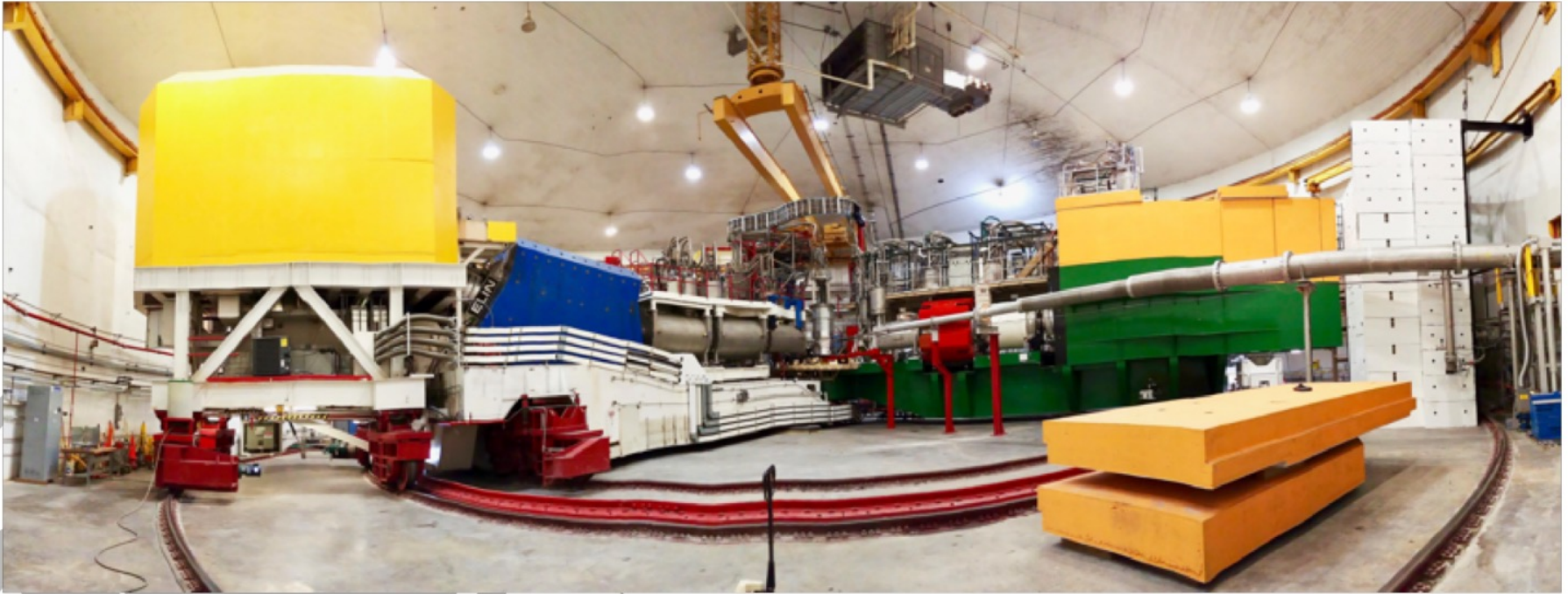


# Update from Hall C



Burcu Duran

On behalf of the Hall C Collaboration

 Jefferson Lab

APS DNP/JPS 2023



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



# Summary of Hall Activities

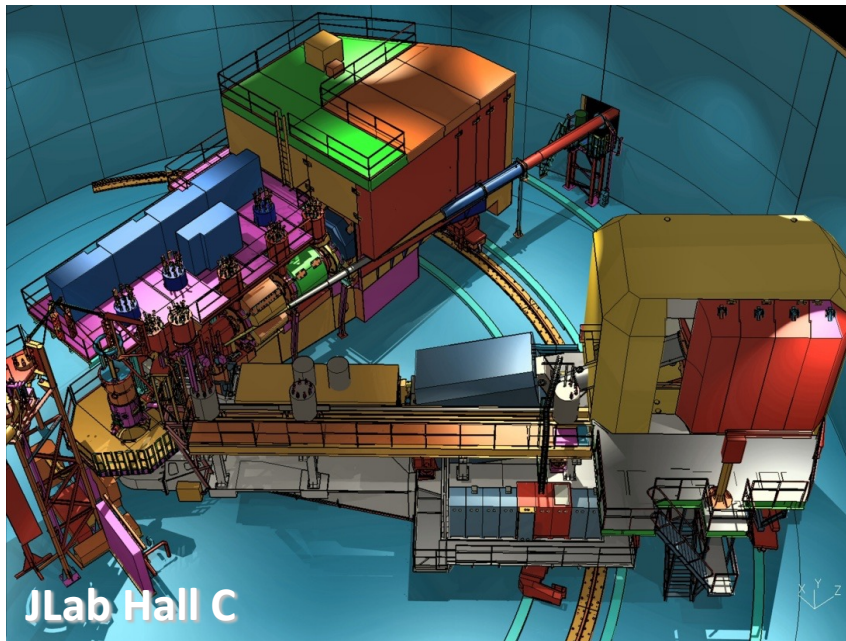
- Summer 2022 run:
  - E12-19-006: L-T separated pion cross section and charged pion form factor at high  $Q^2$
- Fall 2022-Spring 2023 runs:
  - E12-17-005 (CaFe): Short Range Pairing Mechanisms in Heavy Nuclei
  - E12-10-008\* : Nuclear dependence of  $F_2$  in light nuclei
  - E12-06-105\* : Inclusive scattering from nuclei at  $x > 1$  in QE and DIS regimes
