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Charge Amplification in Sub-atmospheric CF₄, SF₆, Helium Mixtures

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Low pressure gaseous Time Projection Chambers (TPCs) are a viable technology for directional Dark Matter (DM) searches and have the potential for exploring the parameter space below the neutrino fog. Gases like CF₄ and SF₆ are advantageous because they contain Fluorine which is predicted to have heightened elastic scattering rates with a possible Weakly Interacting Massive Particle (WIMP) DM candidate. The low pressure of CF₄ and SF₆ must be maintained, ideally lower than 100 Torr, in order to elongate potential Nuclear Recoil (NR) tracks which allows for improved directional sensitivity and NR/Electron Recoil (ER) discrimination. Recent evidence suggests that He can be added to heavier molecular gases, like CF₄ and SF₆, without significantly affecting the length of ¹²C, ¹⁹F, and ¹⁶S recoils due to its lower mass. Such addition of He has the advantage of improving sensitivity to lower mass WIMPs. Simulations can not reliably predict operational stability in these low pressure gas mixtures and thus must be demonstrated experimentally. In this paper we investigate how the addition of He to low pressure CF₄ and SF₆ affects the gas gain and energy resolution achieved with a single Thick Gaseous Electron Multiplier (ThGEM) and a multistage MMThGEM.

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