§4. Spectroscopic Observations of Beam and Source Plasma Light for LHD-NBI Large Area H⁻ Source

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We have been made further improvements to high performance negative ion source system for LHD-NBIs to achieve the reliable long pulse high-power capability. The velocity spectra of the negative ion based neutral beams with Doppler-shifted H α spectroscopy as well as the source plasma light spectra has been studied and/or collaborated with PPPL and JAEA[1].

In FY2006, remote control system in the control room was instrumented to scan the wave length of the spectrometer in the LHD-hall. Studies were focused on the following. (I) H α line at three different locations along the NBI beam as well as the spectrum profile for case of different grid area (numbers of accelerator segments of 1-, 3-, and 5-segments (which mean full sized accelerator to LHD-NNBI ion source)) were studied. (II) We also have measured Caesium (impurity) lines for source plasma light in Beam Line-1, to make recheck Cs neutral-/ion-lines with temporal behaviors found in Beam Line-2, as reported in the Annual Report of 2006[2].

(I) Cleaner spectra (Fig.1) of Doppler-shifted H α line with only a small level of background light are obtained at a new observation port which viewed the blue-shifted light in the drift region after the accelerator of an LHD ion source. This region suffered much less contamination from molecular line arising from background plasma than did the previous neutralizer sightlines (Fig.2).

With increasing segment numbers (Fig.3), the width of the full energy component increases proportionally. On the basis of those spectra there was expected to construct the monitor system for the long-pulse high power beam with this means.

(II) It was re-assured for the Beam Line-1 plasma source as same as for BL-2 that both the amount of Cs I (Cs+) and Cs II (neutral Cs) lines in the source plasma light rose sharply when beam acceleration began, and continued high during 10 s pulse. It was considered that this was because the cesium was evaporated/sputtered off by the back-streaming ions, as reported in the reference(ibid). Impurity line of tungsten from filamentary discharge source light was not detected. Oxygen line was detected in a weak intensity and decreased a little bit through a one-day run.

Reference,
1) Oka Y., et al., Rev. Sci. Instrum., 77, 03A538 (2006)
2) Oka. Y., et al., Ann. Rep. NIFS (2005-2006),136.

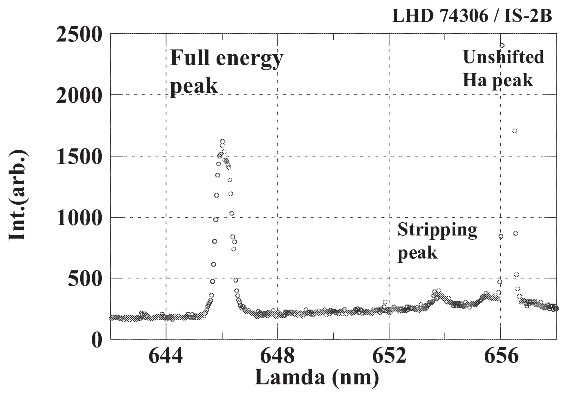

Fig.1. Doppler-shifted H α line observed at a port of post-accelerator. Beam energy=171keV. Iacc(drain)=72A/2

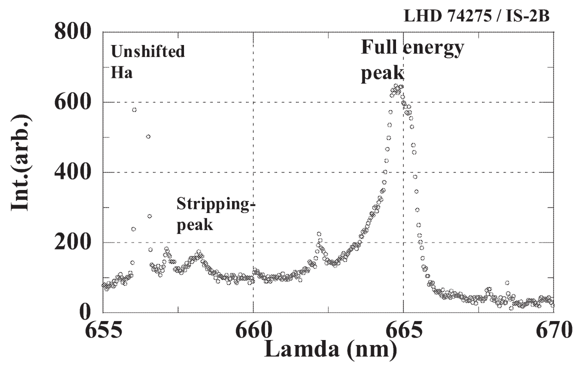

Fig.2. Doppler-shifted H α line observed at a port of neutralizer downstream. Beam energy=171keV.

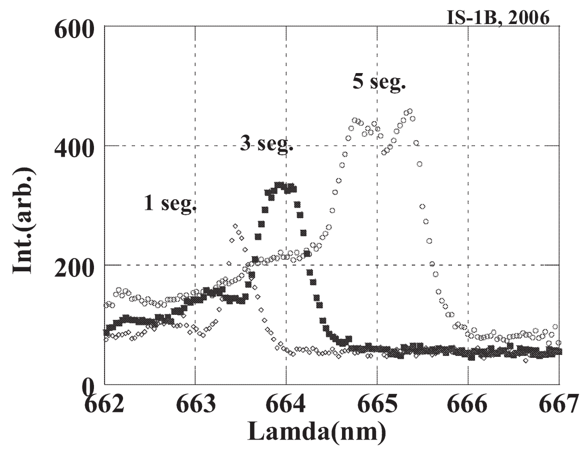

Fig.3. Profiles of Doppler-shifted H α with 1/5-, 3/5-, and 5/5-segment of IS-1B accelerator. Beam for each operation was focused on calorimeter at ~8m downstream