The Beam Loss Monitoring System in Taiwan Photon Source

C. H. Huang, Demi Lee, Jenny Chen, Y. S. Cheng, K. H. Hu, C. Y. Wu, P. C. Chiu and K. T. Hsu

National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan

Abstract

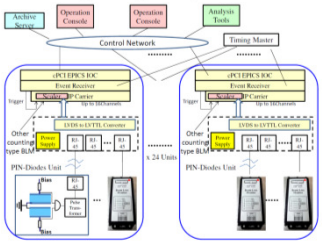
Taiwan Photon Source is a third generation and 3 GeV synchrotron light source during beam commissioning in NSRRC. Several types of beam loss monitors (BLMs) such as PIN diodes, scintillation detectors, Cherenkov BLMs and RadFETs are installed in the storage ring and booster ring to study the beam loss distribution and mechanism. The installation infrastructure, design of reader units and integrated graphic user interface will be described in this report. The preliminary experimental results will also be summarized here.

Introduction

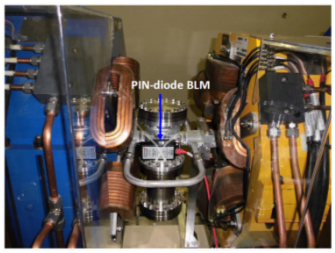
- Taiwan Photon Source (TPS) is a third-generation light source in NSRRC.
- It consists of a 150 MeV linac, linac to booster transfer line, 0.15–3 GeV booster ring, booster to storage ring transfer line, and 3 GeV storage ring.
- In the first initial phase for the beam-line commissioning, seven beam lines with ten inserting devices are installed in the storage ring. At the same time, two superconducting RF (SRF) cavities are also installed during this stage.
- To study the beam loss during the SRF and inserting device commissioning, several types of beam loss monitors (BLMs) are setup in the storage ring and booster ring.

PIN-diode Beam Loss Monitor

- Bergoz's PIN-diode BLM is made of two diodes mounted face-to-face. For the coincidence readout of the signal of two channels, the dual PIN-diode BLM detects charge particle rather than synchrotron radiation and reduces the dart counts due to the noise.
- To simply the wiring, a custom designed version of Bergoz's BLM was adopted in which the original 10 pin connector is replaced by a RJ-45 connector.
- Four pairs of twisted cables are used to connect BLM to the signal converter. This twisted cable provides power to a BLM and sends the coincident count pulse back.
- Data acquisition for BLMs is performed by a 16-channel scaler installed at the cPCI EPICS IOC on the equipment area. The configuration is shown in Fig. (a).
- Six PIN-diode BLMs in each cell are installed in the inside-wall chamber of the storage ring using cable ties or Kapton tapes as shown in Fig. (b).



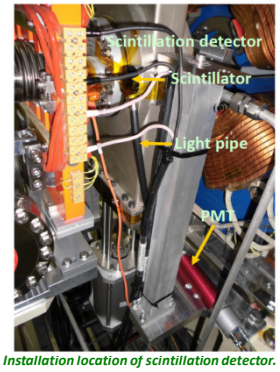
(a) Block diagram of the PIN-diode beam loss monitoring system.



(b) The setup of a PIN-diode BLM.

Scintillation-type Beam Loss Monitor

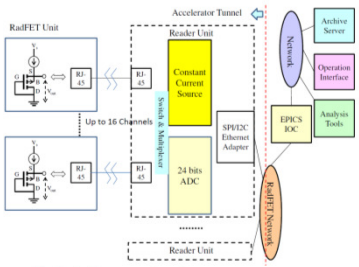
- Several scintillation type BLMs are installed in the first cell below the injection straight.
- It is consistent of a photomultiplier tube (PMT) and a probe which are connected with a 1m-long light pipe.
- A piece of plastic scintillator which is sensitive to the charge particles is installed in the probe.
- The diameter of the plastic scintillator is 30 mm and the thickness is 10 mm.
- In the first stage, the signal is observed by an oscilloscope.
- Another type of signal convert would be designed for the scalar input.



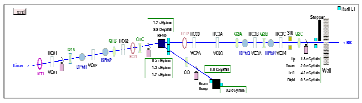
Installation location of scintillation detector.

Radiation-sensing Field-effect Transistor (RadFET)

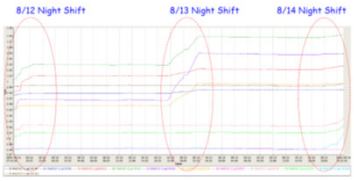
- The RadFET is a discrete p-channel MOSFET optimized for ionizing radiation.
- The threshold voltage of a RadFET between the gate and source changes due to radiation-induced charges in the oxide layer when applying a constant drain current.
- To obtain high-density installation, the reader is designed up to sixteen channels.
- A SPI interface is used to read the threshold voltage of RadFETs in an ADC. The process is controlled by a program inside the EPICS IOC in Fig. (a).
- Dosage rate is calculated by the EPICS record processing and published into control network.



(a) Block diagram of RadFETs setup.



(b) Values along accelerator synoptic display.



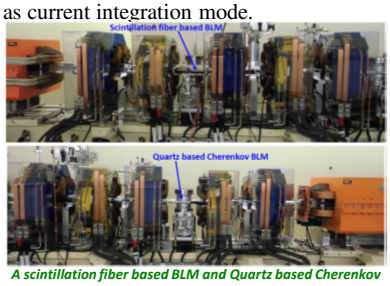
(c) The archived data of the threshold voltages of RadFETs installed in LTB.

- During the Linac and LTB commissioning, several RadFETs are installed in the LTB, shown in Fig. (b).
- The threshold voltage of RadFETs are recorded in the archive server, shown in Fig. (c) for further usage.
- RadFETs are also installed before the fifty-four bending magnets of the booster synchrotron.
- In the storage ring, six RadFETs in each cell are installed in the inside wall of the vacuum chamber, shown in Fig. (d).

(d) RadFETs are installed in the inside-wall chamber of the storage ring.

Miscellaneous Efforts

- Single PIN diode based solid ionization chamber accompanied with a current to frequency converter is in development.
- Scintillation based BLMs in ESRF type are also considered to be used to support various beam loss study.
- This detector includes Zynq based system-on-chip data acquisition unit which supports the counting mode as well as current integration mode.
- A scintillation fiber based BLM which equips with two silicon photomultiplier (SiPM) at both ends of the fiber is installed behind the injection straight in the first cell.
- A quartz rod based Cherenkov-type BLM which equips with two SiPMs at both ends of quartz rode is also installed here.



A scintillation fiber based BLM and Quartz based Cherenkov BLs are installed behind the injection straight.

Current Status & Summary

- Phase I commissioning was proceeded with two 5-cell PETRA cavities and without insertion devices from December 2014 to March 2015.
- RadFETs are setup in the LTB and booster ring to help beam commissioning.
- During the long shutdown from April to August, various devices of BLMs are setup in the storage ring. Data acquisition for counting type beam loss monitor were setup.
- The system testing is scheduled in September 2015 which accompanies with the phase II commissioning.

#E-mail: huang.james@nsrrc.org.tw