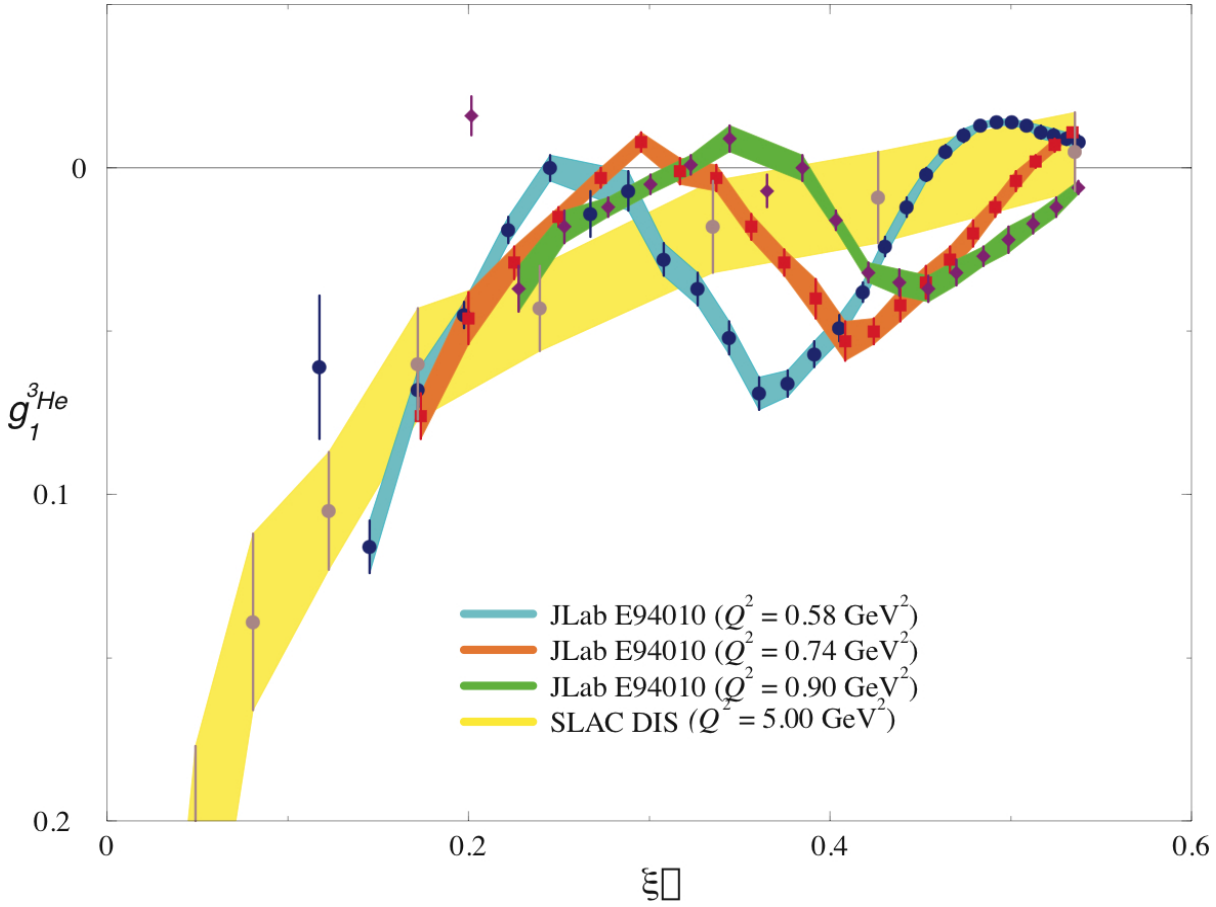
In order to gain a broad-based understanding of duality, need to explore duality in:

- Proton vs. Neutron
- Unpolarized vs. Polarized structure functions
- Duality in ratios of structure functions: R
- Duality in Semi-Inclusive reactions.

