Quantitative Comparison of Fast Wave Antenna Loading in DIII-D with Theoretical and Computational Models Incorporating Measured Profiles*

R.I. Pinsker[1], D. Milanesio[2], R. Maggiora[3], N. Commaux[3], E.J. Doyle[4], G.R. Hanson[3],
A. Nagy[5], M. Porkolab[6], P.M. Ryan[3], and L. Zeng[4]

[1]*General Atomics, PO Box 85608, San Diego, California 92186-5608, USA*

[2]*Politecnico di Torino, Dipartimento di Elettronica, Torino, Italy*

[3]*Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, Tennessee, USA*

[4]*University of California-Los Angeles, Los Angeles, California 90095-7099, USA*

[5]*Princeton Plasma Physics Laboratory, Princeton, New Jersey 08543-0451, USA*

[6]*Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*

Plasma heating using compressional Alfvén waves [“fast waves" (FWs)] in the ion cyclotron range of frequencies is a well-established technique in magnetic confinement devices and is part of the ITER day-one heating systems. The large plasma/FW antenna distance foreseen for ITER implies a light antenna load resistance, which will necessitate an antenna rf voltage stand-off near the upper end of what has been demonstrated in experiments. In view of the uncertainties in the far scrape-off layer density profiles in ITER, a crucial point is the rate of decay of the antenna loading as the plasma/antenna distance is increased [1, 2]. In this work, detailed measurements of the resistive and reactive components of the FW antenna loading in DIII-D are compared with predictions from the TOPICA code [3] and from simple slab models of the edge plasma region. Edge density profiles measured with X-mode reflectometers are used in the code calculations. The loading obtained in dynamic scans of the plasma/antenna distance under both L- and H-mode conditions is compared with TOPICA calculations, and very good absolute agreement between the measured and predicted loading is obtained without any adjustable parameters in the TOPICA model. These results indicate that a quantitative understanding of the FW coupling process is in hand, given a precise knowledge of the edge density profiles. Consequently, TOPICA may be used to optimize ICRF antenna designs.

References

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