

§25. Filament Lifetime and Doppler-Shift Spectrum in LHD-NBI Negative Ion Source

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Firstly, in FY 2001, filament lifetime, which brings inevitably an interruption of NBI experiments, de-conditioning of high voltage, Cs deterioration et al, was evaluated in Negative Ion Source of Large Helical Device-Neutral Beam Injector¹⁾. Secondly, energy spectrum of negative ion beam was measured with Doppler-shift spectrometry to study the stripping loss and put more of the power into the full energy component.

H- ion source consists of Cs seeded external filter multi-cusp plasma source and a 25x125cm² multi-aperture accelerator. H- current of ~25A was demonstrated in every six ion sources for 3 Beam-Lines. Each plasma source contains 24 filaments of 1.8 mm diam tungsten wire.

Table I lists the filament weight loss (in column 3), total shots (in column 4), and others during the LHD experimental cycles. It is found that the filaments have to be exchanged in general every 10,000 shots, which occurs approximately every 1~3 months. The loss rate in BL-2 is increased by about 30 % compared to that in previous cycle due to increased total shots for a longer pulse duration of 35s. Filament life time in BL-1 increases drastically in this cycle due to improvement in the source plasma confinement. It was also observed that the filament location of high loss rate corresponded to a position of higher H- production and plasma density.

Experimentally-guided improvements were made to the Doppler-shift spectroscopy system, which consisted of Grating/CCD spectrometer. These enabled us to get the first measurements of the preliminary spectrum of the LHD beams, as shown in Fig.1. It appears that the energy distribution is peaked at the full acceleration energy, but looks as if may have a significant lower energy continuum of beam arising from stripping of negative ions during the acceleration process. As the instrumentation does not permit a qualitative analysis, a much better measurement is needed for the next step of investigation.

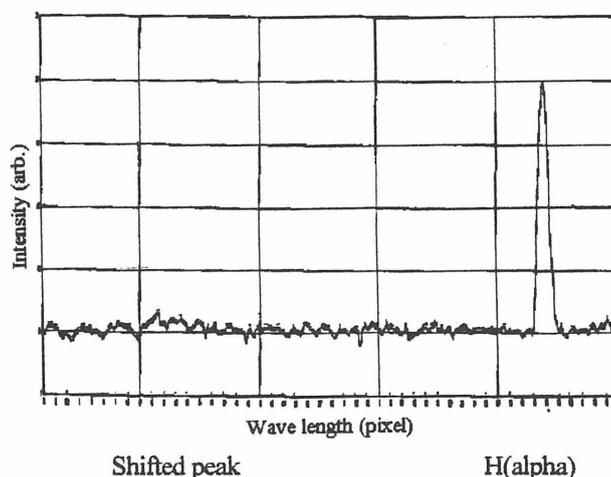


Fig.1 The first measurements of the Doppler-shift spectrum of the LHD beams

Reference

- 1) Oka, Y., et al., Rev. Sci. Instrum. 73, 1054(2002)

TABLE I

Ion source	Run No.	Weight loss (gr/filament) (max)	total shots	Loss rate (mgr/shot /filament)	total loss (gr/one source)
IS-1A	4	0.571	5536	0.103	(~13.7)
	5	0.081	2458	0.033	
	8		9953	~0.01	
IS-1B	3	0.18	6536	0.028	
	4	0.115	3801	0.03	
IS-2A	4	0.085	8580	0.01	1.17
	7	0.142	6884	0.013	
IS-2B	3	0.103	6874	0.015	1.23
IS-3A	5	0.18	8229	0.022	
IS-3B	5	0.12	8432	0.014	