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MODELING OF NEUTRON LOAD ON TOKAMAK STRUCTURAL ELEMENTS IN OPENMC COMPUTATIONAL ENVIRONMENT *)

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The design of a fusion plant with high neutron yield should be based on a neutronics model. Simulation of neutron and gamma radiation transport in tokamak structural elements allows to obtain neutron and gamma field distributions, to calculate the power of radiation energy release sources, and to analyze the dynamics of activation and cooling. These aspects are of particular importance in the design of superconductor coils, biological protection systems, cooling systems, and for various plasma diagnostics.

MCNP [1] is the only code currently in use at ITER [2] for neutron and photon transport. The OpenMC [3] software package can be its full-fledged alternative. At present, it is necessary to verify OpenMC to use it officially for designing real installations. But already now, it can be useful as a supplement for preliminary estimates, lost particles problem, and weight windows calculations. The code provides a wide and convenient functionality for these tasks. A significant advantage of OpenMC is that it is available as an open source, allowing the code to be customized for specific tasks. A wide community from all over the world supports the project. The pace of code development is fast, because of an experienced team, a thoughtful design process, and the use of modern technologies. In addition, the openness of the code allows it to be used on any, including commercial projects, without the need for regulatory approvals.

This paper presents the use of OpenMC for modeling neutron transport for the models of ITER, TRT [4] and EAST tokamaks: translation of models from MCNP to OpenMC; some results of OpenMC calculations in comparison of OpenMC and MCNP modeling results. To perform part of the tasks, special software was developed to create a neutron plasma source with complex parameterization, and the 3D models themselves were optimized to work with OpenMC. As a result, a 2-3 times increase in the performance of calculation tasks compared to the calculation time previously performed in MCNP for the same models was obtained. The preparation of the model for calculation and visualization of the results is much easier and more efficient than in MCNP, due to the use of well-known Python and C++ programming languages.

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