Contribution ID : **47**   Type : **Short communications**

Neutrino Oscillation: Simulation from NuMI beam to NOνA detector

Thursday, 18 December 2025 11:15 (15)

This work presents a Monte Carlo simulation of neutrino oscillations for muon neutrinos produced by the NuMI beam at Fermilab (Chicago) and detected at the NOνA far detector located in Ash River, Minnesota. The simulated ν_μ are generated by the NuMI facility, which operates at 900 kW beam power and directs the neutrino beam 3.3° downward toward the NOνA detector, situated 810 km from the production point. The experiment's primary objective is to investigate neutrino oscillations, with particular emphasis on the appearance of the electron neutrino flavor (ν_e) at the far detector.

The main goal of the developed program is to provide a Monte Carlo framework suitable for phenomenological studies of this experiment, enabling the testing of alternative neutrino oscillation models using a transparent and accessible Python-based implementation. The simulated results can then be directly compared with published NOνA data.

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Session Classification : HEP - NUCLEAR - F.MEDICA