INTRODUCTION OF OPERATING PROCEDURES AT TPS

C.S. Huang, C. H. Chen, C.C. Liang, T.Y. Lee, M.S. Chiu, J.Y. Chen, Sam Fann, B.Y. Chen, W.Y. Lin, Y.C. Liu, and C.H. Kuo

National Synchrotron Radiation Research Center, Hsinchu, 30076, Taiwan, R.O.C.

Abstract

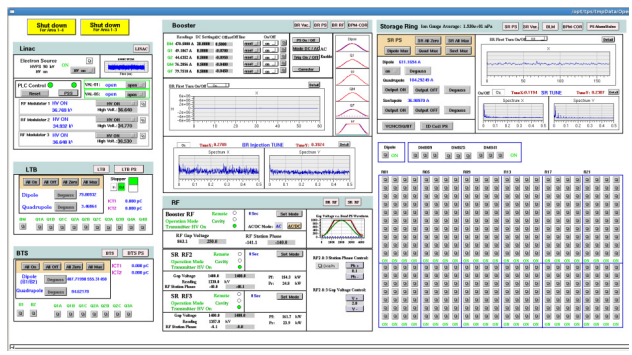
The Taiwan Photon Source (TPS) is the latest generation of 3 GeV synchrotron light source which subsystem includes magnet, power supply, vacuum, RF system, insertion device, control system, etc. The operating procedures and checking items are complex. To speed up the machine start-up and shut-down procedures, check the system's status, and prevent misoperation, we summarize the procedures for routine operation and develop the integrated control interface, which concentrates most machine information and control functions into a single window. This interface clearly indicates the machine status and improves operational efficiency.

INTRODUCTION

The Taiwan Photon Source (TPS) is the latest generation of 3 GeV synchrotron light source which has been under construction at the National Synchrotron Radiation Research Center (NSRRC) in Taiwan. It consists of a 150 MeV Linac, a 0.15 to 3 GeV booster ring, a 3 GeV storage ring, and two transfer lines, LTB and BTS. The TPS storage ring will provide 48 beam lines for users in the future. The storage ring has 24 DBA cells, 18 short straight sections (7m), 6 long straight sections (12m) and 2 SRFs [1]. The IDs, 7 in-vacuum undulators (IU) and 3 elliptically polarized undulators (EPU), are installed in the TPS storage ring to deliver 7 beamlines.

The EPICS (Experimental Physics and Industrial Control System) is a set of open source software tools, libraries and applications developed collaboratively and used to create distributed soft real-time control systems for scientific instruments such as the particle accelerators. The control system infrastructure of TPS is based upon the EPICS framework. [2]. The EDM (Extensible Display Manager) is an interactive GUI builder and execution engine. The integrated control interface of operation is built by using the EDM with the EPICS channel access client [3]. The EDM-based GUI and script were developed to run through all machine procedures, as shown in Figure 1.

The stability of electron beam for the TPS storage ring is related to the correlation among parameters, the installation of new equipment, and the optimization of subsystems are also ongoing. The operation procedure is complex and varied, which is why remembering each step is difficult. To improve the operation efficiency, handle the system's status, and prevent misoperation, the operation procedures must be simplified. Therefore, automation of the operation is an important point for the future [4].



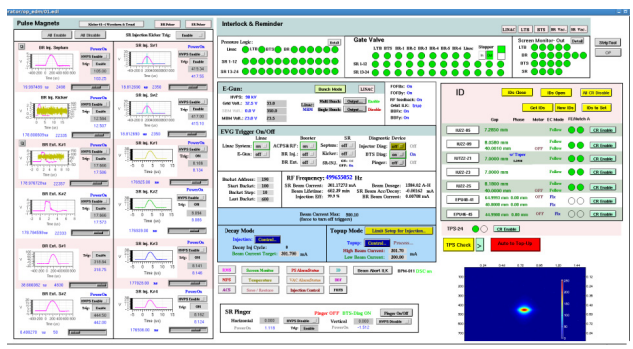


Figure 1: The integrated control interface of operation.

TPS OPERATION SUMMARY

The TPS includes magnet, pulser, power supply, vacuum, RF system, and insertion device. The operating procedures and checking items are complex. Reducing all control windows into one window and developing automatic programs are the main ideas for simplifying and streamlining the complex procedures.

The turn-on Procedure

The turn-on procedure of the TPS is as follows, the flow chart as shown in Figure 2.

