



SuperCDMS

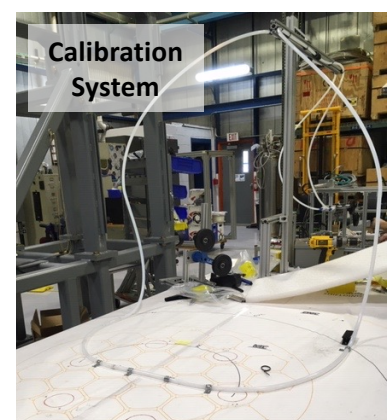
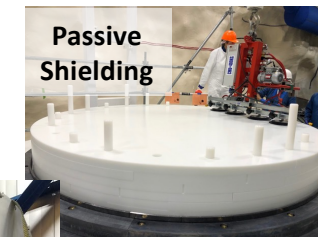
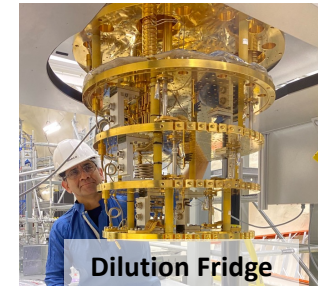
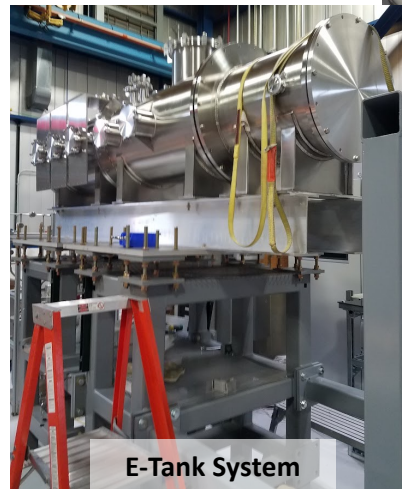
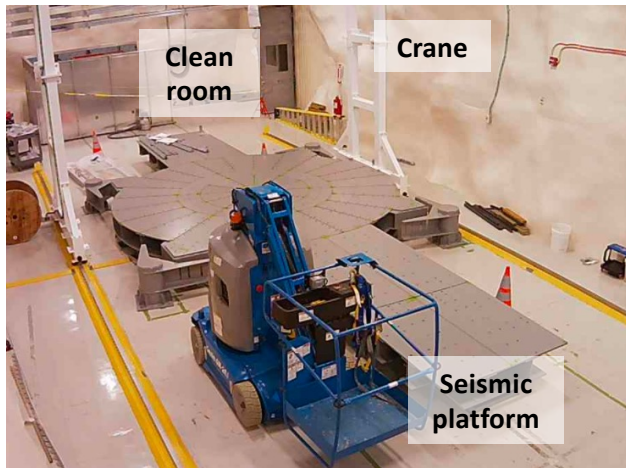
Lauren Hsu

