LEAPS League of European Accelerator-based Photon Sources

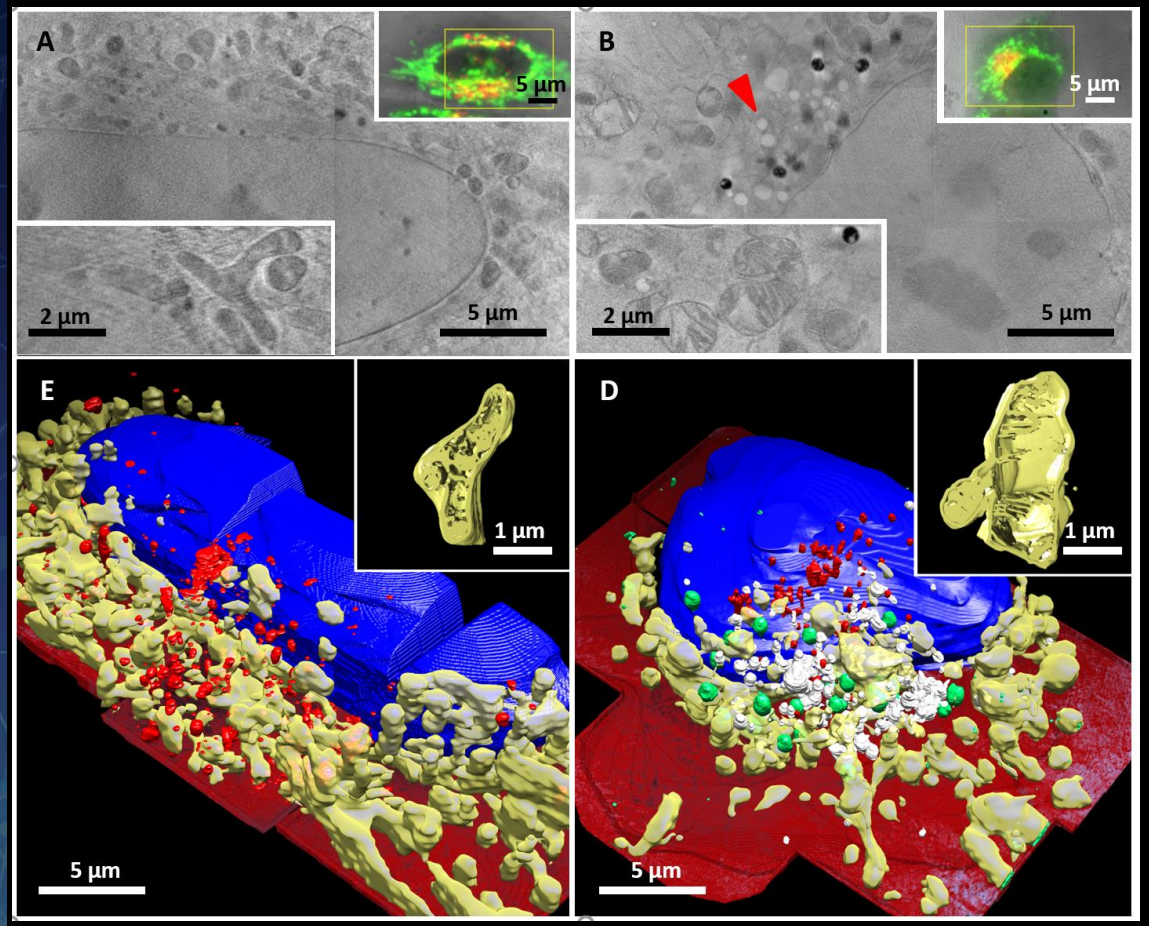
EU RIs as engines for science and innovation. The key to tackle societal challenges

Caterina Biscari
ALBA Synchrotron
LEAPS Chair

European Research Infrastructures: Engines for Science and Innovation
28 October 2020

HEALTH

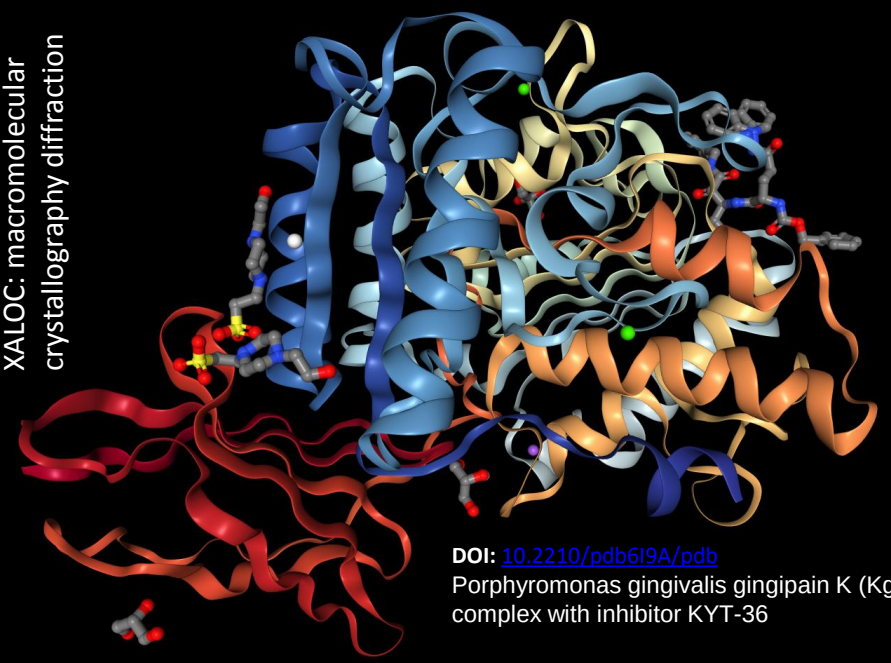
We look at cell's inner details



A combination of X ray tomography (ALBA) and fluorescence imaging (ESRF)

We resolve protein structures down to atomic resolution

XALOC: macromolecular crystallography diffraction



DOI: 10.2210/pdb6I9A/pdb
Porphyromonas gingivalis gingipain K (Kgp) in complex with inhibitor KYT-36

to understand diseases,
to design new treatments, drugs
and vaccines

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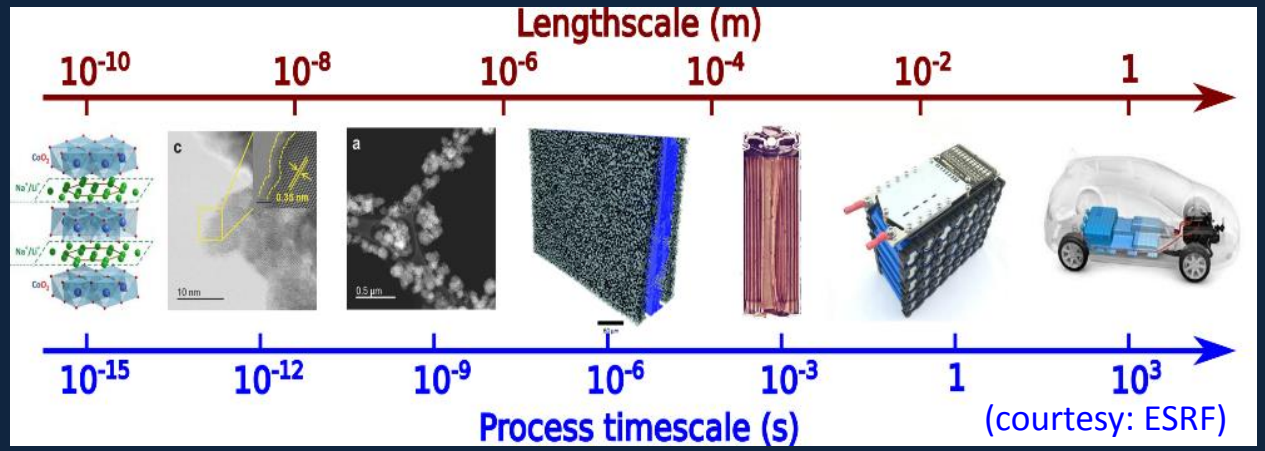
We develop new materials for efficient generation-, storage-, conversion-, and ultimately transport of energy

