The Scintillating Bubble Chamber

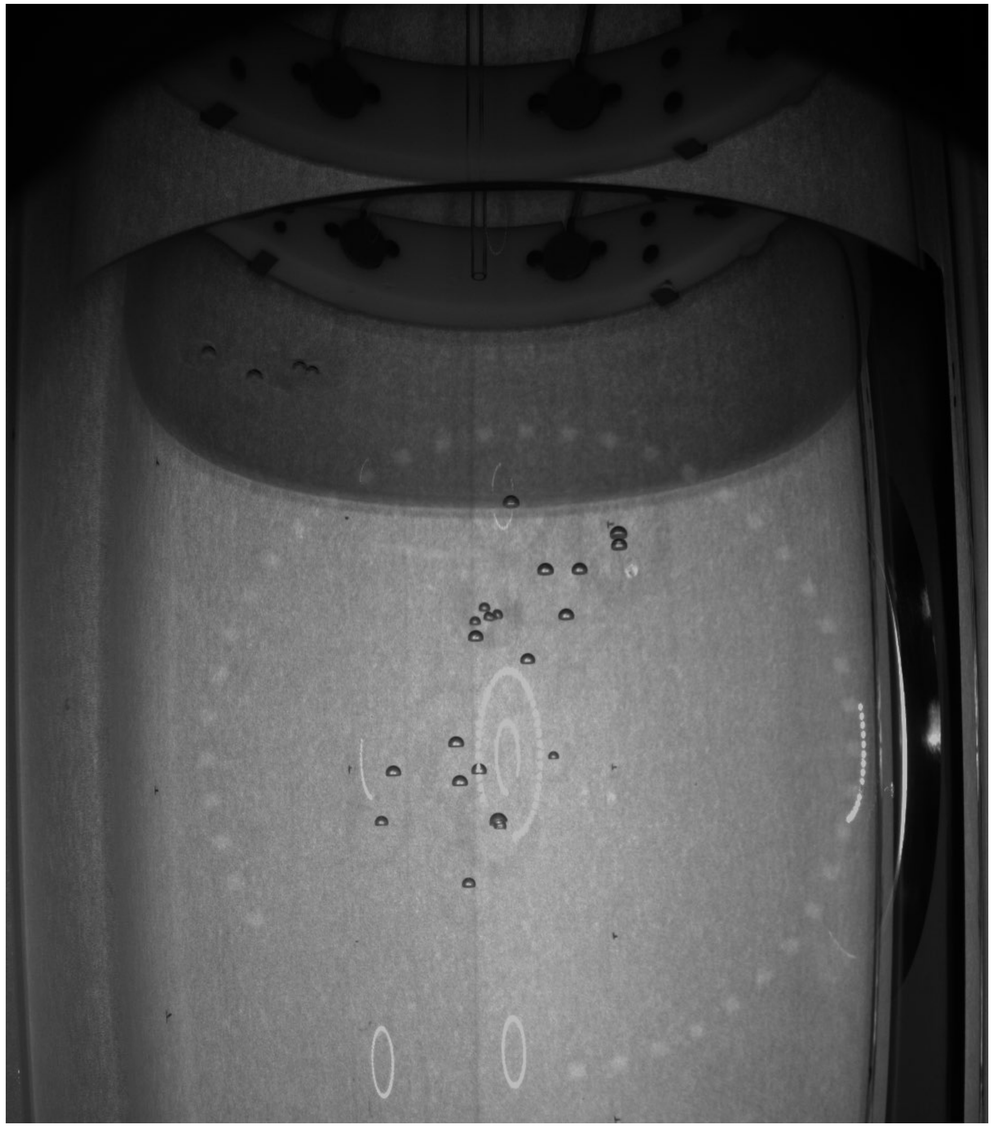
Ken Clark
Queen's University

Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

Queen's University

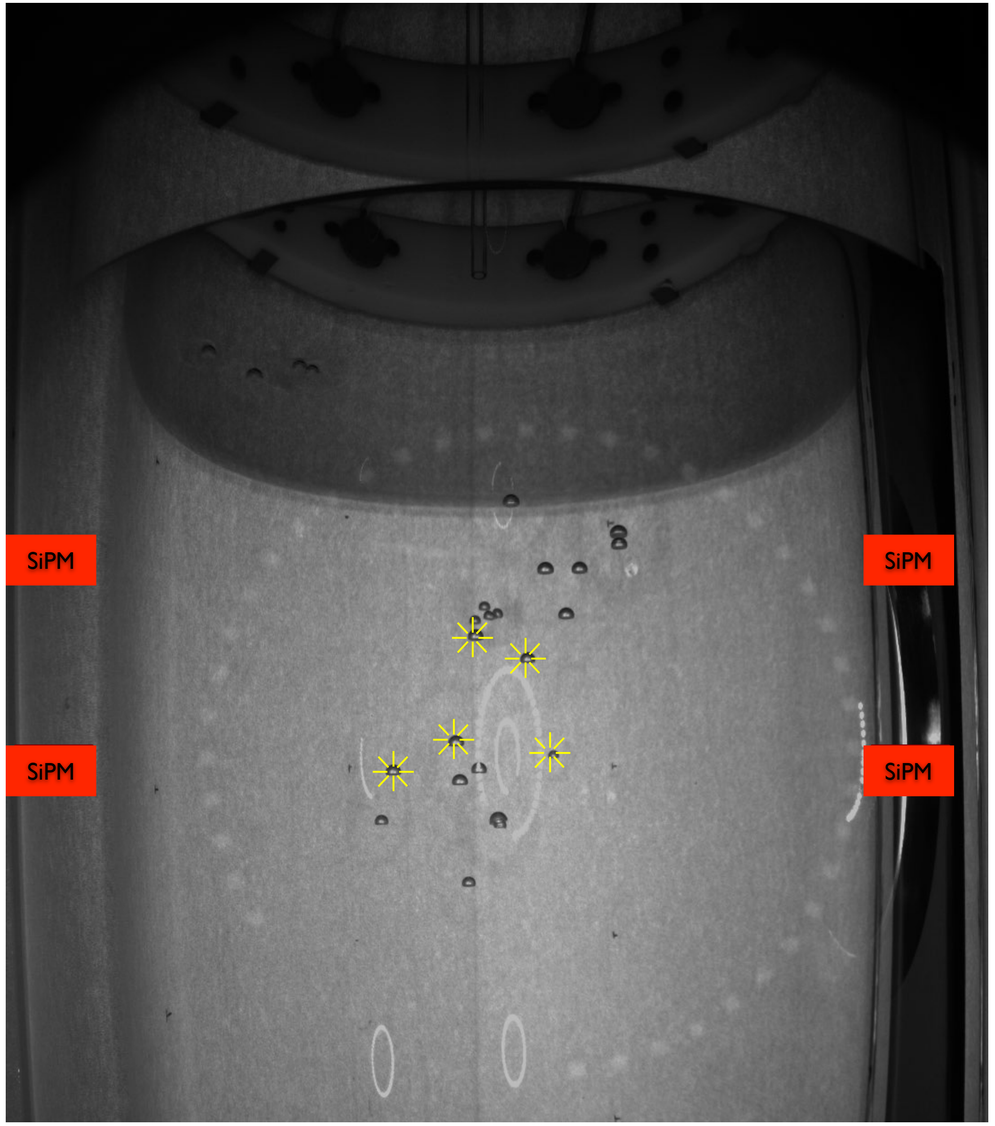
The “traditional” bubble chamber

- Superheated target (C_3F_8, CF_3I…)
- Particle interactions nucleate bubbles
- Cameras and acoustic sensors capture signals
- Chamber recompresses after each event



