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DEPENDENCY MEASUREMENT OF BPM READING IN THE HLS-II STORAGE RING*

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Abstract

Beam orbit stability is essential for the operation of the storage ring based light sources. Orbit feedback systems are commonly adopted to maintain the beam on a reference orbit. Affected by its temperature, change of BPM reading leads to shift of the beam reference orbit. Online experiment is carried out in the HLS-II storage ring to measure the dependence of the BPM reading on the BPM temperature during top-off and decay operation. The result shows that the average change of BPM readings due to BPM temperature variation is about 147 µm horizontally and 47 µm vertically.

INTRODUCTION

Generally, beam orbit stability is required to be better than 10% of the beam size. With the help of the orbit feedback system, the beam is maintained on a reference orbit. However, factors that affect beam position monitor(BPM) reading lead to shift of this reference orbit, which greatly degrades the beam orbit stability.

Factors that affect BPM reading are found in many storage rings. In the Duke storage ring, the dependence of BPM reading on beam current is found to be caused by overloading BPM electronics with high peak voltage [1]. At DIAMOND, the dependency of beam current, filling pattern and enviornmental temprature is studied for the EBPM electronics [2]. At PLS, the BPM chamber movement due to the change of synchrotron radiation heat load and intensity dependence of BPM electronics is found to cause false BPM readings [3].

The button type BPM measures the shift between the beam and the electrode center through the induced charge on the button electrodes [4]. However, the electrode position changes with the movement and deformation of the BPM chamber caused by the parasitic heat load of machine impedances and synchrotron radiation. Therefore, change of BPM reading occurs in spite of an unchanged beam position.

In the HLS-II storage ring, the typical beam size at the middle of the long straight section is 742 µm in the horizontal plane and 76 µm in the vertical plane. Neglecting the change of the reference orbit, the overall beam orbit stability is better than 2 µm in both vertical and horizontal plane with the help of the orbit feedback system [5]. The reference orbit is determined using beam-based alignment(BBA) technique. Being the target of the orbit feedback system, the consistency of the reference orbit is critical for orbit stability.

In this paper we present the on-line measurement of the de-pendence of BPM reading on the BPM temperature during top-off operation and decay operation.

TEMPERATURE DEPENDENCY OF BPM READING

In the HLS-II storage ring, the orbit feedback system is comprised of 32 BPMs and 32 correctors for each plane. To measure the BPM temperature, two temperature sensors are attached to the upper and lower outside surfaces of each BPM.

Change of BPM temperature occurs during top-off oper-ation after injection and decay operation. Because of the hysteresis of the mechanial movement due to thermal effect, the dependncy measurement is carried out in two operation modes, when the orbit feedback system is turned off. To minimize the disturbance to the beam orbit, the gaps of all insertion devices are kept unchanged.

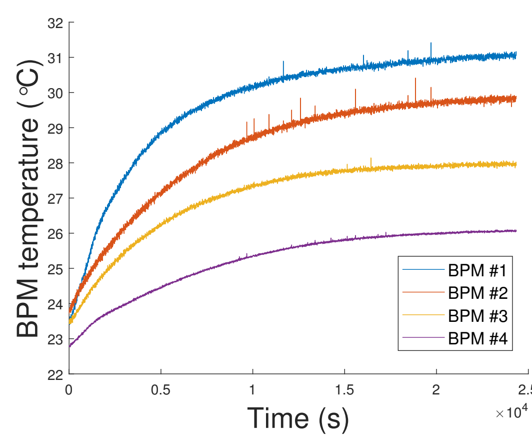

Figure 1: Measured BPM temperature during 400 mA top-off operation after injection.

MEASUREMENT FOR TOP-OFF MODE OPERATION

Before beam injection, the BPM temperature drops to the ambient temperature level of the storage ring tunnel. The measurement starts after the beam is injected to 400 mA with subsequent top-off operation while the orbit feedback system is turned off. During top-off operation, the BPM temperature increases due to the parasitic heat load of ma-

