

WARA-OPS

WORKSHOP ON DATA-DRIVEN RESEARCH AND OPERATIONS 2024

"Towards the Excellence Operation of MAX IV Laboratory Control System"

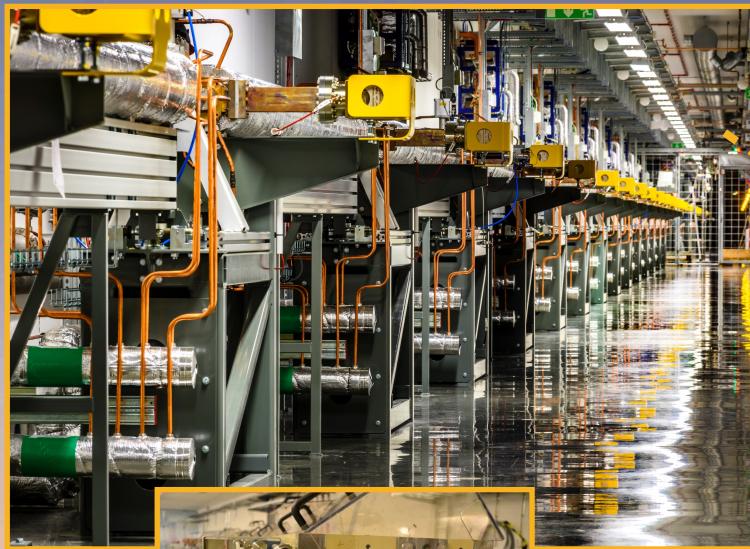
Vincent Hardion, ICT Strategy program manager
Mirjam Lindberg, ICT Software Group Manager

