Ionization cooling is a key enabling technology for muon colliders and stored-muon-beam neutrino factories. The Muon Ionization Cooling Experiment (MICE) is being carried out at Rutherford Appleton Laboratory in the UK by an international collaboration prominently including Fermilab and IIT. MICE was originally proposed as a demonstration of transverse ionization cooling, but emittance exchange between the longitudinal and transverse degrees of freedom can enable cooling of all six phase-space dimensions, as required for a high-luminosity ($\mathcal{L} \sim 10^{34}\text{cm}^{-2}\text{s}^{-1}$) muon collider. Six-dimensional (6D) cooling can be demonstrated in MICE using a wedge absorber and a muon beam with appropriate dispersion, and suitable LiH-wedge absorbers have been ordered by Fermilab, with anticipated delivery in March, 2011. The other ingredients for this test, an Absorber–Focus Coil (AFC) module and two Spectrometer Solenoids, are under construction with delivery expected in the fall of 2011. It is thus likely that the first test of 6D cooling will be carried out in MICE by the spring of 2012. Participation in this test and analysis of the resulting data will form the basis of my PhD thesis. There is however some uncertainty in the magnet delivery schedules, and fallback positions have been considered. Should the AFC module be available but the Spectrometer Solenoids be substantially delayed, a 6D cooling test may still be possible in MICE by using Time-of-Flight (TOF) counters to determine muon positions and momenta. This alternative measurement scheme is somewhat cruder than measurement using the magnetic spectrometers, and it has not yet been demonstrated to be adequate for a 6D cooling demonstration. We will address this possibility with simulation studies. In the event that the Spectrometer Solenoids are delayed and the TOF approach is shown to be inadequate, an alternate thesis project focused on high-gradient RF-cavity R&D in Fermilab's MuCool Test Area will be pursued.

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Proposed start date: June 2011