  - E12-10-003: Deuteron disintegration at very high missing momentum
- Fall 2023 – present
  - E12-13-010 and E12-22-006 measure exclusive Deeply Virtual Compton scattering on proton and neutron
  - E12-09-017 and E12-23-014 measure SIDIS  $^1\text{H}, ^2\text{H}$  ( $e, e', p^0$ ) cross section and  $R = s_L / s_T$  for SIDIS

\* Ran concurrently

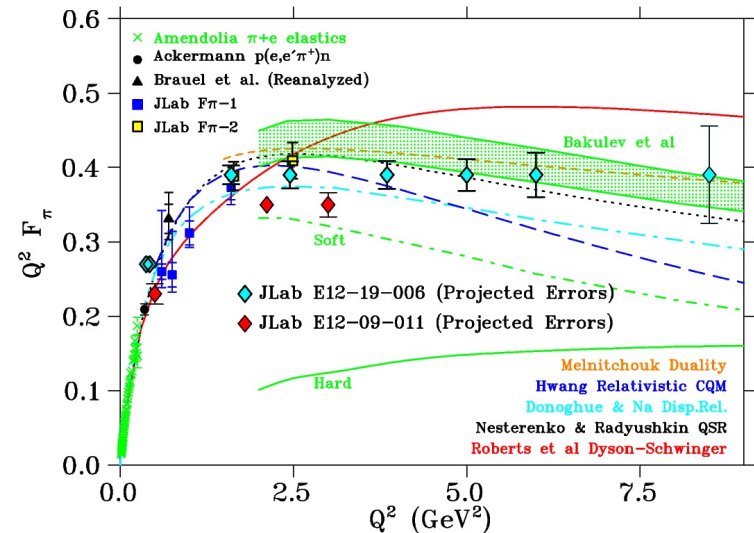
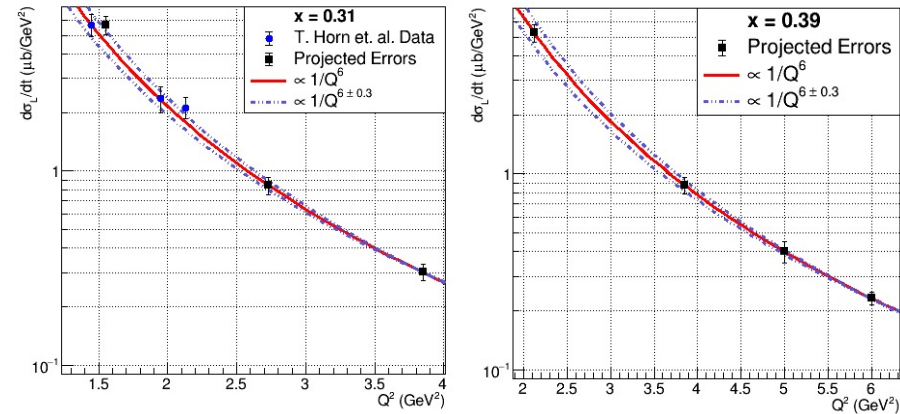
# E12-19-006: Study of the L-T Separated Pion Electroproduction Cross Section at 11 GeV and Measurement of the Charged Pion Form Factor to High $Q^2$

Spokespersons: D. Gaskell (JLab), G.M. Huber (Regina), T. Horn (CUA)