This is MAX IV

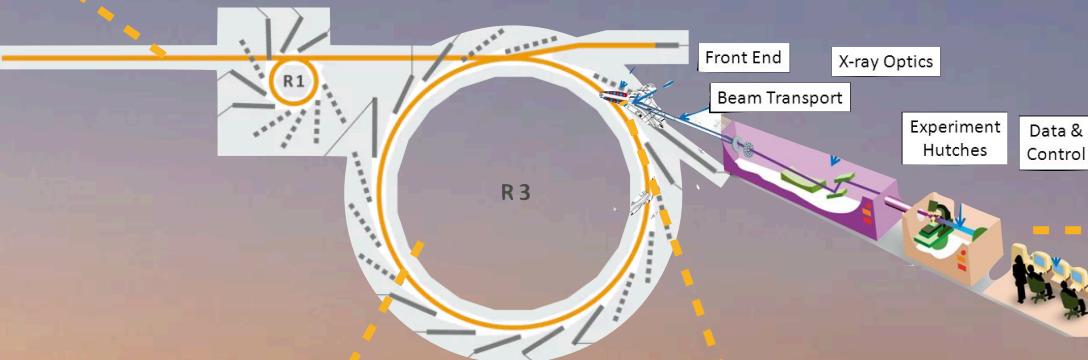


X-Ray Laboratory based on Synchrotron Accelerator

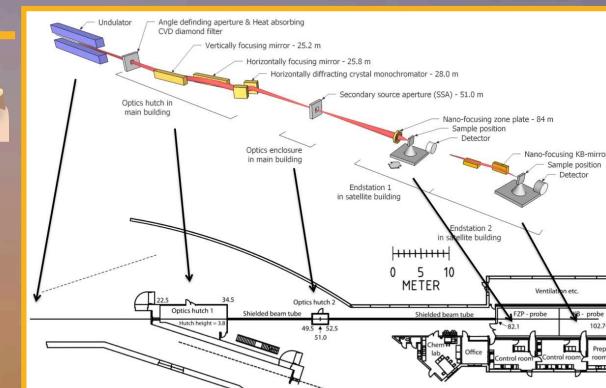
Linear Accelerator



Storage Ring

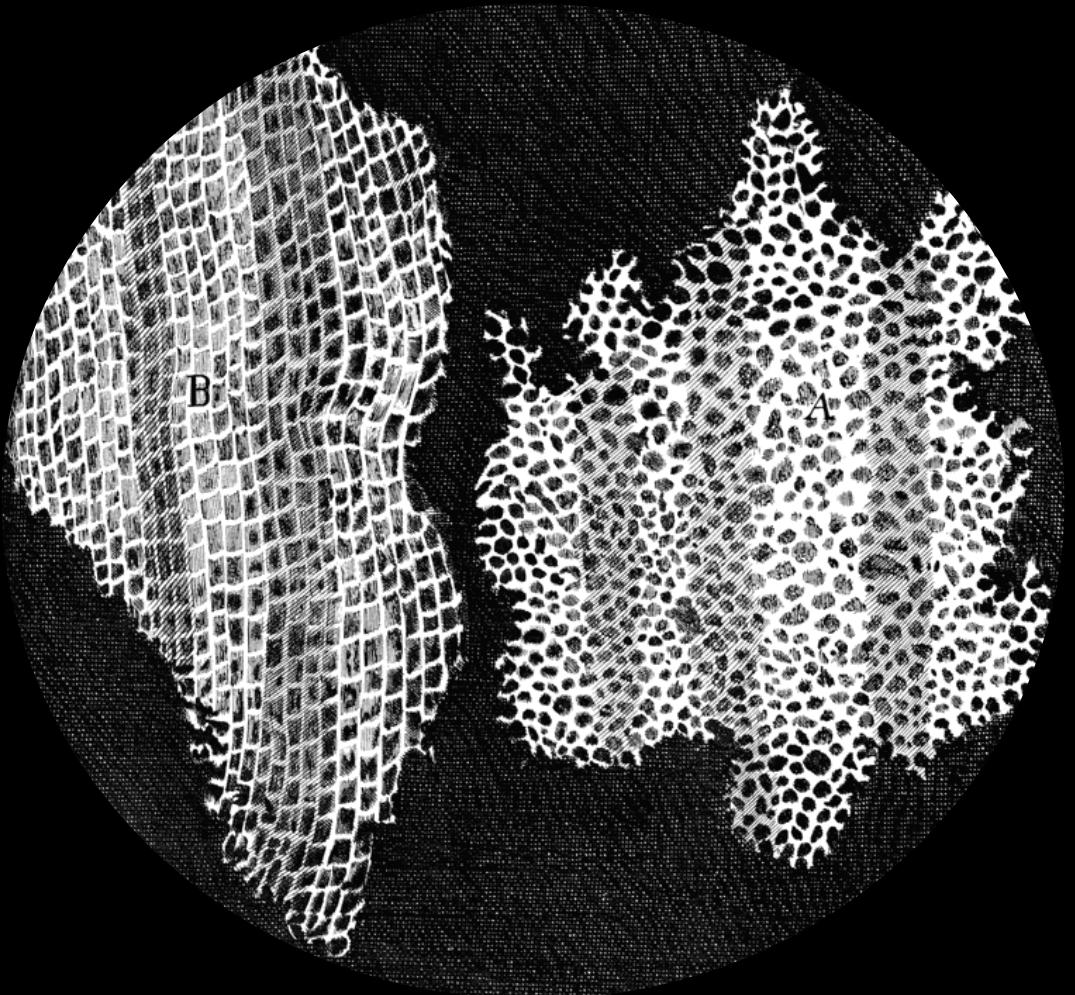


Undulator



Beamline

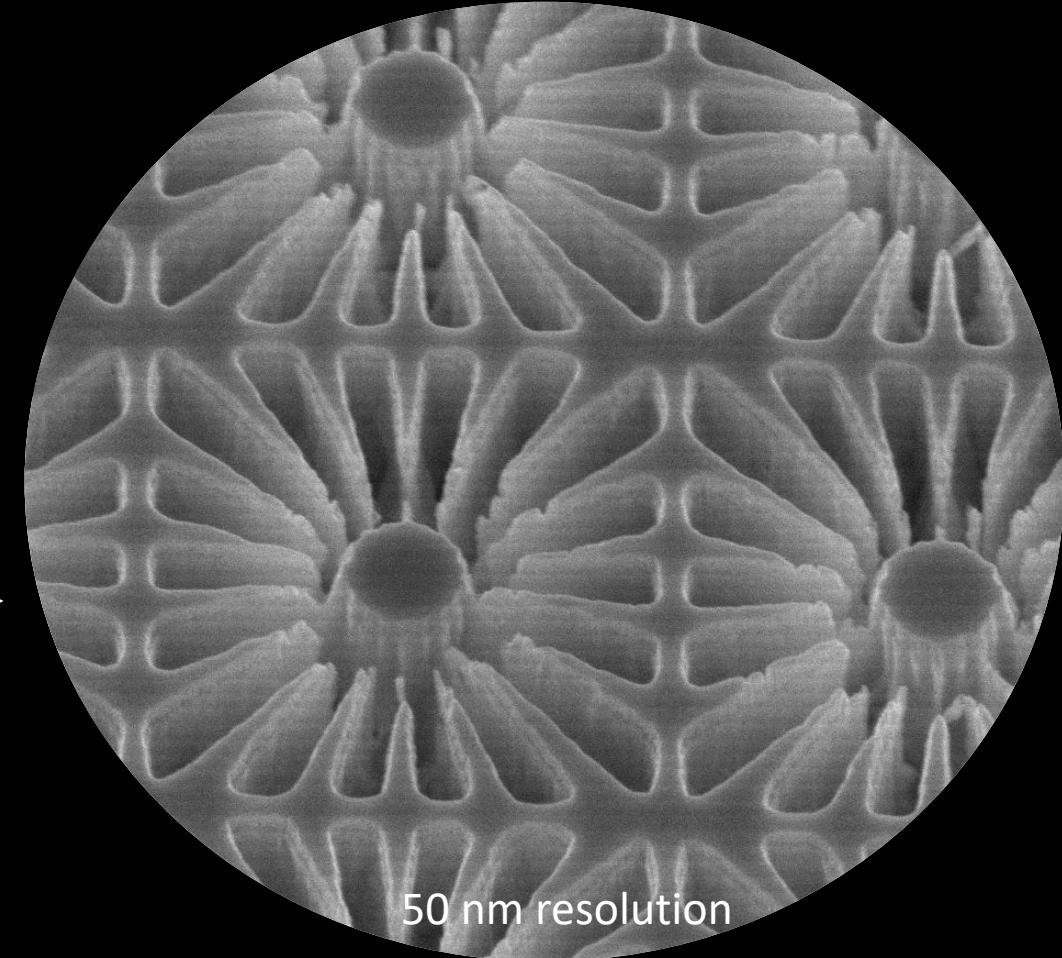
Very Large Microscope



Cork Micrographia

Hooke, 1664
CC BY-SA 3.0

353 years
→

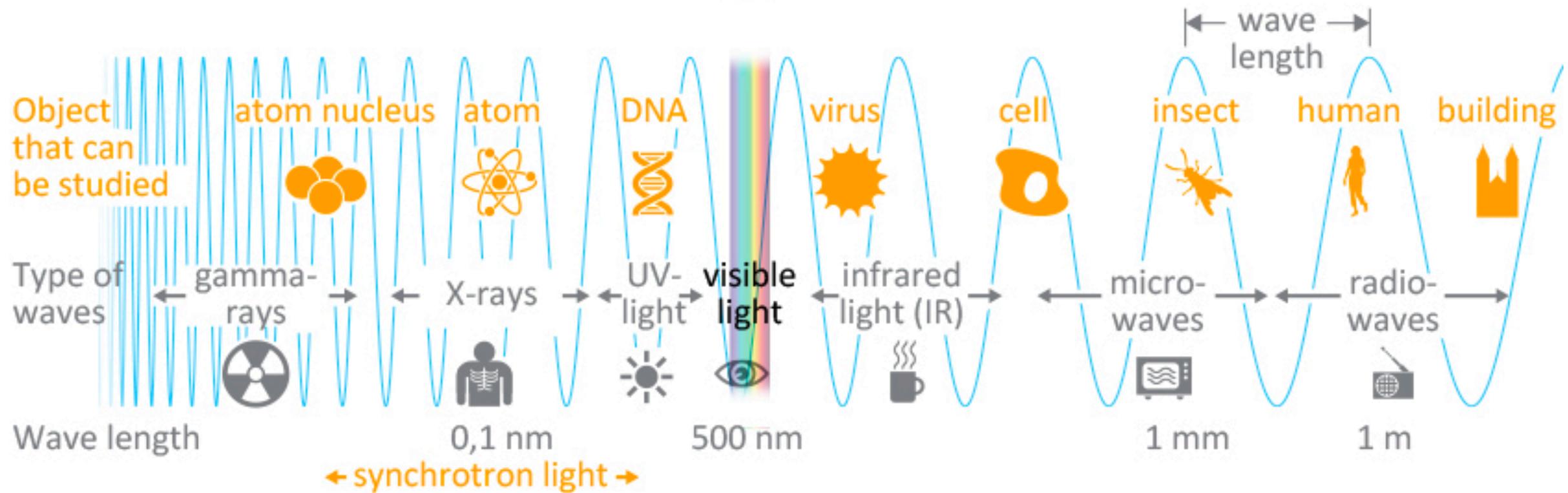


Siesmenses Star

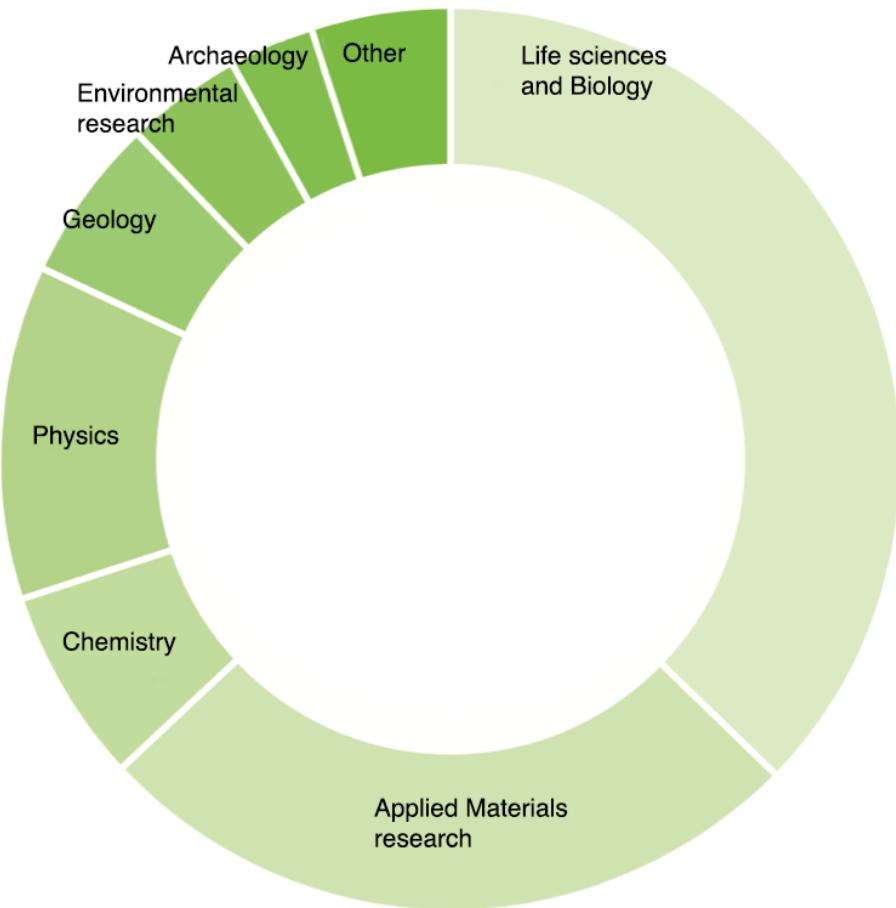
NanoMAX
MAX IV Laboratory, 2017



Just a question of wavelength



Techniques at MAX IV



Imaging – images or film,
surface or interior

NanoMAX, MAXPEEM, CoSAXS,
SoftiMAX, DanMAX, ForMAX

Spectroscopy – chemical
composition

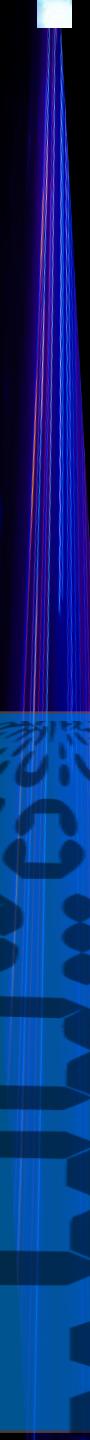
FemtoMAX, Balder, HIPPIE, Bloch,
FinEstBeAMS, SPECIES, FlexPES,
MAXPEEM, CoSAXS

Scattering – atomic &
molecular structure

FemtoMAX, NanoMAX, BioMAX,
VERITAS, SPECIES, CoSAXS, DanMAX,
MicroMAX

From a

Photon
Factory ...



