A dedicated luminometer for CMS

The CMS Pixel Luminosity Telescope (PLT) was installed in the CMS experiment during the recent running period to measure the instantaneous luminosity at the highest energies and highest collision rates foreseen at the LHC. The installation of the PLT was a success! How to unify the response threshold for ~200k pixels:

1. Find an optimal sampling time for analogue telescope data output
   - Correct decoding of header and trailer information

2. Find correct address levels for every telescope
   - Equal setting and delay has to adjust to all telescope signals are found in the correct bunch crossing

3. Measure thresholds and adjust trimmed bits of every pixel to unify response to calibration charges
   - The threshold of a pixel is defined as the 50% point in the response efficiency towards an increasing calibration charge controlled by Vcal,
   - Measure all thresholds
   - Adjust trim bits to match thresholds over all pixels (Vcal 60 chosen as a target here)

4. Qualitative comparison of luminosity measurements done by HF, BCM and the PLT during a luminosity scan of the LHC

Unique mechanisms for a unique detector

The silicon sensors of the PLT need to be cooled to counter the negative effects of radiation damage. The PLT cooling and mechanical structure was manufactured in a novel production process called Selective Laser Melting (SLM). This process allows to create metal structures with complex geometries, thin walls and hidden voids or channels and is perfectly suited for small production batches. Printed as a single piece of titanium alloy, the cooling structure is built as a meandering tube of 2.5(+0.3)mm diameter.

The CMS Pixel Luminosity Telescope

The Big Day, Installation in CMS

Why does CMS need the PLT?

The PLT is the only sub-detector in CMS, whose sole purpose is to measure the delivered instantaneous luminosity. It must do this with a high precision and in real-time. The high precision is needed since the luminosity is an important ingredient in many physics measurements done at the LHC. For example, the measurement of the Higgs cross section. Simultaneously the luminosity measurements has to be directly available to the LHC operators to tune the beams according to CMS requirements.

What is the PLT? And how does it work?

The PLT is built using the same sensor and readout technology already used in the current CMS Pixel detector. Each detector is separated into 4 quarters. Each quarter or cassette is a separate structure that houses 4 telescopes, placed in a half circle around the beam pipe. On each side of CMS two quarters are placed at a distance of 1.75m from the interaction point (IP). The sensor pixel pitch is 150µm. The PLT is built using the same sensor and readout technology already used in the current CMS Pixel detector. The sensor calibration has to be done with a high precision and in real-time. The high precision is needed since the luminosity is an important ingredient in many physics measurements done at the LHC. For example, the measurement of the Higgs cross section. Simultaneously the luminosity measurements has to be directly available to the LHC operators to tune the beams according to CMS requirements.

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First data from collisions

On May 5th the LHC produced the first non-stable collisions at a beam energy of 4500GeV. This was the first time the PLT detector saw particles coming from the interaction point of CMS.

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Qualitative comparison of luminosity measurements done by HF, BCM and the PLT during a luminosity scan of the LHC

Track occupancy data from CMS

A Design overview of a PLT cassette equipped with a single telescope and a picture from the final detector quarter with all four telescopes and electrical connections in comparison..

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Frontier Detector for Frontier Physics – 13th Pisa Meeting on Advanced Detectors, May 24 – 30, 2015, La Biodola, Isola d’Elba (Italy)

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