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The DAQ and clock distribution system of CMS MIP Timing Detector

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The Compact Muon Solenoid (CMS) detector at the CERN Large Hadron Collider (LHC) is undergoing an extensive Phase-II upgrade program to cope with the challenging conditions of the High-Luminosity LHC (HL-LHC). A new timing detector is designed to measure MIPs with a time resolution of 30-60ps during the entire HL-LHC phase. MIP Timing Detector (MTD) will consist of a central barrel region based on LYSO:Ce crystals read out with silicon photomultipliers and two end-caps instrumented with radiation-tolerant, low-gain avalanche diodes. A common data acquisition (DAQ) system will collect data from readout chips, reconstruct timing information, and send data to the event builder. The MTD DAQ system is built around the state-of-the-art ATCA-form-factor Serenity board with two high speed FPGAs. On detector, it communicates with the lpGBT ASIC in both barrel and endcap timing detectors. Control signals and a precision clock that has a RMS jitter of less than 5ps, essential for the timing resolution, are transmitted using the same DAQ link. The precision clock is synchronized to the LHC collision rate of 40MHz and is received at the subsystem and transmitted to the detector via high-speed data links. An advanced monitoring system is being developed to ensure timing synchronization during the operation of the detector. The detector system with full-readout chain has been tested using prototypes of the DAQ, on-detector electronics, and sensors, showing that the system can successfully achieve timing resolution below 30ps. This talk is organized in four parts: first the infrastructure of the DAQ system will be discussed, followed by the precision clock distribution and monitoring system. The third part will focus on software development and organization. The final part will be dedicated to system tests, in which 30ps resolution has been demonstrated with independent measurement channels.

Collaboration

CMS

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