Measurement of Electron Density near Plasma Grid of Large-scaled Negative Ion Source by Means of Millimeter-Wave Interferometer

K. Nagaoka, T. Tokuzawa, K. Tsumori, H. Nakano, M. Osakabe, K. Ikeda, M. Kisaki, Y. Takeiri, O. Kaneko and NBI group

National Institute for Fusion Science,322-6 Oroshi-cho, Toki 509-5292, Japan

nagaoka@nifs.ac.jp

The first result on the measurement of electron density at the beam extraction region of a large-scaled negative ion source by means of millimeter-wave interferometer has been reported. The measurement is applied to investigate the particle dynamics of the electrons, hydrogen negative ions (H^-) and hydrogenous ions (H_n^+, n=1,2,3) at the extraction region. The electron density is possible to obtain using the Langmuir probes in the weak magnetic field. In the vicinity of the extraction region, however, the probe cannot provide correct electron density due to the strong magnetic field more than 10 mT. Furthermore, the density of hydrogen negative ions (H^-) is considerably included in the plasma by seeding cesium (Cs) vapor. On the other hand, the interferometer is one of the reliable diagnostic methods for the electron density without perturbing the plasma. The millimeter-wave interferometer with the frequency of 39 GHz (λ=7.7 mm) is installed on the bias flange between filter magnet and PG. The polarization of the millimetre wave is perpendicular to PG plane. Measurable line-integrated electron density (n_e•l) is $2x10^{16}$ to $7x10^{18}m^{-2}$, where the n_e and l are the electron density and plasma length through the measuring line, respectively. Internal structures the ion source scatter the millimetre wave and induce the interferences of the wave. To reduce those problems, two circular wave-guides are installed in vessel. The wave distribution can be reduced lower than 30 mm from PG. The waveforms of n_e•l obtained with the interferometer (upper) and total arc power (lower) are shown in Fig. 1. The response of electron density to the arc power is observed as shown the figure. The typical length of the plasmas of this region is 200 - 250 mm, and the n_e•l, of ~10^{-17} m^{-3} is consistent with the value observed with the Langmuir probe in the measureable magnetic field. The averaged electron density (n_{e_ave}) as a function of input arc power is shown in Fig. 2. The value of n_{e_ave} goes linearly up by increasing the arc power. The data is obtained with pure hydrogen discharge, and electron density is higher than the case of the Cs seeded plasmas. We are going to present about the change of electron density in case of Cs seeded plasmas.

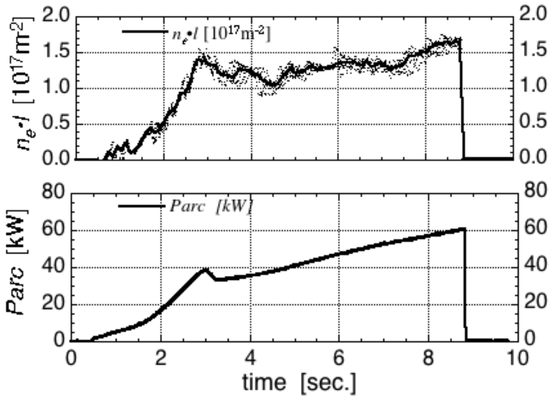

Fig. 1. Waveforms of n_e•l (upper) near plasma grid obtained by means of millimeter-wave interferometer and total input arc power (lower).

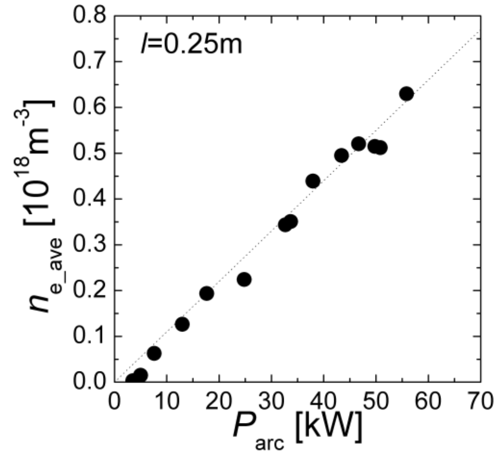

Fig. 2. The arc-power dependence of the averaged electron density near the PG.