Deliverables

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European light sources for industrial innovation: Experience and perspectives from CALIPSO and CALIPSOplus

Foreword

Europe's advanced light sources are powerhouses of scientific and technological excellence. They support Europe's biggest research infrastructure user community including both academic and industrial researchers and an impressive range of science disciplines - and that user base is growing in depth and breadth on a daily basis. Working with industry has become a core mission of the light sources, but it is a fragmented approach, relying on the motivation of individual facilities, but not yet drawing upon the combined power of the LEAPS network of accelerator-based photon sources.

Summarising the experience built during the Framework Programme projects CALIPSO and CALIPSOplus over the last ten years, this paper sets out perspectives and recommendations for actions to realise enhanced engagement by the LEAPS facilities with and for European industry, both large and small. The paper further draws upon experience from other research infrastructure families and European projects, including particularly SINE2020 which was a close partner of many joint outreach actions towards industry and in the industry office networking.

At this moment when academic facilities and industry are open more than ever before to work together, it endeavours to look towards a future approach to work with industry, surpassing borders and cultural divides and opening the portfolio of light sources for industry as a user, as a collaborator, partner and technology co-developer better than ever. The activities suggested will position light sources better in the European Research Area, structuring joint activities and having impact across the European innovation ecosystems.

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1. Industrial networking activities

"Improving awareness is a key requirement. RIs should develop more systematically outreach activities and "industry days" with true business development managers able to help them to answer the question "How best to sell RIs?". The organisation of industrial exhibitions linked with major scientific conferences became common practice. Raising awareness on RI opportunities and their socio-economic impact is needed in all directions: towards RIs themselves, industry and a wider audience (including policy decision makers and the general public)."

ESFRI Inno WG Report 2016

In 2016 the ESFRI Inno WG reported that improving awareness on industry exploitation of research infrastructures, the opportunities and come back was, and in reality still is, a key requirement of driving an ongoing culture change in RIs themselves and within industry. The industry networking activities of the CALIPSO[1] and CALIPSOplus[2] integrating activity Framework Programme projects took this goal very much to heart - already starting to improve awareness five years before the ESFRI report was published.

Although the two Framework projects were focussed largely on the provision of trans-national access for academic researchers to the portfolio of advanced light sources spread across Europe, the growing interest of light sources towards and for industrial research was reflected as a key element of both projects with important strategic networking activities being included: "European Light Sources for Industry and Innovation" (ELSII in CALIPSO and ELSIIplus in CALIPSOplus), and "TamaTA" a pilot SME access programme enabled via CALIPSOplus support (see Section 2).

The ELSII networking activity was conceived to catalyse and enhance the industrial use of and interaction with European light source research infrastructures. ELSII aimed therefore to improve the mutual confidence with industry but also, and equally importantly, to create an active industry office network between the light source facilities themselves via three main activities:

- **NETWORK:** sharing experience and challenges of working with and for industry.
- **ADVICE:** harvesting advice from industry
- **AWARENESS**: raising awareness of light source sciences and techniques to industry

1.1 Building a grassroots ICO network

At the time of the start of CALIPSO, many European light sources had various forms of "Industrial Contact Offices" (ICO) in place, with differing degrees of maturity and scope, but each having the mission to help industry in exploiting the facilities for commercial research and innovation. However, there was little joint work or sharing of best practices and knowledge of what each light source was doing and achieving in its efforts to engage with industry. A major theme of the ELSII and ELSIIplus networking activities was therefore between the industry office staff. Until CALIPSO started, many of the staff running these offices had not met each other.

From the outset of the ELSII work, the networking was structured to be open and porous by building bridges particularly to the neutron source community which were working together in the

[1] "Coordinated Access to Lightsources to Promote Standards and Optimisation" FP7, 2012-2015; cordis.europa.eu/project/id/312284

[2] "Convenient Access to Light Sources Open to Innovation, Science and to the World" Horizon2020, 2017-2021; www.calipsoplus.eu

NMI3[3] integrating activity project and then followed by SINE2020[4]. The SINE2020 project provided a report as a project deliverable on “Business Model for scope, access and IP for "neutrons and industry"[5] during 2019 and which provides a valuable perspective on working with industry from the view of neutron facilities.

These bridges across infrastructure clusters proved important as, especially in the case of X-rays and neutrons, the facilities provide complementary approaches to materials characterisation. As the visibility of the light and neutron source ICOs grew, the critical mass of the industry coordination officers brought together was called upon to support brainstorming with further European projects, BrightnESS2 and NFFA, on how better to approach industry.

Throughout the ELSII project lifetime there has been and continues to be a clear willingness and desire to share industry strategies and ideas between the light sources, and beyond with (e.g.) the neutron sources. These strategies reflect cultural and regional variation, industry size and sector variation, and facility motivation and capacities to work with industrial R&I needs. The ELSII and ELSIIplus networking has led to a number of new initiatives and projects inspired by sharing approaches and ideas. Some of these have been incorporated as sub-tasks or work packages in European project proposals (for example the SME access scheme summarised below). Others are seen in a much more closely knit trans-facility business community, providing a fertile ground to work together in serving industry and building a wider approach at a European level - working together is one way to strengthen the bridge to our European industrial colleagues. This is proving to be important in the emergence of the League of European Accelerator-based Photon Sources[6] (LEAPS) as a strategic consortium of facilities and which actively promotes the quality and impact of industrial research carried out at each facility to the greater benefit of European science and society. Within LEAPS a specific working group formed from the ELSII ICO network is leading on these industry and innovation developments.

1.2 Industry advisory board

The joint 12-strong CALIPSO-NMI3 Industrial Advisory Board meetings provided the opportunity for exchange, meeting and sharing the challenges of how best to work with and for industry as a user of the facilities. The pragmatic IAB advice, as harvested during CALIPSO and NMI3 in 2015, was published subsequently in an ESFRI report. The feedback was valuable in the earlier stages of the joint activities between light sources. An important point is to see how best to continue such feedback and extend it towards industry as a technology supplier and co-developer. The LEAPS Innov project, recently initiated, includes an Innovation Advisory Board focussed towards joint technology development with light source engineers and scientists. Of course, some facilities have their own national-level Industry advisory board, responding to national priorities and the interplay with trans-national approaches need to be considered.

1.3 Outreach to industry

Beyond networking between the facilities which resulted in the strong enabling bond between the facilities, the ELSII and ELSIIplus programmes catalysed and supported numerous outreach actions

[3] “Neutron Scattering and Muon Spectroscopy Integrated Initiative”, FP7, www.nmi3.eu
[4] “Science & Innovation with Neutrons in Europe in 2020”, Horizon2020, www.sine2020.eu
[5] ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5c83b3bc5&appId=PPGMS
[6] www.leaps-initiative.eu

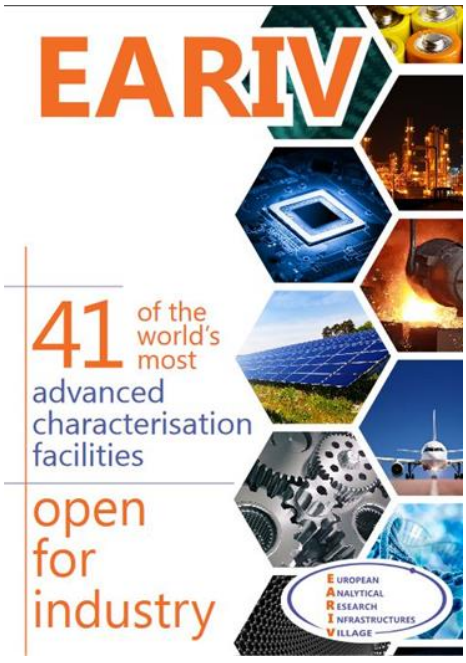
and tools towards industry: events, workshops, training and communication materials, reaching out to a combined audience of well over 10,000 researchers in 1:1, small and large-scale events and exhibitions. The events were developed across two strategic parallel thematics either focussing towards local and regional ecosystems, or encompassing a European-wide approach and drawing upon multiple research infrastructures, often from different clusters, with the aim to demonstrate the combined power of research infrastructures to provide a full picture of industrial materials. From amongst the plethora of events which were held and the tools developed, a few examples are highlighted below. The emergence of COVID altered outreach strategies dramatically with a switch towards webinars and digital outreach. Travel is restarting now, and in-person events will re-emerge (the first such are already booked in light source calendars), but outreach via digital channels is here to stay.

