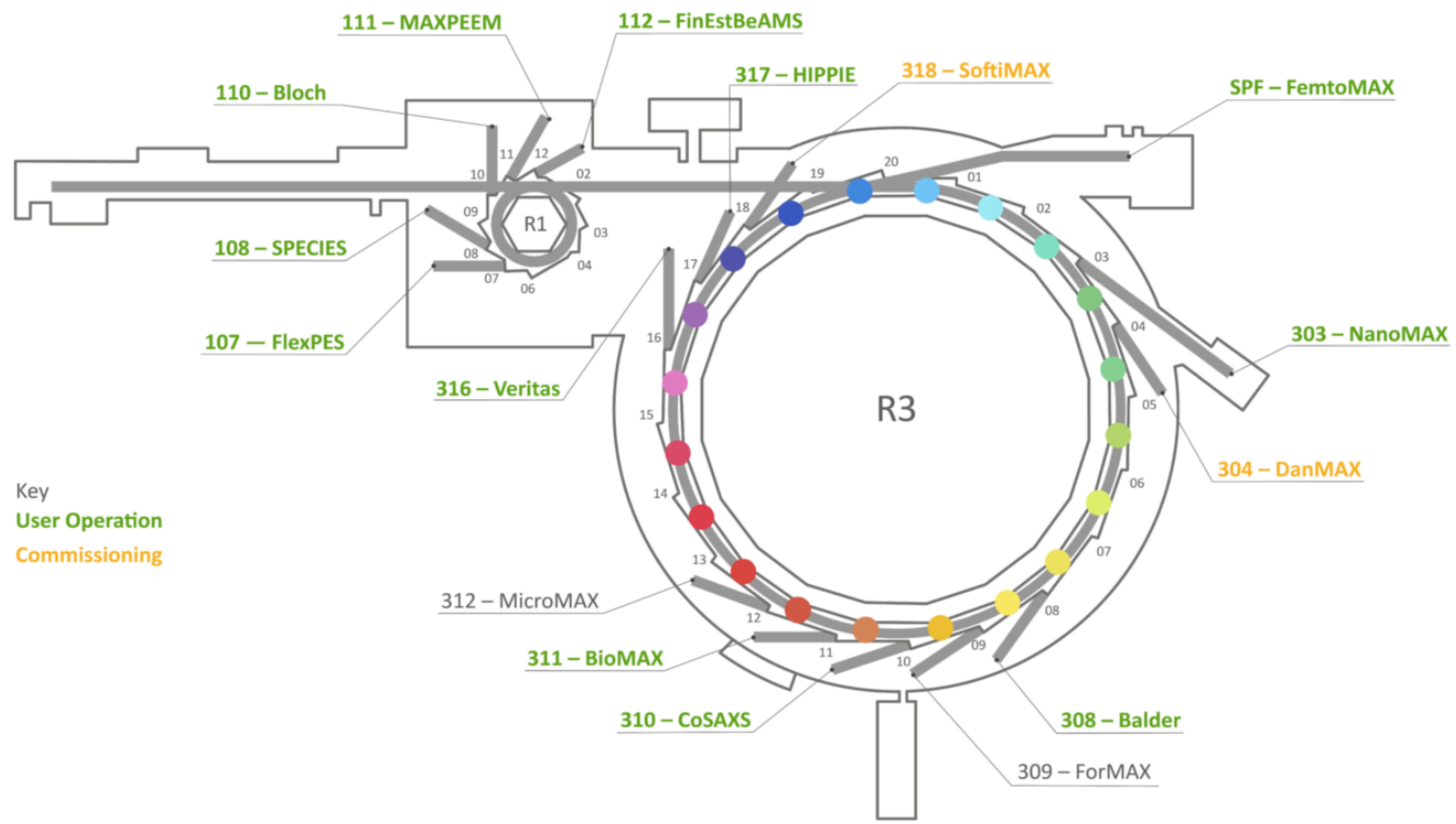
ICALEPCS

Maturity of MAX IV And Phase II development

Vincent Hardion, MOAL01, ICALEPCS 2021


MAX IV

- **MAX IV**
- STATUS
  - Project Management
  - Operation
- KITS Improvement
- Future



General Status

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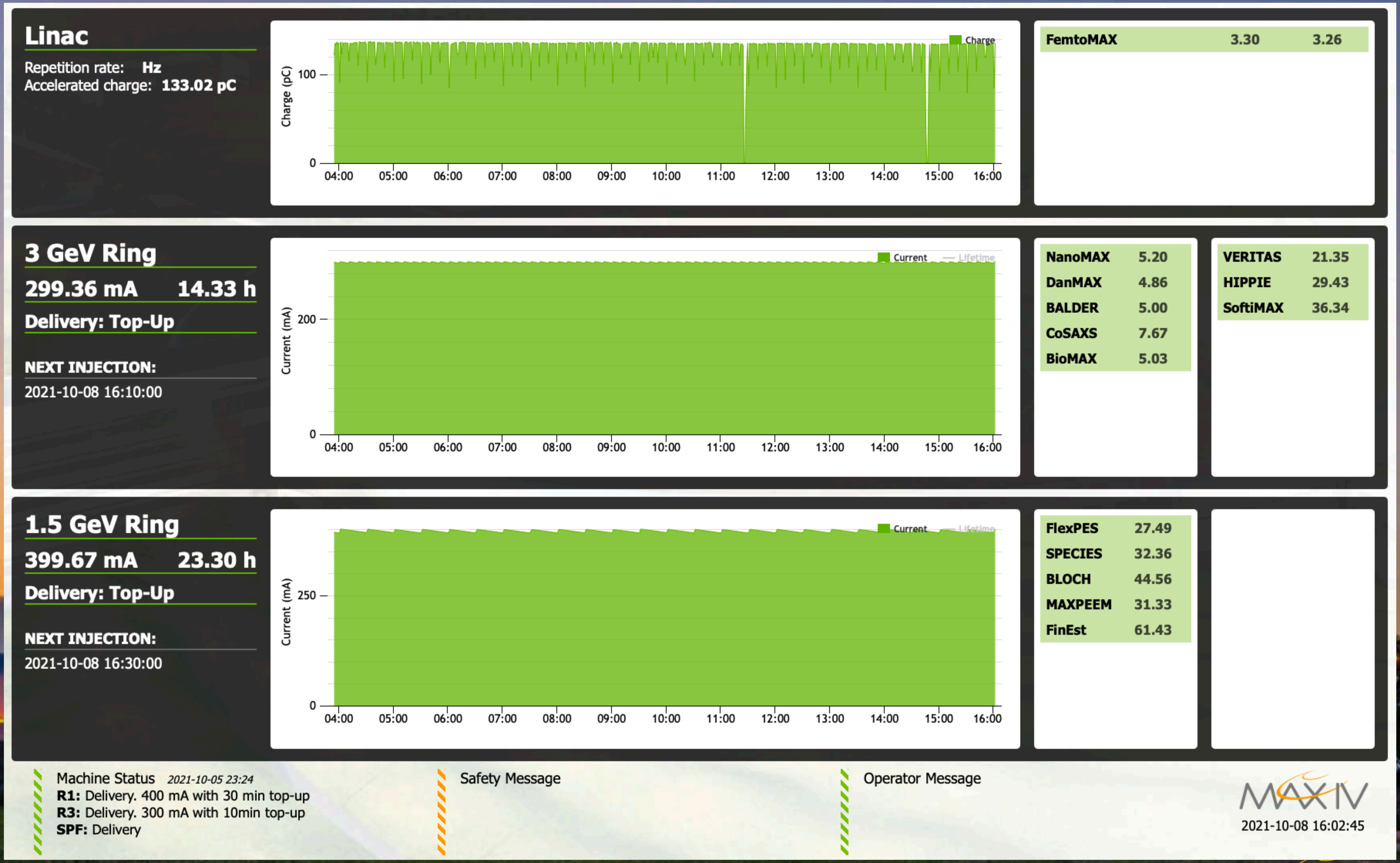
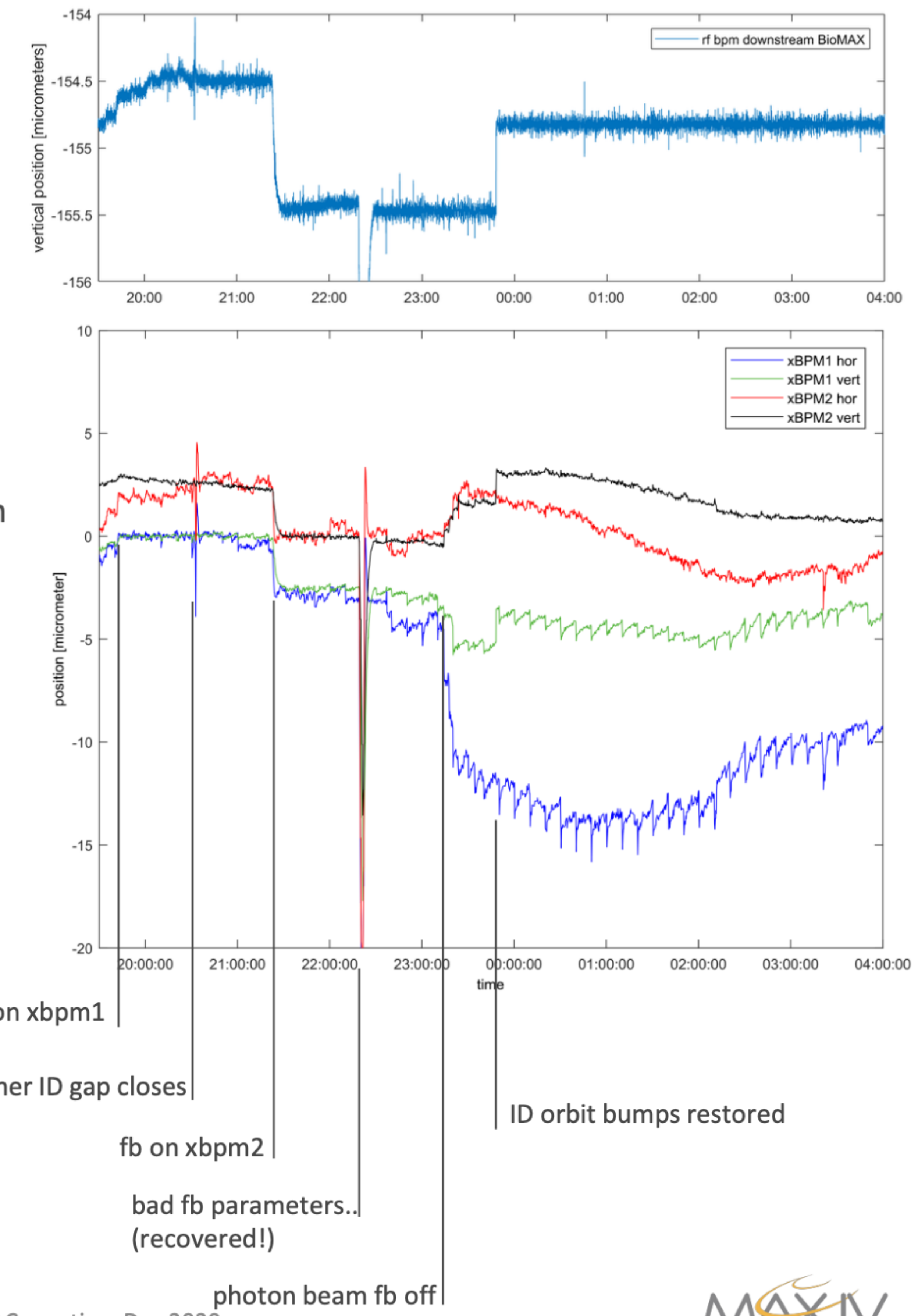


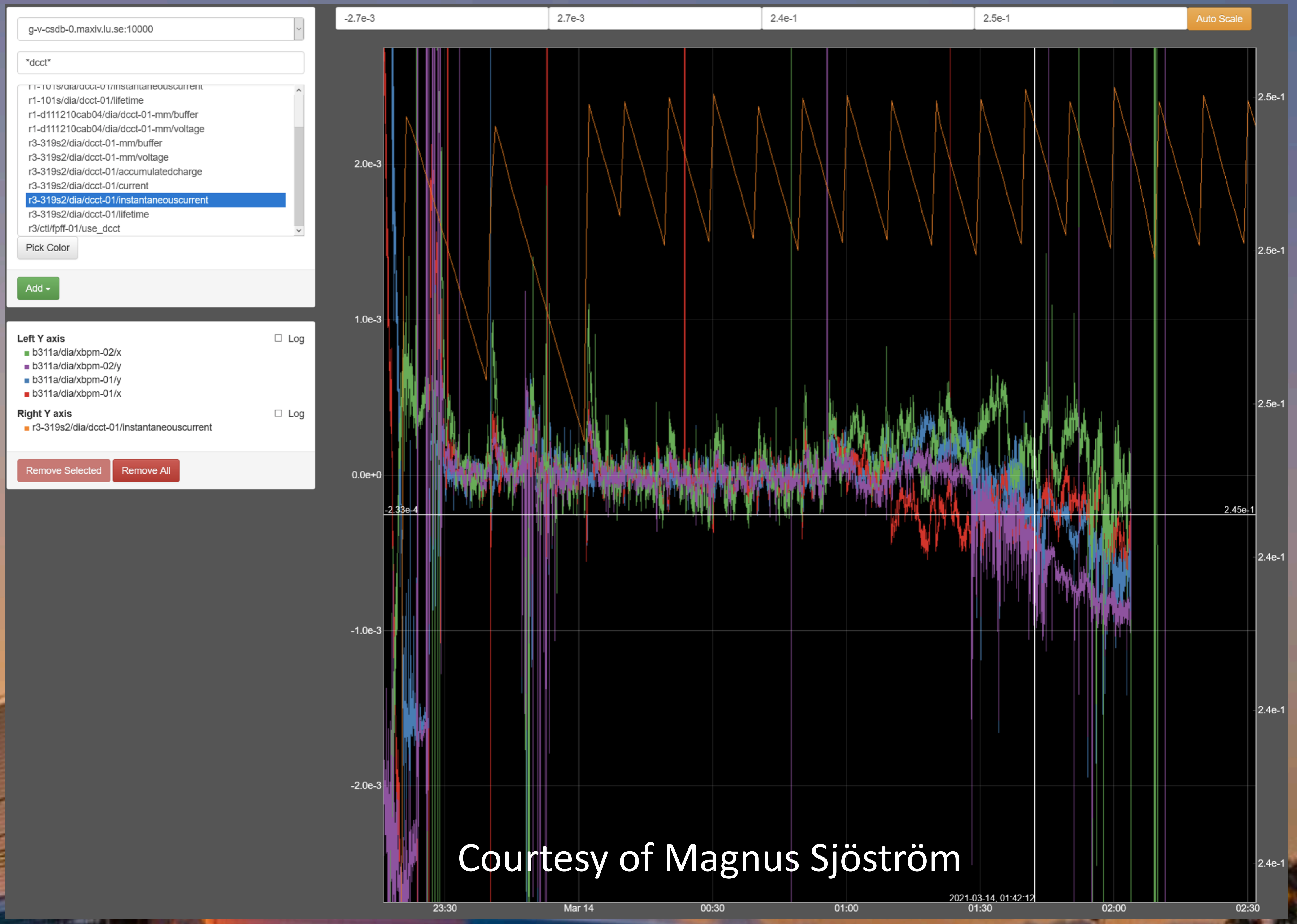
Accelerators Status

X-ray BPMs & orbit feedback

- Test of a photon beam based orbit feedback
  - correcting orbit angle in the long straights
  - update of the orbit reference values every 10 seconds
  - beamline and FE were **not** in thermal equilibrium during this test
  - ID orbit correction applied:
    - hor.: 0.17 µrad on top of a 10 µrad orbit bump
    - vert.: 0.14 µrad on top of a -66 µrad orbit bump
- Compensation of photon beam position drifts
  - top-up injections (every 10 minutes)
  - temperature transients
  - gap drifts
- Next steps
  - correction of position & angle
  - tests with beamlines
  - development and implementation of photon beam position feedback if required



