§ 19. Doppler Shift Spectroscopy System for LHD-NBI H⁻ Ion Source

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We have studied the energy spectrum of the H_0 beam as well as the extent of stripping of H^- ions of the powerful negative ion based NBI system in LHD. First energy spectrum for LHD-NBI was observed with Doppler shift spectrometry[1] (in Hα line). In this year, important improvements were made on intensifying the shifted light and on establishing the algorithm for analysis.

The system (Fig.1) is composed of a condenser lens, optical fiber cable, grating-25cm spectrometer (Bunkoukeiki-CT-25TP) with CCD camera, video recorder, and trigger pulse generator. A thich fiber cable 200 μm in diam. resulted in ~10 times more intensity of the light. The angle of the line of sight is 50 degrees to the beam centerline of IS-2B ion source at the ion source vacuum vessel.

The Doppler shift spectrum (Fig.2) for H^- ion source consists of mainly three components, as marked in the figure: 1) major peak of W by a red shift of Hα light corresponds to fully accelerated neutral beam component, 2) the peak W_c-E corresponds to stripping of H^- ions with extraction energy of 8keV, and 3) continuum beam component seems to exist, where it ranges from full energy to several tens keV, although the level is difficult to gauge. The peak of $W\text{-}_0$ is non-shifted light. When total energy (Fig.3) is changed from 101keV to 153.8keV, observed peak of full energy of W is shifted proportionally along with the calculated wavelength. Existing difference between observation and calculation is considered to come from mis-alignment of the angle by a few degrees. It is noted that full component of W has rather broad energy width. It could be caused by existing difference of line of sight produced by five divided grids (, marked by +2.2 degree to –2.2 degree in figure 2) in accelerator system, beam divergence angle of ~one degree, and probable stripping. When gas pressure with hydrogen in the plasma source is increased, the fraction of low energy component of W_c-E tended to increase with the gas pressure, as would be expected.

In the next LHD experimental cycle, we plan to measure the beam spectrum during the NBI experiment shots for high power- and long pulse (>10sec) beam with the system based on present improvement.

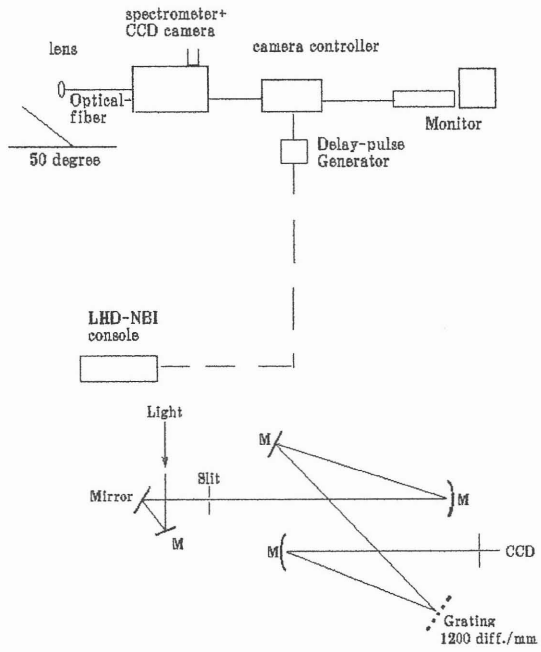

Fig.1 Doppler shift spectroscopy system (top) and grating-25cm spectrometer (bottom)

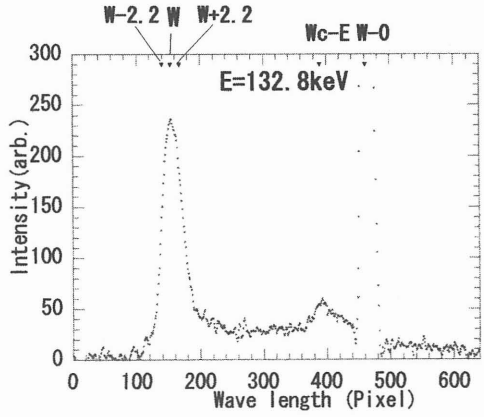

Fig.2 Energy spectrum of H_0 beam in LHD-NBI H^- ion source

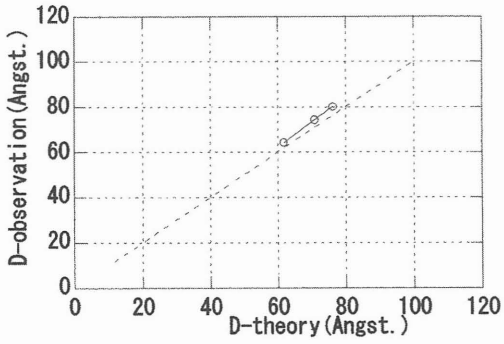

Fig.3 Doppler shifts for calculation and for observation

Reference

1) Oka, Y., et al., Ann. Rep. NIFS(2001-2002)