History of changes

Version	Date	Change
1.0	09.05.2015	Generated new file from Part B Sec. 1-3 and 4+5 submitted to EC in September 2014 and applying suggested modifications: • Removal of cover page • Removal of list of participants • Removal of tables 3.1a, 3.1b, 3.1c • Removal of tables 3.2a and 3.2b • Removal of table 3.4a
1.0	09.05.2015	Removed tables 3.4c and 3.4d form original Part B as these only reflected the budget distribution now entered in the SYGMA system.
1.0	09.05.2015	In section 5.1 Ethics the sentence suggested by the EC was inserted.
1.0	12.05.2015	Inserted work package descriptions into document (from tables 3.4a in original proposal).
2.0	04.06.2015	Several modifications have been entered in Section 4.1 to clarify that named staff is an employee of the respective partner institute.
2.0	04.06.2015	The section 5.1 was revised following the request in the email from May 18, 2015.
2.0	05.06.2015	Following the comment in the email from May 18, 2015 that Table 3.4c was missing (to which text referred), comments were inserted pointing to instances were tables have been removed from the DoA according to EC instructions.
2.0	05.06.2015	Table 3.4b was updated according to the new budget distribution following from the revision of costs, initially identified as subcontracting.
2.0	05.06.2015	Text in Sec. 3.4 was updated in accordance with the modified budget of EUCALL.
2.0	05.06.2015	The section 4.2 was completely removed and replaced by new text following the suggestion in the email from May 18, 2015.
2.1	06.06.2015	Small modifications of text in Section 4.1
2.1	06.06.2015	Adjustment of budget figures in Section 3.4. 4000 € have been moved from WP1 (wrongly allocated costs for auditing at LU) to WP6 (travel).
3.0	11.06.2015	Revision of text in section 3.4 to reflect the case that tables have been removed in the process of creating the DoA from the proposal.
3.0	11.06.2015	Correction of tables 3.4b. I had simply forgotten to update the sums.
3.0	11.06.2015	Reinserting of 4,000 € for auditing LU by back-transferring funds allocated to WP6 travel in version 2.1

3.0	15.06.2015	The text in Sec. 4.1has been slightly altered and the reference to in-kind contribution in Sec. 4.2 has been removed for ELI-HU employee A. Andreev.
3.0	15.06.2015	Inserted for each of the LTPs of ELI the requested funds for personnel and other direct costs in Sec. 4.2.
3.0	15.06.2015	Added text in Sec. 4.2 for IFIN-HH (LTP of ELI) to describe the shift of personnel funds from ELI-DC to this LTP reflecting an contribution to WP3 (so far solely allocated to ELI-DC). This change also affects the total requested PMs mentioned in Sec. 3.4 (increased from 764 to 788), while being cost neutral due to the small costs per PM at IFIN-HH.
4.0	13.06.2018	WP3 Synergy: In Grant Agreement Version 3.0 in WP3 60 PM were located at ELI-DC. This was changed to 24 PM at ELI-DC and 36 PM at IFIN-HH/ELI-NP (no changes to costs and tasks). Of the 36 PM at IFIN-HH/ELI-NP, 4.5 PM will be moved to ELI-HU/ELI-Alps (this includes direct costs of 13,000 Euro for personnel and 500 Euro for travel) and 4 PM will be moved to IoP/ELI-Beamlines (this includes direct costs of 13,000 Euro for personnel and 2,000 for travel). From ELI-DC will be moved to IoP/ELI-Beamlines 990 EUR for other direct costs .
4.0	13.06.2018	WP4 SIMEX: 36 PM were moved/corrected from IFIN-HH/ELI-NP to ELI-HU/ELI-ALPS (no changes to costs and tasks).
4.0	13.06.2018	WP1 Management: From European XFEL to HZDR: 15,200 Euro for the organization of the 1st Annual Meeting at HZDR, Dresden, this includes the transfer of 1.15 PM (3,600 Euro Personnel costs, 11,600 Euro Other Direct Costs). From European XFEL to ESRF: 14,000 Euro for the organization of the 2st Annual Meeting at ERSF, Grenoble, this includes the transfer of 1 PM (4,500 Euro Personnel costs, 9,500 Euro Other Direct Costs). From European XFEL to IP-ASCR/ELI-Beamlines: 21,300 Euro for the organization of the 3st Annual Meeting at ELI-beamlines/IP-ASCR, Dolní Břežany, this includes the transfer of 1 PM (2,300 Euro Personnel costs, 19,000 Euro Other Direct Costs).
4.0	13.06.2018	Transfer of travel costs from ELI-DC to their Linked Third Parties: From ELI-DC to IP-ASCR/ELI-Beamlines: 30,500 Euro for travel costs. From ELI-DC to ELI-HU/ELI-ALPS: 12,000 Euro for travel costs. From ELI-DC to IFIN-HH/ELI-NP: 12,500 Euro for travel costs.
4.0	13.06.2018	WP3 Synergy: From ELI-DC to Elettra: 111,000 Euro Integration/extension of the spreadsheet “UV-X-ray Instrumentation at ALL-RI” into the www.wayforlight.eu database. This cost consists of 24 person months (104,000 €), the direct costs for an IT company (7,000 €) who supports the database (change of Annex I and II)

4.0	13.06.2018	WP5 UFDAC: From ELI-DC to DESY: 44,800 Euro for 7 PM to work on implementing OnDA alongside Karabo. (change of Annex I and II)
4.0	13.06.2018	WP5 UFDAC: From ELI-DC to ESRF: 65,000 Euro for 10 PM for further work on the high speed data link in collaboration with PSI within UDFAC. (change of Annex I and II)
4.0	13.06.2018	WP7 PUCCA: From ELI-DC to Elettra: 29,600 Euro for additional salary costs since Elettra was not able to find a good postdoc candidate and therefore used their own staff to work WP7 which was more expensive. (change of Annex I and II)
4.0	13.06.2018	WP7 PUCCA: From ELI-DC to ESRF: 12,000 € to cover the shipping of wavefront sensing equipment to the location of the laser sources and the travel costs of the people participating to experiments (change of Annex II)
4.0	13.06.2018	WP7 PUCCA: From European XFEL to DESY: transfer of 3 PM and 21,000 Euro, Correction of work package description (e.g. relevant beneficiary)
4.0	13.06.2018	Part B of Annex 1 Table 3.4b“Other Direct Costs” corrected the budget of some beneficiaries and under “4/ELI - Equipment” correction of the work package number for the workstation
4.0	01.08.2018	WP5 UFDAC und WP6 HIREP: ELI-HU/ELI-ALPS transferred 8 PM from WP6 HIREP to WP5 UFDAC, meaning that it delivers 26 PM in WP5 UFDAC and none in WP6 HIREP. IP-ASCR/ELI-Beamlines transferred 8 PM from WP5 UFDAC to WP6 HIREP, meaning that it delivers 4 PM in WP5 UFDAC and 18 in WP6 HIREP. (change of Annex I)
4.0	01.08.2018	Part B of Annex 1 Table 3.4b“Other Direct Costs“: correction of the budget including the description for several partners, for European XFEL, ELI and HZDR adjustments of the budget of categories “Personnel Costs”, “Equipment” and “Other Costs”
4.0	01.08.2018	Part B of Annex 1 Table “4.2 Third parties involved in the project (including use of third party resources)” added for “Participant No 4 Extreme-Light-Infrastructure (ELI)” on selection procedure on subcontracting and corrected data for ELI-HU/ELI-ALPS and IFIN-HH/ELI-NP

4.0	01.08.2018	WP4 SIMEX and WP5 UFDAC: HZDR will provide additional 9.5 PM in WP4 SIMEX, meaning a total of 45.5 PM instead of the planned 36 PM. In WP5 UFDAC HZDR will provide an additional 22 PM, meaning 58 PM compared to the originally planned 36 PM. The positions foreseen in the Grant Agreement were foreseen as postdoc positions, but it became possible to engage a lager number of young, very good students in physics and computer science in EUCALL. Despite the employment of highly qualified students, it requires more effort to implement project tasks, compared to more experienced post-doc researchers. (no change of tasks and budget)
4.0	01.08.2018	WP7 PUCCA: For HZDR the number of person month is reduced from 36 PM to 27.5 PM without any changes in the contribution of HZDR. The reason is that there is additional contribution from HZDR staff to this working group. (no change of tasks and budget).
4.0	01.08.2018	WP6 UFDAC: Lund University/MAX IV will provide 6 additional person months, meaning Lund University/MAX IV will provide 30 PM instead of the planned 24 PM. Reason is that the complexity and cost of the setup developed within WP6 HIREP is higher than anticipated (no change of tasks and budget).

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Excellence

1.1 Objectives

Light is fundamentally important to see, to investigate, and to understand the processes of nature. It is only about 150 years ago that the sun was our brightest source of light, and with our eyes as the only detectors we could see only an octave of its spectrum, from about 400 nm (violet) to 800 nm (dark red) wavelength. Then X-rays were discovered with wavelengths 10 000 times shorter, as short as the size of an atom, enabling us to “see” both through and deep inside matter and to resolve its atomic structure. About 50 years ago, the development of unprecedented new light sources commenced.

On the one hand, a fantastic new light source was discovered that has revolutionized our life: the laser. Optical lasers (based on population inversion and stimulated emission) best work in a spectral range around visible light and the near infrared regime. Applications of optical laser light reach from fundamental science to daily life, including global telecommunication, industrial materials pro cessing on micro and macro scales, medical applications, environmental sensing, high precision metrology, and many more—altogether a key technology with an annual market of hundreds of billions of euro and substantial additional leverage into other technologies.

On the other hand, and only shortly before optical laser light sources were invented, a completely new type of X-ray light source based on radio frequency (RF) electron acceleration was discovered, commonly known as synchrotron radiation. Applications of X-ray radiation by synchrotron light sources may be less prominent in daily life, but have revolutionized scientific and technology applications on their own by enabling us to understand the microscopic structure of even the most complex materials, whether these are proteins, ancient art and paintings, new magnetic materials, or turbine blades.

For a long time, the technologies of these two types of light sources as well as their science applications and methodologies, have developed independently. Applications of optical lasers took advantage of their unique characteristics: a high degree of spatial and temporal coherence and ultranarrow bandwidth on the one hand, or unprecedented peak intensity and ultrashort pulses down to atto-seconds on the other. Optical laser installations can be ultracompact and even larger and sophisticated table-top devices can be operated by few people, often for their own research and applications.

Accelerator-based light sources were built for an extremely wide spectral range from THz to hard X-rays. In particular, in the X-ray or, more generally, short-wavelength regime, these sources had an enormous impact due to very high intensity, collimation and adjustable spectral bandwidth, generally combined in the parameter of average brightness. Owing to the character, size, and complexity of the electron accelerator, synchrotron X-ray light sources have developed as large research infrastructures (RIs) operated by hundreds of dedicated staff and have provided access to external user groups with thousands of users per year.

Due to the different wavelengths, the respective scientific applications, and the different character of the light source installations, the overlap between optical laser light sources and synchrotron X-ray light sources has been limited for a long time. Recent developments on either type of light source have changed this picture significantly. Optical lasers have become so powerful that they are able to drive intense secondary sources of coherent and incoherent X-rays. These sources are increasingly used for X-ray science applications. Since the respective optical laser systems are larger, this community has also started to build large RIs providing access to external user groups. Simultaneously, accelerator-based X-ray light sources now provide coherent and ultrashort X-ray pulses, allowing the investigation of ultrashort time scale processes and employing coherent scattering techniques. In particular, the development of accelerator-based X-ray free-electron lasers (FELs) combines the properties of laser light with X-ray radiation and provides unprecedented brightness in the X-ray regime.

The emerging combination of both powerful laser and X-ray light sources, paired with the huge amount of experience in laser and X-ray technology and science, existing in the two communities that have built, operated, and exploited these light sources, is expected to lead to a new regime of scientific applications, which offer possibilities to contribute to societal challenges in areas such as healthcare, energy research, or new materials.

Prominent examples of such research are:

- The potential to make molecular movies, which means to picture the actions of atoms and electrons during chemical reactions or biological processes, opens completely new applications for the treatment of diseases or the design of new drugs as well as for the development of energy and resource saving chemicals and materials.

- The understanding of microscopic processes during the interaction of intense lasers with matter through enhanced X-ray diagnostics contributes to the development of new types of resource saving and affordable accelerators for medical applications and astrophysical or QED studies as well as to the development of new energy sources.

- The transformation of X-ray laser spectroscopy implementing and transferring a wealth of optical laser spectroscopy techniques to the X-ray regime will provide the possibility of new scientific applications in nearly every area of research and technological development.

EUCALL addresses this emerging overlap of technological and scientific applications. For the purpose of this proposal, we define a RI providing transnational access to a facility which combines powerful optical lasers with high brightness X-ray, or short-wavelength, light sources as an ADVANCED LASER LIGHT SOURCE RESEARCH INFRASTRUCTURE (ALL-RI).

Several ALL-RIs already operate in the European Research Area (ERA) or are currently being implemented. The largest are international projects and have been included in the European Strategy Forum on Research Infrastructures (ESFRI) roadmap:

- Extreme Light Infrastructure (ELI) is a distributed RI with three very high-power optical laser installations, including a large portfolio of secondary sources from the THz to the Gamma spectral range. It is currently under implementation in the Czech Republic, Hungary, and Romania, and will provide first light for users in 2016.

- The European X-Ray Free-Electron Laser Facility (European XFEL) is a single-site RI employing a superconducting linear accelerator for the generation and application of X-ray FEL radiation.

It is currently under implementation in Hamburg, Germany, and will provide first light for users in 2017.

- ESRFup is an ongoing upgrade programme of the operational European Synchrotron Radiation Facility (ESRF), a single-site RI providing X-ray synchrotron radiation and operating an increasing number of science instruments combining high power optical lasers with the high brightness X-ray beams.

All of these ESFRI research infrastructures are established for user access and are based on the developments and experience of a much larger number of national advanced laser light source RIs, either operating, under construction, or planned. These national light sources participate in the EUCALL proposal through two international networks under which they are organised:

- LASERLAB-EUROPE, the Integrated Initiative of European Laser Research Infrastructures, provides transnational access to external users, and is the central place in Europe where new developments in optical laser research take place in a flexible and coordinated fashion beyond the potential of a national scale. The consortium currently brings together 30 leading organizations in laser-based interdisciplinary research from 16 countries.

- FELs OF EUROPE is a collaboration of all free-electron laser facilities in Europe organized under a memorandum of understanding, with the goal to meet the technological and scientific challenges of these novel and rapidly developing technologies and to provide a worldwide unique, pan-European RI that enables exploiting the full scientific potential of these unique accelerator-based light sources. The collaboration comprises 14 organizations from 9 countries.

Figure 1.1a summarizes the present situation in the European Research Area (ERA) showing the ALL-RIs with their huge potential for science and technology and indicating how the three international ESFRI projects are embedded and interact with the nationally operated RIs.

While the ESRFup project represents a rather smooth, though very significant, transition of an operational, well-established multi-user facility, the implementation of the new ESFRI advanced laser light sources ELI and European XFEL is connected with a step change in technology and science. These projects face several **specific challenges** asking for a close collaboration and that are the starting point of the present proposal:

- With the construction of the ALL-RIs, the optical laser and the synchrotron radiation communities (community in the meaning of the combined builders of the light sources and their traditional user communities) enter new territory: the optical laser community enters the X-ray domain, and the synchrotron radiation community the laser domain, with significant overlap in technologies, methodologies, and research opportunities.

- The ALL-RIs, combining the wide spectral range of synchrotron radiation with the femtosecond pulses, ultrahigh brilliance, and coherence of optical lasers, create completely new research opportunities in a broad field of applications. This enormous potential for science and innovation needs to be efficiently explored and exploited.

- In contrast to synchrotron radiation facilities, the ALL-RIs, due to their operation mode and complexity, can accommodate far fewer user groups, but require similar construction and operation costs. This has two serious consequences: (1) The total access time available for experiments (so-called beamtime) and, consequently the quantitative throughput and output of these facilities is limited. Since the demand for using these novel facilities is high, there is a high oversubscription which may lead to research groups losing their interest and the research potential not being fully used. (2) The specific cost of the scientific output requires the highest efficiency in the use of the facility and the highest standards of professionalism, state-of-the-art technology and methodology in their operation in order to be justifiable.

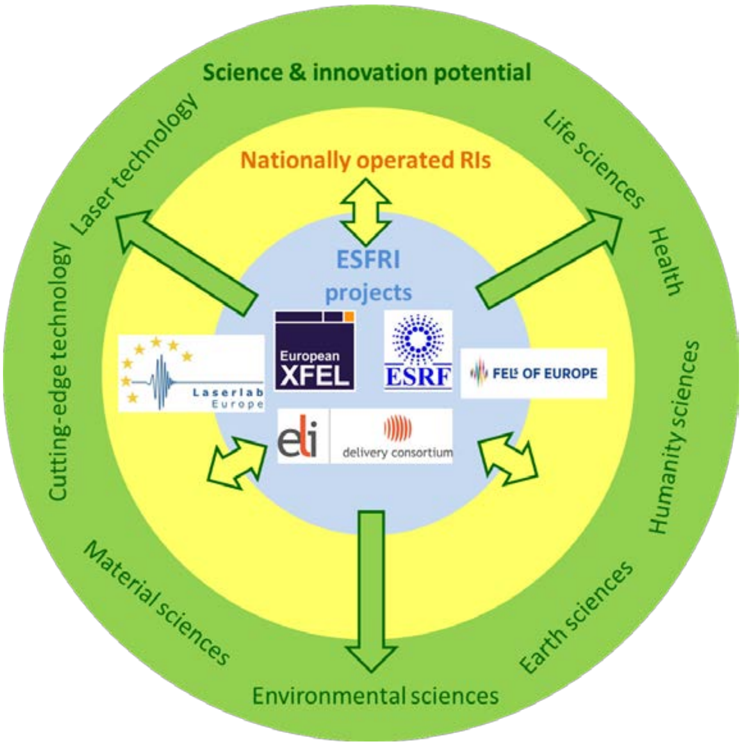


Figure 1.1a: Graphical representation of the interaction of the EUCALL partners, both international ESFRI and national RIs, and their embedding in a large and interdisciplinary science and innovation case.

In order to cope with these challenges, the ALL-RIs in Europe realize the need to collaborate and coordinate common activities. At present, these facilities are all busy with operating or implementing the new infrastructures. Therefore, the present INFRADEV-4 topic is a perfect and timely instrument to initiate such a comprehensive collaboration to meet these challenges. The present proposal brings together both the optical laser and the free-electron laser communities with the goal to make substantial scientific and technological contributions by utilizing the existing knowledge and creating new synergies, common methodologies and research opportunities, and potential new science, new applications, and innovation. It is the first time that the two types of large-scale laser light source RIs in Europe collaborate in such a comprehensive way on technical, scientific and strategic issues, with the goal to sustain this interaction in the future.

The aim of EUCALL is to support the efficient implementation and operation of the ESFRI advanced laser light source projects ELI and European XFEL and to initiate a process assuring that the ensemble of ALL-RIs in Europe is optimally used and further developed for science and innovation in the ERA.

This aim is translated into **three major goals**:

A. To develop and implement cross-cutting services for the photon-oriented ESFRI projects in order to support their efficient implementation and operation.

B. To optimize the use of the ALL-RIs in Europe by efficient resource management and enhanced interoperability, ensuring global competitiveness.

C. To stimulate and support common long-term strategies and research policies for the application of laser-like short-wavelength radiation in science and innovation.

These goals will be reached by achieving **eight main objectives** as indicated in Figure 1.1b and further outlined below. Four of the objectives are related to synergy activities and four are of technical nature. As indicated in Figure 1.1b each of these objectives serves the goals of EUCALL in multiple ways. The experience and know-how of the ensemble of ALL-RIs and their user communities shall be utilized in the activities relating to these objectives.

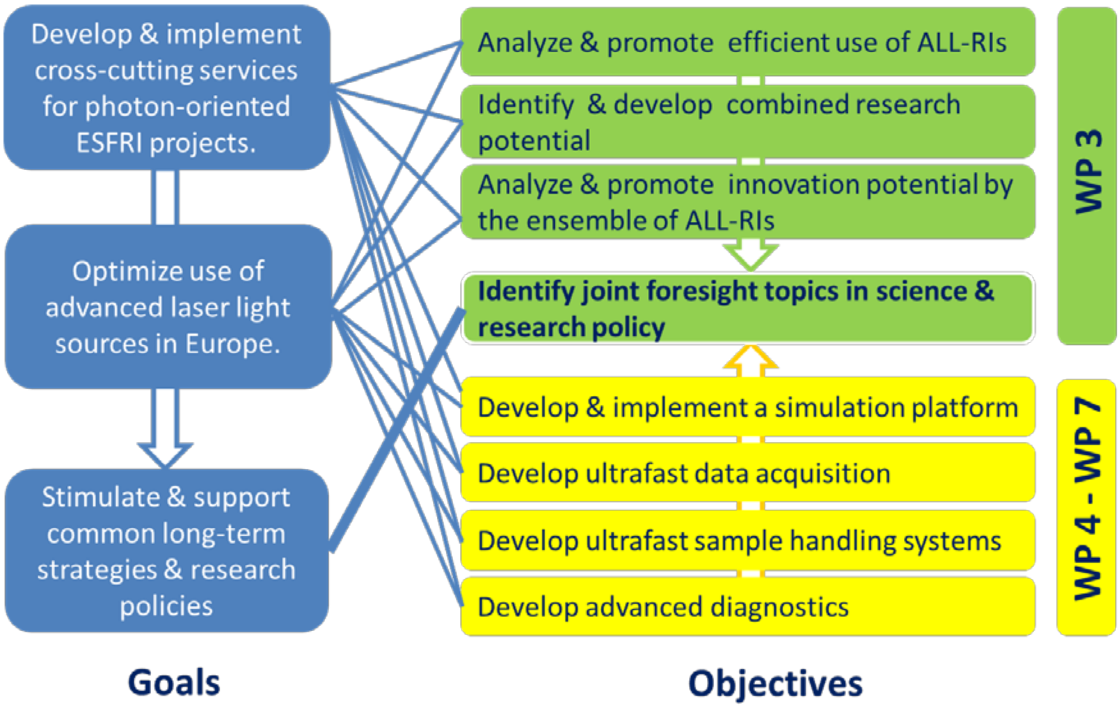


Figure 1.1b: Goals and objectives of the EUCALL proposal. Connecting lines indicate how the objectives relate to the goals. Objectives relating to synergy and technical development activities are indicated in green and yellow and refer to work package WP3 and WP4 – WP7, respectively.

