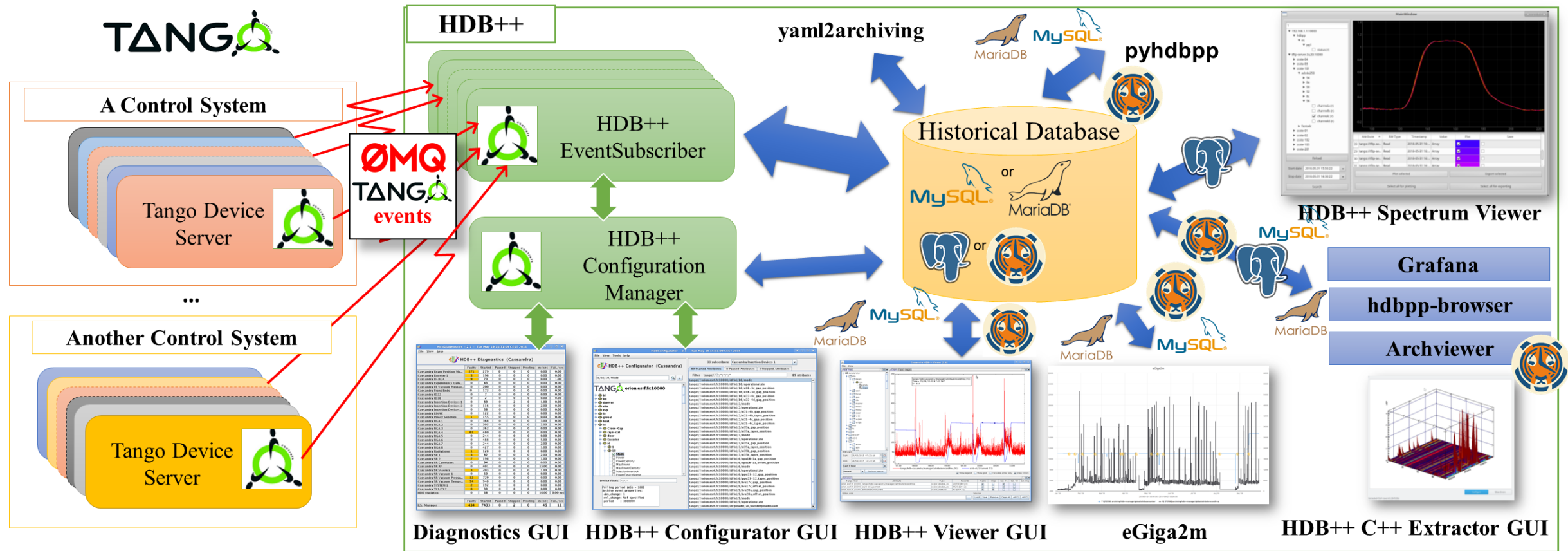




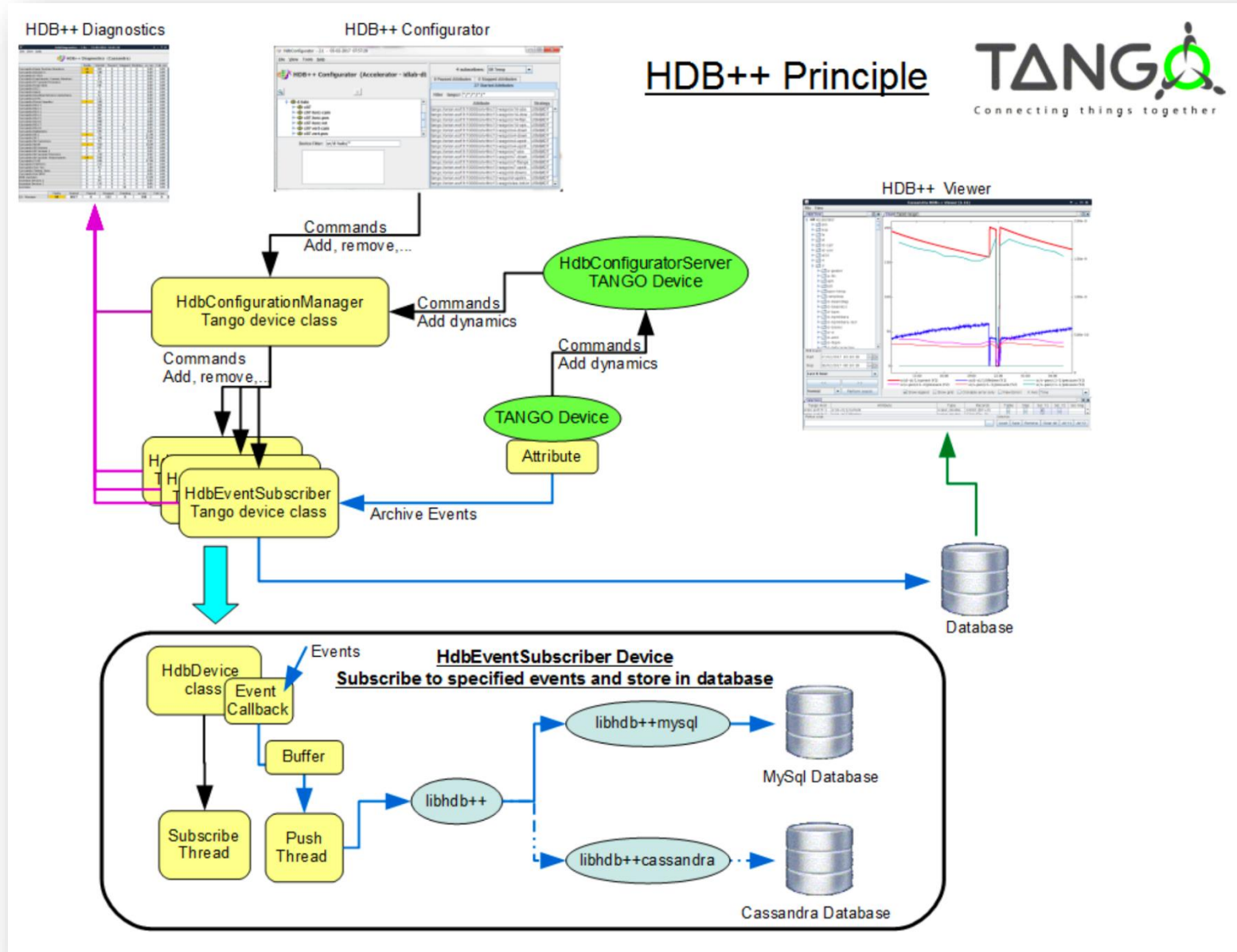
HDB++: The Memory of Tango-Controls

Reynald Bourtembourg - ESRF

HDB++ Overview



HDB++ Overview



Archive Events

- TANGO provides specific event for archiving purposes
- The **archive** event can be sent:
 - on value change → specify absolute or relative threshold
 - periodically → specify period
 - by code (push_archive_event() methods)
- Choosing the right thresholds is mandatory:
 - if the threshold is too large no events are sent → no archiving
 - if the threshold is too small too many events are sent → “noisy” archiving
- The right threshold is **strictly related to the variable/signal** to be archived (type, bandwidth, sampling rate...)

What is archived?

- Attribute value
- Attribute set value (for RW or WO attributes)
- Timestamp with microsecond resolution
- Attribute quality factor (VALID, INVALID, CHANGING, ALARM, WARNING)
- Error description in case of Exception (in case of consecutive errors, only the first error is stored in HDB)
- Attribute Configuration (Archive event configuration, enum labels, units related configuration, label, format, description, ...)

What is archived?

