

A brilliant future for Europe: Advanced laser light sources

Thomas Tschentscher – EUCALL Project Coordinator



LUND UNIVERSITY

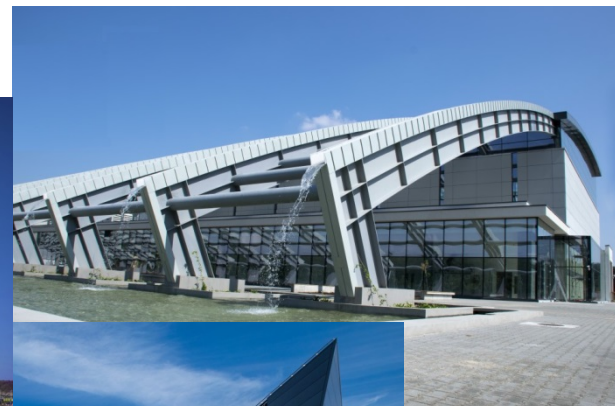


This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 654220



The European dimension of light sources

- Three large-scale and international ESFRI facilities



- Many national facilities contribute tremendous know-how and provide service to the scientific community, too.
- Europe is **already** at the **forefront** in each of the individual areas. Connecting these facilities, their communities, and instrumentation developments will **generate new ideas** and **breakthroughs** thereby **securing a world-leading position**.



Advanced Laser Light Sources



Synchrotron



Free-Electron Laser



Optical Laser

Low emittance electron accelerators

X-ray methods and techniques

User programs

Ultrafast and non-linear science

Optical laser methods

Optical laser (high energy, fs)

Data issues (volume, policies)



Advanced Laser Light Sources



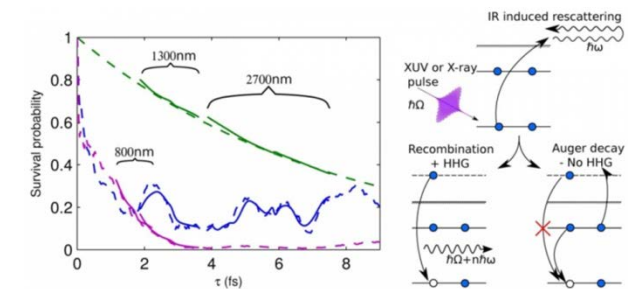
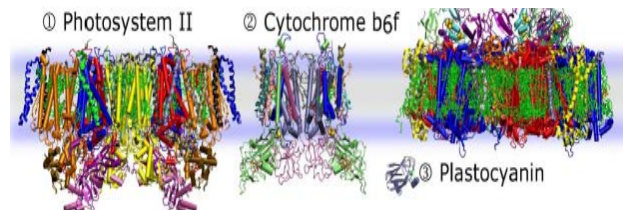
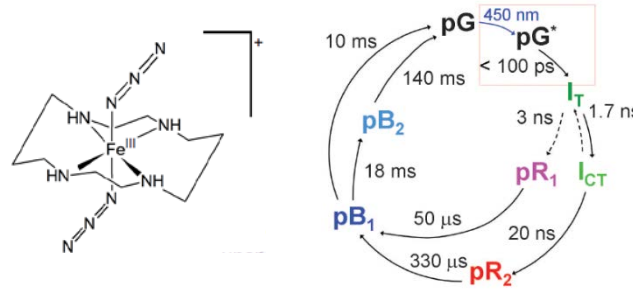
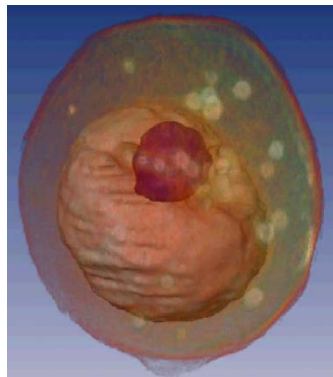
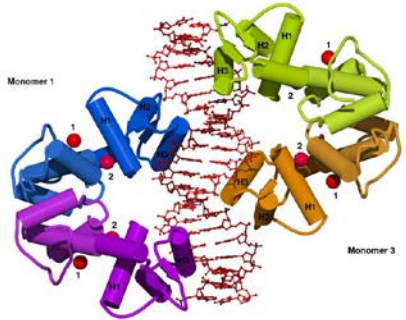
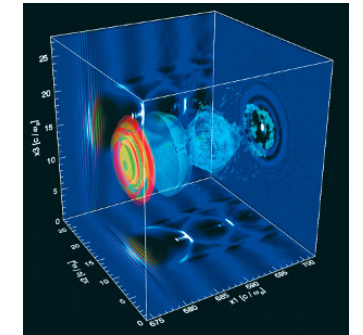
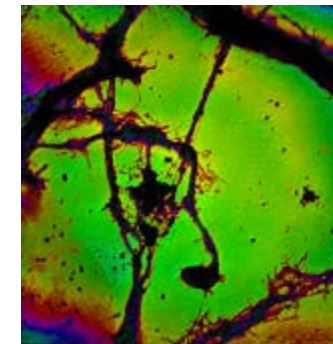
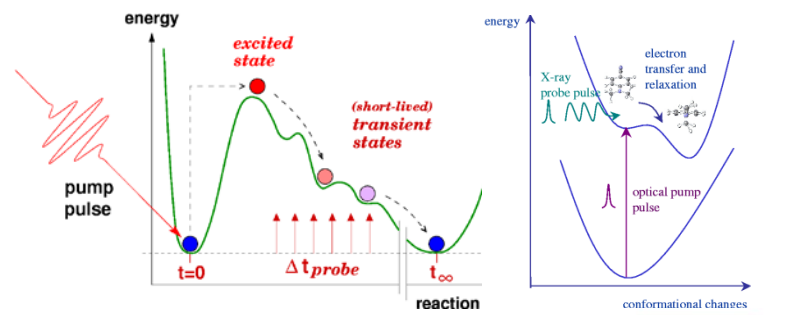
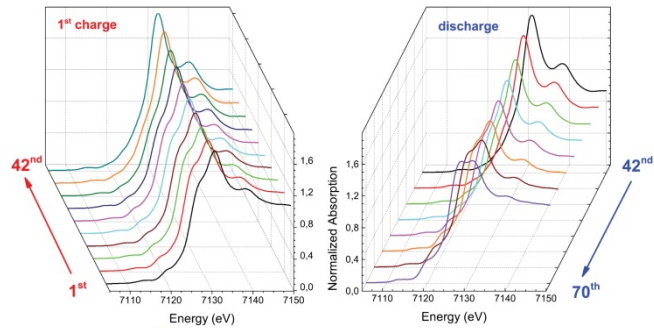
Synchrotron



