

Status of the SuperCDMS Experiment at SNOLAB

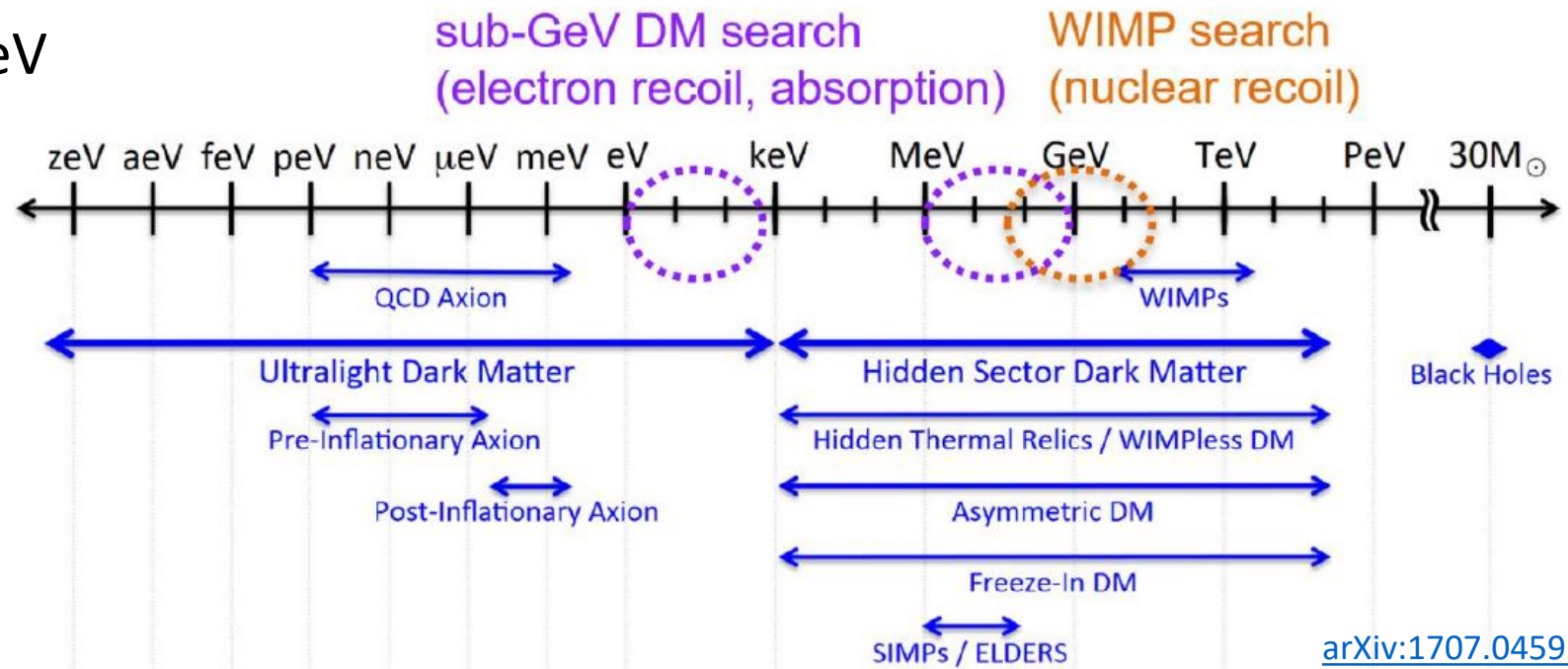
Tyler Reynolds

on behalf of the SuperCDMS Collaboration

June 9, 2025

The Hunt for Dark Matter

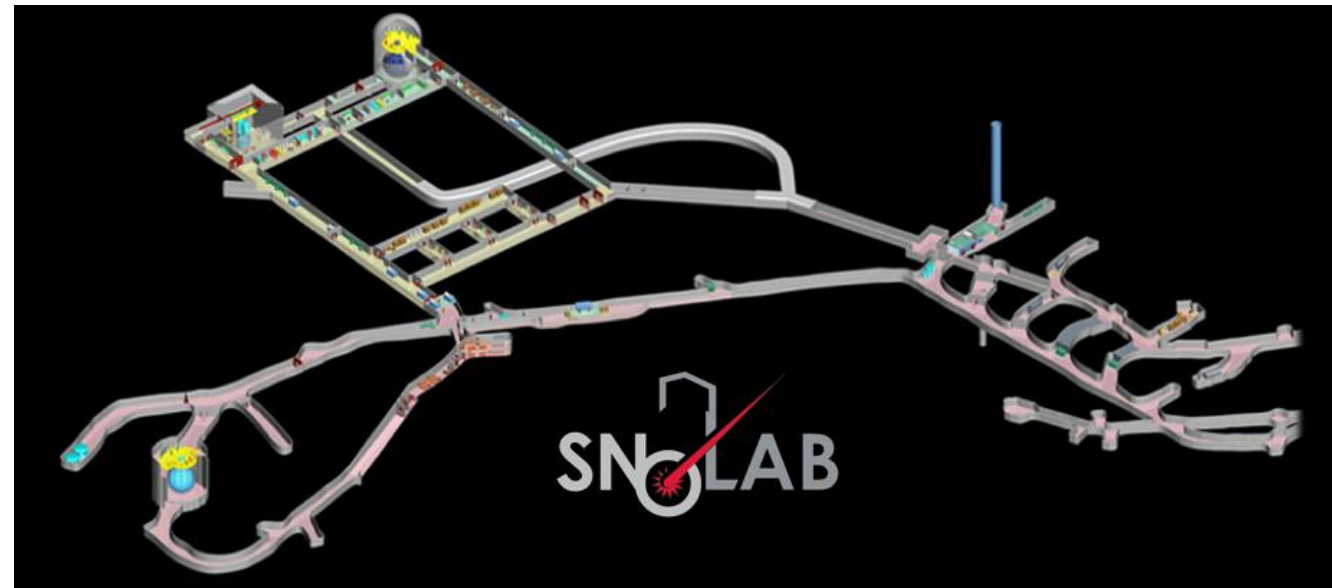
- SuperCDMS is a dark matter direct detection experiment
 - Targeting $< 10 \text{ GeV}/c^2$ nuclear recoiling dark matter
 - Also sensitive to sub-GeV candidates