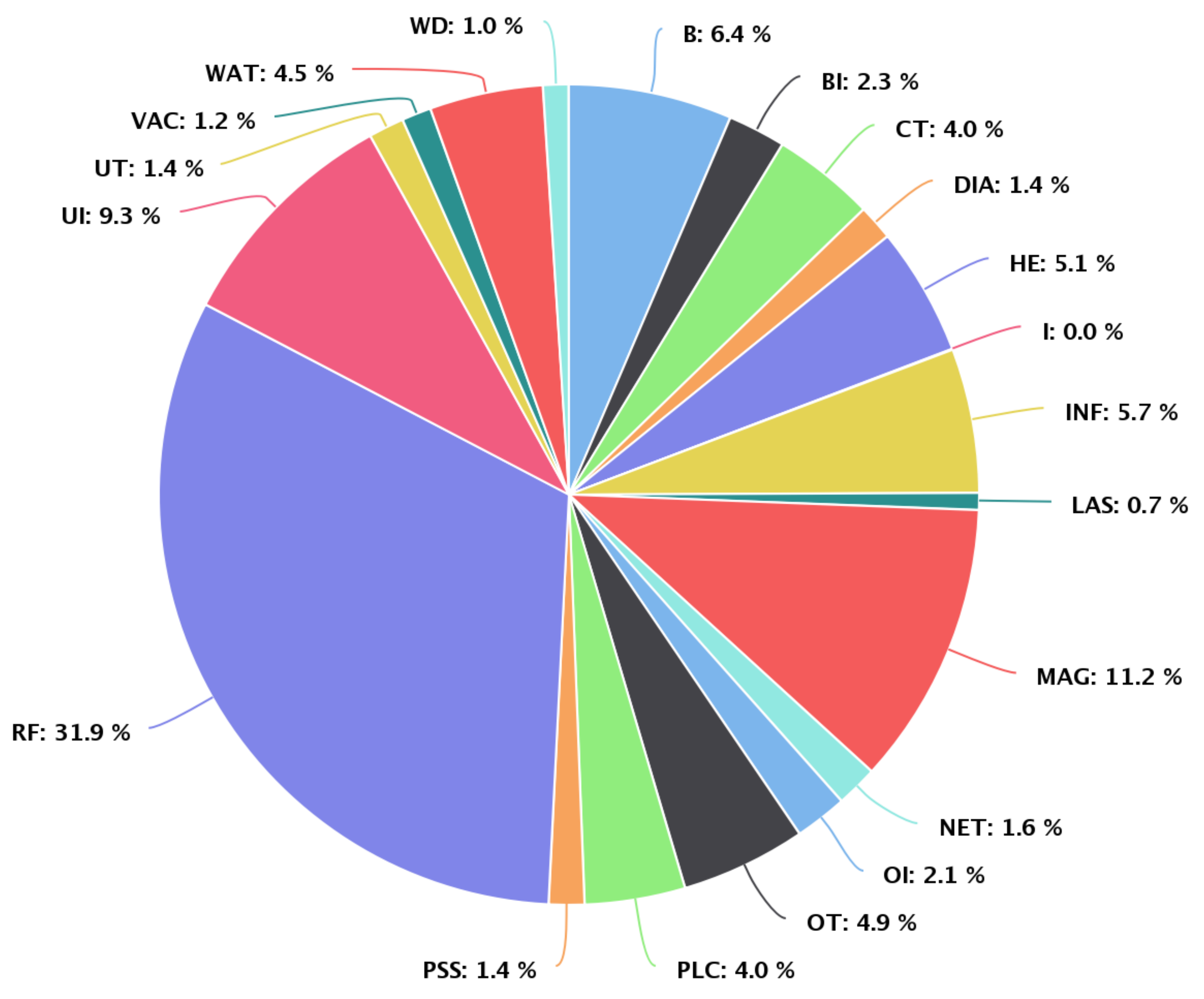
Courtesy of Jonas Breunlin



Courtesy of Magnus Sjöström

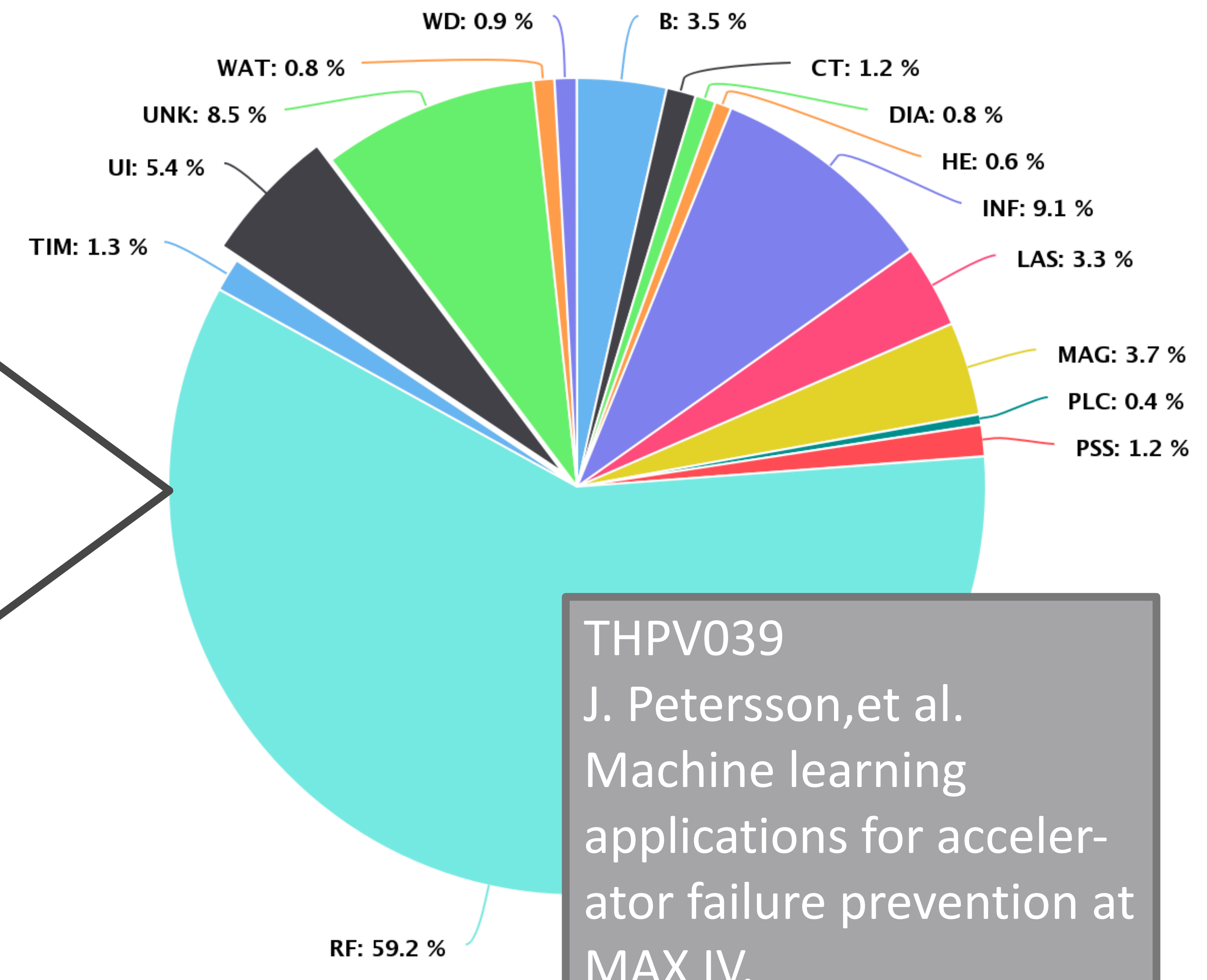
23:26: xofb on
23:29 fofb fixed
00:55 xofb goes off. plan is to keep the gap and the orbit where they are and record the drift for one more hour.

Accelerators Status



Courtesy of Stephan Molloy

Projects
2020-2021:
ID compensation
FOFB
Complement BPM
Bunch Length measurement
Shuntgroup
ID upgrade
MPS
reconfiguration



THPV039
J. Petersson,et al.
Machine learning applications for acceler-ator failure prevention at MAX IV.

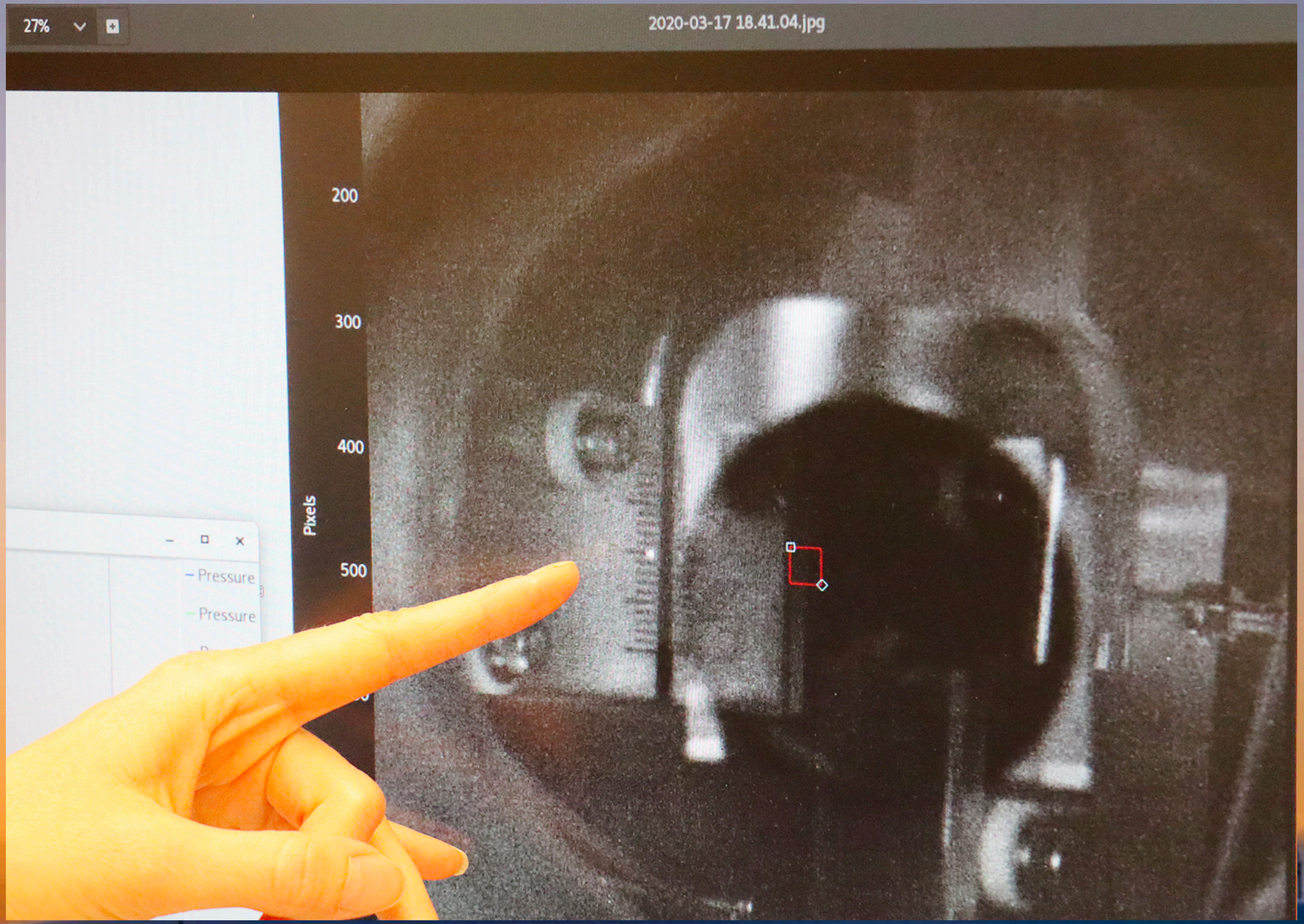
Distribution of downtime per subsystem
2020/01 -> 2020/12.

The downtime is mainly impacted by short interruption.

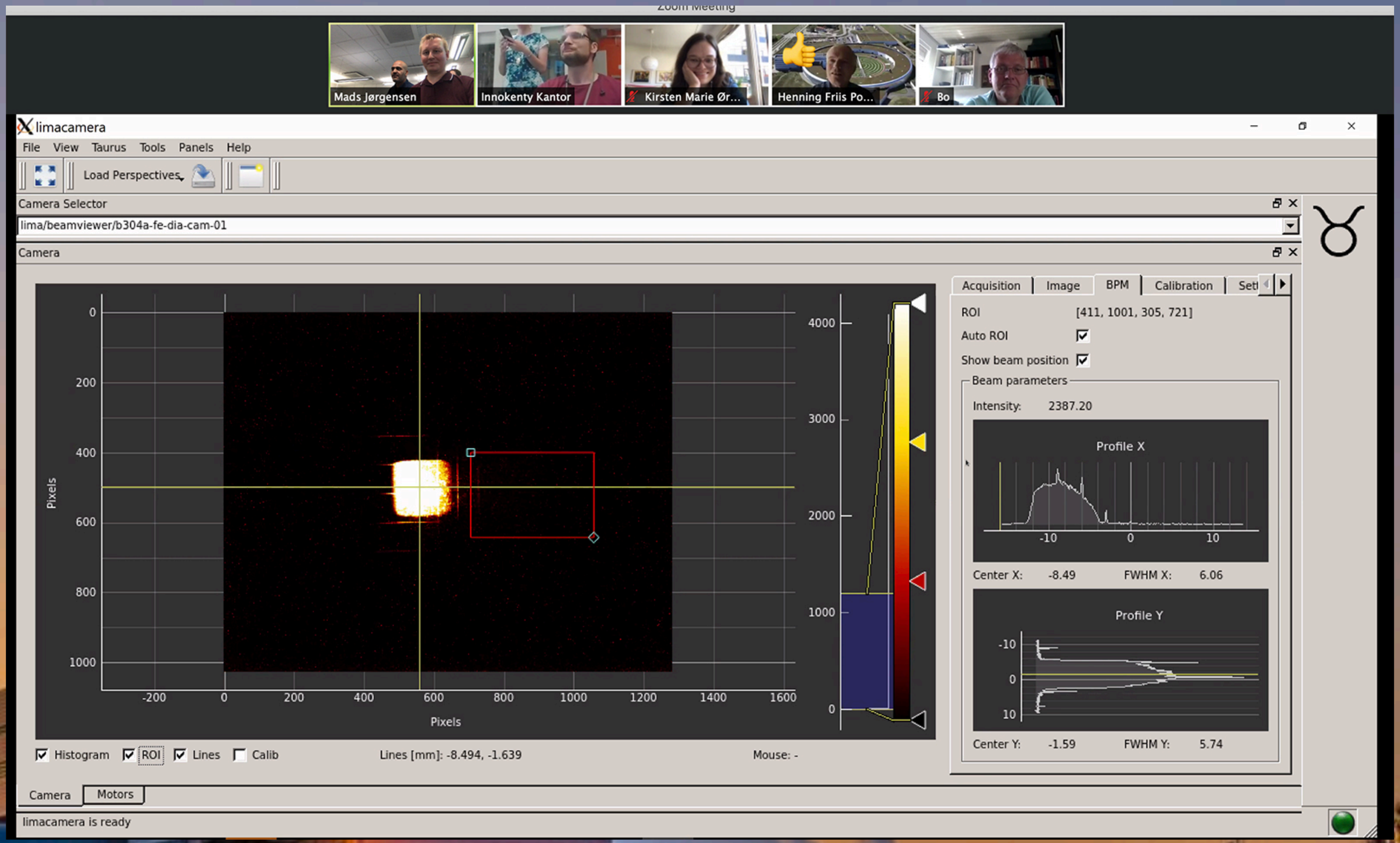
Distribution of downtime per subsystem
2021/01 -> 2021/10.

Nowadays the downtime improvement focused on the system with long recovery time.

Beamlines Status

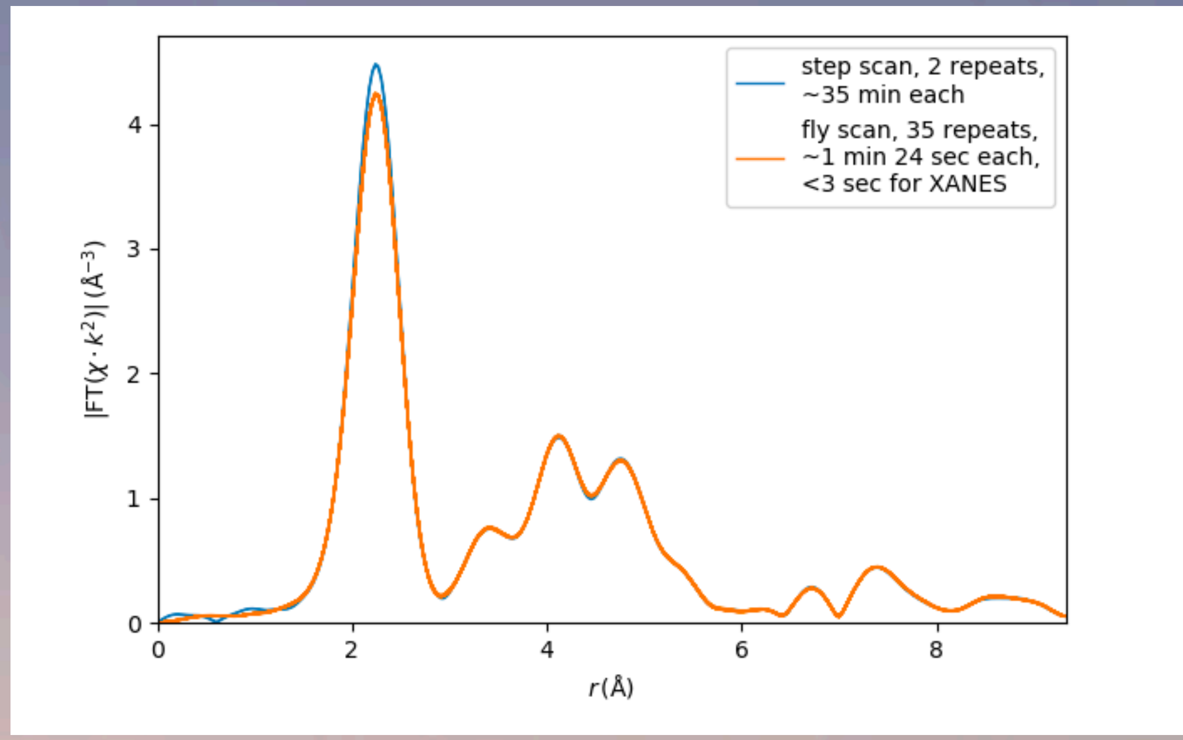


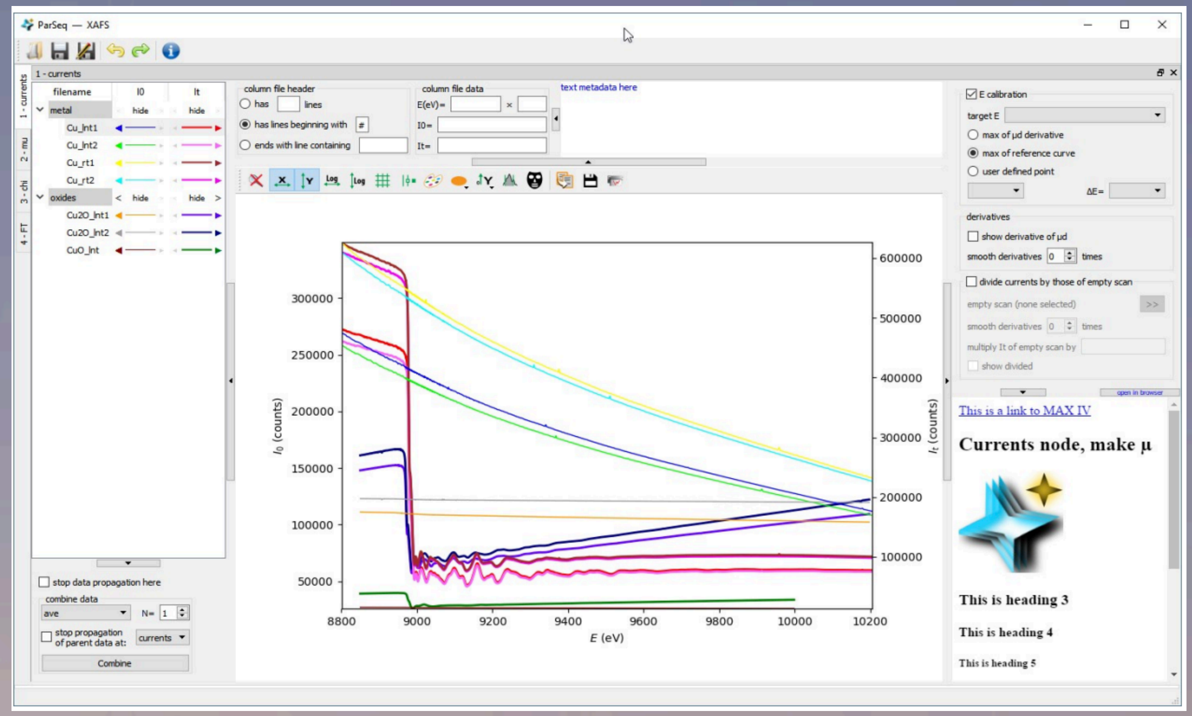
SoftiMAX is the 13th beamline to "see the light" at MAX IV. The synchrotron light was delivered all the way from the undulator to the monochromator within the first few hours after opening the shutter.



