

INTEGRATE EPICS SYSTEM WITH THE TLS CONTROL SYSTEM

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Abstract

The TLS (Taiwan Light Source) is a third generation of synchrotron light source, and it has been operated since 1993. The TLS control system was developed and implemented by ourselves. The control system of our new project (TPS, Taiwan Photon Source) is developed and based upon the EPICS framework. To earn more experiences on the EPICS usage, some of the TLS newly installed subsystem run EPICS directly. For example, BPM system, bunch-by-bunch feedback system, remote oscilloscope waveform access and so on adapt the EPICS interface to control and monitor. The EDM and Matlab (with LabCA) toolkits are used as EPICS graphical user interface, and it is also operated at the TLS control consoles environment normally. The archive system transaction between the TLS control system format and EPICS PVs (Process Variables) has been implemented for user access with the existing archive viewer. The efforts will be described at this report.

INTRODUCTION

The TLS is a third generation of synchrotron light source built at the National Synchrotron Radiation Research Center (NSRRC) site in Taiwan, and it has been operated since 1993. The TLS consists of a 50 MeV electron Linac, a 1.5 GeV booster synchrotron, and a storage ring with 360 mA top-up injection.

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 and large scientific experiments [1]. In the field of accelerators, many facilities particularly have good experiences for the EPICS and adopt it as the accelerator control systems. Many resources and supports are available as well as numerous applications for accelerator have been developed.

The EPICS toolkits were chosen as control system framework for the TPS of 3 GeV synchrotron light source [2]. The control system prototype of TPS with the EPICS mechanism has been gradually built and tested. On the other hand, in order to gain the experiences and more advanced approach and technology, the upgrade and maintenance for the TLS control system are attempted to adopt the EPICS toolkits as its framework. Moreover, since the TLS plan to share the same control room with the TPS in the future to save usage of manpower, some new installed subsystems will run EPICS control environment to reduce working load.

In the TLS, the control console can continuously operate on the existing control system environment and develop additionally in the EPICS framework for the

subsystem upgrade in the meanwhile. One of the advantages is that it should not send signals to the control room by the dedicated cabling in the future.

Utilizing the EPICS channel access mechanism with the specific toolkits, the data can be accessed between the IOCs (Input Output Controller) and the clients. The various operation processes will be developed and tested according to the various operation modes. The implementation of subsystems is introduced as followings.

EPICS ENVIRONMENT OF TLS CONTROL SYSTEM

To implement the EPICS support for some subsystems, the control environment of the IOC is set up with the specific EPICS base, modules and extensions at the Linux operation system. The related software environment is summarized as shown in Table 1. To control and monitor subsystems based on EPICS environment via Ethernet, the clients should be installed the specific EPICS base and the graphical OPI (Operation Interface) toolkits, such as EDM (Extensible Display Manager) [3] and MATLAB (channel access via the labCA module [4]) for EPICS channel access.

Table 1: Software Environment of the EPICS Support

	Version
OS	Fedora Core 11 (2.6.29) RHEL 5 (2.6.18)
EPICS	base-3.14.10
Modules	asyn-4.11a StreamDevice-2.4
Extension	edm-1.12.xx labCA-3.1

Most of EPICS related files at control consoles are mounted to the file server by using the NFS service [5] to simplify software version control. 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, saved data, temporary data and etc.

RUN EPICS IOC ON AN ILC OF TLS CONTROL SYSTEM

An EPICS IOC is activated on an ILC to support homogenous access from TLS console computers. TLS ILCs broadcast their dynamic data, DDB, at 10 Hz to simplify data transaction between consoles and ILCs; with SDB and database-access-library installed TLS

console APs manipulate the signals efficiently. But TLS control system is an isolated system, in order to have the rich support of EPICS, the plans of two insertion devices control system upgrade will adopt EPICS. To support access from existing TLS APs, integrated EPICS IOC into ILC is required. The ILC will be running Linux on cPCI but not LynxOS on VME platform instead. A setting thread and a reading thread of the ILC talk to a PV server (call libca functions) of EPICS to perform setting request on demand and fill the predefined DDB locations (in an input file) for read-back signals at 10 Hz. The system architecture is illustrated as Fig. 1. Several major PVs of the IDs are integrated into TLS control system but the details of the motors status are accessible only via EPICS to simplify the implementation and lighten CPU load on the ILC. An operator may open EDM pages and start TLS main GUI to access the IDs at the same time.

