Effects of SOL on Lower Hybrid Wave Coupling and Current Drive Performance on Alcator C-Mod*

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The lower hybrid current drive (LHCD) system on the Alcator C-Mod tokamak is designed to investigate non-inductive operation under conditions similar to those expected for ITER [1]. An innovative LH launcher based on a novel four-way-splitter concept has been installed and operated at net power densities up to 50 MW/m^2. Although the reflection coefficient can be reduced to as low as $\approx 15\%$ in optimized conditions, its amplitude is usually higher than simulations predicted at the design stage for typical Alcator C-Mod SOL density parameters. The reflection coefficient was observed to increase at higher launched $n_\| \equiv ck_\|/\omega$, suggesting that the waves have to tunnel through a millimetric evanescent layer between the plasma and the launcher. Subsequent edge density profile measurements by means of an X-mode SOL reflectometer [2] were able to accurately document density depletion in the presence of high power LHRF. Good coupling was recovered for non-perturbative power level experiments (few Watts), confirming the role of high power LHRF waves on the edge plasma profiles. The measured reflection coefficients and density profiles were well reproduced by means of a fullwave Finite Element Method (FEM) simulation in which the density depletion by ponderomotive forces is self-consistently taken into account via an iterative approach. This model has been verified with previous 1-D calculations [3] and has been seamlessly extended to efficiently model arbitrary 2-D or 3-D geometries. Considering a realistic geometry further exacerbates the density depletion in front of the launcher and is a key ingredient to get good agreement with the reflectometer measurements. The characterization of the plasma behavior in the vicinity of the coupler fits into a broader investigation taking place at Alcator C-Mod, which aims at understanding the role of the SOL on the LHCD efficiency [4]. In particular, focus has been given to the loss of current drive which is observed at high density. Several experimental observations, supported by ray tracing/Fokker-Planck modeling, suggesting this is due to collisional absorption in the SOL [5]. Ray tracing simulations need to be compared with fullwave simulations including a SOL model to asses the validity of the eikonal approximation in this region of the plasma. Recent experimental results in this area will be highlighted and a direct comparison between ray-tracing and the LHEAF fullwave code [6] will be presented.

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