Hall C Status

Publications and Students in last year

Publications:

Precision measurement of the weak charge of the proton (Qweak)

Nature 557, 207 (2018)

Measurements of the Separated F_L from Hydrogen and Deuterium Targets at Low Q^2

Phys Rev C 97, 045204 (2018)

Direct measurements of the lifetime of medium heavy hypernuclei

Nucl Phys A 973, 116 (2018)

Separated kaon electroproduction cross section and the kaon form factor from 6GeV Jlab data

Phys Rev C 97, 025204 (2018)

GEp-III – GEp-2γ archival paper

Phys Rev C 96, 055203 (2017)

SANE results – submitted (arXiV:1805.08835). Proton FF from SANE expt. – nearing submission

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

Nucl Inst Meth A 900, 69 (2018)

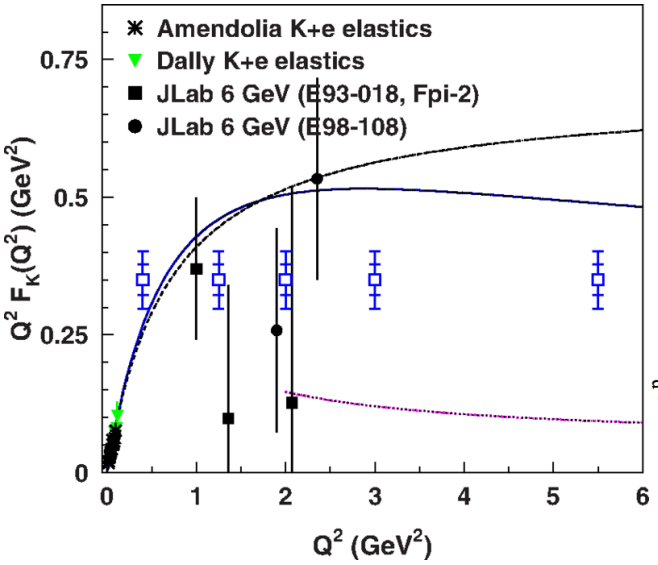
Design and performance of the spin asymmetries of the nucleon experiment (SANE)

Nucl Inst Meth A 885, 145 (2018)

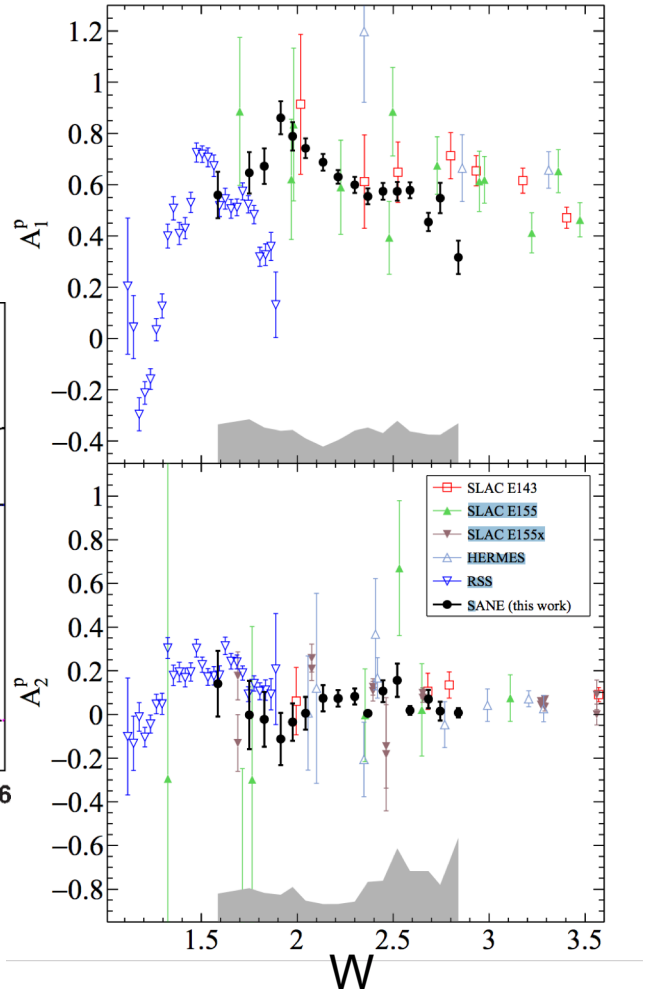
Graduated Students:

Wade Duvall, Valerie Gray, Michael Moore, Hend Nuhait, Samip Basnet, Wenliang Li, Kurtis Bartlett

