

The Scintillating Bubble Chamber



Ben Broerman
Queen's University

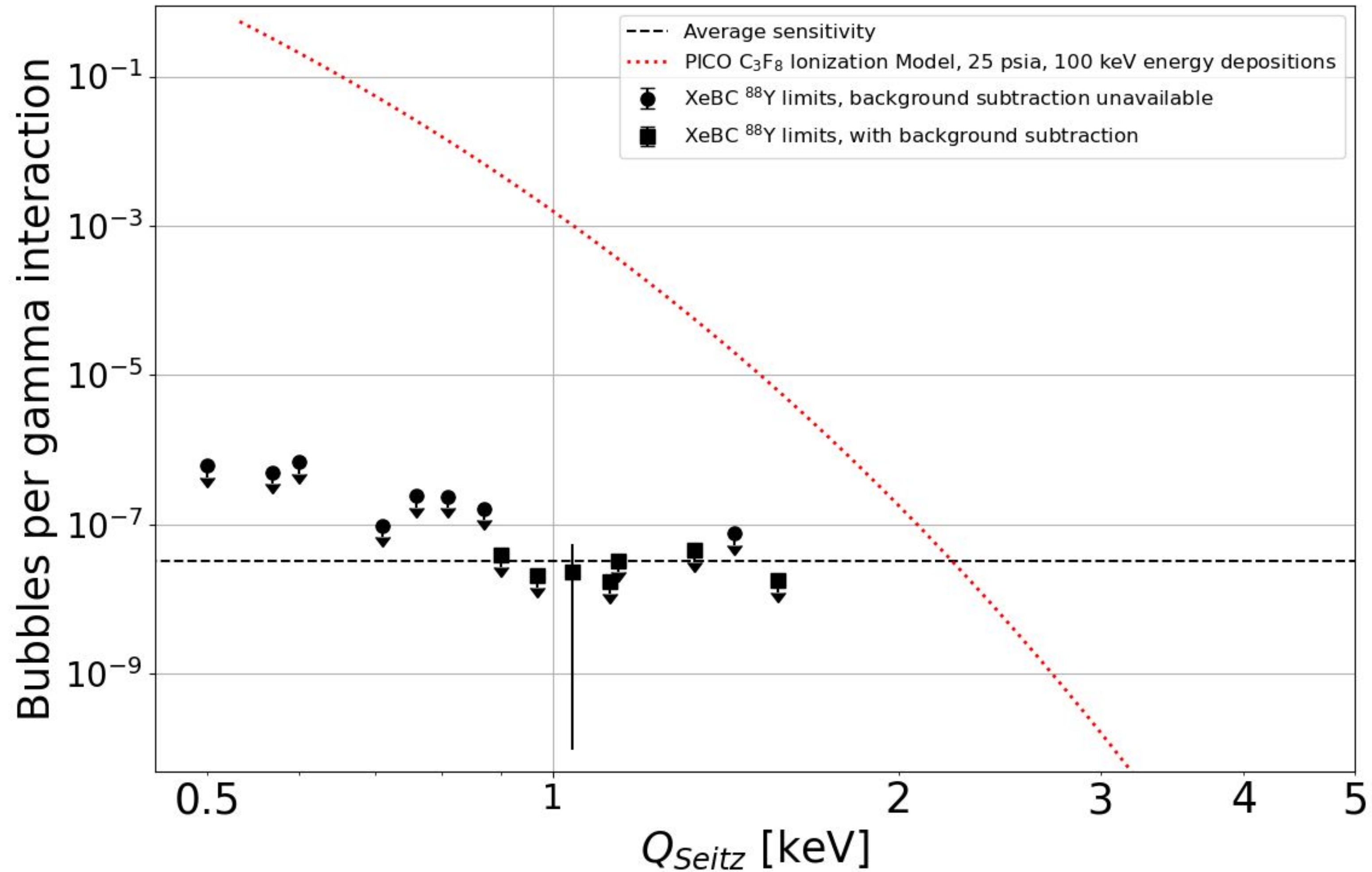


Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

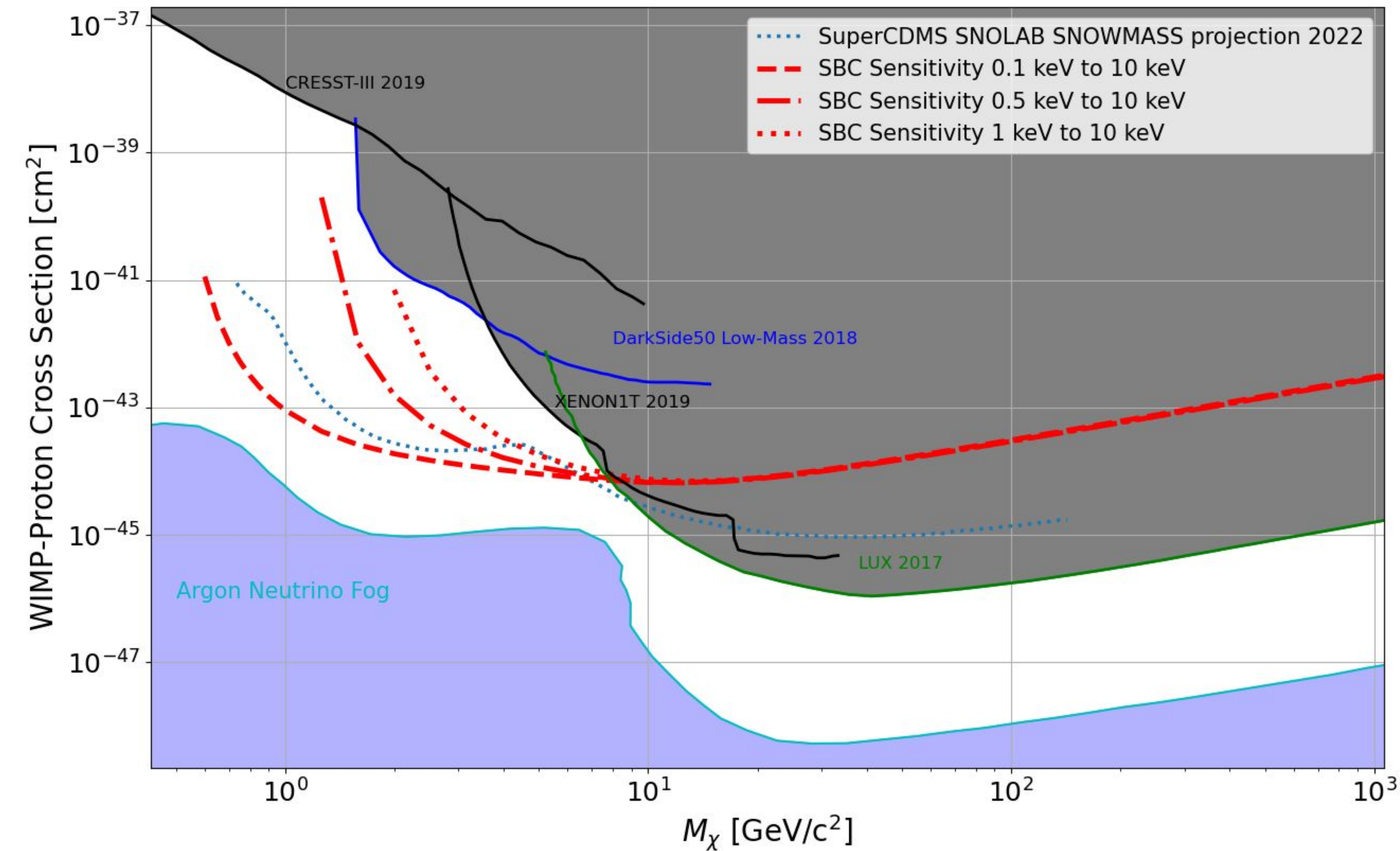


Experiment Overview

- Bubble chambers have been used for dark matter searches with success (see: PICO)
- Low mass region remained out of reach due to increased electron recoils with a lowered threshold
- Not an issue for SBC with the changed energy deposit channels



Why push this threshold?

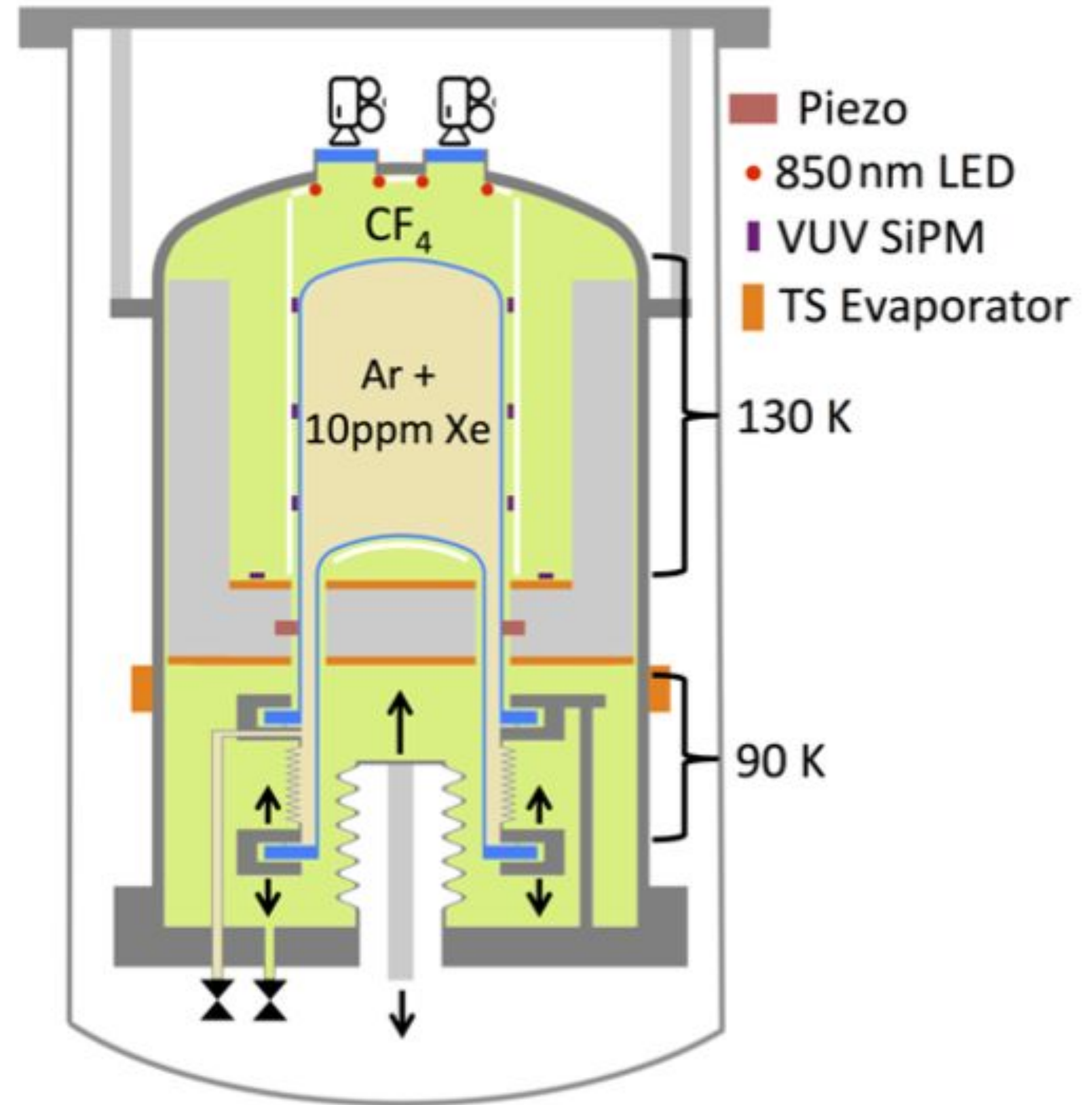


- The ability to reach lower thresholds opens up the lower-mass parameter space
- Note that this plot includes only CEvNS backgrounds and a 10kg-year exposure

