Photon BPM Electronics Development at Taiwan Light Source

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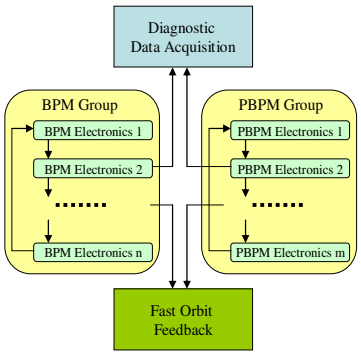
Abstract

Photon BPMs are very useful for photon beam position measurement and stability observation. There are several kinds of photon BPMs and electronics with different design installed at beamline front-ends at Taiwan Light Source. To provide a better integration and efficient usage of the photon BPM, a commercial BPM electronics - Libera Photon was chosen for an integral solution and has showed at least one micron performance for several months of testing. In this report, the installation process and testing results of the photon BPM are presented.

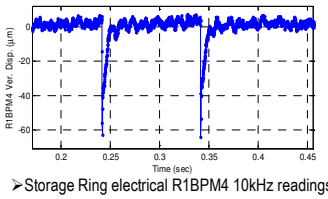
Introduction

- The blade-type pBPM was chosen for less thermal effect and non-destructive way in TLS.
- 2-blade pBPM has been install to detect vertical position of bending magnet and insertion device beamline.
- 4-blade pBPM for both vertical and horizontal detection of undulators.
- It is planned that the system could be integrated with machine control system and have features of easy access from the beamline control system, embedded current-to-voltage converter, embedded high performance ADCs, local computation capability, and integrated control system interface.
- Commercial available Libera Photon is chosen to integrate photon BPMs into control system seamlessly and it is also capable to measure high-frequency motion of the photon beam up to 10 kHz.

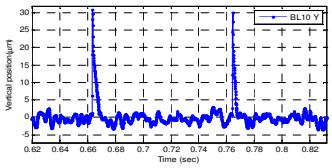
Fast Motion during Injection



➢Fast links of electrical and photon BPM for diagnostic and possible FOFB application.



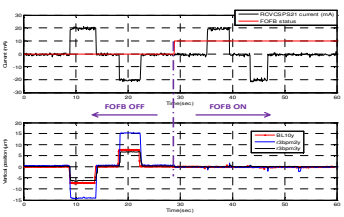
➢Storage Ring electrical R1BPM4 10kHz readings during injection.



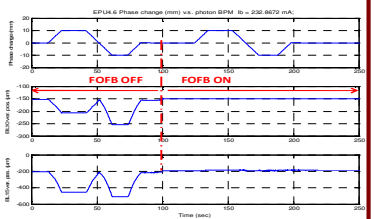
➢BL10 pBPM vertical position 10kHz readings during injection.

- The data flow of Libera Photon is somehow similar with the electrical BPM Libera Brilliance therfore it provides 10 kHz fast data through a dedicated network and enables the synchronous data acquisition between electrical and photon BPM.
- The above left figure shows the possible layout for diagnostic and orbit feedback application.
- Synchronize mechanism allows to correlate beam behaviour of electrical and photon beam. Another network dedicated for photon BPM would not interfere the operating FOFB system during user time.
- The fast links could clarify some fast transient motions of electrical and photon beam and help to improve orbit stability. The above right two figures show an example: the vertical positions of R1BPM and PBPM10 during injection. The behaviours of both are quite similar.

Primary Test by Corrector Kick and ID Phase Change



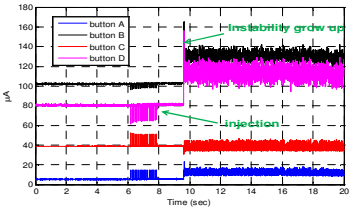
➢ Beamline 10 photon BPM 10Hz reading signal related to the ring BPM.



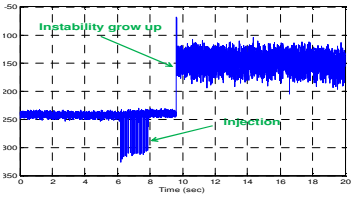
➢Beamline 10 & 11 photon BPM vertical position change v.s. EPU 4.6 phase change with/without FOFB.

