The SuperCDMS SNOLAB experiment

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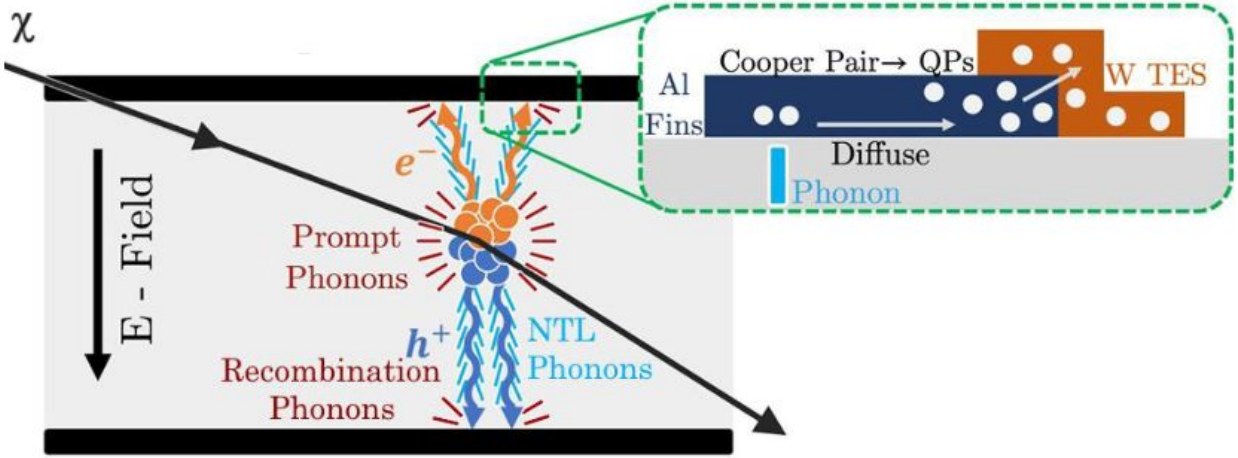
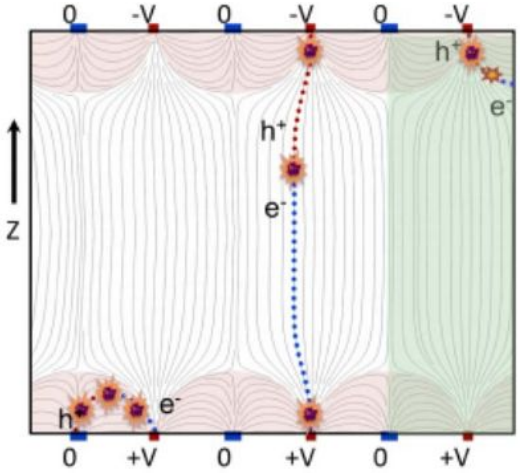
The SuperCDMS collaboration

SuperCDMS is a direct detection experiment which looks for low-mass, <5 GeV/c^2, dark matter particles.

The detection technology

Measure recoil energy dissipated via **heat (phonons)** and **ionization (charges)**



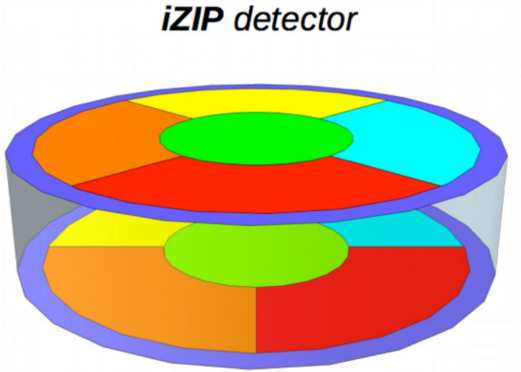


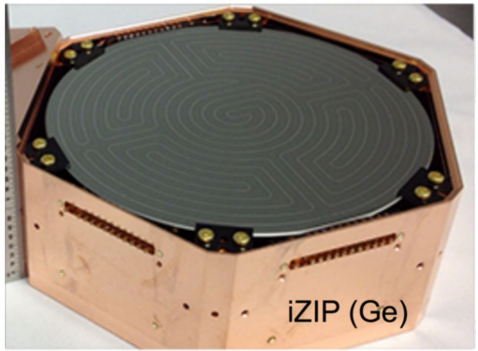
$$E_{\text{phonon}} = E_{\text{recoil}} + n_{\text{eh}} e V_{\text{bias}}$$

