A.8: Indigenous development of triode electron gun with test stand for 10 MeVLinac

The 10 MeV LINAC for irradiation of agricultural products needs a 50 kV electron gun as electron source. Subsequent to the failure of imported electron gun, efforts were launched to design and develop new electron gun with indigenous efforts at PHPMS, RRCAT. Several designs with various geometries were tried and few prototypes were fabricated. Learning from the technical problems faced at high PRR operation; finally an electron gun was successfully developed and tested which was able to produce over 300mA of current from LINAC. With the operational experience gathered and also after detailed performance evaluation, the complete envelope of the electron gun was redesigned to improve the vacuum near cathode as well as to have its correct measurement. Also thermal considerations were given due attention to avoid overheating of ceramic to metal joint of the insulation. Design analysis of the electron gun was done using CST particle studio (Fig. A.8.1). Particle trajectory shows smooth transmission of particles through anode. The phase-space in Z direction indicated the beam size of 2 mm X 2 mm outside the anode. The analysis resulted in the peak emission current of 1.5 A. The new design includes pumping ports for two SIPs of 70 lit/s capacity to maintain the vacuum better than $5X10^{-8}$ torr.

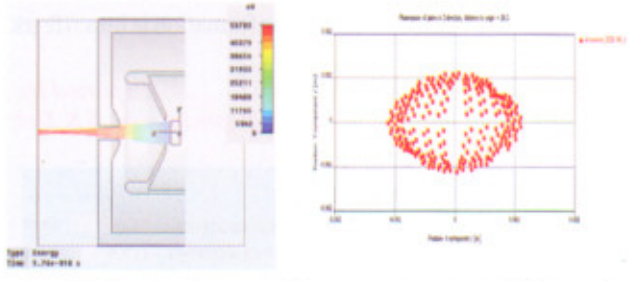


Fig. A.8.1: Simulation of electron gun using CST Particle Studio.

In order to qualify the electron guns, its beam quality and also to establish their reproducible performance a high voltage electron gun test stand was also created at PHPMS (Fig. A.8.2).

Table A.8.1 Specifications of the solid state gun modulator

Parameter	Unit	Value
Pulse voltage output	kV	0 to -55
Pulse duration (adjustable)	µs	5-15
Rise time	µs	<2
Fall time	µs	<3
Pulse repetition rate	Hz	1-300

A hard switched all solid state pulse modulator was also developed indigenously for the test stand with in-house development of its components like 6 kV, 30 A solid state switch, pulse transformer etc. An energy storage capacitor is discharged by high voltage stacked switch through a pulse transformer of step up ratio 1:10 delivering upto 55 kV pulse of 15 µs duration at the output connected to the gun. The pulse voltage and current are measured by means of capacitive divider and pulse current transformer. The test stand has a beam collimator, vacuum pumping system, a beam profile monitor and a UHV compatible faraday cup for beam current measurement.

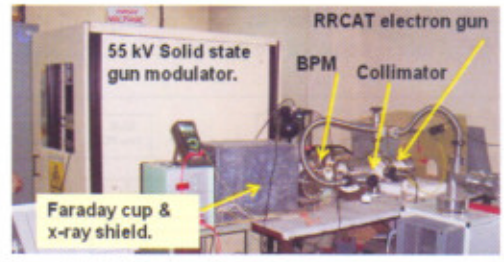
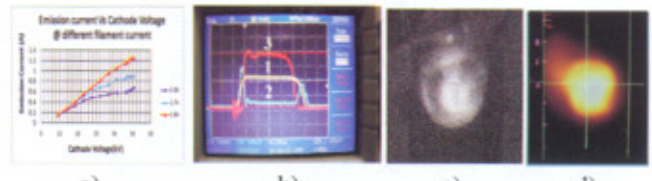


Fig. A.8.2: High voltage electron gun test stand.

Fig. A.8.3: Electron gun developed by PHPMS (shown on left) integrated with 10MeV LINAC at RRCAT.

After detailed performance evaluation, the electron gun was integrated with the 10 MeV LINAC (Fig. A.8.3). A Peak emission current of 1.2 A was achieved at 50 kV cathode voltage. After necessary adjustments on the collimator, steering and focussing magnets the beam was accelerated through the LINAC structure. Peak beam current of 390 mA was achieved at 7.5 MeV. The accelerator was tested at average beam power of 4.5 kW (Fig. A.8.4).



a) b) c) d)

Fig. A.8.4: a) Emission characteristic b) trace 1 microwave power @ 6 MW, trace2 reflected power <100 kW, trace 3 beam current of ~390 mA. c) beam spot on BPM after electron gun d) beam spot after acceleration in 10 MeV LINAC.

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