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Comparison of plasma parameters of with and without caesium seeding in beam extraction region of a negative ion source for NBI

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Production and transport mechanism of hydrogen negative ion (H^-) in caesium (Cs) seeded negative ion source for NBI is one of the important issues to improve the H^- production efficiency, which leads the stability of high power and long pulse beam injection.

We have investigated the plasma in beam extraction region using multi-diagnostic system to improve the negative-ion-based NBI system for LHD. Ionic like plasmas including quite low electron densities have been produced in the extraction region by optimizing the Cs condition in a R&D negative ion source. In those plasmas, voltage-current curve obtained with single Langmuir probe shows symmetric characteristics, and the symmetry breaks by applying electrostatic field for beam extraction. This symmetry breaking is interpreted due to compensation of extracted H^- charge with electrons coming from driver region and is observed in long range of more than 20 mm at the extraction region by measuring Langmuir probe and cavity ring down [1, 2]. Change of plasma parameters before and after applying the extraction field has not been analyzed in pure hydrogen plasmas in our ion source so far. In this presentation, we compare the plasma parameters to applied external field in pure hydrogen and Cs seeded discharges.

Electron and ion saturation currents and H^- density as functions of bias voltage is shown in Fig. 1, and the arc power and H2 gas pressure are 30 ± 2 kW and 1.3 Pa, respectively. The electron saturation current and H^- density are of quite similar dependence as extraction and acceleration currents. Waveforms of electron and ion saturation currents are indicated in Fig. 1A and 1B, which correspond to the cases with the bias voltages of 2 V and 8 V, respectively. Beam extraction field is applied from the time scale of 0 to 1 sec, and the jump-up feature of electron saturation current observed in Cs seeded discharges does not appears in those hydrogen discharges with relatively high gas pressure of 1.3 Pa. Negative charge compensation with electrons in Cs seeded plasmas is not observed in the hydrogen plasma. This indicates the response of ionic-like plasmas to electrostatic field is different from usual electron-ion plasma. Furthermore, electron density plays an important role for electrostatic shielding in ionic-like plasmas. Another noticeable feature is that electron density in the plasma decreases very low in high H2 pressure and high bias voltage case. We will present about the response to gas pressure and electron polar distribution in this presentation, additionally.

[1] K. Tsumori et al, *Rev. Sci. Instrum*, **83**, 02B116-1 - 5 (2012)

[2] H. Nakano et al, *AIP Conf. Proc.* **1390**, 2010, pp. 359-366

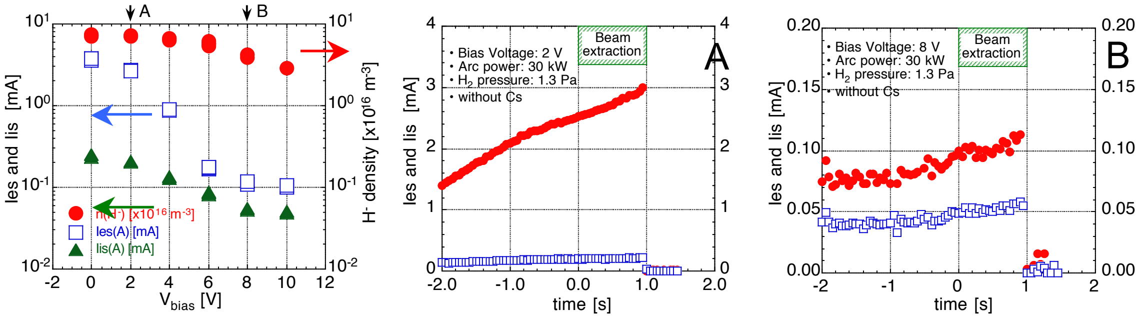

Fig. 1. H- density, ion and electron saturation currents with respect to bias voltage. The waveforms at bias voltages of 2 V and 8 V are shown on right hand side.