

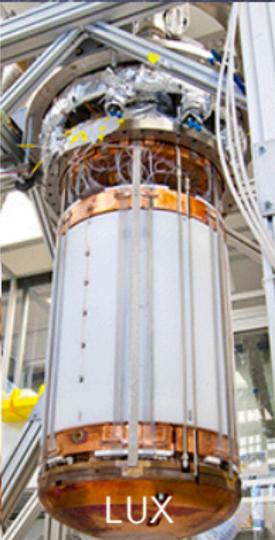
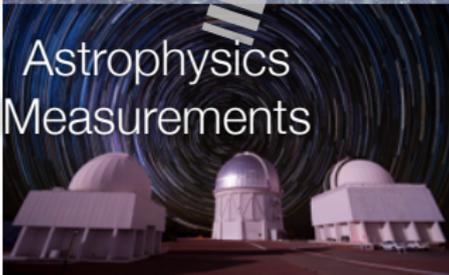
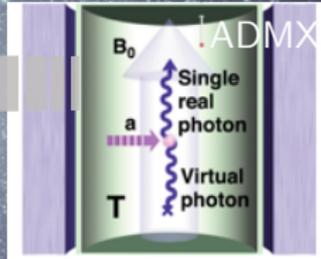
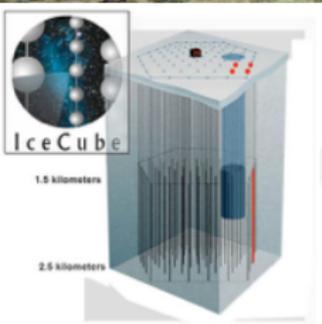
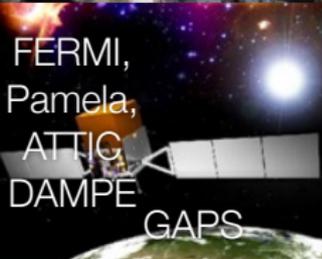
# SuperCDMS in 10 Minutes

Ziqing Hong, for the SuperCDMS Collaboration  
June 18, 2018  
New Perspectives 2018



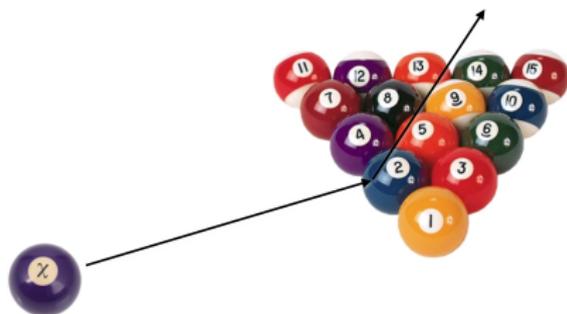
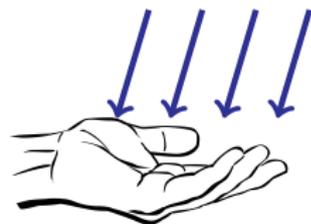
NORTHWESTERN  
UNIVERSITY

# The Hunt for Dark Matter



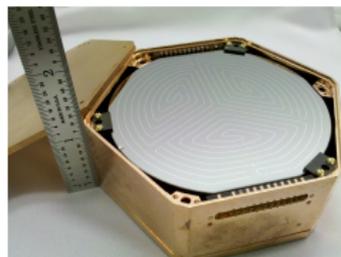
# Dark Matter Direct Detection

- ▶ Dark matter passes through the earth all the time
  - ▶ About 20 million/hand/sec
    - ▶ Assuming  $O(10) \text{ GeV}/c^2$  mass
- ▶ Direct detection experiments measure them via their elastic scattering off target nucleus
  - ▶ Very rare
    - ▶ Or we would have seen it by now...
  - ▶ Expect very low-energy recoils
    - ▶ Leave little to no trace
- ▶ Experimental requirements
  - ▶ Large exposure
  - ▶ Ultra sensitive detectors
  - ▶ Low backgrounds

