



Contribution ID: 439

Type: Poster

Design and qualification of the Mu2e electromagnetic calorimeter electronic system

Friday, 27 May 2022 16:22 (1 minute)

The Mu2e experiment at Fermilab will search for the neutrino-less coherent conversion of a muon into an electron in the field of a nucleus. The observation of this process would be the unambiguous evidence of physics beyond the Standard Model. Mu2e detectors comprise a strawtracker, an electromagnetic calorimeter and a veto for cosmic rays. The calorimeter provides excellent electron identification, pattern recognition and track reconstruction. The detector employs 1348 Cesium Iodide crystals readout by silicon photomultipliers and fast front-end and digitization electronics. A design consisting of two disks positioned at a distance of 70 cm satisfies Mu2e physics requirements. The front-end electronics consists of two discrete chips for each crystal. These provide the amplification and shaping stage, linear regulation of the SiPM bias voltage and monitoring. The SiPM and front-end control electronics is implemented in a battery of mezzanine boards each equipped with an ARM processor that controls a group of 20 Amp-HV chips, distributes the low voltage and the high-voltage reference values, sets and reads back the locally regulated voltages. The electronic is hosted in crates located on the external surface of calorimeter disks. The crates also host the waveform digitizer board (DIRAC) that performs digitization of the front end signals and transmit the digitized data to the Mu2e DAQ. The core of the DIRAC board is a large FPGA (MicroSemi® MPF300T), that handles 10 double channels 12 bits and maximum sample rate of 250 MSPS analog-to-digital converters ADCs. Digitized data are sent to the main DAQ system through a CERN custom designed optical transceiver (VTRX).

Calorimeter electronic is hosted inside the cryostat and it must sustain very high radiation and magnetic field so it was necessary to fully qualify it.

The constraints on the calorimeter front-end and readout electronics, the design technological choices and the qualification tests will be reviewed.

Collaboration

mu2e

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Session Classification: Front End, Trigger, DAQ and Data Management - Poster session