Revealing the Transition Region of QCD with the Proton's g_2 Structure Function

-

C12-24-002
Jefferson Lab PAC 53
7/24/2025

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Experiment Overview

Hall: C

Measurement: Inclusive

Goal Observables:

- g_2 Spin Structure Function
- d_2 Polarizability
- Δ_2 Hydrogen Hyperfine Splitting Contribution
- $\overline{g_2}$ Twist 3 Effects
- g_T PDF

Needed Equipment:

- Solid Transversely-Polarized Target
- Chicane Magnet
- Beamline Instrumentation

Detectors: SHMS

Beam Current: 85 nA

Beam Energies: 4.4 GeV, 8.8 GeV

Target Material: NH_3 (Ammonia)

Q^2 Range: 0.22 – 2.2 GeV^2

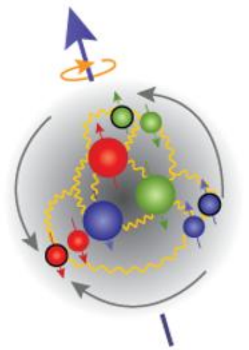
W Range: 1078 – 2400 MeV

Requested Days: 26

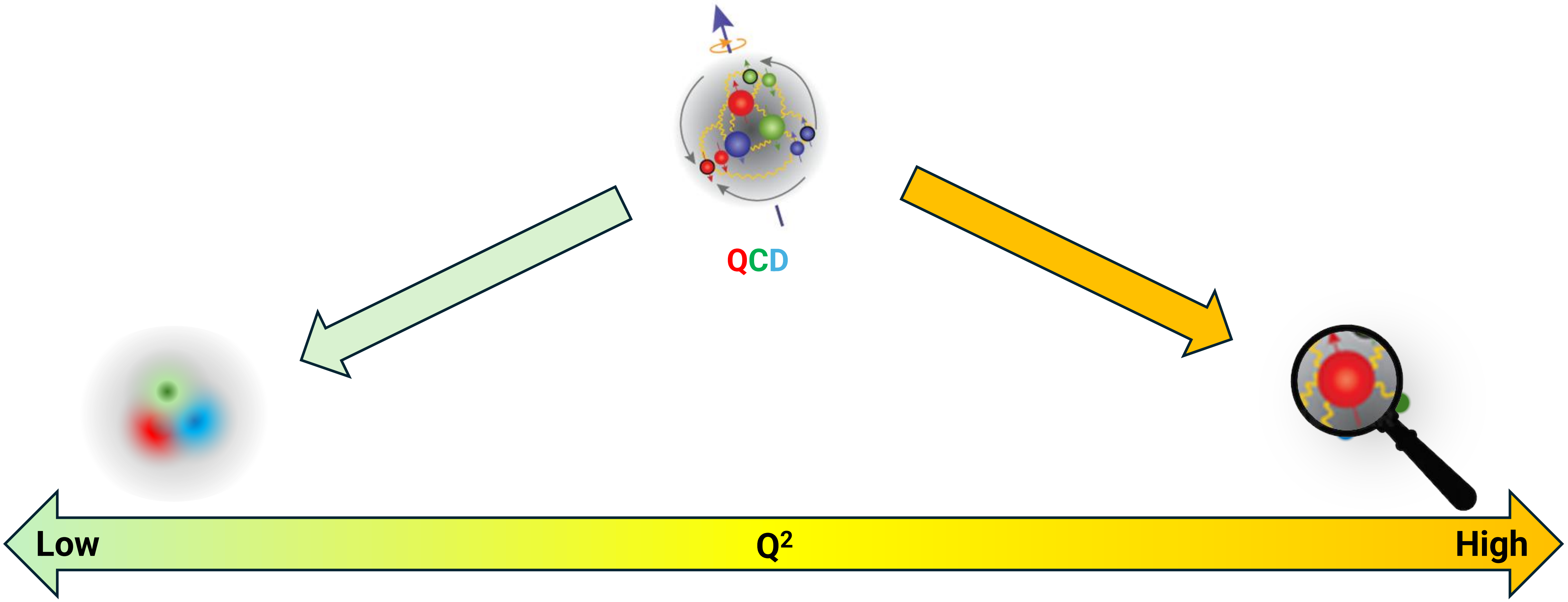
Current Status: C2 (Conditional Approval)

PAC52 Report Conditions:

- "The impact of this new setup on the detector resolution and its subsequent effect on the physics results has not been thoroughly addressed. **A full Monte Carlo simulation** of the new setup and detector is needed." (✅ **Complete**)

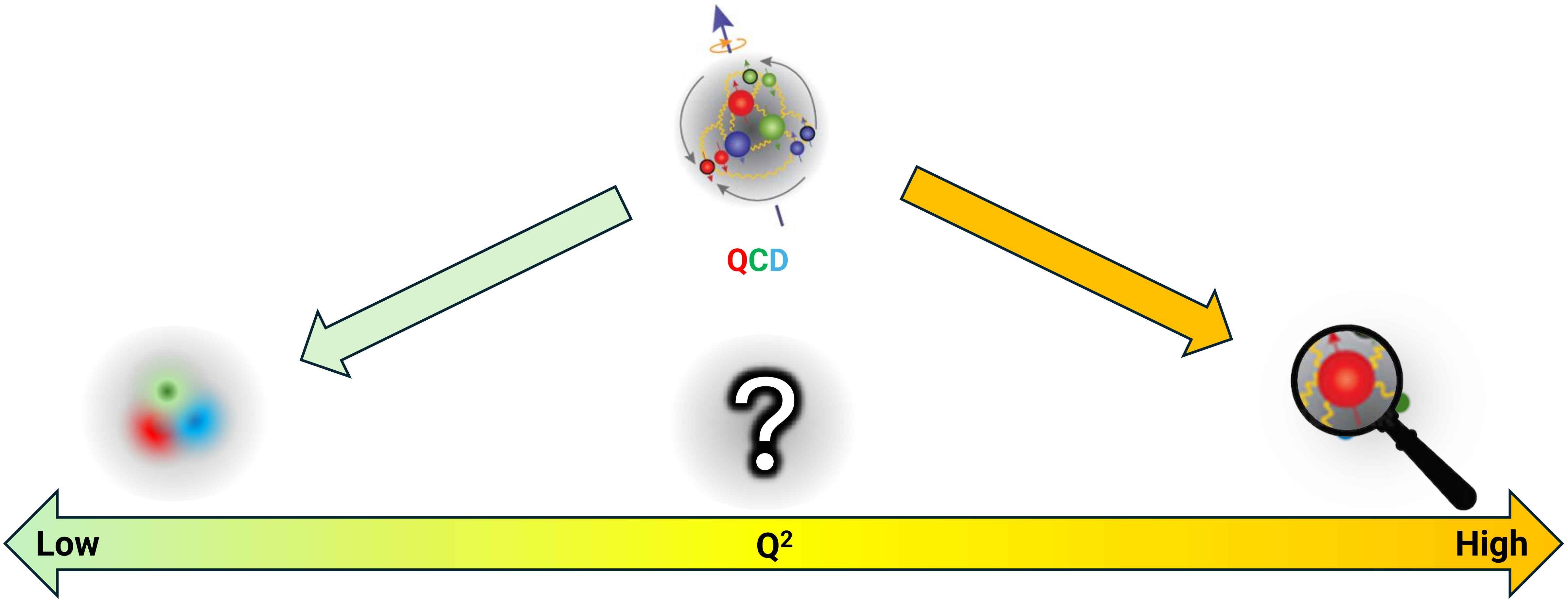


QCD



- Partons Combine to Form Nucleon
- Confinement
- Effective Theories: χPT
- Can't use Twist Approx.

- Individual Partons
- Asymptotic Freedom
- Perturbative QCD
- Leading Twist



- Partons Combine to Form Nucleon
- Confinement
- Effective Theories: χPT
- Can't use Twist Approx.

- Quark/Gluon Correlations
- Lattice QCD
- Higher Twists

- Individual Partons
- Asymptotic Freedom
- Perturbative QCD
- Leading Twist

How to study QCD and higher twist in the transition region?

- In unpolarized systems, F_1 / F_2 structure functions describe quark-gluon distribution:

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

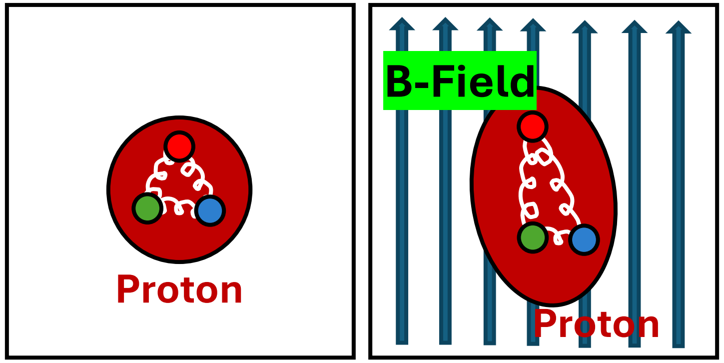
- In a spin-½ polarized system, g_1/g_2 describe the spin distribution :

$$\frac{d^2\sigma^{\pm}}{d\Omega dE'} = \sigma_{\text{Mott}}\left[\alpha F_1(x,Q^2) + \beta F_2(x,Q^2) \pm \gamma \underbrace{g_1(x,Q^2)}_{\text{Nucleon Spin Structure}} \pm \delta \underbrace{g_2(x,Q^2)}_{\text{Quark-Gluon Correlations}}\right]$$

g_2 Structure Function enables direct tests of QCD and higher twist

- **Higher Twist:**

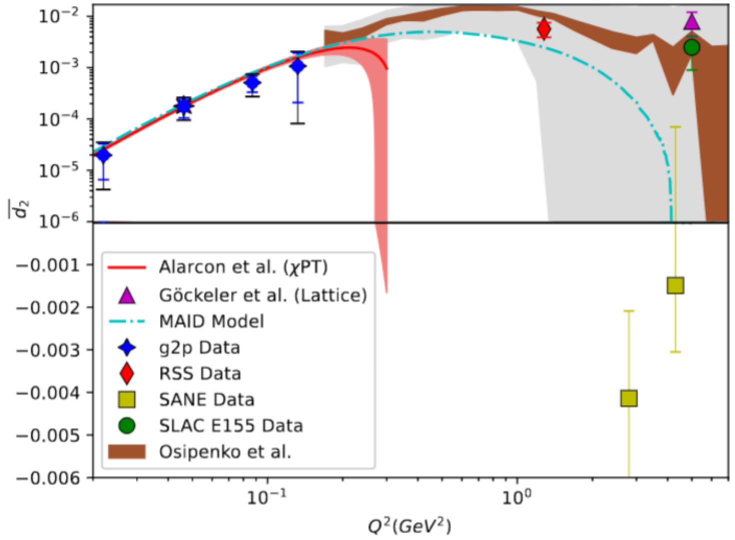
$$g_2(x,Q^2) = \underbrace{g_2^{WW}(x,Q^2)}_{\text{Function of } g_1} - \int_x^1 \frac{\partial}{\partial y}\left[\overbrace{\frac{m_q}{M}h_T(y,Q^2)}^{\text{Small}} + \underbrace{\zeta(y,Q^2)}_{\text{Twist-3}}\right]\frac{dy}{y}$$



- **Benchmarking (Lattice) QCD:**

Weighted integrals (moments) of the spin structure functions can be directly calculated by effective theories:

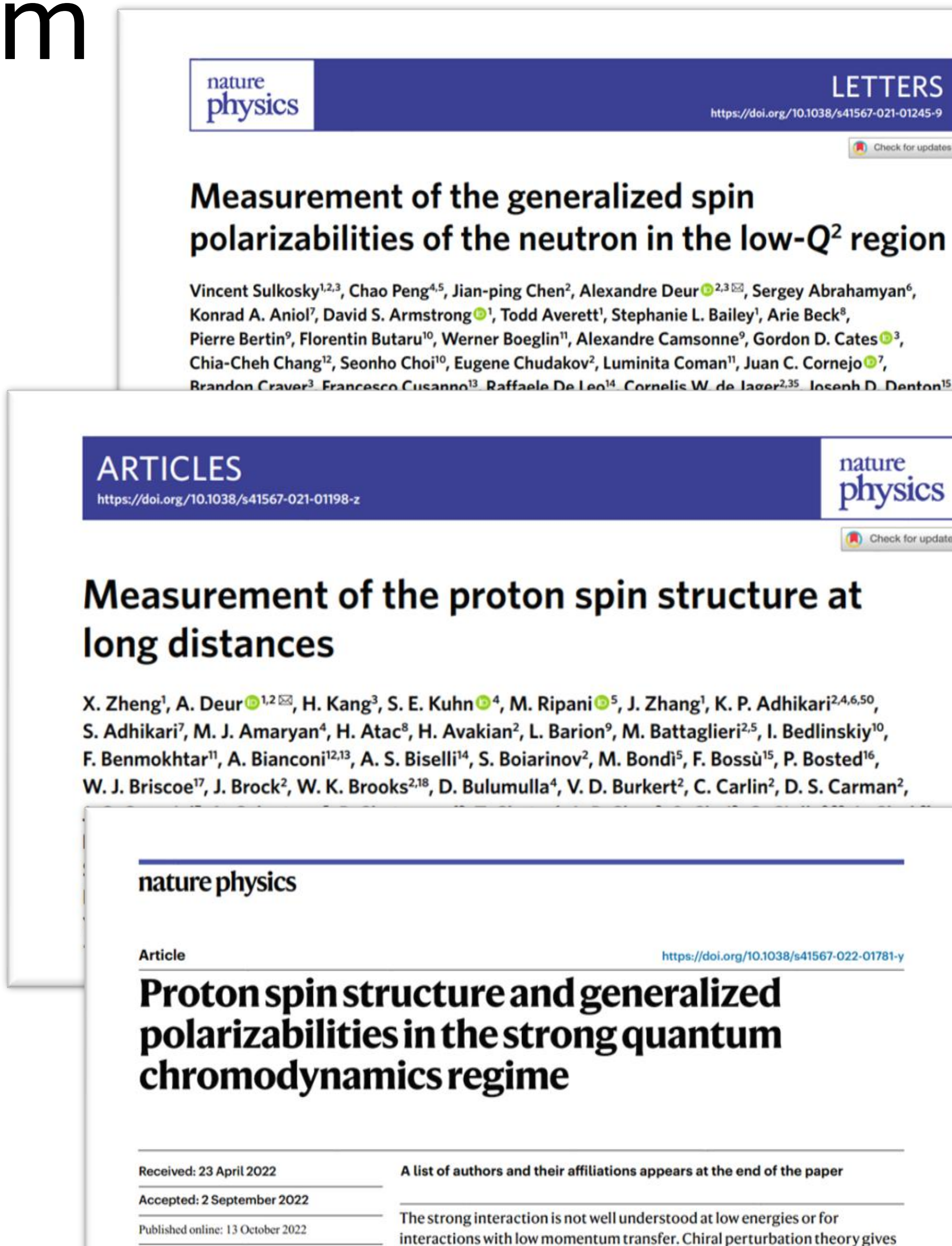
$$\overline{d_2} = \int_0^{x_{th}} x^2[2g_1(x,Q^2) + 3g_2(x,Q^2)]dx$$



