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Upgrade of the CMS Muon system with triple-GEM detectors: performance of the GE1/1 station and detector design and testing of the ME0 station

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The High-Luminosity LHC (HL-LHC) will deliver proton-proton collisions at 5 to 7.5 times the nominal LHC luminosity, with an expected number of 140 to 200 pp-interactions per bunch crossing. To maintain the performance of muon triggering and reconstruction under high background, the forward part of the muon spectrometer of the CMS experiment will be upgraded with Gas Electron Multipliers (GEM) and improved Resistive Plate Chambers (iRPC) detectors. A first GEM station (GE1/1), covering about 50m², was installed during the Long Shutdown 2 (LS2, 2019–2021). Its operation and performance during Run 3 (2022–2025) is described. A second 6-layer station (ME0), covering about 60m², will extend the pseudo-rapidity coverage of the muon system from $|\eta| < 2.4$ to $|\eta| < 2.8$ and will be installed behind the new high-granularity calorimeter (HGCAL) during the third Long Shutdown (LS3, 2026–2028). ME0 will be exposed to a background rate up to 150 kHz/cm² and it required several design modifications. The design and performance under test with beams and irradiation at the GIF++ facility of a prototype 6-layer stack is discussed, and demonstrates that the prototype can operate in the challenging conditions of HL-LHC. The current status of the production and quality control is presented and shows the readiness for installation in 2027.

Primary experiment

CMS collaboration

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