E01-012

Spin Duality Status Report

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Quark-Hadron Duality

- First observed by Bloom and Gilman at SLAC in the 70's on spin independent structure functions

  E.D. Bloom and F.J. Gilman, Phys. Rev. D **4**, 2901 (1971)

- In a certain kinematic region, resonances (*coherent scattering*) average to the scaling curve (*incoherent scattering*).

Duality holds when higher twists are suppressed.

- Why is it important ?
  - → Understanding duality might help us understand confinement.
  - → Study of higher twists.
  - → Structure functions at high x more easily accessible via resonance region.

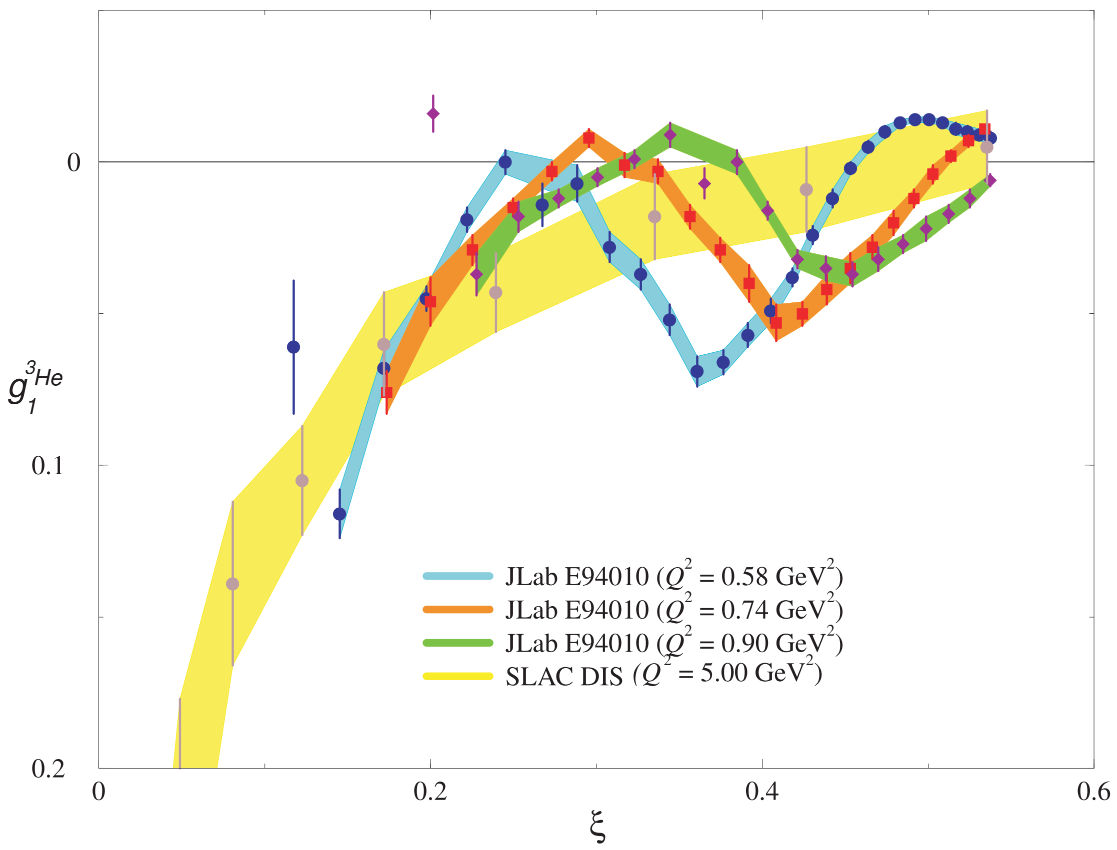
Experimental confirmation

- Confirmation of duality:
  - Hall C for F_2^p

    I. Niculescu et al., Phys. Rev. Lett. **85**, 1186 (2000)

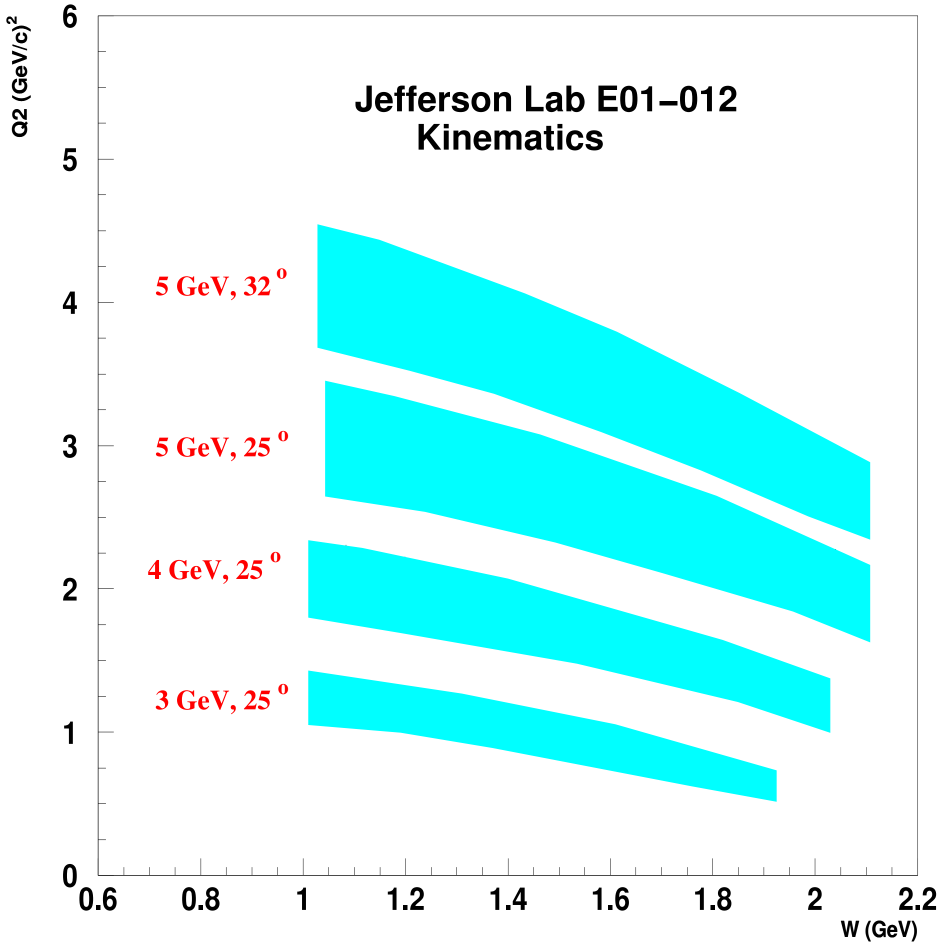
- Indications of duality on spin structure functions:
  - HERMES for A_1^p

    A.Airapetian et al., Phys. Rev. Lett. **90**, 092002 (2003)
  - Hall B for g_1^p and g_1^d
  - Hall A for $g_1^{^3\mathrm{He}}$



The experiment E01-012

- Inclusive experiment: $^3\overrightarrow{\mathrm{He}}(\vec{\mathrm{e}},\mathrm{e}')\mathrm{X}$
