STABILIZATION OF m=2/n=1 TEARING MODES BY ELECTRON CYCLOTRON CURRENT DRIVE IN THE DIII–D TOKAMAK*

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Complete stabilization of m=2/n=1 tearing modes using electron cyclotron current drive (ECCD) in the direction of the total plasma current has been reported previously from both the DIII-D and AUG tokamaks. The experiments reported here extend these initial results with the purpose of identifying the key elements of the stabilization mechanism and testing models of the effect both qualitatively (scalings) and quantitatively (power or current requirements). Experiments evaluating the relative importance of current drive and heating have been carried out for the first time. At the highest power levels, co-ECCD completely suppressed the mode, while heating reduced the mode amplitude only slightly. Counter-ECCD drove the mode to larger amplitude resulting in disruption of the plasma current. At reduced power, similar behavior was seen — partial suppression with co-ECCD, mode growth with counter-ECCD, and slight reduction with heating alone. In the absence of any EC power, the mode eventually locks and disrupts the plasma. Using a slow ramp of the toroidal field, the location of the maximum effect of each of these applications of the EC waves could be determined. The maximum effect of the counter-ECCD is at smaller minor radius than the co-ECCD. This may may allow separation of the relative importance of the modification of classical MHD stability by the ECCD and the direct current driven within the island. Mapping the toroidal field ramp into the coordinate of relative position of the island and the driven current layer indicates that the ECCD width is consistent with predictions from ray tracing. By varying the EC power and the poloidal beta, the scaling of the standard model for the tearing mode width (the Rutherford equation modified to include diamagnetic, neoclassical, and ECCD terms) can be tested. Preliminary analysis shows that the power required to suppress the mode increases with the poloidal beta as expected for modes driven by neoclassical effects. Additional quantitative analysis is in progress. To ensure the maximum effectiveness of the EC power in these cases, a closed-loop feedback is applied to adjust the EC resonance location. In co-ECCD cases, the location of maximum effect is when the co-ECCD is centered on the island. Once the mode has been stabilized, this feedback system has no means by which to maintain the proper location of the EC power. An algorithm has been developed to predict the location of a rational surface as the current profile evolves in the absence of the island. This algorithm has been successfully demonstrated in the case of m=3/n=2 suppression, allowing increase of the plasma pressure up to the expected no-wall n=1 pressure limit. Experiments applying this tracking technique to the q=2 surface are planned.

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