



HDB++

Tango Historical Database

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On behalf of the HDB++ collaboration

- **Written in C++**
- **Event-driven:** exploit the TANGO publish/subscribe mechanism
- Architecture based on:
 - One or more archivers (EventSubscriber TANGO ds)
 - Configuration management (ConfigurationManager TANGO ds)
 - Libraries for data insertion and extraction (C++ and Java)
 - Data extraction: TANGO ds / clients
- **Fast**
 - One database for slow and fast archiving (up to 1000 samples/s, possibly more)
 - Now ~100.000 samples/s sustained
- **Flexible**
 - Easy to manage and maintain even without GUI front-ends
- **Self contained**
 - Single source for all configuration parameters (TANGO database)
- **Modular**
 - Abstraction+implementation libraries to support different database engines and schema
 - Support for **hdb++ new schema** with improved features (μ s timestamp)
 - Support for **noSQL** back-end
 - Support for **TimescaleDB** back-end
 - Easily extensible to additional database/schema
- **Scalable:** same as TANGO, deploy as many DS as needed
- **GUI:** for HDB++ configuration and data extraction as well

Archive event

- TANGO provides specific event for archiving purposes
- The **archive** event can be sent:
 - on value change → specify absolute or relative threshold
 - periodically → specify period
- 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...)

The EventSubscriber TANGO device server is the core of the HDB++ archiving system:

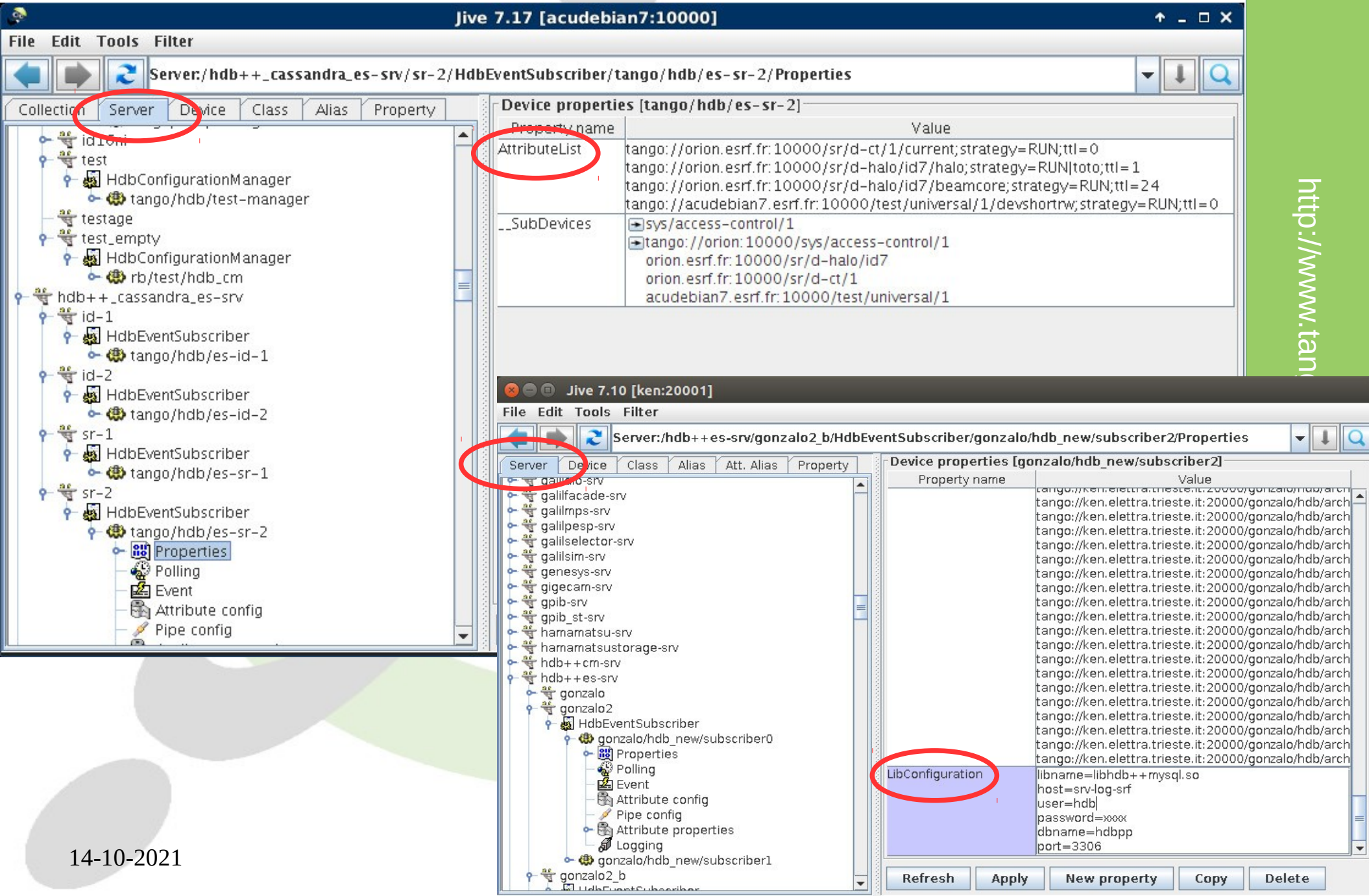
- Event based; TANGO provides **archive events** on change and periodic basis
- Configuration stored in the TANGO database (device)
- One thread in charge of event(s) subscription and callback execution: fills a FIFO acting as producer
- One thread in charge of pushing data into the database; reads the FIFO as consumer

Moreover the EventSubscriber:

- provides methods to perform the following per-instance operations:
 - **add/remove** an Attribute to/from archiving
 - **start/stop** the archiving for all Attributes
 - start/stop the archiving for one Attribute
 - read the status of an Attribute
 - read the number/list of Attributes currently archived (started)
 - read the number/list of Attributes currently not archived (stopped)
 - read the number/list of Attributes in charge
 - read the configuration parameters of each Attribute
 - read the number/list of working Attributes
 - read the number/list of faulty Attributes with diagnostics
 - read the number/list of Attributes pending in the FIFO
 - manage context
 - manage time-to-live

- exposes some **additional figures**:
 - **for each instance**, total number of records per time
 - for each instance, total number of failures per time
 - **for each attribute**, number of records per time
 - for each attribute, number of failures per time
 - for each attribute, time stamp of last record
 - for each attribute, min and max processing and storing times

EventSubscriber device configuration



The image shows two screenshots of the Jive configuration tool. The top screenshot is from Jive 7.17, and the bottom is from Jive 7.10. Both show the configuration of an EventSubscriber device.

