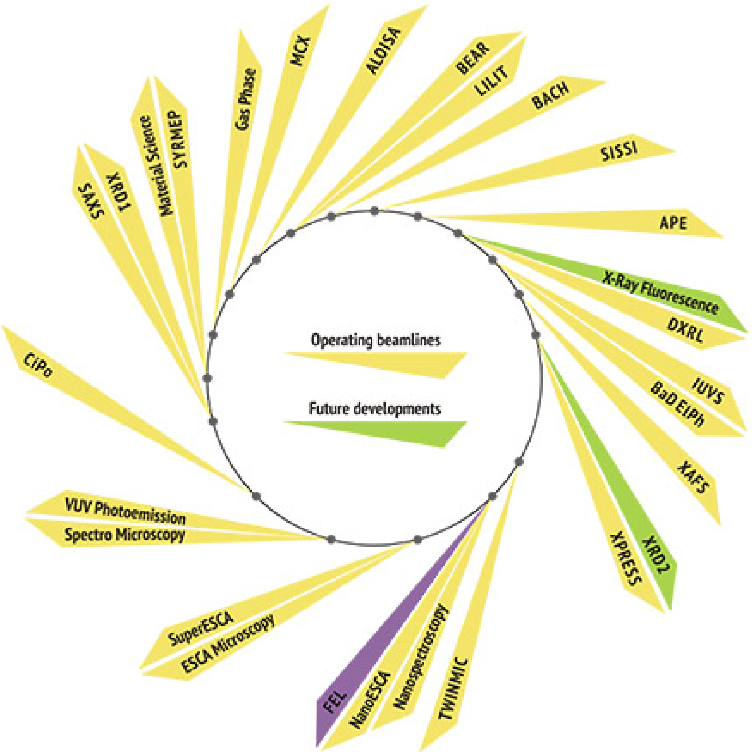
DonkiOrchestra

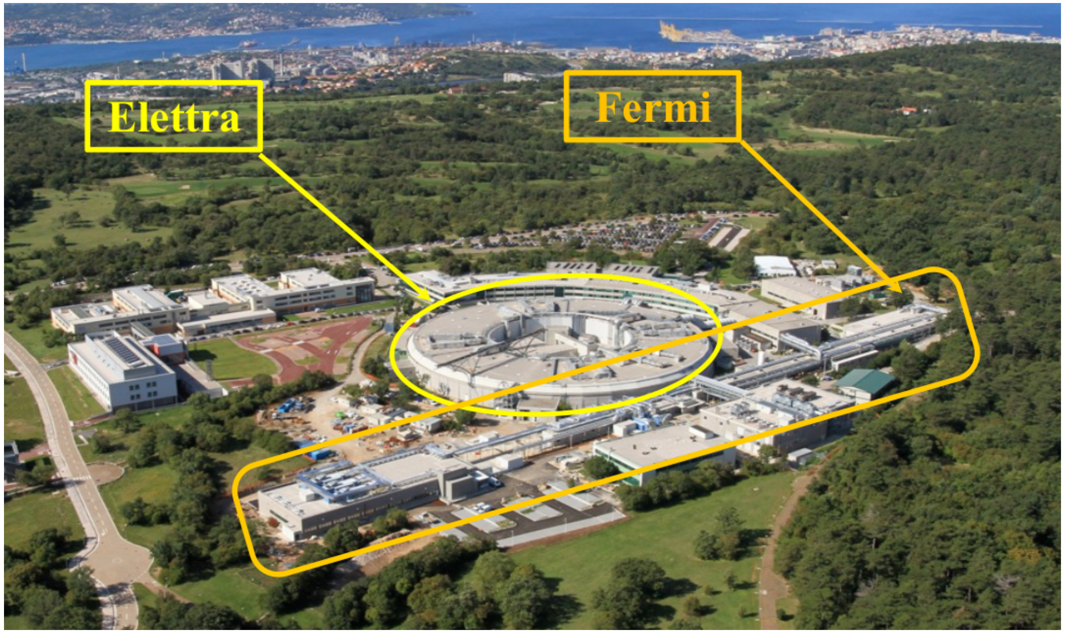
a scalable system for data collection and experiment management based on ZeroMQ distributed messaging

