

NSLS II Physics Application and its Open Architecture



Guobao Shen
Controls Group, Photon Sciences
Brookhaven National Laboratory
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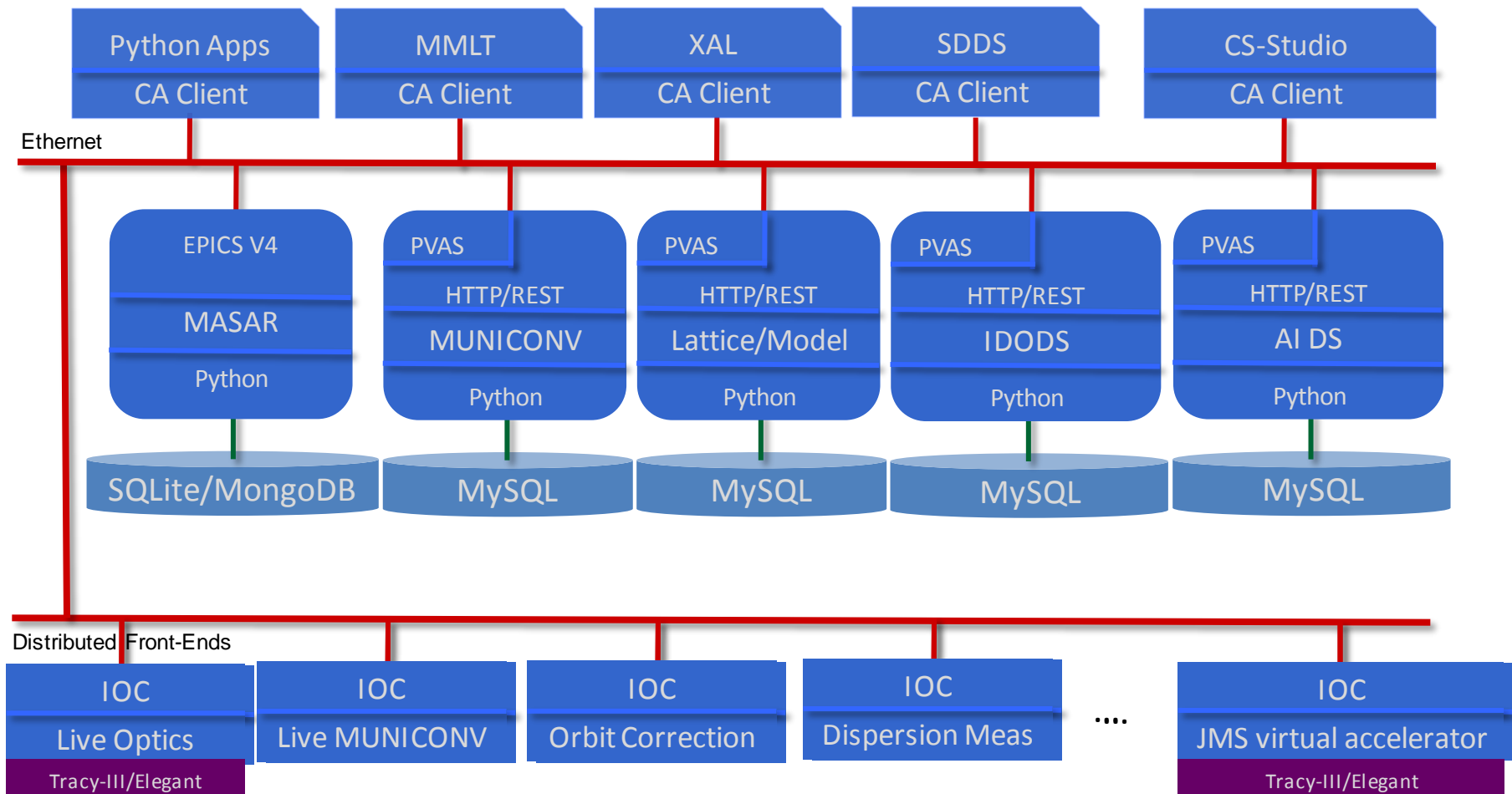
Motivation

- Traditional high level application suites
 - Closed environment
 - Self consistent
 - Come with its own simulation code
 - Work good once successfully configured
 - Expertise needed
- Open structure environment
 - Break into separate modules
 - Portability
 - Reusability

