**Final Report: Science Reach of the SuperCDMS SNOLAB Experiment**

The major goals of this project are to develop a calculation of the SuperCDMS SNOLAB projected sensitivities based on data and Monte-Carlo driven detector response and sophisticated statistical limit setting techniques. These goal are broken down into the following components: Implementing a statistical limit setting technique that makes use of information about the expected background rates (i.e. background subtraction) to determine the sensitivity reach beyond the basic optimum filter method, studying the effect of variation in the ionization yield response on the projected sensitivities to understand the dependence of the science reach at the lowest dark matter masses to variations in the the ionization yield response, especially below 675 eV (254 eV) in silicon (germanium), as well as variation in a possible ionization cutoff recoil energy, and generating a new set of sensitivity prediction for the limits for the full SuperCDMS SNOLAB payload to be used for other near term operations such as HV detector commissioning and testing in the CUTE facility (which is anticipated to take place in early 2019).

At the completion of this project, we have successfully achieved the following tasks, which enabled the aforementioned goals:

- Implemented capability to calculate the sensitivity for an arbitrary mixed detector payload.
- Implemented the ability to use multiple signal models (to calculate sensitivities to signal beyond the standard nuclei recoil WIMP interaction), e.g. the ability to hand electron recoil signals.
- Converted internal "energy basis" of the code from "recoil energy" space to "total deposited energy" space to enable the software it to better handle arbitrary signal models & interactions, and an expanded set of backgrounds.
- Added the capability to accommodate charge leakage backgrounds.
- Implemented a mechanism to automatically remain up-to-date with the latest background information, which are generated separately by the SuperCDMS Backgrounds Working Group.
- Performed calculations as part of the "Long-Term Planning Task Force", to evaluate the potential scientific reach of future SuperCDMS type detectors in 5-10 year period based on expected advances in detector technology and background controls.

The graduate student involved in this work, Tyler Reynolds, gained understanding of, and experience using statistical tools such as profile likelihood ratio analyses, developing, debugging and operating a complex software package, and working as part of a collaborative effort (the group within the SuperCDMS collaboration that was assigned to address the recommendations from the SuperCDMS June 2018 Operations Review) on a deadline

driven task. Dr. Reynolds has since graduated and assumed a postdoctoral position at the University of Toronto.

The PI, Tarek Saab, was Deputy Chair of the Science Working group and member of the SuperCDMS Long-Range Planning Task Force (which was the group tasked with evaluating the potential scientific reach of future SuperCDMS type detectors) during this project's performance period.

To products of this work, were subsequently used by the SuperCDMS Long-Range Planning Task Force to inform a study of the potential dark matter reach of SuperCDMS detector detector technology. This resulted in the "Strategy for Low-Mass Dark Matter Searches with Cryogenic Detectors in the SuperCDMS SNOLAB Facility" white paper written as part of the Snowmass Community Planning Exercise.