Spectroscopic diagnostics for spatial density distribution of plasmoid by pellet injection in Large Helical Device

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A spectroscopic diagnostic to measure the density of plasmoid originated from injected pellets has been developed for the Large Helical Device (LHD). This system can measure the plasmoid density in the range from 10^{22} to 10^{24} m^{-3}. It is also possible to evaluate the plasmoid temperature by the ratio of Balmer-β line to continuum. In this paper, we report this system with the initial result from LHD experiment.

Pellet injection is a primary technique for efficient core plasma fueling in fusion devices. 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 [1, 2]. In particular, recent studies of the ablation behavior have been focused on the drift of pellet ablatant, known as a plasmoid. The behavior of plasmoid following ablating process has a primary effect on the pellet mass deposition. Therefore, the understanding of the pellet ablation and subsequent drift of the plasmoid are required for the optimization of the pellet fueling. This study aims at qualitative evaluation of spatial distribution in the plasmoid and its temporal evolution. A bifurcated fiber scope with five objective lenses is used in this spectroscopic system. Each objective lens has a different narrow-band optical filter for hydrogen Balmer lines and continuum. Five images which are viewed from the same line of sight through different filters are obtained. The images are focused onto a single fast camera to ensure the simultaneity of them. The plasmoid density in each pixel on the image can be obtained from the stark broadening profile of the Balmer-β 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 [3, 4]. In addition to the density and temperature of the plasmoid, the spatial distribution of the density in the plasmoid can be evaluated by using tomography under the assumption that the structure of the plasmoid is rotational axial-symmetry. Parametric dependence and characterization of the plasmoid are discussed.

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