EUCALL

The European Cluster of Advanced Laser Light Sources

Grant Agreement number: 654220

Work Package 3 – Synergy of Advanced Light Sources

Deliverable D3.3
Optimum use of advanced light sources: challenges and potential

Lead Beneficiary: ELI

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Deliverable Type	
R = Report DEM = Demonstrator, pilot, prototype, plan designs DEC = Websites, patents filing, press & media actions, videos, etc. OTHER = Software, technical diagram, etc.	R
Dissemination Level	
PU = Public, fully open, e.g. web CO = Confidential, restricted under conditions set out in Model Grant Agreement CI = Classified, information as referred to in Commission Decision 2001/844/EC	PU

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1. Introduction

In order to develop recommendations for the optimum use of advanced light source research infrastructures, EUCALL members have engaged in a series of activities to promote cross-community experience exchange between laser and accelerator-based sources of UV and x-ray light, and to analyse possible methods to enhance their efficient use. This report summarizes the outcomes of these activities. Experience exchange workshops were held, both for research infrastructure (RI) staff and for open audiences, in order to discuss operational matters and scientific issues of interest to both communities. Previously established cross-community collaborations have been analyzed in order to determine how future activities might be better optimized. Policies of RI clusters involving user access and training have also been studied in order to develop recommendations for a more efficient use of EUCALL's consortium of complementary light sources.

Section 2 contains a description the experience exchange workshops organized during 2017, which were entitled "User Access at Advanced Laser Light Sources", "Innovation Potential of Advanced Laser Light Sources" and "Biology at Advanced Laser Light Sources".

To explore how research collaborations between the accelerator and laser communities can be efficiently stimulated, EUCALL has performed a series of interviews with project leaders of the existing collaborations "Lasers at ESRF", "Table-top FELs at DESY and ELI" and the "HIBEF User Consortium". The responses have been analyzed and led to recommendations for future collaborations, which are presented in Section 3.

The experiences of Laserlab-Europe and of the CALIPSO/CALIPSOplus projects in establishing joint access policies within the laser community and accelerator community respectively have been studied by EUCALL and are summarized in Section 4. The approaches of these two consortia to user training have also been investigated, and a concept for user training from the respective "other" community is presented based on these and on EUCALL's own activities.

A further activity has been to develop suggestions for the promotion of innovative scientific and technical developments at research infrastructures, based on the discussions with the participants of the "Innovation Potential of Advanced Laser Light Sources" meeting and on the outcomes of EUCALL's innovation analysis (presented in Deliverable 3.2). These are presented in Section 5. Finally, in Section 6 we summarize the main findings and recommendations of this work and analyze them in context of the goal of EUCALL to develop recommendations for the optimum use of advanced sources of UV/x-ray light.

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2. Cross-community exchange of know-how and experience

In this section we report on three experience exchange workshops organized within EUCALL WP3, which brought together both RI operators and scientific users of the accelerator and laser communities. The workshop "User Access at Advanced Laser Light Sources" addressed the procedures involved in user access at EUCALL's facilities, while the event "Innovation Potential of Advanced Laser Light Sources" gathered technology transfer experts from participating facilities. The workshop "Biology at Advanced Laser Light Sources" was an open event discussion about how research programs on different kinds of biological systems uses synchrotron, FEL and optical laser facilities.

2.1 User Access at Advanced Laser Light Sources

This event, held on 21 - 22 September 2017 at ELI-Beamlines, was an experience exchange workshop for invited staff of EUCALL facilities, during which the operators of each user facility exchanged information about their standard practices in the area of user access. This was foreseen to be of particular interest for the then under-construction RIs who could develop their user access policies based on practices of currently operational facilities.

The content for this workshop was proposed by representatives of ELI who are responsible for building up its future User Offices, and developed by EUCALL WP3 members. Topics included "Calls for Proposals", "User Portal", "Safety Training for Users, and Safety Staff", "Publication Database" and "Joint Access Policies".

Invited speakers were User Office experts, data handling experts, safety officers and librarians from EUCALL RIs, as well as from some external facilities upon the recommendation of the ELI management (CERIC-ERIC (IT), STFC (UK), LCLS (USA)). The event was held over two days and was attended by 24 participants.

The workshop greatly improved the exchanges between the ELI facilities and the User Offices of the other participating facilities, as could be observed during the discussion following each presentation. Furthermore strong interaction between the staff of the operational facilities (such as DESY, Elettra, ESRF, European XFEL, HZDR, MAX IV, Laserlab-Europe) during the workshop also demonstrated the benefit to these RIs in attending.

EUCALL was also able to address the gathered experts with issues related to the optimum use of RIs, including limitations and the optimum response to a variety of user demands, which was a focus of work presented in EUCALL Deliverable 3.2.

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Participants at the EUCALL Workshop: User Access at Advanced Laser Light Sources at ELI-Beamlines

An important outcome of this workshop was the invitation from MAX IV to ELI, to CERIC-ERIC and to EUCALL WP3 members, to present details of their collaborations and facilities at the European User Office Meeting in Lund (23 - 24 October 2017) in order to extend awareness of these initiatives to other European photon source RIs. This enabled the broader dissemination of EUCALL's goals, objectives and in particular the extension of the Wayforlight database, to the User Office experts of 18 European radiation source user facilities (ALBA, ASTRID2, DESY, Diamond, Elettra, ELI-ALPS, EMBL, European XFEL, ESS, ISIS, FZ-Jülich, HZDR, HZB, MAX IV, PSI, Soleil, SOLARIS, STFC).

A second outcome is that as follow-up activities, ELI-Beamlines and European XFEL organized a training workshop on 29 January 2018, during which ELI-Beamlines Safety Group members attended joint sessions on safety policies and training at European XFEL. A second training workshop took place on 25 - 26 September 2018 during which the ELI-Beamlines User Office staff attended joint sessions on user office practices at European XFEL.

Finally, EUCALL created the emailing list user-access@eucall.eu for all of the participants of the workshop. If any member has an issue to discuss, it is possible to post it to this mailing list and the other members are free to respond.

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User Access at Advanced Laser Light Sources
21 - 22 September 2017

Venue: ELI-Beamlines
Za Radnicí 835, 252 41 Dolní Břežany, Czech Republic

Hotel for participants: Hotel Otar, address: Sevřená 1302/8, 140 00 Prague 4

Thursday 21 September 2017

Time	Programme
10:50	**Meet in front of Hotel Otar for bus departure to ELI-Beamlines**
11:00	**Bus departure from Hotel Otar to ELI-Beamlines**
12:00	**Registration and light lunch**
12:45	***Welcome and Introduction* – G. Appleby / European XFEL**
13:00	***Current User Access agreement for ELI-DC* / ELI TRANS – D. Charalambidis / ELI-ALPS**
13:30	***User Office* – M. Bassanese / Elettra**
14:00	***User Portal* – B. Schramm / HZDR**
14:30	***Calls for Proposals I* – D. Unger / DESY**
15:30	**Coffee Break + Group Photo**
16:00	**Calls for Proposals II – M. Thunnissen / MAX IV**
16:40	***User Feedback* – J. McCarthy / ESRF**
17:10	***Data Handling* – R. Pugliese / Elettra, O. De Giacomo / CERIC-ERIC**
18:30	**Bus departure to Restaurant Kolkovna**
19:00	**Further exchange of information during dinner at Kolkovna restaurant, address: Budějovická 1518/13a, 140 00 Praha 4**
22:00	**Bus departure from restaurant to Hotel Otar**

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Friday 22 September 2017

Time	Programme
07:45	Bus transfer from Hotel Otar to ELI-Beamlines
08:30	*On-site support* – M. Thunnissen / MAX IV
09:15	*Safety training of users, and Safety Staff* – R. Clarke / STFC, I. Evans / LCLS, P. Saffari / European XFEL
10:15	*Joint Access Policies: LaserLab Europe* – D. Normand / CEA
10:35	Coffee Break
11:00	*Joint Access Policies: CALIPSOplus+wayforlight* – B. Schramm / HZDR
11:20	*Publication database* – Alexander Wagner / DESY
11:40	Q&A (roundtable)
12:10	Conclusions
12:30	End
12:45	Bus transfer to Airport

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2.2 Innovation Potential of Advanced Laser Light Sources

This experience exchange workshop, held on 14 – 16 November 2017 in Sitges, Spain, for staff of EUCALL facilities allowed representatives of the innovation environment to present their practices and activities. The EUCALL workshop was a satellite workshop to larger meetings of the industrial liaison offices of synchrotron, FEL and neutron sources: "CALIPSOplus/SINE2020 First Industry Officer Workshop and Networking" (15 - 16 November) and "ESS - Best Practice for Industry Access to Neutrons" (16 November - also relevant to photon sources), both at the same venue. These two workshops specifically addressed activities to promote commercial access of facility instrumentation to industrial users. The EUCALL workshop addressed other issues of technology transfer / innovation potential at EUCALL's light sources, however the decision was made to connect these meetings, as at some facilities (such as DESY, Elettra, ELI and European XFEL), the same staff members are involved in all topics and it is preferable to avoid multiple separate meetings of the same staff members whenever possible.

The EUCALL workshop included presentations from the participants on the best practices of topics such as "patenting and commercialization of intellectual property", "support of spin off companies at RIs" and "science parks/innovation hubs at RIs". A primary aim was to present to the technology transfer staff of the new ELI facilities the best practices that have been developed at operating synchrotron and FEL facilities as well as at laser facilities, particularly in the Laserlab-Europe network. A further goal of the workshop was for EUCALL WP3 members to present the results of the "Innovation Potential of EUCALL" surveys and reports to the participating experts (reported within EUCALL Deliverable 3.2). The event ran for two days and was attended by 27 participants.

The first day was dedicated to presentations from staff of the technology transfer offices of running facilities and organizations, to facilitate knowledge exchange and create networking between the gathered experts. EUCALL also made presentations about the results of its WP3 "Innovation of EUCALL" surveys.

On the second day these discussions continued, but also speakers from the ELI facilities and ELI-TRANS Horizon 2020 project presented their programmes, with some panel discussions and workings groups to push long-term reflections and recommendations.

On 16 November, the EUCALL workshop participants joined the ESS workshop "Best Practice for Industry Access to Neutrons", a common panel with other participants to the meeting discussed commercial access policies in a larger context of European, American and Japanese photon and neutron sources.

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Participants of the EUCALL Workshop: Innovation Potential of Advanced Laser Light Sources in Sitges, Spain

The content for the EUCALL Satellite workshop was generated by EUCALL WP3 members, following up the EUCALL surveys on Innovation Potential, and questions from ELI management responsible for building up the future technology transfer and industrial liaison offices of the infrastructures.

Invited speakers were technology transfer experts of RIs, CEOs of start-ups linked to the research activities, representatives of associations who support innovation. The speakers from many European and international RIs were identified by WP3 members during the analysis of the “Innovation Potential of EUCALL” data collection.

The EUCALL workshop attendees gave very positive feedback on their interest to participate in future networking events of Technology Transfer experts. The presentations and discussions which took place enabled EUCALL to develop many of the recommendations that were presented in the “Innovation Potential of EUCALL” section of Deliverable 3.2. Furthermore the representatives from each ELI facility underlined their interest to learn about the best practices of other communities for dealing with constraints similar to those that ELI faces. The representatives from each ELI facility showed particular interest in the presentations about the projects supporting industrial access to multiple facilities in different countries, such as CALIPSOplus and LINX, as similarities between the problems these projects must face and the challenges of the ELI organization were identified. It was also of benefit to the ELI representatives to have face-to-face networking opportunities with

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the well-established industrial liaison experts from the synchrotron, FEL and neutron facilities.