Synergi2018 and 2019 "Synchrotrons and Neutron Radiation Go Industrial", two international workshops held in Amsterdam and Lyon, brought together many international and national light source and neutron research infrastructures with industry researchers. CALIPSOplus, NFFA and BalticTram joined forces and resources with SINE2020, the main event hosts, for materials-science (2018) and chemistry (2019) focussed awareness raising events.	
"Non-conventional characterisation techniques for food using synchrotron light and neutrons" - a special session at the 31st EFFoST International Conference (2017, Spain). This special session aimed to demonstrate the role and use of synchrotron X-ray and neutron beam characterisation on food science technology challenges, using examples from industrial perspectives. Background information on synchrotron and neutron sources was provided by facility industry offices.	

Pharmaceutical, Cosmetics and Biomedical Industry Day - one of the industry days held at ALBA Synchrotron (Barcelona). These were a series of focussed topic days, held in the local language - important for effective outreach. The industry days built awareness in the Spanish light source locally and further afield across Spain.

Similar days were held at other light sources across Europe, also in the local language.

The European Analytical Research Infrastructures Village (EARIV) outreach tools bringing together 41 light sources, neutron sources, lasers and other research infrastructures in a single prism of industry engagement. This was only possible due to networking between facilities allowing industry staff to work on EARIV together. The EARIV concept was used in a web site (www.eariv.eu), a brochure and exhibition material (used at a number of industrial and political conferences), showing off the European analytical RI portfolio and its impact for industry R&D. With the recent formation of the Analytical Research Infrastructures of Europe (ARIE) partnership, it is planned that the EARIV materials will be transferred to the ARIE branding.



Communication tools for SME access: Production of a multi-language industry dedicated section on the the wayforlight portal[7] including the single entry point for the SME access (see (2) below) and common brochure (English and French) to market the SME access "TamaTA" scheme.

1.4 Outcomes and policy recommendations

- **Networking**

A key value of the ELSII and ELSIIplus activities is very much the creation and nurturing of a new business-based network amongst the light sources This provides a ready forum for discussions exchanges, sharing knowhow, approaches, and has built trust - even enabling clients to be moved between facilities for optimal access needs. Added value was created by extending and being open to other research infrastructures, including especially the neutron source community and where many activities were held fully jointly, enriching the network.

The networking should be maintained and enhanced by being open to further analytical large-scale research infrastructures joining, building on links also to ENRIITC[8] which is constructing an EU-wide industrial contact officer (ICO) and industrial liaison officer (ILO, procurement) network for all types of research infrastructures.

- **Advice direct from industry**

Advice from industry is invaluable, be it for pragmatic or strategic approaches. Two complementary approaches are open:

[7] www.wayforlight.eu/en/industries/

[8] www.enriitc.eu

- ➢ A formal industry or innovation advisory board (typically 5-10 members). Although this can be difficult to maintain, requiring industrial researchers to provide ongoing time, it provides high level strategic advice and visibility;
- ➢ Ad hoc surveys or interviews can be used to harvest timely feedback across a wide range of industries.

A high level industry advisory board should be created to provide strategic level insight and to work with the analytical research infrastructures in multilateral industry engagement. A wide ranging ad hoc survey should be performed to harvest feedback to shape longer term industry engagement approaches, covering industry as a user, as a technology supplier and as a collaborator.

- **Outreach to industry**

Local (regional, national) eco-system events matching local cultures and language are important and are effective in reaching out to industry, lowering communication barriers and limitations of travel. International events can be challenging as it is hard to motivate industry for their staff to be mobile; such events are more impactful therefore when the topics concern strategic discussions or provide a deeper or more formal training and education of industry researchers. Nonetheless, "bolt-on" research infrastructure information events to international conferences can be highly effective as the target audience is already present at the meeting. The pandemic has seen a meteoric rise in remote conferences and webinars, largely democratising participation with no travel requirements and often no charges applied to join the event. Short, targeted webinars can be a useful medium to reach out to audiences, with material recorded and made available in "replay" after the live event. Above all, an industry friendly culture at light sources with motivated staff, related KPI and dedicated staff for industry are critical to work with industry successfully.

Making tailored outreach events and training for industry is a core activity for the industry contact officers as part of their mission for industry engagement. Events are typically regional or national in ambition, targeting a specific industry sector, though wider events can be very impactful. On-line events are now commonplace and accepted as a training and outreach tool; though they should be kept concise and targeted, and as such can be a valuable and effective means of outreach.

2. Targeted and tailored support for SMEs

2.1 Piloting SME-friendly access

SMEs are the innovation engine of the European industrial landscape. However, they are not usually aware of the advantages provided by advanced analytical techniques and know-how available at light sources to help them to achieve better products and improved processes. The "Tailor-made for SMEs Trans-national Access" (TamaTA) pilot programme of CALIPSOplus was designed as a response to this challenge, providing a customised and rapid access to European light sources in a convenient and fast way to meet SME innovation needs. From across Europe ten international and national synchrotron light and free electron laser research infrastructures joined forces to offer a harmonised industry service through a centralised easy-to-use single entry portal.

This access was designed to provide a complete service to the SMEs - from experiment design, data collection, data interpretation, to issuing a report and debriefing that allows the company to take up the knowledge generated and eventually to exploit the results obtained. The ICOs of the facilities provided advice to the companies on the most suitable techniques(s) for their specific requirements. Careful preparation and design of the particular experiments usually required detailed meetings with the companies to reach a deep understanding of their needs. After this initial translation of the research and innovation (R&I) needs, companies were able to prepare a simple proposal for accessing the TamaTA programme. Upon favourable evaluation by an independent expert panel, the SME was then entitled to free access to the selected facility to gather relevant data and results to support innovative R&I for products or processes.

2.2 Pilot results

The TamaTa programme attracted a total of 36 SME proposals from ten European countries, spreading out the impact and showing the inclusivity of this programme across Europe, and even with one application from the US. The remote access approach of TamaTA with sample mail-in allowed SMEs based in countries with no light source to benefit easily and without needing to travel, and also allowed the TamaTA services to be resilient and offered almost non-stop during the pandemic. Furthermore, a very high-speed access was put in place for SMEs working on COVID-19 related concerns and requiring light source techniques, enhancing the impact to the pharmaceutical sector.

