CUTE

An underground test facility for cryogenic detectors

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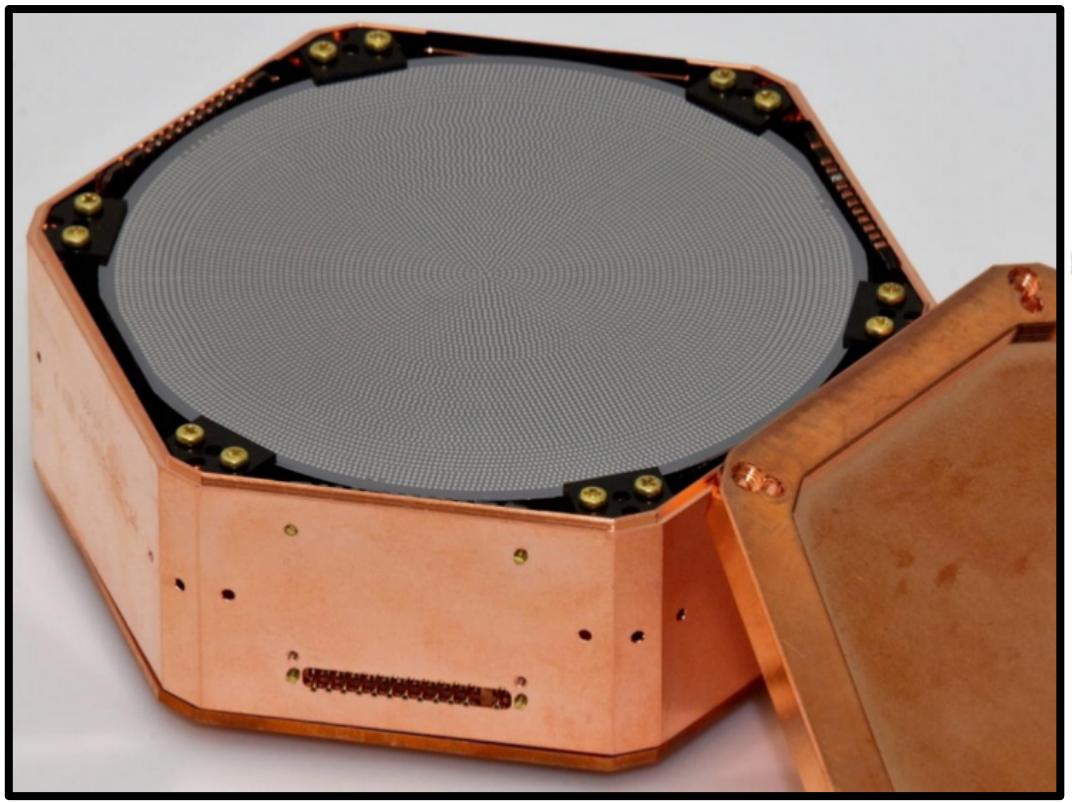
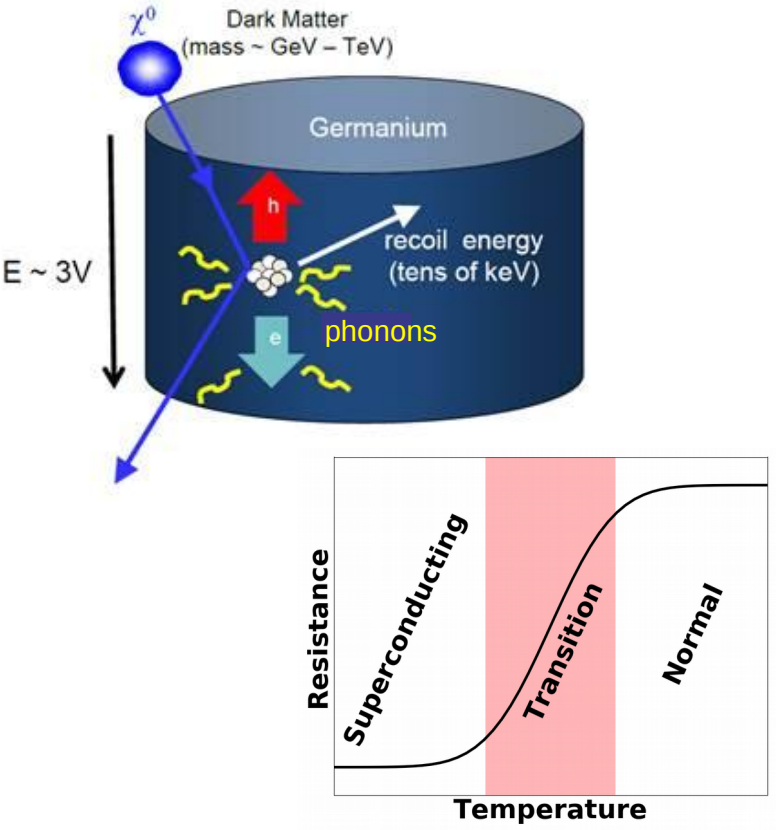
Overview

- SuperCDMS
- CUTE facility
  - Shielding
  - Calibration techniques
  - Suspension system
- Suspension system validation
- Conclusion

