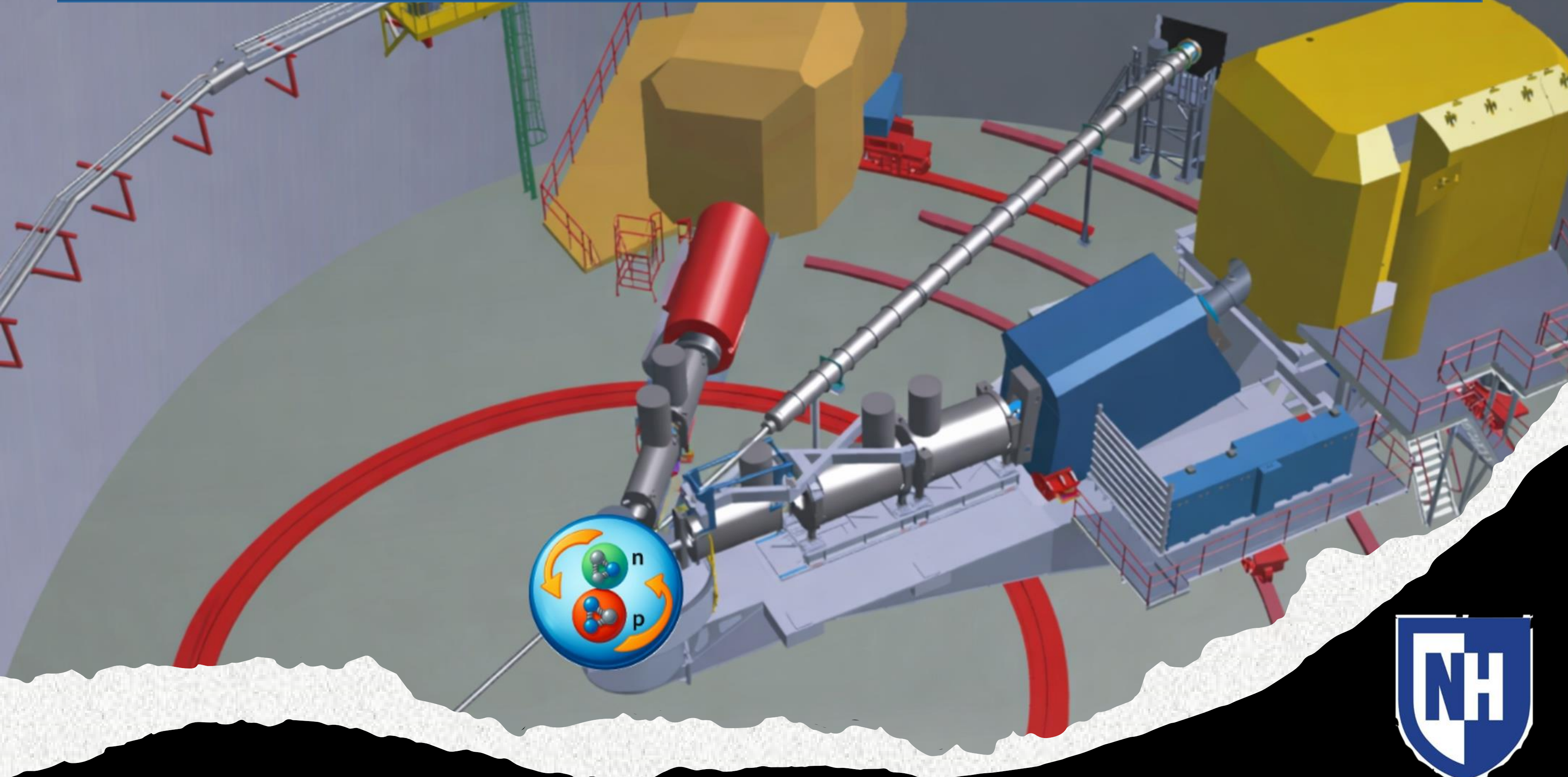
Upcoming Tensor Polarized Experiments in Hall C



Hall C Winter Collaboration Meeting
2026

Nathaly Santiesteban

Hall C Experiments

Number	Name	Scientific Rate	Days Awarded
E2-13-011	The Deuteron Tensor Structure Function b_1	A-	41
E12-15-005	Measurements of the Quasi-Elastic and Elastic Deuteron Tensor Asymmetries	A-	45
LOI12-24-002	Spin-1 TMDs and Structure Functions of the Deuteron		
LOI12-25-002	Exclusive electro-disintegration of tensor polarized deuterium		

Collaboration Team

Graduate Students
Jay Roberts (UVA)
Sujan Subedi (UVA)
Muhammad Farooq (UNH)
Michael McClellan (UNH)
Hector Chinchay (UNH)
Chhetra Lama (UNH)
Anshit Arora (UNH)
Zoe Wolters (UNH)
Devin Seay (UVA)
Aden Whitney (UNH)

Undergraduates
Alexandra Antar (UNH)
Matt Breton (UNH)
Shane Clements (UVA)
Ian Cruz (UVA)
Benjamin Limric (UNH)
Eli Phippard (UNH)

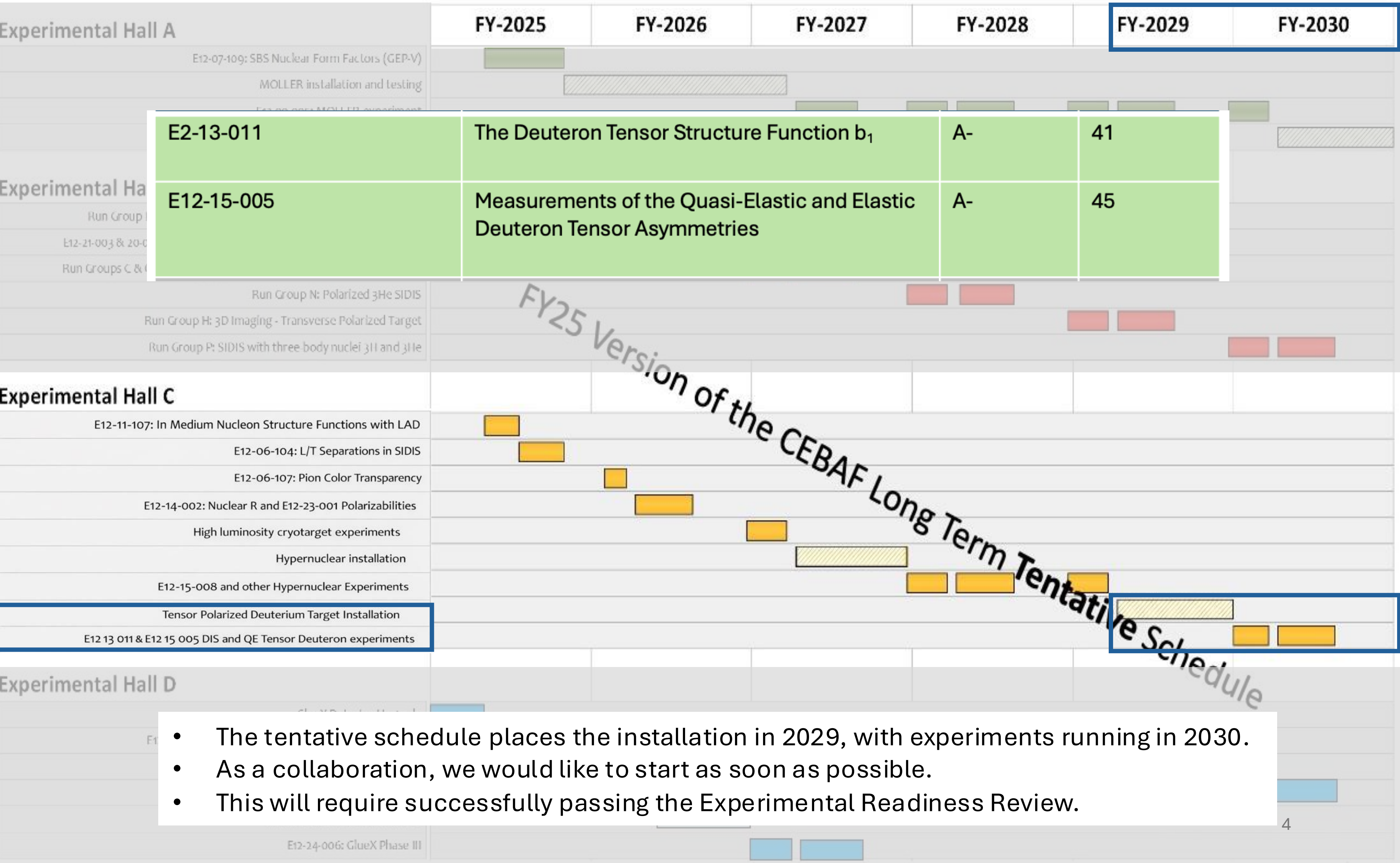
Apologies if any names were unintentionally missed.

Postdocs
Ishara Fernando
Jan Vanek
Forhad Hossain
Allison Zec

Faculty
David Ruth
Carlos Yero

JLab Staff
Jiwan Poudel
Jian-Ping Chen
Chris Keith
James Maxwell
+ full target group
Dave Mack
Doug Higinbotham
Dave Gaskell
Hanjie Liu
Mark M. Dalton

Spokespeople
Jian-Ping Chen
Donal Day
Douglas Higinbotham
Narbe Kalantarians
Dustin Keller
Elena Long
Oscar Rondon
Nathaly Santiesteban
Karl Slifer



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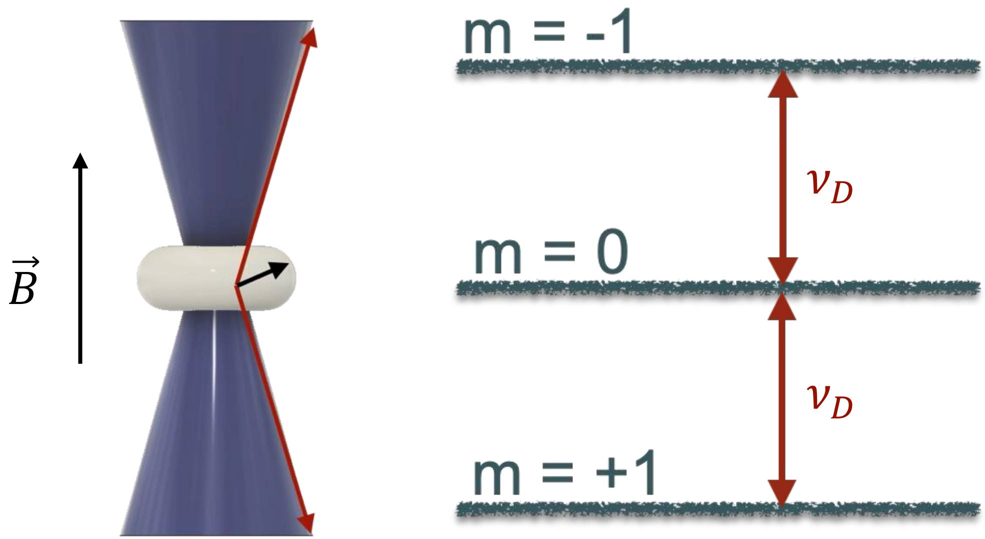
- The tentative schedule places the installation in 2029, with experiments running in 2030.
- As a collaboration, we would like to start as soon as possible.
- This will require successfully passing the Experimental Readiness Review.

What do we need? Large tensor polarization

Spin-1 Polarization



$$\nu_D = \frac{\mu_D B}{h}$$

$$\nu_D = 6.54 \ \text{MHz/T}$$

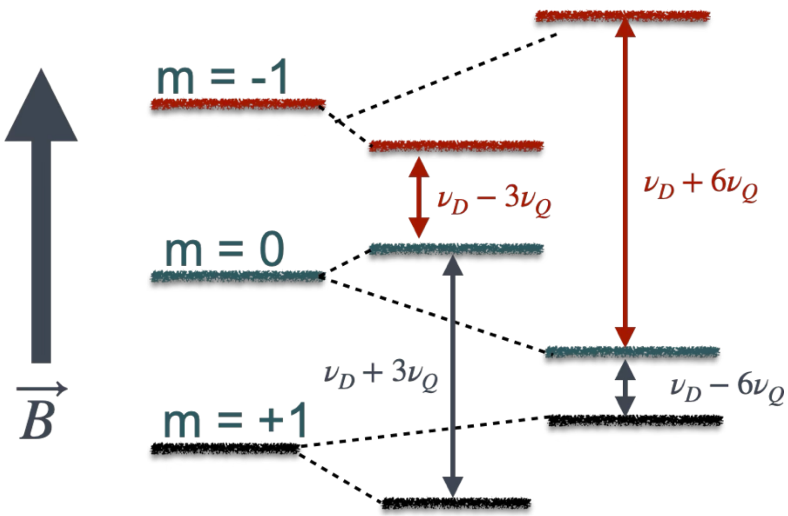
Spin-1 in a magnetic field System

- 3 sub-levels (+1, 0, 1) due to Zeeman interaction.
- Two energy transitions $I_+ (+1 \longrightarrow 0)$ and $I_- (0 \longrightarrow -1)$.