Free-Electron Laser



Optical Laser



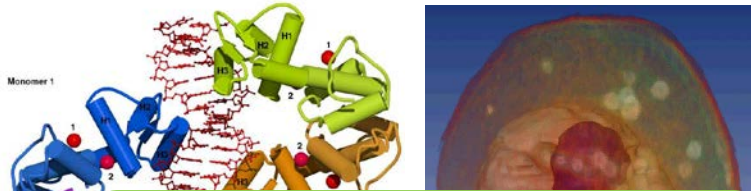
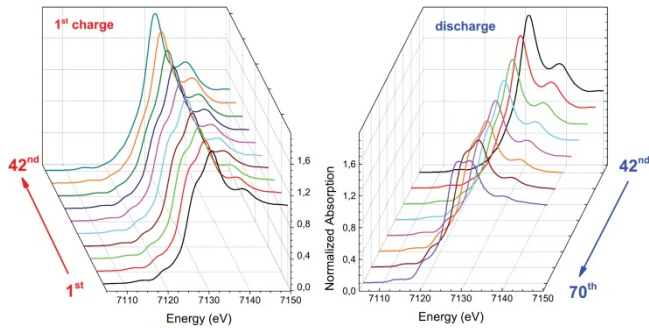
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Advanced Laser Light Sources



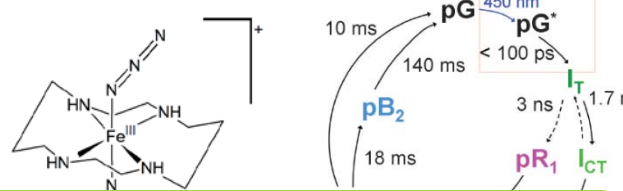
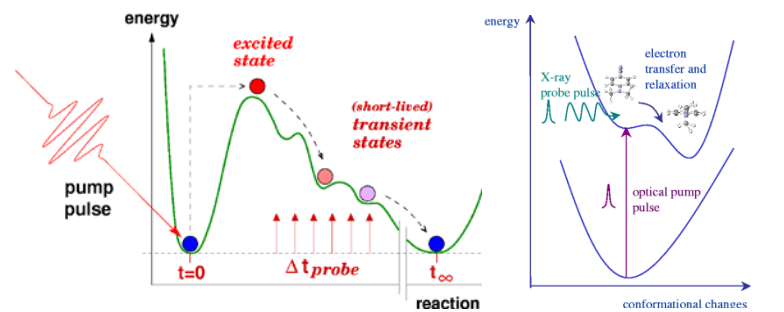
Synchrotron



