IMPROVEMENT OF BPM SYSTEM OF SIAM PHOTON SOURCE

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Abstract

The Siam Photon Source (SPS) is the first synchrotron light source ever built by modifying and relocating a light source from one country to another. The SPS produced its first light in Dec 2001. Useful experimental data could not be obtained until 2005 after some major technical problems have been identified and solved. However, systematic studies and investigations of the machine have just properly been carried out under the supervision of the International Advisory Committee of SLRI in the last two years. This report describes the improvement of the beam position monitoring (BPM) system for the SPS storage ring. The efficiency and reliability of the original BPM system was greatly hindered by the low quality signal cables. The replacement with higher quality (lower loss and better interference shielding) BPM cables and the implementation of a separated cable tray for the BPM cables have significantly improved the quality of the BPM signals, allowing the possibilities for machine study and thus providing further possibilities to improve the machine.

INTRODUCTION

The Siam Photon Source (SPS) of the Synchrotron Light Research Institute (SLRI) of Thailand is a modified light source of SORTEC Cooperation. It was upgraded from 1.0 GeV to 1.2GeV, is currently operating at 1.2 GeV in a decay mode with a maximum electron beam current of 150 mA. The SPS storage ring circumference is 81.3 meter containing 4 superperiods with Double Bend Acromat lattice, 16 horizontal, 12 vertical corrector magnets, 28 quadrupole magnets and 20 BPMs [1-3].

As a dedicated light source, SLRI met an increasing demand of users for better beam orbit stability. To tackle the problems related to the beam orbit stability, our great efforts focused on investigations and improvement of the existing BMP 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.

This work presents the improvement of the BPM system of SPS. The major problems of the existing BPM system was indentified and fixed. The performances of the BPM before and after improvement are compared and discussed. The improved BPM system shows reliable performances and accuracy of measurement in micron-scale resolution.

ORIGINAL BPM SYSTEM

SPS is equipped with 20 BPMs. Figure 1 shows the locations of BPMs, indicated by filled circles. Each BPM composes of a main block, position sensors, coaxial cables, detector electronics board and a control system. The BPM block is directly welded on the vacuum chamber of the storage ring without flanges or bellows. The beam position sensors are mounted in each block.

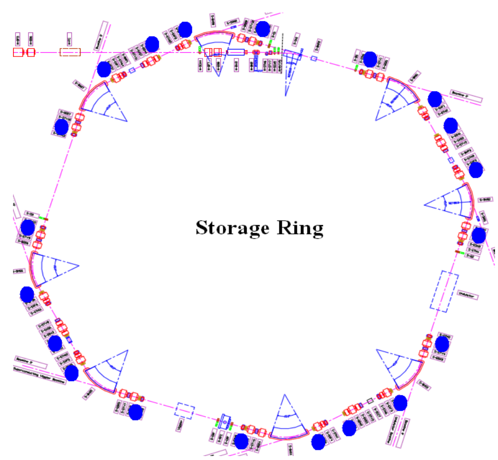

Figure 1: The location of 20 BPMs in the SPS storage ring, indicated by filled circles.

The BPM pick-up system uses four electrodes as position sensors. Beam position is a function of the amplitude difference of the signals from these electrodes. The raw signals from the four electrodes are fed into the BPM electronic modules where they are processed sequentially to provide two beam position outputs: horizontal (X) and vertical (Y), simultaneously [4,5].

The MX-BPM-118.00MHz electronic modules of the BPMs were purchased from the Bergoz Instrumentation, France. The Bergoz modules and all electronic devices for the data acquisition are distributed in two racks, located outside the radiation shield wall of the storage ring.

A set of four coaxial cables (model GX03272, one layer of electromagnetic shielding from HUBER & SHUNER) brings up position sensor signals of each BPM electrode to the local control rack where the signal processing BPM electronic is located. The lengths of coaxial cables vary from about 20 to 30 meters depending upon the location of BPMs in the SPS storage ring.

