

ELECTRON BEAM EXCITATION AT SRRC BOOSTER DURING RAMPING BY USING A X-Y KICKER

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Abstract

Installation of a beam excitation kicker at the SRRC (Synchrotron Radiation Research Center) booster and its test results are described in this report. During the process of energy upgrading (from 1.3 GeV to 1.5 GeV) of the booster and its performance optimization, the tune tracking during beam acceleration plays an important role for this purpose. In order to acquire these parameters efficiently, to improve the accelerator informative situation, and to provide tool for clarifying some coupling features during ramping, a pulsed magnetic kicker, capable of providing both horizontal and vertical excitation fields, has been installed and tested. Its effectiveness in obtaining useful tune drift information during ramping is presented.

1 INTRODUCTION

Tune drift of the electron beam during ramping was observed in SRRC booster when the tracking among magnet power supply families was not optimized [1]. Consequently, it will greatly benefit booster operation if an efficient method of acquiring tune information can be setup for this purpose. Usually, the electron beam horizontal tune signal during ramping can be obtained by disturbing the beam with properly adjusted strength and timing of the extraction kicker. However, operation experience shows that the vertical tune signal does not appeared simultaneously as expected. Consequently, a pulsed magnetic kicker, capable of providing both horizontal and vertical excitation fields, has been installed and tested. In this report, the detailed configuration of this unit, the tune signal acquiring system, and typical test results showing its effectiveness are presented.

2 TUNE MEASUREMENT SYSTEM

A ceramic chamber was first installed onto 12th sector of booster ring. A pulsed magnetic X-Y kicker was then assembled and was capable of providing 0.5 mrad kick strength to the 1.5 GeV electron beam on both horizontal and vertical components.

2.1 Layout of X-Y Coil

A photo picture of the single turn coil made for X-Y kicker is shown in Figure 1. Since magnet components of ceramic chamber and ferrite were taken from the existing parts available to this project, some minor technical difficulty has to be compromised. For example, coil has to be made of thin copper plate so as to fit into the tight space available between ferrite and ceramic chamber. Also, HV breakdown problem within that tightly bounded area has to be taken care of before it is put into operation.

Since a pulsed current source for this kicker magnet was not available at present stage, impedance matched power cable, with high voltage switching connector, was made to connect this X-Y kicker and the existing extraction kicker power supply. Firing of the disturbing source and its strength can be achieved by making use of the existing power supply. However, this arrangement is only available between refilling of the storage ring and a dedicated power supply unit is needed.

2.2 Kicker Chamber Installation

The ceramic chamber was installed during accelerator maintenance shutdown periods at the end of last year. After installing the ceramic chamber, the system was vacuum pumped down immediately and its leak rate was less than 1×10^{-8} mbar.l/s. Then, the X-Y coil, ferrite blocks, and supporting stage were assembled.

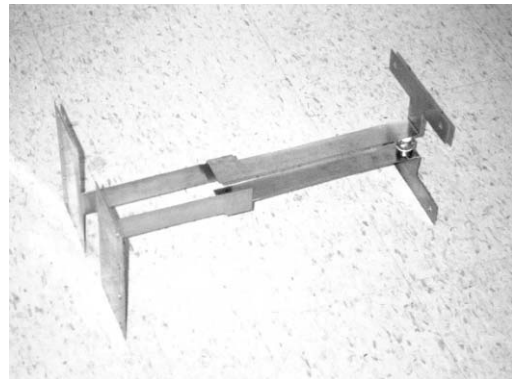


Figure 1: The single turn coil made for X-Y kicker

2.3 The Tune Monitor

Functional block diagram of the tune monitor is given in Figure 2. This setup is basically similar to a previous version [1] except reconfiguring for signal processing, amplification, and a recently installed X-Y kicker. Beam disturbing field of about 300 ns pulsed field was triggered during ramping period of 50 ms. The appropriate field strength to disturb electron beam at various beam energy along ramping cycle was carefully tested. It was correlated with the beam energy so as not to knock out and lost the accelerating beam. For every ramping cycle, a specific ramping moment was chosen, i.e. triggering time of the pulsed magnetic field, then beam kicking and pick-up signal processing were performed. Thus, only one set of tune signal was taken within one ramping cycle. The chosen total sets of tune signal recording defines the amount of ramping cycles it will take to complete the measurement. The reproducibility of the fractional tune

drift during ramping has been checked and found to be within 5%. This is good enough for tune space exploration experiment in the next stage.

3 TEST RESULTS

3.1 Tune Measurement Using X kicker only

In order to illustrate the effectiveness of this recently installed X-Y kicker, a tune drift information obtained by employing the original X-kicker, as the disturbing source to the electron beam, is shown in Figure 3 for comparison purpose. In this figure, the data gives horizontal tune drift around 0.15 along ramping cycle. A weaker tune signal appearing around 0.3 is actually just twice of the horizontal tune. Since the vertical tune signal was too weak to be recognized with this operation condition, the signal of twice of the horizontal tune was somewhat causing confusion.