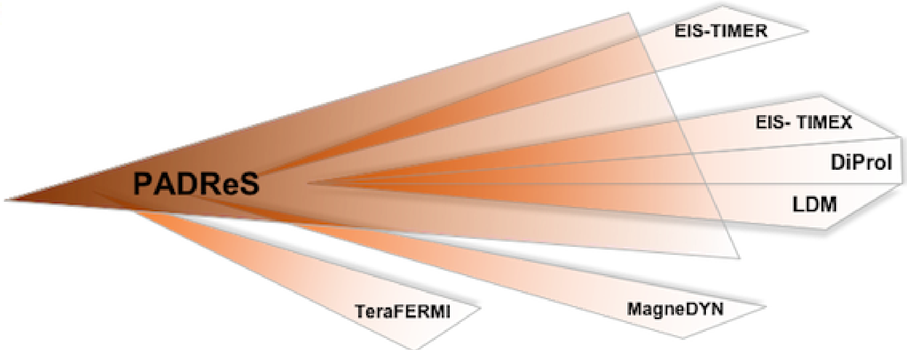
NOBUGS 2016, Copenhagen, Denmark

Roberto Borghes, 18 October 2016

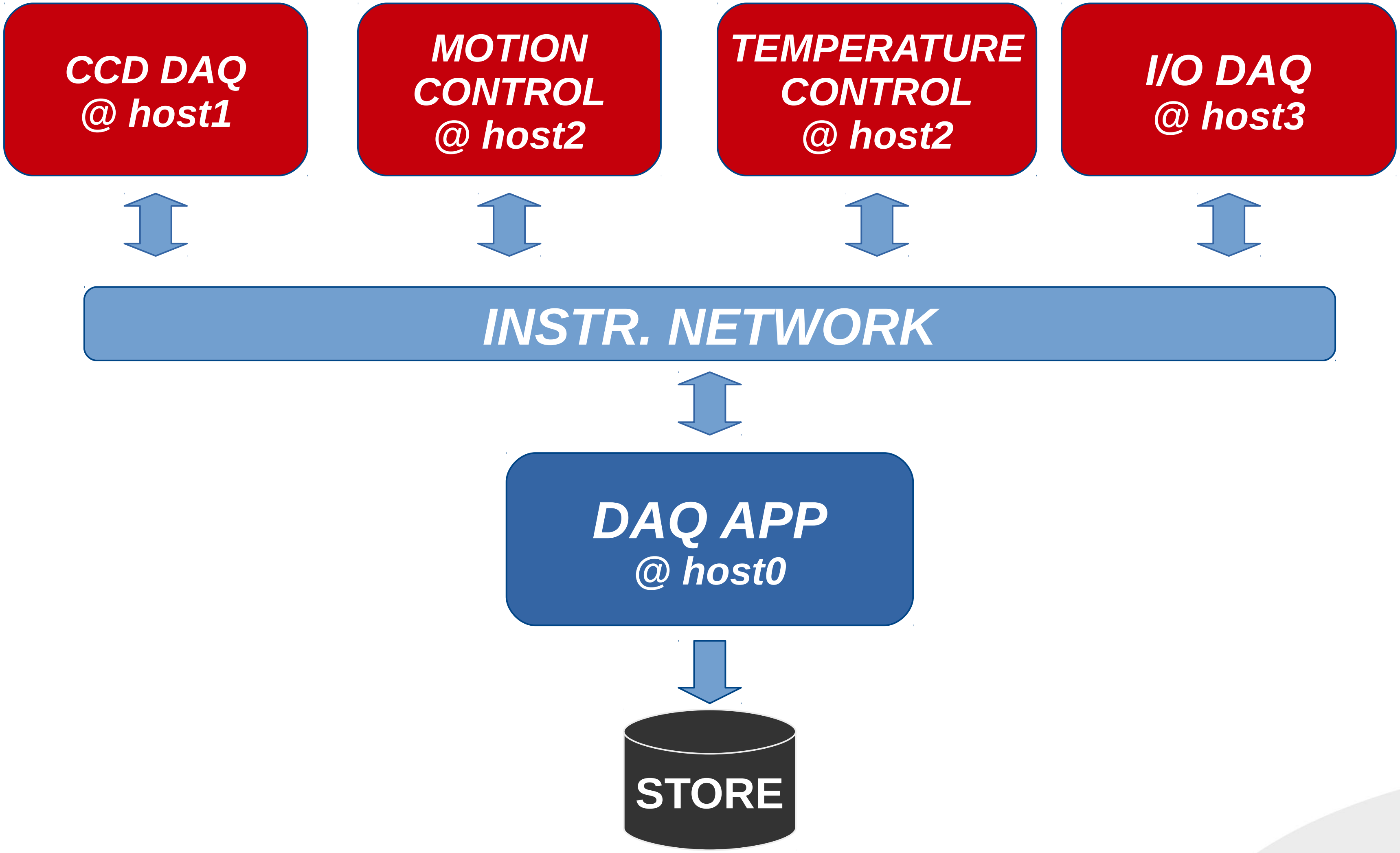
Elettra and Fermi @ Trieste



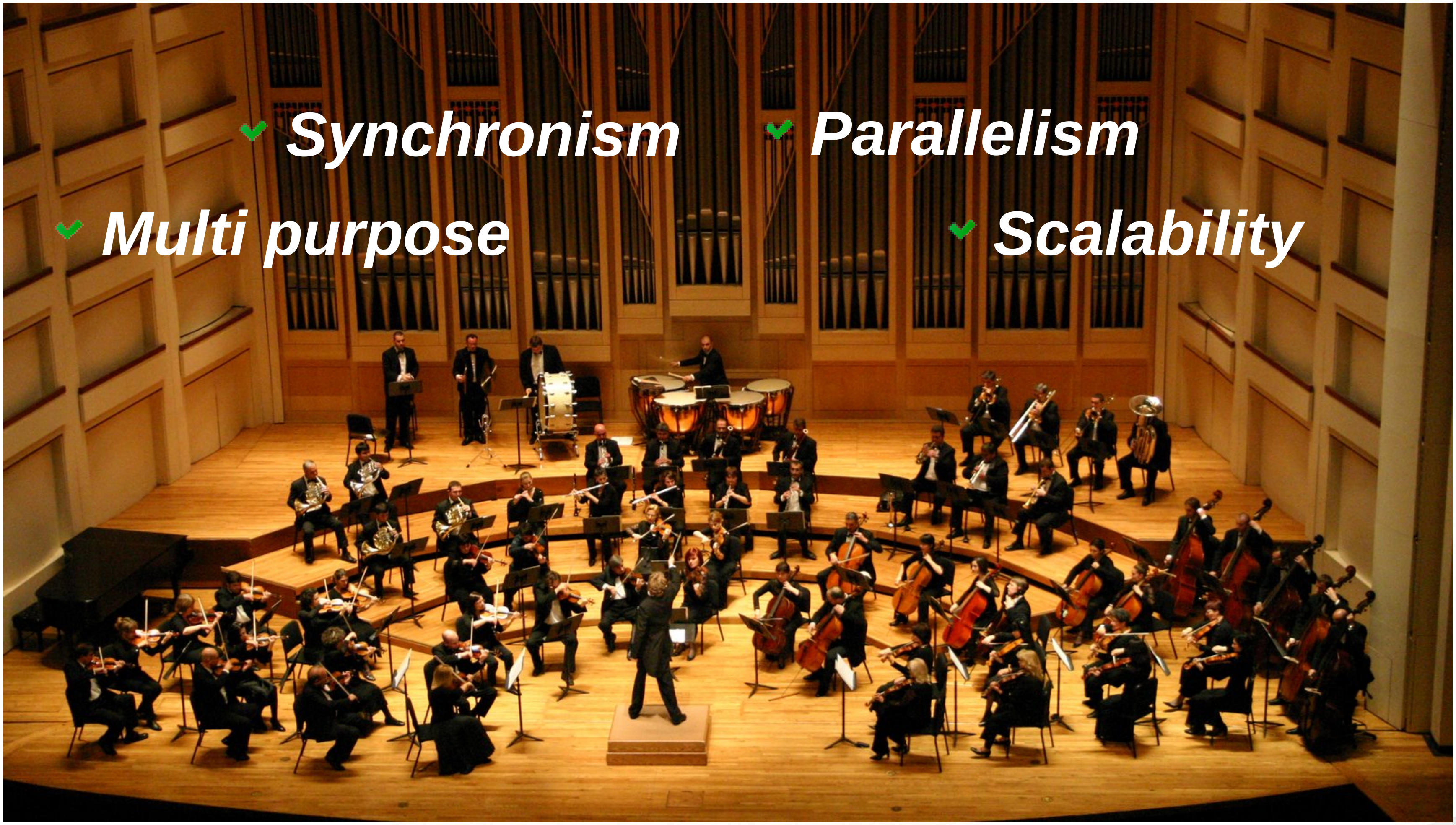




Distributed DAQ for Experiments



Distributed DAQ like an Orchestra



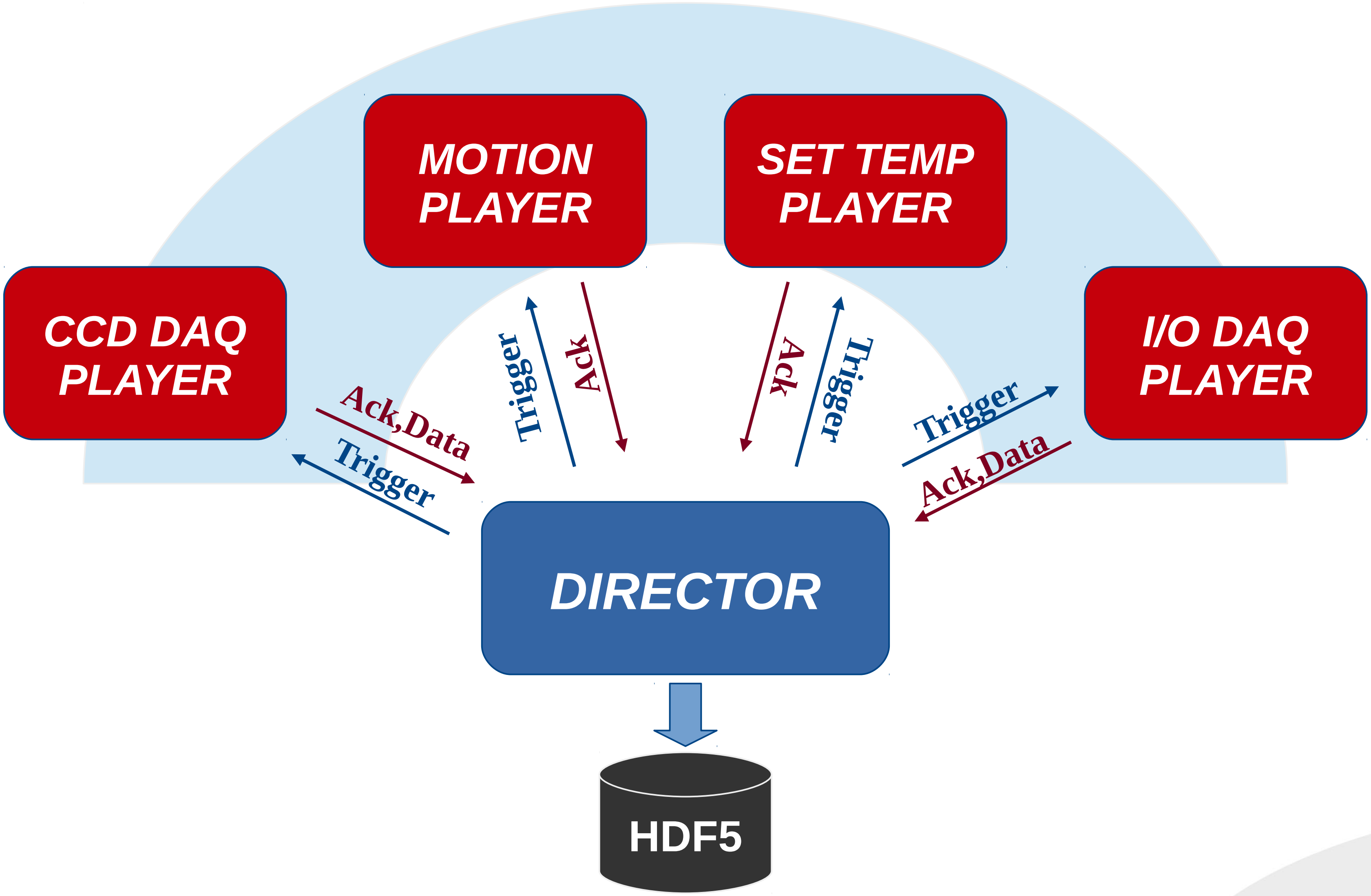
- ✓ ***Synchronism***
- ✓ ***Parallelism***
- ✓ ***Multi purpose***
- ✓ ***Scalability***

Distributed DAQ like an Orchestra

	Time			
	Phase 0	Phase 1	...	Phase N
Priority 0	Move X Move Y	Move X Move Y		Move X Move Y
Priority 1	Set Temp	Set Temp		Set Temp
Priority 2	Acq CCD Acq I/O	Acq CCD Acq I/O		Acq CCD Acq I/O

