

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

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The performance of plasma scattering measurement (S/N ratio, the spatial and wave number resolutions) depends on intensity, wavelength range and quality of a probe beam. Because spatial and wave number resolutions are improved by focusing the beam and increasing the scattering angle, a submillimeter wave beam is most suitable for the measurement. In addition, the application of intense beams is effective in improving the S/N ratio of measurement by increasing the intensity of the scattered wave.

High frequency gyrotrons are superior with higher output powers. A submillimeter wave gyrotron (Gyrotron FU II) has been developed at Fukui University. It covers a wide frequency range from 76 GHz to 402 GHz. In pulsed operation ($\tau = 1$ ms) at the second harmonic of the electron cyclotron frequency, high frequency output (up to $f=402$ GHz) at power level of several kilowatts can be produced. [1] This gyrotron can also produce steady outputs in a long pulse ($P=110$ W, $f=354$ GHz, $\tau \sim 0.6$ s) by closely adjusting the operation parameters. Power fluctuation level is lower than 8 % for the long time interval of 0.45 s except for the beginning of the pulse. [2]

However, the mode conversion of the gyrotron output into a linearly-polarized, well-collimated beam is necessary to their application to the scattering measurement. We are designing a new transmission line which consists of a quasi-optical antenna and three mirrors (Fig.1).

To study the quality of beam, a calculation of the fields by using the Huygens equation has been carried out. The intensity contours of the beam in the plasma are shown in Fig.2. The beam width in the x-direction ($\Delta x=10.6$ mm) is also close to that in the y-direction ($\Delta y=11.5$ mm). This means it is close to a Gaussian beam. The power injected into the plasma is 86.4 percent of the total power.

These results confirm that the quasi-optical system can produce an intense, high quality beam. In this system, beam scanning across the plasma is easily realized by rotating the final mirror. These features make this system extremely suitable for plasma scattering measurements. In addition, the S/N ratio, spatial and wave number resolutions are improved.

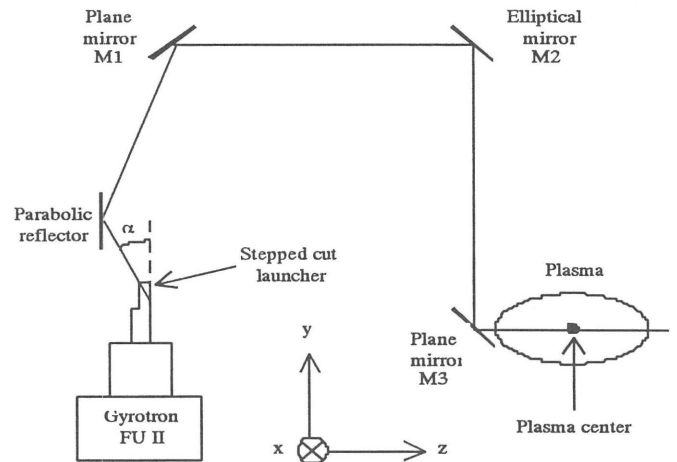


Fig.1 Quasi-optical transmission line to produce a probe beam for plasma scattering.

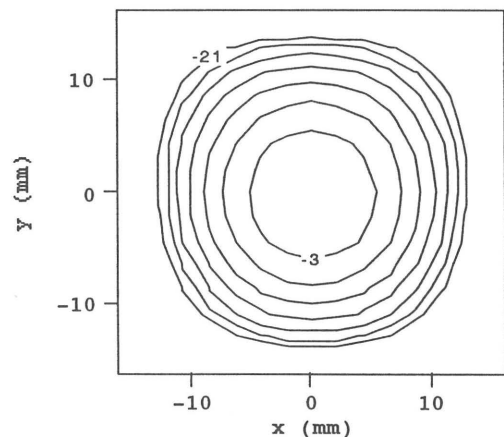


Fig.2 Calculated intensity contour in the plasma.

References

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