

§16. High Power and Steady State Operation of ICRF Test Set in Toki

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The test set of ICRF heating system for the steady state operation of LHD was constructed and being used for the R&D experiment. The test set consists of almost all components which will be used in LHD heating experiment. We have been developed the reliable water cooling system of inner conductors through from transmission line to antenna current strap. ¹⁾

The operation test of R&D antenna and transmission line was carried out at 450A(0-p) and 30 minutes without any additional load. The RF current corresponds to 500kW if the plasma load is assumed to be 5 ohm. During the 30minutes operation, temperatures of antenna carbon protectors and feedthrough ceramics were raised up to several hundred °C and finally feedthrough ceramics had the air leak due to the thermal stress. To extend the operational range to MW level, it is necessary to develop the tough feedthrough ceramics and the better cooling method for side protectors.

High power and pulsed operation test was carried out to check the stand-off voltage and the maximum allowable RF power of antenna system. Figure 1 shows the RF voltage on the transmission line and the output RF power of the transmitter. Data shows that the load of the circuit loss and the launched power loss in the test chamber is about 0.3 ohm. The maximum tested voltage was 55kV and this stand-off voltage value suggests that the RF current of antenna can launch 3MW at the 5 ohm plasma load.

High power CW transmitter has been tested separately. The large water cooled dummy load was used in this experiment. The dummy load is composed of ninety water cooled ceramic resistors. Each resistor has 500 ohm resistance and the system has 30 parallel and 3 series structure of resistors. The fine impedance tuning was done by adjusting the connecting structure between the coaxial line and the resistors. The tested operation range at 50MHz is shown in Fig. 2. 1MW and 30minutes operation was achieved. The operation

of long pulse regime is mainly limited by the temperature increase of the coaxial line which is cooled by the insufficient air flow.

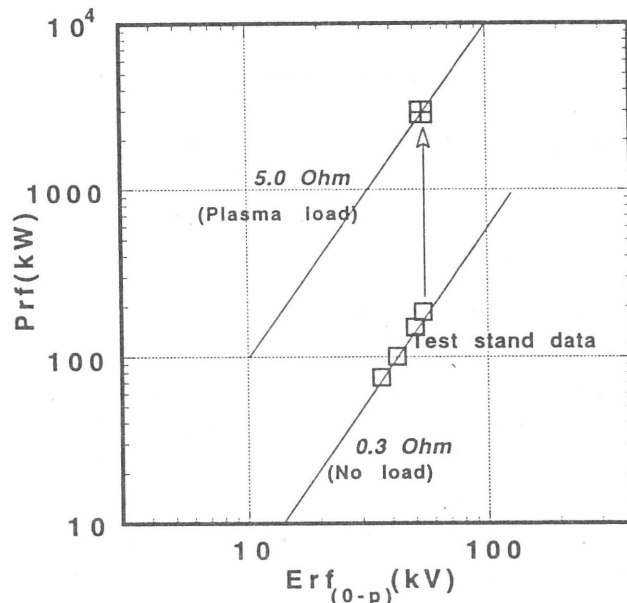


Fig. 1 High power operation test of LHD ICRF test set. $E_{rf}(0-p)$ is maximum RF voltage along the unmatched transmission line. P_{rf} is output power of transmitter. Large square mark is extrapolated power assuming 5 ohm plasma load.

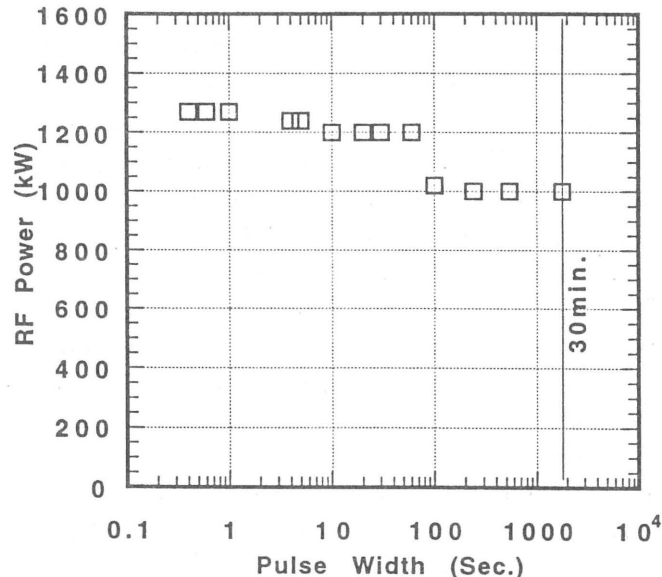


Fig. 2 High power and long pulse operation test of No.2 transmitter. 50 ohm dummy load was used. Frequency is 50MHz.

Reference

- 1) Mutoh, T., Kumazawa, R., Seki, T., Simpo, F., Masuda, S., Watari, T., Fusion Engineering and Design 26 (1995) 387