



Contribution ID: 218

Type: **Poster session**

## Effects of LBNF Neutrino Beam Focusing Uncertainties on DUNE Neutrino Fluxes with a Focus on the Decay Pipe

DUNE is a next generation long baseline neutrino experiment which will study the LBNF neutrino beam at FNAL. Precision measurements of neutrino oscillation parameters with DUNE require estimates of neutrino flux uncertainties. While the dominant uncertainties come from hadron production, uncertainties due to the engineering tolerances for the elements in the LBNF beamline used to focus the beam (so-called focusing effects) are also significant. Some of these elements include the magnetic focusing horns, the geometry of the decay pipe, and the horn currents. The uncertainty due to the decay pipe dominates in the flux's region-of-interest below  $\sim 4.5$  GeV, however, this uncertainty is extracted by simply varying the pipe radius. An in-depth study into the pipe geometry and orientation has been performed to ascertain if it can have further significant impact on the fluxes and is presented here. This study will be used to help guide the allowable tolerances for the decay pipe construction to mitigate the corresponding uncertainties. Results for various Monte Carlo studies for the beam-focusing uncertainties will be presented in this poster.

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**Session Classification:** Neutrino Physics Session 2

**Track Classification:** Neutrino Physics