Orbit Display's Use of the Physics Application Framework

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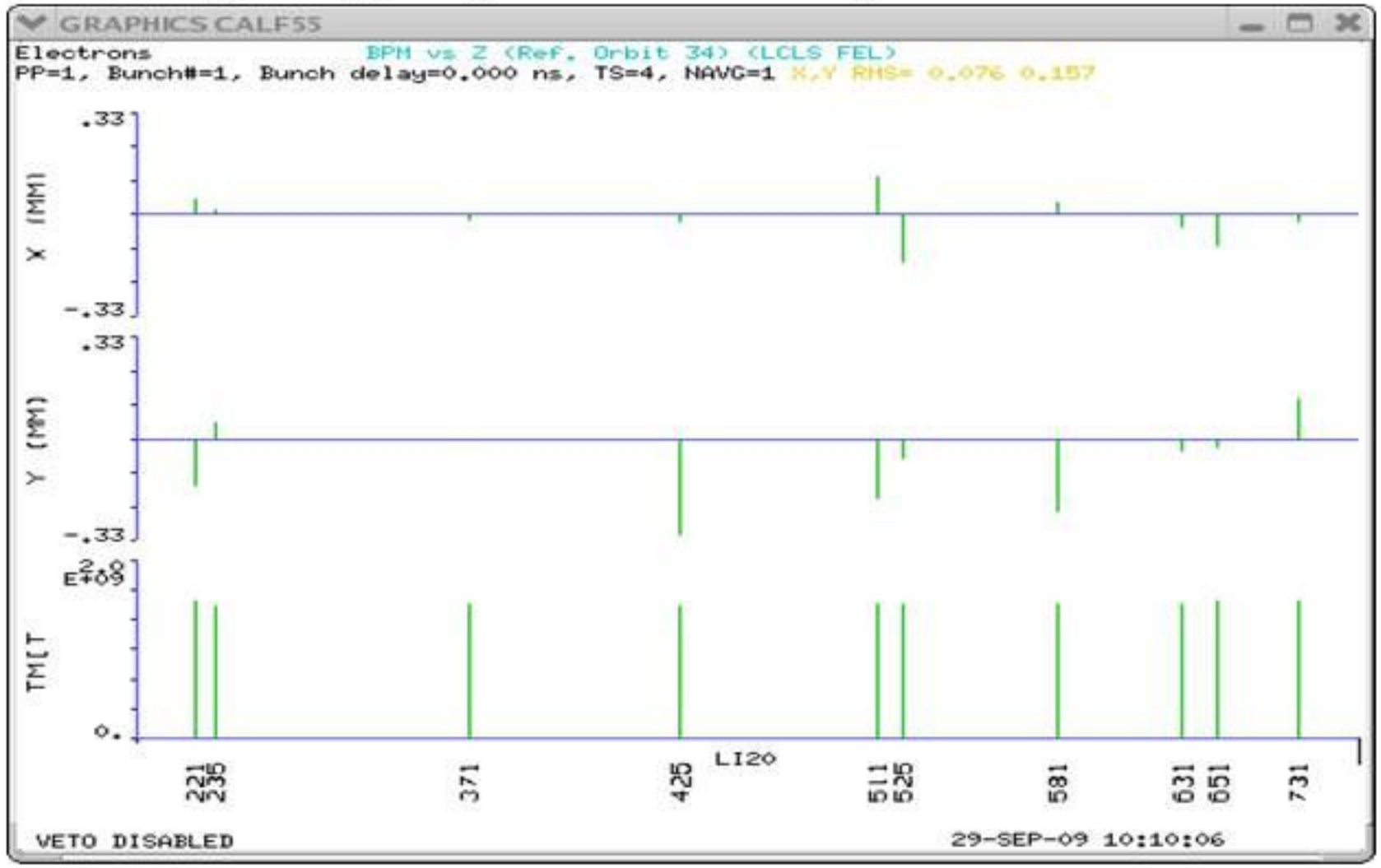
October 15th, 2009

SLAC NATIONAL ACCELERATOR LABORATORY

Why a new Orbit Display?

- Hasn't SLAC been around for 47 years?
  - Replacing legacy control system



Linac Coherent Light Source (LCLS)

- EPICS Toolkit Chosen
  - Communication protocol to control and read devices with Channel Access (CA) is incompatible with our VMS/CAMAC based control system.

