Identifying and quantifying mechanisms responsible for the substantial loss of HHFW power in the SOL of NSTX

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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 [1-4]; up to 60% of the coupled HHFW power is observed to be missing from the core [1,2]. Recent simulations using AORSA [5] have verified that the RF fields in the SOL become significant as the right-hand cutoff for fast waves is moved toward and beyond the antenna [6], but the underlying mechanism(s) by which these fields produce a heat flux on the divertor has not yet been identified. Possible candidates for the loss mechanism(s) are: (1) a two-stream instability of the RF currents; (2) far-field RF sheaths at the divertor; and (3) parametric decay instability of the HHFW wave into an ion Bernstein wave. Here we investigate the possible contributions of each candidate mechanism and compare them to experimental estimates of the losses [7]. We also constrain the candidate mechanisms by using the numerically-computed RF fields to estimate the losses and compare these to experiments. This work will guide future experimentation on NSTX-U and other machines in definitely identifying the mechanisms and minimizing their effects, which is important for optimizing high-power long-pulse ICRF heating on ITER while guarding against excessive erosion in the divertor region.

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