...to a

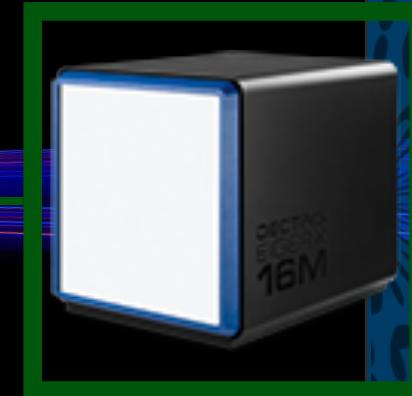
Scientific Data
Factory

MAX IV DATA LIFECYCLE

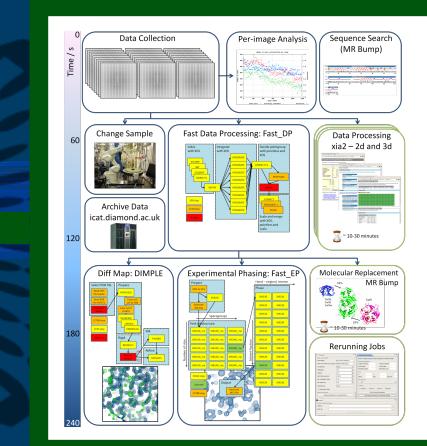
Source



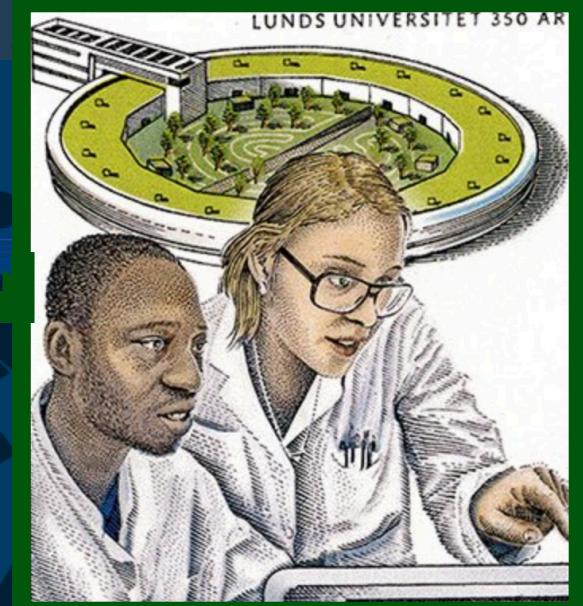
Data Acquisition



Data Analysis



Data Interpretation



Timescale

~ fs

~us to mn

~s to months

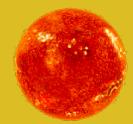
months to years

Entropy



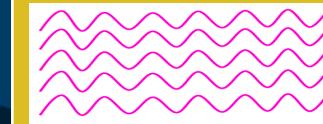


Source: New 4th Generation of Synchrotron

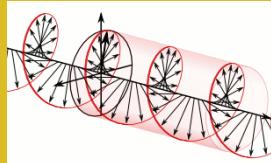


$\times 10^{14}$