New Duality data in these areas are just coming in

Previous data from hall A: E94-010, low Q^2

Indication of duality from Jlab Hall A for $g_1^{^3He}$



The experiment E01-012

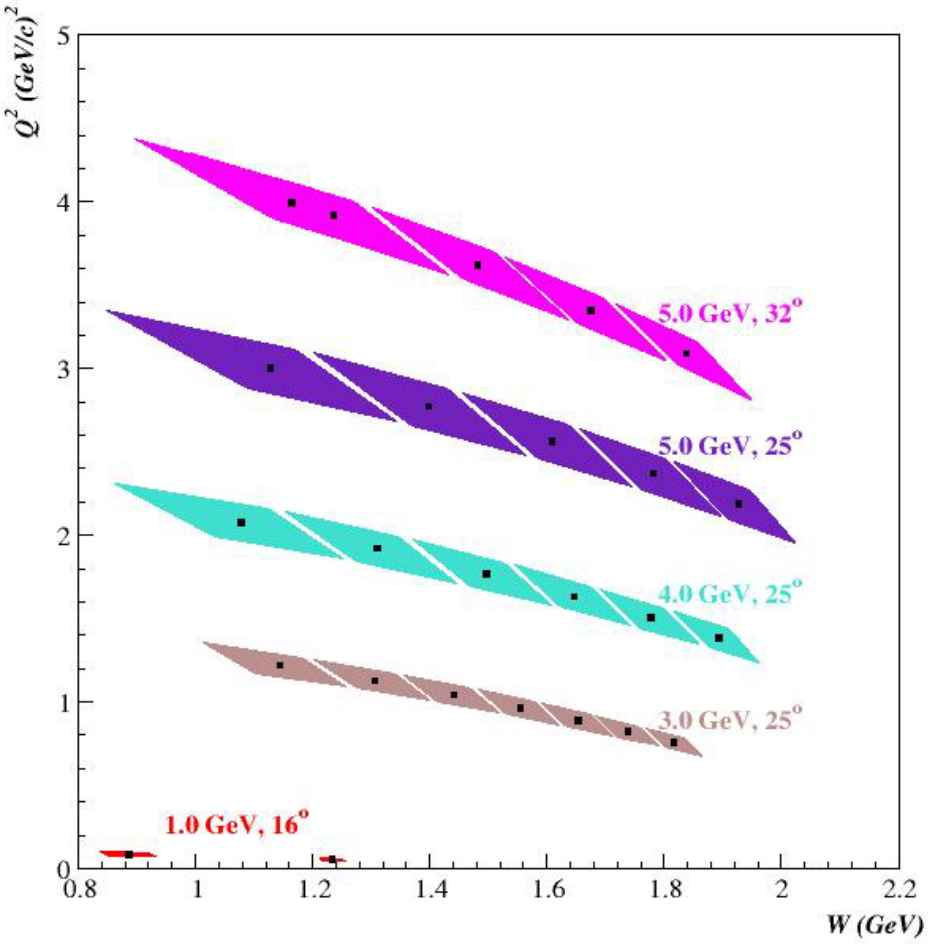
- Ran in Jan.-Feb. 2003

- Inclusive experiment:

