

Hall A & C Status



Hall A Publications + students

First Measurement of the Ar(e,e')X Cross Section at Jefferson Lab

Phys. Rev. C 99, 054608 (2019) (H. Dai et al.)

First Measurement of the Ti(e,e')X Cross Section at Jefferson Lab

Phys. Rev. C 98, 014617 (2018) (H. Dai et al.)

High-resolution hypernuclear spectroscopy at Jefferson Lab, Hall A

Phys. Rev. C 99, 054309 (2019) (F. Garibaldi et al.)

Measurement of double-polarization asymmetries in the quasi-elastic ${}^3\text{He}\uparrow(e\uparrow, e'p)$ process

Phys. Lett. B 788, 117 (2019) (M. Mihovilović et al.)

Proton charge radius extraction from e scatt. data using dispersively improved chiral effective field theory

Phys. Rev. C 99, 044303 (2019) (J.M. Alarcón, D.W. Higinbotham, C. Weiss, Z. Ye.)

Density Changes in Low Pressure Gas Targets for Electron Scattering Experiments

Accepted NIM A - 10.1016/j.nima.2019.06.025 (S.N. Santiesteban et al.)

Graduated Students: Dien Nguyen, Scott Barcus, Thir Gautam, Barak Schmookler

Hall A Publication Drafts

Measurement of the single-spin asymmetry A_y^0 in quasi-elastic ${}^3\text{He}\uparrow(e,e'n)$ scattering at $0.4 < Q^2 < 1.0 \text{ GeV}/c^2$

[arXiv:1906.04075](#) (E. Long et al.)

Probing for high momentum protons in ${}^4\text{He}$ via the ${}^4\text{He}(e,e'p)X$ reaction

[arXiv:1905.00541](#) (S. Iqbal et al.)

Comparing proton momentum distributions in $A=3$ nuclei via ${}^3\text{He}$ and ${}^3\text{H}(e,e'p)$ measurements

[arXiv:1902.06358](#) (R. Cruz-Torres et al.)

Dispersive Corrections to the Born Approximation in Elastic eA Scattering in the Intermediate Energy Regime

[arXiv:1805.12441](#) (P. Guèye et al.)

The Double Spin Asym. of Nitrogen in Elastic and Quasi el. Kin. from a Solid Ammonia Dynamically Pol. target

[arXiv:1905.12550](#) (Moshe Friedman, Jessica Campbell, Adam Sarty, Douglas W. Higinbotham, Guy Ron)

Hall C Publications + students

Measurements of Non-Singlet Moments of the Nucleon SF and Comparison ... for $Q^2=4 \text{ GeV}^2$

Accepted PRL – arXiv:1807.06061 (I. Albayrak et al.)

Revealing Color Forces with Transverse Polarized Electron Scattering (SANE)

Phys. Rev. Lett. 122, 022002 (2019) (W. Armstrong et al.)

Technical Supplement to “Polarization Transfer Observables ...” (GEP-III, GEP-2 γ)

Nucl Inst Meth A 910, 54 (2018) (A.J.R. Puckett et al.)

Experimental techniques and performance of Λ -hypernuclear spectroscopy (HKS)

Nucl Inst Meth A 900, 69 (2018) (T. Gogami et al.)

Determination of the Proton’s Weak Charge and its constraints on the Standard Model

Annual Review of Nuclear and Particle Science – 2019 (Carlini, W. van Oers, M. Pitt, and G. Smith)

Graduated Students: Kurtis Bartlett, James Dowd, Sheren Alsalmi

Hall C Publication Drafts

Unique Access to u-Channel Physics: Exclusive Back.-Angle Omega Meson Electroprod. (FPI)

(W.B. Li et al.)

Exclusive π^+ electroproduction off the proton from low to high $-t$ (FPI)

(S. Basnet et al.)

Parity-Violating Inelastic Electron-Proton Scattering at Low Q^2 (Qweak 3 Pass ancillary measurements)

(Qweak collaboration) – Inclusive e^- and π^- asymmetries with longitudinal and transverse polarized beams

Testing the Standard Model at the Precision Frontier with the Qweak Experiment

To be submitted to Nuclear Physics News International (Carlini, W. van Oers, M. Pitt, and G. Smith)

Weak charge of ^{27}Al (and Al neutron radius – AREX?)

(Qweak collaboration)

Beam normal spin asymmetries on ^{27}Al

(Qweak collaboration)

Beam normal spin asymmetries on the proton

(B. Waidyawansa, Qweak collaboration)

Hall A – 2018/9

Fall 2018 – Tritium Era

E12-10-103 MARATHON

E12-11-112 Short Range Correlations (high X)

