The g_2^p Experiment

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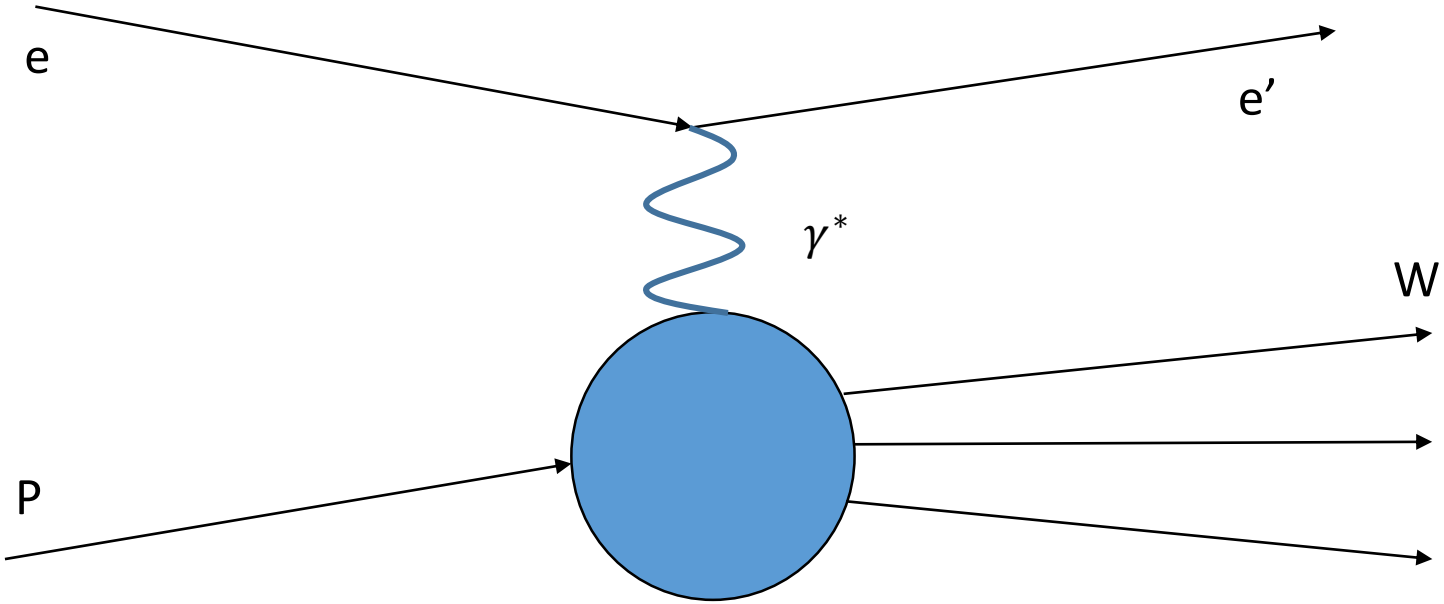
The University of New Hampshire
On Behalf of the E08-027 Collaboration

