§20. High-speed Imaging Spectroscopy for Electron Density and Temperature Measurements in Plasmoid in LHD

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A fast imaging spectroscopy with high spatiotemporal resolution (26,000 pixel resolutions and time resolution of 20,000 fps) has been applied to estimate the electron density and temperature inside the pellet plasmoid (ionized ablation cloud) in the Large Helical Device(LHD)[1]. The difference in the electron density inside the plasmoid, in the case of the high temperature and the low temperature background plasma is investigated.

Although the large-scale electron density and temperature in the plasmoid have been already measured by global spectroscopy, well diagnosed experiments are needed to understand the ablation behavior in more detail. The objective of this study is to evaluate two-dimensional electron density and temperature distribution in the plasmoid quantitatively, and finally to identify the initial imparted amount from the pellet at the ablation.

In this spectroscopic system, a five-branch fiberscope is used. Each objective lens has a different narrowband optical filter for the hydrogen Balmer lines and background continuum radiation. The electron density and temperature in a plasmoid can be obtained from the intensity ratio measured with these filters. The five images are focused onto a single fast camera so that the simultaneity is ensured.

The density and the temperature inside the plasmoid are evaluated from the intensity ratio H_β(FWHM5nm)/H_β(FWHM20nm) and H_γ(FWHM20nm)/H_β(FWHM20nm). Figure 1 shows the typical results of density and temperature imaging. The density distribution in the range of $10^{22} - 10^{24}$ m^{-3} and the temperature distribution in about 1 eV are observed. These orders are in agreement with the global spectroscopic measurements[2].

The electron densities inside the plasmoid, in the case of a high and low background temperature plasma are compared. Figure 2 shows the density profiles across the magnetic field line. The pellet particles inside the plasmoid at higher background plasma are large. The result is consistent with higher ablation rate at higher background plasma.

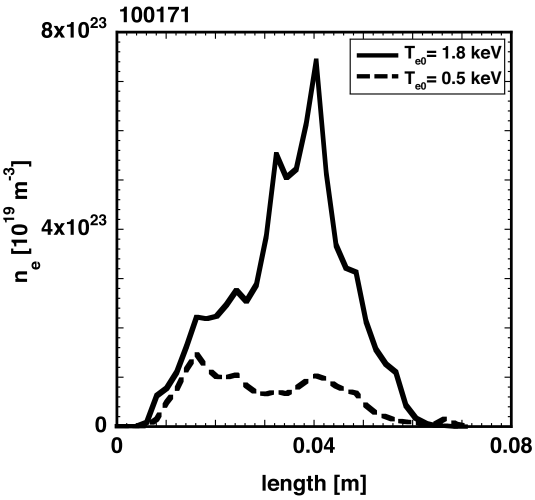

Fig. 2: Density profiles across the magnetic field line.

1) G. Motojima *et al.*, Proceedings of 37th European Physical Society conference on Plasma Physics, pp. P5-173, Dublin, Ireland (2010).

2) M. Goto *et al.*, Plasma Physics. Control Fusion **49**, 1163 (2007).

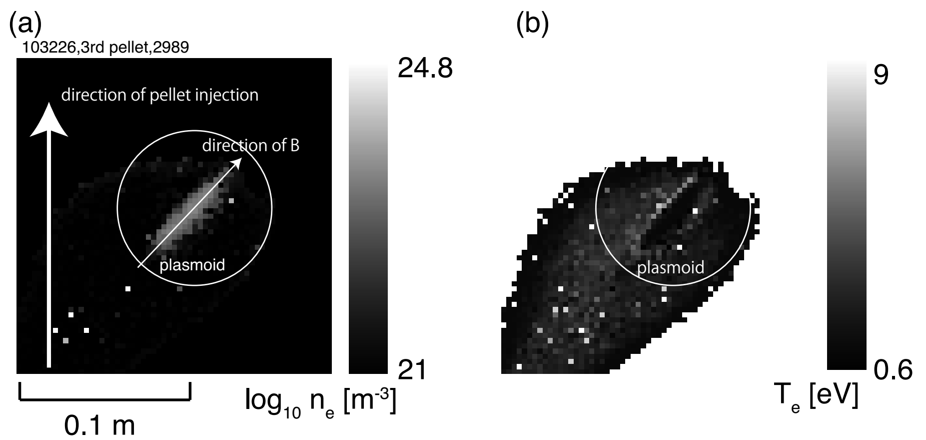

Fig. 1: Typical result of (a)density and (b)temperature imaging. The plasmoid is shown in the circle.