DIII-D Quiescent Double Barrier Regime Experiments and Modeling*

T.A. Casper,[1] K.H. Burrell,[2] J.C. DeBoo,[2] E.J. Doyle,[3] P. Gohil,[2] C.M. Greenfield,[2]
R.J. Groebner,[2] T.B. Kaiser,[1] J.E. Kinsey,[4] L.L. Lao,[2] M.A. Makowski,[1] G.R. McKee,[5]
R.A. Moyer,[6] L.D. Pearlstein,[1] T.L. Rhodes,[3] D.L. Rudakov,[6] G.M. Staebler,[2]
B.W. Stallard,[1] and W.P. West[2]

[1]*Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94551 USA*
[2]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608 USA*
[3]*University of California, Los Angeles, Box 951597, Los Angeles, California 20742 USA*
[4]*Lehigh University, Bethlehem, Pennsylvania 18015 USA*
[5]*University of Wisconsin, Madison, Wisconsin 53706-1687 USA*
[6]*University of California, San Diego, 9500 Gilman Drive, La Jolla, California 92093 USA*

We continue to explore the quiescent double barrier (QDB) regime, a recently identified tokamak operating mode [1], with experiments on DIII-D to improve detailed understanding of methods for formation of the QDB and to determine its potential for scaling to steady-state relevant for next step reactor experiments. The formation of an internal transport barrier (ITB) provides a naturally peaked core pressure profile. This peaked pressure in combination with an H-mode edge barrier and its resulting temperature pedestal provide the path to high performance yielding $\beta_N H_{89} \leq 7$ for several energy confinement times ($\leq 25\ \tau_E$). We are exploring methods to control and broaden the pressure profile consistent with stability requirements for high β. With the excitation of a quasi-coherent edge mode, a continuous MHD-like oscillation, coupling to the divertor region for pumping and density control is achieved without the transient effects associated with edge localized mode (ELM) activity. While the current profiles continue to evolve, discharges have been maintained in DIII-D for times in excess of 3.5 s and are limited in duration by the neutral beam heating system. Currently, this configuration is formed with counter neutral beam injection to create the radial electric field profile shape believed responsible for maintaining the separation between barriers. The reliance on counter injection and impurity accumulation associated with a strongly peaked density profile are concerns for application to next step devices. Barrier formation is consistent with the generation of radial electric fields driving substantial rotational shearing rates. Balanced neutral beam injection is not currently available on DIII-D, however, calculations indicate that both counter- and balanced-neutral beam injection can provide the required dominant pressure drive in the rotational shear. The resulting long duration, steady discharges have density and electron temperature profiles consistent with requirements for high efficiency electron cyclotron heating (ECH) and current drive (ECCD) from the upgraded system on DIII-D. Modeling of ECH and ECCD in these QDB discharges have indicated the potential for further modification and control of the safety factor profile, *q*, and for sustaining the current profiles in steady-state. Based on this modeling, experiments on DIII-D have been designed and proposed to explore these effects.

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