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Structural Analysis of a Diagnostics Slim Cassette for DEMO

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The reflectometry diagnostic is foreseen to provide the radial edge density at several poloidal angles for feedback and control of plasma position and shape in DEMO. The main approach to integrate microwave reflectometry into the device~~in DEMO~~ is to incorporate several groups of antennas and waveguides into a Diagnostics Slim Cassette (DSC), a full poloidal sector to be integrated with the Water-Cooled Lithium Lead (WCLL) breeding blanket (BB), which is expected to house up to 100 antennas and waveguides. As the front-end components of the DSC will be directly exposed to the extreme nuclear and thermal loads, a structural analysis is mandatory.

This work presents the results of preliminary steady-state structural analysis performed on the DSC. To carry out these analyses, a CAD model of a DSC section was used to develop finite-element models in ANSYS Workbench. The thermal fields, calculated in a previous work [1] – which took into account the plasma thermal radiation, the nuclear heat loads and the fluid-solid interactions (FSI) between the structural components of the DSC and its cooling systems – were input as the body temperature boundary condition (BC). To model the BC caused by other structures, the CAD model of the BB was imported and assumed as a rigid body. Bonded contact was applied for the surface contact between the DSC and the WCLL BB (assuming the DSC will be attached to the WCLL BB). Temperature-dependent material properties were assumed. As the maximum temperature of the DSC is slightly above the maximum allowable temperature for EUROFER under irradiation, the outcome of this analysis will provide an important input for a redesign of the cooling system, allowing to identify possible locations of failure with the RCC-MR code.

References

[1] Y. Nietiadi *et al.*, "Nuclear and thermal analysis of a multi-reflectometer system for DEMO," *Fusion Eng. Des.*, vol. 167, p. 112349, Jun. 2021, doi: 10.1016/j.fusengdes.2021.112349.