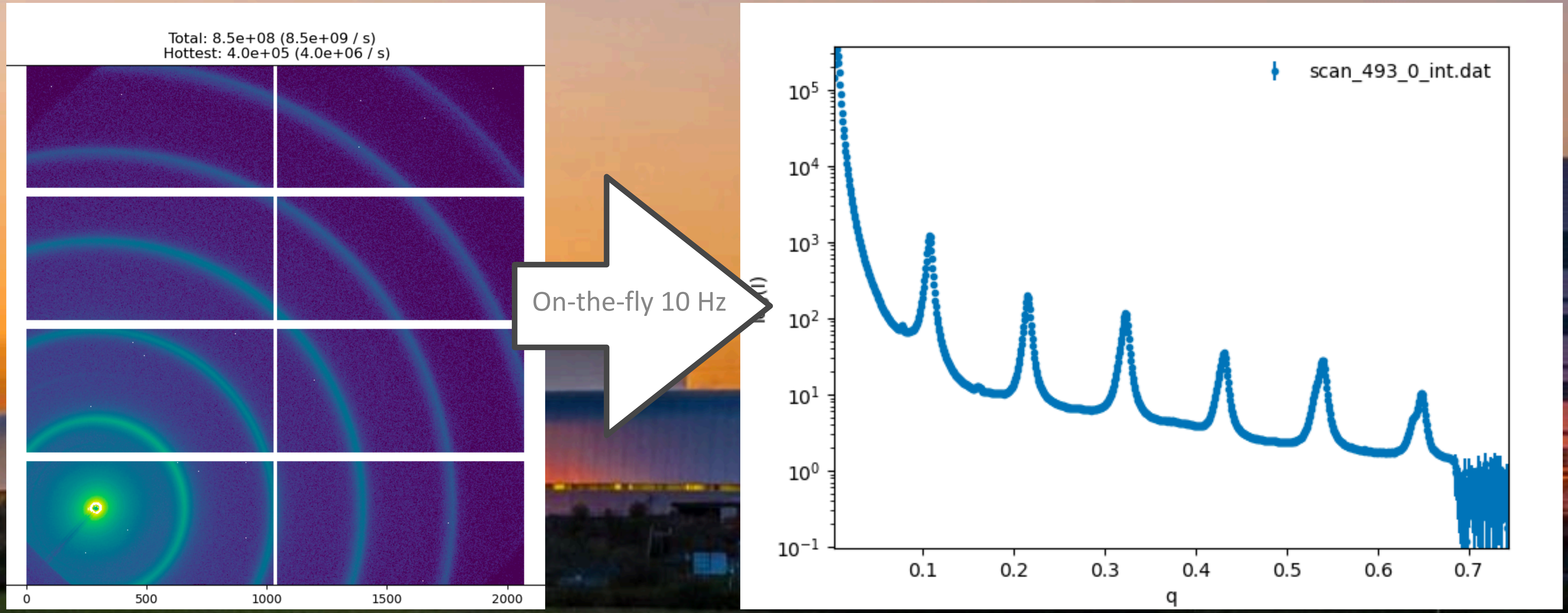
2 June 2020 the Danish beamline **DanMAX** saw first light. Representatives from DTU, Aarhus University and the University of Copenhagen followed the process online.

Beamlines Status

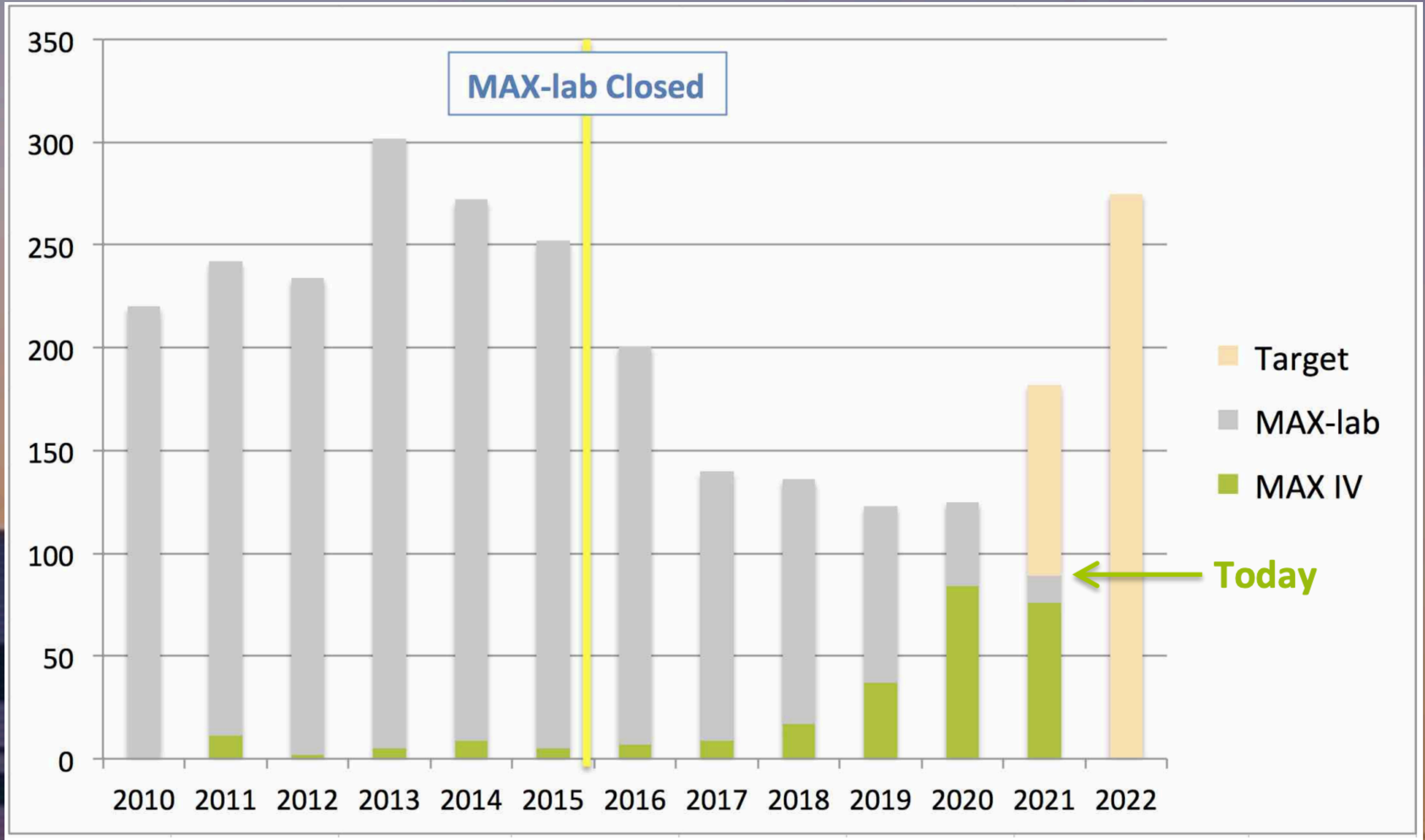




Balder, Copper foil EXAFS, Fly scan with a total accumulation time down to ~30 sec per full EXAFS.
Parallel Execution of Sequential Data Analysis (right) is done online.



CoSAXS, Silver behenate use to calibrate SAXS data at short sample-to-detector distance.
The Azimuthal Integration (right) shown in linear plot is computed on the fly at 10 Hz. (A. Terry)



Publication of MAX IV Laboratory vs MaxLab.

Project Management

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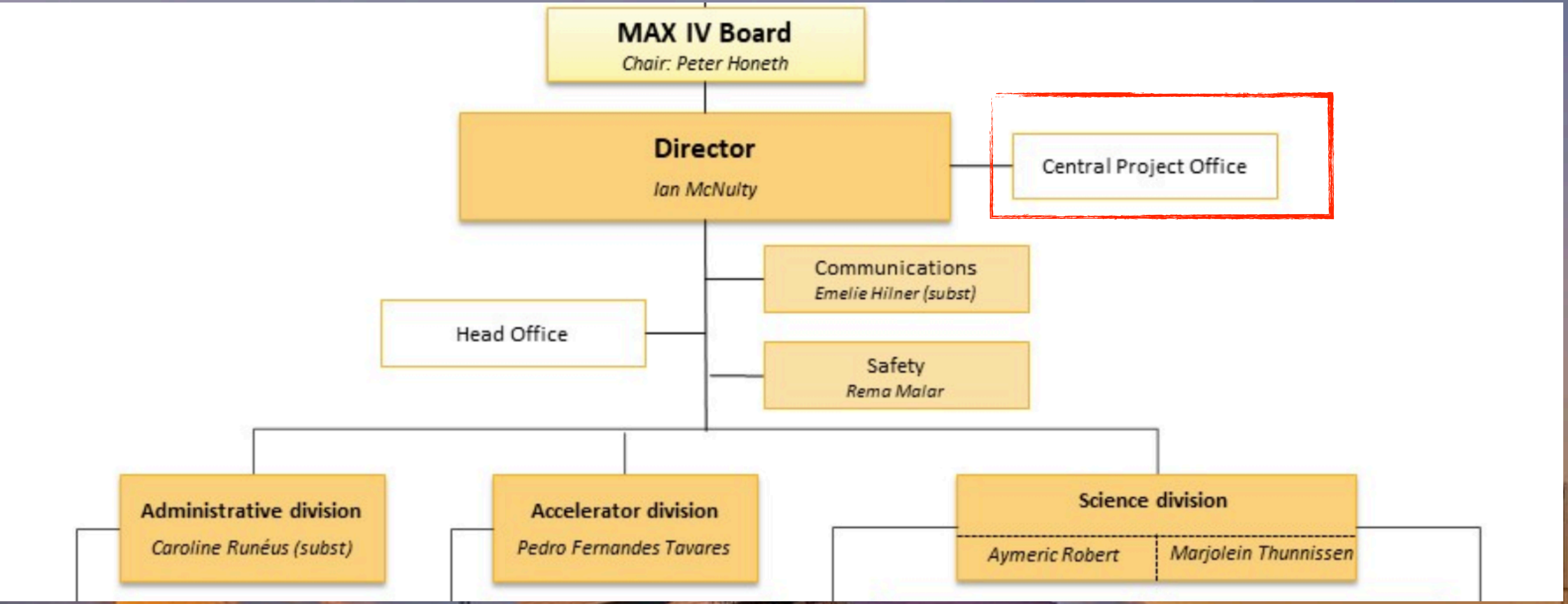

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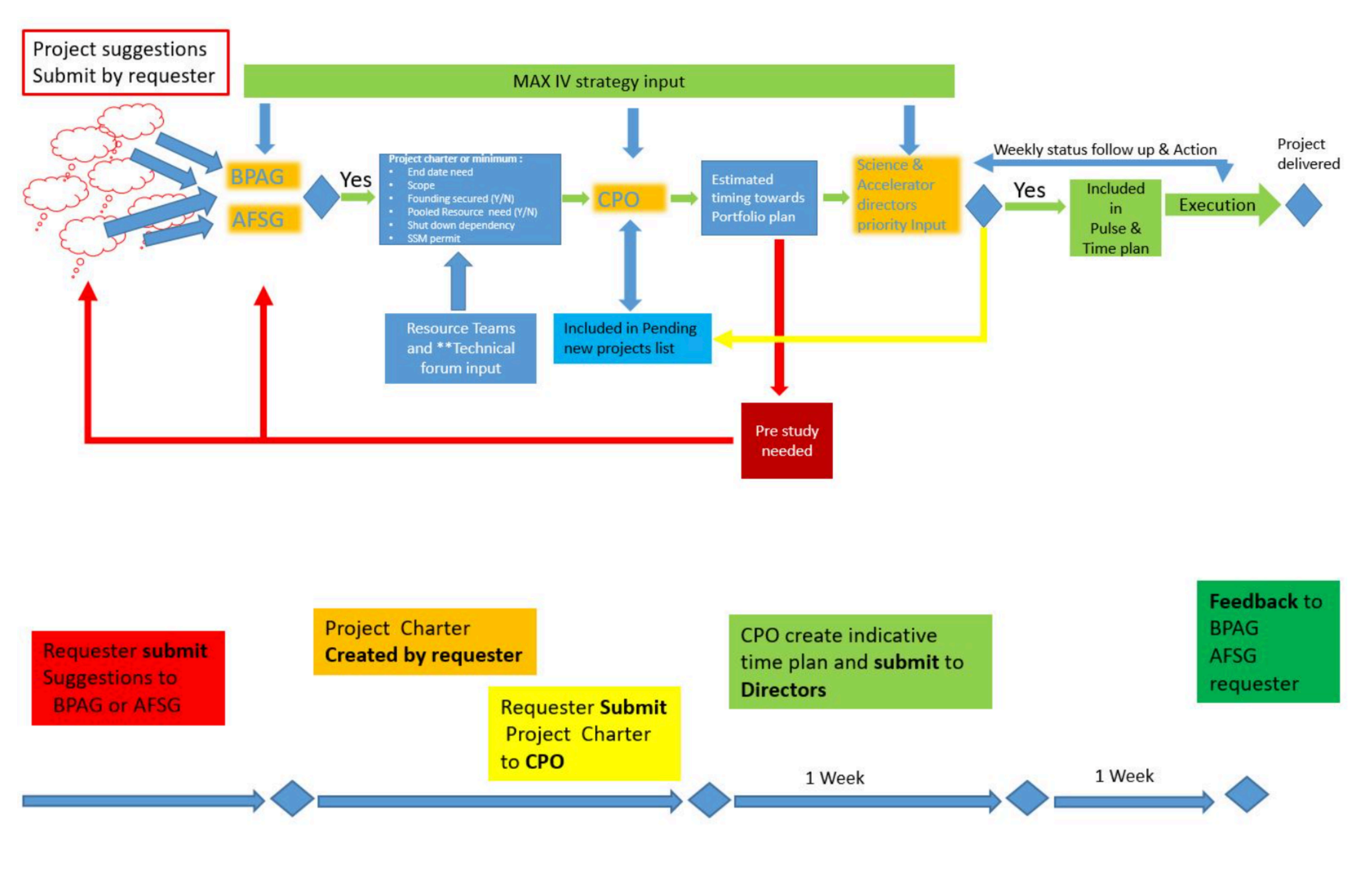