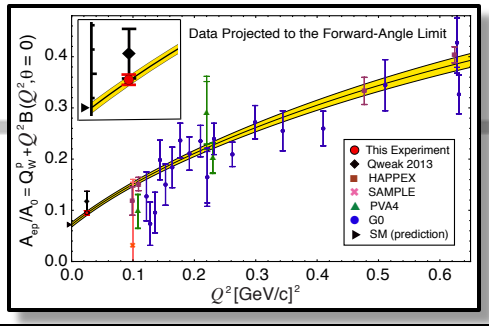
Recent Publications

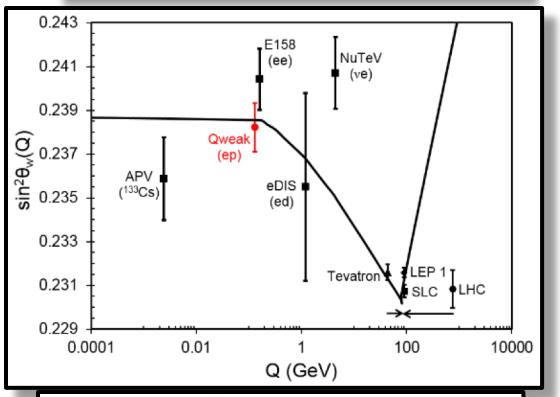


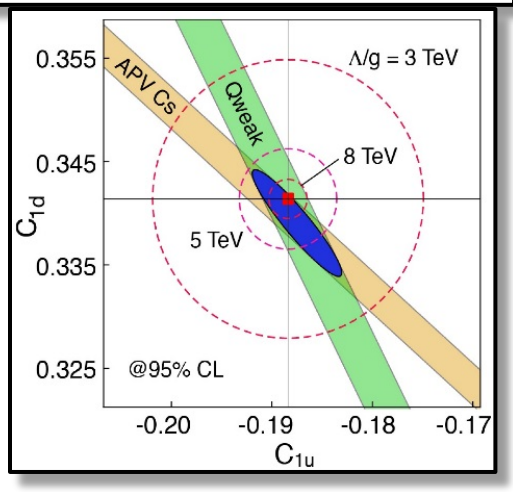
Kaon Form Factor



SANE





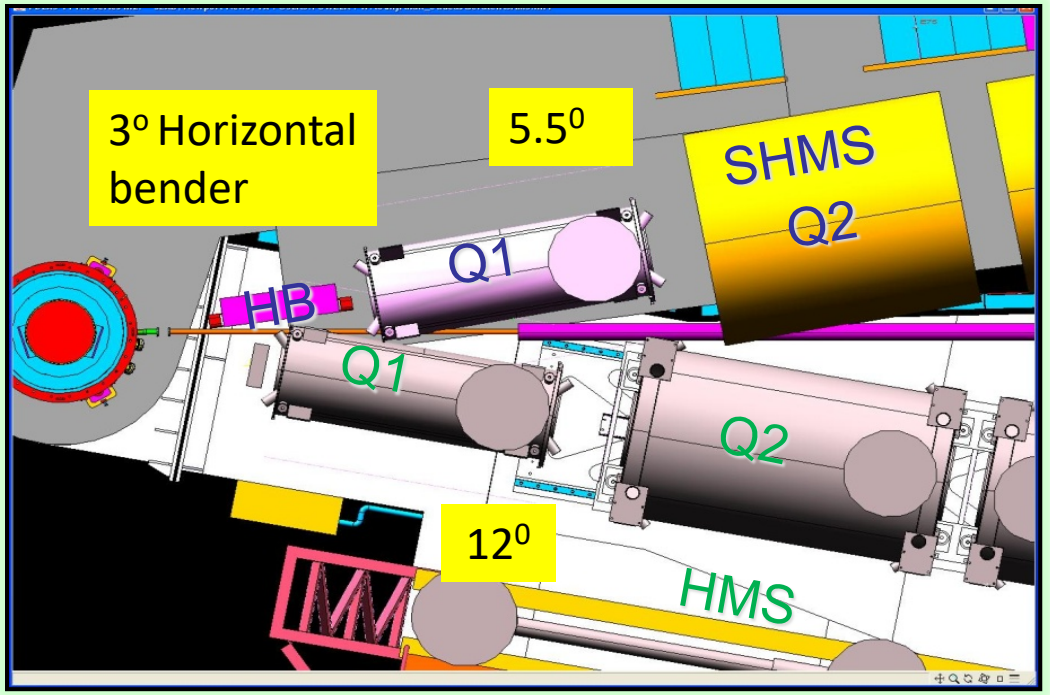


Qweak

Hall C after 12 GeV Upgrade

- Beam Energy: 2 – 11 GeV/c
- NEW Super High Momentum Spectrometer (SHMS)
  - P≤11 GeV/c (replaces ≤ 2Gev/c)
  - Horizontal Bender, 3 Quads, Dipole
  - dP/P 0.5 – 1.0x10^{-3}
  - Acceptance: 4msr, ΔP/P=30%
  - 5.5° < θ < 40°
  - Good e^-/π^- $e^+/\pi^+/K^+/p$ PID
- High Momentum Spectrometer (HMS)
  - P → 7.5 GeV/c
  - dP/P 0.5 - 1.0x10^{-3}
  - Acceptance: 6.5msr, Δp/p=18%
  - 10.5° < θ < 90°
  - Good e^-/π^- $e^+/\pi^+/K^+/p$ PID
- Minimum opening angle: ~17°

- Well shielded detector huts
- 2 beamline polarimeters
- Ideal facility for:
  - Rosenbluth (L/T) separations
  - Exclusive reactions
  - Low cross sections (neutrino level)



Hall C Spring 2018 Run

Successful run, completing planned Hall C Commissioning "Experiment".

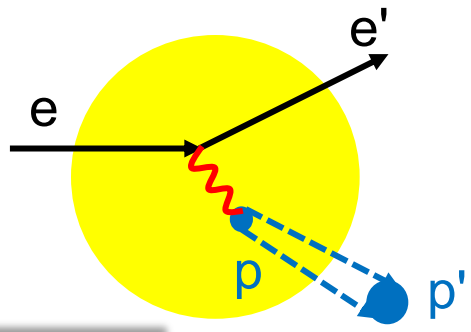
Commissioned SHMS and recommissioned HMS to higher momentum.

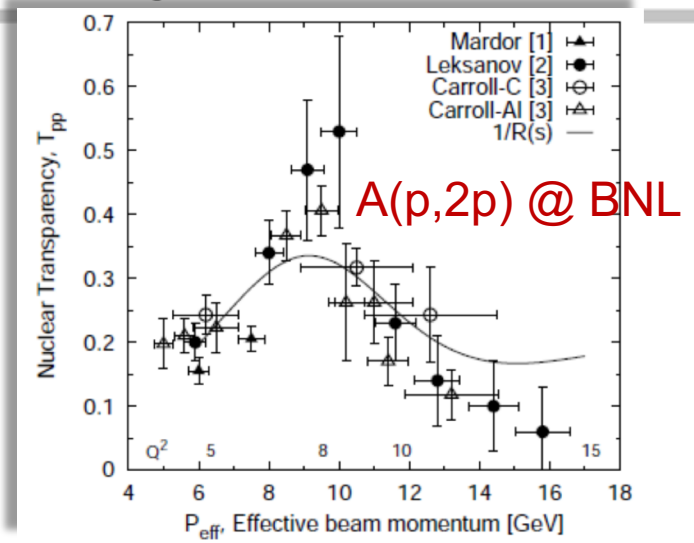
All of E12-10-002 – Large x & Q^2 F_2.
C(e,e'p) part of E12-06-107 – Color Transparency
Some light nuclei from E12-10-008 – EMC
2 kinematics of E12-10-003 – d(e,e'p) at high P_m

