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Performance and longevity of ATLAS RPCs with new lower GWP mixtures

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Resistive Plate Chambers (RPCs) are critical components of the muon systems of most HL-LHC experiments. Until 2023, all HL-LHC RPC systems used a so-called standard mixture, consisting of 95.7% $C_2H_2F_4$ (R134a), 5% i-C_4H_{10}, and 0.3% SF_6, highly tuned for RPC performance but having very high global warming potential (GWP). Environmental impact and increasing difficulty in procuring this type of fluorinated gases imposes to pursue a solution for the long-term experiment's plans, such as a new mixture having a lower GWP and preserving, as well, the detector performance and longevity. In the last 2 years, ATLAS muons are pursuing such strategy, by progressively replacing TFE (GWP: 1300) with CO_2 (GWP:1), and validating the choice with extensive aging tests performed on realistic ATLAS RPC prototypes. This led ATLAS to be the first experiment replacing the RPC gas mixture in July 2023 with a new mixture, where 30% of TFE has been replaced with CO_2; the ATLAS RPC system behavior has been since then studied carefully, to spot in vivo any eventual sign of accelerated aging. More challenging perspectives, presently under validation, prior to apply them in the experiment, include a further reduction of TFE to 40%, and a lowering, or a total replacement of SF_6, which GWP (23500) is extremely high. We will present the experience of this 2-year long study, including the results of one full HL-LHC year of the ATLAS RPC system with the new gas.

Primary experiment

ATLAS Muon Spectrometer

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