Benchmark between antenna code TOPICA and Petra-M for the JET ITER-like antenna*

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Plasma heating and non-inductive current drive in the ion cyclotron range of frequency (ICRF) will play a crucial role in the ignition and sustainment of burning plasmas in ITER. ITER will use 20 MW of ICRF heating. At this RF power level in long pulses, the interactions of IC waves and the SOL plasma together with the wall can be potentially a substantial plasma material interactions (PMI) driver, resulting in impurity generation and plasma facing component damage. For this reason, both modeling and experimental efforts to better understand the interaction of the IC waves with the edge of the plasma currently constitute an important research topic in RF community. Commonly, RF simulation has been limited to a relatively small volume in front of the antenna, and handled the actual experimental situation through simplified models, such as stratifying antenna strap structure, flat antenna model and/or treating the antenna front volume as vacuum. Moreover, discrepancies between experimental observations and simulations have been found and not yet fully clarified when using curved antenna model, for instance, in JET with ITER-like antenna (ILA) [1, 2, 3]. In this work, we employ the Petra-M code [4], which is a recently developed electromagnetic simulation tool for modeling RF wave propagation based on MFEM [http://mfem.org]. This code can potentially overcome some limitations of the current state-of-the-art RF SOL/antenna simulation. Furthermore, with the self-consistent core-edge coupling [5], the model built on Petra-M can be applicable to a broad range of experimental conditions even where the core heating efficiency is not strong enough. This condition is indeed beyond the validity range of most existing simulation models. However, the Petra-M code verification and validation are still missing. For this reason, this paper reports a detailed benchmark between the well tested antenna code TOPICA [6] and Petra-M for the ILA JET antenna assuming both flat and curved models. The impact of the different antenna models will be quantified for different JET edge plasma conditions. Moreover, an initial comparison between the numerical simulations and the JET experimental data will be also discussed.

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