§10. Study of Structural Effects of Langmuir Probe Array on Edge Fluctuation Measurement in CHS

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Langmuir probe (LP) is a very convenient tool to measure the plasma parameters and their fluctuations in the edge plasma region with high temporal and spatial resolutions. More-over, it is also a powerful diagnostic method to evaluate the particle and heat fluxes induced by electrostatic fluctuations in the plasma edge. But, it should be carefully employed to measure these quantities.

We compare the structure of two types of the LP array in Fig. 1, of which array consists of four sets of triple probes. The four triple probe sets are displaced only in the poloidal direction and called 'type A' probe array. In another probe array, type B, the triple probe sets are displaced both in toroidal and poloidal direction to minimize the shadow effect from each other. The radial separation of four probe sets makes it possible to simultaneously measure the radial profiles of plasma parameters in one plasma shot. The type A (type B) probe array has five (four) electrodes which are made of molybdenum rod with 0.5 mm diameter and 2.0 mm length. The type B probe array works as four sets of standard triple probes[1] with four electrodes. The modified triple probes[2] with five electrodes are employed in the type A probe array. The floating potential is measured at two positions poloidally separated by Δl = 6 mm in the type A and 4.5 mm in the type B probe array. The fluctuation of the poloidal electric field which is needed to calculate the radial particle and heat fluxes, is evaluated from the difference of these floating potentials divided by the separation Δl.

In these experiments, both probe arrays are able to measure the stationary plasma parameters (electron temperature, density and plasma potential), amplitudes of these fluctuations and these profiles which have similar characteristics discussed previously[3]. This result indicates that all probe sets in the type A and type B probe array do not suffer from the shadow effect because all probe sets in both types are arranged in the poloidal direction.

Measurements of the radial particle flux induced by electrostatic fluctuations require the poloidal electric field fluctuations. As predicted from the probe structure shown in Fig. 1, the fluctuations propagated in the poloidal direction might be appreciably affected by neighboring sets of triple probes in the type A probe array. We have investigated whether or not the cross-correlation function of two floating potential signals is affected by the shadow effect due to poloidally arranged electrodes. At the first step, these quantities for the third probe set are measured, where the third probe set might be affected by the shadow of the first and second probe sets. Next, these quantities for the first probe set are measured when it is moved out to the same position of the third one at the first step. In this situation, of course, the first probe would never suffer from any shadow effect. Figure 2 shows the maximum cross-correlation coefficient R and the characteristic delay time τ of the two floating potential fluctuations. These quantities are measured by the first ($R(\tau_1)$, t_1) and the third probe set ($R(\tau_3)$, τ_3) in the similar discharges. If the shot conditions are completely the same and the structural effects are negligible, these values should be on the diagonal line. Data points in Figs. 2(a) and (c) which are measured by the type A probe array appreciably deviate from the expected diagonal line, and those in Figs. 2(b) and (d) which are measured by type B probe array stay closer to the line. These results indicate that the type B probe array seems to be reliable for the measurements of these parameters and particle flux, compared with those by the type A probe array.

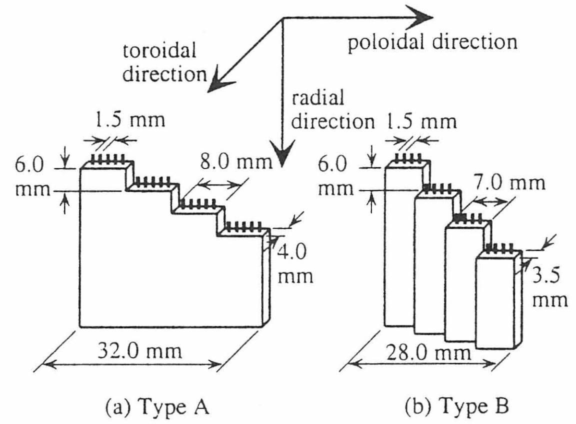

Fig. 1 Schematic drawing of the Langmuir probe arrays.

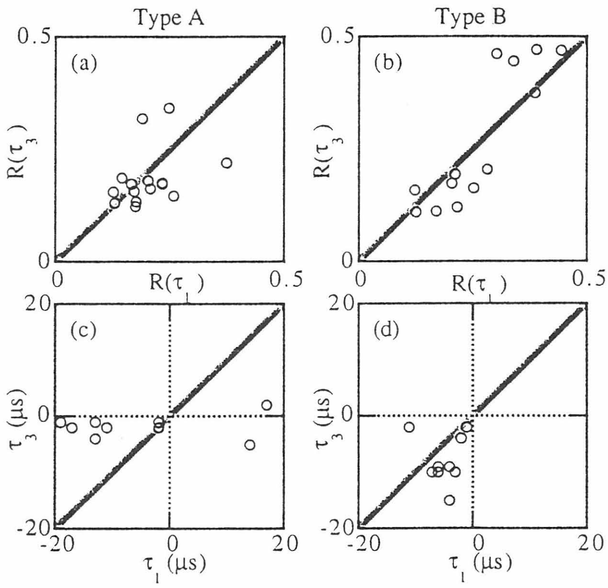

Fig. 2 Relationship between the maximum of the cross-correlation coefficient and characteristic delay time obtained by the third probe set placed at r/<a>~0.96 and these quantities obtained by the first probe set when it is moved out to the same position of the third one at r/<a>~0.96.

Reference

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