GEn-II Analysis and Thesis Progress

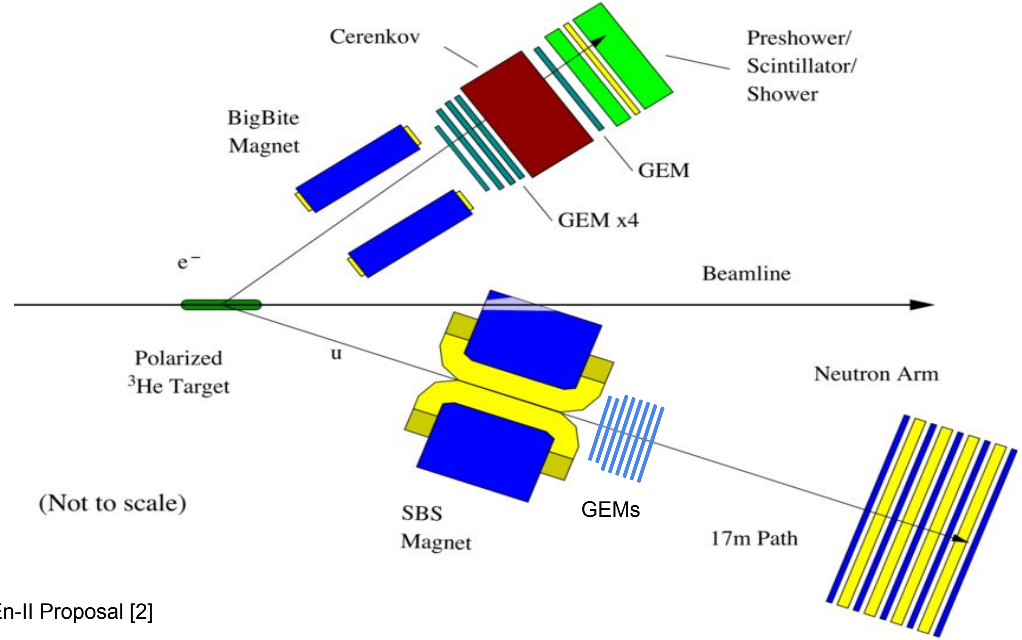
Sean Jeffas

University of Virginia

July 17, 2023

SBS GEn-II Experiment

- Ran in October 2022 through March 2023.
  - Extension in September 2023 to finish 9.7 GeV^2 point.
- GEn-II experiment collided polarized electron beams onto a polarized ^3He target.
- Measure the neutron FF ratio at Q^2 = 2.9, 6.6, and 9.7 GeV^2.



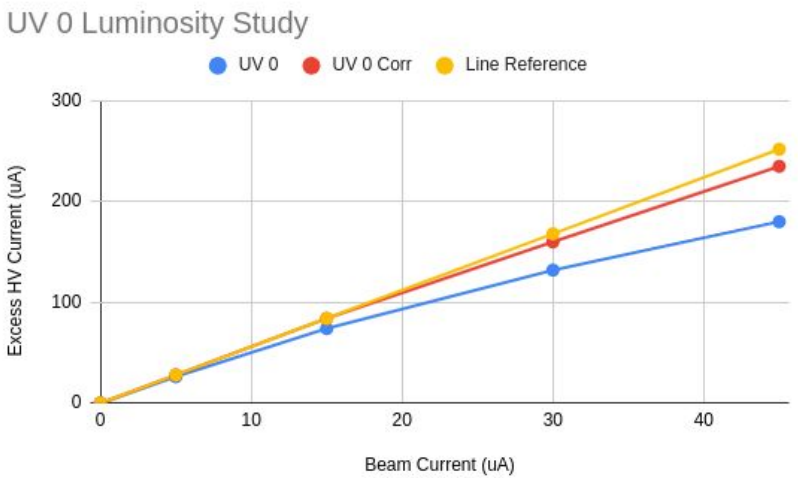
GEn-II Proposal [2]

