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Technological Challenges and Electronics Development for the ALICE 3 RICH Detector

Content

The ALICE experiment will undergo a major upgrade (ALICE 3), in which a new generation of detectors will be designed and built from scratch to incorporate emerging technologies and achieve significantly improved performance [1]. Development efforts toward these detectors started several years ago to ensure their readiness for installation around 2035 [2].

Mexican researchers are contributing to the development of the Ring-Imaging Cherenkov (RICH) detector for the ALICE 3 upgrade, designed to "extend the particle identification to transverse momenta out of reach for the outer TOF detector" [2]. The current RICH design consists of 11 rings, each containing 44 modules (18 cm $\times$ 17 cm). Every module integrates approximately 5376 silicon photomultipliers (SiPMs) for the detection of Cherenkov radiation produced in an aerogel radiator. In total, the detector comprises about 2.6 million channels that must be read out, processed, digitized, and transmitted using standard communication protocols, generating data rates of up to 4.96 Tb/s.

The front-end electronics are based on the DENEB ASIC, currently under development, which will be capable of reading up to 1024 SiPMs simultaneously. In addition, reducing the SiPM dark count rate requires operation at temperatures near –40 °C, demanding efficient heat extraction from the system. The high-density integration of SiPMs, the radiation environment in which the detector will operate, and the associated thermal constraints make the module design a significant technological challenge requiring multidisciplinary expertise.

This work presents an overview of the ALICE 3 RICH detector, its main technological challenges, and the current status of the electronics integration and cooling system development.

[1] https://indico.cern.ch/event/1639916/contributions/6899253/attachments/3215122/5727585/ACC-PM-MS-0004_5_0.pdf

[2] https://arxiv.org/pdf/2211.02491

Summary

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