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Production of spectator neutrons, protons and light fragments on fixed targets at NICA

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Study of hot and dense baryon-rich matter is a central point of the BM@N [1] and MPD [2] experiments at NICA facility. Both experiments are equipped with forward detectors capable to measure the energies of spectator nucleons and nuclear fragments representing remnants of initial nuclei beyond their hot overlap region (fireball) [1, 2]. The signals from the forward detectors can be used to determine the centrality of each nucleus-nucleus collision event and its reaction plane [3]. In addition, the BM@N experiment is equipped with the Highly-Granular time-of-flight Neutron Detector (HGND) [4]. Therefore, the procedure of centrality and event plane determination should be based on a reliable model of the production of spectator protons, neutrons and nuclear fragments.

In this work, the microscopic ultra-relativistic quantum molecular dynamics (UrQMD) transport model [5, 6] was coupled with the MST-clustering and statistical decay models previously used in the Abrasion-Ablation Monte Carlo for Colliders model [7-9]. In this model combination, the primary evolution during the first few hundred fm/c is calculated using UrQMD. The MST-clustering algorithm is then used to determine the bound excited spectator fragments [9]. Their decay is simulated using evaporation, SMM and Fermi Breakup models from the Geant4 toolkit [10]. The yields of neutrons and light nuclear fragments, their rapidity and transverse momentum distributions, were calculated and compared with the experimental data on the collisions of 600A MeV Sn + Sn [11] and 10.6A GeV Au + Au [12]. In this combined approach, the multiparticle evolution of individual nucleons simulated with UrQMD is supplemented by their clustering to simulate the production of spectator nuclear fragments and their response in forward detectors.

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