



Instrumentation R&D for Resolving Nuclear Recoils in Argon Based TPCs

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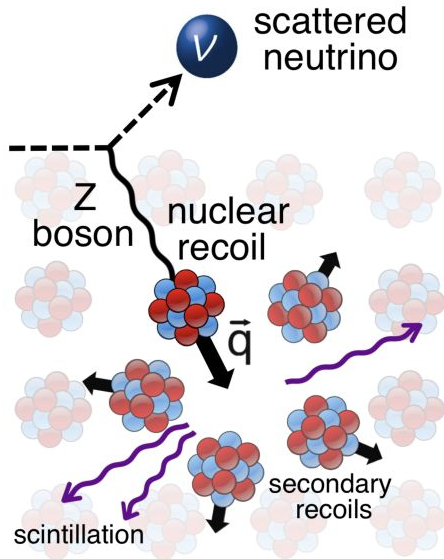
11/01/2024

Overview

- **Detector R&D Motivations and Projects for Argon TPCs:**
 - Nuclear Recoils from CEvNS
 - **LArCADE: anode geometries for E-Field magnification**
 - Nuclear Recoil tracking in gas
- **LArCADE Tip Fabrication at Brookhaven National Lab**
 - Took a 2 week trip to BNL in Spring 2024
 - Made anode geometries for E-field magnification
- **LArCADE Tip Fabrication Testing at Fermilab**
 - Spent two months at Fermilab over the summer
 - Tested one anode from the BNL trip in both liquid and gaseous argon
- **More Detector R&D at UCSB**
 - Cryostat, GAr TPC with GEMs, UCSB clean room
- **Summary & Future Work**

Detector R&D Motivations

- Focus is on nuclear recoil imaging for **Coherent Elastic Neutrino Nucleus Scattering (CEvNS)**



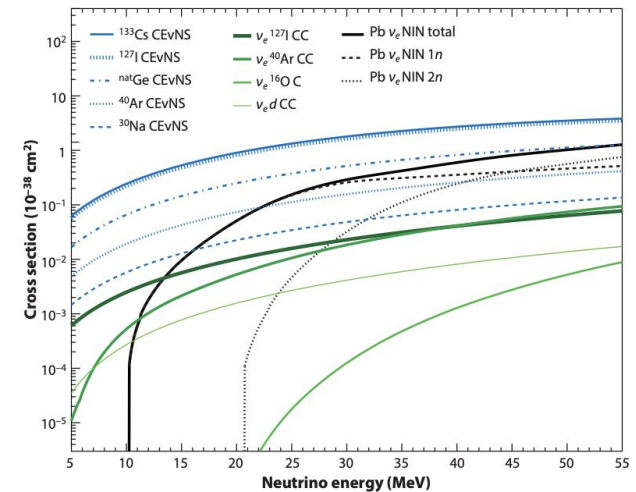
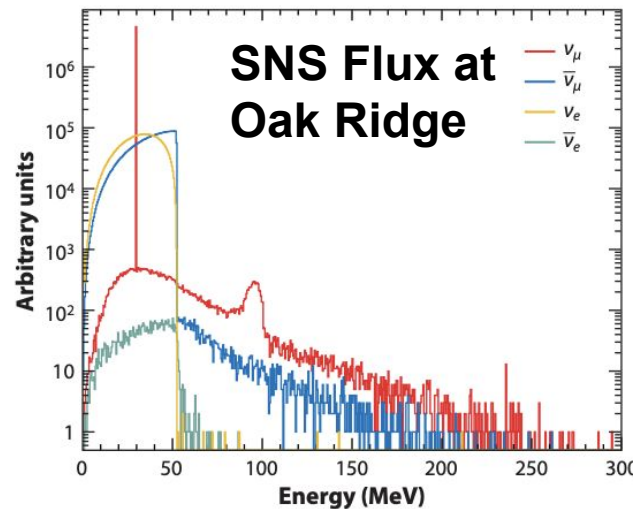
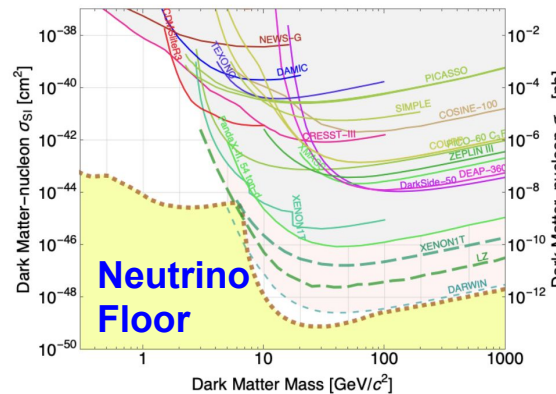
$$E_r = \frac{2m_N E_\nu^2 \cos^2 \theta_r}{(E_\nu + m_N)^2 - E_\nu^2 \cos^2 \theta_r}$$