O1 Analyze and promote the efficient use of ALL-RIs

Information on user demand versus availability of beamlines and equipment ("overbooking") will be collected and analysed. Limitations restricting the optimum use of the infrastructures and the optimum response to user demands will be identified. Some of the existing networks have already implemented network-wide access policies designed to address and remove such limitations. Strategies for the removal of limitations, considering the combined portfolio of facilities/beamlines within this project, will be investigated and promoted. Strategies towards a "joint access policy" will be developed and will be practically investigated. Coordinated training of users and management, as a measure to promote strategies for more efficient RI use, will be investigated.

O2 Identify and develop the combined research potential

Information of the research potential versus technical specifications will be compiled into a suitable "super matrix", allowing the identification and analysis of duplications and missing elements, or new research opportunities arising from the combination of offers by different RIs. EUCALL will support, monitor, and analyze prototype experiments based on the combined use of advanced optical and accelerator-based lasers. Here, the employment of state-of-the-art devices with unprecedented specifications on both sides presents significant and new challenges. Best practices will be identified and disseminated throughout the consortium. It will be explored how such initiatives can be better stimulated.

O3 Analyze and promote the innovation potential offered by the ensemble of ALL-RIs

An analysis of the innovation potential of the individual RIs, but more importantly of the potential following from their combination, will be performed and used to develop and recommend strategies for effective exploitation. Developments of specific activities to promote innovative technological and scientific developments will be based on this analysis. Recommendations will be established in collaboration with industry liaison officers of the partners, and including input from the major national and international stakeholders. Finally active promotion of the results among the stakeholders will occur.

O4 Identify joint foresight topics in science and research policy, further strengthening the portfolio of advanced laser light source RIs within the ERA

Involving joint user communities, facility operators, political stakeholders, and funding agencies the identification of foresight topics shall be performed in terms of unique and complementary instrumentation directions, new research opportunities, and novel science and innovation potentials with societal dimension. This new potential is enabled through the (combined) use of the ALL-RIs, and the activities will mainly be performed through workshops and expert round tables involving the respective stakeholder groups.

The next four, more technical objectives are of common and urgent need to the ensemble of ALL-RIs, but also present excellent cases in which the cross-community cooperation of partners with largely complementary background will contribute to find new and original solutions to specific technical challenges. These specific joint development activities therefore serve as first examples for the development of cross-cutting services and the optimization of the RIs addressed by the synergy activities of EUCALL.

O5 Development and implementation of a simulation platform

The challenging scientific goals, the often complex experimental schemes, and the high oversubscription of advanced laser light source RIs—coupled with a user community using different types of experiment installations—require tools to efficiently prepare proposals and experiments, and to enable the best use of valuable facility time. One such tool is to simulate experiments in order to predict or validate experiments and scientific results, or assist in optimally planning the use of valuable beamtime. The development and implementation of a modular simulation platform will enable users and RI operators to create sophisticated simulations of a wide breadth of experiments using the various advanced laser RIs.

O6 Development of ultrafast data acquisition

The high repetition rates of the laser light sources and the need for a most efficient usage of facility time at the RIs leads to the urgent need of higher performance and ultrafast data acquisition techniques. In particular, the inspection of experimental results requires the and analysis of data at the time of collection (online). Given the complexity of data acquisition systems, this leads to the requirement for high-performance computing capabilities close to data taking systems. Furthermore, the bandwidth of data acquisition systems and the need to optimize the use of data acquisition and storage installations leads to a need to validate data as early as possible in the data acquisition chain in order to enable rejection of invalid data. Specific developments address the development of Field Programmable Gate Array (FPGA) and Graphics Processing Unit (GPU) programming as part of the data acquisition chain for online processing of data, quality enhancement, data compression and treatment techniques (e.g. image and pulse analysis, vetoing, selection, correlation), and of high-speed data interfaces and injection techniques to allow online processing and transfer to subsequent analysis and storage clusters.

O7 Development of sample handling and positioning systems

High repetition rate laser facilities offer new possibilities to study laser-matter interaction processes across a wide parameter range and overcome low count-rate limitations. While the light sources provide such high repetition rate, systems for the quick and precise manipulation of samples into the laser beam require urgent attention. Each light source has systems for sample replacement, however, so far no attempt has been made to unify the necessary steps of sample characterization and positioning with the aim of giving external user groups a service for a more efficient conduct of experiments and interoperability between facilities. An integrated concept for decentralized sample characterization and fast sample positioning at the participating facilities will be developed.

O8 Joint development of advanced diagnostics

All ALL-RIs produce intense, ultrashort X-ray pulses whose properties may vary from pulse to pulse. To operate these sources, control the pulse parameters, and perform quantitative experiments it is therefore essential to measure the X-ray light pulse properties shot-to-shot and—if possible—in a way that does not noticeably alter the pulses. The development of suitable diagnostics devices and methodology for the key parameters of pulse energy, shape of the wave front, and exact arrival time is indispensable for all facilities. Techniques originally developed by the two light source communities for different parameter ranges will be adapted to the wavelength range, pulse energies and repetition rates of the individual facilities, and thus made commonly available.

The objectives of EUCALL will be achieved through activities grouped in seven work packages with clearly defined milestones and deliverables, described in detail in Chapter 3. The objectives outlined above have been defined in a way to be realistically achievable during the proposed three-year duration of EUCALL.

1.2 Relation to the work programme

In the frame of EUCALL common solutions are developed supporting the implementation and operation of cross-cutting services for world-class research infrastructures in the domain of advanced light sources. To enable these joint developments and avoid fragmentation, EUCALL gathers the main stakeholders and defines a program and activities building up synergy. EUCALL is a cluster of international and national laser RIs which operate or are being constructed as dedicated user facilities. Through the two networks EUCALL is integrating 29 national advanced laser light source RIs with the three ESFRI projects, see Figure 1.2a. Including the countries participating in the ESFRI projects, in total 18 countries are involved in the project. Furthermore, EUCALL is directly linked to relevant Integrating Activity projects (I3), funded by the European Commission under Framework Programme Seven (FP7), as well as to future initiatives in the domain of advanced light sources. This link is established by the fact that all partners of EUCALL are beneficiaries in either the laser I3 (LASERLAB-EUROPE) or the two synchrotron I3s (Coordinated Access to Lightsources to Promote Standards and Optimization (CALIPSO), "Transnational access and enhancement of integrated Biological Structure determination at synchrotron X-ray radiation facilities" (BioStruct-X)).

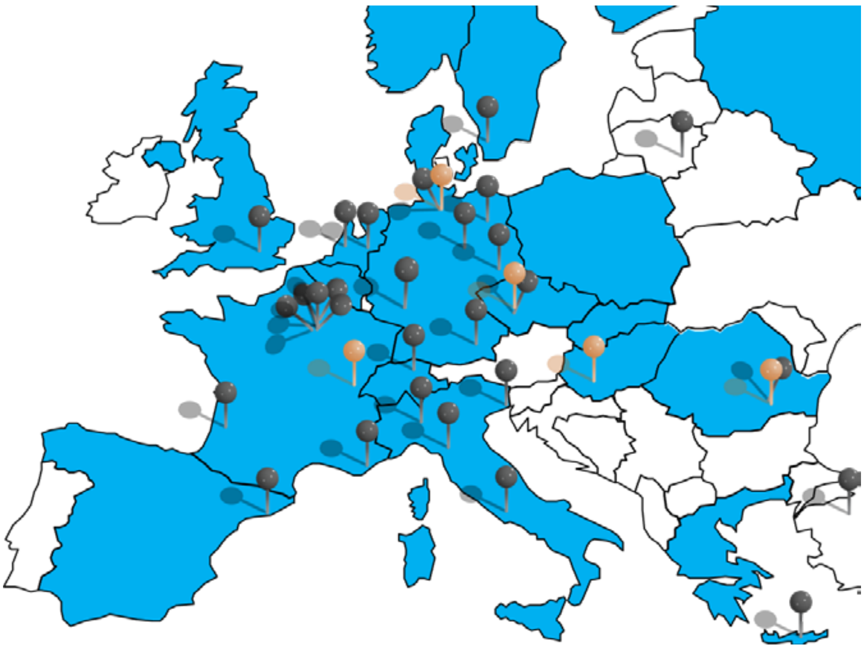


Figure 1.2a: Map of Europe showing the participating ESFRI projects (orange) and nationally operated RIs (grey). Countries benefitting from EUCALL through their partnership in one or several of the international ESRFI projects are highlighted in blue.

EUCALL relates to the INFRADEV-4-2014/2015 topic of the work programme and addresses the specific challenge and scope of this topic in the following way:

- **Coordinating common activities**: EUCALL will address the synergy aspects among the light sources. This task of WP3 includes the analysis, development, promotion and implementation of synergy aspects of the new ensemble of ALL-RIs and their user communities. Furthermore, long-term strategies for research and scientific policies shall be worked out and promoted to decision makers. In addition, through four technical developments, the partners will jointly work on common solutions, likewise avoiding parallel development and diverging results and implementations. Furthermore EUCALL will support and analyze existing initiatives on prototype experiments based on combined optical and accelerator based lasers. EUCALL will also explore how one can stimulate more of such initiatives.

- **Enhance interoperability**: EUCALL will directly contribute to this topic through the joint development of technical and organizational services and their implementation at the RIs. In a first step the possibilities for enhancing interoperability between the advanced laser light sources will be evaluated in WP3.

- **Harmonize policies for access**: Harmonizing access policies is a special challenge taken up by the consortium in WP3 with the aim to develop a strategy to use the portfolio of facilities and/or beamlines most efficiently considering the large overbooking at X-ray FELs.

- **Training of staff managing and operating RIs:** There are several initiatives in Europe which already organize training and exchange of best practices regarding RI operation and management, e.g. RAMIRI and ERF-AISBL. EUCALL will address this issue in a very specific way by organizing workshops for RI staff from instrument operation and management. These workshops will be used to promote new strategies and harmonized procedures established in the frame of EUCALL, e.g. for increasing the RI efficiency through improved user services.

- **Technical innovation with key industry**: Physical large-scale RIs are important technology drivers through their state-of-the-art equipment, technologies and methodologies and through the limited lifecycles and frequent upgrades of their equipment. As a consequence technology exchange interaction with industry as supplier and user is very common and frequently results in the creation of a regional eco-system of academic institutions, high-tech companies and spin-offs in the vicinity of large RIs. This can be observed at existing RIs (ESRF, DESY, HZDR etc.), as well as at new RIs (XFEL, ELI), especially when implemented with the use of European Regional Development Funds ERDF (ELI). EUCALL will analyze the situation and develop strategies for the exploitation of new opportunities arising from clustering of laser-based and accelerator-based ALL-RIs. EUCALL will include input from major national and international stakeholders like EU technology Platform Photonics21.

- **Developing common solutions**: Based on cross-community experience the EUCALL partners will jointly develop common solutions to four common technical challenges in the areas of experiment simulation, ultrafast data acquisition, rapid and accurate sample delivery and characterization of the X-ray pulses (WP4 to WP7). EUCALL will develop and promote the implementation of strategies and procedures to maximize synergy between the advanced laser light sources (WP3). These strategies will directly address the combined research potential, the efficient use of facilities, the enhancement of research opportunities, and the innovation potential.

- **Developing and deploying common technological services**: In particular the developments in WP4, WP6 and WP7 will lead to the generation of new and interoperable services at the RIs. The availability of simulation tools (WP4) and of common sample positioning protocols and standards (WP6) will greatly improve the use conditions of the RIs. The development of well-characterized and standardized diagnostics methods (WP7) is a pre-requisite to providing the respective data as a service to users, thus improving data quality. These services will be available for facility operators and user communities, make the use of the RIs more efficient, and thereby enhance the competitiveness of RIs and scientific research. In WP5 the development of software and algorithms for ultrafast data acquisition will in a similar way be the basis for on-line data analysis tools to be used at the experimenter's level to control the experimental data quality and thereby enabling a significant rise of experiment efficiency.

- **Implementing critical physical components**: EUCALL will directly contribute to the development of instrumentation beyond state of the art for sample positioning devices allowing high repetition rate, of order 10 Hz, and micron-scale accurate positioning devices, including the necessary sample identification, metrology, and positioning software, a technology urgently required for new high power laser installations, both optical and FEL. A second area is the development of diagnostics devices required for the characterization and metrology of the ultrashort, coherent, intense, but also fluctuating pulse properties emerging from these new light sources. In particular in these areas EUCALL provides highly welcomed assistance for the two ESFRI projects ELI and European XFEL in developing instrumentation that is needed by both of them and can be developed most efficiently by utilizing the combined expertise of the laser and X-ray communities.

- **Prepare standardization**: The joint developments of services, software and devices will lead to common solutions that will be implemented by the RIs. Common protocols, e.g. for sample identification and positioning, will already be considered to become a standard. However, the rigorous implementation of standards is not planned at this time. Both, the joint development and the later implementation of these services and components, lead to a harmonization among the RIs, increasing the interoperability of services, devices and data.

- **Solutions for data handling**: EUCALL will develop common solutions for high-performance ultrafast data acquisition in order to make most efficient use of the high-repetition-rate laser light sources. Data management, although a major issue for all ALL-RIs, in particular for the ESFRI projects, will not be addressed directly because, firstly, it would broaden the scope of the project too much and, thus, dilute the main intention of EUCALL to create a cluster focusing on topics specific to the advanced laser light source research infrastructures, and secondly, data management is an important issue affecting a much larger group of research infrastructures which would therefore need to participate EUCALL partners are deeply involved in national and international projects and networks dealing with data management on a broad bases.

1.3 Concept and approach

In Section 1.1, we have defined and briefly introduced the objectives of EUCALL. Here we describe which activities are necessary to reach these objectives most efficiently (Overall concept) and how EUCALL is structured (Overall approach and methodology) to ensure that the activities can be performed efficiently and the cooperation of the different partners works smoothly in order to achieve the proposed tasks, milestones and deliverables. Details on partners, project governance, activities, and deliverables are described in the respective sections of Chapters 3 and 4.

1.3.1 Overall concept

The objectives of EUCALL are most efficiently addressed by a **specifically-tailored cluster**. The participation in the cluster must be broad enough to gather the critical mass required for the development and implementation of joint solutions, while at the same time the selection of activities should be focused enough to enable synergies among these activities to be efficiently used towards achieving the project objectives. Existing initiatives need to be well integrated. This tailoring will, at the same time, limit the number of partners. EUCALL, with its involvement of all ALL-RIs in Europe, international and national, does provide the required critical mass and therefore will be able to move this field an essential step forward. To reach all stakeholders in Europe, EUCALL includes the two established networks of optical laser and FEL light sources.

An important aspect for the success of EUCALL is the interaction with and the **involvement of the user communities** of the participating facilities. EUCALL offers the unique opportunity to address the enlarged group of users of all involved RIs. With the goals to optimize the use of ALL-RIs in Europe, to enhance interoperability, and to ensure global competitiveness, EUCALL relates directly to user community requirements. The interaction with the user communities will be achieved through a number of activities, such as meetings, workshops, and strategy meetings of EUCALL boards. The issue of requirements by the overall user community and possible ways to improve or create new services will be a central topic of these interactions. EUCALL will further establish links to the non-European activities in this field, either by inviting experts to committees, strategy meetings, and workshops, or through the participation of EUCALL partners in collaborations with non-European partners.

The activities in EUCALL are mostly of **synergy and technical development** character. They are performed in the six work packages (WPs), WP2–WP7. Activities under WP3 SYNERGY are targeted towards achieving the objectives O1–O4 and concern the synergy aspects arising from the formation of this cluster. These activities address in particular

- the analysis of the situation with respect to research potential, facility use and user research opportunities, and innovation potential,
- the identification and recommendation of synergies, and
- the development, promotion and implementation of strategies for the optimal use of the ALL-RIs through cross-community exchange, prototype installations and experiments, user training and innovation.

These activities are gathered into one work package, because they are highly interlinked and require a common approach. Therefore, a special Synergy Board (SB) will be created as part of WP3 to work efficiently on this task. By including experts from inside and outside the cluster, the SB will connect to the other work packages, to the RIs, to the user communities, but also to industry and organizations. WP3 SYNERGY is of central importance for EUCALL and for the achievement of many of its objectives. WP2 supports WP3 with respective dissemination and outreach activities.

The technical development activities, directly addressing objectives O5 – O8, are each dealt with in a specific work package, because each of the technical problems is rather different and requires the involvement of different experts inside and outside the cluster. Several links exist between the WPs which are described in the WP descriptions (Table 3.1a). The technical issues addressed are

- the simulation of experiments (WP4 SIMEX),
- ultrafast data acquisition (WP5 UFDAC),
- high repetition rate sample delivery (WP6 HIREP), and
- pulse characterization and control (WP7 PUCCA).

In addition, coordination of the overall cluster is part of WP1.

All activities under EUCALL are jointly approached. This is also reflected in the partner participation in the different activities, respectively work packages, shown in Table 3.3a on page 63. The set of activities is well-balanced between synergy activities, enforcing synergies between the partners, and technical development activities, employing and supporting the complementarity of the partners.

The definition of activities under EUCALL follows the principles of analysis – development – promotion – implementation. These principles will in particular be applied for the synergy activities under WP3, but will also be relevant to the technical developments in WP4–WP7.

Analysis: Collect from the RIs, the relevant communities, and experts information about the status quo and the boundary conditions and requirements, both determined by the RIs and by the user communities. This collection could apply to services provided by the RIs, for example beam time application or dissemination rules, but also applies to the technical solutions, where the start of development involves a thorough analysis of the present know-how and a collection of requirements for development, deployment, and implementation.

Development: In the respective WPs experts will evaluate this information resulting from the analysis of the status quo and will prepare summary and recommendation documents to be used for the further processing. In the technical development WPs this phase also includes working on the technical details and solutions and exchange within the WP (and across the participants) about progress, status, but, and interfaces. These processes already involve significant cross-community exchange between the experts of either community in the WPs.

Promotion: Promotion is a particularly important aspect of EUCALL. The objective to optimize the use of RIs is closely connected to an implementation of common solutions and a harmonization of services. To achieve these targets it will be necessary to promote the results from the development phase intensively at the RIs and user communities. Rather than being a pure dissemination action, this promotion will involve an important interaction between the respective experts of EUCALL. Even if the device or service developed by EUCALL matches the needs of the respective end-users, they might not be interested or may not have the resources to modify an existing system or to implement a new one. The promotion through the experts will enable them to emphasize the additional benefits arising through the implementation of common solutions and is expected to likewise increase acceptance and contribute to a better harmonization of services and instrumentation. One specific promotion activity would be the creation of standards, which will create a high incentive for the implementation of the corresponding service or device. A second one will be coordinated dissemination and outreach activities in particular to address young researchers by providing bursaries to attend ALL-RI related events.

Implementation: Implementation is the final phase of the different activities. Owing to the different nature of developments and results as well as the RIs involved in the developments, implementation of services or devices will take different durations. A long-term collaboration of the ALL-RIs will ensure a sustained process far beyond the EUCALL duration.

All activities under EUCALL are jointly approached. This is also reflected in the partner participation in the different activities, respectively work packages, shown in Table 3.3a on page 63. The set of activities is well-balanced between synergy activities, enforcing synergies between the partners, and technical development activities, employing and supporting the complementarity of the partners.

1.3.2 National and international research and innovation activities

The different partners of EUCALL are participating in a large number of international collaborations and projects. For the success of EUCALL, it is important that knowledge about activities by others, relevant to the involved RIs or to the goals and activities pursued by EUCALL, is made available, analysed, and suitably responded to. For the gathering of information about such activities, several possible channels exist. One channel is established through the participation of one or more partners in such an activity. Another channel could be the formal appointment of a representative of one or several such activities in one of the EUCALL oversight boards, or vice versa through the appointment of a EUCALL representative to the oversight board of another activity. Through these information channels new developments, being in research or innovation, can be brought to the attention of the entire cluster by means of internal dissemination, workshops, and annual meetings. In the oversight boards and the SB, the impact of such developments will be discussed and, eventually suggestions for their integration into the cluster tasks be made.

Only some of the most important of national and international collaborations and projects are mentioned here:

- The hard X-ray FEL facilities in Europe, the USA, Japan, and Korea collaborate in terms of accelerator and X-ray instrumentation development. European XFEL, DESY, and PSI are partners in this collaboration and will ensure information flow from and to the EUCALL partners.

- The Research Data Alliance (RDA) is a global organization aiming towards sharing research data without barriers and was founded in 2012. Some partners of EUCALL are actively participating in RDA. DESY is one of the chairs of a new interest groups which focus on data related issues of science applications associated with large scale source facilities, including e.g synchrotron and free-electron laser X-ray sources, neutron sources, muon sources, and high-power laser facilities.

