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A novel ML approach for the reconstruction of particle showers with a tracking detector

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SND@LHC is a newly approved detector under construction at the LHC, aimed at studying the interactions of neutrinos of all flavours produced by proton-proton collisions at the LHC. The energy range under study, few hundreds MeVs up to about 5 TeVs, is currently unexplored. In particular, electron neutrino and tau neutrino cross sections are unknown in that energy range, whereas muon neutrino data stops at a few hundreds GeVs. The SND@LHC detector will allow to fill in these gaps for all three flavours, enabling crucial tests of the SM. The detector is also ideally suited to look for scattering signatures of hypothetical light Dark Matter particles. The neutrino interaction target is made of alternating layers of tungsten plates, nuclear emulsion films and scintillating fiber (SciFi) trackers. As such, it provides micrometric accuracy for track reconstruction when the emulsion films are taken out for development, every few months. However, the presence of the SciFi layers allow for real-time event analysis.
This talks presents for the first time a new approach to calorimetry with a tracking detector. Conventional tracking methods are not useful in the context of high-multiplicity particle showers, as are expected in neutrino scattering events. Machine learning techniques will therefore be employed in order to analyse data from the SciFi tracker in real time, providing a measurement of the neutrino energy and flavour tagging. Preliminary studies prove that the SciFi planes do behave as the active layers of a sampling calorimeter. Various techniques based on Neural Networks (NN), including Bayesan and Convolutional NNs, are being developed, allowing to overcome technical challenges such as the presence of ghost hits, and to supplement calorimetric information with topological event reconstruction, a first-time attempt in the field.
The idea reported in this talk represents a general breakthrough for the reconstruction of complex events with an electronic detector, a crucial asset in view of operating a particle detector at a high luminosity collider or beam dump, and much more so for a neutrino experiment requiring flavour tagging. This talk will give an overview of the results already achieved and of the short term prospects. These results had never been publicly presented before.

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