Construction and plasma initiation of the tokamak-helical hybrid device TOKASTAR-2

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We proposed a TOKASTAR configuration [1-2] which is a tokamak-helical hybrid system. It has advantage of both tokamak and helical system so that TOKASTAR is expected to make an easy start-up of plasma operation and to reduce the probability of plasma current disruptions.

Construction of a small device named "TOKASTAR-2" was started in April 2008, and completed in March 2009. Now we are preliminarily optimizing TOKASTAR-2 plasma operations.

The TOKASTAR-2 machine is characterized by the external outer helical coil system added to tokamak device. Figure 1 shows coil configuration of TOKASTAR-2. Four kinds of coils were prepared. Toroidal field (TF) coils form toroidal magnetic field strength of ~1[kG] at plasma center R ~12[cm]. Ohmic heating (OH) coil can drive plasma current (I_p) up to ~1[kA]. Two outer helical field (HF) coils form helical magnetic field, which are positioned symmetrically outside TF coils. A pair of vertical field (VF) coils is installed outside the vacuum chamber. Microwave generator having 2.45[GHz] and 2[kW] magnetron oscillator was prepared for ECH (electron cyclotron heating) plasma generation. Several 200[μF] capacitors are utilized to energize pulsed current to each coil. Table 1 shows basic machine parameters of TOKASTAR-2.

ECH Helium plasma generation was attained, duration of which is several milliseconds. Electrostatic probes were prepared in order to analyze plasma temperature (T_e) and density (n_e), and Rogowski coil was prepared in order to measure I_p. At present we attain helium plasma with parameters T_e~10[eV], n_e~10^{16}[m^{-3}], and I_p~20[A].

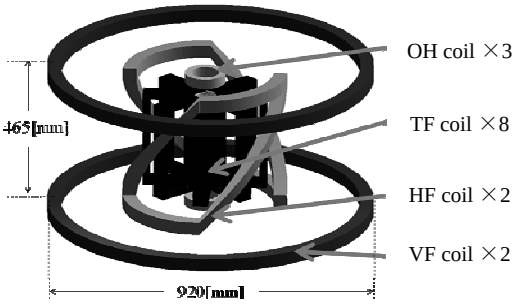

Fig. 1 Coil configuration of TOKASTAR-2

Table. 1 Basic machine parameters of TOKASTAR-2

Maximum toroidal magnetic field	$B_{t\text{-}max}$	～0.1[T]
Major radius of plasma	R	～0.1[m]
Minor radius of plasma	a	～0.04[m]
Microwave injection power	P_{ECH}	～2[kW]
Plasma current	I_p	＜1[kA]

[1] K. Yamazaki and Y. Abe: "Tokastar: Tokamak-Stellarator Hybrid with Possible Bean-Shaped operation", Research Report of the Institute of Plasma Physics, Nagoya, Japan, IPPJ-718(1985).

[2] T. Sawafuji et al.: Proceedings of International symposium on Eco Topia Science 2007, ISET07(2007)444.