EPICS Archiver Appliance Update

Presented by Murali Shankar on behalf of multiple contributors from the EPICS collaboration

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

Goals

- Scale to 1-2 millions PV's
- Fast data retrieval
- Users add PV's to archiver
- Zero oversight
- Flexible configurations on a per PV basis

The EPICS Archiver Appliance is 10 years old

What's in an appliance?

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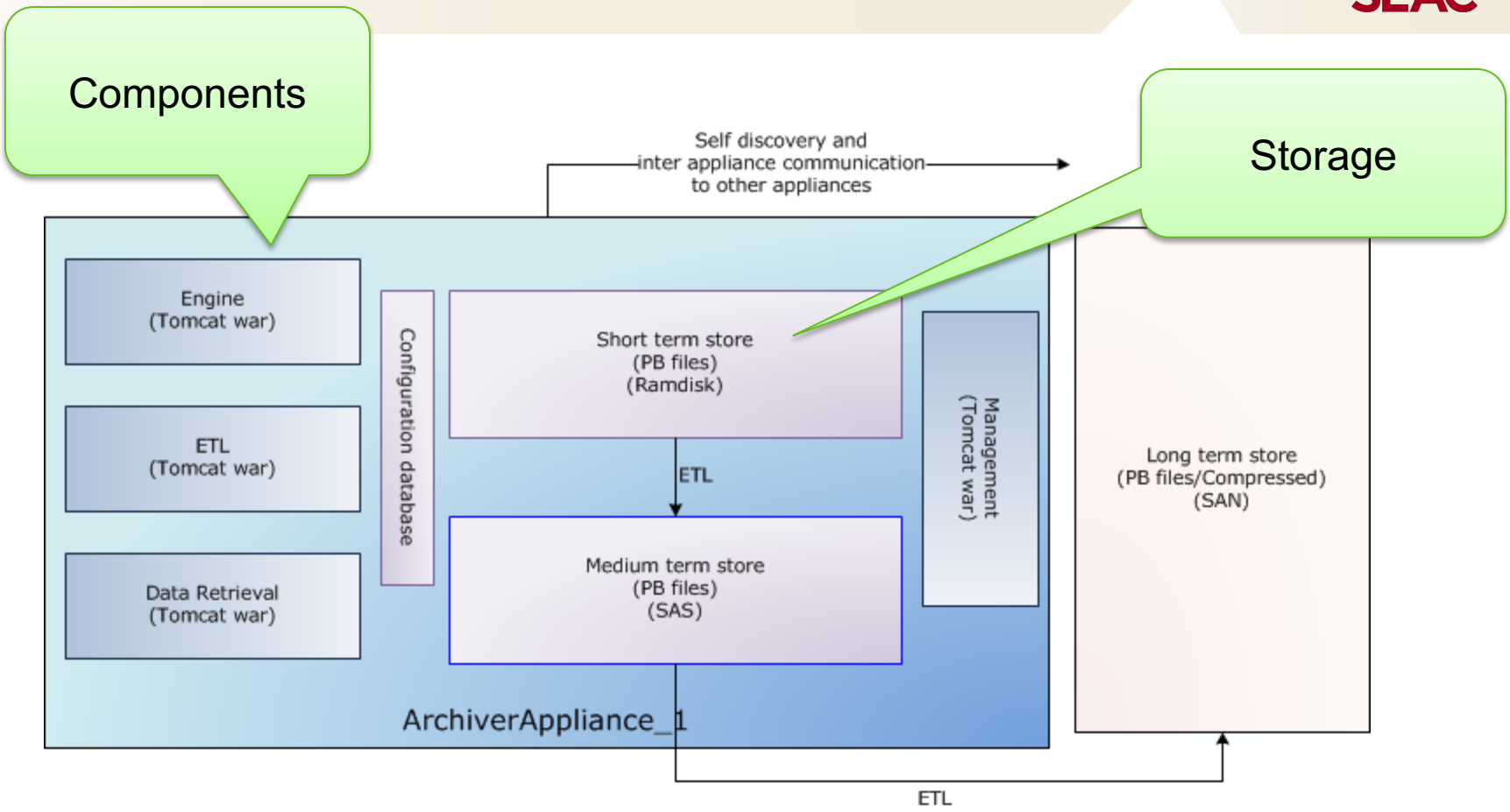
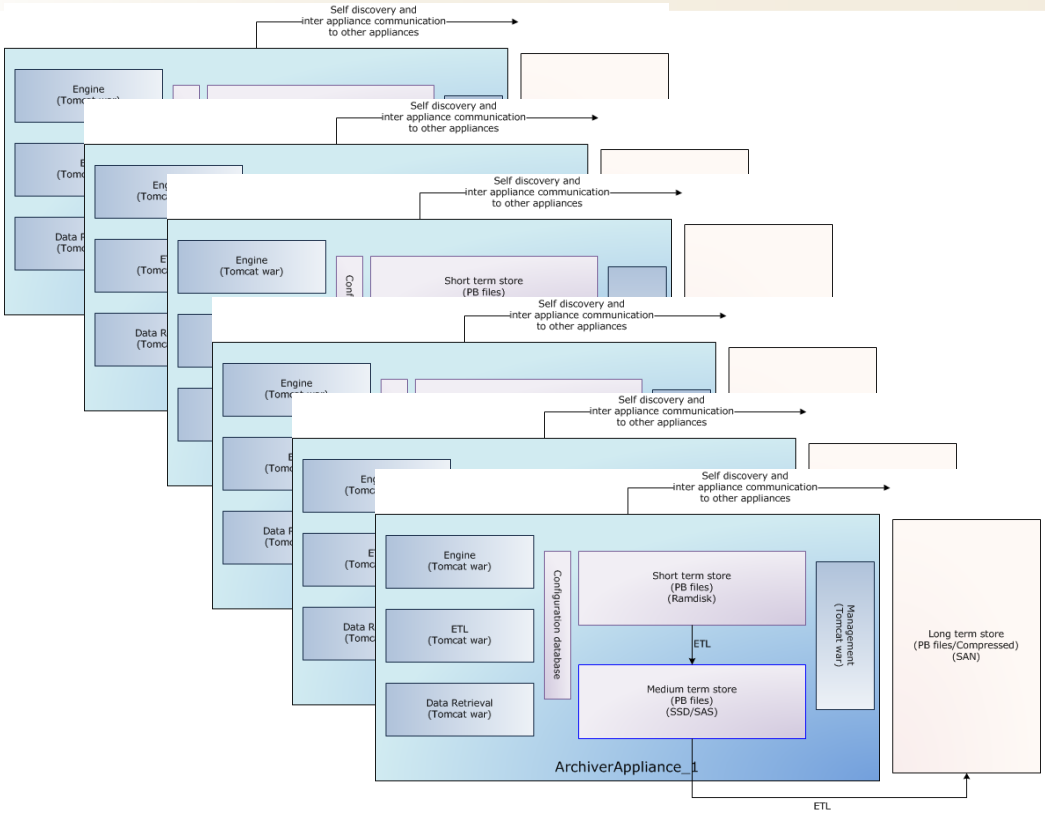
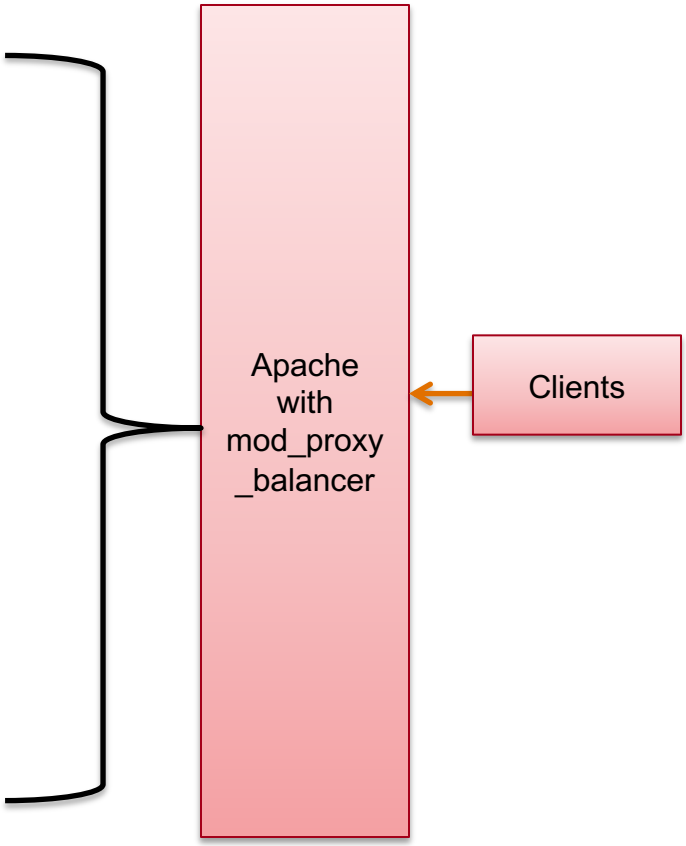


