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

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HIBP is capable of very localized measurement of the turbulence. Compared with the conventional 2-points measurement in HIBP turbulence study, multiple-point measurement up to 7 points is performed. Although we have not utilize fully the advantages of the increase of the measurement points in turbulence study, we at least got a clear view of propagation of the turbulence in a tokamak plasma.

Figure 1 shows positions of arrays of 7 sample volumes in the JIPP T-IIU 3-Tesla plasmas when the primary thallium beam of 450 keV is swept poloidally at the entrance to the tokamak in 5 steps (a to e), and the auto- and cross-correlation coefficient functions of detector signals (five sample volumes in the case of Fig. 1) at each step, proportional to the local densities at each sample volume. They clearly show by the shift of the peaks of the cross correlation coefficient functions that the main turbulence propagates in the electron-diamagnetic-drift direction in a core of the low density (1-2 x $10^{13}/cm^3$) OH-plasma.

Since the direction of arrays (d,e) near the plasma center is rather poloidal, we are able to get a poloidal propagation velocity of about 10 km/sec by a shift of peaks of correlation curves. The electric potential in low density plasmas is a little less than -1,0 keV and it does not have large gradient near the center of the plasma.[1] In addition, the coupling of the toroidal wavenumber of the turbulence with toroidal rotation velocity gives a propagation of turbulence in poloidal direction with the speed reduced by r/Rp/q(r) and this value is small in the OH plasmas. Accordingly, this velocity is much faster than the fluid velocity like diamagnetic drift or the poloidal rotation velocity by the electric field, similar to the results of turbulence study by HIBP in TEXT tokamak.[2] The Fourie spectra of these cross correlation coefficients, have a broad peak around 100-200 kHz.

A sharp transition of the correlation curves characterized by the change of correlation time and frequency is observed near the plasma boundary. Since the sample volumes are expanded in radial direction near the plasma boundary in this case, the measurement of the turbulence near the boundary is performed by a different array of the sample volumes and the propagation of turbulence near the plasma boundary is in the direction of the ion diamagnetic drift.

The change of the characteristics of the turbulence along the minor radius was recently found in TFTR using beam emission spectroscopy (BES).[3] Their result showed the turbulence propagating into the ion diamagnetic direction (ITG-mode) dominates in an inner region of the NBI-heated high-T_i plasmas. Our result shows the dominance of a pure electron drift wave in a linear ohmic confinement (LOC) plasmas (fast-electron-wave uni-modal) where BES measurement is not applicable due to the absence of the strong neutral beam and in NBI-heated L-mode plasmas.

Reference

1) Y. Hamada et al., Plasma Physics and Controlled Fusion 36 (1994) 1050.
2) T.P.Crowley et al., Nuclear Fusion 32 (1992) 1295
3) R.Fonck et al., Phys. Rev. Lett., 70 (1993) 3736

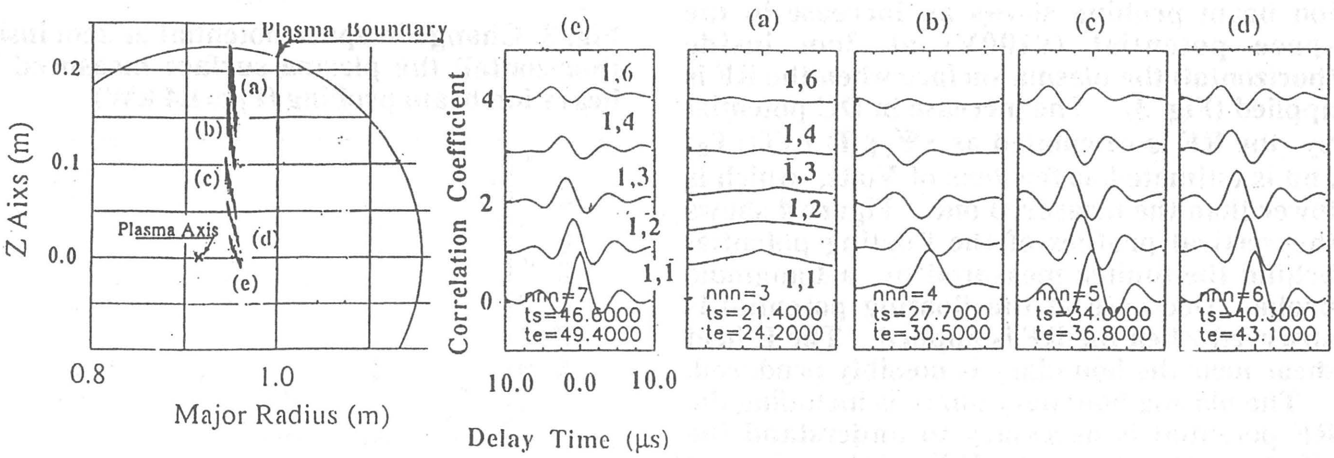

Figure 1. Schematics of 5 arrays (a-e) of 7 sample volumes and 5 curves of cross correlation coefficient function