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CUTE Neutron Calibration System

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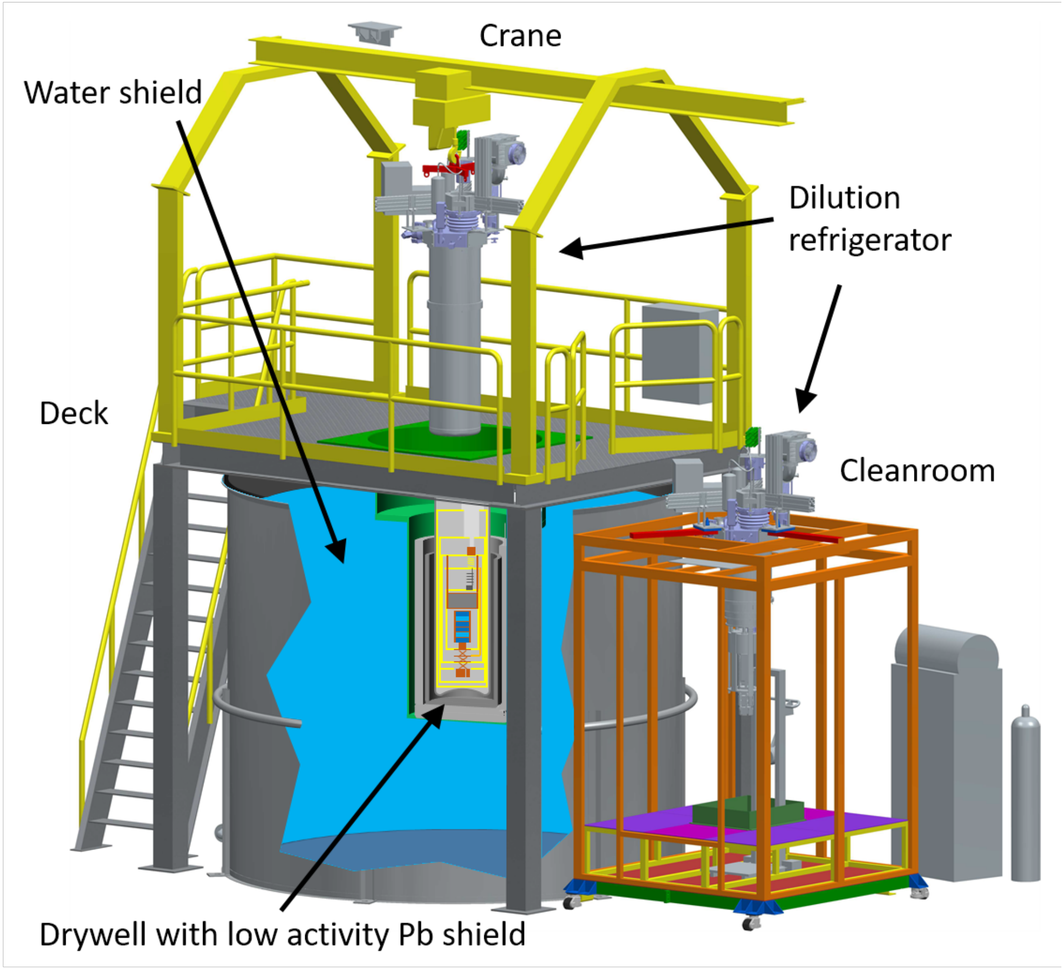
Cryogenic Underground TEst facility (CUTE)

What does CUTE do?

- SNOLAB test facility
- Currently testing high-voltage (HV) SuperCDMS cryogenic (Si and Ge) detectors
- Operational temperature as low as 15 mK
- Low overall radioactive background
- Low-radon cleanroom space to change payload
- Availability of gamma calibration sources