Spin-1 Polarization

$$E_m = -h\nu_D m + h\nu_Q(cos^2\theta - 1)(3m^2 - 2)$$

eQ: Electric quadrupole interaction (shifts the energy levels)
eq: Electric field gradient
θ: angle between eq and eQ



Vector Polarization:
$P = N_+ - N_-$
$-1 < P < +1$

Tensor Polarization:
$Q = N_+ + N_- - 2N_0$
$-2 < Q < +1$

Normalization:
$1 = N_+ + N_- + N_0$

Spin-1 Polarization

$$E_m = -h\nu_D m + h\nu_Q(\cos^2\theta - 1)(3m^2 - 2)$$

eQ: Electric quadrupole interaction (shifts the energy levels)
eq: Electric field gradient
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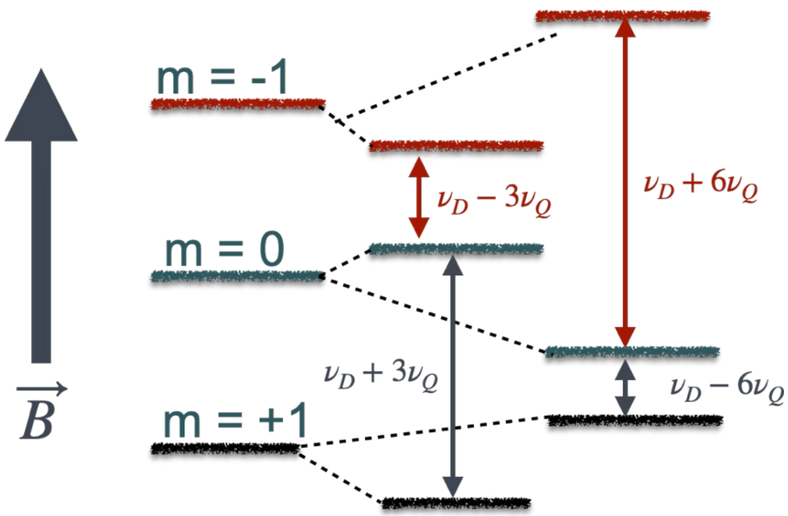
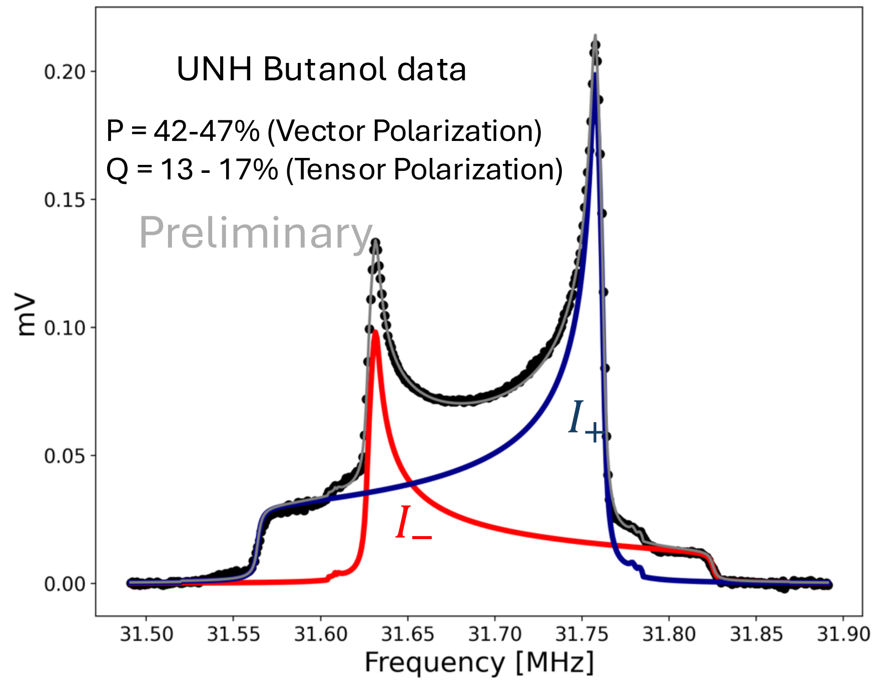
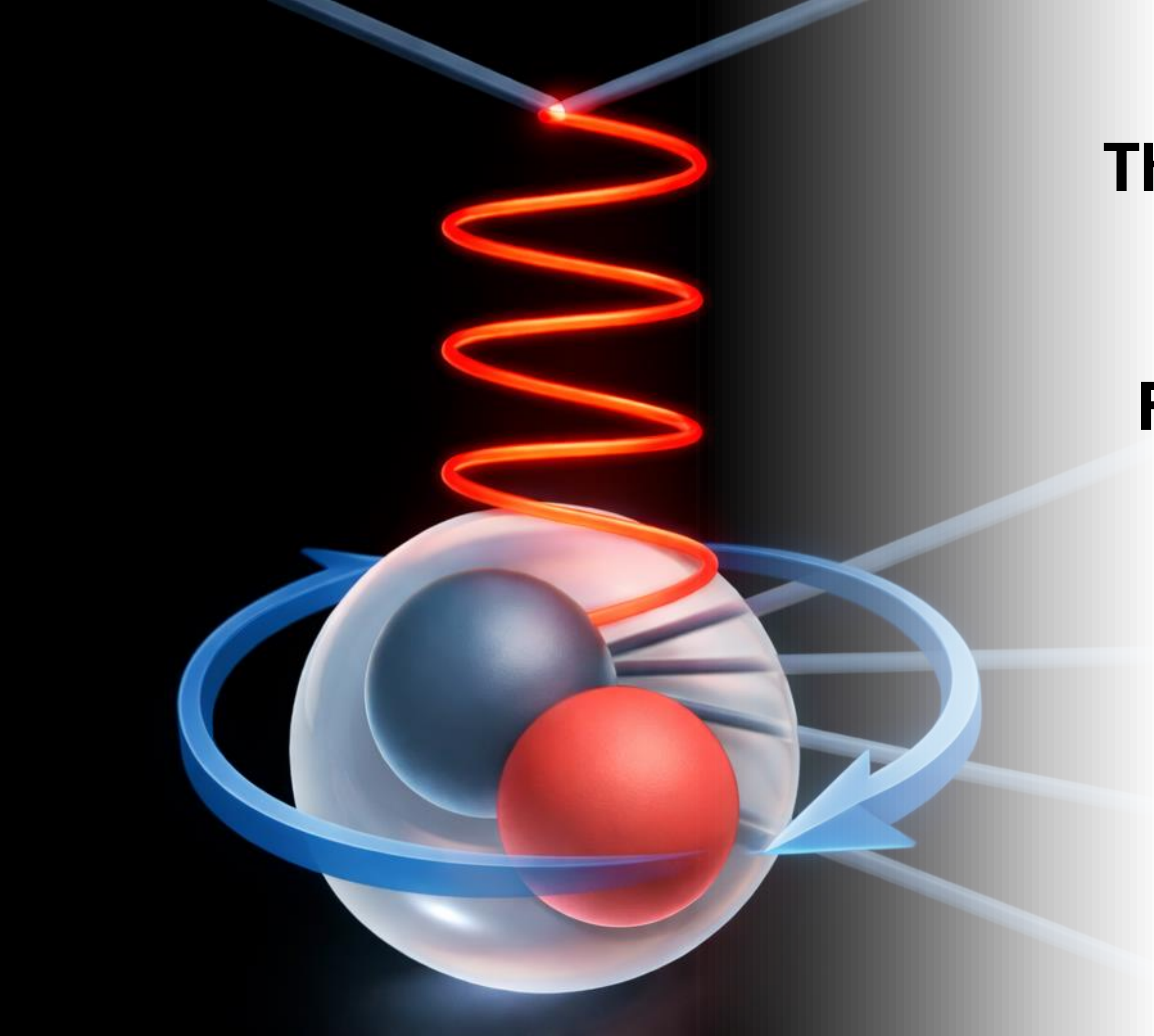




NMR signal



The Deuteron Tensor Structure Function b_1 E2-13-011

DIS Hadron Spin Tensor

$$W^{\mu\nu}_{\lambda'\lambda}(P,q) = -F_1 \hat{g}^{\mu\nu} + \frac{F_2}{M\nu}\hat{P}^\mu \hat{P}^\nu$$

Unpolarized structure functions

$$+ig_1 \epsilon^{\mu\nu\alpha\beta} q_\alpha S_\beta + ig_2 \frac{1}{M\nu}\epsilon^{\mu\nu\alpha\beta} q_\alpha (P \cdot q\, S_\beta - S \cdot q\, P_\beta)$$

Spin-1/2 Structure functions

$$-b_1 r^{\mu\nu} + \frac{b_2}{6}(s^{\mu\nu} + t^{\mu\nu} + u^{\mu\nu}) + \frac{b_3}{2}(s^{\mu\nu} - u^{\mu\nu}) + \frac{b_4}{2}(s^{\mu\nu} - t^{\mu\nu})$$

Tensor Structure functions

b_1 and b_2 are leading twist and directly probe tensor-polarized quark distributions

Tensor structure functions are accessible only in spin-1 systems

Jaffe, Manohar. Nuclear Physics B321 (1989)

Partonic Interpretation

In terms of tensor-polarized parton distributions:

$$b_1(x) = \frac{1}{2} \sum_q e_q^2 \left[\delta_T q(x) + \delta_T \bar{q}(x) \right]$$

with:

$$\delta_T q(x) = q^{(0)}(x) - \frac{q^{(+1)}(x) + q^{(-1)}(x)}{2}$$

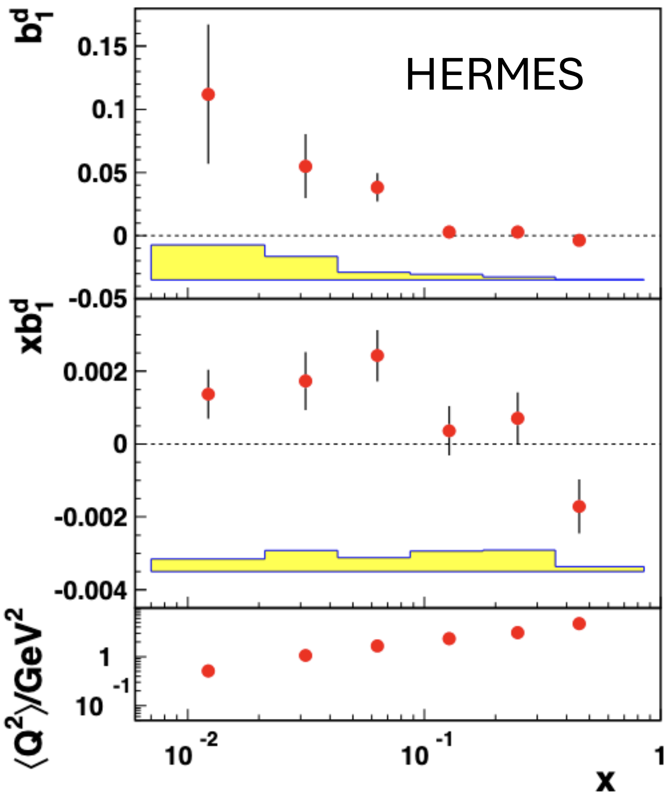
b_1 measures how different the quark distributions are when the deuteron is in the $m = 0$ spin state compared to the average of the $m = \pm 1$ states.

If the deuteron was spherically symmetric $b_1(x)$=0.