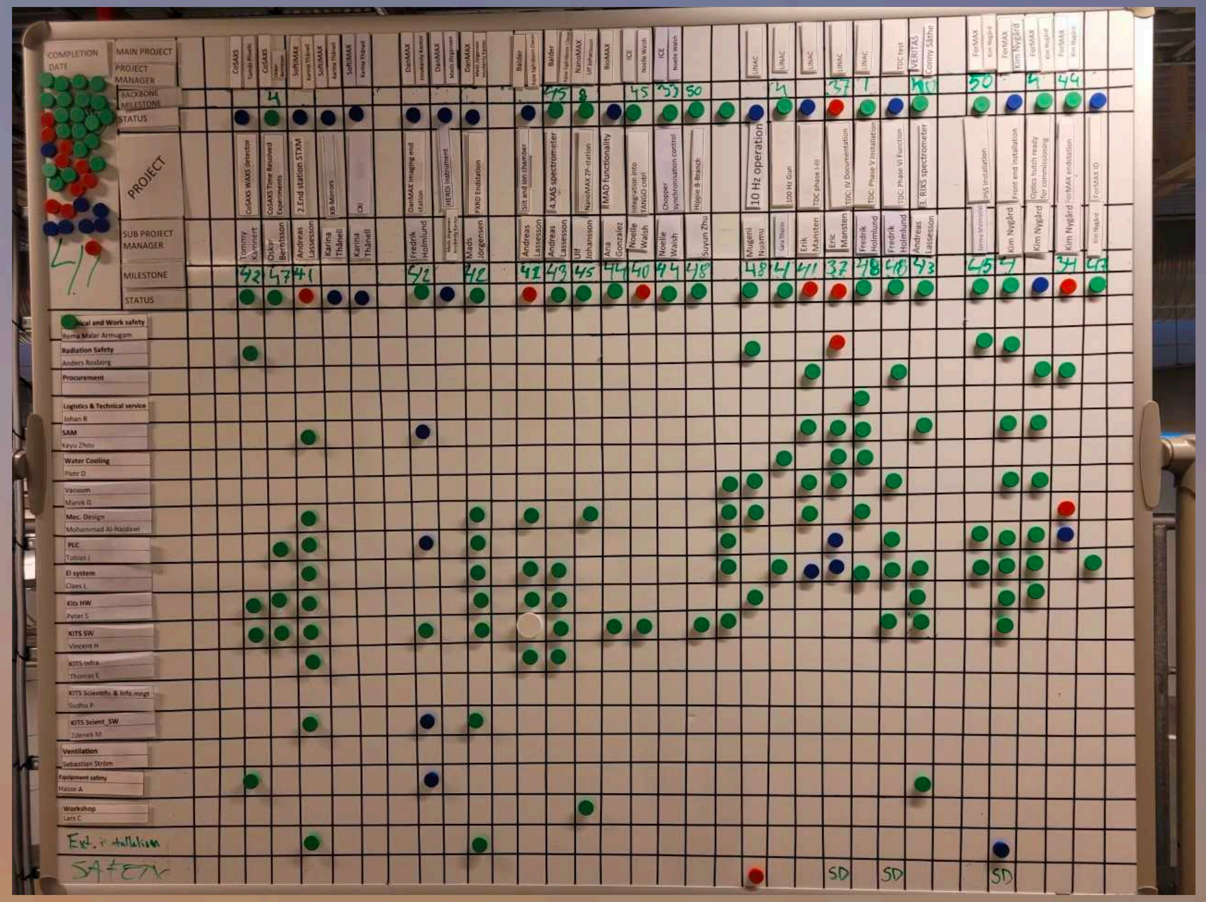

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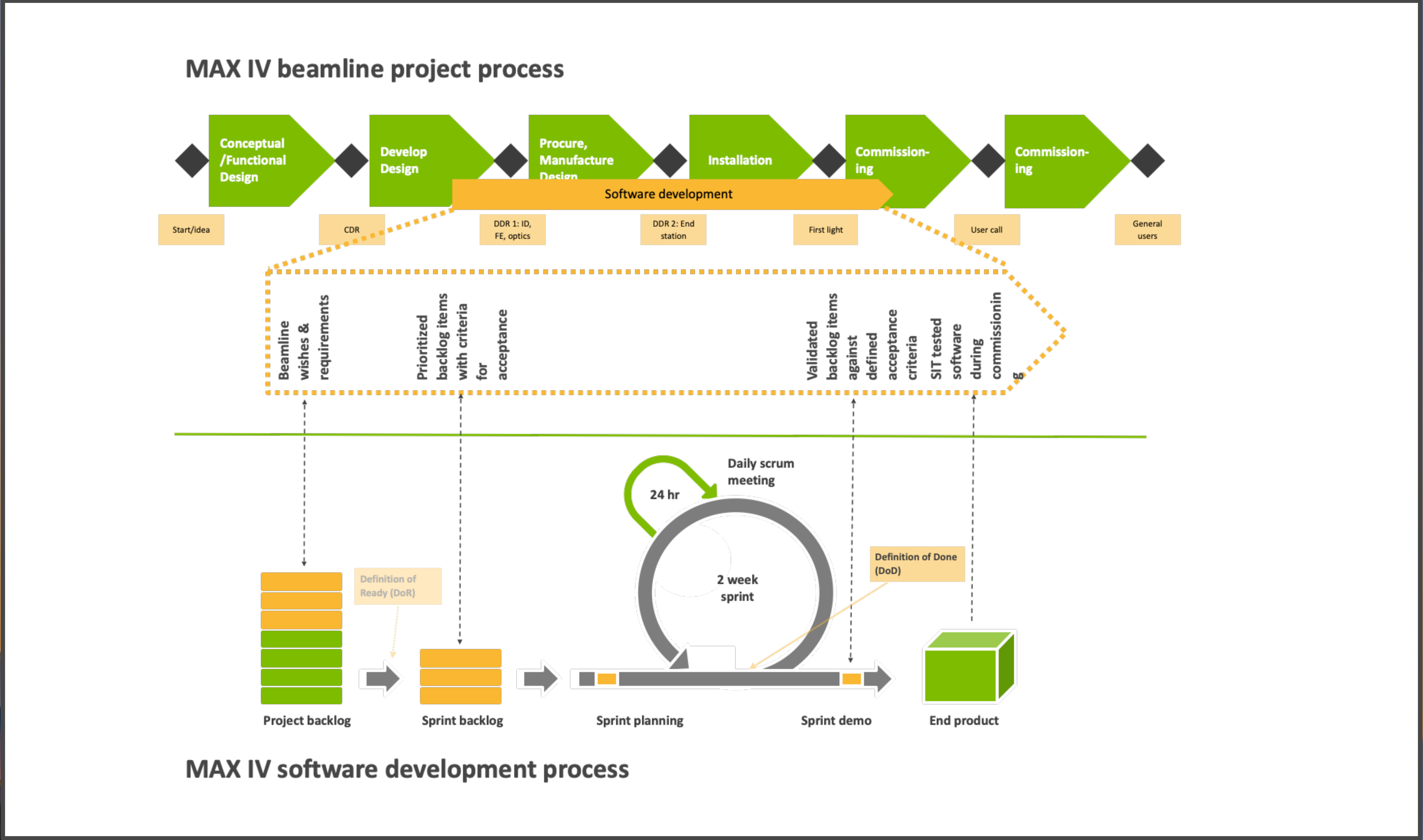

Operation

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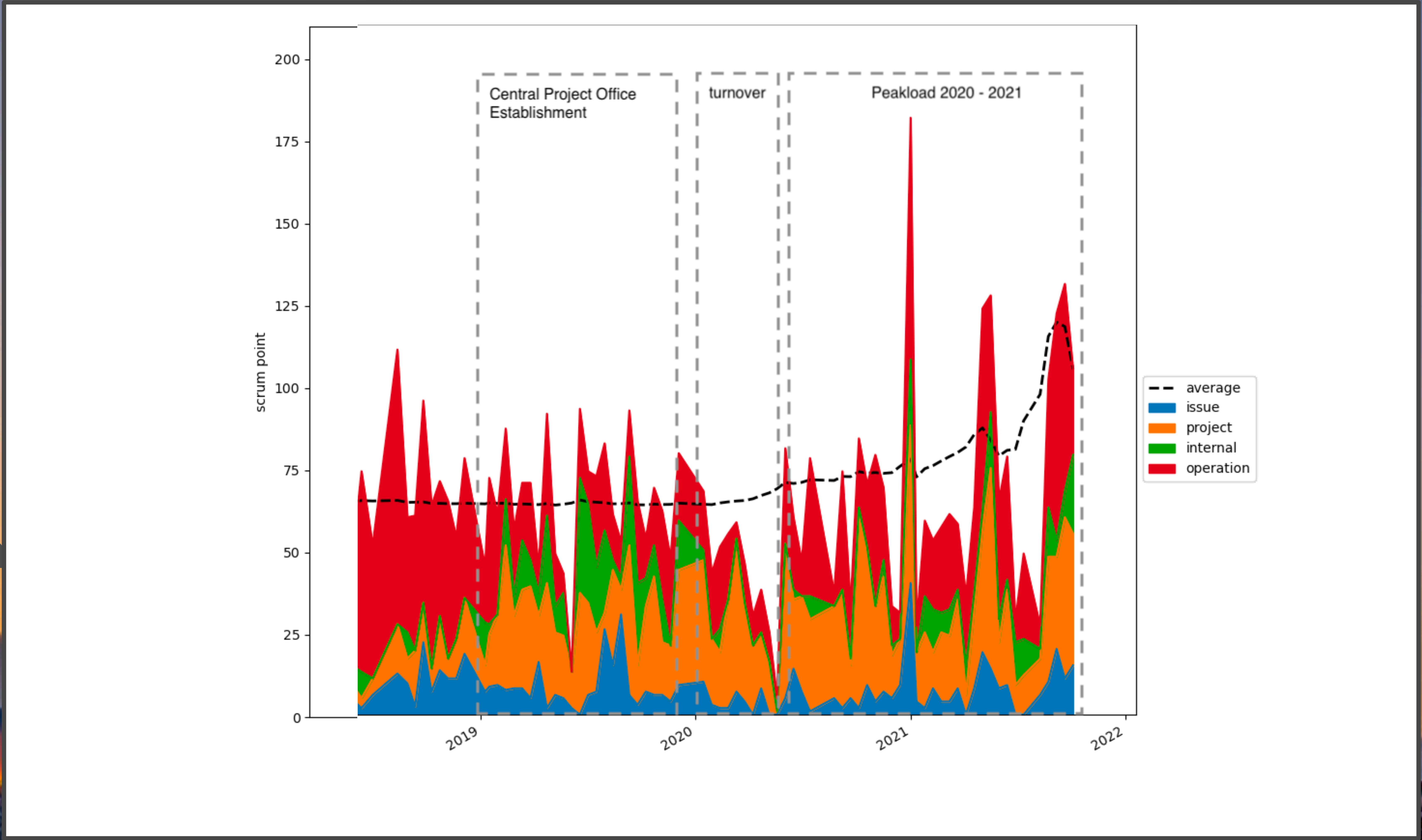

Operation

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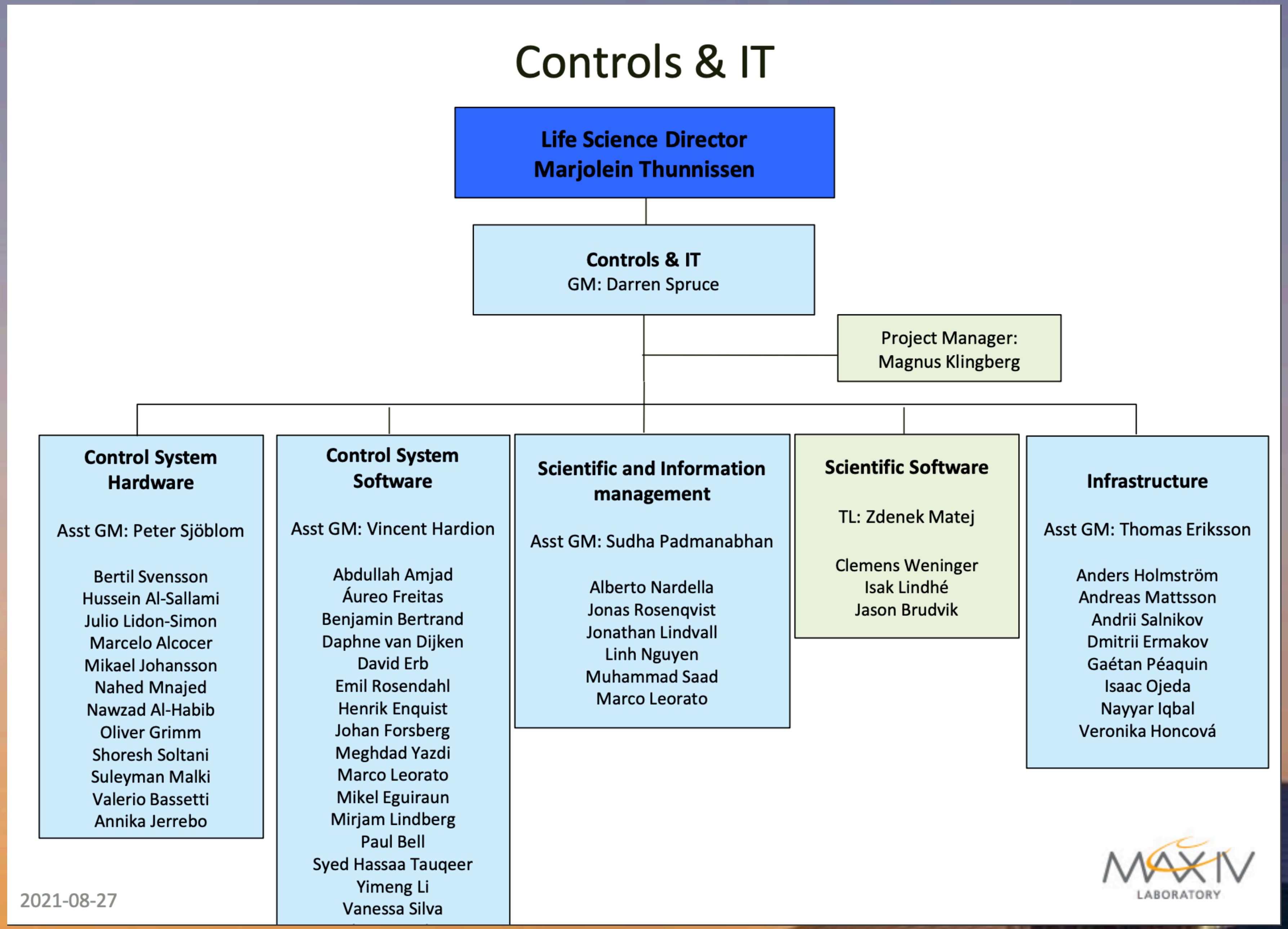


ISSUES	CAUSE
RELIABILITY and PERFORMANCE	Project Priority on the Feature
ROBUSTNESS	Behaviour of the equipment not fully understood
USABILITY (User friendliness)	Limited commissioning time
SUPPORT RESPONSENESS	Lack of resource

KITS Operational Support

KITOS

Proactive monitoring

KITOS shift crew

Staff in user operation

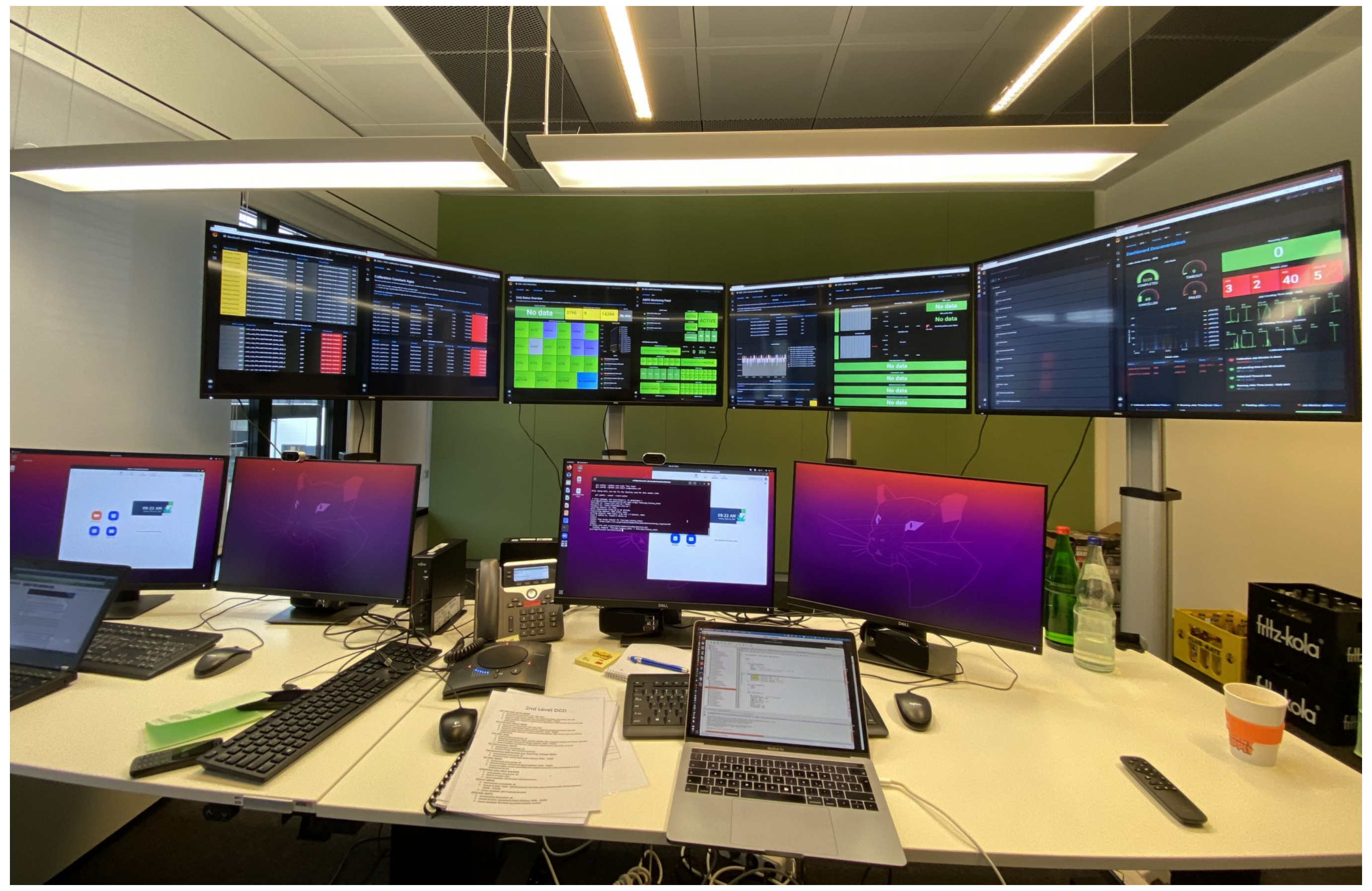
PROJECT

Longer term follow-up

KITS teams Expert second line support

Courtesy of Mirjam Lindberg

Inspired by the XFEL Data Operations Center (DOC), users access the expertise through a single number on support



XFEL DOC has access to a state-of-the art proactive monitoring.

Courtesy of S. Aplin, S. Hauf and the DOC team, XFEL.