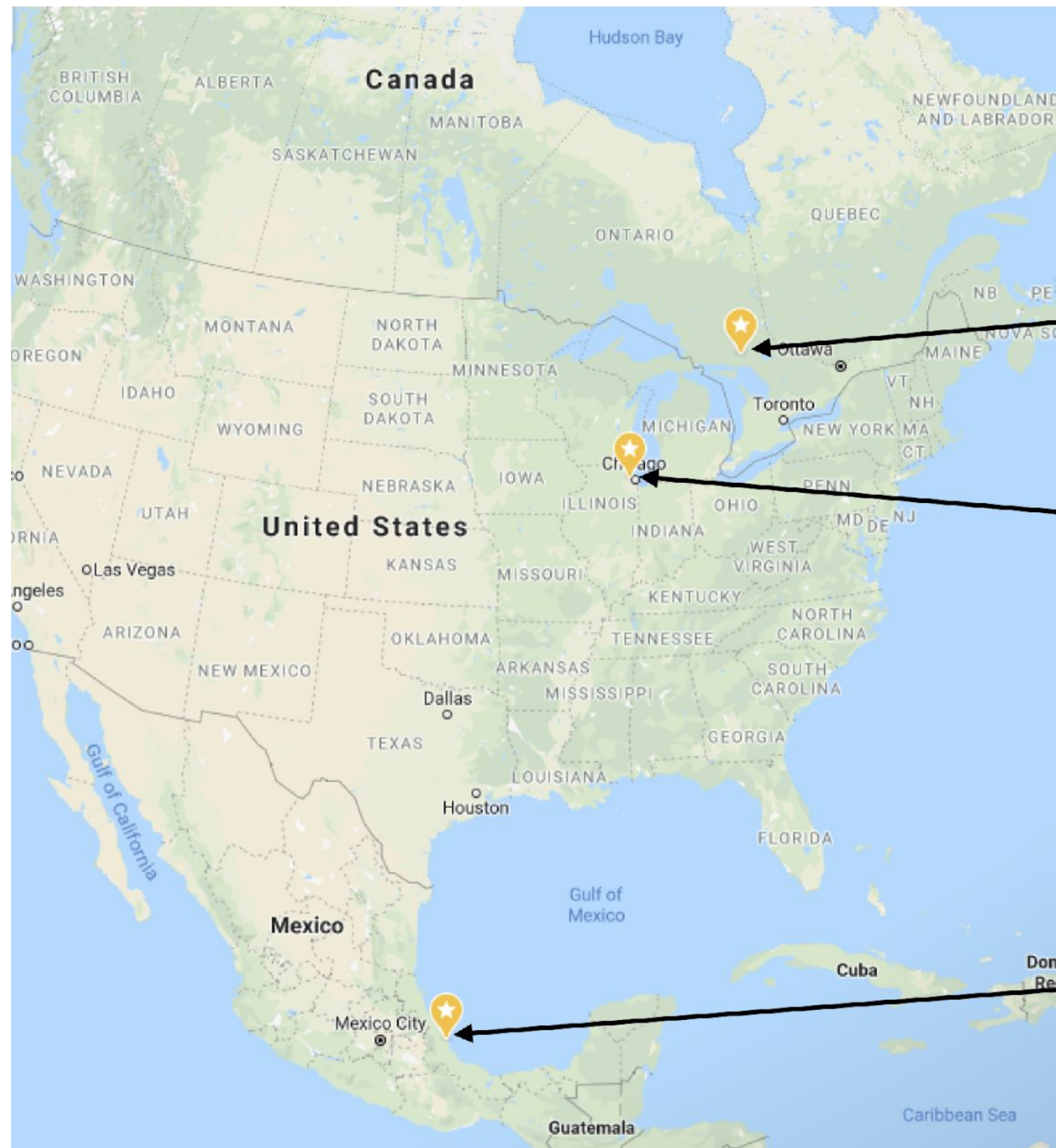


How will we do this?

- Roughly 10kg of argon
- SiPMs used for scintillation detection
- Much of the internal detail modelled on PICO 500
- “Only” added challenge is to keep it cold



