Accounting for gamma-quanta absorption reactions in the ^{235}U fission chain reaction modeling by the TPT3 program

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The TPT3 program is developed in Dukhov Research Institute of Automatics for the parallel radiation transport simulation on the multicore CPU and GPGPU architectures with SIMD instructions. One of its key features is the simplified voxel geometry beneficial for massively parallel computations. The TPT3 physics covers nearly all aspects of interactions of atomic ions and neutrons with matter in a wide energy range and can transport the weighted particles. The weighted particles transport lets simulate nuclear chain reactions with high multiplication factors in almost arbitrary nuclear fuel assemblies subdivided in billions of Cartesian cells – voxels, characterized by a uniform concentration of nuclear isotopes, and take into account the nuclear fuel burnout and the dynamic modification of the simulation environment by the isotopes of the fission products.

The weighted simulation results for the chain fission reaction with the fuel burnout modeling in the uranium cube are presented. The time dependences of the numbers of neutrons, gamma-quanta, generated fission fragments, and generated heavy uranium isotopes, produced in the radiation capture reactions, are calculated. The results are compared for the simulations with and without photofission, Bethe-Heitler reactions, and the Compton scattering. The degree of the nuclear fuel burnout, growth constant, heavy isotopes generation, and the time before explosion are calculated as functions of the uranium cube edge length.