§14. Study of MHD Fluctuation with Tearing-Like Mode Structure in LHD

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The magnetohydrodynamic (MHD) stability behavior of plasmas in the toroidal magnetic confinement devices is one of the important issues for the achievement of the nuclear fusion power plant. In the Large Helical Device (LHD), MHD activities have been reported under various conditions[1, 2]. For example, the interchange mode is appeared in the weak magnetic shear configuration, which is formed by the plasma current generated by unbalanced Neutral Beam (NB) injection. Furthermore, when the plasma current of the opposite direction to the toroidal magnetic field is induced by NB injection, the electron temperature fluctuations are appeared in the core region by injection of supersonic gas puffing (SSGP) and the tearing-like mode structure is measured by electron cyclotron emission (ECE) diagnostics[3]. It is suggested that the fluctuation is caused by a rotating m/n= 2/1 magnetic island. On the other hand, in the calculation for stability analysis, it is found that the tearing mode becomes unstable if the plasma current is higher than above experiment. In this study, it aims that the appearance mechanism of tearing-like mode, which is triggered by SSGP under the condition of relatively low plasma current, is clarified. In order to analyze the MHD stability, the rotational transform profile before and after SSGP injection is measured by motional Stark effect (MSE) diagnostic.

Figure 1 shows the temporal evolution of the electorn density and temperature measured by FIR interferometer and ECE diagnostics with SSGP injection. The experimental condition is as follow: the magnetic axis R_{ax} = 3.6 m, B_t = −2.75 T, which is the toroidal field at R_{ax}. SSGP is injected at t = 4.8 sec and the plasma current is about 43 kA. From Fig. 1, the electron density is rapidly increased and the electron temperature is decreased just after injection of SSGP. Unfortunately, electron temperature fluctuations triggered by SSGP is not appeared in this experiment.

Figure 2 shows the rotational transform profile just before and after SSGP injection. It is found that the rotational transform profile is hardly changed by SSGP and the current density profile is not changed, too. Therefore, it is considered that m/n= 2/1 tearing mode remain stable and electron temperature fluctuation can't be observed. Figure 3 shows perturbation profiles of the electrostatic potential and poloidal magnetic flux estimated by the calculation for stability analysis. The circular cylinder model is used in the calculation. From Fig. 3, it is found that the magnetic confinement structure becomes the interchange mode structure and this calculation result is consist with the experimental result, which isn't appear the m/n = 2/1 magnetic island. In this study, but the tearing-like mode structure can't be observed, it is important that the current density profile with the mode structure is clarified in order to understand more about MHD instability of helical devices.

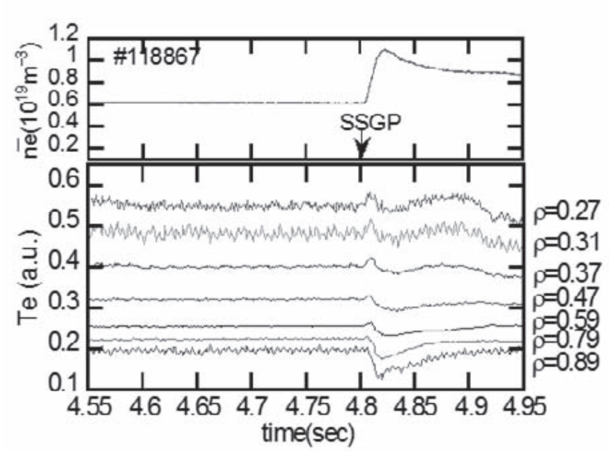

Fig. 1. Temporal evolution of the line averaged electron density and temperature before and after SSGP injection.

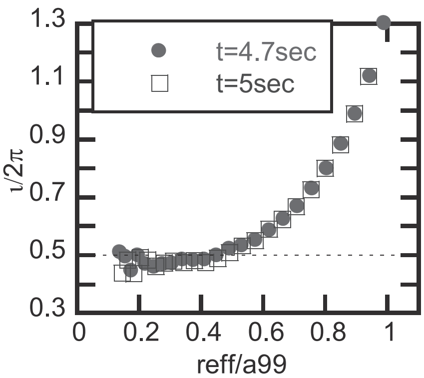

Fig. 2. The rotational transform profile just before and after SSGP injection.

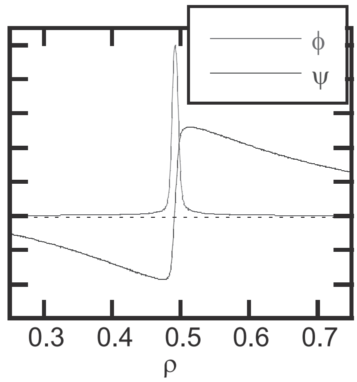

Fig. 3. Perturbation profiles of electrostatic potential ϕ and poloidal magnetic flux ψ estimated by calculation for stability analysis just after SSGP injection.

1) Sakakibara, S. et al.: Plasma Phys. Control Fusion **44** (2002) A217.
2) Sakakibara, S. et al.: Fusion Sci. Technol. **50** (2006) 177.
3) Murakami, A. et al.: Plasma Fusion Res. **6** (2011) 1402135.