Polarizabilities describe nucleon's <u>ensemble</u> response to an external field

Recent Successful JLab Program

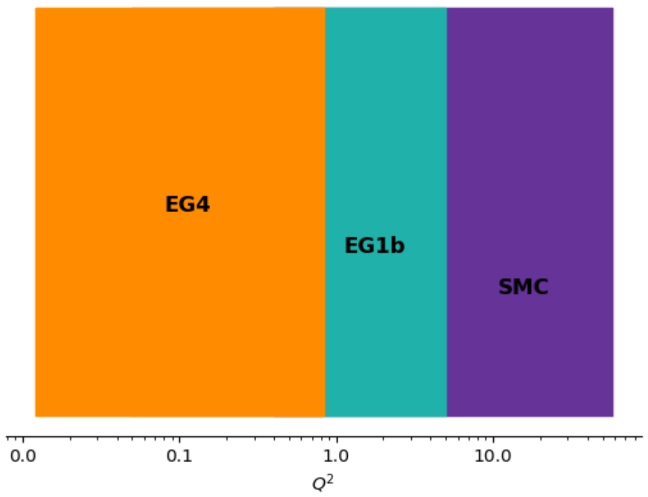
- **Highly** successful program to measure SSF
- Three different experiments published recent SSF results in *Nature Physics*
- 2007 JLab Review: DOE Milestone to "measure g_1 and g_2 over an enlarged range of x and Q^2"

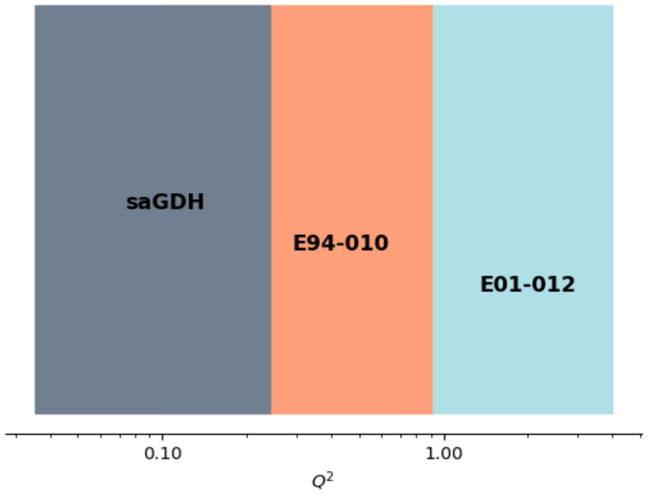


Proton

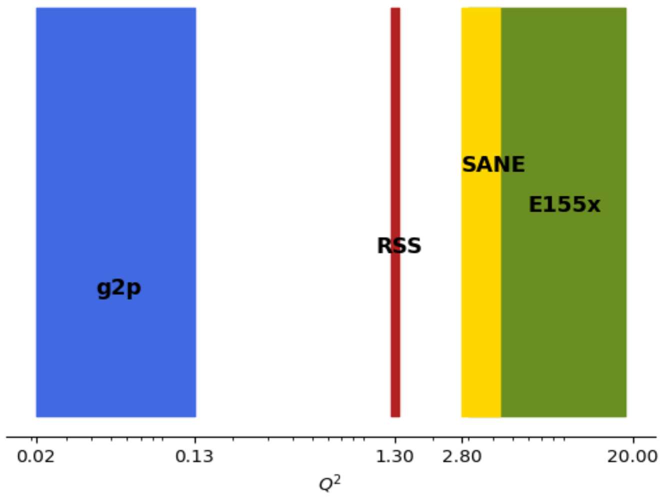
Neutron

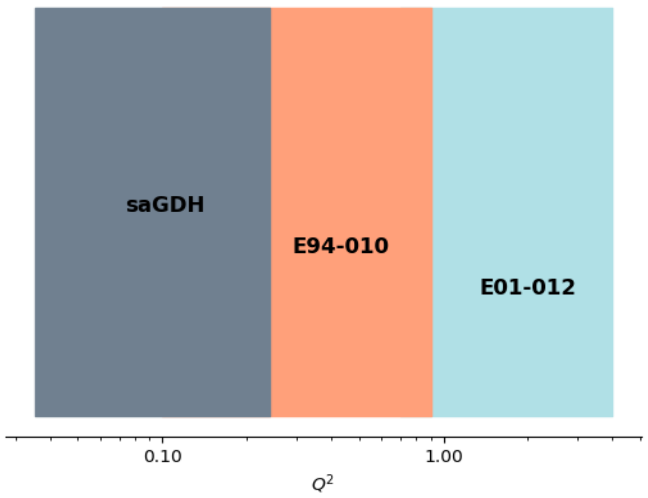
g_1





g_2





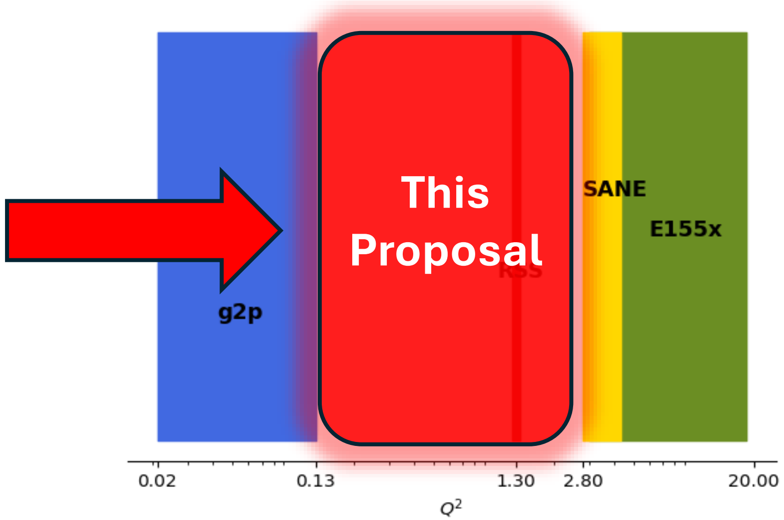
Builds on 3 previous Hall A/C Successful measurements with near identical setup, plus:

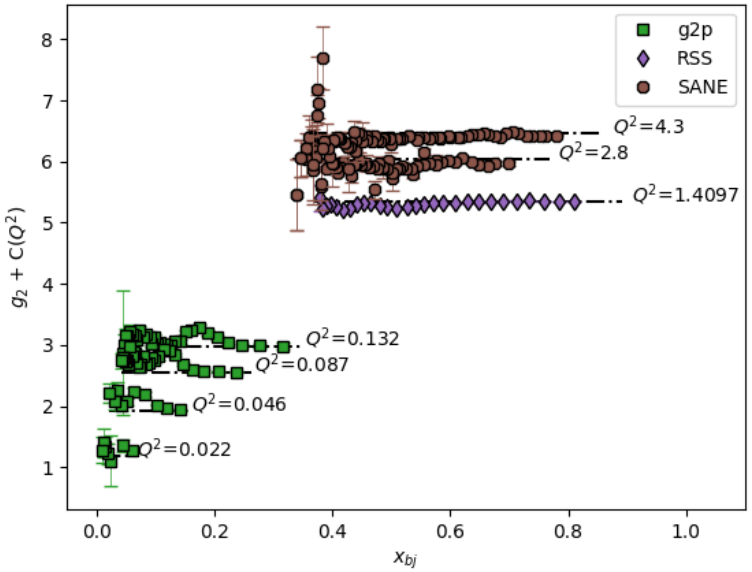
- **<u>Much higher rates</u>** than the higher Q^2 experiments
- **<u>Smaller out-of-plane angle</u>** than the low Q^2 data

Transition Region g_2 has Strong scientific motivation:

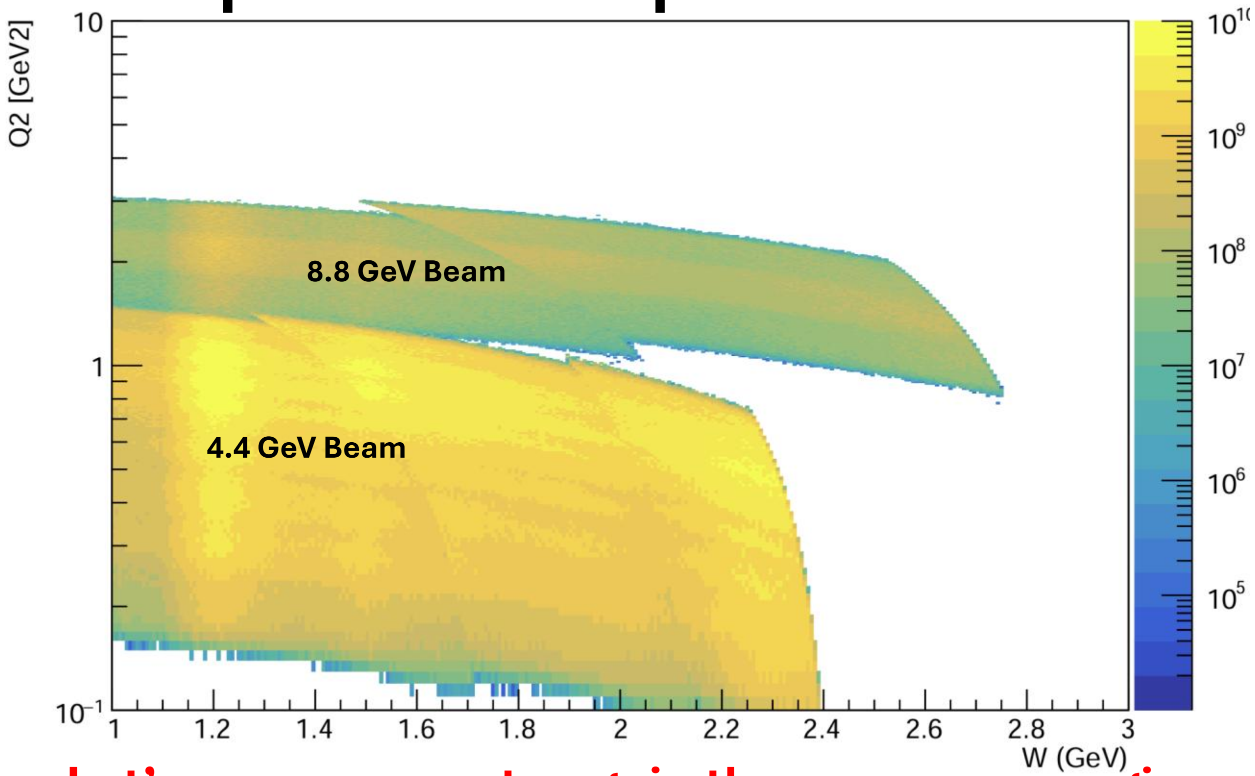
- **<u>Needed</u> as a Benchmark for Lattice QCD**
- **Unique Sensitivity to Twist-3 Effects**

g_2





Proposed Experiment



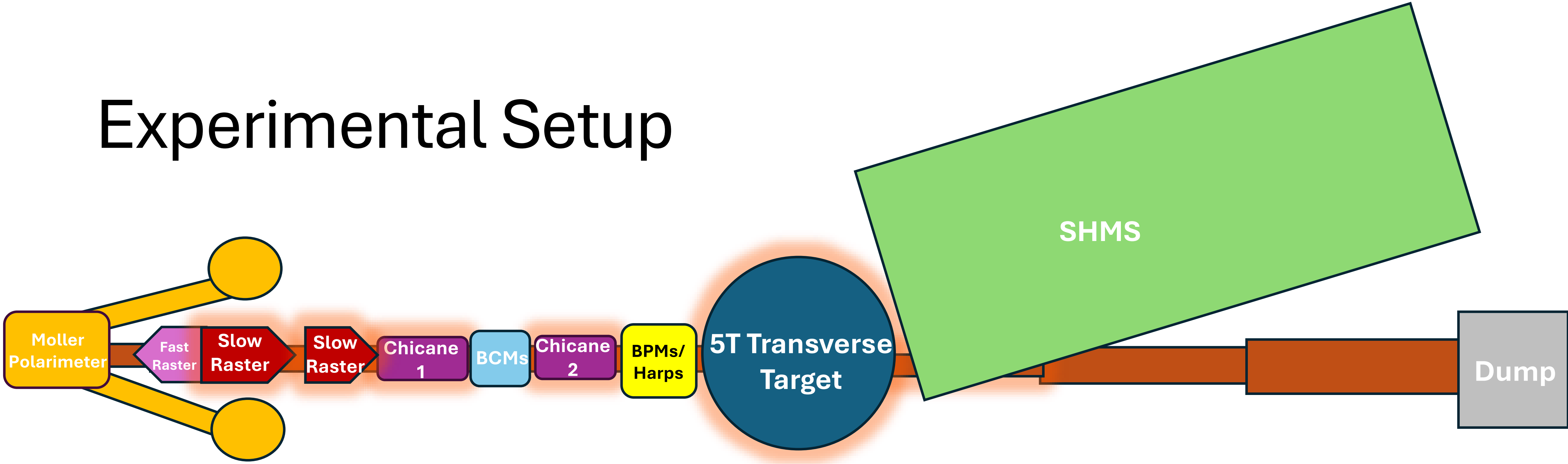
How:

- **Hall C**
- **Transversely Polarized NH_3 Target**
- **SHMS Detector**
- **85 nA Current**
- **4.4 + 8.8 GeV Beam Energies**

- **Let's measure proton g_2 in the resonance region across the missing part of the transition regime**
- **Full order of magnitude in Q^2 :** 0.2 GeV^2 - 2.2 GeV^2

- First ever transition region measurement of the proton's g_2 structure function -- extract moments and higher twist effects

Experimental Setup



Standard equipment package, plus:

- 5T polarized target
- Chicane Magnet
- Low current beamline configuration
- Slow Raster

