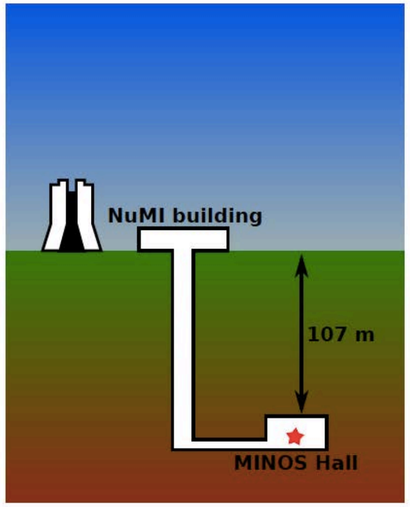
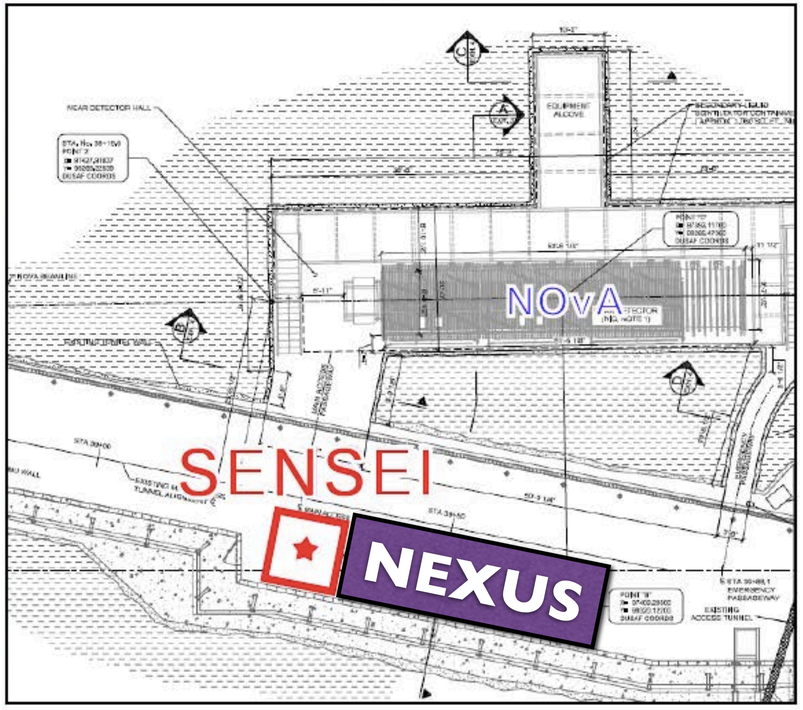

Enectalí Figueroa-Feliciano

# NEXUS@FNAL Facility

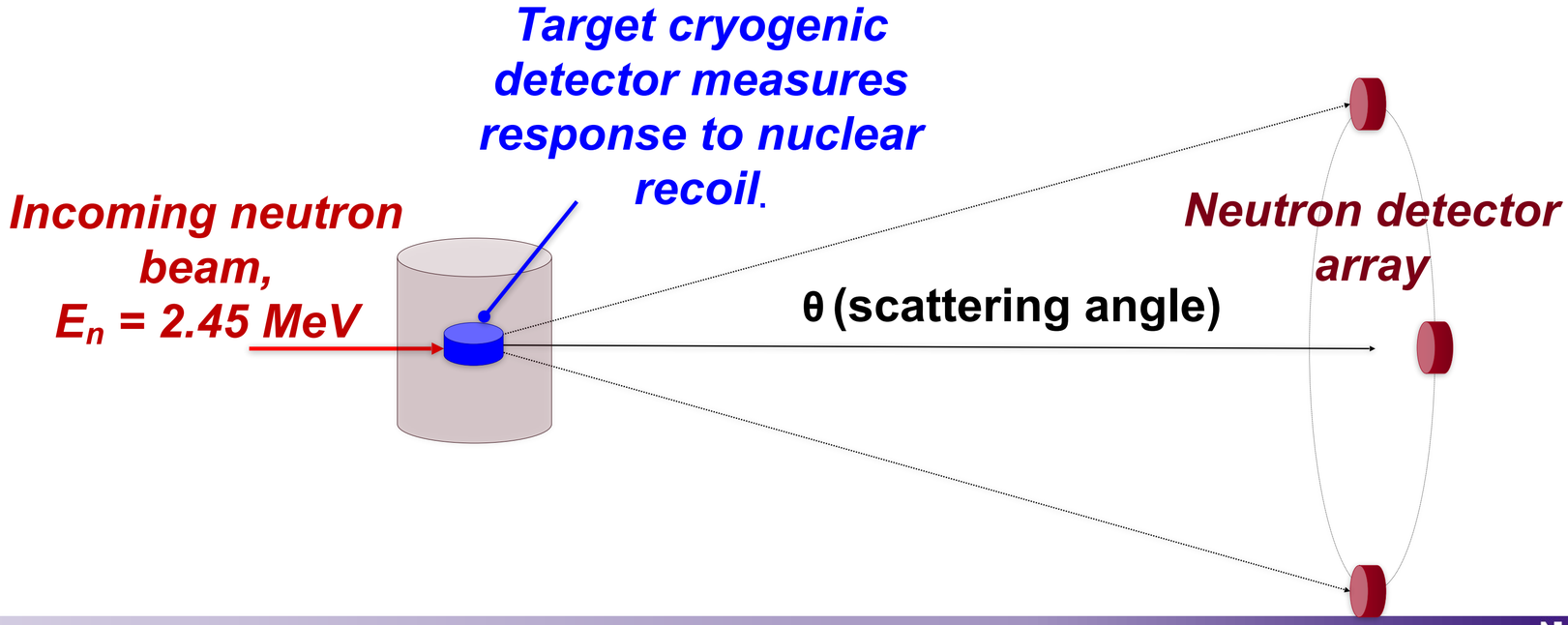
- Northwestern Experimental Underground Site at Fermilab
- Underground cryogenic facility in class 10,000 clean room
- Vibration-isolated dry dilution refrigerator with 8mK base temperature
- 107 m depth (300 meters water equivalent) + lead shielding
  - Expected background < 100 events/keV/kg/day
- Optical fiber, neutron, gamma calibration sources