- ERF-AISBL is a not-for-profit association to promote the cooperation between European-level RIs open to external and international researchers. Members are national RIs or European networks of RIs. So far the members of ERF-AISBL belong to the light source, neutron RI, ion RI and e-infrastructure communities. LASERLAB-EUROPE and many of the EUCALL partners are members of ERF-AISBL. The director of ELI-DC is currently chairing the ERF association.

- Some EUCALL partners participate in PaNdataODI, a FP7 project (PaNdata = photon and neutron data infrastructure) to create a fully integrated, pan-European, information infrastructure supporting the scientific process. As a follow-up of this initiative a new proposal PANDAAS will be submitted to the INFRADEV-4 call, too. PANDAAS addresses the important IT topics data storage and data analysis. The activities addressed by the PANDAAS cluster proposal have no overlap with the activities and tasks of EUCALL. PANDAAS will furthermore establish the link to e-infrastructure initiatives in Europe and worldwide, which will become relevant too. The results results achieved in PANDAAS will be made available to the EUCALL partners.

- PNI-HDRI is a national project on High Data Rate Processing and Analysis Initiative for Photon, neutron and Ion RIs (http://www.pni-hdri.de/). DESY is a leading partner of HDRI and will transfer information about HDRI results to the EUCALL partners.

1.3.3 Overall approach and methodology

The overall approach and methodology of EUCALL supports the cooperation of its partners, being beneficiaries or network partners, in reaching the deliverables of the tasks, in conducting the different activities and in achieving the overall goals of the project.

EUCALL includes partners from both light source communities addressed by this project, and involves them in an equal manner. The eight partners of EUCALL include the three ESFRI projects ELI, European XFEL, and ESRF, and the national RIs are represented by DESY, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Paul-Scherrer-Institut (PSI), Elettra Sincrotrone Trieste (ELETTRA), and Lund University. Lund University and DESY additionally participate on behalf of the LASERLAB-EUROPE and the FELs OF EUROPE networks, respectively. The balanced participation of the optical laser and FEL light source communities is implemented in the cluster by distributing responsibility in equal identical shares. Out of the six work packages for synergy and technical development, three are chaired by institutes belonging to the optical laser light sources and the remaining three by FEL light sources. A further measure to enhance the exchange between and the harmonization of the participating communities is to define for each work package a leader (WPL) and a co-leader (WPC). If the WPL is from the FEL community, then the WPC is from the optical laser community, and vice-versa, thereby involving both participating communities.

The coordination of EUCALL is given to European XFEL being one of the flagship ESFRI projects and having already reached an advanced status of implementation.

The nationally funded ALL-RIs need to be fully integrated into the EUCALL processes and work-flows. This is important to include their experience, know-how, and requirements, but also to include them in the anticipated harmonization measures. These RIs are participating either directly, like DESY, ELETTRA, HZDR or PSI, or they are represented by one of the two networks in EUCALL. These networks take a central role, as they effectively are in charge of representing the respective light sources. The networks will, in particular, contribute to the activities concerning synergy and innovation aspects under WP3. In addition, and to emphasize the importance of the full involvement of the networks, both networks will have a seat in the EUCALL steering committee. Because these networks do not possess the structure of a legal entity, they cannot become a partner directly. Instead, EUCALL includes the home institute of the network chairperson as a partner, acting on behalf of the respective network.

The involvement of the user communities of the ALL- RIs is very important and will be assured through several measures. At the highest level, two user representatives will become member of the EUCALL Steering Committee. These persons shall combine experience with using large-scale optical laser and FEL RIs and shall be nominated following suggestions by the existing user organizations such as the European Synchrotron Users Organization (ESUO), for the synchrotron and FEL community, and an analogous body for the optical laser community. At the level of the work packages, users provide a large amount of additional experience and know-how. In order to include this know-how in the targeted technical developments, the organization of screening workshops is considered as part of the work packages. These workshops will not only allow to screen technical solutions existing in the user communities, but also to re-confirm the requirements set out for the respective developments against the user needs and expectations. The involvement of expert users in the respective developments is a possibility that should be evaluated following these workshops.
In WP3 SYNERGY, users are involved through participation in expert meetings and workshops.
The third level of interactions with the user communities are the training, dissemination activities, and annual meetings offered through EUCALL.

There are two expert boards in EUCALL ensuring a most efficient and coherent execution of the cluster activities.

- The Synergy Board (SB) is part of WP3 SYNERGY and has been described in Section 1.3.1, “Overall concept”. It involves experts from inside and outside the cluster and will be the central instance to analyze the situation and to develop strategies and recommendations. For this the SB, through WP3, will connect to other work packages, RIs, user communities, but also to industry and organizations.

- The Scientific Advisory Board (SAC) is an independent panel installed to advise the Steering Committee, the coordinator, and the work package leaders and co-leaders. It includes experts from the user communities, other relevant RIs, non-European ALL-RIs, and, if available, from industry. This panel will provide advice on developments by the cluster, on priorities and particular conditions, and about new developments in Europe and worldwide.

The interrelation between the work packages of EUCALL is shown in Figure 1.3a. The presentation includes interactions between the WPs due to coordination of activities (WP1), internal communication (WP2), and in synergy and innovation matters. It also shows some of the major exchange channels with the surrounding communities.

The three-year duration of the project was chosen following the expected duration of the different synergy and technical development activities. It is expected that, within a three-year period, significant progress can be achieved in each of the activities, which will make it possible to reach a new level of technology development, to establish evaluation reports, and to make recommendations. These results of EUCALL shall then be used and implemented in a long-term and sustained collaboration of the ALL-RIs.

A kick-off meeting and three annual meetings are planned to allow for an exchange of knowledge and experience. These in-person meetings will enable direct contact and exchange at a level not possible through other means of communication channels. They will be aimed at all cluster participants and further stakeholders in Europe but will also address partners and interested parties worldwide. In addition, targeted workshops will allow addressing specific topics, likewise enabling more focused and in-depth discussion, analysis, and evaluation. For example, it is planned to conduct cross-border workshops to evaluate the harmonization and synergy potential in managerial aspects. In these workshops, experts from EUCALL and from external organizations, both European and non-European, shall contribute.

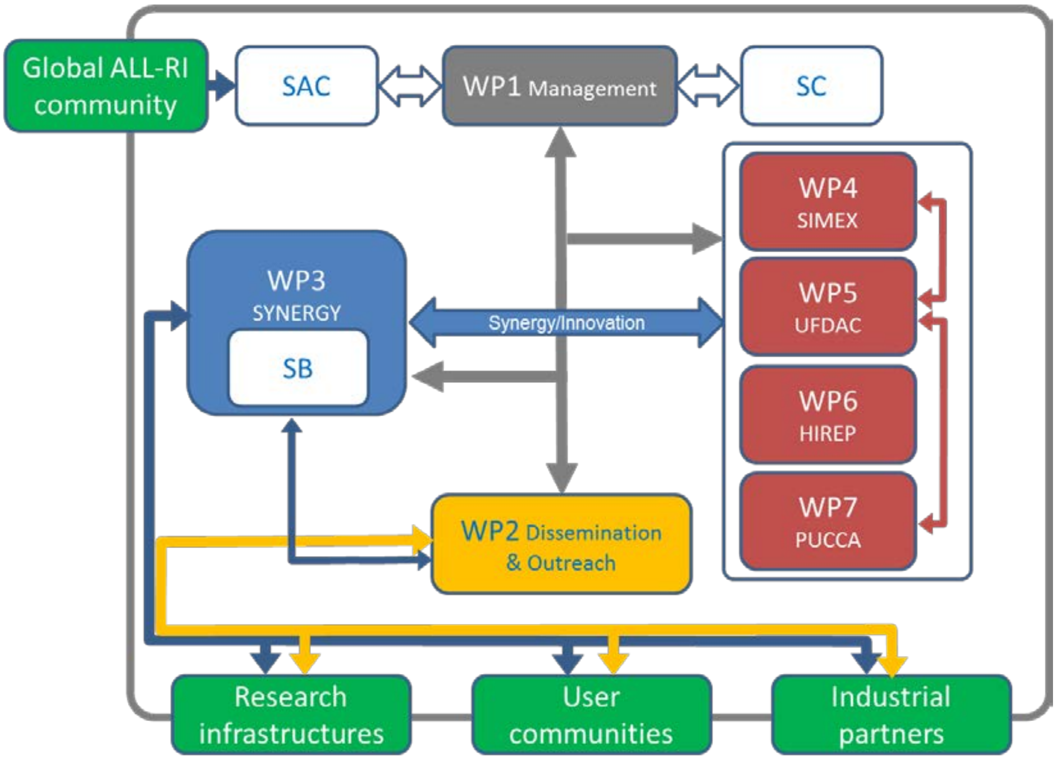


Figure 1.3a: Relation of the EUCALL work packages including major exchange channels with surrounding communities and organizations. SC: EUCALL Steering Committee.

1.3.4 Gender issues

The partners of EUCALL are committed to strengthen the role of women in science and technology. All partners have corresponding rules of procedure in place, and they practice them. No explicit measures exceeding these rules will be attempted as part of the EUCALL project. For all tasks and positions of EUCALL staffing will take place irrespective of sex and gender.

1.4 Ambition

The goals of EUCALL, as outlined in Section 1.1, all represent significant advances of the state of the art. We use these goals in the following to describe some of the major advances and also indicate where these activities are ambitious and how scientific and technological innovation can be expected.

Goal A—**to develop and implement cross-cutting services for photon-oriented ESFRI projects**—refers to the current situation where the involved RIs act rather independently to complete their implementation and to establish efficient and successful operation. For this purpose, the RIs are given the funding to develop, construct, and implement instrumentation, to explore their research potentials, and to establish the adequate user services a RI needs to provide at present. Of course, there exist collaborations among the existing networks and also single point collaborations to external partners, enabling to widen experience and know-how with the aim to achieve better results. However, today no cooperation exists between the communities of optical laser and accelerator-based ALL-RIs in Europe to support a common efficient implementation and successful operation of these light sources together. By developing and exploiting synergies of the different partners' know-how and expertise, joint solutions to common technological and operational challenges can be developed and implemented. Such a cross-community cooperation will provide additional benefit, based on a much wider know-how, and will increase the operational success through a more efficient and improved use of the facilities.

Reaching this goal is ambitious since the involved RIs are in an implementation or operation phase with high load on staff and resources to meet the goals set out by the individual facilities for these phases. The needed technical solutions are at the same time ambitious, in that the technological challenges are significant. Also, the solutions for operational challenges, in particular when it comes to harmonization, are complex and need to include a wide range of operating conditions of the different RIs. Different RIs will have installed specific services fitting their respective needs. To replace or change these services will mean an additional effort for them. The new ESFRI projects ELI and European XFEL have an advantage in this respect, as protocols and procedures are not yet fully defined. For EUCALL and for the reason of resource limitation it is a must to design the activities and deliverables such that they can be performed and achieved with a minimum of effort by the partners, but at the same time advance the state of the art enough to be so attractive that the partners will commit to them. EUCALL has defined its activities and deliverables, but also its budget, such that all partners are enabled to contribute to achieving the EUCALL objectives.

Goal B—**to optimize the use of the ALL-RIs in Europe by efficient resource management, to enhance interoperability, and to ensure global competitiveness**—refers to the current situation of limited resources for research infrastructures and significant variations between different light sources in their services to users and for user experiments. A certain level of harmonization is provided through exchange among each of the two classes of light sources. However, in the emerging situation, in which the ALL-RIs provide science and technology potential for users across the borders of established communities, the interoperability, and eventually the standardization, of services and instrumentation needs to be advanced. EUCALL will contribute significantly to this advance by jointly building instrumentation and services. Harmonization of access rules, sample systems, data formats, etc. will make it much easier for an enlarged user community of advanced optical laser and accelerator-based laser light sources to request beamtime, perform and analyze experiments, and publish scientific results. Bringing these user communities together will nurture the development of new experimental techniques, thus enabling new scientific breakthroughs. In particular, this last aspect is expected to have a significant impact on the overall success and competitiveness of all the ALL-RIs.

The ambition among both light source builders and the respective user communities to use EUCALL for bridging the gap between currently rather separated communities is outstanding. While such an unification would be extremely advantageous for the affected light sources and communities, it has to be realized that the status quo has developed over quite a long period of time and will therefore require some effort to be changed. Examples of already existing cross-community cooperation—e.g. the installation of high power and high energy optical lasers at the European XFEL in the frame of the HIBEF consortium or at ID24 at the ESRF—will be used in this project to demonstrate the advantages and opportunities opening through cross-community cooperation.

Goal C—**to stimulate and support common long-term strategies and research policies for the application of laser-like short-wavelength radiation in science and innovation**— refers to the emerging need to develop long-term perspectives for the ALL-RIs. This is important in order to identify new scientific directions and potential that become accessible through the combination of optical laser and FEL light sources, to develop the technological and scientific requirements for such applications, but also to initiate strategic decisions enabling such developments. These strategic decisions are relevant to the RIs themselves, as they may need to provide resources for such developments, but also to policy makers and government organization, as these may need to include such new directions in their long-term planning or even define funding corridors to keep Europe competitive world-wide.

This goal is ambitious because the long-term forecast for a newly developing field of science and technology is more difficult to establish. There is a risk that the full potential provided by this new field may still be hidden by challenging technology issues, limiting to reach the full potential of the relevant RIs and their science and technology output.

The **innovation potential** offered by EUCALL arises, in particular, from the new cooperation of the two types of advanced laser light source RIs in Europe, i.e. optical laser and accelerator-based light sources. One can distinguish three classes of innovation potential. These different types of innovation will also be explored as part of WP3 SYNERGY.

A first innovation potential arises from the exchange of experience among the EUCALL partners with respect to innovation and how to best support innovation. All partners are making more or less dedicated efforts to support innovation and have made their experiences with this task. EUCALL offers a platform to collect and exchange these experiences and to work jointly on concepts for how to improve the conditions for innovation at the participating facilities but also within the consortium as a whole. The development of a common concept for innovation responds to the issue of limited resources at the partner sites to address this topic.

A second innovation potential arises from the new science and technology opportunities opened by the combination of optical laser and X-ray technologies and scientific applications. New scientific applications and their results provide the grounds on which new products can be invented. Through the combined science and technology potential opened by EUCALL, the development and introduction of new products or protocols will be facilitated. This process will require the interaction with the private sector, as the participating RIs generally do not have the means to carry out such development.

Examples could be contributions to the development of new energy harvesting or magnetic materials, or to the development of plasma-based ion accelerators to be used in medical therapy.

A third innovation potential arises from the specific results obtained through the joint technical developments included in the EUCALL project. In particular, the developments to be achieved in UFDAC (WP5) and HIREP (WP6) bear a significant potential for ultrafast data recognition and analysis, which is also an emerging topic for industrial applications, and for precise and high-speed sample positioning systems, where products might be supplied by private companies. It would, however, be too ambitious to describe, as part of this proposal, products or services coming directly out of this project.

2 Impact

2.1 Expected impact

The EUCALL proposal is the beginning of a completely new level of collaboration between the two types of advanced laser light sources in Europe. Through the comprehensive cooperation it will support the ongoing implementation of the involved ESFRI projects and prepare the grounds for a most efficient and comprehensive exploitation of the enormous research and innovation potential of the whole ensemble of advanced laser light source installations in Europe.

EUCALL will contribute to the expected impact set out in the work programme as follows:

Contribution to the realisation of the Innovation Union flagship initiative's Commitment** n. 5: "to complete or launch the construction of 60% of the ESFRI projects by 2015"; **saving of resources

The joint development of technical components and solutions that are required for all facilities will make sure that the complementary know-how existing in the consortium is shared and the most suitable solutions are implemented at all facilities in an efficient way. Together with the actions planned to develop, promote, and implement strategies towards optimum combined use of the ALL-RIs, including user operation, harmonized access policies and training, this work will support the efficient implementation and start of user operation of the ESFRI facilities. As all these activities promote efficiency, they will also contribute significantly to saving resources.

*Common ready-to-use services, systems, standards or other types of components will be made available to the involved research infrastructures initiatives, including the non-ESFRI projects, thus contributing to the **development of a consistent European research infrastructures ecosystem**.*

It is the intention of the project to initiate a comprehensive cooperation in all relevant areas of common interest, including technology development, science applications, optimum use of the cluster RIs, harmonized access policies and optimum exploitation of their science and innovation potential. In addition, the cluster consortium is well-defined and comprises all European ALL-RIs and the associated networks. Therefore EUCALL will have a strong impact on the development of a consistent European RI ecosystem in this field, extending even beyond into and connecting with the wider optical laser and synchrotron radiation RI networks.

Interoperability *between research infrastructure services, including data services,* ***enables novel research*** *leading to innovation and new insights;*

Interoperability of EUCALL RIs is a specific goal of WP3 SYNERGY in order to use the complementary ensemble of RIs in the most efficient way. In addition, the technical work packages will considerably enhance interoperability by developing standard solutions for the simulation of experiments, sample handling, data services and photon diagnostics. This will enable researchers to use a combination of different instruments and services at different RIs for their research without significant additional effort, thus widening the research potential and leading potentially to novel applications and innovation. At the same time, it will lead to a merging of the traditional user communities and, together with other measures planned under WP3, to the attraction of new user communities and a higher success rate of their new projects.

The efficiency and productivity of researchers rise thanks to an ***easier and seamless access to complementary services provided by different infrastructures*** *and/or to reliable and open data services and infrastructures for discovering, accessing, and reusing data;*

The comprehensive approach to interoperability of the facility services throughout the EUCALL RIs together with harmonized access policies and common strategies for enhancing and optimizing complementarities of the characteristic features of the RIs and the experimental stations and services they provide, will dramatically enhance the efficiency and productivity of researchers and, hence, ensure the most efficient use of the ensemble of RIs.

Improving innovation capacity

As described above, improved interoperability between the different RIs and their services will considerably enhance the capacity for research and potential innovation. One Task of WP3 focuses specifically on strategies how to exploit the research for innovation, based on experience available in the consortium. This will result in a more efficient transfer of research results to commercial products and services and will also enhance the level of support for and cooperation with industry.

Other important impacts

The comprehensive cooperation attempted by the EUCALL project is unprecedented in the world and will significantly contribute to Europe’s competitiveness and leadership in terms of research and innovation capacity.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

Dissemination and outreach is an important measure for the success of the clustering of the ALL-RIs and to raise awareness for the scientific potential of this cluster in the European research area. WP2 takes care of these activities in concert with the Synergy Board of WP3, in particular when it comes to the promotion of strategies and results of WP3. EUCALL defined a dissemination and exploitation plan outlined in Table 2.2a.

Within the new cluster of ALL-RIs, including all partners of the networks LASERLAB –EUROPE and FELs OF EUROPE, it is important to define a joint identity and operate an appropriate project website. Therefore, right at the beginning of the project an identity package with a logo and templates and rules for presentations of project activities will be worked out. Developing the project website has to consider the existence of the websites of the single RIs, the two networks, as well as the website operated by CALIPSO. EUCALL will take care of this and evaluate which information shall be disseminated via the EUCALL website to support the overall objectives of the cluster.

EUCALL will promote the project goals and results via the project website, at appropriate scientific conferences and workshops, at user workshops of the participating RIs, and will organize targeted events to raise the awareness for the broad scientific opportunities by the ALL-RIs. This promotion is of high importance to achieve a broad support by the scientific community for this joint effort.

To attract young researchers to the science and research of ALL-RIs bursaries shall be provided for attending selected workshops, conferences or special trainings organized or supported by consortium members. European XFEL has been very successful with a young scientist bursary program related to its annual user workshop. Another example to implement this tool is the Science@FELs conference, regularly organized by FELs OF EUROPE. In combination with the summer schools, run by many partners, EUCALL will employ such opportunities to address young researchers as potential future employees or users.

EUCALL will prepare targeted dissemination material on joint opportunities of ALL-RIs for policy makers and the general public, in particular for young people. DESY has good experiences developing such material with students of the University of Hamburg and by soft skill trainings of young scientists on dissemination of scientific results. All partners of EUCALL as well as the networks have many years of experience with and sizable capacities for dissemination of science. EUCALL will take advantage of this experience and capacity. EUCALL will promote the exchange of experiences within the consortium and develop a common strategy for dissemination activities which either integrate and enrich existing activities or go beyond. Moreover, it will pursue the adaptation of this common strategy by the individual partners.

The large consortium of EUCALL has the unique advantage of being able to provide a comprehensive overview of the innovation potential of laser technology and to identify best practices. One example of a successful exploitation of technology initially developed for RIs is the Alliance for MTCA (Micro Telecommunications Computing Architecture) in Research and Industry (http://mtca.desy.de). Within this alliance of developers, users, module manufacturers and system integrators from industry and research centers of the Helmholtz Association jointly develop MCTA. The MTCA standard has gained popularity as a compact, versatile and cost-efficient alternative wherever ultra-high speed analog and digital signal processing is required. Exploiting the innovation potential of joint technical developments is a special task within WP2 and WP3. Within WP3 a joint strategy and measures will be defined based on the long-standing experiences of the participating RIs. The Synergy Board (SB) of WP3 will develop these exploitation measures towards industry in close assistance with the techno-logy transfer offices of the partner institutions and WP2 will provide support to implement them.

Scientific exploitation of the project's results will be supervised by the EUCALL Executive Board.The consortium intends to take advantage of the project results to improve the attractiveness of their research activities for engineers, PhD students and postdoctoral researchers fostering their scientific interest towards laser technology in general and specifically towards the technical fields of WP4 to WP7. The new knowledge gained in those fields will be disseminated through advanced courses at graduate level, training events and seminars, taught by participants of the project. The consortium supports the strategy of open-access for publication of project results and royal access to research data generated during the project for all partners. Details will be set out in the consortium agreement.