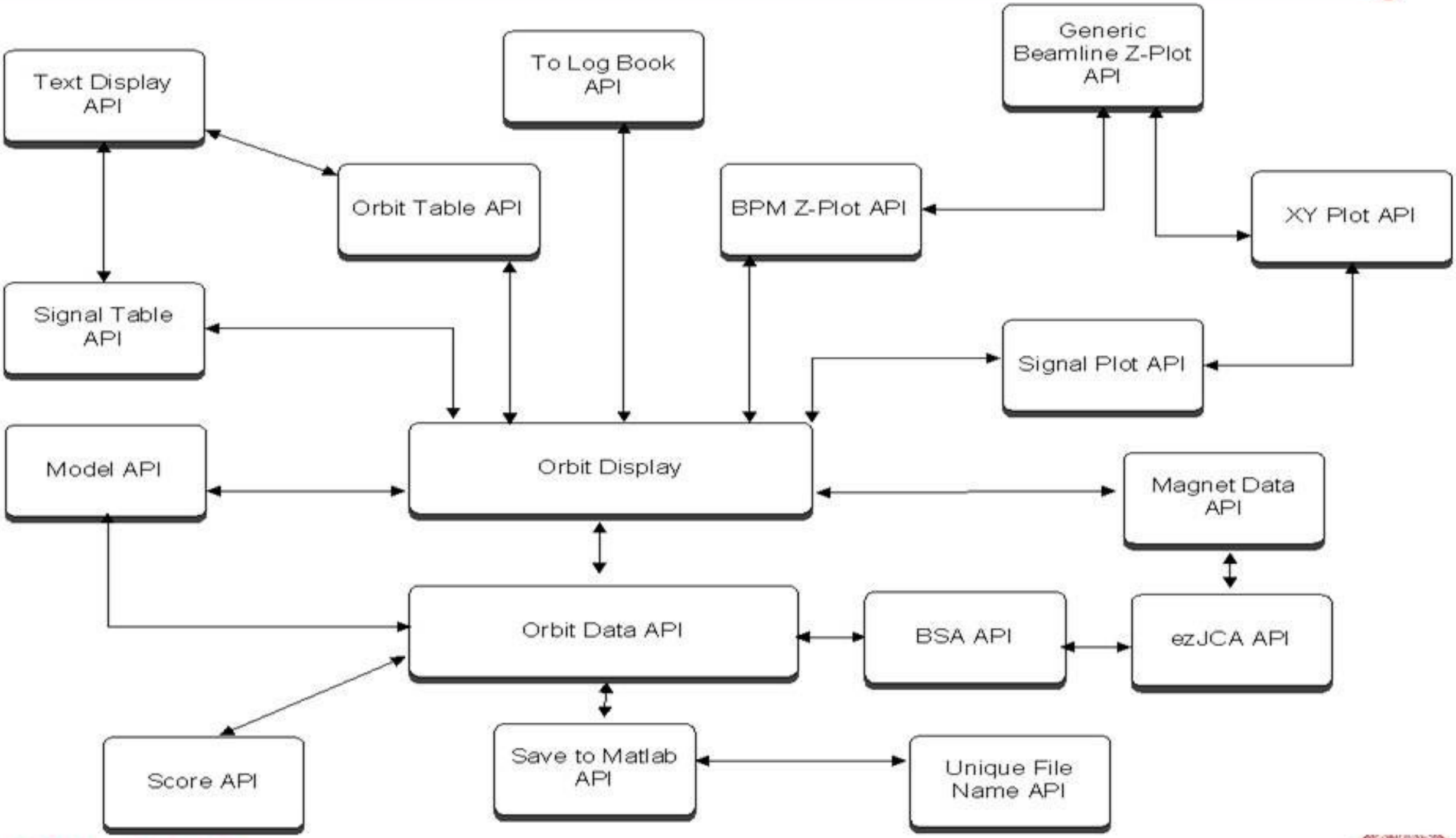
XAL from SNS

- Accelerator Application Framework
- Online Model (Twiss Parameters & Beam Trajectories)
- > 20 Physics Applications, but these applications didn't meet the unique requirements of LCLS at SLAC.

Decided to Develop in Java/Swing

- Reuse and customize many pieces of XAL
- XAL written in Java
- Many freely available Java libraries
- Easy to use Matlab API to Java

SLAC Java Libraries



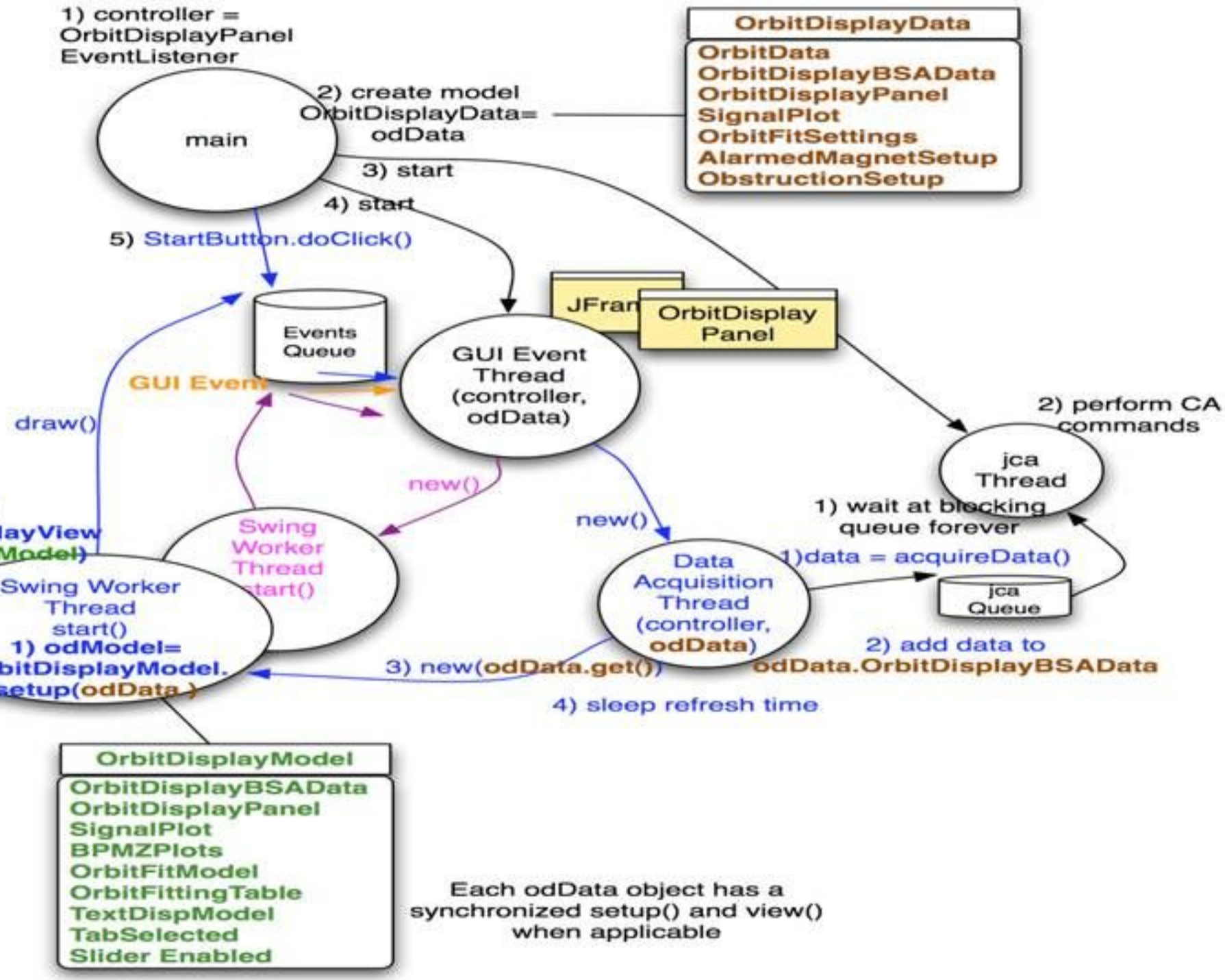
Difficulties with Java

- CLASSPATH environment variable
  - The Java class Path is often quite different between development and production environments
- Threading
  - GUI items MUST be done in the Java GUI thread
  - Java Channel Access (JCA) is single threaded

Eclipse

- Use Eclipse as an IDE, but not RCP due to learning curve
- Easy to create and distribute Java Jar's
- With a little shell script coaxing, can use Eclipse administrative file to set CLASSPATH environment variable