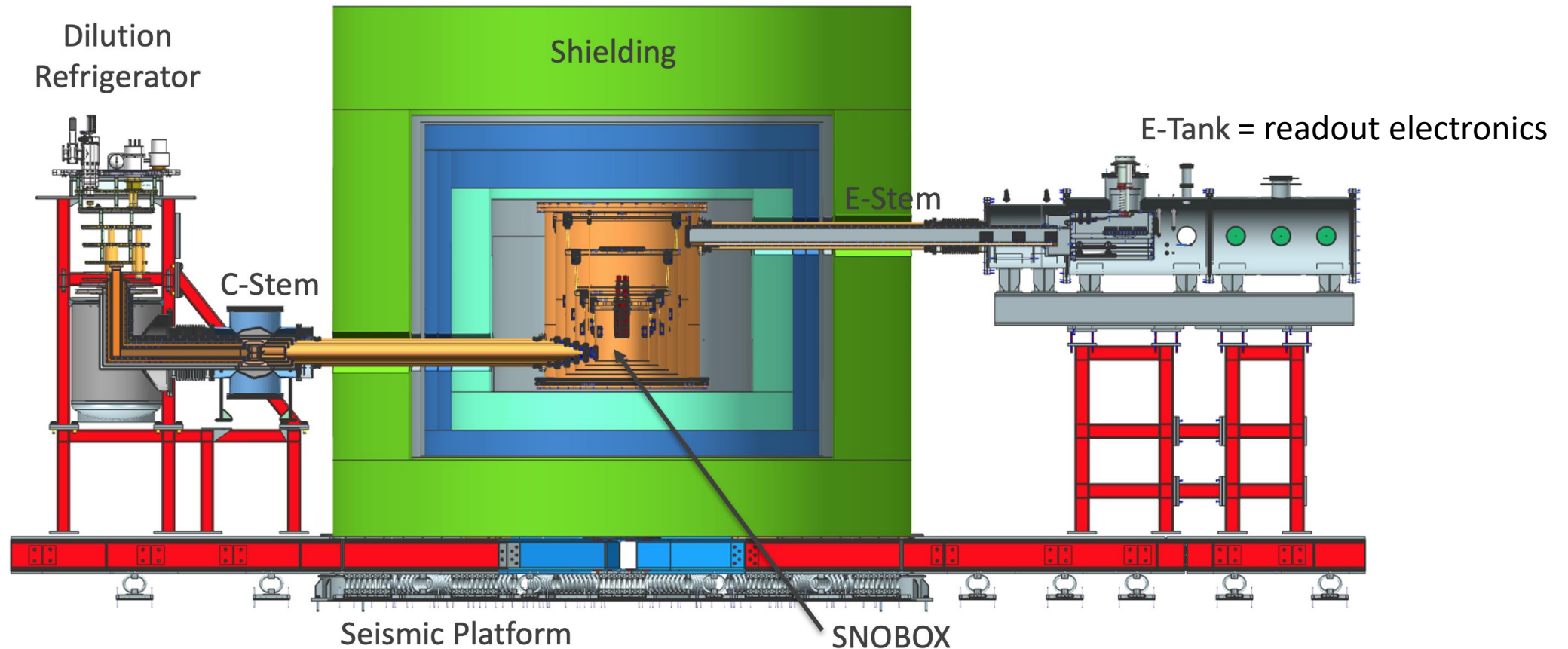
[arXiv:1707.04591](https://arxiv.org/abs/1707.04591)

Mining for Dark Matter: SNOLAB

- Located in Sudbury, ON
- 2 km rock overburden shields from cosmic rays (6 km.w.e.)
 - Muon flux of $0.27/\text{m}^2/\text{day}$
- Class 2000 cleanroom