E12-14-011 ${}^3\text{H}(e,e'p)$ ${}^3\text{He}(e,e'p)$ – momentum distribution

E12-17-003 Λ n search

Spring 2019

E12-10-009 APEX dark matter

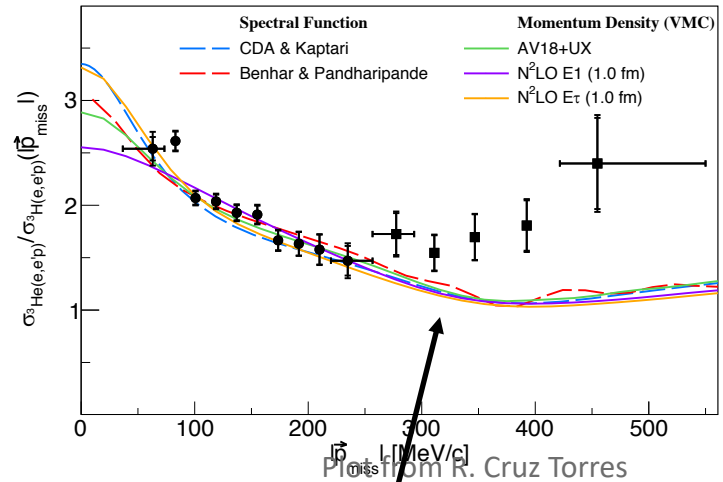
Now

E12-11-101 PREX2 neutron skin in lead

Fall 2019

E12-12-004 CREX neutron radius in Calcium

Hall A Tritium (and Argon) Running Completed

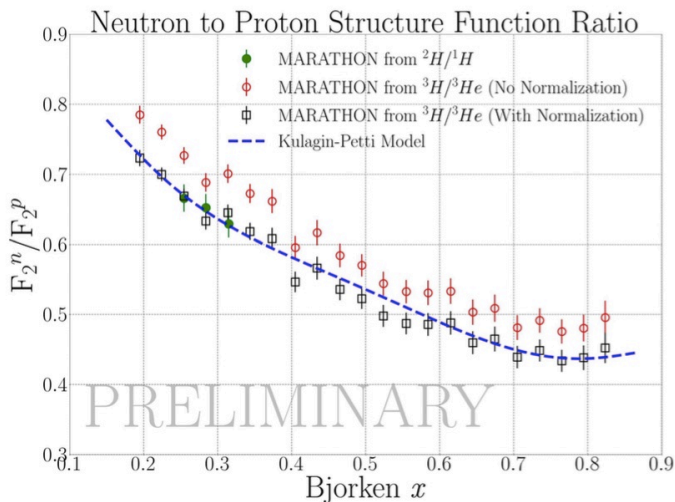


³H(e,e'p) / ³He(e,e'p) draft under collaboration review

Titanium and Argon results published

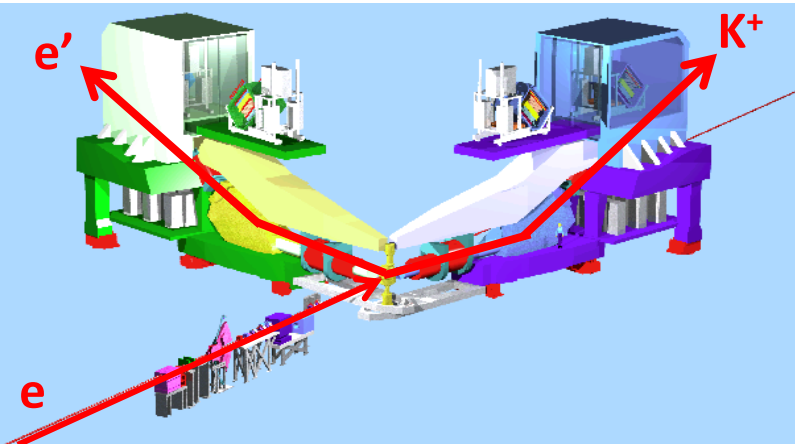
Target density changes paper published

See S. Li, S. Santiesteban, R. Cruz Torres, T. Kutz, L. Gu talks



E12-17-003: Searching for The Possible Λ n Resonance

- Λ p and Λ n interaction properties are so far treated as the same, based on negligible **CSB** found in NN interactions.
- Significant **CSB** in Λ N interactions is confirmed by the isospin pair hypernuclei: ${}^4_{\Lambda}\text{He}$ and ${}^4_{\Lambda}\text{H}$.
- The origin of such **CSB** is important to understand BB interactions in all flavors within the SU(3) framework.
- There are Λ p scattering data although very limited. However, Λ n data do not exist.
- A GSI experiment recently reported possible existence of a (bound) Λ n state.
- ${}^3\text{H}(e, e'K^+)\Lambda$ n reaction at JLab is currently the best method to search and study such a state by measuring its binding energy and natural width. It may provide experimental data on Λ n interaction for the first time.



- ❑ Variety of data were taken from H, T, He, multi-C for purposes of calibration and production
- ❑ Achieved ~80% of approved production time but gained on additionally needed calibration data. It is sufficient for the experiment at the current level.
- ❑ Online spectra showed good Λ productions
- ❑ Critical analyses undergoing:
 - Optics optimization for both HRS's (resolution)
 - Kin. calibration (precision on absolute MM)

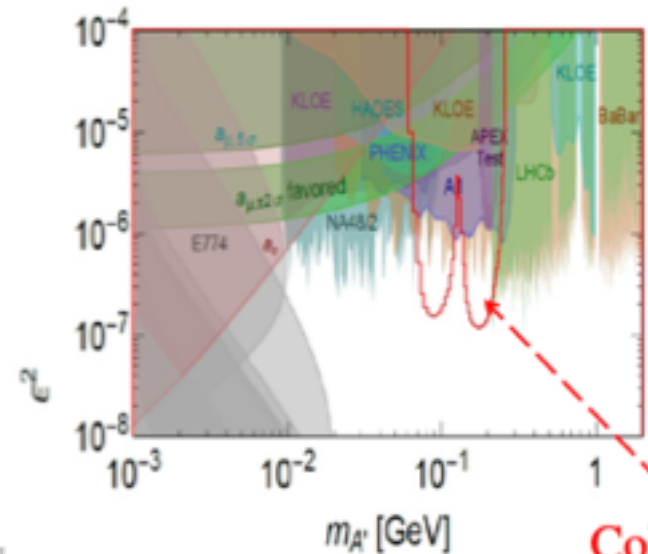
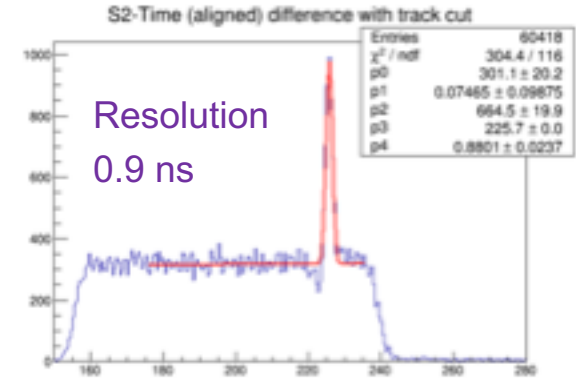
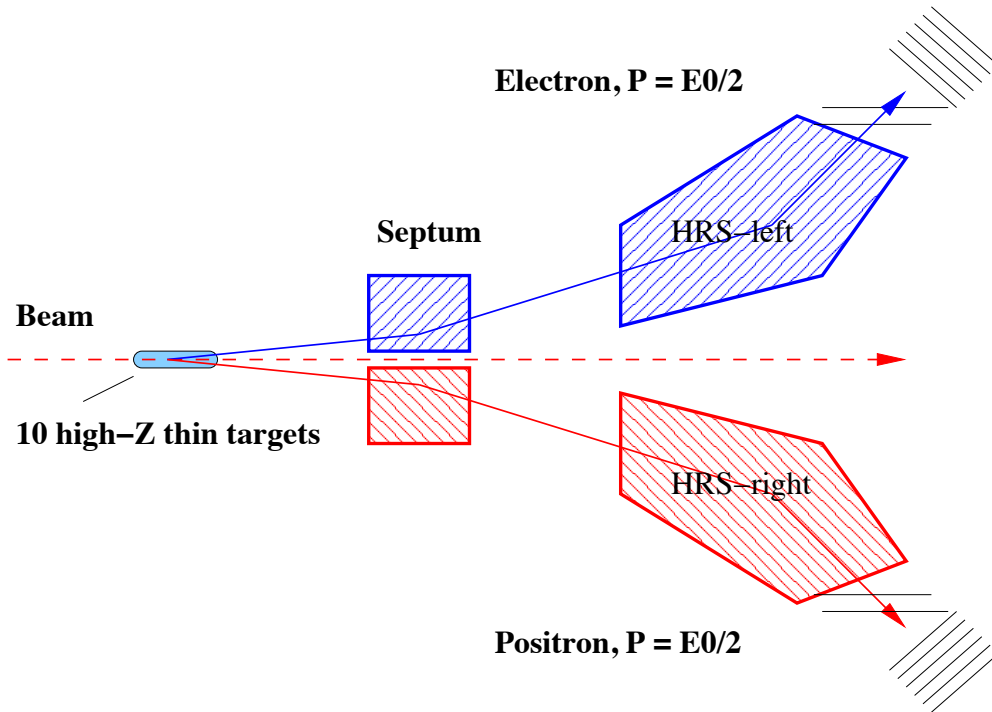
E12-17-003: done in Hall A in Nov. 2018
Two HRS's were set at the smallest angle

