Effect of external magnetic perturbation on MHD characteristics in the Large Helical Device

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An understanding of characteristics of ideal and resistive pressure driven instabilities in net current-free plasmas is one of major key issues for realization of high-beta plasma production. In standard configuration of Large Helical Device (LHD), the m/n = 1/1 mode where the resonance is located in periphery with magnetic hill and strong magnetic shear has been enhanced with increasing beta and pressure gradient. Also strong dependence of the mode on a magnetic Reynolds number has been found out, and it is close to that predicted by linear theory of resistive interchange mode [1]. In this study, the following subjects have been considered in order to understand the configuration dependence of low-*m* pressure-driven mode, that is, (1) effect of the magnetic shear on the mode, and (2) interaction with m/n = 1/1 static magnetic island. The magnetic shear can be changed by increasing or decreasing a plasma aspect ratio. When the plasma aspect ratio increases from standard value (5.8) to 8.3, the central rotational transform increases, which leads to a reduction of the magnetic shear at $\iota/2\pi = 1$ surface. It means that the m/n = 1/1 mode moves from resistive *unstable* state to ideal *unstable* one. In the low-magnetic shear configuration, the strong m/n = 1/1 mode without rotation displaced the resistive mode observed in standard configuration, and it leads to a large degradation of a core plasma. The mode was also destabilized by the plasma current reducing magnetic shear, and the appearance is qualitatively consistent with ideal stability limit. This mode was easily stabilized by moderate m/n = 1/1 perturbation field with optimum spatial position. Also, the growth of the mode in different magnetic shear configurations has been investigated experimentally. On the other hand, the perturbation field was also applied to resistive m/n = 1/1 mode in order to verify the stabilization effect and to investigate their interaction, which is important for understanding relationship between an excitation of the mode and magnetic structures ergodized by finite-beta effects. The amplitude of the mode gradually decreased with increasing the perturbation field and the mode was completely suppressed when the field exceeds a certain value. The rotation of the mode slowed down before the complete suppression.

[1] S. Sakakibara et al., Fusion Sci. Technol. 50 (2006) 177.