EUCALL created the emailing list innovation@eucall.eu for all of the participants of the workshop. If any member has an issue to discuss, it is possible post it to this mailing list and the other members are free to respond.

A very useful outcome of this activity has been the invitation of the Technology Transfer Office Group Leader of ELI-Beamlines to participate on behalf of ELI into the industrial liaison activities of the CALIPSOplus, NFFA and the SINE2020 Horizon 2020 projects, which in effect bridges ELI with both the accelerator and neutron communities, and will continue beyond the end of EUCALL's funding period. EUCALL's collaboration with these projects has developed the formation of the joint "European Analytical Research Infrastructure Village (EARIV)" identity which performs outreach activities to industry. This further enables ELI to be involved in clustering activities that can effectively offer a full-service to industry, covering applications of synchrotron and FEL radiation, optical laser-based sources and neutrons.

A further outcome of this activity was that ELI-NP organized a complementary event on 17 September 2018 called "Industry Day" to provide an experience exchange opportunity aiming at providing the business community with insights on the way the Romanian industry and in particular SMEs may engage with ELI-NP. This event was conceived as a practical exercise taking stock of and disseminating the main outcomes of the previous activities of EUCALL in that field. Five actions were developed as conclusions and follow-ups of the conference:

1. Intense Educational Program for the Management of Knowledge and Technology Transfer for ELI Activity and Partners (Bucharest Academy of Economic Studies and Sofia University), to train young researchers in innovation policies.
2. Definition of the industrial activities that ELI-NP must address, recognizing that Magurele High Tech Cluster is the best candidate to be the contact entity and shall initiate cooperation with the industrial sectors potentially industry in cooperation with ELI-NP.
3. Establish a partnership with the Romanian Association for Export – Import, create a working group with the goal to internationalize the advanced research activity of the institutes and innovative companies' partners of ELI-NP.
4. Joint Research Projects: conditions should be defined to attract innovative companies to become involved in research projects with ELI-NP and its partners and attract third party funding.
5. Development of INNOGATE21 (online communication platform created and managed by ELI-NP and MHTC) together with ELI-Beamlines and ELI-ALPS, to share content concerning the innovation possibilities within the ELI facilities, with a special focus on the industrial collaborations.

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Innovation Potential of Advanced Laser Light Sources
14 - 15 November 2017

Venue: Hotel Melia Sitges – Room: Mestral 1+2
Carrer de Joan Salvat Papasseit 38, 08870 Sitges, Barcelona, Spain

Tuesday 14 November 2017

Time	Programme
12:00	Registration and light lunch
13:00	*Welcome and Introduction* – G. Appleby / European XFEL
13:30	*Photonics21 support to spin-offs and technology road-maps* – S. Royo / Photonics21
14:00	*Fraunhofer support to spin-offs and technology road-maps* – H. Hoffmann / ILT Aachen
14:30	*Patenting and protection of Intellectual Property* – A. Zennaro / CERIC-ERIC
15:00	Coffee Break + Group Photo
15:30	*Support of Spin-Offs* – M. Peloi / Elettra
16:00	*Support of Spin-Offs and Commercialization of IP at EUCALL facilities* – F. Canova / ELI-DC
16:30	*Experience of a light source's spin-off company* – R. Geometrante / Kyma Undulators
17:00	*Innovation Hubs around light sources* – D. Drossmann / DESY
17:30	*Commercial Access at Advanced Laser Light Sources* – G. Appleby / European XFEL
18:00	End of Session
20:00	Further exchange of information during dinner at "*La Taberna del Puerto*" - Avenida del Port d'Aiguadolç 24

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Wednesday 15 November 2017

Time	Programme
09:00	*Technological transfer road-map at CEA* – D. Normand / CEA
09:30	*Activities of LaserLab-Europe industrial board* – C. Simon Boisson / Thales
10:00	*Panel Discussion: Publication vs commercialization*
11:00	Coffee Break
11:30	*Joint Development of Technology at EUCALL facilities* – G. Appleby / European XFEL
12:00	*Technology Transfer at European XFEL* – A. Bonucci / European XFEL
12:30	*Technology Transfer at ELI-ERIC / ELI TRANS* – A. Hála / ELI-Beamlines
13:00	Networking Lunch with CALIPSOplus/SINE2020 meeting participants
14:00	*Science parks and technological support at ELI* – I. Molnar / ELI-ALPS; A. Hála / ELI-Beamlines; D. Seuleanu / ELI-NP
15:20	Joint coffee break with CALIPSOplus/SINE2020 meeting participants
15:50	*Dissemination in Science: ELI perspectives* – I. Ghinet / ELI-NP
16:20	Working groups: Promotion of innovative technological and scientific developments at Advanced Laser Light Sources
17:15	Summary and Close-out
17:30	End of Workshop
20:00	Further discussion with CALIPSOplus/SINE2020/ESS meeting participants during dinner at "*Fragata*" – Passeig de la Ribera 1

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2.3 Biology at Advanced Laser Light Sources

This event was held on 30 November – 01 December 2017 as an experience exchange workshop between synchrotron, FEL and optical laser communities, for RI operators and users. The focus on biology applications was selected since these are currently of high relevance to all of the participating facilities within EUCALL. The program was designed to recognize the specific strengths of synchrotron, FEL and optical laser light sources in biological applications and inform participants about the large array of scientific applications provided by this suite of installations to the scientific community and to highlight the complementarity of the different sources.

The meeting consisted of a series of presentations about the history, development and current capabilities of biological imaging using synchrotron radiation, high-power laser generated UV and x-ray radiation and then using free-electron laser radiation. This provided a clear overview of the strengths of each type of RI in biological imaging, including direct comparisons of images of the same systems using different light sources. This session was concluded with an overview of the new ELI-BIO project, which included an overview of ELI-Beamlines as well as a presentation of how the facility will allow biological studies in the future.

Further presentations discussed radiobiology using high-power lasers, an overview of sample delivery methods for biological experiments at high repetition-rate x-ray science facilities and the challenges for data handling, storage and analysis at advanced light sources – which highlighted statistics such as that facilities like European XFEL is expected to generate up to 100 TB/hr of data during 2018. The challenges for crystallography at synchrotrons and FELs were also presented, as well the use of time-dependent crystallography in observing molecular motion, time-resolved SAXS/WAXS in biological systems, and the application of ultrafast x-ray spectroscopy in biological studies. The industrial use of Diamond Light Source's facilities for study of biological systems was also presented.

EUCALL considers that this workshop was a great success and very positive feedback and comments were provided from both participants and invited speakers. The workshop attracted significant interest within the scientific community, as very high level speakers accepted EUCALL's invitation to participate. This was further confirmed when 100 participants registered for the workshop within the first two weeks of opening the registration.

Half of the participants came from synchrotron (21), FEL (20) or optical laser facilities (13) while the other half came from universities (26), biological research facilities (21) or "other" types of institutes (6) such as institutes for physics or the Swedish Research Council. This shows that the workshop was able to attract an equal mix of RI operators (from the laser and accelerator communities) and users, which is considered by EUCALL to be a very successful outcome.

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Emma Springate (CLF, UK) presents "Imaging bio-matter and objects (HHG - optical laser sources)" at the EUCALL Workshop: Biology at Advanced Laser Light Sources at European XFEL.

This workshop was a very effective experience exchange event which brought together RI staff, from synchrotron, FEL and optical laser RIs, and users from 14 countries. For the future it is recommended to organize similar events for other topics of common scientific interest to each type of EUCALL RI, such as high-energy density physics or condensed matter physics.

Biology at Advanced Laser Light Sources

30 November - 01 December 2017

Venue: European X-ray Free-Electron Laser Facility
Holzkoppel 4, 22869 Schenefeld, Germany

Thursday 30 November 2017

Time	Programme
12:00	**Registration and light lunch**
13:00	***Welcome to European XFEL* – R. Feidenhans'l / European XFEL**
13:05	***EUCALL and its Facilities* – T. Tschentscher / European XFEL**
	Structure Investigations I
13:15	***Imaging bio-matter and objects (synchrotrons)* – J. Kirz / ALS**
13:45	***Imaging bio-matter and objects (HHG)* – E. Springate / CLF**
14:15	***Imaging single particles and fixed objects (FELs)* – F. Maia / Uni. Uppsala**
14:45	***The ELIBIO project* – J. Hajdu / ELI-Beamlines**
15:15	**Coffee Break**
	Other Methods and Method Development
15:45	***Radiobiology at High Power Laser Facilities: The A-SAIL project* – K. Price / Queen's Uni. Belfast**
16:15	***Radiobiology research with laser driven ionizing radiation* – K. Hideghéty / ELI-ALPS**
16:45	***Sample injection techniques* – A. Meents / CFEL**
17:15	***Challenges in data collection, storage, analysis* – A. Barty / CFEL**
17:45 – 22:00	**Poster session and Dinner including rotating facility tours**

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Friday 01 December 2017

Time	Programme
	Structure Investigations II
09:00	***Challenges for crystallography at Synchrotrons and FELs*** **– D. Stuart / Diamond Light Source**
09:30	***Tracking molecular motion by time-dependant crystallography*** **– R. Neutze / Uni. Gothenberg**
10:00	***Use of large scale facilities for study of bio-systems by industry*** **– J. Waterman / Diamond Light Source**
10:30	**Coffee Break**
	Structure Investigations III
11:00	***Bio-dynamics from SAXS/WAXS experiments*** **– A. Langkilde / Uni. Copenhagen**
11:30	***Spectroscopy investigations*** **– S. DeBeer / Max Planck Institute**
12:00	**Wrap up and Close-out – A. Mancuso / European XFEL**
12:15	**End of Workshop**

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2.4 Possible future activities

During the EUCALL project, discussions with staff within various groups at the different facilities has led to suggestions for further experience exchange, that may be considered beyond EUCALL's funding period. Members of various Public Relations (PR) groups at RIs foresee a benefit in collaborating with PR groups of other facilities, especially in the development of Visitor Centers, and of developing virtual reality "tours" of the different RIs. To explore this concept, ELI-NP organized the conference "Novel Channels of Communication for Promoting Advanced Light Sources" in on 10 September 2018 in Măgurele, Romania, where the PR managers of each ELI facility were able to exchange on their practices and interact with managers from Romanian high-tech Industry, bilateral chambers of commerce, and Radio Romania.

Technical Service groups of EUCALL facilities have also benefitted in organizing their own exchanges, for example a visit of ELI-ALPS operators to European XFEL on 26 June 2018. RI groups responsible for archiving and publication databases also considered it useful to exchange common practices between different types of EUCALL RIs.

3. Prototype experiments based on combined optical and accelerator-based lasers

In this section we report on the history, status, prospects of and lessons learned from pioneering cross-community projects, which combine optical and accelerator-based lasers, at facilities such as European XFEL, ESRF and DESY. This activity was performed by interviewing individuals involved in the projects, using a questionnaire prepared by WP3 members. In Section 3.1 the selected cross-community projects and the interviewed individuals are introduced in detail. In Section 3.2, the feedback is summarized in various categories.

3.1 Selected cross-community projects

For each of the selected projects, at least two responsible individuals were interviewed, with a focus on acquiring feedback from the project management and from the project operators. The collection of both types of information was useful to perform an analysis on the projects. During the discussions, the questions and the answers were refocused, whenever necessary, on the cross-community aspects, more than on the specific scientific case of the project.

HIBEF (at European XFEL)

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 ultraintense optical lasers, similar to those 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.

For this analysis of the HIBEF project T. Tschentscher (European XFEL, Scientific Director), and T. Cowan (HZDR, Director Institute of Radiation Physics, Head High Energy Density) were interviewed.