- Events History
 - attribute archiving add event
 - attribute archiving start event
 - attribute archiving stop event
 - attribute archiving pause event
 - attribute archiving removal event
 - attribute archiving crash event

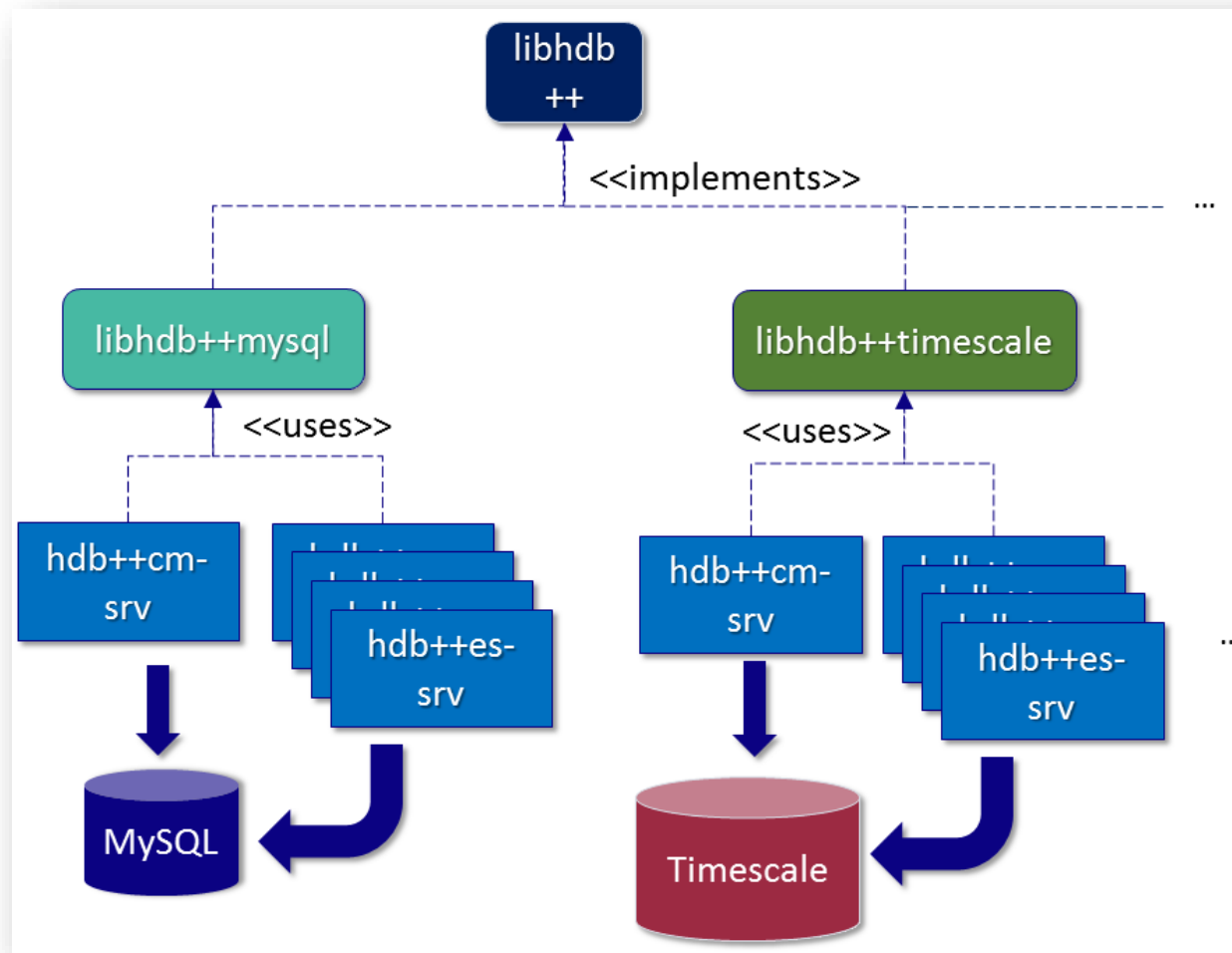
Special Features - TTL

- TTL (Time to Live) => Data can be automatically deleted after a configured period.
 - Setting per attribute
 - Deleting expired data delegated to the SQL backend

Special Features – Archiving Strategies & Contexts

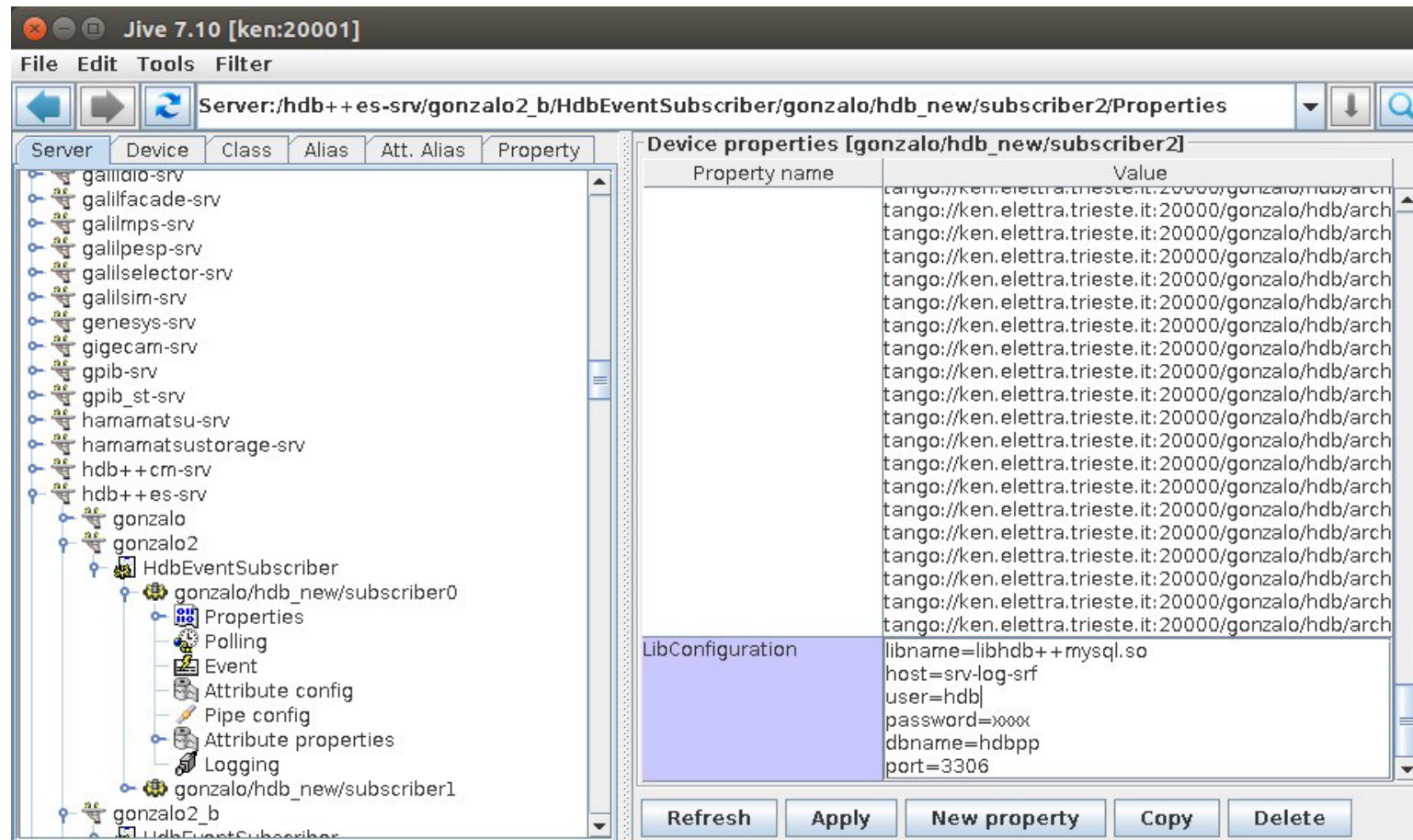
- You can define your own archiving contexts
- Example:
 - ALWAYS
 - RUN
 - SHUTDOWN
 - SERVICE
- Trick: NEVER context could be used to stop archiving temporarily some attributes linked to hardware in maintenance

HDB++ Archivers & Configurators



HDB++ Archivers & Configurators

hdbpp-es and hdbpp-cm = Device servers independent from DB backend
DB backend library dynamically loaded



HDB++ Archivers & Configurators

Conda packages available:

```
> conda install hdbpp-es hdbpp-cm
```

```
> conda install libhdbpp-timescale
```

HDB++ Extraction Libraries

- pyhdbpp (libhdbpp-python)
- Java Extraction Library (can be used from Matlab)
- C++ Extraction Library (only MySQL?)