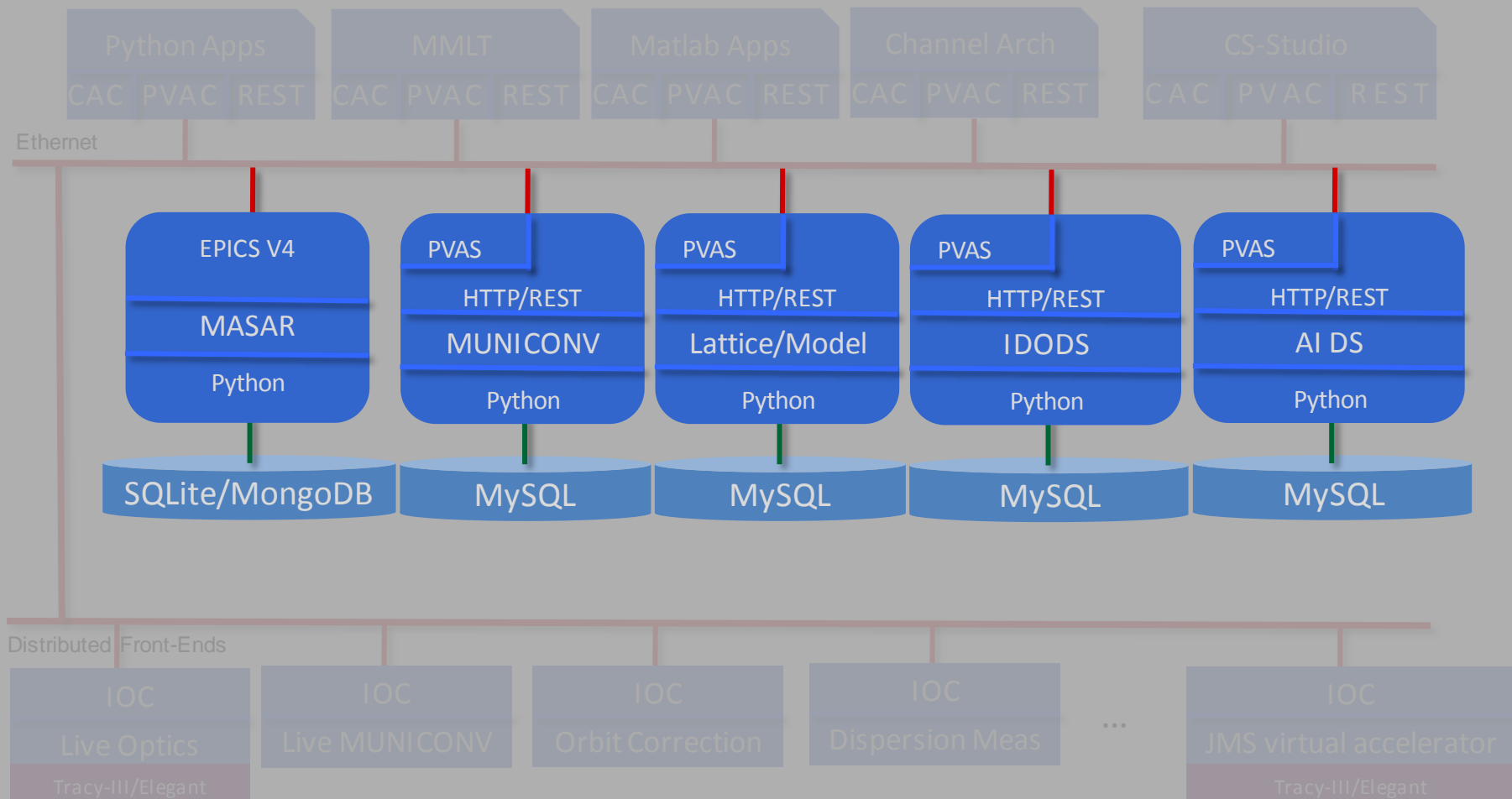


System Architecture

- 3-tier open architecture at NSLS II



Middle Layer Services



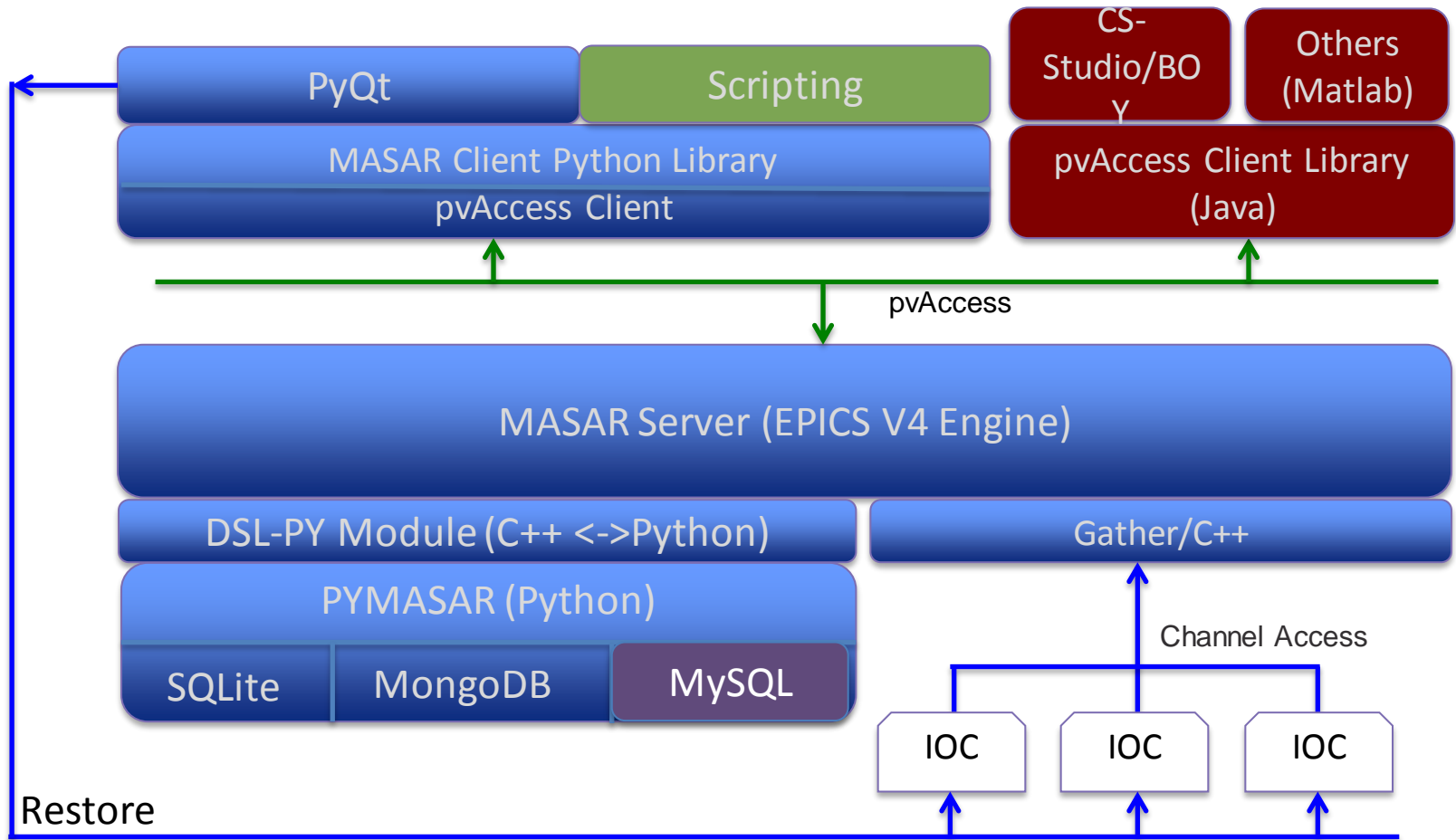
Middle Layer Services

- MASAR
 - A save/restore tool
 - Machine Snapshot, Archiving, and Retrieve
 - EPICS **V4** Service to snapshot machines
 - General purpose tool
 - Globally handle PVs distributed in different IOCs
 - Machine
 - A collection of EPICS PVs
 - Snapshot
 - Data at specific time point
 - Value, time stamp, connection status, alarm status, alarm severity
- Similar, but different purpose tools
 - Autosave
 - Single IOC bumpless rebooting
 - Channel Archiver
 - Archive periodically
 - Save time serially data



Middle Layer Services

- MASAR Architecture

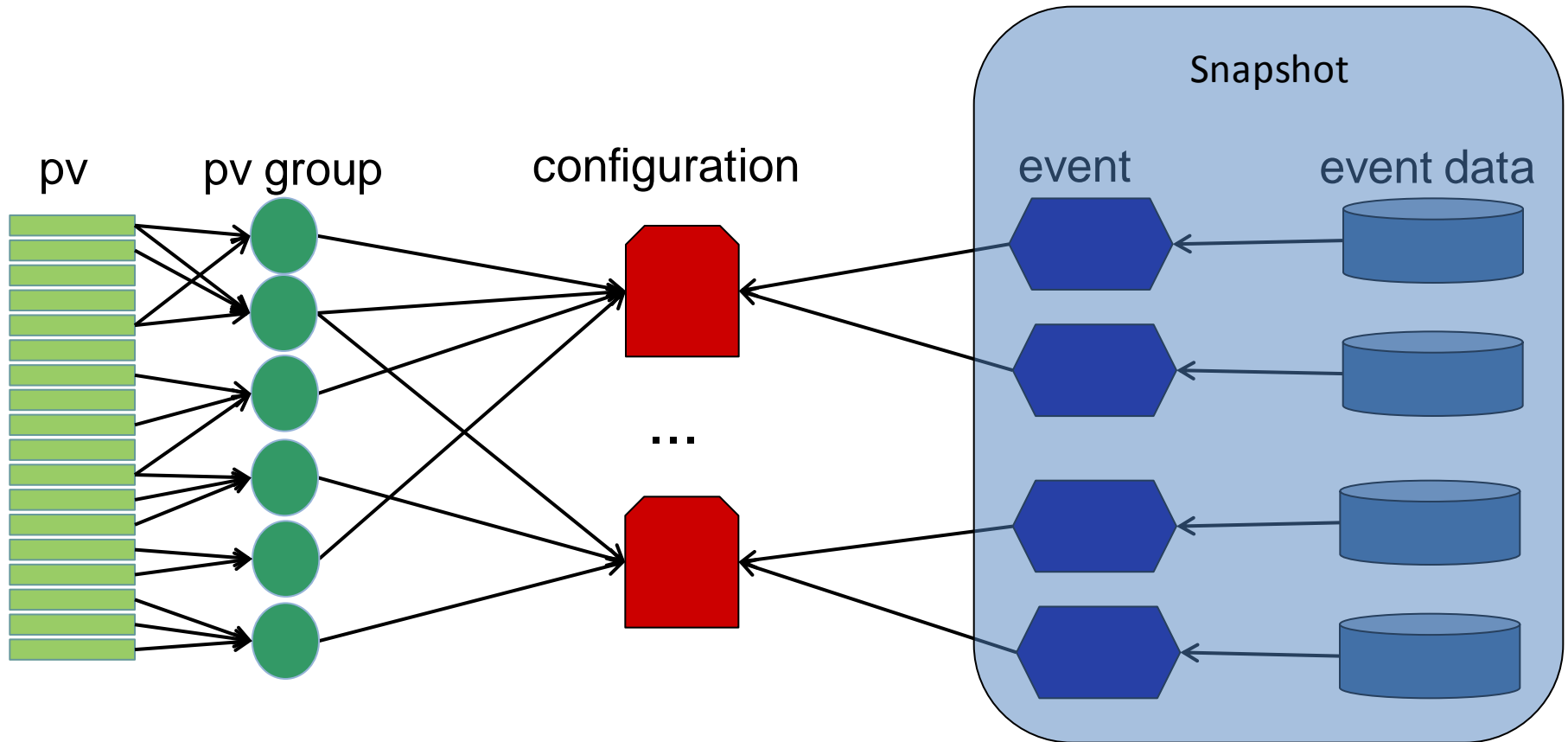


Finished
 User Apps
 Plan
 Developing



Middle Layer Services

- MASAR terminologies



Middle Layer Services

- MASAR Client PyQt4 UI

The screenshot displays the MASAR Viewer interface. On the left, there is a 'Config Filter' section and a table of configurations. The main area shows a detailed table of configurations with columns for PV Name, Saved Connection, Not Restore, Saved Value, Live Value, Diff, Saved Timestamp, Saved Status, Saved Severity, and Live. A blue callout box highlights configuration 6, 'SR_All_SCR_20140421', and its snapshot 1226, 'LOCO beta-beat&gamma=2.8% δ1.5%'. An arrow points from this callout to a text overlay that reads: 'Become official lattice ID in our commissioning reports, log, ...'.

