Hall A Update

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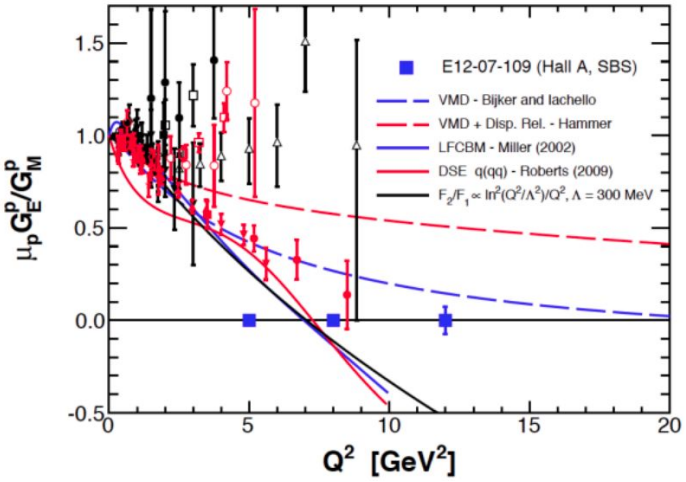
Super BigBite Spectrometer (SBS) Program

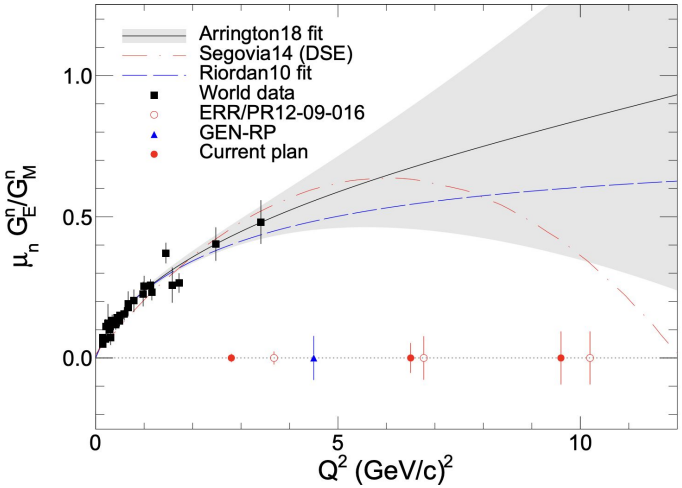
- **Precision Measurement of the Neutron Magnetic Form Factor up to Q^2 = 14.0 $(GeV/c)^2$ by the Ratio Method (GMn).**
- **Measurement of the Neutron Electromagnetic Form Factor Ratio G_E^n/G_M^n at High Q^2 (GEn-II).**
- Measurement of the Ratio G_E^n/G_M^n by the Double-polarized $^2\mathrm{H}(\vec{e}, e'\vec{n})$ Reaction (GEn-RP).
- Large Acceptance Proton Form Factor Ratio Measurements up to 12 $(GeV/c)^2$ Using Recoil Polarization Method (GEp-V).

Neutron Electromagnetic Form Factor

- Previous experiments measured the proton ratio G_E^p/G_M^p up to Q^2 = 8 GeV^2 and the neutron ratio G_E^n/G_M^n up to Q^2 = 3.5 GeV^2.
- They found that G_E^p/G_M^p sharply declined after Q^2 ~ 1 GeV^2.
- It is suspected that G_E^n/G_M^n will exhibit the same behavior at higher Q^2.

