2D THEORY OF LH GRILL COUPLING AND EFFICIENT FULL WAVE CODE

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Lower hybrid (LH) waves are very important for heating and current drive in contemporary tokamaks. A slowdown structure is required for launching waves at these frequencies. Phased arrays of rectangular waveguides are frequently used for this purpose. While the simple 1D coupling theory of parallel plate waveguides to a plasma slab with linear density profile was successful [1], it nevertheles ignored the coupling of the fast to slow wave in the inaccessible region as well as the effect of any poloidal magnetic field (i.e. it ignored inhomogeneous magnetic shear and any B-field that is oblique to the long walls of the waveguides). These drawbacks were overcome by 2D full wave grill theory [2] assuming rectangular waveguides. However, for large structures, this method is rarely used as its direct implementation requires evaluation of a very large number of 2D infinite integrals in the $k$-space for coupling elements [3]. However, by clever use of symmetry rules and working with high order Gaussian quadratures and 2D B-splines for the integrands in the $(N_{pol}, N_{tor})$ – space we have overcame this drawback. At the same time, we have adopted an efficient accurate algorithm to determine the eigenmodes exited by the LH grill in the so-called inaccessible $N_{tor}$-region and clarified the role of collisions. We discuss the significance of a singularity in $(N_{pol}, N_{tor})$ – plane and its influence on the first super-intensive eigenmodes. We also consider the effect of the eigenmodes on the electric field in front of grill.

As an example, we determine the spectra of two different LH grills: an 8-waveguide grill at 1.3 GHz on COMPASS tokamak and the 5-waveguide circular grill at 2.45 GHz on WEGA stelarator. The 3D electric field in front of these structures is determined.