LENS LEAGUE OF ADVANCED EUROPEAN NEUTRON SOURCES

LENS Colloquium

How neutrons contribute to mission-based research

11th February 2020

Bibliothèque Solvay

brightness²

BrightnESS² is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 823867

LENS LEAGUE OF ADVANCED EUROPEAN NEUTRON SOURCES

Greetings from LEAPS

Caterina Biscari: Chair of LEAPS; Director of ALBA Synchrotron

brightness²

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LEAPS League of European Accelerator-based Photon Sources

Greetings from LEAPS

Caterina Biscari, LEAPS Chair

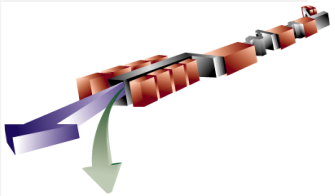
ALBA Synchrotron

LENS Colloquium
Brussels, 11 February 2020

LEAPS League of European Accelerator-based Photon Sources

A new consortium of excellence in Europe devising a transformative level of coordination and integration

European Synchrotron Radiation and FEL Facilities



are joining forces
to master
the challenges of the next decades

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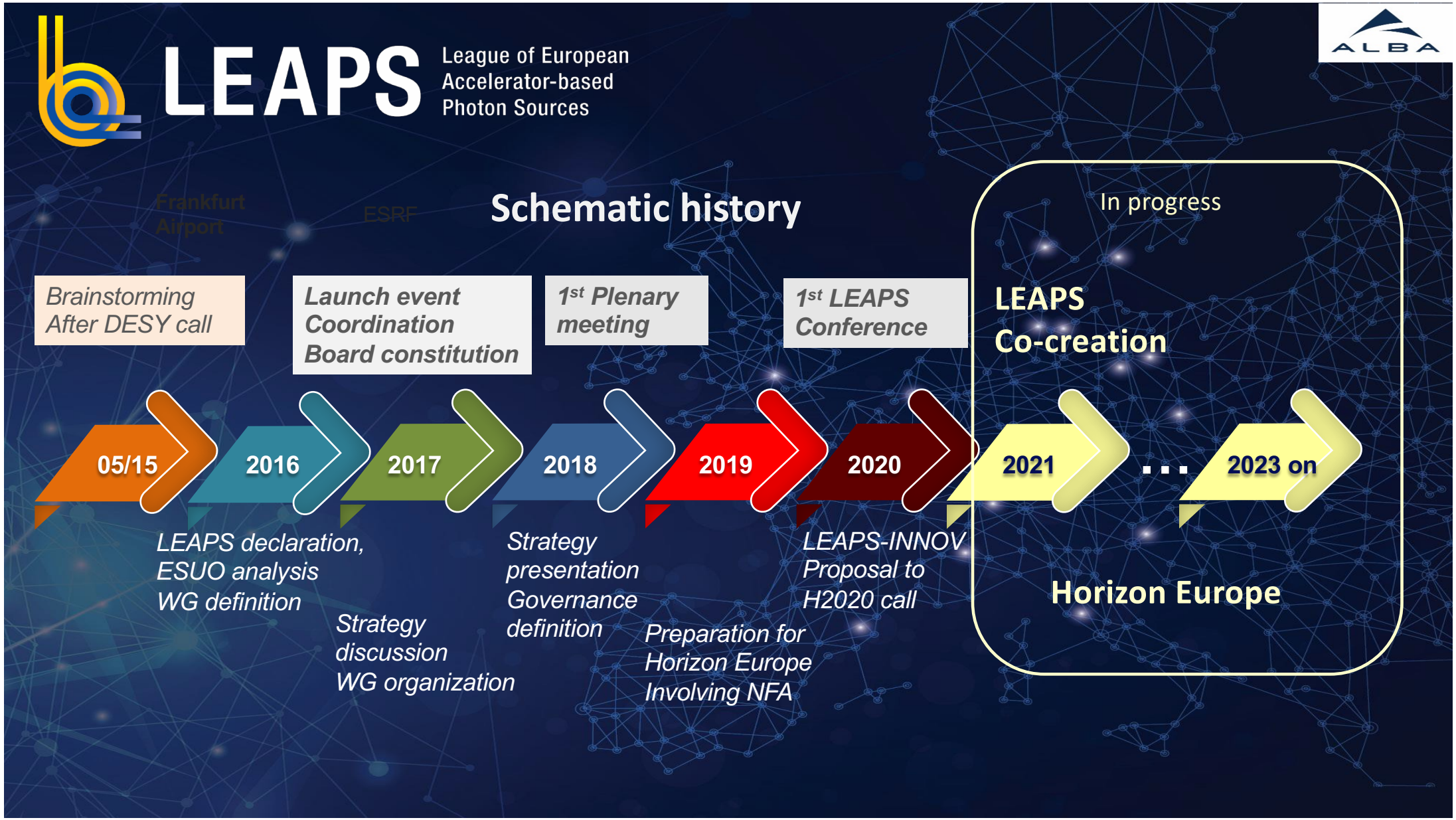
LEAPS
League of European Accelerator-based Photon Sources
ALBA
Schematic history
In progress
Brainstorming
After DESY call
Launch event
Coordination
Board constitution
1st Plenary meeting
1st LEAPS Conference
LEAPS
Co-creation
05/15
2016
2017
2018
2019
2020
2021
...
2023 on
LEAPS declaration,
ESUO analysis
WG definition
Strategy
discussion
WG organization
Strategy
presentation
Governance
definition
Preparation for
Horizon Europe
Involving NFA
LEAPS-INNOV
Proposal to
H2020 call
Horizon Europe