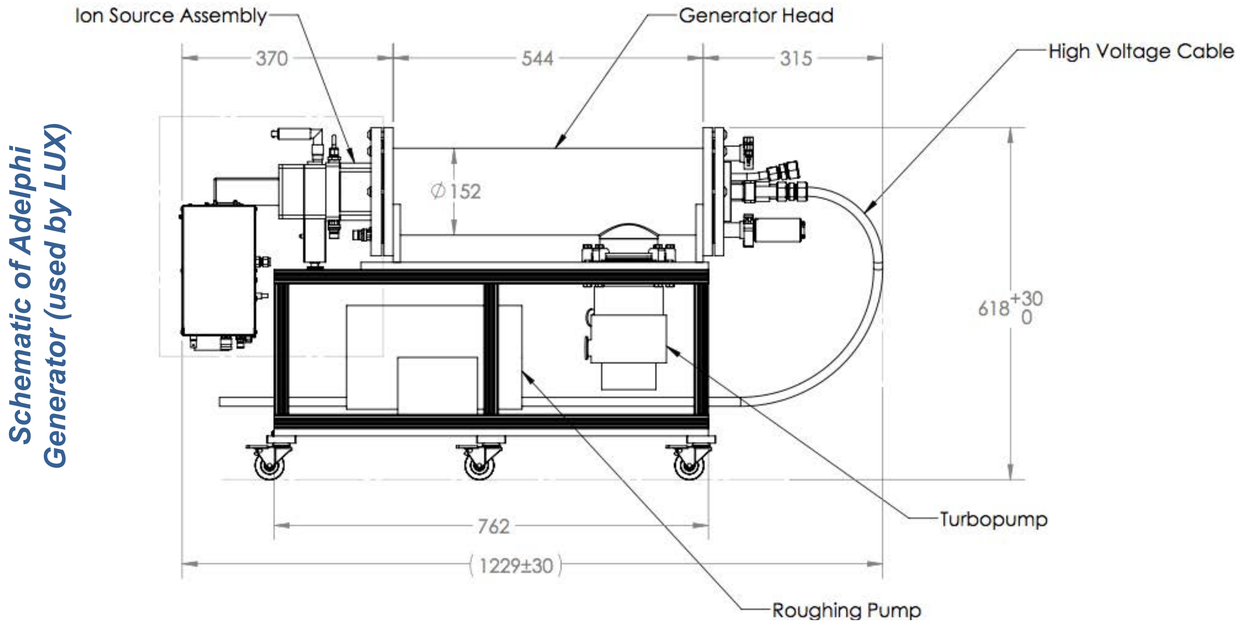
# Detector Calibration via Scattering Angle Measurement

- A standard way characterize detector response to nuclear recoils is with a neutron scattering setup
- Precise knowledge of the scattering angle provides the recoil energy in the detector
- The detector signal can then be calibrated as a function of neutron recoil energy