Jive 7.17 [acudebian7:10000]
 Server: /hdb+_+_cassandra_es-srv/sr-2/HdbEventSubscriber/tango/hdb/es-sr-2/Properties

Navigation tabs: Collection, **Server**, Device, Class, Alias, Property.

Device properties [tango/hdb/es-sr-2]

Property name	Value
AttributeList	tango://orion.esrf.fr:10000/sr/d-ct/1/current;strategy=RUN;ttl=0 tango://orion.esrf.fr:10000/sr/d-halo/id7/halo;strategy=RUN toto;ttl=1 tango://orion.esrf.fr:10000/sr/d-halo/id7/beamcore;strategy=RUN;ttl=24 tango://acudebian7.esrf.fr:10000/test/universal/1/devshortrw;strategy=RUN;ttl=0
__SubDevices	sys/access-control/1 tango://orion:10000/sys/access-control/1 orion.esrf.fr:10000/sr/d-halo/id7 orion.esrf.fr:10000/sr/d-ct/1 acudebian7.esrf.fr:10000/test/universal/1

Jive 7.10 [ken:20001]
 Server: /hdb+_+_es-srv/gonzalo2_b/HdbEventSubscriber/gonzalo/hdb_new/subscriber2/Properties

Navigation tabs: Server, **Device**, Class, Alias, Att. Alias, Property.

Device properties [gonzalo/hdb_new/subscriber2]

Property name	Value
LibConfiguration	libname=libhdb+_+_mysql.so host=srv-log-srf user=hdbj password=xxx dbname=hdbpp port=3306

EventSubscriber Class configuration

Jive 7.17 [acudebian7:10000]

File Edit Tools Filter

Class:/HdbEventSubscriber/Properties

Collection Server Device **Class** Alias Property

Group3Dtm141
HakaPoC
HarmAnalysis
HdbAccess
HdbArchiver
HdbArchivingWatcher
HdbConfigServer
HdbConfigurationManager
 Properties
 Attribute properties
 Devices
HdbConfiguratorServer
HdbEventHandler
HdbEventSubscriber
 Properties
 Attribute properties
 Devices
HdbExtractor
HdbLogger
HdbManagerSimu
HdbRecordCounter
HdbSigArchiveSurvey
HdbUtilities
HlsCaptor

Class properties [HdbEventSubscriber]

Property name	Value
ContextsList	ALWAYS: Store in HDB++ under any circumstances SHUTDOWN: Store in HDB++ in SHUTDOWN period RUN: Store in HDB++ in RUN period toto: tsoin tsoin
cvs_location	/home/cvsadm/cvsroot/fermi/servers/hdb++/hdb++es/src/
DbHost	cassandra2
DbName	hdbtest
DefaultStrategy	RUN
Description	This class is able to subscribe on archive events and store value in Historical DB
doc_url	http://www.esrf.eu/computing/cs/tango/tango_doc/ds_doc/
InheritedFrom	TANGO_BASE_CLASS
LibConfiguration	keyspace=hdbtest contact_points=cassandra2 user=hdbwriter password=MyPass libname=libhdb++cassandra.so logging_enabled=true
PollingThreadPeriod	1
ProjectTitle	Tango Device Server
StartArchivingAtStartup	false
StatisticsTimeWindow	1
SubscribeRetryPeriod	10

Refresh Apply New property Copy Delete

The ConfigurationManager TANGO device server simplifies HDB++ archiving system management:

- **handle** the request of archiving a new Attribute
 - setup the Attribute archive event configuration
 - assign the Attribute to one of the archivers
- **move** an Attribute from one archiver to another
- keep trace of which Attribute is assigned to which archiver
- **start/stop** the archiving
- **remove** an Attribute from archiving
- manage EventSubscriber context
- manage Attribute time-to-live

The Configuration manager exposes some **global statistics**:

- total number of Archivers
- total number of working/faulty attributes
- total number of events per second
- overall minimum and maximum processing and storing time



ConfigurationManager Device/Class configuration

jive 7.21 [srv-tango-srf-01:20000]

File Edit Tools Filter

Server: /hdb++ cm-srv/global/HdbConfigurationManager/archiving/hdb++ manager/global/Properties

Server Device Class Alias Att. Alias Property

diagnostics
fermi
global
HdbConfigurationManager
archiving/hdb++ manager/global
Properties
Polling
Event
Attribute config
Pipe config
Attribute properties
Logging

Device properties [archiving/hdb++ manager/global]

Property name	Value
ArchiverList	tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/alarm tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/blm tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/climate tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/mod tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/mps tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/pdu tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/procfs tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/radfet tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/stat tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/tertiary tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/ps tango://srv-tango-srf-01.fcs.elettra.trieste.it:20000/archiving/hdb++ archiver/vacuum-si

jive 7.21 [srv-tango-srf-01:20000]

File Edit Tools Filter

Class: HdbConfigurationManager/Properties

Server Device Class Alias Att. Alias Property

genesys
GigeCam
Gpib
HdbConfigurationManager
Properties
Attribute properties
Devices
HdbEventSubscriber
Hp34401a
HV
Ifcd
Im540
ImgProc
IniSolenoid

Class properties [HdbConfigurationManager]

Property name	Value
Description	
InheritedFrom	TANGO_BASE_CLASS
LibConfiguration	libname=libhdb++ mysql.so.6 host=srv-db-srf-01.fcs.elettra.trieste.it user=hdbpprw password= dbname=hdbpp port=3306
MaxSearchSize	1000
ProjectTitle	Hdb++ configuration manager

controls.org

A C++ API decouples the archiving engine (EventSubscriber) from the database back-end