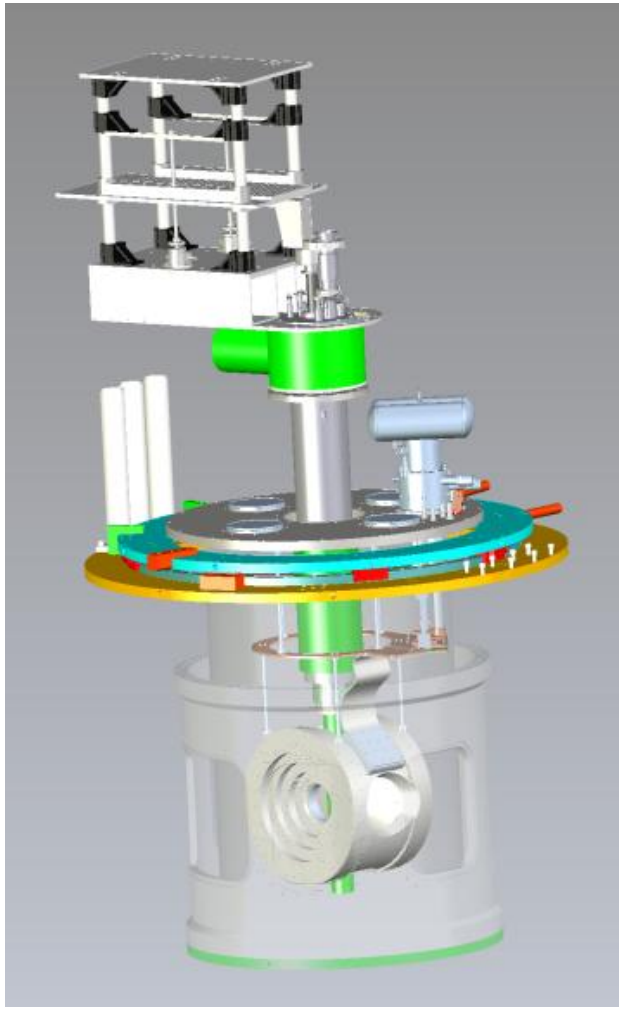
Nearly identical to the successful setup for previous Hall A/C experiments RSS, EG4, g2p

Polarized Target

- NH_3 (Ammonia) target
- Transversely Polarized with Dynamic Nuclear Polarization (DNP)

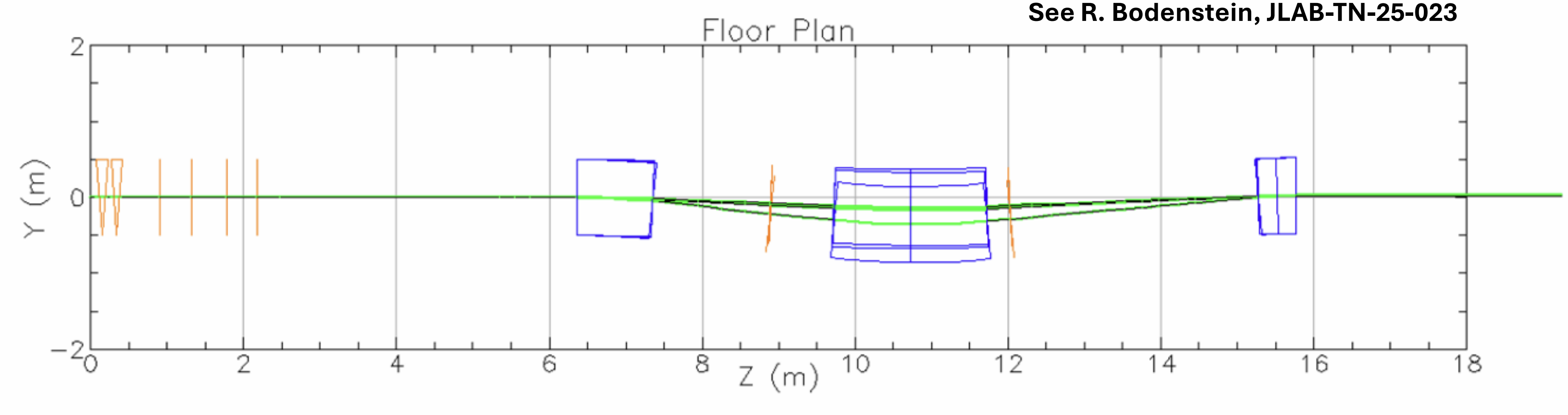
- Since previous experiments:
  - New Target Group magnet **more optimized for transverse running!**
  - Needs installation w/ UVA PT fridge & scattering chamber

  - **Collaboration will send students & work together with Target Group on this project**



Chicane Magnet

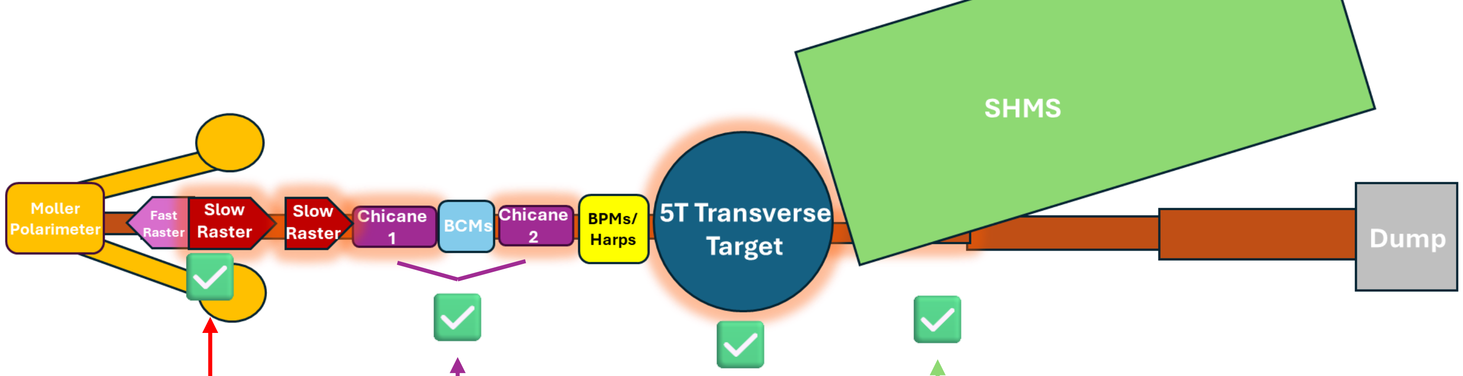
See R. Bodenstein, JLAB-TN-25-023



- Transverse target field needs pre-bending of the beam
- Chicane design (J. Benesch) replaces two existing 1m dipoles
- Further BMAD optimization performed by R. Bodenstein
- Chicane is needed for SoLID + any experiment with transverse PT

- Allows beam to **cleanly** reach hall dump – no local dump needed!

Simulation Study



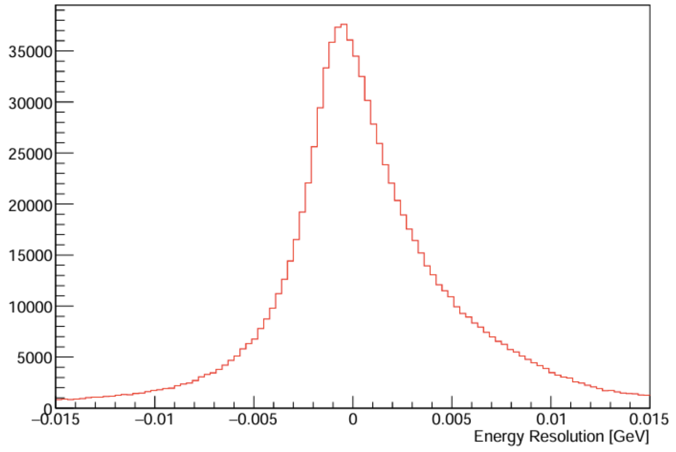
- **Monte-Carlo simulation performed with all effects included & accounted for:**
  - **Raster**
  - **Chicane**
  - **Target Field**
  - **Spectrometer Optics**
  - **Multiple Scattering**
  - **Radiative Effects**
  - **Ionization Energy Loss**
  - **Particle Decay**
- Chicane optimization: BMAD and Optim
- Standard Hall C analysis cuts
- <u>Systematic impact on observable **now included**</u>

All following plots are for the **worst case** kinematic setting at the lowest Q^2.

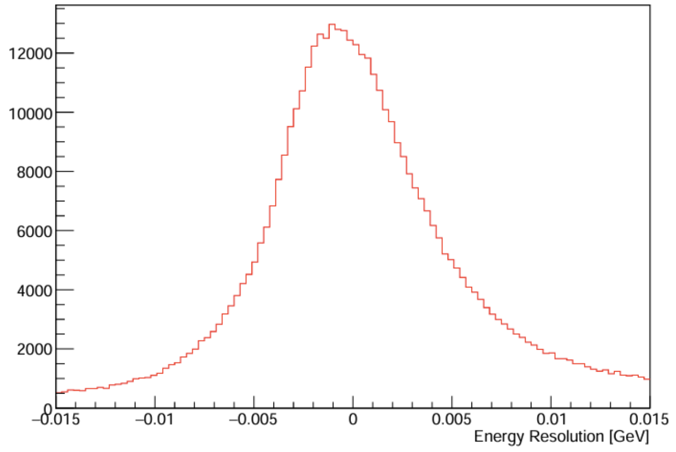
Target field/chicane effects are smaller for all other settings.

Thanks to Jefferson Lab Staff Scientists
Dave Gaskell, Jay Benesch, and Ryan Bodenstein for their help!

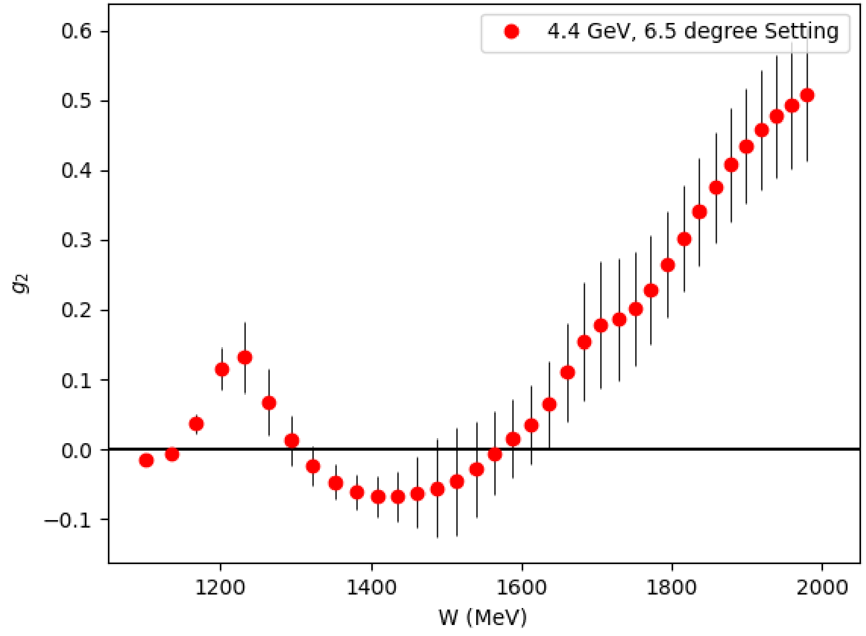
Resolutions



Without Target Field/Chicane



With Target Field/Chicane

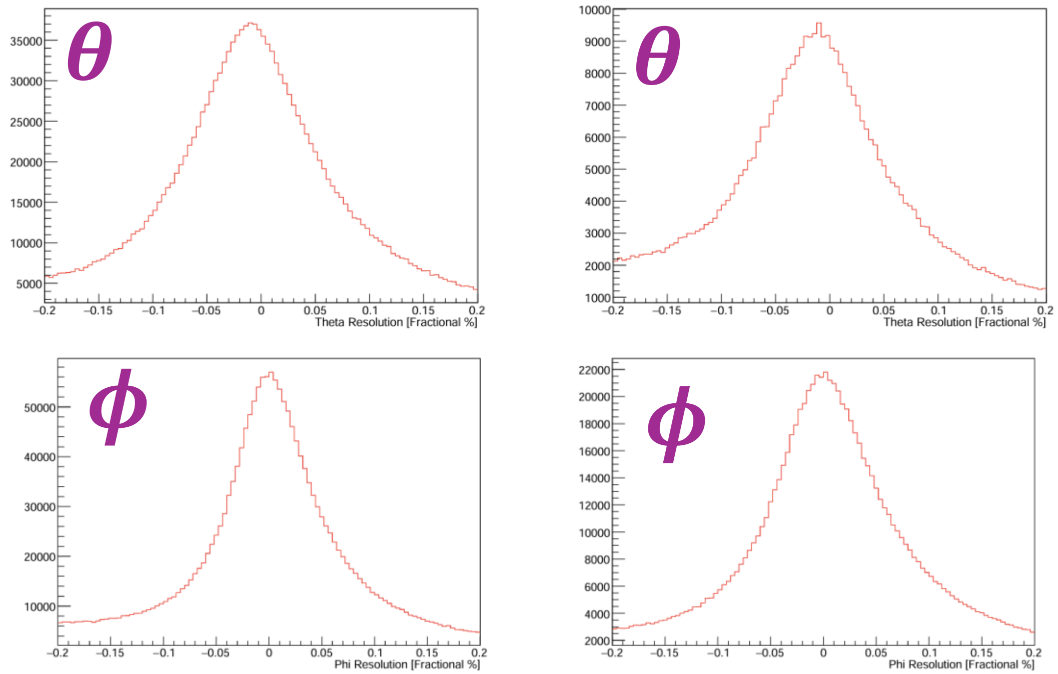


Planned Bin Size: > 30 MeV

Resolution w/ Target: 10-20 MeV

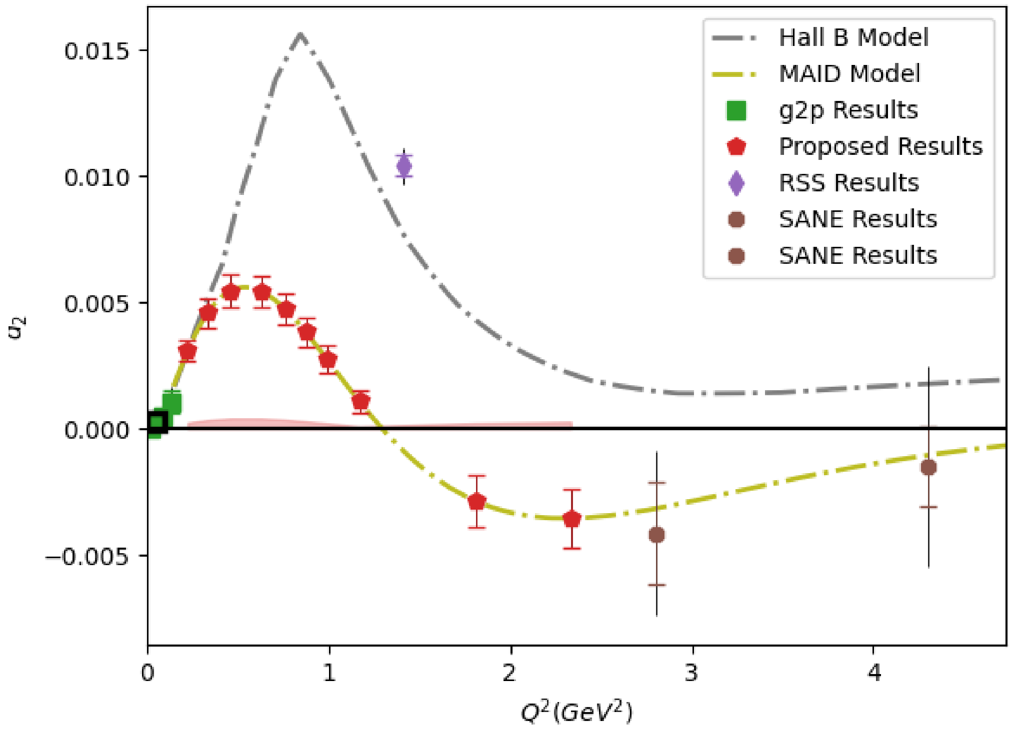
- **There should be no issue resolving the resonances of g_2p**

