

# *LCLS Undulator Positioning Control System*

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# Outline

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- Undulator Positioning Control System Hardware
- Field IOC Hardware
- Network Scheme
- IOC Software
- EPICS Database
- EPICS SmartMotor driver
- User Graphic Interface: MEDM vs Java
- Things to do



# Undulator Positioning Control System Hardware and Requirements

- LCLS has 33 undulator segments, each segment has a positioning system that consists of:
  - 5-axis girder cam mover system
  - 2-axis undulator translation system
  - 5 absolute angular position readouts
  - 8 absolute linear position readouts
  - Total: 231 motion axis and 429 position feedbacks
  - Each segment has one IOC
- Quadrupole Motion Positioning Repeatability  $\pm 7 \mu\text{m}$
- Short-Term (1 h) BPM and Quad Stability  $\pm 2 \mu\text{m}$
- Long-Term (24 h) BPM and Quad Stability  $\pm 5 \mu\text{m}$
- Thermal limitations
- CAM mover system has five degrees of freedom
  - X-translation
  - Y-translation
  - Pitch motion
  - Roll motion
  - Yaw motion



## Field IOC Hardware

- Off-the-shelf Integrated Industrial Computer Systems (PC-104 based): 486DX2/100M, 32MB SDRAM (Diamond Systems Co.)
  - 16 channel single ended/8 differential ADCs (16-bit) for position readouts.
  - Programmable input range:  $\pm 10V/0-10v$
  - 24 programmable digital I/O
- One Ethernet port, and 12 serial ports, including add-on 8 channel serial port board for motion control:
  - Configurable RS232, RS422, RS485
- 32M flash disk; IDE driver connector
- two USB ports, one parallel port
- Floppy disk driver connector



# Network Scheme

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- 33 IOCs with a DHCP/NFS server
- On each IOC:
  - scp for file copy
  - sshd for remote login
  - dhclient for dynamic IP address configuration
- IP address setup scheme
  - Run dhclient, if success, save IP address in a script.
  - Otherwise, run the pre-saved script.
  - If no pre-saved script exists, run the default script.



# IOC Software

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- Linux 2.4.22: boot from local flash disk
  - IOC kernel and application program are updated through scp command from the server as needed.
- EPICS base 3.14.8.2
- ASYN 4-4
- Device/driver support for the ADC/DIO on CPU board
- Kernel module for the 8 channel serial port PC104 board
- Motor record and SmartMotor driver support
- EPICS database



## SmartMotor driver support

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- SmartMotor: Servo Motor with RS-232 interface.
  - <http://www.animatics.com/>
- Motor record and device support
- Based on Intelligent Motion System's IM483 driver





## EPICS Database

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- PV naming scheme: prefix of PV name is assigned according to the last 8 bits of IOC's IP address, e.g.
  - IP: xxx.xxx.xxx.101 → id001:xxxx
  - IP: xxx.xxx.xxx.133 → id033:xxxx
- Motion Algorithms are implemented through calc records.





## *MEDM User Interfaces*

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- Position Control
- Undulator Position Control
- Undulator Position Calibration
- Girder Position Control
- Girder CAM Position Calibration
- Girder Parameter
- Potentiometer Readout
- Motor setup (7)



# MEDM User Interface

position\_control.adl

## LCLS SEGMENT NUMBER 001 Position Control

ID Calibration	ID Read(mm)	Quad X Read(um)	Quad Y Read(um)	Girder Calibration
	5.0974	2021.25	5926.23	ID STOP
ID Control	ID Set(mm)	Quad X Set(um)	Quad Y Set(um)	Girder Control
	5.0100	0.00	0.00	CAM STOP

Please check if ID motors stoped or comm failed

undulator\_posi\_call.adl

## LCLS SEGMENT NUMBER 001 Undulator Position Calibration

Pos Set(mm)	ID STOP	Pos Read(mm)	Zero Offset(mm)	Gain	ID Control
Upstream 5.0100	Sync Stop	5.1326	1.9900	10.0000	
Downstream 5.0100	Sync Stop	5.0608	5.0000	10.0000	Potentiometer Read

Please check if ID motors stoped or comm failed

undulator\_posi\_control.adl

## LCLS SETMENT NUMBER 001 Undulator Position Control

Downstrm X Read(mm)	Upstrm X Read(mm)	ID Calibration
5.0639	ID STOP	5.1362
Ins Bck	X Set(mm)	Ups Bck
Dns Back	5.0100	Ups Back
		Motor Setup

girder\_posi\_control.adl

## LCLS SEGMENT NUMBER 001 Girder Position Control

Downstrm X Read(um)	Upstrm X Read(um)	Roll Read(mrad)
658.44	-4388.34	6.1451
Downstrm X Set(um)	Upstrm X Set(um)	Roll Set(mrad)
100.00	0.04	0.0000
Downstrm Y Read(um)	Upstrm Y Read(um)	Girder Calib
6050.18	6503.12	
Downstrm Y Set(um)	Upstrm Y Set(um)	Parameter Set
0.00	0.00	
		Motor Setup
		Go
		CAM STOP

