Research Statement

Michael Mooney, *Brookhaven National Laboratory* Intensity Frontier Fellow (*Fermilab*)

I have been involved with the MicroBooNE collaboration for a little over a year now, having made a transition from hadron-collider physics at the CMS experiment. As I graduate student at Princeton University, my chief research was on the search for the Standard Model Higgs boson produced in the VH($\mathrm{b\bar{b}}$) channel (where the vector boson, V, decays leptonically). While it was an incredible experience for me to take part in the discovery of the Higgs boson, I decided at the end of my graduate career to switch to neutrino physics in order to take advantage of the considerable opportunity that is growing within the intensity frontier. This led me to become a postdoctoral research associate at Brookhaven National Laboratory, where I am still employed.

My chief focus presently is serving as the Run Coordinator for the MicroBooNE experiment. This is an especially exciting (and busy) time as MicroBooNE is still in its first operations. My main responsibilities in this role include overseeing all detector operations, prioritizing and scheduling of detector system developement and maintenance, training of shifters and organization of shift-taking, maintaining updated operational procedures, and communicating between the collaboration, operations support groups, and the Fermilab Directorate. While this is a significant undertaking, I have still managed to find the time to work on studying TPC-related noise and electronics issues that were uncovered during first operations of the experiment. My studying in detail of the noise on the TPC wires has helped in leading us to eliminate a number of noise and electronics issues either in hardware or software, enabling a successful physics program at the MicroBooNE experiment. Part of my plans as an Intensity Frontier Fellow is to summarize what we've learned about noise and electronics issues within our detector in a publication submitted on behalf of the experiment.

My research as a postdoctoral research associate on MicroBooNE has been largely centered around topics in detector physics. My first work at MicroBooNE was the studying of the space charge effect in the MicroBooNE TPC. The space charge effect is the build-up of slow-moving positive ions in a detector due to, for instance, ionization from cosmic rays, leading to a distortion of the electric field within the detector. This effect leads to a displacement in the reconstructed position of signal ionization electrons in LArTPC detectors. By developing simulations of the space charge effect with a stand-alone software suite that I wrote, I first established the magnitude of the effect at MicroBooNE (up to 5% distortion in E field within the TPC at design cathode voltage) as well as characterized the impact of the effect on tracking. I am continuing to work on a space charge effect calibration scheme making use of the MicroBooNE UV laser system and cosmic muon tracks.

Another detector physics topic I have spent a significant amount of my research time on is signal processing of the MicroBooNE TPC wire readout. Along with helping others at Brookhaven National Laboratory improve the deconvolution scheme that removes the detector response from the raw waveforms, I developed a method to account for dynamic induced charge (DIC) effects on TPC wires in our reconstruction software. These effects may lead to induced signals on neighboring wires that depend on the angle of the particle track in the TPC, complicating the reconstruction of particle trajectories in the detector. The methodology I created has now been implemented in the LArSoft framework and will allow us to address this potential problem. A large part of my plans as an Intensity Frontier Fellow builds off of my previous signal processing work. In addition to further characterizing the field response of the TPC wires to ionization signal, I would like to establish the charge resolution of our TPC for both raw and deconvoluted waveforms. This work includes the development of noise removal techniques and improvements to our deconvolution methodology to maximize our capability to estimate the charge deposited on the TPC wires. This work would be the first step in another research interest of mine, the development of particle reconstruction techniques using the Wire-Cell tool to be used eventually in physics analyses at MicroBooNE.

Serving as the MicroBooNE Run Coordinator for the experiment's first operations has given me considerable experience as a leader on the experiment, while working on various topics in detector physics has given me a solid understanding of the LArTPC technology. I strongly believe that both of these experiences will enable me to make a significant impact on the advancement of the LArTPC technology as an Intensity Frontier Fellow at Fermilab.