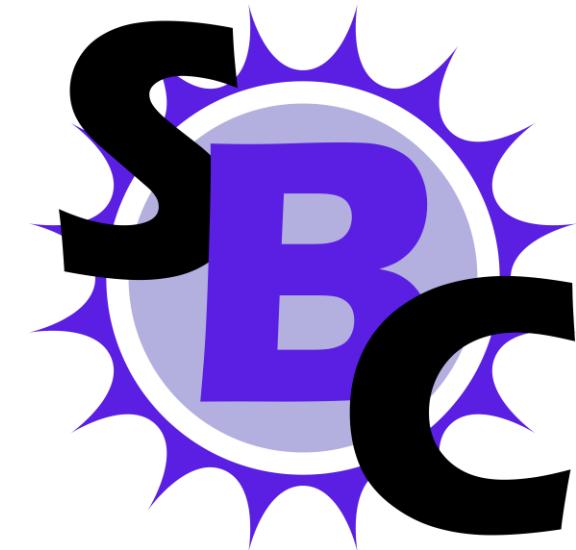




Arthur B. McDonald  
Canadian Astroparticle Physics Research Institute

# Update on the Scintillating Bubble Chamber (SBC) collaboration and SBC-LAr10

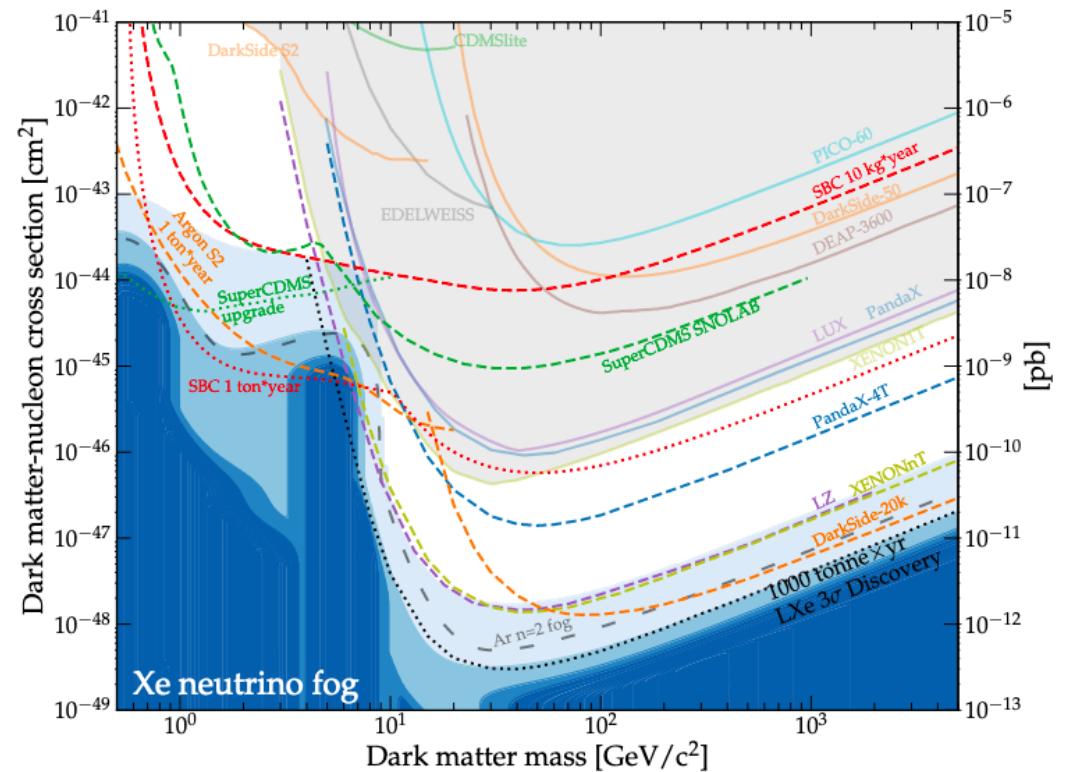
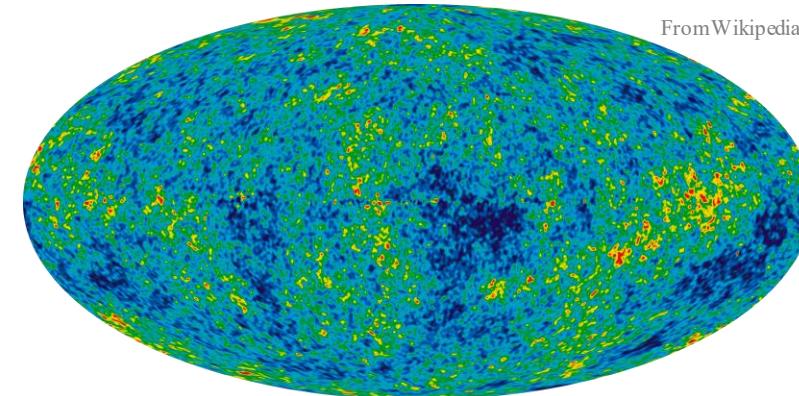


Hector Hawley Herrera on behalf of SBC

Queen's University, Department of Physics,  
Engineering Physics & Astronomy, Kingston, ON, Canada

# Dark Matter Motivation

- It exists: CMB, galaxy rotation curves, and many others.
- WIMP models ( $10\text{-}100$  GeV/c $^2$ ) favorable parameter space has been explored.
- ADM models  $O(\text{GeV}/c^2)$  require low thresholds and new technologies with better background reduction techniques.