pyhdbpp

Python3 package for data extraction

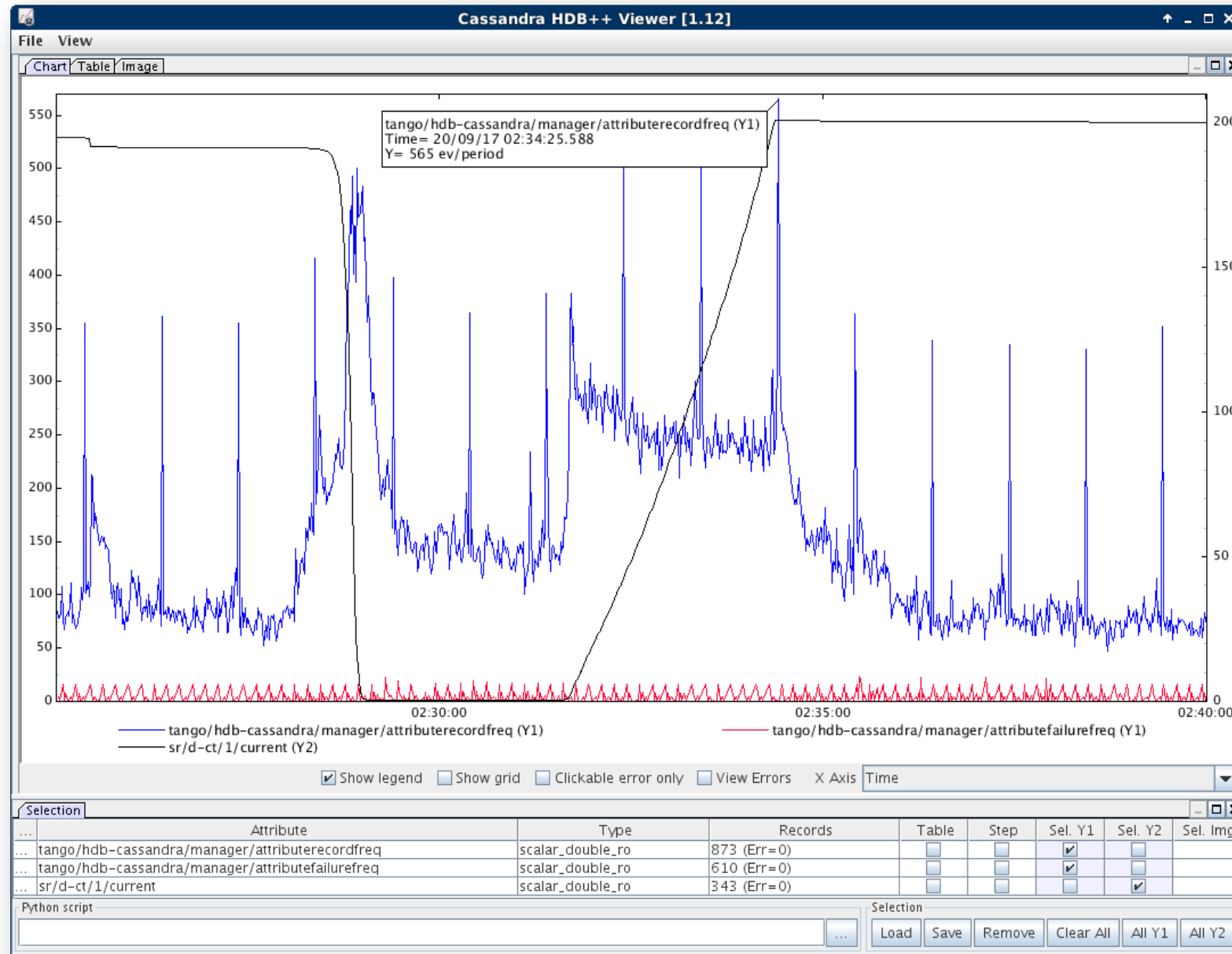
> **pip3 install pyhdbpp**

- Common API for MariaDB, MySQL and TimeScaleDB
- AbstractReader object provides generic extraction interface
- Dedicated DB back-end implementation is loaded at runtime
- Connection setup is stored in .yaml or Tango properties
- Taurus Widget available! (pyqtgraph)

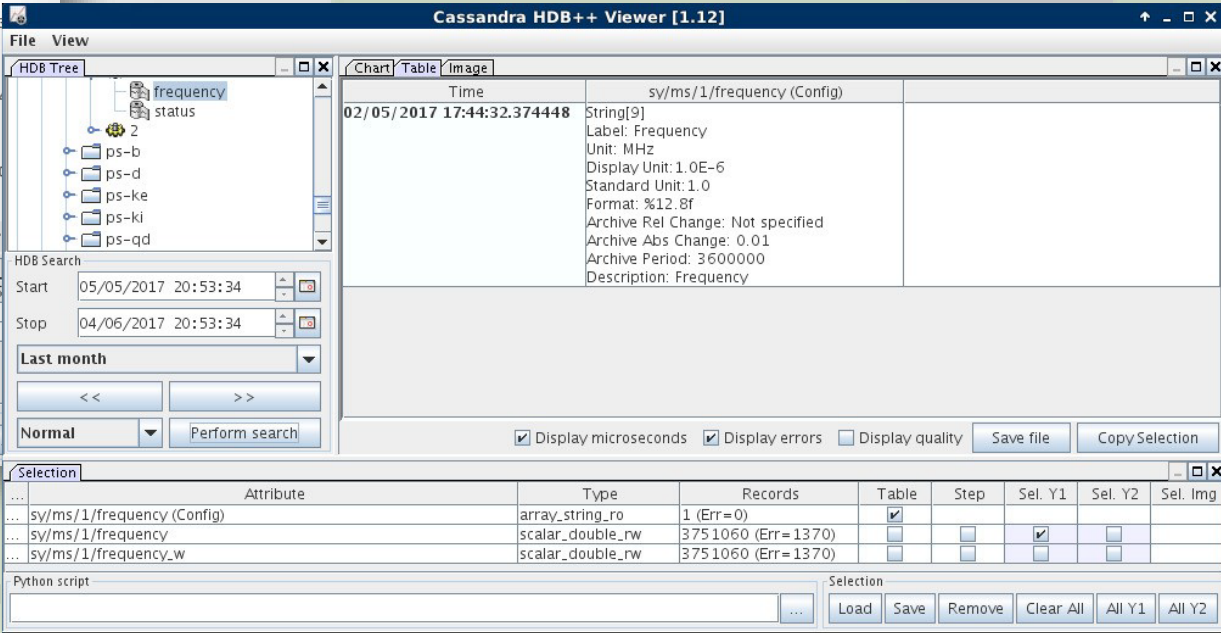
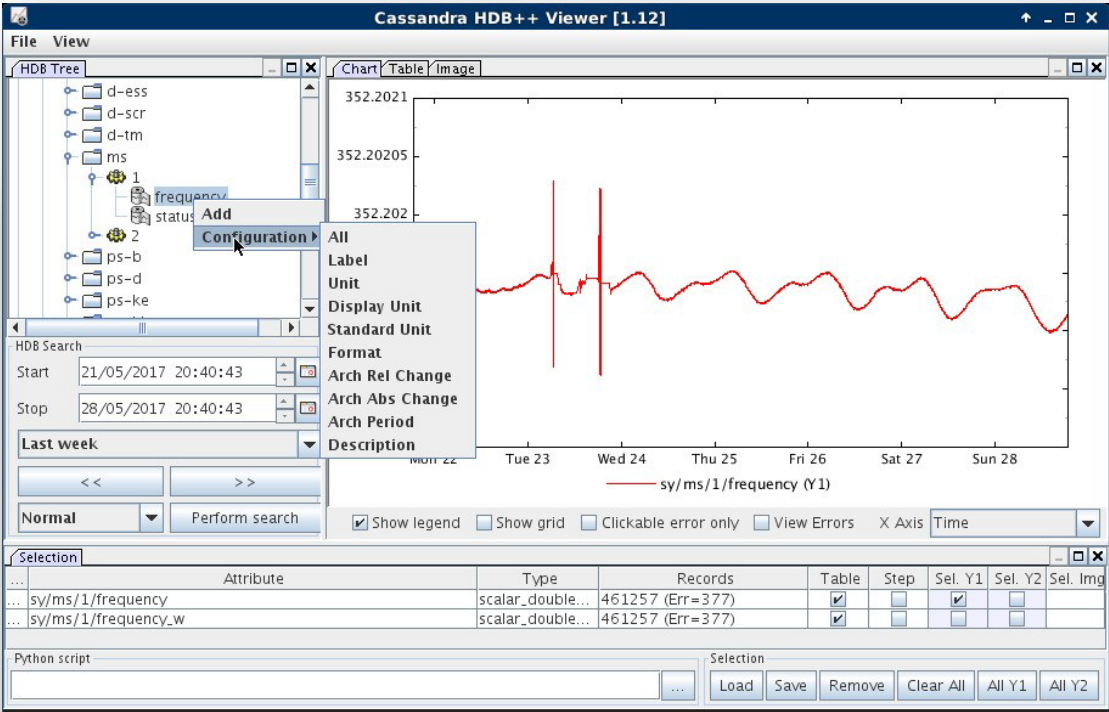
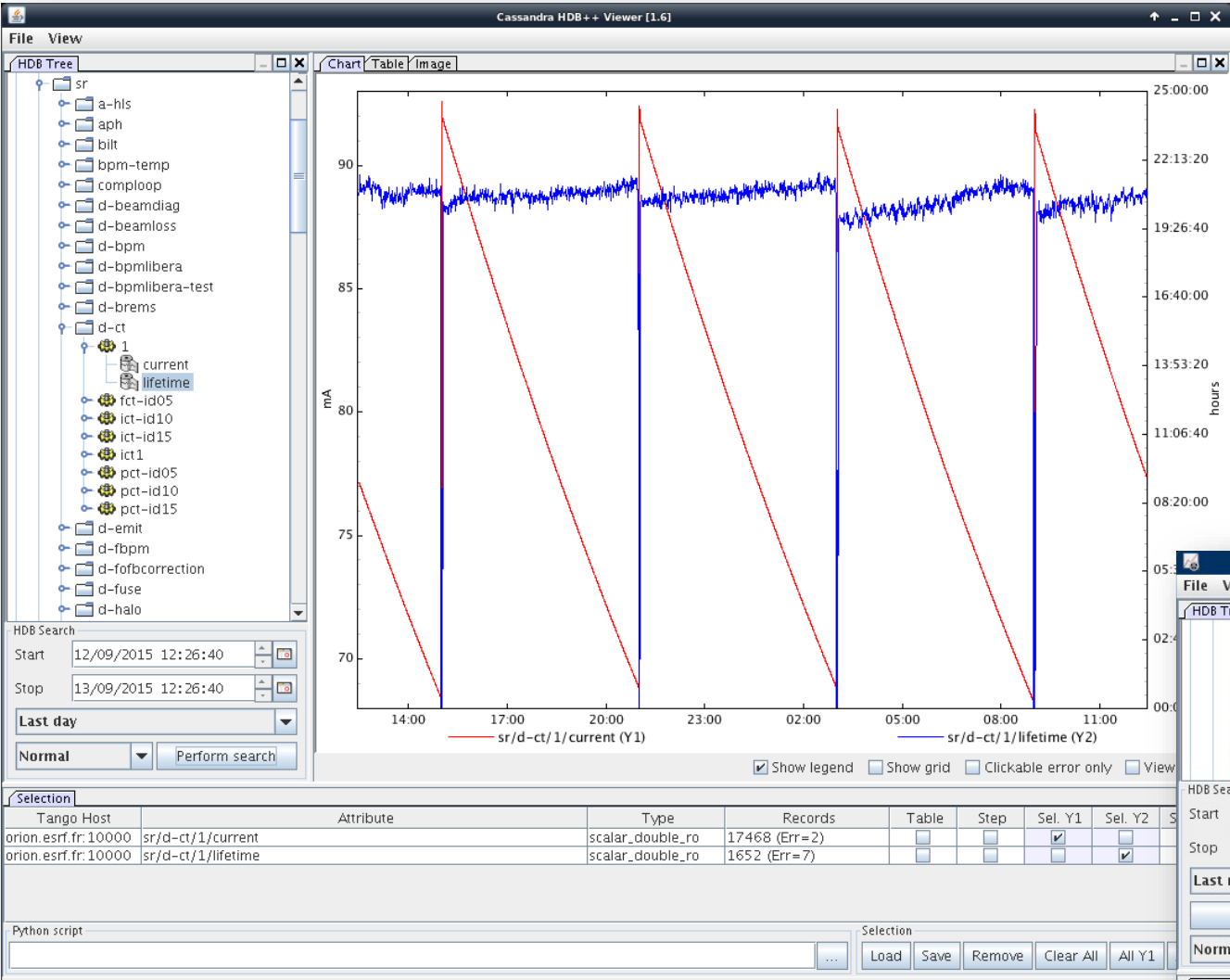
```
import pyhdbpp
rd = pyhdbpp.get_default_reader()
rd.get_attribute_values('sr/vc/01/pressure', '2023-06-03', '2023-06-04')
Out: ((1685782812.169, 1.4e-08, 0),
      (1685782842.011, 1.5e-08, 0), ...)
```

