ICALEPCS2017
Barcelona · Spain, October 8-13 · Palau de Congressos de Catalunya

The First Operation of the MAX IV Laboratory

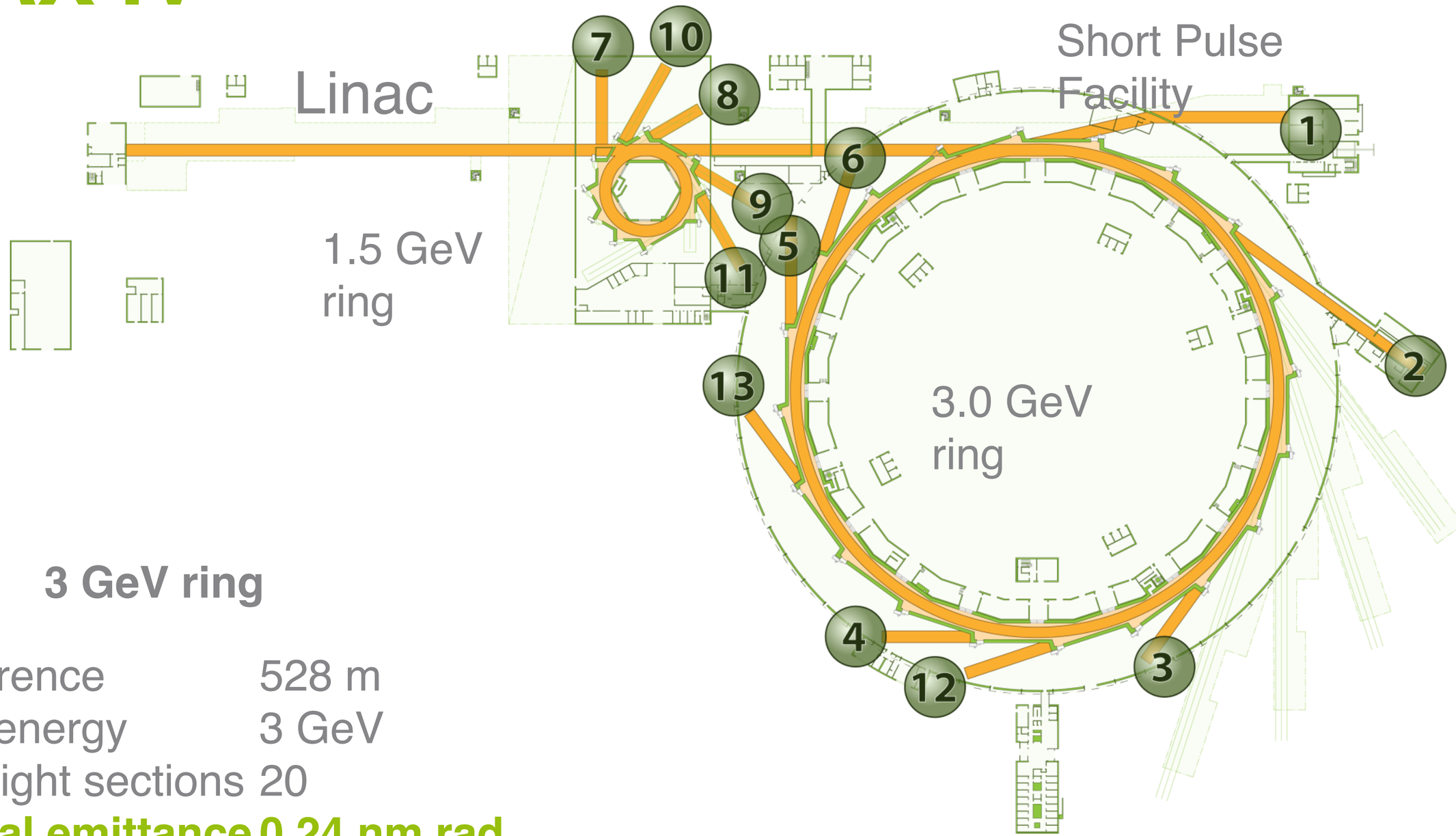
Vincent Hardion on behalf of KITS Group, MAXIV
ICALEPCS 2017

MAX IV

MAX IV

February 2017

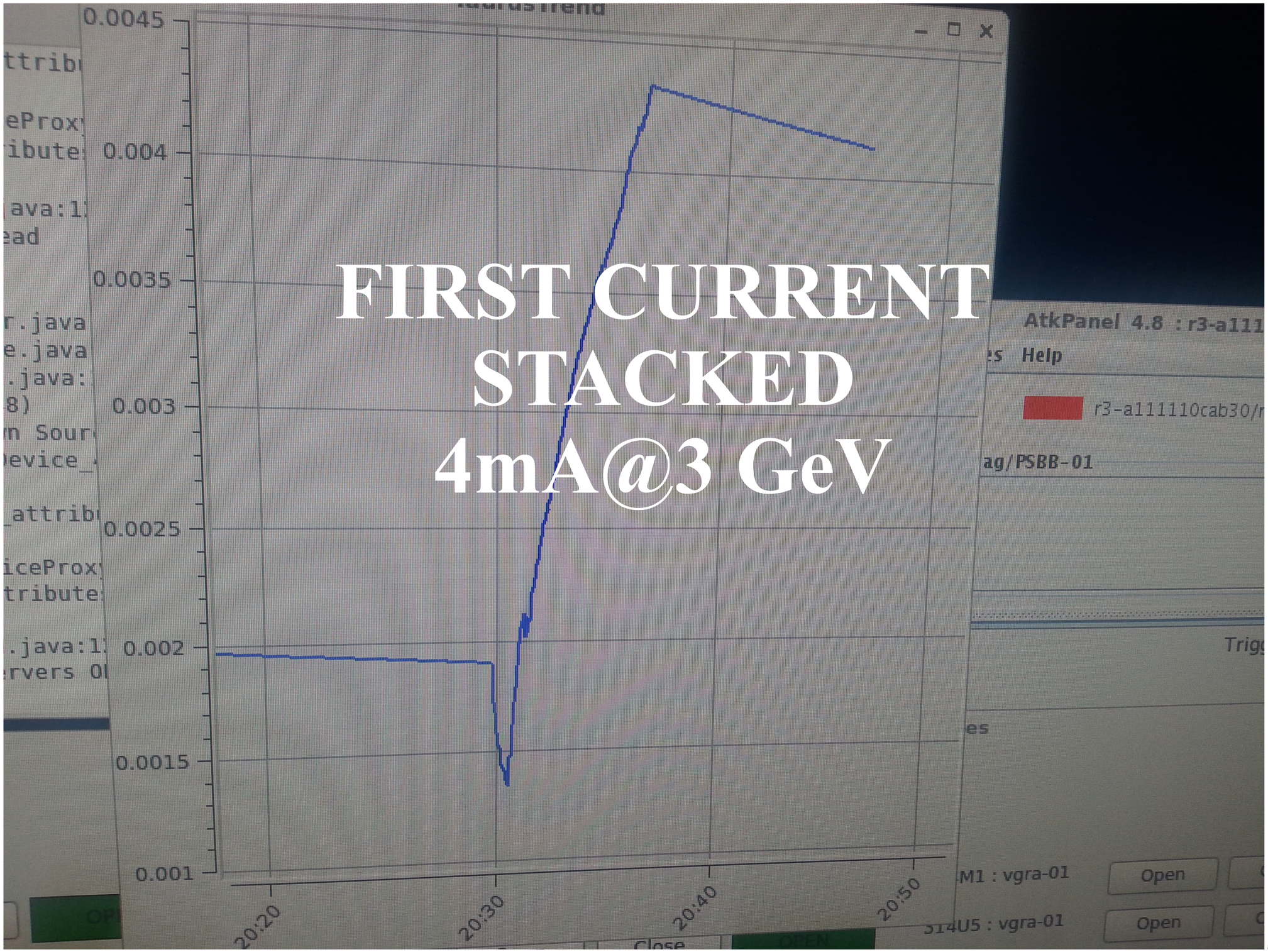
MAX IV



3 GeV ring

Circumference	528 m
Electron energy	3 GeV
Nr of straight sections	20
Horizontal emittance	**0.24 nm rad**
Current	500 mA
Horizontal RMS beam size	45 um
Vertical RMS beam size	1-4 um

