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Integration Concept of the CBM Micro Vertex Detector

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The Micro Vertex Detector (MVD) is the first downstream detector of the fixed-target CBM experiment at the future Facility for Antiproton and Ion Research (FAIR). It enables high-precision tracking of low-momentum particles in direct proximity of the target, e.g., the first out of four planar stations is placed only 8 cm downstream the interaction point. Thus, minimizing the material budget while operating the dedicated CMOS (MAPS) pixel sensors called MIMOSIS in the moderate target chamber vacuum is challenging. Each detector plane will feature a material budget x/X0 ranging between 0.3 and 0.5%. The harsh radiation environment of up to 7 · 1013 neq/cm2 and 5 Mrad per CBM running year poses challenging constraints on the choice of technology and materials, and in particular on the sensors. Stable sub-0° C operation to maintain high detection efficiency and low fake rate is mandatory.

The baseline integration technique relies on integrating the large-area (31.15×17.25 mm2) thinned (50 µm) pixel sensors onto planar carriers of Thermal Pyrolytic Graphite (TPG, 380 µm, ~ 1500 W/m · K). The carriers provide both mechanical support and superior thermal conductivity inside the geometrical acceptance. They are mounted to actively cooled aluminum heat sinks outside the acceptance. The sensors are wire-bonded to dedicated thin flex cables which are fed into front-end boards mounted on the heat sinks inside the vacuum. Providing seamless active pixel coverage inside the geometrical acceptance per MVD plane calls for the - vacuum-compatible - integration of sensors on both sides of each TPG carrier. With up to 28 individual sensors per carrier the mechanical integration yield of the sensors is, accordingly, of concern and challenging.

This contribution will present the detector and sensor integration concept, elaborating on the selection and preparation of materials, dedicated assembly procedures and quality assessment steps. Carriers made of TPG feature pros (outstanding heat conductivity and price) as well as cons (surface quality and softness) and we will present solutions developed during prototyping recommending employing this material in high-precision vertex trackers operated in vacuum.

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