New Control System for the EPU 4.6

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Abstract

The Elliptically Polarized Undulator 4.6 (EPU4.6) for the Taiwan Light Source (TLS) was contracted to the vendor in late 2004. Due to various reasons in vendor side, the system was not delivered with full functionalities on time. The contract was terminated and the vendor agreed to deliver it to NSRRC in January 2009 after long negotiation. After intensive examination had been processed, revamp was started from March include mechanical and control system. Due to proprietary design of the vendor and lack of required technical documents of the existed motion control system, abandon these devices and replace the original design with another open solution is the most difficult decision. New control system implementation for the EPU4.6 was done recently. This project is not only to rebuild the entire control system but also to meet the original specifications. Features and benefits of the new control system of EPU4.6 will be summarized in this report.

## The Reasons and Advantages of Redesign EPU4.6 Control System

Reasons :

· Various of reasons in vendor side, the system cannot delivery with full functionalities on time.

· A lack of the detail technical information and complex design of the existed motion control system.

· Before making the rebuild EPU4.6 control system, the schedule, manpower, expertise of current staffs and further requirements were evaluated.

Advantages :

· Full functionality.

· Updated motion control hardware and software.

· Simple design.

· Common expertise for EPU4.6 project, the existed insertion devices of TLS and future TPS requirements.

EPU4.6 New Control System Infrastructure
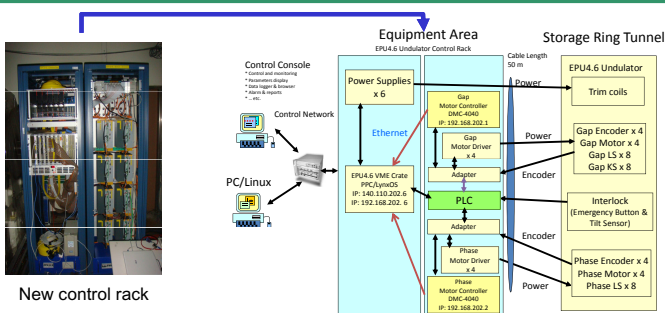
New control rack

· The VME ILC provides the user interface and high level control.

· The motion controllers are connected to the VME CPU via Ethernet directly.

· The interconnection between motion controllers and Compax3 drivers is performed via the adapter boards.

· The motor controllers equip SSI interface to communicate with the encoders.

· All Motor Driver Control mode setup to torque mode.

· The simple PLC dedicated for interlock protection.

EPU4.6 New Control System — Hardware

· VME create
  - · CPU board (LnynxOS)
  - · Digital input module
  - · Digital Output module — · status monitoring / · reset the motor controller
  - · Analog input module
  - · Analog Output module — · Trim power supplies control / · Tilt reading

· Motors => Allen-Brandy AC servo motor (MPL-A4530K-MK24AA).

· Motor drivers => Parker Hannifin Compax3 S150 motor driver.

· Motion controllers => The Galil DMC-4040 Ethernet based controller for gap and phase motion.

· Encoders => TR Electronic TR-140S SSI absolute linear encoder with 0.1 µm resolution.

· Tilt sensors => ADI's Tuff Tilt with micro-radian resolution.

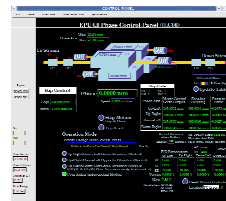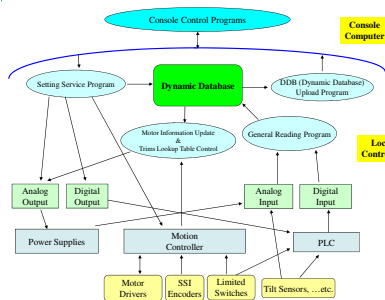· Trim power supplies => MCOR30 system manufactured by BiRa Systems.

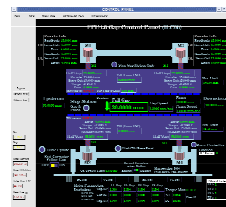### The body of EPU4.6

EPU4.6 motion control diagram
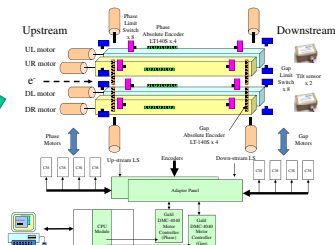
EPU4.6 New Control System — Software


Gap control page

Phase control page

· The software structure of the EPU4.6 follows the framework of the TLS control system.

· The DMC-40x0 creates a record and sends it to the VME periodically via a UDP/IP Ethernet handler.

· All motion control related parameters are updated at rate of 200 Hz.

· Feed-forward Table management: Trim coils compensation scheme is used to compensate the defect of the files from EPU4.6.

· The graphical user interface (GUI) is installed on Linux PCs as the control consoles.

Interlock Protection

· Fast Interlock in motor controller (response time is 0.5 msec)

  · over travel limit switches, torque limits, motor over temperature, encoder fault, position error.

· VME Host (response time is 5 msec)

  · calculate the precision tilt of upper and lower beams form encoders reading.

· PLC based protection system (response time is few msec)

  · It will protect the structure from failures in the motion control system, notice that the protection mechanism works independently of the motion control system.

  · PLC can halt the motion of any axis by disabling the given motor. And it can also trip the whole system until all errors are cleared or overridden.

Performance
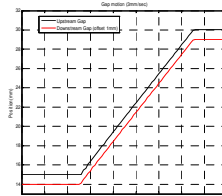
Gap movement
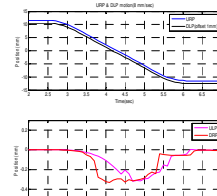
Phase movement

· The gap motion profile for 3 mm/s motion.

· The encoders recorded simultaneously while phase motion in 8 mm/s.

· The positioning performance in gap and phase seems not good enough due to bad design in mechanical system, reasons of the shortage combine large backlash, less rigidity of the fixture of the driven mechanism, and modification is under way.

Summary

· Basic functionalities of the new control system for the EPU4.6 were achieved.

· Optimize the motion control performance, enhance functionality, improve engineering and reliability of the EPU4.6 control system are underway accompany with the mechanical improvement are expected to be done before the end of 2009.

· Setup of EPICS support for motion control to evaluate various functionalities is future work.