COMPARISON OF DISCHARGES WITH CORE TRANSPORT BARRIERS ON DIII–D AND JET*

T.C. Luce, E.J. Strait, E.A. Lazarus,[a] C.M. Greenfield, B.W. Rice,[b] M.R. Wade,[a] T.S. Taylor, J.R. Ferron, A.D. Turnbull, G.M. Staebler, F.X. Söldner,[c] A.C.C. Sips,[c] C. Gormezano,[c] D. Ward,[c] B.J.D. Tubbing,[c] G. Cottrell,[c] D. O'Brien,[c] J.C.M. de Haas,[c] C.D. Challis[c]

General Atomics, P.O. Box 85608, San Diego, CA 92138-9784

Significant improvements in both normalized and absolute performance have been obtained in the DIII–D and JET tokamaks by optimizing the current and pressure profiles. These discharges produced the largest D-D neutron rates (S_n) in single-null plasmas in both machines ($S_n = 1.2 \times 10^{16}$/s for DIII–D, 5.0×10^{16}/s for JET). On DIII–D, $\beta_N = 4$ and $H = 4$ have been achieved simultaneously. On JET, the normalized confinement improves significantly ($H \approx 3$); however, MHD modes limit the β to $\beta_N \lesssim 2$. The higher β_N in DIII–D provides hope that profile optimization can lead to further significant increase in JET performance ($S_n \propto \beta^2$) and motivates this comparison.

The MHD behavior at the time of peak β is similar for the two machines. Equilibrium reconstructions for both machines give monotonic *q* profiles with $q(0) \simeq 1$ (corroborated on both machines by the observation of m=1/n=1 bursts). In JET, discharges in which the edge remains in L mode at the peak of β disrupt following the appearance of a rapidly growing n=1 internal mode. This is similar to the pressure-driven ideal mode observed in double-null L–mode edge plasmas on DIII–D [1]. Both theoretical analysis and empirical evidence show that the pressure peaking must be reduced to increase significantly the β limit. In both machines this is accomplished by timing the H–mode transition. In DIII–D, β limit increases nearly a factor of 2. The limiting mode in this case is similar to the "X-event" which limits the performance in VH–modes (DIII–D) and hot-ion modes (JET). Stability analysis indicates that both the large pressure gradient in the edge and the large current density contribute to the instability drive. The difference in β limits between DIII–D and JET is not yet understood, but it could arise from differences in the plasma shape, wall stabilization, or the plasma response to the H–mode transition.

The confinement behavior of both machines is similar. A steep gradient forms most noticeably in the ion temperature in the core, then moves toward the edge, resulting in increasingly good confinement. In DIII–D discharges with an H–mode edge, the core and edge regions of good confinement meet, and the ion transport is at or below neoclassical levels. Quantitative comparisons show the E×B shearing rate exceeds the maximum linear growth rate everywhere in the plasma. In JET, the transport barrier moves out to near the q = 2 surface, which is near the position where the β limiting instabilities are observed. Comparison of the E×B shearing rate and the maximum linear growth rate for these discharges is in progress.

[1] E.J. Strait, et al., APS invited talk.

*Work supported by the U.S. Department of Energy under Contract Nos. DE-AC03-89ER51114 , DE-AC05-96OR22464, and W-7405-ENG-48.

[a] Oak Ridge National Laboratory, Oak Ridge, Tennessee.
[b] Lawrence Livermore National Laboratory, Livermore, California.
[c] Joint European Torus, Culham, United Kingdom.