SuperCDMS



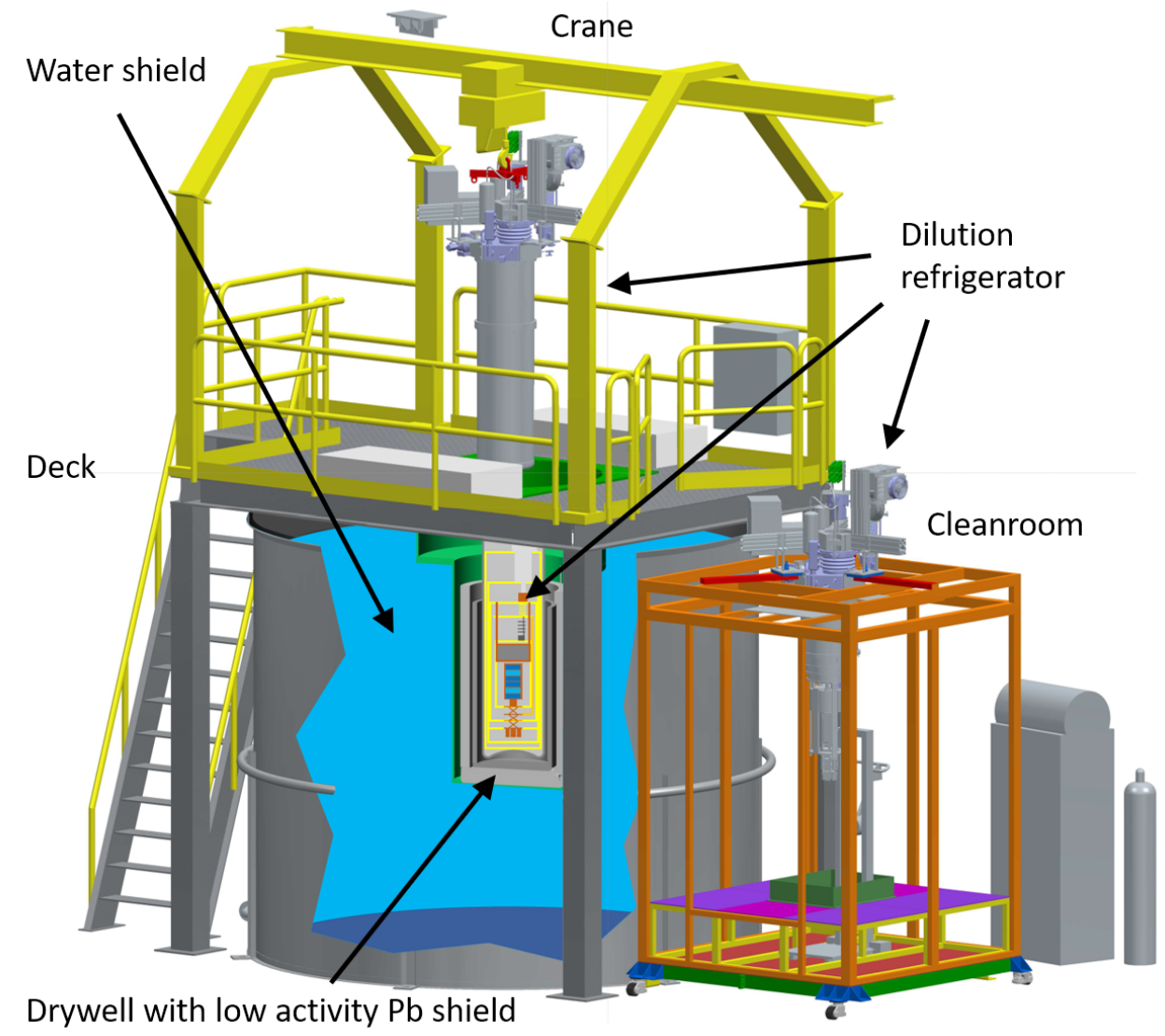


- SuperCDMS uses cryogenic semiconductor detectors instrumented with transition edge sensors and charge collecting electrodes to search for dark matter
- Different detector types provide ER/NR discrimination (iZIP) or very low energy thresholds (HV)
- The next phase of SuperCDMS will take place at SNOLAB near Sudbury, ON, about 2 km underground

CUTE Facility Motivation

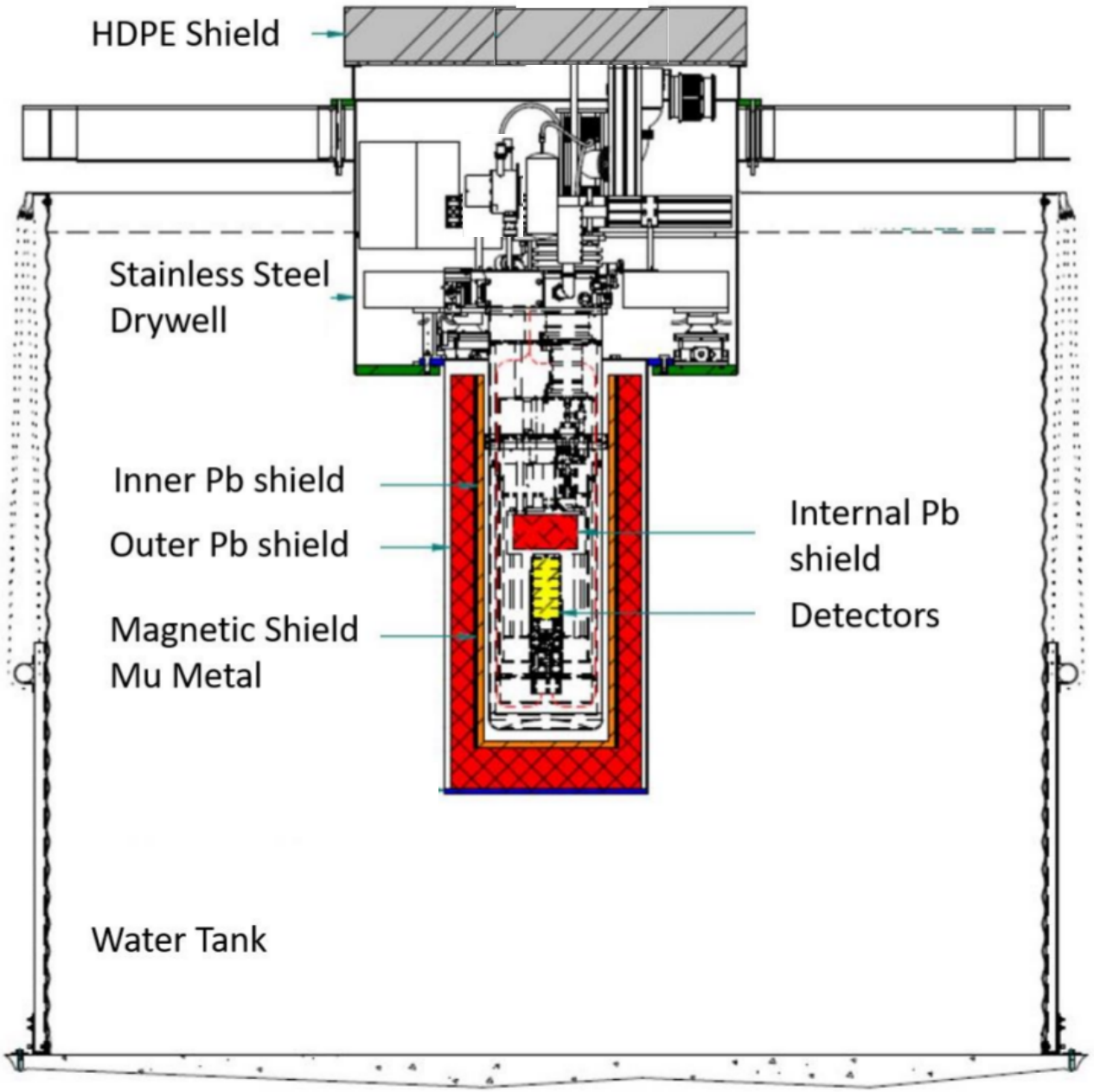
- Testing of the SuperCDMS detectors on the surface is limited by the high background from cosmic rays
- Cosmogenic activation of the detectors can increase the background rate, so it is important to minimize their time on the surface
- Therefore, a well shielded detector testing facility (CUTE) was designed, constructed, and commissioned at SNOLAB
- Testing of the detectors and read-out electronics at CUTE can help identify potential challenges that may come up in SuperCDMS SNOLAB
- A dark matter search may also be performed at CUTE with SuperCDMS SNOLAB detectors prior to the completion of the construction of the main experiment
- After the testing of SuperCDMS detectors is complete and the main experiment is underway, CUTE will operate new experiments that request facility time on a proposal basis