Geometric and electronic structures
in-situ measurements
 Images of mesoscale objects



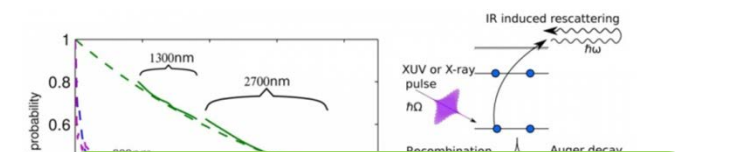
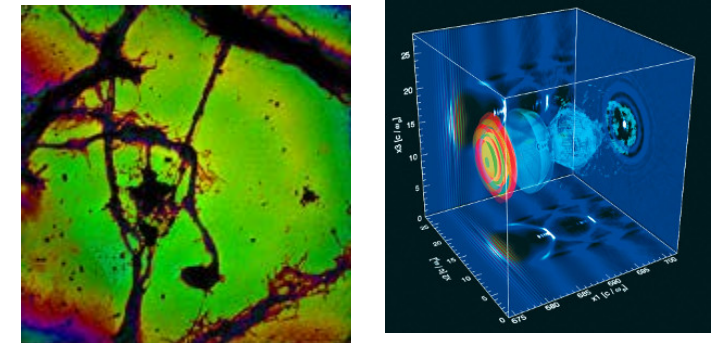
Free-Electron Laser