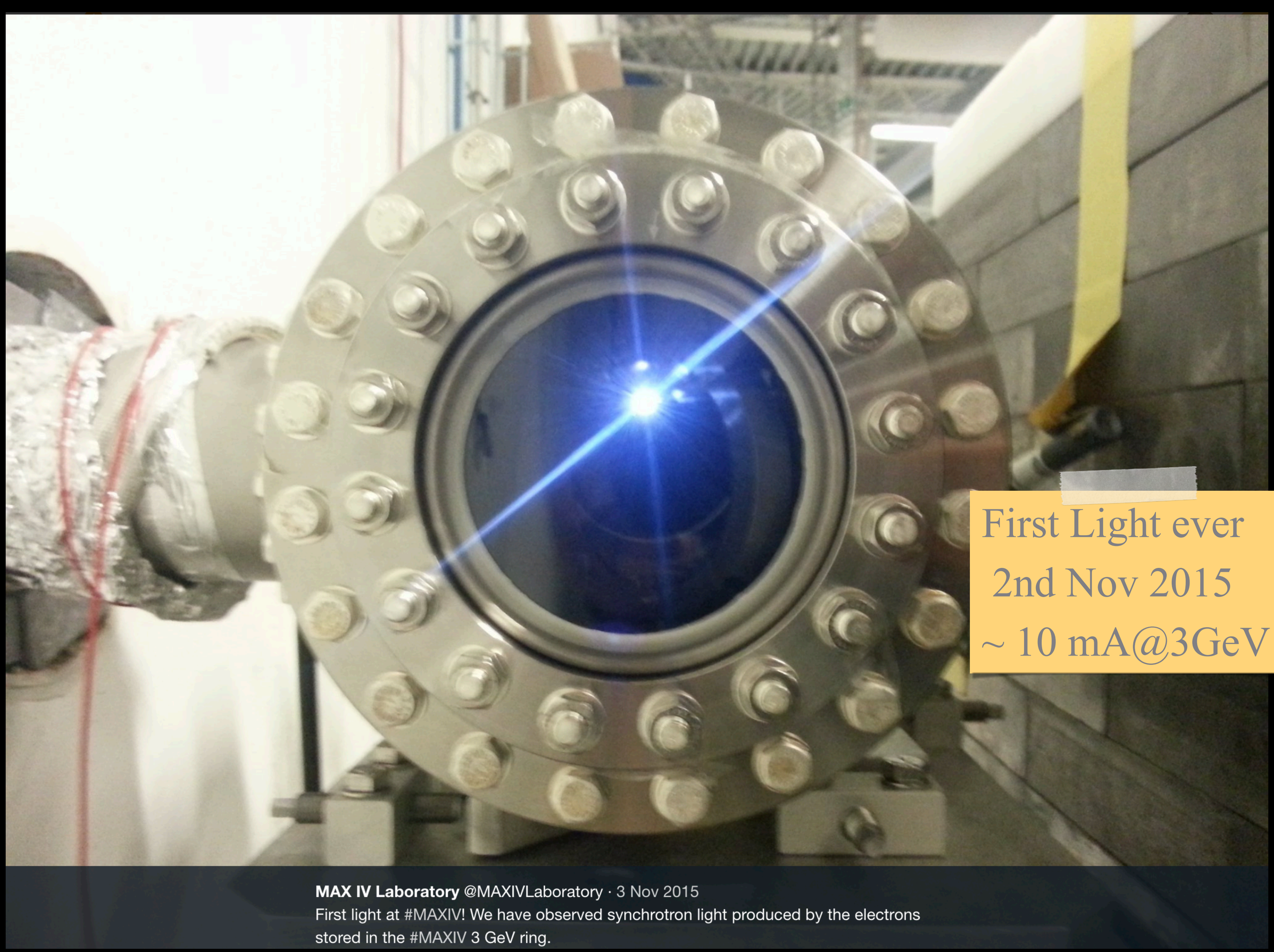
Last ICALEPCS- Oct 2015



Since then, there was light

First Light ever
5th Nov 2015
~ 10 mA@3GeV

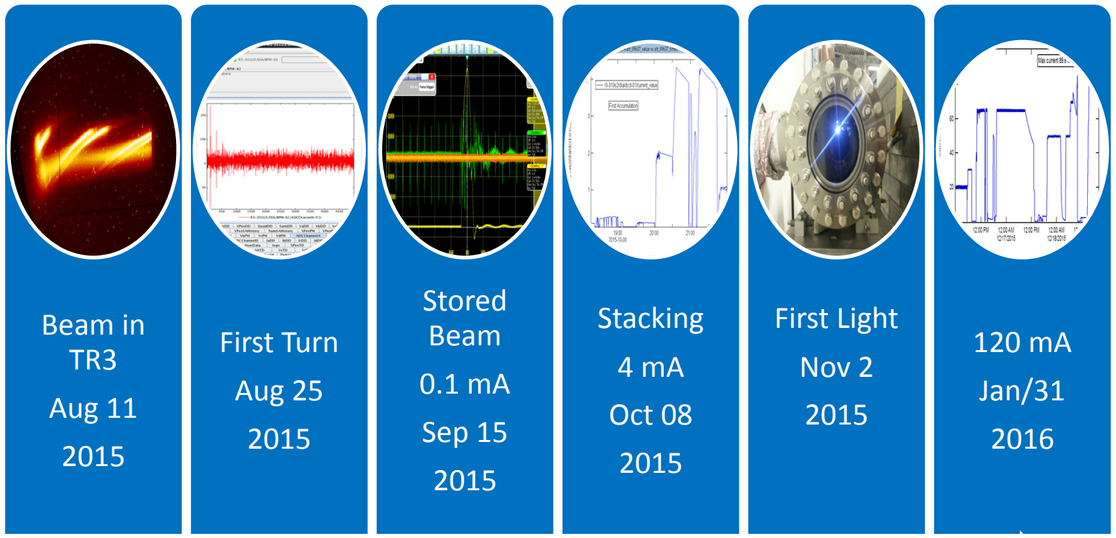
Since then, there was light



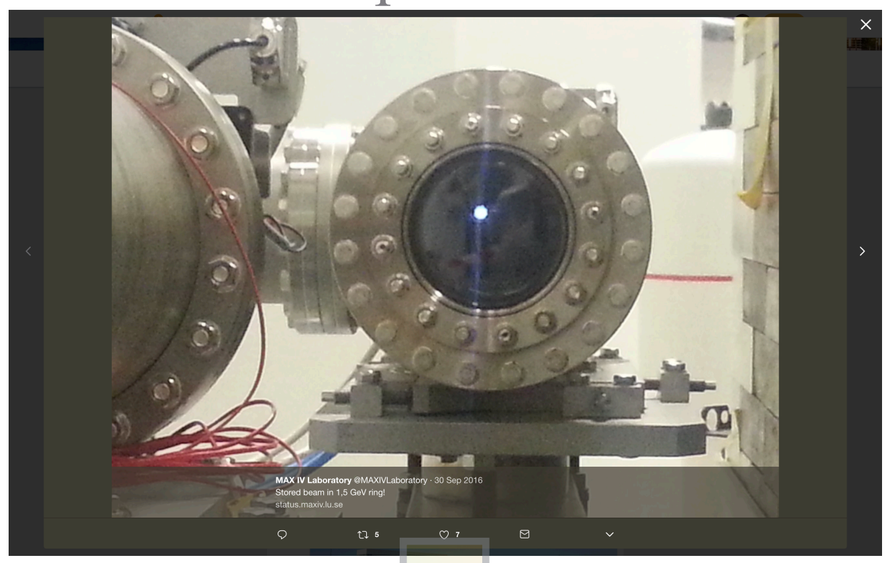
Since then, there was light

Accelerators Status

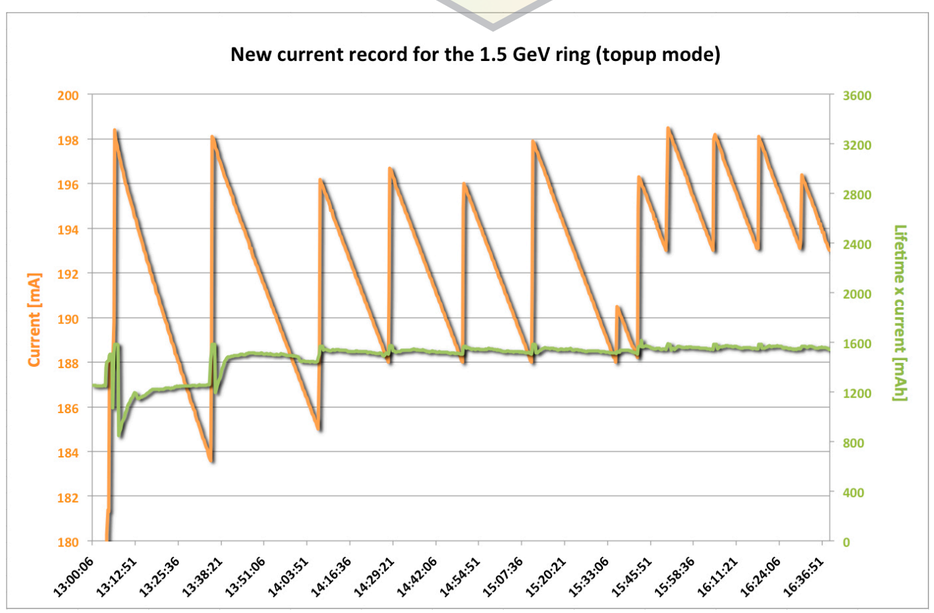
3 GeV Operation
Feb 2016



1.5 GeV, First X-Ray beam,
30 Sept 2016

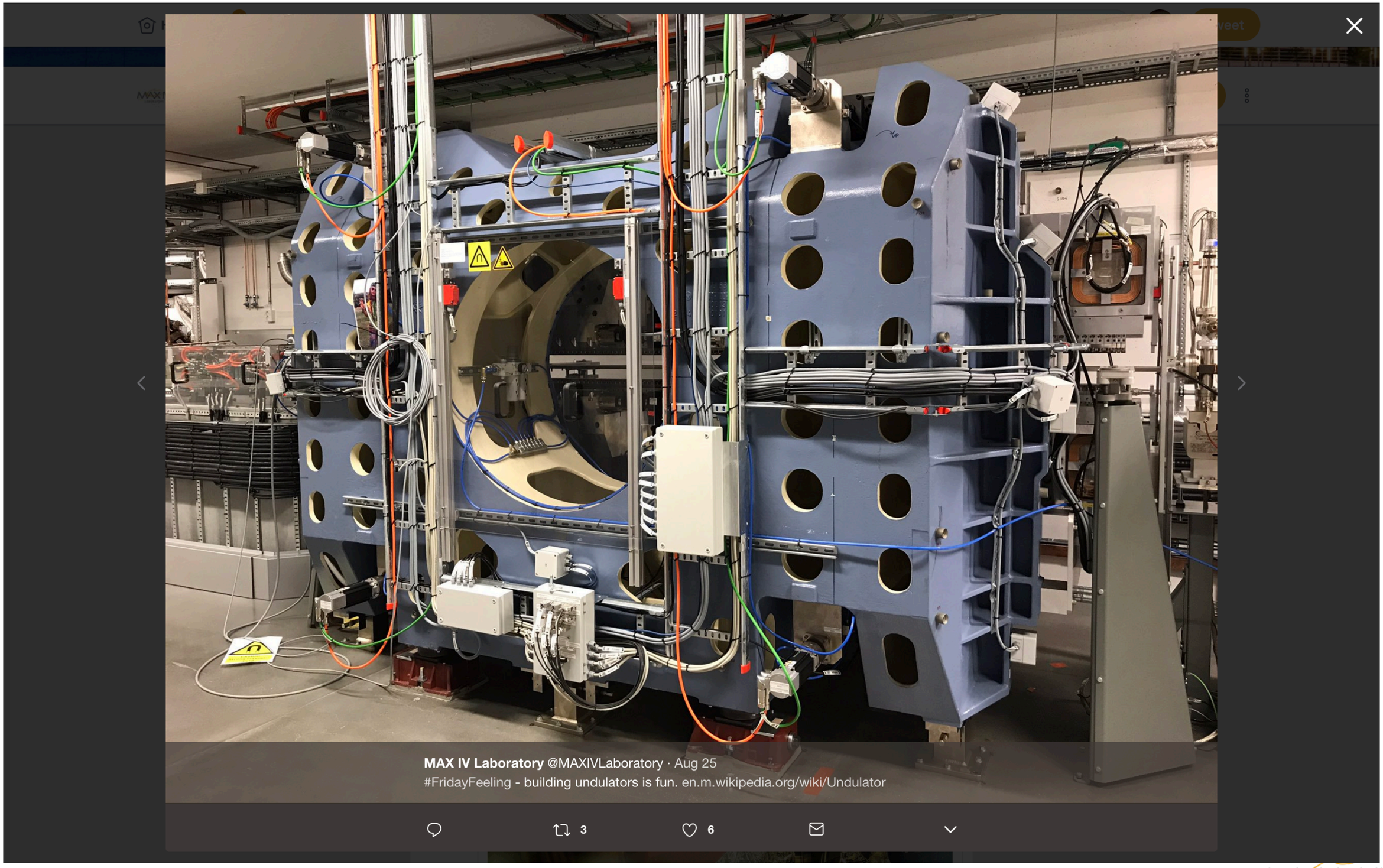


Max-Lab Shutdown, end of an era

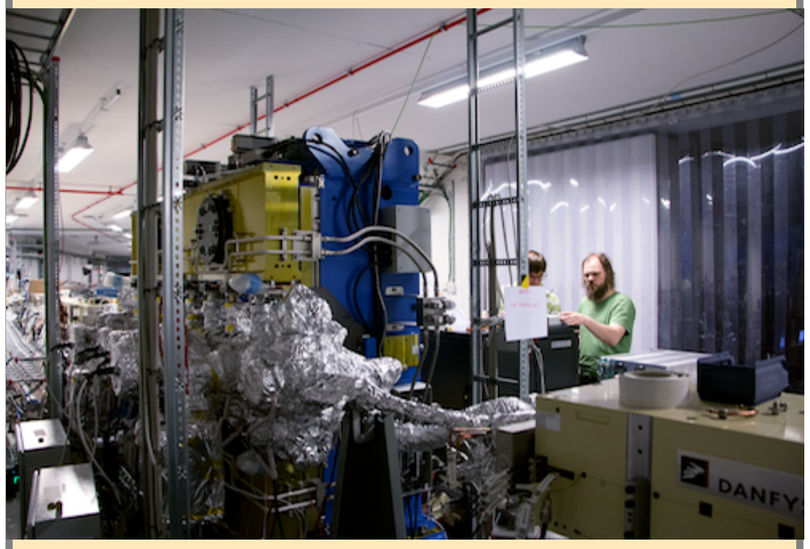


1.5 GeV, Top Up mode

Beamlines Status



3GeV Beamlines Commissioning
June 2016

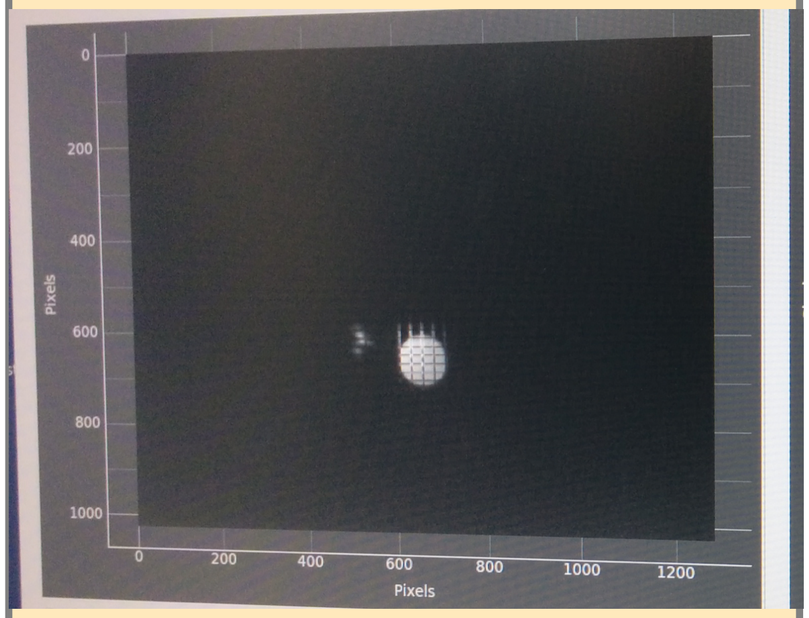


3 GeV/Biomax

–

First In Vacuum Undulator

April 2016

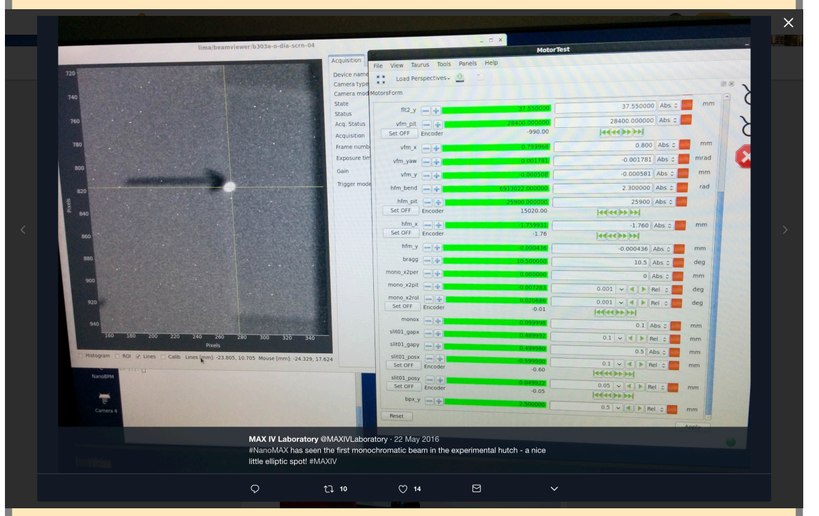


NanoMAX

–

First light from id

1st May 2016



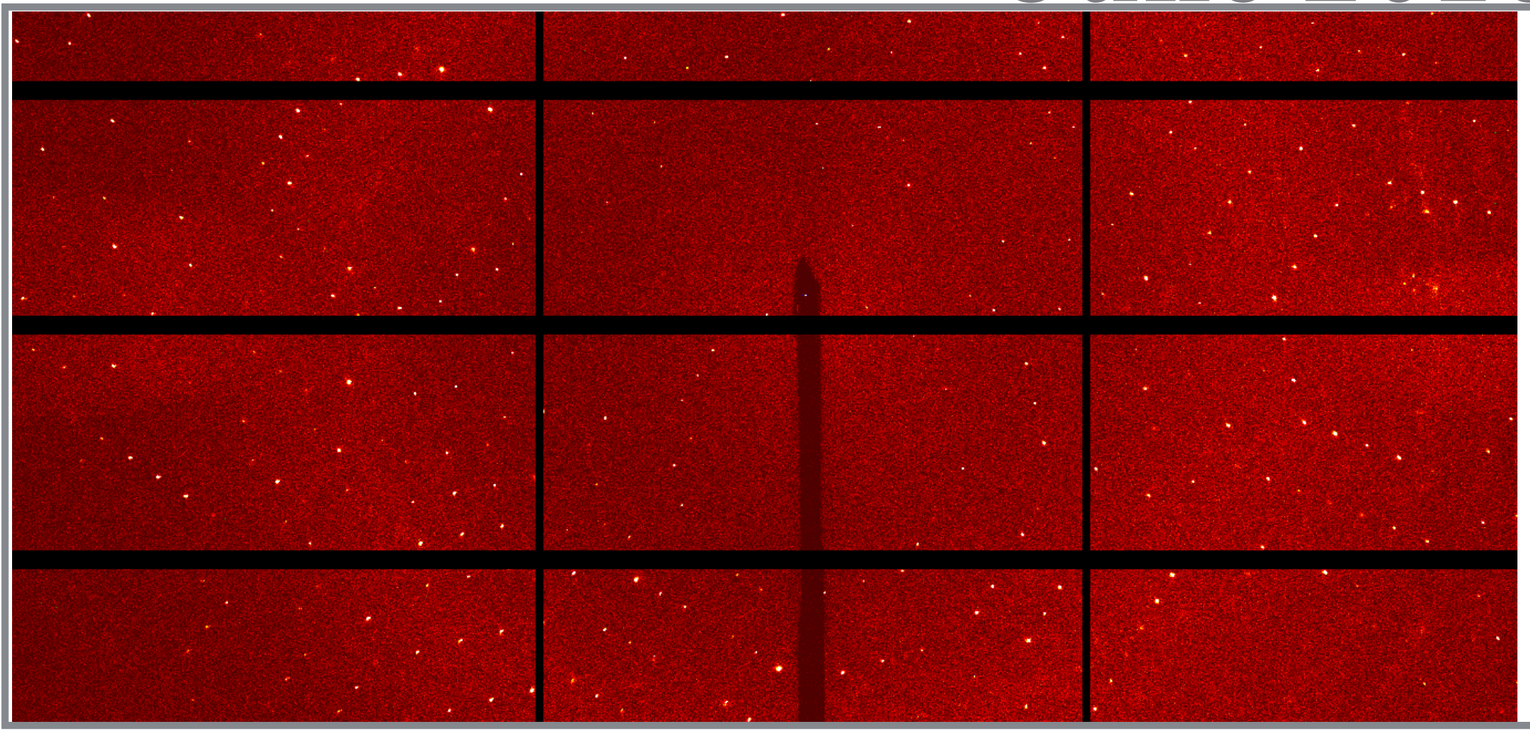
NanoMAX

–

First Monochromatic light