- The pion is seen as key to confirm mechanisms that dynamically generate almost all hadron mass and is central to effort to understand hadron structure
- $1/Q^n$  scaling of L-T separated exclusive  $\pi^+$   $d\sigma/dt$  at fixed  $x_B$  probes applicability of GPD collinear factorization theorem at JLab kinematics



The new SHMS, with its far-forward capabilities, has enabled a near quadrupling of the  $Q^2$  range over which the  $\pi^+$  form factor is known



High  $Q^2$  : study non-perturbative dynamics of QCD while also searching for a transition to the perturbative regime

# CaFe Experiment

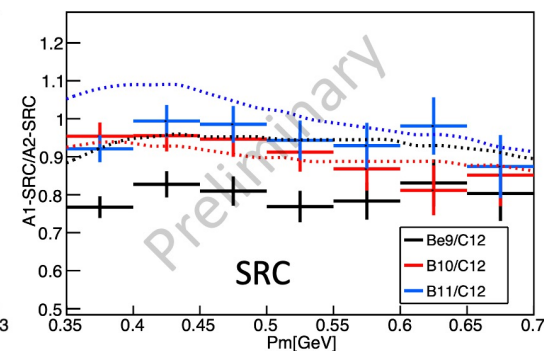
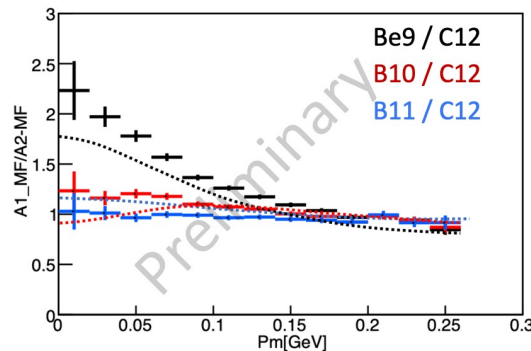
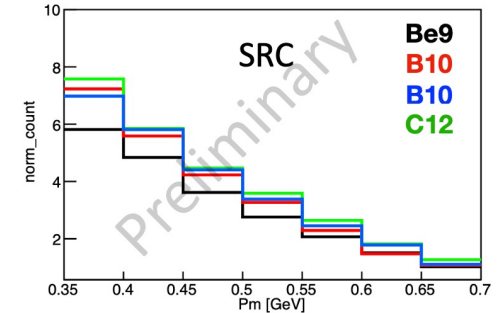
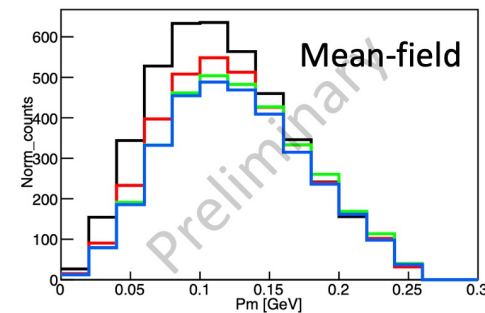
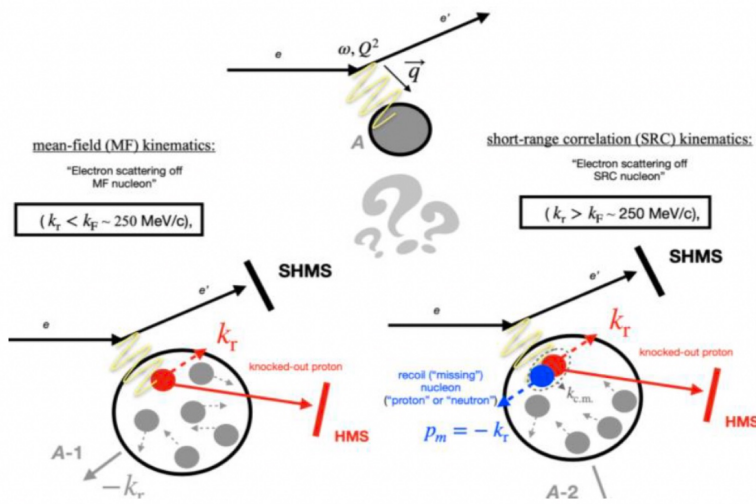
Coincidence (e,e'p) measurement in the kinematics dominated by scattering off **1)** mean field ( $k < k_f$ ) and **2)** SRC pairs ( $k > k_f$ )

