Suggested Topical Area: EX-W

Recent Developments in High-Harmonic Fast Wave Physics in NSTX*

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Understanding the interaction between ion cyclotron range of frequency (ICRF) fast waves and the fast-ions created by neutral beam injection (NBI) is critical for future devices such as ITER, which rely on a combination ICRF and NBI. Experiments in NSTX which use 30 MHz High-Harmonic Fast-Wave (HHFW) ICRF[1] and NBI heating show a strong competition between electron heating via Landau damping and transit-time magnetic pumping, and rf acceleration of NBI generated fast ions. Understanding and mitigating some of the rf power loss mechanisms outside the last closed flux surface (LCFS) has resulted in improved rf heating inside the LCFS. First wall lithium coating was found an effective tool in achieving these goals. A similar magnitude of rf power is absorbed by the fast ions and electrons within the LCFS.

Experimental observations point toward the rf excitation of surface waves[2], which disperse wave power outside the LCFS, as a leading loss mechanism. Lithium coatings lower the density at the antenna, thereby moving the critical density for perpendicular fast-wave propagation away from the antenna and surrounding material surfaces. Visible and infrared imaging reveal flows of rf power along open field lines into the divertor region.

When rf power is coupled to NBI plasmas the neutron production rate (S_n) increases and the fast-ion profile broadens and is enhanced[3], indicative of a significant interaction of fast waves with NBI fast ions. Power deposition into the fast ions can be estimated by comparing the measured S_n to that predicted by the TRANSP code which includes the TORIC[4] full-wave code, and by the CQL3D[5] Fokker-Planck code.

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