

Accelerator Directorate



LCLS Control System Overview

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Department**

Linac Coherent Light Source at SLAC

X-ray FEL uses last 1-km of existing 3-km linac

Last 1/3 Linac (1 km)

e^- Transfer Line (340 m)

Undulator (130 m)

Electron Beam Dump

Damping Rings

Main Linac

LCLS Injector

Injector (35° at 2-km point)

PEP-II

SABER

End Station B

ILCTA

End Station A

SPEAR3

Guest House

LCLS Near Hall

LCLS

LCLS Far Hall

CEH

SABER



EPICS at LCLS (as of Oct. 8th, 2012)

- As of October 2012 100% of LCLS is controlled by EPICS!
- Electron Controls
 - 507 IOCs = 110 soft IOCs + 173 VME IOCs + 224 non-VME IOCs
 - 1,833,777 PVs
 - Commissioning our first uTCA IOC
- Photon Controls
 - 485 IOCs = 438 soft IOCs + 47 VME IOCs
 - 297,404 PVs

What did Bob ask for?

- Challenges they have faced
- Unique solutions
- Problems that have occurred
- Limitations that were found with EPICS and how they were overcome

Channel Archive

- **Problem:**

- We have requests to archive ~1 million PVs and the index file doesn't scale
- Requires too much hands-on maintenance

- **Solution:**

- Helped create new Archive Appliance - collaboration with other labs.
- [Separate talk Tuesday 2012-10-23 9:40-10:00 \[M. Zelazny for M. Shankar – EPICS Archive Appliance Status\]](#)

Tracking Single Pulse down the Accelerator

- **Problem:**

- Physicists need a way to track a single pulse of electrons as it travels from the electron gun to the electron dump to study beam jitter

- **Solution:**

- Developed Beam Synchronous Acquisition (BSA) system
- Separate talks Monday 2012-10-22 in Timing System session
 - 14:30-14:50 K. Kim – LCLS real time low level timing system
 - 15:30-15:50 M. Zelazny – LCLS timing system (pattern design, evGUI, and high level)

Typos in PV Names

- **Problem:**
 - Engineers and physicists mistype PV names when creating applications, edm screens, etc...
- **Solution:**
 - Run caSnooper daily
 - Track down rogue requests.

caSnooper Report

CaSnooper terminating after 600.00 seconds [10.00 minutes]
Data collected for 600.00 seconds [10.00 minutes]

Oct 16 12:50:01:

There were 384923 requests to check for PV existence for 37320 different PVs.

Max(Hz): 73.29
Mean(Hz): 0.02
StDev(Hz): 0.38

PVs with top 500 requests:

1	mccas0.slac.stanford.edu:51197 TRS1:AS2:LOST:PAVE.VAL	73.29
2	lcls-srv03.slac.stanford.edu:45962 BPMS:DMP1:199:YBR	2.57
3	lcls-srv03.slac.stanford.edu:45962 BPMS:DMP1:199:XBR	2.57
4	lcls-srv03.slac.stanford.edu:45962 BPMS:DMP1:199:TMITBR	2.57
5	ioc-in20-mg01.slac.stanford.edu:1035 IRIPL	0.68

[snip]

====> NOW CHECKING FOR PVS THAT ARE NOT CONNECTING...

1 TRS1:AS2:LOST:PAVE.VAL NOT connected
2 BPMS:DMP1:199:YBR NOT connected
3 BPMS:DMP1:199:XBR NOT connected
4 BPMS:DMP1:199:TMITBR NOT connected
5 IRIPL NOT connected

[snip]

Many UDP Broadcasts

- **Problem:**

- Some Channel Access clients flood the network with UDP broadcasts when they startup. We, for example, archive 150,646 LCLS PVs and restart 16 Channel Archive engines daily.

- **Solution:**

- We could use name server, but...
- We stagger the restarts so that most connections are made before moving to next engine restart.

Message Logging

- **Problem:**

- We downloaded and installed the JLAB cmLog ~15 years ago. It has served us well, but we have outgrown it.

