Mechanical Integration of the CBM MVD Prototype*

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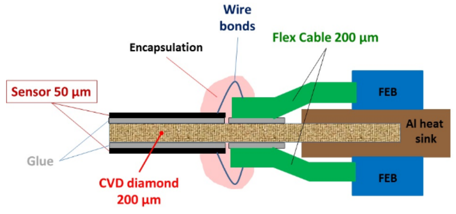
The need of prototyping and characterizing the CBM-Micro Vertex Detector (MVD) motivated the construction of an ultra-low mass, high precision detector setup comprising several stations. This setup aims at validating the detector concept (Figure 1 a) and selected technologies. The setup - one double-sided and four single-sided stations - was successfully tested at CERN SPS in November 2012.

Geometry

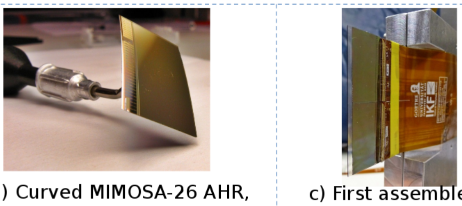
Served by a customized data acquisition for the sensor read-out, each station contains two (single-sided station) or four (double-sided station) $50\ \mu$m thick thinned CMOS sensors (MIMOSA-26 AHR [1]). The sensors are glued to $200\ \mu$m thin CVD diamond [2] carriers which provide at the same time a mechanical support and efficient heat evacuation. The setup allows for different distances between the single-sided stations, for different incident angles of the beam to the double-sided station, and for temperature cycling in a range between $-20\,^\circ$C and $+20\,^\circ$C. The double-sided station - the ultra thin, stand alone tracking device with a material budget of $0.3\%X_0$ - represents the prototype and is closest to the MVD geometry. Its active sensor area covers $1/4$ of the active sensor area of the final detector. However, the relative position of the front- and back-side sensors focus on stand alone tracking (rather than on maximum acceptance). The four single-sided stations are serving as reference system also demonstrating the scalability of the read-out system. In contrast to the double-sided station, the CVD diamond carriers of the single-sided stations provide cut-outs in the major part of the active area of the sensors to achieve a minimum material budget for reference system of $0.053\%X_0$ per station.

Integration methods and tools

The integration of the $50\ \mu$m thick thinned sensors calls for dedicated customized pick-up and positioning tools. The mechanical and thermal connection between the sensors and their carriers is realized with a low viscosity glue E501 - from Epotency. The thickness of the deposited glue has been evaluated to be less than $50\ \mu$m. The electrical connectivity between a dedicated FlexPrint-Cable (based on copper-traces [3]) and the sensors is established via wire bonding. The wire bonds were encapsulated with Sylgard 186 - a soft, silicon-based elastomer - to be protected against mechanical damage while handling.

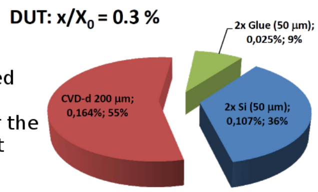


a) Cross-sectional view on the micro-vertex tracker



b) Curved MIMOSA-26 AHR, 50 µm thin

c) First assembled micro-vertex tracker



d) Achieved material budget for the active part

Figure 1: Mechanical integration - overview

Results

For the first time, a detector station in a **double-sided** arrangement was realized with two $50\ \mu$m thick thinned sensors glued on each side of a $200\ \mu$m thin CVD diamond carrier, see Figure 1 c). The active area of the sensors is chosen to be overlapping to allow for mirco-tracking with a fixed distance forming a double-sided, ultra thin tracking device with a thickness of $0.3\%X_0$, Figure 1 d).
The reference stations provide precision tracking with a minimum material budget of $0.053\%X_0$ per station.
The preliminary analysis of the recorded data results a spatial resolution of the double-sided station of $< 4\mu$m with a detection efficiency $> 99.8\%$.

References

[1] MIMOSA-26, DOI: 10.1016/j.nima.2010.03.043.

[2] T. Tischler et. al , GSI Scientific Report 2010.

[3] C. Schrader et. al , GSI Scientific Report 2011.

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