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Validation of nuclear de-excitation models of Geant4 toolkit

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Geant4 is a powerful Monte Carlo modeling toolkit [1] to describe the propagation and interactions of particles and nuclei in various media. It was originally designed for experiments at the LHC, but its area of application is rapidly extending well beyond high energy physics to low energy nuclear physics, astrophysics, space science, medical physics and radiation protection [2].

Nuclear reactions induced by hadrons and nuclei are modeled by Geant4 as multistage processes. In particular, the Binary Cascade (BIC) [3] and Liege Intranuclear Cascade (INCL) [4] models are used to simulate the emission of fast particles at the first cascade stage resulting in an exited nuclear residue. Depending on the excitation energy calculated per nucleon of the residual nucleus E/*A various decay processes take place. At* *E*/A<2 MeV the evaporation of neutrons, protons and alpha-particles from residual nuclei [5] is modeled, while the Statistical Multifragmentation Model (SMM) [6] is employed to simulate the decays into nucleons and multiple nuclear fragments at higher excitation energies. Nuclear de-excitation models of Geant4 were validated in its early version of 9.1 [7].

In the present work we validate nuclear de-excitation models of recent Geant4 versions 10.4 and 11.0 by means of standalone tests for specific residual nuclei and excitation energies. Calculation results are compared to measured energy spectra of evaporated neutrons, protons and alpha-particles [8] and to charge distributions of secondary fragments calculated with FORTRAN version of SMM [6]. A detailed analysis of the momentum distributions of SMM products is performed and several suggestions to improve the results of the modeling were reported to Geant4 developers. After the revisions, the latest versions of de-excitation models of Geant4 can be used in our Abrasion-Ablation Monte Carlo for Colliders model (AAMCC) [9] to simulate the properties of spectator matter in collisions of relativistic nuclei.

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The speaker is a student or young scientist

Yes

Section

1. Applications of nuclear methods in science and technology

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