Qualitative Assessment of the Industrial Use of Neutron Sources in Europe

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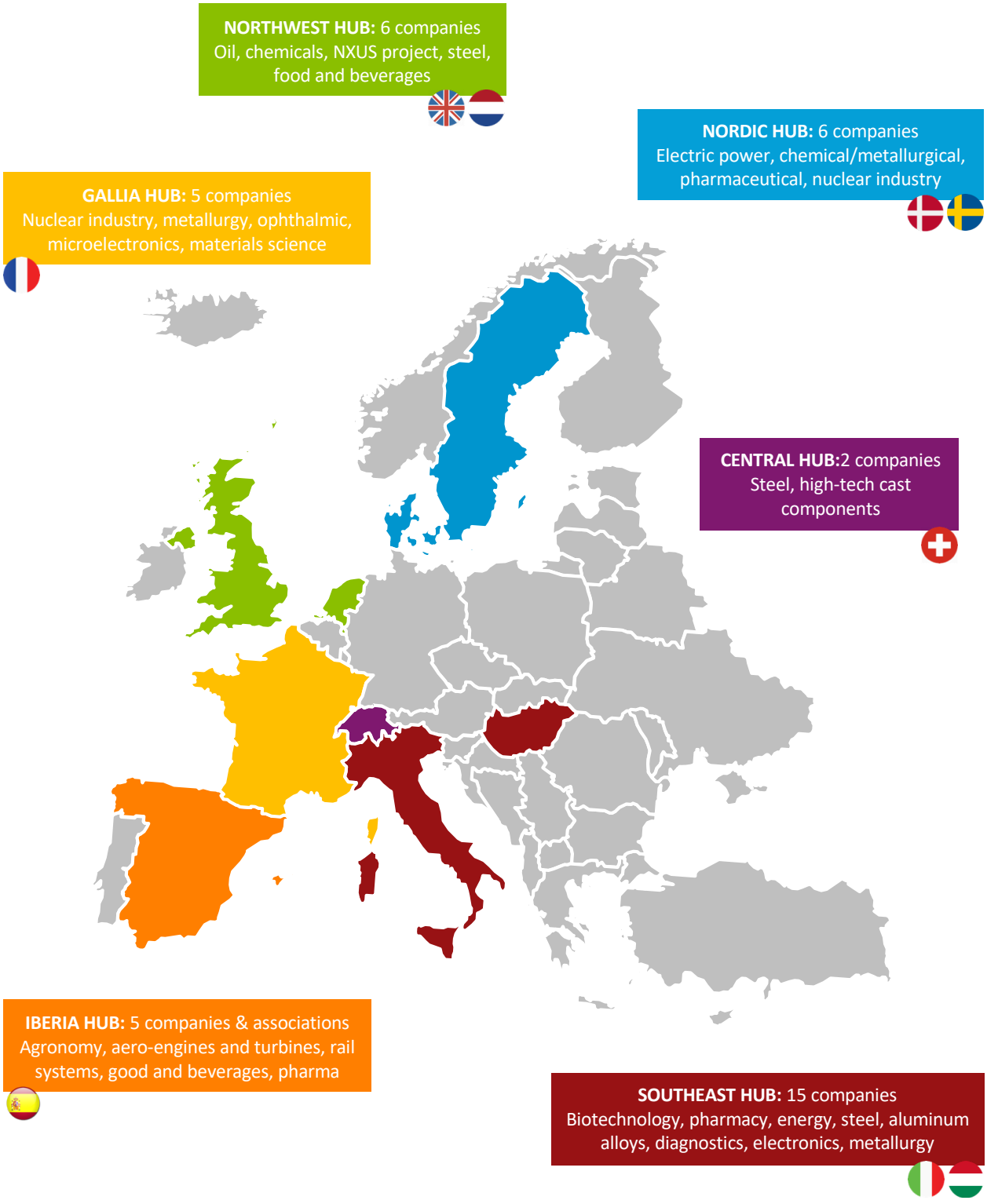
CONTENT

Regional Hubs Participating in the Assessment



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 INTRODUCTION

The objective of this qualitative assessment of industrial users of neutrons at European Research Infrastructures (RIs) is to provide ESS with insights and first-hand information in order to address industry's needs and expectations in the future ESS User Programme. The report aims to:

- Provide a better understanding of the industrial use of neutron sources on European and regional levels,
- Identify best practices,
- Identify key areas of investigation and development.