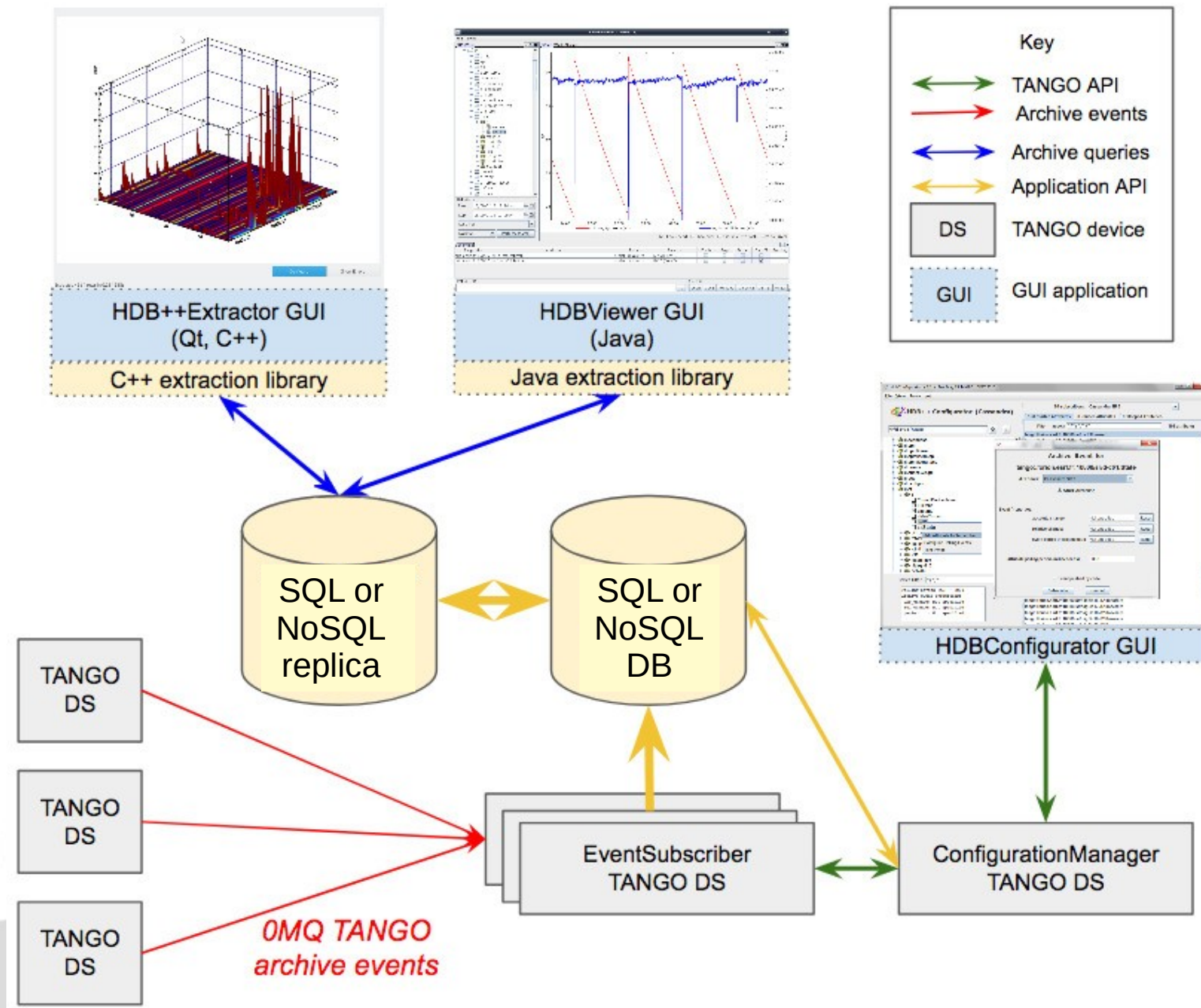
- **libhdb++** : database abstraction layer
- **libhdb++mysql** : implementation, HDB++ schema support, MySQL back-end
- **libhdb++cassandra** : implementation, HDB++ schema support, Cassandra back-end
- **libhdb++timescale** : implementation, HDB++ schema support, Timescale back-end
- **libhdb++postgres** : implementation, HDB++ schema support, Postgres back-end
- **libhdb++elk** : implementation, HDB++ schema support, ELK back-end
- **libhdbmysql** : implementation, legacy HDB schema support, MySQL back-end

The libraries allow reusing the EventSubscriber, the ConfigurationManager and the GUIs without changes

HDB++ is easily extendable to support additional back-ends(*) just writing the specific implementation library

(*) not limited to database engines... HDF5 format on file?

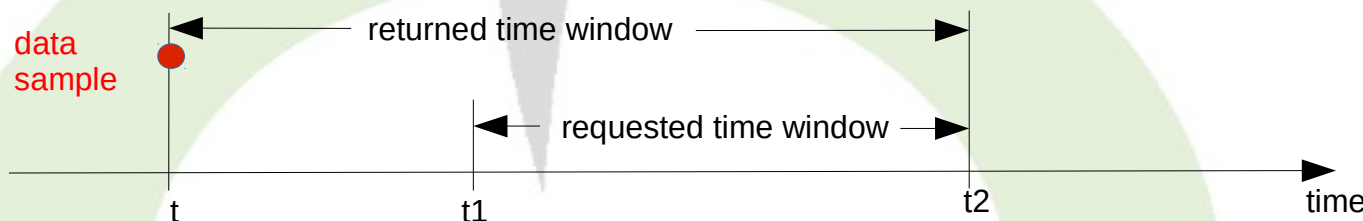
HDB++ in one picture



C++, Java and Python native extraction libraries

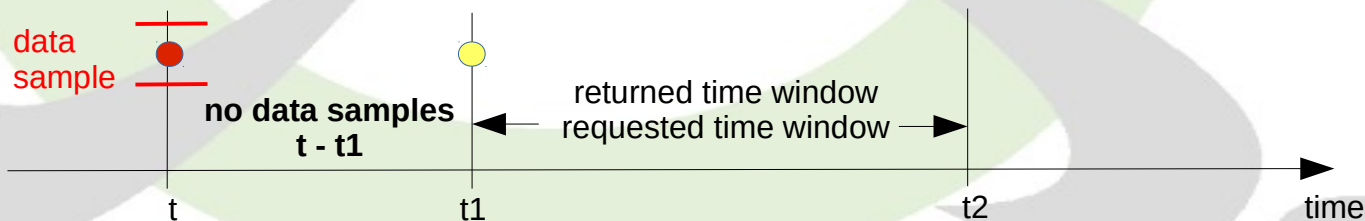
The data extraction library shall be able to **deal with event based archiving, i.e. data value change with respect to specified thresholds**; the possible lack of data in the requested time window shall be properly managed:

- returning some no-data-available error: in this case the reply contains no data
- enlarging the time window to include some archived data; no fake samples introduced



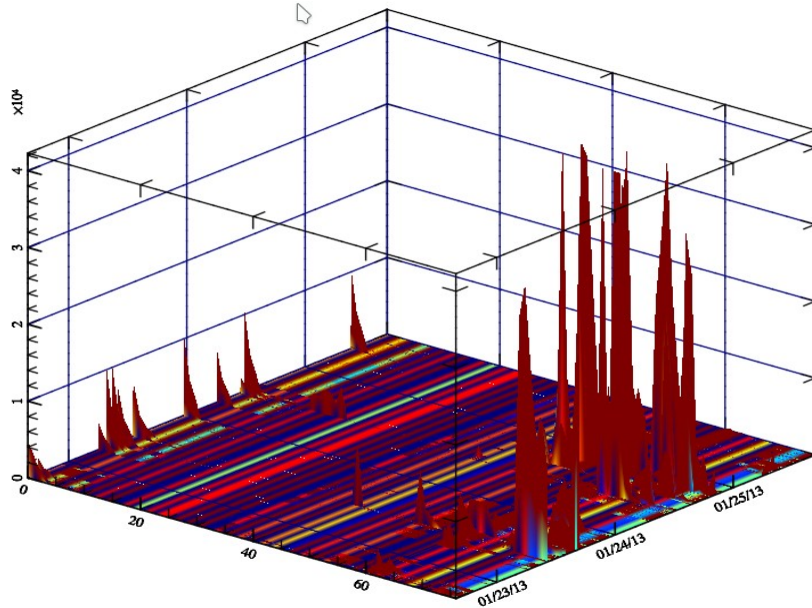
- returning the value of the last archived data anyhow; the requested time interval is kept and the last available data sample returned; the data value is guaranteed when **archiving on change**, care must be taken in case of **periodic archiving**