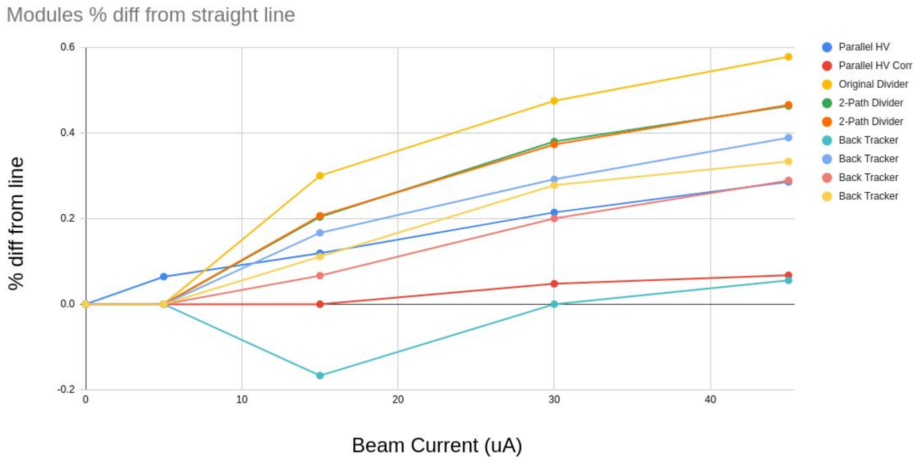
Thesis Scope

- Calibration and physics extraction from GEn-II.
  - Complete pass-1 replay and look at early results.
- Focus on GEM optimization and performance.
  - Includes GMn data which was critical to changes made before GEn running.
  - HV divider changes.
  - Common mode algorithms and corrections.

HV Current Draw Mitigation

- HV current draw should follow a straight line if the gain is stable.
- GEn was not high luminosity so multiple configurations could be tested.
  - Layer 0 has the highest rate, and used the parallel power supply.
  - Layer 2 & 3 has a modified HV divider.
  - Layer 1 has the original divider.
  - Layer 4 has significantly low rates, not relevant to this study.
- Clear improvements with the new dividers and they will be applied for the next experiment.



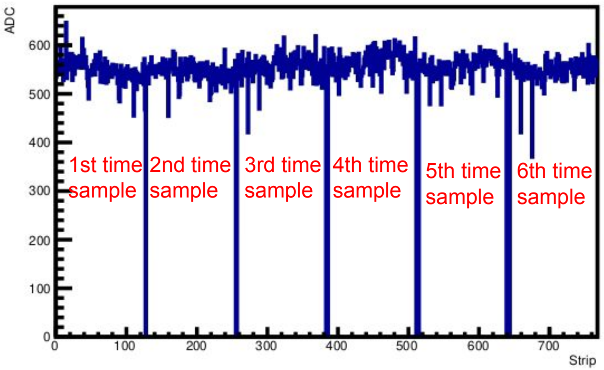


Sean Jeffas, University of Virginia

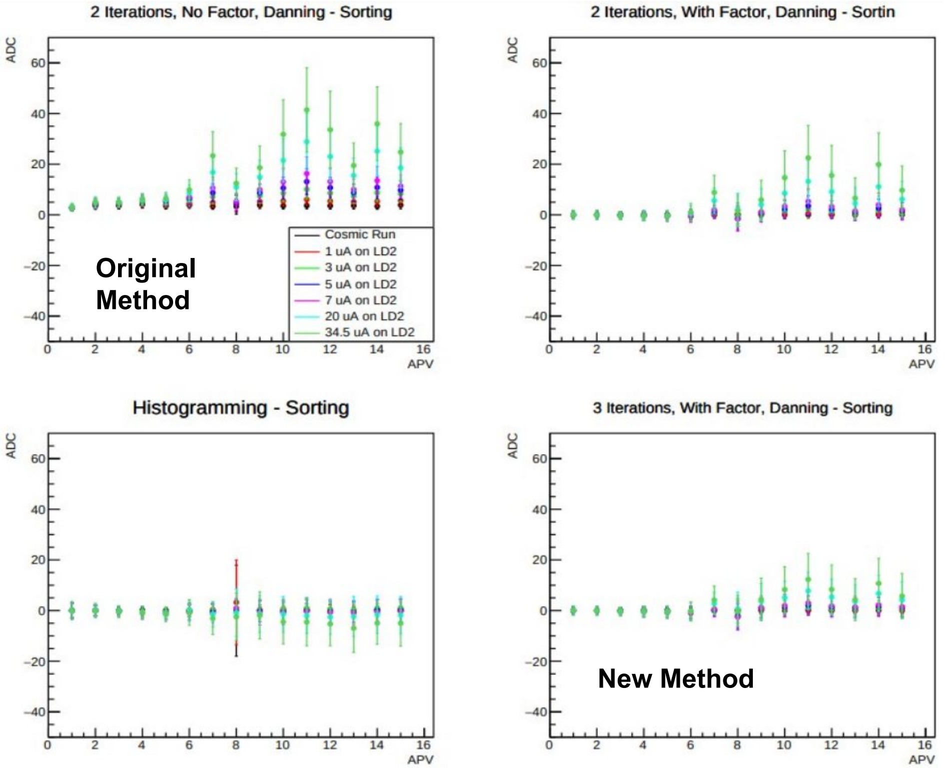
GEM Common Mode Calculation

- APV data frames have common mode (CM) offsets which must be calculated by the DAQ electronics before saving data.
- Subtracting the CM is critical to reconstructing accurate hits.
- Four methods tested and the closest results to the "true" baseline was selected.
- Results are improved from ~20 ADC to ~5 ADC.
    - Real signals are ~ 100 ADC

