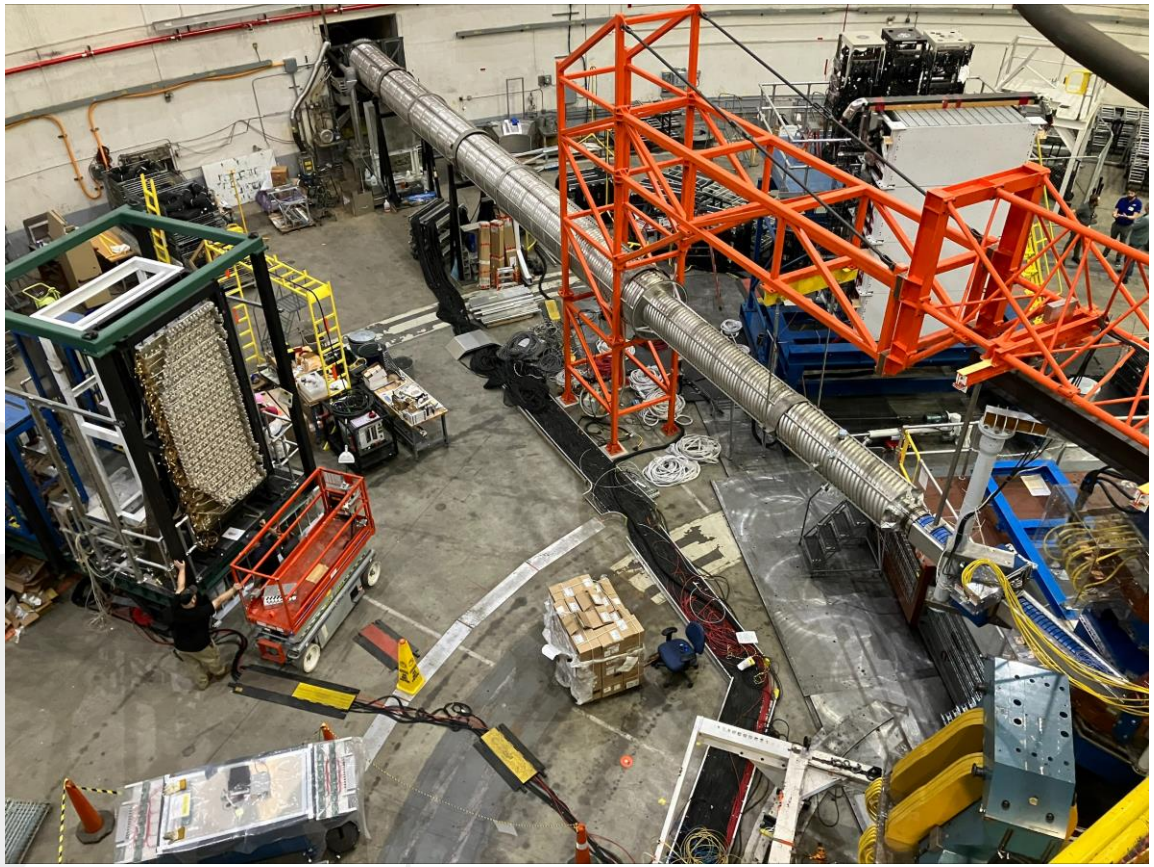
Hall A run plan for GEp and detectors

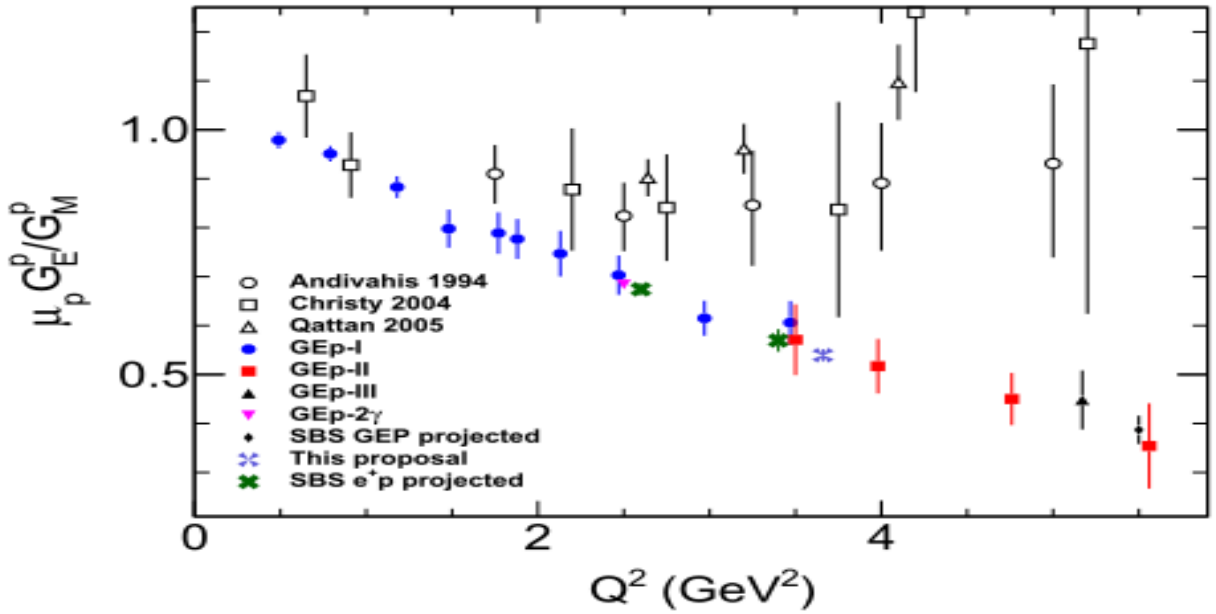


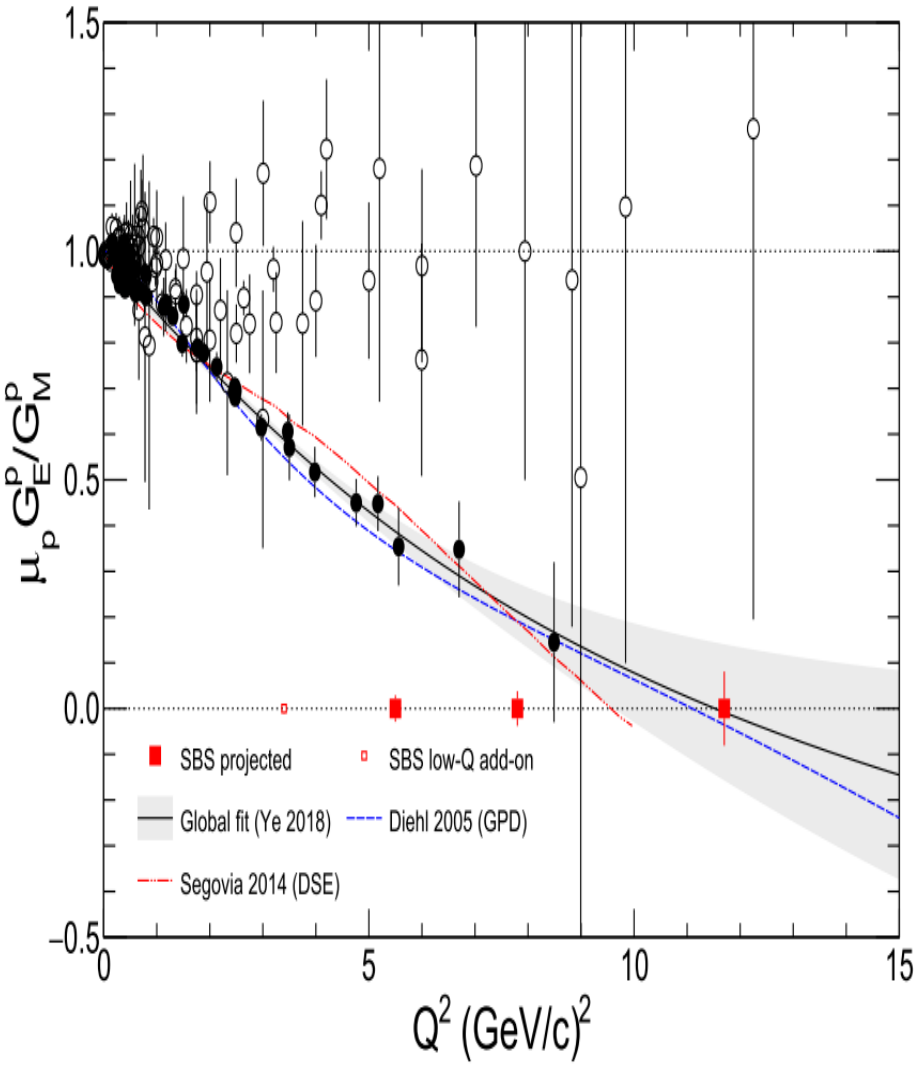
Mark Jones

September 2024 SBS Collaboration Meeting

GEP: Ratio of proton electric to magnetic form factor

- Last experiment in series of neutron and proton elastic electric and magnetic form factor experiments.
- E12-07-109 Measure proton electric form factor to Q^2 =12
- E12-24-010 High-precision measurement of proton form factor ratio with Polarization Transfer,
  - Spokespeople: A. Puckett*, J. Bernauer and A. Schmidt
  - Measure proton G_E/G_M to 1% statistical precision at Q^2 = 3.8
  - *"The primary motivation for this request is to improve the precision of the polarization data at this Q^2 in anticipation of the comparison to a future measurement using positrons, described in a previous LOI to PAC51 (LOI12-23-008)."*