See B. Pandey talk

Recent Running – APEX (A)

APEX ran Feb/Mar 2019

$$M_{A'} = \sqrt{E^+ E^-} (\theta_1 + \theta_2)$$



See B. Wojtsekhowski talk

Hall C – 2019

Spring 2019

E12-16-007 LHCb charmed pentaquark via J/ψ
production (59% completed)

E12-09-002 Completed SIDIS-CSV (100%)

E12-09-011 (e,e'K) Completed data need for L/T
separations (80%)

Now

E12-06-101/E12-07-105 Short low pass run for
pion form factor + scaling

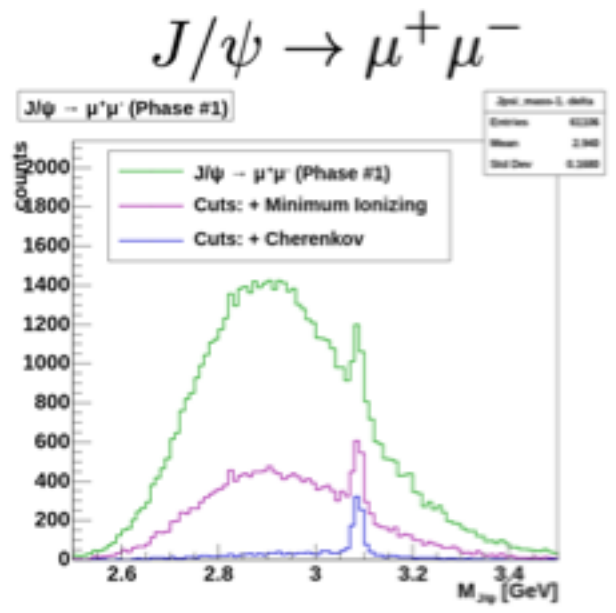
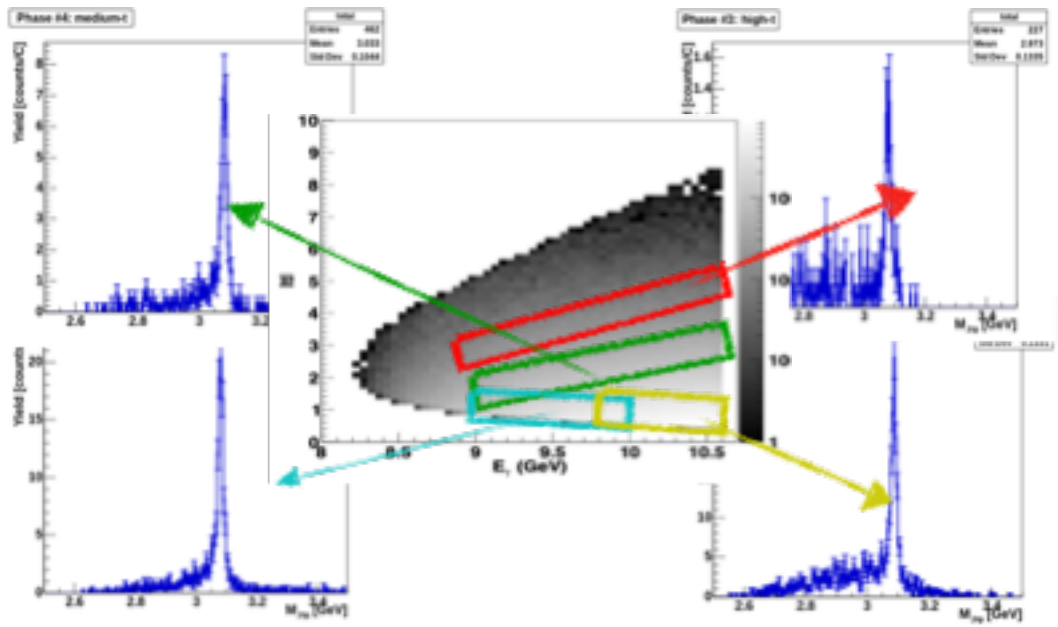
E12-15-001 Generalized polarizabilities of the
proton in VCS

Late 2019

E12-06-110 A1n (polarized ^3He)

E12-06-121 g2n/d2n (in 2020)

Recent running – LHCb Pentaquark search



LHCb Pentaquark search.
 Largest data set of
 photoproduced J/ψ 's.
 Preliminary results soon.

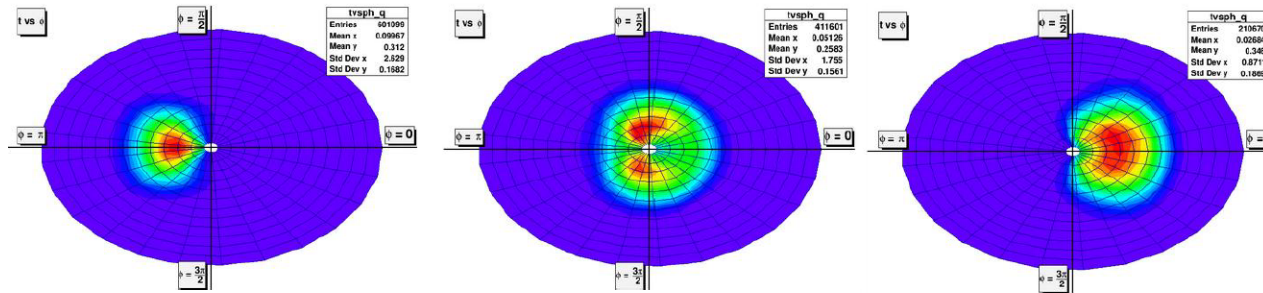
Double statistics with $\mu^+\mu^-$
 channel?

