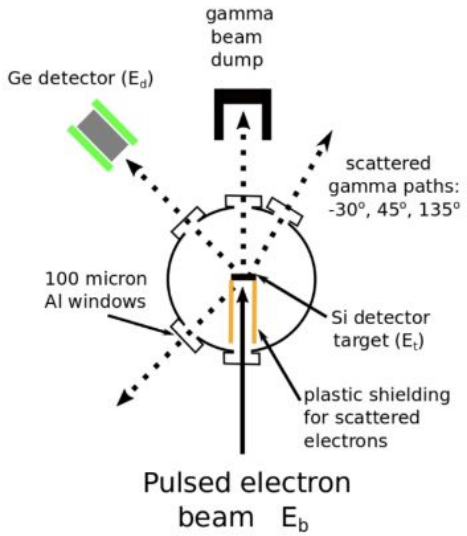
Detector System Discussion

Calibrations, Open Sources, Goop!, 3rd Mount, Timing Detector

Calibrations and Detector Qualification

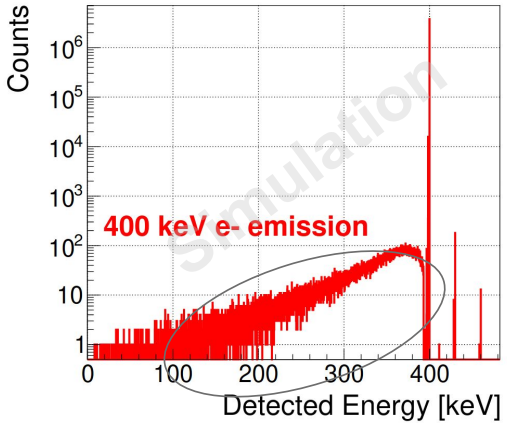
- Electron energy calibration
  - Some requirements for *a* are already met
  - Preliminary stability studies look good for both detectors
  - Offset: statistical uncertainty ~0.3 keV, but systematic contribution of 0.37 keV from source mylar thickness uncertainty
- Tail characterization
  - NCSU/TUNL e^- accelerator for detailed measurement of bremsstrahlung
  - Direct measurement with open sources
  - New simulation studies by Jin



Specification for	**$\Delta a = 3 \cdot 10^{-5}$ in Nab**	**$\Delta A = 3 \cdot 10^{-5}$ in pNAB**	**$\Delta b = 5 \cdot 10^{-4}$ in Nab**
gain factor ($\Delta g/g$)	fit parameter	**0.18% ✔**	fit parameter
Offset E_0 (ΔE_0)	**0.3 keV**	0.2 keV	0.03 keV
nonlinearity (ΔE_{max})	**1.5 keV ✔**	0.3 keV	0.03 keV
peak width (Δw)	**1 keV ✔**	**10 keV ✔**	**3 keV ✔**
tail amplitude (Δt of peak)	10^{-4}	0.024	10^{-3}

Open Sources

- We need the open sources to measure the electron response function
  - From the parametric studies, the fraction of events in the tail (f) needs to be known to the relative precision of 1% (σ_f/f)
- 2022-2023: “In-house” preparations of the open sources using 0.5 um Mylar backing foil (single layer) for ^{113}Sn, ^{109}Cd, and ^{207}Bi
  - Thinner graphite foils are on-hand as well
- 2025: LANL collaborators have performed the vacuum & cryogenic tests to study their stability
  - And they are stable! (113Sn source still at LANL)



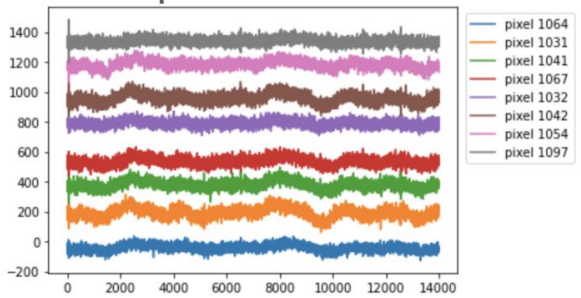
2026 needs:

- New calibration sources and source-holders should be fabricated (graphite and mylar thin film sources for 113Sn, 131Ce)
- Existing 207Bi and 139Cd sources should probably be checked for stability under pumpdown and cooling
- New six-source holder for CAL2702's should be produced
- Additional 207Bi sources are needed: 2 more are needed to populate a full six-source holder, and a stronger 207Bi source is needed for timing bias analysis (see final 2 slides)
- Probably CAL2702's should be characterized for density distributions – assuming they will still be needed for some of our high precision reconstruction work
- IDP data taken in test stand (especially for lower detector?) – bias scan data taken and some preliminary analysis available, but lower detector looks scary