- **Solution:**

- We developed our own Message Logging facility which:
 - Adds more tags
 - Writes to RDB
 - Throttles messages
 - Has better message viewer
 - Easier to understand filters with ability to save complex queries and launch viewer with predetermined filter
 - Loads messages 32 times faster while fetching large data sets
 - Displays more messages – breaks 256K cmLog barrier
 - Fully customized columns

Message Logging

The screenshot shows the 'MESSAGE LOG VIEWER' application window. The title bar includes standard window controls and buttons for 'Log Book...', 'Help...', and 'Exit'. The main interface is divided into two tabs: 'Messages' and 'Advanced'. The 'Messages' tab is active and contains a 'Show/Hide Table Columns' section with a list of checkboxes for various fields: Program, Facility, Severity, Message Text, Time, Code, Host, User, Status, Process, and Serial#. An 'Apply' button is located below this list. The 'Advanced' tab is also visible and contains a 'Filter Messages' section with three filter rows, each with a 'Facility' dropdown and an 'Add Query' button. Below the filters are radio buttons for 'Listen to live messages' and 'Retrieve old messages', with the latter selected. A date and time selection area shows 'Start: 10/16/2012 03:24:00 PM' and 'End: 10/16/2012 03:34:00 PM'. At the bottom of the 'Advanced' tab are 'Apply' and 'Reset' buttons. A 'Save / Import Filters' section at the very bottom contains 'Save Filter' and 'Import Filter' buttons. The status bar at the bottom of the window displays the message: '10/16 15:33:52 INFO Message Log Viewer successfully launched!' and a breadcrumb trail: 'physics | lcls-srv02 | 13779 | MessageLogViewer-R0-0-4'.

Message Logging

CMLog Viewer

File Edit Help

No Filter 10 minutes

Facility	Severity	Text
cmlogS		Received browser connection from host lcls-zelazny.slac.stanford.edu
cmlogS		Received user zelazny launched browser from lcls-zelazny.slac.stanf
Prod		15:07:05.51 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:06.51 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:07.49 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:08.47 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:09.47 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:17.33 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:18.31 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:19.31 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:20.29 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:26.17 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:27.17 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:28.15 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:28.15 stat=LOLO sevr=MAJOR fac=Alarm host=eioc-b34-mp01
Prod		15:07:29.15 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B
Prod		15:07:29.15 stat=HIHI sevr=MAJOR fac=Alarm host=eioc-b34-mp01 B

Connected to lcls-dev2:9003 838 messages. Auto Scroll

MESSAGE LOG VIEWER

Message Log Viewer

Messages Advanced

View Log Messages

The results are based on the filters set on the right hand side.