fs-ps-ns-μs dynamics
 RT diffraction w/o damage
 Images of nanoscale objects



Optical Laser

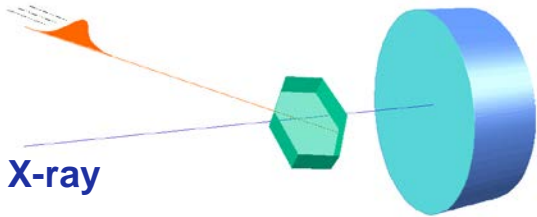


as-fs dynamics
 Rel. laser matter interaction
 High-field physics

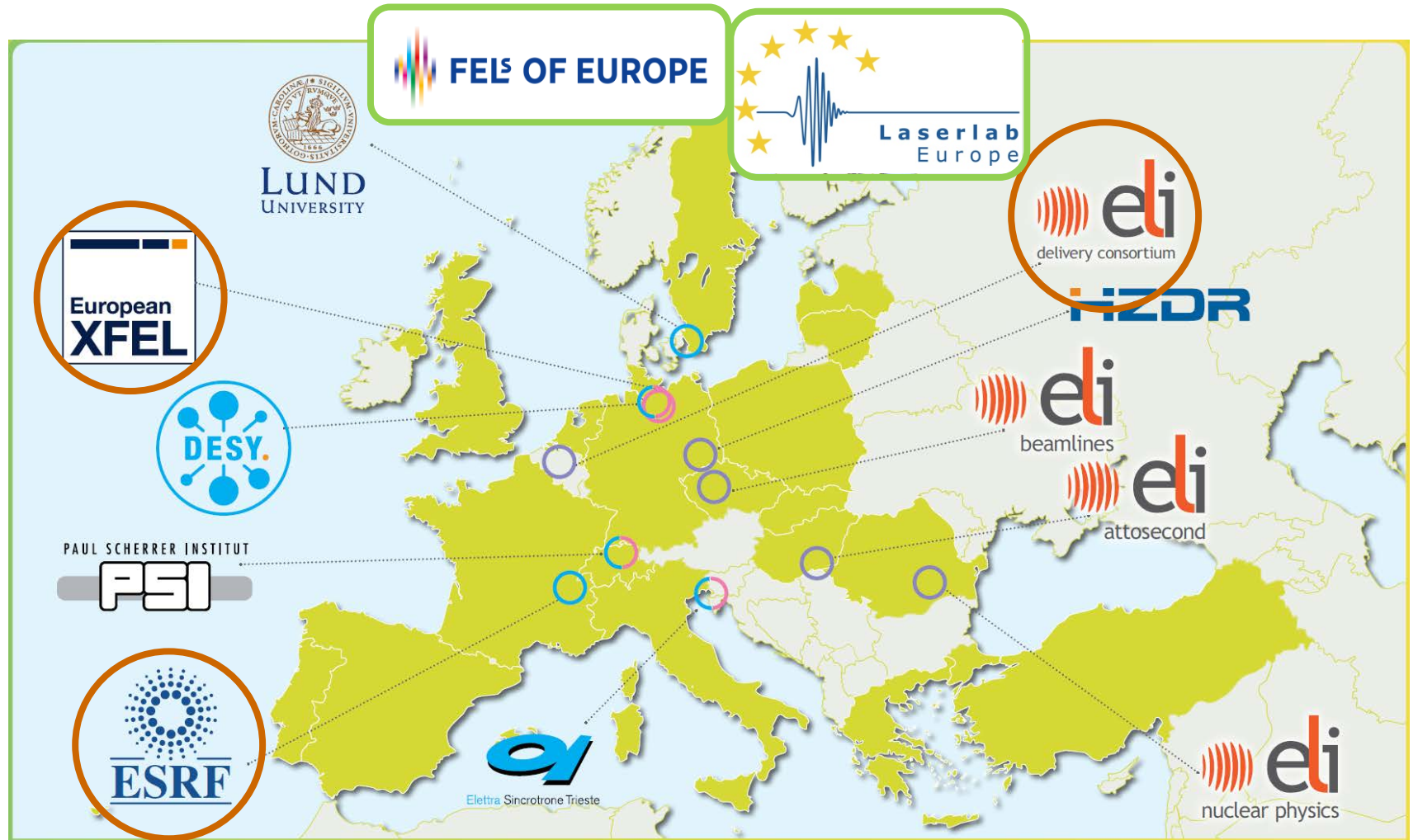
The EUCALL facilities

- Research Infrastructures
- Short-wavelength / X-rays
- Laser-like radiation
- Ultrashort time-scales

Optical
Laser



X-ray



ESFRI facilities



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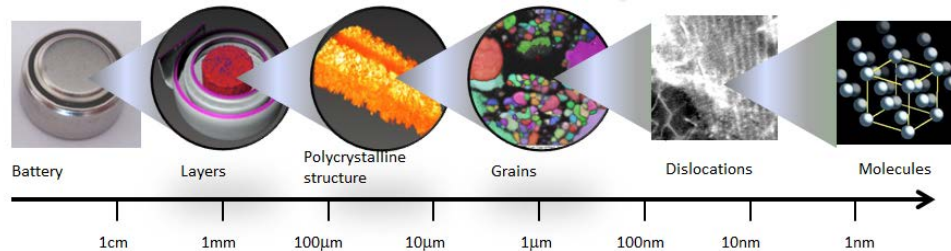
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The Impact of Advanced Laser Light Sources

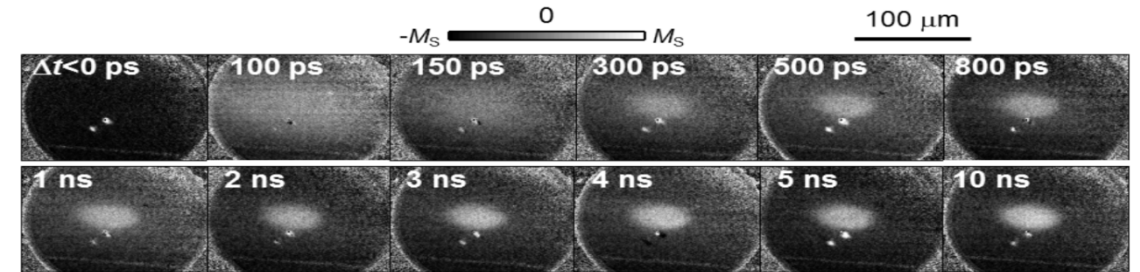
Engineering

- Understanding structural damage in systems from the atomic scale to macroscopic scales



