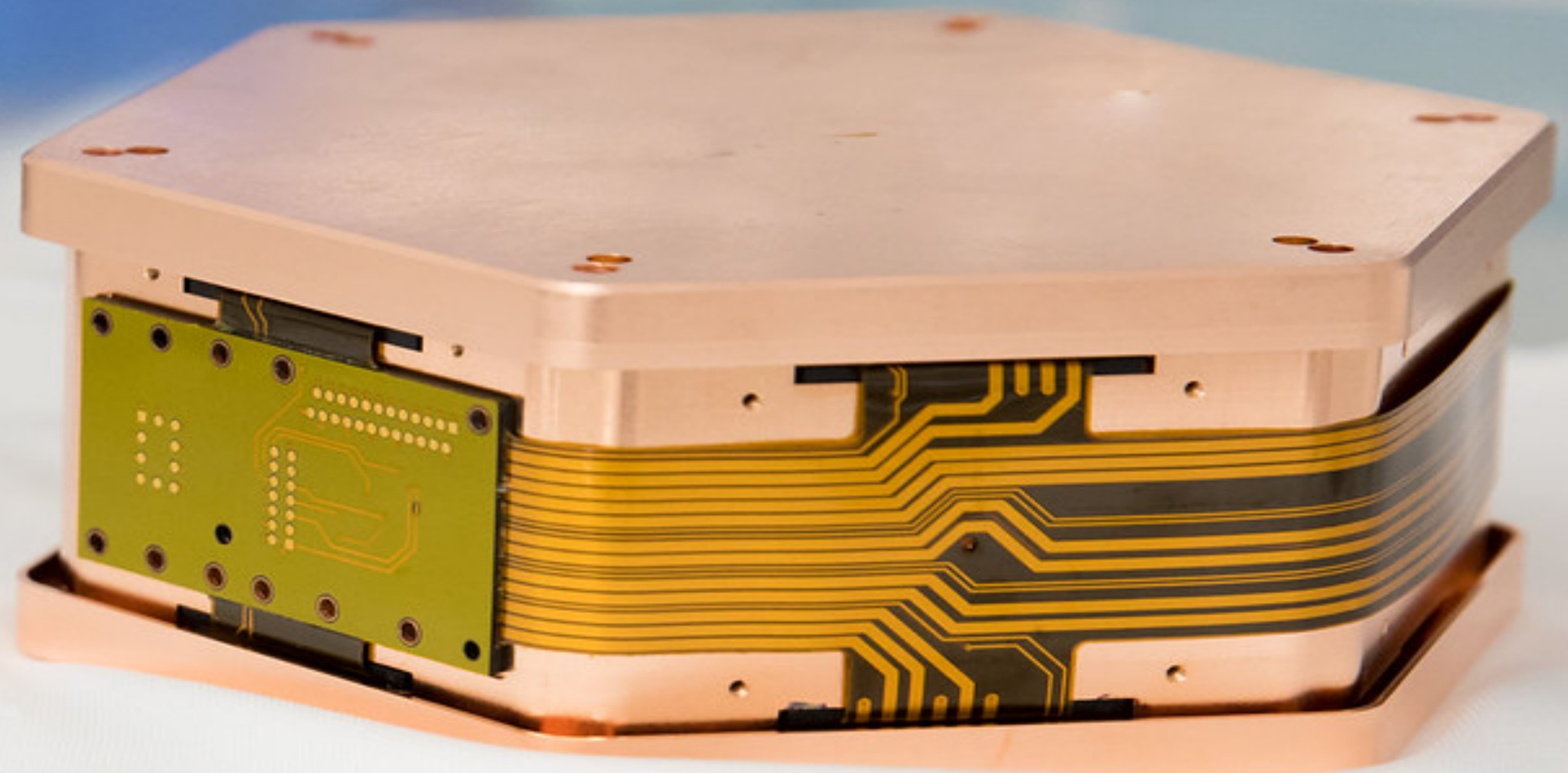
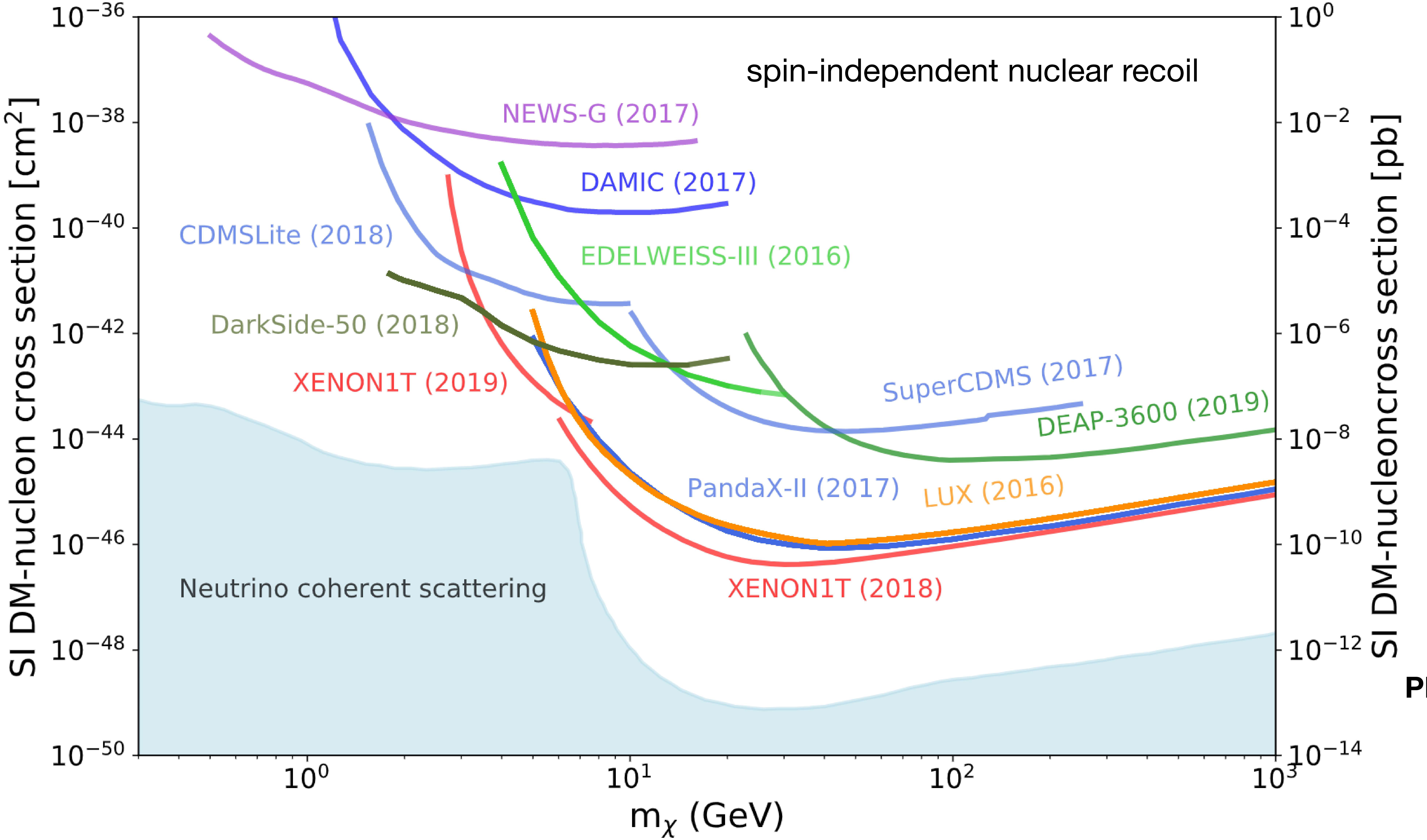
Current Status and Future Plans for SuperCDMS SNOLAB