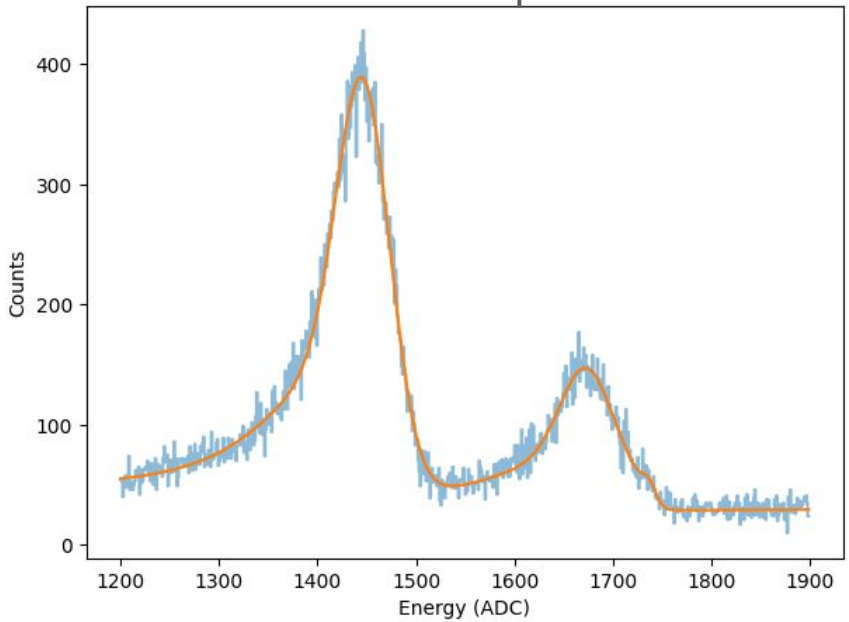
Lower Detector (Goop!) Noise

- Low frequency correlated noise
- Affects energy extraction
- Shorter filters can improve energy extraction
- Goop! should be removed and characterized
  - Replace with a pristine detector that will also need be characterized