Study the individual probabilities of finding SRC protons and neutrons in neutron rich symmetric and asymmetric nuclei

- Various targets ( $^{40}\text{Ca}$  -  $^{48}\text{Ca}$  -  $^{54}\text{Fe}$ ,  $^9\text{Be}$  -  $^{10}\text{B}$  -  $^{11}\text{B}$  -  $^{12}\text{C}$ , d)

## Missing Momentum and Single Ratios (light)

R. B. Wiringa, R. Schiavilla, Steven C. Pieper, and J. Carlson Phys. Rev. C 89, 024305 (2014)

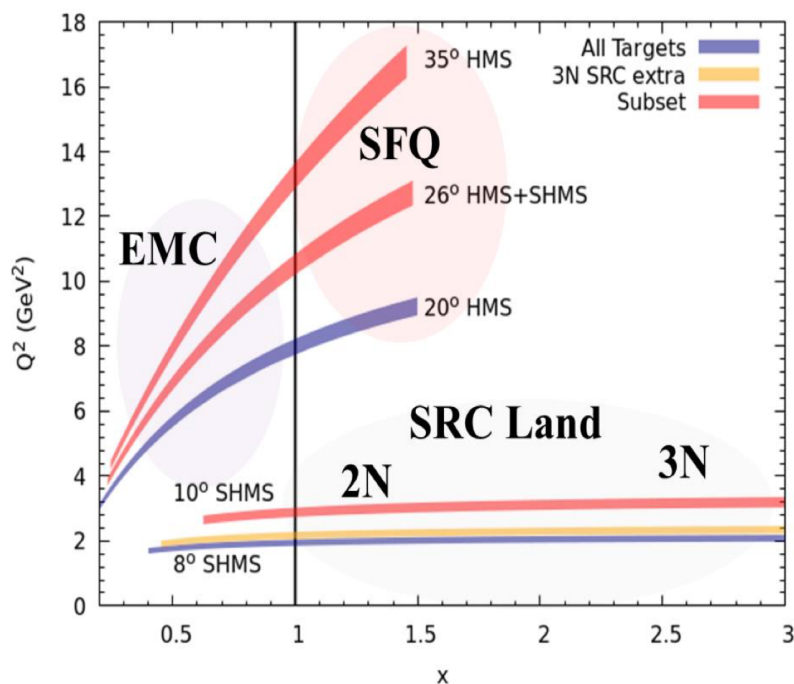


# E12-10-008 and E12-06-105 Experiments



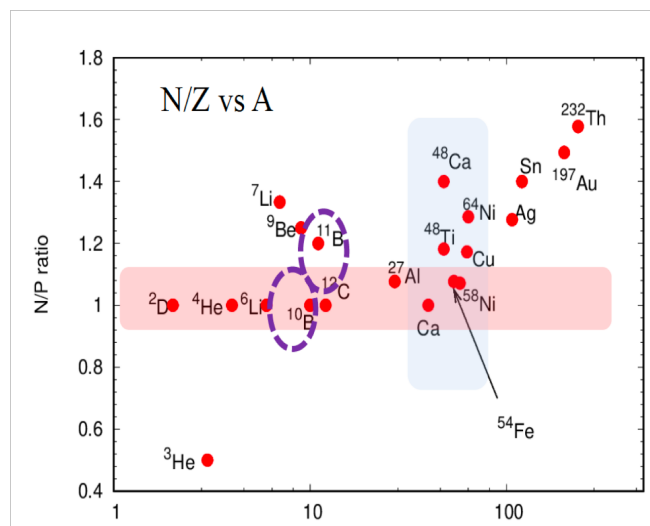
**E12-10-008:** J. Arrington, A. Daniel, N. Fomin, D. Gaskell

Detailed Studies of the nuclear dependence of  $F_2$  in light nuclei



**E12-06-105:** J. Arrington, D. Day, N. Fomin, P. Solvignon

Inclusive Scattering from Nuclei at  $x > 1$  in the quasielastic and deeply inelastic regimes