“Coherent elastic neutrino-nucleus scattering with directional detectors”

PRD 102 (2020) 1, 015009

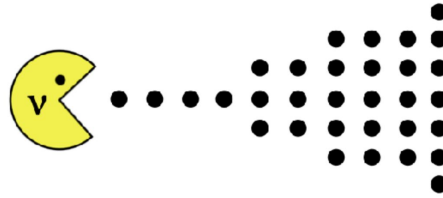
M. Abdullah, D. Aristizabal Sierra, B. Dutta, L. Strigari

High Intensity Stopped Pion Source at Oak Ridge perfect for measuring CEvNS!

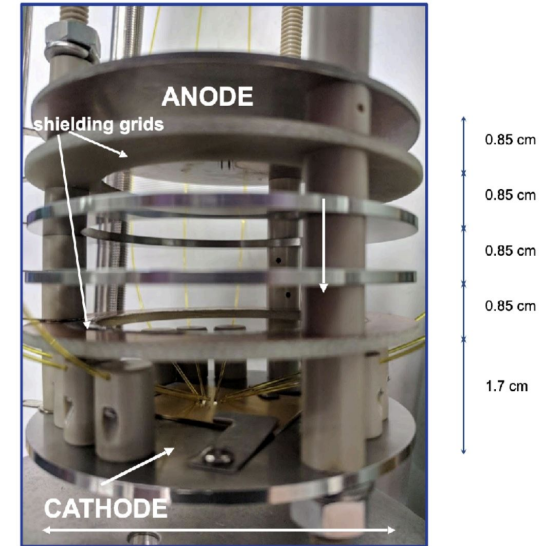
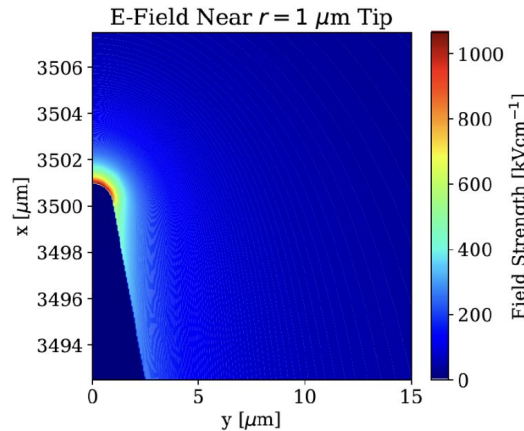
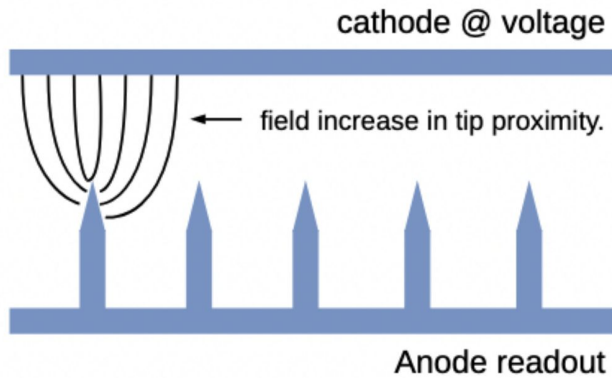