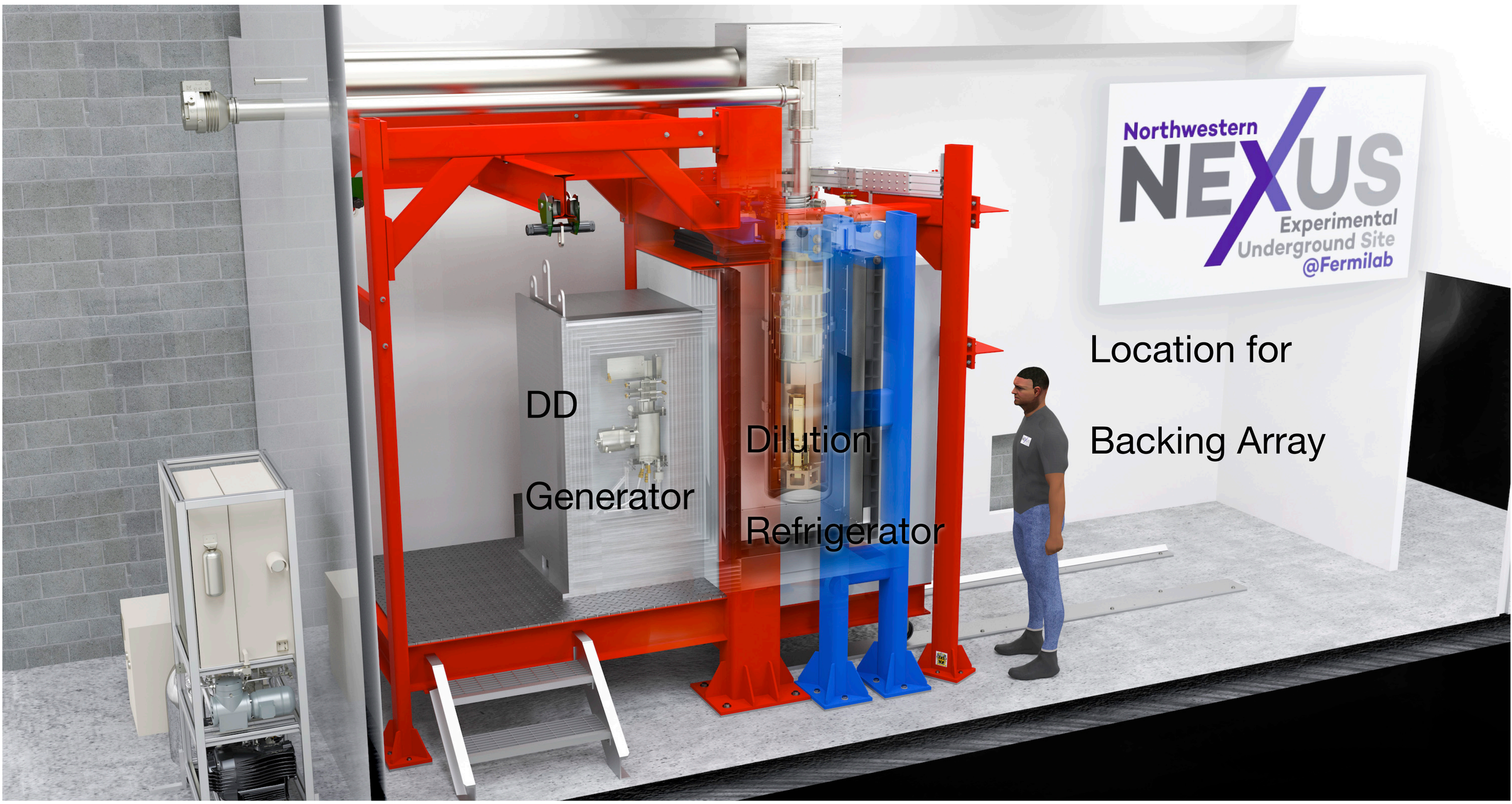


# D-D Generator

- **Reaction:** D + D -> $^{3}$He + n, Q = 3.36 MeV
- **$10^{8}$ neutrons/s into 4pi w/ energy of 2.45 MeV**
- **Delivered to FNAL and tested in February 2020**