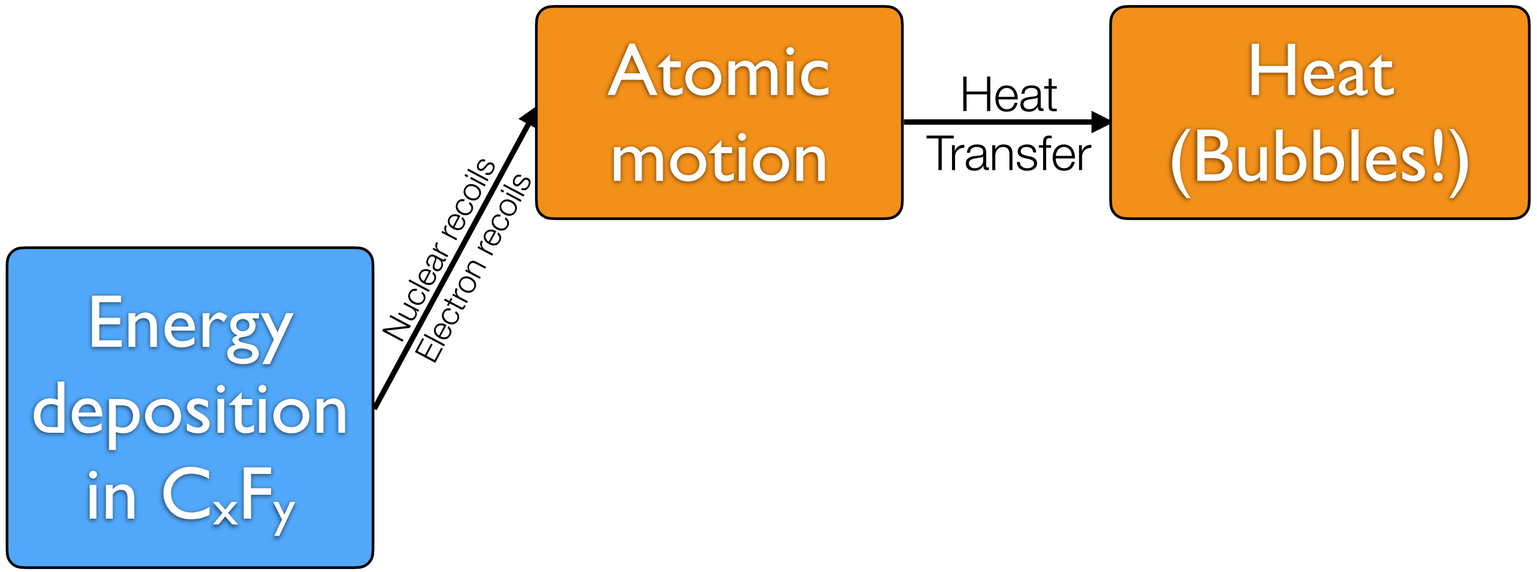
The *scintillating* bubble chamber

- Superheated scintillator (Xe, Ar…)
- Particle interactions nucleate bubbles and cause scintillation
- Cameras and acoustic sensors capture signals, photodetectors collect scintillation light
- Chamber recompresses after each event



Why would we want to do this?

- This is a difficult thing to do
- Lower thresholds are not possible with a traditional chamber
- The superheated scintillator allows this to happen



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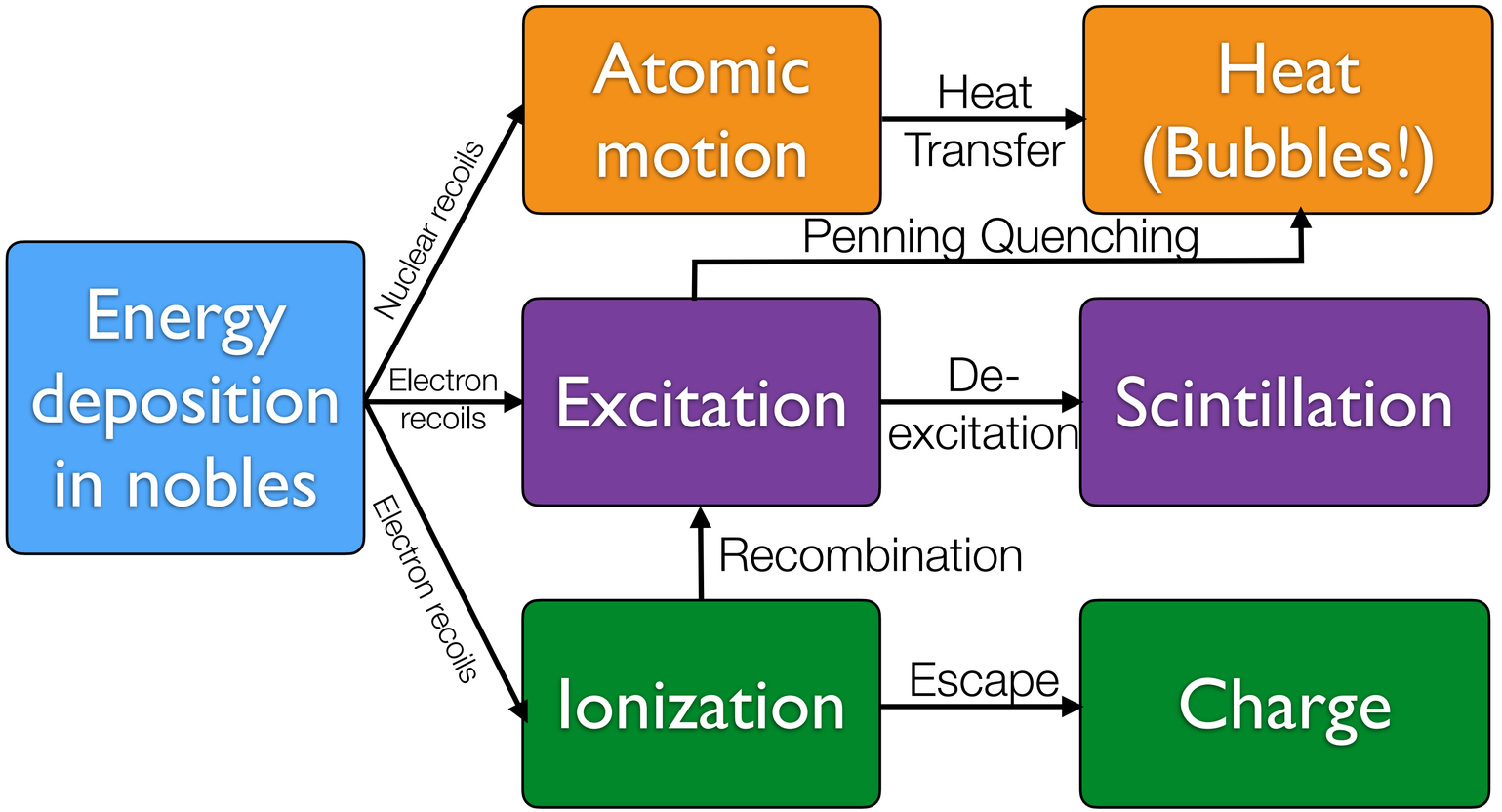