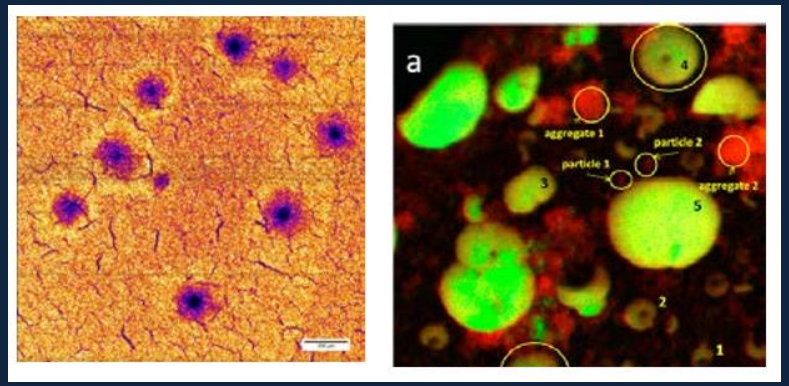
ENERGY

see K. Edström talk

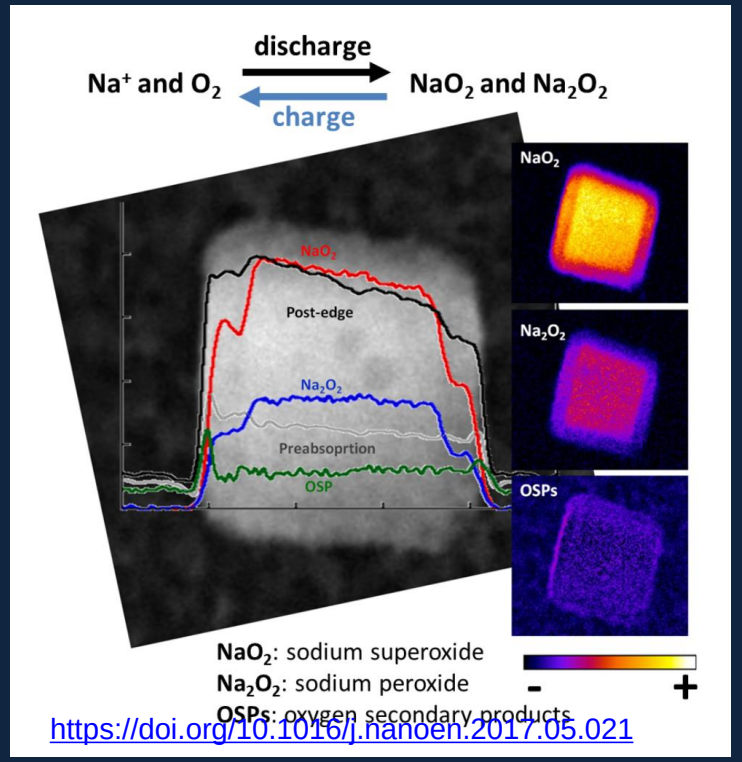


(courtesy: ESRF)

Length scale challenge in battery research
Bridging spatial, temporal and chemical information



Synchrotron X-ray studies of Li battery materials (courtesy: ALBA)



Li is expensive and scarce. Research on batteries based on alternative electrodes are investigated in LEAPS facilities
Example: Na based batteries (Na, V, P, O and F) at ALBA –

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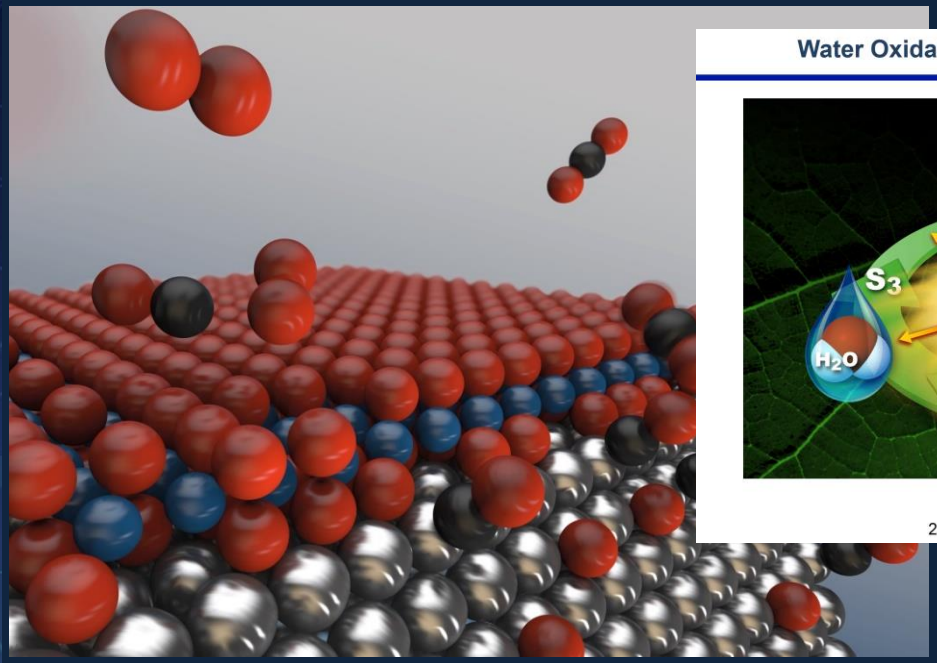
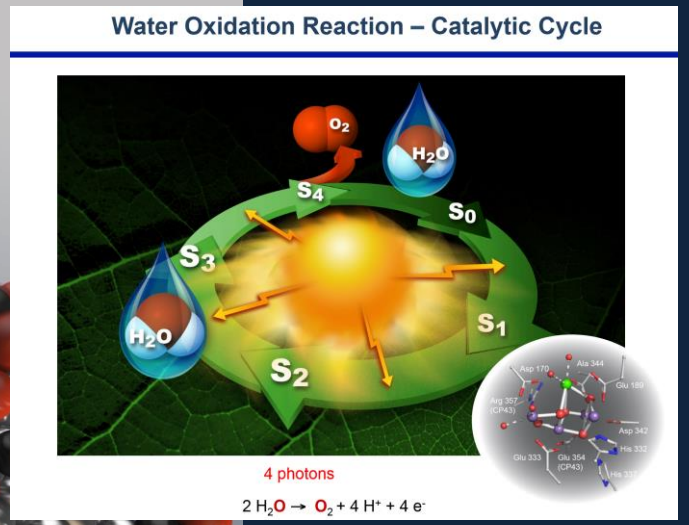
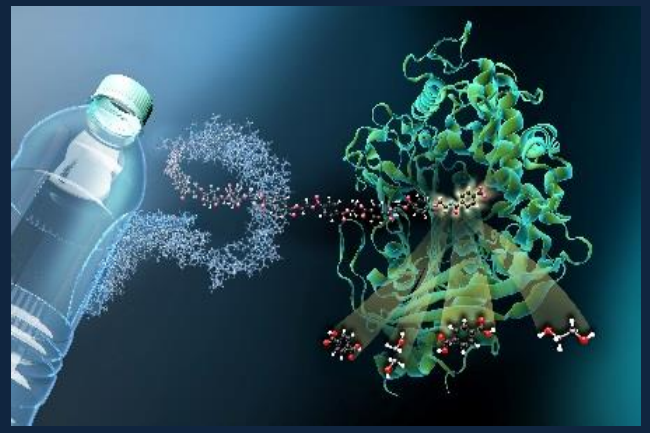
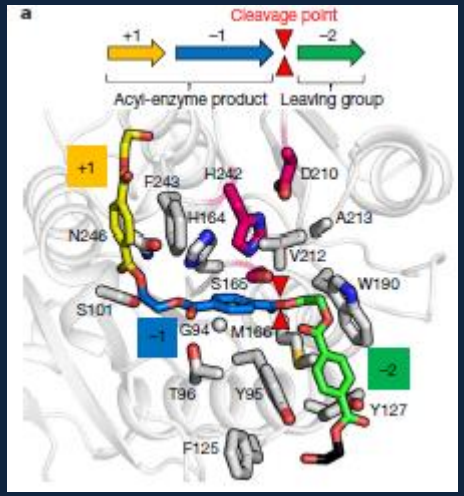
ENVIRONMENT

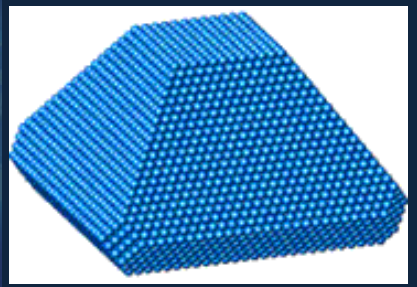
We care for environment
developing new catalysts … or PET digesting bacteria

