



Scintillating Bubble Chamber

Rare Event Searches with SBC

Carter Garrah

February 14, 2025

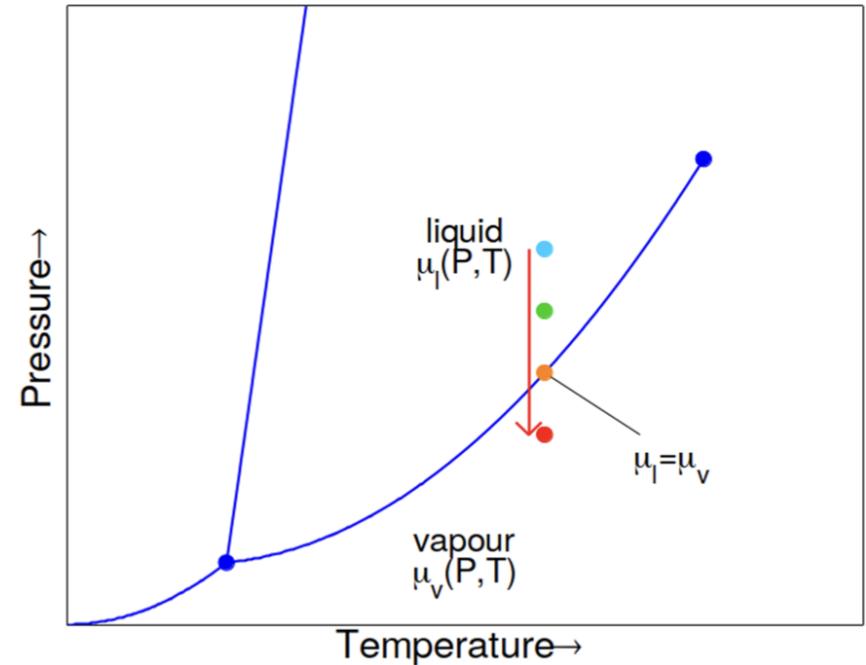
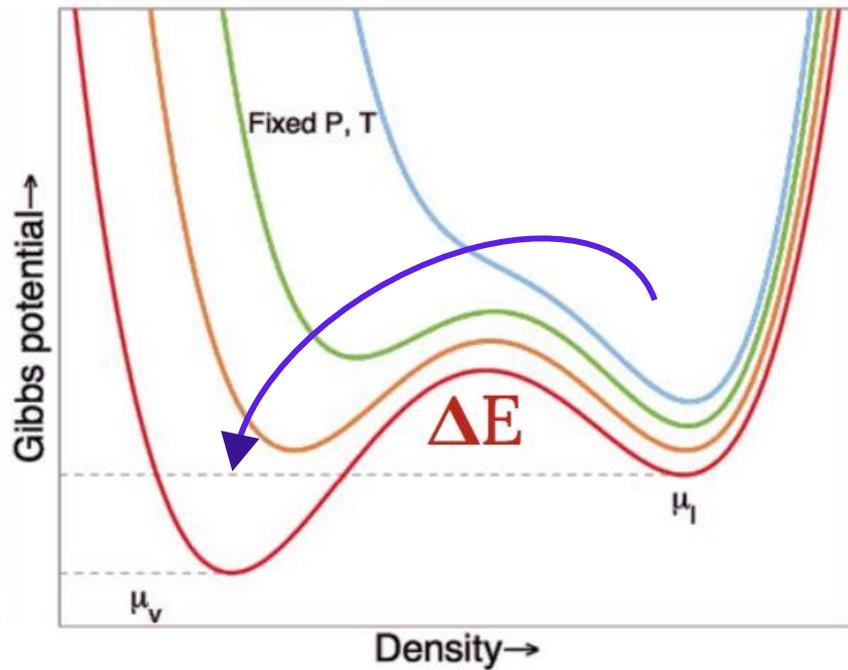
WNPPC 2025



Queen's
UNIVERSITY



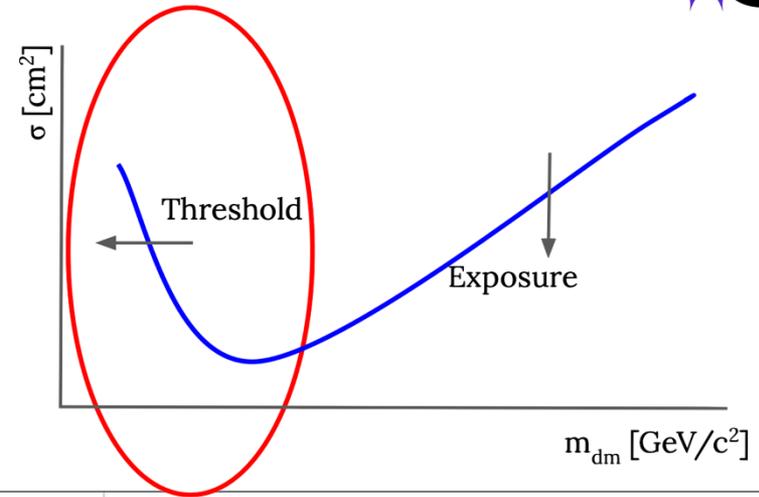
McDonald
Institute



- Threshold detectors which maintain a superheated target fluid
- Sufficient energy deposition results in bubble formation (acoustic/pressure + visual signal)
- Insensitive to β and γ particles