1. Turn on linac to booster (LTB), booster to storage ring (BTS), and storage ring (SR) power supplies.
2. In order to establish reproducible magnetic fields, each magnet should be degaussed.
3. After degaussing, all power supplies' currents are set to max, and the desired lattice is loaded.
4. The booster ring (BR) power supplies are turned on, and the desired lattice is loaded.

ISBN 978-3-95450-182-3

5. BR and SR RF systems are set to operation mode.
6. BR and SR pulsers' high voltage and timing control are enabled.
7. Linac electron source and RF modulators are set to HV On; the desired lattice is loaded.
8. After all systems are ready, the vacuum valves and electron beam stopper will be open for injection.

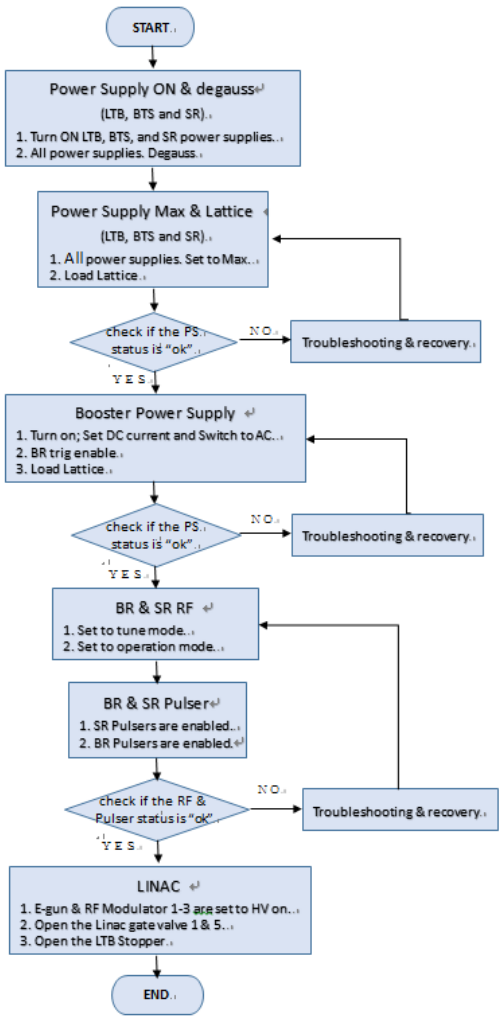


Figure 2: The flow chart of turn on.

The Turn-off Procedure

The turn-off procedure of the TPS is as follows, the flow chart as shown in Figure 3.

1. The beam current is checked to ensure that it is set to 0 mA, and the vacuum valves and electron beam stopper are closed.
2. Whether all IDs' gaps to their parking positions and all beamline frontends have been disabled are checked.
3. All power supplies' currents are set to zero (LTB, BTS, and SR).
4. LTB, BTS, and SR power supplies are turned off.
5. BR power supplies' trig is disabled and turned off.
6. BR and SR RF systems are set to off mode.
7. SR and BR pulsers' high voltages and timing control are disabled.
8. Linac electron source and RF modulators are inactivated.

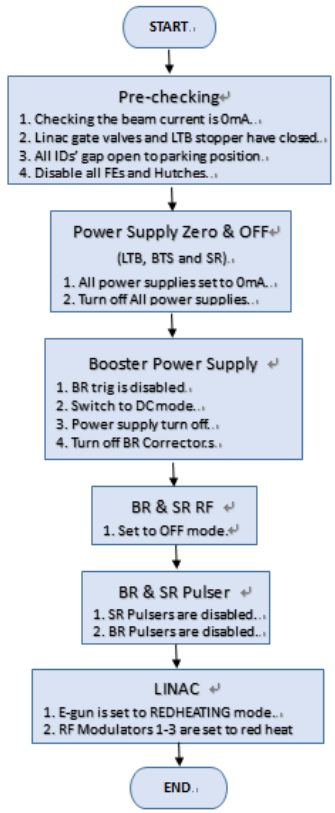


Figure 3: The flow chart of turn off.

Auto Top-up Injection

The main way is to simplify the procedures by developing an auto-injection program. After start-up of TPS, the auto-injection program is run. The program can automatically run the machine injection procedures and archive the orbit at 30 and 300 mA as follows. (Figure 4 and Figure 5)

1. Whether all IDs' gaps to their parking positions and all beamline frontends have been disabled are checked.
2. Orbit interlock, BBF, and FOFB are checked to see if they have been disabled.
3. Injection to 30 mA is performed.
4. Orbit correction and archiving at 30 mA are conducted.
5. The working tune is checked, and BBF is turned on.
6. Injection to target current (302 mA) is performed.
7. Orbit interlock and FOFB are enabled; IDs' gap is to target positions
8. The orbit is archived at 302 mA.
9. Top-Up operation is performed, and all beamline frontends are enabled.