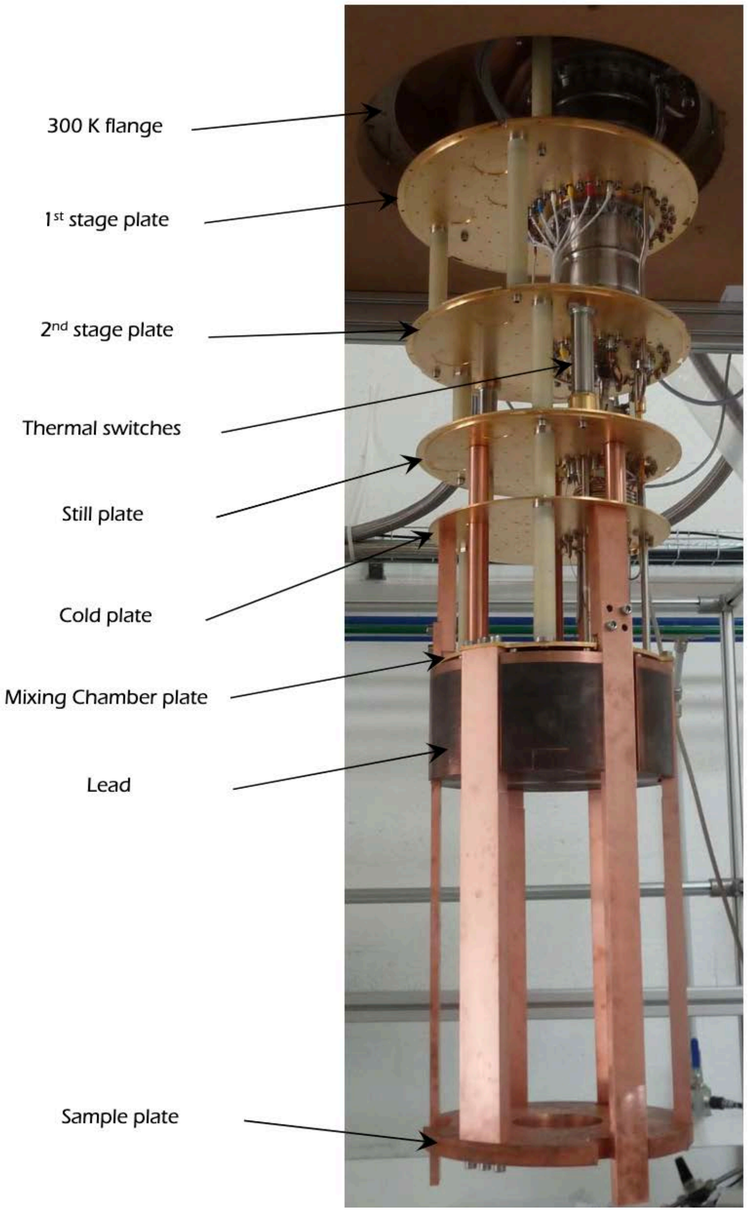



*Schematic of Adelphi Generator (used by LUX)*

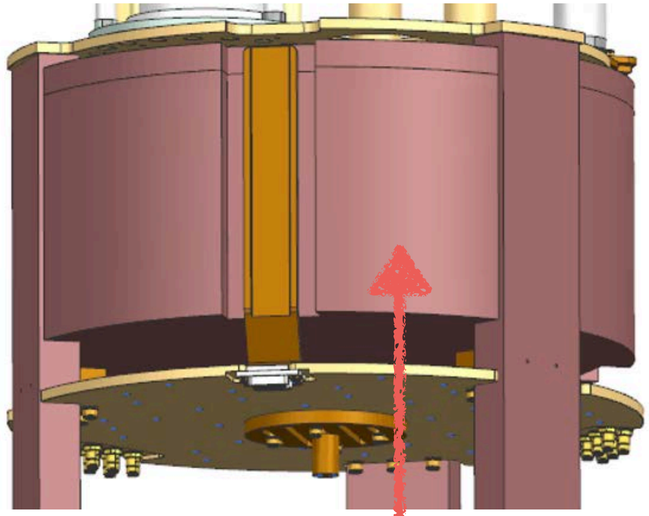

Northwestern
NEXUS
Experimental
Underground Site
@Fermilab
DD
Generator
Dilution
Refrigerator
Location for
Backing Array

# Experimental Space

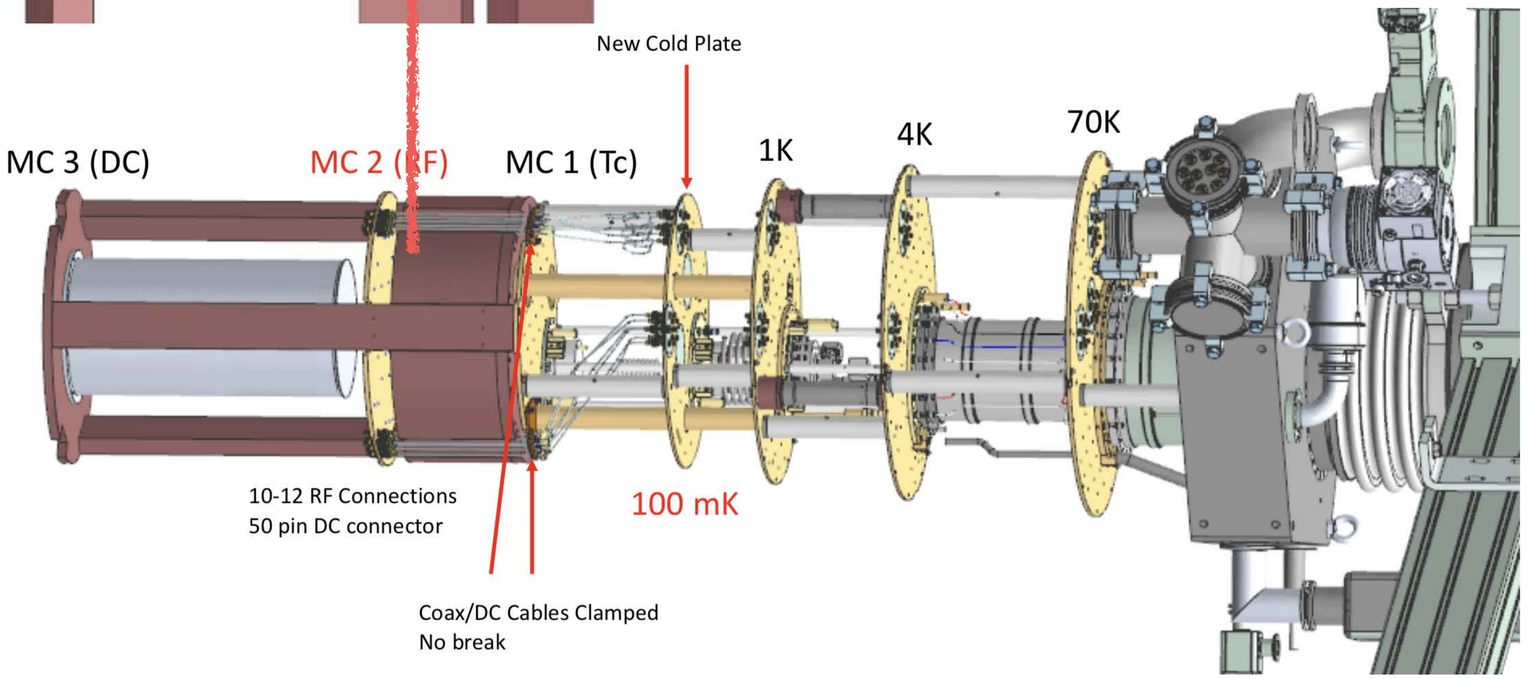
- Experimental space: 500 x 300 mm
- Readout: 8 DC SQUID channels (expanding to 12)
- 6 4-wire measurement channels
- 10 RF channels being installed by end of year.



