§6. Spectroscopic Measurement of the Density Profile and the Divergence Angle of the Neutral Beam

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The density profile measurement of the fully ionized impurity ions is required to investigate the poloidal flux conservation[1]. To obtain the density profile from the intensity of the charge exchange excited spectral lines of impurity ions, the chord integrated density profile of the heating neutral beam was investigated with the H_α emission from the beam in vacuum. The neutral beam was injected into CHS without the target plasma and the magnetic field(B=0T). Figure 1 and Figure 2 show the H_α spectral profile and the radial distribution of the intensity measured at the vertically elongated sections where the bidirectional charge exchange spectroscopic measurement of the poloidal rotation is being done. The negligibly small intensity measured via the background reference channel(port 8D), which is looking off the beam, indicates that there are no plasmas emitting H_α line. The spectra observed at port 7U and 7D, where the beam passes, have 'cold' components emitted from cold neutral gas with the temperature of $T\sim$1eV generated by the beam-wall interaction and/or released from NB injector. The cold components are separated using a double Gaussian fitting. The hot components emitted from the beam have the Doppler broadening corresponding to the beam divergence angle of HWHM/(ln2)$^{1/2}/\lambda_\alpha \times c/v_b \sim 1.4°$ as shown in Figure 3, where λ_α, c and v_b are the wavelength of H_α, the velocity of light and the velocity of the beam, respectively. This broadening includes the effect of staring angle thus has a weakly peaking profile. The chord integrated density profile in the plasmas can be calculated from this intensity profile and the measured density and temperature of electron assuming the beam attenuation due to charge exchange, electron impact ionization and proton impact ionization.

The measured intensity profile is broad and flat compared with the prediction from the design value of the beam focusing length. It suggests the shift of the focusing point and the increased aperture loss due to the shift. The recent measurement of the beam profile using the calorimeter[2] in the torus also detects the broadening of the beam caused by the shift of the focusing point. As demonstrated by these results, the spectroscopic measurements of the beam profile offer the simple checking method of the beam deposition complementing that by calorimeters.

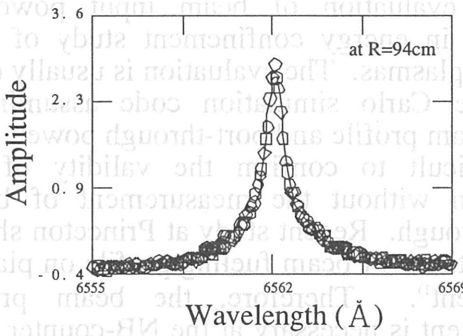

Fig.1 Spectral profile of H_α line from the beam.

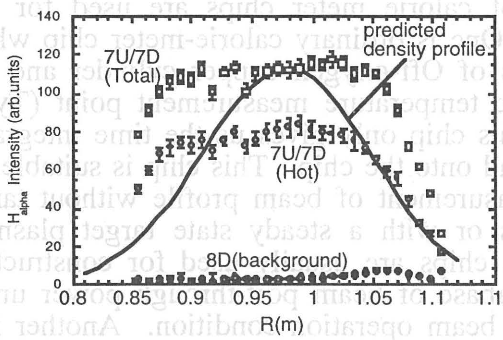

Fig.2 Radial distribution of the H_α intensity.

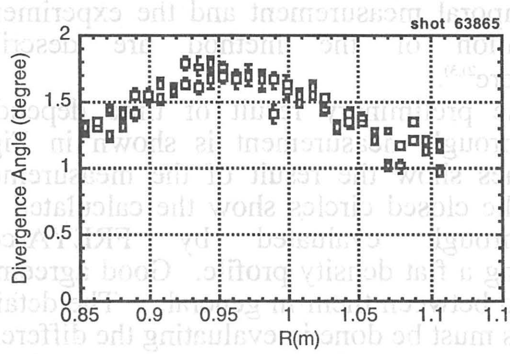

Fig.3 Divergence angle obtained from the Doppler broadening of the 'Hot' component.

References
1)Nishimura,S.,et al.;Ann.Rep.NIFS(1997)p.224
2)Osakabe,M. et al.;Ann.Rep.NIFS(1997)p.117