+ started (60%) E12-09-017 - Transverse momentum dependence of SIDIS

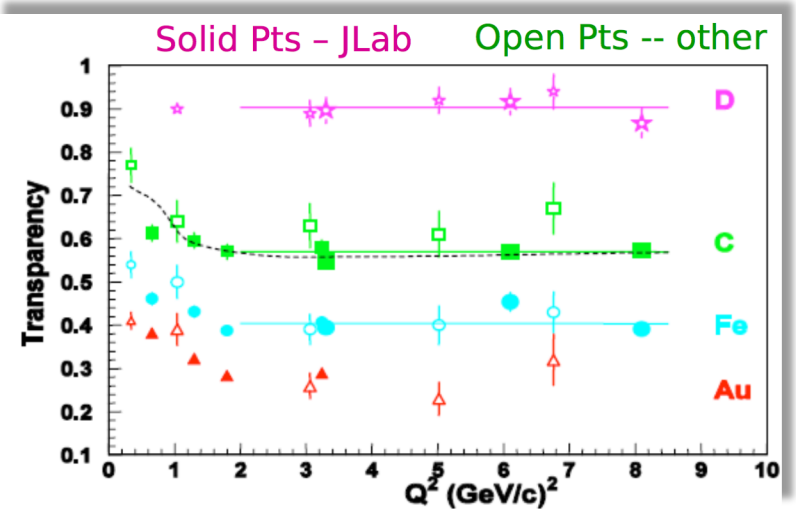
Color Transparency

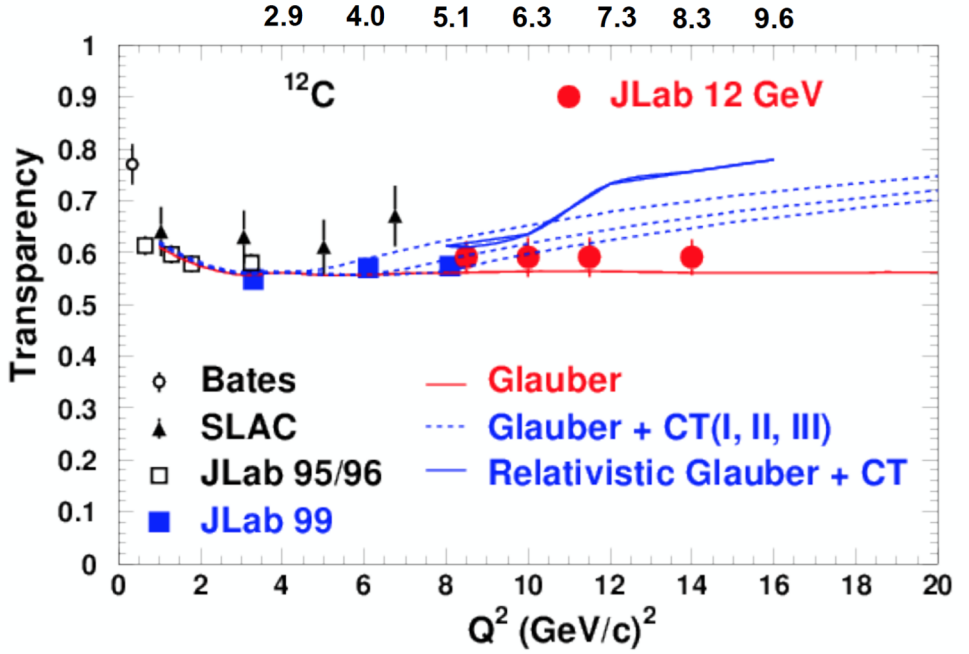
$$T_A = \frac{\sigma_{A(e,e'p)}}{Z\,\sigma_{p(e,e'p)}}$$





A(p,2p) @ BNL





Preliminary results – end of 2018

Publish – spring/summer 2019

EMC effect

Detailed study of EMC effect planned in Hall C. (E12-10-008)

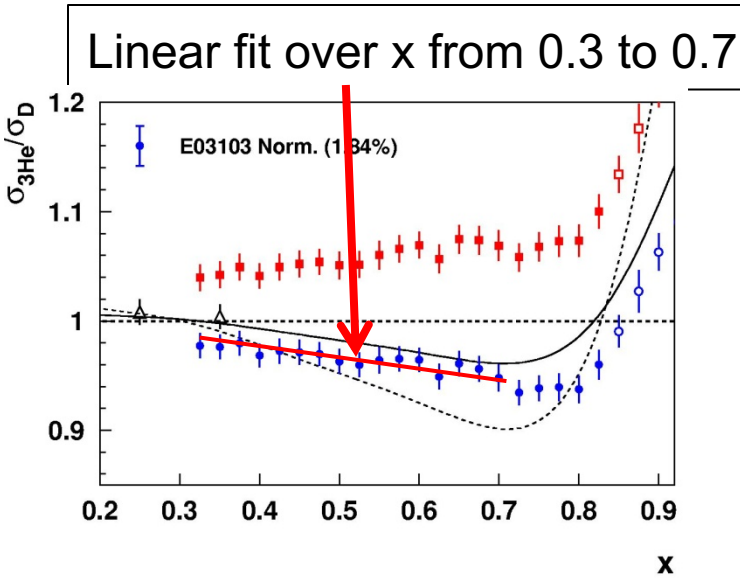
- 0.1<x<0.9 Up to $Q^2 \approx 15 GeV^2$
- Light nuclei: ^{1}H, ^{2}H, ^{3}He, ^{4}He, $^{6,7}Li$, 9Be, $^{10,11}B$, $_{12}C$
- Medium/Heavy nuclei: Al, $^{40,48}Ca$, Ti, ^{54}Fe, Ni, Cu, Ag, Sn, Au, Th

