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Quality Control of Mass-Produced GEM Detectors for the CMS ME0 Muon Upgrade

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The series of Large Hadron Collider upgrades, culminating in the High-Luminosity Large Hadron Collider, will significantly expand the physics program of the Compact Muon Solenoid (CMS) experiment. However, these upgrades will also create more challenging experimental conditions, affecting detector operations, triggering, and data analysis [1]. During Run 3, the LHC is designed to achieve an integrated luminosity of approximately $150 - 300 fb^{-1}$ per experiment. In terms of instantaneous luminosity, the LHC is expected to operate with a luminosity of up to $2 * 10^{34} cm^{-2} s^{-1}$, and will be at least $5 - 7.5 * 10^{34} cm^{-2} s^{-1}$ when the High Luminosity Large Hadron Collider is completed for Run 4. These conditions will affect muon triggering, identification, and measurement, which are critical capabilities of the experiment.

To address these challenges, additional muon detectors are being installed on the CMS endcaps, based on gaseous electron multiplier technology. In 2019, 161 were installed with the GE1/1 station. We are now working on the ME0 upgrade, which will be installed in 2026. The assembly and quality control of ME0 detectors is distributed to several production centers around the world (CERN, PKU and Frascati). The quality control procedures to standardize the performance of the detectors and the status of ME0 production is presented. The quality controls: Component acceptance, Foil leakage current, Module gas leakage, high voltage (HV), gas gain and uniformity, HV stability, electronics test/validation and Chamber cosmic-stand ensure that the project achieves a high success rate.

[1] Abbas, M., et al. (2022). Quality control of mass-produced GEM detectors for the CMS GE1/1 muon upgrade. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1034, 166716. https://doi.org/10.1016/j.nima.2022.166716

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