Jaffe, Manohar. Nuclear Physics B321 (1989)

First and Only Measurement of b_1

(to date)



$$b_1^{\mathrm{d}} = -\frac{3}{2} A_{zz}^{\mathrm{d}} F_1^{\mathrm{d}}$$

$$F_1^{\mathrm{d}} = \frac{(1+Q^2/\nu^2) F_2^{\mathrm{d}}}{2x(1+R)} \qquad F_2^{\mathrm{d}} = F_2^{\mathrm{p}}(1 + F_2^{\mathrm{n}}/F_2^{\mathrm{p}})/2$$

the measured asymmetry:

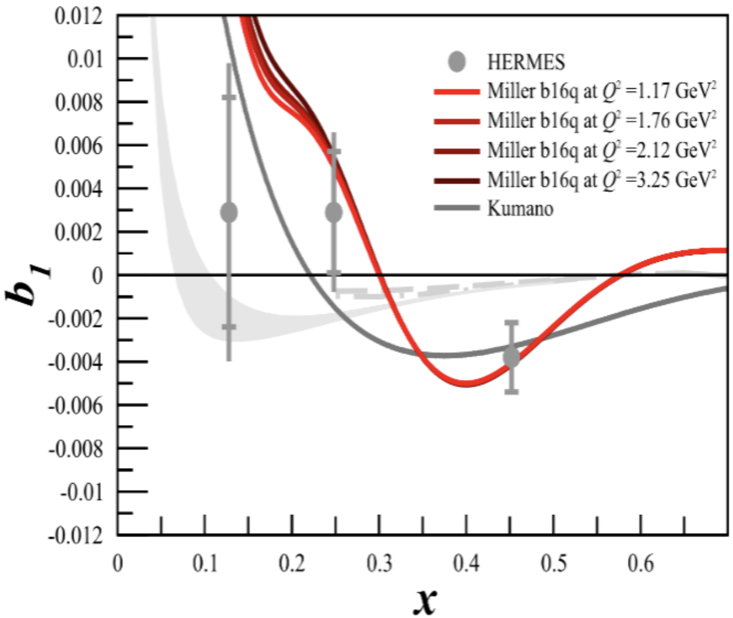
$$A_{zz}^{\mathrm{d}} = \frac{2\sigma^1 - 2\sigma^0}{3\sigma_U P_{zz}^{\mathrm{eff}}}$$

$$\sigma^1 = (\sigma^{\overleftarrow{\Leftarrow}} + \sigma^{\overrightarrow{\Rightarrow}} + \sigma^{\Leftrightarrow})/3 \qquad \sigma_U = (2\sigma^1 + \sigma^0)/3$$

$$P_{zz}^{\mathrm{eff}} = (P_{zz}^{\overrightarrow{\Rightarrow}} + P_{zz}^{\overleftarrow{\Leftarrow}} + P_{zz}^{\Leftrightarrow} - 3P_{zz}^{0})/9$$

HERMES collaboration. Phys. Rev. Lett. 95 (2005)

Observation: non-zero $b_1(x)$ at intermediate *x*.



The HERMES result suggests that at the quark level the deuteron has:

•non-trivial tensor polarization effects

•partonic correlations beyond nucleon degrees of freedom

•sensitivity to:

- quark orbital angular momentum
- possible non-nucleonic components (e.g. hidden-color configurations)

Results: provocative but not conclusive

Limited statistics and kinematic coverage

•the detailed x-dependence of b_1

•whether sea quarks dominate the signal

•the role of gluons

•the validity of the b_1 sum rule

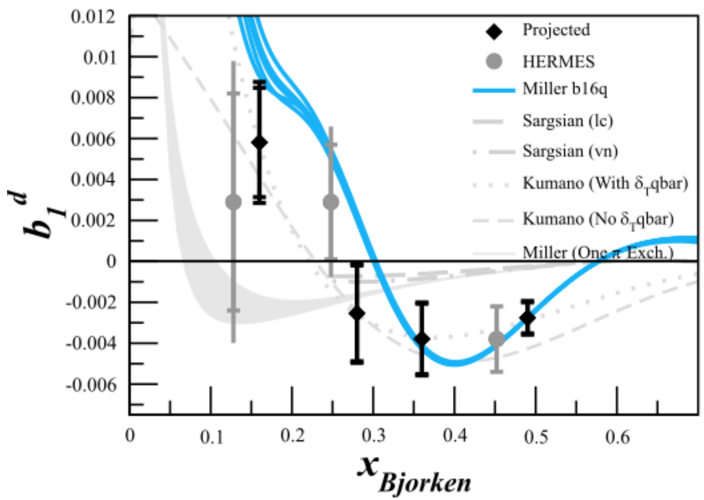
Khan, Hoodbhoy, PRC 44 ,1219 (1991)
Relativistic convolution model with binding

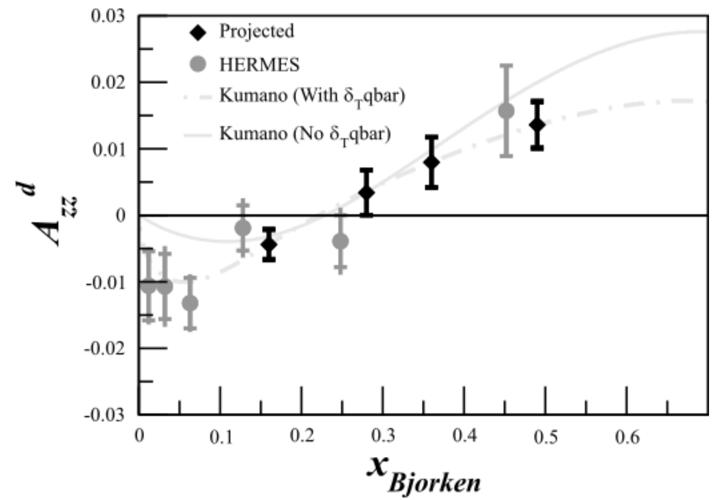
Umnikov, PLB 391, 177 (1997)
Relativistic convolution with Bethe-Salpeter formalism

W. Cosyn, Y. Dong, S. Kumano, M. Sargsian PRD95 (2017)
Standard Convolution description

G. Miller PRC89 (2014)
Pionic contributions and Hidden-color six-quark configurations

E12-13-011: Proposed measurement





Projected results with:

- Tensor polarization Q=26%
- Current I = 85 nA

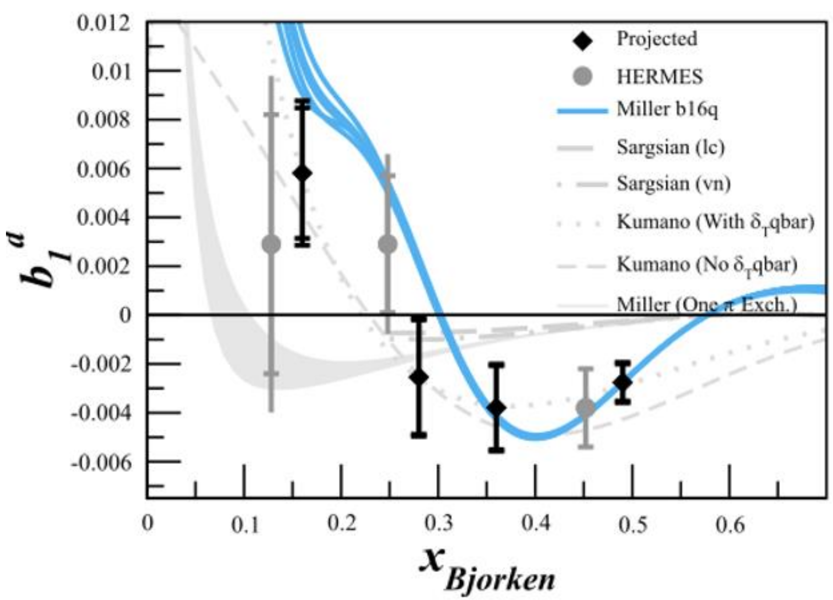
$$b_1^{\mathrm{d}} = -\frac{3}{2} A_{zz}^{\mathrm{d}} F_1^{\mathrm{d}}$$

$$A_{zz} = \frac{2}{fQ}\left(\frac{\sigma(+P,Q)+\sigma(-P,Q)}{\sigma(+P,0)+\sigma(-P,0)} - 1\right)$$

f: Dilution factor; Q: Tensor polarization; P: Vector polarization

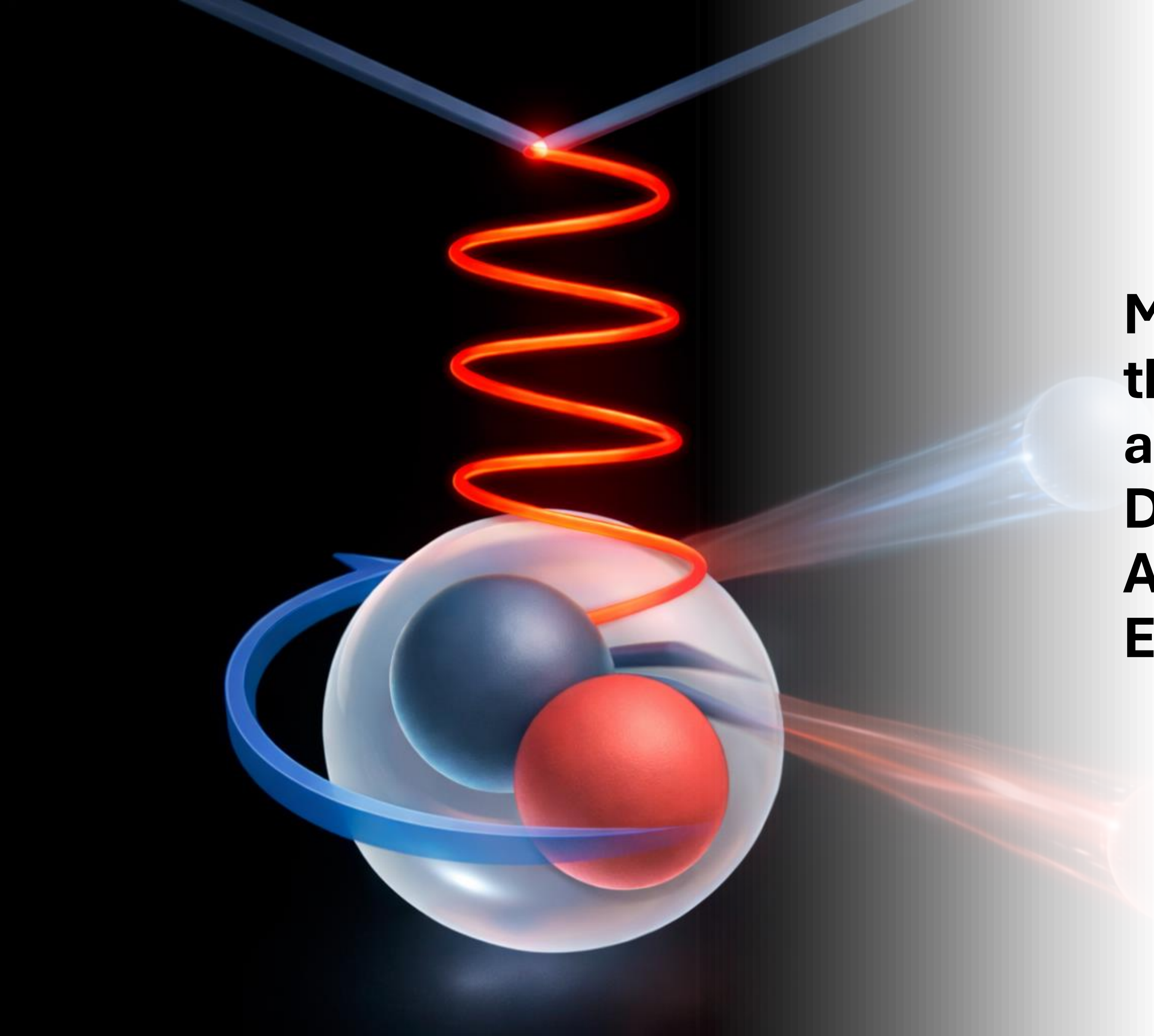
E12-13-011: Equipment and Running Conditions

	$\overline{x}$	$\overline{Q^2}$ (GeV^2)	$\overline{W}$ (GeV)	P_0 (GeV)	θ (deg.)	time (days)
SHMS	0.15	1.21	2.78	6.70	7.35	6
SHMS	0.30	2.00	2.36	7.45	8.96	9
SHMS	0.452	2.58	2.00	7.96	9.85	15
HMS	0.55	3.81	2.00	7.31	12.50	30



- 11 GeV electron beam
- Tensor-polarized deuteron target (solid ND_3)
- Hall C magnetic spectrometers: HMS and SHMS for scattered electron detection
- Beam diagnostics: raster system (fast and slow), beam current monitors, Faraday cup*
- Polarization cycling and monitoring to control systematic uncertainties

Major R&D and installation
Installation
Development and Installation



Measurements of the Quasi-Elastic and Elastic Deuteron Tensor Asymmetries E12-15-005

Quasi-elastic Measurement

Experimental Cross-Section

$$\sigma = \sigma_0 \left[1 + PA_V^d + QA_{zz}^d + h\left(A_e + PA_V^{ed} + QA_{zz}^{ed}\right)\right]$$

$$A_{zz} = \frac{\rho_{20}}{\rho_{unp}}$$

Unpolarized:

$$\rho_{unp}(p) = n(p) = |u(p)|^2 + |w(p)|^2$$

Tensor polarized:

$$\rho_{20}(p, \theta_N) = \frac{3\cos^2(\theta_N) - 1}{2}\left[2\sqrt{2}u(p)w(p) - w^2(p)\right]$$