- E01-012 measured asymmetries and cross section differences in the resonance region.



- will extract $g_1^{^3\mathrm{He}}$, $g_2^{^3\mathrm{He}}$, $A_1^{^3\mathrm{He}}$ and $A_2^{^3\mathrm{He}}$.
- test duality on the neutron spin structure functions.

Polarized structure functions

→ From asymmetries:

$$A_{\parallel} = \frac{\sigma^{\downarrow\Uparrow} - \sigma^{\uparrow\Uparrow}}{\sigma^{\downarrow\Uparrow} + \sigma^{\uparrow\Uparrow}} \quad \text{and} \quad A_{\perp} = \frac{\sigma^{\downarrow\Rightarrow} - \sigma^{\uparrow\Rightarrow}}{\sigma^{\downarrow\Rightarrow} + \sigma^{\uparrow\Rightarrow}}$$

$$A_1 = \frac{A_{\parallel}}{D(1+\eta\xi)} - \frac{\eta A_{\perp}}{d(1+\eta\xi)}, \quad A_2 = \frac{\xi A_{\parallel}}{D(1+\eta\xi)} + \frac{A_{\perp}}{d(1+\eta\xi)}$$

→ From cross sections:

$$g_1 = \frac{MQ^2\nu}{4\alpha_e^2}\frac{E}{E'}\frac{1}{E+E'}\left[\Delta\sigma_{\parallel} + tan(\frac{\theta}{2})\Delta\sigma_{\perp}\right]$$

$$g_2 = \frac{MQ^2\nu^2}{4\alpha_e^2}\frac{1}{2E'(E+E')}\left[-\Delta\sigma_{\parallel} + \frac{E+E'cos\theta}{E'sin\theta}\Delta\sigma_{\perp}\right]$$

$$A_1 = \frac{g_1 - \gamma^2 g_2}{F_1} \quad \text{and} \quad A_2 = \frac{\gamma[g_1+g_2]}{F_1}$$

