Advanced Tokamak Physics Studies on an Intermediate-Scale Spherical Tokamak

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The H-mode confinement regime is achieved at near-unity aspect ratio (A < 1.2) on the Pegasus Toroidal Experiment. Ohmic H-mode is attained in both limited and diverted configurations through the use of high-field-side fueling. Features of the L-H transition are: reduced D_α emissions; formation of a quiescent edge and an edge current pedestal; improved energy confinement; and the presence of ELMs. Increased central heating is inferred from passive ion spectroscopy and Thomson scattering measurements. With no external momentum input, core impurity rotation continuously accelerates from near rest to ~15 km/s in the counter-I_p direction following the transition. The measured energy confinement is consistent with the ITER98pb(y,2) scaling. On Pegasus, the lowest-A device to have accessed H-mode, the power threshold (P_{th}) exceeds predictions from high-A empirical scalings by a factor of ~11. This result complements earlier findings from MAST and NSTX and implies that the required threshold power becomes increasingly higher than predicted by the conventional high-A scaling as A decreases. Modest temperatures and pulse lengths in Pegasus allow the use of insertable probes to measure the properties of the edge plasma with high spatial and temporal resolution, even in ELMy H-mode. Two classes of ELMs have been identified to date by their proximity to the power threshold and measured n spectra. Small, Type III-like ELMs are present at input power $P_{OH} \sim P_{th}$ and have $n \leq 4$. At $P_{OH} >> P_{th,}$ they transition to large, Type-I-like ELMs with intermediate $5 < n < 15$. These general mode numbers are opposite those seen at large A and reflect the increased peeling drive present at low A. The unique operating characteristics available at A~1 in Pegasus allow long-sought measurements of the time evolution of the $J_{edge}(R)$ pedestal collapse during an ELM event. They show a complex, multimodal pedestal collapse and the subsequent ejection of a current-carrying filament.

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