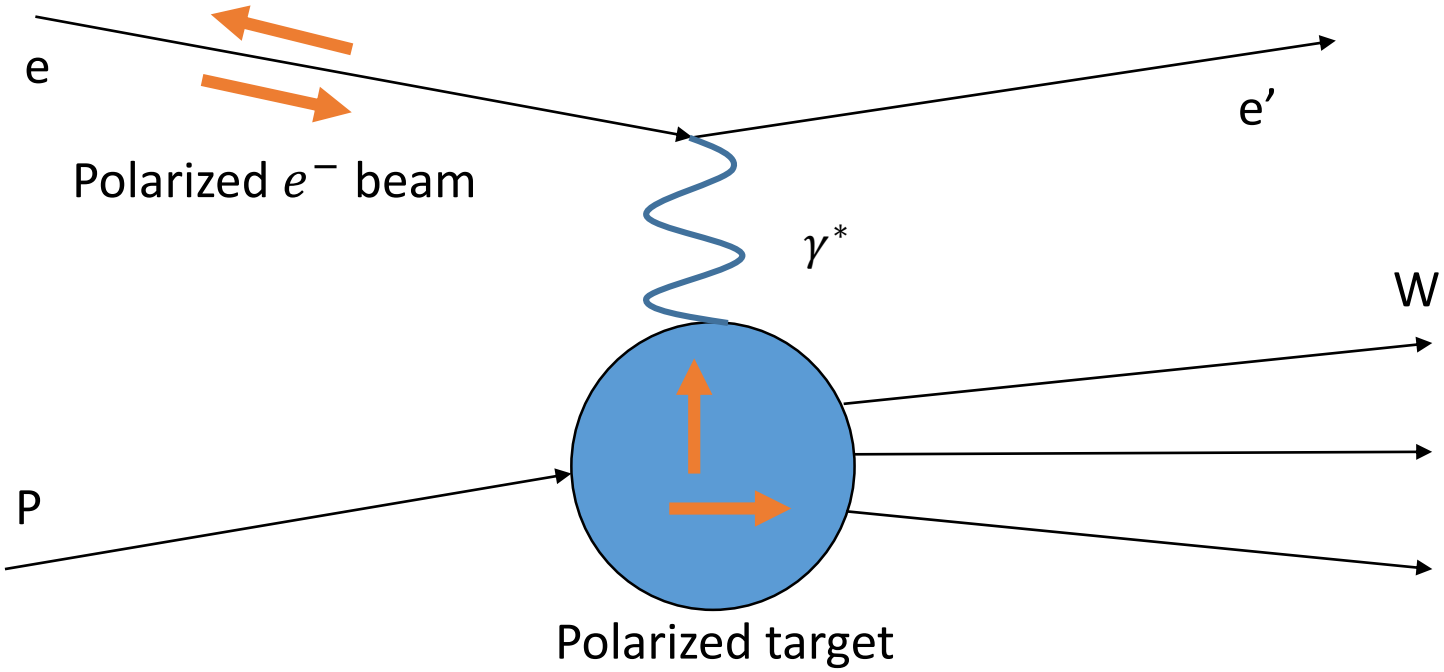
Inclusive Electron Scattering



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

Unpolarized nucleon structure functions.

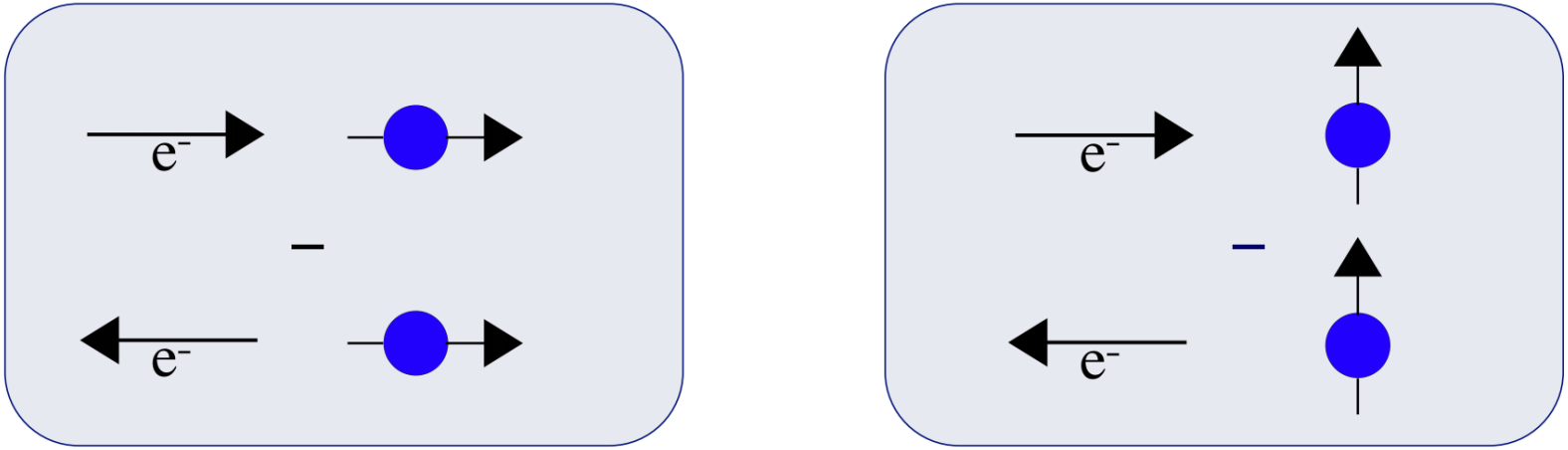
Inclusive Electron Scattering



$$\frac{d\sigma}{d\Omega dE'} = \sigma_{Mott}\left[\frac{1}{\nu}F_2(x,Q^2) + \frac{2}{M}F_1(x,Q^2)tan^2\frac{\theta}{2} + \gamma g_1(x,Q^2) + \delta g_2(x,Q^2)\right]$$

Polarized nucleon spin structure functions.

Inclusive Electron Scattering



$$\Delta\sigma_{\parallel} = \frac{d^2\sigma^{\uparrow\Uparrow}}{d\Omega dE} - \frac{d^2d^{\downarrow\Uparrow}}{d\Omega dE} \propto \alpha g_1(x,Q^2) - \beta g_2(x,Q^2)$$

$$\Delta\sigma_{\perp} = \frac{d^2\sigma^{\uparrow\Rightarrow}}{d\Omega dE} - \frac{d^2d^{\downarrow\Rightarrow}}{d\Omega dE} \propto \gamma g_1(x,Q^2) + \delta g_2(x,Q^2)$$

Inclusive Electron Scattering

$$g_1(x, Q^2) \propto \Delta\sigma_{\parallel} + \tan\frac{\theta}{2}\Delta\sigma_{\perp}$$