See B. Duran talk

Recent Running E12-09-011 (KaonLT)

Spokespersons: T. Horn (CUA), G. Huber (URegina), P. Markowitz (FIU)

Grad. Students: R. Ambrose (URegina, M.S. 2018), V. Kumar (URegina), M. Muhoza (CUA), R. Trotta (CUA)



Three SHMS angles

Two beam energies

$$2\pi \frac{d^2\sigma}{dt d\phi} = \varepsilon \frac{d\sigma_L}{dt} + \frac{d\sigma_T}{dt} + \sqrt{2\varepsilon(\varepsilon+1)} \frac{d\sigma_{LT}}{dt} \cos\phi + \varepsilon \frac{d\sigma_{TT}}{dt} \cos 2\phi$$

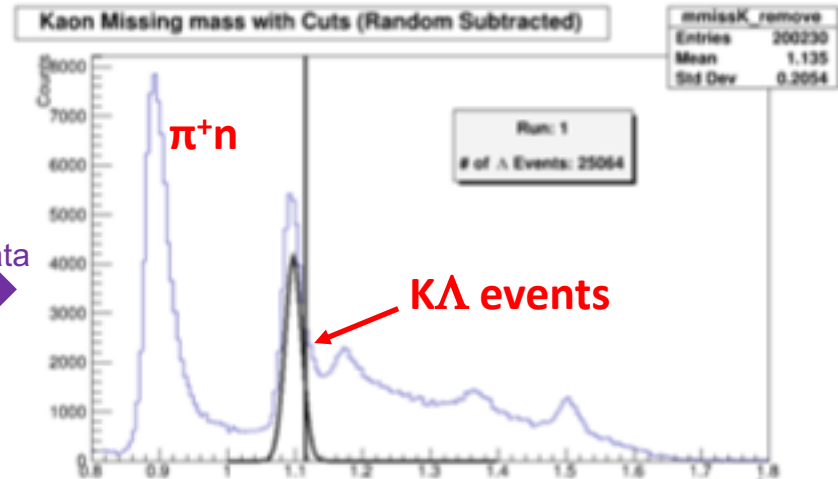
Physics cross section

Polarized beam
FREE

$$+ h \frac{d\sigma_{LT}}{dt} \sin\phi$$

Setting	Low ε data	High ε data
Q ² =0.50 W=2.40	✓	✓
Q ² =2.1 W=2.95	✓	✓
Q ² =3.0 W=2.32	✓	✓
Q ² =3.0 W=3.14	✓	✓
Q ² =4.4 W=2.74	✓	✓
Q ² =5.5 W=3.02	✓	✓

Spring 2019

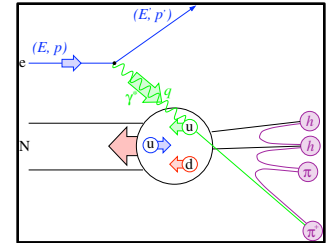


Online data

Thomas Jefferson National Accelerator See R. Trotta talk

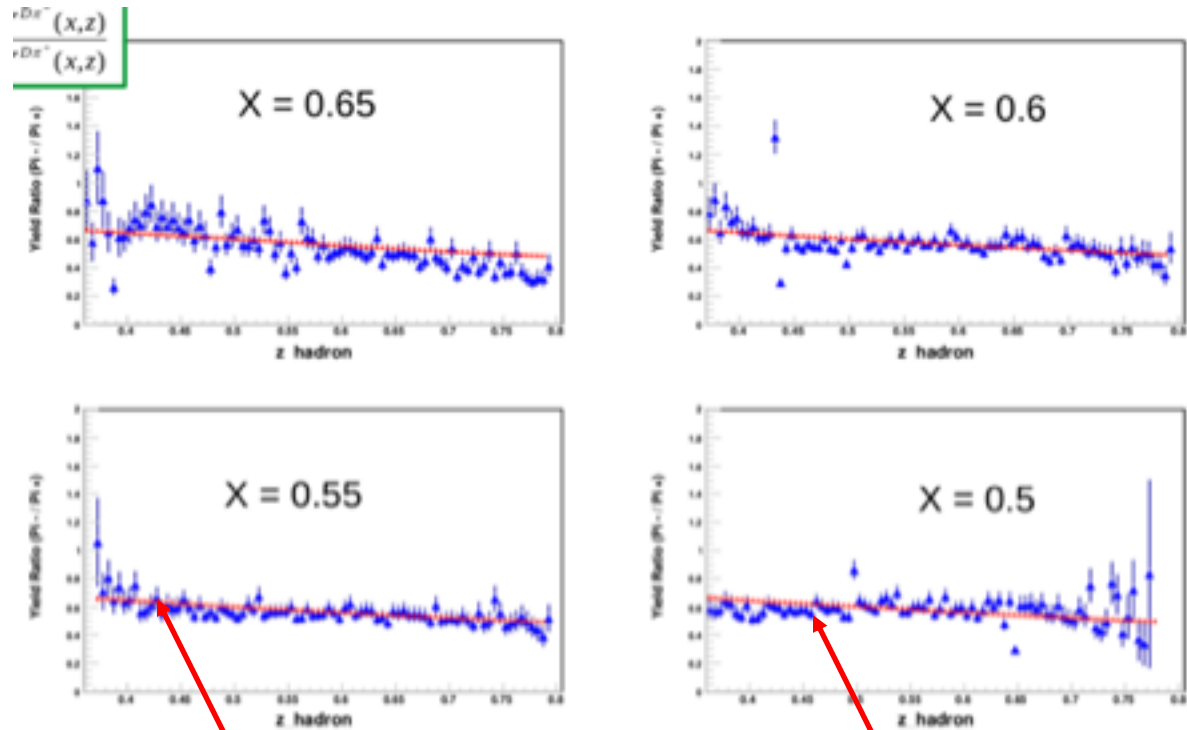
Charge Symmetry Violation - SIDIS

Measurement ratio of semi inclusive yields Y_{π^-} and Y_{π^+} of $d(e, e' \pi^-)$ and $d(e, e' \pi^+)$ to test charge symmetry

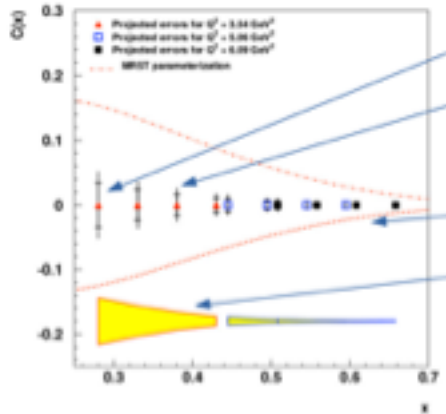


Yield ratios: Calibrations completed.
No corrections.

$$R_y(x, z) = \frac{Y_{\pi^+}(x, z)}{Y_{\pi^-}(x, z)}$$



Ratio predictions from HERMES data (no CSV)