Mining for Dark Matter: SuperCDMS @ SNOLAB

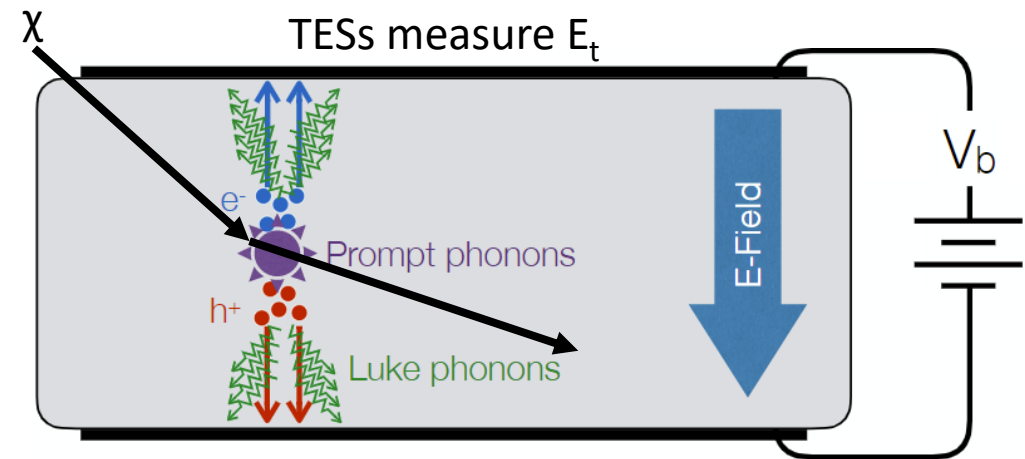


- Dilution fridge: 15 mK base temperature
- Vibration isolation
 - Seismic platform
 - SNOBOX cans suspended via Kevlar ropes
- Polyethylene, water tank, and graded radiopure lead as shielding
- Shield incorporates radon purge barrier

Crystal Visions: SuperCDMS Detectors

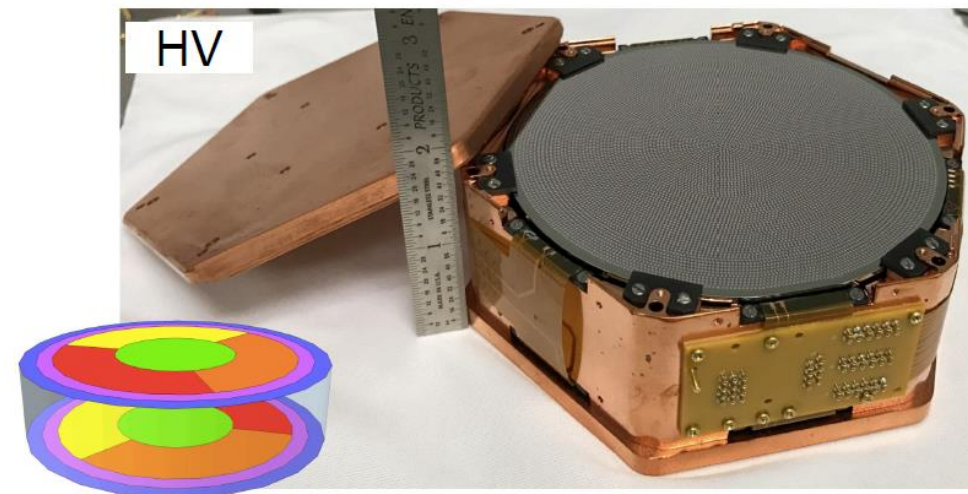
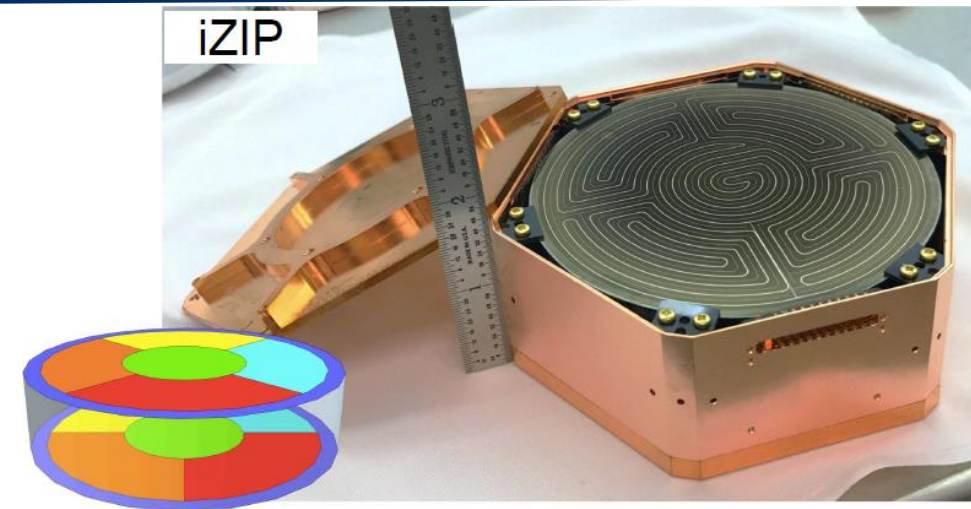
- Particle interactions deposit energy E_R in crystal, producing prompt phonons and electron-hole pairs
- Electric field accelerates charge carriers
- Neganov-Trofimov-Luke effect: accelerated charge carriers emit phonons, amplifying signal