Yan Liu for the ***SuperCDMS*** collaboration

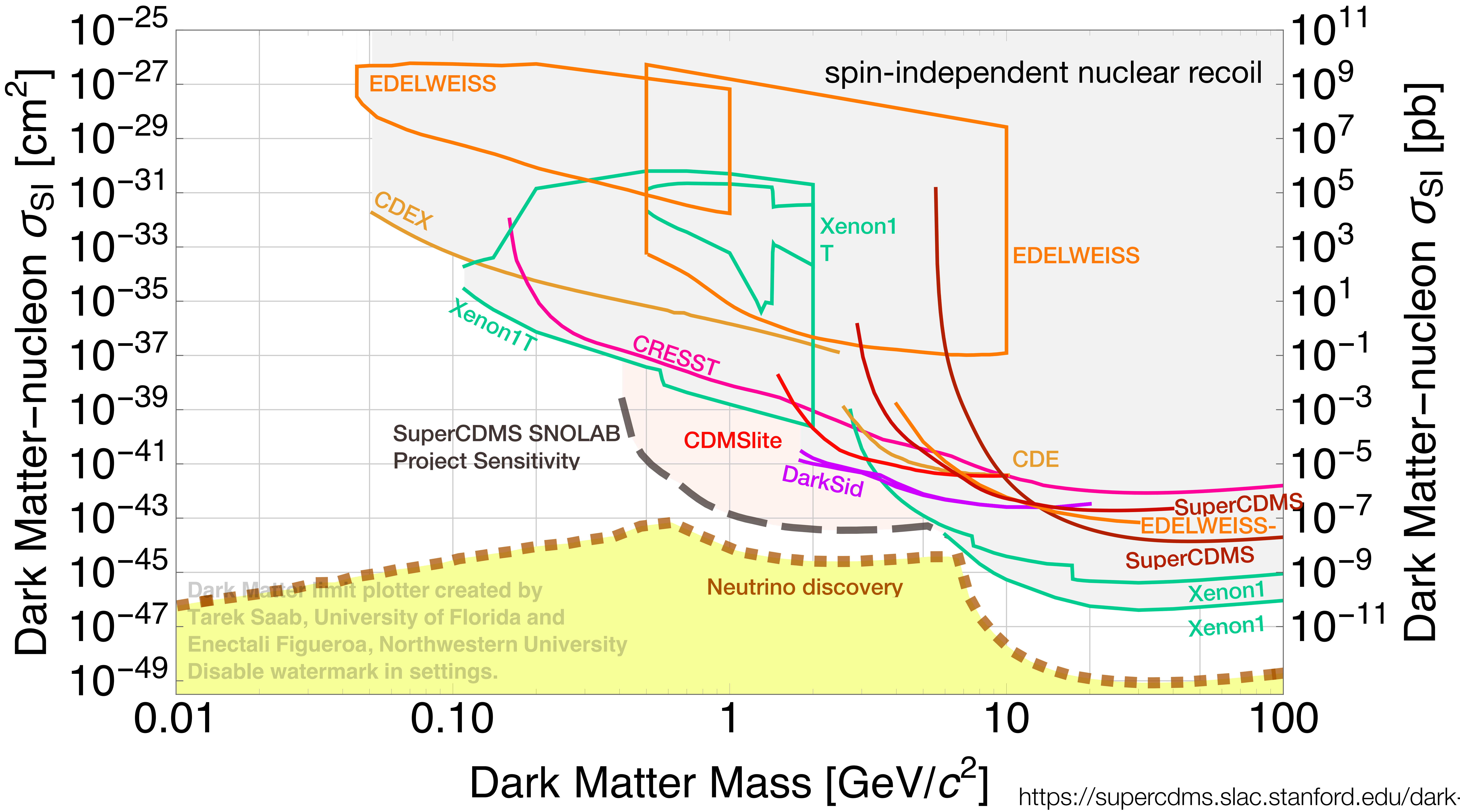
July 26, 2021

Worldwide Dark Matter Direct Detection



PDG 2020

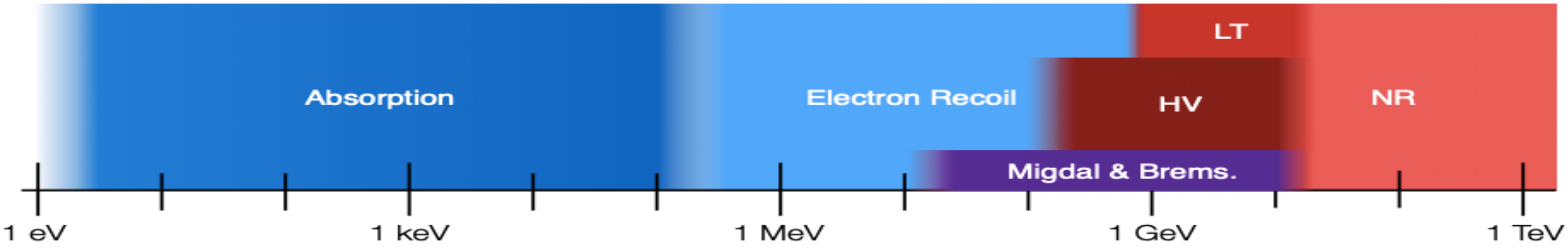
SuperCDMS SNOLAB Contribution



https://supercdms.slac.stanford.edu/dark-matter-limit-plotter

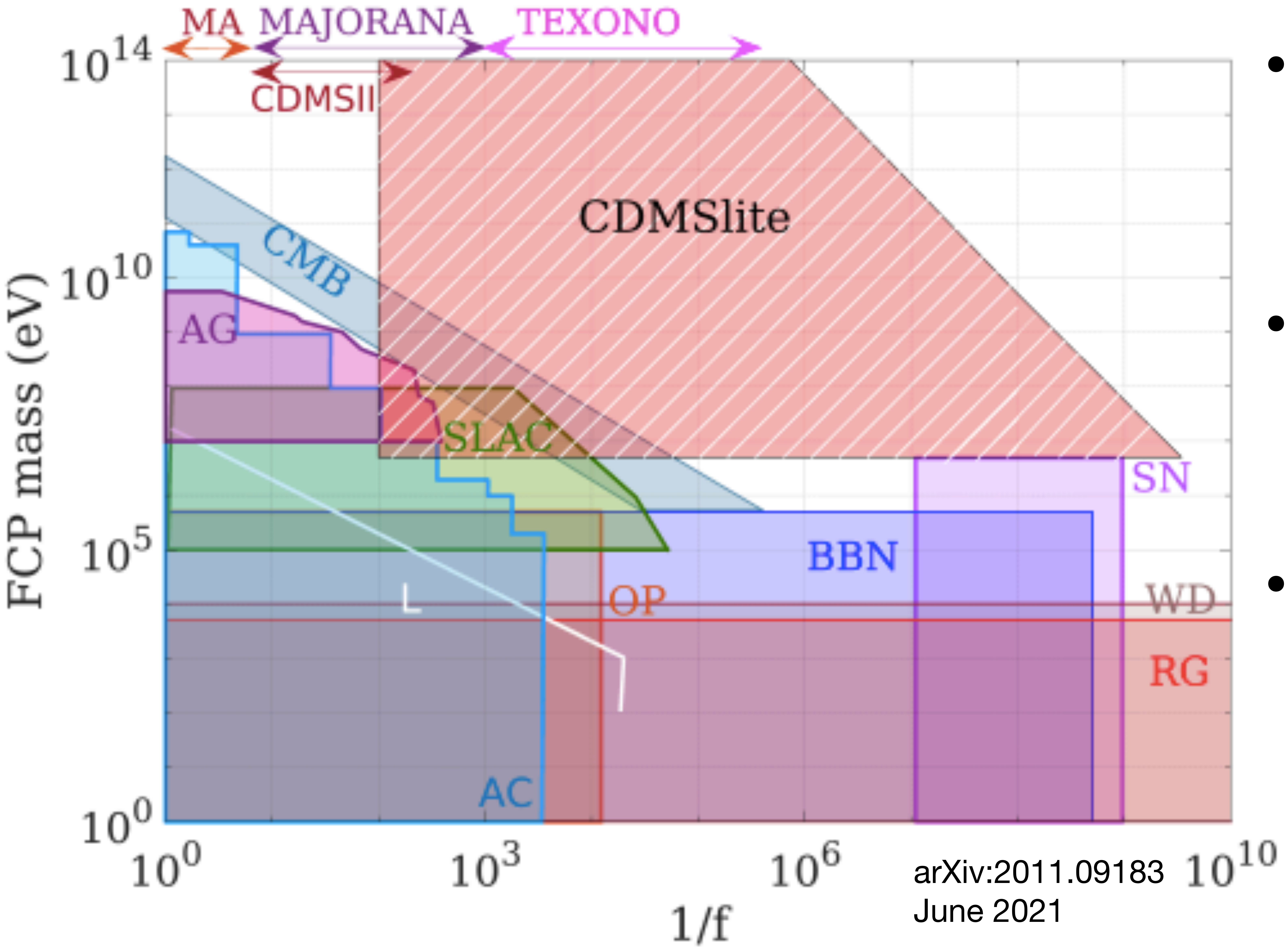
Many more detection channels!

		dark matter mass
• Nuclear recoil (NR) channel		
• iZIP detectors	=>	> 3 GeV
• iZIP detectors with low threshold	=>	> 1 GeV
• HV detectors	=>	0.3 GeV ~ 10 GeV
• Electron recoil (ER) channel		
• HV detectors	=>	0.5 MeV ~ 1 GeV
• Absorption channel		
• HV detectors	=>	1 eV ~ 0.5 MeV
• …		