Ultimately, the key findings of this assessment will be used to shape ESS's strategy and policies that focus on relations with industry, and to outline outreach activities accordingly. The activity was carried out by BrightnESS partner institutes by means of focus groups and interviews. It predominantly targeted companies with previous Research and Development (R&D) experience at research infrastructures.

Since its launch in September 2015, the BrightnESS project has been engaging key target groups of ESS; i.e. science and academia, industry, and players in the innovation ecosystem. For this purpose, six regional hubs were created in Europe based on the location of BrightnESS partner institutes and national RIs. This decision has proven instrumental for the process of gathering information and the consecutive analysis. The system of geographical hubs has allowed BrightnESS to use local and regional networks, and to link the information to the local reality and established practices.

In each BrightnESS hub, representatives of partner institutes assessed the local industrial use of neutrons by organising focus groups and one-to-one interviews with companies with diverse level of engagement in R&D activities at RIs. In some cases, the option of one-to-one interviews was preferred to that of focus groups because of the difficulty in finding a suitable date for all invited participants. In addition, some industry representatives preferred interviews in order to avoid disclosure of sensitive information to potential competitors. The qualitative assessment of industrial users focused on the following areas:

- Awareness level of R&D opportunities using neutrons at European RIs,
- Access policies,
- Services and expert support, including training,
- Intellectual Property Right (IPR) management.

The key findings and recommendations in this consolidated analysis are based on insights and information presented in the individual reports from all BrightnESS regional hubs, which are included in this document in the form of Annexes.

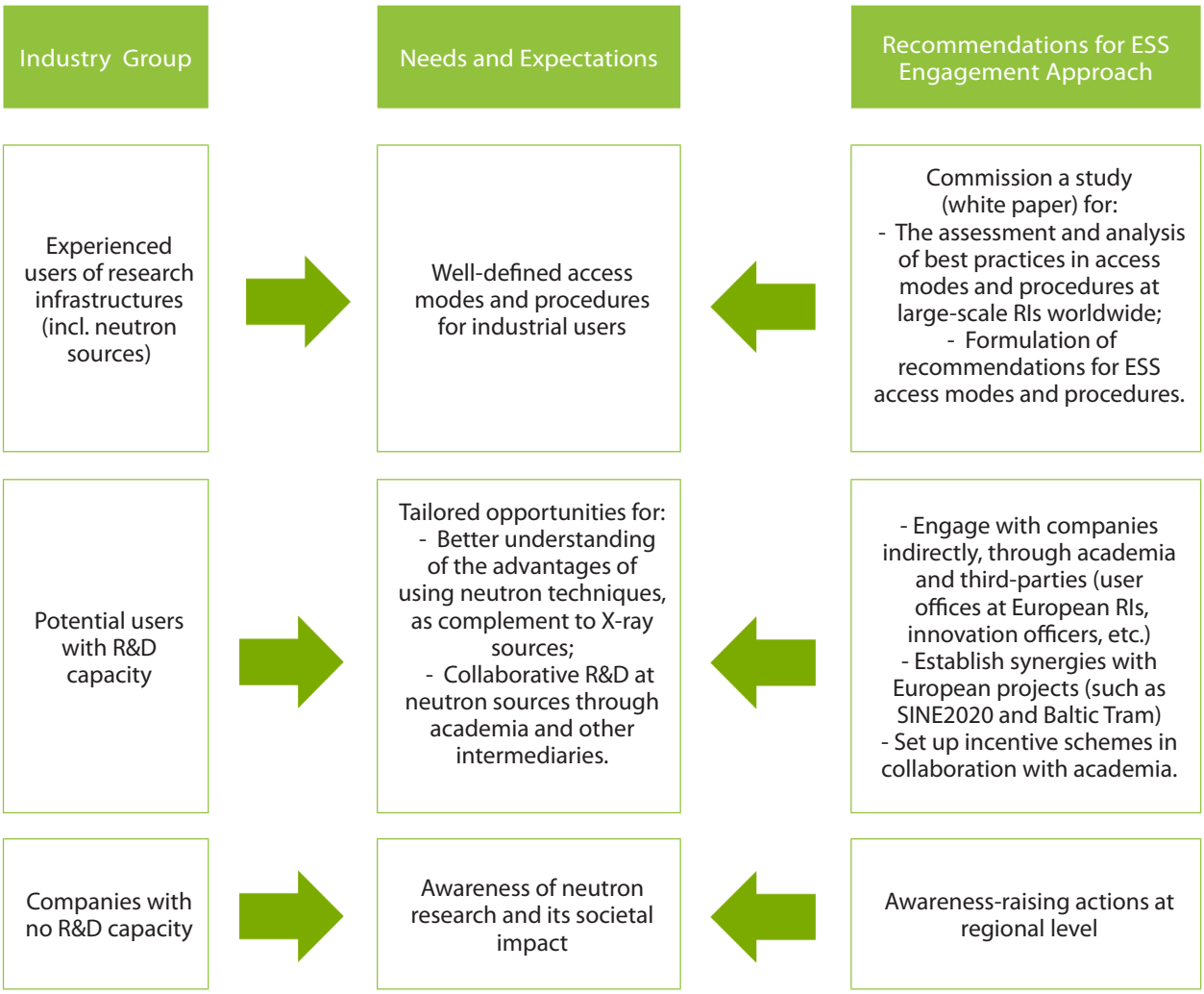
Table 1: Summary of Focus Groups and Interviews Carried Out in BrightnESS Regional Hubs