$$E_t = E_R + n_{eh} eV_b$$
- Phonon energy measured by transition edge sensors



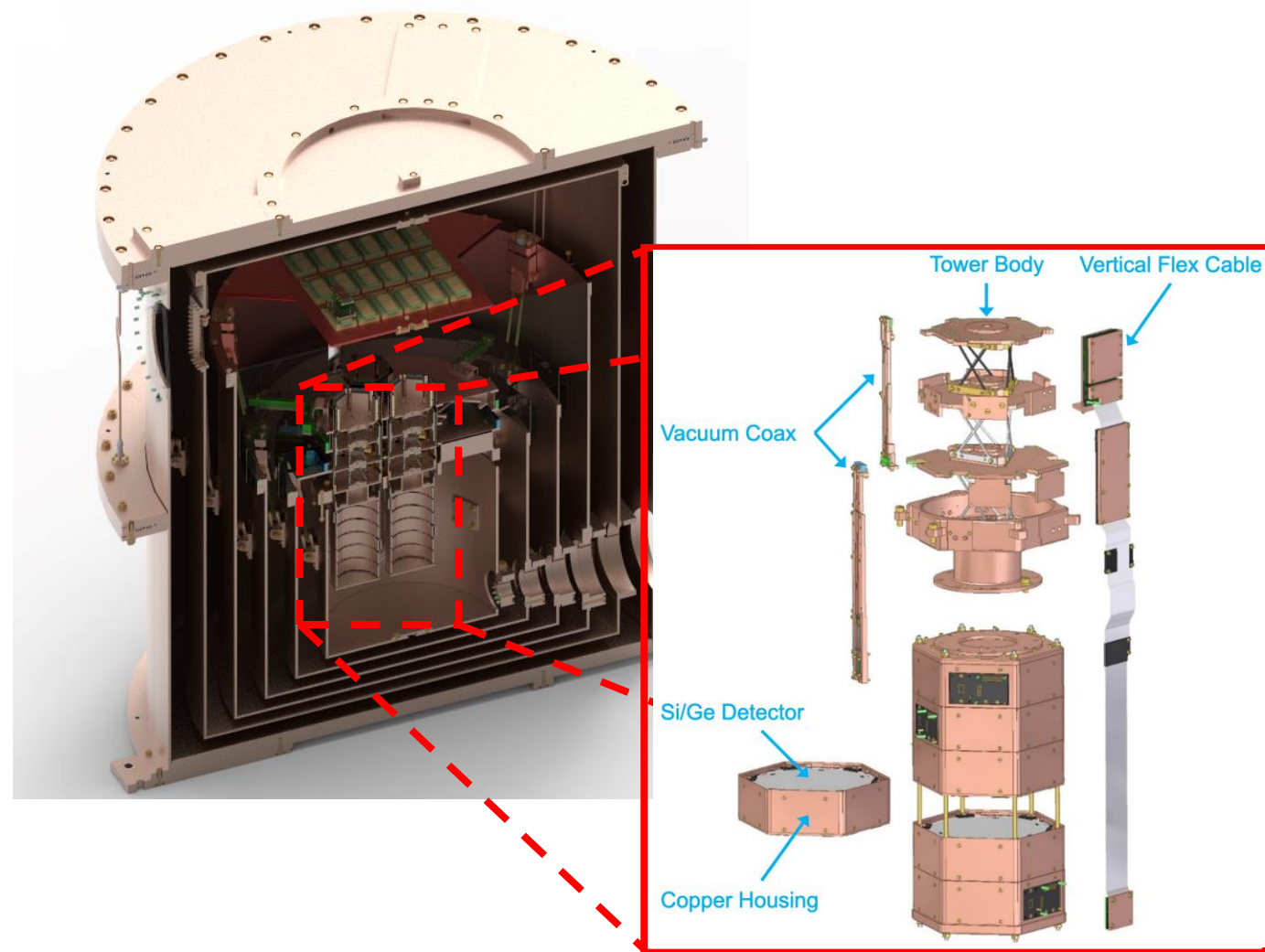
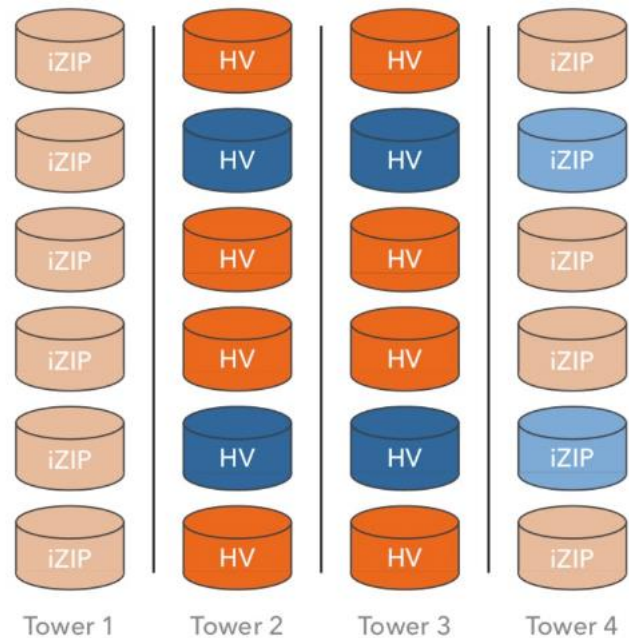
Crystal Visions: SuperCDMS Detectors

- Ultrapure Ge and Si crystals
 - ~1 kg each, 100 mm \varnothing x 33 mm height
- iZIP (background suppressing) detectors
 - Measure phonons and ionization
 - Discrimination between electron and nuclear recoils = background discrimination
- HV (low threshold) detectors
 - Measure phonon signal only
 - < 100 eV threshold via NTL signal amplification
- Channel layout allows for fiducialization and position reconstruction



