Extension of DIII-D Hybrid Plasmas to Reactor Relevant Conditions With $T_e \sim T_i$ and Low Rotation*

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Hybrid scenario discharges developed on DIII-D address the requirement for long pulse, high fluence operation on ITER [1-3]. These plasmas are inductively driven, have a fully relaxed current profile with $q_0 \sim 1$, and have reduced transport across most of the plasma radius without the formation of localized internal transport barriers. Hybrid plasmas typically operate in a hot ion mode ($T_i > T_e$), which reduces turbulence growth rates, and also have high plasma rotation, which also reduces turbulent transport via ExB shear effects. A major goal of recent and planned DIII-D experiments has been to extend hybrid scenario plasma operation to more ITER and reactor relevant conditions, specifically with low plasma rotation and $T_i/T_e \sim 1$. Low plasma rotation hybrid operation on DIII-D [3], has been enabled by a new co and counter neutral beam injection capability, which provides plasma heating with variable torque input. With this new capability, plasma rotation has been scanned across a wide range, with central Mach number M, $0.07 < M < 0.6$. At low, ITER-like rotation, the confinement factor H_{89} degrades by a modest amount, typically 10%-30%. With this reduction in confinement, hybrid discharges with $q_{95} \sim 3$ project to meet ITER fusion performance targets, with fusion performance parameter $G \equiv \beta_N H_{89P}/q_{95}^2$ above the 0.42 value corresponding to $Q_{fus} = 10$ operation on ITER. Transport modeling using the GLF23 code indicates that the change in transport as the rotation is reduced can be accounted for by the reduction in the ExB shearing rate. Ongoing experiments using high power electron cyclotron heating are studying the effects of raising T_e towards T_i. Initial results show that momentum transport is most sensitive to electron heating.

[1] T.C. Luce, *et al.*, Nucl. Fusion **43**, 321 (2003).

[2] M.R. Wade, *et al.*, Nucl. Fusion **44**, 407 (2005).

[3] P.A. Politzer, *et al.*, Proceedings of 21st IAEA Fusion Energy Conference, EX/P1-9, Chengdu China (2006).

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