Collaboration Plan



2) Build and install
2nd detector at SNOLAB
for DM search

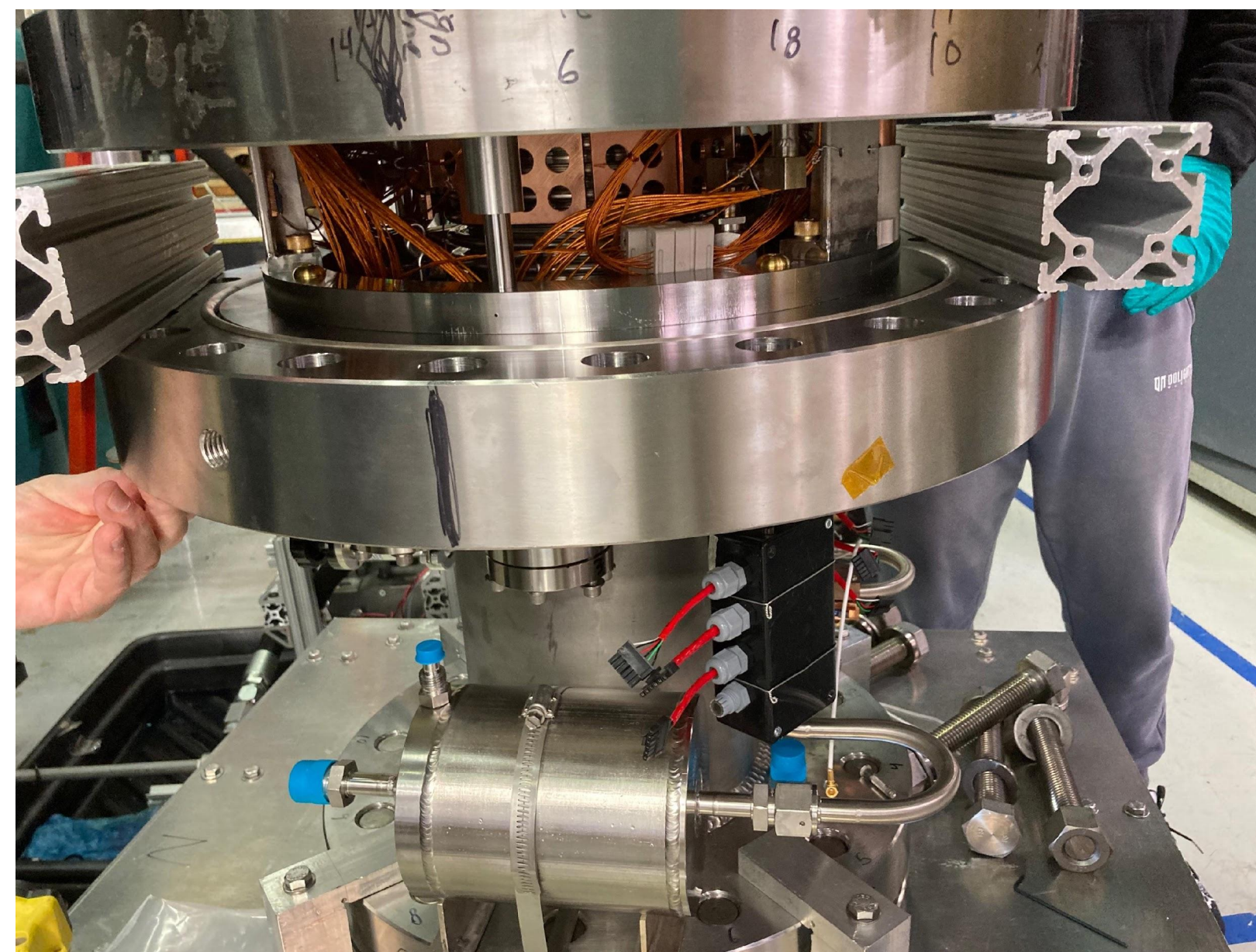
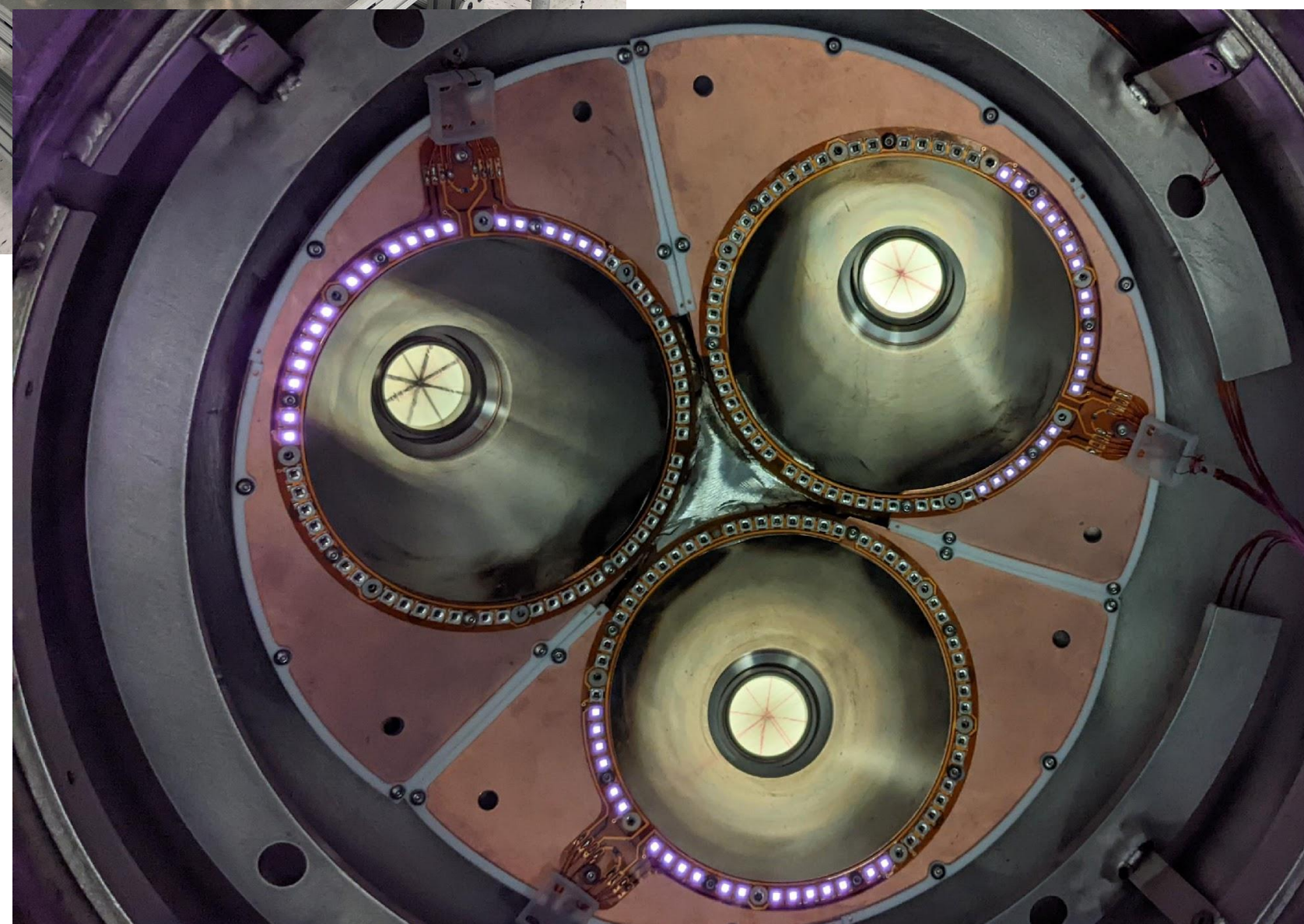
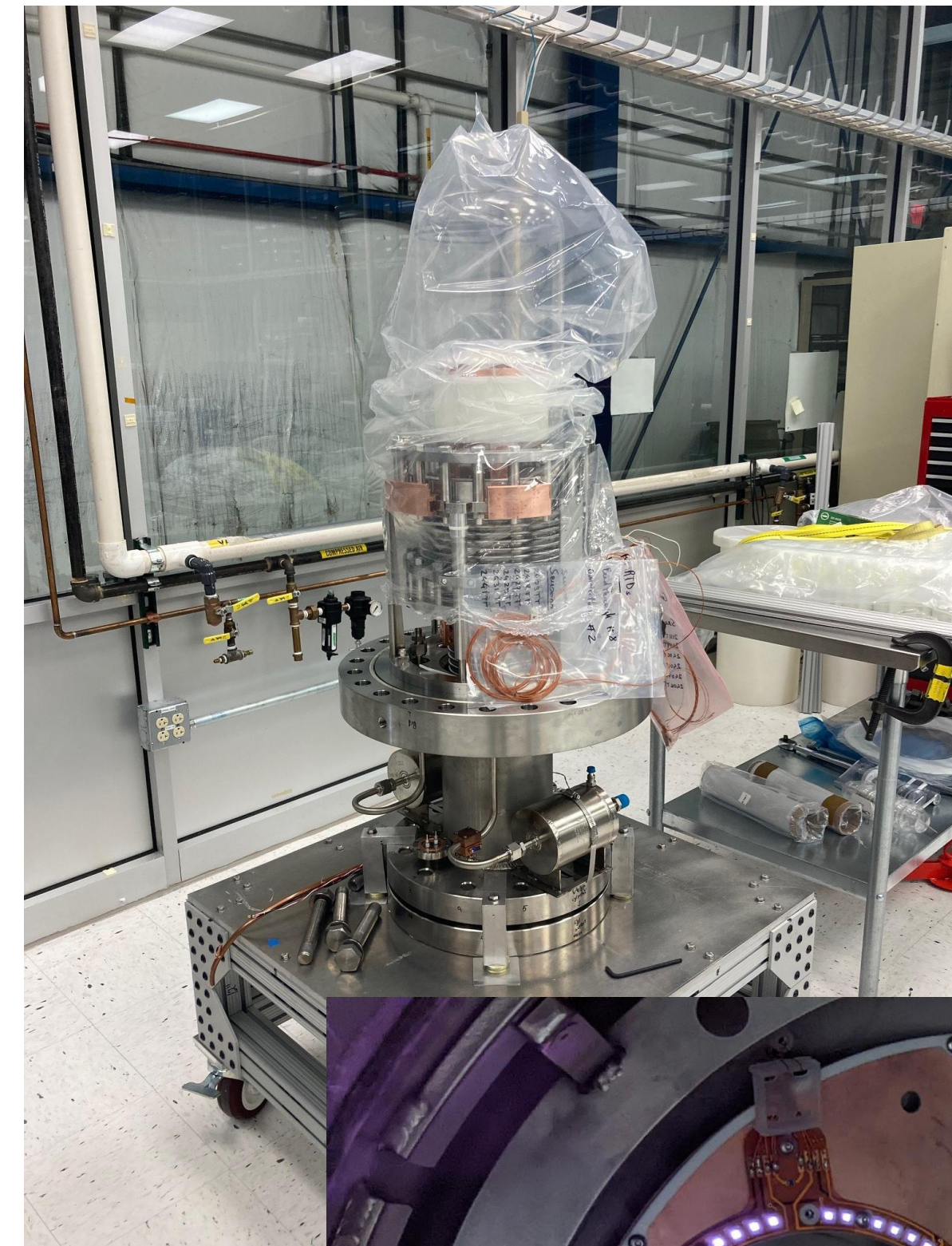
1) Build and
commission
detector at
Fermilab

3) Upgrade and
install detector from
1) at a reactor for
CEvNS studies



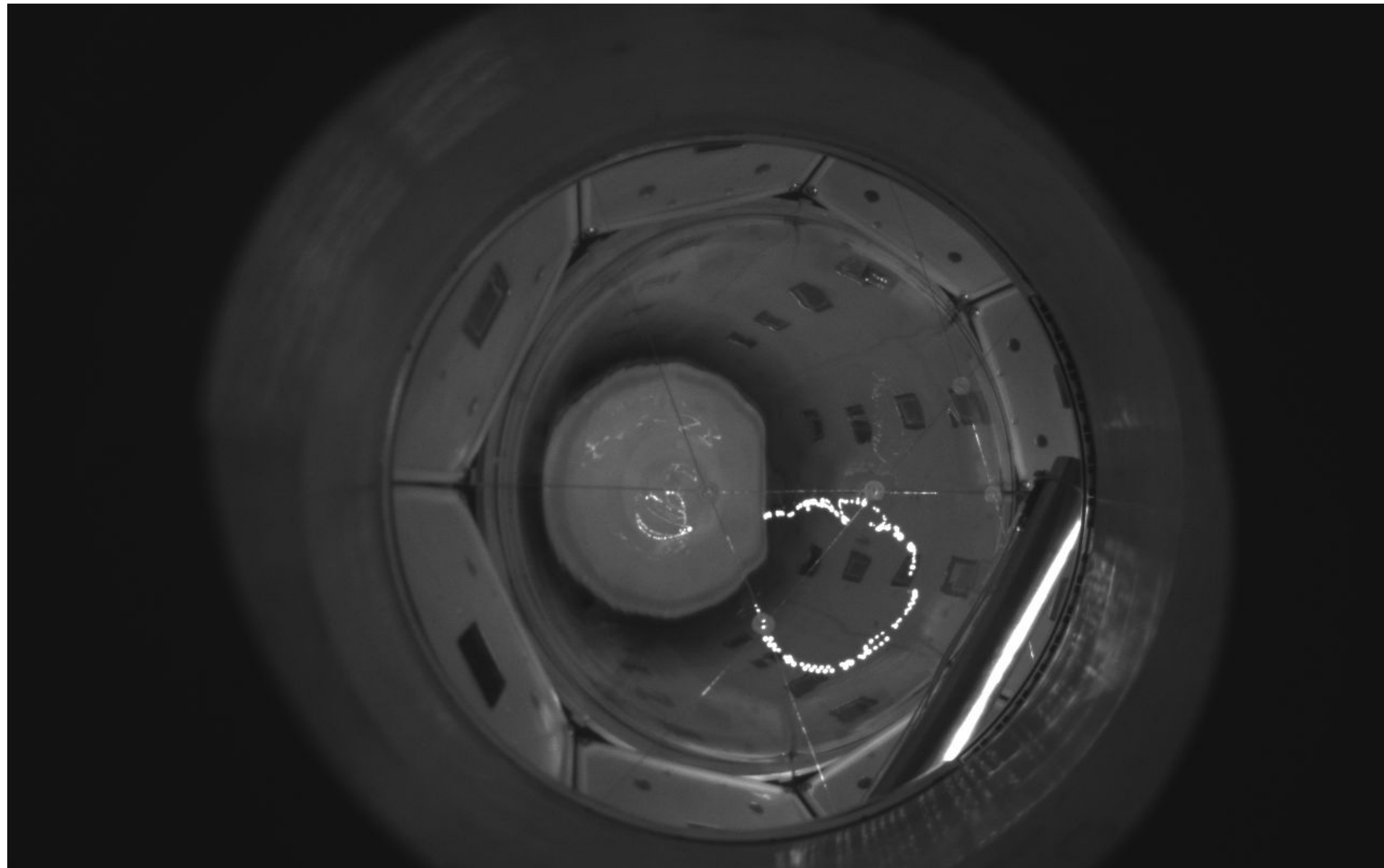
Fermilab Progress

- Instrumentation wiring is complete
- PV installed in vacuum jacket
- Cold test on surface