Resolutions



Without Target Field/Chicane

With Target Field/Chicane

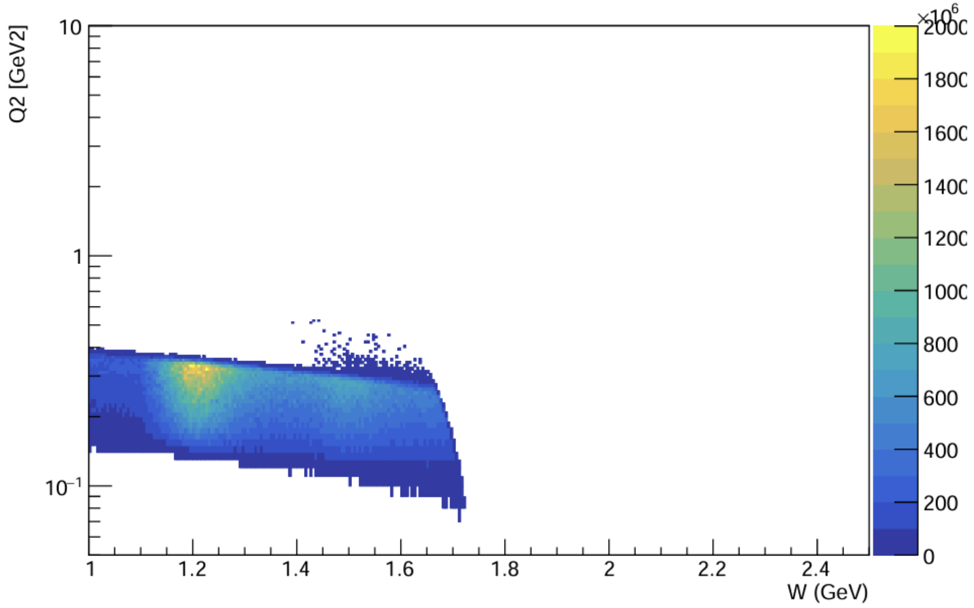


Planned Scattering Angle Bin Size: ~1.0 - 2.5°

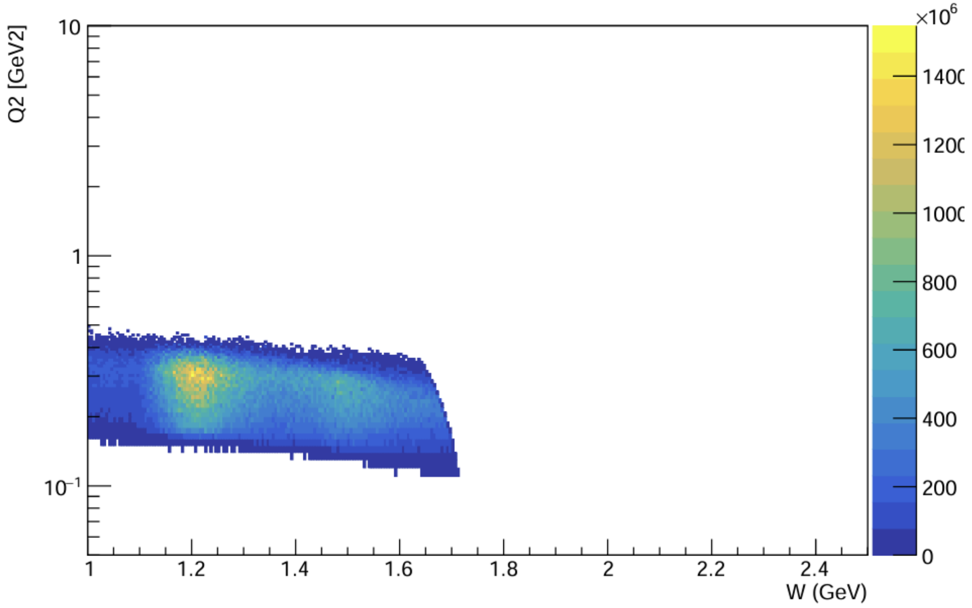
Resolution w/ Target: ~0.96°

- **<u>There should be no issue resolving the features of the moments</u>**

Impact on Coverage



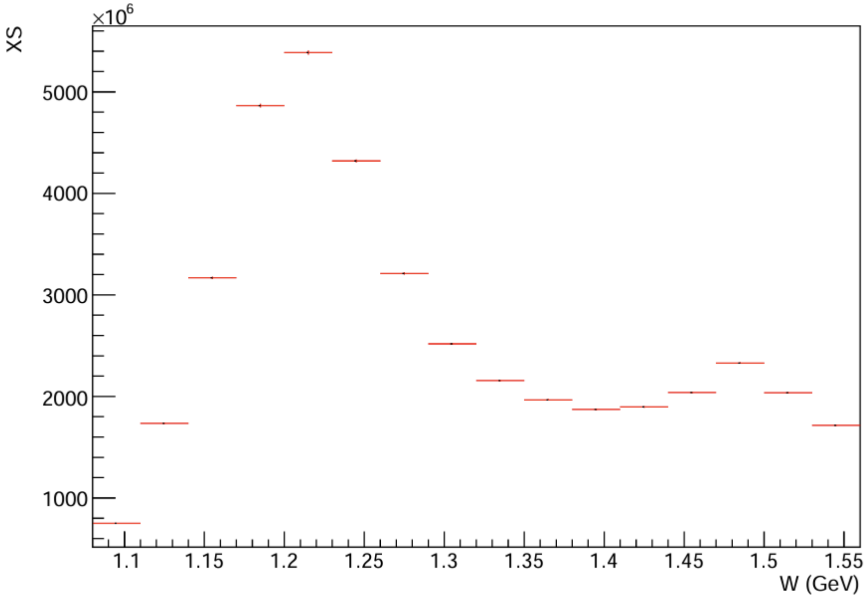
Without Target Field/Chicane



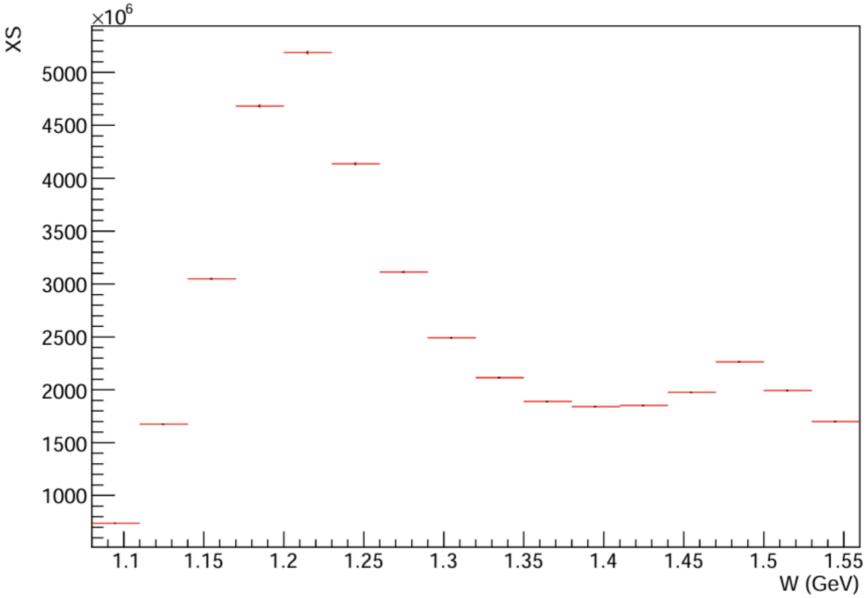
With Target Field/Chicane

- **<u>Effects on the kinematic coverage are small and well-understood</u>**

Systematic Impact



Truth



Reconstructed

- **Around a 2% or less effect from the resolution on the XS**
- **Included in new systematics calculation**

Simulation Conclusions

- **PAC52 Conditional:** "The impact of this new setup on the detector resolution and its subsequent effect on the physics results has not been thoroughly addressed. **<u>A full Monte Carlo simulation</u>** of the new setup and detector is needed."
  (✅ Complete)
- Resolutions enlarged by the target field = 2% syst. uncertainty contribution
- We have fulfilled PAC52's condition and the impact of the target and chicane is now **well understood and accounted for**

g_2 Extraction Method

- Measure Asymmetry and Cross Section:

$$A_\perp^{Raw} = \frac{\sigma^{\uparrow\Rightarrow} - \sigma^{\downarrow\Rightarrow}}{\sigma^{\uparrow\Rightarrow} + \sigma^{\downarrow\Rightarrow}}$$

$$\frac{d^2\sigma}{d\Omega dE'} = \frac{(ps)N}{N_{in}\rho(LT)\epsilon_{det}}\frac{f}{\Delta\Omega\Delta E'\Delta Z}$$

$$A^{\mathrm{exp}} = \frac{1}{f \cdot P_t \cdot P_b} A^{\mathrm{raw}}$$

Spin-Dependent Effects

Unpolarized Scattering

- Form Polarized XS Difference:

$$\Delta\sigma_\perp = 2\boxed{A_\perp^{exp}}\boxed{\sigma_0}$$

- Extract g_2

Input from Hall B Data

$$g_2(x, Q^2) = \frac{K_1 y}{2}\left[\boxed{\Delta\sigma_\perp}\left(K_2 + \tan\frac{\theta}{2}\right)\right] + \frac{\boxed{g_1(x, Q^2)}\,y}{2}$$

Beam Time Required

Source	Time (PAC Days)
$Q^2 = 0.22$ GeV^2	0.1
$Q^2 = 0.33$ GeV^2	0.2
$Q^2 = 0.46$ GeV^2	0.3
$Q^2 = 0.62$ GeV^2	0.8
$Q^2 = 0.77$ GeV^2	1.1
$Q^2 = 0.89$ GeV^2	1.8
$Q^2 = 1.03$ GeV^2	2.3
$Q^2 = 1.25$ GeV^2	4.6
$Q^2 = 1.84$ GeV^2	0.9
$Q^2 = 2.2$ GeV^2	0.9
Total Physics Days	**13**
Overhead Days	13

Only

26 Days

To measure 10 Q^2 settings of g_2 with high precision...

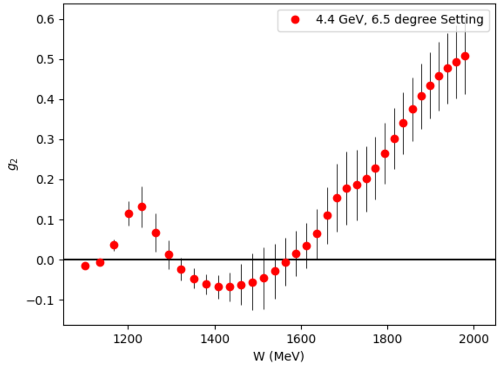
covering a **full order of magnitude** of the transition region!

