Status of the TPS Insertion Devices Controls

C. Y. Wu*, Jenny Chen, C. Y. Liao, Y. S. Cheng, K. T. Hsu

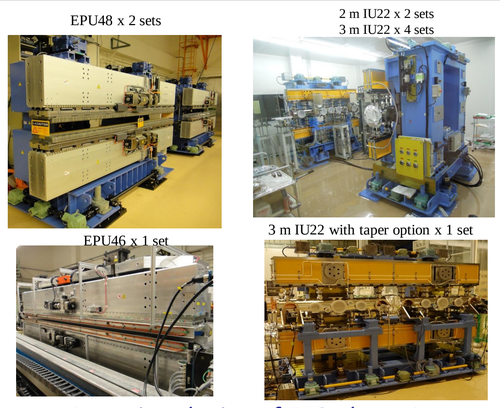
National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan

Abstract

The Insertion devices (ID) for Taiwan Photon Source are under construction. There are eight insertion devices under construction. These devices include in-vacuum undulators with or without taper, elliptical polarized undulators. Control framework for all IDs was developed. Using common hardware and software components are as possible. Motion control functionality for gap and phase adjustment supports servo motors, stepper motors, absolute encoders, and protection. The control system for all IDs is based on the EPICS architecture. Trimming power supply for corrector magnets and phase shifter control functionality are also addressed. Miscellaneous controls include ion pumpers and BA gauges for vacuum system, temperature sensors for ID environmental monitoring and baking, limit switches, emergency button. User interface for ID beamline users are included to help them to do experiment, such as ID gap control and on-the fly experimental. The progress of IDs control system will be summarized in the report.

Introduction

- The TPS is planned to install one set of EPU46, two sets of EPU48 and seven sets of IU (In-Vacuum Undulator) which are arranged in seven straight sections to fulfill various experimental requirements in the first phase of TPS project.
- The main hard X-ray undulator source will be from IU22, and out-of-vacuum EPU48 and EPU46 will cover soft X-ray regions.
- EPU48 and EPU46 which are most commonly used permanent magnet based device requires up to six or eight motors whose motions must be coordinated.
- Two IU22 which is 2 meter long and two EPU48 have been delivered to NSRRC.
- The control system of IU22 is developed in-house and used to support filed measurement of two IU22s in the laboratory.
- The parameters of IDs are shown in Table 1. Features related to control of the insertion devices and its motors used are summarized.
- Control system for all insertion devices are developed in-house by NSRRC control team to achieve the goal to deliver a similar control environment and economically.

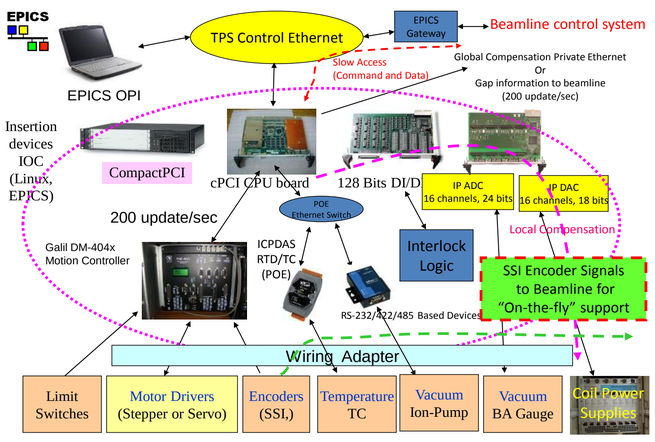


Insertion device of TPS phase-I.

3 GeV		EPU48	EPU46	IU22	IU22	IUT22
Photon Energy (keV)	HP	0.45-1.5		5-20	5-20	5-20
	VP			-	-	-
Period (mm)		48	46	22	22	22
Nperiod		67	83	95	137	137
B_y (T)		0.85	0.83	0.79	0.79	0.79
B_x (T)		0.59	0.59	-	-	-
$K_y$max		3.81	3.57	1.54	1.54	1.54
$K_x$max		2.6	2.5	-	-	-
L (m)		3.2	3.57	2	3	3
Gap (mm)		13	13.5	3.5	5	5
Number of devices		2	1	2	4	**1**
Number of gap/(phase) motors		2/(4)	4/(4)	1	1	2
Type of motor		Servo motors		Stepping	Servo motors	
Main body vendor		In-house	ADC*, In-house	Hitachi-Metals		
Controls		TPS standard insertion devices control environment (In-house)				