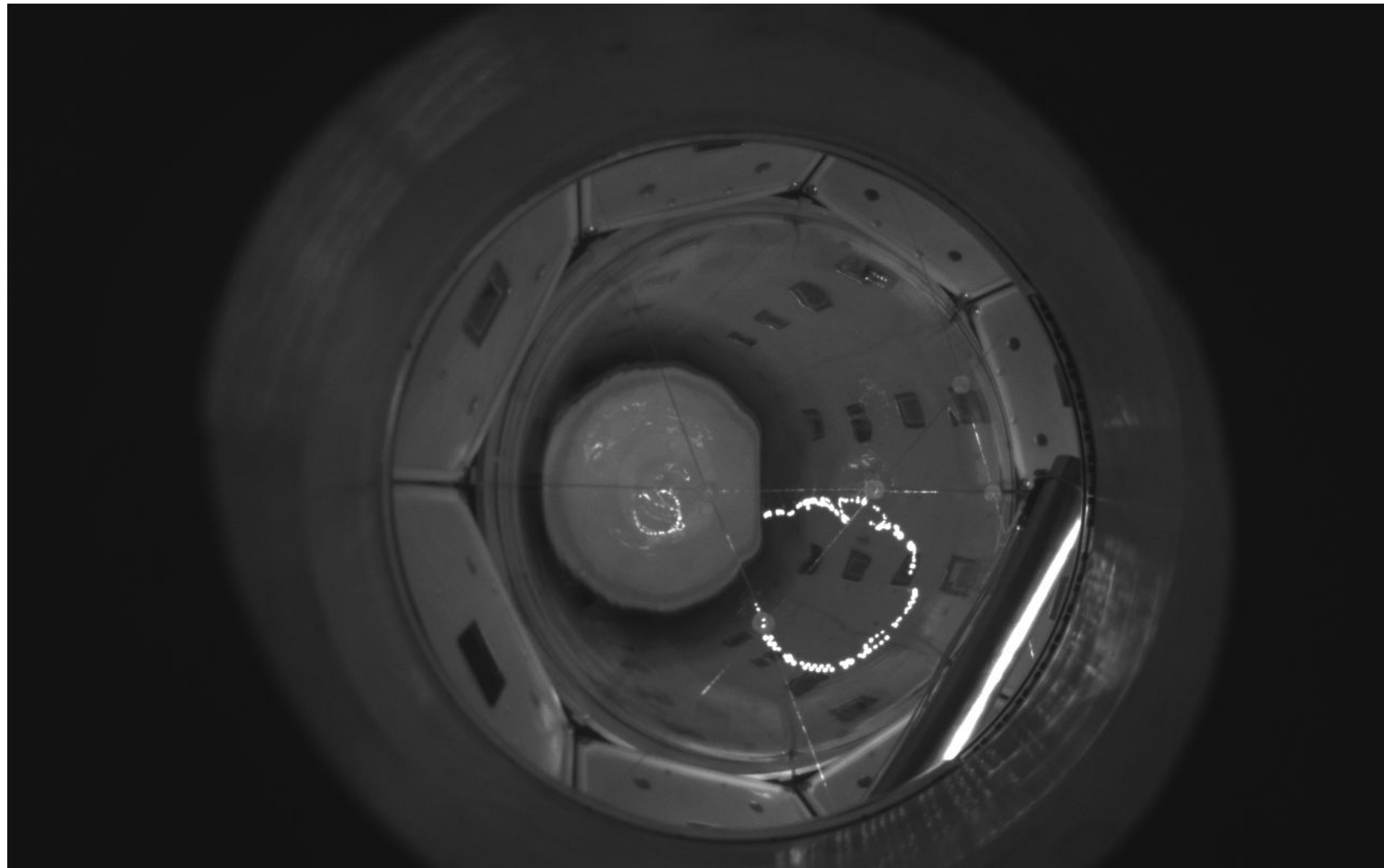
Fermilab Progress

- Cameras & recompression system have been tested and work well!



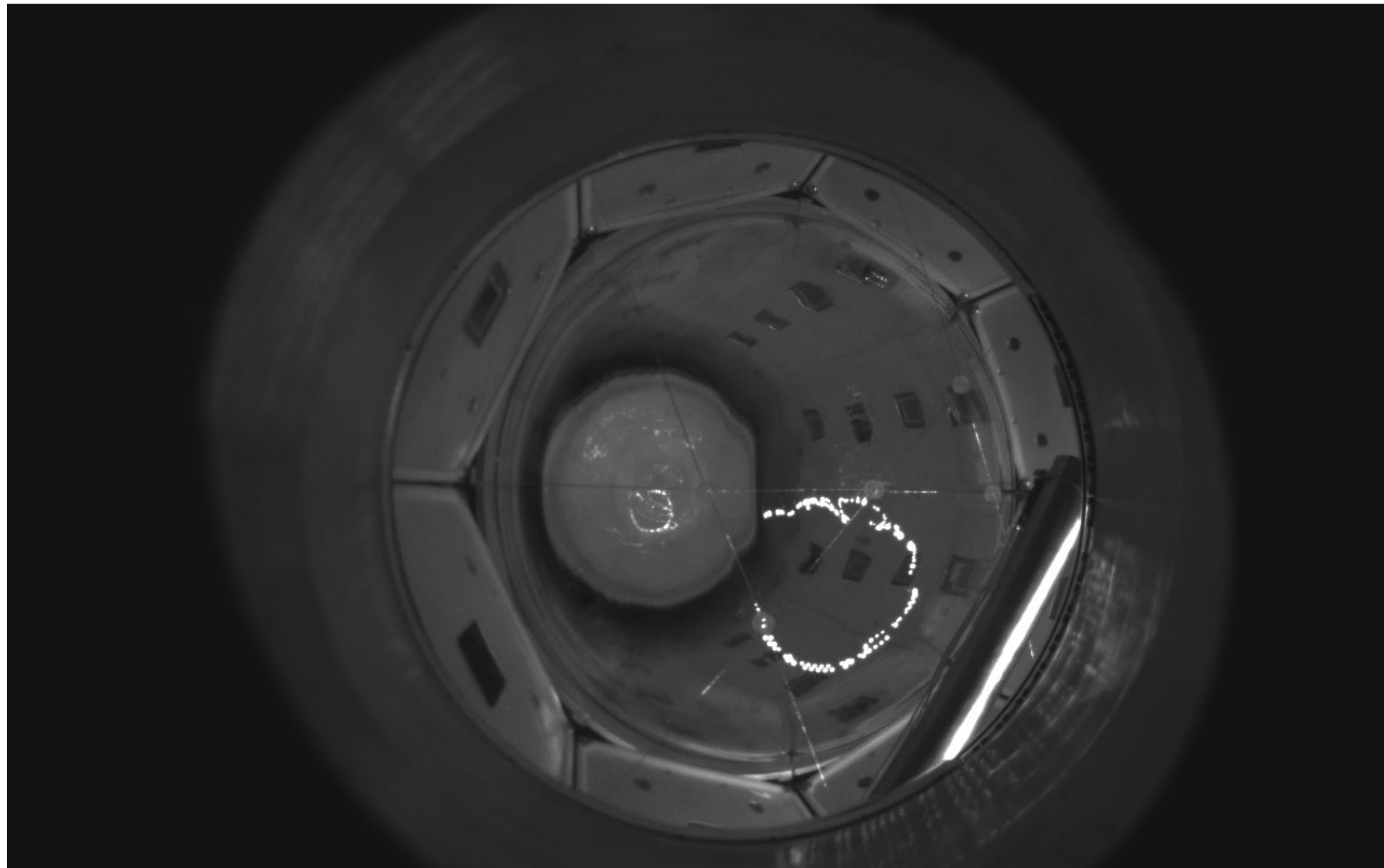
Fermilab Progress

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Fermilab Progress

- Cameras & recompression system have been tested and work well!



Fermilab Progress

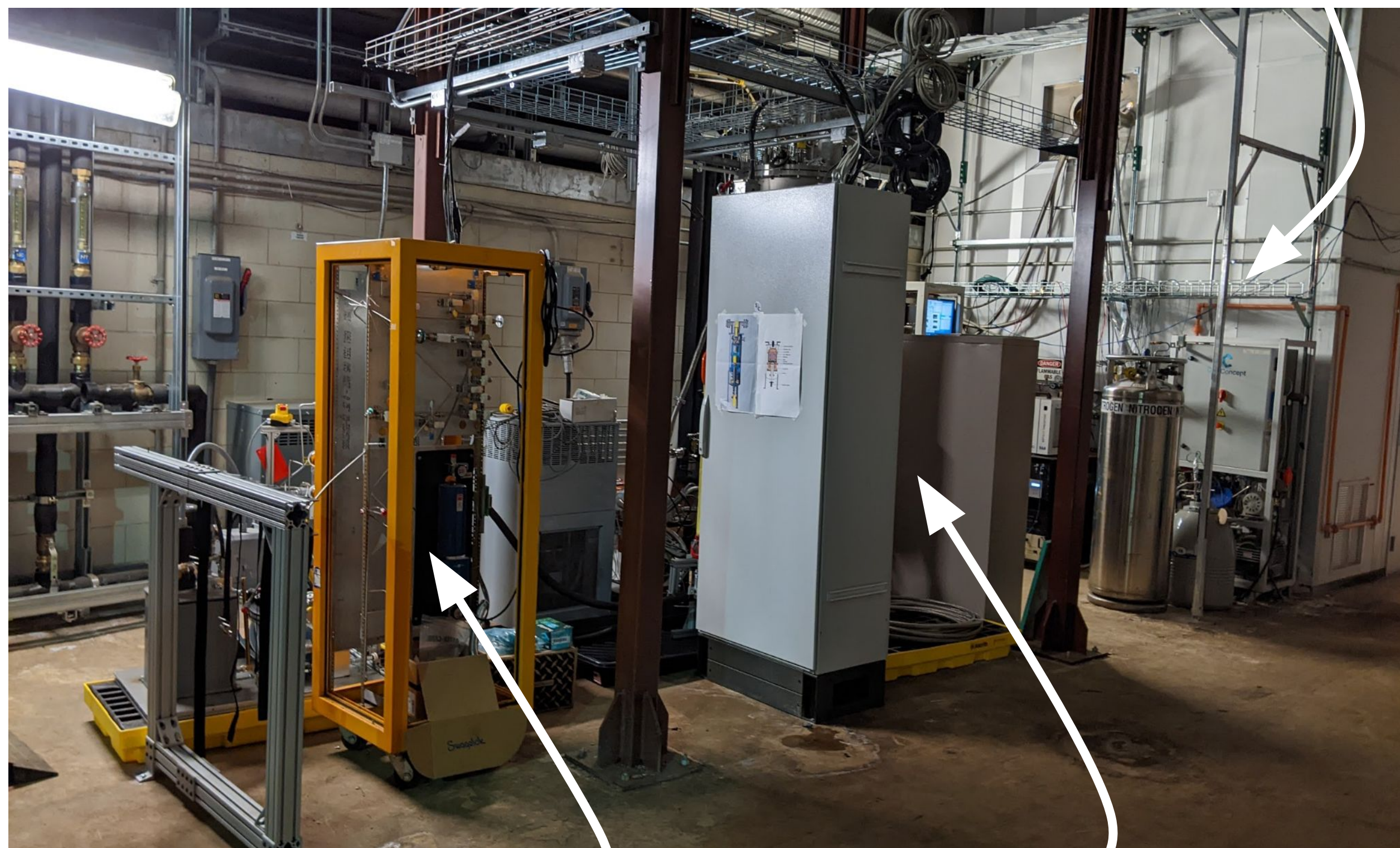
Relocated to MINOS tunnel underground space.



