Vibration and Beam Motion Diagnostic in TLS

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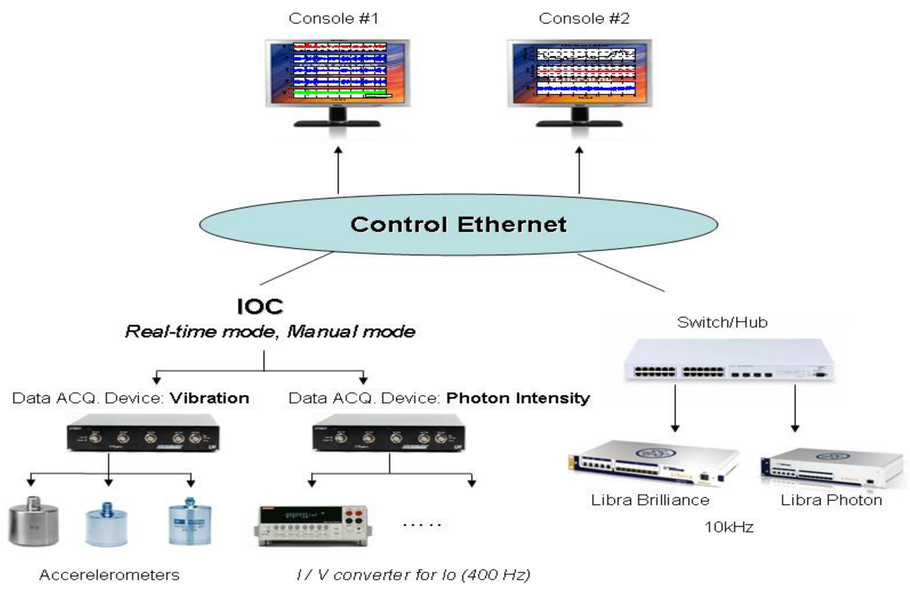
Abstract

Beam stability is crucial in a modern synchrotron light source. Beam motion caused by various factors should be remedy by various approaches to achieve high beam stability. Vibration will deteriorate beam stability and need consider as part for beam diagnostic. Due to the inconsistency sampling rates of different kind of devices, synchronize different kinds of the data acquisition system include BPM system, vibration monitoring system are need to correlate the relationship between event and data. An integrated environment for beam orbit and vibration monitoring system was sat up for various studies. Implementation details and some beam observation will present in this report.

Introduction

- TLS is still operating when TPS has been under construction, the excavating and pile-sinking at some specific time window in the civil construction works caused large ground motion suddenly.
- Furthermore deteriorated the stability of TLS beamline intensity (ΔIo/Io) from 0.1% to 10% or more.
- The stability of intensity between beamlines is not always consistency. In contrast with the inconsistency intensity between beamlines, the spectrum of electron beam is concordant while normal operation and large vibration occurred.
- To figure out these inconsistent results, the vibration diagnostic system is necessary to build and planned to be integrated with current diagnostic system.

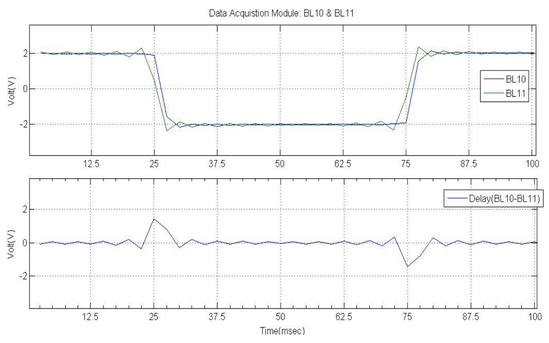
The Structure of Data Acquisition System



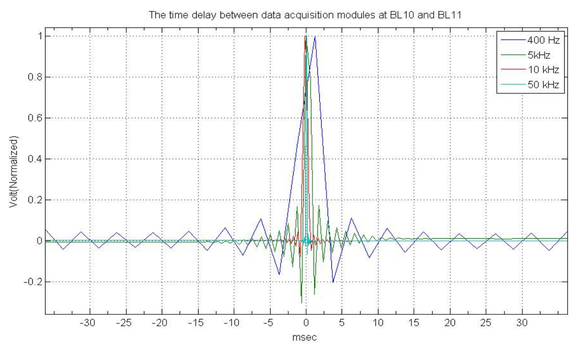
➢The data acquisition system for vibration diagnostic system with other subsystem.