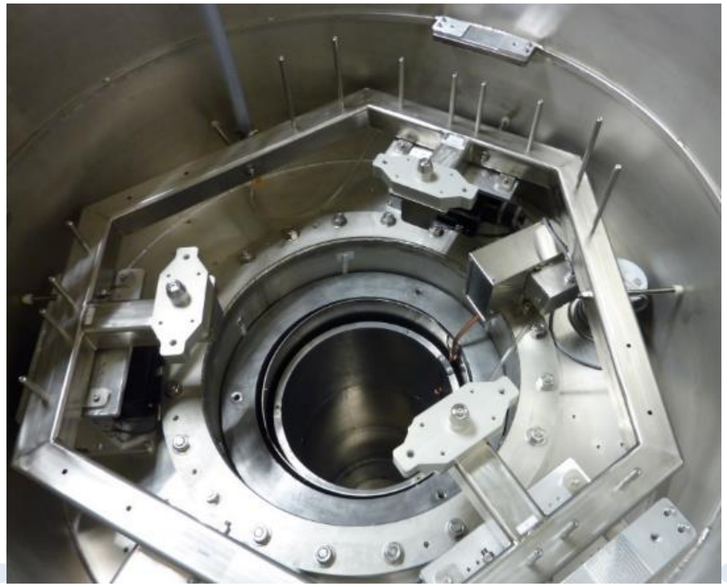
CUTE Facility



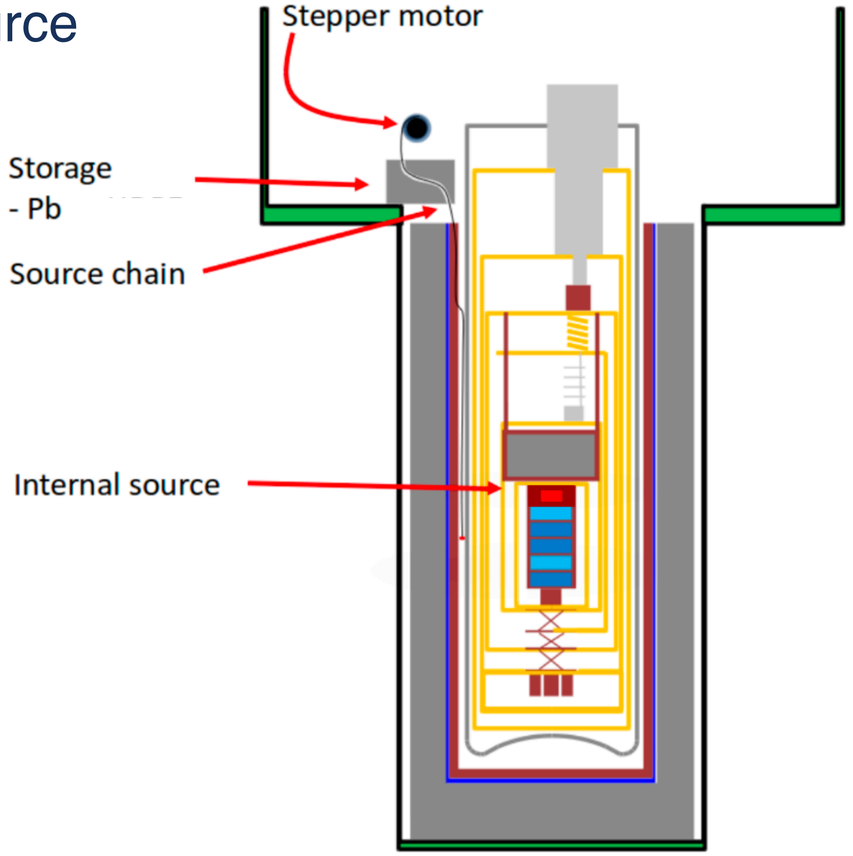
Energy Calibration of the Detectors

- Detector response characterized with calibration source
- ^{133}Ba source for “high” energy γ calibration
- Removable ^{55}Fe source for low energy γ calibration