17
Vlns. 1
Vlns. 2
Vlas.
Cel/Bass
ff
3

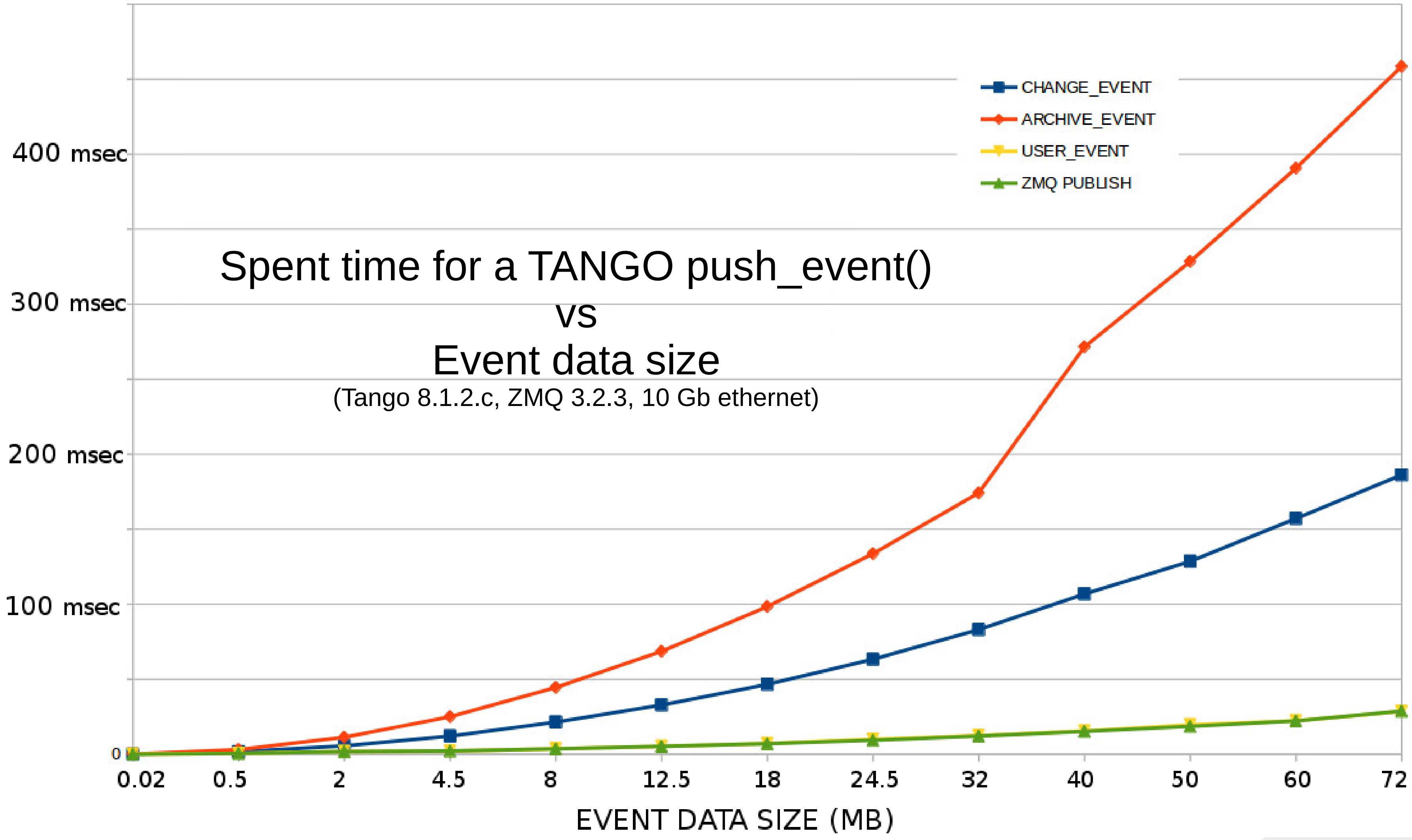
DonkiOrchestra at a glance



DonkiOrchestra starting points

- Experiment segmented in a **triggered sequence**
- Orchestra **Director** sets the rhythm
- Distributed **Players** perform actions (concurrency)
- **Players** can be removed or added
- **Event based** communication protocol
- **HDF5** centralized data storage

Can we bet on ZMQ for data sharing?



DonkiOrchestra Director

Planning

(Pre-Acquisition)

- **Players** Tango devices are defined in an XML
- **Priorities** are read from the players (scalability)
- **Pre-operation** signal sento to the players

Collection

(Data Acquisition)

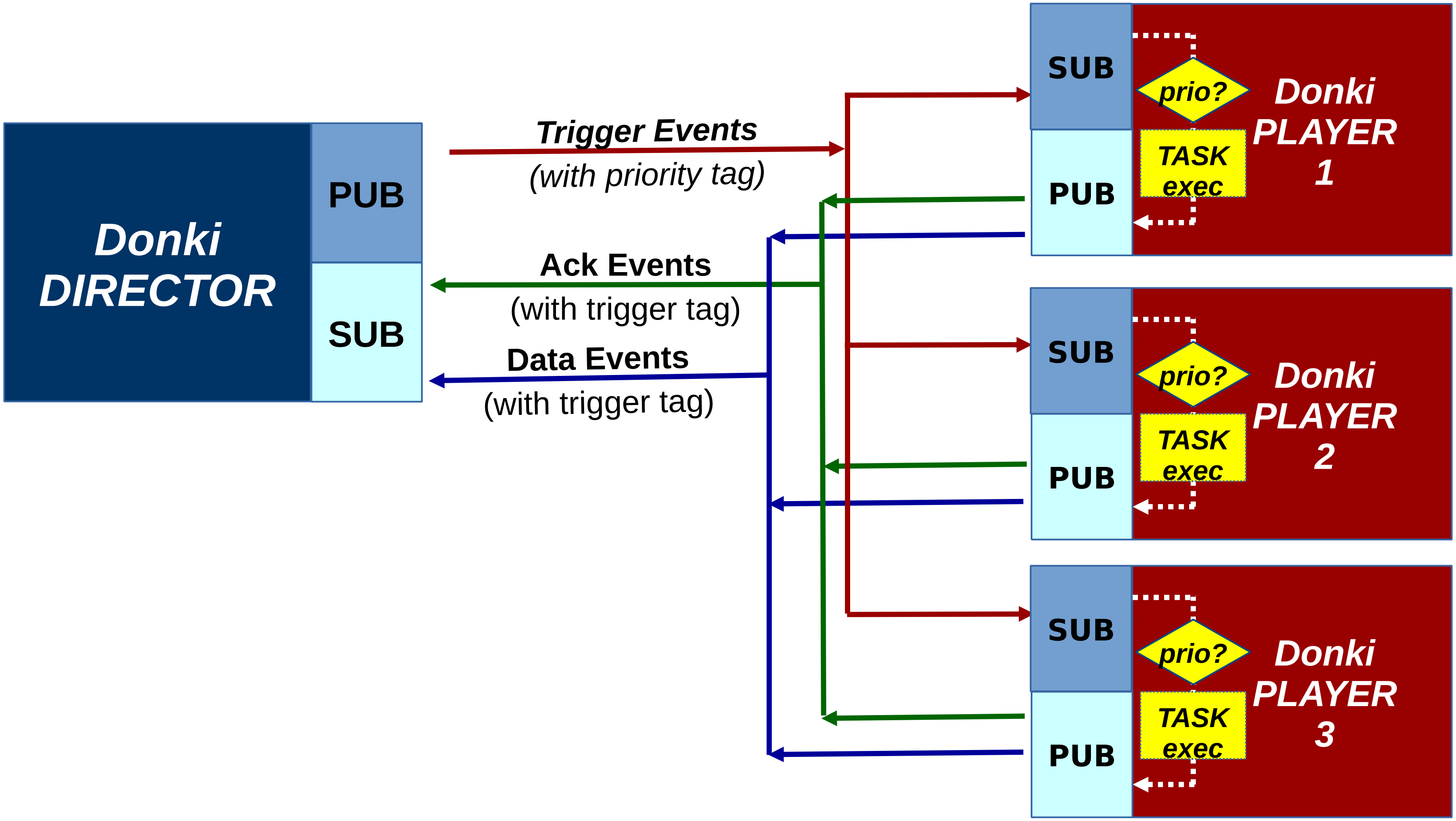
- The **sequence of triggers** is sent to the players with a “**priority based**” partition
- DAQ players push data with a **'trigger number'** tag
- A pool of internal threads acquires and writes data to **HDF5 files**

