



Preparation of the CMS Pixel Detector for Run 3



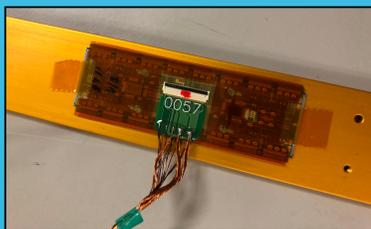
Grace Haza on behalf of the CMS Tracker Group
2021 November LHCC Meeting: 18 November 2021

Background

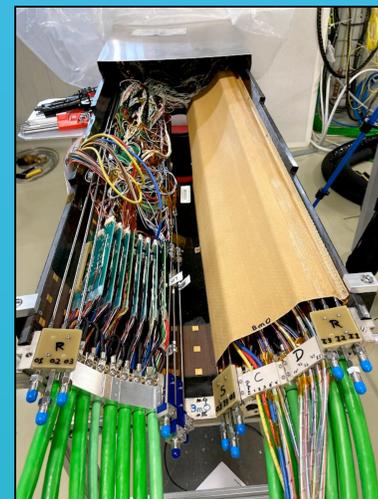
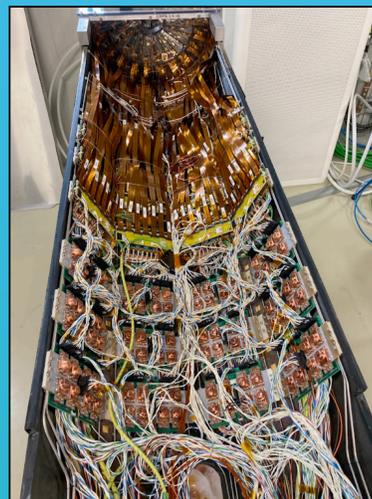
The pixel detector of CMS was extracted at the end of the data-taking period of Run 2 and has been kept in cool, dry boxes above ground during LS2. It has been refurbished with a new innermost layer of barrel pixels, new DCDC converters, cooling pipe repairs, and increased granularity in high voltage lines. Following these improvements, the detector was successfully reinstalled in the heart of CMS and is being commissioned in preparation for Run 3.

About the CMS pixel detector

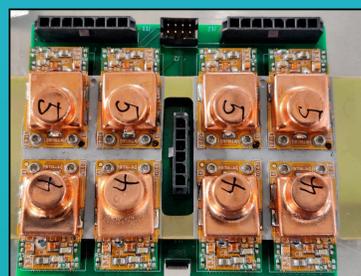
- 4 barrel layers and 3 endcap disks
- 1856 modules, 16 readout chips (ROCs) per module, 80x52 pixels per ROC = 124M channels
- Modules with n+ in n sensors with pixels of 100 x 150 μm^2 and an active layer of 285 μm



Refurbishments



- Innermost layer of barrel pixel modules exchanged with new modules, which are free from radiation damage and permit an additional delay between the two innermost layers
- New digital current to digital current converters redesigned for more stable running and mounted on more effective cooling bridges
- New filterboards with increased granularity of the high voltage supply, allowing greater flexibility for powering the detector



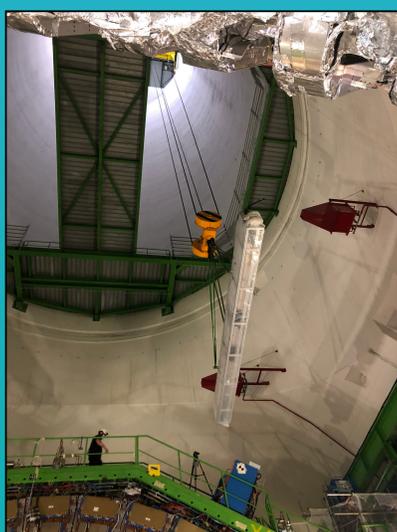
New DCDC converters.