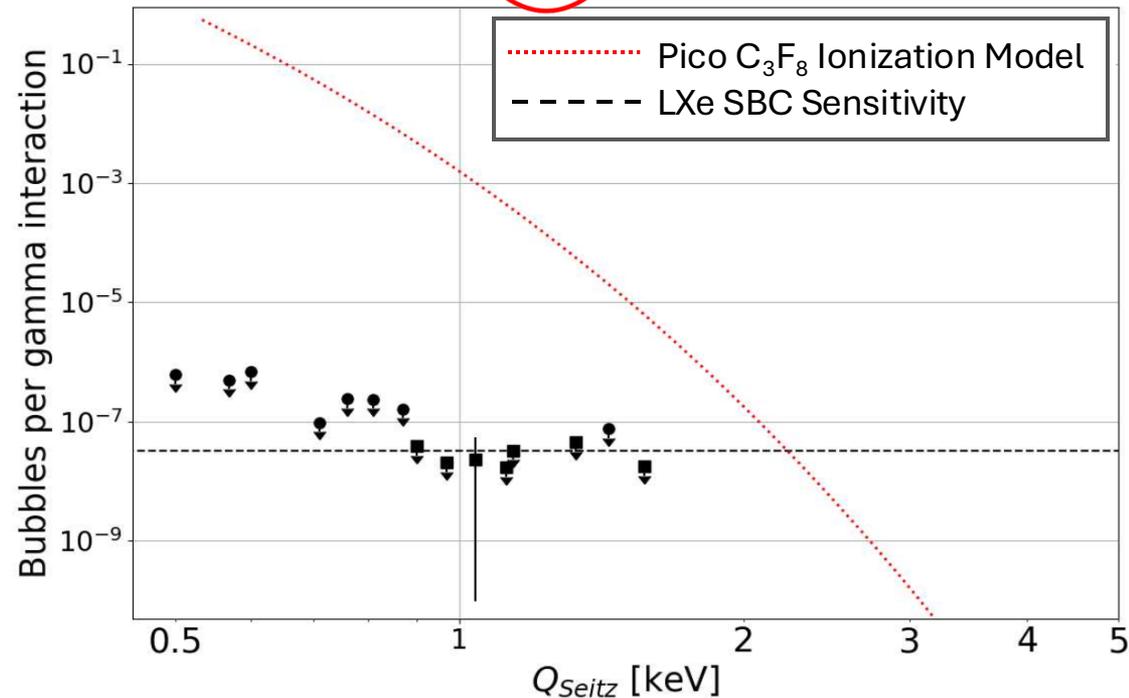
- Freon target:

- Purely threshold detectors (no energy information)
- Becomes sensitive to β and γ at low-thresholds



- Liquid-noble target:

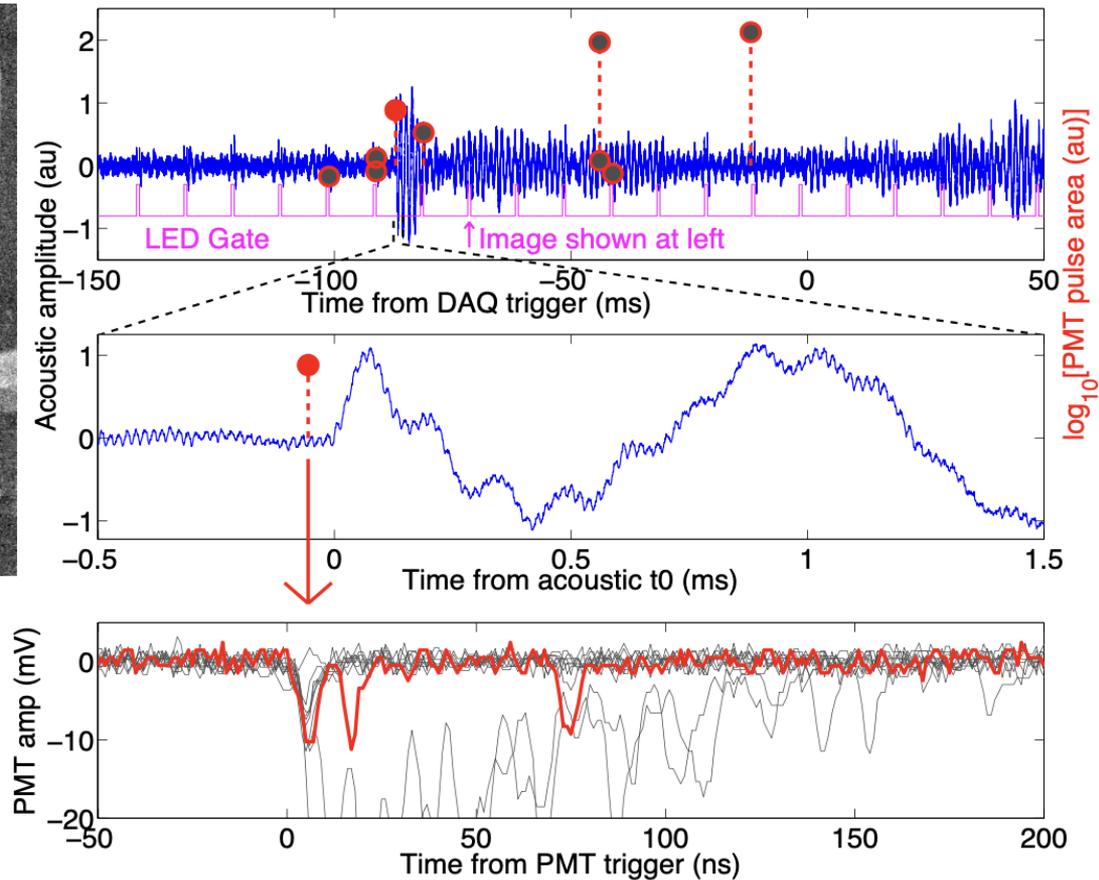
- Scintillation signal
- Improved β and γ suppression at low thresholds



The Scintillating Bubble Chamber



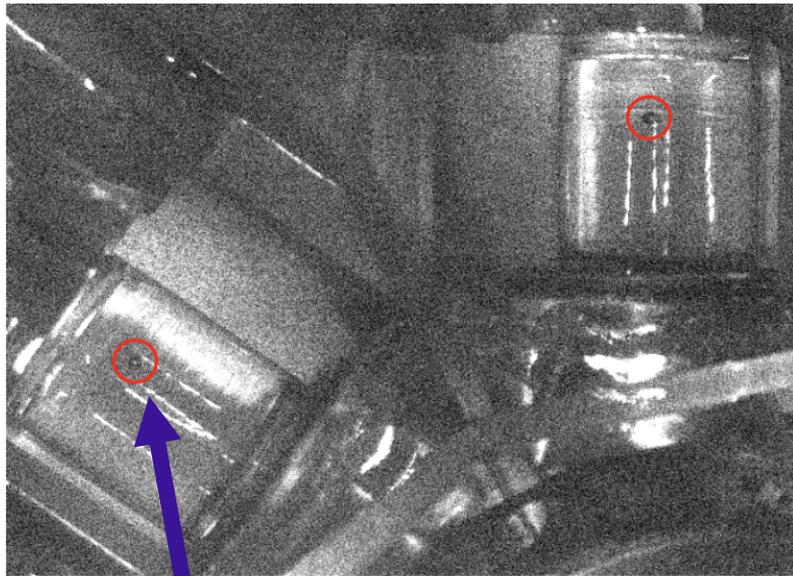
- First demonstration with a 30-g bubble chamber with a liquid xenon target; single event readout for x3 sensory channels