iZIP: interleaved Z-dependent Ionization and Phonon **HV: High Voltage**

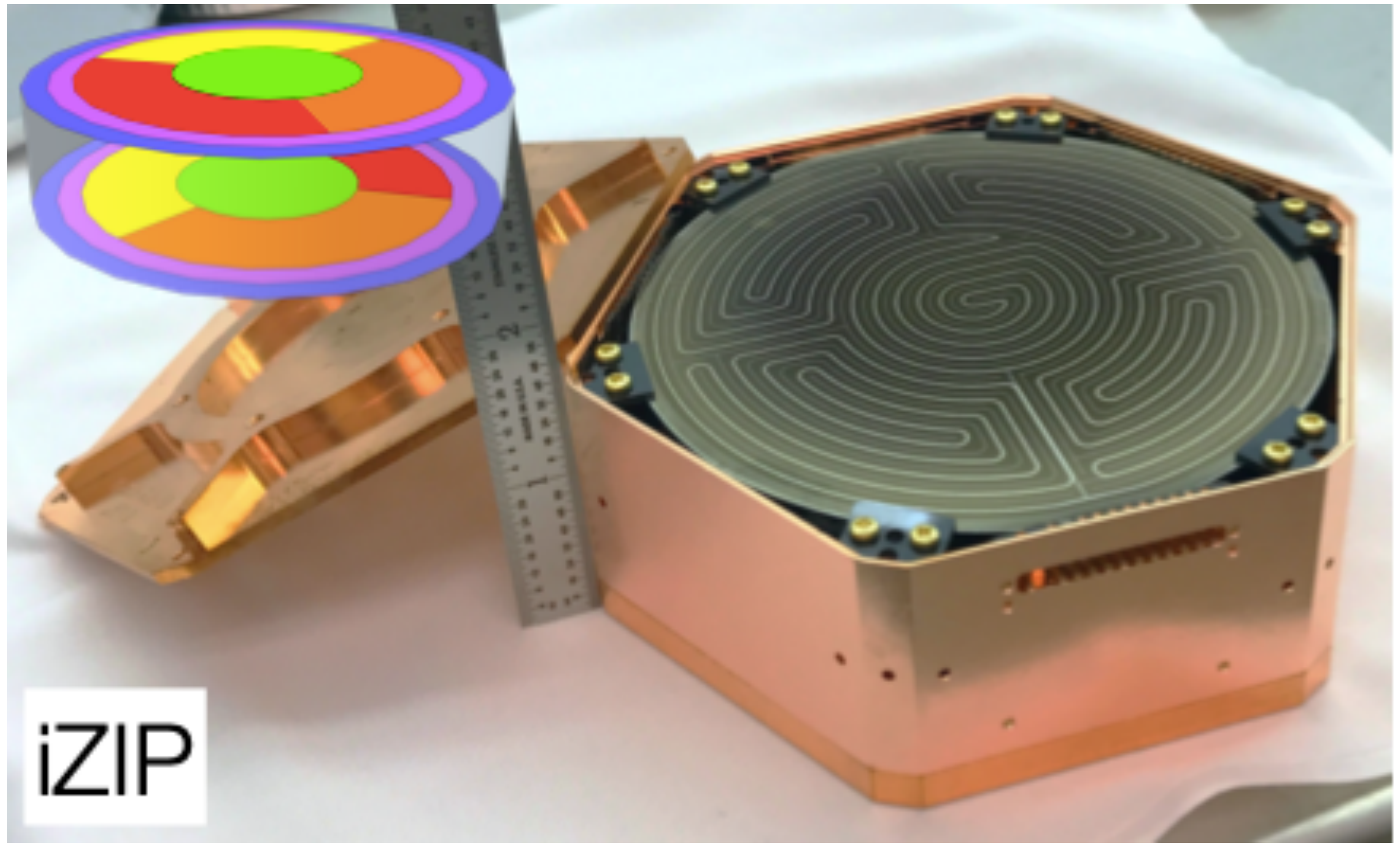
CDMSlite LIP search

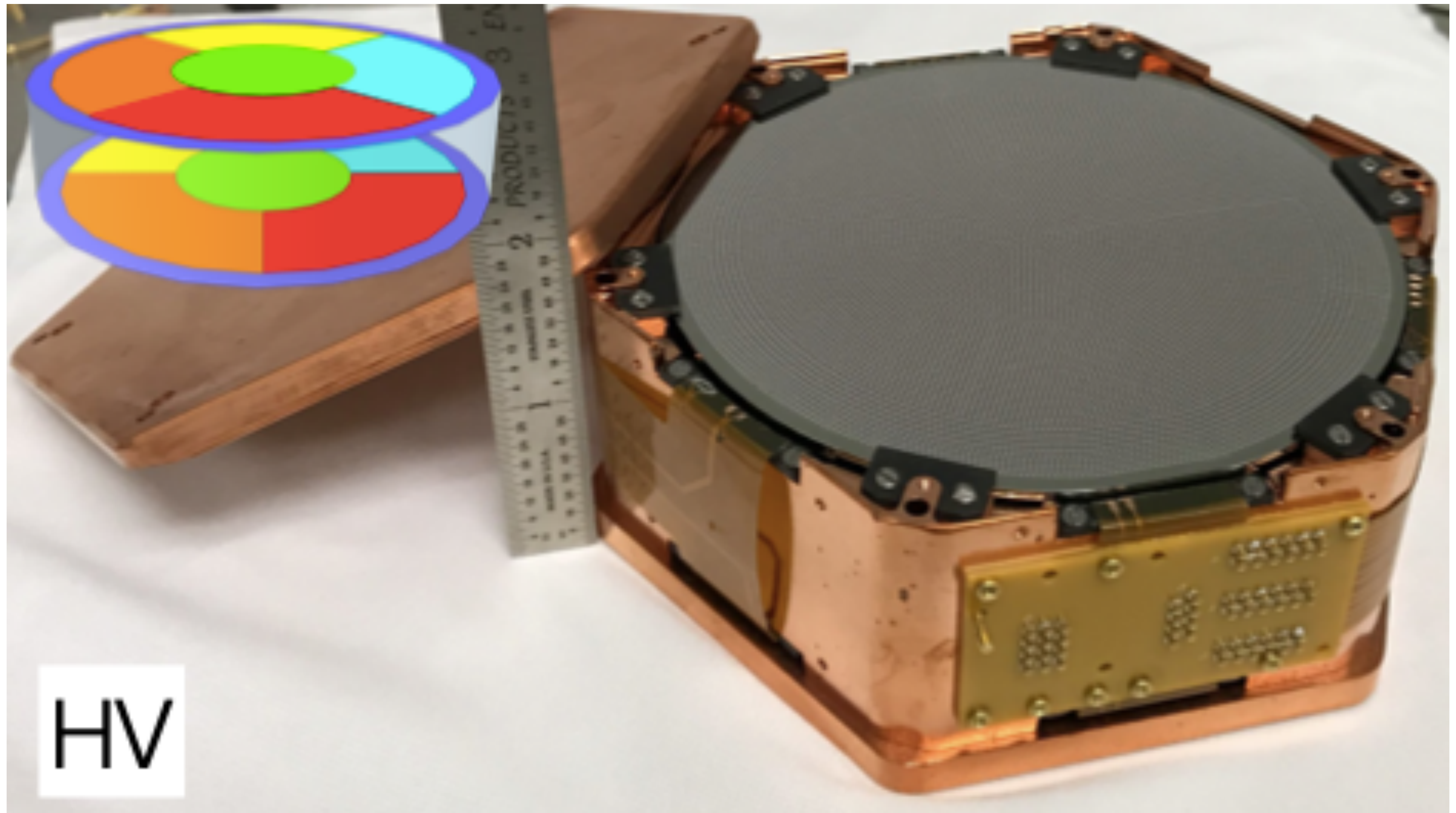


- Lightly Ionizing Particles (Fractionally-Charged particle with small charge)
- Lose energy at a rate proportional to f^2 (f is the fraction of charge)
- first limit for LIP with $f < 3 \times 10^5$, and strongest limit to date for $f < 1/160$

