## §16. Evaluation of MHD Stability of Weak Shear Configuration in LHD Plasma

Okamoto, M. (Ishikawa National College of Technology), Watanabe, K.Y.

In the toroidal magnetic confinement devices, the stable sustainment of high beta plasma is one of the important issues for the achievement of the nuclear fusion power plant. The plasma beta is limited by the plasma current and pressure driven magnetohydrodynamic (MHD) instabilities. The minor collapse and disruption are occurred by MHD instabilities in tokamak plasmas. In the Large Helical Device (LHD), MHD activities have been also reported in high beta operation. We focus on the minor collapse caused by the abrupt growth of m / n = 1 / 1 mode without rotation in the weak shear configuration, where m and n are the poloidal and toroidal mode number, respectively[1)]. In the last experimental cycle, we clearly observed the MHD precursor to minor collapse and obtained the result that Mercier parameter $D_I$ is very high value, which is very higher than 0.2, at the initial phase of precursor phenomenon, here it was numerically calculated that the global mode becomes unstable whenever $D_I > 0.2$[2)]. On the other hand, the minor collapse without precursor phenomenon is observed when the toroidal magnetic field $B_t$ is comparatively low. In this experiment, we investigate the condition which the MHD precursor appears before minor collapse.

Figure 1 shows the typical waveform of the discharge with the minor collapse at $B_t$ lower than last experimental cycle. The experimental condition is as follow: the magnetic axis $R_{ax}$ = 3.6 m, $B_t = -0.75$ T, which is the toroidal field at $R_{ax}$, and the plasma aspect ratio $A_p$ is set at 7.1. The minor collapse is occurred at about $t$ = 4.28 sec, $I_p/B_t$ = 47 kA/T, and $<\beta_{dia}>$ = 1.27 %. In the case of high $B_t$, after constant magnetic fluctuation is appeared over a period of time, decrease of the fluctuation frequency and increase of fluctuation magnitude are observed and then minor collapse is occurred. From Fig.1, in the case of low $B_t$, it is found that the fluctuation frequency and $<\beta_{dia}>$ are gradually decreased immediately after magnetic fluctuation appears at about $t$ = 4.09 sec. Then $<\beta_{dia}>$ and the electron temperature at plasma center are rapidly decreased at about $t$ = 4.28 sec.

We evaluated the temporal evolution of $D_I$ until minor collapse in Fig. 2. The horizontal axis of Fig. 2 corresponds to the time periods because $I_p$ increases with time until minor collapse and $B_t$ is constant in time. In Fig. 2 (a), the closed circle of legend (I) is the value of $D_I$ before the appearance of MHD activity, the opened triangle of legend (II) is during the observation of constant magnetic fluctuation and the cross of legend (III) is just before the minor collapse. The values of $D_I$ in Fig.2 (b) are calculation results assumed as flat and parabolic and hollow current profile, respectively. From Fig. 2, it is found that $D_I$ of both low and high $B_t$ becomes very high at the appearance of magnetic fluctuation.

In low $B_t$ region, minor collapse is occurred by $m/n$ = 1/1 interchange mode immediately after MHD activity appears. On the other hand, the estimated $D_I$ at the appearance of MHD activity becomes very high value as well as experimental result of high $B_t$ region.

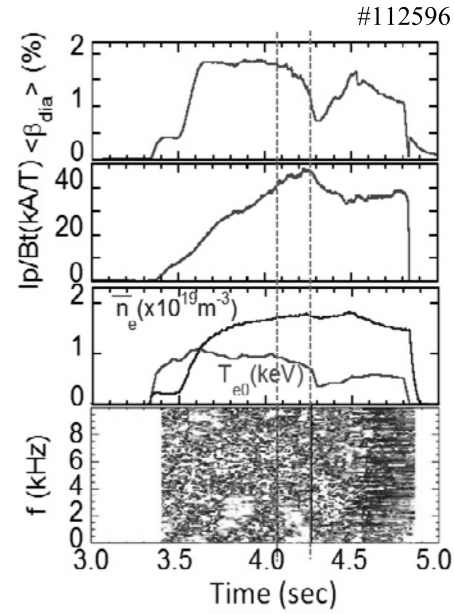


Fig. 1. Temporal evolution of volume averaged beta $<\beta_{dia}>$, ratio of plasma current $I_p$ and toroidal magnetic field $B_t$, electron temperature at the plasma center, line averaged electron density, and frequency of poloidal magnetic fluctuation.

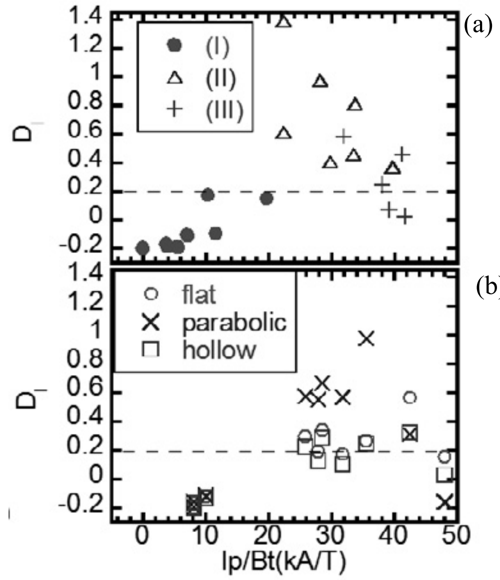


Fig. 2. Temporal evolution of Mercier parameter $D_I$ until minor collapse. (a) $B_t$ = -1.266 T, (b) $B_t$ = -0.75 T.

1) S. Sakakibara et al Fusion Sci. Technol. **50** (2006) 177.
2) Y. Nakamura et al., J. Phys. Soc. Japan 58 (1989) 3175.