Arenhövel, Leidemann, Tomusiak PRC **46**, 455 (1992)

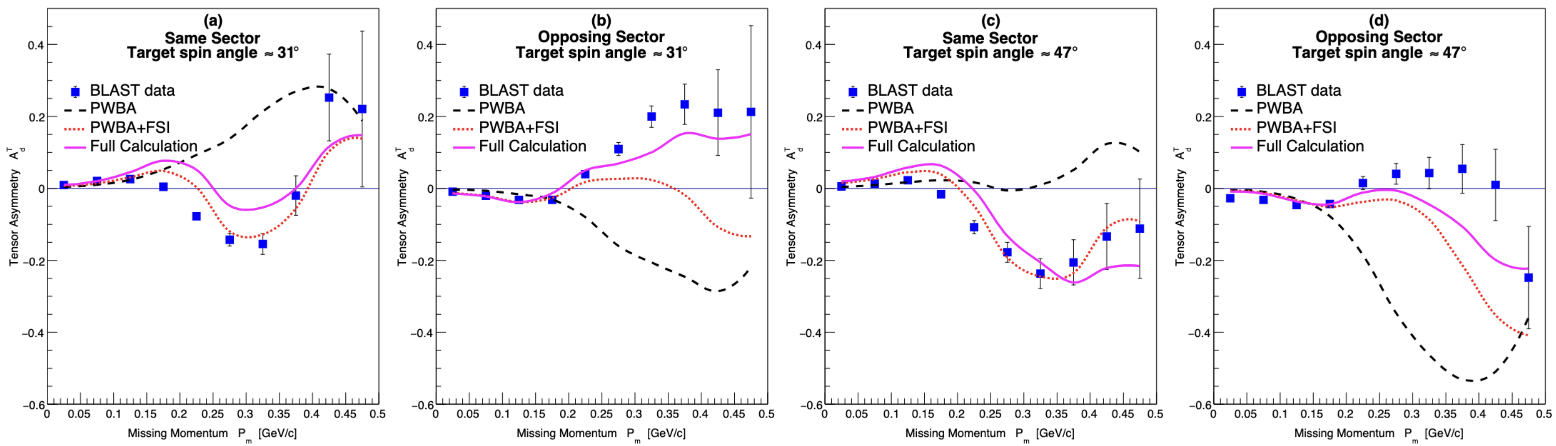
Quasi-elastic Measurement

$$\sigma = \sigma_0 \left[1 + PA_V^d + QA_{zz}^d + h\left(A_e + PA_V^{ed} + QA_{zz}^{ed}\right)\right]$$

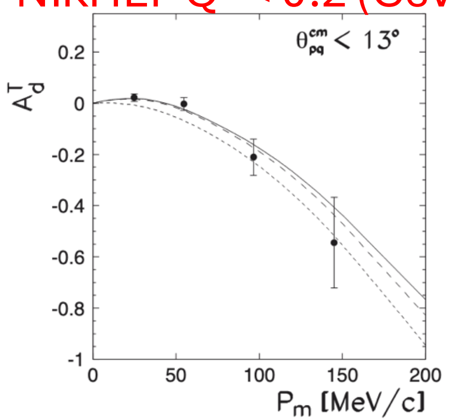
- Born approximation A_e, A_V^d, A_{ZZ}^{ed} are all zero.
- In a purely S-state A_{zz}^d is also zero but will vary from zero as D-state contributions become important providing a measure of the tensor component of the NN interaction.
- A_V^d will vary as D-state contributions become significant.

Previous Measurements

MIT-Bates $0.1 < Q^2 < 0.5$ (GeV/c)^2



NIKHEF $Q^2 < 0.2$ (GeV/c)^2

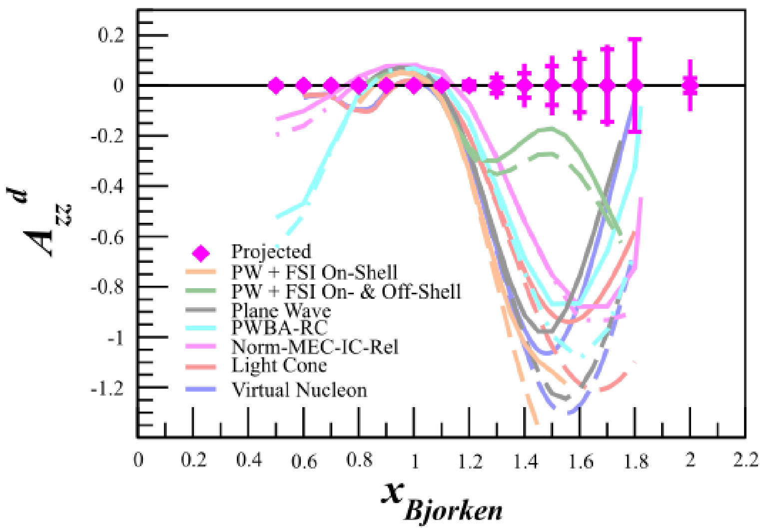


Z.-L. Zhou et al., Phys. Rev. Lett. 82, 687 (1999)

A. DeGrush et al., Phys. Rev. Lett. 119, 182501 (2017)

There are no previous measurements of the inclusive asymmetry

E12-15-005: Proposed measurement



- Very Large Tensor Asymmetries predicted
- Sensitive to the S/D-wave ratio in the deuteron wave function
- 4σ discrimination between hard/soft wave functions
- 6 σ discrimination between relativistic models

Projected results with:

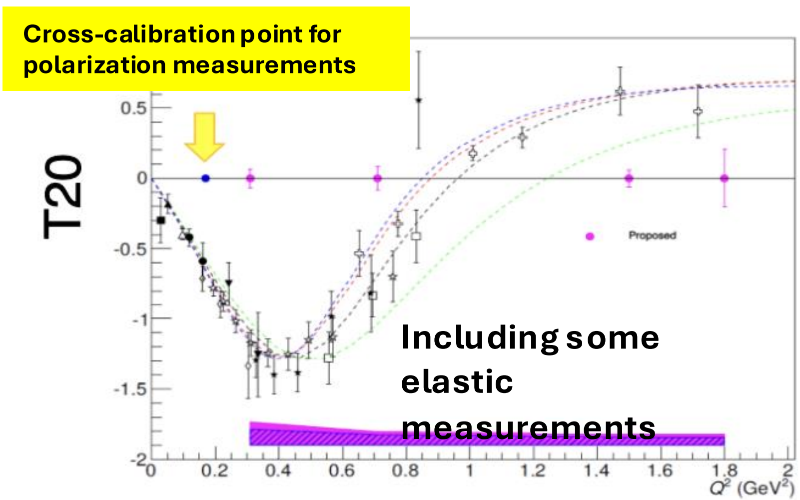
- Tensor polarization Q=26%
- Current I = 85 nA

$$A_{zz} = \frac{2}{fQ}\left(\frac{\sigma(+P,Q)+\sigma(-P,Q)}{\sigma(+P,0)+\sigma(-P,0)} - 1\right)$$

f: Dilution factor; Q: Tensor polarization; P: Vector polarization

E12-15-005: Equipment and Running Conditions

		E_0 (GeV)	Q^2 (GeV^2)	E' (GeV)	$\theta_{e'}$ (°)	PAC Time (Days)
SHMS	(S1)	8.8	1.5	8.36	8.2	25
HMS	(H1)	8.8	2.9	7.26	12.2	25
SHMS	(S2)	6.6	0.7	6.35	7.5	8
HMS	(H2)	6.6	1.8	5.96	12.3	8
SHMS	(S3)	2.2	0.2	2.15	10.9	1
HMS	(H3)	2.2	0.3	2.11	14.9	1



- 2.2, 6.6, 8.8 GeV electron beam
- Tensor-polarized deuteron target (solid ND_3)
- Hall C magnetic spectrometers: HMS and SHMS for scattered electron detection
- Beam diagnostics: raster system (fast and slow), beam current monitors, Faraday cup*
- Polarization cycling and monitoring to control systematic uncertainties

Major R&D and installation
Installation
Development and Installation

Preparing for Experimental Readiness Review: Tensor Experiments

Enhancing Vector Polarization with DNP

- At thermal equilibrium (B = 5 T and T = 1 K), the vector polarization in Deuterium is P ~0.1%
- Dynamic Nuclear Polarization (DNP) enhances the vector polarization to up to 50% in deuterated butanol and deuterated ammonia

  Paramagnetic centers in the material, either chemically doped or irradiated, induce spin transitions through the application of microwaves to the sample, which is already in a magnetic field at very low temperatures.

Vector Polarization:

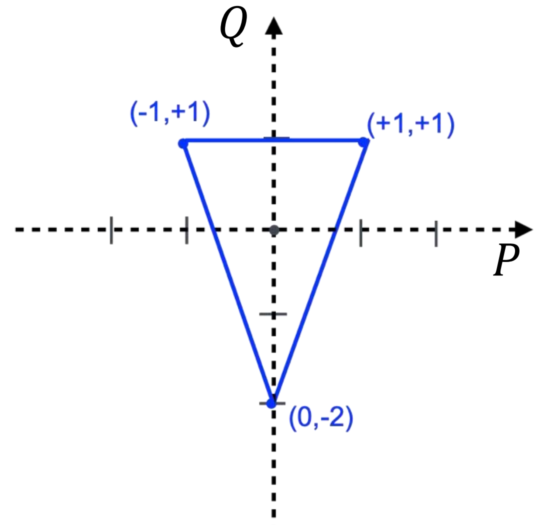
$$P = N_+ - N_-$$
$$-1 < P < +1$$

Tensor Polarization:

$$Q = N_+ + N_- - 2N_0$$
$$-2 < Q < +1$$

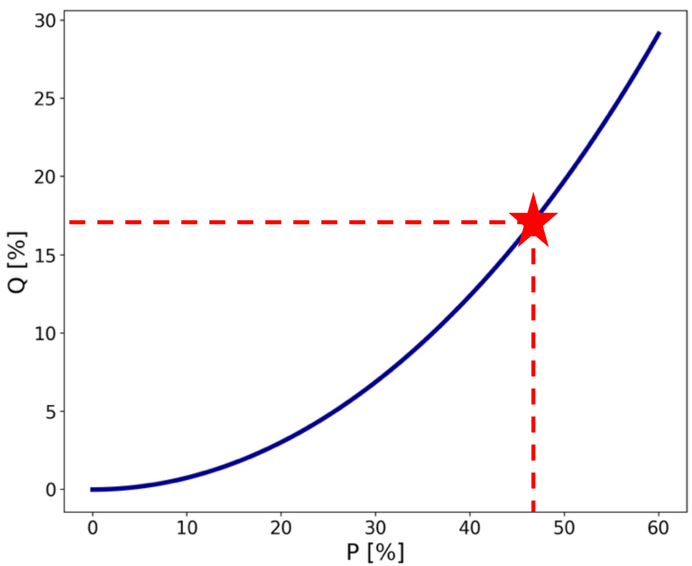
Normalization:

$$1 = N_+ + N_- + N_0$$

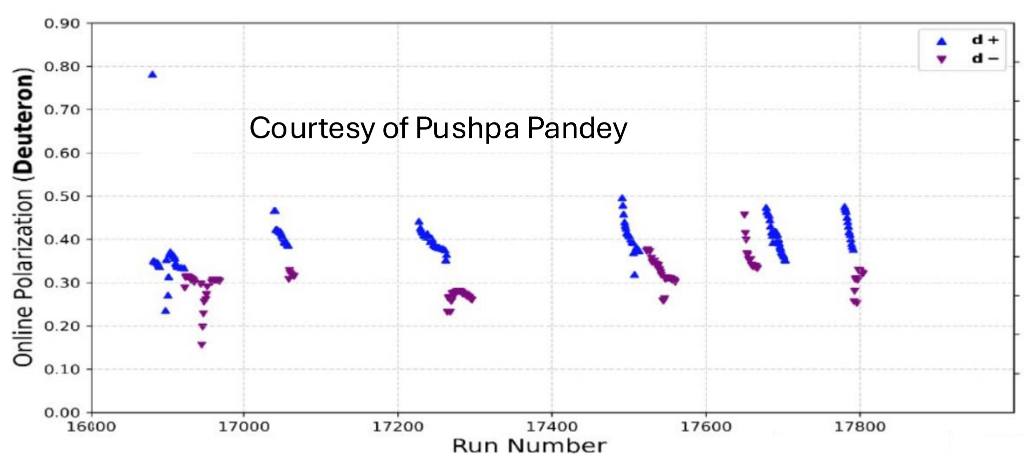


Can we perform an experiment with this technique?