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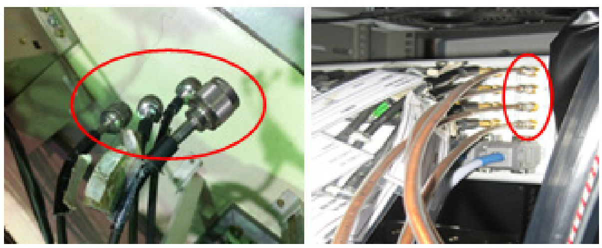
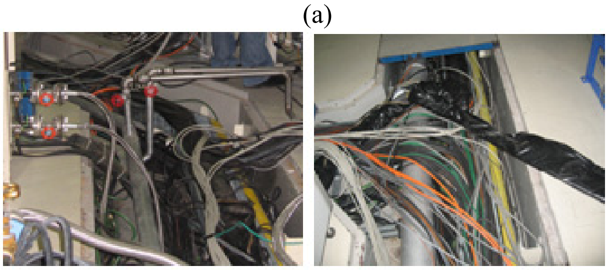
Figure 2(a) shows the GX03272 coaxial cables, crimped one side of the cables with N-type connectors (left), and another with SMA-type connectors (right). Each end of the cables is connected to BPM blocks and BPM modules, located inside and outside the shield wall of the storage ring, respectively.

Figure 2(b) shows the original installation of BPM signal cables in cable trench around storage ring without the cable tray separations. Different types of the cables such as signal and power cables, including water cooling pipes are put together in this cable trench. It is rather obvious that this could be one of the causes of induced electrical noise and even EMI problem and leads to the misleading and unreliability of BPM reading system.



(a)



(b)

Figure 2: The original BPM cables and their installation.

IMPROVED BPM SYSTEM

Systematic investigations of the original BMP system found that an inaccuracy of the SPS storage ring BPMs was mainly caused by the use low-quality BPM signal cables and the mixing of different types of cables in the cable trench.

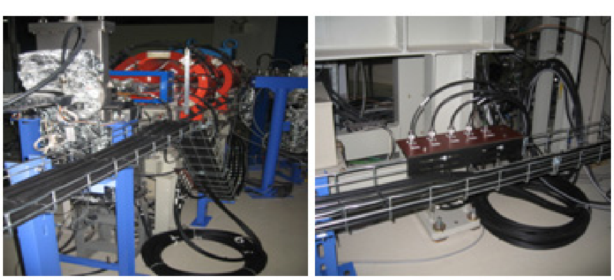


Figure 3: The new BPM signal cables installation.

The original cables have high loss rate and one layer of electromagnetic shielding. Thus the replacement of the BPM cables with better quality is required. Figure 3 shows the installation of new BPM cables with the higher quality (SUCOFEED type with lower loss and double layer of interference shielding, made by HUBER & SHUNER). Different types of cables are separated in different cable trays.

Calibration of all BPM electronic modules was carried out to compensate the differences in length of the cables and the input powers by adjusting the on-board button attenuators: A, B, C and D until the SDEMOD signal has minimum level difference, meanwhile X and Y reading from a digital multi meter are closed to zero or within ± 20 mV (find more details in Ref. [4]). A good BPM electronic performance indicates by linearity behavior over the dynamic range when the power difference between input signals is kept to a minimum. This is obtained for a centered beam and four-cables with equal attenuation [4, 5]. Figure 4 shows the measurement setup on site using Bergoz toolkit (table-top test kit: BPM-KIT) [4].

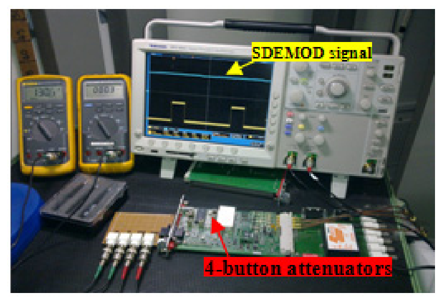


Figure 4: The measurement setup for the calibration of the BPM electronic modules.

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 BPMs before and after the replacement of BPM signal cables and proper cabling task have been done. Before the cabling problems were fixed, the X and Y positions obtained from all BPMs fluctuated all times. The maximum horizontal and vertical changes in 5 hours were about 150 and 170 µm, respectively. In some cases, we found that without connecting the cables to BPMs, irregular signals were also observed. After the cabling problems were fixed, the fluctuations of the X and Y positions are dramatically reduced to about 20 micron. The results show a significant increase of BPM reading performance.

