IMPROVEMENT OF THE SIAM PHOTON SOURCE BEAM LOSS MONITOR SYSTEM

N. Suradet, S. Krainara, P. Sudmuang, S. Taewphet, G. G. Hoyes, P. Klysubun
SLRI, 111 University Avenue, Muang District, Nakhon Ratchasima, 30000, Thailand

Abstract

A description of the newly re-built beam loss monitor (BLM) system at the Siam Photon Source (SPS) is presented. The original BLM system was designed and installed in the 1.2 GeV SPS storage ring in 2005. The main problems of this system were poor performance due to RF electromagnetic interference and the use of now obsolete data acquisition electronics. The beam loss detector used is a PIN-diode type from Bergoz. The new BLM system has been implemented using low-noise coaxial cable and an acquisition system based on NI-PXI. The hardware and software modifications incorporated into the new BLM system are presented.

INTRODUCTION

The Siam Photon Source (SPS) is a second generation synchrotron light source operated by Synchrotron Light Research Institute (SLRI) under the Ministry of Science and Technology, and is located in Nakhon Ratchasima, 250 km northeast of Bangkok, Thailand. The accelerator components consist of a 40 MeV linear accelerator, 1.0 GeV booster synchrotron and a 1.2 GeV electron storage ring. The maximum operating beam current is 150 mA in decay mode. The storage ring circumference is 81.3 meters and contains four super-periods of double bend achromat with a total of 8 bending magnets with 3 insertion devices, a permanent magnet undulator, a superconducting magnet wavelength shifter, and a multipole wiggler, providing synchrotron radiation from infrared to hard x-rays to synchrotron light users.

The existing beam loss monitor system (BLM) was designed and installed in the storage ring in mid-2005. The system was intended for measurement and analysis of the closed orbit distortion (COD) with beam loss rate and beam scraping of the vacuum chamber around the storage ring. It used PIN-diode BLMs from Bergoz. The acquisition and control electronics were based on a conventional PCI interface bus using standalone PCs. The major problems of that system were high RF interference in the BLMs and cables and the non-expandable, now obsolete control electronics.

The new system was implemented and subsequently improved in 2014. The major objectives of this improvement are to reduce and protect from RF electromagnetic interference and to better observe the unstable beam around the ring. This paper is organized as follows. Section 2 describes the hardware improvements, while Section 3 presents software improvements. Finally, the measurement results are presented in Section 4.

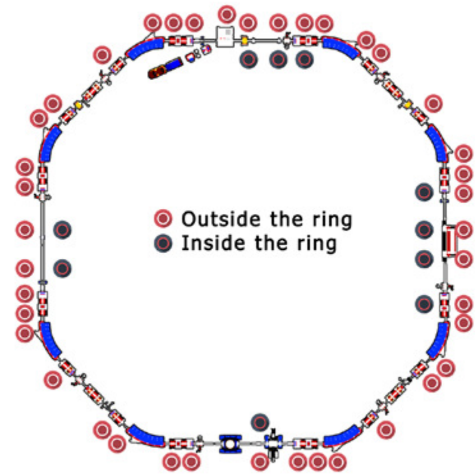

Figure 1: New SPS beam loss monitor positioning layout in storage ring.

HARDWARE IMPROVEMENTS

Sensors and Power Supplies

There are 50 Bergoz's beam loss monitors (Fig. 1), each of which comprises of two pin-photodiodes operating in coincidence mode [1]. The BLMs have been assembled and placed around the vacuum chamber in the storage ring. Regulated low noise power supplies (+5 VDC, -5 VDC, +24 VDC) for up to 10 BLMs is provided from each of 8 transformer units (+12 VDC, -12 VDC, +31.2 VDC) distributed around the ring. The power and signal cables between regulated power supplies and detectors are covered with RF shielding as seen in Figure 2. Also the sources of the RF interference, our bump magnets, were shielded with copper.

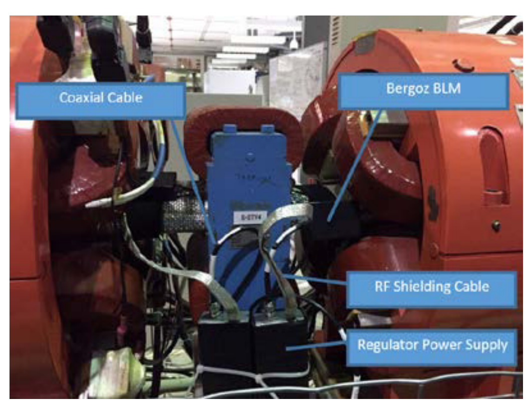

Figure 2: BLMs with RF shielding attached to the vacuum chamber.