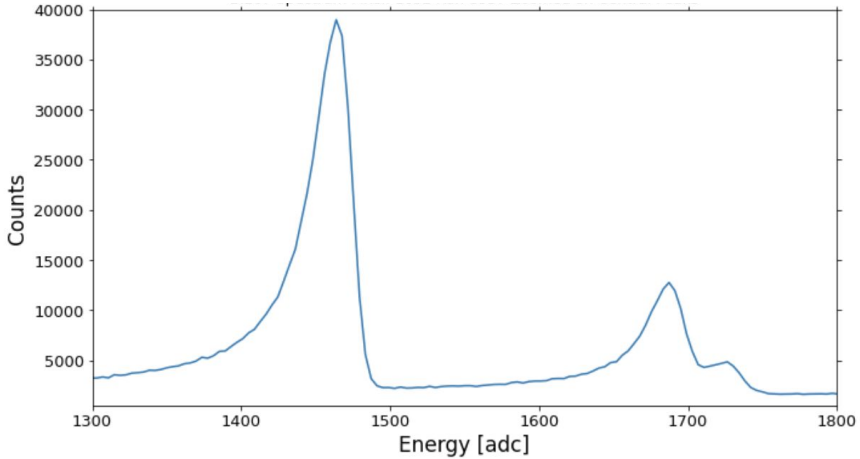
Goop! Baseline Trace



1250 50 1250 Trapezoidal Filter



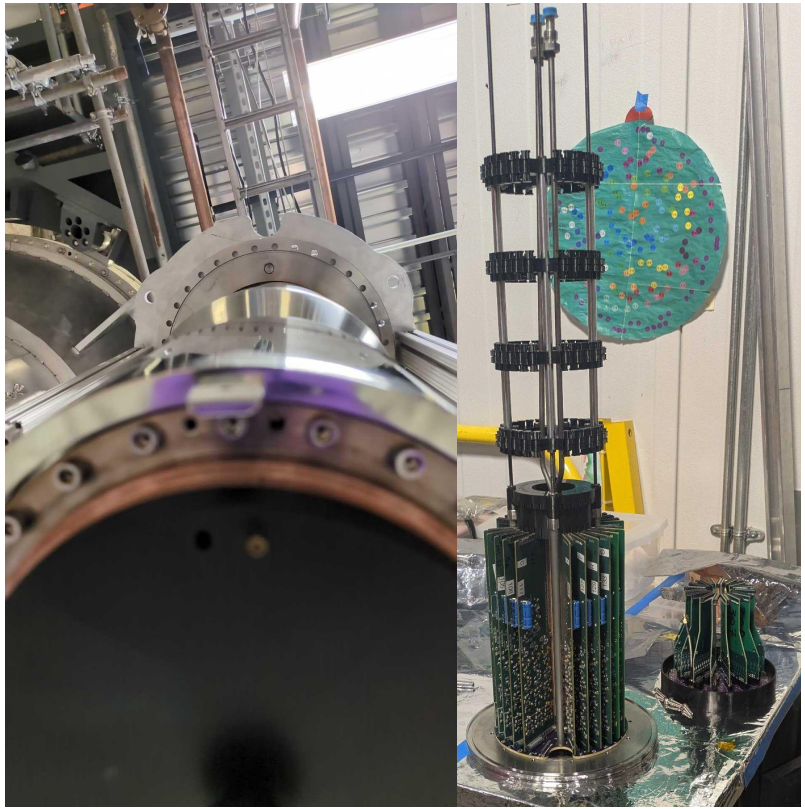
150 20 1250 Trapezoidal Filter



A. Shelby (NCSU)

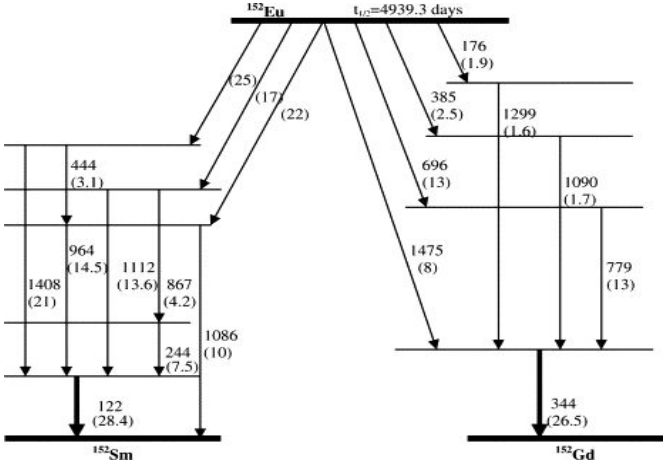
3rd Mount

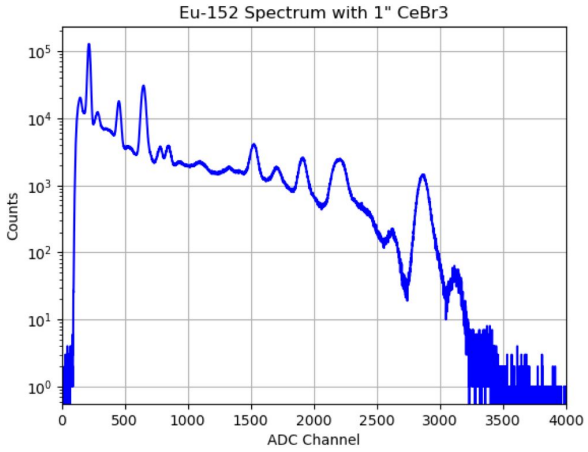
- Status
  - Atmosphere-side electronics assembled
  - Working on closing FET vacuum volume
  - Amplifier cables + thermometry ordered
    - Should arrive in new year
  - Amplifier power distribution panel in the works
    - Likely completed in Mar/April
- Next steps
  - Minichamber 2.0?