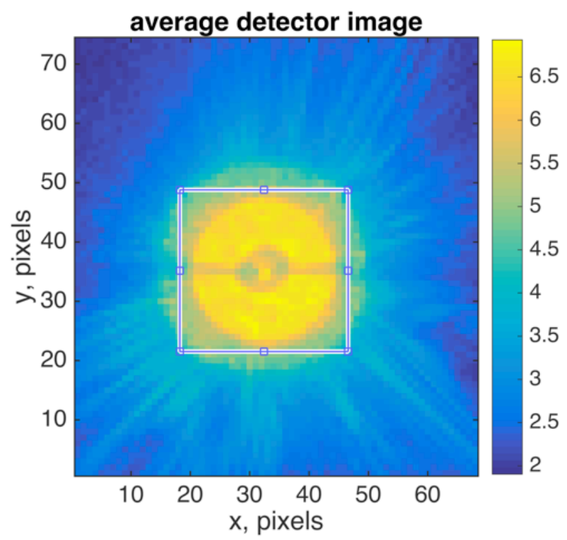
12 May 2016

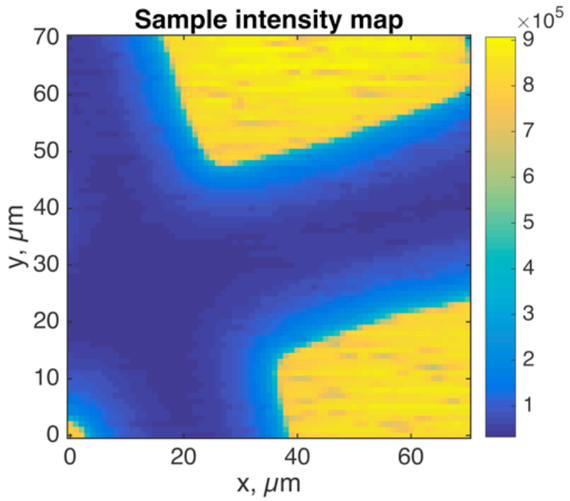
3GeV Beamlines Commissioning
June 2016

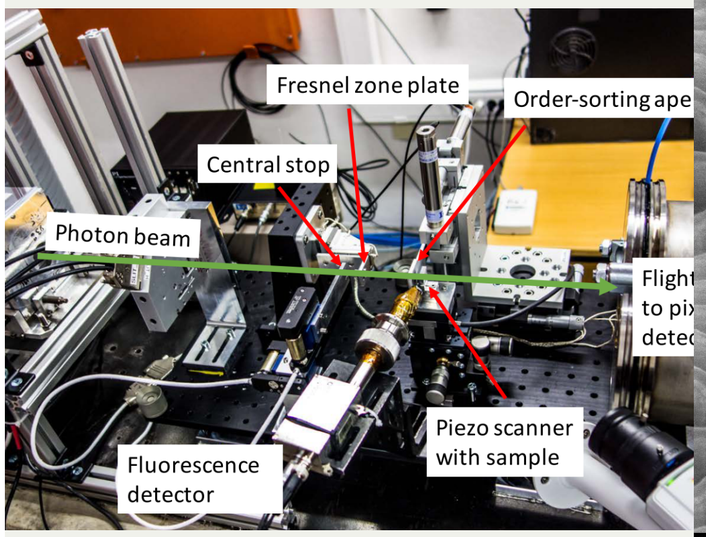


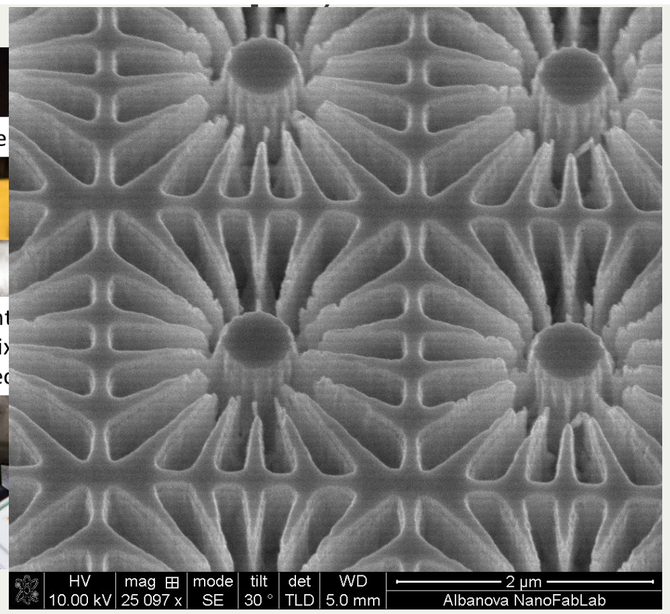
First diffraction at BioMAX

9 June 2016









NanoMAX

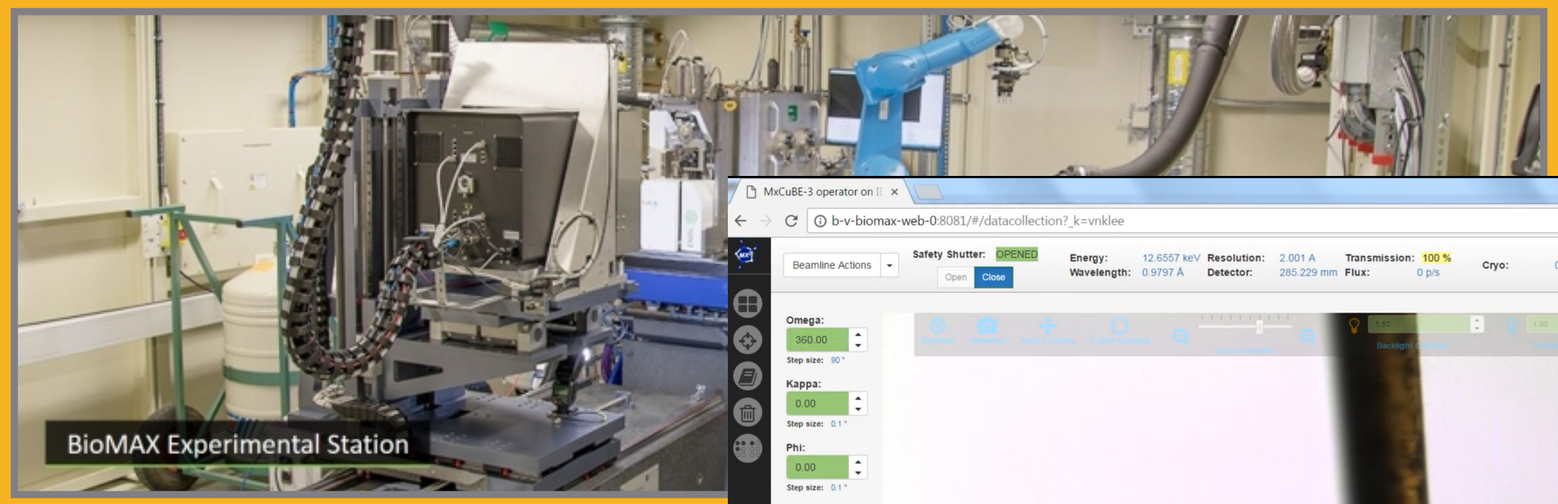
June 16 first light on sample

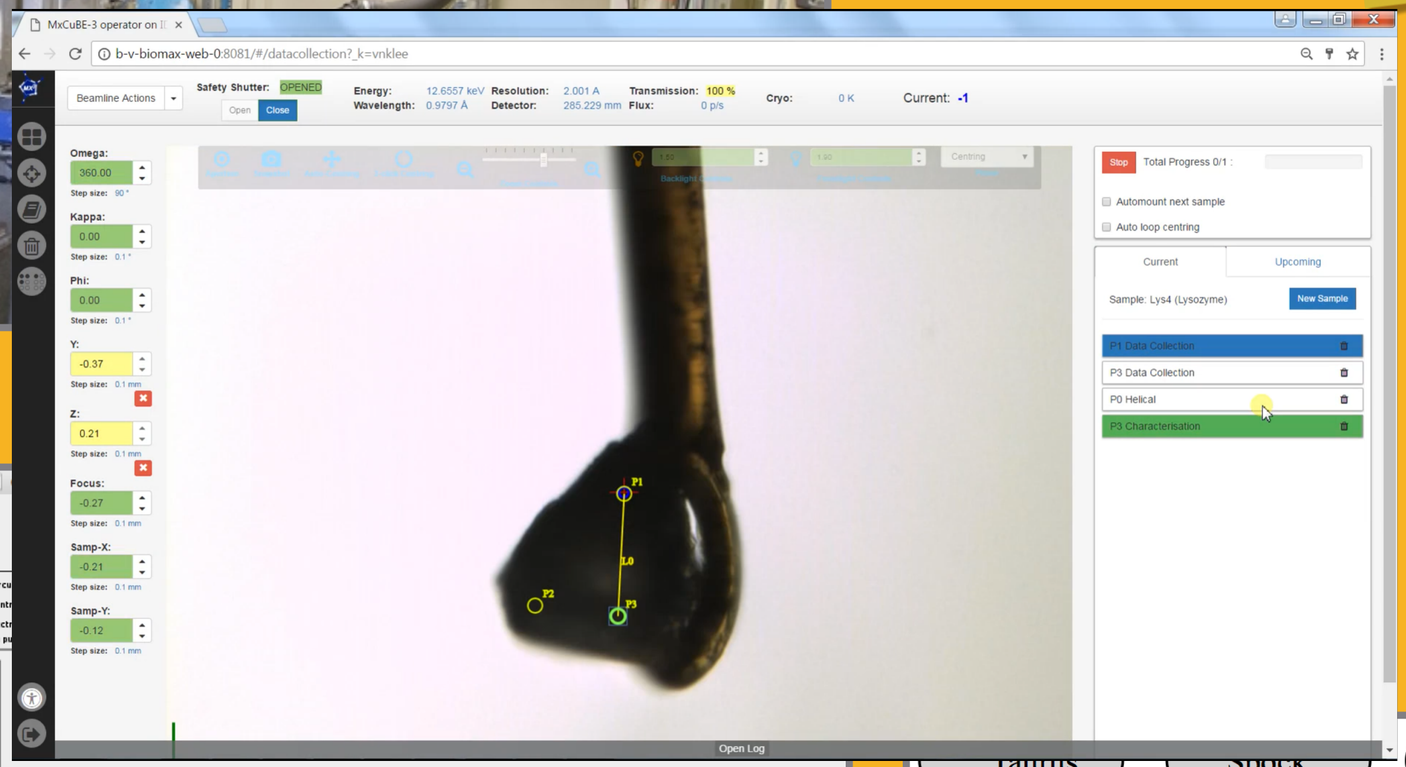
NanoMAX

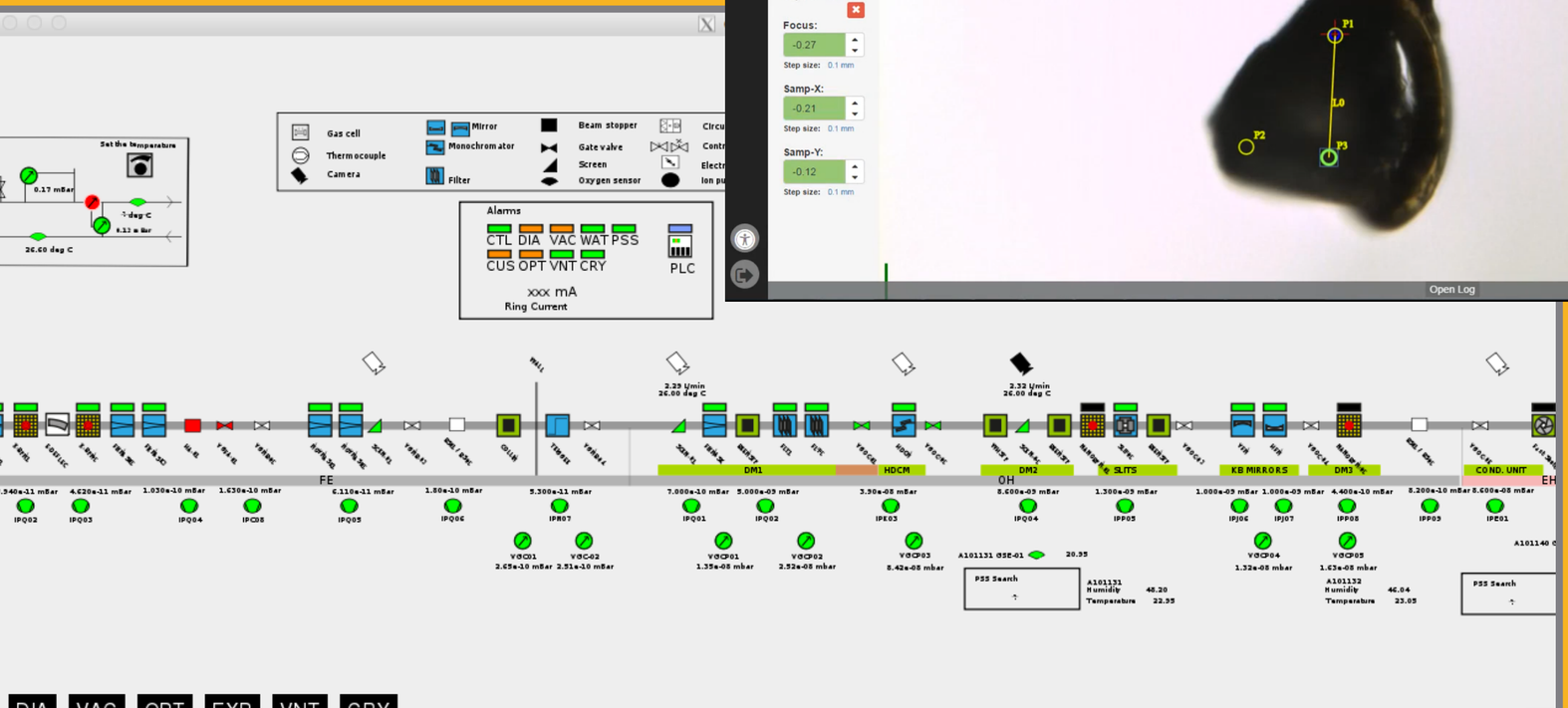
Nov 16 first ptychography

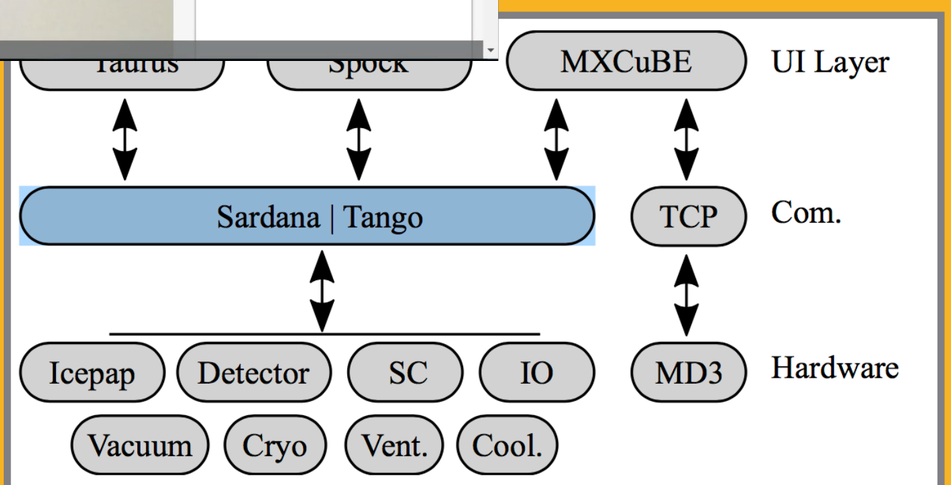
MAX IV BIOMAX Beamline Control System: From Commissioning Into User Operation

TUMPL08
Poster Session
Tuesday

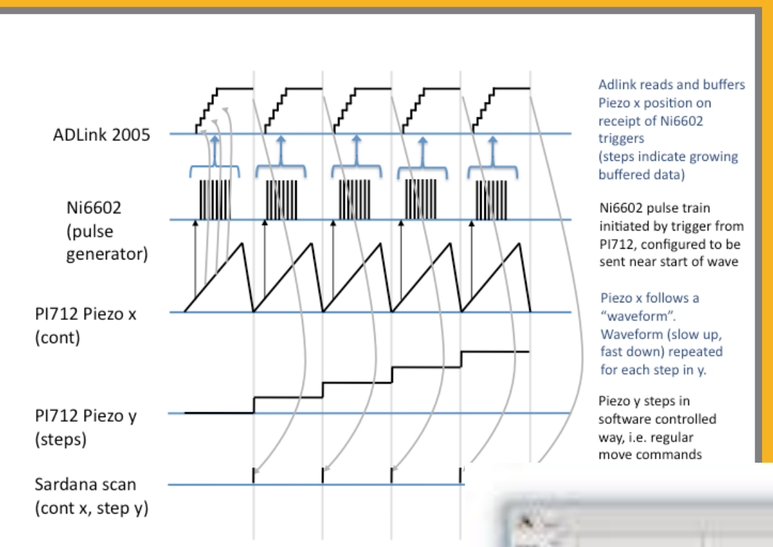


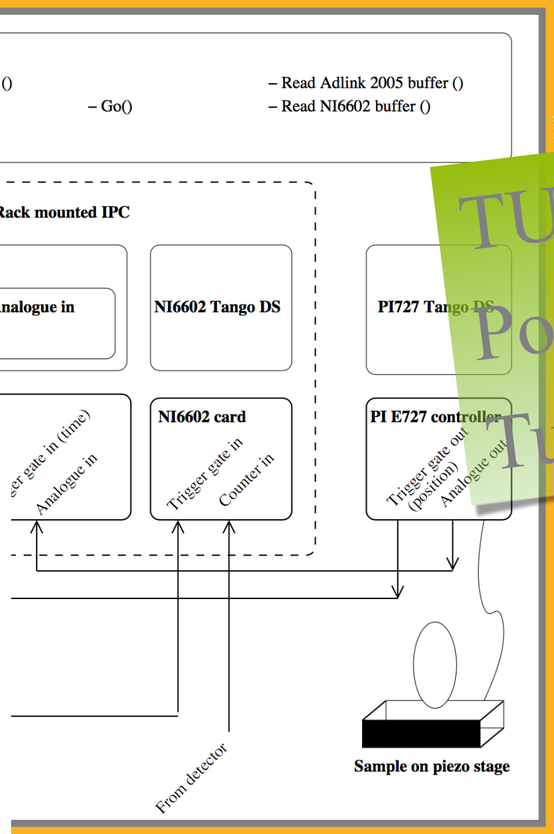


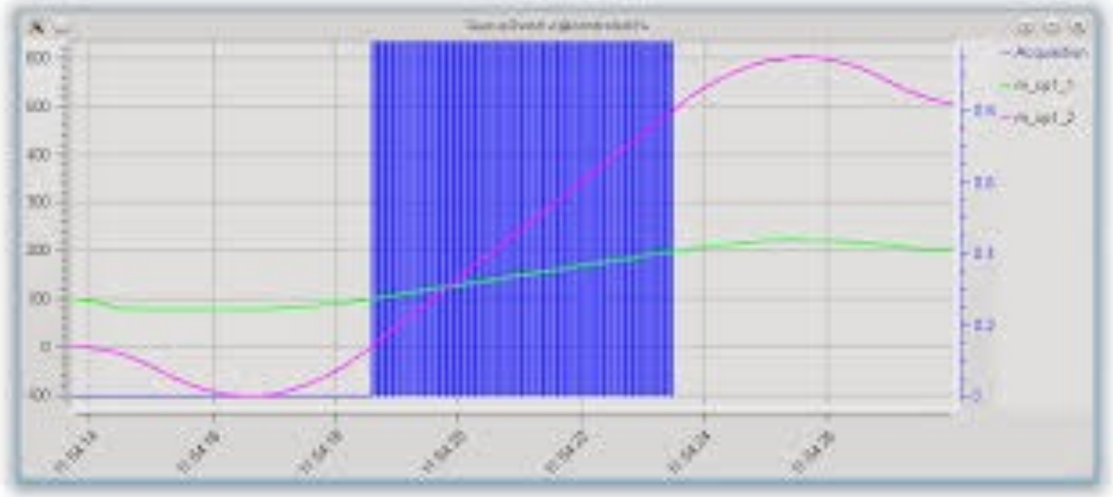


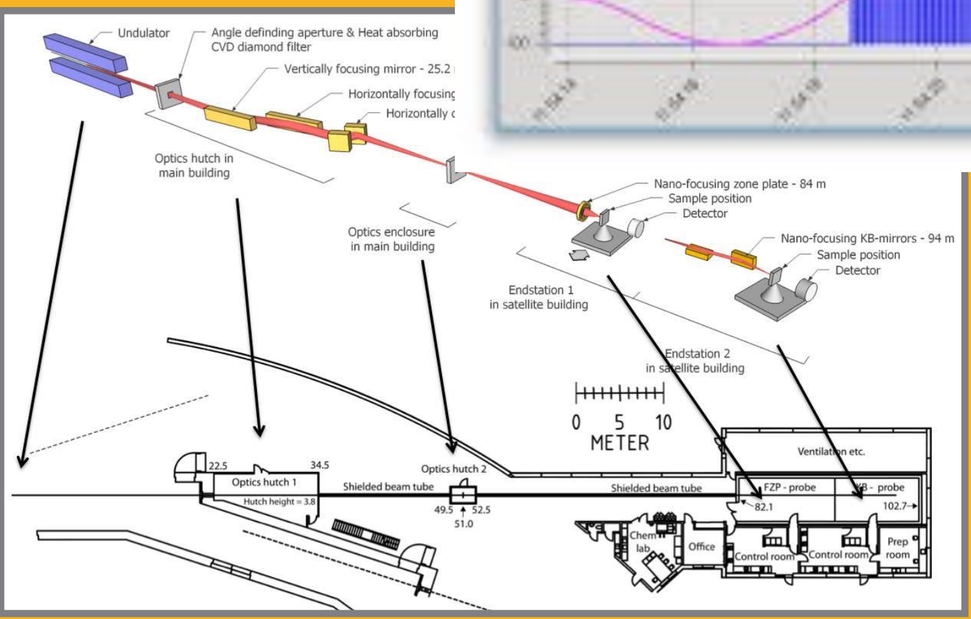


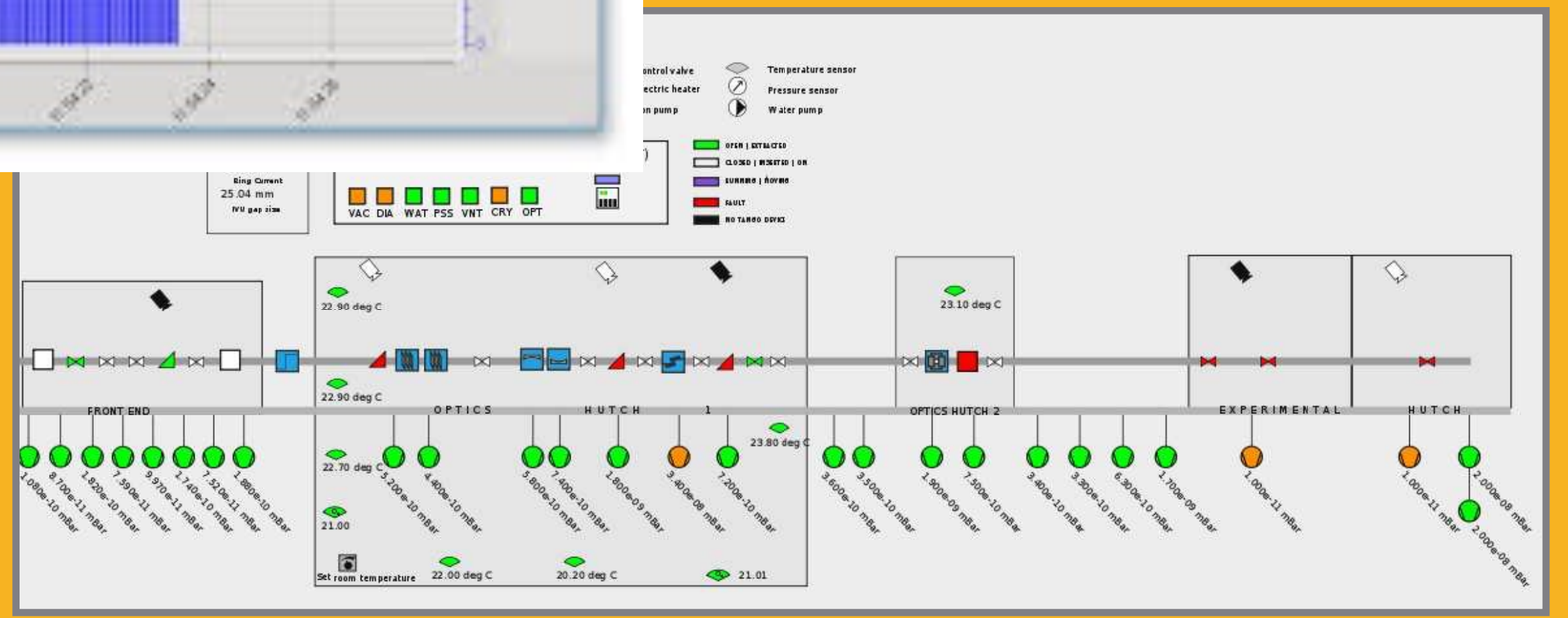
CONTROL AND DATA ACQUISITION USING TANGO AND SARDANA AT THE NANOMAX BEAMLINE AT MAX IV





