Current design of the data acquisition system at the Centre for Advanced Laser Applications (CALA)

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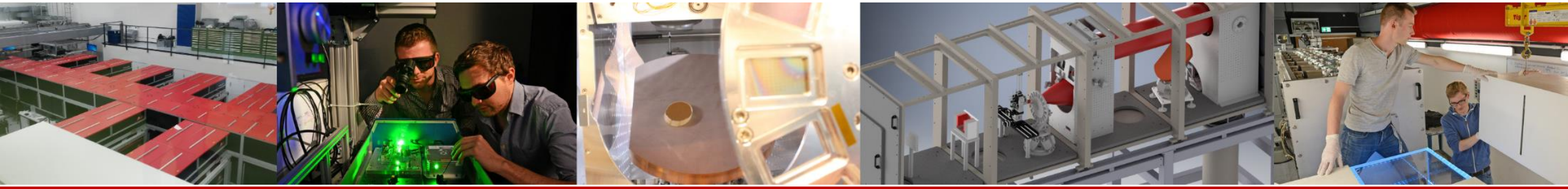
https://www.pulse.physik.uni-muenchen.de/

The Centre for Advanced Laser Applications (CALA) in Munich is home to the ATLAS-3000 high power laser dedicated to research on laser particle acceleration and applications thereof. The laser and each experimental area are running control systems based on Tango controls. In addition to the hardware control, this is used to record experimental data in an automated fashion with every laser shot. As the laser shots are executed via software, the system emits a software trigger to acquire data on slow diagnostics, as well as an electrical trigger for hardware-triggered devices. In this poster, the current design of this data archiving system including file formats, call hierarchy, timings and some example diagnostics will be presented.



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Tango Controls

- toolkit for network-distributed control
- C++, **Python**, Java, …
- https://www.tango-controls.org/
- see poster N. Weiße

Infrastructure ATLAS-3000

- 3PW Ti:Sa laser system
- 1Hz, 90J, ~20fs
- 4 experiment areas
  - Proton/carbon/heavy ion acceleration
  - Electron acceleration
- individual Tango servers for laser + each target area

Archiving system

- on-shot, single shot up to 1Hz
- software trigger:
  - record motor positions, states, …
  - arm hardware triggers
- hardware trigger:
  - cameras, oscilloscopes, …
- folder/ file based, text file tables

```
./Experiments/20210831/
├── CamIncoming
│   ├── 20211026_172315387_0001_BSEPM51_20211026_172317086383.png
│   ├── 20211026_172726013_0002_BSEPM51_20211026_172728292350.png
│   ├── 20211026_182237023_0003_BSEPM51_20211026_182239085573.png
│   ├── 20211026_183504253_0004_BSEPM51_20211026_183506086249.png
│   └── ...
├── expcontrol
│   └── main.txt
├── motor
│   ├── air-verti
│   ├── buncher-x
│   ├── buncher-y
│   ├── buncher-z
│   └── ...
└── vacuum
    └── tpg.txt
```

20210831/vacuum/tpg.txt

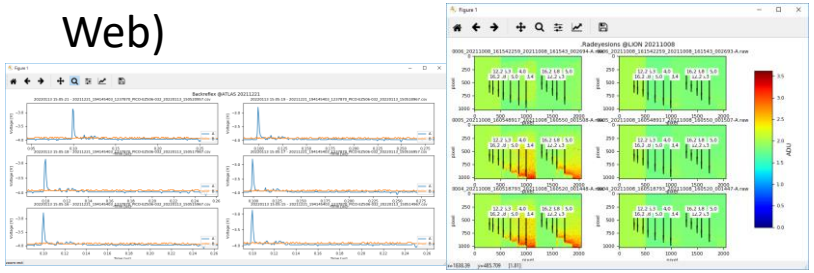
ShotTime	Shot	Run	SensorState	Pressure
20211026_172315387	1	0	True	2.82e-06
20211026_172726013	2	0	True	2.81e-06
20211026_182237023	3	0	True	2.72e-06
20211026_183504253	4	0	True	2.7e-06
20211026_185003429	5	0	True	2.69e-06
20211026_185007426	6	0	True	2.69e-06
20211026_185011423	7	0	True	2.69e-06
20211026_185015425	8	0	True	2.69e-06
20211026_185211181	9	0	True	2.68e-06
20211026_185213181	10	0	True	2.68e-06
20211026_185215181	11	0	True	2.68e-06

Design criteria

- per-shot data log, not e.g. ML in mind
- KISS
- main users: students, not long-term staff

Online readout

- currently limited to previews (Python, Web)



Future plans

- more online evaluation
- better file format **OR** database?
- module to gather all data for 1 shot
- interop with automated tools / ML?

