

# MASAR Service

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U.S. DEPARTMENT OF  
**ENERGY**

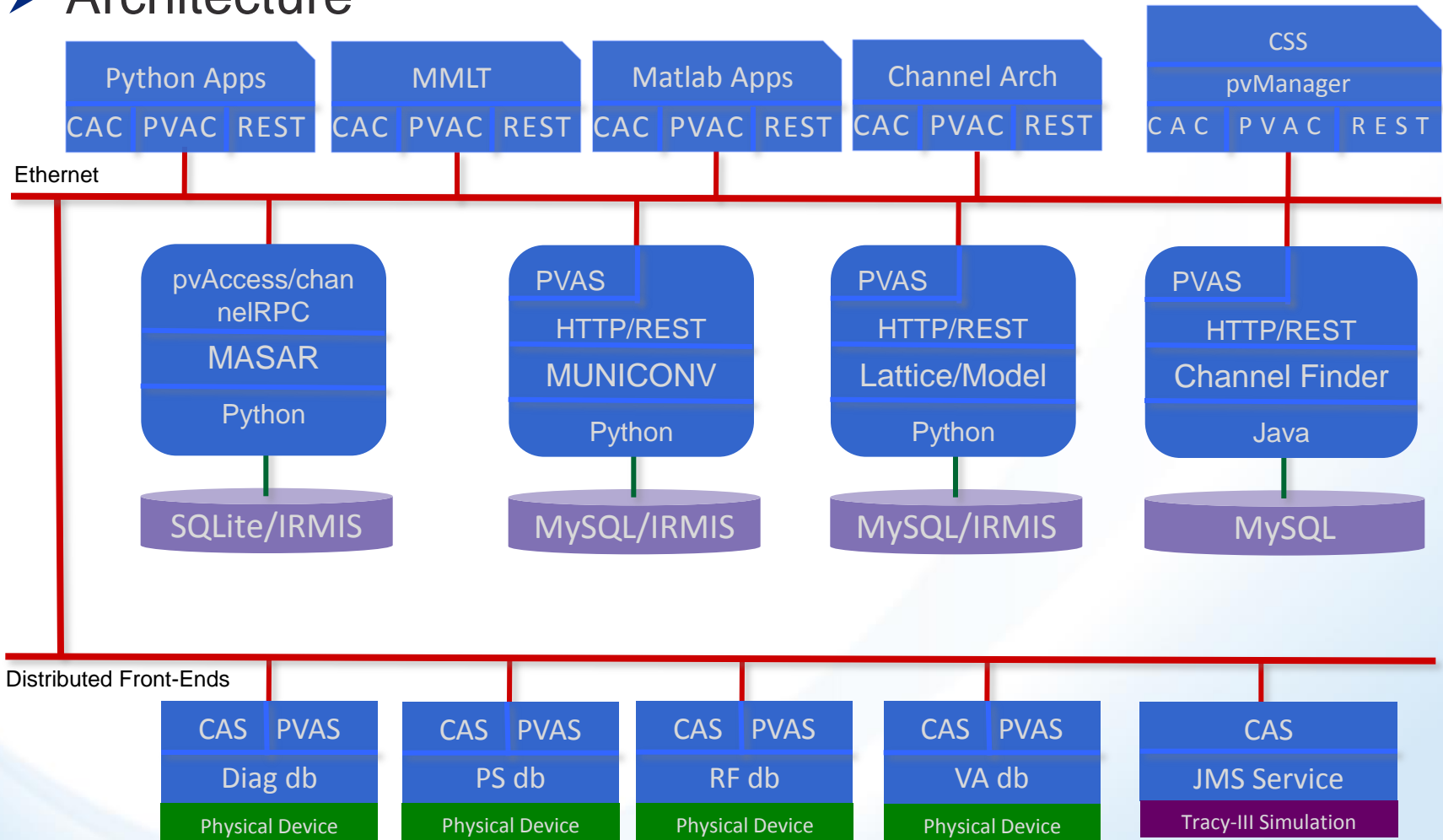
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# Outline

- What's MASAR & architecture
- MASAR server
- MASAR client
- Experience at NSLS II

# Infrastructure

## ➤ Architecture



# What's MASAR?

## ➤ MASAR

- ❖ Machine Snapshot, Archiving, and Retrieve
- ❖ An EPICS tool for experimental control system

## ➤ Machine

- ❖ A facility controlled by EPICS, accelerator for example

## ➤ Snapshot

- ❖ Data at specific time point
  - ❖ Value, time stamp, connection status, alarm status, alarm severity

## ➤ Similar tools, but different purpose

- ❖ IOC automatic save & restore
  - ❖ IOC bumpless rebooting
- ❖ Channel Archiving
  - ❖ Archive pre-defined configuration periodically
  - ❖ All data saved time serially

# What's MASAR?

## ➤ MASAR Glance

System: all

Config Filter: \*

Select Config(s)

	Config Name	Config Id	
1	BR_RF_SC_20130426	12	BR RF daily sav
2	BR_MG_SCR_20130419	11	BR ramping PS
3	LN_LTB_BPM_Expert_20120621	10	Expert control
4	LN-LTB-Phasel-All_20120511	9	Linac and LTB c
5	LN-LTB-Phasel-SBM-All_20120426	8	Linac and LTB c
6	LN_Phasel_SCR_All_20120402	7	Linac daily SCR
7	LN_Phasel_SCR_All	1	Linac daily SCR
8	LN_Phasel_SC_All	2	Linac daily refe
9	LTD1_Phasel_SCR_All	3	LTD1 daily SCR
10	LTD1_Phasel_SC_All	4	LTD1 daily refer

Snapshot Desc: \*

Author: \*

Use time range:

From: 2013-09-23 12:15:39

To: 2013-09-23 12:15:39

Select Snapshot(s)

Welcome to MASAR

MASAR is an EPICS V4 service which does Machine Snapshot, Archiving, and Retrieve [1] [2]. This software was originally developed by National Synchrotron Light Source II at Brookhaven National Laboratory.