Closeout

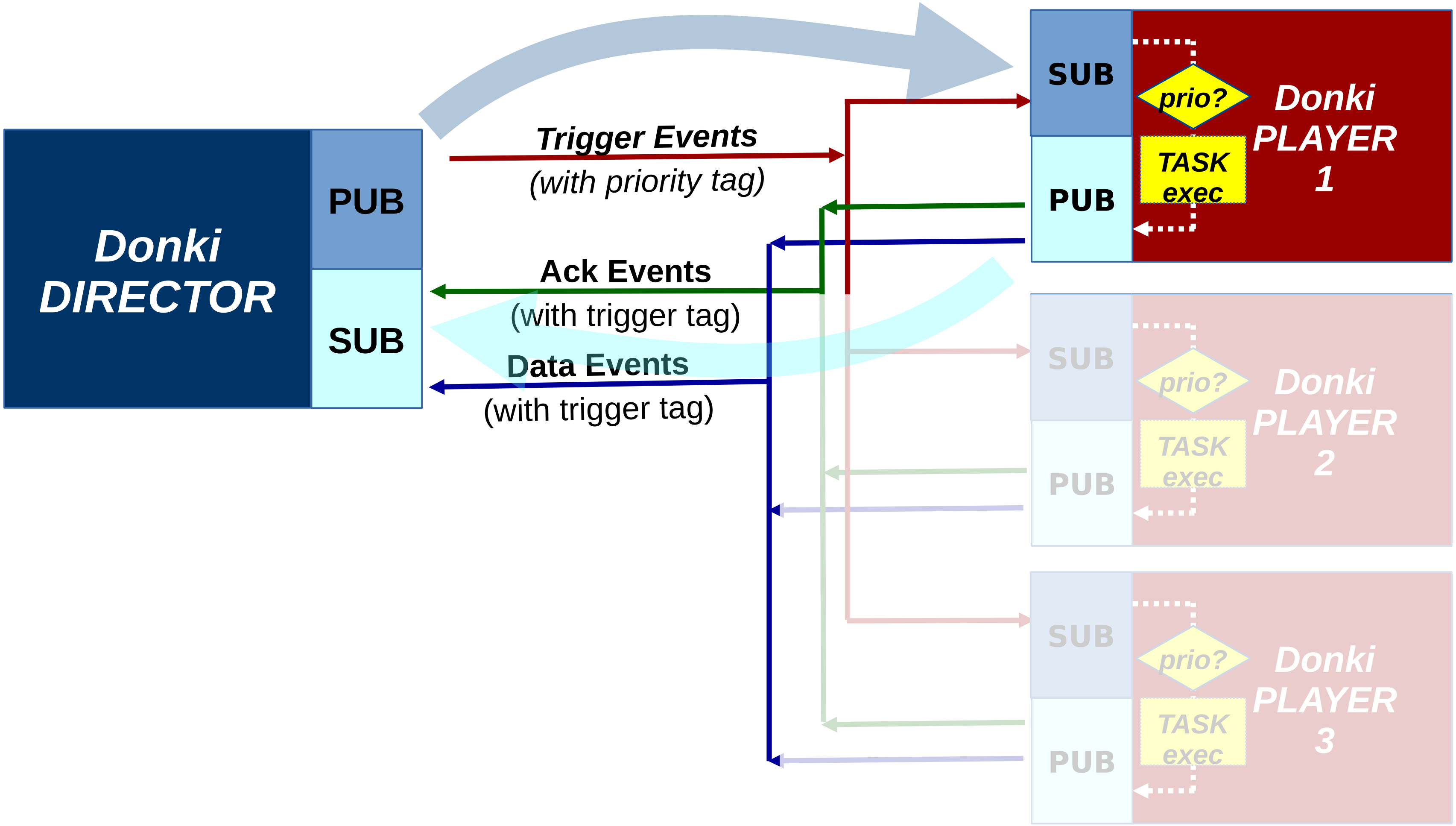
(Post-Acquisition)

