

The SBC Dark Matter Experiment and Calibration Plan

APS Global Summit
18 March 2026



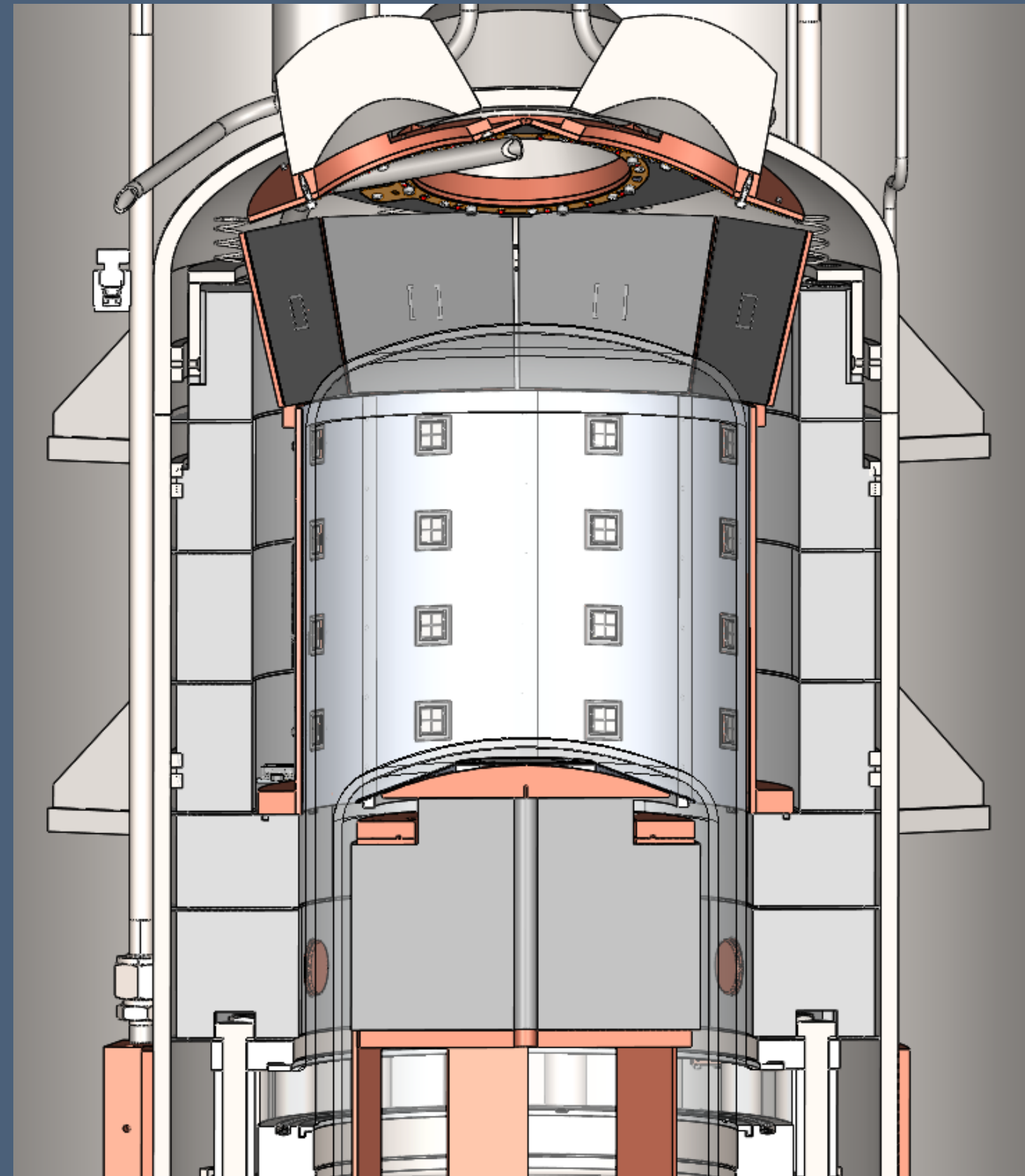
Drexel University
Department of
Physics
College of Arts and Sciences