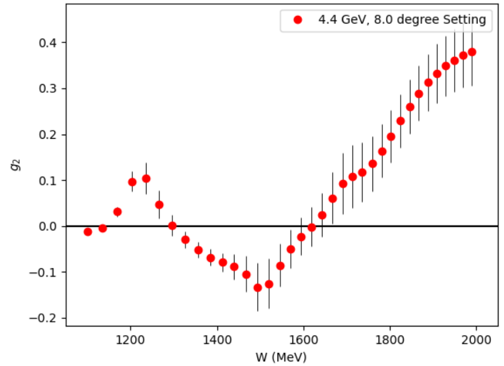
Projected Systematics

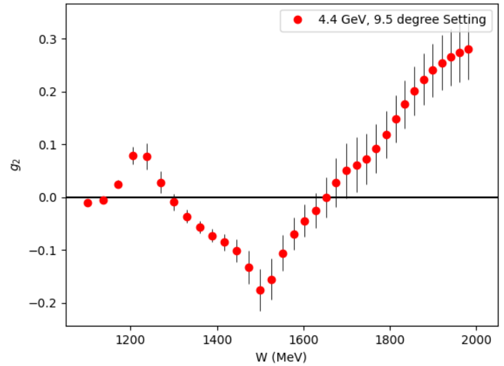
- Dominating systematics are **target polarization** and **acceptance**

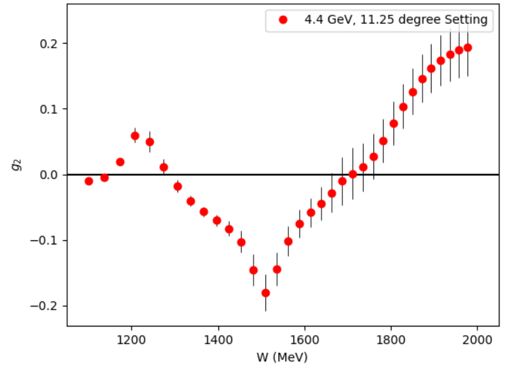
Source	%
Acceptance	4-6
Packing Fraction	3
Charge Determination	1
Tracking Efficiency	1
PID Efficiencies	< 1
Software Cut Efficiency	< 1
Resolution/Simulation	< 2
Energy	0.5
Deadtime	< 1
XS Total	5-7
Target Polarization	5
Beam Polarization	3
Radiative Corrections	3
Parallel Contribution	2
Const Q^2 Adjustment	< 1
S.F. Total	8.5-9.8

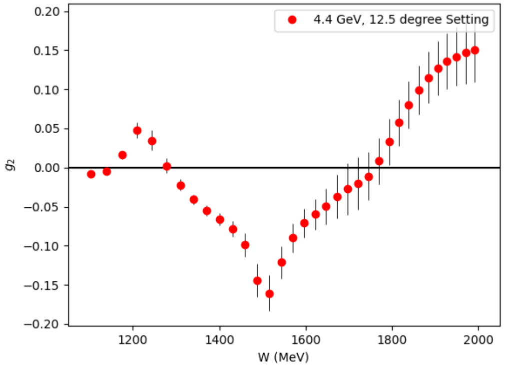
Projected g_2 Uncertainties

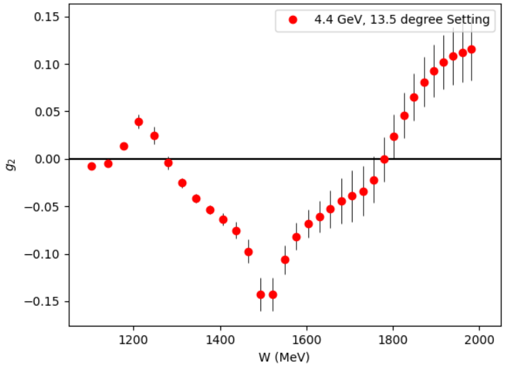


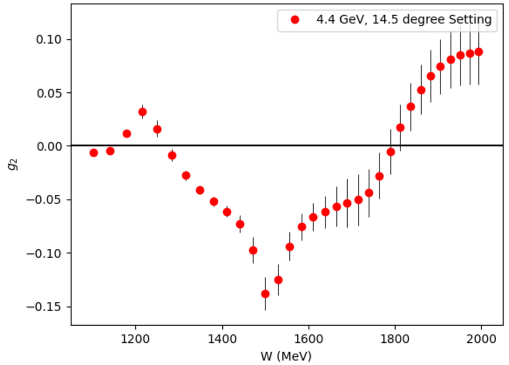


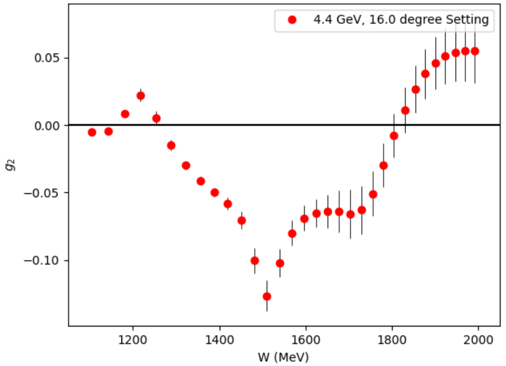




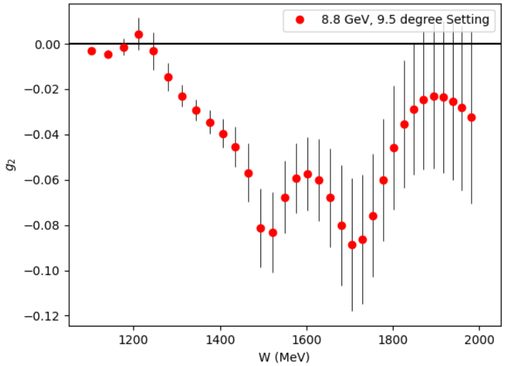


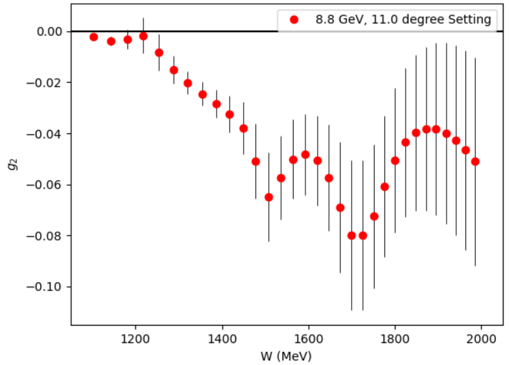






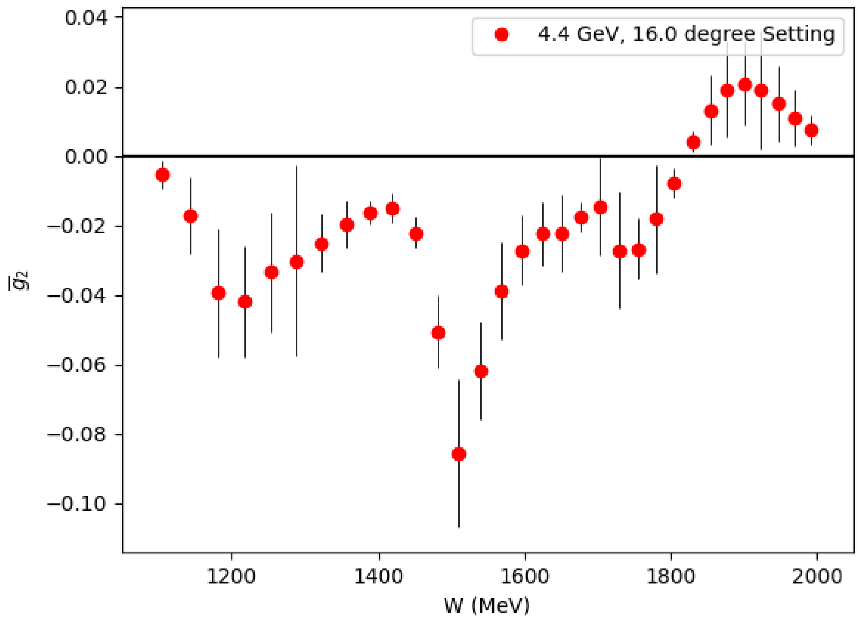
Covers almost the entire transition region





Fills the last major Q^2 spectrum gap for the nucleon spin structure functions

$\overline{g_2}$ (Twist 3 Extraction)



Small

$$g_2(x,Q^2) = \underbrace{g_2^{WW}(x,Q^2)}_{} - \int_x^1 \frac{\partial}{\partial y}\left[\frac{m_q}{M} h_T(y,Q^2) + \underbrace{\zeta(y,Q^2)}_{}\right]\frac{dy}{y}$$

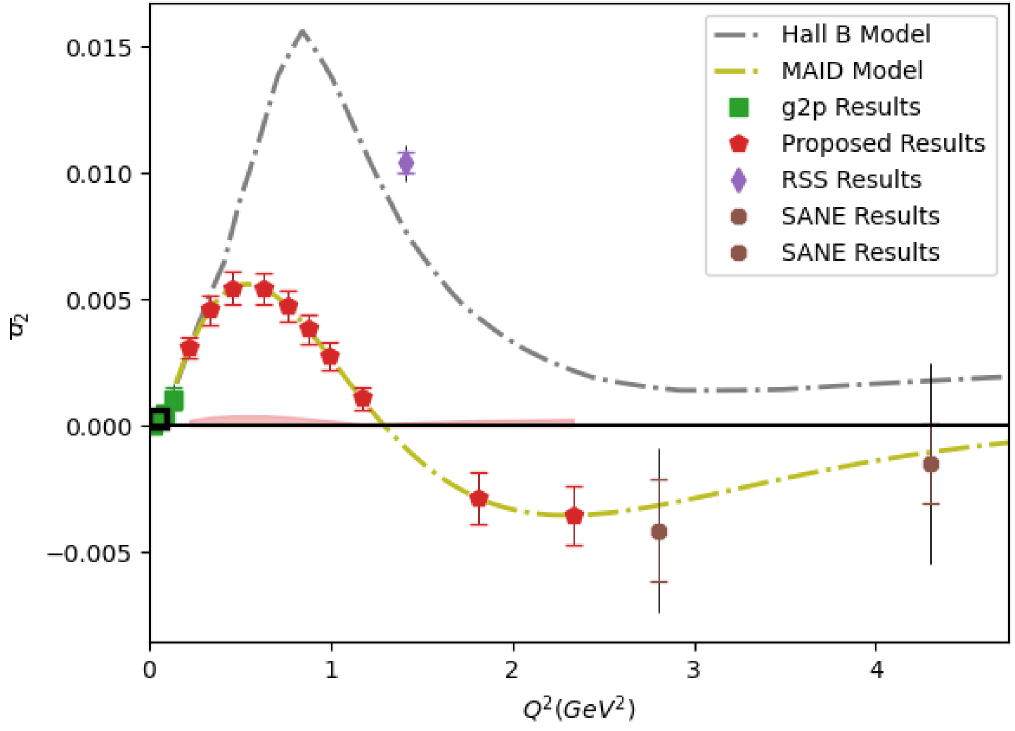
Utilize CLAS Hall B Results for g_1 in same regime

$\overline{g_2}$ (Twist-3)

Direct extraction of Twist 3 effects
in the regime they contribute most significantly

First ever extraction of this quantity for the proton!

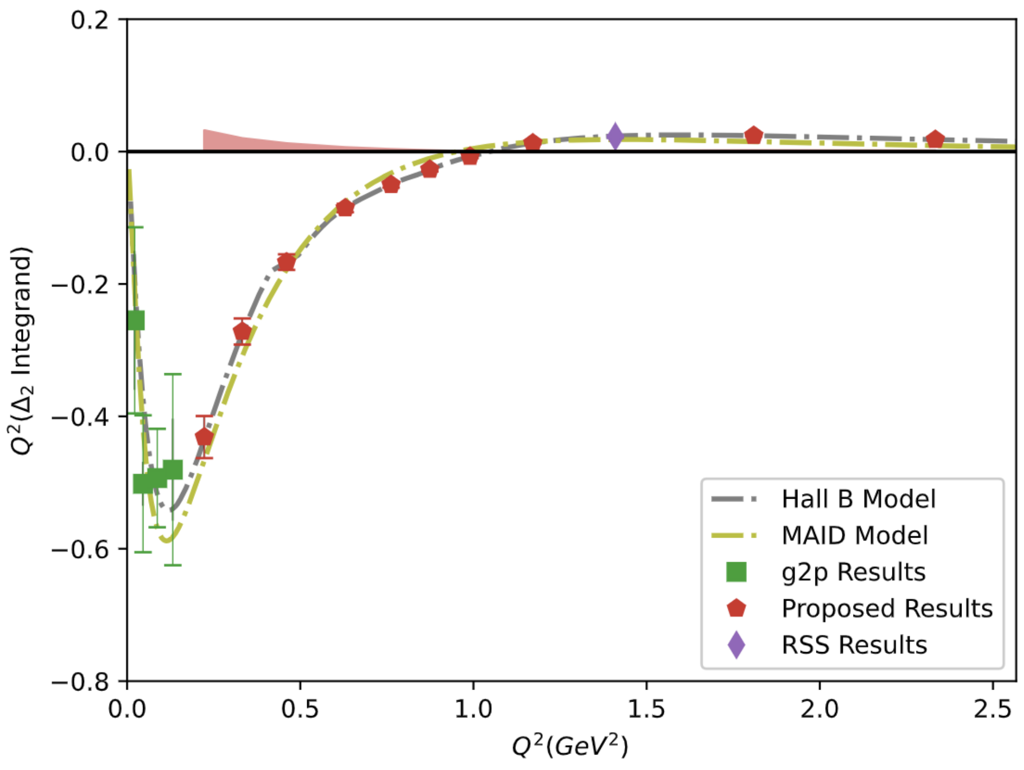
Projected $\overline{d_2}$ Uncertainties



Can benchmark Lattice QCD **in the regime where Perturbative QCD starts failing**

New Lattice calculations expected in next few years!

Hydrogen Hyperfine Splitting Impact



- One of the "best-measured" quantities in physics
- Theoretical precision is six orders of magnitude worse than experimental precision
- ***Dominating theoretical uncertainty driven by lack of g_2 data!***
- This proposal covers 30% of the relevant Δ_2 contribution

What do the theorists have to say…?

> “A clear case of ‘low-hanging fruit’ with a wealth of opportunities to address long-standing open questions.”
>
> – PR12-23-007 Theory Report
>
> 2023

What do the theorists have to say…?

“Scientifically sound, with a clear rationale and a well-designed experimental plan”

– PR12-24-002 Theory Report

2024

“A clear case of ‘low-hanging fruit’ with a wealth of opportunities to address long-standing open questions.”

– PR12-23-007 Theory Report

2023

What do the theorists have to say...?

"The motivation remains as strong as in the original proposal"

– C12-24-002 Theory Report

2025

"A clear case of 'low-hanging fruit' with a wealth of opportunities to address long-standing open questions."

– PR12-23-007 Theory Report

2023

"Scientifically sound, with a clear rationale and a well-designed experimental plan"

– PR12-24-002 Theory Report

2024

PAC Status

"The PAC recognizes the significant importance of measuring the fundamental proton structure function g_2 for the proton. The presented physics case and the proponents' approach to the future measurement are solid."

– PAC52 Report

2024

PAC Status

Conditional Requirements:

- "The impact of this new setup on the detector resolution and its subsequent effect on the physics results has not been thoroughly addressed. <u>**A full Monte Carlo simulation**</u> of the new setup and detector is needed."

– PAC52 Report

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– PAC52 Report

2024

PAC Report / Conditional Status

Conditional Requirements:

- "The impact of this new setup on the detector resolution and its subsequent effect on the physics results has not been thoroughly addressed. **A full Monte Carlo simulation** of the new setup and detector is needed."

– PAC52 Report

✅

"In our view, this requirement has been fulfilled in great detail. The effects of the chicane and the transverse target field on the resolution of the SHMS and the experimental observables are fully understood and quantified. "

-PAC53 Readers

(Prof. Alexandra Gade & Prof. Bernhard Ketzer)

"The PAC recognizes the significant importance of measuring the fundamental proton structure function g_2 for the proton. The presented physics case and the proponents' approach to the future measurement are solid."