Neganov-Trofimov-Luke (NTL) gain

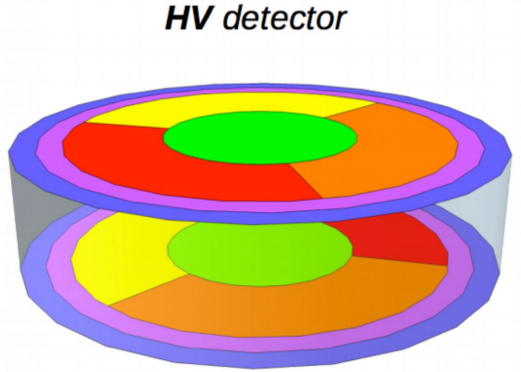
Charges measured via interleaved electrodes

The detectors



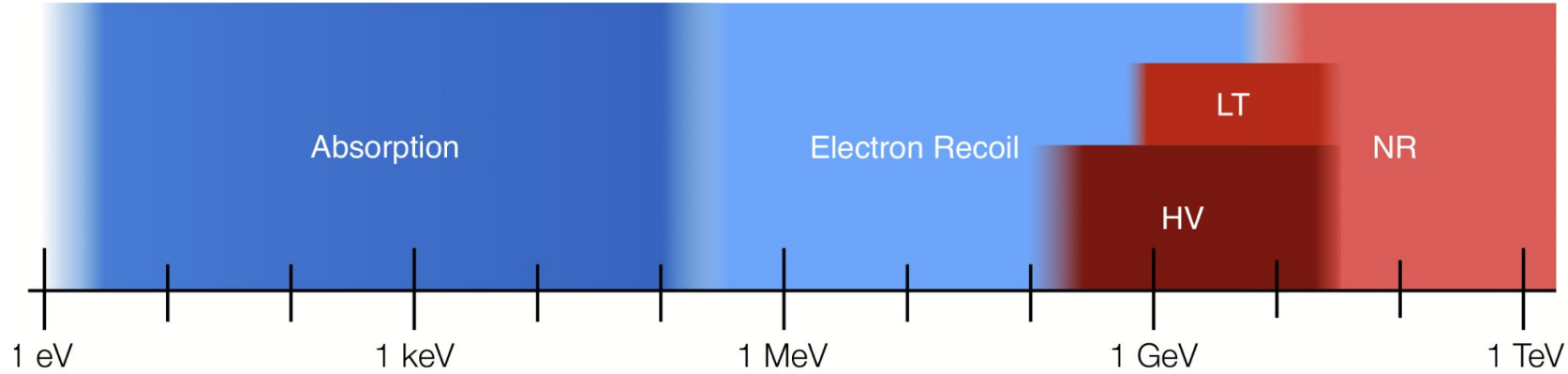


- iZIP: interleaved Z-sensitive Ionization and Phonon detector
- 12 phonon and 4 charge channels
- <10 V across the detector
- ~1 keV threshold, electron/nuclear recoil (ER/NR) discrimination



- HV: High Voltage detector
- 12 phonon channels
- 100 V across the detector to exploit NTL effect
- ~100 eV phonon energy threshold for Si detectors

SuperCDMS: a broad band dark matter search



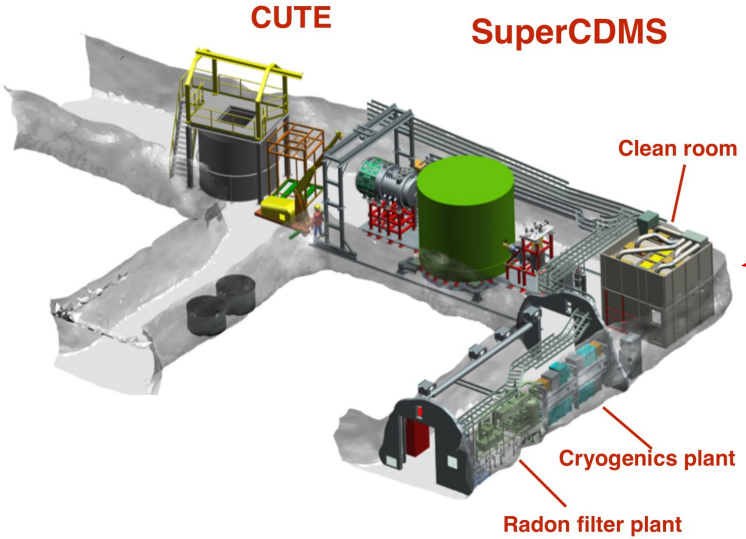
Signal	Detector type	Mass range
Traditional Nuclear Recoil	iZIP, Background free	> 5 GeV
Low Threshold NR	iZIP, limited discrimination	> 1 GeV
HV mode	HV	0.3 - 10 GeV
Electron recoil	HV	0.5 MeV - 10 GeV
Absorption	HV	10 eV - 500 keV

