Status of the CBM MVD simulation model[*]

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The MVD simulation model is subject to a major revision and considerable progress has been achieved. In the following its motivation and status are discussed.

Motivation

Due to its proximity to the target and its excellent spatial resolution the MVD is the dedicated detector to resolve secondary vertices. In addition, its capability to clean-up background in di-electron spectra is subject of a dedicated study [1]. However, the primal implementation in simulation lacked in a realistic description (with respect to e.g. the material budget or peculiar sensor features) for advanced studies. These studies are needed to develop strategies to achieve best performances, to analyze critical points and to finalize the concept of the MVD and its tools.

The revision of the MVD model, to be incorporated to the CbmRoot simulation framework, aims at a more realistic description of the current understanding of the MVD. Before, in the standard scenario, the MVD was simplified as two homogeneous discs at 5 cm and 10 cm downstream the target, with an outer (inner) radius of 2.5 cm (0.5 cm) and 5 cm (0.5 cm), respectively. As no representation of individual sensors was included, this simplification possesses many limitations. The limitations involves mainly sensor properties beyond the hit response as e.g. the data parallelism of sensors, the rolling-shutter frame read-out, bandwidth limitations, busy circuits, a definition of a fake hit rate, time stamping and the data format.

The new approach [2] addresses these issues and is based on a segmented geometry with four stations (at 5 cm, 10 cm, 15 cm and 20 cm downstream the target) including all relevant features. Its underlying sensor characteristics are borrowed from MIMOSIS. The detailed geometry was elaborated in CAD. The conversion from the respective description into the ROOT geometry format was conducted by a dedicated tool. In this way we are able to respond very quickly to changes in the detector design.

Along with the proper representation of the gradual material budget, there is the possibility to incorporate the missing features mentioned above, as hits are assigned to sensors now. The data parallelism is incorporated by restructuring the data processing through the three process steps called digitizer, clusterfinder and hitfinder. Here, the corresponding data representations called Monte Carlo (MC) hits, digis (firing pixels) and clusters, which serve as input for the respective process step are assigned to the respective sensors. All further properties of the sensors are incorporated within the digitizer. As previously mentioned digis are particularly important, as they describe the response of the sensor to impinging hits mimicked by the digitizer. Apart from the generated pattern of single hits the interference among hits is important to consider. This is implemented in the digitizer by creating the signal amplitudes and distributions of all hits before jointly discriminating to generate the binary charge measurement. Hits from consecutive events might pile-up and/or neighboring hits merge. This is particularly true due the long integration time of one frame of $\sim 30\ \mu s$. The respective output is dependent upon the features included as listed above. These features require a definition of the temporal sequence of the recorded MC hits accordingly. Its considerations are relevant especially for the time-based track reconstruction of CBM. The time-based consideration is a necessary condition to use the reconstruction software with real data, too.

In order to verify the performance in the reconstruction (e.g. tracking) matching of all data states is incorporated. All geometry information are accessible via the ’GeoHandler’-Class. For the tracking a simplified representation of the material budget is provided in the form of a map in dedicated files provided together with the digitizer.

In order to study the impact of misalignment the position of the individual sensors can be modified within simulation.

Status

The new MVD geometry and data processing has been incorporated and uploaded to CbmRoot. All functionality has been re-established and can be used within the event-based reconstruction. Due to constraints on the part of CbmRoot, the time-based reconstruction is not fully available for the time being. Likewise the MVD model does not yet comprise all the details. However, all preparations necessary have been provided. The pile-up of events can be studied via background events. Moreover, further details related to the performance of the sensor (as e.g. aging with the integrated radiation dose, noisy pixels, different pixel geometries) have not yet been treated.

The current representation of the MVD in simulation is the prerequisite to allow for realistic simulations on the performance of the MVD in secondary vertexing and background rejection in di-electorn spectroscopy.

References

[1] Erik Krebs, ”Background rejection in the dilepton analysis with the CBM-Micro Vertex Detector”, this report

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