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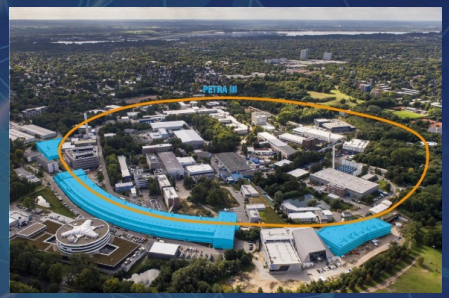
Synchrotrons

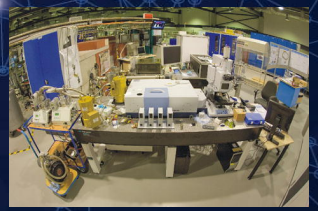
ALBA

ESRF & PETRA III
6 GeV



Alba, Diamond, Elettra, Max IV, SLS, Soleil
2-3 GeV

ASTRID, BESSY II, DAFNE, Max IV, PTB, Solaris
< 2 GeV



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FELs from Hard X rays to IR

ALBA

European XFEL

SwissFEL

FERMI

FELIX

ELBE

LEAPS welcomed SESAME as 1st associate lab

Signing Ceremony on 13-11-18
Helmut Dosch, LEAPS Chair and
Rolf Heur, SESAME Council chair

SESAME is operating two beamlines, commissioning the third one, building two more
First papers with results from beamtime have been published
Collaboration with many LEAPS members, for technological programs since the design stage, through construction and operation, training, new projects

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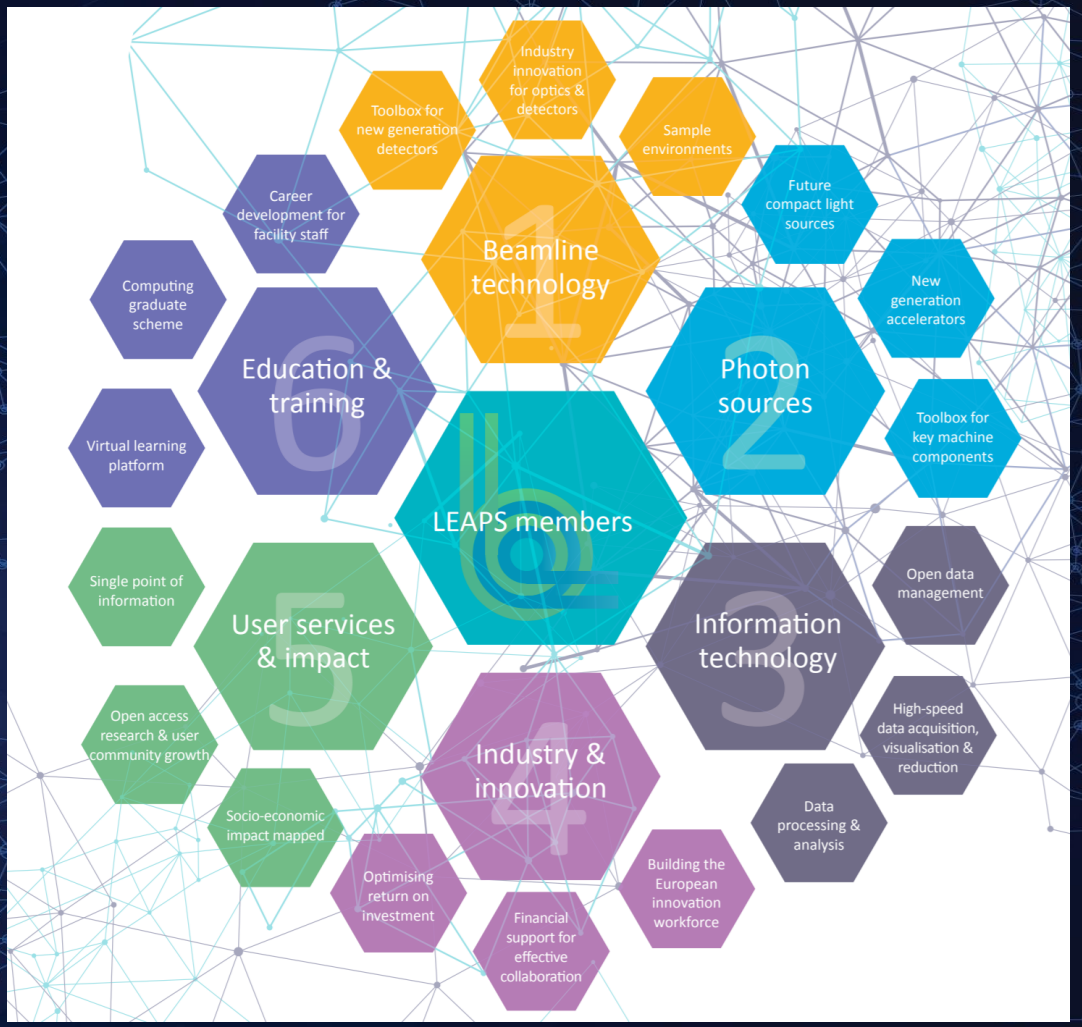
ALBA

