Tests of ITER limiter L-mode SOL power width scaling in DIII-D*

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An experiment aimed at benchmarking the scrape-off layer (SOL) power width scaling in limited L-mode discharges adopted for ITER [1] has been conducted on DIII-D. The ITER first wall is designed to allow plasma start-up and ramp down on the actively cooled beryllium panels, with options for both low field side and high field side limited plasmas. The power handling is determined by both the panel shaping and the parallel heat flux density, the latter characterized by the SOL power flux density e-folding length, λ_q. In the ITER thermal load specifications [1], the limiter phase λ_q is derived from a modified L-mode divertor plasma scaling based mostly on JT-60U and JET results. In DIII-D we have used inner-wall-limited (IWL) plasmas and scanned the main scaling parameters, plasma density, n_e, plasma current, I_p, and power into the SOL, P_{SOL}. Using the near-SOL density and temperature e-folding lengths, λ_n, λ_T, determined from reciprocating Langmuir probe measurements made near the outer midplane, λ_q is derived assuming $T_e = T_i$ in the SOL. The measurements show that λ_n and λ_T are correlated ($\lambda_T \sim 1.2\ \lambda_n$) and both are up to 2.5 times larger in IWL configurations than in lower single null (LSN), in agreement with ITER assumptions. In moderate elongation ($\varkappa$~1.4) IWL discharges, λ_q is largest and agrees with the assumed ITER scaling within a factor of ~2. In LSN discharges with attached outer strike point, IRTV and probe measurements of λ_q agree within a factor of ~2. In IWL discharges, the measured λ_q are consistent with the expectations of simple SOL power balance. Scaling dependencies of λ_q on the individual discharge parameters are not clear from our data. However, the fact that scaled JT-60U and JET data agree with the DIII-D measurements supports the strong machine size dependence ($\lambda_q \propto R^2$, where R is the major radius) assumed by the ITER scaling.

[1] A. Loarte, et al., Proc. 22nd IAEA Fusion Energy Conf., IT/P6-13 (2008)

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