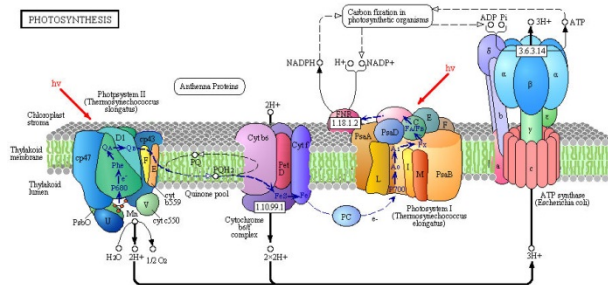
Information Technology

- Ultrafast magnetism and related technologies for next generation computing and devices



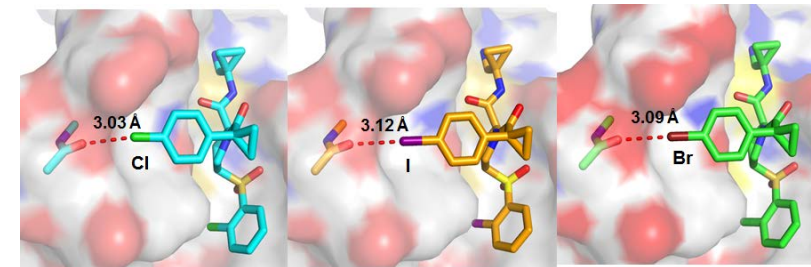
Energy

- Development of solar energy sources via understanding of ultrafast photo-chemical reactions
- High power laser plasma research for realization of nuclear fusion
- Artificial photosynthesis



Health

- Targeted drug delivery from structural biology and ultrafast spectroscopy results
- Novel laser and radiation medical treatments



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EUCALL's goals

- Accelerator- and laser-based photon science RIs start to develop significant overlap. EUCALL is the first project addressing this overlap, focussing on common technical, scientific, and strategic issues with the following goals:
 - Optimize use of advanced laser light sources in Europe.
 - Stimulate & support common long-term strategies & research policies
 - Develop & implement cross-cutting services for European XFEL, ESRF and ELI
- EUCALL activities were focussed on:
 - **Synergy** – analysis and recommendations for enhancing the research potential of the cluster
 - **Innovation** – optimizing the innovation potential of this cluster of complimentary light sources
 - **Technical/Scientific developments** – standardisation of hardware and software at multiple facilities



Landscape analysis of light source capabilities in Europe

- Work performed:
 - Compilation of data on “UV/x-ray instrumentation at European light sources” & subsequent analysis.
 - 22 characteristics of 121 beamlines at 17 light sources.
- Sustainable implementation:
 - Integration of EUCALL facility data into existing and sustainable public database 
- Recommendations:
 - Keep **broad range of instruments** to enable and support broad scope of scientific applications. **Multiplicity of certain instruments is a benefit**, e.g. in order to respond to very high demand.
 - Request for local and international, but also **highly specific and multi-purpose facilities** to respond best to community needs.
 - Encourage experimental campaigns making use of different type of light sources for **complimentary measurements** (eg. as – ns).
 - Develop FELs/laser instruments such as to reach the **stability, operational performance and versatility of synchrotron** instruments.
 - **Standardize instruments** through joint developments & sharing of know-how to enable easier access and more effective use. Enable to use complementary facilities using known techniques.
 - Consider using compact (laboratory based; possibly local RI) **sources for pre-characterisation** before performing experiments at large-scale, often highly over-subscribed RIs.




Innovation potential of Advanced Laser Light Sources

- Work performed:
 - Detailed study of Technology Transfer (TT) & Industrial Liaison practices at 14 light sources and collection of 'Best practices'
- Recommendations:
 - Disseminate 'Best practices' to new/starting RIs. (List of most important BPs exists.)
 - Establish a **networking of TTOs** to initiate new types collaborations. (Ideas for coll. exist)
 - Develop and introduce new and common **Key Performance Indicators** to measure economic impact of RIs
 - Develop/recognize elements for **TT policies** to be adhered to by different RIs or even be used for a **common TT charter**
 - Develop and disseminate **training programs for young researchers** with the aim to sensitize them for identification of relevant intellectual property, ways of protection and commercialization



Optimize use of advanced laser light sources in Europe

- EUCALL developed and spread tools (hw & sw) to make the use of light sources more efficient and enable 'better' scientific usage:
 - Simulation tools
 - Faster data transfer and computation
 - Automation and standardized sample positioning schemes
 - Advanced beam characterization
- EUCALL supported a standardized and homogenized data collection and presentation about light source instrumentation enabling users to better judge and select facilities. → The logo for "Way for Light", featuring a stylized, colorful knot-like symbol in blue, purple, and yellow, with the text "WAY FOR LIGHT" in purple to its right.
- EUCALL supported education through schools, workshops and conferences, but also through targeted facility visits, enabling new generation of scientists to use and apply light sources and their techniques to address societal challenges.

