Edge and Divertor Profiles During ELM-free Quiescent H-mode Operation on DIII-D *

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The quiescent H-mode (QH mode) is a quasi-stationary edge localized mode (ELM) free mode of operation with high global energy confinement, a high edge pressure pedestal, and controlled density. It is observed on DIII-D during beam heated discharges with the plasma current direction opposed to the direction of beam injection. High normalized performance levels (β_N H_{ITER89} ~ 7 for >10 τ_E) have been achieved in QH mode discharges with stable density profiles. This paper presents edge and divertor plasma properties of the QH mode plasmas in DIII-D. This high confinement mode is of interest for future machines particulary due to its lack of ELMs. Type 1 ELMs are commonly observed during long-pulse high performance operation on today's major tokamaks. Because these ELMs are predicted to impulsively heat the divertor strike plate on ITER past the ablation limit, high confinement modes with no ELMs are of interest both as a possible operation mode and as a means for understanding the stability of the edge pedestal.

Edge electron and ion density and temperature profiles during QH and ELMing operation in the same discharge have been measured using Thomson scattering, reflectometry, and charge exchange recombination spectroscopy. Edge current profiles have been derived self consistently using the measured plasma profiles, neoclassical bootstrap models and equilibrium reconstruction from the external magnetics data. In some cases, comparison of the resulting magnetic field pitch angles in the plasma edge to Li beam polarimetry data are used to benchmark the edge current reconstruction. The measured edge plasma pressure and current profiles will be used in edge stability modeling (ELITE, GATO, DCON). Comparison of the ELMing and QH phases will provide an assessment of the nature (e.g. peeling or ballooning) of the ELM instability in these discharges.

Although the impulsive heating from ELMs is missing, the QH mode typically operates at low normalized density, where high continuous divertor heat flux is expected. However, unusually broad footprints of heat flux and ion flux at the outer divertor strike plate are observed, lowering the observed peak heat flux wall below the expected value. In addition, we have been able to increase the pedestal density more than a factor of 2 using strong shaping coupled with reduced exhaust efficiency.

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