PALLAS control command and data acquisition systems

current status

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Introduction

- **PALLAS** is laser-plasma accelerator test facility *under construction* at IJClab. First beam expected in 2023.

- Sharing the experience of deploying a control command and acquisition (CCA) ... .for LPA machine

- System ready for "*large*" dataset acquisition, timestamping, online machine optimization...

- Configuration, choices and present status

PALLAS ?

Accelerator test facility for laser-plasma injectors (LPI)

- LPI delivering 150-250 MeV, 30pC, 1 mm.mrad beam with stability and control comparable to standard RF accelerator.

- Main axis of R&D accelerator : advanced laser control, targetry, electron beam manipulation for staging

optimize and operate an LPI at 10 Hz => (1) data acquisition, (2) monitoring, (3) feed-back loop
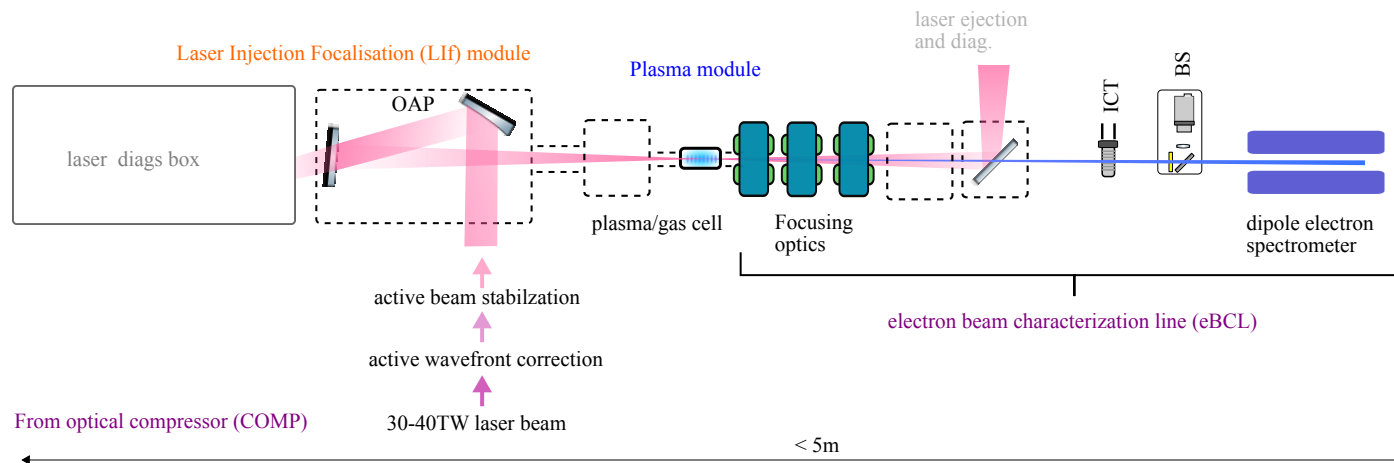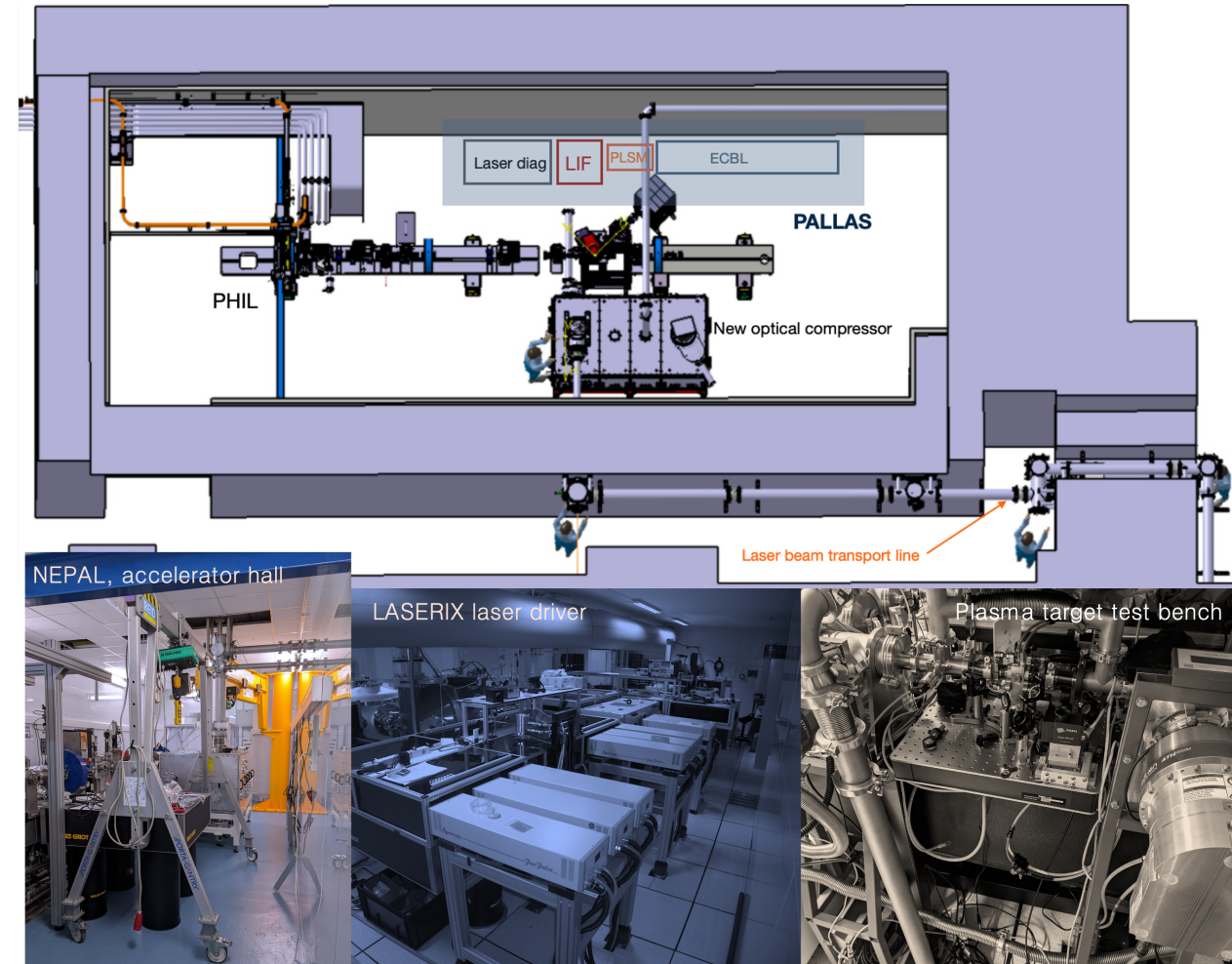
System overview

