

SINGLE BUNCHED BEAM TESTING FOR SPRING-8 LINAC

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Abstract

A new grid pulser for a short pulse was installed in the electron gun system. The emission pulse length can be changed from 250ps to 1ns with the peak current of 1.6A. The single bunch operation in the storage ring was successfully achieved with the purity of 10^{-6} order.

1 INTRODUCTION

The SPring-8 is a third generation synchrotron radiation X-ray facility with a 1GeV linac, 8GeV booster synchrotron and 8GeV storage ring. We succeeded in the acceleration to 1GeV by the linac in August 1996, and in acceleration to 8GeV by the booster synchrotron in December 1996. In March 1997, the storage ring was accumulated the 20mA beam current with long life time. In May 1998, the storage ring was stored the electron beam with maximum current of 100mA.

SPring-8 linac with maximum energy of 1GeV is consisted of 13 high power klystrons(E3712,80MW) and 26 acceleration tubes[1,2]. The preinjector of the linac is composed of 200kV thermionic gun[3], two single-cavity prebunchers, a standing wave buncher and a high-gradient acceleration tube. The emission current from the linac has been produced various kinds of the pulse length from 10ns to 1 μ s and an energy of 60MeV, which are requested by the operation modes of the storage ring. We have been planned the 1ns emission of the linac for the efficient injection to the storage ring. Since this autumn, 1GeV storage ring(so called New SUBARU) which is under construction in SPring8 site will be also injected the 1ns emission from the linac. However, the 1ns emission have not been supplied in the 8GeV storage ring. Recently, the single bunched beam operation of the storage ring was achieved by using the new grid pulser(three fixed outputs 250ps,500ps,1ns).

2 PERFORMANCE OF GRID PULSER FOR SINGLE BUNCH EMISSION

The grid pulser system is shown in Fig.1. This system has three grid pulsers; a single-mode grid pulser(less than 1ns), a short-mode grid pulser (10-40ns) and long-mode grid pulser(1 μ s). The single-mode pulser has three outputs with the fixed pulse length of 250ps, 500ps and 1ns through the front panel N-type connectors, and the rise time of each pulse is about 200ps. These grid pulser are installed on the gun high-voltage deck. In order to achieve rapid exchange of the grid pulsers, the grid pulser

system is connected with a coaxial rotary switch controlled remotely from the control room. The emission test was carried out with the 1ns pulse length of the single-mode grid pulser.

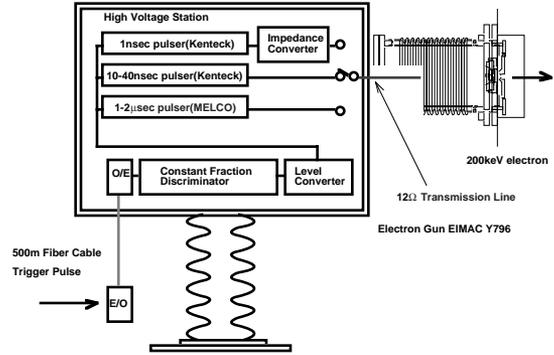


Figure 1: Schematic drawing of the grid pulser system.

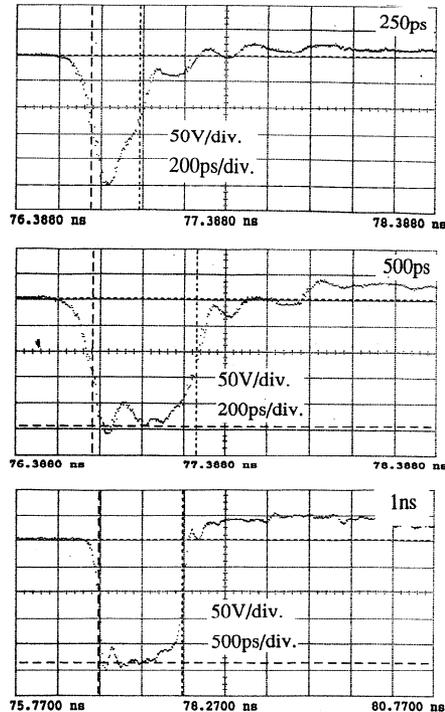


Figure 2: Waveform of three fixed outputs of single-mode grid pulser(250ps,500ps,1ns)

The external grid pulser trigger was transmitted through a single-mode optical fiber, which has low dependence on the room temperature, developed by Sumitomo electric industries. This fiber has a thermal coefficient for a delay of less than 0.4ppm. We use circuits made by ORTEL Co. as electrical-to-optical(E/O) and optical-to-electrical(O/E) converters, with a jitter of less than 2ps(rms) and a maximum frequency of 10GHz. The external trigger of grid pulser is synchronized both 508MHz(synchrotron, storage ring) and 60Hz(line frequency).

The waveform of the three fixed outputs of the single-mode grid pulser is shown in Fig.2. The peak-to-peak time jitter of three fixed output(250ps,500ps and 1ns) is 26ps, 28ps and 25ps, respectively. The relationship between pulser control voltage and pulser output voltage is shown in Fig.3. The output voltage of grid pulser is changed from 120V to 300V at the port of 1ns output.