Facility	Severity	Message Text	Time
Alarm	MINOR	EIOC.LI29.MP01.P3D3V_MON changed to 2.999	10/16/2012 03:46:02 PM
Alarm	MAJOR	LASR.IN20GR.RF01.STATSUMY changed to 0	10/16/2012 03:46:02 PM
Alarm	MINOR	EIOC.LI29.MP01.P3D3V_MON changed to 2.999	10/16/2012 03:45:58 PM
Alarm	MINOR	KLYS.LI28.71.DL_WG_TEMPDP changed to 0	10/16/2012 03:45:57 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:56 PM
Channel	MINOR	KLYS.LI28.71.DL_WG_TEMP SEVR changed from NO_A...	10/16/2012 03:45:55 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:55 PM
Alarm	MAJOR	ACCL.LI21.LIBC1.RF01.LIX:STATSUMY changed to 0	10/16/2012 03:45:54 PM
Alarm	MAJOR	SIOC.SYS0.EV51.HEARTBEATSUM changed to ABSENTE...	10/16/2012 03:45:54 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:54 PM
Alarm	MAJOR	ACCL.LI21.180.LIX:WTDIFF changed to 0	10/16/2012 03:45:53 PM
Alarm	MINOR	SIOC.SYS0.EV51.HEARTBEATSUM changed to INTERMI...	10/16/2012 03:45:52 PM
Alarm	MINOR	EIOC.LI29.MP01.P3D3V_MON changed to 2.999	10/16/2012 03:45:50 PM
Alarm	MAJOR	ACCL.LI21.LIBC1.RF01.LIX:STATSUMY changed to 0	10/16/2012 03:45:48 PM
Alarm	MAJOR	ACCL.LI21.180.LIX:WTDIFF changed to 0	10/16/2012 03:45:47 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:46 PM
Channel	MINOR	PSC.LI29.MG08:CONTROLTEMP SEVR changed from M...	10/16/2012 03:45:42 PM
Alarm	MAJOR	LASR.IN20GR.RF01.STATSUMY changed to 0	10/16/2012 03:45:42 PM
Alarm	MAJOR	ACCL.LI21.LIBC1.RF01.LIX:STATSUMY changed to 0	10/16/2012 03:45:40 PM
Channel	MAJOR	PSC.LI21.MG01:CONTROLTEMP SEVR changed from M...	10/16/2012 03:45:39 PM
Alarm	MAJOR	ACCL.LI21.180.LIX:WTDIFF changed to 0	10/16/2012 03:45:39 PM
Alarm	MAJOR	LASR.IN20GR.RF01.STATSUMY changed to 0	10/16/2012 03:45:34 PM
Alarm	MINOR	COLL.LTU1.253.LVPOS changed to -3.0	10/16/2012 03:45:32 PM
Alarm	MAJOR	LASR.IN20GR.RF01.STATSUMY changed to 0	10/16/2012 03:45:28 PM
Alarm	MAJOR	ACCL.LI21.180.LIX:WTDIFF changed to 0	10/16/2012 03:45:27 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:26 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:25 PM
Channel	MAJOR	PSC.LI21.MG01:CONTROLTEMP SEVR changed from M...	10/16/2012 03:45:24 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:25 PM
Alarm	MAJOR	PDU.LI26.423:STATSUMYDP changed to 0	10/16/2012 03:45:19 PM
Channel	MAJOR	PDU.LI26.423:FID_GONE changed from Detected to N...	10/16/2012 03:45:18 PM
Channel	MAJOR	PDU.LI26.423:FID changed from Fid Detected to No Fi...	10/16/2012 03:45:18 PM
Channel	MAJOR	PDU.LI26.423:BPLN changed from Enabled to Disabled	10/16/2012 03:45:18 PM
Channel	MAJOR	PDU.LI26.423:SEQR changed from Enabled to Disabled	10/16/2012 03:45:18 PM
Alarm	MAJOR	ACCL.LI21.LIBC1.RF01.LIX:STATSUMY changed to 0	10/16/2012 03:45:16 PM
Alarm	MAJOR	DUPLICATE COUNT 1 - FBCK:FB03:TR01:STATUSSTR ...	10/16/2012 03:45:16 PM
Alarm	MAJOR	ACCL.LI21.180.LIX:WTDIFF changed to 0	10/16/2012 03:45:15 PM

Stop Getting Message

10/16 15:40:45 INFO Message Log Viewer successfully launched!

10/16 15:40:51 INFO Successfully imported the filter configurations!

