83 MHZ ELECTRON GUN SYSTEM

E. Minehara, JAERI, Ibaraki, Japan
K. Whitham, Titan Beta, Dublin, CA 94568

Abstract

A 100+ keV electron gun has been built that delivers up to 500 ma of peak beam current in 1 and 4 ns pulse widths at up to 83 MHz rep rate. This electron gun was designed and built for application at the JAERI Superconducting FEL. The design and performance are described.

1 INTRODUCTION

The electron gun developed for this system was based on one that Titan Beta had used in several accelerators Refs. 1, 2 and 3. For beam optimization and component maintenance, the gun was designed with removable cathode and anode electrodes, and the cathode was designed to be easily replaceable, as it is mounted on a conflat flange accessible from the back of the gun.

The E-gun (ref. Hermannsfeldt) computer simulation was used to optimize the anode-cathode geometry. A one-half square cm cathode was used. The thermal emittance from this cathode was less than 2 pi mm-mrad (normalized) edge emittance.

The gun body and ceramic were designed for 200 kV operation. We baked out the assembly and keep it under hard vacuum. We high voltage conditioned the gun to near 170 kV and operated it below 120 kV.

Figure 1 shows an outline drawing of the gun assembly.

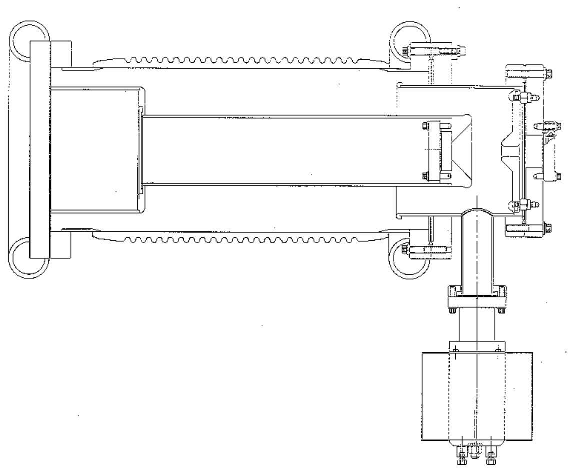

Figure 1. Gun Assembly

The one half square cm cathode is capable of producing over 1 amp of current. There is 8-12% interception of the cathode current by the grid. The current capability of the gun exceeds the .5 ampere requirement. The dispenser-type cathode is expected to have a lifetime of over a year in good vacuum (1x10-8 torr).

Figure 2 shows a picture of the system assembly.

Figure 2. System Assembly.

2 ELECTRON GUN ELECTRONICS

The electron gun electronics were developed at Titan Beta.

The E-gun/injector floating deck was controlled by fiber-optically coupled control and trigger links. A pair of multi-channel fiber-optical data links transmit various analog and digital signals between the H.V. floating deck and the ground based control system. Four analog channels and six digital commands are used. Figure 3 shows the Block Diagram of the JAERI RF System.

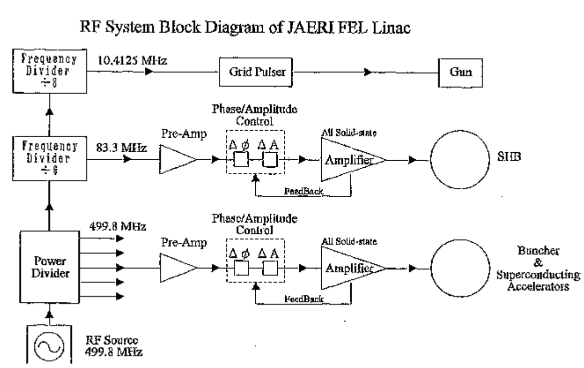

Figure 3. JAERI RF System

Another pair of fiber-optical links provide control and trigger to the E-gun trigger generator. The E-gun electronics also include a power supply to provide filament power, E-gun and pulser DC bias supplies.

Figure 4 is a picture of the floating deck assembly.

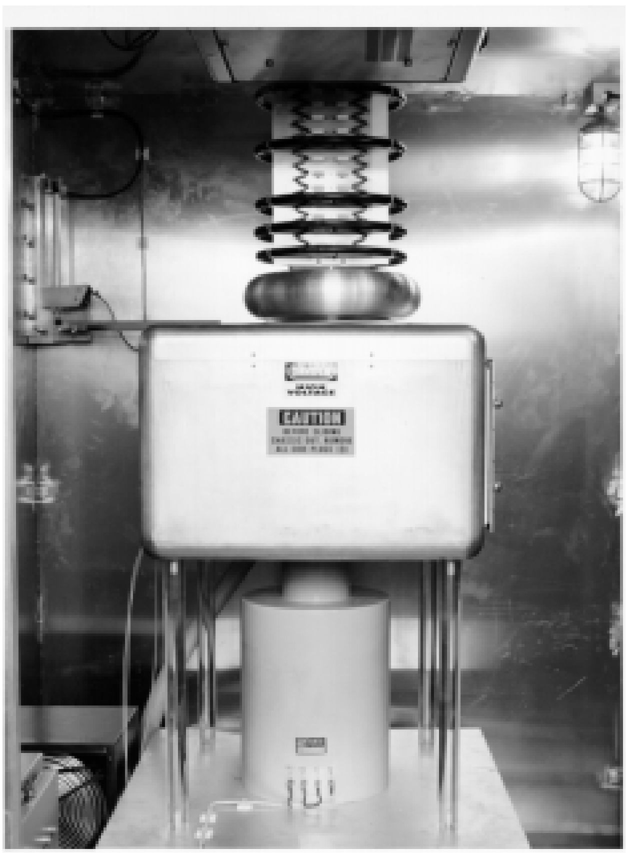

Figure 4. Floating Deck Assembly.