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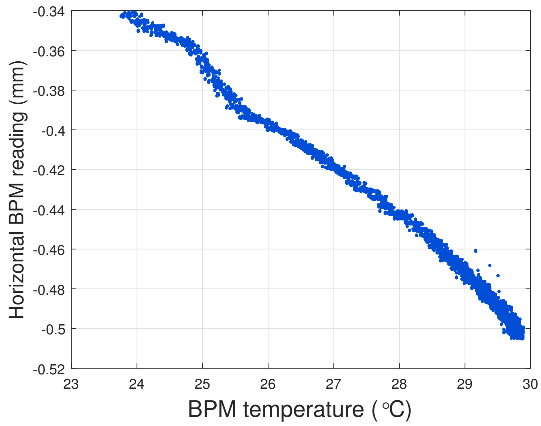

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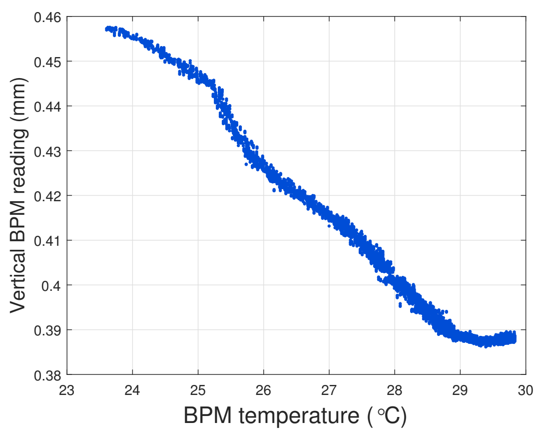


(b)

Figure 2: The BPM reading dependency of its temperature during top-off operation. (a) Horizontal BPM reading. (b) Vertical BPM reading.

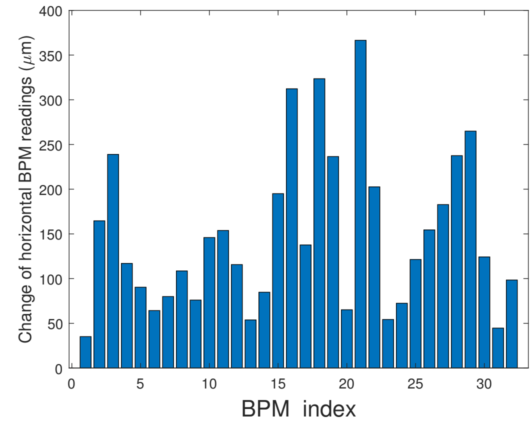
chine impedances and synchrotron radiation. The measured temperatue of four BPMs is shown in Fig. 1.

The average value from the two temperature sensors is used as the BPM temperature. The measured temperature dependency for one BPM is shown in Fig. 2.

Figure 3 shows the variation range of BPM readings caused by the change of BPM temperature during top-off operation for all BPMs. The average BPM reading variation is around 147 µm in the horizontal plane and 47 µm in the vertical plane. The related BPM average temperature changes from 23.3 °C to 28.2 °C.

MEASUREMENT FOR DECAY MODE OPERATION

Before decay, the storage ring is operated on top-off mode and the BPM temperature is on a high level. The measurement starts after the beam decays from 400 mA while the orbit feedback system is turned off.



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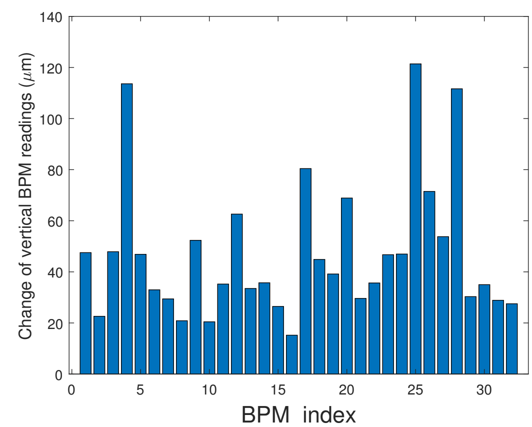

(b)

Figure 3: Range of BPM reading variation caused by change of BPM temperature for all BPMs during top-off operation. The average BPM temperature increases from 23.3 °C to 28.2 °C. (a) Range of horizontal BPM readings. (b) Range of vertical BPM readings.

During decay operation, the BPM temperature drops with the decrease of the beam current. The measured temperature dependency for one BPM is shown in Fig. 4.

Figure 5 shows the variation range of BPM readings caused by the change of BPM temperature during decay operation for all BPMs. The average BPM reading variation is around 60 µm in the horizontal plane and 32 µm in the vertical plane, which is differnt from the result of BPM temperature dependency measurement in top-off operation. During this measurement, the average BPM temperature changes from 28.2 °C to 26.8 °C. The beam current changes from 400 mA to 190 mA.