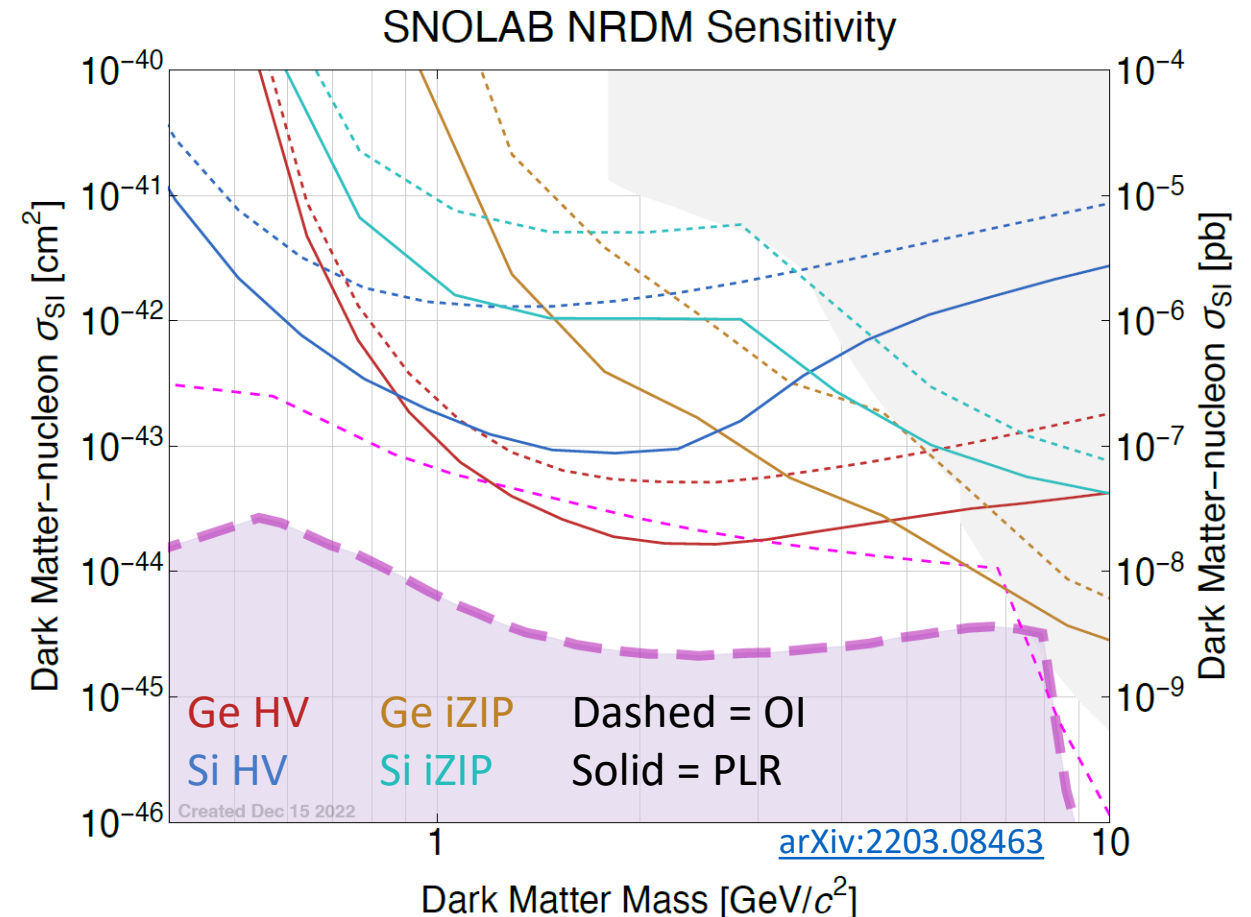
Crystal Visions: Initial Payload

- One tower = six detectors
- Four towers total
 - 18 Ge, 6 Si



Crystal Visions: Expected Science Reach

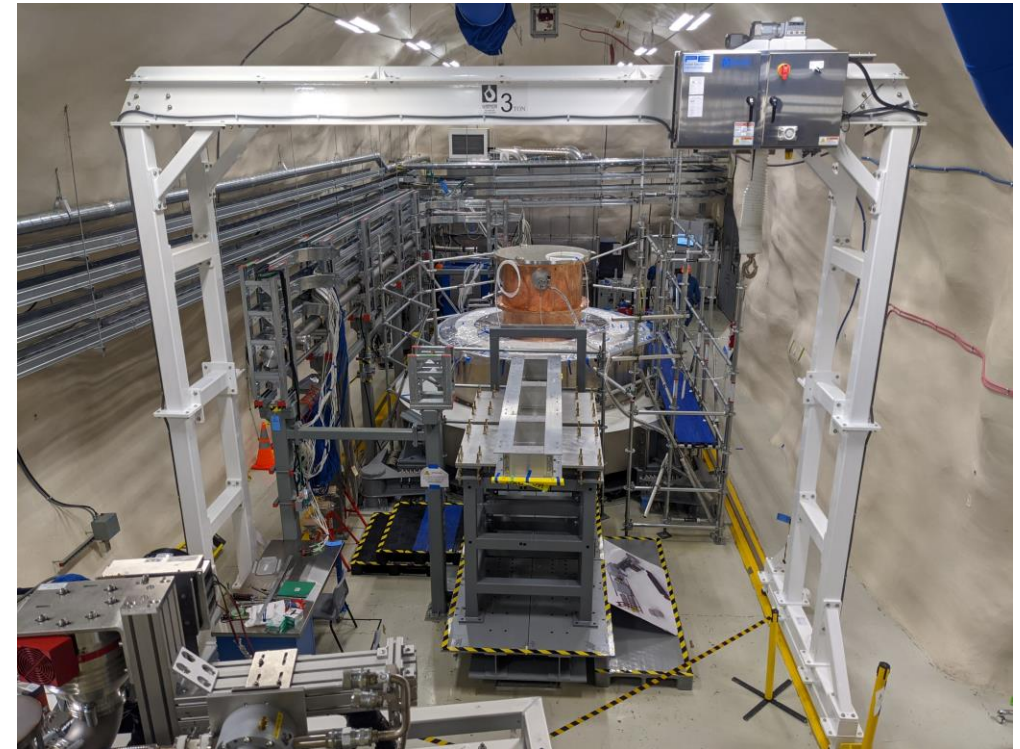
- Carving out new parameter space for nuclear recoiling dark matter (NRDM) with $< 10 \text{ GeV}/c^2$ mass
- Detector materials complement each other
 - Ge pushes into lower cross section parameter space
 - Si pushes into lower mass parameter space