Raw APV Data



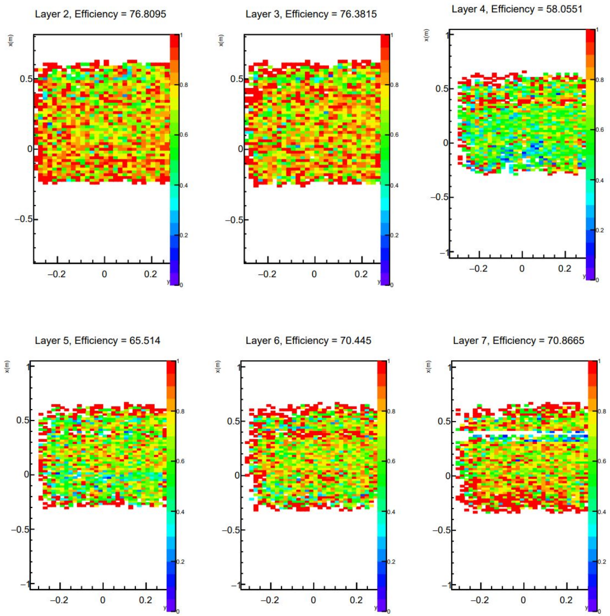
Data From GMn



Sean Jeffas, University of Virginia

SBS GEM Testing

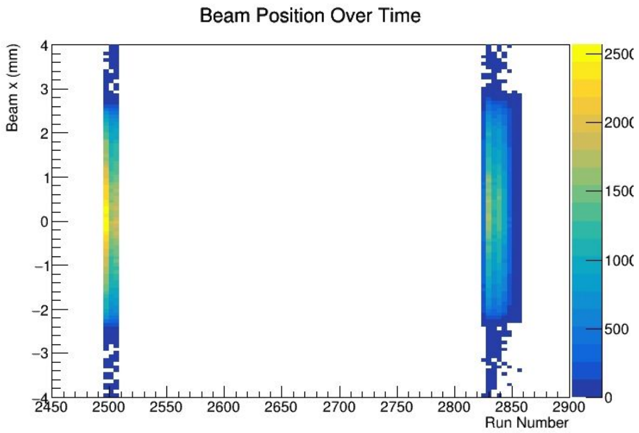
- SBS GEMs installed and tested intermittently throughout GEN.
- Data not yet thoroughly analyzed, as it was not needed for GEN analysis.
  - Will provide important tracking insights to be implemented for future experiments.

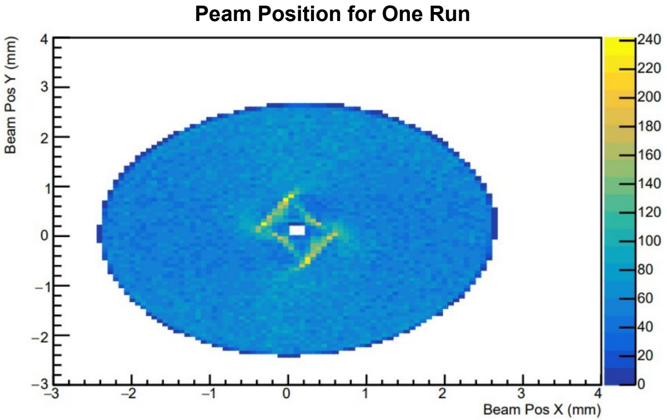


Beamline Calibration

- We know the beam width is very close to 5 mm.
- Convert the raster current units to 5mm width.
- Beam position can be determined event by event.
  - Use BPMs to get the beam center.
  - Use raster to get position for each event.

$$x/y_{beam} = x/y_{beam\ cen} + (x/y_{raster} - x/y_{raster\ cen}) * \mathrm{scale}_{x/y}$$