Config Name	Config Id	Description
1 SR_Diag_BPM_Timing_20140626	43	Timing and Event Coc
2 SR_Diag_BPM_Offsets_20140626	42	BBA, User and Refere
3 SR_Diag_BPM_Control_20140626	41	Control and Readout
4 SR_Diag_BPM_Atten_20140626	40	RF Attenuator Setting
5 SR_Diag_BPM_SDI_20140423	38	Fast Orbit Feedback S
6 SR_All_SCR_20140421	29	SR daily SCR setpoint
7 LTB_BR_BTS_20140421	28	BR SCR PVs with IS ic
8 LN-LTB-All-20131219	18	Unac and LTB daily S
9 SR_Diag_BPM_Timing_20140423	39	Timing and Event Coc
10 SR_Diag_BPM_Offsets_20140423	37	BBA, User and Refere
11 SR_Diag_BPM_Control_20140423	36	Control and Readout
12 SR_Diag_BPM_Atten_20140423	35	RF Attenuator Setting

Config Name	Snapshot Id	Description
1 SR_All_SCR_20140421	1229	0 A PS except diole
2 SR_All_SCR_20140421	1228	0 A PS except dipole
3 SR_All_SCR_20140421	1226	LOCO beta-beat&gamma=2.8% δ1.5%
4 SR_All_SCR_20140421	1225	LOCO 4x-Hdispersion
5 SR_All_SCR_20140421	1224	before correction
6 SR_All_SCR_20140421	1221	Beta Beat improve from 5 per to 3
7 SR_All_SCR_20140421	1220	Corresponds with 1192, zero chro
8 SR_All_SCR_20140421	1217	sameQuad with LOCO data large-c
9 SR_All_SCR_20140421	1213	50mA achieved!
10 SR_All_SCR_20140421	1211	LOCO correction betax2.4%betay1.
11 SR_All_SCR_20140421	1208	afterLOCO-correction
12 SR_All_SCR_20140421	1207	before loco measurement
13 SR_All_SCR_20140421	1206	orbit correction on masar1192
14 SR_All_SCR_20140421	1202	start1192masr-rmsx0.17mm-rmsy
15 SR_All_SCR_20140421	1200	beta-beatx2.3%beta-beaty3.9%

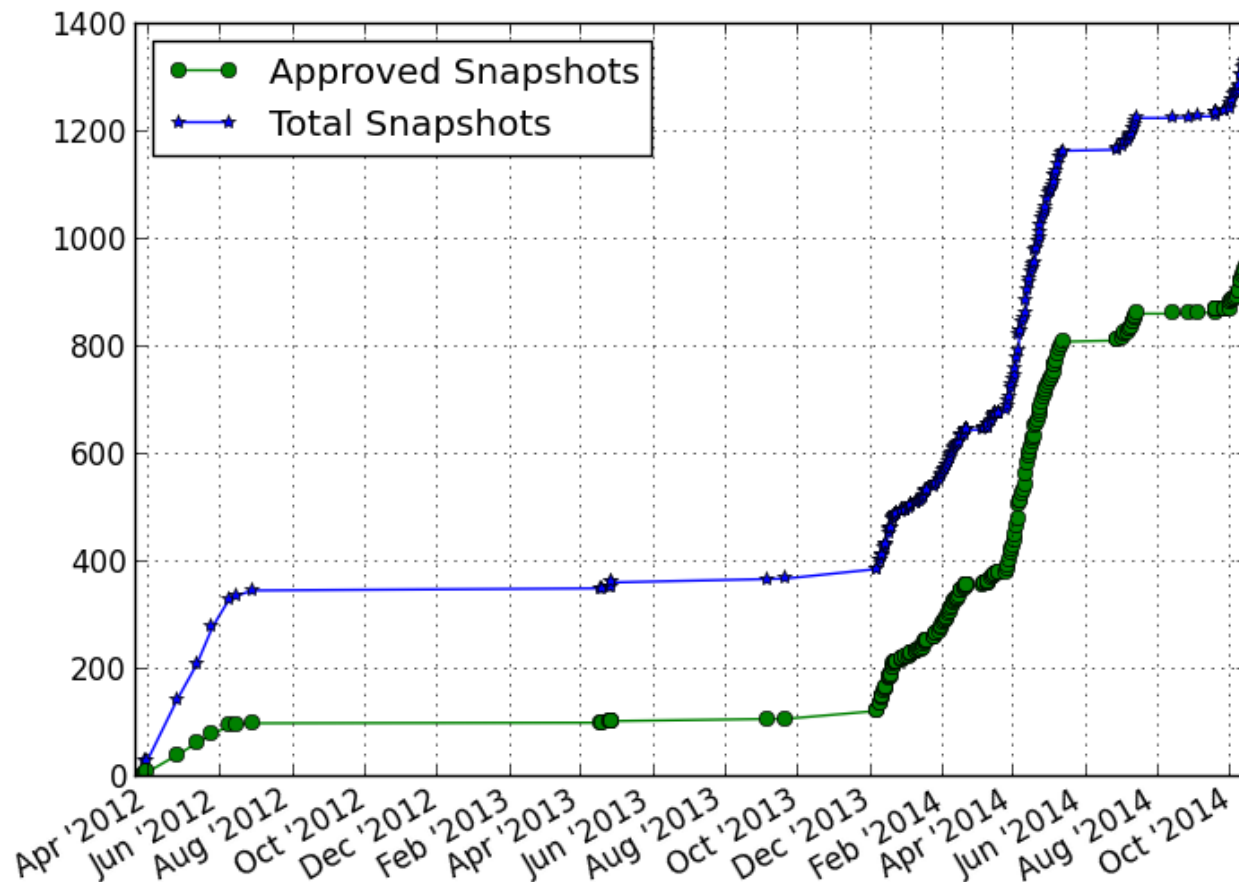
Text overlay: Become official lattice ID in our commissioning reports, log, ...



Middle Layer Services

- Deployed in control network from the first day (3/27/2012)
- MASAR snapshots taken with time (up to 10/15/2014)

Snapshots



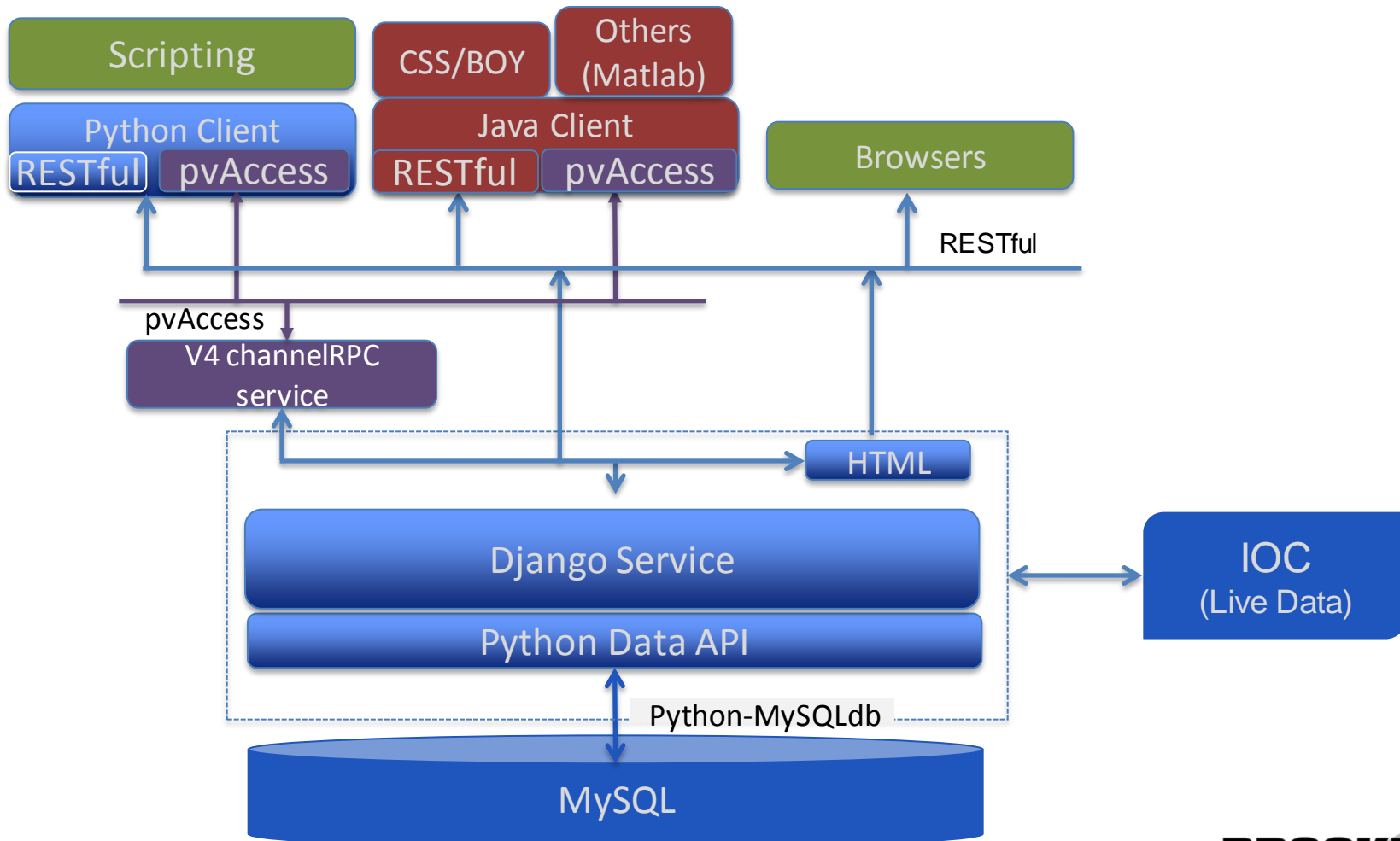
Middle Layer Services

- RESTful based middle layer services
 - For static data
 - Data warehouse
 - Middle layer IOC for live data
 - In V3 currently, and planned to be in V4
- Services at NSLS II
 - MUNICONV: multiple unit conversion
 - Lattice/Model
 - Beam based interlock data service
 - Insertion device data service



Middle Layer Services

- Architecture for RESTful based Service



Middle Layer Services

- MUNICONV Service
 - Multiple unit conversion
 - First implementation targeting on magnets
 - Convert value between different unit systems
 - i: power supply current
 - b: magnetic fields
 - k: value in model/lattice domain
 - Implemented with Django
 - MySQL as RDB backend
 - Client support
 - Python library
 - Web UI



Middle Layer Services

- MUNICONV WEB View

The screenshot displays the MUNICONV WEB View interface in a Mozilla Firefox browser. The page is titled "Unit Conversion" and shows a search for devices on the left, a conversion form in the center, and a plot of field vs current on the right.