Lasers at ESRF

ESRF collaborates with various laser laboratories in France and the UK to develop a laser device to be implemented at several x-ray beamlines in order to study dynamically

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compressed matter and warm dense matter at local thermal equilibrium. This experience can also be transferred and used at FEL facilities.
For "Lasers at ESRF" S. Pascarelli (ESRF, MEx Group Leader) was interviewed about the new high power laser facility (HPLF), as well as M. Wulff (ESRF, Complex systems and biomedical sciences Group Leader) about the pump-probe synchrotron experiments started during the 1990s.

Table-top FELs at DESY and ELI

The ELI-Beamlines facility in the Czech Republic, in collaboration with 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.
R. Assmann (DESY, Leading Scientist W3) was interviewed about DESY's new activities in this area, specifically on the currently running EUPRAXIA Horizon 2020 project, while F. Grüner (University of Hamburg, Professor) was interviewed about the LUX project at ELI-Beamlines.

3.2 Feedback on the selected cross-community projects

The objective of this activity was to identify best practices, disseminating these throughout the consortium and to explore how such initiatives can be stimulated. The focus is on cross-community aspects, and specific topics concerning what happens at the communities' interfaces were analyzed. The feedback is summarized in various categories.

Project initiation, funding and community creation

Each of the studied projects originates from the strong commitment of one research infrastructure (providing both human and financial resources) and at least one highly motivated researcher. The risk-taking profile of the involved research infrastructure has a high impact on the timing of the creation of a new, cross-community project. DESY, for example, is committed to innovation with a special division and initiates such projects by gathering researchers for a special task, anticipating the creation of an international community. Others, like ESRF, wait for the creation of an international community to consider that the need for the new instrument has reached critical mass, and then invest with a long-term approach. This approach does not seem to hinder the success of the project, but defines the priorities of the researchers driving the project (which for a few years are focused on two fronts: new instrument definition and engagement of the user community). The European XFEL seems to have found a compromise: the community creation tool, the HIBEF consortium, which acts as an external entity gathering the drive around a new scientific case. European XFEL itself stays dedicated to the new instrument definition, and implementation. This scenario stresses the requirement to interact between teams of different institutions and communities.

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The key point for a successful cross-community project is the creation of a strong and connected user base. In most cases this point was identified as the main concern of the interviewed researchers and it is considered critical to the success of the project. It is a long-term occupation, covering many years, as the user community engagement has to start very early in the project and must continue during all its phases. Geographical proximity or the established collaboration networks play a crucial role in helping the researchers to build the networks out of their own community. The EUCALL project was identified by interviewed project leaders as a considerable boost to the existing activities. The formal and informal exchanges brought by EUCALL's activities were reported to have been extremely useful to widen the researchers' knowledge of the "other" community, and have been potentially useful to build further collaborations. The HIBEF consortium and the ESRF team reported that following exchanges during the EUCALL project a collaboration to develop a new x-ray diagnostic tool was initiated. In addition to that, the ESRF team reported that EUCALL's technical WPs, helped them extend their expertise beyond their initial community.

The funding of the studied projects came mainly from the national agencies already supporting the hosting research infrastructure. The availability of large amounts of funds, to hire researchers, to acquire equipment and to animate the community, is a necessity to realize cross-community projects. These projects are usually more expensive compared to the standards of the national programs in the different countries. Nevertheless, none of the interviewed project leaders has identified a lack of funding as a long-term risk for the project. For each of the cross-community projects presented here, the scientific cases have been strong enough to motivate and to engage large funding agencies in the different European countries. However, the management of the funding was identified as an issue – often the cross-community projects are managed through a user consortium (for example HIBEF), and problems can arise when the decision on such projects are decoupled from respective funding decisions. A delay or mismatch in funding often directly translates into project delays or scope reduction of the consortium activities. A possible way out may be that the user consortium identifies already at an early stage of applying for cross-community projects its possible funding sources, and begins as early as possible to define a proposal for funding. To support this, the RIs targeted by such projects should already at this early time provide recommendations to potential funding sources, in order to aid the funding decision process.

Project management and legal issues

The cross-community projects were identified as challenging in terms of management: the different communities follow written (and unwritten) rules that are sometime incompatible. The interviewed researchers underlined that it requires significant effort to avoid conflict due to the different, and sometimes opposing, working habits (e.g. available experimental preparation time, or degree of involvement of the users in the preparation of the

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experimental area). As a byproduct of these cultural differences, risk assessment and management were also identified as stressful tasks: the risk of missing a deadline on a complicated task is higher when teams that are not used to working together are involved. Once again, geographical proximity and existing networking projects seem to be a great facilitator to teach the different communities how to work together. Most of the interviewed researchers recognize that they underestimated, at the beginning of the project, the importance and the complexity of risk management, especially the risks concerning the delays in the integration of the new technological solutions and in the organization of the legal framework of the projects. Another point underlined unanimously is the difficulty to plan for contingencies in the relatively unknown environment of a cross-community project.

The legal and administrative constraints of large projects in general are important and require a management team with respective experiences. If these management tasks are assigned to research scientists without the appropriate experience, these scientists may face challenges mostly in the legal, administrative and project management areas. In order to prevent such occurrences it should be considered to offer these scientists training courses and lessons-learned before engaging fully on their new tasks.

Role of the existing environment (geographical and networks)

All of the interviewed researchers underlined the role of the existing environment at the research infrastructure around which the project is developing. It is critical to initiate the user community and the project team. This environment implies a physical proximity, like at DESY with the laser, accelerator and life science communities present on the same spot, or a strong networking, like at ESRF, where the French and other European networks helped to bring the laser community to a synchrotron facility. The ideal environment should make available scientific competences of the users, technical competence for the instrument, and theory/simulation capabilities.

Perspective for cross-community projects like EUCALL

The interviewed researchers unanimously affirmed that the number of cross-community projects will increase in the near future. The reason is that through a multi-disciplinary approach these projects can tackle exciting problems of fundamental science and can deliver promising real-life application of the scientific discoveries.

EUCALL itself, as a cross-community clustering project brought a unique advantage to solve these issues because it provided a framework for exchanges and networking between the different participants. In addition to that, the financial support from cross-communities clustering projects such as EUCALL was identified as a strong development driver by HIBEF and ESRF. Clustering actions like EUCALL are particularly effective compared to any other networking project because they address the fundamental questions on how the different infrastructures work on common problems, and how they share efforts to define tasks and propose solutions up to the implementation stage. In this context cross-community clustering projects like EUCALL have been able to synthesize best practices from the different RIs and communities. This approach will facilitate the creation of new cross-community project within emerging RIs such as ELI. Specifically, it can provide the fertile, connected environment for exchanges that was identified as critical to the initiation of such projects. The ELI project is a unique chance for scientific researchers as it gathers experts and users around a completely new research infrastructure. The harmonization of the cultures of different communities is one of the great challenges of ELI.

Recommendations on how cross-community projects can be better stimulated

- Create flexible but steady platforms where researchers from various communities of analytical facilities can meet.
- RIs should help user consortia with the expertise needed to deal with legal and administrative problems.

4. User training, facility operation, and access principles

In this section we report on the activities within the Laserlab-Europe consortium and within the CALIPSO/CALIPSOplus projects which reflect the establishment of “joint access policies” for users, and on the implication of these strategies for the EUCALL consortium. Concepts for user training are also reported, based on programs run by Laserlab-Europe as well as CALIPSO/CALIPSOplus’ twinning activities, the community proposals encouraged by European XFEL, the EUCALL Exchange Program and the potential use of SIMEX.

4.1 Joint access policies

A “joint access policy” for users to an ensemble of complementary laser light source facilities such as those involved in EUCALL would require standardized proposal forms acceptable by and suited to all facilities, as well as common proposal review committees. Such committees would need to review each submitted proposal and also recommend at which facility the experiment should be performed. The facilities would thus allow a part of their user-access to be managed by an external entity. Laserlab-Europe runs a transnational access program that organizes user access to its consortium members via a standard application form and evaluation procedure. The CALIPSO/CALIPSOplus projects develop a standardized proposal form for its consortium members to provide simpler access for users. These activities are summarized in the following.

Laserlab-Europe

The Laserlab-Europe consortium presently brings together 33 leading organizations in laser-based inter-disciplinary research from 16 EU countries. A total of 22 facilities offer trans-national access to their labs to external users (status September 2018). The access time provided through Laserlab-Europe represents typically 5 - 10% of the total user access time at each participating facility. The consortium runs an online proposal system that allows users to submit their proposal using a standard application form.

This standard application form is available on the Laserlab-Europe website in RTF format and collects all the administrative, technical and scientific information necessary to evaluate the proposal. A common external Selection Panel (SP) and a common external pool of referees evaluate the proposals based on scientific excellence. The SP evaluates the request of the users to access a specific facility, but can also propose to relocate the experiment to another Laserlab-Europe partner facility. The main criteria for relocation of the experiment are the technical feasibility and access time availability.

The joint access policy and proposal management of Laserlab-Europe was initiated by a group of facilities that worked together to unify resources and to efficiently share the

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workload to put together a common application process in order to manage their individual trans-national access programs, funded by the FP4 Program, and to jointly present their offer of access to part of their available beamtime to European users.

The definition of a standard application form and the common pool of external referees were welcomed by these facilities as it represented a clear advantage resulting from their common work. When the Laserlab-Europe project started in FP6, the joint access program had evolved and included also facilities with individual proposal management and selection processes, requiring integration of different systems into a joint system and partly modifications of the system to allow for specific local needs.

Today, all 22 facilities provide user access via the Laserlab-Europe platform and most of them use the standard application form. Only five facilities require applicants to take additional steps, to use a different proposal form or to submit proposals via the facility's own user portal. In case that a user submits a proposal to Laserlab-Europe applying for access to one of these five facilities, the SP can pre-review the proposals and give a pre-clearance of Laserlab-Europe for submission.

The Laserlab-Europe AISBL (non-profit organisation within Belgian law) entity was created in September 2018, and the official kick-off will be held in October 2018. All involved facilities may provide access to their labs outside an EU-funded project under conditions still to be defined. The joint access policy will remain a key feature.

CALIPSO/CALIPSOplus

Under the CALIPSO (FP7) project, a standardized proposal system for the participating 14 synchrotron sources and seven FELs (including infrared FELs) has been established. This standardized proposal form (SPF) is presented on the www.wayforlight.eu website, and allows users to fill out an online form describing their planned experiment, including full details of involved samples and associated safety issues, any additional equipment needed, the number of eight-hour shifts of beamtime required and expected outcome. The user is then able to download a standardized version of the proposal form in XML format, which can be submitted for evaluation by the individual partner facilities.

Of the 14 participating synchrotron sources, five accept SPF proposals generated this way, in XML format via the Wayforlight website. Five of the other facilities accept SPF proposals in PDF format, submitted directly via their own user portals, while the remaining four do not accept SPF proposals. Out of the seven participating FEL facilities, one supports submission of SPF proposals in XML format, and three FELs allow the submission of SPFs in PDF format via their user portals. The remaining three FELs do not accept SPF proposals

A reason that several of the light sources involved in CALIPSO do not support the use of the SPF is that it is considered that the information required in proposals for FEL experiments is significantly different than that required for those at synchrotrons, which renders an SPF for

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synchrotron access almost incompatible with the use of FEL sources. Some synchrotron sources have their own internal rules that further restrict the use of the SPF.
The ongoing CALIPSOplus (Horizon 2020) project aims to develop the SPF further, including a strategy to include European XFEL (which was not part of CALIPSO) and identity all fields in the proposal form which overlap all facilities.