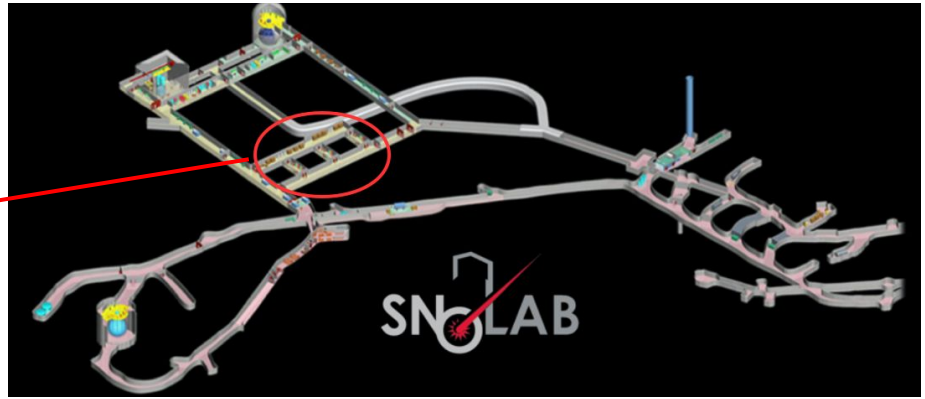
The SNOLAB laboratory

2 km underground, 6800 mwe overburden

Whole lab cleanroom of class 2000 or better

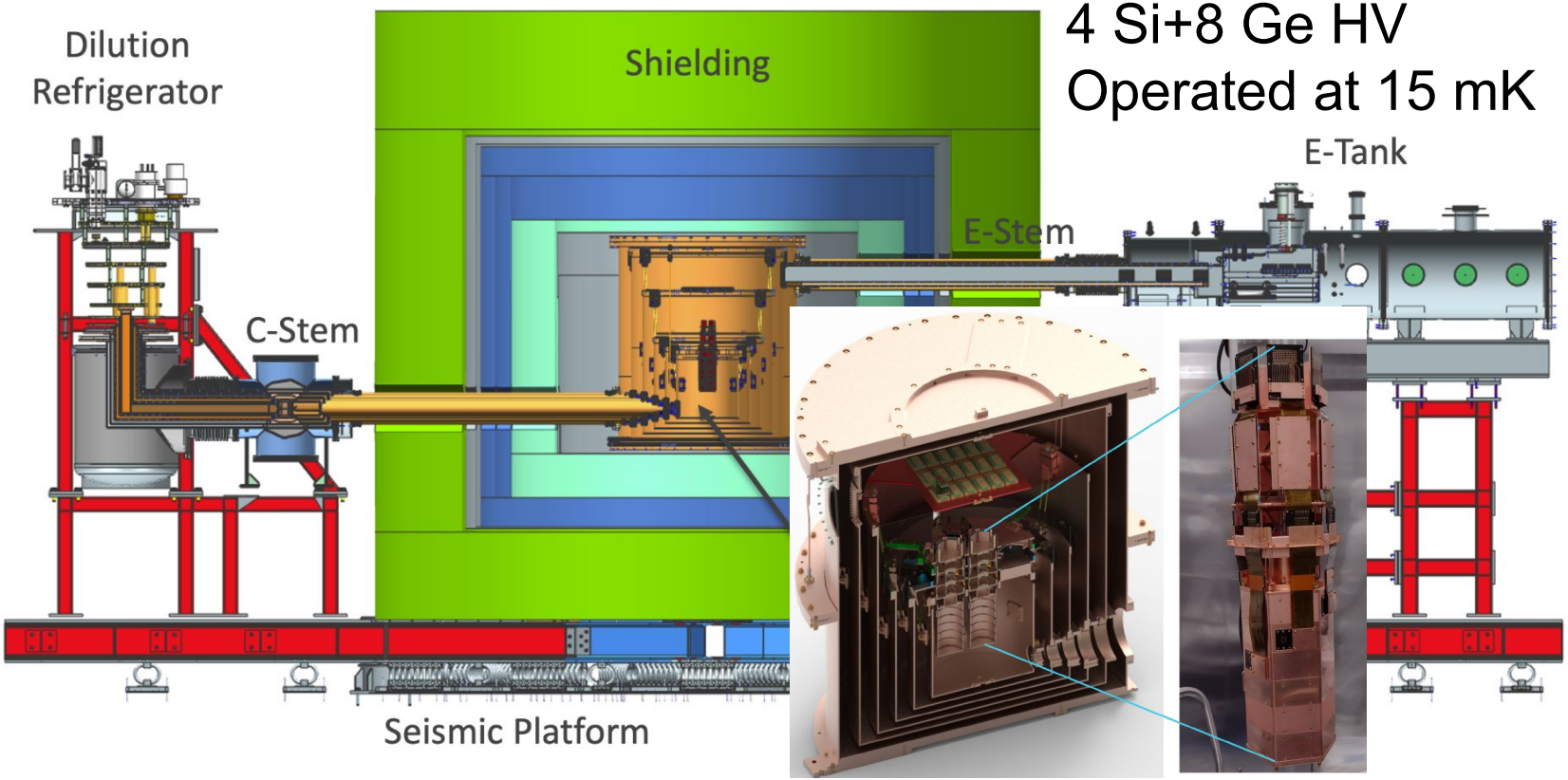
Muon flux of 2.86 μ/m²/day



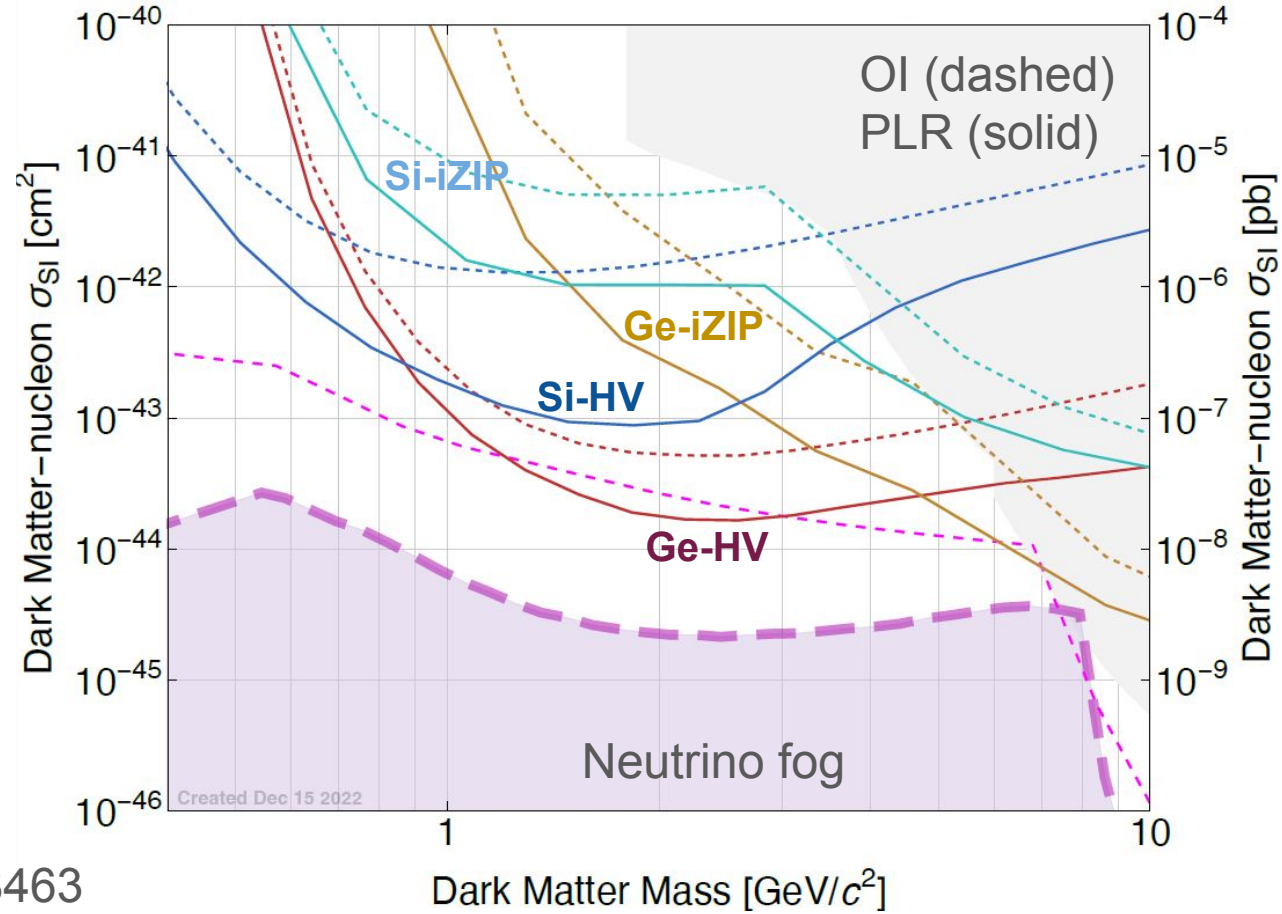


The SuperCDMS SNOLAB experiment

2 Si+10 Ge iZIP
4 Si+8 Ge HV
Operated at 15 mK

