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First Directional Neutron Recoil Results from a 1 m^3 scale SF6 TPC Vessel with a Coupled MMThGEM-Micromegas Readout

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Directional Dark Matter (DM) detection, with low pressure gaseous Time Projection Chambers (TPCs), is seen as a viable means for confidently probing below the neutrino fog, for instance in searches planned by CYGNO and the CYGNUS collaboration. Negative Ion Drift (NID) gases like SF6 are essential for reducing drift phase charge diffusion. However, it is notoriously difficult to produce significant charge avalanches in these gases. Recent results from a novel two stage Multi-Mesh Thick Gaseous Electron Multiplier (MMThGEM) have shown that with careful design and optimisation of such a gain charge device, sub 10^5 gas gains can be achieved. This offers an order of magnitude improvement in what was previously considered possible with such a gas. We present results in low pressure SF6 with the MMThGEM, operating as a gain stage device, coupled to a Micromegas readout plane including: gas gain measurements with 55Fe x-rays, a 2D alpha track reconstruction algorithm and neutron recoil measurements in a small test vessel. Finally we present nuclear recoil results in a large 1 m^3 scale detector volume, termed the BENTO vessel, along with supplementary SRIM and SREM simulation results. These results successfully demonstrate the MMThGEM as a gain stage device with a full scale NID target volume.

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