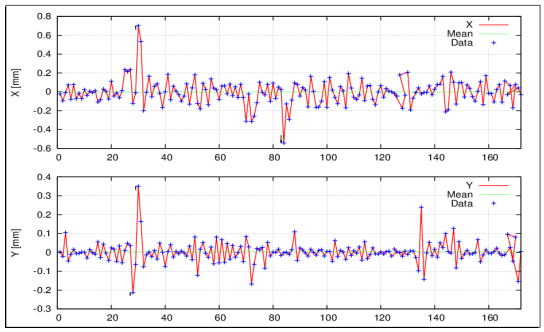


Figure 4: The archive of SR orbit (302mA).

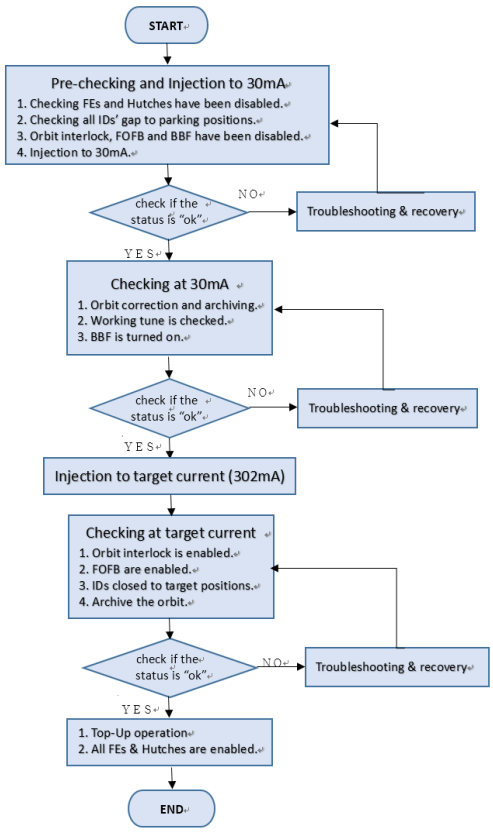


Figure 5: The flow chart of Injection

Auto Check of TPS

To allow the operator to check the system status faster, selecting proper parameters as key information is important. The operator can find abnormal problems for the machine within a short time by adding the TPS auto-check program. The key features of the program are as follows:

1. Checking LTB, BTS, and SR power supplies' current are in spec.
2. Checking vacuum valves and electron beam stopper are in the parking position.
3. Checking if BR and SR pulsers' high voltage and timing control are enabled.
4. Checking if BR and SR RF are in remote control and the voltages are normal.
5. Checking if SR BPM's switch is enabled and the status is normal.
6. Checking all screen monitors are in the parking position.
7. Checking if E-gun and linac modulators' HVPS are normal.
8. Checking if LTB slits are in the parking position.
9. Checking if BTS scrapers are in the parking position.
10. Checking if all functions are ready for injection.

One-button Shutdown

The one-button shutdown program can turn-off the machine within a short time. The program includes setting all power supplies to zero, turning off all power supplies, disabling pulsers, inactivating the linac electron source and RF modulators, closing the vacuum valves and the electron beam stopper. This program can be used in an emergency.

IDs' Gap Control

Ten IDs are present in the TPS SR. Before dumping the beam current, the IDs' gap must be open to their parking positions. For users' time, the IDs' gap must be close to the target. The programs can quickly control all IDs' gap to their parking positions or to the target positions. Also, they can save the IDs' current positions and close to their saving positions. The programs help an operator simplify the procedures for controlling IDs' gap.

CONCLUSION

In this report, we summarize the procedures and introductions for routine operation. In addition to following a machine's standard operation procedures, automatic turn-on, turn-off, and top-up injection programs were introduced to accelerate operation. The auto-check program can help find the abnormal status of the TPS. Some automatic programs that can help the operator simplify and streamline the complex procedures are still ongoing.

ACKNOWLEDGE

The signal resources provided by Instrumentation and Control Group and Vacuum Group are highly appreciated.

REFERENCES

[1] TPS Design Handbook, version 16, June 2009.
[2] EPICS: http://www.aps.anl.gov/epics/index.php
[3] Y. S. Cheng, et al. "Control System of The Taiwan Photon Source for Commissioning", IPAC, 3177–3179 (2014).
[4] T.Y. Lee, et al. "Development of Automatic Turn-On System for TPS MA-CHINE", IPAC, (2016).

ISBN 978-3-95450-182-3