2.2.2 Communication Activities

Communication is essential in EUCALL for building synergy and trust between the broad range of RIs. The ESFRI projects as well as the networks have long-standing experiences managing communication across different cultures and to various audiences. EUCALL will benefit from this.

WP1 and WP2 will support and ensure efficient internal and external communication between EUCALL partners, their users and the relevant international RI communities (see also Figure 1.3a). The following communication tools will be used to address the different audiences listed in Table 2.2a:

- Project public website
- Intranet collaboration workspace
- Project mailing lists
- Newsletters of the community
- Social media channels (e.g. YouTube, Twitter)
- Open meetings and events
- Leaflet

The EUCALL website as well as the newsletters of the two networks and those of the partners will be important communication channels. EUCALL will evaluate where synergy among the various communication channels shall be strengthened. Furthermore, the executive boards of the networks as well as those of the ESFRI projects are important communication platforms, in particular for strategy and policy matters.

EUCALL will ensure that information about outreach activities and material like schools, videos, special outreach events, but also scientific or technical workshops and conferences organized by one of the consortium partners or which are of interest to the consortium, is available to all partners. EUCALL reinforces the opening of workshops and conferences across the two communities.

Within the EUCALL consortium there are various channels to communicate with users. The most direct channel is the immediate connection between each individual user and the individual RIs that he/she is using for his/her research. Other well-established communication channels are those of the European wide networks LASERLAB-EUROPE, FELs OF EUROPE and CALIPSO, as well as through the European Synchrotron User Organisation (ESUO) which is a communication channel to more than 10000 users of synchrotrons and FELs from all over Europe. EUCALL partners are very active within these networks and therefore EUCALL will make use of these channels. EUCALL will establish links to users who could benefit especially from the combined optical and accelerator-based lasers. Users representatives in the EUCALL SC can monitor the success of these activities.

EUCALL provides a solid basis for extensive global networking. Many of the EUCALL partners have cultivated close international collaborations to similar RIs in the US, Japan and elsewhere. For example, facilities outside of Europe have gladly contributed news articles to the newsletters of the two European networks. The management structure of EUCALL will support active participation of representatives of those facilities as members of the Sscientific Advisory Board.

Table 2.2a: Overview of EUCALL dissemination and communication activities

Target group	Type	Identified needs	How to reach them	Expected outcome
Project members (individuals)	Internal, scientific and administrative contacts	Project information, participants, contacts, events, results, deliverables, outreach materials	Website, mailing lists, Intranet, telephone/ video conferences, project meetings	Enhanced connectedness, greater efficiency, heightened motivation
Young scientists	PhD students from all scien-tific fields, in particular laser technology	Papers, information on the project and participating RIs	Fellowships to attend selected workshops/ conferences of the consortium, summer schools & training courses of the partners, social media	Raising interest for the scientific field of the project as future working area
User communities	Scientists from all scientific fields e.g. previously used synchrotrons, lasers, neutron sources	Information on project, contacts, research potential, access policy, technical	Website, project meetings, special workshops, papers, dissemination channel of ESUO, user representatives in EUCALL SC and of participating RIs	Two-way information on research potential and need, enhanced connectedness, greater efficiency
General scientific and research communities	Scientific, non-project community	Information on the project, contacts, events, papers, joint events	Dissemination channels of partners and LASERLAB-EUROPE, FELs OF EUROPE, and via wayforlight.eu, open events, conferences, publications	Identifying common challenges, sharing knowledge, future collaboration
Industry	R&D activities and/ or project related products	Papers, information on technologies being developed by the project	Website, workshops	Two-way knowledge exchange, technology transfer and procurement
Policy stakeholders	Responsible for ESFRI projects, RIs, laser R&D programmes	Recommendations, information on state-of-the-art, foresight topics, summary of results	Newsletters, general public web-site, leaflet, workshop	Confirmation that investment in public research is paying off; paving way for future projects
General Public	Of any kind, including school children and students	General information, how laser light sources are relevant to daily life	Website, new media tools (e.g. social media), leaflet, public talks	Societal impact of the project, knowledge that fundamental research can benefit everybody

3 Implementation

3.1 Work plan—Work packages, deliverables, and milestones

EUCALL is organized in seven work packages, each having specific tasks, deliverables, and milestones. Figure 3.1a shows the work packages and their interconnection. The joint technical development work packages have been put together in one block of activities, as their scope and integration into the overall cluster is very similar, at least from an organizational point of view.

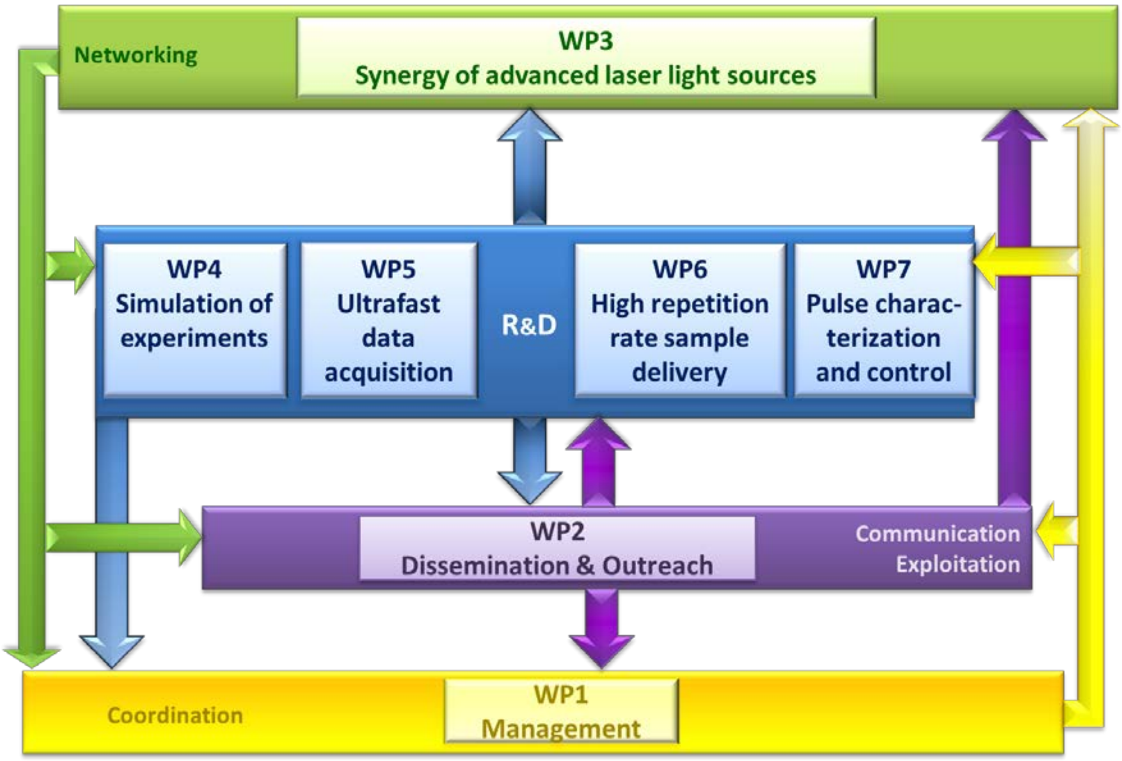
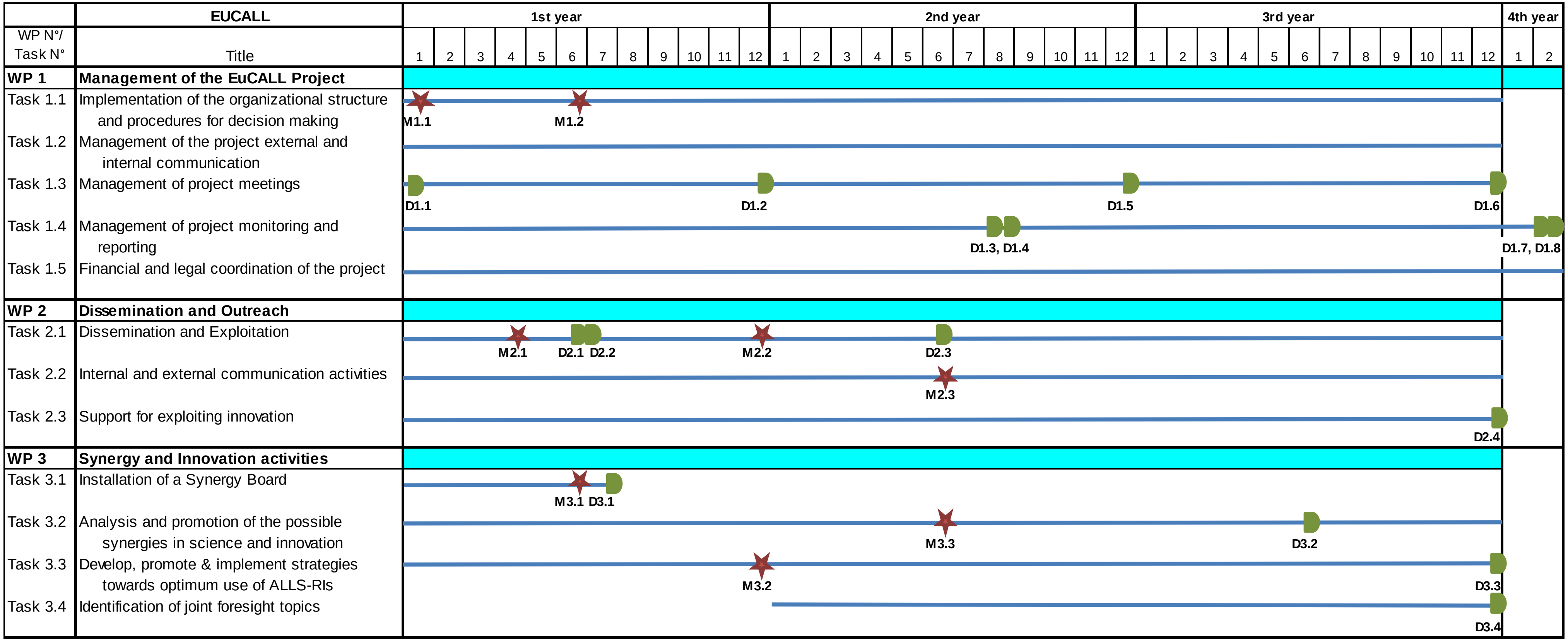
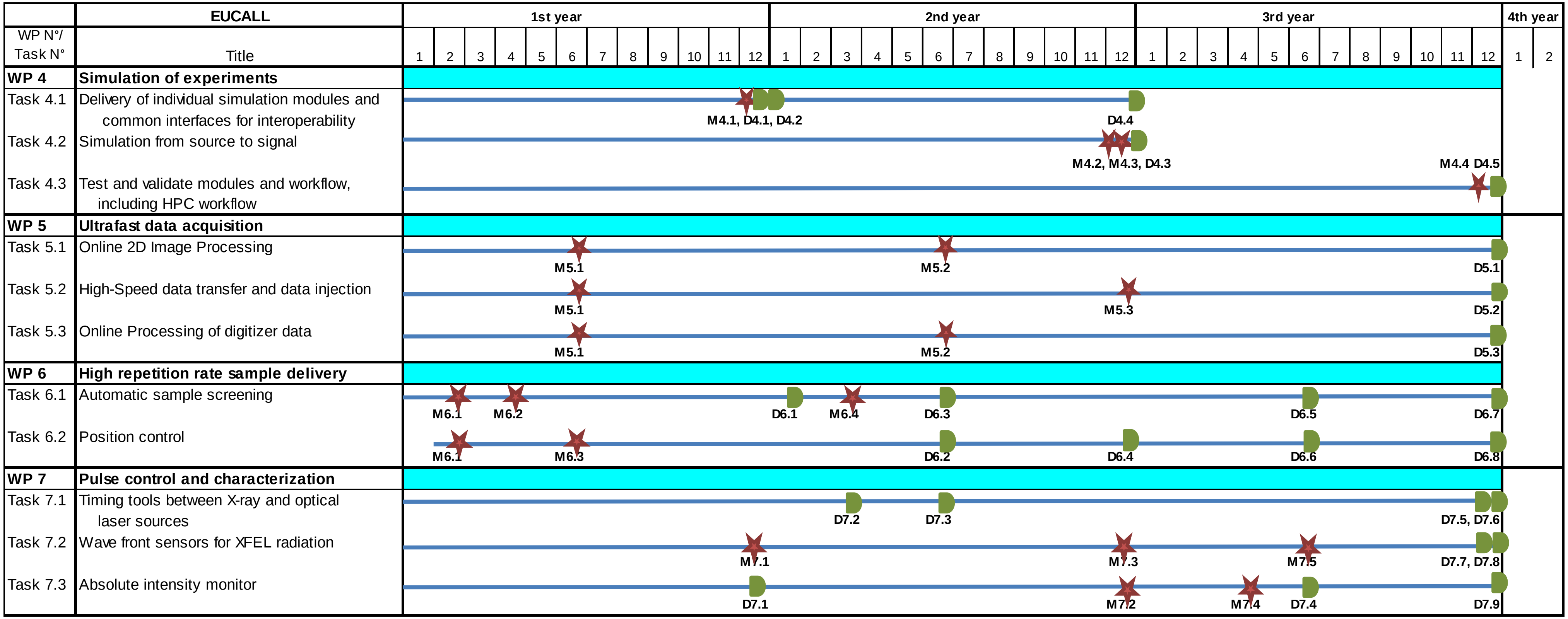


Figure 3.1a: Graphical representation of the interconnections between EUCALL work packages

Gantt chart for the work packages



Gantt chart for the work packages (continued)



3.1.1 Work package descriptions

Description of work: WP1 – Management of the EUCALL project

Task 1.1: Implementation of the organizational structure and procedures for decision making

- To set up and maintain the organizational structure, including the nomination of the Executive Board
- To define and implement the relevant processes for a timely provision of all necessary information and materials to facilitate the Executive Board decisions and management tasks
- To draw up the project document templates

Task 1.2: Definition of the communication infrastructure and processes

- To ensure smooth information flow to and from the European Commission (EC)
- To establish and maintain a dedicated web platform for EUCALL internal communication to host the project website as well as the project documents for meetings and telephone conferences in order to ensure the smooth implementation of the work and to maximize interactions and synergy activities across the work packages

Task 1.3: Management of project meetings

- To organize and draft the documents of the kick-off and annual meetings of the whole consortium to be hosted by varying partners of EUCALL
- To organize and draft the documents of the Steering Committee and Executive Board meetings
- To organize the Scientific Advisory Board meetings and support its work related to administrative, financial, and legal issues

Task 1.4: Management of project monitoring and reporting

- To continuously monitor the project performance through the reception of requested regular updates on the project progress and the meeting of milestones and deliverables
- To collect all contractual deliverables and financial reports and to ensure their compliance with the terms of the Grant Agreement
- To draft and review the periodic reports and the final report

Task 1.5: Financial and legal coordination of the project

- To advice partners on financial and legal issues as well as to follow-up on updates to EU regulations and rules
- To regularly administer the EC financial contribution and the project budget

- To prepare, coordinate, and control the financial statements and certificates submitted by EUCALL partners as well as to set up the financial reports based on the financial statements

- To follow-up on EC payments and ensure the timely distribution to partners

Description of work: WP2 – Dissemination and Outreach

Task 2.1: Dissemination and Outreach

- To establish and communicate to partners the “identity package” of the project, including the logo and the templates for PowerPoint presentations and posters

- To operate and update the EUCALL project website

- To prepare targeted dissemination materials on the joint opportunities of the ALL-RIs for policy makers, industry, and the general public, in particular for young people (special website, leaflet)

- To participate in events targeting the general public, with the aim of cultivating positive attitudes among young people, particularly among girls, towards laser technology and science

- To participate in and/or organize events targeting the industry to raise its awareness of the potential of ALL-RIs for its activities as users as well as suppliers or collaborators to exploit innovative technological developments together with the laser RI community

- To promote the project in the scientific community (e.g. at conferences and relevant schools for Ph.D. students and postdocs, organized by the involved laser RIs), providing dissemination material, giving lectures.

- To provide bursaries to targeted young researchers to attend trainings, workshops or conferences performed or supported by consortium members.

- To support the exploitation of the project’s results

Task 2.2: Promotion of communication activities

- To support the Synergy Board of WP3 in spreading requests, results, and information to a broader audience than the EUCALL partners; this implies close collaboration with the network managers of LASERLAB-EUROPE and FELs OF EUROPE and further initiatives in Europe or beyond

- To establish a communication platform between facilities and users based on the recommendations of the SB of WP3

- To support work packages in organizing workshops, for a wide range of participants targeting neighboring and international communities

- To support the work packages in organizing exchange of experiences (e.g. between staff of RIs and by training events)

Task 2.3: Support for exploiting innovation

- To communicate the strategy on promoting innovative technology and science developed under WP3 internally to the technical development work packages and to the appropriate contact persons of the EUCALL partners

- To provide support to implement the exploitation measures developed under WP3

Description of work: WP3 – SYNERGY: Synergy of advanced light sources

Task 3.1: Installation of a Synergy Board (ELI)

A Synergy Board (SB) will be set up to advise and support the Work Package Leader (WPL) and Work Package Co-Leader (WPC) in performing the tasks of WP3 (e.g. defining the criteria of analyses and actions). The SB members shall be balanced between both communities, and shall have long-term experience in operating laser RIs. The SB will consist of:

- WPL and WPC
- One representative each of the two infrastructure networks
- Up to five representatives nominated by the optical laser, FEL, and synchrotron RIs involved in EUCALL

The SB shall be chaired by the WPL. Its members shall be appointed by the EUCALL Steering Committee upon nomination by the WP partners. It shall develop its own terms of references, which shall be approved by the EUCALL Steering Committee. Ad hoc members (e.g. users or WPLs of the technical WPs) may be invited for certain tasks if needed.

Task 3.2: Analyse and promote possible synergies in science and innovation (all)

Task 3.2.1: Analyse the combined research potential of the facilities involved in EUCALL

The matrices of research potential (scientific applications) versus technical specifications of planned and existing individual RIs are largely known (e.g. from their science cases). They will be collected and compiled into a suitable “super matrix”, allowing the identification and analysis of duplications and missing elements, or new research opportunities arising from the combination of offers by different RIs. The analysis will include, to the extent possible, data from international RIs for an assessment of the international scientific competitiveness of the ERA in this field.

Task 3.2.2 Analyse the potential for more efficient use of the facilities and optimization of user research opportunities

In addition to the above, information on user demand versus availability of beamlines and equipment (“overbooking”) will be collected and analysed. Limitations restricting the optimum use of the infrastructures and the optimum response to user demands will be identified. Some of the existing networks from both communities have already implemented network-wide access policies designed to address and remove such limitations, and to develop synergies through standardization and optimization (cf. LASERLAB-EUROPE in http://www.laserlab-europe.eu, or CALIPSO in http://www.wayforlight.eu).

The data collected in the “super matrix” (Task 3.2.1) will be incorporated into the www.wayforlight.eu database. The outcome will be that ELI and (selected) Laserlab-Europe instruments can be found on this public Wayforlight database, while properties of optical lasers at FEL and synchrotron instruments will be better and more completely presented in a standardized format. This will allow standardization and harmonization of the presentation of characteristics of all kinds of ALL-RI light sources, and provide users with simpler access to finding the most suitable facility/instrument for their particular experiment.

The Wayforlight database will be further upgraded to incorporate the functionality that RI Operators can enter their instrument's data into a new standardized database interface, which can then be automatically updated to both the Wayforlight database and to the RI's own website.

Furthermore the development of simulation models for experiments as they are developed in WP4 will be an important tool in preparing user experiments efficiently. The task will involve discussing with beamline scientists, facility managers, and experienced users how best to overcome those limitations on a larger scale across the two communities. Strategies considering the combined portfolio of facilities/beamlines within this project will be developed and recommended as a basis for Task 3.3.3.

Task 3.2.3: Analyze the innovation potential of the ensemble of different RIs combined in this project

Although the mission of the individual RIs involved in this project is largely focused on fundamental science, their existing and future scientific output contains a multitude of short- and long-term applications of societal and industrial relevance. Secondly, large RIs are important technology drivers by themselves through their state-of-the-art equipment, technologies, and methodologies, and through the limited life cycles and frequent upgrades of their equipment. This is particularly true for laser-based RIs. Thirdly, they can directly support innovations by offering research opportunities to industrial users. All this frequently results in the creation of a regional ecosystem of academic institutions, high-tech companies, and spin-offs in the vicinity of large RIs, as can be observed in existing RIs (ESRF, DESY, HZDR. etc.) as well as in new RIs (European XFEL, ELI), especially when implemented with the use of European Regional Development Funds (ERDF), as is the case with ELI.

The present task shall analyse the situation and innovation potential of the individual RIs of this project, and develop and recommend strategies for the exploitation of new opportunities arising from the cooperation between accelerator-based and laser-based advanced light sources.

Task 3.2.4: Identify and recommend possible synergies

Based on the above analysis, as well as on the experiences within the technical work packages (WP4 to WP7) and within WP2 on external communication activities, the SB will identify and work out recommendations on possible synergies and long-term collaboration.

Task 3.3: Develop, promote, and implement strategies towards optimum combined use of advanced laser light sources (all)

Task 3.3.1: Cross-community exchange of know-how and experience

Technical know-how and experience across borders between facility operators and user groups shall be exchanged in dedicated staff workshops and user meetings.

