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

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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.

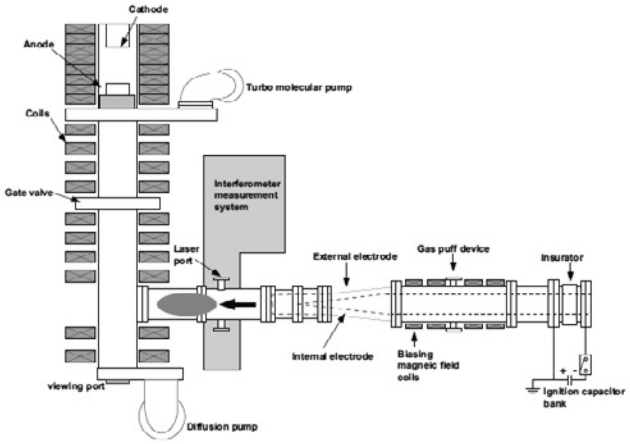

Fig. 1 A schematic of the experimental device. A plasma gun device is connected to the linear plasma device NAGDIS-I.

An interferometer measurement system was installed to the plasma gun device. The position of the system can be seen in Fig. 1. Two small view ports were used for the measurement and the laser beam was introduced to a port and reflected back with a mirror located outside the facing port. The averaged electron density of the plasma was expected to be 10^{21}-10^{22} m^{-3} from previous study.

A He-Ne Zeeman laser (QQD-H), which oscillates orthogonal linearly-polarized components with a frequency difference $\Delta\omega$ of 208 kHz, is used as a light source. The Zeeman laser enables to build a heterodyne interferometer with simple optical system. After the quarter-wave plate to compensate the elliptically polarization, the laser beam is split into two: probe and local beams. Polarizers with orthogonal transmission directions at each chord select one of polarization components. The digital demodulation technique(2) was used for extraction of the phase shift.

To confirm the validity of the measurement results, the measurement was conducted as changing the bias voltage applied to the external bias field coil. As changing the bias voltage, the ejection property of produced plasmoid changes.

Figure 2 shows the measurement results of different bias voltages at (a) 0.3, (b) 0.4, and (c) 1.5 kV. As increasing the bias voltage, the plasma at the measurement region gradually decreased, because the plasma was confined in the production region by a strong magnetic field. When the bias voltage was 1.5 kV, the plasma at the measurement region did not come out to the measurement region at all. It was confirmed that the signal definitely presents the density of the produced plasmoid.

The discharge voltage dependence of the peak density was measured by the interferometer. The size of the plasma was assumed to be 70 mm. The density increases with the discharge power and reach 10^{22} m^{-3} when the discharge voltage was 5 kV.

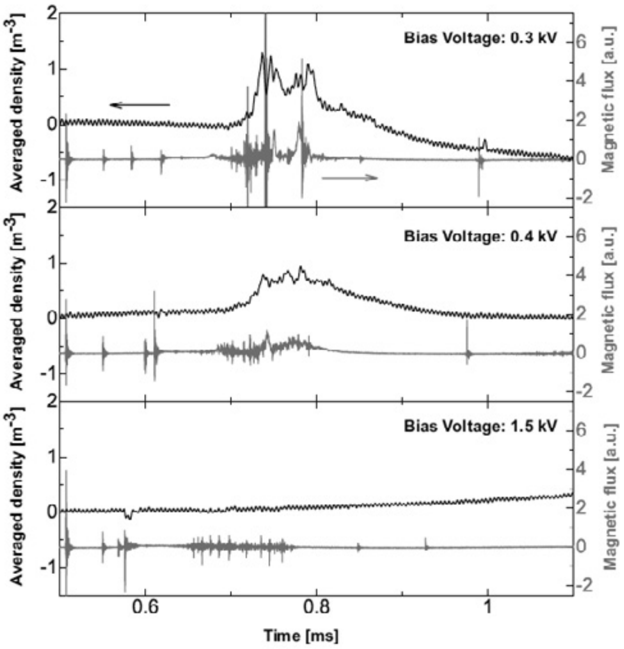

Fig. 2 The temporal evolution of the electron density measure with interferometer and the signal of a magnetic probe at different biasing voltages, i.e. (a) 0.3, (b) 0.4, and (c) 1.5 kV.

1) S. Kajita, N. Ohno, T. Akiyama, T. Nihashi, T. Uchiyama, M. Osaka, Y. Kikuchi, M. Nagata, J. Nucl. Mater. (2013) http://dx.doi.org/10.1016/j.jnucmat.2012.12.046.
2) Y. Jiang, D. L. Brower, L. Zeng, and J. Howard, Review of Scientific Instruments, **68** (1997) 902.