Threads


1) controller = OrbitDisplayPanel EventListener
main
2) create model OrbitDisplayData= odData
OrbitDisplayData
OrbitData
OrbitDisplayBSAData
OrbitDisplayPanel
SignalPlot
OrbitFitSettings
AlarmedMagnetSetup
ObstructionSetup
3) start
4) start
5) StartButton.doClick()
Events Queue
GUI Event
GUI Event Thread (controller, odData)
JFran
OrbitDisplay Panel
draw()
2) perform CA commands
jca Thread
1) wait at blocking queue forever
1)data = acquireData()
jca Queue
2) add data to odData.OrbitDisplayBSAData
new()
new()
new()
2) OrbitDisplayView .view(odModel)
Swing Worker Thread start()
Swing Worker Thread start()
1) odModel= OrbitDisplayModel. setup(odData)
Data Acquisition Thread (controller, odData)
3) new(odData.get())
4) sleep refresh time
OrbitDisplayModel
OrbitDisplayBSAData
OrbitDisplayPanel
SignalPlot
BPMZPlots
OrbitFitModel
OrbitFittingTable
TextDispModel
TabSelected
Slider Enabled
Each odData object has a synchronized setup() and view() when applicable

Standard GUI Framework

Beam Line "Z" Plot

Orbit Table

CATHODE TO DUMP OrbitDisplay-R0-0-51 softegr lcls-srv02 18757

-> Log Book | Stop | One Shot | Save Instant Ref | Absolute Orbit | Help | Beam Rate is 10.0 Hz

Z Plot | Table | BuffAcq

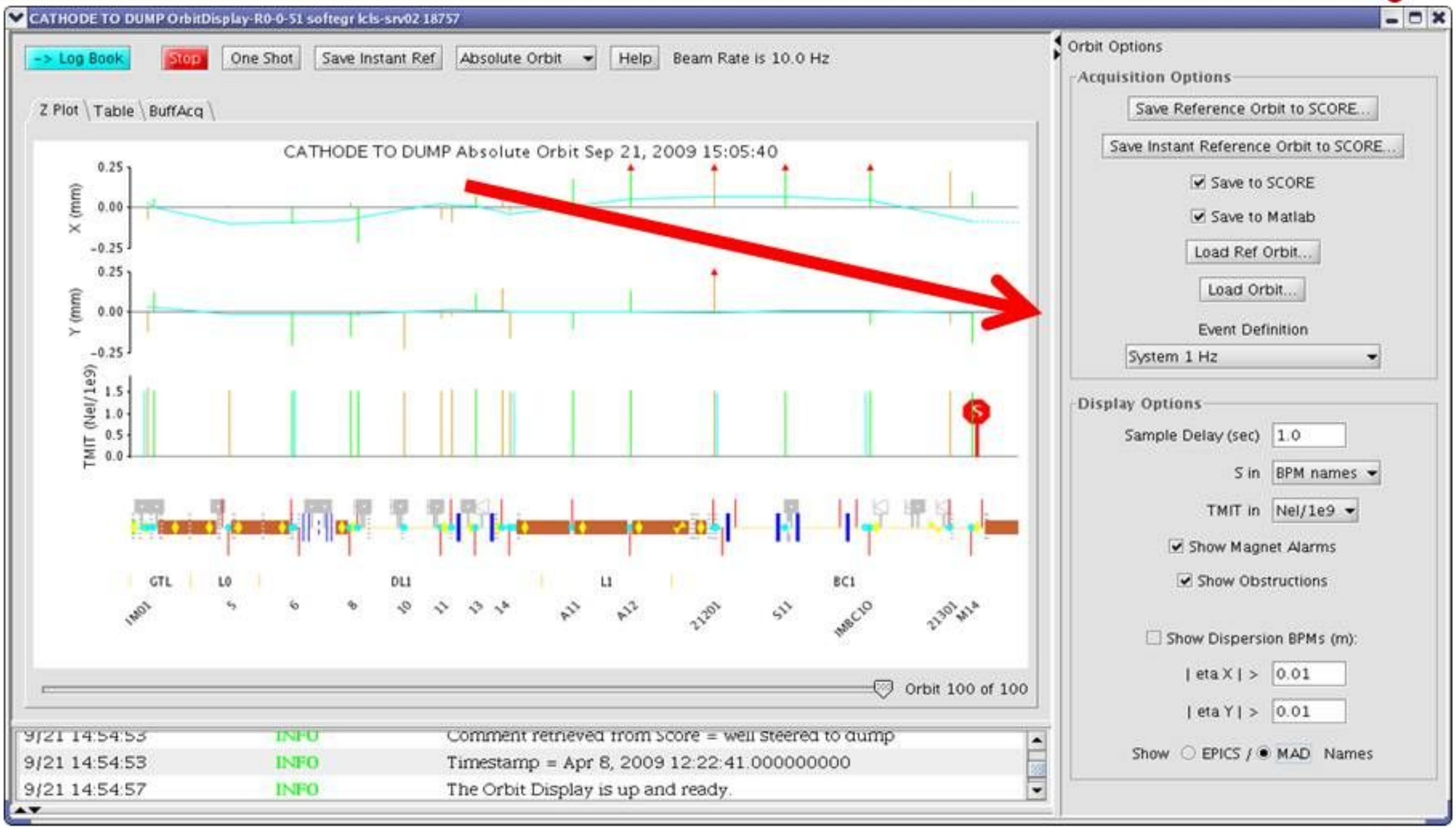
CATHODE TO DUMP Absolute Orbit Sep 21, 2009 14:58:24

