Diagnostics of the TPS booster synchrotron for beam commissioning

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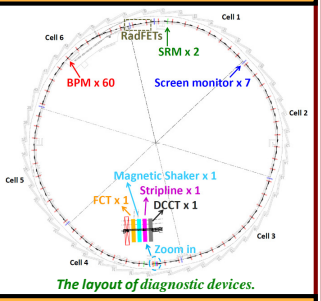
Abstract

Booster synchrotron for the TPS project is in commissioning. Diagnostics which consist of screen monitors, intensity monitors, beam position monitors, tune monitors, visible light synchrotron radiation monitors and RadFETs are integrated with the accelerator control system. Integration and functionality checks were done recently. Details of these diagnostics and preliminary test results will be summarized in this report.

Introduction

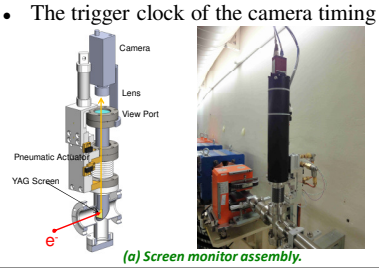
- Taiwan Photon Source (TPS) is a low emittance, third-generation light source in NSRRC.
- It consists of a 150 MeV linac, linac to booster transfer line, 0.15–3 GeV booster ring, booster to storage ring transfer line, and 3 GeV storage ring.
- The booster has 6 FODO cells which include 7 BD dipoles with 1.6 m long and 2 BH dipoles with 0.8m long in each cell.



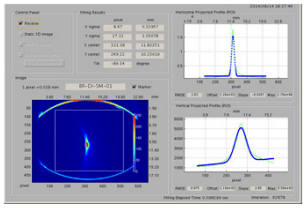
The layout of diagnostic devices.

Screen monitor

- Seven screen monitors, made of YAG:Ce, are designed in the beginning of six cells and behind the 1st DB dipole of the 1st cell for beam commission.
- The PoE switches are used to connect the cameras and to uplink to the vision system EPICS IOC.
- The trigger clock of the camera timing is locked with TPS injection system.



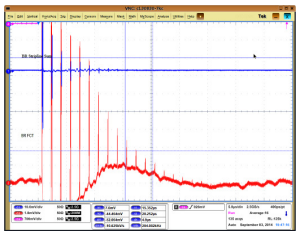
(a) Screen monitor assembly.



(b) The image profile as the beam passes through the 1st screen of the booster ring.

Current intensity monitor

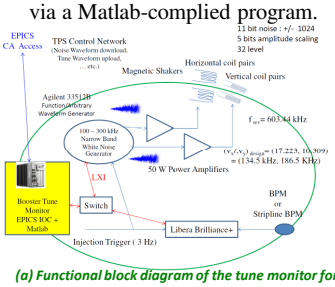
- A fast current transformer (FCT) is used to observe the filling pattern.
- The trigger is delivered by the timing system, which can shift to any step of beam energy during a ramping cycle.
- Average beam current is measured by a NPCT, in which current waveform can be obtained using analog-to-digital converter (ADC) and the average beam current can be obtained using a digital voltmeter.



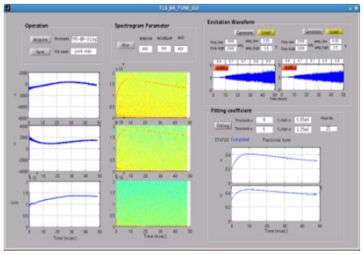
Beam singles observed by FCT and stripline showing in an oscilloscope.

Tune monitor

- A magnetic shaker is installed in the 4th cell to continuously excite the beam for the measurement in a ramping cycle.
- The turn-by-turn beam oscillation data is observed by the BPM electronics via a Matlab-complied program.



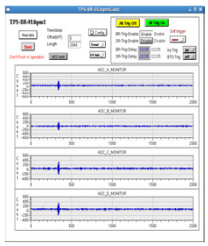
(a) Functional block diagram of the tune monitor for the TPS booster synchrotron.



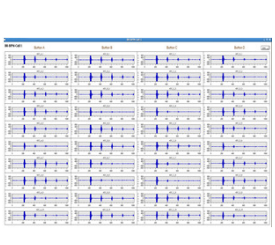
(b) Graphical user interface of tune monitor.

Beam position monitor

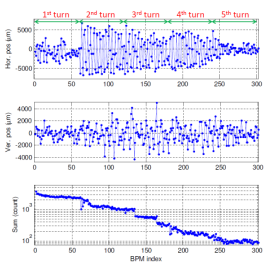
- The booster synchrotron equips with 60 button-type BPMs using Libera Brilliance+ electronics.
- All cables are assembled with equal length to achieve equal attenuation, and it will make the sum signal as an intensity indicator.
- BPM electronics supports beam position and intensity data for commissioning and routine operation.
- It is shown in Fig. (a) that the first beam passes through the injection septum and kicker and then arrives the 1st BPM of the booster synchrotron.
- The ADC raw data, single pass, turn-by-turn, 10 kHz and 10 Hz beam position data will be deployed and accessed by EPICS PVs.
- The ADC raw data and trajectory of the beam which has completely circulated more 5 turns are shown in Fig. (b) and (c).



(a) ADC raw data as first beam passes through the 1st beam after the kicker.



(b) The ADC data as the beam circulates complete 5 turns in the booster.



(c) The trajectory of the beams.

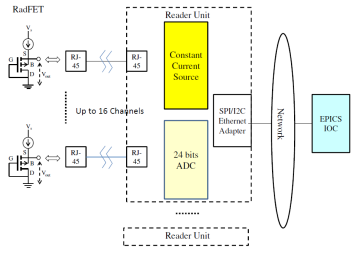
Synchrotron radiation monitor

- There are two synchrotron monitors, in which two extraction viewport are installed at the 2nd BH dipole of the 1st cell and 4th cell.
- One port can extract light outside the shielding wall for the possible measurement of a streak camera.
- Beam size of the booster synchrotron radiation is captured a GigE vision CCD camera using a external trigger synchronized with the machine cycle.

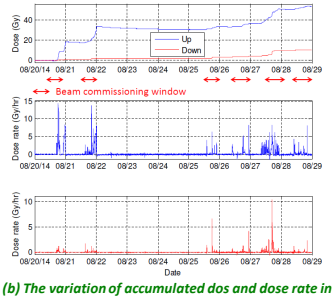
The setup of synchrotron monitor.

Radiation sensitive MOSFET

- A prototype RadFET reader, shown in Fig. (a), has been implemented, in which one reader unit can accommodate up to 16 RadFETs.
- The accumulated beam loss and beam loss rate in the up side and down side of the chamber after the kicker is shown in Fig. (b).



(a) Block diagram of the RadFET.



(b) The variation of accumulated dos and dose rate in the up and down side of the chamber after the kicker.

Current status & summary

- Final system integration test and preliminary beam commissioning of the booster synchrotron is in progress.
- Beam was circulated one turn soon after commissioning work started.
- Effort to store beam and ramp to 3 GeV is current efforts.
- Diagnostics for the booster synchrotron has been exercised with beam during the last several works.
- Functionality and software tool supports have been revised.
- Preliminary results shows the diagnostic support fulfills its role.

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