- **Closeout-operation** signal is sent to the players

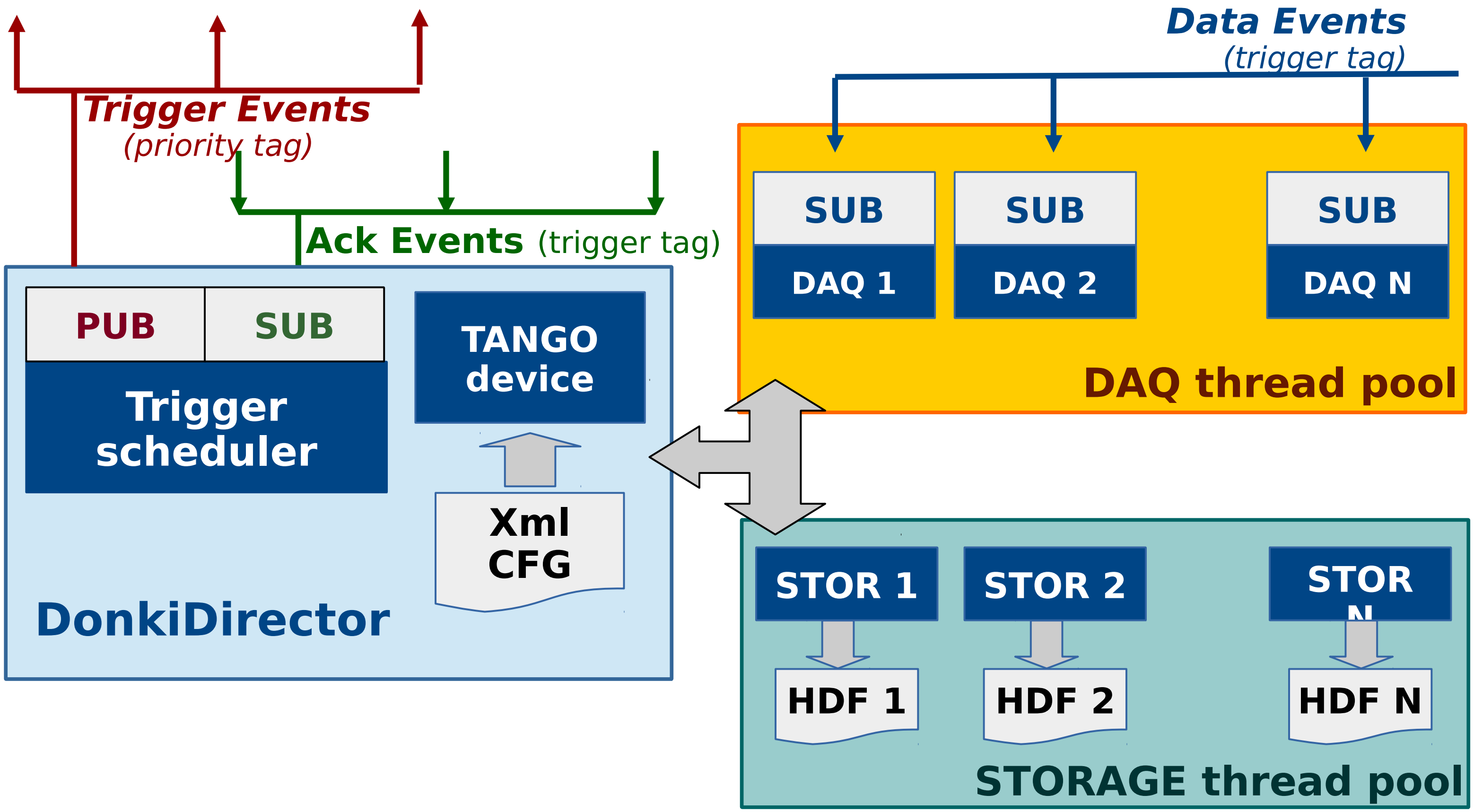
ZeroMQ event based communication



ZeroMQ event based communication



DonkiDirector: inside look

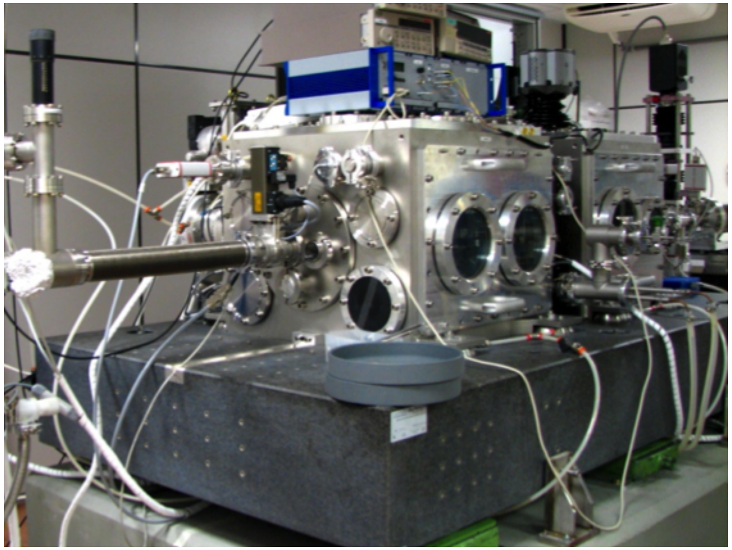


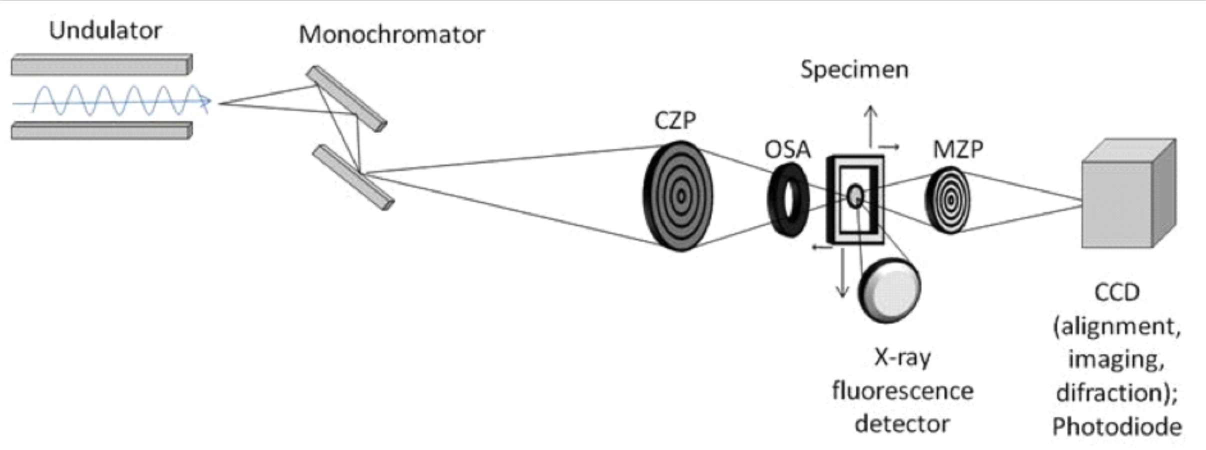
DonkiOrchestra tech details

- Fully Python based
- Tango 8.1.2.c (PyTango binding)