arXiv:2011.09183
June 2021

SuperCDMS SNOLAB Technology

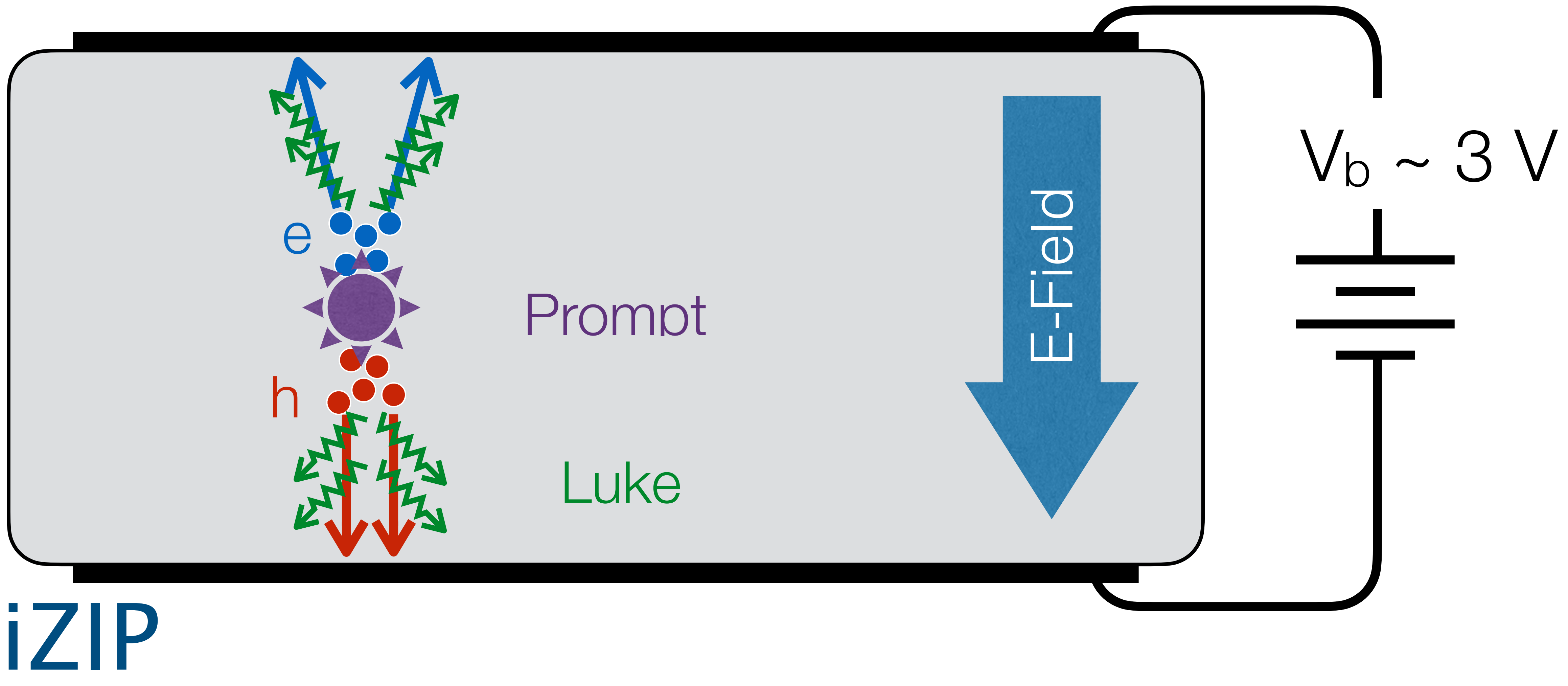


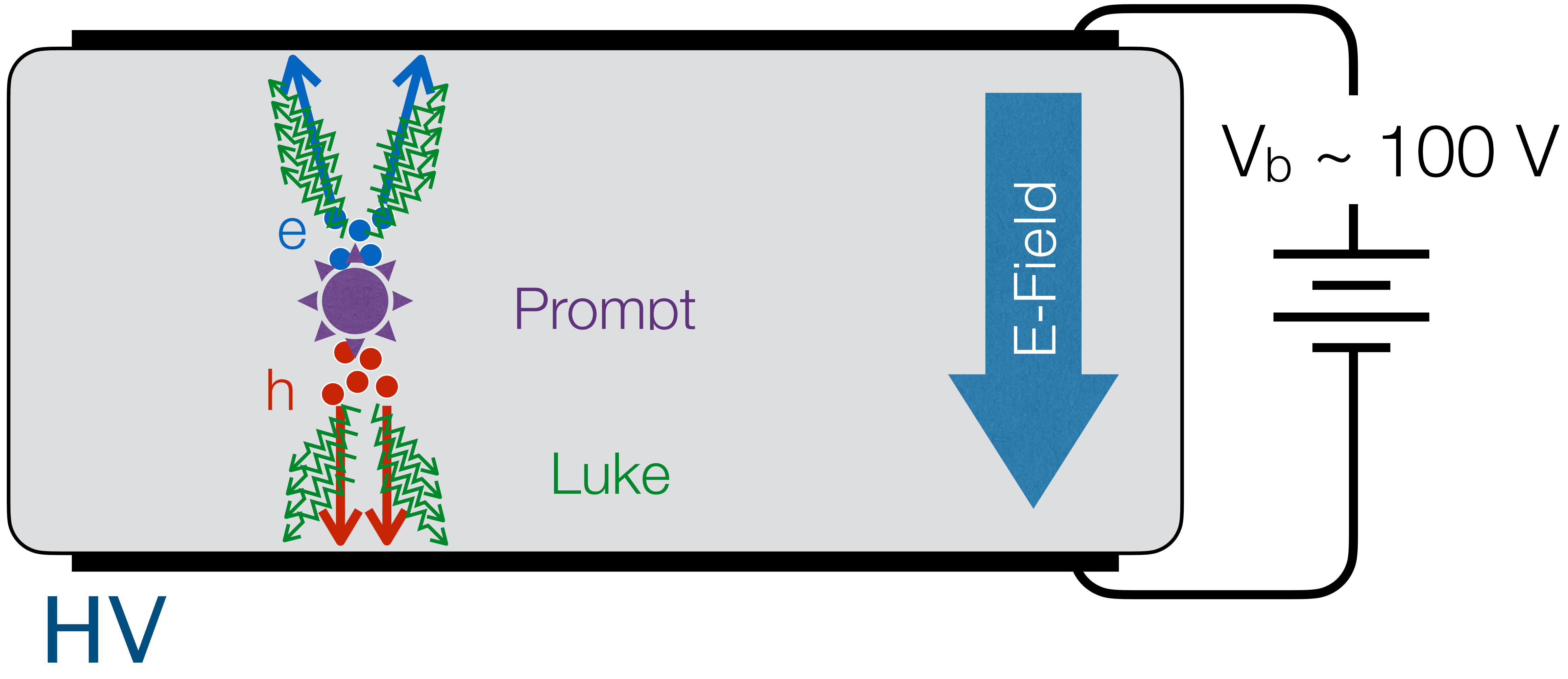


- Read out both charge and phonon channels
- NR and ER discrimination for background rejection

- Read out only phonon channels
- Superb energy resolution and low threshold
  - Recoil energy resolution ~ 10 eV
- Rich position information

SuperCDMS SNOLAB Technology



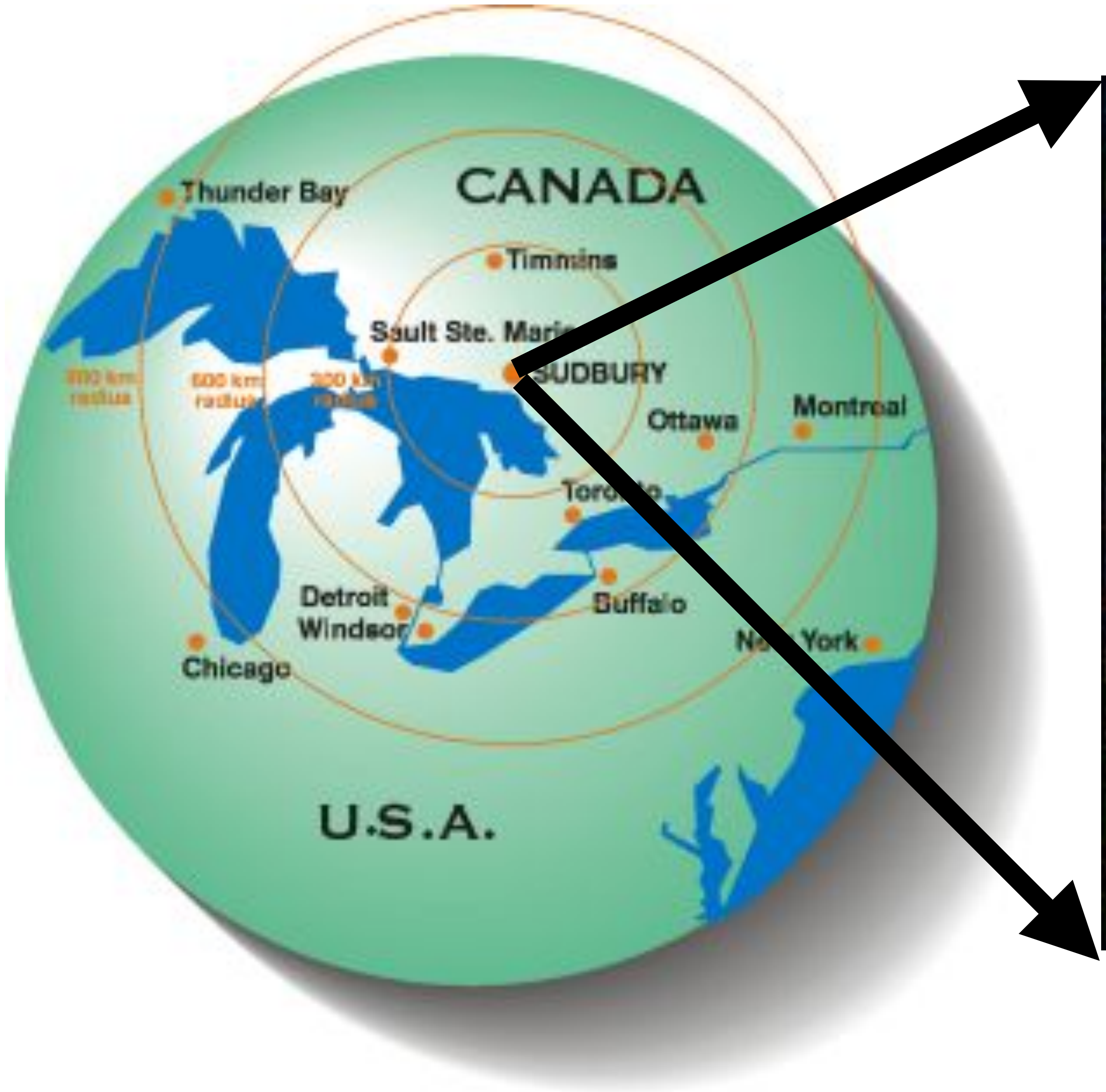


- Charge measured by HEMTs
- Phonons measured by TESs
- Ratio of charge/phonon is indicative of interaction type (NR or ER)

