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NOvA central value tuning and uncertainties for the hN FSI model in GENIE 3

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In a neutrino interaction, hadrons are produced and traverse the nuclear medium before they are observed. However, while traversing the nucleus, hadrons can re-interact with nucleons resulting in final state interactions (FSI). In historical versions of the neutrino generator GENIE, FSI is modeled using an “effective” cascade model, hA, where possible final-state hadrons are fixed directly from hadron scattering data. However, for NOvA’s 2020 analysis, we employ GENIE’s semi-classical hN FSI model. In hN, hadrons steps through the nucleus via a nuclear density profile calculating step-by-step probabilities using a theory-based cross section model relating external pion scattering data to scattering amplitudes inside the nucleus. However, agreement to external pion scattering data is poor, motivating a tuning procedure of the relative pion probabilities in hN based on extant pion scattering data to produce NOvA’s hN Central Value tune. The nominal hN model also does not have any reweightable uncertainties, so we create them utilizing similar work done by T2K to obtain uncorrelated uncertainties on our tuned Central Value. Finally, we train a Boosted Decision Tree to construct a reweighting scheme from the nominal value to our tuned Central Value, so as to avoid reproducing NOvA’s full production with our Central Value tune. The result, from our uncorrelated uncertainties on the Central Value, is a 5-10% variation for true pion observables in a generated neutrino sample.

Summary

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