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Integration Conceptual Study of Reflectometry Diagnostic for the Main Plasma in DEMO

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The reflectometry diagnostic may present several advantages from the point of view of radiation robustness and components life time as compared to some other traditionally used diagnostics in large fusion devices. From the hardware perspective it does not contain front end elements such as mirrors or sensors which are expected to underperform earlier than the antennas and waveguides when subjected to similar radiation fluxes and deposition/erosion processes. On the other end stresses arising from thermal expansions and electromagnetic (EM) forces can be larger for the waveguides and are accommodated by design. The role of such diagnostic for DEMO is twofold: i) to provide the radial density profile at several poloidal angles (2D map) and ii) to provide data for the feedback control for plasma position. Several groups of antennas need to be distributed along the poloidal section in a number that can satisfy the DEMO control requirements. The study of diagnostic performance and control requirements definition is still being developed and the final number of diagnostic channels is not yet defined, nevertheless several aspects regarding integration can be readily assessed. This paper presents the first case study of integration of antenna groups and waveguides located at several poloidal angular positions covering a full poloidal section of the Helium Cooled Lithium Lead breading (HCLL) blanket. The integration design shall satisfy strong machine driven constraints (in addition to the physics performance). Diagnostic components installed in the blanket segments must: i) survive for the all period between blanket replacement, ii) be remote handling (RH) compatible with blanket, iii) behave thermomechanical as the blanket structure, iv) cross with integrity the vacuum and reference boundaries (vessel/cryostat/building) and tolerate their relative displacements and v) be compatible with the blanket shielding and cooling services. The present solution developed so far respects several of the main constraints namely, RH compatibility with the full blanket segment and its thermomechanical properties and cooling compatibility but also identifies important issues on the interfaces between the diagnostic antennae extensions and the pipe services at the vessel and also interfaces between vessel and cryostat requiring challenging RH and self-alignment solutions to be demonstrated. Monte Carlo neutronic simulations have been initiated in order to evaluate the heat loads and shielding capabilities of the system. The first results indicate that the cooling for the EUROFER diagnostic components (antennas and waveguides) can in principle be provided by the blanket cooling services (He is considered) via connection to the main Back Supporting Structure (BSS) and routed via the main diagnostic structure body to specific hot spots in the antennas.

Eligible for student paper award?

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