SNOWMASS 2021

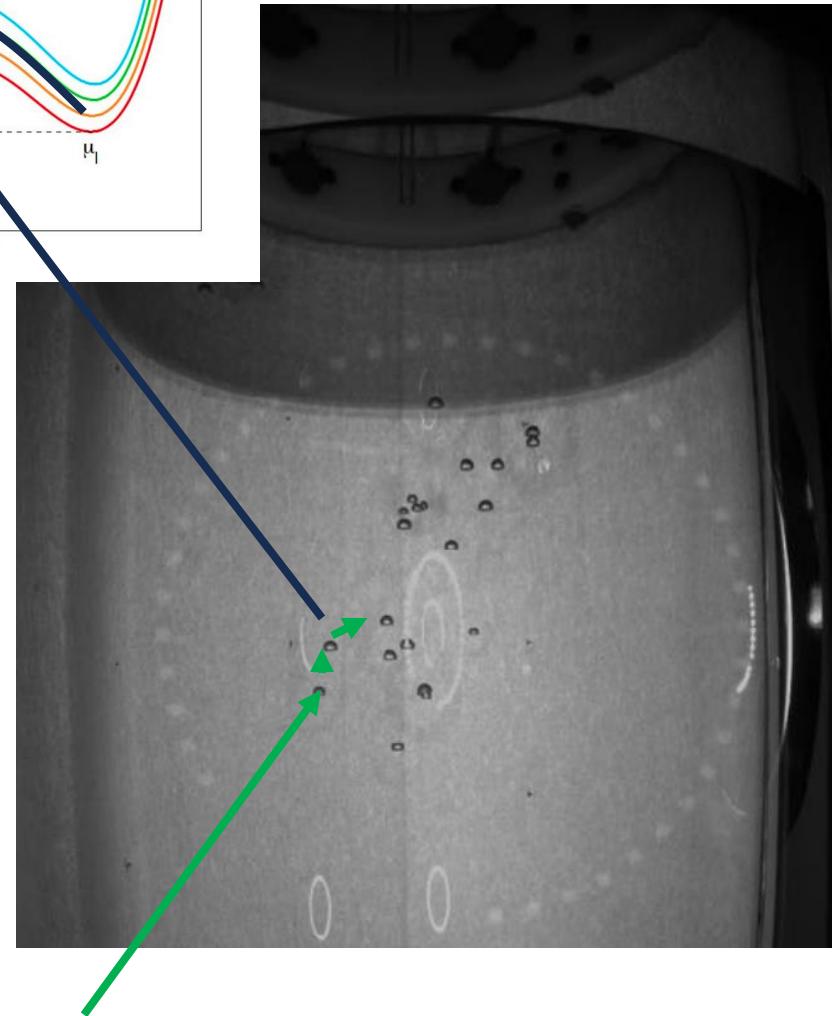
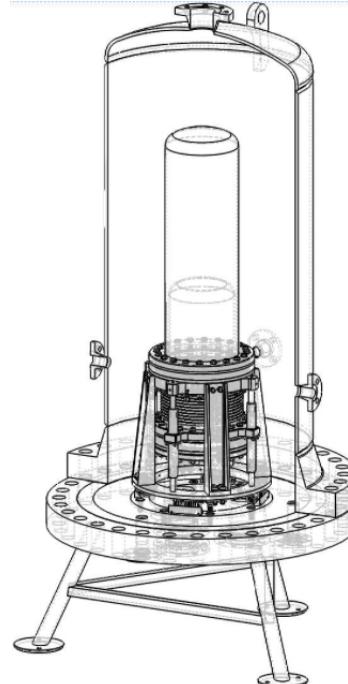
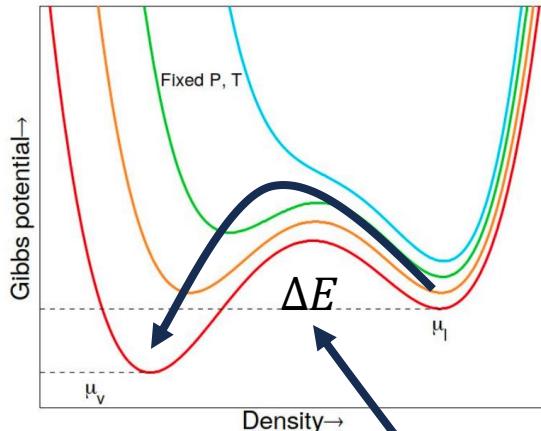
[arXiv:2203.08084](https://arxiv.org/abs/2203.08084)

# Bubble Chambers

A nuclear-recoil generates a bubble in a supercritical fluid

- Great electron-recoils (ER) suppression
- Low nuclear-recoil (NR) threshold and great NR efficiencies
- PICO: C<sub>3</sub>F<sub>8</sub> supercritical fluid, cameras, and piezos
- **No event-by-event energy information**

See C. Moore talk: “**PICO-40L Bubble Chamber Status and First Results**” on Aug 30<sup>th</sup> (Wednesday)

