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

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In GAMMA 10, the formation of high pressure plasmas in the anchor cell is required for Magneto-Hydro-Dynamic (MHD) stabilization. In the standard discharge, ion cyclotron range of frequency (ICRF) waves excited in the central cell propagate to anchor region and heat ions at the ion-cyclotron resonance layer. GAMMA 10 has the nonaxisymmetric magnetic field configuration in the anchor cell. By use of a three-dimensional full wave code (TASK/WF3), the wave excitation in the anchor cell has been studied [1]. The direct anchor heating with anchor antennas has been started from 2009. As predicted in 2010, the loading resistance at the frequency of 9.7 MHz is very small under the present experimental conditions with a previous antenna. This small loading is confirmed also in the experiment. To improve antenna loading, new antennas are installed in both east and west anchor cells in 2011. Figure 1 shows a cross sectional view of the previous and new antennas on x-y plane at z=-4.95 m in the east anchor cell. A elliptic line (red) indicates a cross-section of the plasma. A strate line (green) and dotted lines (blue) are shapes of the previous and the new (double arc type: DAT) antennas, respectively. The shape of the new antenna is designed to match with the plasma cross-section. The loading resistance of the previous bar-type antenna and the new DAT antenna are calculated by use of a three-dimensional full wave numerical code.

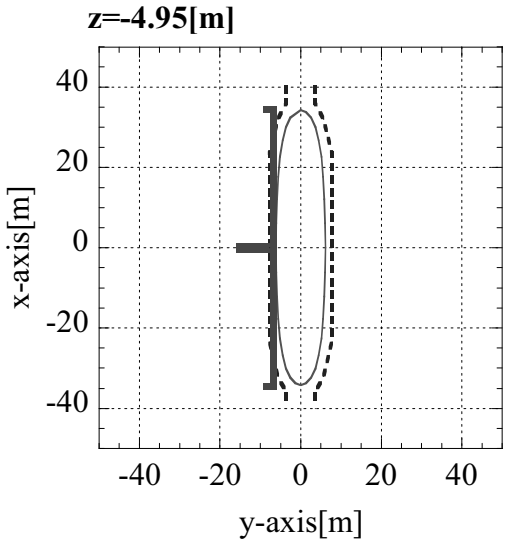

Fig. 1. A cross sectional view of previous (straght line) and new type (dotted lines) antennas on x-y plane at z=-4.95 m in the east anchor cell.

Figure 2(a) shows the temporal evolution of line densities in the central and east anchor cells. The increase of the diamagnetism in the east anchor cell is clearly shown in Fig.2(b) and antenna loading, which is defined as the ratio of net power to input power, is shown in Fig.2(c). In the case of the bar-type antenna, only one-sixth of input power is radiated to the plasma. On the contrary, almost 60 % of input power is radiated from the antenna in the case of DAT antenna. The antenna loading is improved more than twice [2].

The new antenna is designed under some restrictions, for example, without blocking the beam line of neutral beam injection (NBI) system and the line of sight in diagnostics. The shape of antennas is only changed in 2011 as indicated in Fig.1. The evaluation with the three-dimensional full wave code is needed to optimize the wave excitation in such complicated configuration as minimum-B field. It is suggested that more effective ion-heating can be expected by optimizing antenna configuration in the anchor cell.

[1]Y.Yamaguchi, M.Ichimura, T.Yokoyama, A.Fukuyama, et al., Fusion Science and Technology, 59, No.1T (2011) 253-255
[2] T.Yokoyama, et al., accepted for publication on Plasma Fusion Res. (2012).

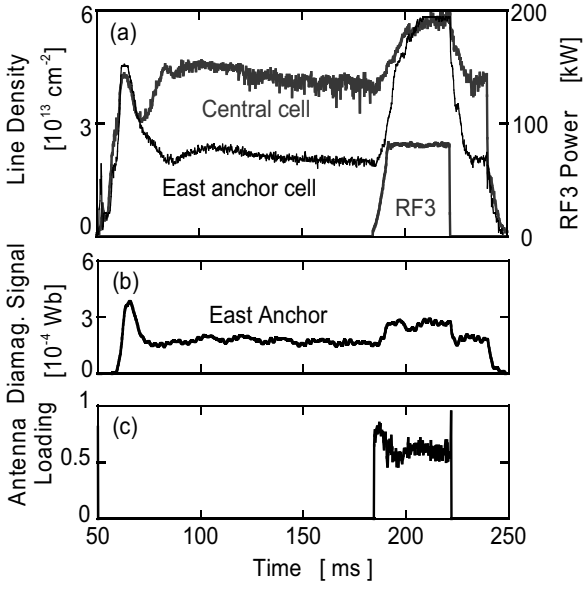

Fig.2. Temporal evolution of (a) line density in the central and east anchor cell, (b) diamagnetic signal in the east anchor and (c) loading of DAT antenna