§53. Analyses of the Polarization Resolved H-alpha Spectra in Various Magnetic Configurations in LHD

Shoji, M.,
Iwamae, A., Sakaue, A., Atake, M. (Dept. Eng. Phy. Mech. Graduate School of Eng., Kyoto Univ.)

The analyses of the behavior of neutral particles in the divertor region and the plasma periphery are important issues for efficient particle control and divertor detachment. The control of the neutral density in the plasma periphery is essential for good plasma confinement and for sustaining the thermal transport barrier.

For measurement of the behavior of neutral particles, H_α intensity profiles have been monitored with a 10ch vertical detector array installed in an outer port (1-O). Recently, polarization resolved H_α spectra are also measured with a spectrometer with polarization separation optics (PSO). The location and intensity of the emission along the line of sight of the detectors can be identified by the least-squares fitting with abroad Gaussian profile [1].

The polarization resolved spectra are analyzed by a fully three-dimensional neutral particle transport simulation code (EIRENE) with newly including the following three effects:

1. Doppler broadening due to the velocity of neutral hydrogen atoms and molecules,
2. fine structure splitting of the H_α line spectrum by Zeeman effect,
3. polarization of H_α emission by the effect of the magnetic field.

Polarization resolved spectra (e-ray and o-ray) are calculated by integrating calculated H_α spectra along the line of sights with considering the instrumental function of the detectors and the polarization angle of the PSOs.

The strike points are calculated by magnetic field line traces from the LCFS. The distribution of released neutral particles (hydrogen atoms and molecules) is determined basing on that of the strike points. The simulation predicts that the density of neutral hydrogen molecules is relatively high in the inboard side of the torus in three magnetic configurations (R_{ax}=3.50, 3.65, 3.75m). The reason for formation of the high density is attributed to the complicated shape of the vacuum vessel.

Figure 1 illustrates the measurements and calculations of the vertical profile of the H_α intensity in the all magnetic configurations. The calculations are obtained by summing the H_α emission along horizontal lines on the poloidal plane of the detectors. It shows quite agreement with the measurements, indicating that the calculated density profiles of neutral particles are reasonable.

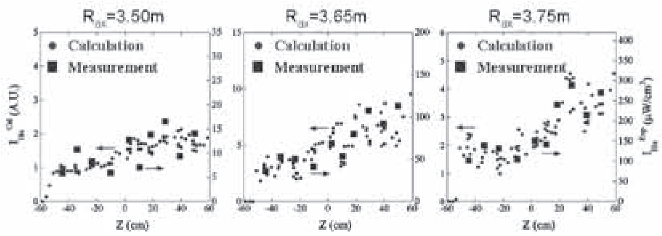

Fig. 1. The measurements and calculations of the vertical profile of the H_α intensity in the three magnetic configurations (R_{ax}=3.50, 3.65, 3.75m).

Figure 2 gives the calculations and measurements of the polarization resolved H_α spectra in the three magnetic configurations, which shows no significant disagreement between them. The measured narrow peak of the o-ray (λ~656.24nm) for R_{ax}=3.50m is likely to be reflected light from the vacuum vessel because of the unbalanced intensity of the two polarized spectra (e-ray and o-ray).

The simulation can reproduce the measurements of the vertical intensity profile and the polarization resolved spectra, which verify the high neutral density in the inboard side of the torus in all the magnetic configurations. It strongly suggests that the closed divertor configuration in the inboard side of the torus is efficient and realistic for particle control in LHD plasmas.

Reference
1) Iwamae, A. et al.: Phys. Plasmas 12 (2005) 042501.

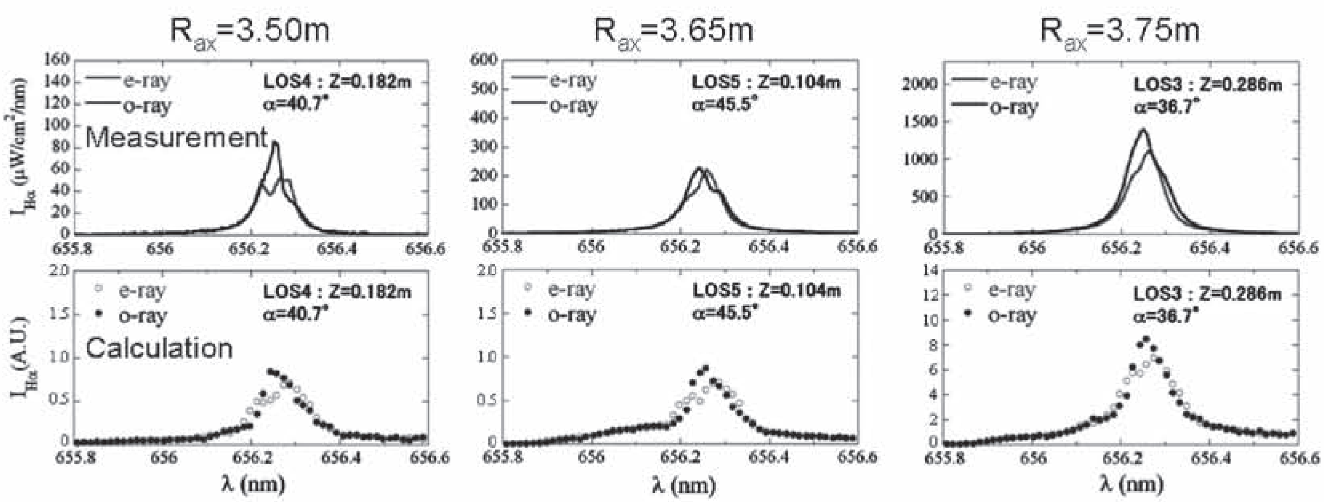

Fig. 2. The measurements and calculations of the polarization resolved H_α spectra (e-ray and o-ray) in the magnetic configurations (R_{ax}=3.50, 3.65, 3.75m), which are the results of a typical detector channel in each magnetic configurations.