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Studies on RPC detectors operated with environmentally friendly gas mixtures in LHC-like conditions

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RPC detectors are largely employed in LHC experiments thanks to their excellent trigger efficiency, time performance, and contained production costs. They are operated with 90-95% of R-134a, 5%-10% of isobutane and 0.3% of SF6. R-134a and SF6 are nowadays known to be greenhouse gases, with a GWP of 1430 and 22800 respectively, therefore subjected to European regulations aiming at reducing their availability on the market. The CERN gas group has adopted several strategies to reduce greenhouse gases, among which the use of alternative gases for RPC detectors was identified. Several low GWP gases were identified as possible alternatives to R-134a and SF6. First, the detectors were tested in laboratory conditions with cosmics muons. Different gas mixtures were tested by evaluating detectors performances in terms of currents, efficiency, streamer probability, prompt charge, cluster size and time resolution. Few selected gas mixtures were then used to test RPCs performance in the presence of a muon beam and high gamma background rate at CERN GIF++.
RPCs were tested by adding up to 30-40% of He or CO2 to the standard gas mixture and up to 500 Hz/cm2 gamma counting rates. Few gas mixtures based on the addition of R-1234ze combined with R-134a and He or CO2 were also tested to investigate possible GWP reductions.
Several alternatives to SF6 were evaluated: C4F8O, CF3I, Novec 5110, Novec 4710 and Amolea 1224yd. For some of these gases, preliminary results showed similar performance to the SF6-based gas mixture.
A fluoride measurement campaign was also started to investigate the F- production of different gas mixtures at different gamma rates.

Collaboration

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