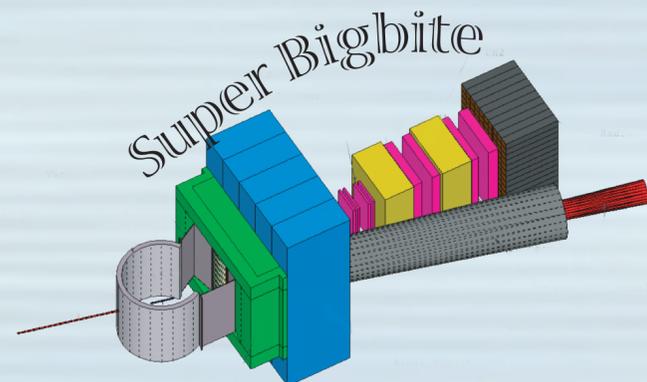


GEN-III

- What follows should NOT yet be taken as a serious proposal
- Rather, what follows should be looked at as a starting point for a discussion.
- Given what we have learned during GEN-II, what might be possible for a follow-on experiment?

Ideas herein from myself, Bogdan and Vimukthi Gamage



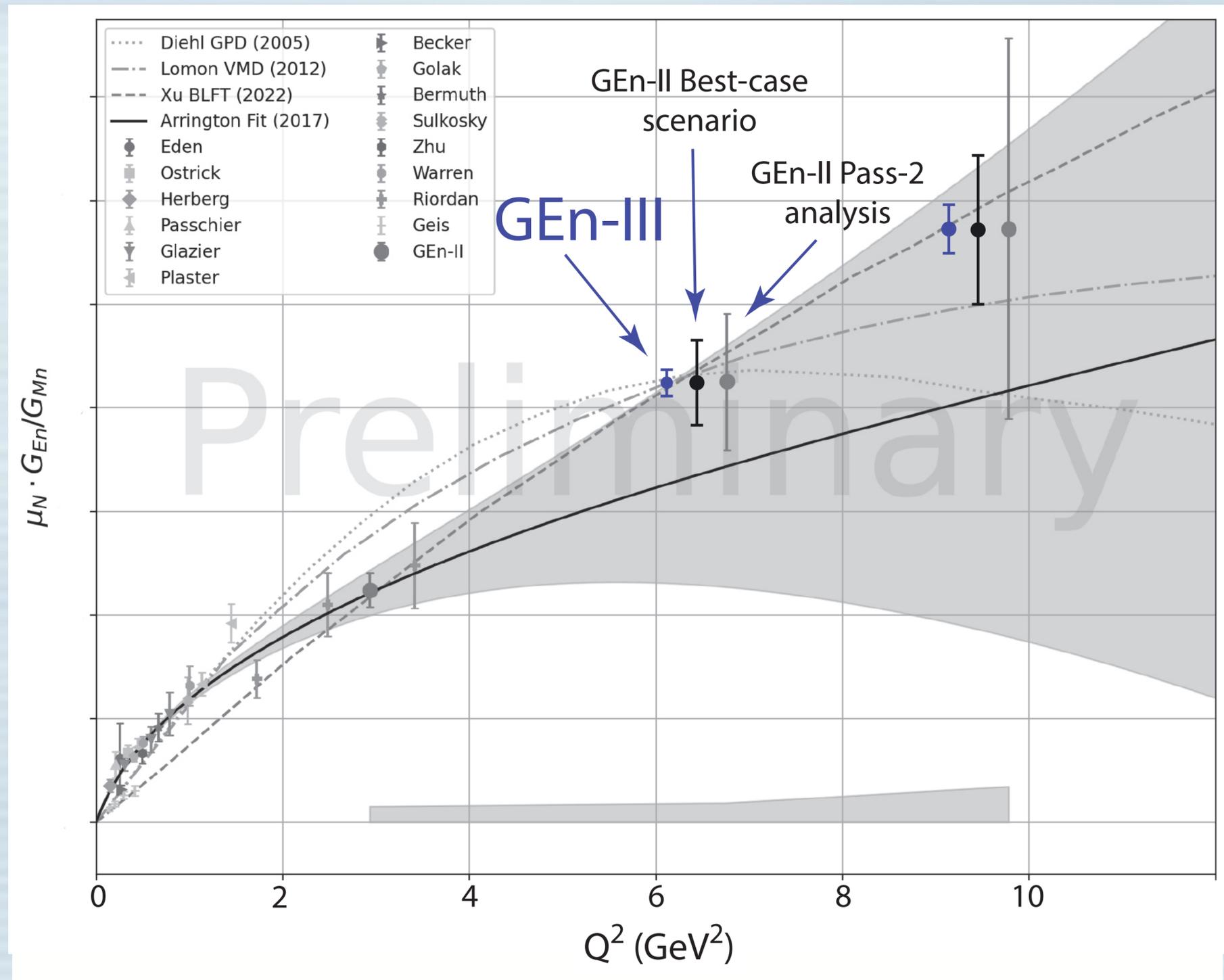
Gordon D. Cates
March 3, 2026



We start by (somewhat arbitrarily) choosing a goal for GEn-III

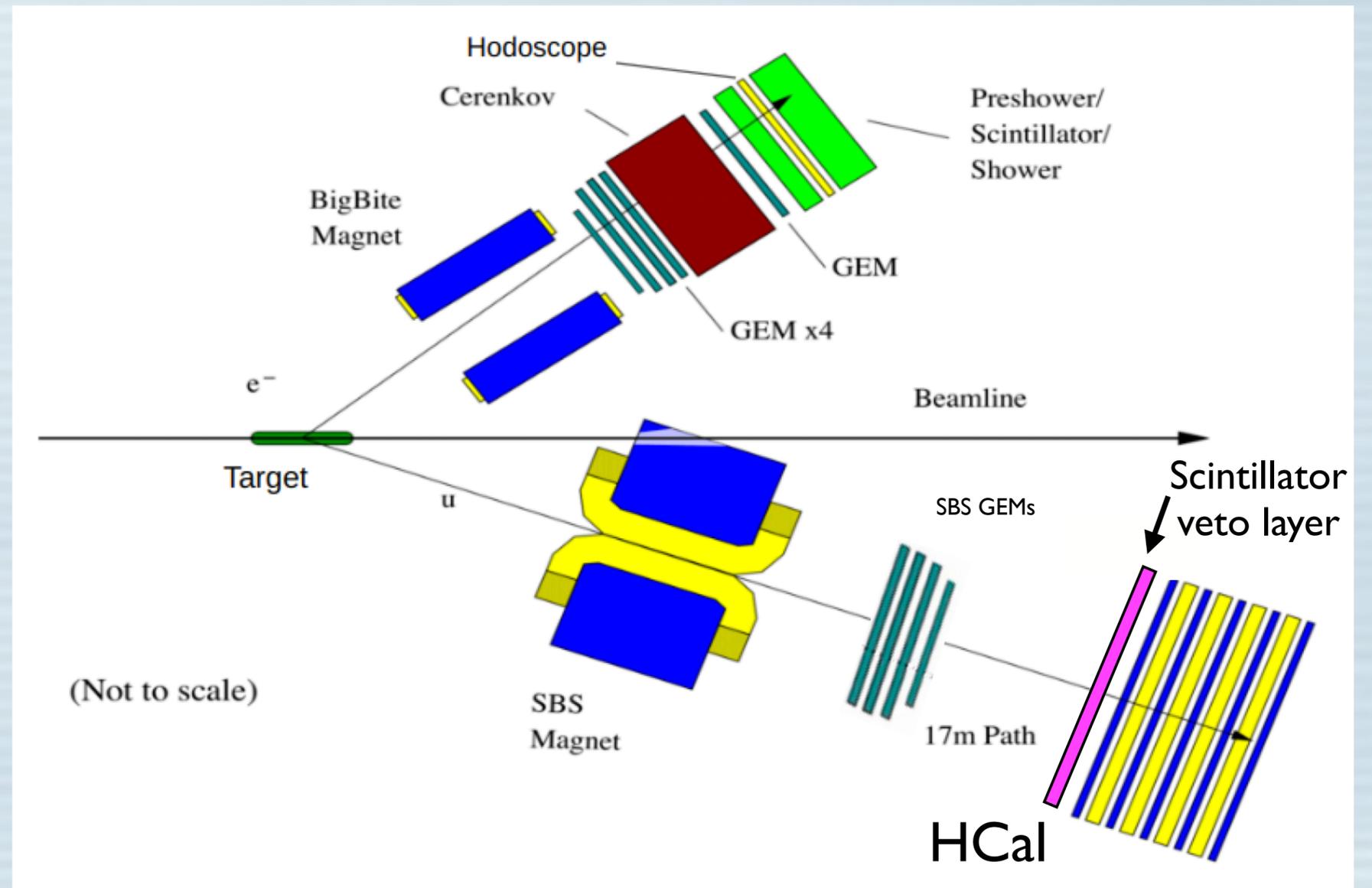
For the sake of argument, let's assume the following for our goal for GEn-III:

