A.8: Development of 1 MW, 352.2 MHz cw and pulsed RF test stand

1 MW, 352.2 MHz cw and pulsed RF test stand has been developed and tested at RRCAT, Indore for performance evaluation and characterization of RF components and accelerating structures. Major subsystems of this high power test stand include Thales make TH 2089, 1 MW, 352.2 MHz klystron amplifier along with its various power supplies, control system, driver amplifier, waveguide transmission line, 1 MW circulator, dummy load and LCW cooling system. The photograph of 1 MW RF test stand is shown in Fig.A.8.1.

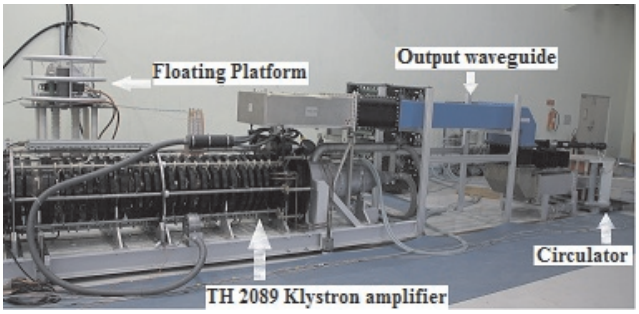

Fig. A.8.1: Photograph of 1 MW RF test stand

Various power supplies namely one no. of high voltage beam bias power supply (-100 kV, 25 A, DC), one no. of mod anode power supply (85 kV, 20 mA, DC), one no. of filament power supply (20 V, 25 A, DC), two nos. of electromagnet power supplies (300 V, 12 A, DC) and two nos. of ion pump power supplies (5 kV, 10 mA, DC) are utilized for operation of this klystron amplifier. Pulse step modulation based solid state modular -100 kV, 25 A crowbar less DC power supply with 24 pulse input capability has been employed as the beam bias power supply of this klystron amplifier. It has 176 switch power modules which are suitably staggered and connected in series to provide -100 kV DC output with very high effective output ripple frequency. This reduces output filter capacitance requirement substantially and thereby avoiding expensive crowbar. Wire burn test was conducted on this power supply to ensure that its stored energy during klystron arcing condition is less than 10 Joule. Mod anode and filament power supplies are floating at cathode potential of -100 kV, DC and hence suitable high voltage floating platform was developed to house these power supplies. The control and interlock signals are transmitted to these floating power supplies through optical fibres.

NI cRIO 9081 controller based real time control system has been developed to operate various power supplies of this klystron amplifier in a particular sequence. It also controls and monitors crucial RF, water flow and temperature parameters of this test stand.The control system first checks the availability of cooling water and air before putting ion pump power supplies ON to establish proper vacuum inside klystron tube. Then filament power supply is turned ON with 15 minutes slow start time in order to limit filament surge current. Subsequently solenoid power supplies are put ON to ensure proper focussing of electron beam inside the tube. Later mod anode power supply is turned ON and set at 0.1 kV before putting HV cathode bias power supply ON and set at 20 kV. Now output of mod anode and beam bias power supplies are ramped simultaneously up to their final operating points. Reverse sequence is followed during turn OFF. Care has been taken to ensure that the potential difference between the body and the mod-anode is never less than 5 kV to avoid excessive interception of electron beam by drift tube. Various protections and interlocks have been incorporated in this test stand to protect the klystron amplifier and other subsystems in case of any fault. Suitable flow meters and temperature sensors are installed in water pipe lines and integrated with control system for remote supervision and interlocking of water flow parameters. In case of arcing in klystron amplifier, -100 kV, 25 A, DC beam bias power supply is switched OFF within 5 µS to prevent any damage to klystron amplifier. The control system also monitors klystron forward and reflected power and trips the entire system if these powers exceed their safe limits.

The klystron amplifier was initially tested in diode mode (without RF drive power) up to 16.6 A by increasing the mod-anode voltage, keeping beam voltage constant at 87 kV, DC. It was tested up to 65.2 kW CW power and 254 kW pulse power on water cooled dummy load and their spectrums are presented in Fig. A.8.2 and Fig. A.8.3 respectively.

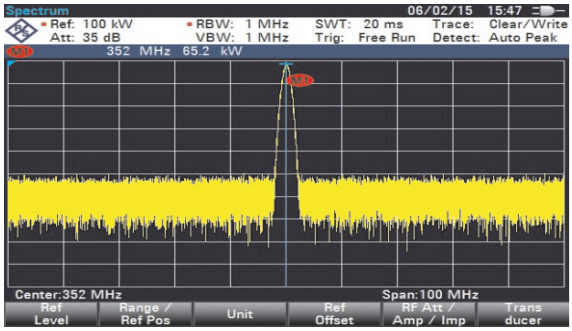

Fig. A.8.2: RF output spectrum at 65.2 kW cw output

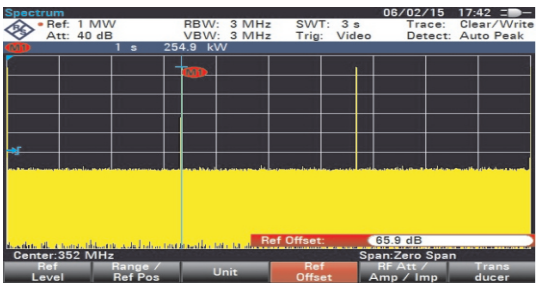

Fig.A.8.3: RF output spectrum at 254 kW pulse output

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