DPP07-2007-001130

Abstract for an Invited Paper
for the DPP07 Meeting of
the American Physical Society

The Relationship between Type I ELM Severity and Perturbed Electron Transport in NSTX[1]

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NSTX provides a unique test bed for probing electron transport due both to its significant role in the steady-state power balance and features of the electron response to transient perturbations. In neutral-beam-heated plasmas in NSTX, most of the heating power is deposited on the electrons. Following large Type I ELMs in some H-mode NSTX discharges, global Te profile declines of 10-30% amplitude are observed. While the soft X-ray data indicates that the ELM itself is causing only a peripheral T_e perturbation, the inward propagation of the cold pulse initiated by the ELM is unusually fast ($\sim$ms timescale) and can extend to the core of the plasma. The perturbed electron thermal diffusivity is $\sim$300 m^2/s for $r/a > 0.4$, and $\sim$30 m^2/s for $r/a < 0.4$. However, in high-triangularity regimes, which exhibit smaller Type I ELM perturbations and an energy loss of a few percent, the perturbation propagation time of several ms implies a perturbed electron thermal diffusivity of 10-20 m^2/s across the plasma radius. Comparison of the ELM energy loss with the electron thermal diffusivity inferred from both ELM and pellet induced 'cold pulses', shows a rough proportionality between the ELM magnitude and the perturbed electron thermal diffusivity. Furthermore, comparisons of the linear growth rates of instabilities calculated with the GS2 code show large differences between the large and small Type I ELM regimes. In particular, the ETG mode is the dominant instability following large ELMs, but absent during the small Type I ELM. Interestingly, high-k measurements during ELM events show an increase of short wavelength fluctuations in both the core and edge regions of the plasma, with the increase in amplitude most prominent at wavenumbers of 14-16 cm^{-1}. These results suggest that electron thermal transport plays an important role in determining the total energy loss from Type I ELMs.

[1]supported by US DOE contract DE-AC02-76CH03073 at PPPL.