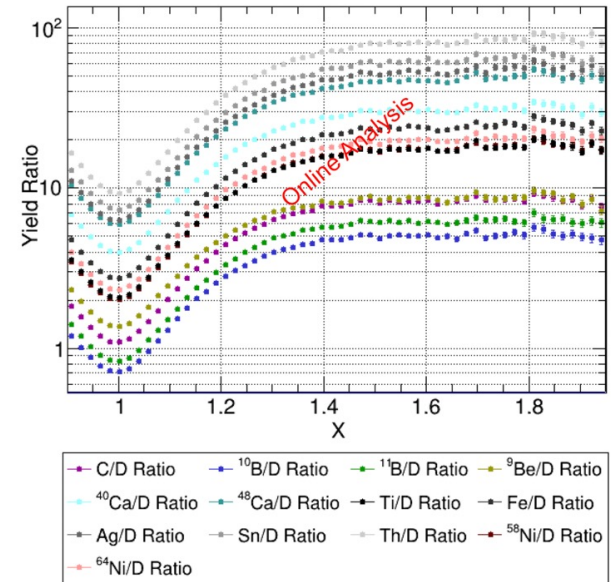
# E12-10-008 and E12-06-105 Experiments

PHYSICAL REVIEW C **108**, 035201 (2023)

## First Measurement of the EMC effect in $^{10}\text{B}$ and $^{11}\text{B}$

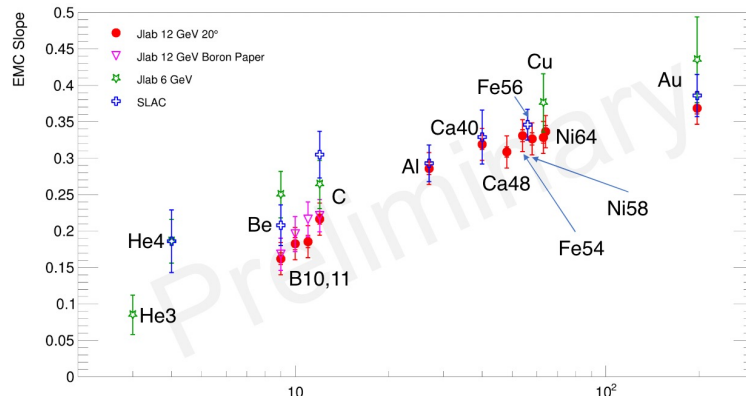
A. Karki,<sup>1</sup> D. Biswas,<sup>2,\*</sup> F. A. Gonzalez,<sup>3</sup> W. Henry,<sup>4</sup> C. Morean,<sup>5</sup> A. Nadeeshani,<sup>2</sup> A. Sun,<sup>6</sup> D. Abrams,<sup>7</sup> Z. Ahmed,<sup>8</sup> B. Aljawrneh,<sup>9,†</sup> S. Alsalmi,<sup>10</sup> R. Ambrose,<sup>8</sup> D. Androic,<sup>11</sup> W. Armstrong,<sup>12</sup> J. Arrington,<sup>13</sup> A. Asaturyan,<sup>14</sup> K. Assumin-Gyimah,<sup>1</sup> C. Ayerbe Gayoso,<sup>15,1</sup> A. Bandari,<sup>15</sup> J. Bane,<sup>5</sup> J. Barrow,<sup>5</sup> S. Basnet,<sup>8</sup> V. Berdnikov,<sup>16</sup> H. Bhatt,<sup>1</sup> D. Bhetuwal,<sup>1</sup> W. U. Boeglin,<sup>17</sup> P. Bosted,<sup>15</sup> E. Brash,<sup>18</sup> M. H. S. Bukhari,<sup>19</sup> H. Chen,<sup>7</sup> J. P. Chen,<sup>4</sup> M. Chen,<sup>7</sup> M. E. Christy,<sup>2</sup> S. Covrig,<sup>4</sup> K. Craycraft,<sup>5</sup> S. Danagoulian,<sup>9</sup> D. Day,<sup>7</sup> M. Diefenthaler,<sup>4</sup> M. Dlamini,<sup>20</sup> J. Dunne,<sup>1</sup> B. Duran,<sup>21</sup> D. Dutta,<sup>1</sup> C. Elliott,<sup>5</sup> R. Ent,<sup>4</sup> H. Fenker,<sup>4</sup> N. Fomin,<sup>5</sup> E. Fuchey,<sup>22</sup> D. Gaskell,<sup>4</sup> T. N. Gautam,<sup>2</sup> J. O. Hansen,<sup>4</sup> F. Hauenstein,<sup>23</sup> A. V. Hernandez,<sup>16</sup> T. Horn,<sup>16</sup> G. M. Huber,<sup>8</sup> M. K. Jones,<sup>4</sup> S. Joosten,<sup>12</sup> M. L. Kabir,<sup>1</sup> N. Kalantarians,<sup>24</sup> C. Keppel,<sup>4</sup> A. Khanal,<sup>17</sup> P. M. King,<sup>20</sup> E. Kinney,<sup>25</sup> H. S. Ko,<sup>26</sup> M. Kohl,<sup>2</sup> N. Lashley-Colthirst,<sup>2</sup> S. Li,<sup>27</sup> W. B. Li,<sup>15</sup> A. H. Liyanage,<sup>2</sup> D. Mack,<sup>4</sup> S. Malace,<sup>4</sup> P. Markowitz,<sup>17</sup> J. Matter,<sup>7</sup> D. Meekins,<sup>4</sup> R. Michaels,<sup>4</sup> A. Mkrtchyan,<sup>14</sup> H. Mkrtchyan,<sup>14</sup> S. Nanda,<sup>1</sup> D. Nguyen,<sup>7</sup> G. Niculescu,<sup>28</sup> I. Niculescu,<sup>28</sup> Nuruzzaman,<sup>29</sup> B. Pandey,<sup>2</sup> S. Park,<sup>3</sup> E. Pooser,<sup>4</sup> A. J. R. Puckett,<sup>22</sup> M. Rehfuß,<sup>1</sup> J. Reinhold,<sup>17</sup> N. Santiesteban,<sup>27</sup> B. Sawatzky,<sup>4</sup> G. R. Smith,<sup>4</sup> H. Szumila-Vance,<sup>4</sup> A. S. Tadepalli,<sup>29</sup> V. Tadevosyan,<sup>14</sup> R. Trotta,<sup>16</sup> S. A. Wood,<sup>4</sup> C. Yero,<sup>17</sup> and J. Zhang<sup>3,‡</sup>  
(Hall C Collaboration)