Quick Start ...

1. To restore the machine to a particular state/snapshot: double click on one row in the left-top Config table --> double click on one row in the left-bottom Snapshot table --> click the button "Restore Machine";
2. To save a machine snapshot: double click on one row in the left-top Config table --> click "Save Machine Snapshot ..." --> put a concise comment (<80 characters) such as: "SBM EmitX and Y 69 nm. This is golden"

Tips ...

1. Always put the mouse cursor over the things you don't know for 2 seconds, the GUI will show you what it is or how to do it;
2. Always follow the instructions on the pop-up message which shows something is not working as expected and how to fix it;
3. MASAR GUI is mainly table-based. Treat the table as Microsoft Excel: resize the column, sort by the column, select multiple rows, Ctr + c to copy one single cell ...

Terminology ...

- \* machine: it can be accelerator, system, etc.: Linac, Booster, Storage Ring, BPM system, Magnet system ...
- \* snapshot: a list of PVs associated with data (value, time stamp, alarm status ... ) saved at a particular time for a particular machine state.
- \* config table: pre-defined a list of configurations for different machines; it has a unique Name, Description, Date when it is created ...
- \* snapshot table: a list of saved snapshots for a particular config; it has Config Name which is listed in the config table, Description, Author ...
- \* snapshot tab: the data of one snapshot is presented in the form of table in a Tab window.

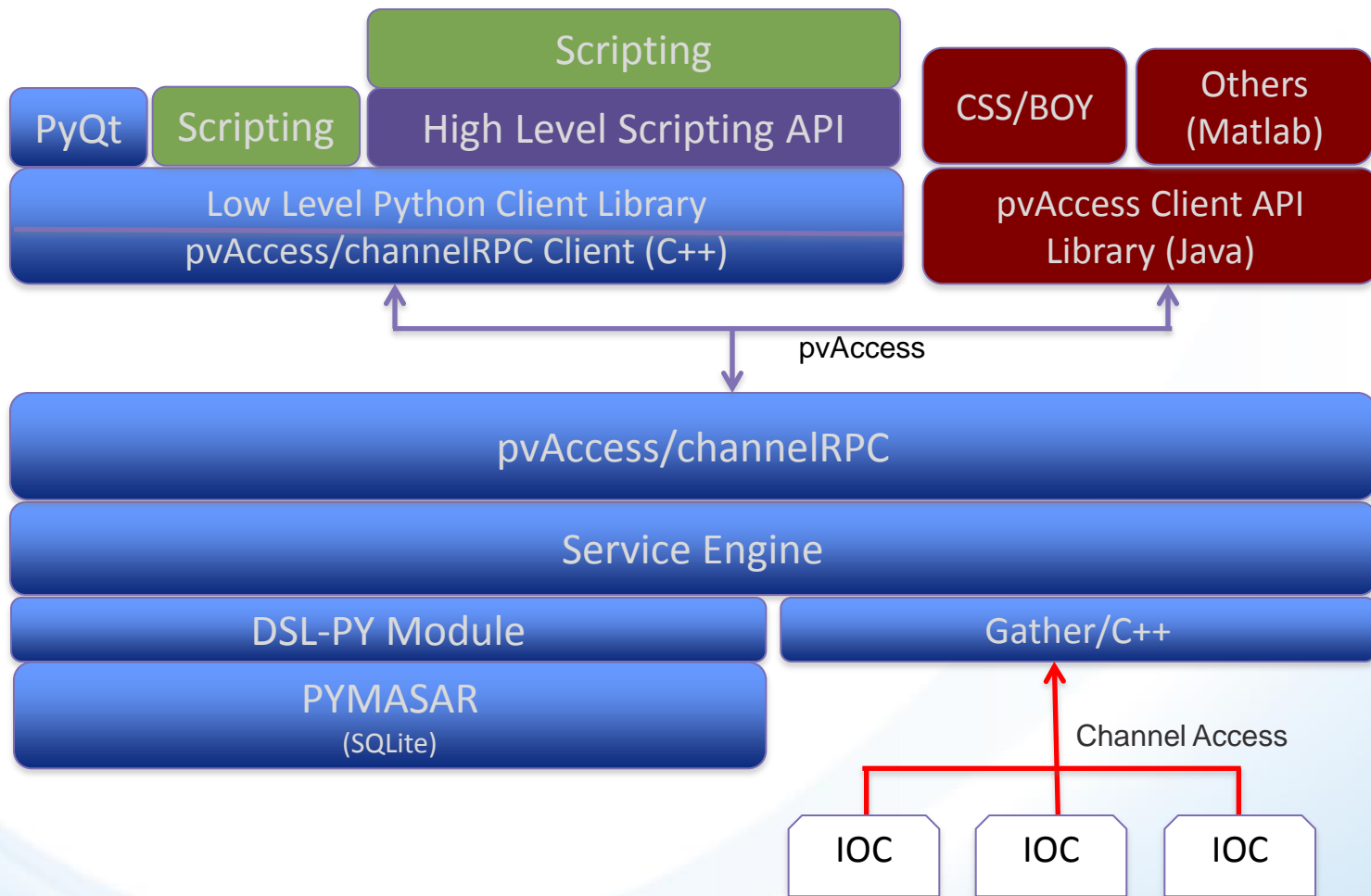
More Info ...

please check out the links below:

- [1] <http://epics-pvdata.sourceforge.net/>
- [2] <http://epics-pvdata.hg.sourceforge.net/hgweb/epics-pvdata/masarService/raw-file/tip/documentation/userManual.html>

Display Snapshot(s) | Restore Machine | Compare Live Machine | Save Machine Snapshot ... | Compare Snapshots... | Export Snapshot to File ...