Fermilab Progress

- Now located in the MINOS tunnel, engineering/calibration studies to begin in ~month

NEXUS



MINOS
Near Detector

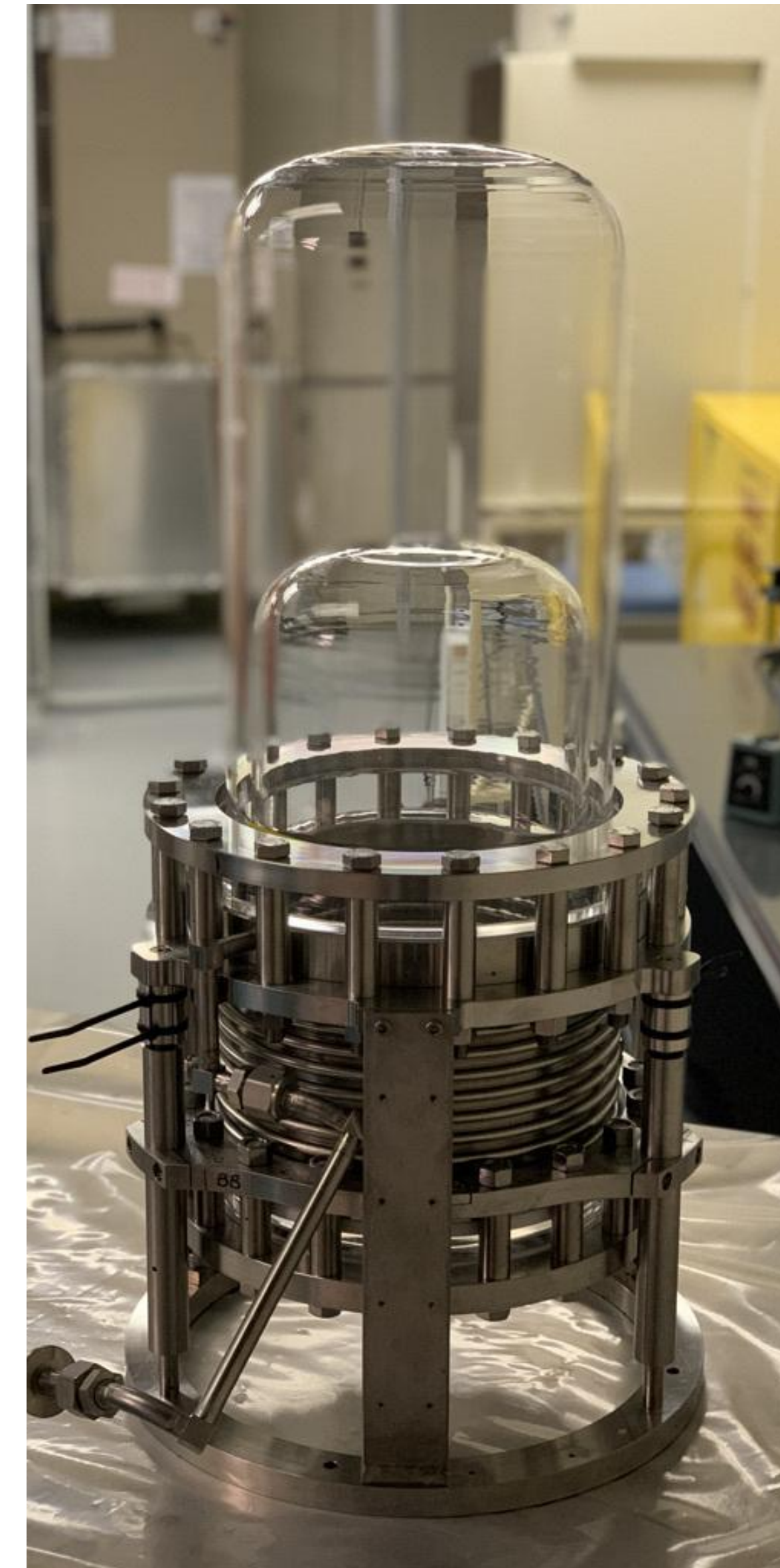
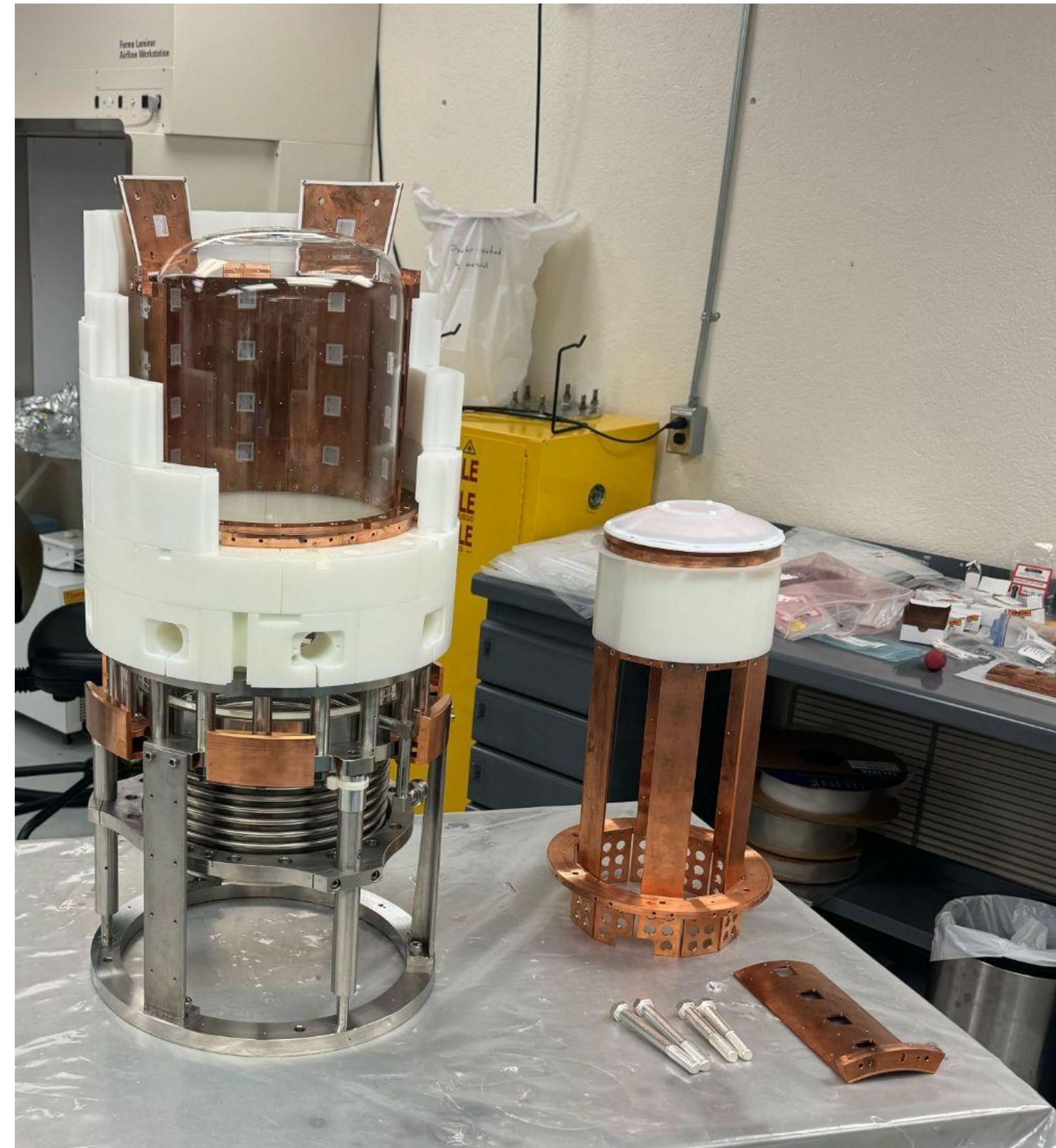
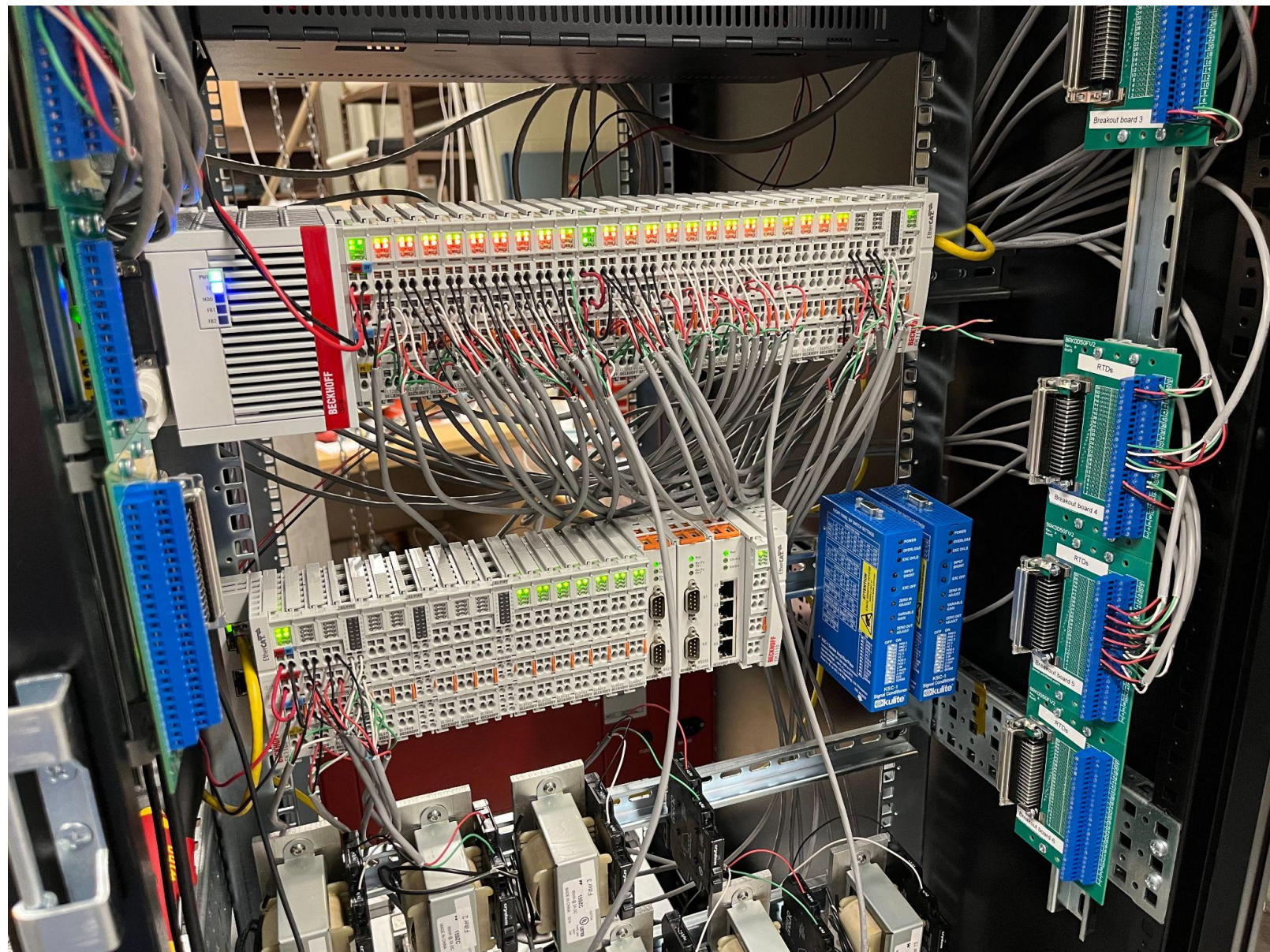
Gas handling
system