KITS Improvement

- MAX IV
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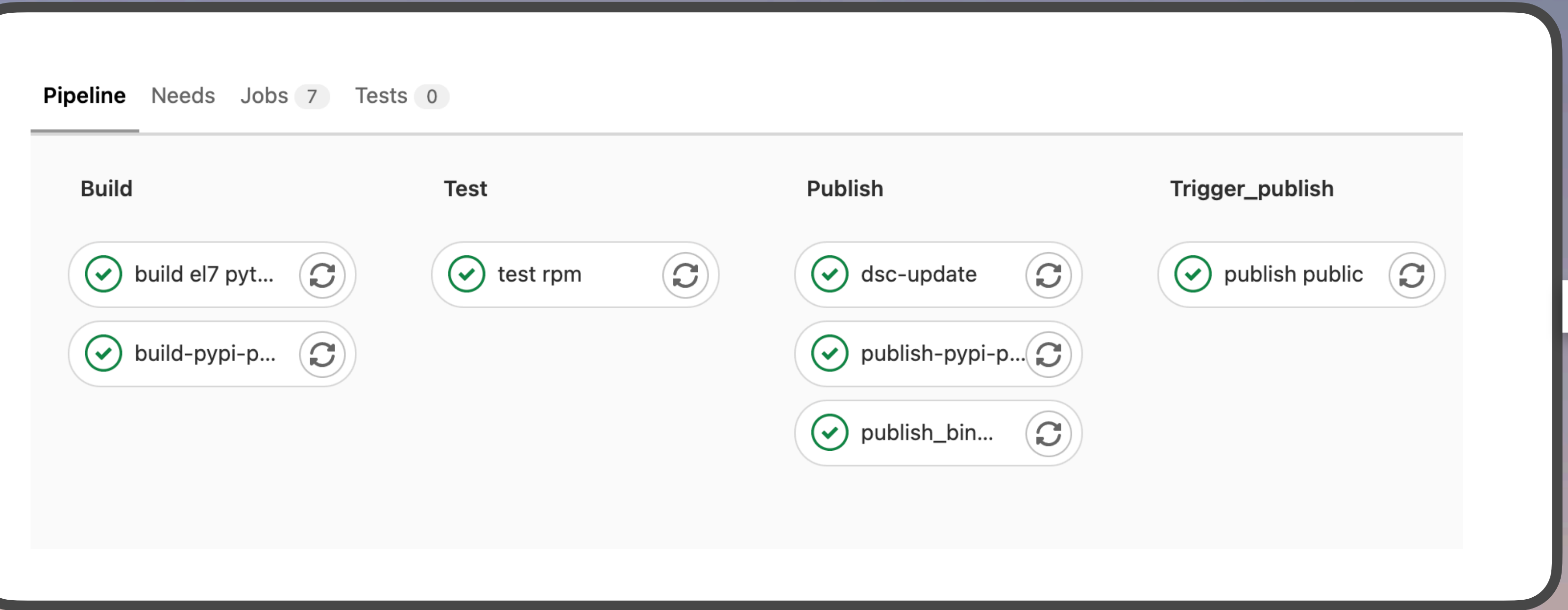
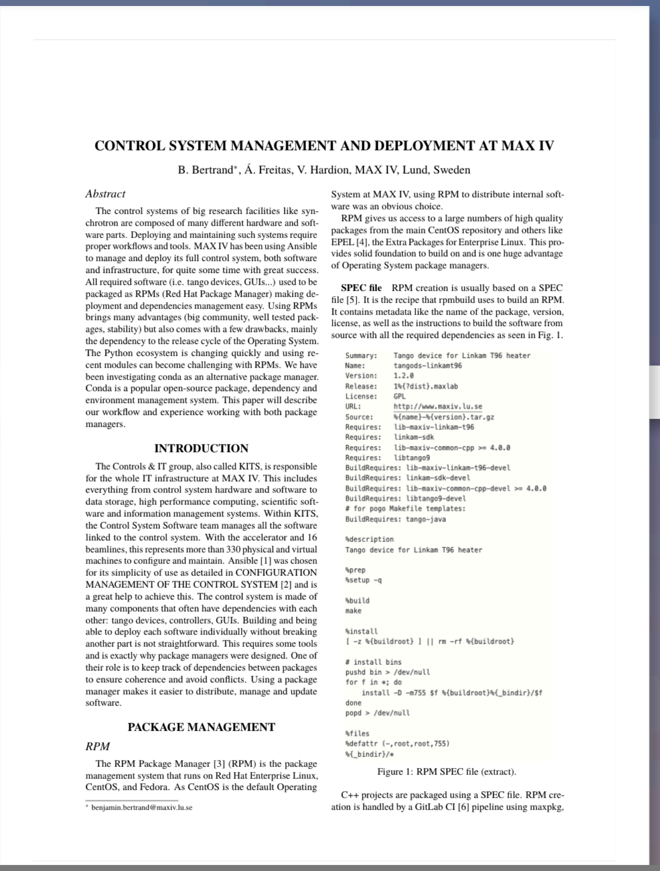
Deployment and Monitoring



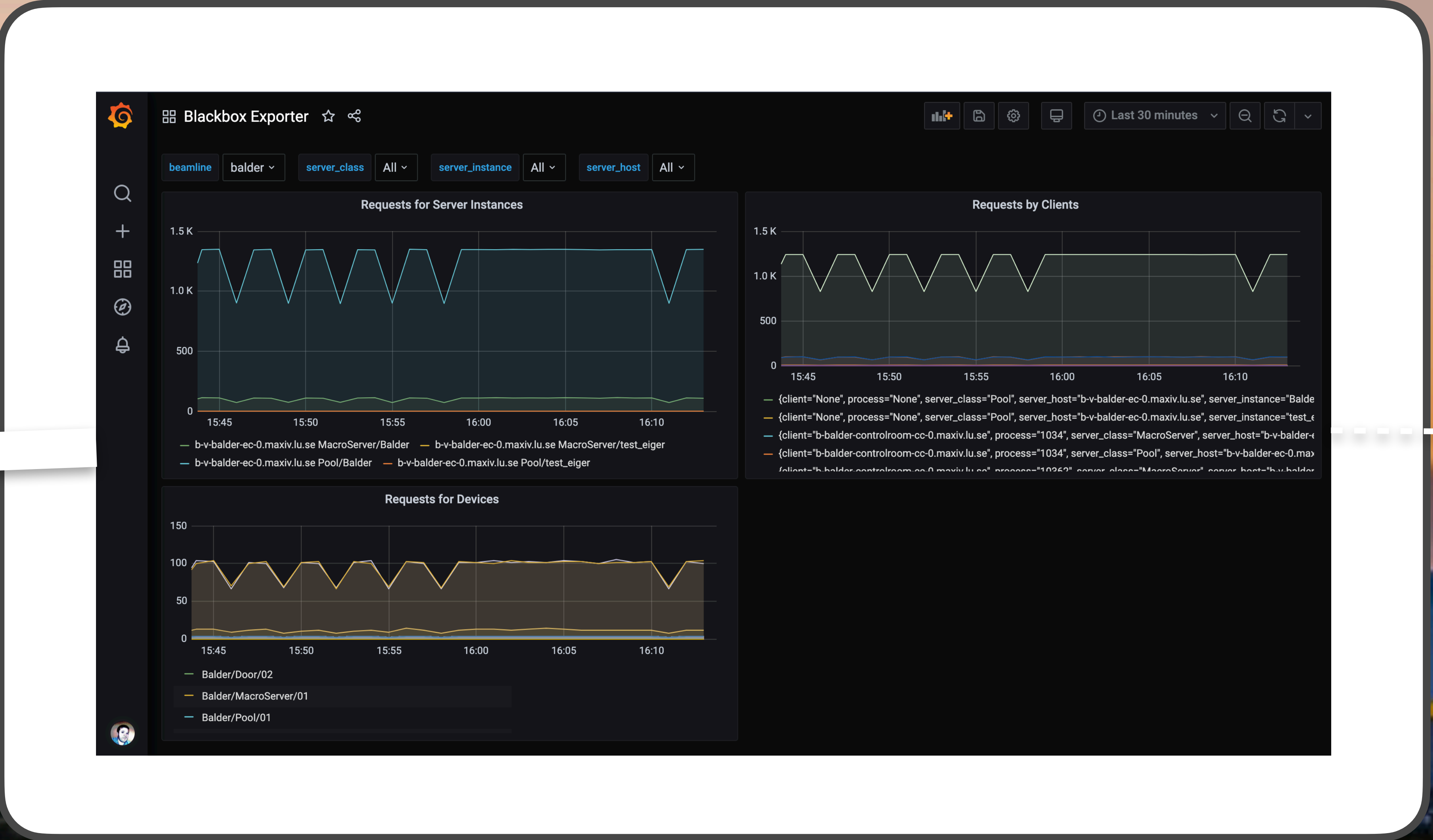
Continuous Integration with Gitlab pipeline

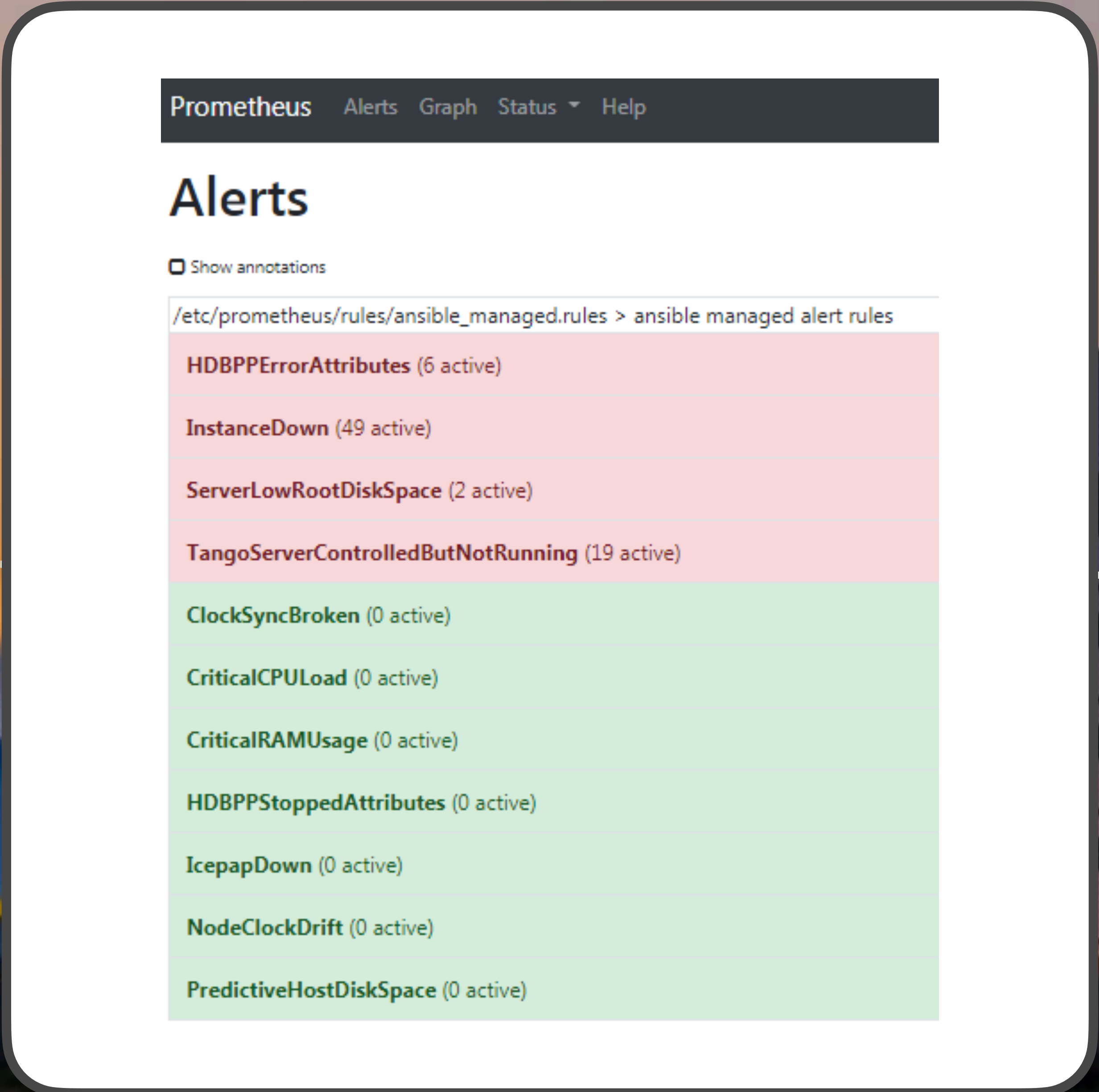
Continuous Delivery

Deployment with Ansible



THBL01
B. Bertrand, et al.
Control System Management and Deployment at MAX IV.



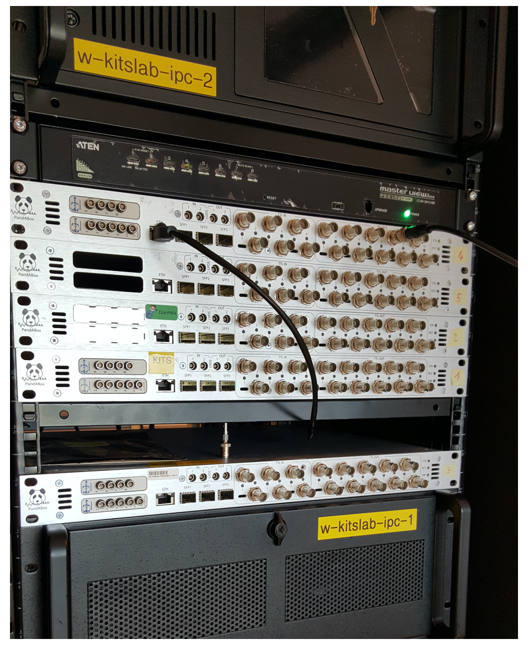


THPV011
B. Bertrand, et al.
Notifications With Native Mobile Application

Tango Performance Monitoring with Graphana (source ELK)

Prometheus alerts system showing the IcePAP controllers down (email alerts)

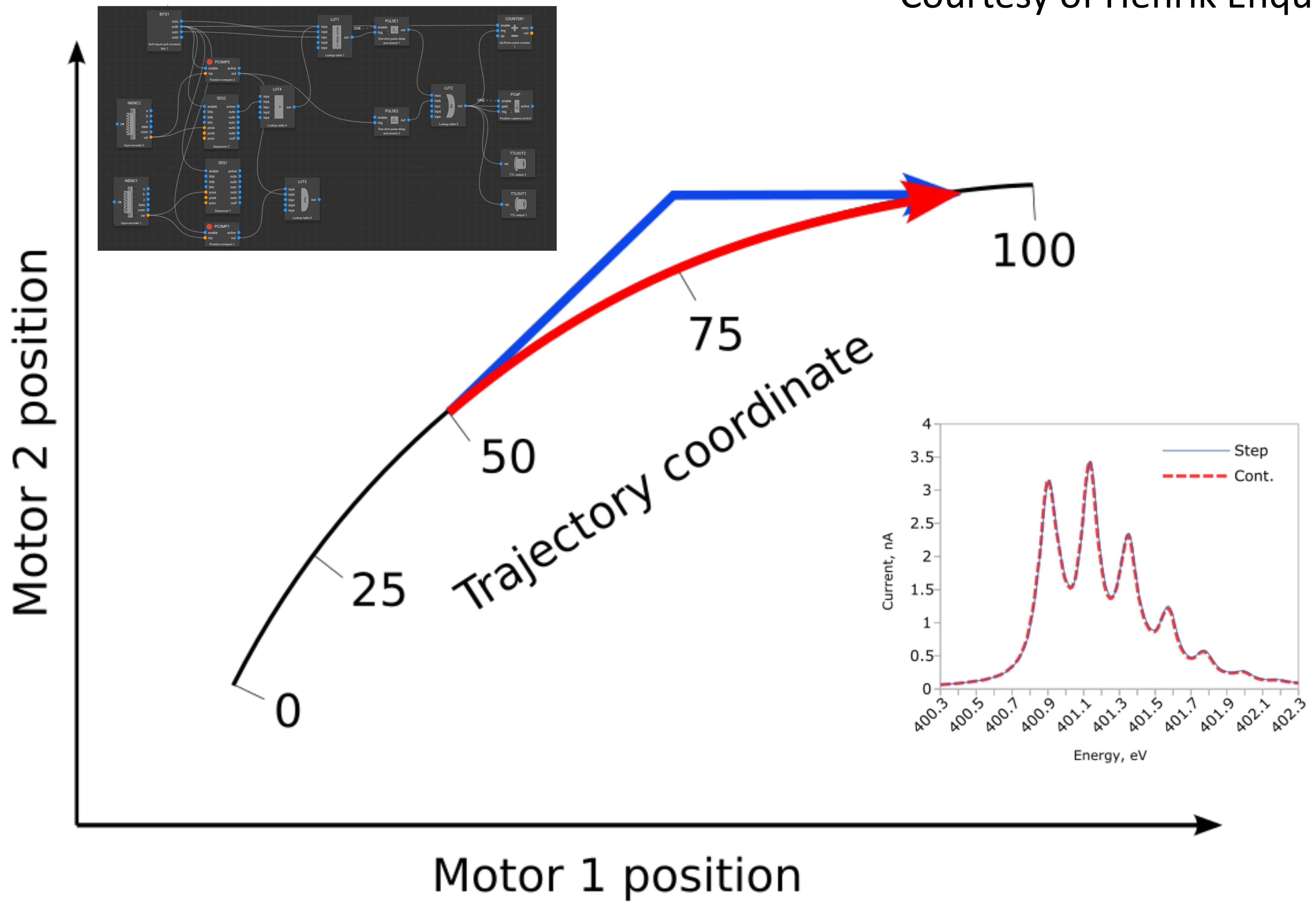
Continuous Scanning



Danmax receives it's first.

Upgrade of the Hardware Standard with PandABox (Credit SOLEIL/ DIAMOND), replacing hard-to-maintain IOC.

Courtesy of Henrik Enquist



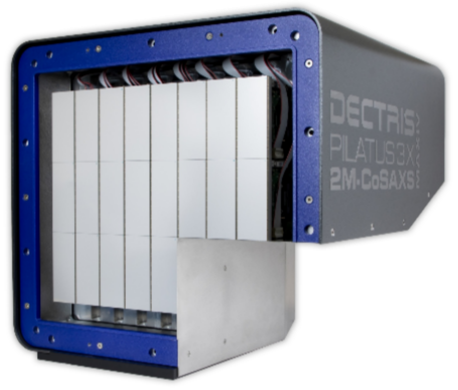
Continuous Scanning is the standard type of scan to match the performance of the detectors.