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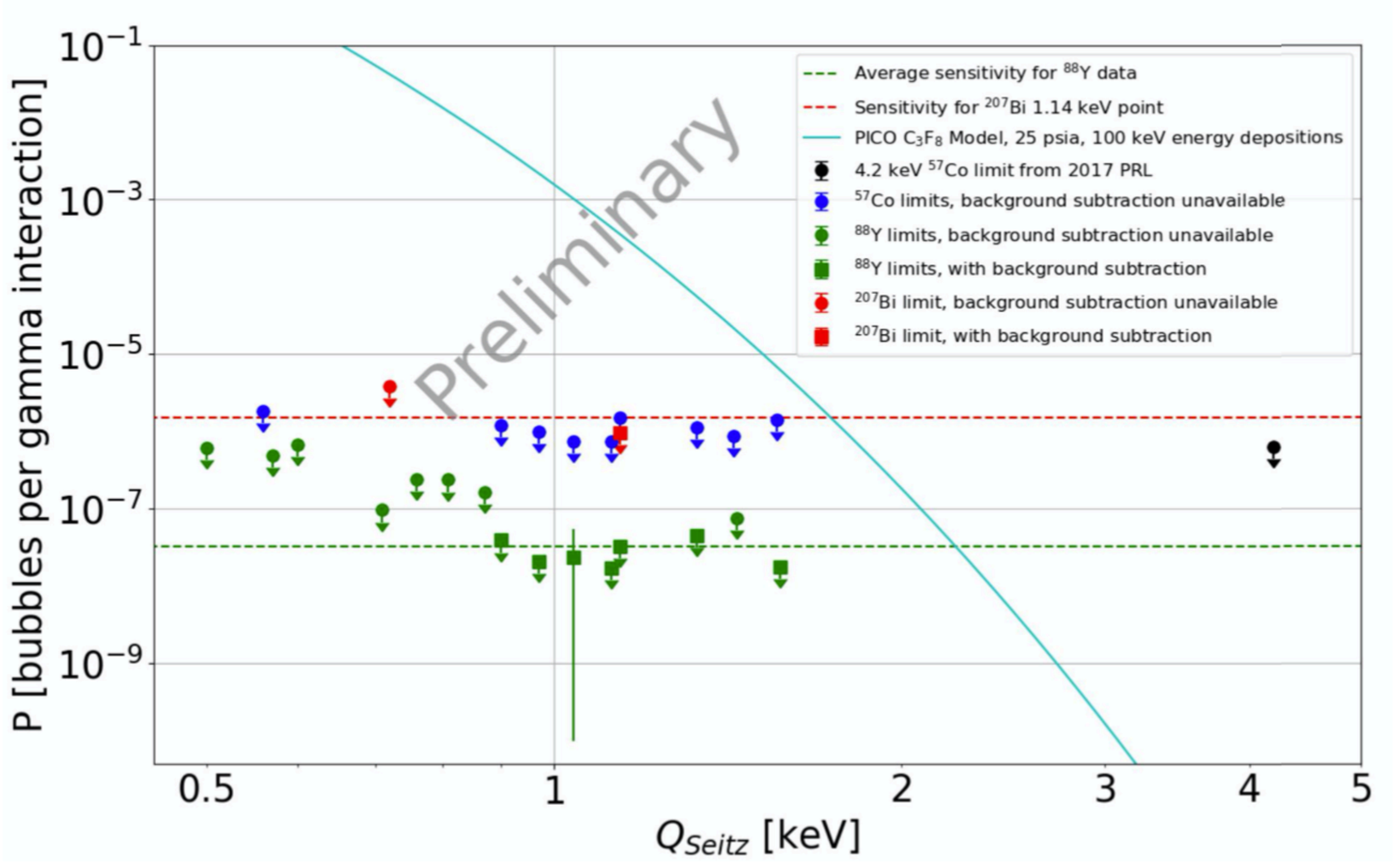
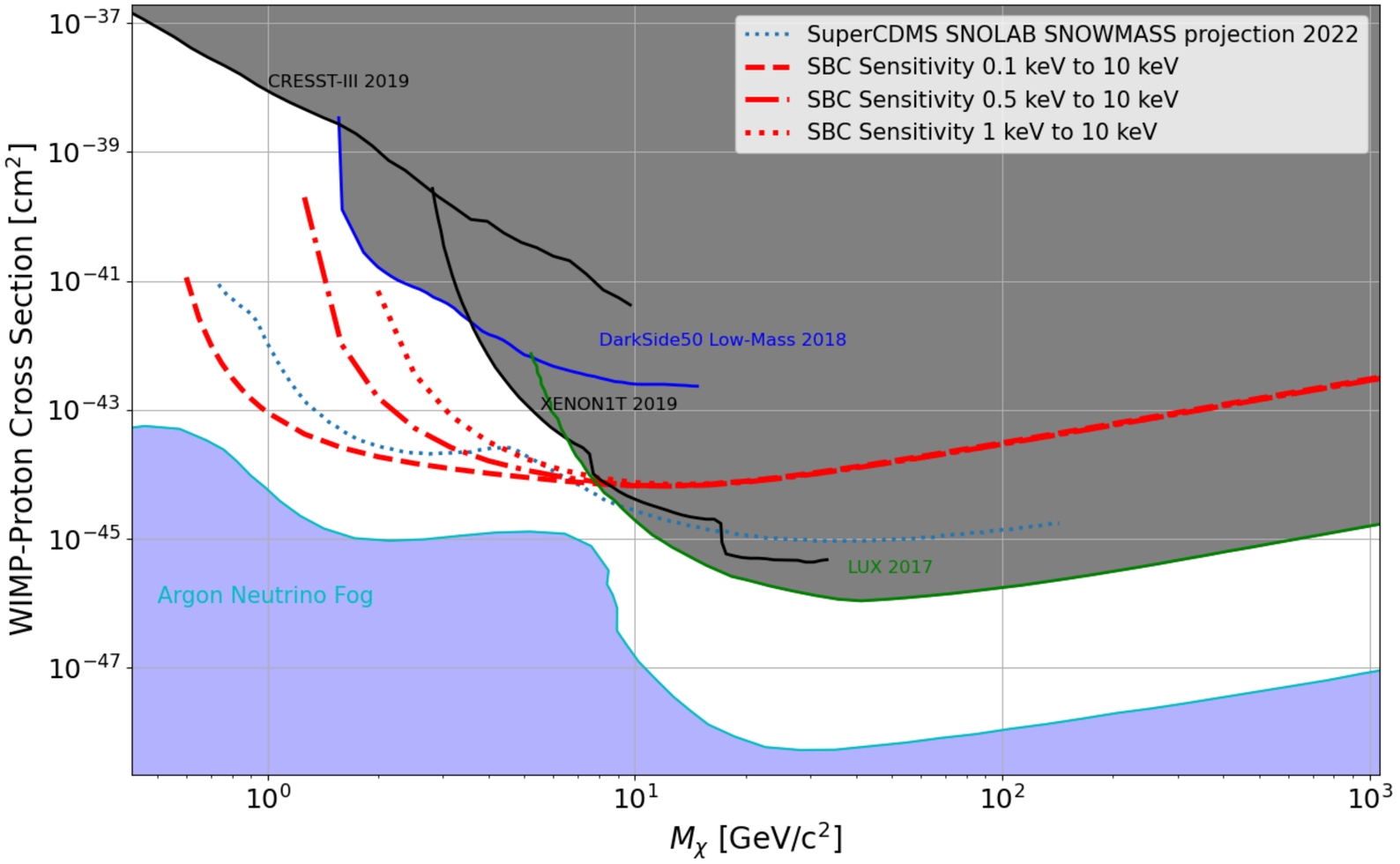
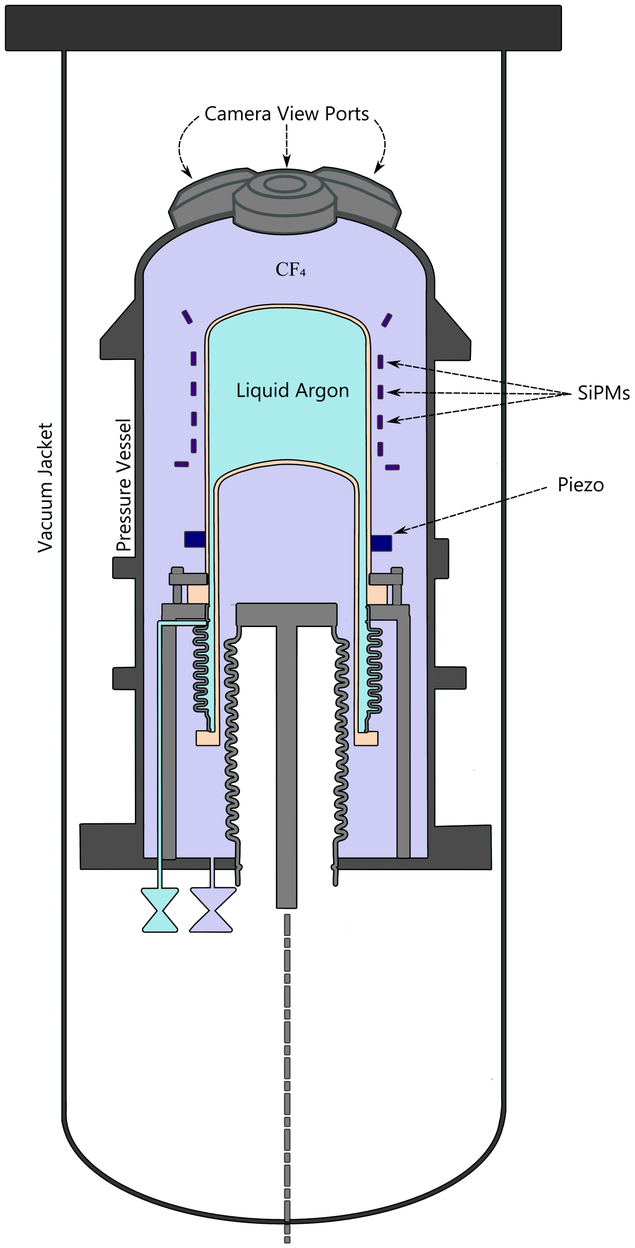


What does this gain us?