Light source techniques are highly polyvalent - applicable to a panoply of materials and processes, with a wide range of industry using facilities. This is also seen in the TamaTA programme where a wide variety of industrial sectors was addressed by the TamaTA proposals as shown in Figure 2.1. It represents one aspect of the impact of this programme which addressed a diversity of markets producing an impact across a broad range of industry ecosystems. This versatility is an important pillar for promoting and supporting SME-driven innovation in Europe.

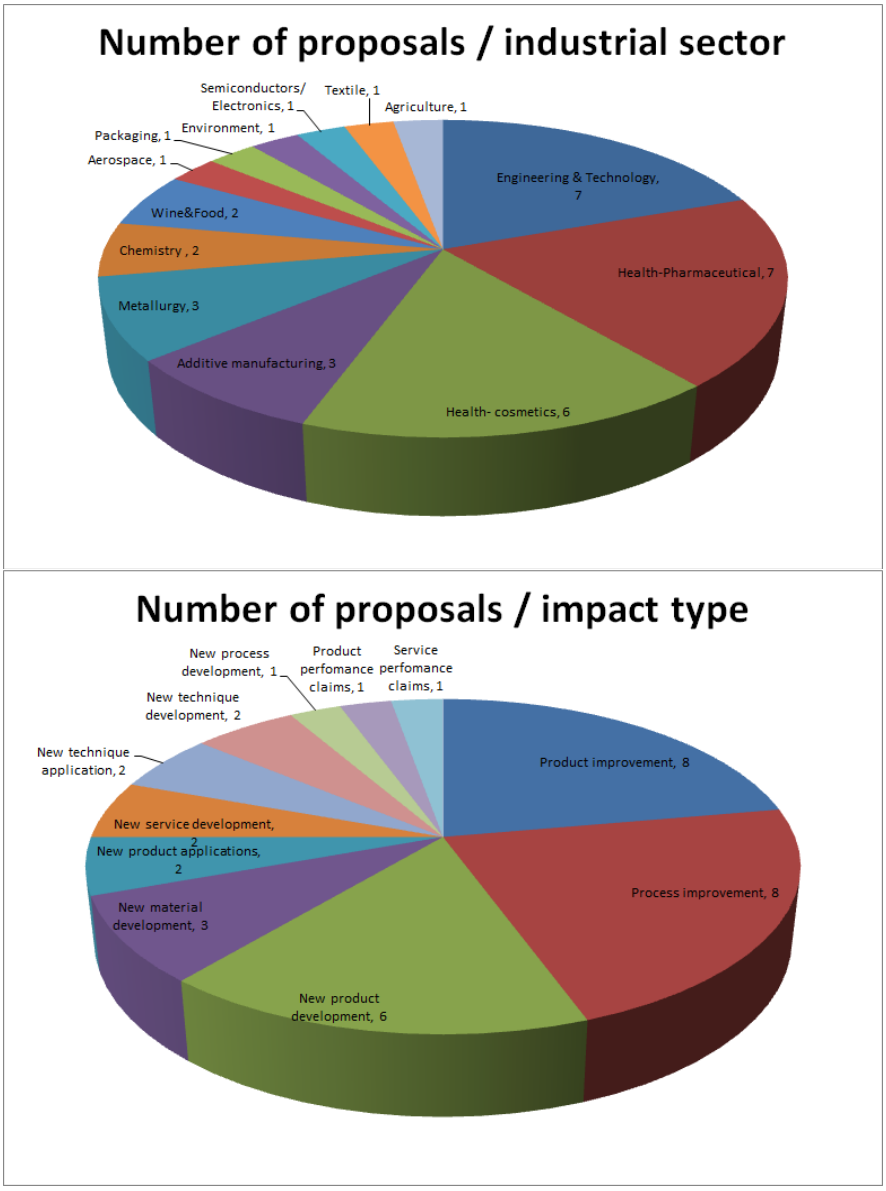


FIgure 2.1*: Top: Industrial sectors tackled by the TamaTA SME proposals. Lower: Type of impact of the TamaTA SME proposals. Process and product improvement and new product development make the prominent cluster of TamaTA exploitation and impact.*

Health is the predominant sector which exploited the TamaTA programme, combining both pharmaceutical and cosmetics. From the pharmaceutical perspective, thanks to TamaTA, the SMEs were able to perform their own drug discovery activities for developing new pharmaceutical products, to improve their structural biology service range to other companies, to develop new analytical techniques to improve structure determination and, interestingly, to showcase the unique analytical power of light source techniques, further demonstrating their high potential towards other pharmaceutical companies. From cosmetics, the SMEs focussed on determining the effects of existing products on skin maintenance and repair leading to new applications of these products. A lower cost and more efficient metal oxide production process for UV filters (sun blocks) was also the subject of TamaTA proposals. Another interesting study focussed on the development of a technique to determine the effect of cosmetic products on the internal structure of hair to show additional, undemonstrated, performance of those products.

Engineering and technology is another important industrial sector where TamaTA proposals aimed to improve detectors for industrial, security and medical applications. Defect free and higher quality optical elements were also characterised for performance enhancement of those products. Process improvement for quartz-based devices and fabrication of X-ray crystal optics were tackled in other proposals. An improved ultrafast lab-based X-ray imaging system for opening up new industrial applications, such as additive manufacturing and powder compaction, was the subject matter of another TamaTA proposal.

The emerging **additive manufacturing** sector was targeted by several TamaTA proposals. New materials such as new steels and composites were developed and their evolution under operando conditions was studied for improving their performance and for lowering their manufacturing cost.

Most of the TamaTA proposals dealing with the **metallurgy** sector were related to steel innovations. New steels with high nitrogen content were studied to increase the fatigue resistance lifetime of the parts working under extreme conditions like combustion engines. New applications of existing light source techniques are developed in other TamaTA proposals to better elucidate the quality of innovative materials and processes.
Proposals for developing new sustainable rubber compounds for specific industrial applications and for improving formulation of polishes products in terms of efficacy and efficiency were industry needs targeted in the **chemistry** sector

The **aerospace** sector was addressed for developing a new defect-free manufacturing process of a carbon fibre reinforced polymer. A new adhesive with selenium nanoparticles for better preserving packaged food was tackled in the **packaging** sector. Related to the **agriculture** sector, product improvements for slow delivery of chelated agents (i.e. Cu (II)) to plant tissues were pursued. The next generation of organic semiconductors were addressed in the **semiconductors and electronics** sector. Improved water and oil repellent properties through innovative processes were sought in the **textile** sector.

From this wide set of R&I drivers benefiting from advanced light source analytical techniques, the potential is clear in terms of fostering and supporting industry innovation such as new product and material developments, improved products and materials, new and improved processes, improved services and techniques and new product and service performance claims. The relevant information generated by the light sources at the micro-nano scales allows predictive material and product behaviours, in turn enabling failure avoidance and longer lifetimes with the subsequent impact in the success of the SME's commercial endeavour. Such knowledge about the inner structure of matter boosts innovation by allowing the development of new materials and products with outstanding properties. Figure 2.1 shows a view of the impact of the TamaTA proposals in these respects. The SMEs supported by the TamaTA programme were surveyed post-access. Comments about the contribution of the synchrotron and free electron laser techniques to their material, product and services improvements and developments were very encouraging.

To illustrate the pilot TamaTA programme, an example of an SME access is shown below.

XNEXT

Italian SME uses ESRF to perfect its detector for food safety

ESRF
The European Synchrotron

Summary of the project

X-ray machines in the food industry today can easily detect high density foreign bodies, such as metal, lead, stones, bones and glass, hidden inside non-transparent foodstuff and non-transparent containers. There are, however, some challenging materials that go undetectable, such as low density foreign materials like wood, low density polymers, cigarette butts, dry fruit shells and insects, to name a few.