# MASAR Architecture



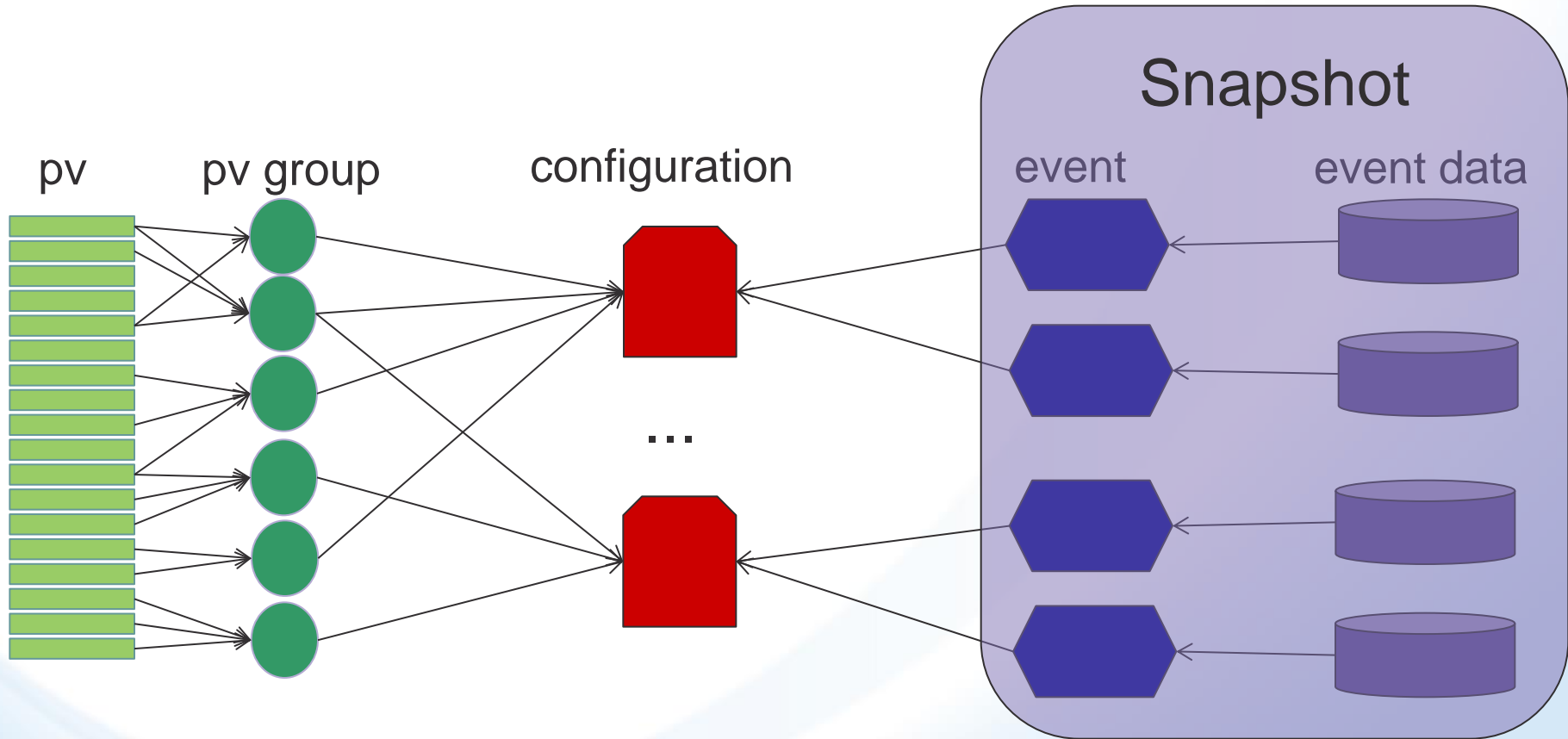
Finished
  User Apps
  Planning
  Developing

# MASAR Server

- Snapshot taken with pre-configuration
- RDB to store configuration and snapshot data
  - ❖ SQLite
  - ❖ PYMASAY to access SQLite
    - ❖ API in Python
    - ❖ Isolate RDB and service engine
    - ❖ Schema change transparent
    - ❖ RDB pluggable
- DSL-PY to manage data in Python & C++ domain
- Service engine
  - ❖ Analyze & response client commands
  - ❖ Implement in EPICS V4/C++
  - ❖ Use pvAccess/channelRPC for communication

# MASAR Server

## ➤ Snapshot configuration





# MASAR Server

## ➤ Snapshot configuration

- ❖ EPICS PV orientated
  - ❖ Support all scalar and waveform PV types
    - ❖ Float, double, string, and enum
- ❖ PV group
  - ❖ Collection of PV names
    - ❖ Can be a mix of any of the types
  - ❖ One PV can be in many PV groups
- ❖ Configuration
  - ❖ Collection of PV groups, therefore, collection of PV names
  - ❖ One PV group can be in many configurations

