FORMATION, SUSTAINMENT AND CHARACTERISTICS OF CURRENT HOLE PLASMAS IN DIII-D DISCHARGES

R.J. Jayakumar,[a] M.A. Austin,[b] C.M. Greenfield,[c] N.C. Hawkes,[d] J.E. Kinsey,[e] L.L. Lao,[c] P.B. Parks,[c] E.R. Solano,[f] and T.S. Taylor[c]

[a]Lawrence Livermore National Laboratory, Livermore, California, USA
[b]University of Texas, Austin, Texas, USA
[c]General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA
[d]JET Joint Undertaking, Abingdon, Oxfordshire, UK
[e]Lehigh University, Bethlehem, Pennsylvania, USA
[f]Associación EURATOM-CIEMAT para Fusión, Madrid, 28008, Spain

ABSTRACT. Plasmas with zero or near-zero current density in a wide region of the core have been produced in the DIII-D discharges. The discharges were obtained with early neutral beam and electron cyclotron heating (ECH) during the plasma current ramp. Wide current holes with up to 50% of the plasma radius and a duration of up to 1.1 s (comparable to current relaxation time), have been obtained. Equilibria and pressure profiles were obtained by including kinetic and motional Stark effect (MSE) data using the code TRANSP. Agreement between calculated and measured neutron fluxes is obtained only when the fast-ion diffusion coefficient is set to very high values which results in considerable fast-ion redistribution and a broadened pressure profile. The MSE-only equilibrium fits are in good agreement with such kinetic fits. While current holes collapse due to tearing modes, bursty MHD activity coherent with electron temperature relaxation events is observed when the current holes are sustained. Some collapse events also appear to be coincident with edge localized modes. The current hole phase seems to have been limited by the no-wall beta limit. In the present set of discharges, wider current holes (steeper temperature gradients) appear to collapse at somewhat lower β. Double tearing modes are seen to cause shrinking of the current hole. While early electron heating is strongly dependent on the timing and power of the neutral beam and by the ECH power, it is seen that larger neutral beam powers are correlated with wider current holes which do not decay significantly. This indicates that radial plasma flow may be playing a key role in creating and sustaining the zero or near-zero core current.