$$^3\vec{He}(\vec{e},e')X$$

- Measured polarized cross section differences

- Form g_1 and g_2

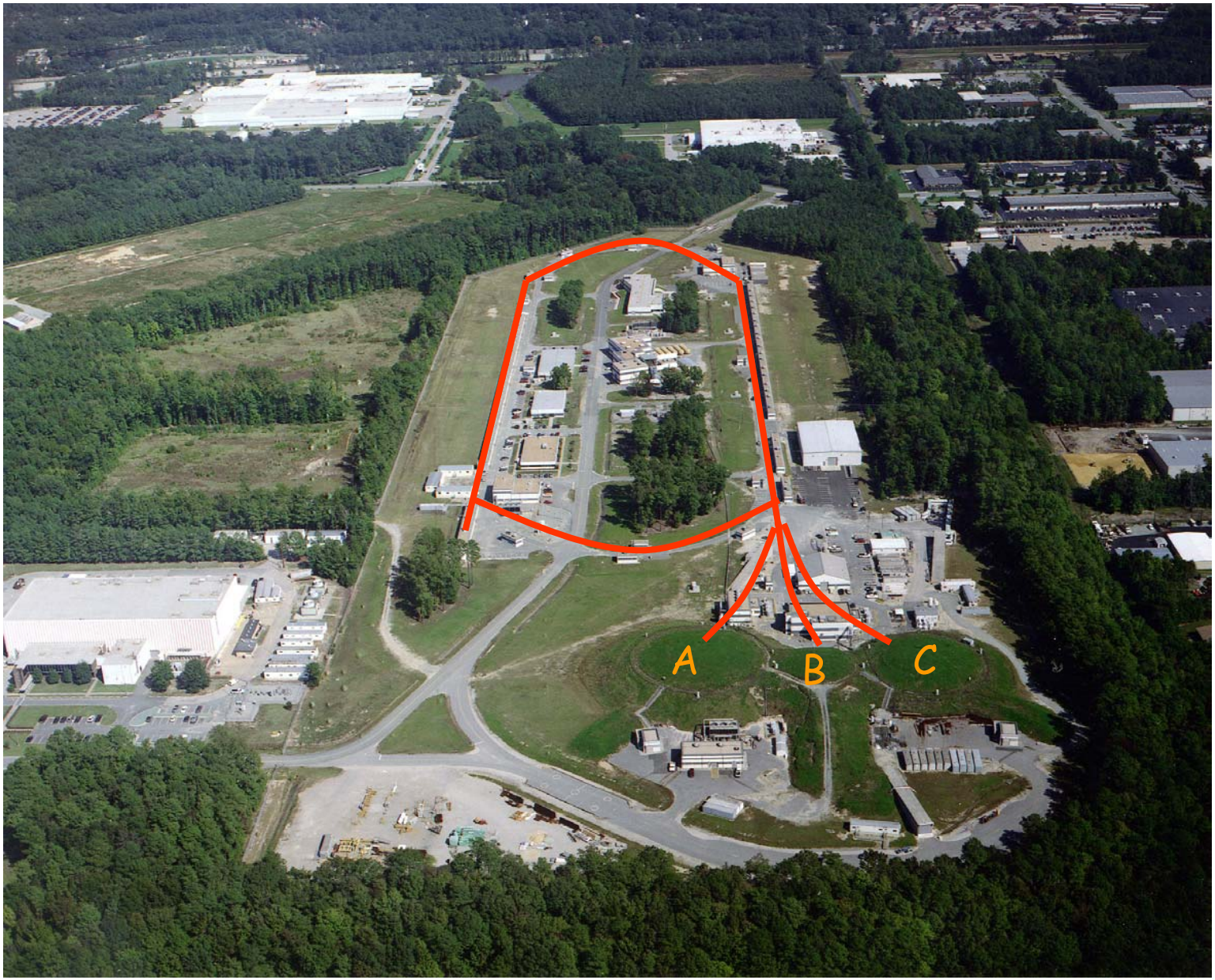


➥ **Test of spin duality on the neutron (and ^{3}He)**

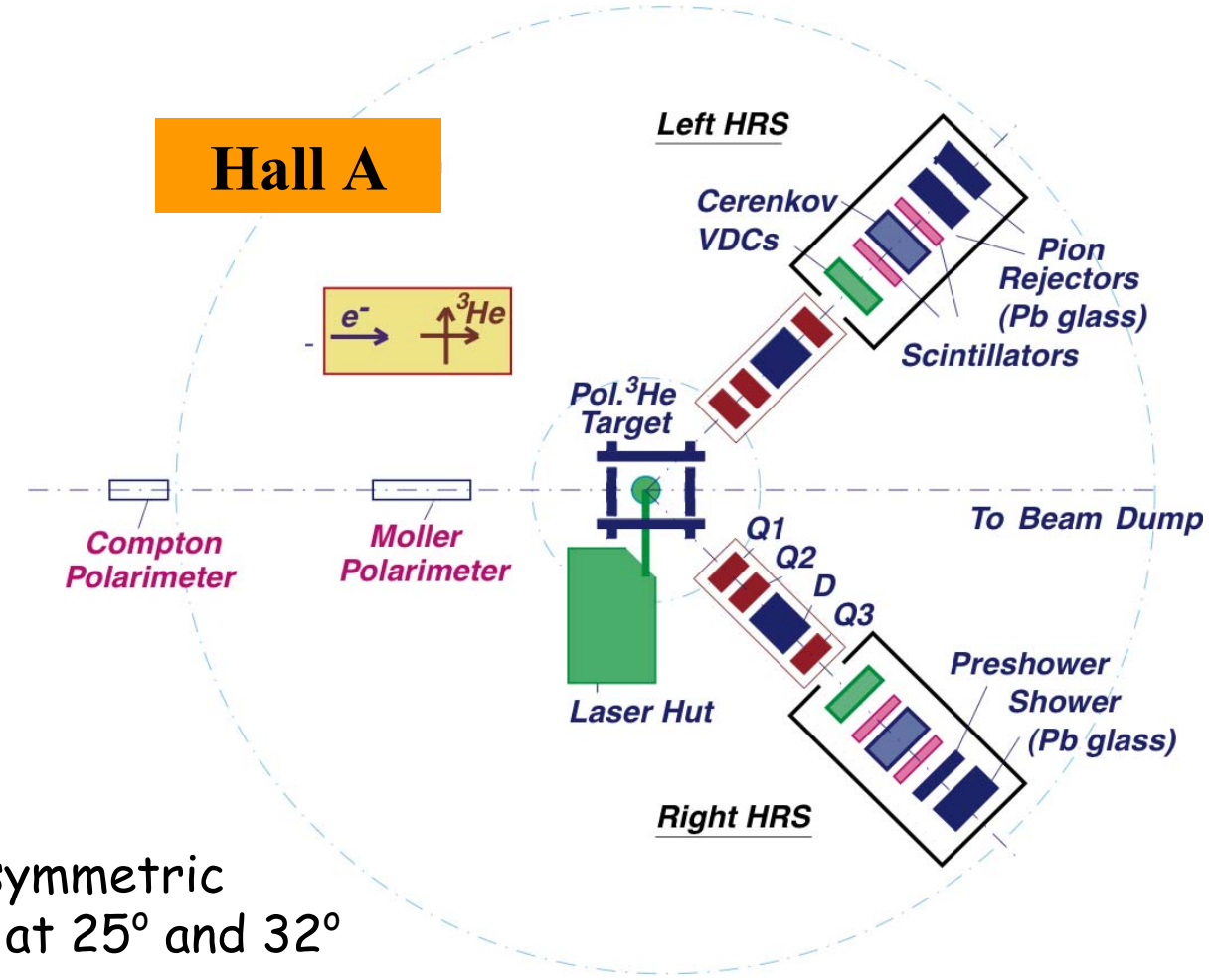
The E01-012 Collaboration

K. Aniol, T. Averett, W. Boeglin, A. Camsonne, G.D. Cates, G. Chang, J.-P. Chen, Seonho Choi, E. Chudakov, B. Craver, F. Cusanno, A. Deur, D. Dutta, R. Ent, R. Feuerbach, S. Frullani, H. Gao, F. Garibaldi, R. Gilman, C. Glashausser, O. Hansen, C. Hyde-Wright, D. Higinbotham, H. Ibrahim, X. Jiang, M. Jones,