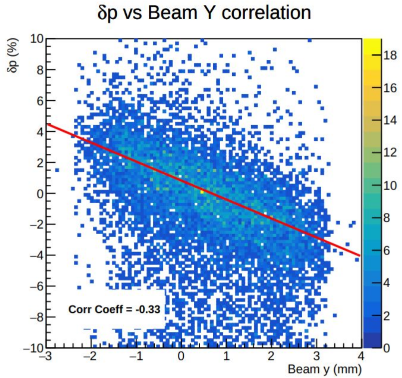


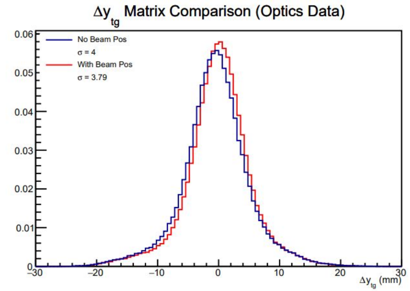


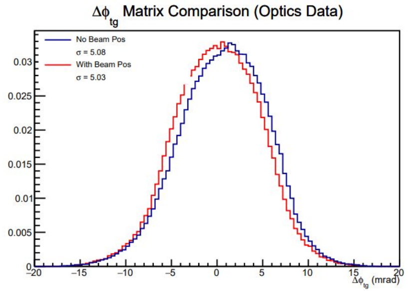
Sean Jeffas, University of Virginia

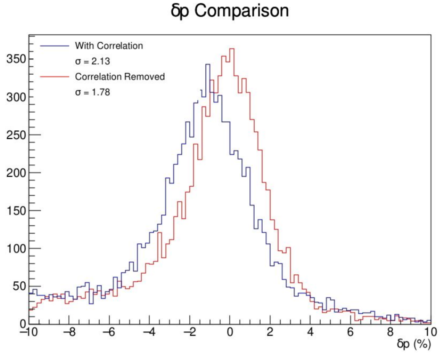
Optics Corrections

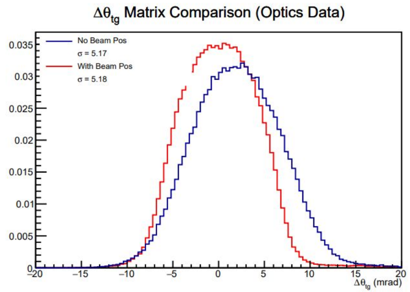
- Old optics assumed beam position of (0,0).
- Optics runs with rastered beam used to re-optimize optics with raster corrections.
- Clear improvements in offsets and resolutions for all reconstruction variables.
- Needs to be applied to all kinematics.