SBC



SNOLAB Progress

- The inner assembly components built
- A fabricator for the pressure vessel and vacuum jacket has been identified, the contract is signed, iterating final design
- Wiring & PLC work has begun



Experiment Status - SBC and the TSSA

- Status as of February

Item (manufacturer)	Status	Notes
Sapphire windows (Ceramtec)	Purchased 4 (one for testing), sent for testing	PVEng consulting, redesigned to survive 10x burst test (5250 psi)
Electrical feedthroughs (Ceramtec)	Existing feedthrough sent for testing	PVEng suggested making them thicker, we will test the ones we currently have to 10x first
HV Feedthrough (Solid Sealing Tech)	Existing feedthrough sent for testing	PVEng suggested thicker flange, needs to be tested to 10x pressure
Argon getter (SAES/Entegris)	Removed from panel	P&ID redone to avoid being connected to pressure vessel
CF4 Purifier (Pall/NuPure)	Use PICO's C3F8 purifier, for which they are getting CRN	Overkill for what we need, but thanks PICO!
Pressure Vessel	In talks with fabricator	Will be certified
Pressure Vessel Relief Valve	Investigating options, Aquatrol very promising	Only available with triclamp, tested at Queen's to survive cold and pressure
Gas Panels Orbital Welding (SNOLAB?)	Looking for manufacturer that won't take all the money we've ever had	SNOLAB looking into becoming certified, which would alleviate this entirely
Cryovalve (Stohr)	They are "looking into how much it would cost to let us get a CRN"	Probably going to use another solution here, likely solenoid valve
Dome loaded pressure balancing regulator (?)	Redesigning P&ID	No suppliers found with CRN or any interest in getting them registered



Experiment Status - SBC and the TSSA

Current status. Still working with PVEng to get through the TSSA processes

Item (manufacturer)	Status	Notes
Sapphire windows (Ceramtec)	Purchased 4, arrived at Queen's, will go out to PVEng for burst testing	PVEng consulting, redesigned to survive 10x burst test (5250 psi)
Electrical feedthroughs (Ceramtec)	Ordered, have one to test at PVEng	PVEng suggested making them thicker, we will test the ones we currently have to 10x first
HV Feedthrough (Solid Sealing Tech)	Existing feedthrough sent for testing	PVEng suggested thicker flange, needs to be tested to 10x pressure
Argon getter (SAES/Entegris)	Removed from panel	P&ID redone to avoid being connected to pressure vessel
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Gas Panels Orbital Welding (SNOLAB?)	Looking for manufacturer that won't take all the money we've ever had	SNOLAB looking into becoming certified, which would alleviate this entirely
Cryovalve (Stohr)	Stohr agreed to send documentation for TSSA registration	We've paid for docs+valves, send docs to PVEng
Dome loaded pressure balancing regulator (?)	Redesigned P&ID	No suppliers found with CRN or any interest in getting them registered

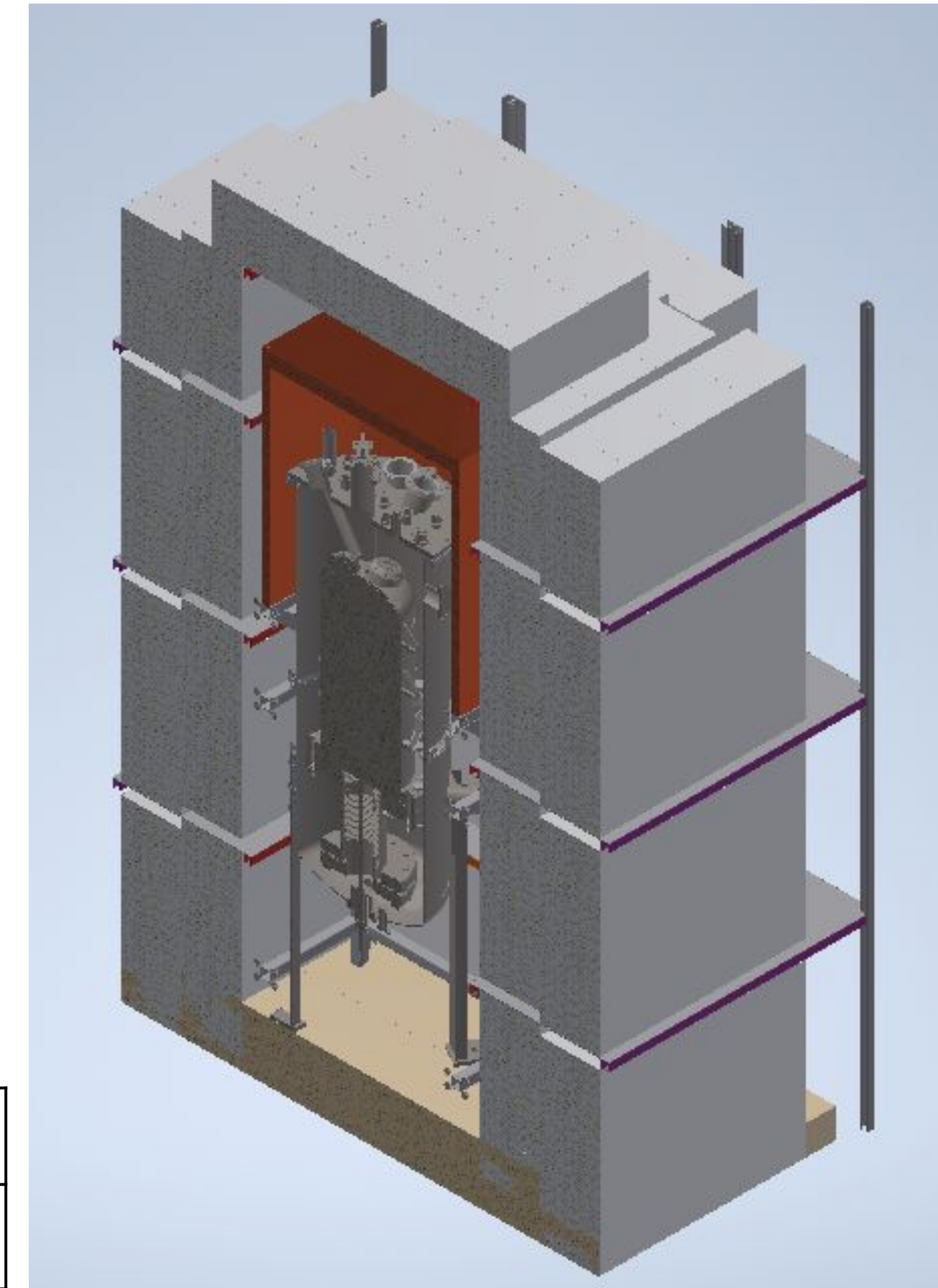


Experiment Status - Shielding

- Extensive effort put into determining shielding necessary to run u/g
- Both neutron and gamma budget being finalized, have guided the path forward for our operations plan
- Shield design through SNOLAB engineering support

	Neutrons		Gammas
	Single Scatters / y	Single Scatters in ROI / y	Single Scatters in ROI / y
Unshield	4009 +/- 771 (Sys.) +/- 41 (Stat.)	3310 +/- 652 (Sys.) +/- 38 (Stat.)	2100
w/ shield	5 +/- 1 (Sys). +/- 2 (Stat.)	5 +/- 1 (Sys). +/- 2 (Stat.)	10 +/- in progress

