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Structural and thermal analysis of a distributed ICRF antenna integrated in European DEMO blanket

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The use of efficient heating and current drive systems is an important research priority for DEMO. One such system in consideration for the European DEMO is the ion cyclotron range of frequency (ICRF) heating system. Extensive operational experience on several existing fusion facilities, a relatively low cost and high plug to power efficiencies motivates the consideration of ICRF for the heating and current drive mix in the European DEMO project.

In the present baseline configuration considered for DEMO, the ICRF antenna consists of several radiating metallic straps integrated in the blanket's first wall, and protected at the front, if necessary, by a toroidally segmented structure called the Faraday shield. Since the antenna shall be integrated in DEMO, a main requirement is its ability to withstand the stringent operational conditions, including plasma steady state and transient loads. Thus, the antenna design shall be designed from the start to be compatible with such loading conditions. Furthermore, simplifying the overall machine design is naturally desirable. Since the antenna lifetime has to be equivalent to that of the blanket in terms of neutron fluence the choice of the structural material is currently limited to EUROFER.

This paper provides a definition of the most critical (i.e. thermo-mechanical) loads to be considered when creating the ICRF antenna design. The structural integrity of the baseline ICRF antenna configuration is then analyzed using finite element analysis tools against the given primary loads in DEMO. The results of this exercise will be reported in this paper. Furthermore, the baseline antenna design is modified where ever necessary to adapt the operational loads in DEMO. Any design change will ultimately need to fulfill the DEMO machine constraints and RF physics requirements. Results presented here may thus not be final, and further iteration might prove necessary.

Presently, four blanket concepts are being considered for DEMO, though two cooling liquids are used: Helium and water, for all four blanket types. Whenever possible, cooling of the ICRF antenna shall be part of its hosting unit, i.e. the blanket. This particular issue has been considered during the investigation as described in this paper.

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Eligible for student paper award?

No

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