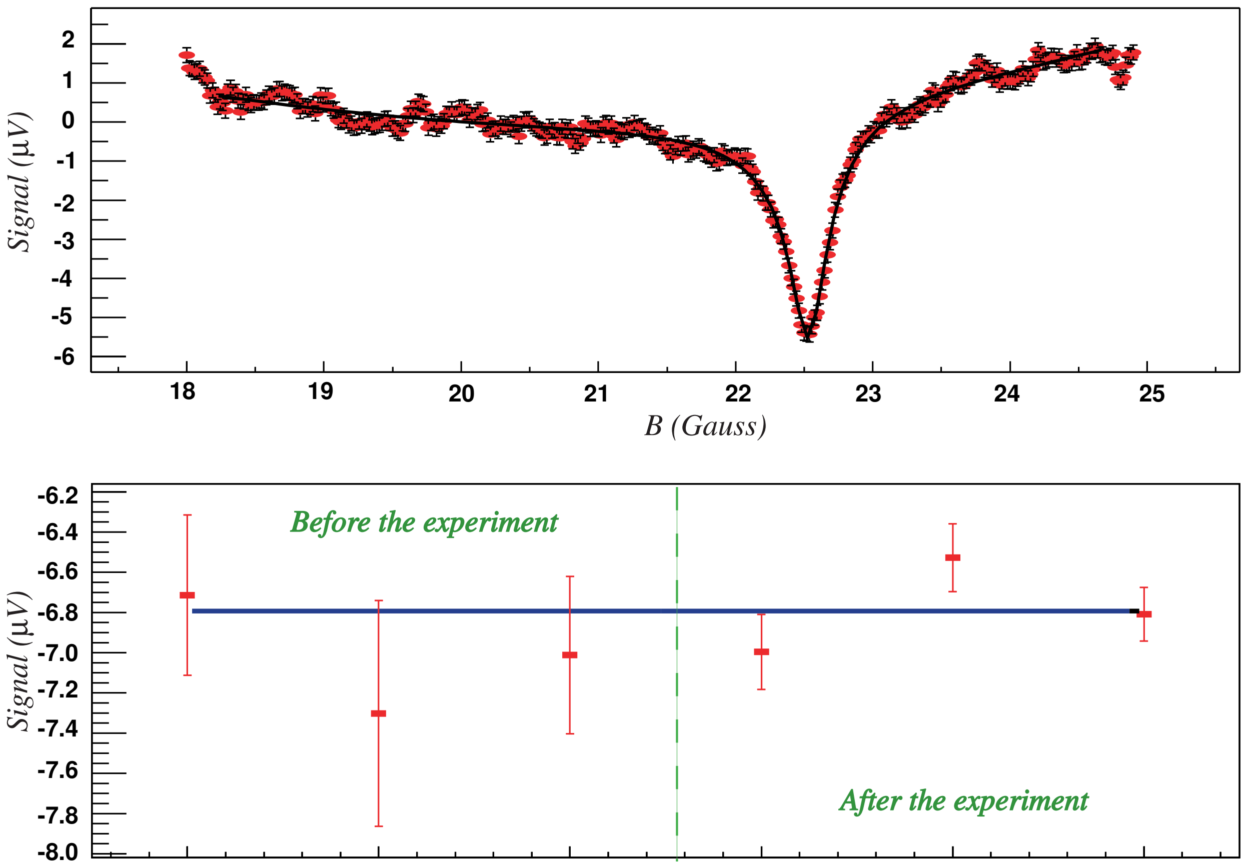
Analysis update

Target analysis

→ NMR polarimetry calibration by measuring the thermal polarization of the proton in water.

→ Analysis done by V. Sulkosky.

→ Water calibration: major contributor to ^{3}He NMR polarimetry uncertainties.