- Lowering the threshold opens up significant area in the low mass search
- Note this assumes only CEvNS backgrounds and 10kg-year live time

How are we doing 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

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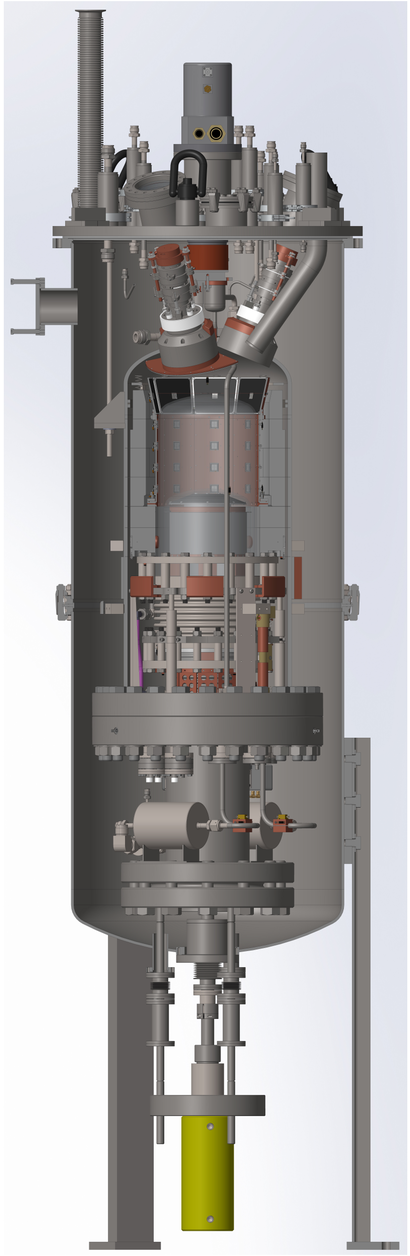

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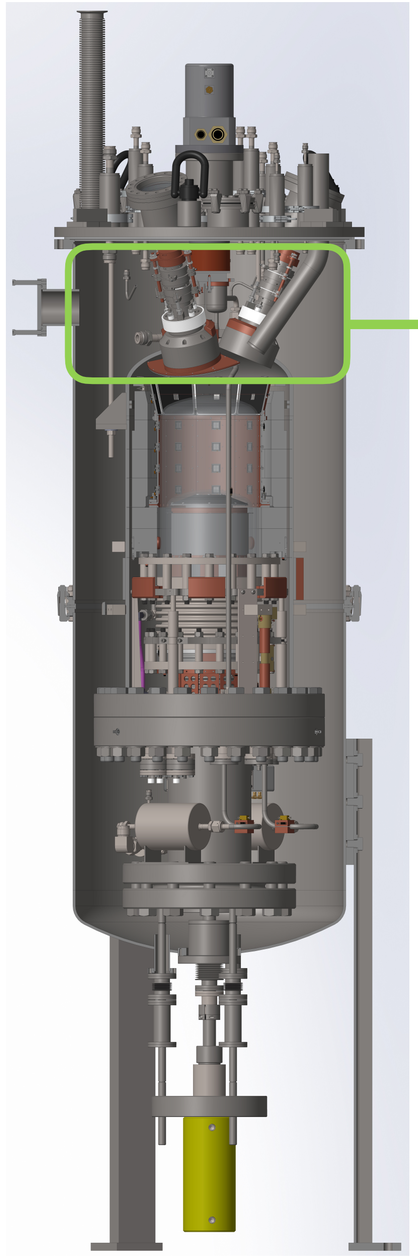
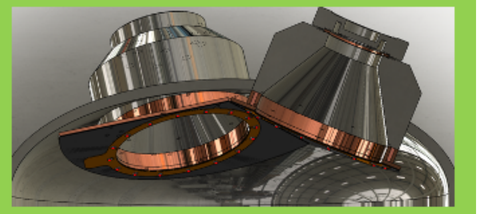
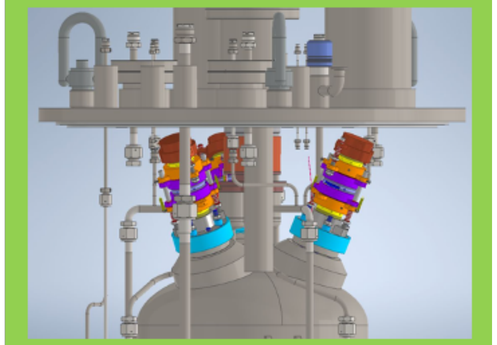
Data Collection

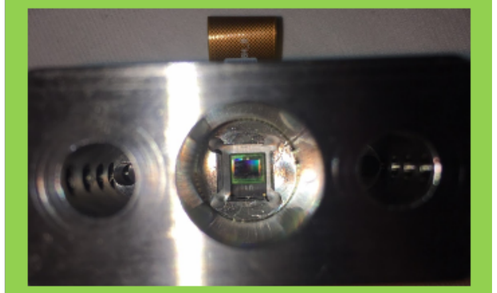


Bubble Imaging

3 Raspberry-Pi Cameras + LEDs







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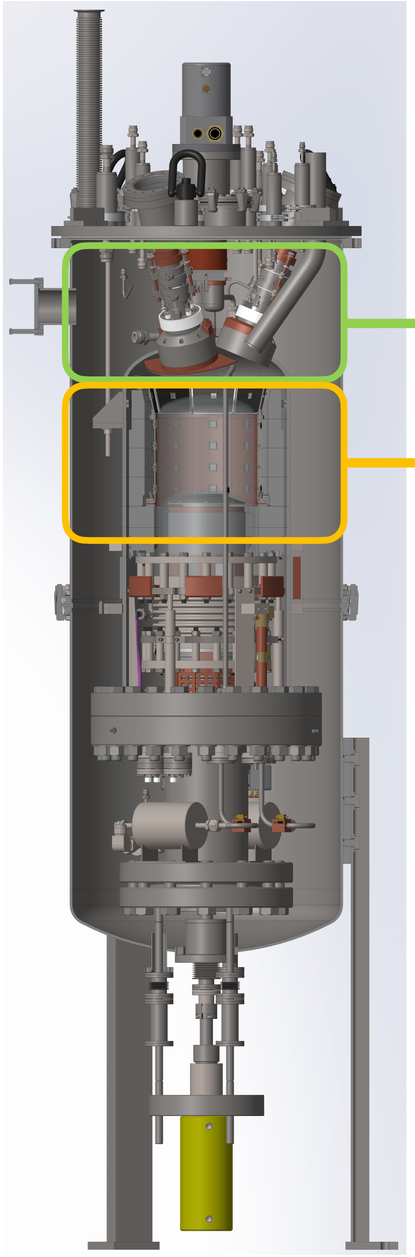

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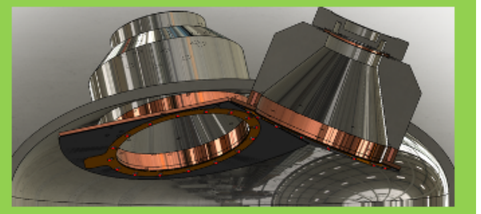
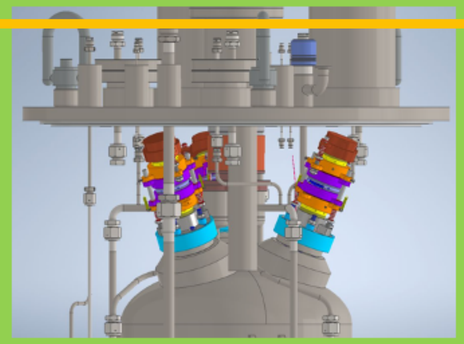
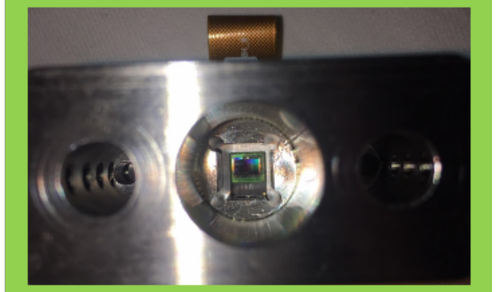
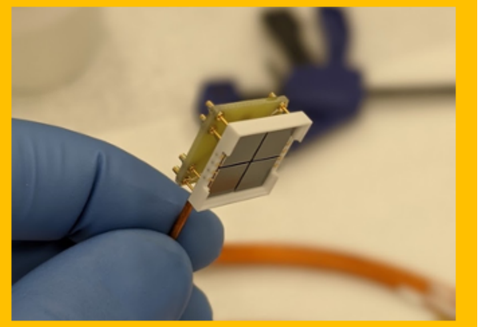