Figures by Andrew Puckett from E12-24-010 proposal

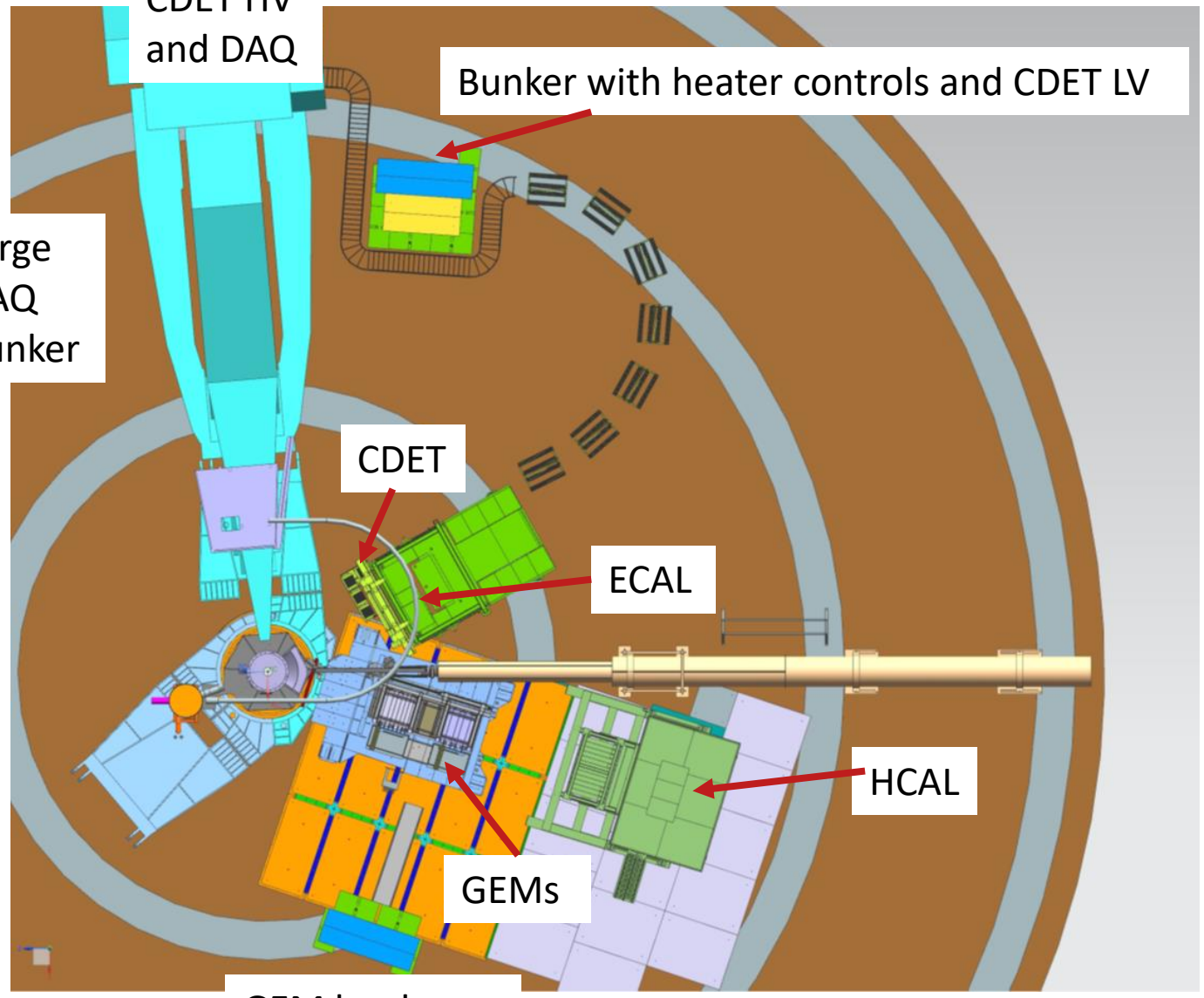
Jefferson Lab

Draft beam schedule

- Lab has been in a LOTO pause. Delayed beam delivery and work in the hall
- Tentative beam schedule
  - Hall C and D startup Jan 24, 2025
  - Hall B startup Jan 27, 2025
  - Hall A startup Jan 30, 2025 at 3pass.
    - 3 pass is 11 Calendar days followed by 3 days for kinematic change, 1 day pass change
    - 4 pass is 31 Calendar days followed by 3 days for kinematic change, 1 day pass change
    - 2 pass is 4 Calendar days followed by 3 days for kinematic change, 1 day pass change
    - 5 pass is 89 Calendar days

Setting	Ebeam	Q^2	Proton Momentum	Proton ang SBS	Electron momentum	Electron ang ECAL	ECAL dis
1	6.476	5.7	3.88	25.7	3.4	29.47	8m
2	8.588	8.1	5.18	22.1	4.3	27.27	6.5m
2a	4.359	3.8	2.73	28.5	2.4	35.0	5m
3	10.688	12.0	7.29	16.9	4.3	29.7	4.7m

Overview of detectors: Layout for Q^2= 12 kinematic point



Electron Detection

- Electron Calorimeter (ECAL)
  - 1656 Lead glass blocks
  - Trigger formed in FADC from clusters
  - Need good energy calibration at FADC
