PHYSICS OF LOCKED MODES IN ITER: ERROR FIELD LIMITS, ROTATION FOR OBVIATION, AND MEASUREMENT OF FIELD ERRORS

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ABSTRACT

The existing theoretical and experimental basis for predicting the levels of resonant static error field at different components m,n that stop plasma rotation and produce a locked mode is reviewed. (This report is a complement to Refs. 1 and 2.) For ITER ohmic discharges, the slow rotation of the very large plasma is predicted to incur a locked mode (and subsequent disastrous large magnetic islands) at a simultaneous weighted error field $(\Sigma_1^3 w_{m1} B_{rm1}^2)^{1/2} / B_T \gtrsim 1.9 \times 10^{-5}$. Here the weights w_{m1} are empirically determined from measurements on DIII–D to be $w_{11} = 0.2$, $w_{21} = 1.0$, and $w_{31} = 0.8$ and point out the relative importance of different error field components.

This could be greatly obviated by application of counter injected neutral beams (which adds fluid flow to the natural ohmic electron drift). The addition of 5 MW of 1 MeV beams at 45° injection would increase the error field limit by a factor of 5; 13 MW would produce a factor of 10 improvement. Co-injection beams would also be effective but not as much as counter-injection as the co direction opposes the intrinsic rotation while the counter direction adds to it.

A means for measuring individual PF and TF coil total axisymmetric field error to less than 1 in 10,000 is described. This would allow alignment of coils to mm accuracy and with correction coils [3] make possible the very low levels of error field needed.