Search for devices: Filter devices... Search in: Inventory Installation System: Name: Q* Component type: Serial number: Search

Conversion form: Source unit: i Destination unit: b Initial value: 45.00 Energy: Convert

Algorithms:

Alg	Funcnt	Init Unit	Alg Id	Res Unit	Aux Info
b2k	input/(0.025*3.33567*energy)	T-m	0	1/m2	2
i2b	interpolating	A	3	T-m	0

Conversion results: Measurement data Properties

Clear table

Algorithm	Initial value	Initial unit	Converted value	Converted unit	Show
i2b	45.00	A	0.05053585286152892	T-m	Show

Select data on axis x: current and y: field

Plot all points together Plot according to direction Dn Up

Redraw plot

Plot: field vs current. Legend: Up (yellow squares), Conversion results (blue squares). The plot shows a linear relationship between current and field.

Middle Layer Services

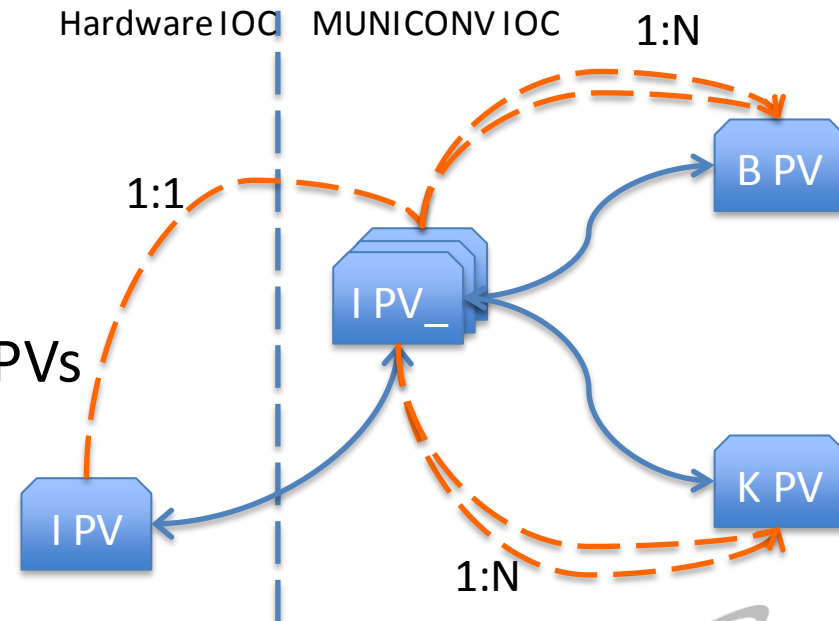
- MUNICONV IOC

- pyDevSup: Python Device Support
- Initialize IOC thru RESTful web service
- Trigger processing when HW record processed

- ~ 1K HWs
- ~ 4K soft records
 - SP, RB
 - B, K values
- 1 HW PVs => 1 or more soft PVs
 - Power chain

- Separate from H/W IOC

- PV Mapping & relation thru C.F.



C01 Manget Monitor

C01: All Magnets

C01: Quadrupols

Name	Setpoint	Readback	GL	GL	K1L SP	K1L RB
QL1A	98.534596	99 AMP	4.3923	4.3924	0.4389	0.4389
QL2A	110.337966	110 AMP	8.1437	8.1438	0.8138	0.8138
QL3A	91.401227	91 AMP	4.0814	4.0811	0.4079	0.4078
QM1A	91.743840	92 AMP	2.0169	2.017	0.2016	0.2016
QM2A	138.824476	139 AMP	3.4464	3.4465	0.3444	0.3444
QM2B	138.301333	138 AMP	3.4484	3.4484	0.3446	0.3446
QM1B	91.563021	92 AMP	2.0138	2.0138	0.2012	0.2012
QH3B	104.839300	105 AMP	4.6967	4.6965	0.4693	0.4693
QH2B	88.492427	88 AMP	6.6098	6.6101	0.6605	0.6606
QH1B	38.090089	38 AMP	1.7187	1.7188	0.1718	0.1718

C01: H Correctors

Name	Setpoint	Readback	BL SP	BL	K SP	K RB
CL1A	3.808968	4 AMP	0.0017	0.0017	0.0002	0.0002
CL2A	-4.532356	-5 AMP	-0.0021	-0.0021	-0.0002	-0.0002
CM1A	-0.214303	-0 AMP	-0.0001	-0.0001	-0	-0
CM1B	-3.593793	-4 AMP	-0.0018	-0.0018	-0.0002	-0.0002
CH2B	-6.220626	-6 AMP	-0.0032	-0.0032	-0.0003	-0.0003
CH1B	1.788608	2 AMP	0.0008	0.0008	0.0001	0.0001

C01: Sextupoles

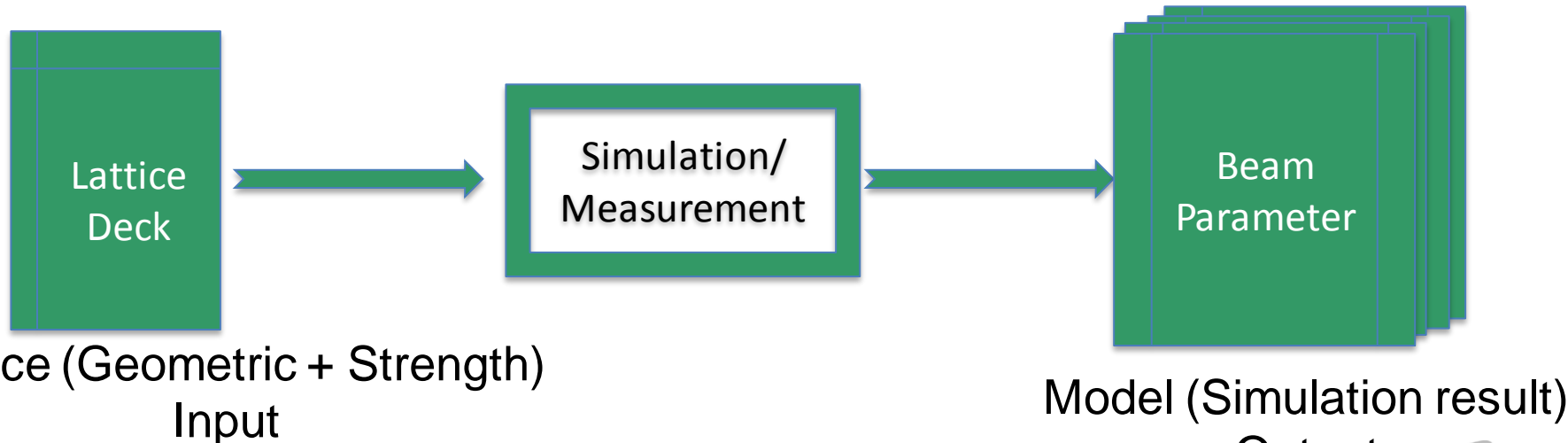
Name	Setpoint	Readback	SL SP	SL	K2L SP	K2L RB
SL1-P2	31.731711	32 AMP	13.276	13.2757	2.6533	2.6533
SL2-P2	85.692446	86 AMP	35.6832	35.6844	7.1316	7.1319
SL3-P2	70.593440	71 AMP	29.3998	29.3978	5.8758	5.8754
SM1A-P2	56.379616	56 AMP	23.6958	23.6948	4.7358	4.7356
SM2B-P2	96.361718	96 AMP	35.9353	35.9367	7.182	7.1823
SM1B-P2	62.160290	62 AMP	25.926	25.9243	5.1816	5.1812
SH4-P2	37.783664	38 AMP	15.9888	15.9892	3.1955	3.1956
SH3-P2	13.730147	14 AMP	5.8548	5.8548	1.1701	1.1701
SH1-P2	47.550206	48 AMP	19.8802	19.8812	3.9732	3.9734

C01: V Correctors

Name	Setpoint	Readback	BL SP	BL	K SP	K RB
CL1A	3.808968	3 AMP	0.0017	0.0014	0.0002	0.0001
CL2A	-4.532356	-0 AMP	-0.0021	-0.0002	-0.0002	-0
CM1A	-0.214303	-6 AMP	-0.0001	-0.0032	-0	-0.0003
CM1B	-3.593793	1 AMP	-0.0018	0.0007	-0.0002	0.0001
CH2B	-6.220626	-1 AMP	-0.0032	-0.0003	-0.0003	-0
CH1B	1.788608	0 AMP	0.0008	0.0002	0.0001	0

Middle Layer Services

- Lattice/Model Service
 - A further development based on our virtual accelerator
 - Consists of 2 parts
 - WEB service
 - Live IOC for online requirement
 - Support 2 simulation codes (Tracy-3 & Elegant)
 - Transparent switching between each other



Middle Layer Services

- Lattice view

The screenshot displays the 'Lattice & Model' web application interface. The browser address bar shows the URL: `http://phyweb.cs.nsls2.local/lattice/web/#/type/lattice/status/name/version/branch/desc/creator/latticeid/type/id/comm-ring_20140506_191521||live||1399418121`. The page title is 'Lattice & Model' and the user is logged in as 'Guest'.