The Scintillating Bubble Chamber



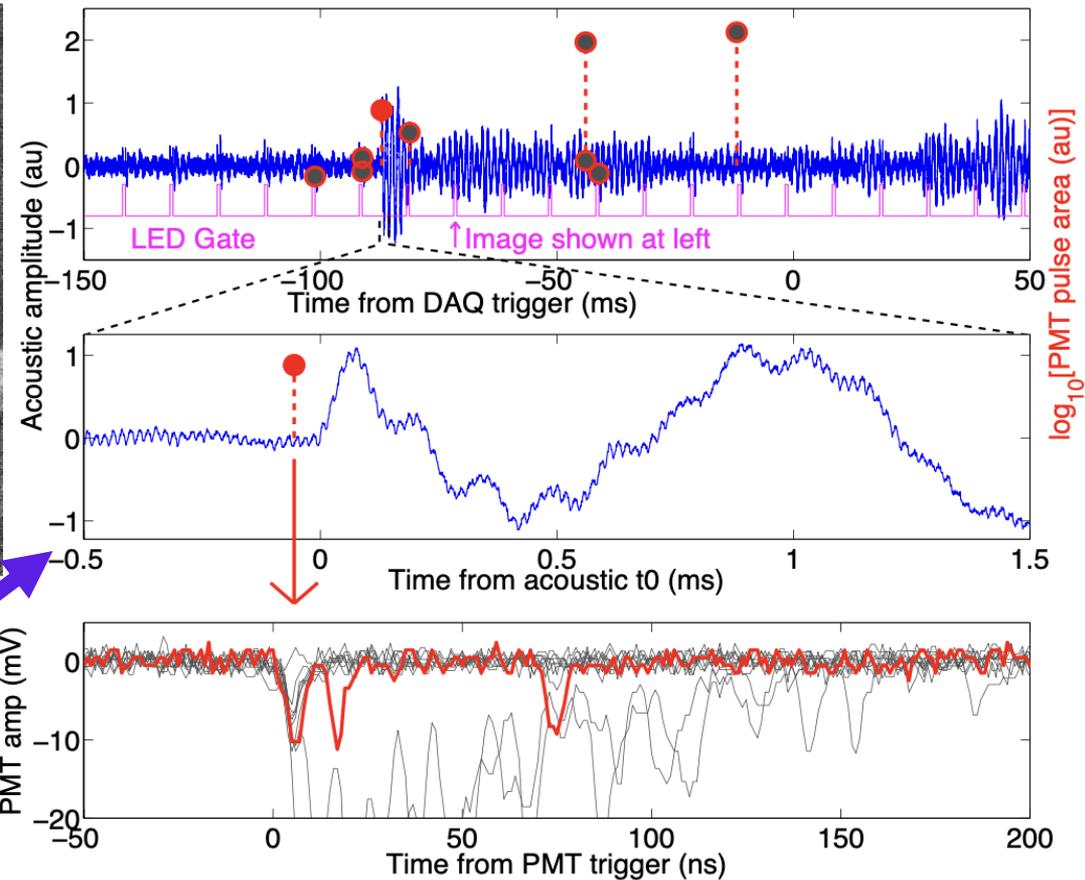
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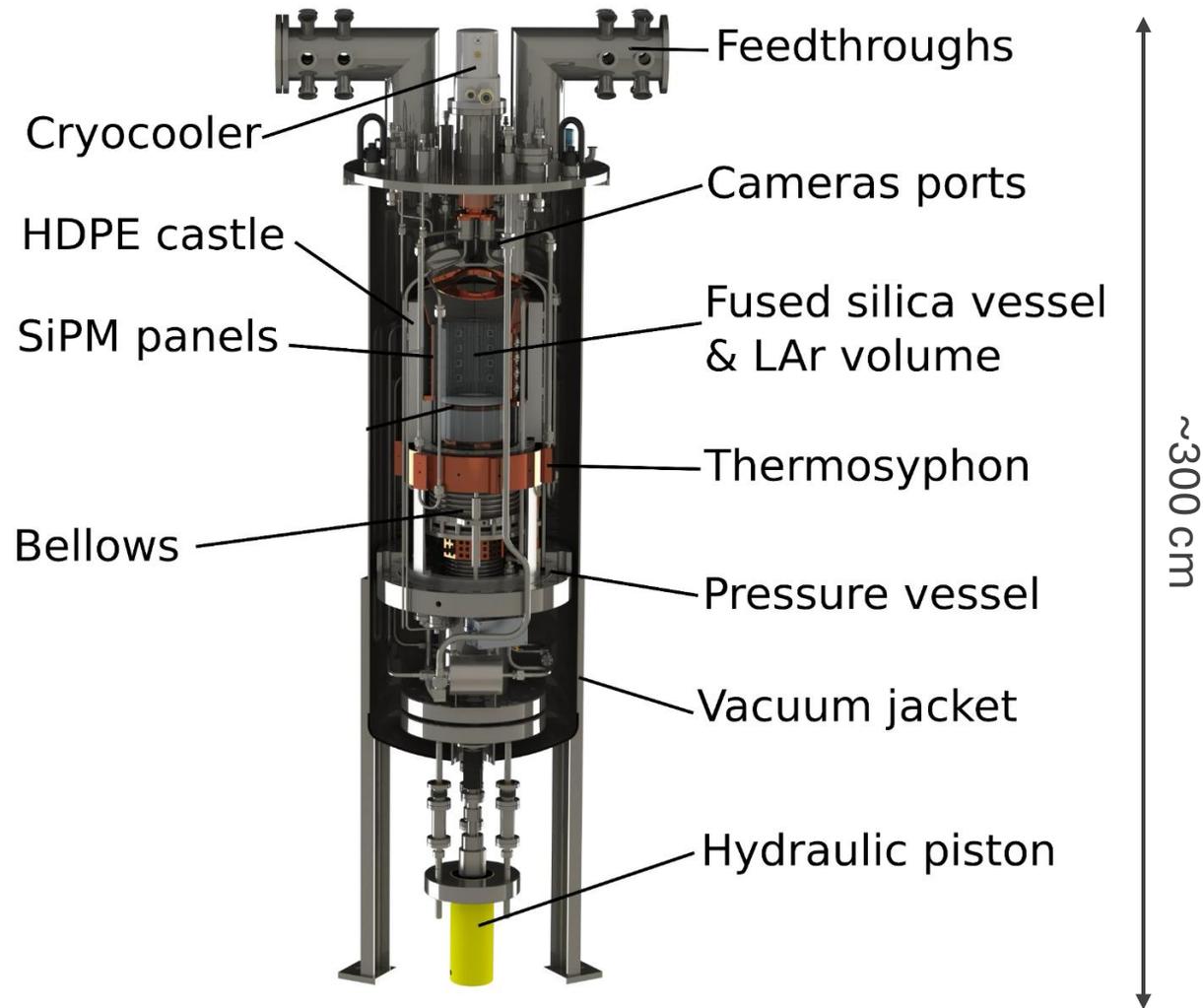
CAMERA
(VISUAL)

