MEASUREMENT OF THE BEAM MATCHING FOR THE SYNCHRONIZED TRANSFER OF THE BOOSTER TO THE MAIN RING

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In the KEK 12 GeV PS, a bunched beam of the booster ring is transferd to the main ring. At the transfer, RF bucket of the main ring must be mutched to longtudinal phase spread and momentum of the extracted bunch from the booster. In order to ckeck this mutching, measurement of the beam phase oscillation is required and its measurement system has been developed.

Introduction

Fig. 3 is the mountain view of single bunches in the main ring. Horizontal sweep is triggered by a signal clocked with main ring RF, and the fast bunch current monitor is observed. Variation of the beam signal position means the coherent motion of the bunch due to the phase oscillation. Therefore variation of the time interval from the trigger to the beam signal every turn shows the dipole oscillation, directly.

To show bunch signal position, the best way is taking center of the charges, and it is possible when the charges distribution is simple. If the density of charges is symmetrically and highest in center, the peak of the bunch signal corresponds to center of charges. These assumptions are satisfied, as show in Fig. 3.

The current signal is differentiated and the charge center can be detected by the zero crossing method.

The Measuring System

Fig. 1 shows the block diagram and Fig. 2 show the timing chart.

Injection frequency of the main ring fm is 6.015 MHz, acceptable longitudinal stable zone correspond to ± 83 nsec. against to the center of the RF bucket. The harmonic number of the booster ring is one and that of the main ring is nine, and the revolution period of the main ring at the injection is 1.5 μsec.

The bunch is detected by the fast bunch current monitor installed near the injection point of the main ring and is processed to find the charges center.

Start of the TAC (time to amplitude conveter) is triggered by the clock pulse that frequency is one nineth of the main ring RF, and the TAC is stoped by the beam center signal. The output voltage change of the TAC is proportional to the phase oscillation. A fixed delay is used for the optimum range 100 nsec. maximum on the TAC. The TAC output displays on the digital oscilloscope. Data acquisition time is required 2.2 μsec, so data can be take every other orbit revolutions.

The system starts the measurement when the beam is injected and stores the data for 3 msec.

Results

The synchrotron oscillation can be observed clearly by Fig. 4 and Fig. 5. It shows precisely phase and frequency miss-mutching. Fig. 6, the matching is correct.

We plan to connect this system with the computer, and then we able to know to adjustments of the main ring frequency and phase correction for the synchronization.

Reference

Y. Kimura, et al., "Synchronous transfer of beam from the booster to the main ring in the KEK proton synchrotron", IEEE Trans. on Nucl. Sci. Vol. NS-24, No.3, June 1977.

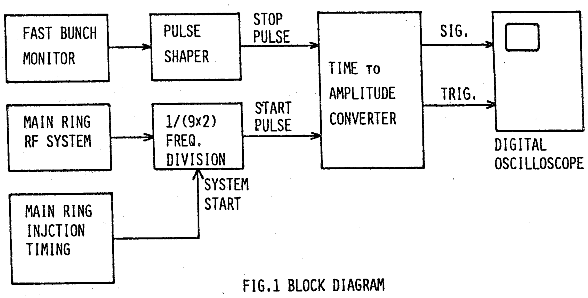

FIG.1 BLOCK DIAGRAM

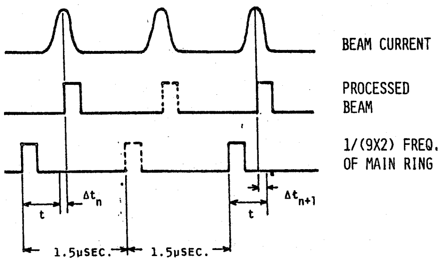

FIG.2 TIMING CHART

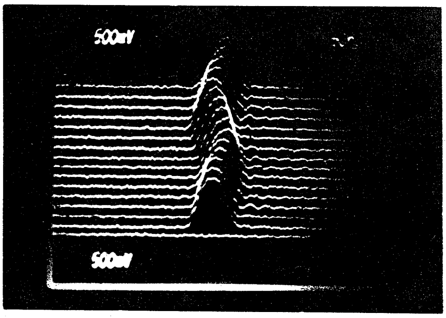

Fig.3 Horiz. 24μsec./sweep

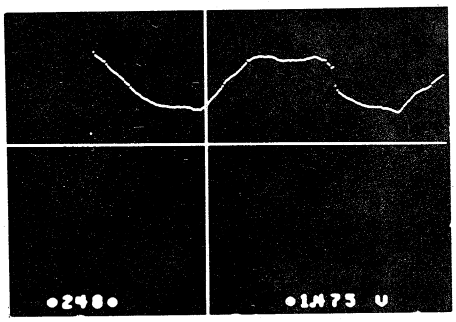

Fig.4

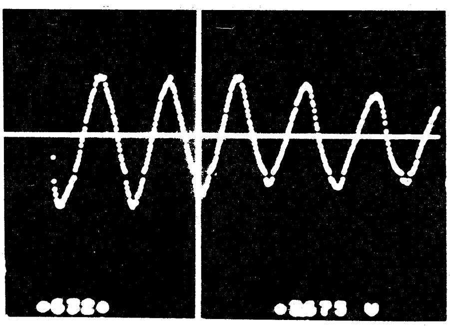

Fig.5

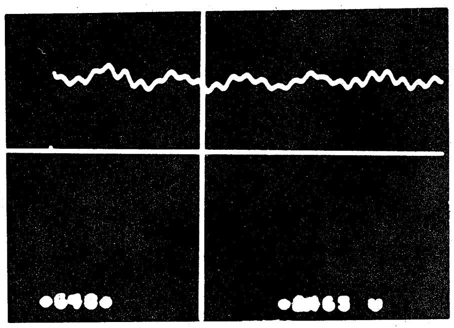

Fig.6