§8. Electron Density Measurement in 1/3 Negative Ion Source for LHD during Beam Extraction

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The surface wave probe (SWP) has been installed to the 1/3 negative ion source for LHD in order to measure the local electron density. The behavior of the electron in the extraction region has been investigated without beam extraction by the SWP [1]. In recent studies, the drop of the negative hydrogen density has been observed in the vicinity of the plasma grid (PG) with the Cavity-Ring-Down method (CRD) when the extraction voltage is applied [2]. It is important to clarify the response of the electron to the beam extraction because the beam extracted from the source consists of not only the negative ion but also the electron and both of ion and electron have key role on the beam formation.

In this study, the electron density measurement was carried out with beam extraction by means of SWP and the spatial distribution of the electron density was obtained to understand the response of the electron to the beam extraction in different positions.

Figure 1 shows the time evolution of the electron density during plasma discharge. The time resolution of SWP is 0.44 s and limited by the data logging of network analyzer. The electron density in the extraction region was measured successfully with beam extraction and the rapid increase of the electron density was observed when the extraction voltage was applied. This indicates that the electron flows into the extraction region during beam extraction to keep the charge neutrality while the negative ion density shows the rapid decrease.

To investigate the spatial distribution of the electron density and the influence of the beam extraction on the electron near the PG, the electron density in the Cs-seeded plasma was obtained at different z position, where the z-axis is defined as the axis perpendicular to the PG. Figure 2 shows the variation of the electron density as a function of the distance from the PG. The circle and square show the electron densities above the PG metal and aperture, respectively. The electron density above the metal is higher than that above the aperture because the cusp magnetic field is formed near the PG by the magnets embedded in the extraction grid (EG) and the electron moves along the cusp field. The electron density stays constant up to 12 mm from the PG surface and starts increasing. On the other hand, the negative ion density measured with CRD shows the opposite trend, that is, the negative ion density starts decreasing from certain z position. This indicates that in the Cs-seeded plasma the negative ion generated from the PG surface has key role in determining the spatial distribution of the electron density. The electron density difference before and after beam extraction is shown in Figure 3. Amount of electron density change also starts increasing from same z position and continue to increase up to 26 mm from the PG.

For further works, the behavior of the electron and negative ion will be investigated in detail at various discharge conditions during beam extraction.

1) M. Kisaki, et al.: Rev. Sci. Instrum. **85**, 02B131 (2013).
2) Haruhisa Nakano, et al: AIP Conf. Proc. 1390, 359 (2011).

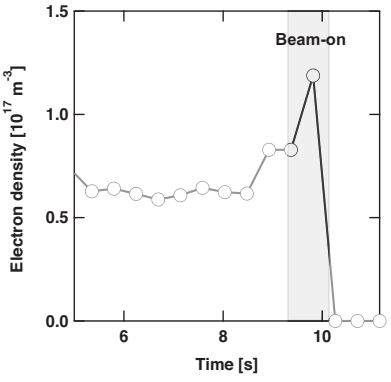

Fig. 1. Time evolution of electron density during plasma discharge.

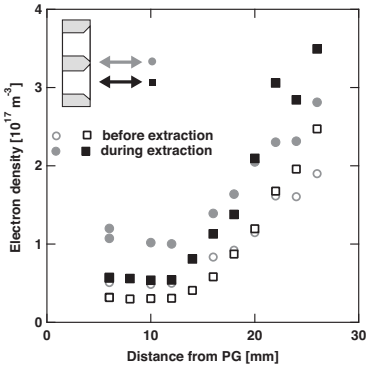

Fig. 2. Electron density at different z positions above metal and aperture.

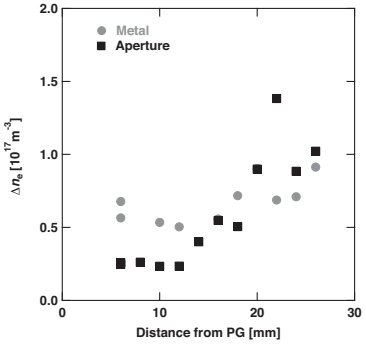

Fig. 3. Amount of electron density change before and after beam extraction.