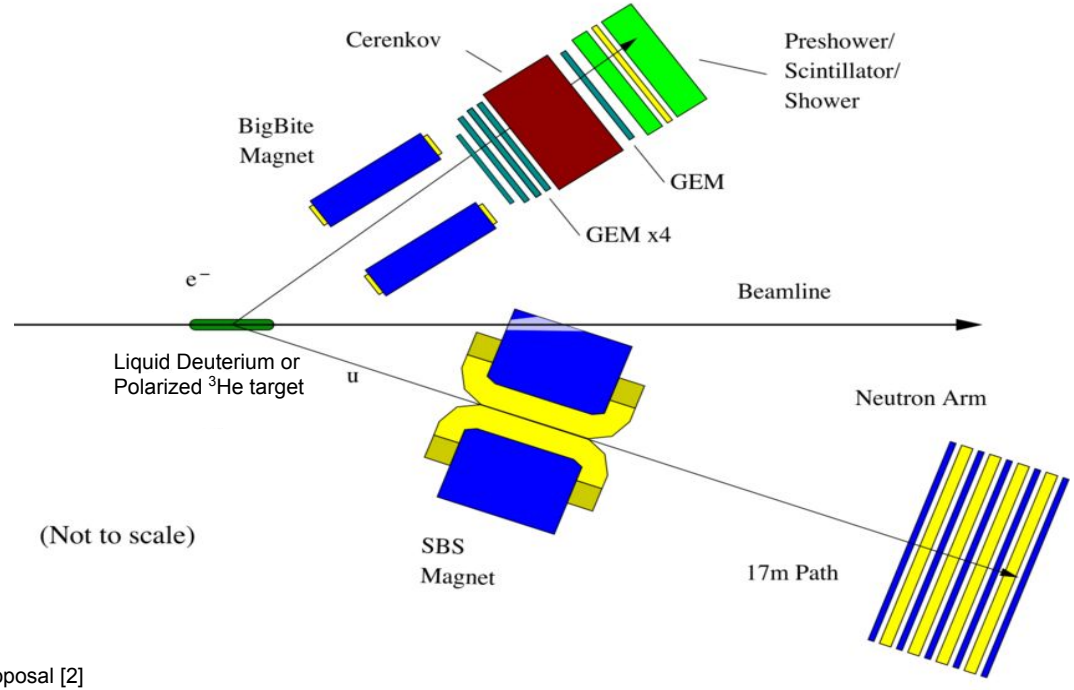


Taken from Mark Jones, SBS Collaboration Meeting [1]



SBS Experimental Setup

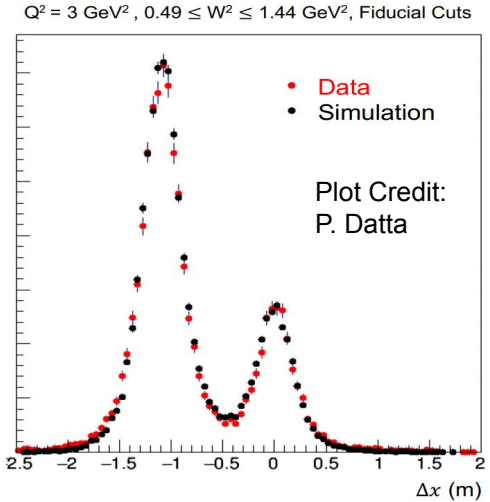
- Only difference between GMn/GEn is the target.
- Next SBS experiments will use slightly different setups.

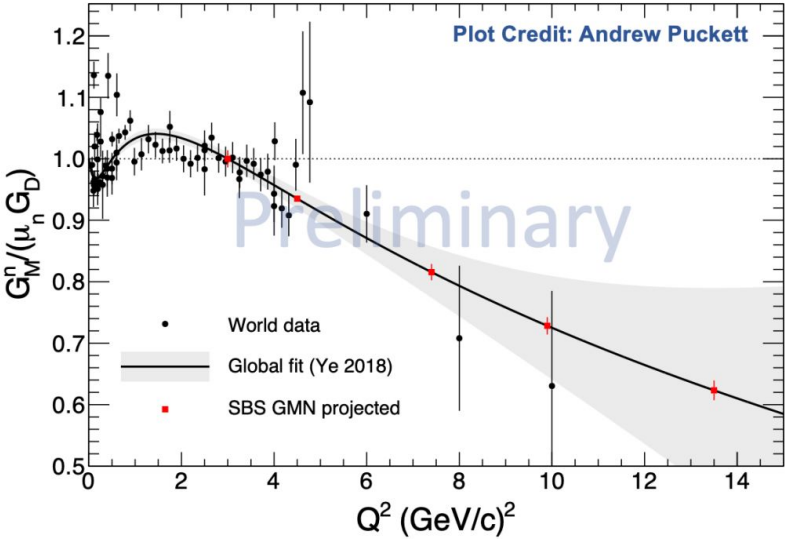


GEn-II Proposal [2]

GMn Experiment Running

- GMn ran from October 2021 to February 2022.
- Over 2 PB of raw data collected, 5 times more than all previous experiments.
- Virtually all detector systems were new, partly a commissioning run.
  - BBCal HV adjustments, GEM high luminosity limitations, magnetic optics reconstruction.