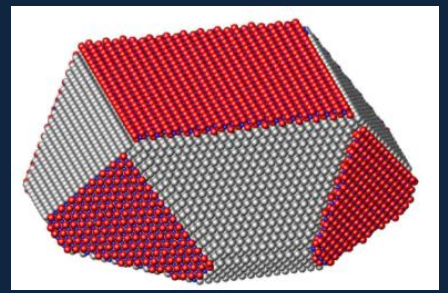


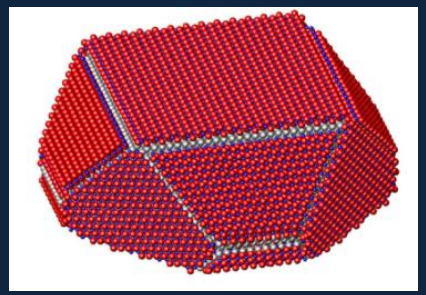












Identification of a catalytically highly active surface phase for CO oxidation over PtRh nanoparticles under operando reaction conditions; U. Hejral, ... S. Francoual, J. Strempfer, and A. Stierle; Physical Review Letters (2018)

Tournier, V et al. *Nature* (2020), doi.org/10.1038/s41586-020-2149-4

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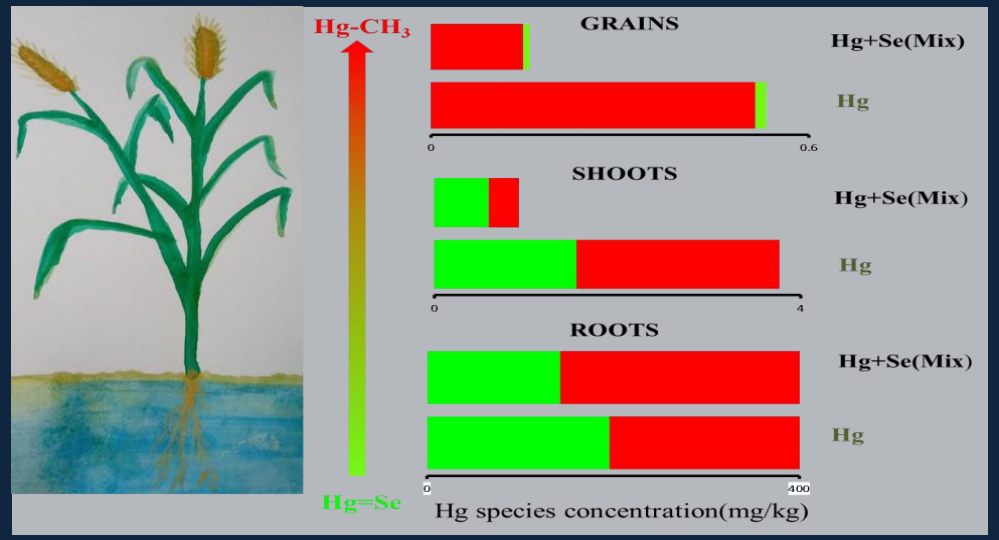
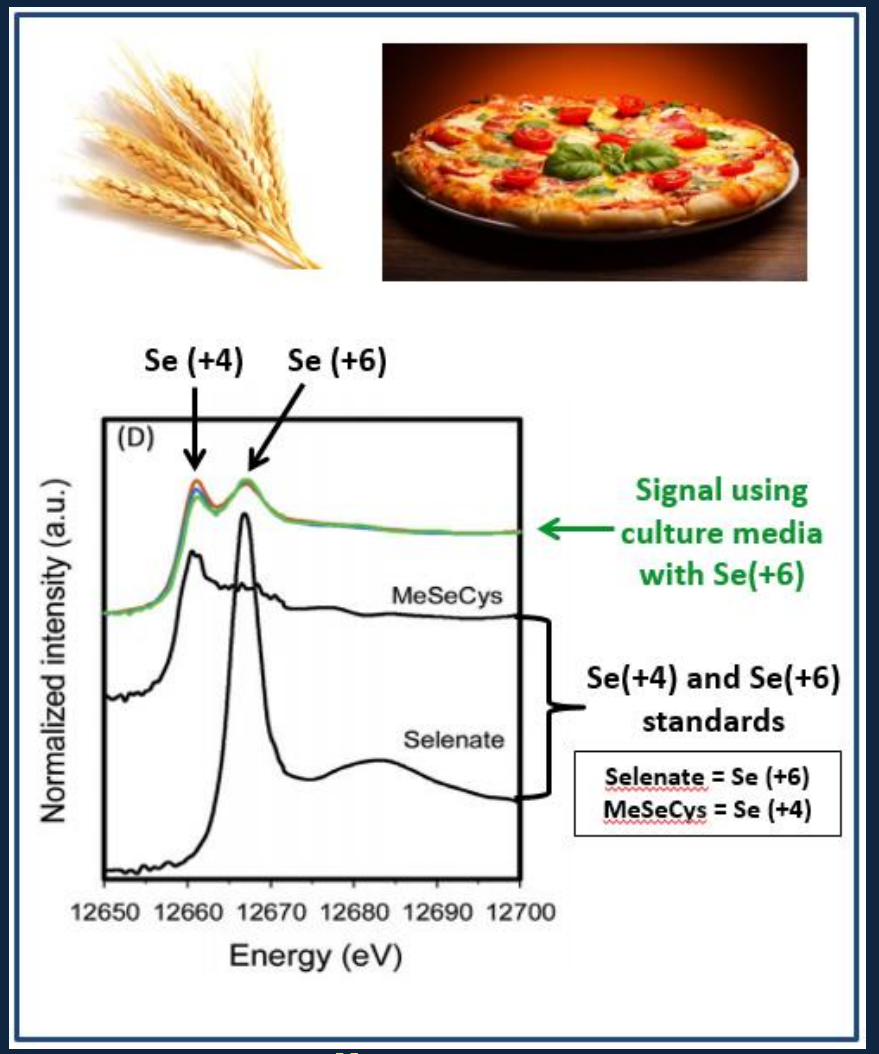
FOOD

We care for food, its production and conservation

Monitoring contamination, developing environment-friendly packaging



Characterization of wheat plants with Se: Se(+4), Se(+6), Se(organic). Selenium benefits: helps to prevent common forms of cancer, to fight off viruses, defend against heart disease, and to slow down symptoms correlated with other serious conditions like asthma.

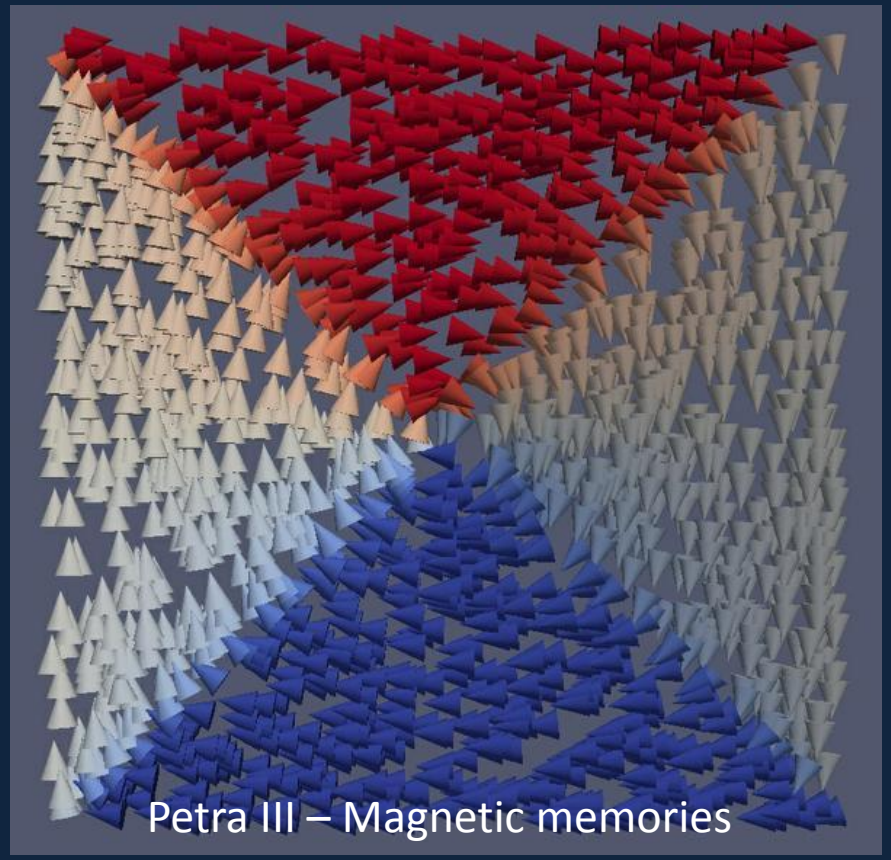


B. Guerrero, Tesis UAB, 2013; Wang et al. doi:10.1093/jxb/erv254

Tools for the ERA of Complexity

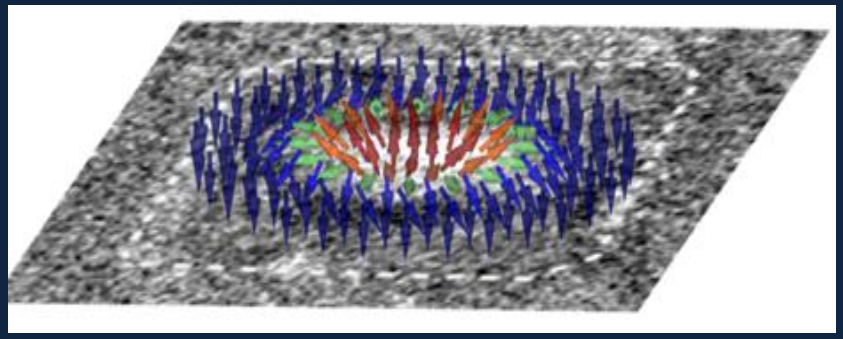
We advance in complex materials and technologies developments