- Python 2.7.5, h5py 1.3.1, ZMQ3
- CentOS 6.4 x64

TWINMIC endstation @ Elettra

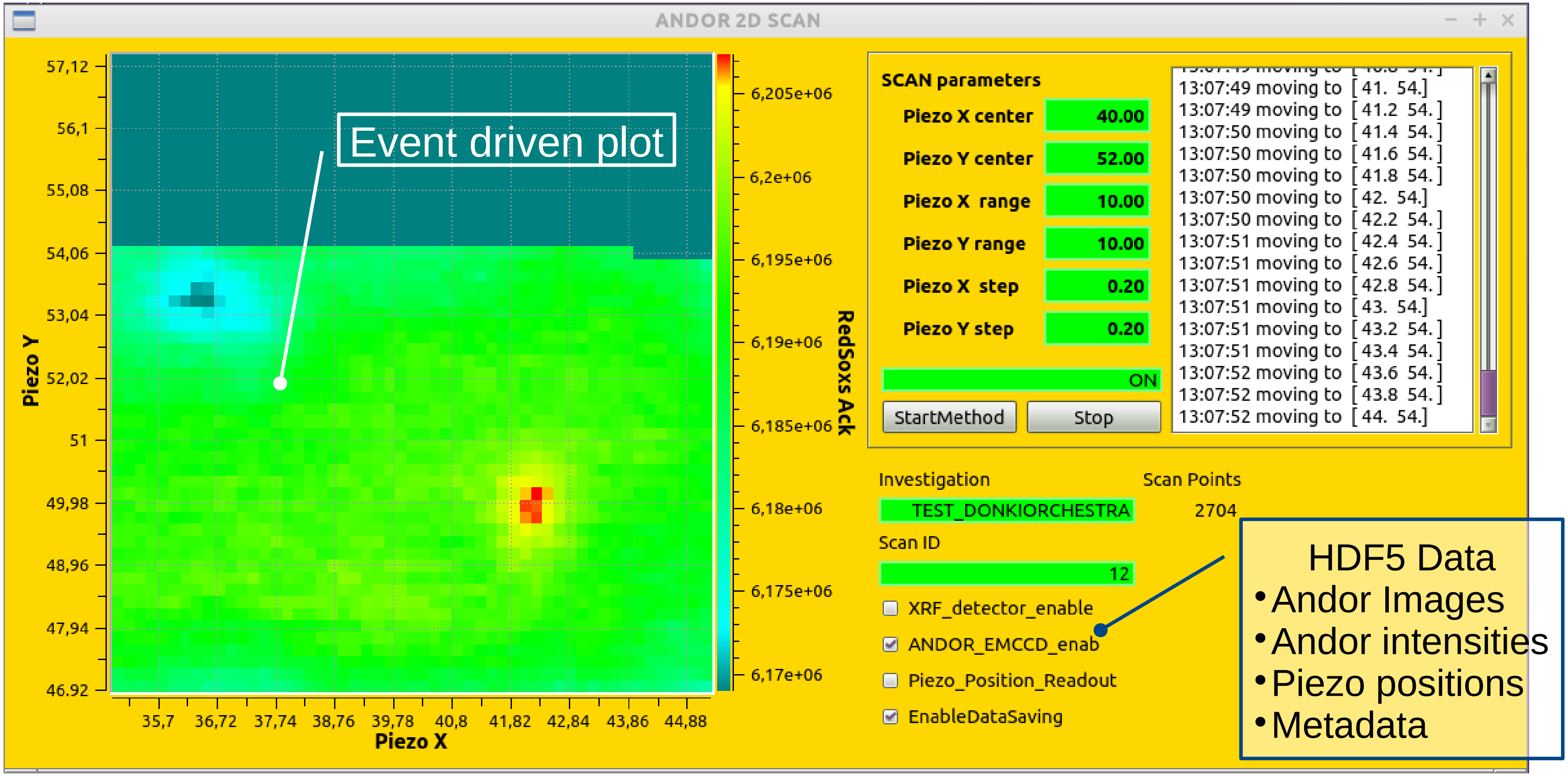
- PI piezoelectric sample stage
- Princeton X-ray CCD 1300x1340
- Andor IXON DV860
- XGLab low-energy X-ray fluorescence detectors




Undulator
Monochromator
Specimen
CZP
OSA
MZP
CCD (alignment, imaging, difraction); Photodiode
X-ray fluorescence detector