CUTE Facility



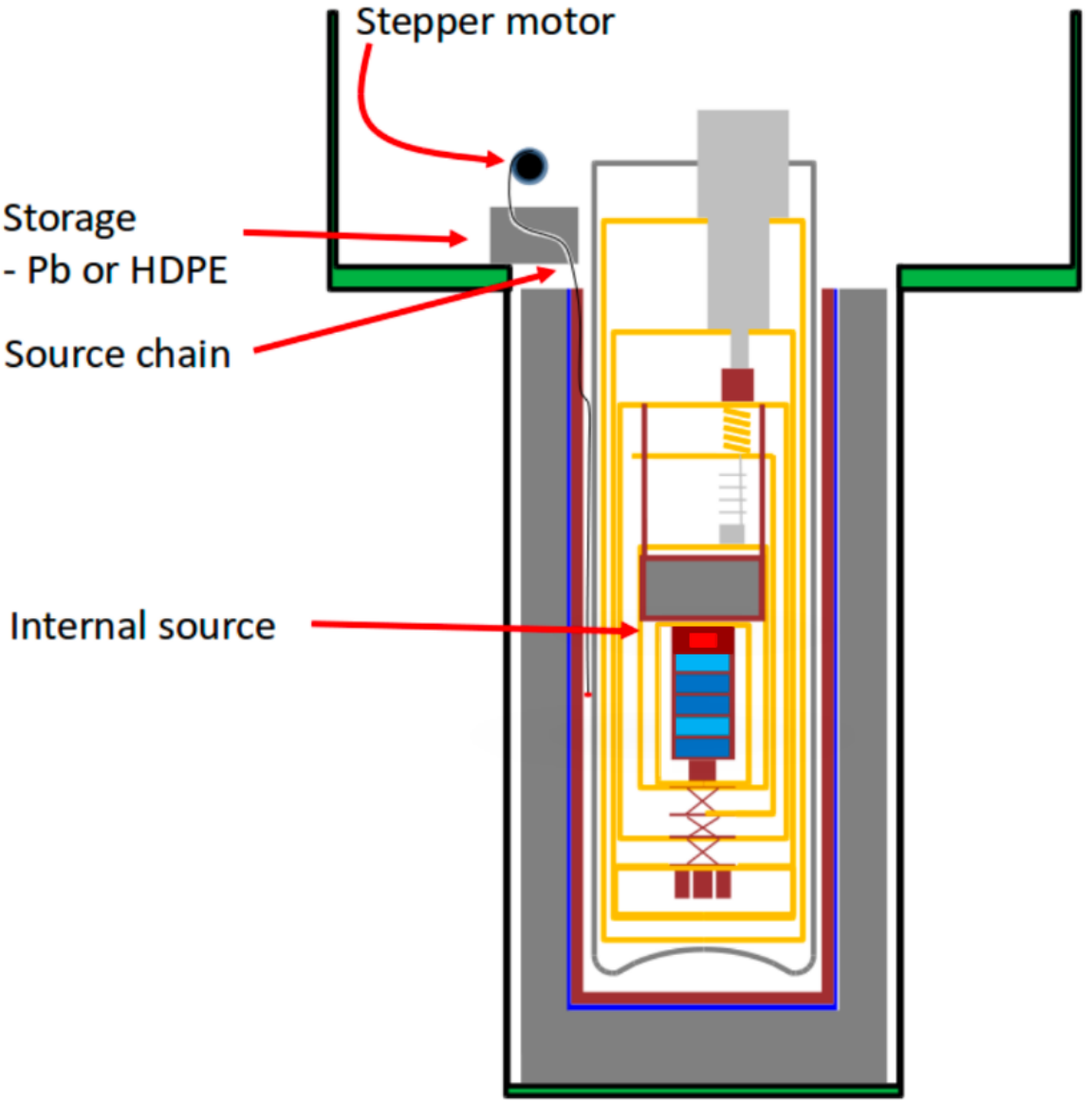
Shielding

- A water tank provides excellent shielding from both photons and neutrons
- Two cylindrical lead shields of different purities provide additional photon shielding
- An internal lead plug shields gammas from the top of the cryostat
- An HDPE shield reduces the flux of neutrons from the top
- A magnetic shield reduces magnetic fields so the detectors can be operated properly

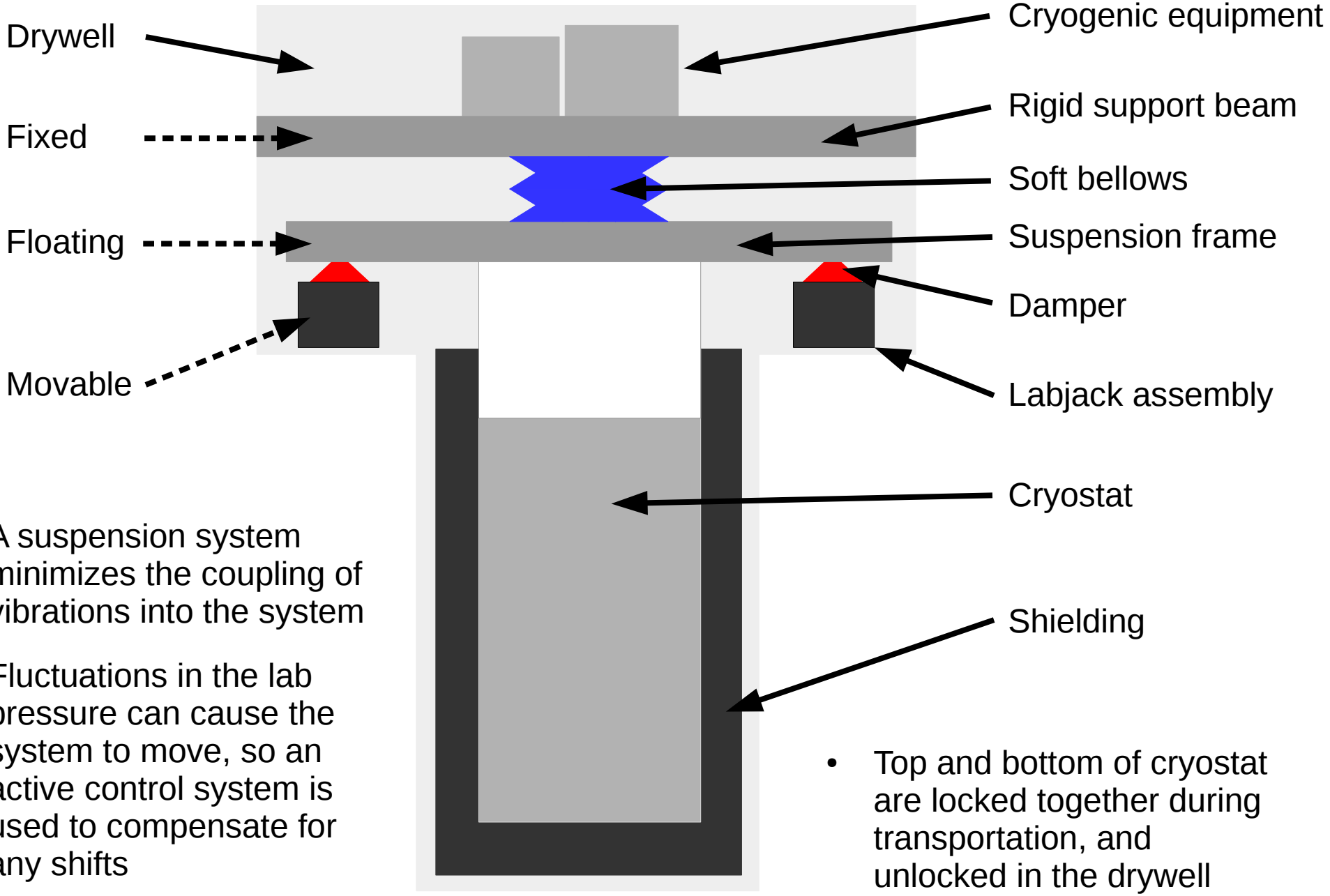


Calibration

- A ^{133}Ba gamma source can be deployed into the shielding with a stepper motor
- An internal ^{55}Fe source has been used to provide a low energy calibration point for low threshold detectors
- A ^{252}Cf neutron source will soon be installed in the water tank
- Measurements with a SuperCDMS Soudan detector provides information about the facility background rate