  - Tight cut on elastic to reduce accidentals
  - Measure angle and energy
- Coordinate Detector (CDET)
  - 2352 scintillator bars
  - Measures vertical angle
  - Aids track finding in front GEMs
  - Reduce the photon background

Proton Detection

- GEMS Front and rear tracker
  - Each 8 layers of GEMs
  - Measure momentum, z-target, angles
  - Plastic analyzer for rescattering protons
  - Measure the recoil polarization of protons
- Hadron Calorimeter (HCAL)
  - 288 iron/scintillator blocks
  - Trigger formed in FADC from clusters
  - Aids track finding in rear trackers

SBS GEMs

- SBS Dipole magnet at 2.4 Tm which bend protons by about 6 deg (at p = 7.3) and spin precession, χ_θ , of 80 degrees.
- Can be mixing in the non-dispersive plane, $\Delta\phi$, which mixed Pt and Pl and needs to be understood.

$$\frac{P_t}{P_\ell} = \frac{P_t^{spec}}{P_n^{spec}} \sin\chi_\theta + \gamma_p(\mu_p - 1)\Delta\phi$$

$$\mu_p \frac{G_E}{G_M} = -\mu_p \frac{E_e + E'_e}{2m_p} \tan\frac{\theta_e}{2} \left(\frac{P_t^{spec}}{P_n^{spec}} \sin\chi_\theta + \gamma_p(\mu_p - 1)\Delta\phi \right)$$

