# Performance of Electron Gun for SPring-8 Linac

Takao ASAKA, Toshihiko HORI and Linac Group

SPring-8 site, Kanaji, Kamigori, Akoh, Hyogo, 678-12 Japan.

## 1. Introduction

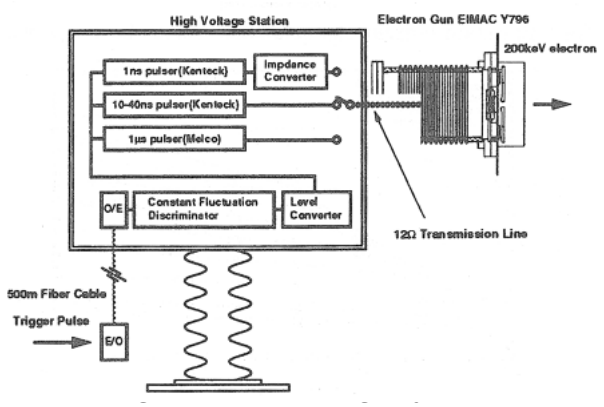
A thermionic gun of the injector linac for SPring-8 which is required to generate different beam pulse width, 1nsec, 10-40nsec and 1μsec. Three types of grid pulsers were prepared to generate different beam pulse width. The gun uses cathode-grid assembly (EIMAC Y796) and operates up to 200kV anode voltage.

The beam commissioning of injector linac has been started from August 1996 after sufficient rf processing, and the commissioning of the booster synchrotron ring has been started in December. In especially, a peak electron beam current of 50mA with beam pulse width of 10nsec at gun exit is required from the first beam condition for the commissioning of booster synchrotron. Its peak current is very low, however, a only grid potential of the Y796 is not able to be used for current control owing to strain of the waveform of emission current that is observed by the wall current monitor [1]. In order to generate the low beam current with rectangular waveform, the gun was operated by controlling both heater power and grid voltage. The optimum parameters of gun system is obtained from the measurement results of emission current dependence on anode voltage, heater power and grid voltage under consideration for shaping waveform of emission current. In this paper, the pulser system and characteristics of the emission current in region from 30mA to 19A are described.

## 2. Gun design and grid pulser system

The thermionic gun is used the EIMAC Y796 cathode grid assembly, which has a circular cathode area of 2cm$^2$ equivalent to 8mm in radius. The gun is pulsed at 60Hz with a rectangular waveform variable from 1nsec to 1μsec. E-GUN was used to design the thermionic gun focus, anode electrode shape and the gap between cathode and anode, and to simulate the beam parameters in the gun region. The optimum of gun geometry was determined by obtained minimum emittance at the gun exit (150mm from cathode plane). The anode cathode gap distance is 30mm and the designed perveance is 0.20mperv. A space charge limited flow at 200kV is 18.2A. The anode voltage of 200kV has been chosen as high as possible in order to produce low emittance beam. The normalized emittance at gun exit is 15.3pmm.mrad and the beam radius is 8.1mm.

A schematic drawing of the gun system is shown in fig.1. Three types of grid pulsers are prepared to generate different beam pulse width. A long pulse of more than 1μsec is generated by a constant voltage pulse generator (Melco), and a short pulse of 10-40nsec is generated by nanosecond pulser (Kentech Instruments Ltd.), and a single pulse of 1nsec is generated by a high voltage modular pulse source (Kentech Instruments Ltd.). These pulsers are carried by a high voltage station, and are connected by two type transmission lines which made of 1068mm long axial rigid tubes with 12W impedance. One is used for generating short pulse and long pulse and other is used for generating single bunch, it is composed with impedance converter and short termination of stab [2]. Since the timing jitter of trigger signal less than 30psec(FWHM) is required to inject the 2nsec rf bucket of the 508.58MHz booster synchrotron and the 508.58MHz storage ring in single bunch beam operation, the gun trigger system and transfer line is used the passive circuit, the first rf amplifier, the optical fiber cable and the EO/OE transmitter and receiver which have low jitter and temperature dependence.




## 3. Emission current measurement

The measurements of emission current from gun was observed by the wall current monitor sensitivity (1.4V/A) which was calibrated by means of a tapered coaxial test stand. The monitor is placed at the beam pipe prolongs for about 45cm after the cathode. The helmholtz coil is positioned right next to the gun. An adjustment of the beam size was performed by using the helmholtz coil and the fluorescent screen monitor.

The waveform of the emission current at 10nsec

pulse width is shown in fig. 2. The gun parameters are follows: iris f1.2mm, heater power 35W, anode voltage 180kV and grid net drive voltage 90V. And the pressure level of the gun is kept in the range of $10^{-8}$Torr. For the results of the first gun test without using the iris, the behavior of emission current as a function of the grid bias voltage for different values of the heater power, the anode voltage and the bias voltage are shown in fig.3, 4, 5. The measured average perveance from fig.4 is 0.35mperv which is higher than design value.

