Low-energy neutrino cross-section measurement in Argon and Cosmogenic background studies at MicroBooNE

With the recent realization of the importance of low-energy neutrino cross-section measurements, Liquid Argon Time Projection chambers (LArTPCs) are rapidly growing to be the desirable technology choice for future neutrino detectors due to their fine-grained tracking and calorimetric capabilities. MicroBooNE is a short-baseline 170 ton LArTPC (largest so far in the U.S.) that is in its final stages of completion, and is scheduled to begin taking data on Fermilab's Booster Neutrino Beam-line (BNB) soon. MicroBooNE's R&D is of great importance and will serve as a design-example for future multi-kiloton LArTPCs.

Two major physics goals of the MicroBooNE experiment are to address the low energy excess observed by the MiniBooNE experiment and make precision cross-section measurements of ~1 GeV neutrino interactions on liquid argon. Historically, neutrino and anti-neutrino cross-sections in the ~1 GeV energy range are not well understood. Measuring cross-sections in this region will provide crucial inputs to future short and long-baseline neutrino experiments. One of my major goals during the fellowship period is to develop an analysis method and necessary tools to perform a charged-current inclusive muon-neutrino cross-section measurement at MicroBooNE using the early BNB data. Excellent tracking and particle identification capability along with efficient cosmic removal are particularly essential to do this measurement.

Since MicroBooNE will sit just below surface, a large flux of cosmic rays is expected. Understanding these backgrounds would not only benefit MicroBooNE but the entire short-baseline neutrino (SBN) program at Fermilab. In particular, estimating the cosmic electro-magnetic (EM) background is crucially important for single electron/gamma searches and so to address the low energy excess observed by the MiniBooNE experiment. Developing cosmic rejection techniques that identify and reject cosmic muons and generated EM showers is very important. As convener of the MicroBooNE cosmogenics group, I have been actively leading this effort within the collaboration. I would like to continue this effort during the fellowship period.

Detector calibration is one of the very first things that needs to be done before being able to use data to perform any physics analysis. There are various factors (Argon purity, diffusion, space charge accumulation etc.) that can affect the signal in a LArTPC. Electro-negative impurities in Ar can absorb the ionization electrons causing signal attenuation. Diffusion is another factor that affects both drift time and spatial resolution. I am currently involved in developing data-driven techniques to extract electron lifetime and longitudinal diffusion, and study their effects on argon purity and spatial resolution, respectively. I hope to be able to continue these studies as well.