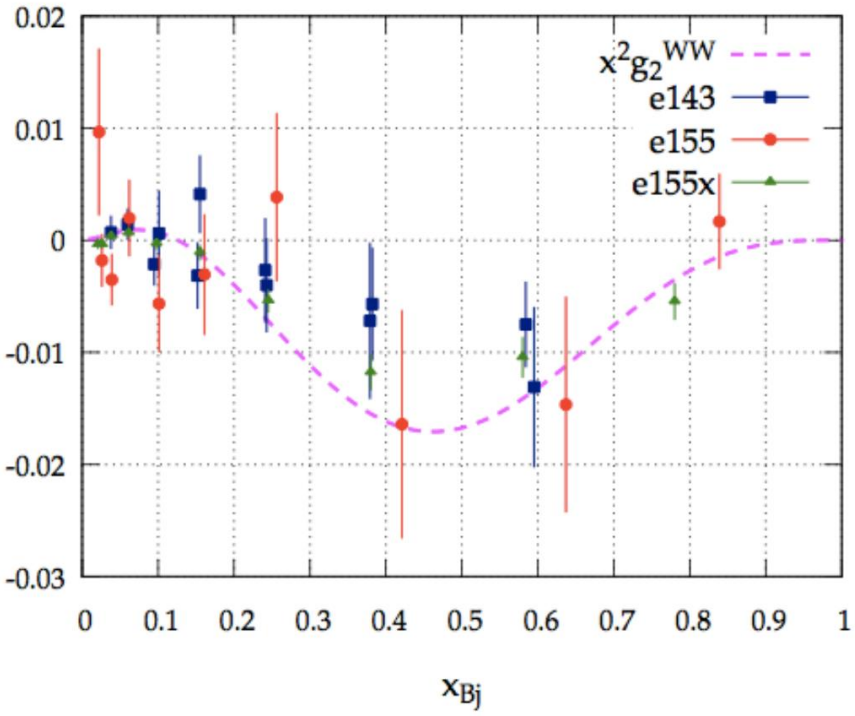
$$g_2(x, Q^2) \propto -\Delta\sigma_{\parallel} + \frac{1 + (1-y)\cos\theta}{(1-y)\sin\theta}\Delta\sigma_{\perp}$$

- $\Delta\sigma_{\parallel}$ is highly suppressed in the kinematic range where we are measuring g_2 (2-8% of total contribution to g_2).
- For kinematic settings where we will not measure $\Delta\sigma_{\parallel}$, EG4 data will be combined with our $\Delta\sigma_{\perp}$ data to calculate g_2.

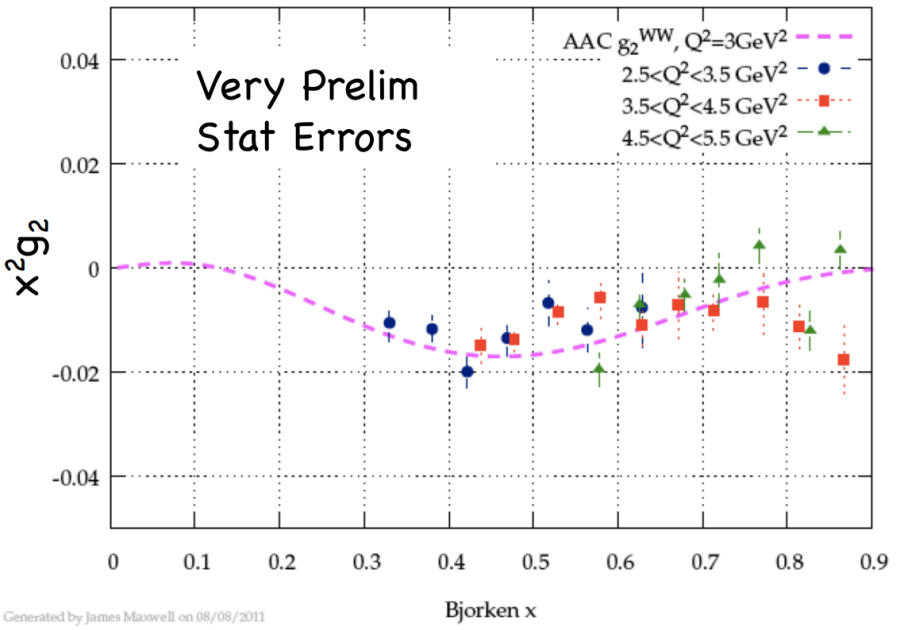
Motivation

- Measure the proton structure function, g_2, in the low Q^2 region for the first time.

SLAC



JLAB SANE



Motivation

- Measure the proton structure function, g_2, in the low Q^2 region for the first time.

- Provides a unique opportunity to test the Burkhardt-Cottingham Sum Rule in the low Q^2 region.

