# §4. Spatial Density Distribution of Plasmoid by Pellet Injection Using Spectroscopic Diagnostics

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To investigate the behavior of a plasmoid consisting of pellet ablatant ionized by background plasma, two dimensional imaging measurements of high-speed spectroscopy have been developed using a fast camera in LHD[1]. An initial result shows that the plasmoid density is obtained within a factor of 2 by imaging measurements.

Ablating process of injected pellets is a key element to optimize efficiency of pellet fueling. In LHD, the behavior of pellet ablation has been investigated using a fast camera [2][3]. In particular, recent studies of the ablation behavior have been focused on the drift of the plasmoid. The behavior of the plasmoid following the ablation process has a primary effect on the pellet mass deposition. Therefore, understanding not only pellet ablation but also the subsequent behavior of the plasmoid helps in optimizing pellet fueling. This study aims at quantitative evaluation of the two dimensional density distribution in the plasmoid on the basis of imaging measurements with high-speed spectroscopic diagnostics.

A bifurcated fiber scope with two objective lenses is used in this spectroscopic system. Each objective lens has a different narrow-band optical filter for hydrogen Balmer lines. Two images viewed from the same line of sight located just behind the pellet injector are obtained. The images are focused onto a single fast camera so that simultaneity is ensured. The plasmoid density in each pixel on the image can be obtained from the stark broadening profile of the Balmer-$\beta$ line. The stark broadening profile is determined from the ratio of intensities through the filters which have same central wavelength of 486.1 nm and different full width at half maximum of 5 nm and 20 nm. Here, the filter parameters suitable for various presumed densities and temperatures in a plasmoid were selected using the spectra estimated from the fitting with the theoretical data [4][5].

Figure 1(a) shows the density distribution in the plasmoid. Plasmoid density is of the order of $10^{23}$ m$^{-3}$ except in the center region of the plasmoid. The size of plasmoid is defined as the area with significant intensity of the emission. In the center region of the plasmoid, it seems that the density is lower. The reason might be attributed to the actual temperature range being lower than that assumed. Figure 1 (b) shows the electron density distribution in a direction perpendicular to the magnetic field line passing through the maximum intensity point. A maximum electron density of $2.3 \pm 0.7 \times 10^{23}$ m$^{-3}$ is observed.

1) Motojima, G., *et al.*, accepted to Plasma and Fusion Research.

2) Sakamoto, R., *et al.*, Nucl. Fusion **44** (2004) 624.

3) Sakamoto, R., *et al.*, Rev. Scient. Inst. **76** (2005) 103502.

4) Stehle, C. and Hutcheon, R., Astron. Astrophys. Suppl. Ser. **140** (1999) 93.

5) Fujimoto, T., Plasma Spectroscopy (Oxford: Oxford University Press) (2004).

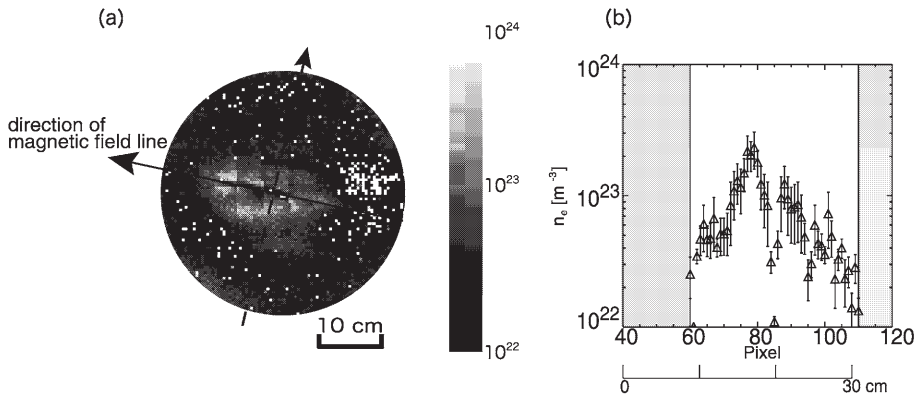


Fig. 1: (a) Density distribution in the plasmoid and (b) electron density distribution along the dashed line in a direction perpendicular to the magnetic field line passing through the maximum intensity point. Here, solid line shows the direction of the magnetic field line; dashed line shows the direction perpendicular to the magnetic field line.