A. Kelleher, J. Kelly, C. Keppel, W. Kim, W. Korsch,K. Kramer, G. Kumbartzki, J. LeRose, R. Lindgren, N. Liyanage, B. Ma, D. Margaziotis, P. Markowitz, K. McCormick, Z.-E. Meziani, R. Michaels, B. Moffit, P. Monaghan, C. Munoz Camacho, K. Paschke, B. Reitz, A. Saha, R. Sheyor, J. Singh, K. Slifer, P. Solvignon, V. Sulkosky, A. Tobias, G. Urciuoli, K. Wang, K. Wijesooriya, B. Wojtsekhowski, S. Woo, J.-C. Yang, X. Zheng, L. Zhu
and the Jefferson Lab Hall A Collaboration

The Jefferson Lab Accelerator



Experimental setup



Both HRS in symmetric configuration at 25° and 32°

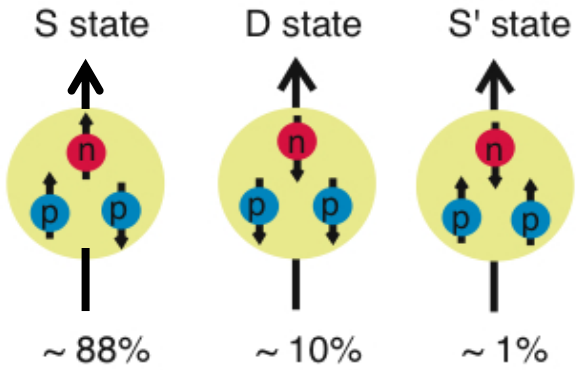
- ➥ double the statistics
- ➥ control the systematics

