§31. Completion of an LID Magnetic Configuration System for LHD

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The LID is a divertor that uses an m/n=1/1 island formed at the edge region, so the LID experiment is performed by combining a coil system for controlling magnetic islands and an LID head system for receiving heat and particle fluxes from the core. In February, the construction of one of these two, that is, an LID magnetic configuration system, was completed, and various tests of the system were successfully finished. This system can be also used to eliminate natural islands, which may be produced by error field, for example, due to ferromagnetic material located near LHD and small misarrangement of helical and poloidal coils.

A clean m/n=1/1 island for the LID has been demonstrated numerically to be generated by the LID magnetic configuration system, as shown in Fig. 1 [1]. When a resonant perturbation field, generated by a couple of island control coils located above and below the torus, is added to the standard LHD magnetic configuration, an m/n=1/1 island appears at the $\iota/2\pi=1$ surface, together with m/n=2/1 islands which appear owing to the toroidal coupling at the $\iota/2\pi=0.5$ surface. However, since the m/n=2/1 islands can be generated by another couple of island control coils, the m/n=2/1 islands are eliminated by a proper arrangement of the control coil currents. One of the remarkable features of this type of configuration is a very sharp transition (within 2 mm in radial direction) from the closed magnetic surface to the open region, where field lines circulate around the torus less than several times before striking divertor plates. This is in contrast to the case of the helical divertor, with a transition width of about 50 mm [2], and is useful for removing vague edge plasmas.

We constructed the 20 island control coils, as shown in Fig. 2, and 3 electric dc power supplies that provide currents for the coils. The 3 electric dc power supplies are necessary for generating the m/n=1/1 island and eliminating the m/n=2/1 islands, individually, that is, for achieving the proper arrangement of the control coil currents, as mentioned above. The island control coils were installed around the upper and lower ports of the LHD cryostat, as shown in Fig. 1. The power supplies were situated in the basement, and connected with the island control coils by distributing current feeders. The LID magnetic configuration, obtained numerically by this system, shows that an island with a full width of about 15 cm is formed in a steady state with a toroidal magnetic field B_0 of 3 tesla. In a pulse operation, a factor of about 1.2 wider island can be generated.

For generating the islands, the output voltage and current of one of the three power supplies are 240 V and 1,920 A, respectively, in a steady state, and 350 V and 3,840 A, respectively, in a pulse. Those of two other supplies are 460 V and 1,920 A, respectively, in a steady state, and 680 V and 3,840 A, respectively, in a pulse. In the pulse operation, the ramp-up and ramp-down times are 1~5 sec, and the flat-top duration is 5~10 sec. The time interval between shots is 5~60 min. The higher harmonics are generated in the ac line by thyristors, and distort the voltage waveform on the power lines. Thus the harmonic filters (5th, 7th, and 11th) are installed at the 6.6 kV power line when the power supplies are operated. The ripple of the output current has been designed to be less than about 2%.

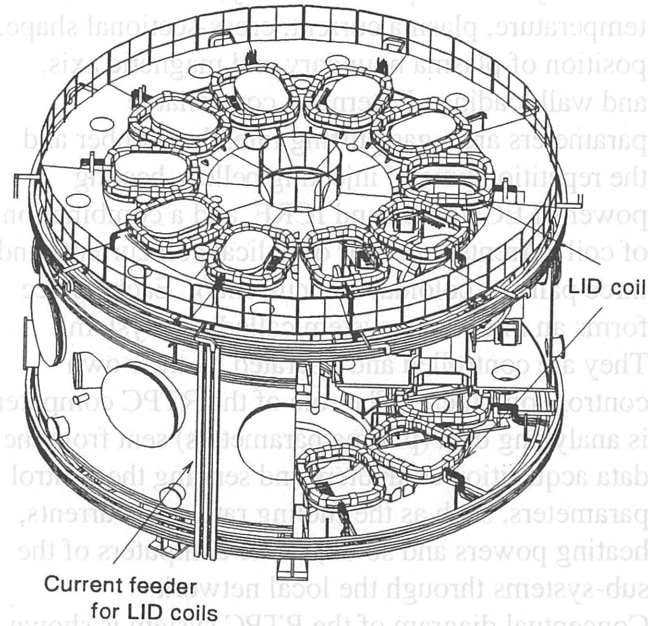

Fig. 1. Schematic view of island control coils with distributing current feeders and cooling pipes.

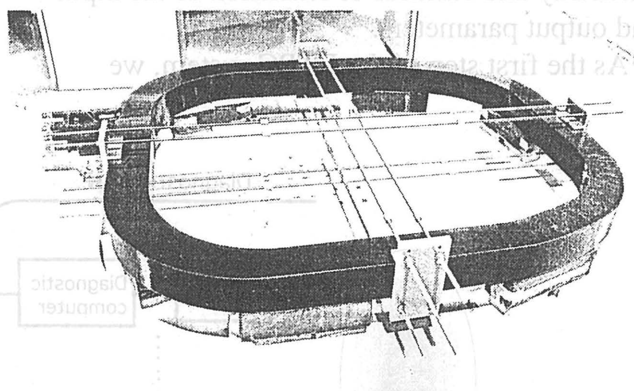

Fig. 2. An island control coil.

References
[1]Komori, A., *et al.*, in *Plasma Physics and Controlled Nuclear Fusion Research 1994*, Seville(IAEA, Vienna, 1996), Vol. 2, p. 773.
[2]Ohyabu, N., *et al.*, Nucl. Fusion 34, 387 (1994).