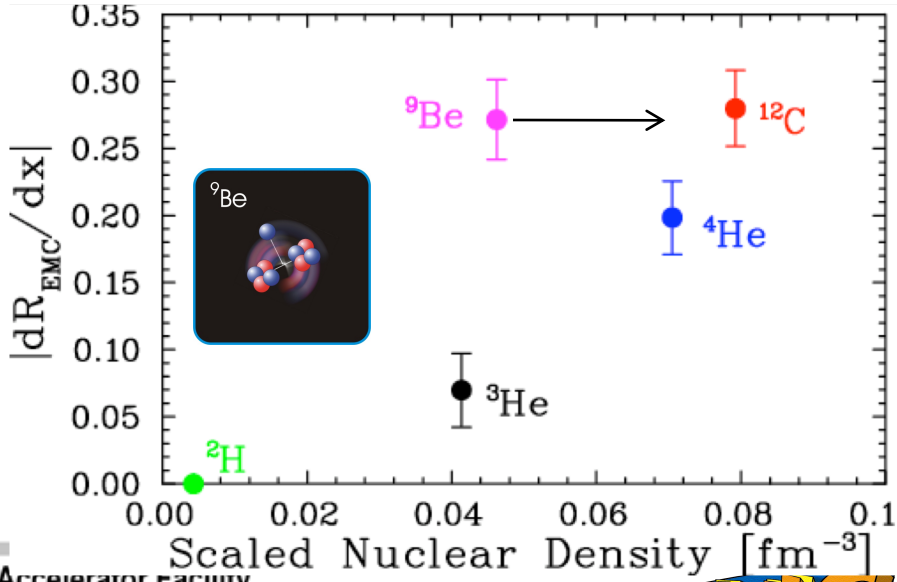
Early 2018 ran ^{9}Be, $^{10,11}B$, ^{12}C

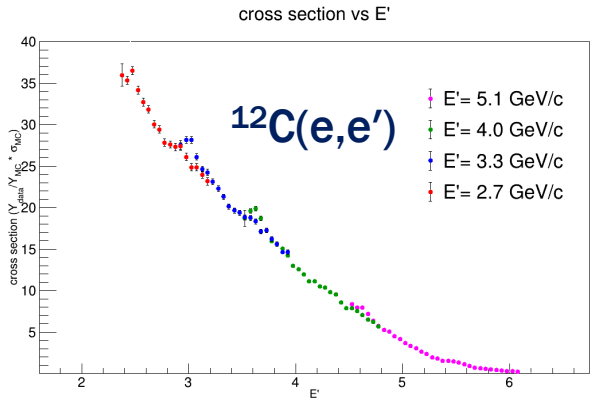
- Examine single nucleon differences

Publication:

- **Early 2019** – ratios with prelimary radiative corrections
- **Summer 2019** – submit publication (PRL?)



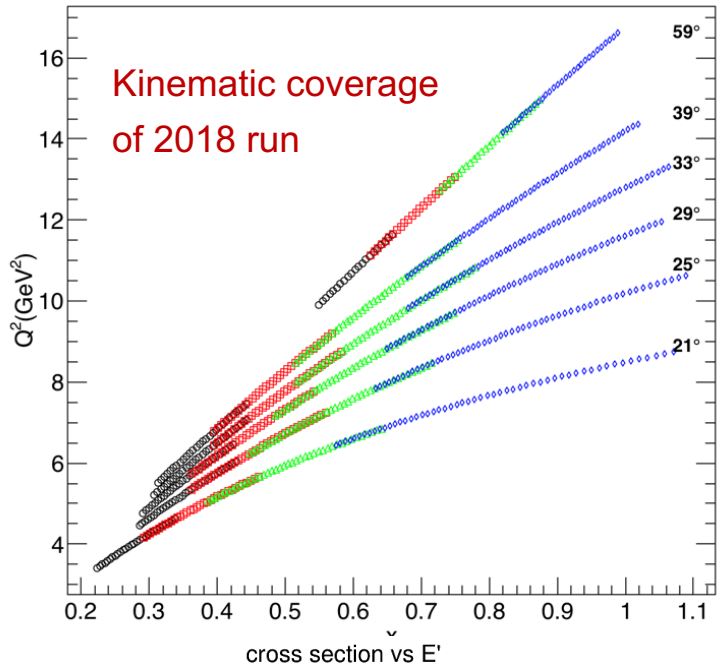


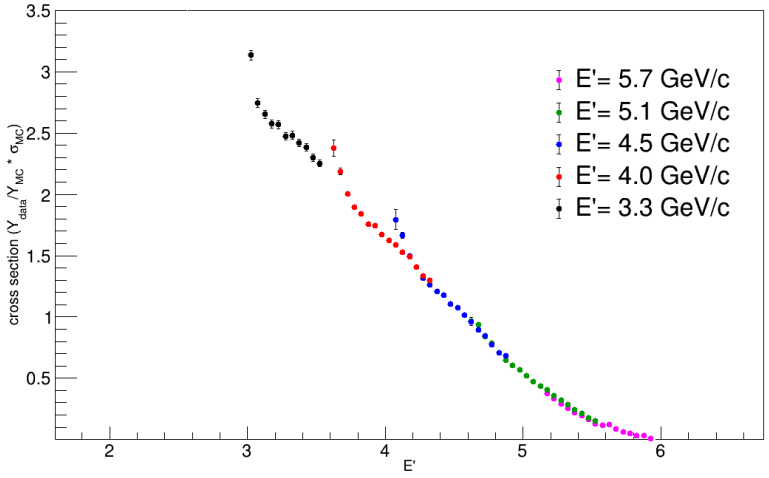


E12-10-002 Precision F_2 structure function at high x

Extend proton and deuteron F_2 structure function precision measurements to larger x and Q^2. Measuring p(e,e′) and d(e,e′) (absolute) cross sections to 3% (2% systematics) in the resonance region and beyond up to $Q^2 \sim 17$ GeV^2 and $x \sim 0.99$