Search Panel: Includes a search filter, search for options (Lattice selected), and input fields for Name, Branch, Version, Description, Creator, Lattice type, and Status. A 'Search' button is at the bottom.

Lattice Info Panel: Shows details for a selected lattice (Id: 148):

- Name:** comm-ring_20140506_191521
- Version:** 1399418121
- Branch:** live
- Desc:** This is a lattice from set point for live machine on Tue, 06 May 2014, 19:15:21 EDT
- Type:** elegant

Lattice Models Table:

Creator	Description	Id	LatticeId	Link	Name	OriginalDate
latticeioc	live machine result performed by lattice IOC on Tue, 06 May 2014, 19:15:21 EDT	147	148	go to model	live machine model for set point on Tue, 06 May 2014, 19:15:21 EDT for comm-ring_20140506_191521 (branch live, version 1399418121)	2014-05-06T19:15:33

Buttons below the table: [Download the original file](#), [Download zip with original file and maps](#)

Lattice Table:

Id	Name	Type	Length	Position	ON_PASS	FITPOINT	K2	N_KICKS	K1	ANGLE	E1
475679	_BEG_	MARK	0	0							
475836	MA1	MALIGN	0	0	1						
478052	MK4G1C30A	MARK	0	0		1					
478206	DH02G1A	DRIF	4.29379	4.29379							
478342	DFT	DRIF	0.022	4.31579							
477348	FH2G1C30A	MARK	0	4.31579							
478683	DFT	DRIF	0.022	4.33779							
478816	DH1G1A	DRIF	0.31221	4.65							
477643	GEG1C30A	MULT	0	4.65							
477214	GSQ2C30A	MULT	0	4.65							

Middle Layer Services

- Model view

The screenshot displays the 'Lattice & Model' web application interface. On the left, a search sidebar lists several models with their IDs, names, and descriptions. The main area shows the details for model 147, including its name, description, and a 'Select data to plot' section. This section contains checkboxes for parameters: alpha, alphas, betax, betay, etapx, etapy, etax, etay, and phasex. The 'betax' and 'betay' checkboxes are checked. Below this is a line graph titled 'betax 1x, betay 1x' vs 'Position', showing two oscillating data series. At the bottom, a 'Model details' table provides numerical values for various parameters across different indices.

Search Results (Left Panel):

- Model 147: live machine model for set point on Tue, 06 May 2014, 19:15:21 EDT for comm-ring_20140506_191521 (branch live, version 1399418121) live machine result performed Desc: by lattice IOC on Tue, 06 May 2014, 19:15:21 EDT
- Model 146: live machine model for set point on Sun, 04 May 2014, 14:49:10 EDT for comm-ring_20140504_144910 (branch live, version 1399229350) live machine result performed Desc: by lattice IOC on Sun, 04 May 2014, 14:49:10 EDT
- Model 145: live machine model for set point on Sun, 04 May 2014, 13:58:23 EDT for comm-ring_20140504_135823 (branch live, version 1399226303) live machine result performed Desc: by lattice IOC on Sun, 04 May 2014, 13:58:23 EDT
- Model 144: live machine model for set point on Sun, 04 May 2014, 09:12:54 EDT for comm-ring_20140504_091254 (branch live, version 1399209174) live machine result performed Desc: by lattice IOC on Sun, 04 May 2014, 09:12:54 EDT

Model 147 Details (Right Panel):

Tunex: 33.15761
Tuney: 16.43642

Select data to plot:

alpha	alphay	betax	betay	etapx	etapy	etax	etay	phasex
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Graph: betax 1x, betay 1x vs Position. The graph shows two oscillating data series, betax 1x (yellow) and betay 1x (blue), plotted against Position (0.0000 to 90.0000). The y-axis ranges from 0.0000 to 35.0000.

Model details:

0	100	Twiss
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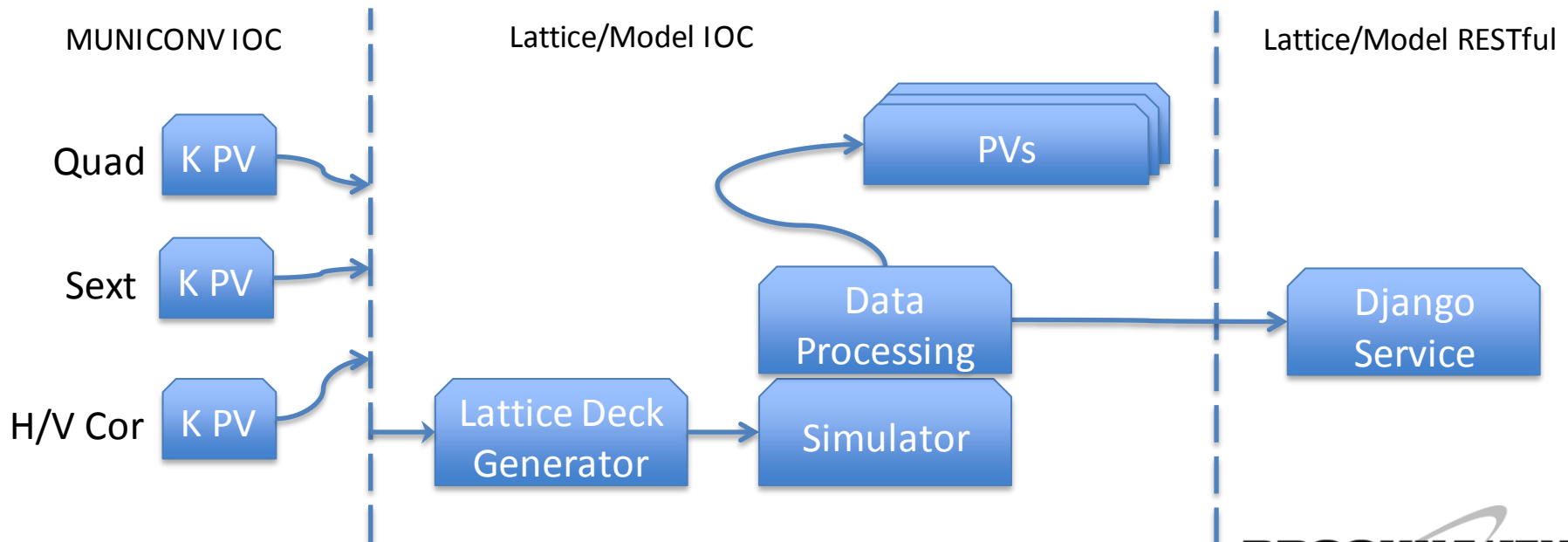
Decimal precision: 4

Index	name	position	etapy	etapx	phasey	phasex	alphax	alphay	etax	etay
0	_BEG_	0.0000	0.0000	-0.0007	0.0000	0.0000	0.0799	0.0293	0.0040	0.0000
1	MA1	0.0000	0.0000	-0.0007	0.0000	0.0000	0.0799	0.0293	0.0040	0.0000
2	MK4G1C30A	0.0000	0.0000	-0.0007	0.0000	0.0000	0.0799	0.0293	0.0040	0.0000



