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Towards Eco-Friendly gas solutions for Resistive Plate Chambers: A sustainable alternative to SF₆

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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-C₄H₁₀/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 (GWP¹⁰⁰1450, being the GWP of CO₂=1) and SF₆ (GWP¹⁰⁰22400). 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 (GWP¹⁰⁰1). 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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