HDB++ Viewers – Taurus widgets

HDB++ Viewers - jhdbviewer



HDB++ Viewers - jhdbviewer

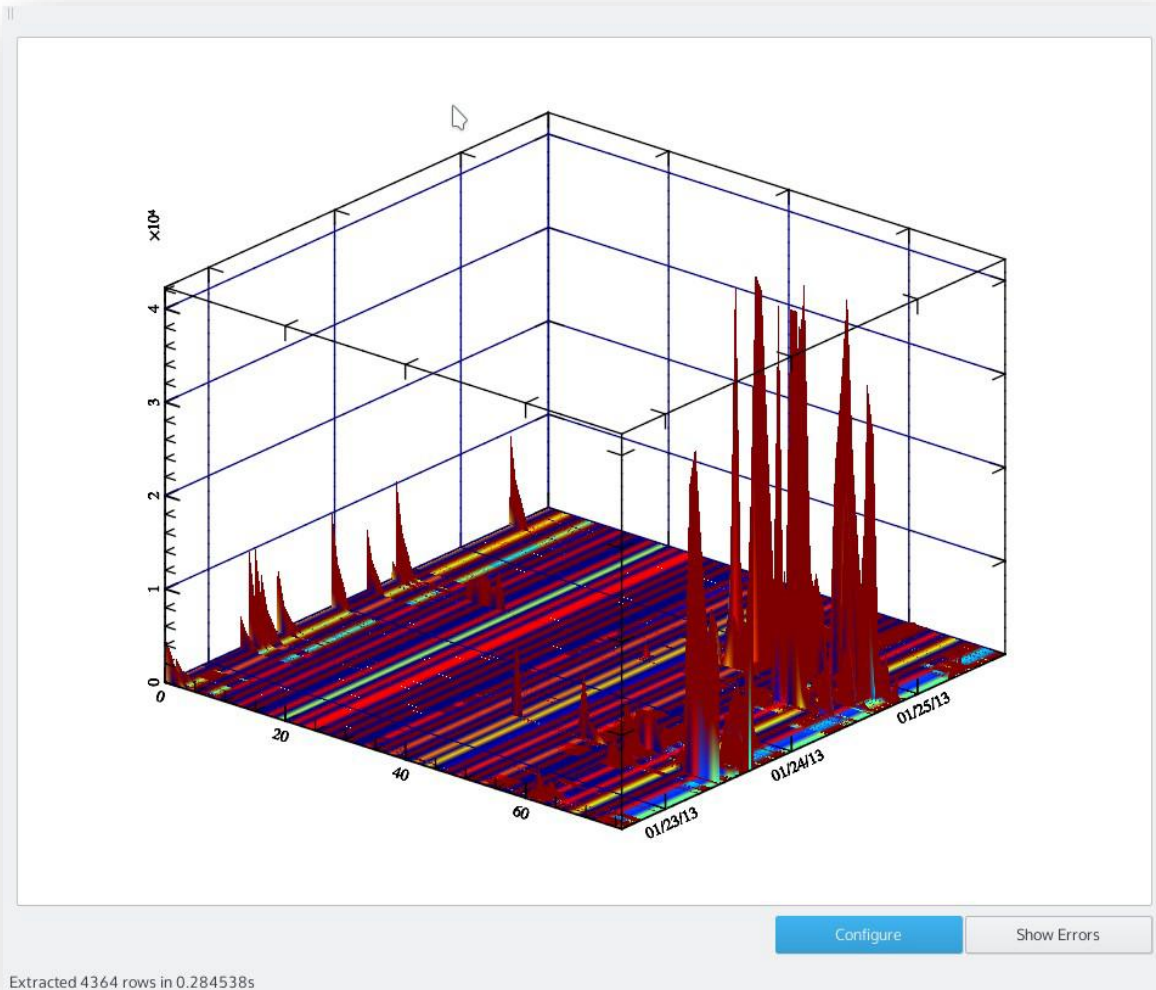


HDB++ Viewers – eGiga2m



- 1) Time period selection
- 2) Time series selection. Strikethrough means time series are not current. A tooltip shows the last date the archiving was active, if available.
- 3) Chart tooltip shows time series numerical value or error explanation
- 4) Legend. Click to hide/show the corresponding curve. A tooltip shows the number of samples and extraction time
- 5) Adjustable

HDBExtractor++ GUI



HDB++ Viewers – Archive Viewer (PostgreSQL)

Archive Viewer

Left sidebar tree view:

- ☒ tftp-server.liu20:10000
 - ☐ crate-02
 - ☐ crate-01
 - ☐ crate-03
 - ☐ crate-04
 - ☐ crate-102
 - ☐ crate-103
 - ☒ crate-101
 - ☒ adc4x250
 - ☐ 8c
 - ☐ 8e
 - ☒ 90
 - ☒ channela (r)
 - ☒ channelb (r)
 - ☒ channelc (r)
 - ☒ channeld (r)
 - ☒ 92
 - ☐ 94
 - ☐ 96
 - ☐ fastadc
 - ☐ crate-201
 - ☐ vme2
- ☐ 192.168.1.1:10000
 - ☐ hdbpp
 - ☐ es
 - ☐ pg1

