Report on the Mapping of the Innovation Ecosystem of ESS

brightness is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 676548.

CONTENT

1 PREFACE

The European Spallation Source (ESS) is a partnership of 13 Founding Member and two Founding Observer countries committed to the goal of building and operating the world-leading facility for research using neutrons. The research infrastructure is under construction in Lund, Sweden, while the ESS Data Management and Software Centre (DMSC) is located in Copenhagen, Denmark. A total of 15 instruments will be built during the Construction Phase to serve the neutron user community, with more instruments built during Operations. The suite of ESS instruments will gain 10-100 times compared to current performance, enabling neutron methods to study real-world samples under real-world conditions. Generating neutron beams for science will add value to a broad range of research, from life sciences to engineering materials, heritage conservation to magnetism, and particle physics. The foreseen start of the ESS user programme is in 2023.

Acknowledging the relevance of ESS in the European science landscape, the European Union financially supports ESS through BrightnESS.[1] The three-year project implemented by 18 European partners aims to ensure that key challenges are met in order to build a European research infrastructure that can deliver high-impact scientific and technological knowledge.

In its INFRADEV-3-2015 call, the European Commission recognised the challenges and difficulties faced by new pan-European infrastructures such as ESS in the process of becoming fully operational, when technologies, services, and procedures need to be finalised, and users' trust and awareness must be built. As a response to the appeal from the European Commission on research infrastructures to give specific attention to interactions with end-users, one of the strategic goals of BrightnESS is to gain the trust of future users of ESS from science and industry, and to understand the role of key players in the innovation ecosystem that ESS will foster. To this end, the BrightnESS team, within the framework of Work Package 6, entitled "*Collaboration, Communication, and Dissemination*", and Work Package 3, entitled "*Organisational Innovation*", designed and carried out activities with the aim of acquiring a profound understanding of target groups relevant for ESS and its partners. In 2016, BrightnESS launched three parallel initiatives, aimed at identifying the needs and expectations of:

- Scientific and academic users,
- Industrial users,
- Players in innovation ecosystems.

The ultimate goal of the set of activities was not only to gain a deeper insight into each of the groups, but also to use the findings to develop tailored outreach and engagement strategies, and to shape ESS policies for access and innovation. Each group was assessed through a custom-made approach which best conformed to the group specifics.

[1] BrightnESS is an EU-funded project in support of ESS within the European Commission's Horizon 2020 Research and Innovation programme, under the INFRADEV-3 call. It is a partnership of 18 European institutes and universities from 11 countries, with a total budget of almost 20 MEUR and a duration of three years.

European survey of scientific and academic users

- The future users of ESS from science and academia were assessed through a survey of existing neutron research infrastructures in Europe. The development of the survey questionnaire was a collaborative effort of BrightnESS partners and research facilities participating in the survey. In March 2016, the final version of the electronic questionnaire was distributed to neutron sources across Europe. 15 out of 17 neutron sources invited to take part in the survey provided answers. While Demokritos and Joint Research Centre opted out, their absence did not affect the results of the survey due to the relatively small size of these facilities.
- The aim of the activity was to collect consolidated information on users of neutron sources in Europe, and identify scientific trends in the European neutron scattering community.
- The results are presented in a separately published report that serves as a compendium of fifteen neutron sources in Europe, and provides the scientific community with a detailed and up-to-date overview of, among other things, their technical capacity, user community, and the usage of instruments across scientific disciplines. The report also includes a consolidated section, which presents the collected data in a pan-European context.

Regional focus groups and one-on-one interviews with industrial users

- The future users of ESS from industry were assessed through focus groups and one-to-one interviews carried out by BrightnESS partner institutes in six different regional hubs in Europe, which were specifically created to maximise the geographical impact of engagement and outreach activities conducted within the framework of the project.
- The aim of the activity was to gather information about past experiences from industrial users, ideally representing R&D departments, who have already conducted measurements at research facilities using neutrons and/or X-rays, and to find out what needs and expectations they have regarding future services provided by ESS.
- The results are presented in the report you are reading, summarising the main findings from each hub. The report provides a qualitative analysis of the potential industrial user community in Europe, and also includes detailed hub-specific sections.

Mapping of the innovation ecosystem of ESS

- Players in the innovation ecosystem of ESS were assessed through a mapping exercise supported by a thorough desk research, a benchmarking analysis, and assessment of the overall competitiveness of regions similar to the one where ESS is based, as well as qualitative interviews with innovation experts and technology transfer officers in the selected regions.
- The aim of the activity was to identify key players and assess the potential of the innovation ecosystem surrounding ESS.
- The results are presented in a separately published report that compares the scientific capacity of the region where ESS is based to other regions in Europe, identifies key players in the innovation ecosystem of ESS, and recommends which actions and mechanisms adopted by research facilities elsewhere could be successfully replicated for the benefit of ESS, its region, and Europe at large.

2 EXECUTIVE SUMMARY

The report assesses the potential of the innovation ecosystem surrounding ESS and presents the capacity of the Öresund region, referred to as the Greater Copenhagen region, to attract foreign direct investment in research and development. The analysis is based on the comparison of the Greater Copenhagen region, where ESS is based, to three competing regions in Europe which host research infrastructures similar to ESS and are a home to a population of comparable size: Rhône Alpes (France), Thames Valley (United Kingdom), and Aargau (Switzerland).