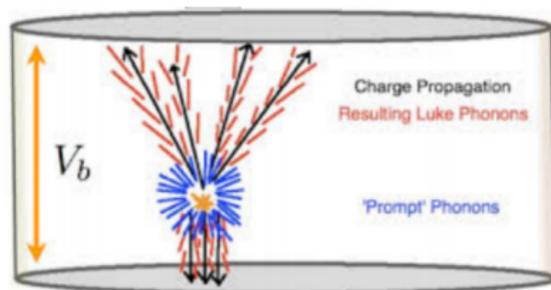


## Direct Detection and SuperCDMS

- ▶ **Cryogenic Dark Matter Search**
- ▶ Germanium and Silicon detectors
  - ▶ Tens of kilograms of detector mass next generation
  - ▶ Can scale up if needed
- ▶ Transition Edge Sensors (TES)
  - ▶ Operated at 60 mK or below
  - ▶ Down to  $O(10)$  eV sensitivity
  - ▶ Use state of the art cold electronics for the best signal to noise
- ▶ Operate deep underground, with layers of shielding
  - ▶ SNOLAB, 2000 m underground
  - ▶ Meticulous choice of low radioactivity material and extra care to cleanliness
  - ▶ Robust shielding scheme
  - ▶ 0.1 background events /kg/keV/day

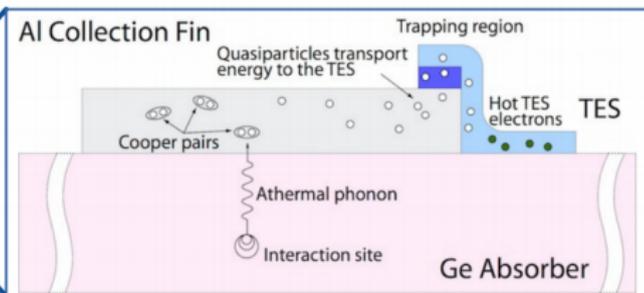
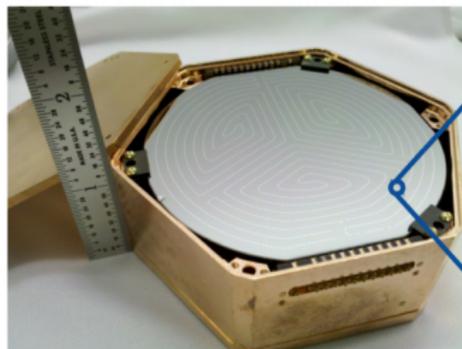


# SuperCDMS Detector Principle

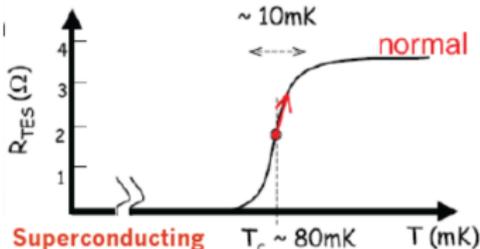


- ▶ Cool down Ge or Si crystal to near 0K
- ▶ Dark matter scatter off nucleus in the crystal
- ▶ Creates lattice vibration in crystals
  - ▶ Athermal phonons
- ▶ TES deposited on the crystal surface serves to detect phonons