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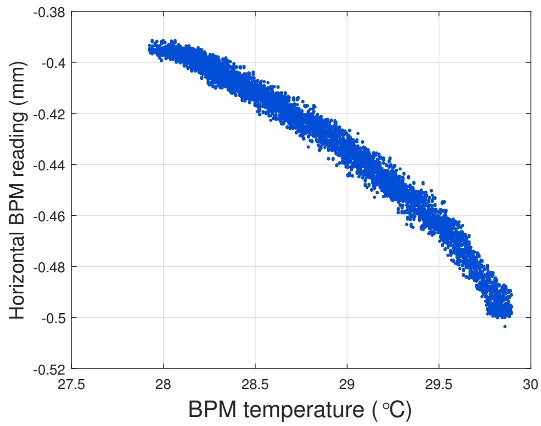

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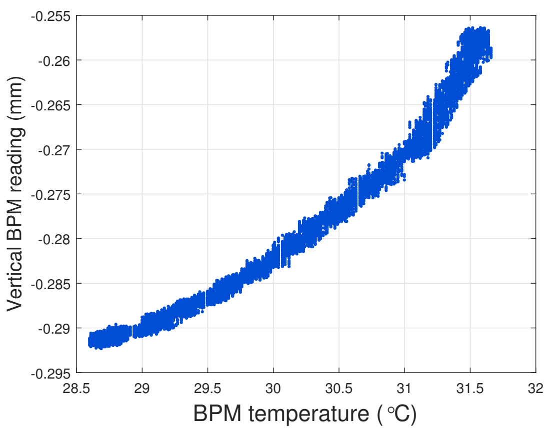
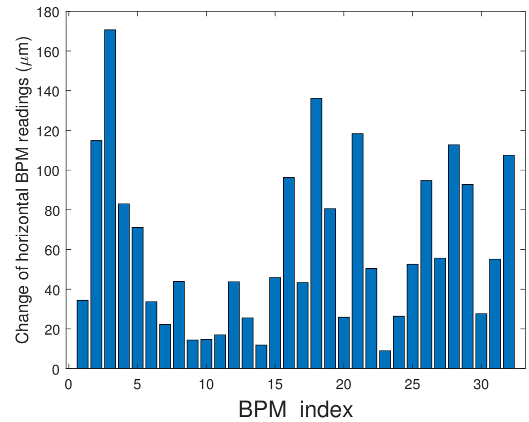


(b)

Figure 4: The BPM reading dependency of its temperature during decay operation. (a) Horizontal BPM reading. (b) Vertical BPM reading.



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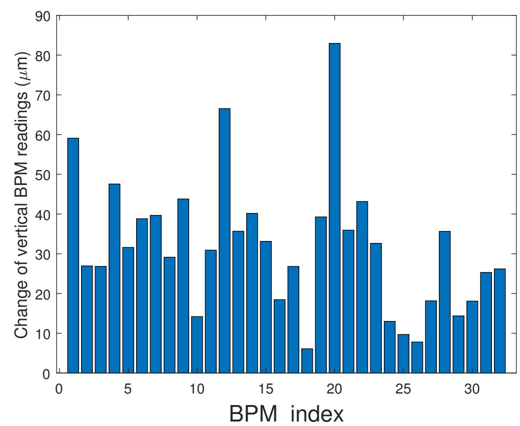

(b)

Figure 5: Range of BPM reading variation caused by change of BPM temperature for all BPMs during decay operation. The average BPM temperature decreases from 28.2 °C to 26.8 °C. (a) Range of horizontal BPM readings. (b) Range of vertical BPM readings.

SUMMARY

In the HLS-II storage ring, on-line experiment is carried out to measure the BPM reading dependency of its temperature in top-off operation and decay operation. The average change of BPM readings caused by BPM temperature variation is around 147 μm in the horizontal plane and 47 μm in the vertical plane with the related average BPM temperature increasing from 23.3 °C to 28.2 °C. The average change of BPM readings with decreasing temperature is around 60 μm horizontally and 32 μm vertically when the beam current decays from 400 mA to 190 mA. For further work, a reference orbit compensation system can be developed to improve the orbit stability according to the measured dependency, which is more important for a fourth generation storage ring with a much smaller beam size.

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