- Constrain Parton Distribution Functions at large x
- Distinguish different mechanisms of spin-flavor symmetry breaking (d/u at large x) with precision F_2^n/F_2^d (combining with BONUS/Hall B (E12-06-113) F2n/F2d)
- Extend studies of local quark-hadron duality in proton and neutron F_2

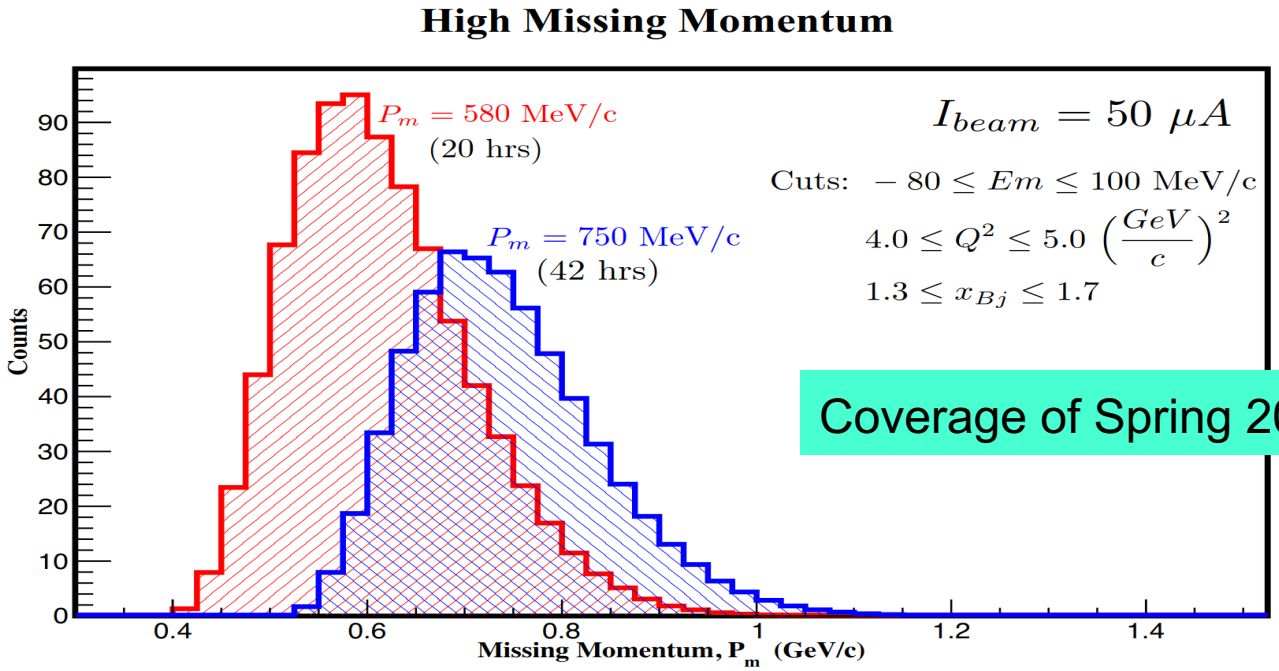




d(e,e'p)

Motivation:

- Explore a new kinematical region of the 2-nucleon system above p_m> 500
- No Deuteron data exist at these kinematics!
- Short range correlation studies cover similar region on missing momenta
- Models are able to reproduce the present data with 20%.
- Signs of a dependence on NN potential at highest missing momentum
- Measure at well defined kinematic settings, selected to minimize contributions from FSI and delta at Q^2 = 4.25



Coverage of Spring 2018 run

E12-09-017 TMD of SIDIS at 12 GeV

Map transverse momentum dependence of (e,e′π) over range:

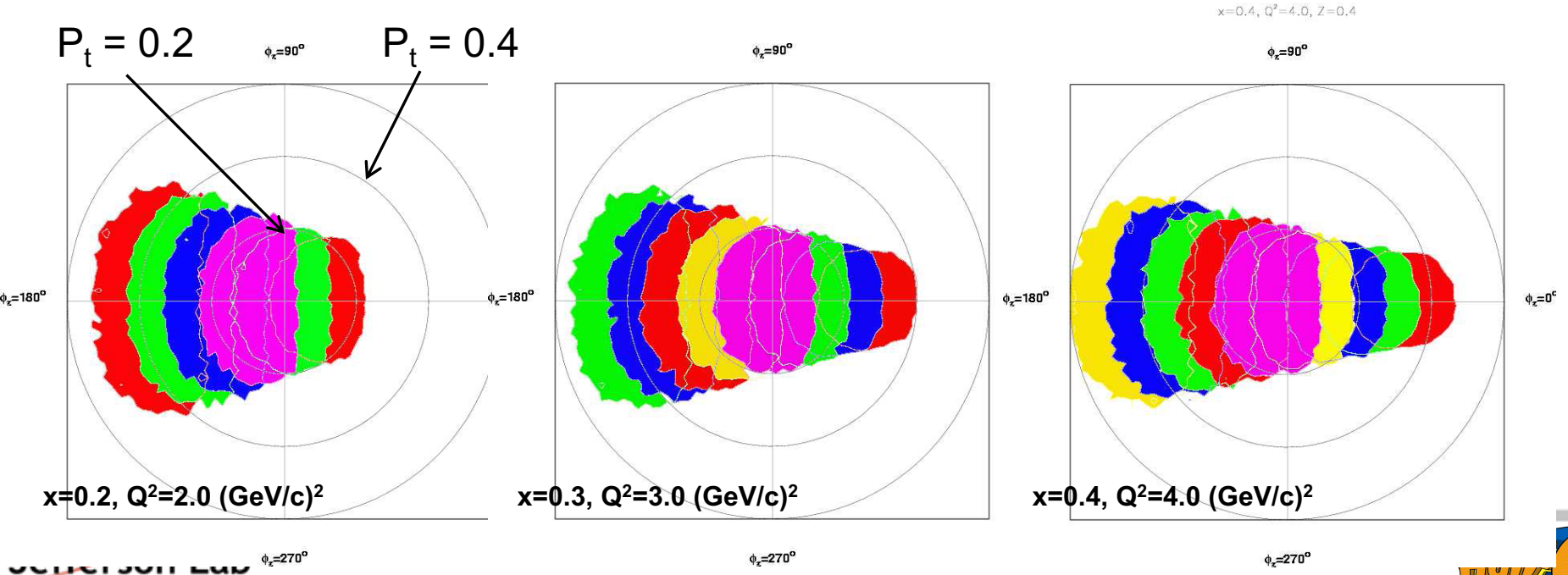
$0.2 < x < 0.5$, $2 < Q^2 < 5$ GeV^2, $0.3 < z < 0.5$ and $P_t < 0.5$ GeV