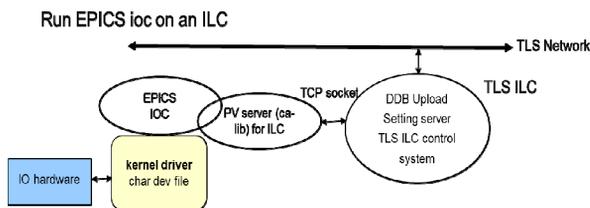


Figure 1: System architecture of EPICS IOC on TLS ILC.

ARCHIVE EPICS PV WITH THE SAME FORMAT OF TLS LOG

Besides the basic control functionalities to fuse both control environments together, the archive system is another important issue needed addressed. The archive system of TLS control system is simple; the file format is pure text including time stamp and value columns only. There are two types of archive, logged at 10 sec and 100 ms, named as slow and fast log the timestamp scales are different: minute and second. The log files are stored in directory hierarchy: yy/mm/dd/signalName.yyyymmdd to support easily access by NFS clients or FTP transfer. A viewer running on Windows system may show trends of two different logs to analyse events. Supporting the viewer to access logs of EPICS PVs which belong to TLS besides the existed logs is useful. An “acquire” and a “store” program are implemented to archive EPICS PVs with the same format as TLS fast logs. The “acquire” and “store” process pair may handle up to 500 PVs at once. Because the EPICS PV names mostly include a char ‘:’ and cannot be part of a file-name on Windows system, it is converted to ‘_’ by the “store” program while creating then insert the name in the top of the file as description.

EPICS APPLICATIONS DELIVERY TO TLS USAGE

TLS BPM EPICS Applications

TLS had gradually upgraded the BPM electronics for both the storage ring and the transport line and completed respectively in 2009 and 2012. Besides integrating into the original TLS home-made control system, since the

electronics has embedded EPICS server, it also provides GUI for display and configuration by EPICS implemented as Fig. 2 and Fig. 3. The storage ring BPM GUI done by LabVIEW EPICS interface is mainly responsible for configuration and synchronization functionalities of 10 kHz BPM grouping data; it also support to display various BPM data flow. In the case of BTS BPM GUI, it is developed by EDM toolkit and will be also adopted in the single pass BPM for the future TPS project.

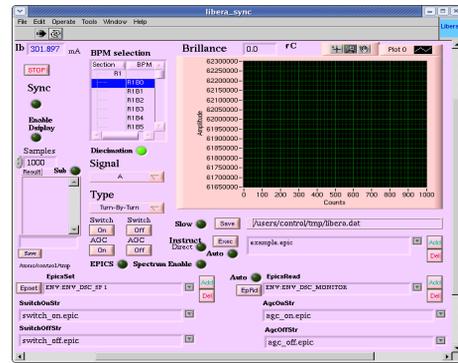


Figure 2: SR BPM OPI by LabVIEW EPICS interface.

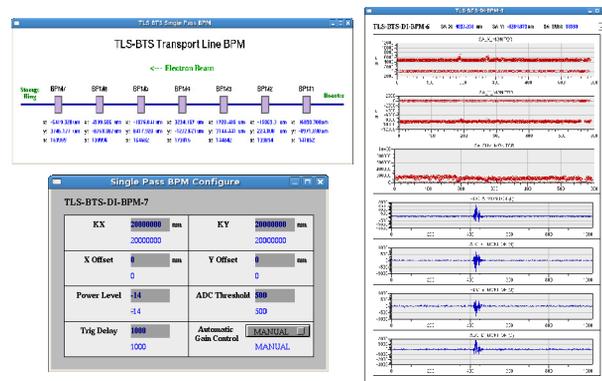


Figure 3: BTS BPM GUI for display and configuration implemented by EDM toolkit.

TCSPC Application

The TCSPC (Time-Correlated Single Photon Counting) can record the time difference between the single photon event and storage ring revolution trigger to measure the fill pattern. The layout of the EDM display GUI for fill pattern measurement is shown in Fig. 4. The GUI can run on the multiple clients simultaneously and control the TCSPC parameters, read/display the results from EPICS IOC. The GUI contains two parts: control panel (in left side), results (in right side). The control panel provides display of the system status, resolution, program heartbeat and setting the system key parameters such as DFC, divider, range, acquisition time, and etc. The raw data of the fill pattern with marked-peak position is integrated into the right side. In the below figure, some important parameters of the two-channel input signal are also shown.

