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First years of running for the LHCb calorimeter system

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The LHCb experiment is dedicated to precision measurements of CP violation and rare decays of B hadrons at the Large Hadron Collider (LHC) at CERN (Geneva). It comprises a calorimeter system composed of four subdetectors: an electromagnetic calorimeter (ECAL) followed by a hadron calorimeter (HCAL). In addition the system includes in front of them the Scintillating Pad Detector (SPD) and Pre-Shower (PS). They are used to select transverse energy hadron, electron and photon candidates for the first trigger level and they provides the identification of electrons, photons and hadrons as well as the measurement of their energies and positions.

The calorimeter has been pre-calibrated before its installation in the pit, and the calibration techniques have been tested with the data taken in 2010. During operation, hadronic, leptonic and photon triggers of particular interest for hadronic B decays and radiative decays are provided by the calorimeter system.

The design and construction characteristics of the LHCb calorimeter will be recalled. Strategies for monitoring and calibration during data taking will be detailed in all aspects. Scintillating fibres, plastics and photomultipliers suffer from ageing due to radiation damage or high currents. Different methods which are used to calibrate the detectors and to recover the initial performances will be presented. The performances achieved will be illustrated in selected channels of interest for B physics.

Summary

The LHCb experiment is dedicated to precision measurements of CP violation and rare decays of B hadrons at the Large Hadron Collider (LHC) at CERN (Geneva) [1, 2]. LHCb is a single-arm spectrometer with a forward angular coverage from approximately 10 mrad to 300 mrad. It comprises a calorimeter system composed of four subdetectors [3], selecting transverse energy hadron, electron and photon candidates for the first trigger level (L0), which makes a decision 4μs after the interaction. It provides the identification of electrons, photons and hadrons as well as the measurement of their energies and positions. The set of constraints resulting from these functionalities defines the general structure and the main characteristics of the calorimeter system and its associated electronics. A classical structure of an electromagnetic calorimeter (ECAL) followed by a hadron calorimeter (HCAL) has been adopted. In addition the system includes in front of them the Scintillating Pad Detector (SPD) and Pre-Shower (PS), which are two planes of scintillating pads separated by a 2.5 radiation length lead sheet, aimed at tagging the electric charge and the electromagnetic nature of the calorimeter clusters for the first level of trigger. ECAL, PS and SPD account for about 6000 channels each with three degrees of granularity, concentric around the beam pipe, namely, the inner, the middle and the outer parts. HCAL is made of about 1500 channels and is divided into two parts only. All four detectors are arranged in pseudo-projective geometry and follow the general principle of reading the light from scintillator tiles with wave-length shifting fibers, and transporting the light towards photomultipliers, all following the 25 ns readout. During operation, hadronic, leptonic and photon triggers of particular interest for hadronic B decays and radiative decays were provided by the calorimeter system.

The calorimeter has been pre-calibrated before its installation in the pit, and each part of the calorimeter system follows a different strategy for calibration. The calibration techniques have been tested with the data taken in 2010 and have evolved to improve performances taking benefit of the high statistics recorded. Detector ageing are scrutinized regularly. They affect detector response and trigger rates but the severity of the

impact on data depends on the detector type and of its use. Calibration techniques are also used to compensate for these effects. Regularly, a precise calibration is derived from a large sample of pi0 from two separated photons. Short term effects are followed with electrons from conversion looking at the ratio of the deposited energy of the electron in the calorimeter to its momentum measured by the tracking system (E/p) in ranges of ˜40 pb-1. Initial performances of the electromagnetic calorimeter and its expected resolution are recovered for pi0 and B decays including photons.

The design and construction characteristics of the LHCb calorimeter will be recalled. Strategies for monitoring and calibration during data taking will be detailed in all aspects. Scintillating fibres, plastics and photomultipliers suffer from ageing due to radiation damage or high currents. Different methods which are used to calibrate the detectors and to recover the initial performances will be presented. The performances achieved will be illustrated in selected channels of interest for B physics.

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[1] LHCb Collaboration, The LHCb Detector at the LHC, JINST 3 S08005 (2008), and references therein.
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