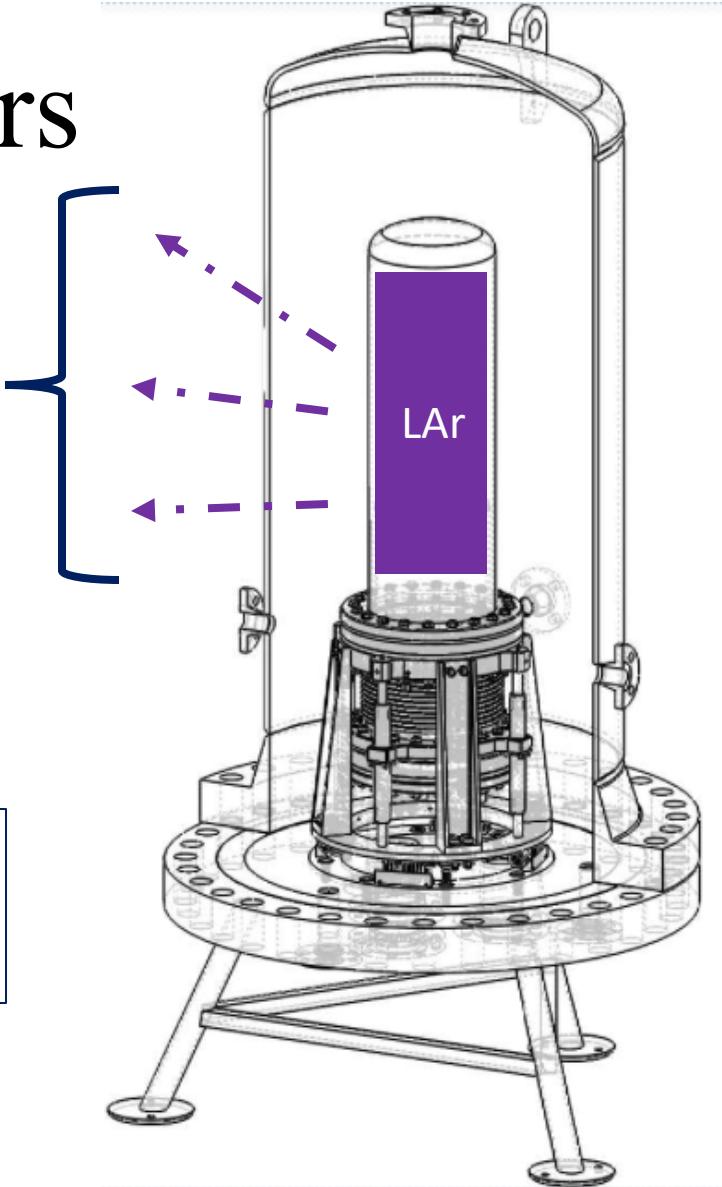
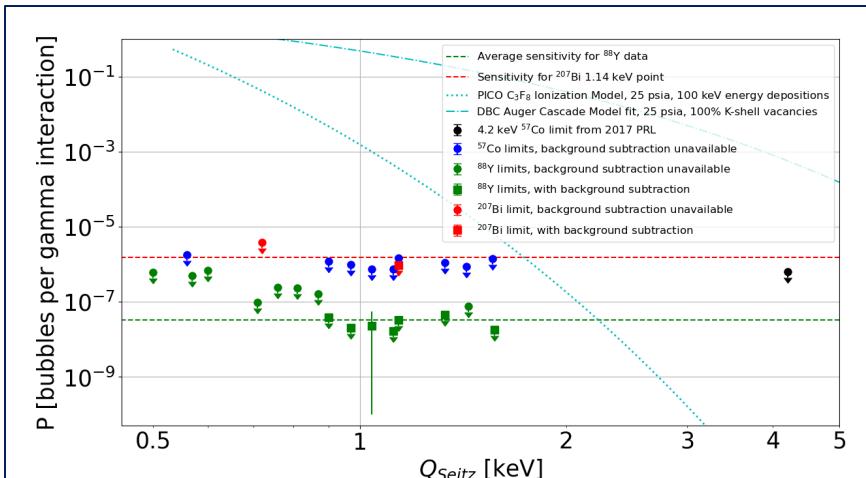


# Scintillation in Bubble Chambers

**Liquid noble element intrinsic lower energy threshold** – lack of molecular degrees of freedom for recoiling electrons to deposit heat in the system.

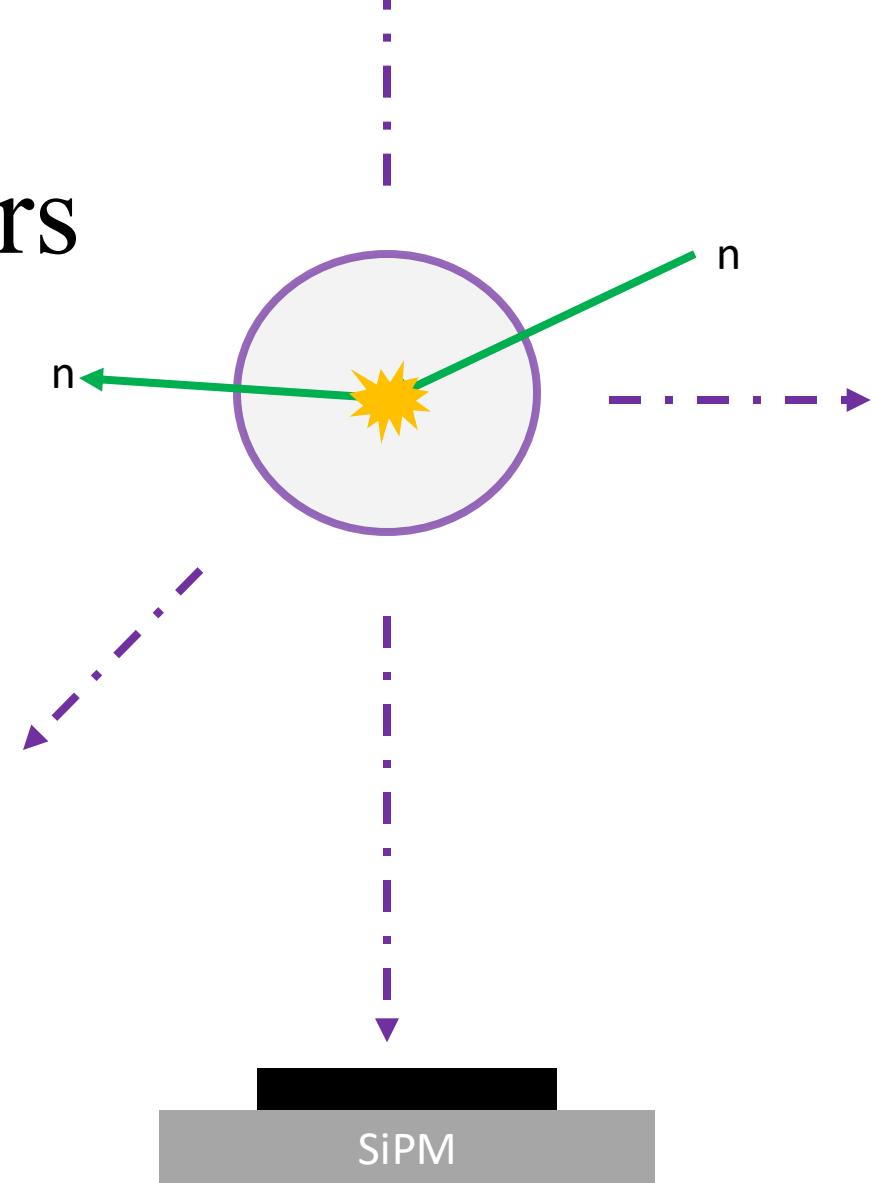
Scintillation channel = more background control possibilities.