The report includes parts and conclusions from the ESS & MAX IV Benchmark and Situation Analysis Report prepared within the framework of ESS & MAX IV: Cross Border Science & Society project, where ESS is one of the project partners actively contributing to, among others, the sub-project International Attractiveness. This report expands on the findings of the benchmark analysis by providing additional information gathered within the framework of BrightnESS through qualitative interviews with innovation experts and technology transfer officers in the said regions.

- The report concludes that incubators, public and private funding, private companies, and support networks are the key players in the innovation ecosystem of ESS which need to be addressed by the future custom-made Innovation Policy for ESS.

- The findings of the innovation mapping also serve as guidelines for ESS to effectively engage with the identified players, replicate good practices observed and proved in other European regions, and establish strategic partnerships to push the boundaries of innovation.

All in all, the report provides ESS and its partners with a comprehensive overview of the innovation ecosystem which surrounds the facility and raises the understanding of the potential the region presents in terms of breakthrough science, innovation, research and development.

3 INTRODUCTION

ESS is involved in a number of collaborative EU-funded projects aiming to support research, innovation, and excellent science in Europe, and drive economic growth and competitiveness. Within the framework of two of these projects, BrightnESS, funded under Horizon 2020, and ESS & MAX IV: Cross Border Science & Society (hereinafter referred to as "Interreg project"), funded under European Territorial Co-operation (Interreg), ESS, together with the consortiums of project partners, engages in activities that complement each other and aim to support the same cause through various means. This presents a unique opportunity to maximise efforts and create synergies, where possible. With this in mind, a decision was made to combine the results of those activities within the two projects that focus on innovation and international attractiveness, and present them in a coherent way. This approach brings additional value by exploiting the collaborative efforts within and between the two EU-funded projects.

This chapter presents the main objectives of the report, the methodology used, and also the description of innovation model, which will serve as the basis for the development of the future custom-made innovation model of ESS.

3.1 Objectives

The objective of this report is to identify key players in the innovation ecosystem of ESS, assess the way they interact with each other, as well as with other stakeholders in the region, and to recommend how to effectively engage them in order to generate innovation for the benefit of ESS, the region where ESS is based, and also Europe at large. The report also aims to provide guidance for ESS in developing its Innovation Policy and all innovation-related processes.

ESS plans to build its Innovation Policy on the concept of open innovation[2], which suggests that companies can advance their technology by encouraging interactions between internal and external players, and exploiting resources on both sides. As a result, there is a need to define an internal innovation model for ESS, ESS's external innovation ecosystem, and the relation between the two. To this end, the report describes internal innovation models at four well-established research facilities based in regions similar to ESS, in terms of their scientific and economic capacity and size of population. The report also assesses how these models interact with their corresponding external innovation ecosystems.

In an open innovation environment, internal capabilities, core strengths, and external innovation ecosystems are complementary. Such integrity enables a higher focus on key competences, thus making the innovation process more efficient. The boundaries between the two domains can shift and develop over time as they are affected by internal strategic choices and external factors that are constantly changing.

Outreach activities targeting innovation ecosystems relevant to ESS would be beneficial for the establishment of necessary partnerships and relationships that can contribute to open innovation at ESS, not only during the construction but also the operational phase. Naturally, the scope and type of innovation will change when ESS moves to operations, but generally speaking the ecosystem is expected to stay the same.

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[2] https://en.wikipedia.org/wiki/Open_innovation

3.2 Methodology and Approach

In order to understand the potential of scientific research and development in boosting innovation, the BrightnESS team interviewed innovation experts and technology transfer officers in European regions which host facilities similar to ESS. This activity is complementary to the activity carried out within the framework of the Interreg project, the aim of which is to market the Öresund region (in this report referred to as the Greater Copenhagen region), as a hot spot for materials and life sciences. The benchmark analysis titled *ESS & MAX IV Benchmark and Situation Analysis Report*[3], prepared for the Interreg project, compares the region of ESS to other regions in Europe where major neutron facilities are co-located with synchrotron research infrastructures, Rhône Alpes (France), Thames Valley (UK), and Aargau (Switzerland), and assesses their potential and framework conditions for attracting foreign direct investment (fDi) in research and development. These regions overlap with those selected for the BrightnESS innovation mapping exercise. As a result, this report includes some parts and conclusions from the analysis prepared within the framework of the Interreg project and expands on them by providing additional information gathered through qualitative interviews with innovation experts in the said regions, which were conducted within the framework of BrightnESS.

3.3 Innovation Model

The model used in this mapping is a generic and well-established Innovation Value Chain , which outlines three different phases every innovation goes through; i.e. idea generation, conversion, and diffusion. Each phase brings additional value. ESS is currently in the process of developing its own innovation model. The model will, of course, be adapted to the specifics of ESS, but its generic elements are predicted to be the same as in the Innovation Value Chain[4].

- In-house
- Cross polination
- External

- Selection
- Development

- Spread

Idea generation could be done in-house, externally, or through cross-pollination. In an open innovation environment, it is important to consider external resources as an integral part of the Innovation Value Chain.

Conversion consists of two parts; i.e. selection and development. They are iterative in the sense that selection has to be done continuously during development. Development contains all activities needed to reach the last phase, diffusion. It is important to take into account external resources at this stage too.

