STABILITY LIMITS OF HIGH BETA PLASMAS IN DIII-D

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Abstract. Stability at high beta is an important requirement for a compact, economically attractive fusion reactor. DIII-D experiments have shown that ideal magnetohydrodynamic (MHD) theory is an accurate predictor of the ultimate stability limits for tokamaks, and the Troyon scaling law has provided a useful approximation of ideal stability limits for discharges with “conventional” profiles. However, variation of the discharge shape, pressure profile and current density profile can lead to ideal MHD beta limits that differ significantly from simple Troyon scaling. The need for profiles consistent with steady-state operation places an important additional constraint on plasma stability. Non-ideal effects can also be important and must be taken into account. For example, neoclassical tearing modes, resulting from plasma resistivity and the nonlinear effects of the bootstrap current, can become unstable at beta values well below the ideal MHD limit. DIII-D experiments are now entering a new era of unprecedented control over plasma stability, including suppression of neoclassical tearing modes by localized

current drive at the island location, and direct feedback stabilization of kink modes with a resistive wall. The continuing development of physics understanding and control tools holds the potential for stable, steady state fusion plasmas at high beta.