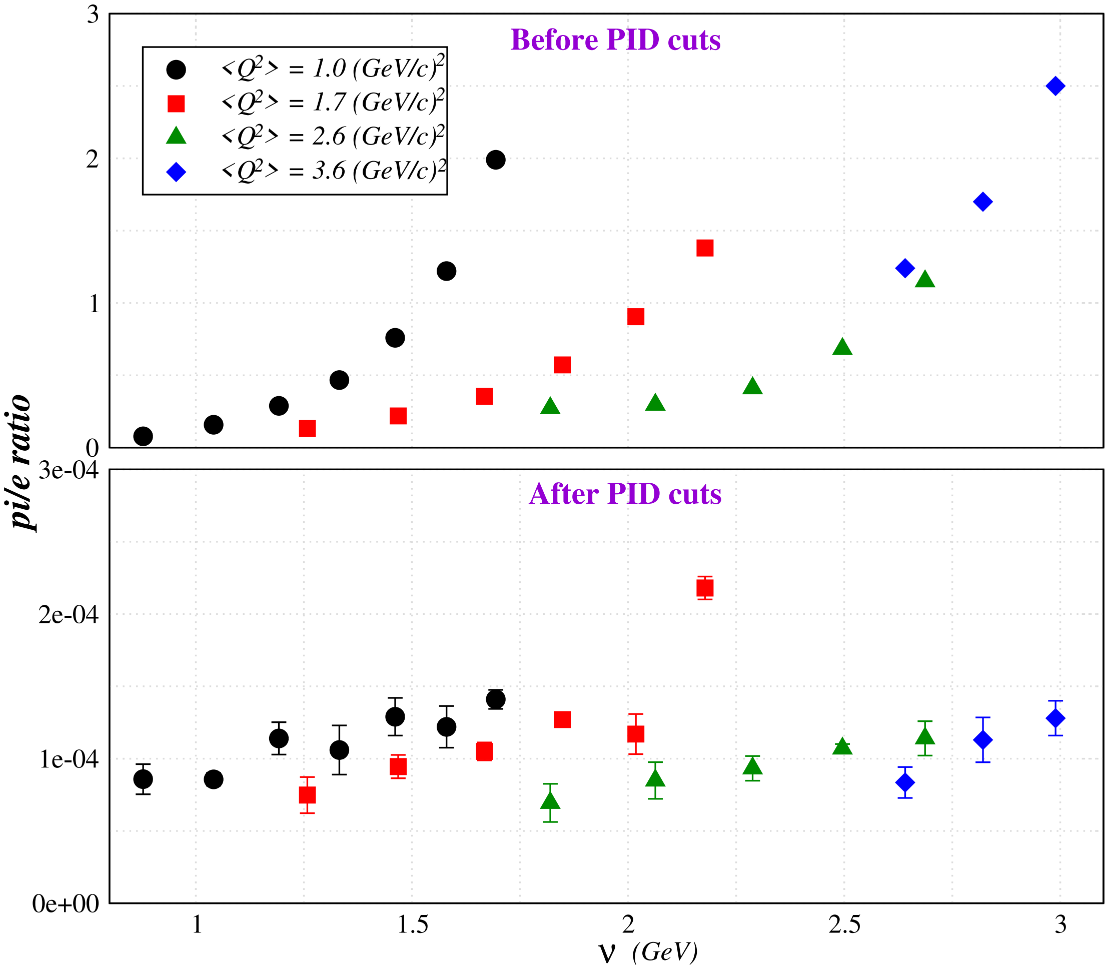


→ Target polarization ~ 37% in beam (from on-line NMR and EPR).