Particle ID = Cerenkov + EM calorimeter

- ➥ π/e reduced by 10^4

^{3}He as an effective neutron target

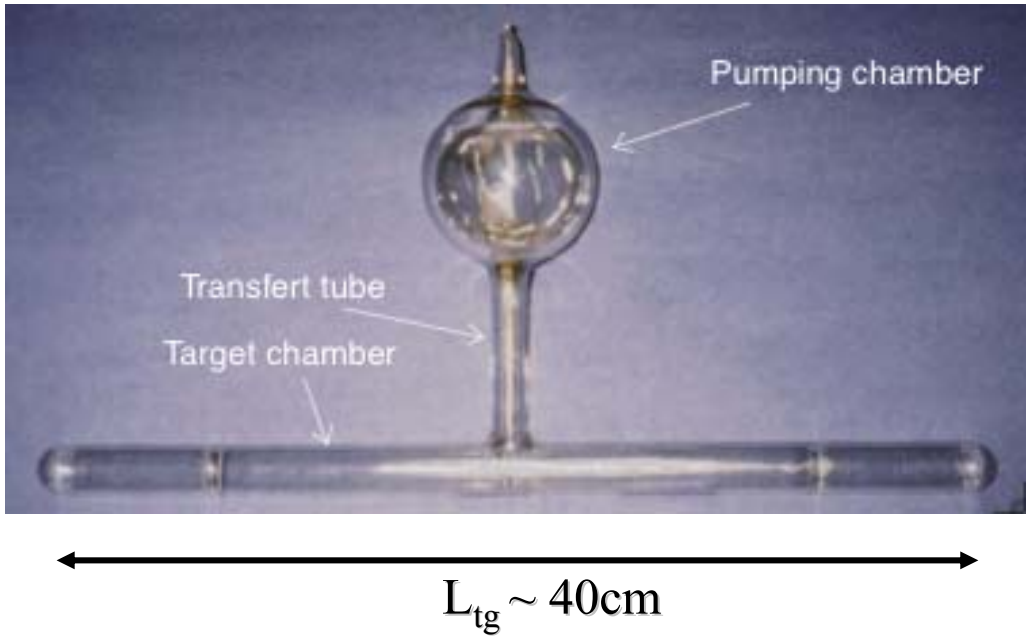
^{3}He as neutron target



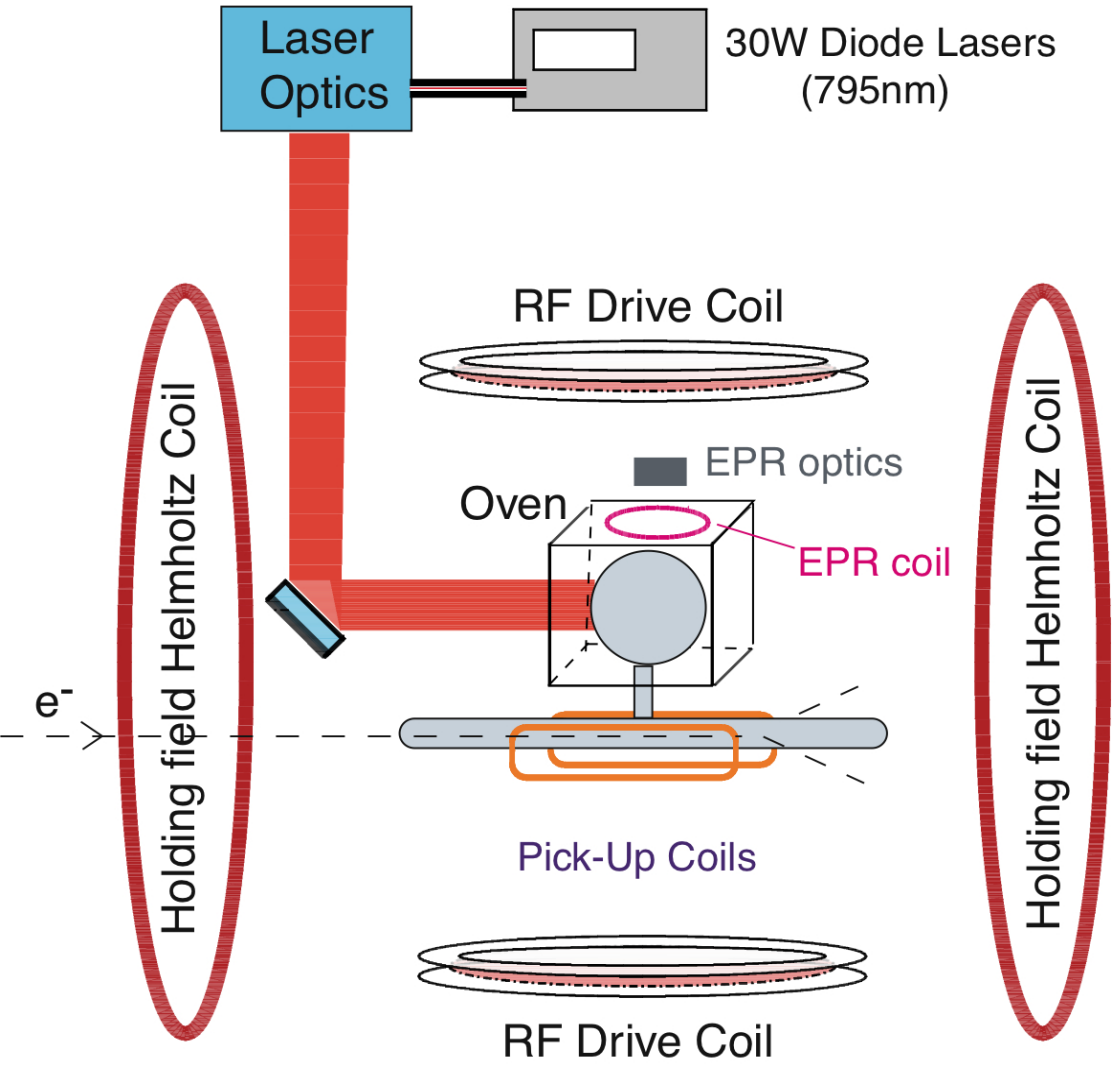
$P_n = 86\%$ and $P_p = -2.8\%$

The polarized ^{3}He target

- Two chamber cell
- Pressure ~ 14 atm under running conditions
- High luminosity: 10^{36} $s^{-1}cm^{-2}$



