Abstract

Future commercial fusion power plants likely need to operate in regimes with high energy confinement. In tokamak-based concepts one of the most attractive high confinement states is the H-mode exhibiting a strong transport barrier just inside the separatrix separating the confined plasma region from the scrape-off layer (SOL) above a certain ion heat flux through the plasma edge. In the past 30 years enormous progress has been made to understand the access to H-mode but a predictive theory based on first principles is still lacking. Hence, the access requirements for future devices are still based on empirical scaling laws for the threshold power such as $P_{L2H} = 0.05 B_t^{0.8} n_{20}^{0.7} S^{0.9}$ [1] (B_t: toroidal field on the geometric centre in T, n_{20}: electron density in $10^{20} m^{-3}$, S: plasma surface) derived by regression from a multi-machine database. Extrapolations based on this regression have a large uncertainty and are also only valid above a certain density as $P_{L2H}(n_e)$ is a non-monotonic function with a minimum. Furthermore, dedicated investigations on individual devices show a strong sensitivity of P_{L2H} that are now captured by the variables usually used for the regression such as wall conditions, magnetic divertor configuration, the ion ∇B drift direction with respect to the X-point and plasma flow. In this talk a review of some of the most sensitive factors is given to stimulate the discussion. Of particular interest are effects that defy our current understanding of the transition based on the physics on closed flux surfaces only such as the impact of the SOL.

[1] YR Martin, T Takizuka, i the ITPA CDBM H-mode Threshold Database Working Group, 'Power requirement for accessing the H-mode in ITER', *J Phys Conf Ser*, vol. 123, núm. 1, p 12033, 2008.