Optimizing complex materials needs experimental tools including extreme conditions (T, P, magnetic fields) and real-time control (in-situ and operando) of relevant parameters and their functionality: quantum materials, superconductors, nanomagnetism are bricks of complex technologies



Petra III – Magnetic memories

Skyrmion schematic



Nature Nanotechnology (2016) O. Bulle ….L. Aballe, M. Foester, …G. Gaudin , ALBA

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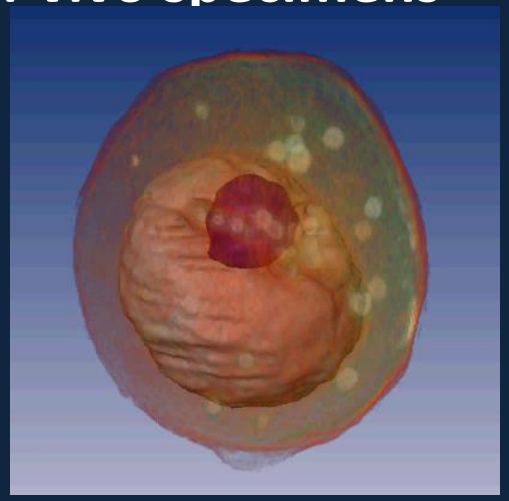
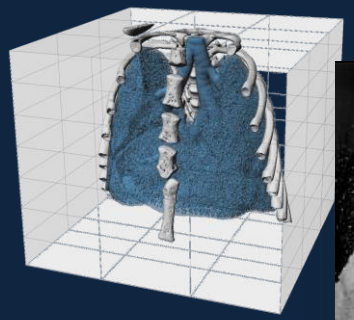
Exploring inner details

We have the power to image from the nanometer details to extended systems, up to in-vivo specimens



Martin Kundrát (Uppsala University) / Paul Tafforeau (ESRF)



E. Borisova et al., Histochem Cell Biol (2020), 10.1007/s00418-020-01868-8 - PSI

Walker et al., PloS Biology (2014) & Mokso et al., SciRep (2015) PSI

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We are Research Infrastructures

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19 facilities - 16 institutions - 10 countries

