§29. Development of Scattering Measurement System Using a Gyrotron as a Power Source and its Application to CHS

Idehara, T., Tatsukawa, T., Ogawa, I., Kanemaki, T. (Dept. Appl. Phys., Fukui Univ.)
Fujita, J., Matsuoka, K., Iguchi, H., Kawahata, K.

Intense electromagnetic wave sources in the submillimeter wavelength range are necessary for plasma scattering measurements. In scattering measurements, a submillimeter beam gives better spatial resolution. An intense beam raises the intensity of the scattered waves and improves the S/N ratio of the measurement. Gyrotrons are well suited sources for this work at these submillimeter wavelengths because of their capacity for high powers [1]. The gyrotron used in the present work delivers long pulses (τ=0.6 s) of suitably high power (p~110 W) at submillimeter wavelengths (f=354 GHz, λ=0.847 mm) [2] and has the capability of providing high spatial resolution and a high S/N ratio. The conversion of the gyrotron output into a high quality beam is indispensable for scattering measurements. A transmission line has been designed to optimize mode purity and focusing in the plasma.

The transmission line consists of a quasi-optical antenna, mirrors and polarizer. The gyrotron output is converted into a parallel, linearly-polarized beam with a rectangular cross section by a quasi-optical antenna installed near the gyrotron window. The mode purity of this transmission line is better than the conventional waveguide system for two reasons. One, the results of any spurious mode conversion within the gyrotron are separated from the main beam over the long propagation distance from the quasi-optical antenna to plasma because the angles of emission from the gyrotron window are different. Two, the corner reflectors which produce further mode conversion have been removed. There is a polarizer installed between the mirrors which have the longest distance. It plays the important role of ensuring that an O-wave is injected into the plasma. Each mirror is wide enough to avoid any diffraction loss of the main beam due to beam truncation.

In order to investigate the quality of beam, the fields given by the Huygens equation have been numerically calculated, which estimates a scalar diffraction of beam. The intensity profile at the plasma center is shown in Fig. 1. There is no sidelobe of more than -30 dB of the peak power of main beam. Most of the power (83 %) of the image source is transferred to the plane within an area of 100 cm^2 at this position.

Mode conversion in the output waveguide of the gyrotron results in spurious output modes. These modes make only a very small contribution at the plasma center. The total powers over the plane within an area of 100 cm^2 at plasma center are several % of image source power. This demonstrates that even when the output of the submillimeter wave gyrotron contains unwanted modes, the quality of the beam at the center of the plasma is not degraded.

Its application to plasma scattering measurement will provide a high S/N ratio and high spatial and wave number resolutions.

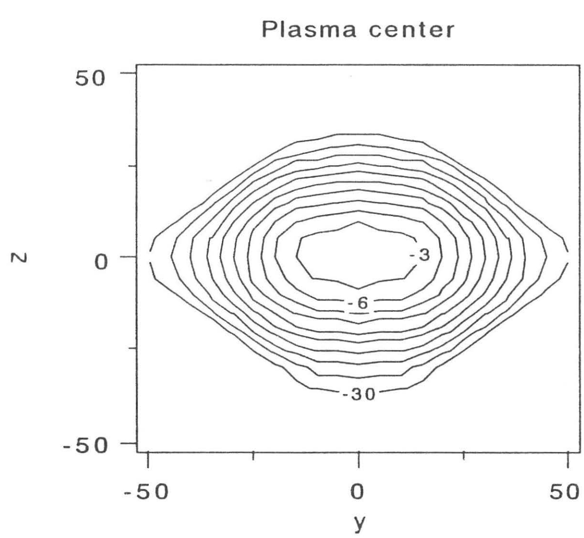

Fig. 1. The intensity profile at the plasma center.

References

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