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Advances in High-Harmonic Fast Wave Physics in the National Spherical Torus Experiment[1]

GARY TAYLOR, Princeton Plasma Physics Laboratory, Princeton University

Improved core high-harmonic fast wave (HHFW) heating, particularly at longer wavelengths and during low-density start-up and current ramp-up, has now been obtained by lowering the edge density with lithium conditioning, thereby moving the propagation onset away from the vessel wall. Significant core electron heating of deuterium neutral beam injection (NBI) fuelled H-modes has been observed for the first time over a range of launched wavelengths. The observed broadening of the electron heating profile in H-mode relative to L-mode plasmas is consistent with simulations obtained with ray tracing and full wave models. Newly taken camera images indicate that fast wave interactions can deposit considerable RF energy on the outboard divertor plate, especially at longer wavelengths that begin to propagate closer to the vessel walls. Edge power loss can also arise from HHFW-generated parametric decay instabilities that drive ions in the edge onto direct loss orbits that intersect the wall, and may be the cause for an observed drag on edge toroidal rotation in combined HHFW and NBI discharges. Fast-Ion D-alpha emission clearly shows fast-ion profile broadening in the plasma core that is much greater than predicted by Fokker-Planck modeling when HHFW power is applied to NBI-fuelled plasmas, pointing to the need for a full-orbit treatment in the simulation. Large ELMs have been observed immediately following the termination of RF power, whether the power turn off is programmed or due to antenna arcing. RF power has been successfully applied during large ELMs by setting the source reflection coefficient trip levels to relatively high values – an approach potentially important for ITER ICRF heating. Plans for an HHFW ELM-resilience upgrade will be presented.

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