Stimulate & support common long-term strategies & research policies

- EUCALL shows the meaningfulness of **well-defined cluster projects** joining facilities and people from different communities to address and solve issues of **high relevance to the European science** area. Such projects should be considered in **future calls without too narrow definition** about the topics of such a cluster project.
- Upcoming **new RIs take huge benefit from cross-connecting to operating RIs** in establishing operation procedures in a most efficient way. Such cross-connection projects require **additional resources** at the operating facilities and may be enabled in the future through separate projects.
- With the establishment of large collaborations of RIs in Europe (LEAPS, Laserlab-Europe, and similar) serving specific communities it will still be important to **cross-connect in areas of common interest**. Ways to enable such cross-connection shall be defined and require resourcing.
- Creation of a network and specific **collaboration activities of technology transfer experts** at light source RIs, probably including other, related RI networks of materials and analytical facilities, to support an **optimized utilization of the innovation potential** of these RIs.



Activities supporting Advanced Laser Light Sources in future

Laser targetry and related matters

- Workshop in May 2018 at ELI-Beamlines
- mitigation of debris and shrapnel
- protection from electromagnetic pulses
- issues related to the target environment
- supply of 10^3 - 10^5 targets per year



Theory and simulations of photon-matter interaction

- Workshop in July 2018 at ELI-ALPS
- interpolate between condensed matter and hot dense matter
- attosecond dynamics using high harmonic sources
- High field physics near / beyond the Schwinger limit

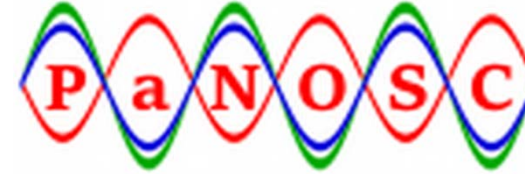


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Reaching beyond EUCALL as a Horizon 2020 project



- FELs, SR and OL sources all included with standardised data layouts
- After EUCALL ends, database sustained at Elettra and by Horizon 2020 IA project CALIPSOplus
- ESRF, European XFEL, ELI joined with ESS, ILL for a recently accepted proposal for 4-year Horizon 2020 cluster project on data and cloud issues.

Other collaborations within EUCALL are considering to continue through new grant opportunities: ATTRACT, ...

Continue collaboration through network activity
EUCALL forum

Interest in getting involved has been indicated by several SR facilities



Relation to larger collaborations

- Laserlab-Europe
 - From beginning partner within EUCALL with the task to enable connection to laser facilities



- LEAPS
 - Network of SR and FEL facilities (RIs)
 - Formed in 2017



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Activities like those pursued within EUCALL create a bridge between the two major collaborations.
➔ Ways to embed activities into these collaborations are presently defined