archive change event thresholds



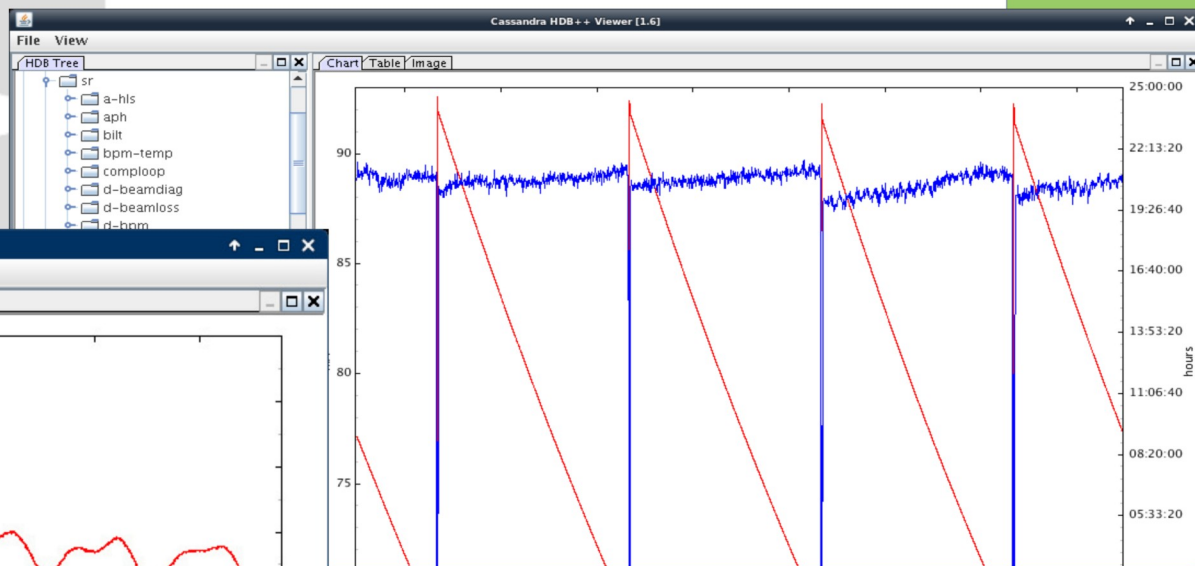
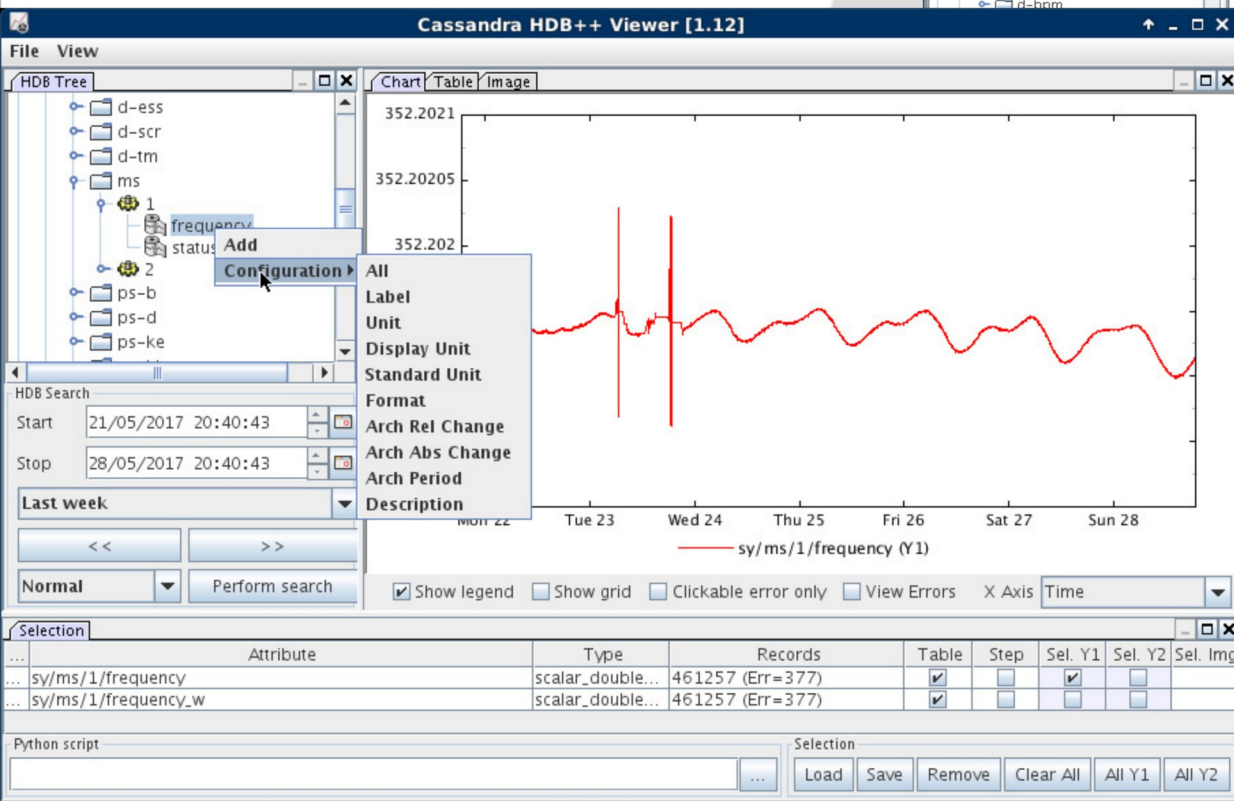
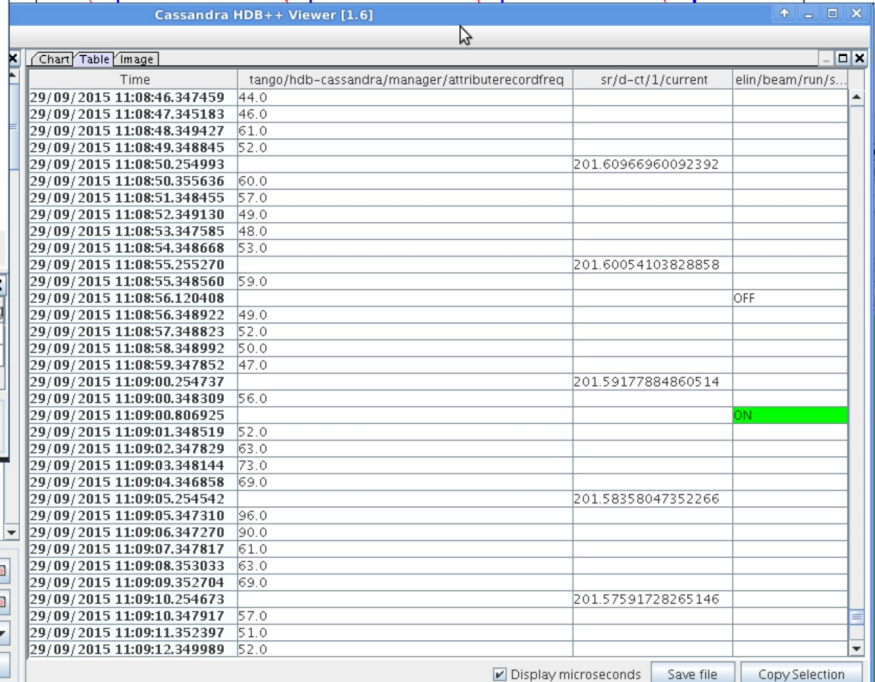
N.B. not available for all back-ends/extraction libraries

- Qt based GUI using the MathGL framework for plotting
- Exploits the C++ extraction library
- Supports multiline and surface plots



Configure Show Errors

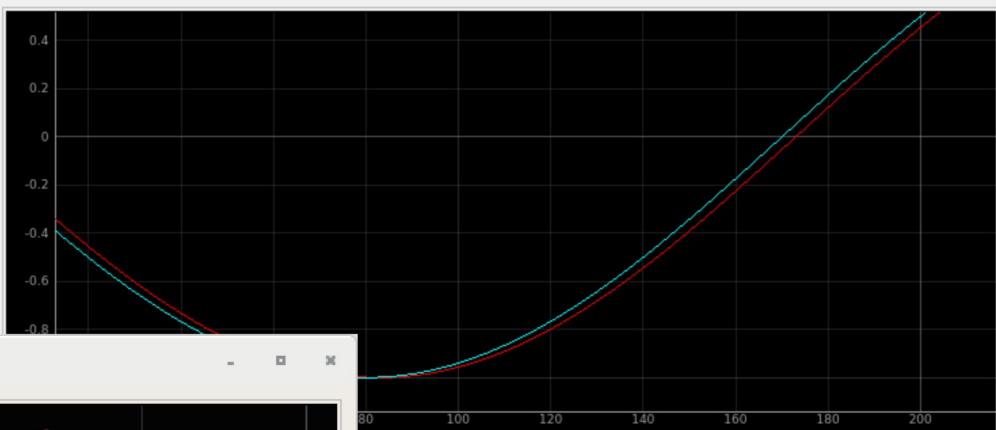
- Java based GUI for plotting
- Exploits the Java extraction library
- Table and multiline plots