Top View of ^{133}Ba calibration system



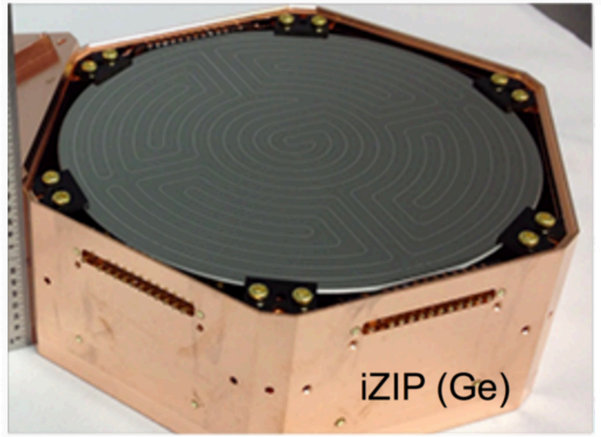
Current calibration systems

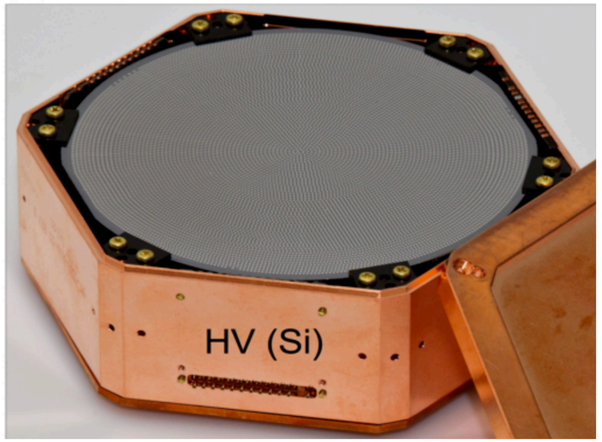


iZIP Tower

- Currently testing HV detectors
- HV detectors cannot discriminate between nuclear and electron recoils, iZIP detectors have this discrimination power
- Nuclear interactions (dark matter particles and neutrons) will ionize 3x less than an electron does
- CUTE will test iZIP detectors in Fall 2023