Cosmic Day – Astrophysics Department Meeting

October 30 2023

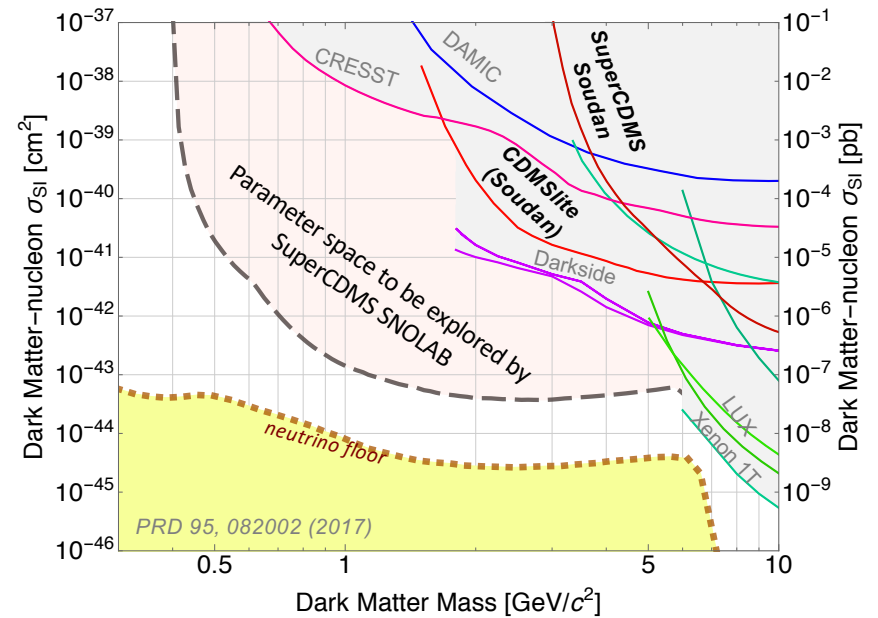
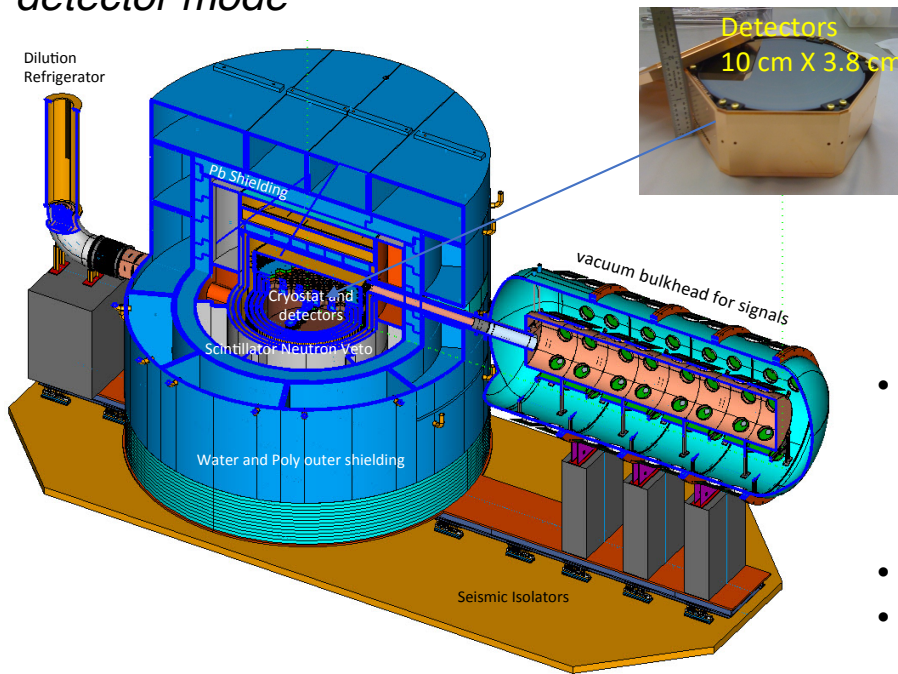
SuperCDMS SNOLAB

- One of “Generation 2” suite of dark matter experiments
- Will provide **multiple orders of magnitude** improved sensitivity to dark matter with masses 0.5-10 GeV/c², using cryogenic detectors
- Currently undergoing installation underground at SNOLAB
- First physics run in 2025? Expected 3-5 years operation
- Fermilab continuing 25 years of involvement with CDMS technology



Overview

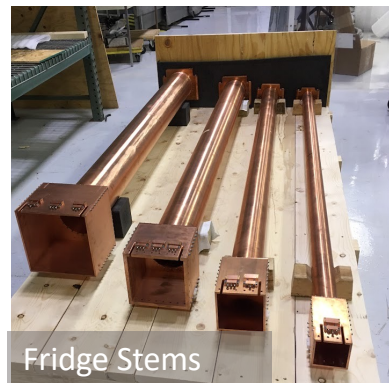
Superb sensitivity to dark matter particles with masses in the 0.5-10 GeV/c² range; using array of Ge and Si detectors operated in “iZIP” and “HV” detector mode