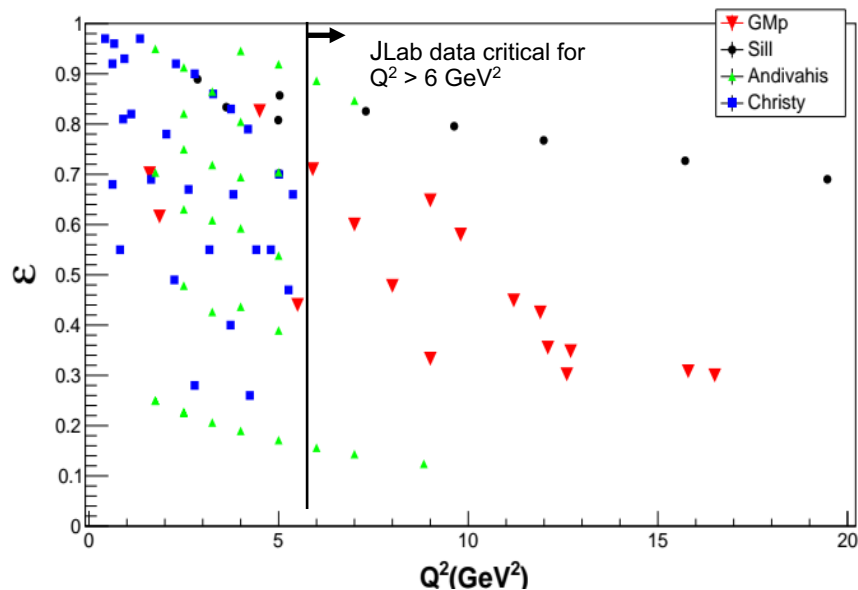
E12-09-002

Analysis updates

12 GeV Era GMp Experiment: E12-07-108

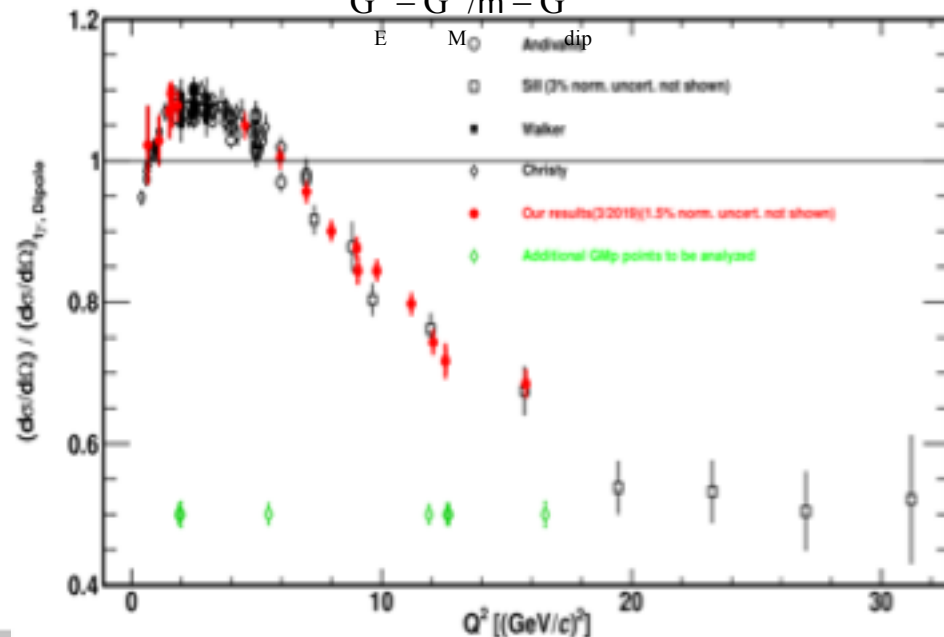
Precision Measurement of the Proton Elastic Cross-Section at High Q^2

- Precision e-p elastic cross-section necessary for:
 - Baseline cross section for many 12 GeV hadronic physics measurements
 - Determination of G_E^p , G_M^p and 2- Ω effects at high Q^2 in combination with polarization measurements
- Systematic uncertainties on Fall 2016 LHRS data $\sim 1.3\%$ (pt-pt), 1.5% (norm) RHRS (additional 2% from optics)
- Fall 2016 data finalized. First paper to collaboration in July 2019.



Cross section relative to 1-g cross section calculated with

$$G = G_E / m = G_M$$



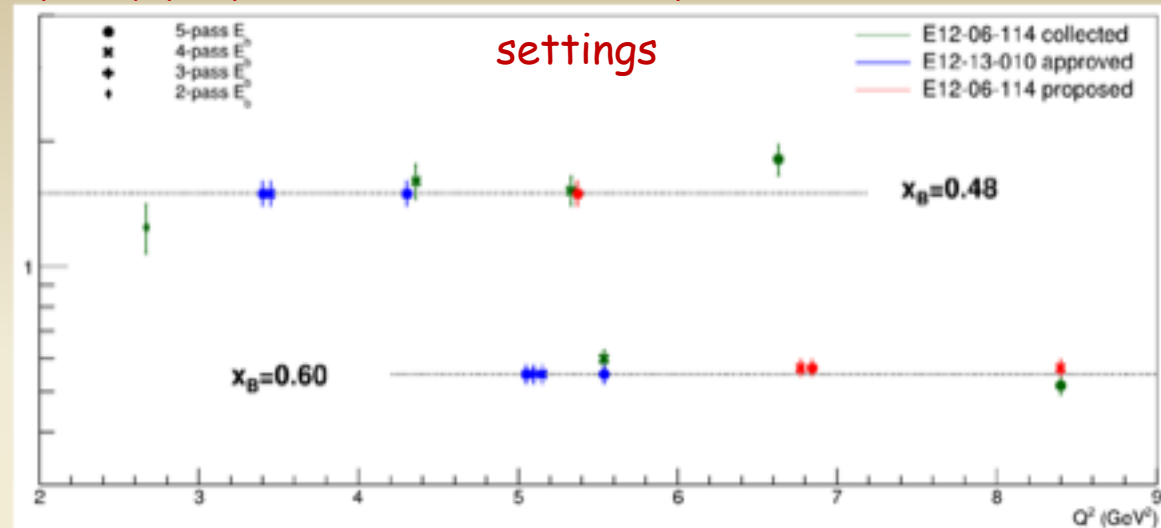
E12-06-114 DVCS/Hall A Experiment at 11 GeV

100 PAC days approved:

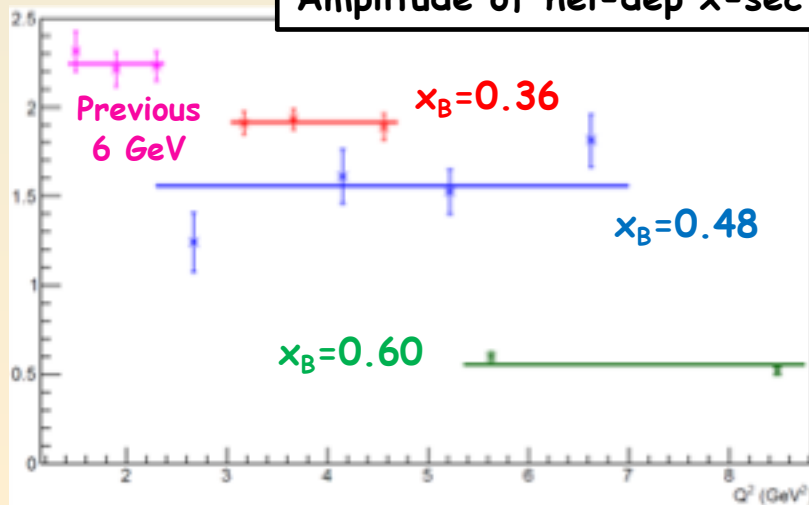
- High impact experiment for nucleon 3D imaging program
- High precision scaling tests of the DVCS cross section at fixed x_B
- CEBAF12 allows to explore for the first time the high x_B region

