§4. Development of High Performance Antennas for Electron Heating in GAMMA 10

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i) Objective

The role of electron cyclotron resonance heating (ECRH) in the GAMMA 10 tandem mirror is creating the plasma confining potential and heating of electrons in the central cell. Present important issues are high potential creation with high power microwave injection and controlling the radial potential profile. For central cell electron heating, is anticipated reduction of electron drag on hot ions. To achieve the above issues, it is necessary to radiate microwave power efficiently to the resonance surface. It is particularly important in a mirror device to control the radiation profile from an antenna, because the cyclotron resonance layer exists at a given position along the machine axis. The key issue is the design of mirrors for the transport of the microwave beam. The objective of the present study is development of the mirrors with necessary performance and application to the GAMMA 10 experiment.

ii) Method and procedure

A computer code was newly developed for calculation of electromagnetic (EM) field of the radiated microwave with a rather long wavelength corresponding to the frequency of 28 GHz. This code has been verified by low power tests. The EM field on the reflecting mirror is calculated from the field distribution over the open end of the power transmitting waveguide and that on the resonance layer is evaluated from the current induced on the reflecting mirror. The shape of the mirror is determined so that the EM field is to be axi-symmetric on the resonance layer through iterative calculation.

iii) Results

A new gyrotron of 28 GHz, 500kW was installed for high power electron heating at the plug position. Then a new antenna system was developed corresponding to HE11 mode transmission of the microwave power. A record value of an ion confining potential of 2.1 kV, which is three times as high as that in the experiment in the previous experiment, has been generated with the new antenna.

For electron heating in the central cell, the TE02 mode delivered from a 200 kW gyrotron was converted to the TE11 mode and radiated off the reflecting mirror installed just at the open end of the waveguide. Then, the distribution of the radiated field on the resonance layer has been optimized. Fig. 1 shows the distribution of the power density transmitted to the resonance layer along the vertical (x-axis of GAMMA 10 coordinates) direction. Its peak value is twelve times as high as that in two years ago and two times as high as that in the last year experiment. The new antenna system has been installed in March 2005.

iv) Next task

We will develop a new design technique of an antenna radiating EM field with an arbitrary power distribution for control of the radial potential profile in the next year. Experiments of central cell electron heating will be carried out and an antenna with further high performance will be developed. Application of the present technique to LHD will be considered.

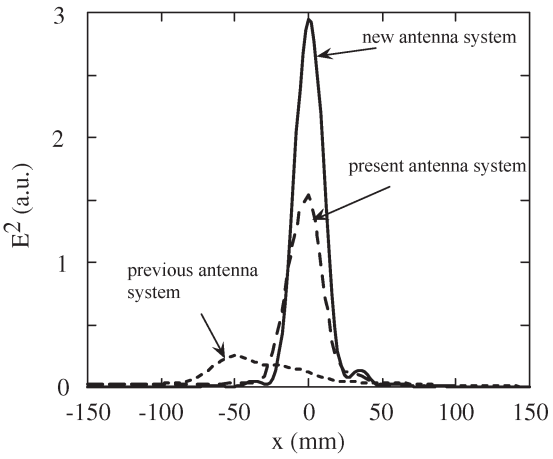

Fig. 1. The power distribution on the resonance layer in the central cell radiated from the new antenna is shown along with those from previous antennas.

References

1) Tatematsu, Y. et al.: in *"US-Japan Workshop on "Applications of RF Physics for Plasma Heating and Current Drive"*

2) Tatematsu, Y. et al.: Trans. Fusion. Sci. Tech. **47** (2005) 257.