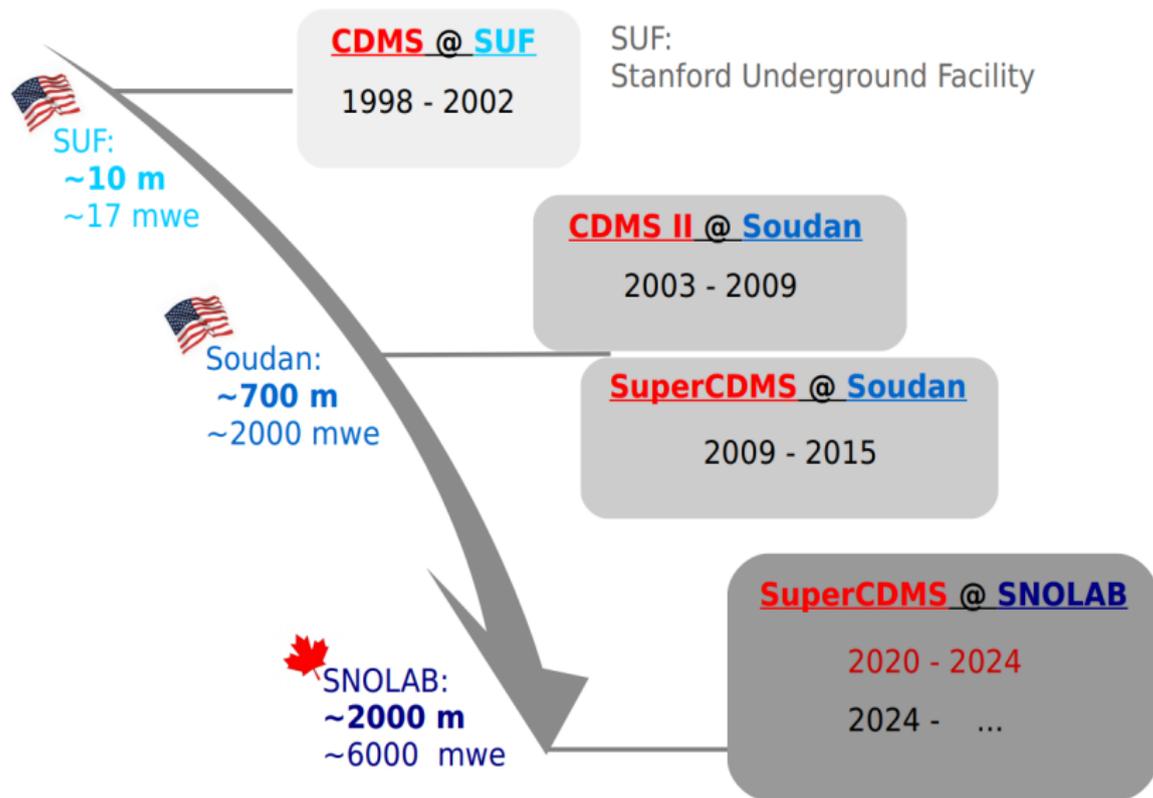
# TES as Phonon Detectors



- ▶ Bring TES to the middle of its superconducting transition
- ▶ Collect phonons with Aluminum fins, then focus their energy towards the TES
  - ▶ Like an antenna
- ▶ Small change in temperature  $\rightarrow$  measurable change in resistance  $\rightarrow$  Great signal to noise

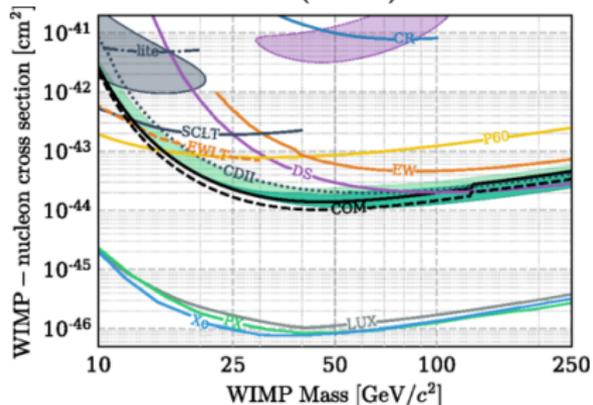


# Past and future of SuperCDMS

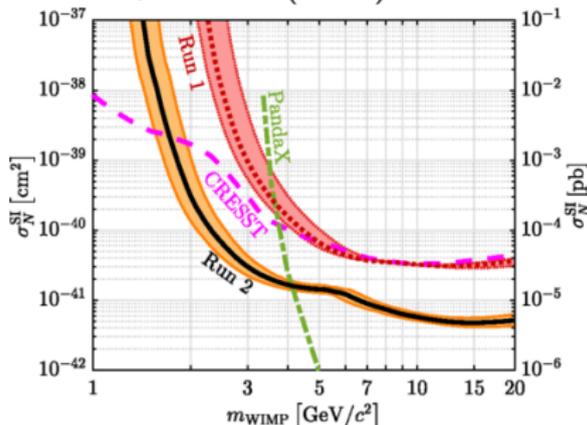


# SuperCDMS Soudan Results

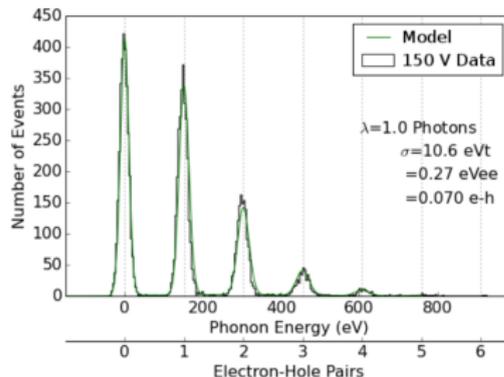
PRL 120, 061802 (2018)



