Observation of the beam structure in 20 MeV linac

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Abstract

The bunch monitor was constructed and set at the position of 4.75 m behind the 20 MeV linac tank. This is divided into two parts, 50 Ω tapered line and the catcher.

The bunch width and peak were observed as a function of the tank field level and the beam intensity. The emittance growth in the 20 MeV linac is given.

1. Introduction

In the KEK 20 MeV linac, to measure the characteristics of beam, many monitors are set as seen in Figure 1. The transversal characteristics of beam were measured with the emittance monitor 1 (the slit method) set in front of the linac tank and the five profile monitors set on the injection line of the 500 MeV booster[1]. The emittance growth rate in the 20 MeV linac is shown in Figure 2. As seen in Figure 2, the vertical emittance growth would be due to the coupling of the longitudinal to the transversal motion and due to the space charge effect. As for the horizontal motion, the other effects complicate the emittance growth, for example off-axis injection etc.

Using the current monitor at the just end of the 20 MeV linac tank and the bunch monitor, the relation between the beam intensity and the tank field level was measured and is shown in Figure 3. The results measured show the saturation-like pattern above the tank field level of 6.1, which may be corresponding to the accelerating field of about 1.69 MV/m at the first tank. This phenomenon agrees with the results calculated with the program "PARMILA", containing the emittance of beam injected to the 20 MeV linac[2].

From these results observed, the coupling of the longitudinal to the transversal motion is interested in. Therefore, to observe the longitudinal motion, the bunch monitor, which has 50 Ω tapered line and the catcher, was constructed and set at the position of 4.75 m behind the linac tank.

2. Bunch monitor

Figure 4 shows the cross sectional view. To intercept the RF signal induced by the beam, the catcher is surrounded with the copper and the Aℓ-foil (20 μm), which is the entrance of beam and is insulated from the copper box to supply the bias voltage. The electrical transmission of this bunch monitor was investigated. This monitor has the stray capacitance around the catcher but the rise time is below 300 ps including the long cable.

The results that the bunch would be triangular with 600 ∿ 700 ps rise time were reported in reference 3. Therefore, it would not be serious to observe the bunch width and peak with this bunch monitor. The bunch observed is shown in Figure 5. The fine structure of the bunch would be observed but the interest would not be induced in this fine structure because of the limit of the response time.

3. Results and Conclusion

To observe the bunch at the required time in the beam, the trigger system seen in Figure 6 was used. This trigger system has a jitter of 200 ps.

The movements of the bunch width and peak were measured with the tank field level and the results are shown in Figures 7 and 8. As seen in Figs. 7 and 8, the field strength affects the bunch width and peak. The change of bunch width and peak with the tank field level would agree with change of the phase width and peak preliminarily calculated containing the normalized transversal emittance of 0.4 π cm•mrad. From these, it is important to discuss the coupling of the longitudinal to the transversal motion and to observe the fine structures of the bunch. The bunch monitor will be improved to the completely 50 Ω matching type monitor.

References

1) K. Ebihara et al.; Proceedings of the 3rd Symposium on Accelerator Science and Technology (1980), p.155.
2) T. Kato et al.; KEK internal ASN-220.
3) I. Sato et al.; KEK-77-28, p.65.

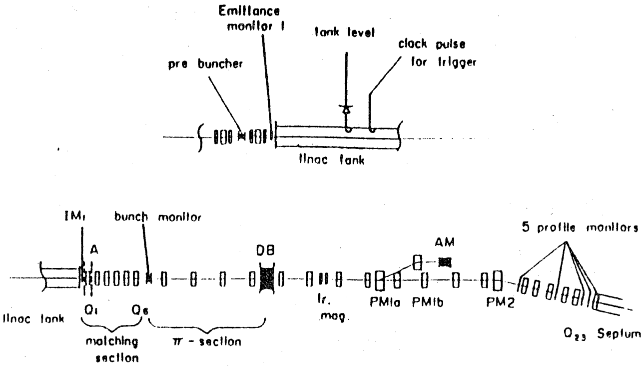

Fig. 1 Layout of monitors.

