# §21. Wave Excitation in the Anchor Cell of GAMMA 10 with Nonaxisymmetric Configuration

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The ion cyclotron range of frequency (ICRF) waves are used to control high performance plasmas for the experiments toward the divertor simulation in GAMMA 10. In the standard discharge, ICRF waves excited by Nagoya Type-III antennas in the central cell propagate to anchor region and heat ions at the ion cyclotron resonance layer. The study of wave excitation and absorption in the anchor cell with nonaxisymmetric mirror configuration is important because the formation of high-pressure plasmas in the anchor cell is required for Magneto-Hydro-Dynamic (MHD) stabilization of whole plasmas. As the anchor-region has a minimum-B configuration, ion cyclotron resonance layer is shaped ellipsoidal and its size depends on ICRF frequency (Fig. 1 (a)).

By the use of a three-dimensional full wave code (TASK/WF3), the wave excitation and absorption in the anchor cell has been studied to analyze the experimental observations in GAMMA 10.[1] This code solves the Maxwell's equation for the wave electric-field as a boundary-value problem using the finite element method. In the model, it is assumed that a cold and inhomogeneous plasma is surrounded by conducting walls. The power absorption through the collisional damping is described by introducing effective collisions in the dielectric tensor. Figure 1(b) shows the radial dependence of the calculated absorbed power density of ICRF waves. It is suggested that the plasma parameters in the central cell are affected by the applied frequency.

A double arc type (DAT) antenna has been installed in the anchor cell. The radial profiles of the electron-density in the central cell under the condition of w/o and with ICRF heating by DAT antennas are shown in Fig. 2. The wave of 9.4 MHz is used and electron density increases inside of the resonance region, but decreases in peripheral region. Furthermore, due to the efficient heating in core region, the change of potential profile in the radial direction is observed. These results are qualitatively consistent with the dependence calculated by TASK/WF3 code.[2]

Experiments and calculations show that, more effective control of plasma parameters in the radial direction is expected owing to excited wave frequencies by DAT antennas in the anchor cells. The optimizations with the wave analysis for the high-density plasma production experiments and for the divertor simulation experiments are continuing.

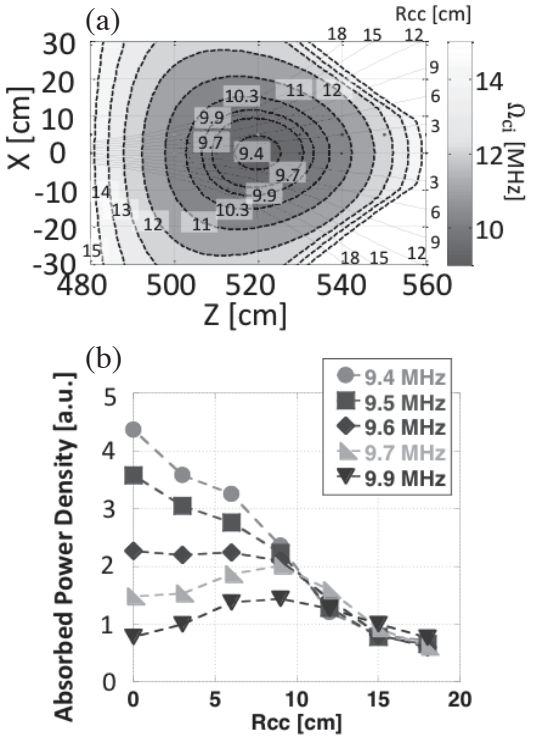


Fig.1 (a) Ion cyclotron resonance layers for the wave frequencies in the anchor cell. Gray lines indicate the magnetic lines from the radial position of the central cell midplane, Rcc. (b) Radial dependence of the calculated ICRF absorbed-power density in the anchor cell. The DAT antennas with several frequencies are used.

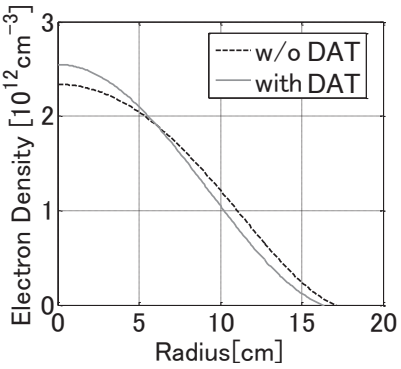


Fig.2 Observed electron-density profiles under the condition of 9.4 MHz ICRF frequencies applied in DAT antennas.

1) T. Yokoyama, M. Ichimura, A. Fukuyama, M. Hirata, et al., "Analysis of wave excitation of the phase-control ICRF antennas with theree dimensional full wave code on GAMMA 10", Fusion Science and Technology **68**, 185 (2015).

2) S. Sumida, M. Ichimura, M. Hirata, A. Fukuyama, et al., "High-density plasma production with ICRF heating in the anchor cells on GAMMA 10/PDX", 32nd Annual Meeting of The Japan Society of Plasma Science and Nuclear Fusion Research., Nagoya University, Nov. 24-27, 2015.