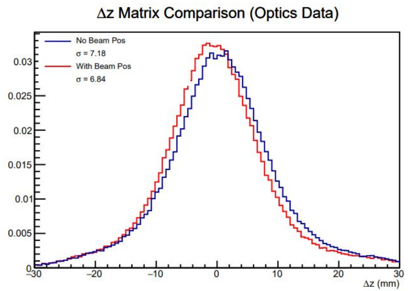








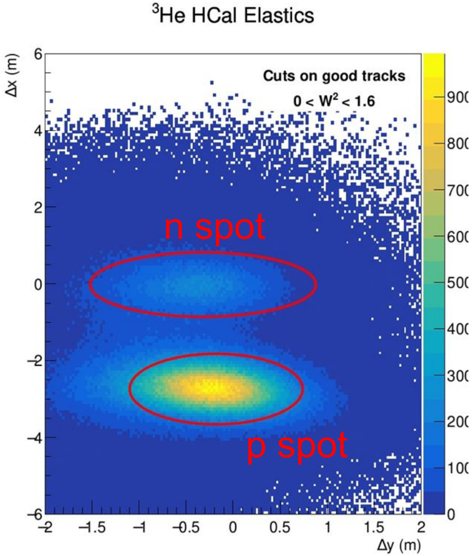


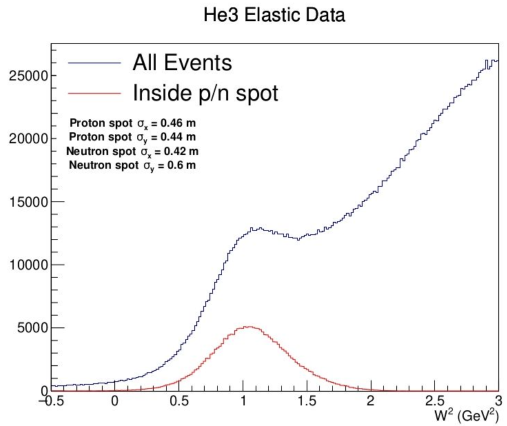


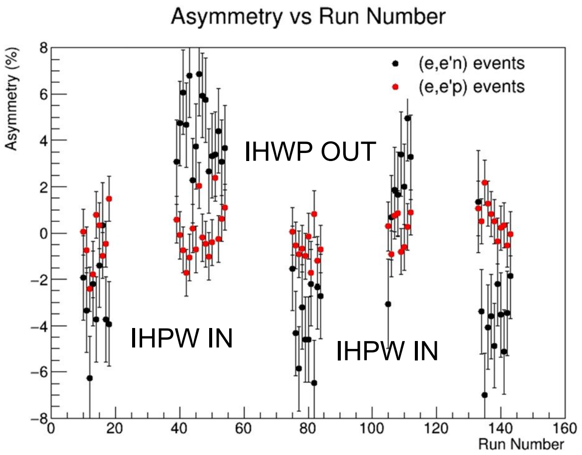
Sean Jeffas, University of Virginia

Elastic Event Selection, Q^2 = 2.9 GeV

- Neutron/proton separation in HCal.
- Selection on spots gives good elastic peak.
- Asymmetry flips for as IHWP flips, as expected.





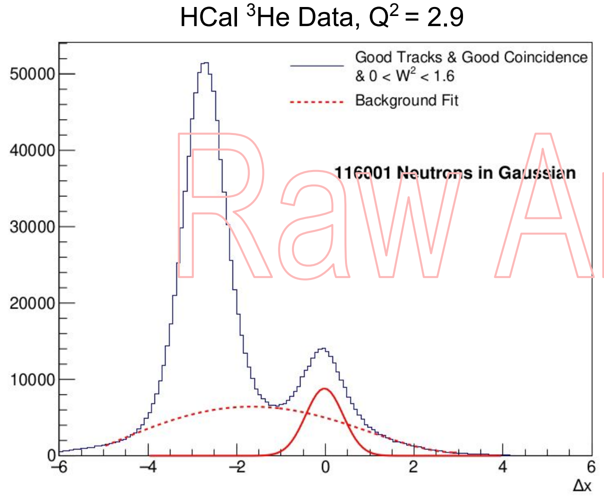


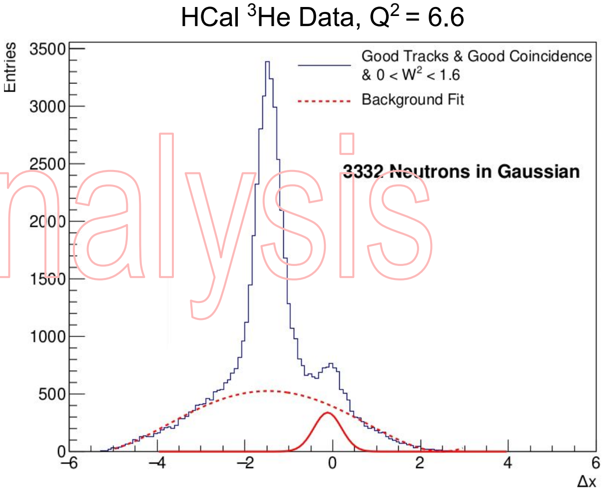
Sean Jeffas, University of Virginia

Neutron Yield, First Look

- Extremely raw look at physics.
  - Full replay not completed.
  - No detector calibrations or corrections applied.
  - Pass-1 replay will certainly have improved yields.
- Raw A_N ~3% and A_P ~ 0% consistent with expectations.
- Thorough analysis to be done on all points.

$$A = \frac{Y_+ - Y_-}{Y_+ + Y_-}$$





	Q^2 = 2.9	Q^2 = 6.6
A_N	3.63% +/- 0.25%	2.59% +/- 1.25%
A_P	0.11% +/- 0.13%	-0.04% +/- 0.69%

Outlook

- Apply all optics corrections.
- Calibrate detectors, **huge thanks to GMn students**.
- Pass 0 replay -> within weeks.
- Further calibrations and analysis corrections.
- Pass 1 replay -> fall of 2023.

- Complete last kinematic in October

References

[1] SBS Collaboration Meeting, Feb 17 - 18 2021: https://indico.jlab.org/event/430/contributions/7832/attachments/6493/8711/mkjones_sbs_ecal_feb_2021.pdf

[2] B. Wojtsekhowski, T. Averett, G. Cates, S. Riordan (spokespersons), Jefferson Lab experiment E12-09-016 - GEn(2): https://misportal.jlab.org/mis/physics/experiments/viewProposal.cfm?paperId=617

[3] B. Sawatzky, V. Bellini, K. Gnanvo, D. Hamilton, M. Kohl, N. Piskunov, B. Wojtsekhowski (spokespersons), Jefferson Lab experiment E2-17-004 (GEn-RP): https://misportal.jlab.org/mis/physics/experiments/viewProposal.cfm?paperId=919