50% of experiment planned & completed in 2014-2016

Jeopardy proposal to PAC47 to complete $x_B=0.50$ and $x_B=0.60$



Amplitude of hel-dep χ -sec

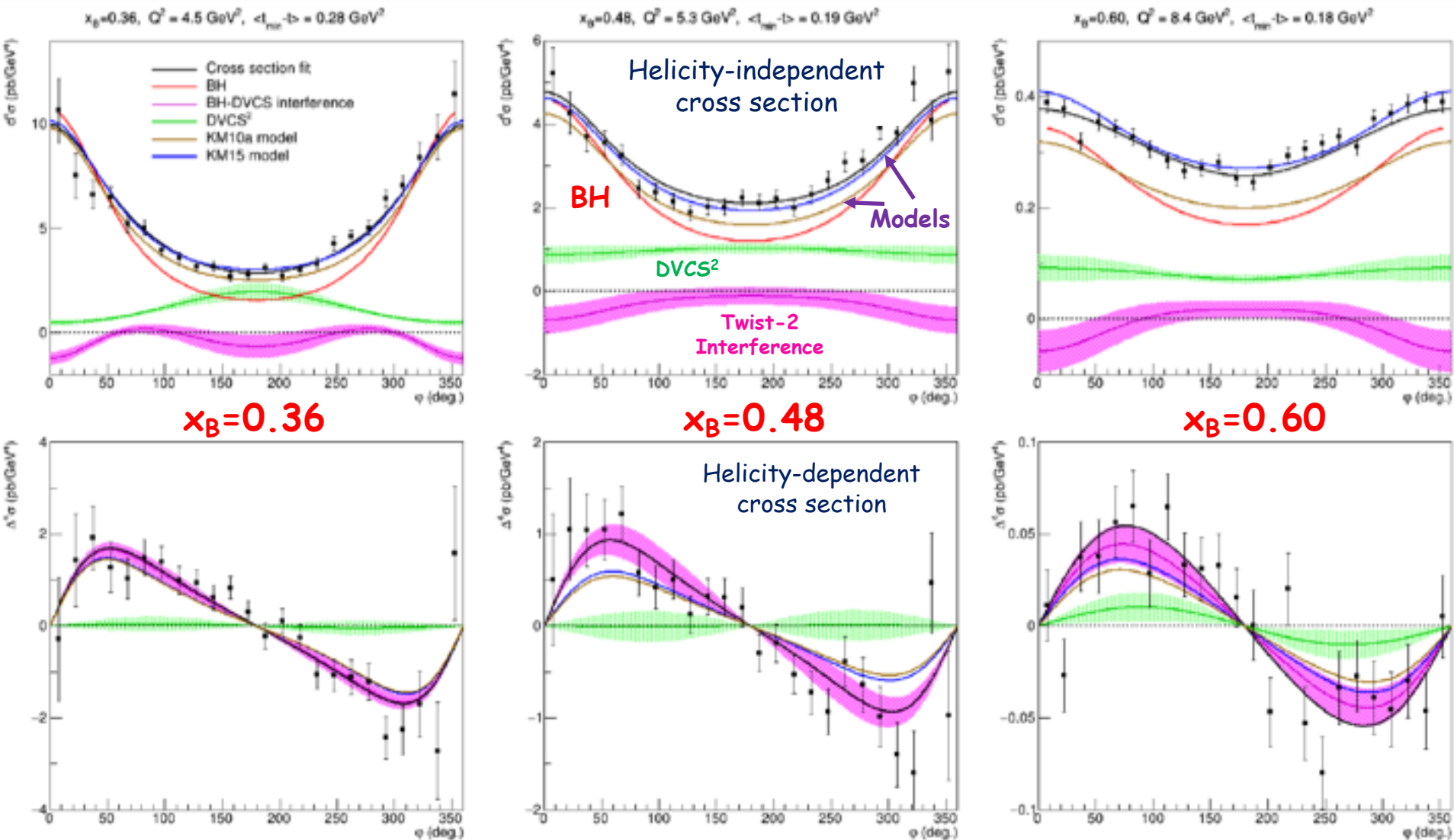


Analysis status:

- Analysis of DVCS cross sections completed for *all 9 kinematic settings* (presented at SPIN 2018)
- Publication being drafted, expected to be circulated by the end of **July'19**
- π^0 electroproduction results and publication will follow soon afterwards

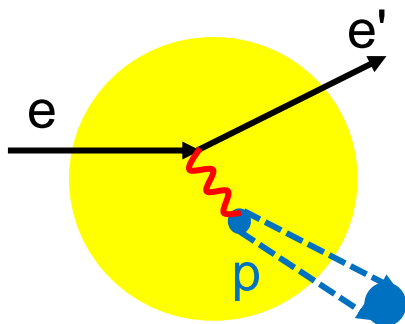
E12-06-114 DVCS/Hall A Experiment at 11 GeV

Sample of cross-section results:



E12-06-107 Color Transparency

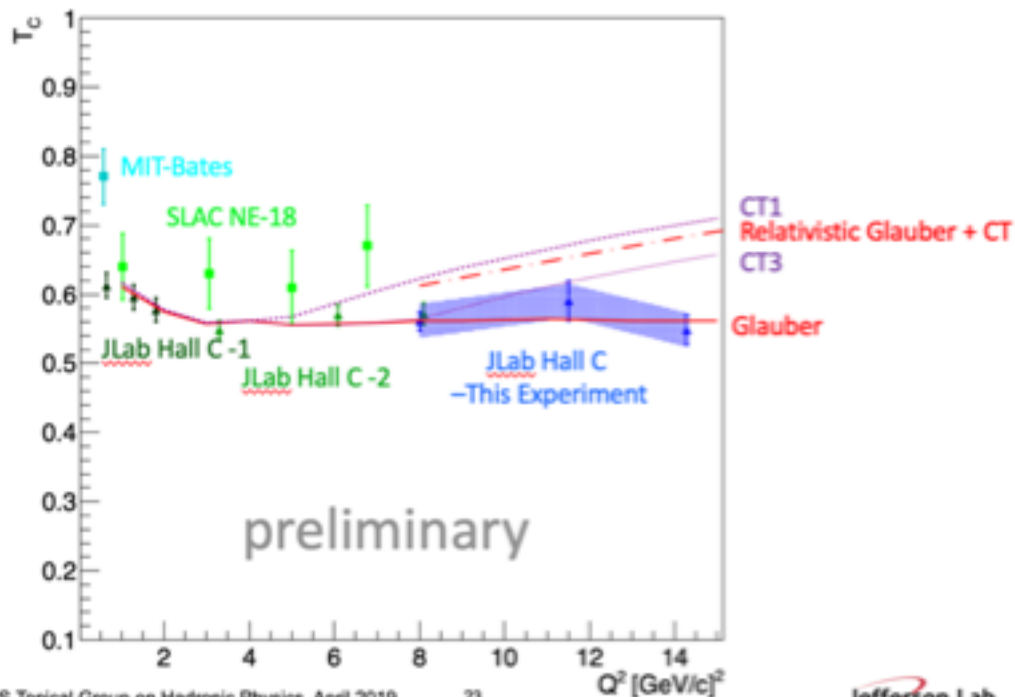
$$T_A = \frac{\sigma_{A(e,e'p)}}{Z \sigma_{p(e,e'p)}}$$