Detector R&D Projects

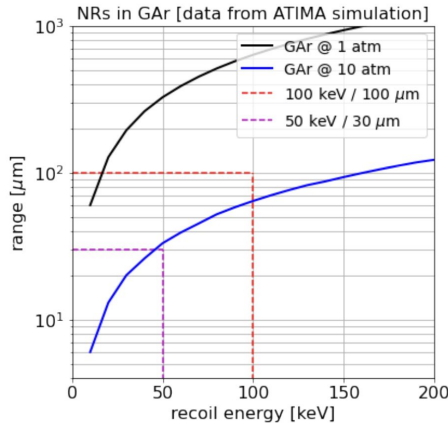
LArCADE Project



R&D effort launched by Angela Fava (FNAL) with LDRD

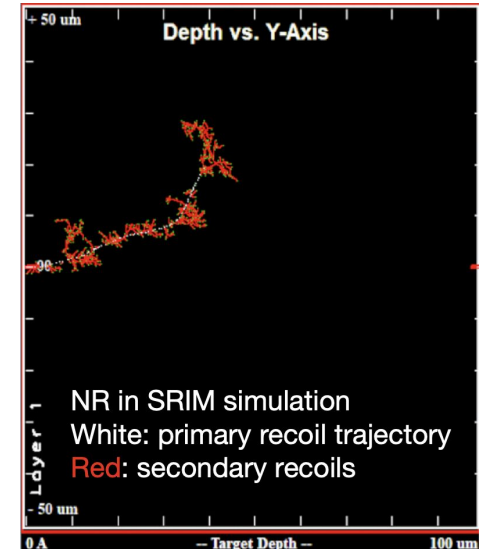


Nuclear Recoil Tracking in Gas



$$E_r = \frac{2m_N E_\nu^2 \cos^2 \theta_r}{(E_\nu + m_N)^2 - E_\nu^2 \cos^2 \theta_r}$$

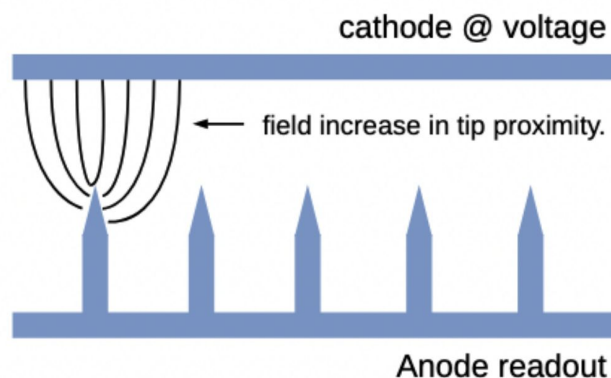
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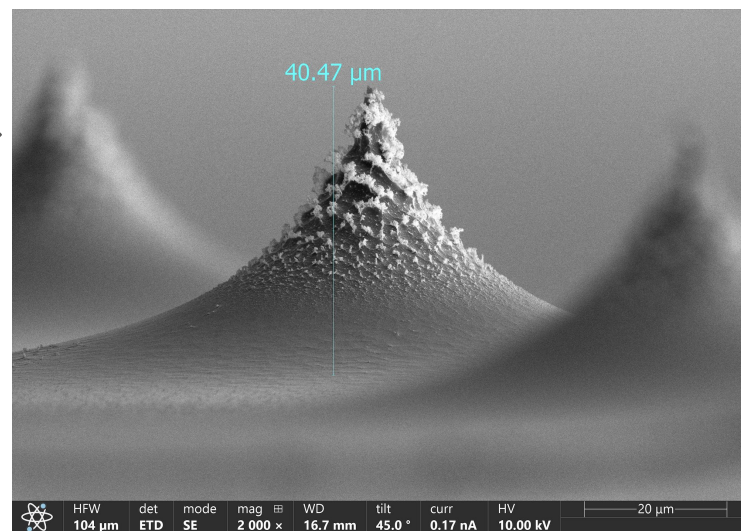
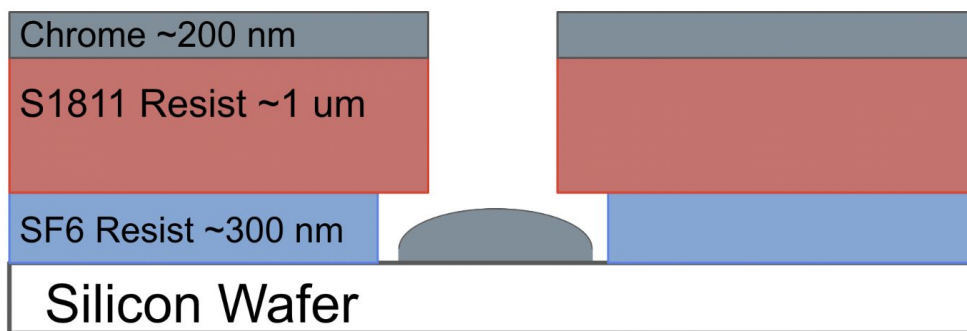
LArCADe at Brookhaven National Lab



