

Accurate design of ICRF antennas for RF plasma thruster acceleration units with TOPICA*

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In recent years electromagnetic (RF) plasma generation and acceleration concepts for plasma-based propulsion systems have received growing interest, inasmuch as they can yield continuous thrust as well as highly controllable and wide-ranging exhaust velocities. The acceleration units mostly adopt the Ion Cyclotron Resonance Frequency (ICRF)—a proven technology in fusion experiments for transferring large RF powers into magnetized plasmas, and also used by the VASIMR propulsion system [1]. In this work we propose and demonstrate the use of TOPICA code [2] to design and optimize the ICRF antenna of a typical acceleration stage. To this end, TOPICA was extended to cope with magnetized cylindrically-symmetric radially-inhomogeneous warm plasmas, which required coding a new module charged with solving Maxwell's equations within the plasma to obtain the relevant Green's function $\underline{\underline{Y}}(m, k_z)$ in the Fourier domain, i.e. the relation between the transverse magnetic and electric fields at the air-plasma interface. Then, calculating the antenna input impedance—and hence the loading—relies on an integral-equation formulation and subsequent finite-element weighted-residual solution scheme for the *self-consistent* evaluation of the current density distribution on the conducting bodies and at the air-plasma interface [2].

[1] J.P. Squire *et al.*, Fusion Sc. and Tech. **43**, 111 (2003)

[2] V. Lancellotti *et al.*, Nucl. Fusion **46**, S476–S499 (2006)

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