+24000 users

+300 operating End Stations

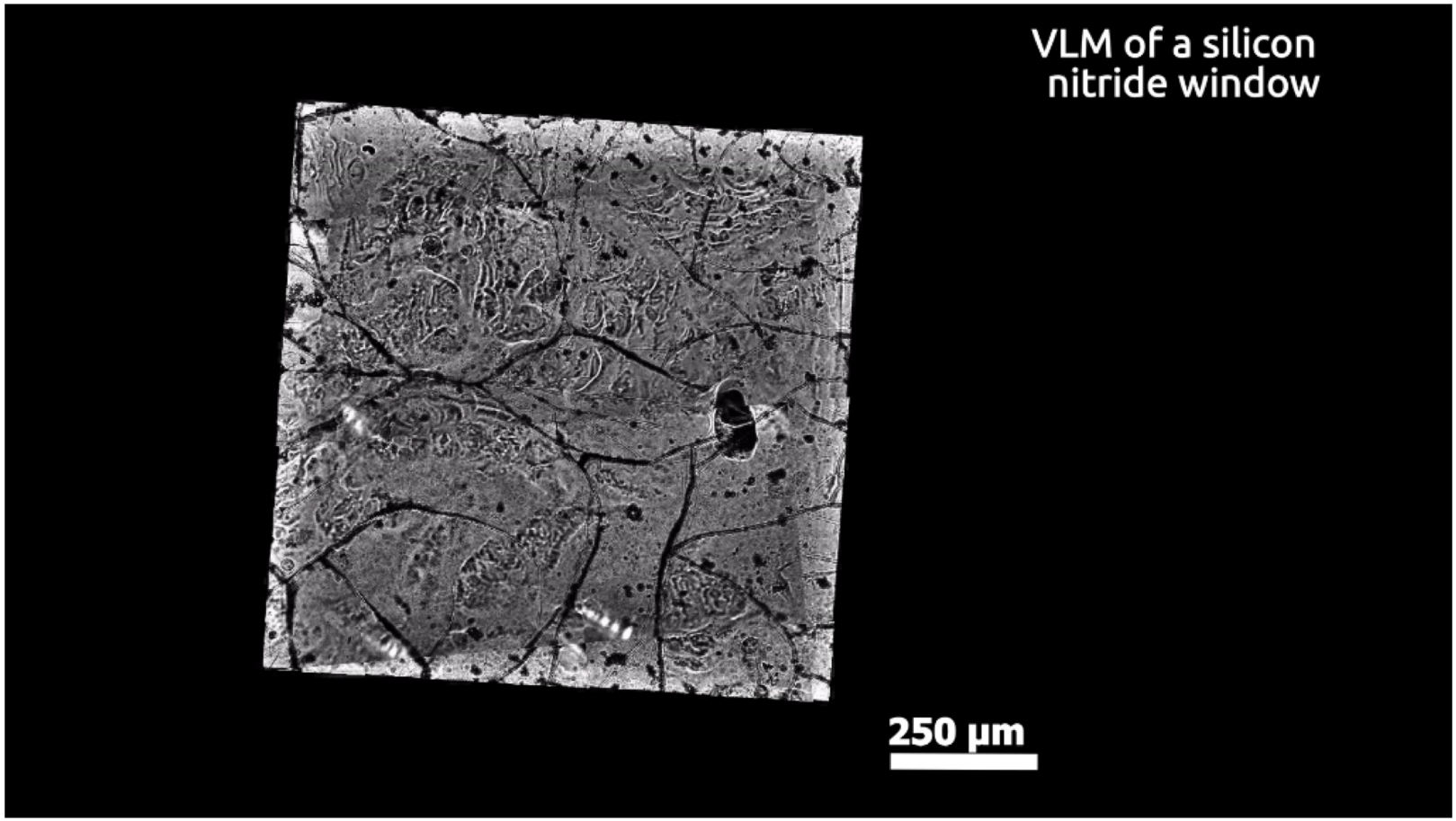
Hundreds of M€ integrated operating budgets

