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Performance of triple-GEM detectors for the Phase-2 CMS upgrade and a high-resolution GEM telescope measured in a test beam

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In view of the LHC Phase-2, the CMS experiment is being upgraded with three stations of triple-GEM detectors (GE1/1, GE2/1 and ME0) to maintain the excellent trigger pT resolution of its muon spectrometer in the high-luminosity LHC environment and extending its coverage to the very-forward pseudorapidity region $2.4 < |\eta| < 2.8$. The challenges faced for adapting the triple-GEM technology to a large-area detector have required the introduction of innovations such as discharge protection, an optimized GEM foil segmentation, and the development of complex front-end electronics. The CMS GEM detectors have been tested for the first time under beam irradiation in their final design with their complete front-end electronics and data acquisition software in Fall 2021 at the CERN North Area, with the goals of demonstrating the operation of their full readout chain, measuring their efficiency and space resolution under intense beam irradiation, and verifying the operating principle of a novel foil sectorization. We describe the setup of the test beam, made of a GE2/1 detector and a second-generation ME0 detector and completed by a high-space resolution beam telescope made of four 10x10 cm2 triple-GEMs. We discuss the preparation of the full DAQ chain, made by the VFAT3 front-end ASIC, an OptoHybrid front-end FPGA and a custom back-end made of a commercial FPGA (CVP-13), all operated with the final CMS GEM acquisition software. We report on the performance of both the large-area detectors and the tracker, measured with muons and pions.

Collaboration

CMS

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