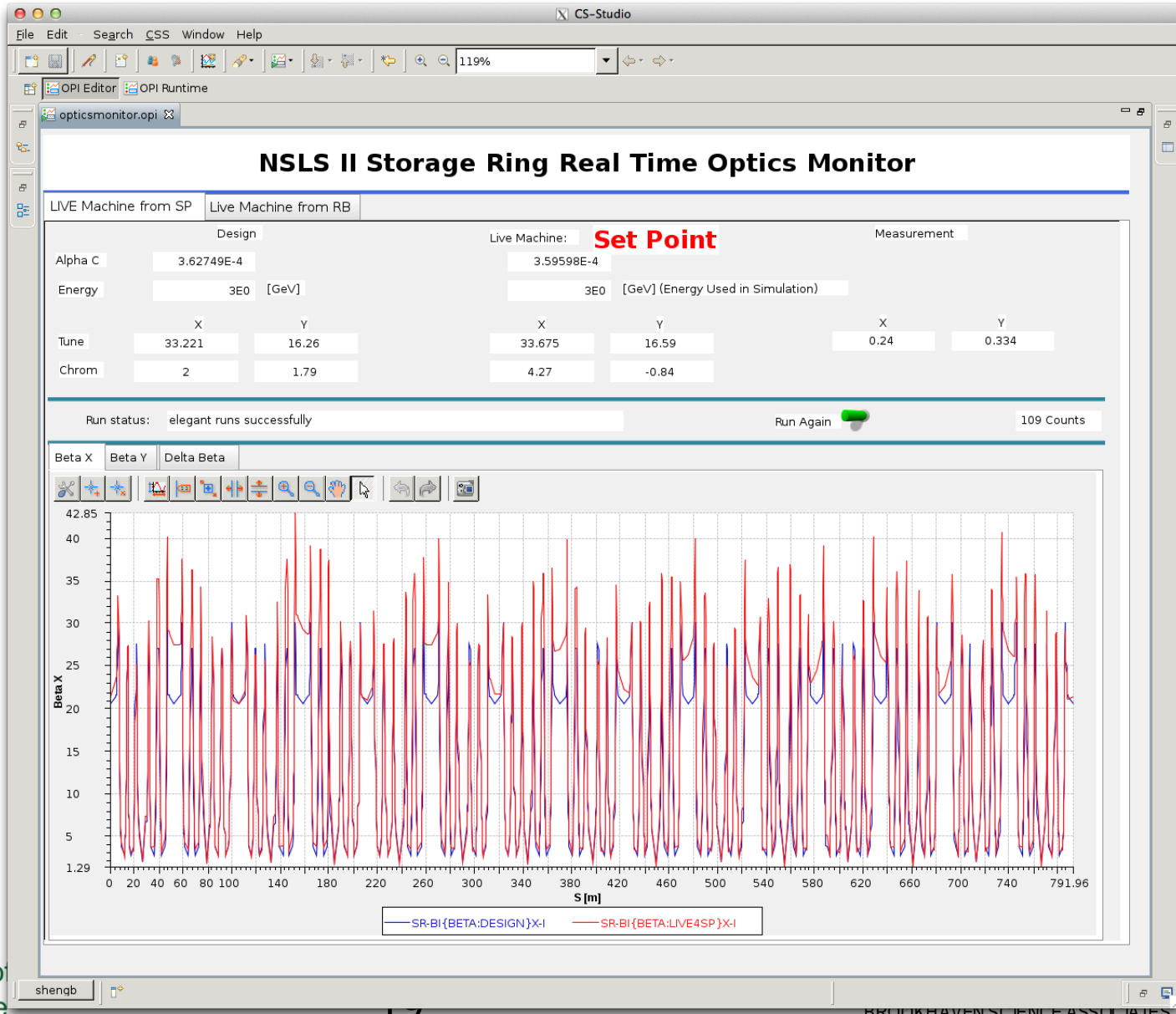
Middle Layer Services

- Lattice/Model IOC
 - On demand mode
 - CF to get all PVs
 - MUNICONV to get physics unit
 - Lattice/Model to produce result
 - WEB service to capture all history data
 - CS-Studio panel to present results