PRD 97, 022002 (2018)

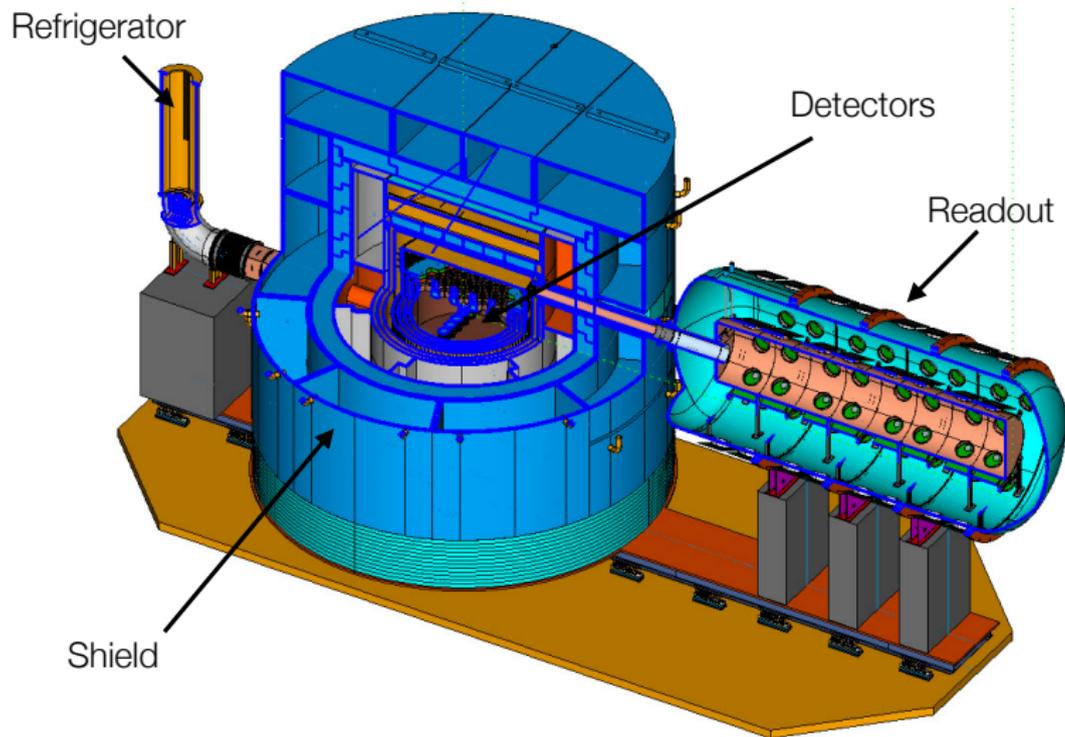


arXiv:1804.10697

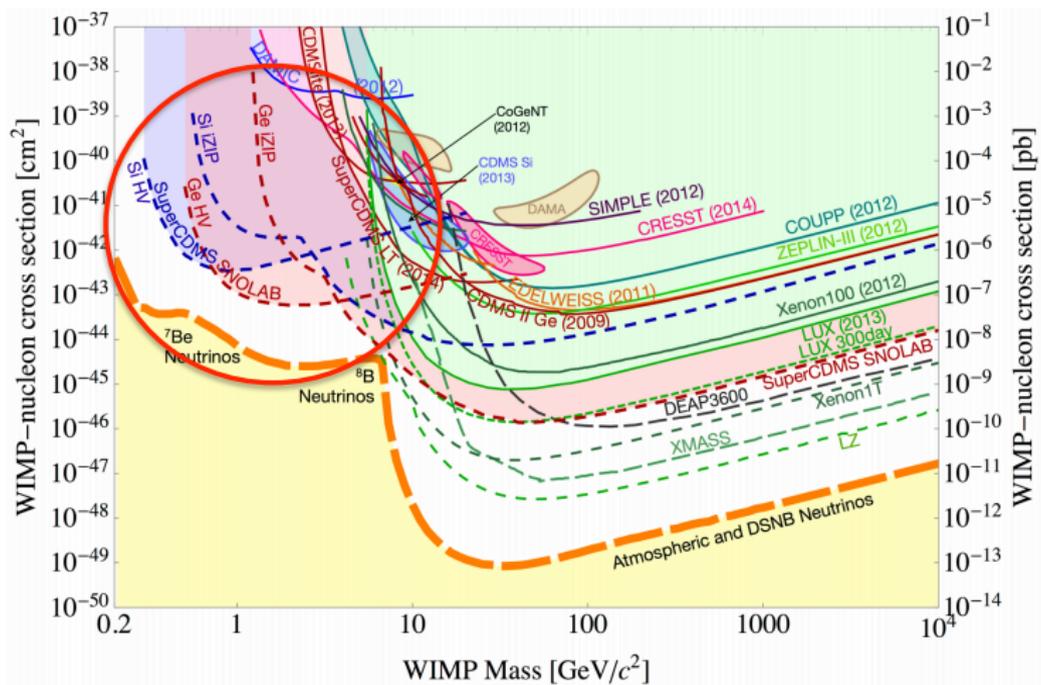


- ▶ Many great results from SuperCDMS Soudan
- ▶ Recent results show sensitivity of  $O(10)$  eV

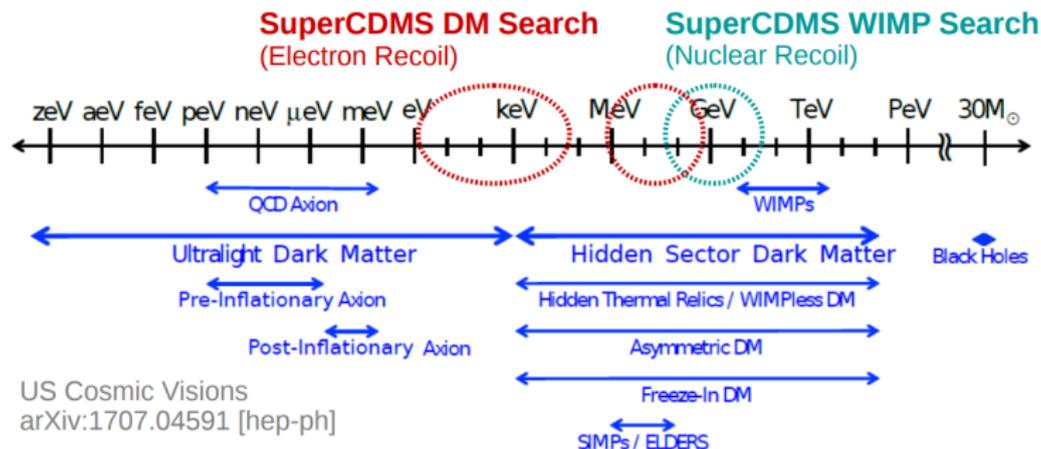
# SuperCDMS SNOLAB



# SuperCDMS Projected Sensitivity



# SuperCDMS Electron Recoil



- ▶ SuperCDMS is also sensitive to sub-GeV dark matter through electron recoil signal search

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## Conclusions

- ▶ Dark matter direct detection helps identify dark matter properties
- ▶ SuperCDMS looking for lower mass dark matter
  - ▶ Below  $10 \text{ GeV}/c^2$
- ▶ Employs germanium and silicon crystals equipped with transition edge sensors
  - ▶ Ultra high sensitivity and low energy threshold
- ▶ Many great results from previous operations
- ▶ Moving to SNOLAB
  - ▶ At the forefront of dark matter direct detection over its previous runs at Soudan.
  - ▶ Expect turning on in 2020
- ▶ Stay tuned

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# Backup Slides

Backup slides