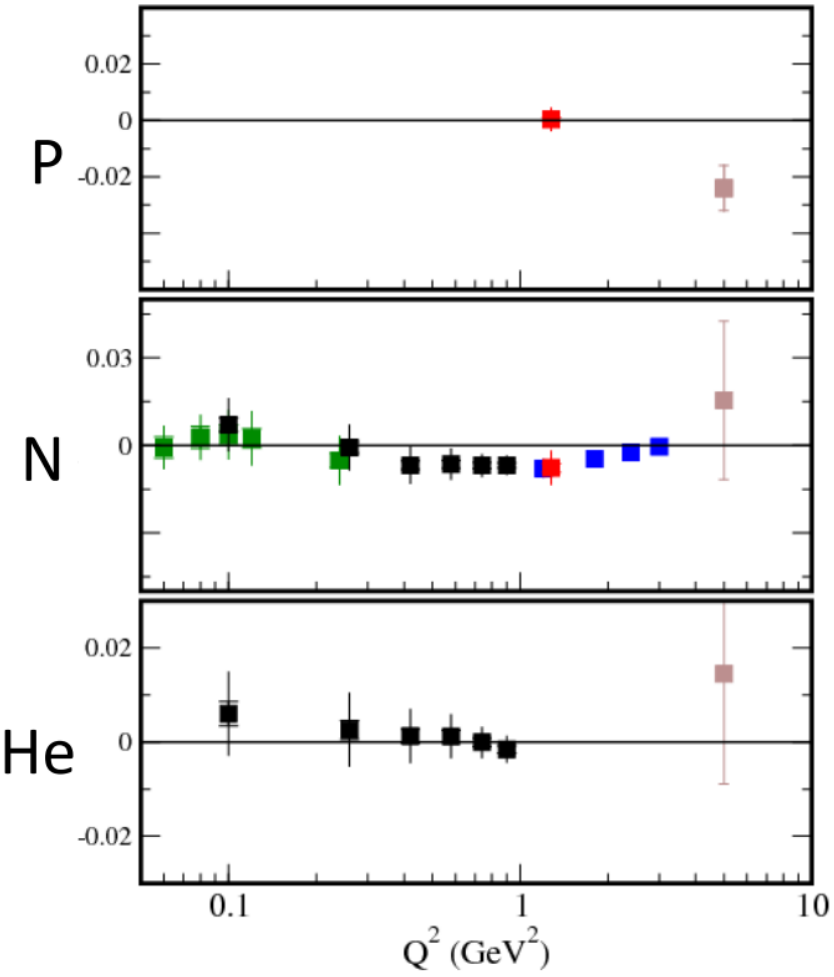
Motivation

Brown: SLAC E155x
Red: Hall C RSS
Black: Hall A E94-010
Green: Hall A E97-110
Blue: Hall A E01-012

The 0^{th} moment of g_2 should satisfy (for all Q^2):

$$\int_0^1 g_2(x, Q^2)\, dx = 0$$

- Good agreement with existing Neutron data.
- Some disagreement with existing proton data.
- More proton data is needed.



Motivation

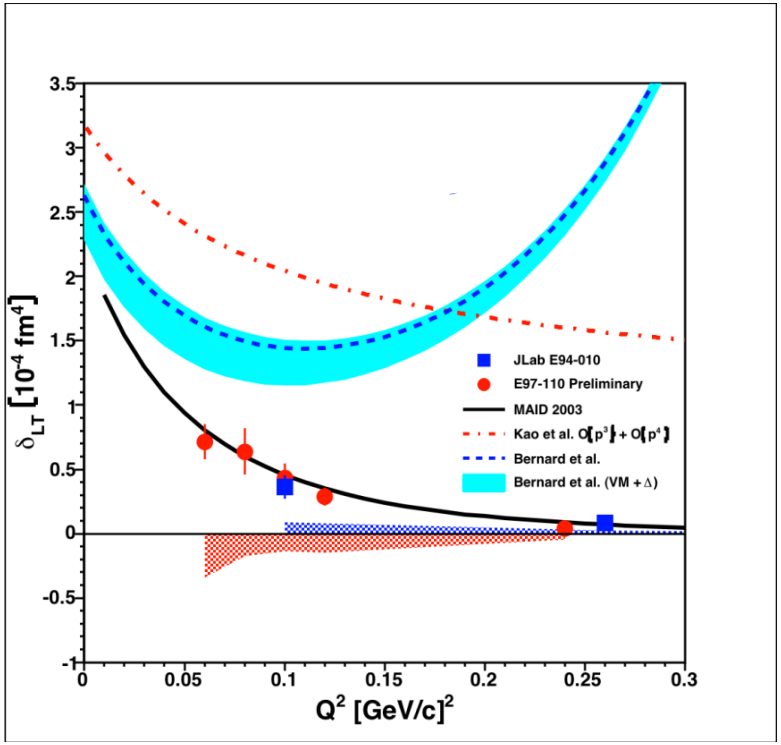
- Measure the proton structure function, g_2, in the low Q^2 region for the first time.
- Provides a unique opportunity to test the Burkhardt-Cottingham Sum Rule in the low Q^2 region.
- Benchmark test of Chiral Perturbation Theory by extracting the generalized longitudinal-transverse spin polarizability.

Spin Polarizability

$$\delta_{LT}(Q^2) = \frac{16\alpha M^2}{Q^6}\int_0^{x_0} dx\, x^2[g_1(x,Q^2) + g_2(x,Q^2)]$$

- Neutron data shows deviations from χ_{PT} calculations.
- No proton data yet!

