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Integration and Testing of the DAQ System for the CMS Phase 1 Pixel Upgrade

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The CMS pixel detector phase 1 upgrade in 2017 requires an upgraded DAQ to accept higher data rates. A new DAQ system has been developed based on a combination of custom and standard microTCA parts. Custom mezzanines on FC7 AMCs provide a front-end driver for readout, and front-end controller for configuration, clock and trigger. The DAQ system is undergoing a series of integration tests including readout of the pilot pixel detector already installed in CMS, checkout of the phase 1 detector during its assembly, and testing with the CMS central DAQ.

Summary

The CMS pixel detector will be upgraded in the 2016/17 LHC year end technical stop. A more efficient readout chip (ROC), along with an extra detector layer in both barrel and forward regions, and a substantial mass reduction inside the pixel detector tracking volume, will provide better tracking and vertexing performance. A higher bandwidth readout system is required to manage the greater rate of pixel data as the LHC luminosity increases and the hit occupancy of the modules increases. New backend DAQ system components, based on the microTCA platform, with front-end driver (FED) cards and front-end controller (FEC) cards, for readout and configuration/clock/trigger respectively, have been developed and prototyped with custom optical link mezzanines mounted on the FC7 AMC and custom firmware. The backend hardware is in production and pre-production parts are being used in several pixel detector test-stands, including readout and control of a pilot detector, a system of eight prototype upgraded pixel modules installed inside the present CMS forward pixel detector during LS1. The pilot detector is being read out with a prototype microTCA FED, and controlled with the prototype microTCA FECs. Assembly of the full, final upgraded pixel detector is proceeding in parallel with DAQ developments. Each of the assembled sub-structures of the final detector (four half-cylinders for forward pixels, and two half-barrels for barrel pixels) is being validated with the microTCA backend. In parallel, pixel DAQ integration tests with the CMS central DAQ system are taking place at Point 5, along with running of the pilot detector, in order to assure a smooth upgrade.

This paper describes the DAQ system, integration tests and results, and an outline of the activities up to commissioning the final system at CMS in 2017.

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