Daniel Pyda, on behalf of the SBC Collaboration

Scintillating Bubble Chamber

- WIMP DM detection
- 10kg LAr
- ~100 eV NR threshold
 - ER blindness



1. Calibration:
SBC-LAr10
FNAL (~100m)

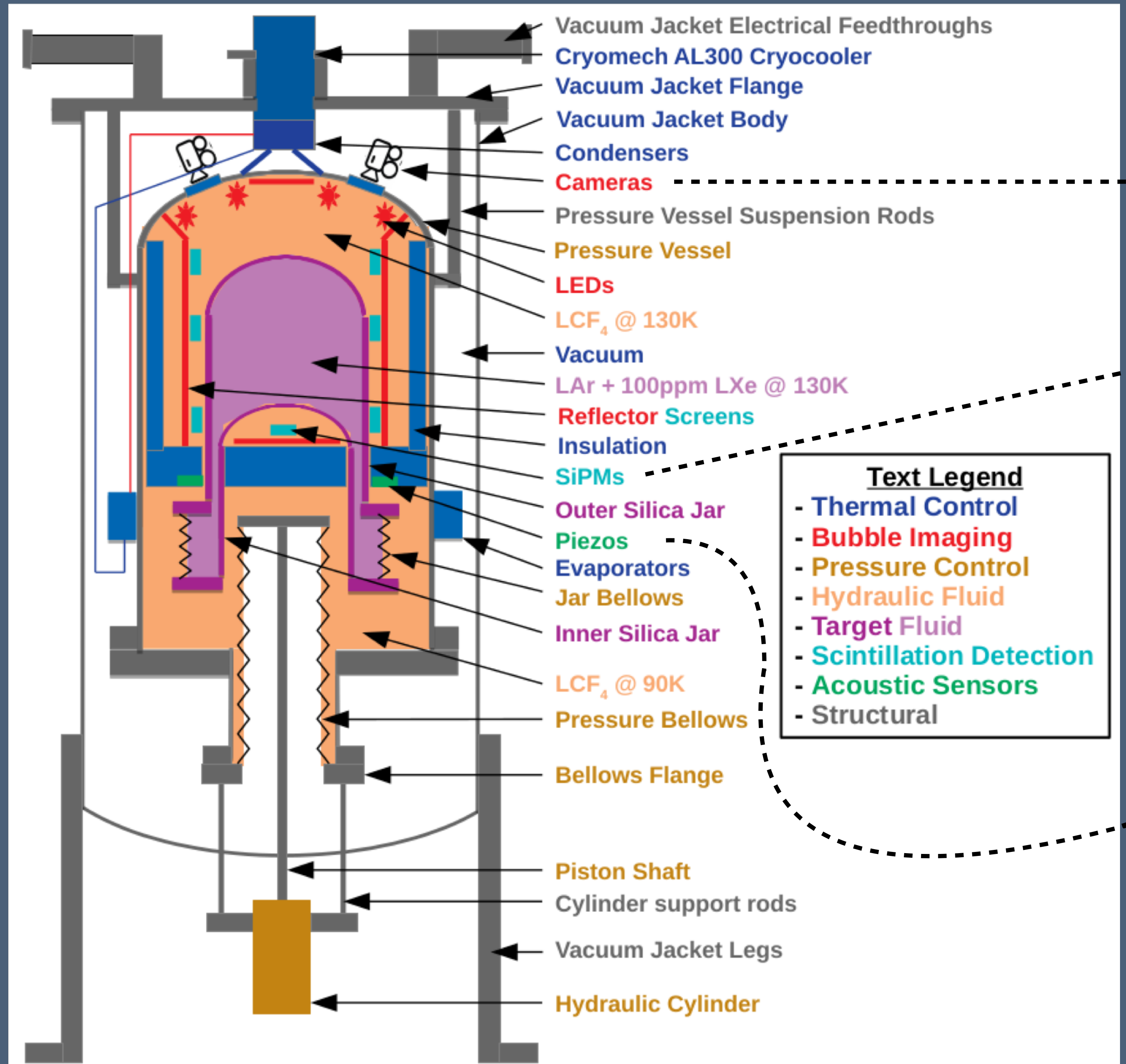
★ We are here

2. DM Search:
SBC-SNOLAB
SNOLAB (~2km)

~1-2 years

3. Neutrino Study:
Future detector
Reactor site

Future Physics



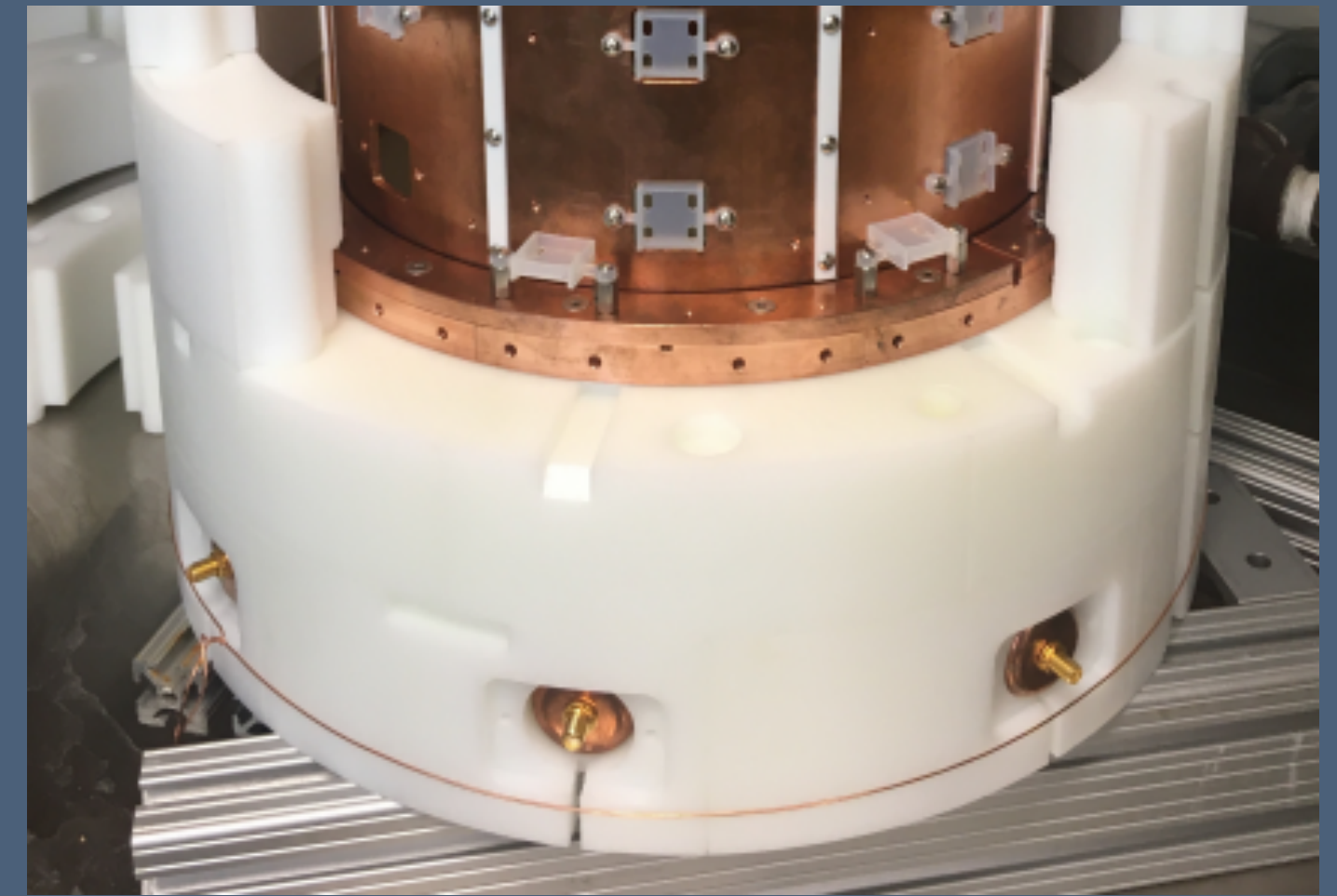
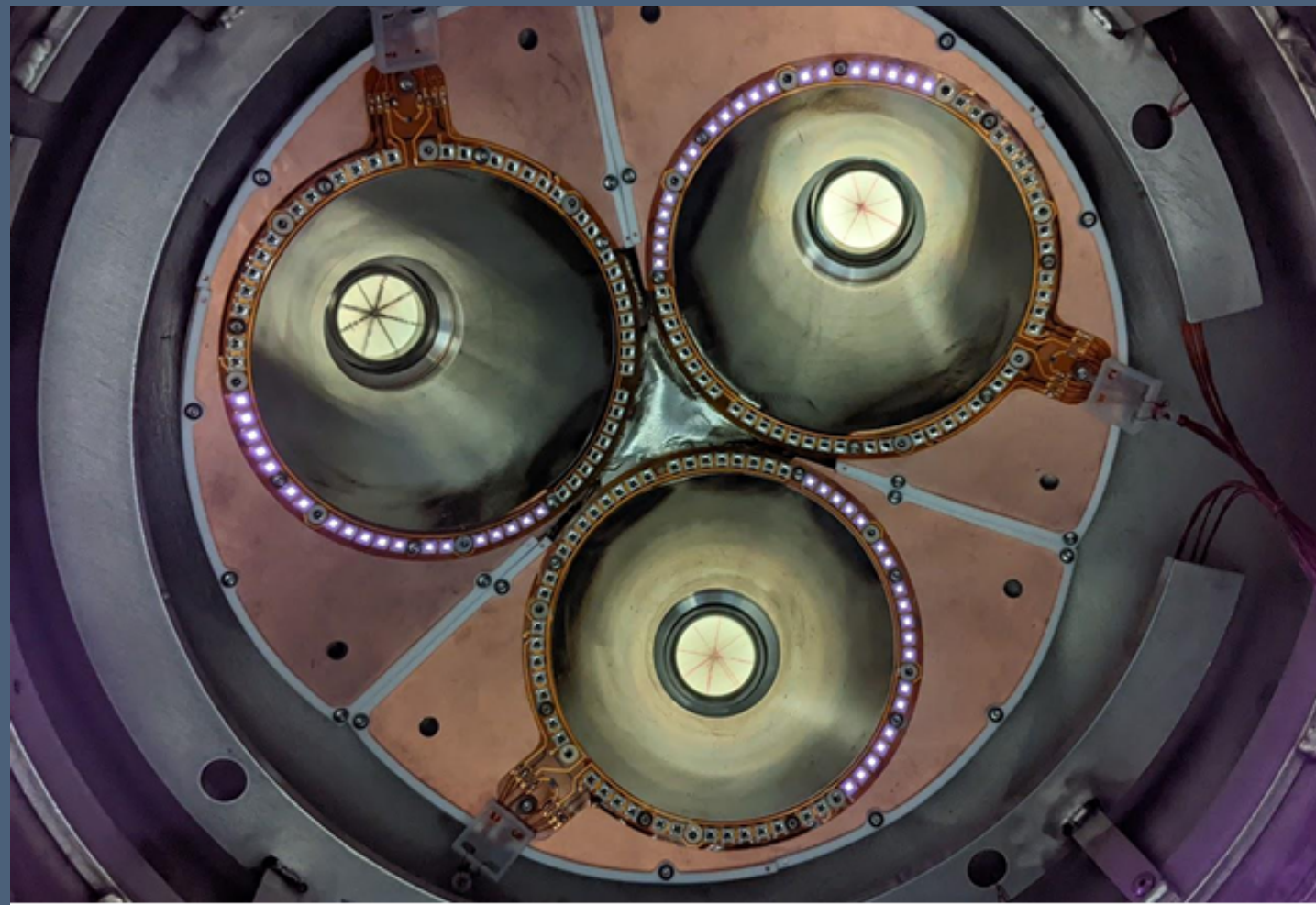
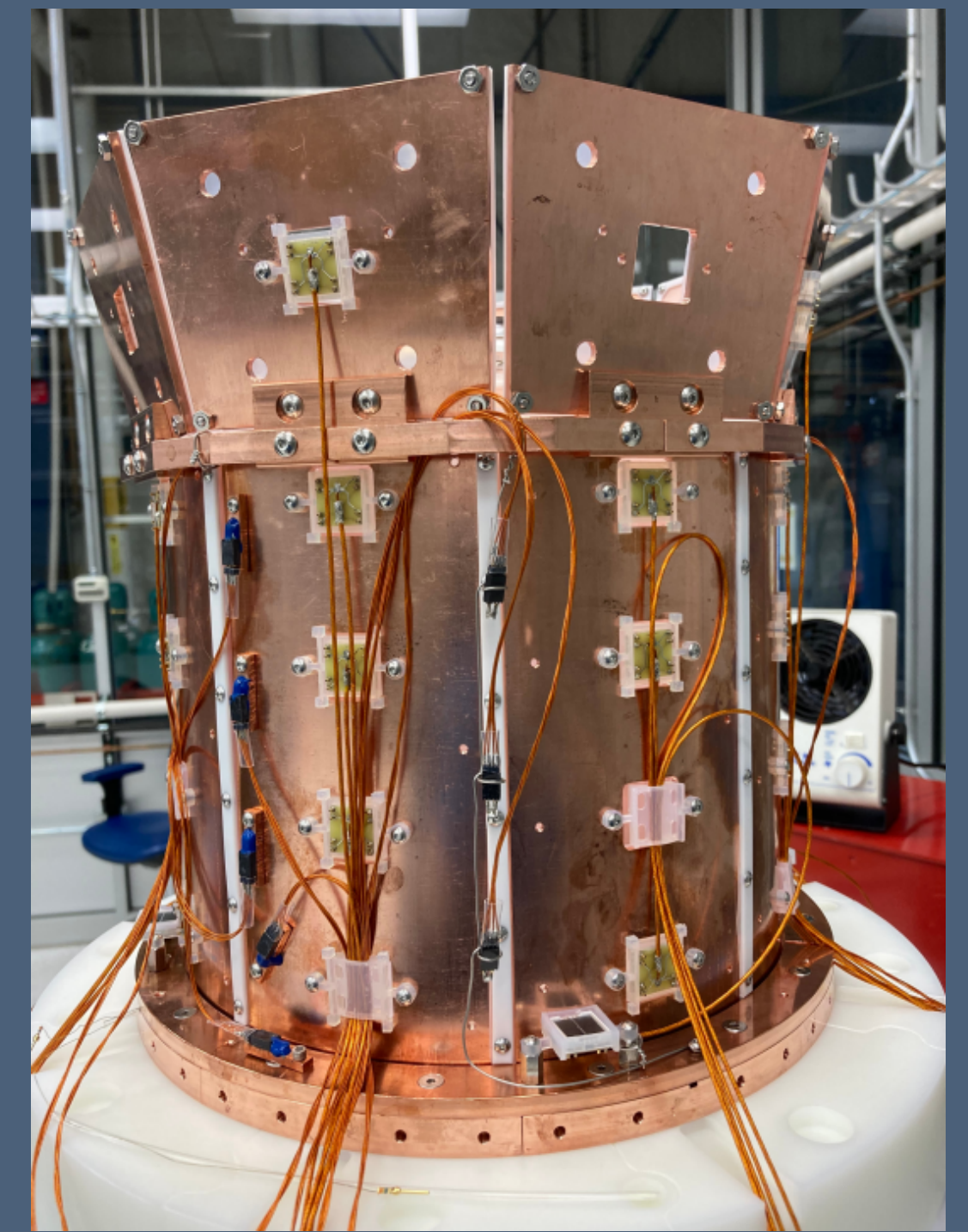
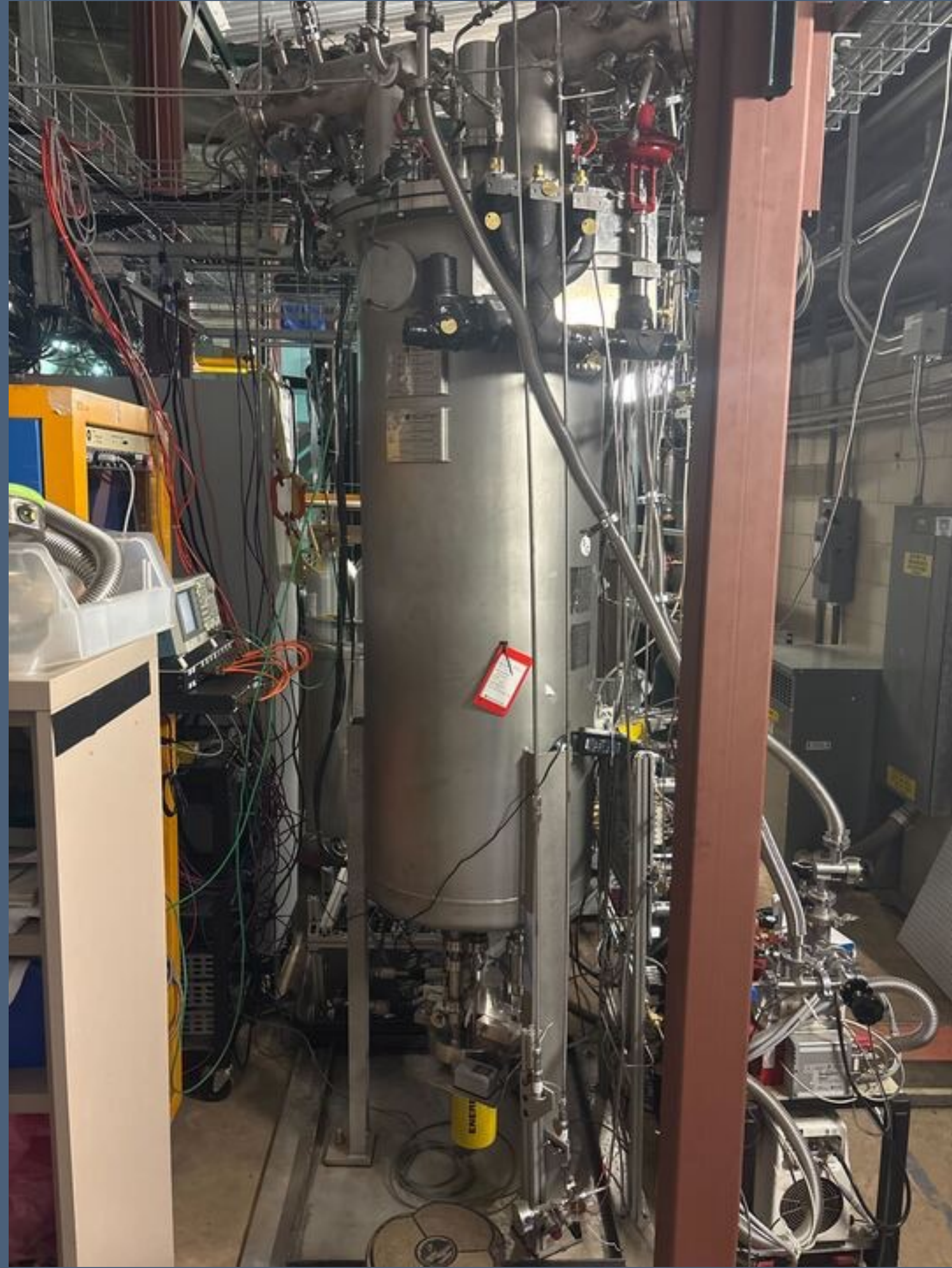
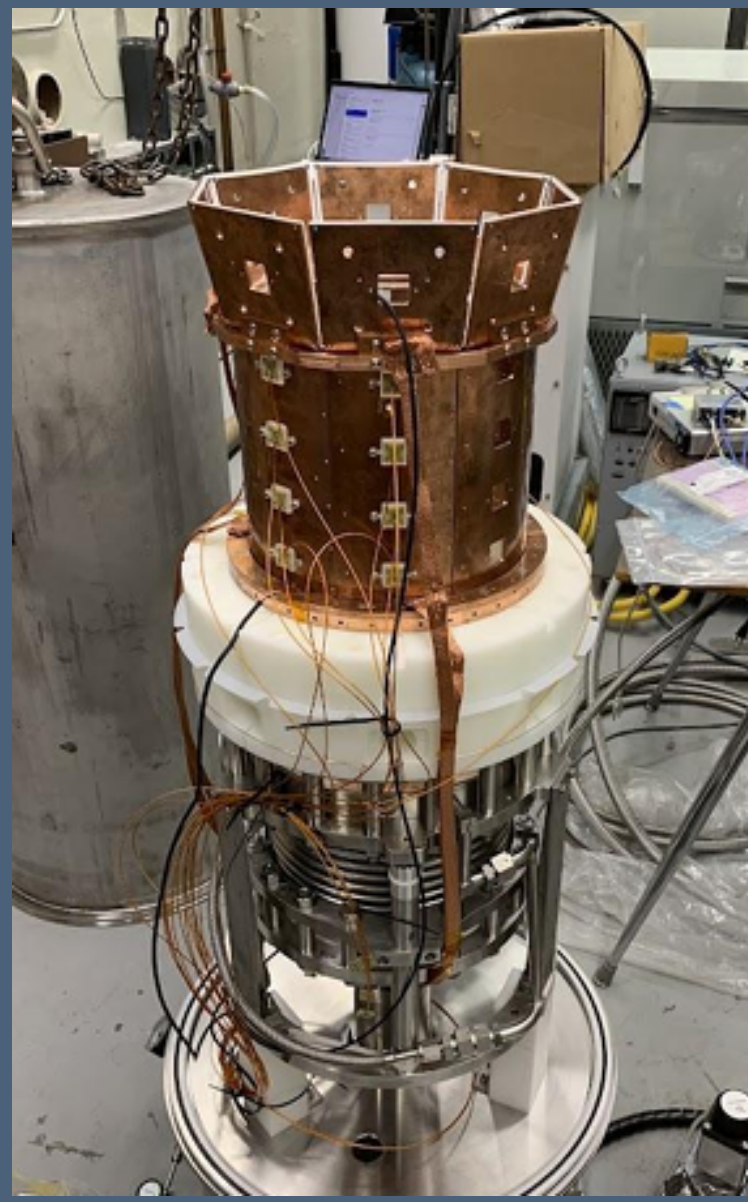
Data Streams