The one half square cm cathode assembly takes approximately 70V of positive grid drive above the cutoff bias. The 1 ns and 4 ns pulses required are generated at first at low level (few volts) and amplified by an rf amplifier chain to produce the required grid drive. This rf chain output stage is a pair of 100 watt, 1 GHz bandwidth RF amplifiers. Their output is combined and the 200 watts into the 50 ohm termination at the gun provides 100 V. The cutoff bias of the gun is approximately 30 V. The combination of the two amplifiers allowed adequate grid drive to be developed.

The termination at the electron gun has to be a good match for the RF as well as provide connections for filament and bias all in a small area. This was accomplished with nested set of printed circuit boards which retained the RF match and performed the other functions.

3 TEST RESULTS

Individual gun current pulses for 1 and 4 ns pulse widths are given in Figures 5 and 6. The 1 ns pulse width is actually about 600 ps FWHM.

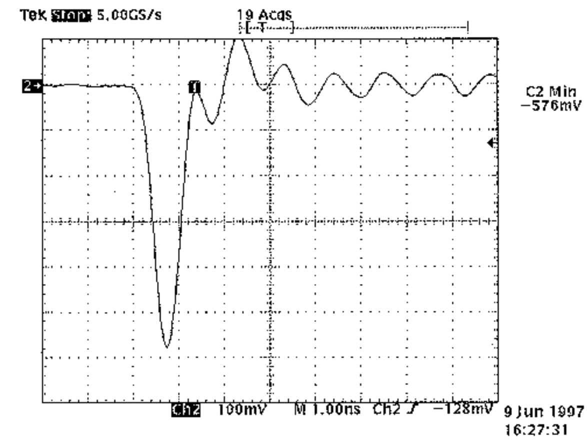

Figure 5. Gun current pulses, 1ns pulse width.

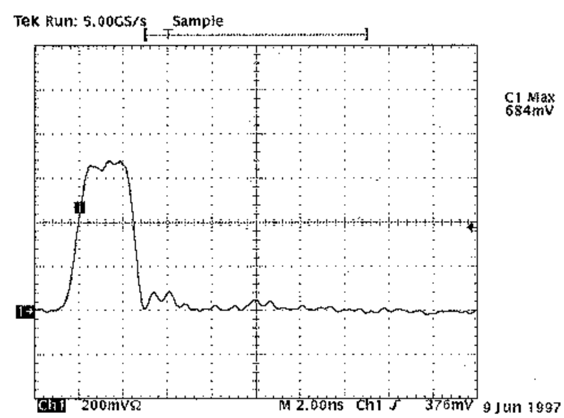

Figure 6. Gun Current Pulses, 4ns pulse width.

Pulse trains of 1 ns pulses at 20 and 83 MHz are shown in Figures 7 and 8.

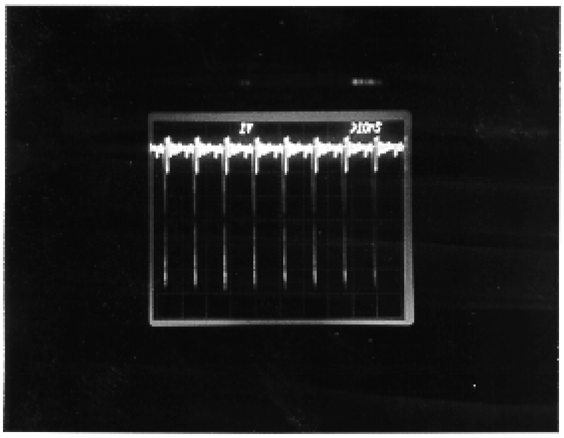

Figure 7. 83 MHz 1 ns Pulse Train.

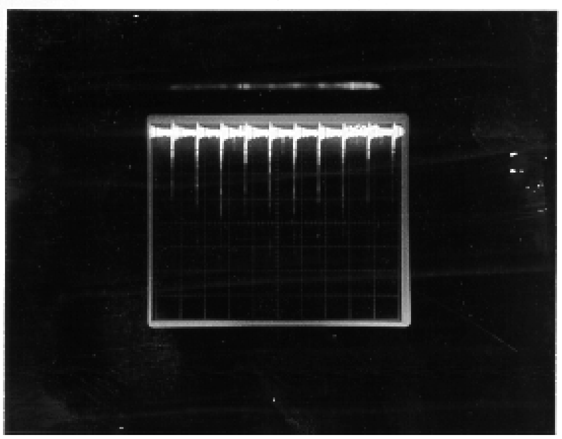

Figure 8. 20 MHz 1 ns Pulse Train.

Note: There is a large bias adjustment needed between 83 MHz and 20 MHz, otherwise 20 MHz has many spurious components.

We were able to achieve pulse repetition rates of over 200 MHz during test.

4 CONCLUSION

The use of an RF amplifier chain to provide a train of fast pulses from an electron gun or sub-nanosecond individual pulses has been demonstrated. Care has to be taken in the match at the grid cathode and with choice of grid-cathode assembly. The application of this concept may allow the elimination of subharmonic bunchers and replacement with RF modulated electron guns.

5 REFERENCES

1. Anamkath, H., Lyons, S., Miller, R., Nett, D., Treas, P., Whitham, K., Zante, A., Design and Factory Test of the e+/e- Frascatti Linear Accelerator for DAΦNE. EPAC 94

2. Whitham, K., Anamkath, H., Lyons, S., Manca, J., Miller, R., Treas, P., Zante, A., 200 MeV Linac for Brookhaven National Laboratory.

3. Whitham, K., Lyons, S., Miller, R., Nett, D. Treas, P., Zante, A., Linear Accelerator for Radiation Chemistry Research at Notre Dame. PAC 1995.