A 100 MeV INJECTOR FOR THE ELECTRON STORAGE RING AT KYOTO UNIVERSITY

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An electron linear accelerator has been constructed at Kyoto University, which is an injector for the 300 MeV storage ring . The output beam energy from the injector is 100 MeV and the designed beam current is 100 mA at the pulse width of 1 μsec. The component test is under going. The electron beam of 300 mA is extracted from the electron gun and the peak RF power of 20 MW is successfully fed to the accelerating structures at the pulse width of 2 μsec.

I. INTRODUCTION

An electron storage ring has been developed at the Institute for Chemical Research, Kyoto University. The storage ring (Kaken Storage Ring, KSR) has a race track shape and the maximum energy is 300 MeV. It will be used as the synchrotron radiation source from the dipole magnet and the insertion device [1]. It will be also used for the research of the free electron laser. The electron beam is injected to the KSR by a 100 MeV linear accelerator [2]. The layout of the electron linac and the KSR is shown in Fig. 1.

Table 1 shows the beam parameters and the main specification of the injector. The output beam parameters are determined by the injection requirements of the KSR. The maximum repetition is limited by the capability of the power supply and the radiation shield. The repetition is 0.5 Hz at the

Table 1 Output beam parameters and the main specification of the injector.

Output Electron Beam		
	Energy	100 MeV
	Beam Current	100 mA
	Pulse Width	1 μsec
	Maximum Repetition	20 Hz
Electron Gun (Pierce type)		
	Cathode Assembly	Y-796 (Eimac)
	Extraction Voltage	-100 kV DC
	Grid Voltage (typ.)	100 V
Accelerating Structure		
	Mode	2/3π, Constant Gradient
	Number of Cell	85
	Bore Radius	11.74 - 13.4 mm
	Length	3 m
	Operating Frequency	2857 MHz
	Shunt Impedance	53 MW/m
	Maximum Electric Field	15 MV/m at 20 MW input
Klystron (ITT-8568)		
	Cathode Voltage	250 kV, 250 A
	Output RF Power	21 MW
	Gain	53 dB

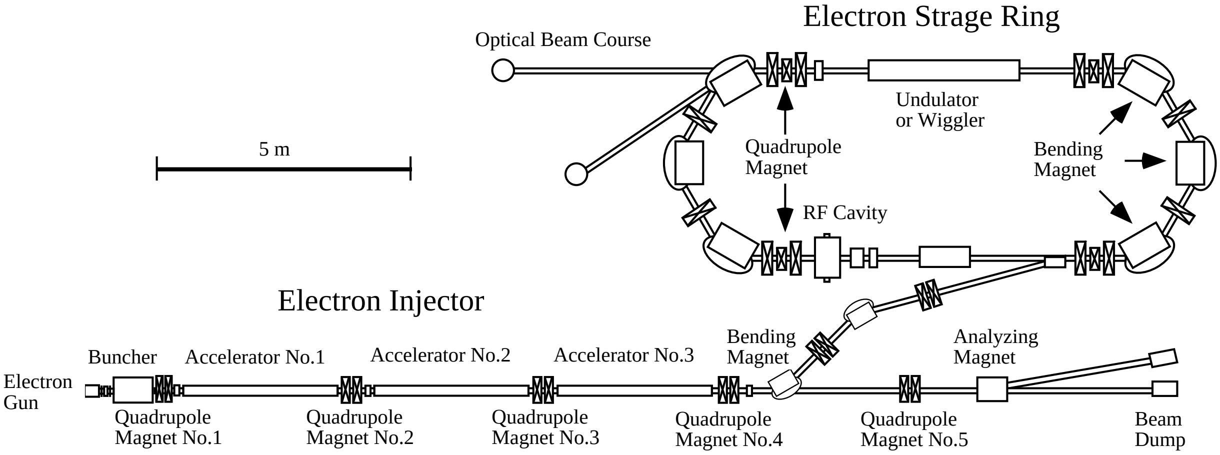

Figure 1. Layout of the electron linac and the KSR.

Photo 1 View of the front part of the accelerator. The electron gun, the buncher, and the first accelerating structure from the right to left.

KSR injection and the higher repetition is used for the beam tuning and for some physical and chemical experiments with the electron beam of the linac.

II. ACCELERATOR

The view of the front part of the accelerator (the electron gun, the buncher, and the first accelerating structure) is shown in photo 1.

