

Advancements in Resistive Plate Chambers: CMS Operations, Longevity, and the Shift Toward Sustainable Gas Mixtures

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Resistive Plate Chambers (RPCs) are a cornerstone of the Compact Muon Solenoid (CMS) Muon System, providing robust, redundant tracking and fast triggering capabilities at the energy frontier. Following 15 years of continuous operation, the CMS RPC system has maintained exceptional stability during LHC Run 3, achieving an active channel fraction consistently above 95% with negligible detector-related downtime. As the High-Luminosity LHC (HL-LHC) era approaches, requiring detectors to sustain unprecedented background rates up to 200 Hz/cm^2 and integrated charges of 840 mC/cm^2 , extensive longevity campaigns at the CERN Gamma Irradiation Facility (GIF++) have successfully certified the existing architecture for prolonged operation.

Concurrently, tightening European Union mandates to reduce greenhouse gas emissions necessitate a critical ecological transition for gaseous particle detectors. This talk explores the multi-tiered strategies employed by CMS to phase out fluorinated gases (F-gases) characterized by high Global Warming Potential (GWP), detailing the operational performance of alternative CO_2 -blended mixtures and novel chlorinated hydrofluoroolefins (HCFOs). The presentation highlights broader future perspectives for the technology, including autonomous gas-tight sealed glass-RPCs for cosmic-ray muography and the extreme tracking requirements envisioned for the Future Circular Collider (FCC).

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