PROGRESS TOWARDS SUSTAINMENT OF INTERNAL TRANSPORT BARRIERS IN DIII–D*

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Internal Transport Barriers (ITB) have been observed in many tokamaks with negative central magnetic shear (NCS) or, in some cases, with weakly positive shear. To date, however, the duration of the ITB is generally limited to about 1–2 energy confinement times (τ_E). In this paper, we present results of recent experiments on DIII–D to produce and sustain the ITB for longer pulse lengths. High-performance NCS plasmas with an ITB can be produced with either L–mode or H–mode edge characteristics. The L–mode edge discharges are generally limited to $\beta_N<2.5$ by internal MHD modes driven by excessive pressure peaking in the core; performance in H–mode edge discharges is typically limited by edge ballooning/kink modes and type I ELMs driven by steep edge pressure gradients. In light of these observations, we have focused our efforts on reducing the pressure peaking in L–mode edge discharges and modifying the edge stability characteristics in ELMing H–modes.

In recent L–mode edge discharges, internal transport barriers (ITB) have been sustained for more than 1 s ($>5\tau_E$). The improvement in pulse length was achieved by reducing the shear (smaller $q_0 - q_{\min}$) and lowering of the neutral beam power and hence central fueling. We have also just begun experiments on expanding the radius of $\rho_{q\min}$ as a technique to expand the ITB radius and broaden the pressure profile. Using H–mode transitions early in the current ramp to help raise the electron temperature and slow the inward diffusion of current, NCS profiles with $\rho_{q\min}$ =0.7 have been obtained.

In ELMing H–mode discharges we have succeeded in sustaining an NCS q profile for up to 2 s; however, no significant ITB is observed and confinement times remain typical of standard ELMing H–modes. The combined effects of higher density, reduced T_i/T_e, reduced E×B shear, and perturbations due to ELMS are believed to contribute to the lack of improved transport in the core. In order to reduce the effect of ELMs, we have increased the squareness shape parameter in NCS discharges. This modification to the plasma shape reduces second stable access at the edge for ballooning modes and lowers the first stability limit on p'. Small high-frequency ELMs were observed in this shape, consistent with expectations from ballooning stability calculations. Weak ITBs were observed and sustained under these conditions, but the β limit and overall performance is not significantly improved over standard H–mode.

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