laser driver

30-40 TW, 10Hz, CPA laser system (Amplitude)

accelerator LPI beamline

divided in 4 modules:

- laser beam transport line + 300TW compressor .
- laser driver focusing and stabilization + interaction region diags
- plasma module
- e- characterization beamline

Advanced control ... state of the art SCADA

Context :

- CCA based on Tango-controls with experienced team (ThomX project, Andromede, Agata ...)

- web based IHM : adaCore Webserver + Grafana + python scripting / API

- Data acquisition : archiving tango system TDB/HDB++

- PLC : vacuum, gas target, person safety.

- upgrade of network architecture

- virtualData storage

- laser driver with its own control command system
  - ElliOOs based on distributed control system.
  - Instruments : 21 CCD, 4 spectrometers, motorized mirror mount, pump laser control ...

... starting with TANGO

- **open-source**, active community acceleratos (ALBA, ESRF, SOLEIL,...), large detectors SKAO and laser facilities (APPOLON,ELIBEAMLINES , ELI-ALPS, CALA ...).

- interoperatibility, high customization ⚙

- It is an object oriernted distributed control system based on :
    - Corba synchronous communications
   - Zeromq for asynchronous (event based) communications

- coding C++, Java, Python

http://tango-controls.com

https://github.com/tango-controls -> https://gitlab.com/tango-controls

Try it with the **tangobox** in VM or docker

Tango concept in a nutshell

- each element hardware **or** software to be controlled is a **device**

- A device is an instance of a **Tango class** being specific to a hardware / software

- A device supports **commands** (actions) and **attributes** (data)

- Tango classes are merged in operating system process called **Device Server (DS)**

- All **Devices configuration** parameters are stored in a database (Tangodb)

- All devices have **State** with multiple possible values depending on device (`ON, OFF, MOVING, UNKNOWN, FAULT...`)

