First steps towards a time-based simulation and reconstruction for the CBM experiment

V. Friese[1] *and E. Kryshen*[2]
[1]GSI, Darmstadt, Germany; [2]PNPI, Gatchina, Russia

Simulation, reconstruction and analysis for the CBM experiment are performed using the FAIRROOT software framework. The feasibility studies performed so far include the transport of events through the CBM geometry, the simulation of the detector response according to the present knowledge on detector and read-out electronics properties, and full hit, track and vertex reconstruction. With these tools, the feasibility of the measurement of all major observables of the CBM physics programme was demonstrated.

However, the framework, and consequently all simulation results, are based on event-by-event processing, i.e. the association of hits in the detector to physical events is given *a priori*. This corresponds to a conventional experiment where events are defined by a hardware trigger before readout. The data acquisition concept of CBM, in contrast, will not employ a latency-limited trigger, but foresees autonomous, self-triggered read-out electronics which will send time-stamped hit information into the DAQ chain whenever the corresponding detector channel is activated. The association of the hit information to physical events must thus be performed in software.

In order to demonstrate the feasibility of such a read-out concept, in particular for event rates as high as envisaged for CBM, the following tasks arise:

- The detector response simulation shall consider the Monte-Carlo time information and, in turn, provide a time tag for the produced detector hit, taking into account the anticipated behaviour of the detector and, in particular, of the front-end electronics. This means for instance that a double hit in a detector channel is not defined by two tracks in this channel within one event, but within a given time interval (detector dead time).

- Based on this time-based hit information, an algorithm for "event building", i.e. the association of hits to physical events must be developed. In the simplest case (low interaction rates), when the average time between two subsequent events is large compared to the variation of hit times within one event, this can be done using the time information alone. The already developed event-based reconstruction can then proceed as before.

- For high interaction rates, events will overlap in time. The association of hits to events is thus no longer trivial. Then, space-time correlations must be employed, such that track and event reconstruction will operate in four dimensions (instead of the common three ones).

As a first step towards these developments, the software framework was extended to facilitate the treatment of data based on time and not on events. A dedicated task class (`CbmMCStreamer`) regroups the Monte-Carlo hits delivered by the event-by-event transport according to their hit time into time slices (*epochs*), thus destroying the correlation of the MC hits to the input events from the generator. The format for this new data level is still a ROOT TTree, but now with one entry per epoch instead of one entry per event. The size of the epoch is adjustable to the user's convenience. It should be noted that the epoch on the MC level need not conicide with any time scale defined by the read-out and DAQ system, but is in first place just a mean to discretise a continuous data stream. Parameters for the MC-Streamer are the average interaction rate and a model of the time profile of the beam.

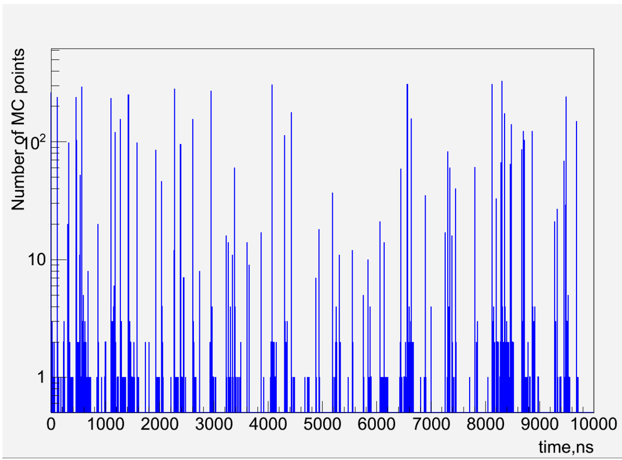

Figure 1: Time sequence of MC hits in the CBM silicon tracking system, assuming an average interaction rate of 10 MHz and a white beam, for Au+Au collisions at $25A$ GeV

As a simple application of the new data format, Fig. 1 shows the time sequence of MC hits in the CBM-STS detector system, assuming an average interaction rate of 10 MHz with a white beam. With the new data format as input, the development of advanced, time-based digitisers for the different detector systems will be the next steps towards the full simulation and reconstruction of the data flow in CBM.