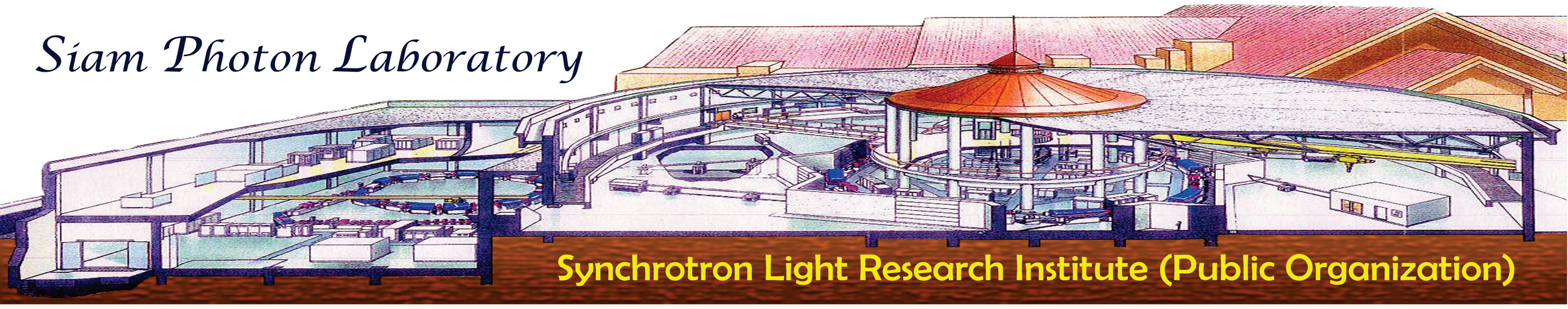
Siam Photon Laboratory



IMPROVEMENT OF TUNE MEASUREMENT SYSTEM AT SIAM PHOTON SOURCE

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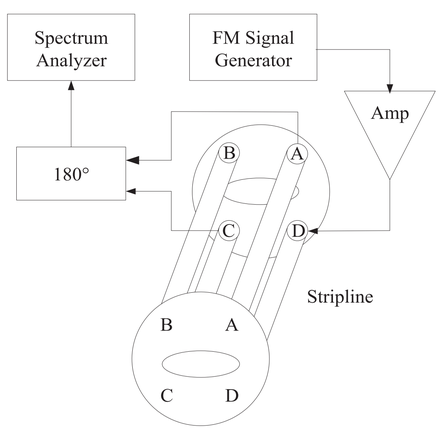
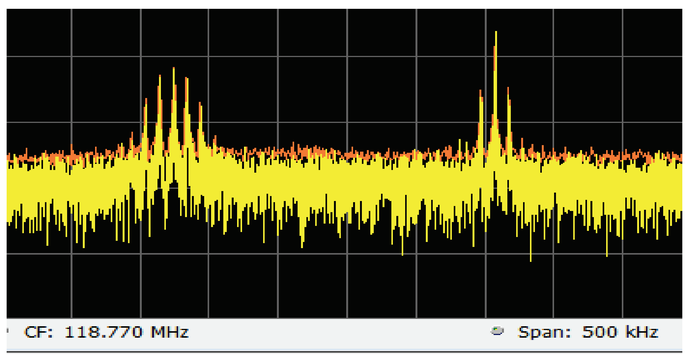
INTRODUCTION

A new tune measurement system was recently developed and implemented at Siam Photon Source (SPS) for both the booster synchrotron and the 1.2 GeV electron storage ring. A new electronic module was installed at the SPS booster for collecting the turn-by-turn signal generated when the beam was excited with white noise and fast kicker. The beam excitation was carefully studied in order to determine the optimum beam response. With this system we observed the variation of the tune during energy ramping. The measurement provides information needed to optimize the working tune and to keep it constant. At the SPS storage ring, the excitation signal was changed from swept frequency signal to frequency modulation (FM) signal to reduce the measurement time.

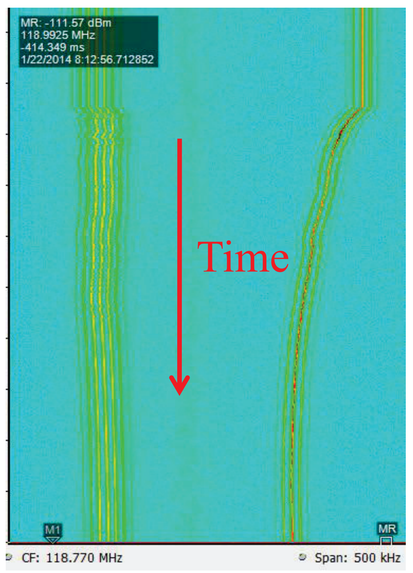


Top: layout of the tune measurement system at the SPS storage ring.



Top: result of tune measurement in the storage ring using FM signal.