Buttons: Reload, Start date: 2018.09.21 16:30:30, Stop date: 2018.09.21 18:30:30, Search

Plot area:

Table:

	Attribute	RW Type	Timestamp	Value	
1	tango://tftp-s...	Read	2018-09-21 ...	Array	☒
2	tango://tftp-s...	Read	2018-09-21 ...	Array	☒
3	tango://tftp-s...	Read	2018-09-21 ...	Array	☒

Buttons: Plot selected, Export selected, Select all for plotting, Select all for exporting

HDB++ Viewers – archviewer (web)



HDB++ Viewers – Grafana

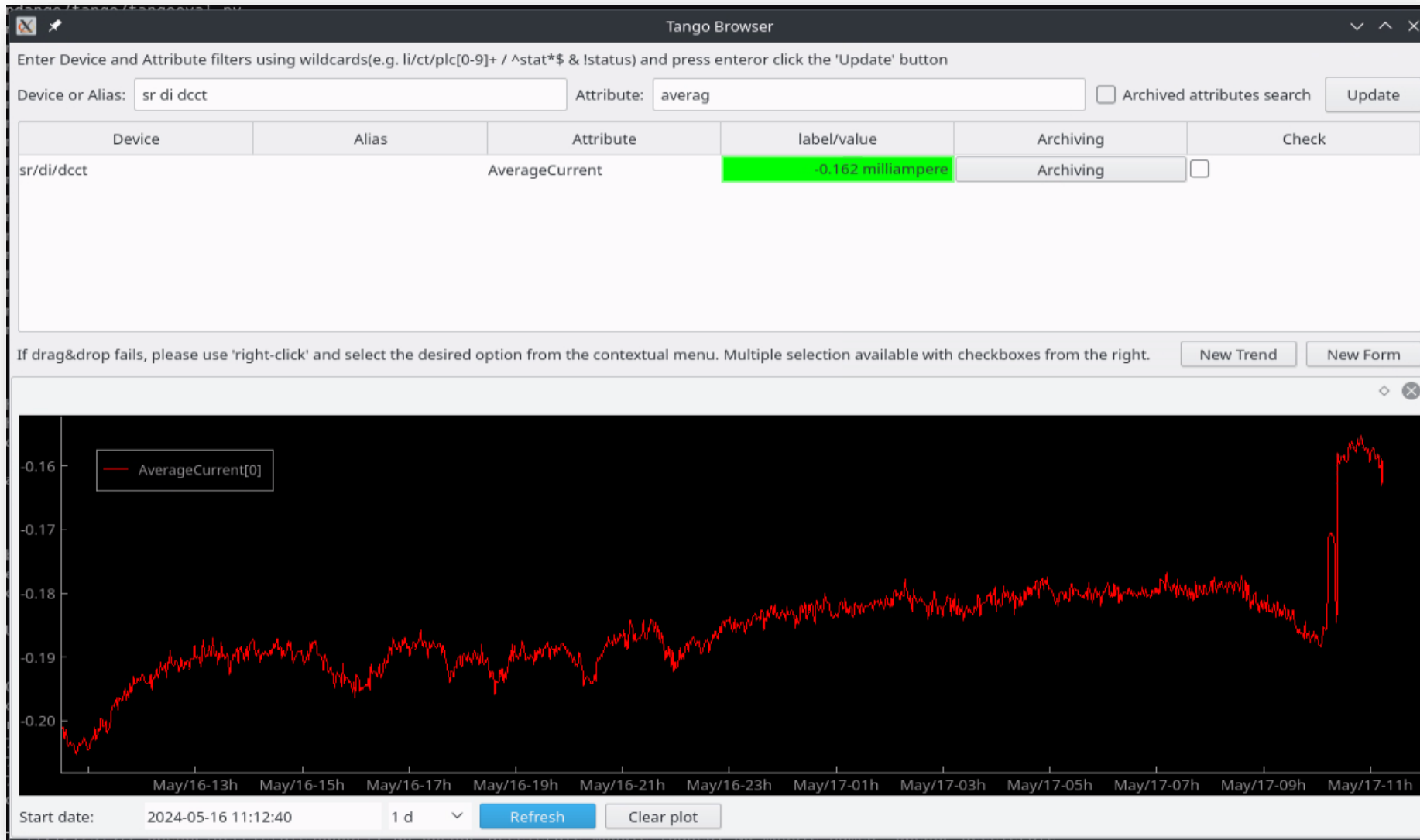


HDB++ Viewers – Grafana



➤ <https://gitlab.com/tango-controls/hdbpp/libhdbpp-grafana-connector>

HDB++ Viewers – Tango Browser



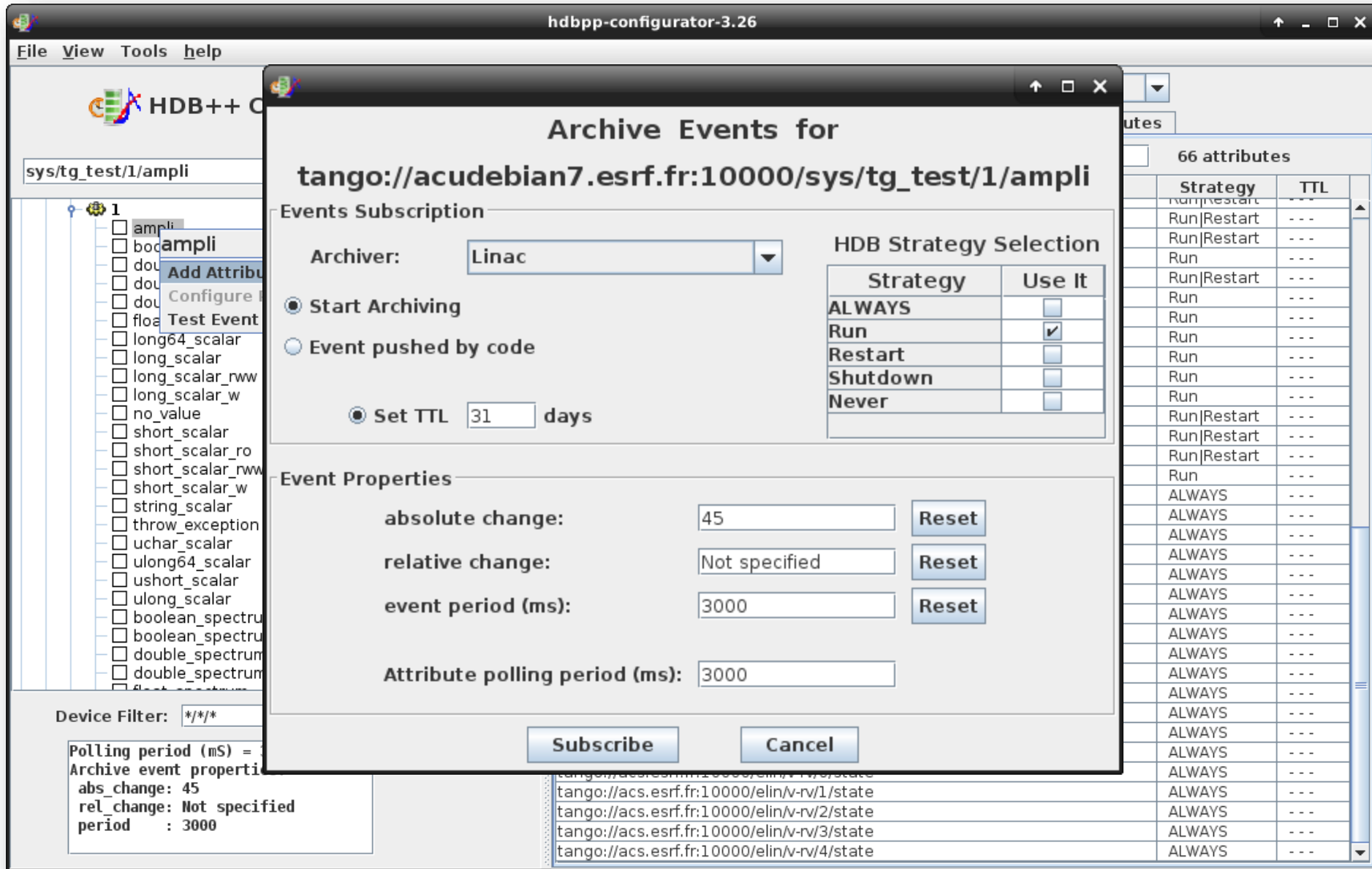
<https://gitlab.com/tango-controls/hdbpp/libhdbpp-tangobrowser>