## ➤ Snapshot

- ❖ An event happened at a particular time
- ❖ Belongs to one configuration
  - ❖ One configuration can have many events
- ❖ Each event is one data set
  - ❖ Header information + meta data (value, time stamp)

# MASAR Client/UI

## ➤ API for scripting environment

- ❖ 7 APIs in Python

## ➤ PyQt UI

- ❖ Based on above APIs
- ❖ Browse config
- ❖ Browse event
- ❖ Take snapshot
- ❖ Retrieve data
- ❖ Compare data
- ❖ Restore machine
- ❖ Export data

The screenshot displays the MASAR Viewer application window. The main area is a table listing various PVs (Process Variables) with columns for PV Name, Saved Connection, Not Restore, Saved Value, Live Value, Delta, Saved Timestamp, and Saved Status. The table contains 31 rows of data, including entries like 'LN-RF (Mtr:1) Pos-Set' and 'LTD1\_Phase1\_SCR\_All'. Below the table, there are buttons for 'Display Snapshot(s)', 'Restore Machine', 'Compare Live Machine', 'Save Machine Snapshot...', 'Compare Snapshots...', and 'Export Snapshot to File...'. On the left side, there is a 'Config Filter' section with a 'Select Config(s)' table showing a list of configurations with columns for Config Name, Config Id, and a description. Below this is a 'Snapshot Desc' section with fields for Author, Use time range (From and To), and a 'Select Snapshot(s)' table showing a list of snapshots with columns for Config Name, Snapshot Id, and a description.

# MASAR Client/UI

## ➤ Data plot for waveform PV

- ❖ Saved data and live data of one waveform PV in one graph

The screenshot displays the MASAR Viewer interface. On the left, there are two configuration tables. The top table lists various configurations with columns for Config Name, Config ID, and Description. The bottom table lists snapshots with columns for Config Name, Snapshot ID, and Description. The main area shows a table of PVs with columns for PV Name, Saved Connection, Not Restore, Saved Value, Live Value, Delta, Saved Timestamp, Saved Status, Saved Severity, Live Connection, and Live Timestamp. A 'waveform data' window is open on the right, showing a plot of 'Saved data Value' versus 'Data Point' for the PV BR:A3-PS(6A:SD1)-SP. The plot shows a blue line representing the waveform, with a peak around 4000 data points and a sharp drop to zero around 8000 data points.

Config Name	Config ID	Description
BR_RF_SC_20130426	12	BR RF daily save
BR_MG_SCR_20130419	11	BR ramping PS daily SCR setpoint
LN_UTB_BPM_Expert_20120621	10	Expert control pvs for Linac and UTB bpms
LN_UTB-Phase-All_20120511	9	Linac and UTB daily SCR setpoint
LN-UTB-Phase-SBM-All_20120426	8	Linac and UTB daily SCR setpoint
LN_Phase_SCR_All_20120402	7	Linac daily SCR setpoint on Apr 02, 2012
LN_Phase_SCR_All	1	Linac daily SCR setpoint
LN_Phase_SC_All	2	Linac daily reference
LTD1_Phase_SCR_All	3	LTD1 daily SCR setpoint
LTD1_Phase_SC_All	4	LTD1 daily reference
LTD2_Phase_SCR_All	5	LTD2 daily SCR setpoint
LTD2_Phase_SC_All	6	LTD2 daily reference

Config Name	Snapshot ID	Description
BR_MG_SCR_20130419	368	DCInj_Sim_1stTurn_CorFinalRMatrix_extendBPM
BR_MG_SCR_20130419	367	DCInj_Sim_1stTurn_CorFinalRecord_matrix_1mm
BR_MG_SCR_20130419	366	ZeroAllCurrent
BR_MG_SCR_20130419	365	Injection flat ideal current
BR_MG_SCR_20130419	352	Booster ramping waveform