- Target material used in tensor polarized techniques: deuterated ammonia (ND_3)
- After DNP, Vector and tensor polarizations are related as: $Q = 2 - \sqrt{4 - 3P^2}$



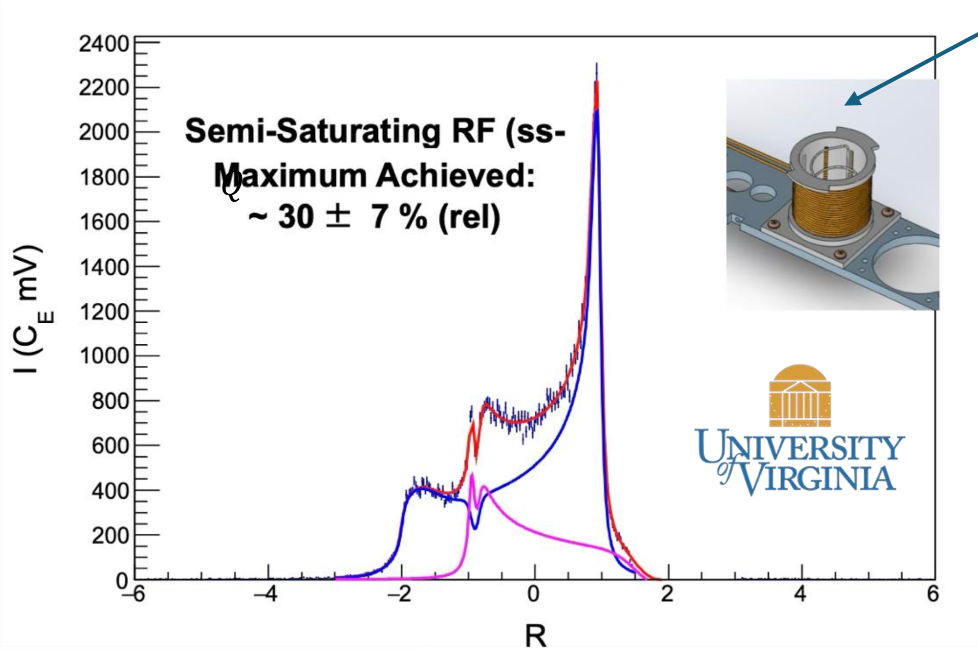
Tensor polarization with DNP is at best 15 – 20% and decays with dose (under electron beam)



Need additional techniques to enhance the tensor polarization

Our Plan: Use ss-RF to Enhance Tensor polarization

Target cup



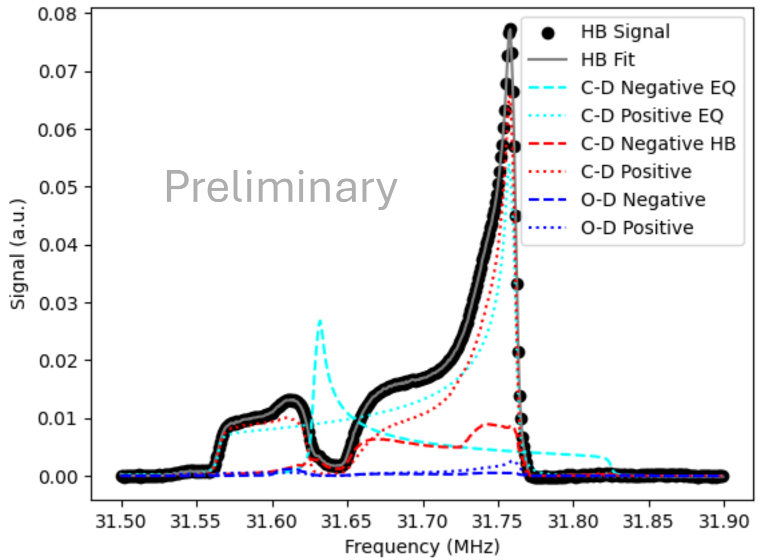
D. Keller Eur. Phys. J. A53 (2017)

- Use optimized radiofrequency (RF) to manipulate the NMR line of deuteron. Semi-Selective RF (ss-RF)
- Technique has been successful with deuterated butanol.
- Work is ongoing to demonstrate its effectiveness in ND_3, with the goal of running the approved experiments b_1 and A_{zz}.

Current Work Toward Experimental Readiness

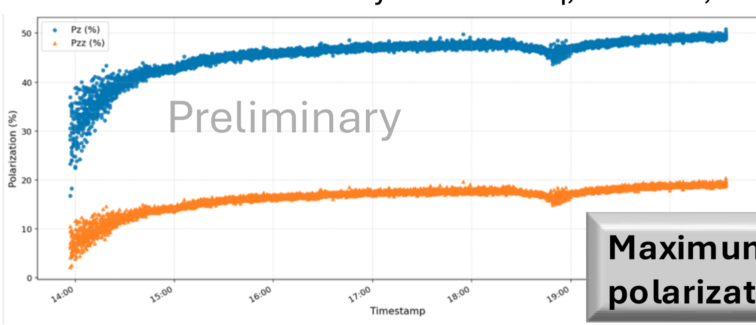
- Demonstrate and characterize cold irradiated ND_3.
- Quantify and minimize NMR and RF systematic errors.
- Upgrade and test ss-RF and AFP hardware plus adaptive control.
- Validate lineshape models against experimental benchmarks.
- Evaluate paths to higher tensor polarization benchmarks.
- Perform cross-checks with alternate scattering measurements. (elastic scattering: such as the one proposed with E12-15-005)
- Fully map spin diffusion effects (with/without DNP).

A Snapshot of Current Analysis
(Data taken in December 2025)

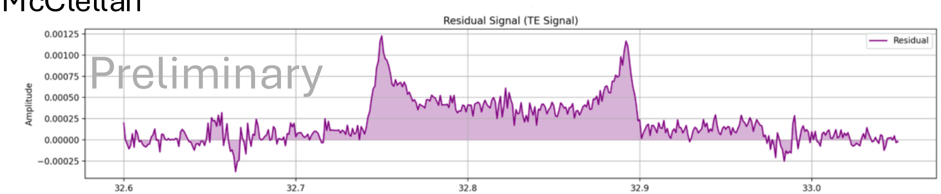


Courtesy of M. Farooq, C. Lama, E. Long, M. McClellan

Successfully manipulated spin populations of ND_3

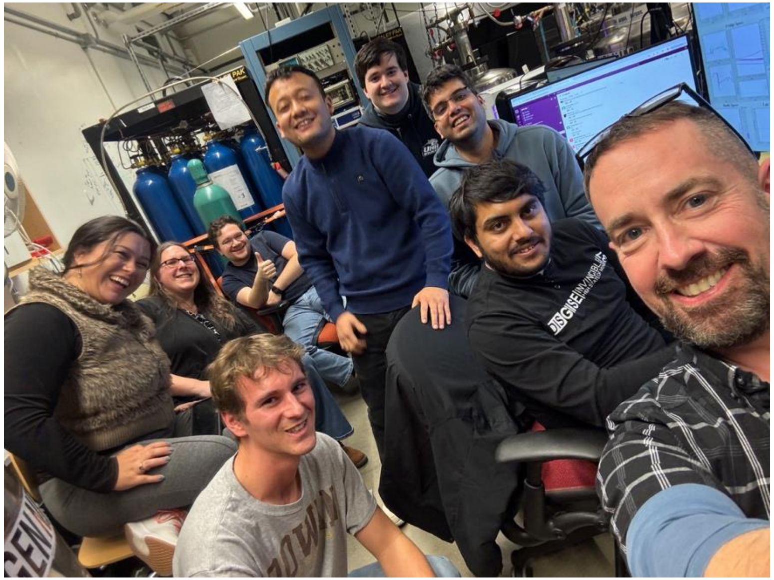


Maximum vector polarization: P~50%

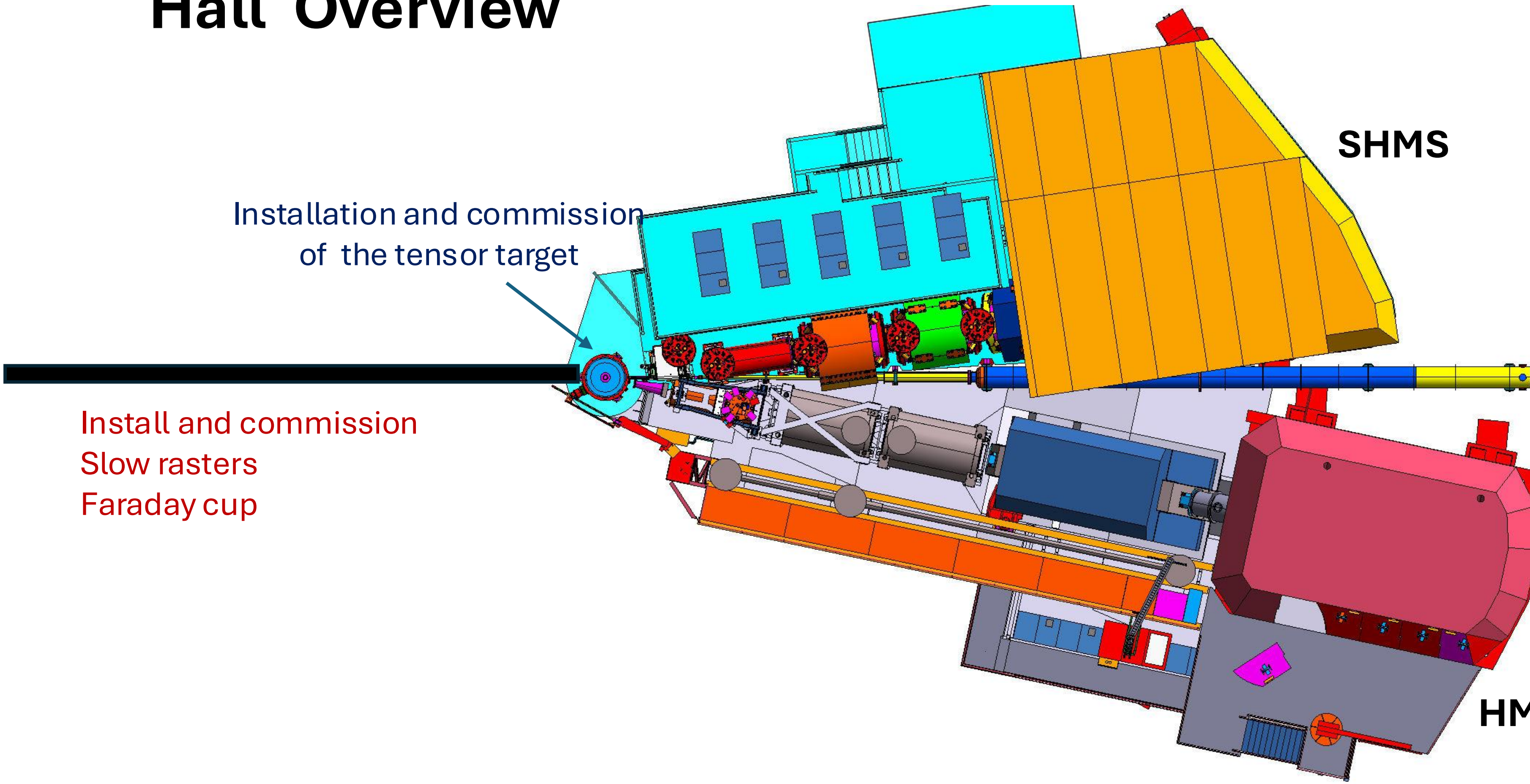


Measured TE signal

Two Active Laboratories



Hall Overview

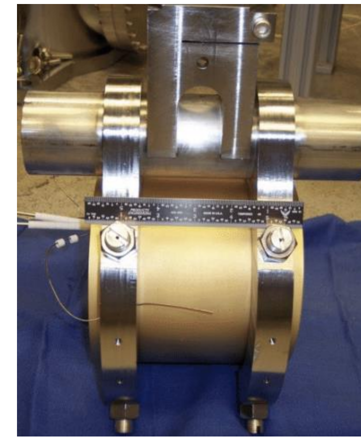


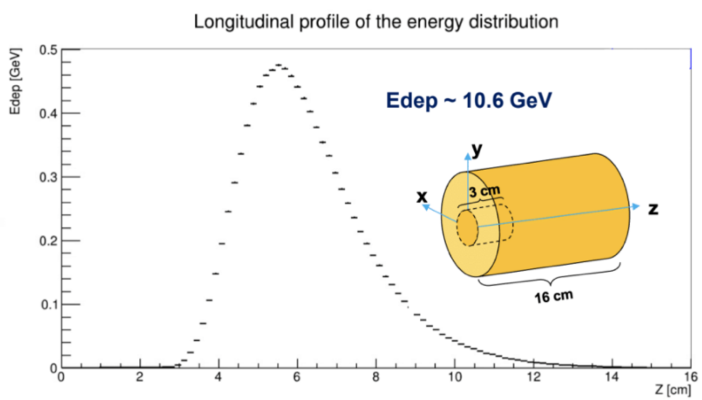
Prepare electronics and trigger

Faraday Cup for b_1 and A_{zz}

The tensor-polarized target experiments require monitoring relative changes in the beam current at the 0.01% level on an hourly basis.

