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The Importance of Proper Flux Treatment and Model Validation in Cross Section Measurements and Comparisons

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Neutrino-nucleus cross section measurements are needed to improve interaction modeling to enable upcoming precision oscillation measurements and searches for physics beyond the standard model. There are two methods for extracting cross sections, which rely on using either the real or nominal flux prediction for the measurement. We examine the different challenges faced by these methods, and how they must be treated when comparing to a theoretical prediction. Furthermore, the necessity for model validation in both procedures is addressed, and differences between "traditional"fake-data based validation and data-driven validation are discussed. Data-driven model validation leverages goodness-of-fit tests enhanced by the conditional constraint procedure. This procedure aims to validate a model for a specific measurement so that any bias introduced in unfolding will be within the quoted uncertainties of the measurement. Results are shown for the first measurement of the differential cross section $d^2\sigma(E_\nu)/d\cos(\theta_\mu)dP_\mu$ for inclusive muon-neutrino charged-current scattering on argon, which uses data from MicroBooNE, a nominal-flux-prediction unfolding, and data-driven model validation.

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