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Searching for an eco-friendly gas mixture for the ALICE Resistive Plate Chambers

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Resistive Plate Chambers (RPCs) are gaseous detectors with parallel plate geometry and resistive electrodes, widely employed at the LHC. In ALICE (A Large Hadron Collider Experiment) 72 RPCs are installed in the forward muon spectrometer and provide muon identification.

The ALICE RPCs are operated with a mixture of 89.7% $C_2H_2F_4$, 10% i-C_4H_{10} and 0.3% SF_6. $C_2H_2F_4$ and SF_6 are fluorinated greenhouse gases (F-gases) with a high Global Warming Potential (GWP). New European Union regulations have imposed a progressive phase-down of the production and usage of F-gases, aiming to cut down their emission by two thirds in 2030 with respect to 2014.

Even though research activities are excluded from these regulations, the F-gases phase-down will inevitably increase their price and CERN is also aiming to cut down on its emissions. For these reasons it is crucial to find a more eco-friendly gas mixture for RPCs by the LHC long shutdown 3, foreseen in 2026. Since $C_2H_2F_4$ is the main contributor to the mixture's GWP an extensive R&D process has started to replace it with tetrafluoropropene ($C_3H_2F_4$), due to its chemical similarity with $C_2H_2F_4$ and its low GWP (around 7). Laboratory studies have shown promising results in terms of detector performance and the next step is to study the long term behavior of RPCs operated with these new gas mixtures (aging studies). Since this is a subject of interest for all the LHC experiments, a collaboration, ECOgas@GIF++, was setup to carry out joint studies. Among others,
small-size, ALICE-like RPCs were installed at the Gamma Irradiation Facility at CERN, where they are exposed to a strong radiation field, coming from a 14 TBq ^{137}Cs source, which allows one to simulate many years of operation in a relatively short time. The facility also provides a muon beam in specific times of the year, which can be used to study the detector performance (e.g. efficiency and cluster size) during and after irradiation.

This poster will report the current status of the measurements, focusing on the preliminary results of the irradiation campaign and of beam tests carried out in 2021.

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