Two Detector Types



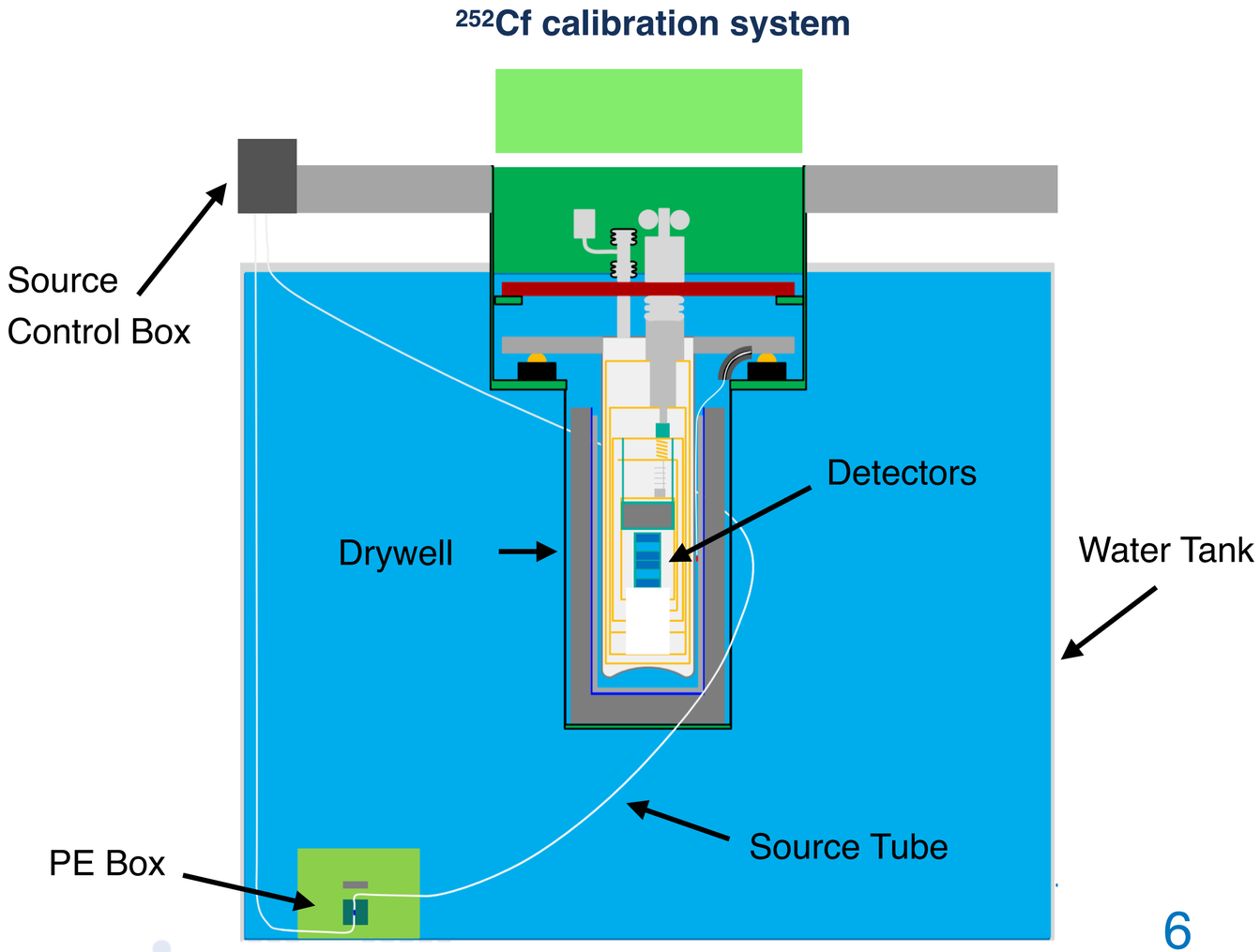


The neutron calibration system is critical for the characterization of the SuperCDMS tower 1 (6 germanium iZIP detectors)

CUTE Neutron Calibration System

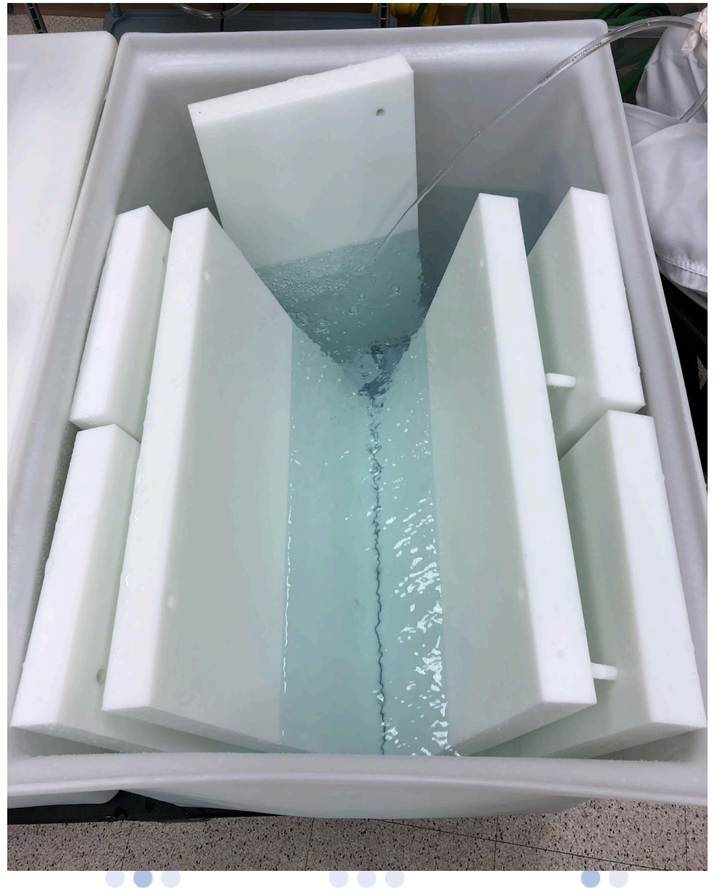
- ^{252}Cf source on chain
- Stored in polyethylene (PE) box
- Induction sensors to identify position
- Deployed between 0-10 cm from the drywell