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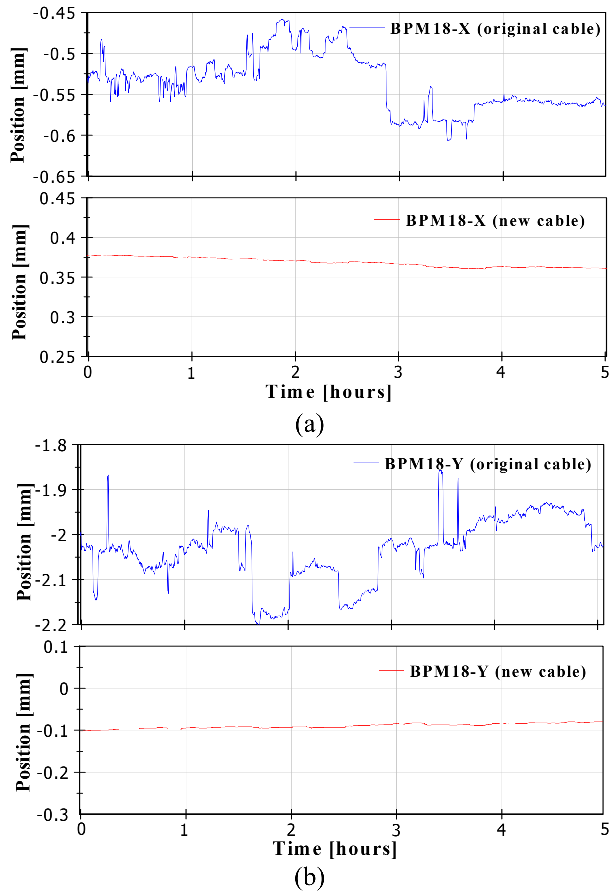

Figure 5: The BPM no. 18 reading during machine operation.

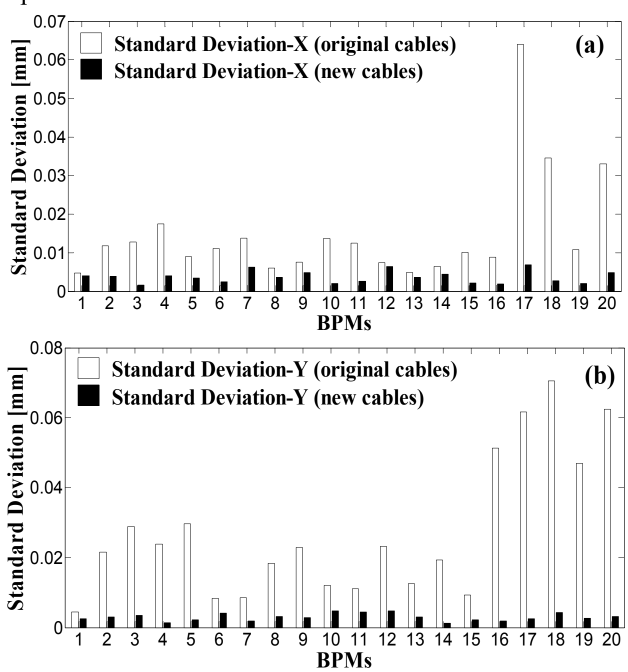

Figure 6: The bar plot of the standard deviations before and after BPM cable replacement.

Figure 6 shows the standard deviations of X and Y positions obtained from all BPMs before and after the cabling problems were fixed. The open and filled bars correspond to standard deviations of the BPM readings before and after the cabling problems were fixed, respectively. The results show the big improvement of the BPM system of the SPS storage ring.

CONSLUSION

The major causes of the unreliable signals from the BPM system of the SPS storage ring have identified and solved. The improper signal cables and cabling task for all 20 BMPs was the major caused. The old cables were replaced with better quality cables, and new cabling task was carried out to separate different types of cables in separated cable trays. The improved BMP system has opened opportunities for machine study to improve the beam quality that had not been possible since the machine produced its first synchrotron light.

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