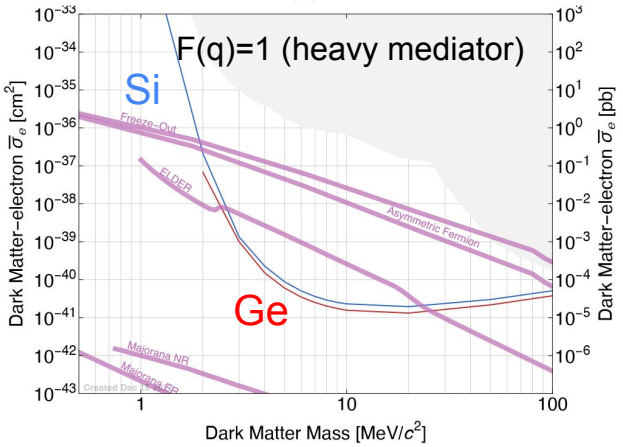


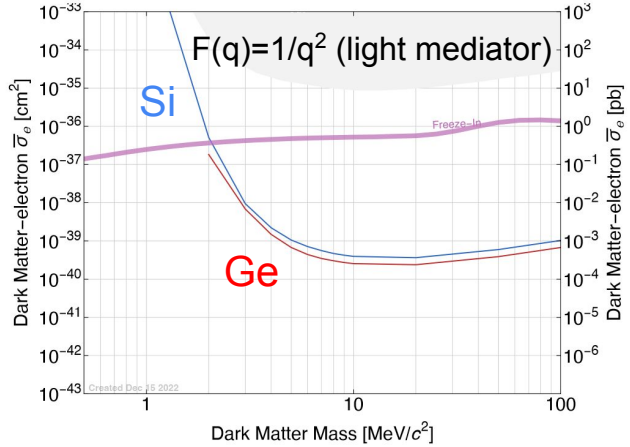
Nuclear recoil projected sensitivity

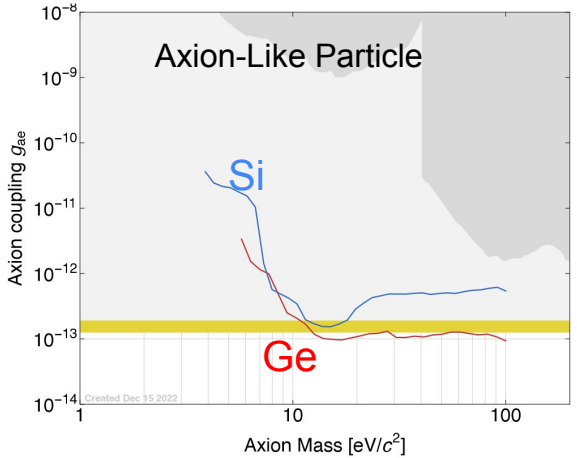


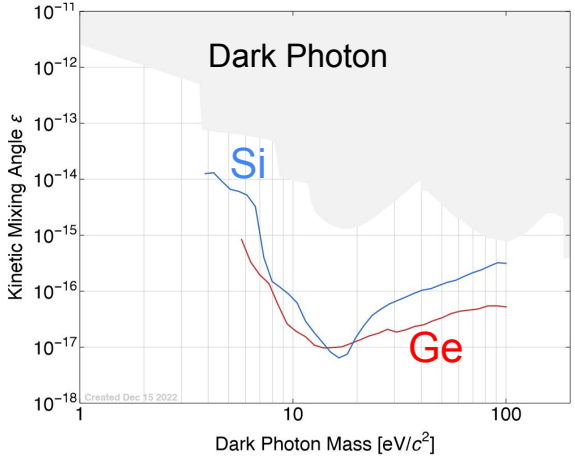
arxiv/2203.08463

Electron recoil scattering and absorption sensitivity







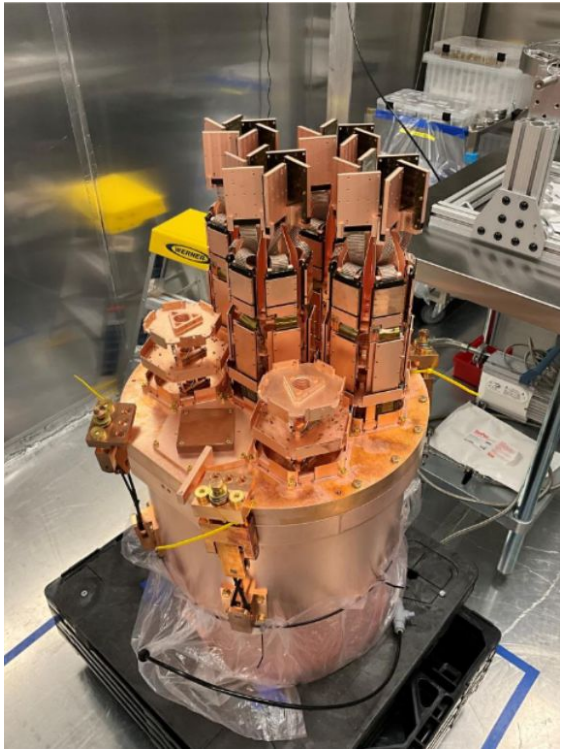


