Status of the electron identification algorithm for the RICH and TRD detector systems of the CBM experiment

S. Lebedev[1,2]*, C. Höhne*[3]*, and G. Ososkov*[2]

[1]GSI, Darmstadt, Germany; [2]JINR, Dubna, Russia; [3]Justus Liebig University, Giessen, Germany

RICH detector

In the ring reconstruction algorithm [1] a further speedup optimization and the event level parallelism was investigated. In order to test the ring reconstruction algorithm, central UrQMD Au+Au collisions at 25 $AGeV$ beam energy with 10 embedded primary e^+ and e^- were simulated. The test computer has two Intel Core i7 CPUs with 4 cores each at 2.67 GHz (16 logical cores in total).

The ring reconstruction efficiency is the same for the scalar and parallel version and equals to 93% integrated over momentum. The number of fake rings is 2.7 per event, the number of clone rings is 0.9 per event, which has to be compared to a total number of 80 rings per event. A speed up factor of 74 is achieved by the optimization of the algorithm. Using SIMDization and multithreading the speed of the algorithm was increased further by a factor of 2. In total a speed up factor of 143 was achieved (from 357 ms/event to 2.5 ms/event) for the optimized parallel version in comparison to the initial algorithm.

Event level parallelism was studied as well. Events are accumulated in a buffer, then groups of events are reconstructed in parallel in different threads (different CPU cores). A thread scheduler was developed in order to control the creation and life cycle of threads. It allows to run threads on a certain CPU core. The scalability of the event level parallelism was investigated: N events were read from the event buffer, an individual thread was created for this group of events and the reconstruction was executed. The first thread executes on the first logical core of the first CPU, the second thread executes on the second logical core of the first CPU. The next two threads execute on the second core, and so on. Our tests show that the performance increased linearly in dependence on the number of running threads. Using the computer CPUs at a maximum (16 running threads) algorithm reconstructs more than 1800 central events per second (500 μs/event) and roughly 8000 mbias events per second (125 μs/event).

Table 1: Pion suppression in the RICH detector for two different algorithms

	ANN	Cuts
π suppression ($p < 6GeV/c$)	500	200
π suppression ($p > 6GeV/c$)	260	130

Two algorithms for electron identification in the RICH detector were implemented: 1) standard ring radius cut method, 2) method based on the ANN [2]. The comparison of the pion suppression results assuming 93% electron identification efficiency is presented in Table 1.

TRD detector

In addition to previous studies [3] further investigations of the electron identification algorithm in the TRD were performed. To calculate the pion suppression factor 10^6 electrons and 10^6 pions were simulated with the following parameters $\theta = (2.5°, 25°)$, $\phi = (0°, 360°)$ and a momentum of 1.5 GeV/c. A set of radiator parameters was used which was tuned to describe the experimental results (3rd set in [3]). The BDT method was applied for this study [4].

Due to the high track multiplicity and density, the track reconstruction algorithm sometimes assigns fake hits to a track. For example, from 12 hits of an electron track 11 hits were found correctly and one hit was wrongly substituted by a pion hit. This effect has been studied in two ways (see Table 2): 1) assign fake pion hits to an electron track, 2) assign fake electron hits to a pion track.

Table 2: Pion suppression in the TRD detector in dependence on the number of wrong hits per track

Number of wrong hits	0	1	2	3	4	5
π supp., variant 1	660	225	89	37	17	9
π supp., variant 2	660	215	74	30	13	7

The BDT method was adapted to identify electrons which have 6 to 12 hits in the TRD. This is necessary because 1) different geometries with different number of layers have to be investigated; 2) detector inefficiency; 3) tracks which do not pass through all layers should also be identified; 4) the track reconstruction algorithm might find only a part of a track. The dependence of the pion suppression on the number of hits per track is presented in Table 3. The gain of the pion suppression due to the additional hit is presented too. The gains are calculated as pion suppression for tracks with N hits divided by the pion suppression for tracks with (N-1) hits.

Table 3: Pion suppression in the TRD detector in dependence on the number of hits per track

# of hits	12	11	10	9	8	7	6
π supp.	660	500	334	215	132	85	54
Gain	1.33	1.55	1.50	1.63	1.55	1.6	—

References

[1] S. Lebedev *et al.*, CBM Progress report 2009, p. 79

[2] S. Lebedev *et al.*, CBM Progress report 2008, p. 84

[3] S. Lebedev *et al.*, CBM Progress report 2009, p. 81

[4] G. Ososkov *et al.*, *e^-/π separation with TRD*, https://www.gsi.de/documents/DOC-2009-Oct-232-1.pdf