- Assume two points at a Q^2 similar to GEn-II Kin3 and Kin4
- Assume that we want an overall figure-of-merit a factor of 10 better than the GEn-II best-case scenario presented yesterday.
- Assume finally that, experimentally, we use GEn-II as a starting point.



The GEn-II best-case scenario assumes background at have the level achieved during pass2

- In pass 2, we believe that roughly half the background was charged (Vimukthi will discuss this point later today).
- Including a veto layer on HCal should make it possible to eliminate at least that component of the background.



An improved version of HCal ?

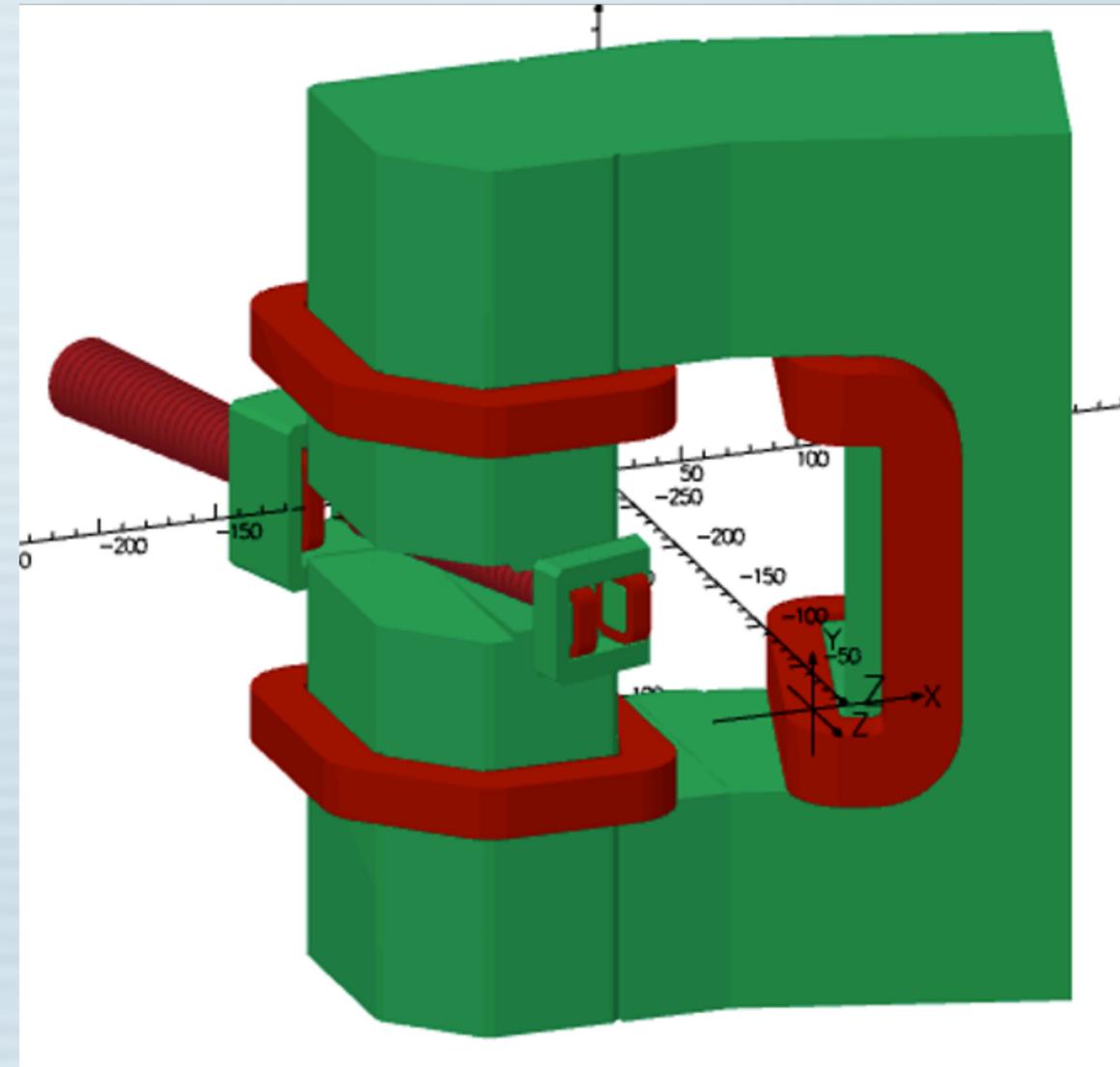
While adding a veto layer to HCal might be straightforward, other improvements would benefit this effort enormously.