+35000 users from all EU & beyond

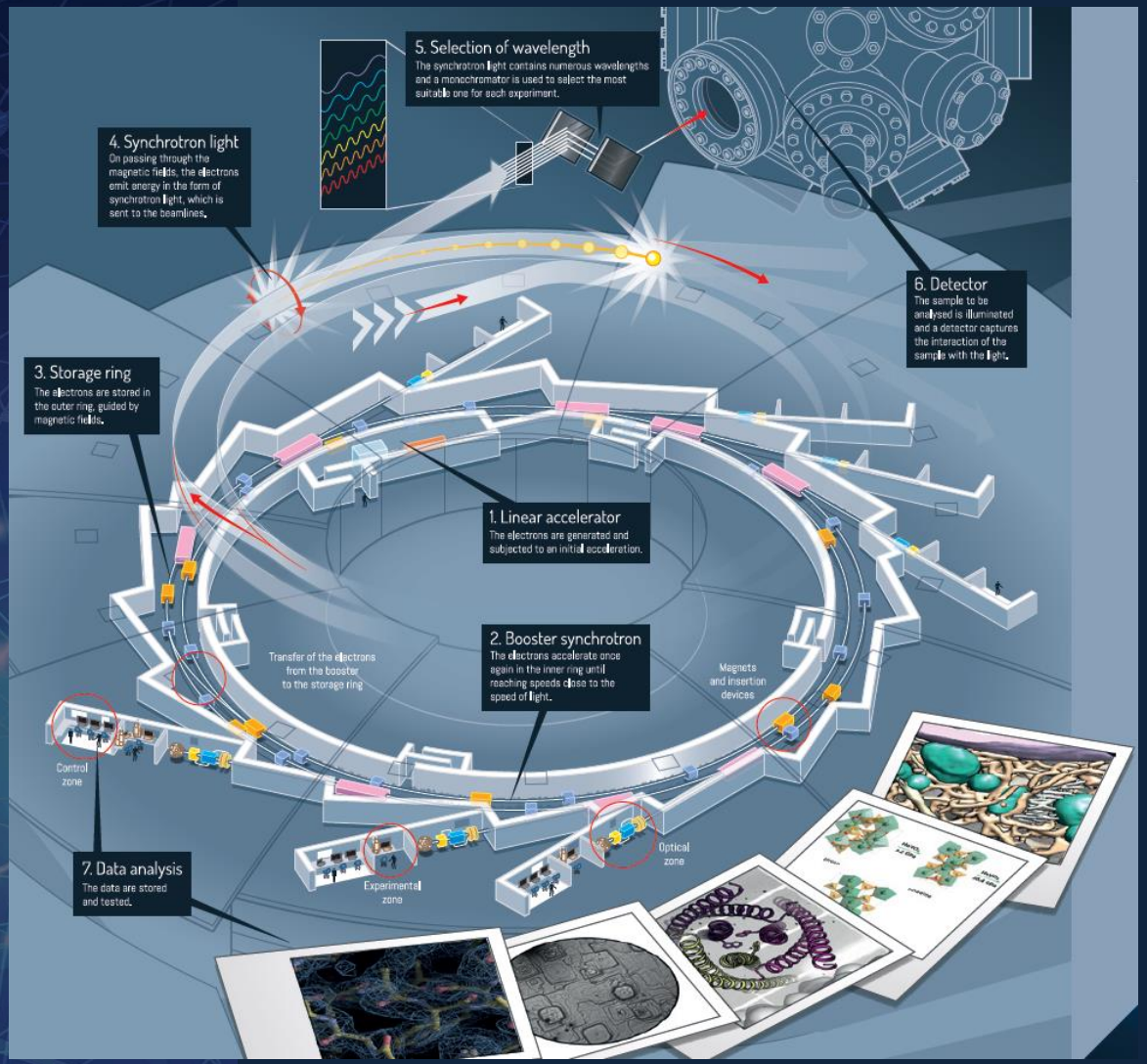
+300 operating End Stations

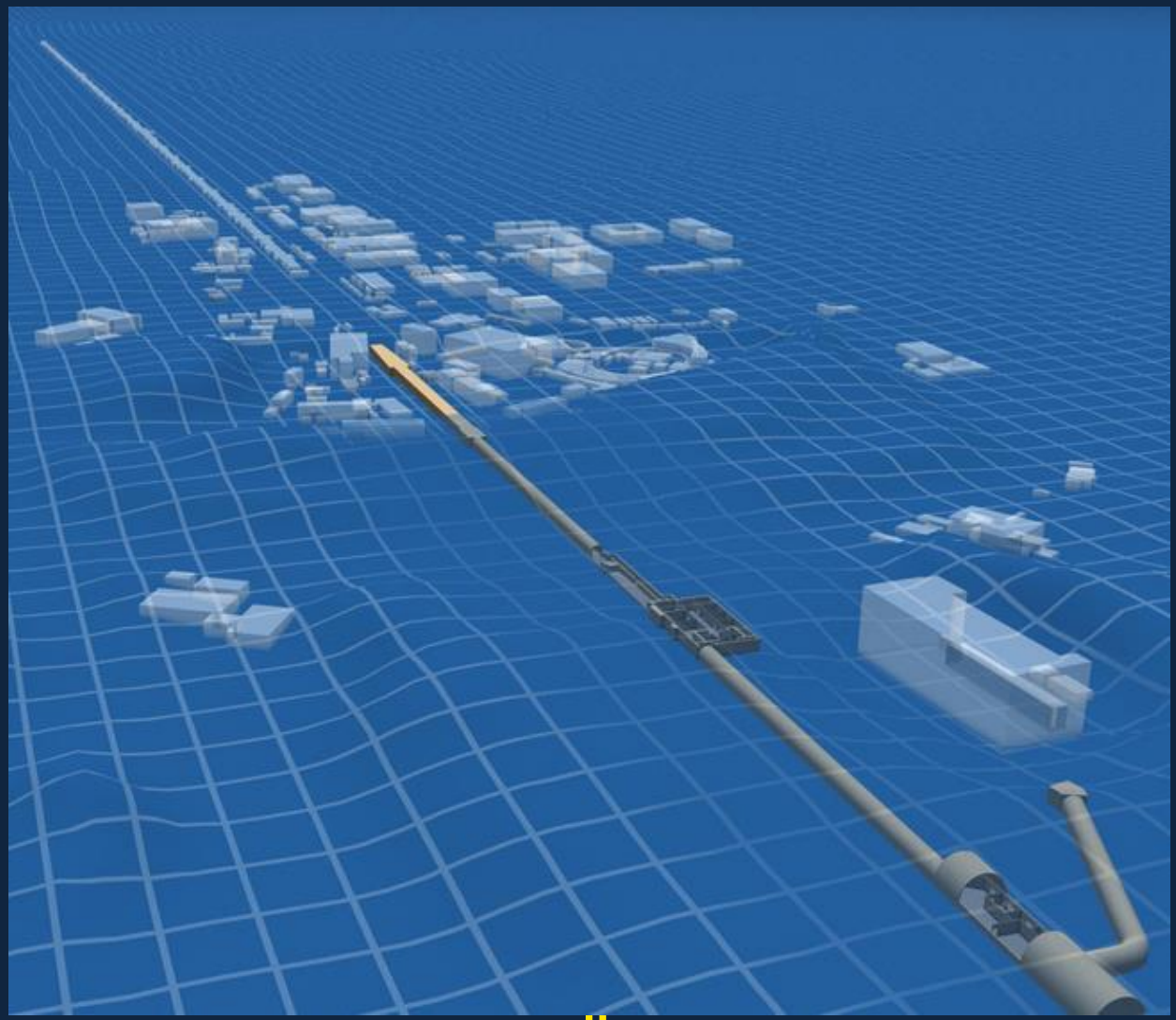
+25000 publications In last 5 years

offering +800000 h/year

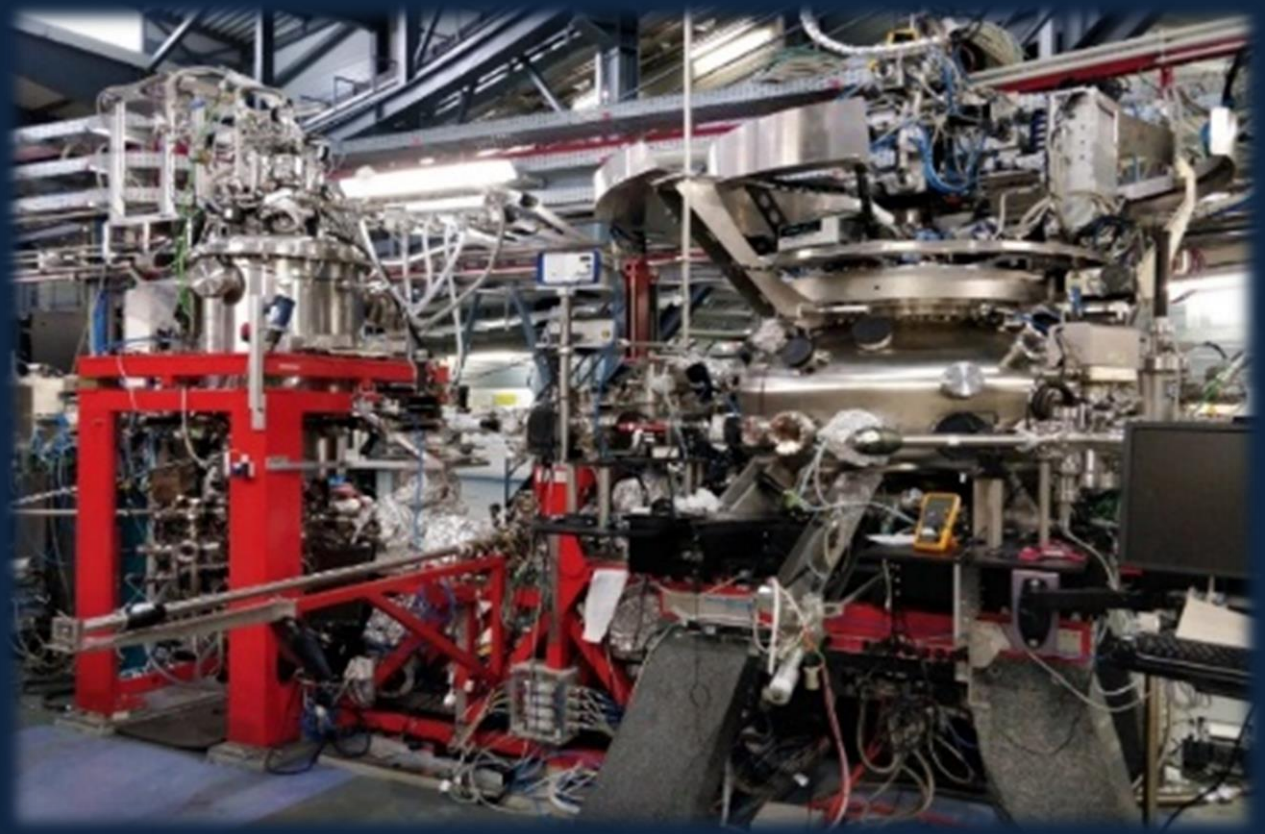
Associate: SESAME (Jordan)
Partners: LENS, CLS

Synchrotrons and FELS – accelerating electrons to some GeV and producing the precious synchrotron and FEL radiation

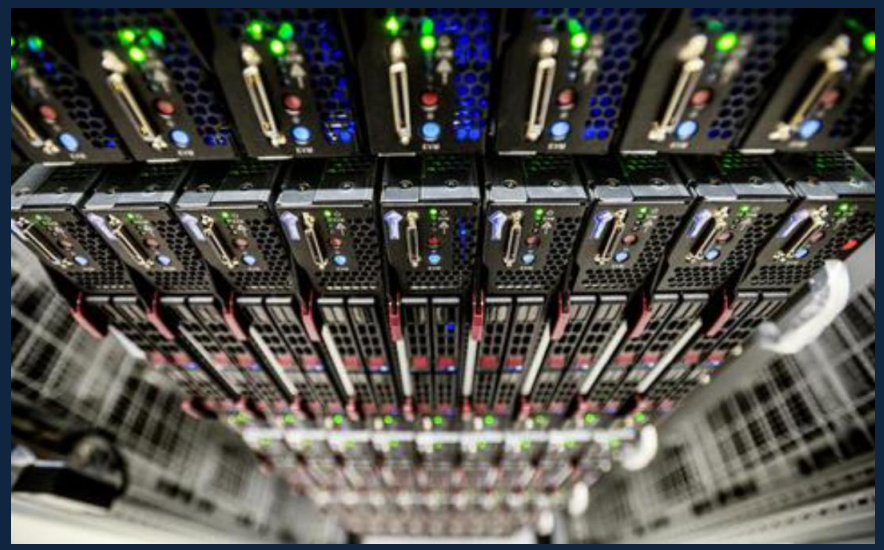




Exploited in the experimental stations, providing tools to users for unveiling matter properties, producing valuable data, to produce open science



BOREAS BL at ALBA



Supercomputing Center at NCBJ in Otwock-Świerk near Warsaw servin also EuXFEL

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2 international facilities
17 national facilities

Funded by national governements
Offering free access to all public researchers, based on competitive excellence
Offering advanced and cost effective instruments to all industrial world

Vision

A world where European science is a catalyst for solving global challenges, a key driver for competitiveness and a compelling force for closer integration and peace through scientific collaboration.