Over B€ foreseen integrated upgrade budgets for next decade



One example – life science

Iridium Anticancer Compound Intracellular drug localization and quantification is a mandatory step to understand both on-target and off-target effects and so as to improve rational drug design on intrinsic metallodrug fluorescence and organelle specific probing for visible light fluorescence microscopy



Unambiguous Intracellular Localization and Quantification of a Potent Iridium Anticancer Compound by Correlative 3D Cryo X-Ray Imaging José Javier Conesa,*[b] Ana C. Carrasco,[a] Vanessa Rodríguez-Fanjul,[a] Yang Yang,[c] José L. Carrascosa,[d,e] Peter Cloetens,[c] Eva Pereiro,[b] and Ana M. Pizarro*[a,e] Angewandte Chemie

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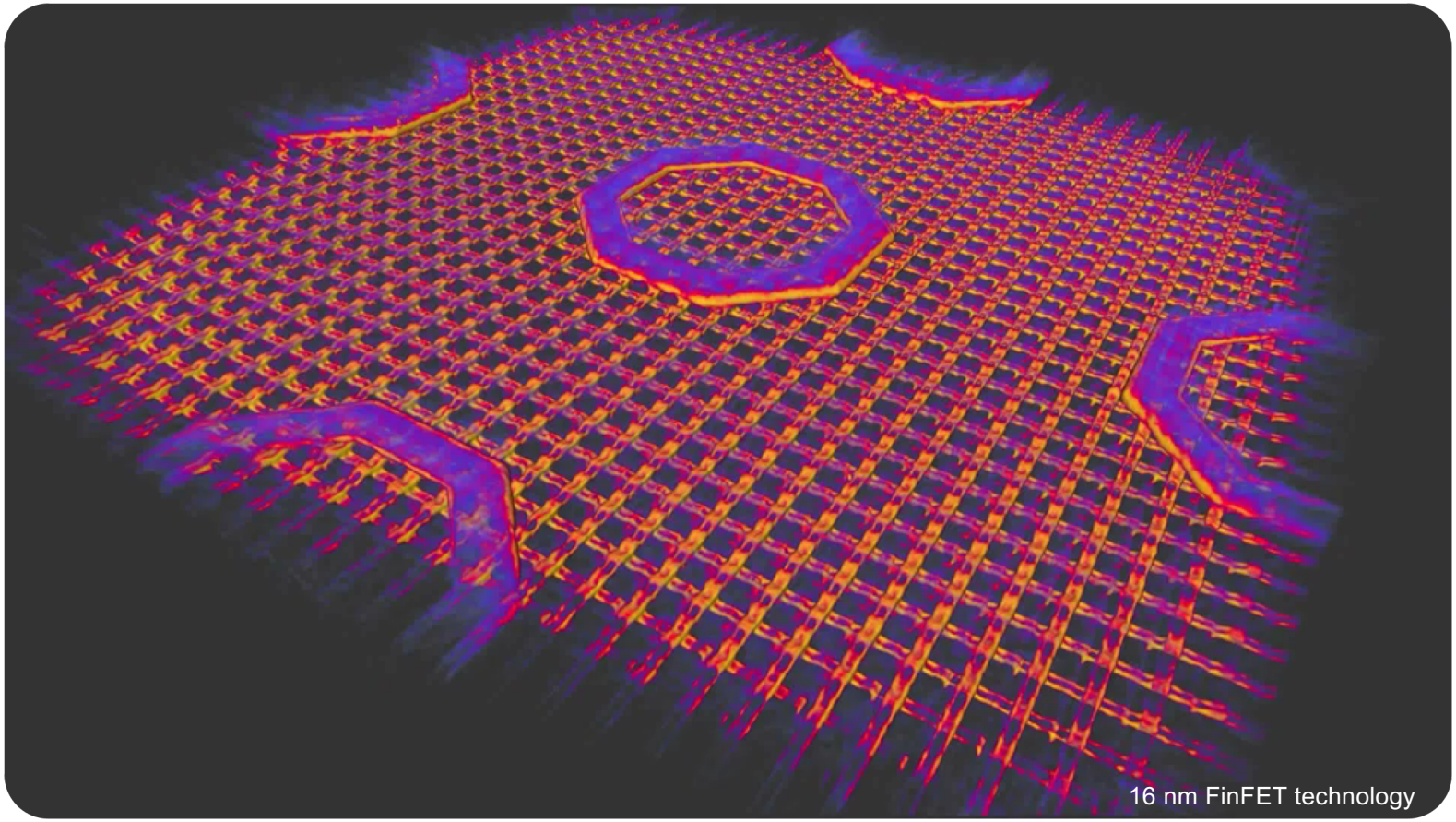
One example – material science