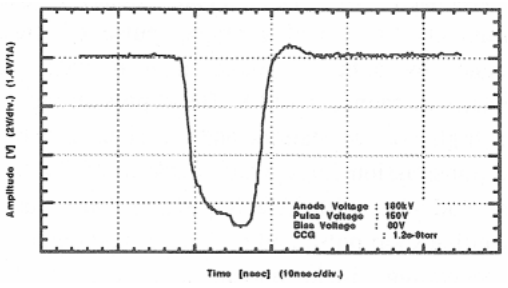



fig.2 The emission current at 10nsec pulse width

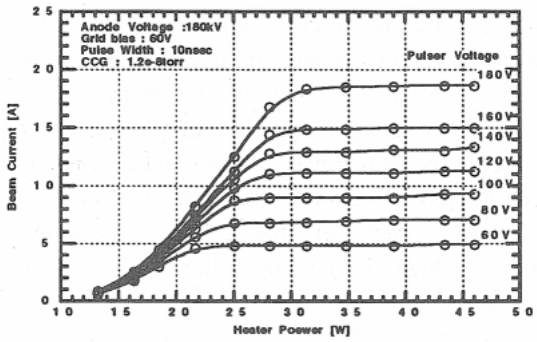



fig.3 Emission current characteristics versus heater power

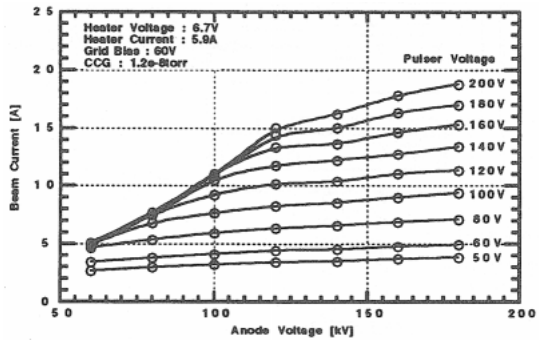



fig.4Emission current characteristics versus anode voltage

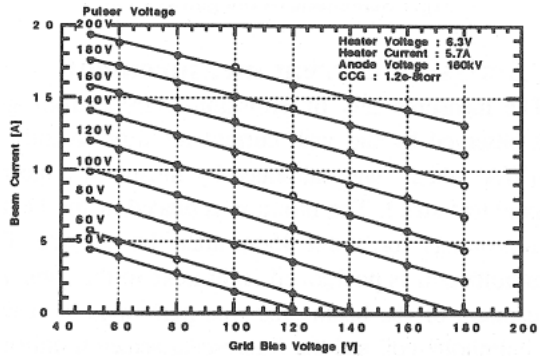



fig.5 Emission current characteristics versus grid voltage

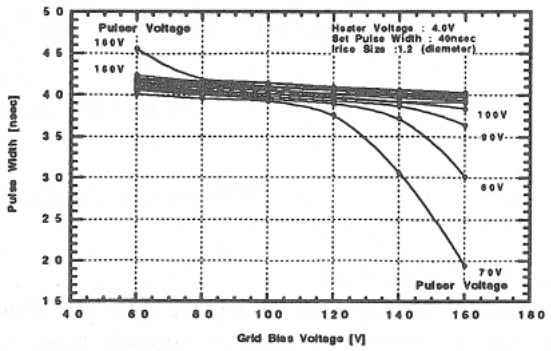



fig.6 Pulse width characteristics versus grid voltage

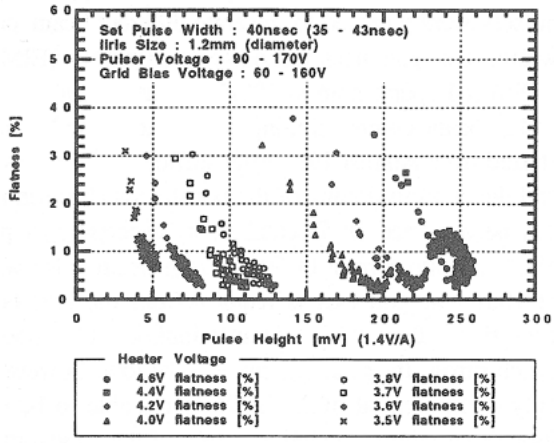



fig.7 Dependence on the pulse flatness

In order to realize rectangular waveform at the low current beam generation, it is effective to control both of the using an iris and the heater power, simultaneously. Figure 6 shows the example of pulse width which depend on the grid bias voltage with the heater power of 15W. Figure 7 shows the flatness of waveform as a function of the heater power for different values of the emission current on condition that the pulse width measures from 35 to 43nsec (FWHM). In case of the commissioning of the booster synchrotron ring, the optimum value is determined 3.5-3.6V in heater voltage from the results of fig.7.

## 4. Conclusion

We have generated the emission current in region from 30mA to 19A with the fast rise and fast fall time using three types of grid pulsers. In order to realize rectangular waveform at the low current beam generation, it is performed by control both of an iris and the heater power, simultaneously.

## 5. Reference

[1] K. Yanagida, Wall Current Monitor for SPring-8 Linac, JAERI-M 94-078.

[2] H. Yoshikawa, et al., "High Current 1ns Pulse Electron Gun", Proc. of the17th International Linac Conference(Tsukuba), Aug. 1994