Diffusion is a process of spreading innovation into a traditionally established product, which consequently leads to market expansion. This is an outreach activity by nature.

[3] The report is part of the sub-project "International Attractiveness" in the Öresund-Kattegat-Skagerrak Interreg Project ESS & MAX IV: Cross Border Science & Society, where ESS is one of the project partners. The report is available at: http://www.scienceandsociety.eu/wp-content/uploads/Final-ESS-MAX-IV-benchmark-and-situation-analysis-report-2016-09-15-002.pdf
[4] https://hbr.org/2007/06/the-innovation-value-chain

4 RESULTS AND FINDINGS

This chapter is divided into two sections. The first one presents parts of the analysis prepared for the Interreg project, and outlines the position of the Greater Copenhagen region in comparison with Rhône Alpes (France), Thames Valley (UK), and Aargau (Switzerland). The second section focuses on the interviews conducted within the framework of BrightnESS, and presents the main findings and observations of innovation practices in the said regions.

4.1 Benchmarking of Comparable Regions

To assist corporate analyses of potential fDi locations, the Financial Times created a tool to benchmark countries or cities against each other. It allows companies, consultancies, and investment promotion agencies to create an overview of relevant data on the quality and cost of locations. A subscription to the fDi Benchmark tool grants access to up to 1 112 data points from a range of reliable sources. To use the fDi Benchmark tool, two overall variables need to be defined: Locations and sector profile.

4.1.1. Locations

"The three competing regions are Rhône Alpes (France), Thames Valley (UK), and Aargau (Switzerland). The regions are mainly defined with population size in mind, to increase comparability to Greater Copenhagen. In addition, industry clusters connected to their respective facilities are often found in neighbouring regions or countries, which occasionally has led to the inclusion of geographically distant, but always connected, regions. Nevertheless, we acknowledge that defining locations in terms of population and industry clusters does not create a complete depiction of competing regions and that differences in population size can create an unfair advantage in some data points." [5]

Location	Population
Greater Copenhagen	3 877 887
Rhône Alpes	6 510 561
Thames Valley	2 361 105
Aargau	4 089 991

4.1.1.1 Rhône Alpes (France)

"The Institut Laue-Langevin (ILL) is situated in Grenoble within the department of Isère. The respective competing region is defined as Rhône Alpes with NUTS[6] code FR71. This includes eight departments with a combined population of 6.51 million. According to the Rhône-Alpes Chamber of Commerce and Industry (CCI), the strengths of the Rhône Alpes are found in high-tech industries. The region is the only French member among the 19 member regions in the European Chemical Regions Network. Chemical products make up 17.3 per cent of the total exports in the region, placing it second in the percentage of total exports, behind mechanical, electrical, electronic and computer equipment at 34.6 per cent[7].

[5] Copenhagen Capacity & Invest in Skåne (2016). ESS and MAX IV Benchmark and Situation Analysis Report, p. 9
[6] Nomenclature of Territorial Units for Statistics (NUTS) is standardised system of regions and sub-regions made by Eurostat for statistical purposes
[7] CCI Rhone Alpes (2014-2015), Key figures for Rhône-Alpes Region

A Smart specialisation strategy (RIS-3), developed in 2013 by Rhône Alpes Region and the European Commission, set down three objectives for further specialisation in chosen industries. Two of the objectives are dedicated to innovation, mainly focusing on sustainability and high-tech solutions[8]" [9]

4.1.1.2 Thames Valley (United Kingdom)

"The ISIS research facility is situated in Harwell, Oxfordshire. Due to the remoteness of the facility and the small size of Oxfordshire, the competing region has been defined as a group of counties within the region of Southeast England. This includes Oxfordshire, Berkshire, and Buckinghamshire (including Milton Keynes), which roughly equals the unofficial region of Thames Valley; a region known for its intense business activity from top global brands and European HQs, and its easy access to London[10]. Compared to other competing regions, Thames Valley has a wider reach of industries. It is nicknamed the 'Silicon Valley of Europe' due to its large activity in technology and science, but it also spans Biopharma, Healthcare, and Advanced engineering[3]." [11]

4.1.1.3 Aargau (Switzerland and Germany)

"The Paul Scherrer Institut (PSI) is located in the Aargau canton of Switzerland, however relevant industry activity exists in many neighbouring regions. As such, we have named the competing region as Aargau, but it includes four Swiss regions, as well as parts of the German region of Freiburg, equalling 4.1 million in total population. This is half the Swiss population, which makes industry characteristics similar to Switzerland as a whole. The country has been praised as the leader in innovation among European countries due to its strong business-university link[12], and the Aargau canton has twice the number of people working in R&D as the Swiss average[13]. Both Zurich and Basel contain a large concentration of biotech and pharmaceutical companies. The biotech sector accounted for 45 per cent of all venture capital between 1999 and 2009, and the pharmaceutical industry accounted for 5.7 per cent of gross added value in Switzerland in 2011[14]." [15]

4.1.2 Sector Profile

"While ESS and MAX IV will be unique in one sense – unparalleled brilliance – it serves well to compare the two facilities, in the framework of their ecosystem, to existing neutron and synchrotron X-ray sources. To this end, we have chosen to focus on three operating research centres in the respective regions, Aargau, Thames Valley, and Rhône-Alpes, where neutron and synchrotron X-ray sources exist side by side. Here, we give a brief introduction into the characteristics and strengths of the various sources and how they compare.

