Locked-Tearing Mode Control by 3D Magnetic Field Entrainment in the presence of Static Error Fields

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DIII-D experiments on control of locked tearing modes using applied 3D fields are in good qualitative agreement with predictions of a non-linear reduced MHD code (AEOLUS-IT) [1]. The plasma condition was the ITER base line scenario target with low safety factor discharges. The simulation is nonlinear, but highlights fundamental processes by simplifying the physics to isolate a single helicity with m/n=2/1, using only the vorticity equation and Ohm's law without any additional transport properties. In the experiment, internal mode structures were monitored by the perturbed rotation and ion temperature profiles measured by Charge Exchange Recombination (CER) in this very low mode frequency (zero-100 Hz) regime. Experiments have illuminated several critical physical processes that are qualitatively consistent with non-linear reduced MHD simulations. One example is the consistency of external kink- and tearing- mode structure in the partial / full applied 3D field penetration. This shows that the possible non-linear process of kink-tearing mode coupling during tearing mode locking can be well represented by a relatively simplified model. Another example is the qualitative agreement of the formation of second-harmonic-type rotational structure very near q=2 surface with very little fundamental component. On the other hand, the magnetic structure remains fundamental. This implies a possible second harmonic effect for non-linear self-stabilization. Predictive understanding of mode time-evolution is crucial to designing a feedback scheme that will help to avoid disruptions in present and future devices. This work was supported in part by the US Department of Energy under DE-AC02-09CH11466, DE-FC02-04ER54698, DE-FG02-04ER54761

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