Ptychographic laminography



Mirko Holler *et al.*, *Three-dimensional imaging of integrated circuits with macro to nanoscale zoom*, Nature Electron. **2**, DOI 10.1038/s41928-019-0309-z (2019)

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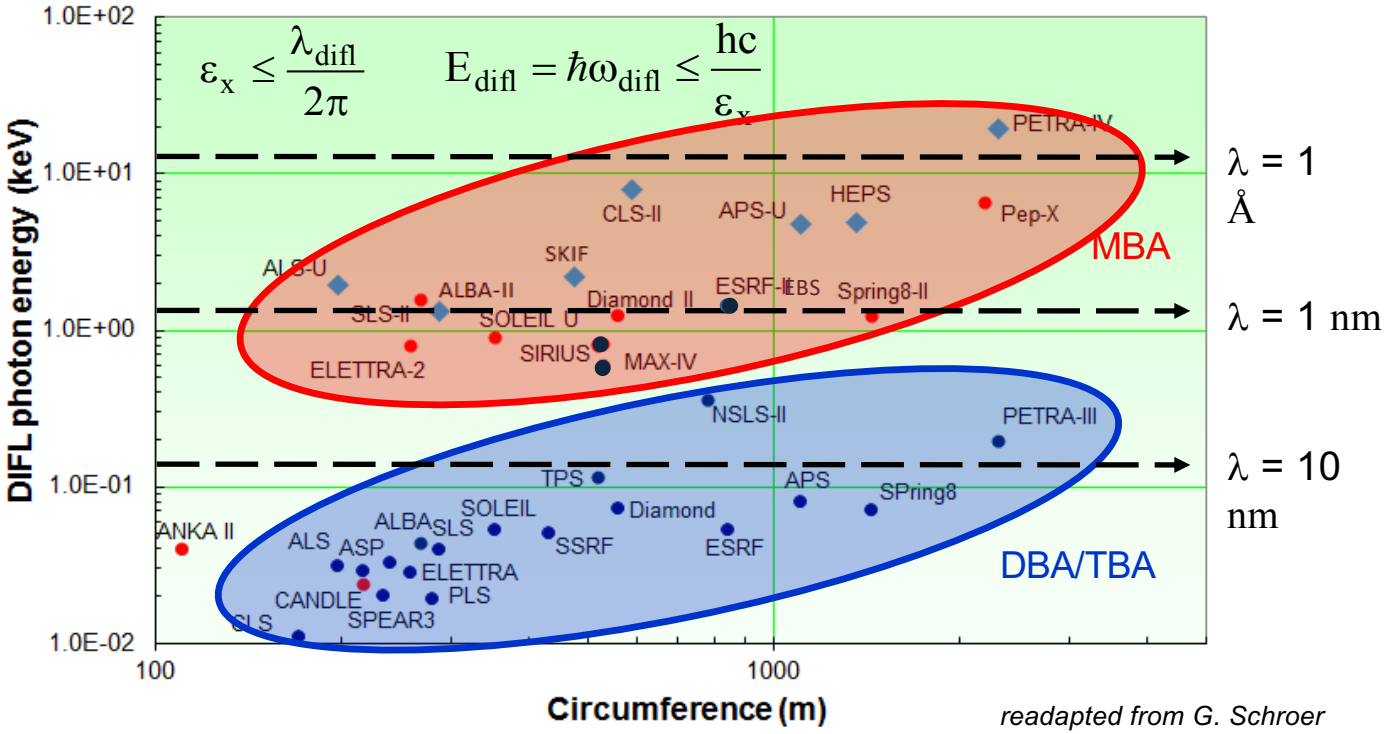
Europe is leading the technological advances in synchrotron light sources