Yet to see evidence of ER in LXe down to 500eV

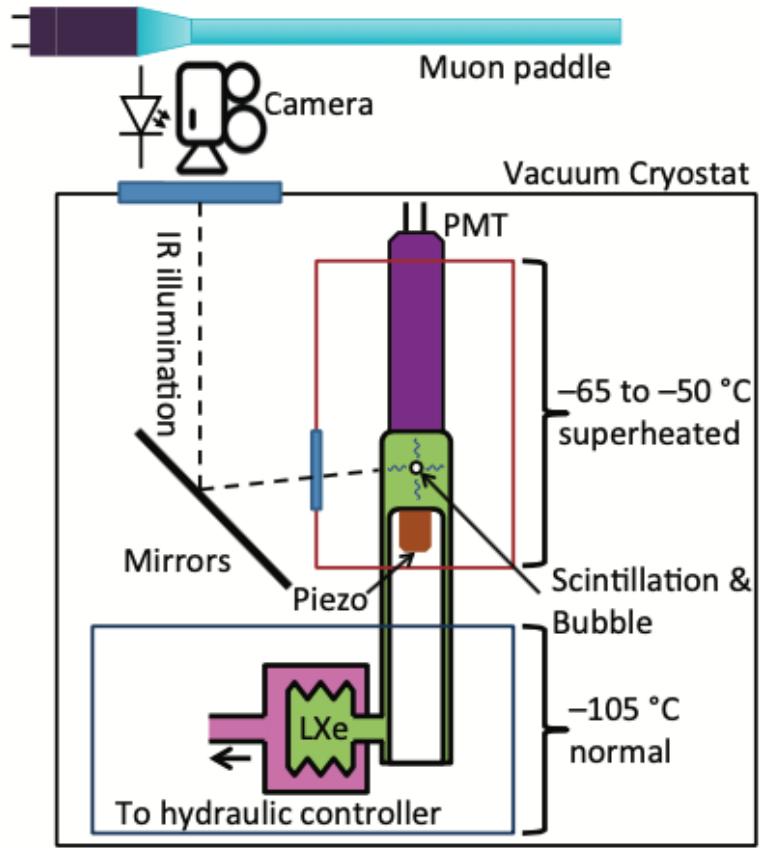


# Scintillation in Bubble Chambers

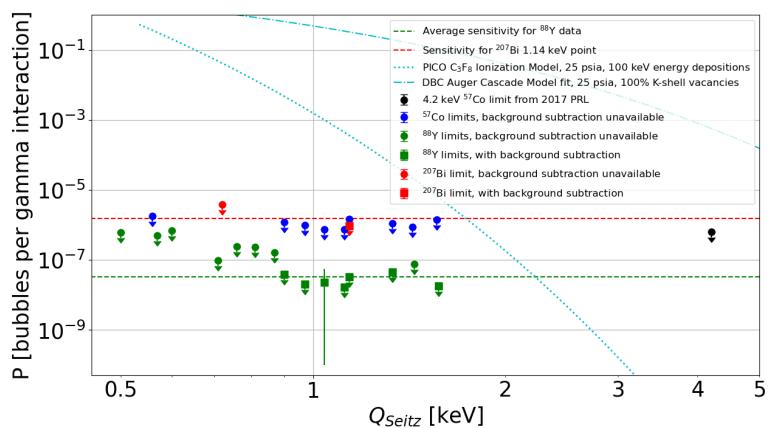
- Dark matter searches – veto by energy (# of photons). Ideally, 1 pe threshold.
- **Scintillation collection system goal is to collect photons not necessary to do energy reconstruction** – eases the readout electronic and optical design and collection efficiency is desired but not required.



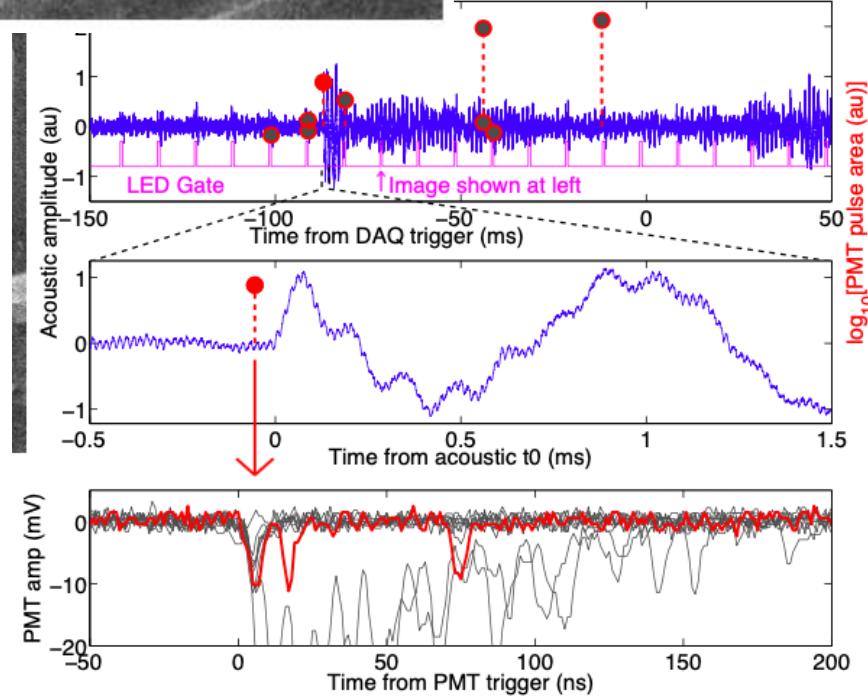
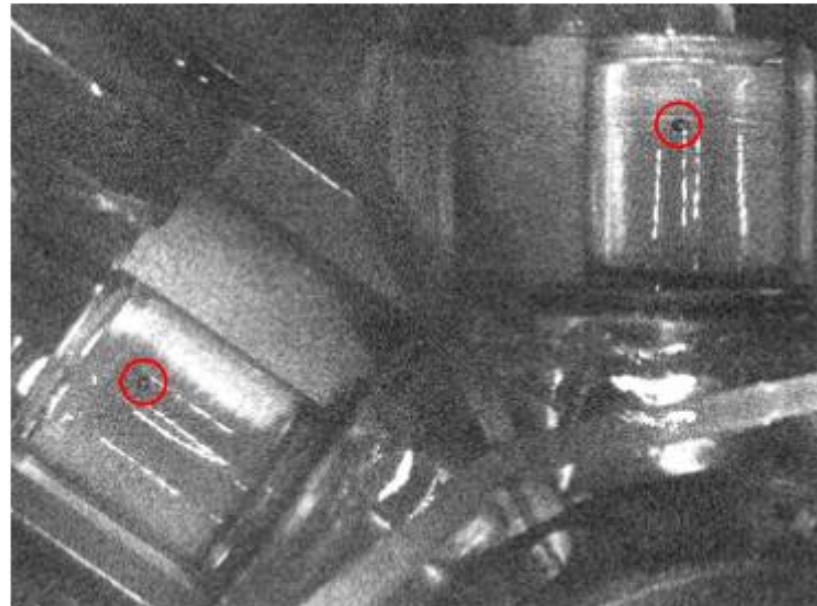
# NU LXe Chamber



