Background Study for the GE1/1 Detector in the CMS Experiment

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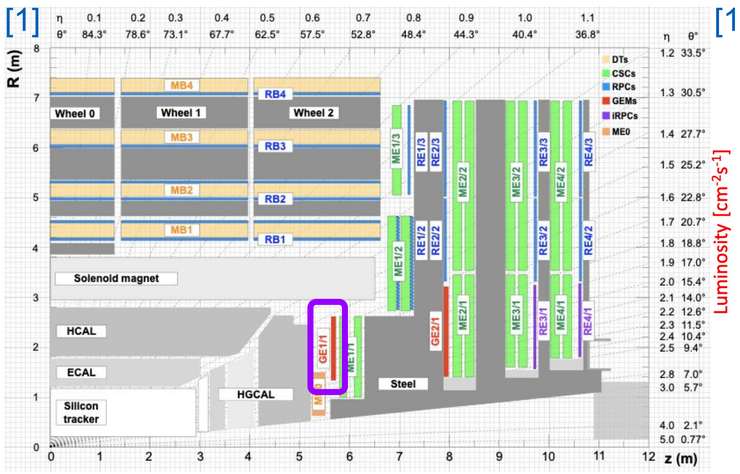
Introduction

- As a part of the CMS muon system upgrade, the installation of GE1/1 has been completed for Run 3 data taking
- The GE1/1 system is located in the forward region of the CMS endcap, and the interaction of beam creates a high radiation environment in this region
- Study of the background rate is important to understand the level of radiation damage
- The background rate on GE1/1 is also measured during the GE1/1 slice test in Run 2 and compared with the simulation

[1]



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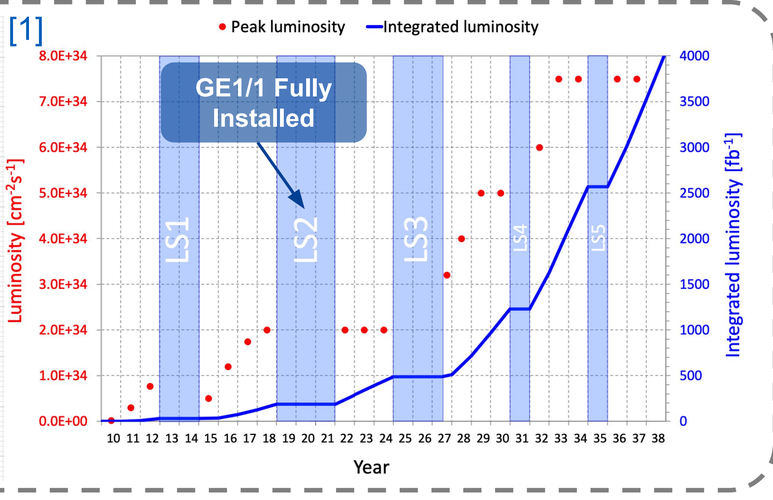
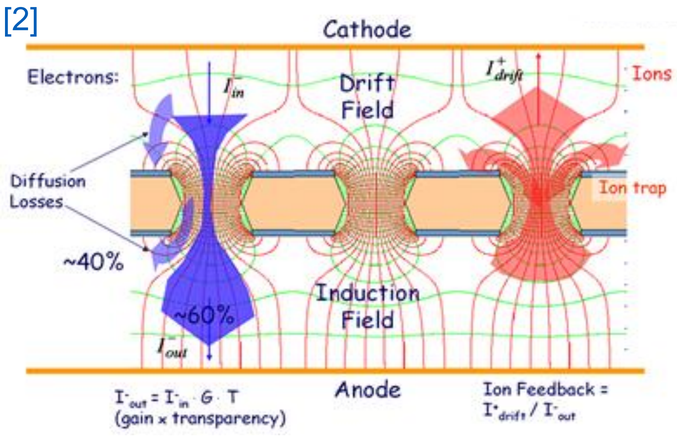
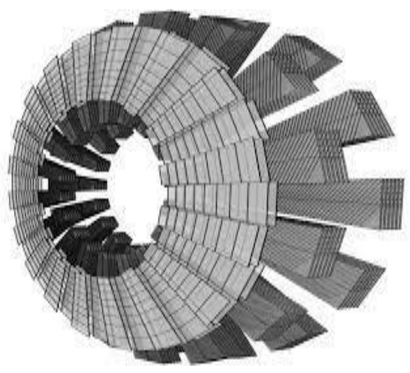


