

GEM Detectors for the CMS Endcap Muon System: status of three new detector stations

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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 p_T 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 a 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 2021 and 2022 at the CERN North Area, with the goal 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 10×10 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, and present the performance of both the large-area detectors and the tracker measured with muons and pions.

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