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Strategies for reducing the environmental impact of gaseous detector operation at the CERN-LHC experiments

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The emission of greenhouse gases is becoming an important subject for the design of future particle detectors and the operation of the present experiments. The particle physics detector community has already demonstrated to be sensitive to this topic at the design level: indeed, most of the gas systems recirculate the mixture injected.
Contributions from R134a, CF4 and SF6 dominate the overall emission in terms of CO2 equivalent. Presently, gas mixture re-circulation and recuperation of gases from the exhaust mixture are the main strategies for reducing the environmental impact of particle detection activities. However, as long term prospective, also the use of less invasive gases should be investigated.
The present contribution describes preliminary tests performed with a new recently developed Freon (R1234yf) and results obtained during operation of a large LHC detector system with recuperated CF4.
The R1234yf has proposed as a replacement for R134a as a refrigerant in automobile air conditioners. In fact, R1234yf has a 100 year GWP (Global-Warming Potential) of 4, to be compared with 1430 being the 100 year GWP of R134a. Unfortunately, R1234yf is at the moment about 25 times more expensive than the currently used R134a.
A small replica of a new gas mixer and recirculation system has been prepared for monitoring basic parameters like efficiency, pulse charge, streamer probability as well as long term performances of two Resistive Plate Chambers (RPC) detectors.
Firstly, the new R1234yf Freon was analysed with gas chromatographic and mass-spectrometer techniques. Subsequently, the gas system (mixer and recirculation) was tuned according to the new gas parameters. At the moment of writing, tests for the characterization of the detector performances and the evaluation of purifiers' performances are ongoing.
A CF4 recuperation plant based on warm separation was developed in the past few years for a LHC-CSC (Cathode Strip Chamber) detector system using Ar-CO2-CF4 mixture. It is based on CO2 bulk separation through membrane, CO2 residual separation with 4 Å molecular sieve and final CF4 adsorption in 13X molecular sieve. The recuperation plant allows reducing the CF4 emission by more than a factor two. About 70 m3 have been recuperated during 2012 operation; however, the recuperated gas was never used since the risk of affecting the detector performances during data taking was considered too high. Now, the LHC-Long Shutdown 1 (where there is not data taking) offers the opportunity to test the effect of injecting the recuperated gas. Gas mixture composition and detector performances will be monitored all along the test with gas chromatograph, infrared analyser and dedicated detector monitoring.

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