Bubble Images

Scintillation Pulses

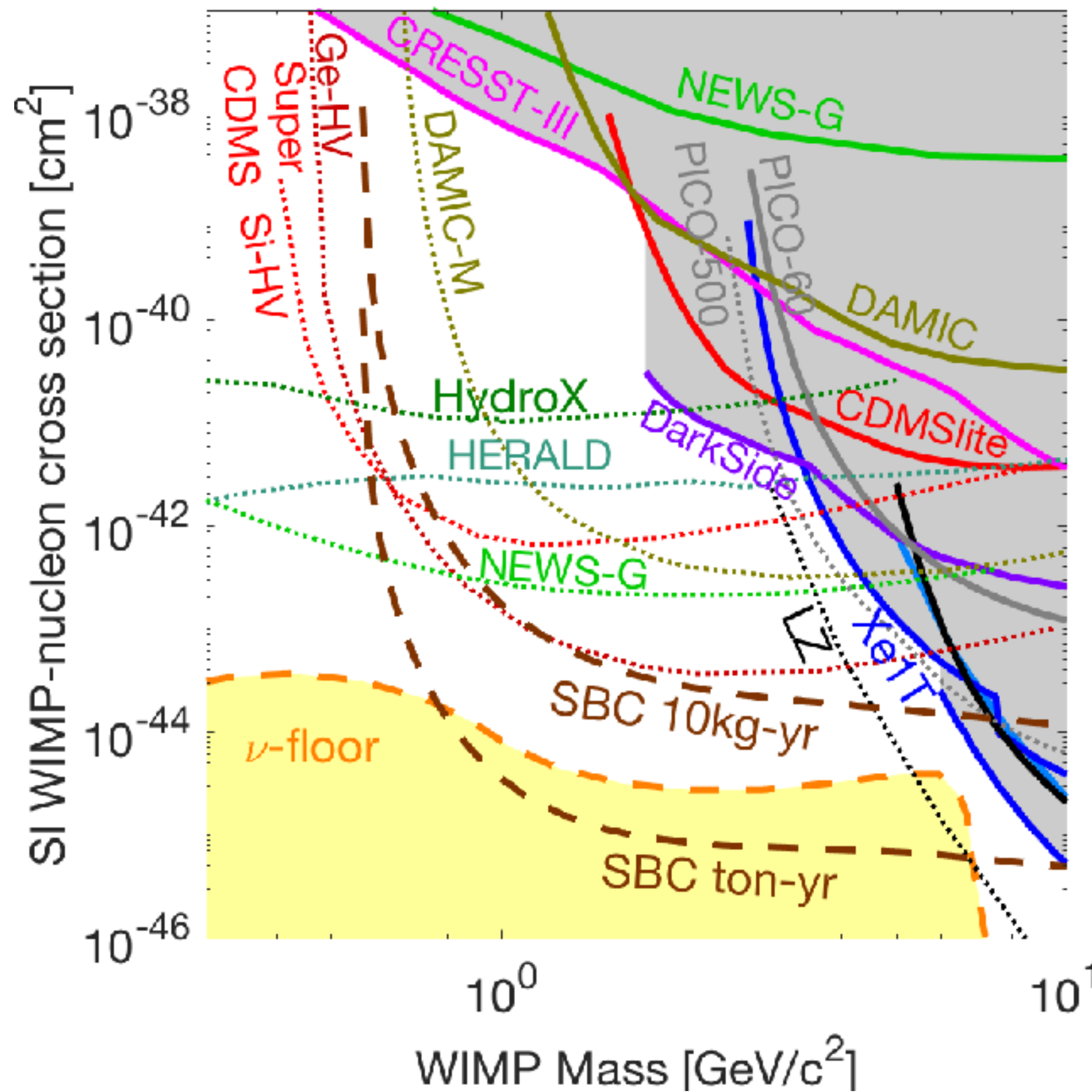
Pressure Variations
 Transducers throughout chamber

