DPP05-2005-001429

Abstract for an Invited Paper
for the DPP05 Meeting of
the American Physical Society

Modeling of Resistive Wall Mode and its Control in Experiments and ITER

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To maintain a high beta advanced tokamak in steady state, the plasma has to be stabilized against the resistive wall mode (RWM) — an external kink mode with growth rate slowed down to the resistive diffusion time of the surrounding wall. This work presents new theory development and modeling results using the MARS-F code, for the control of the RWM in a rotating plasma, with specific emphasis on the comparison with experiments on JET/DIII-D and the predictions for ITER. Two unique features are included in our work. The first is to adopt a physics based kinetic damping model, derived from the drift kinetic energy principle, to describe the transfer of toroidal angular momentum between the RWM and the rotating plasma. The second is to employ a compact description for the response of the plasma and also the external hardware to the feedback signal. These response characteristics are included in terms of their frequency dependent transfer functions. Extensive comparison with both DIII-D and JET experiments has revealed that the present kinetic damping model is adequate for the description of the experiments. Important results include the parametric dependence of the critical rotation required for stabilization of the RWM, demonstration of the advantages of inside versus outside placed feedback coils and sensor geometries, and the frequency dependent plasma response to the prescribed external perturbation. Single mode approximation describes well the stable RWM dynamics; unstable RWM are better described by a superposition of multiple modes. The combination of plasma rotation and active feedback provides a viable way to stabilize the RWM in ITER.

[1]In collaboration with JET EFDA contributors and the DIII-D team