Combine with CLAS12 data to constrain transverse widths of u/d quarks and fragmentation functions

Obtain some statistics on transverse momentum dependence of (e,e′K^+)

~60% of data acquired, remainder in late 2018.

Presentable results – by end of 2019



Hall C Summer 2018

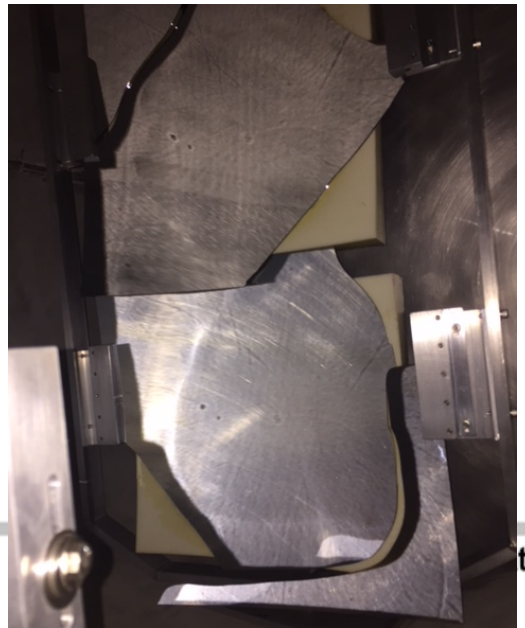
Beamline changes LHCb pentaquark exp – radiator for photon beam.
(Part of work needed to allow polarized ^{3}He target.)

Providing AC service for Moller Polarimeter quads @ 11 GeV (needed for A_1^n/d_2^n)

Spectrometer cryo and power supply maintenance.

Some support functions moving from engineering group to Hall A/C Spectrometer Support Group.

Some detector work (e.g. replace broken mirrors in ~25 y old HMS Cherenkov)



Polarized 3He target

Preparing for A_1^n (E12-06-110) in late 2019.

Engineering/Design complete, parts delivered, preparing drawing book for technicians.

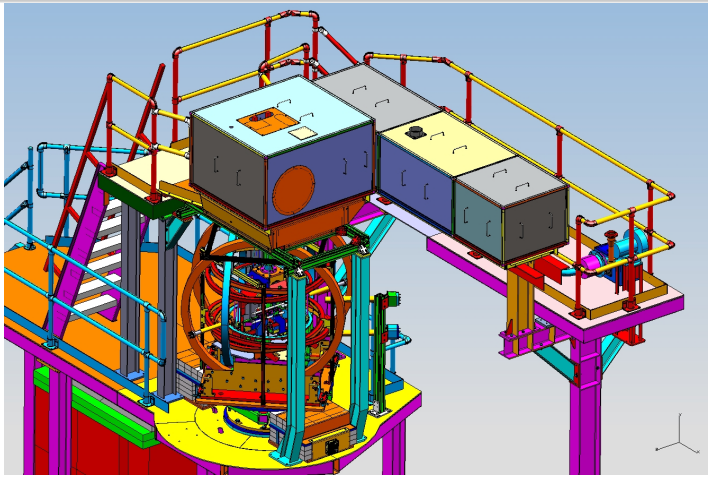
Installation planning ongoing.

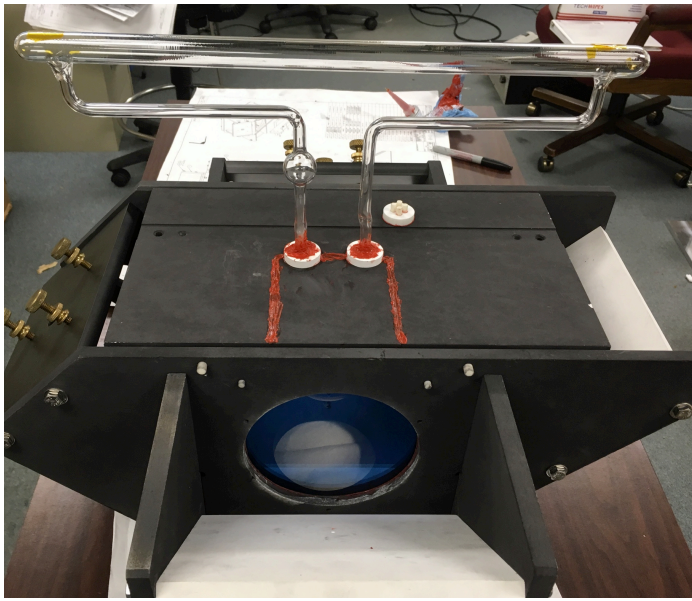
Cell production, led by UVA, started. First good cell at JLab for full characterization.

Cell window heating and stress studies done.