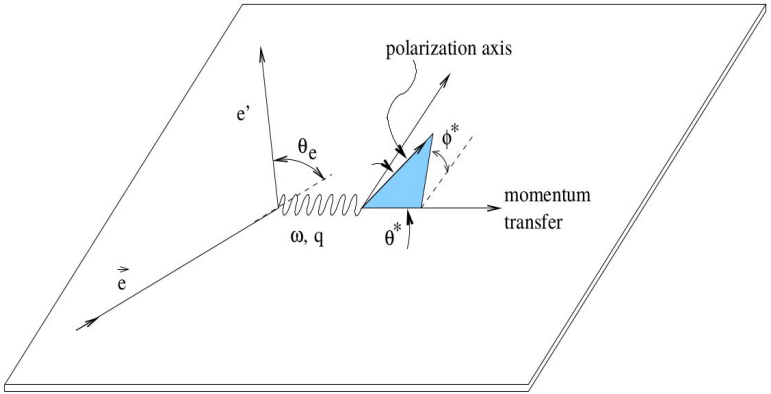
GEn Double Polarization Method

- With a polarized electron beam on a polarized ^{3}He target the elastic scattering cross section can be written as the sum of two parts:
  - Σ corresponds to the unpolarized cross section.
  - Δ corresponds to the polarized cross section.
  - h is helicity (± 1)

$$\sigma = \Sigma + h\Delta$$

- The spin asymmetry is then:

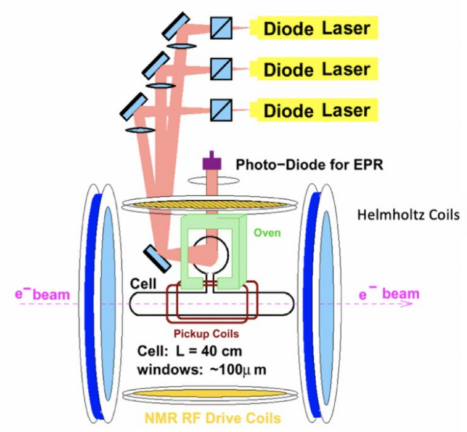
$$A_N = \frac{\sigma_+ - \sigma_-}{\sigma_+ + \sigma_-} = \frac{\Delta}{\Sigma}$$

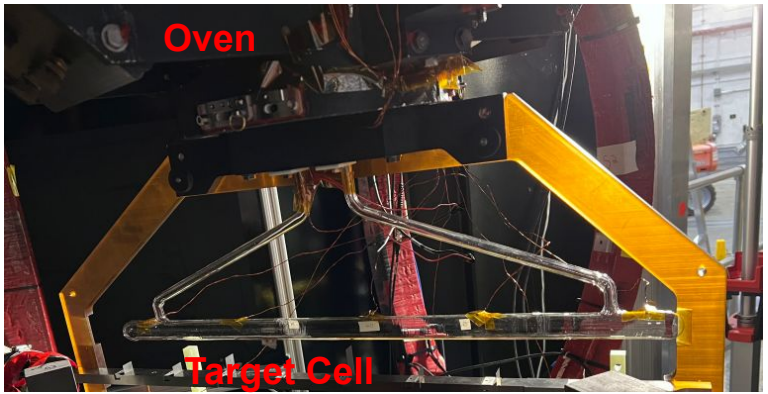


$$A_N = \frac{-\frac{G_E^n}{G_M^n} 2\sqrt{\tau(1+\tau)}\tan(\theta/2)\sin\theta^*\cos\phi^* - 2\tau\sqrt{1+\tau+(1+\tau)^2\tan^2(\theta/2)}\tan(\theta/2)\cos\theta^*}{\left(\frac{G_E^n}{G_M^n}\right)^2 + (\tau + 2\tau(1+\tau))\tan^2(\theta/2)}$$

GEn-II Polarized Target

- Only difference between GMn and GEn is the target.
- Polarized target enclosure began installation in March 2022.
- Novel large target cell installed.
  - 60 cm length, 200 W lasers, 10 atm pressure.
- Magnetic field mapping.





