§19. Neutral Particle Transport Analysis with Multi-channel Hα-line Emission Measurement System in Heliotron J

Nakashima, Y., Hosoi, K., Yonenaga, R., Ozawa, H., Takeda, H., Ishii, T., Sakamoto, M. (PRC, Tsukuba Univ.), Kobayashi, S., Mizuuchi, T., Okada, H. (IAE, Kyoto Univ.), Kagawa, T., Minami, T. (GSES, Kyoto Univ.), Shoji, M.

In magnetically confined plasmas, neutral particle transport analysis is an important subject for understanding edge plasma behavior and for the particle transport and confinement study. The density modulation experiment has been widely used to determine the local diffusion coefficient. The estimation of the variation of the particle source profile is desirable for the precise transport analysis without ignoring the effect of the particle source term. In this study, we report the results on the density modulation experiments in Heliotron J and the Hα/Dα-line emission measurements.

The Hα/Dα lime emission profiles have been measured using the multi-chord Hα/Dα-line emission measurement system installed in Heliotron J[1]. Multi-sightline of the Hα/Dα detector system observes the plasma cross-section with 23 chords, which enables us to measure the profile of Hα/Dα emission precisely. The Hα/Dα-line emission measurement system consists of an objective lens, a bundle fiber and an interference-filter monochromator with an imaging lens and a multi-anode photomultiplier (Hamamatsu; H7260). The size of each anode of photomultiplier is 0.8 x 7 mm and it is aligned by a pitch of 1 mm. The spatial resolution was 12mm at the plasma core. The cutoff frequency of the system is around 100 kHz.

Figure 1 shows the waveforms obtained in the density modulation experiments in the ECH discharge. The input signal of gas puffing was modulated rectangularly with a frequency of 50 Hz. The line-averaged electron density $\bar{n}_e$ was $0.7\times10^{19}m^{-3}$ having the modulation density $\Delta\bar{n}_e$ of $\pm0.1\times10^{19}m^{-3}$. The averaged gas puffing rate was decreased slightly so as to keep the line-averaged electron density constant. Note that a clear phase shift between the stored energy W_{DIA} and $\bar{n}_e$ was found. The Hα/Dα line emission also modulated according to the modulation of the electron density, which indicates the particle source varied due to the modulation. In this discharge, the radial profile of the electron density was measured with the AM-reflectometer.

The phase analysis was carried for the Hα/Dα line emission intensity. The modulation amplitude normalized by the mean value of the Hα/Dα intensity is shown in Fig. 2 (a) as a function of the major radius. The phase difference was also shown in Fig. 2(b). The normalized amplitude is almost flat, while the phase difference has a dependence on the radial position. The phase difference delays by 30 deg. from R=1.35m to 1.10m. This implies the variation of the particle source profile due to the modulation. In order to estimate the particle source profile with a high spatial resolution, we improved the mesh model for the neutral particle transport simulation. The mesh size in the radial direction inside the last closed flux surface increased from 10 to 30. The validity of this mesh model was checked. The variation of the particle source profile for the transport analysis will estimate using the results of the neutral particle transport simulation and the Hα/Dα line emission measurement.

[1] S. Kobayashi et al., Rev. Sci. Inst. **77**, 10E527 (2006).

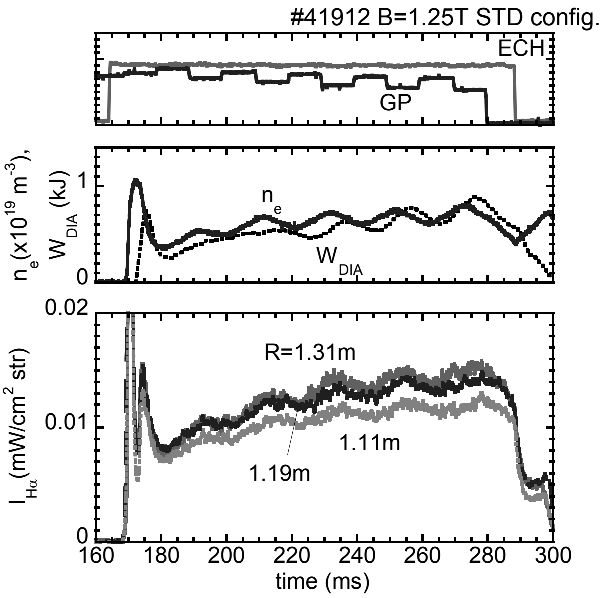

Fig. 1. Time evolution of plasma parameters obtained in density modulation experiments in Heliotron J.

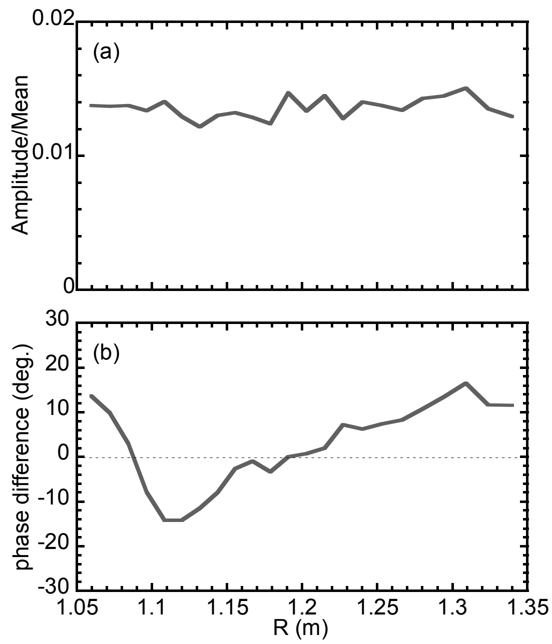

Fig. 2. Radial profile of (a) modulation amplitude normalized by mean value of Hα/Dα line emission intensity and (b) phase difference as a function of the major radius.