Revisiting Neutrino Oscillation Physics in presence of Nuclear Effects

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The future Long-Baseline Neutrino Experiment, as one of the third generation neutrino experiment is focusing on the determination of neutrino mass hierarchy, octant degeneracy and CP violation. To realize this ambitious program it is necessary to pin down the systematic uncertainties in the proposed experiments. The relevant sources of uncertainty (i.e. energy calibration, flux normalization , nuclear effects and so on) must be examined carefully, particularly those related to neutrino energy reconstruction since in neutrino oscillation experiments, the oscillation parameters are extracted from the energy distribution of collected events. Hence a precise reconstruction of neutrino energy is a prerequisite for a precise predictions of oscillation physics. In these experiments the neutrino interacts with a nucleon present in the target nucleus of the detector. Materials with high atomic number are used as detector materials in order to increase the interaction rates. This reduces the statistical uncertainty but nuclear effects are highly intertwined in the nuclear targets (i.e. nuclear fermi motion effects, uncertainties from the binding energy, multinuclear correlation and final state interactions of produced hadrons in different interaction channels) which necessitates their thoughtful presence in theoretical models used for neutrino oscillation prediction. The effect of Final state Interaction on neutrino oscillation experiment physics and their quantification is discussed, with the studies made at near and far detector both.