Contribution ID: **31**

Type: **Poster**

Automated assembly of large double-sided microstrip detectors of the CBM Silicon Tracking System at FAIR

Thursday 5 September 2019 16:55 (20 minutes)

The detector module of the Silicon Tracking System (STS) of the Compressed Baryonic Matter (CBM) experiment at FAIR (GSI) consists of large double-sided silicon microstrip sensors with a size up to 124 mm x 62 mm. Due to material budget constraints, the sensors are connected to the read-out electronics by long flexible microcables. As the manual assembly of the modules is time-consuming and difficult, a fully customized in-house bonding machine has been developed which allows for a highly automated detector module assembly. We present the bonding machine together with the electrical characterization of the first modules built with it.

Summary

The CBM experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, aims to explore the quantum chromodynamics (QCD) phase diagram for high baryon densities. One of the core detectors of CBM is the Silicon Tracking System (STS). It consists of eight tracking stations of double-sided silicon microstrip detectors. Each sensor contains 2048 strips, 1024 strips for n- and p-side, respectively. Sixteen STSXYTER readout ASICs with 128 channels each are connected to one sensor. Because of the very low material budget requirements, the front-end electronics are located far from the sensitive sensor region and are therefore connected by low-mass copper flex microcables. With the help of this double-layered microcable, a novel interconnection technology involving a gold stud –solder paste flip chip process has been developed. It combines low cost and high parallelization capability with good mechanical and electrical reliability and has been presented last year at TWEPP 2018.
The first step in module assembly is the connection of the microcables with the readout ASICs which can be done by a commercial flip chip machine. In the following, eight microcables to ASICs structures are placed side-by-side on the p-side of the sensor. After bonding the p-side of the sensor, the complete structure has to be flipped to allow the bonding of eight more microcables on the n-side. To achieve this much more challenging sensor-side interconnection with high accuracy and high throughput, a fully customized in-house bonding machine is under construction.
In this bonding machine, four highly precise step motors are combined with a dual-camera (top and bottom) pattern recognition system for detecting the sensor and microcables with sub-µm accuracy. In the end, the goal is to achieve a bonding accuracy in the range of a few microns. Additional features of the bonding machine are temperature regulated heating of the bond head as well as the sensor plate, an automated vacuum control system, a camera calibration procedure, and the possibility for automated application of the underfill glue for spark protection between the HV sensor and the LV microcables.
The bonding machine setup, its bonding performance and electrical test results of the first assembled detector modules will be presented.

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Session Classification: Posters

Track Classification: Production, Testing and Reliability