Yield Ratio 2022 (Arbitrary normalization)



## Selected Preliminary Results

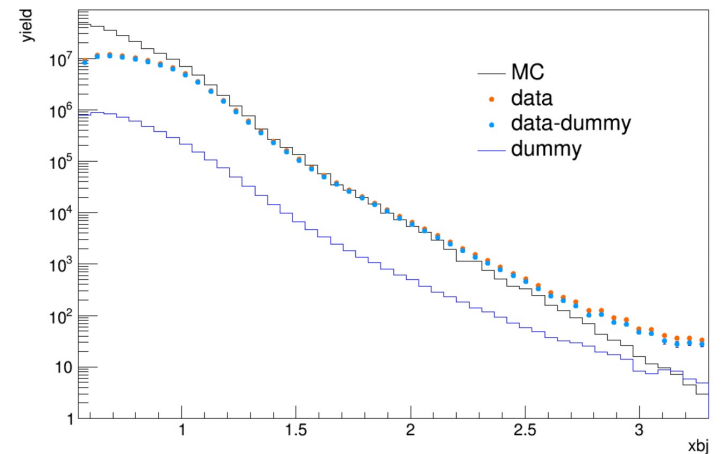
World EMC Slopes



\*Error bars on our data are estimated – will likely be smaller

Cameron Cotton – EMC Effect Preliminary Results

A 15



# Hall C Experiments running Sept 2023 to May 2024

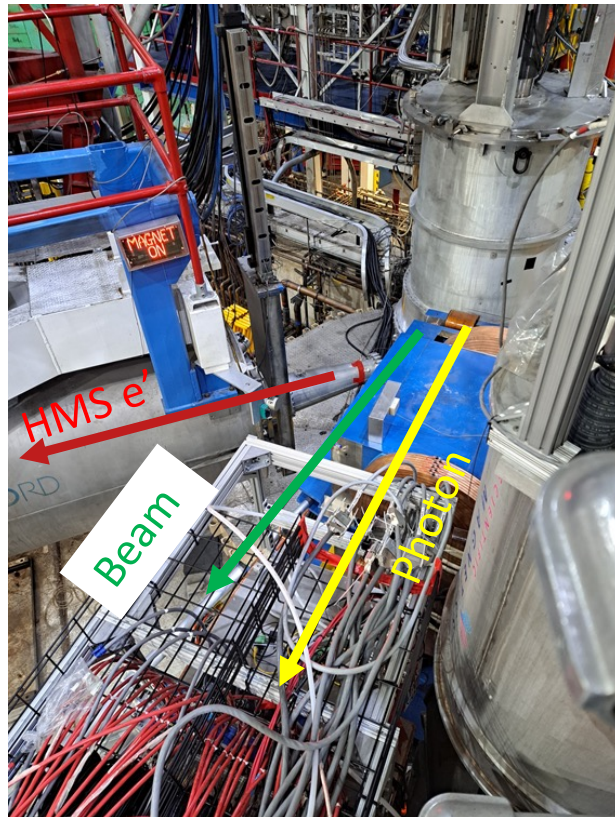
## Neutral Particle Spectrometer (NPS)

