One of the greatest mysteries in cosmology is a bizarre component known as *dark energy*, which we study by using large radio telescope arrays to survey the sky. We present a multi-faceted proposal to build a novel, remotely deployable signal processor—the McGill “back-end” (MBE)—that will be a game-changing addition to radio astronomy. The MBE will be developed in a new radio instrumentation lab at McGill. This lab will also build antennas to search for areas in northern Quebec with little human-generated radio interference, which will serve as potential deployment sites for the MBE working in concert with future radio telescope arrays.

The MBE is a portable, custom-built signal processing core that can process 3.25 terabits of information per second. Radio telescope arrays generate an enormous amount of data, thus presenting a daunting data transport challenge. The MBE offers a unique solution in that the system can be moved physically to the telescopes, thus eliminating the burden transferring the data to a remote processing center. The first deployment of the MBE will be as the heart of the Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX), a new telescope array that will be sited in a radio-quiet region in South Africa. With the MBE in place, HIRAX will produce 50 TB of data per day, or 70 PB over HIRAX's 4-year lifetime. Understanding how to distill such massive amounts of data for the elusive dark energy signal is a major data challenge that directly addresses the SQRI goal "analytique des données massives". Instrument modelling and simulations are key to HIRAX analysis, thus addressing the SQRI goal "Modélisation, simulation et jeux". The MBE will also address the SQRI goal "Intelligence artificielle", which will be used to search for transient events and other unexpected phenomena in the HIRAX data.

We will build a radio instrumentation lab at McGill to develop the MBE, as well as novel antennas that will be deployed to northern Canada. Northern Quebec offers extensive fiber optic and road networks, while simultaneously being sparsely populated. Each of these factors are critical for radio astronomy, and the rare combination of both gives northern Quebec a truly unique geographic advantage. We will use our novel antennas to search for areas in northern Quebec with minimal human-made interference yet good infrastructure. With these sites identified, we will have the groundwork in place for proposing next-generation radio telescope arrays in Quebec, which will then be empowered by the MBE. Our work will lay the path forward for cementing Quebec's position as an international leader in radio astronomy and cosmology.