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Study on a correlation between the GAMMA 10/PDX central-cell fluctuation and ICRF heating in the anchor cell

GAMMA 10/PDXにおけるアンカー部高周波加熱とセントラル部密度揺動との相関

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On GAMMA 10/PDX, ICRF heating in the anchor cell with DAT antenna has a large influence on several plasma parameters. We have implemented superimposing experiments of the anchor ICRF heating with DAT antenna on hot-ion mode plasmas. As the results, the increase of the central-cell density has been observed. Meanwhile, low-frequency-density fluctuations are suppressed in the central cell. We will advance identification of these density fluctuations and detail analysis for revealing the effect with the DAT antenna.

1. Introduction

In the GAMMA 10/PDX minimum-B anchored tandem mirror, Ion Cyclotron Range of Frequency (ICRF) heating is used for plasma production, anchor plasma buildup and ion heating [1]. It has been reported that ICRF heating in the anchor cell has a large influence on several plasma parameters [2,3]. Utilizing the anchor ICRF heating, high particle flux (>1.6×10^{23} $m^{-2}s^{-1}$) has been produced for extending operation regimes on recent divertor simulation experiment [3,4]. Understanding detail effects of the anchor ICRF heating is important for further extension of the experimental regimes.

2. ICRF Heating Systems

There are five ICRF antennas in the central and west anchor cells as shown in Fig.1. Nagoya Type-III (Type-III) antennas are used for the anchor ICRF heating and plasma production. Double Half Turn (DHT) antennas are installed for Ion Cyclotron Resonance Heating (ICRH) in the central cell. A Double Arc Type (DAT) antenna in the anchor cell is designed for an efficient ICRH on a minimum-B magnetic configuration [5]. An ion cyclotron resonance layer shapes an ellipsoid around midplane of the anchor cell.

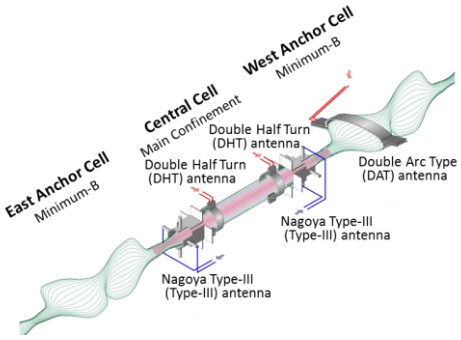

Fig.1. Schematic drawing of ICRF antennas on GAMMA 10/PDX

3. Superimposing Experiment on Central-Cell Hot-Ion-Mode Plasmas with DAT Antenna

In this experiment, hot-ion-mode plasmas are produced with both Type-III and DHT antennas during 51-240 ms. The DAT antenna superimposes on the plasmas as an additional anchor ICRF heating tool from 180 ms to 240 ms. Figure 2 shows the temporal evolution of the central-cell line density and the anchor ICRF heating with the DAT antenna. Superimposing the DAT antenna, line density in the central cell increases while the fluctuations on the line density decrease. Radial

profile of electron density in the central cell with the DAT antenna is steepened at the peripheral region and the internal density rises as shown in Fig.3. Moreover, it has been observed that the potential in the core region increases clearly. To investigate the relation among the density profile, potential and fluctuations, we have focused on the density fluctuations in detail. ElectroStatic Probe (ESP) is installed for measuring the density fluctuation at the peripheral region of the plasma in the central cell [6]. Figure 4 shows the temporal evolution of the intensity plot of the frequency spectrum of the density fluctuations measured with ESP. Two frequency peaks around 5 and 10 kHz are clearly observed as shown in Fig.4. When the anchor ICRF heating is superimposed, frequencies of both peaks increase gradually and the peak around 10 kHz disappears. The peak around 5 kHz still exists during the anchor ICRF heating.

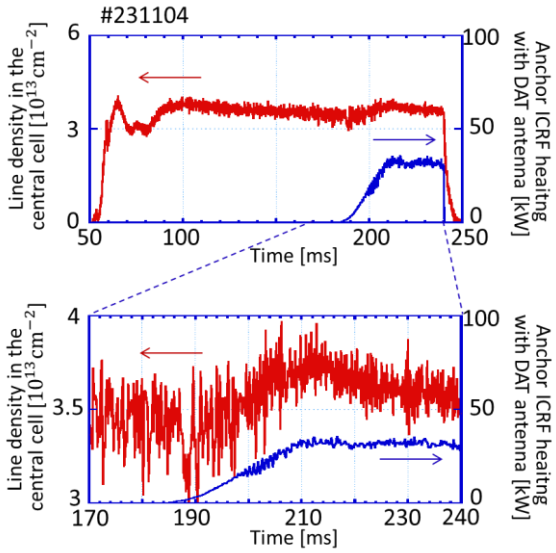

Fig.2. Time evolution of line density in the central cell and the anchor ICRF heating with the DAT antenna.

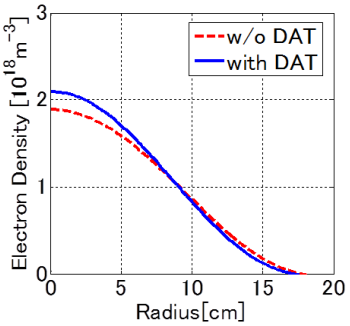

Fig.3. Radial profile of the central-cell electron density with the DAT antenna.

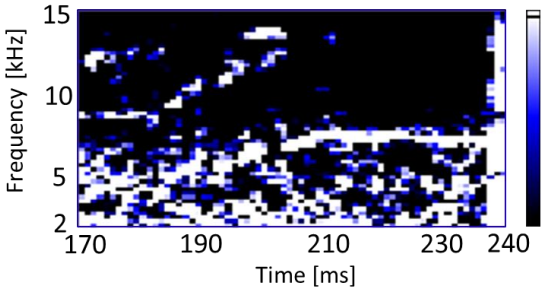

Fig.4. Time evolution of the density fluctuations in the central cell.

4. Discussion

It has been already confirmed that the anchor ICRF heating suppresses flute-type instability based on minimum-B concept. By contrast, the density fluctuation remains during the anchor ICRF heating in this experiment. It has been reported that there are two types of density fluctuations in relatively low frequency on GAMMA 10/PDX. One is flute type, and the other is drift wave type. These results imply that the DAT antenna can transform radial profile of plasma potential, and density, and also affect the fluctuations.

Absorption power profile of the anchor ICRF heating with the DAT antenna is important information for a detail discussion. We will analysis with TASK/WF as a full wave code [7].

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