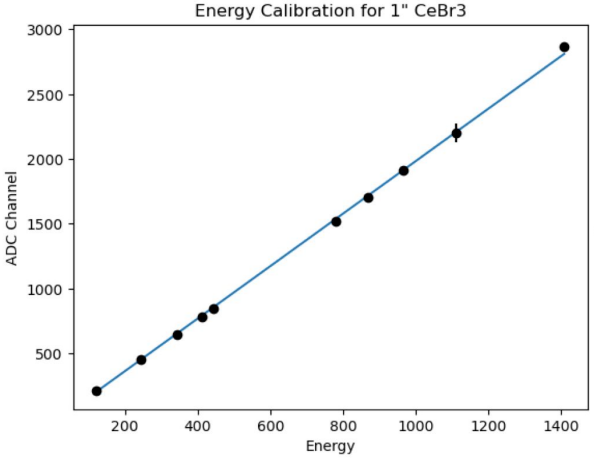


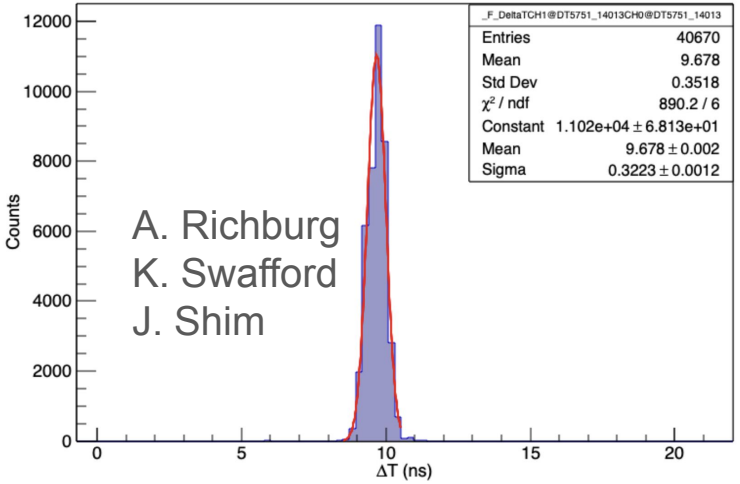
Timing detector

- Nab spec: timing bias $\Delta t_{p\text{-}e}$ < 0.3 ns. Timing offsets from different particle types, hit locations. How to correct?
  - CeBr3 detector has been characterized with gamma-gamma coincidence methods to ~few keV and FWHM < 300 ps coincidence window
  - Tested with ^{60}Co, ^{152}Eu, and ^{22}Na at EKU, and ^{113}Sn and ^{207}Bi at ORNL





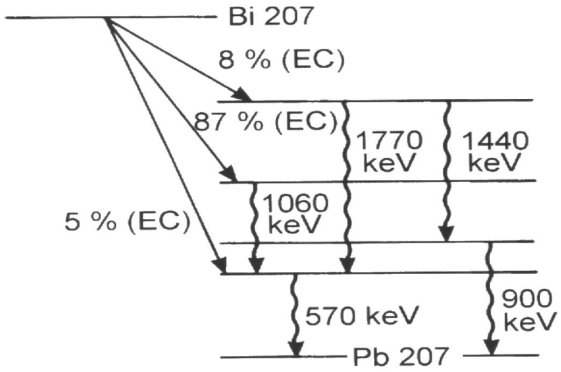




Addition: we need to order high activity sources!

Timing detector

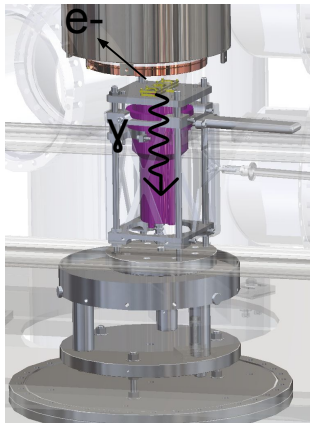
- Use timing detector to build database of pulse shapes (timing offsets) as function of particle types, hit locations, detector settings.
  - e- waveform start determined from fast detection of coincident ɣ
  - Measure offsets directly using sources with fast “timing detector” → benchmark NESSE
- Measure ex-situ (better control) and in-situ (match Nab operating conditions)



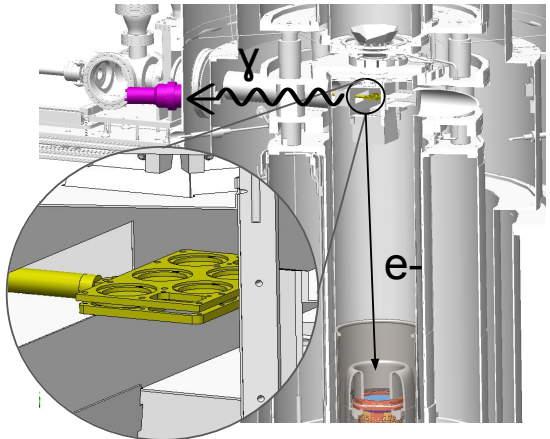
Ex-situ goals for 2026

1. Assemble system and perform single pixel demonstration
   a. Bias scans, temp scans
2. Integrate 2D motion and collimation
   a. Pixel-by-pixel and interpixel timing offsets

Ex-situ method



In-situ method



In-situ goals for 2026

1. Produce simulation for electron flight paths and timing for ^{207}Bi as a function of energy and angle
2. Single pixel demonstration with the CAEN DT5751. Begin multiple pixel coincidences