# Impurity Particle Transport in High Confinement Regimes Without ELMs on DIII-D*

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Recent experiments on DIII-D using trace levels of fluorine gas injection have shown that high confinement regimes without ELMs can achieve rapid transport of impurity ions. Much attention has recently been given to regimes with H-mode energy confinement without edge-localized modes (ELMs), accessed either through Resonant Magnetic Perturbations (RMPs) or MHD such as edge harmonic oscillations or quasi-coherent edge oscillations. Experiments on DIII-D have used gas puffing of trace levels of fluorine to introduce this fully-stripped, non-intrinsic and non-recycling impurity that can be easily measured with charge-exchange recombination spectroscopy. Trace fluorine is used because the time-history of the fluorine density profile permits direct extraction of the confinement time, particle diffusivity and convective velocity without relying on atomic modeling or assumptions about the source recycling. Results indicate impurity accumulation is more pronounced in RMP ELM suppressed plasmas with a pure n=3 spectrum compared with mixed n=1 and n=3 RMP fields with reduced number of control coils. In cases where strong central carbon impurity accumulation occurs, trace fluorine analysis reveals a strong inward impurity pinch. Conversely, in plasmas with weak central carbon accumulation, the fluorine pinch is significantly lower. These measurements of impurity influx are consistent with TGLF modeling of the ELM-suppressed phase of the discharge revealing that strong impurity influx occurs when the ratio V/D is between -1 to -3. In this work, the dependencies of impurity transport on local driving gradients will be presented, and the means of increasing the impurity diffusion to recover high purity plasmas will be discussed providing a basis for achieving low-dilution, stationary ELM-free operation in ITER and future devices.

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