§1. Design of the Closed Helical Divertor in LHD

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Particle control using divertor is a key issue for controlled nuclear fusion in magnetically plasma confinement devices. In the Large Helical Device (LHD), performing the efficient particle control using divertor to improve the plasma confinement and to achieve long pulse discharges with high heating power is one of the major experimental goals. The LHD experiments have been conducted mainly under the intrinsic helical divertor (HD) configuration in which no active particle controllability is equipped ("open" HD). The modification of the open HD to the "closed" HD has been investigated to accomplish the active particle control using the HD configuration using fully three-dimensional neutral transport code EIRENE [1-3]. Because the substantial part of the divertor particle and heat load deposit to the divertor tiles at the torus-inboard side, the open HD in there will be modified for the first step of the modification. Rearrangement of divertor plates and arrange of additional components, such as dome structure were studied, and we met a solution as shown in Fig. 1. This configuration is expected to make the neutral particles to be compressed well in the divertor region [3]. An in-vessel cryo-pump will be installed under the dome, and effective divertor pumping will be possible.

The position of the divertor trace and the angle of incidence of magnetic field lines to the divertor tiles were investigated with the magnetic tracing calculation as shown in Fig. 2 and Fig. 3, respectively. Figure 3 shows that the angle is larger in the closed HD case than that in the open HD case, and it is better from the view point of the heat and particle load dispersion.

Plasma facing components for the closed HD have been designed. The main components are divertor tile and dome structure. Figure 4 shows basic designs of them schematically. They are mechanically attached type module [4]. As shown in Fig. 4, they consist of a couple of armor tiles made of iso-graphite, respectively, which are tightened by two stainless (SUS316) or molybdenum bolts horizontally sandwiching a SUS316 cooling pipe. The heat load examinations for these components have been performed by using electron beam irradiation in ACT [4,5].

In 2010, the modification of the HD will be conducted for two toroidal sections, and the performances of the new closed HD will be investigated in the experimental campaign 2010.

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[2] M. Shoji et al., Contrib. Plasma Phys. **48** (2008) 185.
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[5] M. Tokitani et al., in this volume.

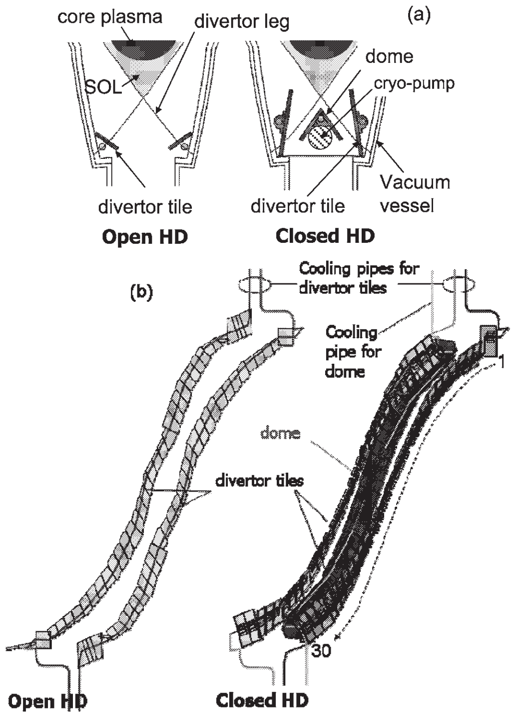

Fig. 1. Schematic views of the open and closed helical divertor (HD) configurations at the torus-inboard side. (a) horizontal cross-section at the equatorial plane. (b) birds-eye view of the divertors.

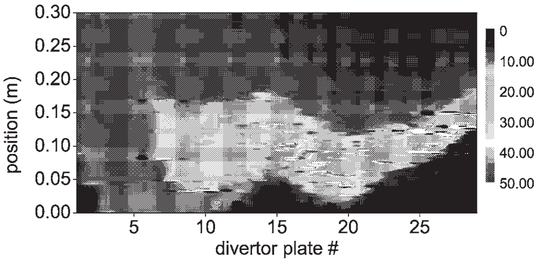

Fig. 2. Distribution of the connection length of the magnetic field lines on the divertor tiles ($R_{ax} = 3.6$ m, $\gamma = 1.254$). Divertor plate number is defined as shown in Fig. 1(b).

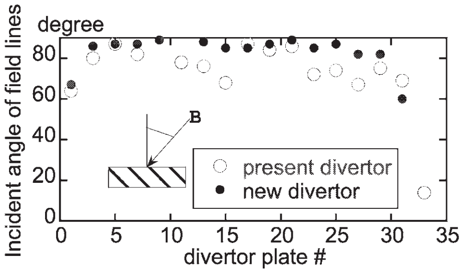

Fig. 3. Incident angles of the magnetic field lines as a function of the divertor tiles positions. Divertor plate number is defined as shown in Fig. 1(b).

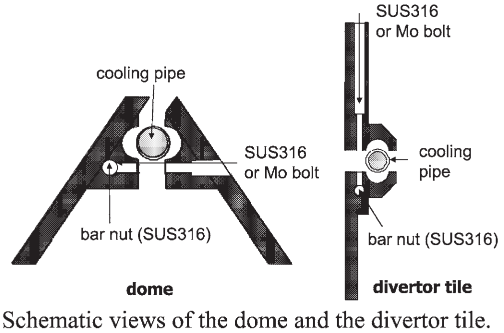

Fig. 4. Schematic views of the dome and the divertor tile.