DonkiOrchestra @ TWINMIC

X-ray Absorption Raster Scan



Event driven plot

SCAN parameters

Piezo X center 40.00

Piezo Y center 52.00

Piezo X range 10.00

Piezo Y range 10.00

Piezo X step 0.20

Piezo Y step 0.20

ON

```
13:07:49 moving to [41.  54.]
13:07:49 moving to [41.2 54.]
13:07:50 moving to [41.4 54.]
13:07:50 moving to [41.6 54.]
13:07:50 moving to [41.8 54.]
13:07:50 moving to [42.  54.]
13:07:50 moving to [42.2 54.]
13:07:51 moving to [42.4 54.]
13:07:51 moving to [42.6 54.]
13:07:51 moving to [42.8 54.]
13:07:51 moving to [43.  54.]
13:07:51 moving to [43.2 54.]
13:07:51 moving to [43.4 54.]
13:07:52 moving to [43.6 54.]
13:07:52 moving to [43.8 54.]
13:07:52 moving to [44.  54.]
```

Investigation: TEST_DONKIORCHESTRA

Scan Points: 2704

Scan ID: 12

☐ XRF_detector_enable

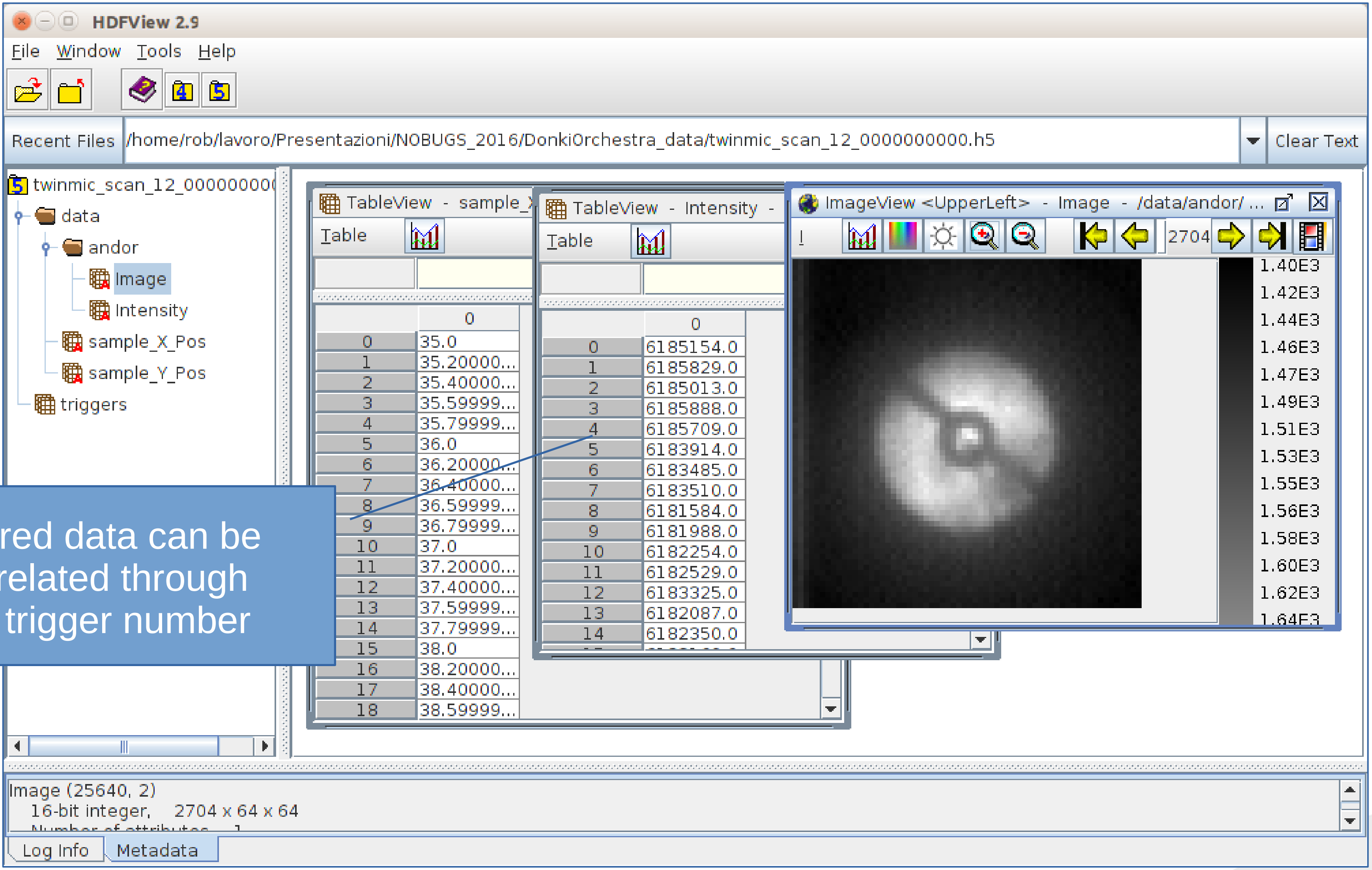
☑ ANDOR_EMCCD_enab

☐ Piezo_Position_Readout

☑ EnableDataSaving

HDF5 Data
- Andor Images
- Andor intensities
- Piezo positions
- Metadata

DonkiOrchestra @ TWINMIC



/home/rob/lavoro/Presentazioni/NOBUGS_2016/DonkiOrchestra_data/twinmic_scan_12_0000000000.h5

	0
0	35.0
1	35.20000...
2	35.40000...
3	35.59999...
4	35.79999...
5	36.0
6	36.20000...
7	36.40000...
8	36.59999...
9	36.79999...
10	37.0
11	37.20000...
12	37.40000...
13	37.59999...
14	37.79999...
15	38.0
16	38.20000...
17	38.40000...
18	38.59999...

	0
0	6185154.0
1	6185829.0
2	6185013.0
3	6185888.0
4	6185709.0
5	6183914.0
6	6183485.0
7	6183510.0
8	6181584.0
9	6181988.0
10	6182254.0
11	6182529.0
12	6183325.0
13	6182087.0
14	6182350.0

```
Image (25640, 2)
   16-bit integer,    2704 x 64 x 64
```

Stored data can be correlated through the trigger number

Conclusions

DonkiOrchestra...

... maximizes efficiency with concurrency (ZeroMQ)

... is scalable and reusable

... uses an optimized data format (HDF5)

... is portable (Python)

... it's simple

Elettra
Sincrotrone
Trieste

Thank you!

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