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Archiving system: requirements

- **Goal**: automated shot log → make writing of lab-book easier, quicker, less error prone
- trigger with laser shot (single shot up to 1Hz)
- master:
  - save shot number, timestamp, user parameters (target type, manual comments, …)
- motors, vacuum gauge, …:
  - save position/pressure/… (+state)
- cameras, picoscope, …:
  - set filename, arm trigger, then save on hardware trigger
- after beam time:
  - easily readable by inexperienced user/student

Implementation

- device software:
  - registers for software event “Shot”
  - saves data locally **OR**
  - chooses file name and arms trigger
- works for Tango services
- may work on non-Tango software

Formats

- folder for each beam time, subfolder for each device
- SingleFileArchiver
  - (shot log, motors, energy meter, …)
  - Single .txt table of “observables”
- MultiFileArchiver
  - (camera, oscilloscope, …)
  - Common file naming
  - File contents depends on device
  - Useful to combine with SingleFileArchiver for metadata

Text file approach vs. database

- Pro:
  - KISS
  - Easy to learn for new people
  - Long term stable
  - Unified solution: some diagnostics will always be file based
- Con:
  - Performance limit ?
  - (currently) not defined strictly enough → no inherent enforcing of structure

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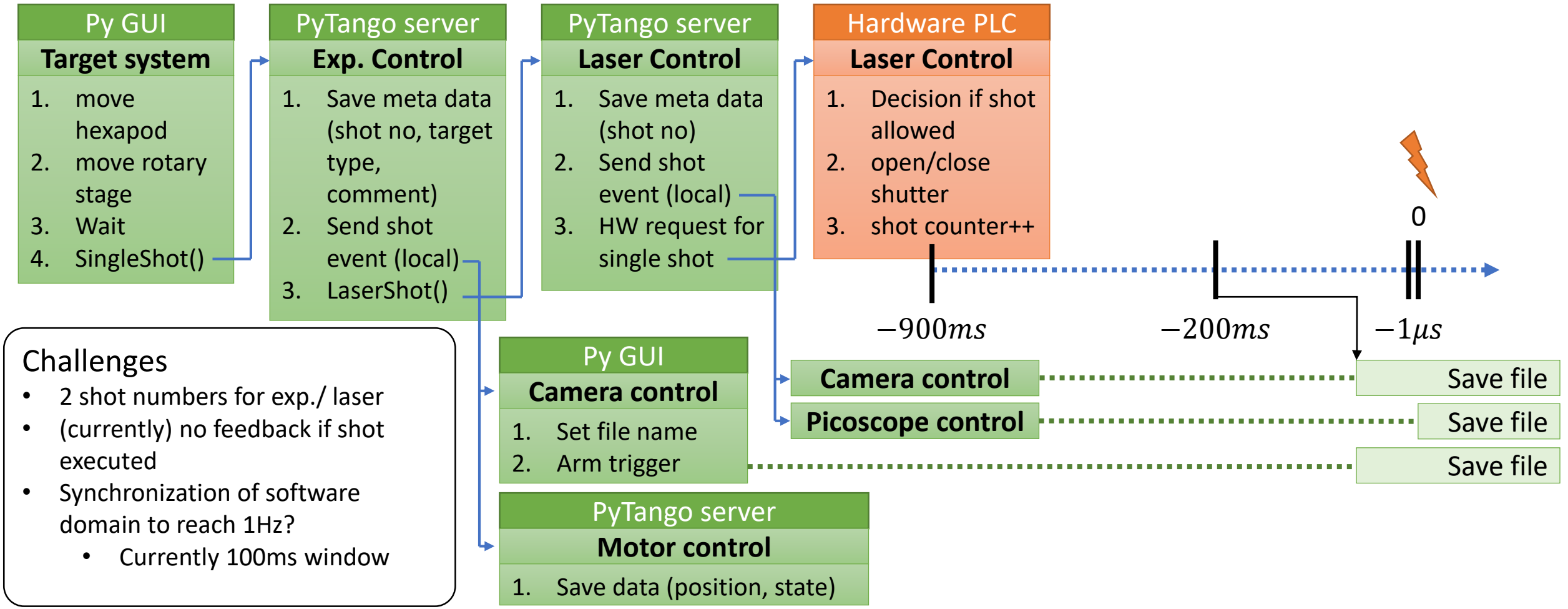
Flow of command on trigger



Challenges

- 2 shot numbers for exp./ laser
- (currently) no feedback if shot executed
- Synchronization of software domain to reach 1Hz?
  - Currently 100ms window