Three of the listed synchrotron facilities have in common that the ring energy is ca 3 GeV, with the exception of the ESRF having 6 GeV. This gives the ESRF a clear advantage in the very high energies >40keV, which is useful for many material science and engineering applications. The specific magnet design of MAX IV gives it a particularly small emittance, which in turn makes it the most brilliant and coherent source ever.

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[8] European Commission (2013), Rhône-Alpes Smart specialisation strategy - RIS-3 https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/policy-document/rh%C3%B4ne-alpes-smart-specialisation-strategy-ris-3

[9] Copenhagen Capacity & Invest in Skåne (2016), p. 10

[10] Thames Valley Chamber of Commerce, http://www.thamesvalley.co.uk/global-brands/

[11] Copenhagen Capacity & Invest in Skåne (2016), p. 10

[12] World Bank (2012), Golden Growth: Restoring the lustre of the European economic model

[13] The European Business Review (2015), Aargau, Switzerland - The Centre for High-Tech Industries

[14] Interpharma (2011), The Importance of the Pharmaceutical Industry for Switzerland

[15] Copenhagen Capacity & Invest in Skåne (2016), p. 10

However, with its compact design, the number of beamlines under construction (15) and planned (up to 25) is small by comparison to other, established facilities, which typically boast 30-40+ beam lines. Beam lines in this sense are instruments at the facilities dedicated for a particular type of study. MAX IV has the smallest number of beam lines for the time being, and the energy range accessible at MAX IV makes it less useful for bulk studies, and it used to concentrate on surface studies.

Diamond and the Swiss Light Source are relatively similar in terms of age, energy, scientific scope, and capabilities etc.

Table 1: Some basic facts about the facilities and the surrounding infrastructures

	ESS/MAX IV	SINQ/SLS	ISIS/Diamond	ESRF/ILL
Region	Greater Copenhagen	Aargau	Thames Valley	Rhône-Alpes
In service since	2024/2016	1997/2001	1977/2007	1992/1972
No. beamlines	16/15	20/30+	30+/30+	40+/40+
International or National lab (IL/NL)	IL/NL	NL/NL	NL/NL	IL/IL
Campus	Science Village Scandinavia	PSI	Harwell	GIANT/EPN
Employees (Approx.)	1000+	2000	5000	11000+
Local university	Lund, Copenhagen, DTU	ETH, Zurich, EPFL Lausanne	Oxford University	Grenoble, Joseph Fourier, INP

The spectrum of science undertaken at synchrotron and neutrons sources is relatively broad and typically covers all aspects of natural sciences, from chemistry, physics, biology, and medicine to materials engineering. While most research is of a 'fundamental' nature, there is no limit to studying materials and substances for varying technology-readiness levels. Indeed, there is a growing trend to investigate materials in-operando; e.g. battery materials during charge-discharge cycles.

For the neutron facilities, the difference in neutron techniques is rather different. ILL and ISIS have for many decades dominated the field of neutron studies and have been by far the most productive facilities, scientifically and in terms of publications, supported by the large number of beam lines. While the underlying neutron production methods are different (short pulse spallation at ISIS, very highly-enriched uranium fission at the ILL, and continuous spallation at SINQ), the scientific application and methods are very similar.

ESS will have a novel type of spallation pulse structure (long pulse), but is in principle similar to the SINQ and ISIS spallation sources in the underlying neutron production, and consequently the layout of the facility (accelerator based). The trend in neutron science has been towards using spallation as the preferred method of neutron production due to the safety (no criticality or fission) and due to energy considerations. Indeed, part of the motivation towards a new neutron source in Europe has been the phasing-out of reactor-based sources, now and in the forthcoming years.

While peak brilliance (neutron per unit time) in the long pulse at ESS will be very high, the time-averaged flux of neutrons at ESS will be on a par with that of the continuous reactor source at ILL. So any instrument that does not require pulsed mode (time-of-flight) but relies on the total number of neutrons delivered to the beam lines will have an equal performance measure, while others that rely on the pulsed nature of spallation neutrons (TOF method) will see gains of potentially several orders of magnitude.

The organisational structure of all these facilities also differs, ranging among non-profit companies, national laboratories, and parts of a local university. But in addition to the way that scientists access these facilities, they share the fact that they are embedded in regional science and innovation ecosystems, where a considerable number of scientists work in the immediate vicinity of the facility. Like the Lund location, the SINQ/SLS installations in the Aargau region lie close to a national border, and many employees chose to commute between two countries in order to go to work, which serves as an interesting comparisons to the Greater Copenhagen region. Likewise, all locations have very strong links to nearby universities, with scientific staff being increasingly often affiliated with one university or another. Together with the local supervision of students, this ensure that staff receive recognition for their work, as well as being embedded in a vibrant academic system.

