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§8. Closed Helical Divertor Experiments

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The baffle-structured closed Helical Divertor (CHD) is being constructed in LHD to aim at active control of the edge plasma. The CHD in LHD consists of ten discrete modules. Following the numerical expectations, it is partially installed on the inboard side of the torus, where ~ 88 % of diverted particles flow into. Each module consists of two vertical target plate arrays and a "dome" structure, while it has not been equipped with a pumping system yet. In the 15th experimental campaing in 2011, two of ten modules were installed. Comparing with numerical expectations, performance of CHD had experimentally been investigated since the beginning of the CHD experiments in 2010. During the continuous gas puffing discharge, it was observed that the neutral pressure in the CHD was more than 10 times higher than that in the open helical divertor (HD) region [1].

In the 15th experimental campaign, neutral particle behaviors especially with different gases were investigated. For this study, a new diagnostics called "Penning spectroscopy system" was installed in the dome in CHD, which can measure hydrogen and helium pressures simultaneously during the discharge. Although the present CHD is not equipped with the pumping system, it is crucial to know the helium behavior in CHD, since helium should be pumped out together with hydrogen. Experiments were carried out in hydrogen discharges, puffing helium at 3.8 s for 0.12 s. Figure 1 (a) shows the temporal behavior of total pressure measured with first ion gauges in the CHD and the open HD. Partial pressures of hydrogen and helium in the CHD and the open HD are shown in Fig. 1 (b) and (c), respectively. The hatched period represents the helium gas puffing. It is found that the total pressure and the helium partial pressure suddenly rise just after the helium puffing. The interesting point is that the helium pressure in CHD keeps on rising until 0.2 s after stopping helium puffing, on the other hand, it decreases soon after stopping the helium puffing in the open HD. This result suggests the enhanced recycling or plugging for helium in CHD, which may contribute the efficient pumping for helium when the pumping system is installed in CHD.

The cryogenic pump system to be installed in the dome have been developed to remove excess neutrals in CHD. The cryopump consists of gaseous helium cooled cryosorption panels, liquid nitrogen cooled chevrons and water cooled louvers. A prototype of cryopump shown in Fig. 2 was made and tested in a test chamber. From the test result, it was found that the pumping speed was ~ 70 m^3/s for the whole area of the torus, which is about the same value as expected in the design. Six cryopump units for one CHD module have just been installed in the LHD vacuum vessel for the forthcoming experimental campaign. The rest of units for other modules will be fabricated and installed sequentially.

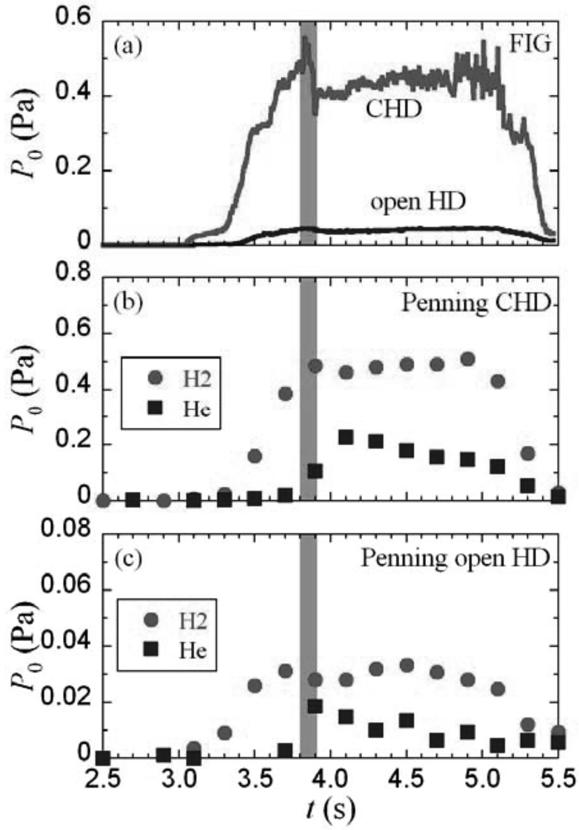

Fig. 1. (a) Total neutral pressure in CHD and open HD measured with FIG. Partial pressure of hydrogen and helium in (b) CHD and (c) open HD measured with Penning spectroscopy system. Helium is puffed during hatched period during hydrogen discharge.

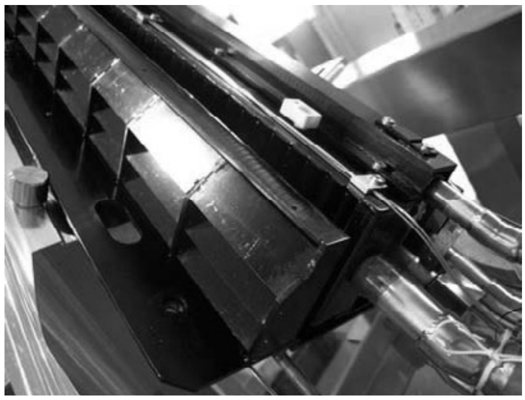

Fig. 2. Cryopump unit to be installed in dome

1) Masuzaki, S. et al.: Plasma and Fusion Research **6** (2011) 1202007.