

Impurity Confinement Times in QH-mode Plasmas is Shorter Than ELMing Plasmas in DIII-D*

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Impurity particle confinement in the presence of the edge harmonic oscillation (EHO) in stationary, quiescent H-mode discharges in DIII-D is comparable to or below the impurity confinement in ELMing plasmas (Fig. 1). This indicates that the EHO is effective at maintaining steady density control without ELMs, and also maintaining core impurity flushing. As the external torque from neutral beam injection is lowered, the global energy confinement time increases in the QH-mode operating regime, making this attractive for future devices with low relative torque from neutral beams. By controlled scans of neutral beam torque on repeat discharges, we observe an increase in the energy confinement, while the impurity confinement time does not display any increase. The efficiency of impurity flushing by the EHO is comparable for both low ($n=1$) and high (broadband) toroidal mode number fluctuations. This is advantageous for QH-mode operation at low torque because the high- n EHO exhibits less drag on the wall, and the high- n EHO discharges are less likely to encounter locked modes. These measurements of impurity confinement are accomplished by utilizing non-intrinsic, non-recycling fully-stripped fluorine as the diagnostic species monitored by charge-exchange recombination spectroscopy. Short 5 ms gas puffs introduce a mix of D_2 and CF_4 gas at the plasma boundary. Uptake of the injected fluorine is recorded by charge-exchange spectroscopy, and emission decay time constants following the peak in fluorine emission provide direct measurement of the confinement time of fluorine. Assessment of the particle transport coefficients will be presented in QH-mode conditions, and discharges with ELM-suppression by resonant magnetic perturbations. With these results, coupled with performance extension to high Greenwald fraction highlight the promise of QH-mode as a potential ELM-free $Q=10$ regime in ITER.

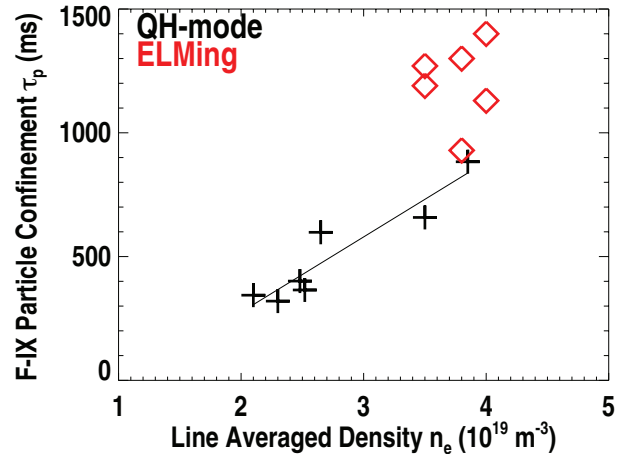


Fig. 1. Comparison of fluorine confinement time in QH-mode and ELMing conditions

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