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Artificial neural networks application in estimating the impact parameter in heavy ion collision using the microchannel plate detector data

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Evaluation of the impact parameter in a single event of relativistic heavy ion collision is crucial for correct and efficient data processing and analysis. In this work, we studied the possibility of estimating the impact parameter in heavy ion collisions by using artificial neural networks applied to the charged particle data from the fast microchannel plate (MCP) detectors.

To carry out computational event-by-event experiments, we used simulated data from 200,000 A+A collisions of gold nuclei ($A = 197, Z = 79$), at $\sqrt{s_{NN}} = 11$ GeV, obtained by the QGSM MC event generator. Charged particles multiplicity, their spatial distribution and time-of-flight data were used as event features to be analyzed by the artificial neural network algorithms.

We investigated two different configurations of microchannel plate detectors layout:

- consisting of three pairs of small MCP segmented rings with 5 cm outer and 3 cm of the inner diameter positioned inside the vacuum beam-pipe symmetrically at distances of 1 m, 1.7 m and 2.5 m from the center of installation
- consisting of one pair of large area segmented MCP rings with the outer diameter of 50 cm and 6 cm of the inner one positioned outside the vacuum beam-pipe symmetrically at a distance of 4 m from the center of installation

These two configurations of MCP detectors layout have different data sets requirements and computational requirements. In both configurations the readout anodes of the MCP rings have certain segmentation in azimuth and radius. (The fast microchannel plate detector of charged particles was previously proposed for experiments at NICA in [1]).

We show that the developed artificial neural networks technique is capable, for both configurations of MCP detectors layout, to provide sufficiently good and fast results on the impact parameter determination in a single heavy ion collision event. In our first exercises, the proposed algorithm was capable to successfully classify more than 90% of Au + Au collision events with the impact parameter less than 5 fm, and it can be valuable as the fast trigger. We discuss also further developments and possible applications of this technique in the future experimental setups.

[1] A. A. Baldin, G. A. Feofilov, P. Har'yuzov, F.F.Valiev, Fast beam–beam collisions monitor for experiments at NICA, NIMA, 958, 162154, 2019, Reported at the VCI2019, DOI:10.1016/j.nima.2019.04.10

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