It is worth mentioning here that all the facilities have the same type of operations model, based on peer-reviewed biannual proposal systems, which gives free access to the facility based on the scientific excellence of the proposal and the condition that the results be made publicly available. Commercial access is typically also provided for competitive research, within a similar access framework, but the cost of accessing beam time differs significantly between neutron and synchrotron X-ray facilities, as well as within each class of facilities. The synchrotrons X-ray facilities discussed here all have industrial liaison offices which provide access services to industrial clients. For all synchrotrons, the pharmaceutical industries have a significant portion of commercial access, but several other techniques are emerging as industrially relevant; from tomographic imaging to chemical analysis of reactions (using absorption spectroscopy) and nano-structural characterisation. Access mechanisms vary slightly between techniques employed and range, from mail-in remote sample characterisation to complex experiments planned and executed over a period of months.

The commercial use of neutrons is relatively small by comparison and differs significantly between neutron facilities. Of the neutron facilities, ISIS is the notable exception for steady, and sometimes pioneering, commercial use, partly supported through pragmatic policies of national institutions, such as the department of trade and industry. The SINQ neutron source has been notable in the growth of its commercial neutron imaging facilities. But no facility can and will be self-sustaining in terms of being revenue generated, and commercial beam time is essentially subsidised and priced to a market.

For academic access, national facilities typically do not reimburse users from outside the home country, but several EU-funded projects exist which reimburse scientists from within the EU for their cost of accessing the facilities. In some cases, such as MAX IV, reimbursements schemes for researchers based in the home countries do not even exist, while international facilities typically reimburse all scientific (academic) users from member countries. The same will most likely be the case for ESS, but its operational modes are not yet defined.

In terms of scientific excellence and volume of published research, the ESRF/ILL in Grenoble probably has the highest scientific impact, but it is very difficult to assess the scientific productivity quantitatively due to the inability to normalise the output versus, for example, the number of beam lines, impact, etc." [16]

4.1.3 ESS/MAX IV Foreign Direct Investment Benchmark Analysis

"The overall result shows that the Aargau has a significant lead in quality, largely due to Switzerland's rich tradition of research and development, and its predominant position in chemical, pharmaceutical, and biotech industries. However, this matches an equally high operating cost that exceeds the average by 50 per cent.

Thames Valley benefits from a strong international position as an entry point for overseas companies seeking access to European markets. It has a strong prevalence of foreign ownership, high rate of tertiary education, and extensive access to major overseas markets through London.

The industry cluster in the Greater Copenhagen region suffers from a low number of companies, however it has the largest research and development activity as a percentage of GDP. Although the Greater Copenhagen profiles cover the same geographical area, they differ in some framework conditions. Denmark comes out on top due to a low tax rate of 24.5 per cent and a flexible labour market.

Rhône Alpes ranks in the lower half in most quality data points. It has advantages in its low cost and large size. The region has the largest population, which also benefits it in numbers of companies in research and development, clinical trials, and GDP.

The fDi Benchmark tool has clear strengths in its wide reach of data points and customisability. There are few topics that are not touched upon directly or indirectly. However, this also makes it complex and difficult to make an overall conclusion. It is important to remember that preferences vary depending on industry, home country, and specific firms, and that any conclusions taken from this report should be supported by tier three data points." [17]

[16] Copenhagen Capacity & Invest in Skåne (2016), p. 6-7
[17] Copenhagen Capacity & Invest in Skåne (2016), p. 5

4.2 Interviews with Innovation Experts

In order to gain a deeper understanding of innovation activities and ecosystems relevant for neutron and synchrotron research, the BrightnESS team reached out to the following research facilities in the three regions analysed in the Interreg project, and conducted qualitative interviews with their respective innovation experts and technology transfer offices (TTOs):

- Rhône Alpes (France)
  - European Synchrotron Radiation Facility (ESRF) in France
- Thames Valley (United Kingdom)
  - ISIS, under the umbrella of the Science and Technology Facilities Council (STFC) in the United Kingdom
  - Diamond Light Source, under the umbrella of the Science and Technology Facilities Council (STFC) in the United Kingdom
- Aargau (Switzerland)
  - Paul Scherrer Institute (PSI) in Switzerland
  - European Organisation for Nuclear Research (CERN) in Switzerland

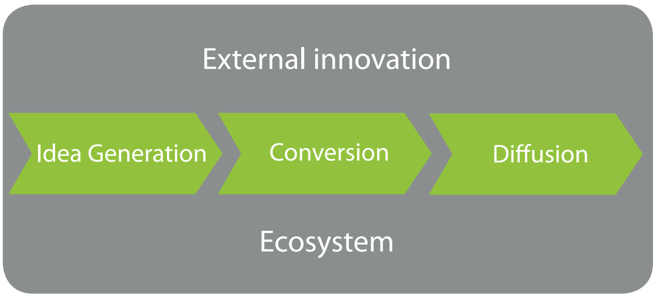
The institutes were selected based on their similarity with ESS and MAX IV Laboratory; i.e. two leading facilities in neutron and synchrotron research based in Lund. CERN was included because of its well-established internal innovation model, as well as its recognised methods to drive innovation in the setting of a large research infrastructure.

