§25. Development of Gyrotrons as Radiation Sources for Diagnostics of LHD Plasma and Their Application to Scattering Measurements

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High frequency gyrotrons have many advantages compared to the conventional sources and are also the most promising candidates as high power sources of microwave radiation. For many applications the stability of the output power is very important. It can be achieved by stabilizing the cathode potential and by a proper control of the anode voltage.

We have successfully performed cw operation of the submillimeter wave gyrotron, Gyrotron FU IV. This gyrotron consists of sealed-off tube and magnet system. The superconducting magnet produces the main field in the cavity region whose intensity can be raised up to 12 T. Three subsidiary copper field coils are used in the electron gun region. Both fields can be adjusted independently to control the formation of the electron beam in the MIG.

The cw operation (TE_{03} mode, f=301 GHz, P=20 W) is obtained under the following conditions: magnetic field intensity in the cavity region B_0=10.8 T, cathode potential V_k=-16 kV, anode potential V_a=-2.9 kV. The fluctuations of the output power correlate with that of the cathode potential (Fig.1). When the cathode potential decreases to the minimum value, the output power reaches its maximum.

In order to suppress the fluctuation of the cathode potential, high voltage power supply is equipped with a smoothing circuit consisting of a resistor, an induction coil and a capacitor. The fluctuation level was reduced from 40 V to 3 V by introducing this smoothing circuit. Accordingly, the fluctuations of the output power were decreased from 4.3 % to 1.3 %.

A conventional high frequency gyrotron is characterized by its capacity to deliver high power in submillimeter wavelength range and frequency step tunability due to the alternation of the operating mode. On the other hand, a quasi-optical gyrotron is a high power source offering the continuous frequency tunability in the millimeter wave range. Since some applications like plasma scattering measurements need high intensity waves, both types of gyrotrons are the most promising candidates for power sources in the millimeter to submillimeter wavelength range.

We have begun construction of a quasi-optical gyrotron with Fabry-Perot resonator. One of the main advantages of the quasi-optical gyrotron over the conventional gyrotron is the possibility for broad band frequency tunability. For the present setup about ten percent tunability can be achieved around frequency near 90 GHz (fundamental operation) and 180 GHz (second harmonic). The gyrotron will be used for plasma diagnostics in the Large Helical Device at NIFS.

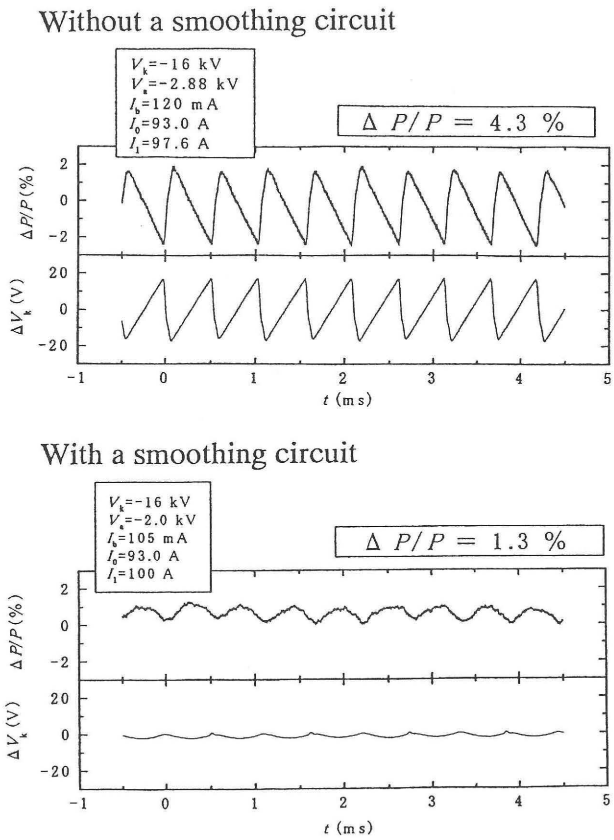

Fig. 1. Time evolution of operational parameters: ΔP fluctuation of gytotron output power, ΔV_k that of cathode potential; without smoothing circuit (upper trace), (b) with smoothing circuit (lower trace).