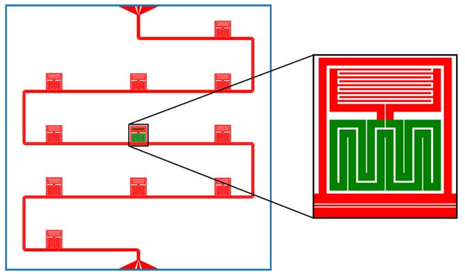
# Status: NEXUS RF Wiring Redesign Complete



- New cold plate, 10x RF cables (superconducting and stainless for output/ input respectively)
- New RF mixing chamber plate (lower plate is for DC readout detectors)
- All plates in hand, planning passivation and installation by November
- New vacuum feedthrough accommodates 96 DC twisted pairs, 10 coaxes, 2 optical fibers.

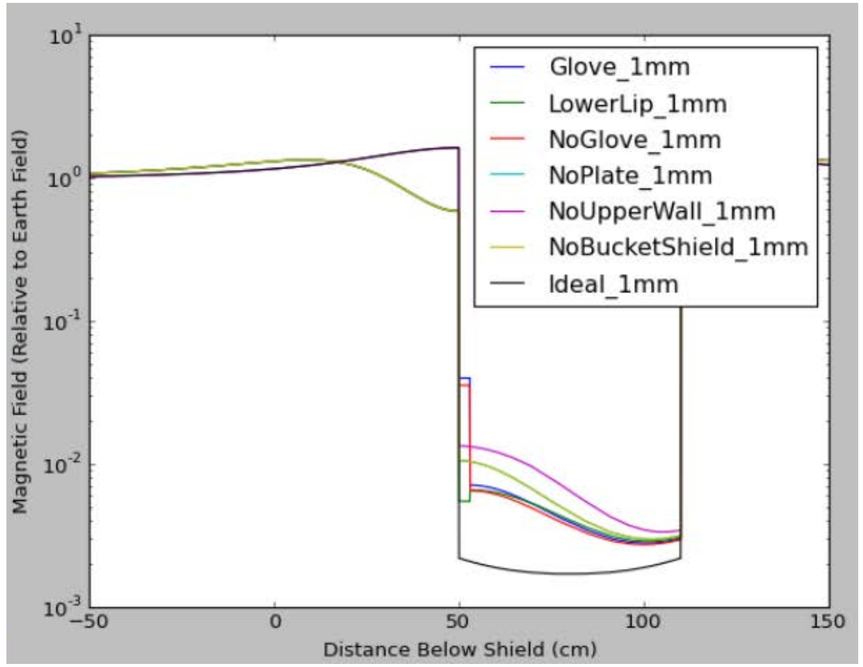


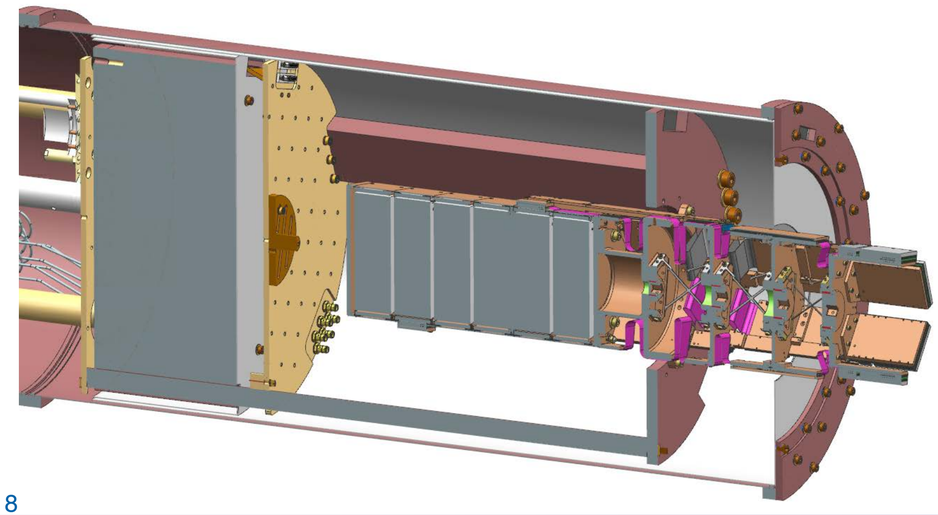

- Readout will accommodate both MKID and Qbit devices

