BEAM CHARACTERISTICS OF PF LINAC INJECTION SYSTEM

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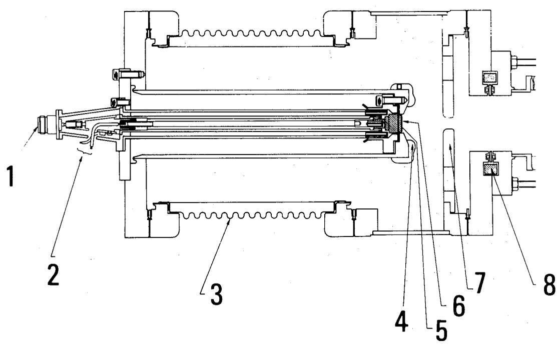
Abstract

The injector components of PF linac are briefly described. The capture efficiency and bunch width of the bunching system were measured to give a good agreement with the design expectations.

1. Accelerator Components and Systems [1,2]

The injector is a small linear accelerator consisting of the following accelerator components; (1) an electron gun operated at a voltage of 100 kV, (2) a prebuncher and a buncher accelerating electrons up to about 5 MeV, (3) two of 2m long accelerator guides with which electrons gain an energy of 35 MeV.

A development was made in the electron gun which has an assembly of a barium-oxide coated cathode and grid, currently used for a planner triode. The gun has advantages that the amplitude of the grid pulse required is much smaller than is usually used, and that a high current beam can easily be obtainable with a small diameter (Fig. 1).



(1) grid lead (2) heater (3) insulator
(4) focusing (5) cathode (6) grid
(7) anode (8) current monitor

Fig.1 Electron gun assembly.

The prebuncher is of traveling wave type, and consists of 6 cavities. The buncher consists of two sections, one is a buncher section with 9 cavities whose phase velocity ranging from 0.75 to 0.98, and the other a regular section with 12 cavities. The prebuncher operates with several kW rf, accelerating electrons a little, while the buncher powered with an rf power of about 7 MW. With this bunching system about 70% of the injected electrons are designed to be captured and have a bunch width of less than 4°.

The microwave power for the prebuncher, buncher and two accelerator guides comes from a standard klystron. The waveguide system for the prebuncher and the buncher is different from that for the accelerator guides in that it has an attenuator and a phase shifter in the high power waveguides pressurized by SF_6 gas. In the beam transport system magnetic lenses and solenoid coils are used for the low energy part of the injector, and quadrupoles for the high energy part, together with steering coils distributed along the injector.

2. Beam Characteristics [3,4]

Test operation of the injector was made with an rf power of about 20 MW. Beam currents along the injector were measured with four current monitors located behind the gun (labeled as 01), in front of prebuncher (02), the 1st accelerator guide (03), the 2nd guide (04), and two in the first sector (10, 11). At an injection current the bunching and transport elements were adjusted to produce the maximum accelerated currents. The results are shown in Fig. 2. At low currents about 70% of the beam are captured in a good agreement with the calculation. When the injected current increases, the capture efficiency decreases a little, but still remains at 60 to 55%.

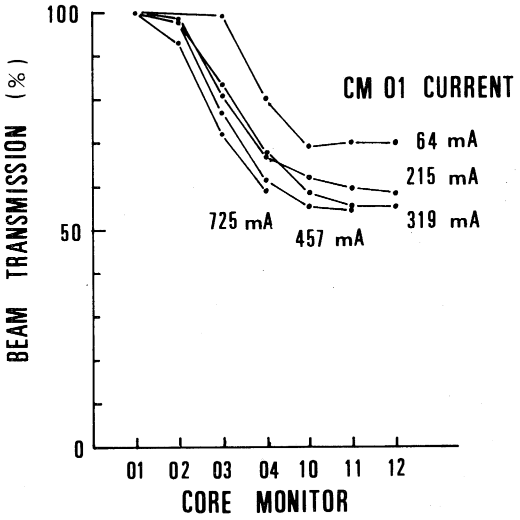


Fig.2 Beam transmission.

The width of a beam bunch was estimated from the beam energy spread. To do this precisely, the energy spread arising from other reasons should be much smaller than that from the actual bunch width. In order to satisfy this condition approximately, the spectrum was measured using an energy analyzing system isntalled at the end of the first accelerator sector. There are 8 klystrons in the first sector, and their phases were first carefully adjusted for the electrons to be on the top of rf wave. The the injector rf phase was deliberately varied from those of the first sector in such a way that the center of bunch deviate from the rf peak by 5°, 10°, and 15° over the sector to produce appreciable energy spread. At the end of the electrons thus accelerated had the energy spread which was mainly caused by the finite bunch width. An example of measurements in shown in Fig. 3. The width changes with the variation of the injector condition, but it was usually less than 4° and likely to be 2° to 3° when well adjusted, and showed the design expectation was satisfied.

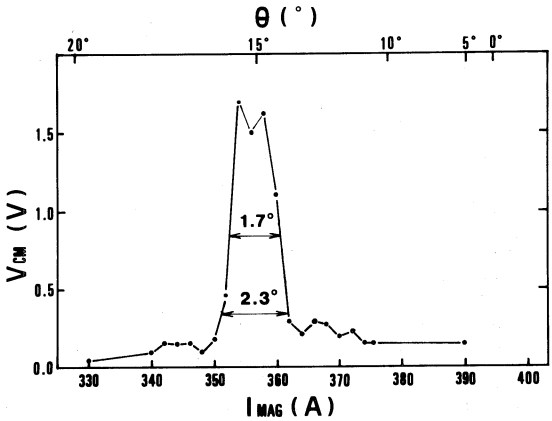


Fig.3 Energy spectrum vs phase.

Reference

1) A. Asami et al: Proc. 6th Meeting on LInac in Japan, July 1981, SAPPORO, JAPAN (1981) p59.
2) J. Tanaka et al: Proc. 1981 Linac Conf., Santa Fe, Oct. 1981, LA-9234-C (1981) 360.
3) A. Asami et al: Proc. 7th Meeting on Linac in Japan, August 1982, KEK, JAPAN (1982) to be published.
4) S. Ohsawa et al: ibid