- Better energy resolution
- Better timing
- Incorporating some PID capability

Clearly an area where good ideas are needed.

Increase the usable acceptance of the SBS magnet by a factor of two

- You heard earlier about increasing the solid-angle acceptance of the SBS magnet from around 70 msr to over 200 msr.
- While this huge increase might not be usable for GEN-III when the electron arm is taken into account, a factor of two seems quite reasonable.



A "first" increase in the figure-of-merit of the polarized ^3He target by x2

- The original proposal for GEn-II included metal end windows.
 - We made considerable progress in this direction.
 - Tragically, the expert with whom we had been working at Epner Technology Inc. died of COVID during the pandemic.
 - Implementing metal end windows over several years is quite doable.
 - This should enable an increase in beam current from $45\mu\text{A}$ to $60\mu\text{A}$.
- Spin relaxation in our larger convection-based target cells is significantly faster than in previous smaller targets.
 - We have made considerable progress understanding these effects.
 - Going from $P_{\text{He}} \sim 45\%$ to $P_{\text{He}} \sim 55\%$ over several years is also doable.

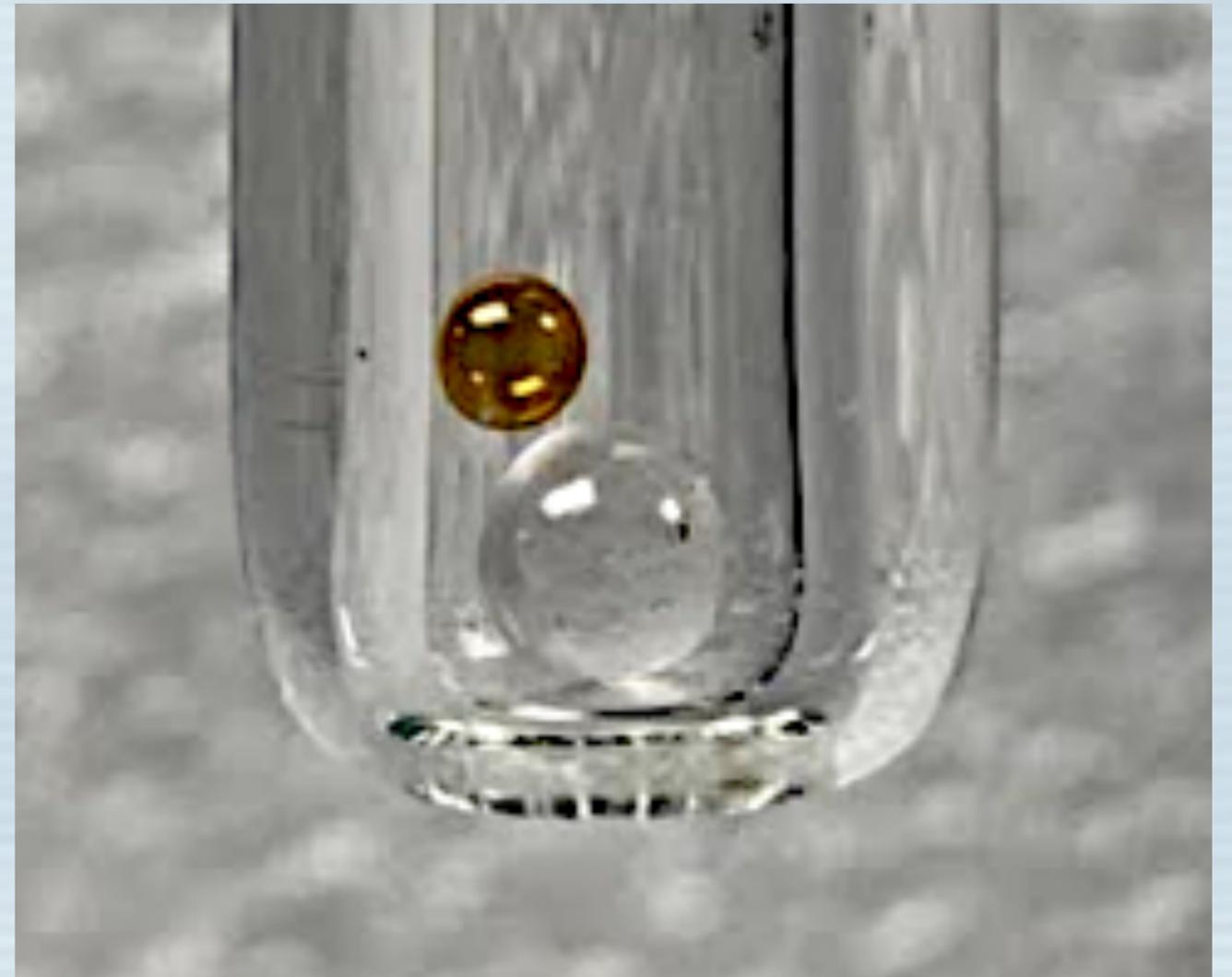
$$\text{Increase in figure-of-merit} \approx (60\mu\text{A}/45\mu\text{A}) * (55\%/45\%)^2 \approx 2.0$$

A further increase in the figure-of-merit of the polarized ^3He target will require going to higher density

- Operating at around 77K could increase the density by over x3.
- But are there materials with favorable spin-relaxation properties at such low temperatures?