Scintillation System

32 FBK SiPMs



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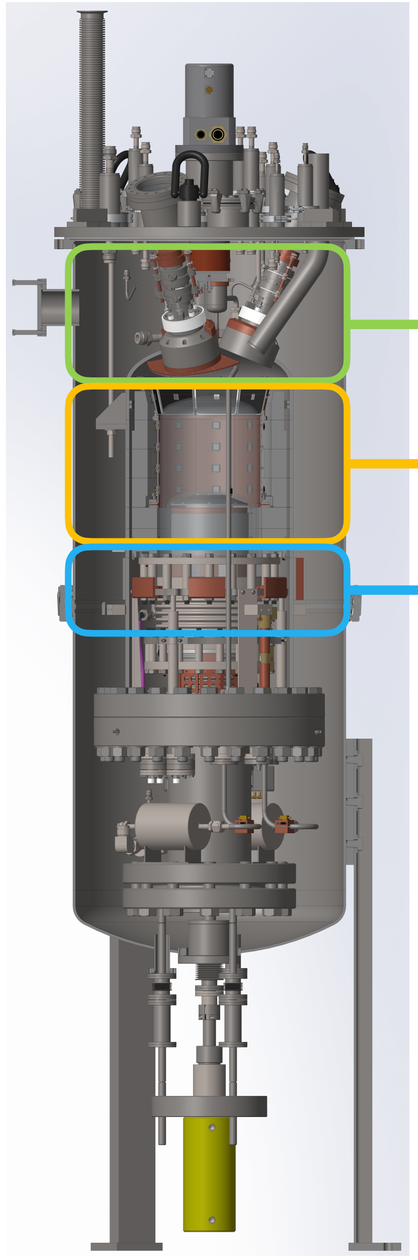

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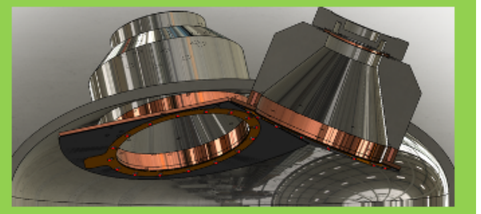

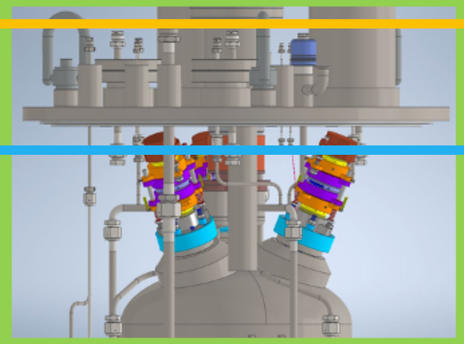

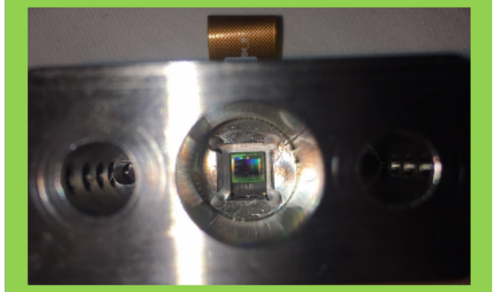

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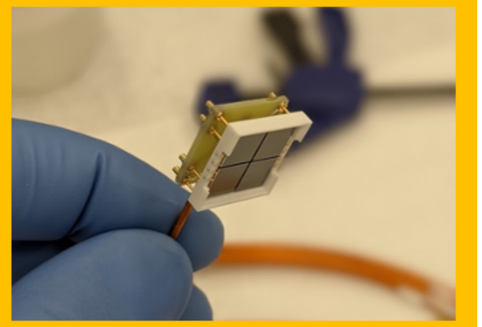
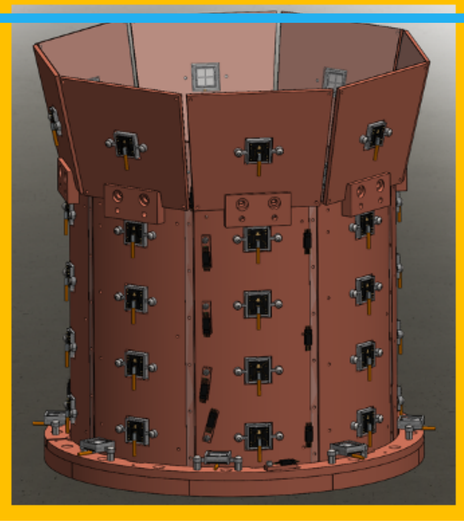
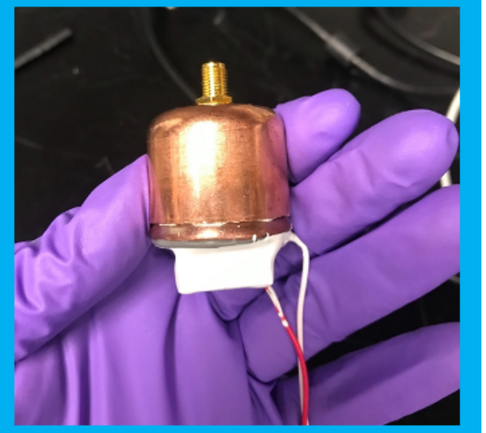
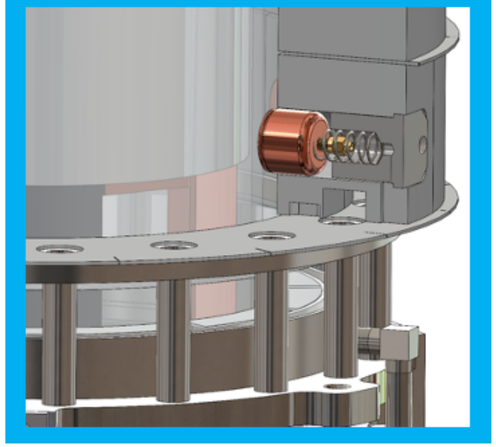