Acoustic Waveforms



Physics Reach - DM

- 1-10 GeV WIMP mass range
- Assumes near background free (~1-10 events/year)



E. Alfonso-Pita et al., *Scintillating Bubble Chambers: Liquid-noble Bubble Chambers for Dark Matter and CEνNS Detection*, arXiv:2207.12400 (2022).

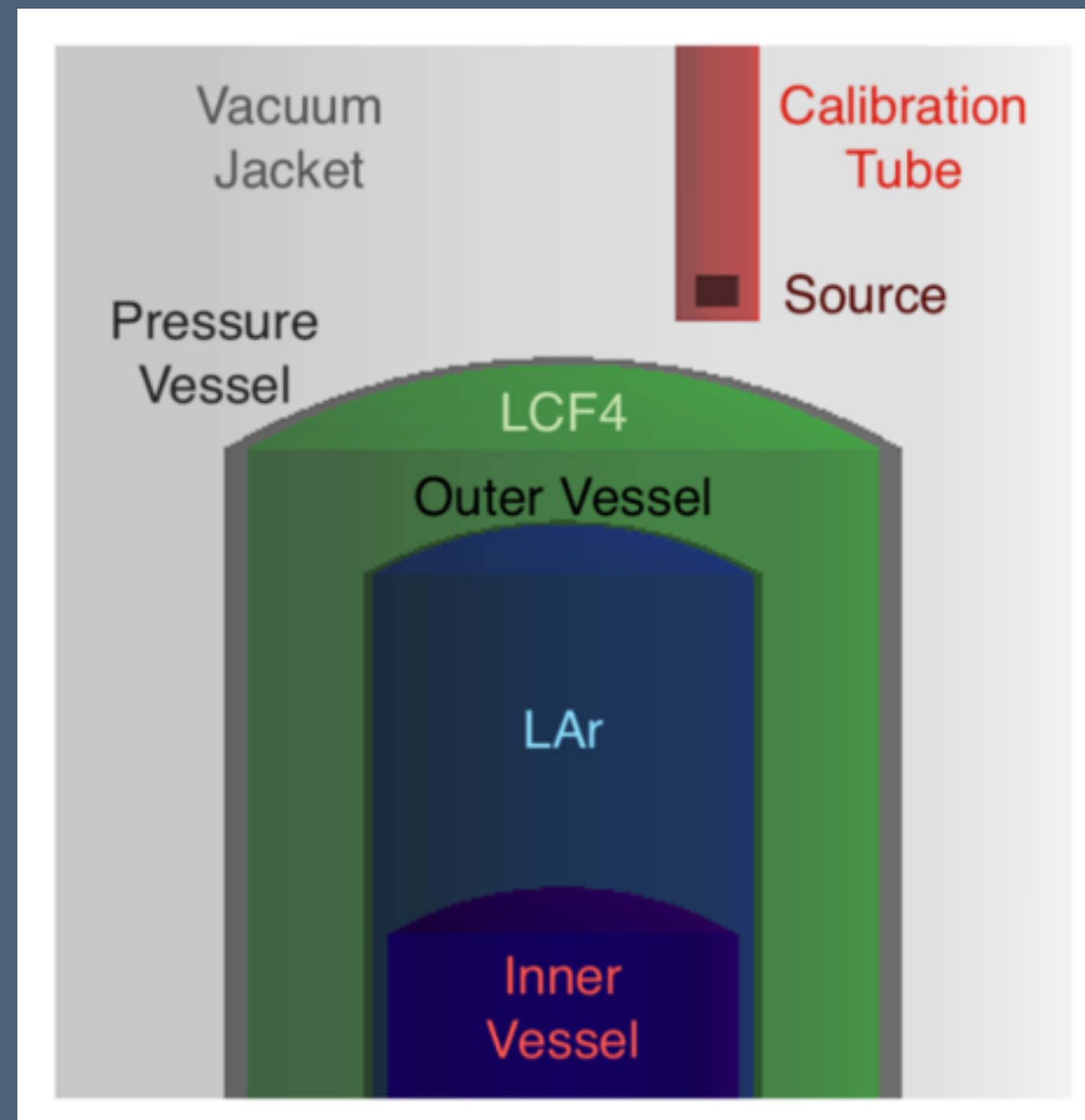
CEνNS

- Coherent Elastic Neutrino-Nucleus Scattering
- Dozens/hundreds CEνNS events per day
- Weak mixing angle, neutrino magnetic moment, Z' light gauge bosons, sterile neutrinos

Calibration

Goals

- Recoil sensitivity
 - **Nucleation efficiency function:**
probability of bubble formation given some energy deposit
- General detector performance



Methodology

- Calibration sources + simulations
- ER blindness
 - High activity gammas
- NR sensitivity
 - Photoneutron scattering
 - Nuclear Thomson scattering
 - Thermal neutron capture

Calibration Sources

Table 1: Information on the photoneutron sources considered for use in the calibration. The photoneutron sources produce approximately mono-energetic neutrons, with an energy spread of $O(10\%)$. The max NR energy describes the max recoil energy on argon.

Source	Primary Gammas [MeV]	Branching Ratio [%]	Mean Neutron Energy [keV]	Max NR Energy [keV]	Half-Life [years]
$^{58}\text{Co-Be}$	1.675	0.52	9.1	0.94	0.19
$^{124}\text{Sb-Be}$	1.691, 2.091	47, 5	24, 380	2.4, 37	0.16
$^{207}\text{Bi-Be}$	1.770	7	94	9.2	31.6

Photoneutron

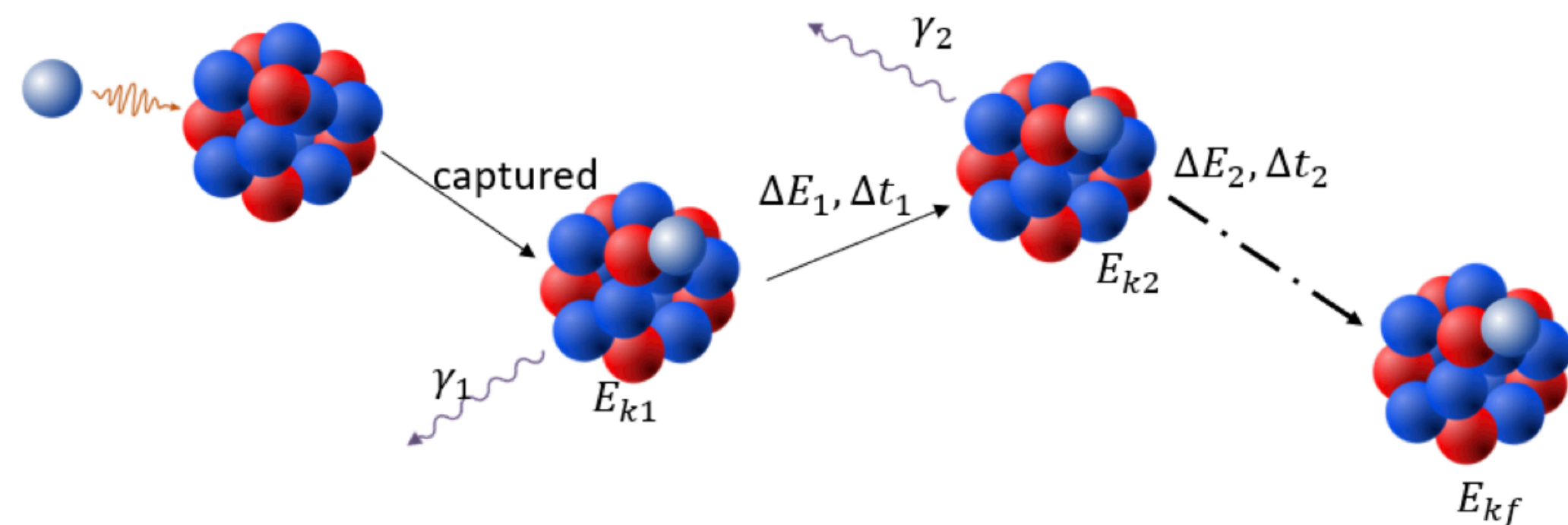
Table 2: Information on the Thomson scattering sources considered for use in the calibration. The max NR column describes the maximum energy recoil on argon. The high energy ^{228}Th gamma-ray comes from the ^{208}Tl daughter isotope.