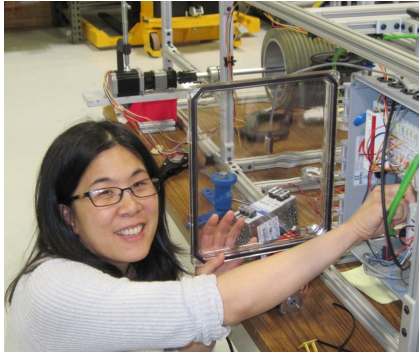
- 4 towers (6 detectors per tower) installed in ultra-clean installation
 - 2 towers iZIP (ionization & phonon)
 - 2 towers HV (NTL amplification)
- TES sensors measure phonons from particle interactions
- First year of operation with HV detectors will probe substantial new territory in the few GeV/c² mass range

Fermilab Roles

- FNAL continuing 25 years of involvement in SuperCDMS
- Cryogenics:
 - Dilution Refrigerator procured and tested by FNAL
 - E-tank, cryo stems, PLC controls – designed/assembled by FNAL
 - Copper cryostat (SNOBOX) had to be downsized due to budget/schedule, final design by SLAC
 - COVID-19 delays forced the project to be re-baselined in 2021
- Electronics, Calibration designed and tested at FNAL (latter also fabricated at FNAL)
- Infrastructure partially installed at SNOLAB
 - Seismic platform, cleanroom, crane, utilities mostly designed by FNAL



Who Works on SuperCDMS at Fermilab?



Lauren Hsu
Senior Scientist



Pat Lukens
Senior Scientist



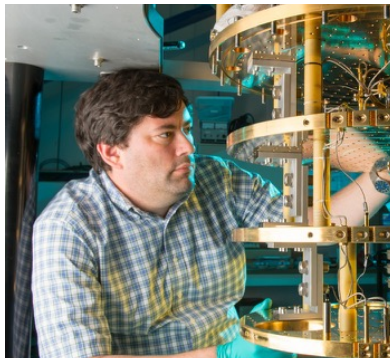
Tali Figueroa-Feliciano
(and group)
Joint Faculty (NU Professor)



