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Multi-layer Thick GEM (M-THGEM): New MPGD structure for high gain operation at low pressure

The operating principle and performances of a novel micro-pattern gaseous detector concept, the Multi-layer Thick Gaseous Electron Multiplier (MTHGEM), will be discussed. Inspired by the multi-cascade Thick Gaseous Electron Multiplier, The M-THGEM detector is made of a single, robust assembly comprising of several THGEM elements stacked together. The M-THGEM is produced by multi-layer printed-circuit-board (PCB) technique, consisting of mechanical drilling of alternate layers of copper and core material (i.e., FR-4, Kapton, Kevlar, ceramic etc.) laminated together. The electron avalanche processes occur along the successive multiplication stages within the M-THGEM holes, under the action of strong dipole fields resulting from the application of suitable potential differences between the electrodes.

We will report on the performance investigation of two different geometries: a two-layer M-THGEM (either as single or double-cascade detector) and a single three-layer M-THGEM element, tested in various low-pressure gas mixtures. The intrinsically robust confinement of the avalanche volume within the M-THGEM holes provides an efficient reduction of the photon-induced secondary effects, resulting in a high-gain operation over a broad pressure range, even in pure elemental gas. The operational principle, main properties (maximum achievable gain, long-term stability, energy resolution, etc.) under different irradiation conditions, as well as capabilities are presented and discussed.

Finally we will discuss potential applications of the M-THGEM, which include high-gain operation at low pressure such as for heavy-ion tracking/triggering, as well as operation in pure noble gas, such as needed for time projection chamber readout in active target mode. Other potential applications may include large-area UV photon detectors, muon trackers, hadron calorimetry, X-ray/neutron imaging, and secondary scintillation readout for rare event physics.

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