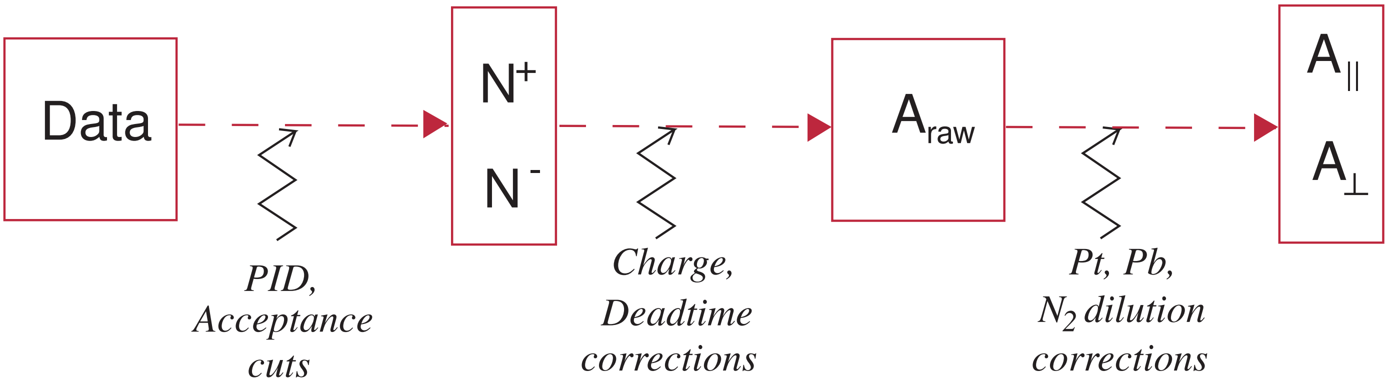
PID performance

$\rightarrow$ π/e^- ratio reduced by a factor better than 10^4.

$\rightarrow$ electron efficiency $> 99\%$ for all kinematics.



From data to asymmetries



$$A^{raw}_{\parallel,\perp} = \frac{N^{-}_{corr.} - N^{+}_{corr.}}{N^{-}_{corr.} + N^{+}_{corr.}}$$

$$A^{phys}_{\parallel,\perp} = \frac{A^{raw}_{\parallel,\perp}}{f_{N_2}.P_{beam}.P_{targ}}$$

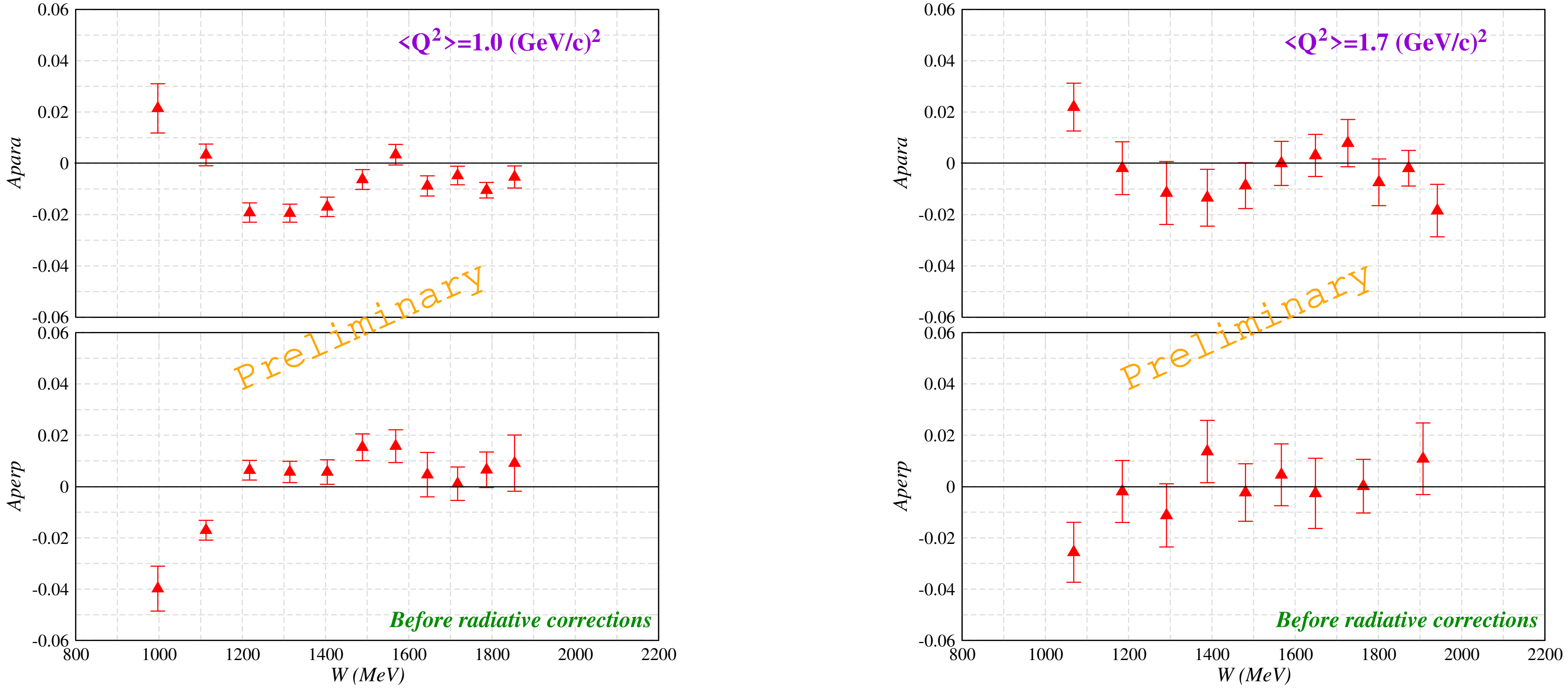
In the following:

