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EX/1-3: Progress in Performance and Understanding of Steady ELM-free I-modes on Alcator C-Mod

Tuesday, 9 October 2012 14:00 (4h 45m)

The I-mode regime of operation has been extended in recent Alcator C-Mod campaigns in duration and robustness, over a wide range of parameters. This attractive regime features an edge thermal barrier, and H-mode like energy transport, in combination with L-mode like density profiles and particle transport. This prevents accumulation of impurities, and means that ELMs are not needed to expel them. I-modes are now routinely maintained in stationary conditions for over 10 Tau_E. They are usually ELM free, a key advantage given the concern over divertor heat pulses on ITER. Instead, a continuous pedestal fluctuation appears to enhance selectively particle over thermal transport [2]. High performance I-modes are usually obtained with unfavourable ion drift direction. They have been produced in both upper and lower null plasmas, with q_95= 2.5-5.3 and extending to low nu*. Tau_E is in the range of H-mode, with H98,y2 up to 1.2, and exhibits less degradation with power (W˜Pˆ0.7). Power thresholds for I-mode are somewhat higher than typical L-H scalings, and increase with Ip as well as with density. The widest power range for I-mode, nearly a factor of two above the L-I threshold, has been obtained in reversed field, lower null discharges at moderate ne. Detailed measurements have been made of profiles and turbulence in the edge pedestal region, aiming to understand the separation of particle and energy transport. At the L-I transition, broadband turbulence in the 50-150 kHz range decreases. A pedestal-localized weakly coherent mode at ˜200-250 kHz is observed on density, magnetic and Te diagnostics [3]. Stability analysis using ELITE shows that the pedestal is deeply stable to peeling-ballooning modes, consistent with the lack of ELMs. Initial assessments of the potential application of the I-mode regime on ITER, extrapolating from C-Mod results, indicate that an attractive operating scenario is possible, if issues of operation in the unfavourable drift configuration can be addressed. The L-I transition should be accessible at low density, and Q=10 is projected at n¬e_95 =5x10ˆ19 m-3. This exercise also highlights some of the key issues remaining to be addressed, on C-Mod and in joint experiments.
[1] Whyte D G et al 2010 Nucl. Fusion 50 105005 [2] Hubbard A E et al 2011 Phys. Plasmas 18 056115 [3] White A E et al Nucl. Fusion 51 (2011) 113005

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