Measurement and Modeling of Tearing Mode Stability for Steady-State Plasmas in DIII-D*

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High-performance steady-state scenario discharges in the DIII-D tokamak are strongly affected by the appearance of tearing modes, which cause loss of energy confinement and a radial redistribution of the current density J that is not recoverable with the available non-inductive current drive sources. Tearing modes appear in operation at constant pressure on a resistive evolution time scale (1–2 s). It is routinely observed that the tearing stability is affected by the application of electron cyclotron current drive (ECCD). Depending on its location and distribution, the applied current can prevent the onset of the tearing instability. This effect is not a direct interaction at the mode rational surface. Several sets of high-beta discharges, which differ only in the location and distribution of the EC-driven current, have been analyzed. Current density measurements by motional Stark effect spectroscopy show a pattern in the local evolution of the current density that characterizes the unstable discharges, highlighting a correlation of the local current gradient with the mode triggering. The goal is to determine whether an "active" region of the current profile that is important for the discharge stability can be defined, specifically the region where ∇J determines the mode evolution, and where localized EC current can lead to the stabilization of the mode. Modeling with the DCON, GATO and PEST3 codes, with localized perturbations of the J profile mimicking the effect of ECCD, will be used to identify this "active" region from the theoretical changes in the tearing stability when the different ECCD configurations are applied. This exercise ultimately allows the validation of tearing stability codes against experimental observations.

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