DPP14-2014-000591

Abstract for an Invited Paper
for the DPP14 Meeting of
the American Physical Society

The Quiescent H-mode Regime for High Performance ELM-Stable Operation in Future Burning Plasmas[1]

A.M. GAROFALO, General Atomics

Recent experiments on DIII-D have increased confidence in the ability to achieve high confinement, ELM-stable operation on ITER through implementation of the quiescent H-mode (QH-mode) regime. By tailoring the plasma shape to improve the edge stability, the QH-mode operating space has been extended to densities exceeding 70% of the Greenwald limit, overcoming the long-standing low-density limit of QH-mode operation. In addition, the simultaneous achievement of QH-mode at ITER relevant values for beta, confinement, and safety factor sustained for many energy confinement times in an ITER similar shape has been demonstrated for the first time. QH-mode provides excellent energy confinement, even at near zero plasma rotation, while operating without ELMs and with strong impurity transport via the benign edge harmonic oscillation (EHO). Peeling-ballooning theory of the plasma edge explains the EHO as a saturated kink-peeling mode, and predicts that ITER will operate in the edge regime where QH-mode can exist. In the theory, the density range over which the plasma encounters the kink-peeling boundary widens as the plasma cross-section shaping is increased, thus increasing the QH-mode density threshold. The DIII-D results are in excellent agreement with these predictions, and non-linear MHD analysis of reconstructed QH-mode equilibria shows unstable low n kink-peeling modes growing to a saturated level, consistent with the theoretical picture of the EHO. Furthermore, high density operation in the QH-mode regime has opened a path to a new, previously predicted region of parameter space dubbed "Super H-mode," characterized by very high pedestals that can be more than a factor of two above the peeling-ballooning stability limit for similar ELMing H-mode discharges at the same density.

[1]Supported by the US Department of Energy under DE-FC02-04ER54698.