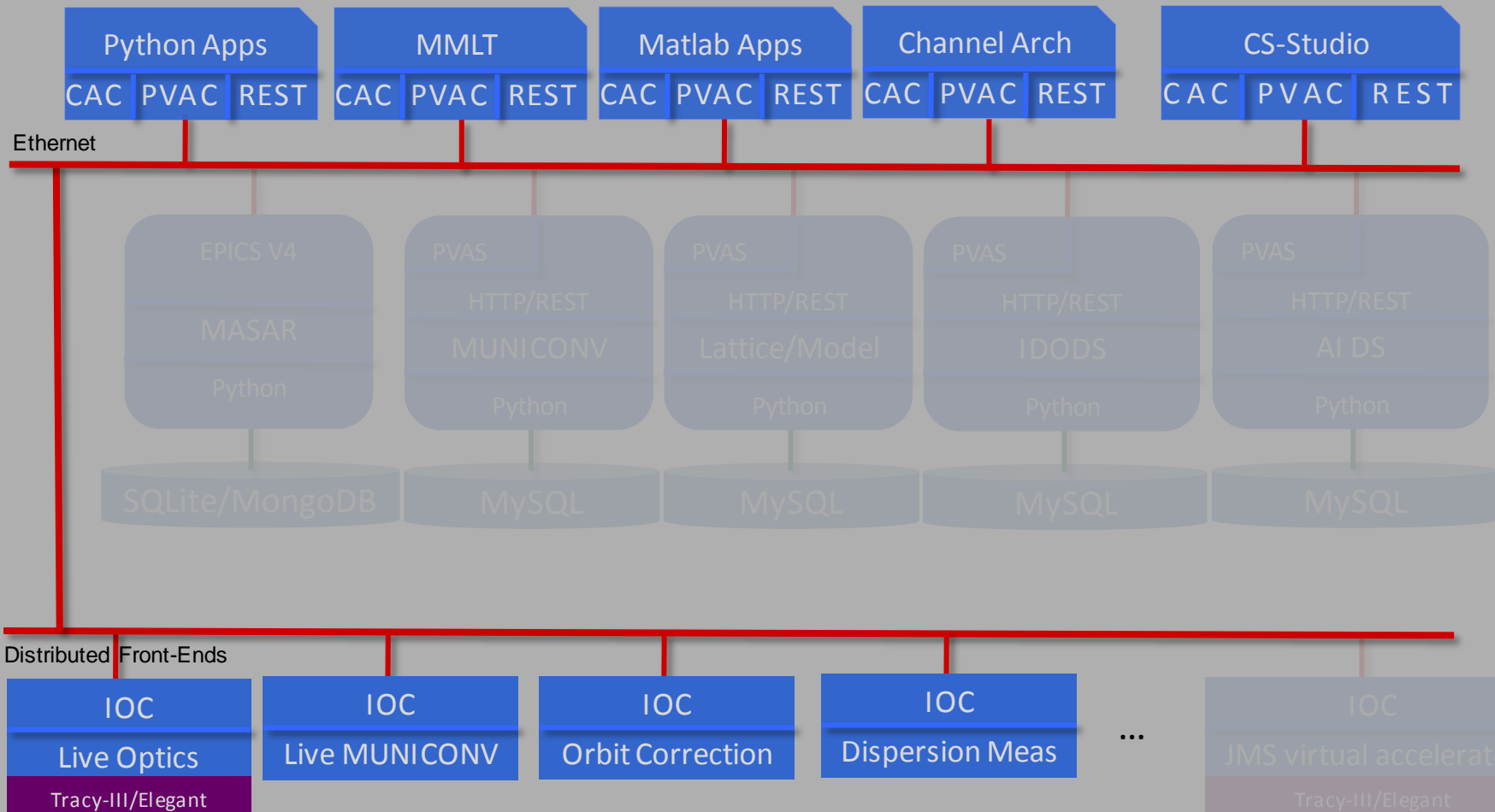


Middle Layer Services

- Lattice/Model
IOC CSS Panel

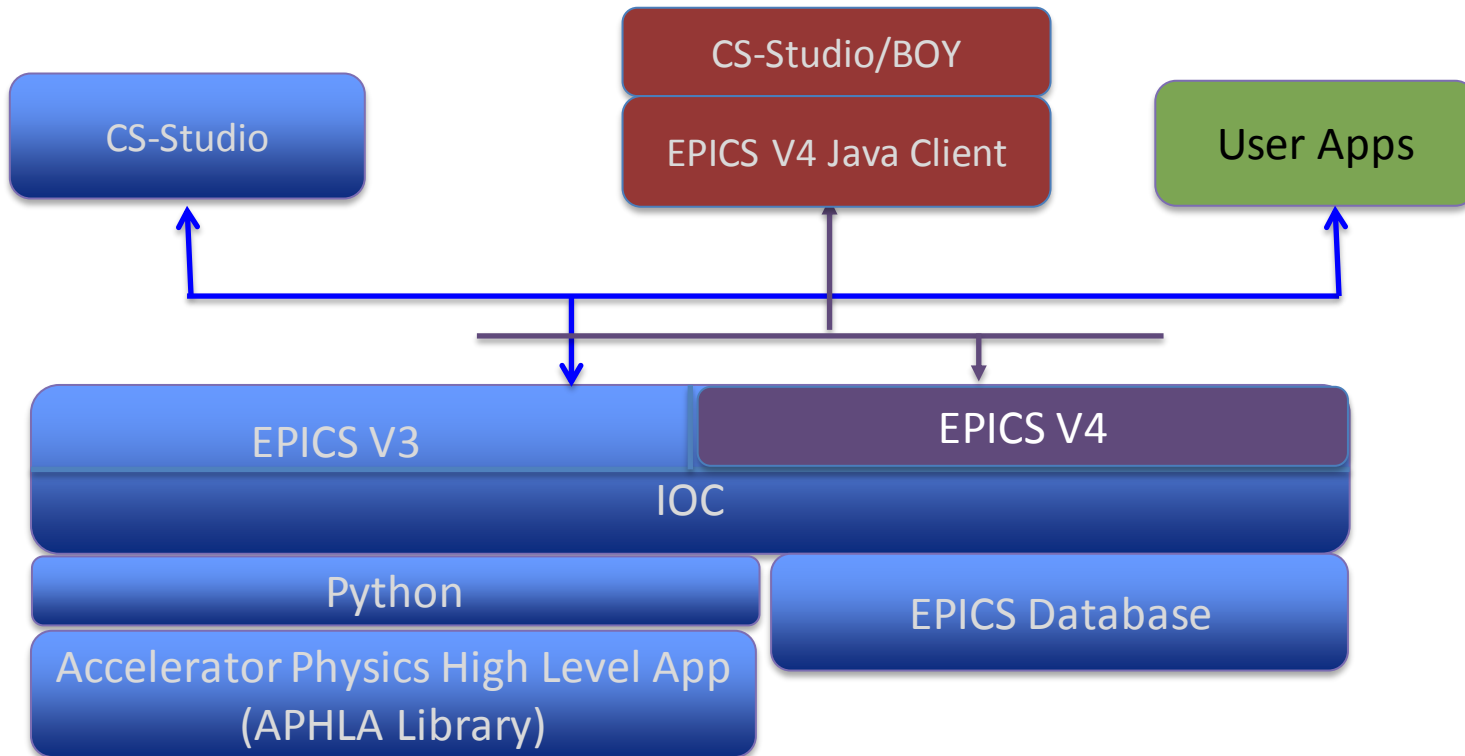


High Level Physics Applications



High Level Physics Applications

- Architecture

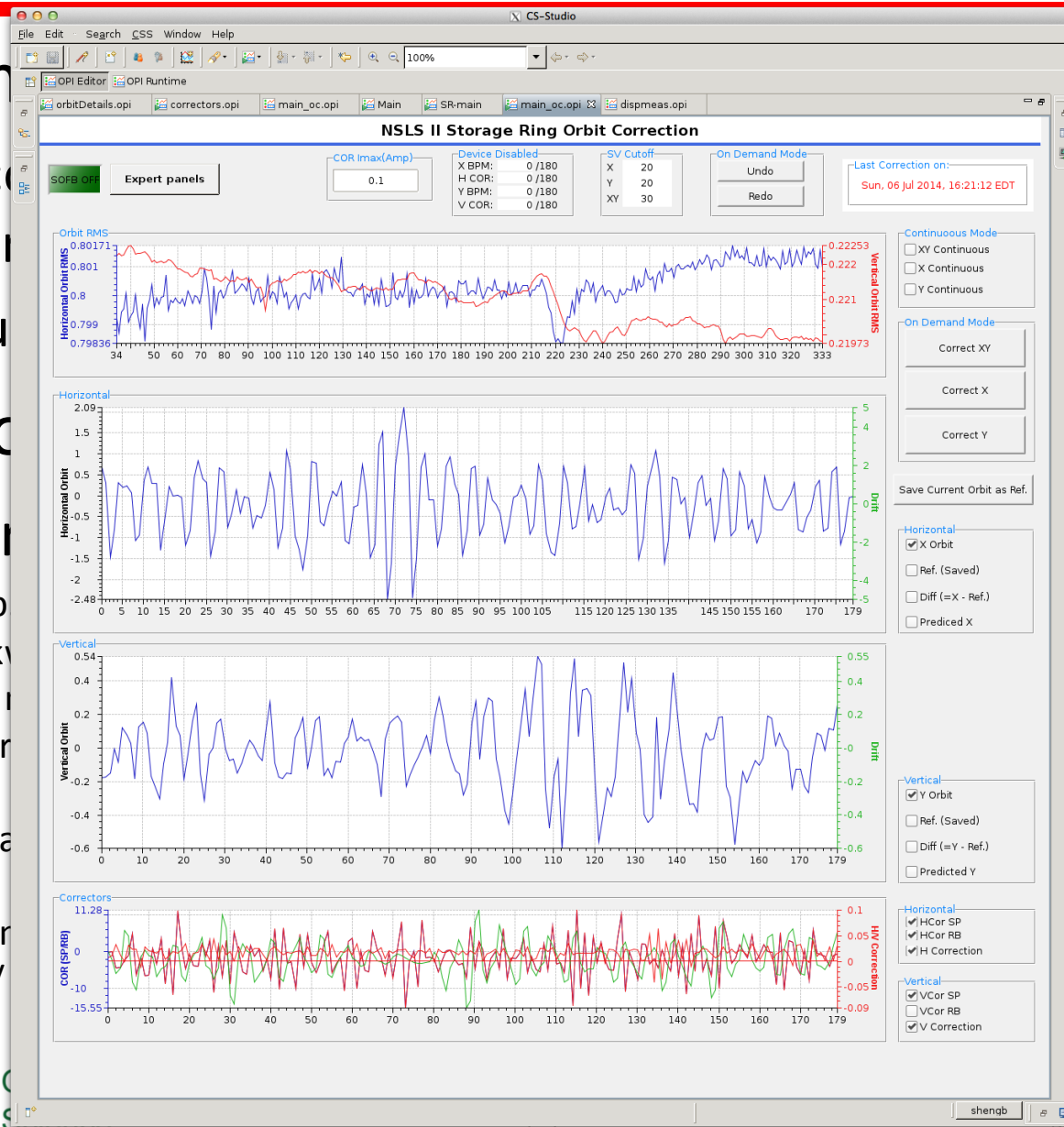


Finished User Apps Planning Developing



High Level Physics Applications

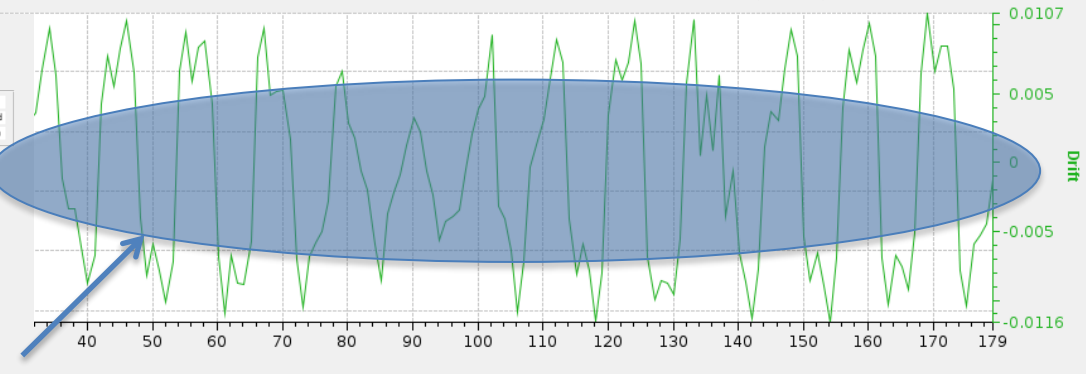
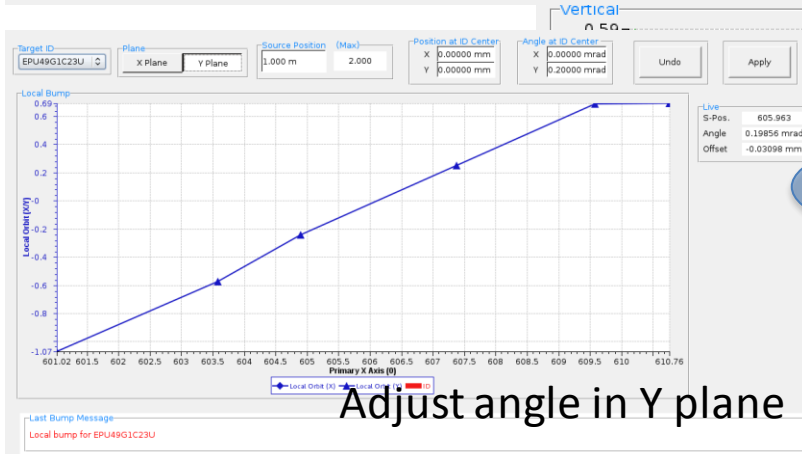
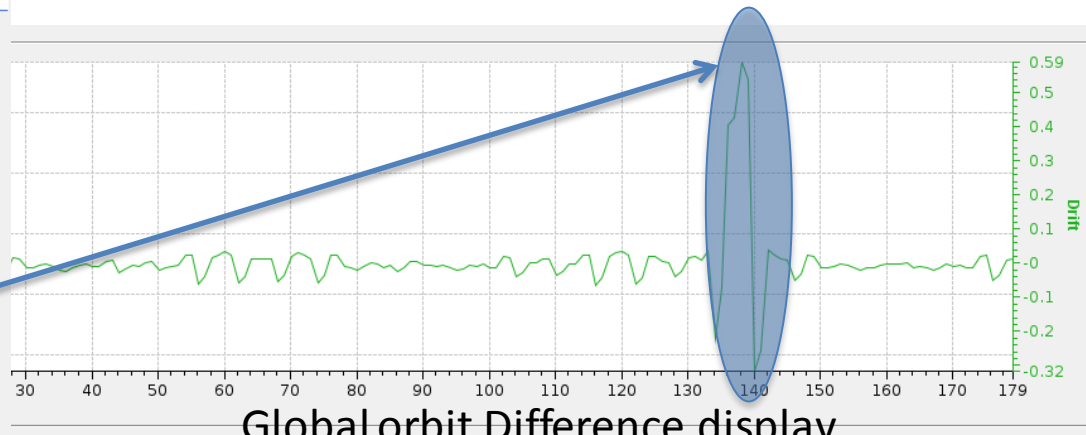
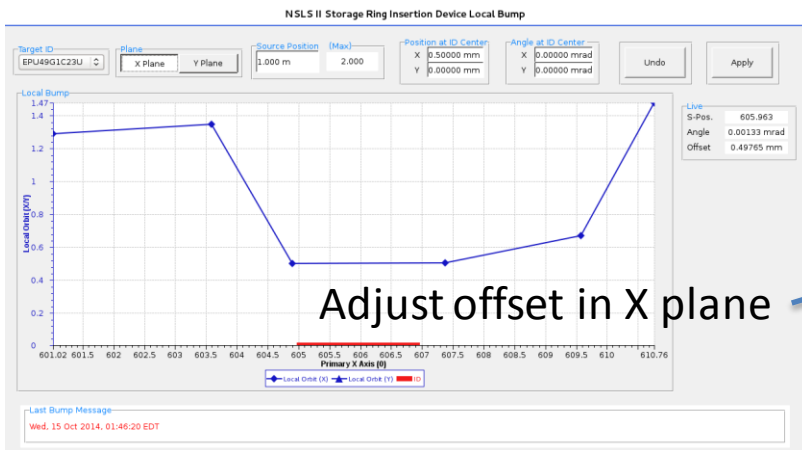
- IOC as n
 - Orbit c
 - measur
 - beta fu
- Orbit Co
 - Use or
 - U, s, V = np
 - rcond = s[k
 - # solve for
 - dk, resids, r
 - k0 = np.arr
 - if dlmax is r
 - dk = dk /