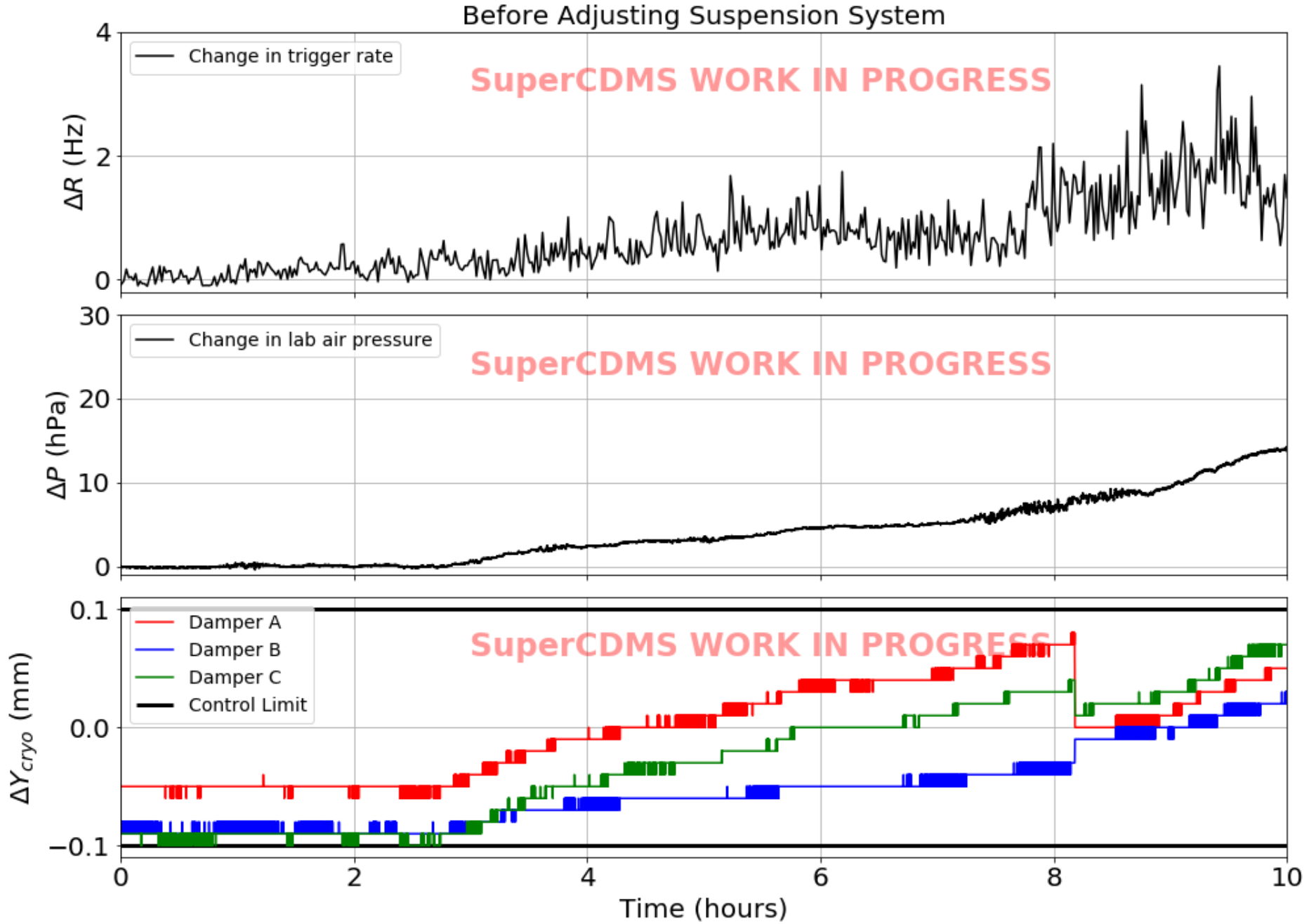
Suspension System



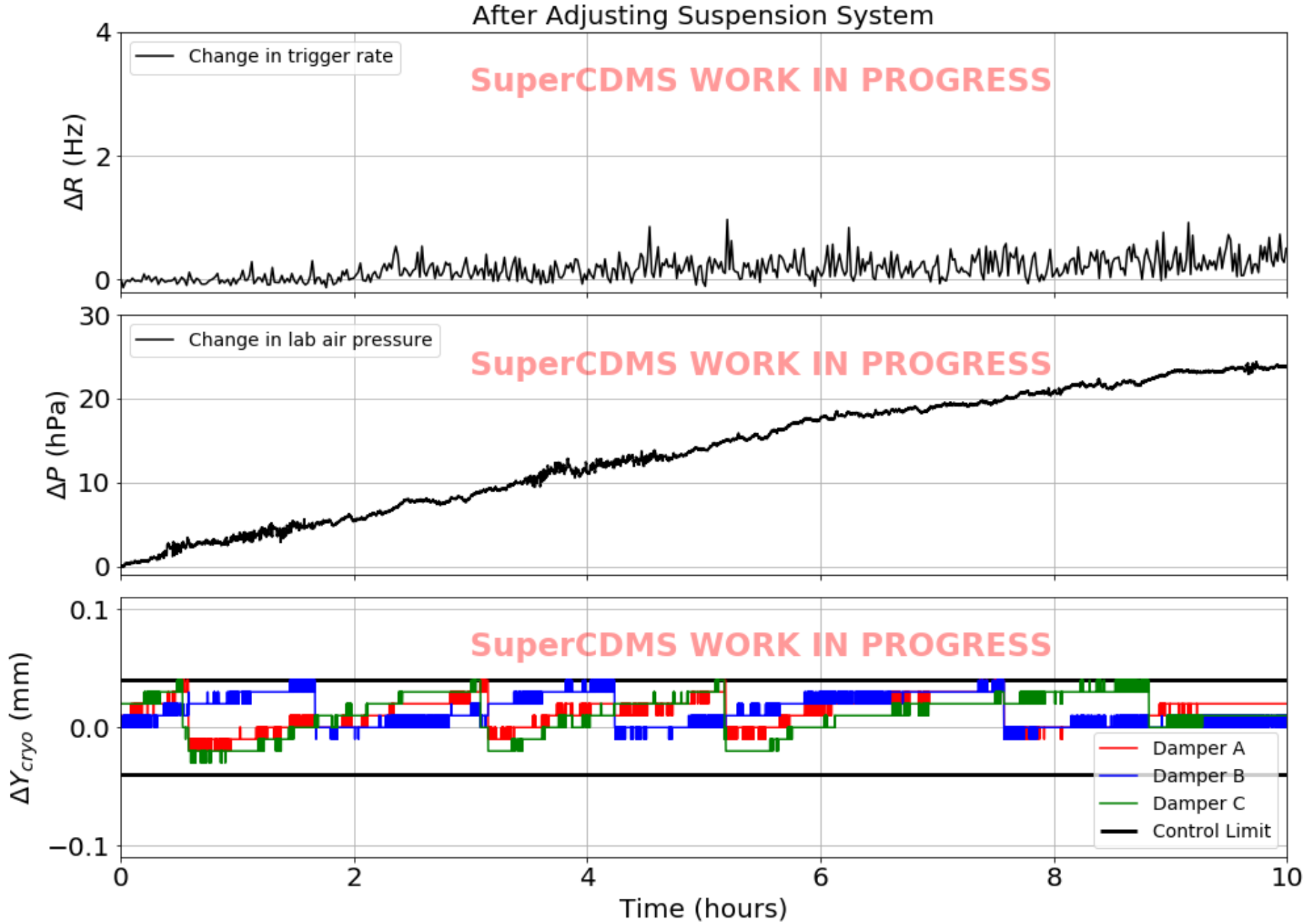
- A suspension system minimizes the coupling of vibrations into the system
- Fluctuations in the lab pressure can cause the system to move, so an active control system is used to compensate for any shifts

- Top and bottom of cryostat are locked together during transportation, and unlocked in the drywell

