

Electronics of LHCb calorimeter monitoring system

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All calorimeter sub-detectors in LHCb, the Scintillator Pad Detector (SPD), the Preshower detector (PS), the Electromagnetic Calorimeter (ECAL) and the Hadron Calorimeter (HCAL) are equipped with the Hamamatsu photomultiplier tubes (PMT) as devices for light to electrical signal conversion. The PMT gain behavior is not stable in a time, due to changes in the load current and due to ageing.

The calorimeter light emitting diode (LED) monitoring system has been developed to monitor the PMT gain over time during data taking. Furthermore the system will play an important role during the detector commissioning and during LHC machine stops, in order to perform tests of the PMTs, cables and FE boards and measurements of relative time alignment.

The aim of the paper is to describe the LED monitoring system architecture, some technical details of the electronics implementation based on radiation tolerant components and to summarize the system performance.

Summary

The main aim of the LHCb calorimeter light emitting diode (LED) monitoring system is to monitor the PMT gain in time of data taking with precision better than 0.5 %. The other important role of the system will be during the detector commissioning and testing in the LHC machine stops for PMT, cables and FE board tests and relative time alignment.

Each LED of the system illuminates up to 40 tubes and total amount of the monitoring channels is about 700. The electronics of the LED monitoring system consists of three functional parts. The 700 LED drivers with PIN diode and amplifier are used for illuminating tubes and monitoring the LED stability itself. The light emitting diodes are different for each sub-detector and optimized for the individual detector requirements. A subsystem for the LED intensity control allows a variation of the LED intensity across a wide range for the PMT linearity measurements. This subsystem includes 40 electronic boards. A LED Triggering Signal Board (LEDTSB) (a 9U VME module) is performing the LED triggering pulse control and distribution. Twelve LEDTSB boards are used for precise time adjustment of the calibration signals with respect to the calibration trigger signal.

The calorimeter monitoring system is placed on the detector in a radiation hard environment. The electronics has been designed taken into account this factor.

Main characteristics of the monitoring system are mentioned below:

- Precision of the PMT gain monitoring is about 0.3 %.
- Individual time setting for each LED in range of 300 ns with 1 ns step.
- PIN diode with amplifier is used for monitoring the LED stability itself.
- Control Logic FPGA is placed on a mezzanine card and equipped with radiation hard ACTEL pro-ASIC chip APA300.
- Memory of the scanning algorithm FPGA with 64 patterns of the output trigger signals allows perform all needed sequences for LED flashing.
- The calorimeter monitoring system is linked to the LHCb ECS system by the SPECS serial bus (developed in LAL).

Last year the LHCb calorimeter monitoring system is intensively used for detector commissioning and tested for getting the first data of this year.

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