§62. Velocity Spectrum for the LHD-Neutral Beam Injector Beam

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We made high resolution measurements of the doppler-shifted H α spectrum using the JAERI spectrometer system provided for the NIFS/PPPL/JAERI negative-ion collaboration.

We found that under normal operating conditions (i.e., ~25A of H-) almost all of the transmitted beam is at approximately the full acceleration energy of 167keV(in Fig.1). The full energy peak is not quite gaussian with a few percent of its area in a lower-side stripping tail. We also observed a small non-gaussian very low energy peak- corresponding to beam particles that are stripped in the extractor gap, where the pressure is higher, and the potential reaches only 7-8keV. This peak is only a few percent the area of the full energy peak. After conpensating for the longer dwell time of this low velocity component within the viewing volume, it probably corresponds to no more than about one percent of the transmitted beam particles, and a negligible portion of the power. We observed a considerable number of small amplitude gaussian peaks with widths at the instrumental resolution which arise from molecular lines excited in the neutralizer gas by the passage of the beam. The beam peaks are wider due to stripping, beam divergence, and perhaps slight variations in acceleration potential. When the acceleration voltage was changed, the doppler-shifted beam peaks changed wavelengths they should, while the molecular peaks from the neutralizer gas were unchanged, confirming their origin.

The molecular lines are spread across the observed spectrum, including several on the opposite side of the unshifted H α line (which would correspond to backward-moving beam if one thought they were doppler-shifted H α light instead of molecular lines). There was also at least one molecular peak at a wavelength that would correspond to an energy several tens of keV higher than the acceleration energy if one thought it was due to doppler-shifted H α instead of a molecular line. Thus, the wide distribution of these lines confirms their origins in the molecular neutralizer gas.

Some of these molecular lines lie between the full energy doppler-shifted H α peak and the unshifted H α peak, and thus contribute to the apparent continuum that occurs in that region. We collected data when the arc was on before beam extraction to confirm that these molecular lines are only visible when the passage of the beam is exciting the neutralizer gas, so it is not feasible to subtract them from the observed spectrum.

We observed the doppler-shifted H α spectrum at different times during 1.5 second beam pulses, and saw no significant changes in stripping, showing that the pressure in the accelerator was not changing due to out-gassing from grid heating.

It is reasonable to expect that the new ground grid design with slots instead of apertures should have a lower pressure in the accelerator because of the greater conductance and thus that the beam stripping tail should be even lower. We should like to confirm this by comparing the doppler-shifted H α spectrum from one of these sources with the one for which we have made measurements. Thus we began the design of an apparatus to allow measurements on Beamline #1, where it is more challenging to obtain a suitable sight line.

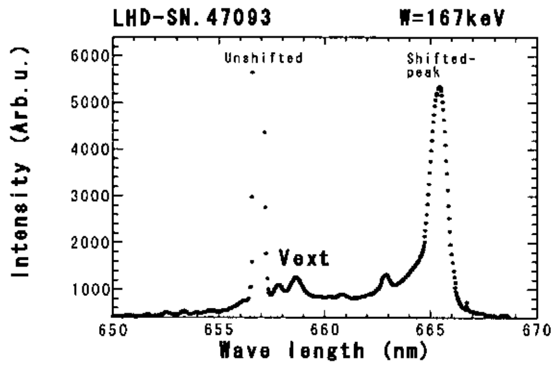

Fig.1 Velocity spectrum of LHD-NBI S-No.47093 beam (IS-2B H- ion source).

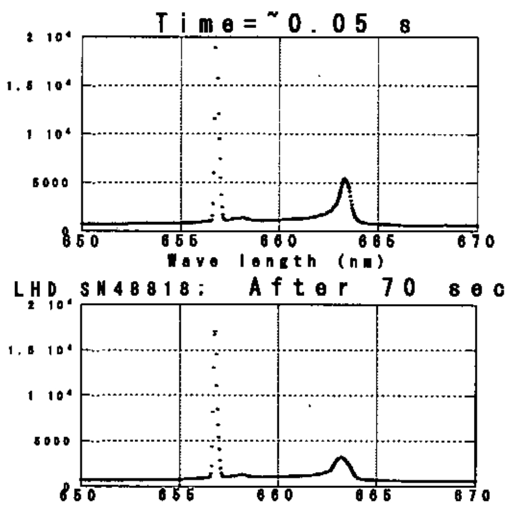

Fig.2 Velocity spectrum of long-pulse 72.7 sec beam of S-No.48818. At time of 0.05s(top) and at time70.05s(bottom).

We succeeded in obtaining the temporal change of the velocity spectrum for long pulse LHD-NBI beam of 72.7 sec by every 10 sec (in Fig.2). This is allowing an evaluation of changes in beam stripping due to gas evaluation in the accelerator.