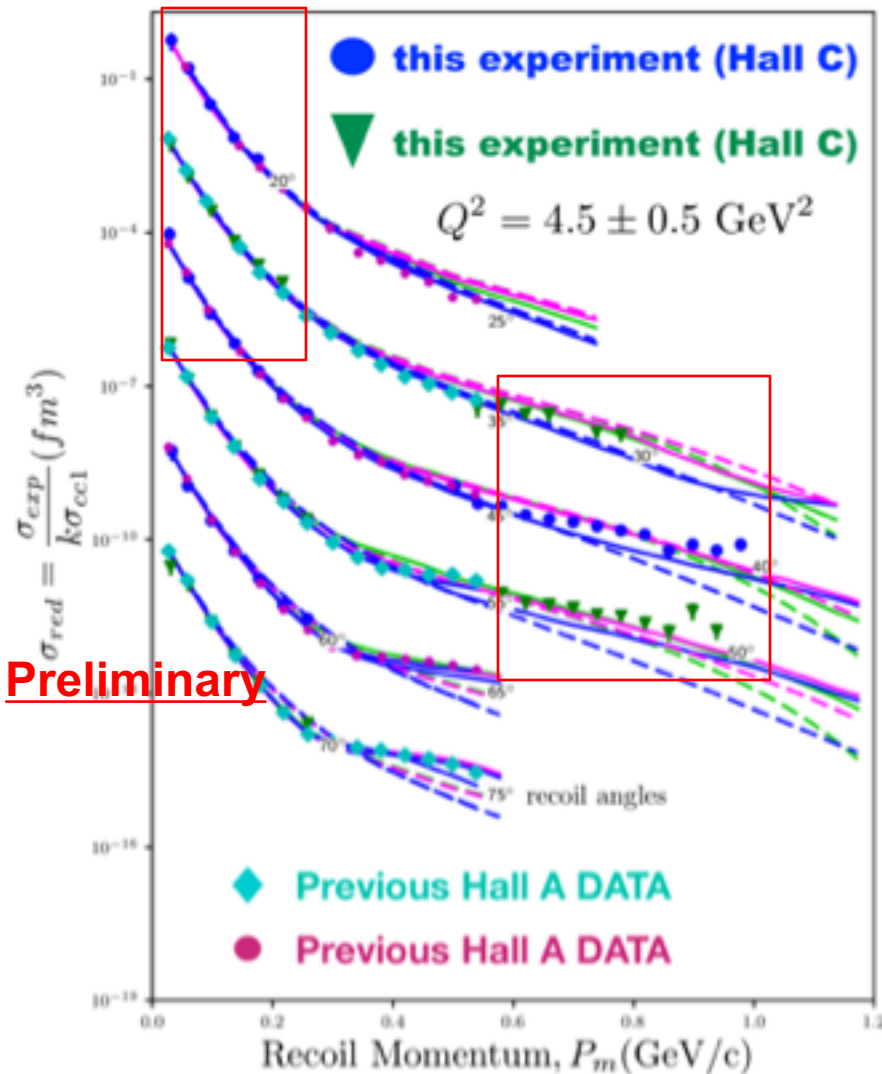
First commissioning experiment

Preliminary $^{12}\text{C}(e,e'p)$ Color Transparency results shown at APS meeting and UGM.

See D. Bhetuwal talk



E12-10-003 $d(e,e'p)$



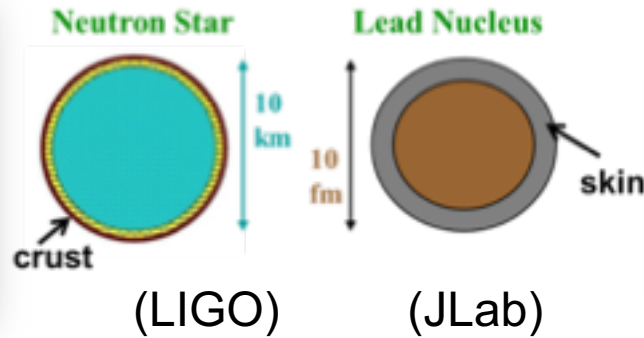
Commissioning experiment

Preliminary results matching to previous Hall A data.

Extends P_m to 1000 MeV/c.

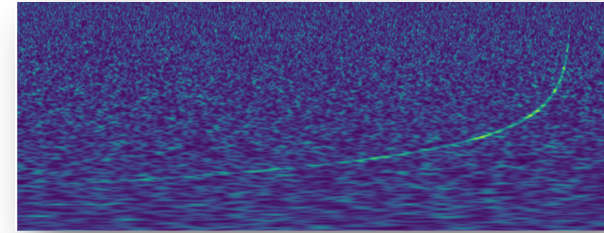
See C. Yero talk

2019 Hall A Summer Run: PREX2/CREX

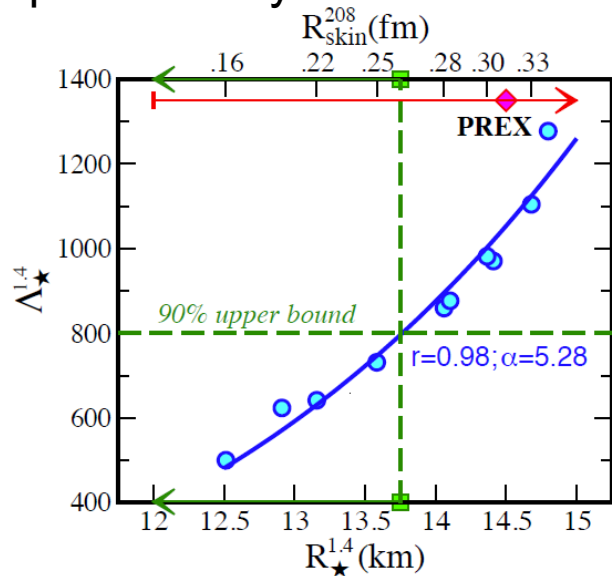


(LIGO)

(JLab)



Measurement of neutron skin at JLab constrains tidal polarizability of neutron stars



Phys. Rev. Lett. 120, 172702 (2018)



Running in Hall A

Neutral Particle Spectrometer

NPS (Experiments E12-13-010/E13-13-007, E12-14-003/E12-14-005) passed ERR with recommendations.

