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LHDにおける協同トムソン散乱計測のための300 GHz帯実機ジャイロトロンの開発
Development of a 300 GHz Band Gyrotron for Practical Use in Collective Thomson Scattering Diagnostics in LHD

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In FIR center, University of Fukui, a high power 300 GHz band gyrotron is under development for application to collective Thomson scattering (CTS) diagnostics in Large Helical Device (LHD) [1]. At this frequency, CTS condition is satisfied for high density plasmas in LHD with no limitations on the scattering angle. It has also advantages in delivering the probe-wave without electron cyclotron resonance condition, and in detecting the scattering signal without critical influences of electron cyclotron emissions. To ensure a high signal to noise ratio, a power of higher than several hundred kilowatts is required.

We have developed a prototype gyrotron. The oscillation mode is the $TE_{14,2}$ mode, and a single-mode oscillation with 246 kW maximum output power at 295 GHz was demonstrated. Following these results, we designed and fabricated the practical gyrotron aiming at oscillation power more than 300 kW. For power enhancement, the cavity radius and the beam radius must be increased for decrease in the ohmic loss on the cavity wall and the space charge density of the electron beam. Therefore, a higher order mode more than the $TE_{14,2}$ mode must be selected. Based on the mode competition calculation, we selected the $TE_{22,2}$ mode. Single mode oscillation of this mode was expected by suppressing competing modes.

Figure 1 plots the transmission signal of a Fabry-Perot interferometer as a function of the mesh distance. Narrow peaks appear with almost equal distances, indicating the single-mode oscillation. The frequency evaluated from the interval is about 303.1 GHz, which is almost equal to the design frequency of the $TE_{22,2}$ mode. The oscillation frequency was measured more accurately with a heterodyne receiver system, which showed a sharp spectral-peak at 303.27 GHz with -3 dB bandwidth no more than 10 MHz.

The radiation pattern was measured with a target made of polyvinyl chloride plate and an infrared camera. The obtained pattern was highly Gaussian-like distribution which was well fitted with the calculated pattern.

The oscillation power was measured with a water load. Figure 2 indicates the measured output power and the efficiency as functions of the beam current. The measured oscillation power increased with the beam current, and the maximum output power reached 300 kW.

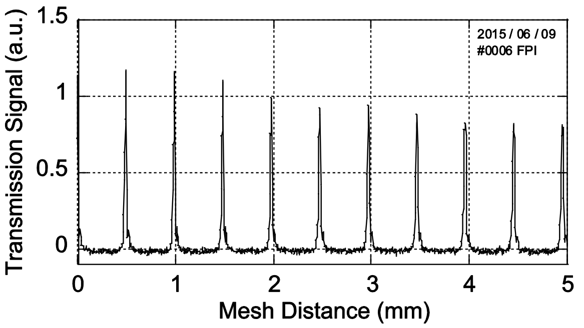

Fig. 1. Transmission signal of the Fabry-Perot interferometer as a function of the distance between two parallel meshes.

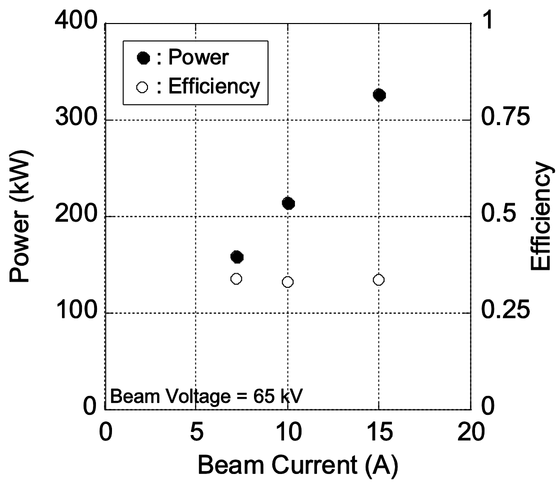

Fig. 2. Measured output power and efficiency as functions of the beam current.

References

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