All BLMs have been re-calibrated for background noise count rate with the new cables and acquisition system. Each BLM circuit was re-calibrated to within a spurious count rate of 10 kHz ±800 Hz as per Bergoz's manual [2]. Figure 3 show the comparisons of the count rate in test mode before and after calibration. It shows that the count rate after calibrate is between 10 kHz ± 300 Hz.

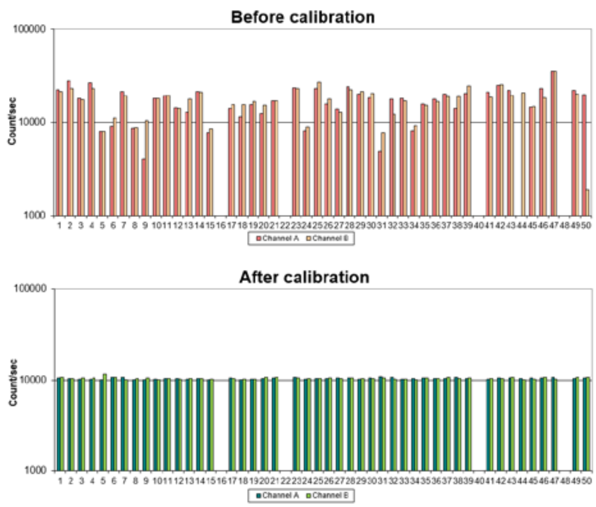

Figure 3: The count rate of BLMs in test mode before and after re-calibration.

Signal Cables

One cause of the RF electromagnetic interference problem is that we previously used low quality signal cables which were susceptible to external interference. Therefore, we replaced the existing cables with HUBER+SUHNER model RG-223/U. This particular cable has double shielding, an impedance of 50 ohms, and operating frequency up to 6 GHz. Both sides of the cable are HUBER + SUHNER BNC 50 ohms. We use 50 ohms terminator to prevent reflection of signals. We also installed all cables in a dedicated mesh-type cable tray, separated from other cables.

Acquisition System

All count signals from the 50 BLMs are collected by NI PXIe-6612 counter modules connecting to BNC terminal boxes as shown in Figure 4. The specifications of these modules are summarized in Table 1. They are based on National Instruments PXI Express platform (NI PXIe) [3] instead of the NI-PCI 6602 counter cards previously used. There are 8 counter modules which are installed in an NI PXIe-1078 PXI Express chassis with a NI PXIe-8820 2.2 GHz Celeron dual-core controller processor and 2 GB, 1333 MHz memory. The PXI is a rugged PC-based platform for measurement and automation systems. It is a high-performance, low-cost deployment platform, and is an especially expandable system for the future.

Table 1: NI PXIe-6612 Counter Module Specifications

Specifications	
Max Source Frequency	80 MHz
Min Input Pulse Width	12.5 ns
Logic Levels	TTL
50 Ohms Terminator	No
Counter Channels	8
Bits	32

Figure 4: BNC terminal boxes installed on rear rack.

SOFTWARE IMPROVEMENTS

In system we use LabVIEW programming platform to collect and analyse input signal from BLM units. The PXIe-6612 counter/timer card from NI is programmed via NI DAQmx software. The block diagram of the program is shown in Figure 5. It first initializes and configures each card for counting up and then starts the counters in the cards. After that it reads data from each input channel at specific intervals, then analyses and displays the count rate.

This program developed in-house can display both real-time and historical data, and has the options to switch between machine layout display, trend chart, and intensity chart. The acquisition system collects the data every 1 second (1 Hz) using controller storage (NI PXIe-8820) and main data logger. This data is broadcasted using NI shared variable protocol via ethernet.

