The CBM-MVD: Progress in Mechanical Integration *

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This report summarizes the activities undertaken towards the construction of the Micro Vertex Detector (MVD) of the Compressed Baryonic Matter (CBM) experiment.

Quality assurance of 50 μm thin PRESTO sensors: Thinned MIMOSA-26 sensors will be used for assembly the so called PRESTO module. PRESTO addresses the double-sided integration of 15 MIMOSA-26 sensors (dummies and working sensors) onto a 8×8 cm^2 CVD diamond support (see [1] for more details). Sensors will be connected with the R/O system by means of a newly designed ultra-low material budget flex cable employing commercially available processes based on copper traces [2]. Constructing the PRESTO allows to estimate the integration yield providing that the employed sensors are tested prior to assembly. Up to now, 18 MIMOSA-26 AHR sensors thinned to 50 μm were probe tested using the setup described in [3]. The setup allows testing the standard operation modes of the sensor as well as measure the fixed pattern and temporal noise by the means of so called s-curves. 12 sensors were found without a significant number of dead/noisy pixels; they were qualified as fully operational. Four sensors exhibiting some dead rows/columns were marked as faulty. The two remaining sensors were not operational due to a power supply short (one sensor) and problems while powering one out of the four MIMOSA-26 sub-matrices. The estimated yield was then of about 65% which is in agreement with expectations for this type of sensors [4]. The temporal noise was found to be of about 1.6-1.8 mV and the fixed patter noise of about 0.5-1.0 mV. This is by factor of 2-3 higher than the noise specified by a sensor provider. This was nevertheless as expected since the sensor power signals were generated outside the probe card. The addressed probe tests allowed also to establish test procedures required for non-destructive tests of thinned CMOS sensors and can be applied for testing the final MVD sensors.

Development of a custom made glue: An ”ideal” adhesive for the integration of the sensors onto their supports should be easy to dispense in a thin and uniform layer—calling for a low viscosity—, radiation hard as well as flexible (to compensate for the thermal expansion mismatches between the sensor and their support material) within the temperature range foreseen for the operation of the MVD sensors. Since there are none ”on-shelf” products that meet these requirements, a custom-made, two compound adhesive with a working name RAL-247 was manufactured at the Rutherford Appleton Laboratory (RAL), Composites and Materials Testing Group, UK. The glue features a glass temperature of -45 °C, a viscosity of below 100 mPa·s and a curing time of 48 h at +50 °C. To investigate its radiation hardness, RAL-247 samples were irradiated with X-rays to 100 Mrad and to a proton dose of about 10^{15} n_{eq}/cm^2. The irradiated samples were sent to RAL for further Dynamic Mechanical Analysis tests which unraveled no significant change of properties [5] that confirms the expected radiation hardness at the range of radiation doses expected at the MVD.

Development of the heat sinks for the MVD: The operation of the MVD in vacuum requires a continuous cooling of the sensors to limit radiation induced defects as well as noise. To keep the material budget of the individual MVD station as low as possible, the cooling approach of the MVD employs highly thermal conductive sensor support materials (CVD diamond [6] and encapsulated high performance graphite) in the acceptance of the MVD and actively cooled aluminum-based heat sinks outside of this area. To evaluate the cooling concept and its vacuum compatibility, half-station heat sinks of the first three MVD stations were manufactured at COOLTEK GmbH. The heat sinks incorporate a buried cooling pipe and have thermally been simulated prior their manufacturing using a worst case scenario for the sensor power dissipation plus an additional safety factor of four. These heat sinks are currently being evaluated under laboratory conditions focusing on their vacuum compatibility [7]. The heat dissipation of the MVD sensors is provided by kapton insulated flexible heaters from OMEGA Engineering, INC.

References

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