§8. Various Applications of High Temperature Superconductor Coils for Plasma Confinement Devices

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Various applications of a high temperature superconductor (HTS) have been conducted in many fields. We are now exploring a utilization of a HTS coil for a plasma confinement device with a floating coil, where a new relaxation phenomenon theoretically predicted by Mahajan-Yoshida[1] should be examined and high beta plasmas could be investigated. Many devices with a floating coil such as Spherator and Levitron were constructed in the past, and plasma experiments were carried out[2]. Recently MIT/Columbia group is constructing a floating coil device called LDX[3]. In all of these devices low temperature superconductors have been employed. Since the HTS has many advantages in coil operation and plasma experiment, in comparison with a low temperature conductor, we have examined the feasibility of the HTS coil for plasma confinement experiments with the floating coil device[4]. Especially the position of the floating coil should be controlled within an accuracy of a few tens micrometers. This is a first challenge to introduce the HTS coil into the plasma confinement device.

Here we have designed a toroidal device with a levitated super-conducting internal coil (called Mini-RT) for the non-neutral plasma trapping experiments.

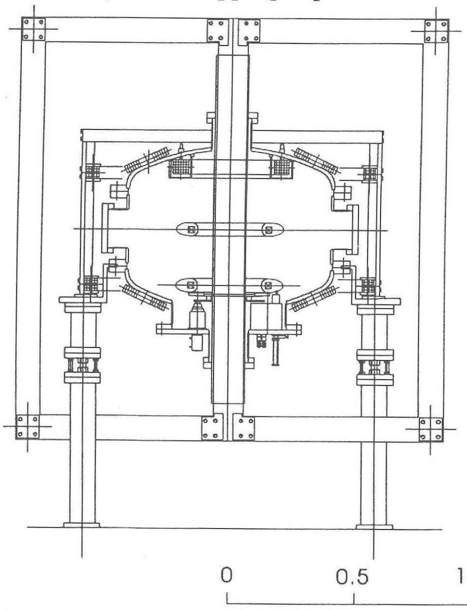

Fig. 1. The Internal Ring Device called Mini-RT.

The basic specification of the levitated internal ring coil is listed in Table I. It is expected that the internal ring coil is levitating during a few hours or more.

conductor size :	0.26mm x 4.3 mm
total turns :	423
critical current at 77K, s.f., 1μV/cm	Ic = 108 A
conductor current :	Iop = 119 A
operation temperature :	T = 20 - 40 K
stored energy of the coil :	Wmag = 0.6 kJ
maximum field :Br,max = 0.52 T	Bz,max = 0.66 T
residual voltage of coil :	$V=2x10^{-5}$ V
→ current decay time :	τ = 13.8 hours

Table I. Design Parameters of HTS Coil

We have manufactured a small-sized HTS coil, and examined the characteristics at 77 K. The HTS coil current is induced by the field cooling method. Figure 2 shows the temporal evolution of the magnetic field strength. Just after the turn-off of the current of the primary winding coil, the magnetic field strength begins to decrease gradually, where two time constants have been observed; one is τ_1 = 41.7 s in the initial phase and another is τ_2 = 3306 s in the later phase. The time constant of the initial phase is accounted for the flux flow resistance if *n*-value of around 10 is taken into accounted, while that of the later phase is coming from the resistance at the lap joint.

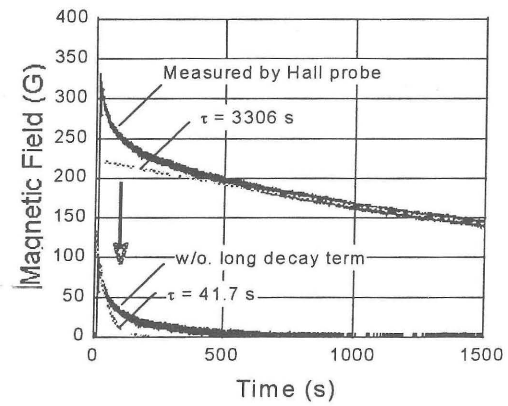

Fig. 2. The current decay of the HTS coil.

References

1) Mahajan, S.M. and Yoshida, Z., Phys. Rev. Lett., **81**, (1998) 4863.
2) S. Yoshikawa: *Nucl. Fusion* **13** (1973) 433.
3) J. Schultz, *et al.*: *IEEE Trans. on Appl. Supercond.* **9** (1999) 378.
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