§14. Effect of Outboard Helical Field on Toroidal Plasmas

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Tokamak and helical systems have been widely recognized as efficient toroidal magnetic plasma confinement devices. The machine TOKASTAR-2 is a new plasma confinement device which has both tokamak and helical confinement properties[1,2]. There are outboard helical field (HF) coils with the toroidal period $N = 2$ or 1 outside eight toroidal field (TF) coils (Fig.1). One of main ultimate purposes of this experiment is to evaluate the effect of external outboard helical field application on tokamak plasma confinement. As an initial confinement experiment, we produced plasmas in simple toroidal field configuration and applied outboard helical field to these plasmas which are created by the electron cyclotron heating (ECH) using 2.45GHz microwave with pulsed power up to 2 kW. The toroidal plasma current is not inductively induced in this experiment.

The outboard helical field was applied to these ECH plasmas. The peak location of electron density profile in the *R*-direction agrees with first electron cyclotron resonance layer position at initial break-down period and at final disappearance period, but not at the middle time zone of the plasma discharge. Second higher harmonic resonance, upper hybrid resonance, and the effect of toroidal drift are being examined for this density profile.

The bursting oscillations observed at the upper side of the equatorial plane by *Z*-probe are suppressed by applying an external helical magnetic field (Fig.2). The profile shift under *Z*-direction was reduced in the case of helical field application according to the *Z*-probe measurement. The outward plasma expansion in the *R*-direction may be suppressed by the helical field application. Effects of the helical magnetic field application on plasma fluctuation and movement are being reported[1-3] in detail.

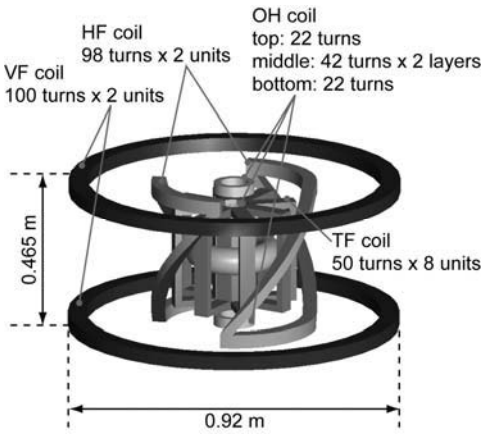

Fig.1 Coil configuration of TOKASTAR-2 device

Relevant to helical field application, neoclassical tearing mode (NTM) in fusion plasmas is analyzed[4]. The electron cyclotron current drive (ECCD) and the non-resonant external helical field (NRHF) application are simulated using the 1.5-dimensional equilibrium/transport simulation code (TOTAL code), and the 3/2 NTM is stabilized by external non-resonant helical field application[4].

1) K. Baba, K. Yamazaki, H. Arimoto, T. Oishi, K. Okano, M. Hasegawa and T. Shoji, Plasma and Fusion Research: Regular Articles **5** (2010) S2036.
2) K. Okano, K. Yamazaki, H. Arimoto, T. Oishi, K. Baba, M. Hasegawa and T. Shoji, Plasma and Fusion Research: Regular Articles **5** (2010) S2037.
3) T. Oishi, K. Yamazaki, H. Arimoto, K. Baba, M. Hasegawa, H. Ozeki, T. Shoji, M. I. Mikhailov, Proc. IAEA-Fusion Energy Conference, ICC/P5-04 (Deajeon, Korea, Oct.10-15, 2010).
4) S. Taniguchi, K. Yamazaki I, T. Oishi, H. Arimoto and T. Shoji, Plasma and Fusion Research: Regular Articles **5** (2010) S2035.

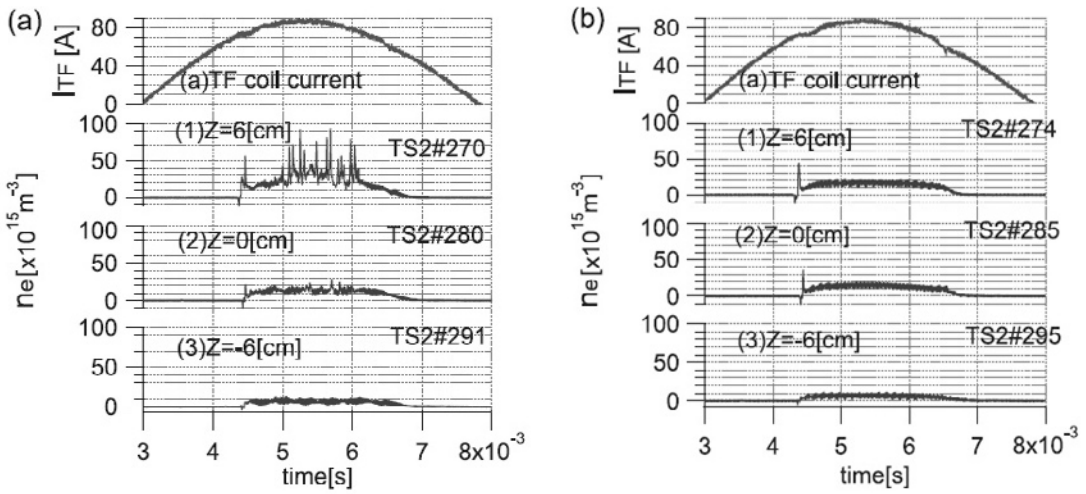

Fig.2 Toroidal coil current and electron density traces at respective measuring points using vertical probe (a) without and (b) with static helical field application.