Scale by clustering appliances





A few deployments

Facility	PVs	Data rate (GB/day)	Cluster size
LCLS (Electron)	616K	170.04	6
LCLS (Photon)	237K	110.4	2
SPEAR	42K	6.43	1
BNL	127K	127	1
BNL - Multiple	323K	157	25+ installs
LNLS	127K	86	1
Keck1	1.5K	27	1
Keck2	1.3K	20	1
ANSTO	103K	6	1
Diamond	N/A		
PSI	N/A		
FHI	2.5K	1.06	2
Canadian Light Source	26K	2	1
SESAME	8.5K	13.3	1
Others….			

Retrieval times

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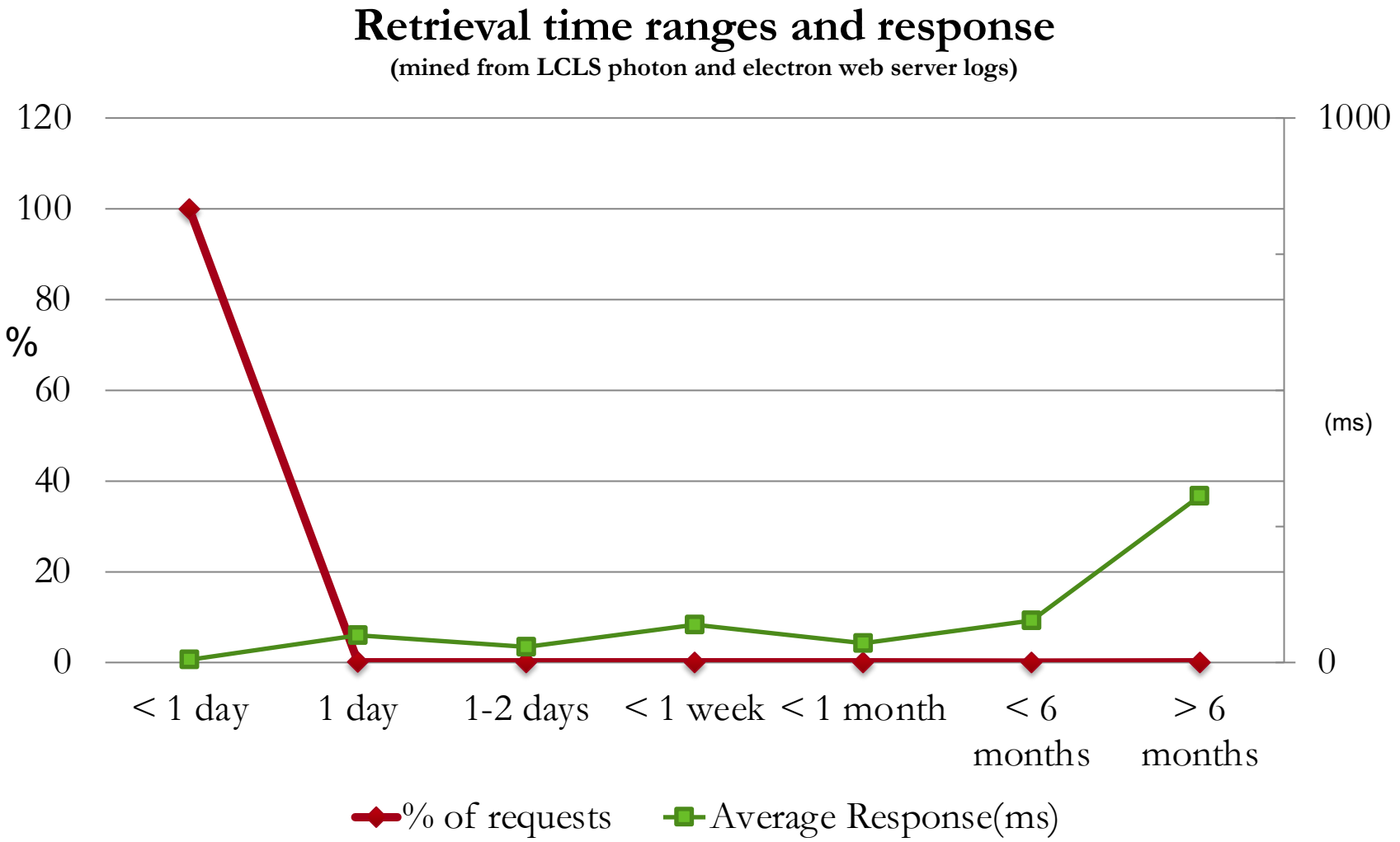

