PRESENT STATUS OF THE 38 MeV OSAKA UNIVERSITY ELECTRON LINAC

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1. Introduction

The Osaka University Single Bunch Electron Linear Accelerator has been operated for the experiments in the ultrafast transient reaction region and machine studies for the past 3 years. A new 5 MW RF source was installed to drive buncher sections for improve to operate the machine in higher performance. For the purpose of increasing single bunch charge, a bunch chopper has been designed and installed to the output end of a linac. As a result, single bunch charge has been increased from 14 nC to 30.4 nC.

2. Improvement of the RF System for the Buncher Section

In originally designed rf system for the Osaka University Linac, the output power of the klystron was fed to both the buncher section and the main accelerating waveguide by a variable power splitter. This system is a simple rf system to reduce the total cost of the machine. However, the rf power levers of the two outputs are affected mutually, when the power flow is to be controlled. It is very difficult to control the machine to obtain the most appropriate condition. Therefore, it was decided that the improvement of the rf system. A schematic diagram of the new rf system is shown in Fig. 1. The buncher section is driven by a new 5 MW rf source and the main accelerating waveguide is directly connected to a 20 MW rf source in use. The new rf source is composed of a 5 MW klystron(Toshiba E-3775A) and a conventional line type modulator. The flatness of the klystron high voltage pulse is less than 1% during 3.5 s and the high voltage pulse stabilization is less than 0.5% with the de-Qing action. The new system was fablicated by Toshiba Electric Corp., and all the installation has been finished in October, 1981.

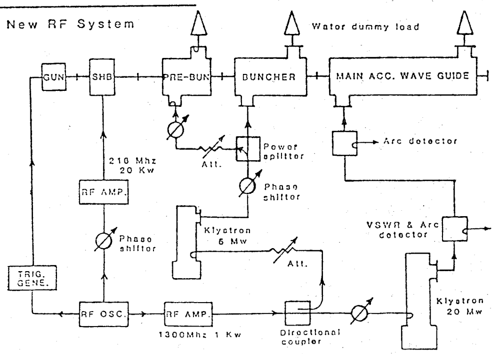

Fig. 1 A schematic diagram of the new rf system.

Figure 2 shows typical beam loading in transient mode operation before and after the improvement. Two rf systems have the advantage in increasing the beam energy up to 38 MeV. Moreover, the machine can easily be controlled and adjusted by the operator with two rf systems.

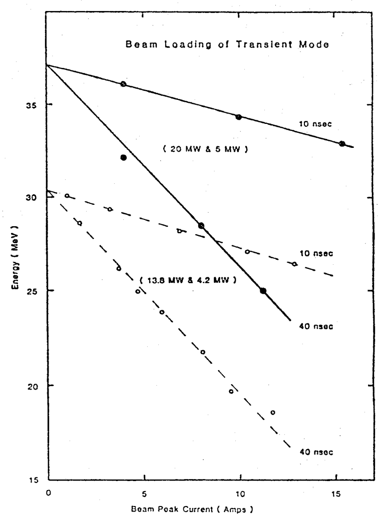

Fig. 2 Beam loading in transient mode operation before and after the improvement.

3. Attachment of the Bunch Chopper for the Increasing of the Single Bunch Charge

For the purpose of increasing single bunch charge, the bunch chopper has been attached to the output end of the main accelerating waveguide. The principle of the beam chopper with a travelling wave deflector should be based on the view that the electron bunch interacts with the electromagnetic waves. When the bunch chopper is excited by the subharmonic of the fundamental frequency(1300 MHz), all bunches are deflected except the bunch timed to coincide with a zero-crossing of the rf. If the chopper is driven by the 12th subharmonic frequency(108 MHz), 10 satellites of bunch can be deflected except the main bunch to accelerate as the high current single bunch.

Figure 3 shows the bunch chopper consists of a deflector, a rf amplifier, and beam collimator in a beam transport system. The deflector was made of a copper plate which is formed to U-shape, and its length was roughly corrected to $\lambda/4$ resonance point at 108 MHz. In operation, the deflector must be tuned completely to 12th subharmonic of the fundamental accelerating frequency. Therefore, a fine tuning device by the variable capacitor is provided near the open end of the deflector. The rf voltage monitors using a capacitor devider in order to measure the reflection voltage are provided both side of the deflector. The output power of the rf amplifier is fed to the deflector by a movable coupling loop with a vaccum-tight connector. The optimum VSWR is determined through adjustment of the coupler by measuring the transmission and reflection with a Wiltron model 640 rf analyzer. The best performance of the VSWR has been obtained to be about 1.25. The 8 to 20 KW pulsed rf power which is required to drive the deflector is generated through the high power vaccum tube amplifier(exiter: RCA7651, final: RCA7214) and the transistorized low level amplifier with a phase shifter which can be varied 360 degree. When the deflector is exited by the maximum rf power, a deflection voltage at the open end could be generated about 198 kV, and that a filling time due to rf resonance at the deflector has been measured 17 μs by the rf monitor signal. The roughly estimated Q value which is

