FOR ABSTRACT SUBMISSION

Paper Title

H-mode and Non-Solenoidal Startup in the Pegasus Ultralow-A Tokamak

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Abstract Text: Enter the abstract in one continuous paragraph (maximum 2400 characters including spaces); text exceeding the space limit will be truncated. Do not use mathematical characters or expressions, Greek or other symbols, and superscripts or subscripts. The size of the text box cannot be exceeded.

Studies at near-unity aspect ratio offer unique insights into the high confinement (H-mode) regime and support development of novel startup scenarios. Ohmic H-mode operation has been attained at A < 1.3. Edge plasma parameters permit probe measurements of the edge pedestal, including the local current density profile, with high spatial and temporal resolution. H-mode plasmas have standard L-H transition phenomena: a drop in D_alpha radiation; the formation of pressure and current pedestals; field-aligned filament ejection during ELMs; and a doubling of energy confinement time from H_98 ~ 0.5 to ~1. The L-H power threshold P_LH increases monotonically with n_e, consistent with the ITPA08 empirical scaling used for ITER and the theoretical FM3 model. Unlike at high A, P_LH is comparable in limited and single-null diverted topologies at A ~ 1.2, consistent with FM3 predictions. The magnitude of P_LH exceeds ITPA scalings by an order of magnitude, with P_LH/P_ITPA08 increasing as A approaches 1. Multiple n modes are observed during two classes of ELMs, consistent with excitation of multiple peeling-ballooning modes. Small, Type III-like ELMs occur at P_OH ~ P_LH with n <= 4. Large, Type-I-like ELMs occur with P_OH > P_LH and intermediate 5 < n < 15. Helical edge current injection appears to suppress Type III ELM activity. J_edge(R,t) measurements across single ELMs show the nonlinear generation and expulsion of current-carrying filaments during the ELM crash. Local Helicity Injection (LHI) offers a nonsolenoidal tokamak startup technique. Helicity is injected via current sources at the plasma edge. A circuit model that treats the plasma as a resistive element with time-varying inductance reasonably predicts I_p(t). The electron confinement governs the power balance. Initial measurements show peaked T_e and pressure profiles, which are comparable to Ohmic-like transport or moderately stochastic confinement. Extrapolation suggests I_p ~ 1 MA may be achievable in NSTX-U. Resistive MHD simulations suggest I_p is built from current rings injected during reconnection between unstable helical current streams. Several experimental observations support this model: imaging of the merging current streams; n=1 MHD activity localized in the plasma edge; and anomalously high impurity ion heating in the edge region.