Current Status: From Past...



March 2023
Dilution fridge underground for
stand-alone testing



November 2024
Shield base and SNOBOX
OVC in place

Current Status: ...To Present!

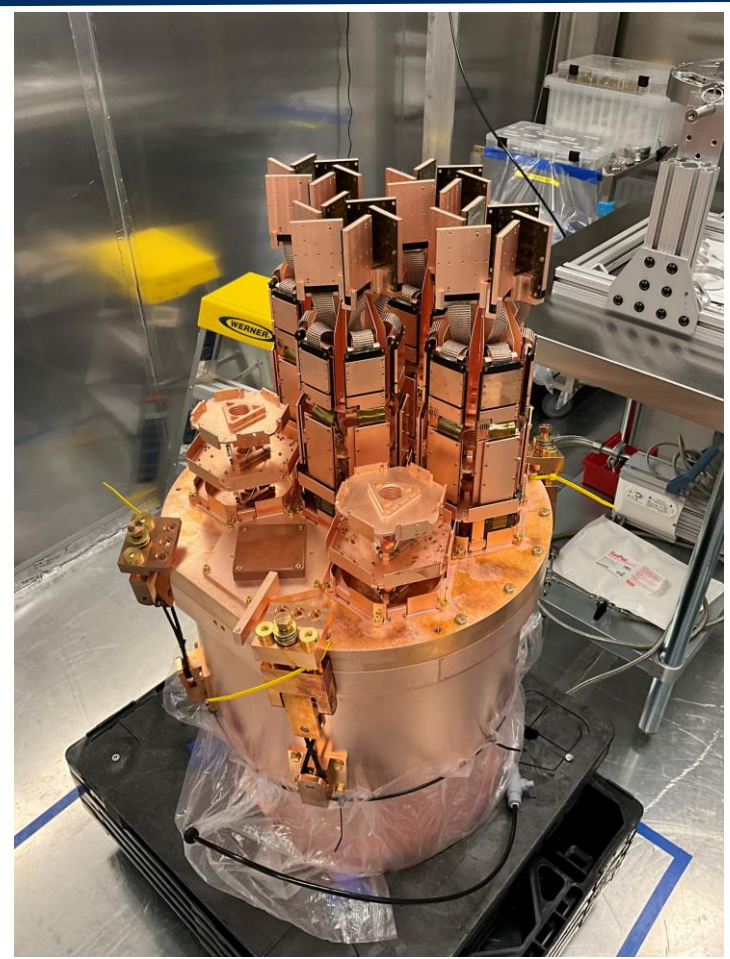


March 2025
Shield wall 2/3 complete

Current Status: ...To Present!