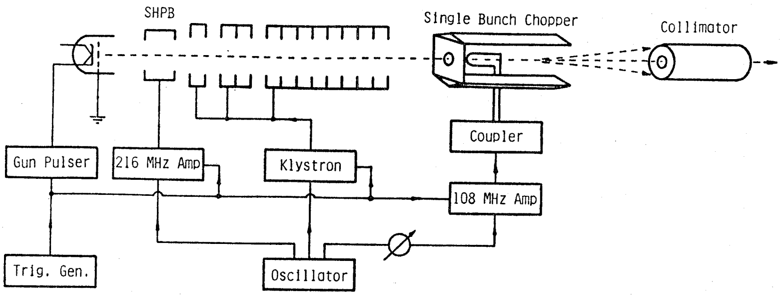

Fig. 3 A schematic diagram of the bunch chopper system.

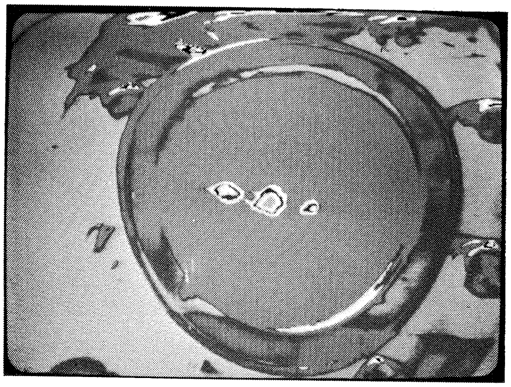

Fig.4 The separated beam by the bunch chopper. Main bunch (middle spot), satellites (both side).

calculated by a filling time and resonance frequency is obtained about 1800.

When the 30 MeV single bunch beam with several satellites pass through the bunch chopper which is driven by the 8 KW rf power, the deflected beams can be observed on the fluorescent plate attached to the front of the beam window. The three separate beams that the main bunch(middle spot) and the nearest satellites(both side spots) are illustrated in Fig. 4. The rf power is more increased up to 18 KW, the satellites could be separated completely from the main bunch. The phase jitter of the rf amplifier due to mechanical vibration of the resonance circuit including the vaccum tube occur by an air cooling system or to instability of the high voltage power supply was careful designed to reduce. It is because that main bunch is must be always coincide with a zero-crossing of the deflecting rf. In order to confirm with respect to the phase jitter, the fluctuation of the main bunch position was measured at the beam window which is straight distant about 18 m from the deflector. As a result, the beam fluctuation could not be observed on the fluorescent plate. It means that the design goal of the phase jitter(less than 7 degree, 180 ps) was achieved completely.

For the purpose of increasing charge per single bunch, the development and installation of the bunch chopper have been finished and the single bunch charge has been increased from 14 nC to 30.6 nC. This is a highest performance of the single bunch electron linac illustrated in Fig. 5.

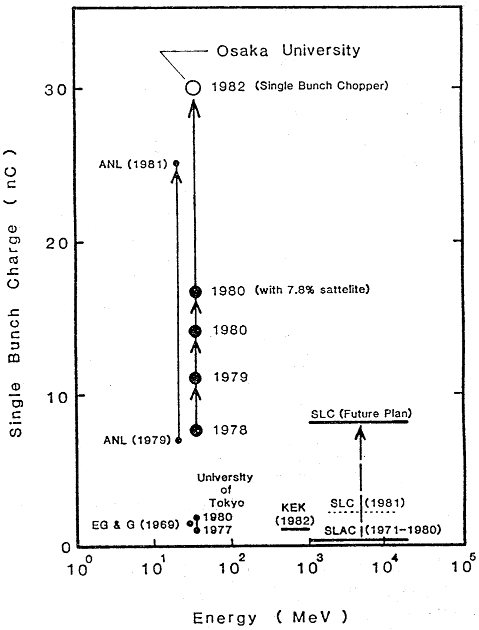

Fig. 5 Comparative graph of various single bunch linac.