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STUDIES ON ELECTRON SWARMS AND STREAMER DISCHARGES IN ECO-FRIENDLY RPC GASES

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Abstract. In this work, we study the transport of electrons and the propagation of streamers in resistive plate chambers (RPC). We are considering the performance of new eco-friendly gas mixtures instead of the currently used $C_2H_2F_4$ and SF_6.

Resistive plate chambers are gaseous particle detectors often used for timing and triggering purposes in high-energy physics experiments. At the Large Hadron Collider (LHC) at CERN, all key experiments, including ALICE, ATLAS, CMS and LHCb employ RPC detectors. RPCs in these experiments are operated with gas mixtures in which the main component is $C_2H_2F_4$. $C_2H_2F_4$ is mixed with i-C_4H_{10} and SF_6 in various percentages, to control the amount of liberated charge and the occurrence of violent discharges. However, $C_2H_2F_4$ and SF_6 are characterized by high global warming potentials. In this work, we study the performance of new eco-friendly RPC gas mixtures. The $C_2H_2F_4$ is replaced with a proper mixture of $C_3H_2F_4$ and CO_2, while CF_3I, C_4F_7N and $C_5F_{10}O$ were considered as alternatives to SF_6. We approach the problem at three stages: (1) First, we propose complete and consistent sets of cross sections for $C_3H_2F_4$ and strongly attaching gases, including CF_3I, C_4F_7N and $C_5F_{10}O$, (2) Second, we investigate the transport of electrons in various eco-friendly gas mixtures, and (3) Third, we simulate the inception and propagation of streamers in LHC-like conditions. Swarm analysis was performed using pulsed-Townsend measurements of swarm data, numerical solutions of Boltzmann's equation, and Monte Carlo simulations. The inception and propagation of streamers were simulated using the classical fluid model, which involves the drift-diffusion approximation and local field approximation. The model is implemented in 3D setup within the AMReX environment.

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