§34. Measurement of Fine Spectral Profiles of Hα in LHD Plasmas

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In magnetically confined plasmas, it is important to understand the behavior of neutral hydrogen for controlling recycling process and obtaining good confinement plasmas. The most essential parameters for understanding the neutral hydrogen atoms are their velocity distribution function and the flow velocity. High- resolution spectroscopy is powerful to measure above parameters. In this study, fine profiles of Hα were measured in LHD plasmas.

The spectroscopic system consists of a collecting optics, optical fibers, visible spectrometer with an echelle grating and CCD detector. The absolute wavelength and the dispersion were calibrated by a hollow discharge in the magnetic field strength of 1.13 T. The hydrogen and deuterium plasma were produced and six spectral lines, σ and π components, of Hα and Dα were used for calibration. The reciprocal dispersion is 0.1 nm/mm (0.0024 nm/pixel). The minimum detectable velocity for this system is estimated as 10^3 m/s. (The calibration was performed at Kyoto university.)

Figure 1 shows a poloidal cross-section of LHD and the lines of sight. The lines of sight view the inner side of the torus from the outer side. Sight lines #31-50 are viewing the inner divertor plate. The spatial resolution is 20 mm and the distance between the successive lines is 40 mm at the inner divertor plate.

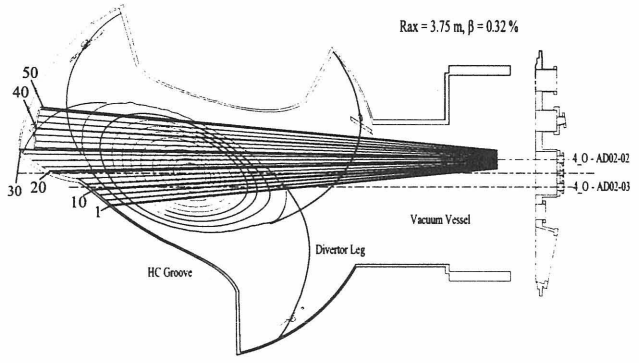

Figure 1. The poloidal cross-section of LHD and lines of sight.

Other sight lines are viewing the inner vessel wall.

Figure 2 shows an example of Hα spectral profile measured in long-pulse NBI plasma. In Fig. 2, reference profile of Hα by H_2 lamp is also shown. The shift of central wavelength is observed. The velocity of neutral hydrogen atoms is estimated as 8.0×10^3 m/s. Figure 3 shows the time evolution of the shift of central wavelength for five sight lines and the electron density. The magnetic axis was 3.6 m and the magnetic field was 2.75 T. The pulse duration was 36 s. The average electron density is 3.3×10^{19} m^{-3} in the steady state phase. The blue shift of the central wavelength is clearly observed. The shift increases as the electron density increases for 10 s. After the electron density reaches to 3.3×10^{19} m^{-3}, the shifts keep also constant values. The highest shift is observed in the #25 sight line and the velocity of neutral hydrogen atoms is 10×10^3 m/s.

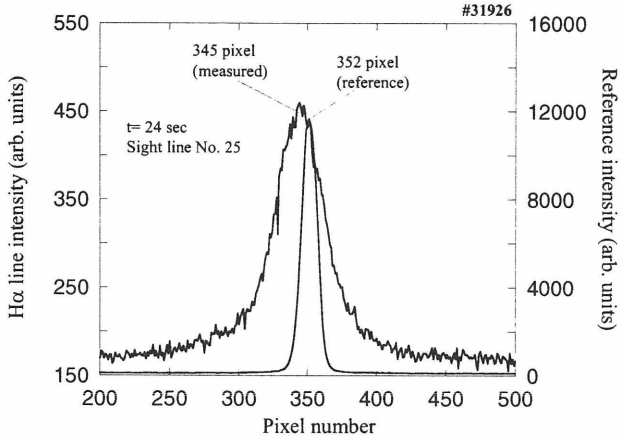

Figure 2. The profile of Hα observed in the NBI long pulse discharge.

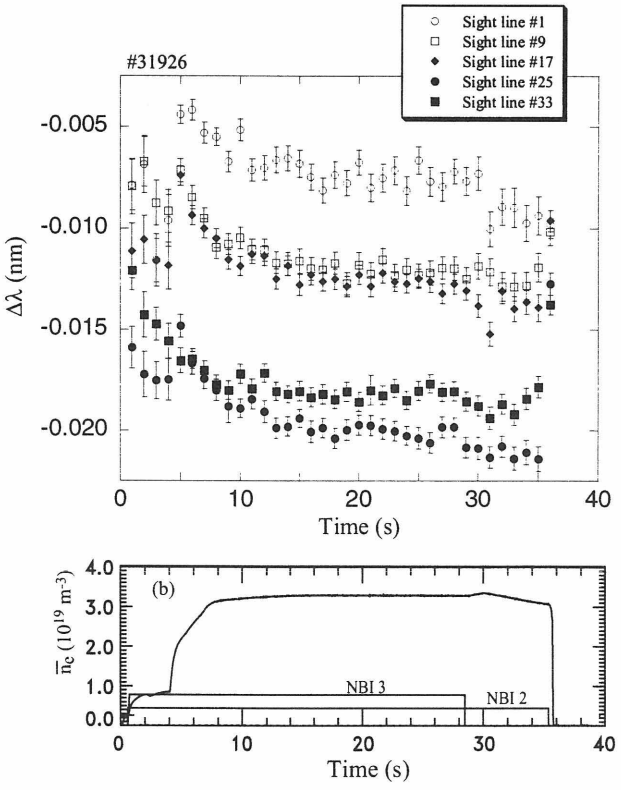

Figure 3. Time evolution of the shift of central wavelength for several sight lines (a) and the electron density (b).