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Study of final-state interactions of protons in neutrino-nucleus scattering with INCL and NuWro cascade models

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As neutrino oscillation physics enters the precision era, the modeling of neutrino-nucleus interactions constitutes an increasingly challenging source of systematic uncertainty for new measurements. To confront such uncertainties, a new generation of detectors is being developed, which aim to measure the complete (exclusive) final state of particles resulting from neutrino interactions. In order to fully benefit from the improved detector capabilities, precise simulations of the nuclear effects on the final-state nucleons are needed.

To address this problem, we have studied the in-medium propagation of knocked-out protons, i.e., final-state interactions (FSI), comparing the NuWro and INCL cascade models. INCL is a nuclear-physics model primarily designed to simulate nucleon-, pion- and light-ion-induced reactions on nuclei. This study of INCL in the framework of neutrino interactions highlights various novelties in the model, including the production of nuclear clusters (e.g., deuterons, α particles) in the final state.

We present a characterization of the hadronic final state after FSI, comparisons to available measurements of transverse kinematic imbalance, and an assessment of the observability of nuclear clusters.

The study presented here is a crucial milestone toward the precise simulation of FSI in neutrino-nucleus interactions and a complete estimation of related uncertainties.

Auteur principal: ERSHOVA, Anna (CEA Saclay)

Orateur: ERSHOVA, Anna (CEA Saclay)

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