ACOUSTIC

SCINTILLATION

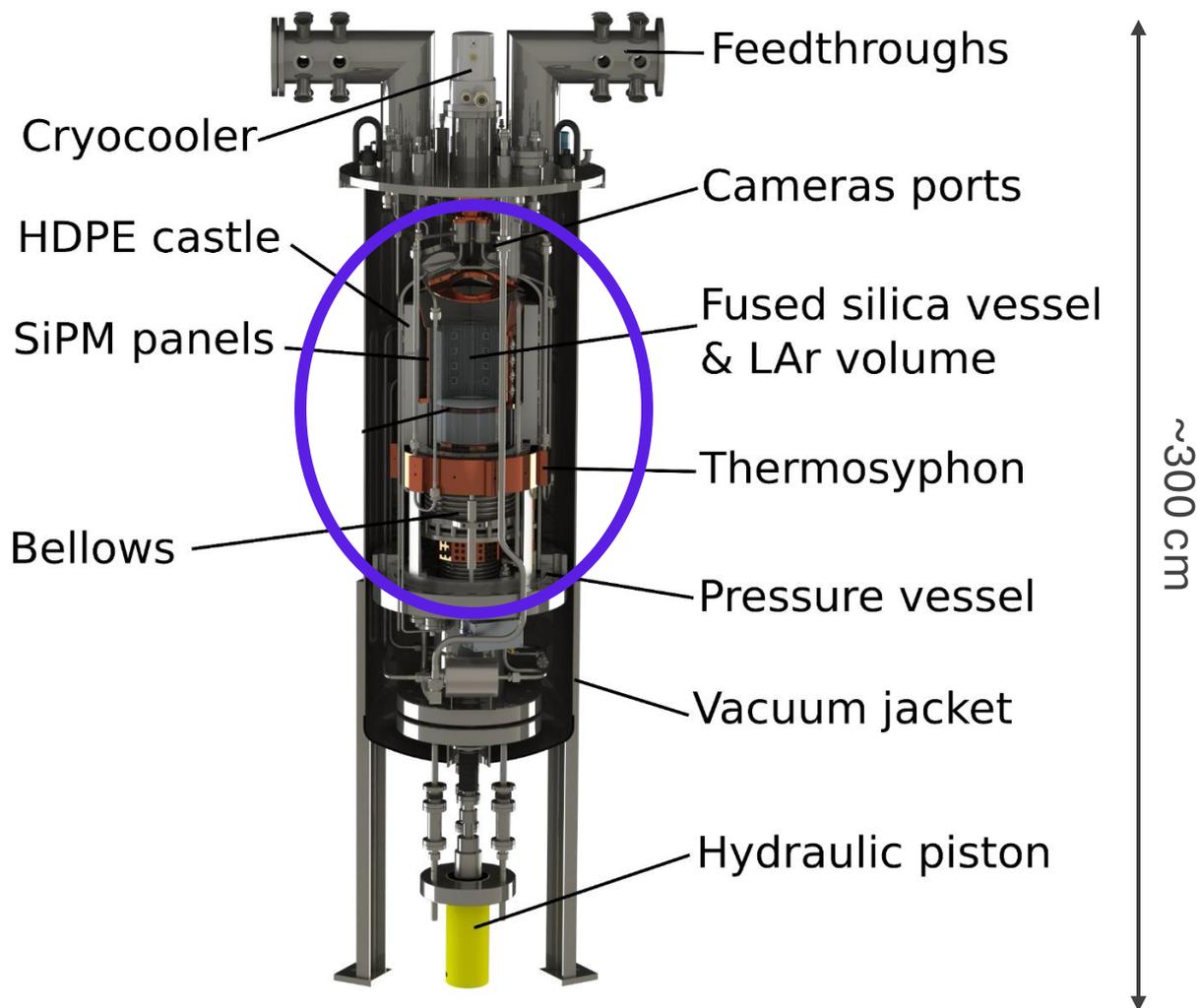


- x2 nearly identical SBC detectors:
 - SBC-LAr10
 - SBC-SNOLAB
- 10 kg LAr doped with Xe
- 100 eV nuclear recoil threshold
- Chamber operated at 130 K and 30 psi



