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DEVELOPMENT OF EPICS APPLICATIONS FOR THE TAIWAN LIGHT SOURCE

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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 is a proprietary design. It was performed minor upgrade several times to avoid obsolete of some system components and keep up-to-date during last two decades. The control system of the TPS project (Taiwan Photon Source) is based upon the EPICS framework. To save resources for TLS control system maintenance, adopt EPICS for newly developed and rejuvenated subsystems for some of the TLS control interfaces includes BPM system, insertion devices, bunch-by-bunch feedbacks, electronics instruments interface and so on. Some EPICS related applications have been developed, and EPICS graphical user interface is also operated at the TLS control consoles environment normally. Current system allowed two kinds of control environments working together. 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 TLS Control system is a proprietary design [1]. Several minor upgrades had been performed to avoid obsolete during last two decades. It consists of console level workstations and VME based intelligent local controller (ILC) to interface with subsystems. Hardware and software on console level workstation change several times due to evolution of fast evolution of computer technology. PC running Linux is the current configuration. Due to the well design of the original control software structure, port to new platform without difficult.

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 [2]. Many particle accelerator facilities adopt EPICS framework for their control systems and gain good experiences. 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 Taiwan Photon Sourece (TPS) of 3 GeV synchrotron light source [3]. The TPS control system with the EPICS mechanism has been integrated and commissioned. On the other hand, in order to adopt update technology and re-use expertise of manpower, the upgrade and maintenance for TLS control system adopts the EPICS as its framework. Moreover, some new installed subsystems runs EPICS control environment to reduce working load and use the same expertise of manpower.

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.

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 are 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. To control and monitor subsystems based on EPICS environment via Ethernet, the clients should be installed the specific EPICS base and the graphical operation toolkits, such as EDM (Extensible Display Manager) and MATLAB (channel access via the labCA module) for EPICS channel access.

Most of EPICS related files at control consoles are mounted from the file server by using the NFS service (Network File System) 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. The TLS control system is an isolated system. To have the rich support of EPICS, the plans of two insertion devices control system upgrade had adopted the EPICS framework. To support access from existing TLS

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applications, 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.

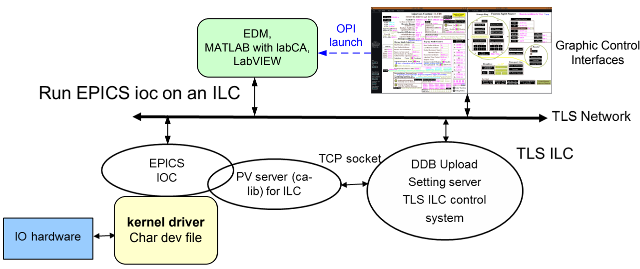

Figure 1: System architecture of EPICS IOC on TLS ILC.

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.yyymmdd to support easily access by NFS clients or FTP transfer. A viewer running on Windows system may show trends of two different logs to analyze 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

The TLS had gradually upgraded the BPM electronics for both the storage ring and the transport line and completed respectively in 2008 and 2012 [4]. 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. The storage ring BPM GUI done by EDM and MATLAB 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.

Figure 2: SR BPM GUI by EDM and MATLAB interface.

Bunch-by-Bunch Feedback Applications

One of commercial bunch-by-bunch feedback solutions is iGp (Integrated Giga-sample Processor) [5]. 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 [6]. A simple GUI was deployed for the control room operator usage as shown in Fig. 3. Several waveforms accompany this interface let the operator tell whether the bunch-by-bunch system is working properly or not. The tune monitor based on the transverse feedback system is the waveform access from iGp, and specific EDM page is created as also shown in Fig. 3. 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.

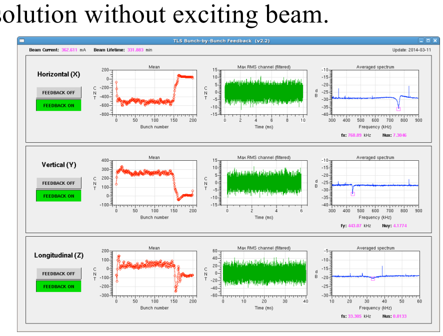

Figure 3: Operator interface to operate the bunch-by-bunch feedback system include transverse as well as longitudinal feedback system.