PV Name	Saved Connection	Not Restore	Saved Value	Live Value	Delta	Saved Timestamp	Saved Status	Saved Severity	Live Connection	Live Timestamp
BR:A3-PS(6A:CX1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)			2013-04-24 14:17:08.220436	NO_ALARM	NO_ALARM		
BR:A1-PS(6A:CX1)-SP	Disconnected	<input checked="" type="checkbox"/>					UDF_ALARM	INVALID_ALARM		
BR:A1-PS(6A:CY1)-SP	Connected	<input type="checkbox"/>	(-5.9990, ...)			2013-04-24 14:16:39.260113	NO_ALARM	NO_ALARM		
BR:A2-PS(6A:CX1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)			2013-04-24 14:17:00.197428	NO_ALARM	NO_ALARM		
BR:A4-PS(6A:CX3)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)			2013-04-24 14:17:18.172692	NO_ALARM	NO_ALARM		
BR:A4-PS(6A:CX1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)			2013-04-24 14:17:17.171859	NO_ALARM	NO_ALARM		
BR:A1-PS(6A:CX3)-SP	Disconnected	<input checked="" type="checkbox"/>					UDF_ALARM	INVALID_ALARM		
BR-PS(PS:QF)-SP	Connected	<input type="checkbox"/>	(1.0, 2349, ...)							
BR:A4-PS(6A:SD1)-SP	Connected	<input type="checkbox"/>	(0.16400, ...)							
BR:A3-PS(6A:CX3)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A3-PS(6A:SF2)-SP	Connected	<input type="checkbox"/>	(0.21799, ...)							
BR:A1-PS(6A:SD1)-SP	Connected	<input type="checkbox"/>	(0.16400, ...)							
BR:A4-PS(6A:SF1)-SP	Connected	<input type="checkbox"/>	(0.21799, ...)							
BR:A4-PS(6A:CY3)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A4-PS(6A:CY2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR-PS(PS:BD2)-SP	Connected	<input type="checkbox"/>	(48.7849, ...)							
BR:A3-PS(6A:CV4)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A4-PS(6A:CX2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A4-PS(6A:SD2)-SP	Connected	<input type="checkbox"/>	(0.16400, ...)							
BR:A3-PS(6A:SD1)-SP	Connected	<input type="checkbox"/>	(0.16400, ...)							
BR:CS-PS(6A:CW2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A2-PS(6A:SF2)-SP	Connected	<input type="checkbox"/>	(0.21799, ...)							
BR:A4-PS(6A:CY1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A3-PS(6A:SF1)-SP	Connected	<input type="checkbox"/>	(0.21799, ...)							
BR:A3-PS(6A:CY3)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A3-PS(6A:CY2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:CS-PS(6A:CW1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A2-PS(6A:CV4)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A3-PS(6A:CX2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A3-PS(6A:SD2)-SP	Connected	<input type="checkbox"/>	(0.16400, ...)							
BR:A2-PS(6A:SD1)-SP	Connected	<input type="checkbox"/>	(0.16400, ...)							
BR:X5-PS(6A:CW2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A1-PS(6A:SF2)-SP	Connected	<input type="checkbox"/>	(0.21799, ...)							
BR:A3-PS(6A:CY1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A2-PS(6A:SF1)-SP	Connected	<input type="checkbox"/>	(0.21799, ...)							
BR:A2-PS(6A:CY3)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR-PS(PS:QD)-SP	Connected	<input type="checkbox"/>	(7.23299, ...)							
BR:X5-PS(6A:CW1)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A1-PS(6A:CV4)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							
BR:A2-PS(6A:CX2)-SP	Connected	<input type="checkbox"/>	(0.0, 0.0, ...)							

Waveform Data Plot: Saved data Value vs Data Point. The plot shows a blue line representing the waveform, with a peak around 4000 data points and a sharp drop to zero around 8000 data points.

# MASAR Client/UI

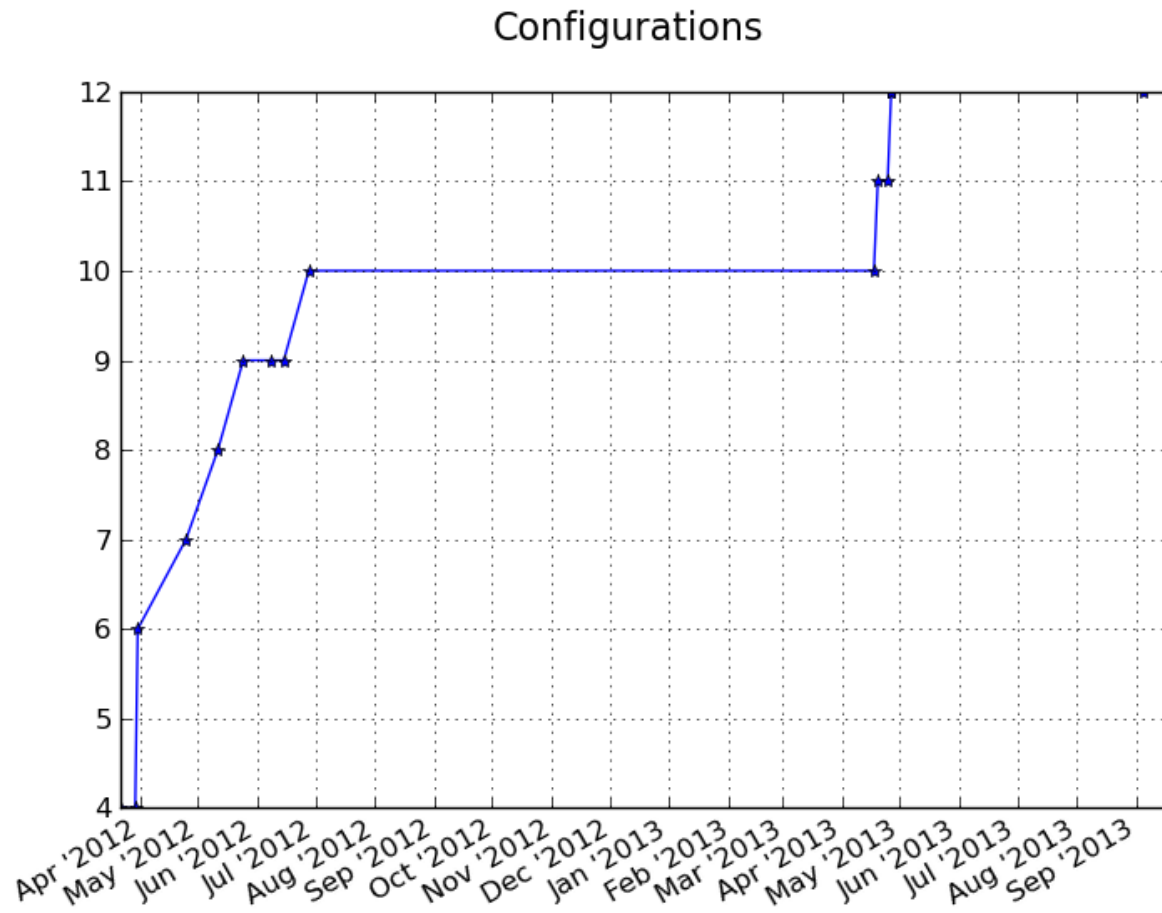
- Multiple data sets comparison
  - ❖ Support up to 9 data sets

The screenshot displays the MASAR Viewer application interface. The main window is titled "MASAR Viewer" and shows a comparison of snapshots for various PV names. The interface includes a "System" dropdown, a "Config Filter" field, and a "Select Config(s)" table. The "Compare Snapshots" table is the central focus, displaying columns for PV name, Saved Value 1 (in snapshot 331), Saved Value 2 (in snapshot 338), Saved Value 3 (in snapshot 335), Saved Value 4 (in snapshot 330), Live Value 0, Delta21, and Delta31. The table lists 31 rows of data, including PV names like "LN-BI{VF:5} cam1:Gain" and "LN-ITB-Phasel-All\_20120511".