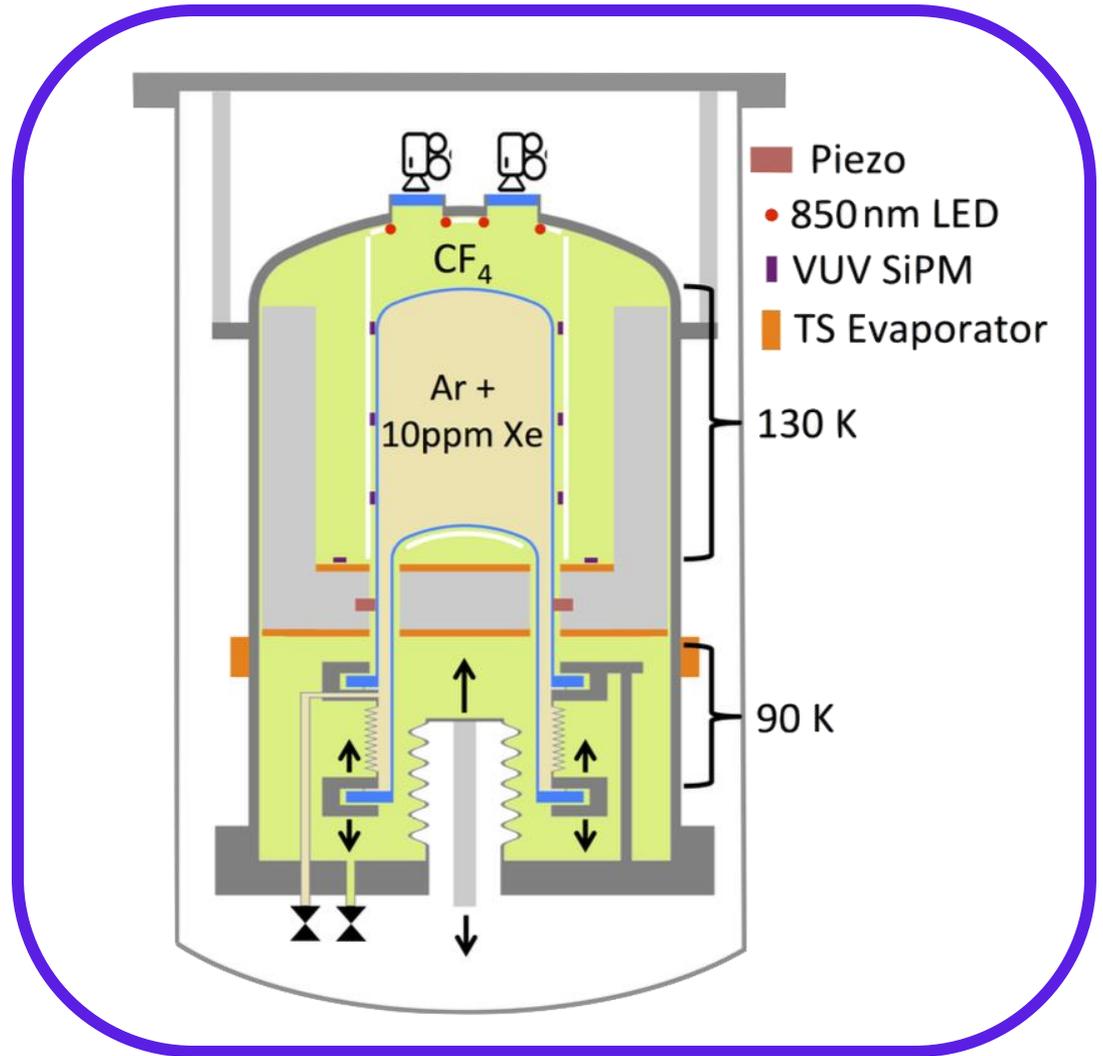
SBC-LAr10 Render of Inner/Outer Vessel

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SBC-LAr10 Render of Inner/Outer Vessel

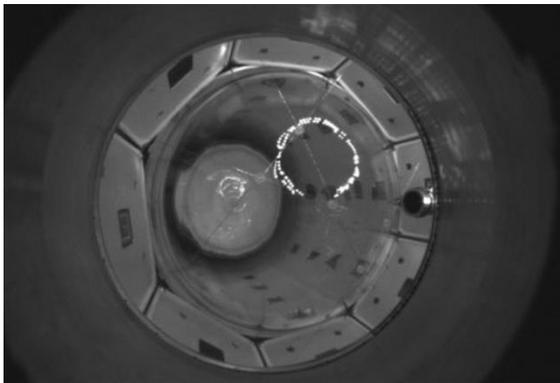
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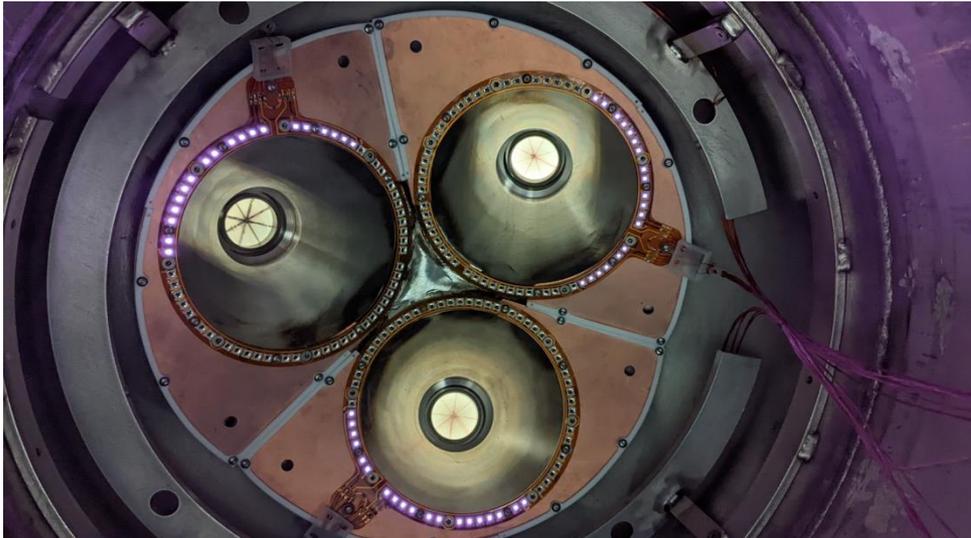
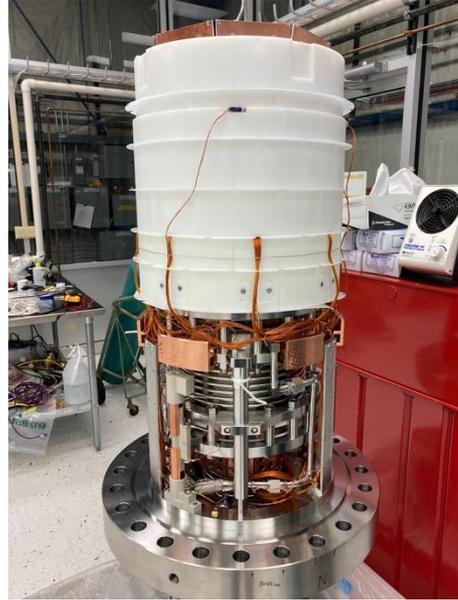


