L-H transition studies on DIII-D to determine H-mode access for operational scenarios in ITER

P. Gohil[1], T.E. Evans[1], M.E. Fenstermacher[2], J.R. Ferron[1], T.H. Osborne[1], J.M. Park[3], O. Schmitz[4] J.T. Scoville[1], and E.A. Unterberg[3]

[1]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA*

[2] *Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, California 94550, USA*

[3]*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*

[4]*Forschungszentrum Jülich, GmbH, IEF4-Plasma Physics, 52428 Jülich, Germany*

Abstract

A comprehensive set of L-H transition experiments has been performed on DIII-D to determine the requirements for access to H-mode plasmas in ITER's first (non-nuclear) operational phase with H and He plasmas and the second (activated) operational phase with D plasmas. The H-mode power threshold, P_{TH}, was evaluated for different operational configurations and auxiliary heating methods for the different main ion species. Helium plasmas have significantly higher P_{TH} than deuterium plasmas at low densities for all heating schemes, but similar P_{TH} as deuterium plasmas at high densities except for H-neutral beam injection-heated discharges, which are still higher. Changes in P_{TH} are observed when helium concentration levels in deuterium plasmas exceed 40%. There is a strong dependence of P_{TH} on the magnetic geometry in the vicinity of the divertor. The trend of decreasing P_{TH} with decreasing X-point height is observed for all the main ion species irrespective of the heating method, which appears to indicate that there is a common physics process behind this effect for all the ion species. Helium and deuterium plasmas exhibit a significant increase in P_{TH} for strong resonant magnetic perturbations. The application of a local magnetic ripple of 3% from test blanket module mock-up coils did not change P_{TH} in deuterium plasmas.

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