$\rightarrow$ Nitrogen dilution ~ 0.94

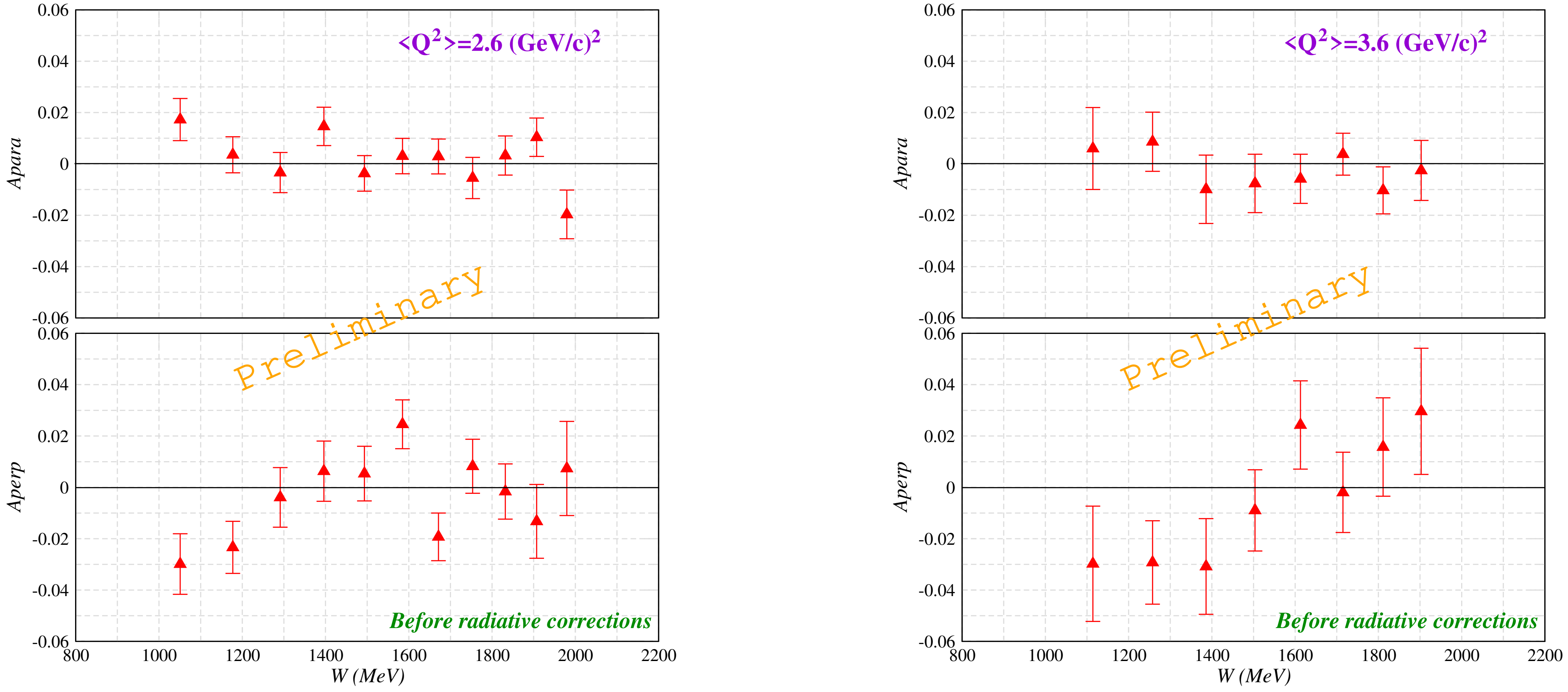
$\rightarrow$ Extract A_1 and A_2 from $A_{\parallel}$ and $A_{\perp}$ for ^{3}He

