FEM based simulation of IC and LH antenna-plasma coupling

S. Shiraiwa and O. Meneghini

Massachusetts Institute of Technology - Plasma Science and Fusion Center
77 Massachusetts Avenue, Cambridge 02138, Massachusetts, USA

shiraiwa@psfc.mit.edu

Antenna coupling efficiency plays a significant role in determining the effectiveness of ICRF and LH wave heating and current drive systems. The accurate modeling of the antenna plasma coupling has been extensively studied and a number of numerical codes have been developed for both ICRF and LH regimes (such as GRILL, ALOHA, TOPLHA, RAND3D, and TOPICA). However, those codes are based on a simplified antenna geometry, stratified plasma models, or are limited to the calculation of the vacuum region. In the latter case, the plasma effect is introduced via the plasma surface impedance. In our study, we explored the possibility of using COMSOL for the purpose of modeling the coupling problem. This commercial FEM package allows direct access to its equation system through either its own GUI or Matlab and a spatially non-uniform anisotropic material, such as a cold plasma with collisions, can be modeled in a straight forward way. Besides all benefits of using an RF engineering software, such as its affinity to CAD softwares and the possibility of easily manipulating the boundary conditions and the material properties, this approach allows a seamless handling of the plasma and vacuum regions while retaining the details of the antenna structure. The capability to analyze the ICRF and LH antenna problems both in 2D and 3D space using the same software package is beneficial for improving the efficiency of the antenna design work. Our approach has been verified analytically (Airy functions) [1] and by comparison with other numerical codes (TOPLHA, ALOHA), indicating good agreement. Our method has been applied to the near field analysis of the new Alcator C-Mod ICRF antenna, studying the effect of tilting the antenna strap on the edge parallel electric field. In the poster, the performance of the new LH antenna planned to be installed on the TST-2 spherical tokamak will also be discussed.

[1] S. Shiraiwa, et. al., *"Plasma wave simulation based on versatile FEM solver on Alcator C-mod"* , in Proc. of 18th topical conference on radio frequency power in plasmas (2009).