BUNCHING SYSTEM OF THE LINAC FOR SPRING-8

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Abstract

The bunching system of the linac for SPring-8 is designed on base of the optimization for a high current beam to get positrons as many as possible(1). But otherwise this linac should be used as a accurate electron beam generator for commissioning on the whole facility. This report shows diffences of the beam specification between a high current beam and low current beam.

Introduction

The linac for SPring-8 injects 1.1GeV electron beam and 0.9GeV positron beam to the booster synchrotron. It consists of 26 accelerator sections of S-band, and the part of injector has two prebunchers and a buncher of standing wave. Each of a electron beam and a positron beam has a long pulse mode and a short pulse mode. In the part of injector, the high current mode corresponds to positron beam mode. The beam optics is quite different between those modes, because the number of particles per bunch of short pulse high current mode is hundred times as many as its of long pulse electron mode. Same electron gun is used for every modes, and a small diameter iris is set in front of the anode when electron modes.

High current mode

In order to get a good yield of positron, it is necessary to increase of beam current. The emission current of the electron gun is 20A 1ns at a short pulse mode, and 6nC per bunch is rather severe. The scheme of positron production is almost same as APS(2) and ESRF, consists of a tungsten retractable target, a pulsed solenoid and DC solenoid field superimposed to first accelerator section.

Two prebunchers are same structure of single gap cavity type. The beam from the electron gun comes into first prebuncher at 200kV and goes through 20kV of the gap voltage. The drift length between first buncher and second buncher is 220mm. The beam, after 30kV gap voltage of second prebuncher and 142mm drift space, is bunched into 40 degree at the inlet of the buncher. The buncher has 15 cavities of standing wave type. DC solenoid field is superimposed in all these devices.

Low current mode

When electron mode is required, the center region of the beam which has good emittance cut out for latter sections by putting a small iris located immediately after the electron gun. Field of solenoid coils is decrease a little and modified so as no to be over focused. The focusing effect of prebunchers is larger than high current mode. The voltage of second prebuncher must be trimmed for the best bunching.

Simulation

The difference between the high current mode and the low current mode was compared by a simulation. The used simulation code is TRACE-PC, 3D code including a space charge effect.

The initial beam parameter was gave from a calculation of EGUN. The emittance is 26π mm.mmrad, the beam size is 8.5mm and maximum dx is 42mrad. In this simulation, twiss parameters are assumed from the beam ellipse in a phase space, $\alpha_x = \alpha_y = 7.0$, $\beta_x = \beta_y = 1.5$. The beam ellipse of high current mod is shown in Fig. 1. The beam ellipse of low current mode is assumed as $\alpha_x = \alpha_y = 2.0$, $\beta_x = \beta_y = 0.5$, which is shown in Fig. 2.

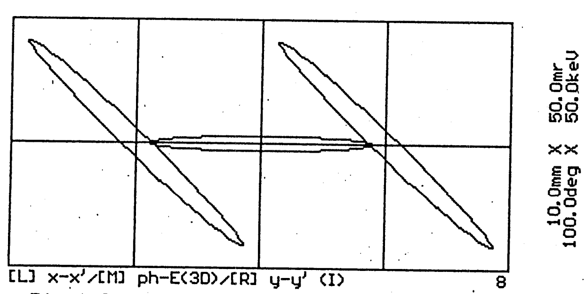

Fig. 1 Initial beam ellipse of high current mode.

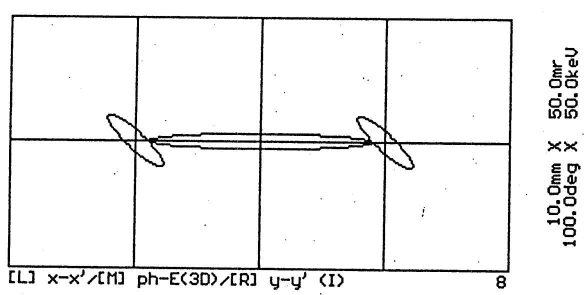

Fig. 2 Initial beam ellipse of low current mode.

From the result of this simulation, it is known that the beam is bunched into 40° and the energy spread is ±30kV in front of the buncher. The beam envelope in the high current mode is shown in Fig. 3. If the beam of low current mode was operated under the condition of the same parameter as the high current mode, it would be over bunched and the energy spread would be ±40kV like Fig. 4.

Conclusion

Adjustment of the solenoid field is very important for the good beam transport in this injector section. The control of the bunching effect is easier than optimization of solenoid field because there are many parameter of the coils to fit a field gradient, and simulation is become important. It is difficult to set that α becomes smaller at the prebunchers, because no information of the beam envelope in the prebunchers can be obtained. In the high current mode, The field of solenoids no less than 800G is required.