The current plan is to re-purpose and commission the W–Cu calorimeter previously used in Hall C.

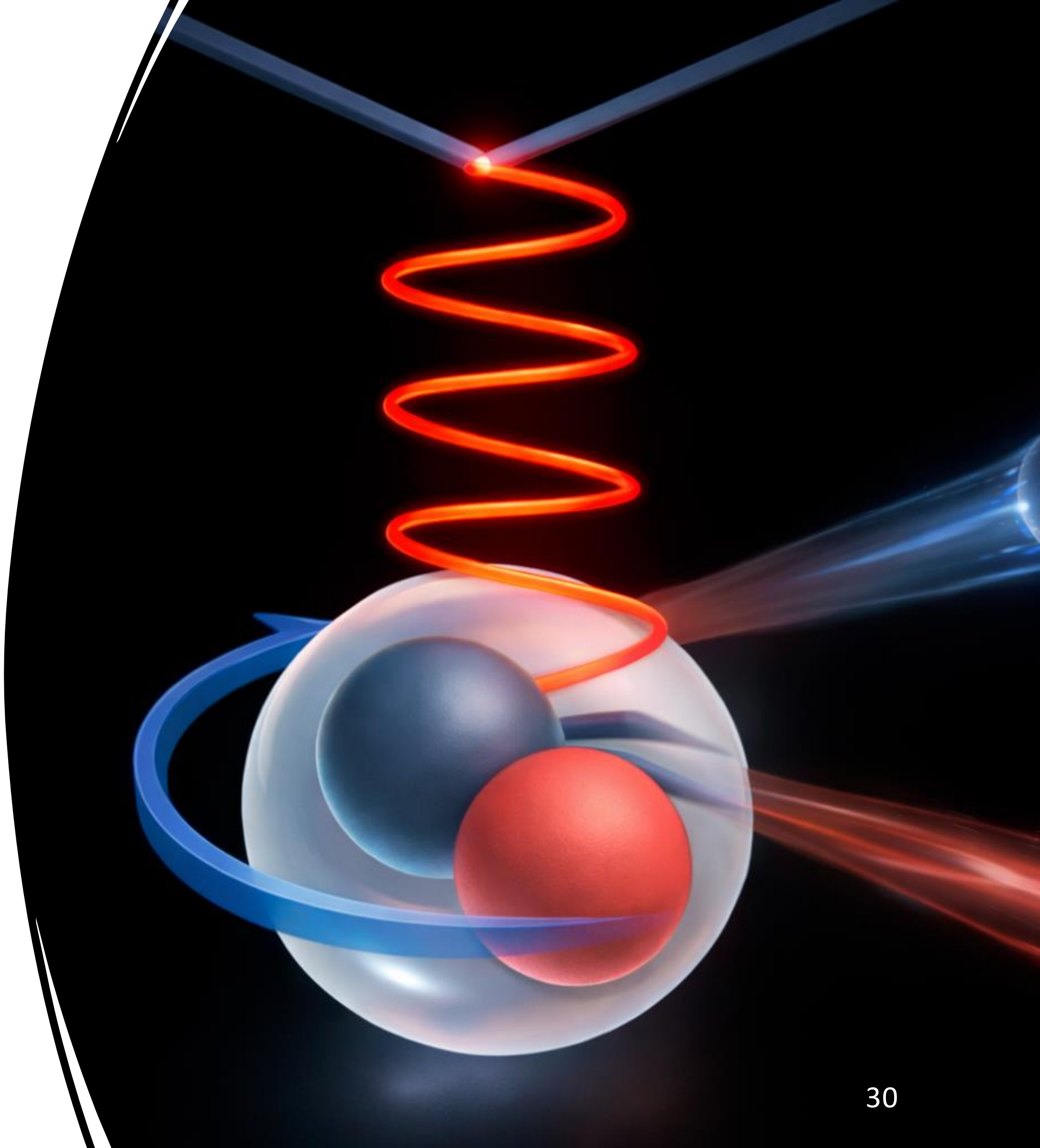




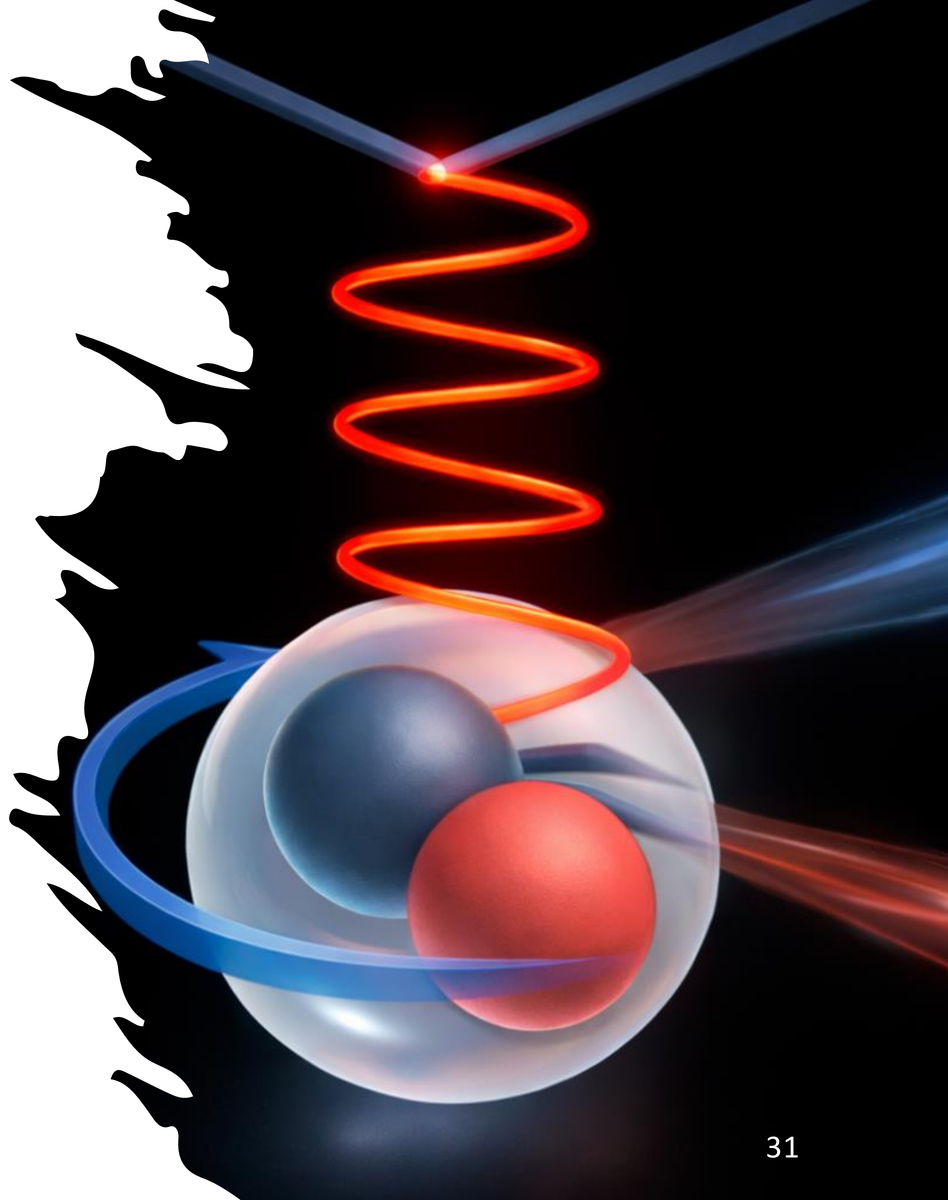
Courtesy of Hector Chinchay

Work lead by D. Mack
Not sure what will be the next step now?

Looking Beyond b_1 and A_{zz}



LOI: Exclusive Electro-Disintegration of Tensor Polarized Deuterium



Probing the NN core

$$\rho_{unp}(p_m) = |u(p_m)|^2 + |w(p_m)|^2$$

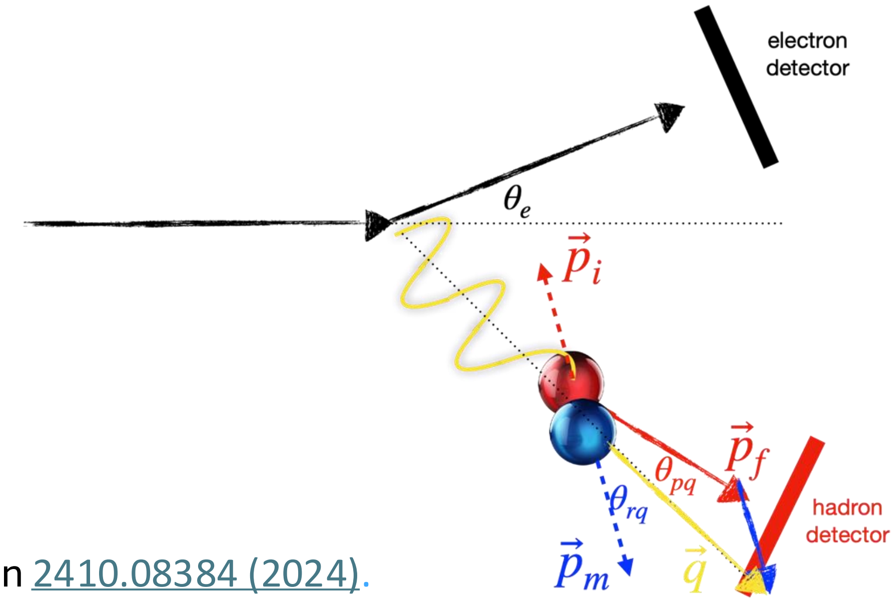
unpolarized

$u(p_m)$: S-partial wave of the deuteron
$w(p_m)$: D-partial wave of the deuteron

$$\rho_{20}(p_m) = \frac{3cos^2(\theta_N) \; - 1}{2}[2\sqrt{2}u(p_m)w(p_m) - w(p_m)^2|]$$

Tensor polarized

θ_N : direction of internal momenta with respect to the polarization axis of the deuteron



- e- scattering off bound nucleon with internal momenta, $\vec{p}_i$
- reconstructed (undetected) recoil nucleon momenta, $\vec{p}_m = \vec{q} - \vec{p}_f$

M. Sargsian 2410.08384 (2024).

Probing the NN Core

$$\rho_{unp}(p_m) = |u(p_m)|^2 + |w(p_m)|^2$$

unpolarized

$u(p_m)$: S-partial wave of the deuteron
w(p_m): D-partial wave of the deuteron

$$\rho_{20}(p_m) = \frac{3cos^2(\theta_N)\ -1}{2}\left[2\sqrt{2}u(p_m)w(p_m) - w(p_m)^2|\right]$$

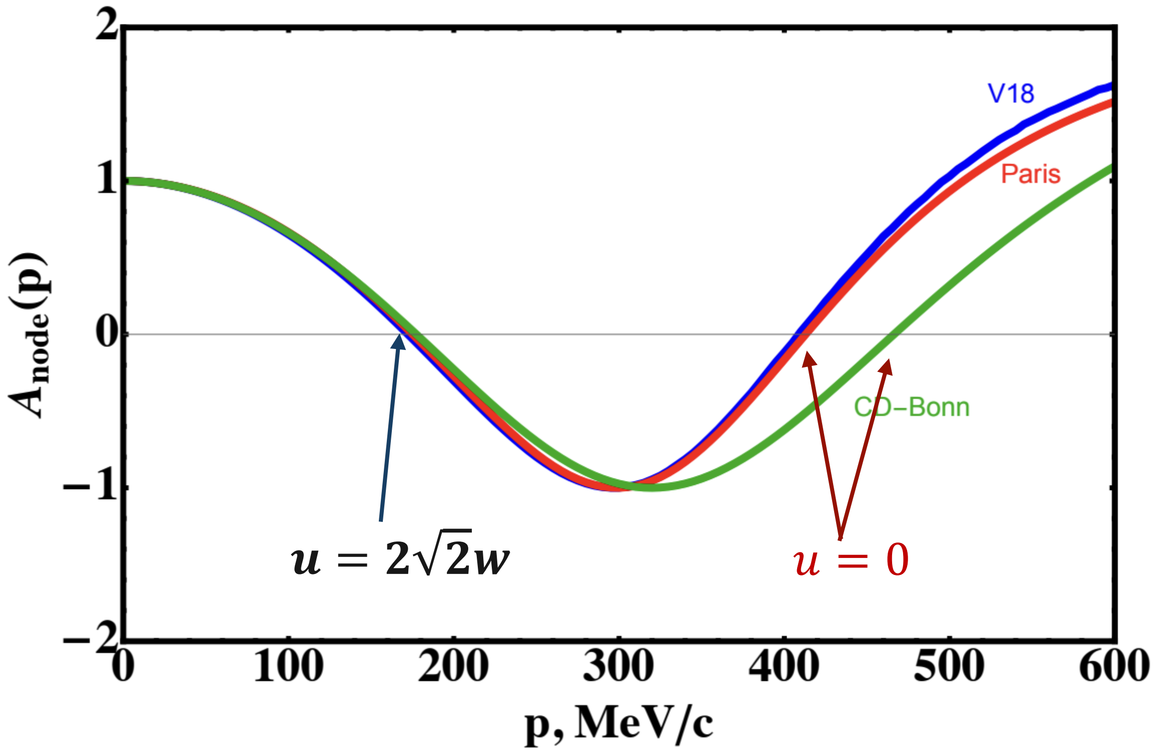
Tensor polarized

θ_N : direction of internal momenta with respect to the polarization axis of the deuteron

$$A_{node} = \frac{u(p_m)^2 + 2\sqrt{2}u(p_m)w(p_m)}{|u(p_m)|^2 + |w(p_m)|^2}$$

$$A_{node} = 0, \quad \begin{cases} u(p_m) = -2\sqrt{2}w(p_m), & p_m \sim 180 \text{ MeV} \\ u(p_m) = 0, & p_m \geq 400 \text{ MeV} \end{cases}$$