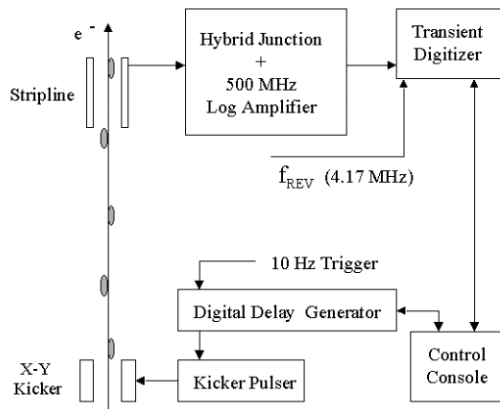


Figure 2: Functional block diagram of the tune monitor

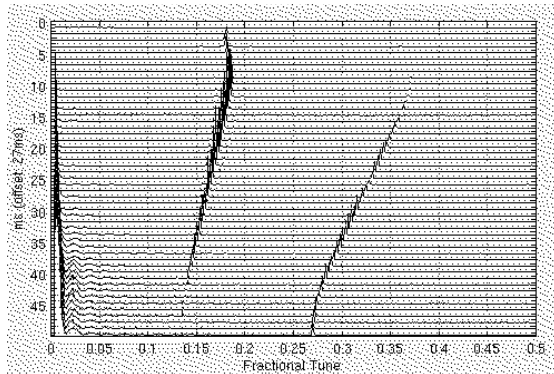


Figure 3: Tune drift signal using X kicker only

3.2 Tune Measurement Using X-Y Kicker

A set of similar tune drift data recorded with the excitation source using X-Y kicker is shown in Figure 4 under the same experimental condition as that of Figure 3. The horizontal tunes in both Figure 3 and Figure 4 are the same. However, the vertical tune signal, appearing in Figure 4, has been significantly enhanced due to beam disturbance on the vertical component. Signal at the twice of that horizontal tune is also seen in Figure 4. Yet, it is

insignificant to and distinguishable from both horizontal and vertical tunes.

3.3 Turn-by-Turn Signals Observation

During the system test of measuring tune drift information, higher order resonance feature was observed at some particular booster operation conditions. In order to explore the observed feature, a turn-by-turn beam position monitoring system is equipped in the booster ring for this purpose. In the observed case, beam disturbing amplitude did not decay as most of the measuring cases. A typical example of this observation is shown in Figure 5 for the case of tunes at 0.15 and 0.35 of horizontal and vertical components, respectively. As can be recognized in Figure 4, this observation point occurred at around the 35th ms of the ramping cycle, which corresponds to beam energy of 1.2 GeV. The turn-by-turn beam position acquisition system was achieved by using typical transient digitizer technique [3]. Beam spectrum information was obtained by performing Fourier transform of the recording data. The upper figure gives turn-by-turn beam signal readings once the excitation kicker was triggered. The recording length was 2000 turns. The lower figure shows its corresponding beam spectrum.

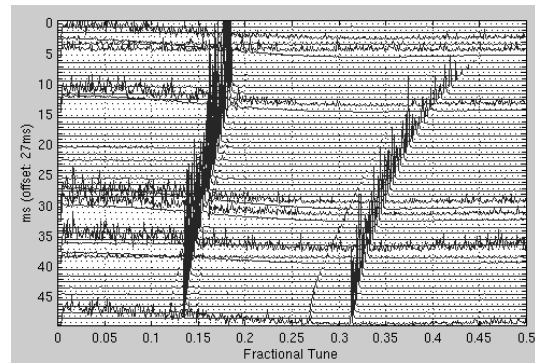


Figure 4: Tune drift signal using X-Y kicker

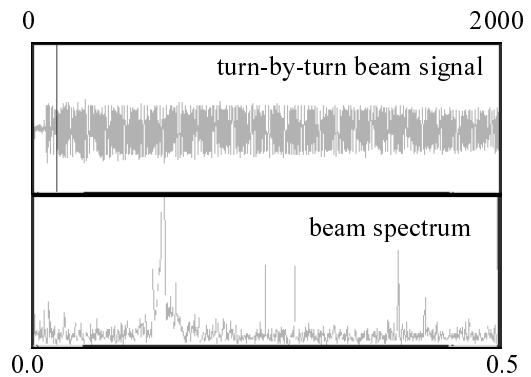


Figure 5: Example of turn-by-turn signal observation

Calibration of the beam position signal and installing a pair of this type of turn-by-turn beam position monitoring system will be carried out soon. It will provide capability of extracting phase space information of the accelerated beam at a particular moment of interest.

4 SUMMARY

With the installation of a X-Y kicker, the accelerated electron beam can be perturbed on both horizontal and vertical directions. This arrangement has enhanced the vertical tune information significantly. It also provides capability of exploring tune space of potential working points for booster operation. Beam resonant feature was observed at some particular moment during ramping. A turn-by-turn beam position monitoring system will be able to provide detailed dynamic properties of the accelerated electron beam.

5 REFERENCES

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