§8. Effect of Outboard Helical Field on Toroidal Plasmas

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Some combinations among tokamak and helical configurations have been proposed for a compact steady-state system without plasma current disruptions. Moreover, coil arrangement with reduced helical coil numbers in the hybrid design has been proposed for enough plasma-coil space and easy reactor maintenance. TOKASTAR configuration is one of compact tokamak-helical hybrid confinement systems. We proposed an N (toroidal mode number) =1 or N = 2 compact coil system C-TOKASTAR (Compact Tokamak/Stellarator Hybrid) without toroidal coil system. This system has several advantages: (1) steady-state operation by helical coils, (2) no current disruption risk by external helical field application, (3) probable high-beta achievement by strong magnetic well, (4) enough divertor space by simple coil configuration, (5) compact economic system by spherical configuration and (6) easy maintenance by simple N =1 or N =2 coil system. Based on the achievement of C-TOKASTAR, a new small device named "TOKASTAR-2" was designed and constructed. Different from the C-TOKASTAR coil system, the toroidal field coil system is added in the TOKASTAR-2 (Fig. 1) to generate both tokamak and helical configurations independently.

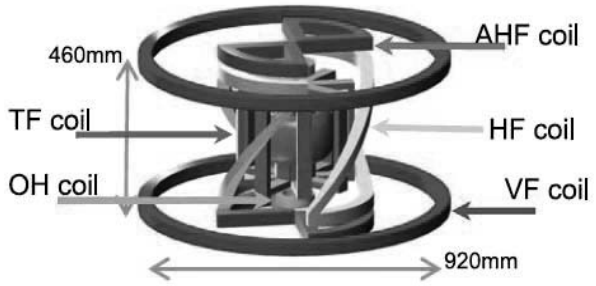

Fig. 1 Coil configuration of TOKASTAR-2.
AHF (Additional Helical Coil) is newly installed

Using OH coils (pulse discharge) and VF coils (static DC power supply), previously we obtained only 90A plasma current. Moreover, the vertical displacement of OH plasma was observed using a fast camera (40500fps) [1-2]. Then, we installed a conductive shell to increase plasma current and to suppress the vertical plasma displacement. Figure 2 (a) shows one sector of the conductive shell. The total shell consists of four pieces and is installed inside the TF coils as shown in Fig.2 (b).

Figure 3 shows the dependence of plasma current without and with the conductive shell on helium gas pressure. Compared with the values of plasma current without the conductive shell, induced plasma current with the shell increases by 40 A. This increase in plasma current was due to the suppression of the vertical displacement by the conductive shell.

To induce more plasma current and to apply appropriate time-varying vertical field which balances with the hoop force, we are constructing a new pair of VF coil. New VF coils are installed inside vacuum chamber and used with pulsed power supply.

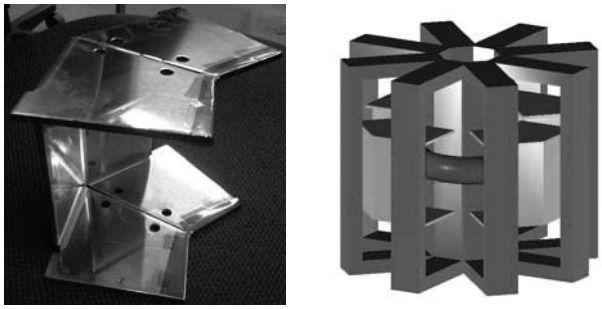

Fig.2 The conductive shell. Photo (a) shows one sector of the shell and drawing (b) shows the layout of four sectors of the shell inside TF coils.

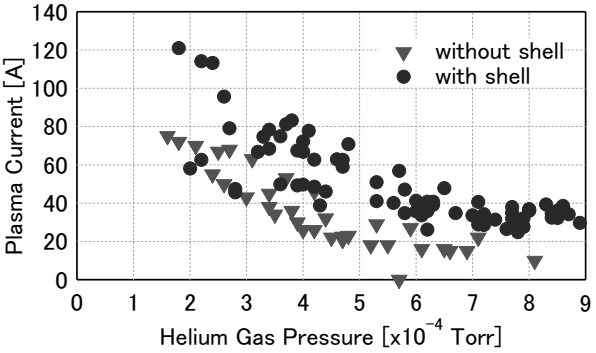

Fig.3 The dependence of plasma current with or without the shell on helium gas pressure.

1) K. Baba, K. Yamazaki, H. Arimoto, T. Oishi, M. Hasegawa, M. Suwabe, T. Shoji, Plasma and Fusion Research **6** (2011) 2402088
2) M. Hasegawa, K. Yamazaki, H. Arimoto, T. Oishi, K. Baba, M. Suwabe, T. Shoji, Plasma and Fusion Research **6** (2011) 2402141