Max IV – First 4th generation Synchrotron Light Source in operation
ESRF-EBS – First high energy 4th generation Synchrotron Light Source and first one upgrading from 3rd to 4th generation



readapted from G. Schroer (DESY)

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LEAPS Plans for Upgrades

Next decade will see other synchrotron upgrades to 4th generation

This evolution is one of the LEAPS drivers

Develop together the technology for the new sources

- Accelerators
- Detectors
- Data handling
- Experimental stations with challenging characteristics
- Avoid unnecessary duplications
- Qualify European industry
- Provide advanced research platforms for user
- Be inclusive with all Europe and beyond

Plus mayor upgrades in FELs:

- European XFEL: new Beamlines
- Swiss FEL: new Beamlines
- FERMI: higher photon energy

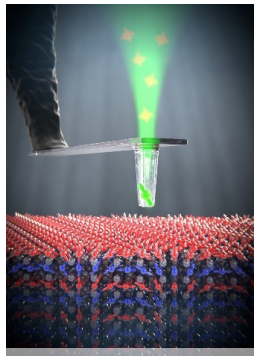
Plus new facilities in progress
Example: EuPRAXIA

On going LEAPS activities

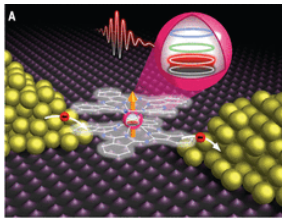
Organization of the 1st LEAPS Conference

LEAPS meets Quantum Technology

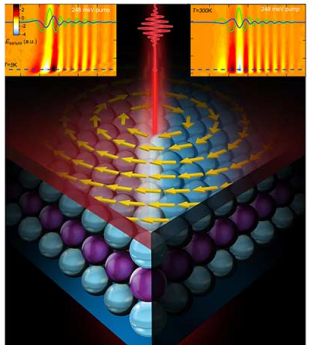
- Quantum Technology: Opening the Mind
- Atoms-Defects-Spins: Coupling and Decoupling of Spin Systems
- Quantum Materials and Quantum Dots: Coupling and Decoupling of Spin Systems
- Quantum Properties of Light



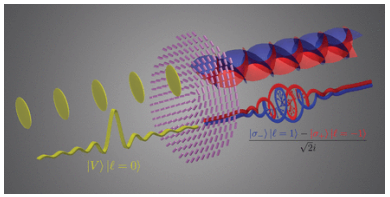
http://www.solidstatequantumtechl2c.fr/research/quantumsensing



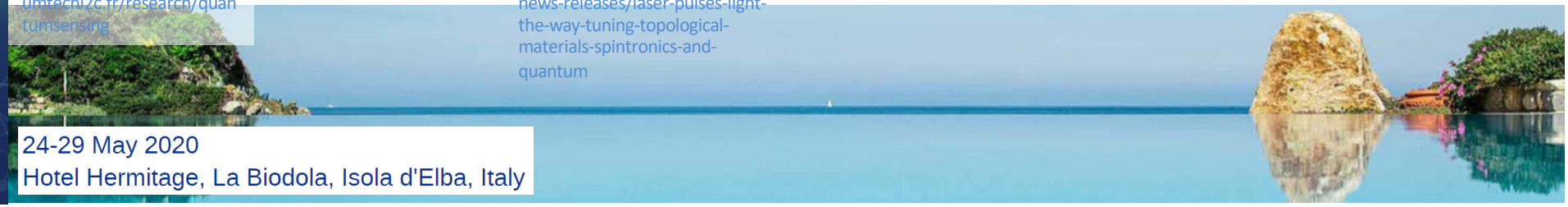
https://science.sciencemag.org/content/344/6188/1135/tab-figures-data



https://www.ameslab.gov/news/news-releases/laser-pulses-light-the-way-tuning-topological-materials-spintronics-and-quantum



https://science.sciencemag.org/content/361/6407/1101/tab-figures-data



24-29 May 2020
Hotel Hermitage, La Biodola, Isola d'Elba, Italy

Committees

Conference Chairs

Caterina Biscari *(ALBA)* and Helmut Dosch (DESY)

Organizing Committee

Massimo Ferrario *(co-chair, INFN - LNF)*
Søren Pape Møller *(co-chair, Aarhus University)*
Maria Rita Ferrazza *(INFN - LNF)*
Julia Hauk *(DESY)*
Ute Krell *(DESY)*
Lucia Lilli *(INFN - Pisa)*
Francesco Sette *(ESRF)*
Francesco Stellato *(University of Roma "Tor Vergata")*
Fabio Villa *(INFN - LNF)*

