IMPROVEMENT OF THE SIAM PHOTON SOURCE STORAGE RING BPM SYSTEM

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Abstract

This report describes the improvement of the Beam Position Monitor (BPM) system of the 1.2 GeV storage ring of the Siam Photon Source (SPS). Systematic studies and investigations to improve the machine performance, and storage ring BPM system have been carried out in the last few years. Major technical problems have been found and solved. The causes of the unreliability of the original BPM system were also identified. It was mainly caused by the low quality and improper installation of BPM signal cables. Detailed descriptions of the replacement with higher quality (lower loss and better interference shielding) BPM cables and implementation of a separate cable trays for the BPM cables, as well as the work on BPM electronic board calibration will be described. The measurement results before and after the improvement of the BPM system will also be presented.

INTRODUCTION

The Siam Photon Source storage ring routinely operates at 1.2 GeV with a nominal current of 150 mA. The ring circumference is 81.3 meters. Its lattice is Double Bend Achromat (DBA). The ring has, among other components, 20 button-type BPMs. [1, 2]

As the number of users increases, so does the demand for better quality beam. Our first efforts focused on investigation and improvement of the existing BPM system since the BPM is the most important diagnostic tool for both machine studies and routine machine operation. In addition, it will be an indispensable part of our orbit feedback system in the near future. In the beginning of 2011, major problems of the original BPM system were indentified and fixed by the machine group and visiting machine physicists from NSRRC, Taiwan. The improved BPM system shows reliable performance and exhibits accuracy of measurement in micron-scale resolution.

In the following sections, we first describe the status of the original SPS storage ring BPM system. We then present our work on replacing BPM signal cables and calibrating the BPM electronic modules. Finally, measurement results before and after the improvement of the BPM system are presented.

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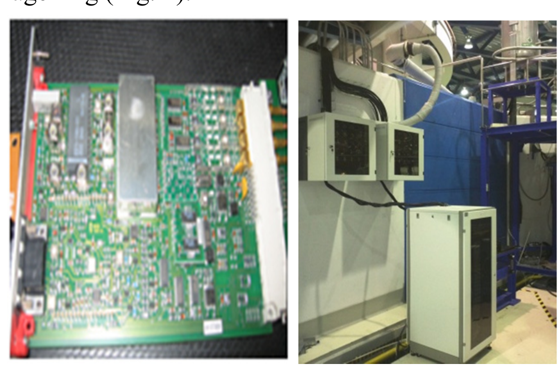
ORIGINAL SPS STORAGE RING BPM SYSTEM

Back in the year 2000, the SPS storage ring was just installed and commissioned. The ring incorporated a set of 20 button-type BPMs, with each BPM comprised of a BPM block, position sensors, coaxial cables, and detector electronics board. The signals from each individual board were collected and processed by the control system. The BPM block is directly welded on the storage ring vacuum chambers without flanges or bellows.

BPM Electronic Modules

The BPM pick-up system uses four electrodes as position sensors. Beam position is a function of the amplitude difference of these electrodes' signals. These signals are fed into the BPM electronic modules where they are processed sequentially to provide simultaneously two outputs: horizontal (X) and vertical (Y) beam positions. [3, 4]

The MX-BPM-118.00MHz electronic modules of the BPMs were made by Bergoz Instrumentation. All the modules and data acquisition equipments are distributed into two groups, the housing of which are located outside the radiation shielding wall on the opposing sides of the storage ring (Fig. 1).



(a) (b)

Figure 1: (a) Bergoz BPM electronic module. (b) Electronic device rack.

BPM Cables

The old system uses HUBER&SHUNER GX03272 coaxial cables, with one layer of electromagnetic shielding, mounted with N-type and SMA-type connectors on each end. The BPM electrode signal is

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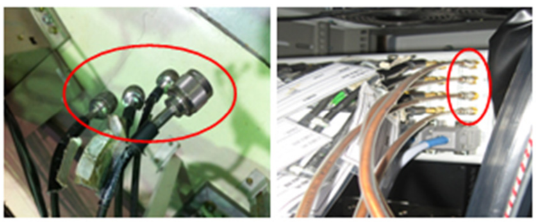
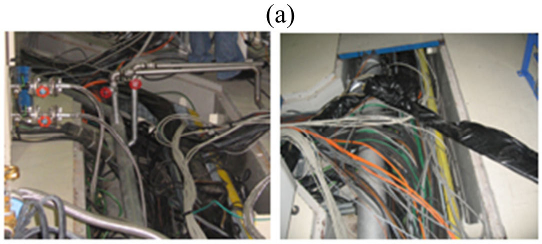
carried by these cables to the local control rack where the signal processing BPM electronic is located. The lengths of the cables vary from approximately 20 to around 30 meters depending on the BPM's location in the storage ring.

Figure 2(a) shows the GX03272 coaxial cables, crimped on one side of the cables with N-type connectors (left), and another with SMA-type connectors (right). The N-type connector connects to the BPM electrode, while the SMA-type connector connects to the BPM electronic module located outside the storage ring.

Figure 2(b) shows the original installation of the BPM signal cables in the cable trench inside the storage ring. The trench carries all types of the cables, and even includes cooling water pipes seen in the pictures.



(a)



(b)

Figure 2: Original BPM cables and their installation.