Proven the concept of the  
scintillating bubble chamber

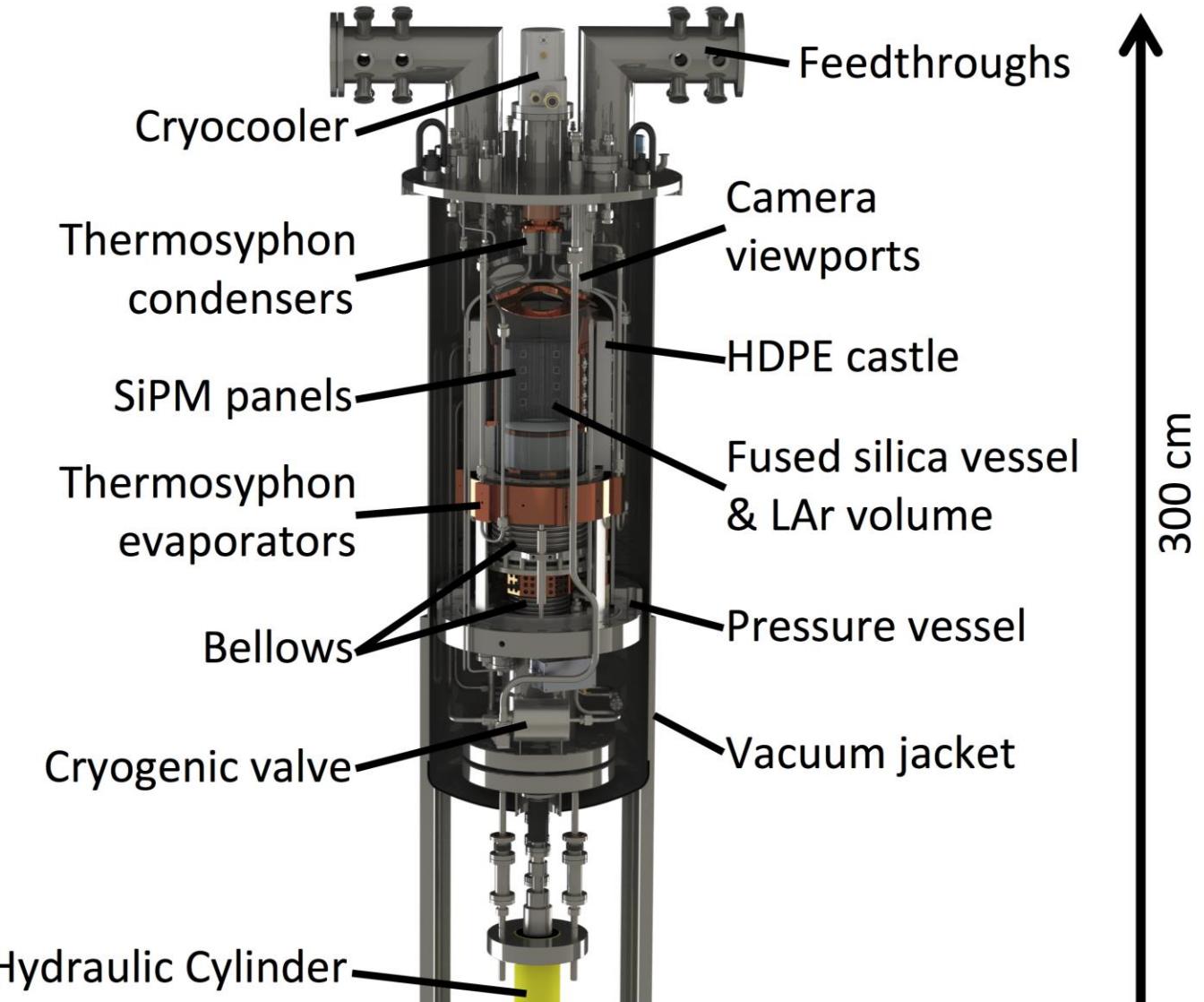


D. Baxter et al Phys. Rev. Lett. 2017 **118** 2313-1



# SBC-LAr10

- Two detectors:
  - SBC-LAr10 @ Fermilab (engineering, calibration, CE $\nu$ NS)
  - SBC-LAr10 @ SNOLAB (dark matter search)
- 10 kg LAr + (10-100 ppm) Xe as a wavelength shifter
- targeting 100 eV NR threshold
- Cold region ~90 K,  
Warm region ~130 K
- Expanded ~30 psi,  
Compressed ~200 psi

