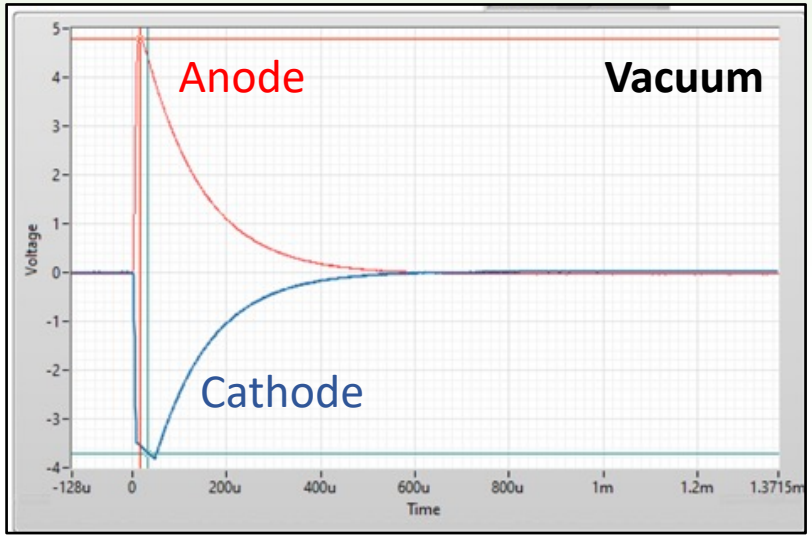
2x2 Purity Monitor: Focused Studies in Vacuum & LAr

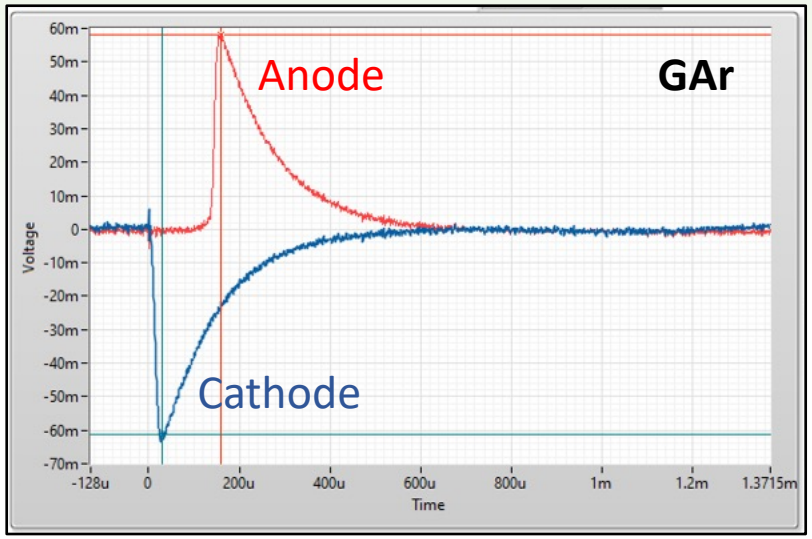
Elise Hinkle, Alan Hahn

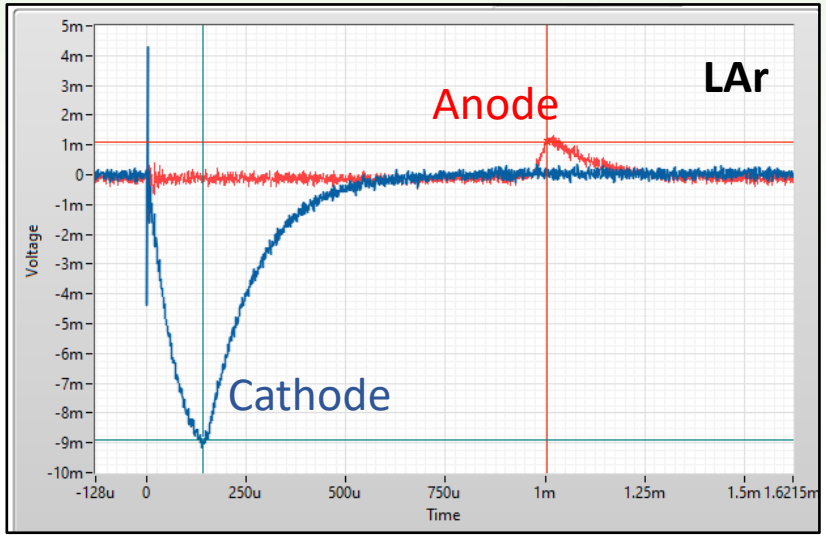
August 28, 2023

Why test the PrM in vacuum, GAr, & LAr?