All of the selected facilities have been in operation for several years. Interviews conducted by the BrightnESS team between December 2015 and February 2016 have therefore provided the opportunity to explore examples of best practices and innovation activities from the perspective of mature innovation experts and TTOs. The list of participating interviewees, including dates of the interviews, is as follows:

- Giorgio Travaglini (Head of Technology Transfer, PSI), 22nd December 2016
- Edward Mitchell (Head of Business Development Office, ESRF), 7th January 2016
- Chris Bee (Head of Business Development, STFC), 7th January 2016
- Enrico Chesta (TTO, CERN, Chairman TWG EIROForum), 19th January 2016
- Pablo Garcia (TTO, CERN), 1st February 2016

The mapping exercise was also instrumental in collating an up-to-date snapshot of established facilities on the European research map. The interviews conducted by the BrightnESS team are presented as a narrative, and not in a comparative way. The answers provided are not specifically associated with any of the participating research facilities, and are structured according to the three phases of Innovation Value Chain.

The following section aims to highlight examples and best practices, and to describe how the selected institutes work with their respective external innovation ecosystems. For the purposes of this study, external ecosystems were defined as stakeholders that are a part of innovation ecosystems surrounding the participating research institutes, but not a part of the institutes themselves.



4.2.1 What Are Typical Interactions with the Innovation Ecosystem in the Idea Generation Phase?
A TTO is most likely to be contacted once it is well-established within the organisation, is mature, and when innovation happens. Such a TTO does not really have the need or the resources to do targeted idea-mining activities. A TTO participates in numerous internal activities and information meetings and is also included in all general presentations. This raises awareness and makes the TTO a natural point for innovation.

To be able to collaborate internally in an effective way on generating new ideas, a TTO can have innovation champions in different departments of the organisation. With the support of the department management, these champions drive innovation in their respective department. The whole process is coordinated by the TTO.

Educational training targeting innovation can help to tackle the challenge of working with scientists from the entrepreneurial perspective. In this case, TTOs provide, sometimes with the help of partners in their respective support networks, courses on entrepreneurship, which include topics such as 'what is a business plan', 'what is a roadmap', etc.

A specific example of a targeted activity is a "Knowledge Transfer and Innovation Day" organised by one of the interviewed TTOs once or twice a year. The event rotates between different disciplines and departments, and generates around 25 new ideas per year. Up to now, the activity has contributed to approximately 100 ideas in total.

To bring in innovative ideas, one research institute works with a dedicated incubator network tasked to bring startups to the research facility for a screening process. If their ideas get accepted, startups get access to internal innovation resources and follow the internal innovation process of the institute.

An idea becomes an innovation asset of the research institute during the idea generation phase. This is usually done through an invention disclosure form (IDF). The IDF also serves as a formal document to initiate a potential patent submission. Although there is a cost associated with submitting a patent, by protecting ideas through patents, research institutes gain freedom to use innovation the way they prefer. Depending on the institute and the particular situation, the work related to IDF and patent submission is either done internally, externally, or in combination.

4.2.2 What Are Typical Interactions with the Innovation Ecosystem in the Conversion Phase?

The screening process is commonly done in a network of internal and sometimes also external experts. Depending on the stage of innovation, the network can be a combination of technical and commercial experts.

All interviewed TTOs have a more or less developed process of innovation screening and innovation development. Commonly, it is a stage-gate innovation process and is measured and tracked. It helps to evaluate whether the next stage has been reached and to make decisions on the next steps. Typically, a decision would be one of the following: go, stop, or pivot; i.e. change direction. TTOs usually have a clear role and mandate in the organisation to support and drive innovation, and to manage relations between internal and external resources and the players involved in the process.

An example of an open innovation is when TTOs match internal innovation with external entrepreneurs. In that case, TTOs bring external entrepreneurs to the organisation in order to find ideas and make use of innovation. The ideas can get funded and good internal visibility can then provide a greater incentive for new ideas. This is a good example of a positive cycle in generating and using ideas in open innovation.

None of the interviewed research institutes have their own incubator. Instead, they work with local incubators or, in one case, with an incubator network consisting of selected incubators in several countries. The incubators provide useful services to TTOs, such as hosting spin-off companies, and providing access to funding and professional services, including business and/or legal advice to startups. One TTO highlighted that the proximity to other research institutes is helpful when it comes to access to competence, joint research, and domain-specific funding. A TTO who is active on a campus becomes a part of the campus ecosystem. This brings in positive networking effects, and consequently triggers the inflow and outflow of ideas, and increases commercialisation opportunities.

One of the selected TTOs works with an open, nationally-funded innovation centre; 50% of which is funded by industry and the remaining 50% through public funding.

The funding situation of every research facility is different. However, there is a common need for early financing through a proof of concept (PoC) and, in later stages, a need for financing to build and further expand the institute.

In one case, the TTO neither provides seed money nor venture capital. Instead, the office works with a local incubator which is a part of the national incubator network, and provides funding in the form of a grant support – usually within the range of 50-100k Euro per idea.

One of the participating research facilities has access to a good investor network but faces difficulties when trying to find seed money. Even if national seed funding is available, there is a lack of early stage financing. When it comes to investor networks, it is generally easier to fund ideas that are in a more mature phase, and to support companies which have already passed the venture stage. In order to address the lack of seed money, the facility in question has an ambition to raise an innovation fund at the innovation park to support the PoC.

The fund would be owned by the research institution together with banks and some fairly large companies, and would provide funding in the range of 150k Euro per project. The finances would be mostly used to sponsor a PhD student who would take the idea to a concept level. The fund is expected to support six to seven ideas per year.

