RECENT DEVELOPMENTS IN PRE-EQUILIBRIUM AND DE-EXCITATION MODELS IN GEANT4

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Área temática: Aplicaciones de la Física Nuclear

Geant4 is a powerful toolkit for the simulation of the passage of particles through matter. Primary the focus of Geant4 was on preparation of experiments for the Large Hadron Collider [1, 2]. At the same time its areas of applications are growing and include high energy, nuclear and accelerator physics, studies in hadronic therapy, tomography, space dosimetry, and others. Geant4 physics includes different models for simulation of interactions of hadrons with nuclei [2, 3].

Geant4 native pre-equilibrium and de-excitation models are used for sampling of residual nucleus fragmentation in a number of generators of inelastic hadron/ion interaction with nuclei including Binary Cascade [4], Quantum Molecular Dynamics [5] and some others. The pre-compound model is responsible for pre-equlibrium emission of protons, neutrons and light ions. The de-excitation model provides sampling of evaporation of neutrons, protons and light fragments up to Mg, Fermi break-up, statistical multifragmentation, fission and photon emission.

Geant4 has recently contributed to the IAEA nuclear spallation reactions benchmark [6] with simulation results for all mandatory set of data including neutron production, light charged particle production, isotopes production, excitation functions up to 3GeV, pions production. For the simulation of spallation reactions, two hadronic multi-staged intra-nuclear cascade models were used in calculations, the Bertini-style cascade [7] and the Binary Cascade. These cascades are used in many Geant4 applications and are applicable within the energy range of the benchmark 20MeV-3GeV.

During the participation in the IAEA nuclear spallation reactions benchmark a review of the native pre-equilibrium and de-excitation models of Geant4 included in BIC has been performed and several improvements introduced [8,9]. Validation versus various published data has been made.

In the course of Geant4 applications to Medical Physics (Hadrontherapy) additional model developments in de-excitation models (Fermi break-up, photon evaporation) have also been carried out.

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[3] Wright, D. H., et. al., "Recent Developments and Validations in Geant4 Hadronic Physics", AIP Conf. Proc., 896 (2007) 479.

[4] Folger, G., et. al., "The Binary Cascade", Eur. Phys. J., A 21 (2007) 407.

[5] Koi Tet al, "Interfacing the JQMD and JAM nuclear reaction codes to GEANT4". Computing in High Energy and Nuclear Physics (24–28 March 2003, La Jolla, California) SLAC-PUB-9978

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[7] Heikkinen, A., et. al., "Bertini intra-nuclear cascade implementation in Geant4", CHEP'03 (La Jolla, California, USA, 24-28 March 2003), Preprint CHEP-2003-MOMT008, e-Print physics/0306008.

[8] J. M. Quesada on behalf of Geant4 Hadronics Working Group , "Results obtained with nuclear models of Geant4 in IAEA Benchmark of Spallation ", International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators. Satellite Meeting on Spallation Reactions (IAEA, Vienna, 4-8 May, 2009)

[9] J. M. Quesada on behalf of Geant4 Hadronics Working Group ,"Results obtained with nuclear models of Geant4 in IAEA Benchmark of Spallation ", Second Advanced Workshop on Model Codes for Spallation Reactions (CEA, Saclay, 8-11, February, 2010)
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