UNDERSTANDING, MODELING AND IMPLEMENTING THE ANALOGUE RESPONSE OF THE SILICON TRACKING SYSTEM OF THE CBM EXPERIMENT AT GSI/FAIR

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The particle physics community has increasingly moved towards the use of silicon-based detector technologies, driven by their superior speed, granularity, and robustness, which offer versatile potential for improving experimental precision and reliability in a wide range of applications. In the field of heavy ion physics, however, this transition presents unique challenges. The necessity of managing the high occupancies reached in relativistic nucleus- nucleus collisions, along with the need for precise reconstruction of low-momentum tracks, often makes it essential to continue using traditional gaseous detector technologies, such as multi-wire drift chambers and time projection chambers, for charged particle tracking.

Built out of these challenges, and relying on recent technological advantages, the Silicon Tracking System for the Compressed Baryonic Matter (CBM) experiment at FAIR, Darmstadt aims to combine excellent performance in momentum resolution to outstanding capabilities in managing high data rates with a trigger-less free streaming readout concept. A detailed understanding of the detector response is crucial for an efficient operation of the detector, which exploits its full potential, even beyond tracking, as well as to precisely characterize the response model in Monte Carlo simulations.

A method for simulating the functioning of analog electronics of detector modules based on double-sided microstrip silicon sensors of the Silicon Tracking System (STS) of the CBM experiment has been developed. The method uses the LTspice analog electronic circuit simulator. It provides the ability to simulate the signal charge and its distribution between the detector components, as well as the frequency response of the STS detector module. The simulation results indicate the suitability of this method for validating the characteristics, optimizing the parameters and improving the operation of the STS modules, and the possibility of using it for monitoring the STS during the operation of the CBM experiment.

The results of this project are essential for optimizing the detector operation, and fully utilizing its potential, not only for tracking and momentum reconstruction, but also for particle identification, through the measurement of energy loss, and extend the strategies for its broader applications, as e.g. in proton and carbon therapy.