Quality Control (QC) Testing and Data Analysis of DUNE Detector Cold Electronics

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ABSTRACT

The Deep Underground Neutrino Experiment (DUNE) will be one of the next-generation experiments to uncover the nature of neutrino oscillations which will help understand how neutrinos play a part in the creation of the universe. The measurements will provide incredibly high statistics on the probability of neutrinos oscillating between their electron, muon, and tau flavors. The experiment will consist of a neutrino beam generator, a near detector at Fermilab in Batavia, Illinois, and the Far Detector, located thirteen hundred kilometers downstream of the neutrino beam at the Sanford Underground Research Facility. Measurements of the neutrinos will be made using Liquid Argon Time Projection Chambers (LArTPCs). Those detectors will provide analog signals, which will be processed and converted to digital data through electronic circuits, including Liquid Argon Application-Specific Integrated Circuits (LArASICs). Given that these components must remain operational for a 30-year duration without maintenance and replacement, the quality control of LArASICs is of utmost importance. The reliability of LArASIC chips is paramount for achieving the physics by DUNE. With a vast quantity of approximately 40,000 LArASICs required, there is a strong need for automating the quality control testing process. To this challenge, a Python program has been written to accept input from a directory containing multiple folders with all the tested chips. Each LArASIC's results are compiled into a CSV file (Result). Subsequently, the program processes the data, employing specific criteria to generate aggregated results from a series of the nine tests. These results serve to determine whether each chip passed or failed conclusively. The program also keeps track of how many chips passed or failed the tests. This program is an invaluable solution, eliminating the need for manual inspection and saving significant time.

Keywords: DUNE, LArTPCs, LArASIC