

Experimental studies of L-H confinement transition on Alcator C-Mod

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The low-to-high confinement (L-H) transition has been experimentally studied on Alcator C-Mod. It is seen that the dependence of H-mode power threshold (P_{th}) on plasma density, toroidal magnetic field, and the positioning of X-points/strike points are more complicated than those suggested by the prevailing empirical scaling law [1]. It is found that the scaling with plasma density is nonlinear, with a local minimum between $1.1 \times 10^{20} \text{m}^{-3}$ and $1.5 \times 10^{20} \text{m}^{-3}$ for 5.4T plasmas, independent of plasma current. Rather than scaling strictly linear with toroidal field, power threshold has a B_T dependence that changes depending on the density range chosen. An experiment performing X-point/strike point scans revealed a clear anti-correlation between P_{th} and outer divertor leg length, where the reduction of P_{th} can be up to a factor of 3. Local edge conditions (e.g. $T_{e,95}$, $n_{e,95}$, $P_{e,95}$) and their spatial gradients at the L-H transition are also characterized as a function of density, current and toroidal field. Plasma current dependence was not identified in scaling of local edge conditions, but emerges in that of their spatial gradients. As in P_{th} , the magnetic field dependence is found to differ in different density ranges. A model based on resistive-ballooning mode stabilization [2] was tested using C-Mod experimental data, extending earlier work [3]. The L- and H-mode operational space predictions from the model agree reasonably well with experimental observations. In addition, the critical edge T_e scaling with density and magnetic field suggested by the theory generally are supported by experimental data. L-H transition experiments at low density have yielded both ELMy H-mode and I-mode. ELMy H-modes were accessed in high current (low q) low density plasmas with typical equilibrium magnetic configuration; I-mode was observed in some low density ($\bar{n}_e \sim 0.6 \times 10^{20} \text{m}^{-3}$) ICRF heated plasmas with ion grad-B drift directed toward the X-point before accessing H-mode.

[1] Y. Martin, J. Phys. Conf. **123** (2008) 012033

[2] J.W.Connor, PPCF **42** (2000)

[3] A.E.Hubbard, PPCF **40** (1998) 689