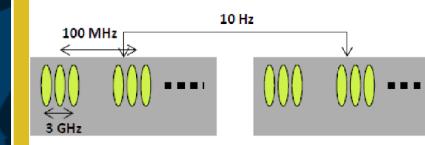
Brilliance



Coherence



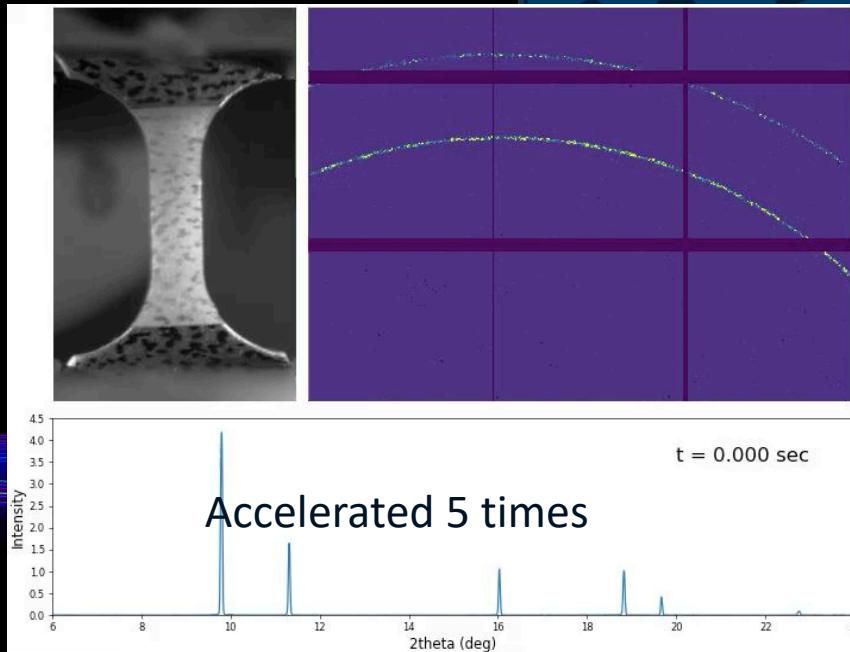
Polarisation



Structure



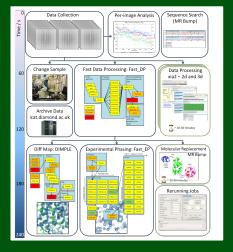
DATA Acquisition: Faster and more sensitive



Austenite to martensite phase transition observed at 250Hz

TRansformation Induced Plasticity (TRIP) steels are used in many applications due to their outstanding combination of strength and ductility



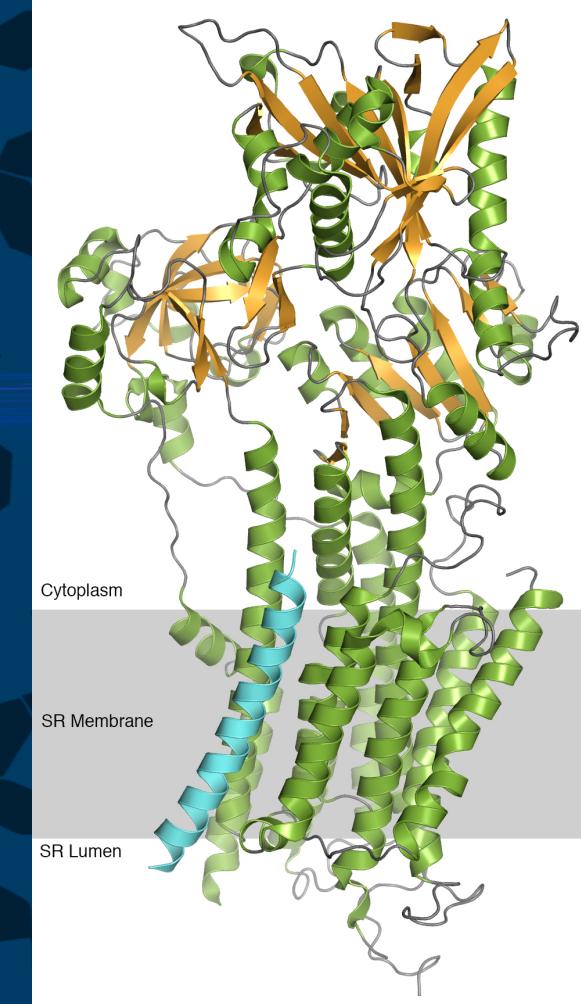
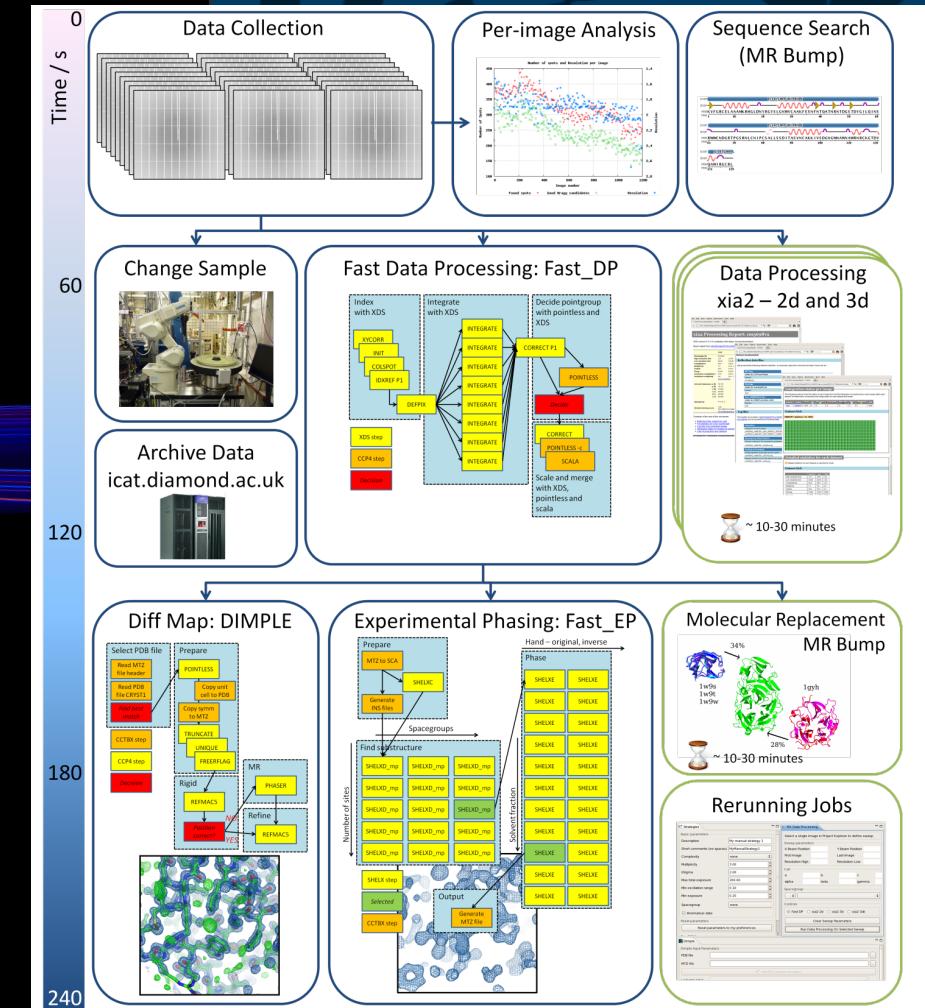


