CMS PIXEL ONLINE SOFTWARE

ABSTRACT: The CMS experiment at the LHC incorporates a 66 million channel silicon pixel detector at its center for track seeding and precise vertexing. The Pixel Online Software orchestrates the operation, calibration and monitoring of the pixel detector. It is based on two libraries: XDAQ, a cross-platform Data Acquisition library written in C++, and RCMS, a Run Control and Monitoring System library written in Java. Applications that comprise Pixel Online Software may be controlled by a pixel detector expert over the world wide web, or by CMS central run control. The various calibrations required to prepare the detector for taking data are carried out using Pixel Online Software. Some characteristics of the readout can also be monitored in real time by the Pixel Online Software. The interaction of the Software with the Detector Control System is used to automatically turn the detector on in stages.

The readout chips have two voltages of interest, the analog voltage (Vana) and the digital voltage (Vldig). The Vana can be either OFF (0 V) or ON (2.6 V). The Vldig for the BPix can be either OFF (0 V) or ON (2.1 V). The Vldig for the FPix can be either OFF (0 V), ON_REDUCED (2.1 V) or ON (2.6 V). PixelTFECSupervisor coordinates with PixelDCSFSMInterface before programming them.

The DAQ DCS Integration

For purposes of automatic detector turn-on, the detector is partitioned into 8 segments. The Portcard and CCUs in the service cylinders have two voltage states: OFF at 0 V and ON at 2.6 V. The PixelTFECSupervisor coordinates with PixelDCSFSMInterface to ensure they are turned on before programming.

The Finite State Machine Structure

TheFiniteStateMachineStructure

All the XDAQ supervisors work within a finite state machine framework whose states closely resemble those of Level 0 Function Manager. This ensures that the system is in a well defined state at any point in time. The inputs for changing the state of PixelSupervisor, trickle down to the lower supervisors. But it is not until the states of the lower supervisors have been updated that the state of PixelSupervisor can be updated.

Each lower supervisor can be cycled through its states independently through its own web-based GUI for debugging programming, triggering or readout pathways.

All calibrations and forms of data taking are implemented within this finite state machine framework.

The Some Calibrations

TheFEDBaselineCalibration nearly centers the baseline of all the analog readout lines for the signal to exploit the full dynamical range.

For the FED to decode the analog readout, it must know the address level thresholds. These are determined through Address Levels Calibration.

The noise and threshold of every pixel is measured by injecting various amounts of charge and plotting the response efficiency in a procedure called the 5-Curve Calibration.

The linearity of response between the amount of charge injected and the pulse height reported is quantified by the Gain Calibration.