



# Integrating the Measuring System of Vibration and Beam Position Monitor to Study the Beam Stability

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## Abstract

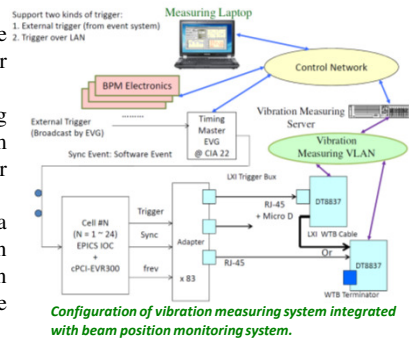
For a low emittance, third-generation light source such as Taiwan Photon Source (TPS), beam orbit motion needs to be controlled within submicron for obtaining a high quality light source. Magnets vibration especially quadruples will be one of the main sources to destroy the beam stability. In order to study the relationship between vibration and beam motion, a synchronous data acquisition system which integrates measurement of vibration and beam position monitoring system is highly desirable. For a larger vibration such as earthquakes are also deleterious to beam stability or even make the beam trip due to the quench of superconducting RF cavity. A data acquisition system integrated with an earthquake P-wave detector is also quite necessary to show and archive the data on the control system. First, the data acquisition systems of vibration and earthquake measurement are summarized in this report. The preliminary study of the relationship between the beam motion and magnets vibration will also be presented here.

## Introduction

- For a low emittance, third-generation light source such as TPS, it imposes a stringent requirement for the orbit stability.
- There are many sources which may destroy the beam stability such as vibration, ill function of power supply, septum/kicker field leakage, etc.
- To achieve submicron stability, various efforts and studies should be continuously performed such as power supply performance, RF system performance, cooling water, mechanical vibration, orbit feedback system and bunch-by-bunch feedbacks.
- Besides, it is also important to identify various sources and minimize their effect to the beam instability.
- In this paper, the data acquisition system and setup for measuring the vibration and beam position is introduced first.
- The preliminary vibration measuring results and beam stability study will also be summarized here.

## Vibration Detector and Data Acquisition System

- Low noise three-components seismometers, LE-3Dlite Mark II, with frequency range 1- 100 Hz is used in this study.
- The data acquisition unit (DT8837) provides Ethernet accesses via SCPI command to acquire data.
- Multiple DT8837s can be synchronized by wired trigger bus (WTB) interface.
- A Matlab script can be running in the sever for the long-term measurement or in the laptop for the short-term measurement.
- The synchronous data acquisition between vibration measurement and beam position monitoring system is through the timing system.

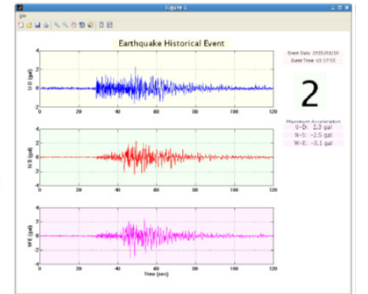
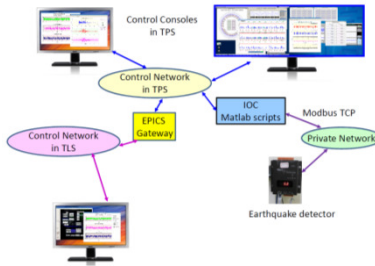


## Beam Position Monitoring System

- The TPS storage ring is divided into 24 cells and 7 beam position monitors (BPMs) are installed in each cell.
- Another six BPMs are installed at three long straight lines with inserting devices for the local measurement.
- The BPM electronics provide several data types for various application.
- Analog-to-digital converter (ADC) and turn-by-turn (TBT) data are acquired for first turn and betatron tune analysis.
- 10 Hz slow acquisition data (SA) is for DC average orbit; 10 kHz fast acquisition data (FA) could be applied for fast orbit feedback application and beam stability analysis.
- An EPICS IOC is embedded in the electronics platform to control, monitor and configure the BPM system in the control network.

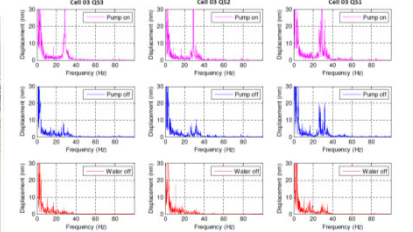
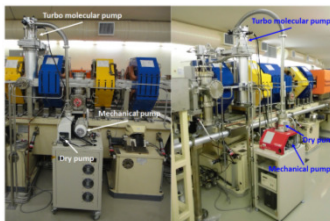
## Earthquake Monitoring System

- An earthquake P-wave detector which equips with MEMS accelerometers and an ADC with 16-bit output resolution is installed in the TPS building.
- A compiled Matlab program is used to communicate with the earthquake detector through Modbus TCP protocol, and to transfer the useful information into the created IOC through the soft PVs, shown in Fig. (a).
- As detecting an earthquake, the earthquake information with 30 seconds before trigger and 90 seconds after trigger is recorded in the archived file for further analysis, shown in Fig. (b).



## Vibration Caused by Turbo Molecular Pump System

- In the first phase commissioning during December 2014 to March 2015, an obvious beam motion around 29 Hz is observed. A sharp peak around 29 Hz can also be found in the magnet vibration.
- The vibration source is from the mechanical pump in the turbo molecular pump (TMP) system, shown in Fig. (a).
- Propagation path: Mechanical pump → Dry pump → Vacuum pipe → TMP → Vacuum chamber → Girder → Magnet.
- The peak of magnets vibration around 29 Hz is disappeared as the TMP system is turned off. When the cooling water of magnets and vacuum chamber is turned off, the vibration around 20 - 40 Hz is greatly reduced, shown in Fig. (b).



## Preliminary Analysis of Beam Stability

- In the beginning of the phase II commissioning, we found a 3-Hz oscillation in horizontal axis plane from the 10 Hz BPM data. As the ramping the booster power supply is turned off, the 3 Hz peak is disappear, shown in Fig. (a).
- In order to test the data acquisition between vibration and BPM system, the TPM in the 3<sup>rd</sup> girder of cell #7 is turned on. Comparing with the results as all TMP systems are turned off, a strong beam motion can be observed around 29 Hz in the vertical direction, shown in Fig. (b).
- As measuring the coherence between the quadruple vibration and beam motion, the coherence around 29 Hz is almost 1 and the coherence in the other frequencies is lower, shown in Fig. (c).