Task 3.3.2: Studying prototype experiments based on combined optical and accelerator-based lasers

HIBEF: The Helmholtz International Beamline for Extreme Fields at the European XFEL (HIBEF), a consortium of 80 research teams from 16 countries, proposes a facility for high-power and ultra-intense optical lasers, as presently being implemented at ELI, and high field pulsed magnets, in conjunction with the high energy density (HED) scientific instrument at the European XFEL. Scientifically, it represents a worldwide unique combination of research capabilities arising at the intersection between disciplines including hard X-ray science, high power laser and plasma physics, materials research using strong magnetic fields, and geo-science and planetary research at high pressure, to name only a few.

Lasers at ESRF: ESRF collaborates with various laser laboratories in France and the UK to develop a laser device to be implemented on several X-ray beamlines in order to study dynamically compressed matter and warm dense matter at local thermal equilibrium. This experience will be transferred and used at X-ray FELs, too.

Table-top FELs at DESY and ELI: The ELI Beamlines facility in the Czech Republic, in collaboration with similar efforts at DESY, develops laser based table-top vacuum-ultraviolet free-electron laser (VUV FEL) sources for the combined use of tunable VUV and optical laser light. Although the facilities will not commence operation before 2018, the respective user communities are already designing and developing experiment stations and research programs.

EUCALL will support, monitor, and analyse such initiatives. There is, so far, limited experience in the initiation, management and operation of joint experiments from both communities. Early initiatives from the late 1990s installing femtosecond lasers at synchrotron beamlines for novel pump–probe studies exhibited technical challenges due to synchronisation, duty-cycle mismatch, data acquisition techniques and detectors, laboratory environment issues, and others. Many of these problems have been overcome in the meantime, but the employment of new state-of-the-art devices with unprecedented specifications on both sides presents new challenges. Best practices will be identified and disseminated throughout the consortium. WP3 will explore how such initiatives can be better stimulated.

Task 3.3.3: User training, facility operation, and access principles for efficient use of ensembles of complementary laser facilities

Efficient use of beamtime at highly overbooked facilities requires a variety of measures. Individual facilities have developed a balanced portfolio of facility operation practices, access policies, and user involvement and training. Optimizing the efficient use of an *ensemble of complementary facilities* adds new degrees of freedom, opportunities and challenges. Strategies towards a “joint access policy” will be developed in Task 3.2.2, and will be practically investigated here, following the examples of LASERLAB-EUROPE and CALIPSO, including the involvement of user organisations like the European Synchrotron User Organisation (ESUO, www.ESUO.org). Coordinated training of users and improved preparation of complex experiments is a crucial element for high-throughput user facilities, and has proven highly successful in networks like LASERLAB-EUROPE and CALIPSO. This task will develop schemes for user training from the respective “other” community, utilizing e.g. training opportunities at suitable synchrotron radiation or laser facilities.

In addition, it will organize workshops to develop concepts for best-practice management of cross-community research with facility managers. They will, in particular, evaluate where common standards for interoperability are needed and promote their implementation.

Task 3.3.4 Promote innovation

Based on the analyses of the innovation potential in Task 3.2.3 this task will develop and recommend specific activities to promote innovative technological and scientific developments. The recommendation will be developed together with the industry liaison officers of the partners, and include input from major national and international stakeholders like the EU Technology Platform Photonics21 (a PPP under Horizon 2020) and national organisations like the Fraunhofer Gesellschaft (Germany). Active support on promotion will be provided under WP2.

Task 3.4 Identify joint foresight topics (all)

Based on the work being carried out throughout the cluster, this task shall identify foresight topics addressing and involving the following stakeholder groups:

- Joint user communities of optical lasers and accelerator-based X-ray lasers
- Facility operators from both research areas
- Political stakeholders and funding agencies, recognizing new research opportunities for their scientific communities, innovations, and societal applications through the exploitation of synergies between the two research fields

a) For the *user communities*, the foresight activities will concentrate on the identification of new research opportunities through the combined use of optical lasers and accelerator-based advanced light sources, and the development of new detection and data collection techniques.

b) For the *facility operators*, the focus will be on the development and implementation of combined laser- and accelerator-based light sources, experiment stations, detectors and data acquisition, and the sharpening of the scientific profile and uniqueness of the individual RIs in the context of global competition. It will also include the development of appropriate access policies for research that require the use of different but complementary facilities to succeed. Finally, for the EUCALL cluster as a whole, including the ESFRI projects as well as the other RIs and networks, the task will identify the potential for a sustainable existence after the EC funding.

c) For the *political stakeholders and funding agencies*, the focus will be on novel science and innovation potential through the combined action of the two scientific communities involved, and on novel applications of societal importance like health, energy conservation and supply, environmental protection, climate, mobility, and others. Foresight in this area also includes the provision of a basis for future funding decisions for the respective national and pan-European facilities.

The foresight activities and recommendations will be mainly developed in workshops and expert round tables involving the respective stakeholder groups.

Description of work: WP4 – SIMEX: Simulation of Experiments

The development and implementation of a simulation platform is based on contributions by all participating partners. European XFEL is coordinating this WP due to its extensive previous work in this area. Three major tasks have been defined within this WP. The first addresses individual modules to simulate specific physical processes relating to parts of the overall experiment. Here, the different partners enter with their core expertise and can address specifically their problems and applications. Planned contributions are modules for imaging of weakly scattering biomolecules (European XFEL), of density modulations following laser–matter interaction (HZDR, ELI), and of dynamically compressed matter similar to planetary cores (ESRF). Additional modules addressing different problems could be created by further RI operators or users groups inside or outside EUCALL. The modules are connected via a common interface protocol. This protocol allows the integration of modules from different sources and with differing purposes into the overall platform. A second task is to apply the platform, first to example cases and later to generalized problems. The third task concerns the technical implementation with eventually large compute requests and a modular structure of the software. All of these tasks are explicitly open to additional contributions by users or further RI operators. The WP makes explicit use of the specific know-how and background by the different RIs to include modules reflecting the physical properties encountered in these specific conditions. Likewise, this expertise will become available to all RIs and for the user programs. Open-source programming makes this effort accessible to the user community and the output of these simulations–modeled scattering data can also be used for testing or benchmarking the algorithms developed in WP5 (UFDAC). Innovation aspects include the commercialization of these simulation tools and the commercialization of hardware solutions.

Task 4.1: Delivery of individual simulation modules and common interfaces for interoperability (all)

Different "modules" of simulation are required for a "source to signal" simulation, including numerical propagation of radiation, description of the photon–matter interaction (in different physical regimes), and the scattering of radiation from a sample to a detector.

Task 4.1.1: X-ray optics and beam propagation (XFEL, ESRF)
Simulation of coherent and partially coherent X-ray beams propagating through X-ray optical systems to produce accurate estimates of the focal spots of such systems, including the structure of these focal spots.

Task 4.1.2: Sample-photon interaction (XFEL, HZDR, ESRF, ELI)
Sample-photon interaction: Simulation of the sample-photon interaction and the diffraction signal that different samples (single particles, nanocrystals, plasmas–including atomic physics processes) produce from such interactions with both longer nano-, and pico-second pulses, as well as shorter femto- and atto-second pulses.

Task 4.1.3: Scattering signal simulation (XFEL, ELI)
Calculation of ideal scattering signal from a sample as described in Task 4.1.2.

Task 4.1.4: Detection (all)
Investigation of the processes involved in full simulation of advanced X-ray detectors for future workflow integration.

Task 4.2: Simulation from source to signal (all)

Task 4.2.1: First example (XFEL, all)
An initial example simulation using one source model, one propagation module, one type of photon–matter interaction and one type of scattering model is a necessary step in the definition of intermodule interfaces and as a precursor to a generalised simulation. For this first example, an X-ray free-electron laser source, focusing X-ray optics, a photon–matter interaction with a biomolecule and an ideal signal at a detector will be modelled.

Task 4.2.2: Generalized simulation(s) (all)
As per Task 4.2.1, simulations will now be carried out using several different models of photon–matter interaction and scattering. The generalized simulation includes different X-ray sources (XFELs, plasmas, etc), different propagation (focusing, divergent, ray tracing, or coherent wave), different photon–matter interaction (radiation damage in biosamples, plasmas, shock waves in matter) and signal generation from optically "thin" and "thick" samples.

Task 4.3: Test and validate modules and workflow, including HPC workflow (DESY, all)

Task 4.3.1: Benchmarking, testing, and cross validation
Benchmarking, testing, and cross validation of simulation workflows against each other and—where possible—measured data.

Task 4.3.2: HPC, data management, and data analysis
Provide a framework towards a service to users to optimize their experiment setup (pre-experiment) and data analysis (post-experiment) as well as archive, publish, and share simulations, including negative results.

Description of work: WP5 – UFDAC: Ultrafast Data Acquisition

Task 5.1: Online 2D image processing (HZDR, DESY, XFEL, PSI, ELI (observer), ESRF (observer))

2D image detectors and related data transfer and processing plays an important role in all participating RIs. This is emphasized by the high data bandwidth. The joint development is focusing on data correction, classification of images, and online image reconstruction. In particular, moving veto capabilities as far up the DAQ chain as possible will lighten the computation and data transfer load on downstream components.

HZDR: Definition of several image reconstruction algorithms (e.g. HIO) and implementation of them for accelerator hardware using OpenCL, OpenACC, OpenMP, CUDA, and optimized libraries.

DESY: Implementation of serial crystallography and single particle imaging frame analysis software (e.g. Cheetah) within the XFEL accelerated computing framework (Karabo) for rapid experiment feedback and data volume reduction. Define core image processing algorithms, and, where possible, to be implemented in low-level data pipelines (e.g. FPGA front-end hardware).

Implementation of OnDA alongside Karabo (Nov. 2017-Sep. 2018): This additional effort results from complications encountered during integration into Karabo, which proved to be more technically challenging due to the changing circumstances at European XFEL as the facility moved into user operations during summer 2017, as several aspects of the originally planned interface was not present as initially anticipated.

XFEL: Investigation of scientific-relevant classification algorithms (e.g. good, bad, uncertain) and reference implementation. This would allow following online processing as well as storage and analysis systems to decide on the data handling. Organization of a joint workshop.

PSI: Development of algorithms for online conversion of data from dynamic gain switching charge integrating detectors (e.g. AGIPD, Jungfrau, or Gotthard) into a number of photons for hardware processing boards (either FPGA- or GPU-based). This allows online visualization, data compression, and fast data analysis. This is especially important for high-frame-rate experiments at synchrotrons using large detector systems (e.g. Jungfrau 16 M pixel detector for protein crystallography at 2 kHz frame rate).

Task 5.2 High-speed data transfer and data injection (ELI, XFEL, ESRF, HZDR, DESY (observer), PSI (observer))

Data transfer from detectors and their front-end systems into FPGAs and GPUs for online processing is crucial as well as demanding due to the required high data bandwidth. Modern technologies like 10/40 Gbps Ethernet as well as PCIe along with DMA and zero copy are important aspects of the possible solutions. A joint development is important, as the development time of such implementations is significant. Common standards would also allow for better interoperability between the RIs. Related to the online processing and reconstruction, there will be an interaction with the SIMEX work package.

ELI: Investigation of DMA (direct memory access) between GPU/FPGA for high-speed online processing and (1) Ethernet interfaces and (2) digitizer systems.

XFEL: Investigation of upcoming technologies like high-speed serial memory interfaces, 40/100 Gbps Ethernet. Participate in DMA and zero-copy developments as well as in interfacing digitizers with 10 Gbps Ethernet.

HZDR: Develop parallel data flow distribution and buffering techniques to deploy analysis work to GPU clusters. We will provide for parallel distribution of image data and buffering of image data for scalable deployment to clusters.

ESRF: Advanced data injection mechanisms into FPGA and GPU coprocessors. Investigation and optimization of mechanisms to optimize transfer of detector data from disk or from the detector into the memory buffers of the FPGA and GPU coprocessor boards.

Specification and Initiation of the implementation of a network interface card (NIC) at 100Gbps to be used for data acquisition systems within RASHPA and PSI detectors. This extended activity enhances the initial task that relies on the use of PCIe link.

Task 5.3: Online processing of digitizer data (XFEL, ELI, DESY, ESRF (observer))

Many detectors provide transient signals like pulses and spectral data (e.g. ToF). Those detectors are connected to digitizers implementing analogue to digital converters (ADCs). FPGA processing would allow to calculate the relevant parameters of the signals in real-time with low latency. This would provide multiple advantages and possibilities: (1) The amount of data would be significantly reduced (especially for high-speed digitizers > 1 GHz). Furthermore, the real-time and low latency data could directly be used for (2) feedback loops to optimize laser performance or stability as well as (3) for VETO systems, which would allow to select the most promising data sets captured (especially if the detector storage pipeline or transfer bandwidth was limited). The work in this task will provide interaction with the PUCCA work package.

XFEL: Identification, implementation and tests of processing algorithms. Further development of Simulink-based FPGA algorithms programming framework.

ELI: Investigate and implement FPGA and GPU algorithms for online processing of data for feedback-based, real-time distributed (e.g. EtherCAT-based) control system (e.g. feedback loop (> 10 Hz) for deformable mirror adjustment, handling data of several high-speed cameras; automatic robot-based positioning of targets) as well as online processing of digitized signals from diagnostics and detectors employed by users.

DESY: Develop a proof-of-principle for direct streaming of European XFEL data from OnDA into CrystFEL, allowing for on-the-fly indexing of patterns. This requires programming a data sender from OnDA and a data receiver on CrystFEL and results in (1) online real-time indexing for rapid feedback, and (2) the potential to bypass any need for intermediate files. It is the first step towards high-throughput data processing where data is all processed on-the-fly and not saved to disk.

Description of work: WP6 – HIREP: High Repetition Rate Sample Delivery

High energy lasers, synchrotrons, and X-ray FELs demand fast and precise positioning of micro- or nano-sized samples. These samples can be fabricated in a regular pattern by deposition or etching methods or they can be randomly distributed (e.g. by spraying on a surface). Targets that need to be illuminated with sub-micrometre precision including, e.g. structured surfaces for imaging, isolated targets for high energy density experiments, or to biological samples dried or frozen on a silicon wafer. All these targets have in common that the high intensity sources need fast and precise replacement of the targets, because the targets are destroyed with a single illumination and need to be replaced before the next light pulse arrives.

This work package aims to unify solid sample positioning for the participating facilities. The use of standardized sample frames with fiducial marks and a common coordinate system for the positioning systems will make an exchange of targets between the facilities easier. For external users, it will offer a more transparent access to the facilities.

Today, sample production, quality control, and positioning are conducted mostly manually. Given the possible target, throughput of high repetition rate facilities is therefore often not limited by the repetition rate but by the time that is needed for placing and aligning the target in the focus area of the facility. Standardized and automatized sample screening and positioning systems can overcome this bottleneck and by this means use the full potential of high repetition rate source.

Task 6.1: Automatic sample screening (ELI, XFEL, DESY)

Modern imaging devices, such as light or electron microscopes, are often equipped with image recognition software. Based on this technology, automatic and semi-automatic methods for target identification and localization will be developed. Based on a common coordinate system and a system of fiducial marks on standardized sample frames, the positions of desired targets will be stored in a standardized data format and used at the facilities to retrieve the targets.

After collecting specifications for the different target types used at the participating facilities, a standard data format will be defined. Standard sample frames with fiducial marks for automatic position control will be developed. Many methods for sample production or quality control are already equipped with precise positioning gear and image recognition. For those devices (e.g. electron microscope), software to automatize target recognition and transferring the localization data into the standard format will be developed. For other methods (e.g. light microscopy), a suitable sample positing system will be designed as well.

Task 6.2: Position control (DESY, LU, HZDR, ELI, XFEL)

To reliably illuminate the identified and localized targets, the standard sample frames have to be calibrated with respect to the local sample delivery systems in the participating facilities. A prototype of an automatic calibration system to be used at the facilities will be developed.

In the participating facilities, sample positioning systems with micrometre position are already in use or under construction. For high throughput measurements, however, the demands are increasing and a coordinated effort to produce stages that are compatible with the standard sample holders is necessary. Even higher demands on the positioning hardware are given by the fact that high power laser facilities create electromagnetic pulses (EMP). Part of this work package therefore is the development of EMP hard precision sample stages.

A typical setup will contain microscope optics with illumination and detectors to read the fiducial marks on the sample frame and identify the focal position of the facility. Identifying the positions of these marks in the reference frame of the facility will allow to absolutely position any of the targets into the focus of the facility. Within this work package, a vacuum-compatible microscope for this use will be developed.

In the final step, the stages, microscope, sample holders, and sample identification software will be integrated into a complete package to enable fast and reliable sample exchange for all users of our facilities.

Description of work: WP7 – PUCCA: Pulse Characterization and Control

DESY and XFEL are coordinating this effort to develop and implement the different pulse characterization tools. DESY has a long standing expertize in the development and use of pulse-resolved photon diagnostics for FELs in the extended ultraviolet and X-ray regions, particularly in gas-based intensity monitors, arrival time monitors and wavefront sensors. Within this project DESY will develop an intensity monitor with ultimate resolution for the most difficult hard X-ray region above 12 keV photon energy. It will also contribute to the further development of wavefront sensors.

XFEL is developing 4.5 MHz repetition rate X-ray/optical diagnostics and has already acquired experience in exploiting such high repetition rates at SR sources. XFEL experiments at LCLS and SACLA seeked to reveal dynamic effects on the femtosecond level, and XFEL has also contributed to the 100 Hz development of a sub-10 fs timing tool at LCLS. Within this project XFEL will develop schemes to measure the precise arrival time of pulses from a distant light source (with respect to an independent closer light source) at MHz repetition rates based on fast liquid jets for fast sample exchange on a shot-by-shot basis. This effort aims to exploit the energy range from about 3 – 20 keV, but also throughout the UV-vis-NIR range. Naturally, PUCCA will continuously exchange results with the related HIREP and UFDAC projects in this proposal, but focuses its attention on the delivery of a reliable timing tool with femtosecond precision.

These efforts will be supplemented by the electron-beam based timing scheme developed by HZDR and tested at FERMI at Elettra, which offer an attractively large timing window, which can serve as preparative input into the narrow timing window offered by the liquid jet based timing monitors. ELI joins these timing tool efforts by developing a similar liquid jet based tool to measure the arrival time between two independent laser sources (of which one may serve as an X-ray plasma source).

ESRFup has set up a program to measure the wave front of hard x-radiation in the 8-20 keV range, which is also desired by XFEL, while ELI, FERMI and FELS OF EUROPE have a need to measure the wavefront shape in the soft X-ray to VUV range. ESRF together with DESY, Elettra and ELI will exchange their know-how and deliver a report about the requirements and transferability of techniques to cover the wide spectral range of all the RIs, in particular to include the hard X-ray range. PSI has significant experience in this area and will participate as an oberserver. A prototype device for hard X-rays and extensive software needed for fast interpretation of the recorded data will be developed. This software development can then be inspected and altered by HIREP to adapt to the MHz readout needs of XFEL and other high repetition rate sources.

Task 7.1 Delivery of arrival time monitors between two independent pulsed light sources with femtosecond time resolution (HZDR, XFEL, ELI, DESY, PSI (Observer))

Different approaches are required to satisfy the extremely different demands of the different light sources. Two types of monitors will be developed: accelerator-based monitors and monitors based on thin liquid sheet jets doped with substances suited for efficient arrival time monitoring throughout the entire optical and X-ray spectral regions.

Task 7.1.1 Accelerator-based arrival time monitor: Use of intense THz radiation generated e.g. at the exit of the last undulator to drive an electro-optic sampler, which is transmitted by an extremely chirped white light pulse from the second laser source (HZDR, PSI).

Task 7.1.2 Liquid-jet based arrival time monitor: (Nearly) co-propagate both light pulses (one remaining ultrashort, the other chirped-stretched to a few picoseconds) through a liquid flat sheet jet, doped with selected chromophores which react efficiently to the wavelength of the ultrashort light pulse (XFEL, DESY; ELI).

Task 7.1.3 Combine both tools at one of the ALL-RI facilities to correlate and deselect pulses at the second device, when they are outside its timing window (HZDR, XFEL, ELI, PSI)

Task 7.2 Development of a wavefront sensor and analysis software (ESRF, Elettra, DESY, ELI, XFEL (Observer), PSI (Observer))

Task 7.2.1 Wavefront sensor prototype (ESRF, DESY, XFEL (Oberserver), PSI(observer))
This is based on the use of two detection screens. For the prototype wave front sensor developed for ESRF the first screen will be semi-transparent and the second one fully absorbing. For transferability to XFEL a non-invasive device is needed. A concise report will be delivered, which will treat the issue to obtain information about the wavefront – on a shot-to-shot basis – which does not hamper the actual experiment, thus does not interfere with the x-ray beam propagating through the sample. Different solutions will be studied: i) non-invasive wavefront sensor upstream from the sample based on two semi-transparent screens, ii) possibilities to implement an invasive wavefront sensor behind the sample. The possibilities to implement such a wavefront sensor in-situ at x-ray repetition rate higher than 40 Hz will be examined. This issue is highly detector-dependent.

Task 7.2.2 Analysis software package for wavefront sensors (ESRF, DESY, ELI, Elettra, XFEL (Observer))
Fast analysis software for speckle-based and Hartmann-like wavefront sensors. Implementation of a generic software package capable of reconstruction and analysis of wavefronts from standard image formats, acquired, for instance, with the previously described device as well as with the FERMI FEL Hartmann wavefront sensor. The software features absolute optical wavefront information allowing to compare different beams. The analysis is hardware independent, therefore of interest to all facilities regardless of their spectral and temporal specificities. An initial feedback loop of 10 Hz is envisaged with efforts to reach higher frequencies.

