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The NuMI Flux at ICARUS

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ICARUS is a 430 t liquid argon time projection chamber, neutrino detector located at Fermi National Accelerator Laboratory and serves as the far detector for the Short Baseline Neutrino program. The ICARUS detector lies 795 m downstream and 5.7° above the Neutrinos at the Main Injector (NuMI) neutrino beam. At this large off-axis angle, ICARUS has a unique opportunity to measure a variety of electron and muon (anti-)neutrino interaction rates with argon nuclei, which will be an important input to the Deep Underground Neutrino Experiment. These measurements rely on detailed predictions of the (anti)neutrino fluxes and their related uncertainties to accurately extract the cross sections and estimate uncertainties. In many cases flux uncertainties can dominate the measurement error budget, and thus must be well understood and well characterized. The authors will present the predictions for the NuMI flux at ICARUS along with corrections and estimated uncertainties. The uncertainties have two main sources: hadron production uncertainties, which are characterized using the Package to Predict the Flux (PPFX), and beamline uncertainties which are explored by alternate model configurations. Detailed breakdowns of the flux components by hadron production channel will be shown, as well as studies that elucidate how flux uncertainties evolve with large off-axis angles. Data products used for analyses, including covariances between various fluxes and PCA of the flux uncertainties will also be shown.

Primary author: CHERDACK, Daniel

Presenter: CHERDACK, Daniel

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