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Mirror System and Mirror Alignment Monitoring of the CBM RICH Detector

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This poster presents the progress of the mechanical design, mirror properties and mirror alignment monitoring system of the Ring Imaging Cherenkov (RICH) detector for the Compressed Baryonic Matter (CBM) experiment at FAIR.

CBM is designed to explore the phase structure of strongly interacting matter at high net-baryon densities and moderate temperatures via heavy-ion collisions in the energy range $\sqrt{S_{NN}}$ = 2.9–4.9 GeV. A key observable for the anticipated first order phase transition or even critical point is the electromagnetic radiation from the dense system. Electron identification will be performed in day-1 setup of CBM with a large RICH detector followed by a transition radiation detector (TRD). The RICH detector will use CO2 as radiator gas allowing for electron-pion separation up to 6-8 GeV/c.

The mirror system consists of 80 individual mirror tiles mounted onto an aluminum structure. A simulation was conducted to verify the mechanical stability of the mirror wall. Additionally, a full-scale pillar prototype was constructed and tested. Furthermore, the optical quality and reflectivity of mirror tiles with various coatings were measured. Silicone glue is used to attach circular plates to the back of the mirrors to connect them to the frame. Measurements confirmed that this technique does not introduce measurable mirror deformations.

The RICH is planned to be regularly exchanged with the MUCH detector using a crane. This carries the risk of mirror misalignment. This misalignment must be detected and accounted for during reconstruction to ensure correct ring diameters, locations and thus ring-track matching. Simulation and beam studies have shown that a misalignment of 1 mrad can be tolerated; beyond that value, the RICH-STS track matching quality deteriorates. We intend to use the CLAM (Continuous Line Alignment and Monitoring) method, originally developed for the COMPASS RICH-1.

The CLAM system consists of a grid of reflective stripes, cameras and LEDs for illumination. By observing the mirror image of the reflective grid using cameras, the misalignment of individual tiles can be detected and measured. An optical simulation of the CLAM system is used to determine suitable locations for the components within the CBM-RICH. The mirror tile rotations are determined by simulating the image with misalignment and optimizing for maximum overlap between the measured image and the simulation. The performance of the method is investigated with a focus on the permissible tolerances of component locations and camera intrinsics.

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