It is rather obvious that this was one of the causes of induced electrical noise and even EMI problem, which will directly interfere with the BPM signals, giving rise to inaccuracy and unreliability of the BPM system.

IMPROVED SPS STORAGE RING BPM SYSTEM

As mentioned in the previous section, inaccuracy of the original SPS storage ring BPMs was mainly caused by (i) the use of low-quality BPM signal cables and, (ii) the assimilation of all the different types of cables in the same storage ring cable trench.

This section will describe our efforts on replacing the old cables, and recalibrating the electronic modules of SPS storage ring BPM system.

New BPM Cable Installation

The high level of noise observed in the old BPM cable is due to the fact that it has only one layer of electromagnetic shielding. This makes replacing the cables the top priority. Figure 4 shows the installation of new BPM cables. We selected HUBER&SHUNER SUCOFEED cable, which has low loss rate and double layers of interference shielding. The new BPM cables were put in their own dedicated cable tray.

Figure 3: Installation of the new BPM signal cables.

BPM Electronic Module Calibration

After the new BPM signal cables were installed, it was necessary to calibrate all the BPM electronic modules. Careful calibration was carried out to compensate for the difference in cable lengths and input powers. According to the standard calibration procedure provided by Bergoz Instrumentation [3], the on-board attenuators: A, B, C and D have to be adjusted until the output SDEMOD signal has minimum level difference, while the X and Y readings (shown here on two digital multimeters on the left in Fig. 4) are closed to zero or fall within ± 20 mV. These conditions ensure that the BPM electronics exhibits linearity over the whole dynamic range. [3, 4] Figure 4 shows the calibration equipment setup on site using Bergoz toolkit (table-top test kit: BPM-KIT). [3]

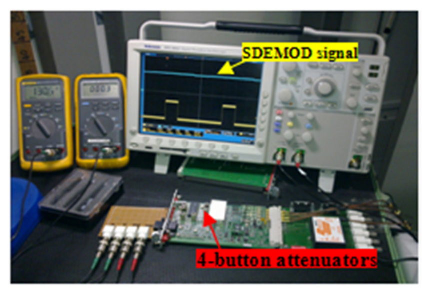


Figure 4: Setup for BPM electronic module calibration.

IMPROVED BPM MEASUREMENT RESULTS

Figures 5(a) and 5(b) show, respectively, typical horizontal (X) and vertical (Y) positions of electron beam in the SPS storage read from BPM no. 18 before and after installation of the new BPM signal cables.

Before the improvement (original cable), the X and Y positions exhibit large fluctuation. The maximum X and Y changes in 5 hours are about 150 and 170 μm, respectively. Here, it is very important to note that *the BPM which has rapid change larger than 10 μm are sorted out as bad BPM.* [5]

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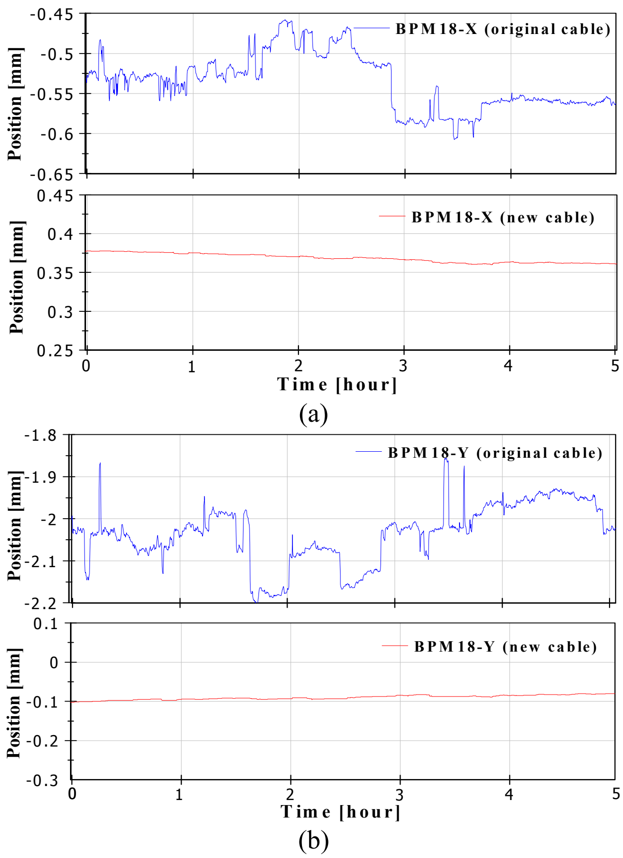

Figure 5: The BPM no. 18 reading during the machine operation.

After the improvement (new cable), the signal fluctuations of the X and Y positions are drastically reduced to only a few microns. Systematic beam drift of about 15-20 μm, which cannot be observed before, can now be easily discernable. The results show significant increase of the BPM performance.

CONCLUSION

The causes of the inaccurate and unreliable BPM signals of the SPS storage ring have been identified and solved. The original BPM cables were replaced with better quality ones, which were relocated to a dedicated cable tray to minimize interference. Since the recommissioning of the storage ring last year, the more accurate BPM system has been instrumental in the undertaking of the machine group to further improve the quality of the beam, as well to setup and implement a slow orbit feedback system.

ACKNOWLEDGMENT

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