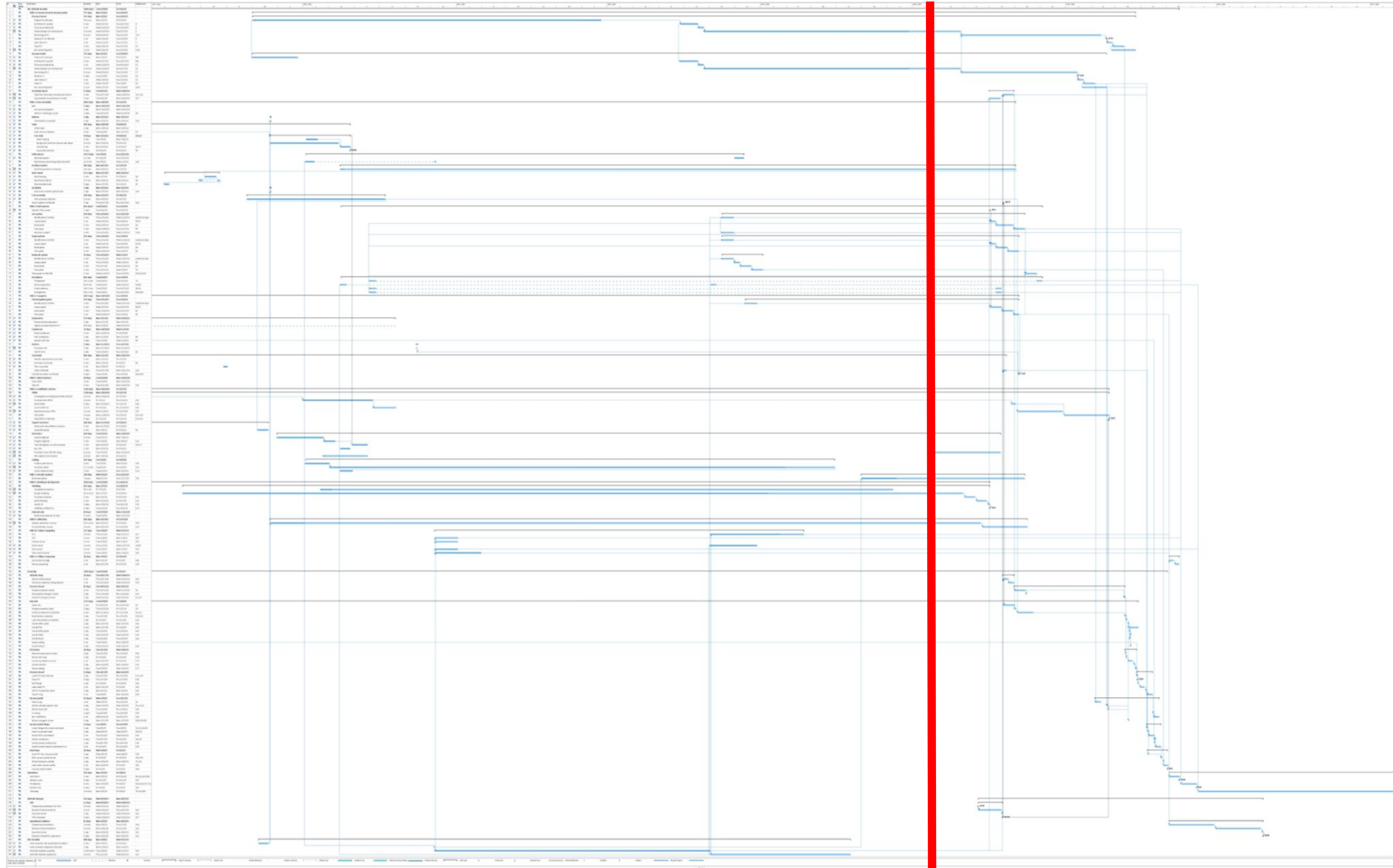
Water box + Cu shield



Schedule

2024

2025

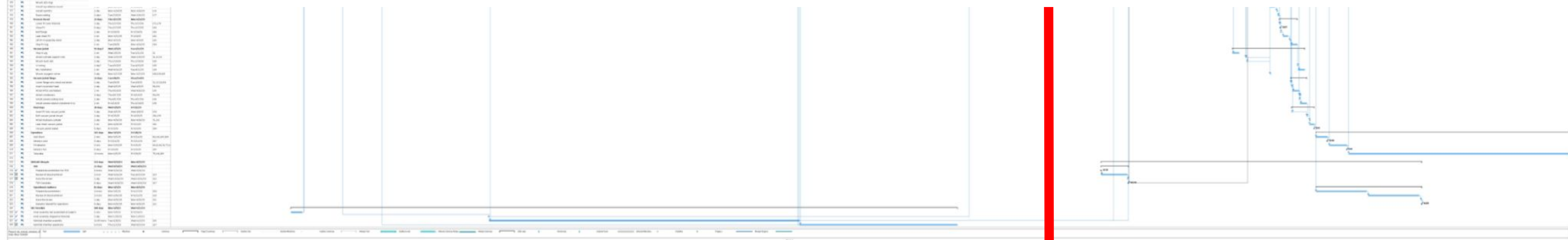


Schedule



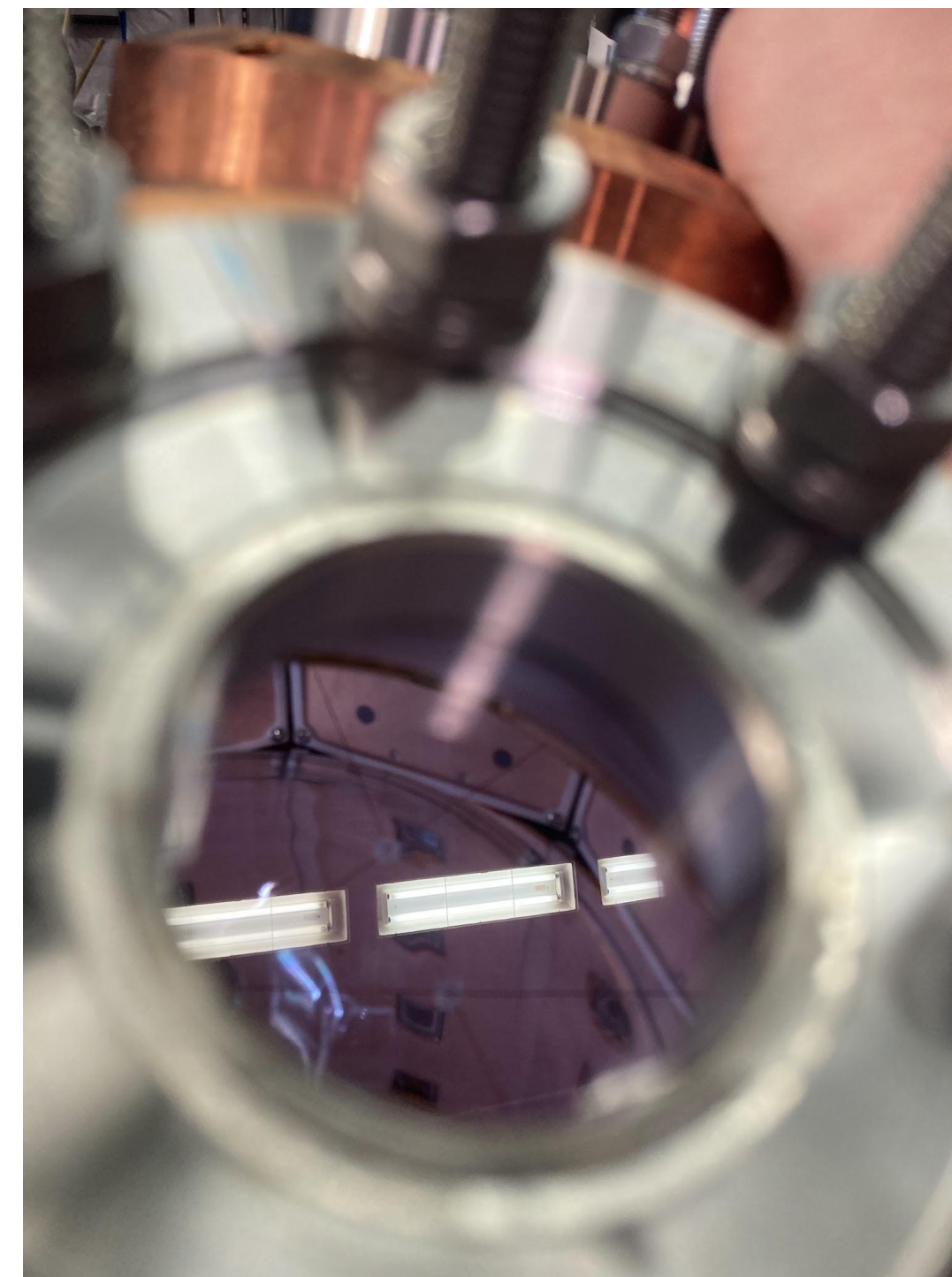
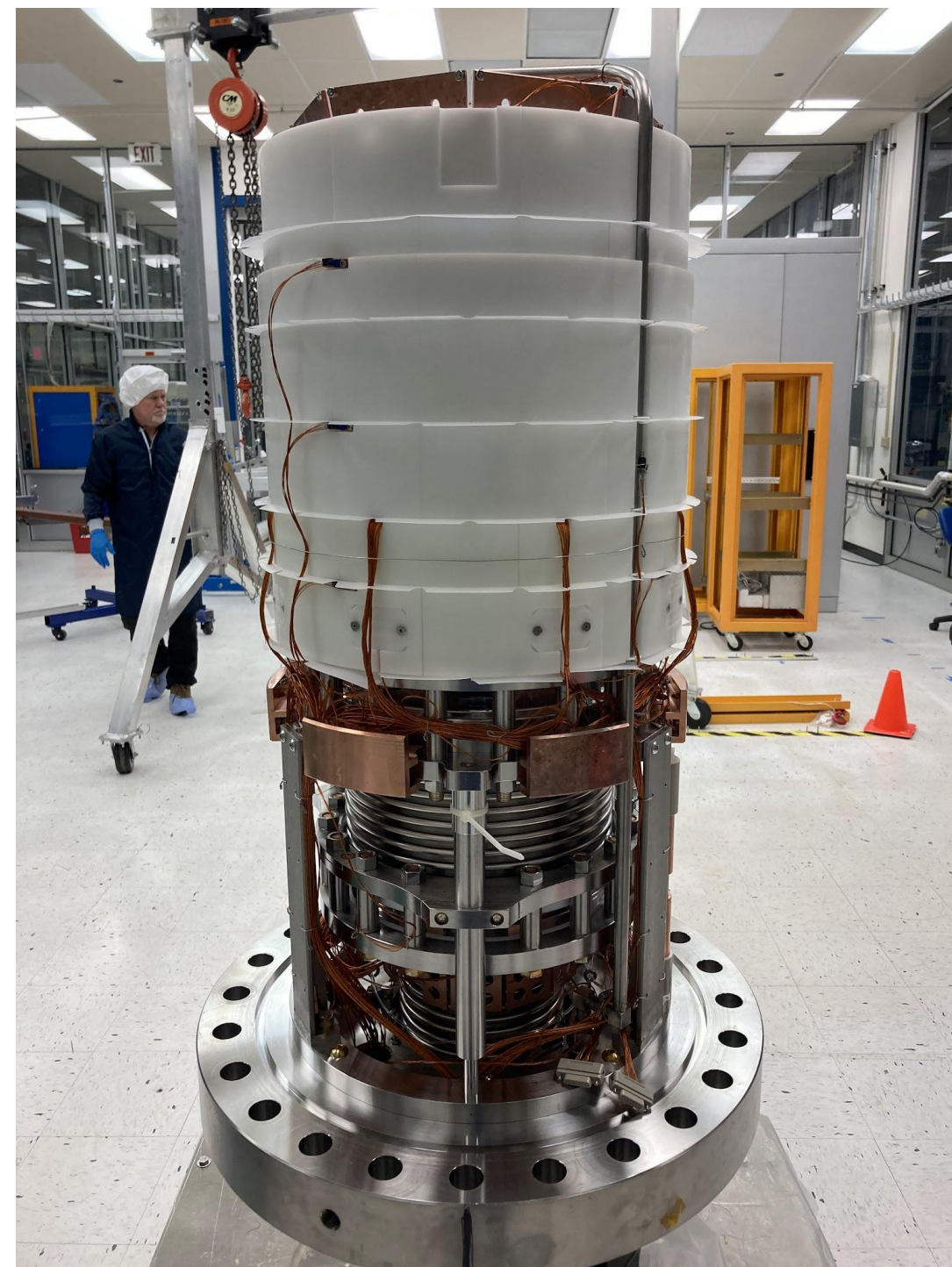
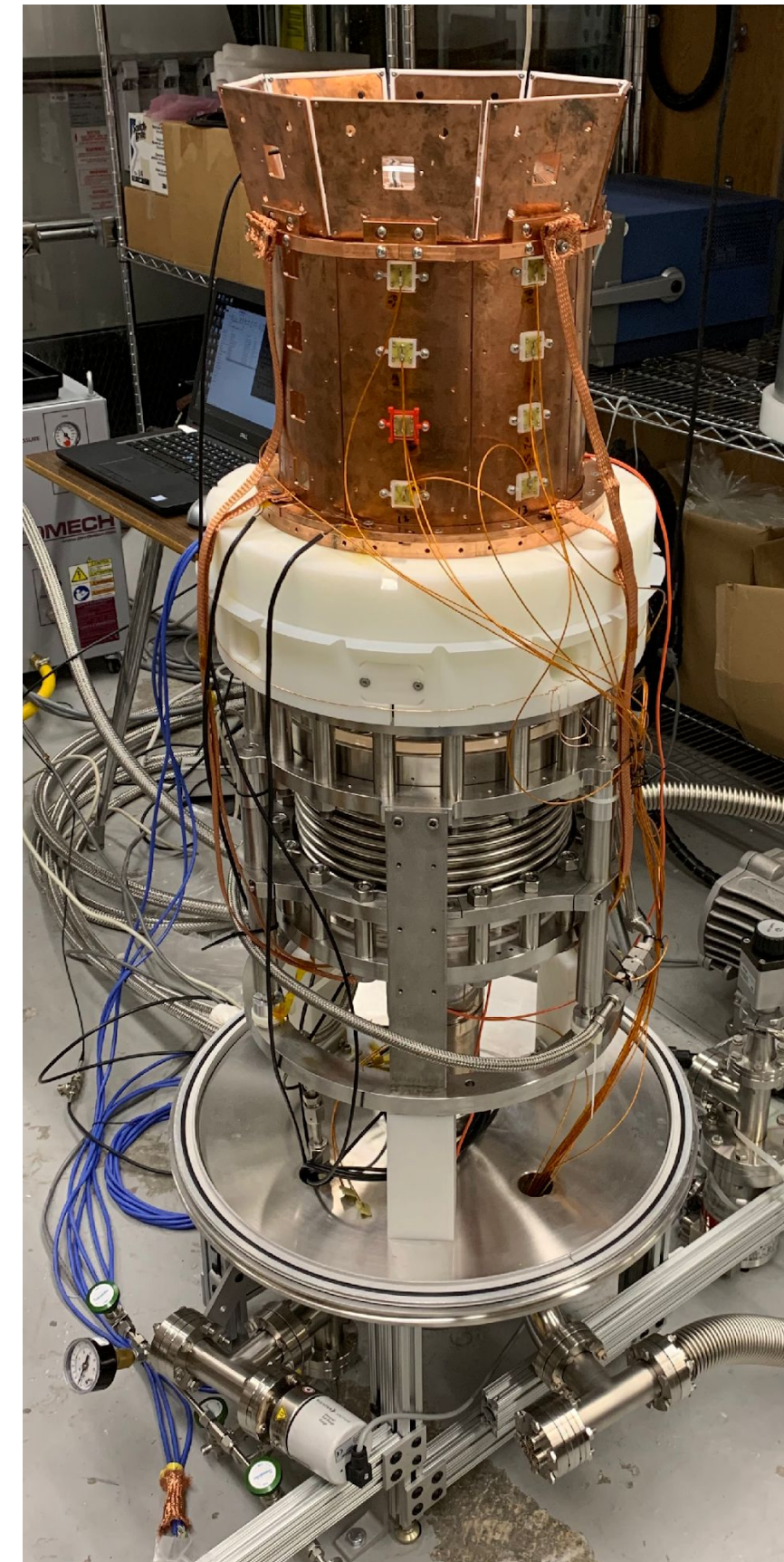
Highlights:

