§14. Development of High Performance Transmission System for Electron Heating in GAMMA 10

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The role of electron cyclotron resonance heating (ECRH) in the central cell of GAMMA 10 is increasing the electron temperature. A new 500 kW gyrotron has been installed in the central-cell ECRH system.[1)] Improvement of the launcher with newly designed reflection mirrors has achieved efficient power transmission to the resonance layer.[2-4)] Further, a polarizer has been designed and just installed on the way of the transmission line to control the incident wave mode and to increase power absorption rate to electrons.[1,5)]

In the central-cell ECRH system, the transmission line is composed of 2.5-inch corrugated waveguides, three miter bends, a taper and a vacuum window. The total length of the transmission line is about 15 m. The launcher is composed of an open ended corrugated waveguide and two mirrors. The inner diameter of the launcher waveguide is 1.25 inches to be installed through a 2-inch port. Then, the waveguide diameter is reduced from 2.5 to 1.25 inches with a taper in the atmosphere. The first mirror is attached at the open end of the waveguide for controlling the beam direction. The second mirror is settled at the bottom of the vacuum vessel. It reflects and focuses the beam onto the resonance layer. The shape of the bottom mirror is an ellipsoid to converge the beam onto the axis of the resonance surface with an axisymmetrical profile. The two mirrors were designed with our electromagnetic field code.

When the microwave with linear polarization, generated by the gyrotron, is injected from the waveguide, the X-mode purity is evaluated to be 69 % for the center ray of the beam incident on the resonance surface, because of oblique injection with the angle of 35 degrees between the direction of the ray and the magnetic field line on the second mirror surface. The microwave of an O-mode component is little absorbed by electrons under the present central-cell plasma density and temperature.

Therefore, it is important to increase the X-mode purity as high as possible. To achieve this, a right-handed elliptically polarized wave with the ellipticity of 34 degrees should be injected from the open ended waveguide. To do so, a set of polarizer composed of two rectangularly grooved mirrors is equipped. The two mirrors consist of a polarization twister with λ/4 groove depth and an elliptic polarizer with λ /8 one. A grooved mirror is shown in Fig.1. Each mirror is set on the miter bend. By rotating the groove directions of the twister and the polarizer; we can set elliptical polarization of which the principal axes coincide with the GAMMA 10 axes. The results are shown in Fig. 2. The solid lines represent theoretical calculation. Data points plotted with closed circles are obtained from a cold test. They well agree with each other. With the introduction of the polarizer, injection in almost pure X-mode is expected. In fact, by using the set of the polarizers, a problem of plasma drop, from which we suffered before, has been resolved now even for high power ECRH operation.

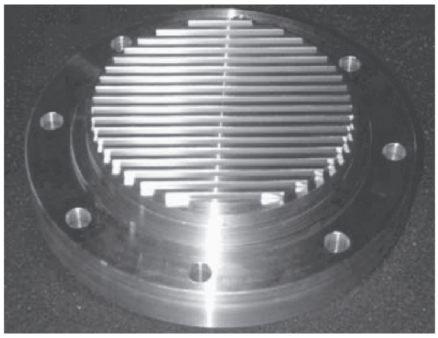

Fig. 1. Photograph of a designed polarizer.

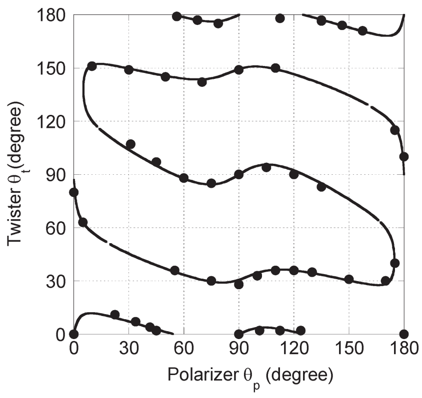

Fig. 2. Comparison between measurement (closed circles) and theoretical calculation (solid lines) for the designed polarizer.

References

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