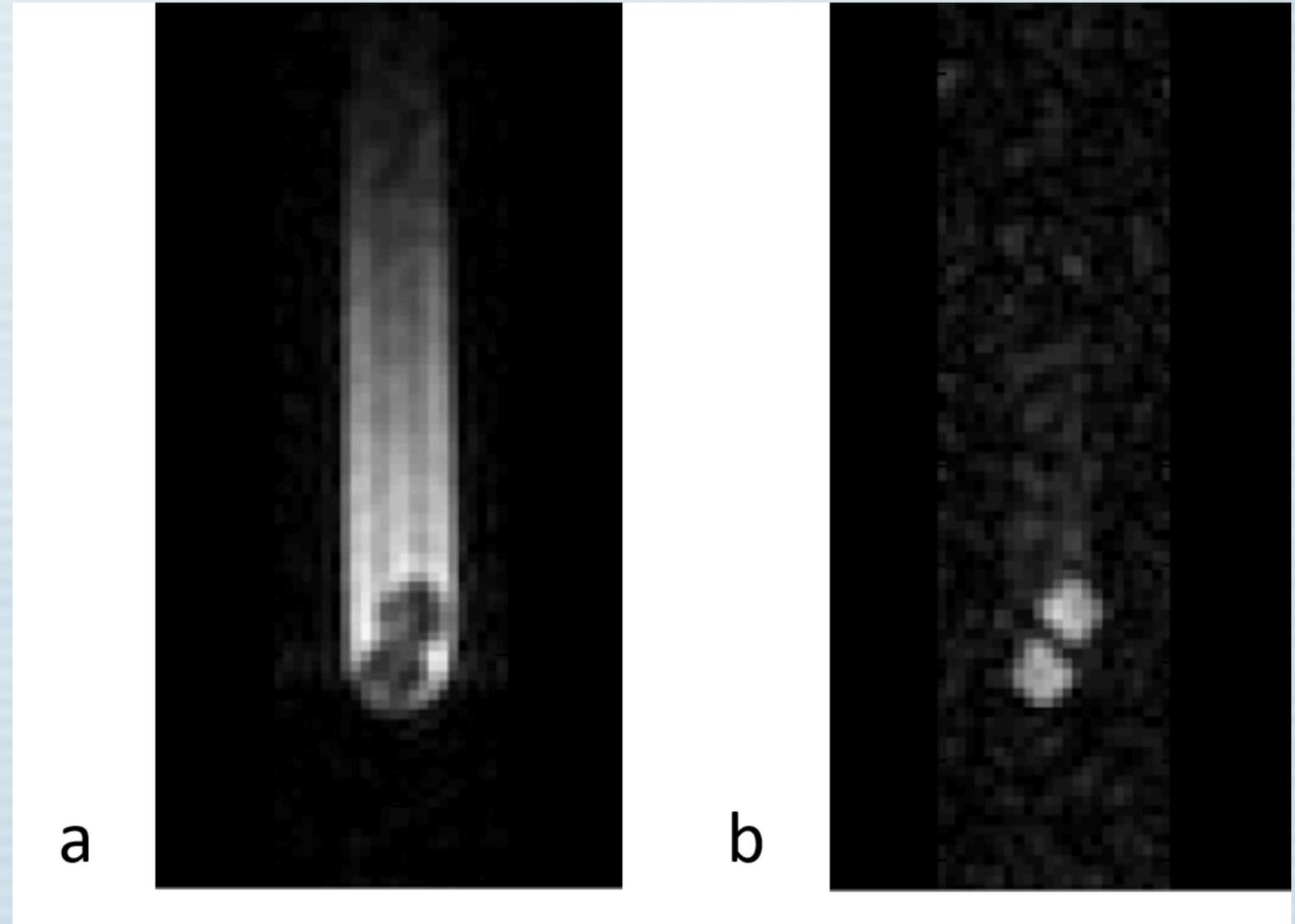
Studies of spin-relaxation of ^3He within the polymer-based pellets used for Inertial Confinement Fusion (ICF)

- The pellets are only a few mm in diameter.
- Spin-relaxation times are tens of hours suggesting much longer times for larger vessels.
- While such polymer-based materials are unlikely to be suitable for electron scattering, this is at some level a proof of principle.

