Onset scaling of locked $n/m = 2/1$ tearing modes generated by the Dynamic Ergodic Divertor on TEXTOR in 3/1 configuration

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The $m/n = 3/1$ operation of the Dynamic Ergodic Divertor (DED) has a long ranging perturbation field with a strong (2/1) sideband. In dc as well as in ac operation this sideband generates an $m = 2$, $n = 1$ tearing mode when a critical current in the perturbation field coils is exceeded. The threshold for mode excitation is highly reproducible and depends on the actual plasma parameters. The mode is always locked to the external perturbation field, i.e. it is in rest with respect to the tokamak frame when the DED is operated in dc mode, and it rotates with the frequency and in direction of the external perturbation field in ac mode.

During recent campaigns a series of experiments were conducted in order to study the dependence of the error field threshold on the plasma parameters. The scaling with electron density shows an increasing critical error field with increasing density. This result is consistent with error field experiments done on Alcator C-mod, DIII-D, and JET.

No clear dependence on the toroidal magnetic field was found, similar to trends observed in C-mod, but quite different to the DIII-D and JET results, which show a strong decrease of the threshold with increasing field.

The most puzzling results of the TEXTOR experiments were obtained when the dependence on the heating power, i.e. beta was investigated. A power scan using ICRH gave twice the critical perturbation field for mode onset when beta was approximately doubled (estimated from the L-mode confinement scaling). The influence of tangential neutral beam heating turned out to be even more counter-intuitive. Using NB injection in co-current direction lowered the threshold for tearing mode onset, whereas counter NBI had a stabilizing effect. At the maximum DED current of 3.75 kA no mode excitation had been observed at full power counter-NBI, i.e. the mode threshold is raised by a factor of 3 to 4. This behaviour could be reproduced at two different levels of auxiliary heating, one scan where co-NBI was gradually replaced by ICRH, and another scan where various amounts of co- and counter-NB injection with a constant total power were applied. The crucial parameter for the observed stability thresholds with NBI is most likely the toroidal plasma rotation induced by the tangential beam injection.

The ICRH beta scan as well as the rotation scan with NBI do not correspond to recent results from JET, where heating by pure ICRH was found to have only a weak influence on the mode threshold, and neutral beam heating is stabilizing for co- and counter-injection.

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