Waveguide to Core: A New Approach to RF Modelling*.

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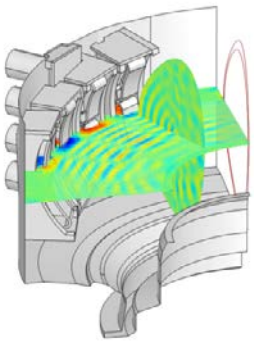

Figure 1: Rotated C-Mod Antenna

Modelling of coupling, propagation and absorption of RF waves in plasmas is known to be a complex task and is typically modelled in separate stages. We present a novel technique for the calculation of RF waves in toroidal geometry that enables, for the first time, the simultaneous incorporation of antenna geometry, plasma facing components (PFCs), the scrape off-layer (SOL), and core propagation [Shiraiwa, Wright et al, Nucl. Fusion **57** 086048 (2017)]. Calculations with this technique naturally capture wave propagation in the SOL, reflection from the core plasma or walls, and wave interactions with non-conforming PFCs as shown in Fig. 1. The technique combines the finite element approach for the SOL and antenna structure and the spectral method for the hot core using a domain decomposition technique with impedance matching to construct the full solution. Using open source software on leadership class computer permits solutions in excess of 30 Million degrees of freedom enabling the resolution of the slow and fast waves together in 3D geometries.

Applications of this model to ICRF minority heating in strong and weak absorption regimes in Alcator C-Mod predict heating loss of 10% and 50% respectively, in the SOL due to collisional processes, in-line with experimental measurements of heating efficiency. Sheaths are an additional loss mechanism in the SOL that can cause localized sputtering. To address the effect of RF rectified sheaths on PFCs we use a post-processing technique that uses the finite element method SOL solution [Myra and Kohno, EPJ Web of Conferences **157** 03037 (2017)] to model sheath rectification. To resolve short wavelength structures at the lower hybrid resonance in front of ICRF antennas, the edge SOL plasma model keeps finite Larmor radius effects to resolve the slow wave to ion Bernstein wave mode conversion that occurs at this layer. Simulations applying these models to the LAPD long cylindrical device, JET, and the Alcator C-Mod field aligned antenna in three dimensions will be presented.

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