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ITER用ジャイロトロン及びジャイロトロンシステムの研究開発

Development of gyrotron and related system for ITER

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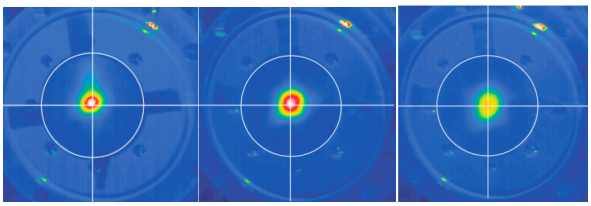

Fig. 1 Beam patterns of the multi-frequnecy gyrotron nearby the output window. Left hand side is 170GHz, the center is 137GHz, the right hand side is 104GHz.

A 170GHz gyrotron and a gyrotron system including a power supply have been developed in Japan Atomic Energy Agency for ITER. Recently, the developments are focused on two topics, i.e., a multi-frequency gyrotron and a power supply system for 5kHz modulation. The multi-frequency 170 GHz/137 GHz (104 GHz and 203GHz as an option) gyrotron with the triode electron gun is designed and tested. In the short pulse experiments (<1 ms), more than 1.3 MW is generated for both frequencies. A preliminary test for optional 104 GHz RF generations is performed. The output beam pattern of the 104GHz oscillation is located at the center of the output window as same as the other frequencies (Fig. 1).

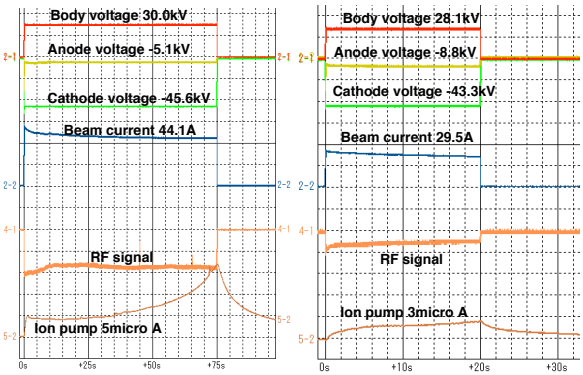

Fig. 2 Waveforms of the long pulse operation of the multi-frequency gyrotron. Left hand side is 170 GHz and right hand side is 137 GHz.

In the Long pulse experiments, 905 kW/45%/75 s for 170 GHz and 540 kW/42%/20 s for 137 GHz are succeeded (Fig. 2). A higher power operation is also progress. The 1080 kW/45 %/5 s is achieved with 170 GHz oscillation and higher power operation is going to attempt for both frequencies. The pulse length and the efficiency will be increased by accessing the hard excitation region with adjustments of the anode voltage and the magnetic field during the pulse.

A 5 kHz modulation is performed with the 1.16 MW / 48% electrical efficiency by using a short-circuited switch between the anode and the cathode (=single switch configuration). In order to improve the rising time of the cathode-anode voltage, another switch is introduced between the anode voltage divider and the anode electrode (=double switch configuration). As a result the voltage is quickly supplied to the anode electrode at the beginning of the RF turn on phase that improves the RF generation. Figure 3 shows the RF signal for both configurations. As shown in the figure, an unwanted mode, generated at the early phase of the RF turn on phase, is successfully suppressed.

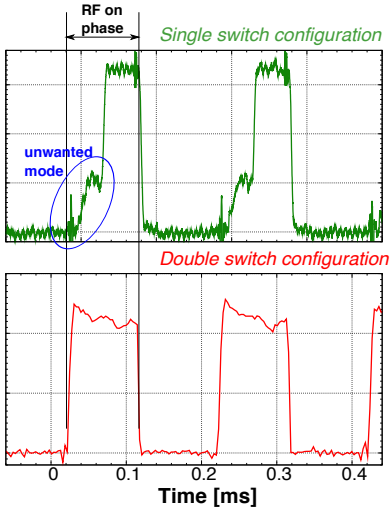

Fig. 3 Comparison of RF waveform of the 5kHz modulation between the single switch and the double switch configuration.