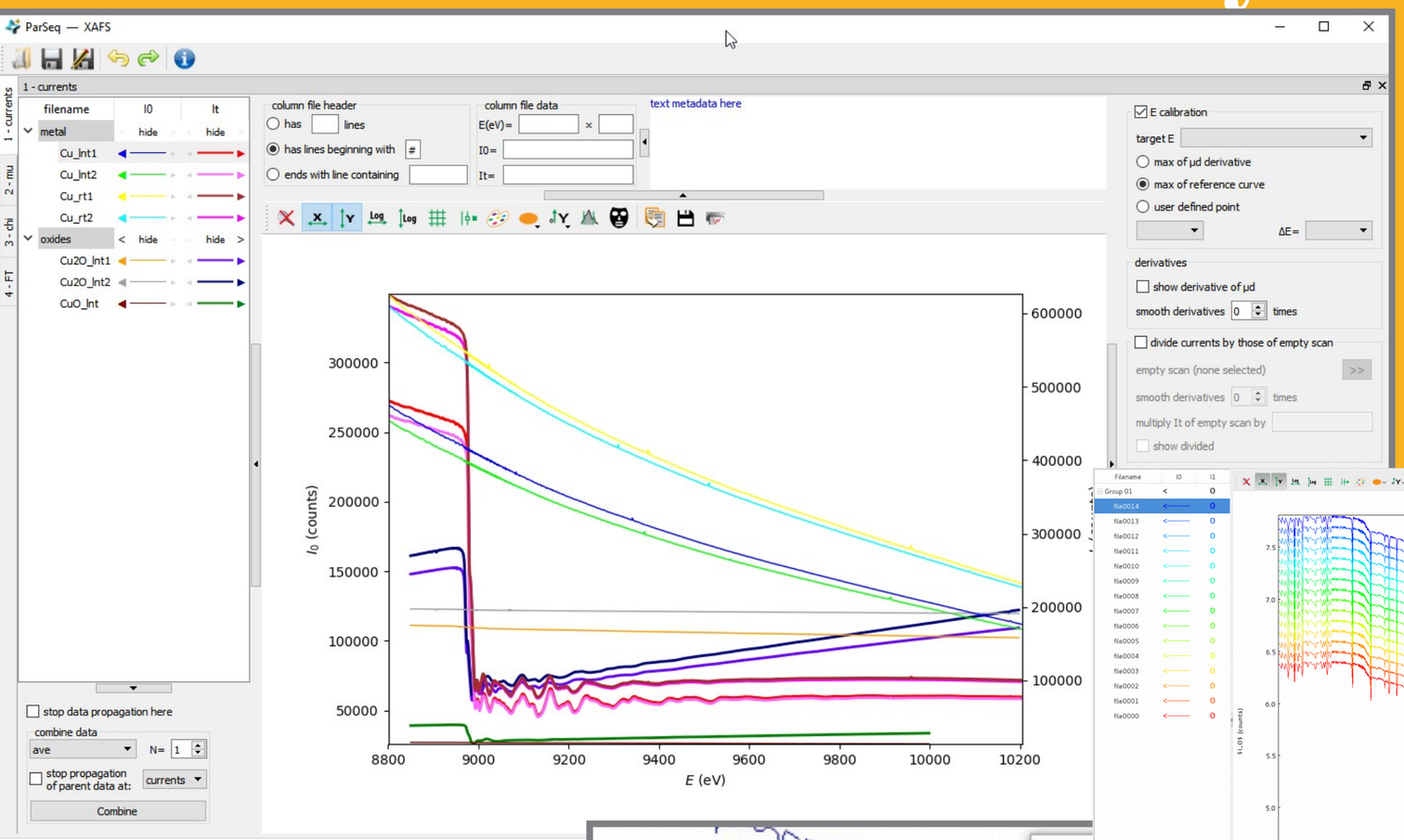


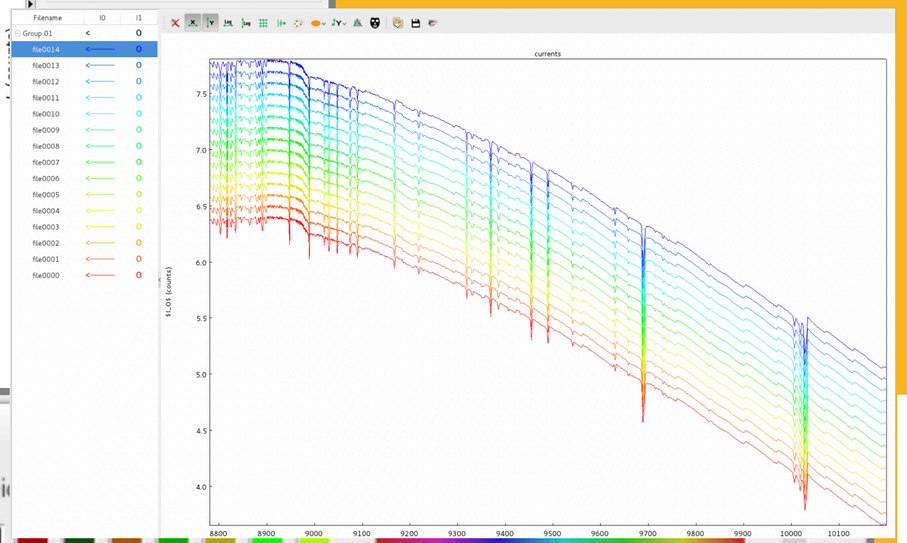


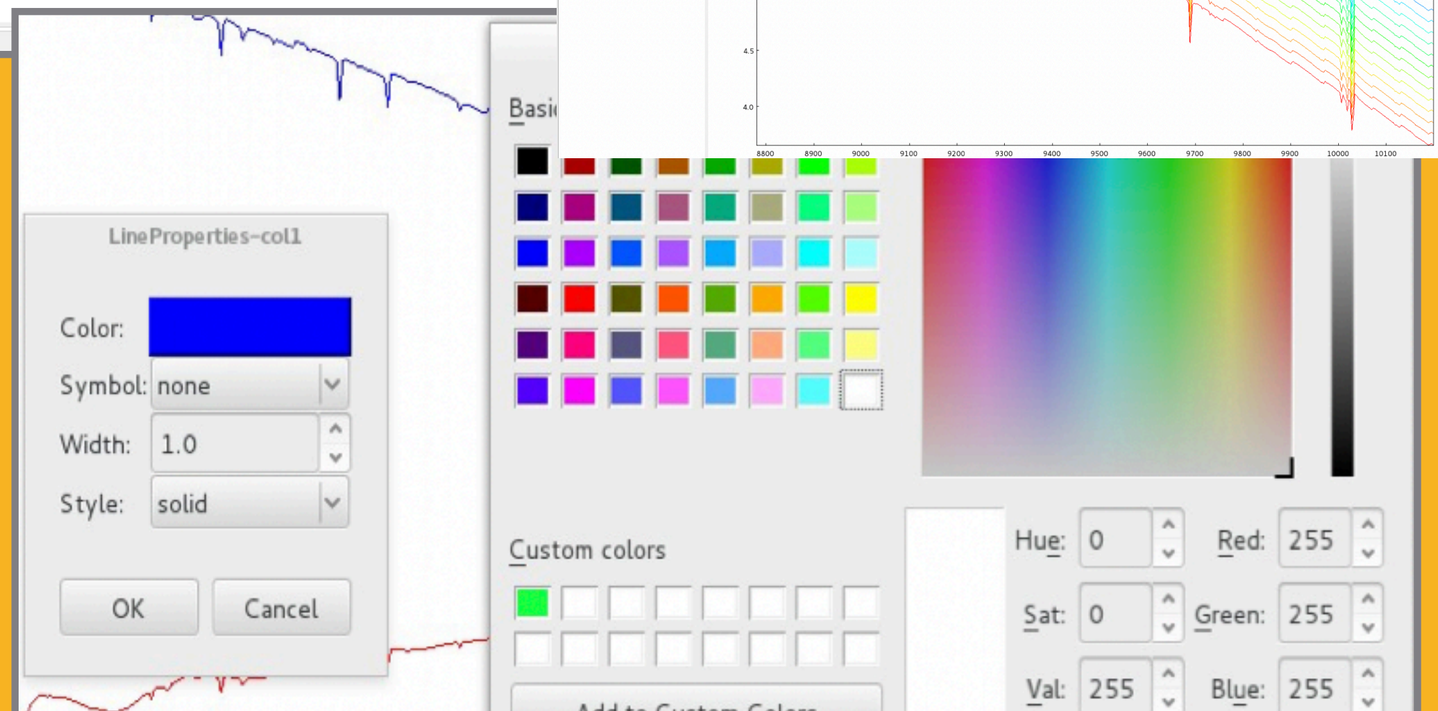


Parallel Execution of Sequential Data Analysis

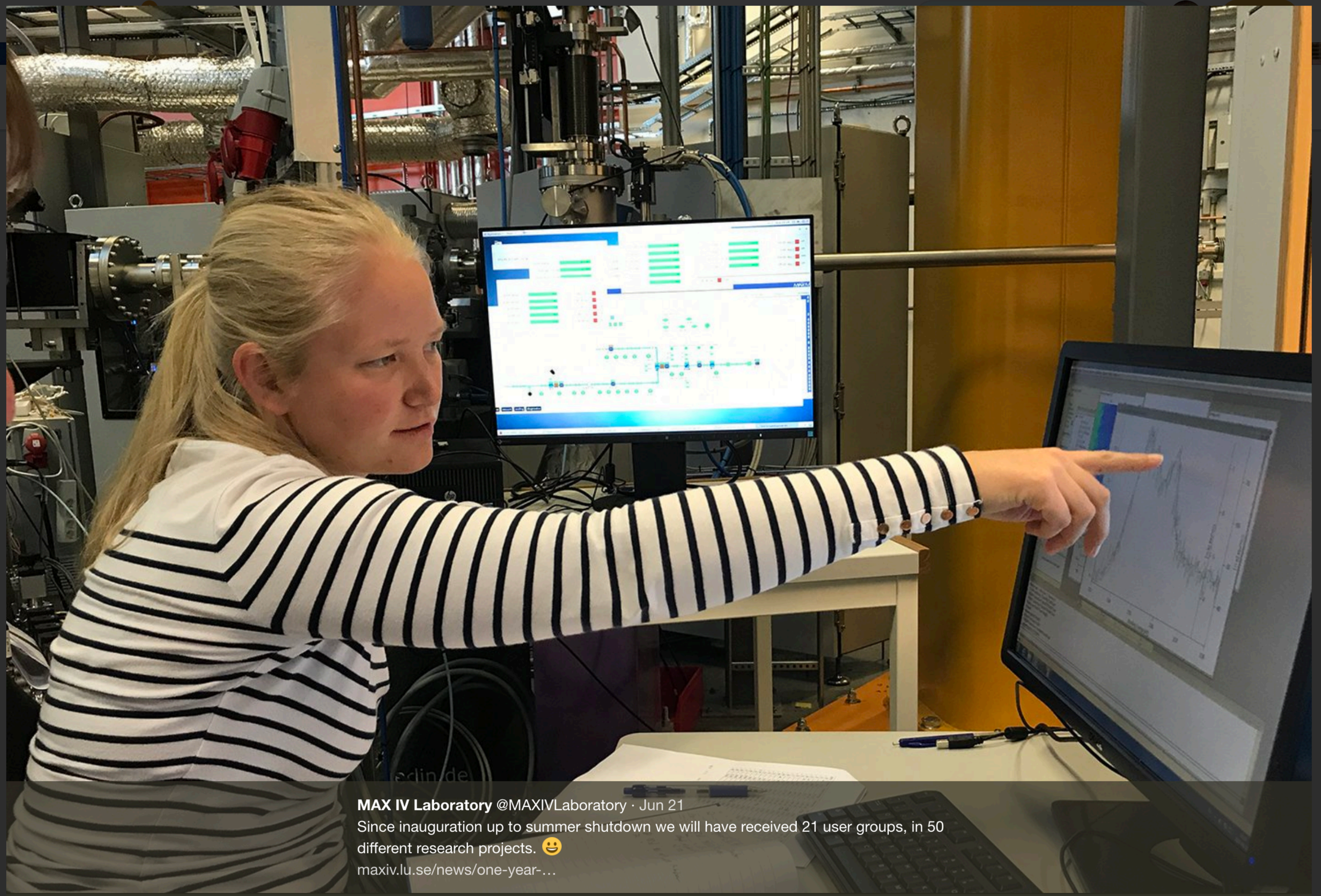
THPHA186
Poster Session
Thursday







First Users
December 2016



MAX IV Laboratory @MAXIVLaboratory · Jun 21
Since inauguration up to summer shutdown we will have received 21 user groups, in 50 different research projects. 😀
maxiv.lu.se/news/one-year-…

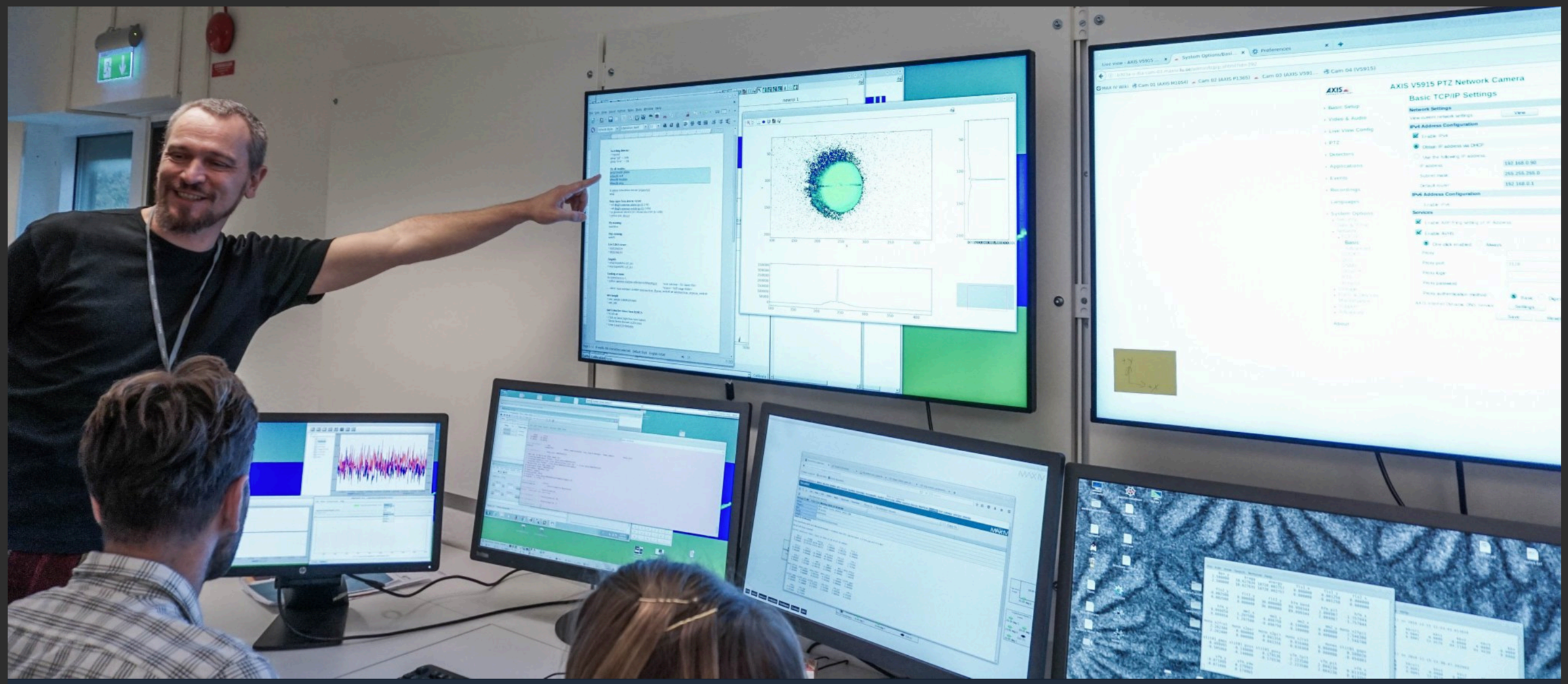
4 12

Home Notifications Messages Search Twitter Tweet

MAX IV Laboratory
@MAXIVLaboratory Follows you

Tweets	Following	Followers	Likes	Lists
1,712	2,105	2,172	1,465	2

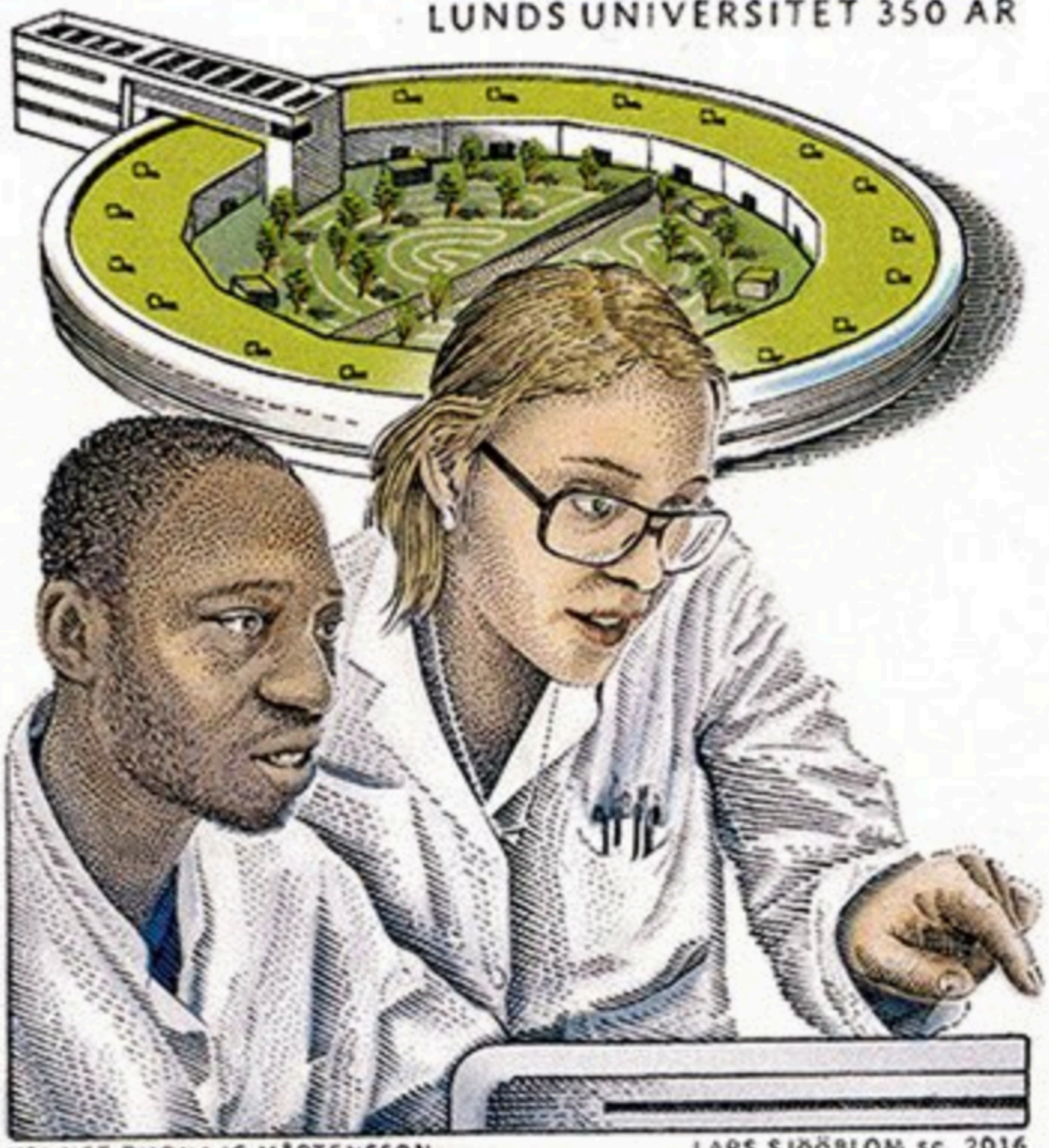
Following



4 8

SVERIGE 13 KR

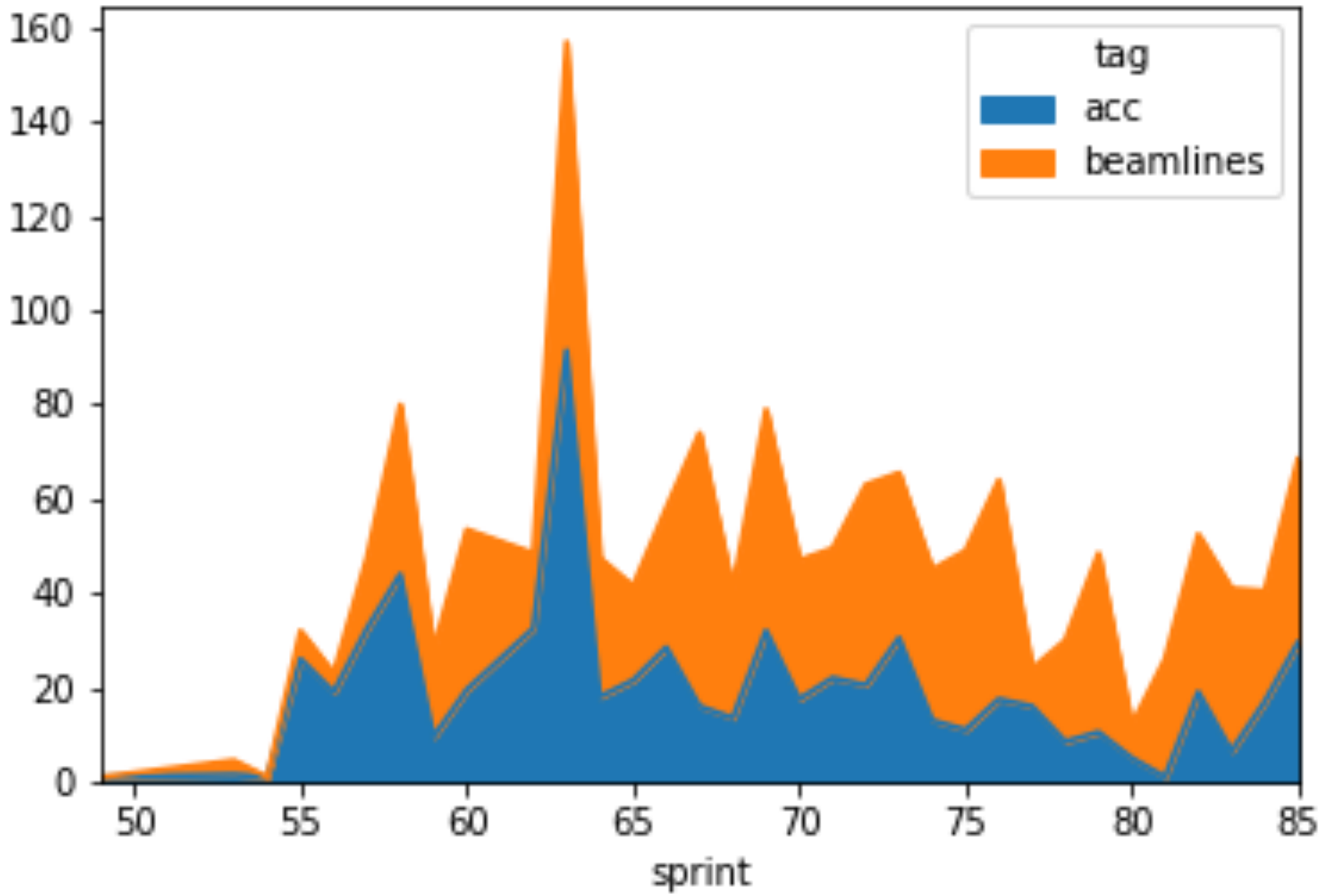
LUNDS UNIVERSITET 350 ÅR



KENNET RUONA/G.MÅRTENSSON

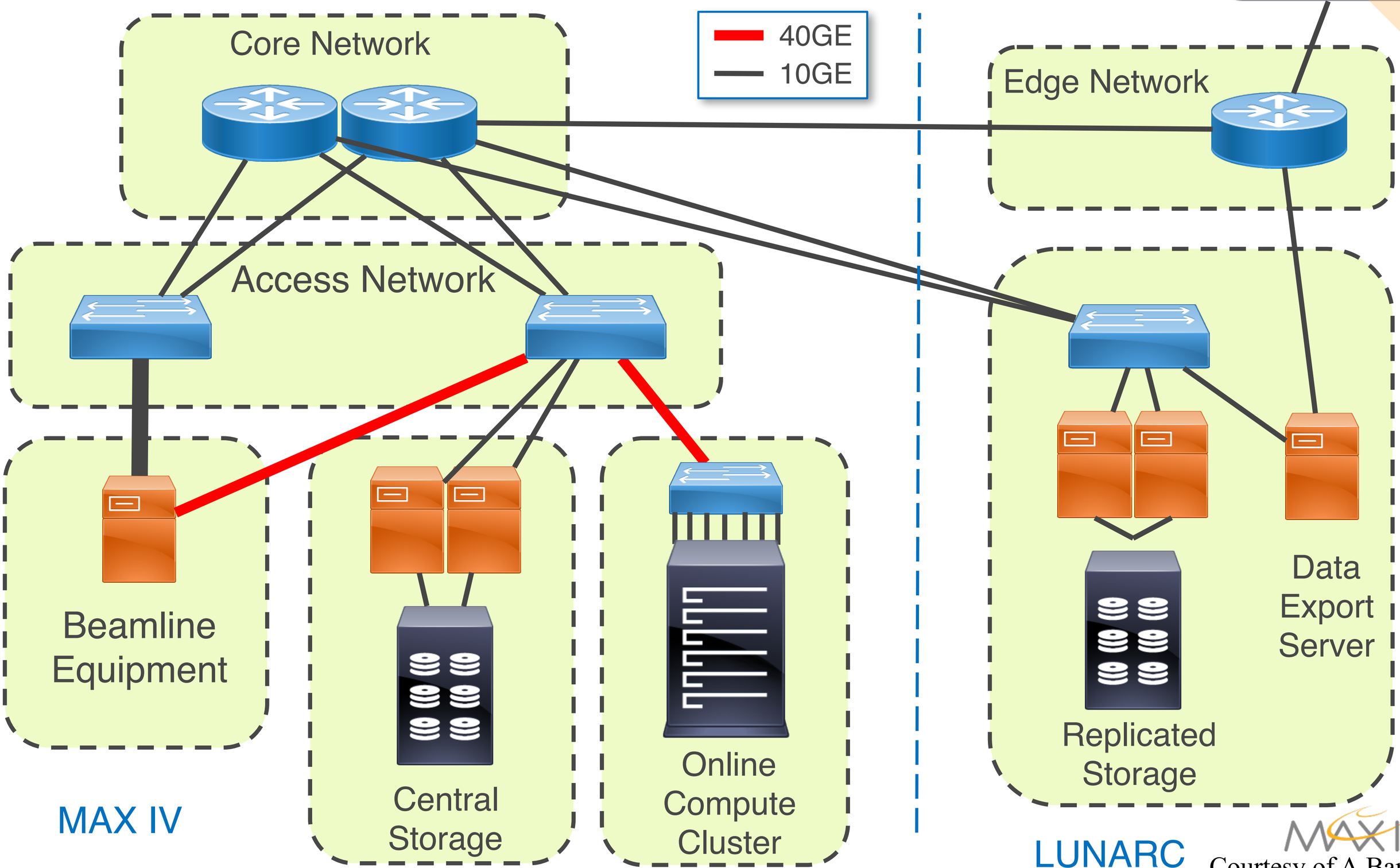
LARS SJÖÖBLOM sc. 2016

KITS teams works hard



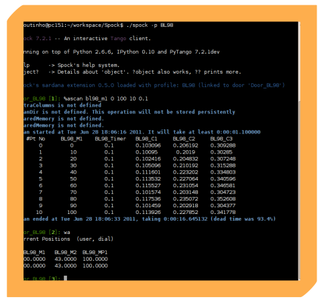
… to get these fingers on the screen

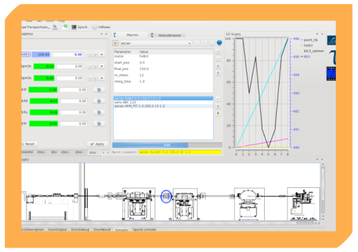
MAX IV Scientific Compute Infrastructure, Plan for 2017



