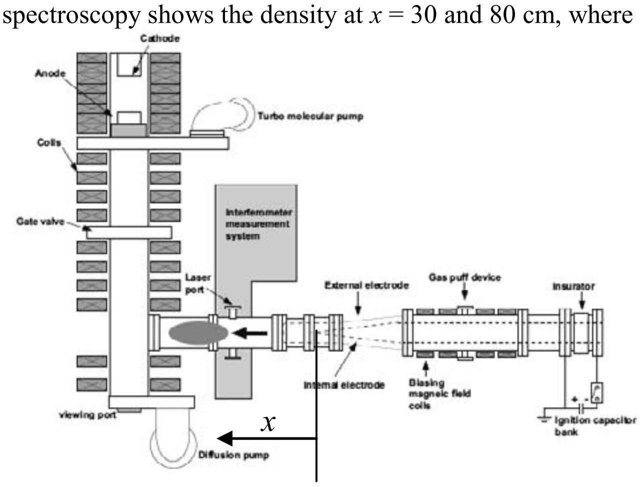
§6. Development of Electron Density Measurement in High Density Blobs Using Laser Interferometry

Kajita, S., Osaka, M., Ohno, N. (Nagoya Univ.),
Akiyama, T.

Control of transient heat and particle loads due to ELMs and its impact to divertor materials will be an important issue in future fusion devices. To simulate the harsh condition, extensive experiments have been conducted by using a laser, an electron beam, and a plasma gun. It has been pointed out that simultaneous irradiation of a plasma and transient loads can lead to a synergistic effect that enhances the surface damages. In this study, the electron density of a plasmoid produced by the plasma gun device[1] was measured with an interferometer system installed[2], and compared with the one measured with a spectroscopic method.

Figure 1 shows a schematic of the experimental device NAGDIS-PG. For the interferometer, a He-Ne Zeeman laser (QQD-H), which oscillates orthogonal linearly-polarized components with a frequency difference Δω of 208 kHz, is used as a light source. The Zeeman laser enables to build a heterodyne interferometer with simple optical system. Figure 1 shows the emission spectrum of the He II from the Gun plasma at the wavelength of 468.54 – 468.59 nm. We deduced the ion temperature and plasma density using the Doppler and Stark broadenings, respectively. In Fig. 2, it is seen that the Voigt function, which includes the both broadening effects, well fitted for the experimental observation. In particular, for the tail part of the spectrum, the profile was closer to the Lorentz profile rather than the Gaussian profile.

Figure 3 shows a comparison of the plasma density between the spectroscopy and interferometer. The spectroscopy shows the density at x = 30 and 80 cm, where



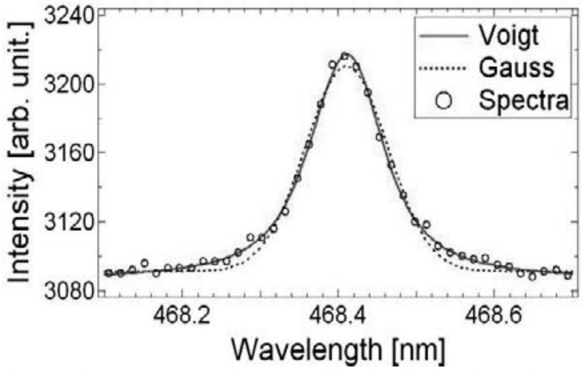


Fig. 2 The spectrum of He II with the fitting function using Voigt and Guass functions.

x is the distance from the tip of the electrode, as shown in Fig. 1. The interferometer shows that at x = 35 cm. The density was on the order of 10^{21} m^{-3} from both of the measurement system and consistent with each other. The electron density in the plasmoid increased with the discharge voltage.

The density decreased with x. Comparing between densities at x=30 and 35 cm obtained from the spectroscopy and interferometer, respectively, the difference was significant. This was because the interferometer deduced the averaged density, while the spectroscopy is sensitive to the peak density, which is the brightest part. The result supported the measured density of the interferometer developed in this collaboration.

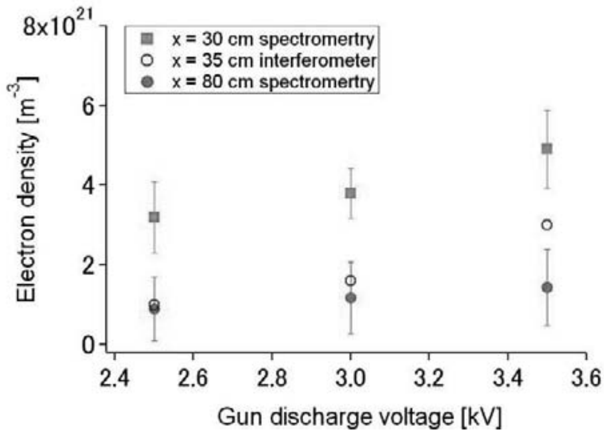


Fig. 3 The temporal evolution of the electron density measure with interferometer and the signal of a magnetic probe at different biasing voltages, i.e. (a) 0.3, (b) 0.4, and (c) 1.5 kV.

1) S. Kajita, N. Ohno, T. Akiyama, T. Nihashi, T. Uchiyama, M. Osaka, Y. Kikuchi, M. Nagata, J. Nucl. Mater. **438** (2013) S707.
2) S. Kajita, T. Akiyama, T. Nihashi, M. Osaka, N. Ohno, Y. Kikuchi, I. Sakuma, and M. Nagata, IEEE Trans Plasma Sci. **41** (2013) 3122.