Performance simulations of the CBM-STS with realistic material budget*

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The task of the Silicon Tracking System (STS) of the CBM experiment is to reconstruct the trajectories of up to 600 charged particles created in nucleus-nucleus collisions. For the performance of the system, its material budget is a crucial issue since multiple scattering in the detector material will lead to a decrease in both track finding efficiency and momentum resolution. In order to assess these performance figures, a realistic implementation of active and passive materials in the simulations is required.

The system is composed of double-sided micro-strip sensors of 300 μm thickness, which was found to be the best balance between signal-to-noise ratio and material budget. In addition to these active sensors, cables transporting the analog signals from the inner sensors to the read-out at the top or bottom of the system add to the material in the acceptance. Lately, a detailed design of the analog cables was developed [1], which now allows to have a realistic description of the material budget as input to the simulations.

The signals will be transported by two staggered layers of Aluminum cables on polyimide carriers. Each module contributes two of these cable stacks, reading out the front and the back side, respectively. In the simulation geometry, these cables are represented by a single volume of 100 μm silicon (0.11 % X_0) as equivalent material budget. At the vertical periphery of a STS station, up to four of such cable volumes overlap. Consequently, the material budget within one station varies with the vertical distance from the beam; its maximal value is about 0.8 %. As an example, the material budget distribution of station 4 at z = 60 cm is shown in Figure 1.

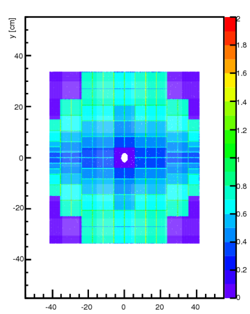

Figure 1: Distribution of material budget in tracking station 4

This model of the STS was implemented in the CBM software framework and subjected to simulations of Au+Au collisions in the CBM detector setup. A realistic detector response was applied as described previously [2]. The tracks were reconstructed by the Cellullar Automaton track finder algorithm; their parameters were determined by the Kalman Filter. The results of these simulations are shown in Fig. 2. The average efficiency for primary tracks above 1 GeV is 96 %, only 1 % less than obtained in previous simulations without the cable materials. Similarly, the efficiency for secondary tracks is hardly affected by the additional material. A more noticeable, but still moderate effect of the cable material is seen in the momentum resolution. Its average value is found to be 0.98 % (Gaussian σ), compared to 0.87 % without cables.

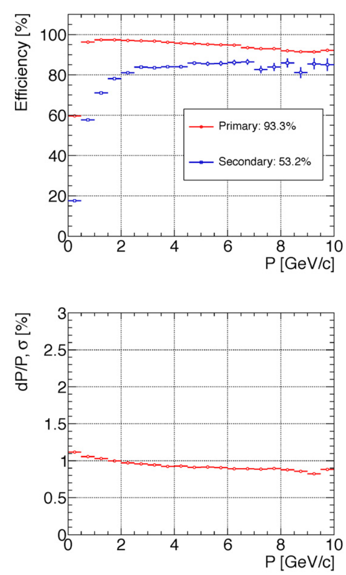

Figure 2: Track reconstruction efficiency (upper panel) and momentum resolution (lower panel) in the STS as a function of the momentum for all tracks in central Au+Au collisions at 25 AGeV projectile energy

In summary, the current simulations of the STS comprise a realistic material budget, including the analog read-out cables. The support structures made of carbon fibre are not yet included, but their contribution to the total material is minor. Within our simulations, we find the track reconstruction efficiency and the momentum resolution to match the CBM requirements. The module concept for the STS can thus be considered validated.

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References

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