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Evaluation of the Influence of the Beam Pipe on the Accuracy of Solving the Problem of Determining the Coordinates of Au-Au Interactions

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The experimental setup for the MPD collider at NICA, currently under construction at JINR [1], is planned to study the fundamental properties of matter in heavy-ion collisions at energies up to 11 GeV/nucleon. This work focuses on the problem of determining the initial coordinates of Au-Au interactions at a system of center-of-mass energy of 7 GeV/nucleon and the impact of different beam pipe configurations on the accuracy of this determination. The approach used is based on the works [2], [3]. The UrQMD 3.4 event generator [4] was used for simulating interactions. The obtained results were then imported into a program implemented with Geant4 via the chromo interface [5]. These results were used to train a neural network model for solving the problem of determining the initial coordinates of ions. Four scenarios were considered: with beam pipe wall thicknesses of 1.2, 3, 5, and 8 mm, and materials of carbon or iron. The detection areas were located 4 meters from the interaction point and consisted of rings with a diameter of 600 mm. The accuracy of the coordinate determination was measured using the square root of the mean square error (MSE). We found that using an beam pipe with a thickness of 1 - 3 mm does not significantly affect the result and allowed us, for example, to achieve a precision for a carbon beam pipe with a thickness of 1.2 mm of $\sqrt{\text{MSE}} \approx 3.82$ cm. Further increasing the thickness of the beam pipe decreases the accuracy of the solution. For an iron beam pipe with a thickness of 8 mm the inaccuracy increases to $\sqrt{\text{MSE}} \approx 6.30$ cm. The work was supported by a grant from Saint Petersburg State University ID 95413904

References

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