§5. Suppression of the MHD Instabilities with Non-resonant RMP

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Magnetic stochasticity plays important role in the high-beta experiment, where the thick magnetic stochastic region is formed naturally outside the last closed flux surface (LCFS). It is noted that pressure-driven modes are always unstable in peripheral region of the LHD because the peripheral region stays in the magnetic hill. The plasma expands from the LCFS in high-beta experiments. There appear MHD instabilities with amplitude of 10^{-4} of the toroidal magnetic field. From the mode number of activities (poloidal / toroidal mode number m/n = 2/3, 1/2, 2/4), the location of corresponding rational surface is near the LCFS or certainly outside the LCFS and is consistent with fluctuation measurements, e.g. ECE measurement (fig. 1(E)). The saturation level increases with the increase of the pressure gradient. Degree of stochasticity is an important factor to affect the saturation level. Since the thickness of the stochastic region and the degree of stochasticity is increased with the increase of plasma beta, the stochasticity becomes more important in high-beta conditions. In order to study the dependence on the stochasticity exclusively, experiments with the resonant magnetic field perturbation (RMP) with m/n = 1/1 is made. While the magnetic island is formed around the iota=1 surface (fig.1 (A)), the stochasticity outside the nested region is enhanced (fig.1 (B)).

The amplitude of the MHD modes, not resonant to the RMP, is shown as a function of the strength of external field in Fig. 2. Amplitude of m/n = 2/3 and 2/4 modes are reduced by the RMP field when the normalized RMP coil current ILID/Bt exceeds 0.3. Since the local pressure gradient and the local plasma parameter are not changed significantly, this reduction is thus caused by the change of the magnetic field structure itself. Local flow velocity or the flow velocity shear can also affect the MHD stability. However, in the present LHD experiment, change in the velocity is small at the mode rational surface (fig. 1(D)). With the increase of the RMP field, increase of the spectral width Δf is observed. The mode frequency of the interchange mode is determined by the electron diamagnetic drift frequency modified by the Doppler shift. The spread of the frequency means the spread of the eigen-function of the mode if we consider the velocity shear around the rational surface (Fig. 1(D)). This is a direct evidence of the effect of the RMP on the MHD instabilities.

In conclusion, stochastisation of the magnetic field found to suppress the MHD activities without causing degradation of the pressure gradient. This tendency is favorable for reactor relevant plasma condition.

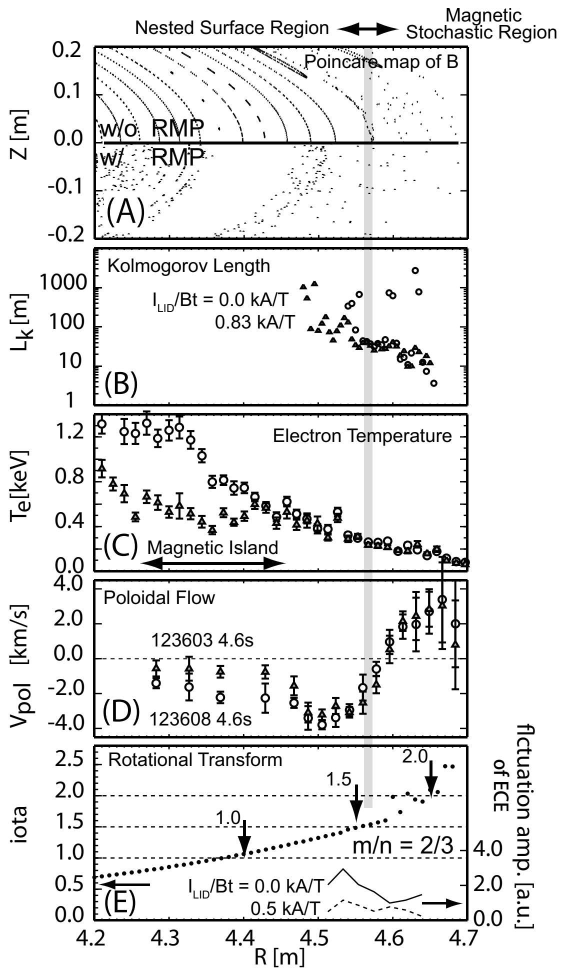

Fig. 1: Profile of the Kolmogorov Length (B), the electron temperature (C), the poloidal velocity (D) and the rotational transform estimated by HINT2 and the mode amplitude profile (E) are shown.

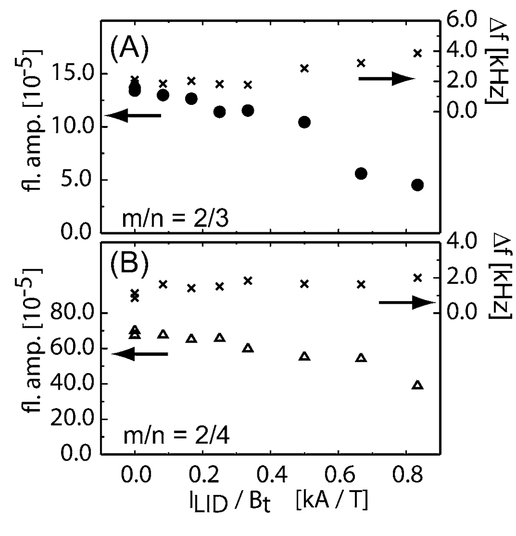

Fig. 2: Mode amplitude and spectral width of MHD activities with m/n = 2/3 (A), 2/4 (B) as a function of the externally applied magnetic field.