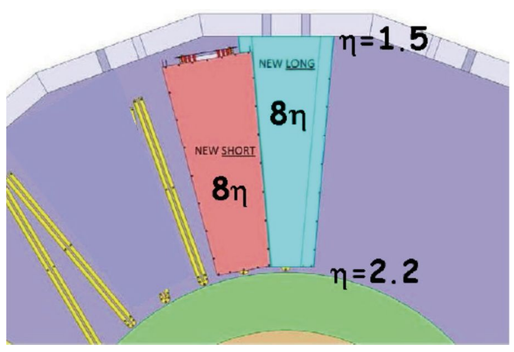
GEM

[2]



- Gas Electron Multiplier (GEM) Detector is a micro-pattern gaseous detector
- High voltage between both sides of the GEM Foils make an electric field in the holes which causes electron avalanches
- The GEM Detector chambers are installed at GE1/1, GE2/1, and ME0 of the CMS endcap, and GE1/1 consists with long chambers (even) and short chambers (odd)
- GE1/1 overview





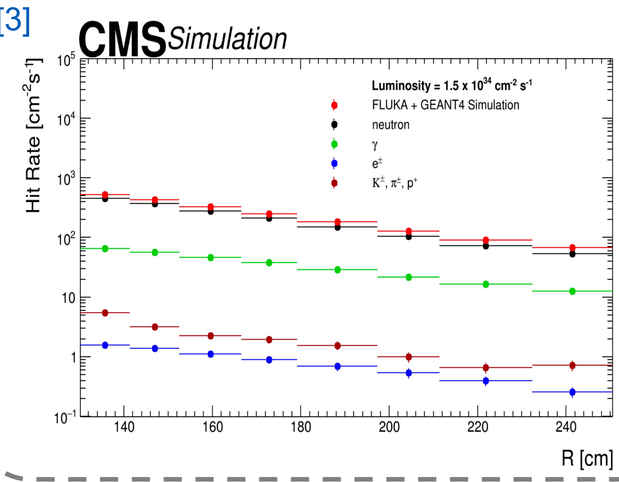
Background Rate

- We measure the background rate by analyzing the ZeroBias dataset, which consists of output recorded from randomly triggered bunch crossings
- The hit rate is calculated using the following formula:

$$\text{Hit rate } [\text{Hz} / \text{cm}^2] = \frac{\text{Number of hits}}{\text{Number of events} \times (8 \times 25\text{ns}) \times \text{Detector area}}$$

  - The GE1/1 detector records hits during 8 bunch crossings for each triggered event

[3]

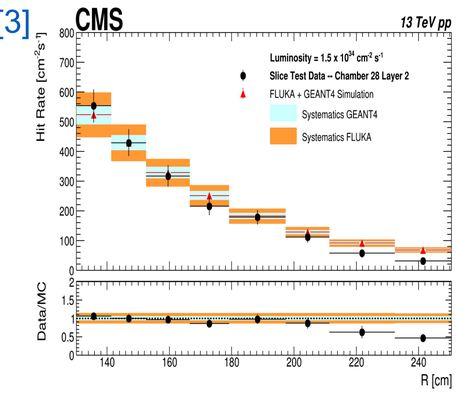


- The primary sources of the background rate include neutrons, photons, electrons (positrons), Kaons, pions, and protons
- The impact of muons is very low (~ O Hz / cm²)

Result

- Background rate in Run 2
  - The background rate for the GE1/1 slice test data was also measured
  - Hit rate was measured as a function of the Instantaneous luminosity for each eta partition of chamber 28 layer 2
  - Hit rate was measured as a function of the distance from beam line (R) at L = 1.5 x 10^{34}cm^{-2}s^{-1}. This value is obtained from the fitted line of the Instantaneous luminosity versus hit rate plot

[3]