physics | lcls-builder | 26396 | MessageLogViewer-R0-0-4



SCORE

- **Problem:**

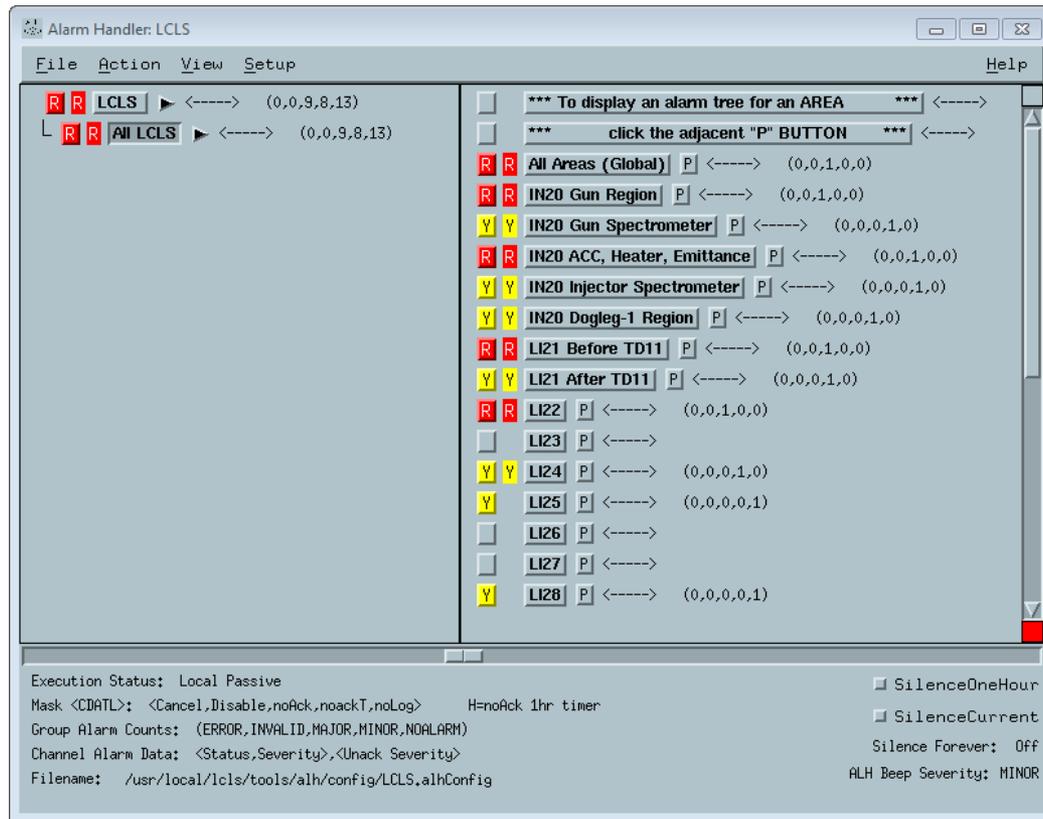
- We downloaded XAL's SCORE (Save Compare Restore), but it didn't meet all of our operational needs

- **Solution:**

- We added "Save the World" functionality
- We added waveform support
- Created programmer's API
- Added ability to knob to a SCORE snapshot
- Added **actions** such as *scale and trim magnet*
- Added color coding comparison between live and saved values