- Commissioning ongoing. Operation foreseen in October 2023



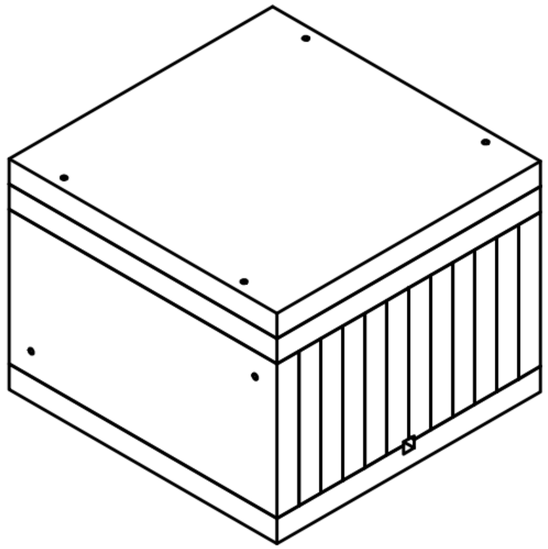
CUTE Neutron Calibration Box

Leaching Bin with UPW and PE Plates



- Degreasing at surface carwash
- Wiping with NoFoam
- Leaching in UPW
  - 2 weeks, flipping
  - 2 weeks
- Drying with nitrogen boil off
- Packaging and shipping underground
- Processed April 6th 2022 to CUTE area underground

PE Box Assembly



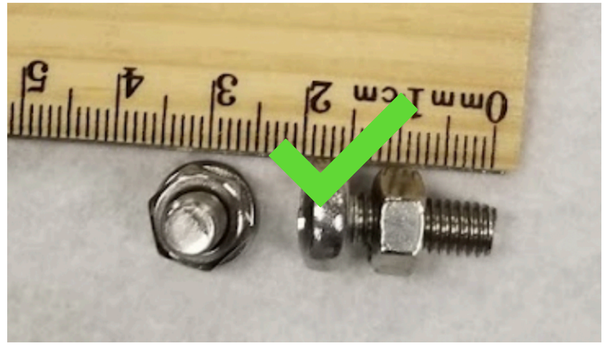
12 Small Plates
1’x2’x2” 9.3kg ea.

3 Large Plates
2’x2’x2” 18.3kg ea.

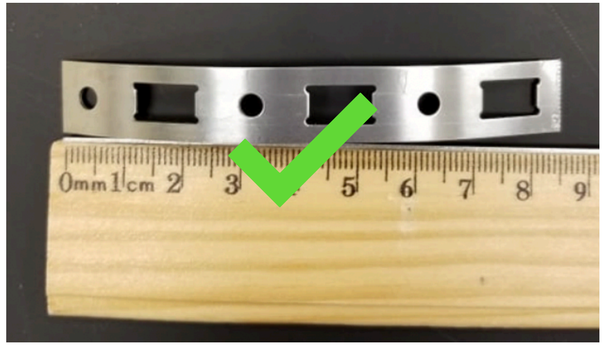
Compatibility Testing

- Water tank contains Brom'N8
- UV-Vis testing material compatibility in water tank
- Tests absorption of wavelengths
- Initial and final microscope images
- Screw and nut and wormdrive band are compatible
- PLA tube and PE tube need further testing