Device	pv	X (mm)	Y (mm)	TMIT (Nel/1e9)	State
Begin_Of_CATHODE TO BXG					
IM01	TORO:IN20:215			1.512	NOT CONNECTED
BPM2	BPMS:IN20:221	-0.079	-0.127	1.605	FEEDBACK
Begin_Of_BXG TO BX01					
BPM3	BPMS:IN20:235	0.076	0.139	1.531	NO ALARM
BPM5	BPMS:IN20:371	0.005	-0.004	1.531	FEEDBACK
BPM6	BPMS:IN20:425	-0.099	-0.208	1.505	NO ALARM
IM02	TORO:IN20:431			1.543	NOT CONNECTED
BPM8	BPMS:IN20:511	0.027	-0.152	1.520	NO ALARM
BPM9	BPMS:IN20:525	-0.217	-0.018	1.513	NO ALARM
BPM10	BPMS:IN20:581	0.011	-0.231	1.488	FEEDBACK
BPM11	BPMS:IN20:631	-0.056	-0.038	1.517	FEEDBACK
BPM12	BPMS:IN20:651	-0.107	-0.023	1.565	FEEDBACK
Begin_Of_BX01 TO BX02					
BPM13	BPMS:IN20:731	0.022	0.123	1.571	NO ALARM
Begin_Of_BX02 TO QM15					
BPM14	BPMS:IN20:771	0.074	0.143	1.540	FEEDBACK
BPM15	BPMS:IN20:781	-0.003	-0.155	1.506	FEEDBACK
IM03	TORO:IN20:791			1.474	NOT CONNECTED
BPMA11	BPMS:LI21:131	0.178	-0.084	1.523	NO ALARM
BPMA12	BPMS:LI21:161	0.317	0.137	1.540	NO ALARM
BPM21201	BPMS:LI21:201	0.248	0.408	1.520	FEEDBACK
IMBC1I	TORO:LI21:205			1.537	NOT CONNECTED
BPMS11	BPMS:LI21:233	-0.015	0.035	1.501	NO ALARM
IMBC1O	TORO:LI21:277			1.547	NOT CONNECTED
BPMM12	BPMS:LI21:278	0.285	-0.077	1.503	NO ALARM
BPM21301	BPMS:LI21:301	0.241	-0.076	1.511	FEEDBACK
BPMM14	BPMS:LI21:315	0.114	-0.195	1.481	NO ALARM
Begin_Of_QM15 TO FV2					
BPM21401	BPMS:LI21:401	0.006	0.001	1.496	FEEDBACK
BPM21501	BPMS:LI21:501	0.112	-0.098	1.468	FEEDBACK
BPM21601	BPMS:LI21:601	-0.161	0.058	1.473	FEEDBACK
BPM21701	BPMS:LI21:701	-0.079	0.127	1.562	NO ALARM

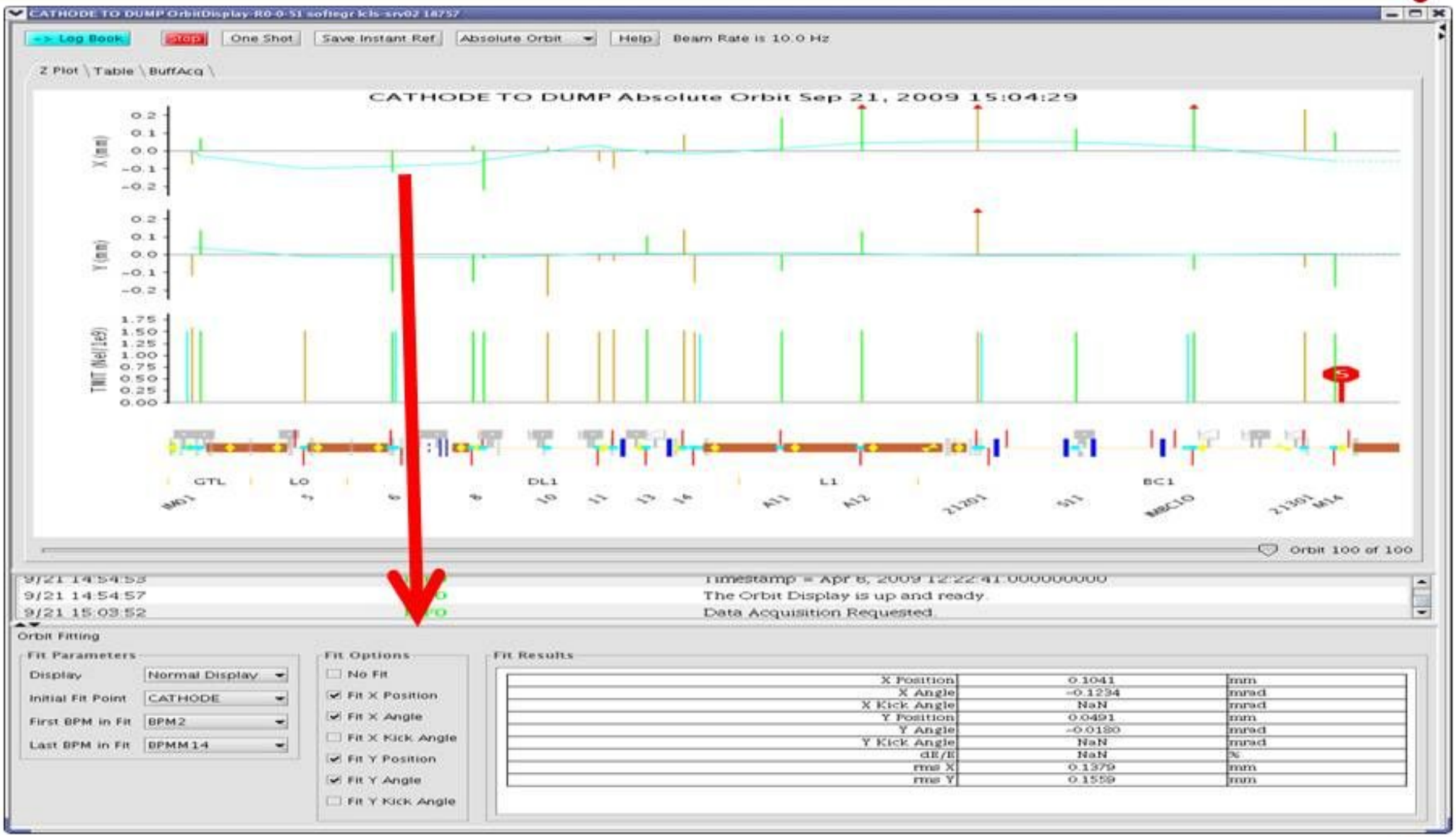
Orbit 100 of 100

9/21 14:54:53	INFO	Comment retrieved from Score = well steered to dump
9/21 14:54:53	INFO	Timestamp = Apr 8, 2009 12:22:41.000000000
9/21 14:54:57	INFO	The Orbit Display is up and ready.

