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Development of Hit Finding Algorithms for the DUNE Experiment Using SiMD Parallel Processing

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The DUNE experiment will start operating at the end of this decade, with the objective of measuring in detail neutrino oscillations, and other rare physics processes. Four far detectors modules (17 kt each) will be installed at SURF, in South Dakota, about 1.5 km underground. The data selection system of one DUNE far detector module's Time Projection Chamber (TPC) relies on the real-time processing of approximately half a million channels sampled at 2 MHz. Data for each channel are analyzed to identify activity incompatible with noise (hit finding). The hits are then clustered and processed further to form a trigger decision. The aim of the DUNE data selection system is to reduce the data volume produced by the detector electronics by four orders of magnitude. In this paper, after the description of the application design, we present the implementation and tuning of multiple software-based hit finding algorithms. The high rate of incoming data (~20 GB/s per host) is sustained through the employment of SiMD parallel processing, using algorithm implementations based on the AVX2 instruction set. We show the obtained performance comparing it across multiple CPU hardware platforms and conclude by illustrating live results from recent tests at a setup using prototype detector components.

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