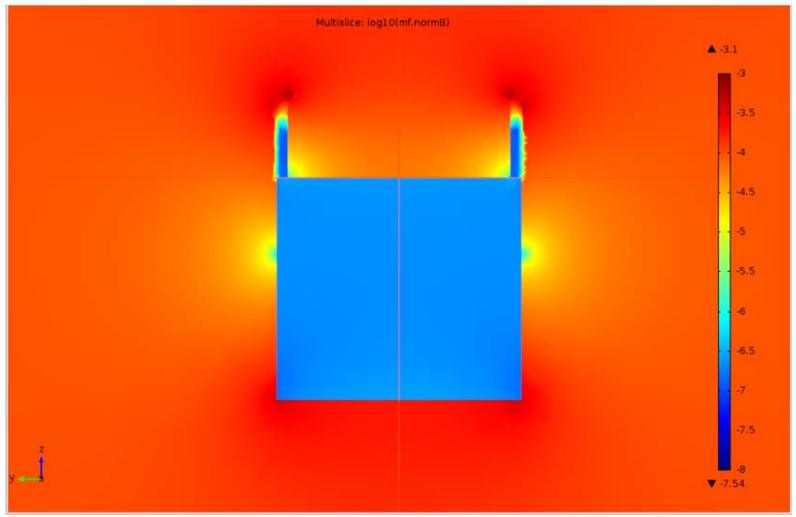


# Status: NEXUS Magnetic Shielding Design Finished

- Simulation-informed design of 1K cryogenic magnetic shield
- New copper supports, 3-piece design to minimize magnetic flux leakage into experimental volume
- Magnetic shield will be installed before end of year.



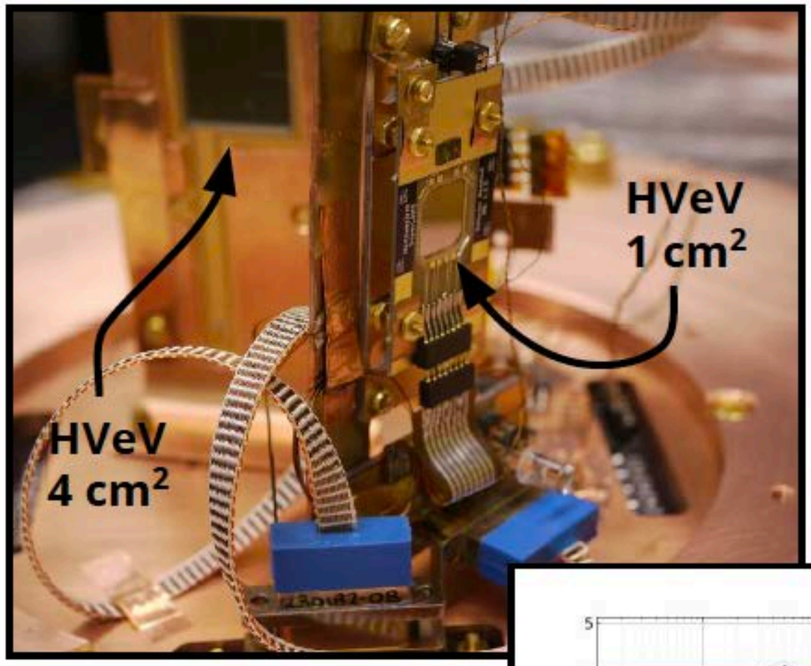


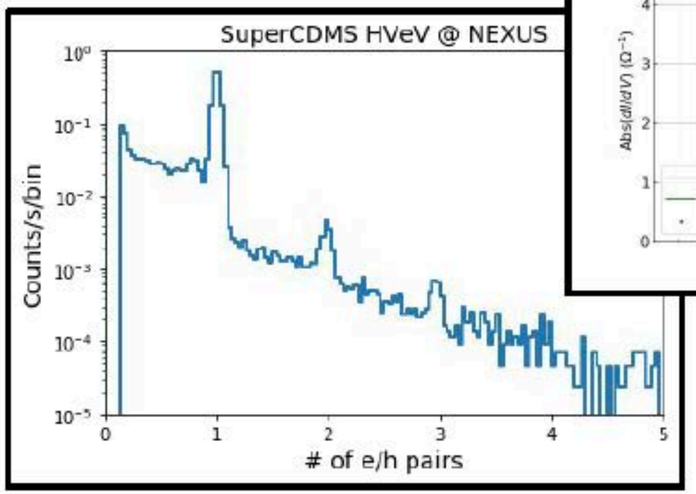
# Status: NEXUS Lead Shield Under Construction

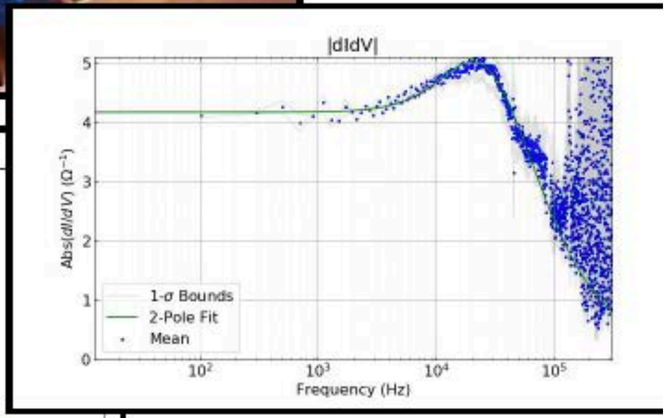
- ~ 4 pi lead shield under construction
- Will be tested in October 2020.

