§2. Negative Hydrogen Ion Density Profiles Parallel to Plasma Grid Electrode with and without Beam Extraction in Negative Hydrogen Ion Source for Neutral Beam

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Negative Hydrogen Ion (H^-) source is utilized to a beam source for neutral beam injector (NBI). Stable operation with high H^- current density enhance the NBI performance. Improvement of H^- beam extraction efficiency contributes the high current density operation, and understanding of H^- dynamics from production to extraction helps the improvement. Cesium is seeded in the H^- source and most H^- production area as extracted beam is a plasma grid electrode which is a boundary surface between a source plasma and beam. Negative hydrogen ion density measurement in the vicinity of the plasma grid electrode is useful for the understanding of the dynamics.

A profile of the H^- density parallel to the plasma grid electrode is shown in Fig. 1. Feed gas pressure is 0.3 Pa, arc power is 50 kW, extraction voltage is 8.0 kV, and acceleration voltage is not applied. To observe clear H^- density difference between with and without beam extraction, bias voltage was applied -3.6 V which much low value from normal operation that is ~+3 V. Cesium is seeded enough. A measure line of H^- density with cavity ringdown method[1] is 4 mm far from the plasma grid electrode surface. Increase of positive *y* value in horizontal axis means approaching to the center of arc chamber. The H^- density gradually increases with *y* value due to global plasma profile. The H^- density is slightly low above the metal surface part of the plasma grid surface. However, in previous study[2], the high H^- density was observed above the metal surface part of the plasma grid surface at 2 mm far from the plasma grid electrode. Although we have not clarified this difference, ion source condition including cesium condition and the distance from the plasma grid electrode surface are candidates to explain this difference.

A difference of H^- density in Fig. 1 with the beam extraction from that without the beam is shown in Fig. 2. In this experiment, the H^- density decreases ~10 % during beam extraction phase in whole area. A reduction of the H^- density is relatively large above the plasma grid electrode aperture[3]. This shows a possibility of a part of H^- beam extracted from distributed H^- in the space emitted from the plasma grid electrode surface. However, a potential of directly extracted H^- beam from the plasma grid electrode surface can not be excluded. Distinction and estimation of a rate between these possibilities are still being researched.

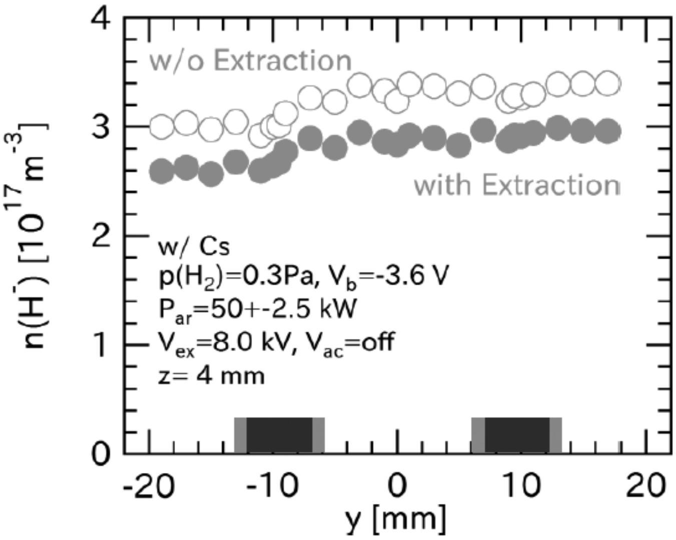

Fig. 1. H^- density parallel to the plasma grid electrode. Open and filled plots show the densities without and with beam extraction. The center of Apertures with 12 mm in diameter are 0mm, -19mm, and 19 mm. Squares above the bottom axis represent metal surface region between apertures.

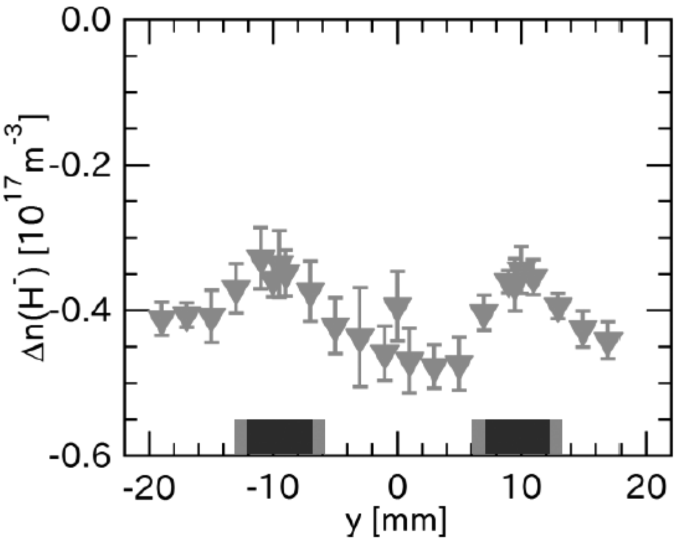

Fig. 2. Difference of H^- density with the beam extraction from that without the beam extraction.

1) Nakano, H., et al.: AIP Conf. Proc. **1390** (2011) 359.
2) Nakano, H., et al.: AIP Conf. Proc. **1515** (2013) 237.
3) Takeiri, Y. et al.: AIP Conf. Proc. **1655** (2015) 060004.