	PV name	Saved Value 1 (in snapshot 331)	Saved Value 2 (in snapshot 338)	Saved Value 3 (in snapshot 335)	Saved Value 4 (in snapshot 330)	Live Value 0	Delta21	Delta31
1	LN-BI{VF:5} cam1:Gain	5.0	12.0	12.0	24.0		NotEqual(7.000000)	NotEqual(7.000000)
2	ITB-BI{VF:1} cam1:Gain	2.0	5.0	1.0	2.0		NotEqual(3.000000)	NotEqual(-1.000000)
3	ITB-MG{Quad:1}i:RampEnd1-SP	0.0	16.0	0.0	18.0		NotEqual(16.000000)	Equal
4	LN-RF:1 {Cav}DnvPhaCtrl-SP	0.5	15.0	1.4	1.2490009027e-16		NotEqual(14.500000)	NotEqual(0.900000)
5	LN-RF:1 {Cav}DnvValD-SP	0.5	15.0	1.4	1.2490009027e-16		NotEqual(14.500000)	NotEqual(0.900000)
6	LN-BI{BPM:1} Trig:AdcDelay-SP	0	1173200	0	0		NotEqual(1173200)	Equal
7	LN-RF:PB {Cav}DnvPhaCtrl-SP	18.9	29.85	9.45	23.95		NotEqual(10.950000)	NotEqual(-9.450000)
8	LN-RF:PB {Cav}DnvValD-SP	18.9	29.85	9.45	23.95		NotEqual(10.950000)	NotEqual(-9.450000)
9	ITB-BI{ES} cam1:AcquireTime	0.02	0.08	0.02	0.02		NotEqual(0.060000)	Equal
10	LN-RF:3 {Cav}DnvValC-SP	0.326	0.345	0.344	0.347		NotEqual(0.019000)	NotEqual(0.010000)
11	LN-RF:3 {Cav}DnvAmpCtrl-SP	0.326	0.345	0.344	0.347		NotEqual(0.019000)	NotEqual(0.010000)
12	ITB-BI{VF:1BD2} cam1:AcquireTime	1.2e-05	0.002	0.002	1.2e-05		NotEqual(0.001988)	NotEqual(0.000000)
13	LN-RF:3 {Cav}DnvValD-SP	-8.55	-16.15	-8.9	-9.05		NotEqual(-7.600000)	NotEqual(-0.350000)
14	LN-RF:3 {Cav}DnvPhaCtrl-SP	-8.55	-16.15	-8.9	-9.05		NotEqual(-7.600000)	NotEqual(-0.350000)
15	LN-BI{VF:6} cam1:Gain	24.0	20.0	20.0	24.0		NotEqual(-4.000000)	NotEqual(-4.000000)
16	LN-RF:BUN {Cav}DnvValD-SP	30.25	-8.1	31.2	-114.6		NotEqual(-38.350000)	NotEqual(0.950000)
17	LN-RF:BUN {Cav}DnvPhaCtrl-SP	30.25	-8.1	31.2	-114.6		NotEqual(-38.350000)	NotEqual(0.950000)
18	LN-BI{VF:3} cam1:Gain	20.0	1.0	1.0	20.0		NotEqual(-19.000000)	NotEqual(-19.000000)
19	ITB-BI{VF:2} cam1:Gain	5.0	4.0	0.0	5.0		NotEqual(-1.000000)	NotEqual(-5.000000)
20	LN-BI{VF:6} cam1:AcquireTime	0.00015	1.2e-05	1.2e-05	0.00015		NotEqual(-0.000138)	NotEqual(-0.000000)
21	LN-BI{VF:3} cam1:AcquireTime	0.00015	1.2e-05	1.2e-05	0.00015		NotEqual(-0.000138)	NotEqual(-0.000000)
22	LN-BI{VF:2} cam1:AcquireTime	0.00015	1.2e-05	0.00015	0.00015		NotEqual(-0.000138)	Equal
23	LN-BI{VF:4} cam1:AcquireTime	0.0001	1.2e-05	0.0001	0.0001		NotEqual(-0.000088)	Equal
24	ITB-BI{DIG:FC} Prescaler-SP	1	1	1	1		Equal	Equal
25	ITB-BI{ES-Ax:1} Mtr:VAL	40.0	40.0	40.0	40.0		Equal	Equal
26	LN-RF:ES {MBM} FF:AmpCtrl-SP	0.65	0.65	0.65	0.65		Equal	Equal
27	LN-BI{BPM:4} Rate:Update-SP	10	10	10	10		Equal	Equal
28	LN-BI{BPM:3} Beam:Gain-SP	100.0	100.0	100.0	100.0		Equal	Equal
29	LN-MG{SOL} :PS-07:Cmd-Pwr	ON	ON	ON	ON		Equal	Equal
30	LN-BI{BPM:2} Trig:Strig-SP	Rdy	Rdy	Rdy	Rdy		Equal	Equal
31	LN-BI{BPM:1} Tbt:GateWidth-SP	10	10	10	10		Equal	Equal