- In this primary test, we made one of vertical correctors (RCVCSPS21) driven by a square wave kick and the orbit change were monitored by the pBPM and eBPM. The results were shown as the above left figure. It can be observed that during FOFB off the corrector changes will cause orbit position over 10 um displacement while during FOFB on the displacement is almost suppressed for the same corrector change.
- The above right figure shows another study of EPU5.6 phase change with/without FOFB. It can also be observed clearly that FOFB could almost suppress the displacement from several hundreds of micron less than one micron.

Transverse Instability Effect on Photon Beam Position



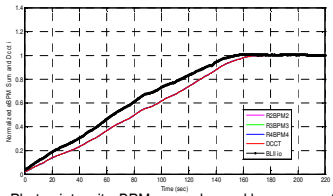
➢ The four blades reading for transverse bunch-by-bunch feedback on/off.



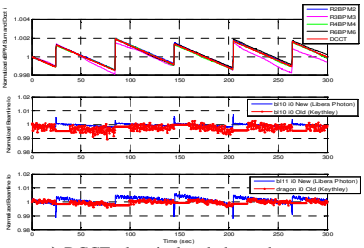
➢ The horizontal photon beam position change for TBF on/off.

- In the past post-mortem analysis, the data had often been revealed that the photon beam position changed before the beam trip while the electronic orbit was not presented such the similar drift behavior. It seemed to happen accompanying with transverse bunch-by-bunch instability. To clarify the phenomenon, the experiment of transverse instability effect on photon beam position was done.
- The above figures the corresponding horizontal position and four blades change before and after transverse bunch-by-bunch feedback on/off. The photon currents of the four blades became quite noisy when instability grew up and blade B and D increased around 30% but blade A and C remained. It thus resulted in the horizontal photon position changed 90 um and the vertical change 25 um. However, the instability actually did not affect the electrical beam orbit.
- The fake position change could be caused by the geometry of pBPM.
- The longitudinal instability experiment was also done while the longitudinal instability affect neither blades readings nor position calculation.

Performance Comparison of Application on Beamline Intensity Measurement

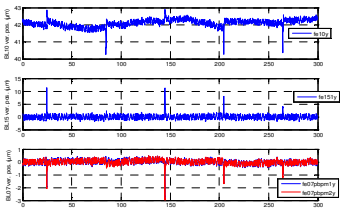


➢ Photon intensity, BPM sum value and beam current change during injection from zero to 360 mA.



➢DCCT, electrical and photon beam intensity in top-up mode.

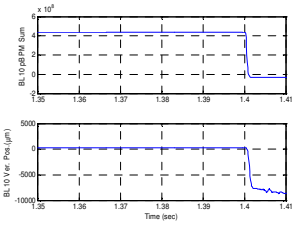
- The right above figure shows the DCCT, electrical and photon beam intensity in top-up mode. DCCT and eBPM sum measurement seems apparently precise and is independent of beam position change (see right below fig.) compared pBPM while it still could be an auxiliary tool compared to the past old Keythley meter.
- The above figure shows the similar photon intensity, BPM sum value and beam current change during injection from zero to 360 mA. The data looks smooth due to the continuous injection and linearity with beam current looks better.



➢The corresponding pBPM position change of the above figure.

Post-mortem Functionality of photon PBM

- The photon BPM is equipped with post mortem buffer up to 16000 samples which can record 1.6 sec data changes before and after external beam trip trigger according to post-mortem buffer offset.
- The recorded length is allowed to observe the orbit related behaviour. High bandwidth also enables to look at some fast transient variation.
- It is planned to be integrated into the existing post-mortem diagnostic system.
- The right figure shows the post-mortem data at one beam trip event. Trip signal arrived at time 1.4 sec.
- According the data, although it can't be figure out the exact cause of this trip, it can be at least excluded the causes from orbit change neither partial beam loss.



➢ BL 10 Photon BPM post-mortem data. The beam trip occurred at time 1.4 sec.

Summary

- This report presents the several primary tests of photon BPM electronics.
- It displays competing sub-micron performance and provides various data flow to observe fast transient and slow averaging photon motions in real time.
- The EPICS compatible environment is also very beneficial to integrate with the control system of the future TPS project.
- Since the fast links is also compatible with the TPS orbit feedback control system, its possible application in the orbit feedback will be carefully considered.

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