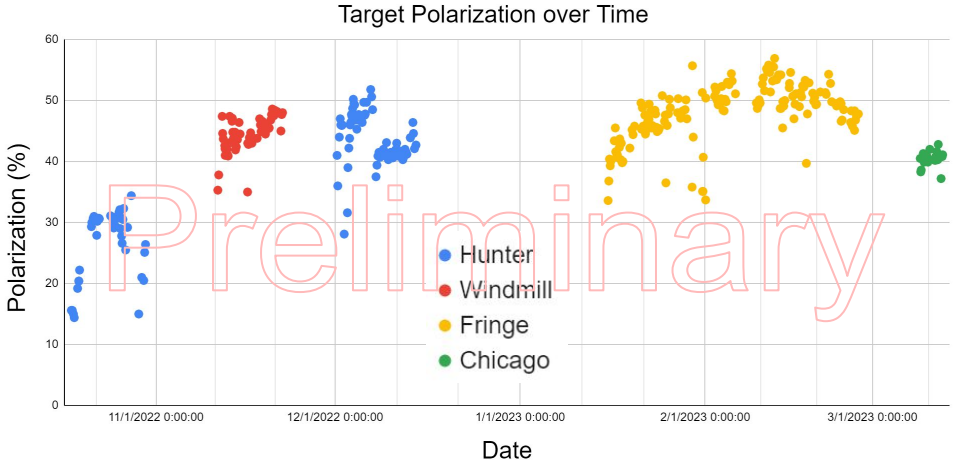
GEn-II Running

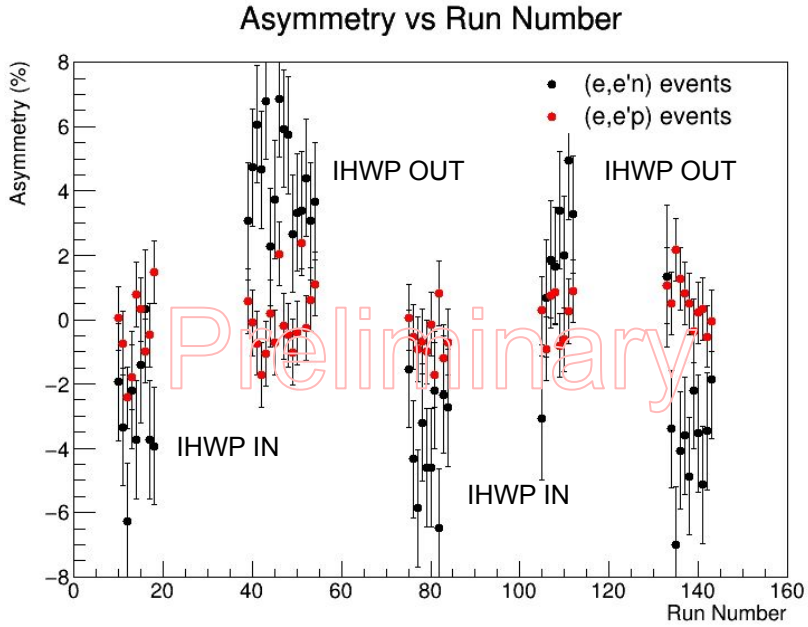
- GEn-II ran from October 2022 to March 2023.
- Significant accelerator downtime reduced our statistics.
  - Will run for five more weeks in August on $Q^2 = 9.7$.
- Expected 45% polarization.
  - Near or exceeding this goal for most of running.
  - **World record for luminosity on 50% polarized target.**

	Commissioning	GEn $Q^2 = 2.9$	GEn $Q^2 = 6.6$	GEn $Q^2 = 9.7$
Time Period	10/10/22 - 10/12/22	10/14/22 - 10/30/22	11/10/22 - 12/14/22	1/15/23 - 3/12/23
Fraction of Data Collected	NA	33%	75%	28%
Average Polarization (in beam)	NA	25%	43.7%	47.6%

GEn-II Preliminary Look

- ^{3}He target required optimization.
  - Determining proper heating, convection, laser settings.
- Preliminary asymmetry measurements are in line with expectation.
- Significant analysis ahead.





Near Future

Date	Activity
Aug 10 – Oct 2 2023	Run 3He GEn and A_LL
Oct 3 2023 – Jan 30 2024	Deinstall polarized 3He target, modify beam line and install cryotarget
Jan 31 – Feb 26 2024	Run GEn-RP and K_LL
Feb 27	Start deinstall GEn-RP and installing GEp

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, Jefferson Lab experiment E12-09-016 - GEn(2): https://misportal.jlab.org/mis/physics/experiments/viewProposal.cfm?paperId=617