Using Spectator Matter for Centrality Determination in MPD experiment at NICA

Igor Pshenichnov

INR RAS and MIPT

It is very challenging to identify signals of phase transition between hadronic matter and quark-gluon plasma in the domain of overlap of colliding relativistic nuclei. At the same time the presence of phase transition between nuclear liquid and gas of free nucleons has been firmly established in spectator matter in numerous experiments. We developed Abrasion-ablation Monte Carlo for Colliders (AAMCC) model to simulate the properties of spectator matter and its decays. With this model we calculated various characteristics of spectator nucleons and nuclear fragments to consider them for event centrality determination in colliders in addition to commonly used measurements of multiplicities of spectator neutrons in forward calorimeters. Because of a non-monotonic dependence of neutron numbers on the event centrality, other characteristics of spectator matter in ^{197}Au–^{197}Au collisions at NICA can be considered to improve the centrality determination. The numbers of spectator deuterons and α-particles and the forward–backward asymmetry of the numbers of free spectator nucleons were calculated with the AAMCC model as functions of event centrality. As shown, the number of charged fragments per spectator nucleon decreases monotonically with the increase of impact parameter and can be involved in estimating the collision centrality. The conditional probabilities that a given event with specific spectator characteristics belongs to a certain centrality class were calculated by means of AAMCC. Such probabilities can be used as an input to Bayesian or other machine-learning methods of centrality determination in ^{197}Au–^{197}Au collisions. Recent developments of AAMCC to include pre-equilibrium clustering of spectator prefragments are also reviewed.