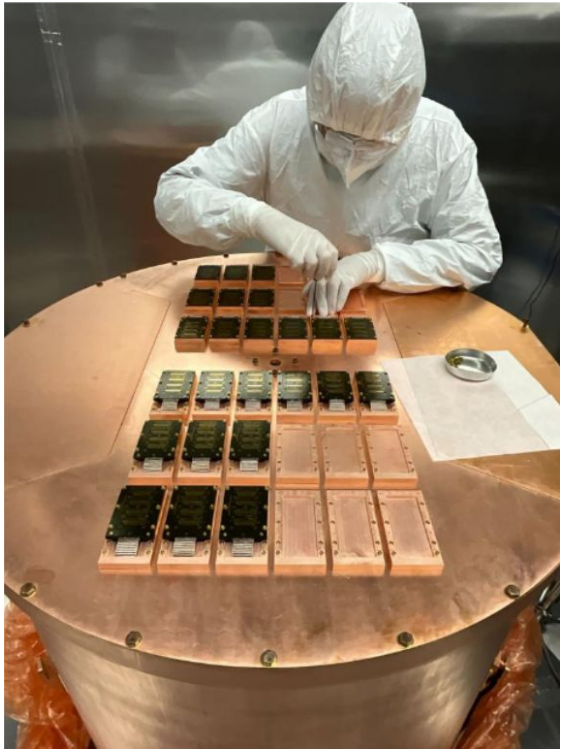
The experiment is coming alive!

¾ of the shielding completed, infrastructure installation almost finished

The experiment is coming alive!

One full HV tower tested underground at CUTE, see Ziqing's talk!





Detectors installed and readout cables connected.

First cool down to begin **early this fall**, science to start **early next year**!

