Monte Carlo simulations of CAD-imported complex geometries for radiation damage in compact fusion reactors

D. Torsello[1,2], F. Ledda[1,2], D. Pettinari[3], S. Meschini[3], S. Sparacio[1,2], G. Ferrero[3], D. Gambino[4], R. Testoni[3], Z. Hartwig[5], A. Trotta[6], M. Zucchetti[4], F. Laviano[1,2]

[1] *Department of Applied Science and Technology, Politecnico di Torino, Torino, Italy*

[2] *Istituto Nazionale di Fisica Nucleare, Sezione di Torino, Torino, Italy*

[3] *Department of Energy, Politecnico di Torino, Torino, Italy*

[4] *Department of Physics, Chemistry and Biology , Linköping University, Linköping, Sweden*

[5] *MIT Plasma Science and Fusion Center, Cambridge, MA, United States of America*

[6] *MAFE, Eni S.p.A., Venezia, Italy*

Radiation damage in compact fusion reactors is a serious issue on most components due to the high flux of energetic particles produced in the plasma combined with the reduced size. This makes particularly important the evaluation of neutron and secondary particles spectra and fluxes on all components, to assess the lifetime of the materials and their performances during operations [1].

In the present work we employ the transport codes PHITS and OpenMC with parallel computing schemes on the CINECA high performance computer HPC4 to analyze the neutronics in a compact fusion reactor, importing 3D geometries from CAD files via a tethragonal meshing scheme.

This approach allows us to discuss the impact of several approximations and choices (of codes, nuclear libraries, nuclear models, domain reduction, source shape) on both integral results and spatially resolved quantities [2].

These efforts contribute to the development of precise and reliable methods to estimate the radiation environment in compact fusion reactors, a crucial preliminary step for the investigation of materials response and damage.

References

[1] D. Torsello, et al., Superconductors Science and Technology, **36**, 014003 (2023)

[2] F. Ledda, et al., Nuclear Fusion (submitted)