Status update by Ching Him Leung

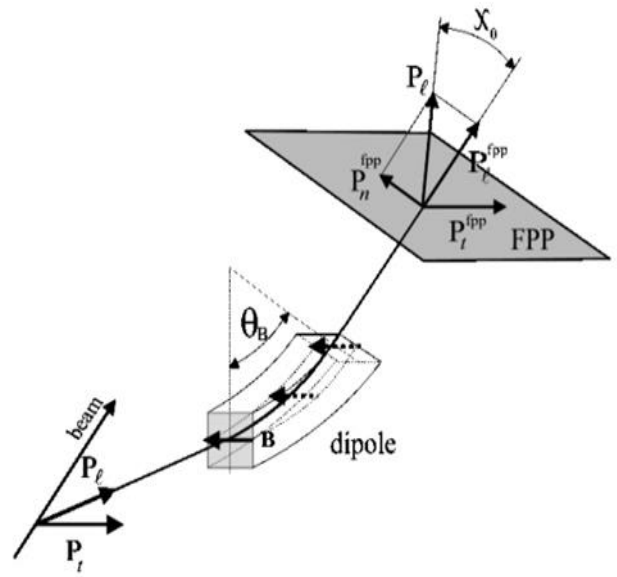


FIG. 15. Precession of the polarization component P_ℓ in the dipole of the HRS by an angle χ_θ.

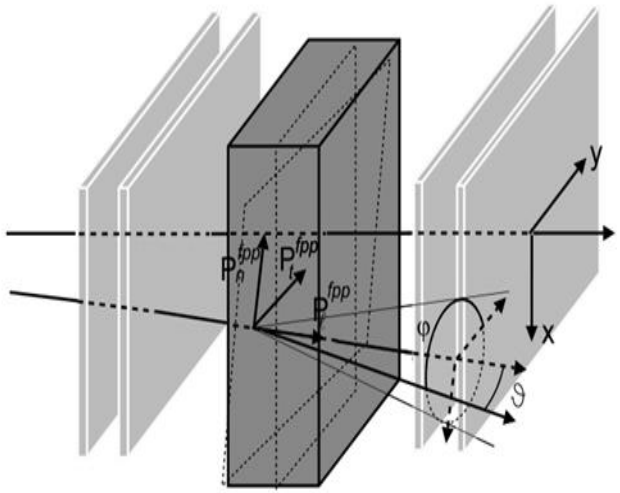


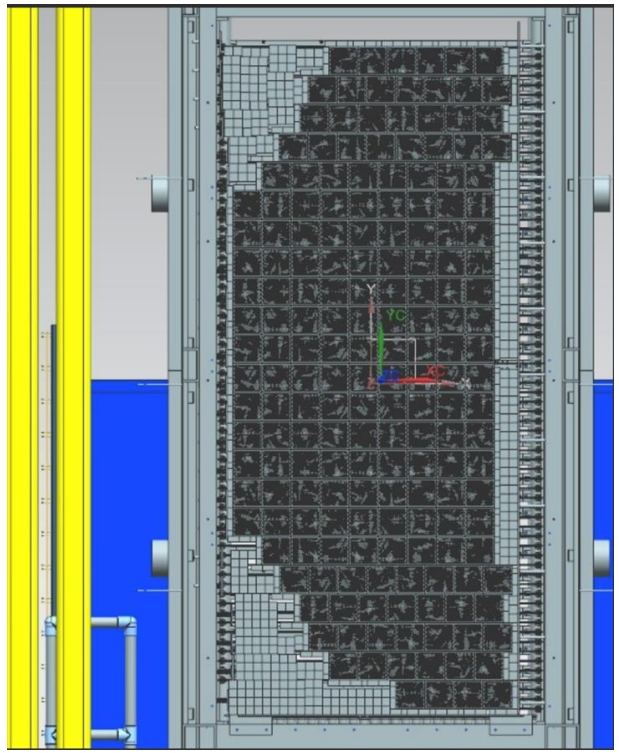
FIG. 9. Principle of the polarimeter, showing a noncentral trajectory through the front chambers, scattering in the analyzer, and a track through the back chambers; ϑ is the polar angle, and φ is the azimuthal angle from the y direction counterclockwise.