- To implement a vibration monitoring system which is compatible with the TLS control system, the vibration data acquisition hardware should comply with the PC/Linux environment.
- Electron beam, photon beam and vibration are synchronized by a software trigger in 100 msec and 10 Hz data from 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.
- 4 channel, LXI-C comply DT8837 was chosen for connecting to voltage signals or ICP accelerometers at any places around the storage ring or experimental floor.
- An UDP trigger packet to start or to stop the data acquisitions for synchronization among multiple data acquisition modules.
- EPICS IOC is used to control DT8837 and convert data unit of the received data and supports two operation modes: one is real-time mode which updates and archived the waveform continuously and the other is on demand by manual or triggered by events.
- There are two nodes to capture the beam orbit data from the 10 kHz data stream of the BPM system (Ethernet grouping of the BPM Libera Brilliance units) are also available for orbit motion analysis.

• Synchronization time difference between DT8837 modules



➢ Synchronization time difference with 400 Hz.

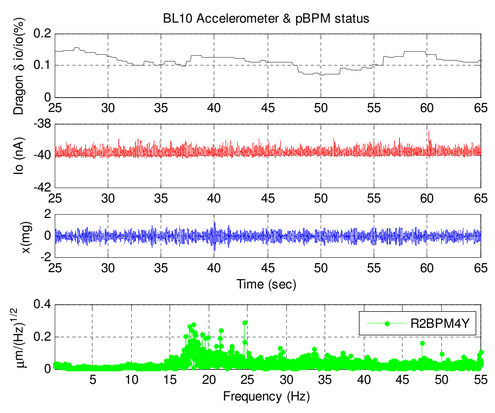


➢Synchronization test with different sampling rate.

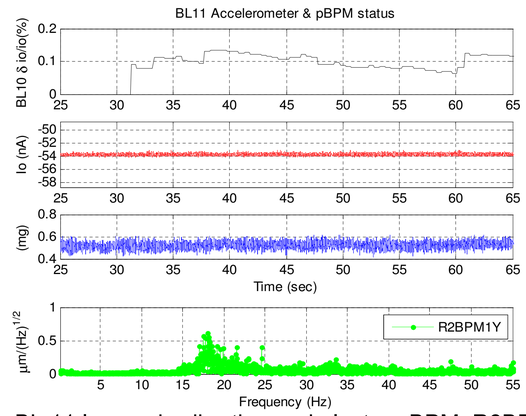
- The delay is differed for one sampling period maximum (2.5 ms for 400 Hz sampling). This time difference will drift slowly (unit dependent, ~ 30 sec for 400 Hz sampling) which is caused by the beating of the ADC clocks difference amount inputs.
- The UTP trigger package will be not contributed sensible delay problem for the sampling frequency up to 10 kHz.
- Phase difference (time difference) for analysis frequency up to 100 Hz, so 400 Hz is still acceptable.

Vibration Analysis with BPM Data

• The status of normal operation



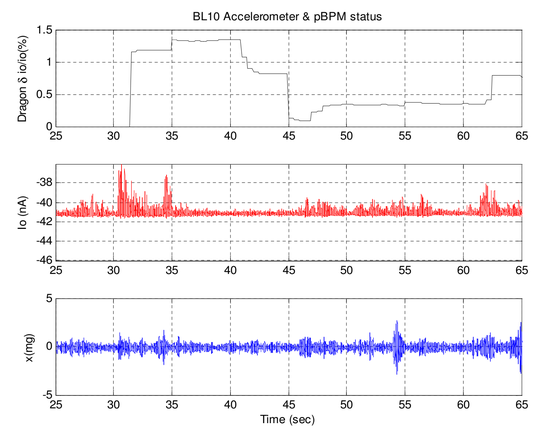
➢ BL 10 Io, x-axis vibration and electron BPM: R2BPM4Y.



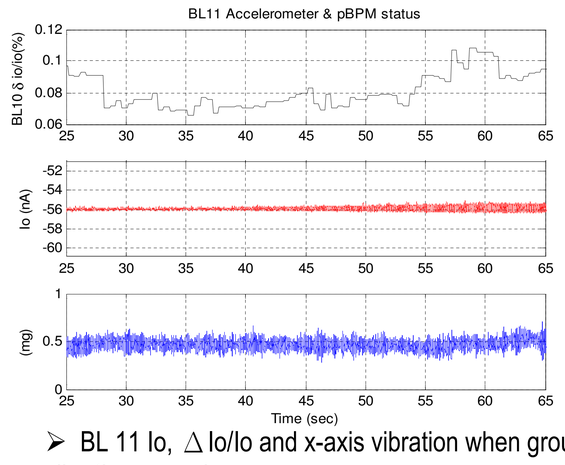
➢ BL 11 Io, x-axis vibration and electron BPM: R2BPM1Y.

