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Performance studies of RPC detectors with new environmentally friendly gas mixtures in presence of LHC-like background radiation

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Resistive Plate Chamber (RPC) detectors are widely used at the CERN LHC experiments as muon trigger thanks to their excellent time resolution. They are operated with a gas mixture containing $C_2H_2F_4$ and SF_6, both greenhouse gases (GHG) with a very high global warming potential (GWP). The search of new environmentally friendly gas mixtures is necessary to reduce GHG emissions and costs as well as to optimize RPC performance. Several recently available gases with low GWP have been identified as possible replacements for $C_2H_2F_4$ and SF_6. In particular,
HFO-1234ze has been studied as a possible replacement for $C_2H_2F_4$ and
several gases like Novec fluoroketones, C_4F_8O and CF_3I were tested as a replacements of both
$C_2H_2F_4$ and SF_6. More than 60 environmentally friendly gas mixtures have been investigated on 2 mm single-gap RPCs. The RPC detectors have been tested in laboratory conditions and a selected mixture was tested at the CERN Gamma Irradiation Facility (GIF++), which provides a high energy muon beam combined with an intense gamma source allowing to simulate the background expected at HL-LHC. The performance of RPCs were studied at different gamma rates in a presence of muon beam by measuring efficiency, streamer probability, rate capability, induced charge, cluster size and time resolution. To finalize the studies, the RPCs are now operated under gas recirculation with the selected new gas mixture and exposed to the intense gamma radiation of GIF++ for evaluating possible long-term aging effects, gas damage due to radiation and compatibility of LHC gas system with new gases.

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