Source	Primary Gammas [MeV]	Branching Ratio [%]	Max NR Energy [eV]	Half-Life [years]
^{22}Na	1.275	100	87	2.6
^{60}Co	1.173, 1.333	100, 100	73, 95	5.3
^{152}Eu	1.408	21	107	13.5
^{88}Y	1.836	99	182	0.29
^{207}Bi	1.064, 1.770	75, 7	61, 168	31.6
^{124}Sb	1.691, 2.091	47, 5	152, 234	0.16
^{228}Th	2.614	36	363	1.9

Thomson scattering

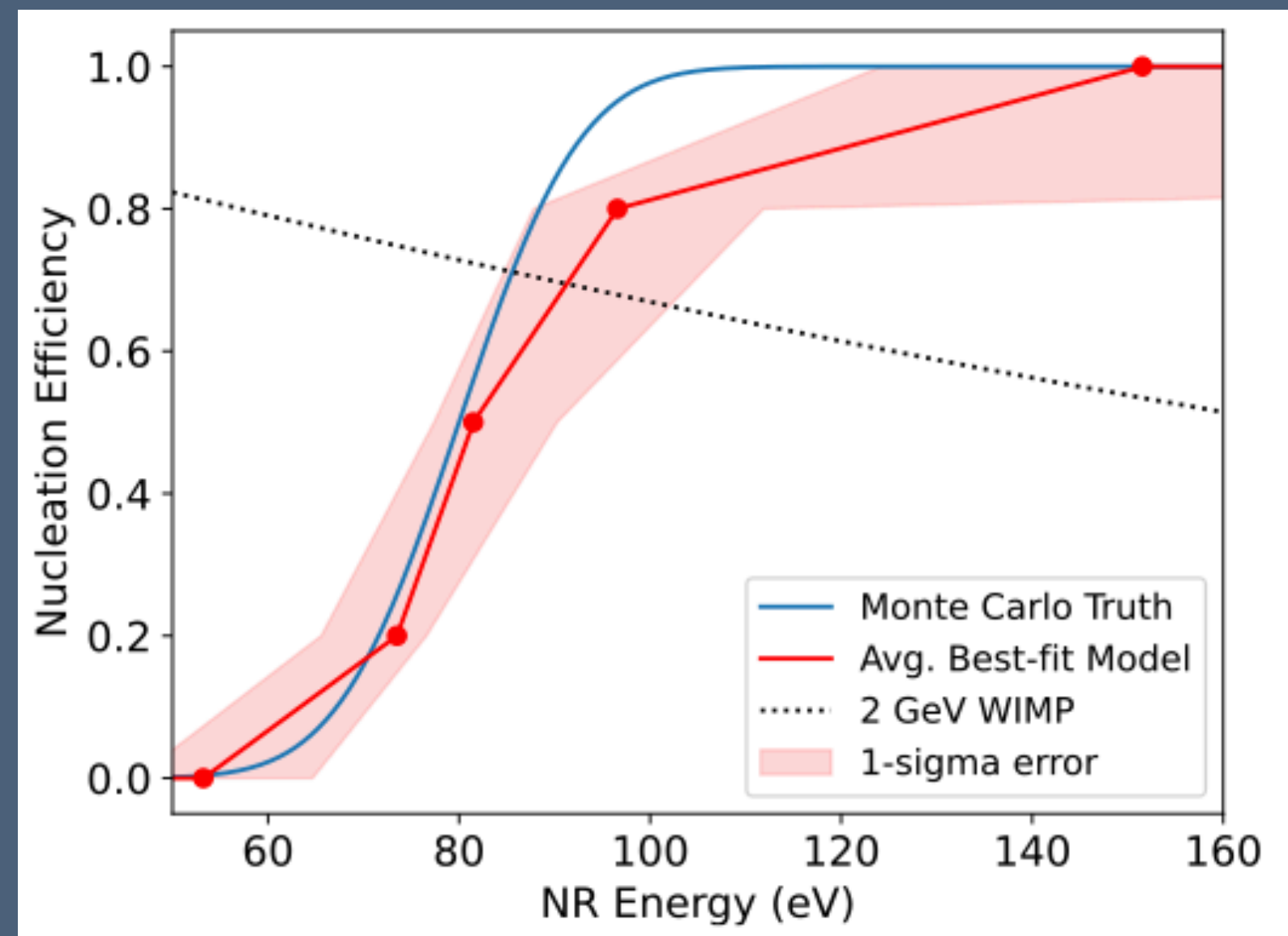
Thermal neutron:
 $^{241}\text{Am-Li}$

E. Alfonso-Pita et al, Calibration plan for the SBC 10-kg liquid argon detector with 100 eV target threshold. 2026 JINST 21 P03020

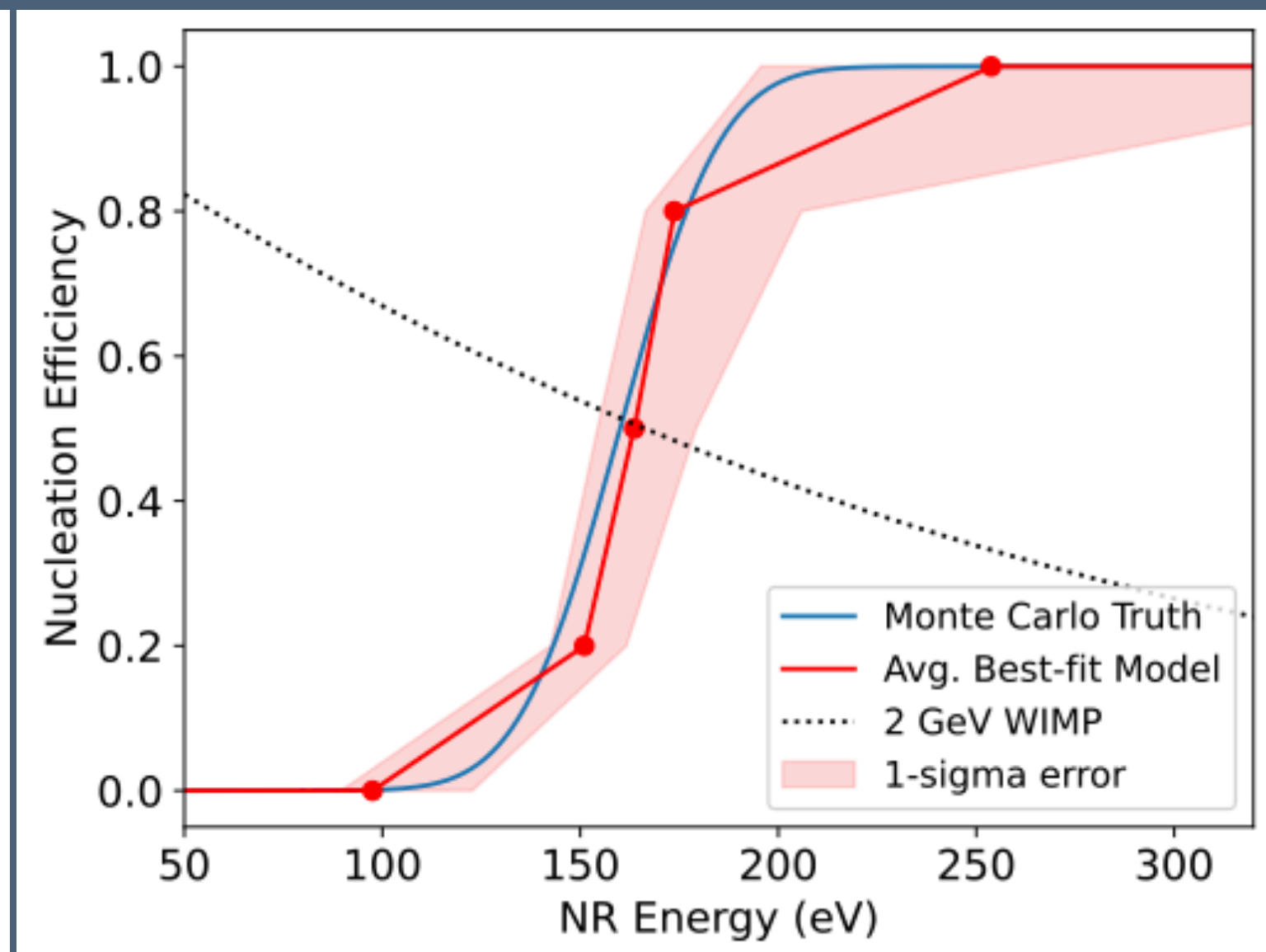


Simulated Calibration

- Nucleation efficiency curves using mock datasets



Threshold center: 80eV



160eV

Recent calibration plan paper!