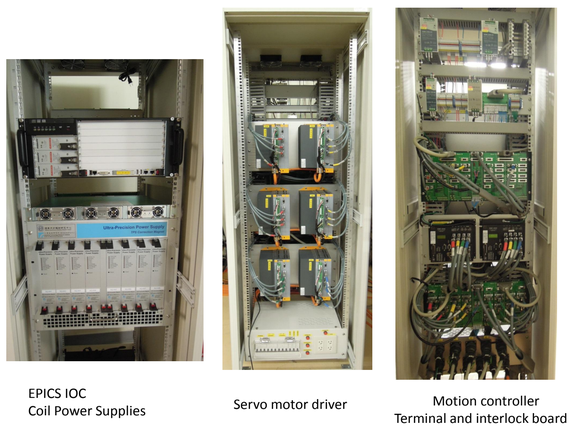
Table 1. Insertion device plan for TPS phase-I.

Insertion Devices Control Environment

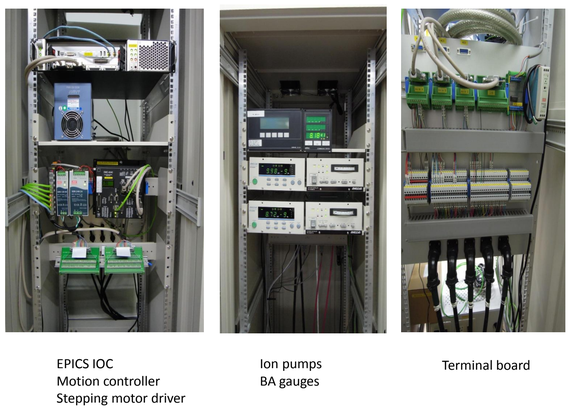


Basic hardware configuration for TPS ID in Phase-I.

- Insertion devices project for the TPS phase-I is in proceed.
- All insertion devices will share the same control environments even these devices are in-house developed and/or contract to vendors.
- The control environment will support the operation of insertion devices.
- The hardware configuration of IDs includes cPCI EPICS IOC, 128 bits DI/DO module, ADC/DAC IP (Industry Packs) modules, motion controller, ion pump and BA gauge interface, temperature monitoring.
- High precision low level power supply control for corrector magnet for feed forward look-up table.



Control rack layout of EPU48 for TPS.



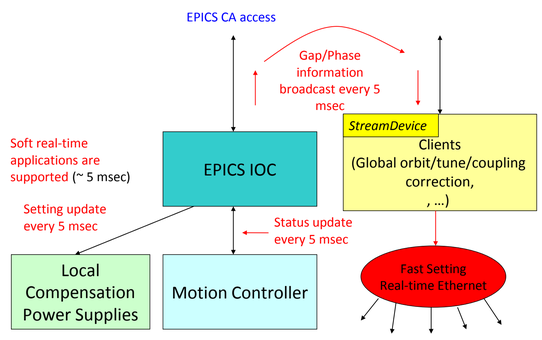
Control rack layout of IU22 for TPS.

Software Configuration

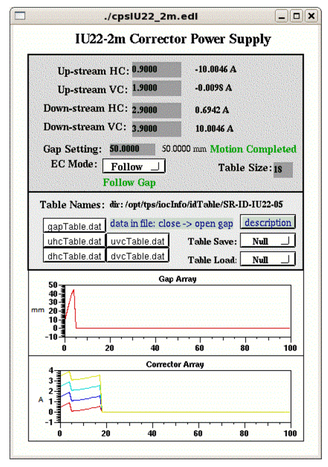
- The status of all axes updated by the motion controller, DMC40X0 series, and its time period can be configured to 5 msec.
- To achieve the update rate in EPICS, an interrupt produced by a kernel driver is involved.
- The kernel driver, char device driver, is installed for the data access for EPICS processes and a data receiver and for passing interrupts.
- The data receiver process running in background receives axes data then flush into the kernel memory created by the kernel driver.
- The feed-forward correction of the magnetic field can be done at the same rate in the IOC or the one provides global correction.
- The streamDevice and asynDriver of EPICS are used for sending position commands to the motion controller.

Residue Filed Compensation

- Stringent beam stability requirement of the TPS storage ring ID straight imposed field error should be controlled to less than a few G.cm of the first integral during the gap change could be tolerated.
- Local compensation is performed by using lookup table to drive corrector magnets. The look-up table could be updated at rate up to 200 times per second.