Nut and Screw



Wormdrive Band



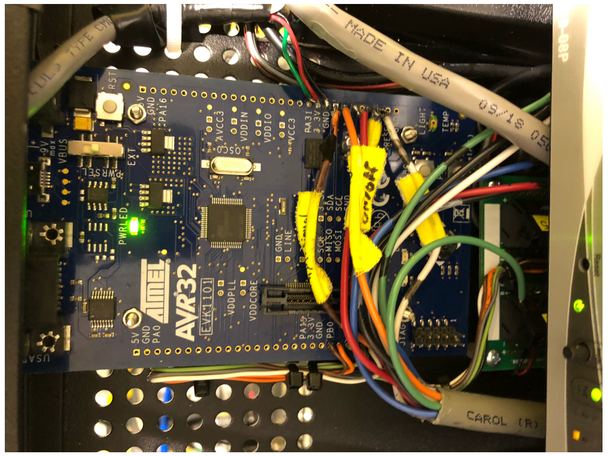
PLA Tubing

PE Tubing

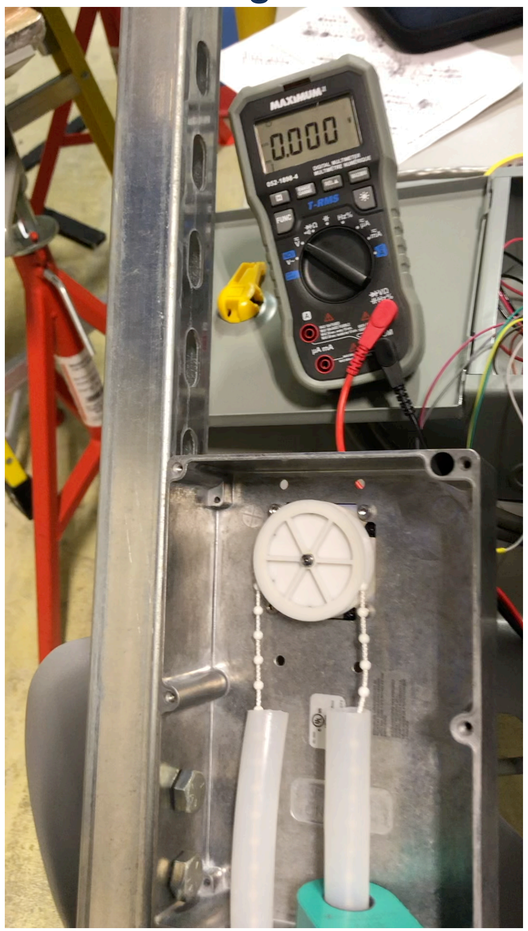
CUTE Neutron Calibration System

- Testing stepper motor on Arduino board
- Testing on AVR board
- Stainless steel pipe for indicator
- Induction sensors identify source position