Implication for EUCALL

The experiences of both the Laserlab-Europe and CALIPSO/CALIPSOplus consortia in developing joint access policies show that developing a platform accepted by all members of one community is not a trivial endeavor. The development of a joint access policy, that could be acceptable by and compatible with all of EUCALL's accelerator and laser RIs, is therefore not to be expected for still some time. EUCALL's integration of ELI and Laserlab-Europe's UV/x-ray instrumentation into the Wayforlight database is a positive step forward in harmonizing user access to light sources of both laser and accelerator communities. This has resulted from the effort of each of the involved facilities to provide information on their sources in a standardized way, even though some specificities of each type of facility had to be taken into account.

4.2 User training

Coordinated training of users and improved preparation of complex experiments is a crucial element for high-throughput user facilities, and has proven successful in Laserlab-Europe and CALIPSO. Here we review schemes for user training from these two networks as well as the "Community Proposals" system employed by European XFEL for its Early User Experiments program (2017 – 2019). We discuss the EUCALL Exchange Program, which encouraged and supported staff-exchanges with the respective "other" community. Finally, we analyze how EUCALL's SIMEX (WP4) tool can be implemented into training of users for photon science experiments at advanced laser light sources.

Laserlab-Europe

Laserlab-Europe runs several user training schemes, including the organization of specific fully open training schools, and intra-consortium staff exchanges. Examples of training schools include:

- Laser Plasma Summer School at CLPU (Salamanca, Spain, September 2018)
- Training Workshop on Time-Resolved Techniques (TReT) (Vestec/Prague, Czech Republic, June 2018)
- Training School on Laser Applications for Biology and Biomolecular Systems (Coimbra, Portugal, July 2017)
- CLF Laserlab Experimental Training School (Vulcan Laser Facility, STFC Rutherford Appleton Laboratory, UK, November 2016)

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- User Training Workshop on Light-Based Technologies (Trnava, Slovakia, September 2015)
- User Training Workshop (Riga, Latvia, April 2014)
- User Training Workshop on Biophotonics (Kosice, Slovakia, June 2013)

The intra-consortium staff exchange program comprises two different networking activities:

- Staff exchanges targeting scientific and technical training and exchange of know-how and best practices primarily for technical staff.
- Joint experiments, i.e. experiments with a clear scientific mission and possibly leading to publications.

CALIPSO/CALIPSOplus

The CALIPSO project approached user training with several key issues:

- Coaching new and existing users on the existing and future techniques
- Guiding them to the best facilities for their needs
- Facilitating their path through the beamtime submission procedures
- Educating the new generations of synchrotron and FEL users

The "USer FRIendliness Across National Borders" (USFRI) networking activity included different components: the development of the Wayforlight instrument and the FEL networking and training initiative (FELNET). This led to schools for PhD/Postdocs and Training of Engineers/Technicians (Science@FELs, PhotonDiag) that are still ongoing, joint measurements campaigns at different facilities under FELs of Europe, and the integration of synchrotron and FEL science at the HERCULES school.

The ongoing CALIPSOplus project has engaged in a new form of user-training with its Twinning Program, which aims to team-up potential users with host groups that could share their know-how and expertise in applying the available experimental techniques to common research areas. Twinning guests benefit from free access to the light source, full coverage of travel and subsistence costs, training in how to use the facilities and in how to execute beamtime, discussion and support in writing their own proposals, direct contact to the facilities and the opportunity to strike new research collaborations. Applicants and potential host groups independently complete registration forms that query their scientific activities and relevant experimental techniques. Applicants are matched with the most suitable host group and collaborations can be established.

Community proposals

The encouragement of community proposals for beamtime during the first user experiments at European XFEL (2017 – 2019) has led to efficient training of users. This concept was established at "Early User Workshops", organized several months before the announcement

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of first call for proposals for the instruments. Registrants for these workshops were asked whether they would be willing to i) share beamtime with other groups, and ii) volunteer to be a principle investigator. Specialized workshop sessions were organized which grouped potential users with the same area of interest, and these user groups developed possible experiments that might be feasible during the early stage experiments at the various instruments. 24 community proposals were received for five of European XFEL's instruments from a combined total of 999 proposers.

It is recognized that this type of community proposal is most useful during the commissioning and early user access to a facility. Once the facility operation has become well established it is less likely that users will be interested to participate in joint collaborations, as they prefer to apply for their own beamtime. It is interesting to note that the FXE instrument of European XFEL did not receive any community proposals, possibly due to high competition between users for this particular scientific application.

EUCALL Exchange Program

EUCALL established a staff Exchange Program (EP) for its beneficiaries, similar to Laserlab-Europe's intra-consortium exchange, which was run under WP2 (Dissemination and Communication). Facility staff members, in particular young scientists, were given the opportunity to develop a technical and instrumental background participating as visitors during periods of commissioning, internal, or user beamtime at different facilities. The EP covered accommodation and travel costs for approved individuals.

The following exchanges were held within the EUCALL Exchange Program, and the travel reports are included in the Annex (Page 36):

Demonstration of generation and shaping of attosecond pulses using an FEL – 15-22.12.2017
Four employees of ELI-ALPS participated in a beamtime experiment at Elettra/FERMI.

X-ray Absorption Spectroscopy with Diamond Anvil Cells and Dynamic Compression at a Synchrotron – 29.01-07.02.2018
One employee of HZDR participated in a beamtime experiment as a guest researcher at ESRF.

Mapping the temporal evolution of the electron emission spectra from nanoparticles exposed to intense soft X-ray FLASH pulses – 09-16.03.2018
Four employees of ELI-Beamlines participated in a beamtime experiment at DESY/FLASH.

Particle-in-Cell simulations for laser-matter interaction experiments at SFB-SFX and HED instruments at European XFEL – 05.03-02.04.2018
One employee of European XFEL participated in a training program as a guest researcher at HZDR.

Introduction to particle-in-cell (PIC) simulations using PIConGPU – 11-31.03.2018

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One employee of ELI-NP participated in a training program as a guest researcher at HZDR.

Mechanical Vacuum Assemblies, Robotics, and Laser Optics Precision for Femtosecond X-ray Experiments – 04-13.04.2018
One employee of European XFEL participated in a training program as a guest researcher at MAX IV Laboratory

First observation of re-crystallization of amorphous GeO_2 under laser shock – 15-20.04.2018
One employee of ESRF participated in a beamtime experiment at LULI.

These completed exchanges serve as examples of staff training, and almost all of the exchanges involved a cross-community element between accelerator and laser RIs. The EP allowed the interested scientist to propose their own exchange, while EUCALL provided funding for its realization. A similar program can be expanded to general users of RIs, to allow them to participate as visitors during periods of commissioning, in-house, or user beamtime at different facilities. In this case a system similar to the twinning program of CALIPSOplus would be useful to allow collaboration between users and host groups who do not previously have contact or cooperation.

Implementation of SIMEX

EUCALL's SIMEX platform (WP4 – Simulation of Experiments) is an open source software platform which provides tools to simulate:

- Start-to-end simulation of entire experiments at advanced laser light sources,
- Including source properties and beam transport to the user samples,
- Including x-ray scattering from molecular systems (diffraction, SAXS, WAXS),
- Including x-ray scattering from hot dense plasmas,
- Including absorption of x-rays in solids, liquids, and plasmas,
- Including laser-plasma acceleration based x-ray sources,
- Including detector response and performance,
- Including first data analysis algorithm e.g. orientation and phasing of diffraction patterns for single-particle imaging.

SIMEX has become a very powerful tool, although having a certain complexity and requiring non-negligible computer resources. EUCALL's Scientific Advisory Committee (SAC) stated that tools like SIMEX may become a prerequisite for gaining beamtime, in order for complex systems and experiments to demonstrate in a quantitative manner the feasibility of an experiment proposal (similar concepts exist at other large-scale infrastructures such as the National Ignition Facility (USA) and the Large Hadron Collider (Switzerland)).

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It follows that potential users would require training in the use of SIMEX, but also that SIMEX itself can be used for users to learn about how to design and run a photon science experiment, and how to optimize the experimental settings to obtain the desired results.

Within the activities of EUCALL WP4, online tutorials for the use of SIMEX have been prepared (www.github.com/eucall-software/simex_notebooks).

The PaNOSC project proposal (INFRAEOSC-04 call, proposed starting date January 2019) includes a work package dedicated to the development of an e-learning platform for photon science, similar to the very successful and established neutron e-learning platform (www.e-neutrons.org). It is foreseen to utilize the SIMEX tools in this new platform and to develop teaching material using SIMEX. These developments will be combined with existing tools to form an integrated e-learning platform for neutron and photon science.

The use of SIMEX for user training could allow both new and experienced users of advanced laser light sources to:

- recognize how the UV/x-ray beam characteristics selected can affect the obtained diffraction/scattering/absorption data
- learn how components of a beamline setup, such as focussing optics and monochromators are affecting the experiment and data quality
- manipulate experimental parameter and observe the effects on the results
- optimize signal-to-noise ratio by trying different x-ray delivery parameters, sample geometries and related details, or sample excitation characteristics. In particular, for complex samples or experiment geometries, this checking may be of benefit in the experiment preparation to estimate feasibility.
- develop a familiarity of how recorded diffraction/scattering/absorption raw data reflects actual structural properties of a material

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5. Promotion of innovation

To promote innovative scientific and technical developments, a network of light source RIs' Technology Transfer officers (first recommended in EUCALL Deliverable 3.2) could establish a platform by which they share information, such as details about their recently acquired patents and new spin-off companies. A benefit from this would be that information about newly acquired patents would be disseminated to a larger, Europe-wide network which will increase the likelihood of finding industrial collaborators and selling licenses. Newly established spin-off companies would benefit as awareness of their existence and activities would be effectively disseminated across the network, and thus extend their outreach to potential customers.

Technology Transfer Officers (TTOs) of EUCALL beneficiaries stated that they would benefit from this type of activity, and have contributed to the following expansion of the concept. There is no need to impose restrictions on the sharing of content of the patents as long as the patents are published, while data about RIs spin-offs is also available from pubic resources. Restrictions may be defined in individual cases based on the type and phase of commercial activity, or based on specific agreements with the related RI and/or with other RIs. During joint developments with private companies, information related to the exploitation of knowledge and technology can be controlled by non-disclosure agreements. Possible suppliers, market information, private funding mechanisms, and alternative applications can be involved and information about these can sometimes not be shared. In the case of intellectual property developed only within one RI, before the public disclosure of the patent, the issue of creating prior art should also be considered and specific non-disclosure agreements would be necessary.

A further activity of a network of TTOs can be to enable the internal disclosure of innovative developments arising from each RI, which have not yet been published or patented. This will require clearly defined non-disclosure agreements between the members of the network. However, it can provide Technology Transfer officers of the participating RIs with a wider view on whether new discoveries and developments are better suited for patenting or for publication. Having the perspective of other members of the networks in different European countries can lead to an understanding of the European innovation landscape which is unavailable to isolated RIs.

Prior to publication of innovative developments, it would be acceptable to share within such a network *what* the inventor has done, but not *how* it was done. However, some facilities have contracts with other facilities and organizations, which oblige them to share all information, thus a conflict of interest can occur, especially when suppliers are involved in the innovative activity. Due to the variety of general and internal laws in each country and at each facility, it is necessary to involve the legal entity of each RI to enable such discussions.

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If internal disclosure of unpublished information takes place it would be necessary to include the following elements:

- a declaration of the ownership of the knowledge;
- the rights of the Recipient;
- the obligations of the Recipient; exemptions from the ND obligations;
- the rights of the Disclosing Party;
- prohibition of any kind of publication,
- provisions governing the “need to know” policy in the internal disclosure in the Recipient;
- indemnification provisions for the case of violation of the non-disclosure obligations;
- term of the agreement; surviving clauses.

