§42. LID Head System

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A divertor head of local island divertor (LID) that utilizes an m/n = 1/1 island was installed on the Large Helical Device (LHD) after the fifth experimental campaign in 2001-2002. The LID was completed, and LID experiments will be performed in the next campaign. The LID has been proposed for the improved confinement, although the island itself was found to deteriorate the plasma performance a little. In the LID, the outward heat and particle fluxes crossing the separatrix of the m/n = 1/1 island flow along the field lines to the backside of the island, where divertor plates are placed on a divertor head to receive the heat and particle loads. The particles recycled on the divertor plates are pumped out by a pumping system with high pumping efficiency of $\geq$ 30%. Highly efficient pumping, combined with core fueling, is the key to realizing the high temperature divertor operation, leading to a significant energy confinement improvement.

The LID head system consists of the divertor head, its driving system, a pumping duct, and an LID chamber. The length of the LID head system is so long that the driving system requires the long LID chamber to take out the head from the LHD vacuum vessel and to seal up it with a gate valve whose inner diameter is 1,400 mm. These driving system and gate valve are necessary for maintaining the LID head system and performing experiments without the LID.

The size of the head is 990 × 664 mm in the front view, and the area of the head, which receives the particle flux is ~0.3 m^2. The head is divided into 8 elements, which consist of small planar carbon tiles joined mechanically to a stainless-steel heat sink with a cooling tube, on the side that the particle flux strikes. Here, angles between the carbon tiles and particle orbits were designed to be less than 10 deg. The average heat flux onto the carbon tiles was designed ~5 MW/m^2 for 3 sec. Ideally the planar plates should be three-dimensional curved tiles that match the magnetic surface. Another side of the head, facing the core plasma, is covered with the molybdenum plates by mechanical joint to protect the heat sink from high-energy neutral particles produced by charge exchange.

The particles recycled on the carbon tiles are pumped out by the pumping system, which has 8 cryogenic pumps with a hydrogen pumping speed of 42,000 l/sec. The effective pumping speed is 1.3 × 10^5 l/sec at the gate valve located between the LID chamber and LHD vacuum vessel, and large enough to realize a molecular flow. The pumping capacity and maximum pumping flux are 3 × 10^5 torrl and 75 torrl/sec, respectively. These satisfy the values required for the LID pumping system to control the LHD edge plasma.

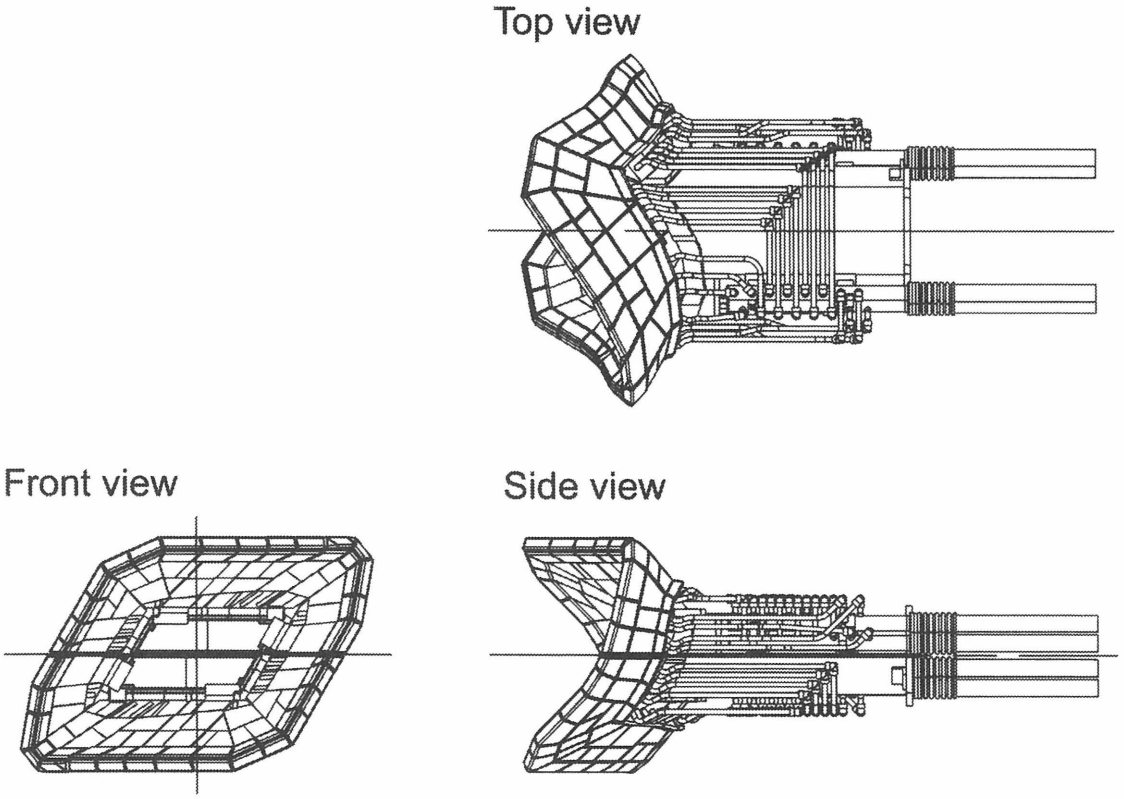

Fig. 1. Divertor head