

# CONTROL SYSTEM SOFTWARE ENVIRONMENT AND INTEGRATION FOR THE TPS

Y. S. Cheng, Jenny Chen, C. Y. Liao, P. C. Chiu, C. H. Huang, C. Y. Wu, C. H. Kuo, K. T. Hsu  
National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan

## Abstract

The TPS (Taiwan Photon Source) is the latest generation 3 GeV synchrotron light source, and the commissioning starts from third quarter of 2014. The EPICS is adopted as control system framework for the TPS. The various EPICS IOCs have implemented for each subsystem. The control system software environment has been established and integrated specifically for the TPS commissioning. The various purposed operation interfaces have been created and mainly include the function of setting, reading, save, restore and etc. The database related applications have been built, and the applications include archive system, alarm system, logbook, Web and etc. The high level applications which are depended upon properties of each subsystem have been developed and are in test phase. The efforts will be summarized at this report.

## INTRODUCTION

The TPS [1] is a latest generation of high brightness synchrotron light source which has been under construction at the National Synchrotron Radiation Research Center (NSRRC) in Taiwan since February 2010. The civil construction works are finished in later 2013. The TPS consists of a 150 MeV electron Linac, a 3 GeV booster synchrotron, and a 3 GeV storage ring, and the accelerator system installation and system integration had started from later 2013. The Linac and transport line (Linac-to-Booster) system had commissioned from half of 2014, and the booster ring is commissioning from the third quarter of 2014. The storage ring will schedule to commission from later 2014.

The EPICS (Experimental Physics and Industrial Control System) [2] framework was also selected as control system infrastructure for the TPS project. The EPICS platform has been gradually built and tested to control and monitor the subsystems of TPS. The various database records have been created for accessing the I/O data and setting parameters at the IOC (Input Output Controller) layer. Adopting the EPICS channel access mechanism with specific toolkits, the data can be accessed between the IOCs and the clients.

During the implementation process of the EPICS support for various subsystems, the operation interfaces of each subsystem are also developed according to the different operation methods. To simulate the operation process, the various operation interfaces are needed to integrate. The centralized management of the EPICS related files is also adopted, and the mechanism of save and restore will be continuously developed. The efforts will be summarized as following.

## SOFTWARE ENVIRONMENT

The client consoles are adopted the Linux operation system. All of the EPICS base, modules, extensions and specific operation toolkits are installed at the Linux system. All EPICS related files at control consoles are mounted from the file server by using the NFS service to simplify software version management. Various directories are created and saved into various versions of related files for various hosts and purposes. Various directories provide a mount point for hosts mounted according to various purposes. The directories include EPICS base, modules, extensions, GUIs, saved data, temporary data and etc.

Several file servers are established to share the loading of NFS file service. The hosts mount specific file server according to its location and purpose. By loading testing, the NFS file service is divided into three parts. Two servers provide the NFS service for all IOCs and consoles; the other server is for engineer development.

## SAVE AND RESTORE MECHANISM

To readily restore a set of the machine parameters for subsystems during operation as well as to optimize and record working points for different machine conditions, the mechanism of save and restore is developed. The save and restore function is established by using the MATLAB with the labCA [3]. The various files of grouped PVs (Process Variables) list are created for saving the respective parameter values of each subsystem. The file with PVs and saved parameters is also selectable for resume the settings. The graphical operation interface of save and restore mechanism is shown as the Fig. 1.

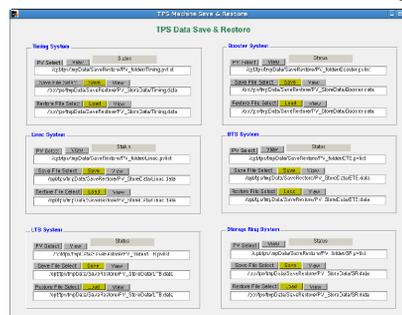


Figure 1: The OPI of save and restore mechanism.

## SUBSYSTEMS CONTROL PAGES

At the commissioning phase, the main GUIs of TPS control system adopt the EDM (Extensible Display Manager) [4] toolkit to develop main graphical operation interface. The EDM OPIs of various subsystems are

created and saved into the NFS file server for client consoles operation.

The top-layer control page is built by the EDM toolkit shown as the Fig. 2. All control pages can be launched from this page. All control components are located at the foreground of the TPS accelerator illustration. For example, the LTB (Linac to Booster) dedicated control page is linked from the main control page for operation shown as the Fig. 3. The related control parameters or components are also located at the same page for tuning easily, such as the control page for the TPS timing as shown in the Fig. 4. These pages will be continuously refined and developed for the commissioning.