- Sweeping Magnet with calorimeter. 1080 Lead-Tungstate blocks in calorimeter to detect  $\gamma$  and  $\pi^0$
- NPS attached to SHMS carriage to allow easy angle change. The calorimeter is on rails.

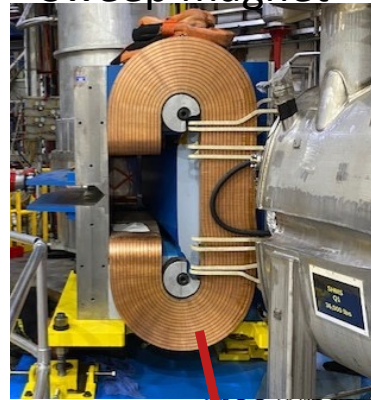
## Concurrent Experiments using the NPS

- [E12-13-010](#) and [E12-22-006](#) measure exclusive Deeply Virtual Compton scattering on proton and neutron
- [E12-09-017](#) and [E12-23-014](#) measure SIDIS  $^1\text{H}, ^2\text{H}$  ( $e, e', \pi^0$ ) cross section and  $R = \sigma_L / \sigma_T$  for SIDIS.

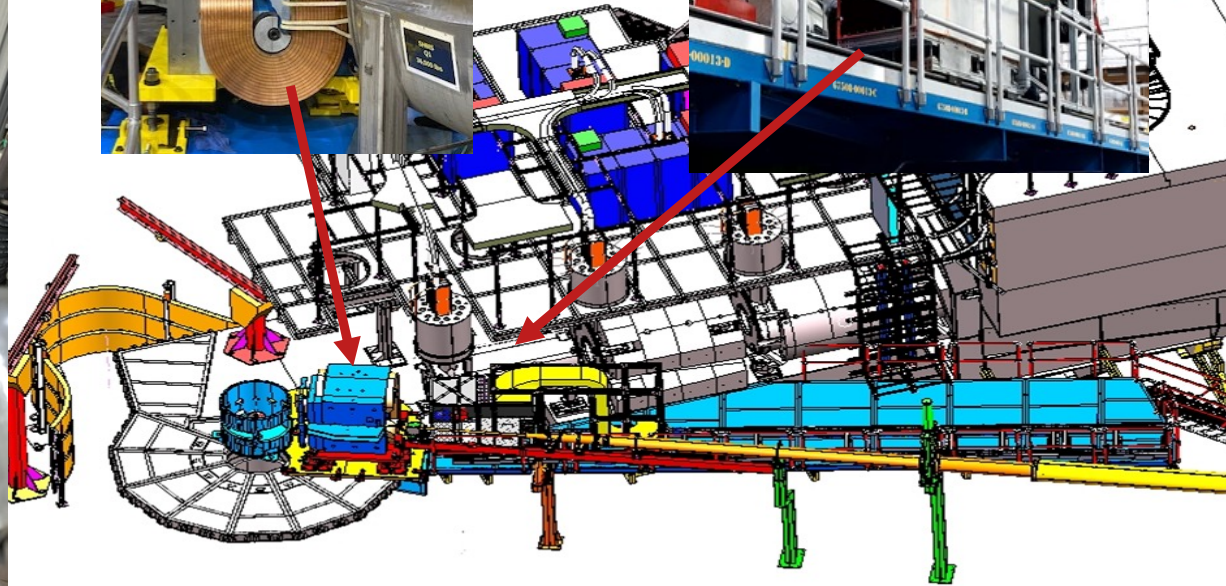
Calorimeter at 3m from target.