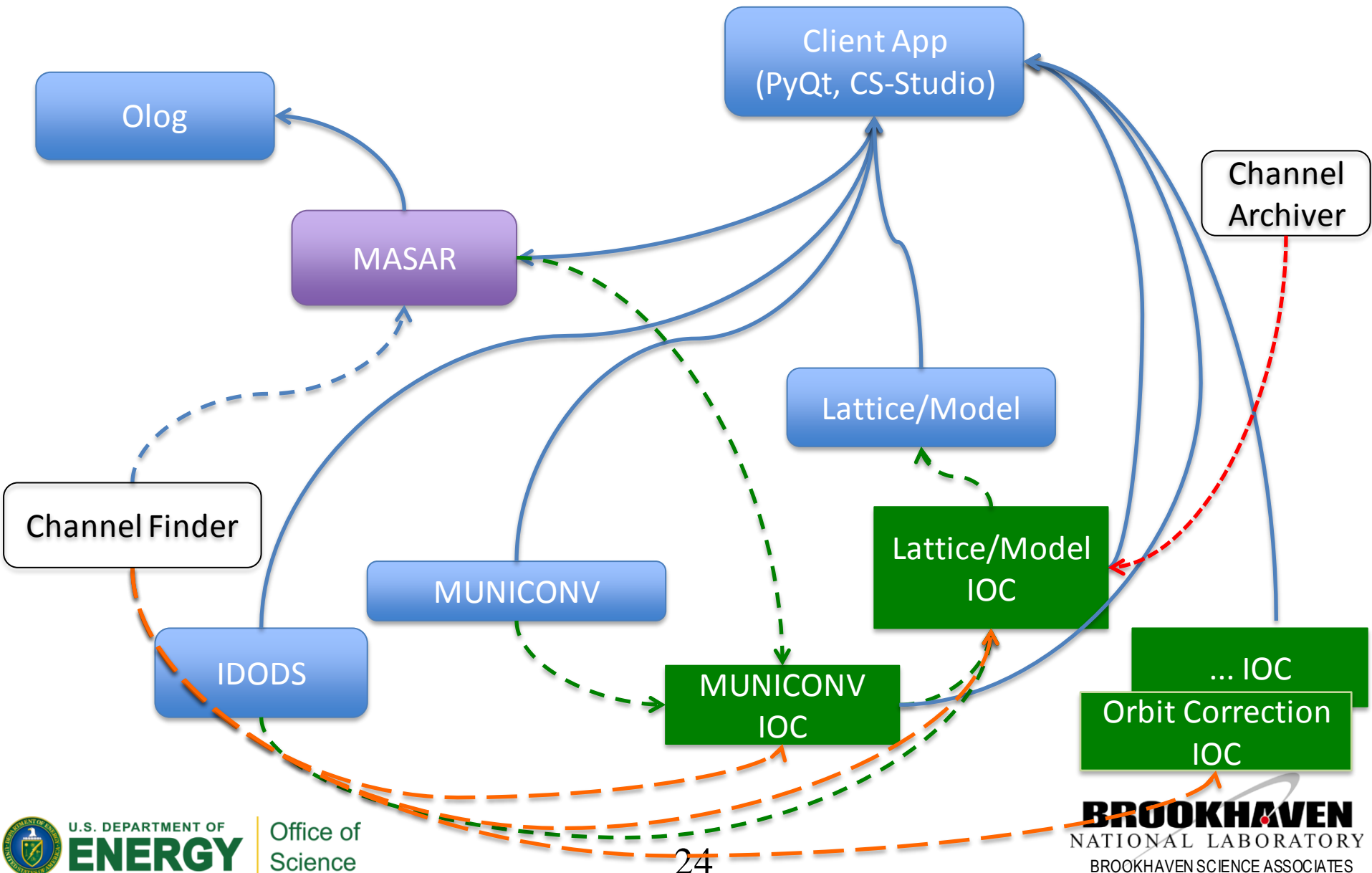
city
ction, ...

High Level Physics Applications

- Local bump for insertion device

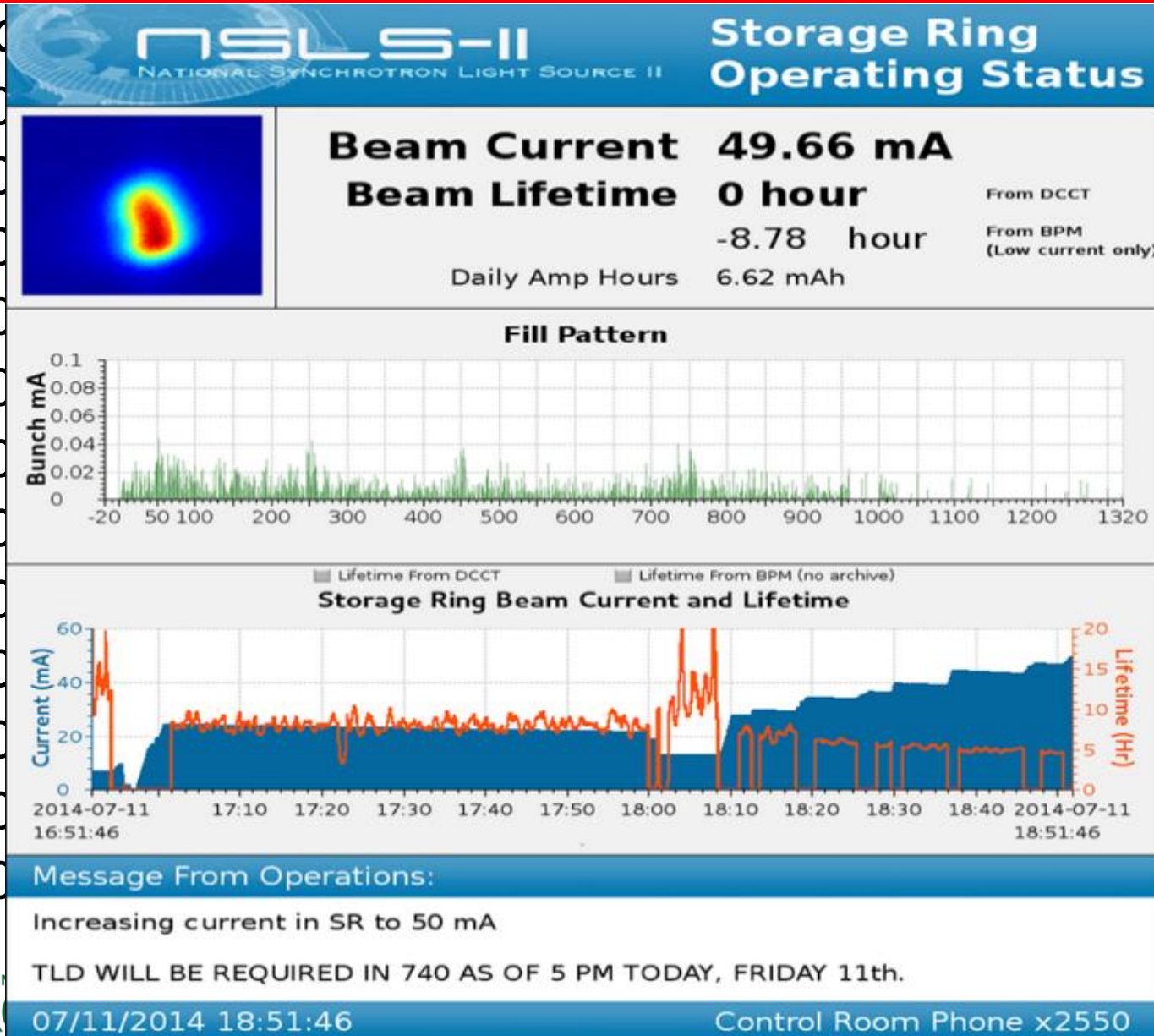


System Integration



Conclusion

• Major



EST) ?