- Signal different in each environment
  - See this in magnitude of peaks and in time between peaks
- 2x2 environment is obviously LAr, but testing in vacuum and GAr can still be informative while also being cheaper



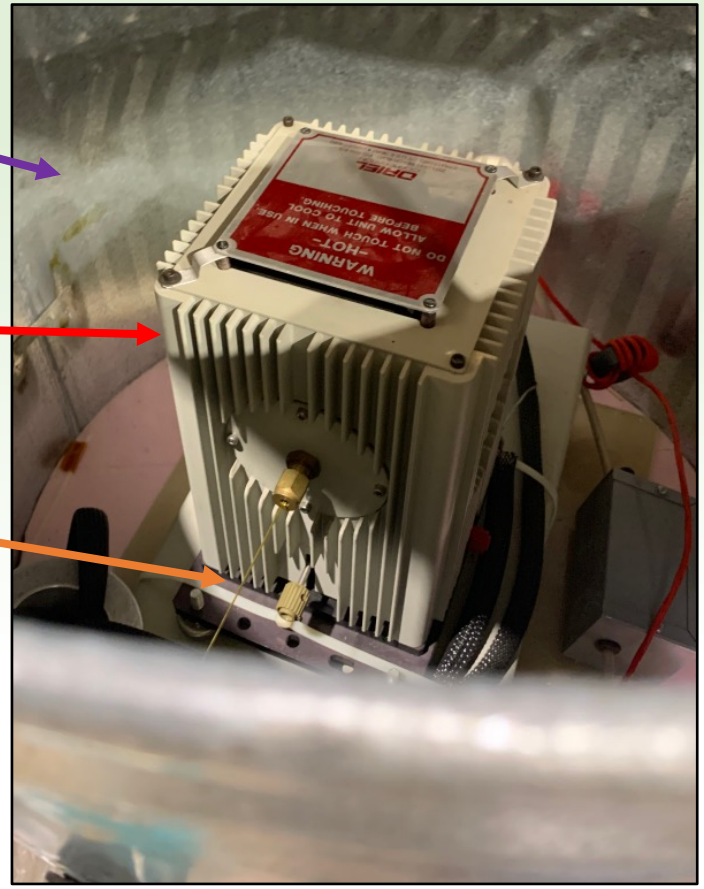




What tests did we do?

- In addition to general performance testing of the purity monitor in vacuum, GAr, and LAr, we had the opportunity to perform some **small, focused studies on certain purity monitor settings**
- **Tests in vacuum:**
  - Single fiber performance
  - Impact of fiber length on performance
- **Tests in LAr:**
  - Can we improve signal strength while preserving measurement sensitivity?