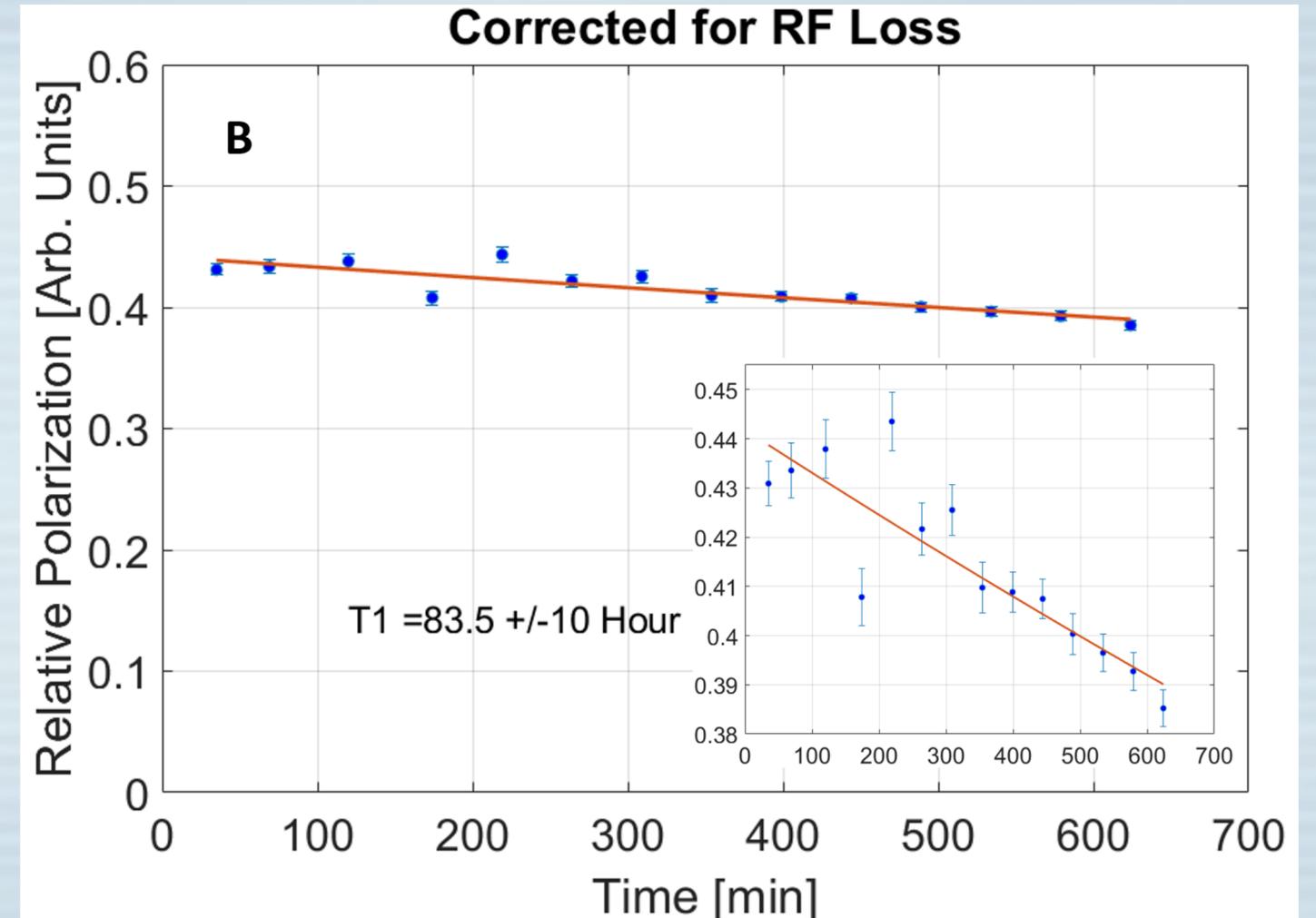
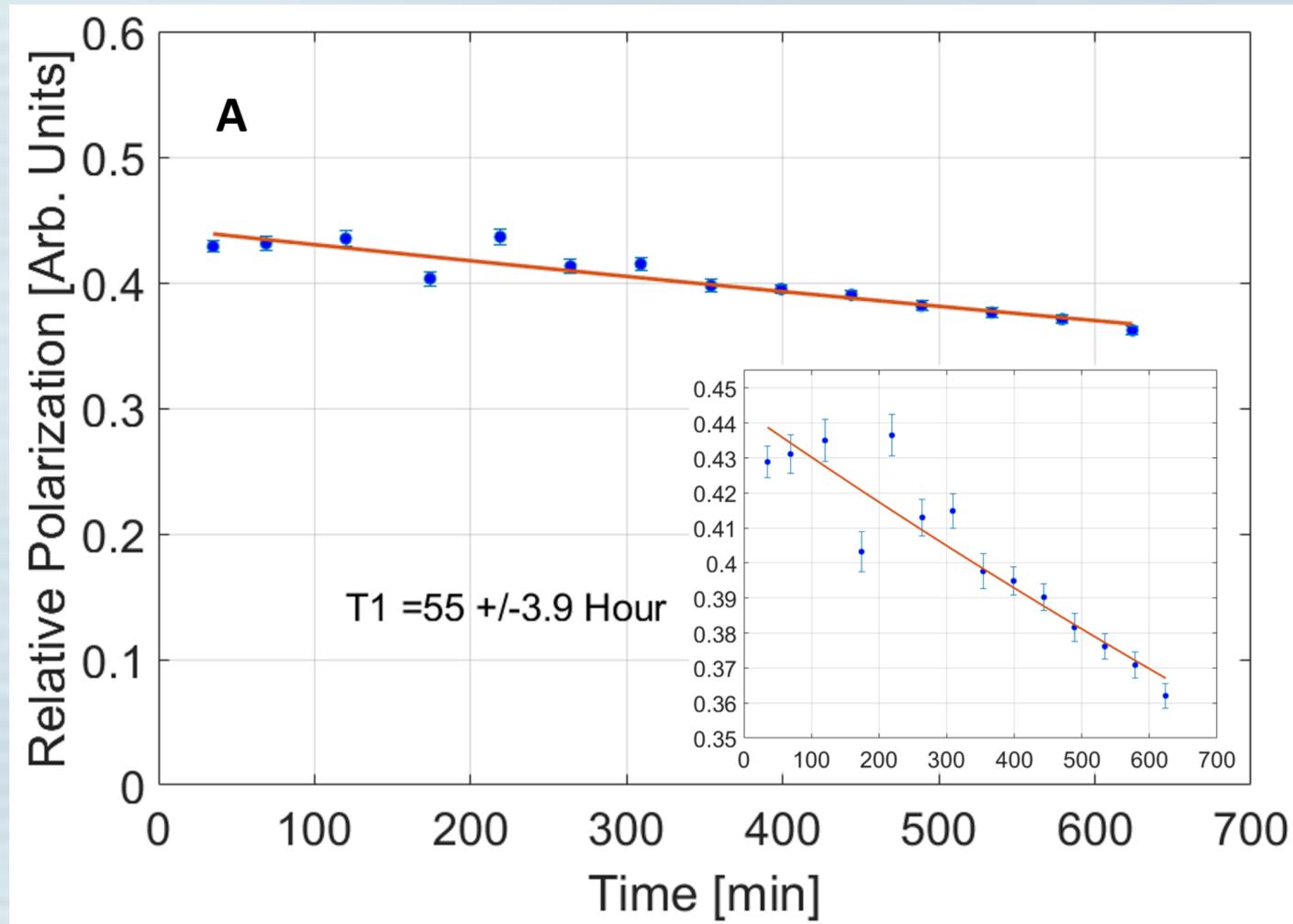


Pellets are permeable to ^3He at room temperature - impermeable at 77K

- Pellets in a glass tube are exposed to ^3He at room temperature and filled with gas.
- Once filled with gas, the apparatus is brought to 77K, sealing the gas in the pellets, and the gas in the tube is pumped away.
- NMR measurements (or MRI) track the polarization as a function of time.



T_1 measurement at 77K



Further measurements are definitely needed to confirm this result

From the thesis of Sina Tafti, a student of Wilson Miller (HAPPEX I),
Xiaochao Zheng and I also played a role in this work.

Summary

- A factor of 4 in effective luminosity with reduced background does not look too difficult with a time scale of several years.
- Increasing effective luminosity by $\times 10$ is probably possible, but relies on as yet undemonstrated developments.
- With all that said, we are still working to “find” our full statistics in GEn-II, so assuming the best-case scenario for the GEn-II analysis is not necessarily the starting point.
- Finally, if effective luminosity really is increased by a factor of 10, doing so in a manageable fashion will have many challenges.