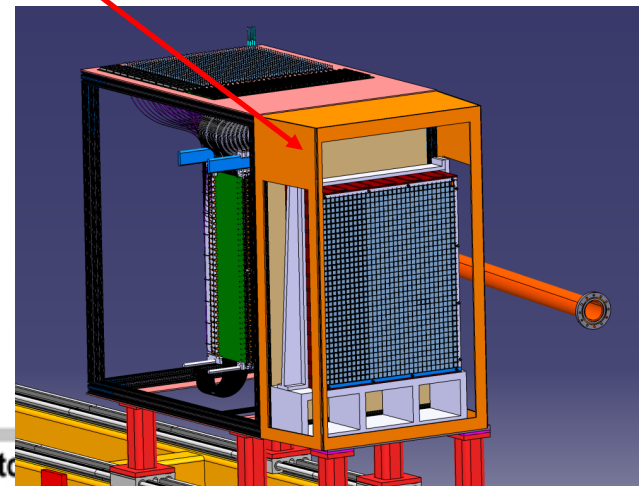
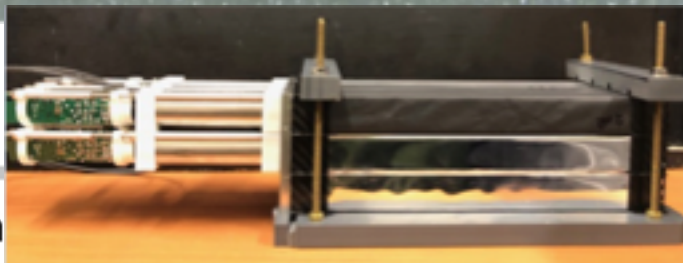
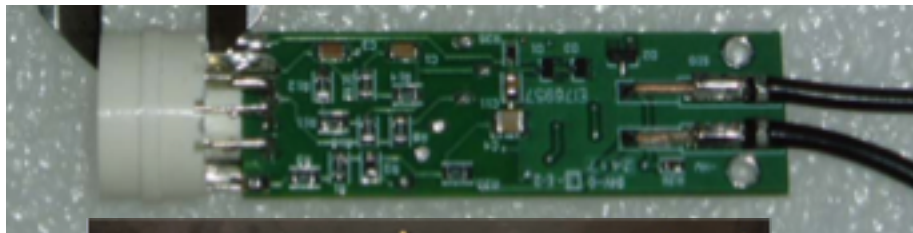
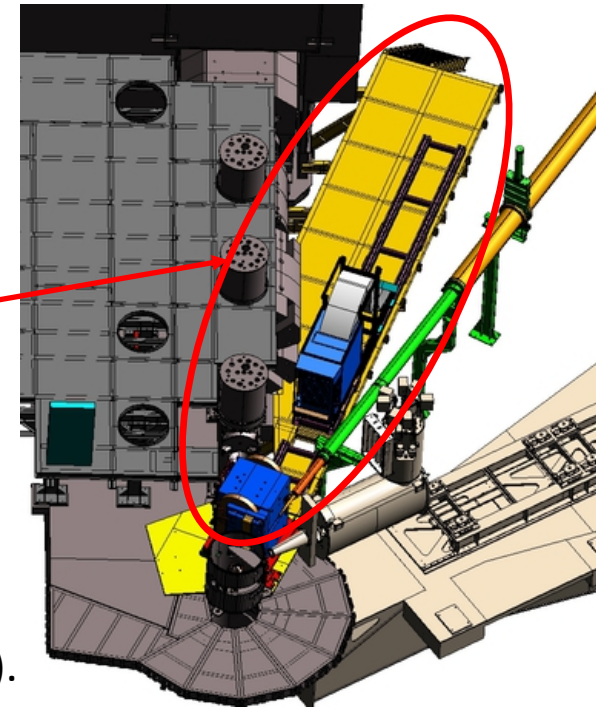
NPS Sweep magnet (MRI CUA/ODU) ready for mapping.

SHMS platform extension (for small angles) designed.

Calorimeter frame designed (IPN-Orsay).

Final crystal procurement underway, testing ongoing (CUA).

All PMTs ordered. Base fabrication nearing completion (Ohio).



Polarized 3He target

Preparing for A_1^n / d_2^n (E12-06-110, E12-06-121) in late 2019.

Design complete.
Fabrication of parts (platform, supports, target) in progress.
Lasers and fibers in hand.
Instrumentation working. EPR and Pulse NMR (new) polarization measurement working.

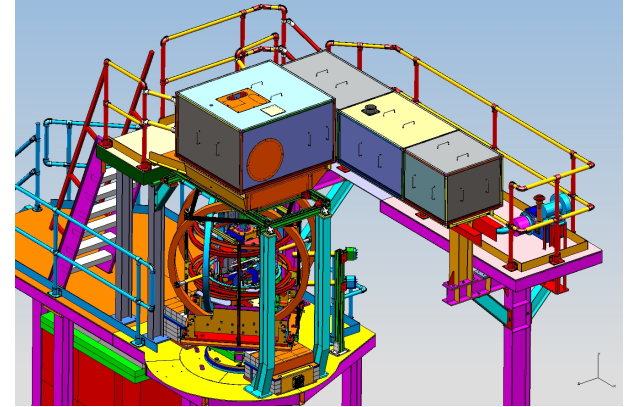
Target cell production has been challenging.
Reacquiring know-how after 10 year hiatus.
Production/filling now at W&M and UVA,
testing/characterization at JLab and UVA.
2-3 usable cells in hand.

Target goals:

30 μA on 40 cm , ~ 10 atm, $L \sim 2.2 \times 10^{36} \text{ cm}^{-2} \text{ s}^{-1}$

In-beam polarization $\sim 55\text{-}60\%$,

Polarization measurement precision $\sim 3\%$



See M. Rehfuss talk

Assorted Notes

HMS reliability – Catching up on maintenance, replacements power supplies for Q1, Q2, Q3 ordered. (Q2 power supply burned up last year.)

SHMS can (with great care) reach 5.55° (design goal 5.5°). HMS 6 GeV minimum was 10.5° . Current beampipe limits HMS to $\sim 11^\circ$. Beampipe designed to allow HMS to 10.5° and safer small SHMS angles at cost of higher radiation. Will fabricate if program requires.

Hall A preplanning to upgrade counting house. (Similar to Hall C upgrade.)

GeNrp (add on to GMn) passed (with recommendations) ERRR recently.

Machine Learning: Weekly lunch discussion - <https://jlab12gev.slack.com/messages/CFTBERJGK>
Looking for useful application of machine learning to Hall A/C problems. (e.g. optics)

Reiterate Stuart's safety comments.