ISBN 978-3-95450-176-2

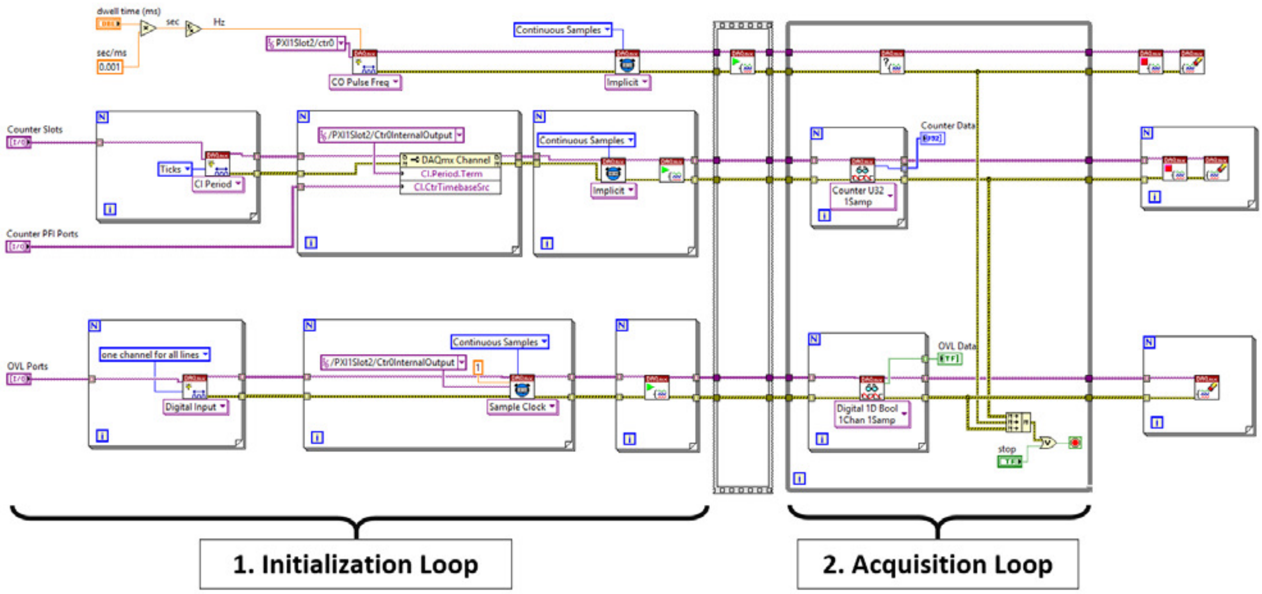

Figure 5: NI LabVIEW DAQmx block diagram.

MEASUREMENT RESULTS

After improving the BLM system, we can clearly detect the variation of beam loss signal during injection, energy ramping, MPW gap change, and excitation of the SWLS. Moreover, we can identify the different loss rates caused by beam instabilities found in the machine during user beam service as shown in Figure 6.

To observe the performance of BLM system, the machine parameters such as working point, beam emittance, machine operation modes were changed to study the effect of loss rate. The details of this study are shown elsewhere [4].

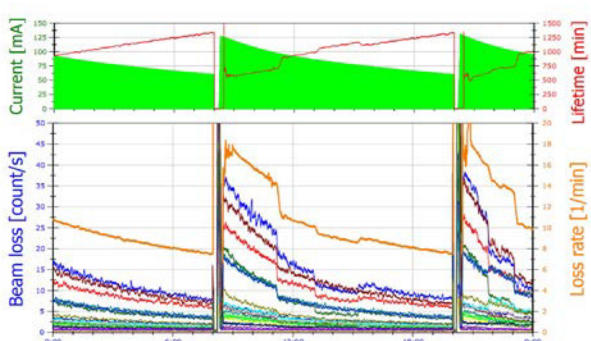

Figure 6: Measured beam loss rate.

CONCLUSION

The improved SPS beam loss monitor system has proved to be extremely useful for machine study and beam loss diagnosis. It is an indispensable tool for our machine physicists for the task to improve the injection efficiency.

ACKNOWLEDGEMENT

We would like to thank all the members of Accelerator Technology Division and the Technical Support team for their assistance, encouragement, and co-operation.

REFERENCES

[1] G. G. Hoyes et al., “A Flexible, Low Cost, Beam Loss Monitor Evaluation System”, AIP Conf. Proc., 879, p. 147-150 (2007).

[2] Bergoz Instrumentation, Beam Loss Monitor User’s Manual: http://www.bergoz.com

[3] PXI Platform National Instruments: http://www.ni.com/pxi

[4] S. Krainara et al., “Observation of Beam Loss Signal at the SPS Storage Ring”, MOPB057, IBIC’2015, Melbourne, Australia (2015).

ISBN 978-3-95450-176-2