§7. LHD-type Magnetic Configuration with Large Blanket Space[1)]

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In the design studies of the magnetic configuration for fusion energy reactor, the balance between blanket space ($\equiv \delta$: the narrowest space between the chaotic field lines outside the last closed flux surface (LCFS) and the inner wall of the helical coils) and plasma volume ($\equiv V_{\rm lcfs}$: the volume enclosed by the LCFS) is an important issue.

We have proposed thin and flat helical coil systems, which are partitioned to three blocks with independent current value control, to satisfy the following requirements: (1) sufficient blanket space and large plasma volume under the helical coils with appropriate major radius and (2) divertor legs with little disorder that turn to the back of the helical coils.

Helical coils are split into three blocks (Fig.1). The optimization of the magnetic field is achieved by adjusting the current values of each coil block. Highly symmetric magnetic surfaces with divertor legs, which turn to the back of the helical coils, are confirmed. The cross-section of the plasma boundary changes from elliptical to racetrack-type as shown in Fig. 2. The confinement performance for high-energy particles is excellent.

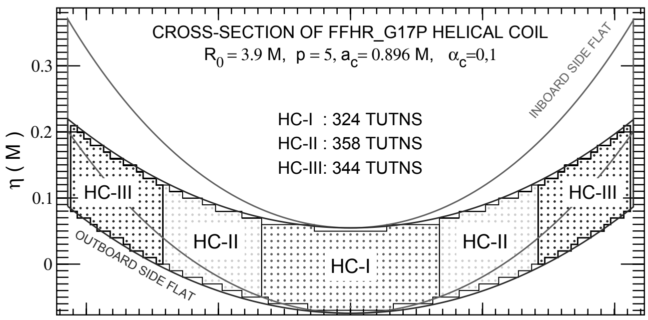

Fig. 1: The thin and flat helical coil is shown in the LHD scale. (ξ, η) is the plane perpendicular to the helical coil. η is the radial direction from the helical coil center. The blue and red lines show the vertical lines at the outboard and inboard side. The center of the helical coil $(0, 0)$ is wound on the circular ring with minor radius $a_{\rm c}$ with helical coil pitch modulation factor $\alpha_c = 0.1$.

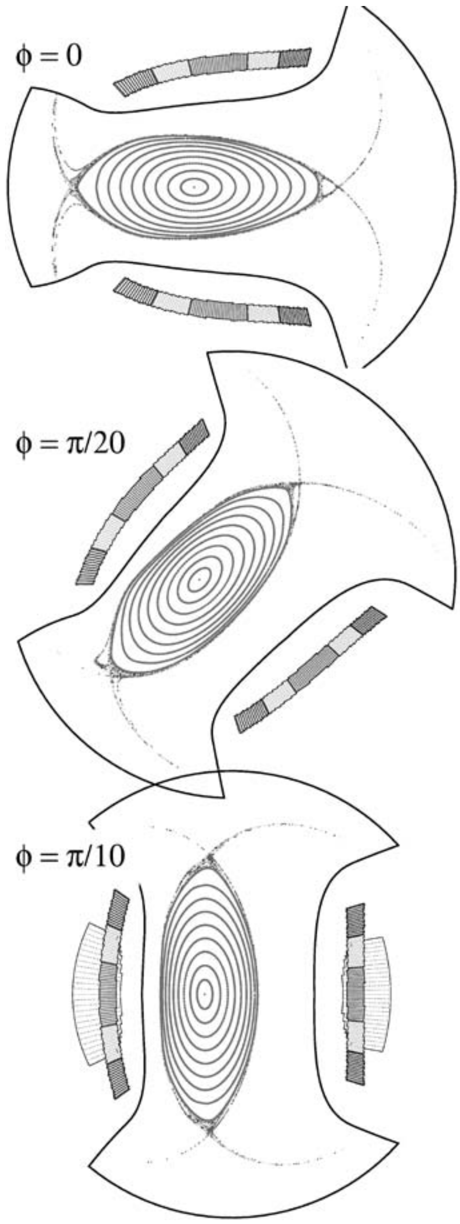

Fig. 2: Magnetic field configuration with large blanket space and large plasma volume. Helical coils (only for the toroidal angle $\phi = \pi/10$) and vacuum vessel that are similar extension of the LHD are also shown.

Table I: Coil parameters for the case of Fig. 2 with $R_0 =$ 16.7 m and $B_{\rm ax} = 5$ T. (δ: blanket space, $V_{\rm lcfs}$: plasma volume)

	HC-I	HC-II	HC-III	δ / $V_{\rm lcfs}$
I(MA)	61.4	−38.0	16.0	1.385 m
$J_{\rm c}$(A/mm^2)	103.4	−57.9	25.4	1731.8 m^3

1) T.Watanabe, N.Nagato, and A.Sagara, LHD-type magnetic configuration with large blanket space, PFR. **9**, 3403089 (2014)