Monte Carlo radiation transport parallel computations on Marconi-Fusion HPC for the IFMIF-DONES radiation shielding tasks

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This work is organized by the EUROfusion consortium aiming to develop the International Fusion Materials Irradiation Facility (IFMIF) with DEMO-Oriented Neutron Source (DONES). IFMIF-DONES is an accelerator-based facility of 125 mA current of deuteron ion (D+) beam of 40 MeV energy impinging on the liquid lithium target inside the facility Test Cell (TC) to generate neutrons having the energy up to 55 MeV on stripping (d-Li) reaction. High-performance computing resources, as well as advanced techniques, are required to meet challenging requests of neutronics applications for IFMIF-DONES, formulated as an aim of the MCHIFI (Monte Carlo High Fidelity) computation project using the EUROfusion High-Performance Computer (Marconi-Fusion HPC). A large number of the Marconi-Fusion HPC nodes and long computation times are needed for the IFMIF-DONES large-scale and models developed by us for the Monte Carlo (MC) radiation transport code MCNP. Running massively MCNP parallel computations on Marconi-Fusion HPC, we have confirmed MPI jobs speed-up of 850 on 1024 cores. With OpenMP/MPI hybrid parallelization, the speed-up is 2500 on 4096 cores. The MCNP parallel performance in terms of the MCNP parallel jobs speedup and efficiency has been estimated in [1]. As the accuracy of the MC computations depends on the number of sampled particles, substantial efforts are spent on the MC variance reduction techniques development. An example of methodology improvement is demonstrated in the recent development of the On-The-Fly (OTF) modification [2] of the MCNP code. The OTF Global Variance Reduction (OTF-GVR) is the state-of-the-art code for the IFMIF-DONES radiation shielding tasks characterized by neutrons deep penetration.

References

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