Jinst PUBLISHED BY IOP PUBLISHING FOR SISSA MEDIALAB

RECEIVED: November 25, 2025
ACCEPTED: January 30, 2026
PUBLISHED: March 11, 2026

Calibration plan for the SBC 10-kg liquid argon detector with 100 eV target threshold



The SBC collaboration

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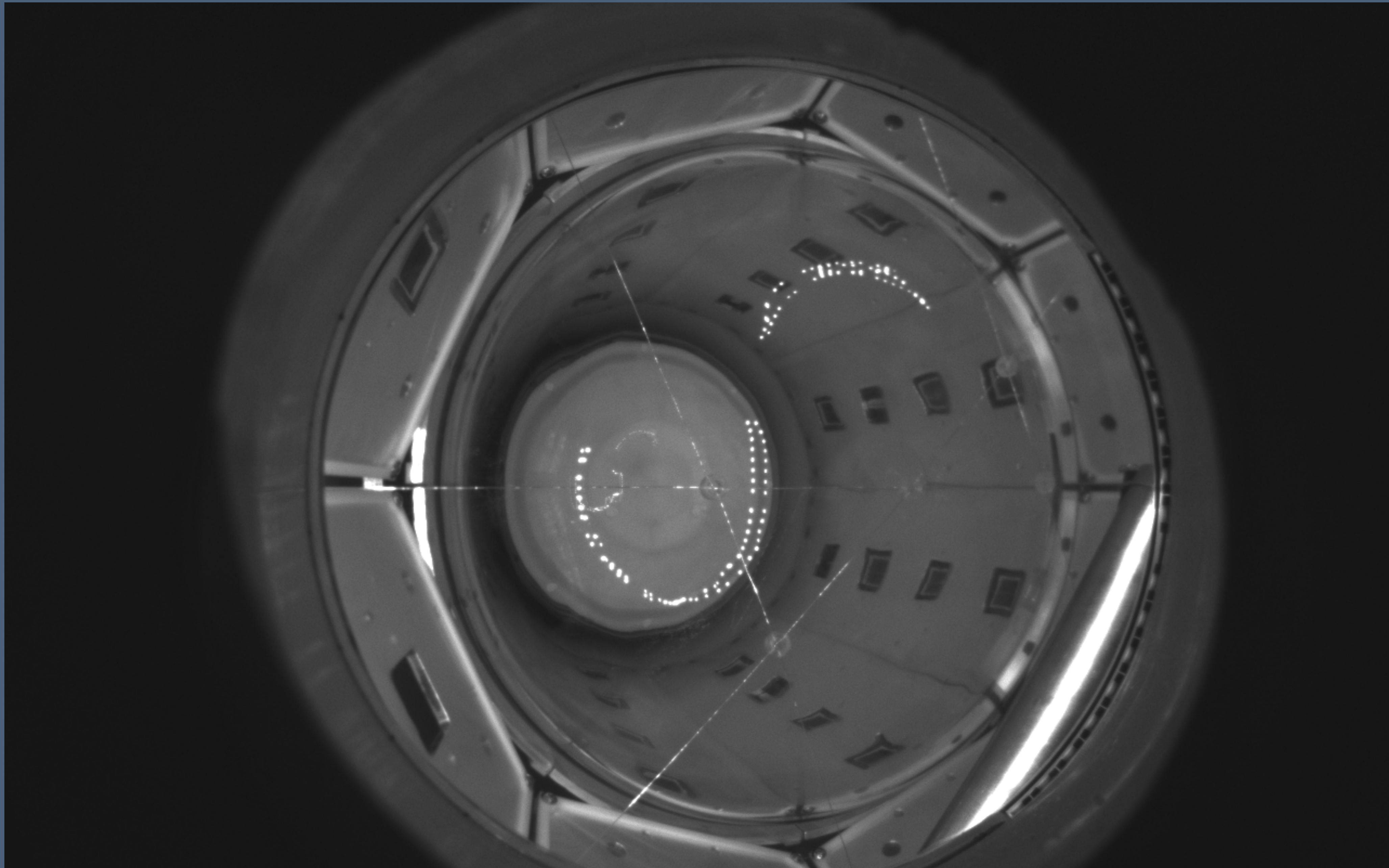
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<https://doi.org/10.1088/1748-0221/21/03/P03020>

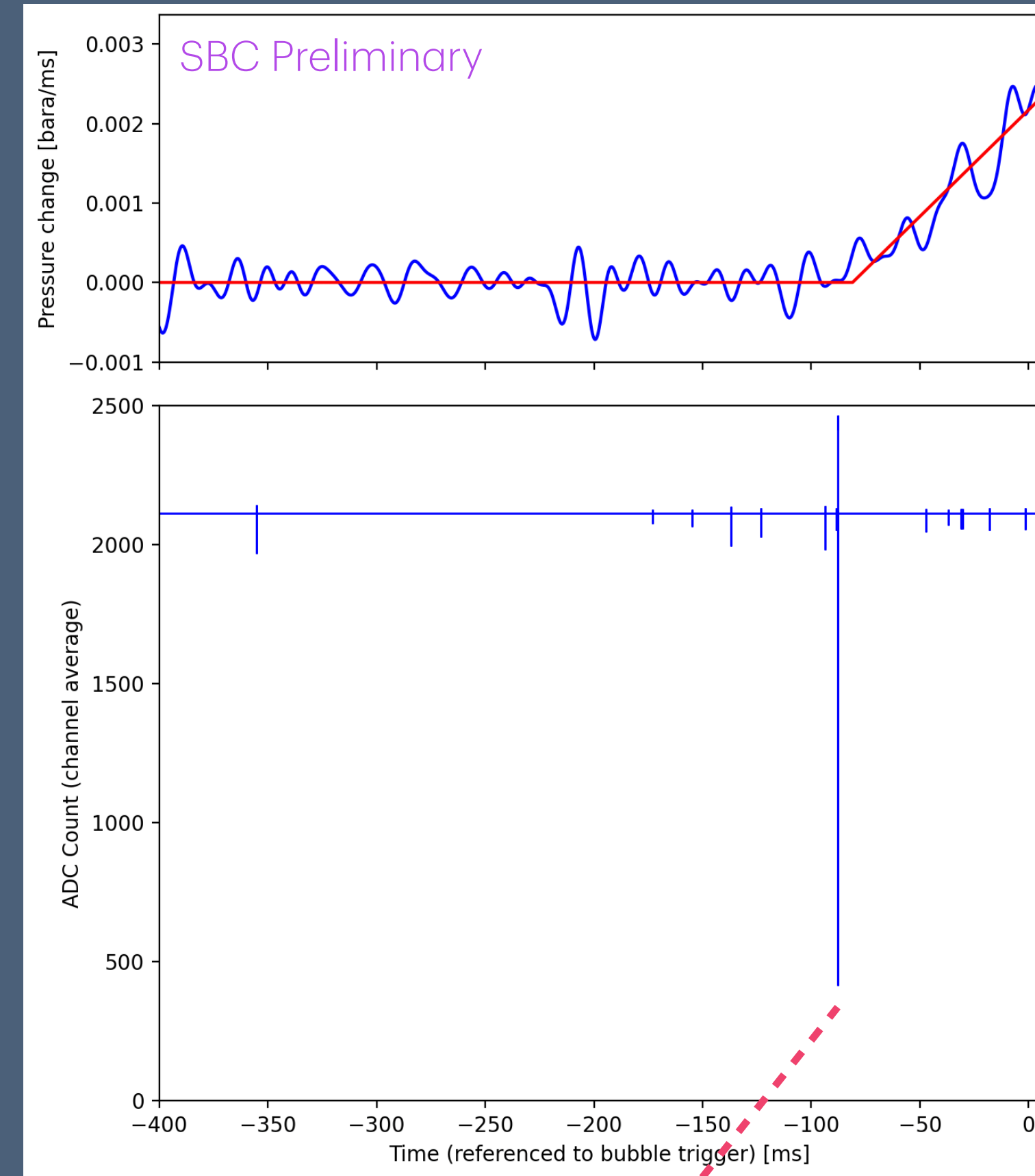
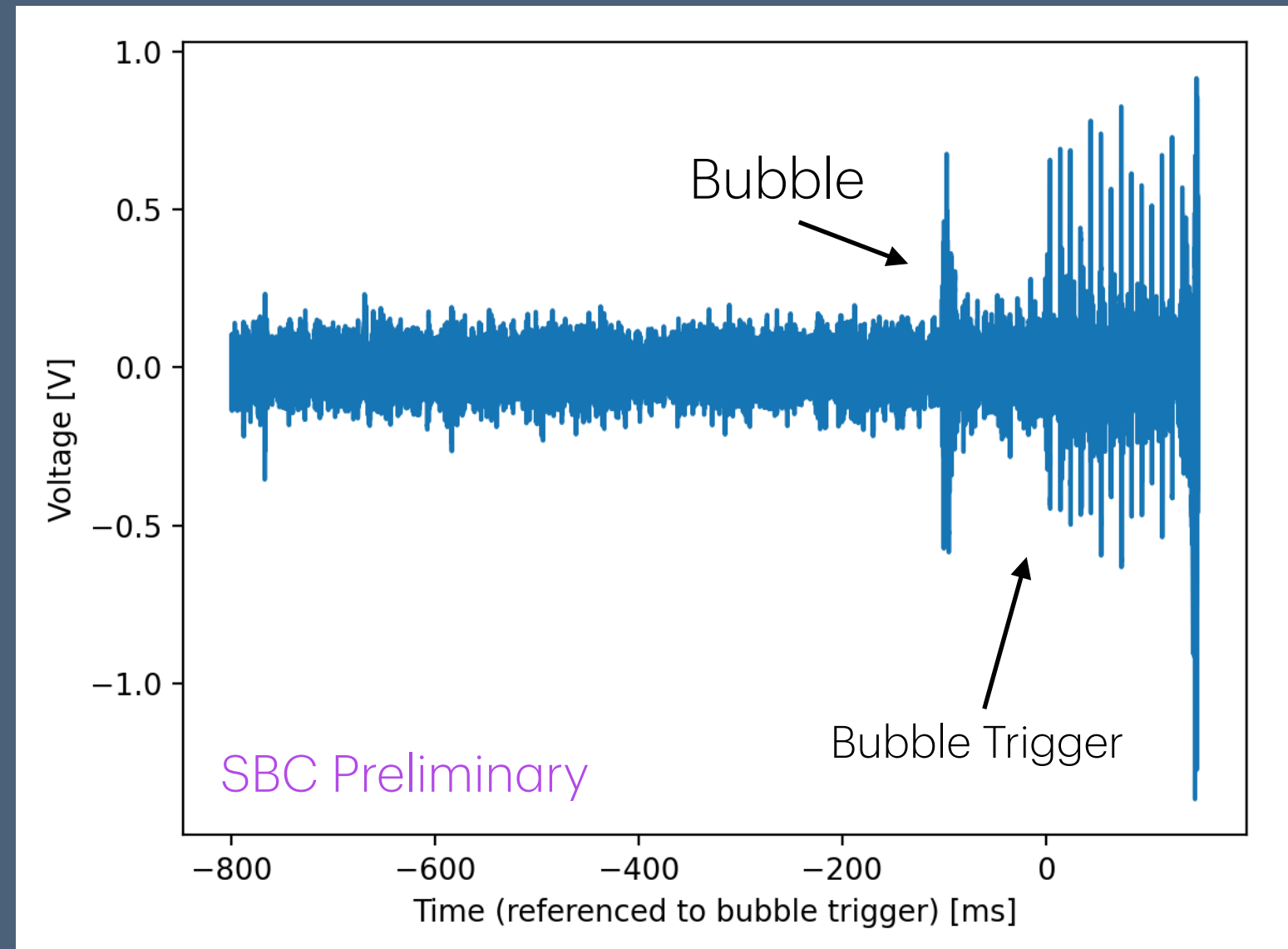
2026 JINST 21 P03020