Testing in Vacuum: Set Up



Internal PrM fibers

External PrM fiber

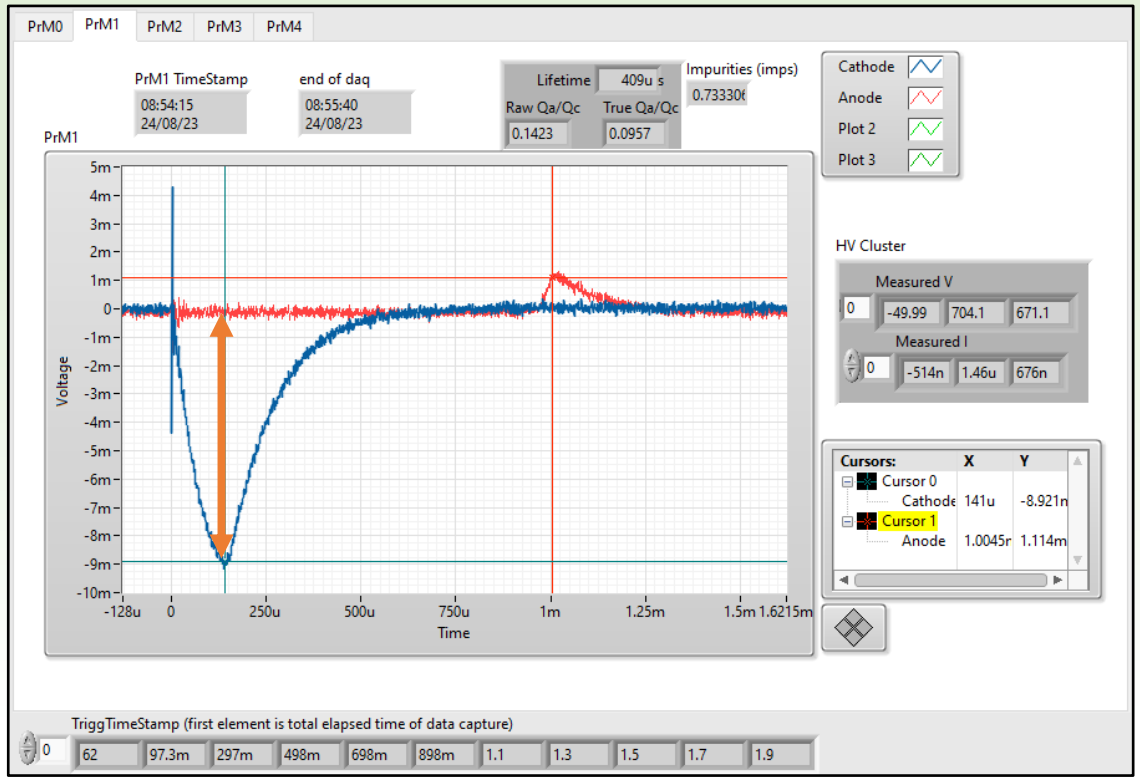
Vacuum Vessel

Faraday Cage

Flash Lamp

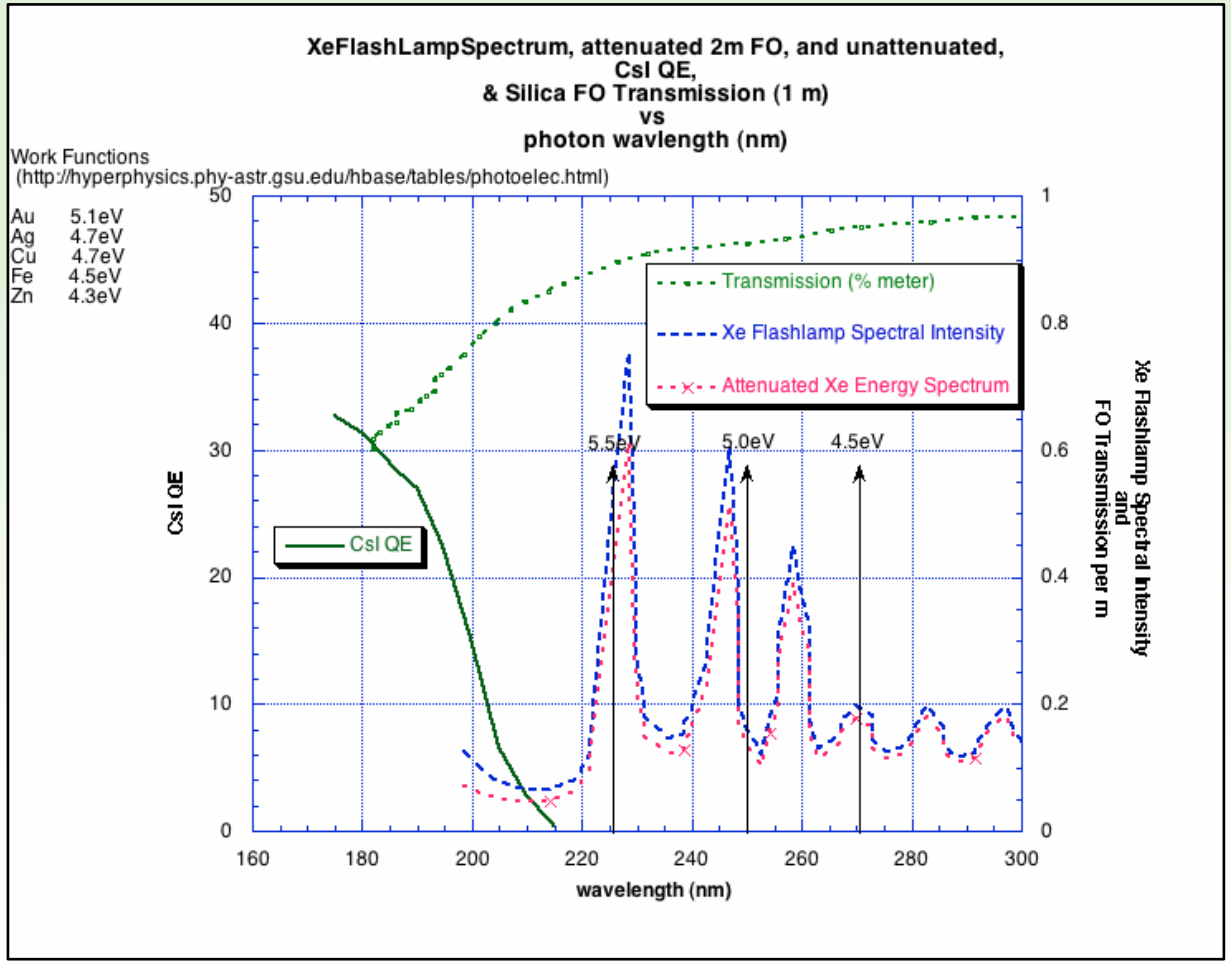
Testing in Vacuum: Single Fiber Performance