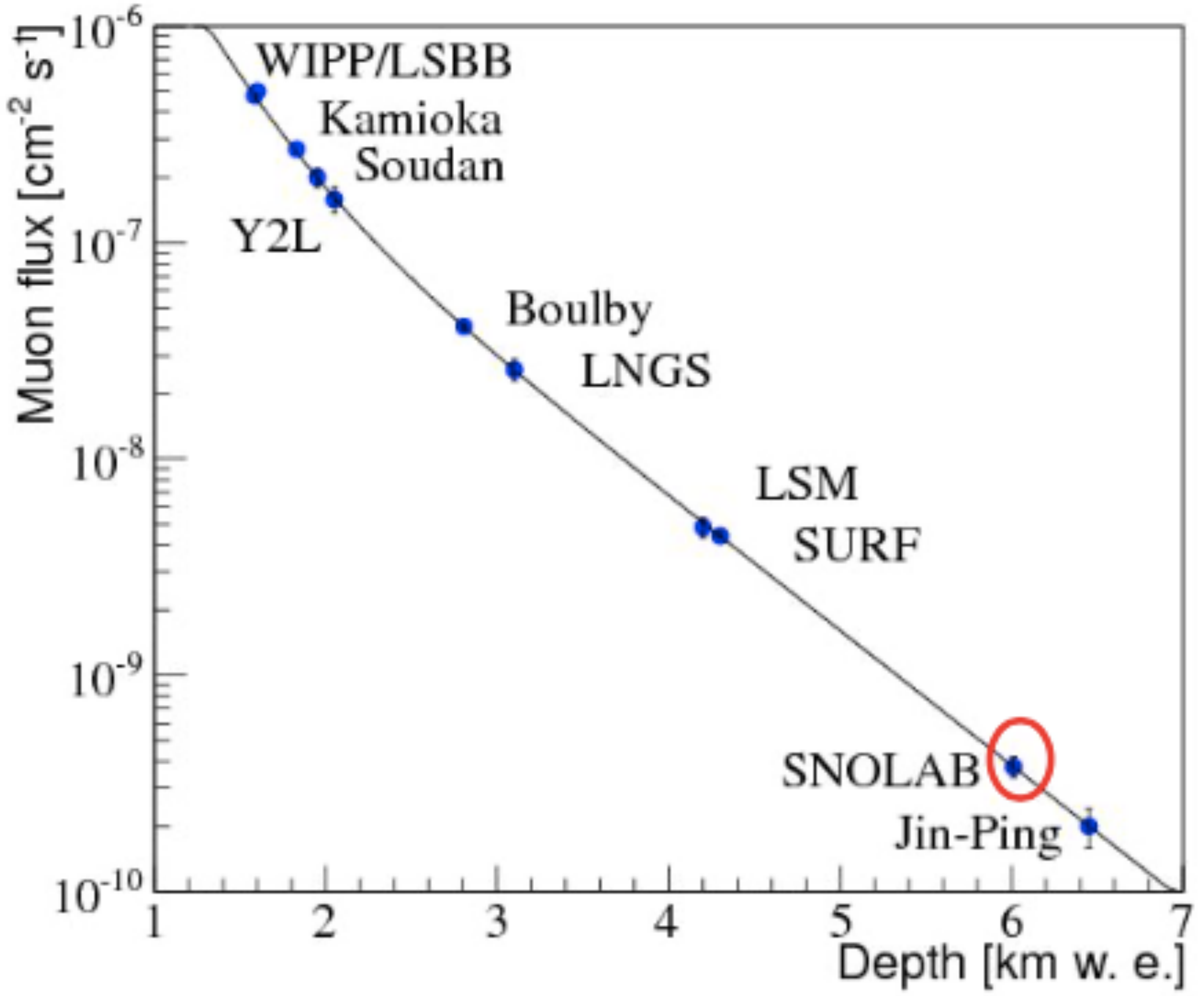
- Phonons measured by TESs
- All energy gets converted to phonons - signals are amplified through the Neganov-Trofimov-Luke effect*

* B. Neganov and V. Trofimov, Otkrytia i Izobret. 146, 7 215 (1985).

SNOLAB



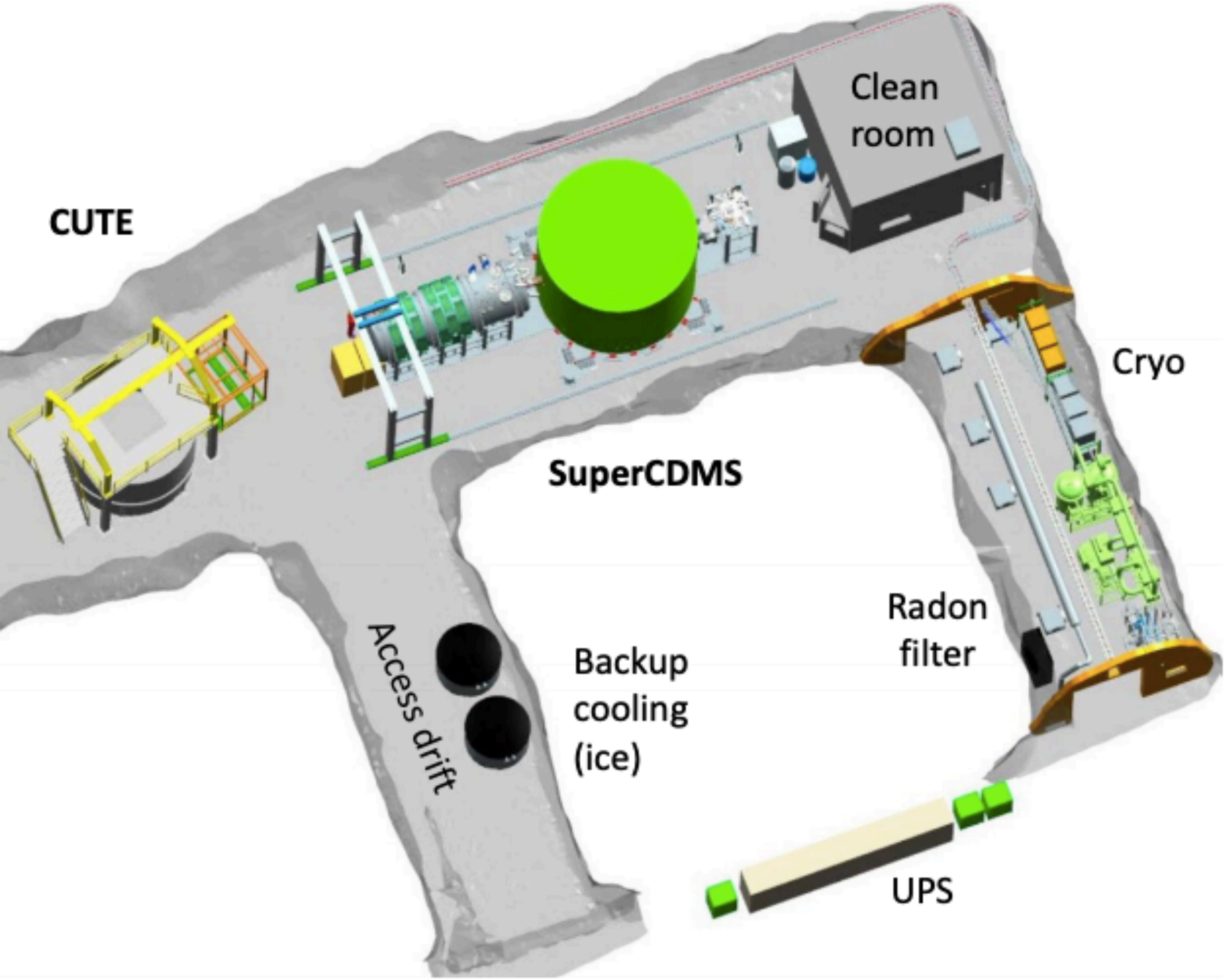
J.Phys. G43 (2016)



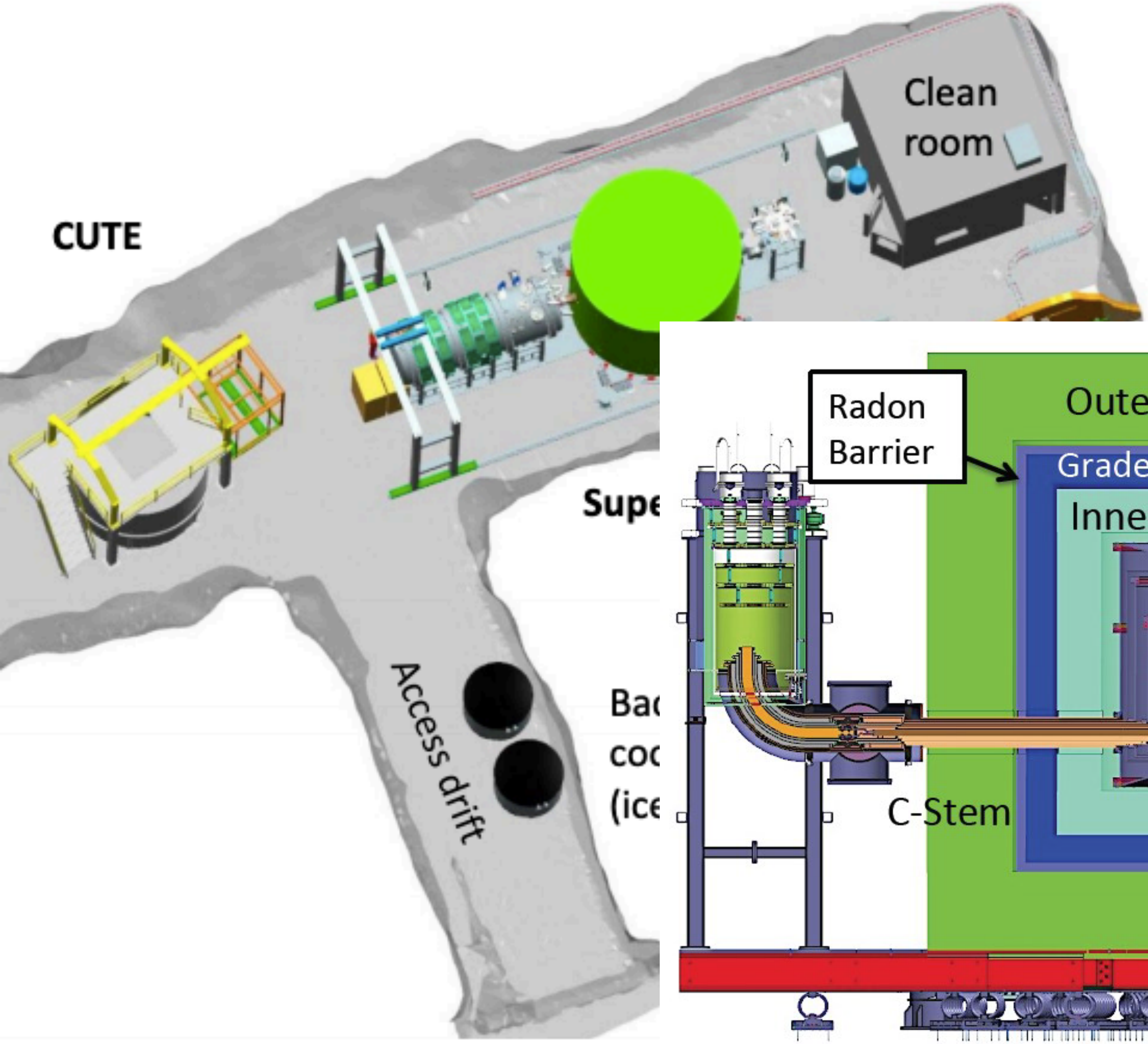
One of the deepest underground clean labs