Xnext, an Italian SME, has developed XSpectra, a new generation of X-ray inspection systems that can detect both low and high density, overcoming the difficulties of conventional X-ray machines. The multispectral detector works by making several scans of the material in different energies. Once the researchers put all the scans together, these can reveal the absorption of low energy photons in the material, which translate into low density objects.

In order to improve their detector, the team came to the ESRF's BM05 beamline in the framework of the Calipso Plus collaboration, which grants SMEs access to synchrotrons and X-FEL sources. “We are very excited to have companies like Xnext coming here to characterise their products before making it commercially available”, explains Ennio Capria, deputy head of the Business Development Office at the ESRF. “The first contact with the company was through an informal exchange that I had with Prof. Giacomo Ghiringhelli. He is a distinguished representative of our academic user community, and it is important to highlight the crucial role played by the academics to support, with their competences and expertise, this process of innovation-unlocking, where the ESRF can be an active player".

The team came to beamline BM05 to find out precisely how the detector reacts in a monochromatic beam, as well as to characterise the detector itself. “Our experience at the ESRF was extremely positive, from the service to the facility itself”, explains Luca Zanotti, system and algorithm engineer at Xnext. “We still have to analyse the data, but preliminary results already show us aspects that we could improve in XSpectra”. The detector is in its final phase of development, and it will be commercially available in the coming year.

2.3 Outcomes and policy recommendations

As has been mentioned, SMEs are a key innovation driver. SMEs are often time- and resource-limited much more than large companies with their own R&D divisions and perhaps dedicated analytical teams. The TamaTA pilot, supporting 36 SMEs, has shown that tailored support for SMEs, with a rapid and easy-to-use access mechanism to light sources can catalyse the exploitation of ARIs by SMEs.

- *The successful pilot TamaTA programme should be continued and expanded, taken to a multi-ARI scale but retaining the slim-line approach for the SMEs. Under such an expanded programme, TamaTA innovation vouchers would provide access to a wide range of valuable materials and living matter characterisation facilities, beyond light sources, including the full scope of analytical research infrastructures in Europe.*

- *TamaTA has worked very well under pandemic conditions due to the mail-in and remote access to the facilities as well as remote access to the data collected. In addition this approach allowed SMEs to select and access the most convenient facilities (taking into account language culture, experimental techniques) and avoided travel costs. This style of remote access is very efficient for a range of "routine" measurements and therefore it is recommended to develop this type of access further.*

- *The scope of support should also be extended to explore novel industry access schemes for industry of all sizes to work better with research infrastructures. Vinnova, the Swedish innovation agency, has pioneered an approach bringing together Swedish industry with knowledge providers (e.g. universities or RTOs) to exploit X-ray or neutron infrastructures to solve an R&D challenge. Aiming to catalyse industry use of facilities, successful applications receive funding to help cover staff time, consumables and infrastructure access, with a two-way exchange of knowledge between the partners. This scheme could be used as a model for a European-level approach.*

- *Industry access, when supported by EC resources and not paid for as commercial access by companies, Open Data and the requirement to "publish" can be strong impediments for industry to make a first step to using a research infrastructure. The definition of "publish" or "publication" is not clear. In the scientific community it has a specific meaning as a peer reviewed journal publication; but this is often anathema to industry which does not wish to publish results, does not have the mission to do so and does not have the time to do so. The same argument applies to Open Data with the need for data to be made public according to facility data policies which follow the EC FAIR guidelines. It is recommended to be clear on what "publication" can mean (e.g. a technical report, a case study, a research summary) and to avoid the requirement for Open Data, or allow a long embargo time (such as 10 years) for industry related data collected under trans-national access conditions.*

- *In all cases, facilities and their industrial partners are encouraged to prepare case studies as one of the outcomes of such funded accesses, using them to inspire further industrial exploitation of the research infrastructures and showing to stakeholders the economical value and interests of the advanced characterisation.*

3. Widening industrial engagement via intermediaries

3.1 Innovation-led access

Large-scale research infrastructures are especially basic research institutions. They have the task of expanding our knowledge of the world and as a result are largely curiosity-driven. In addition to basic research, however, the transfer from basic research into new products, technologies and services has been moving more into the focus of large-scale research infrastructures, and has accelerated in particular over the last years.

In principle, there are two ways for researchers to gain access to research infrastructures: a) via a scientific proposal - in which case access to large-scale research facilities is generally free of charge (in some cases including travel costs), or b) by paying for the services of the research facilities. The basis for the price is the costs of the RI, but not profits. Of course, companies could simply pay for the research at the research infrastructures - but they shy away from this for various reasons: They cannot assess how costly the investigations are and they cannot assess whether the investigations will also lead to expected results, since in many cases they have no experience in cooperating with research infrastructures. Therefore, many companies use cooperation with universities or other research institutions to gain joint access to RI for publishable research (and also often for paid-for proprietary research). These collaborations, regarding publishable research, account for about 20 % of the available beam time (ESFRI):

"Direct access to RIs by industrial users aiming to carry out their own experimental research seems to be low, on average less than 5% of the total available user access time. Industrial direct access is assumed to be proprietary research and therefore a fee, covering the full operational costs, has to be paid for access. But as a matter of fact it is well known that a larger (and partly hidden) involvement of industry in RIs exists (roughly 20% of the total beam time or even more, for analytical facilities) within the framework of partnerships with public (academic) users. These collaborations between industry and academic institutions via (industry-focused) research projects being conducted at many RIs occur in a kind of grey zone. In such cases issues related to IPR, "co-property" and publishing regimes are regulated in the research contract between the public and private partners, usually on the basis of the specific funding scheme (totally private funding, in-kind participation of the academic institution, collaboration in publicly granted projects) and typically there are no concerns on the RI access. It would be necessary to take this practice explicitly into account and the RIs should become a recognised partner in this type of collaboration in order to be able to identify the full real added value of the RI which should not be minimised by the funding authorities."

Source: ESFRI WG INNO_REPORT TO ESFRI (MARCH 2016)

So far, however, there is usually no reason for universities and research institutions to disclose their collaboration with industry and indeed this can still be perceived in a negative way by traditional access review committees founded in fundamental science.

In two forward-looking access programmes, however, additional criteria for access to major research institutions have been included, so that applying consortia of industry with scientific institutions, RTOs and expert service companies (SSCs) have advantages over a purely scientific application:

- **ISIS (the UK neutron source), together with the STFC,** has launched the "ISIS Collaborative R&D Programme". Under this programme, industrial companies - also

together with scientific institutions - are given access to measurements at ISIS under the following conditions:
    - Beam time is free at point of use
    - Beam time may be obtained quickly
    - Criteria for providing the access will be the experiment's **potential economic benefit** to the UK
    - The results remain confidential during the period of the experiment and the subsequent data analysis
    - For each experimental proposal, a company must demonstrate it has deployed **in-kind matching funding to the cost of the ISIS beam time** supplied.

