Towards a SiPM-based Ring Imaging Cherenkov detector at CBM: Desing and characterization of an 8×8 SiPM array.

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Abstract:

The Compressed Baryonic Matter experiment (CBM) at the Facility for Antiproton and Ion Research (FAIR) shall address studying the hadronic phase diagram at high densities and moderate temperatures. Several particle detectors compose the CBM, including a Ring Imaging Cherenkov (RICH) counter. The CBM's RICH has two detection cameras made of H12700 Multi-Anode Photomultipliers (MAPMTs), two spherical glass mirrors as focusing elements, and a CO2 radiator gas. The main drawbacks of MAPMTs are sensitivity to external magnetic fields, low granularity, low photo-detection efficiency, modest mechanical robustness, and high operation voltages. Nowadays, RICHs are moving towards new photo-detection technologies to explore more accurate timing, spatial and amplitude resolutions. Silicon photomultipliers (SiPMs) measure light intensities down to single photon-level with picosecond timing precision, with photo-detection efficiencies reaching up to 50% and magnetic field immunity. However, SiPMs' disadvantages such as temperature dependency and high dark count, make their implementation challenging on RICH detectors. We present the design, implementation, and characterization of an 8×8 SiPM (AFBR-S4N66P024M) array adapted to the CBM's RICH readout electronics. The array front-end consists of a pre-amplification stage with low power consumption (12 mW/channel), high linearity, and low cost. In addition, we analyze the performance of a novelty coincidence-based trigger system for RICH cameras under free-streaming that reduces signal pollution due to dark counts. In this, a majority voting system applied to a narrow coincidence window (∼ns) initiates the trigger signal when a Cherenkov Ring impinges the photo camera.