E-stem and E-tank assembly in progress



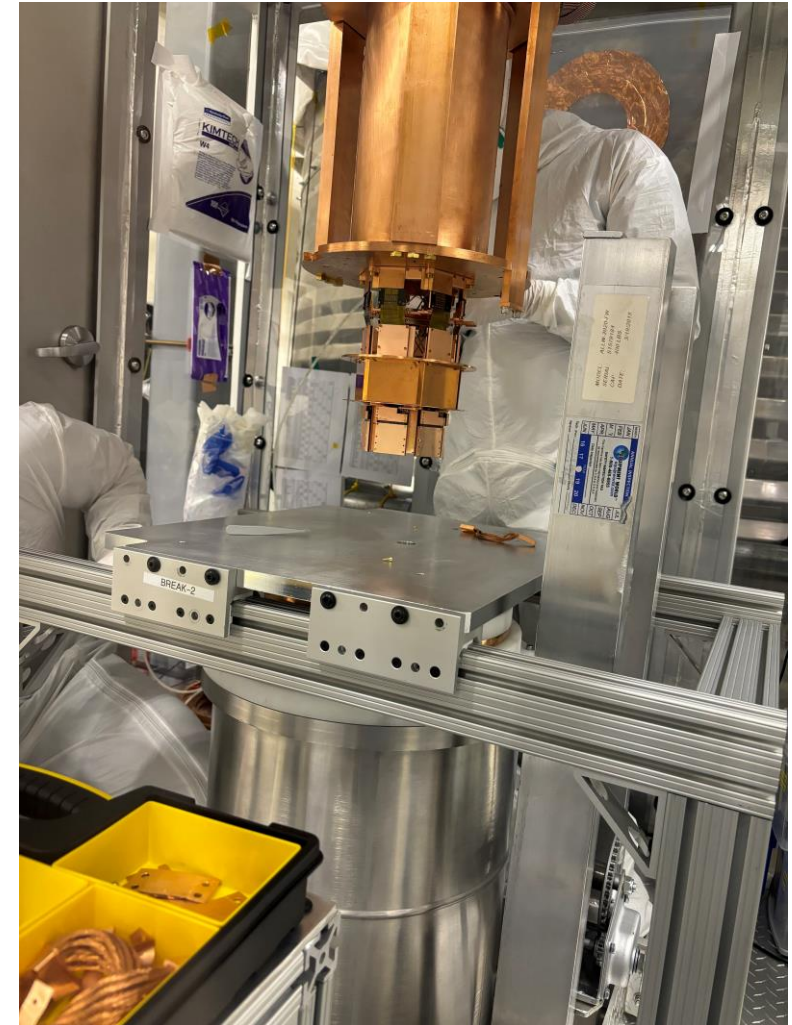
Towers installed in inner SNOBOX can



Detector readout cables connected to 4K can lid

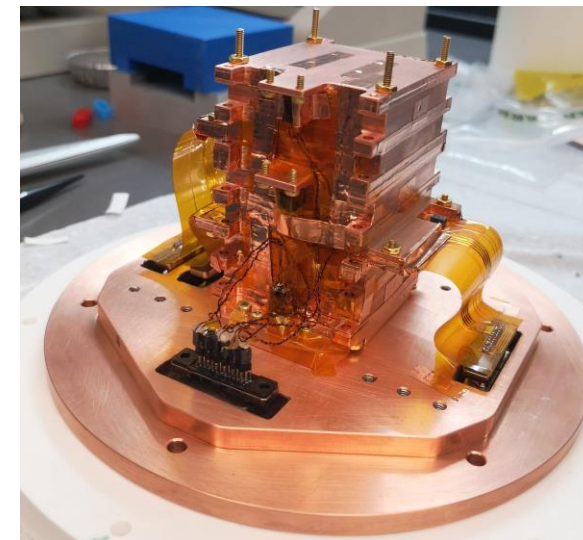
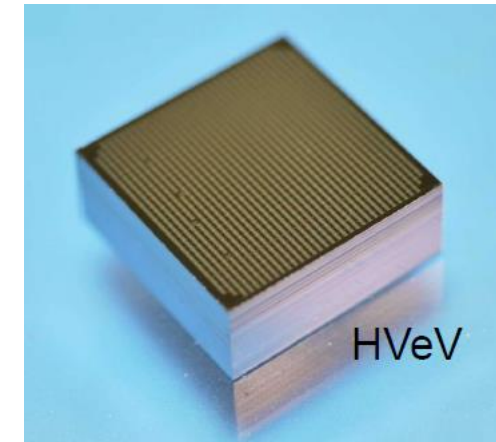
Detectors, Big and Small: An Advertisement

- **Tower testing at CUTE** – see Ariel Zuñiga’s talk
 - Testing of tower 3 (6 HV detectors) at CUTE
 - 5 months worth of detector characterization and calibration data!
- **HVeV detector R&D program** – see Ziqing Hong’s talk
 - Small gram-scale devices
 - Most recently exploring the low-energy excess
- Both talks Thursday in Searches for Dark Matter III session