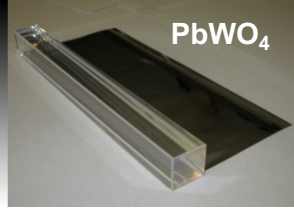
Target goals:

- 30 uA on 40 cm , ~10 atm, L ~ 2.2×10^{36} $cm^{-2}s^{-1}$
- In-beam polarization ~ 55-60%,
- Polarization measurement precision ~ 3%





NPS Project Status

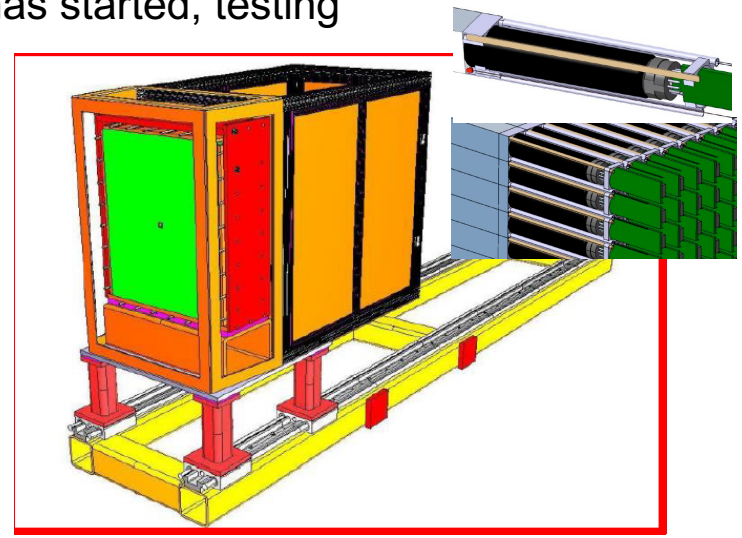


Four fully approved experiments, one conditionally, one PAC46 proposal

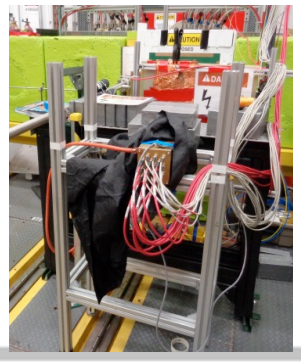
supported by NSF MRI PHY-1530874 (CUA, OU, ODU), international (IPN-Orsay, Glasgow, Yerevan), JLab

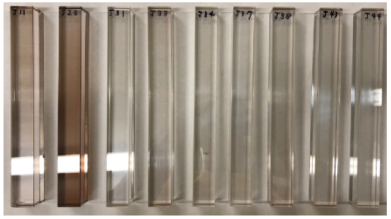

Main coil before shipping

- Magnet: corrector coil, main coil and yoke steel at JLab, assembly has started, testing and field map next



- PMT and HV bases: design drawings final, prototyping, procurement started, first articles received
- Frame and integrated systems: concepts and initial design complete, detailed drawings to be presented later this year, prototype tests ongoing



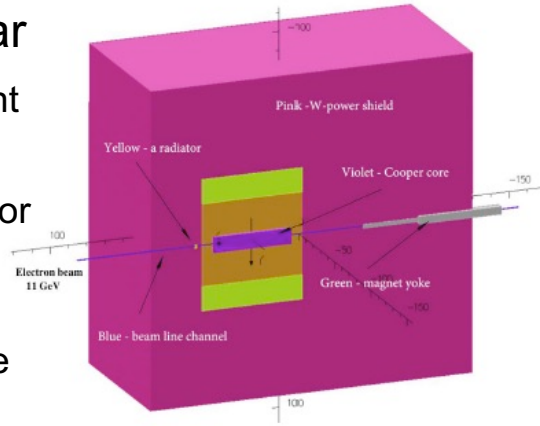


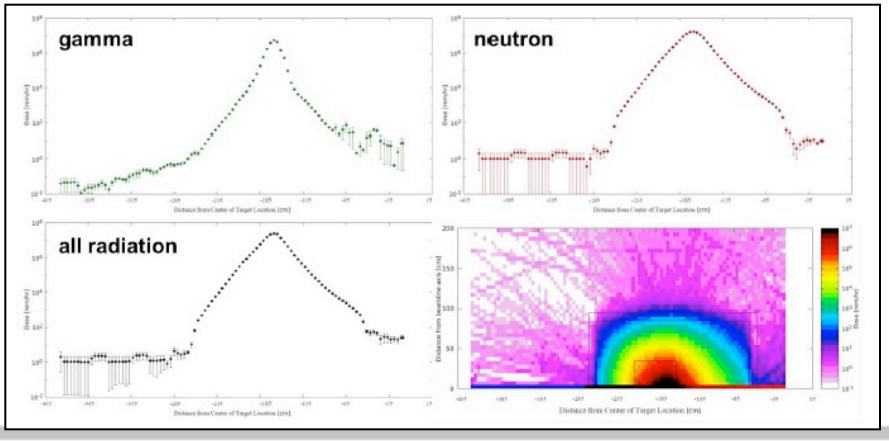
NPS crystal prototype and irradiation studies

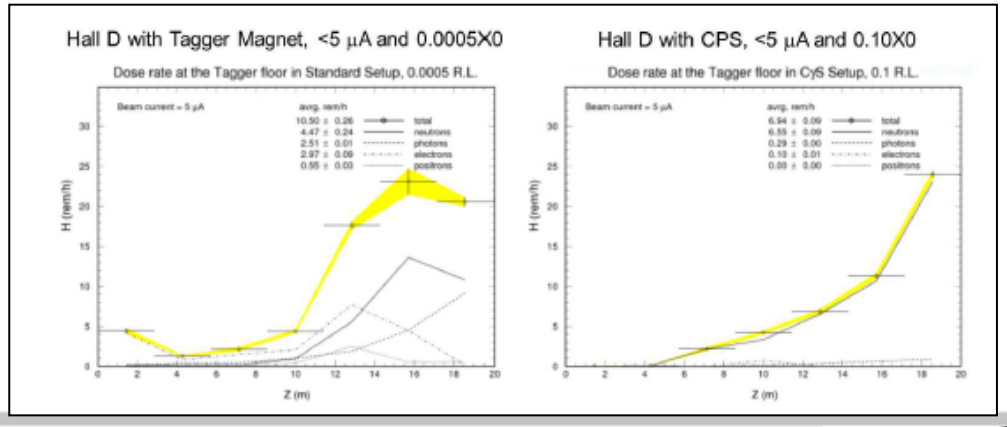
- Crystals: 460 crystals procured from SICCAS in 2017, 400 SICCAS + 100 CRYTUR procurement ongoing in 2018, full crystal testing facilities established at CUA and IPN-Orsay, chemical analysis and crystal growth in collaboration with Vitreous State Laboratory @ CUA, synergy with EIC crystal calorimeter R&D.