$\rightarrow$ Radiative corrections not applied yet

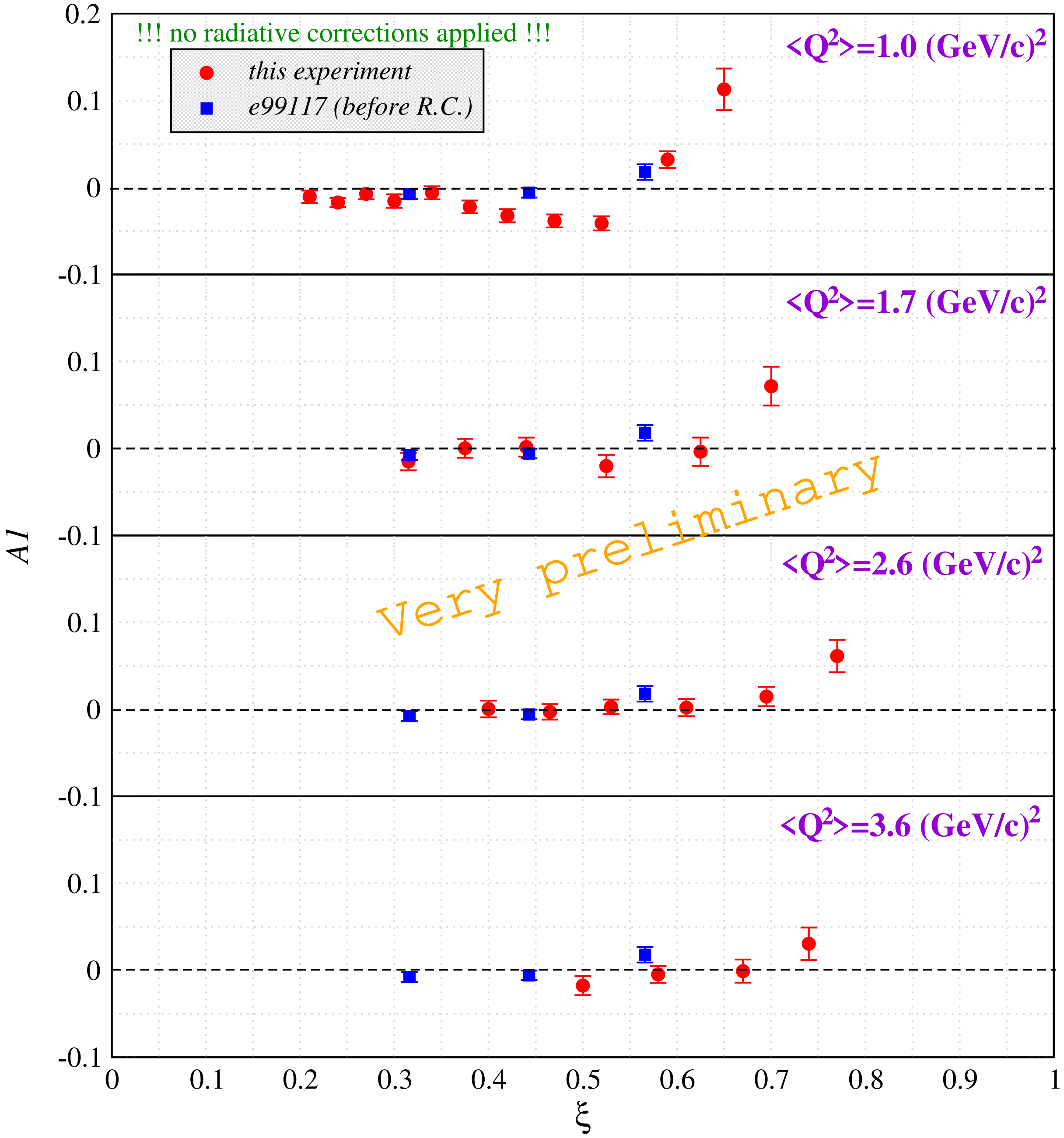
$A_{\parallel}$ and $A_{\perp}$ (^3He)



$A_{\parallel}$ and $A_{\perp}$ (^3He)

