Testing and Integration of the Service Cylinders for the CMS Phase 1 Pixel Detector

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TWEPP-16: Topical Workshop on Electronics for Particle Physics, 26-30 Sep 2016 Karlsruhe Institute of Technology (KIT)

CMS Phase 1 Pixel Detector

The CMS Detector at LHC

The Compact Muon Solenoid (CMS) is one of the large general-purpose particle physics detectors built on the Large Hadron Collider (LHC). It is a complex detector comprising different sub-systems, each designed to perform a specific task.

Current Pixel Detector

The Inner Pixel Detector provides spatial information close to the interaction point:
- n+ implants on n doped silicon bulk
- Excellent hit resolution ~ 10 μm
- Excellent hit efficiency

Designed for the LHC nominal luminosity of 10^{34}cm^{-2}s^{-1} at 25 ns bunch spacing.

Phase 1 Pixel Detector

The LHC plan is to double the luminosity before the third long shutdown in 2024. This results in high track density, trigger rates and pileup. An upgrade of the pixel detector has been designed in order to maintain high performance. It will be installed during the LHC technical stop at the end of 2016.

Improve robustness: high tracking efficiency
- 3 ± 4 barrel layers
- 2×2 × 2×3 endcap disks

Move layers and disks closer to the beam:
- Improve vertexing and b-tagging

Avoid hit inefficiencies with new digital readout chip:
- Reduced dead time and data loss
- Faster digital readout (40 MHz → 400 MHz/s)
- Increased data buffer size

Reduced material in the fiducial tracking volume: reduce multiple scattering and photon conversion, and improve impact parameter resolution
- Electronic boards shifted at high |η|
- Lightweight mechanics and CO2 cooling

Testing Procedure

During the integration of the service cylinders the full functionality of the assembled electronic components has to be verified. A testing procedure which uses pixel modules has been developed for this purpose.

Optical Links

The digital signal of the pixel module is converted from electrical to optical through laser diodes on the Pixel Opto Hybrids (POH).

Test the POHs functionality and quality of optical connections measuring the laser optical power as a function of the supply current.

Module Programming and Readout

Trigger, clock and programming signals are sent to the module through digital-to-optical control links mounted on the service cylinders.

The TBM chip on the pixel module sends a specific data package each time a trigger is received.

The data transmission timing has to be adjusted such that the package is correctly decoded by the DAQ system.

It can be adjusted changing the phase of 2 PLLs (400 MHz and 160 MHz) in the TBM.

Testing at Cold

High level tests can be performed using the ROCs.

For instance: readout of the ROC analog current (Iana) as a function of the analog current (Iana) for each of the PLLs phases.

Conclusions

At the end of 2016, the present 3-layer CMS barrel pixel detector will be replaced with a new 4-layer pixel system to maintain the excellent tracking performance of CMS at the upcoming higher luminosity conditions at the LHC. The new electronic components and cooling loops are currently being assembled on the service cylinders. The full functionality has to be verified in order to assure a quick and reliable integration with the pixel modules before the final installation and commissioning.