Stationary High-Performance Discharges in the DIII–D Tokamak

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Abstract. Discharges which can satisfy the high gain goals of burning plasma experiments have been demonstrated in the DIII–D tokamak under stationary conditions at relatively low plasma current ($q_{95} > 4$). A figure of merit for fusion gain ($\beta_N H_{89}/q_{95}^2$) has been maintained at values corresponding to $Q = 10$ operation in a burning plasma for >6 s or 36 τ_E and $2\tau_R$. The key element is the relaxation of the current profile to a stationary state with $q_{min} > 1$. In the absence of sawteeth and fishbones, stable operation has been achieved up to the estimated no-wall β limit. Feedback control of the energy content and particle inventory allow reproducible, stationary operation. The particle inventory is controlled by gas fueling and active pumping; the wall plays only a small role in the particle balance. The reduced current lessens significantly the potential for structural damage in the event of a major disruption. In addition, the pulse length capability is greatly increased, which is essential for a technology testing phase of a burning plasma experiment where fluence (duty cycle) is important.

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