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Confronting simulations of the performance of an equatorial HFS PPR for DTT obtained using 2D and 3D synthetic diagnostics

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Reflectometry, compatible with a full grade reactor implementation, has been proposed as a source of real-time (RT) plasma position and shape measurements for control purposes, in replacement or complement of standard magnetic measurements, to ensure reliability and safety on the machine. This new control technique, based on multiple, poloidally distributed, non-magnetic measurements, must be tested, in all of its aspects, before it can be fully implemented in future fusion reactors. The Divertor Test Tokamak (DTT) facility will enable the testing and validation of key non-magnetic control diagnostics, such as reflectometry, to assist with DEMO design implementation. To predict the behavior and capabilities of these new reflectometry systems, we propose a comprehensive simulation approach using finite-difference time-domain (FDTD) time-dependent code, including aspects such as propagation in realistic plasmas, the system location based on a CAD model of the vacuum vessel, and accesses to the plasma. Notwithstanding the comprehensive description of reflectometer diagnostics, the use of FDTD codes is computationally intensive, in particular if three-dimensional (3D) codes are used to evaluate the performance of the foreseen diagnostic, which requires access to HPC facilities. This fact makes the use of two-dimensional (2D) codes much more common. It is therefore important to have a good evaluation of the compromises made when using a 2D model in order to decide whether it is applicable to the problem under study, or if the problem rather requires a 3D approach. The present work makes a benchmark assessment of 2D against 3D of the behaviour and capabilities of a design for an Ordinary mode Plasma Position Reflectometer (PPR) system. In particular, this is done for an equatorial line of sight at the High Field Side (HFS) on DTT for a foreseen Single Null plasma scenario. The corresponding, synthetic diagnostics were set up using the 2D REFMULF and the 3D REFMUL3 codes.

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