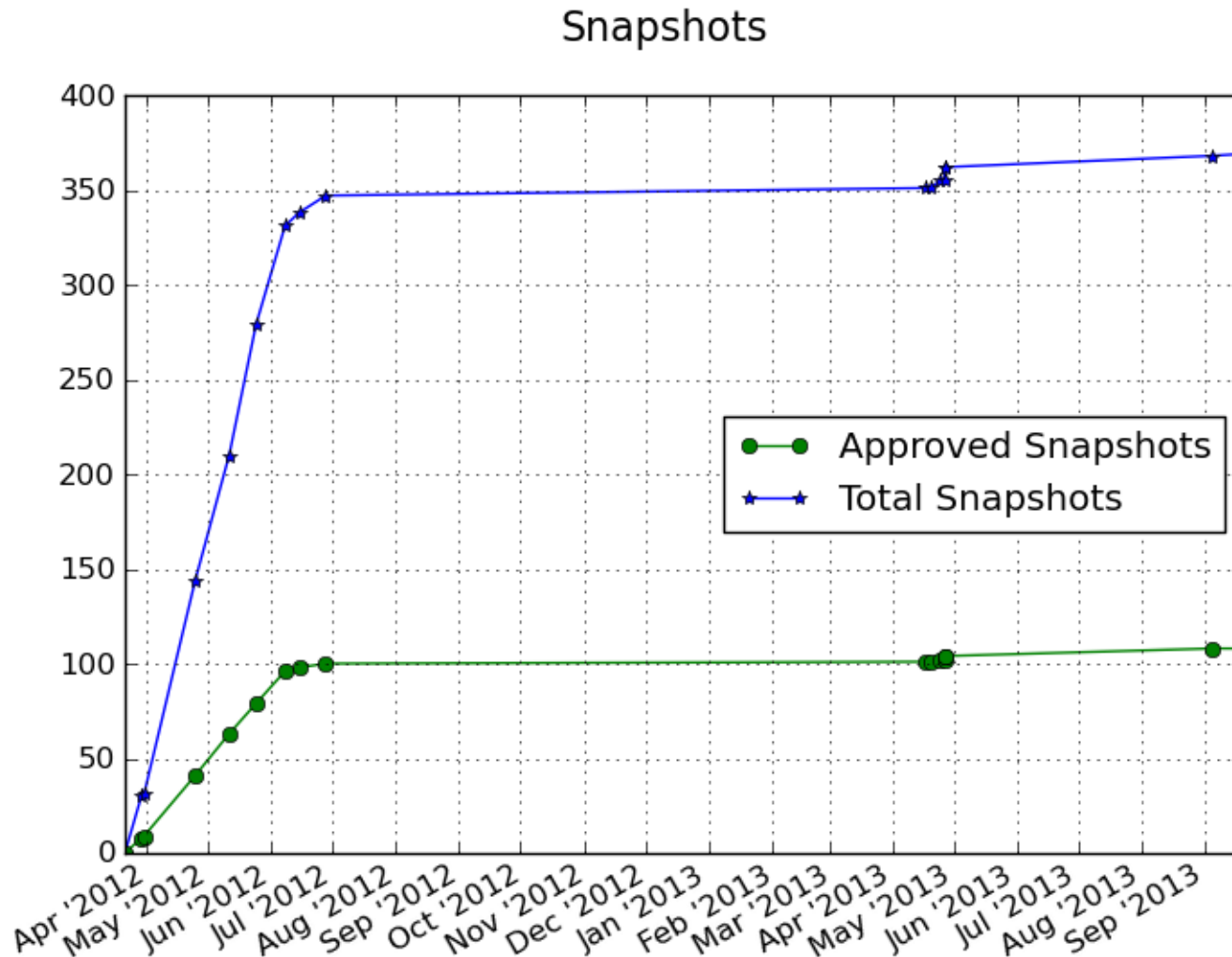
# Experience at NSLS II

- Deployed in control network from the first day (3/27/2012)
- Configuration increasing with time