BrightnESS Regional Hub	Organiser(s)	Means of Assessment	Participants from BrightnESS	Participants from Industry (Number and Areas of Expertise)
Gallia June 2016	CEA, FR	Focus Group	Six representatives: Neutron experts, Industrial Liaison Officers, Communications and External Relations specialist	Five companies: • Nuclear industry • Metallurgy • Ophthalmic • Microelectronics • Materials Science
Northwest February 2016	STFC, UK RID, NL	One-to-one interviews by STFC and RID	At STFC: Industrial Liaison Officers, External Relations specialist, (STFC interviewed ISIS' Industry Liaison Manager) At RID: ILOs, Researchers	Six companies: • Oil • Chemicals • NXUS project • Steel • Food and Beverages
Southeast January 2016 October 2016	BNC, HU Elettra, IT	Focus Group Interviews	At BNC: Scientists from HAS Centre for Energy Research and HAS Wigner RCP At Elettra: Scientists, Technology Transfer and Business Development Experts	Fifteen companies: • Biotechnology • Pharmacy • Energy technology • Materials science as steel • Aluminium alloys • Diagnostics • Electronics • Metallurgy
Central April 2016	PSI, CH	Focus Group	Scientist and Industrial Liaison specialist from PSI	Two companies: • Steel • High-tech cast components
Iberia June 2016	ESS Bilbao, ES	One-to-one interviews Questionnaire	Scientists External Relations specialist	Five companies and industry associations: • Agronomy • Aero-engines and turbines • Rail systems • Food and Beverages • Pharma
Nordic March 2016	ESS, SE	Focus Group	Scientist Science-Business expert External Relations specialist	Six companies: • Electric power • Chemical/metallurgical • Pharmaceutical • Nuclear industry

3 KEY FINDINGS AND RECOMMENDATIONS

The focus groups and interviews conducted in BrightnESS regional hubs have provided useful insights for the future definition of access modes for industrial users at ESS, and for the identification of strategic outreach activities. The scheme below summarises the key findings of the assessment:

- *Left-hand column:* A first analysis of the assessment provided by the regional hubs indicates a segmentation of the target group into three sub-categories according to their level of experience at RIs, their R&D capacity, and interest in using RIs in the near future,
- *Middle column:* For each sub-category, the assessment identifies needs and expectations,
- *Right-hand column*: The listed recommendations highlight a set of actions to be taken in order to achieve the desired outcome for effective engagement.



