

# Mitigating Emissions in Gaseous Particle Physics Detectors: CO<sub>2</sub> as an Eco-Friendly Alternative for RPC Detectors

Wednesday, 22 May 2024 12:33 (1 minute)

High-Pressure Laminate Resistive Plate Chamber (HPL-RPC) detectors are a type of gaseous detector that identifies particles using a mixture of greenhouse gases (GHG) consisting of 95.2% C<sub>2</sub>H<sub>2</sub>F<sub>4</sub> (R-134a), 4.5% i-C<sub>4</sub>H<sub>10</sub>, and 0.3% SF<sub>6</sub>. Notably, the high Global Warming Potential (GWP) of this mixture results in the HPL-RPC detectors being one of the main contributors to CERN's emissions. To fulfil its environmental objectives, CERN has emphasised the need to reduce the emissions from these detectors. One strategy implemented by the gas group is to look into the search for alternative eco-friendly gas mixtures for RPC's use.

After extensive mixture characterisation studies in the laboratory, test beam campaigns, and ongoing ageing tests, the addition of CO<sub>2</sub> to reduce R-134a consumption was found to maintain experimental parameters such as efficiency, time, and spatial resolution while reducing the CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emissions. The results from the 2023 data acquisition campaigns and ageing tests will be presented in the following.

Our results demonstrate the potential of introducing CO<sub>2</sub> to reduce the amount of R-134a, which has a lower GWP than the usual gases used in the RPC mixture. We proposed the addition of 30% CO<sub>2</sub> and 1% SF<sub>6</sub> as an effective solution for reducing emissions. Additional fine-tuning, such as increasing the CO<sub>2</sub> percentage to 40% or reducing the SF<sub>6</sub> amount to 0.5%, which can further reduce emissions, will be presented. Other lower-GWP gases are also being investigated.

The mixture has been successfully validated and is now in use in the ATLAS experiment, resulting in a commendable 15% reduction of emissions. This represents a significant step forward in our collective efforts to mitigate emissions in the particle physics research community. The adoption of this solution can impact our environmental footprint, instilling motivation for further developments.

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**Session Classification:** Poster Session & Lunch