A TTO in another facility manages an internal investment programme that supports the exploration of new ideas by providing pre-grant and pre-industry funding to technical staff. The investment programme is an evergreen fund with a budget of 2M Euro per year. One third of the revenues generated by the programme is reinvested in new ideas managed by the TTO, a further third goes to the department, and the remaining third to the division where the idea originated. The investment programme usually funds four to five projects per year, and the finances are mostly used to cover the cost of material and to hire students.

4.2.3 What Are Typical Interactions with the Innovation Ecosystem in the Diffusion Phase?

During the diffusion phase, incubators continue to provide useful services to TTOs, such as hosting spin-off companies, providing access to funding, and support with professional services, including business and/or legal advice. Activities which take place on a campus that surrounds an incubator contribute to innovation by fostering cross-industry interactions.

The presence of a few large and several small companies on a joint campus can affect networking and collaboration in a positive way. Blue chip companies naturally become the engines for certain domains, such as data processing, accelerators, supercomputing, and medical formulation, to name just a few examples mentioned in the interviews.

The process of diffusion can be simplified, for example, by clustering several industries into a single segment, thereby achieving economies of scale.

In the example of a research facility collaborating with an incubator network, the network allows personnel at the respective research facility to choose which incubator they want to work with. By doing so, the research facility gets access to national and regional funding for innovation that originates at the facility itself. This is an example of an open innovation where internal resources at the research facility are used in combination with external resources at the incubator.

In addition to letting innovators at the research facility choose a suitable incubator, the incubator network can proactively search, via organised events, for companies interested in certain technology from the research facility. The research facility then provides man-hours for free and also no royalty for a couple of years. In cases when special equipment is needed, the research facility also contributes with 40 days of usage and access.

As mentioned earlier, none of the research institutes has its own incubator, even if there is a strong interest in working with incubators and innovation campuses. Nevertheless, one of the facilities created a joint venture together with a property developer. Through its TTO, the institute brings in clients and startup companies. The property developer takes care of the rest, as such creating value for both parties. This approach allows both the research facility and the developer to focus on core competences.

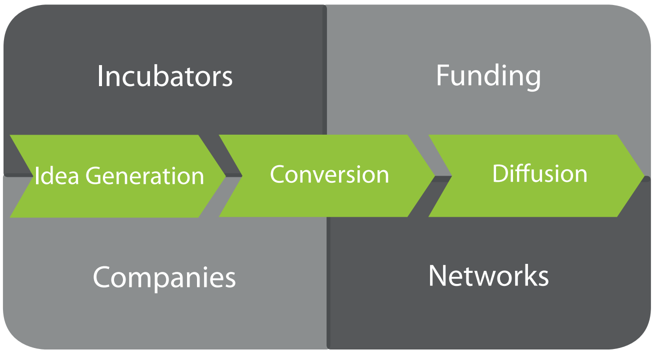
This TTO also creates join ventures to be able to develop technology in collaboration with larger companies and industries that are not typically suitable for a spin-off. An idea that falls into this domain is usually incremental in its nature and instrumentation heavy. Generally speaking, spin-offs that require extensive integration of multiple technologies and assets are better suited to target larger cooperations for the purposes of acquisition, joint venture, or another commercial model. Corporations may have a natural advantage over traditional venture capital in overcoming barriers of difficult access to knowledge and scarce resources.

There is always a balance in making deals. The means that small and large companies' use of making deals are different. TTOs are free to exploit the best way possible to ensure that the future use of innovative ideas is not limited. It is of crucial importance that all agreements provide a freedom to operate and grant the right to publish.

4.2.4 Summary of Interactions with the Innovation Ecosystem

Based on the key findings from the interviews, we can distinguish between four different clusters, which can be used to describe external innovation ecosystems surrounding the research infrastructures participating in the study:

- Incubators
- Public and private funding
- Private companies
- Support networks



Incubators help entrepreneurs to convert promising ideas into startup companies, and consequently grow them quickly. There are also ideas coming from incubators to research facilities.

Public and private funding includes all types of financing, i.e. internal and external funds, grants, different types of loans, venture capital, and private equity, that support and invest in ideas which use different strategies for investment.

Private companies, spanning FT Global 500 Companies, Small and Medium Enterprises (SMEs), and startups, naturally constitute an important part of the innovation ecosystem. All of them have different capabilities and characteristics.

Finally, professional support and business advice networks represented by private and public stakeholders are important actors in the innovation ecosystem and provide valuable know-how.

ESS is in the early stage of setting up its technology transfer office, even though innovation has naturally already happened. The innovation at ESS has been done both internally and in collaboration with external stakeholders. There have also been initial discussions at ESS to find new markets for successful internal innovation.

5 CONCLUSIONS

Looking at the region surrounding ESS, an innovation ecosystem is found in which many players already work with ESS in different ways. The innovation ecosystem of ESS consists of incubators, access to funding, some private companies, and support networks. The structure of the ecosystem is therefore in line with the findings from the interviews.

The innovation ecosystem at ESS is by no means limited to the Greater Copenhagen region. By looking at similar research facilities based elsewhere, it is possible to identify a clear proximity effect. Innovation activities, except for industry-related activities and activities aimed at engaging incubator networks, are happening in the vicinity of research institutes. Incubator networks are usually created in order to address the fact that innovation at facilities which operate on a European level is funded regionally.