E. Alfonso-Pita et al, Calibration plan for the SBC 10-kg liquid argon detector with 100 eV target threshold. 2026 JINST 21 P03020





Current Operations



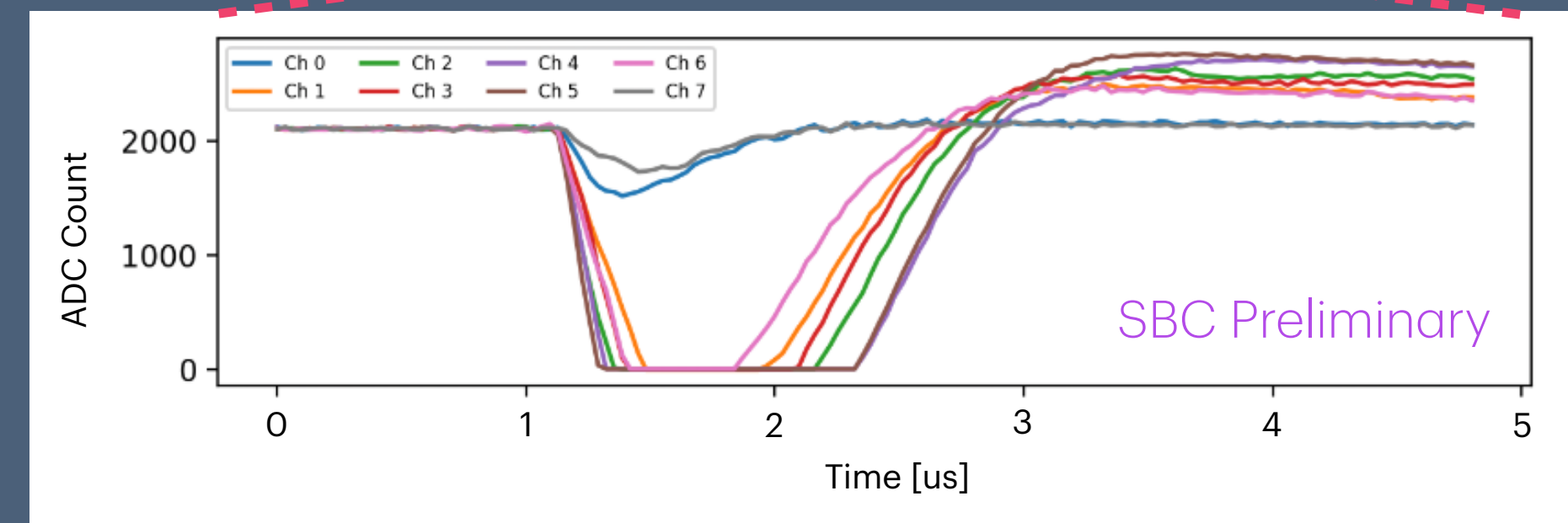
Author
Gray Putnam, Fermi National Accelerator Laboratory

Tue. March 17, 4:54 — 5:06 p.m. **First Bubbles in the SBC-LAr10 Detector at Fermilab**
 Hyatt Regency, Mineral B Part of [APR-L88 Mini-Symposium: Noble Liquids in Particle Physics](#)

The Scintillating Bubble Chamber (SBC) Collaboration develops liquid-noble bubble chambers for the detection of low-mass (GeV-scale) particle dark matter and coherent...

Authors: Eric Dahl, Zhiheng Sheng (presenter), Gray Putnam, Baisakhi Mitra

Previous presentation by Z. Sheng: more details on FNAL operations and first data!



Thanks for listening! Questions?



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- Zhiheng Sheng
- Baisakhi Mitra
- Jianyu Long

Queens University (Canada)

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- Jonathan Corbett
- Austin De St Croix
- Koby Dering
- Hector Hawley
- Gary Sweeny
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- Mitchel Baker
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SNOLAB (Canada)

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TRIUMF (Canada)

- Pietro Giampa

U.S. DEPARTMENT OF ENERGY (USA)

- Office of Science

NSF (USA)

NSERC CRSNG (Canada)

INNOVATION (USA/Canada)

- Canada Foundation for Innovation
- Fondation canadienne pour l'innovation

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- Mathieu Laurin
- Pierre Frédérick

Northeastern University (USA)

- Orin Harris

UC RIVERSIDE (USA)

- Shawn Westerdale

PennState (USA)

- Shashank Priya



Slides, links, more info!



