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## Charge particle detection performance of large area triple-GEM detectors for the forward muon upgrade of the CMS detector

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Gas electron multiplier (GEM) technology is being proposed for the forward muon upgrade of the CMS detector for the Phase 2 of the CERN LHC. The proposed prototypes for CMS upgrade, referred to as GE1/1 detectors, are large-area trapezoidal shaped detectors using three GEM-foils arranged in the 3/1/2/1mm gap configuration with 3072 radial readout strips segmented over 24 readout sectors in the  $(\eta, \phi)$ -plane. Here  $\eta$  is taken as the pseudorapidity defined as  $\eta = -\ln(\tan(\theta/2))$ ; with  $\theta$  being the polar angle and  $\phi$  is taken as the azimuthal angle. The GE1/1 system will be located on the CMS endcap; it will add redundancy and improved trigger momentum resolution, in the  $1.6 < |\eta| < 2.2$  range, to the CMS forward muon system. The charged particle, muons and mixed hadron beams, detection performance of GE1/1 detectors is studied at beam lines supplied by the CERN Super Proton Synchrotron. The experimental setup consists of multiple small triple-GEM detectors, featuring two-dimensional Cartesian readout strips for track reconstruction, and between three and five, depending on the run period, large GE1/1 detector prototypes. Detection efficiencies and time response measurements are made as a function of the gain of the GE1/1 detectors with both Ar:CO<sub>2</sub> (70:30) and Ar:CO<sub>2</sub>:CF<sub>4</sub> (45:15:40) gas mixtures. For the latter the measurements are also repeated as a function of the Cartesian strip pitch. The measured detector performance properties are found to be suitable for the CMS forward muon upgrade.

**Primary author:** Prof. DAVIES, Gavin (Imperial College London)

**Presenter:** Dr GRUCHALA, Marek Michael (CERN)

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