Undulator Controls
Josh Stein : ANL/APS

LCLS Week - Oct 24-26
Notable achievements FY05

• Image capturing system test stand complete
• Motion control test stand complete
• Undulator cradle motion design modifications
• Cable plant planning and routing - heat load considerations
Image Capturing / Analysis System

- Test Stand accomplishments
  - 2 Megapixel Cameralink camera
  - Cameralink frame grabber
  - EPICS integration

- Final system
  - Acquire & analyze beam images @ 30 fps
    - 1600 x 1200 pixel image
    - 12-bit camera
Image Analysis: System Hardware Overview

- **Apple G5 Computer**
  - Dual 2.5 GHz G5, OS 10.4.x
  - Running EPICS 3.14.7

- **Active Silicon, Phoenix Frame Grabber**
  - Cameralink PCI board
  - no onboard custom FPGA programming required

- **Imperx MDC-1600 2 Megapixel Camera**
  - 1600 x 1200 pixels, up to 33 fps, 12-bit resolution
  - Faster frame rate with hardware ROI
Image Screen Shots

Captured Image

Background Subtracted
Current Status/Performance

- Acquire, Process, Analyze, Display @ 10 fps
  - more than 10 fps would overrun current number of capture buffers
  - image display on screen is presently the limiting factor
    - display full image at lower refresh rate
    - display smaller region at faster refresh rate

- Acquire, Process, Analyze, w/o Display @ 30 fps

- Calculations (ROI = 500 x 500 pixels)
  - Background subtraction (entire image)
  - Row & column sums (in ROI)
  - Histogram (in ROI)
  - Centroid,
  - sigma, FWHM, FWTM (in ROI)
OTR Imaging : FY06 Goals

- Although the OTR diagnostic has been de-scoped from the production budget, we still have funding for development.
- Complete SRS - define the client side applications and performance specs
  - What do the scientists need?
  - How to incorporate OTR data with scripting / XAL type tools
- Continue to refine and optimize capturing routines
- Follow processor change in new Macintosh models (buy new Intel based machine this year?)
- Source/Release control for OS X code
  - CVS/Subversion
  - SLAC/APS integration
CAM Mover system

• Test Stand accomplishments
  – Preliminary architecture complete
  – Embedded IOC configured
  – EPICS server configured for DHCP and remote booting
  – Serial based motor control completed

• Mock-up accomplishments
  – LabView based 5 axis control system complete
  – Beta alignment and tuning algorithms complete
  – Cam mover system design changes implemented
    • New bearing design
    • Expanded wedge implemented
    • High ratio gear box added
CAM Mover system: architecture

- Embedded IOC - one per undulator segment
- Serial control of “smart” motors
- On-board ADC to monitor rotary and linear encoders
- EPICS based databases w/mover record support to translate coordinate move requests
- High level application on remote clients for BBA and calibration routines
CAM Mover system: architecture

CA Compliant application(s)

CA over TCP/IP

Field IOC (motion control/position readouts)

Angular Position Sensors

Linear Position Sensors

Motion Drive/Devices

Embedded IOC:
- Boot via network with flash disk backup
- Network configuration via DHCP

DC

Ethernet

RS-232

RS-232
Undulator Controls Status Report

CAM Mover system : Embedded IOC

- [http://www.diamondsystems.com](http://www.diamondsystems.com)
- Prometheus w/16x16 bit ADCs
- Size: 5.5”x5.75”x1.7”. Power: 5W.

CAM Mover system: Smart Motor

SmartMotors from Animatics Corporations
2 for undulator segment translation.
5 for cradle assembly camshafts.
http://www.animatics.com

RS-232
Integrated controller/drive
DC Servo motor
CAM Mover system: Linear transducer

http://www.novotechnik.com
Linear transducers (w/2-micron repeatability) from Novotechnik US, Inc.
2 for undulator segment translation and 8 for cradle assembly.
With 16 bit readout, the resolution is 0.15 micron.

Rotary transducers (w/0.004 degree repeatability) from
Novotechnik US, Inc. 5 for cradle assembly camshafts. With 16 bit
readout, the resolution is 0.005 degree.
Mover system status and FY06 Goals

• Asyn/EPICS/Linux embedded IOC SmartMotor development: Complete
• Motor drive unit test: Complete
• ADC sensor development: Complete
• Cam Shaft motion control and position feedback system development: Feb ‘06
• Client (calibration) tools development: June ‘06
• Verification environment: July ‘06
• Network management: ??
• Configuration management: ??
Other Undulator Controls tasks on the horizon

• Support SUT
  – Integrate EPICS based motion of the undulator axis (Feb 06)
  – Nail down temperature monitoring scope and implement (June 06)
• Determine feasibility of in-vacuum high precision stages (nano-motion)
  – We did some work in FY05 to characterize these stages; now we have to make them work with one of our “standard” motion control solutions (this requires adding activities)
• Support BPM testing at the APS
  – Liaison to APS/Controls
    • Integrate with APS timing system
  – Analysis software (ADC)
• Complete cable routing and thermal analysis of the Undulator hall
• Power supplies for the quads/correctors
Supporting Slides

• Undulator design supporting Slides Follow
Undulator design changes

- Extended wedge
- Roller bearing
- High ratio gearbox
Undulator design changes
Undulator design changes
Undulator design changes
Undulator design changes
Supporting Slides

- Cable and thermal mapping slides follow
Undulator Controls Status Report

Power cable for Quad/ Correctors
18 pairs @ 2W/metre

Cell 1: Assume water cooled electronic boxes ABCD, water cooled cable tray from precision controller water conn.

DlB
5 m&w @ S, 25 W
1 m @ S, 5 W
Current = 6
2
-36 W

Electronics Boxes
A = 12 W
B = 12 W
Motion Iac 7 W
C = Photo multi
D = Alignment 10 W

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### Heat Generators

<table>
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<tr>
<th>Component</th>
<th>Transient Power (W)</th>
<th>Quiescent Power (W)</th>
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**Totals:** 3439.8

**168.4 Entire tunnel power consumption:** 4749.8

**Tunnel Length (m):** 135

**Watts/meter:** 35.1837037

**Stuff added 10/24/05:**
- HLS: 3W/m
- WPM: 800w in two places