Neutron

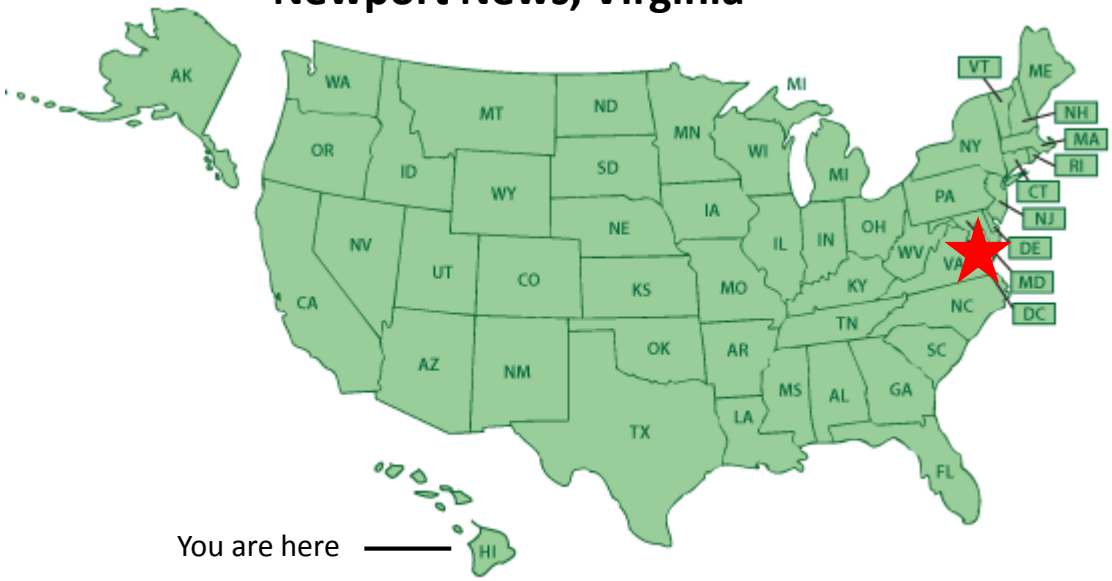


Motivation

- Measure the proton structure function, g_2, in the low Q^2 region for the first time.
- Provides a unique opportunity to test the Burkhardt-Cottingham Sum Rule in the low Q^2 region.
- Benchmark test of Chiral Perturbation Theory by extracting the generalized longitudinal-transverse spin polarizability.
- Improve calculations of Proton Hyperfine Splitting.

Experimental Setup

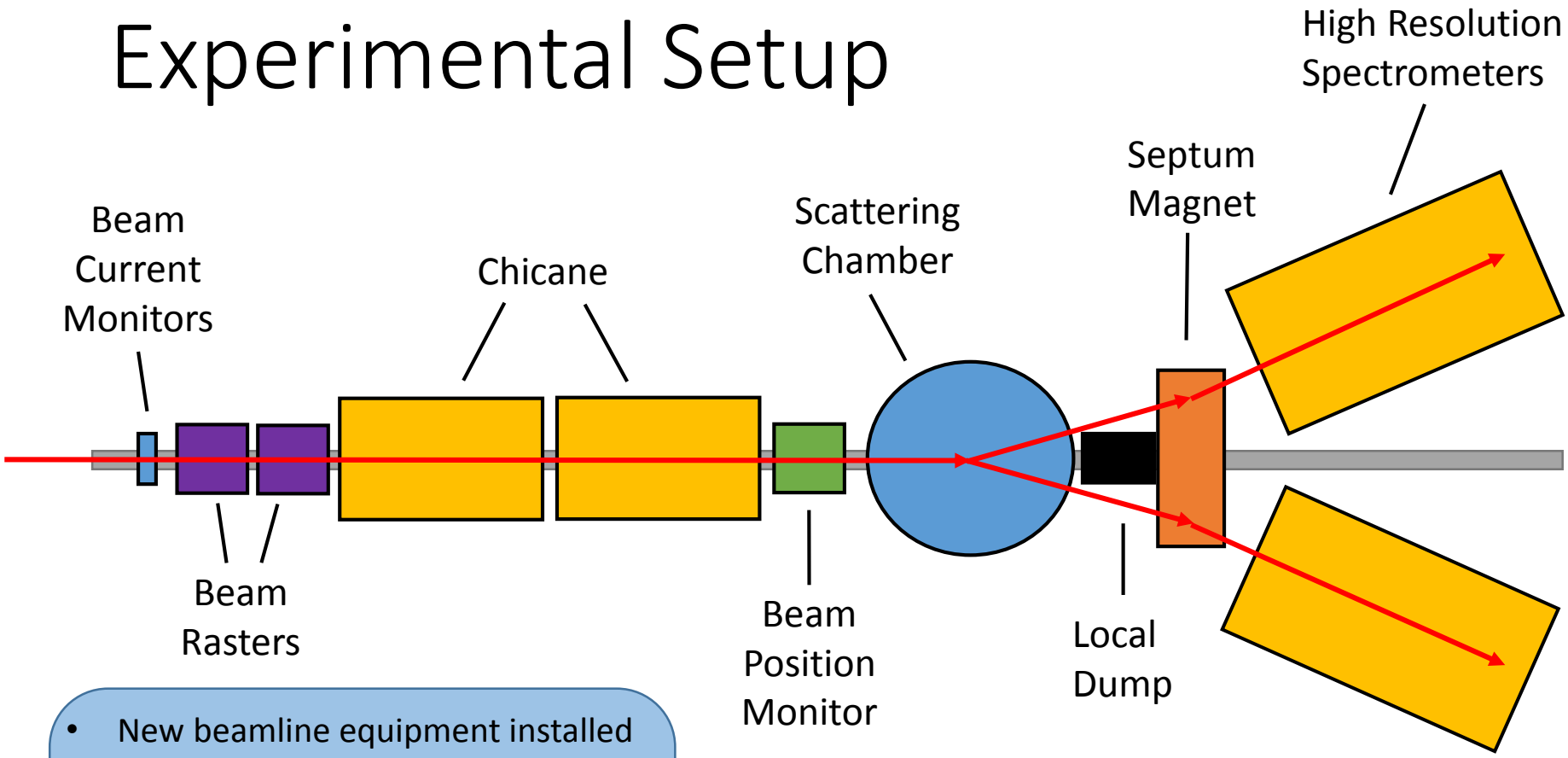
Thomas Jefferson National Laboratory
Newport News, Virginia



Continuous Electron Beam Accelerator Facility (CEBAF)

