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Analysis of Core Plasma Fluctuation in Divertor Simulation Experiments on GAMMA10

GAMMA10 におけるダイバーター模擬実験時のコアプラズマ揺動解析

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Diverter simulation experiments have been performed in the GAMMA10 tandem mirror. The effect of the insert of the divertor plate to the end region on plasma potential and its fluctuation at the core plasma is investigated by using a gold neutral beam probe. In the case of the plasma sustained by ICH and ECH, plasma potential increased when the diverter plate was inserted. The effect of the diverter plate on the potential fluctuation is discussed.

1. Introduction

Recently, divertor simulation experiments have also been performed by using a mirror end of the tandem mirror GAMMA10, where the plasma is initiated by a plasma gun and sustained using ion cyclotron heating (ICH) and electron cyclotron heating (ECH) [1,2]. Plug-ECH and Barrier-ECH produces positive and negative potentials at both end mirrors for the axial confinement, respectively. In this study, we investigate influence of the divertor plate, which is inserted at the exit of the end mirror, on the core plasma. Potential and its fluctuations of the core plasma at the central cell were measured and analyzed by means of a gold neutral beam probe (GNBP) [3,4].

2. Experimental device

GNBP is installed at the central cell of GAMMA10. The gold neutral beam is injected to the plasma and it is ionized in the plasma. The ionized process is mainly electron impact ionization. Therefore, the ionized beam current corresponds to the electron density at the ionization point. In addition, the difference between the neutral and ionized beam energy corresponds to the plasma potential at the ionization point. The measurement point was changed from R = 0 cm to R = 14 cm shot by shot. The time and spatial resolutions are estimated to be about 3 μs and 10 mm (i.e. a beam diameter), respectively.

3. Experimental result

The divertor plate was inserted to the west mirror end of GAMMA10. Initial plasma generated by a plasma gun was heated and sustained by ICH. Then, Barrier-ECH and Plug-ECH were applied to plasma in the period of 160 ms to 190 ms and of 161 ms to 181 ms, respectively. Here, period in which the

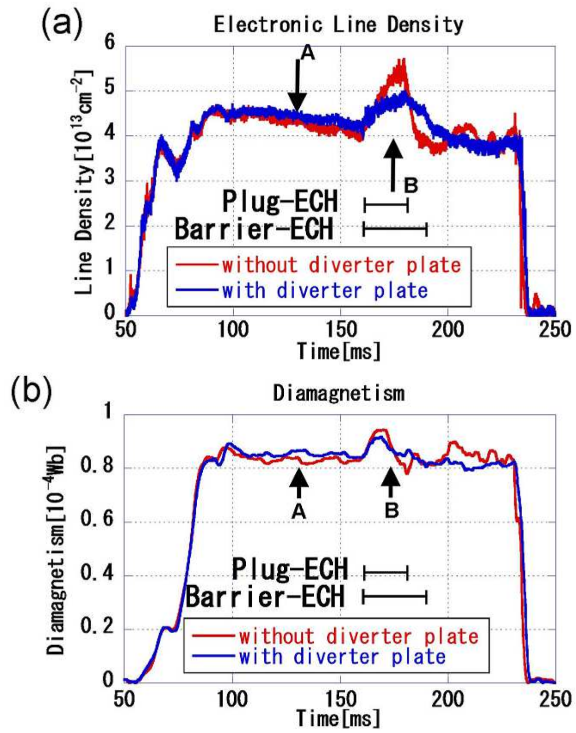

Fig. 1. Line density and diamagnetic flux of the plasma

plasma is sustained by ICH only and by ICH and ECH is called as “ICH period” and “ECH period” respectively. It is noted that the initial plasma was generated only by the east plasma gun in this experiment, since the divertor plate was inserted at the west mirror end. Usually, both east and west plasma guns were used. Time evolutions of line density and diamagnetism are shown in Fig. 1(a) and (b), respectively. Red and Blue lines indicate those without and with insertion of the divertor plate, respectively. The line density increased due to applying the Plug-ECH until it was switched off at t = 181 ms. On the other hand, the diamagnetism also increased due to the Plug-ECH but it started to decrease during the Plug-ECH (around t = 170ms). The behaviors of line density and diamagnetism during the Plug-ECH seem to differ with each other.

Radial profiles of plasma potential at the central cell are shown in Fig. 2. The profiles in Fig. 2 correspond to the time indicated by the arrows of A and B in Fig. 1. The circle and the triangle in the figure indicate the potential in the ICH period and the ECH period, respectively. The yellow hatching indicates the projected region of the divertor plate at the central cell. When the divertor plate was inserted to the west end, the potential increased in the whole radial region of the plasma in the ECH period. On the other hand, the potential did not change in the ICH period even though the divertor plate was inserted.

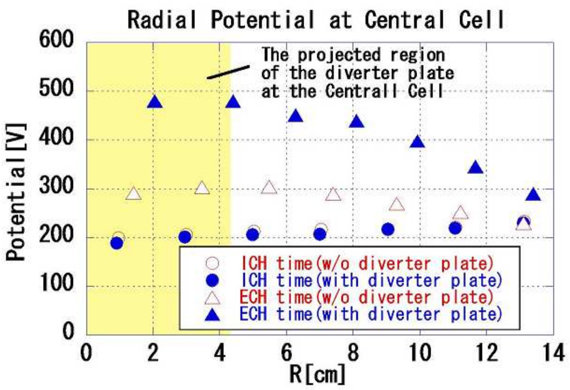

Fig. 2. Radial profile of plasma potential. ICH and ECH time in Figure indicated by the arrows of A and Bin Fig. 1, respectively.

Figure 3 shows radial profile of low frequency fluctuation amplitude in the latter half of the Plug-ECH period (i.e. t=170-180 ms). The characteristic fluctuation was 8 to 14 kHz for the case without the divertor plate and 16 to 19 kHz for the case with the divertor plate. In the case of the insertion of the divertor plate, the signals were at the noise level, and the characteristic fluctuation was not observed around the central region. On the other hand, at the outer side, the fluctuation amplitude became higher in the case of the insertion of the divertor plate.

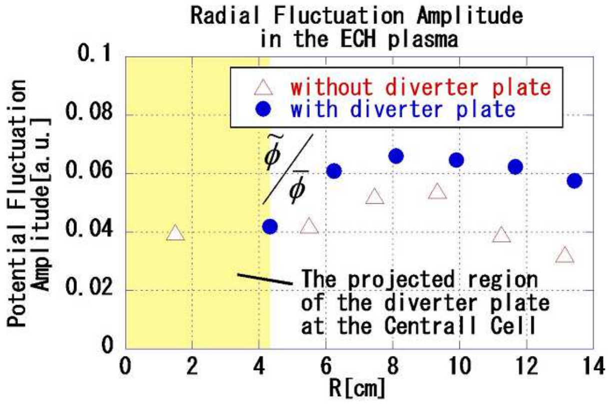

Fig. 3. Radial profile of fluctuation amplitude

4. Summary

In the divertor simulation experiments of GAMMA10, the plasma potential and its fluctuations at the central cell are measured by means of GNBP. When the divertor plate is inserted at the mirror end, plasma potential increased at the whole radial region over the projected region of the divertor plate in the period of the ECH period. The characteristic fluctuation is not observed within the central area that is projected region of the divertor plate. In the outer side, characteristic fluctuation of which frequency is 16-19 kHz can be observed.

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