Finally, as recommended in Deliverable 3.2, a key step in the promotion of innovative technical and scientific developments is the training of young researchers from an early level about processes involved in protection and commercialization of intellectual property. RIs will benefit if the next generation of scientists is already aware of the need to approach the technology transfer office directly following an interesting invention or discovery. A network of Technology Transfer Offices could organize a regular training program for PhD students of the member RIs. TTOs of EUCALL beneficiaries emphasized that this initiative seems to be the most important aspect for potential cooperation of the RIs. It is of high importance to educate scientists and build an innovation culture in the RIs, which properly supports the industrial liaison of the RIs. TTOs of EUCALL beneficiaries indicated willingness to support such training programs, in kind or through direct financing.

6. Conclusions, recommendations and future activities

This section summarizes the most important conclusions and recommendations for areas addressed in this report.

6.1 Cross-community exchange of experience

The experience exchange workshops described in Section 2 have been very important activities for bringing together the accelerator and the laser communities in a way that has not been done prior to the EUCALL project. The "User Access at Advanced Laser Light Sources" workshop enabled the user office staff of the ELI facilities to learn about best practices from the since long operating accelerator RIs. This meeting also enabled additional exchange between the user office experts of the accelerator RIs, who meet regularly but do not often discuss their common practices. A useful outcome of this meeting is the integration of the staff of each ELI pillars' User Office into the established "European User Office Meeting" series enabling ELI's operators to regularly exchange with experts from at least 17 European radiation sources.

The "Innovation Potential of Advanced Laser Light Sources" workshop was the first meeting of light sources' Technology Transfer experts (independent of Industrial Liaison experts) and all participants reported a willingness to join a proposed network of Technology Transfer experts, to engage in further exchange of expertise, to develop joint training programs for young researchers, and for broader dissemination of each RI's patents and spin-off companies. This meeting also enabled the then in-preparation facilities ELI and European XFEL to benefit from the discussion on best practices of the since long operating RIs.

The "Biology at Advanced Laser Light Sources" was an open-conference type of event, which was highly successful in attracting participation from staff of synchrotron, FEL and optical laser RIs, and users from 14 countries. Invited speakers presented extremely insightful overviews of the relative strengths of each type of light source for performing experiments in biological sciences. It provided users from one type of light source with an opportunity to learn about possibilities for potential experiments at the "other" type of light source. It is recommended that advanced laser light sources organize similar joint events in the future focussing on scientific topics relevant to both laser and accelerator RIs.

6.2 Cross-community projects between laser and accelerator RIs

EUCALL has studied existing cross-community projects between laser and accelerator facilities, namely the HIBEF consortium, Lasers at ESRF, and Tabletop FELs at DESY and ELI.

Each of the studied projects originated from the strong commitment of one research infrastructure (proving both human and financial resources) and at least one highly motivated researcher. Initiation of such projects always requires the creation of an international community in order to prove the scientific need. However, after having identified the need projects could be either realized for this community, typically by RIs or the communities become active themselves in requesting funding and realizing projects. Both approaches require interaction between teams of different institutions and communities and with a strong and connected user base.

Management of project funding was identified as an issue. Cross-community projects are often managed through a user consortium and problems can arise when the decision on such projects are decoupled from respective funding decisions. A recommendation is that the user consortium identifies already at an early stage its possible funding sources, and to define a proposal for funding. To support this, the RIs targeted by such projects should at an early phase provide recommendations to potential funding sources, in order to aid the funding decision process.

The legal and administrative constraints of large projects in general are important and require a management team with respective experiences. If these management tasks are assigned to research scientists without the appropriate experience, these scientists may face challenges mostly in the legal, administrative and project management areas. In order to prevent such occurrences it should be considered to offer these scientists training courses and lessons-learned before engaging fully on their new tasks.

All the interviewed researchers underlined the role of the existing environment at the research infrastructure in welcoming the project. It is critical to initiate the user community and the project team. This environment implies either physical proximity of the different communities, for example an interdisciplinary institute or campus; or a strong networking, like at ESRF, where the French and other European networks helped to bring the laser community to a synchrotron facility. The ideal environment should make available scientific competences of the users, technical competences for the instrument, and theory/ simulation capabilities.

6.3 User access principles and user training

EUCALL has analyzed the activities of the Laserlab-Europe consortium in providing a joint access policy to users of its optical laser facilities, as well as the activities of the CALIPSO/CALIPSOplus projects which aim at developing a standardized proposal form that users can submit to any of the participating synchrotron and FEL radiation sources. A joint access policy for the complimentary light sources within EUCALL is not currently considered as feasible or of high priority, due to the rather different requirements of the RIs involved.

EUCALL's integration of optical laser based light sources into the www.wayforlight.eu database will however provide users with a platform where they can compare the capabilities of complementary light sources for their planned experiments. In this database, characteristics of instrumentation will be presented in a standardized format, and it will be simpler for RI operators to keep the information up to date. This development is an important outcome in optimization of user access to advanced laser light sources in Europe.

The activities of Laserlab-Europe and CALIPSO/CALIPSOplus in training of users have also been studied, and a suggestion for training users from the “other” community has been formulated based on the experience of EUCALL’s Staff Exchange Program. Users could be given the opportunity to participate as visitors during periods of commissioning, internal, or user beamtime at the “other” type of facility from which they usually identify themselves. A twinning program similar to that of the current CALIPSOplus project would be useful to allow collaboration between users and host groups who do not previously have contact or cooperation.

The encouragement of community proposals from large groups of users has enabled a form of training for early users during the first user access of European XFEL. This type of activity is recommended also for other new light sources when they begin their user operation.

The SIMEX software developed under EUCALL WP4 has a strong potential as a tool for user training, allowing users to gain familiarity with the set-up and control of photon science beamlines and instrumentation and how to adjust experimental parameters to optimize the experimental results.

6.4 Promotion of innovation

Together with the Technology Transfer Officers of EUCALL beneficiaries, EUCALL developed recommendations for the promotion of innovative scientific and technical developments. In Deliverable 3.2 it is recommended that the Technology Transfer Officers (TTOs) of light sources should form a network for experience exchange and other collaborations. One particular activity should be the sharing of information about recently acquired patents and new spin-off companies. This will increase the likelihood of finding industrial collaborators and possibly selling licenses for patents across a larger, Europe-wide network, while spin-off companies could extend their outreach to potential customers spread out across the entire network. The internal disclosure within this network of innovative developments arising from each RI, which have not yet been published or patented, will provide Technology Transfer officers of the participating RIs with a wider view on whether new discoveries and developments are better suited for patenting or for publication. However it will be necessary to involve the legal entity of each RI to develop non-disclosure agreements to enable such discussions.

TTOs of EUCALL beneficiaries believe that a training program for PhD students of the members can also be very important for increased cooperation of the RIs. Scientists should be educated about policies of innovation to build an IP culture in the RIs, which can properly support the industrial liaison of the RIs. TTOs of EUCALL beneficiaries expressed interest in supporting such training programs, in kind or through direct financing.

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7. Summary and Outlook

The experience exchange workshops for facility operators and RI staff organized under EUCALL WP3 were very useful to identify and disseminate among the EUCALL facilities and beyond standard policies and best practices in the areas of “User Access” and “Technology Transfer”. A particularly useful outcome of these workshops has been the integration of the ELI facilities into the regular “European User Office Meeting” (EUOM initiative), and the stated willingness of Technology Transfer Office staff to engage durably into networking activities and enhance promotion of innovation. These ensure that experience exchange will continue beyond the end of EUCALL’s funding period.

The open experience exchange workshop “Biology at Advanced Laser Light Sources” was particularly successful in attracting a large audience of staff and users from both accelerator and laser RIs, and similar events are recommended for the future to enhance awareness of the strengths and capabilities of both types of light source within both communities.

EUCALL’s analysis of cross-community projects between laser and accelerator RIs shows two approaches to initiate such projects - to get key researchers to work together for a special task in anticipation of the formation of an international community, or to wait for the formation of such an international community to reach a critical mass, and then invest with a long-term approach. Limitations in project progress can be caused by delays in accessing funding, and specific recommendations to address that challenge is firstly that user consortia should define at an early stage possible funding sources, and that involved RIs should provide recommendations for potential funding sources, in order to aid the decision process. Research scientists who are assigned tasks in the management of cross-community projects should be offered training in project management and in legal and administrative issues. It is also recommended to offer such training to young researchers.

Development of joint access policies for all the complementary light sources involved in EUCALL is presently of limited relevance due to different requirements of the RIs. EUCALL recommends that effective training of users from the “other” community be achieved, for example, by running a program based on EUCALL’s Staff Exchange Program, with a possible integration of a twinning program (similar to CALIPSOplus) to initiate contact between users and potential host groups from the “other” community. EUCALL also suggests the use of WP4’s SIMEX platform to enable users to gain familiarity with experiments at advanced laser light sources using an e-learning platform.

Annex: EUCALL Exchange Program reports

Travel report

Brief title of the travel: *Demonstration of generation and shaping of attosecond pulses using a FEL*

Participants name: *NANDIGA GOPALAKRISHNA Harshitha, CSIZMADIA Tamás, DUMERGUE Mathieu, KÜHN Sergei*

Place and time: *Elettra - Sincrotrone Trieste S.C.p.A. S.S. 14 - km 163,5 in AREA Science Park 34149 Basovizza, Trieste, Italy,*
2017.12.15. – 2017.12.22.

Text**: **aim/necessity of travel, benefit and value added, expected results:

The FERMI free electron laser (FEL) connected to the Elettra synchrotron storage ring at Trieste (Italy) is one of ELIs long term strategic partner. Beamtime at this facility has been awarded from the 15th to the 22nd of December to conduct pioneering research with the participation of multiple international research groups.

During the beam time we had two main goals:
1) To demonstrate, for the first time, the reliable generation of trains of attosecond pulses using the coherent superposition of three consecutive harmonics of a free-electron laser (FEL) source. In the experiment, we used the 7th, 8th and 9th harmonics of the seed laser by tuning 2+2+2 undulators to the desired wavelengths.
2) To demonstrate a complete (amplitude and phase) temporal shaping of these attosecond pulses

In order to characterize the temporal shape of the created attosecond bursts, we did a RABITT-like measurement, although the delay jitter (estimated in a few femtoseconds) between the XUV harmonics and the IR field prevented the direct measurement of sideband oscillations as a function of the relative delay. Therefore, we acquired single-shot photoelectron spectra with a high-collection efficiency electron spectrometer (~2m long magnetic bottle) and did covariance/correlated analysis of the sideband variations.
During the first two days the machine people set the harmonics 7-8-9 of the seed laser of the FEL by tuning 2+2+2 undulators to the desired wavelengths. The transport beamline was aligned and PADRES group optimized the focus of both XUV and IR radiation. FEL was tuned at the resonance 1s2p of helium and we performed a delay scan between the XUV and IR pulses to find the temporal overlap (t0). We found the spatial overlap as well by maximizing the sideband signal (number of sideband photoelectron and order of the sidebands) by changing the tilting of the recombination mirror. The maximum sideband signal was determined during a delay scan in order to re-check the previously found t0 value. After the initial alignment was done we continued with test measurements using a single intense harmonic (H8) and then a two-colour configuration (H8&H9). The main objective of this test part was to extract the intensity variation of the main photoelectron peaks as a function of the phase of a harmonic. Obviously, we expected no dependence of the correlation of PE peaks on the phase.
Then we shifted to the final three harmonic configuration and we saw the expected change of the correlation when changing the relative phase of H7 both in neon and argon gases.
During the last two shifts we shifted to 4 harmonic configuration (H7, H8, H9 & H10 - 1u+1u+1u+1u+0u+0u) and observed again clear oscillations in the correlation of two integrated sideband signals. This is a clear indication of a unique, customizable attosecond pulse train having a roughly estimated 200 as length per pulse with a few uJ total energy.

