§13. MHD Characteristics in Low Magnetic Shear Configuration

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It has been found out that in the magnetic shear configurations, strong m/n = 1/1 mode abruptly appears and leads to the minor collapse in core plasma[1]. The reduction of the magnetic shear is caused by decreasing γ_c and/or increasing positive plasma current, where the γ_c is the pitch parameter of the helical coil. The magnetic shear $d\iota/d\rho$, decreases from 2.8 to 1.1 in vacuum when γ_c decreases from 1.25 to 1.13. The V" also decreases from 0.8 to 0.1, where V" is the index of the magnetic well/hill and positive V" corresponds to magnetic hill. When $<\beta_{dia}>$ increases, both $d\iota/d\rho$ and V" decrease. The changes of their parameters in the γ_c = 1.25 case are larger than the γ_c = 1.13 case because of the difference of Shafranov shift.

Figure 1 shows an example of the minor collapse observed in the configuration with γ_c = 1.13 and B_t = 1 T. After the $<\beta_{dia}>$ increased with $\bar{n}_e$, it abruptly reduced at 0.84 s. Then I_p/B_t is less than 20 kA/T, which is relatively small. The $\tilde{b}_{rll}/B_t$, which is radial component of m/n = 1/1 perturbation on the resonance and estimated by saddle loop measurements, started to increase just before the collapse. After that, the $\tilde{b}_{rll}/B_t$ synchronized the $<\beta_{dia}>$ signal, which means the mode affects the plasma confinement directly. Several experiments results show that this kind of m/n = 1/1 mode has no rotation and grows at the specific position. The mode rotating with an order of electron diamagnetic frequency, which is well observed in the experiments, was not observed in this discharge. The S parameter is about 10^8, which is relatively high compared with highest-beta discharge ($S \sim 10^6$). Ref 1 shows that the amplitude of the mode decreases with an increment of S and the dependence is almost similar to that of the growth rate of resistive interchange mode. It may be one of reasons for disappearance of the rotating mode.

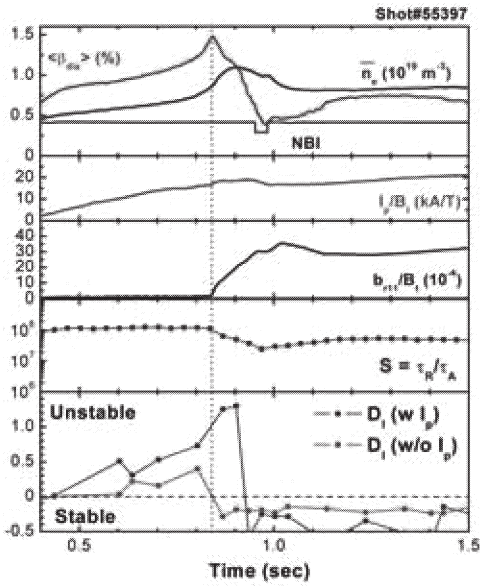

Fig.1 Minor collapse observed in γ_c = 1.13 configuration.

The bottom figure shows the temporal change of D_I on the $\iota/2\pi$ = 1 resonant surface, where D_I is Mercier criterion, which is well used as the index of ideal stability boundary and D_I < 0 means that ideal mode is stable. The current profile is assumed as $j(\rho) = j_0(1-\rho)^2$. The D_I has the positive value from the beginning of the discharge even in the currentless case, and the D_I with the I_p effect approached 0.7 at 0.803 s just before the collapse. The increment of D_I is caused by reduction of magnetic shear due to I_p as well as the increase in the pressure gradient. Even in the currentless discharge, the growth of this mode has been observed.

The appearance of *non-rotating* m/n = 1/1 mode (NR mode) in the $<\beta_{dia}>$ and $\iota_0/2\pi$ diagram is shown in fig.2. The difference color corresponds to the amplitude of the radial component of the NR mode. Since edge iota is about 1.6 in any γ_c configurations, the central $\iota/2\pi$ is correlated with magnetic shear around $\iota/2\pi$ = 1 resonance. The mode appears in high- $\iota/2\pi$ region and clear operational limit was found out. This limit is qualitatively consistent with the ideal stability limit. On the other hand, in a configuration with high-shear and low plasma current, plasmas can approach to the high-beta region by passing through the "*stable*" area. Recent experiments indicate that the strong m/n = 1/1 mode is suppressed by giving the resonant magnetic field by external coils[2].

Reference

1) S. Sakakibara *et al*., Fusion Science and Technology **50**, 2 (2006) 177.
2) S.Sakakibara *et al., Proc. 33rd EPS conference on Plasma Physics*, Rome, Italy, June 19-23, 2006.

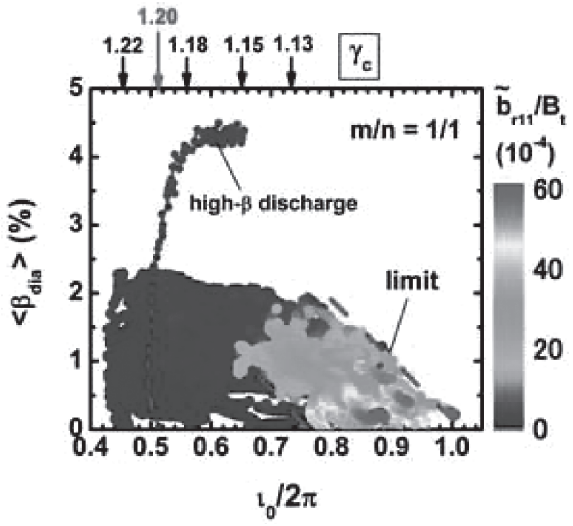

Fig.2 Appearance of non-rotating m/n = 1/1 mode in the $<\beta_{dia}>$ and $\iota_0/2\pi$ diagram.