The layout of the CBM Silicon Tracking System*

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As the central detector in the Compressed Baryonic Matter experiment, the Silicon Tracking System (STS) is required to perform efficient charged-particle tracking with high momentum resolution. With feedback from the engineering activities, the detector's layout has been further optimized, in particular to minimize the number of modules, the component with most complex assembly and associated production risks and costs.

Detector structure

The STS will be located in the gap of the 1 T dipole magnet and will comprise 8 tracking stations between 30 and 100 cm distance downstream of the target. Its polar aperture, where minimal material budget is achieved, is 2.5-25°. The STS stations are built from detector ladders that are populated with detector modules. A detector modules is the functional unit of a single silicon microstrip sensor (or a pair of daisy-chained sensors), read out by two front-end electronics boards, and read-out cables between the sensoric part and the electronics. Eight or ten modules mounted onto a carbon fiber support structure form a ladder; the electronics is arranged at the top and bottom end of the ladder, reaching already out of the physics aperture. The ladders themselves are arranged on further support frames to form the stations of the STS. As an active material double-sided silicon sensors of 300 μm thickness and readout strip pitch of 58 μm will be used. The angle between front and back side is 7.5^o where only the strips of the p-side are tilted and n-side strips are vertically oriented. Different strip lengths are used for the different regions of the STS (short in inner region and long in outer areas). Such way the maximum occupancies are kept all over the tracker below few per cent. Sensors and read-out electronics will be interconnected via low-mass micro-cables.The total material budget in a station ranges from 0.3% X_0 (inner regions) to 1.2% X_0 (outer parts).

Minimizing STS modules

The recent optimization to the detector layout were made due to a paradigm change with respect to the component with most complex assembly. As this was previously the detector ladder, where the mechanical assembly had to be made with highest accuracy and involved costly machinery and survey time, the recent progress in the module development now revealed that the modules themselves present as the most work intensive objects. The ladders turned out to need less absolute mechanical precision, but stability and compatibility with mechanical survey for later alignment procedures with straight particle tracks and suitable software. An optimization of the population of STS ladders with modules of different strip length was possible since there was a reserve of unnecessarily high segmentation near the horizontal coordinate, a consequence of multiply deployed ladders of the same design.

New STS layout

The new layout of the STS stations reduces now significantly the absolute number of modules. The variety of modules increases, though, but only involving differently long read-out cables that can be accommodated in the assembly fixtures and leave the mechanical complexity unchanged. The stations were commuted into doublets, where four (almost) identical pairs of stations were introduced, increasing the number of identically populated ladders.

The STS breaks down into 106 ladders to be produced in 17 variations, i.e. that many different module combinations are to be arranged on carbon fiber supports. They realize a symmetrical granularity within the stations decreasing from their center to the outer edge. The total number of modules in the STS amounts to 896. The modules come in 18 varieties having differently long sensors and read-out cables in certain combinations. In the optimized layout requirements such as full acceptance coverage (including the innermost areas around the beam-pipe) have been considered. The layout of one pair of stations is shown in Fig. 1. The performance of the re-arranged detector system has been verified in simulation studies. The tracking efficiency of 97% for fast primary tracks and 90% for secondary tracks together with a momentum resolution of 1.3% were confirmed.

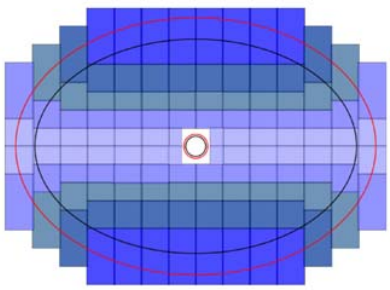

Figure 1: Layout of the second doublet of STS tracking stations. Black and red lines indicate the acceptance for stations number 3 and 4, respectively, including the horizontal enlargement for low-momentum tracks.

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