CONTINUOUS SCANS WITH POSITION BASED HARDWARE TRIGGERS
H. Enquist, A. Bartalesi, B. Bertrand, J. Forsberg, A. Freitas, V. Hardion, M. Lindberg, C. Takahashi, MAX IV Laboratory, Lund, Sweden

FRBR04
H. Enquist, et al.
Continuous Scan with Position Based Triggers.

Detectors and Streaming

Commercial solutions



All beamlines in operation so far use commercial detectors and cameras.

Inventory 2021:

Hybrid Pixel Detectors

- 3x Dectris Eiger2 4M, 3x Eiger1 1M, 1x Eiger1 16M
- 1x Dectris Pilatus3 2M, 1x Pilatus2 1M
- 1x Dectris Pilatus3 2M (custom WAXS L-shaped)
- 1x Dectris Mythen
- 1x QD Merlin Quad
- 1x XSpectrum Lamdba 3M (custom WAXS centre hole)

sCMOS cameras

- Numerous Andor Zyla, 1x Andor Balor
- 1x Tucsen "DhyanaX" (NB: Adapted for vacuum following Soleil)

Energy resolving + pulse processors

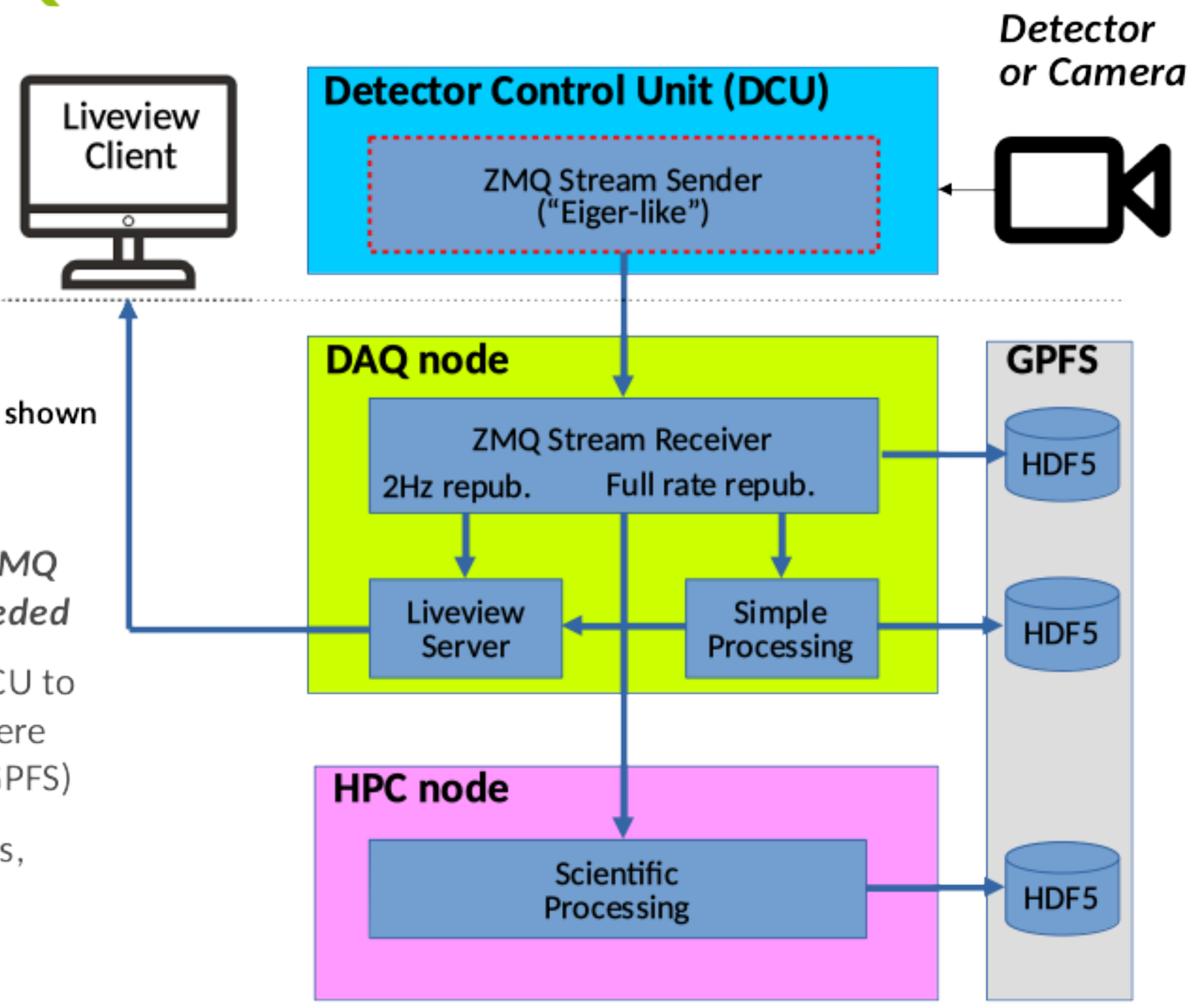
- 2x Amptek XR-100 SDD via QD Xspress3
- 2x Rayspec SDD via QD Xspress3
- 1x Canberra/Mirion 7 element SDD / HPGe via QD Xspress3
- 1x Rayspec SDD Xia FalconX

MAX IV DAQ flow scheme

Beamline

Server room

NB Control layer (Tango) not shown

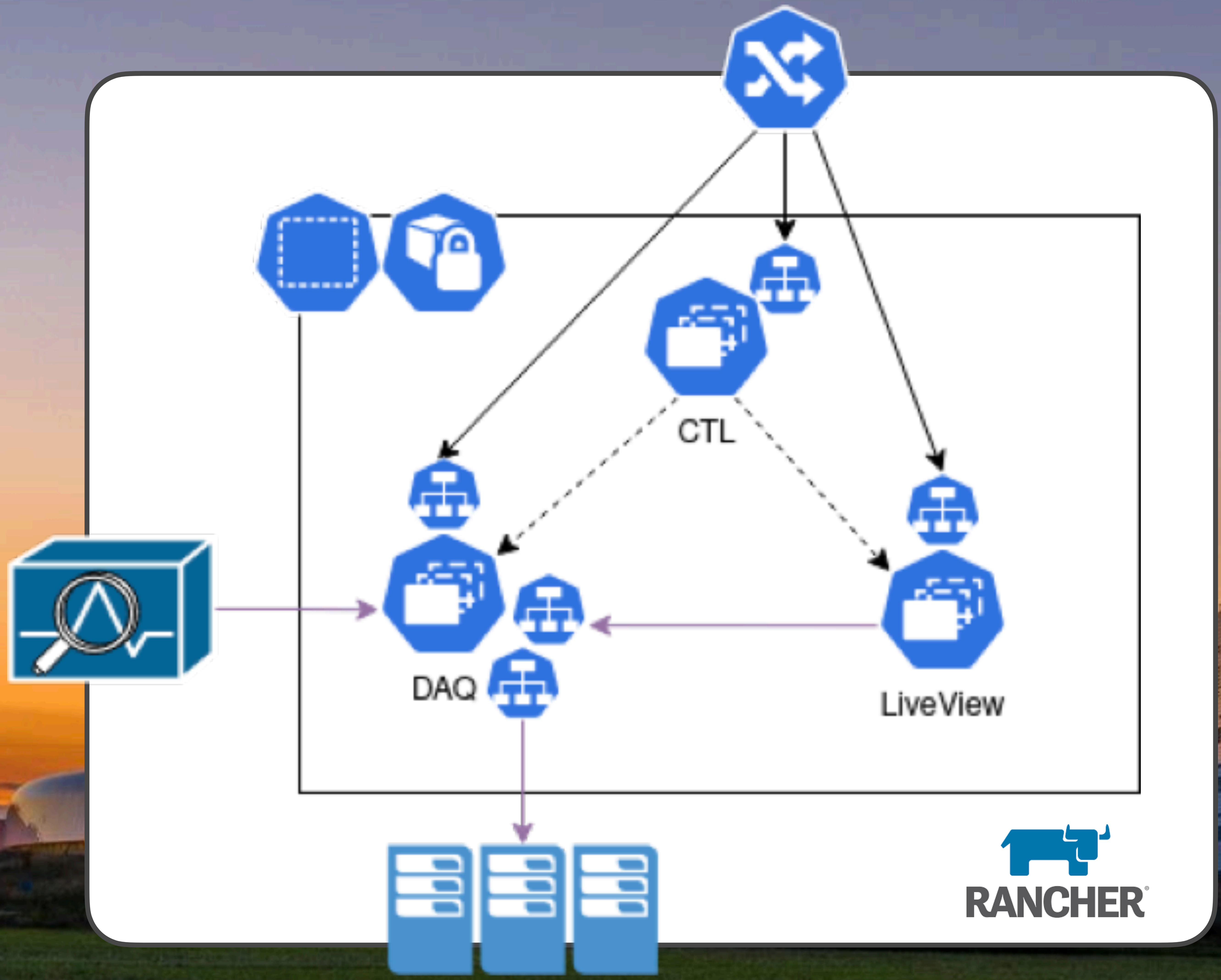


- *Design: implement ZMQ streaming where needed*
- 40GbE connection DCU to DAQ cluster from where data saved to hdf5 (GPFS)
- **~Done**: (Eiger), Pilatus, Andor, Dhyana

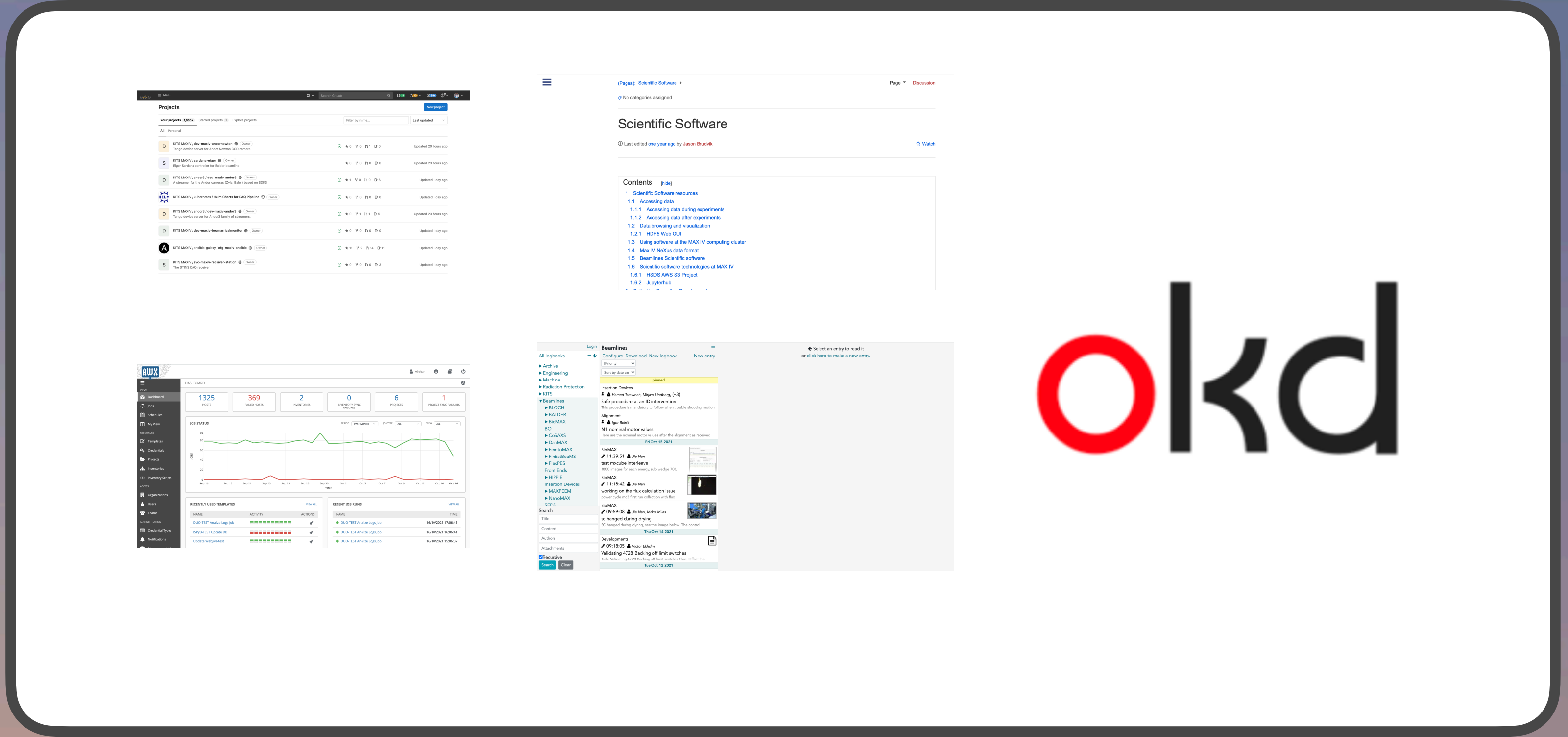
Particule Detectors are the most complex piece of hardware on the Beamlines. In 2019, a small team were dedicated to increase the KITS knowledge in Particle Detectors.

Approximately half the KITS software effort is now spent on data acquisition (DAQ) , especially on the data and metadata streaming with ZMQ over 40G links to a central DAQ cluste.

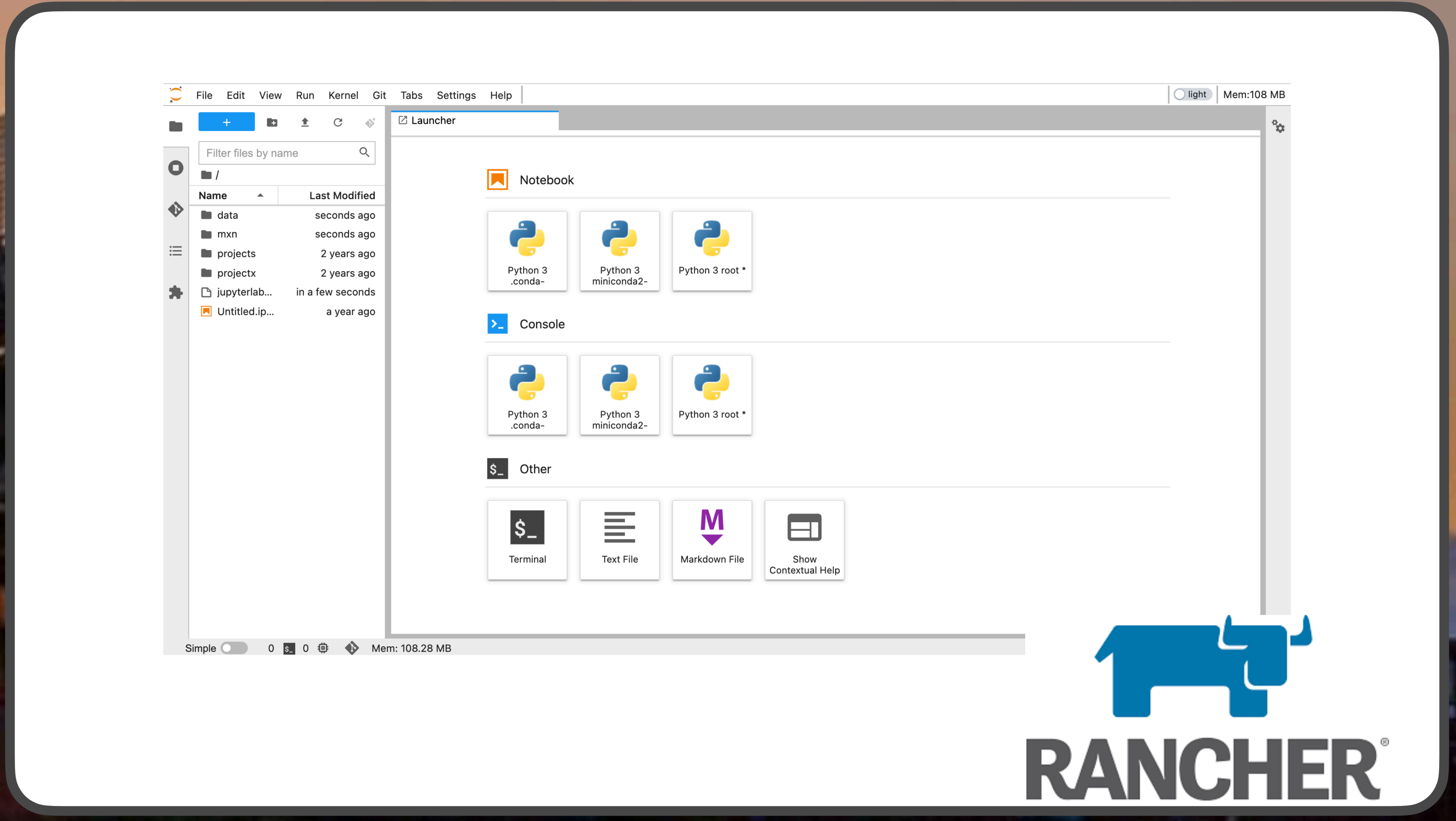
Kubernetes Cluster



The kubernetes architecture for the Data Acquisition Cluster (DAQ Cluster).

