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A National mK User Facility

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Overview

Proposal is to set up a User Facility in a similar vein to the NHMFL with a focus on mK engineering and testing facilities.

The goal is to democratize R&D in cryogenics generally, but in mK cryogenics in particular. There is a high bar to entry into R&D in the mK space:

- Equipment is expensive, so can represent a major investment for smaller research groups or PIs with limited startup funding
- Technologically challenging - physics and engineering is counterintuitive in this regime
- Proof-of-principles for proposals are challenging. Many great ideas, but difficult to get funding if you can't claim the idea works

Will require funding, and so adopting a fee-based model is likely the most viable. Sliding scale of fees for access depending upon the customer – industry will clearly pay more, thus subsidizing academic users.

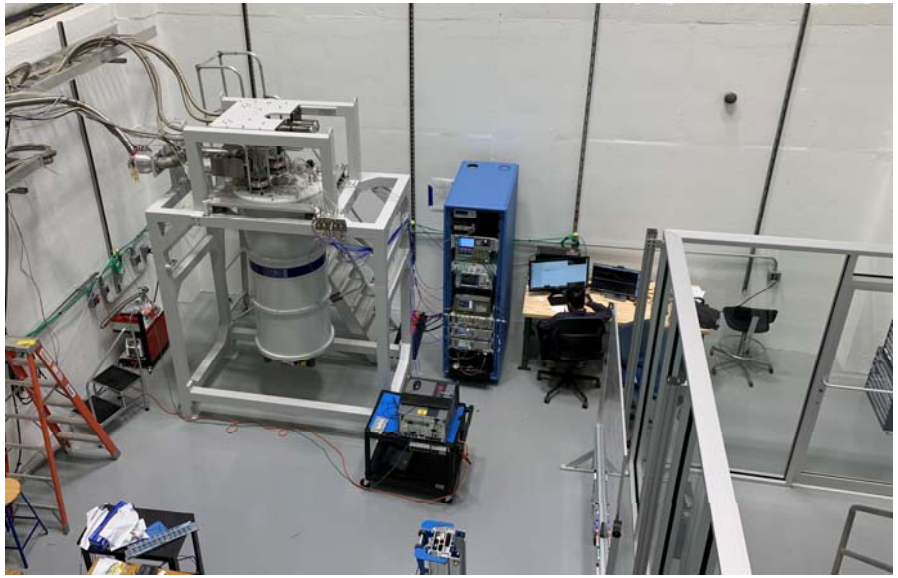
As an aside, such a facility was recently identified as a priority for the Quantum Economic Development Consortium group (https://quantumconsortium.org) to drive the national ecosystem and workforce development.

Thrust 1: Test Facilities

Originally conceived to provide test facilities for superconducting detectors and electronics, the idea can easily be extended to encompass low background facilities specifically for dark matter detector development.

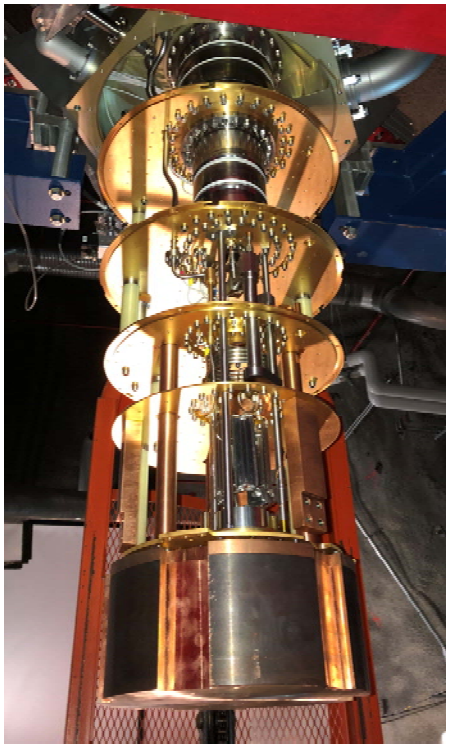
Surface Stands

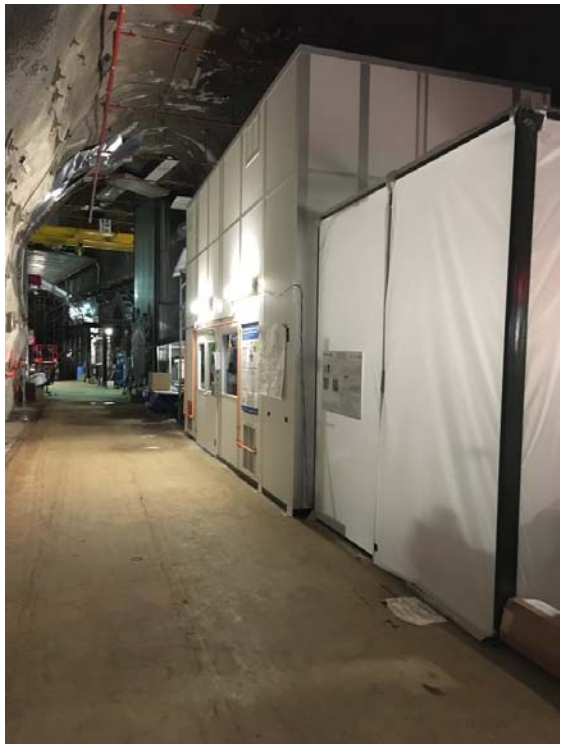
Envisage a range of fridges of different configurations (sizes, magnets…) for different flavors of experiment.



Underground Stands

NEXUS already operational at FNAL. Planning for a second underground stand related to the QSC Center.





Thrust 2: Engineering Resources

Designing and conducting experiments in the mK regime is often challenging since the behavior of circuits and materials at ultra-low temperatures can be very different to ambient.

In a more general sense, even information about materials at low temperature is sparse and frequently very specific to a particular experiment or application. Projects often have to design extremely conservatively or have to do specific measurements internally which can lead to duplication of effort.

A National Facililty could serve as a central repository of data and engineering for users conducting R&D in the mK regime, similar to the old NIST Materials Database (which hasn't been actively maintained or updated in nearly 20 years).

Thrust 3: Workforce Development

Training of the next generation of scientists and engineers in mK Cryogenics is challenging due to limited access to facilities for hands-on experience.

Further compounded by the cost of investment – if a University Lab has a mK fridge, it is unlikely that students will have access to the system for learning purposes. This is particularly acute for groups that are only just getting started in the field.

A NMKUF has the potential to provide these facilities. This could take the form of students applying for time to run experiments, or Summer Schools that would offer a combination of theoretical background with practical training.

This is already being planned on a limited scale at Northwestern as part of the SQMS Center. Initially one, and possible more, dilution fridges will be available part-time to train Undergraduate or Postgraduate students, although the focus is more on measurements of quantum devices rather than more general work.