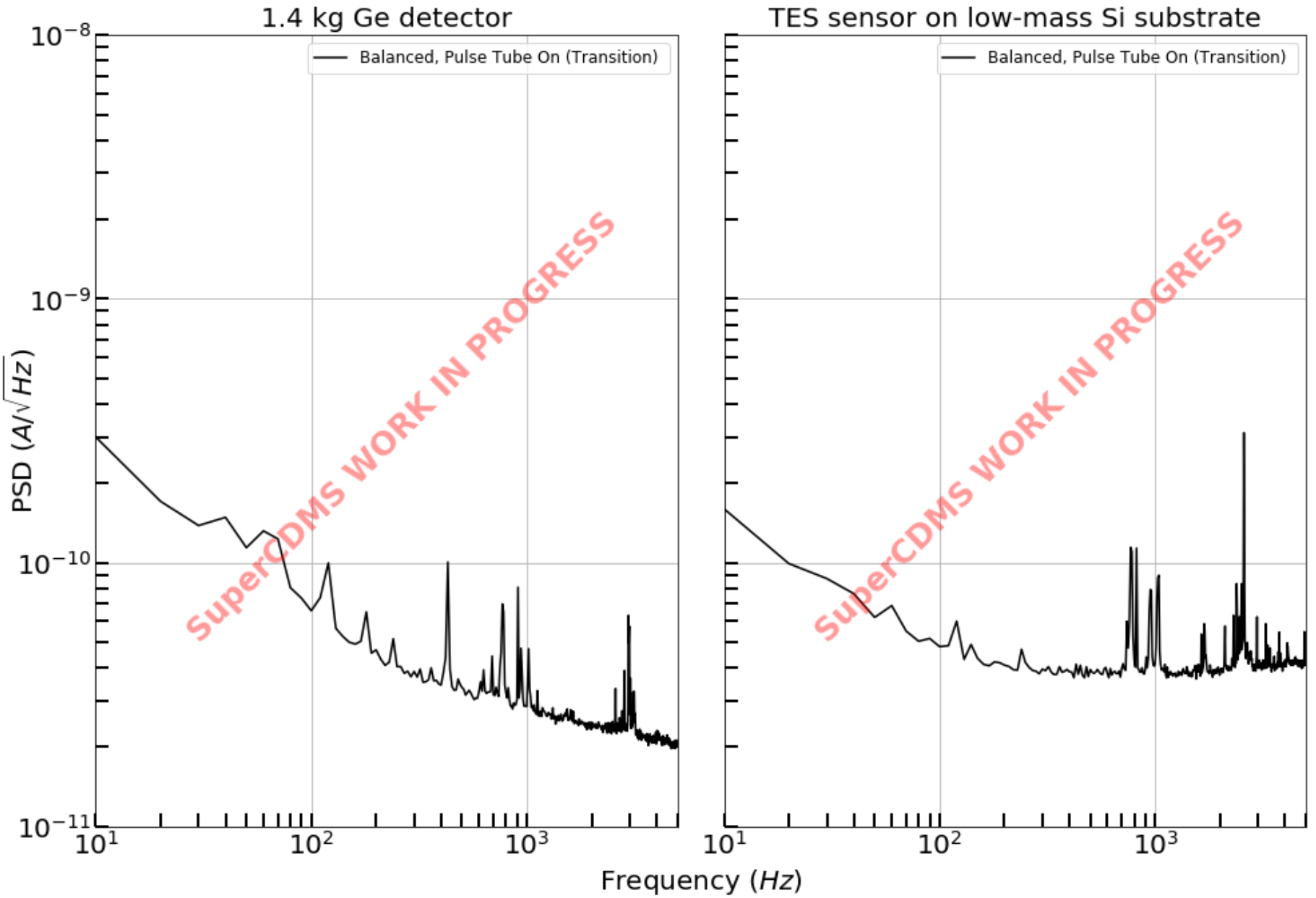
Suspension System Performance



Suspension System Performance



Suspension System Validation



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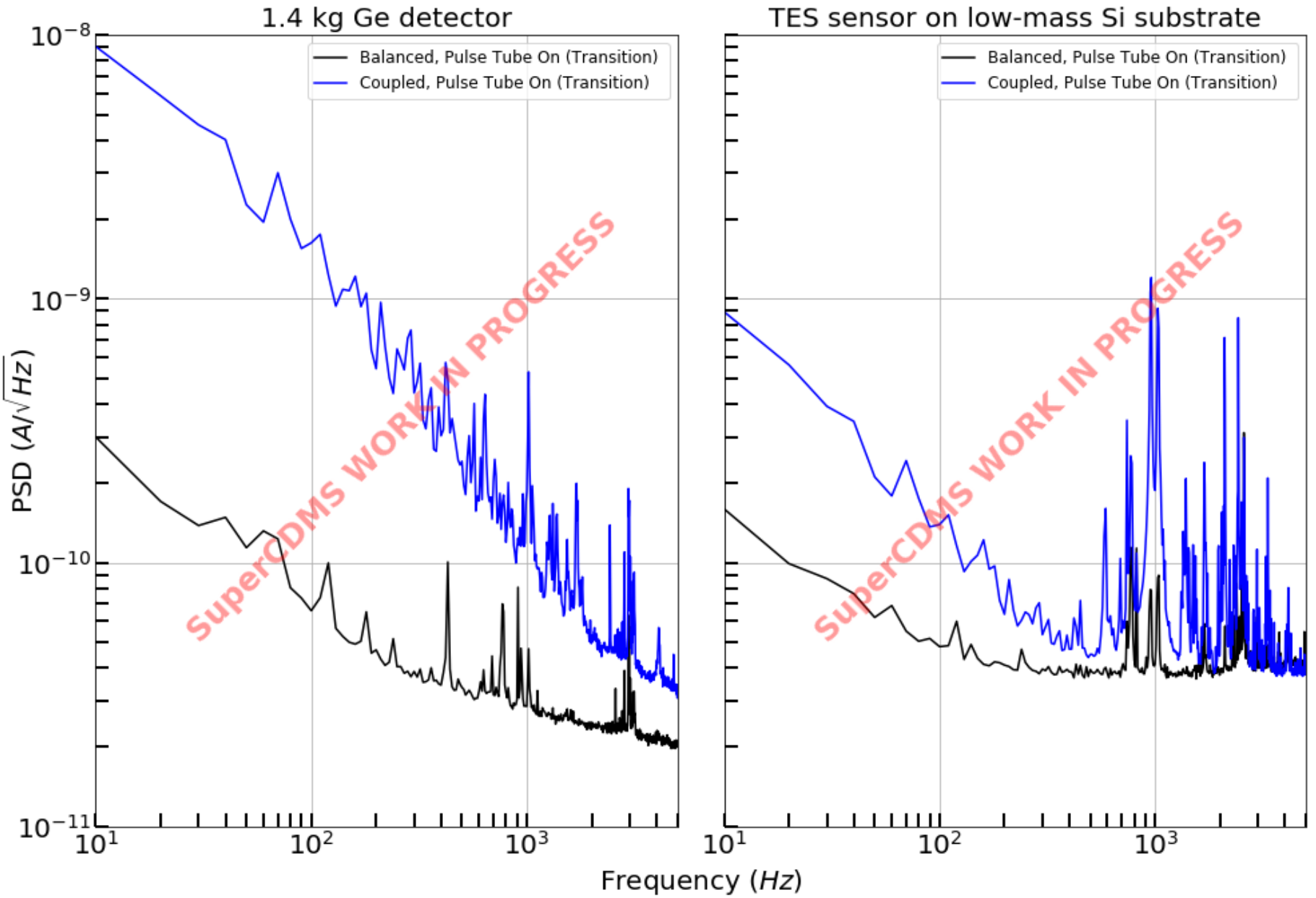

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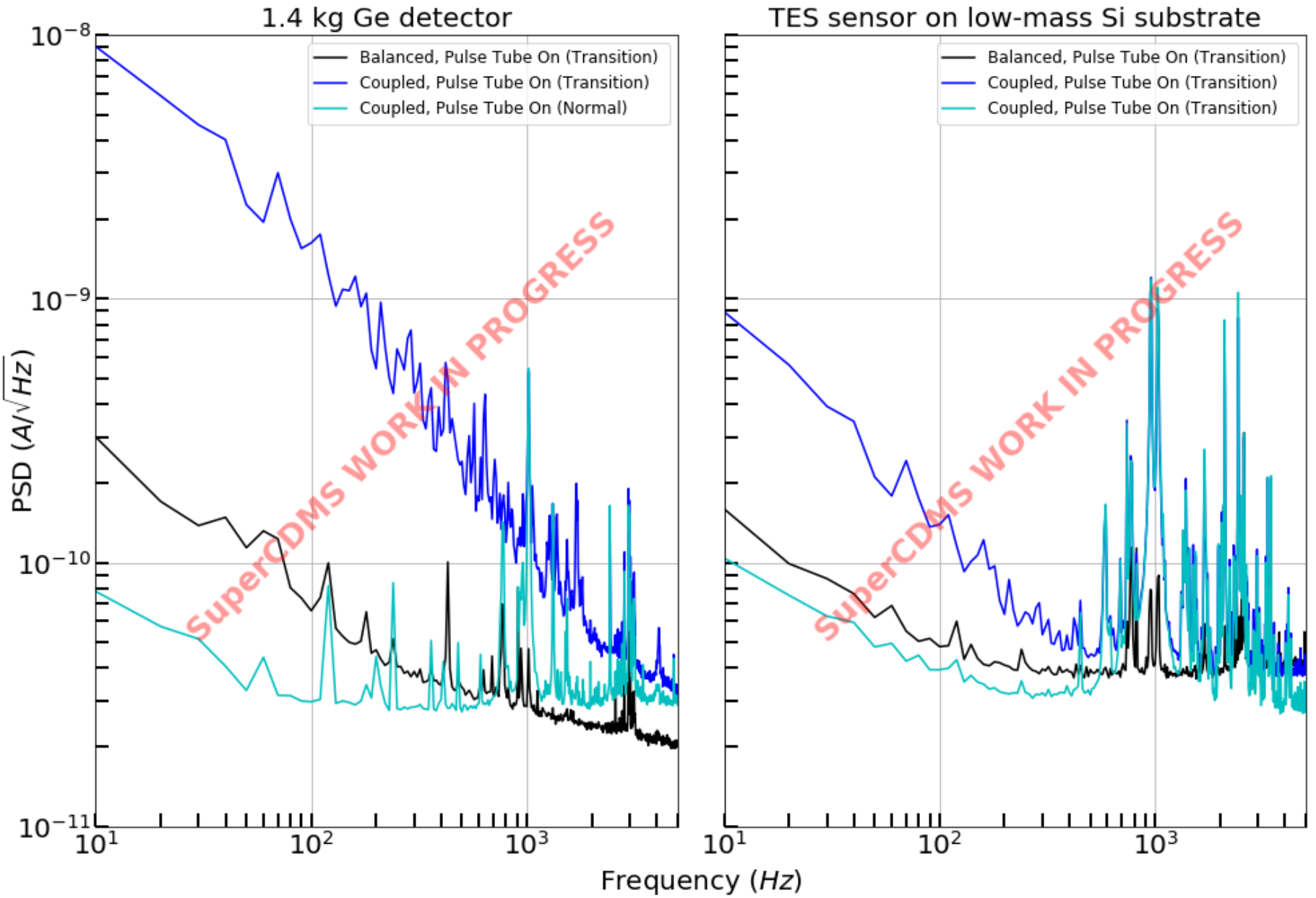