The HVeV program - SuperCDMS R&D

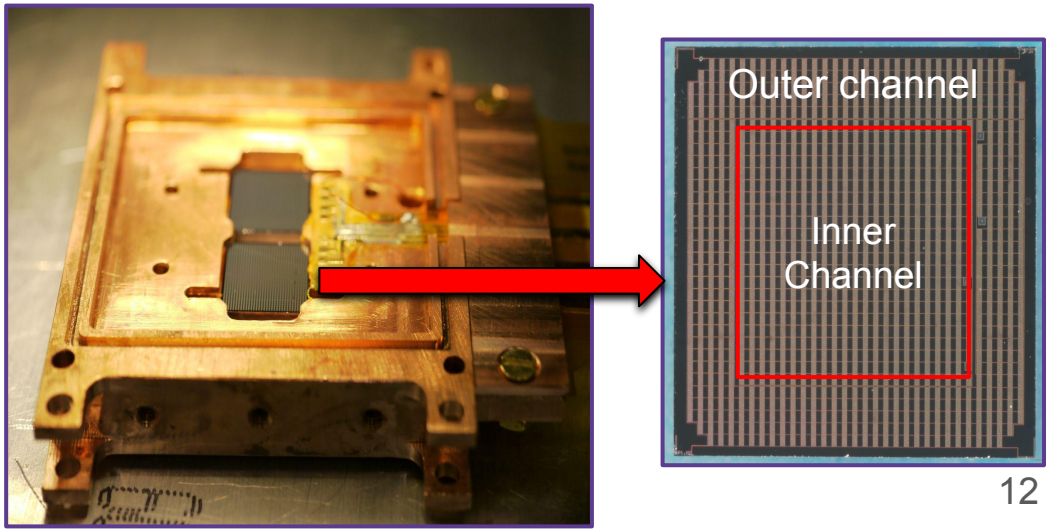
HVeV: R&D projects to develop detectors pushing the energy resolution

The detectors:
1 cm^2, 2-channel gram-size detectors with eV baseline resolution.
With voltage bias applied, capability to resolve single charge!

Ideal detectors for:

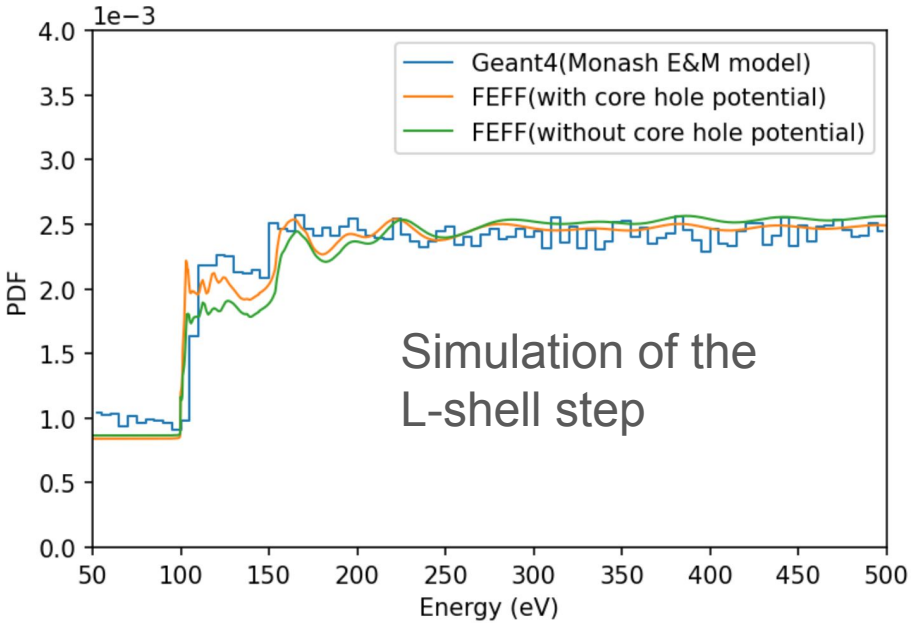
- Background classification
- Charge-transport studies
- Low-mass DM searches

New data from deep UG CUTE facility with new detectors, see Ziqing's talk!



The HVeV program - Compton step analysis

Compton scattering provides step-like features, **Compton steps**, at about 100 eV and 150 eV (L shell), and 1.8 keV (K shell).
Perfect for detector calibration!

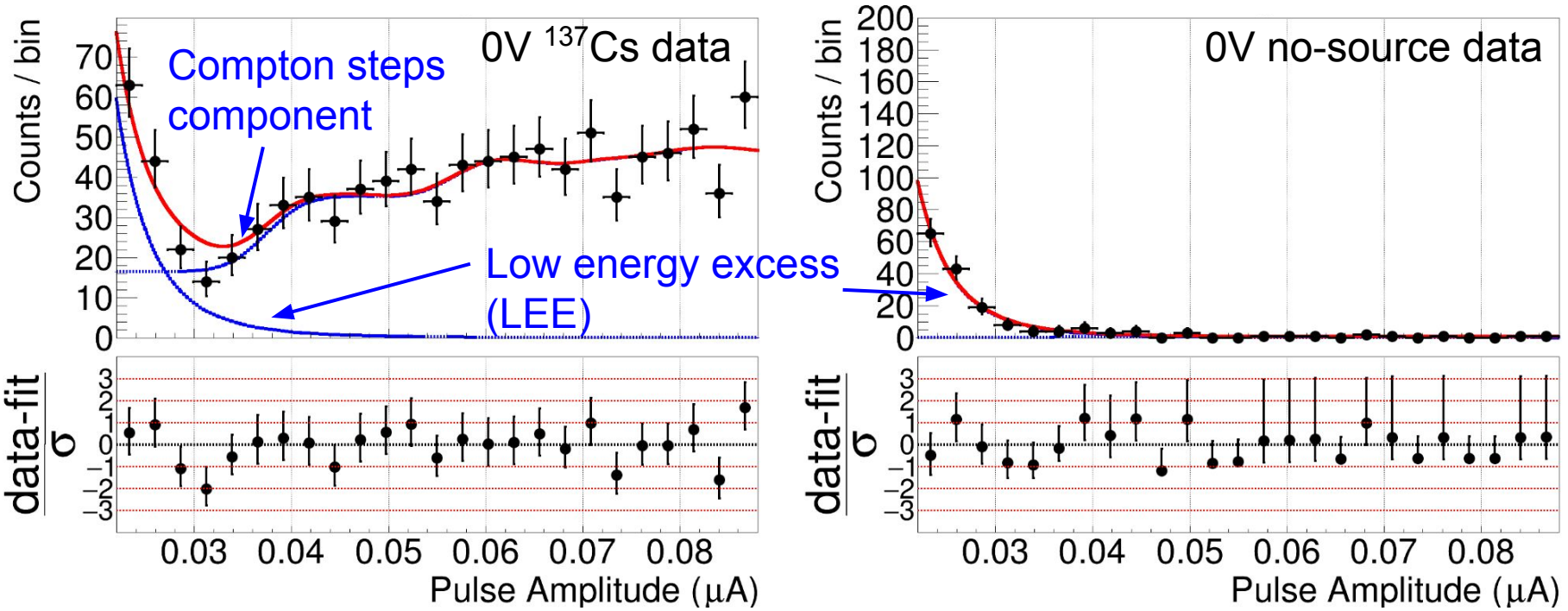


Using ^{137}Cs data taken during run at shallow UG facility at NEXUS

Simulate the process using GEANT4 and FEFF (ab initio calculation), and compare to the data.

The HVeV program - Compton step analysis

arxiv/2508.02402



0V calibration 30% weaker compared to HV. More investigation needed
Also, new results on eDM out soon!