2-1 Electron Gun

The electron gun has the Pierce electrode and the cathode assembly is the Y-796 (Eimac). The maximum extraction voltage is -100 kV DC. The pulse width of the grid pulser is variable from 10 nsec to 1 μsec. The beam current of 300 mA has been achieved at the pulse width of 1 μsec.

2-2 Pre-buncher and Buncher

The pre-buncher is a single reentrant cavity. It is designed to bunch the beam within the phase spread of 60 degree. The buncher is a disc-loaded and 3 step constant gradient structure. It has 21 cells and the total length is 777 mm. The designed phase spread is within 3 degree at the beam current of 100 mA when the input power is 12 MW.

2-3 Accelerating structure

The main characteristics of the accelerating structure are listed in Table 1. The maximum electric field is 45 MV per an accelerating structure without beam loading at the input power of 20 MW.

The doublet of the quadrupole magnets is used as a focusing element between the accelerating structures. The calculated beam radius is kept within 6 mm along the beam axis. It is assumed that the normalized emittance is 100 $\pi\cdot$mm$\cdot$mrad. The steering coils are placed at the entrance of the first and the third accelerating structures.

III. RF SYSTEM

3-1 Low Level System

The block diagram of the RF system is shown in Fig. 2. The master RF oscillator is a synthesized signal generator (HP-8664A). The booster klystron (TH-2436, Thomson) has a gain of 40 dB and the output power is 10 kW. The pulse width is 3.5 μsec. The output power is divided by the 4-way RF divider and supplied to the four main klystrons. RF attenuators and phase shifters are inserted between them.

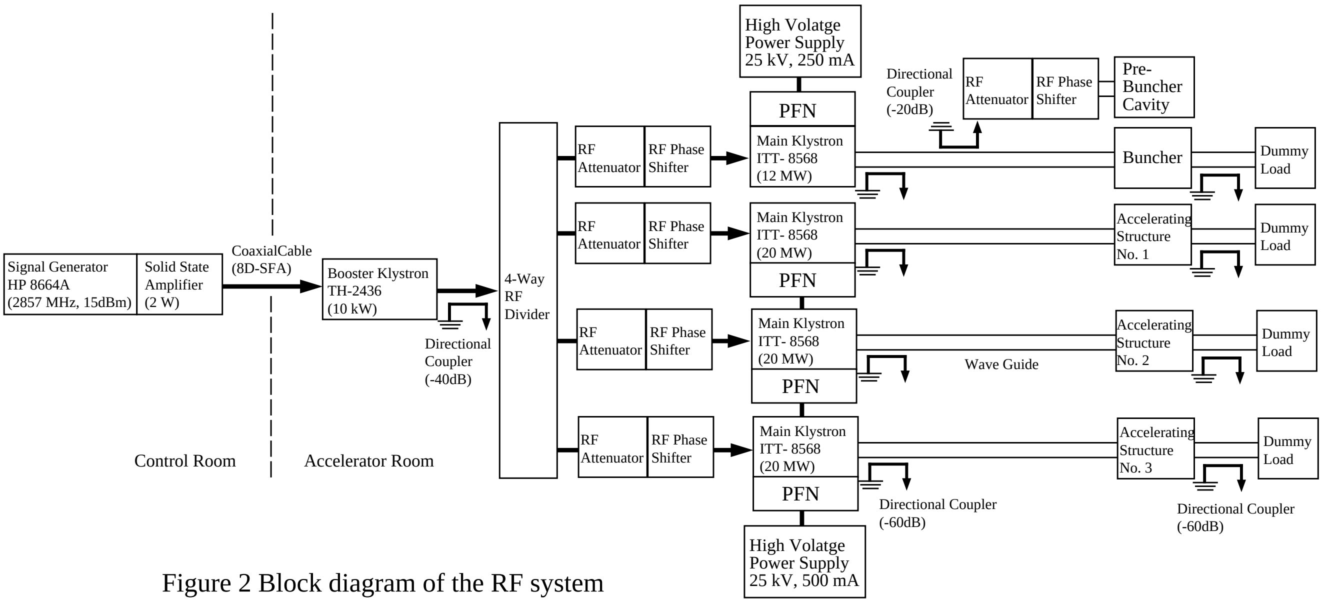

Figure 2 Block diagram of the RF system

3-2 Klystron and Modulator

The main klystron is ITT-8568. The maximum output power is 21 MW. Figure 3 shows the input RF power of the first and third accelerating structures. The peak RF power is 20 MW and the RF frequency is 2857 MHz. The repetition is 3.5 Hz. The RF pulses are picked up by the directional couplers and detected by the RF diodes.