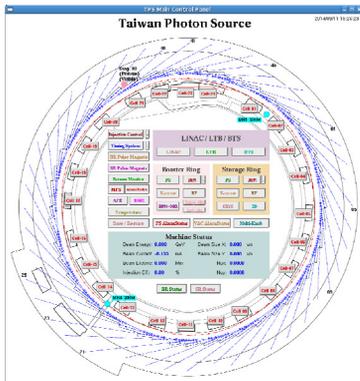


Figure 2: TPS main control page.

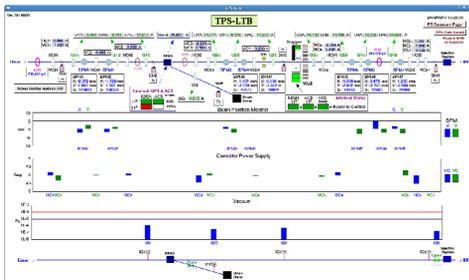


Figure 3: The LTB control page.

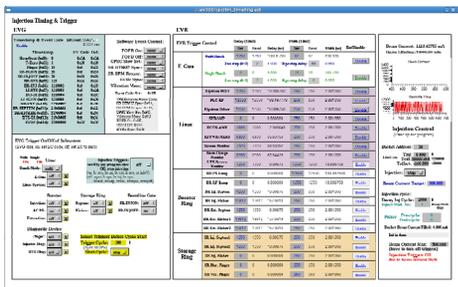


Figure 4: The control page for the TPS timing system.

The EDM toolkit is also adopted to develop the main control pages of power supplies. Each main page is included the same kind of power supplies. These main control pages are shown critical information for observing status easily, and the major operation functions are also executed from the main page. The sub-pages which included all detail parameters are also launched from this page. For example, the control page of booster ring power supplies is shown as Fig. 5.

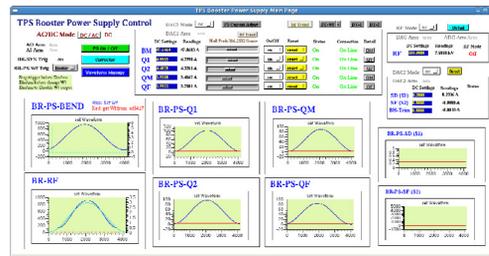


Figure 5: The control page of booster ring power supplies.

The status page of power supplies is created by the EDM toolkit for monitoring as shown in Fig. 6. These observed signals are usually the interlock signals. If one of power supply drops, this page will show one of red point to let operators know which problem is.

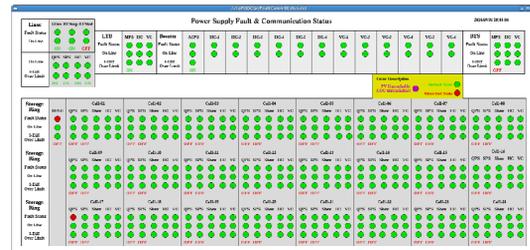


Figure 6: The status page for monitoring power supplies.

One of the benefits on EPICS waveform supports is that various LXI-based oscilloscopes can be controlled remotely and users can easily observe the acquired waveform data by using display toolkit on the control pages. The EPICS waveform supports of pulse magnets power supply CT, FCT, ICT, Linac RF power, WCM and etc. are built for observing and analyzing.

### MATLAB-BASED APPLICATIONS

GigE Vision cameras are used to capture images. A dedicated EPICS IOC is used to acquire images and delivery waveform process variables (PVs) which represent the images. The image analysis IOC embedded MATLAB environment to perform image processing and analysis. The screen monitor analysis GUI as shown in Fig. 7 [5], has been developing and has various features including specify region-of-interest (ROI), optional background subtraction, 3D image viewing, and software multiple exposure. It also can create a simulated beam image for the purpose of evaluating the fitting correctness. All fitted parameters will be stored as EPICS PVs such that clients can easily access it for further usage.

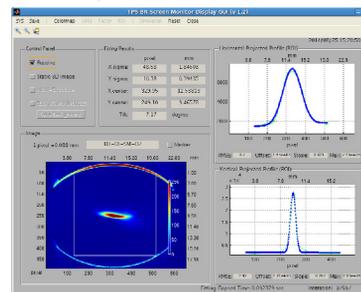


Figure 7: The Matlab analysis GUI for screen monitor.

New generation digital BPM electronics is equipped with Ethernet interface for configuration and served as EPICS CA server with 10 Hz data rate. Another multi-gigabit interface will deliver beam position for fast orbit feedback purpose at rate up to 10 kHz. The BPM electronics will also provide post-mortem buffer for orbit analysis during specific event happened like beam loss. Post-mortem analysis can help to find the weakest point and provide information to improve system reliability. The BPM GUI has created to analyze by using MATLAB. Fig. 8 shows main page for the TPS booster ring BPM first turn data.