Retrieval Mime Types

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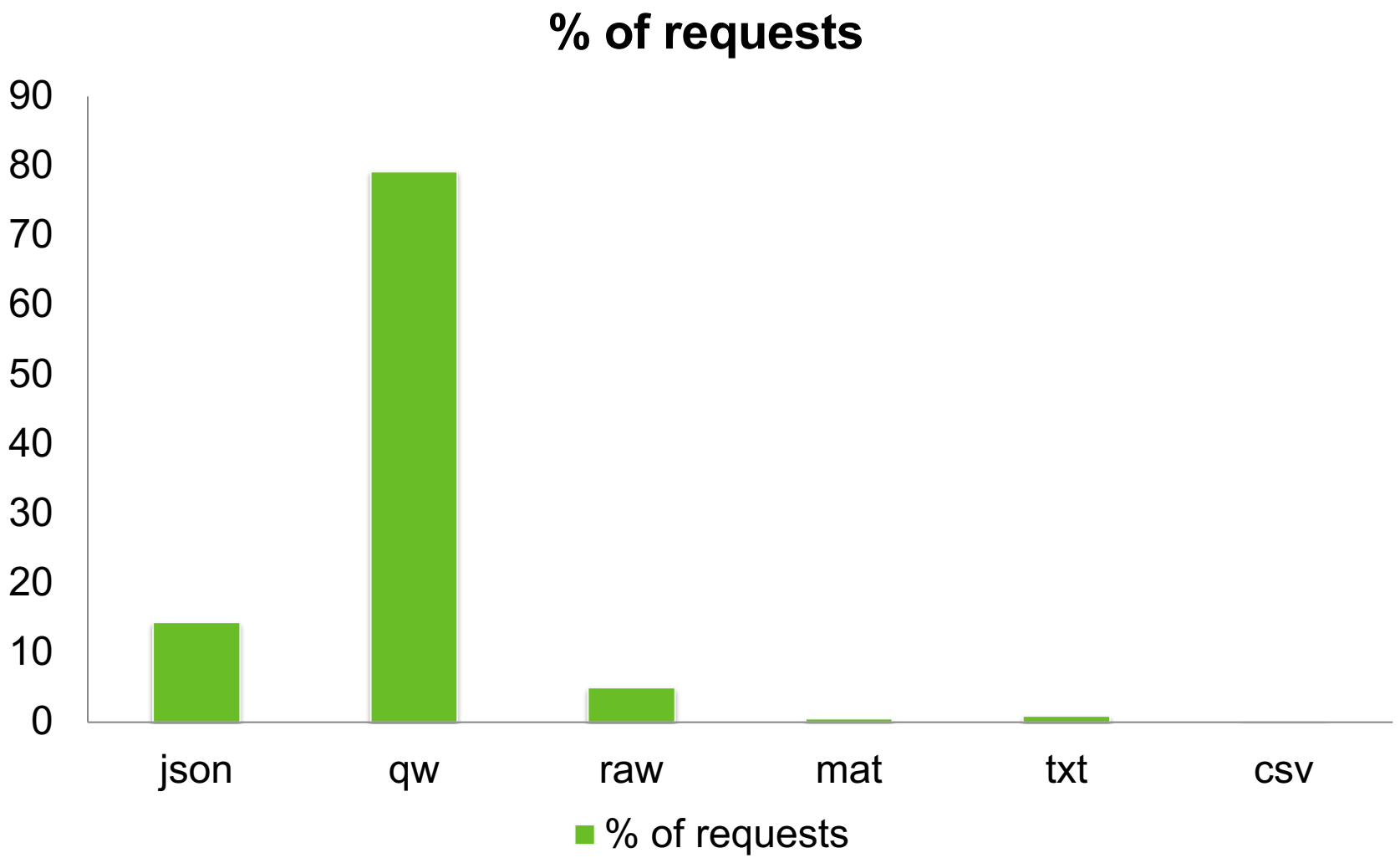
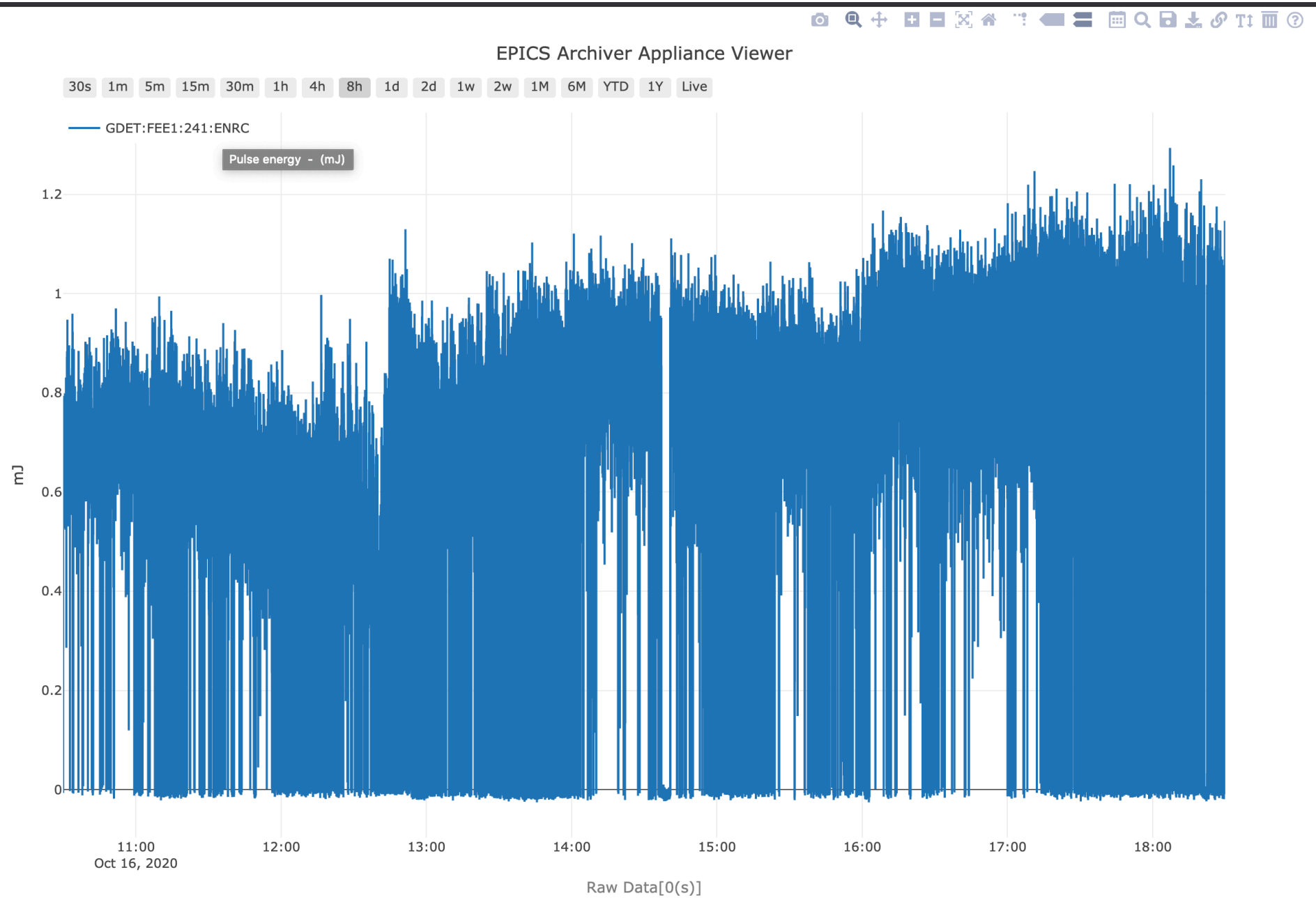