Mission

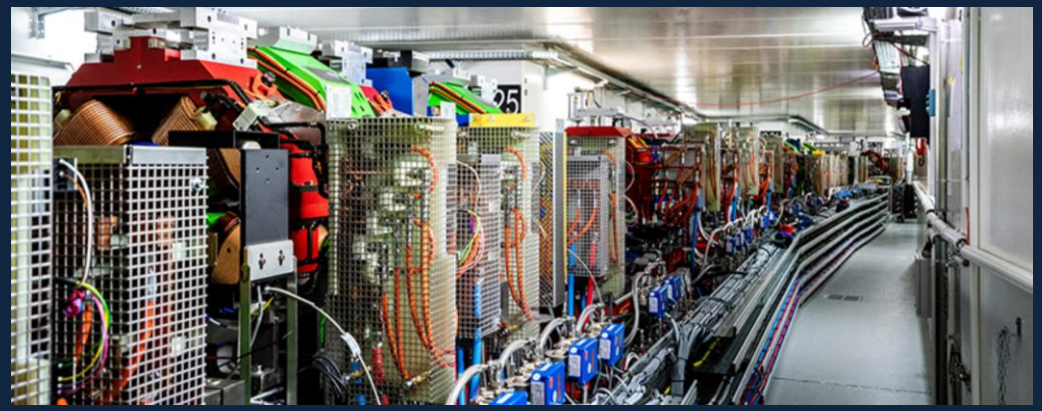
LEAPS use the power of its combined voice to ensure that member light source facilities continue to be world - leading, to act as a powerful tool for the development and integration of skills with a view to address 21st century global challenges, and to consolidate Europe's leadership in the field.

World leadership in technologies

Leading world leap from 3rd to 4th generation synchrotrons

MaX IV, the first 4th gen Synchrotron

ESRF-EBS, the first upgraded from 3rd to 4th

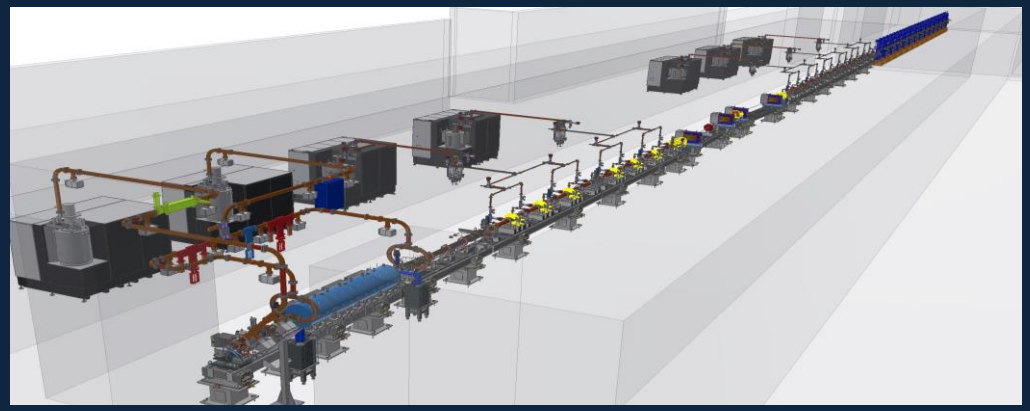


Its example followed all over the world. @ LEAPS: Alba, Diamond, Elettra, Petra III, Soleil, SLS

…and FEL technologies

EuXFEL the highest energy FEL

EuPRAXIA - in construction, LNF



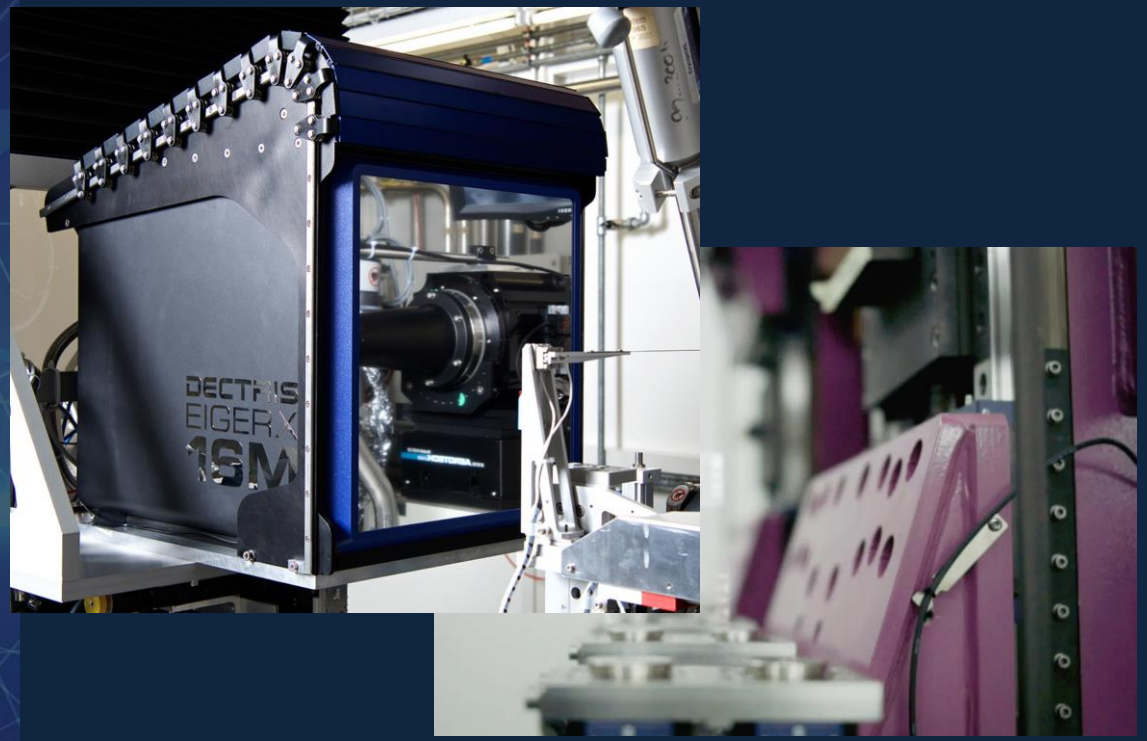
the 1st plasma acceleration based FEL facility, based on H2020 EU design study

Innovation hubs

see A. Sanstrom talk

Industry as provider

- Technology transfer through licensing, patents, spin-off
- Manufacturing



Examples: Dectris (PSI), KYMA (Elettra)

Industry as a research collaborator

- Direct Industrial access to beamlines, facilities, and expertise
- + Academic access in collaboration with industries (around 30-40% of the total)
- + EU projects granting free access for SME

CALIPSOplus

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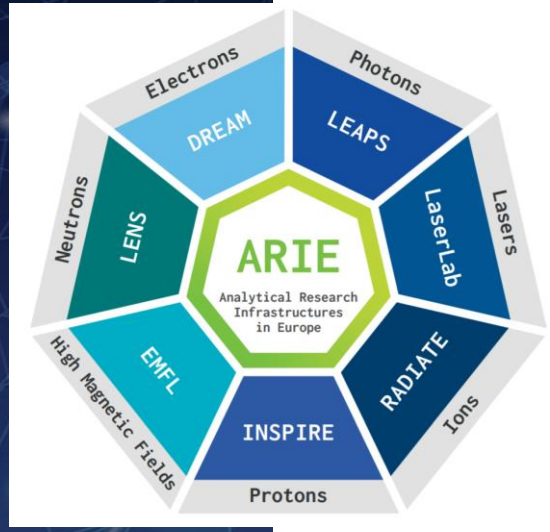
Training centers

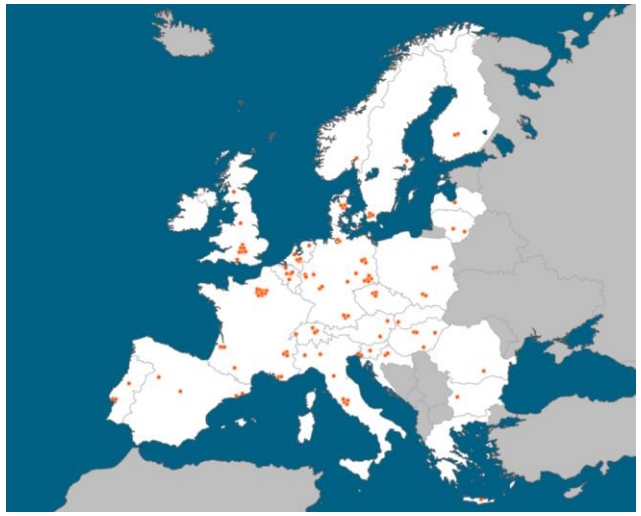
In normal and also in exceptional circumstances

- Training new generations of scientists, engineers, technicians, administrative officers, communication experts at different stages of
- PhD programs + PhD participation to user programs

Outreaching to society

Cooperation with other European Analytical RIs: ARIE, a powerful tool for solving societal challenges