HDB++ Configurator GUI

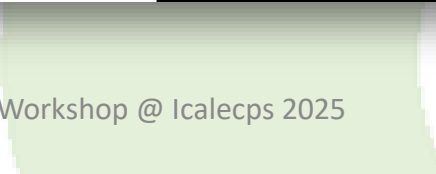
The screenshot shows the HDB++ Configurator GUI with the following components:

- Menu Bar:** File, View, Tools, help
- Header:** HDB++ Configurator
- Search Bar:** sys/tg_test/1/ampli
- Tree View:** A list of attributes under the path sys/tg_test/1/ampli. A context menu is open over the 'ampli' node with options: 'Add Attribute to Subscriber', 'Configure Polling Events', and 'Test Event'.
- Subscriber List:** 37 subscribers: Linac
- Attribute Status:** 66 Started Attributes, 0 Paused Attributes, 0 Stopped Attributes
- Filter:** tango:// */**/*
- Table:** A table with 66 attributes, showing columns for Attribute, Strategy, and TTL.
- Device Filter:** */**/*
- Polling period (mS):** 3000
- Archive event properties:** abs_change: 45, rel_change: Not specified, period: 3000

Attribute	Strategy	TTL
tango://acs.esrf.fr:10000/elin/mod1/run/peakpowerout	Run Restart	---
tango://acs.esrf.fr:10000/elin/mod2/aux/heat	Run Restart	---
tango://acs.esrf.fr:10000/elin/mod2/hv/highvoltage	Run Restart	---
tango://acs.esrf.fr:10000/elin/mod2/run/delay	Run	---
tango://acs.esrf.fr:10000/elin/mod2/run/peakpowerout	Run Restart	---
tango://acs.esrf.fr:10000/elin/rf/run/bunchphase	Run	---
tango://acs.esrf.fr:10000/elin/rf/run/delay	Run	---
tango://acs.esrf.fr:10000/elin/rf/run/frequency	Run	---
tango://acs.esrf.fr:10000/elin/rf/run/pbunchattenu	Run	---
tango://acs.esrf.fr:10000/elin/rf/run/pbunchphase	Run	---
tango://acs.esrf.fr:10000/elin/rf/run/sect2phase	Run	---
tango://acs.esrf.fr:10000/elin/steer/1/current	Run Restart	---
tango://acs.esrf.fr:10000/elin/steer/1/state	Run Restart	---
tango://acs.esrf.fr:10000/elin/steer/1/voltage	Run Restart	---
tango://acs.esrf.fr:10000/elin/t-rf/ccd/delay	Run	---
tango://acs.esrf.fr:10000/elin/v-ip/2/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/3/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/4/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/gun1/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/gun2/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/gun3/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/kly1/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/kly2/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-ip/kly3/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-pen/2/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-pen/3/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-pen/4/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-pen/gun1/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-pen/gun2/pressure	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-rv/0/state	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-rv/1/state	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-rv/2/state	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-rv/3/state	ALWAYS	---
tango://acs.esrf.fr:10000/elin/v-rv/4/state	ALWAYS	---



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HDB++ Diagnostics GUI

hdbpp-configurator-3.26-SNAPSHOT

File View help

HDB++ Diagnostics

	Faulty	Started	Paused	Stopped	Pending	ev/sec	Fail./sec	Context
"HDB++" statistics	0	150	0	0	0	26.00	0.00	Run
Booster	0	43	0	0	0	1.00	0.00 ev	Run
FE Pressures	2	555	0	0	0	6.00	2.00	Run
FrontEnds	0	153	0	0	0	0.00 ev	0.00 ev	Run
INFRA	7	209	0	0	0	2.00	0.00 ev	Run
Injection/Extraction	2	69	0	0	0	1.00	0.00 ev	Run
Insertion Devices 1	0	111	0	0	0	0.00	0.00	Run
Insertion Devices 2	0	119	0	0	0	0.00	0.00	Run
Linac	0	46	0	0	0	0.00	0.00	Run
Radio Frequency	0	449	0	0	0	12.00	0.00 ev	Run
SR Pressures	0	864	0	0	0	2.00	0.00 ev	Run
SR RGA 1	19	530	0	0	0	3.00	0.00 ev	Run
SR RGA 2	2	456	0	0	0	1.00	0.00 ev	Run
SR RGA 3	0	399	0	19	0	0.00	0.00 ev	Run
SR RGA 4	0	418	0	0	0	0.00	0.00 ev	Run
SR Vacuum	0	387	0	0	0	0.00	0.00 ev	Run
SR-BPM	0	30	0	0	0	12.00	0.00 ev	Run
SR-DIAG	0	598					0.00 ev	Run
SR-MAG	6	147					0.00	Run
SR1 PowerSupplies	0	535					0.00	Run
SR2 PowerSupplies	0	512					0.00	Run
SR3 PowerSupplies	0	512					0.00	Run
SR4 PowerSupplies	0	512					0.00	Run
SY PowerSupplies	0	246					0.00	Run
SY Pressures	0	101					0.00	Run
SY-DIAG	8	8	0				0.00 ev	Run
Safety	10	387	0				0.00	Run
TL1	4	27	0	0	0	0.00	0.00	Run
TL2	1	74	0	0	0	0.00	0.00	Run
Undulators	0	218	0	7	0	5.00	0.00 ev	Run
old tanqo	0	0	0	0	0	0.00 ev	0.00 ev	Run
	Faulty	Started	Paused	Stopped	Pending	ev/sec	Fail./sec	Context
E.S. Manager	61	8865	0	26	0	311.00	2.00	Run

Selection

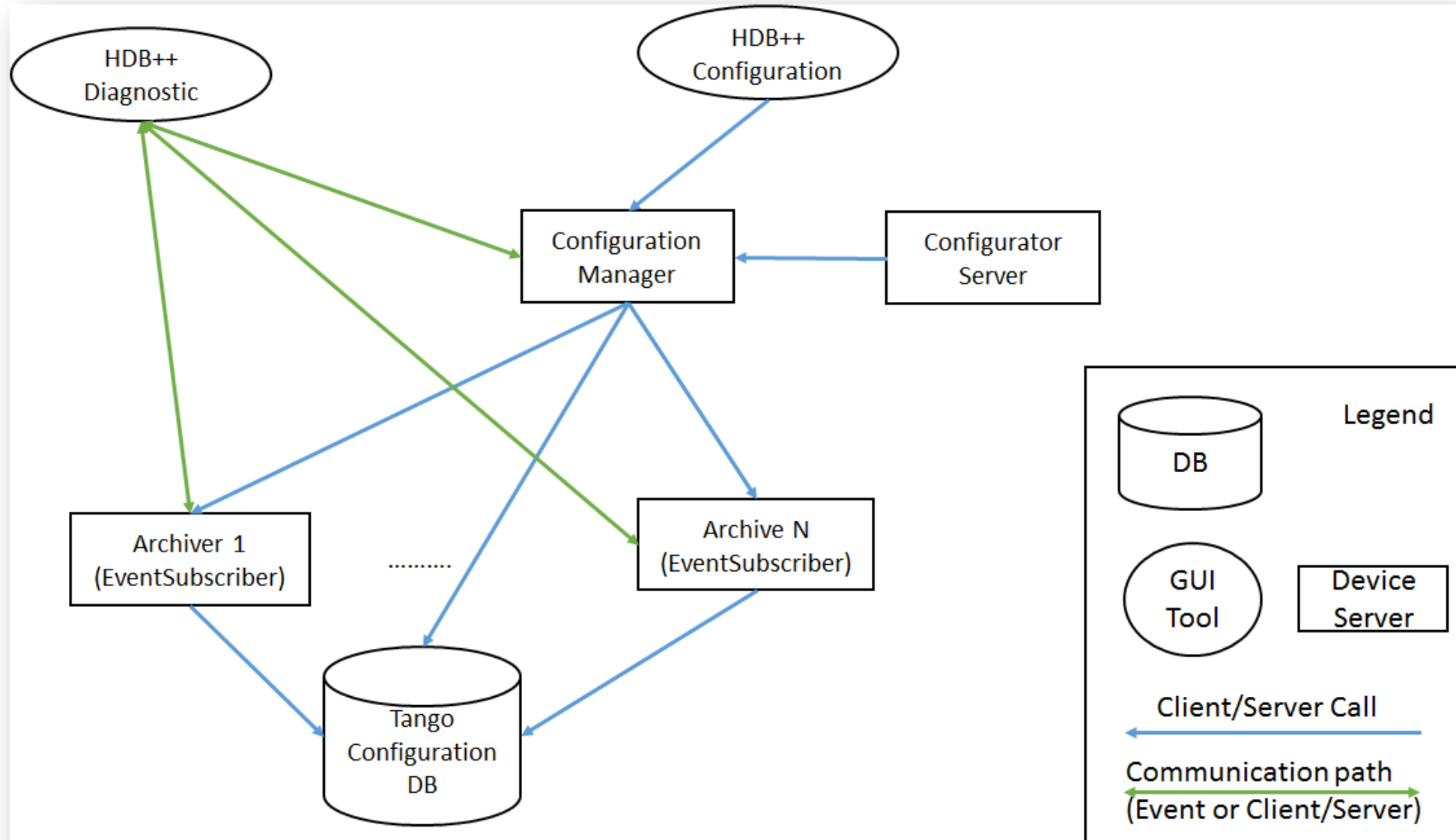
Context ?

