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Novel technique for large GEM-foils production the "Random Segmentation"; Simpler production method with higher GEM detector performances

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Production of large-size Gaseous Electron Multiplier (GEM) [1] foils, relay on the multiple sectorization of the electrode for the High Voltage distribution; typically, with sector size of about 100 cm2.
The GEM sectorization allow for reduction of the capacitance between the two side of the foil, quenching consequently the energy released in the discharge events, moreover even in the extreme case of destructive high voltage breakdown causing a permanent short sectorization make only a small fraction (one sector) to fail.
Sectorization is realized stripping the conductive layer (typically copper) deposit on the base material, polyimide, between two sectors patterned with the GEM holes, reverting in an insulation region. The insulating region never overlap the gem hole to avoid irregularities on the HV distributions which could make the GEM foils unstable. The stripping process relies on lithography and chemical etching process which, on large GEM foils, require nontrivial alignment process. The insulating strips usually not less than 200 um wide, which directly affect the detector performance with efficiency drops in the corresponding areas.
Resuming an old GEM manufacturing idea [2,3,4], we investigated a new design of GEM-foil sectorization with a random alignment between the hole pattern and the sector gap. Such alternative design is a promising solution also in terms of manufacturing of large area foils, as this technique does not require a precise alignment of the sector gap with the hole pattern.

The authors will describe the recent R&D phases currently ongoing on triple-GEM detector prototypes, mounting a double-sided random segmented GEM-foils based on the single-mask photolithography technique. Detectors with different sizes have been designed and assembled to prove the stability and performance of random sectorization compared with those obtained with the traditional blank insulating gaps. Results from beam tests, proving the higher detector performance with respect to the traditional sectorization method are also presented.

[1] F. Sauli, GEM: a new concept for electron amplification in gas detectors, Nucl. Instrum. Meth. A 386 (1997) 531.
[2] C. Altunbaset al, NIMA 490(2002)177
[3] M. Zigler, PhD Thesis, Development of a triple GEM detector for the LHCb Experiment, CERN-THESIS-2004-006
[4] F. Brunbaueret al, NIMA 875 (2017) 16

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