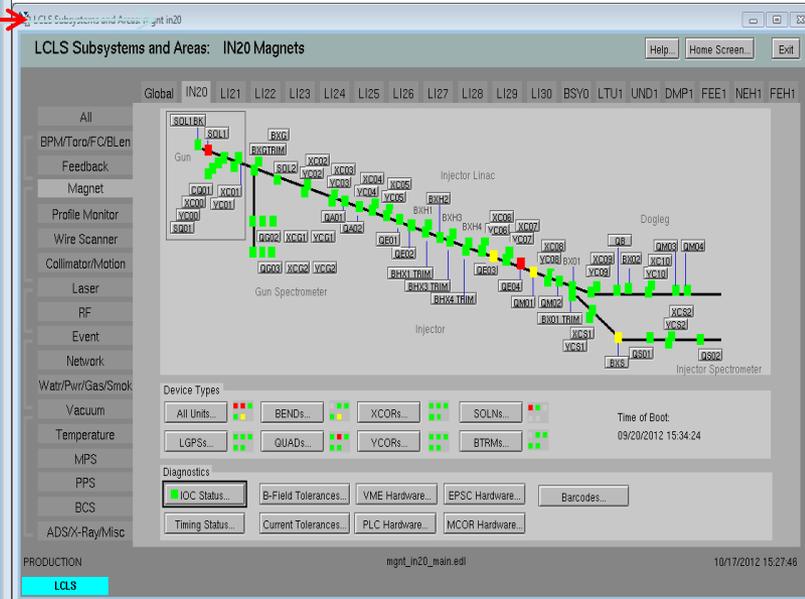
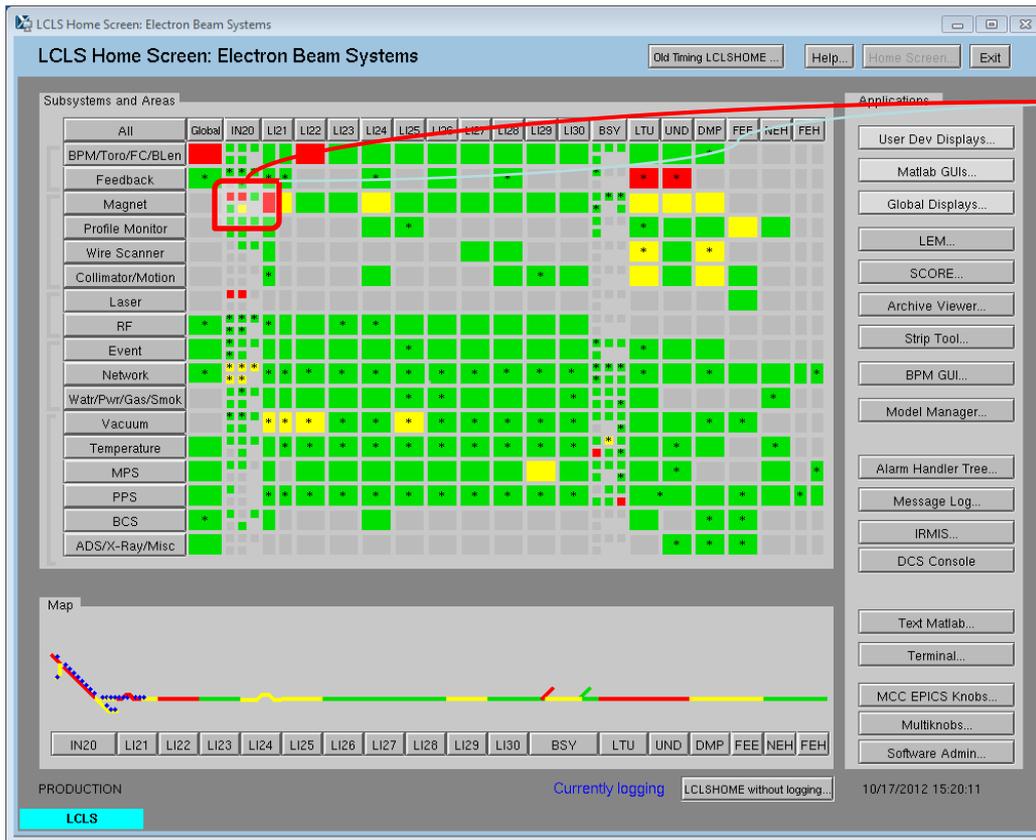
Alarms

- **Problem:**
 - No one pays attention to the Alarm Handler GUI



Alarms

- Solution:
 - Integrate alarms into edm screens



Meta Data

- **Problem:**

- Physicists would like, for example, to get a list of all active klystrons in their MATLAB programs. They could read several hundred PVs, but they think this is ridiculous and error prone.

- **Solution:**

- Add middle-ware to resolve commonly requested data sets or device lists and return them in one logical object.

User Defined PVs

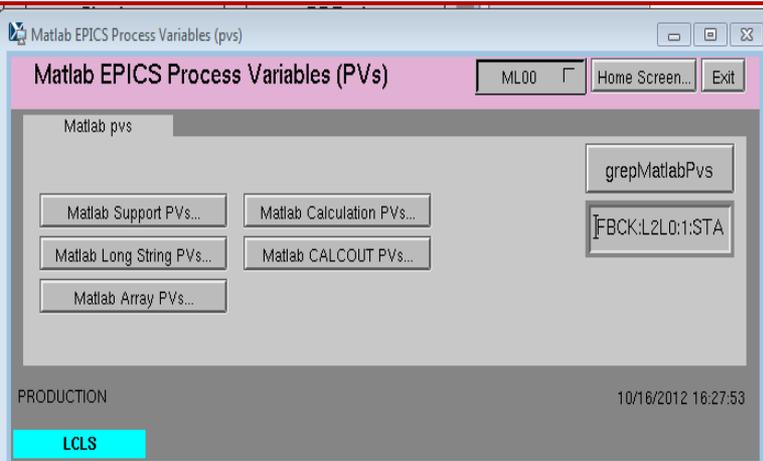
- **Problem:**

- Physicists like labCA (ezca for MATLAB) and want to use it to communicate between their own MATLAB programs. We created several soft IOCs with various types of PVs, but those PV names are static, and don't reflect the PV's function.