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Summary

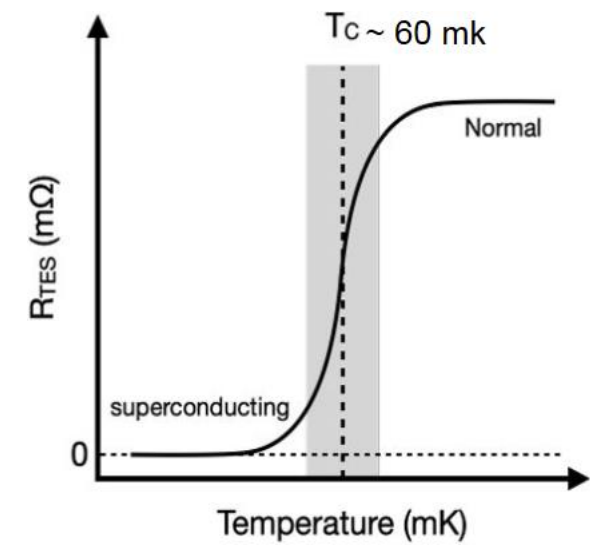
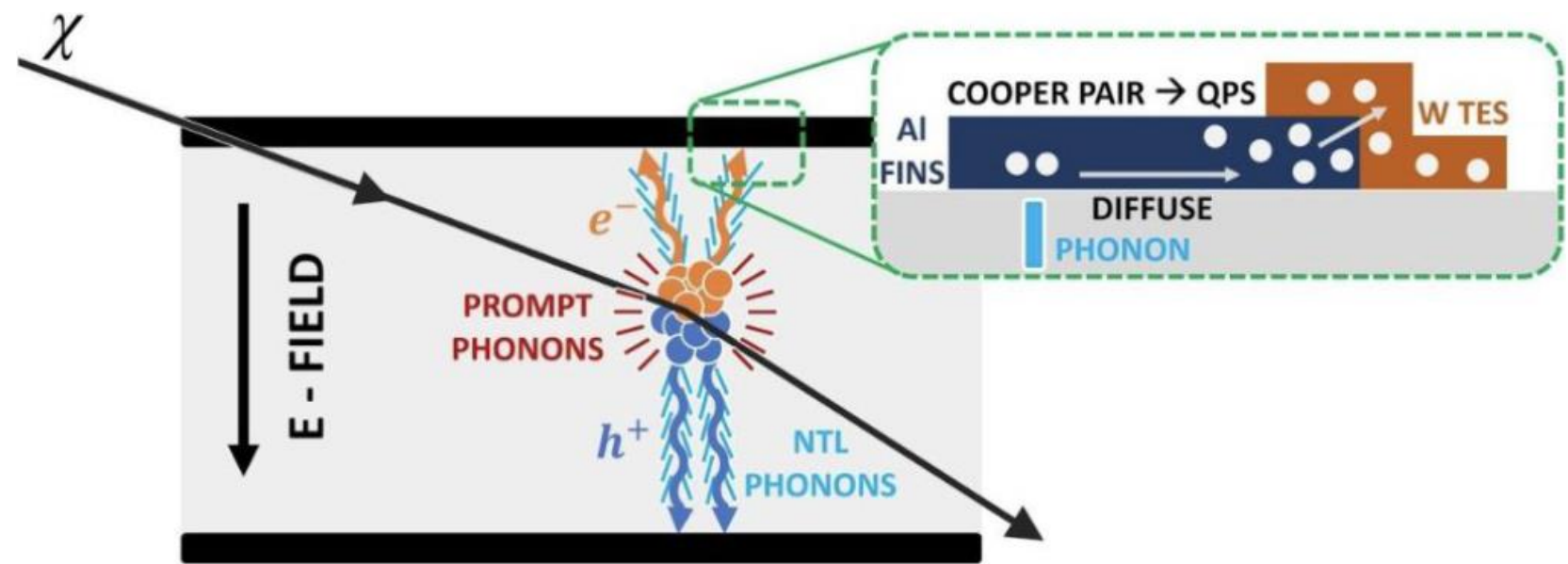
- SuperCDMS uses complementary detector technology to search for dark matter $< 10 \text{ GeV}/c^2$
- Installation is progressing rapidly!
- Detectors come online this year

Thank you!

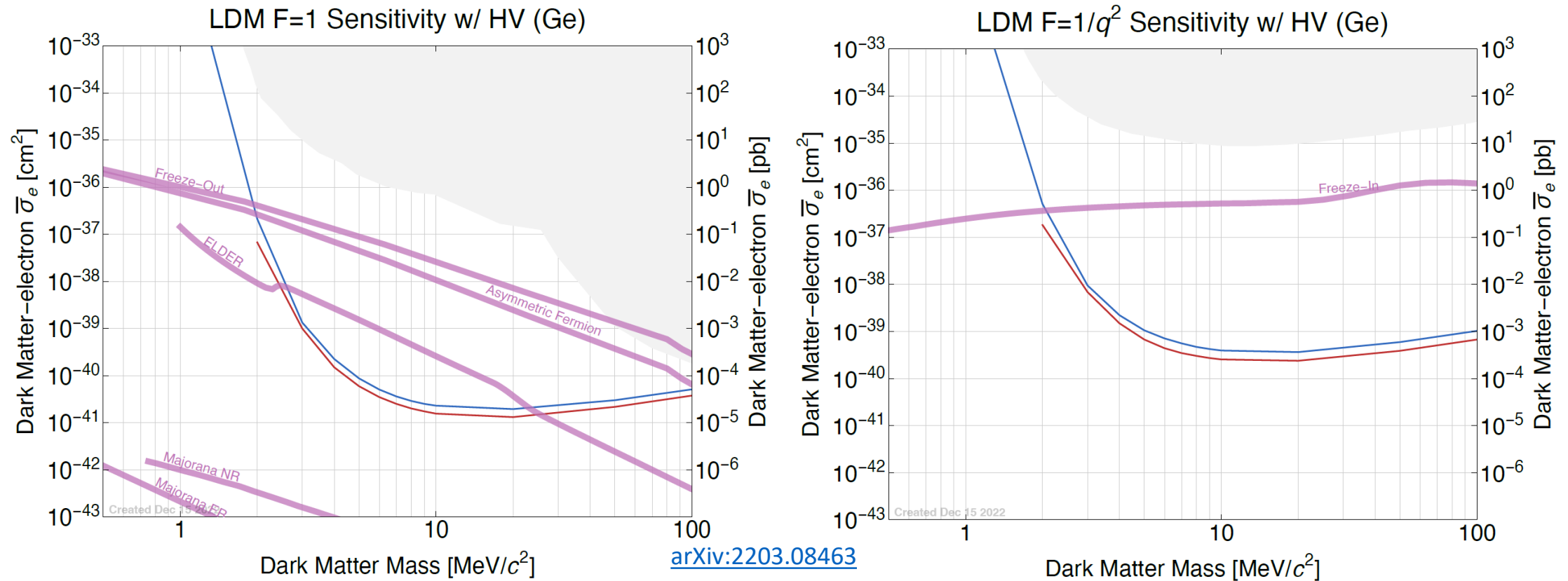


Backup Slides

QETs



Science Reach – Low-Mass ERDM



Science Reach – Dark Photon and ALPs

