H-mode Access and ELM Characterization on NSTX*

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Abstract. Edge parameters play a critical role in H-mode access, which is a key component of discharge optimization in present day toroidal confinement experiments and next generation device designs. Because the edge magnetic topology of a spherical torus (ST) differs from a conventional aspect ratio tokamak, H-modes in STs may exhibit important differences as compared with tokamaks. We quantify the dependence of the NSTX edge plasma on heating power, including the L-H transition requirements and the occurrence of edge-localized modes (ELMs), and on divertor configuration. The threshold power for the H-mode transition in NSTX is generally above a recent ITER scaling. For example, in 600 kA, 0.45 T lower single-null (LSN) divertor discharges, an H-mode transition occurred at ~315 kW of NBI power and a total loss power of ~ 650 kW, about 3 times the scaling prediction. Correlations of transition and ELM phenomena with turbulent fluctuations revealed by Gas Puff Imaging (GPI) and reflectometry are observed. In both LSN and double-null divertor (DND) discharges, the density peaks off-axis, sometimes developing prominent "ears" which can be sustained for many energy confinement times, τ_E, in the absence of ELMs. H-mode transitions in LSN are typically accompanied by a 50-100% increase in τ_E. There is a class of high β, high triangularity DND plasmas in which confinement prior to the H-mode transition is already improved, up to 1.2 times ITER98pby(2), and τ_E improves by only ~ 20% from the L-mode to the ELM-free H-mode. In these discharges, the density profile has a low peaking factor of ~1.2 and a more peaked T_e profile (peaking factor ~2). Transition to H-mode in these DND plasmas produces a rapid increase in edge n_e and reductions in central T_e, T_i, and central rotation by 25-50%. The interplay between enhanced core and edge confinement governing the global τ_E increase will be discussed.

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