- **Solution:**

- Invite physicists to write an appropriate .DESC .EGU & comments for their PVs.

User Defined PVs Example



.NAME

SIOC:SYS0:ML00:A0058
 SIOC:SYS0:ML00:A0059
 SIOC:SYS0:ML00:A0060
 SIOC:SYS0:ML00:A0061
 SIOC:SYS0:ML00:A0062
 SIOC:SYS0:ML00:A0063
 SIOC:SYS0:ML00:A0064
 SIOC:SYS0:ML00:A0065
 SIOC:SYS0:ML00:A0066
 SIOC:SYS0:ML00:A0067
 SIOC:SYS0:ML00:A0068
 SIOC:SYS0:ML00:A0069
 SIOC:SYS0:ML00:A0070
 SIOC:SYS0:ML00:A0071
 SIOC:SYS0:ML00:A0072
 SIOC:SYS0:ML00:A0073
 SIOC:SYS0:ML00:A0074
 SIOC:SYS0:ML00:A0075
 SIOC:SYS0:ML00:A0076
 SIOC:SYS0:ML00:A0077
 SIOC:SYS0:ML00:A0078

.DESC

.EGU

Comment PV

L2 sb phase readback	-35.770	DegS	SBST phase only	08/16/2012 11:40:57
L3 sb phase readback	-0.063	DegS	Frisch	08/16/2012 11:40:57
L2 sb phase control	-35.741	DegS	Use AO061 Instead	08/16/2012 11:40:57
L3 sb phase control	-0.044	DegS	frisch	08/16/2012 11:40:57
L2 klystrons Activated:	-4		24-4,23-8,23-7,23-6	10/16/2012 11:44:36
L3 klystrons Deactivated:	-1		30-8	08/16/2012 11:40:57
phase_control	18952522	watchdog	counter	08/16/2012 16:29:24
Enable fancy phase control	1.0000	ON/OFF	USE WITH CARE	10/15/2012 05:31:27
L2 Energy	5822.39	MeV	phase_control.m	09/28/2012 17:35:21
BC1 phase delay	-22.8239	degS	phase_control.m	09/28/2012 00:42:47
L2 Phase control	-36.3594	degS	phase_control.m	09/28/2012 17:35:21
L2 Phase offset	18.4428	degS	Use to gold L2	08/16/2012 11:40:57
BC2 phase delay	28.5465	degS	phase_control.m	09/28/2012 00:39:43
L3 Phase control	0.0000	degS	phase_control.m	09/28/2012 17:35:22
L3 phase offset	-11.8975	degS	phase_control.m	08/16/2012 11:40:57
Phase control BUSY	0.0000	.	1 means busy	08/16/2012 11:40:57
L2 Fudge input	0.9400	.	phase_control.m	08/16/2012 11:40:57
laser_camera_running	873.0		laser_camera.m	10/16/2012 16:29:25
Integrated intensity	238344	arb	laser_camera.m	10/16/2012 16:29:21
Saturation	0.0000	ratio	laser_camera.m	10/16/2012 16:29:21
RMS variation	0.274		0 is perfect	10/16/2012 16:29:21
Diameter	0.953	mm	laser_camera.m	10/16/2012 16:29:21
Xcenter	-0.013	mm	laser_camera.m	10/16/2012 16:29:21
Ycenter	-0.013	mm	laser_camera.m	10/16/2012 16:29:21
L3 Energy	8825.4800	MeV	phase_control.m	09/28/2012 17:35:22
phase_control	1343400	watchdog	Frisch	10/16/2012 16:29:24
spare	8148	egu	Multi-test	08/16/2012 11:40:57
spare	12301	egu	Multi-test	08/16/2012 11:40:57