Field-Aligned SOL Losses of HHFW Power and RF Rectification in the Divertor of NSTX

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The National Spherical Torus eXperiment (NSTX) can exhibit a major loss of high-harmonic fast wave (HHFW) power to the upper and lower divertor regions along scrape-off layer (SOL) field lines passing in front of the antenna, resulting in bright and hot spirals on both the upper and lower divertor regions. This appears to be a fast-wave propagation effect, but it is not clear whether it is general to fast-wave systems or specialized to the HHFW regime or to spherical-tokamak geometry [1]. One possible mechanism for converting wave power into a heat flux is RF sheaths forming at the divertors. We present swept-voltage Langmuir probe characteristics for probes under the spiral that are shifted relative to those not under the spiral in a manner consistent with RF rectification. From this shift in characteristics, we estimate both the magnitude of the RF voltage across the sheath and the sheath heat flux transmission coefficient in the presence of the RF field [2]. Although precise comparison between the computed heat flux and infrared (IR) thermography cannot yet be made, the computed heat deposition compares favorably with the projections from IR camera measurements. The RF sheath losses, calculated in this fashion, are significant and contribute substantially to the total SOL losses of HHFW power to the divertor for the cases studied. This work will guide experimentation on NSTX-U, where a wide-angle IR camera and a dedicated set of coaxial Langmuir probes for directly measuring the RF sheath voltage will quantify the contribution of RF sheath rectification to the heat deposition from the SOL to the divertor.

This work is supported by USDOE Contract No. DE-AC02-09CH11466.

[1] N. Bertelli *et al.*, presentation at this workshop.

[2] R. J. Perkins *et al.*, Phys. Plasmas **22**, 042506 (2015).