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Calculations of the efficiency of the Highly Granular Neutron Detector prototype in detecting spectator neutrons in the BM@N experiment

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The Highly Granular Neutron Detector (HGND) is now developed and constructed to measure the yields and flow of neutrons produced in nucleus-nucleus collisions in the BM@N experiment at the NICA accelerator complex at JINR (Dubna) to study the equation of state of nuclear matter at high baryon densities. The HGHD will be composed of multiple longitudinally alternating absorber and high transverse granularity scintillator layers. Each scintillator layer consists of 144 individual scintillator detectors with a time resolution of about 130 ps. The HGND is designed to measure neutron kinetic energy in the range from 300 MeV to 4 GeV via time-of-flight. A compact HGND prototype has already been designed and constructed to validate the concept of the full-scale HGND. The first experimental data on spectator neutron yields have been collected for the collisions of 3.8A GeV Xe with CsI target by the BM@N experiment at the beginning of 2023.

This work presents the results of the efficiency and geometric acceptance simulation of the HGND prototype for the detection of forward spectator neutrons from Xe-CsI collisions using two models to generate secondary particles and nuclear fragments. The Dubna Cascade Model coupled with the Statistical Multifragmentation Model (DCM-QGSM-SMM) and the Ultrarelativistic Quantum Molecular Dynamics Model coupled with the Abrasion Monte Carlo (UrQMD-AMC) were used. The difference in efficiency and geometric acceptance calculated with these models is used to estimate the systematic uncertainties of these quantities.

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