Task 7.3 Precise transparent intensity monitor (DESY, Elettra, XFEL)

Task 7.3.1 Analysis of X-ray intensity monitors based on gas ionisation (DESY): study of the ultimate uncertainty achievable with transparent intensity monitors (based on the statistics of ionization events) for the different FEL and ELI sources; design study of optimized intensity monitors based on the present design for XFEL.

Task 7.3.2 Construction and test of a prototype X-ray intensity monitor (DESY, XFEL). The prototype will be optimized for intensity measurements of hard X-rays with ultimate precision, i.e. the most difficult application of this monitor concept. Absolute calibration at PTB (Physikalisch-Technische Bundesanstalt); test at XFEL (if available), LCLS and SACLA; measurements at ELI sources and other FELs as much as possible.

3.2 Management structure and procedures

3.2.1 Management structure and decision-making mechanism

The cluster EUCALL involves eight partners operating either a laser, a FEL, or a synchrotron radiation RI. Most partners are involved in one of the two networks: LASERLAB-EUROPE and FELs OF EUROPE. The networks themselves are composed of many more RIs; therefore, they are additionally represented by their chairs in the Steering Committee of EUCALL. User feedback is essential for EUCALL. Users will be represented in the Steering Committee and will be given the opportunity to integrate the activities of the European Synchrotron User Organisation (ESUO) into EUCALL. The participation of international experts in the Scientific Advisory Board will further integrate the EUCALL project globally.

The management and organizational structure of EUCALL is shown in Figure 3.2a. The organizational structure of EUCALL enables equal involvement of representatives from the laser and FEL community in all levels and collaboration with non-European laser RIs.

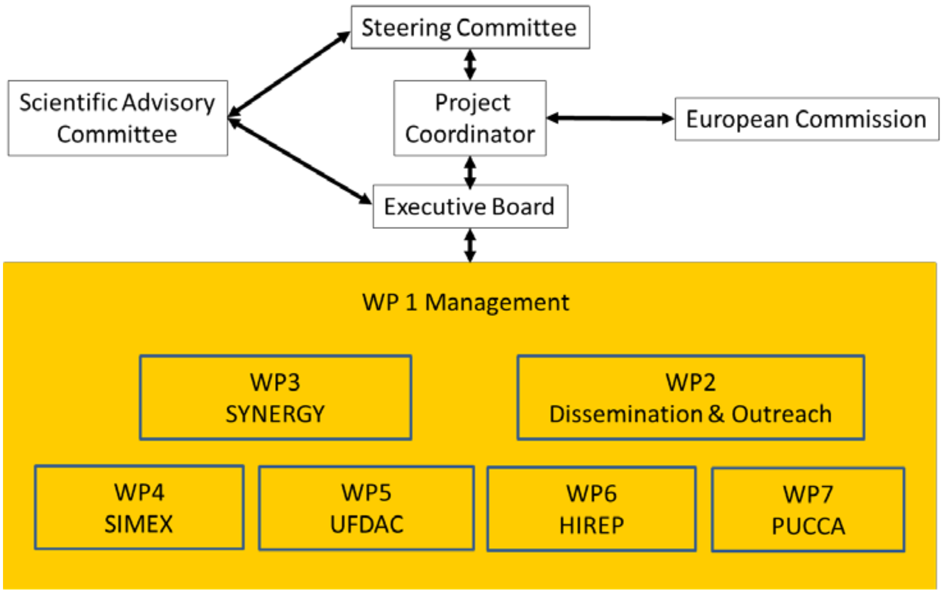


Figure 3.2a: Project management structure of EUCALL

Steering Committee (SC)

The SC is the ultimate decision-making body of the consortium. It shall be responsible for the project policy and the definition of the program of activities. It shall have oversight of the project’s target and time schedules; project planning and control; dissemination and exploitation activities; and financial planning. It shall review reported progress, approve corrective actions where necessary, and validate proposed plans for future activities.

It shall meet at least once a year and more often upon request by its chair, the Executive Board (EB), the Project Coordinator (PC), or any WPL.

All beneficiaries shall be represented in the SC, with voting rights. The SC shall select its chair and co-chair from among the members for the whole period of the project, while chair and co-chair shall be coming each from one of the participating laser or FEL community. The PC and his/her deputy(ies) shall be ex-officio members of the SC, without voting rights. In addition, the networks LASERLAB-EUROPE and FELs OF EUROPE shall be represented by one person each (the chairs or their deputies) as well as two user representatives who combine experience with using large-scale optical laser and FEL RIs and shall be nominated following suggestions by ESUO and an analogous user body for the optical laser community. A delegate of the Scientific Advisory Committee (SAC) shall be present in the SC.

The voting rules and practical aspects (e.g. on convening meetings by the PC) shall be set out in the Consortium Agreement. Consensus shall be sought whenever possible and appropriate.

Scientific Advisory Board (SAC)

The SAC is an advisory board to the SC and, on request to the EB, on all scientific and strategic matters related to clustering the European Laser and FEL RIs.

The SAC shall be composed of representatives from European and non-European large-scale laser or FEL laboratories or synchrotrons and internationally recognized experts in laser science and technology, if available, also experts from industry.

The SAC members (4–6) shall be approved by the SC for the whole project period. The SAC shall select its chair. It shall meet at least once a year.

Executive Board (EB)

The EB is the executive body of the EUCALL project. It shall assist the PC in the management of the project and ensure the quality assurance and timely implementation of the work package activities. The EB may, via the PC, make proposals to the SC concerning modification of the work programme or to allocation of funding by the European Commission (EC), on accession and withdrawal of partners as on default and termination. The EB may call for internal reviews.

The EB shall meet at least four times a year and as often as felt necessary.

The EB shall be composed of the Project Coordinator team, WPL, and WPCs, and shall be chaired by the PC.

The voting rules will be set out in the Consortium Agreement.

Project Coordinator (PC)

The PC is the coordinating person of the EUCALL project and responsible for the day-to-day management. The PC shall be responsible for the financial administration of the project and shall duly carry out the tasks attributed to the Coordinator in the Grant Agreement of Horizon 2020. The PC shall carry out the tasks as specified in the Management of the EUCALL Project (WP1) and shall be assisted by one deputy and an administrative management team, all appointed by the PC.

The PC shall ensure proper communication between the consortium and the Commission.

Work Package Leaders (WPL) and Co-Leaders (WPC)

Each WP shall have a WPL and WPC. The WPL and WPC shall be appointed by the SC on the proposal of the PC for the whole period of the project. If the WPL is from the FEL community, then the WPC shall be from the optical laser community, and vice-versa.

The WPL, together with the WPC, shall coordinate the individual WP activity. They shall ensure the effective coordination between the participants of their tasks, monitor the progress of the work, and review the milestones and deliverables. They shall report to the PC on a quarterly (three-monthly) basis and contribute to the preparation of all periodic and final reports regarding their WPs.

3.2.2 Innovation and risk management

The innovation potential of the EUCALL project will be directly coordinated within WP3, while WP2 will take care of disseminating the scientific and technical ideas, potentially appropriate to the market, making sure that these ideas reach the targeted audience within the industry and are appropriately exploited following the measures defined in a plan for dissemination and exploitation. The innovation potential of the work performed in the WPs will be inquired and targeted during the regular reporting of the WPLs in the EB meetings. If any research result is detected as having an innovation potential, the measures described in the plan for the dissemination and exploitation will be implemented according to the defined processes for the implementation of these measures and the technology transfer offices of the different partners involved. More precisely, based on the expertise of the technology-transfer offices, the SC will decide on the most appropriate exploitation measures of the plan for the dissemination and exploitation to be applied within the project. The Consortium Agreement will define the legal framework of such activities.

The PC is responsible for the overall risk management of the project. By means of the quarterly (three-monthly) reports of the WPLs, the PC will be informed well in time of any difficulties impacting the work progress. The PC and the related WPL/WPC with EB support will search for a solution. An extraordinary meeting of the SC (e.g. by phone or via videoconference) will be requested by the PC if an urgent decision is needed (e.g. concerning work and budget shifts). Details shall be set out in the Consortium Agreement.

3.3 Consortium as a whole

EUCALL is clustering the European research infrastructures in the domain of advanced laser light sources. The proposal addresses the cross-community cooperation of optical laser and accelerator-based advanced light sources. The two ESRFI projects ELI and European XFEL are in the focus of this activity, being under implementation at present and starting operation and user programs during the course of this project. To best reach its objectives the EUCALL consortium is set up following the two principles of high efficiency and high completeness of its partners.

- High efficiency is achieved by involving as partners those institutes providing the experience and know-how, but also with the commitment to significantly contribute to the synergy and joint technical work packages.

- High completeness is achieved by involving in this project all advanced laser light source research infrastructures in Europe, operating, under construction or planned. To maintain the goal of efficiency the large number of nationally operated research infrastructures is included through their two well-established networks LASERLAB-EUROPE and FELs OF EUROPE.

In addition, the consortium has well-defined links to external interest groups, in particular to the user communities of the advanced laser light source research infrastructures. The partners of EUCALL complement each other in their core expertise and will correspondingly contribute jointly to the activities under EUCALL. Some of their core expertise is listed in Chapter 4 and the contribution of partners to the seven work packages of EUCALL is shown in Table 3.3a.

- European **XFEL** is currently under construction with planned user operation in 2017. European XFEL works closely together with the traditional optical laser and accelerator based light source user communities. A prominent example is the HIBEF (Helmholtz International Beamline for Extreme Fields at the European XFEL) project, a large international user consortium preparing the installation of high power and high energy laser systems at the European XFEL. European XFEL is member of the FELs OF EUROPE network. XFEL is the coordinator of EUCALL and contributes to all work packages. XFEL leads WP2 and WP4 and contributes to all work packages.

- **ELI is** a new Research Infrastructure (RI) of pan-European interest and part of the European ESFRI Roadmap, currently in the implementation phase of facilities at three sites (pillars): ELI-Nuclear Physics (ELI-NP), Romania; ELI-Attosecond Facility Light Pulse Source (ELI-ALPS), Hungary and the ELI-Beamlines Facility, Czech Republic. ELI is participating in EUCALL via the ELI-Delivery Consortium International Association, an international non-profit organisation after Belgian law (AISBL). ELI leads WP3 and contributes to all work packages.

- **ESRF** represents an ESFRI project (ESRFup) based on an operating synchrotron research infrastructure. ESRF provides more than 20 years of experience and know-how in X-ray technologies and in operating an extremely successful user facility. Today the ESRF is spearheading for the synchrotron community the development, implementation and operation of installations combining high power optical lasers with X-ray radiation with many commonalities with the dedicated advanced laser light sources. ESRF contributes to WP2, WP3, WP4, WP5 and WP7.

- **DESY** has been operating FLASH since 2005 as the first soft X-ray FEL user facility world-wide. DESY is participating in EUCALL in all technical work packages as well as in WP3 SYNERGY as the chairing institute of the FELs OF EUROPE network, with Dr. Josef Feldhaus as the chair, and therefore acts also on behalf of FELs OF EUROPE, thus establishing the link to the national accelerator-based advanced laser light sources in Europe. DESY leads WP7 and contributes to all work packages.

- **HZDR** is operating the ELBE user facility which houses two high power laser systems of Petawatt class, an electron LINAC, and two infrared free electron lasers. HZDR is part of LASERLAB-EUROPE and FELs OF EUROPE. HZDR is the coordinator of the HIBEF consortium, founded 2012 as an international consortium of 80 research teams from 16 countries. HZDR leads WP5 and contributes to all work packages.

- **LU** is involved in EUCALL through two activities. LU is the chairing institute of the LASERLAB-EUROPE network, with Prof. Claes-Göran Wahlström as the chair, and therefore acts on behalf of LASERLAB-EUROPE thus establishing the important link to the optical laser based advanced light sources. Furthermore LU is hosting the national synchrotron RI MAX-IV contributing to the technical work packages. LU contributes to WP3 and WP6.

- **PSI** and **ELETTRA** contribute to one of the technical work packages with their technical expertise. They both are members of the FELs OF EUROPE network. PSI has long-standing and outstanding experience in developing detectors for photon science which even led to a successful spin-off. Therefore, the participation of PSI in WP5 as well as being an observer in WP7 is of high importance.

DESY, ELETTRA, LU and PSI also have long-standing experiences in developing and operating X-ray synchrotrons including the development of cutting-edge experimental instrumentation for users.

The two networks FELs OF EUROPE and LASERLAB-EUROPE:

- The optical laser RIs are organized in the LASERLAB-EUROPE network proposing in parallel to this proposal an Integrating Activity project on its own and totally complementary. LASERLAB-EUROPE brought in the third phase of successful collaboration together 30 leading institutions in laser-based inter-disciplinary research from 16 countries plus additional 19 subcontractors or associated partners. 20 laboratories provide transnational access and are so-called nationally operated laser RIs.

- The FEL RIs are organized in the FELs OF EUROPE network. The FELs OF EUROPE network is a further development of the former ESFRI project EUROFEL and includes all accelerator-based FEL and short-pulse facilities and projects existing today in Europe. In FELs OF EUROPE in total 14 FEL projects in 9 countries are participating of which five are in user operation.

Each of the partner institutions has long-standing experience with industry as supplier, and many have industry liaison or technology transfer offices. Therefore, any results of a technical WP with the potential for innovation and commercialization will be exploited with strong assistance of these technology transfer offices, as described under Section 2.2.

Table 3.3a: Contribution of EUCALL partners to the EUCALL work packages. WPL responsibilities are indicated by underlining. DESY and LU furthermore represent the networks involved in EUCALL.

WP	XFEL	DESY	ELETTRA	ELI	ESRF	HZDR	LU	PSI
		network					network	
1	X			X	X	X		
2	X			X				
3	X	X	X	X			X	
4	X	X		X	X	X		

WP	XFEL	DESY	ELETTRA	ELI	ESRF	HZDR	LU	PSI
5	X	X		X	X	X		X
6	X	X		X		X	X	
7	X	X	X	X	X	X		X

3.4 Resources to be committed

The financial request to the European Commission for EUCALL totals 7,000,000 € and is a result of careful cost containment and optimization by each partner. The budget calculation follows the Horizon 2020 financial rules, including personnel costs, travel, equipment, and other direct costs, and 25% overheads.

The resources requested within EUCALL will be primarily used for covering additional staff resources and for synergy activities, such as workshops, expert meetings, or trainings. The request for additional staff resources, at a level of about 860 person-months, follows from the extreme workload faced by all partners and facilities at present. The three ESFRI projects are in the heat of their implementation phase and the national RIs, being in operation or under implementation, have to reach ambitious goals for operation or implementation with very restricted budgets due to the overall economic situation. Therefore, in both cases, existing staff is already highly committed and is not able to perform the additional tasks of EUCALL. Additional staff resources are an absolute must to perform these tasks. The existing experienced staff will contribute to the activities through in-kind contributions as part of their working time, both for initiation of the tasks and activities and subsequently for guidance of the new staff. The request for personnel resources is more than 75% of the requested funding and is absolutely vital to engage in the tasks as described in the proposal.

The majority of the remaining request for funds is related to the organization of meetings and workshops, and for travel. All of these costs relate to the fact that, within EUCALL, an intense exchange among experts shall be established and maintained. The large involvement of project-external experts makes it necessary to cover their travel funds, which are therefore a significant fraction of the costs for synergy and dissemination activities.

In contrast only a small fraction of the requested funding will be used for equipment, because the necessary equipment and hardware will be contributed by the EUCALL partners in-kind.

With a total request budget of 7,000,000 €, EUCALL will achieve, in a three-year time frame, a very important contribution to the harmonization of the RI landscape in the ERA in general, and to the competitiveness and long-term relevance and sustainability of the advanced laser light source RIs in particular.

Personnel: The total requested staff effort is 810 person months, which corresponds to a sum of personnel direct costs of 4,621,140€, in addition contributes PSI with 48 PM to the action. These person-months correspond to the person-months underlying the work package description in Chapter 3.1.

The other costs amount in total to around 917,000€. They are specified in Table 3.4b for the beneficiaries, where the “other direct costs” exceed 15% of their personnel costs, with respect to the overall EUCALL budget stated in Part A . These costs are explained in further detail as follows:

Travel: in total around 385,000 €. This cost item is particularly high because networking is a central issue of EUCALL and the success of EUCALL relies very much on person-to-person contacts. The travel budget includes the cost for the young researcher bursary of Task 2.1.

Equipment: in total around 199,000 €. This cost item is not high, as most of the equipment is contributed in kind by the partners. Just a few prototype elements of the instrumentation needed to succeed in the technical work packages WP4 to WP7 are requested for EC funding.

Other direct goods/services: in total around 333,000 €. This sum includes all costs occurring for kick-off and annual meetings, work package meetings, topical workshops, dissemination material, contracts for web-services for the EUCALL internal communication platform and the official EUCALL website, for auditing and for consumables.

Subcontracting: in total about 77,000 €. The ELI budget includes the subcontracts to reimburse the expenses of up to four experts to be nominated in the Synergy Board of WP3. The only other item concerns a calibration measurement to be subcontracted as part of WP7 at DESY. (see Chapter 4.2).

Management costs: the WP1 costs amount in total to around 290,000 €. The calculation of these costs is based on extensive experiences of coordinating FP6 and FP7 projects. The manpower for the EUCALL project management is estimated at 28 person-months, comprising the administrative coordinator and one assistant on a part-time basis for the organization of the Kick-Off and Annual Meetings. Personal resources for the coordinator will be provided by European XFEL as an in-kind contribution. The travel budget of around 45,000 € will be used by the Project Coordinator as described above, as well as by the SAC members and the SC observers.

Swiss participation: It is to be noted that, due to the current status of Switzerland as a third country with respect to Horizon 2020, the Swiss beneficiary PSI does not request any EC funding. They will obtain the necessary funding for covering their costs in the project from the Swiss State Secretariat for Research and Education, following a recent decision of the Federal Council of Switzerland

Table 3.4b "Other direct cost" per beneficiary where these exceed 15% of their personnel costs

1 / XFEL	Cost (€)	Justification
Travel	174,600	Travel of SAC members and SC observers, bursaries of young researchers, exchange programme, expert visits, and of XFEL staff to meetings, conferences, experimental measurements and EUCALL events of all WPs.
Equipment	3,000	Workstation for prototyping workflow implementations (WP4)
Other	88,760	Organization and catering of Kick-off meeting and work package meetings, dissemination material and activities, development, maintenance and operation of the web-platform, for the internal communication of the EUCALL partners; auditing costs; consumables for meetings; and consumables for samples and nonlinear optics in WP7 as well as sample holder in WP6.
Total	**266,360**	

2 / DESY	Cost (€)	Justification
Travel	35,000	Travel of DESY staff to meetings, conferences, experimental measurements and EUCALL events of all WPs., for the one representative of FELs OF EUROPE (WP3), Travel for invited external speakers, accommodation for young researchers as part of the Young Researchers Travel Bursaries
Equipment	24,000	Linear stages for prototype (WP6), the XGM prototype for 5-20 keV (WP7); Workstation (WP4)
Other	17,000	Consumables, e.g. for rare gases for calibration (WP7), organization and catering for workshops and auditing costs.
Total	**76,000**	

3/ELETTRA	Cost (€)	Justification
Travel	8,000	Travel for Elettra staff to meetings, conferences, experimental measurements and other EUCALL events (all work packages)
Other	7,000	Technical integration of the planned new features for the wayforlight database by Promoscience srl, for a cost of 7.000 Euro."
Total	**15,000**	

4 / ELI	Cost (€)	Justification
Travel	94,300	Travel for ELI staff to meetings, conferences, experimental measurements and other EUCALL events (all work packages), Travel for the invited external speakers and for Members of the Synergy Board

Equipment	61,000	Workstation for prototyping workflow implementations (WP4) and software development (WP6); FPGA Evaluation KIT (WP5); Modification of the sample delivery system for arrival time measurements (WP7)
Other	143,000	To cover costs of organization of the workshops and large meetings planned in WP3 including the participation costs of the invited external speakers, Organization and catering of EUCALL annual meeting and work package meetings, costs for the Young Researcher Travel Bursaries, costs for an exhibition booth, and auditing costs (4000 EUR).
Total	**298,300**	

5 / ESRF	**Cost (€)**	**Justification**
Travel	24,000	Travel of ESRF staff to meetings, conferences, experimental measurements and other EUCALL events (all work packages)
Equipment	40,000	Components for the wavefront sensor to validate the software (WP7)
Other	35,400	Consumables, such as scintillators, membranes (WP7), shipping of equipment, organization and catering for EUCALL annual meeting and auditing costs.
Total	**99,400**	

6 / HZDR	**Cost (€)**	**Justification**
Travel	35,300	Travel of HZDR staff to meetings, conferences, experimental measurements and other EUCALL events (all work packages)
Equipment	39,000	Workstation for prototyping workflow implementations (WP3); Linear stages and hardware for prototypes (WP6, WP7)
Other	45,100	Organization and catering for EUCALL annual meeting and work package meetings, Consumables such as nonlinear crystals and chemicals for the arrival time monitors (WP7) and auditing costs.
Total	**119,400**	

7 / LU	**Cost (€)**	**Justification**
Travel	13,800	Travel for one of LASERLAB-EUROPE (WP3) and for LU staff to meetings, conferences, experimental measurements and other EUCALL events (all work packages)
Equipment	25,000	Linear stage and vacuum compatible optics for prototype D6.6 (WP6)
Other	4,000	Auditing costs
Total	**42,800**	

4 Members of the consortium

4.1 Participants (applicants)

<u>Participant No 1</u>

European X-Ray Free-Electron Laser Facility GmbH (XFEL) is a limited liability company under German law that was officially founded in Hamburg, Germany, on 28 September 2009. At present, 12 countries are participating in the European XFEL project: Denmark, France, Germany, Greece, Hungary, Italy, Poland, Russia, Slovakia, Spain, Sweden, and Switzerland. The company is in charge of the construction and operation of what will be the world's brightest source of ultrashort X-ray pulses: the European XFEL, a 3.4 km long X-ray free-electron laser facility extending from Hamburg to the neighbouring town of Schenefeld in the German federal state of Schleswig-Holstein. It is being realized as a joint effort of many partners. To this end, European XFEL cooperates closely with the research centre DESY and other organizations worldwide. Civil construction started in early 2009; the beginning of user operation is planned for 2017. With its repetition rate of 27 000 pulses per second and a peak brilliance a billion times higher than that of the best synchrotron X-ray radiation sources, the European XFEL will open up new research opportunities for scientists and industrial users. Thanks to its ultrashort X-ray flashes, the facility will enable scientists to map the atomic details of viruses, take three-dimensional images of the nanoworld, film chemical reactions, and study processes such as those occurring deep inside planets.