Cassandra HDB++ Viewer [1.6] interface showing a table view of data. The table has columns for Time, Attribute, Type, Records, Table, Step, Sel. Y1, Sel. Y2, and Sel. Img. The data is sorted by Time, showing records from 29/09/2015 11:08:46.347459 to 29/09/2015 11:09:12.349989. The Attribute column shows values like 'tango/hdb-cassandra/manager/attributerecordfreq' and 'sr/d-ct/1/current'. The Type column shows values like 'scalar_double_ro' and 'scalar_state_ro'. The Records column shows values like 44.0, 46.0, 61.0, 52.0, 60.0, 57.0, 49.0, 48.0, 53.0, 59.0, 49.0, 52.0, 50.0, 47.0, 56.0, 63.0, 73.0, 69.0, 96.0, 90.0, 61.0, 63.0, 69.0, 57.0, 51.0, and 52.0. The Table column shows values like '201.60966960092392', '201.60054103828858', and '201.59177884860514'. The Step column shows values like 'OFF' and 'ON'. The Sel. Y1 and Sel. Y2 columns show values like '44.0', '46.0', '61.0', '52.0', '60.0', '57.0', '49.0', '48.0', '53.0', '59.0', '49.0', '52.0', '50.0', '47.0', '56.0', '63.0', '73.0', '69.0', '96.0', '90.0', '61.0', '63.0', '69.0', '57.0', '51.0', and '52.0'. The Sel. Img column shows values like 'OFF' and 'ON'.

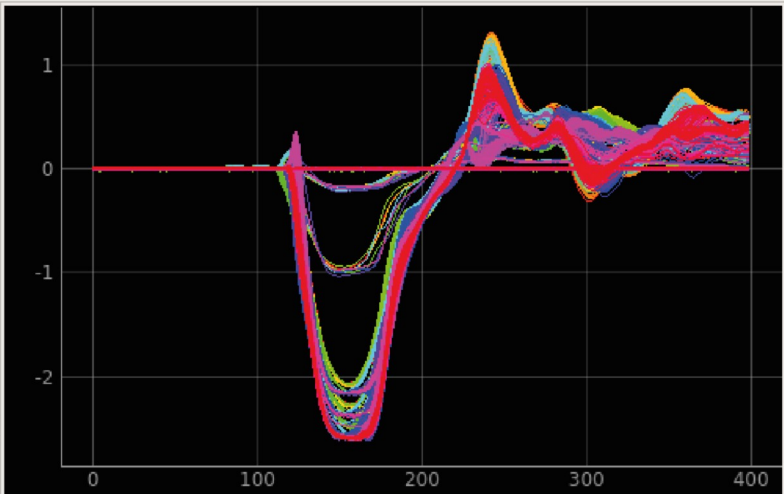
MainWindow

- ubuntu:10000
 - my
 - sys
 - tg_test
 - 1
 - float_scalar (r)
 - float_scalar (w)
 - double_scalar (r)
 - double_scalar (w)
 - string_scalar (r)
 - string_scalar (w)
 - long_spectrum_ro (r)
 - boolean_scalar (r)
 - boolean_scalar (w)
 - short_scalar (r)
 - short_scalar (w)
 - long64_scalar (r)
 - long64_scalar (w)
 - uchar_scalar (r)
 - uchar_scalar (w)
 - ushort_scalar (r)
 - ushort_scalar (w)
 - ulong_scalar (r)



Archive Viewer

- 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



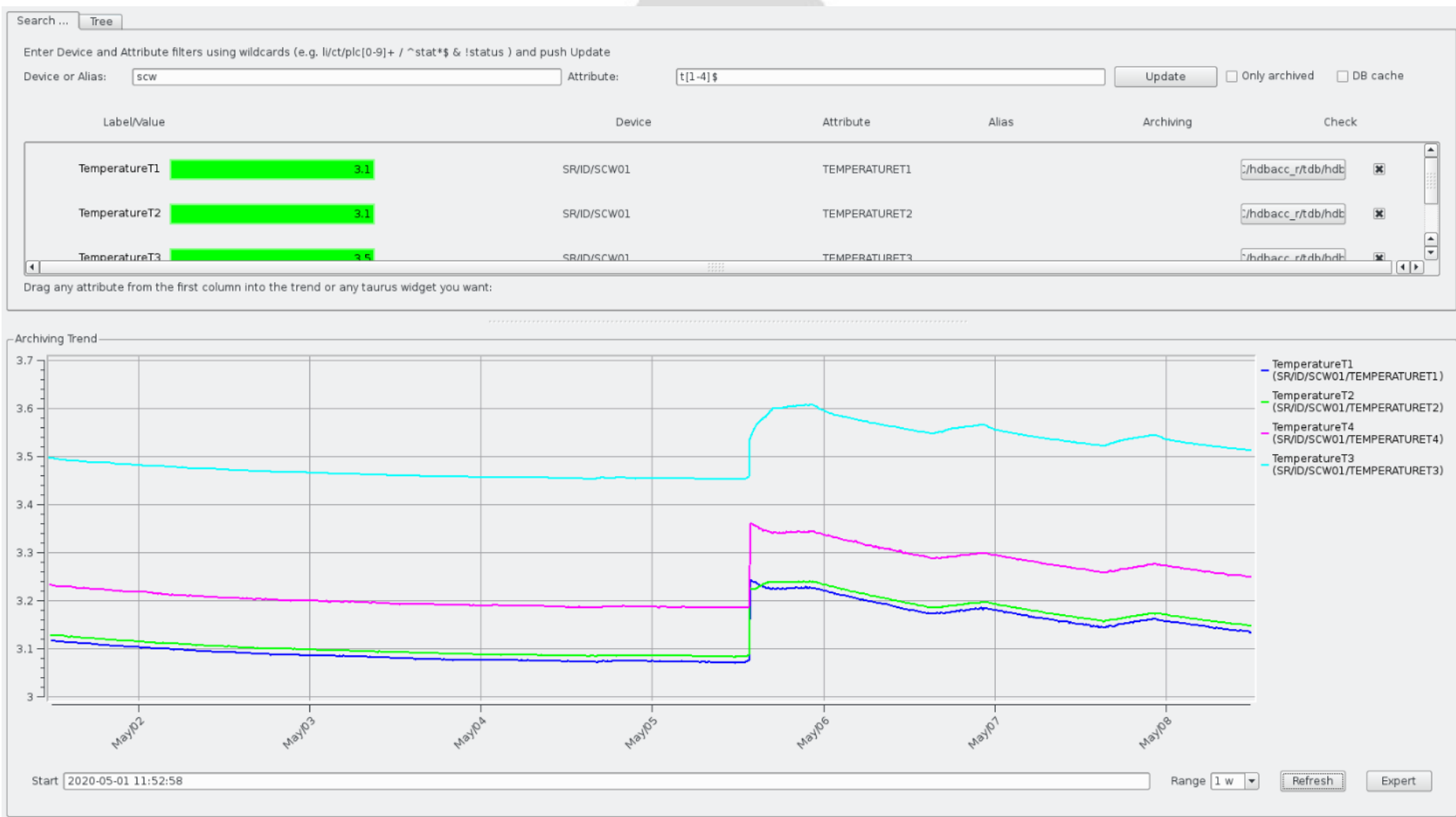
Attribute	RW Type	Timestamp	Value	
1	tango://tftp-s...	Read	2018-09-21 ...	Array <input checked="" type="checkbox"/>
2	tango://tftp-s...	Read	2018-09-21 ...	Array <input checked="" type="checkbox"/>
3	tango://tftp-s...	Read	2018-09-21 ...	Array <input checked="" type="checkbox"/>