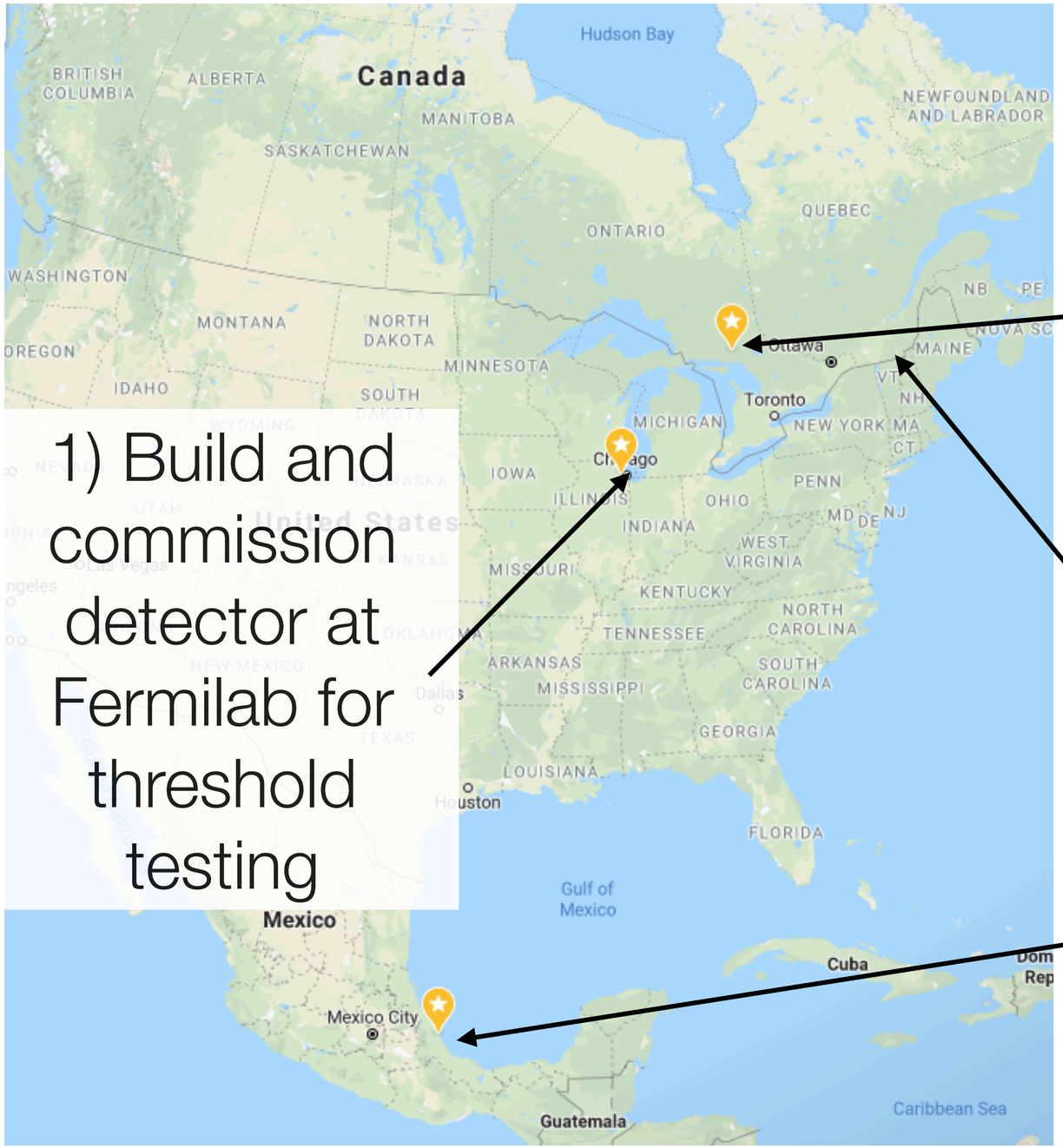
Acoustic Sensors

8 Piezoelectric Transducers





Collaboration Plan



1) Build and commission detector at Fermilab for threshold testing

2) Build and install detector at SNOLAB for DM search

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

Fermilab Progress

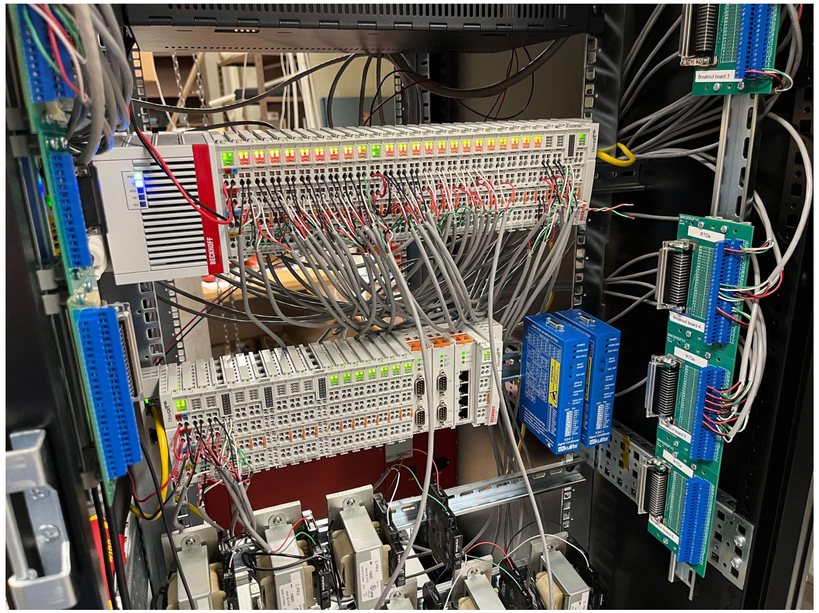
Relocated to MINOS tunnel underground space.

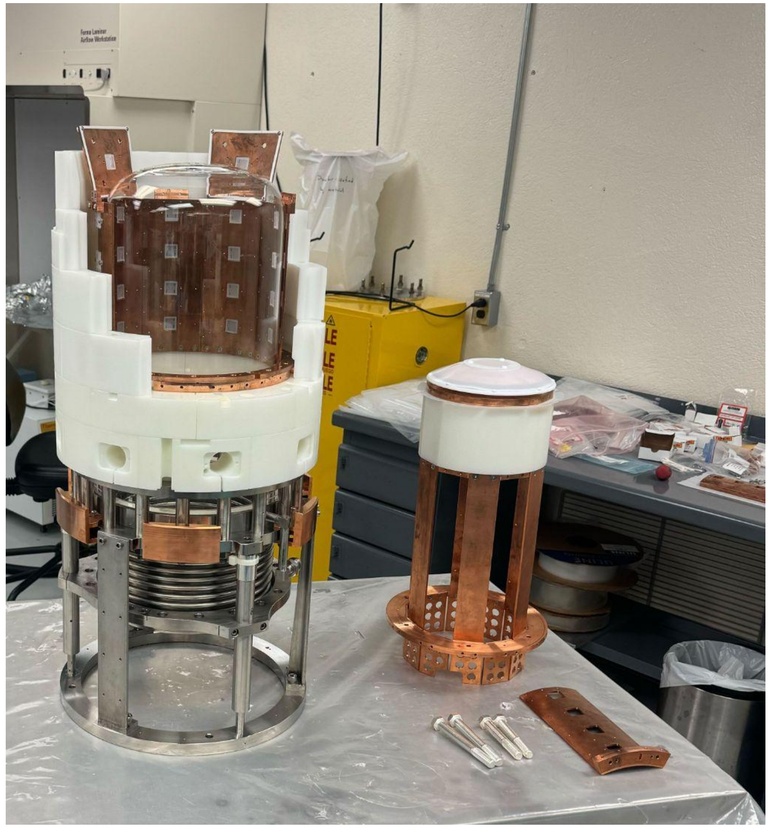
Fermilab Progress

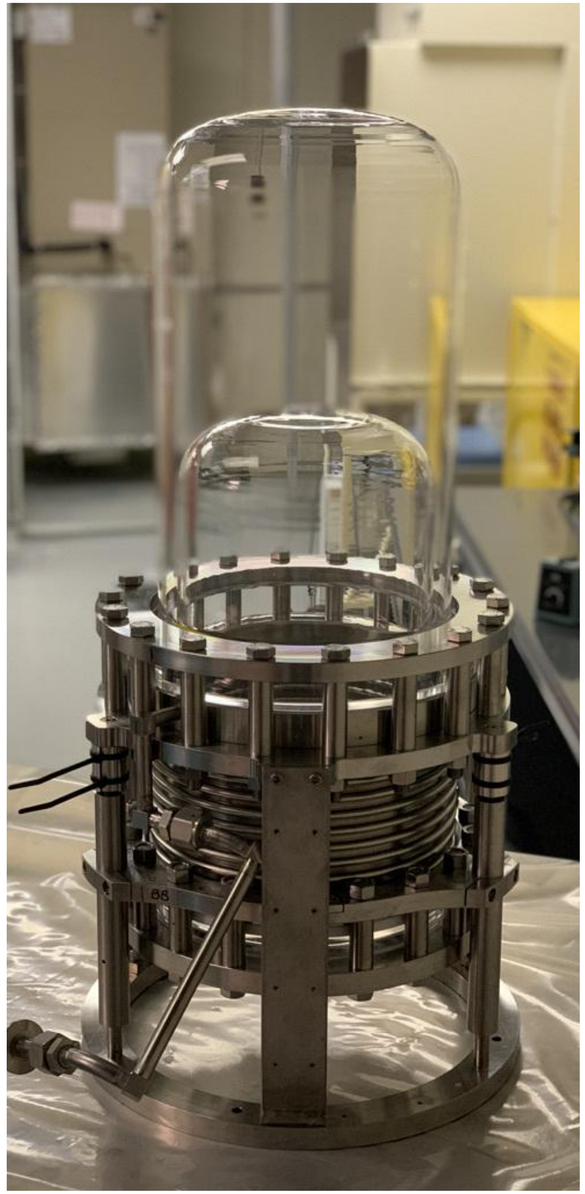
- Now located in the MINOS tunnel, engineering/calibration studies to begin in ~month

