§8. Magnetic Axis Swing Experiments

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Magnetic axis position, R_{ax}, is a key parameter characterizing MHD equilibrium, stability, transport and heating efficiency of neutral beams in heliotron configurations. In the FY2008 experiments of the LHD, capability of power supplies of poloidal coils determining the R_{ax} was increased to allow a swing of R_{ax} during a discharge, which is valid for the detail optimization of the magnetic configuration for high-beta plasma production, identification of MHD stability boundary, understanding of equilibrium beta-limit and so on.

The shortest time of R_{ax} swing is 1.4 s when R_{ax} is shifted from 3.6 m to 3.5 m in the configuration with B_t = -0.45 T and γ_c = 1.20, which is decided by the capability of power supplies. The movements of R_{ax} and magnetic surfaces with the preset were confirmed through the profile measurements. Figure 1 shows a comparison of MHD activities in plasmas with and without R_{ax} swing. The R_{ax} was preset to change from 3.6 m (t = 1 s) to 3.5 m (t = 3 s) in the configuration with B_t = -0.45 T and γ_c = 1.20. The two co-NBI's were applied from 1.3 s and a counter NBI was from 1.8 s in both discharges. The Shafranov shift identified by electron temperature profile was about less than 20 cm when the averaged beta is about 4 %, and the R_{ax} shifted to the inward with the preset. The volume averaged beta value, $<\beta_{dia}>$, achieved around 4 % in both discharges, whereas $<\beta_{dia}>$ in the R_{ax} swing case abruptly decreased at 2.23 s. Although the temporal changes of central electron temperature were almost similar in both discharges, the rapid drop was observed at 2.2 s in the case of the R_{ax} swing and it was led by strong m/n = 2/1 mode. Then the profile flattening was occurred around the m/n = 2/1 resonance located at $\rho \sim 0.5$. This observation is consistent with a theoretical prediction of ideal MHD stability boundary, and it is due to an enhancement of magnetic hill with the inward shift of R_{ax}. The edge MHD activity with m/n = 2/3 was suppressed by the inward shift of R_{ax}, which is due to a decrease in edge iota leading a reduction of the pressure gradient around the resonance. This tendency is clarified by the statistical analysis including various discharges.

The previous experiments in the preset-R_{ax} = 3.5 m configuration indicate that m/n = 2/1 mode limited the achieved beta value[1], and therefore R_{ax} swing technique is useful for clarifying the stability boundary, especially, in the high-beta regime. The results of various R_{ax} swing discharges are summarized in Fig.2. The closed circle corresponds to the appearance of m/n = 2/1 mode, and the mode obviously appeared in the case of R_{ax} < 3.65 m. Although the excitation of the mode sometimes minor collapse as shown in fig.1, no major collapse occurs. The onset of the mode was clearly found.

1) S. Sakakibara *et al., Plasma Fusion Res.* **1** (2006) 003

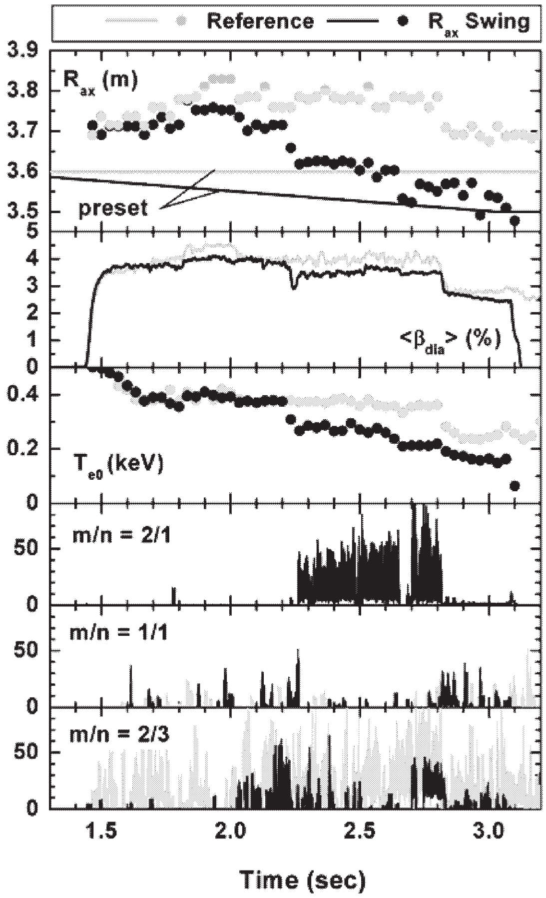

Fig.1. Discharges with and without R_{ax} swing.

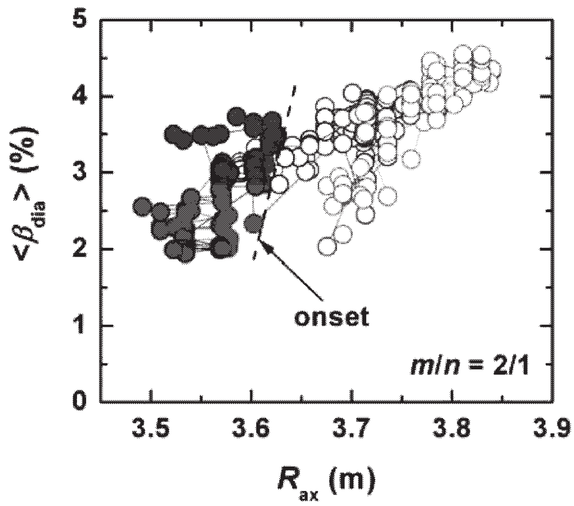

Fig.2. Appearance of m/n = 2/1 mode on the $<\beta_{dia}>$ and R_{ax} diagram.