# RWM Feedback Stabilization in DIII-D: Experiment-Theory Comparisons and Implications for ITER*

A.M. Garofalo,[1] J. Bialek,[1] M.S. Chance,[2] M.S. Chu,[3] D.H. Edgell,[4] G.L. Jackson,[3] T.H. Jensen,[3] R.J. La Haye,[3] G.A. Navratil,[1] M. Okabayashi,[2] H. Reimerdes,[1] J.T. Scoville,[3] and E.J. Strait[3]

[1]*Columbia University, New York, New York USA*
[2]*Princeton Plasma Physics Laboratory, Princeton, New Jersey USA*
[3]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA*
[4]*FAR-TECH, Inc., San Diego, California USA*

Direct feedback stabilization of the RWM, i.e. without the stabilizing help of toroidal plasma rotation, has been demonstrated in DIII-D experiments. This result, obtained both using the external coil set (C-coil) and the newly installed, internal coil set (I-coil), is in agreement with the results of several feedback simulation codes. The demonstration is crucial to open the possibility of operation above the free-boundary stability limit to advanced tokamak scenarios in ITER, since in the fusion-reactor regime the rate of rotation needed for RWM stability may not be achieved, due to lower external torque then in lacking the large external torque of present neutral-beam driven tokamaks.

DIII-D studies of the RWM feedback stabilization process in absence of significant plasma rotation have pursued two approaches: d`evelop target plasmas where the toroidal plasma rotation is minimized, and plasmas where the plasma rotation threshold for RWM stabilization is increased. With reduced neutral-beam torque, the slower-rotating plasma exhibited an unstable RWM, which was stabilized by C-coil feedback with no change in toroidal rotation. In other experiments, strong magnetic braking reduced the plasma rotation to essentially zero over most of the plasma. With I-coil feedback control, this discharge survives for more than 100 ms after the rotation is reduced. A similar discharge without feedback becomes unstable earlier, despite higher rotation and lower beta. We also carried out experiments where the plasma rotation threshold for RWM stabilization is increased by controlling the plasma density. In fact, a reduction of the plasma density, which leads to higher Alfvén frequency, also leads to RWM onset at values of plasma rotation that are stable at higher plasma density.

These feedback experiments are compared to calculations carried out with the 3-D code VALEN, to assess the effect on RWM stabilization of different sensors and coil location; with the spectral code MARS, to assess the effects of multiple modes; and with an analytic feedback model, to benchmark the limitations imposed by the open-loop transfer function of the digital control system and amplifiers

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