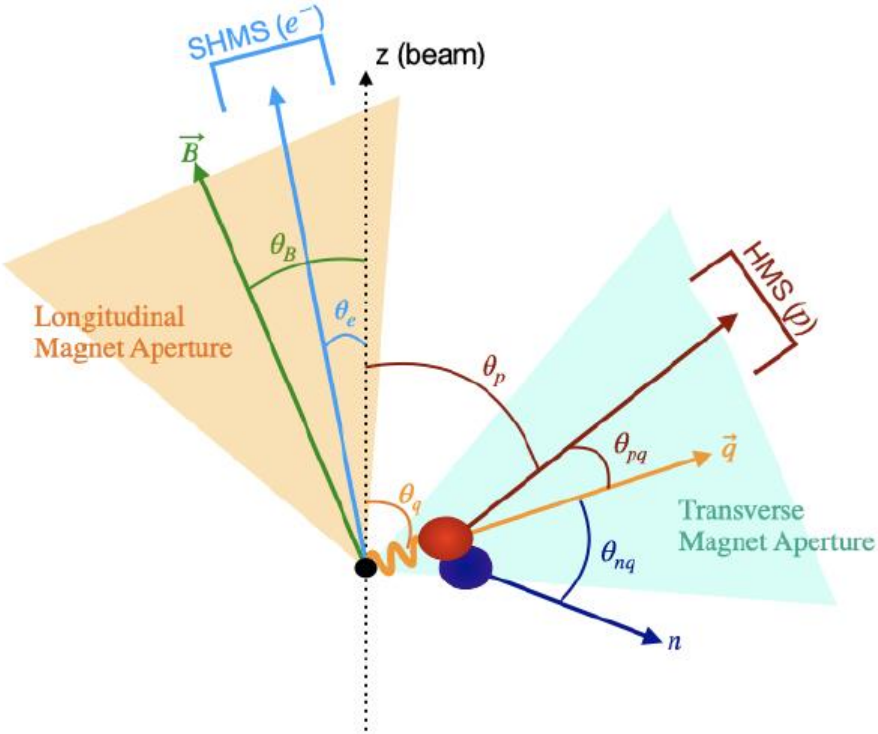
M. Sargsian 2410.08384 (2024).



The node is a signature of nuclear repulsive core: In the PWIA approximation, if deuteron consisted of only the S-state, then in this case the node is like a hole in the momentum space through which the probe-electron will pass without interaction.

M. Sargsian 2410.08384 (2024).

Experimental Setup



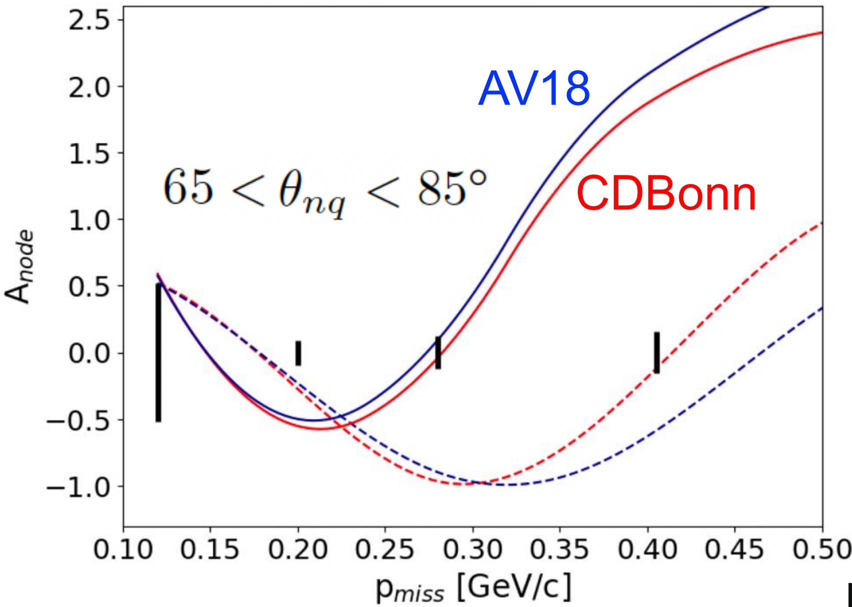
Looking at forward kinematics to minimize FSI ($0 < \theta_{nq} < 35$).
In short, this implies $\theta_p > 50\ deg$

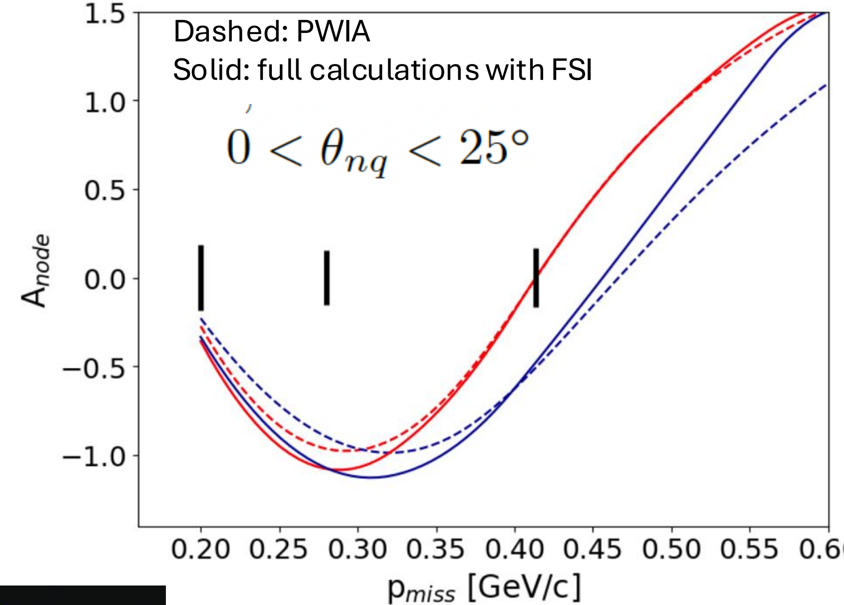
We currently are limited by the acceptance of the target magnet (± 35 deg).

We can rotate the magnet maximum 20 deg:
Proton side up to 50 deg.

Challenge: find the appropriate magnet for the target. The current magnet in the longitudinal configuration has an aperture of 35^o and in the transverse configuration an aperture of 25^o.

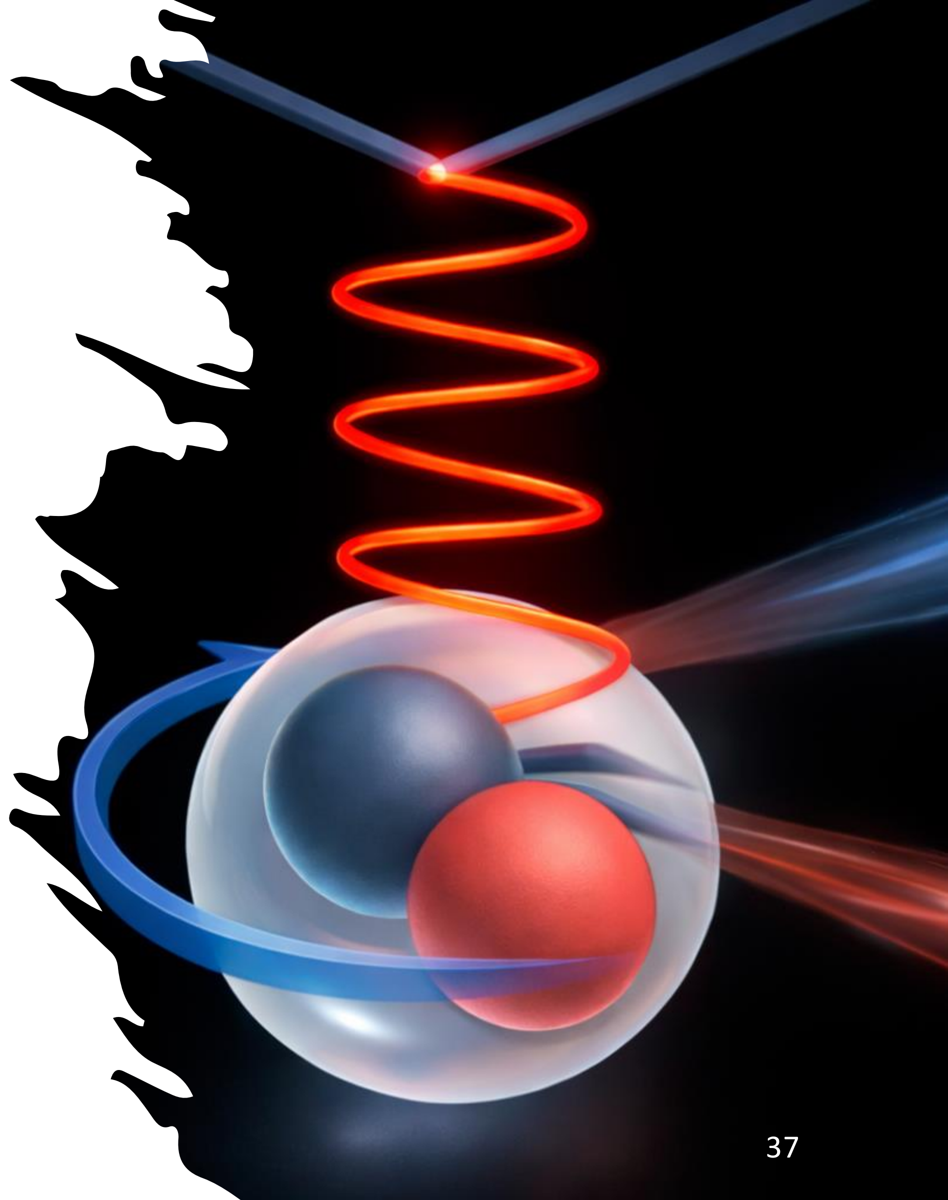
Current Projected Measurements





$$A_{node}(p) \equiv \frac{\rho_{node}(p)}{\rho_{unp}(p)} = 1 + \frac{2A_{zz}(p,\theta_N)}{3\cos^2(\theta_N) - 1} = \frac{u^2(p) + 2\sqrt{2}u(p)w(p)}{u(p)^2 + w(p)^2}$$

LOI: Spin-1 TMDs and Structure Functions of the Deuteron



Leading Twist Distribution Functions

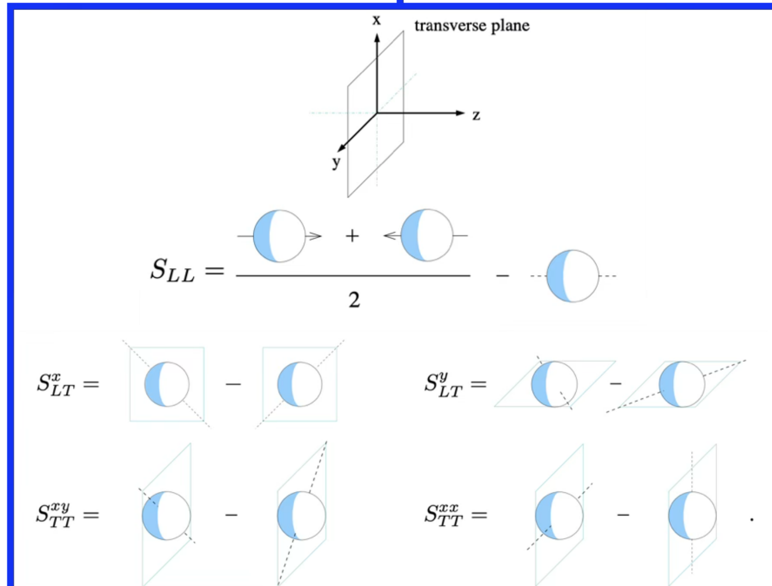
Quark / Hadron	U (γ^+)		L ($\gamma^+\gamma_5$)		T ($i\sigma^{i+}\gamma_5 / \sigma^{i+}$)	
	T-even	T-odd	T-even	T-odd	T-even	T-odd
LL	f_{1LL}					$[h_{1LL}^{\perp}]$
LT	f_{1LT}			g_{1LT}		$[h_{1LT}], [h_{1LT}^{\perp}]$
TT	f_{1TT}			g_{1TT}		$[h_{1TT}], [h_{1TT}^{\perp}]$