Scientific Program Committee

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Ralph Assmann *(DESY)*
Simon Gerber *(PSI)*
Giacomo Ghiringhelli *(Politecnico di Milano)*
Andrei I. Kirilyuk *(Radboud University Nijmegen)*
Andrea Locatelli *(Elettra - Trieste)*
Ralf Röhlsberger *(DESY)*
Tobias Schulli *(ESRF)*
Thomas Tschentscher *(XFEL)*
Joachim Wosnitza *(HZDR)*

LEAPS CONNECTIONS for Co-Creation

Horizon Europe and beyond

EUROPEAN COMMISSION

10 National Funding Agencies + ESRF/EUXFEL members
National roadmaps

All EU Member States
LEAPS benefits all

Experienced Users
Including research institutions and Universities

ESUO EUROPEAN SYNCHROTRON AND FEL USER ORGANISATION

+ New User Communities

Industry as provider, user and collaborator

Other RI networks as

eric
nfn

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LEAPS as a key tool for Missions

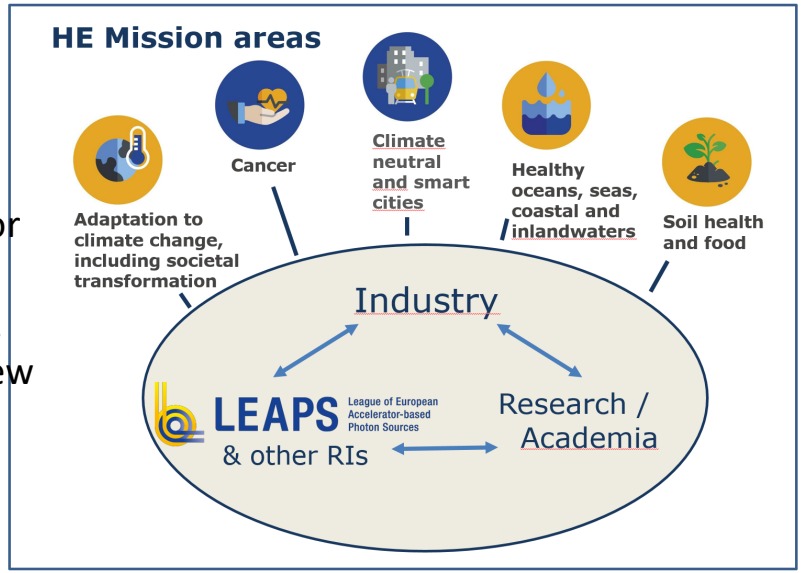
Grand challenges & LEAPS impact

Membrane proteins, imaging, drugs development

Batteries, Smart windows, Cooling technology, Air quality, more powerful electronics and data handling

Identify pollutants, develop alternatives to plastic, accelerate the decomposition rate

New ways for resource extraction & recycling, new materials



Antibiotic and herbicide resistance, Soil health, pollution, identification of nanoparticles that can be transferred all along the food chain to humans

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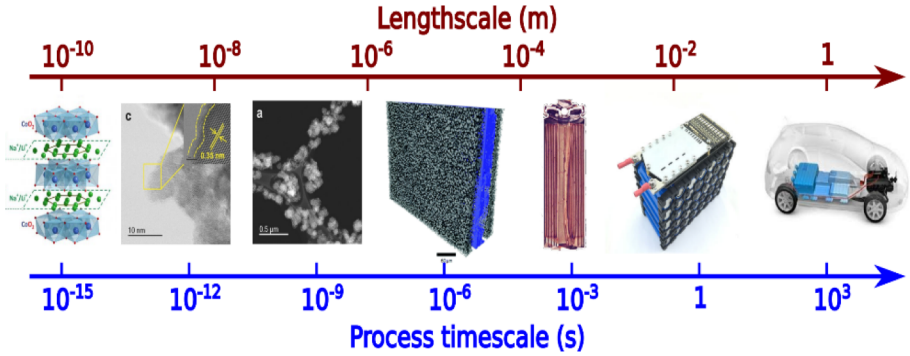
Position Paper on Battery Challenge

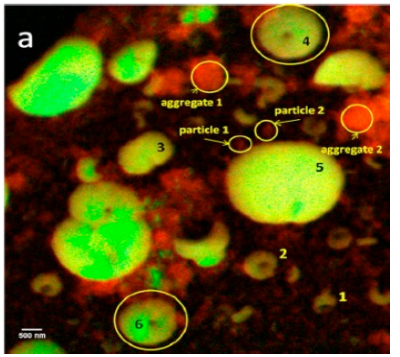
*(*https://leaps-initiative.eu/wp-content/uploads/2020/02/LEAPS-Battery-Roadmap2030.pdf *)*

