§5. Study of Turbulence by HIBP in JIPP T-IIU Tokamak

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HIBP is capable of the very localized measurement of the turbulence.Multiple detection system up to 13 measurement points (p1 to p13) is recently installed at the analyzer. Because of the increase of the measurement points in turbulence study, we got the clear view of propagation of the turbulence in the tokamak plasma.

Separation of the input slits is 5 mm each with total separation of about 6.5 cm. At 3 points a detector set of 4 plates per point is adopted. At 10 points, 2 plates per point is adopted. Typical dimension of the detector plate is 2 mm X 80 mm. The study of plasma turbulence by this multiple-slit system is encouraging as shown in Fig.1. Figure 1 shows the cross correlation coefficients of sum of the detector currents of 4 neighbouring points of the measurement (p4,p5,p6,p8), proportional to the local densities in the OH plasmas with average density of $2x10^{13}/cm^3$. Each sample volumes is about 2 cm in the radial direction and about 1 mm in poloidal direction, displaced each other about 5 mm in radial direction and about 1 mm in poploidal direction. All sample volumes are at r/a_p= about 0.8-1.0. Compared to the previous measurement of turbulence by 2 point measurement, new results are obtained. The correlation of the one pair (position 5 and 6) clearly shows that the main turbulence propagates into electron diamagnetic direction and a small component propagates into the ion diamagnetic direction. The correlation of the other pair (p. 5 and p. 4) has a peak in the opposite side in τ, but has the same propagation because p. 4 is at the opposite position to p. 6 compared with p. 5. The correlation of the pair (p. 5 and p. 8) shows the decay of the correlation with distance and the larger propagation time. In addition, the negative values in these coherence coefficients at τ= 0 in Fig. 1 may be caused by the path integral effect discussed in the beam emission spectroscopy (BES) turbulence study. When the beam moves into the plasma, the beam decays due to the ionization by plasma electrons and ions and carries the information of the turbulence in the outer layer to the inner layer of the plasma by this decay, so-called path integral effect. Since the beam velocity is so fast, its effect should be in the near τ =0 if the effect of the ionization of the secondary beam can be neglected. HIBP turbulence study may be relatively free from path integral effect if we analyze the data of correlation with careful treament of the value at τ = 0. As the observation point goes deeper into the ohmic plasma, the component with ion diamagnetic direction decays and the observed turbulence propagates only in the electron diamagnetic drift direction in contrast to the TFTR results measured by BES in the L-mode experiments.

Figure 1. Cross correlation coefficient functions of 4 neighbouring measurement points (p4,p5,p6,p8) in ohmically heated plasmas with average density of $2x10^{13}/cm^3$. The points of measurement are placed at r/a_p= about 0.8-0.9.