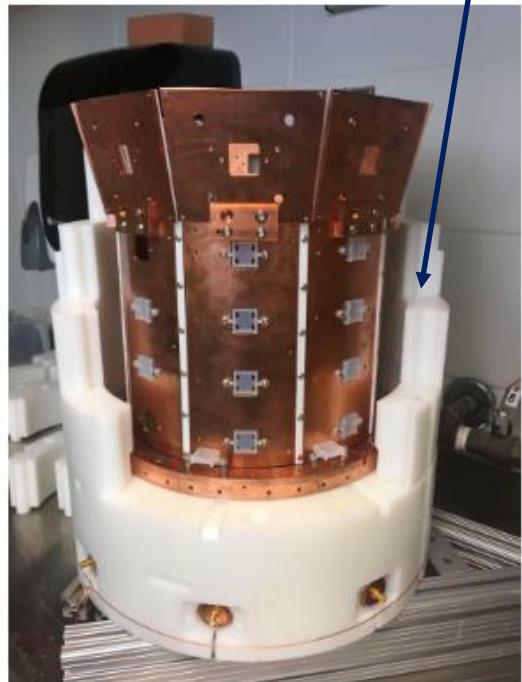


[SBC white paper: arXiv:2207.12400](https://arxiv.org/abs/2207.12400)

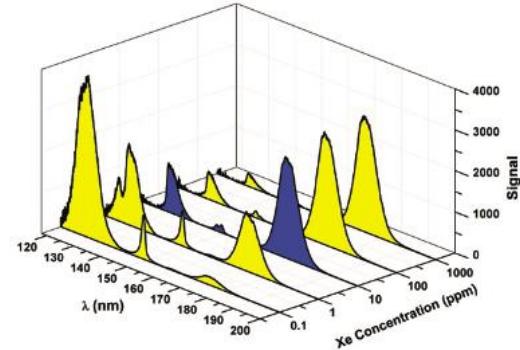
# Inner Assembly

A sealed cryogenic chamber with LCF<sub>4</sub> as the hydraulic fluid.

The supercritical LAr insulated from the colder LCF<sub>4</sub> with a tower of HDPE



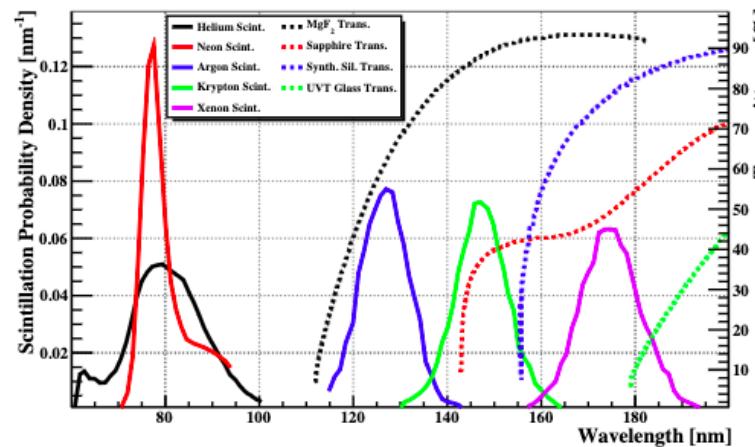
# Scintillation system



A. Neumeier *et al* 2015 EPL 109 12001



Quartz blocks LAr scintillation. The addition of the Xe waveshifts aids in the transmission and collection.