# Dark Matter: SuperCDMS R&D

- Currently testing new generations of small (~1g) "HVeV" devices with **single e/h pair resolution**
- Improving superconducting Transition Edge Sensor (TES) design
  - Complex impedance measurements (N. Mishra and R. Chen)
- Studying detector leakage currents when biased with ~100 V to inform operation of larger devices at SNOLAB
- Investigating low energy excesses (2002.06937)
- Good platform for **low mass (<1 GeV/c$^2$) DM searches**
  - Exposure comparable to recent HVeV DM searches (2005.14067) in far less time

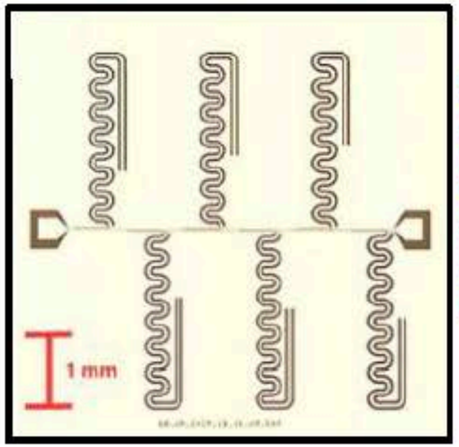


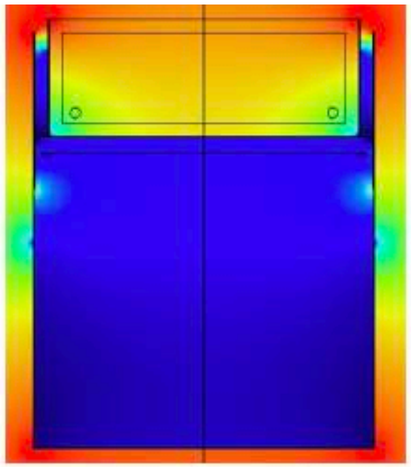



# Quantum Information Science

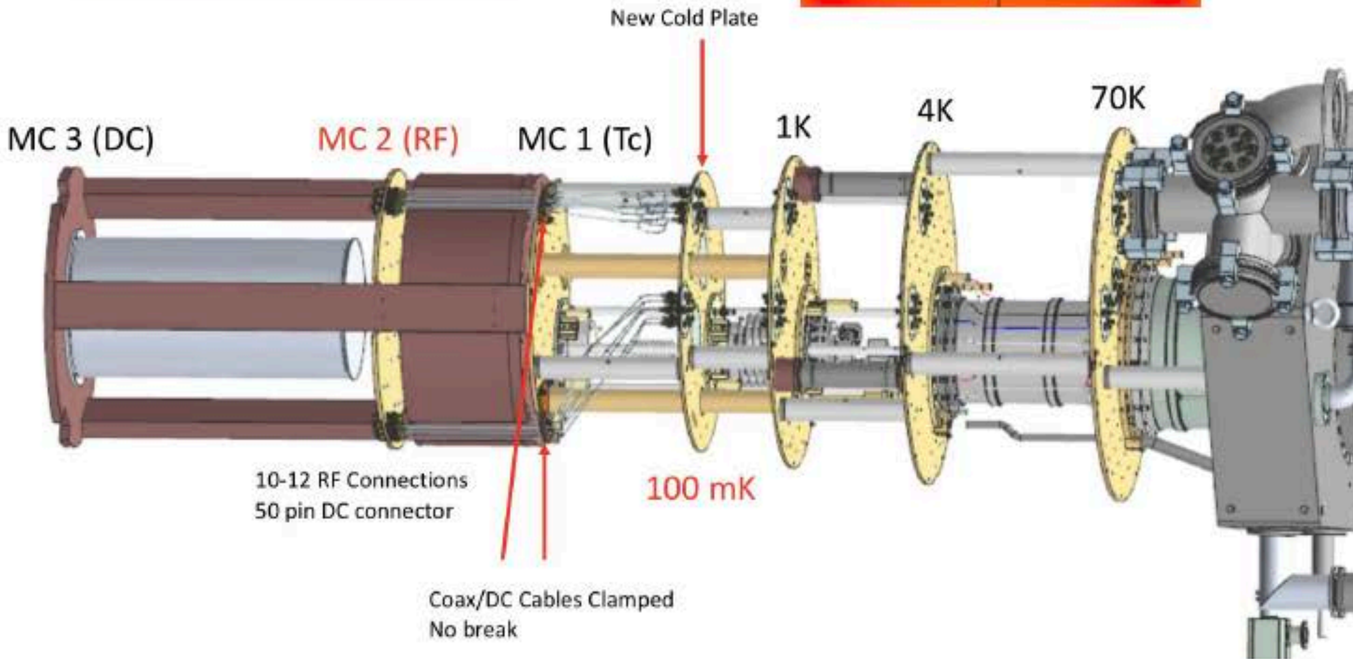
- Collaboration with R. McDermott (UW-Madison), D. Bowring (FNAL), et al.
  - Study Quasiparticle Poisoning in **Superconducting Microwave Resonators** (1610.09351)
- Quantum coherence improved underground (2005.02286)
- Will use NEXUS to study coherence time in **low background environments**
- Fridge upgrades (2020 FNAL LDRD, Bowring DOE ECA)
  - Superconducting coax wiring for RF signals
  - Additional MC plate
  - Magnetic shielding (@ 1K stage)
  - Improved light and EMI shielding
  - Vibration reduction