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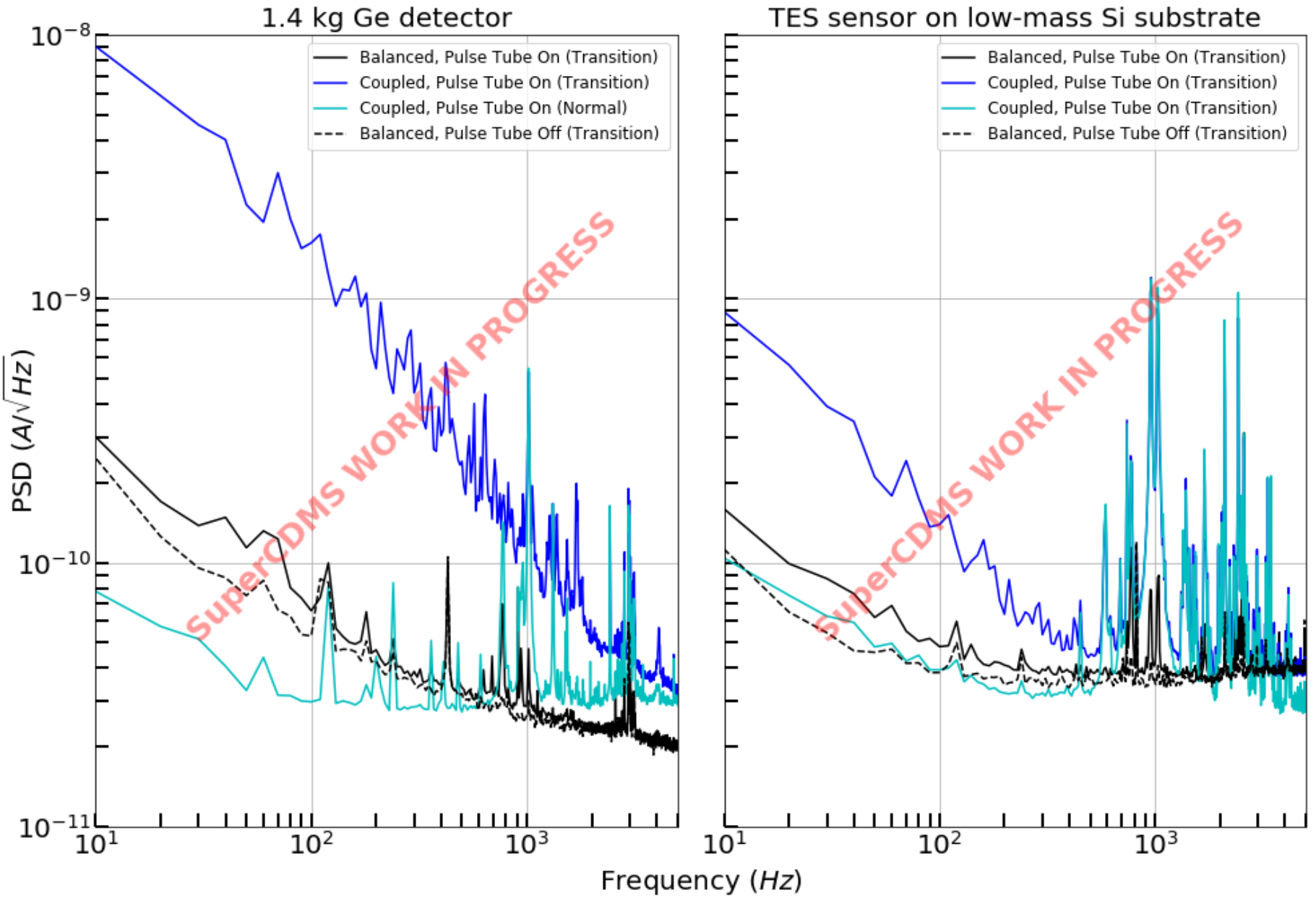

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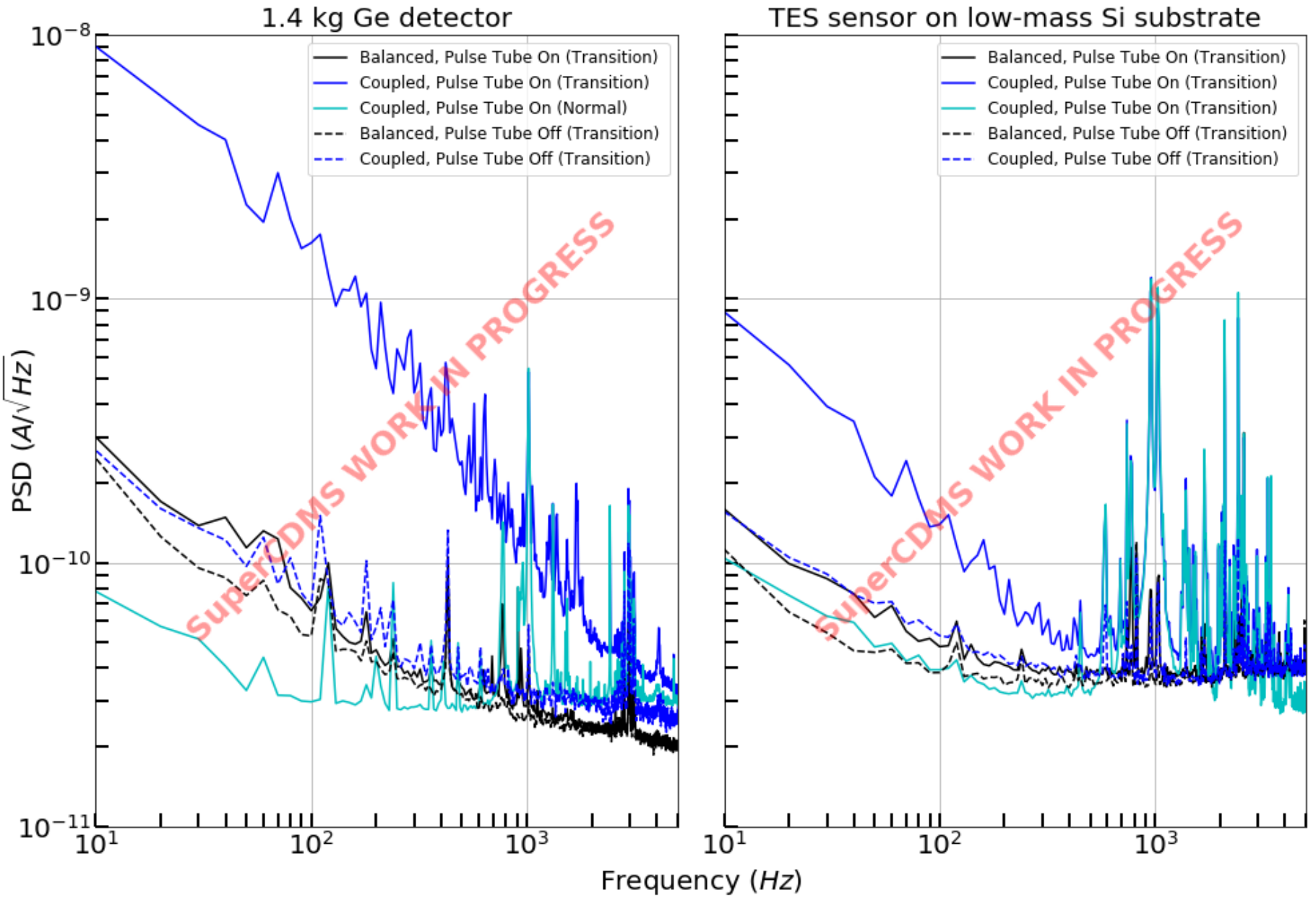