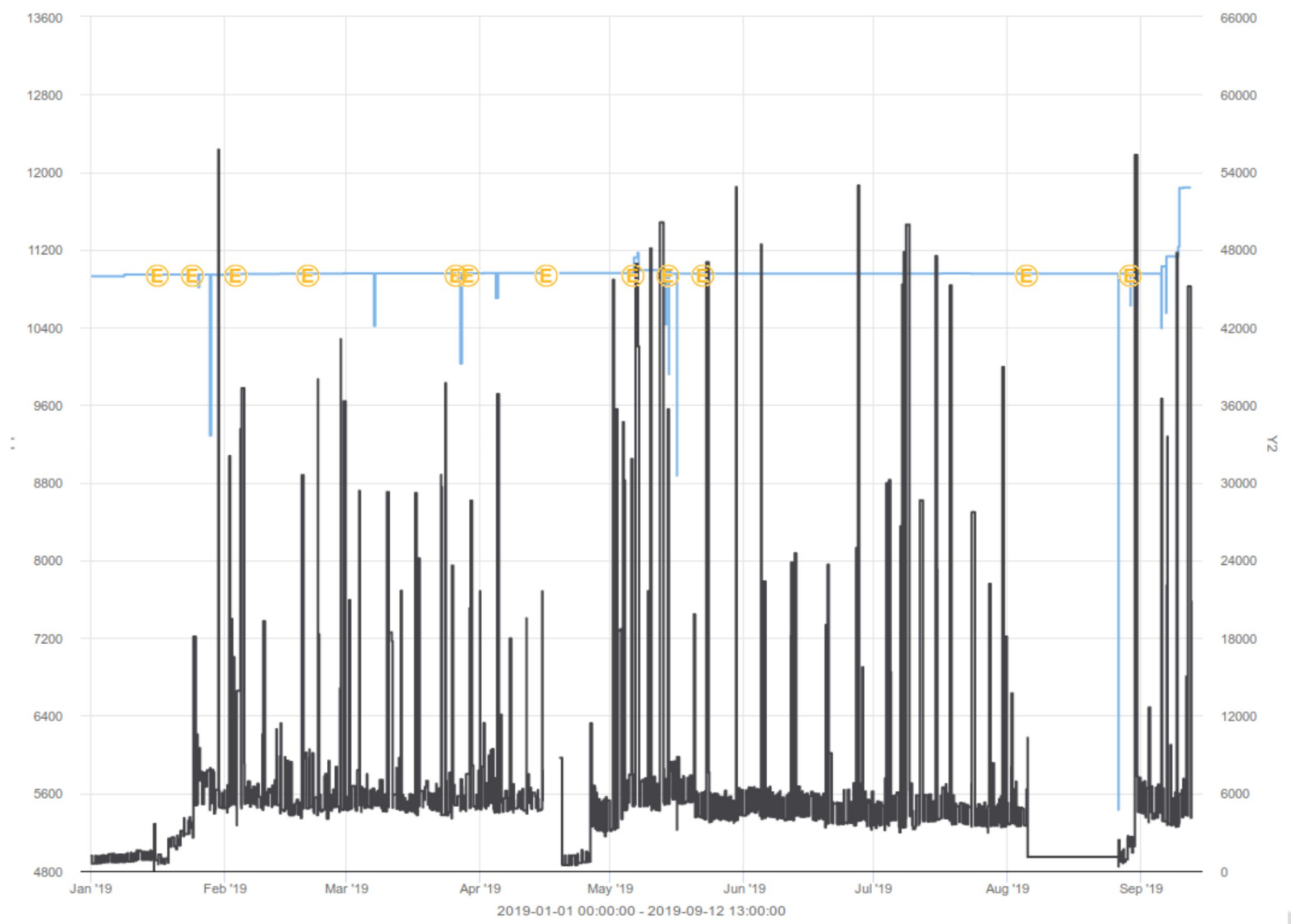
Plot selected

Export selected

Select all for plotting

Select all for exporting



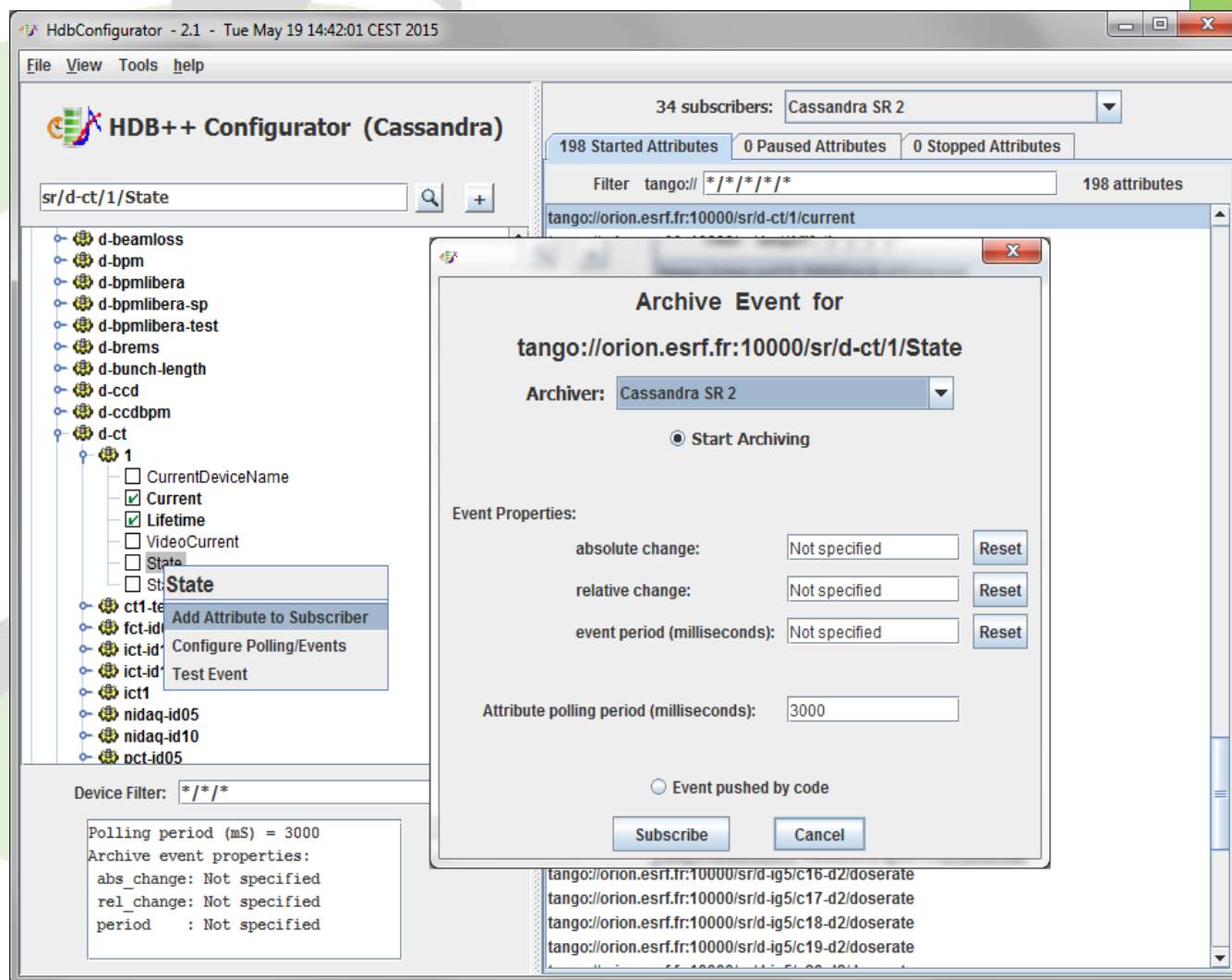


◆ Y1 [FERMI] archiving/hdb++manager/global/attributenummer
 ◆ Y2 [FERMI] archiving/hdb++manager/global/attributerecordfreq

ⓔ Errors

HdbConfigurator: a graphical user interface for the ConfigurationManager device

- Jive-like device tree
- Selected Attribute archive event parameters bottom left
- Started, stopped, paused attribute lists
- Pop-up to select archiver and parameters



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	20.00	0.00	Run
Booster	0	43	0	0	0	3.00	0.00 ev,	Run
FE Pressures	0	555	0	0	0	2.00	0.00	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	1	46	0	0	0	0.00	1.00	Run
Radio Frequency	0	140	0	0	0	6.00	0.00 ev,	Run
SR Pressures	0	140	0	0	0	10.00	0.00 ev,	Run
SR RGA 1	19	140	0	0	0	0.00	0.00 ev,	Run
SR RGA 2	0	140	0	0	0	0.00	0.00 ev,	Run
SR RGA 3	0	140	0	0	0	0.00	0.00 ev,	Run
SR RGA 4	0	140	0	0	0	0.00	0.00 ev,	Run
SR Vacuum	0	140	0	0	0	0.00	0.00 ev,	Run
SR-BPM	0	140	0	0	0	12.00	0.00 ev,	Run
SR-DIAG	0	140	0	0	0	26.00	0.00 ev,	Run
SR-MAG	6	147	0	0	0	61.00	0.00	Run
SR1 PowerSupplies	0	535	0	0	0	39.00	0.00	Run
SR2 PowerSupplies	0	512	0	0	0	33.00	0.00	Run
SR3 PowerSupplies	0	512	0	0	0	42.00	2.00	Run
SR4 PowerSupplies	0	512	0	0	0	38.00	0.00	Run