Courtesy of A.Barczyk

ID Control





Acquisition

Undulator

TANGO

ETHERNET

EtherIP

icepap controller

icepap Motors

Mono

PLC

Icepap

Icepap

Correction Coils

Switch

Brake

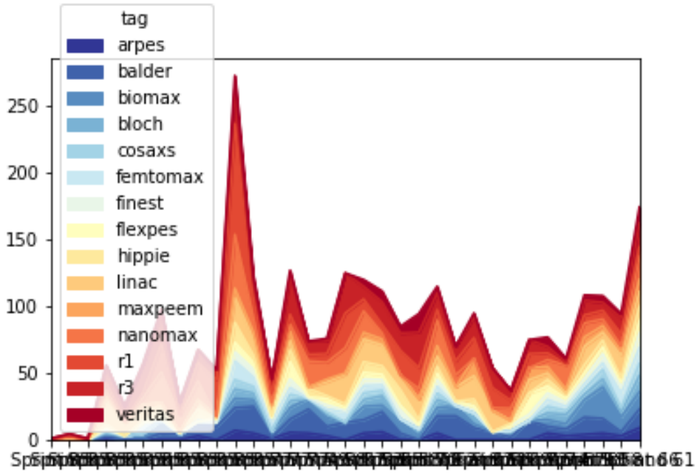
Limit switches

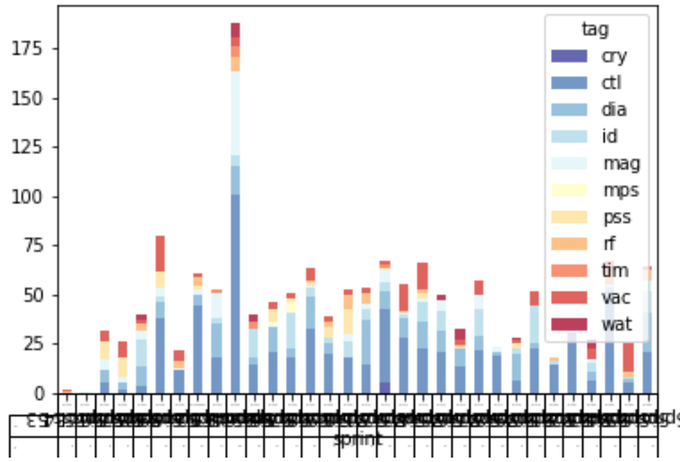
Drivers

Motors

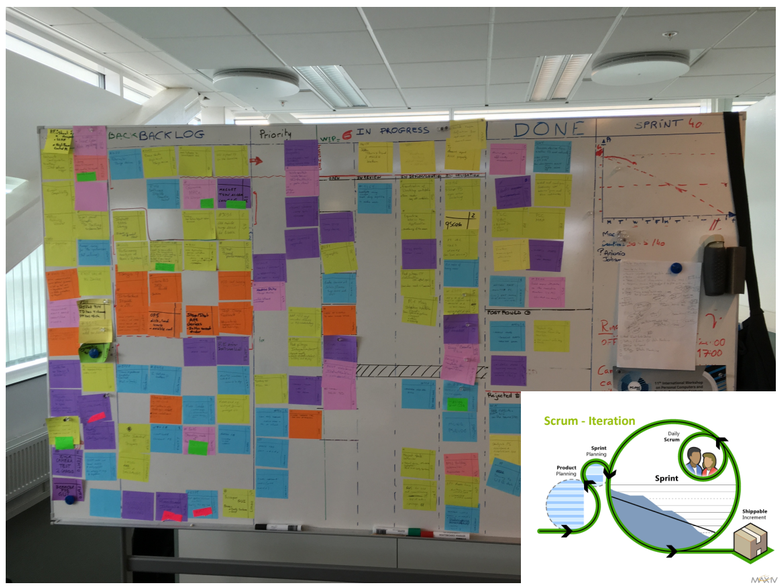
Encoders

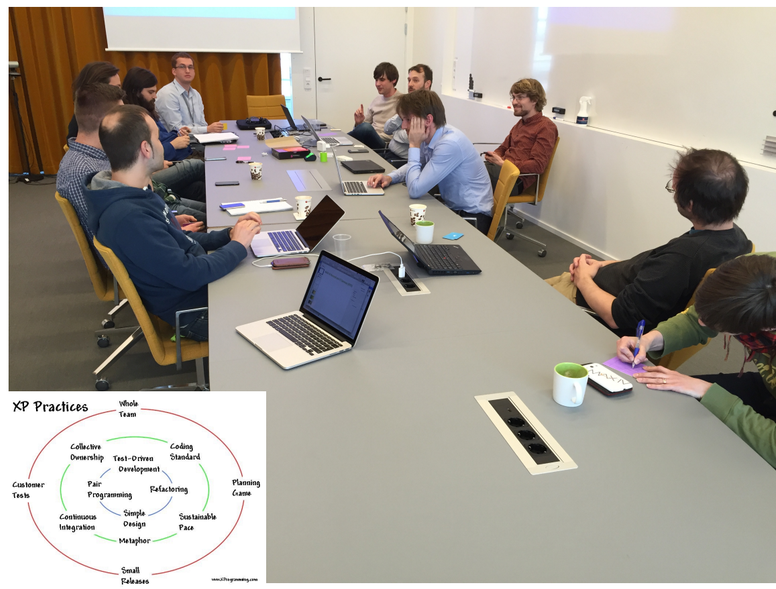
Agile and Lean





5 years
80 sprints
4000 points
2000 stories
66 points/sprint





Core upgrade

CentOS	6		7
TANGO Connecting things together	8		9
python™	2.7	In progress	3.4
sardana	1.8		2.3

MAX IV

Migration

MySQL® HDB → HDB++ cassandra

MML → Slow correction → TANGO Connecting things together

Qt → In progress → HTML CSS JS

MAX IV

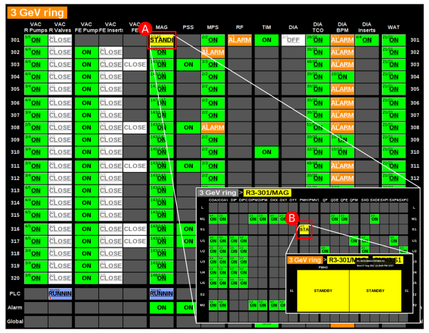
Usage and Development of Web Services at MAX IV

A. Milan-Otero, J. Forsberg, F. Bolmsten, J. Brudvik, M. Eguiraun, V. Hardion, L. Kjellsson, D. P. Spruce, L. Zytniak, MAX IV Laboratory, Lund University, Sweden.

Monitoring and Status

State Grid

The state grid is mainly implemented as a HTML5 application using JavaScript. It is backed by a specifically developed TANGO device that collects the current state from a configured set of devices via event subscriptions and makes this information available as an attribute.

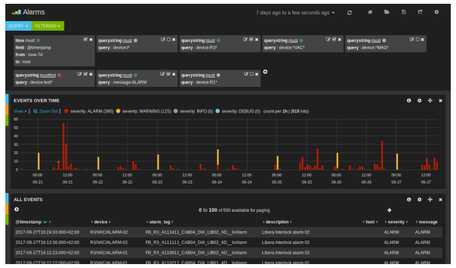


HTML

Knockout

Logging

A Tango device server has been developed to be used as a logger for the control system. It uses ElastichSearch as a back-end and Kibana 3 as front-end.

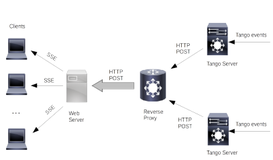


kibana

Elastic Search

Machine Status

Based on Server Send Events, this application is updating its contend based on events generated in the system.
Tango events are generated by the control system and forwarded as HTTP POST to a reverse proxy that them again to a web server located in a DMZ. This web server send Server Send Events to the clients in order to update them.



Flask
web development, one drop at a time

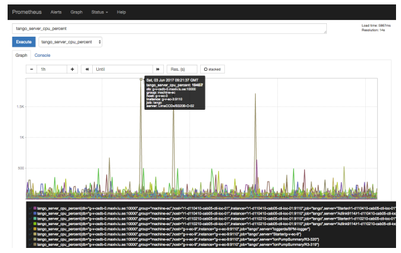
Bootstrap

Monitor and Alerts

Apart from the usual system metrics (CPU, memory, network, etc) for each server in the system, we have also developed an "exporter" that monitors TANGO servers.

Prometheus can be configured to send out alerts if some arbitrary conditions are fulfilled, based on recent data.

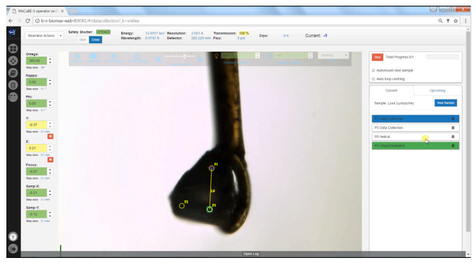
Grafana is used to display the data reported by prometheus.



Beamline Control and Acquisition

MxCUBE 3

Single page application developed in collaboration between ESRF and MAXIV. Its main purpose is to automate routines in an MX Beamline.
It's using Flask as a back-end and a React and Redux for the front-end.



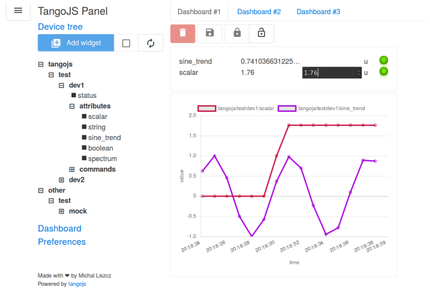
React

Redux

Flask
web development, one drop at a time

TangoJS

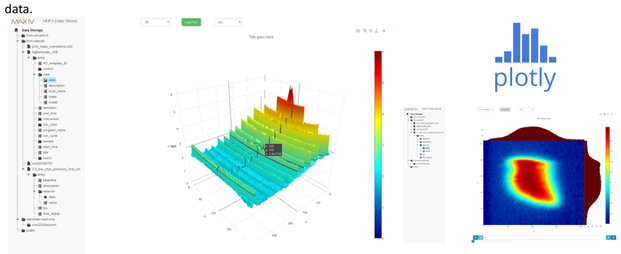
TangoJS is a complete solution for creating TANGO clients in a web application.
Built with Node.js, TangoJS is available in npm, making easier its integrations into any Node.js project.



Data Access

HDF5 Viewer

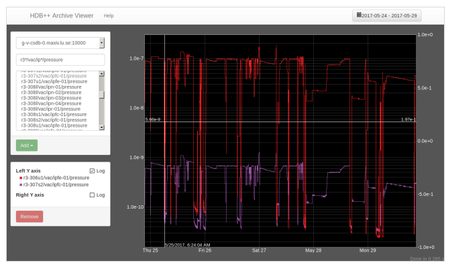
Based on a REST API web service, this application provides a quick inspection of the data taken, without the need to download or install any software, and allows in an easy way, the remote access and analysis of that data.



HDB++ Viewer

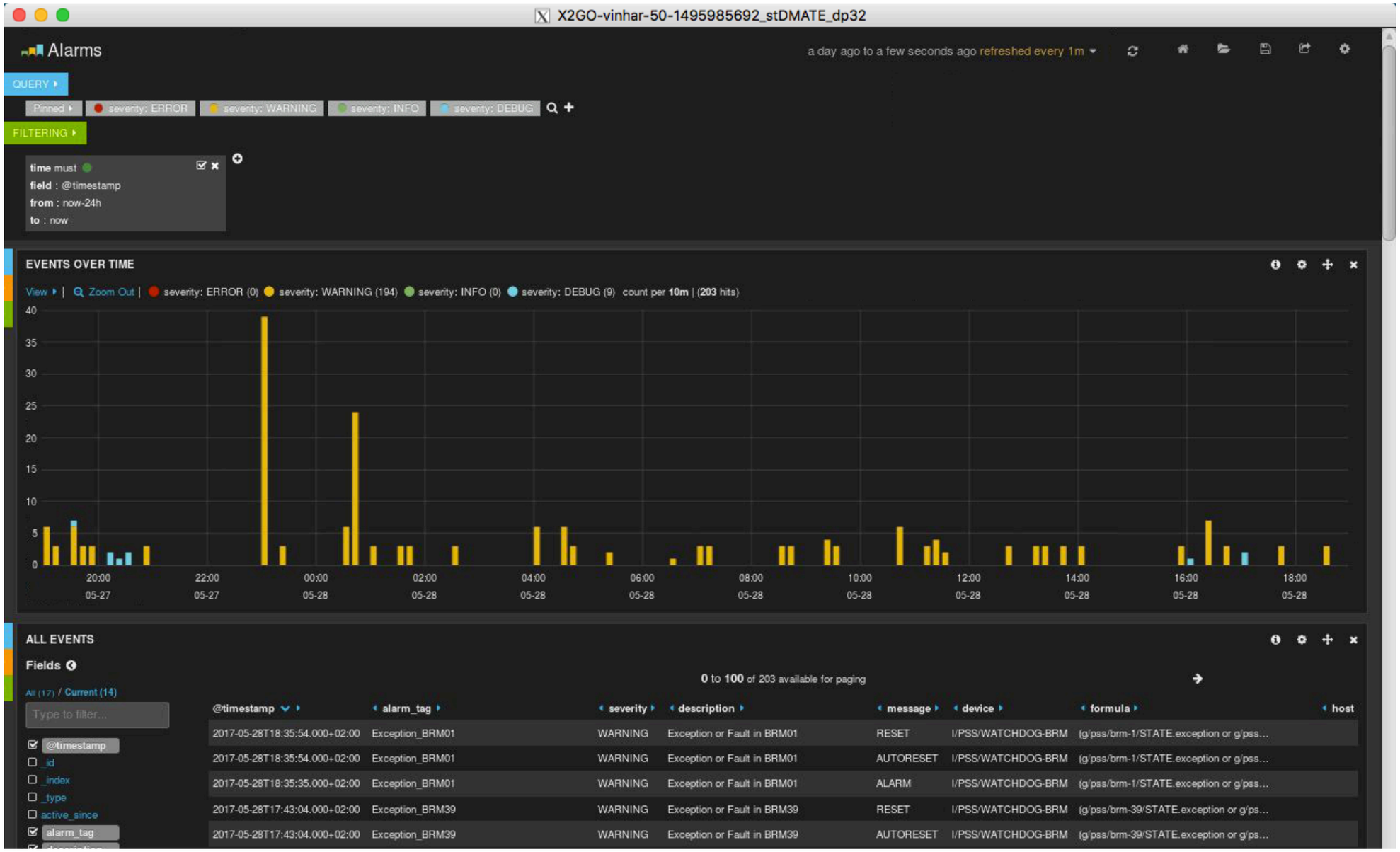
This web interface provides a quick way of filtering attributes, adding them to a plot and zooming/panning the plot using the mouse.

There is also a date picker for more exact setting of time period. When the settings are changed, the front-end requests a new plot image via HTTP, and draws it.



THPHA170
Poster Session
Thursday

Alarms



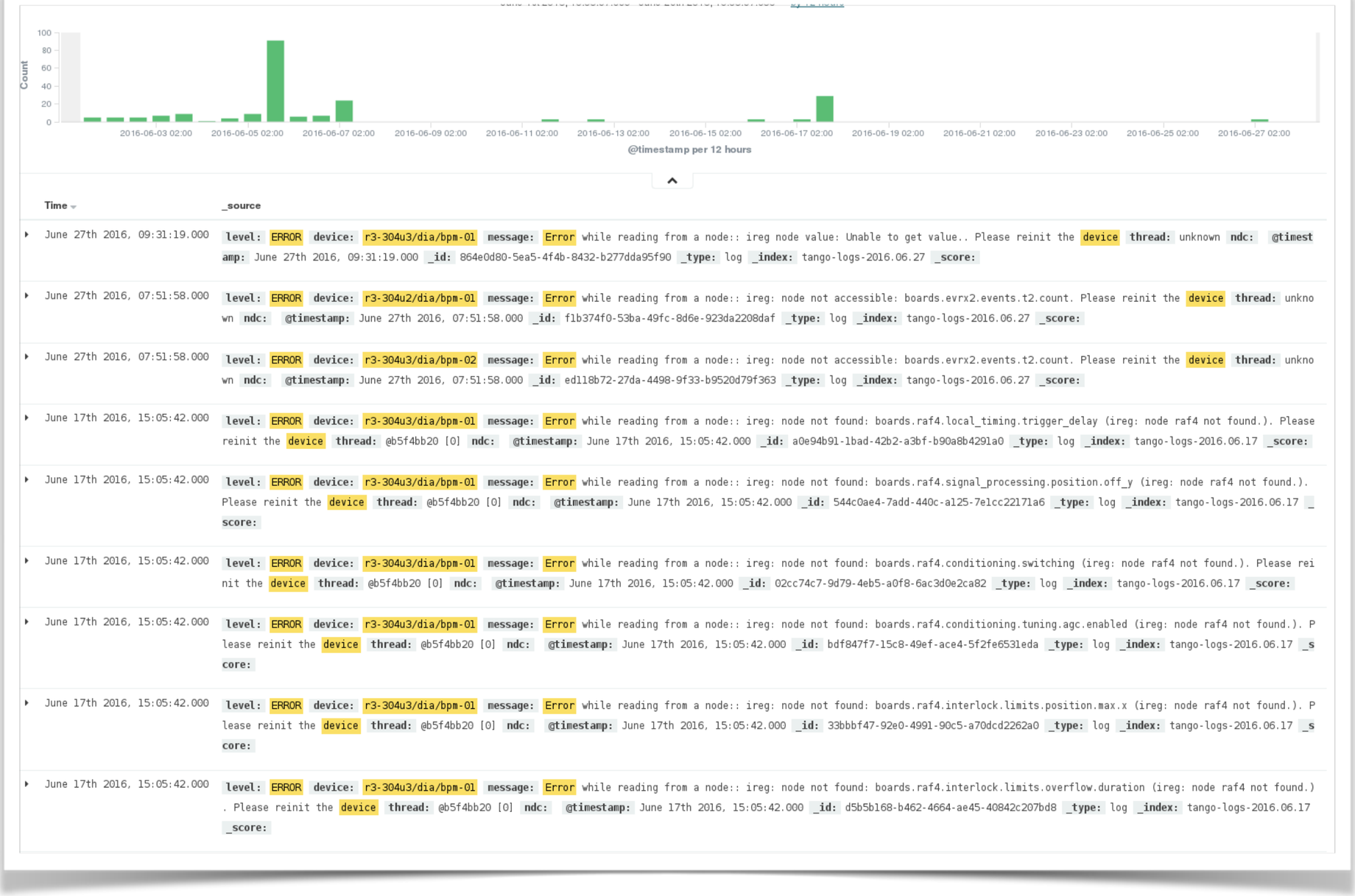
kibana

Elastic Search

Kibana + ElasticSearch

MAX IV

Logging



Time	_source
June 27th 2016, 09:31:19.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg node value: Unable to get value.. Please reinit the device thread: unknown ndc: @timestamp: June 27th 2016, 09:31:19.000 _id: 864e0d80-5ea5-4f4b-8432-b277dda95f90 _type: log _index: tango-logs-2016.06.27 _score:
June 27th 2016, 07:51:58.000	level: ERROR device: r3-304u2/dia/bpm-01 message: Error while reading from a node:: ireg: node not accessible: boards.evrx2.events.t2.count. Please reinit the device thread: unknown ndc: @timestamp: June 27th 2016, 07:51:58.000 _id: f1b374f0-53ba-49fc-8d6e-923da2208daf _type: log _index: tango-logs-2016.06.27 _score:
June 27th 2016, 07:51:58.000	level: ERROR device: r3-304u3/dia/bpm-02 message: Error while reading from a node:: ireg: node not accessible: boards.evrx2.events.t2.count. Please reinit the device thread: unknown ndc: @timestamp: June 27th 2016, 07:51:58.000 _id: ed118b72-27da-4498-9f33-b9520d79f363 _type: log _index: tango-logs-2016.06.27 _score:
June 17th 2016, 15:05:42.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg: node not found: boards.raf4.local_timing.trigger_delay (ireg: node raf4 not found.). Please reinit the device thread: @b5f4bb20 [0] ndc: @timestamp: June 17th 2016, 15:05:42.000 _id: a0e94b91-1bad-42b2-a3bf-b90a8b4291a0 _type: log _index: tango-logs-2016.06.17 _score:
June 17th 2016, 15:05:42.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg: node not found: boards.raf4.signal_processing.position.off_y (ireg: node raf4 not found.). Please reinit the device thread: @b5f4bb20 [0] ndc: @timestamp: June 17th 2016, 15:05:42.000 _id: 544c0ae4-7add-440c-a125-7e1cc22171a6 _type: log _index: tango-logs-2016.06.17 _score:
June 17th 2016, 15:05:42.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg: node not found: boards.raf4.conditioning.switching (ireg: node raf4 not found.). Please reinit the device thread: @b5f4bb20 [0] ndc: @timestamp: June 17th 2016, 15:05:42.000 _id: 02cc74c7-9d79-4eb5-a0f8-6ac3d0e2ca82 _type: log _index: tango-logs-2016.06.17 _score:
June 17th 2016, 15:05:42.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg: node not found: boards.raf4.conditioning.tuning.agc.enabled (ireg: node raf4 not found.). Please reinit the device thread: @b5f4bb20 [0] ndc: @timestamp: June 17th 2016, 15:05:42.000 _id: bdf847f7-15c8-49ef-ace4-5f2fe6531eda _type: log _index: tango-logs-2016.06.17 _score:
June 17th 2016, 15:05:42.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg: node not found: boards.raf4.interlock.limits.position.max.x (ireg: node raf4 not found.). Please reinit the device thread: @b5f4bb20 [0] ndc: @timestamp: June 17th 2016, 15:05:42.000 _id: 33bbbf47-92e0-4991-90c5-a70dcd2262a0 _type: log _index: tango-logs-2016.06.17 _score:
June 17th 2016, 15:05:42.000	level: ERROR device: r3-304u3/dia/bpm-01 message: Error while reading from a node:: ireg: node not found: boards.raf4.interlock.limits.overflow.duration (ireg: node raf4 not found.). Please reinit the device thread: @b5f4bb20 [0] ndc: @timestamp: June 17th 2016, 15:05:42.000 _id: d5b5b168-b462-4664-ae45-40842c207bd8 _type: log _index: tango-logs-2016.06.17 _score:

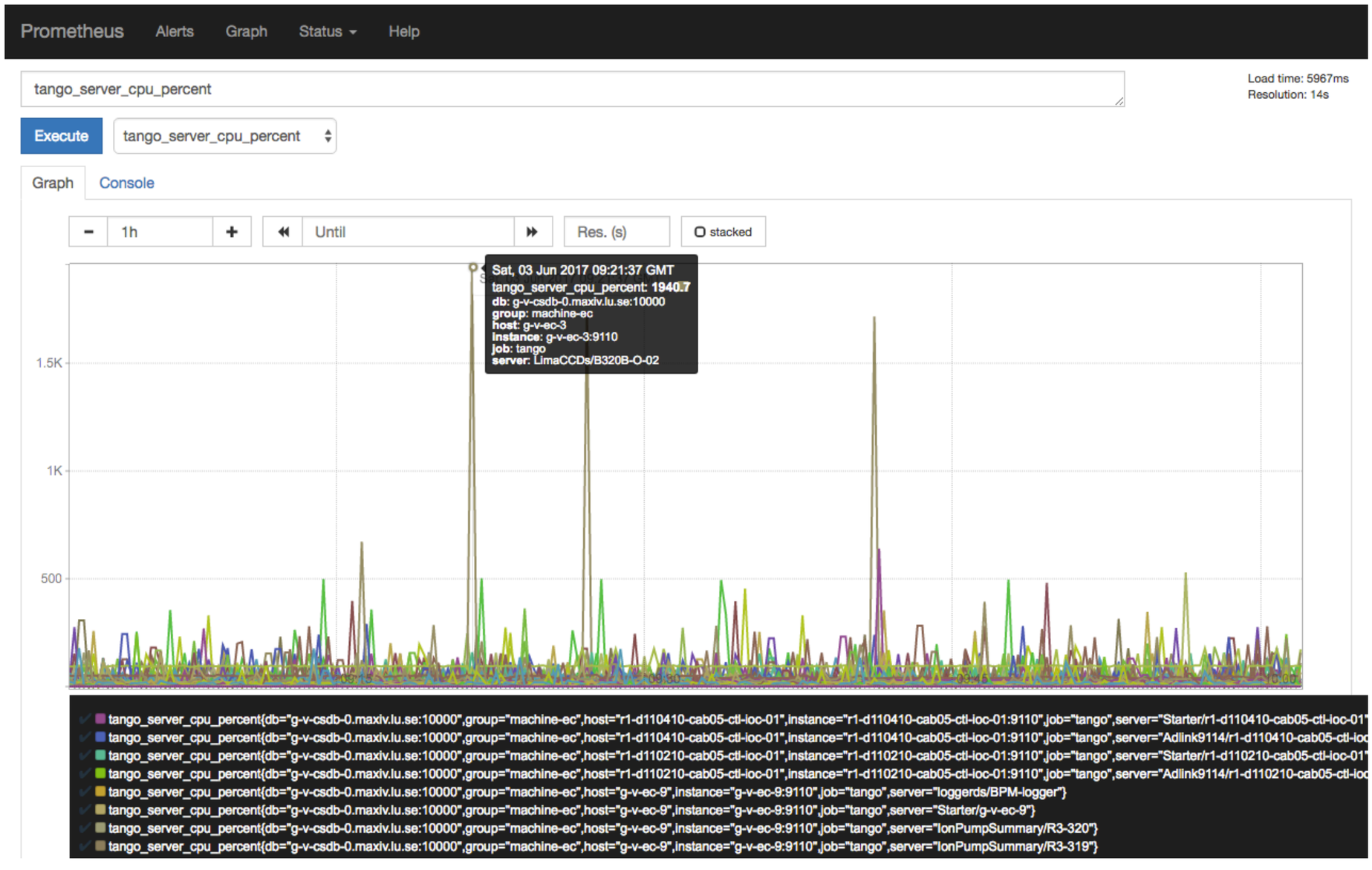
kibana

Elastic Search

MAX IV

Monitoring

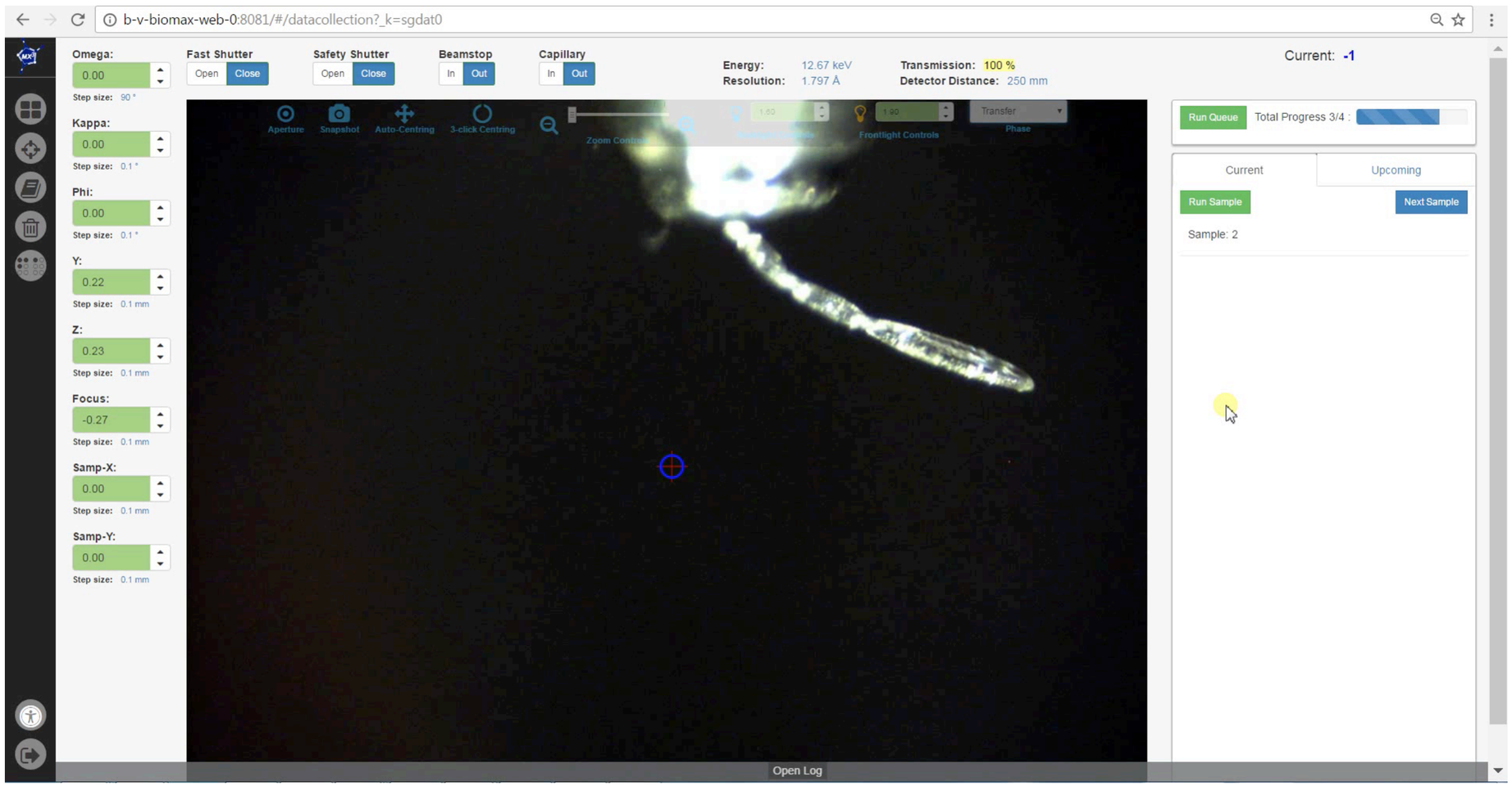
Monitor Tango system and resources

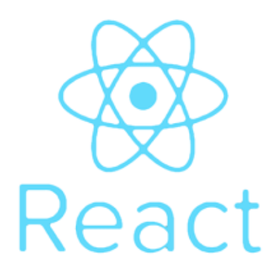


MAX IV

MxCube 3 Web

Single Page Web App for Data Collection on fully automated Beamlines





Machine Status

Event Based Status Webpage: status.maxiv.lu.se

LEARN HIGHCHARTS
Interactive map charts

jQuery

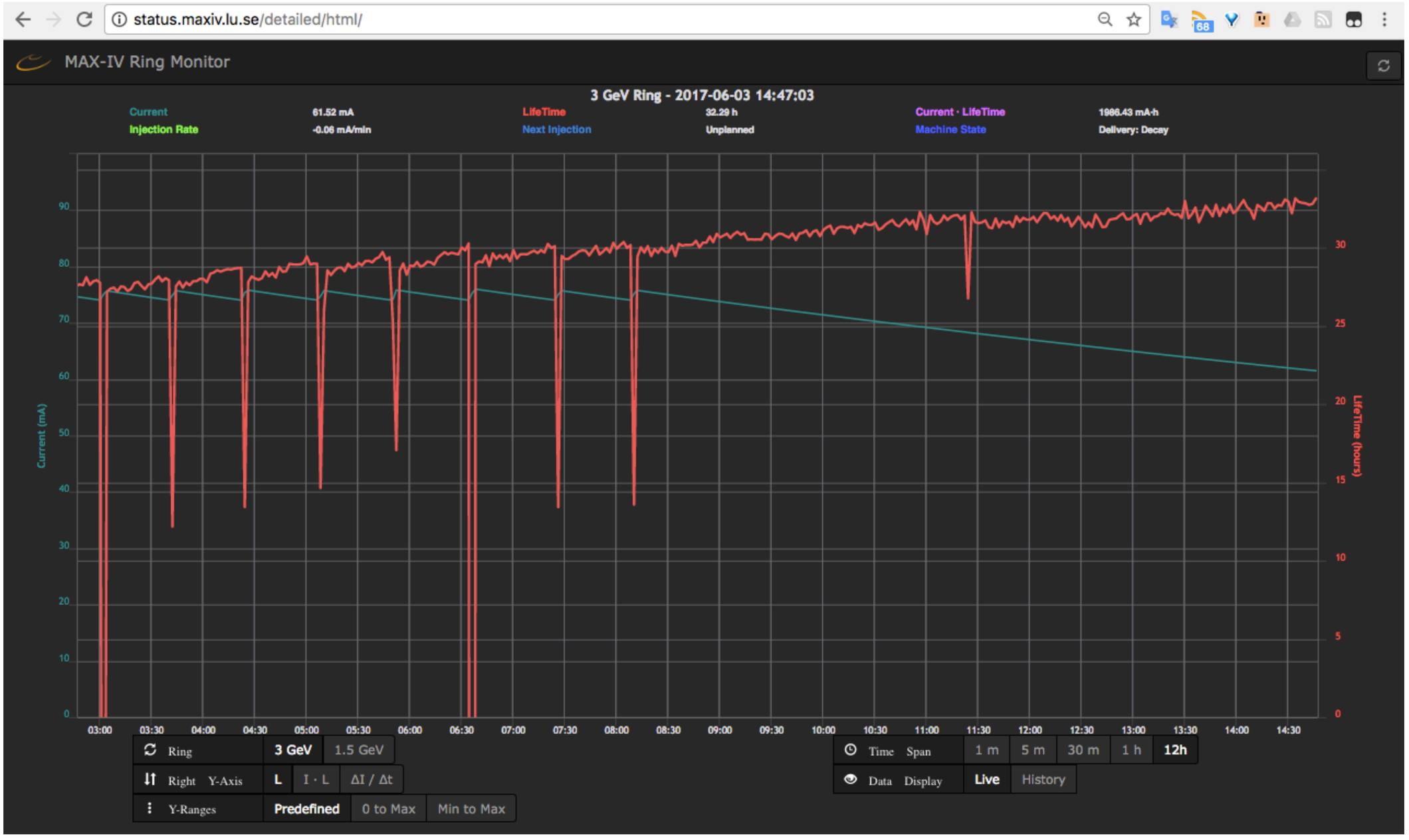
Bootstrap

Flask
web development, one drop at a time

Apache

MAX IV

Detailed Status



PSS Radiation Monitoring

All | Ring 1 | Ring 3 | Others

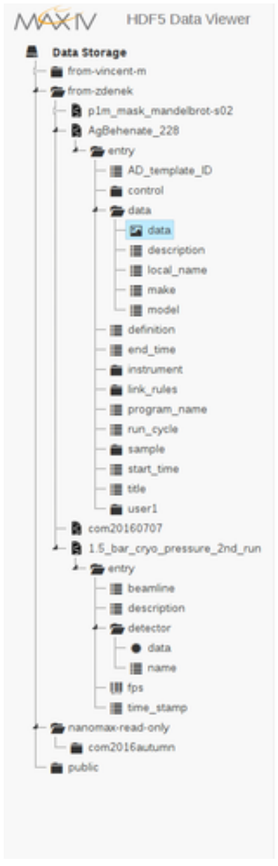
Alarms

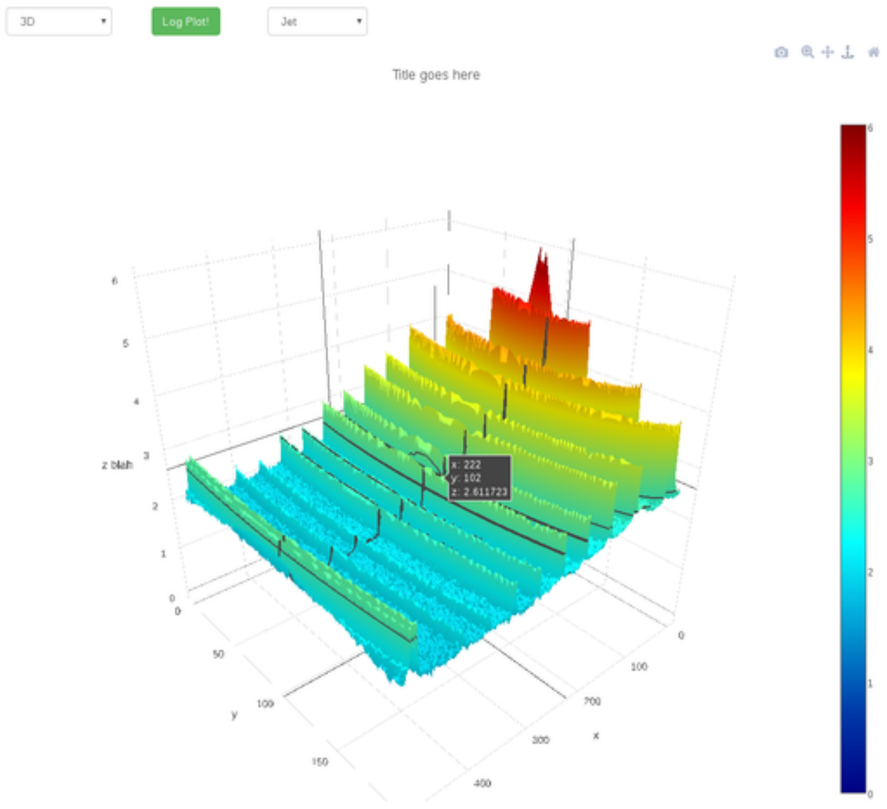
Position	Values (μSv/h)	Devices Name

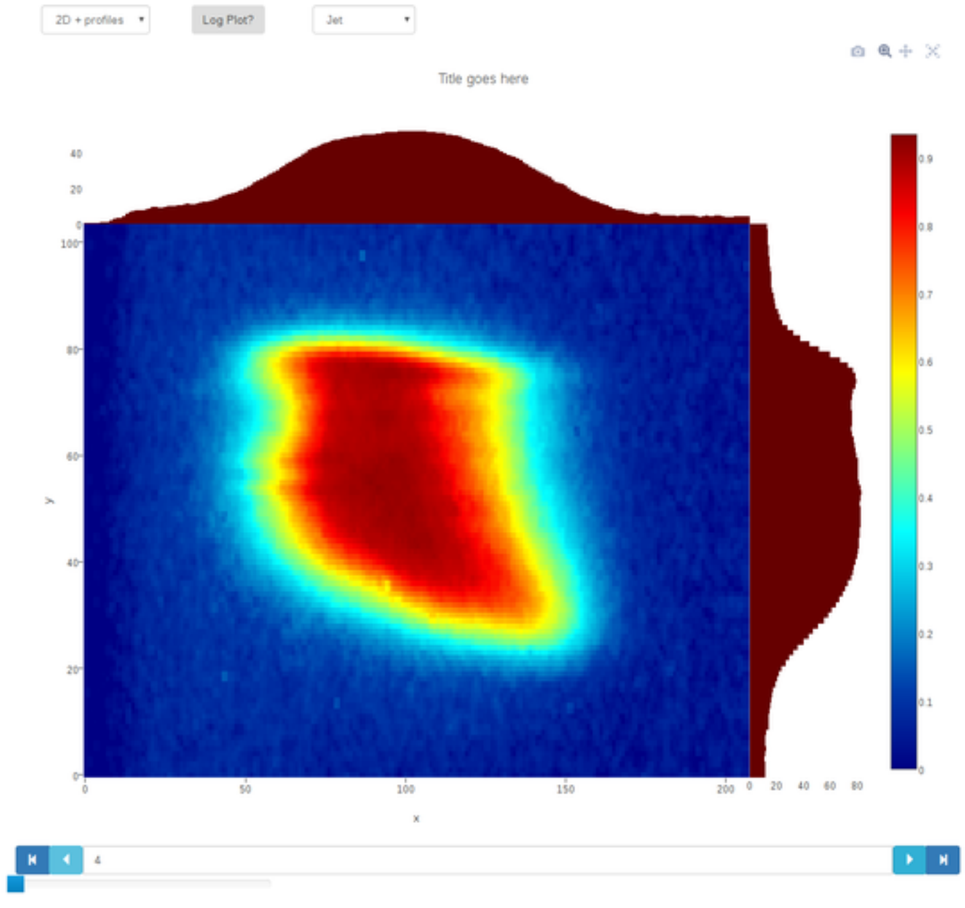
Devices

Position	Values (μSv/h)	Devices Name
KG_TR1	0.1468	BRM-9
R1 roof	0.1288	BRM-40
R1_Ach02	0.1556	BRM-34
R1_Ach04	0.1692	BRM-35
R1_Ach06	0.1367	BRM-36
R1_Ach08	0.1633	BRM-37
R1_Ach10	0.1234	BRM-38
R1_Ach12	0.1205	BRM-39
R1_Origo	0.1237	BRM-4

HDF5 Viewer





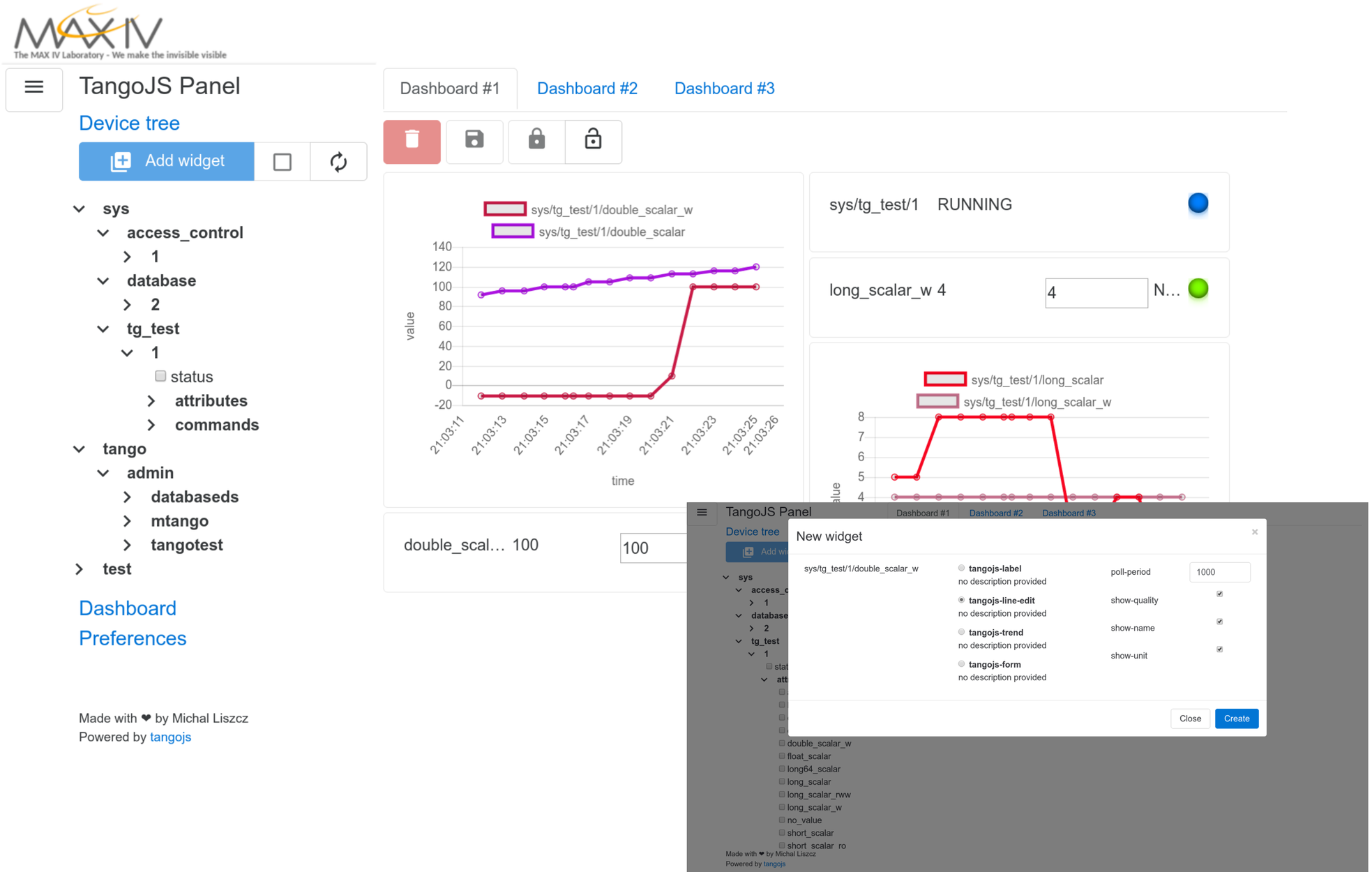


This web GUI is written in javascript, sprinkled with a bit of jquery, and makes use of the plotly graphing libraries.