5.1 Relevant Target Groups within the ESS Innovation Ecosystem

In order to take full advantage of the innovation ecosystem surrounding ESS, there is a need to establish relations with incubators, business accelerators, private companies, business advice and support networks, and players involved in funding schemes.

Open innovation requires a well-functioning internal innovation system. When building the internal innovation model at ESS, it would be beneficial to systematically collaborate with external stakeholders in a way similar to other research facilities. Most innovation activities will initially need to be supported by active outreach. However, as ESS becomes more established, external players will naturally reach out to ESS to join forces in innovation.

The recommendations below aim to provide a starting point for systematic outreach activities in the innovation ecosystem at ESS, as well as the process of establishing a TTO.

5.1.1 Incubators

Incubators in the Greater Copenhagen region are a natural point of contact for ESS but, as a European research infrastructure, ESS also needs to explore possibilities to establish contacts with selected incubators in Europe or business incubator networks.

In the Greater Copenhagen region, there is *Ideon Innovation*[18] in Sweden, and *SkyLab*[19] at the Technical University of Denmark (DTU). Both incubators are well established and could become a part of the ESS innovation ecosystem. At the research park Ideon there is also *Ideon Open*[20], an open innovation platform which is a member of the European innovation network *EBN*[21].

5.1.2 Public and Private Funding

In addition to the established ESS grant activities, it would be beneficial for the organisation to explore other types of funding. In the Greater Copenhagen region, there is *Almi*[22] and *Industrifonden*[22] in Sweden, and *SEED Capital*[24] in Denmark. Since these funds have a slightly different scope and investment strategy than "traditional" funding schemes, it would be useful for ESS to gain a better understanding of how they work.

Funding should not be viewed and approached in a reactive way only, that is to say looking for finance when there is an idea that needs to be funded. With the scope and position of ESS, it is possible to seek strategic private and public funds on a more general basis. A proactive approach to exploring prospective funding opportunities would provide guidance on what areas ESS can strategically focus on within open innovation.

5.1.3 Private Companies

From the perspective of construction, upgrade, operations innovation, and future usage, it is essential to engage private companies. The information collected during the interviews demonstrates that the presence of one or several large companies in the region where a research facility is based is of crucial importance for the development of a healthy innovation ecosystem. Large companies located on innovation campuses contribute to innovation in a positive way. Companies can also stimulate innovation by establishing research centres in the vicinity of research facilities.

The data presented in Table 1 shows that, in terms of FT Global 500 companies, the Greater Copenhagen region is well below the regions where STFC and PSI are based. While there are 13 companies in the region of PSI, and 15 companies in the region of STFC, the Greater Copenhagen region only hosts six companies. However, according to data presented in the Report[25] by the Interreg project, Greater Copenhagen surpasses both regions in R&D spending as a percentage of GDP.

Outreach activities in the Greater Copenhagen region could not only target companies that are prospective future users of ESS, but also the ones that would like to establish an antenna in the region for operation and maintenance. A company would not necessarily have to establish a full research site from day one. A modest presence could increase over time and leverage the potential of the local ecosystem, including that for ESS.

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[18] http://www.ideoninnovation.se
[19] http://www.skylab.dtu.dk
[20] http://www.ideon.se/om-ideon/ideon-open
[21] http://ebn.eu
[22] http://www.almi.se
[23] http://www.industrifonden.se
[24] http://www.seedcapital.dk
[25] Copenhagen Capacity & Invest in Skåne (2016), p. 13

5.1.4 Support Networks

Last but not least, support networks need to be identified and established. There are already initiatives around the ESS facility and the MAX IV Laboratory aiming to support the innovation ecosystem. Once ESS has developed its innovation policy and established a custom-made innovation model, these support networks will be able to understand the innovation process at ESS and consequently adapt, develop, and provide the support needed.

Invest in Skåne[26] and *Copenhagen Capacity*[27] are natural regional points of contact for outreach activities aiming at innovation and a stronger engagement of locally based companies. *Science Village Scandinavia*[28] could also become a part of the innovation ecosystem. However, one can envision that the innovation campus will, in its early stage, have a strong focus on ESS. Finally, it would also be useful to interact with *Innovation at DTU*[29] and *Innovation at Lund University*[30].

[26] http://www.investinskane.com
[27] http://www.copcap.com
[28] http://sciencevillage.com
[29] http://www.dtu.dk/Samarbejde/Innovation-og-entreprenoerskab
[30] http://innovation.lu.se

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PICTURE OF THE ESS FACILITY
Credit: ESS/Team Henning Larsen

PRODUCTION AND LAYOUT
Marie Powell (ESS), Lenka Peťková (ESS)

PROOFREADING
Marie Powell (ESS)

PUBLISHER
European Spallation Source ERIC

ADDRESS
Odarslövsvägen 113, 225 92 Lund, Sweden

WEBSITE
europeanspallationsource.se
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PUBLISHED
August 2018

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ESS & MAX IV:
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European Regional Development Fund
EUROPEAN UNION

BrightnESS is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 676548.

This publication includes parts and conclusions from the ESS & MAX IV Benchmark and Situation Analysis Report, which was prepared within the framework of ESS & MAX IV: Cross Border Science & Society project funded by the European Regional Development Fund's (Interreg) Öresund-Kattegat-Skagerrak programme.

brightness is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 676548.