SY PowerSupplies	0	246	0	0	0	5.00	0.00	Run
SY Pressures	0	101	0	0	0	0.00	0.00	Run
SY-DIAG	8	8	0	0	0	0.00	0.00 ev,	Run
Safety	10	387	0	0	0	12.00	0.00	Run
TL1	4	27	0	0	0	0.00	0.00	Run
TL2	1	74	0	0	0	2.00	0.00	Run
Undulators	0	218	0	7	0	0.00	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	57	8865	0	26	1	320.00	4.00	Run

Selection

Context ?

- Run
- Run
- Restart
- Shutdown

<https://github.com/orgs/tango-controls-hdbpp> (To be moved to GitLab)

Build from source, your back-end of choice:

```
git clone --recursive https://github.com/tango-controls-hdbpp/hdbpp-es.git
mkdir build && cd build
cmake .. -DFETCH_LIBHDBPP=ON -DLIBHDBPP_BACKEND=<your-backend-of-choice>
        -DCMAKE_INSTALL_PREFIX=<your-prefix-of-choice>
make && sudo make install
```

Create the SQL database, HDB++ new schema:

```
git clone --recursive https://github.com/tango-controls-hdbpp/hdbpp-mysql-project.git
cd hdbpp-mysql-project/resources/schema
sudo mysql -u root < hdb_innodb_schema.sql
sudo mysql -u root < hdb_innodb_partition.sql
sudo mysql -u root < hdb_innodb_user.sql
```

Thank-you!

The HDB++ collaboration team:

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Jean-Luc Pons**

**Johan Forsberg
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Mangesh Patil
Matteo Di Carlo
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