Based on the HDF5 file server REST Server

Bloch Beamline Status

Goal: Provide an extensible, standard-based solution for building TANGO clients for web browsers.

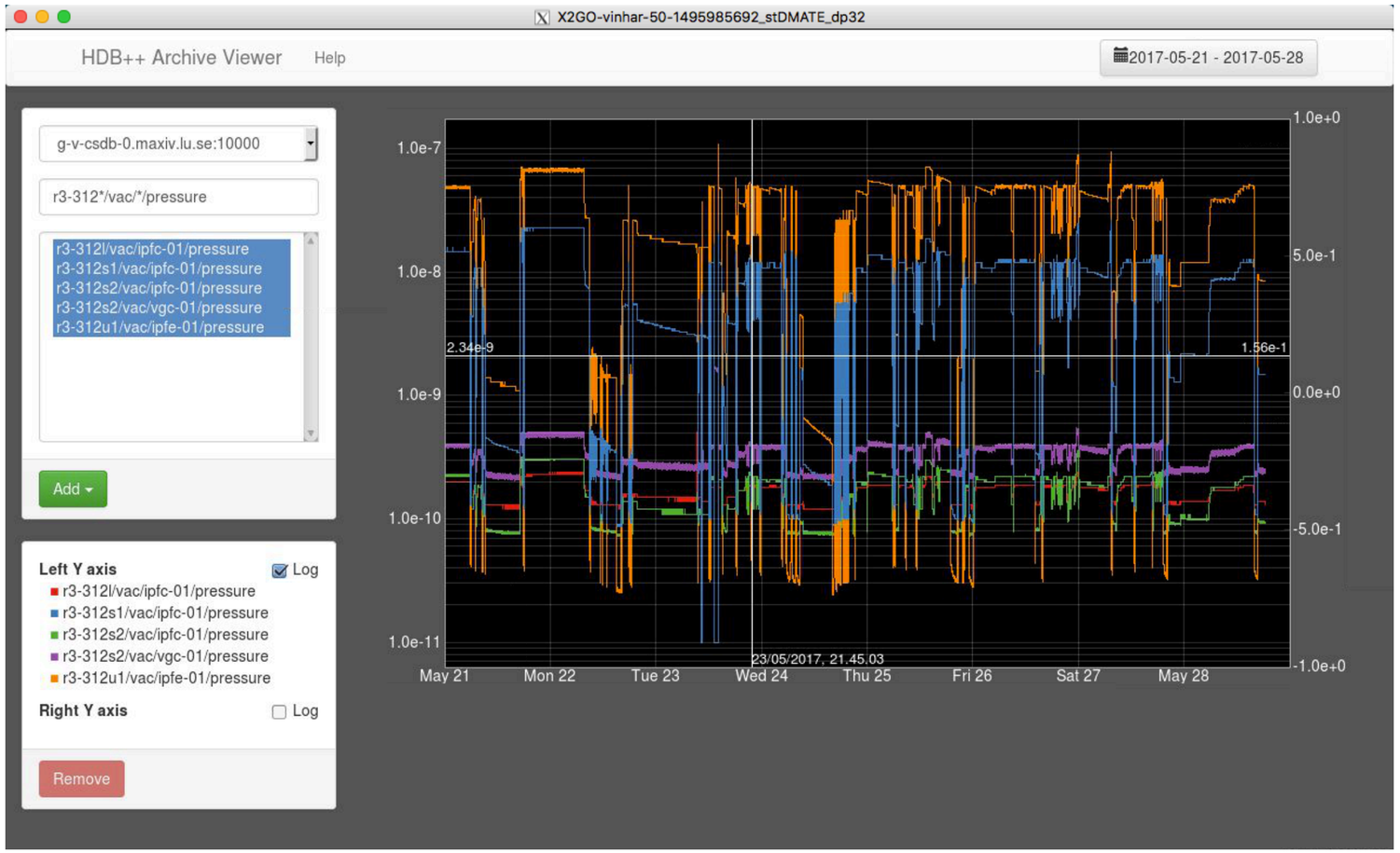


TangoJS

SOLARIS
NARODOWE CENTRUM PROMIENIOWANIA SYNCHROTRONOWEGO

MAX IV

HDB ++ Viewer



A web based viewer for HDB++ archive data, currently only supporting the Cassandra backend.

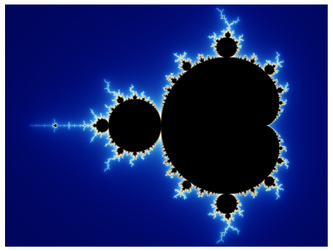
FrontEnd: node.js, babel, react and redux and managed with webpack

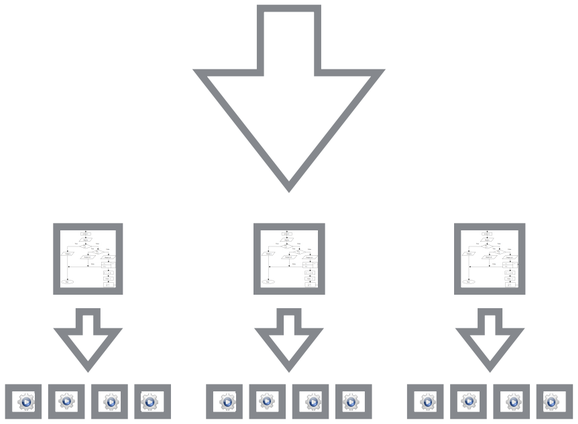
BackEnd: aiohttp, Bokeh/datashader

Automatic Machine

Constraints of Automation?

When to start and stop?

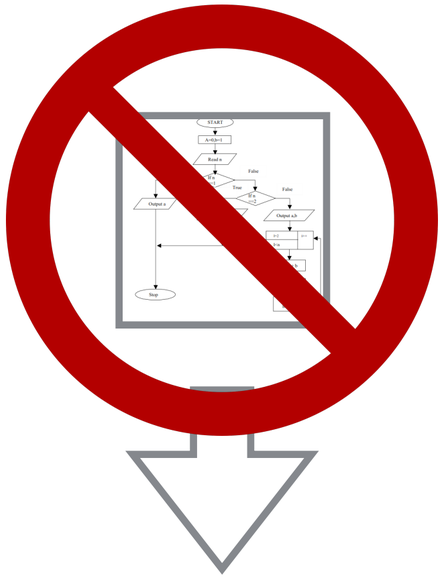




Virtually no limit

Based on pattern

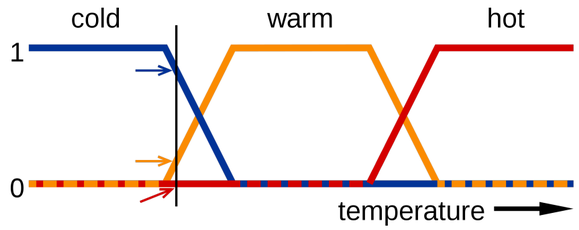
Stable



Operations

vs R&D

Analysis of feedback



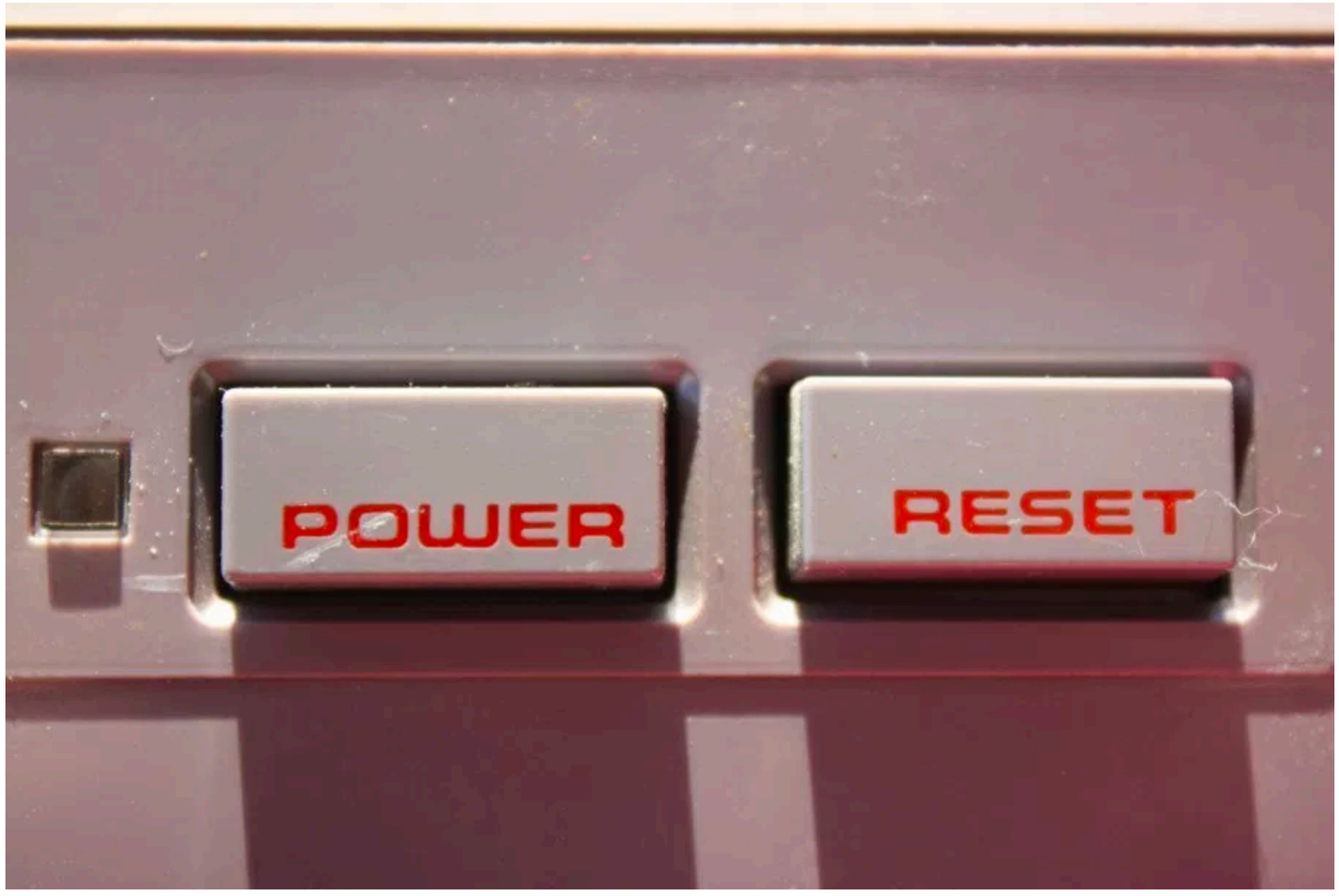
Sometimes the more measurable drives out the most important.

--René Dubos

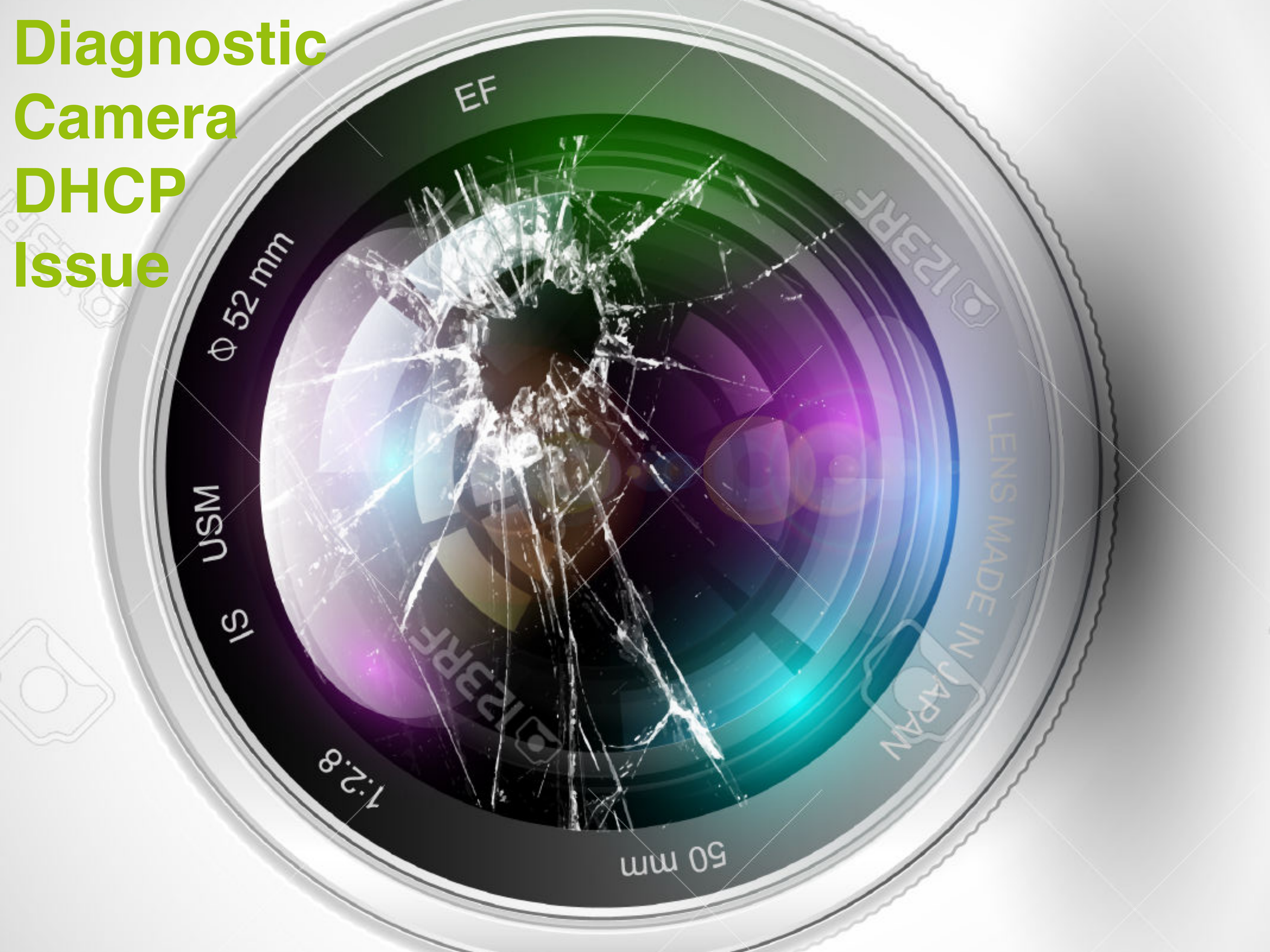
Robustness for the automation ISO 9126

Functionality	Usability	Reliability	Performance	Support.
~300 000 channels R/W @HW and Computation level **Need Feedback, Correction, Compensation and diagnostic**	Human factor: **Limited on general services**	Availability: MTTF in improvement (PSS Watchdog) but **Powersupply, Libera, Basler camera**… Known software issue (**Radiation Monitor**,…)	Speed: dependent on the hardware but enough for 100 Hz fast diagnostic	Testability: - Unit test on most of the Tango device, - Maintenance smoked test, - Incremental validation - **but less available time** - **obsolescence to manage**
Accurateness: functions tested and reviewed	Documentation: **Expert and Experienced People only**	Failure Extent: no metrics but day oncall support. VM fail over, monitoring of the servers	Efficiency: - T**ime stamping in review**, - **Not enough for Archiving, snapshot and alarms**	Flexibility: - modularity of Tango - within scope > real time - management of the configuration **but Archiving, Snapshot …**
Reusability: - between accelerators - Tango binding and MML	Consistency: Standard Naming and behaviour (ALARM vs FAULT state)	Stability: overall the system is predictable	Resource consumption: 40 CPU & 80 GB, **Some HW bandwidth are consumed** (ITest)	Speed: - min 2 weeks iteration - real time for critical operation
Security: not required	Responsiveness to improve	Accuracy (Frequency/ Severity): No metrics but less urgent call; in continuous improvement	Throughput: Should handle camera at 50 Hz	Install-ability: - Accessible from dedicated local and remote computer
Compliance: not required			Capacity: **Scalability: yes but general service (mysql, polling system)**	Capacity: - possibility to increase the inventory

Losing control of Power supplies



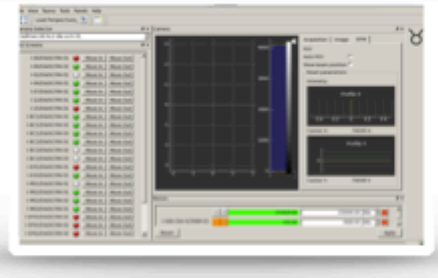
Diagnostic Camera DHCP Issue



Dying BPM

Archiving Performance polling vs cache/event

Cache/Event Case:



events

Tango Device

Current	*2.4*
Voltage	*4.81*
Resistance	*2*
Interlocked	*FALSE*
Output	*ON*
...	