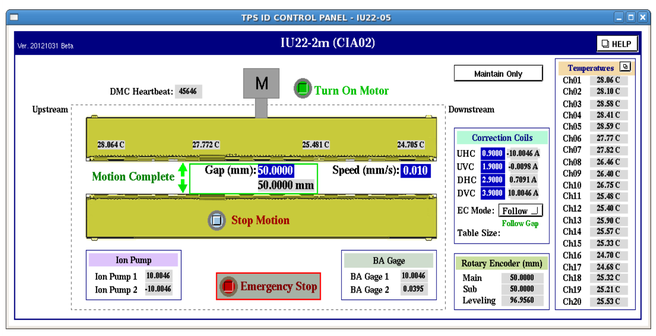
Local and global residue filed compensation schema for in vacuum undulator.



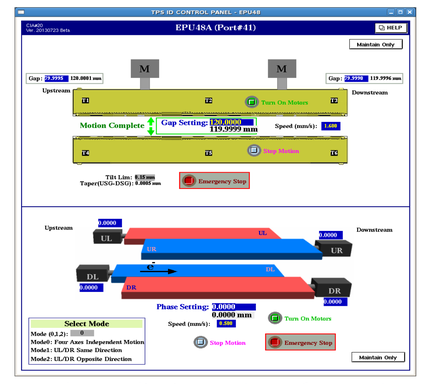
Local compensation prototype for IU22.

Graphical User Interface

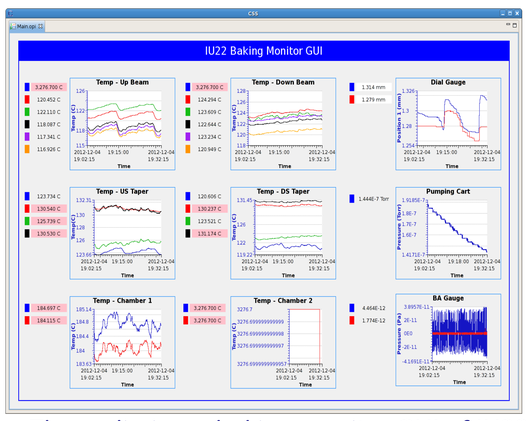
- The graphical user interface is implemented by using EPICS EDM and CSS (Control System Studio).
- The main pages with IU22, EPU46 and EP48 are for general operation and a maintain only page shows all status and adjustable PVs which are PID parameters, torque limit … etc.



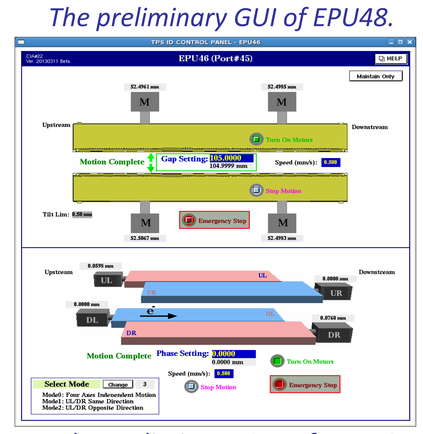
The preliminary GUI of IU22.



The preliminary GUI of EPU48.



The preliminary baking monitor GUI of IU22.



The preliminary GUI of EPU46.

On-the-Fly Experiments Support for Beamline

- Current agreement between ID controls and beamline controls plan to set the ID as master to provide ID information, beamline monochromator just follow to do the energy scan.
- There are two schemes to provide gap information of IDs for on-the-fly experiments:
  - Beamline or experiment station computer can read the gap position over the network through EPICS PV channel access (100 update/s or faster).
  - The control system can provide clock and data hardware signals of absolute SSI encoder to the beamline or experimental station via optical fibre link (1000 update/s).

Summary

- First two sets of 2 meter long IU22 were delivered in June 2012. Preliminary test of control system for IU22 and EPU48 were done.
- Various EPICS supports and GUI were developed for IU22, EPU46 and EPU48.
- Deliveries of 3 meter long IU22/IUT22 by magnet group are in proceeding continuously.
- Controls integration of 3 meter long IU22/IUT22 maybe starts from the first quarter of 2014.
- Controls for all phase-I insertion devices are scheduled to finish at end of 2014.

*E-mail: chunyiwu@nsrrc.org.tw