DPP17-2017-001617

Abstract for an Invited Paper
for the DPP17 Meeting of
the American Physical Society

From core to coax: extending core RF modelling to include SOL, Antenna, and PFC[1]

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A new technique for the calculation of RF waves in toroidal geometry enables the simultaneous incorporation of antenna geometry, plasma facing components (PFCs), the scrape off-layer (SOL), and core propagation [1,2]. Traditionally, core RF wave propagation and antenna coupling has been calculated separately both using rather simplified SOL plasmas. The new approach, instead, allows capturing wave propagation in the SOL and its interactions with non-conforming PFCs permitting self-consistent calculation of core absorption and edge power loss, as well as investigating far and near field impurity generation from RF sheaths and a breakdown issue from antenna electric fields. Our approach combines the field solutions obtained from a core spectral code with a hot plasma dielectric and an edge FEM code using a cold plasma approximation via surface admittance-like matrix. Our approach was verified using the TORIC core ICRF spectral code and the commercial COMSOL FEM package [2], and was extended to 3D torus using open-source scalable MFEM library. The simulation result revealed that as the core wave damping gets weaker, the wave absorption in edge could become non-negligible. Three dimensional capabilities with non axisymmetric edge are being applied to study the antenna characteristic difference between the field aligned and toroidally aligned antennas on Alcator C-Mod, as well as the surface wave excitation on NSTX-U. [1] J. Wright and S. Shiraiwa,Coupling an ICRF core spectral solver to an edge FEM code, AIP Conference Proceedings,1689 (2015). [2] S. Shiraiwa, J. Wright, et. al., "HIS-TORIC: Extending core ICRF wave simulation to include realistic SOL plasmas", Nucl. Fusion (2017) in press.

[1]Work supported by the U.S. DoE, OFES, using User Facility Alcator C-Mod, DE-FC02-99ER54512 and Contract No. DE-FC02-01ER54648.