Summary

The SuperCDMS SNOLAB experiment is designed to probe a broad range of dark matter models, with access to unexplored low-mass parameter space. Entering now in a very exciting phase:

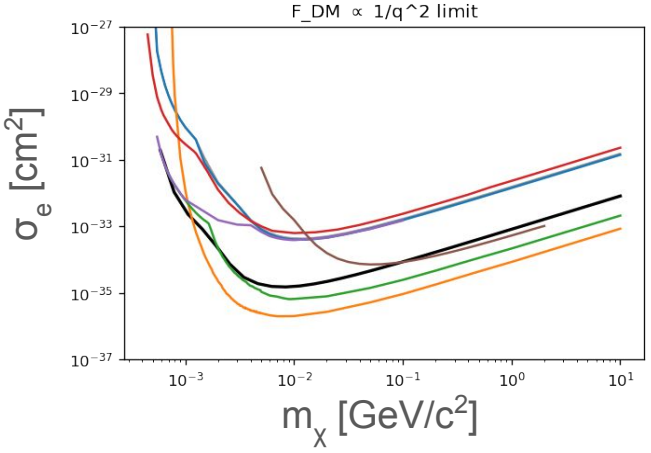
- Installation well underway - on track to start the first cool down and commissioning phase in a few months
- Science run to start early next year!

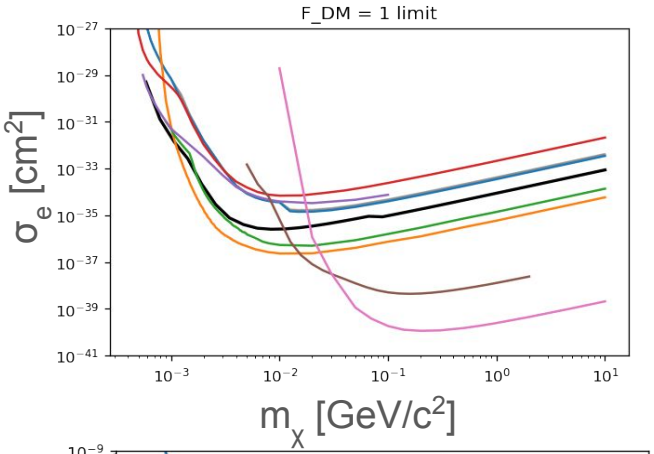
In parallel, R&D effort continues:

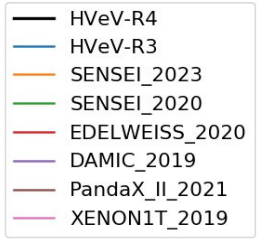
- New science results from HVeV detectors
- Pushing the boundaries for energy resolution and new science reach even further

The HVeV program - HVeV R4 eDM search

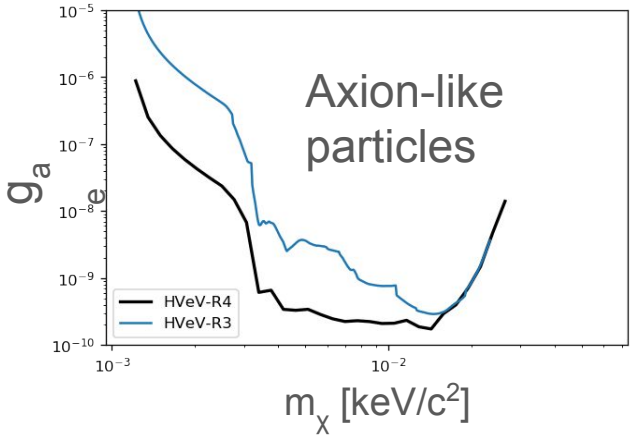
DM-electron scattering

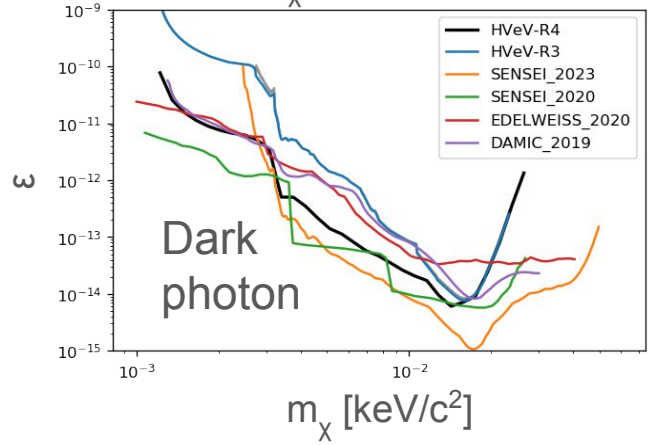






Absorption channels





Data from shallow UG NEXUS facility

Paper out soon!