Orbit Options



Orbit Fitting



Acknowledgements

- Sergei Chevtsov
- Diane Fairley
- Partha Natampalli
- Greg White
- Paul Chu
- Patrick Krejcik
- Debbie Rogind
- Mike Zelazny

Orbit Fitting Table

CATHODE TO DUMP OrbitDisplay-R0-0-51 sofiegr lcls-srv02 18757

-> Log Book | stop | One Shot | Save Instant Ref | Absolute Orbit | Help | Beam Rate is 10.0 Hz

Z Plot | Table | BuffAcq |

CATHODE TO DUMP Absolute Orbit Sep 21, 2009 15:04:42

BPM	Measured X (mm)	Fitted X (mm)	Delta X (mm)	Measured Y (mm)	Fitted Y (mm)	Delta Y (mm)	TMIT(Nel/1e9)	State
Begin_Of_CATHODE TO BXG								
IM01							1.519	NOT CONNECTED
BPM2	-0.081	0.022	-0.103	-0.120	0.037	-0.157	1.627	FEEDBACK
Begin_Of_BXG TO BX01								
BPM3	0.073	-0.019	0.092	0.137	0.033	0.103	1.552	NO ALARM
BPM5	-0.022	-0.118	0.097	-0.004	-0.015	0.011	1.553	FEEDBACK
BPM6	-0.121	-0.108	-0.013	-0.208	-0.021	-0.187	1.525	NO ALARM
IM02							1.587	NOT CONNECTED
BPM8	0.004	-0.091	0.095	-0.155	-0.015	-0.139	1.542	NO ALARM
BPM9	-0.233	-0.070	-0.164	-0.022	-0.015	-0.007	1.533	NO ALARM
BPM10	0.015	-0.010	0.026	-0.224	-0.001	-0.223	1.520	FEEDBACK
BPM11	-0.053	0.036	-0.089	-0.032	0.011	-0.043	1.539	FEEDBACK
BPM12	-0.086	0.017	-0.103	-0.013	0.024	-0.037	1.590	FEEDBACK
Begin_Of_BX01 TO BX02								
BPM13	0.065	0.001	0.064	0.115	0.008	0.107	1.594	NO ALARM
Begin_Of_BX02 TO QM15								
BPM14	0.089	-0.020	0.109	0.148	0.009	0.139	1.562	FEEDBACK
BPM15	-0.005	-0.032	0.027	-0.159	0.006	-0.165	1.529	FEEDBACK
IM03							1.511	NOT CONNECTED
BPMA11	0.189	0.012	0.176	-0.100	0.003	-0.102	1.544	NO ALARM
BPMA12	0.333	0.059	0.274	0.133	-0.002	0.136	1.562	NO ALARM
BPM21201	0.273	0.073	0.200	0.404	-0.011	0.415	1.541	FEEDBACK
IMBC1I							1.518	NOT CONNECTED
BPMS11	0.195	0.070	0.125	-0.010	0.007	-0.017	1.528	NO ALARM

Orbit 100 of 100

9/21 14:54:53	INFO	Timestamp = Apr 8, 2009 12:22:41.000000000
9/21 14:54:57	INFO	The Orbit Display is up and ready.
9/21 15:03:52	INFO	Data Acquisition Requested.

Orbit Fitting

Fit Parameters

Display: Normal Display
Initial Fit Point: CATHODE
First BPM in Fit: BPM2
Last BPM in Fit: BPMM14

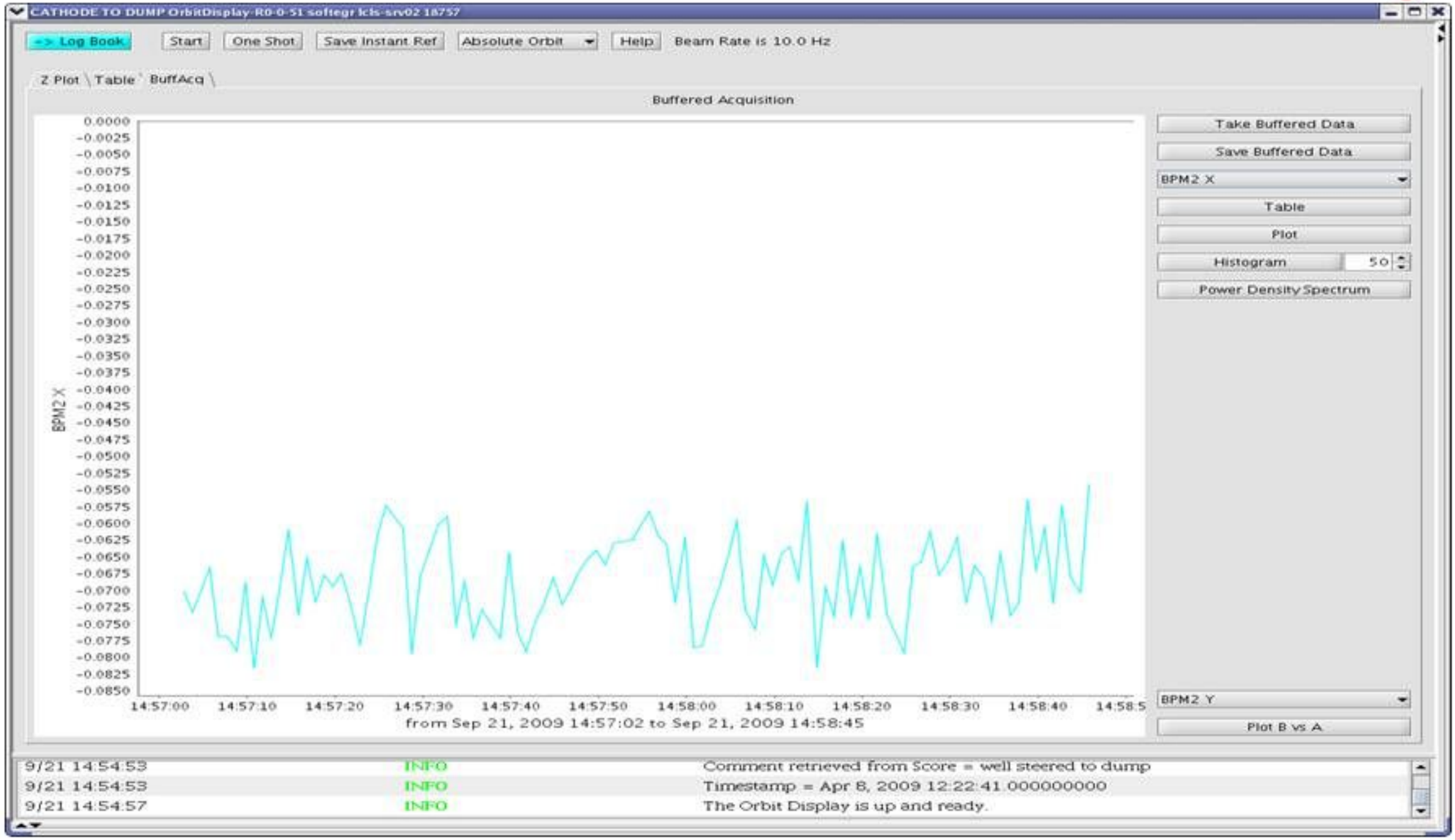
Fit Options

- [ ] No Fit
- [x] Fit X Position
- [x] Fit X Angle
- [ ] Fit X Kick Angle
- [x] Fit Y Position
- [x] Fit Y Angle
- [ ] Fit Y Kick Angle