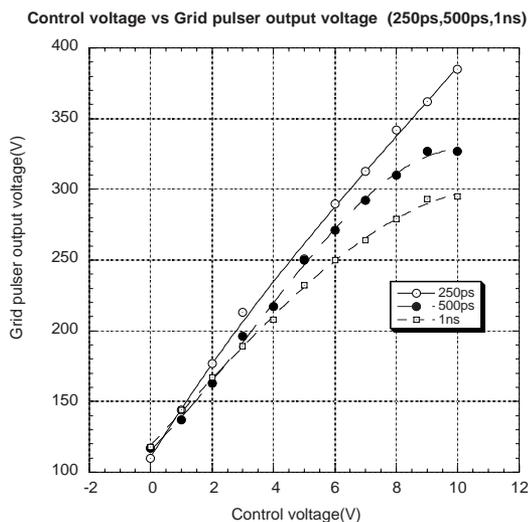


Figure 3: Control voltage vs grid pulser output voltage

3 EMISSION & ACCELERATION TESTING

The waveform of the emission current from Y796 electron gun is measured by the SCM(wall current monitor) as shown in Fig. 4[4,5]. The maximum emission current is 1.6A with pulse length of 1ns.

Fig.5 shows the relationship between emission current and the output voltage of the single-mode grid pulser. The 1ns emission current shows the good linearity. We measured the characteristics of the 1ns beam which was accelerated up to the maximum energy of 1GeV. The beam position and shape were adjusted by checking screen monitors and the beam current was measured by wall current monitors. After fine adjustment of the beam transport, the transmission efficiency of the bunching section of linac was about 60%, and the transmission efficiency of the whole linac from the bunching section to

an 1GeV beam dump was 95%. Using the chicane after the last acceleration tube, the energy spread and the beam energy was measured. The energy spread of beam was observed by the profile of screen monitor at the chicane center point(dispersion function 1m). The x-direction distribution of screen monitor at the chicane center point was 7mm. Consequently, energy spread of beam was within 0.7%.

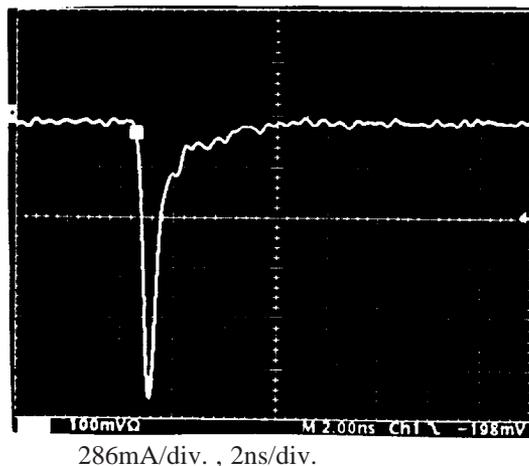


Figure 4: Waveform of 1ns emission

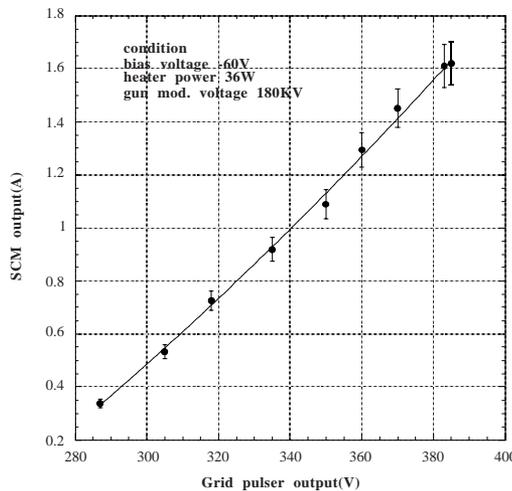


Figure 5: Relationship between grid pulser output and emission current

4 SINGLE BUNCH OPERATION OF STORAGE RING

We tried single bunched beam operation which accumulated the 1ns beam from the linac at the 21 buckets of the storage ring. Because Y796 cathode assembly was used for last 3 years, the grid was coated with Ba so that the grid emission has been increased. The current of the grid emission of 10^{-4} compared with the peak current of 1ns electron beam. By kicking the satellite

beam by the RF-KO of the synchrotron, the pure single bunched beam was obtained. The purity of the single bunched beam was observed by the technique of the optical measurement as shown in Fig.6. The purity of the single bunched beam was achieved to be the order of 10^{-6} .

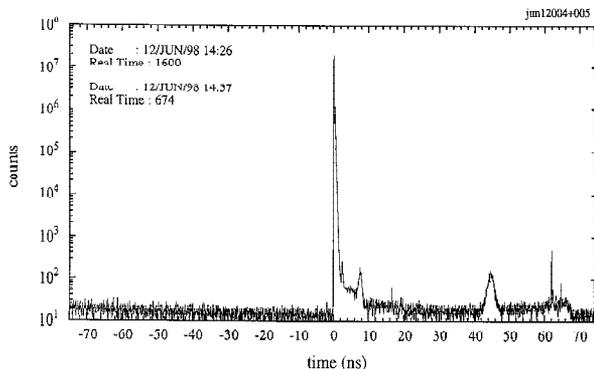


Figure 6: Measurement of single bunched beam of storage ring

5 CONCLUSIONS

We succeeded for accelerating the 1ns electron beam and accumulating the single bunched beam at the 8GeV storage ring. The grid emission was observed to be order of 10^{-4} compared with the electron beam. The purity of the single bunched beam of the storage ring was obtained to be order of 10^{-6} by means of eliminating the satellite beam by RF-KO of synchrotron.

6 ACKNOWLEDGEMENTS

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