- General questions:
  - Does each fiber produce a “strong” signal? → Yes!
  - Do the three fibers perform similarly? → Yes!
- Performance is measured by cathode voltage peak height
  - ”Strong” signal in vacuum = >1 V
    - Plot at right shows signal in LAr, which is expected to be smaller than in vacuum



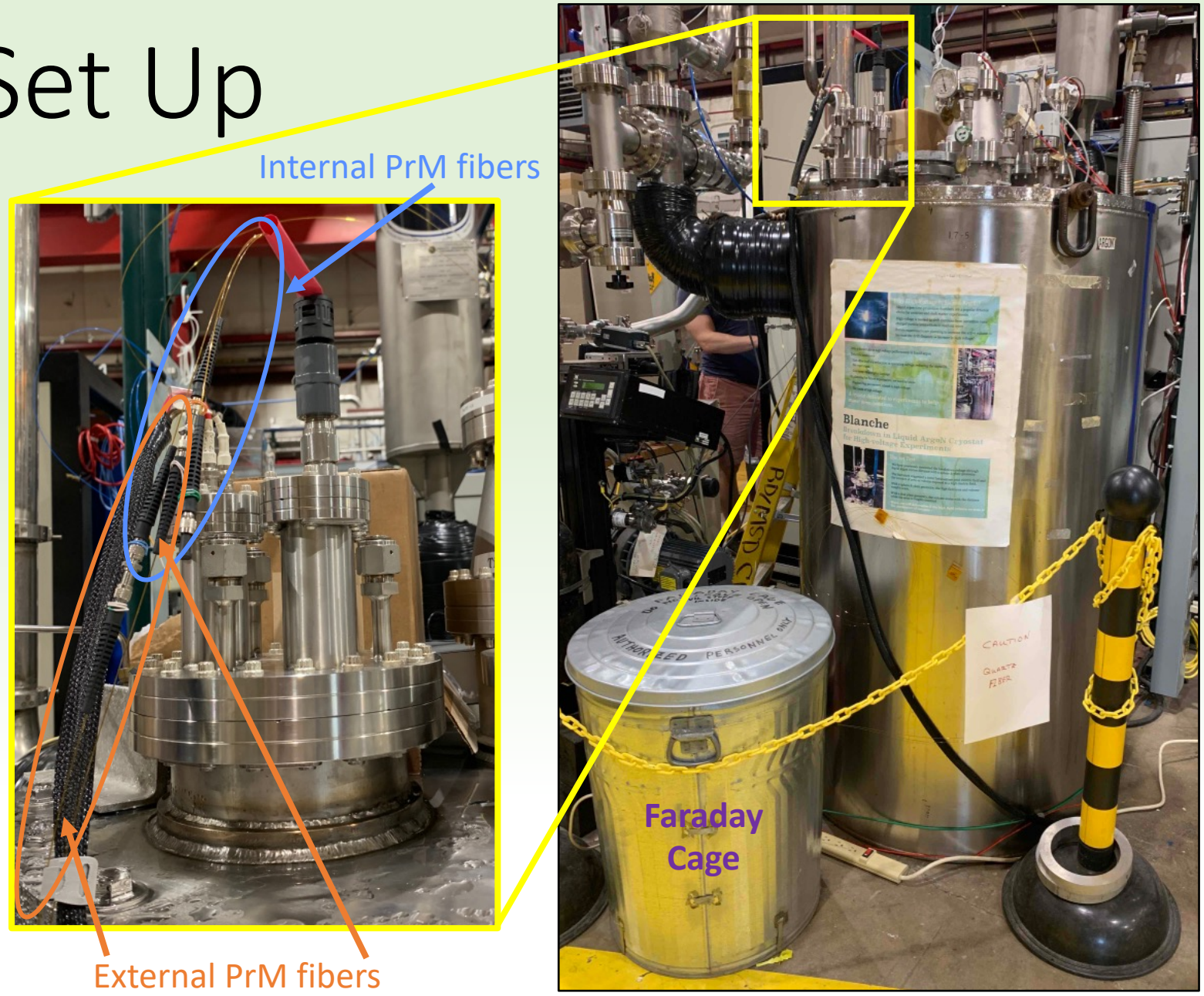
Testing in Vacuum: Effect of Fiber Length