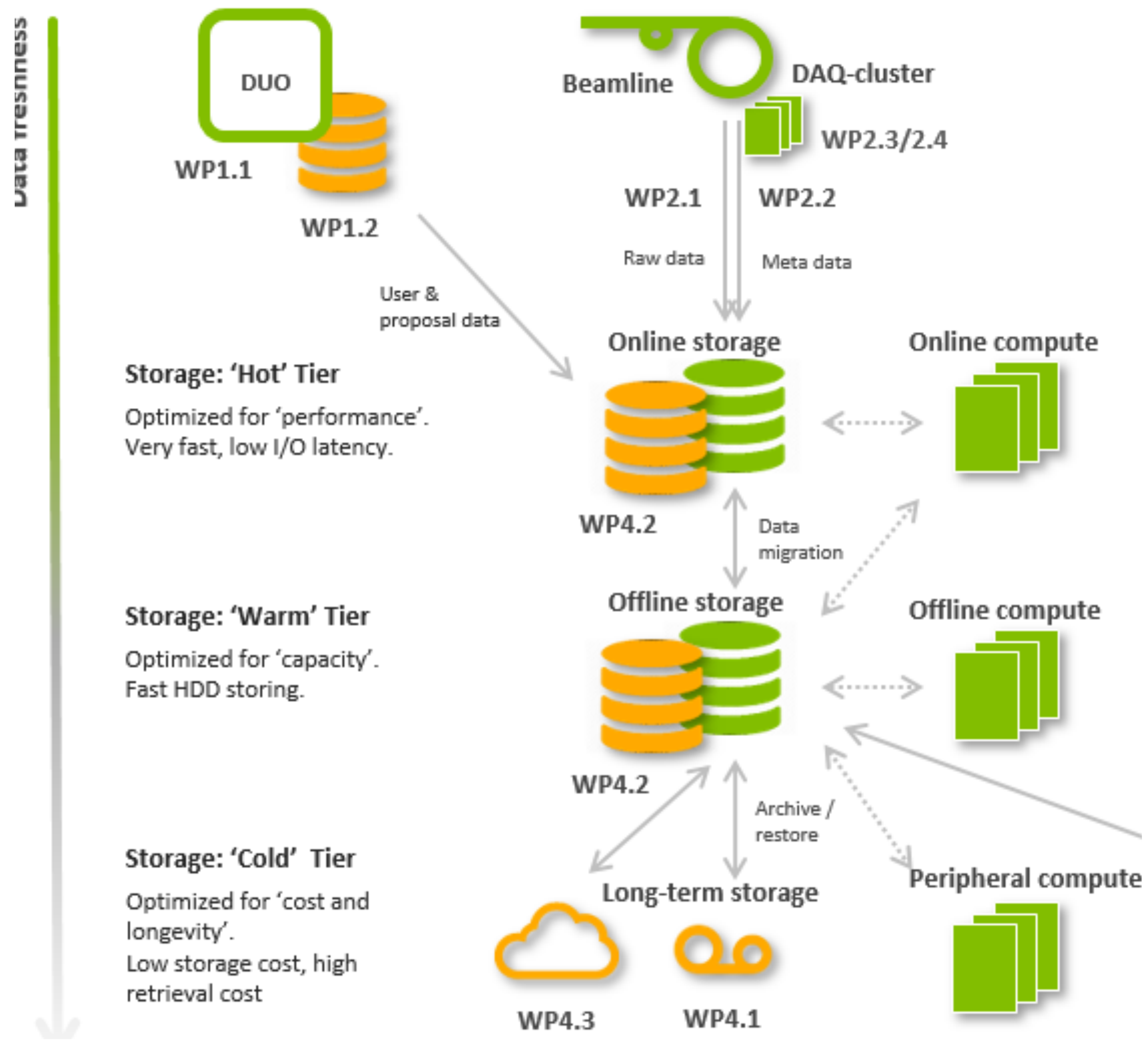


General web services run on OKD Cluster.

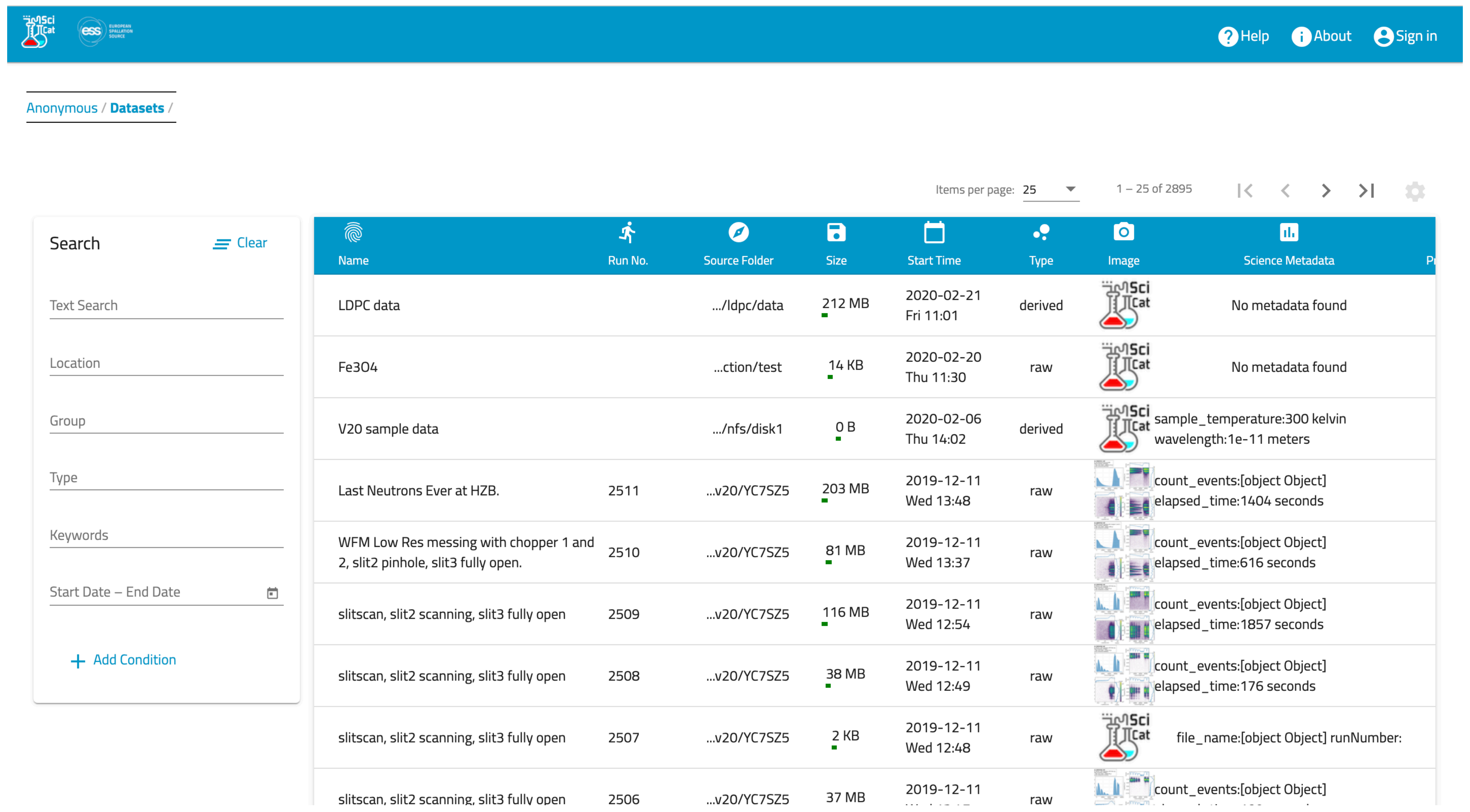


JupyterHub Cluster with GPU (similar DAQ Cluster Architecture).

Data Management



SciCAT Metadata catalog



PAUL SCHERRER INSTITUT PSI

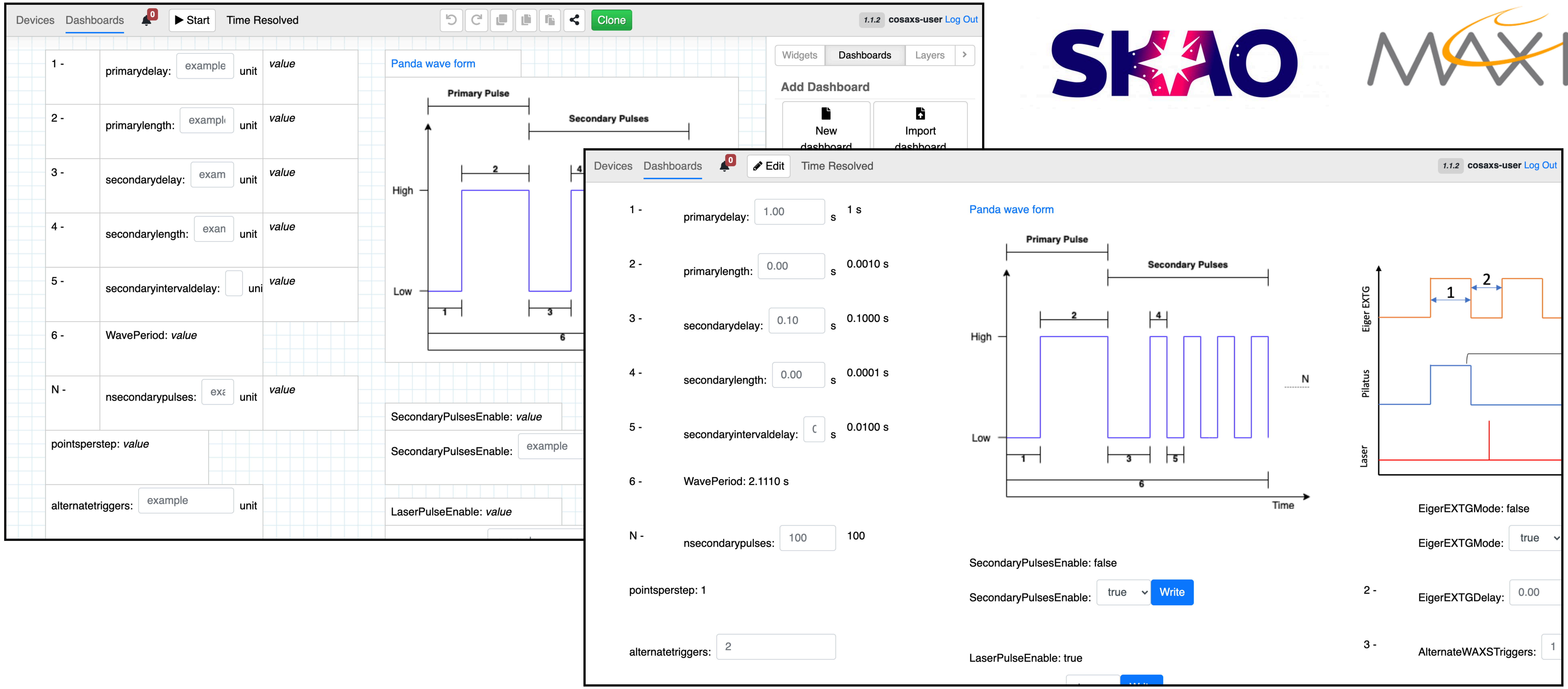
EUROPEAN SPALLATION SOURCE

MAX IV

Main Upgrade of the Data Infrastructure: Performance and 10 years retention

SciCAT is currently deployed on 9 beamlines

Web Interfaces



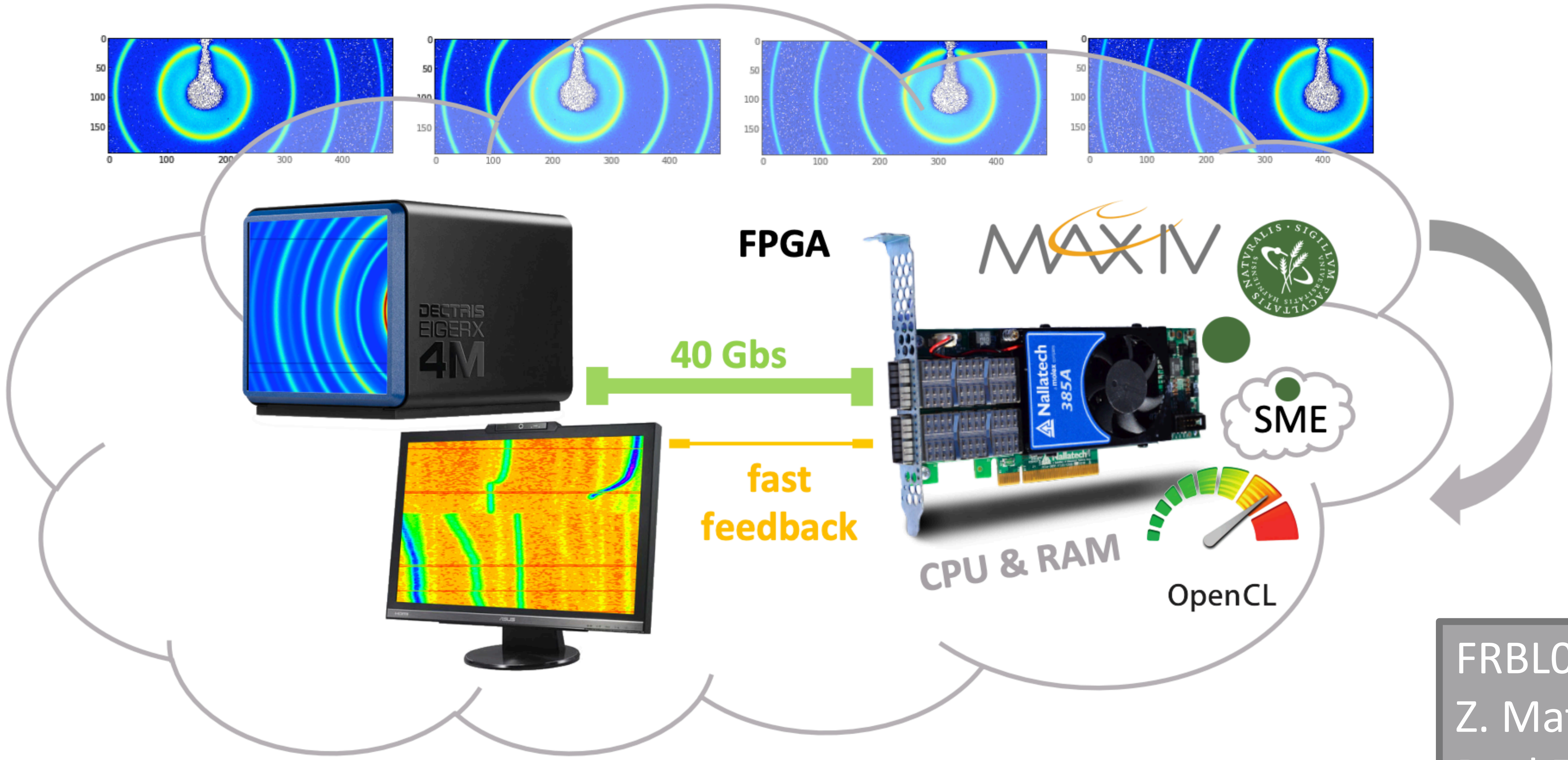
Courtesy of Roberto Appio

FRAR01
M. Eguiraun, et al.
TARANTA, THE NO-CODE WEB DASHBOARD IN PRODUCTION.

An example of Taranta Dashboard created by the staff and immediately available

Scientific Software

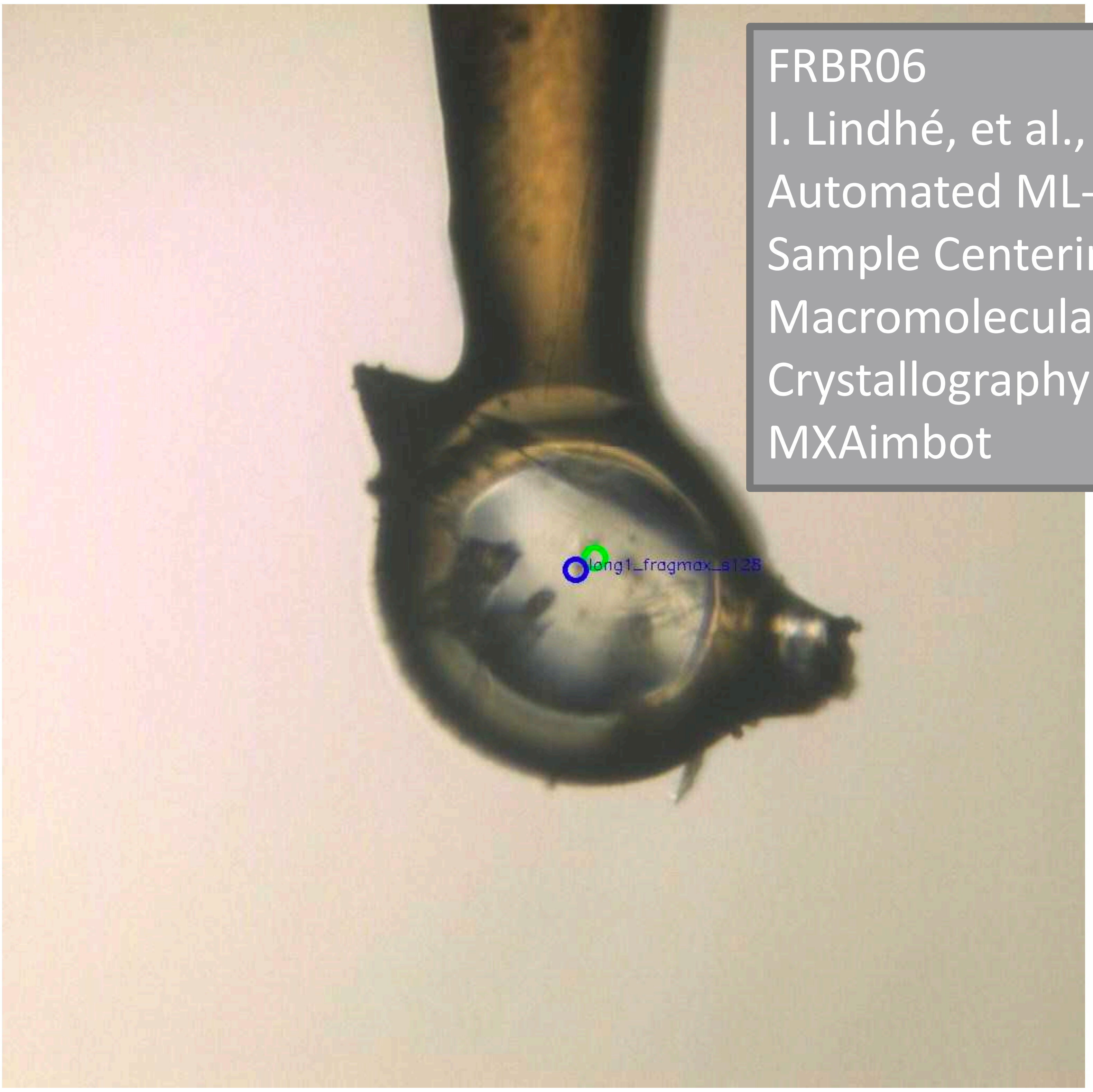
Real-Time Azimuthal Integration on FPGAs



FRBL04
Z. Matej, et al.,
Real-Time Azimuthal Integration of X-Ray Scattering Data on FPGAs

4th generation synchrotron and performance of data acquisition moves the bottleneck to the data processing for a fast data quality assessment. FPGA can be programmed to process on-the-fly.