References

(1) N. Nakamura, et al. "Design of a Injection System for a SPring-8 Electron Linac." (196), Proc. of Linear Acc. Meeting, 1991.

(2) A. Nassiri, et al. "The Linac Injector For The ANL 7GeV Advanced Photon Source." LINAC Conf. Proc. 1990.

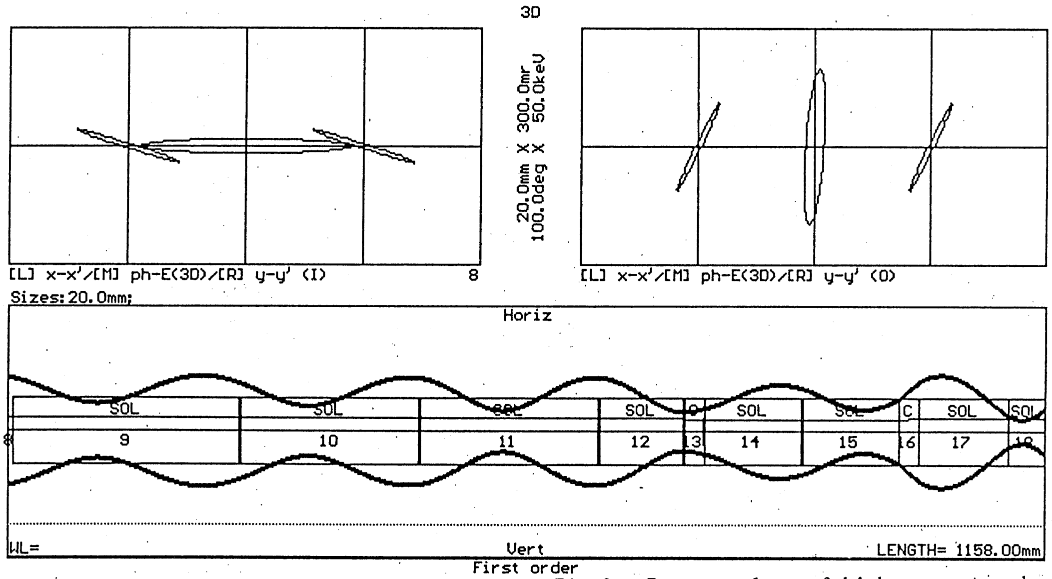

Fig. 3 Beam envelope of high current mode.

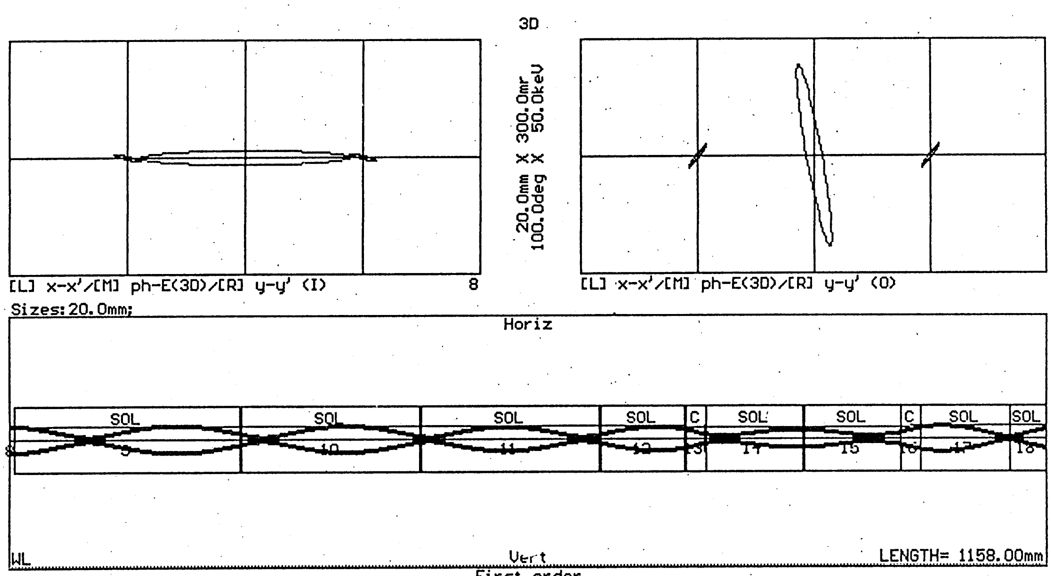

Fig. 4 Beam envelope of low current mode.