AVR Board

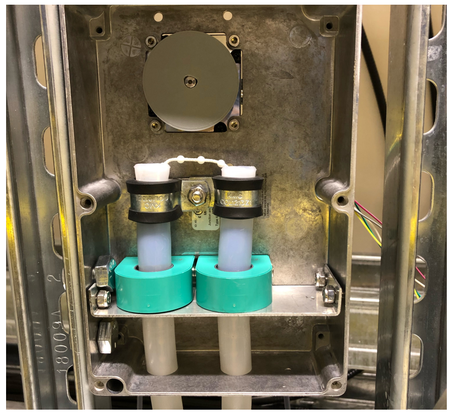


Testing Motor



Position Indicator

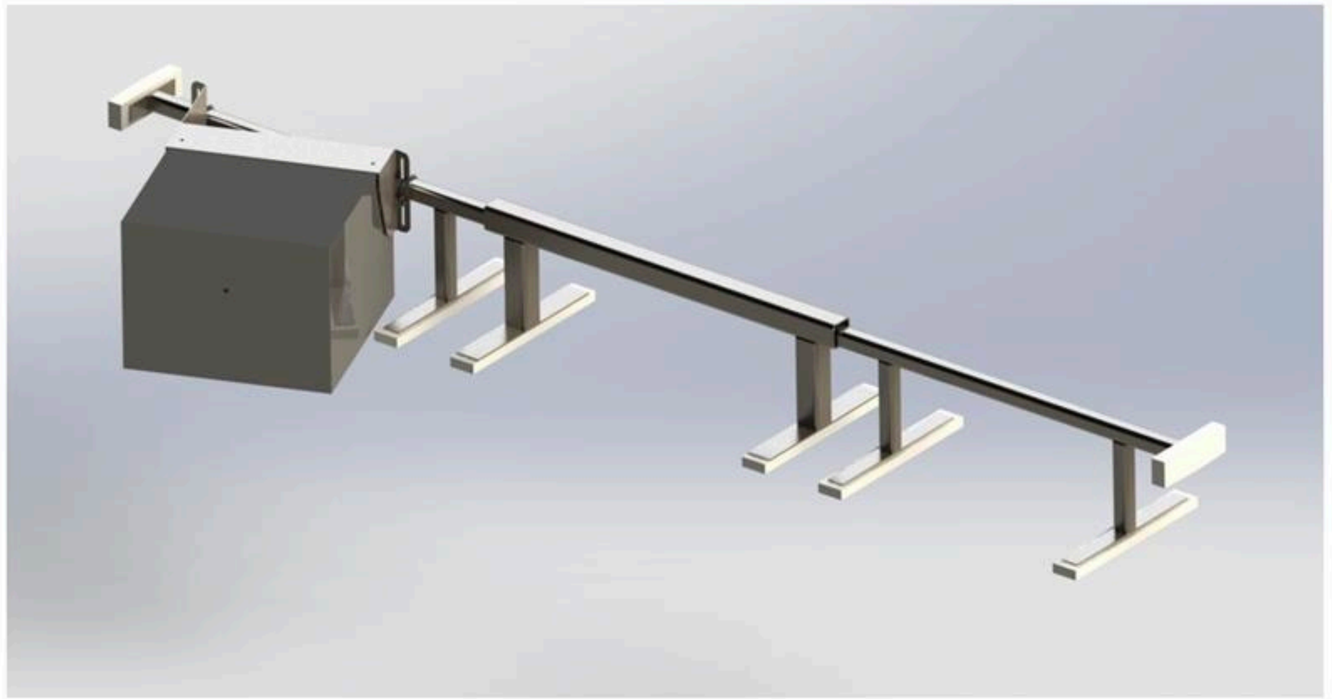
Sensors



Installation

- Installed in empty water tank
- Telescoping structure will ensure consistent box position
- Structure will press against sides of the water tank
- PE bars on the bottom prevent tears in the liner

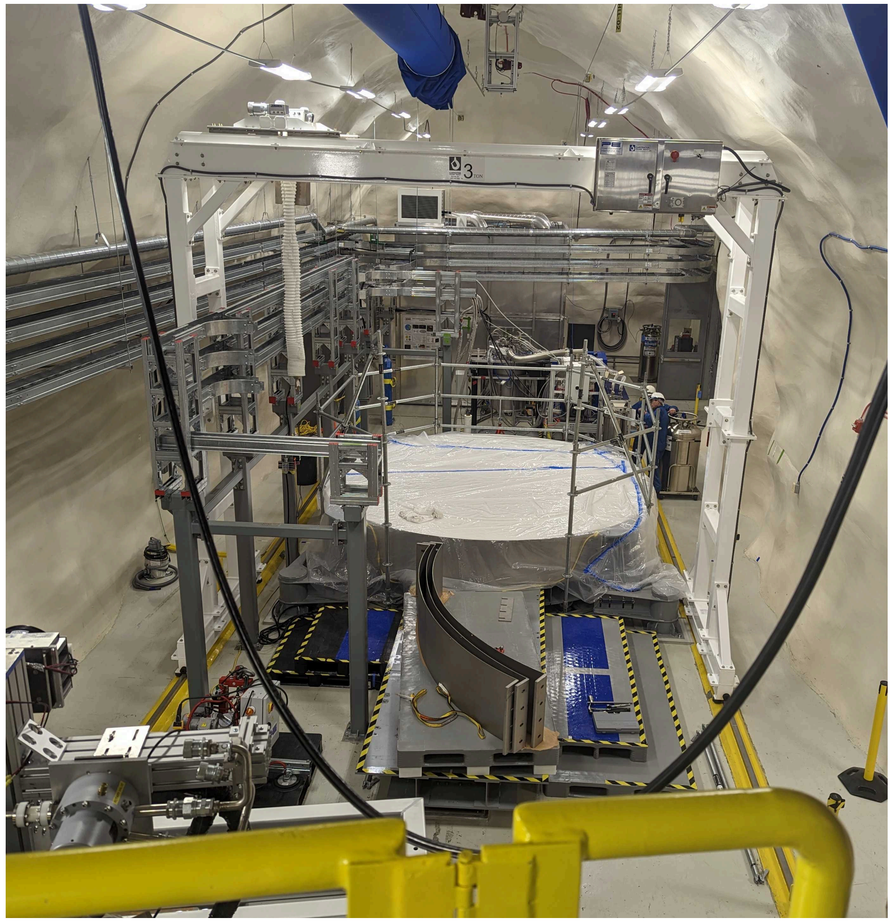
Telescoping Structure



What is Next for the Neutron Calibration System?

- Finalize compatibility tests
- Complete testing of system with source control software
- Final commissioning of telescoping structure
- Dry run of complete assembly
- System installation inside water tank

SuperCDMS Experiment Progress



Thank you!

Are there any Questions?