More than 120 European RIs

*The **ARIEs**, accessed by tens of thousands of researchers every year, also serve as interdisciplinary training platforms for students, future scientists, engineers and technicians, and are paradigms for European collaboration in large, high-tech projects*

Complementary
Multi-scale
Multi-modal

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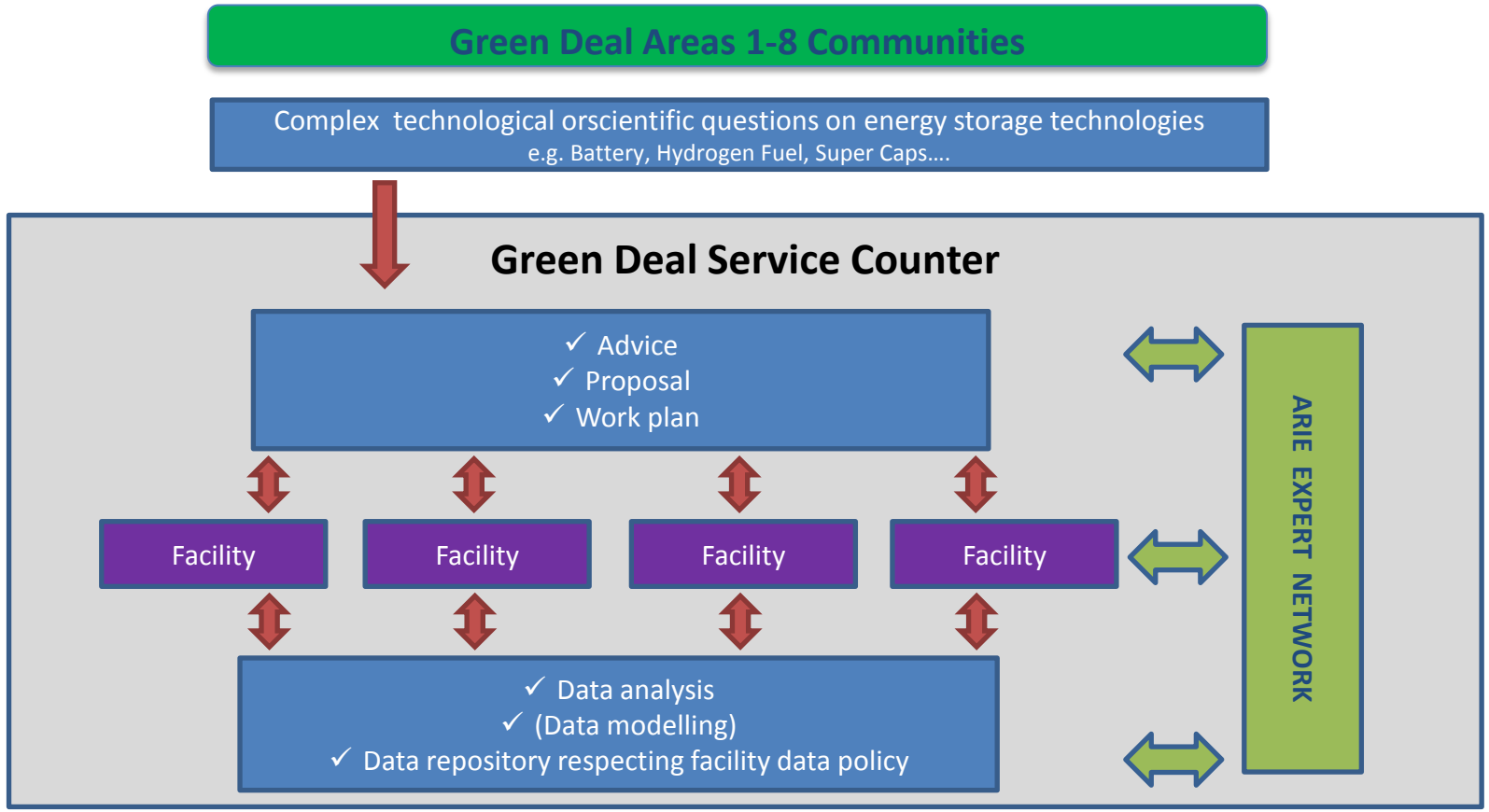
Preparing the participation to H2020 Green Deal Call: ARIE Green Deal Advanced Service Platform

Distributed Research Infrastructures and **Open Innovation Test Beds** for scientific questions on **energy** technologies.

Full range of TRL and whole value chain of possible industrial applications.



OBJECTIVE 1: energy tech R&D (translation, experiment design & execution, data analysis and reporting)

OBJECTIVE 2: ARIEs working together to achieve a comprehensive support in a time limited framework for specific and urgent challenges

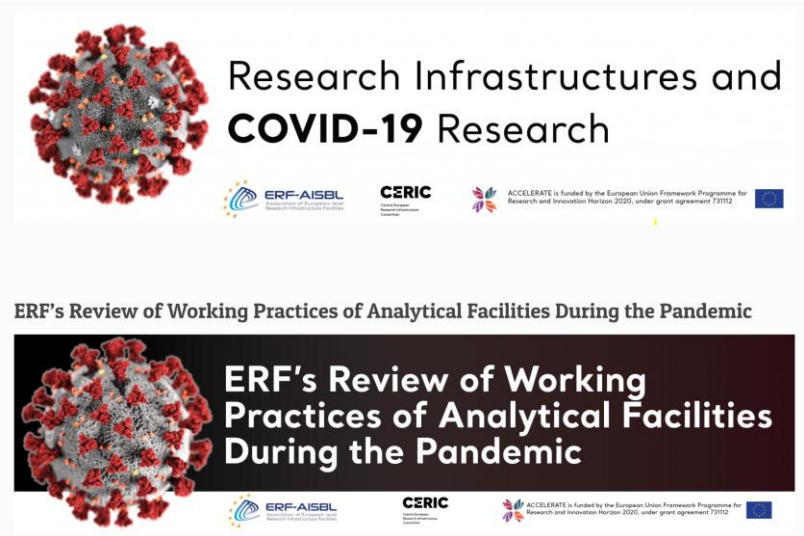
OBJECTIVE 3: create a working governance and operational structure for ARIE transversal support platforms

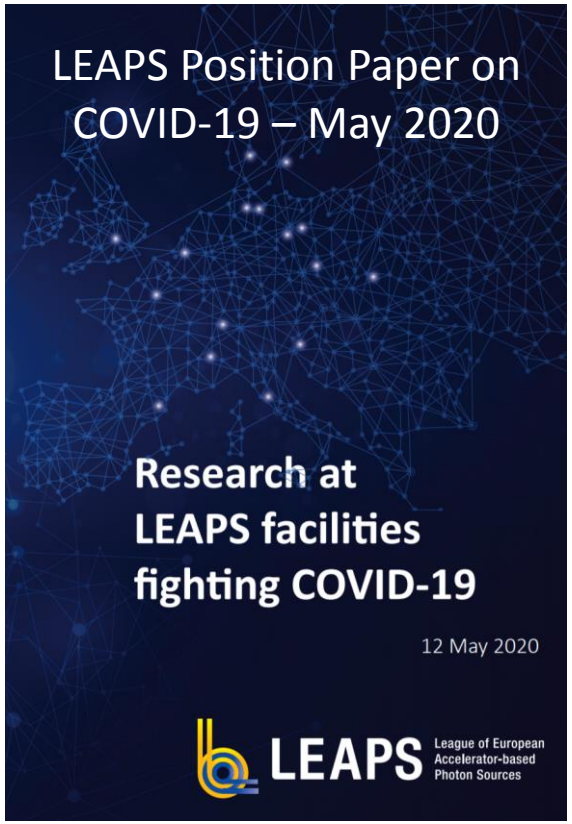
Green Deal

Reaction to Pandemic

Answering to COVID-19 Pandemic

Dedicated **fast track access mode** on almost all LEAPS facilities, addressed to Academy and Industry from the very first moment, compatibly with each country pandemic conditions.