3.1 Three Categories of Industrial Users

The European landscape of industrial neutron users is very diverse. The level of industrial involvement in neutron research depends on the particular business sector as well as the relevant regional context. This trend was also confirmed by the results of qualitative assessments carried out in BrightnESS hubs. Based on the information collected, it is possible to identify three groups of industrial users:

Industry Group 1: Experienced Users of RIs

These companies:

- Have previous and/or ongoing experience of using RIs, including neutron sources, for their R&D activities carried out by in-house scientists,
- Are interested in well-established access modes and procedures that include collaboration with academia in the form of consulting, contract research, bilateral academia-industry partnerships, or other public-private partnerships.

Industry Group 2: High-Potential Users of RIs

These companies:

- Have previous and/or ongoing experience with RIs, but no or limited experience with neutron sources,
- Are interested in learning more about the innovation potential of R&D at neutron sources, and are open to the idea of accessing RIs in collaboration with academia.

Industry Group 3: Potential Users of RIs

These companies:

- Have no experience with RIs, but are active in a industry sectors of relevance for neutron research,
- Are interested in learning more about neutron science on a generic level.

Recommendation

When engaging existing and potential industrial users of RIs, ESS needs to take into account the diversity of users in the European landscape. In order to provide for inclusive and open access modes, the outreach activities of ESS need to be diversified and tailored for the specific needs of each of the three groups identified in this assessment, i.e. experienced, high-potential, and potential users of RIs.

3.2 Engagement with Industry Group 1: Experienced Users of RIs

This section provides detailed information about experienced industrial users of RIs that have already carried out research at neutron sources. It also presents their experiences with, and expectations from, RIs. All observations and conclusions are supported by quotations from the individual reports prepared by BrightnESS regional hubs.

2.1 Description

Experience

Companies in Industry Group 1 have a good level of awareness and understanding of the use of neutrons and research infrastructures in general for their R&D activities. *"The interviewees had used neutrons for a variety of reasons, including understanding the structure of their nano-sized products, studying the formation processes, assessment of multiscale food structure, diffusion measurements, and phase transformations in metals allowing them to gain information that couldn't be obtained with other techniques, such as X-rays. Some were now actively expanding their use of neutrons and utilising other methodologies (Northwest Hub)."*

Interest

The companies in this group are familiar with facilities that have a well-established policy of working with the private sector, such as ISIS in the United Kingdom and Institut Laue Langevin (ILL) in France. In some cases, companies had chosen a particular facility for its scientific capability and its access policy, regardless of the geographical proximity and costs. *"Some of the participants in the focus group have carried out research at facilities based not only in Europe, but also in the USA and Japan. They generally agreed that when choosing between different research infrastructures, they sometimes tend to opt for the one that offers the best service even if this is not the most cost-effective option (Nordic Hub)."*

However, for companies based in countries with RIs, proximity becomes a relevant factor. *"One of the companies interviewed reported performing lots of experiments at Synchrotron facilities in France (ESRF and SOLEIL) because of the geographical proximity (Gallia Hub)."*

2.2 Input

The experience of companies with a variety of RIs has allowed for the collection of valuable input on how the industrial use of neutrons at ESS could be optimised in order to meet the needs and expectations of experienced users. The insights shared by experienced users during the assessment are presented below.

Tailored Scientific and Technical Information

The participating companies agree that there is a need for more technical and industry-oriented information that would help industrial users to better understand the technical as well as scientific aspects of R&D activities, and also provide details about the way they could access and use the respective research facility. *"There is a need to explain in detail the cost and time needed to obtain results that would benefit companies (Iberia Hub)."*

Ideally, this information should cover costs and timing. *"Companies agreed that websites of RIs do not currently provide information that could help industrial users to understand what RIs have to offer or what problems could be solved using the specific instrument; i.e. there is lack of product-oriented information, and case studies do not provide background on the timeframe and costs associated with the research in question (Nordic Hub)."*

More detailed information about the use of large-scale RIs is encouraged through dedicated meetings tailored on industrial needs and expectations. "[There is a need to] *Raise awareness through workshops for industry on the benefits of large RIs (Iberia Hub)."*

Access Policy

Companies from all regional hubs agree on the need to have clear and well-defined access modes for industrial users at ESS that would describe and document every aspect of their interaction with the RI. *"Important factors for successful collaboration between ESS and industrial partners include the importance of time, provided steady quality and well-written agreements (Central Hub)."*

