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

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Resistive Plate Chambers at LHC

Alternatives to R-134a: tests with cosmics muons
-  R-1234ze as main R-134a alternative
  - Cannot be replaced 1:1, working point too high
  - Around ~70% of CO2 needed to achieve w.p.
  - When used with CO2, R-1234ze shows higher currents than the R-134a equivalent mixture

Alternatives to R-134a: tests in LHC-like conditions
- SF6 could be substituted by Novec 4710 or Amolea 1224yd
- Addition of R-134a helps stabilizing performances in terms of currents and streamers when evaluated at rates > 400 Hz/cm²

Conclusions
- Addition of CO2 or He required to lower w.p. when using HFO in the gas mixture
- He usage is still a matter of concern in LHC caverns: CO2 is preferable
- Higher concentrations (> 30-40%) of CO2 increases streamer contamination and currents
- Novec 4710 and Amolea 1224yd tested with muon beam and gamma rate (~ 500 Hz/cm²)
  - Novec 4710 shows excellent performances at 0.1%
  - Amolea tested at 0.5% to 0.3% shows higher working point and higher currents

Freons molecules breaking under high electric field and gamma irradiation → F- ions produced
F- combines with H2O → HF formation
HF is an aggressive compound which may damage RPC inner surface
- Further investigations needed to understand its impacts on RPCs

Laboratory tests
- 10% of CO2 lowers of 200 V and 10% of He of 600 V
- Novec 4710 and Amolea 1224yd: good performances at 0.3%
- Amolea tested at 0.5% shows significant current increase when working point ~ 250 V

LHC-like condition tests
- Same applies for He
- HFO shows higher currents than R-134a
- Streamer probability and cluster size are comparable

Results
- At fixed irradiation: F- linear with Currents
- F- production depends on the internal efficiency of the chamber
- HFO is breaking 10 times more easily than R-134a

Rate @ w.p.
- Addition of CO2 or He required to lower w.p. when using HFO in the gas mixture (10% of CO2 lowers of 200 V and 10% of He of 600 V)
- He usage is still a matter of concern in LHC caverns: CO2 is preferable

 gotta do it