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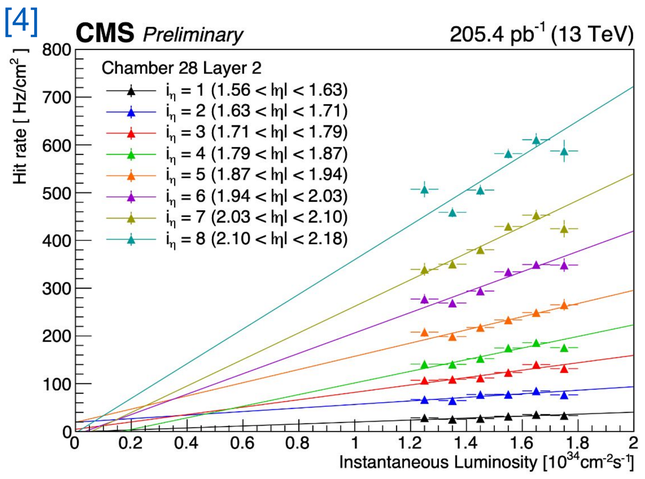
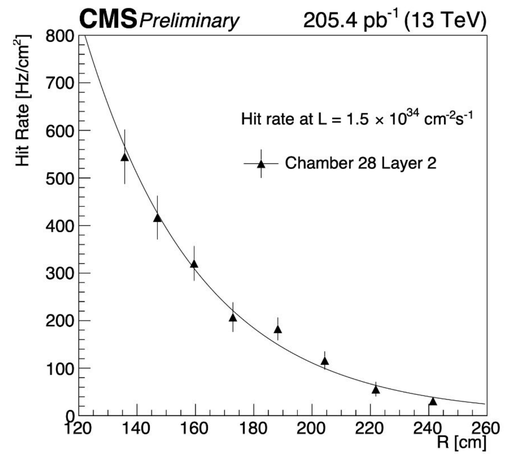
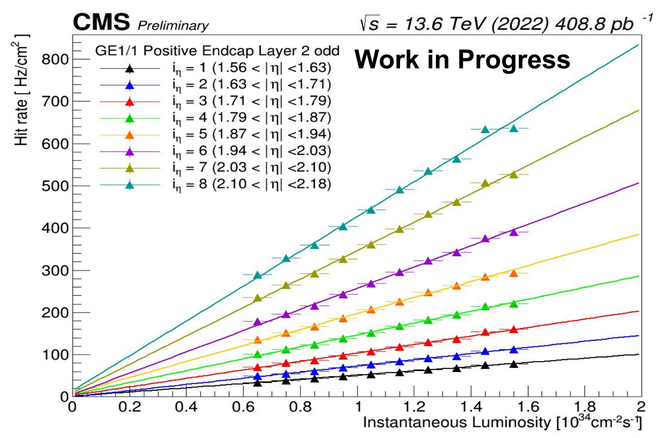
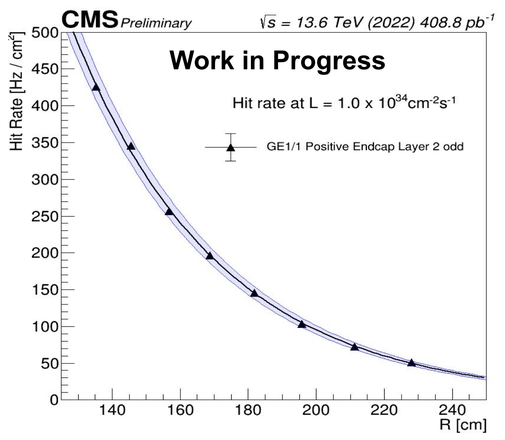




- Background rate in Run 3
  - The background rate is shown as a function of Instantaneous luminosity and distance from beam line (R) at L = 1.0 x 10^{34}cm^{-2}s^{-1}
  - Data used in this study is recorded at a center-of-mass energy of 13.6 TeV





Summary

- The background rate of the fully installed GE1/1 detector in the CMS was measured using data from Run 3 (2022)
- There is good agreement with the Run 2 slice test measurement and the simulation

References

[1] Thomas Hebbeker and Andrey Korytov. The Phase-2 Upgrade of the CMS Muon Detectors. 9 2017.
[2] F.Murtas. *GEMINI project.* accessed 09 April, 2023, https://web.infn.it/GEMINI/index.php/component/content/article?id=2:scientific-program
[3] M. Abbas et al. Benchmarking LHC background particle simulation with the CMS triple-GEM detector. JINST, 16(12):P12026, 2021.
[4] M. Abbas et al. Performance of a triple-GEM demonstrator in pp collisions at the CMS detector. JINST, 16(11):P11014, 2021.

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