Quality assessment of ultra-thin CMOS sensors for the Micro Vertex Detector of the CBM experiment at FAIR.*

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The future Compressed Baryonic Matter experiment (CBM) will be equipped with a high-precision micro-vertex detector (MVD) aiming at an outstanding primary and secondary vertex resolution. Highly granular and ultra-light, so-called Monolithic Active Pixel Sensors (MAPS), which are manufactured with standard CMOS processes, will be employed. Imperfections in the CMOS production as well as the subsequent dicing and thinning procedures may limit the production yield of the sensors to about 60-70%. Probe testing the sensors prior to integrating them to the MVD is a mandatory step of the quality assurance related to the mass production of this detector. This is as it allows to recognize and reject sensors with insufficient performance.

The feasibility of probe testing the only 50 µm thick sensors was studied with the MIMOSA-26 prototype, which is considered as a realistic precursor of the final sensor of the MVD. Moreover, the existing readout system of the MVD-prototype [1] could be used for the test.

The probe-tests were carried in the IKF technology lab. As shown in Figure 1, the probe tester was equipped with a probe-card hosting 65 tungsten needles with a minimum pitch of 120 µm. The MIMOSA-26 sensors were held by a chuck adapter with micro-vacuum channels, contacted with the needles and their signals were routed through the probe-card to a so-called adapter-card. The latter was introduced as building it came out to be easier and cheaper than adapting the probe-card itself to our readout system. In addition, a test board hosting a wire-bonded working MIMOSA-26 sensor was manufactured. It is to test the readout chain including the probe-card independently of the delicate issue of contacting of sensors with needles.

After commissioning the system, first tests with 300 µm thick MIMOSA-26 sensors were carried out. The response of the sensors to JTAG programming and to various threshold settings matched our expectations. Next, the 50 µm sensors were probe-tested. The distance between the probe-card and the sensor, which is needed to establish a save contact between sensors and needles, was found smaller than expected from the tests with thicker sensors. This is attributed to the fact that the 50 µm sensors become soft enough to follow the imperfections of the surface of their support. Nevertheless, we succeeded to probe-test the thinned sensors.

In a next step, we are working on implementing a full test protocol, which is suited for testing the sizable number of sensors foreseen in the future mass production. To do so, we intend to update the software of our readout system and to migrate this system from the current TRBv2 to a TRBv3 platform [4].

Concluding, a 50 µm-thin precursor of a final CBM-MVD sensors was successfully tested with a probe-card. This activity and the related know-how found meanwhile some interest of a larger community, which is employing thinned MIMOSA-26 sensors into various experimental setups. This includes the PLUME project and the vertex detector project of the NA-61 experiment at CERN.

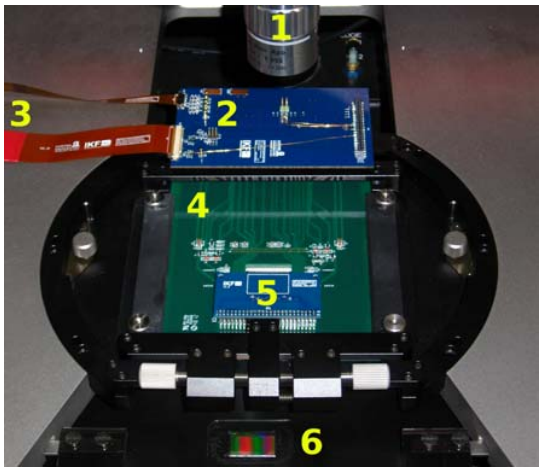

Figure 1: Probe-station setup: (1) microscope lens, (2) adapter-card, (3) connectivity to DAQ, (4) probe-card, (5) test-board hosting the reference sensor and (6) chuck-adapter with one Mimosa-26 sensor.

References

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