Sharing experiences and solutions through webinars

- Operation during and after the pandemic
- Scientific contribution to fight the pandemic

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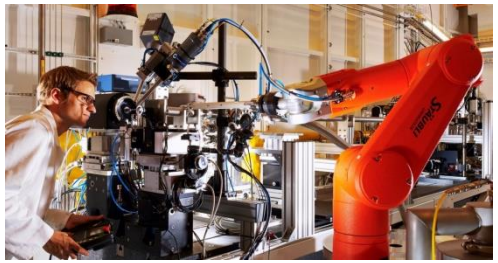
Learning from present challenges

Digital LEAPS



- **AI-assisted resilient and energy-saving operation of LEAPS Research Infrastructures**

Autonomous operation of complex accelerators
Remote operation

- **Digital user operation modes**

Remote user experiments
Real-time analysis of data and
real-time (exascale) simulations

- **Advanced digital communication**

Lessons Learnt: new digital forms of communication between labs and between labs and users

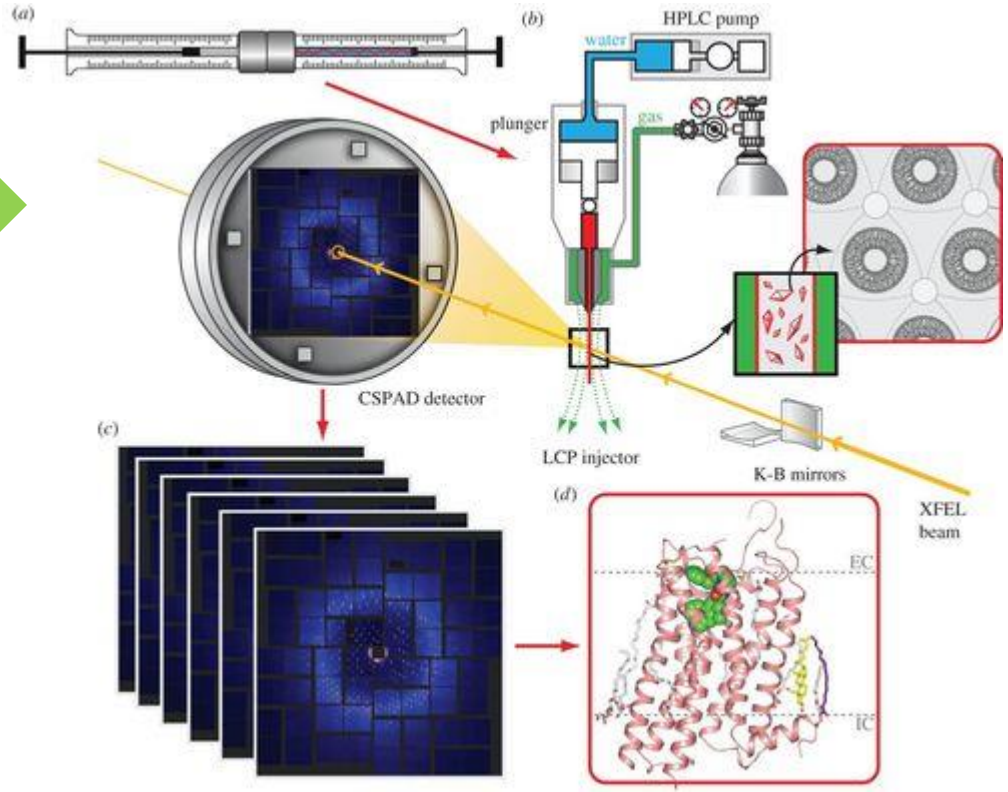
- **Digital training concepts**

New forms of training exploiting Virtual Reality (from schools to universities)

- **AI-assisted molecular infection fight**

LEAPS facilities prepare for future infection fight *(virus, bacteria, parasites)*

- **Advanced materials for the digital transformation and circular economy**



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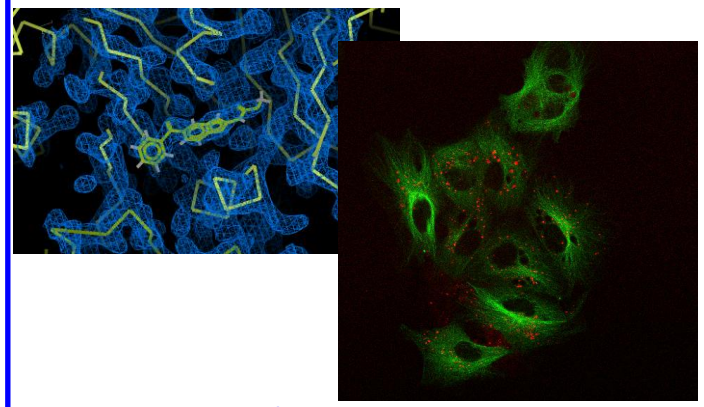
COVID-19 research

Not exhaustive list, see M. Ackermann talk

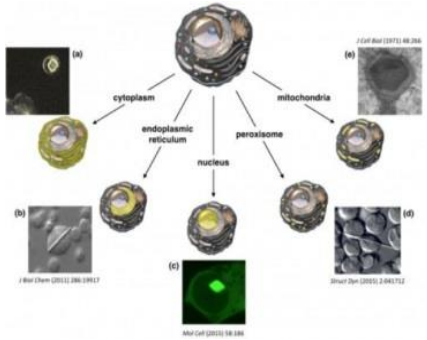
COVID-19 related research at LEAPS

At *ALBA* (INIA) Investigating inhibition of viral replication with mebendazole, combining MX (ALBA) and fluorescence microscopy (CIB)



CIB Margarita Salas, INIA, ALBA

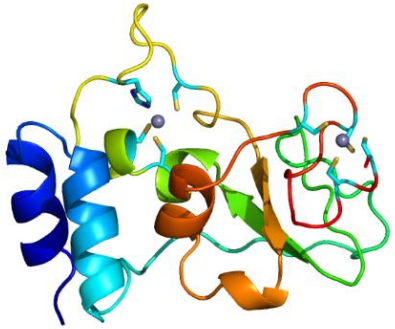
At *SOLEIL* *(with INRAe and SANOFI) to express and crystallize in-vivo all SARS-CoV2 proteins and screen them against industrial fragment library*



https://www.synchrotron-soleil.fr/en/beamlines/proxima-1/acces-ge-covid-19

*At **MaxIV***

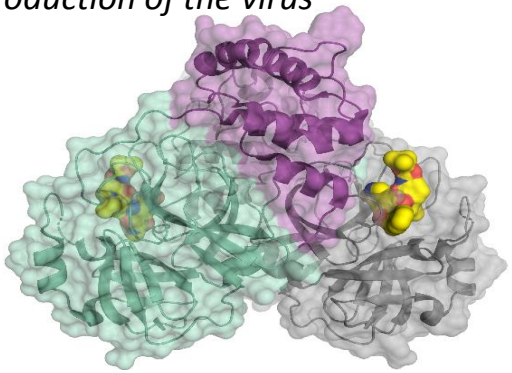
Structure of SARS-CoV-2 Nsp10, important roles in viral replication and transcription in its unbound form



doi: 10.3390/ijms21197375 PMID: 33036230

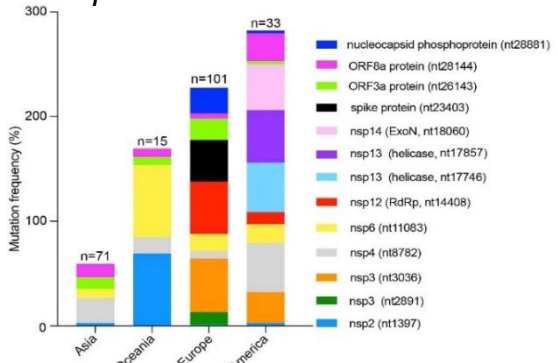
*At **BESSY II***

Decoded the 3D architecture of the main protease of SARS-CoV-2, involved in the reproduction of the virus



https://science.sciencemag.org/content/368/6489/409 (doi: 10.1126/science.abb3405)

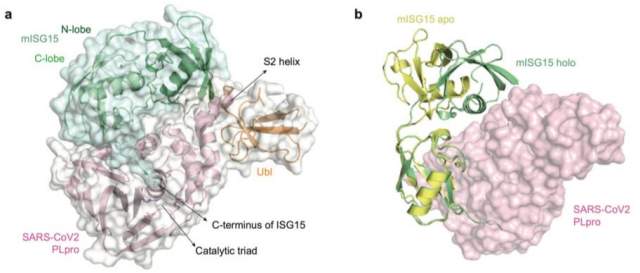
*At **Elettra** - Studying how the virus is evolving revealing that EU, North American and Asian strains might coexist, each of them characterized by a different mutation pattern.*



https://doi.org/10.1186/s12967-020-02344-6).

*At **SLS***

studying how the inhibition of papain-like protease PLpro blocks SARS-CoV-2 spread and promotion of anti-viral immunity



https://doi.org/10.1038/s41586-020-2601-5

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Tool for European inclusiveness

“The strength of LEAPS lies in its staff and users, hailing from all European countries, beyond those which host the facilities.”

Tak

Tack

Thanks

Bedankt

Danke

Dziękuję

Merci

Grazie

Gracias

https://leaps-initiative.eu

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