Cache polling fit bandwidth

80%

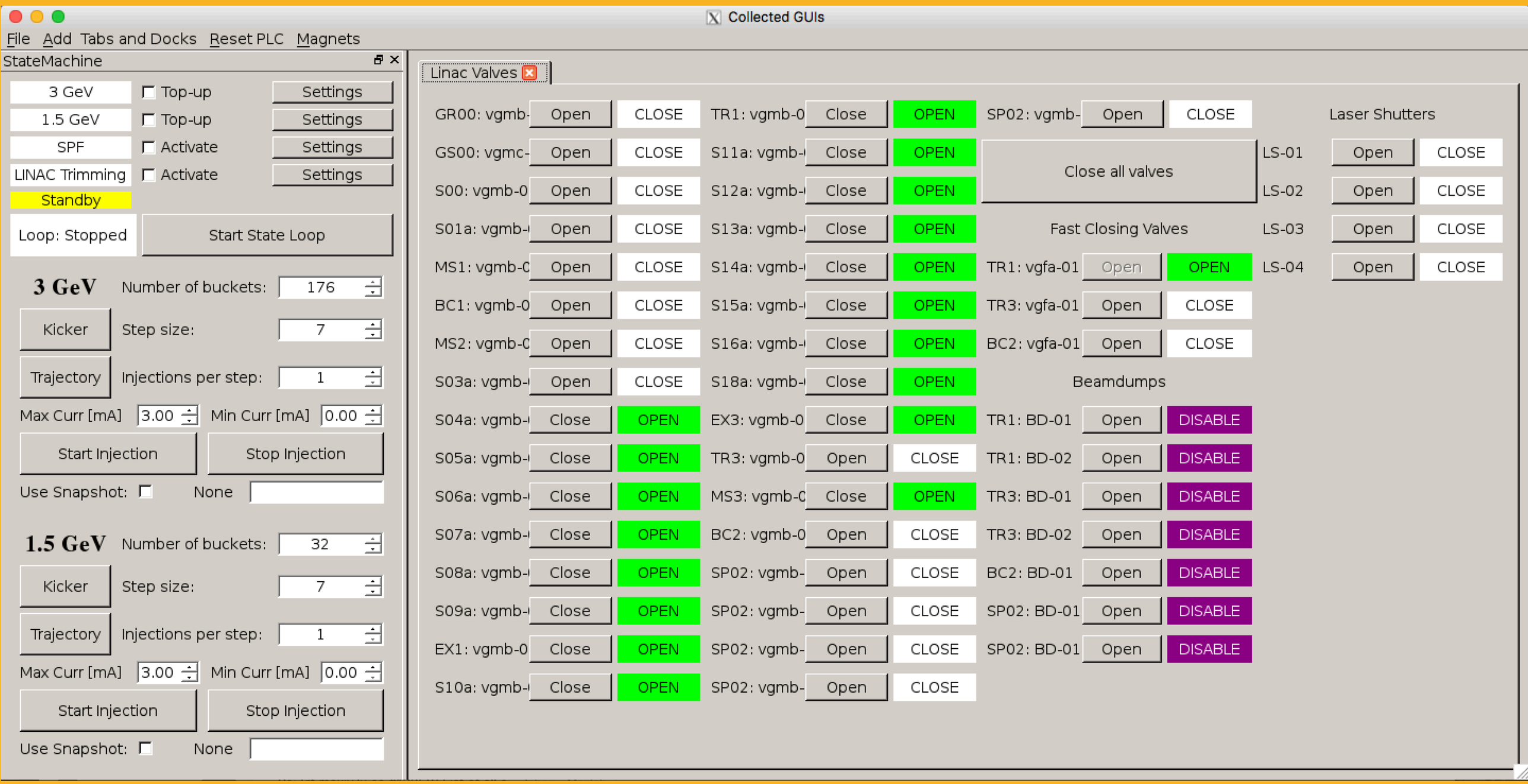
Hardware

Hardware performance = 100 request/s

Tango Performance = 10000 request/s + events

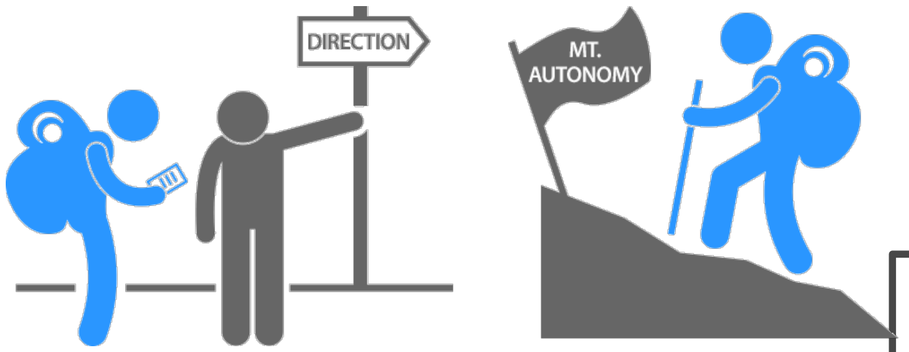
Drawback: Accept delay in answer

Operator's state machine



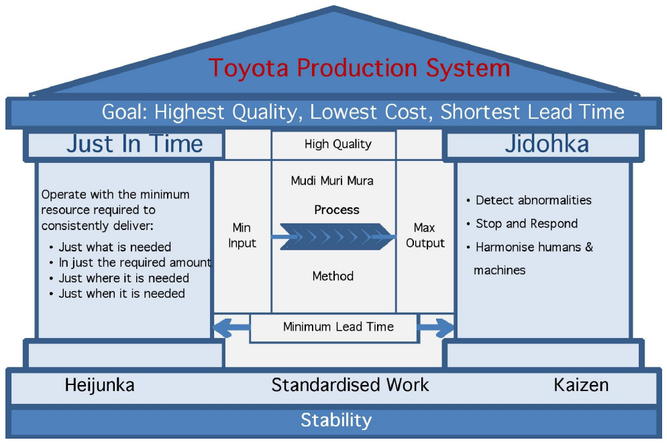
KITS Values

User Autonomy



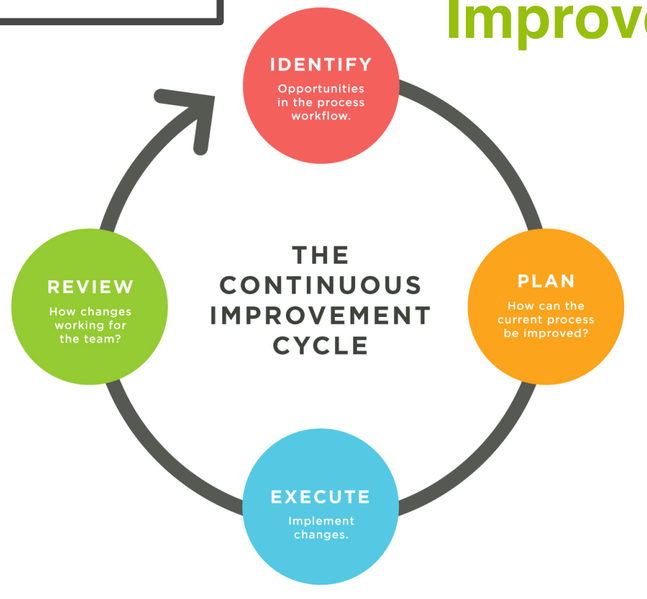
Flexibility

Lean Management



Knowledge Spread

Continuous Improvement



leankit

Bunch By Bunch

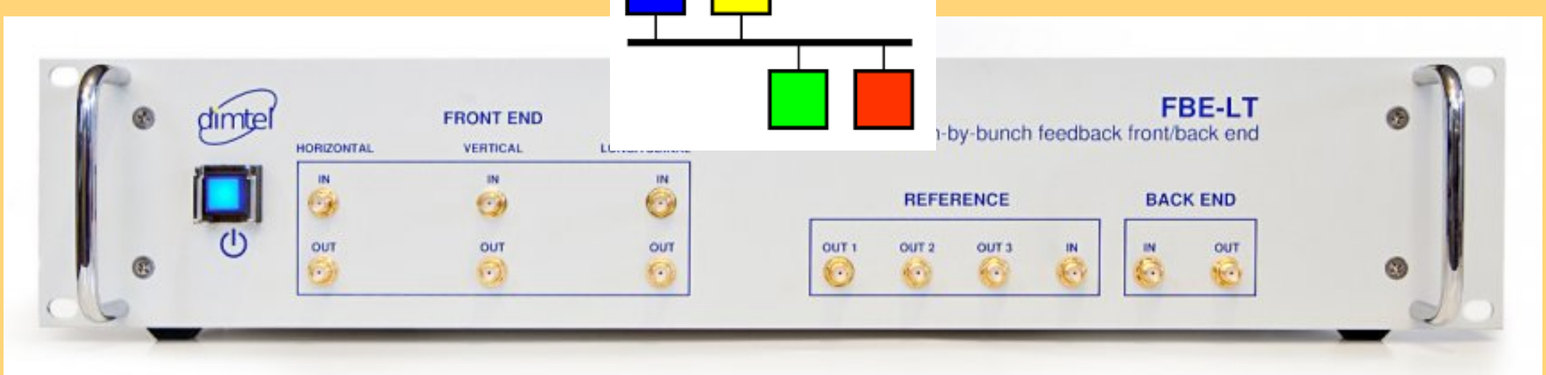
HDB++

cassandra

TANGO

Connecting [illegible] together

EPICS



MAX IV

IcePAP controlling Hippie EPU

Elliptic polarized light

8 servo motors

8 incremental encoders

8 absolute encoders

5 more encoders for safety

32 travel switches

2 tilt sensors

24 temperature sensors

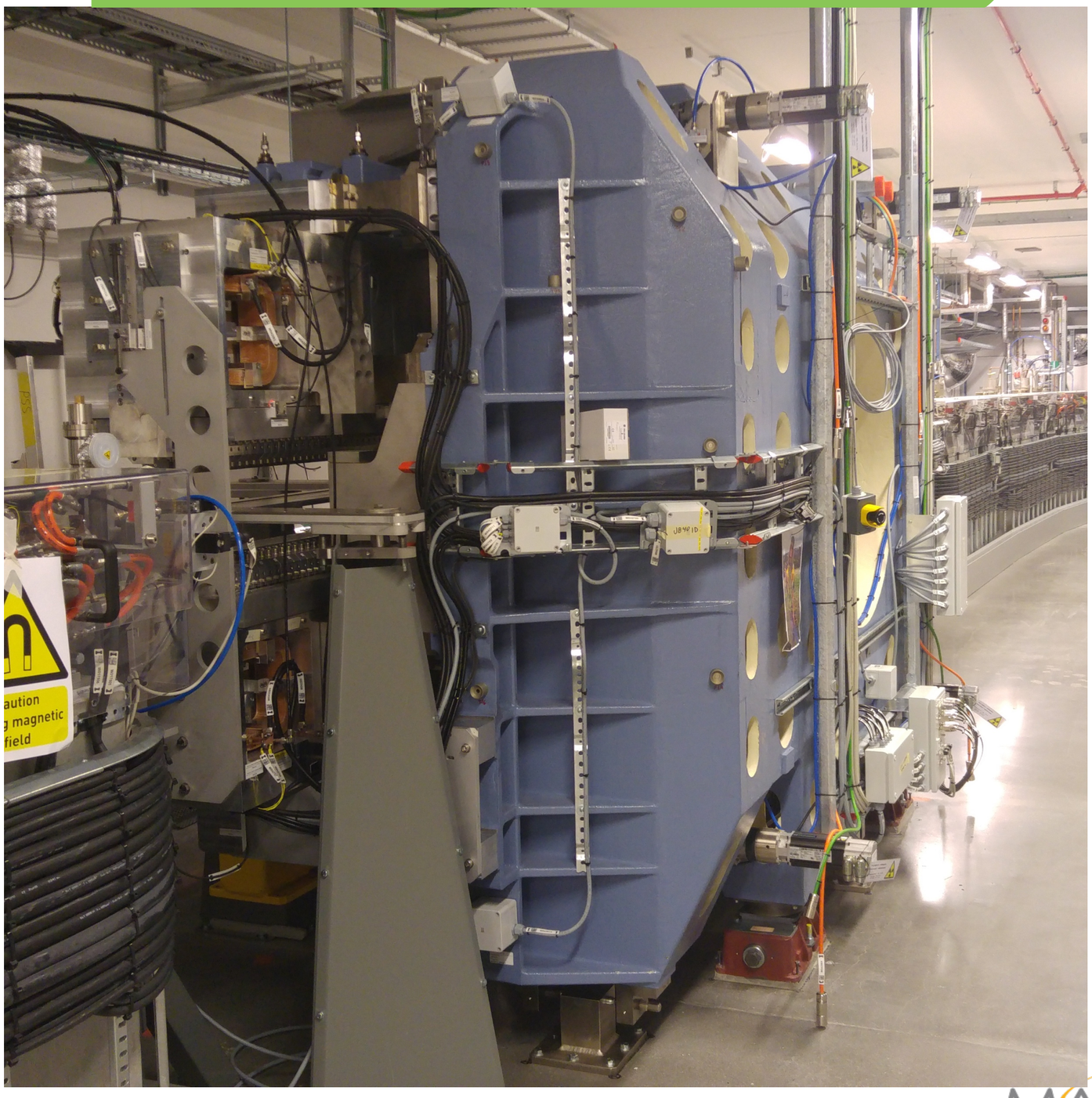
converters

power supplies

And hundreds of individual magnets aligned and placed within microns.

Force: -30 to 40 kN depending on phase.

In total 3 cabinets full of equipment to control it.

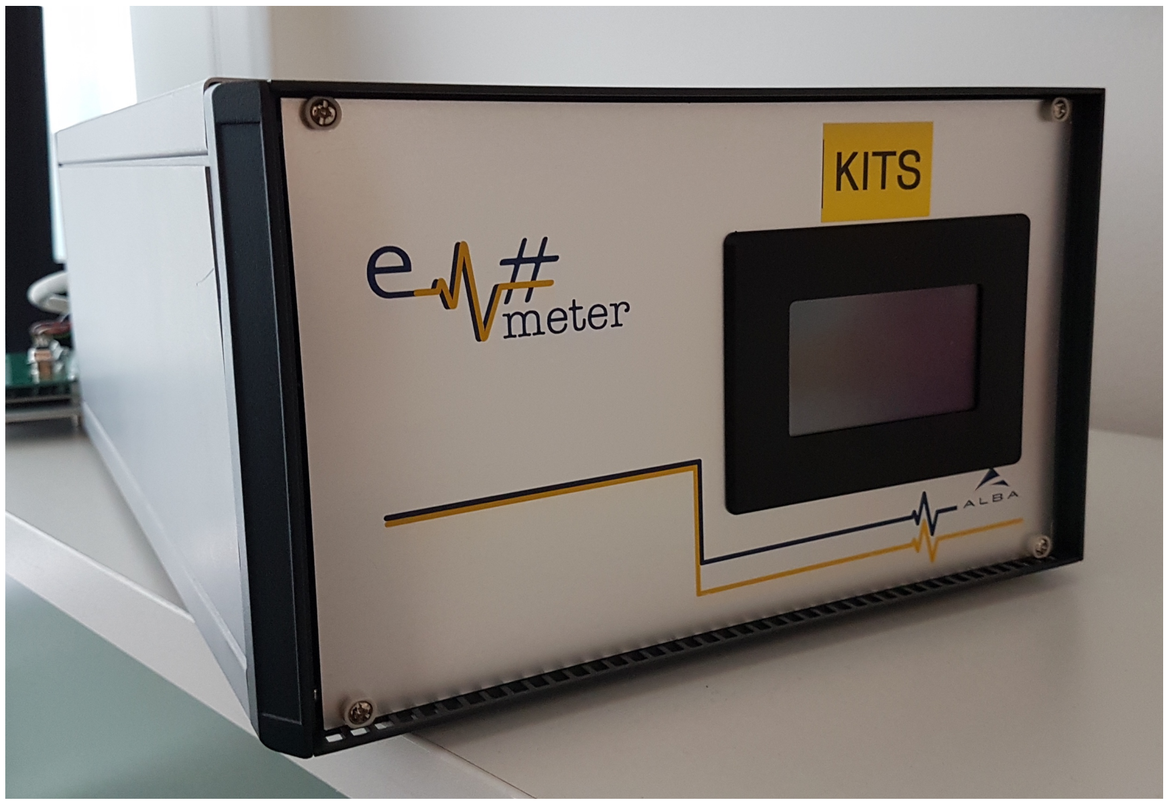


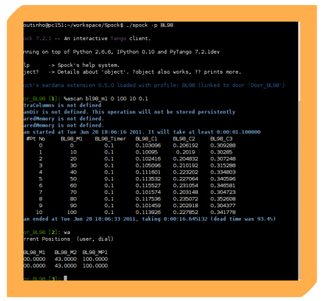
Electrometer

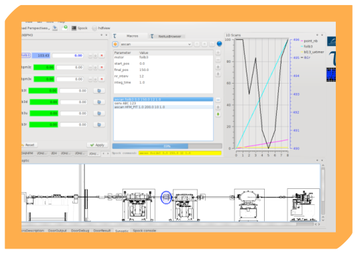
- Collaboration with ALBA
- 4 channel input per unit
- Picoampere resolution
- Fully integrated into our control system
- 25 units delivered, 50 more on its way

EM# 4-CHANNEL ELECTROMETER SPECIFICATIONS

Current Amplifier	Eight independent ranges (from 100pA to 1mA) and five 2nd order analog filters (from 0.1Hz to full bandwidth)
ADC	4x 400kS/s @18 bits SAR
Ground Voltage Bias	Up to 1kV
Analog Outputs	4x ±10V 100kS/s @16 bits
Trigger In	1 x CMOS/TTL compatible
High-Speed I/O	4x configurable Input/Output 100MHz BW (can be used as independent channel triggers)
General I/O	9x Input/Output @5V 20MHz (unipol/diff) + 4x 5V output max 500mA







sardana

COSYLAB
CONTROL SYSTEM LABORATORY

Undulator

TANGO

EtherIP

icepap controller

icepap Motors

Mono

ETHERNET

PLC

Icepap

Icepap

Correction Coils

Switch

Brake

Limit switches

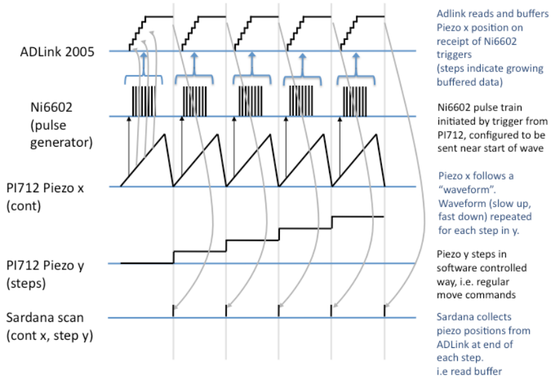
Drivers

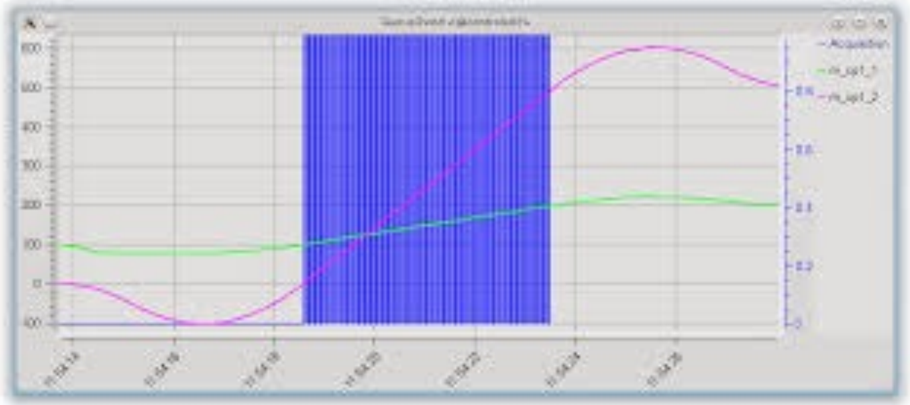
Motors

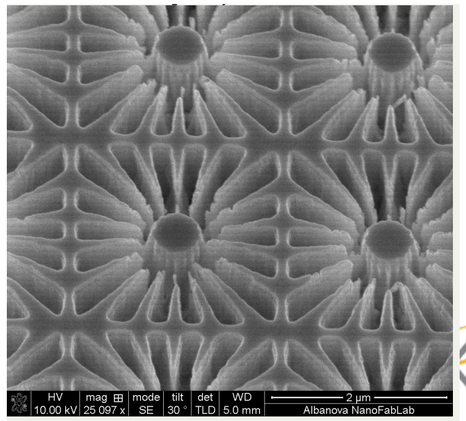
Encoders

MAX IV


sardana


ADLink 2005
Ni6602 (pulse generator)
PI712 Piezo x (cont)
PI712 Piezo y (steps)
Sardana scan (cont x, step y)
Adlink reads and buffers Piezo x position on receipt of Ni6602 triggers (steps indicate growing buffered data)
Ni6602 pulse train initiated by trigger from PI712, configured to be sent near start of wave
Piezo x follows a "waveform". Waveform (slow up, fast down) repeated for each step in y.
Piezo y steps in software controlled way, i.e. regular move commands
Sardana collects piezo positions from ADLink at end of each step. i.e read buffer




HV 10.00 kV
mag 25 097 x
mode SE
tilt 30 °
det TLD
WD 5.0 mm
2 µm
Albanova NanoFabLab

What's next?

Home · Notifications · Messages · Search Twitter · Tweet

MAX IV LABORATORY

Tweets 1,712 · Following 2,105 · Followers 2,172 · Likes 1,465 · Lists 2 · Following

MAX IV Laboratory
@MAXIVLaboratory Follows you

We make the invisible visible.
Synchrotron Radiation Facility.

Lund, Sweden
maxiv.se
Joined January 2011
Born on March 27, 1985

Tweet to · Message

12 Followers you know

Tweets · Tweets & replies · Media

MAX IV Laboratory Retweeted

Pia Kinhult @kinhult · 8h

Här borde kopplas ett forskningsprojekt till @essneutron och @MAXIVLaboratory så vi får moderna o bättre batterier. Inte bara dagens.

ABB Sverige @ABBSverige
ABB och @northvolt i samarbete om Europas största batterifabrik abb.se/cawp/seitp202/…

Translate from Swedish

2 · 5

MAX IV Laboratory Retweeted

NIB @nib · Jan 25

NIB-financed European Spallation Source: Bridging the innovation gap ow.ly/4ngR308in7x @essneutron @JohnWomersley

Who to follow · Refresh · View all

ESS @essneutron — Follow
Lund University @lunduni… — Follow
European Synchrotron @… — Follow

Find people you know

Trends for you · Change

#vdagarna
Katalonien

Follow our twitter account!!

MAX IV

Question?

Credits:

All KITS members and honorary members.

Accelerator and Beamlines Staff

All our collaborators