Conclusion

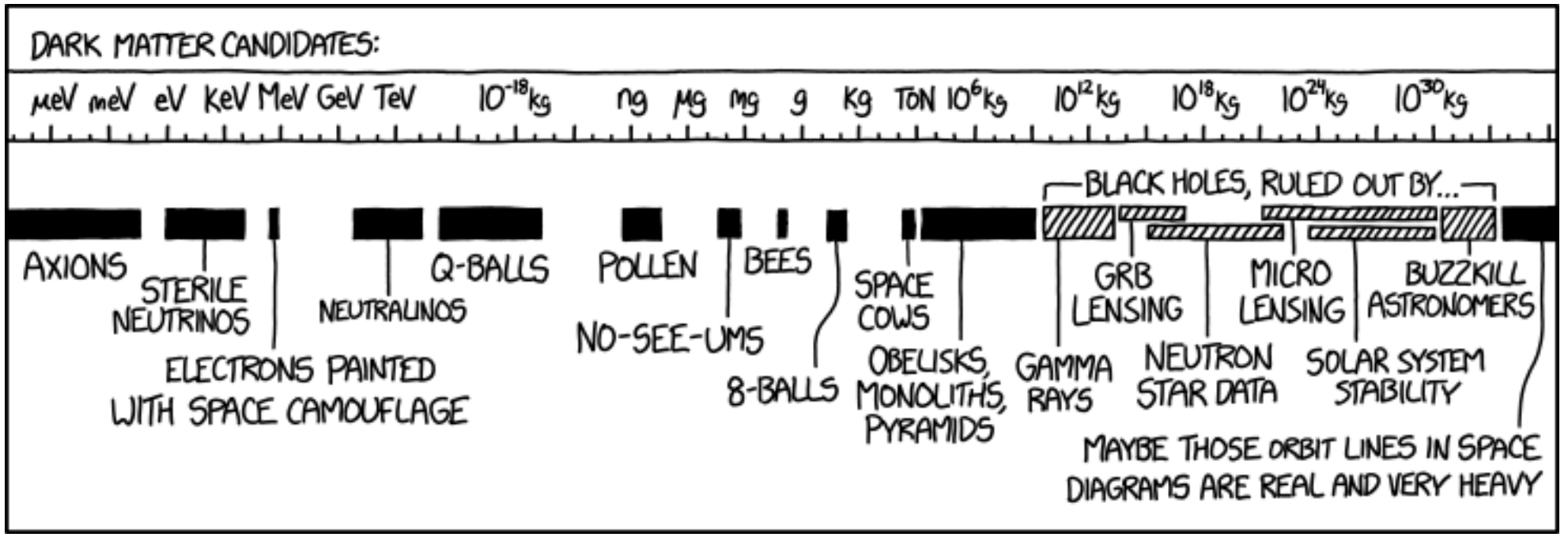
- A low-background environment is required for rare-event searches and detector testing
- The CUTE facility at SNOLAB provides such an environment for testing cryogenic detectors underground
- For the past 2 years, CUTE has tested a variety of SuperCDMS detectors, including a prototype SuperCDMS SNOLAB HV detector, an old SuperCDMS Soudan detector, and a gram-scale silicon detector
- Environmental factors at SNOLAB can impact the detector response; environmental monitoring can improve our understanding of these effects
- The high-level of shielding, and calibration sources available at CUTE may allow for high quality dark matter search data to be acquired
- Once the testing of SuperCDMS detectors is complete and SuperCDMS SNOLAB is operational, CUTE is available to host other experiments; time will be allocated based on proposals

Questions

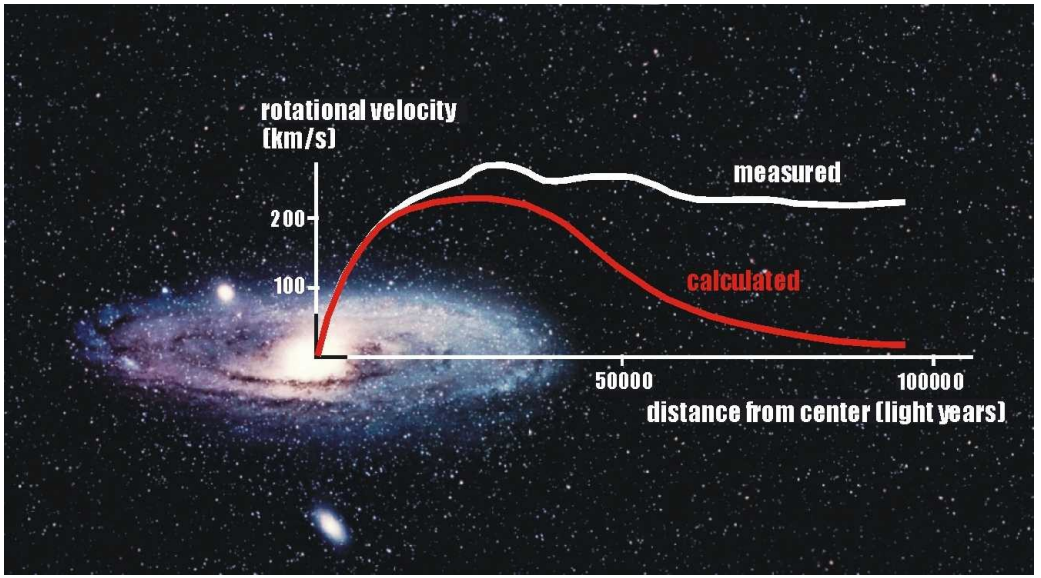
Thank you!