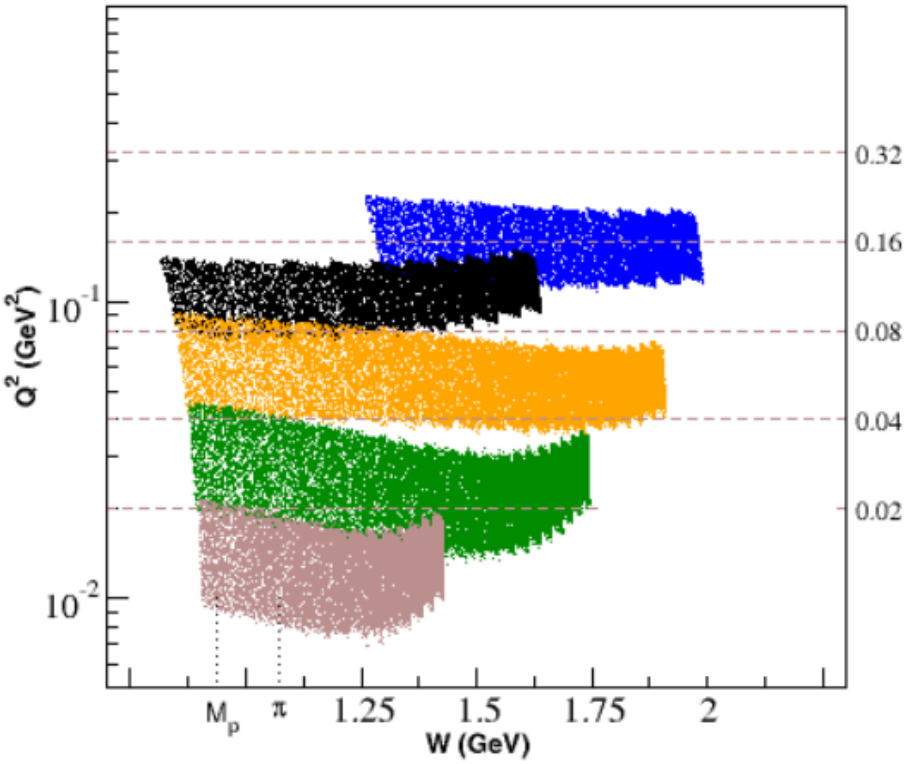
- Maximum Energy 12GeV
- 200μA current
- Electron polarization $\sim 85\%$

Experimental Setup



- New beamline equipment installed for low current running (<100nA)
- Chicane installed for transverse target field requirements.
- Rotatable 2.5T/5T scattering chamber.
- Local dump and septum magnets