– PAC52 Report

2024

Summary

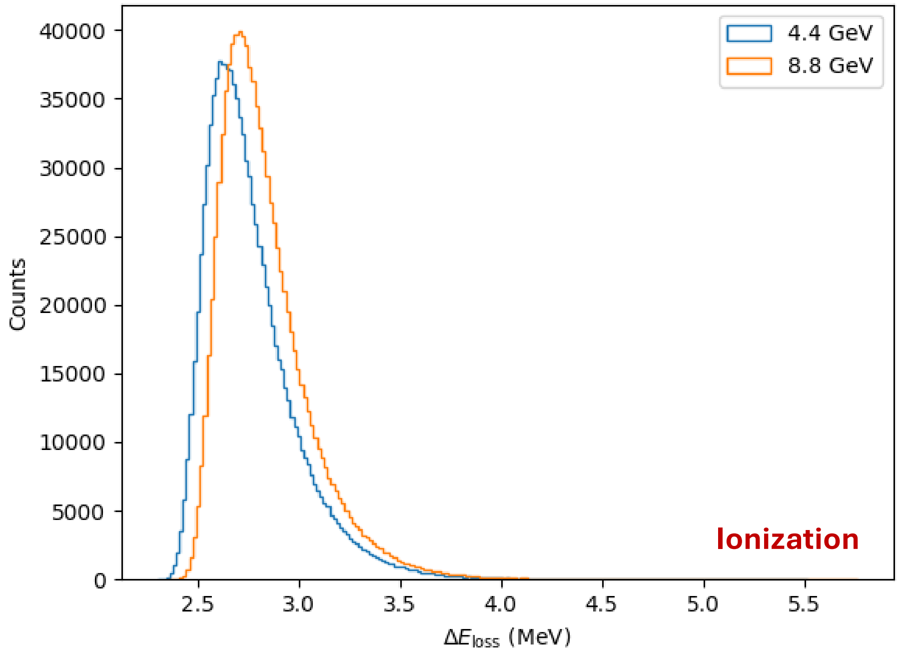
- All of PAC52 Conditional Requirements fulfilled ✅
- Target field impact extensively quantified with simulation ✅
- **Significant and novel physics goals:**
  - ➢ **Study higher twist (interaction-dependent effects)**
  - ➢ **Test Lattice QCD**
  - ➢ **Study hydrogen hyperfine splitting**
  - ➢ **Extract other polarizabilities and moments**
- Collaboration is ready to get to work on helping to prepare the equipment ✅

Let's make it happen!

Backup Slides

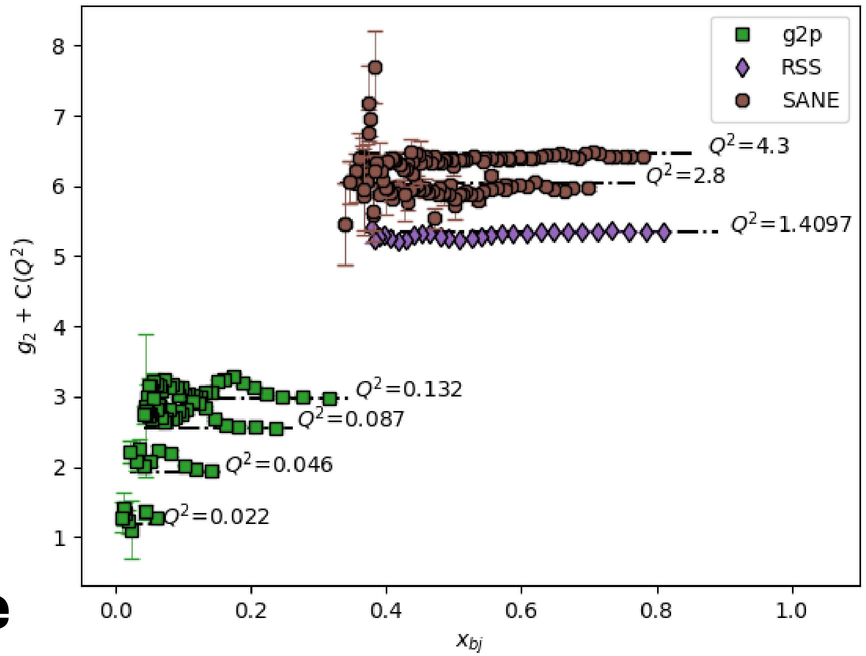
TAC/Reader Questions Summary

- **Is the downstream beampipe interaction due to low energy tails/multiple scattering a concern?**
  - ❖ No, we calculated this interaction to be small and the detector is shielded against these backgrounds
- **Is a local beam dump an option?**
  - ❖ We investigated this option in the proposal's first iteration and it is a worse option due to open questions about small detector angles and heat load from the high energy beam.
- **How long to check the low current BCM linearity?**
  - ❖ Dr. Mack (BCM Expert) will help us check and obtain a <1% nonlinearity with a few days of work and an RF signal generator.
- **Is the wrong luminosity included in the rates calculation and will you exceed the DAQ rate limit?**
  - ❖ No, there was just an unclear sentence in the proposal. The correct rate was used and we will not exceed the DAQ limit.



TAC/Reader Questions Summary

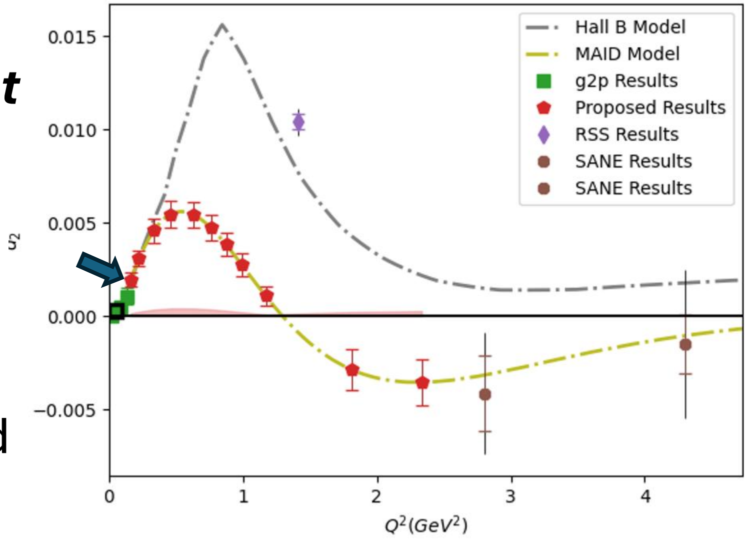
- **Can the polarized target be commissioned in time?**
  - ❖Yes, there is a significant amount of work to be done by the Target Group, but they have no doubts it can be done in time and the collaboration will help however we can.
- **Overhead for a T.E. should be 4 hours, not 2.25**
  - ❖Fixed, does not increase PAC days request
- **What do the planned statistics mean in the context of model uncertainties?**
  - ❖The primary goal of the statistics is to check theory directly, but the data will also hugely improve the phenomenological models, which are almost unconstrained in this region.
- **Are some events lost in the simulation when the target field is added?**
  - ❖Yes, some events are smeared outside the analysis cuts. This never effects more than 5% of events at most, and is not a significant impact on the statistics.

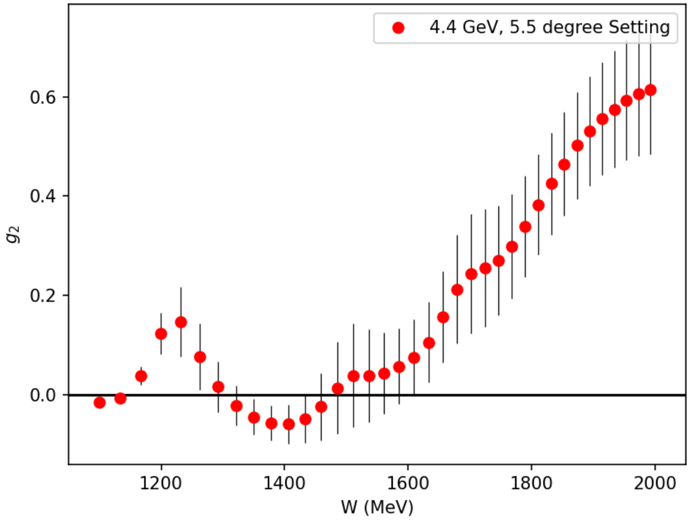


Option: Going Lower in Q^2

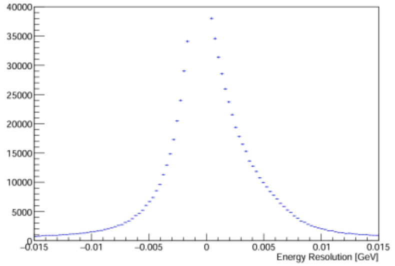
Reader Question: B. Ketzer

- ***What if we add a kinematic setting at the minimum Scattering Angle of SHMS (5.5 deg)?***
- $Q^2 = 0.16\ \mathrm{GeV}^2$
- 3 additional hours running + 5 additional hours overhead
- Would exceed DAQ rate limit and need a prescale factor
- Impact on resolutions in simulation seems similar to that shown for 6.5 deg setting
- We would need 1 additional PAC day to safely add this setting (total **27 days**)
- **Creates more continuous coverage by connecting more closely to g2p results at low Q^2**





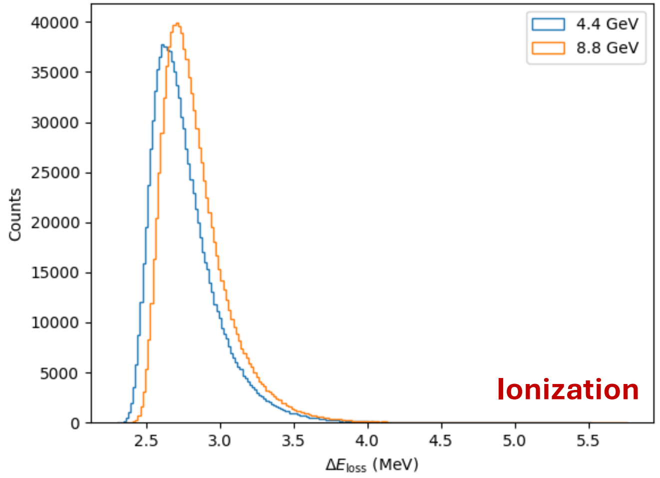
E_0	Θ	P_0	W	Q^2	Rate P (Hz)	Rate (kHz)	Pre	$\mathcal{L}$	$P_b P_t$	I (nA)	Time (h)
4.4	5.5	3.607	1.49	0.146	77	40.0	2	0.9E+35	0.60	85	1.0
4.4	5.5	2.661	2.01	0.108	108	40.0	1	0.9E+35	0.60	85	1.0
4.4	5.5	1.963	2.32	0.080	134	37.6	1	0.9E+35	0.60	85	1.0

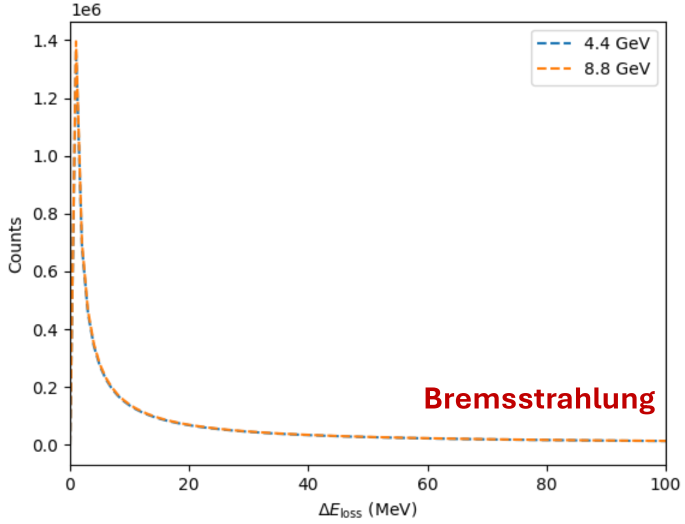


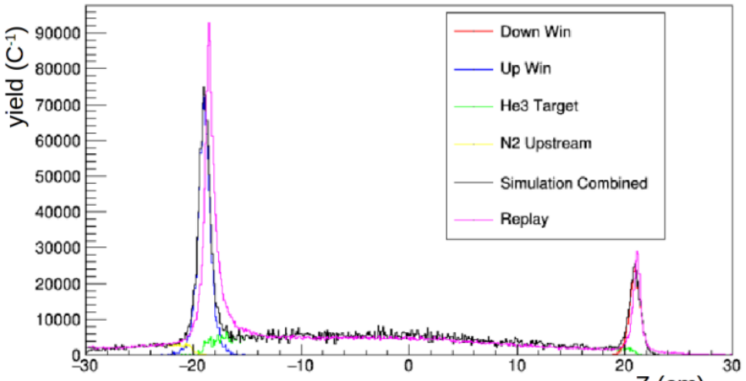
Downstream Beam Pipe

- A few TAC questions about beam interaction with downstream beam pipe
- A small fraction of the post-target beam [O(1) nA] interacts with pipe

- No consequential background:
  - **Out of line of sight of SHMS electron acceptance**
  - SHMS has shielded detector hut explicitly to remove these backgrounds!
  - Any residue is removed by cutting on Z_{target}
- No radiological hazard:
  - Beam current is already low
  - Only a small fraction of the beam actually interacts with beampipe

