§9. Extraction of Spatial Plasma Structures by Analyzing Fluctuations in Core and Edge of GAMMA 10

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The tandem mirror device GAMMA10 has common magnetic field lines in central (core) and end (edge) regions. This study aims to clarify the interdependency between the core and edge plasmas for improving controllability and performance from the statistical analyses of electrostatic fluctuations[1]. In order to measure the central plasma fluctuation, we used the gold neutral beam probe (GNBP)[2] and the fast reciprocating Langmuir probe installed near the central limiter. Further, edge fluctuations were acquired by the target plate, the end-plate, and/or Langmuir probes inside the divertor module.

In the fiscal year 2015, we had investigated the relatively reproducibly-observed fluctuations during an application of the central ECH (C-ECH). In the C-ECH period (shot number: #235840), drops of the electron line density and the diamagnetism were observed; in addition, core-plasma potential and the end-loss electron increased.

Figure 1 shows the radially and azimuthally divided west end-plate. We used 8 electrodes for the simultaneous potential measurement with high-time resolution of 1 MHz. Figure 2 shows the raw signals at 1-T, 3-T, and 5-T electrodes during the C-ECH. It is found that ~4.4 kHz fluctuation appeared almost in-phase at wide range in the radial direction. Same fluctuation was also detected by the GNBP and the reciprocating probe; therefore, ~4.4 kHz fluctuation appeared in extremely large region along and across the magnetic field.

Further, the end-plate clarified an existence of ~32 kHz fluctuation near the radial center (1-T and 2-T). Figure 3 shows the auto- and cross-correlation coefficients of ~32 kHz components calculated with the azimuthally divided electrodes (1-T, 1-S, 1-B, and 1-N). Fluctuations at neighboring electrodes have a phase shift of ~90 degrees, suggesting that the mode number of ~32 kHz fluctuation would be $m = 1$. Additionally, this fluctuation propagated in a clockwise direction in Fig. 1, which is corresponding to the $\mathbf{E} \times \mathbf{B}$ drift direction during the C-ECH period.

This study indicates an availability of the end-plate measurement for the investigation of mode structure and its behavior. We will plan to measure such phenomena by multi-point measurements with more than 8 electrodes. We are also planning to investigate largely-appearing fluctuations during the super molecular beam injection (SMBI) application and the plasma detachment phase in the divertor module.

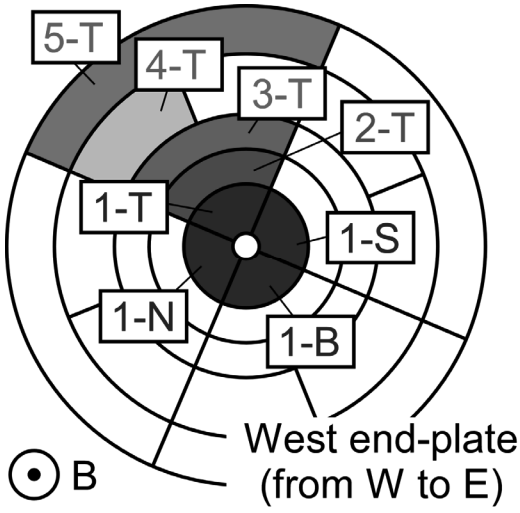

Fig. 1. Radially and azimuthally divided end-plate. Simultaneous measurement was carried out with 8 electrodes for analyses of radial (1-T, 2-T, 3-T, 4-T, and 5-T) and azimuthal (1-T, 1-S, 1-B, and 1-N) motions.

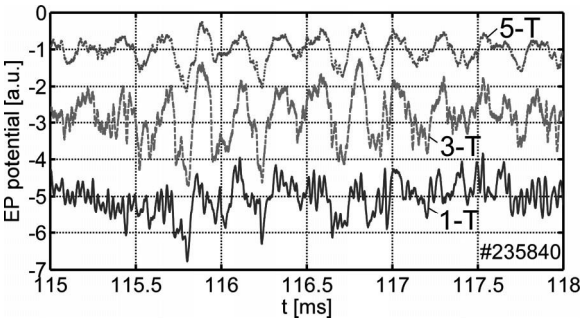

Fig. 2. Time series of end-plate potentials at 1-T (solid line), 3-T (dashed line), and 5-T (dotted line) during the C-ECH period.

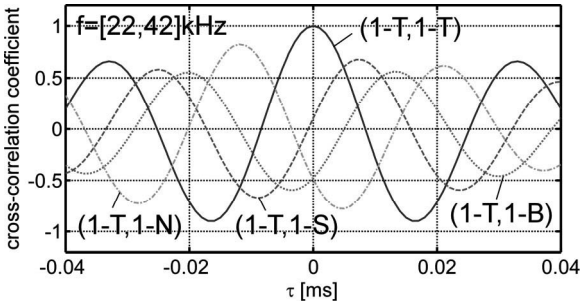

Fig. 3. Auto- and cross-correlation coefficients between end-plate potentials of [22, 42] kHz components at 1-T and 1-T (solid line), 1-T and 1-S (dashed line), 1-T and 1-B (dotted line), and 1-T and 1-N (dashed dotted line).

1) Tanaka, H. et al.: Fusion Sci. Technol. **68** (2015) 125.
2) Mizuguchi, M. et al.: Rev. Sci. Instrum. **79** (2008) 10F309.