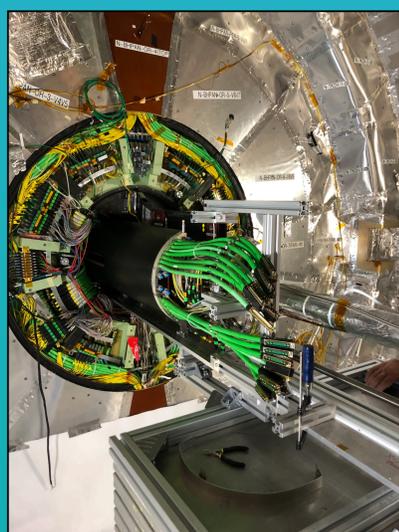
New filter boards installed in a half cylinder of the forward pixels.

Installation

During LS2, the pixel detector was enclosed in boxes in clean rooms above ground at P5. Conditions like temperature, dry air flow, and humidity were monitored to ensure proper preservation of the pixel modules. The boxes were open to begin hardware refurbishment in Spring 2021, and the pixel detector was lowered one half cylinder at a time via crane down the shaft to the CMS detector, where it was installed within 1.1mm precision with respect to the beampipe during Summer 2021.



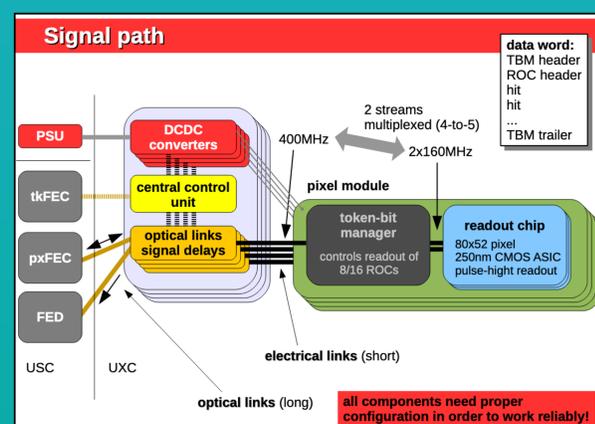
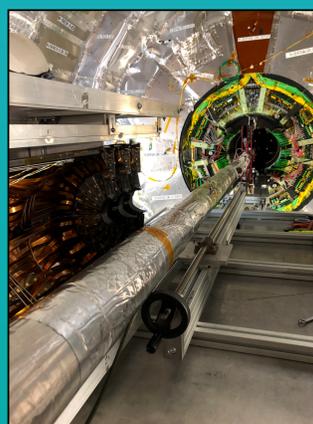
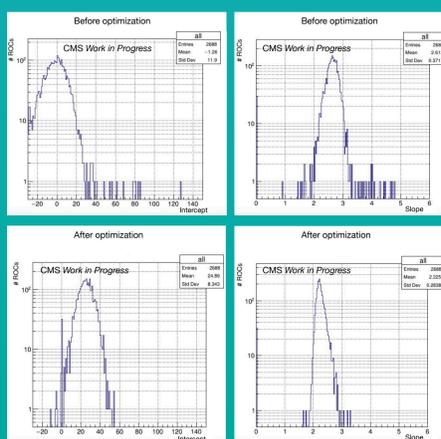
View from underground as part of the barrel pixels are lowered down the shaft of CMS.



One half cylinder of forward pixels partially inserted in CMS near the beampipe.

Commissioning and calibration

One example of a calibration is the pulse height optimization, which controls the conversion of the charge measurement seen by a pixel to an ADC value between 0 and 255. To take advantage of the full range of values, we expect an intercept greater than 0 and a small slope.



Outlook

The active detector fraction (>98%) is unchanged since Run 2. We have continued to fully calibrate the detector including timing settings during the pilot beam test and are prepared for a successful Run 3.

References

CMS Technical Design Report for the Pixel Detector Upgrade, 26 September 2012