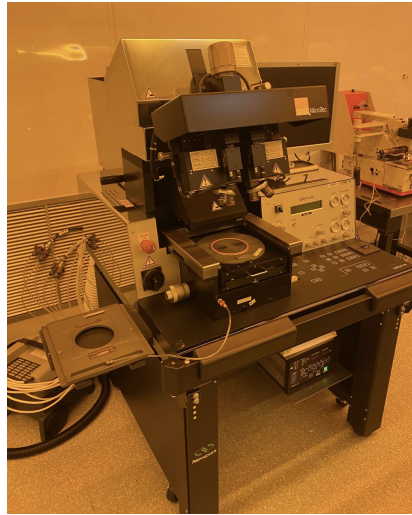
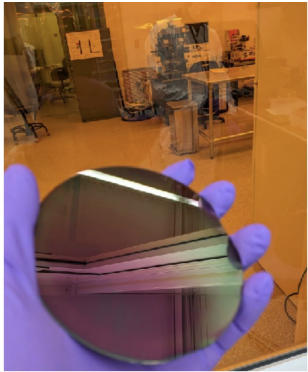
<https://www.bnl.gov/cfn/>



Launched development of tip-arrays @ BNL's Center for Functional Nanomaterials (CFN)



LArCAdE Tip Fabrication at BNL

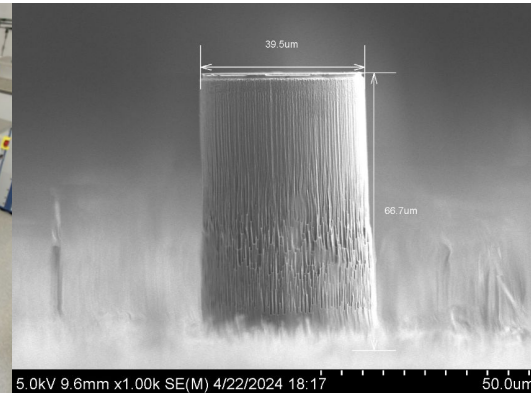
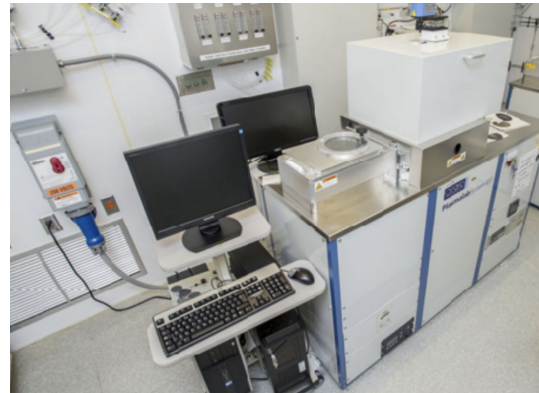
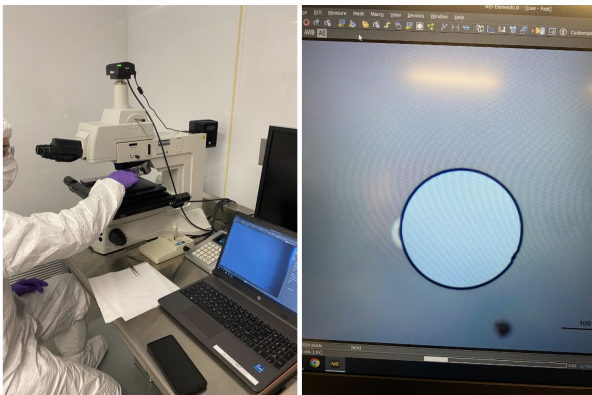


