NSTX Research on the Physics of High-Performance ELM-Free Regimes

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Recent NSTX analysis has focused on understanding quasi-steady high-performance regimes devoid of large ELMs; these studies have focused on i) the Enhanced Pedestal H-mode (EP H-mode), ii) transport and turbulence in the ELM-free, lithium PFC conditioned H-mode pedestal, and iii) the physics of observed low-amplitude edge harmonic oscillations (EHOs), with the ultimate goal of driving those modes to large amplitude. With regard to the EP H-mode, identified as a confinement regime with very steep ion temperature gradients that is often triggered by an ELM, new long-pulse examples have been found. Examination of the profile shapes shows that the region of steep T_i gradient can be at the plasma edge, or shifted substantially inwards; this gradient is always accompanied by a region of strong toroidal flow shear. However, there is no ubiquitous reduction in turbulence in EP H-mode. Triggering of the EP H-mode transition can be achieved by selecting scenarios with known favorable ELM dynamics, or by externally triggering the ELMs by 3D fields. With regard to pedestal turbulence and transport in ELM-free regimes, the lack of ELMs, along with changes to the carbon transport due to modifications of the main-ion temperature and density profiles, explains the core carbon accumulation in discharges with lithium PFC conditioning, though anomalous carbon transport in the pedestal is required to explain the details of the profile shapes. The enhancement of neoclassical lithium diffusivities due to the high carbon concentration is partly responsible for the low lithium core concentration. Experimental analysis of pedestal turbulence amplitudes from BES show trends consistent with TEM/KBM turbulence drives; the trends are notably inconsistent with ITG driven turbulence. Research into observed weak EHOs in NSTX using the BES diagnostic has confirmed that the modes are located at the very edge of the plasma, and that the pedestal is near the peeling stability boundary. Calculations of the coupling of the NSTX-U HHFW antenna to the plasma, motivated by the desire to stimulate these modes to larger amplitude where they may have an effect on the transport, show that the coupling in NSTX-U will be best at low values of q_{95}.