CONTROL OF MHD INSTABILITIES BY ELECTRON CYCLOTRON RESONANCE HEATING AND CURRENT DRIVE IN TEXTOR

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A powerful 800 kW, 140 GHz, 10 s GYCOM gyrotron is available on the TEXTOR tokamak for electron cyclotron resonance heating (ECRH) and current drive (ECCD). The high degree of flexibility of the launcher and the strong focusing of the wave beam inside the plasma make the TEXTOR ECRH system particularly suited for applications, which require very localized heating or current drive. One such application is MHD control: in particular, the control of sawteeth and tearing modes, as illustrated by the examples in this paper.

The effect of ECCD on sawteeth is studied by means of magnetic field ramps in which the position of the current drive layer is slowly moved through the q=1 surface. To separate the effect of the non-inductive current from a similar effect of the concurrent heating, the sawtooth period response as a function of the deposition radius is normalized on a reference discharge with only heating. The experimental results are compared with theoretical expectations. On the basis of Porcelli's critical shear model for the sawtooth crash [1] a criterion for effective sawtooth control was obtained, $I_{cd} > 2\ (\Delta r/r_{q=1})^2\ I_{q=1}$, and all ECCD discharges are shown to satisfy this criterion. The observed shortening and lengthening of the sawtooth period are compared with expectations based on predicted changes in the shear evolution at q=1 as obtained from simple model calculations.

The Dynamic Ergodic Divertor (DED) on TEXTOR can be operated to generate perturbation fields at various mode numbers and frequencies [2]. When it is operated to create a dominant m=3, n=1 perturbation also a strong m=2, n=1 side-band is produced. Above a threshold, a 2/1 magnetic island is induced in the plasma, which locks to the DED perturbation. This controlled generation of tearing modes was used for a study of the suppression of the m=2, n=1 tearing modes by localized ECRH or ECCD. Various radial scans at different power deposition widths show that stabilization is only achieved for deposition exactly on the q=2 surface. Also, the stabilizing effect hardly changes as the toroidal injection angle and consequently, the driven current is varied. By modulated ECRH in phase with the island rotation, it has been observed that much more efficient stabilization is obtained when ECRH is only applied during phases in which the O-point of the island passes through the power deposition region then when ECRH is applied when the X-point passes through the deposition region. This leads one to the conclusion that heating rather than current drive inside the magnetic island is responsible for the stabilization of the m=2, n=1 magnetic island in TEXTOR. Heating may well play a role in NTM stabilization in ITER as well and, consequently, result in lower power requirements for NTM stabilization by ECCD in ITER.

[1] F. Porcelli, et al., Plasma Phys. Control. Fusion **38** (1996) 2163.
[2] K.H. Finken (Ed.), Fusion Eng. Design **37** (1997) 335.