DATA ACQUISITION AND STUDIES OF VIBRATION MOTION IN TLS BEAMLINES

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Abstract

TPS (Taiwan Photon Source) is being under construction while TLS (Taiwan Light Source) is still on operation at the same NSRRC site. It was observed that the stability of photon beam intensity (Io) of TLS seemed a little deteriorated at daytime, when civil work is busy, compared to the nighttime. The intensity changes at different beamlines, however, aren't consistent with each other in each time, furthermore not so agreeing with the electron beam. Therefore, to correlate how the ground vibration due to civil construction effected on beam behaviour, the vibration measurement system is integrated into the existing TLS control system. The system will support waveform acquisition which could be acquired on demand. Meanwhile, realtime 10 Hz rms detector which could be archived continuously is also considered to be built in the future.

INTRODUCTION

The TPS is a 3 GeV energy electron ring with 512 meter circumference and planned to be delivered to users' end stations in 2014. During the periods of its constructions, the TLS at the same site will continuous be on operations. The quakes caused by excavators or pile drivers as Fig. 1 seem to have deteriorated the stability of beamline intensity (ΔIo/Io) from 0.1% up to 10% or more. On the other hand, these stability indicators ΔIo/Io between different beamlines have been not always concordant. Furthermore, it has been confused us over a long period that the indicators sometimes became worsen while the related subsystem remained normal even before TPS construction. It is suspected that different characteristics of vibration of different girders quite would be one of possible causes. Therefore, to clarify these inconsistent and not-yet-explained phenomena, the data acquisition system of vibration is planned to be built and continual expanded. In this report, the infrastructure of vibration data acquisition system will be presented as well as correlations of electron orbit, photon beam and vibrations of several spots will be shown.

INFRASTRUCTURE OF DATA ACQUISITION FOR VIBRATION

The DT8837 manufactured by Data Translation Inc. is employed as data acquisition tools for the accelerometers and photon intensity of beamlines distributed around the rings. The device supports functionality of bias current enable for ICP input. The equipped Ethernet interface is convenient for cabling and UDP trigger packet also provides sufficient synchronization mechanism for the distributed modules. Fig. 2 shows the infrastructure of the related system. All of the data from electron beam, photon beam, and vibrations could be synchronous acquired by software trigger within 100 msec. As Fig. 2 shown, besides the 10 Hz data from IOC/ILC could be acquired in real-time and archived, the fast transient motion could be also observed in adjustable higher time resolution and sampling rate up to 10 kHz.

Figure 1: TPS construction site in Sep 2010.

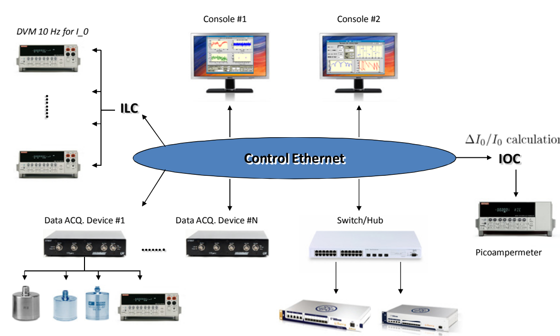
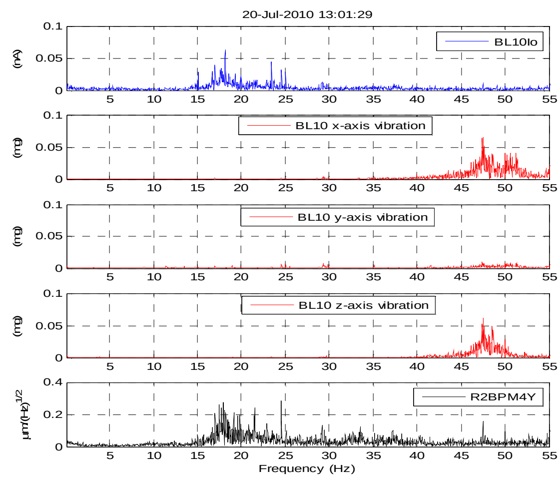


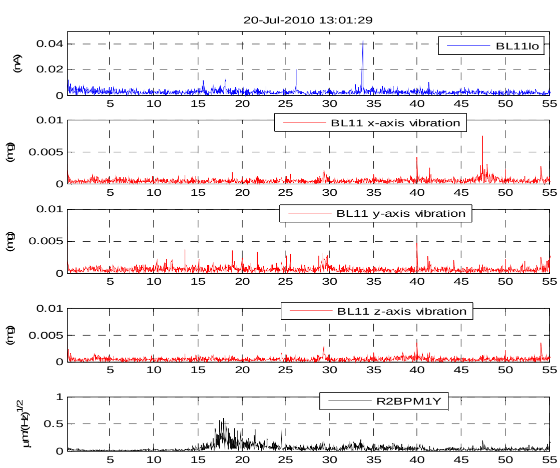
Figure 2: Infrastructure of data acquisition for vibration and the other related subsystem.