In addition, companies agree on the need to reduce bureaucratic workload related to the process of gaining access to RIs. *"Participants shared that bureaucracy generally slows research projects down and as a consequence discourages them from using research facilities. They would therefore prefer to have standardised administrative across different facilities, or to have the option to pay them out of the administrative burden. It was mentioned that whenever a project involves IP negotiations, these take three months on average, and thus slows the project even further (Nordic Hub)."*

Participants underlined the need to provide for the option of a fast track when companies need to carry out standard measurements. *"Fast and easy access (one week is considered an acceptable time lag) is essential for routine investigations intended for more direct and commercial applications or for solving a specific problem (Gallia Hub)."* The timing for the use of RIs is of vital importance. *"In relation to timeframes, companies are interested in fast solutions to their problems, which implies fast access, fast data and fast analysis (Northwest Hub)."* Many industry sectors are dynamic and fast changing. As a result, quick access to data and quick analysis are equally important as quick access to an RI. *"Industry highlighted their requirement for quick results when employing standard processes and analysis methods; four weeks as a maximum turnaround time was deemed acceptable (Central Hub)."* In order to provide a service that would match the time requirements of the private sector, it was suggested that ESS could optimise the management of beamtime by creating a *"dedicated service (internal or external) in charge of performing routine investigations, in particular with the development of an automatic sample changer (Gallia Hub)."*

The access modes at ESS should include the possibility for companies to conduct research at MAX IV Laboratory in a reasonable time frame. *"Since neutron research is complementary to synchrotron research, [it would be useful to] introduce the possibility to conduct research at ESS and MAX IV in one day, have a coordinated experimental programme, share facilities, and provide standardised set-ups (Nordic Hub)."*

Management of Intellectual Property

As expected, the management of intellectual property (IP) associated with their R&D is of vital importance to companies. "*Industry is hesitant concerning their engagement in common research projects because of issues with intellectual property rights. They see the employment of (not only) neutron-based techniques in an open research environment as potentially conflicting with their primary aims of optimising their products and production procedures in order to gain an edge over their competitors (Central Hub)."*

"Confidentiality is important as most of their business is based on proprietary technologies (Southeast Hub)."

According to some companies, the negotiations related to IP issues can turn into lengthy processes, causing undesired delays in projects. *"One favoured solution was to have framework agreements in place, and then set up specific project agreements with dedicated IP-arrangements. Nevertheless, companies evaluate the question of IP on a case by case basis, and are often willing to share IP and publish results in case of basic research, or if processes in question are used by all of their customers (Nordic Hub)."*

Supporting Infrastructure and Services

Participating companies stressed that RIs should establish the so-called industry areas around their facilities in order to provide companies with supporting infrastructure necessary to conduct world-class research. This approach would not only attract industry as such, but also trigger wider industrial collaboration.

According to the participants in the assessment, RIs need to be fully equipped with state-of-the-art laboratories. *"It is necessary to be able to service the special needs, for example regarding sample environment and measurement conditions; e.g. variable temperature/pressure/humidity (Southeast Hub)."*

The presence and active engagement of in-house instrument scientists is a valuable asset for the identification of the problem, the rolling-out of the experiment and the interpretation of results. *"Support in understanding more precisely what the benefits are of using neutron scattering in comparison with other techniques, and in identifying that neutron scattering is a good technique to solve this specific problem [is vital]. In this case, discussion with a researcher from the RI itself seems essential (Gallia Hub)."*

Companies suggested that RIs need to pay special attention to services provided to industrial users and make sure they meet their needs. *"Service at research facilities in general could be improved, for example by providing stronger support during experiments, standardised data formats, and fast data analysis (Nordic Hub)."* Almost all participants with previous experience at RIs highlighted the importance of including data analysis to the set of services and support provided to industrial users by RIs.

"Company needs support for data interpretation and analysis (Southeast Hub)."

"Along with better performance capabilities of the RI analysis with respect to the laboratory equipment, users would like to have a more collaborative work from the design of the experiment to the data interpretation (Iberia Hub)." In order to provide large-scale data analysis and report writing to companies, RIs could encourage partnerships between industry and "academics either through consultancy work or collaborations (Northwest Hub)."