Web based viewer

- Bundled with the appliance.
  - Can be deployed separately as well
- Small feature set – zoom/pan/log scales/link/export etc
- Full featured viewers – Phoebus, PyDM, Grafana, Matlab, ArchiveViewer

Web based viewer



Grafana

Create dashboards of multiple PV's for your most commonly viewed systems + alerting

Couple of plugins

- Paul Richards (Keck) has an excellent plugin - https://github.com/KeckObservatory/epics-grafana-datasource
- Shinya Sasaki (KEK) has another excellent plugin - https://github.com/sasaki77/archiverappliance-datasource

KEK Grafana – 1 (courtesy of Paul Richards)

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Temperature charting of one of the telescopes

KEK Grafana - 2

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Azimuth/elevation of the telescope

LCLS Grafana (courtesy of Alex Wallace)

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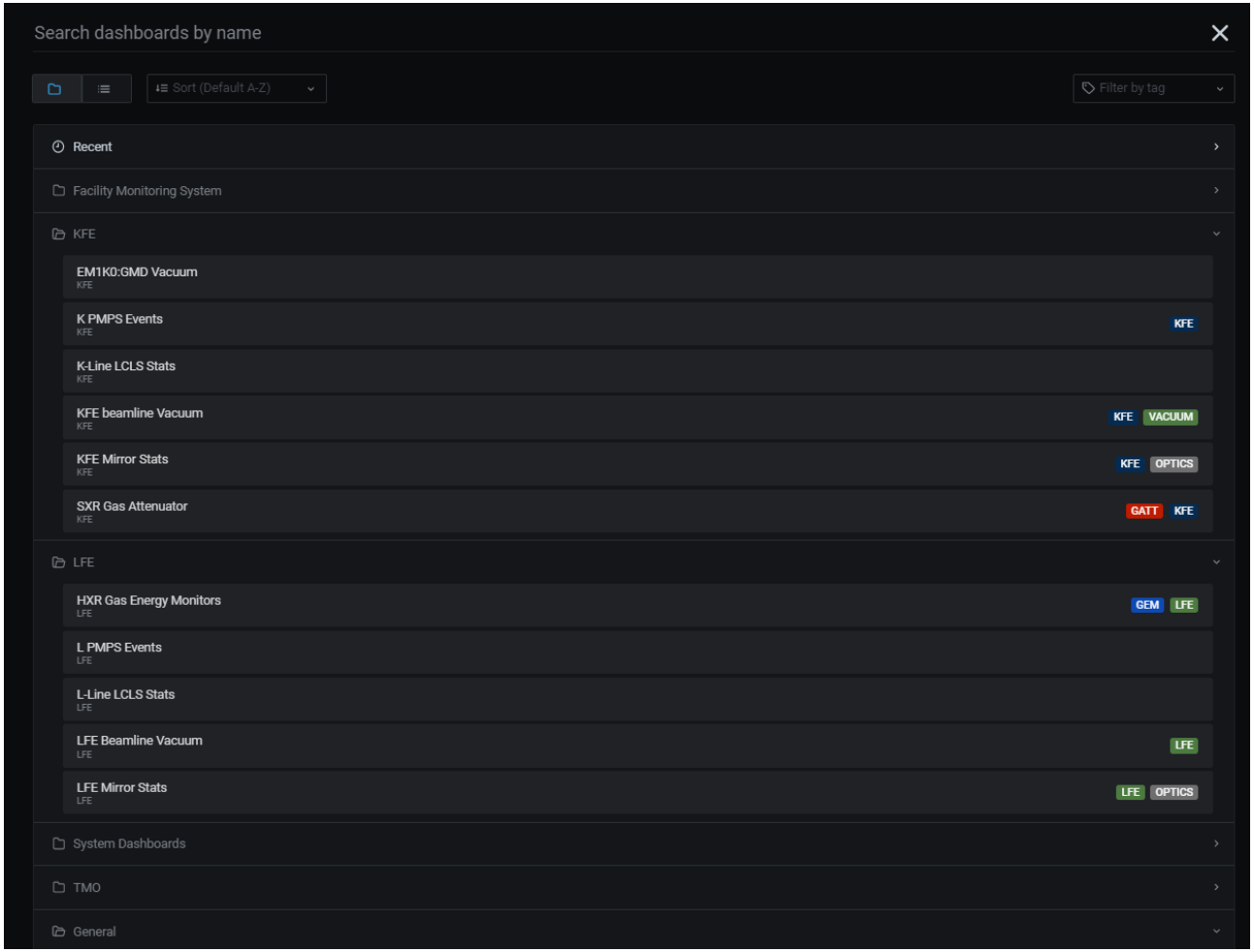
Create multiple panels to trend data