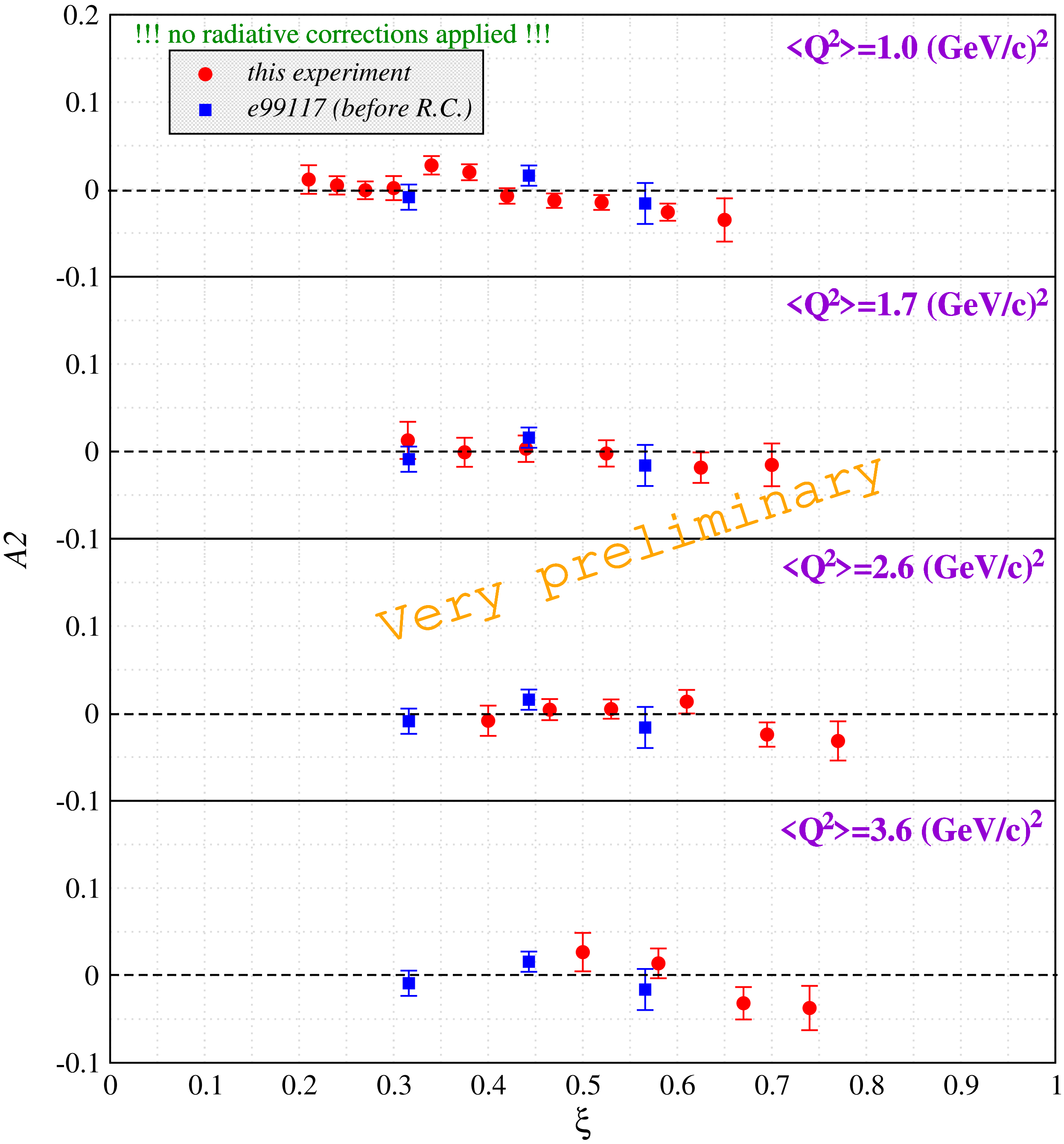


A_1 for ^3He



!!! no radiative corrections applied !!!
this experiment
e99117 (before R.C.)
<Q²>=1.0 (GeV/c)²
<Q²>=1.7 (GeV/c)²
<Q²>=2.6 (GeV/c)²
<Q²>=3.6 (GeV/c)²
Very preliminary
A1
ξ

A_2 *for* ^3He



!!! no radiative corrections applied !!!
this experiment
e99117 (before R.C.)
<Q²>=1.0 (GeV/c)²
<Q²>=1.7 (GeV/c)²
<Q²>=2.6 (GeV/c)²
<Q²>=3.6 (GeV/c)²
Very preliminary
A2
ξ
0.2
0.1
0
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Summary of the data analysis

Work done

- → Water calibration analysis near completion.
- → Nitrogen dilution analysis.
- → Second pass asymmetries.
- → Preliminary A_1 and A_2 for ^{3}He (no rad. cor.).

To do

- → Finalize target analysis (NMR and EPR).
- → Extract cross sections.
- → Radiative corrections.
- → Extract g_1^n and A_1^n.