During the experimental campaign, we acquired useful knowledge in several fields including the acquisition, analysis and interpretation of TOF data, as well as in the operation of the experimental end-station at the facility. These practical skills gained in a large-scale user facility will be very beneficial for our near-future work in ELI-ALPS.

Szeged, 10th January, 2018.

X-ray Absorption Spectroscopy with Diamond Anvil Cells and Dynamic Compression at a Synchrotron

Scientist: *Dr. N. Hartley*

Home Institution: *Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany*

Host Institution: *European Synchrotron Radiation Facility, Grenoble, France*

My aim in the EUCALL staff exchange program was to get first-hand experience of other approaches to studying the materials and pressure-temperature conditions that my own work focuses on. My physics background has mostly comprised X-ray diffraction as a diagnostic of structure and temperature (via the Debye-Waller effect), using laser-driven and XFEL sources. The samples have either been heated, by laser or particle beams, or shock-compressed, and so in both cases the conditions of interest are transient. However, much of the work that this builds on, and indeed much of the cutting-edge work that is still being carried out, instead uses static compression techniques. Due to the wider energy range of the X-ray beams generated by synchrotrons, relative to XFELs or line-emission sources, absorption techniques (XANES and EXAFS) are also possible, giving complementary structural data to that obtained from diffraction.

I was hosted for the staff exchange program by the research group of Dr. Sakura Pascarelli, and joined the experiment of Dr. Silivia Boccato, studying the pressure-dependent melting line of metals. The experiment was part of an ongoing project, using diamond anvil cells and laser heating to observe the effects of pressure on the melting temperature of transition metals, with the aim of determining the effect of an unfilled *d*-band on the relative energies of the liquid and solid states. We mounted metal samples (in this beamtime, generally copper) within a diamond anvil cell, with culet sizes ranging from 150 – 300 μm, held within a rhenium gasket. We heated the samples with a CW laser, and measured the temperature using the thermal (black-body) emission from the target. We had previously absolutely calibrated the spectrometers using emission from a heated tungsten wire. Using the synchrotron X-ray beam, we then probed the heated and compressed target and measured the energy-dependent absorption. Unfortunately, due to the weak coupling between the heating laser and the target, we were not able to obtain clear melting results from any of the copper targets used, although the behaviour of the laser was confirmed by measuring heating in nickel targets, as in previous experiments.

As well as the experiment, I was present at ESRF for the annual user meeting. As part of this, I participated in a workshop on the analysis of EXAFS spectra, and how it can be used to probe structural data on a much shorter range than is possible with diffraction, while also being able to distinguish different atom types. This is obviously very useful when looking at different structures in compounds and mixtures, and was not a technique I had previously understood the power of.

Taking what I have learned from this experiment, I will be returning to ESRF in July for the first experiments with the new high energy laser, using EXAFS techniques to probe a variety of shock-compressed targets. We will also look at submitting a proposal for a static compression experiment after the one year shutdown at ESRF, which starts later this year.

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Travel report

Brief title of the travel: Mapping the temporal evolution of the electron emission spectra from nano-particles exposed to intense soft X-ray FLASH pulses

Participants name: Maria Krikunova, Olena Kulyk, Eva Klimešova, Laura Dittrich, Khakurel Krishna Prasad, Polovinkin Vitaly

Place and time: FLASH, DESY, Hamburg, Germany, from 09.03. to 16.03.2018

Aim of travel, benefit of exchange and expected results:

Since the start of operation of FLASH in 2005 the experiments have opened new frontiers in atomic and molecular physics and many other research fields. In particular, at the beamline 3 of the FLASH1 facility, where a world-wide unique combination of synchronized FEL and multi-cycle THz pulses is available, beamtime (10 shifts between the 20th and 27th of March 2018) was awarded to our group under the guidance of Maria Krikunova for mapping the temporal evolution of the electron emission spectra from nano-particles exposed to intense soft X-ray FLASH pulses (FLASH proposal F-20170535).

The aim of the proposed experiment was the systematic study of the ionization dynamics of nano-particles in the focus of intense FEL pulses. In these experiments THz streak camera approach was applied to map the temporal evolution of the electron emission spectra from nano-particles in order to reveal the dynamics of nano-plasma formation with a few femtosecond temporal resolution. Additionally, during the first part of the experimental campaign streak camera experiment were conducted to run on atomic gas target in parallel with the electron bunch diagnostics. The results of this experiment will provide access to the complex temporal structure of FEL pulses generated by self-amplified spontaneous emission process and be of high relevance for the femtosecond (soft) X-ray pulse metrology as well as for the fundamental understanding of the dynamics of plasma formation and are essential for a variety of photon science applications.

Our ELI-RP4 team contributed with the Gas Dynamic Virtual Nozzle (GVDN) injector for delivery of nano-particles into the interaction region. The GVDN-injector was integrated into the existing streak camera set-up that was developed in Markus Drescher group. The experimental campaign lasted 20 days in total. It started on 9th March with the installation of the set-up at the BL3. Within the installation week three vacuum chambers (main experimental chamber, FEL focusing and THz in-coupling chambers) has been installed and properly aligned to the nominal THz and XUV beam pathways. GVDN-injector has been integrated into the experimental chamber and tested *in situ*. Data acquisition system has been brought into operation. The beamtime started with contingency shifts on the 16th March.

The scientific topics of the experimental campaign are highly relevant for future experiments at ELI-Beamlines and represented the unique possibility to commission the GVDN-injector, which will become accessible to the broad user community at MAC end-station of ELI Beamlines in the near future. The expertise gained by us during the experimental campaign at FLASH is highly essential for promoting high level professionalism needed for the future operation of the MAC user end-station at ELI Beamlines.

Dolní Břežany, 5th of April 2018

Laura Dittrich

Particle-in-Cell simulations for laser-matter interaction experiments at SFB-SFX and HED instruments at European XFEL

05.03.2018 – 30.03.2018

Mohammadreza Banjafar
SPB-SFX group
European XFEL

As a part of collaborations between the SPB-SFX and HED group, I spent 4 weeks at Helmholtz-Zentrum Dresden-Rossendorf (HZDR), from 05.03.2018 to 30.03.2018, to get some training on PIConGPU Particle-in-Cell (PIC) code which is developed and maintained by HZDR. The training included how to run the simulation code, change the inputs and analyze the output data and get some introduction about the PIConGPU data structure to know how we are able to improve and implement the binary collision models between charged particles at high laser intensities and relativistic regime in PIC simulation, which was supposed to be my the main task of my Ph.D. project. Here, I briefly explain the parts of this training.

The PIConGPU training

Having benefited of GPUs, PIConGPU is the fastest PIC code for plasma simulation and its applications. It's very well structured and many physicists and computer scientists have been working in it for a long time and it will make it somehow the leading code in PIC simulation. Although the PIConGPU has a highly complex body and an advanced programming structure, one who has knowledge in PIC simulation and plasma Physics would be able to work with it and change the input parameters and see the results. In this part I briefly mentioned the steps that I've done to know how to work with PIConGPU:

1. How to log in on HZPNOS

   (HYPNOS is the biggest Linux cluster at HZDR which consists of 3 heads and 149 compute nodes. 34 of the nodes on HYPNOS are attached with GPUs and the PIConGPU can be run on those nodes. Not to mention, PIConGPU is able to be run on CPU nodes as well. For this purpose at first I learn how to log in on the log in node of HYPNOS and get familiar with its Bash system. Currently, I'm using the Nomachine application to log in on HYPNOS.)

2. How to install the PIConGPU
3. Submit a job and working with TBG (template batch generator)
4. Run some example from PIConGPU examples
5. Changing the inputs with of simulation with .param files
6. Set upping my own example

   In this part I tried some setups for interaction of the Gaussian laser pulse with a solid target. My final purpose was to create a multilayer solid target as below:

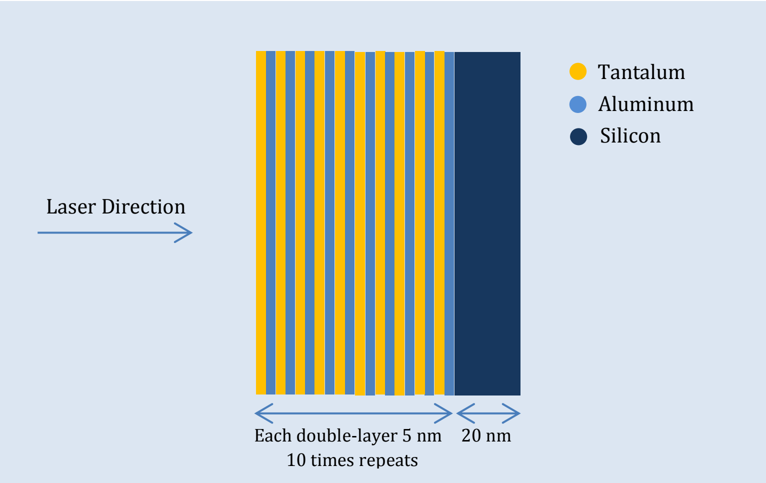

Fig. 1. The eventual setup in my example

To create the solid target these steps were done:

- Defining the cell size as less as possible to have a good resolution
- Defining two new elements, Tantalum and Silicon, in PIConGPU and introduce their properties such as, ionization energy, electron configuration, atomic characteristics and effective nuclear charge.
- Make a density profile for each species
- And initializing the species
- Making a laser pulse with Gaussian profile

(The results of simulations are on the HYPNOS.)

7. How to manage the GPUs in simulation box
8. Post-processing (Analyze and visualizing the output data)

PIConGPU is able to make many different output files but the most handful kind of them are HDF5 files. It also has a really user-friendly library to read and write the HDF5 files, particle mesh data (OpenPMD). In this training, I learned how to use the OpenPMD in Jupyter-Notebook to plot the HDF5 output files which consist charge and current densities, magnetic and electric field, phase space data and many other parameters of the simulation.

9. Getting an overview about the PIConGPU data structure

PICLS

In addition to PIConGPU, there is another PIC simulation code, PICLS, which has been using by HZDR for almost 10 years. It's a 2D3V code and although it's one of the most chaotic codes that I've ever seen but has many features like the ionization and collision. Thomas Kluge and I ran two simulations with the same parameter that I used in PIConGPU simulation. The first simulation included the collision and the second one without the collision, and because the PICLS is much slower than the PIConGPU it takes too much time to finish so, it's still running. As soon as it finishes we will compare its results with PIConGPU.

Implementing the collision in PIConGPU (Proposed by HZDR)

Currently, the collision process has not been implemented in PIConGPU but the HZDR members have a plan to add it to their code, but it's not a quiet easy stuff. As I mentioned, PIConGPU In terms of programming has a complex structure. So, implementing the collision in this code needs to collaborate with some computer scientists and also physicists and also will be time-consuming. Although currently my Ph.D. project is not to implement collision in PIConGPU, I had some really good discussions about it and also some learnings about the PIConGPU code lines and how to go through the particle iterators. Besides that, I met Alex Hubel and talked with him about the possibilities for implementing the coalition in PIConGPU as soon as possible.

For programming part, I met the René Widera and Sebastian Hahn and they aimed to learn the PIConGPU data structure and how the particle iterator of PIConGPU works. For the physics part, I had this opportunity to have some motivating discussions with, Michael Bussmann, Thomas Kluge, and Jan Fiedler. During our discussions we talked about the physics that is behind the modeling and implementing the collision, the role of Coulomb Logarithm in high intensities.

Installing the PIConGPU on Desy Cluster, Maxwell

With the aim of René Widera I did some efforts to install the PIConGPU on the Maxwell. Maxwell already has some nodes which are equipped with GPU. For this purpose we needed to ask the Maxwell Administrator to provide some prerequisites that are needed to install the PIConGPU but it's not done until my stay in Dresden.

