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Green transition of Resistive Plate Chamber detectors for HEP applications

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Resistive Plate Chamber (RPC) are gaseous detectors widely employed in High Energy Physics experiments. Thanks to their comparatively low cost and excellent timing and positioning performance, they are used to cover large detection areas, such as those needed by the muon trigger systems of the LHC experiments (RPCs are currently employed in ALICE, ATLAS and CMS and they are also being considered for the LHCb upgrade II).

The gas mixture employed in RPCs plays a crucial role in their correct operation. Currently the gas mixture mainly in use consists of 95.2% C₂H₂F₄, 4.5% i-C₄H₁₀ and 0.3% SF₆. While this grants an optimal detector response, it also poses environmental issues. Indeed C₂H₂F₄ and SF₆ are classified as fluorinated greenhouse gases (GHGs) with a high Global Warming Potential: on a 100 year time-scale, they are around 1400 and 22800 times that of CO₂ respectively.

Starting from 2015, new European Union regulations ((EU) 517/2014) have imposed a progressive phase-down of GHGs production and usage, aiming at significantly reducing the amount of GHGs placed on the market by the year 2030. This will inevitably lead to a price increase and a reduction in the availability of those gases. CERN has adopted a GHGs usage reduction policy and RPC detectors are especially affected, since their operation contributes to roughly 80% of the total GHGs consumption at CERN.

This talk will give an overview of the second CERN environment report, especially for what concerns RPC operations during LHC Run 1 and 2. It will also discuss the strategies that have been adopted so far to reduce GHGs emission at CERN, focusing on the efforts of the RPC ECOgas@GIF++ collaboration, born in 2019 as a joint effort among RPC experts of the LHC experiments and the CERN detector technology (EP-DT) group. Indeed, all these groups have started to separately look for suitable eco-friendly gas mixtures where C₂H₂F₄ has been substituted with one of its industrial alternative, namely HFO-1234ze, and CO₂ in different concentrations. The work of the collaboration is focused on performing in-depth gas mixture characterization as well as the study of the long-term stability of detector operation. The main results obtained from these studies will also be summarized.

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