§15. Two-Dimensional Study of Edge Carbon Transport in Stochastic Magnetic Layer of LHD

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Two-dimensional (2-D) distribution of carbon has been measured to study the impurity transport in stochastic magnetic field layer of LHD[1]. When the 2-D distribution is observed, the impurity behavior can be separately studied between the inboard and outboard edge X-points. The 2-D distribution of CIV observed at different magnetic axis positions is shown in Figs.1 (a) to (c) for R_{ax}=3.60m, 3.70m and 3.75m, respectively. Symbols of axes, Z and Y, indicate vertical and horizontal positions of LHD plasma. Then, Y=0 means toroidal position at horizontally elongated plasma cross section (φ=18°). In R_{ax}=3.60m the CIV emission from inboard edge X-point is clearly stronger than that from outboard edge X-point. When the magnetic axis position is shifted outwardly, the impurity behavior near X-points drastically changes. In R_{ax}=3.7m the CIV intensity seems to be identical between inboard and outboard X-points, and in R_{ax}=3.75m the CIV intensity distribution along X-point is inversed reflecting the outboard edge X-point trajectory. This intensity change seems to reflect the plasma volume in the vicinity of edge X-point.

2-D CIV distribution is simulated with 3-D edge plasma transport code, EMC3- EIRENE code. The result is plotted in Figs.2 (a) and (b) for R_{ax}=3.60m and 3.75m, respectively. The value of φ=18° in horizontal axis of figures is a toroidal angle normalized by toroidal helical pitch number of M-10, which corresponds to the position of Y=0 mm in Fig.1. The X-point trajectory can be clearly seen in the 2-D distribution of CIV. The CIV emission in R_{ax}=3.75m is strong at the outboard edge X-point, while the CIV emission in R_{ax}=3.60m seems to be enhanced at both the inboard and outboard X-points. The simulation at R_{ax}=3.75m in Fig.2 (b) shows a good agreement with the measurement at R_{ax}=3.75m in Fig.1 (c), although the result at R_{ax}=3.60m tends to be different between the measurement and the simulation.

At present we have no clear comments on the discrepancy between the measurement and the simulation for the R_{ax}=3.6m case due to the limited data base. Nevertheless, it should be pointed out at least that the neutral particles are particularly localized at the inboard side of φ=18° toroidal position due to the geometrically closed space. The localized neutrals can change the local ionization source for density buildup and resultantly also change the density gradient along the magnetic field line. As a result, the edge impurity transport largely affected by the neutrals at the inboard side of torus in φ=18° may modify the carbon density distribution so that the CIV emission distribution can be enhanced along the inboard X-point. The 3-D simulation with locally enhanced neutrals is being carried out to explain the present result.

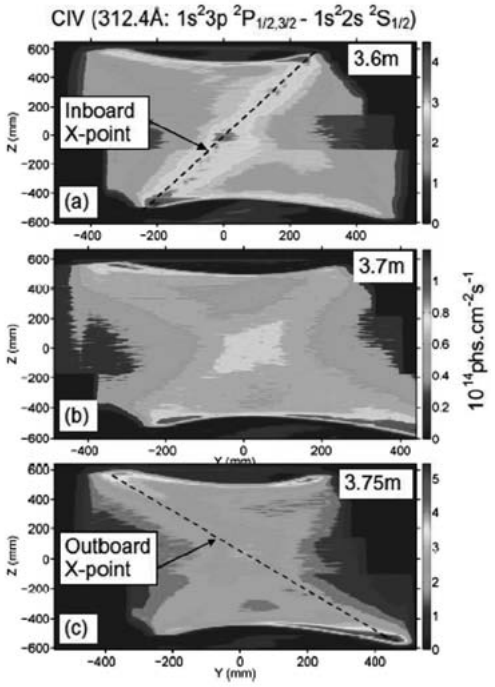

Fig.1 Measured two-dimensional distribution of CIV intensity at (a) R_{ax}=3.60, (b) 3.70 and (c) 3.75m configurations. The toroidal trace of inboard and outboard edge X-points is indicated with dashed lines in figures (a) and (c), respectively.

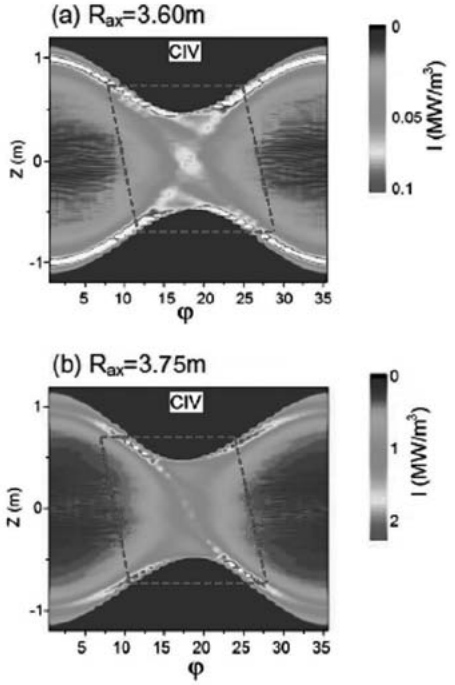

Fig.2 Simulated two-dimensional distribution of CIV emissivity at (a) R_{ax}=3.60m and R_{ax}=3.75m configurations. Horizontal axis means normalized toroidal angle. Diamond dashed line denotes LHD outboard port dimension which mainly defines the image area of the present two-dimensional EUV spectroscopy.

1) S.Morita et al., Joint 19th ISH and 16th RFP workshop, 16-20 Sep. 2013, Padova, Italy (to be published in PPCF).