Contribution ID: **170** Type: **Poster**

Study of environment-friendly gas mixtures for the Resistive Plate Chambers of the ATLAS phase-2 upgrade

Friday, 31 May 2024 15:35 (1 minute)

The standard gas mixture for the Resistive Plate Chambers (RPC), composed of C2H2F4/i-C4H10/SF6, allows the detector operation in avalanche mode, as required by the high-luminosity collider experiments. The gas density, the low current and the comfortable avalanche-streamer separation guarantee high detection efficiency, rate capability and slow detector ageing. This gas mixture has a high Global Warming Potential (GWP~1430) mainly due to the presence of C2H2F4 . The C2H2F4 and SF6 are not recommended for industrial uses anymore, thus their availability will be increasingly difficult over time and the search for an alternative gas mixture is then of absolute priority within the RPC community. Moreover, CERN is pursuing a campaign toward the reduction of these gases, because they represent most of the LHC particle detectors greenhouse gas emission. Within the ATLAS experiment, the search for an environment-friendly gas mixture involves both the legacy system and the new generation of RPC detectors foreseen for the HL-LHC. In the latter case, the choice of the gas mixture is critical because the thin gas gap width, 1 mm, needs a high-density gas in order to achieve high efficiency, due to the less active target available for the primary ionization. The mixture should also guarantee good timing performance and ensure the detector longevity. The results obtained on an upgrade production chamber operated with alternative gas mixtures are shown, following two different approaches. The first study consists in the replacement of the C2H2F4 with a mixture of C3H2F4/CO2 (GWP ~ 200). The second approach consists in adding a modest fraction of CO2 in the standard gas, with the aim to reduce the C2H2F4 emissions and avoid critical impact on the detector ageing. A comprehensive study of the active target, thus efficiency, is given, along with the time resolution and current in different background irradiation environment.

Collaboration

ATLAS Muon

Role of Submitter

The presenter will be selected later by the Collaboration

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Session Classification: Gas Detectors - Poster session

Track Classification: T6 - Gas Detectors