- Spectral intensity attenuation occurs as light from Xe flash lamp travels through silica fibers
  - Plot at right shows attenuation when using 2m fibers
  - **Will our signal be worse when using a longer fiber?**
- We found that each fiber still produced a “strong” signal when using a longer (5m) fiber



Testing in LAr: Set Up

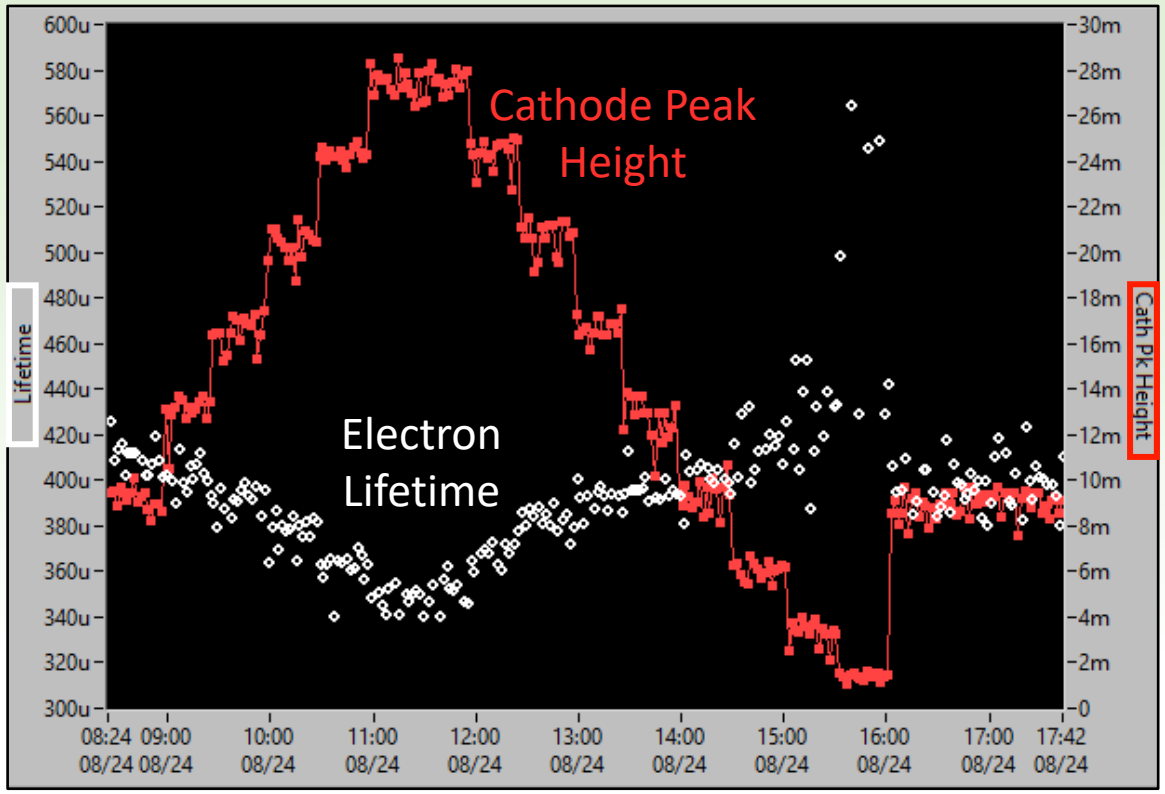
- Testing done in Blanche cryostat during TinyTPC run
- Using two fibers during tests



Testing in LAr: Signal Strength vs. Sensitivity

- We want a **strong signal**, where cathode voltage peak height can be used as a proxy for signal
  - Suggests high electric field in cathode drift region (cathode → cathode grid)
- We want a **long drift time**
  - Suggests low electric field in main drift region (cathode grid → anode grid)
- However, for electrons to not get collected on cathode grid, electric field in main drift region must be higher than in cathode drift region
- **Can we achieve a more effective balance of these interests?'**
  - e.g. such that cathode signal increases, but drift time does not decrease enough to affect sensitivity to electron lifetime measurement

Testing in LAr: Signal Strength vs. Sensitivity



- Variables changed while testing:
  - Cathode voltage (mainly impacts cathode drift region electric field)
  - Anode grid voltage (mainly impacts main drift region electric field)
  - Transparency factor (ratio between cathode drift region and main drift region electric fields)
- Testing is ongoing
  - Will further explore systematics and write final report