Supporting the European Battery 2030+ Roadmap

- **LEAPS facilities for understanding which processes define the performance of a battery**
- Today, we have only a brittle understanding of the role that **particle size and morphology**, **interface structures and chemistry** play in controlling battery performance. We have no sufficiently detailed information on how **reaction fronts** move through liquids and solids and how this varies with temperature and overpotential.
- **Correlating** complex electronic, electrochemical and physical **phenomena across all relevant length and time scales,** from sub-micrometer to millimeter and from femtoseconds to hours
- **Understanding** and **controlling** the complex interphase regions formed at **dynamic interfaces**,
- **Achieving** better energy storage performance through **novel assemblies of matter**, and
- **Devising self-healing structures** and **mitigating detrimental chemistries** for longer lifetime and improved safety



Length scale challenge in future battery research (courtesy: ESRF)



X-ray Transmission microscopy image of the discharge products in ether-based LiO_2 cells. Cyan: Li superoxide, green: Li peroxide, red: carbonate (courtesy: ALBA)

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Long history of collaboration among photon and neutron sources

CRISP
PANOSC
PANDATA
EXPAND
NFFA
CREMLIN
CREMLIN Plus
CERIC_ERIC

DATA

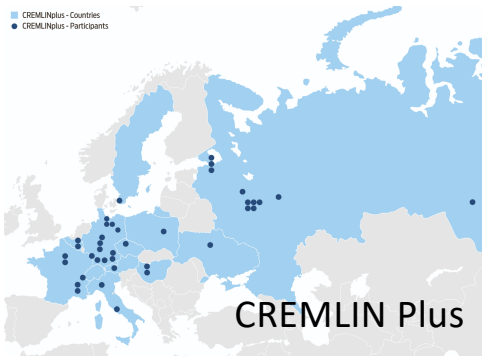
pandata

panosc

ExPaNDS

Collaboration with Russia

Cremlin Connecting
Russian and European Measures
for Large-scale Research Infrastructures



Others

CRISP

nffa.eu
nanoscience foundries & fine analysis

CERIC

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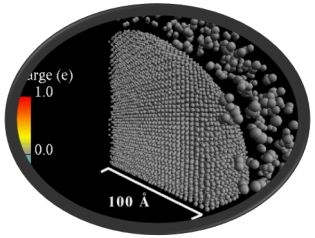
DATA



- Exponential **growth of data volumes** resulting from improvements and upgrades in photon source properties, beam delivery and detector technology
- Far **greater computational power** is required to enable researchers to visualize what they are measuring to make informed decisions about the next step in an experiment.
- Data **cannot be transferred and analysed** at most **home institutions** using current means
- Future requirements for data handling are not scalable in terms of current technology, budgets or environmental impact and will need both **improvements to hardware and development of new algorithms** increasingly using **AI**
- Key aspects: **Bidirectional collaboration with industry**, **open source** licensing, standardized **open data access policy**, federated **access mechanism**, data **analysis** services, **data mining** approaches.
- A close collaboration between different RI communities is ongoing in this area for the **photon and neutron facilities** in the projects PaNOSC and ExPaNDs, in the strategic context of EOSC.
- Acute skills **shortage of data scientists and scientific software engineers:** LEAPS will address education, training and outreach

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USERS

- LEAPS **engagement with the scientific user communities** will build a bridge towards the global challenges and missions of HE. It will enable the existing users of its facilities – from **both academia and industry** – to exploit their full potential. It will **lower barriers to access** the advanced capacities of its facilities for new **users from all European countries**, **new research communities, and industry** - in particular SMEs. It will also support and engage with science communities worldwide.
- LEAPS will provide next grade of **optimum conditions for users**, stimulating their widest participation in response to the needs formulated by their communities. Countries that do not host LEAPS facilities will be better integrated
- LEAPS could ring-fence a part of the open access to its facilities and development of dedicated services to certain user communities of the HE missions. Such support will likely be defined in the next Work Programme for 2020, to be updated in spring 2020, and the subsequent Work Programmes.
- **Joint development of scientific instruments by key user groups** and beamline experts of LEAPS facilities towards future needs **in addressing the global challenges** defined in HE and in particular to contribute to HE Missions. Thereby, bridge from Pillar 1 (Science Excellence) to Pillar 2 (Global Challenges and Industrial competitiveness) of HE could be efficiently built.

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"The strength of LEAPS lies in its staff and its users, hailing from all European countries, beyond those which host the facilities. Member States and facilities should optimize the funding instruments under Horizon Europe for the benefit of researchers and innovators across all Europe"