§14. Measurements of Carbon Emission at the Edge Stochastic Layer for Impurity Transport Study in LHD

Kobayashi, M., Morita, S., Goto, M., LHD Experiment Group

Impurity transport in the edge region is important to determine the influx to the confinement region. In the many devices, it has been observed that the edge stochastic layer has impurity screening effects [1]. The mechanism is considered due to the friction force that drags the impurity towards background plasma flow direction, which is usually pointing to the divertor plates. In order to confirm this mechanism, we need detailed measurements on the edge impurity behavior. For this purpose, a visible spectrometer system has been developed in LHD, that provides two dimensional measurements of impurity emission. The final goal of this work is to quantify the impurity screening effect, i.e., quantify the ratio of impurity density/influx to the impurity source at the divertor plate, and the obtain evidence of friction force as a screening mechanism. In the 17th experimental campaign in LHD, we have conducted the experiments for impurity transport study.

Figure 1 shows a viewing area of the 2D visible spectrometer system, where the magnetic field lines and the envelope of the last closed flux surface (LCFS) are shown together with the spatial location of the individual channels. The number of channels is 130, and they cover the divertor plates, divertor legs, stochastic layer, and the confinement region.

For the present experimental campaign, we have conducted systematic density scan experiments to study impurity transport of carbon and Neon. In order to quantify the impurity source at the divertor plates, it is important to identify the corresponding emission lines. Figure 2 shows the spectra of CH band and C_2 band obtained with the spectrometer system. We have found that these lines are observed only at the channel viewing at the divertor plates (Fig.1) and increases with density, indicating the existence of the chemical sputtering of the carbon, which is considered to be dominant carbon source in LHD. For the Neon transport, we have puffed a certain amount of Neon and the emission line NeI has been also detected. The spectrometer system has been calibrated, so that the quantitative estimation of the carbon and neon source is possible and will be conducted in near future.

In order to identify the existence of the friction force, it is important to investigate the impurity flow behavior. For this purpose, Doppler shift of the carbon emission has been investigated. Figure 3 shows CCD image of the carbon emission CIII (464.742, 465.147 nm) from the channels 61 to 70 ch, which crosses the divertor leg X-point, as shown in Fig.1. There is clear Doppler shift observed, i.e., ch 61 to 65 shift to longer wavelength and ch 66 to 69 shift to shorter wavelength. Since the connection of divertor leg field lines to the divertor plates changes its direction around ch 65, the qualitative change of the shift is considered to reflect the carbon flow parallel to the divertor leg field lines. An estimation of the flow velocity is underway.

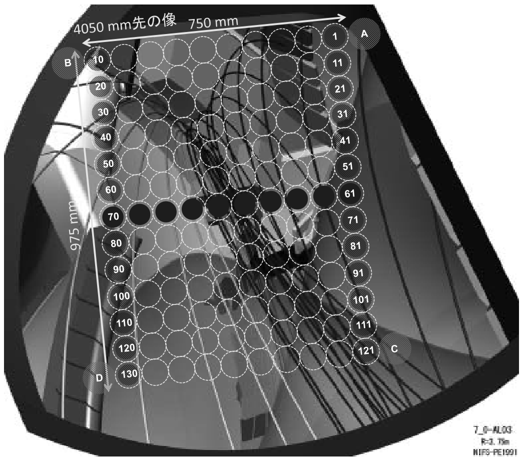

Fig. 1. Viewing area of the divertor spectrometer system. The dashed (yellow) circles represent spatial location of each channel of optic fibers with channel number.

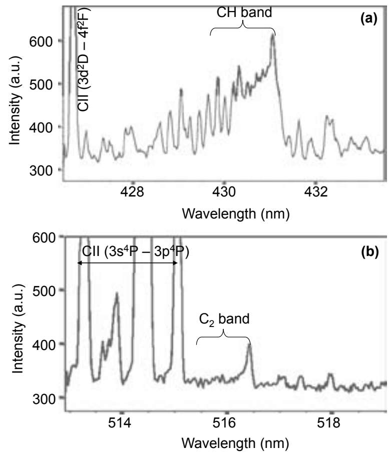

Fig. 2. (a) CH band and (b) C_2 band detected with the 2D spectrometer at the channels viewing the divertor plates (#121178, #121184).

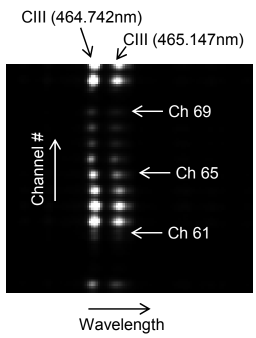

Fig.3. CCD image of CIII (464.742, 465.147 nm) at channel 61 to 69, indicated with red spots in Fig.1.

1) Kobayashi, M. et al.: Nucl. Fusion **53** (2013) 033011.