Conclusion

In summary, regarding the purposes of this trip I'm able to say that almost all of them have been done and it's made me much more motivated and positive to go further. I really enjoyed the very intensive and active scientific environment of HZDR in which everybody is always welcome to contribute, talk, and discussion. They have too many interesting ideas which are able to be the base of some other contribution between European XFEL and HZDR. At the end, I should thank Adrian Mancuso and Carsten Fortmann-Grote for their contribution and helps.

Mohammadreza Banjafar
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Holzkoppel 4
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Germany

Travel report

Brief title of the travel: Introduction to particle-in-cell (PIC) simulations using PIConGPU

Participants name: BERCEANU Andrei

Place and time: Computational Radiation Physics Group, Institute of Radiation Physics, Helmholtz Zentrum Dresden Rossendorf (HZDR), Bautzner Landstrasse 400, D-01328, Dresden, Germany.

11.03.2018 - 31.03.2018

Text: aim/necessity of travel, benefit and value added, expected results:

The Computational Radiation Physics group at HZDR has acquired considerable expertise over the years while developing various scientific computing codes, a prime example of that being PIConGPU. It is a fully relativistic 3D3V particle-in-cell code that can run in parallel on many general purpose graphics processing units (GPUs). The code is fully suited for modeling most of the preparatory experiments that our research group is interested in, such as the PPEx experiment described in ELI-NP's Technical Design Reports.

My visit to Dresden had three main goals: i. learning how to use PIConGPU code, which includes running the code, as well as changing the inputs and analyzing the data; ii. getting familiar with the inner workings and structure of the code; iii. applying the newly acquired knowledge for modeling the PPEx experiment.

During my three week stay in Dresden, I have been granted access to 64 K80 GPUs belonging to the HZDR's Hypnos cluster. After initially configuring the code, I have been instructed on how to change the simulation parameters inside the various input files and how to use the scripts that are distributed together with the source code for submitting jobs to the cluster queue. On modern computer hardware, I/O operations represent one of the significant bottlenecks of the computational process. In order to diminish the time that the code spends writing to disk, the HZDR developer team has implemented a successful data reduction scheme in the PIConGPU code by means of live (runtime) plug-ins. As an illustration, the code can generate at runtime a histogram of the electron energy versus time, filtering, for example, the electron momenta that lie in certain solid angle defined by the target geometry. This greatly reduces the amount of data that needs to be written to disk every few time-steps, instead of writing all the particle and field data and then computing the histogram in the post-processing step. After successfully running the code, I have been given a detailed overview of the C++ class hierarchy, which would allow me to contribute by modifying existing plug-ins or even implementing new ones, depending on the physics needs that arise in our research group.

Concerning the PEPX experiment, I have successfully completed a series of 2D and 3D runs that simulate the interaction of a laser beam with an under-dense nitrogen plasma, resulting in laser-wakefield acceleration. Using the energy histogram plug-in described above, we have noticed that there are two separate points in time when the injection of electrons into the bubble created by the laser takes place. We noticed the first electron batch is lost due to instabilities in the back of the bubble created by a slight mismatch between the beam waist and the bubble radius, while the second batch successfully reaches the tungsten target. We also tested two different ionization models - classical (BSI) and quantum (ADK). We concluded that the classical model is accurate enough to describe the ionization process in the parameter range corresponding to the PPEx experiment. Since the BSI model is less computationally intensive, we plan to use it in future simulations.

During this visit, I have also worked on developing a Python script for pre-processing, which, given the experimental parameters as input, determines if one is in the bubble regime and what would be the maximum expected charge and energy of the accelerated electrons from the laser-wakefield source. The code also gives upper bounds on grid parameters that correctly resolve the laser and plasma wavelengths. I have also contributed in optimizing a post-processing Python framework developed by the Computational Radiation Physics group for filtering and plotting PIConGPU output data, and computing various physically derived quantities such as beam emittance. To conclude, I consider the skills acquired during my stay in Dresden will be beneficial for my future work at ELI-NP.

Bucharest, 18 April, 2018

REPORT

EUCALL Exchange Program

Mechanical Vacuum Assemblies, Robotics, and Laser Optics Precision for Femtosecond X-ray Experiments

August 2018

T. Korsch

for the Scientific Instrument FXE group

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European X-Ray Free-Electron Laser Facility GmbH

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Revisions

Version	Date	Description
1.0	16 August 2018	First release

Abstract

This document summarizes a visit to the FemtoMAX beamline at the MAX IV Laboratory of Synchrotron Radiation in Lund, Sweden, on 4–13 April 2018, which was funded by the European Cluster of Advanced Laser Light Sources (EUCALL) Exchange Program. This visit helped me to get a detailed understanding of the beamline as well as a deeper understanding of the technical requirements of scientists and their need to minimize downtime during an experiment run. Viewing the work of scientist as opposed to the daily work of engineers such as myself gave me some ideas for improving this aspect of the runtime process. High expertise on the part of the technical personnel would help to relieve the scientists of technical work and enable them focus on state-of-the-art science. As a next step, an improved scientific understanding of the experiment by the technical staff could also help to optimize the process, which in turn would lead to improved beamline capabilities.

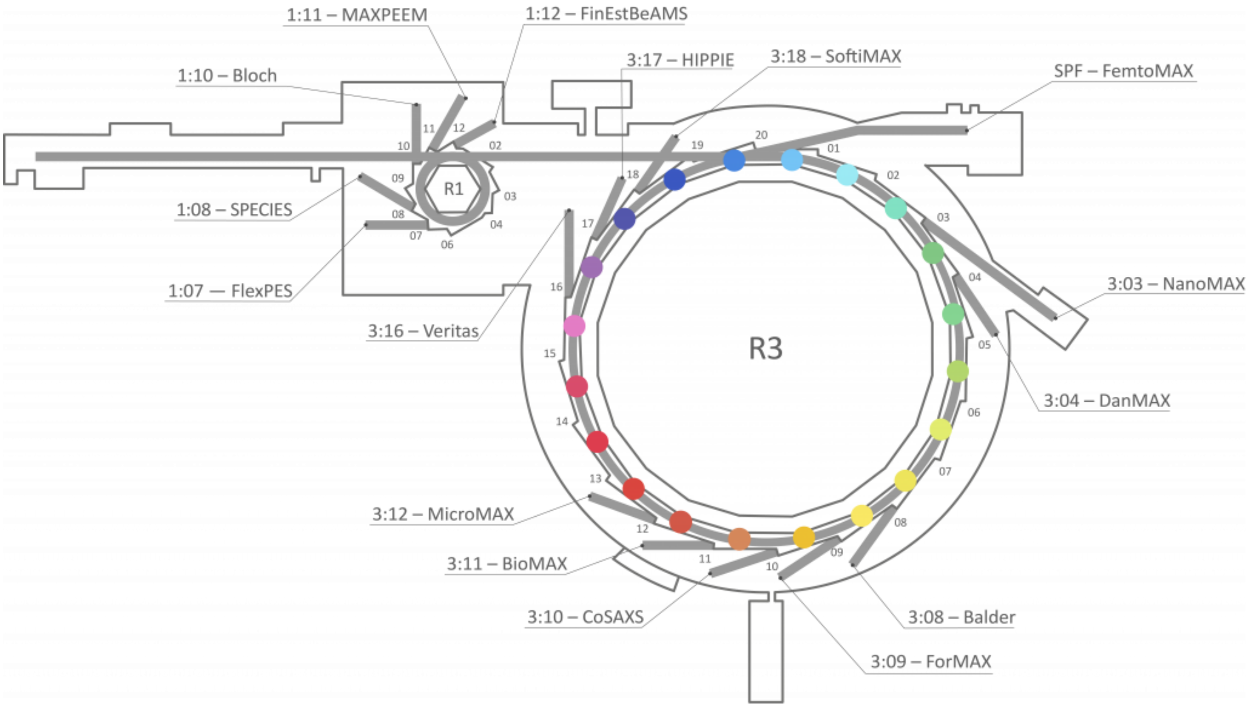
Contents

1 Introduction

The FemtoMax beamline is located at the MAX IV Laboratory in Lund, Sweden. Figure 1 provides an overview of the FemtoMAX short-pulse facility (SPF). The linear accelerator operates for FemtoMAX almost exclusively. Every hour, it switches for a few minutes to the two synchrotrons, R1 and R3. The FemtoMAX beamline aims to provide an energy range of 1.8–20 keV with 100 fs pulses. Two 5m in-vacuum undulators deliver about $4{\cdot}10^5$ photons per pulse. Since July 2017, the energy is 0.5–10 keV, with a temporary long period undulator and of a repetition rate of 2 Hz [1].

Time-resolved techniques include X-ray scattering, X-ray spectroscopies, small-angle X-ray scattering (SAXS), and reflectivity. The unfocused beam is 1 mm in diameter, which is focused to 0.04 mm with cylindrical Be-lenses [2]. All beamline optics and transport components are in vacuum. The sample and detectors are in vacuum as well. The pump–probe laser was not in operation during my visit. This beamline is still in a developmental state, with the components still being commissioned. User operation is expected to commence in 2019.

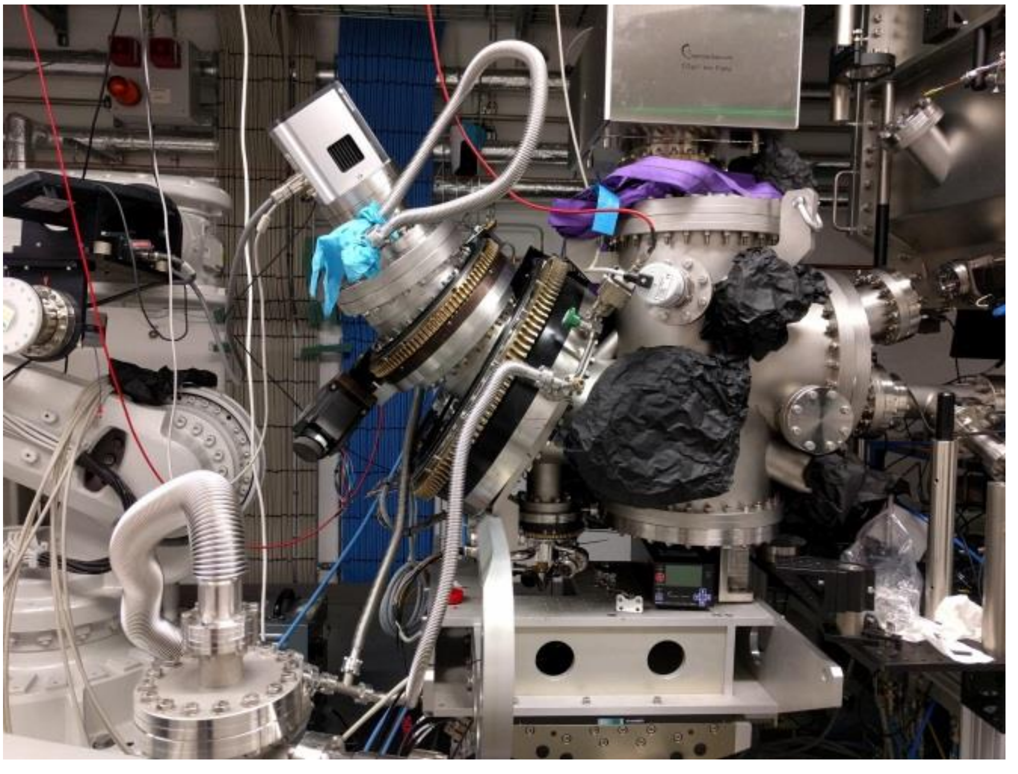
Figure 1: *The beam source on the left provides electrons for the two storage rings, R1 and R3. These are used for synchrotron light. The FemtoMAX short-pulse facility SPF is an extension of the linear accelerator on the right*



2 Beamline commissioning

At the beginning of my 10-day visit to FemtoMAX, I got a short introduction to the different components along the beamline and their functions. I supported the group at the beamline for a static commissioning experiment with an InSn sample in 111 orientation. Its Bragg reflection of the 1st order should be measured with 3.4 keV radiation. This experiment should give the scientists the opportunity to handle all components and test the detectors and data acquisition.