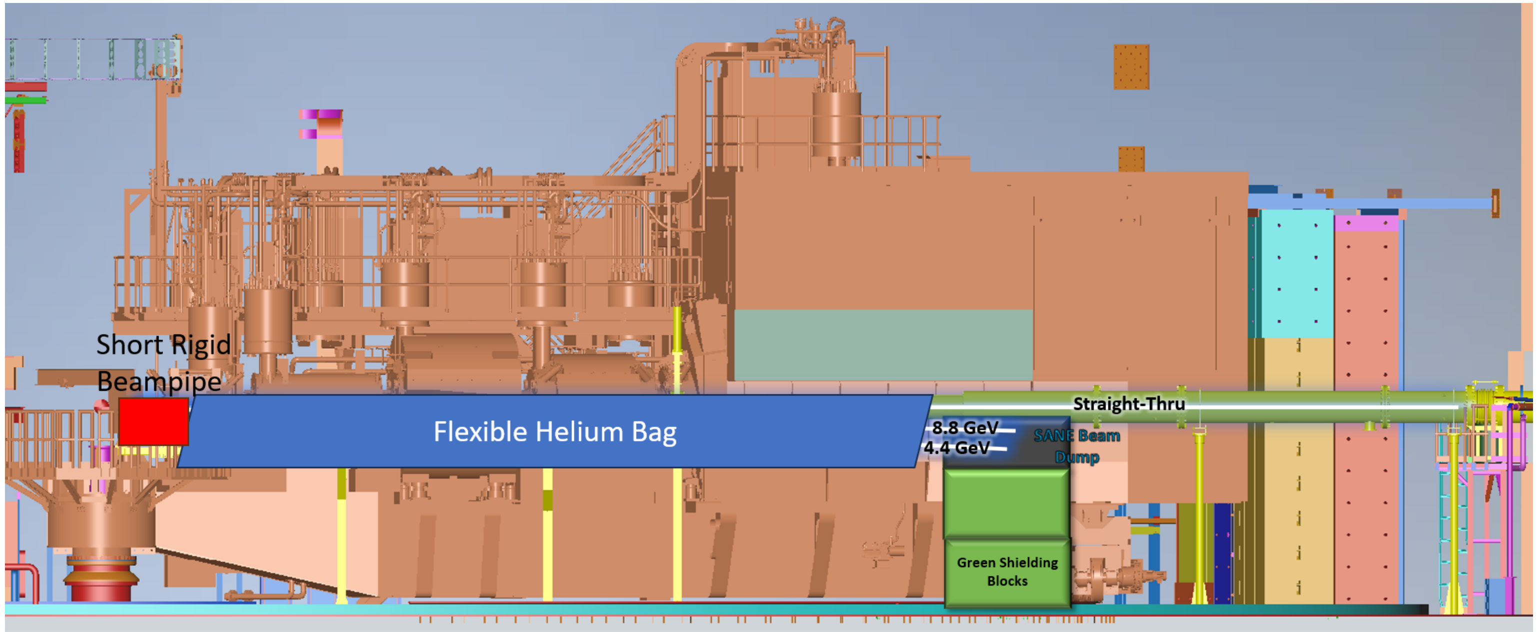






M. Roy E12-06-121 Thesis

Local Beam Dump



- Proposal originally featured Local Dump
- Unknown if higher beam energy will crack steel on old dump
- A helium bag would be needed
- Small SHMS angles would need to dump beam into Q1 steel

Using the Chicane gives a much cleaner measurement

BCM Linearity

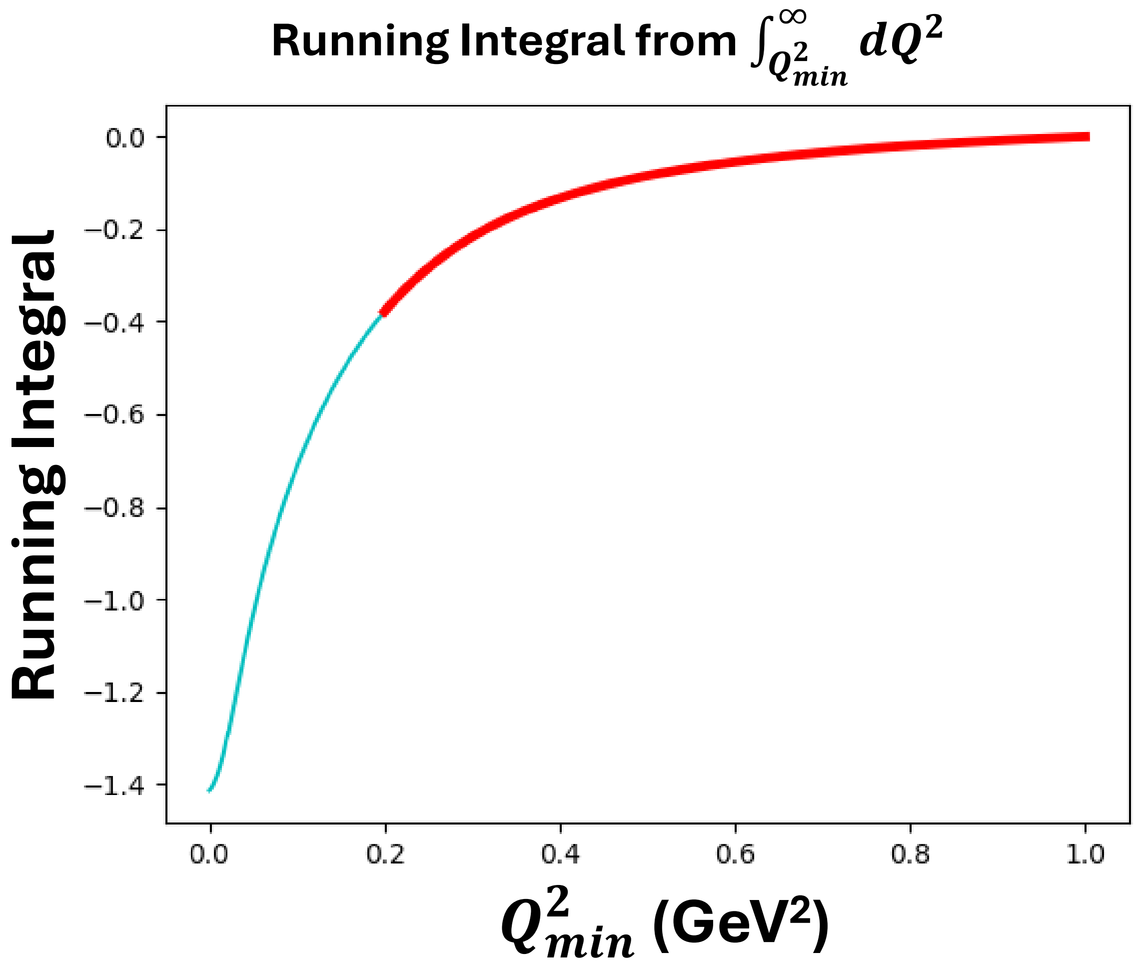
- Beam Charge Asymmetry dQ/Q: 0.1% or better with charge feedback

- Dr. Dave Mack can demonstrate the nonlinearity is not worse than 1% with RF Signal Generator

$$A^{\text{False}}_{\text{Physics}} = \frac{1}{P_b P_t f} \frac{dQ}{Q} \mathcal{N}$$

- This results in 0.01% False Physics Asymmetry (or better)

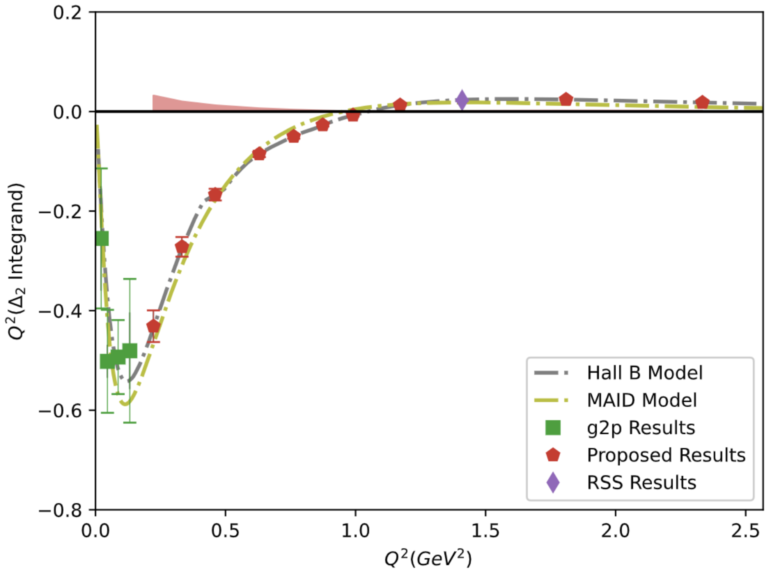
Hyperfine Contribution



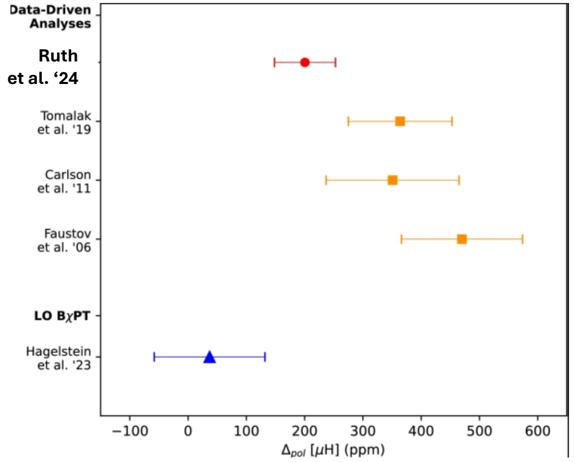
$$\Delta_2 = -24M_p^2 \int_0^{\infty} \frac{dQ^2}{Q^4} \int_0^{x_{th}} \widetilde{\beta_2}(x, Q^2) g_2(x, Q^2) dx$$

- The leading error in theoretical calculations of the hydrogen HFS comes from these spin-structure function dependent integrals!
- The subject of an ongoing tension between theory and experiment
- The transition region accounts for ~30% of the integral!

Hydrogen Hyperfine Splitting Impact



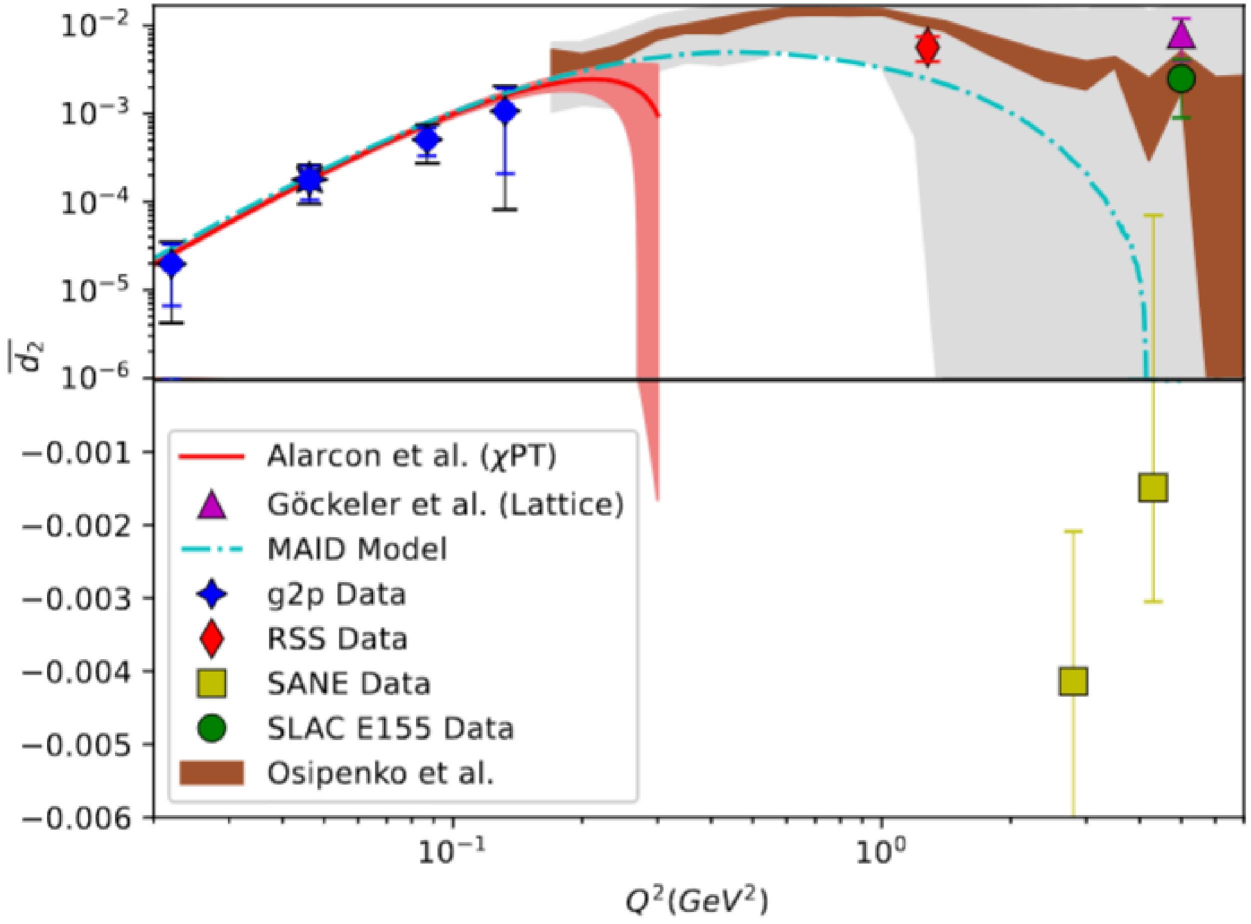
Δ_{pol}



$$\Delta_2 = -24M_p^2 \int_0^\infty \frac{dQ^2}{Q^4} \int_0^{x_{th}} \widetilde{\beta_2}(x, Q^2) g_2(x, Q^2)\, dx$$

- Transition region accounts for **30% of Δ_2**
- These results can cut the error in this region to $^1/_6$ **of the current error**
- $\Delta_{pol} = c(\Delta_1 + \Delta_2)$ accounts for **81%** of the current two-photon Hyperfine Splitting uncertainty
- Opportunity to **study or maybe eliminate a long-standing tension** between theory and experiment for Δ_{pol}!

“Color Polarizability” d_2

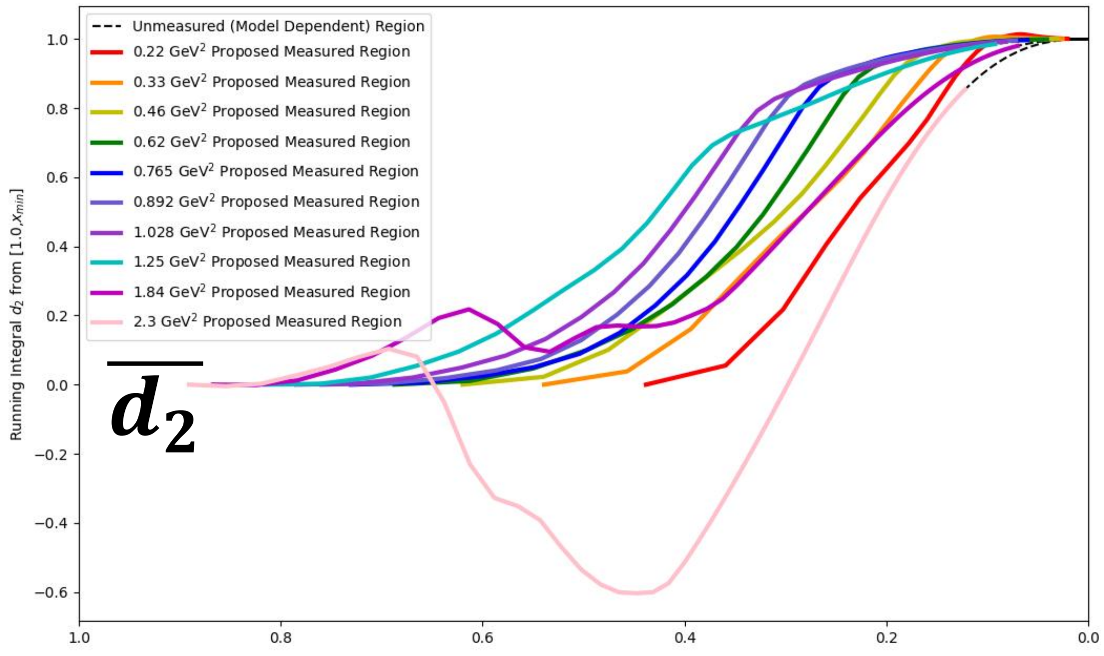


$$\overline{d_2} = \int_0^{x_{th}} x^2[2g_1(x,Q^2) + 3g_2(x,Q^2)]dx$$

- At high Q^2: color polarizability / “color Lorentz force”
- Interesting differences in existing data motivate further study
- **Upcoming lattice predictions** in this region need experimental benchmark!