https://tango-controls.readthedocs.io/en/latest/
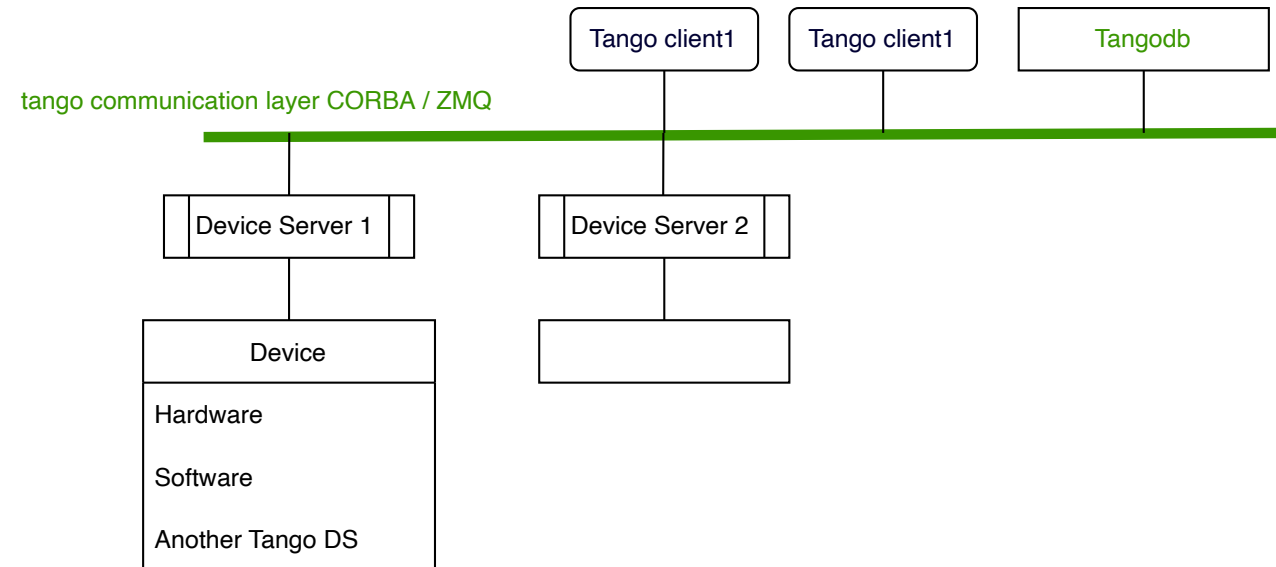
Tango concept in a nutshell

out of the box several graphical tools

- **Configuration:** `jive` (alt. waltz)

- **start/stop system:** `astor`

- **test + monitor device:** `atkpanel` `taurus` (atl. Pytango, waltz,...)

- **archiver:** HBD++
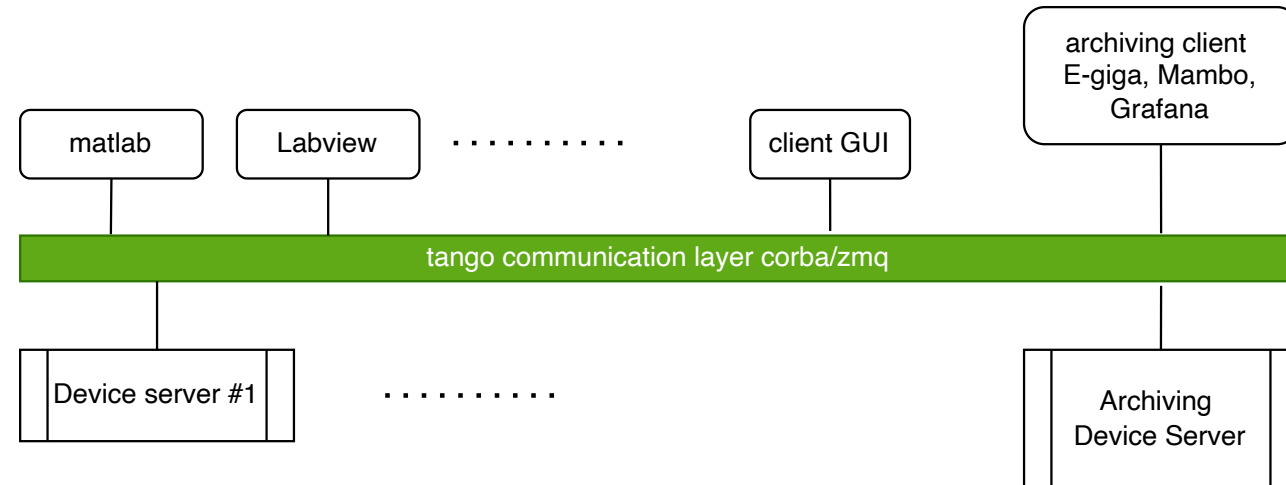
- **logs:** Logviewer

- **alarm handling:** Panic

GUI

- Taurus Gui (Py/Qt), Sardana, Canone (web/php)

Bindings

- REST-API, Labview, Matlab, octave, panorama ...

