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Stabilization of the External Kink and Control of the Resistive Wall Mode in Tokamaks*[1]

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Tokamak based approaches to fusion which depend on significant bootstrap current for steady-state operation will necessarily operate at high normalized beta, well beyond the conventional Troyon beta limit. One promising method of maintaining stability is the use of a conducting wall close to the plasma to stabilize low-n ideal MHD instabilities, combined with an active control system to stabilize the more slowly growing resistive wall modes (RWMs).
Experiments in the DIII–D, PBX-M, and HBT-EP tokamaks[3] have demonstrated that plasmas with a nearby conducting wall can remain stable above the beta limit predicted with the wall at infinity. More recently, detailed, reproducible observations of the $n = 1$ RWM have been possible in DIII–D plasmas above the no wall beta limit. Comparisons with ideal and resistive MHD predictions are helping to distinguish the relative importance for wall stabilization of proposed dissipation mechanisms, such as resonant absorption, viscosity, and resistivity. The DIII–D measurements confirm other characteristics common to several RWM theories. The mode is destabilized as the plasma rotation at the $q = 3$ surface decreases below a critical frequency of 1 to 4 kHz ($\sim 1\%$ of the toroidal Alfvén frequency). The measured mode growth times of 3 to 5 ms agree with measurements and numerical calculations of the dominant DIII–D vessel eigenmode time constants, τ_ω. From its onset, the RWM has little or no toroidal rotation ($\omega_{\rm mode} \leq \tau_{\rm w}^{-1} \ll \omega_{\rm plasma}$), and rapidly reduces the plasma rotation to zero.
Both DIII–D and HBT-EP have adopted the "smart shell"[4] concept as an initial approach to control of these slowly growing RWMs: external coils are controlled by a feedback loop designed to make the resistive wall appear perfectly conducting by maintaining a net zero radial magnetic field at the wall. Initial experimental results from both systems will be presented.

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[3]E.J. Strait *et al.*, Phys. Rev. Lett. **74** (1995) 2483; M. Okabayashi *et al.*, Nucl. Fusion **36** (1996) 1167; T.H. Ivers *et al.*, Phys. Plasmas **3** (1996) 1926.

[4]C.M. Bishop, Plasma Phys. and Contr. Fusion **31** (1989) 1179.