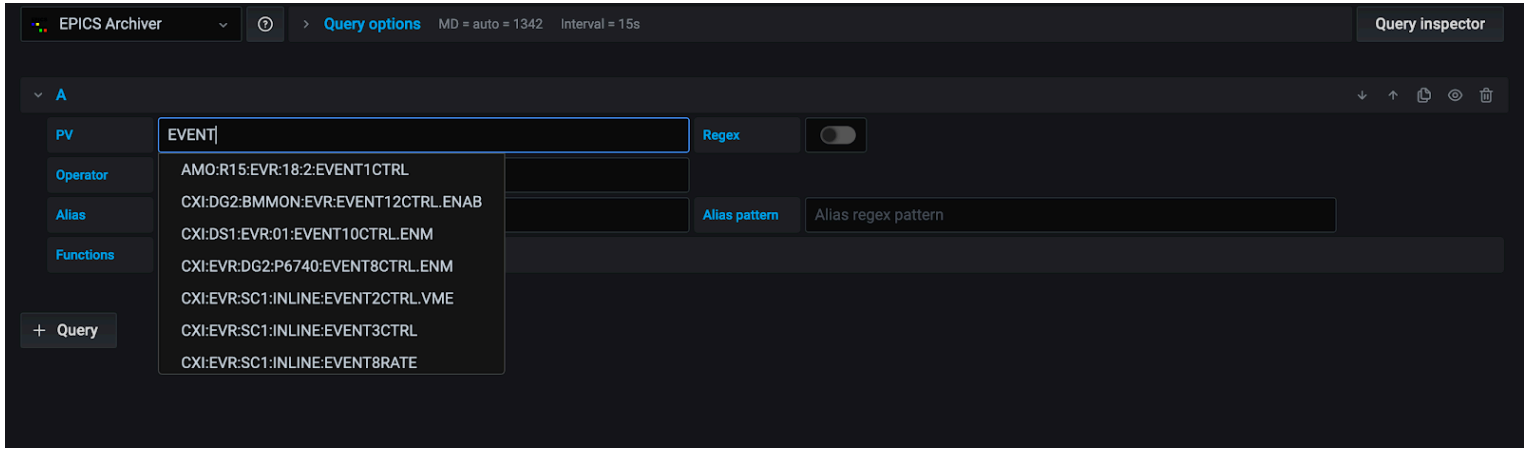
LCLS Grafana

Easily search dashboards

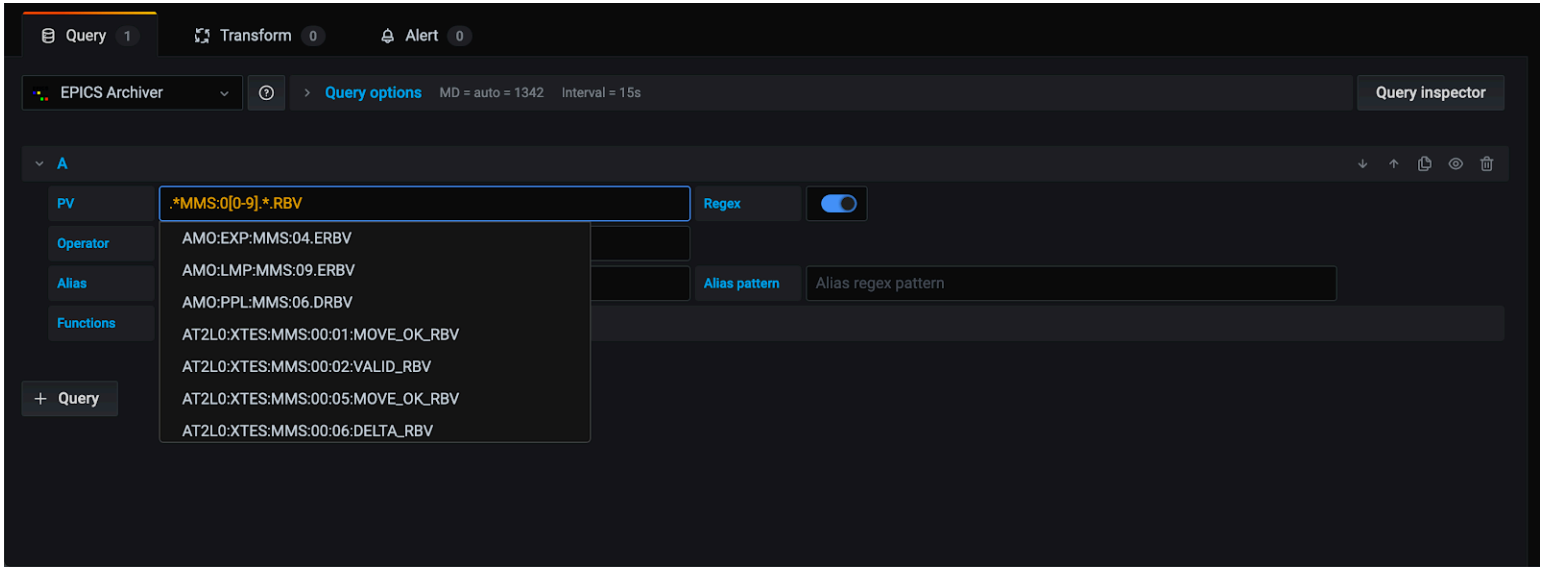


LCLS Grafana

Drop-down list of PVs that match your query



Regular expression support for quickly getting a whole slew of PVs



LCLS Grafana

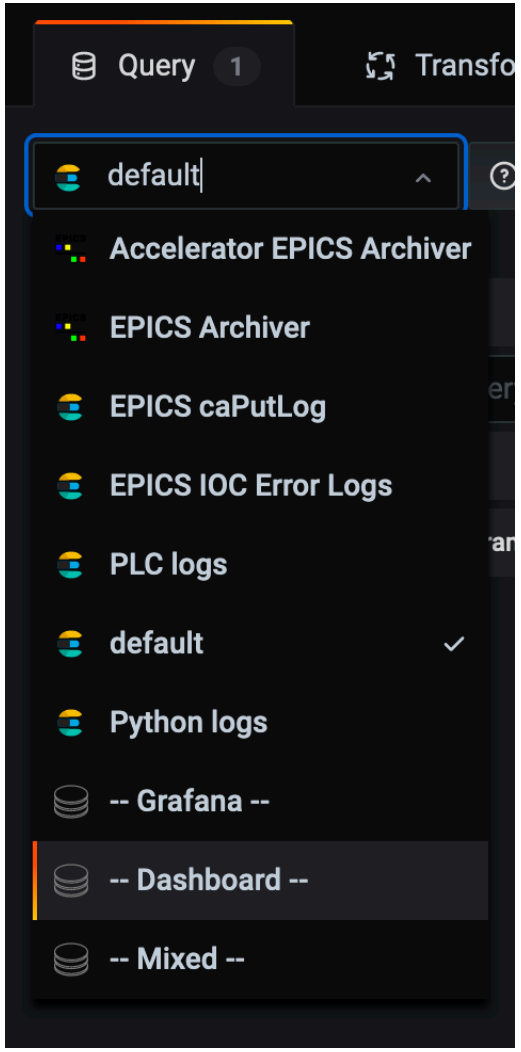
Whole system dashboards with status indicators – energy detector vacuum system

LCLS Grafana

Area access and PPS status display without EPICS

LCLS Grafana

Annotate PV trends with caPutLog (any log) information, or display logs as a panel – data sources galore



LCLS Grafana

LCLS Beam Statistics for current status and longer term trends, auto-refresh rates bring dashboards alive