1605.01996

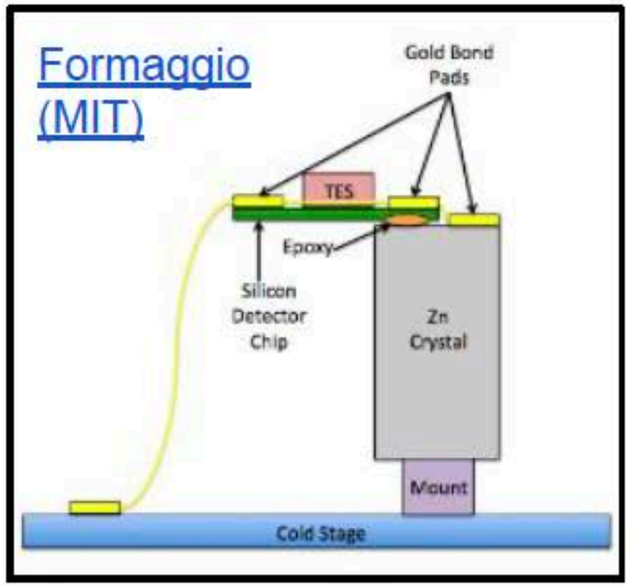


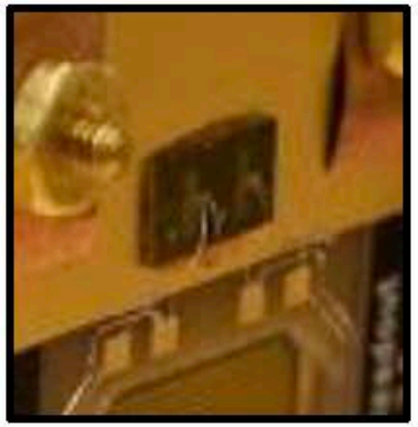
Mag. Shielding Sims
C. Bathurst

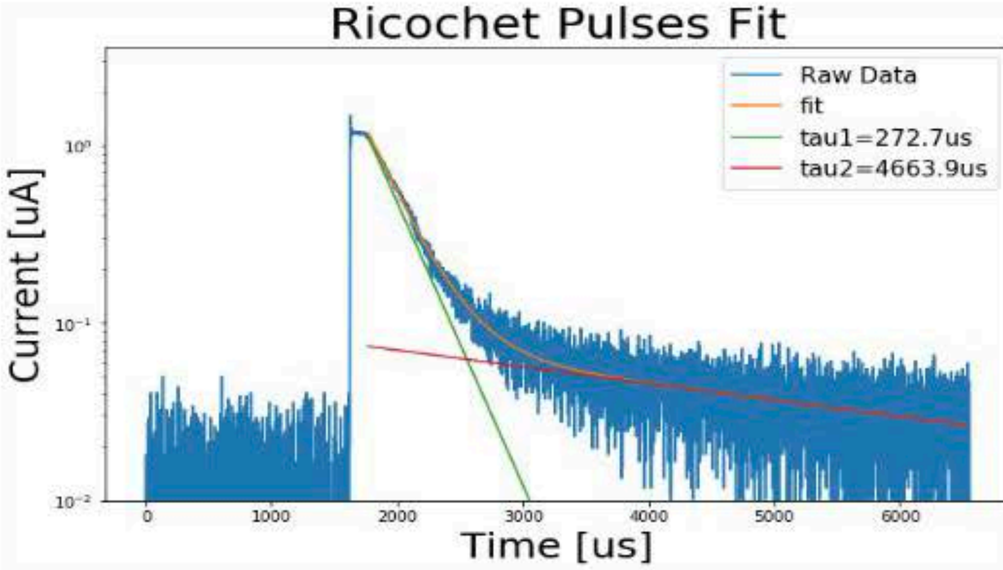


# Neutrino Physics: Ricochet R&D

- Ricochet Collaboration will measure Coherent Elastic Neutrino Nucleus Scattering (**CEvNS**) at nuclear reactor (1107.3512, 1612.09035)
- Need to measure ~100 eV recoil energy
- One possibility: Zn target with Ir/Pt TES
  - **ER/NR discrimination** via pulse shape (different QP/phonon lifetimes)
- **Ir/Pt TES chip** running in NEXUS
  - Pulse shapes experimentally understood (R. Chen, et al., Neutrino 2020, #587)






Thank You!