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LHDにおけるサブテラヘルツ帯協同トムソン散乱計測のための機器開発と準備

Developments of Equipment for Sub-THz CTS Diagnostics in LHD

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I. Introduction

Collective Thomson scattering (CTS) equipment with a 303 GHz gyrotron is under development for CTS diagnostics on the Large Helical Device (LHD). CTS systems with 77 GHz and 154 GHz gyrotrons for electron heating are now working on LHD [1, 2]. The sub-THz CTS expands the CTS-applicable region of plasma parameters. Its use with 77 GHz and 154 GHz CTS in LHD will compose a powerful diagnostic system.

II. Development of High Power Sub-THz Gyrotron

A high power sub-THz gyrotron with a frequency of 303.3 GHz has been developed [3]. A whispering gallery mode (WGM) $TE_{22,2}$ was adopted to avoid mode competition. Purely single mode oscillation has been proved [4]. This is consistent with mode competition calculations taking account of a finite voltage rise time corresponding to the real power supply [5]. The maximum power is higher than 300 kW [4]. This gyrotron oscillates in pulse mode and the maximum pulse width is around 100 μs, which is sufficient for CTS experiments.

A double-disk window can be composed of a disk in addition to the vacuum tight disk. Oscillations of neighboring $TE_{21,2}$ (292.2 GHz) and $TE_{23,3}$ (314.4 GHz) WGM modes were observed by changing the distance between the two disks. The oscillation regions of these three modes are clearly separated and single mode oscillation of the $TE_{22,2}$ mode is obtained in a wide region of the cavity magnetic field strength. This is preferable for application to the CTS experiment.

III. Transmission Line

A low loss transmission line is necessary for the sub-THz CTS. Installation if a new line with 1.25 inch corrugated waveguides (CWG) optimized for the 300 GHz band is one possibility. A sufficiently low loss coefficient was confirmed with test CWG and the 303 GHz gyrotron [6]. However, use an existing line with 3.5 inch CWG for electron heating with 77 GHz and 154 GHz gyrotrons is more realistic at the moment. Transmission test has been carried out with the 303 GHz gyrotron and a sufficiently low loss coefficient has been confirmed. Then, an existing 3.5 inch CWG line will be used in the initial phase of the 303 GHz CTS experiment.

Fig. 1 303 GHz gyrotron (left hand side) and mirrors for coupling of the 303 GHz beam to the 3.5 inch corrugated waveguide system.

As shown in Fig. 1 the gyrotron has already been installed in NIFS and the mirror system for coupling of the 303 GHz beam to the 3.5 inch CWG line has been constructed.

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