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Towards Eco-Friendly gas solutions for Resistive Plate Chambers: A sustainable alternative to SF_6

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The Resistive Plate Chambers (RPC) are gaseous detectors with excellent timing performance used for muon triggering in LHC experiments. They operate using a gas mixture of C2H2F4/i-C4 H10/SF6, which allows their operation in avalanche mode, essential for high-luminosity collider experiments. This mixture provides optimal gas density, low current, and a large separation between avalanche and streamer modes, ensuring high efficiency, rate capability, and longevity. The gas mixture has a high Global Warming Potential (GWP), due to C2H2F4 (GWP˜1450, being the GWP of CO2=1) and SF6 (GWP˜22400). Since both gases are no longer recommended for industrial use, their availability will gradually reduce, making the search for an alternative gas mixture an urgent priority. The most challenging component to replace is the SF6, which acts as streamer suppressor, enabling RPC operation at low currents, essential for high rate capability. In this study, the SF6 is replaced with the Chloro-Trifluoropropene, C3H2ClF3 (GWP˜ 1). The performance of the RPC detector, including efficiency, streamer probability, and time resolution, has been evaluated at high γ-irradiation rates, simulating conditions expected at the High Luminosity LHC and future colliders. The status of the aging campaign conducted on these environment-friendly gas mixtures is also presented. Additionally, the feasibility of using a gas mixture in future experiments with GWP=10 by replacing both C2H2F4 and SF6, has been explored.

Primary experiment

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