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GNN Classification of Muon- and Electron Neutrino Events for the ESSnuSB+ Near WC Detector

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A long baseline neutrino experiment, the purpose of the ESS Neutrino Superbeam+ (ESSνSB+) is to precisely measure δ_{CP} in the leptonic sector using a powerful proton beam produced at the European Spallation Source (ESS).

In this endeavor, accurate and fast event reconstruction is central for the design and performance of the ESSnuSB detectors. While precise, the currently proposed likelihood-based method is computationally expensive.

In this work, we investigate the use of Graph Neural Networks (GNNs) for classification of muon- and electron neutrino events in the Near Detector of the ESSnuSB experiment, as well as for classification of charged- and neutral current events and of the presence of pion production.

We demonstrate that the accuracy of the GNN method is comparable to that of the likelihood method, and that the GNN can even learn the signatures of, and accurately identify, complex events that are currently discarded, while providing a factor 10^4 increase in reconstruction speed.

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