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大型ヘリカル装置における開・閉ダイバータ領域での中性粒子の計測とその輸送解析

Measurements and Analyses of Neutral Particle Transport in Open and Closed Divertor Regions in LHD

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Two toroidal modules for testing a closed helical divertor were installed in the last experimental campaign (2011y). The main purposes of the divertor modules are:

1. High performance plasma production by peaked plasma density profiles with reduction of neutral particles desorbed from the divertor regions,
2. Control of penetration of impurity ions released from divertor plates to the main plasma confinement region,
3. Heat load reduction on divertor plates by detachment with effective confinement of neutral particles in the divertor region,
4. Investigation of the possibility of effective helium ash removal in future helical fusion reactors by evaluating the pumping efficiency of neutral particles (hydrogen and helium) in the closed helical divertor.

CCD cameras with interference filters, which are for measuring H_α and HeI line emission, were installed in two outer ports in the last experimental campaign. It is for monitoring confinement of neutral particles and the pumping efficiency in the both divertor regions with and without the closed helical divertor modules (closed and open divertor configurations). Figure 1 is the images of H_α and HeI line intensity profiles measured with the CCD cameras in the both divertor configurations for R_{ax}=3.60m, which shows a dark strike in the region between two helical coils (private region) in the inboard side of the torus.

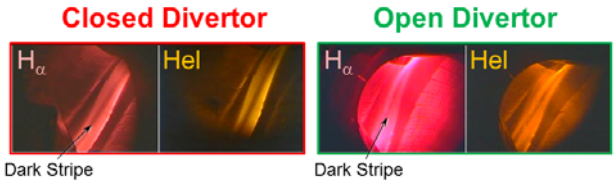

Fig. 1　Observed intensity profiles of H_α and HeI line emission in the closed and open divertor regions.

A fully three-dimensional neutral particle transport simulation code (EIRENE) is a powerful tool for understanding and interpreting the measured intensity profiles of H_α and HeI line emission. It calculates the three-dimensional density profiles of hydrogen atoms/molecules and helium atoms in the plasma periphery and the divertor regions. The images of the intensity profiles of the emission are obtained from the calculated neutral density profiles and the plasma parameter profiles (T_e, n_e).

Figure 2 illustrates the poloidal cross-sections of the calculated H_α and HeI lime emission profiles in the both divertor configurations. In this JSPF annual meeting, calculated images of the H_α and HeI lime emission are presented. And the analysis of the performance of helium pumping for the closed helical divertor is also reported.

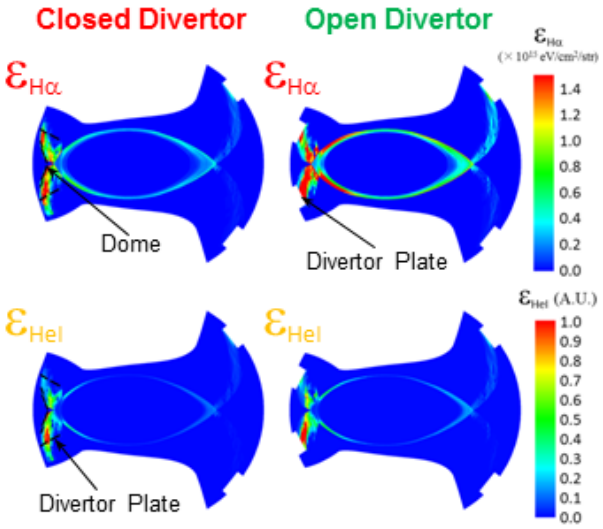

Fig. 2　Poloidal cross-sections of calculated emission profiles of H_α and HeI in the closed and open divertor configurations.