§24. Development of a Quasi Optical Gyrotron and Its Application to the Collective Thomson Scattering Diagnostics for LHD as a Radiation Source

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Figure 1 shows a schematic drawing of a quasi optical gyrotron which is being developed by the collaboration between National Institute for Fusion Science and Fukui University. In the gyrotron, Fabry-Perot resonator is installed. It enables frequency tuning in wide ranges near 90 GHz and 180 GHz. The operation parameters of the gyrotron are listed in Table 1. The output power obtained by numerical simulations is around 100 kW for fundamental operations and 50 kW for second harmonic ones.

Frequency tunability of such a high power gyrotron will be useful for application to plasma diagnostics and high power spectroscopies in wide fields.

We have performed initial design of the LHD CTS system based on the gyrotron as a radiation source. The main advantage of the using gyrotron as a radiation source instead of CO_2 laser is as follows. In the case of lasers the spectrum changes very rapidly with angle, only small-angle scattering can be used. This is made more difficult to obtain accurate spatial resolution. In contrast, at gyrotron frequencies, much larger scattering angles are available, the spectra change on slowly with angle, and reasonably large collection solid angles can be used – limited only by coherence requirements for heterodyne detection. The choice of the scattered angle will depend primarily on effects of plasma refraction and diagnostic port arrangement.

Table 1 The operation parameters of the quasi optical gyrotron

Frequency ranges
80~100 GHz (fundamental operations)
160~200 GHz (second harmonic operations)
Output power
~100 kW (fundamental operations)
~50 kW (second harmonic operations)
Efficiencies
20~30 % (fundamental operations)
10~20 % (second harmonic operations)
Maximum field
4.5 T
Electron beam parameter
70 kV, 10 A, 1msec (first stage)
80 kV, 20 A, 10 msec (final stage)

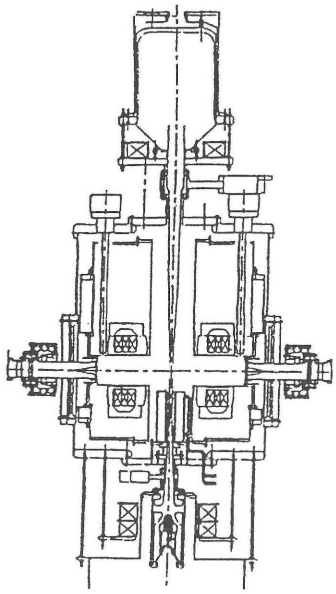

Fig. 1 A schematic drawing of the quasi optical gyrotron

Scattered power in the calculations was limited by crossing volume of incident Gaussian-like beam and receiving antenna. More accurate calculation (future plans) will include effect of the scattering from 'neighborhood' plasma.

Preliminary estimates suggest that a gyrotron with power up to hundred watts, and pulse duration about 1-2 sec is well suited for 'ion feature' evaluation. The arrangement of detection system is not influenced by scattering angle. Both, forward and backward scattering are allowed if gyrotron will be used as a radiation source.

For the further investigation the effect of magnetic shear, which is cause the rotation of the polarization of incident and scattering radiation, has to be considered.