STATUS OF NORMAL OPERATION

Fig. 2 shows the normal status of the beam stability in quiet: the stability of beamline intensity (ΔIo/Io) is usually under 0.1%, the spectrum amplitude of electron beam stability is also less than 0.5 um below 50 Hz. The overall RMS stability of electron beam can achieve submicron level from DC to 50 Hz in normal operation [1][2]. The mechanic design of BL11 looks better than BL10's where the vibrations of three-axis at BL11 are all less than 0.01 mg and are less 0.1 mg at BL10 as Fig. 3. It is required further studied to seek for causes of these differences. It is clear from Fig. 3 that the spectrums of two electron BPM are very similar while they are not consistent with the spectrum of photon intensity Io between BL10 and BL11. Furthermore, even these two Io cannot agree with each other. The vibration characteristics of two beamlines are not consistent so much. The fact that 47.5Hz noise is observed in both of the electron beam and accelerometers but is invisible in photon beam. It seems very necessary with more sensors for detection and analysis.



(a)

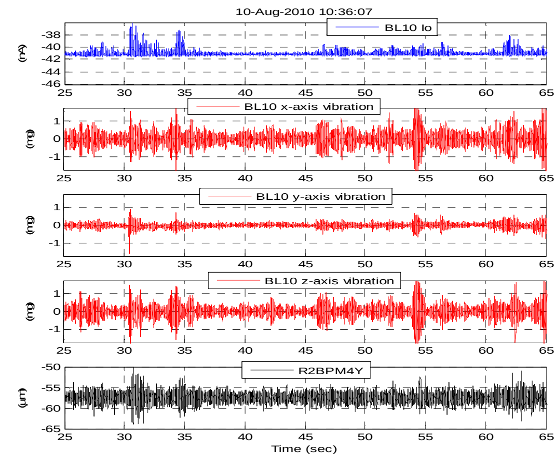


(b)

Figure 3: (a) Spectrum of BL 10 Io, three-axis vibration and electron BPM: R2BPM4Y. (a) Spectrum of BL 11 Io, three-axis vibration and electron BPM: R2BPM1Y.

LARGE VIBRATION CONDITION

The inconsistence of the above section is also presented when large vibration occurs. Although the scales of the instabilities of photon intensity and vibration became larger when excavators or pile drivers were operated, but the characteristic of the behavior is still quite differed. Fig. 4 shows one of the examples. It can be observed that in the time domain, the transient motions (spikes) occurred simultaneously but the spectrums of these signals aren't so correlated much as Fig. 5.



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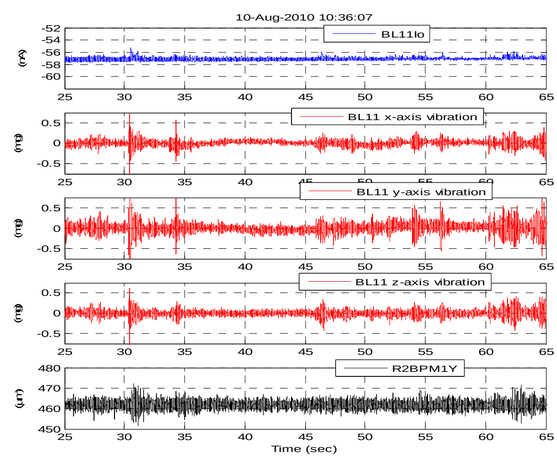
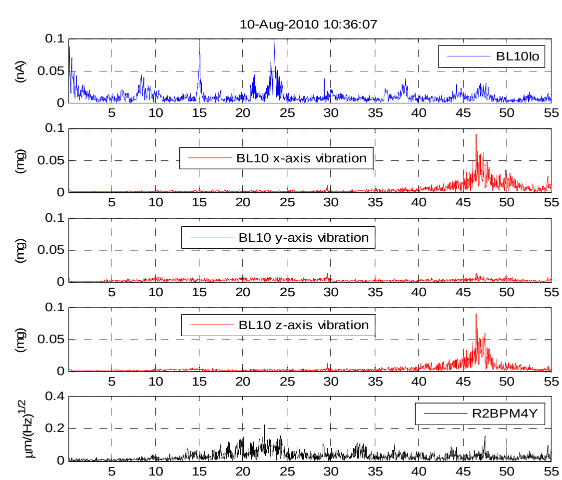


(b)

Figure 4: (a) Time series of BL 10 Io and three-axis vibration and electron BPM R2BPM4Y. (a) Time series of BL 11 Io and three-axis vibration and electron BPM R2BPM1Y when large vibration occurs.