Rejuvenation of the Undulator 50 and 90

The undulator U50 and U90 for Taiwan Light Source (TLS) was installed on March 1997 and March 1999 at NSRRC. Both undulator provide service for more than 15 years. Control system of U50 includes a PC running MS-

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DOS for local control. Control system of U90 includes a VME crate which equips with PowerPC CPU module running LynxOS. New U50/U90 control system shares the standard environment for insertion devices (ID) control for the Taiwan Photon Source (TPS) project. Ethernet based motion controller was chosen to drive motor drivers. All control functionality will coordinate by the cPCI EPICS IOC. To compatible with TLS existed control environment, a server program was develop to translate the protocol to EPICS PVs. All existed GUI of TLS still can be used. These improvements of control system for U50/U90 are essential upgrading geared to avoid obsolescence of the control related parts, increase productivity and support on-the-fly experiments [7].

The new control system is based on the EPICS framework, thus, a simulated TLS intelligent local controller (ILC) is also developed and running with EPICS IOC on the same cPCI platform. As a result, the TLS U50/U90 existed GUI is still workable. The user interface implemented by using EPICS EDM (Extensible Display Manager) was also created. The EDM control page with ID images, as shown in Fig. 4, is for general operation and a detail maintenance page can show all status and adjustable PVs parameters (PID, torque limit and etc).

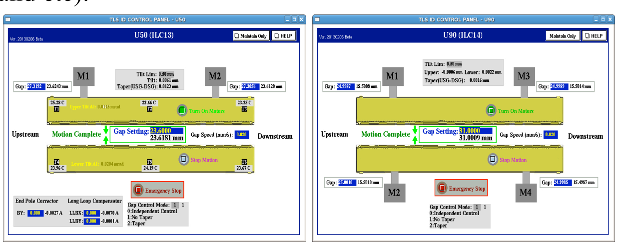

Figure 4: EDM based TLS U50 and U90 control GUI.

Remote Access of Ethernet-based Oscilloscope

Several types of oscilloscopes had been used for different purposes at the TLS control system. The DPO4000 are usually used for observing Linac-related waveforms. The DSO9000H is higher resolution oscilloscope and specially used for observing and analyzing waveforms of storage ring injection kicker current transformer in detail at every injection. One dedicated EPICS IOC was set up to implement the EPICS support, and communicates with the oscilloscope via Ethernet interface [8]. 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 GUI of SR injection septum and kickers CT waveform was created as shown in Fig. 5. The DSO9000H oscilloscope is also used to observe the storage ring fill pattern which signal from one of BPM (Beam Position Monitor). The 400K-point waveform data of beam signal can be acquired to the dedicated EPICS IOC, and its waveform acquired rate is satisfied with 1 updated/second. The fill pattern measurement interface has been developed by use of the MATLAB to calculate every bunch current. All calculated bunch currents are formed to one waveform array and save into the dedicated PV, and the specific EDM page was created to show the calculated fill pattern as Fig. 6.

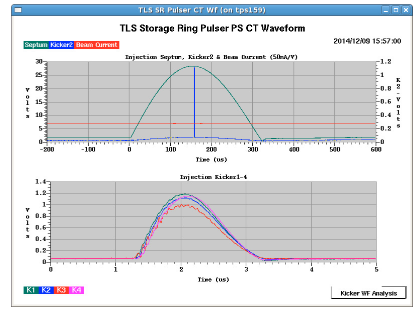

Figure 5: GUI for observing the waveforms of TLS storage ring injection septum and kickers.

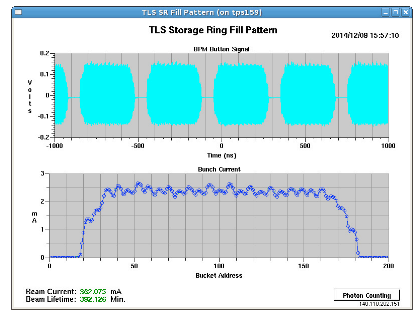

Figure 6: GUI for monitoring TLS storage ring fill pattern.

CURRENT STATUS

To support both of the existing TLS control system and the developing EPICS environment, the client consoles were setup with 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 and improvements are under way.

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