ISSN: 1391-8796
Proceedings of 10th Ruhuna International Science & Technology Conference
University of Ruhuna, Matara, Sri Lanka
January 18, 2023

Measurement and reduction of noise of the front-end electronics of GE1/1 chambers for the CMS muon upgrade during mass production

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Gas Electron Multiplier (GEM) based chambers are used in the most forward and inner most layers of the Compact Muon Solenoid (CMS) detector to enhance the trigger performance during the High Luminosity phase of the Large Hadron Collider (HL-LHC). This phase of the experiment will be used to collect data for the physics program beyond the discovery of the Higgs Boson. The new GEM system has been designed to improve the triggering and tracking capability of CMS in this particularly harsh region during HL-LHC. To reach those objectives, each detector must be operated at acceptable electronics thresholds to ensure high detection efficiency of minimum ionizing particles (MIPs) (> 97%), while limiting the noise to maintain the Level-1 muon trigger rate at acceptable levels. This work aimed to study the noise at different stages of the final assembly of the chambers and to come up with a proper grounding scheme to keep the noise rates at a minimum level. The noise rates were measured against the threshold in each of the readout sectors using an Application Specific Integrated Circuit (ASIC). The measurement was repeated after the introduction of additional components, or whenever a variation was done on the grounding scheme with the intention of bringing down the already observed noise levels. The developed methods and techniques through this study, allowed the chambers with the final grounding scheme to be operated at thresholds of a maximum of $8fC$, which is favorable for data collection at CMS.

Keywords: CMS, GEM, Noise, Electronics

Acknowledgements: *CMS Collaboration and State Ministry of Skills Development, Vocational Education, Research & Innovation, Sri Lanka are acknowledged.*

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