We propose to build a new flexible, deployable back-end for an array of radio telescopes, to develop a lab to build and test radio antennas, and to build prototype antennas to search for remote areas in northern Canada with low amounts of human-generated radio interference.

The heart of this proposal is to build the McGill back-end (MBE), portable custom-built core of an array of radio telescopes. The MBE will process 3.25 terabits of information every second, equivalent to the international internet bandwidth of many countries. This back-end relies on technology already developed at McGill for the Canadian Hydrogen Intensity Mapping Experiment (CHIME). The new McGill back-end (MBE) will be the second-largest system in the world when measured by number of simultaneously processed input radio telescopes, second only to CHIME itself. The data rate is so large, that we need to bring the MBE to the telescopes, rather than telescope data to the MBE. The first deployment of the MBE will be as the heart of HIRAX, a southern hemisphere analog of CHIME. HIRAX will be located in the South African Karoo desert, on land owned and protected from interference by the South African Radio Astronomy Observatory (SARAO). Between them, CHIME and HIRAX will map almost the entire sky, looking to understand dark energy, the mysterious thing that is causing the expansion of the universe to accelerate. Dark energy, which acts almost like antigravity, is arguably the greatest mystery in physics today, and the MBE will enable significant steps towards measuring its history. HIRAX already has significant funding in place, ensuring there will be an array of dishes that will connect to the MBE. With the MBE in-place, HIRAX will produce around 50 TB of raw telescope data per day, or 70 PB over HIRAX's 4-year lifetime. Understanding how to search such massive amounts of data, and to compress them while not corrupting the dark energy signal is a major data challenge aligned with the SQRI key area of "analytique des données massives". Understanding the system and the implications of data will require "Modélisation, simulation et jeux", and we plan to use "Intelligence artificielle" to search of transient events in the data.

While the MBE is integrated at McGill then deployed in South Africa, we will build a radio lab at McGill to first verify the MBE, and to build and text low-frequency antennas. Northern Quebec is almost unique in offering relatively extensive fiber optic connections and road access, while being one of the most sparsely populated areas in the world. This makes it extremely attractive to search for areas with minimal interference yet good infrastructure, where we could build further low-frequency radio telescopes. With good sites in hand, we can propose to build new radio telescopes in Quebec, where we plan to have future deployments of the MBE. While the future deployments are beyond the scope of this proposal, laying the groundwork for them is an essential part of our current work.