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Optimization of the closed loop gas system for the Resistive Plate Chamber operation at the Large Hadron Collider experiment

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Resistive Plate Chambers (RPCs) thanks to their high time resolution (~1 ns), a suitable space resolution (~1 cm) and the low production cost (~25 €/m2) are widely employed for the muon trigger system at the Large Hadron Collider (LHC) experiments where they are covering a surface of about 4000 m2 (16 m3 of gas volume) both in ATLAS and in CMS. The large detector volume and the use of a relatively expensive gas mixture make a closed loop circulation unavoidable. However, at the LHC experiments, RPCs are expected to operate in a high background environment, a condition in which a large amount of impurities (potentially dangerous for long term operation) have been observed in the return gas. Several cleaning agents are currently in use in order to avoid accumulation of impurities in the closed loop circuit. We present the results of a systematic study for the characterization of each cleaning agent. During the test, several RPCs were operated at the CERN Gamma Irradiation Facility (GIF) in a high radiation environment in order to observe the production of the RPC typical impurities: mainly fluoride ions, other molecules of the Freon group and hydrocarbons. The polluted return gas was sent to several cartridges each containing a different cleaning agent. The effectiveness of each material was studied using gas chromatography and mass-spectrometry techniques. Results of this test have revealed a possible optimized configuration that is now under validation. In the presence of radiation, RPCs work well with a relatively high flow rate, equivalent to 0.5-1 volume changes per hour. A finite element simulation study has, therefore, been commend in order to understand and eventually optimize the gas flow distribution inside the RPCs.

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