Inner Chamber Schematic



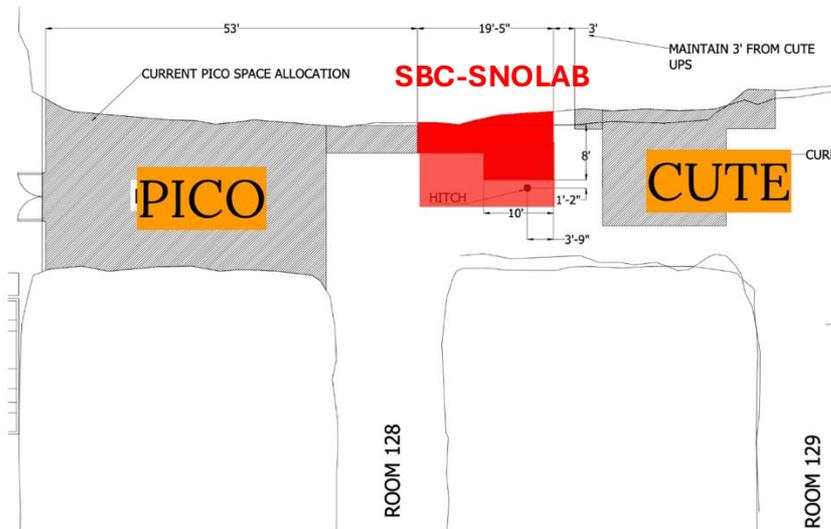
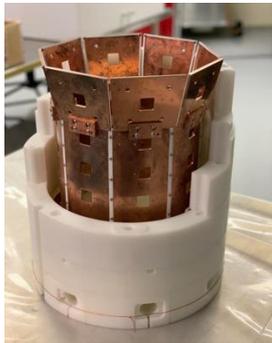
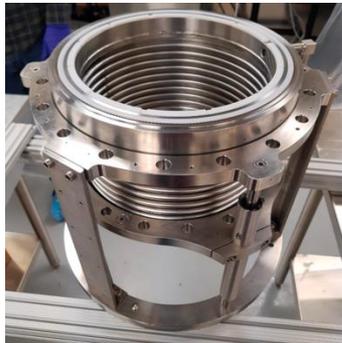
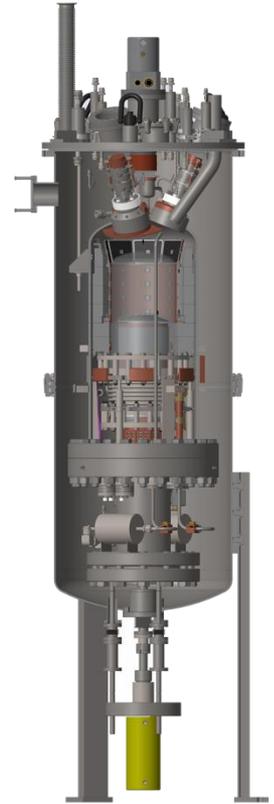
- First of two identical detectors being developed simultaneously; being commissioned right now!
- **Physics goals:**
 - Detector gamma calibration
 - Development prototyping for SNOLAB chamber

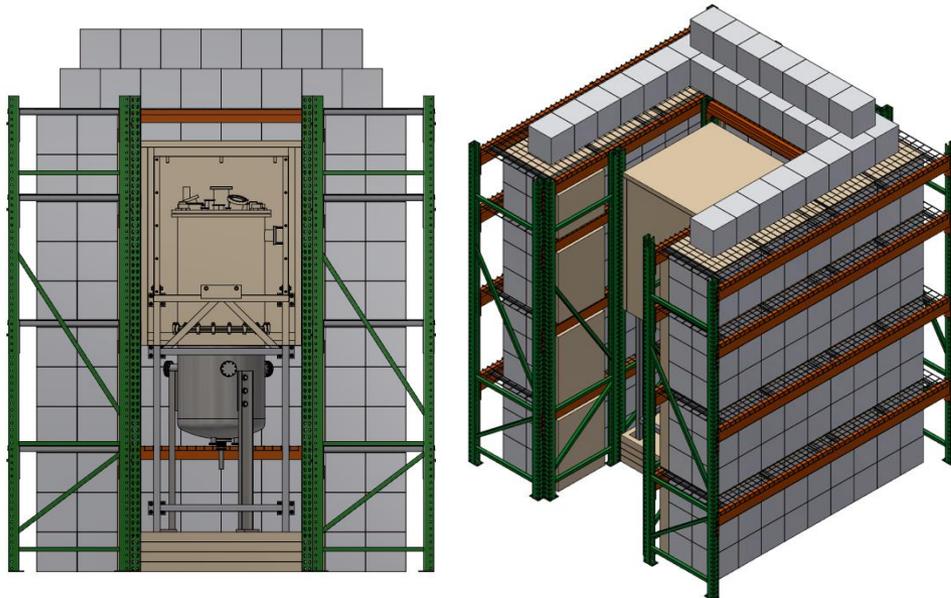
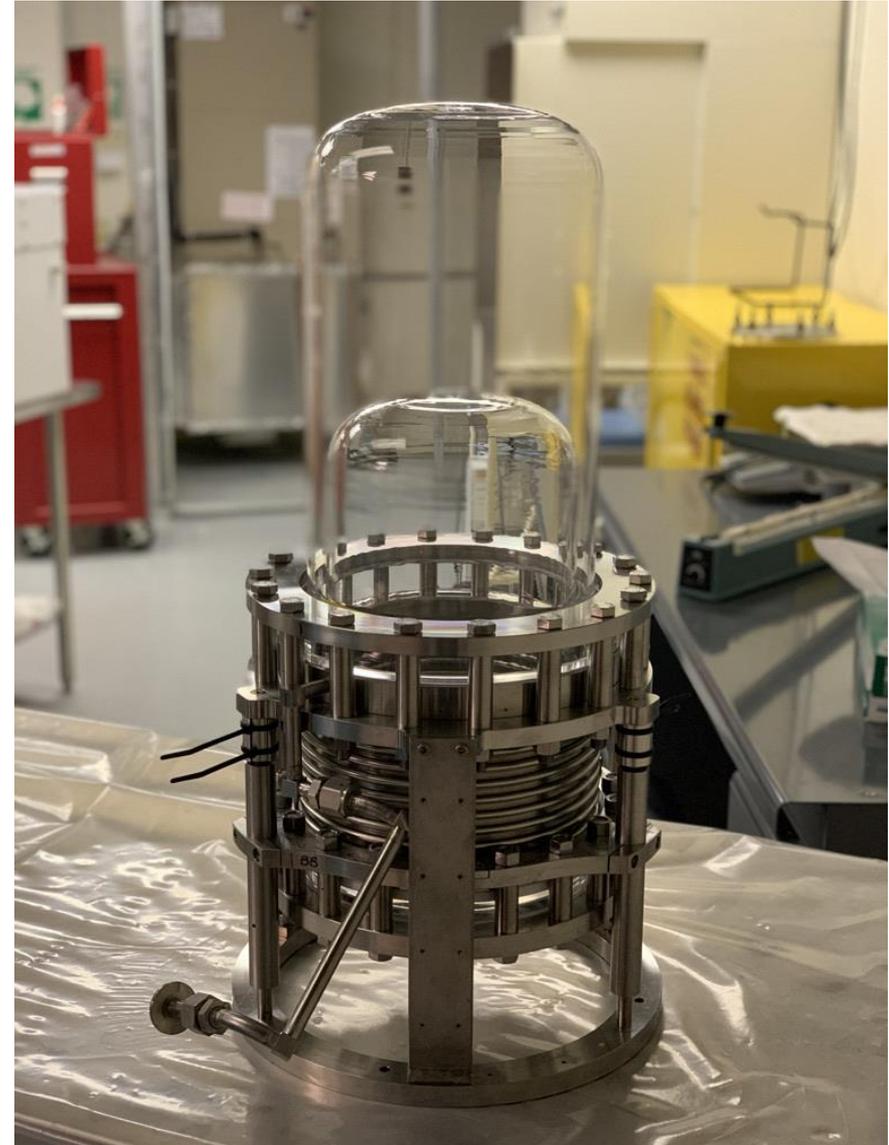
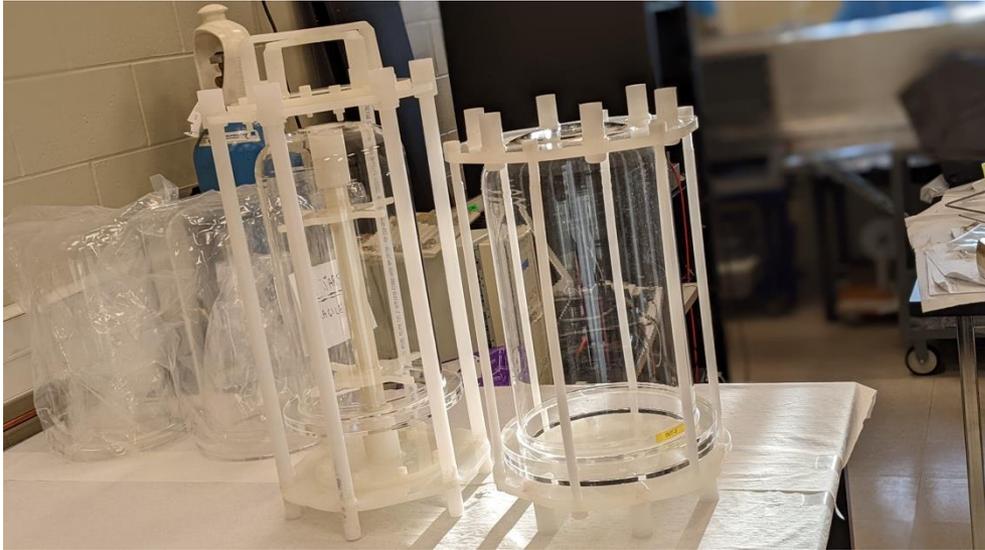