Kinematics and Projections

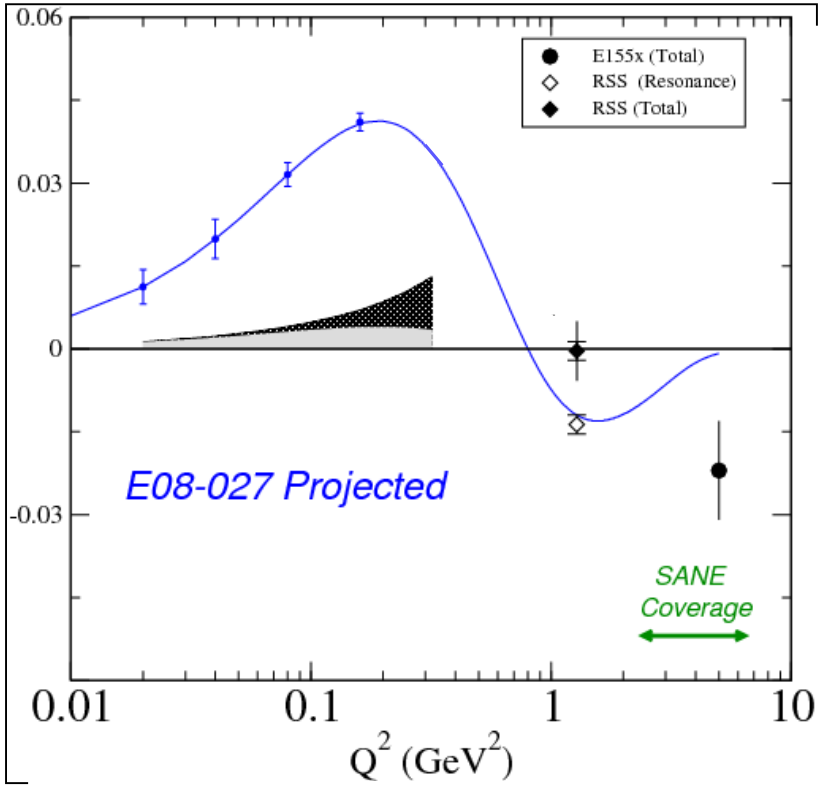


$0.02 < Q^2 < 0.2 GeV^2$

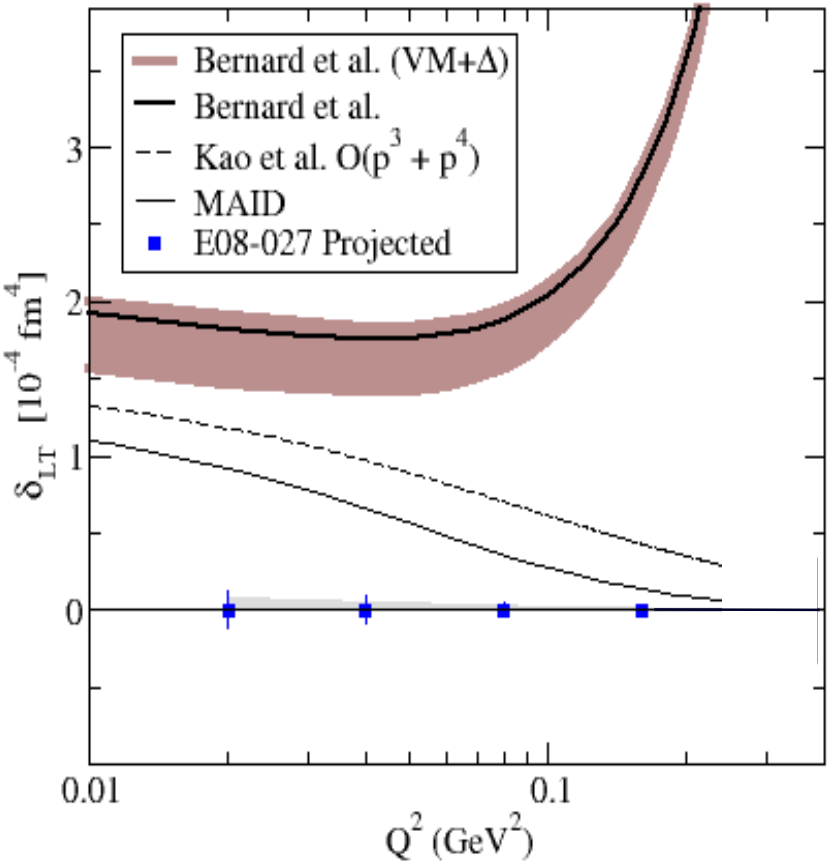
Beam Energy (GeV)	Target Field (T)
1.158	2.5
1.706	2.5
2.254	2.5
2.254	5.0
3.352	5.0

