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OPERATION OF HYBRID MICROPATTERN GASEOUS DETECTOR IN LOW-PRESSURE HYDROGEN, DEUTERIUM AND HELIUM, FOR ACTIVE-TARGET TIME PROJECTION CHAMBER APPLICATIONS

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In view of a possible application as a charge-particle track readout for an Active-Target Time Projection Chamber (AT-TPC), the properties of a hybrid Micro-Pattern Gaseous Detector (MPGD) were investigated in pure low-pressure Hydrogen (H2), Deuterium (D2) and Helium (He).

The detector consists of a MICROMesh GAseous Structure (MICROMEGAS) coupled to a single-, or double-cascade Thick Gaseous Electron Multiplier (THGEM) as a pre-amplification stage. The advantages of combined THGEM and Micromegas structures lies on one hand on the extended thickness of the multiplication region within the THGEM holes, several times larger than the mean free path of the avalanche electrons even at low pressure, which allows stable operation conditions and relative high effective gain. On the other hand, a position-sensitive charge-readout based on Micromegas provides excellent spatial resolution (crucial for a precise and wide-range kinematics reconstruction), and it is extremely versatile: for instance, different gas gains for different pad positions may be achieved by increasing or decreasing the anode pad potential individually, providing a large dynamic range over a large active area.

We will present and discuss the study of the effective gain dependence of the hybrid-MPGD on pressure (in the range of 100-760 torr) for different detector arrangements, long-term gain stability, ion-back flow, and energy resolution from tracks of 5.5 MeV alpha particles. In pure Helium (He), stable operational conditions and maximum achievable gains of 10^4-10^7 have been demonstrated at pressure ranging from 100 torr up to 760 torr. An energy resolution of 2.4% for 5.5 MeV alpha tracks was obtained at a pressure of 350 torr. In hydrogen (H2) and Deuterium (D2), maximum achievable gains above 10^4, from single photoelectrons avalanche, were achieve for a pressure of 200 torr and above; for lower pressure the maximum gain was limited to a value of around 10^3.

The results of this work are relevant in the field of avalanche mechanism in low-pressure, low-mass noble gases, in particularly for applications of MPGD end-cap readout for active-target Time Projection Chambers (TPC) in the field of nuclear physics and nuclear astrophysics.

Primary author: Dr CORTESI, Marco (National Superconducting Cyclotron Laboratory (Michigan State University))

Co-authors: Prof. STOLZ, Andreas (National Superconducting Cyclotron Laboratory (Michigan State University)); Prof. DANIEL, Bazin (National Superconducting Cyclotron Laboratory (Michigan State University)); Mr YURKON, John (National Superconducting Cyclotron Laboratory (Michigan State University)); Dr BECEIRO-NOVO, Saul (National Superconducting Cyclotron Laboratory (Michigan State University)); Prof. MITTIG, Wolfgang (National Superconducting Cyclotron Laboratory (Michigan State University))

Presenter: Dr CORTESI, Marco (National Superconducting Cyclotron Laboratory (Michigan State University))

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