LCLS Grafana

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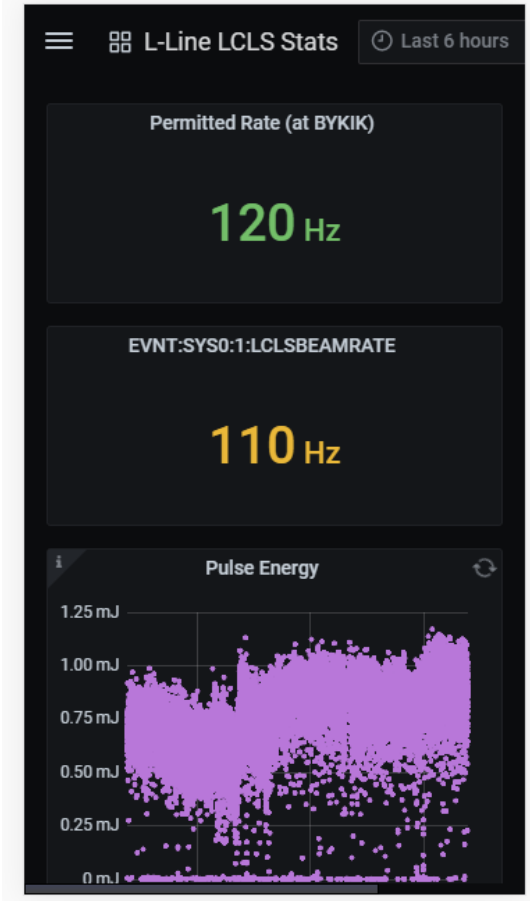
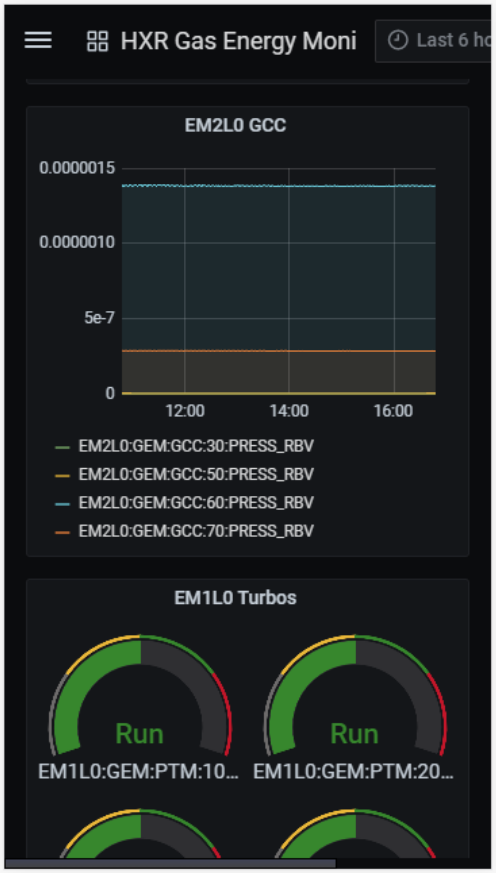
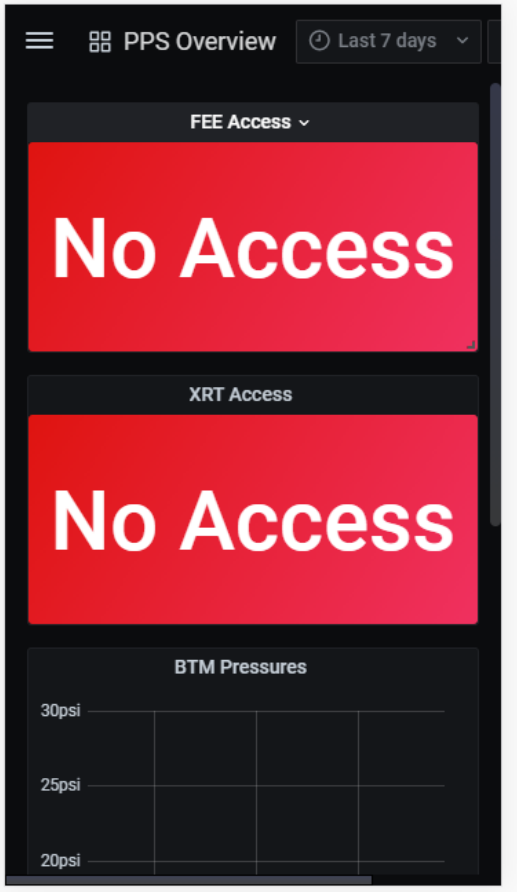
Grafana Renders Nicely On Mobile Devices







PVAccess support

- NTScalars and NTScalarArrays are stored as their channel access counterparts
  - Existing viewers should work with these types
- Other PVData structures are stored as a bunch of bytes.
  - Add any V4 type to the archiver
  - V4 service to get archiver data over PVAccess
  - Also, over JSON
- Lots of teething issues
  - Checking for a PVA PV's liveness using CA will not work