- Schedule currently driven by PV & VJ procurement
 - this gives more time to prepare for surface work
- TDR this fall
 - SNOLAB cleanroom installation to begin thereafter
- Operation u/g in end of 2025



Conclusion

- SBC continues to make progress, faster than in the past and accelerating all the time
- Operation of the Fermilab chamber will provide proof of threshold, the SNOLAB chamber will proceed quickly
- The next update should continue this positive trend





K. Clark, A. Wright, B. Broerman
A de St Croix, C. Garrah, H. Hawley
Herrera, G. Sweeney, E. Wyman,
J. Walker, K. Dering,
J. Corbett, N. Moss



UNIVERSITY OF
ALBERTA

M.-C. Piro, M. Baker, Y. Ko



R. Castelloux, J. Hall

Université 
de Montréal

M. Laurin



P. Giampa



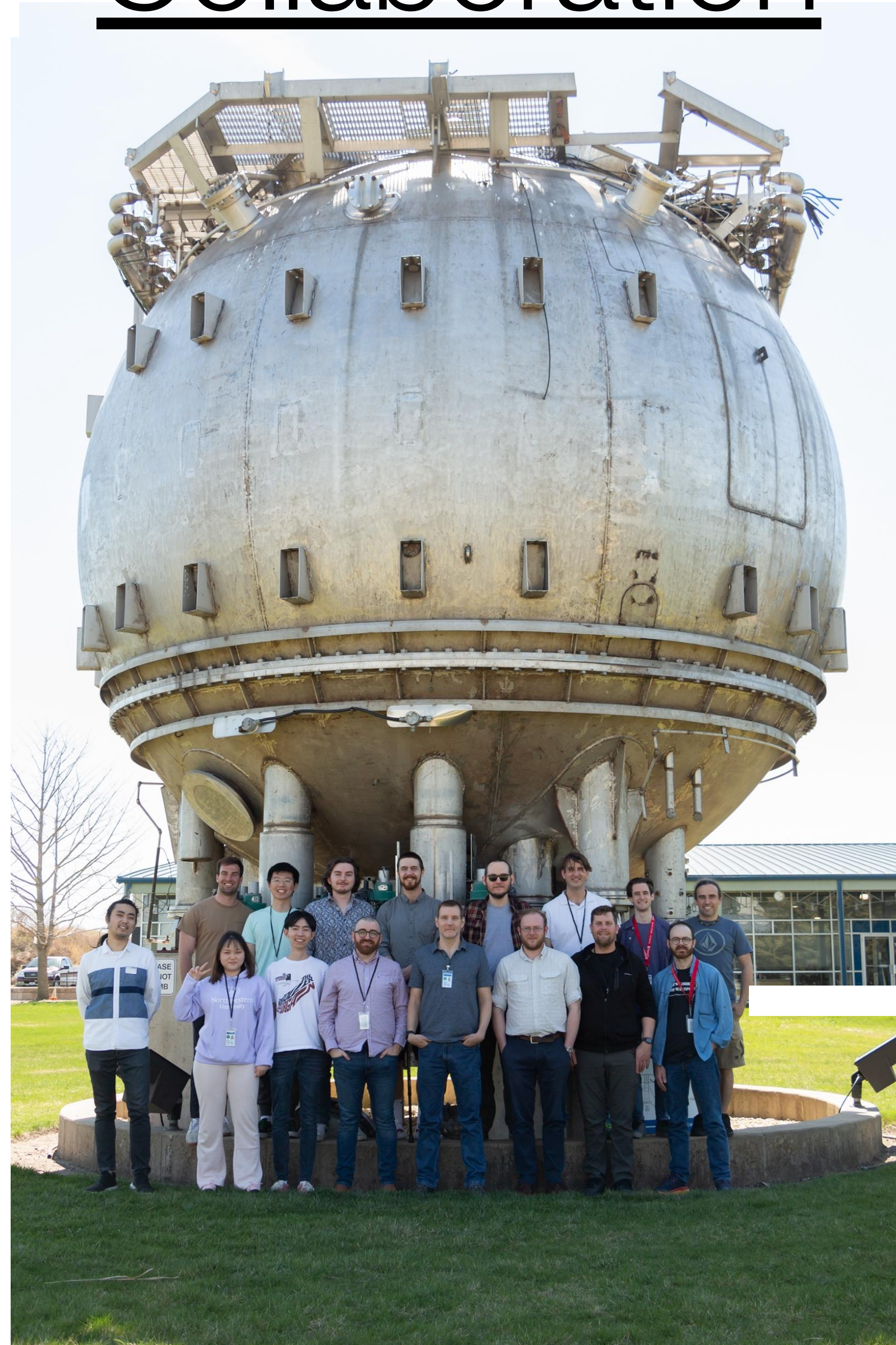
E. Vazquez-Jauregui,
E. Alfonso Pita,
O. Ivan Valdez Martinez



O. Harris



Collaboration



Northwestern
University

C.E. Dahl, B. Mitra, J.
Long, Z. Sheng,
E. Rengifo, P. Rodriguez,
D. Campos



R. Neilson, N. Lamb,
D. Pyda, J. Fritz-Littman



H. Lippincott, T. Whitis,
R. Zhang, L. Joseph



INDIANA UNIVERSITY
SOUTH BEND

I. Levine, E. Behnke,
C. Cripe



D. Baxter, G. Putnam



PennState

S. Priya



S. Westerdale



Pacific Northwest
NATIONAL LABORATORY

C. Jackson