https://tango-controls.readthedocs.io/en/latest/

CCA system

Present configuration :

laser driver

- 1 Gb network
- 3 embedded computers, 1 data server 20 To mysql dB (*21 CCD, 4 spectometers* ...)
- Timing/ synchronization : shotcounter based on **ØMQ** for timestamping
- Tango Gateway => laser status, fire command

PALLAS beamline

Module	device	DS	area detector	total max bw [Gb/s]	stored data [Mo/s]	frep [Hz]
4	82	23	>30	~ 5700	50-250	10

Gives input for network and hardware design :

- 2 x 10 Gb network
- 1 gateway, 2 servers, 3 embedded computers + local (diag dedicated computer interface)
- data server : 12To TDB / 12To HDB then overnight transfer to datacenter virtualData

PALLAS CCA system
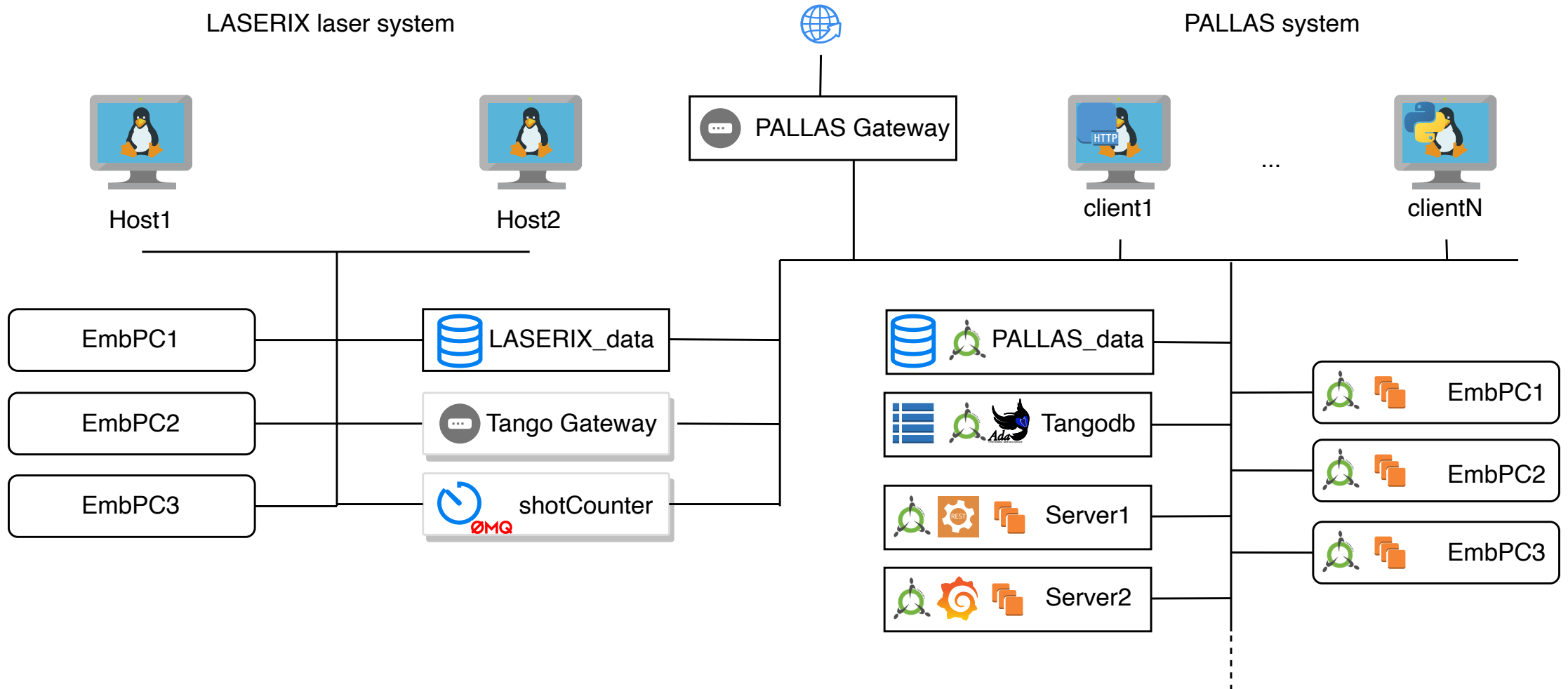
CCA development

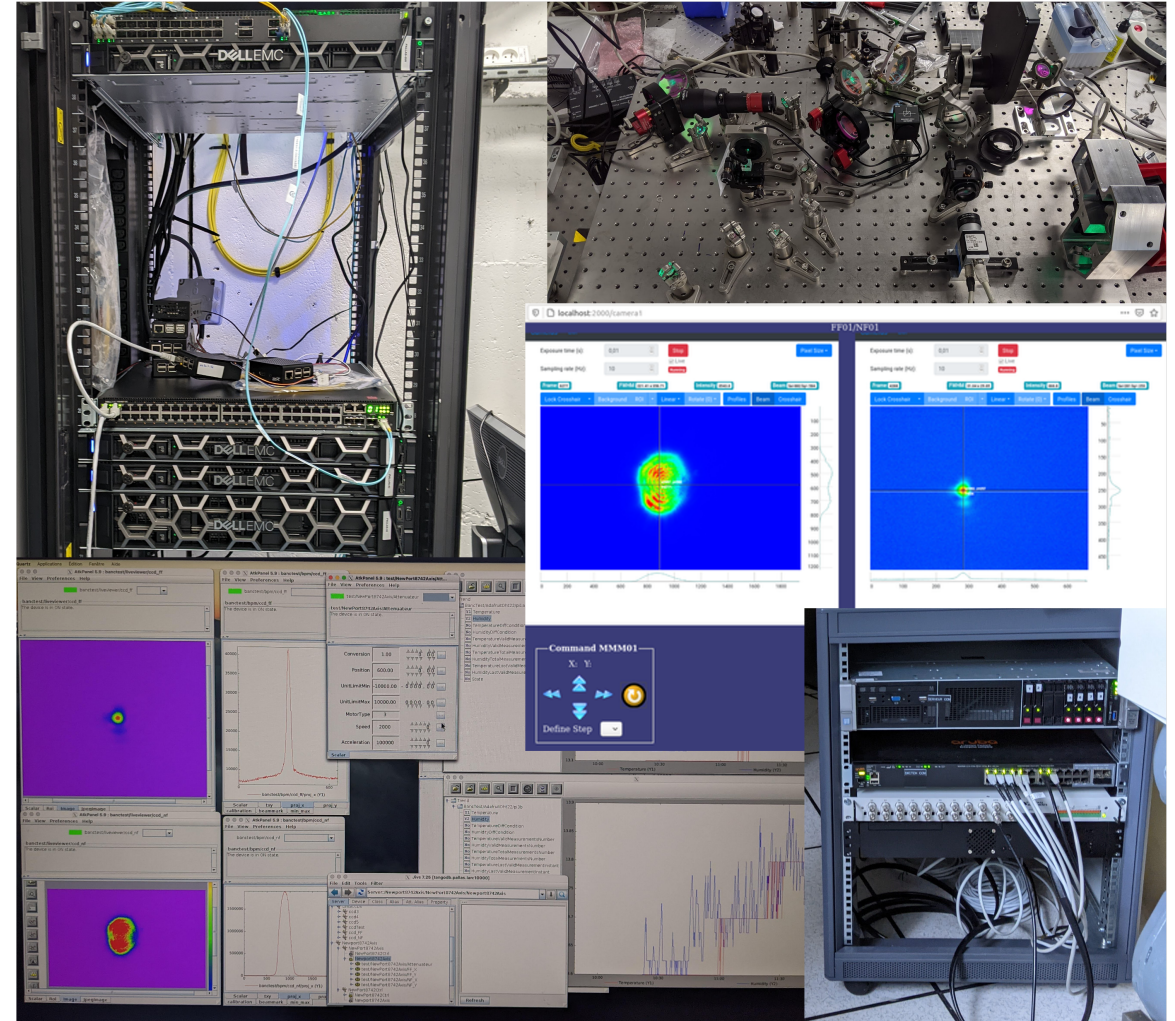## The team

- 6 persons ~ 2.2 FTE

DS development and HW testing

small HW test bench for DS development for parallel testing with machine integration

- DS testing
- Script for automatic installation/re-installation of DS and machines
- Data recording / timestamping testing

GUI development

- based on ada webserver and Tango REST-API

Current status ... next steps

DS testing and dev progress

Device server class	testing state	dev state
15	26%	60%

https://www.tango-controls.org/developers/class-doc/

Present hardware configuration

- LBTL and optical compressor under connection
- Network cabling complete Control command system installed in the final technical room
- Timestamping -shotCounter (Amplitude) zmq server publishing on both network LASERIX/PALLAS `[runID, shotID, datetime]`

Coming next

- GUI integration / testing
- database link to Grafana and dashboard config
- DS for run configuration
- single board computer for image processing of large area detectors @ 10Hz

Community experience on Tango based CCA for LPA

To conclude, we are seeking:

- to share experience on specific aspect of LPA CCA : triggered area-detector network loading, laser diagnostics tango device, etc…

- common format for sharing data ?

Thanks

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