§11. Measurement of the Plasma Parameters in a Large-scaled Negative Ion Source Using Time-resolved Langmuir Probe

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As is described in the other report of this annual issue, we have observed the ion-ion plasmas consisting of hydrogen positive and negative ions in a Cs seeded large-scaled negative ion source. To investigate the characteristic of the ion-ion plasma further, time-resolved Langmuir single probe is installed in a caesium-seeded negative ion source, whose size is half of the ion source of LHD NBI.

Figure 1(a) shows a schematic of the Langmuir probe system. To obtain the plasma parameters with and without applying high voltage to extract the H^- beams. A unit of the probe, an amplifier and a resister box are lifted up on the high voltage stage of the beamline. The unit is indicated the devices surrounded with a rectangular. A unit of the data acquisition system and a function generator is situated at the electrically ground level to avoid the influence of the large surge noises at voltage breakdown. Both units are connected with optical fibres for voltage insulation. The probe current and voltage are shown as a waveform in Fig. 1(b) and (c), respectively. The probe voltage is swept with 50 Hz, and plasma parameters are obtained by every scan.

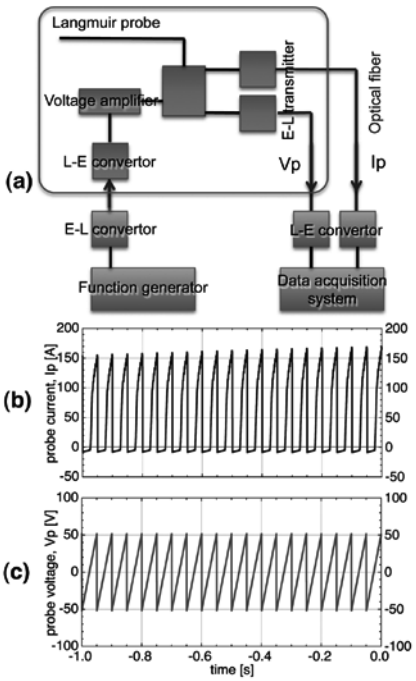

Fig. 1. Schematic of probe system (a), the waveforms of the probe current (b), and the swept probe voltage (c).

The time-resolved probe is applied to measure the caesium-seeded plasma in the beam extraction region of a large-scaled negative ion source. Figures 2(a), (b) and (c) shows respectively the waveforms of the negative (I_-), positive saturation currents (I_+) and the difference of those currents ($\Delta I = I_- - I_+$) measured with the time-resolved Langmuir probe. The intensities of the negative and positive saturation currents are estimated by defining every inflection point in the scanned probe V-I curves as the current origin. The H^- beam is extracted from the origin of the time scale, and the shaded areas in Fig. 2 correspond to the beam-extraction duration. As shown in the figure, all the current increase the slops just after beam extraction. It is noticeable that the current difference is almost zero before beam extraction, while the difference increases during beam extraction. This feature indicates ion-ion plasma is generated for the timing only with source plasma, and negative charge flux flows to the probe tip for beam extraction duration. The difference of the V-I curves before and after the beam extraction is shown in Fig. 3(a) and (b), respectively. A typical characteristic of the ion-ion plasma disappears after beam extraction, and the slope on the negative current side becomes steeply. The change of the slope is interpreted that the bulk electrons flow to the probe tip during the beam extraction.

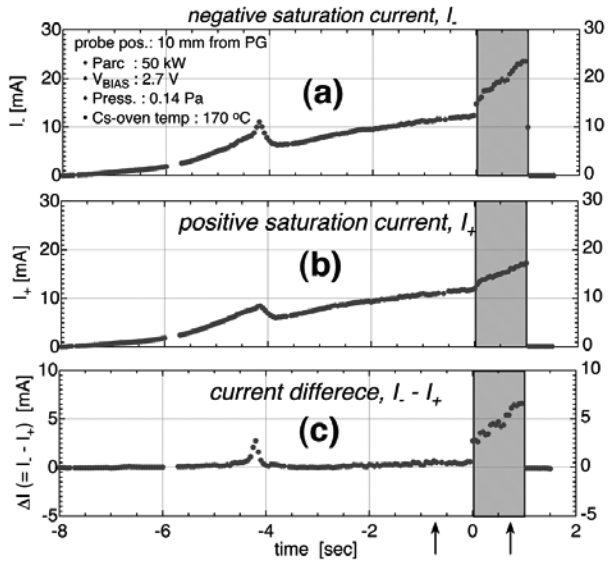

Fig. 2. Waveforms of the negative (a), positive saturation currents (b) and the current difference (c) obtained in the beam extraction region in the caesium seeded negative ion source.

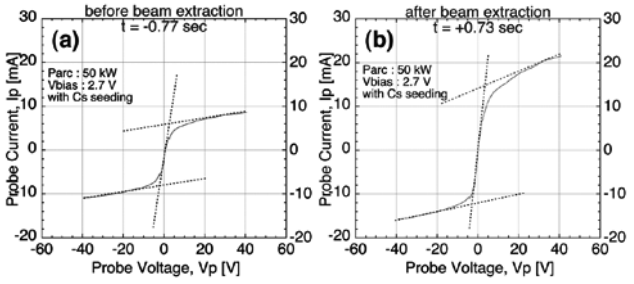

Fig. 3. Probe V-I curves before (a) and after (b) beam extraction. The symmetry of the curve in case of (a) breaks during the beam extraction. Measured timing is indicated as the arrows below Fig. 2(c).