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/Entergis)	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

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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
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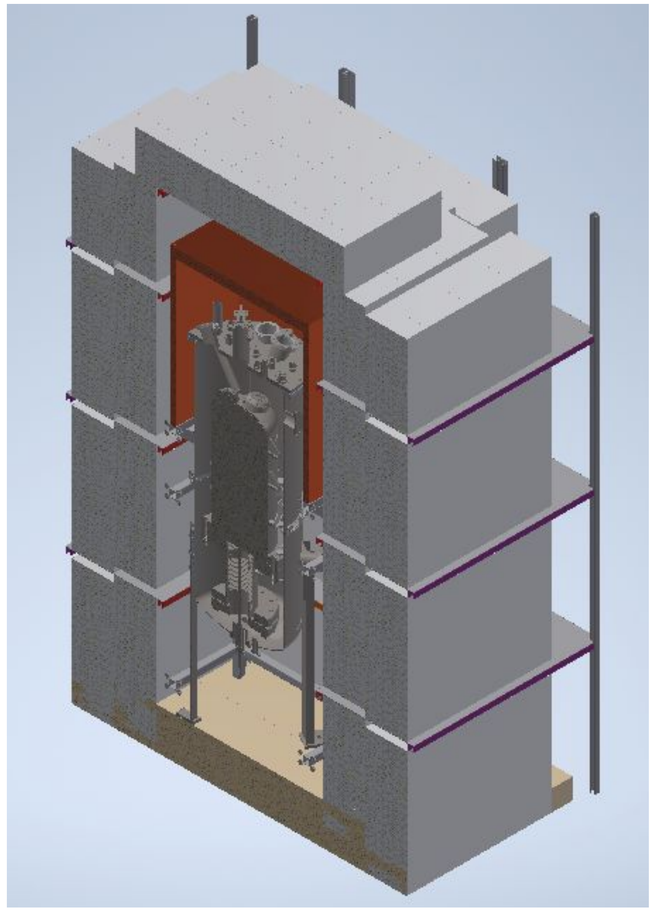
Gas Panels Orbital Welding (SNOLAB?)	Looking for manufacturer that won't take all the money we've ever had	SNOLAB looking into becoming certified, which would alleviate this entirely
Cryovalve (Stohr)	Stohr agreed to send documentation for TSSA registration	We've paid for docs+valves, send docs to PVEng
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

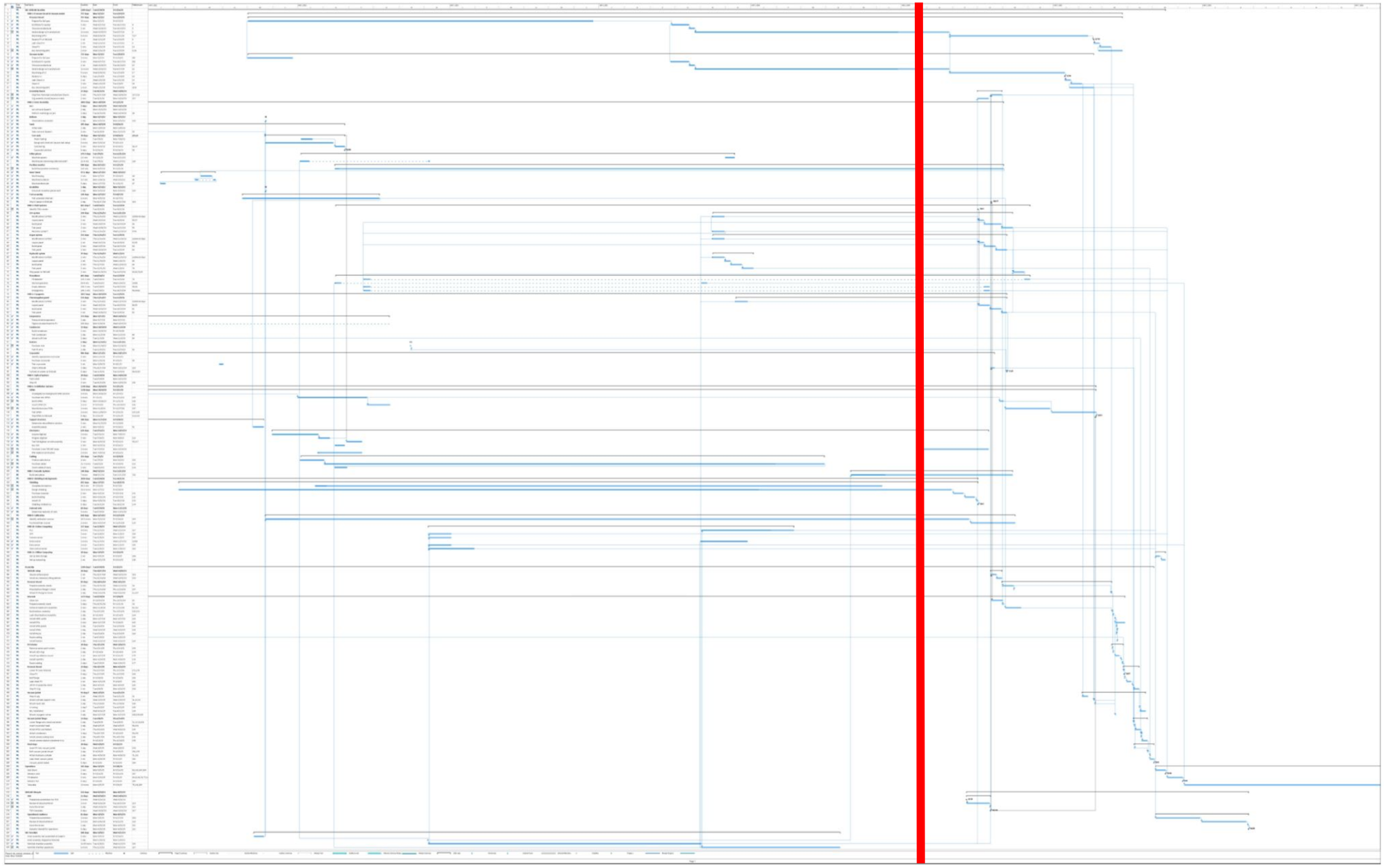
Water box + Cu shield



	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

Schedule

2024 2025



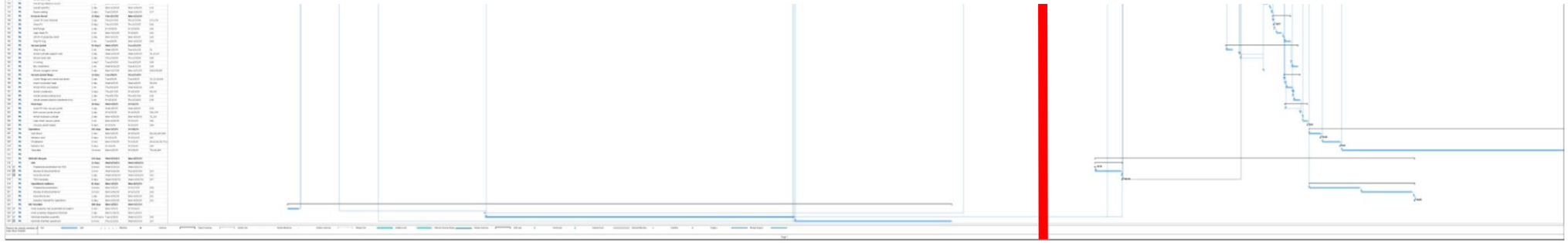
Schedule

Highlights:

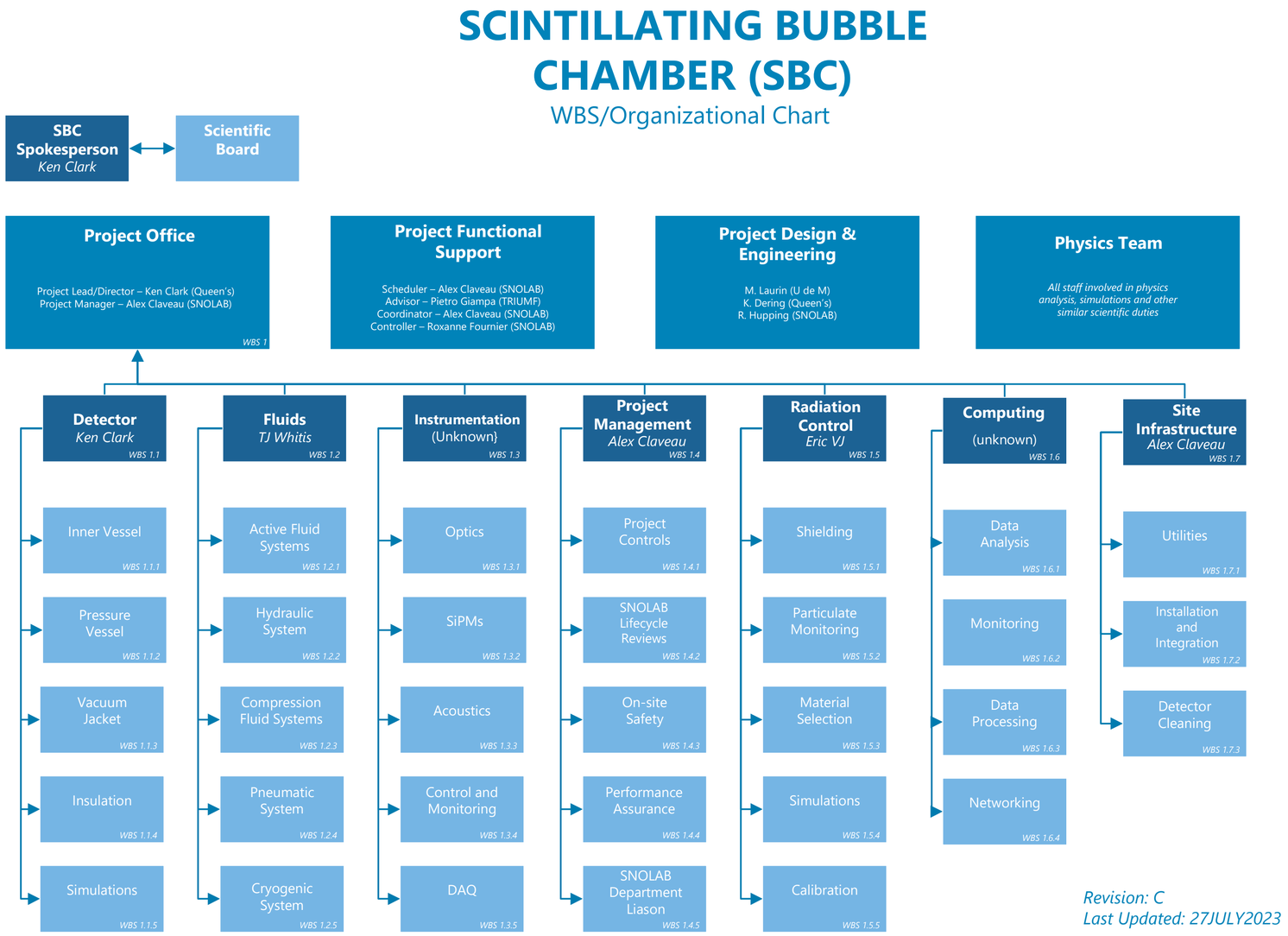
- Schedule currently driven by PV & VJ procurement
    - this gives more time to prepare for surface work

- TDR this fall
    - SNOLAB cleanroom installation to begin thereafter

- Operation u/g in end of 2025

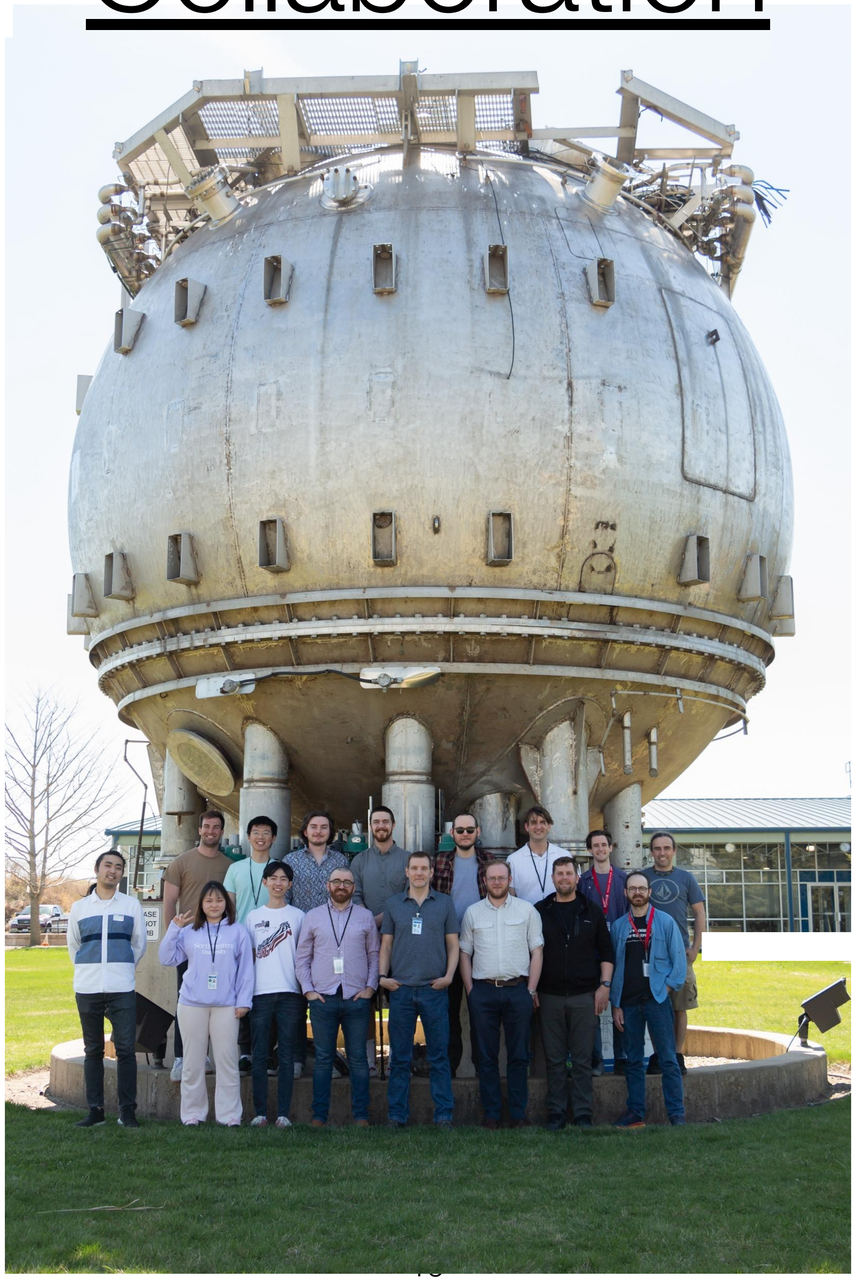


Canadian & HQP Leadership



- Canadians hold many leadership positions
- Of particular note, Canadian HQP (non-faculty) lead several of the major components

Collaboration



Queen's University

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

SNOLAB

R. Castilloux, J. Hall

Université de Montréal

M. Laurin

TRIUMF

P. Giampa

Universidad Nacional Autónoma de México

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

Northeastern Illinois University

O. Harris

Northwestern University

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

Drexel University

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

University of California Santa Barbara

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

Indiana University South Bend

I. Levine, E. Behnke,
C. Cripe

Fermilab

D. Baxter, G. Putnam

PennState

S. Priya

UC Riverside

S. Westerdale

Pacific Northwest National Laboratory

C. Jackson

Queen's University