§47. Fast Ion Charge Exchange Spectroscopy Measurement Using Radially Injected Neutral Beam on Large Helical Device

Osakabe, M., Murakami, S. (Dept. Nucl. Eng., Kyoto Univ.), Yoshinuma, M., Ida, K., Goto, M., Whiteford, A. (Dept. Phys., Univ. Strathclyde, UK), Kato, D., Kato, T., Nagaoka, K., Tokuzawa, T., Takeiri, Y., Kaneko, O.

A new experimental technique to investigate the fast ion confinement based on charge exchange spectroscopy of Hydrogen Balmer-alpha(H_{α}) light was applied to evaluate the confinement property of perpendicular fast ions on LHD. The method was basically similar to the Fast Ion Deuterium-Alpha(FIDA) measurement which was proposed and demonstrated by Heidbrink,*et.al*[1]. The main difference from FIDA measurement is the geometry of NB injection and the species of ions being measured. Instead of using the tangential NB like in DIIID, we are using the radial-NB as shown in Fig.1 since the energy of our tangential NB, which is 180[keV] with Hydrogen, is too high to use it as an active neutral source for CXS measurement.

The difference of the injection geometry gives us the different response of Doppler shifted H_a spectra, which makes the interpretation of the measurement difficult. Sensitivities of the H_{α}-spectra to the pitch angles of injected NB's and these to the angle between the Lines Of Sight (LOS) and NB-injection path are examined and are shown in Fig.2. The energy dependence of the charge exchange cross section (Fig.3) significantly affects the observed spectra since the driving NB is injected perpendicular to the magnetic field lines in the observation geometry of LHD. The measured spectra are compared with the spectra of GNET-simulation[2] results (Fig.4). The simulated spectra agreed with the experimental spectra by taking into an account of the contribution of halo neutrals. Although it is difficult to obtain the fast ion distribution functions directly, this technique will provide us useful experimental data in benchmarking simulation-codes.

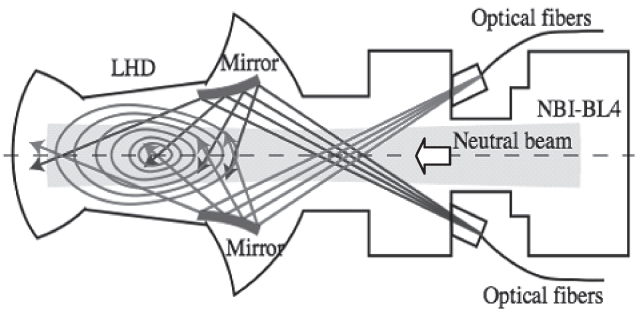

Fig.1 Schematic drawing of FICXS measurement geometry on LHD

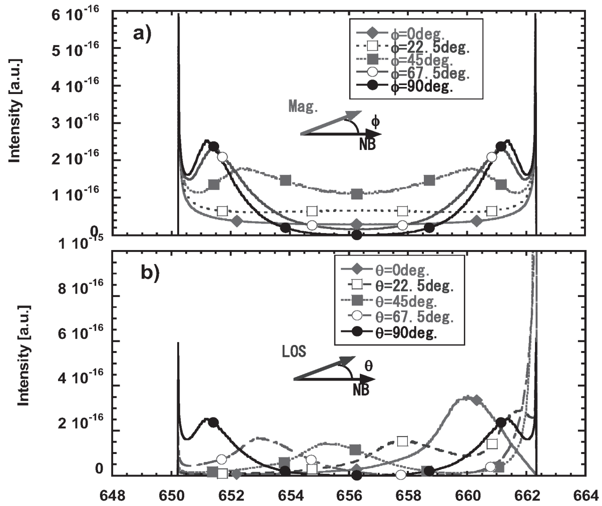

Fig.2 Variations of Doppler shifted H_{α}-spectra for mono-energetic fast ions with the change of (a) the NB-injection pitch angle and (b)the angle between NB-injection path and the Line Of Sights (LOS). The directions of the LOS, the magnetic field lines and the NB-injection are orthogonal to each other, if the angles between two of them are not indicated.

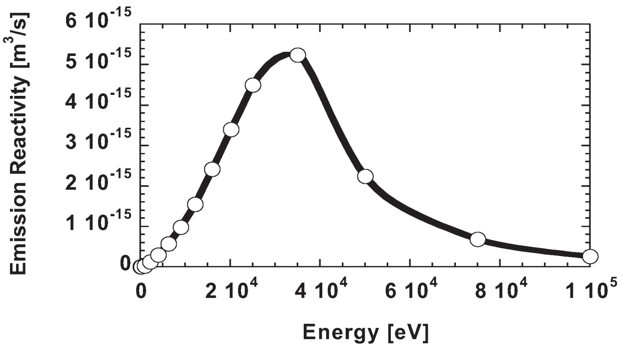

Fig.3 Energy dependence of charge exchange reaction rate.

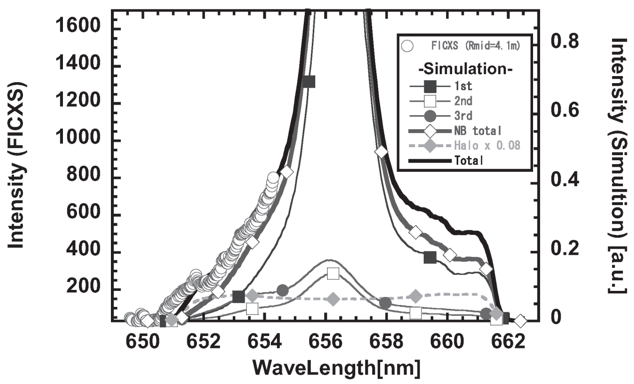

Fig.4 Comparison of the GNET simulated spectra to the FICXS spectra ($E_{rad.-NB}$=33.5keV/ shot#82644, t=1.3s).

1) W. W. Heidbrink, *et al.,* Plasma Phys. and Control Fusion, **46**(2004)1855
2) S. Murakami, *et al.*, Nuclear Fusion, **40** (2000) 693