Retrieval for complex types

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```
/retrieval/data/getData.json?pv=VRGA:GUNB:100:BARDATA"
```


```
                "timeStamp": {
                    "nanoseconds": 699300096,
                    "secondsPastEpoch": 1586199005,
                    "userTag": 0
                },
                "value": {
                    "Mass": [
                        0.0,
                        0.0,
                        0.0
                    ],
                    "Pressure": [
                        1.935e-15,
                        7.5035e-14,
                        -2.365e-14,
                        1.05887e-13,
```

Save/Restore API

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- Get the value of several PV's as of a point in time
- Primarily aimed at save/restore applications – SCORE/MASAR
  - Archiver data is often used as quality control
- Performance.
  - At least one IOP per PV.

Save/Restore API - performance

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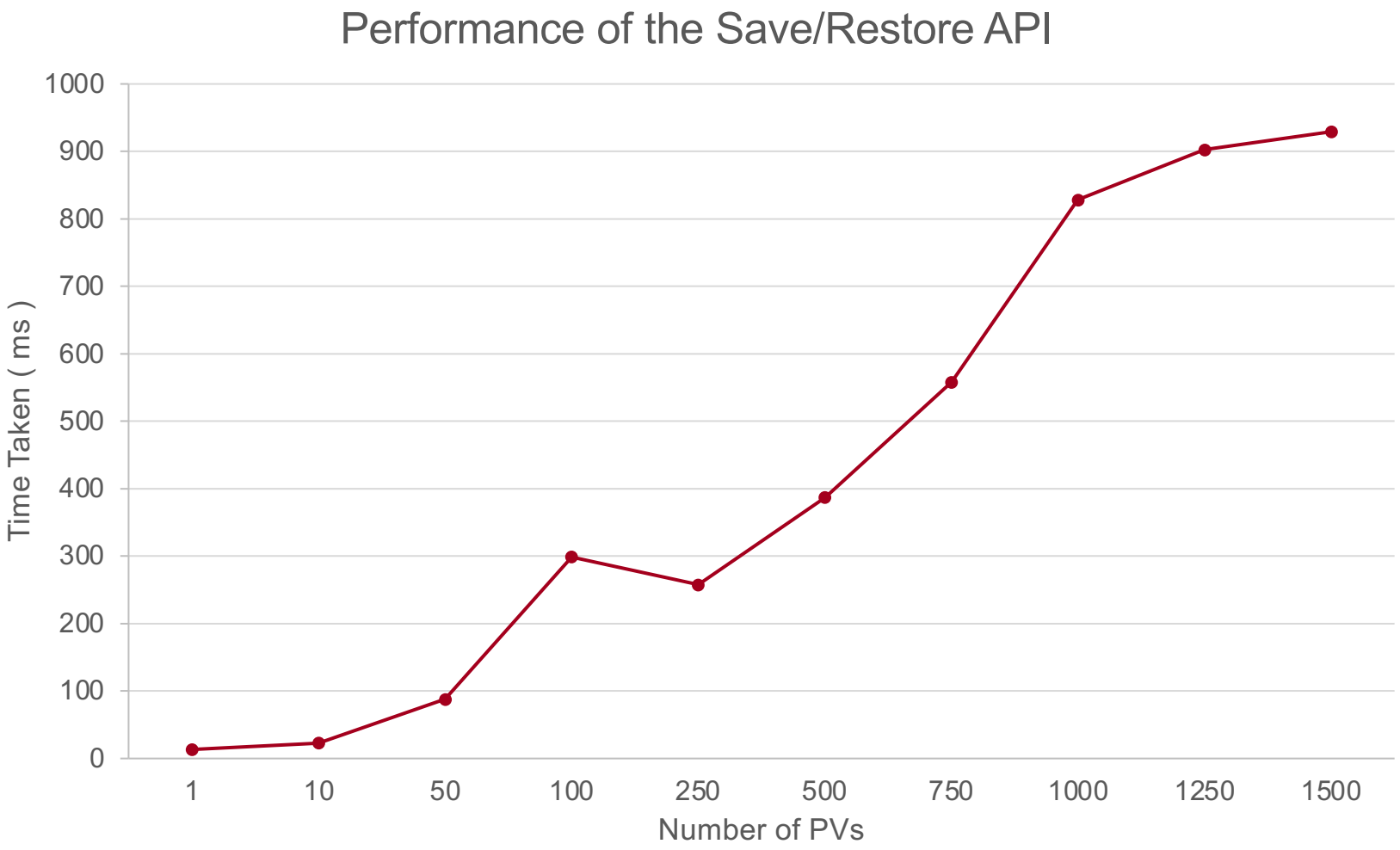

EPICS archiver data for anomaly detection (Anwesha Das)

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- Beam loss, RF trips, DC magnet faults etc
- Analyze 1000s of PV trends together over diverse space-time and conduct statistical multi-variate time-series analysis with comparative ease.
  - Irregular sparse time-series, thus anomaly identification non-trivial
- Assimilate all the PV data at one location (skip the server).

EPICS archiver data for anomaly detection (Anwesha Das)

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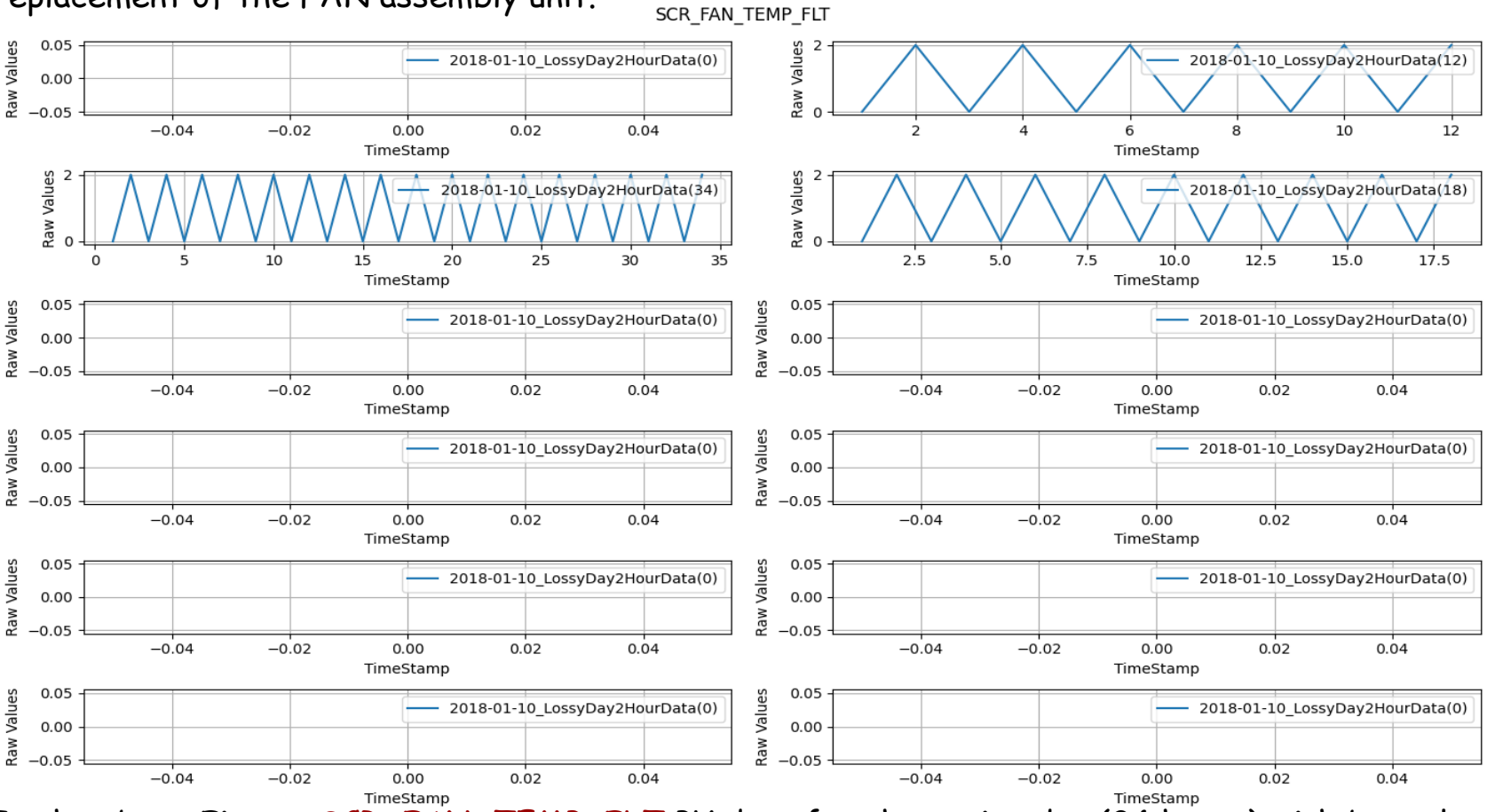
Fan Fault: For a beam failure caused by SCR temperature fault, SCR_FAN_TEMP_FLT PV shows clear indications of anomaly during the day shift (i.e., 8 am to 4 pm) and beyond. Recovery in this case was replacement of the FAN assembly unit.



In the above Figure, SCR_FAN_TEMP_FLT PV data for the entire day (24 hours) with beam loss is shown as 2 hour periods (left to right, top to bottom).

Deployment

- Migrated to JDK 1.12+/Tomcat 9
  - Upgrade is relatively straightforward; a few labs have already done this.
  - But this is a migration; simply replacing the WAR's may not work.
  - Other versions of Tomcat should be fine.

Gateways (Jingchen Zhou/Bruce Hill)

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- LCLS uses gateways to protect the IOC's from the archiver.
  - Accumulation of dead PV's.
  - Lots of CA search requests.
- LCLS Photon folks use a gateway per hutch (approx).
- The LCLS accelerator folks use 6 gateways (all running on the same machine)