- **VINNOVA, a funding agency in Sweden,** has launched a series of biannual calls for proposals in their programme "Industrial pilot projects for the utilisation of neutron and photon based techniques at large-scale infrastructures" with the following conditions (extract):
    - The project proposal should be based on the **needs of at least one Swedish company which is also a participant of the project**. The project activities must be related to the verification of how neutron or photon-based techniques can be applied in order to meet a company's problems or development needs. Planning and implementation of experiments, as well as interpreting the results, should be carried out in active collaboration with appropriate expertise in neutron- and/or photon based techniques.
    - The project consortium shall therefore also **include at least one Swedish participant organisation that assists with such expertise**. The call for proposals funds experiments at MAX IV as well as at international large-scale research infrastructures for neutron and photon-based techniques. All types of access for experimental/beam time are allowed and **beam time is also an eligible cost**.

The parts of the funding conditions highlighted in bold should be exemplary for future conditions of access for consortia from industry, universities, RTOs and expert service companies to such innovation-led access programmes, but built at the European scale.

3.2 Working with RTO and TI

Research technology organisations (RTO) and technology infrastructures (TI) are critical hubs in the innovation ecosystem, filling space between pure academia and the wholly commercial word. They now play a central role in developing the new science and technology to be applied to real world challenges and, as such, often engage proactively with the industrial world. For example the French *Commissariat à l'Énergie Atomique* in Grenoble states that it "devotes most of its research to the development of innovative solutions in the fields of energy, health, information and communication".

The R&I challenges being met by these centres can benefit from research infrastructure (RI) analytical tools, particularly those of the light sources. Some RTO and TI have already partially turned towards RIs for support in their programmes with industry, and there does exist strong 1:1 links, especially when the RI is physically close to an RTO or TI, or there is an RI "connaisseur" in the RTO or TI. But there is not yet the "automatic" reflex to consider the advanced techniques available for more routine exploitation in the development programmes.

This situation should be proactively changed. Outreach and training can help, but also refining access programmes to encourage strongly applied science in partnership with industrial partners.

Such science can often be very challenging and may need customised services (such as sample environments or complex data analysis) and/or a long-term guaranteed access over several years as the RI techniques provide continual input into the (e.g.) materials development cycle.

3.3 Expert service companies

Small, nimble expert service companies (ESCs) have emerged over the last years as specialists in bridging the gap from industry to research infrastructures. ESCs do not necessarily develop outstanding products or processes themselves - but are service providers, often for deep tech companies, with a profound background in science. These service companies are thus an important accelerator or catalyst for innovation. In the context of RIs, ESCs provide niche expert support in translating an industry problem to RI techniques, are able to analyse data and often run experiments at the RIs with their own staff. As such the companies provide a strong added dimension to the RI access and support landscape, complementing other industry access methods such as direct peer review access, commercial access, and collaborations with academic and technological partners.

ESC can be defined as:

- Companies that act as facilitators between research infrastructures and industrial clients, providing support, consultancy, analytical research and measurement services.
- They are private companies and profit-oriented.
- The definition of ESCs is not necessarily limited to cooperation with large research infrastructures, but the focus is on scientific excellence. In practice, this means that ESCs exploit techniques that can be provided by large-scale research infrastructures.

In summary: expert service companies act as innovative problem solvers and facilitate applicable customised solutions for industrial and societal challenges involving industry and science.

The emergence of the companies, often set-up by research infrastructure researchers spotting the opportunity to run their own service entity, is undoubtedly enlarging the commercial user base of the research infrastructures, providing marketing and visibility which the facilities are often not able to do themselves due to limited resources and perceived risk. This free-market opportunism is therefore welcome as a further demonstration of the value of the large-scale facilities for industry and creation of value.

Because they are for-profit SMEs with private owners, they need to be agile and will be able to respond quickly to the wishes of research-based industrial companies. They mash-up with existing large-scale research facilities, usually by using measuring instruments already available at synchrotrons and other public facilities and thus increasing their exploitation. Furthermore, they offer young scientists alternative perspectives for their future in an entrepreneurial career.

Since they usually act internationally and do not require a large initial investment, the ESCs could be well-suited to be located in less innovative member states. Though the current ESCs are based largely in western Europe, there is a good potential to provide highly qualified jobs in the country of domicile, wherever in Europe, and create economic value by exporting their services.

On the other hand, they are not interesting for venture capital companies (and the public funding programmes for deep tech companies) because they grow organically and are not very scalable. Of course, measurements and analysis can be automated to some extent - but they are always dependent on the work of the scientists in the ESCs to interpret the results and advise their commercial clients. However, there are economies of scale when ESCs work together in networks,

as this allows costs for advertising, development of measurement and evaluation methods, training and legal advice to be shared.

For the large-scale research facilities, cooperation with ESCs is a strategic decision as to whether to offer scientific services in-house or outsourced. Especially in fields of low demand, ESCs can bundle industry needs together and thus work effectively and tenably with industry. This means that the large research institutions do not have to provide in-house resources for every industry sector and every measurement method. On the other hand, if there are enough customers, the in-house solution brings better planning and internal competence and income/visibility for the large-scale research facilities. Thus the large facilities often adopt a mixed approach according to appetite for risk, positioning, available resources and overall strategy for industry engagement.

Recently, a Baltic Region INTERREG project "CAROTS" (www.carots.eu) has explored more of the evolution of these companies and their ecosystem, and developed an overview presented in a policy brief on ESCs and their impact[9]. Two pilot activities were initiated out within the framework of CAROTS:

- **Startup School - coaching researchers in creating and nurturing ESC start-ups:** For the very first run of the Startup School 11 scientists from Estonia, Finland, Germany, Sweden, and Switzerland were selected by jurors from 48 applications received across Europe and the Baltic Sea Region. The focus of the CAROTS Startup School was on practical knowledge transfer. To this end, six experienced founders and CEOs of successful ESCs shared their knowledge with Startup School participants in moderated webinars and 1-to-1 coaching sessions from the end of March to the end of June 2021. Five participants are already on their way to founding a company, either as a standalone startup or a spin off within an institute.

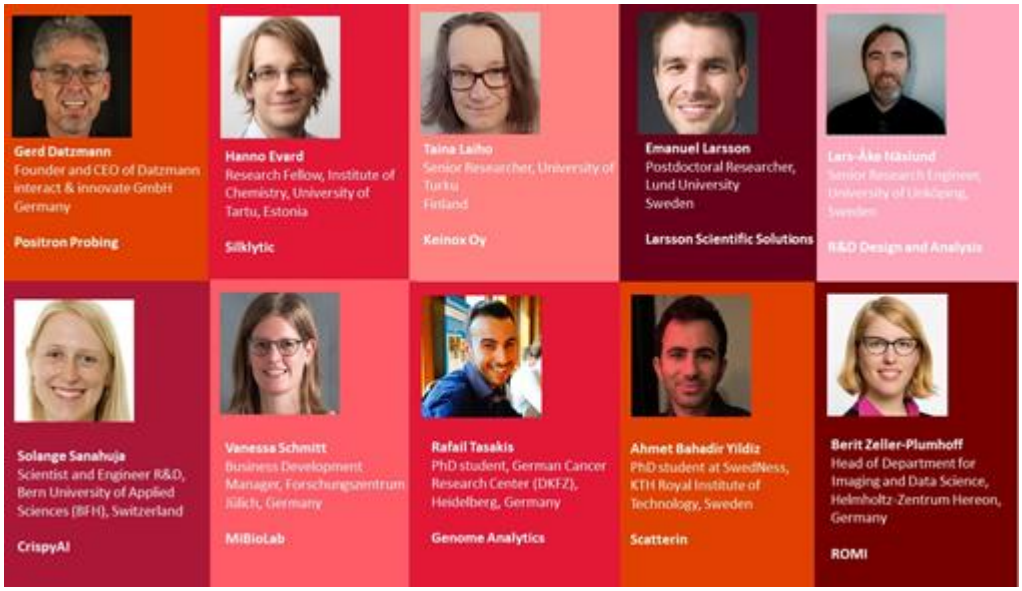


Figure 3.1: *The participants in the first CAROTs StartUp School.*

[9] www.carots.eu/sites/sites_custom/site_carots/content/e114136/e121947/CAROTSPolicyBrief.pdf