- Run
- ALWAYS
- Run
- Restart
- Shutdown
- Never

HDB++ Diagnostics GUI

8247 Attributes distributed in 36 Subscribers						
5023814 events received during 17 h 16 mn 26 sec. -> average = 80.787 ev/sec.						
Attributes	Performances	Table				
Subscriber	Attributes	Nb Events	Max Store	Max Pending	Reset Time	Duration
"HDB++" statistics	78	1039314	2.45 sec	30	21 Sep 20:00:11	17 h 16 mn 26 sec.
Beam Position Monitors	294	364819	1.72 sec	250	21 Sep 20:00:11	17 h 16 mn 26 sec.
Booster 1	234	124002	1.34 sec	19	21 Sep 20:00:11	17 h 16 mn 26 sec.
D-RGA	62	360436	2.54 sec	15	21 Sep 20:00:11	17 h 16 mn 26 sec.
Experiments Gamma Monitors	43	44755	202.74 ms.	3	21 Sep 20:00:11	17 h 16 mn 26 sec.
FE Vacuum Pressures	375	10788	23.03 ms.	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
Fast BPM	4	68	1199.01 us	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
Front Ends	177	1108	22.31 ms.	3	21 Sep 20:00:11	17 h 16 mn 26 sec.
ID22	7	86940	39.42 ms.	20	21 Sep 20:00:11	17 h 16 mn 26 sec.
Injext	38	69510	1.74 sec	5	21 Sep 20:00:11	17 h 16 mn 26 sec.
Insertion Devices 1	94	12449	44.63 ms.	52	21 Sep 20:00:11	17 h 16 mn 26 sec.
Insertion Devices 2	115	34748	2.37 sec	59	21 Sep 20:00:11	17 h 16 mn 26 sec.
Insertion Devices Corrections	32	147	2.19 ms.	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
LINAC	121	4313	21.38 ms.	2	21 Sep 20:00:11	17 h 16 mn 26 sec.
Power Supplies	189	13220	21.49 ms.	21	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 1	368	94758	1.55 sec	6	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 2	305	59739	1.29 sec	2	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 3	364	66566	48.73 ms.	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 4	497	18024	30.61 ms.	2	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 5	303	43287	1.78 sec	4	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 6	488	55327	30.21 ms.	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 7	244	61964	43.51 ms.	2	21 Sep 20:00:11	17 h 16 mn 26 sec.
RGA 8	424	16619	23.10 ms.	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
Radiations	199	73135	1.80 sec	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR 1	82	471926	2.47 sec	16	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR 2	200	172602	2.00 sec	6	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR Correctors	94	2320	10.86 ms.	1	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR RF	443	1118458	2.30 sec	39	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR Steerers	201	7540	29.67 ms.	2	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR Vacuum 1	61	35996	540.20 ms.	3	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR Vacuum Pressures	741	54928	36.43 ms.	2	21 Sep 20:00:11	17 h 16 mn 26 sec.
SR Vacuum Temperatures	935	103975	37.43 ms.	58	21 Sep 20:00:11	17 h 16 mn 26 sec.
SY RF	107	254354	2.35 sec	8	21 Sep 20:00:11	17 h 16 mn 26 sec.
SYSTEM 1	215	41098	1.51 sec	48	21 Sep 20:00:11	17 h 16 mn 26 sec.
TL1/TL2	43	70633	317.32 ms.	3	21 Sep 20:00:11	17 h 16 mn 26 sec.
test labs	70	33948	1.49 sec	4	21 Sep 20:00:11	17 h 16 mn 26 sec.
Dismiss						

HDB++ Diagnostics GUI



yaml2archiving

- Script to ease the configuration of the HDB++ Archiving by using YAML format files in order to add/remove/update archived attributes.
- Each YAML file corresponds to one HdbEventSubscriber device and can include the state of the archived attributes with their settings.
- <https://gitlab.com/tango-controls/hdbpp/yaml2archiving>

yaml2archiving

```
db: "g-v-csdb-0.maxiv.lu.se:10000"
manager: hdb/config/1
archiver: AUX/KITS/ARCHIVER-01
configuration:
  TangoTest:
    attributes:
      short_scalar_ro:
        archive_period: 6000
        polling_period: 3000
        archive_strategy: SERVICE
      short_scalar:
        archive_period: 7000
        polling_period: 3000
        archive_rel_change: 5
```


yaml2archiving

```
$ yaml2archiving path/to/config.yaml
```

```
...
```

```
CHANGE tango://g-v-csdb-0.maxiv.lu.se:10000/sys/tg_test/3/short_scalar_ro  
  archive_strategy: ALWAYS -> SERVICE  
  polling_period: 2000 -> 3000
```

```
CHANGE tango://g-v-csdb-0.maxiv.lu.se:10000/sys/tg_test/4/short_scalar_ro  
  archive_strategy: ALWAYS -> SERVICE  
  polling_period: 2000 -> 3000
```

```
ADD tango://g-v-csdb-0.maxiv.lu.se:10000/sys/tg_test/1/short_scalar_ro  
  archive_strategy: SERVICE  
  archive_abs_change: Not specified  
  archive_rel_change: Not specified  
  archive_period: 6000  
  polling_period: 3000  
  archive_rel_change: 5
```

```
REMOVE tango://g-v-csdb-0.maxiv.lu.se:10000/sys/tg_test1/1/short_scalar_ro      ** Does not exist in the  
TangoDB (Cleanup Action)
```

```
REMOVE tango://g-v-csdb-0.maxiv.lu.se:10000/sys/tg_test1/1/short_scalar      ** Does not exist in the TangoDB  
(Cleanup Action)
```

```
...
```

```
=== No changes were made, try the '--write' option to apply. ===
```

archwizard

- simple web interface to the HDB++ archiving system for monitoring and troubleshooting, not maintenance such as adding and removing attributes.
- built using Python, FastAPI, Jinja2 and PyTango
- **Features**
 - Display archiving statistics and errors
 - Searching on attributes
 - Filtering on archivers, attribute name and status (NOK, stopped, etc)
 - Temporarily starting and stopping archiving of individual attributes
- <https://gitlab.com/tango-controls/hdbpp/archwizard>

