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In-beam performance of a Resistive Plate Chamber operated with an eco-friendly gas mixture

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ALICE (A Large Ion Collider Experiment) studies the quark-gluon plasma (QGP), a deconfined state of nuclear matter which can be obtained in ultra-relativistic heavy-ion collisions. One of the key probes for QGP characterization is the study of quarkonia and open heavy flavour production, of which ALICE exploits the muonic decay. In particular, a set of Resistive Plate Chambers (RPCs), placed in the forward rapidity region of the ALICE detector, is used for muon identification purposes.

The correct operation of these detectors is ensured by the choice of the proper gas mixture. Currently they are operated with a mixture of $C_2H_2F_4$, i-C_4H_{10} and SF_6 but, starting from 2017, new European Union regulations have enforced a progressive phase-out of $C_2H_2F_4$, because of its large Global Warming Potential (GWP), making it difficult and costly to purchase. Moreover, CERN asked LHC experiments to reduce greenhouse gases emissions, to which RPC operation contributes for about 80% of the total.

A possible low-GWP alternative for $C_2H_2F_4$ is the $C_3H_2F_4$ (diluted with other gases, such as CO_2), which has been extensively tested using cosmic muons; few promising gas mixtures have been devised and next crucial steps are their detailed in-beam characterization as well as the study of their performance under increasing background irradiation.

This contribution will describe the methodology and results of a series of beam tests carried out at the CERN Gamma Irradiation Facility (equipped with a high activity 137Cs source and muon beam) with an ALICE-like RPC prototype, operated with several mixtures with varying proportions of CO_2, $C_3H_2F_4$, i-C_4H_{10} and SF_6, in the framework of the RPC EcoGas@GIF++ Collaboration. Results on absorbed currents, efficiencies, prompt charges, cluster sizes, time resolutions and rate capabilities will be presented, both from digitized (for shape and charge analysis) and discriminated (using the same front-end electronics employed in ALICE) signals.

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