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# Stabilization of Tokamak Plasma Position by the Local Helical Coils in TOKASTAR-2

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Positional instability results in the high heat flux and electromagnetic force to in-vessel components in tokamak devices. Helical field is thought to provide improved positional stability. Stabilization of the plasma position by applying the helical field to the tokamak plasma was shown in experiment [1-5]. TOKASTAR-2 is a tokamak-stellarator hybrid plasma confinement device with a low aspect ratio ($A \sim 3$) which has local helical coils. One of the main purposes of TOKASTAR-2 is to study the stabilization effect of the tokamak plasma position by applying the helical field of the local helical coils and investigate the condition of the local helical field to stabilize the plasma position. The local helical coil system consists of two HF (Helical Field) coils in parallelogram shape, four AHF (Additional Helical Field) coils in fan shape and two circular VF (Vertical Field) coils. These coils are connected to DC power supplies and this study aims to stabilize the plasma position without the active feedback. They are designed so that the vacuum magnetic surfaces are generated without the plasma current. The HF coils are located outside in the radial direction while the AHF coils are located on upper and lower sides. The shape and arrangement of the local helical coils are simple and easier to apply to tokamak devices than conventional helical coils.

We investigated the effect of the helical field on the tokamak plasma radial position with the circular cross section in TOKASTAR-2. We estimated the tokamak plasma position and shape using external magnetic measurements [6]. A poloidal magnetic probe array (MPA) installed in TOKASTAR-2 has the 16 sensor coils located along the TF coils. All sensor coils are outside the plasma and do not influence on the plasma. The magnetic field was obtained by numerically integrating the voltage of the sensor coils. We also used four magnetic flux loops. We used filament current approximation method to estimate the tokamak plasma position and shape. We modeled the plasma current by the six ring filaments and calculated the poloidal magnetic flux generated by the plasma current. We used multipole magnetic field to calculate the poloidal magnetic flux generated by the coils current and the eddy current.

To study the effects of the helical field, the helical field was applied to the tokamak plasma which is unstable in the radial direction. Figure 1 shows the time evolution of the position of the current centroid and of the plasma current with and without the helical field under the weak vertical field. The position of the tokamak plasma with the helical field was obtained ignoring the three-dimensionality of the plasma current distribution. The oscillation of the radial position observed in a shot without the helical field. In contrast, the oscillation of the radial position was suppressed, and the tokamak radial position was stabilized by applying the helical field.

To estimate the condition of the local helical field to stabilize the plasma radial position, the helical coils current was scanned. The plasma radial position was not stabilized by applying the weak helical field. In the conference, the necessary condition of the helical field to stabilize the plasma radial position will also be presented.

References

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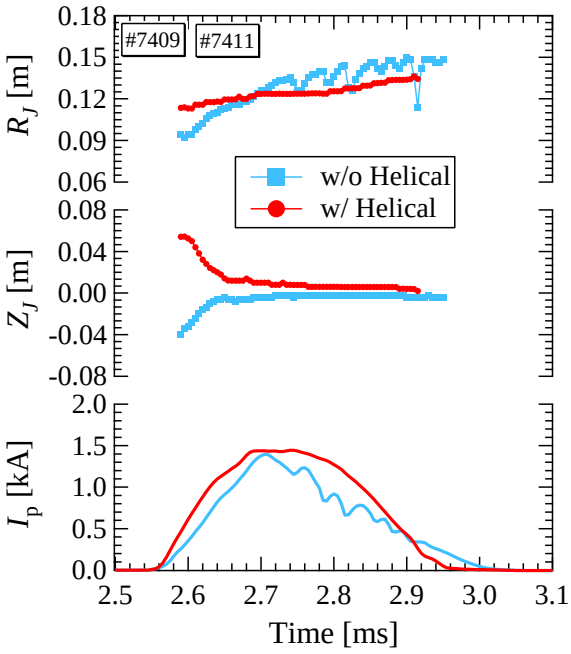


Fig.1 Stabilization of the plasma radial position by applying the helical field. (Top) the radial position (Middle) the vertical position of the current centroid. (Bottom) Plasma current.