# MEDM User Interface

girder\_cam\_posi\_cali.adl

## LCLS SEGMENT NUMBER 001 Girder CAM Postion Calibration

	CAM Set(deg)	Sync	Stop	CAM Read(deg)	Zero Offset(deg)	Gain	
CAM Mover #1	196.920			196.8735	149.6000	344.1700	Girder Calibration
CAM Mover #2	70.560			70.6574	277.7000	344.3700	Parameter Set
CAM Mover #3	161.820			162.0713	178.4600	343.7770	Motor Setup
CAM Mover #4	63.620			163.7538	183.6600	344.2600	Potentiometer Read
CAM Mover #5	165.240			165.2223	179.9500	344.2000	<b>CAM STOP</b>

girder\_param.adl

## LCLS SEGMENT NUMBER 001 Girder Parameters

X1/X4 (mm)	X2 (mm)	X3/X5 (mm)	Y (mm)
228.2200	228.2200	339.2900	438.0000
Z (mm)	L (mm)	r (mm)	rf (mm)
330.0000	2340.0000	1.5000	2.1260

Potentiometer Read    Motor Setup    Girder Calibration

girder\_linear\_posi\_cali.adl

## LCLS SEGMENT NUMBER 001 Girder Linear Postion Calibration

	DOWNSTREAM			UPSTREAM		
	Read(um)	Zero Offset(um)	Gain	Read(um)	Zero Offset(um)	Gain
X	5009.4152	5000.0000	1.0000.0000	4947.5800	5000.0000	1.0000.0000
in Y	5110.4382	5000.0000	1.0000.0000	5101.0230	5000.0000	1.0000.0000
out Y	4935.8746	5000.0000	1.0000.0000	5140.4652	5000.0000	1.0000.0000

Potentiometer Read    Motor Setup    Parameter Set    Girder Calibration

potentiometer\_readout.adl

## LCLS SEGMENT NUMBER 001 Potentiometer Readout

	Ch1 CAM#1	Ch2 CAM#2	Ch3 CAM#3	Ch4 CAM#4	Ch5 CAM#5
CAM Read	6.0371	6.0664	5.9413	6.0529	6.0149
CAM Norm	1.0067	1.0116	0.9907	1.0093	1.0030
Upstrm Read	Ch6 X	Ch8 in Y	Ch10 cut Y	Ch12 ID	Ch14/15 SPR
Upstrm Read	5.9680	6.0603	6.0837	6.0725	
Upstrm Norm	Ch7 X	Ch9 in Y	Ch11 cut Y	Ch13 ID	Ch0 Exit
Upstrm Norm	0.9951	1.0105	1.0144	1.0126	
Downstrm Read	6.0059	6.0660	5.9605	6.0352	
Downstrm Norm	1.0015	1.0115	0.9939	1.0063	5.9972

ID Calibration    ID Control    Motor Set    Parameter Set    Girder Calibration

## *Java User interface*

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- Eclipse 3.1 IDE on Linux
- Visual Editor
- Jca 2.16 CA library
- RCP (Rich Client Platform)
- Manage the control and display of all the undulators in one window



# GUI (Java version)

LCLS Undulator Positioning Control System

File Help

Overview Motor Setup Position Control Undulator Position Control Girder Parameter

Select ID  
1

High Limit  Position Read(deg) 0.000 Position Read(raw) 0 Low Limit

Select Motor  
motor 1

Set Position(deg) 196.920 Set Position(raw) 1094 Command Go

Set Speed(deg/s) 360.000 Set Accelerator(s) 0.200

X1/X4(mm) 204.2200 X2(mm) 228.2200 X3/X5(mm) 339.2900 Y(mm) 438.0000  
Z(mm) 630.0000 L(mm) 2340.0000 r(mm) 1.5000 rf(mm) 2.1260

Girder Position Control Undulator Position Calibration Girder CAM Position Calibration Pct Readout

	CAM Set(deg)	<input type="button" value="CAMSTOP"/>	CAM Read(de)	Zero Offset(deg)	Gain
CAM Mover #1	196.920	<input type="button" value="sync"/>	<input type="button" value="Stop"/> 196.8296	149.6000	344.1700
CAM Mover #2	70.560	<input type="button" value="sync"/>	<input type="button" value="Stop"/> 70.6047	277.7000	344.3700
CAM Mover #3	161.820	<input type="button" value="sync"/>	<input type="button" value="Stop"/> 161.9927	178.4600	343.7770
CAM Mover #4	63.620	<input type="button" value="sync"/>	<input type="button" value="Stop"/> 163.6749	183.6600	344.2600
CAM Mover #5	165.240	<input type="button" value="sync"/>	<input type="button" value="Stop"/> 165.1434	179.9500	344.2000



# GUI (Java version)

The screenshot displays the LCLS Undulator Positioning Control System GUI. The window title is "LCLS Undulator Positioning Control System". The interface is organized into several functional panels:

- Overview Panel (Left):** Contains a "Select ID" dropdown menu with the value "p".
- Motor Setup Panel (Top Middle):** Features input fields for "High Limit", "Position Read(deg)", "Position Read(raw)", and "Low Limit". It includes a "Select Motor" dropdown menu set to "motor 1", and fields for "Set Position(deg)", "Set Position(raw)", "Command", "Set Speed(deg/s)", and "Set Accelerator(s)".
- Undulator Position Control Panel (Top Right):** Contains input fields for "X1/X4(mm)", "X2(mm)", "X3/X5(mm)", "Y(mm)", "Z(mm)", "L(mm)", "r(mm)", and "rf(mm)".
- Girder CAM Position Calibration Panel (Bottom):** Includes a "CAMSTOP" button and a table for five CAM Movers. The table has columns for "CAM Set(deg)", "CAM Read(de)", "Zero Offset(deg)", and "Gain". Each row also contains "Sync" and "Stop" buttons.





## *Things to Do*

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- EDM GUI
- System verification on SUT (Single Undulator Test) system
- Network verification
- Undulator motion control design review
- Integrate software into source/release controls system at SLAC (subversion).
- Determine operator/engineering interfaces required for LCLS operation.







***Thank you for your attention***

