

Neutrino energy reconstruction is one of the largest sources of uncertainty in modern neutrino oscillation experiments. The neutrino oscillation probability is a function of the energy, and uncertainty in determining this energy limits the precision of measuring theoretical oscillation parameters. Accurate energy reconstruction is fundamental to the success of the upcoming Deep Underground Neutrino Experiment (DUNE).

Neutrino energy is estimated from the final state particles produced by neutrino-nucleus interactions within detectors. This energy can be underestimated if final state particles interact inelastically or are unable to be reconstructed because of scattering in the detector medium. This is referred to as Secondary Interactions (SI) of particles. These particles can also interact within the initial target nucleus, resulting in Final State Interactions (FSI). FSI and SI are currently modeled using a microscopic cascade model, where the particle is tracked through the initial nucleus – for FSI – or in the detector – for SI – with a chance of re-interaction.

Our current understanding of FSI and SI is lacking, and this will be a significant problem for DUNE. ProtoDUNE – a prototype for DUNE’s liquid argon detector technology – will sit in a charged particle test beam at CERN, and will provide data that can be used to test FSI and SI models.

One component of the test beam will be positively charged pions. Pions are commonly produced in neutrino-nucleus interactions, and are subject to FSI and SI. There is a particular lack of pion-argon scattering data at energies relevant to DUNE. We propose to use the ProtoDUNE test beam data to measure the charged pion-argon interaction cross section. This will provide valuable constraints to the FSI and SI models for DUNE as well as other current and future liquid argon neutrino experiments.