§9. Development of Transmission System for Efficient Electron Heating in GAMMA 10

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In GAMMA10, an Electron Cyclotron Heating (ECH) is employed to get high ion confining potential and high electron temperature for the purpose of the research of confinement improvement physics by the plasma potential. High power gyrotron development for upgrade of 28GHz gyrotron ECH system have been explored, based on the scaling of potential formation[1]. The GAMMA 10 is a tandem-mirror device and axisymmetric mirror cells in both ends play important role to improve axial confinement of both ions and electrons through the formation of thermal barrier for electrons and plug potential for ions. The ECH power is a main tool to produce these confining potential in these plug/barrier cells and, at the same time, the electron heating in the central cell. To get high potential and efficient electron heating, it is quite important to design transmission line and antenna efficient. In this collaborative work, a two dimensional measurement system for radiation pattern profile was developed and applied it to the low power test of the newly developed antenna. Improvement of the polarizer was also done.

Fig. 1 shows the two dimensional measurement system for radiation pattern profile developed[2]. It is consist of horizontal scan system, waveguide detector and vertical moving stage with stepping motor. Using this system, the power profile radiated from the HE11 waveguide, was measured to confirm the reliability of this measurement system. It is confirmed that the measured radiation profile agreed very well with the calculated one.

This measurement system was applied to the new antenna development for the central ECH system. The central ECH antenna has two focusing mirrors to have efficient transmission efficiency and peaked profile at the resonance surface. To get higher efficiency and more symmetric profile, we have changed the design of the second mirror. To confirm this design improvement, we carried out the low power measurements of the test antenna made of aluminum with the same antenna configuration on the GAMMA 10. The figure 2 shows comparison between the calculated (dotted line) and measured (solid line) power profiles of the new antenna. It is seen both agree well. We also measured the transmission efficiencies of both new and previous antenna and confirmed the 10% improvement. From these measurements, we have fabricated the actual central ECH antenna for the installation into the GAMMA 10.

Since the wave launching angle is oblique incidence to the magnetic field with the X-mode (R wave) launch from the strong field side, the polarizer to optimize launching polarization of the waves is required. The improved polarizer of miter bend type with two grooved mirrors, which changed the design of rotational grooved mirror was fabricated and has been used in the central cell ECH experiments[3]. High power injection with more than 300 kW become possible with the new polarizer system, while the previous one sometimes broke down with ~ 200 kW.

High power and efficient central cell ECH will be done with these improved transmission line and antenna system in the coming experiments and contributes to the study of the central cell electron heating and the improvement of the confinement with plasma potential and electric field structure.

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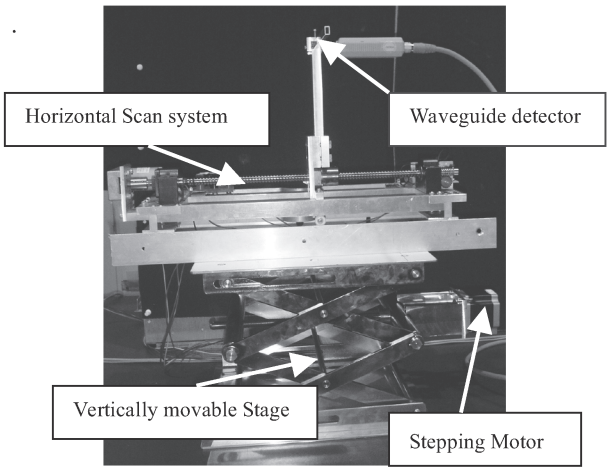

Fig. 1 Two dimensional radiation power profile detector system for millimeter wave antenna development

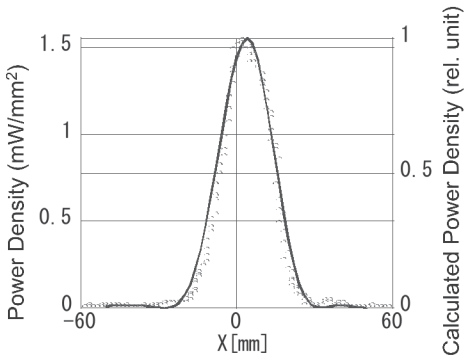

Fig. 2 Comparison between calculation (solid line) and low power measurements (dotted line) of the radiation pattern at the resonance surface.

[1] T.Imai, et al., Transac. of Fusion Sci. and Tech. 51 2T (2007) 208..
[2]. M. Nakamura et al., The 24th annual. meeting of Jap. Soc. of Plas. Sci. and Nucl. Fus.(2007) 30aC25P.
[3] M. Harigae, et. al., The 24th annual meeting of Jap. Soc. of Plas. Sci. and Nucl. Fus.(2007) 30aC26P.