TRANSPORT IN HIGH PERFORMANCE WEAK AND NEGATIVE CENTRAL SHEAR DISCHARGES IN DIII–D*

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In recent experiments in the DIII–D tokamak, plasmas with Negative Central Shear (NCS) and Weak Negative Shear (WNS) have exhibited improved confinement, increased beta limits, and record levels of D–D fusion reactivity ($R_{DD} \leq 4.8 \times 10^{16} s^{-1}$, $Q_{DD} \leq 0.00146$). In such discharges, the core magnetic shear is reversed by tailoring of the current profile through application of early, low power, neutral beam injection. These plasmas often undergo a transition to a high performance state, usually following an increase in the applied heating power. At this time, we observe the formation of an internal transport barrier near the location of the minimum safety factor, q_{min}. Formation of this barrier, which can result in peaking profiles of both the ion and electron temperature and density, is consistent with suppression of turbulence by locally enhanced $\boldsymbol{E}\times\boldsymbol{B}$ flow shear. Beam emission spectroscopy and far infrared scattering measurements made in the vicinity of the barrier show that at the time of transition to high performance, fluctuation levels are reduced to below the threshold of detection ($\tilde{n}/n \leq 0.1\%$). Several of these plasmas have been analyzed using the ONETWO and TRANSP analysis codes, which indicate concomitant reductions in the core ion thermal diffusivity to levels at or below standard neoclassical. Smaller reductions are indicated for the electrons. TRANSP was also used to predict the behavior of similar discharges in which a portion of the deuterium is replaced by tritium. These simulations indicate that the best discharges achieve equivalent Q_{DT} in excess of 0.3. Simulation results will be presented showing the expected outcome of extending this transient state for longer periods of time in upcoming experiments. A comparison of the effects of strong vs. weak negative shear in determination of transport behavior and performance will also be shown.

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