Photolithography

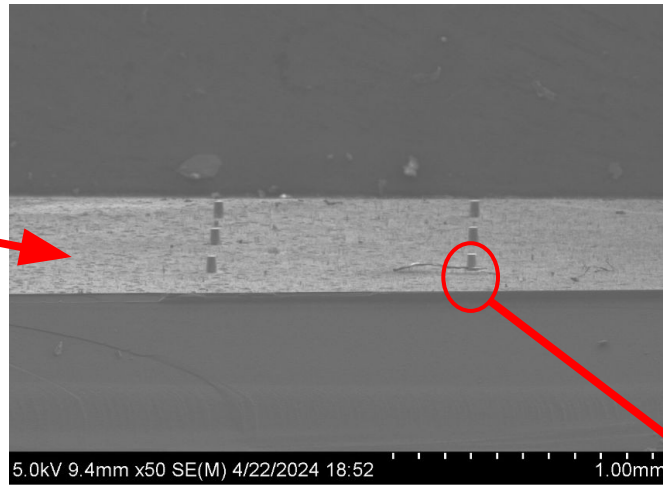
Mask Deposition

Mask Alignment

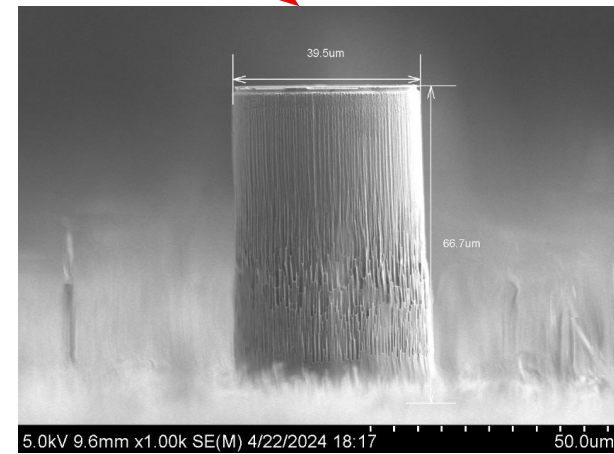
Etching



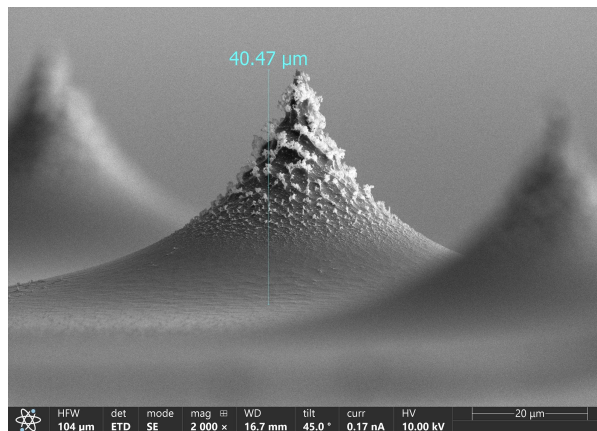
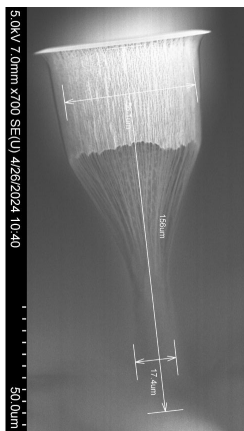
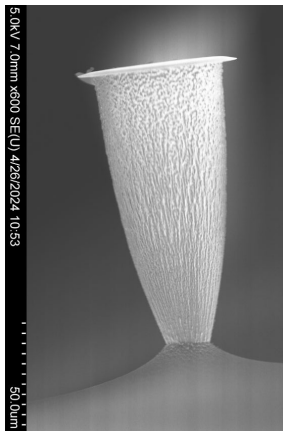
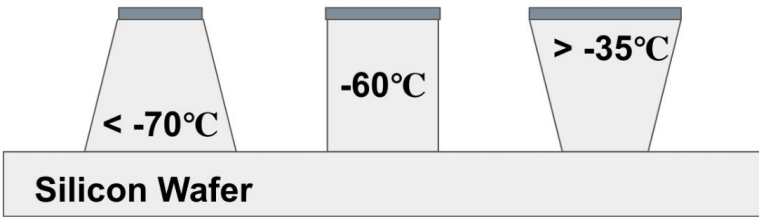
Tip Fabrication at BNL