Kinematics and Projections

BC Sum Integral



LT Spin Polarizability



Analysis Progress

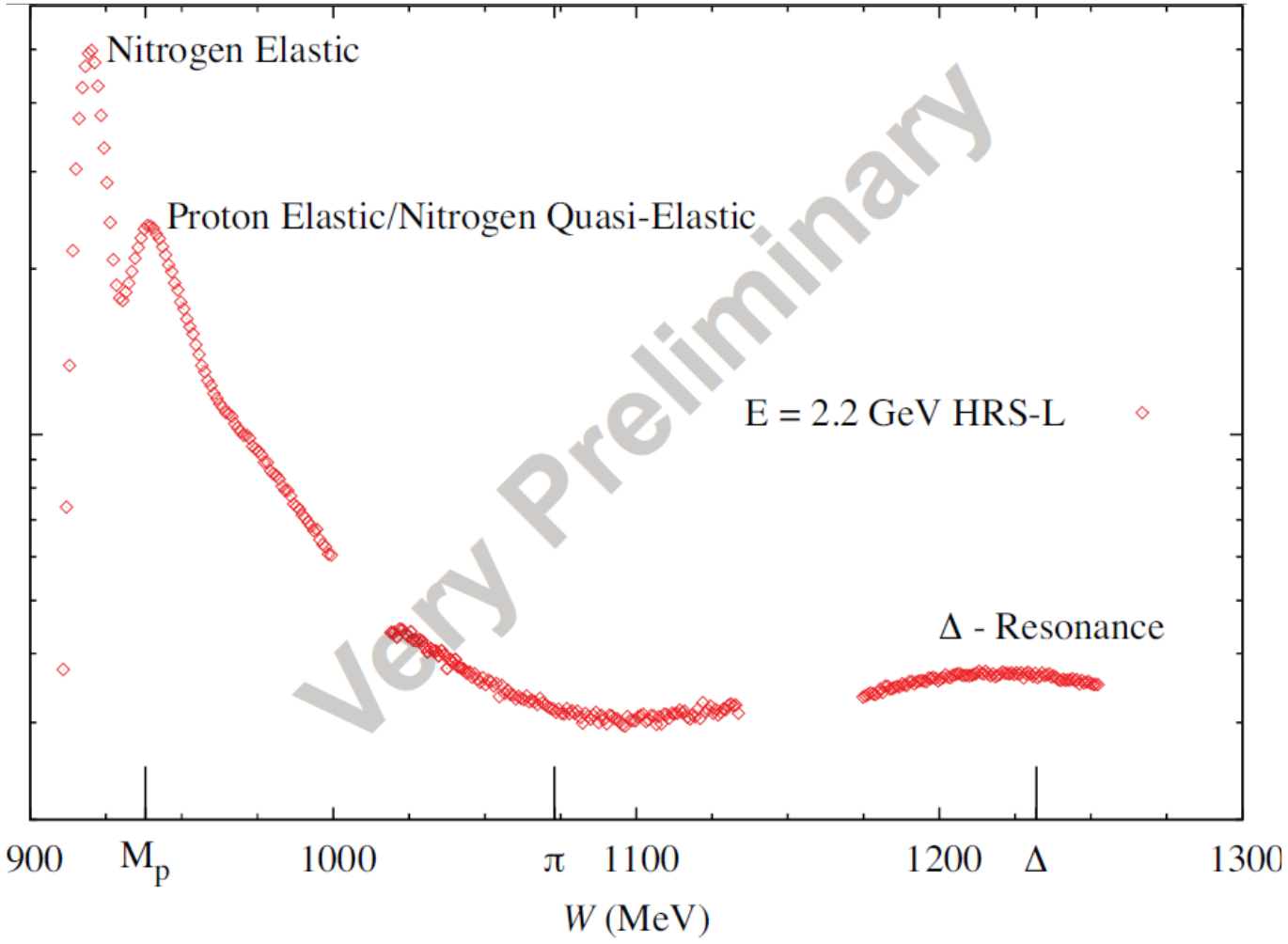
Completed

- Run DB
- HRS Optics
  - Field Measurement Analysis
  - VDC t_0 calibration
  - Simulation Package
  - Optics Reconstruction
- Detector Calibrations/Efficiencies
- Scalers
  - Helicity Decoding
  - BCM calibrations
  - Deadtime calculations
- Target Polarizations
- BPM calibrations
- Raster size calibration

In Progress

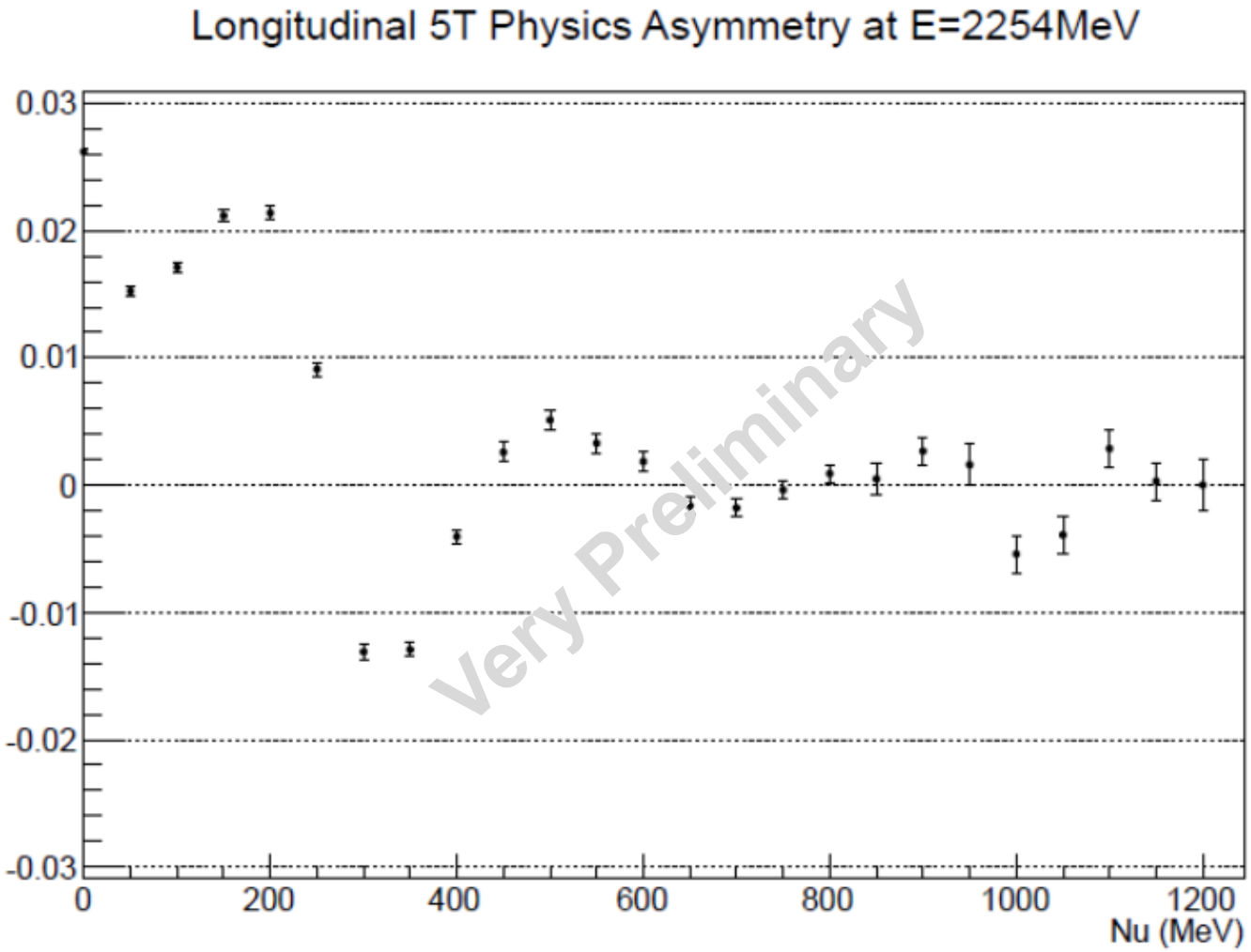
- Packing fraction/dilution analysis
- Elastic $P_B P_t$ check
- Radiative corrections
- Acceptance study

Online Results



Courtesy R. Zielinski

Online Results



Summary

- The g_2^p Experiment ran very successfully in spring, 2012.
- New instrumentation and beam requirements (and fires) introduced many challenges to the running and analysis.
- A first pass of production data is complete and analysis is well underway!
- We hope to have offline asymmetries and cross-sections by spring of next year
- g_2 calculation shortly after, possibly by summer, 2015.

E08-027 Collaboration

Spokespeople

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Min Huang
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Ryan Zielinski

Thank You!