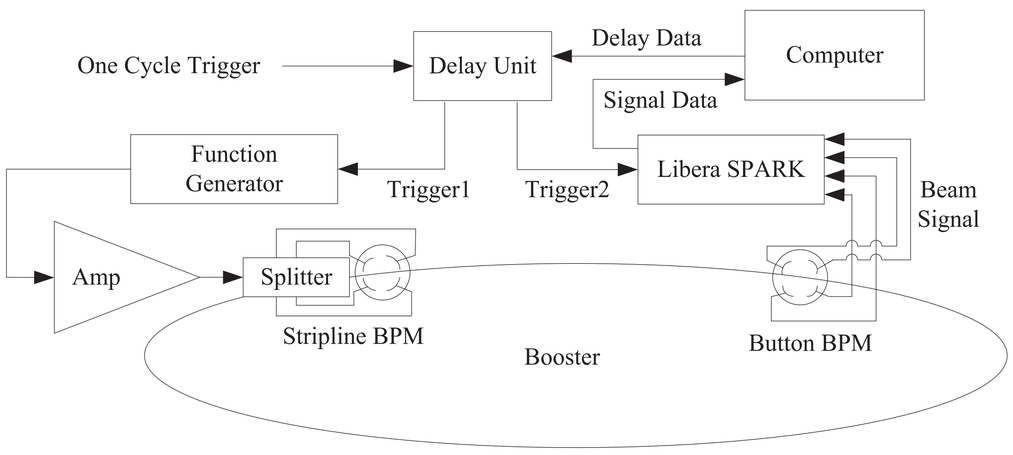
Right: tune shifted can be seen real-time in the storage ring. This result was measured while closing a gap of a wiggler.



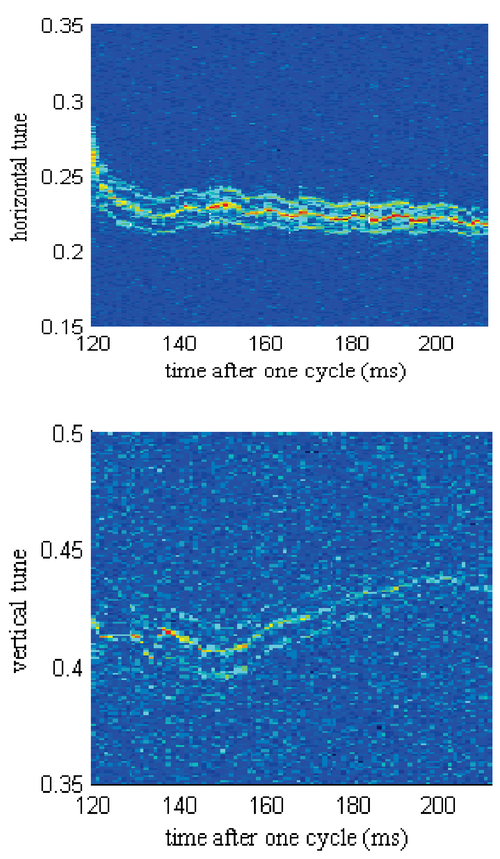
BOOSTER

Layout of the tune measurement system at the SPS booster is illustrated below. The system has two subsystems: the excitation system and the signal detection system, which work together synchronously.

Layout of the tune measurement in the booster



Horizontal and vertical tune



The tune excitation system consists of a function generator (Agilent 33250A), a 150W rf power amplifier (ENI A150) and a stripline which was used as a kicker. The function generator was used to generate the white noise signal with 0 to 3.4 MHz bandwidth. The signal was amplified before being sent to the stripline with constant amplitude. The tune can be measured in approximately 10 ms for one measurement and it is possible to do only one measurement per one cycle of acceleration. Betatron tune of the whole ramping process is finally constructed from each of these measurements.

The signal detection system consists of a four-button BPM and a Libera SPARK module. The button BPM was used to detect the beam signal and send it to Libera SPARK for data collection. MATLAB routine was used to analyse the data by finding the bunch-by-bunch data and performing Fast Fourier Transform (FFT). Figures above (right) show averaged FFT signal of all bunches when electrons were injected into the booster. The horizontal and vertical tunes can be clearly seen with the resolution of 10^{-3}, which is sufficient for operation. However, the vertical tune cannot be seen after around 500 ms after injection. This is probably because the power of the excitation signal is not high enough, or it may be because the BPM probe was located where the vertical betatron tune is low. Therefore fast kicker pulse is also used with white noise to excite the tune at higher energy.

STORAGE RING

The tune measurement system at the SPS storage ring has undergone a minor modification. The old measurement system used swept frequency signal to excite the stored beam through a stripline. Each measurement took 10-30 seconds, resulted in a long machine study time. The FM signal was therefore used instead of the swept frequency signal to improve the measurement speed. Real-time spectrum analyser is used to find the tune. This setup is capable of measuring the betatron tunes with 10^{-3} resolution.

SUMMARY

New system for tune measurement at the booster and storage ring were developed. The new electronic module installed at the SPS booster will provide betatron tune information during machine commissioning for the 1.2 GeV full energy injection. At the SPS storage ring, FM excitation signal can reduce the measurement time from 10-30 seconds per measurement in the old system to real-time in the new system which saves time considerably during machine study.

ACKNOWLEDGMENT

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