§4. Measurement of Change of H-alpha Intensity Profiles by Closed Helical Divertor Components

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A closed helical divertor with a cryo-sorption pumping system was installed in an inner port (6-I) before the 16th experimental campaign in LHD. In order to investigate the effect of the closed helical divertor components on the neutral particle transport in the divertor region and the plasma periphery, the intensity profiles of line-integrated H-alpha emission (H_α: λ=656.3nm) were measured from an outer port (6-O) with a H-alpha filtered CCD camera. The measurements are compared with the intensity profiles for the open divertor configuration in the 14th experimental campaign, which were observed from almost the same position in the last experimental campaign.

Shown in Figure 1 (a) and (b) are the measured intensity profiles of H-alpha emission in the open and the closed divertor configurations for R_{ax}=3.60m, respectively. It is easily recognized that the difference of the intensity profile for the two different divertor configurations. For the open divertor, the H-alpha intensity in the lower side of the viewing area is high. The high H-alpha intensity position changes to the upper-right in the viewing area for the closed helical divertor configuration.

A three-dimensional neutral particle transport simulation analysis using the EIRENE code was applied to investigation of the change of the H-alpha intensity profile in the different divertor configurations. Two fully three-dimensional grid models including the geometry of the LHD plasma, the vacuum vessel and the open/closed divertor components were constructed for the simulation. The trajectories of many test particles, which are representative of neutral hydrogen atoms/molecules, released from the strike points on the divertor plates are traced in the grid models. The density profile of the neutral particles is calculated by summing up the statistical weight of the test particles in the grids. The H-alpha intensity profiles (2-D images) are obtained by integrating the emissivity of H-alpha emission at positions along totally 14,000 sight lines (100 in horizontal × 140 in vertical) from the camera position to an intersection point with components inside of the LHD vacuum vessel. The emissivity at a position on one of the sight lines is derived from calculations of the collisional radiative model for hydrogen atoms/molecules using the plasma parameters (n_e, T_e, etc.) and the density of the neutral particles. The three-dimensional profile of the plasma parameters in the plasma is from a calculation by the EMC3-EIRENE code in a typical NBI heated plasma for a typical magnetic configuration (R_{ax}=3.60m).

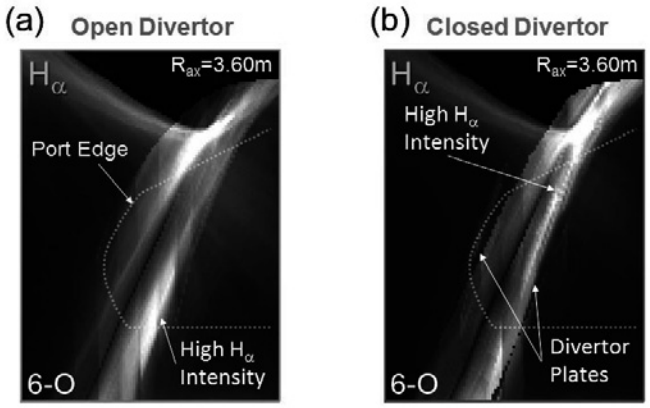

Fig. 2 Calculations of the intensity profile of the line integrated H-alpha emission from an outer port in the open (a) and the closed divertor configurations (b).

The neutral particle transport simulation has already predicted the reduction of H-alpha emission on the ergodic layer in the inboard side of the torus for the closed helical divertor compared to that for the open divertor. Figure 2 (a) and (b) indicate the calculated profiles of the H-alpha intensity in the open and closed divertor configurations, respectively. The calculations are qualitatively consistent with the measurements in the both divertor configurations, which indicate that the prediction of the neutral particle transport simulation is reasonable with the measurements.

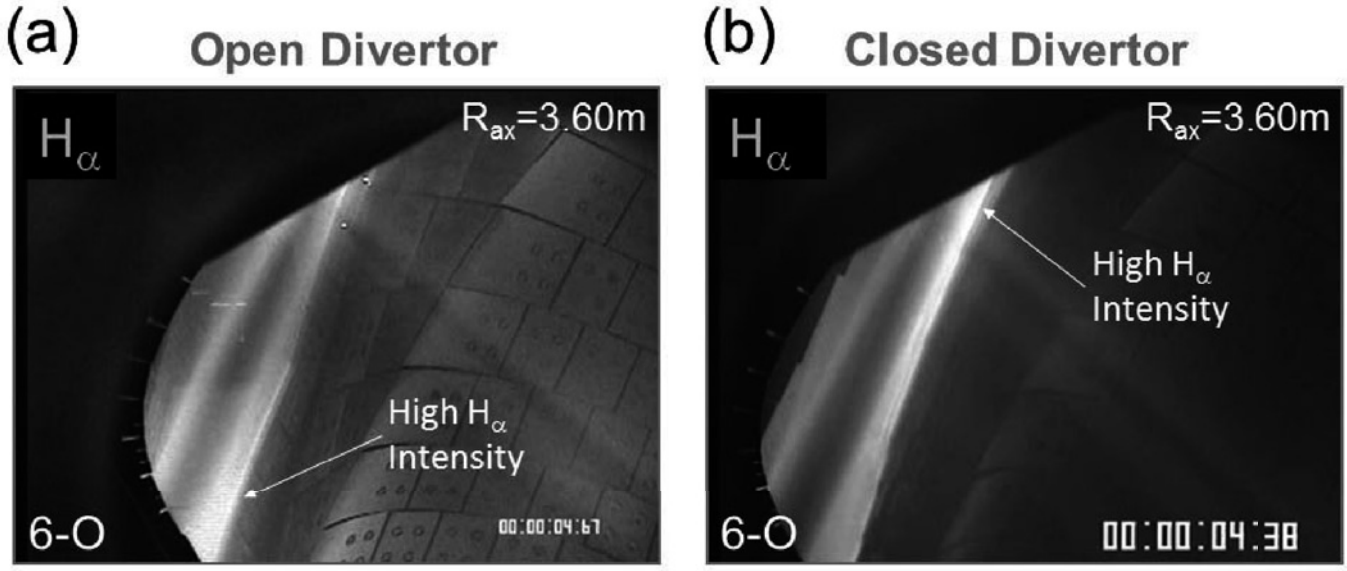

Fig. 1 Measurements of the H-alpha intensity profile in the open (a) and closed divertor configurations (b) for R_{ax}=3.60m.