Figure 2: *The beam arrives from the right in the sample chamber. The place of the sample is marked in green. The detector is in the left part of the chamber.*



The sample was already installed when I arrived. In Figure 2, the sample chamber and detector is shown. We started with an improvement of a camera to provide a sharp and high-contrast picture on a luminescent screen (phosphor). Therefore, the optics of the camera was focused at the screen with the scattered light from an alignment laser on the sample. An unknown second spot was observed on the screen, and we investigated. In the end, the phosphor screen itself reflected the laser beam back to the polished surface of the sample and back onto the screen.

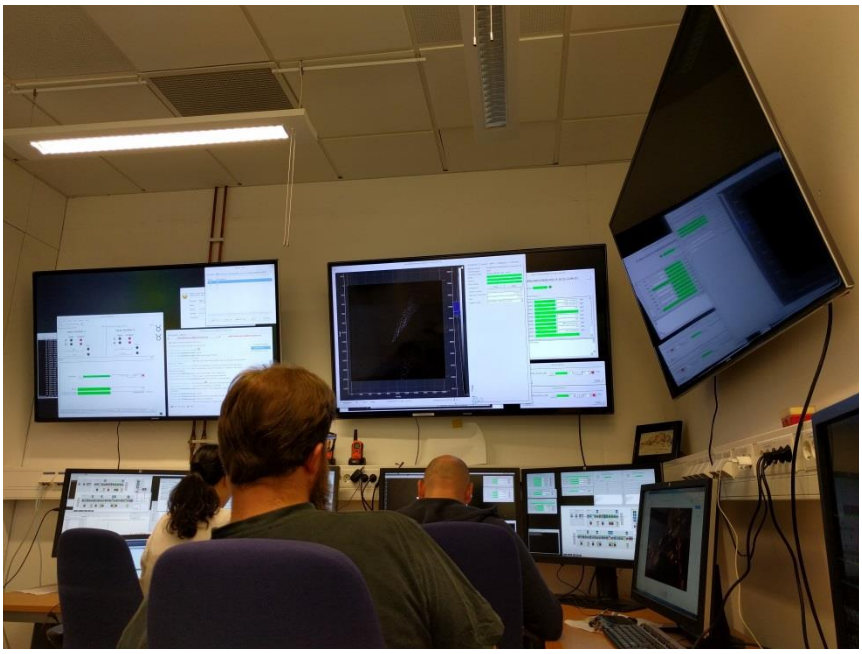
A noisy diode signal, measuring the intensity of the incident X-ray beam, was noticed. The signal-to-noise ratio was too low. Many different possibilities were checked—cables, connectors, and feedthrough—but, in the end, it turned out to be an electromagnetic compatibility (EMC) problem of the amplifier box behind the diode.

The Bragg reflection was still not visible on the screen. We cross-checked the position of the sample in the vacuum chamber and the position shown for the operator. This was also a time-consuming part of the preparation. The sample was not high enough to receive the X-ray beam. Therefore, we had to lower the slit blades. It took hours to find the right drawings of the components of the beamline. We found out that the slit system was already in the limit of the movable range. The entire slit system had to be moved some millimeters. Therefore, the entire chamber and mounted parts were displaced about three millimeters down.

As an additional exercise during this commissioning time, I was trained in the use of HDF5 datasets and how to plot them for a first inspection and get a feeling of what it would be like to look at the region of interest.

This visit to the beamline commissioning took altogether eight workdays. The Bragg reflection was seen in the end (Figure 3), and additional time was used to increase the signal on the detector.

Figure 3: *Experiment control room with the final Bragg reflection on the big screen*



3 Beyond my daily work

Next to the actual experiment, I learned some points about the facility. The MAX IV Laboratory has been operational since more than 30 years [3]. Most groups—such as Software, Vacuum, Radiation Protection, and many more—were well organized to work together.

A comparison of the European XFEL and MAX IV shows some striking differences (Table 1).

***Table 1**: Comparison of the European XFEL and MAX IV*

	Max IV	**European XFEL**
Control software	Tango	Karabo
Motor driver	Icepap (by ESRF)	Self-developed / Beckhoff
Beamline support	Vacuum and support of all experiments	Vacuum (mostly tunnel)
	Mechanical design and workshop	Workshop and two mechanic FTEs
	Stability, alignment, and metrology (SAM)	MEA 2 by DESY
	Electrical systems and PLC automation	AE and CAS

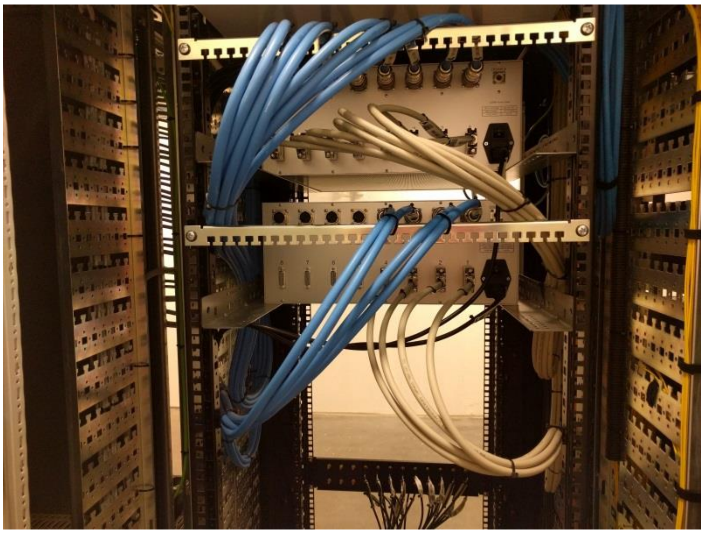
The control system software for the MAX IV facility and the FemtoMAX beamline is Tango. There is a strong cooperation with the European Synchrotron Radiation Facility (ESRF) to use this software. This gives guest scientists easy access to the software and a good recognition value. This can help to reduce the time to start with the operation of the control system. The expected dataflow at FemtoMAX is not as high as the data acquisition at the European XFEL. That is one of the major points at the European XFEL: the use of Karabo.

The motor drivers at MAX IV are developed at ESRF and named Icepap (Figure 4). This choice allows a quick release of single modules, if needed. The cables on the back side are handled with connectors that are plugged without special tools (Figure 5). This could reduce the costs for rack implementation and reduce time if a module needed to be exchanged. It also makes it possible to exchange a single module without shutting down the system.

These two points show a significant difference in the philosophy of the technical infrastructure between the European XFEL and MAX IV: using well-developed systems, on the one hand, and state-of-the-art techniques, on the other.

Figure 4: *Icepap module in a 19-inch module frame*

Figure 5: *Back side of the Icepap frame*



Overall, the FemtoMAX beamline has much more commissioning time available. Since autumn 2016, they have the X-ray beam. Therefore, they practice the work with each component thoroughly. The education situation for Ph.D. students is very comfortable: they can also handle this setup more or less on their own.

4 Additional observations

Additional observations made at MAX IV Laboratory for users more comfortable compared to the European XFEL:

- The bus stop is in front of MAX IV and is also named “MAX IV”.
- Every two days, they provide several baskets of fruit—including apples, bananas, pears, and kiwis—as well as other healthy food for all internal groups.
- A free coffee dispenser is located in various corners.
- There is an online chat log to communicate between the machine control room and user experiment control. This is used for daily program schedule and error messages.

5 Conclusion

This exchange helped me to get a better understanding of the beamline requirements, a simple experimental setup, and the interaction with the influence of varying parameters in different components on the beam quality. It also helped me to understand the technical needs for the scientists at the preparation and support before and during experiments.

Some essential points to improve our instrument and to minimize the downtime in an experiment run are to provide:

- Documents of the mounted setup
- Good documentation of each component and its connections
- Well selected cabinet for replacements and other often-needed equipment for the urgent replacement of damaged equipment

As a final conclusion, this Exchange Program, supported by EUCALL, gave me a new view of the handling of work by scientists as compared to the daily work of engineers. I also learned to fix single problems and to provide comprehensive solutions. In the future, our group could improve its strategic planning. This could be facilitated by a deeper understanding by the technical personnel to relieve scientists of technical work, so they can focus on state-of-the-art science.

This Exchange Program should go on to provide especially non-scientific staff the opportunity to get a comprehensive perspective on the experiment installations and the work during beamtimes.

A References

[1] H. Enquist, A. Jurgilaitis, A. Jarnac, Å.U.J. Bengtsson, M. Burza, F. Curbis, C. Disch, J.C. Ekström, M. Harb, L. Isaksson, M. Kotur, D. Kroon, F. Lindau, E. Mansten, J. Nygaard, A.I.H. Persson, V.T. Pham, M. Rissi, S. Thorin, C.-M. Tu, E. Wallén, X. Wang, S. Werina, J. Larsson: "FemtoMAX – an X-ray beamline for structural dynamics at the short-pulse facility of MAX IV", J. Synchr. Rad. **25** (2) 2018, 570–579

[2] FemtoMAX website (4/2018): www.maxiv.lu.se/accelerators-beamlines/beamlines/femtomax/

[3] FemtoMAX website (4/2018): www.maxiv.lu.se/about-us/

Acknowledgements

This work was funded as part of the European Cluster of Advanced Laser Light Sources (EUCALL) project, which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654220.

TRAVEL REPORT

Brief title of the travel: *First observation of re-crystallization of amorphous GeO2 under laser shock*

Participants name: *TORCHIO Raffaella*

Place and time: LULI, Ecole Polytechnique, 91128 Palaiseau cedex, France
2018.04.15 – 2018.04.20.

Text*: *aim/necessity of travel, benefit and value added, expected results:

The main aim of this travel was to perform an experiment on laser shocked amorphous GeO_2 probed by in situ XRD and VISAR/SOP in order to investigate its phase diagram, melting and metallization. This proposal was allocated two weeks of beamtime at LULI.

The interest in this materials is related to its strong similarities with SiO_2, a major component of earth's interior, in particular the structure of glass GeO_2 is a good model for liquid or molten SiO_2.

In the first days of the experiment we have been optimizing the in-situ XRD diagnostics by testing different backlighters (Fe and Cu) and different pinholes with different sizes. Once this was done, the laser shock induced re-crystallization of amorphous GeO_2 to a rutile structure was for the first time observed similarly as recently observed for SiO_2.

The re-crystallization was observed using nominal laser power in between 3.6-5 10^{12} W/cm^2 . Above this power the starting amorphous GeO_2 likely melts and no diffraction lines could be detected. The interpretation of the VISAR data is not straight-forward so for the time being no pressure condition could be deduced. At much high laser powers (around 10^{13}W/cm^2) the metallization of GeO_2 was observed. This is extremely interesting for a future experiment to be performed at the ESRF again on GeO_2 and in collaboration with the LULI group, using x-ray absorption.

For me this was a unique opportunity to perform a laser shock experiment in a laser facility with some of the maximum experts in Europe. This experience will be extremely useful for the development of the laser facility at the ESRF that I'm responsible of. In particular I could learn some important details about the setup, some VISAR data analysis and hydrodynamic simulations.

On my side I could contribute with my knowledge of XRD and of course of the scientific case.

Grenoble, 24/04/2018