Fit Results

X Position	0.1360	mm
X Angle	-0.1275	mrad
X Kick Angle	NaN	mrad
Y Position	0.0466	mm
Y Angle	-0.0111	mrad
Y Kick Angle	NaN	mrad
dE/E	NaN	%
rms X	0.1922	mm
rms Y	0.1559	mm

Buffered Acquisition Plot



Buffered Acquisition Table

CATHODE TO DUMP OrbitDisplay-R0-0-51 softegr lcls-srv02 18757

-> Log Book | Start | One Shot | Save Instant Ref | Absolute Orbit | Help | Beam Rate is 10.0 Hz

Z Plot \ Table \ BuffAcq \

Buffered Acquisition

CATHODE TO DUMP BPM2 X

Time Stamp	Value
100 Sep 21, 2009 14:58:45.775882491	-0.054
99 Sep 21, 2009 14:58:44.775882131	-0.070
98 Sep 21, 2009 14:58:43.775881771	-0.068
97 Sep 21, 2009 14:58:42.775881411	-0.057
96 Sep 21, 2009 14:58:41.775749979	-0.072
95 Sep 21, 2009 14:58:40.775749619	-0.061
94 Sep 21, 2009 14:58:39.775749259	-0.067
93 Sep 21, 2009 14:58:38.775617827	-0.057
92 Sep 21, 2009 14:58:37.775617467	-0.072
91 Sep 21, 2009 14:58:36.775486035	-0.074
90 Sep 21, 2009 14:58:35.775354603	-0.064
89 Sep 21, 2009 14:58:34.775223171	-0.075
88 Sep 21, 2009 14:58:33.775222811	-0.068
87 Sep 21, 2009 14:58:32.775091379	-0.066
86 Sep 21, 2009 14:58:31.774959947	-0.072
85 Sep 21, 2009 14:58:30.774828515	-0.062
84 Sep 21, 2009 14:58:29.774697083	-0.065
83 Sep 21, 2009 14:58:28.774565651	-0.068
82 Sep 21, 2009 14:58:27.774434219	-0.061
81 Sep 21, 2009 14:58:26.774302787	-0.066
80 Sep 21, 2009 14:58:25.774171355	-0.066
79 Sep 21, 2009 14:58:24.774039923	-0.079
78 Sep 21, 2009 14:58:22.773777059	-0.074
77 Sep 21, 2009 14:58:21.773645627	-0.061
76 Sep 21, 2009 14:58:20.773645267	-0.074
75 Sep 21, 2009 14:58:19.773513835	-0.066
74 Sep 21, 2009 14:58:18.773382403	-0.074
73 Sep 21, 2009 14:58:17.773250971	-0.063
72 Sep 21, 2009 14:58:16.773119539	-0.074
71 Sep 21, 2009 14:58:15.773119179	-0.069
70 Sep 21, 2009 14:58:14.772987747	-0.081
69 Sep 21, 2009 14:58:13.772856315	-0.057
68 Sep 21, 2009 14:58:12.772855955	-0.069

