Compatibility of internal transport barrier with steady-state operation in the high bootstrap fraction regime on DIII-D

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Abstract

Recent EAST/DIII-D joint experiments on the high poloidal beta tokamak regime in DIII-D have demonstrated fully noninductive operation with an internal transport barrier (ITB) at large minor radius, at normalized fusion performance increased by ≥30% relative to earlier work [P.A Politzer, et al., Nucl. Fusion 45, 417 (2005)]. The advancement was enabled by improved understanding of the "relaxation oscillations", previously attributed to repetitive ITB collapses, and of the fast ion behavior in this regime. It was found that the "relaxation oscillations" are coupled core-edge modes amenable to wall-stabilization, and that fast ion losses which previously dictated a large plasma-wall separation to avoid wall over-heating, can be reduced to classical levels with sufficient plasma density. By using optimized waveforms of the plasma-wall separation and plasma density, fully noninductive plasmas have been sustained for long durations with excellent energy confinement quality, bootstrap fraction ≥ 80%, $\beta_N \le 4$, $\beta_P \ge 3$, and $\beta_T \ge 2\%$. These results bolster the applicability of the high poloidal beta tokamak regime toward the realization of a steady-state fusion reactor.