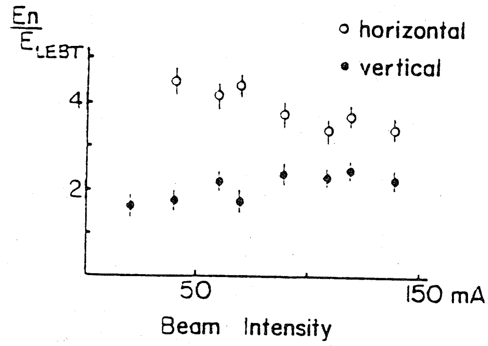

Fig. 2 Emittance growth in the 20 MeV linac.

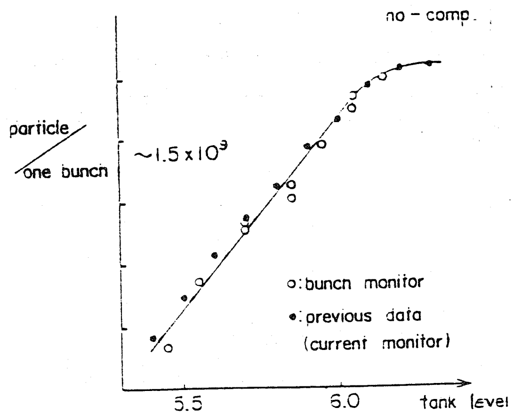

Fig. 3 Intensity vs. tank field level.

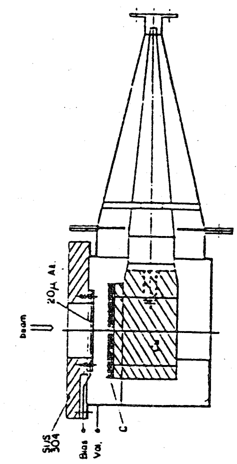

Fig. 4 Cross sectional view of bunch monitor.

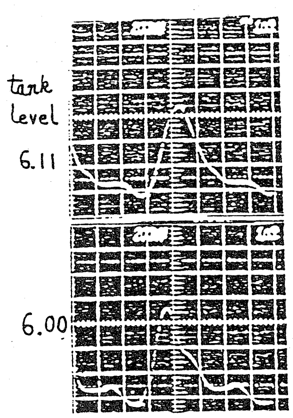

Fig. 5 Bunch observed with the bunch monitor.

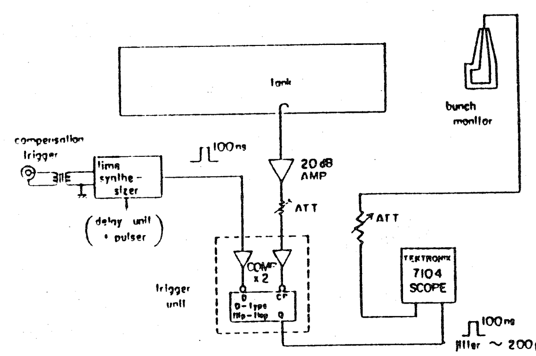

Fig. 6 Trigger system.

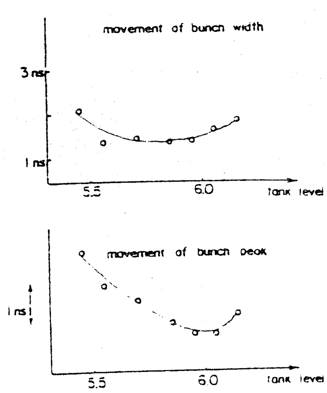

Fig. 7 bunch width and peak vs. tank field level.

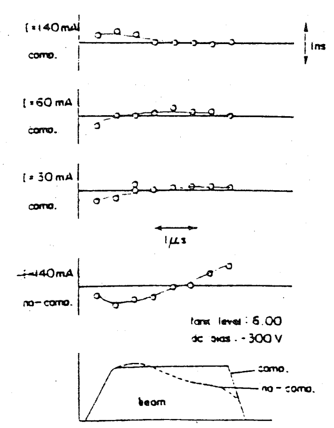

Fig. 8 Movements of bunch peak in beam.