§5. H^- Density Profile Parallel to Plasma Grid in H^- Source for Neutral Beam

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In cesium seeded negative hydrogen ion (H^-) source for fusion, most H^- ions extracted as beam are believed to be produced a plasma grid (PG) surface. However, particle dynamics from the H^- production to extraction is not perfectly clear. To understand the dynamics in experimental study, we performed to measure several physical values in the vicinity of the PG with Langmuir probe, surface wave probe, optical emission spectroscopy, and cavity ring-down method (CRD) with which a line-averaged H^- density is evaluated. The H^- density profile is one of the most important parameters for understanding the dynamics.

Figure 1 shows a schematic view of a movable CRD system on the R&D H^- source for the H^- source of LHD-NBI. The line-averaged H^- density profile can be measured with the movable CRD system in which laser path and cavity mirrors move by drive units. The maximum measure area is 2 mm to 27 mm from the PG surface and 50 mm in vertical direction. Measure accuracy of CRD depends on the decay time. In the movable CRD system, the decay time changes when the cavity axis moves. The variation of the decay time without the source plasma is about 20 % in whole measure region.

In the H^- source with cesium seeding, a vertical profile of the H^- density at 2 mm from the PG without beam extraction was measured (Fig. 2(a))[1]. The H^- density at the laser path aligned above the center of apertures is lower than that at the laser path aligned above the metal surface between apertures. This supports that the PG surface covered by cesium is one of the H^- production region. If the measure line aligns above the aperture center, the measure line passes above not only the PG aperture but also the PG metal surface. Inside of the efficient plasma width, the fraction of aperture to metal area in the projection of measure line to the PG is 74 %. From Fig. 2(a), we assume the measured line-averaged density at the measure line above aperture centers and above metal surface between apertures are 4×10^{15} m^{-3}/kW and 4.5×10^{15} m^{-3}/kW, respectively, which are normalized by input arc power that is about 50 kW. Thus, above only apertures, the normalized H^- density is evaluated 3.8×10^{15} m^{-3}/kW. At 2 mm from the PG surface, the H^- density above aperture is a small but comparable to the density above the metal surface.

At distance of 24 mm from the PG, a variation of the H^- density does not observed except for aperture closed area which is more than 6 mm of vertical position in Fig. 2(b). The surface produced H^- ions spread from the PG and distribute homogeneously above grids region.

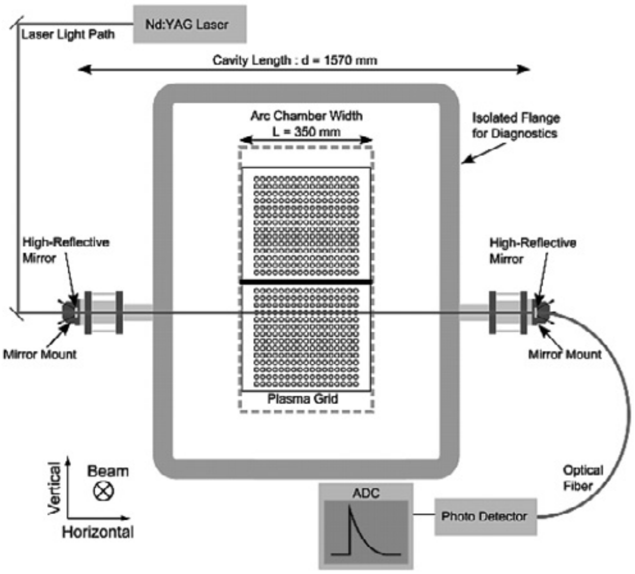

Fig. 1. The CRD system including relation between the laser path and the PG apertures. High-reflective cavity mirrors move vertical and bean direction by two dimensional drive units.

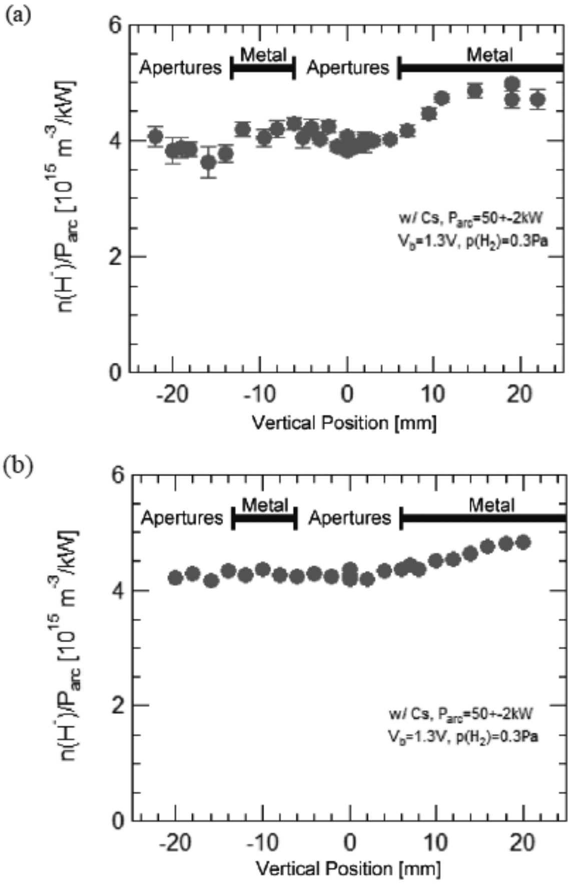

Fig. 2.Vertical profile of H^- density in the cases of laser paths aligned (a) 2mm and (b) 24 mm from the PG surface.

1) Nakano, H. et al..: AIP Conf. Proc. **1515**, 237 (2013).