- Second detector, currently being developed at Queen's University
- **Physics goals:**
 - WIMP / particle dark matter search in low-background environment
 - Improved shielding and background mitigation (see talk: Gary Sweeney)



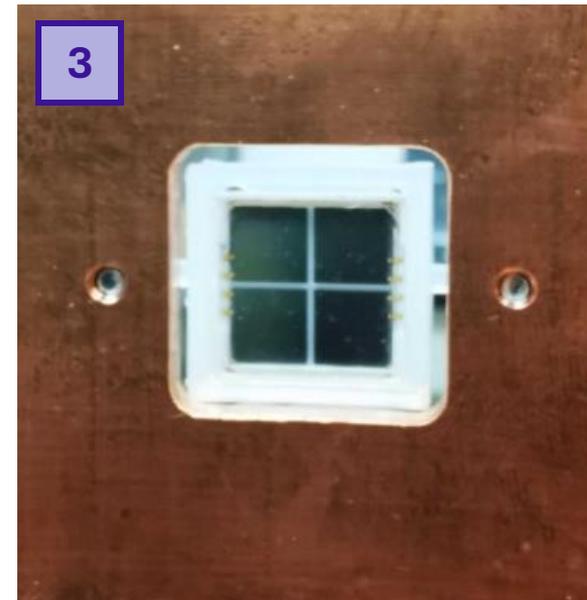
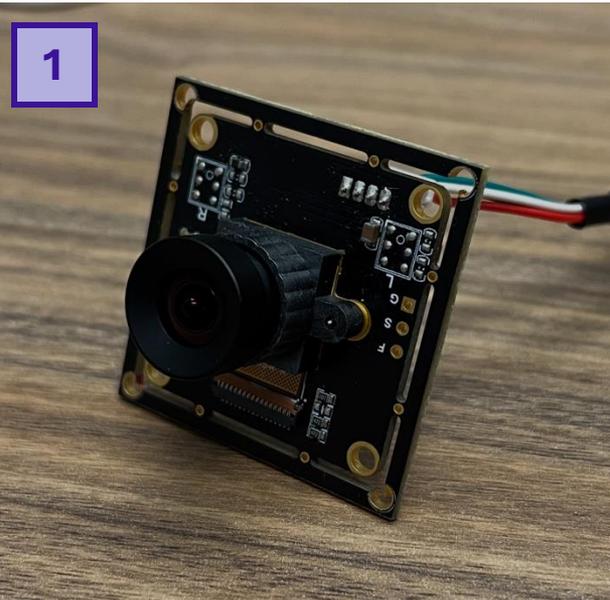


- Signal reconstruction includes streaming three types of data channels:

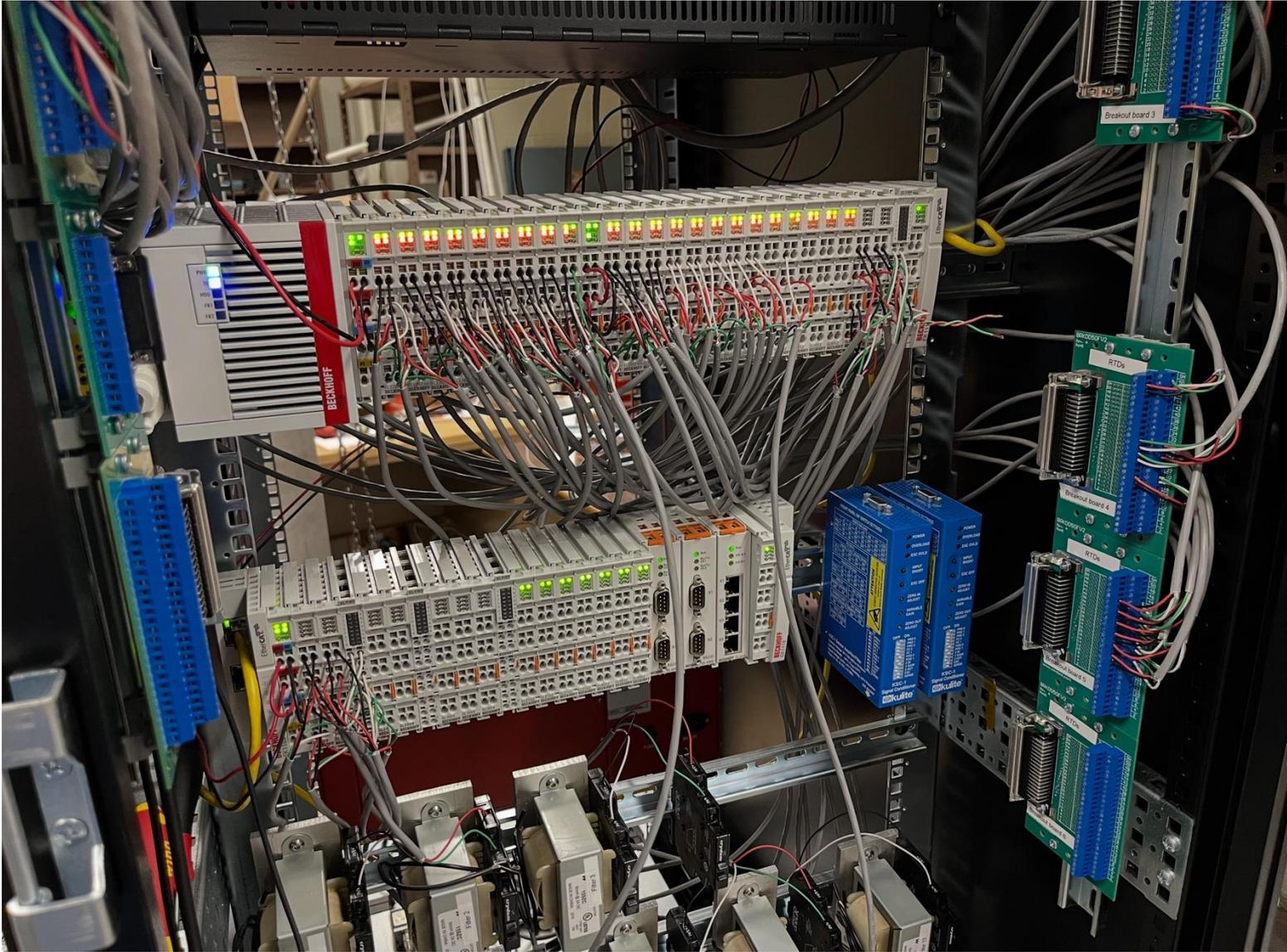
1. Positional Reconstruction: x3 Arducam Cameras

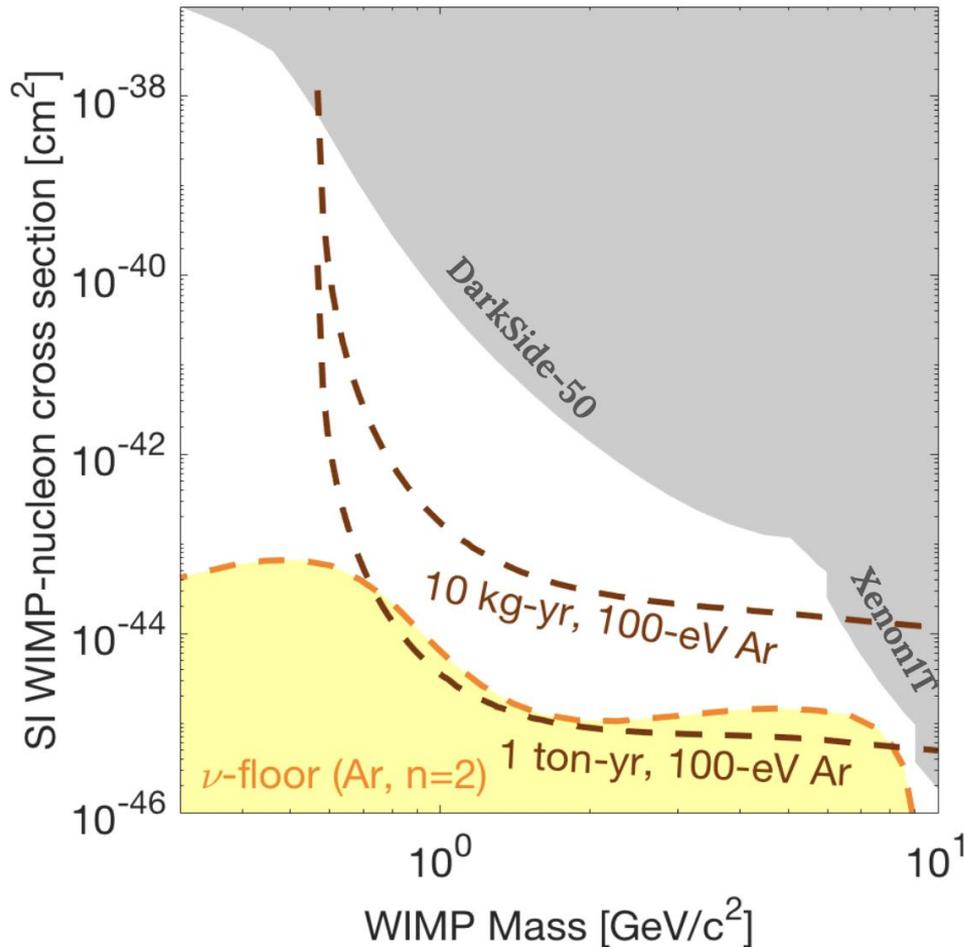
2. Acoustic Signal: x8 Piezo Transducers

3. Scintillation Signal: x48 FBK SiPMs



- Event timing blueprint laid out in LXe test-chamber methodology (slide 4)
- Sensors and triggers operated via an electronics cabinet containing power supplies, DAQs, and readout systems including PLC-based PC (Beckhoff)





- Fermilab chamber currently being commissioned: expect data this year!
- SNOLAB chamber work ongoing; above-ground assembly to begin soon
- Plans for scaling up to a tonne-scale detector post-SNOLAB with potential for ν -floor sensitivity



Thank You for Listening!