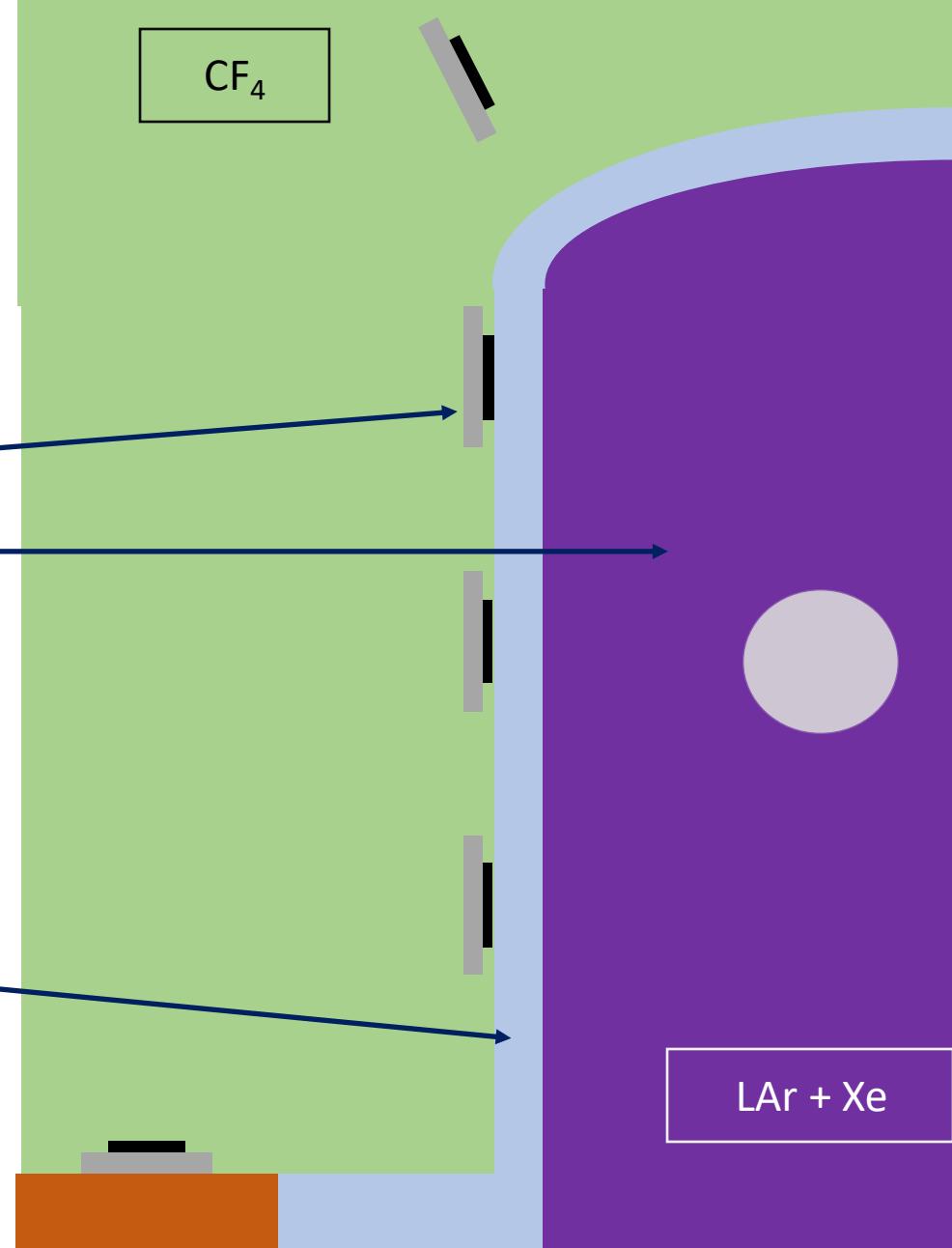


V.M. Gehman *et al* 2011 NIM 654 116-121



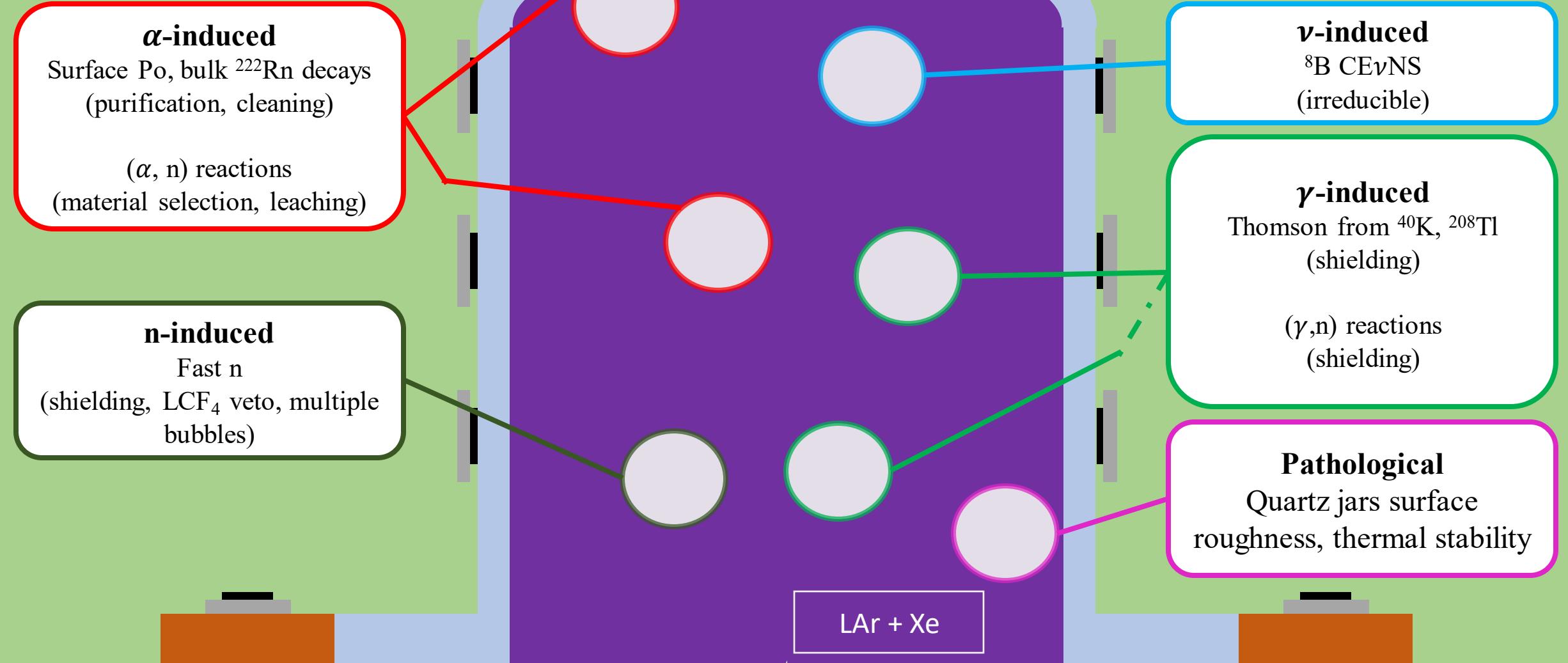
34 VUV4 for Fermilab.  
FBK VUV for SBC for radiopurity.