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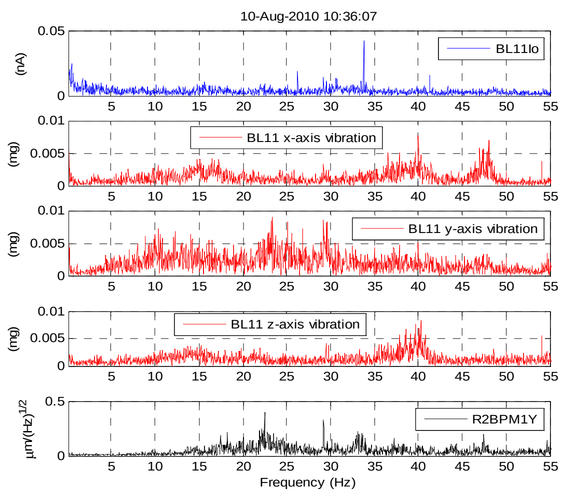
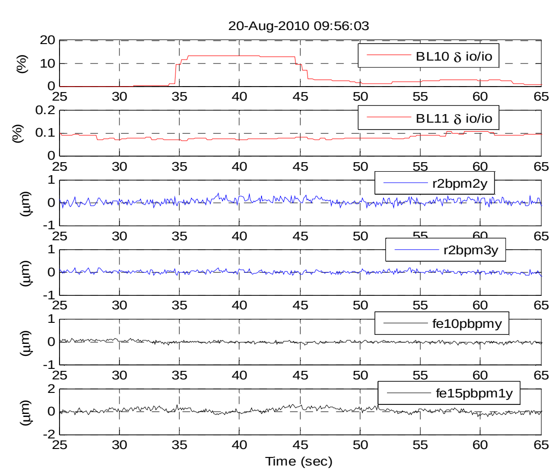


(b)

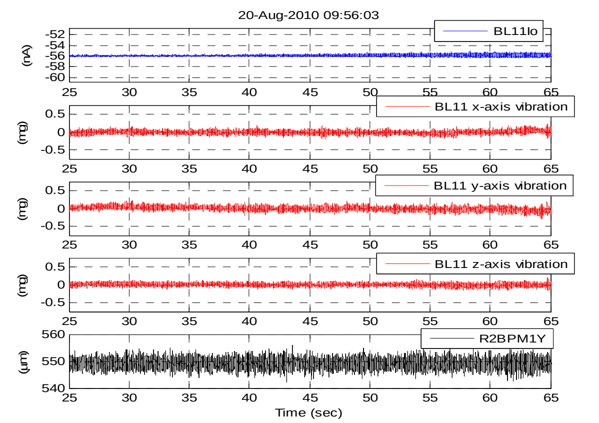
Figure 5: (a) Spectrum of BL 10 Io and three-axis vibration and electron BPM R2BPM4Y. (a) Spectrum of BL 11 Io and three-axis vibration and electron BPM R2BPM1Y when large vibration occurs.

△Io/Io change study

As Fig. 6 (a) shown, the stability indicators△Io/Io of one beamline (in this examples, BL10) became worsen sometimes. In the meanwhile, the other (BL11) still remained normal and the electron beam orbit was also steady. We check the vibrations of these two beamlines at that moment as Fig. 4 (a) & (b). Transparently, an individual vibration event nearby this beamline caused the BL10 quake. The vibration was local not global. If not all of the indicators △ Io/Io become worsen simultaneously, the indicators are meaningless. However, even if the global vibration result in instabilities, the change of photon beam motion is not majorly from electron beam but itself vibration contributed more. In fact, the electron beam is more stable than photon beam when large vibration occurs. The stability of photon beam deteriorated over twice while the electron beam almost not changed comparing Fig. 3 and Fig. 5.



(a)



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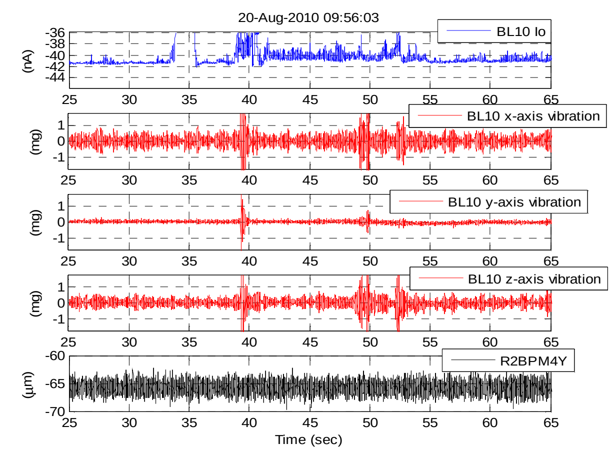

(c)

Figure 6: (a) 10Hz data of △Io/Io and electron and photon BPM (b) Time series of BL 10 Io and three-axis vibration and electron R2BPM4Y. (c) Time series of BL 11 Io and three-axis vibration and BPM R2BPM1Y when large vibration occurs.

SUMMARY

The installation of the accelerometers and its data acquisition are presented. The vibration acquisition system provides information about ground vibration so that it could be correlated with electron and photon beam. It helps to clarify some unclear events and contradictions in the TLS operation. For examples, the inconsistency of △Io/Io between different beamlines was possibly resulted from local ground motion. The characteristic of the different girders quite differed. The firmness of storage ring girder is better than beamlines and the electron beam are more immune from vibration than photon beam.

REFERENCES

[1] C. H. Kuo, et al., “Fast Orbit Feedback System Upgrade in the TLS”, Proceedings of ICALEPCS 2007.

[2] P. C. Chiu, et al., “Orbit Stability Observation of the Taiwan Light Source” , 2009 OCPA, January, 2009