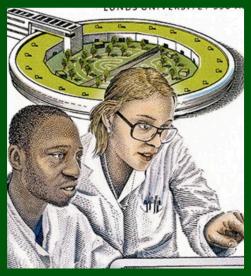
DATA Analysis: Smarter Algorithm and more processing power

A protein essential for the functioning of muscle cells, such as the heart muscle. Dysfunction in the protein is linked to virtually all heart disease, and certain gastrointestinal cancers.

Increasing our knowledge of how this protein works holds potential for better drug development.

Article published in Nature, March 2013

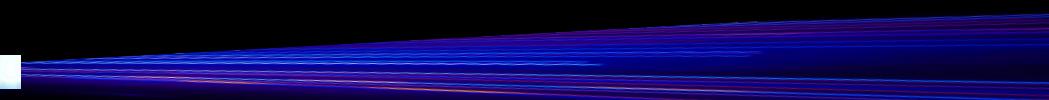




DATA Interpretation: More and more complexity in Scientific Experimentation

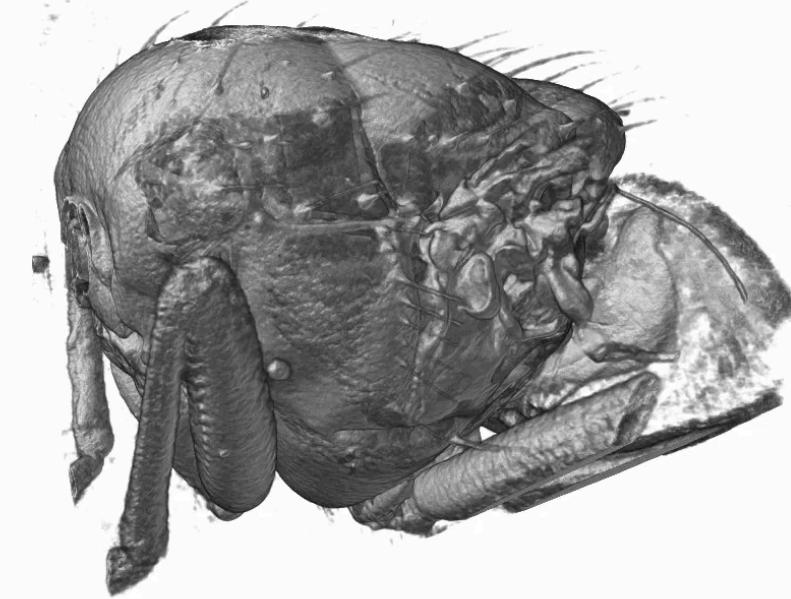
Tomography

Insect flies in 3 dimensions.