Simon Mork
SULI



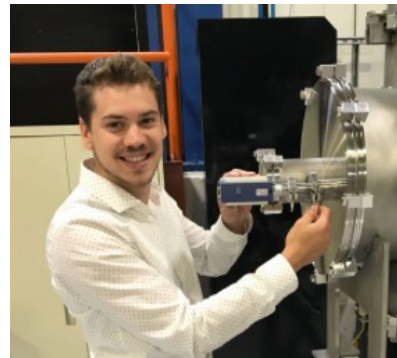
Zach Williams
SCGSR, U. Minnesota



Matt Hollister
Cryo Group Lead



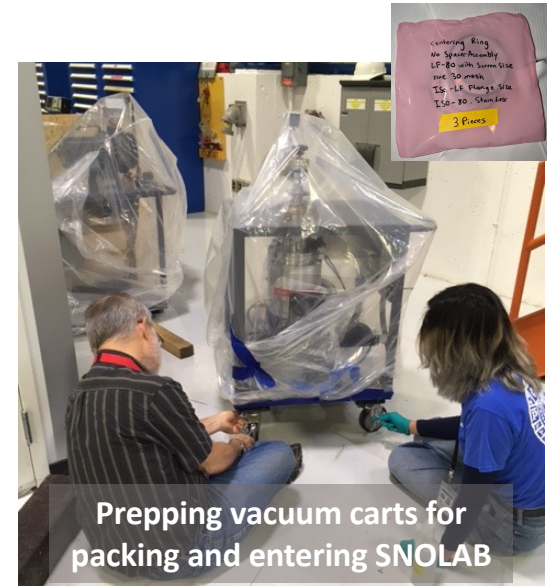
Greg Tatkowski
Cryo Engineer



Luke Martin
Senior Mech. Engineer

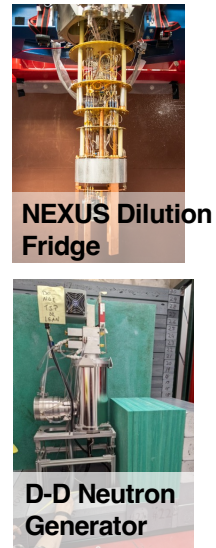
Status of SNOLAB Experiment

- **2018** - CD-2/3 (start of construction), **2020** - de-scope of cryostat, **2021** - rebaselined after covid delays and cost overruns
- **FY 2023 progress:**
 - Fabrication of all subsystems completed; CD-4 in March
 - Cleaning and packing for more than a year (60+ pallets of equipment)
 - Oct. 2023, FNAL shipping nearly all its deliverables to Sudbury (end of project tracking at Fermilab) – *MMR for last full truckload in progress*
- **FY 2024: Installation and integration at SNOLAB**
 - First HV tower operating in underground test stand (CUTE) – opportunity for early science?

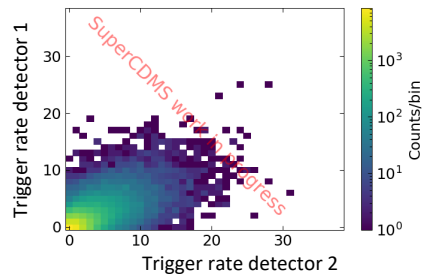


NEXUS: Underground Cryogenic Detector Test Facility in NuMI

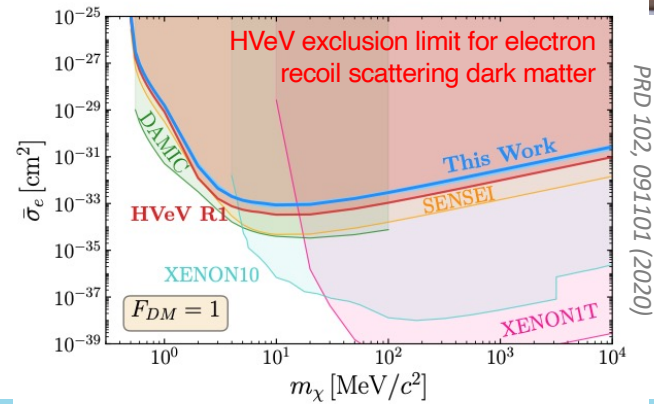
- Developed jointly by Northwestern and Fermilab as a calibration and low background test facility for SuperCDMS
- Functionality has since been broadened to include QIS devices, KIDs and future neutrino detectors
- Neutron generator commissioning underway; allows precise determination of nuclear recoil energy scale, setting sensitivity for SuperCDMS SNOLAB



SuperCDMS HVeV detector has world-leading sensitivity to sub-GeV dark matter; provides resolution of single e/h pairs



Data taken at NEXUS shed light on a class of low energy events; will yield substantial improvement in sensitivity - Stay tuned for results!



Nuclear Recoil Calibration with NEXUS

- Neutron (DD) generator installed alongside cryostat. Aiming to turn on before end of the year (effort lead by Pat Lukens):
 - Neutron scattering measurement allows kinematic determination of the nuclear recoil energy scale in SuperCDMS detectors
 - Lack of data and poor understanding of systematics at low energy
 - DD108 Adelphi generator can produce up to 10^8 n/s; surrounded by layers of borated and plain HDPE with a “collimated” beamline aimed at NEXUS
- Fine-grained backing array will measure recoil angle of neutrons
 - U Minnesota student, Zach Williams, awarded SCGSR scholarship, will spend Spring 2024 at Fermilab implementing prototype backing array
 - SULI student Simon Mork simulating backing array response to optimize design

