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高速度カメラを用いたTOKASTAR-2プラズマ挙動の研究

Measurement of plasma behavior using a high-speed camera in TOKASTAR-2

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To study tokamak-stellarator hybrid confinement system [1], TOKASTAR-2 device was designed and constructed. This device is able to generate tokamak and helical configurations independently by using different types of coils. The magnetic field strength is B_tR~ 0.01 Tm. It has a major radius of R_p ~ 12 cm and a minor radius of a~ 5 cm. The electron cyclotron resonance (ECR) heating (2.45 GHz) is used for the pre-ionization and the injection power is ~1.4 kW.

To improve tokamak equilibrium control, we adjusted the charging voltage of the capacitor (V_{PVF}) for the Pulsed Vertical Field (PVF) coil circuit. In this study, the effect of helical field application on tokamak plasma is evaluated. The plasma position and shape are evaluated by emission intensity distribution of the high-speed camera images taken in the tangential direction (60,000FPS, 320×160pixels). Figure 1 shows the top view of TOKASTAR-2 device and camera sightlines and photograph of the view in the tangential direction.

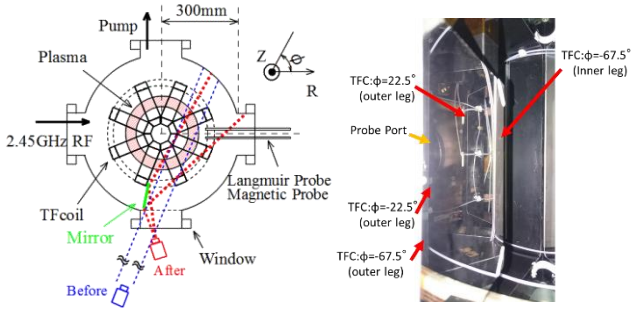

Fig.1 (Left)Top view of high speed camera sightline
(Right) Photograph of the view in the tangential direction

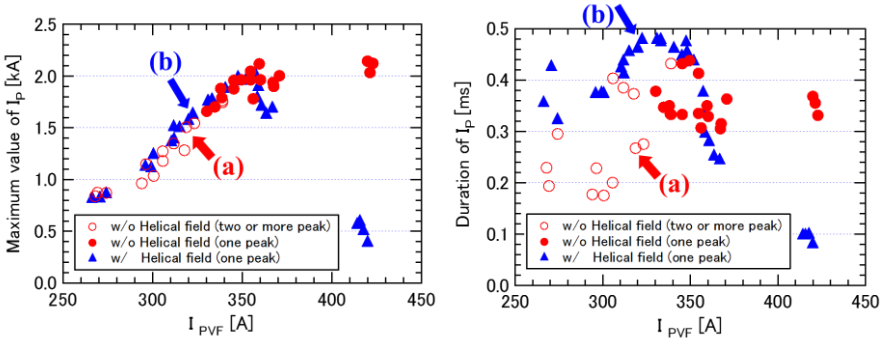

Fig.2 (Left) The peak value of plasma current and (Right) the duration of plasma current as function of the PVF coil current. (Red circle) tokamak discharge without external helical field, (Blue triangle) that with external helical field

We installed a mirror in the vacuum vessel to expand the field of view, which was previously limited to R ≦ 115mm by the outer legs of TF coils [2]. The camera lens was also changed to a wide-angle lens (C-mount lens f = 16 mm).

Figure 2 shows the peak value and the duration of plasma current as a function of I_{PVF}. It was found that under the condition of weak vertical field (I_{PVF} < 350 A), the duration and the plasma current of tokamak discharge were improved by the external helical field.

Figure 3 shows camera images at the same time (t = 2.7167ms) under the condition of I_{PVF} = 322 A. The outward plasma displacement was suppressed in tokamak discharge with the external helical field. The plasma was located stably in contact with the inner legs of the TF coils. These indicates that external helical field contributed to the positional stability of the radial direction in the tokamak discharge under the condition of I_{PVF} < 350 A.

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[1] K. Yamazaki et al. J. Plasma Fusion Res. SERIES **8** (2009) 1044.
[2] T. Sakito, et al Plasma Fusion Res. 10, 3402033 (2015).

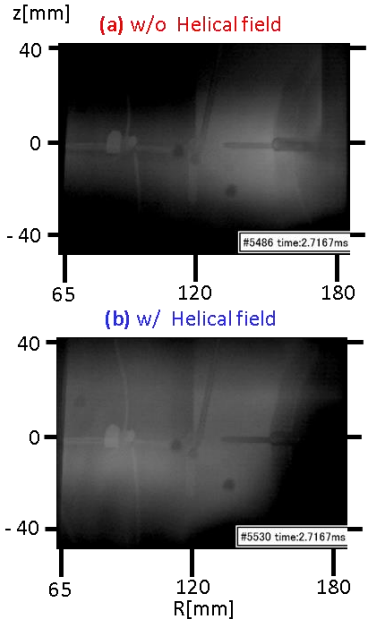

Fig.3 Images in tokamak discharge (a) without Helical field, (b) with Helical field