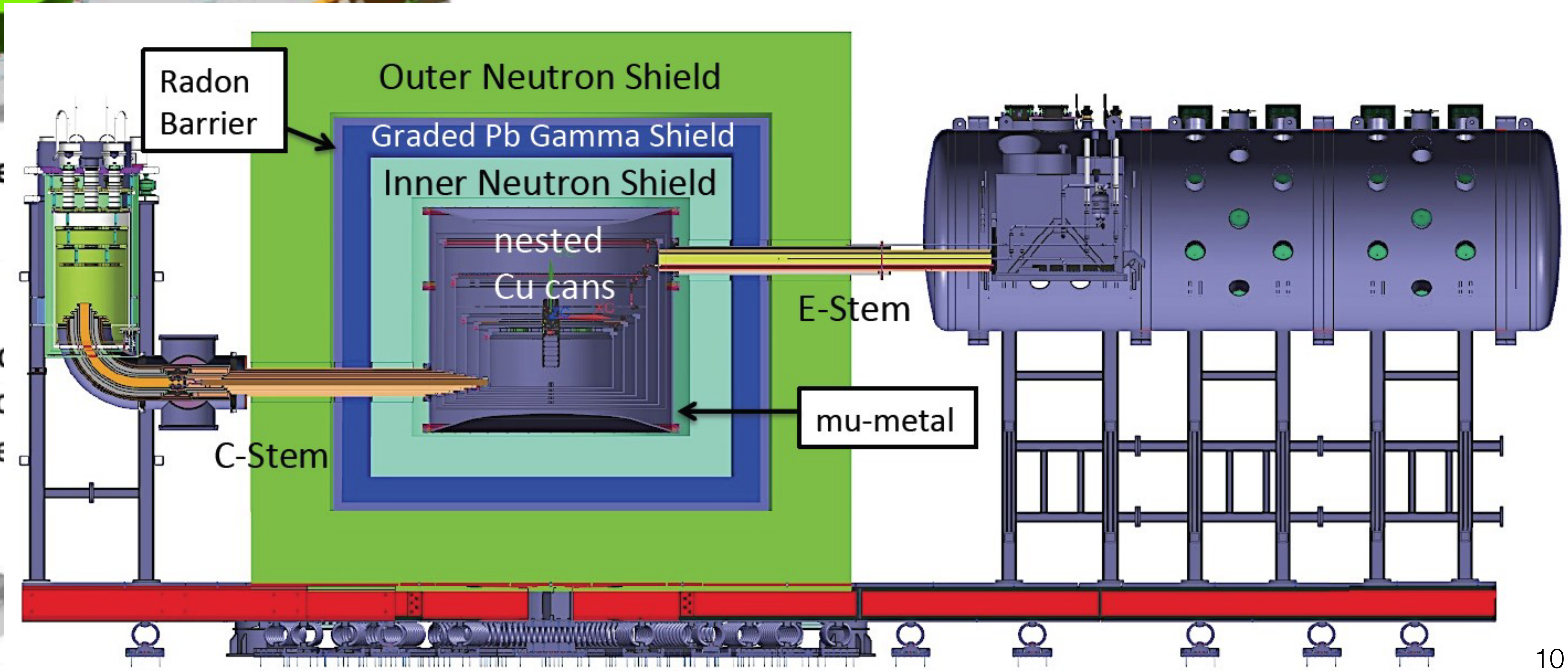
- significant reduction of muon flux

SuperCDMS @ SNOLAB



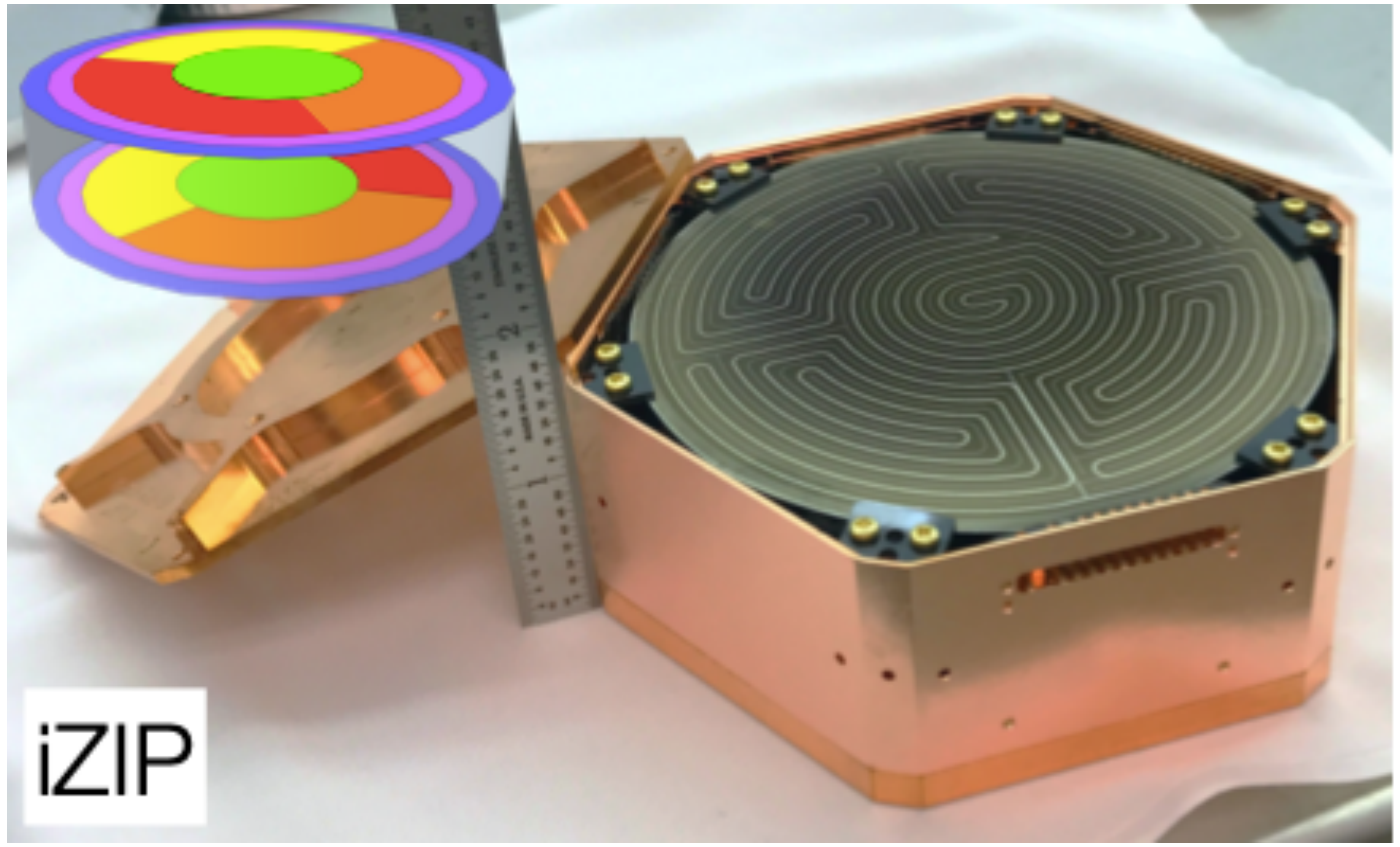
SuperCDMS @ SNOLAB

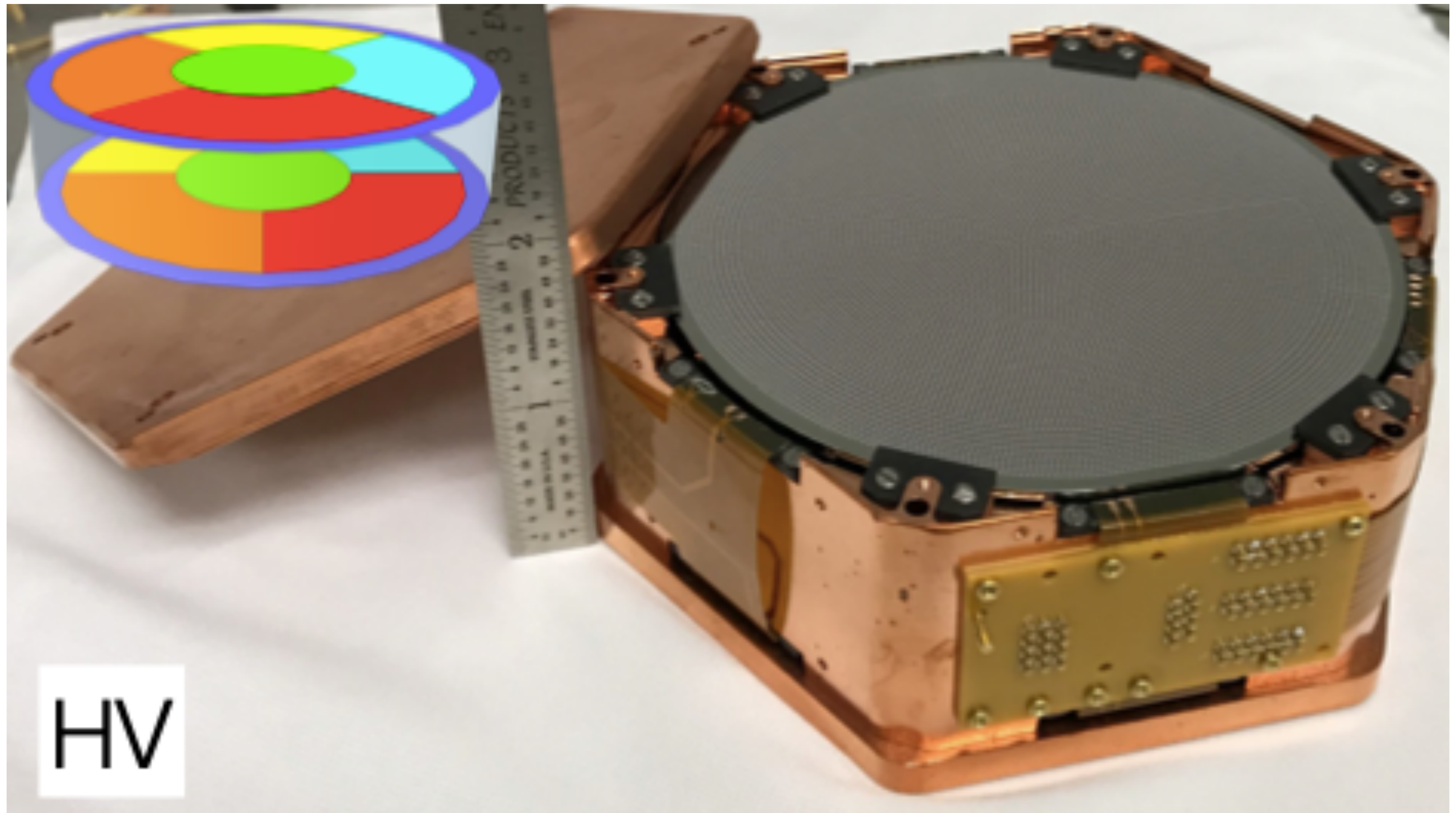




SuperCDMS @ SNOLAB

SuperCDMS SNOLAB

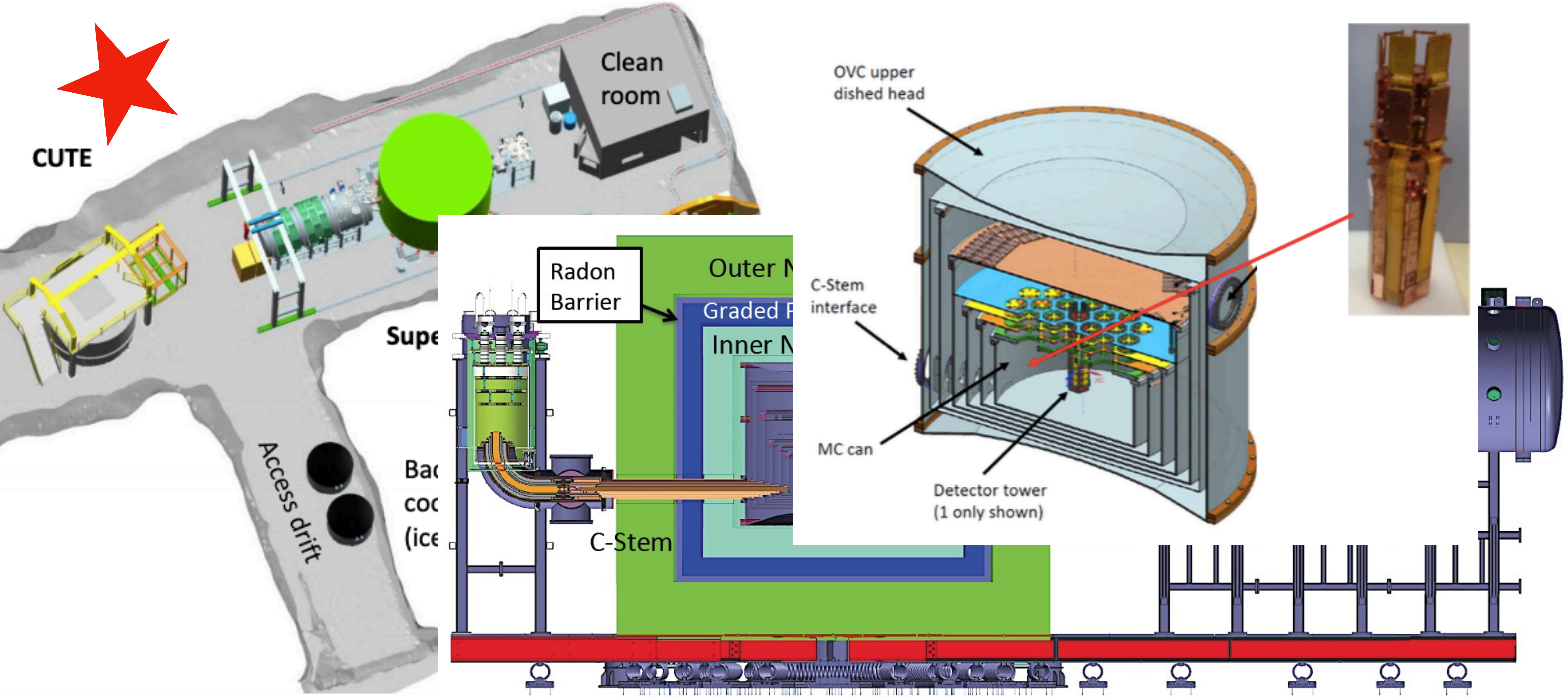


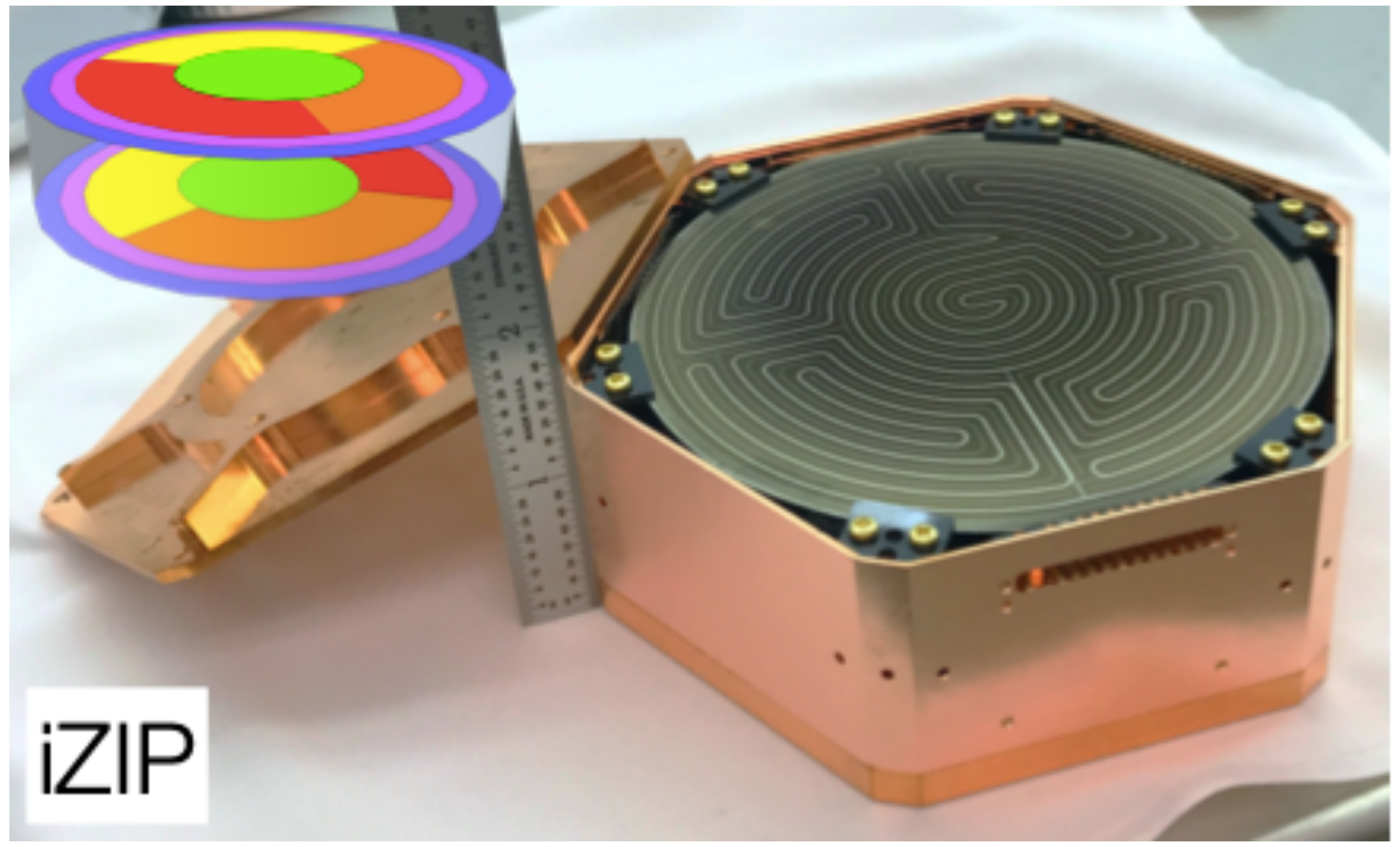


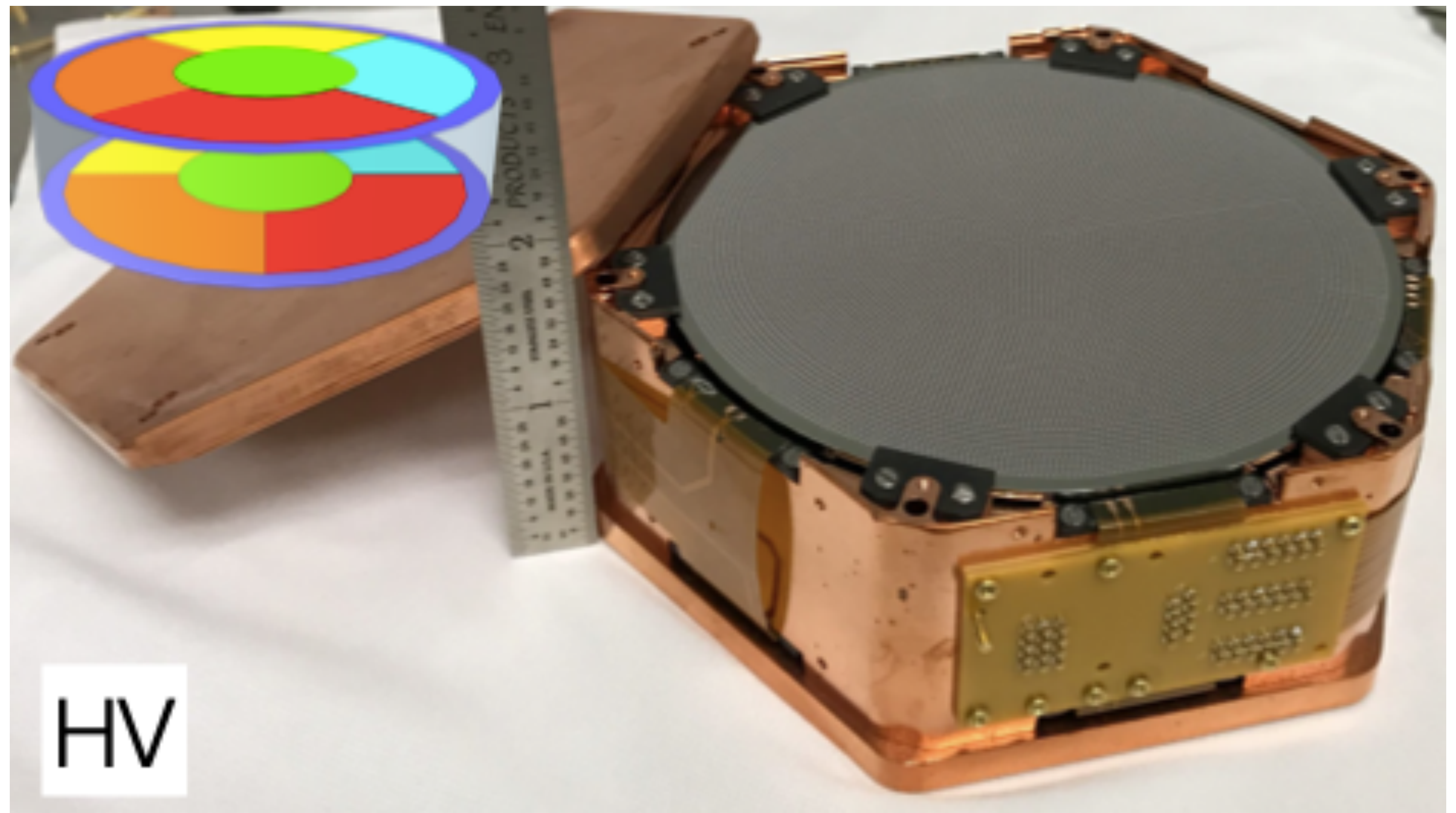
- 2 Towers: 10 Ge, 2 Si
- 2 Towers: 8 Ge, 4 Si

- Complementary target isotopes.
    - Ge for better sensitivity and Si for better mass reach