The polarized ^{3}He system

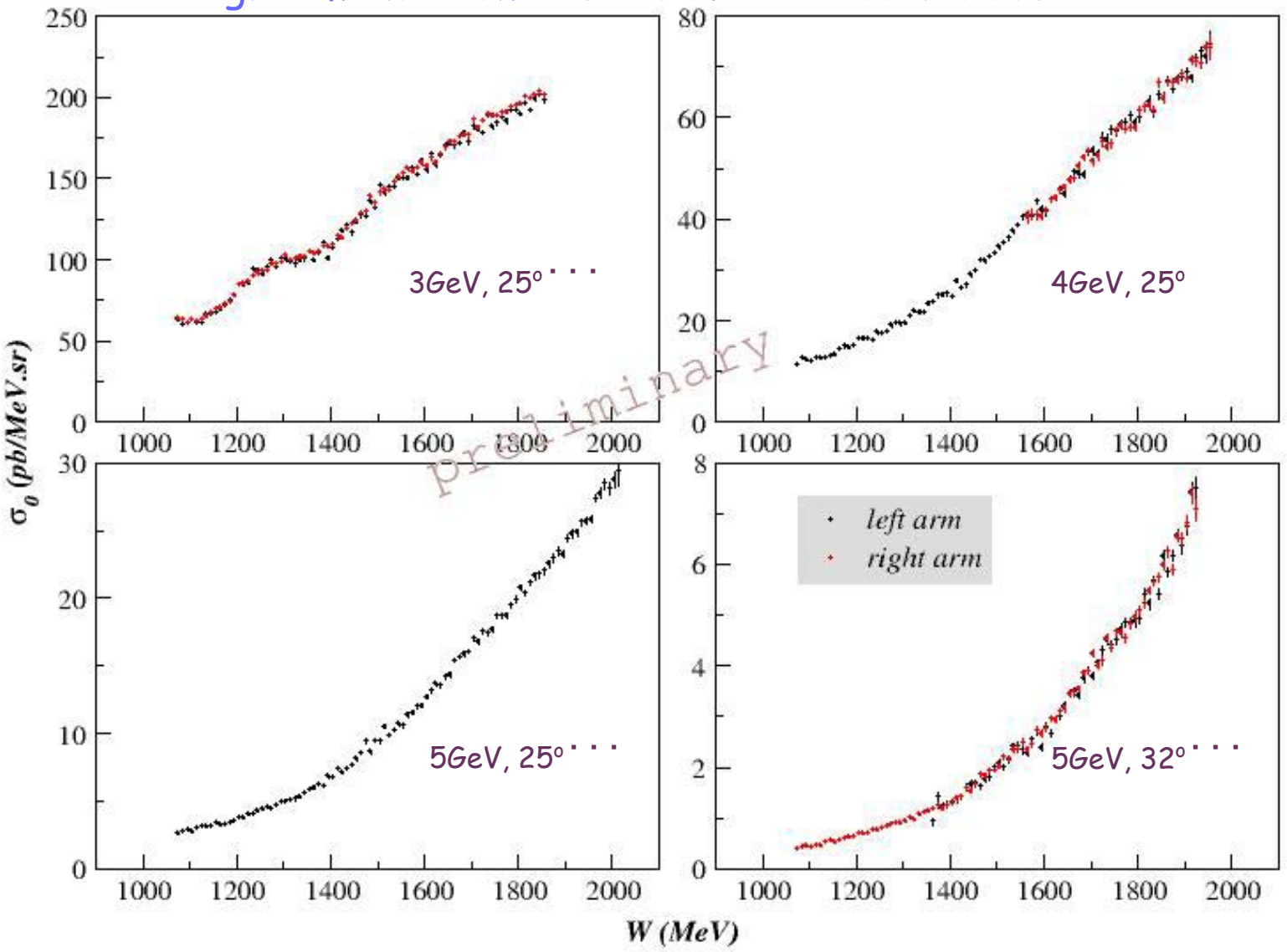


- Longitudinal and transverse configurations

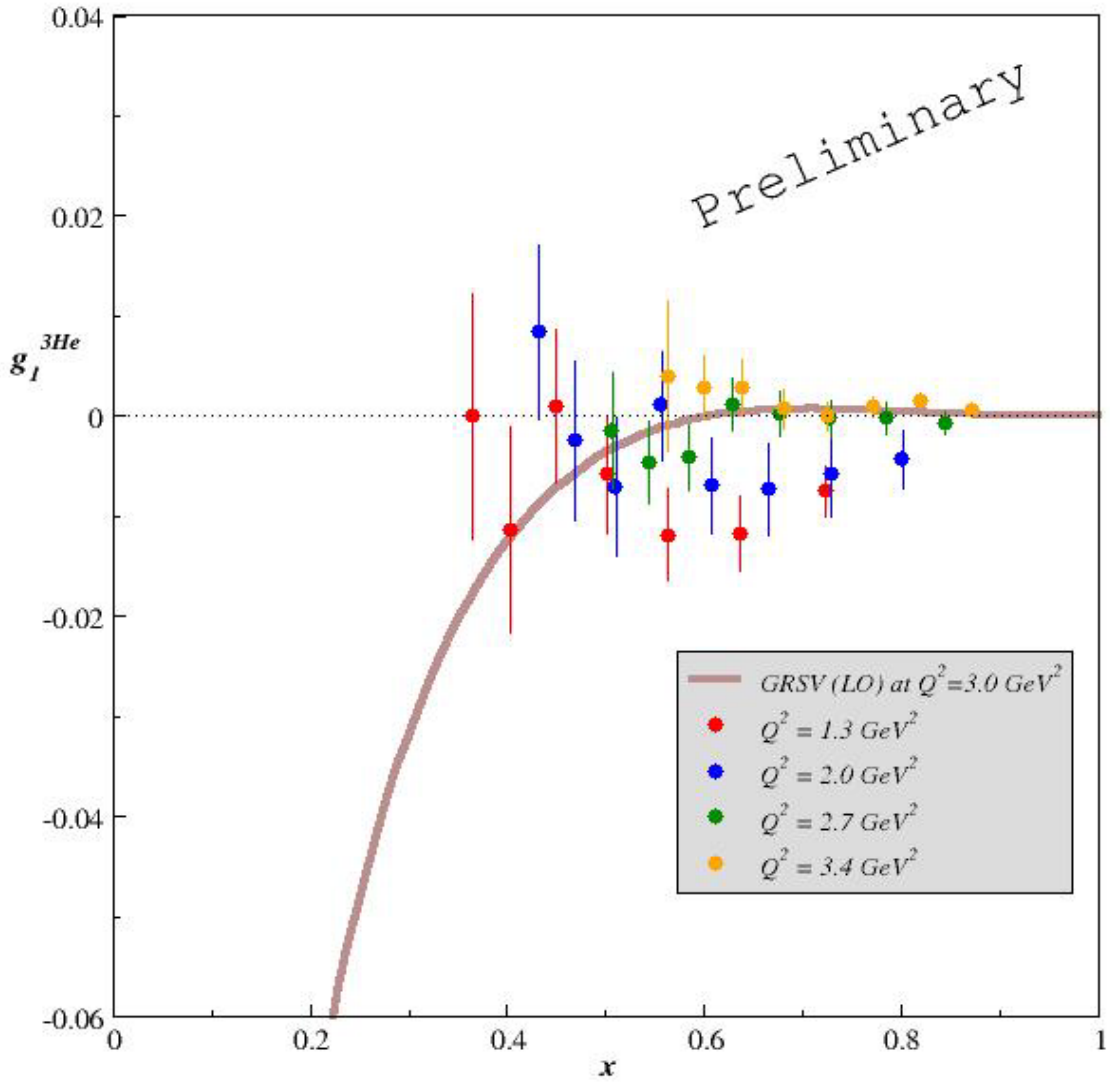
- 2 independent polarimetries: NMR and EPR

Unpolarized cross sections: ^{3}He(ee')

Agreement between both HRS better than 2%



g_1^{3He} at constant Q^2



Virtual Photon-Nucleon Asymmetry

In the parton model:

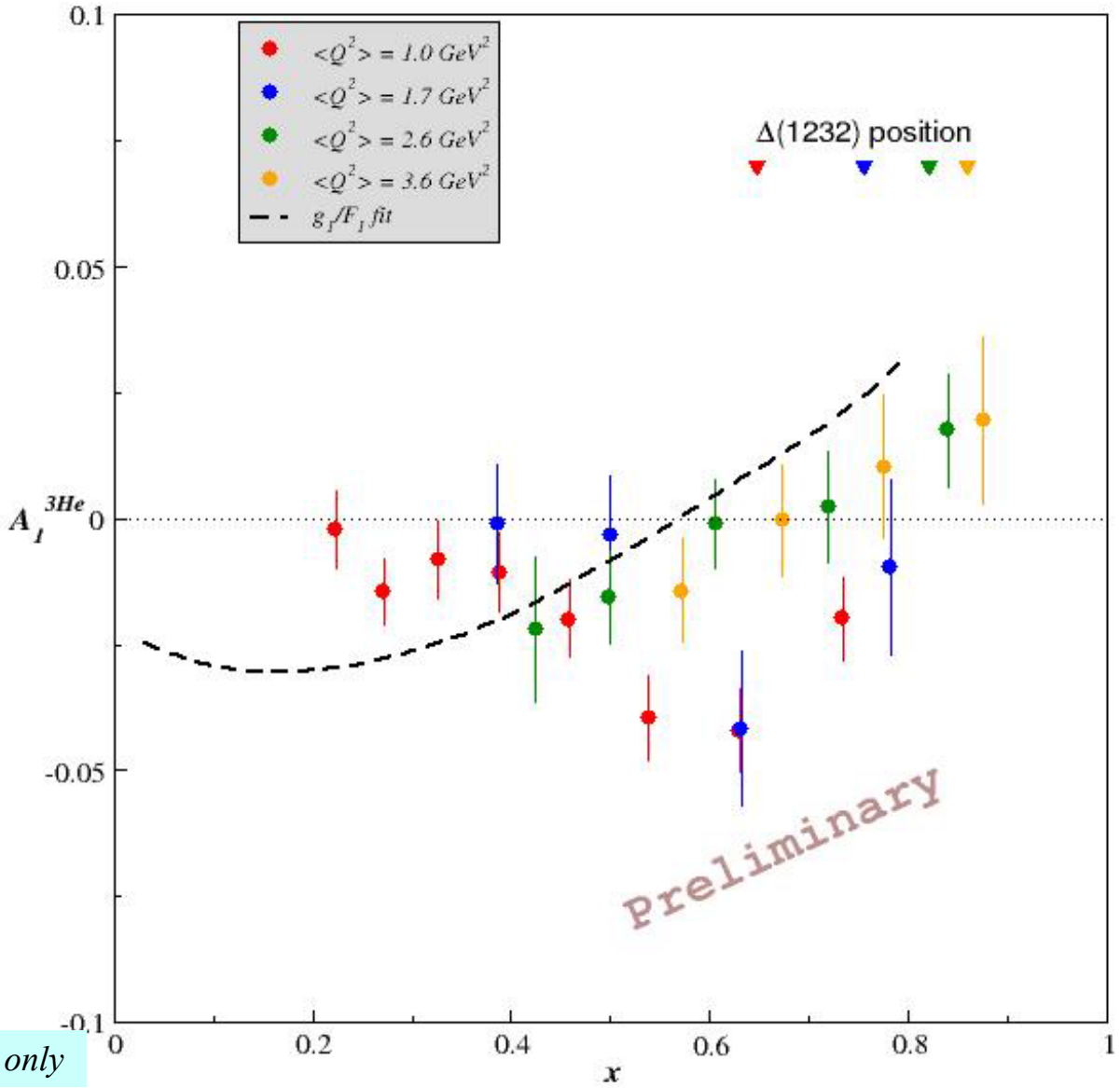
$$A_1(x,Q^2) \approx \frac{g_1(x,Q^2)}{F_1(x,Q^2)}$$

If Q^2 dependence similar for g_1 and for $F_1 \Rightarrow$ weak Q^2 dependence of A_1

From the resonance:

If local duality observed in g_1 and F_1 → $A_1^{res} = A_1^{dis}$

$A_1^{^3He}$



Statistical errors only

Summary

- E01-012 provides precision data of Spin Structure Functions on neutron (^{3}He) in the resonance region for $1.0<Q^2<4.0(GeV/c)^2$

- Direct extraction of g_1 and g_2 from our data

- Overlap between E01-012 resonance data and DIS data

→ First dedicated test of Quark-Hadron Duality for neutron and ^{3}He SSF

→ Final results expected soon