Add 10 leading functions completely unexplored

After integrating over the transverse momentum:

Quark / Hadron	U (γ^+)		L ($\gamma^+\gamma_5$)		T ($i\sigma^{i+}\gamma_5 / \sigma^{i+}$)	
	T-even	T-odd	T-even	T-odd	T-even	T-odd
LL	$f_{1LL}(b_1)$					
LT						*1
TT						

Spin 1



Longitudinally Polarized Target

$$\frac{d\sigma}{dx\,dy\,d\psi\,dz\,d\phi_h\,dP_{h\perp}^2} = \frac{\alpha^2}{xyQ^2}\,\frac{y^2}{2\,(1-\varepsilon)}\left(1+\frac{\gamma^2}{2x}\right)$$

$$\Big\{ F_{UU,T} + \varepsilon F_{UU,L} + \sqrt{2\,\varepsilon(1+\varepsilon)}\,\cos\phi_h\,F_{UU}^{\cos\phi_h}$$

$$+\,\varepsilon\cos(2\phi_h)\,F_{UU}^{\cos 2\phi_h} + \lambda_e\,\sqrt{2\,\varepsilon(1-\varepsilon)}\,\sin\phi_h\,F_{LU}^{\sin\phi_h}$$

vector

$$+\,S_{\parallel}\left[\sqrt{2\,\varepsilon(1+\varepsilon)}\,\sin\phi_h\,F_{UL}^{\sin\phi_h} + \varepsilon\sin(2\phi_h)\,F_{UL}^{\sin 2\phi_h}\right]$$

$$+\,S_{\parallel}\lambda_e\left[\sqrt{1-\varepsilon^2}\,F_{LL} + \sqrt{2\,\varepsilon(1-\varepsilon)}\,\cos\phi_h\,F_{LL}^{\cos\phi_h}\right]$$

tensor

$$+\,T_{\parallel\parallel}\Big[F_{U(LL),T} + \varepsilon F_{U(LL),L} + \sqrt{2\,\varepsilon(1+\varepsilon)}\,\cos\phi_h\,F_{U(LL)}^{\cos\phi_h}$$

$$+\,\varepsilon\cos(2\phi_h)\,F_{U(LL)}^{\cos 2\phi_h} + \lambda_e\,\sqrt{2\,\varepsilon(1-\varepsilon)}\,\sin\phi_h\,F_{L(LL)}^{\sin\phi_h}\Big]\Big\}.$$

J. Zhao et al., arXiv:2508.06134 (2025).

Longitudinally Polarized Target

$$\frac{d\sigma}{dx\,dy\,d\psi\,dz\,d\phi_h\,dP_{h\perp}^2} =$$

tensor

$$+\,T_{\|\|}\Big[F_{U(LL),T} + \varepsilon F_{U(LL),L} + \sqrt{2\,\varepsilon(1+\varepsilon)}\,\cos\phi_h\,F_{U(LL)}^{\cos\phi_h}$$
$$+\,\varepsilon\cos(2\phi_h)\,F_{U(LL)}^{\cos 2\phi_h} + \lambda_e\sqrt{2\,\varepsilon(1-\varepsilon)}\,\sin\phi_h\,F_{L(LL)}^{\sin\phi_h}\Big]\Big\}.$$

5 structure functions analogous to the unpolarized

J. Zhao et al., arXiv:2508.06134 (2025).

Tensor polarized structure functions

tensor

$$+ T_{\parallel\parallel}\Big[F_{U(LL),T} + \varepsilon F_{U(LL),L} + \sqrt{2\,\varepsilon(1+\varepsilon)}\,\cos\phi_h\,F_{U(LL)}^{\cos\phi_h}$$

$$+ \varepsilon\cos(2\phi_h)\,F_{U(LL)}^{\cos 2\phi_h} + \lambda_e\,\sqrt{2\,\varepsilon(1-\varepsilon)}\,\sin\phi_h\,F_{L(LL)}^{\sin\phi_h}\Big]\Big\}.$$

$$F_{U(LL),T} = \mathcal{C}\big[f_{1LL}D_1\big],$$

$$F_{U(LL),L} = 0,$$

$$F_{U(LL)}^{\cos\phi_h} = \frac{2M}{Q}\,\mathcal{C}\Big[-\frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{k}_T}{M_h}\Big(xh_{LL}\,H_1^{\perp} + \frac{M_h}{M}\,f_{1LL}\frac{\tilde{D}^{\perp}}{z}\Big) - \frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{p}_T}{M}\Big(xf_{LL}^{\perp}D_1 + \frac{M_h}{M}\,h_{1LL}^{\perp}\frac{\tilde{H}}{z}\Big)\Big],$$

$$F_{U(LL)}^{\cos 2\phi_h} = \mathcal{C}\Big[-\frac{2\,(\hat{\boldsymbol{h}}\cdot\boldsymbol{k}_T)\,(\hat{\boldsymbol{h}}\cdot\boldsymbol{p}_T) - \boldsymbol{k}_T\cdot\boldsymbol{p}_T}{MM_h}h_{1LL}^{\perp}H_1^{\perp}\Big],$$

$$F_{L(LL)}^{\sin\phi_h} = \frac{2M}{Q}\,\mathcal{C}\Big[-\frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{k}_T}{M_h}\Big(xe_{LL}\,H_1^{\perp} + \frac{M_h}{M}\,f_{1LL}\frac{\tilde{G}^{\perp}}{z}\Big) + \frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{p}_T}{M}\Big(xg_{LL}^{\perp}D_1 + \frac{M_h}{M}\,h_{1LL}^{\perp}\frac{\tilde{E}}{z}\Big)\Big].$$

Tensor polarized structure functions

tensor

$$+T_{\|\|\|}\Big[F_{U(LL),T}+\varepsilon F_{U(LL),L}+\sqrt{2\,\varepsilon(1+\varepsilon)}\,\cos\phi_h\,F_{U(LL)}^{\cos\phi_h}$$

$$+\varepsilon\cos(2\phi_h)\,F_{U(LL)}^{\cos 2\phi_h}+\lambda_e\sqrt{2\,\varepsilon(1-\varepsilon)}\,\sin\phi_h\,F_{L(LL)}^{\sin\phi_h}\Big]\Big\}.$$

$$F_{U(LL),T}=\mathcal{C}\big[f_{1LL}D_1\big],$$

$$F_{U(LL),L}=0,$$

$$F_{U(LL)}^{\cos\phi_h}=\frac{2M}{Q}\,\mathcal{C}\Big[-\frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{k}_T}{M_h}\Big(xh_{LL}\,H_1^{\perp}+\frac{M_h}{M}f_{1LL}\frac{\tilde{D}^{\perp}}{z}\Big)-\frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{p}_T}{M}\Big(xf_{LL}^{\perp}D_1+\frac{M_h}{M}h_{1LL}^{\perp}\frac{\tilde{H}}{z}\Big)\Big],$$

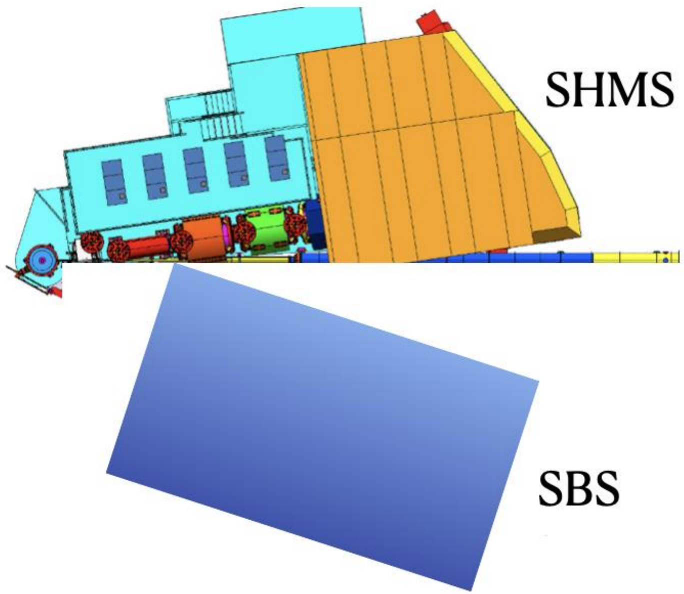
$$F_{U(LL)}^{\cos 2\phi_h}=\mathcal{C}\Big[-\frac{2\,(\hat{\boldsymbol{h}}\cdot\boldsymbol{k}_T)\,(\hat{\boldsymbol{h}}\cdot\boldsymbol{p}_T)-\boldsymbol{k}_T\cdot\boldsymbol{p}_T}{MM_h}h_{1LL}^{\perp}H_1^{\perp}\Big],$$

$$F_{L(LL)}^{\sin\phi_h}=\frac{2M}{Q}\,\mathcal{C}\Big[-\frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{k}_T}{M_h}\Big(xe_{LL}\,H_1^{\perp}+\frac{M_h}{M}f_{1LL}\frac{\tilde{G}^{\perp}}{z}\Big)+\frac{\hat{\boldsymbol{h}}\cdot\boldsymbol{p}_T}{M}\Big(xg_{LL}^{\perp}D_1+\frac{M_h}{M}h_{1LL}^{\perp}\frac{\tilde{E}}{z}\Big)\Big].$$

Quark / Hadron	U (γ^+)		L ($\gamma^+\gamma_5$)		T ($i\sigma^{i+}\gamma_5$ / σ^{i+})	
	T-even	T-odd	T-even	T-odd	T-even	T-odd
LL	f_{1LL}					$[h_{1LL}^{\perp}]$

Leading twist

Experiment Overview



"*Spin-1 TMDs and Structure Functions of the Deuteron*"
at Hall C

Letter of Intent (LOI12-24-002 PAC 52, 2024)

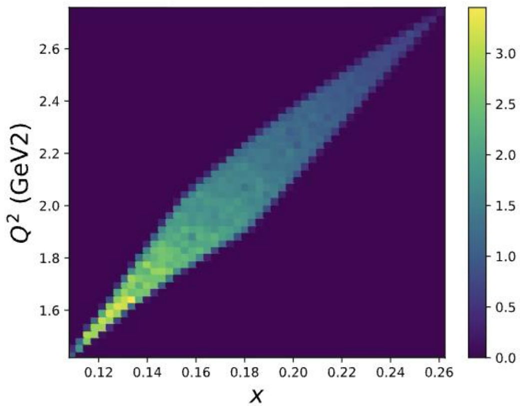
Goal: Dedicated Measurement in Hall C ($eD \rightarrow e'\pi^{\pm}X$)

A longitudinally tensor polarized deuteron target

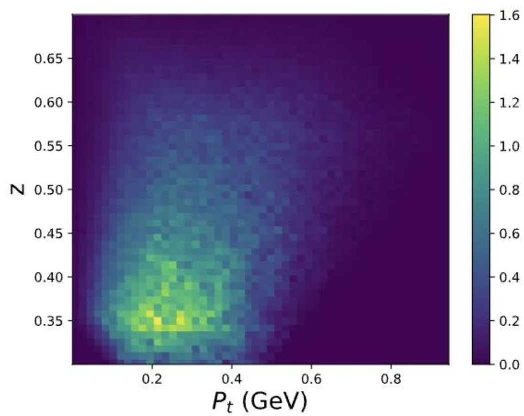
The Super BigBite (SBS) Spectrometer, which will be used to measure the produced hadron

The Super High Momentum Spectrometer (SHMS) will be used to measure the scattered electron

Experiment Overview



	θ (deg.)	ϕ (deg.)	P (GeV)
Electron	10.3 - 12.4	-2.87 - 2.87	4.0 - 5.4
Hadron	5.0 - 15.0	167 - 193	2.0 - 4.0



Tensor Deuteron Target: Driving Exciting Times Ahead for Jefferson Lab and the Nuclear Physics Community

- Large number of young scientists in the program
- Growing number of experiments
- Numerous opportunities

Thank you!

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