Scaling of Divertor Heat Flux Profile Widths in DIII-D*

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The width of the divertor heat flux profile $w_{q,div}$ is of great interest in future large tokamaks as well as many present devices. Previous studies examining the parametric dependence of $w_{q,div}$ have arrived at diverse scalings. We attempt here to perform a new series of experiments in DIII-D under controlled conditions to obtain scaling of the divertor heat flux peak value, profile width, and divertor plate power as a function of plasma input parameters and scrape-off layer power, while accounting for as many independent variables as possible, with the maximum number of divertor and scrape-off-layer (SOL) diagnostics brought to bear.

We performed measurements in lower single-null ELMing H-mode diverted configurations that were not strongly pumped due to the strike-point positions. We varied the plasma current I_p by a factor of 2.6 at constant toroidal field (B_t) and density by a factor of 1.6 at constant I_p and B_t. The neutral beam injected power was changed by by a factor of 6.2 at constant I_p and B_t, B_t by a factor of 1.6 at constant I_p. We varied B_t/I_p at constant q_{95}. The divertor heat flux was calculated from infrared camera measurements using a new high-resolution fast-framing IR camera. Bolometer arrays were used to record radiated power from the plasma.

The IR camera recorded diverter plate surface thermal emission at many-kilohertz frame rates through the whole discharge, so that time-averaged data as well as rapid changes due to ELMs were obtained. The heat flux at each position in the radial profile was calculated at each of the times steps using the THEODOR 2D heat flux analysis code (up to 80,000 time points per discharge). The analysis will show scaling of the divertor heat flux peak value, profile width, and divertor plate power as a function of the parameters varied, but also as a function of power crossing out through the separatrix as determined from divertor power and 2-D radiated power bolometer measurements. Scaling results will be compared with published results from other devices where available. We also examine the variation of ELM heat flux profile width at the divertor plate with the parameter variations above.

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