5.0kV 9.4mm x50 SE(M) 4/22/2024 18:52 1.00mm



5.0kV 9.6mm x1.00k SE(M) 4/22/2024 18:17 50.0um

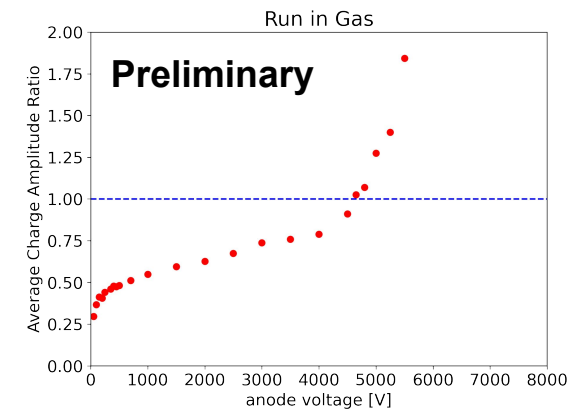
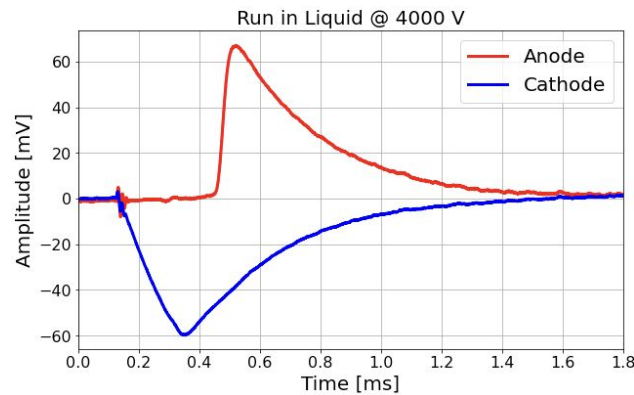
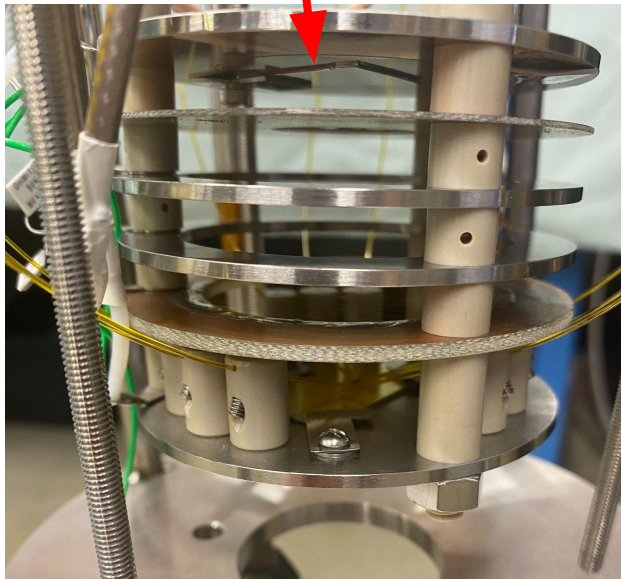
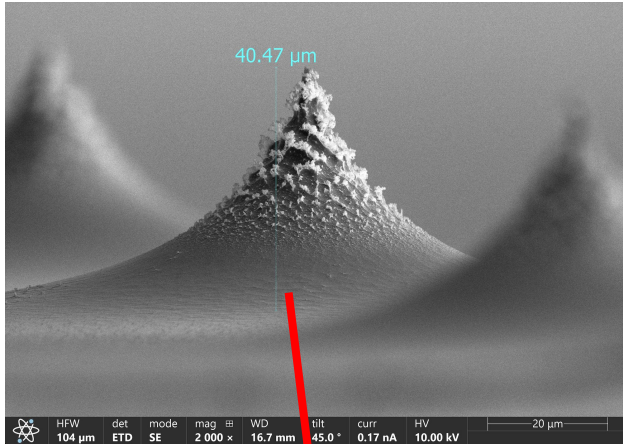


Testing at Fermilab



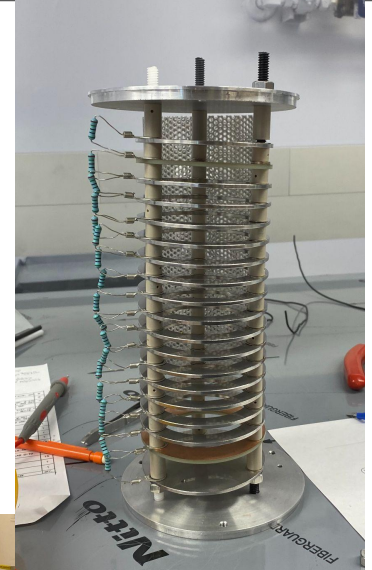
- We were able to finish one sample at Brookhaven
- Spent two months at Fermilab with travel support from the URA Visiting Scholars Program (July and August 2024)
- Was able to test our sample with Angela Fava at the Proton Assembly Building (BLANCHE HV Cryostat)...

Testing at Fermilab



More Detector R&D at UCSB

- **UCSB Cryostat under development**
 - Gearing up for first vacuum tests
 - Eventually Prototype GAr TPC with GEMs for tracking
- **UCSB has a cleanroom (UCSB Nanofab)**
 - Continue LArCADE tip fabrication



