§18. Achievement of High Power and Long Pulse Operation with Low Impedance Mode

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In previous section we describe the successful operation of RF oscillator in 1.6MW with 5000sec. This operation can be achieved in low impedance mode for tetrode tube, 4CM2500KG. Final amplifier consists of double coaxial cavity, which are terminated by two movable short-ends as described in previous section. The cavity is 4m long so that it accommodates a wide frequency operation, 25-100MHz by adjusting two movable short-ends. Inner and outer movable stub-tuners are referred to T-stub tuner and M-stub-tuner, respectively. RF power output transmission line is connected in M-stub tuner. As the length of M-stub tuner becomes shorter, the length of T-stub tuner becomes longer in according to that to acquire high gain. Then swing RF voltage on the anode in the tetrode tube decreases and low impedance mode is realized.

We carried out the experiment to change the impedance of tetrode tube in 1MW of RF power with 1sec operation in 2sec interval. Figure 1 shows the dependence of cathode current, Ik on M-stub tuner position, which is arbitrary number, however, the larger number indicates the longer M-stub tuner. The power amplification factor ranges from 15 to 16 in this experimental range. When the position of M-stub tuner is at 685, Ik is 74A. Then the M-stub tuner length becomes shorter, the larger Ik is acquired, which shows a low impedance mode. Here RF conversion efficiency is 46%. The screen grid current, Isg becomes smaller in low impedance operation from 1.7A to 0.5A as shown in Fig.1. The ion current, Ic also decreases with Isg. The lower value of Ic is important for long pulse operation. When Ic exceeds 3μA, arc discharge in the tetrode tube prevents the long pulse operation. We selected the M-stub tuner position at 625 and the RF conversion efficiency is 62% in lower Isg and Ic.

In the selected positions of M- and T-stub tuner, we executed a high power and long pulse experiment as shown in Fig.2. We had increased RF power from 1MW to 1.6MW in several steps with 1sec operation in 2sec interval before starting 5000sec operation. The ion current, Ic keeps a constant value of 0.5μA. Here we describes several important parameters in Table 1. The temperature of inner transmission line increased to 125oC instead of forced air flow.

Table 1

Frequency:	50MHz
Plate voltage: 21.5kV,	Cathode current: 110A
Control grid voltage & current:	-550V / 3A
Screen grid voltage & current:	1450V / 0.8A
Ion current:	0.5mA
Input RF power:	95kW
RF conversion efficiency:	66%

Reference
1)R.Kumazawa et al., Proc. the 17th Symposium on Fusion Technology, 554(1992)

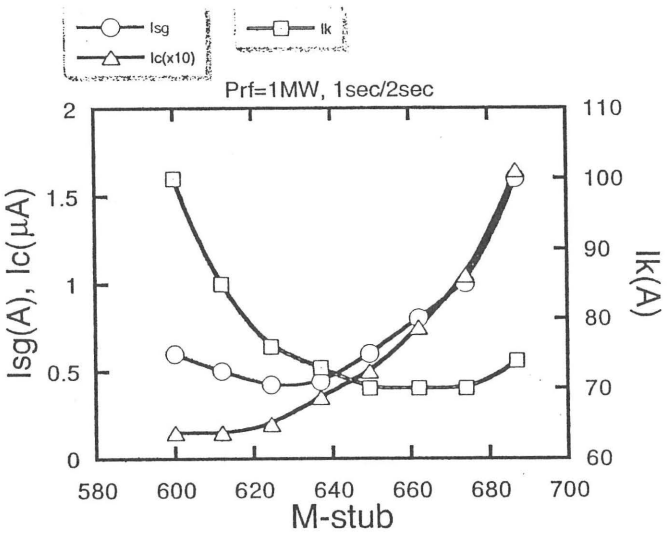

Fig.1 Dependencies of screen grid current, ion current and cathode current on M-stub position at 1MW with 1sec operation in 2sec.

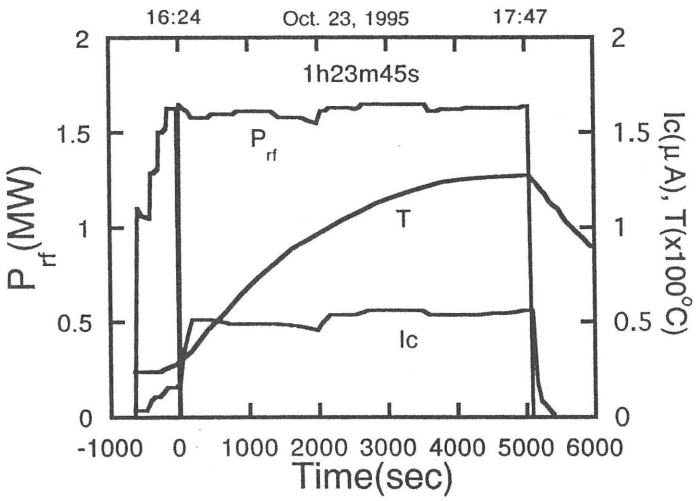

Fig.2 Time evolution of RF power, ion current and inner transmission temperature in high power, 1.6MW and long pulse, 5000sec operation.