Take Buffered Data

Save Buffered Data

BPM2 X

Table

Plot

Histogram 50

Power Density Spectrum

BPM2 Y

Plot B vs A

9/21 14:54:53	INFO	Comment retrieved from Score = well steered to dump
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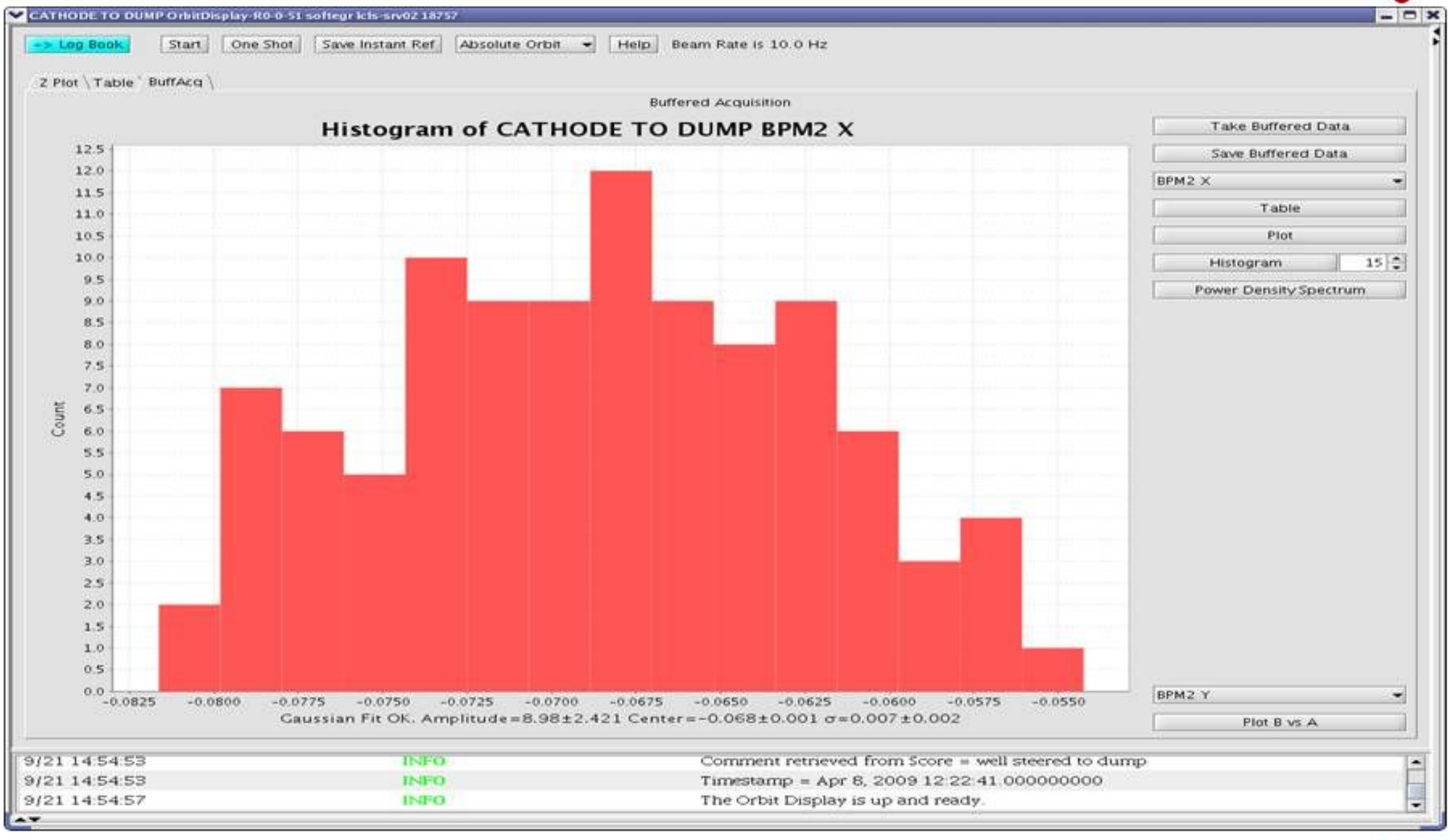
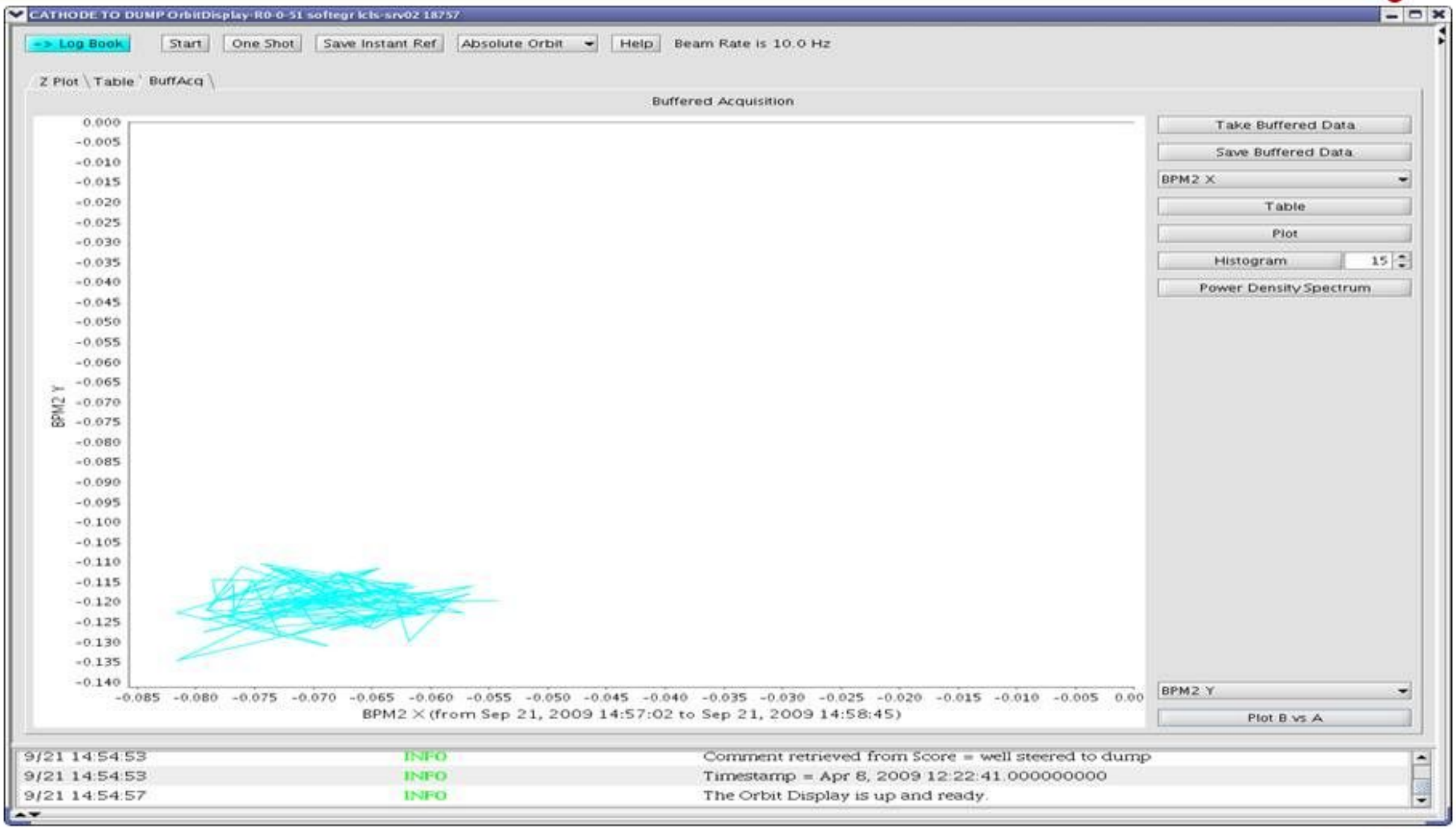
9/21 14:54:57	INFO	The Orbit Display is up and ready.

