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Scalable DAQ Performance for Supernova Neutrino Observations in DUNE

The Deep Underground Neutrino Experiment (DUNE) is an international next-generation project that will use a powerful neutrino beam produced at Fermilab and two detectors: a near detector at Fermilab and a far detector ~1300 kilometers away at the Sanford Underground Research Facility in South Dakota. DUNE features a high-throughput, modular data acquisition system (DAQ) specifically designed to capture intense physics events, including Supernova Neutrino Bursts (SNBs). Within the first 10 seconds of such a burst, approximately 10^57 neutrinos are emitted, with around 60 expected to interact in the far detectors. Given DUNE's ambitious scientific goals and the rarity of supernova bursts, the DAQ is required to meet stringent performance criteria: the ability to run continuously for extended periods with a 99% up-time requirement, the functionality to record both beam neutrinos and low-energy neutrinos, data throughputs of up to 1.8 TB/s for the far detectors, and a total storage capacity of 30 PB per year.
The system's modular design enables this workload to be shared evenly across 150 identical detector units, distributed among high-performance commercial off-the shelf servers where one readout server manages four detector units. These servers interface directly with the detector electronics, receiving data over Ethernet. The data are then buffered and processed to extract "trigger primitives"used for data selection. In this talk we present the results of performance tests conducted using the protoDUNE horizontal drift time projection chamber at the Neutrino Platform at CERN, including the ability to record a 100 s-long data capture that will be used for SNB readout. We show that the DUNE DAQ readout system is reliable and scalable for capturing SNB neutrino interactions in DUNE's far detector modules.

Submitter Email

robert.mihai.amarinei@cern.ch

Submitter Name

Robert-Mihai Amarinei

Submitter Institution

University of Toronto

Primary author: AMARINEI, Robert-Mihai (University of Toronto)

Co-authors: COLLABORATION, DUNE; ILIC, Nikolina (University of Toronto)

Presenter: AMARINEI, Robert-Mihai (University of Toronto)

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