# Experience at NSLS II

➤ Snapshots taken with time



# Experience at NSLS II

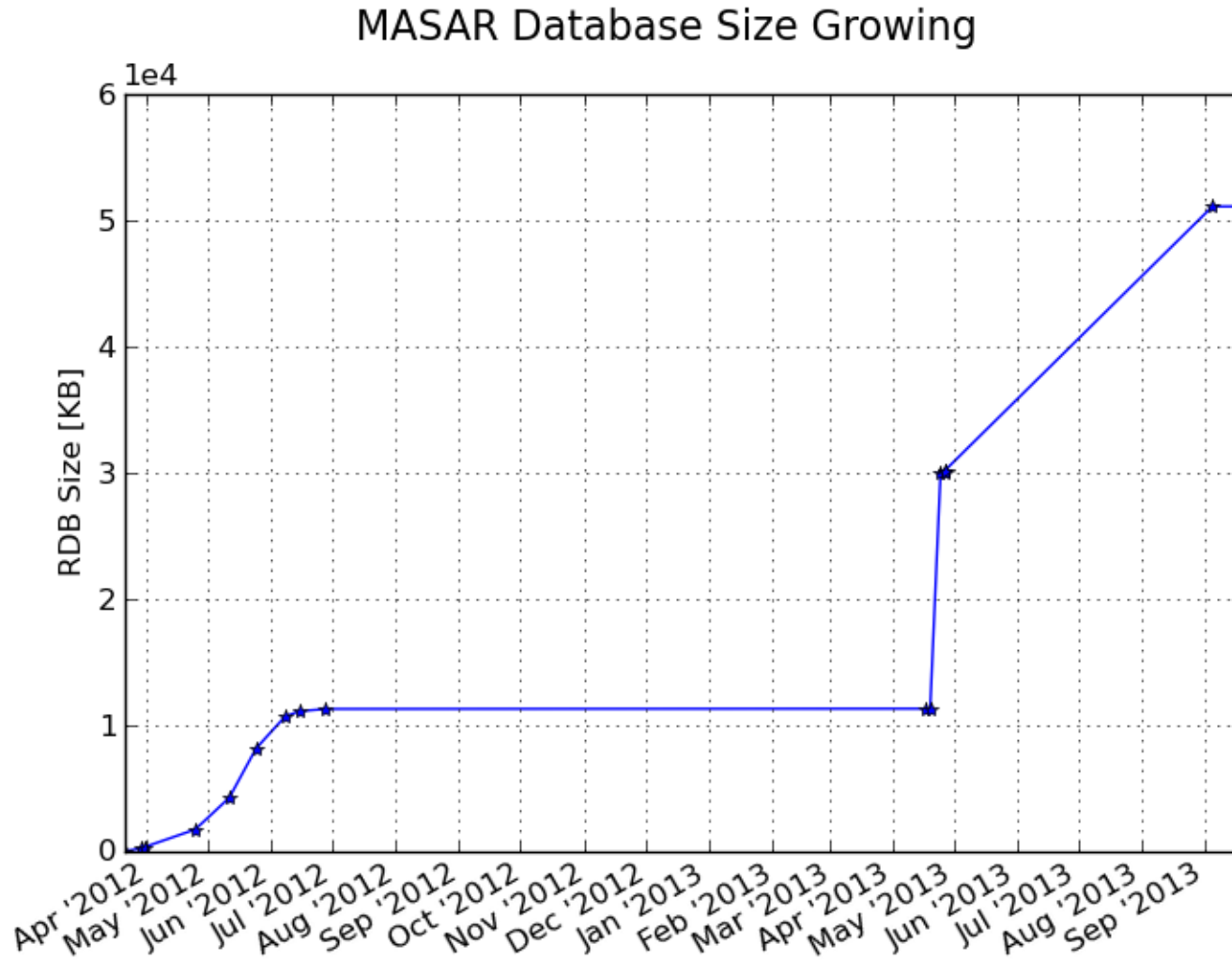
## ➤ Snapshots taken with time

❖ Events (by 2013-09-19 11:18:48) total taken: 369, approved: 108

Date	Snapshots taken	Snapshots Approved
3-21-2012 9:28 AM	0	0
3-29-2012 10:32 AM	30	8
3-30-2012 6:01 PM	31	9
4-24-2012 8:02 PM	144	41
5-11-2012 10:27 AM	210	63
5-24-2012 2:25 PM	279	79
6-7-2012 6:28 PM	331	96
6-14-2012 4:13 PM	338	98
6-27-2012 5:02 PM	347	100
4-17-2013 11:30 AM	351	101
4-26-2013 11:13 AM	355	102
4-26-2013 5:24 PM	362	104
5-23-2013 4:03 PM	364	104
9-4-2013 3:38:15 PM	368	108
9-19-2013 11:18:48 AM	369	108

# Experience at NSLS II

- Database size growing over time





# Plan

- Tools for pv group/configuration management
  - ❖ Display all PV& PV group(s) of a configuration
  - ❖ Compare existing configuration
  - ❖ Create a new configuration
- RDB data management
  - ❖ Performance concerns saving large configuration
    - ❖ Lots of PVs
    - ❖ Large data size of PV
  - ❖ Migrate to a dedicate RDB server
  - ❖ Separate meta data out of SQLite
- PyQt UI continuous improvement
- CSS integration for client
- ChannelFinder integration for configuration

# Backup

# Experience at NSLS II

## ➤ Question often asked

- ❖ Why timing mode was often changed?
- ❖ Why BPM calibration offset went back to 0? We just calibrated it recently, and it should not be changed after it was determined.
- ❖ Why all quadrupoles' setting are 0 when I try to restore a snapshot?
- ❖ I want to take one snapshot of configure A, and right after 1 second, take another snapshot of configure B. Then combine those 2 data set to compare them. Does MASAR support this requirement?
- ❖ Why the file size growing with time since the total pv are same?

# Experience at NSLS II

## ➤ Lesson learned

- ❖ Design each configuration carefully
  - ❖ Collect requirement from user: physicist/operator
  - ❖ Ask sub-system control experts to review it before creating a configuration
- ❖ Separate operator configuration and sub-system export configuration
  - ❖ Not all pvs need to be restored
  - ❖ Obvious, but not everyone is aware of it

# Experience at NSLS II

## ➤ Lesson learned

- ❖ MASAR provides restore function inside the PyQt GUI
  - ❖ Check snapshot before restoring
    - ❖ Restoring machine to the status MASAR recorded
    - ❖ Not the status in mind
  - ❖ For that particular question, with Olog, we confirmed that snapshot was taken during machine shutdown.
- ❖ MASAR is aiming to snapshot the data.
  - ❖ User is encouraged to develop their own application to use the data
  - ❖ Check the timestamp of both event and pvs when using the data
    - ❖ Timestamp of event is when the snapshot was taken
    - ❖ Timestamp of pv is when the pv was processed
- ❖ It is the SQLite database file size, not each snapshot.
  - ❖ All snapshots are saved into one database