- **Expert Service Company network:** The project has initiated a network[10] of eleven of the existing expert service companies, focussed on large-scale X-ray and neutron facilities, providing greater visibility and making links between the companies across Europe. On the signing of a letter of intent the network "Mediators connecting Industry to X-rays and Neutrons" (MIXN) came officially into being. The network aims to support its members in several ways:
    - Speak with one voice towards facilities and political stakeholders in order to increase visibility and awareness of value creation by the ESCs
    - Reach new customers and collaborate on improved customer service by activating the complementary competences in the network
    - Advocate for easier non-academic access and use of the facilities.

The existing scientific service companies are profitable and growing continuously. It is still a young and growing market. However, the fact that there are only a few such Scientific Service Companies in Europe, they are not sufficiently visible to industry, science, administration and the public.

Furthermore, there are challenges in accessing research infrastructures. Here, very short-term access - which research infrastructures cannot provide due to high utilization by scientific groups - is particularly important.

There are also challenges in the development of new measurement methods by the scientific service companies, as the distribution of costs and rights between the scientific service companies and the research infrastructures is extremely complicated due to diverging interests.

3.4 Policy recommendations

- *Industrial customers require very fast access to advance their research or development. Facilitators such as ESCs also need a fast access mode to large-scale RIs.*

- *Large-scale RIs should expand their rules for review of innovation-led applications to include economic and regional development criteria.*

- *Financial support should be provided for industry access to large-scale RIs - but with an appropriate in-kind contribution from the industrial users.*

- *Promote cooperation between industrial users and universities, RTOs, TIs and ESCs in accessing large-scale RIs*

- *ESCs want to be up to date with measurement methods and have a high interest in developing suitable measurement methods for their industrial customers.*

- *Support the development of measurement methods for industrial customers, which would enable one partner from the private sector and one from a research institution to jointly develop and use these methods.*

- *The number of ESCs is still modest. One of the main barriers for scientists to start such a scientific service company is low knowledge about the business model and the prospects of*

[10] www.mixn.org

such a business start-up. The key to overcoming this barrier is knowledge transfer. Training and coaching via courses such as the StartUp School are important for this and should be continued. To catalyse the startup of ESCs, we further propose integration with existing summer schools of PhD students held at or in relation with the large-scale facilities.

4. Future awareness-raising towards industry as a user

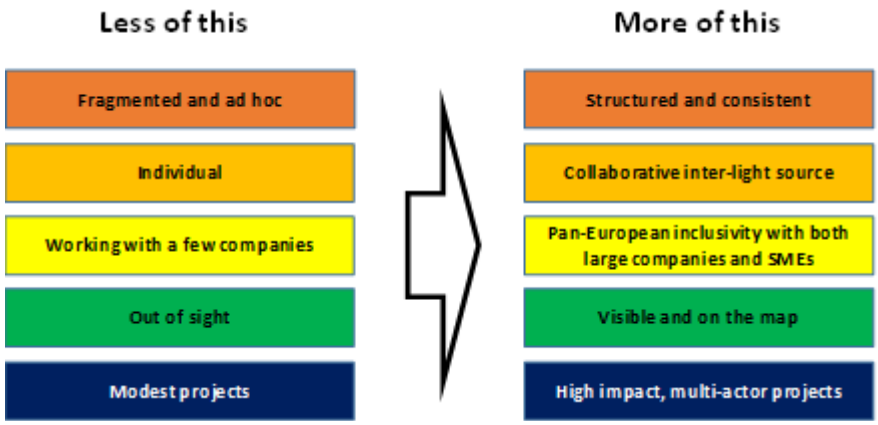
The work done by the ICO teams under the CALIPSO and CALIPSOplus projects has already broadened the industrial awareness of what light sources are able to deliver in terms of analytical facilities; however, there is much more that can be done and here we outline some of the areas where future efforts could be targeted.

The innovation and industry tasks of LEAPS are constructed with actions and tools to engage effectively with European enterprises - regardless of size and location - with the aim to bridge industrial expectations to the LEAPS offer with its know-how and facilities. Further, particular attention is paid to European SMEs and under-performing countries, and linking to regional innovation ecosystems, where "business within walking distance" plays an important factor. Digitalisation of services via remote access together with machine learning and artificial intelligence driving data reduction and analysis are further important development paths opening the facilities to a larger non-specialist user community, including for example industry researchers. The outcome will be upskilled light sources and industry, able to cooperate with each other better than ever before, with enhanced industrial competitiveness and new light source services for industry.

Within the LEAPS-INNOV framework, we propose to build on the success of CALIPSOplus by way of three complementary actions:

1) **Fertilise.** Create a pan-European light source and industry network, linking LEAPS with industry, technology hubs and science-to-business experts to develop new opportunities;
2) **Seed.** Deliver awareness and training to industry and dedicated ICO and industry liaison staff in the photon sources, building mutual trust and giving industrial researchers the knowledge to exploit LEAPS skills and technologies;
3) **Cultivate.** Engage with high-societal impact, open-science projects with both industrial and academic partners, providing access to the LEAPS light sources, thereby transforming our relationship and creating new products and services.

Our goal is to create upskilled light sources and industry cooperating with each other better than ever before across all of Europe, transforming the landscape of light source-industry engagement. Crucially, we will allow European industry, large and small and no matter where located, to strengthen its base of knowledge and its technological know-how from light source expertise and thus to increase their competitiveness in a challenging global economic environment.



LEAPS has the ambition to move light sources from a fragmented, invisible, and modest approach with industry to become coordinated, engaging with industry, large and small across all of Europe.

4.1 Fertilise - Creation of an Ambassador Network

The CALIPSO and CALIPSOplus projects have led to the formation of a strong collaboration between the ICOs at the facilities as outlined above. To further build on this work, we suggest the creation of an "Industry Ambassador Network", tasked with building bridges to European industry beyond the capacity of the individual ICOs. This will include regional innovation ecosystems, taking into account local culture and industrial priorities such as the Regional Strategy for Research and Innovation for Smart Specialisation (RIS3), and assuring pan-European inclusiveness and cohesiveness. This will be particularly important for areas without a "local" light source and low performing countries.
A key impact of such a cooperative network will be to facilitate European industry with access to the most suitable light source research capabilities and services for their R&I needs, even if they are not geographically close by and do not share a common language.

4.2 Seed - Developing Awareness both Internally and Externally

The principal bottleneck in industrial exploitation of LEAPS facilities is an awareness and understanding of how the light sources can enable valuable commercial R&I and of where to go to seek information and to obtain support and eventually access.

By deploying a range of complementary outreach, visibility, and training tools, we aim to ensure that European industry, large and small, has the confidence and knowledge to work with light sources:

- Web-based portal on *wayforlight* and strong digital presence, with information compatible with industry parlance;
- Writing, designing and producing a library of professional outreach and training material;
- Delivering a comprehensive series of science-to-business events, roadshows and workshops at technology campuses, industry centres and individual companies, and participation in innovation and industry conferences; special emphasis will be put on integrating light sources into their local eco-systems and technology campuses, supporting innovation within walking distance.