Compact Photon Source in Halls A/C (& for K_L in Hall D)

- Novel concept allows high photon intensity and low radiation in the hall
- Physics: WACS (C12-17-008), K_L (PAC46), and also: WACS photoproduction, TCS with Polarized Target (PAC46), SRC, photoproduction of few body systems
- Conceptual Design Study of a CPS completed over last year
  - CPS with optimized shielding provides photon flux of 1.5×10^{12} equivalent photons/s, with a factor of 1000 reduction in prompt radiation dose compared to 2.7 μA (30kW) electron beam current striking a 10% radiator
  - CPS meets the acceptable radiation level requirements for a typical time of 1000 hours with the source located 2-3 m from the target
  - CPS technical design & installation in existing hall infrastructure feasible
  - CPS document submitted to JLab management for review







LAD – Large Acceptance Detector

E12-11-007: Deuteron EMC – d(e,e' backward p)

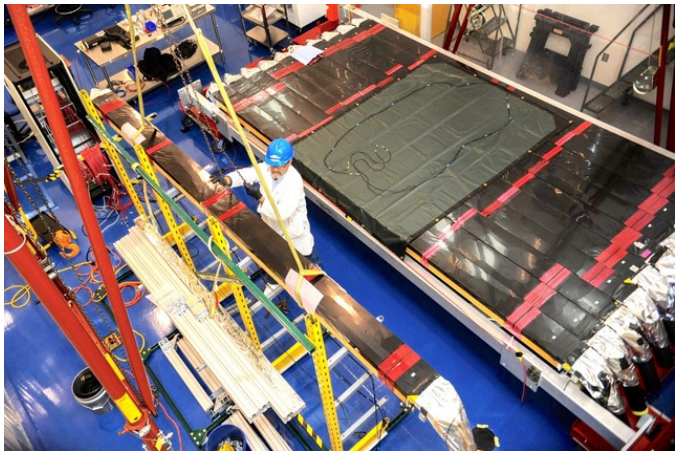
Very large solid angle for $L = 10^{36}$ cm^{-2} s^{-1} and $\theta > 90^{o}$

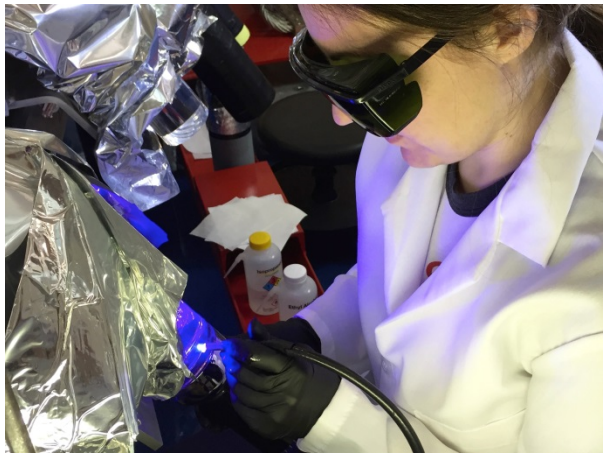
Optimized for medium momentum nucleons

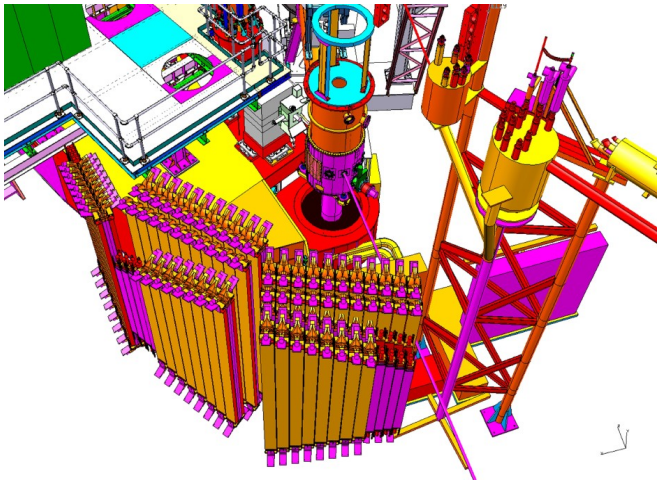
$$0.3 \leq p_N \leq 0.7 \text{ GeV}/c$$

Needs 5 scintillator planes which are built from old CLAS-6 TOF scintillators.

Five planes refurbished @ODU by ODU, KSU, TAU, MIT, GWU and back at JLab.







Published Schedule

- August 23, 2018 – December 19, 2018
  - E12-09-011 (e,e'K+), E12-09-017 (Transverse TMD), E12-09-002 (CSV)
- January 30, 2019 – February 20, 2019
  - E12-16-007 (LHCb Pentaquark)
- February 21, 2019 – March 10, 2019
  - Finish E12-09-002 (CSV)

End of commissioning/"early" experiments. Exercised hall capabilities with physics.

- June 10, 2019 – June 17, 2019
  - E12-06-101/E12-07-105 – low pass running Pion FF, Pion scaling
- June 18, 2019 – June 30, 2019
  - TBD
- October 29, 2019 – December 18, 2019
  - E12-06-110 (A1n)

- Presumably will continue with d_2^n in 2020.