Quiescent H-mode, an ELM-Free High-Confinement Mode on DIII-D With Potential for Stationary State Operation*

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The quiescent H-mode (QH–mode) is a new ELM-free and stationary state mode of operation discovered on DIII-D. This mode achieves H–mode levels of confinement and pedestal pressure while maintaining constant density and impurity levels. The elimination of edge localized modes (ELMs) while maintaining good confinement and good density control is of interest to next generation tokamaks, where the energy reaching the divertor during an ELM may be sufficient to cause excessive ablation of plasma facing components. In this paper we will report on the range of plasma parameters over which this mode has been explored in DIII-D and on experiments to extend the operating range of this mode.

The QH-mode has been observed in beam heated discharges with the beam injection direction counter to the plasma current. Injected powers range from 2.3 MW to 15.7 MW. The edge of the plasma exhibits a sharp pressure pedestal near the separatrix, comparable to the pedestal observed during ELMing H-mode. In most cases the discharge is strongly cryopumped and the electron density at the top of the pedestal ranges from 0.15 to 0.3 of the Greenwald density. To date, the QH-mode has been observed with plasma currents ranging from 0.8 to 2.0 MA, and q_{95} values from 3.1 to 8. Shape configurations range from upper single null, to nearly balanced double null, to lower single-null.

The QH-mode is usually accompanied by a saturated, coherent, multi-harmonic edge electromagnetic mode (EHO). The EHO is observed in magnetic probes on both the inboard and outboard sides of the plasma. The frequency of the n=1 toroidal mode typically lies between 5 and 11 kHz. The oscillation is also seen in the density near the separatrix and the divertor strike plate. The low pedestal densities would be expected to lead to very narrow and intense heat flux profiles in the divertor, but infrared camera data shows a rather broad profile with the peak heat flux about a factor of two less than similar ELMing discharges. Perhaps this is due to EHO induced radial transport. When the QH-mode is coupled with an internal transport barrier, the performance of the plasma can be very good, with $\beta_N * H_{89L}$ product reaching 7 for >10 confinement times.

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