§10. Bispectral Analysis of the Edge Harmonic Oscillation and Turbulence Measured with BES on DIII-D

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A local density fluctuation diagnostic based upon the beam emission spectroscopy (BES)[1] with lattice type optics configuration has been implemented on Large Helical Device (LHD) to investigate the spatiotemporal and spectral characteristics of long wavenumber density fluctuations such as MHD activity. The images of the light collecting fiber set at 9O port viewing NBI#5 has spatial width of 1 cm and spatial pitch of 1 cm on the focal plane. Because of the probe beam width, the sampling volumes of each line of sight pass through several magnetic flux surfaces, and this leads to integration of beam emission across different flux surfaces. Thus, it is essential to estimate this integral effect to evaluate the localization of the measurement. If we define the spatial resolution as the standard deviation in effective minor radius weighted by the multiple value of electron density and beam particle density along each sight line, this is expressed as

$$\Delta r_{\rm eff} = \sqrt{\int w \cdot (r_{\rm eff} - r_{\rm eff\,0})^2 dl}, \tag{1}$$

where, w is defined as,

$$w = \frac{n_{\rm e} \cdot n_{\rm beam}}{\int n_{\rm e} \cdot n_{\rm beam} dl}, \tag{2}$$

and measurement central position in radial direction $r_{\rm eff\,0}$ is defined as,

$$r_{\rm eff\,0} = \int w \cdot r_{\rm eff} dl. \tag{3}$$

Figure 1 shows the contour of (a) the product value of $n_{\rm e}$ and $n_{\rm beam}$, and (b) $r_{\rm eff}$ on the equatrial plane. The probe beam, NBI #5 is injected perpendicularly to the plasma from 1O port. Figure 2 shows the plot of $n_{\rm e} \cdot n_{\rm beam}$ vs $r_{\rm eff}$ for a line of sight which passes through $R = 4.46$ m at the center of the probe beam. The evaluated location for lines of sight in the range of $4.30 < R < 4.65$ m is $0.66 < r_{\rm eff\,0} < 0.53$ m. The spatial resolution is $2\Delta r_{\rm eff} \sim 0.01$ m at the edge and this increases up to 0.10 m. The ratio of the light intensity emitted from the region of $r_{\rm eff\,0} \pm \Delta r_{\rm eff}$ to the total light intensity integrated along a sight line is expressed as,

$$w_0 = \int_{r_{\rm eff\,0}-\Delta r_{\rm eff}}^{r_{\rm eff\,0}+\Delta r_{\rm eff}} w dr_{\rm eff}. \tag{4}$$

For the region of $4.30 < R < 4.65$ m, w_0 was estimated 68%.

1) Fonck, R. J. et al.: Review of Scientific Instruments 61 (1990) 3487

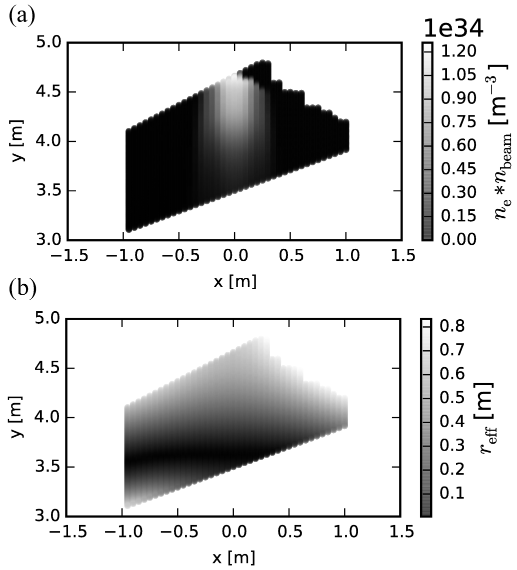

Fig. 1: Contour plot for (a) $n_{\rm e} \cdot n_{\rm beam}$ and (b) $r_{\rm eff}$ on the equatrial plane.

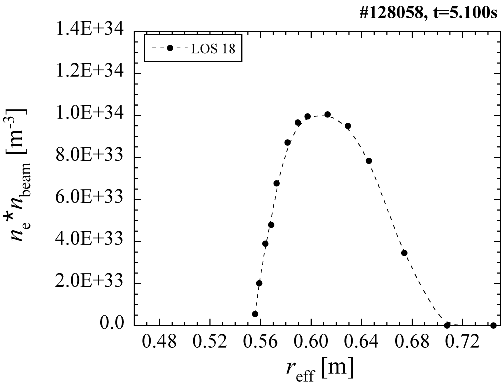

Fig. 2: An example of the plot of $n_{\rm e} \cdot n_{\rm beam}$ vs $r_{\rm eff}$ for a line of sight which passes through $R = 4.46$ m at the center of the probe beam.

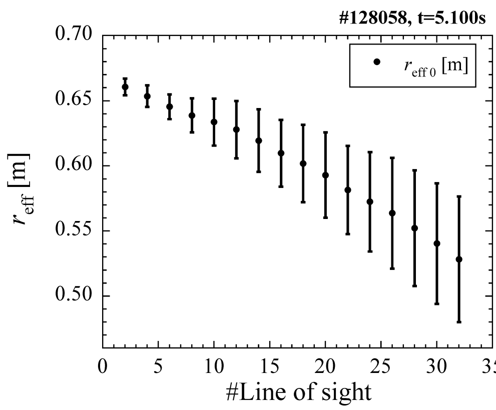

Fig. 3: Evaluation of the location and spatial resolution of lines of sight in the range of $4.30 < R < 4.65$ m.