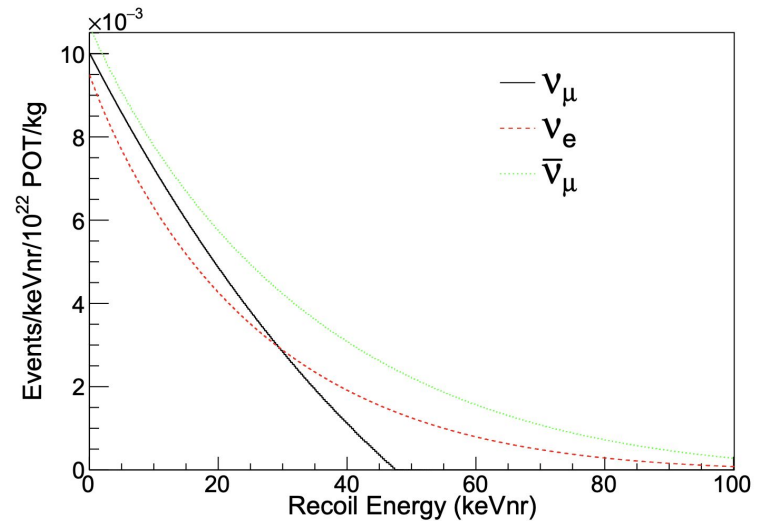
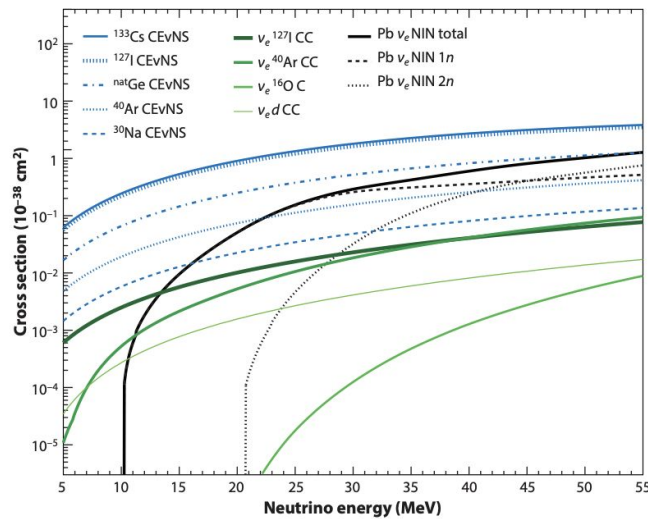
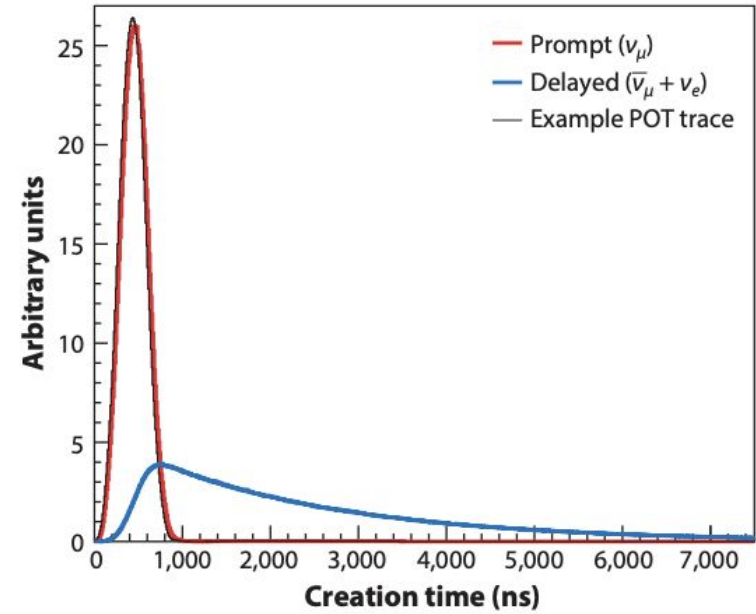
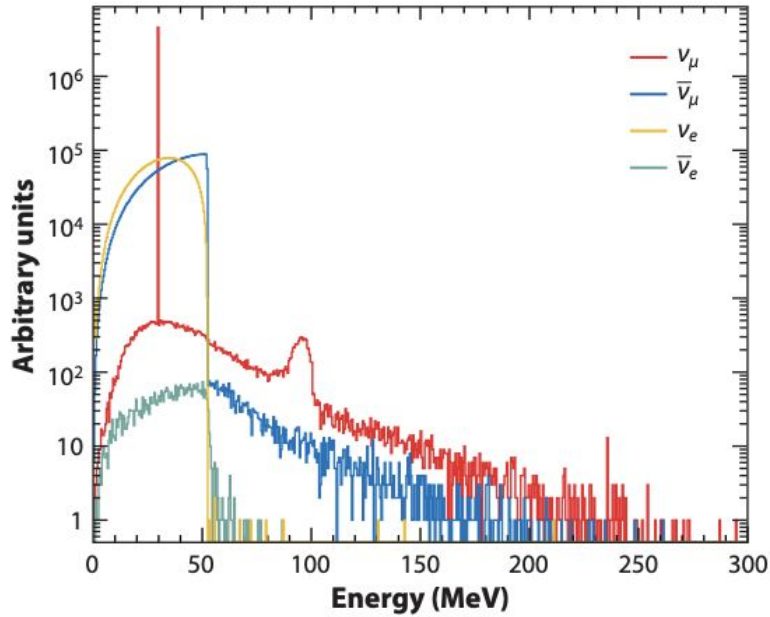
Summary & Future Work