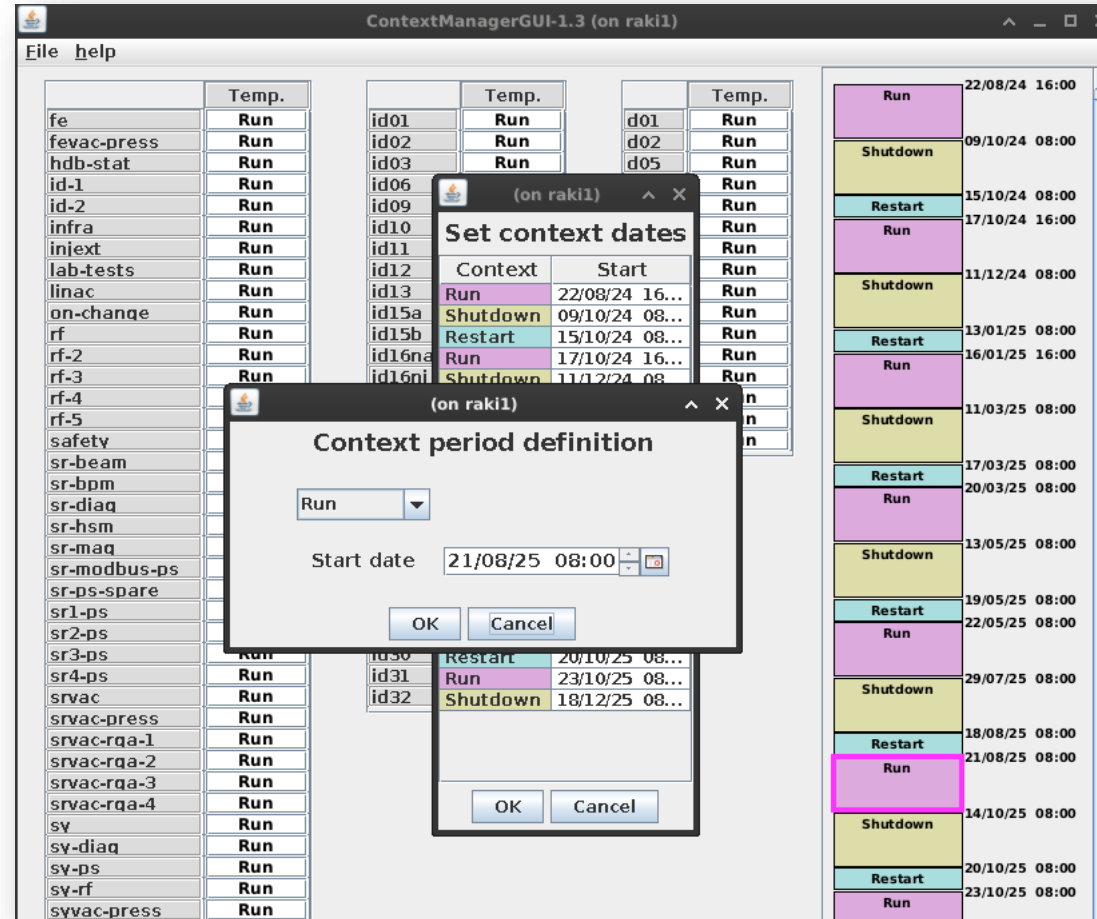
HDBContextManager (GUI & Device Server)

The screenshot shows the HDBContextManager GUI with the following components:

- Main Window:** ContextManagerGUI-1.3 (on raki1). It contains a menu bar (File, help) and a list of contexts with their status (Run).
- Contexts List:** A table with columns for context name and status. The status is 'Run' for all listed contexts.
- Set context dates Dialog:** A dialog titled 'Set context dates' with a table of context dates.
- Context period definition Dialog:** A dialog titled 'Context period definition' with a dropdown menu set to 'Run' and a 'Start date' field set to '21/08/25 08:00'.

Context	Start
Run	22/08/24 16:00
Shutdown	09/10/24 08:00
Restart	15/10/24 08:00
Run	17/10/24 16:00
Shutdown	11/12/24 08:00
Restart	13/01/25 08:00
Run	16/01/25 16:00
Shutdown	11/03/25 08:00
Restart	17/03/25 08:00
Run	20/03/25 08:00
Shutdown	13/05/25 08:00
Restart	19/05/25 08:00
Run	22/05/25 08:00
Shutdown	29/07/25 08:00
Restart	18/08/25 08:00
Run	21/08/25 08:00
Shutdown	14/10/25 08:00
Restart	20/10/25 08:00
Run	23/10/25 08:00

HDBContextManager (GUI & Device Server)



- <https://gitlab.com/tango-controls/hdbpp/ContextManager>
- <https://gitlab.com/tango-controls/hdbpp/ContextManagerGUI>

HDB++ Backends comparison

DB Backend	Pros	Cons
	Good for small DB ProxySQL can be used to redirect queries to master slave or other MySQL/MariaDB DBs Legacy DB schema compatible with old TANGO HDB tools	Not optimized for arrays Bad performance if DB is too big
	High Availability for write datacenter Cassandra HDB++ backend could be used in theory with ScyllaDB	Not good with arrays Big queries could bring down several nodes because of Java Garbage Collector
	Native support for arrays, so good performance of queries involving arrays Ability to query individual elements of an array	Bad performance if DB is too big
	Same as PostgreSQL + optimized for time series, scalable, automatic hypertables creation, extended API for time series, automatic continuous aggregation, gap filling	Chunk level data reordering operation MUST be run regularly to guarantee good query performance
 elasticsearch	Advantages of ELK stack (Kibana viewers,...) Flexible schema	Requires a lot of memory No security

* Cassandra and elasticsearch HDB++ backends are no longer actively maintained

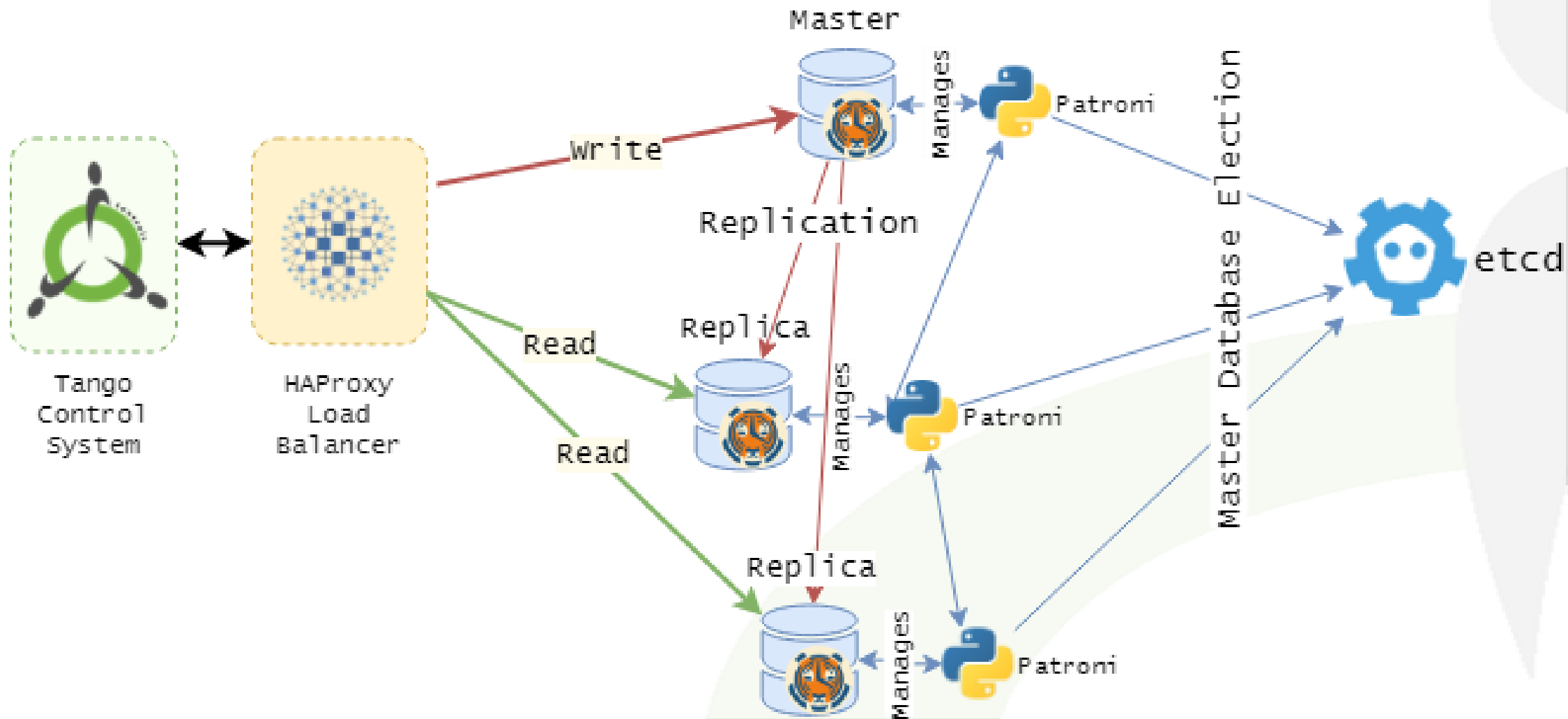
TimescaleDB

TimescaleDB is a [Postgres extension](#) for time series and demanding workloads that ingest and query high volumes of data.

Timescale installation:

➤ <https://docs.tigerdata.com/self-hosted/latest/install>

HDB++ Timescale Deployment @ ESRF



Using barman for the backups

Useful links

<https://gitlab.com/tango-controls/hdbpp>

<https://tango-controls.readthedocs.io/en/latest/tools-and-extensions/archiving/HDB++.html>

<https://gitlab.com/tango-controls/hdbpp/hdbpp-tickets>

<https://forum.tango-controls.org>

[hdbpp channel on Mattermost tango-controls](#)

Thank you

Many thanks to all the HDB++ contributors!

Feel free to join us at our regular HDB++ Meetings (1 Zoom meeting every 1 to 2 months)

You can also subscribe to the hdbpp mailing list

➔ <https://lists.tango-controls.org/wws/info/hdbpp>