Upskilling of light source engineers, technicians and scientists, particularly in the context of technological development projects on aspects of industry engagement, intellectual property and technology transfer issues is needed. This will allow results to be exploited in the best possible way. By delivering a comprehensive set of training, drawing on the expertise of those facilities which have the most experience in technology transfer, a more commercially aware workforce will inevitably lead to more commercial exploitation of the world-leading technology which light sources produce as a matter of routine". The LEAPS INNO project is one example of this approach, including both multiple routes of working with industry on instrumentation and building up awareness of facility staff in the sensibilities of working with industry and managing IPR issues.

4.3 Cultivate - Engaging with other projects

The LEAPS INNOV project is just one of many that are funded via the EC. We suggest that exploration of potential collaborations with industrial players on topics linked to the Horizon Europe Clusters and Mission areas should be a focus of future work. But rather than undertaking this task in isolation, it should be done in partnership with other research infrastructure groups

such as other Innovation Pilots (names of the two in here) and analytical research infrastructure facilities, e.g. LENS and relevant ESFRI projects.
Such an approach is starting to emerge with the recent INFRA-SERV calls for consortia of research infrastructures to provide access and services via trans-national access on focussed topics such as circular economy and cancer. Within this context the "Analytical Research Infrastructures of Europe" (ARIE) have teamed up and responded to several calls. ARIE includes the following research infrastructure networks:

- High magnetic field laboratories – European Magnetic Field Laboratory (EMFL, emfl.eu)
- Electron microscopes – e-DREAM (e-dream-eu.org)
- Proton beams – INSPIRE (protonsinspire.eu)
- Laser light sources – Laserlab-Europe (laserlab-europe.eu)
- Accelerator-based light sources – League of Accelerator-based Photon Sources (LEAPS, leaps-initiative.eu)
- Neutron sources – League of Advanced European Neutron Sources (LENS, lens-initiative.org)
- Ion beams – RADIATE (ionbeamcenters.eu)

This makes for highly inclusive, bringing together all of the large-scale analytical research infrastructure facilities into one approach. Challenges remain in working together with a variety of legal frameworks for each of the networks - some existing formally as AISBL structures, others existing as less formal partnerships.

All recent calls such as the INFRA SERV ones, demand industry to be a strong stakeholder and receiver of the access services to be provided. As mentioned above, trans-national rules can impede this by the requirement for publications and open data which industry can often be reluctant to take on board. The definition of "publication" is unclear - meaning in academia a refereed article in a professional journal, but such an undertaking represents a lot of work which is not a priority for many companies and their researchers. Open data can also pose a problem - particularly if it means revealing details of samples which can have strong confidentiality concerns around detailed composition. One workaround could be for some experiments to have a very long embargo prior to data being released.

4.4 Policy recommendations

- *Creation of an "Industry Ambassador Network", tasked with building bridges to European industry beyond the capacity of the individual ICOs. This will include regional innovation ecosystems, taking into account local culture and industrial priorities, and assuring pan-European inclusiveness and cohesiveness. This will be particularly important for areas without a "local" light source and low performing countries.*

- *Developing joint outreach, visibility, and training tools to ensure that European industry, large and small, has the confidence and knowledge to work with light sources, including the web-based portal on wayforlight, a library of professional outreach and training material and science-to-business events, roadshows and workshops at technology campuses, industry centres and individual companies, and participation in innovation and industry conferences.*

- *Training of light source engineers, technicians and scientists on aspects of industry engagement, intellectual property and technology transfer issues.*

- *Research infrastructure networks should work together, providing strengthened and combined capacity for industry R&I with tailored services matching the needs of industry within the European Research Area. But trans-national access rules need to be clarified and adapted to industry interests to catalyse their uptake.*

5. Working with suppliers and stimulating technology transfer

5.1 A digital collaboration platform

One of the aims of the CALIPSOplus project was to have the relevant synchrotrons and free electron lasers in Europe join forces to tackle the new challenges arising from the commitment of the EU to open innovation. The goal was addressed in various work packages, in particular improving the relationship with industry at different levels, such as user and as collaborator for common developments. For example, joint research activities have focussed on the metrology of diffraction limited optics in collaboration with the manufacturing industry, which is of particular importance for the new hard X-ray free electron lasers as well as for the next generation synchrotrons, and on software tools for remote data analysis. With a view of initiating a longer-term basis for virtual tools to support alternative methods of networking and making connections with industry across Europe, the creation of a virtual Innovation Mall via a digital platform is recommended, providing a richer basis for collaboration and industry engagement.

The light sources, although grouped via LEAPS, are rather fragmented, geographically dispersed and culturally distinct. This poses a challenge to efficient networking and sharing ideas and technologies within LEAPS and with industry. The objective is therefore to provide an effective and modern digital social collaboration platform within LEAPS for both internal (to LEAPS) and external networking and exchange of information and ideas, and to inspire collaborations. The platform will target both scientific, engineering and technical staff and external researchers and industry suppliers.

As such, the digital collaboration platform will perform the following core functions:

- **Technology news:** registered expert people, from LEAPS and technology providers, will have the possibility to publish their achievements (paper, patent and any successful commissioning or new partnerships). Typically, this information is either too limited for bilateral trustful relationships or excessively shared on social media, where due attention is lost in the large mass of information. The digital collaboration platform will both allow a larger audience than a simple bilateral relationship, but a more restricted and engaged audience than the usual social network platforms. This balanced approach will allow for more information to be shared in an open and useful way.
- **Innovation Mall:** Technology providers will be able to publish attractive information about their developments and can propose “technology challenges”, by looking for possible partnerships.
- **Database of competences:** expert people will register to the platform with a short description of their competences, by searchable keywords. It is worth highlighting that people will be the focus, not just a representative of their institution. From the same institution, more people with different competences will participate, with their own overall background and knowledge.

It is important to note that this is not a centralised website, like the successfully developed Wayforlight. The digital collaboration platform is a dynamic tool and an available place for virtual and viral information exchanges and call for partnerships. As stated, the digital collaboration platform will not be focussed on institutions, like the centralised website or on a repository of documentation, with a structured archive and database fields to be compiled. In the digital collaboration platform, the collective intelligence of people will be the focus with its typical redundancy, able to inspire a leap into the innovation and transversal collaboration, never

considered before. As the platform is tested and proven, further functionalities could be considered for addition.

5.2 Procurement officer network

The networks of ICO and ILO are becoming mature. However, networking and contacts between light source procurement officer staff are very limited. A strong recommendation is to initiate such a network, allowing procurement experts to share best practice, approaches and consider ways to enhance procurement of basic and high-technology to the benefit of both the light sources and suppliers. An important aspect of this is for SMEs to become better known internationally. Local SMEs to a particular light source may be well known and trusted, but faced challenges to become a supplier to a wider range of light sources or even large-scale research infrastructures more generally. A procurement officer network would help to share good (and bad) supplier contacts, supporting competition and driving high quality companies which can also supply beyond the European client base.

5.3 Valorisation of light source technology

Although technology transfer has not yet been at the core of transversal industry activities of the LEAPS light sources, there is much potential to be harvested given the rich technology developments made at the light sources. And the internal awareness of opportunities within LEAPS needs to be raised.

