The TPT3 program for parallel simulation of radiation transport

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Today, when the Moore's law raise for the CPU (central processing unit) clock rate is technologically limited, the only way to increase the performance of the Monte-Carlo (MC) simulation of the radiation transport is to utilize properly the multiple threads and the vector instructions of the CPU in a parallel program. But it is difficult to parallelize the existing complicated serial MC radiation transport codes. The deep research in the scope of the parallel MC simulation of the radiation transport led recently to development of several parallel MC codes.

The TPT3 program is developed for the parallel radiation transport simulation on the multi-core CPU and GPGPU (general-purpose computing on graphics processing units) architectures with SIMD (single instruction, multiple data) 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. As the weights of the transported particles are high, the TPT3 simulation can take into account the nuclear fuel burnup and the dynamic modification of the simulation environment by the isotopes of the fission products. The key features of the parallel TPT3 program architecture and the TPT3 applications for different environments and different radiation sources are discussed.