  - Gateway 0 is the default gateway

    # allow everything, deny patterns
    EVALUATION ORDER ALLOW, DENY
    .* ALLOW
    ^[A-Za-z0-9]+:UND1:.* DENY
    ...
  - Others match on PV name patterns – LINAC sectors

    EVALUATION ORDER DENY, ALLOW
    .* DENY
    ^[A-Za-z0-9]+:UND1:.* ALLOW

Administration/monitoring (Bruce Hill)

- https://github.com/slaclab/epicsarchiver_automation
- Archive request files as part of the IOC build
- Auto pause/auto resume
- Liveness of disconnected PV's.
  - If using gateways, bypass these for this check.

Multi-step BPL

- Changes in naming conventions
  - Append old PV data to new PV
  - Delete old PV
  - Add old PV name as an alias
- Can do this outside from within Python
- Frequent usecase, we moved this inside the archiver
  - /appendAndAliasPV

PBEditor (Anthony Carriveau, FRIB)

Post processing PB files for storage reclamation

- GATE: post process delete records based on controlling PV
  - optional minimum record or time-frame before and after
  - Keeps records with field changes
- DEDUP: delete identical records
  - Value
  - Timestamp
  - both
- ADEL: delete records based on a new ADEL value
- MERGE: merge two PB files from separate archivers
- DECIMATE: delete records according to normal decimation rules

Requested Features

- Failover
- Simple authorization
- Event building
- Compression/Reduce number of files
- Fast Archiving
- Puppet based installation
- Timestamps in the logger/better logging
- Better self-diagnosis

Gallery of bugs

- Reconnect bugs
- “No data” display bugs
- Very slow “Delete PV”

Quickstart/evaluate

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Google “EPICS archiver appliance”

Download archiver appliance and tomcat

Run using

- ./quickstart.sh apache-tomcat-9.0.20.tar.gz

```
[ quickstart_test ]$ ls -l
total 312440
-rw-r--r-- 1 mshankar cd     11358 Sep  9 16:03 Apache_2.0_License.txt
-rw-r--r-- 1 mshankar cd  10851264 Nov 13 08:08 apache-tomcat-9.0.20.tar.gz
-rw-r--r-- 1 mshankar cd 154003400 Nov 13 08:08 archappl_v0.0.1_SNAPSHOT_12-November-2019T21-10-12.tar.gz
```

```
... INFO  config.org.epics.archiverappliance.config.DefaultConfigService  - Start complete for webapp ENGINE
... INFO  config.org.epics.archiverappliance.config.DefaultConfigService  - Start complete for webapp ETL
... INFO  config.org.epics.archiverappliance.config.DefaultConfigService  - Start complete for webapp RETRIEVAL
... INFO  config.org.epics.archiverappliance.mgmt.MgmtRuntimeState  - All components in this appliance have started up. We should be read
y to start accepting UI requests
```

Questions

Thanks for listening