This value of such technology, particularly when done in partnership with industry is starting to be realised more strongly through the LEAPS Innov[11] Horizon2020 project where a multitude of means of working with industry partners is being tested. Nonetheless, some specific measures within LEAPS could drive more transfer of technology and working with industry for instrumentation. The key issue for a successful technology transfer is an excellent knowledge about the specific markets. The LEAPS shared knowledge could support the light source to evaluate the market compatibility for the science-driven technology developments.

Catalyse technology transfer
The LEAPS light sources frequently require off-the-shelf solutions that are developed in-house or jointly with industry such as X-ray detectors, sample positioning manipulators and environments, high-performance control and metrology. The LEAPS technology-driven activities will generate new ideas and technologies susceptible to be transferred to a supplier company for their commercialisation. LEAPS could therefore instigate proactive “technology scouting and brokerage” as a community-wide activity, facilitating the identification and maturation, hand-in-hand with local TT support systems, of commercialisation opportunities arising from light source instrumentation and IP.

Micro-seeds and sabbaticals for an enhanced entrepreneurial environment
The activities of LEAPS is expected to generate a vibrant innovation and industrial atmosphere that can create opportunities for start-ups and spin-off companies. The basis for spin-offs and start-ups is a technology which can be placed at the market. But even more important are the people who start a company. The emergence and capturing of the opportunities for start-ups should be supported at a high level by facilitating 12-month business creation sabbaticals for light

[11] www.leaps-innov.eu

source staff and at a lower level with “micro-seed” support (few kEuros per project) to encourage staff, particularly younger staff, to take a first dip of their toes in the entrepreneurial world.

Light sources are often located in dynamic technology campuses, including business schools. The support of these campuses and especially the business schools could be sought for these entrepreneurial activities, in the form of training to both younger and more senior staff in entrepreneurship and IPR and the combination of business school students with the light source researchers in the form of “live business cases” where the teams work together towards a common goal of a new business, service or start-up.

5.4 Policy recommendations

- *Test and develop a digital collaboration platform as a tool to enhance technology sharing within and beyond LEAPS, driving internal LEAPS collaborations and with industrial technology providers (this action is being initiated in CALIPSOplus and is expected to be developed in LEAPS Innov).*

- *Initiate a procurement officer network, matching that of the ICOs, and allowing procurement experts to share best practice, approaches and consider ways to enhance procurement of basic and high-technology to the benefit of both the light sources and suppliers.*

- *Instigate a proactive “technology scouting and brokerage” as a LEAPS community-wide activity, facilitating the identification and maturation, hand-in-hand with local TT support systems, of commercialisation opportunities arising from light source instrumentation and IP. This will support facilities with less experience and open combined use and sharing of technology.*

- *Support potential entrepreneurs in the LEAPS network with micro-seed grants to catalyse the first steps of taking a technology to market or creating a start-up (which could be based on a technology or a service provision), as well as enabling secure business-creation sabbaticals for such activities.*

6. Summarised recommendations

Selected ideas and recommendations arising through the experience of CALIPSO and CALIPSOplus, and the collaboration with NMI3, SINE2020 and other integrating activity projects, are already being taken up via the LEAPS INNOV Horizon Europe project. This includes the continued networking between the LEAPS ICO, engaging also with further RI communities such as LENS, and the TamaTA SME access programme will restart in November 2021 with its first call under the LEAPS INNOV banner. The recommendations are also feeding reflections in the ICO/ILO network of ENRIITC on longer-term industry engagement and how future European support could be most effectively deployed.

Across all of the activities and recommendations, digitalisation is a common transversal thematic. The COVID pandemic has highlighted the power and convenience of using electronic means for meetings, training, collaboration and even convenient access by remote control and mail-in of samples for facility experts to perform experiments and measurements.

6.1 Appropriate industry access and outreach

The provision of optimised industry access routes, allowing fast and flexible access should be supported at facility, LEAPS and European funding level. In particular:

- The TamaTA SME access programme scaled-up to all large-scale analytical research infrastructures whilst retaining an easy-to-use and supported approach with expert scientific and technical advice.
- Piloting the “Vinnova style” exploitation of X-ray and neutron research infrastructures at a European scale to catalyse and serve industry and knowledge partner collaborations. These modest scale grants encourage industry with a R&I challenge to team up with an academic and exploit a research infrastructure, using the academic as a knowledge-provider and the research infrastructure as a data provider.
- Further develop remote mail-in access to be more resilient to pandemic situations and to broaden the base of industry clients and enable faster routine access not requiring travel.
- Growing links to exploit the existing and growing industry networks of RTOs and technology infrastructures, supporting translating industry R&I challenges to research infrastructure capacities.
- Strategic-based thematic combined light source access on priorities involving industry and being transversal across research infrastructure techniques, allowing inclusive analytical approaches for problem solving; industrial access must be appropriate allowing confidentiality of results.
- The European Innovation Council should actively draw upon and include analytical research infrastructure instruments, skills and services provided by RIs, RTOs and TIs and ESCs to support European innovation in its programmes.
- Make European supported trans-national access better for industry with more appropriate and clear framework on access conditions (publication requirements, open data embargo), and supporting service customisation as required.
- Provision for innovation-friendly public access mode to light sources, allowing beam time proposals to be fairly evaluated on their merit of innovation and economic impact, including potentially regionally important criteria.
- Encourage and support co-design, -creation and -development, involving the light sources, industry, RTOs, TIs and expert service companies, for new measurement methods and services specifically tailored for industry interests. These may require long-term

investments and access mechanisms for dedicated test benches for (e.g.) materials ageing in the context of the circular economy.

These access routes need to be disseminated together with promoting the power of light sources towards industry:

- Joint awareness raising and training actions which are central to industry researchers learning about light source opportunities, including baseline awareness and higher-level European Schools for industry, fostering a balanced “brain-circulation” in Europe. Internal resources to light sources do not permit this activity to be done at a significant level, and European support over recent years has been central to pushing outreach. These actions should ideally be combined with complementary analytical research infrastructures, mobilising a stronger impact and a demultiplication of effort.
- Creation of an “Ambassador Network” through a new job profile going beyond the ICO capacity with the mission to reach out via regional technology centres and the ERA Hubs to the local industry base. This is particularly important for those countries without a “local” light source and for low performing countries.

Providing a backbone to these actions across LEAPS, and beyond to other RIs, continued support must be provided to the light source ICO network and the professionalisation of the ICO role, whilst being open and inclusive of further analytical research infrastructures and networks and the ICOs or burgeoning ICOs in less mature RIs. This should be further supported by a wide ranging survey with European industry to shape longer term industry engagement.

6.2 Industry as a supplier and user of technology

Industry is a supplier of technology to the light sources, and both supplier and facility could benefit from a more sophisticated relationship beyond pure supply:

- Initiate procurement officer network to complement the existing ICO network, sharing know-how, supplier information and supporting the visibility of SMEs across Europe and beyond for technology supply.
- Develop an electronic virtual collaboration platform for internal and external technology visibility of LEAPS, engaging with industry suppliers and providing a central focus to foster transversal collaborations and improve the involvement of industry suppliers.
- Develop technology scouting and exploitation within LEAPS and which draws upon the collaboration platform, as well as building awareness internally within the facilities on aspects of industry engagement and technology valorisation, providing industry with new opportunities.
- Provide micro-seed support for LEAPS staff to make the first steps towards valorising technology or their science and skills, either as a start-up, a technology transfer or a technology maturation.