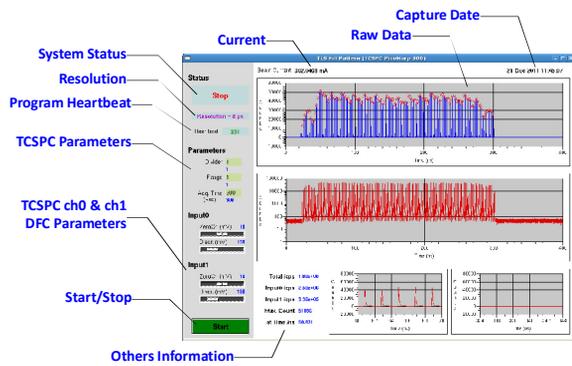


Figure 4: Layout of the TCSPC EDM page.

Bunch-by-Bunch Feedback Applications

One of commercial bunch-by-bunch feedback solutions is iGp (Integrated Giga-sample Processor) [6]. The iGp system is embedded into the EPICS framework. The commissioning of the iGp is ongoing to upgrade the bunch-by-bunch feedback system to enhance functionalities and get better performance [7][8]. The tune monitor based on the transverse feedback system is the waveform access from iGp, and specific EDM page is created as shown in Fig. 5. The two notches in averaged spectrum corresponding to vertical and horizontal reject betatron sideband. It can be a betatron tune monitor with high resolution without exciting beam.

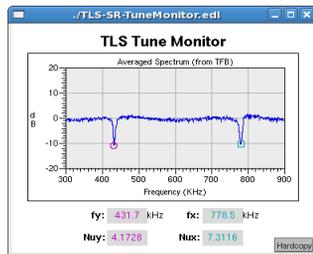


Figure 5: EDM page for tune monitor based on the transverse feedback system from iGp.

A simple GUI was deployed for the control room operator usage as shown in Fig. 6. Several waveforms accompany this interface let the operator tell whether the bunch-by-bunch system is working properly or not.

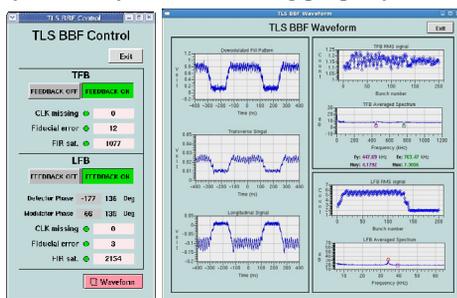
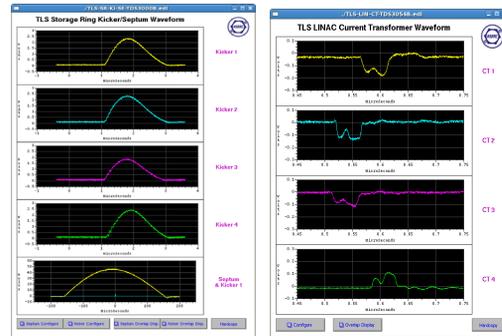


Figure 6: Operator interface to operate the bunch-by-bunch feedback system include transverse as well as longitudinal feedback system. Various waveforms include filling pattern, beam oscillation amplitude in RMS and bunch phase oscillation in RMS, are shown on the integrated with front-end and iGp control page.

Remote Access of Ethernet-based Oscilloscope

The existed Ethernet-based oscilloscope, Tektronix TDS3000B series, was chosen to be built with the EPICS support for observing waveform in the TLS. The TDS3000B consists of the 100Mbps Ethernet interface, 500 MHz bandwidth, and 5 GS/sec sample rate and etc. One server as the dedicated EPICS soft-IOC is set up to implement the EPICS support, and communicates with the TDS oscilloscope via Ethernet interface [9]. In order to learn the effect of EPICS waveform support, the actual signals of the TLS are applied in these implementations to observe remote waveform access. The specific EDM pages were created as shown in Fig. 7.



(a) (b)

Figure 7: EDM page for Ethernet-based oscilloscope: (a) TLS storage ring injection kickers and septum waveforms. (b) TLS LINAC current transformer waveform.

CURRENT STATUS

To support both of the existing TLS control system and the developing EPICS environment, the client consoles were setup with basis EPICS environment for access the upgraded subsystems via PV channel access from the dedicated IOCs. The various EDM pages of different purposes were created for operation at the TLS. These implementations will be improved continually in under way, and will be applied for the TPS project in the future.

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