CF<sub>4</sub>

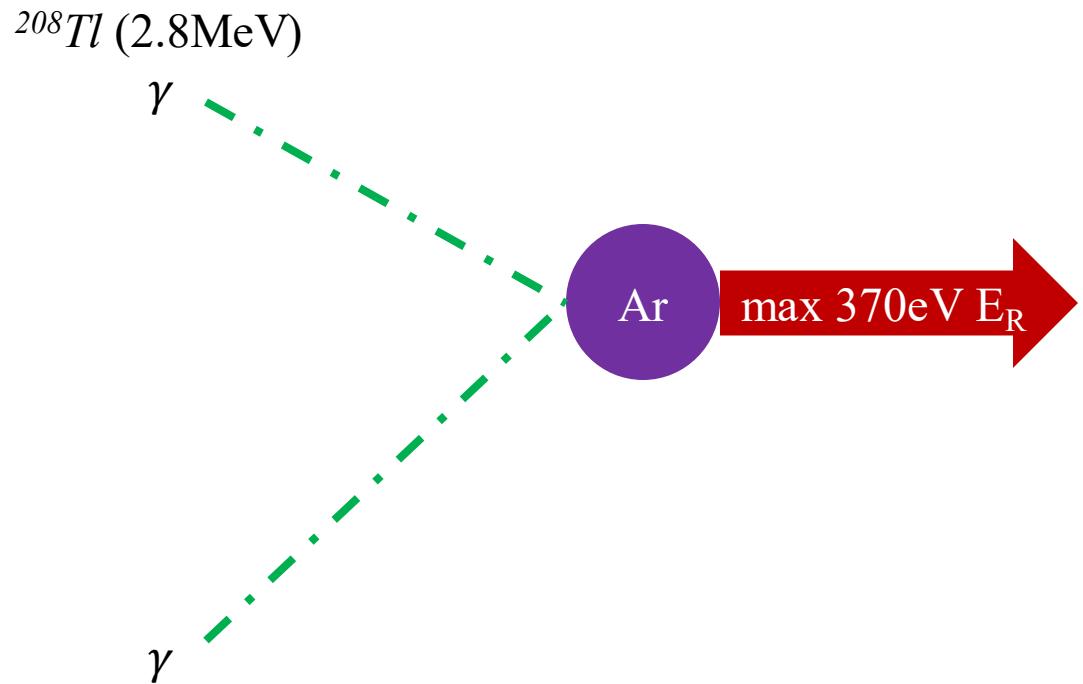


LAr + Xe

# Backgrounds



# Calibration



## NR Calibration

- Photoneutron sources (1k-10keV NR)  
 $^{124}\text{Se}$ -Be,  $^{207}\text{Bi}$ -Be
- Thomson Scattering ( $\sim 100\text{eV}$ )  
 $^{208}\text{Tl}$
- Argon neutron capture ( $< 100\text{eV}$ )

# Current status



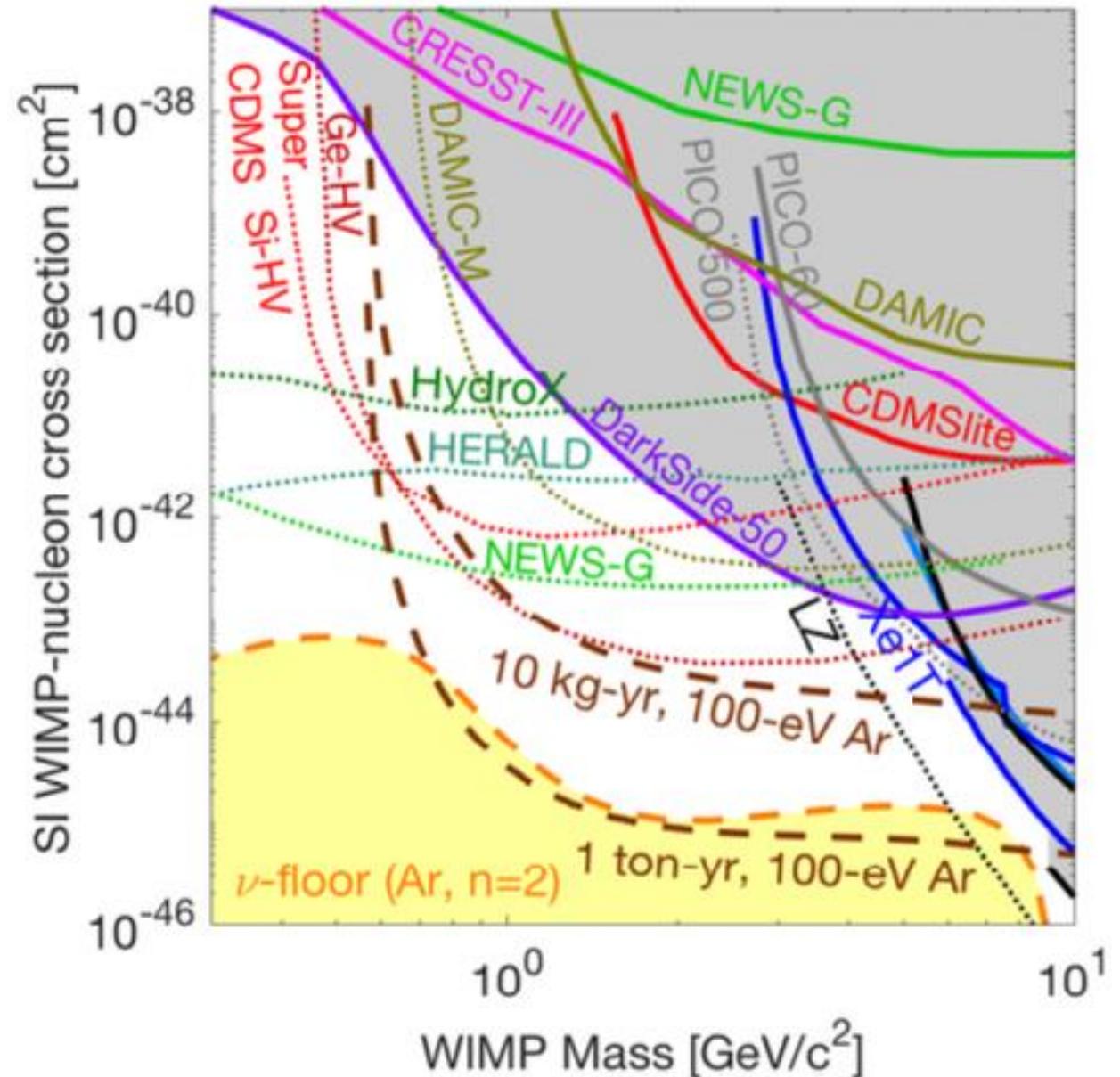
Fermilab SBC-LAr10 under construction at Fermilab: inner assembly almost complete. Study ER suppression with mCi gamma sources. Finish construction end of fall.

Currently working on the screening and design of the SNOLAB SBC-LAr10 chamber. Construction O(2024)

Open to new collaborators!

# Physics Goals

- **SBC-LAr10:** Study the NR in the region of interest (0.1-10)keV
- **SBC-LAr10:** (100-300)eV threshold
- **SBC** goal reach a ton-year at SNOLAB to reach the Ar neutrino fog.
- CEvNS potential see: L. J. Flores and E. Peinado, 2021, Phys. Rev. D **103**, L091301





Northwestern  
University





