

## Simulation of neutron and nuclear fragment production in Urqmd 3.4 model supplemented by clustering model and multi-fragmentation statistical model

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Many experiments in high energy physics use the URQMD model at the design stage, for predictions of experimental data and also for analysis of the obtained results. We used the new version of the URQMD 3.4 model to analyze the experimental data of the NA61/SHINE collaboration. We obtained that the UrQMD 3.4 model reproduces the data on  $\pi^\pm$ , K-, proton and anti-proton production in  $40\text{Ar} + 45\text{Sc}$  interactions with the appropriate choice of the impact parameter. We also apply the UrQMD 3.4 model to study the spectra of neutrons produced in proton-nucleus interactions. The model well reproduces energetic ( $E_n > 10$  MeV) neutron spectra in  $p + \text{Al, Fe, Pb}$  at the energy 3 GeV in the so-called “cascade” mode. Off-shell mass neutrons are dominate at lower neutron energies. The off-shell nucleons have to form residual nuclei at de-excitation of which evaporated nucleons and light nuclei have to be produced. In order to simulate the process, we have coupled the UrQMD 3.4 model with the clustering model and Statistical Multi-fragmentation model (SMM) using “potential” mode of the UrQMD model. We have reached a good description of energy distributions of slow and fast neutrons produced in proton-nucleus and nucleus-nucleus interactions. UrQMD 3.4 +SMM model also reproduces sufficiently well the atomic mass and charge distributions of nuclear fragments in nucleus-nucleus interactions. UrQMD 3.4 +SMM can be applied at NICA experiments.

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