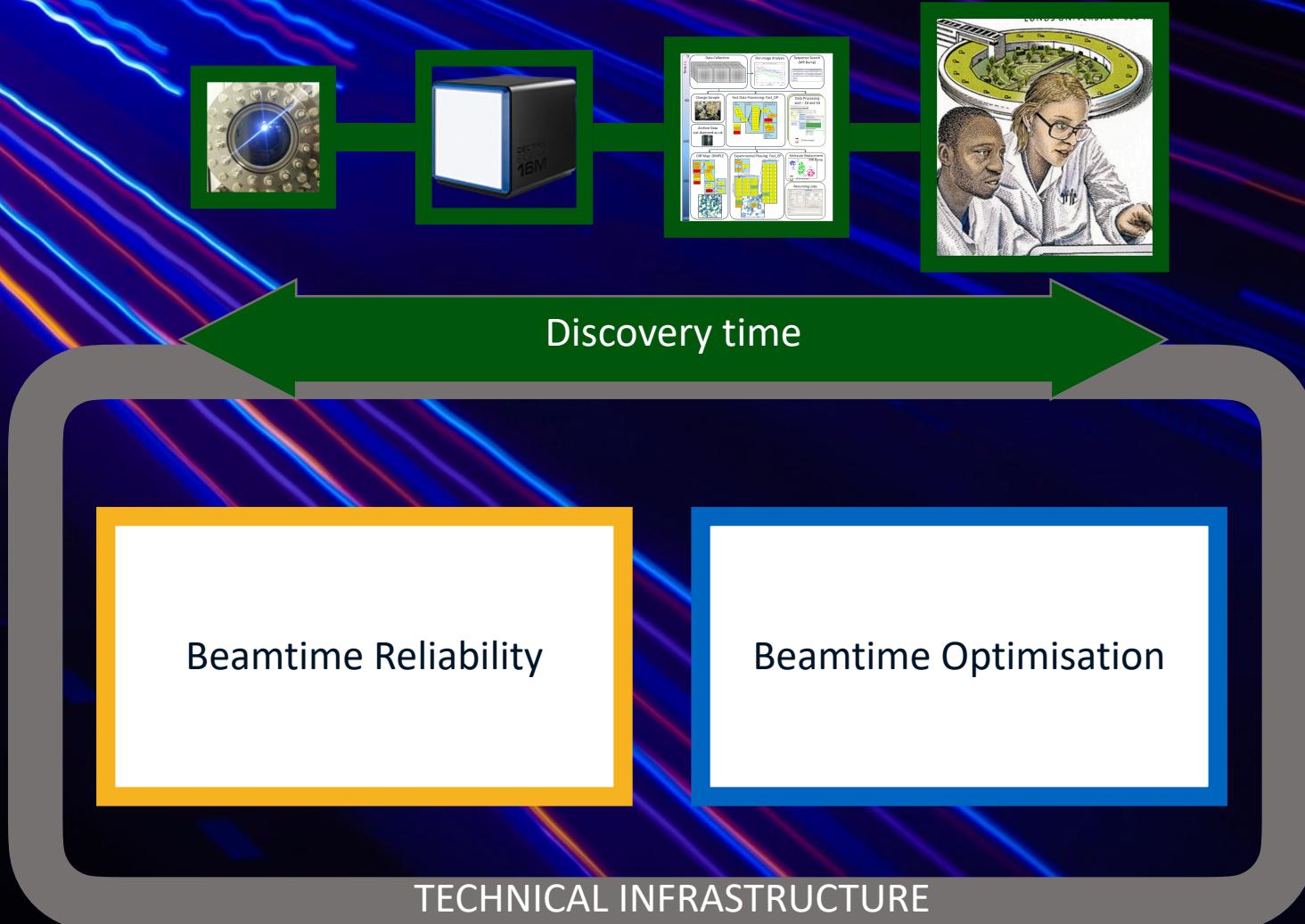
The tissues of the rib cage block visible light but not x-rays.

This research makes it possible to learn the biomechanics involved and thus improve robotic movements.



Courtesy of Dr Rajmund Mokso

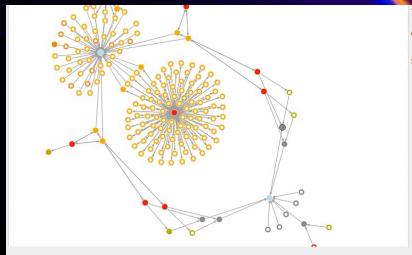
Toward Excellence Operation



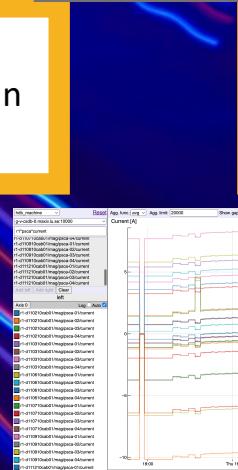
Toward Excellence Operation

More Beamtime

Challenge to
Improve performance and reliability in
Large-scale Software system

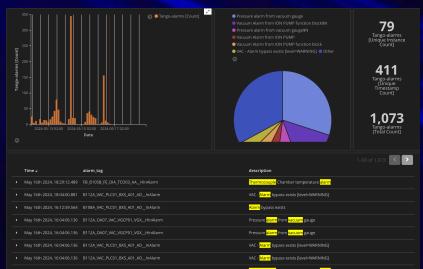


1 million control points

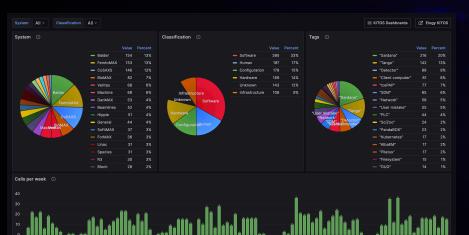


Machine
parameter archiving

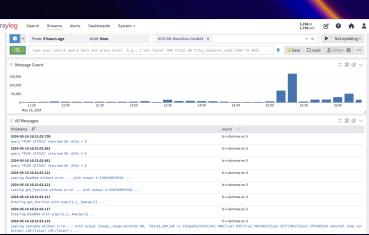
Collecting huge amount of operational
meta-data from the accelerator system
to the experimental system



