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GE1/1 Sustained Operations Investigations

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Ten ”slice test”triple-GEM detectors were installed into the CMS endcap in 2017. Data was recorded in 2017-2018, using both cosmic ray muons and LHC collisions. During the slice test, a loss of VFAT2 input channels was observed, with two detectors exhibiting rapidly-increasing channel loss beginning mid-2018.

Concurrent investigations into the cause of the channel loss were launched, one
using the in-situ data from P5, the other seeking to recreate the loss in the controlled setting of an external lab. Results from each investigation, and the steps that were taken to prevent such loss in the future, will be reported.

Summary

In this contribution, we will present the results of the investigations into the sustained operation of the triple-GEM (gas electron multiplier) detectors of the GE1/1 system, which is planned for installation into the Compact Muon Solenoid (CMS) in 2019-2020 (LS2).

Ten ”slice test”detectors were installed into the CMS endcap in January 2017, as a proof of concept for the full GE1/1 system. These detectors are read out on the front end using 24 VFAT2 chips and a corresponding v2 optohybrid board, and from the back end utilizing a microTCA crate containing CTP7 and AMC13 boards. An additional two detectors were added in 2018, which represent the newer VFAT3-based design, which utilizes a split-GEB (GEM electronics board) and v3 optohybrid on the front end.

Data was recorded throughout the 2017-2018 runs, using both cosmic ray muons and LHC collisions. During the slice test, a loss of VFAT2 input channels was observed, with two detectors exhibiting rapidly-increasing channel loss starting from mid-2018.

Concurrent investigations into the cause of the channel loss were launched. One investigation used the in-situ data from P5, comparing the channel loss times with HV, LV, and current fluctuations, changes in magnetic field, and beam intensity. The other investigation sought to recreate the loss in the controlled setting of an external lab and examine four possible causes of the channel loss, including normal operation of the detector, improper operation of the detector, highly-ionizing background particles, and GEM foil discharges.

Results from each of these investigations, and the steps that were taken to prevent such channel loss in the future, will be reported in this contribution.

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