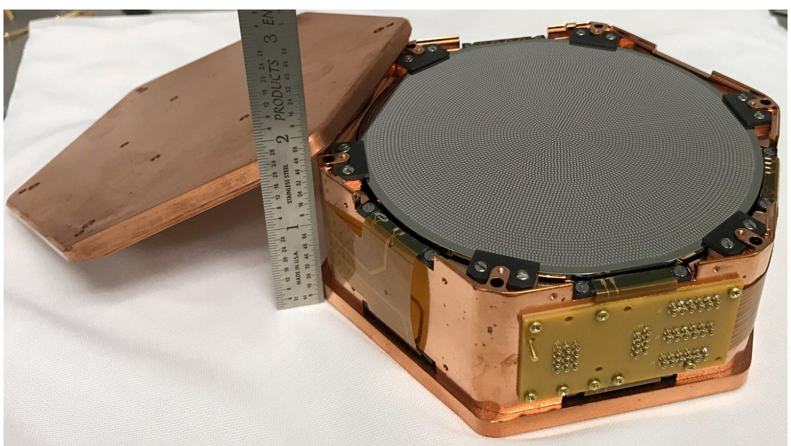
1. Description

Dark matter is a hypothetical form of matter that, if it exists, may account for more than a quarter of the energy density of our universe. Despite the variety of astrophysical evidence pointing to its existence, the direct interaction of dark matter in a terrestrial detector is yet to be observed. This does not stop us from searching, as the existence of dark matter is one of the biggest hints that our current physics theory is not complete. Unveiling the nature of dark matter can point us towards better understanding of the world we live in.

There are different strategies to tackle the dark matter detection task. Some take advantage of big machines like particle colliders. Others build giant telescopes, and sometimes put them into space. The experiment our group is involved in, The Super Cryogenic Dark matter Search (SuperCDMS) experiment, is (literally) one of the coolest.

The SuperCDMS experiment tries to observe a dark matter signal in silicon and germanium detectors operated below 50 miliKelvin. The unparalleled advantage of our experiment is the “Transition Edge Sensor” detector technology. We deploy small chunks of superconductors onto pure silicon and germanium crystals. As superconductors cool down to their transition temperature, the resistances of the superconductors drop abruptly to zero, i.e. go through superconducting transition. We carefully control the temperature of the detector in the middle of the transition -- hence the name of “Transition Edge Sensor” -- so that a small energy deposited in the detector induces a big change in the detector resistance. Thus, our detectors are sensitive to tiny energy depositions down to electronVolts.



The SuperCDMS collaboration is building the next generation experiment in SNOLAB, Canada's world-leading astroparticle physics facility located 2 km below the surface in the Vale Creighton Mine near Sudbury. With the main experiment under construction, a few pilot “test facilities” have been commissioned and are supporting the main experiment by performing detector development, characterization and calibration. These test facilities include the Cryogenic Underground TEst (CUTE) facility at SNOLAB, and a portable test stand that is currently in a neutron beam at Université de Montréal and will be moved to our new cryogenic lab at UofT.

We have two summer projects available.

The first project will focus on two aspects: 1) the design and optimization of the new detector supporting structure, motivated by existing data taken by SuperCDMS test facilities and hints of detector supporting structure induced backgrounds; and 2) analysis of data from CUTE and the portable test stand. The hardware design part involves CAD drawing and electrostatic simulation. No prior knowledge about CAD programs or electrostatic simulation is required. The analysis is mainly done in Python, within an existing analysis framework.
Contact: Ziqing Hong

The second project will focus on validation and testing of the software that is used to reconstruct the properties of physics events from the electronic pulses recorded by the detector. The software is partly Python and partly C++.
Contact: Miriam Diamond

In the scenario of restricted lab access, all the tasks can be done remotely, and hours are flexible. If the pandemic situation improves to the degree that lab work can be performed with minimum to no risks, lab-based work can be included upon mutual interest. The student will have the opportunity to collaborate with other collaboration members remotely. The research group, as well as the wider collaboration, emphasizes principles of Equity, Diversity & Inclusion in the work environment.

For more information:

https://supercdms.slac.stanford.edu/

http://www.snolab.ca/

2. Requirements:

- 3rd year or above
- Familiarity with at least one programming language, python and/or C++ preferred
- Knowledge about CAD programs, like SolidWorks, is preferred but not required