The modulator is composed of the high voltage power supply, the pulse forming network (PFN) and the pulse transformer. The stabilized power supply for the modulator is adopted to keep the electron beam energy constant. The maximum voltage is 25 kV and the current is 500 mA. It can feed the power to the three PFNs for the accelerators at the repetition of 20 Hz. The voltage stability is less than 10^{-3}.

The pulse voltage generated by the PFN is 22.5 kV and the peak current is 3000 A. The pulse width is 2 μsec. The output voltage is stepped up 12 times by the pulse transformer and supplied to the klystron.

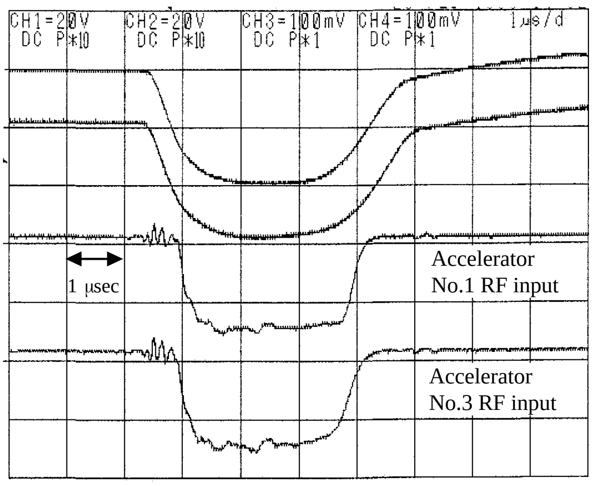

Figure 3 Input RF pulse to the first and thied accelerating structures. The peak power is 20 MW and the repetition is 3.5 Hz.

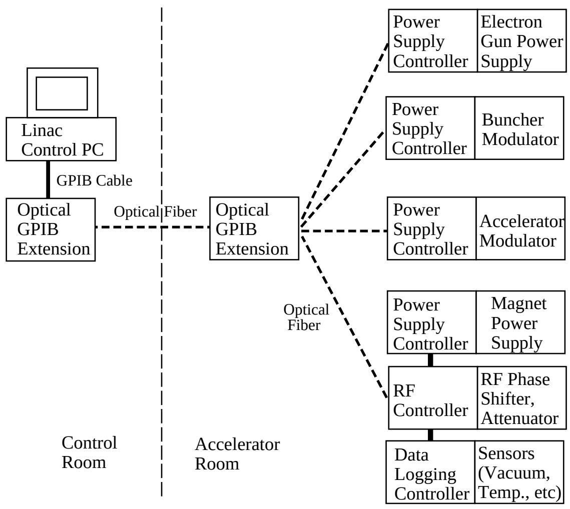

Figure 4 Block diagram of the control system.

IV. BEAM MONITOR

The current monitor is installed between the accelerating structures. The monitor is the ferrite core with the coil of 30 turns. The current sensitivity is 1 mV/mA.

The beam profile monitors will be installed at the close to the current monitors. The material of the beam screen is an alumina ceramic in which a little chromium oxide is homogeneously doped (Desmarquest, AF995R). The beam profile monitor is also used for the emittance measurements combined with the upstream quadrupole magnets

V. CONTROL SYSTEM

The block diagram of the device control system is shown in Fig. 4. The controller units have the GP-IB interface and connected by the optical fiber each other. The fiber cable isolates each devices and reduces the noise. The master controller is a personal computer IBM-PC/AT with ISA GP-IB card (AT-GPIB, National Instrument). The control software works on the Microsoft Windows system. A user can operate by the mouse or a touch panel.

VI. SUMMARY

The construction of the 100 MeV electron injector had been finished and the tests of the main components such as the klystrons and the electron gun were carried out. We succeeded to feed the 20 MW into the accelerating structure at the low repetition. The conditioning work is now in progress. The beam acceleration test of 100 MeV is scheduled in summer 1995.

VII. ACKNOWLEDGMENTS

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VIII. REFERENCES

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[2] K.Takekoshi, et al., "Design, Construction and Operation of JAERI-Linac", JAERI-Report 1238, 1975