SBC-SNOLAB

Status

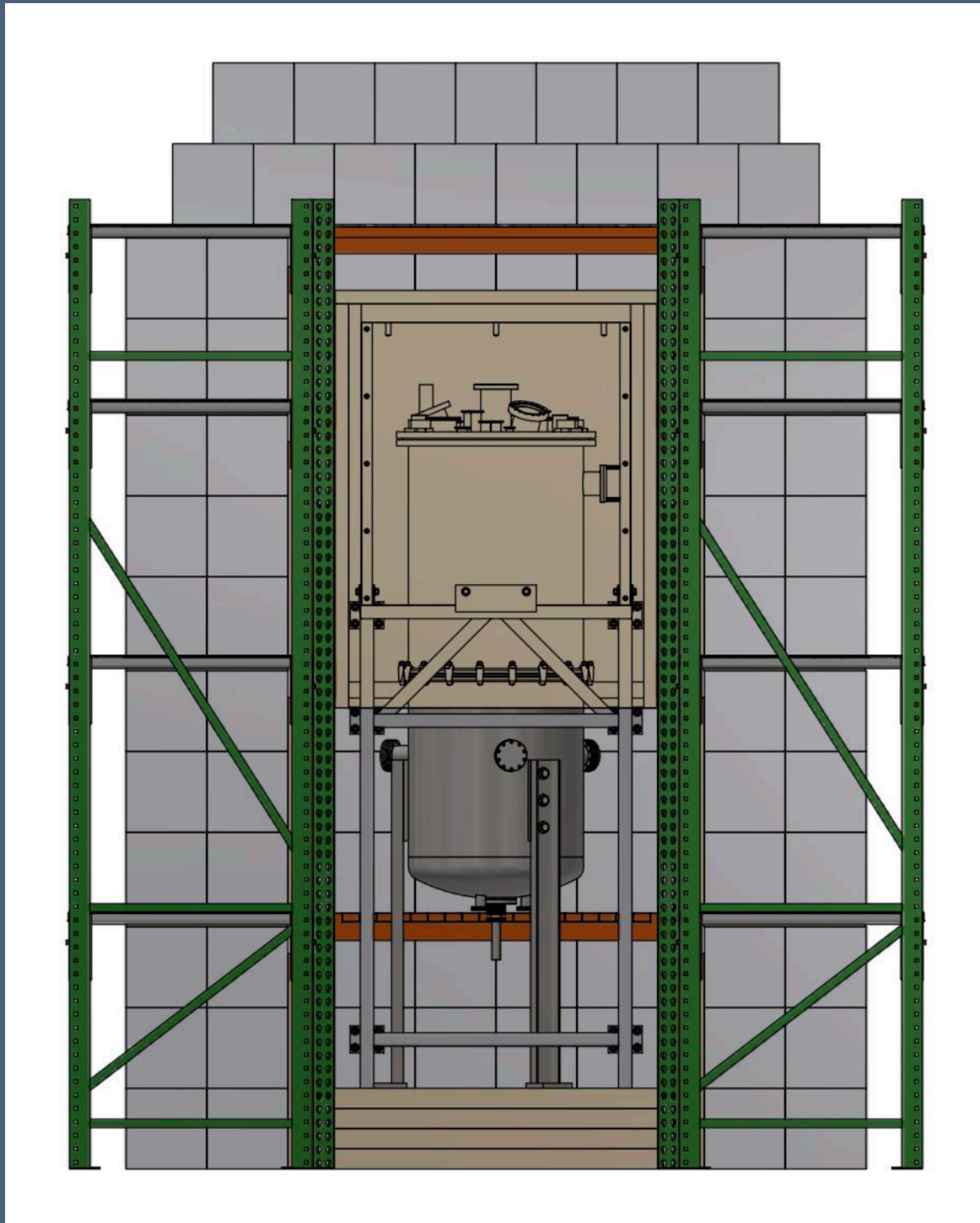
Compared to FNAL chamber

Functionally identical

20x greater depth

+ shielding

+ radio-purity



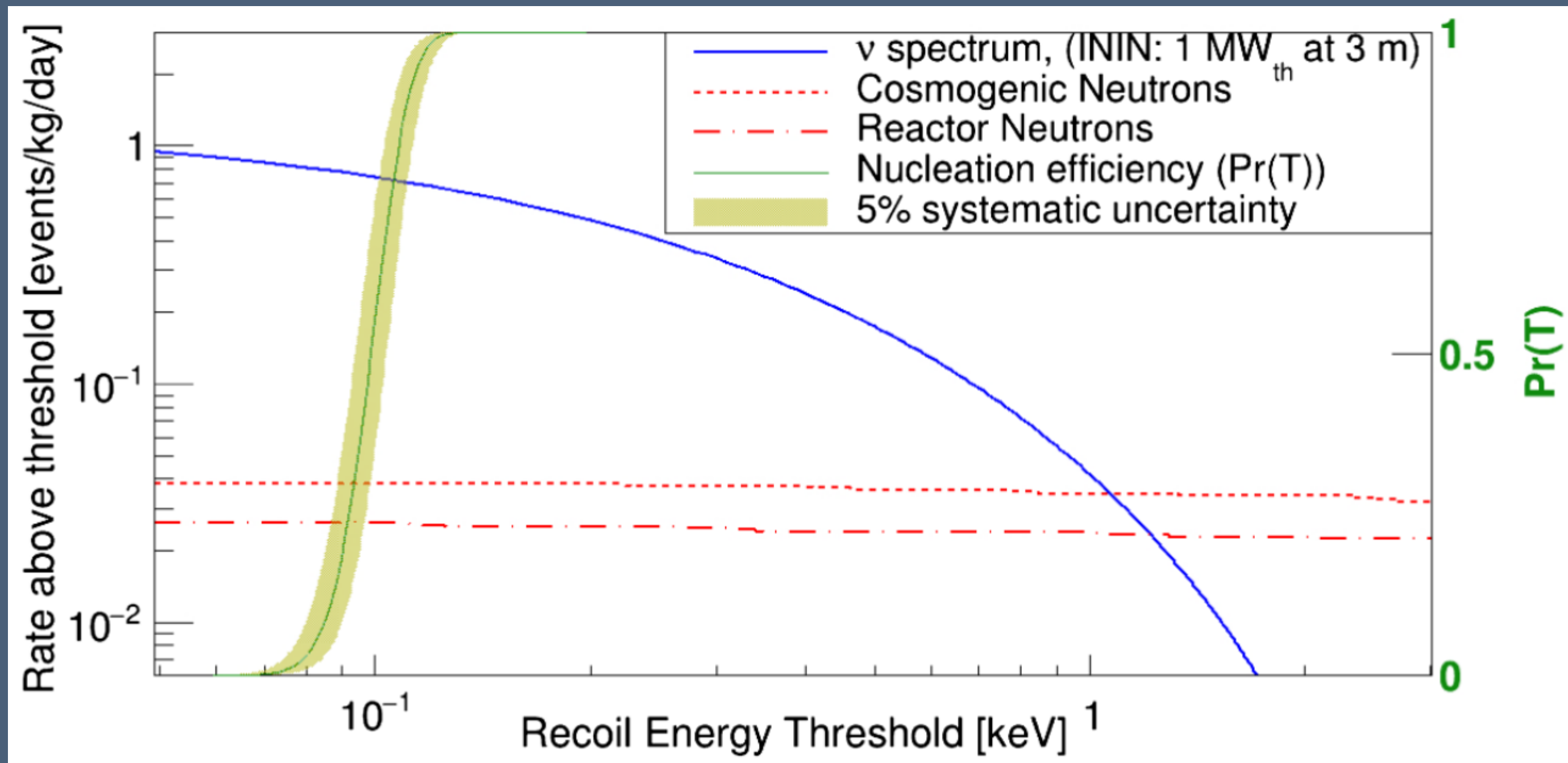
Assembly soon

Operational in 1-2 years

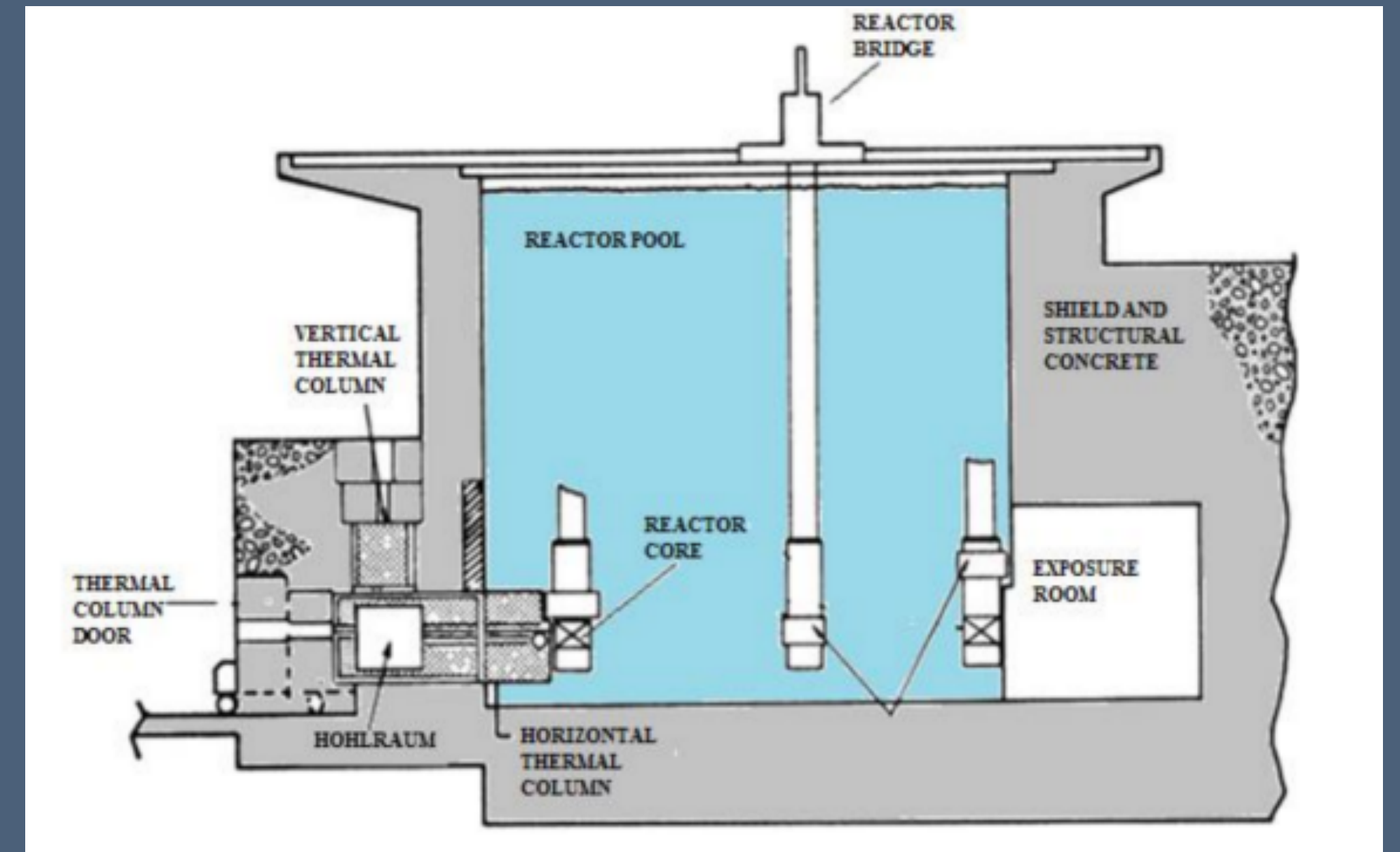


CE ν NS

- High exposure \rightarrow neutrino fog boundary \rightarrow CE ν NS study
- Reactor neutrinos:
 Instituto Nacional de Investigaciones Nucleares (ININ) TRIGA Mark III
 HFIR Oak Ridge National Laboratory



L.J. Flores *et al.*, *Physics reach of a low threshold scintillating argon bubble chamber in coherent elastic neutrino-nucleus scattering reactor experiments*, Phys. Rev. D 103, 091301 (2021).



E. Alfonso-Pita *et al.*, *Scintillating Bubble Chambers: Liquid-noble Bubble Chambers for Dark Matter and CE ν NS Detection*, arXiv:2207.12400 (2022).