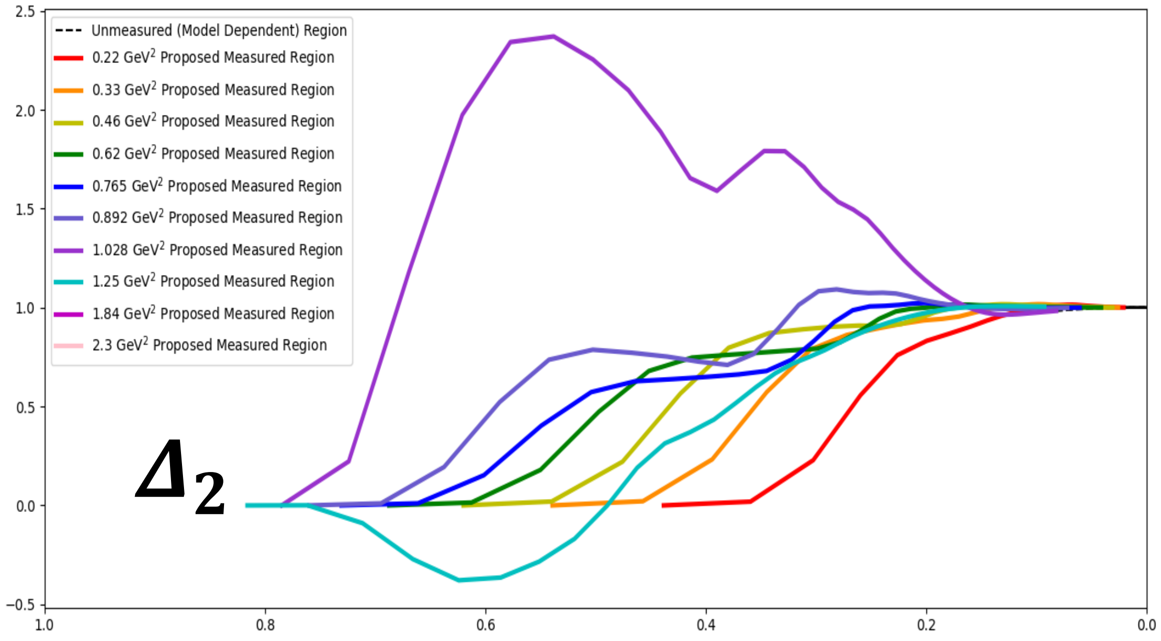
Running Integrals as % Total Value ($\int_{x_{min}}^{1} dx$)

Running Integral (% Total)



x_{min}

Running Integral (% Total)



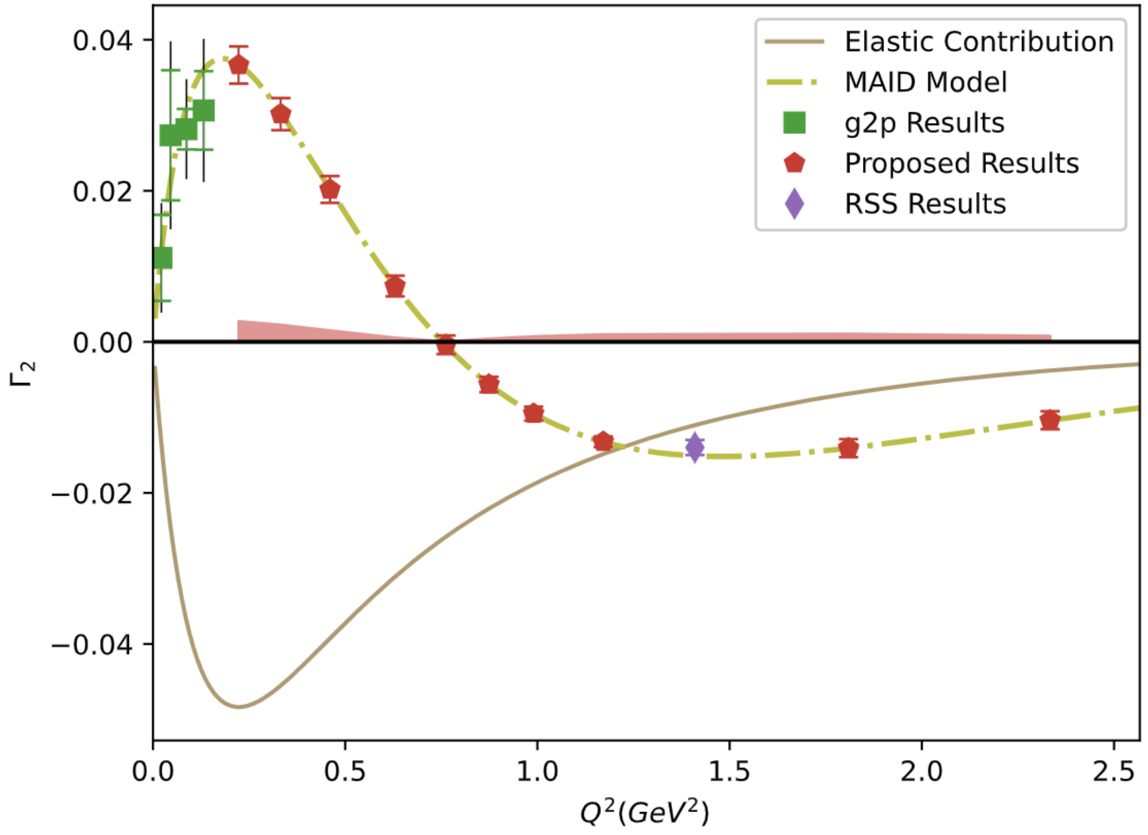
x_{min}

- Integrals are saturated in the measured region (flat slope)
- Therefore, **<u>the low-x regime is irrelevant to these integrals</u>**

Projected Γ_2 Uncertainties

- Having data in the regime where twist-2 assumption fails helps us better understand the small-x regime

- If B.C. Sum Rule is followed, then we directly measure how the low-x part transitions from g_2^{WW} into a more complex form!



Dynamical Mass Generation

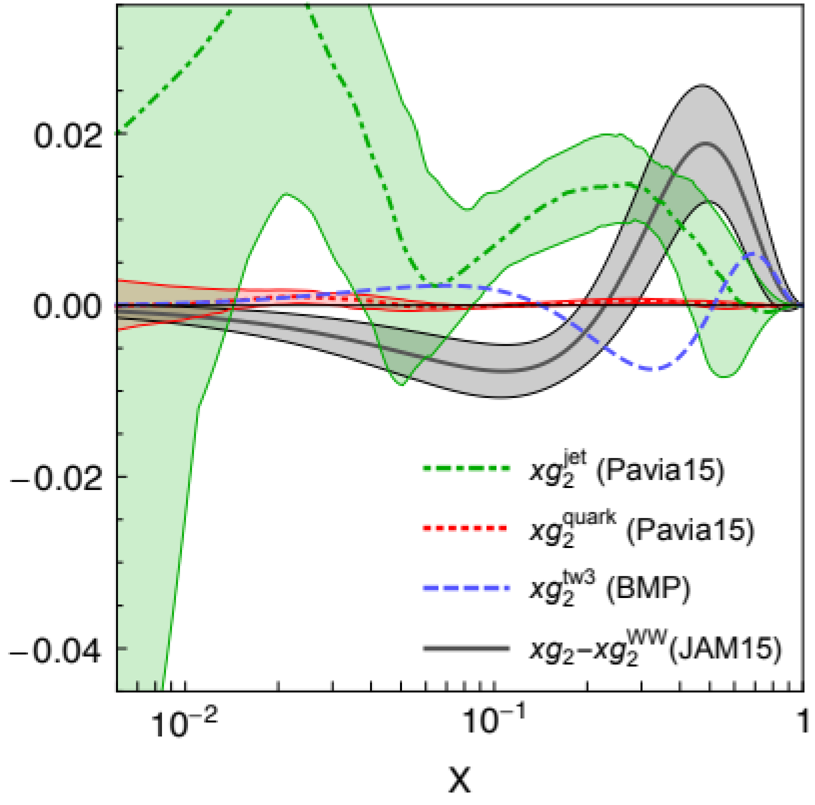
- g_2 can also directly probe dynamical mass generation in QCD!

$$g_2^{\rm quark} = \frac{1}{2}\sum_q e_q^2 \frac{m_q}{M}\left(\frac{h_1^q}{x}\right)^{\star}(x_B)\ ,$$
$$g_2^{\rm jet} = \frac{1}{2}\sum_q e_q^2 \frac{M_q - m_q}{M}\frac{h_1^q(x_B)}{x_B}\ .$$

- <u>Strong</u> theory interest in this aspect

- Will coordinate with global QCD analysis groups (JAM/CJ collaborations at JLab) to optimally use data

A. Accardi & A. Bacchetta, PLB 2017



Rates Table

Total PAC Days: 13.0

E_0 (GeV)	Scattering Angle (deg)	P_0 (GeV)	Target Q^2 (GeV^2)	Proton Rate (Hz)	Rate (kHz)	Time (h)
4.4	6.5	3.607	0.22	77	40.0	1
		2.661		65	25.1	1
		1.963		69	18.9	1
	8	3.607	0.33	41	21.4	1.3
		2.661		28	11.5	1.9
		1.963		30	8.3	1.8
	9.5	3.607	0.46	18	9.1	2.3
		2.661		14	5.9	3.0
		1.963		15	4.3	2.8
	11.2	3.607	0.62	7	3.7	6.0
		2.661		6	3.0	6.5
		1.963		7	2.2	5.9
	12.5	3.607	0.765	4	2.0	9.1
		2.661		4	1.9	8.5
		1.963		4	1.5	7.6
	13.5	3.607	0.892	2	1.3	16.5
		2.661		3	1.3	13.7
		1.963		3	1.1	12.1
	14.5	3.607	1.028	1	0.8	23.2
		2.661		2	1.0	17.4
		1.963		2	0.8	14.9
	16	3.607	1.250	0	0.4	50.8
		2.661		1	0.6	32.7
		1.963		1	0.5	26.6
8.8	11	7.213	2.3	0	0.5	33.3
		5.321		0	0.8	19.0
	14	7.213	3.44	0	0.1	101.8
		5.321		0	0.2	31.6

Overhead

- **Total: 12.7 Overhead Days (305.5)**

Overhead	Number	Time Per (hr)	(hr)
Target Anneal	26	2.0	52.0
Beamline Survey	10	8.0	80.0
Target Swap	2	4.0	8.0
Target T.E.	6	4	24.0
Target Field Ramp	10	1.0	10.0
Carbon, Dummy, Empty runs	28	0.5	14.0
Pass Change	2	4.0	8.0
Momentum Change	28	0.5	14.0
Moller Measurement	10(+1 shift)	4.0(+8.0)	48.0
Pair-Symmetric Background	2	4.0	8.0
Optics Calibration	2	16.0	32.0
BCM Calibration	2	4.0	8.0

Burkhardt-Cottingham Sum Rule

$$\boxed{\boldsymbol{\Gamma_2 = \int_0^{x_{th}} g_2(x, Q^2) dx = 0}}$$

- "Superconvergence" Sum Rule for an amplitude whose imaginary part is g_2
- Assuming convergent dispersion relations for $g_2(\nu)$ and $\nu g_2(\nu)$, arises naturally from subtraction of VVCS amplitudes:
  - $Im\, S_2(\nu, Q^2) = \frac{2\pi}{\nu^2 M} g_2(x, Q^2)$
  - $S_2(\nu, Q^2) = \frac{2}{\pi} \int_{\nu_{th}}^{\infty} \frac{\nu\, Im\, S_2}{\nu'^2 - \nu^2} d\nu'$
  - $\nu S_2(\nu, Q^2) = \frac{2}{\pi} \int_{\nu_{th}}^{\infty} \frac{\nu'\, Im\, S_2}{\nu'^2 - \nu^2} d\nu'$
- B.C. Integral converges to 0 in both QED and Perturbative QCD, and follows from Wandzura-Wilczek relation (Altarelli et al [1994], R. L. Jaffe [1990 Review])

Reliability of the Chicane

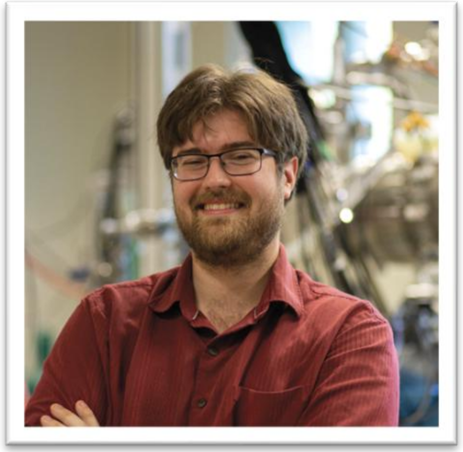
- Chicane is a <u>new</u> installation, not a refurbishment of the old chicane
- Design is fundamentally similar to numerous similar projects by the JLab staff, nothing untested or uncertain about it
- Dr. Benesch is the longest serving member of the TAC and has designed resistive and superconducting magnets since 1976
- Staff scientists are very confident that chicane will be carefully built and tested and will work well, but will need some time to commission

Collaboration

Jian-Ping Chen

Nathaly Santiesteban

Karl Slifer



David Ruth

g2p Analysis

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J.P. Chen
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SANE Analysis

W. Armstrong
J. Maxwell
Z.E. Meziani
M. Jones

RSS Analysis

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Polarized Target Experts

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