Full Wave Simulations of Fast Wave Scrape-off Layer Losses of NSTX/ NSTX-U in Mid/High Harmonic Regime and a Comparison with C-Mod/EAST in the Minority Heating Regime

N. Bertelli[1], E. F. Jaeger[2], J. C. Hosea[1], R. J. Perkins[1], C. K. Phillips[1], and G. Taylor[1]

[1]*Princeton Plasma Physics Laboratory, Princeton, New Jersey 08543, USA*
[2]*XCEL Engineering Inc., 1066 Commerce Park Drive, Oak Ridge, Tennessee 37830, USA*

Lead-author e-mail: nbertell@pppl.gov

Recent experimental studies of high harmonic fast wave (HHFW) heating on the National Spherical Torus eXperiment (NSTX) have demonstrated that substantial HHFW power loss can occur along the open field lines in the scrape-off layer (SOL) when edge densities are high enough that the fast waves can propagate close to the launcher. For several decades, RF modelling codes have neglected the presence of the SOL, concentrating instead on understanding the wave dynamics in the core plasma bounded by the last closed flux surface LCFS. In this work we examine fast wave propagation and power loss in the SOL of tokamak plasmas by using the full wave code AORSA, with the edge plasma beyond the LCFS included in the solution domain and with a collisional damping parameter used as a proxy to represent the real, and most likely nonlinear, damping processes. 2D and 3D AORSA results for the NSTX, show a strong transition to higher SOL power losses (driven by the RF field) when the FW cut-off is removed from in front of the antenna by increasing the edge density. Predictions for NSTX-Upgrade (NSTX-U) indicate similar result obtained for NSTX. However, an important difference is that the transition to high losses is predicted to occur at higher densities (about a factor two) in NSTX-U, indicating a wider SOL density range in which the experiment can run with lower SOL power losses. This result will be further verified in the upcoming NSTX-U experimental campaign. As a comparison, full wave simulations have been extended to "conventional" tokamaks with higher aspect ratios, such as Alcator C-Mod and EAST devices, which unlike NSTX/NSTX-U that operate in the mid/high harmonic regime, operate in the minority heating regime. In the minority heating regime AORSA results indicate lower SOL power losses with increasing density in front of the antenna, in agreement with the experimental observation that increasing the density in front of the antenna leads to better antenna-plasma coupling.

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