Jefferson Lab

ECAL and CDET

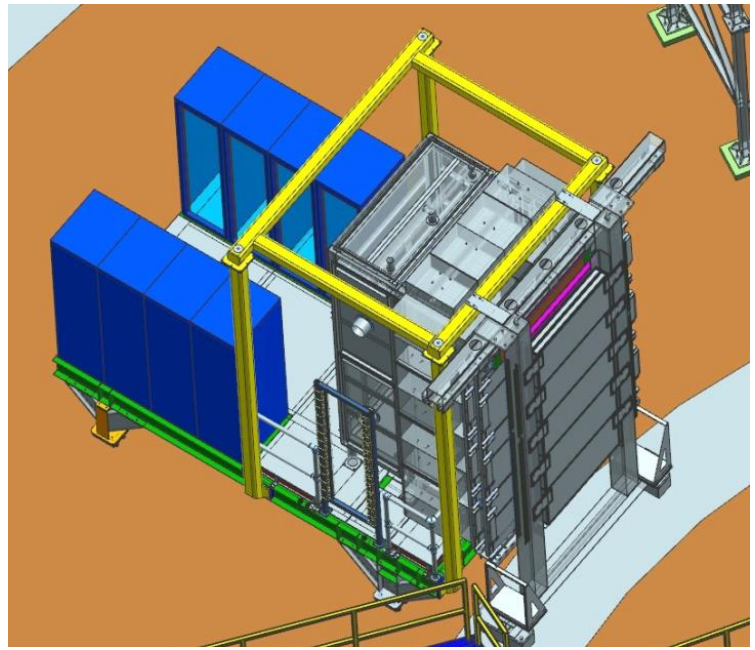
ECAL

- Don Jones will give status update
- Need constant heating to anneal lead glass from radiation damage.
- Small test with 6 supermodules during GEN/GEN-RP was successful
- Major people effort for cabling detector.
  - Volunteers welcome