This event

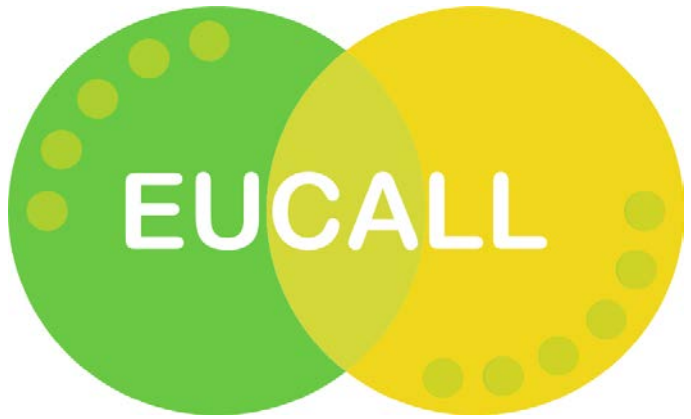
Time	Programme
12:00	Registration, coffee and light lunch Exhibition and discussion of EUCALL technical results
12:50	<i>Welcome</i> – T. Tschentscher / European XFEL
13:00	<i>Expectations from RI clusters</i> – P. Froissard / European Commission
13:10	<i>A brilliant future for Europe: Advanced laser light sources</i> – T. Tschentscher / European XFEL
13:30	<i>Exploring ultimate time-scales in information technology: The role of ultrashort x-ray pulses</i> – C.M. Schneider / FZ Jülich
13:45	Panel discussion <i>Value added through cross-community activities – Highlights of EUCALL</i> <ul style="list-style-type: none"> - <i>Technical results & experience exchange</i> – S. Pascarelli / ESRF - <i>Landscaping analysis</i> – M. Gühr / Uni. Potsdam - <i>Wayforlight database</i> – C. Blasetti / Elettra - <i>Innovation at RIs</i> – A. Bonucci / European XFEL and A. Hála / ELI
14:30	Coffee Break Exhibition and discussion of EUCALL technical results
15:00	<i>Worldwide context</i> – R. Falcone / American Physical Society
15:20	Panel discussion (Moderation: C. Miron / CEA): <ul style="list-style-type: none"> - <i>Benefits of clustering on technical developments</i> – M. Svandrlík / FELs of Europe - <i>Landscaping and standardization of instrumentation data</i> – C.-G. Wahlström / Laserlab-Europe - <i>RI clusters and innovation</i> – J. Hrušák / ESFRI
16:00	<i>Summary & outlook</i> – T. Tschentscher / European XFEL
16:10	End of Meeting

- ← Scientific impact of Advanced Laser Light Sources
- ← Optimized use and Innovation aspects
- ← International perspective
- ← Lessons-learned from EUCALL and future directions
- ← Signing of Letter of Intent for  *forum* network



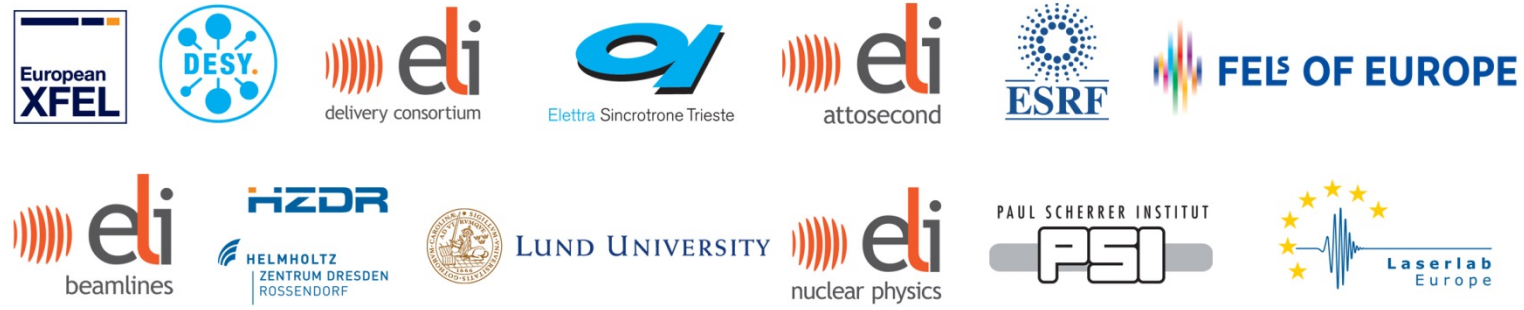
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Thank you for your attention

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Cross-cutting services for European XFEL, ESRF and ELI

- **Improved wayforlight database** now includes ELI, ESRF, European XFEL and presents instrumentation in a standardised, searchable format.
- New **networking activities link TTOs** of ELI, ESRF and European XFEL and shall create common activities.
- SIMEX allows **simulations of experiments** possible at each ESFRI RI
- HIREP's **sample delivery system** accepted for use at ESRF, European XFEL and will also be used for target delivery at ELI
- Exchange in area of **extreme conditions experiments** sparked considerable activity on all sides to jointly develop methods (e.g. targets for experiments)
- PUGCA's **XGM** designed as a tool for both European XFEL and ELI-BL. The **Wavefront Sensor** was based on ESRF designs and developed for European XFEL and ELI. **Liquid jet systems** developed between European XFEL and ELI may develop also into sample delivery systems, might also be useful at ESRF.