Alarm archiving



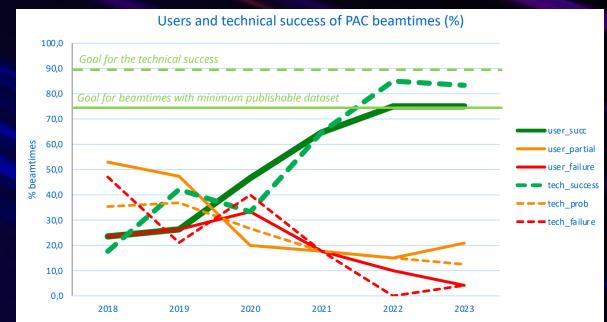
On Call support



Software log

+ post mortem data, ...

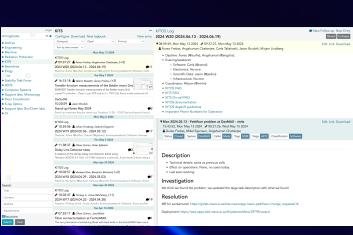
=> Complex system and still lots of
unknown (here is control system
figures)



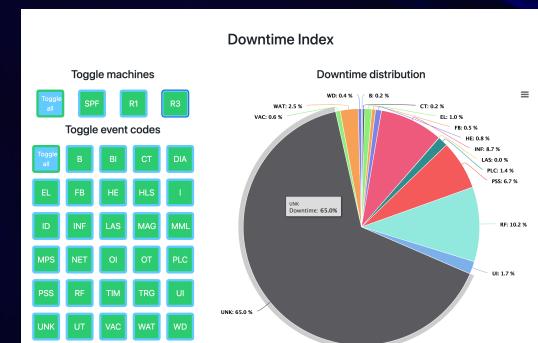
User success monitoring



Monitoring



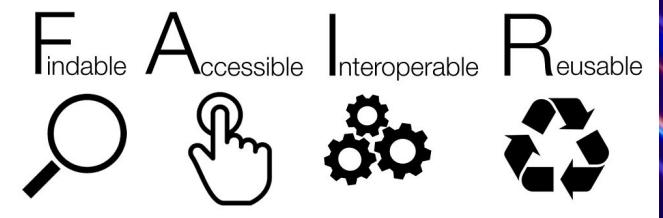
Operator log



Accelerator downtime

Toward Excellence Operation

Challenge to
adapt and optimise constantly
to unique experiment



Feasibility assessment, simulation

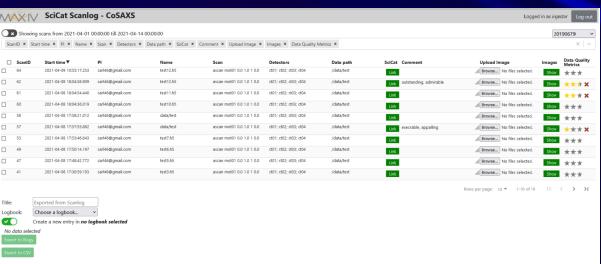
On-the-fly calibration with AI/ML

Autonomous system:
On-the-fly Feedback to
instrumentation

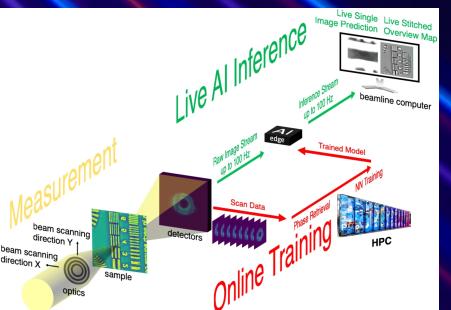
Better Beamtime

Collecting huge amount of scientific
meta-data from the experimental
control system

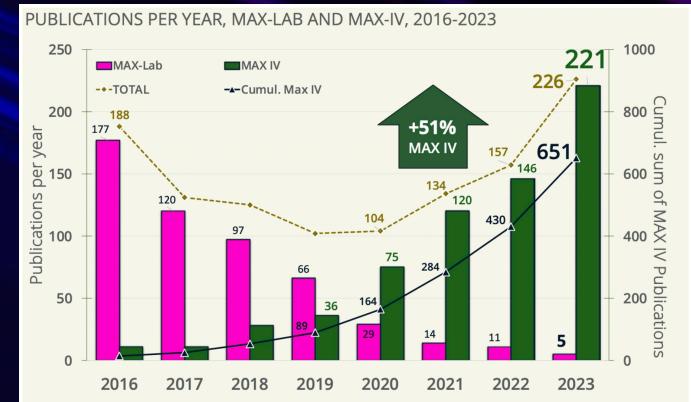
=> Requires of lot of transverse
knowledge to optimise such complex
system



META DATA CATALOG



On-the-fly processing



Ultimate KPI: Articles

Advisory system to compensate the
growing entropy

Toward Excellence Operation

All good practice are in place although
this is a challenge to exploit the data

Summary

- MAX IV a great tool for Scientific Research
- MAX IV source is great, now facing data explosion
- Scientific Data lifecycle is understood but complex
- Race between technology or data
- Challenge to improve reliability and data quality



QUESTION?

MAX IV