- The stability of beamline intensity (ΔIo/Io) is below 0.1%, and the stability of electron beam is also within 0.5 um below 50 Hz.
- For BL10 and BL11, the spectrum of electron beam are quiet similar. However, the amplitude of vibration and photon intensity Io are not, so that vibration characteristics are not always consistent.

• ΔIo/Io Change Studies



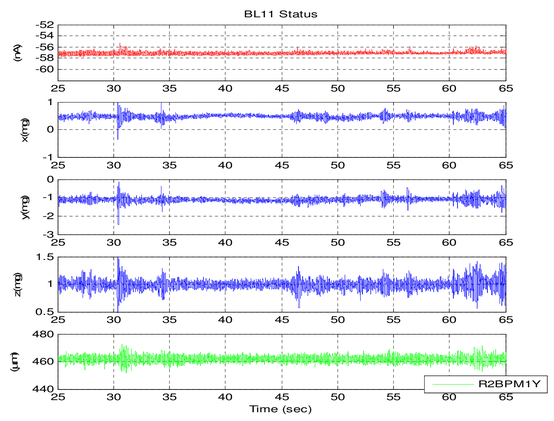
➢BL 10 Io, ΔIo/Io and x-axis vibration.



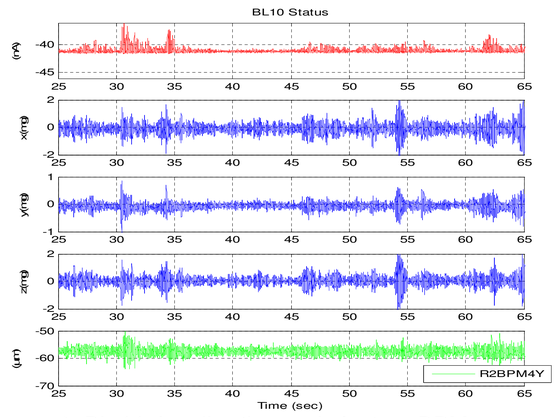
➢ BL 11 Io, ΔIo/Io and x-axis vibration when ground vibration occurring.

- By stability ΔIo/Io, the stability of BL11 is better than BL10. So, it is inferred there is a local vibration event nearby the BL10.
- Indicator ΔIo/Io is not a reasonable parameter to determine the relationship between electron beam and photon beam. .
- Besides, the deflection of photon beam is not the mainly resulted from electron beam even if the instability caused by global vibration but the local vibration contributed more.

• The vibration caused by TPS is under construction

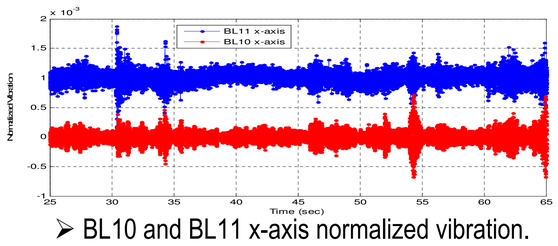


➢BL 10: Io, X, Y and Z-axis vibration and electron BPM R2BPM4Y.

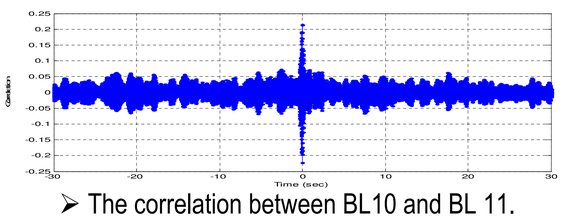


➢BL 11: Io, vibration and electron BPM R2BPM1Y during TPS civil is constructing.

- Enormous photon intensity (Io) variation due to the large vibration occurred.
- Spikes of vibration occurred simultaneously and the correlation coefficient is relative high at the time shifting interval from 0.4 to -0.4 sec.
- The amplitude of three-axis and photon intensity Io of BL11 is also smaller than BL10.
- As above reason, vibration source can be inferred by the same source but the spectrum inconsistency is due to the different natural frequency of different supports structure and chambers of different beamline.



➢ BL10 and BL11 x-axis normalized vibration.



➢ The correlation between BL10 and BL 11.

Summary

- In this report, we show the data acquisition of accelerometers and clarify some contradictive events among electron beam, photon beam and vibration while TLS is operating.
- For instance, the inconsistency of ΔIo/Io between beamlines was possible resulted from local grounding vibration.
- In addition, the characteristic between different beamlines girders are quiet differed.
- The firmness of storage ring girder is better than beamlines and electron beam which is more immune from vibration than photon beam. .

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