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GEM single-mask characterization and influence of GEM foil orientation

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The Gas Electron Multiplier (GEM) technology is used in CMS muon detectors to amplify the electronic charge left after the crossing of a particle. The GEM structure consists of a thin polyimide foil, coated with copper on both sides and perforated with a high density of microscopic holes. Several GEM foils can be associated together with a dedicated stretching structure to form the GEM detectors. The geometry of the holes and their uniformity over the detector define the performance of the detectors.

The upgrade of the CMS muon end-cap with GEM detectors, referred as GE1/1 project, requires the production of large GEM foils (up to 120 cm long) which can only be achieved by transferring the hole pattern using a unique mask on one side of the substrate. The so-called single-mask technique has been optimized during the last years to approach a perfect bi-conical shape obtained with the standard double-mask photolithography. However, a significant geometrical asymmetry is still present between the bottom and the top holes, which tend to be 20% larger in diameter.

The single-mask characterization performed by the CMS muon group aims to evaluate experimentally the single-mask asymmetry and to determine the influence of the GEM foil orientation in triple-GEM structures. A series of tests including effective gain, charging up and rate capability measurements have been conducted with a special prototype with three single-mask GEM foils (in both orientations) and with a standard set of double-mask foils for comparison.

The results have been compiled in order to define the most appropriate configuration for the large GE1/1 chambers, ensuring the best performance at lower supplied voltage.

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