Studies of R134a and SF6 alternative gas mixtures for HPL and Glass RPC detectors for High Energy Physics Applications

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Resistive Plate Chamber (RPC) detectors used in CERN LHC experiments are operated with a freon-based gas mixture that contains R134a and SF6, both of which are greenhouse gases (GHG) with a very high global warming potential. The objective of this study is to investigate new eco-friendly gas mixtures that are compatible with the current CERN RPC systems, maintaining good detector performances, and reducing operational costs. Specifically, the addition of various concentrations of CO_2 as a substitute of $C_2H_2F_4$ is explored.

First, the detector is characterized with cosmic muons to evaluate efficiency, current, streamer probability, prompt charge, cluster size and time resolution. Then, the RPC performance is assessed at the CERN Gamma Irradiation Facility, which allows the simulation of the background radiation experienced in the LHC experiments using a 12 TBq 137Cs source and a muon beam. A long-term irradiation campaign started in January 2023, together with ATLAS and CMS RPC groups. The aim is to evaluate the RPC performance with the CO_2-based gas mixtures under irradiation and over time by continuously monitoring the ohmic and physics currents, as well as the other parameters at muon test beam.

Regarding the reduction of GHG emissions resulting from SF6 contribution, the case of the Glass RPC (GRPC) is considered. These detectors employ high concentrations of SF6 so it is worth to look for alternatives, such as 3M Novec 4710. Results on detector performance with this new alternatives will be presented for both High Pressure Laminate and Glass RPCs.