A.5: Performance studies of 1 MW CW klystron under pulsed operating condition using a long pulse converter modulator

The performance of the 1 MW, 352.2 MHz, CW klystron (TH 2809, Thales Electron Devices make) in pulsed mode operation has been studied using indigenously developed pulsed RF test stand. The system consists of -100 kV, 20 A pulsed modulator [RRCAT Newsletter Vol. 31, Issue 1, 2018, p. 8], solid state input amplifier, WR 2300 waveguide transmission system, RF measurement system and water loads to dissipate the microwave power.

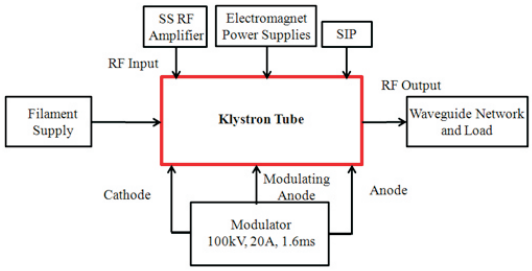

Fig. A.5.1: A simplified block diagram of RF test stand.

The simplified block diagram of the test stand is shown in Figure A.5.1 The modulator is an all solid state, IGBT based system in which high voltage pulse generation has been achieved by the use of nano-crystalline cored high voltage high frequency transformers and high frequency switched converters. A 200 W solid state amplifier (SSA) has been used to energize the input cavity of the klystron. The output RF power from the klystron is coupled from its output ceramic window and fed to water (LCW) load through WR2300 waveguide network. A three port circulator (Advanced Ferrite Technology make) with 40 dB isolation suitable for 352 MHz and high power operation has been used for isolation between source and load. Directional coupler has been used at the klystron output to measure both forward and reflected power. The cathode heater filament of klystron is powered by a 30 V, 35 A DC power supply that is 120 kV isolated as the cathode is floating at high voltage pulse. The coils of focusing electromagnets of the klystron have been powered by 250 V, 20 A DC power supplies. The modulating anode supply has been derived from cathode voltage by using a resistive divider. For maximum output power the modulating anode voltage is kept at 71% of the cathode voltage. The collector body and RF output window are cooled by circulating LCW. The LCW flow circuit, vacuum status of klystron, cathode heater, and focusing coil power supplies are interlocked with the main modulator to avoid any failure of former systems. The operational parameters of the RF test stand are given in Table A.5.1. Figure A.5.2 and Figure A.5.3 show the temporal shape of the cathode voltage, beam current and RF power at maximum cathode voltage of 96 kV, respectively. The variation in the RF power is within ± 0.75%. A phase variation of RF output was observed and it was within ±2.5 degrees (pk-pk) as shown in Figure A.5.4.

Table A.5.1: Operational parameters of RF test stand.

RF output power (peak)	1 MW
Pulse width (max)	1.5 ms
RF frequency (nom)	352.2 MHz
Droop	±0.75 %
Phase stability (in pulse)	±2.5º
Phase stability (pulse to pulse)	±2.5º
Modulator output power	2 MW
PRR capability	1-30 Hz

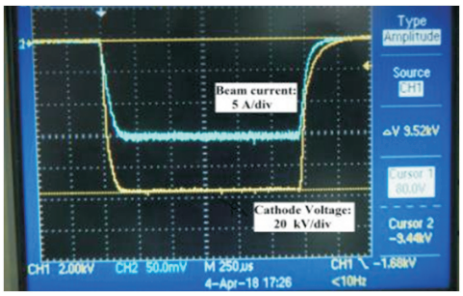

Fig. A.5.2: Waveform of cathode voltage and beam current at 96 kV.

Fig. A.5.3: Temporal profile of the RF output of klystron.

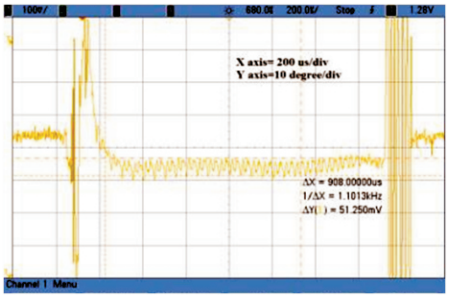

Fig. A.5.4: RF output phase variation within the pulse.

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