European XFEL has benefited from the EU contribution as ESFRI-PP project during its preparatory phase in the framework of the FP7 Pre-XFEL project and is currently participating as a partner in three FP7 projects (BioStruct-X, CRISP, and CALIPSO) and in the European network FELs OF EUROPE.

The following key staff will be involved in the project:

- Thomas Tschentscher (male), WP1, physicist, has a background in synchrotron radiation and solid-state research. As scientific director, he is responsible for the realization of the design goals of the European XFEL. He has several years of experience in coordination of large-scale projects and collaborations; in particular, he is the chairperson of the FP7 CRISP steering committee. He shall act as coordinator of the EUCALL project.

- Adrian Mancuso (male), WP4, physicist, is an expert in X-ray coherence and imaging. He is an European XFEL employee and the author of a series of publications on the fundamentals of X-ray coherent imaging. He is the principle investigator in a number of imaging experiments with free-electron lasers at FLASH, SACLA, and LCLS, and responsible for coherent diffraction and imaging instrument at the European XFEL. He will be SIMEX work package leader.

- Patrick Gessler (male), WP5, engineer and computer scientist, is leading the advanced electronics and FPGA firmware developments for detectors and data acquisition at European XFEL. He has several years of experience in this field and was deputy work package leader in the FP7 IRUVX-PP project. He will be UFDAC deputy work package leader.

- Joachim Schulz (male), WP6, physicist with a background in atomic and molecular spectroscopy and single particle imaging. As group leader, he is responsible for implementing state-of-the-art sample environment technologies into the scientific instruments of the European XFEL. As an instrumentation scientist at the Linac Coherent Light Source (LCLS), he set up sample delivery systems for some of the groundbreaking coherent diffractive imaging experiments at the AMO beamline. He will be HIREP deputy work package leader.

- Christian Bressler (male), WP7, physicist working on ultrafast reaction chemistry. He is responsible for the Femtosecond X-Ray Experiments (FXE) scientific instrument at European XFEL and has been working for more than 10 years with lasers and X-ray beams. He possesses extensive experience in related instrumentation aspects and is the work package leader of the FP7 CRISP WP8. He will be PUCCA deputy work package leader.

The following publications are relevant to the call content:

- H.N. Chapman et al.: “Femtosecond X-ray protein nanocrystallography”, Nature **470**, 73–77 doi:10.1038/nature09750

- J. Schulz, S. Bari, J. Buck, Ch. Uetrecht: “Sample refreshment schemes for high repetition rate FEL experiments”, Proc. SPIE **8778**, 87780T (2013) doi:10.1117/12.2019754

- A.P. Mancuso, M.R. Groves, O.E. Polozhentsev, G.J. Williams, I. Mcnulty, C. Antony, et al.: “Internal structure of an intact Convallaria majalis pollen grain observed with X-ray Fresnel coherent diffractive imaging”, Optics Express **20** (24), 26778–26785 (2012) doi:10.1364/OE.20.026778

- M. Altarelli, R. Brinkmann, M. Chergui et al.: “XFEL: The European X-Ray Free-Electron Laser – Technical Design Report”, DESY Report 2006-197 (2006) doi:10.3204/DESY_06-097

Participant No 2

Stiftung Deutsches Elektronen-Synchrotron DESY (DESY) is one of the world's leading centres for the investigation of the structure of matter. DESY develops, operates, and uses accelerators and detectors for photon science and particle physics. DESY hosts and is a member of several large international collaborations such as the Center for Free Electron Lasers (CFEL), which is to advance science with next generation light sources. DESY operates the free-electron laser (FEL) FLASH and as well as the most brilliant synchrotron radiation source worldwide, PETRA III. PETRA III and FLASH are user facilities with roughly 2500 active users from all over the world, providing scientific and computational services ranging from the preparation of experiments to publication through all stages of data processing, analysis, and management. The user communities are supported by extensive compute resources. DESY has pioneered the development and scientific use of X-ray free-electron lasers and is one of the world-leading centres for FEL science and technology. DESY has a proven record of expertise for data and computer infrastructure capable of dealing with Big Data, high throughput, and performance computing.

DESY represents the network "FELs of Europe", which a collaboration of all FEL facilities in Europe organized under a memorandum of understanding, with the goal to meet the technical and scientific challenges of these novel and rapidly developing technologies and to provide a worldwide-unique, pan-European research infrastructure that enables exploiting the full scientific potential of these unique accelerator-based, short-pulse light sources.

DESY was the coordinator of FP5 development of a pump–probe facility combining a high-power optical laser and a soft X-ray FEL, the FP6 EuroFEL design study, and the FP7 coordination of IRUVX-PP, the Preparatory Phase Project (PPP) of the ESFRI project EuroFEL, and Pre-XFEL the PPP of the European XFEL. DESY is a partner in FP7 CALIPSO, which partly supports the coordination activities of DESY in the network FELs of Europe, and in the two FP7 projects CRISP and PaNdata ODI.

DESY is a partner in the High Data Rate Initiative (PNI-HDRI) of the Helmholtz Association and chairs interest and working groups (PaNSIG, Scientific File Formats, HDF5) within the Research Data Alliance (RDA). DESY is member of the Association of European-Level Research Infrastructure Facilities (www.erf-aisbl.eu).

The following key staff will be involved in the project:

- Josef Feldhaus (male), WP3: Ph.D. in physics; head of the FLASH experiments group at DESY, Hamburg; chair of FELs of Europe; coordinator of previous EU projects in the field of FELs.

- Frank Schlünzen (male), WP4: Ph.D. in physics; background in theoretical physics and macromolecular crystallography; responsible for the scientific high-performance computing (HPC) at DESY-IT.

- Sven Sternberger (male), WP4: computer scientist; responsible for the conception design and technical development of the DESY HPC infrastructure.

- Anton Barty (male), WP5: Ph.D. in physics; He is an expert for FEL imaging methods with emphasis on bioparticles in the DESY group of H. Chapman..

- Alke Meents (male), WP6: Ph.D. in physics; background in X-ray crystallography and synchrotron instrumentation; responsible beamline scientist at DESY for beamline at PETRA III.

- Kai Tiedtke (male), WP7 leader: Ph.D. in physics; head of the photon diagnostics team at the FLASH facility of DESY; coordinator of international projects

The following publications are relevant to the call content:

- W. Ackermann et al.: "Operation of a Free Electron Laser in the Wavelength Range from the Extreme Ultraviolet to the Water Window", Nature Photonics **1**, 336–342 (2007) doi:10.1038/nphoton.2007.76

- J. Feldhaus et al.: "AMO science at the FLASH and European XFEL free-electron laser facilities", J. Phys. B: At. Mol. Opt. Phys. **46**, 164002 (2013) doi:10.1088/0953-4075/46/16/164002

- J. Küpper et al.: “X-Ray Diffraction from Isolated and Strongly Aligned Gas-Phase Molecules with a Free-Electron Laser”, Phys. Rev. Lett. **112**, 083002 (2014) doi:10.1103/PhysRevLett.112.083002

- F. Stellato et al.: “Room-temperature macromolecular serial crystallography using synchrotron radiation”, IUCR J 1, 204–212 (2014) doi:10.1107/S2052252514010070

- K. Tiedtke et al.: “Gas detectors for X-ray lasers”, J. Appl. Phys. **103**, 094511 (2008) doi:10.1063/1.2913328

Participant No 3

Elettra – Sincrotrone Trieste SCpA (Elettra) is a non-profit, publicly funded national research organization based in Trieste, Italy, where it has established the international multidisciplinary laboratory Elettra, specialized in synchrotron radiation and its use in the natural sciences. The mission of Elettra is to promote cultural, social, and economic growth through basic and applied research in relevant fields, technical and scientific training, and technology transfer. Elettra is pursuing at its premises the commissioning of the free-electron laser (FEL) source FERMI@Elettra, based on a project approved and funded by the Italian national government, the local government of the Friuli-Venezia Giulia Region and the European Union (EU), covering the photon spectrum from the visible-ultraviolet to the soft X-rays in order to allow multi-disciplinary research in domains ranging from the fundamental properties of condensed matter to atomic/cluster physics and biological systems. Two FEL lines are present: a low energy one (FEL-1, 100–20 nm), and a high energy one (FEL-2, 20–4 nm). FEL-1 was opened to external users in December 2012; FEL-2 will be opened to user operations in 2015. Thanks to its seeded nature, exploiting the High Gain Harmonic Generation scheme, FERMI benefits from improved energy and intensity stability as well as increased coherence properties with respect to SASE sources. Three endstations/beamlines are currently operative and available to external users (DiProI, LDM, EIS-TIMEX); the other two will be commissioned in 2015 (EIS-TIMER and MagneDYN), together with the THz-beamline TeraFERMI.

Elettra is currently participating as a partner in the FP7 CALIPSO project and in the European network FELs OF EUROPE. Elettra will organize and host the next FELs OF EUROPE conferences/workshops dedicated to photon beam diagnostics and transport systems (PhotonDiag 2015), and science (Science@FELs 2016). These events will further promote the establishing and strengthening of collaborations among the European institutions devoted to research exploiting cutting-edge light sources such as synchrotrons, FELs, and lasers.

The following key staff will be involved in the project:

- Marco Zangrando (male), WP7, physicist working in the field of photon beam diagnostics and transport systems. He is leader of the Photon Beamlines and Diagnostics group at the FERMI@Elettra free-electron laser. He has been involved (> 10 years) in the design, realization, commissioning, and normal operation of several photon-based optical systems, such as synchrotron/FEL beamlines and endstations. He possesses extensive experience in related instrumentation aspects as well as in the activities of networked collaborations (he was the spokesperson/coordinator of one of the Expert Groups in Work Package 3 of the FP7 IRUVX-PP project).

Participant No 4

Extreme-Light-Infrastructure (ELI) is a new Research Infrastructure (RI) of pan-European interest and part of the European ESFRI Roadmap, currently undergoing the implementation of user facilities at three sites (pillars) ELI-Nuclear Physics (ELI-NP) Magurele, Romania; ELI-Attosecond Facility Light Pulse Source (ELI-ALPS), Szeged, Hungary and the ELI-Beamlines Facility Dolni Brezhany, near Prague, Czech Republic. The ELI-Delivery Consortium International Association is an international non-profit organization after Belgian law (AISBL). It supports the three pillars during their construction phase, ensures the character of ELI as one unified pan-European project, conducts the negotiations towards the ELI-ERIC and prepares the establishment of ELI's fourth pillar, planned to push the frontiers of laser power by yet another order of magnitude into the sub-exawatt regime. Each pillar is hosted by a national organization which will act as a linked third party in this project to enable ELI-DC to deliver the research and development activities assigned to the ELI-DC partner. The facilities are detailed in Section 4.2 , "Third parties involved in the project (including use of third party resources)".

ELI has participated and is participating in the following European projects: LASERLAB FP6 (HAPIE and SFINX), ELI-Preparatory Phase, LASERLAB FP7 (Access), COST Action MP0601 (short wavelength laboratory sources), and CRISP.

The following key staff will be involved in the project:

- Professor Wolfgang Sandner (male), WP3, physicist, is Director General and CEO of the ELI-DC International Association AISBL. He is an internationally renowned scientist and science manager. Until 2013, he was Director at the Max-Born-Institut Berlin and Coordinator of LASERLAB-EUROPE, the Integrated Initiative of European Laser Research Infrastructures. He is currently Chair of the European Association of National Research Facilities Laboratories (ERF) and a member of numerous science advisory committees.

- Catalin Miron (male), WP3, physicist, is a specialist of atomic and molecular science using synchrotron radiation as well as conventional and free-electron lasers. He contributed to the current understanding of the ultrafast decay dynamics of inner-shell excited species ranging from atoms and molecules to clusters and recently nanoparticles. He is expert in instrumentation, detectors, and X-ray optics, and has coordinated user facilities and research networks. He is the Scientific and Technical Liaison Officer (STLO) of the Extreme Light Infrastructure Delivery Consortium (ELI-DC). He will lead the SYNERGY work package.

- Professor Alexander Andreev (male), WP4, physicist, is an expert in theory and simulation of laser plasma. He is the author of a series of publications on the fundamentals of laser plasma X-ray generation and its imaging. He is employed on a part time basis by ELI-HU Non-Profit Ltd and will provide the supervision of ELI-HU Non-Profit Ltd full time employees working for the

SIMEX work package. The following ELI-HU Non-Profit Ltd employees will carry out the work Dr. Zsolt Ferencz Lecz, Dr. Dániel Papp and Dr. Ashutosh Sharma.

- Daniele Magarone (male), WP6, is the Leader of Research Program 3 (Particle Acceleration by Lasers) at ELI-Beamlines. His core research activities are laser-driven ion acceleration at different intensity regimes and in different target geometries, corpuscular real-time diagnostics of plasmas generated by laser-matter interaction, and non-linear processes participating at the production of ions with high kinetic energy. He will oversee ELI leadership of the HIREP work package.

- Mihai Cernaianu (male), WP6, engineer, is leading the ELI-NP team dealing with control systems for experimental setups and the two-major instruments at ELI-NP. He will coordinate the ELI-NP effort in the UFDAC and HIREP work packages.

- Jakob Andreasson (male), WP7, is the leader of Research Program 4 of the ELI-Beamlines pillar of ELI, Applications in Molecular, Biomedical, Material Sciences. His core research activities are materials science, strongly correlated electron systems, X-ray free-electron laser science, and instrument development. He will oversee ELI-Beamlines work on timing, pulse duration, and spectral analysis within the PUCCA work package. The ELI-Beamlines work will be carried out by Martin Precek.

The following publications are relevant to the call content:

- A.A. Andreev, P.V. Nickles, K. Yu Platonov: "Generation and transport of energetic electrons in nanowire targets irradiated by relativistic intense laser pulses",
  Plasma Phys. Control. Fusion **56** 084005 (2014)
  doi:10.1088/0741-3335/56/8/084005

- D. Margarone, et al.: "New methods for high current fast ion beam production by laser-driven acceleration", Rev. Sci. Instr. **82** 02B307 (2012)
  doi:10.1063/1.3669796

- J. Andreasson, et al.: "Automated identification and classification of single particle serial femtosecond X-ray diffraction data", Optics Express **22** (3), 2497 (2014)
  doi:10.1364/OE.22.002497

- B. F. Murphy, T. Osipov, Z. Jurek, L. Fang, S.-K. Son, M. Mucke, J. H. D. Eland, V. Zhaunerchyk, R. Feifel, L. Avaldi, P. Bolognesi, C. Bostedt, J. D. Bozek, J. Grilj, M. Guehr, L. J. Frasinski, J. Glownia, D. T. Ha, K. Hoffmann, E. Kukk, B. K. McFarland, C. Miron, E. Sistrunk, R. J. Squibb, K. Ueda, R. Santra, N. Berrah: "Femtosecond X-ray Induced Explosion of C60 at Extreme Intensity", Nature Communications 5, 4281 (2014)
  doi:10.1038/ncomms5281

<u>Participant No 5</u>

Installation européenne de rayonnement synchrotron (ESRF) is a joint facility set up by an intergovernmental convention, supported and shared by 19 European countries, Israel, and South

Africa. It operates the brightest high-energy synchrotron light source in Europe and brings together a wide range of disciplines, including physics, chemistry, materials science, biology, medicine, geophysics, and archaeology. Many industrial applications also benefit from the ESRF's expertise, including pharmaceuticals, cosmetics, petrochemicals, and microelectronics. With some 6400 scientific user visits each year, resulting in more than 1500 refereed publications, the ESRF is recognised as one of the world's most innovative and productive synchrotron light sources.

The ESRF is currently undertaking an ambitious Upgrade Programme, Phase I (2009–2015), which is now close to completion and which benefited from the financial support of the European Community as a Preparatory Phase Project on the ESFRI Roadmap (ESRFUP 2007–2011). The second phase of the ESRF Upgrade Programme will cover new developments from 2015 to 2018 and beyond, and a proposal is currently being elaborated with users, external experts, and the ESRF funding bodies (www.esrf.fr/Accelerators/news/supercharging-the-source).

The ESRF is currently participating in 14 FP7-funded grants, notably the Cluster of Research Infrastructures for Synergies in Physics (CRISP; www.crisp-fp7.eu), of which it is the coordinator, as well as BioStruct-X, CALIPSO, and PanDataODI.

The following key staff will be involved in the project:

- Sakura Pascarelli (female), WP3 and WP4, physicist, has a background in synchrotron radiation and solid-state physics. She is presently Head of the Electronic Structure and Magnetism Group in the Experiments Division of the ESRF. She is an expert of X-ray absorption spectroscopy techniques. Her main research activities deal with the study of matter at extreme conditions, and she is actively involved in implementing at the ESRF dynamic compression experiments using high-power laser shocks. She is the main ESRF contact for EUCALL.

- Manuel Sanchez del Rio (male), WP4, physicist. Member of the data analysis group at ESRF. His professional activity is devoted to synchrotron radiation instrumentation and research. He has more than 100 publications (http://publicationslist.org/srio) in three main fields: (i) computer modelling X-ray optics with applications to the design of synchrotron radiation beamlines and development of related software; (ii) development of data analysis tools targeted for different synchrotron techniques (X-ray absorption spectroscopy, X-ray diffraction, X-ray fluorescence, etc.); and (iii) experimental research related to mesoscopic hybrid materials.

- Pablo Fajardo (male), WP5, physicist and electronic engineering with more than 20 years of experience in synchrotron radiation instrumentation. Currently, he is in charge of the X-ray detector programme and responsible for data acquisition and instrument control at ESRF. He is a member of several evaluation committees, such as the Detector Advisory Committee for the European XFEL, imparted lectures in instrumentation topics, and work package coordinator in several EU-funded projects, including CRISP WP12, High-Throughput Detector Data Streaming.

- Nicolas Janvier (male), WP5, electronics engineers with more than 20 years of experience in product development (including digital sensors, cameras, XR detectors, lasers, etc.); management of projects; and team management. Currently, he is Head of the Electronics Unit at the ESRF.

- Eric Ziegler (male), WP7, physicist, has more than 20 years experience in optics, in particular in the EUV, XUV, and X-ray ranges. During his career, he had the chance to contribute to projects at Argonne National Laboratory (Chicago), Lawrence Berkeley and Livermore National Laboratories, and presently at ESRF, Grenoble. He is currently in charge of the ESRF beamline devoted to the development of new instrumentation and methods. His research activities include the use of online at-wavelength methods to characterize surfaces and thin films and the optimisation of coherence-preserving multilayer optics.

The following publications are relevant to the call content:

- F. Le Mentec, P. Fajardo, C. Herve, A. Homs, T. Le Caer: “RASHPA: A Data Acquisition Framework for 2D X-Ray Detectors”, ICALEPCS2013, San Francisco, California, USA, 6 –11 October 2013, Proceedings ICALEPCS 2013, TUMIB07 (2013)
  ISBN 978-3-95450-139-7

- Ch. Thil, A.Q.R. Baron, P. Fajardo, P. Fischer, H. Graafsma, R. Rüffer: “Pixel readout ASIC for an APD based 2D X-ray hybrid pixel detector with sub-nanosecond resolution”, Proceedings of the 12th International Vienna Conference on Instrumentation,
  Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment **628** (1), 461–464 (2011)
  doi:10.1016/j.nima.2010.07.025

- S. Berujon, E. Ziegler, R. Cerbino, L. Peverini: “Characterizing Concentrated, Multiply Scattering, and Actively Driven Fluorescent Systems with Confocal Differential Dynamic Microscopy”, Physical Review Letters **108** (15), 158102 (2012)
  doi:10.1103/PhysRevLett.108.218103

- F. Cerrina, M. Sanchez del Rio: “Ray-tracing of X-ray Optical Systems”, in: M Bass. (ed.) Handbook of Optics (Volume V) Atmospheric Optics, Modulators, Fiber Optics, X-Ray and Neutron Optics (McGraw-Hill Professional, 2010)
  ISBN 9780071633130

Participant No 6

Helmholtz-Zentrum Dresden-Rossendorf e.V. (HZDR) is a member of the Helmholtz Association of German Research Centres pursuing advanced research in areas of large societal relevance. These include addressing important questions in the research sectors health, energy, and matter in Dresden and three other locations. Three of our five large-scale facilities are also available to external users from around the world to help answer the decisive questions of our society. Scientific research equipment of national and international importance is operated at HZDR and, as such, HZDR is a coordinating member and partner of numerous cooperations and projects. HZDR facilities include the ELBE user facility, which houses two high-power laser systems of Petawatt class, an electron linear accelerator, two infrared free-electron lasers, sources for the generation of X-ray, positron, and neutron beams, and a high-performance computing centre with 8000 CPU cores and 88 GPUs. HZDR leads the consortium of the Helmholtz International Beamline for Extreme Fields at the European

XFEL (HIBEF), which aims at installing a high-power laser and a high-pulse energy laser at the HED instrument of the European XFEL.