- Operational temperature < 30 mK for unparalleled resolution

SuperCDMS @ SNOLAB

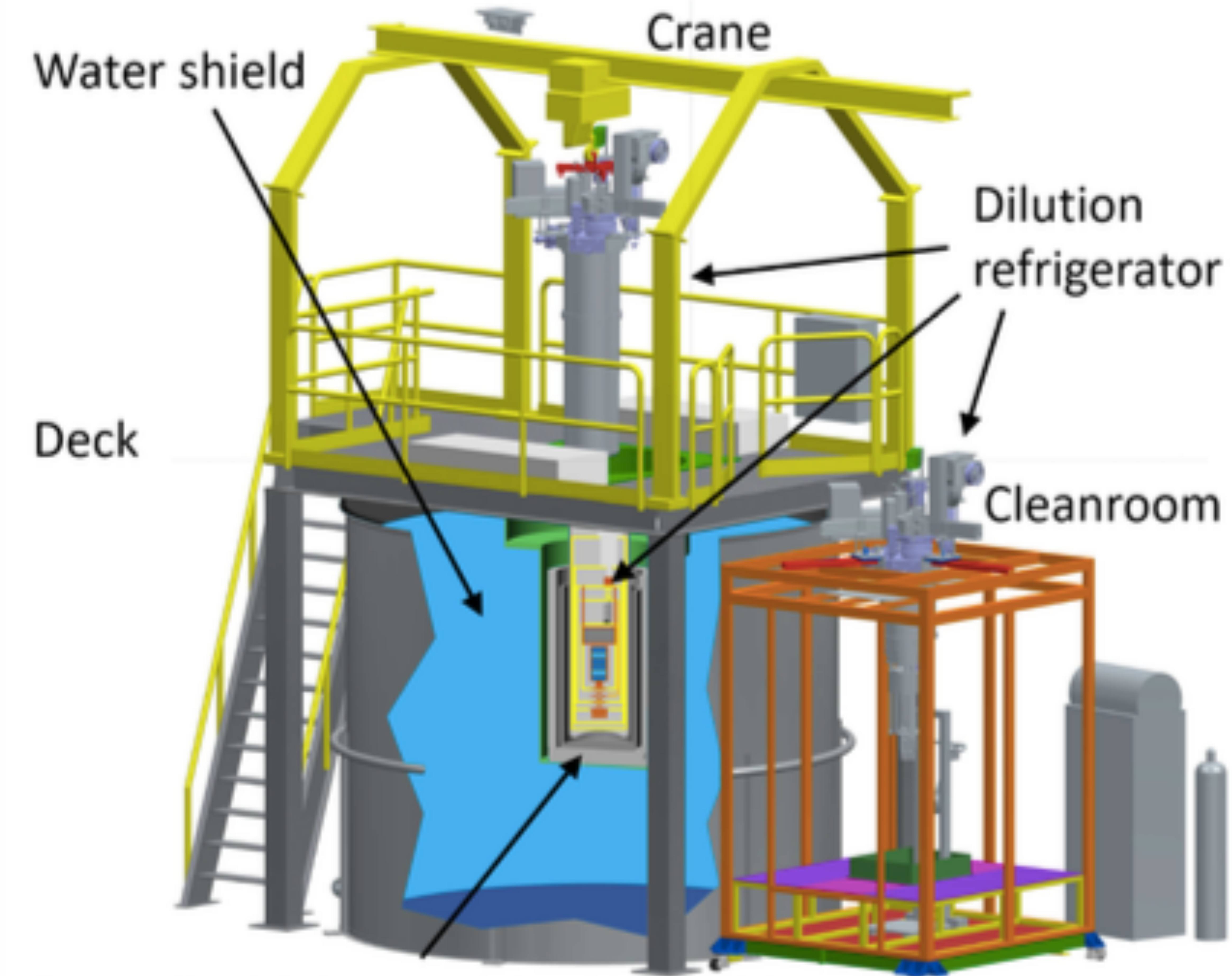






Installation underway. Science data-taking expected to start 2022!

CUTE @ SNOLAB



- Cryogenic Underground TEst
  - Operational temperature comparable to SuperCDMS SNOLAB
  - Capacity up to one full tower
  - Quick fridge turnaround
  - Ideal testbed for SuperCDMS SNOLAB detectors

First HV detector being commissioned right now!

Conclusions

- SuperCDMS SNOLAB is well-positioned to explore the uncharted parameter space in dark matter direction detection.
- Thanks to the variety of the detector technologies, dark matter can be detected via many channels, including nuclear recoil and electron recoil.
- SuperCDMS SNOLAB expects to start data taking in the very near future with an initial load of four towers.
- CUTE can play an important role in both the early science output as well as detector characterization.