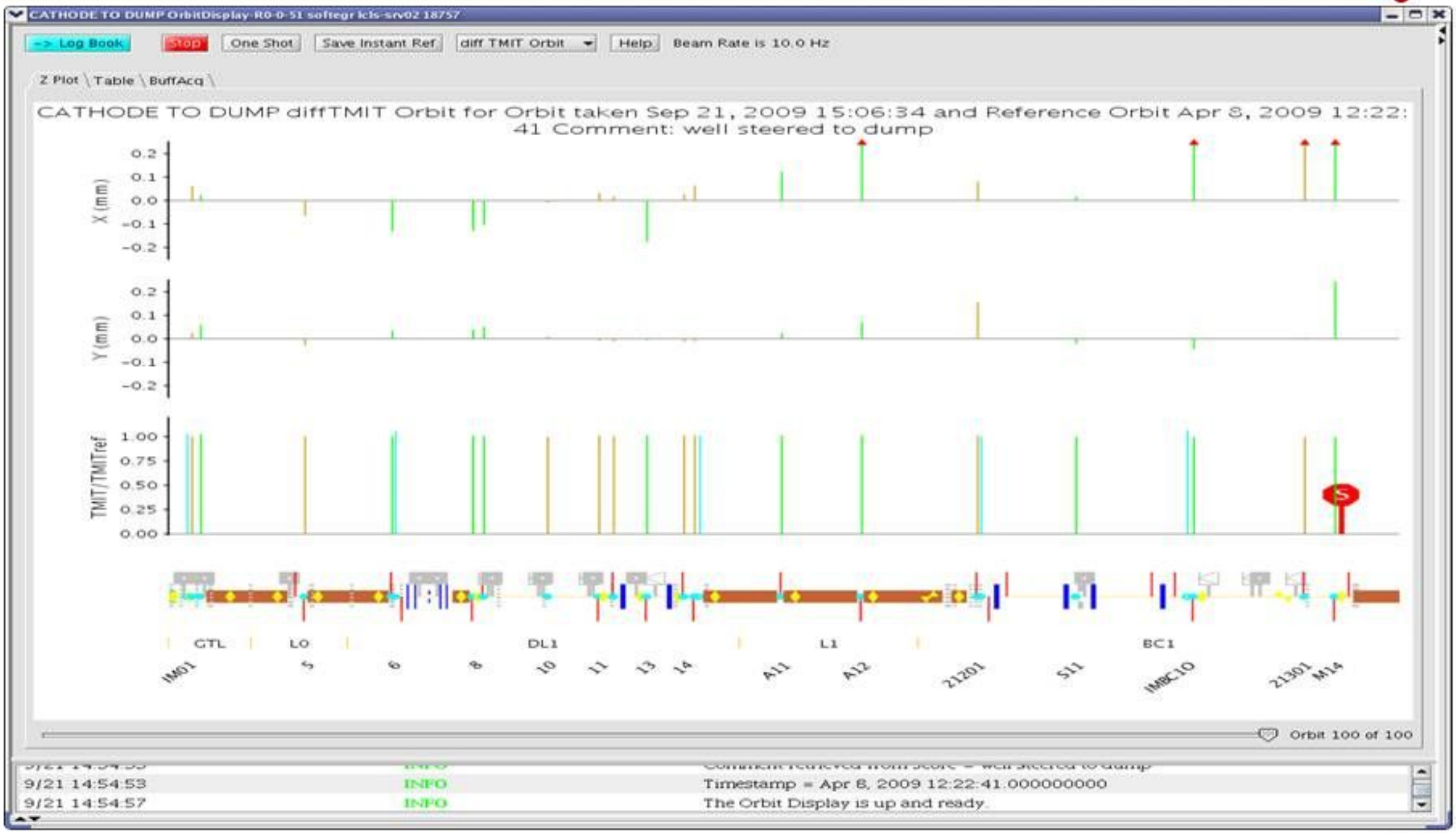
Histogram of Buffered Data



Signal A vs Signal B



Difference to Reference Orbit



Difference to Reference Orbit

CATHODE TO DUMP OrbitDisplay-R0-0-51 softegr lcls-srv02 18757

-> Log Book | Stop | One Shot | Save Instant Ref | diff TMIT Orbit | Help | Beam Rate is 10.0 Hz

Z Plot | Table | BuffAcq

CATHODE TO DUMP diffTMIT Orbit for Orbit taken Sep 21, 2009 15:08:03 and Reference Orbit Apr 8, 2009 12:22:41 Comment: well steered to dump

Device	pv	X (mm)	Y (mm)	TMIT / TMITref	State
Begin_Of_CATHODE TO BXG					
IM01	TORO:IN20:215			1.061	NOT CONNECTED
BPM2	BPMS:IN20:221	0.065	0.048	1.048	FEEDBACK
Begin_Of_BXG TO BX01					
BPM3	BPMS:IN20:235	0.053	0.065	1.074	NO ALARM
BPM5	BPMS:IN20:371	-0.053	-0.019	1.054	FEEDBACK
BPM6	BPMS:IN20:425	-0.130	0.038	1.051	NO ALARM
IM02	TORO:IN20:431			1.098	NOT CONNECTED
BPM8	BPMS:IN20:511	-0.135	0.033	1.057	NO ALARM
BPM9	BPMS:IN20:525	-0.109	0.045	1.052	NO ALARM
BPM10	BPMS:IN20:581	-0.026	0.001	1.043	FEEDBACK
BPM11	BPMS:IN20:631	0.008	-0.035	1.059	FEEDBACK
BPM12	BPMS:IN20:651	0.026	-0.048	1.054	FEEDBACK
Begin_Of_BX01 TO BX02					
BPM13	BPMS:IN20:731	0.021	0.001	1.059	NO ALARM
Begin_Of_BX02 TO QM15					
BPM14	BPMS:IN20:771	-0.013	-0.011	1.059	FEEDBACK
BPM15	BPMS:IN20:781	0.042	-0.010	1.060	FEEDBACK
IM03	TORO:IN20:791			1.075	NOT CONNECTED
BPMA11	BPMS:LI21:131	0.120	0.056	1.061	NO ALARM
BPMA12	BPMS:LI21:161	0.288	0.085	1.062	NO ALARM
BPM21201	BPMS:LI21:201	0.109	0.165	1.059	FEEDBACK
IMBC1I	TORO:LI21:205			1.071	NOT CONNECTED
BPMS11	BPMS:LI21:233	0.084	-0.079	1.048	NO ALARM
IMBC1O	TORO:LI21:277			1.120	NOT CONNECTED
BPMM12	BPMS:LI21:278	0.383	-0.081	1.045	NO ALARM
BPM21301	BPMS:LI21:301	0.226	0.035	1.044	FEEDBACK
BPMM14	BPMS:LI21:315	0.274	0.278	1.045	NO ALARM
Begin_Of_QM15 TO FV2					
BPM21401	BPMS:LI21:401	0.339	0.029	1.038	FEEDBACK
BPM21501	BPMS:LI21:501	0.365	-0.424	1.035	FEEDBACK
BPM21601	BPMS:LI21:601	0.068	-0.595	1.036	FEEDBACK
BPM21701	BPMS:LI21:701	0.088	0.054	1.037	NO ALARM
BPM21801	BPMS:LI21:801	-0.077	0.249	1.032	FEEDBACK

Orbit 100 of 100

9/21 14:54:53 INFO Timestamp = Apr 8, 2009 12:22:41.000000000

9/21 14:54:57 INFO The Orbit Display is up and ready.

Epilogue

- GUI is Swing based
- Chose Java Channel Access (JCA) over Channel Access for Java (CAJ) because at the time there was no one using CAJ to run their accelerator.