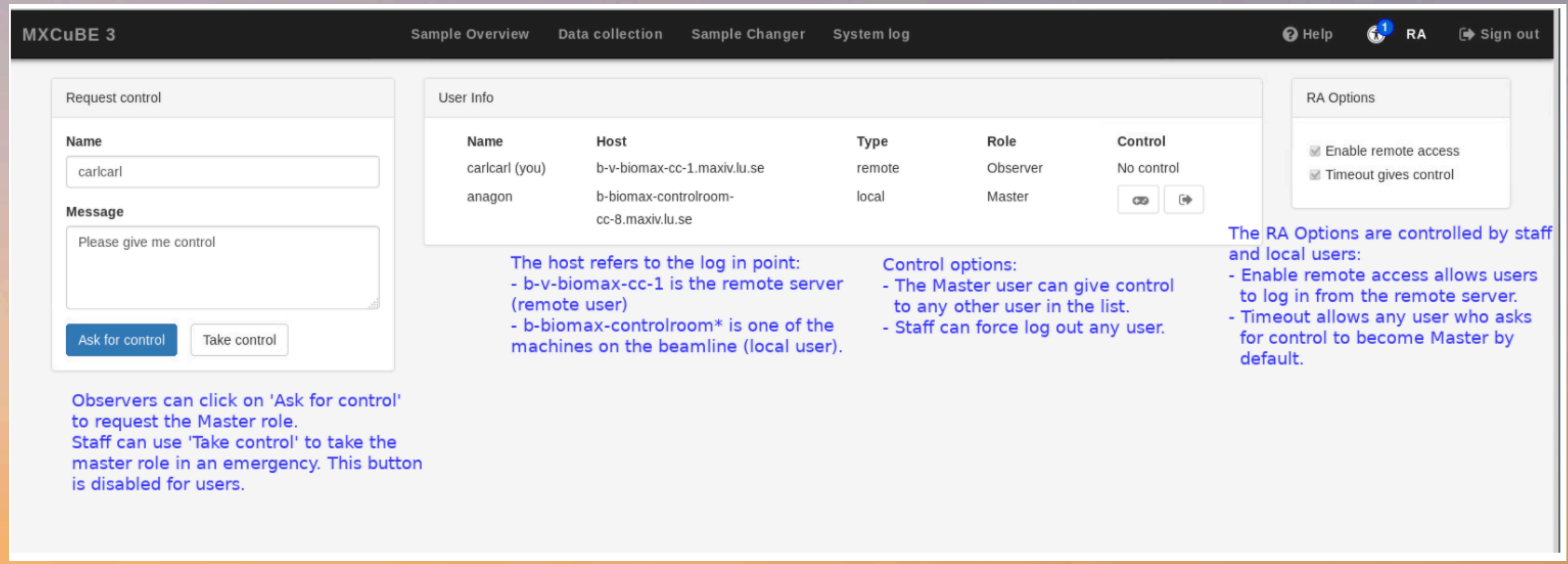
Automated Sample Centering based on Machine Learning



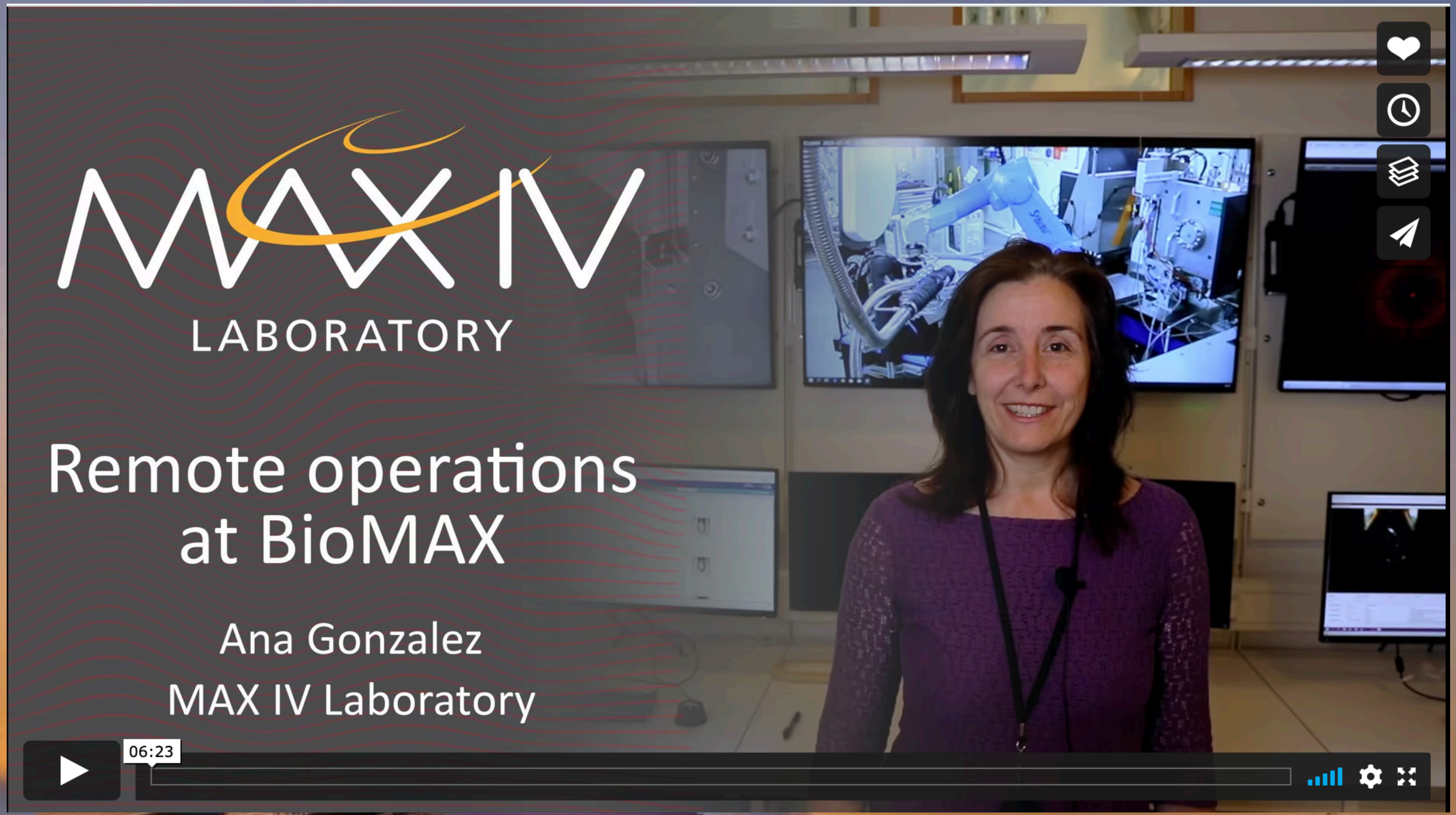
FRBR06
I. Lindhé, et al.,
Automated ML-based Sample Centering for Macromolecular X-Ray Crystallography with MXAimbot

One of the last human interaction in MX collection will be replaced by AI

Remote Operation



Remote Access view in MxCube3



https://www.maxiv.lu.se/news/biomax-remote-experiments/

Proposal	Beamtime with automatic VPN ACCESS (SDM system doi:10.18429/JACoW-ICALEPCS2017-TUBPA04)	Offline cluster access

Future plan

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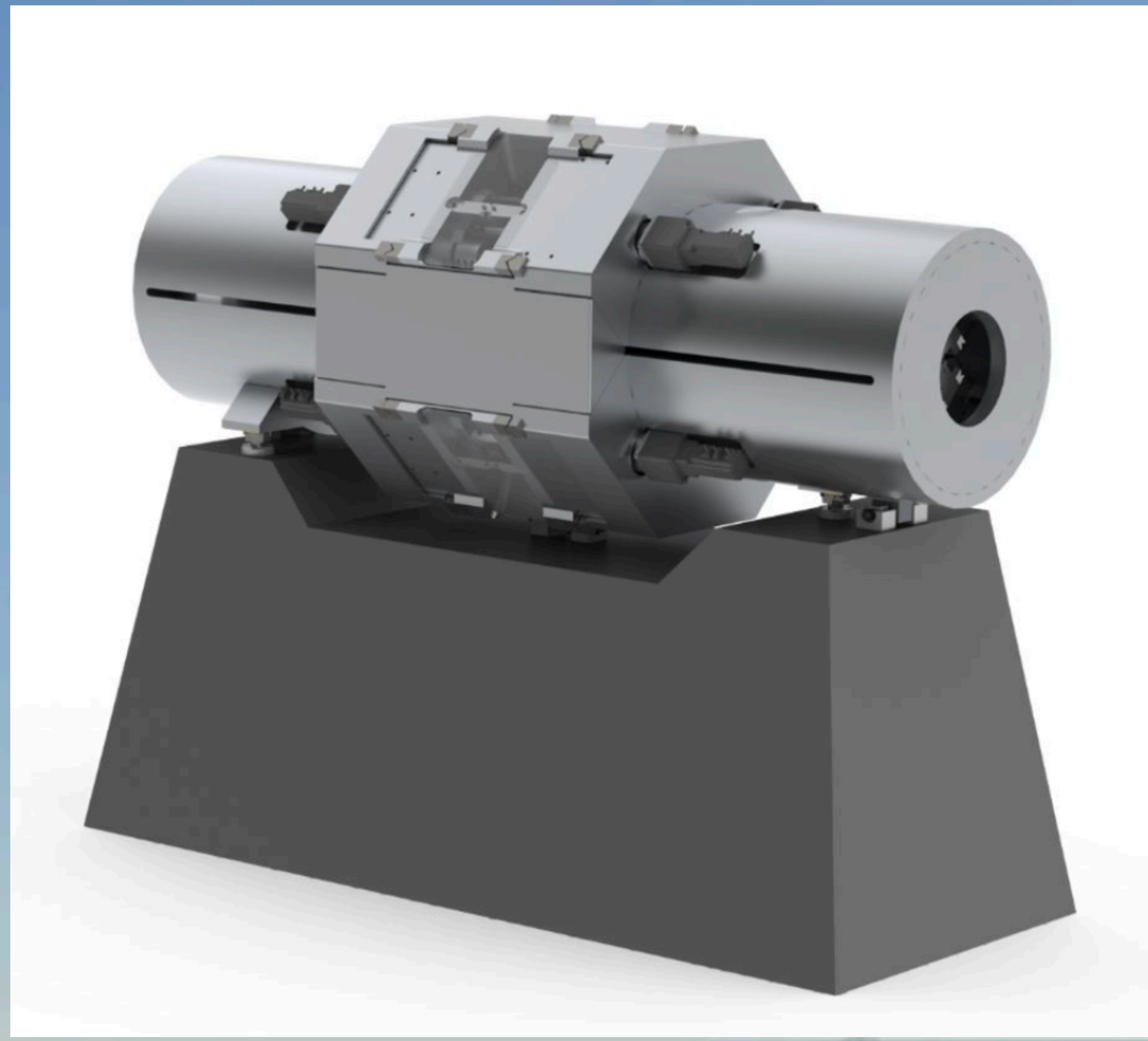
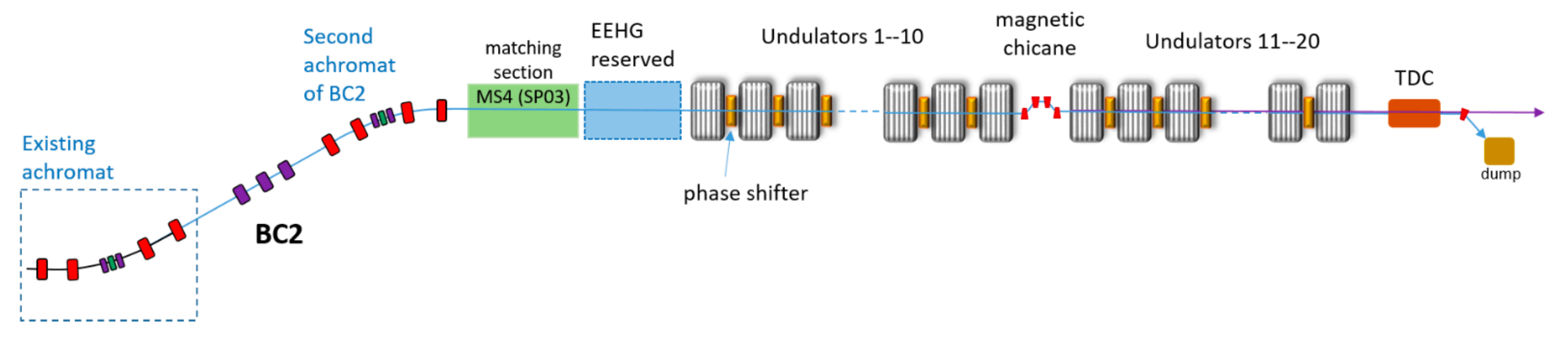
Soft X-Ray Free Electron Laser



A prototype of the APPLE X undulator is planned to be constructed in order to verify the feasibility of the design, the assembly process, and to find the most effective and efficient way of applying magnetic measurements and the subsequent tuning of the device. Funding for the prototype work has been secured through MAX IV and the LEAPS (League of European Accelerator-based Photon Sources) pilot program LEAPS-INNOV.

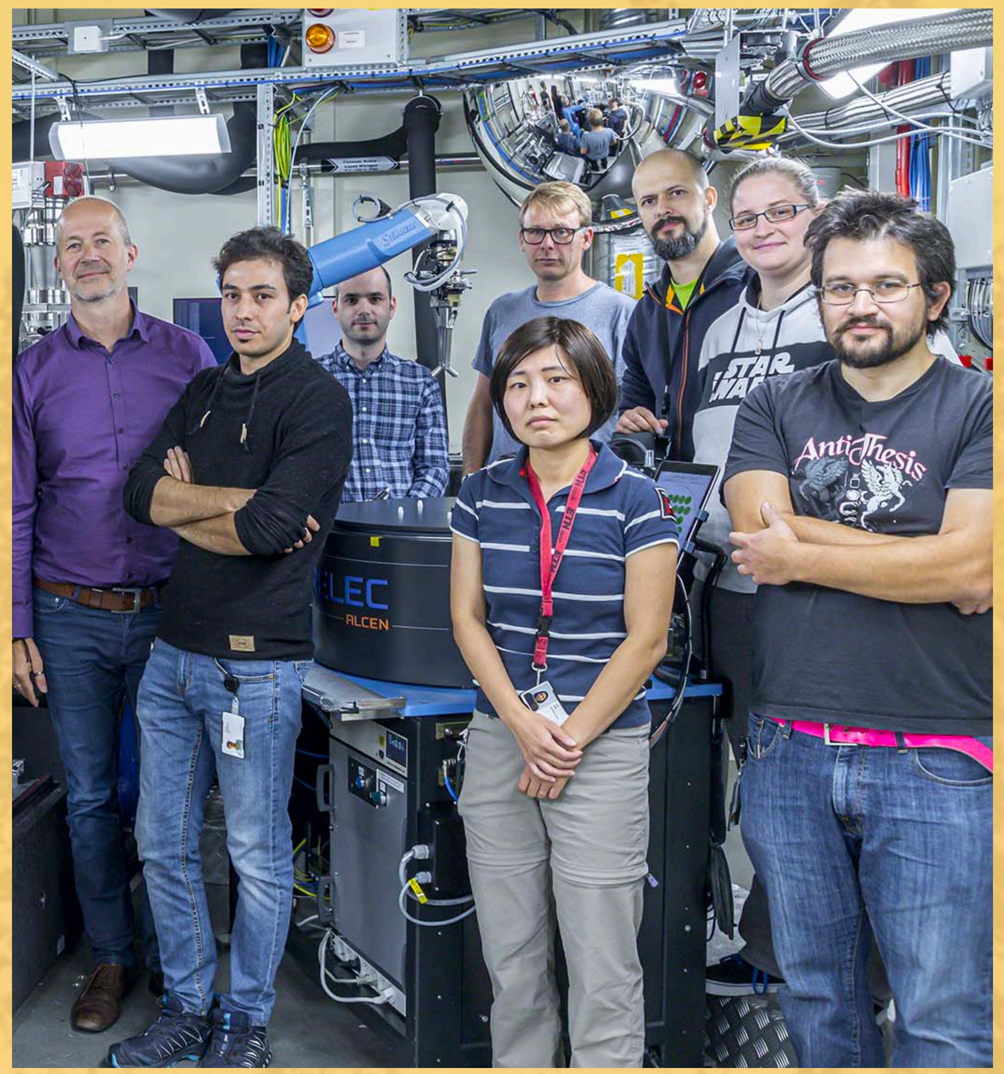


Conclusion

Diversity

Public Domain, wikipedia.org

Hands Teamwork, truthseeker08, pixabay.com



Biomax team, MAXIV.lu.se

Acknowledgment

- The Controls and IT (KITS) group,
- The Beamline Office and the Accelerator Deputy at the MAX IV Laboratory, along with the physicists, engineers and beamline staff
- The support of the Knut And Alice Wallenberg foundation for funding the DataSTAMP project
- XFEL (DOC), SKAO, PSI, ESS, TANGO COMMUNITY