Requirements for active resistive wall mode (RWM) feedback control

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(Received on

Abstract. The requirements for active resistive wall mode (RWM) feedback control have been systematically investigated and established using highly reproducible current-driven RWMs in ohmic discharges in DIII-D. The unambiguous evaluation of the active RWM feedback control was not possible in previous RWM studies primarily due to the variability of the onset of the pressure-driven RWMs; the stability of the pressure-driven RWM is thought to be sensitive to various passive stabilization mechanisms. Both feedback control specifications and physics requirements for RWM stabilization have been clarified using the current-driven RWMs in ohmic discharges, when little or no passive stabilization effects are present. The use of derivative gain on top of proportional gain is found to be advantageous. An effective feedback control system should be equipped with a power supply with bandwidth greater than the resistive wall mode growth rate. It is beneficial to apply a feedback field that is toroidally phase-shifted from the measured RWM phase in the same direction as the plasma current. The efficacy of the RWM feedback control will ultimately be determined by the plasma fluctuations on internal diagnostics, as well as on external magnetics. The proximity of the feedback coils to the plasma appears to be an important factor in determining the effectiveness of the RWM feedback coils. It is desirable that an RWM feedback control system simultaneously handle error field correction in low frequency, along with direct RWM feedback in high frequency. There is an indication of the influence of a second-least stable RWM, which had been theoretically predicted but never identified in experiments. A preliminary investigation based on active MHD spectroscopic measurement showed a strong plasma response around 400 Hz where the typical plasma response associated with the first-least stable RWM was expected to be negligible. Present active feedback control requirements are based on a single mode assumption, so the investigation of the second-least stable RWM is of high interest.

This work was supported by U.S. Department of Energy under DE-FG02-06ER84442, DE-FC02-04ER54698, DE-AC02-09CH11466, and DE-FG02-89ER53297.