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Electron density profile measurement using the LHD Thomson scattering system

LHDトムソン散乱装置による電子密度分布計測

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The LHD Thomson scattering system measures electron temperature and density profiles of LHD plasmas at 144 spatial points along the LHD major radius. Electron densities are determined from absolute measurements of Thomson scattered light. In the LHD Thomson scattering system, large errors in measured electron densities are occasionally seen. This will be caused by the misalignments of laser beam and/or light collection optics. We propose new method to fix the problem, based on the similar concept proposed by the JAEA Thomson scattering diagnostic team.

1. Introduction

The LHD Thomson scattering system measures electron temperature and density profiles of LHD plasmas along the LHD major radius. In the LHD Thomson scattering system, large errors in measured electron densities are seen occasionally due to misalignments of the incident laser beam and/or light collection optics. We proposed a few techniques to fix the problem [1][2][3]. In this paper, we propose new method to resolve the problem, based on the similar concept proposed by the JAEA Thomson scattering diagnostic team. Similar system has been also equipped in the KSTAR Thomson scattering system [5].

2. Image position monitor system

In the LHD Thomson scattering system, two couples of pair fibers are used as an image position monitor system. The half right and left areas are masked in two neighboring fibers, Fa1 and Fa2, respectively, as shown in Fig. 1. When beam image is located at the center of the fibers, signal intensities from the two fibers will be the same, S(Fa1) = S(Fa2), as shown in the top figure. If the image position is shifted to the right, signal intensity from the left-side masked fiber will be higher than the right-side masked fiber, S(Fa1) > S(Fa2), as shown in the middle figure. Therefore, the image position is estimated from the intensity ratio measured by the two fibers. Then, the light loss due to misalignment is estimated from the beam position information.

3. Calibration

We calibrated the image position monitor system by using Raman scattering in gaseous nitrogen. Figures 2 show the signal intensity as a function of the image position. The top and middle figures shows signal intensities from the right-side and left-side masked fibers at inner and out positions, respectively. The bottom figure shows the signal intensity ratios for the inner and outer pairs. From the data, we can estimate the image position and light loss due to misalignment.

3. Experimental Results

Figure 3 shows an example of the comparison of a raw electron density profile data and corrected

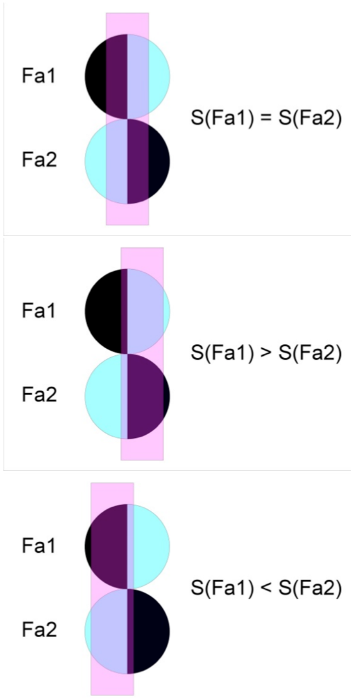

Fig. 1. Principal of the image position monitor system.

data. In this case, Thomson scattering image position is shifted in the outer region, resulting in an asymmetric density profile. The original asymmetric profile data are corrected by using the image position data. The corrected data shows a good symmetric density profile as expected.

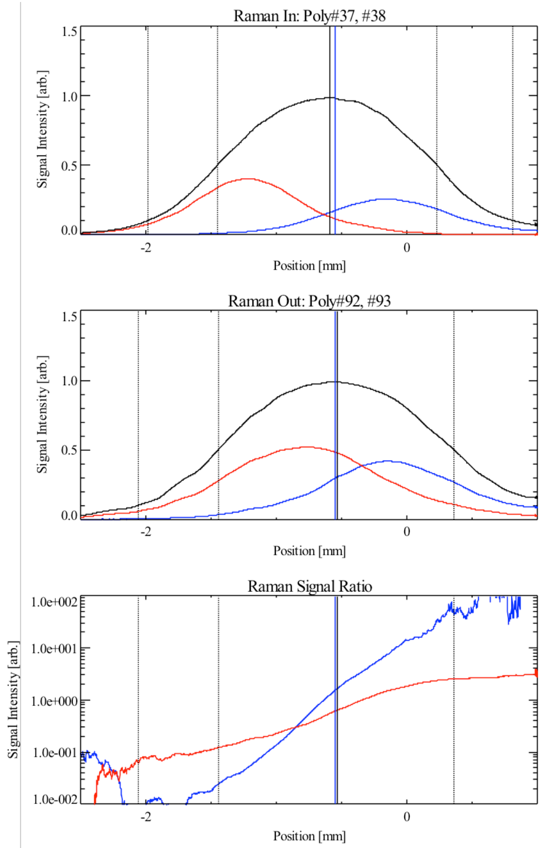

Fig. 2. Signal intensity from the righ-side and left-side masked fibers at inner position (top) and outer position (middle).

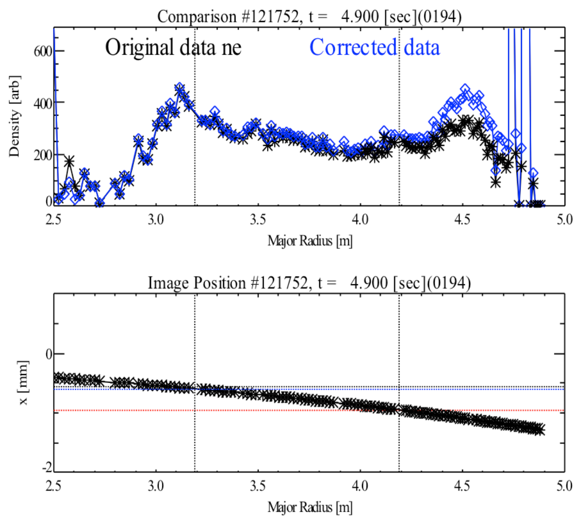

Fig. 3. Comparison of uncorrected and corrected density profiles (top). The lower figure shows image position data estimated from the image position monitor system. It is noted that x = -0.55 mm is the center of the fiber array.

4. Summary and future plan

We have installed an image potion monitor system on the LHD Thomson scattering system to estimate image potion on the fiber array and obtain accurate density profile data. The system works well. We are planning to install a further improved type. In the improved type, we used three fibers to estimate image position more accurately, as shown in Fig. 4.

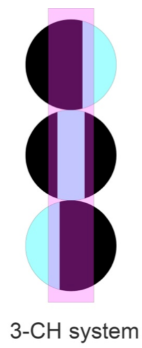

Fig. 4. Three-channel image position system.

Acknowledgments

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