Backup Slides

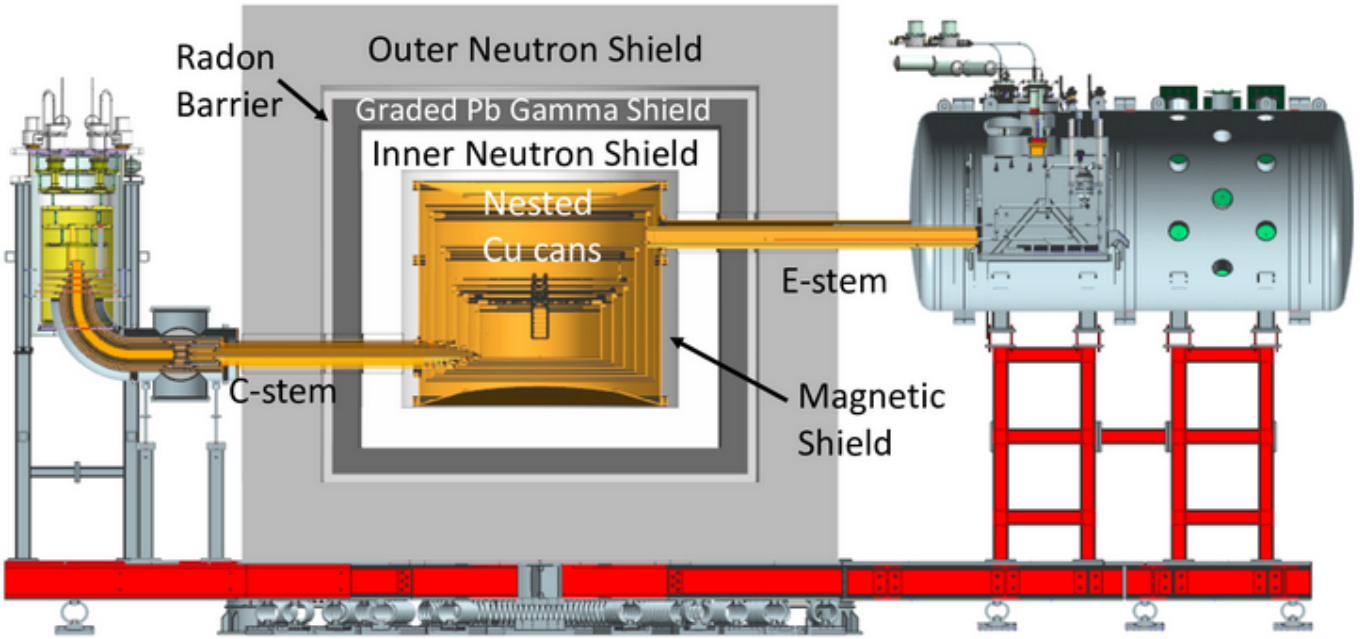
Dark Matter

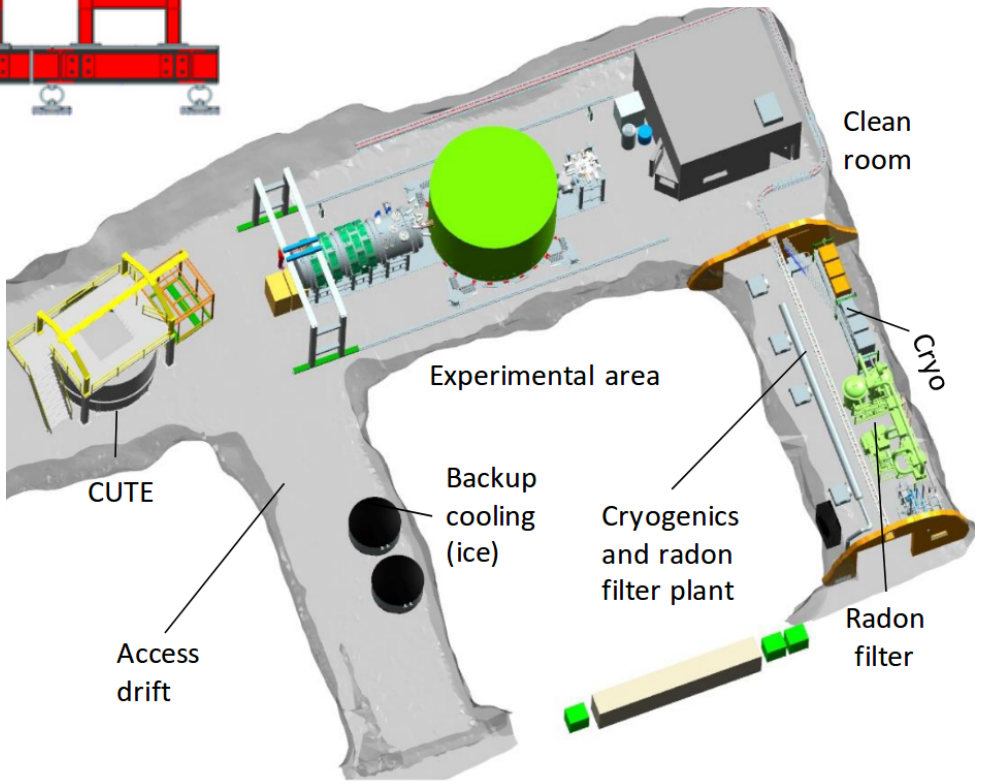


Credit: xkcd



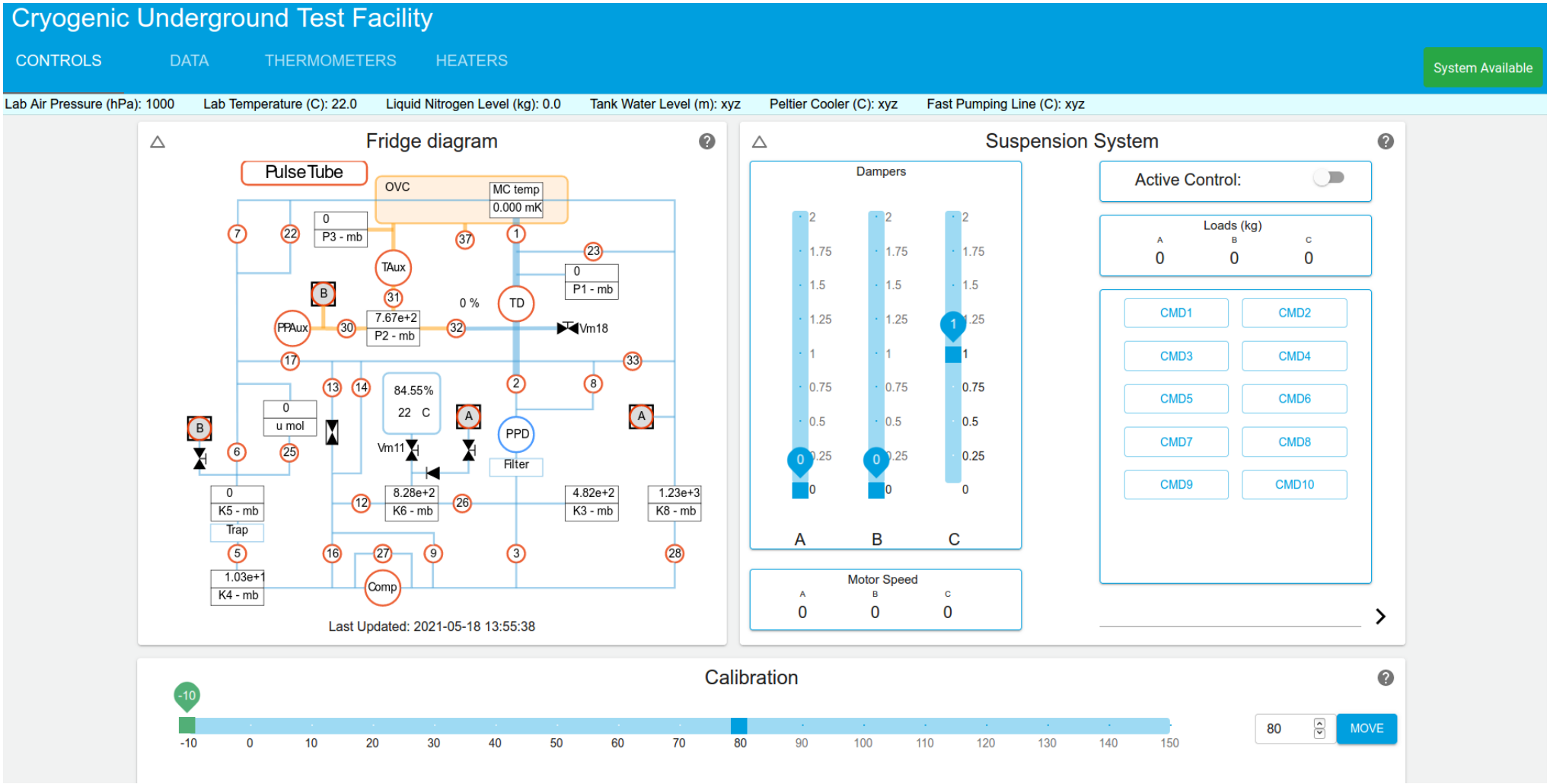
SuperCDMS SNOLAB





Slow Control Interface

- Subsystems (eg. calibration, suspension) are controlled through a unified interface



- Slow control system logs environmental parameters collected from sensors around the facility