Sweep magnet



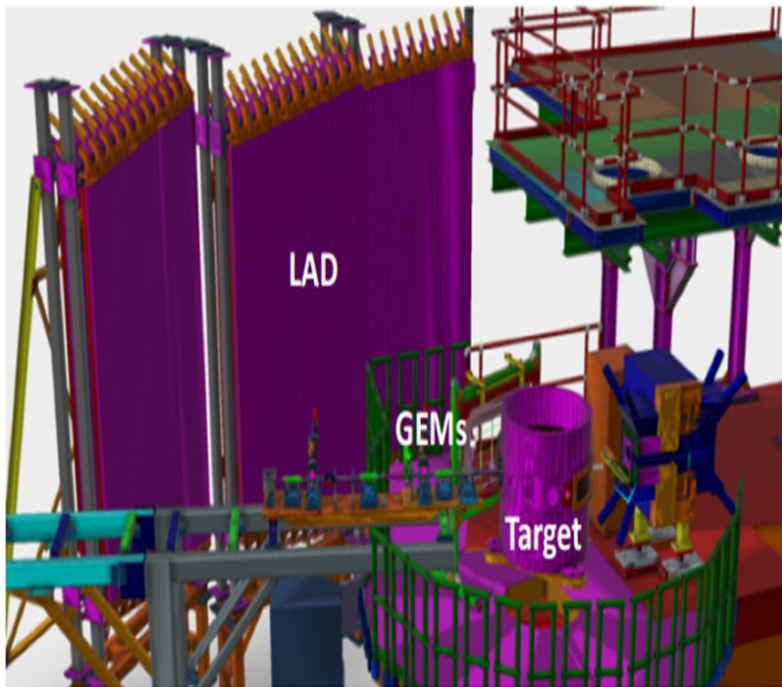
Calorimeter



# Hall C Plans to run from Sept 2024 to May 2025

## LAD to be installed starting in June 2024

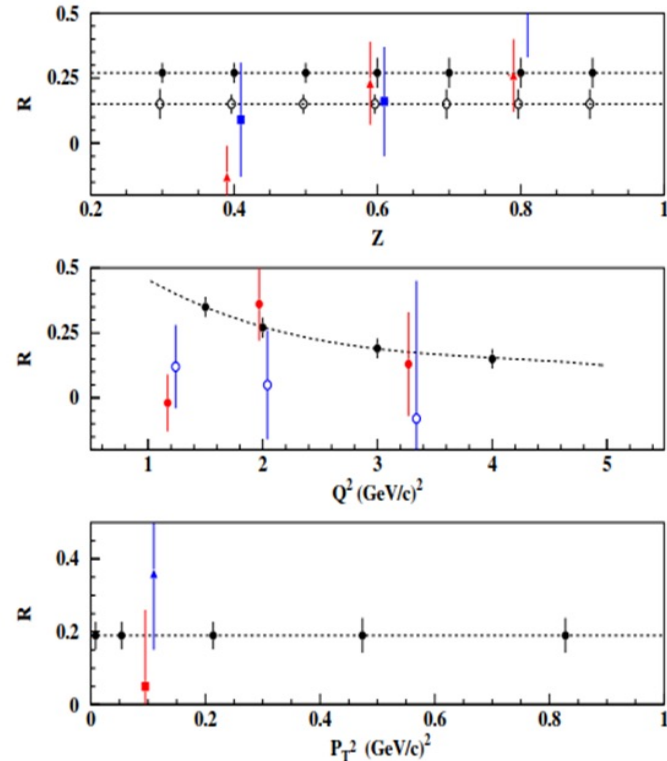
The experiment studies the  $D(ee'p_s)$  reaction which detects electron in SHMS or HMS and the spectator proton in the Large Angle Detector scintillator planes and GEM



## Run experiments

- E12-11-107 Spectator tagged DIS  $d(e, e'p_s)$
- E12-06-104  $R = \sigma_L / \sigma_T$  in SIDIS on 1H and 2H
- E12-06-107 Pion color transparency

## Projected error bars for R in SIDIS






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## Determining the gluonic gravitational form factors of the proton

[B. Duran](#), [Z.-E. Meziani](#) , [S. Joosten](#), [M. K. Jones](#), [S. Prasad](#), [C. Peng](#), [W. Armstrong](#), [H. Atac](#), [E. Chudakov](#), [H. Bhatt](#), [D. Bhetuwal](#), [M. Boer](#), [A. Camsonne](#), [J.-P. Chen](#), [M. M. Dalton](#), [N. Deokar](#), [M. Diefenthaler](#), [J. Dunne](#), [L. El Fassi](#), [E. Fuchey](#), [H. Gao](#), [D. Gaskell](#), [O. Hansen](#), [F. Hauenstein](#), ... [Z. Zhao](#)

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