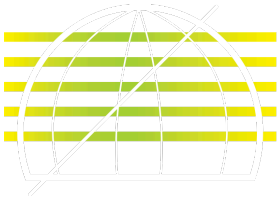

RPC 2022

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On a new environment-friendly gas mixture for Resistive Plate Chambers

Wednesday, 28 September 2022 09:25 (25 minutes)

The standard gas mixture for the Resistive Plate Chambers (RPC), composed of $C_2H_2F_4$/i-C_4H_{10}/SF_6, allows the detector operation in avalanche mode, as required by the high-luminosity collider experiments. The gas density, the low total charge delivered inside the gas and the comfortable avalanche-streamer separation guarantee high detection efficiency, rate capability and slow detector ageing.
The standard RPC gas mixture is mostly based on Hydrofluorocarbons, HFCs, extensively used in the refrigeration industry. The Hydrofluorocarbons are now considered to be non-eco-friendly gases for their high Global Warming Potential (GWP). The SF_6 has the largest GWP, 22900, but, due to its low concentration, it contributes only with few tens of units to the total value. The major contribution comes from the main standard gas mixture component, the $C_2H_2F_4$ (GWP $\sim$ 1300). This gases are not recommended for industrial uses anymore, thus their availability will be increasingly difficult over time and the search for an alternative gas mixture with low-GWP is then of absolute priority within the RPC community.
In this presentation we report the performance of the RPC working with new environment-friendly gases with low GWP which could replace the standard mixture. In this work the standard mixture main component, the $C_2H_2F_4$, is replaced by a proper mixture of CO_2 (GWP = 1) and Tetrafluoropropene ($C_3H_2F_4$, GWP$\sim$6). The other high-GWP component, the SF_6, is replaced by a new molecule, the Chloro-Trifluoropropene ($C_3H_2ClF_3$, GWP $\sim$ 5) never tested in the RPC detectors. The mixtures studied have a total GWP $\sim$ 10.
We report, for several eco-gas mixtures, the detection efficiency, streamer probability, electronic and ionic charge as a function of the high voltage. Moreover the timing properties are studied and the detector time resolution is measured.
We also focus the attention on a new category of signals having intermediate properties between avalanche and streamer, called “transition events”. This category is negligible for the standard gas mixture but relevant for HFO/CO_2-based gas mixtures.
We show a direct comparison between SF_6 and $C_3H_2ClF_3$ to study in depth the possibility to replace an industrially very important molecule like SF_6.

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