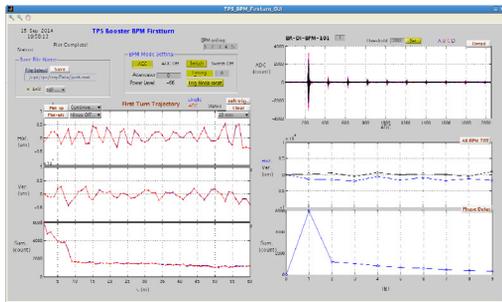


Figure 8: The OPI for TPS booster BPM first turn data.

### DATABASE APPLICATIONS

The archive system of CS-Studio (Control System Studio) [6] which named “BEAUTY” (Best Ever Archive Toolset, yet) was built to be used as the TPS data archive system [7]. The PostgreSQL RDB was adopted as the data storage for the BEAUTY. The archived data can be retrieved in a form of graphical representation using the CS-Studio based data browser. Taking the performance and redundancy into considerations, the storage servers and RDB table structures are tuned relatively. This developed TPS archive system will be utilizing gradually during the installation and commissioning phases.

To observe the temperature variation for in-vacuum insertion device baking, the specific monitor GUI was created by the CS-Studio as shown in Fig. 9, and this page can be displayed the latest 30 minutes historic temperature data trend which retrieved from the database.

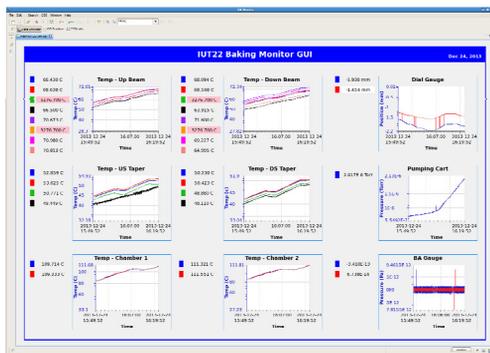


Figure 9: Archive data browsing GUI for ID baking.

The “BEAST” (Best Ever Alarm System Toolkit) of CS-Studio with the MySQL RDB is adopted as the alarm handler for the TPS as shown in Fig. 10. A distributed

alarm system monitors the alarms in a control system and helps operators to make right decisions and actions in the shortest time. In the CS-Studio alarm system, each alarm is supposed to be meaningful, requiring an operator action. An alarm is no status display that operators may ignore. Each alarm requires an operator to react because the control system cannot automatically resolve an issue.

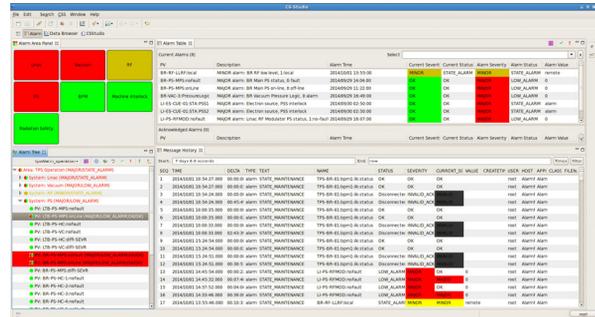


Figure 10: The “BEAST” of CS-Studio used for the TPS alarm system.

The “Olog” [8] solution is selected for the TPS electronic logbook. The TPS logbook is recorded the progress about commissioning information by the commissioning team and operators, and supports print function to copy data into the logbook for logging.

### SUMMARY

The TPS control system adopts the EPICS framework as the control infrastructure. The EPICS supports of various subsystems have been built, and the operation interfaces of various subsystems are also integrated in the meantime. The various GUIs are designed according to the different operation purposes. The management of the EPICS related files system has been established for maintaining files versions easily. The mechanism of save and restore are needed to apply parameters for operation process. Various operation interfaces are integrated and improved continuously during the TPS control system commissioning. Adopt newly developed supports accompany with the EPICS V4 will be included in deploy of the TPS control system includes directory service, high level applications, and etc.

### REFERENCES

- [1] TPS, <http://www.nsrcc.org.tw/english/tps.aspx>
- [2] EPICS, <http://www.aps.anl.gov/epics/>
- [3] labCA, <http://www.slac.stanford.edu/~strauman/labca/>
- [4] EDM, <http://ics-web.sns.ornl.gov/edm/>
- [5] C. Y. Liao, et al., “TPS Screen Monitor User Control Interface”, FPO032, PCaPAC 2014, to be published.
- [6] CS-Studio, <http://ics-web.sns.ornl.gov/css/>
- [7] Y. S. Cheng, et al., “Implementation of the EPICS Data Archive System for the TPS Project,” Proceedings of IPAC2013, Shanghai, China, May 12-17, 2013.
- [8] Olog, <http://olog.sourceforge.net/olog/>