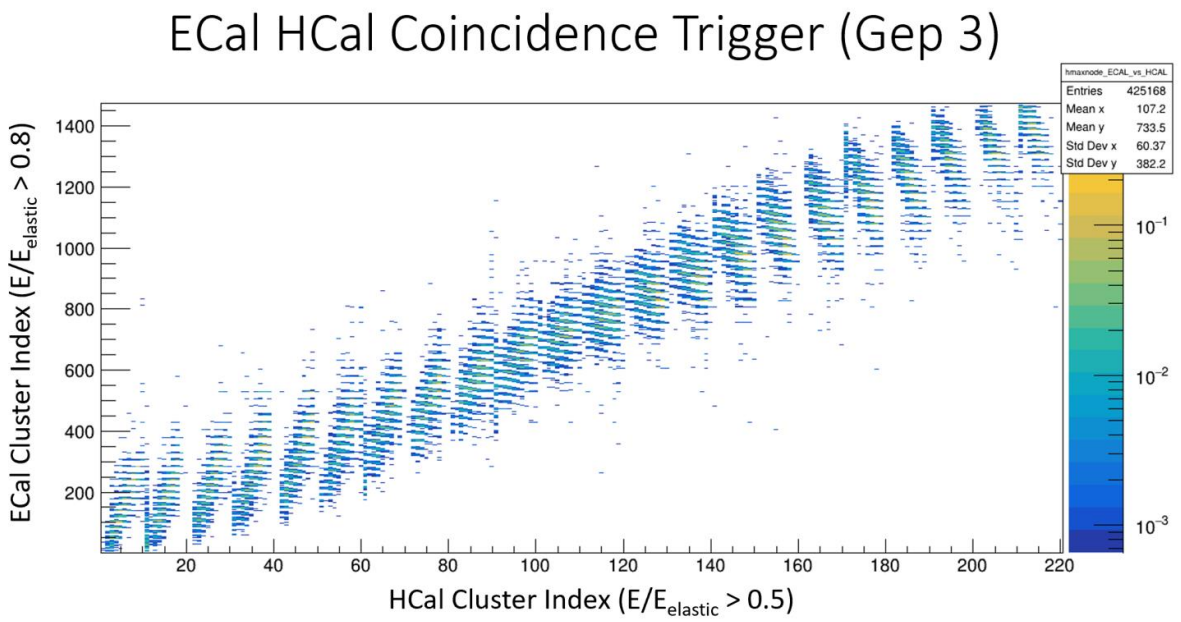
CDET

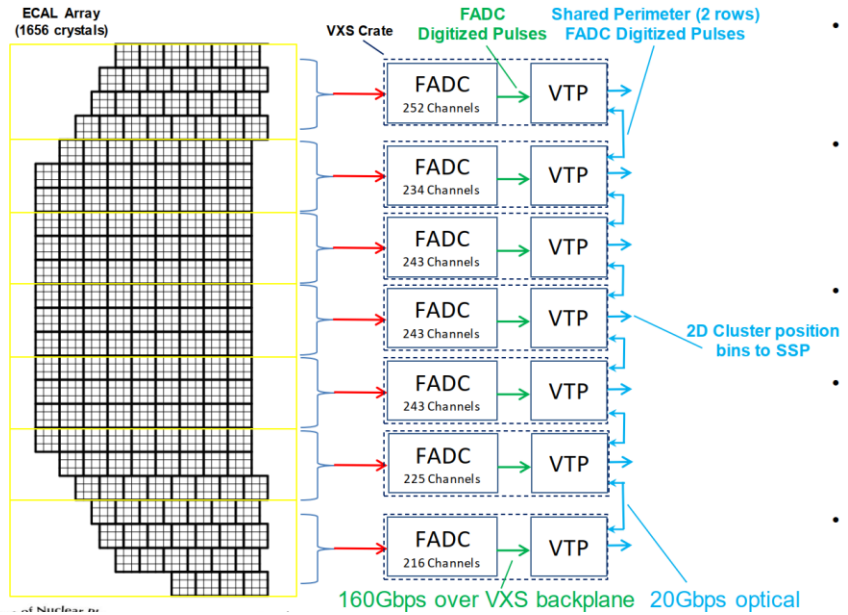
- Peter Monaghan will give status update
- Detectors in the hall
- Have undergrad students, volunteers welcome.

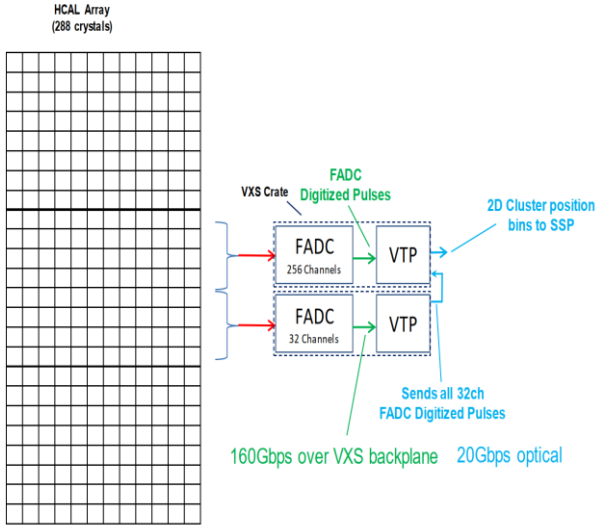


GEP Trigger

- Form ECAL and HCAL singles trigger from clusters in the FADC.
- Correlation between the singles trigger to form the coincidence trigger
- Hanjie Liu is implementing this algorithm with help from Ben Raydo.
- Need to have energy calibration of ADC signals in the FADC
  - Cut on ECAL at 80% of elastic electron
    - Electron energy varying with scattering angle
  - Cut on HCAL at 50% of elastic proton.
  - Example below from Kip Hunt's trigger document
  - Graduate student working on each Q^2 point.







Summary

- Started the GMN experiment in Fall 2021.
  - Completed GMN, GMN-TPE, GEN, GEn-Rp and K_LL.
- Thanks for the techs, designers and engineers
  - Needed to new lead wall design to shield the SBS GEMs.
  - Needed to engineer and design so that CDET is attached to the ECAL and can be moved together.
- The commissioning will be challenging. Only 11 calendar days with 4 days needed for the measurement.
  - Beamline, Helicity, and Moller beam polarimeter
  - Energy Calibration of the HCAL and ECAL in the FADC for the trigger
  - Testing and refinement of the trigger
  - Tracking in the SBS GEMs at high rates
  - Understanding SBS Optics and spin
- The run plan is just starting and is a working document