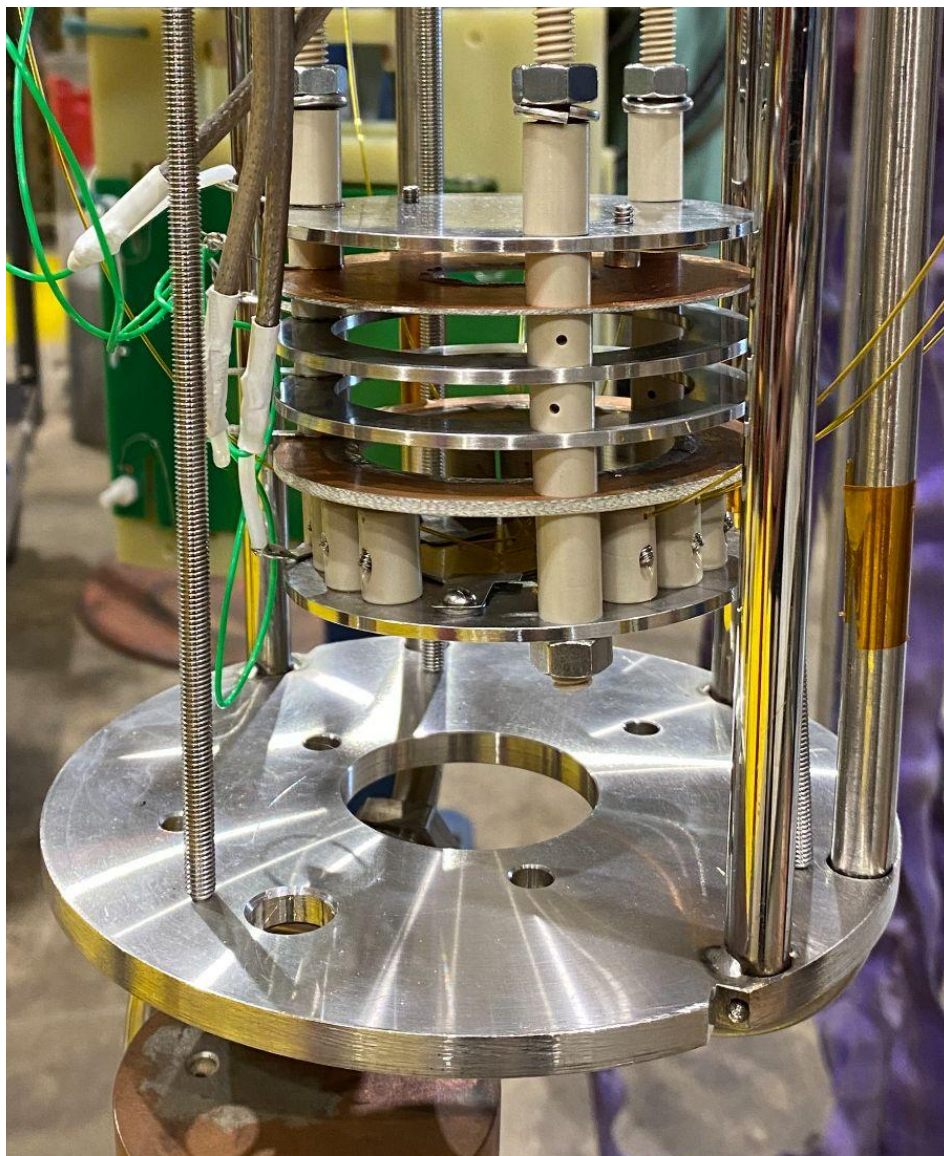
- **Detector R&D focus is on nuclear recoil imaging for CEvNS**
- **Two main projects**
 - LArCADE anode geometries
 - Nuclear recoil tracking in gas
- **Prototyping the LArCADE tips is ongoing**
 - First sample from BNL tested
 - More samples may be finished and tested soon
 - Will continue fabrication at the UCSB cleanroom
- **Working on putting together a test stand at UCSB !**

Thanks for
Listening!

Backup

SNS at Oak Ridge





Fermilab Images