The Junior Group Computational Radiation Physics has contributed to the scientific case of the Helmholtz Beamline at the European XFEL. Michael Bussmann is co-founder of the Dresden CUDA Center of Excellence for GPU Computing, has supervised the development of the GPU accelerated open source particle-in-cell code PIConGPU, which was one of the six finalists in the ACM Gordon Bell Award in 2013 and develops algorithms for real-time, large-scale data analysis. The group currently focuses on including detailed atomic models of laser and X-ray FEL interaction with solid density plasmas and collisional processes into plasma simulations with predictive capabilities. The Institute of Radiation Physics coordinates the HIBEF XFEL User Consortium, which will establish ultraintense and high-power lasers and pulsed magnets at the HED instrument at the European XFEL. In HIBEF, HZDR partners with DESY and over 100 research institutions from 20 countries. The ELBE Center for High Power Radiation Sources, within the HZDR Institute of Radiation Physics, is completing a major upgrade, coupling PW-class lasers with the superconducting ELBE acceleration, and its associated IR/THz FEL. Relevant research areas include ultrafast synchronization and characterization of laser and FEL beams, advanced diagnostics, and all aspects of laser-matter interactions, including high rep rate targetry, detectors, and data acquisition and simulations.

The following key staff will be involved in the project:

- Thomas Cowan (male), WP3, physicist, has expertise in laser-plasma physics, particle acceleration, accelerator physics, strong field QED, and nuclear physics and applications. He currently is professor of Radiation Physics at TU Dresden and directs the Institute of Radiation Physics at HZDR and chairs the HIBEF consortium.

- Michael Bussmann (male), WP4 and WP5, physicist, has expertise in accelerator physics, laser-plasma interaction, high performance scientific computing, and large-scale data analysis. He currently leads a Junior Research Group at HZDR with over 20 members working on simulations, synthetic diagnostics, and data analysis in high-power laser interactions with matter and probing these with X-ray lasers.

- Alexander Pelka (male), WP6, physicist, has experience in laser-plasma physics, laser particle acceleration, optical and X-ray plasma diagnostics, and laser-driven shockwaves and jets. He currently is a postdoc at HZDR, mainly concerned with the HIBEF project at the HED experiment at the European XFEL.

- Michael Gensch (male), WP7, physicist, has experience in photon beam and electron beam diagnostics, linear and nonlinear THz spectroscopy, and material sciences. He currently is senior scientist and group leader of the AG Coherent THz radiation at the Institute of Radidation Physics at HZDR.

The following publications are relevant to the call content:

- T. Kluge, C. Gutt, L.G. Huang, J. Metzkes, U. Schramm, M. Bussmann, T.E. Cowan: “Using x-ray free-electron lasers for probing of complex interaction dynamics of ultra-intense lasers with solid

matter”, Phys. Plasmas **21**, 033110 (2014)
doi:10.1063/1.4869331

- R. Pausch, A. Debus, R. Widera, K. Steiniger, A. Huebl, H. Burau, M. Bussmann, U. Schramm: “How to test and verify radiation diagnostics simulations within particle-in-cell frameworks”, Proceedings of the first European Advanced Accelerator Concepts Workshop 2013, Nuclear Instruments and Methods in Physics Research Section A : Accelerators, Spectrometers, Detectors and Associated Equipment **740**, 250–256 (2014)
  doi:10.1016/j.nima.2013.10.073

- J. Metzkes, T. Kluge, K. Zeil, M. Bussmann, S.D. Kraft, T.E. Cowan, U. Schramm: “Experimental observation of transverse modulations in laser-driven proton beams”, New Journal of Physics, **16** (2), 023008 (2014)
  doi:10.1088/1367-2630/16/2/023008

- L.G. Huang, M. Bussmann, T. Kluge, A.L. Lei, W. Yu, T.E. Cowan: “Ion heating dynamics in solid buried layer targets irradiated by ultra-short intense laser pulses”, Physics of Plasmas **20** (9), 093109 (2013)
  doi:10.1063/1.4822338

- U. Fruehling, M. Wieland, M. Gensch et. al.: “Single-shot terahertz-field-driven X-ray-streak camera”, Nat. Photon. **3**, 523–528 (2009)
  doi:10.1038/nphoton.2009.160

- F. Tavella, N. Stojanovic, G. Geloni, M. Gensch: “Few-Femtosecond Timing at 4th Generation X-ray Lightsources”, Nat. Photon. **5** 162–165 (2011)
  doi:10.1038/nphoton.2010.311

- C. Kaya1, C. Schneider, A. Al-Shemmary, W. Seidel, M. Kuntzsch, J. Bhattacharyya, M. Mittendorff, P. Evtushenko, S. Winnerl, G. Staats, M. Helm, N. Stojanovic, P. Michel, M. Gensch: “Phase sensitive monitoring of electron bunch form and arrival time in superconducting linear accelerators”, Appl. Phys. Lett. **100**, 141103 (2012)
  doi:10.1063/1.3699025

- R. Yurchak, A. Ravasio, A. Pelka, et al.: “Experimental Demonstration of an Inertial Collimation Mechanism in Nested Outflows”, Phys. Rev. Lett. **112**, 155001 (2014)
  doi:10.1103/PhysRevLett.112.155001

Participant No 7

Lunds universitet (LU) is Scandinavia’s largest institution for education and research. It is the host university of two of the partners in this application, the national MAX-IV laboratory and of the Lund Laser Centre (LLC). MAX-IV and LLC are both part of the Lund University, and all staff mentioned at either of these two units are employed by the Lund university.

Lund Laser Centre (LLC): LU coordinates, via LLC, the European network of major laser research infrastructures, LASERLAB-EUROPE. The director of LLC is the coordinator of LASERLAB-EUROPE. The role of LU in the current project is to represent LASERLAB-EUROPE at large. As an integrating activity in FP7, LASERLAB-EUROPE brings together 30 leading organisations in laser-based interdisciplinary research from 16 countries. Together with associate partners, it covers the majority of European member states. The consortium is planning further expansion in Horizon 2020, both in size and in scope of activities, in all areas of an integrating activity (access, networking, and JRAs.)

The main objectives of LASERLAB-EUROPE are:

- To promote, in a coordinated way and on a European scale, the use of advanced lasers and laser-based technologies for research and innovation

- To serve a cross-disciplinary user community, from academia as well as from industry, by providing access to a comprehensive set of advanced laser research installations

- To increase the European basis of human resources in the field of lasers by training new users, including users in new domains of science and technology and from geographical regions of Europe where laser user communities are still less developed

- To improve human and technical resources through technology exchange and sharing of expertise among laser experts and operators across Europe, and through coordinated JRAs enabling world-class research, innovations, and applications beyond the present state of the art

The LLC at LU has since 1996 been a member in EC-funded European consortia of Laser Facilities providing international access. It is a founding member of LASERLAB-EUROPE. In Sweden, LLC is a Linnaeus Environment of Excellence for multidisciplinary laser spectroscopy. It represents LASERLAB-EUROPE in the Association of European-Level Research Infrastructure Facilities (www.erf-aisbl.eu).

The following key staff at Lund LU, active at LLC will be involved in the project:

- Claes-Göran Wahlström (male), WP3, Professor of Physics, Head of the Atomic Physics Research Division, Lund University, Director of Lund Laser Centre, and Coordinator of LASERLAB-EUROPE.

The MAX IV Laboratory (MAX IV) is a national laboratory, but legally a unit within the Lund University, that has been offering synchrotron light to mainly the Swedish and Nordic research community for more than 26 years. It is currently running the existing synchrotron facility MAX-lab as well as building and developing a new facility called MAX IV. Every year close to 1000 scientists visit the current facility MAX-lab, which performs experiments in areas as diverse as electron spectroscopy and protein crystallography. The laboratory is world leading in storage ring technology and development as witnessed by the worldwide interest in the MAX IV design and its impact on design plans at other major facilities. The new facility MAX IV will consist of a 1.5 and a 3 GeV storage ring as well as a short pulse facility for time-resolved experiments. Since the design of the 3 GeV storage ring contains a novel multibend achromat design, the emittance will be below 0.3 nm rad, which means that it will become the world's brightest storage-ring-based light source. The construction of this new facility is currently proceeding, and it is foreseen that the facility will become operational for user experiments during the second half of 2016. The facility has so far secured funding for 13 beamlines, of which a number would benefit from the technical development included in the proposed work package. Long term these developments would also support a future X-ray FEL at MAX IV, which is currently at the planning stage.

The following key staff at Lund LU, active at MAX IV, will be involved in the project:

- Tomas Lundqvist (male), WP6, Life Science Director.
- Thomas Ursby (male), WP6, BioMAX Beamline Project Manager.

The following publications are relevant to the call content:

- Leemann S.C., Andersson Å, Eriksson M., Lindgren L.-J., Wallén E., Bengtsson J., & Streun A. “Beam dynamics and expected performance of Sweden’s new storage-ring light source: MAX IV”, Phys. Rev. ST Accel. Beams **12**, 120701 (2009)
- See also contributions to Special Issue on Diffraction Limited Storage Rings, Journal of Synchrotron Radiation (Sep 2014, in press).

Participant No 8

Paul Scherrer Institut (PSI) is the largest research centre for natural and engineering sciences in Switzerland, conducting cutting-edge research in three main fields: matter and materials, energy and environment, and human health. PSI employs 1900 people, with an annual budget of approximately CHF 350 million, and is primarily financed by the Swiss Confederation. PSI is part of the ETH Domain. PSI develops, builds, and operates complex large-scale research facilities, the **SINQ neutron source**, the **Swiss Light Source (SLS),** and the **SμS muon source,** attracting more than 2200 user scientists per year. The next large-scale facility at PSI—the X-ray laser SwissFEL—should come online in 2016. SwissFEL is a free-electron X-ray laser that will deliver extremely short and intense flashes of coherent X-ray radiation. These properties will enable novel insights to be gained into the structure and dynamics of matter illuminated by the X-ray flashes.

EIGER is the next-generation single-photon counting X-ray pixel detector being developed at the Paul-Scherrer-Institut. With its small pixel size (75 μm) and an extremely high frame rate capability (22 kHz), it produces data rates on the order of 2 GByte/s per detector module. With detector systems that have up to 18 modules (9 Mpx) being commissioned at SLS beamlines, the EIGER project represents a challenge in terms of data transfer rate, storage performance, and CPU power for on-the-fly data compression. The PSI detector group is part of the AGIPD collaboration. AGIPD is a high-speed detector intended for use at the European XFEL. It allows single-pulse imaging at 4.5 MHz frame rate with a dynamic range allowing single-photon detection and detection of more than 10 000 12.4 keV photons in the same image. PSI is active in the ASIC design and in the detector characterization and calibration. With the PILATUS and Mythen photon counting detectors, PSI has acquired a decade-long experience in online and offline data preprocessing (geometry, count rate, flat field corrections), albeit in lower data-rate scenarios.

The following key staff will be involved in the project:

- Bernd Schmitt (male), WP5, has been responsible for detector development at SLS since 2008. He leads a research group with 15 members working on several detector development projects for both synchrotron (EIGER, Mythen, and Moench) and X-ray FEL sources (AGIPD, Gotthard, Jungfrau). He has experience in all aspects of hybrid pixel detector development, from ASIC design to beamline detector integration. Since October 2012, he is member of the Photon Science Committee at DESY in Hamburg.

The following publications are relevant to the call content:

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- B. Henrich, A. Bergamaschi, C. Broennimann et al.: "PILATUS: A single photon counting pixel detector for X-ray applications", Radiation Imaging Detectors 2008 — Proceedings of the 10th International Workshop on Radiation Imaging Detectors, Nuclear Instruments & Methods in Physics Research Section A: Accelerators Spectrometers Detectors and Associated Equipment **607** (1), 247–249 (2009) doi:10.1016/j.nima.2009.03.200
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4.2 Third parties involved in the project (including use of third party resources)

Participant No 1 European X-Ray Free-Electron Laser Facility GmbH (XFEL)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**N**

Does the participant envisage that part of its work is performed by linked third parties[1]?	**N**
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

<u>Participant No 2</u> Stiftung Deutsches Elektronen-Synchrotron DESY (DESY)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**Y**
DESY has developed a calibrated gas monitor detector that is capable of measuring absolute pulse energies non-destructively with an uncertainty of ~ 10% in the photon energy range from 0.1 keV to 12.5 keV. In order to extend the dynamic and photon energy range as well as to improve their accuracy, more R&D and tests at different FEL or laser sources are required. Thus, this device should be calibrated at the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig, Germany, for a cost of 5,000 €.	
Does the participant envisage that part of its work is performed by linked third parties?	**N**
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

<u>Participant No 3</u> Elettra – Sincrotrone Trieste SCpA (Elettra)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**N**
Does the participant envisage that part of its work is performed by linked third parties?	**N**
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

<u>Participant No 4</u> Extreme-Light-Infrastructure (ELI)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**Y**
ELI leads the WP3 which includes the organization of the Synergy Board (SB). Up to five high level representatives shall be appointed to the SB, nominated by the optical laser, FEL, and synchrotron RIs involved in EUCALL. These representatives will provide major input to the SB and will significantly contribute to the definition and evaluation of the data collected to from the partners in preparation of the synergy and efficiency evaluation. The importance of these contributions led to the conclusion to	

[1] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

define these tasks as subcontracting. As indicated above, the selection of the high-level experts shall be based on recommendations of the optical laser, FEL and synchrotron RIs and final approval by the Steering Committee. The nominees shall be recognized experts in their field with extensive knowledge in particular in the operation of advanced light sources. The selection should allow for a balanced representation of the various communities relevant to EUCALL. Experts may be contracted on an individual basis or by the proxy of their home organization. It turned out to be impossible to have more than three experts involved, due to availability constraints. 72,000€ are budgeted to cover for the remuneration and expenses related to their participation in the SB over the duration of the EUCALL project.

Does the participant envisage that part of its work is performed by linked third parties?	**Y**

ELI-DC is the coordinating legal entity for the ESFRI project "Extreme Light Infrastructure". This currently harmonizes the work of the three active pillars that are implementing three elements of the facility. These pillars currently carry out the research work of the ELI project. ELI-DC itself does not carry out R&D work. Each pillar is hosted by an institution in the country implementing the build of that part of ELI and is legally connected to ELI-DC as a host country member of the delivery consortium. These constitute the linked third parties, and the employees of these organizations that work on the ELI project will carry out the ELI elements of the work in all of the R&D work packages of this project.

The three participating host institutions are:

Institute of Physics of the Academy of Sciences of the Czech Republic (Fyzikální ústav AV CR, v.v.i.) in the Czech Republic (short: IP-ASCR)

Hosts the ELI-Beamlines Facility Dolni Brezhany near Prague, Czech Republic. This will provide high-power, high-repetition-rate lasers, high-repetition-rate lasers for high-field physics experiments with focused intensities of about 10^{23} W/cm^2 to investigate exotic plasma physics and non-linear QED effects, and will provide short-pulse secondary sources of radiation and particles for multidisciplinary applications in molecular, biomedical and material sciences, physics of dense plasmas, warm dense matter, and laboratory astrophysics.

IP-ASCR will contribute to:

WP5: The investigation of DMA (direct memory access) between GPU/FPGA for high-speed online processing and (1) Ethernet interfaces and (2) digitizer systems. Further it will investigate and implement FPGA and GPU algorithms for online processing of data for a feedback-based, real-time distributed (e.g. EtherCAT-based) control system (e.g. feedback loop (> 10 Hz) for deformable mirror adjustment, handling data of several high-speed cameras; automatic robot-based positioning of targets) as well as online processing of digitized signals from diagnostics and detectors employed by users. 12 pm will be assigned and the work will be carried out by Petr Pivoňka, Ondřej Janda (replacing Alejandro Vázquez-Otero)

WP6: Development of automatic and semi-automatic methods for target identification and localization and development of a prototype automatic calibration system.10 person months will be assigned. WP6 will be led by Daniele Margarone work will be carried out by members of the targetry team at ELI-Beamlines Piotr Lutowaski and Tuomas Wiste.

WP7: Delivery of arrival time monitors between two independent pulsed light sources with femto-second time resolution, in particular the liquid-jet based arrival time monitor. 12 pm of time has been assigned to this and the work will be carried out by Martin Precek working under Jakob Andreasson. 50000€ will be required for or adaptations of the sample delivery system for arrival time measure-

ments.
For the activities of IP-ASCR the following funds will be transferred to this LTP, specified as direct costs: 219,300 € for personnel costs and 102,490€ for other direct costs amounting to a total: of 321,790 € in direct costs.

ELI-Hu non-profit limited liability company in Hungary (short: ELI-HU Non-Profit Ltd.)
Will host the ELI-Attosecond Facility Light Pulse Source (ELI-ALPS) in Szeged, Hungary, which will provide light sources between THz (10^{12} Hz) and X-ray (10^{18}–10^{19} Hz) frequency range in the form of ultrashort pulses with high repetition rate.
ELI-HU Non-Profit Ltd will contribute to:
WP4: ELI-HU Non-Profit Ltd will be involved in the delivery of individual simulation modules and common interfaces for interoperability. It will be the sole linked third party contributing to this work. It has 36 person months assigned and the work will be under the supervision of Alexander Andreev.
WP5: The investigation of DMA (direct memory access) between GPU/FPGA for high-speed online processing and (1) Ethernet interfaces and (2) digitizer systems. Further it will investigate and implement FPGA and GPU algorithms for online processing of data for a feedback-based, real-time distributed (e.g. EtherCAT-based) control system (e.g. feedback loop (> 10 Hz) for deformable mirror adjustment, handling data of several high-speed cameras; automatic robot-based positioning of targets) as well as online processing of digitized signals from diagnostics and detectors employed by users. 18 pm will be assigned and the work will be supervised by Sandor Brockhauser and Péter Szász.
WP6: Development of automatic and semi-automatic methods for target identification and localization and development of a prototype automatic calibration system 8 person months will be assigned and the work will be coordinated by Patrizio Antici.
For the activities of ELI-HU Non-Profit Ltd the following funds will be transferred to this LTP, specified as direct costs: 251,200 € for personnel costs and 25,300€ for other direct costs amounting to a total: of 276,500 € in direct costs

Horia Hulubei National Institute of Research and Development for Physics and Nuclear Engineering in Romania (short: IFIN-HH)
This is the host of the ELI-Nuclear Physics (ELI-NP) facility in Magurele, Romania, which will focus on laser-based nuclear physics. It will host two machines: a very high-intensity laser, where beams from two 10 PW lasers are coherently added to get intensities of the order of 10^{23}–10^{24} W/cm^2, and a very intense, brilliant gamma beam that is obtained by incoherent Compton back scattering of a laser light off a brilliant electron beam from a conventional linear accelerator.
IFIN-HH will contribute to:
WP3: A new appointment will be made for a full time high level assistant to work with Catalin Miron, the Scientific and Technical Liaison Officer (STLO) of ELI-DC and leader of this work package. Both will be based at this LTP, while Catalin Miron in an employee of ELI-DC and the new staff will be an employee of IFIN-HH. This structure reflects the distributed organization of the ELI project.
WP5: The investigation of DMA (direct memory access) between GPU/FPGA for high-speed online processing and (1) Ethernet interfaces and (2) digitizer systems. Further it will investigate and implement FPGA and GPU algorithms for online processing of data for a feedback-based, real-time distributed (e.g. EtherCAT-based) control system (e.g. feedback loop (> 10 Hz) for deformable mirror adjustment, handling data of several high-speed cameras; automatic robot-based positioning of

targets) as well as online processing of digitized signals from diagnostics and detectors employed by users. 18 pm will be assigned and the work will be coordinated by Mihail Cernaianu. WP6: Development of automatic and semi-automatic methods for target identification and localization and development of a prototype automatic calibration system. 6 person months will be assigned and the work will be coordinated by Mihail Cernaianu. For the activities of IFIN-HH the following funds will be transferred to this LTP, specified as direct costs: 134,500 € for personnel costs and 17,500€ for other direct costs amounting to a total: of 152,000 € in direct costs.

Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

Participant No 5 Installation européenne de rayonnement synchrotron (ESRF)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**N**
Does the participant envisage that part of its work is performed by linked third parties?	**N**
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

Participant No 6 Helmholtz-Zentrum Dresden-Rossendorf e.V. (HZDR)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**N**
Does the participant envisage that part of its work is performed by linked third parties?	**N**
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

Participant No 7 Lunds universitet (LU)

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be subcontracted)?	**N**
Does the participant envisage that part of its work is performed by linked third parties?	**N**
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)?	**N**

5 Ethics and Security

5.1 Ethics

The ethical standards and guidelines of Horizon2020 will be rigorously applied, regardless of the country in which the research is carried out.

5.2 Security[2]

Our project will involve:

- Activities or results raising security issues: NO.

- “EU-classified information” as background or results: NO.

[2] Article 37.1 of Model Grant Agreement. Before disclosing results of activities raising security issues to a third party (including affiliated entities), a beneficiary must inform the coordinator—which must request written approval from the Commission/Agency; Article 37. Activities related to ‘classified deliverables’ must comply with the ‘security requirements’ until they are declassified; Action tasks related to classified deliverables may not be subcontracted without prior explicit written approval from the Commission/Agency.; The beneficiaries must inform the coordinator—which must immediately inform the Commission/Agency—of any changes in the security context and—if necessary—request for Annex 1 to be amended (see Article 55)