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Data Driven Trigger Algorithms to Search for Exotic Physics in the NOvA Detector

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The NOvA experiment at Fermi National Accelerator Lab, due to its unique readout and buffering design, is capable of accessing physics beyond the core neutrino oscillations program for which it was built. In particular the experiment is able to search for evidence of relic cosmic magnetic monopoles and for the signs of the neutrino flash from a near by supernova through uses of a specialized triggering system that is able to be self driven off of the raw readout stream.
These types of "data driven triggers" require fast track reconstruction and rejection over a wide range of time windows and detector conditions. The amount of data that the NOvA detector produces and the continuous streaming nature of the data make this type of real time reconstruction is a challenge for modern computing.
To meet these challenges a fast track reconstruction algorithm has been developed based on N-dimensional Hough Transform which is able to meet the latency requirements of the NOvA data acquisition system. This algorithm forms the basis of both the searches for magnetic monopoles, where it is able to separate out the slow moving monopoles from the prompt cosmic backgrounds, as well as for the supernova detection trigger, where it is used to subtract out the cosmic ray background and leave the low energy EM shower candidates.
In this paper, we will discuss in details of this algorithm and show how it can be used to distinguish and reconstruct slow magnetic monopole tracks verse fast cosmic ray tracks through an expansion of the Hough space to include velocity and pulse height information. We will discuss the scaling of the algorithm and its performance when run on real data. Examples of cosmic rate rejection and the improvements to supernova detection will be discussed and examples of the algorithm and trigger performance will shown for the early running of the NOvA far detector.

Summary

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