Recommendation

When engaging companies that already have previous experience of using research infrastructures for their R&D, ESS needs to be able to offer access modes that address all aspects of interest of industrial users; i.e. access, costs, IP management, timing, and supporting infrastructure and services. In order to establish such modes of access, ESS will organise a workshop on Best Practice for Industry Access to Neutrons. The results of the workshop and best practices identified at existing neutron sources will feed into ESS's Access Policy.

Strategic objective for ESS: Build a community of ESS industrial users

3.3 Engagement with Industry Group 2: High-Potential Users of RIs

This section provides detailed information about high-potential industrial users of RIs that have no or limited experience with carrying out research at neutron sources. It also presents their experiences with, and expectations from, RIs. All observations and conclusions are supported by quotations from the individual reports prepared by BrightnESS regional hubs.

3.3.1 Description

Experience

Companies in Industry Group 2 have previous or ongoing experience with R&D activities at research facilities, but no or limited experience with neutron sources. Their R&D activities have thus far focused mainly on the use of X-ray sources either for "*few measurements, maximum one or two techniques, or for longer collaborations (Southeast Hub)"* at the RI.

Interest

Participants expressed a strong interest in employing neutron science because of the high sensitivity of neutrons to light elements and isotopic contrasts, high penetration, and non-destructive nature. Companies in this category have limited or no experience with neutrons. However, *"strong interest in novel approaches and new means of analysis has been expressed (Central Hub)."* Many participants pointed out the need to have access to specific and technical information that would focus on the advantages of neutron research and explain how it complements other methods such as for example X-rays. *"Companies which are not familiar with neutron science expressed the important need to understand more precisely what the benefits are of using neutron scattering in comparison with others techniques, and how to identify that neutron scattering is a good technique to use to solve a specific problem (Gallia Hub)."* During the focus group in Hungary, a regular user of the ESRF synchrotron radiation facilities in France pointed out *"the importance of using neutron methods together with X-rays and taking advantage of their complementarity in modern experimental evaluation (Southeast Hub)."*

3.3.2 Input

The experience of companies with RIs, which at limited occasions included also neutron sources, has allowed for the collection of valuable input on how ESS could attract industrial users and encourage them to use neutron techniques for their R&D. The insights shared by high-potential users during the assessment are presented below.

Collaboration with Academia

Existing users of RIs, in particular of X-ray sources, have often accessed RIs through collaboration with academia. Collaboration with academia is considered beneficial for companies for a variety of reasons, including access to scientific expertise, technical know-how, and administrative support. *"While each of the participating companies has had a slightly different approach to carrying out research, all of them have collaborated with universities before. The benefit of such collaboration was that universities were willing to take care of the administrative burden associated with research at facilities, and to support industry with data interpretation. On the other hand, participants pointed out that collaboration with academia could often be challenging because of issues related to IP, the question of confidentiality, and last but not least, the overall slow pace (Nordic Hub)."*

Collaboration with academia played a vital role in supporting companies from the Gallia hub in carrying out their neutron research. The companies *"have been involved in research projects involving neutron sciences in collaboration with academia and others companies (Gallia Hub)."* It was concluded that one way to encourage the use of neutron sources in the Iberia hub would be by fostering *"collaboration between academia or other research centres and industry (Iberia Hub)."* Generally speaking, collaborative partnerships of industry and academia are seen as an effective way of bridging the gap between industry and RIs. *"The natural next/first step appears to be to start with some dedicated common project taking advantage of funding support from diverse sources (EU, national), [. . .] involving quick looks on samples to check the principal suitability of the available techniques to current questions (Central Hub)."*

In many cases, companies with internal R&D units have their own equipment and instrumentation to carry out basic measurements. When they need methods and instruments that they do not have in-house, *"they collaborate with universities to carry out experiments at research infrastructures like [for example] ESRF (Southeast Hub)."*

During the focus group organised in the Nordic hub, the presentation of the SINE2020 'Call for Industry' for free measurement tests and feasibility studies motivated two participating companies to submit applications. One of them was awarded beamtime at the neutron source ILL in Grenoble, France, with measurement tests scheduled for December 2016.

Recommendation

A systematic engagement with Industry Group 2 has the potential to develop users with no or limited experience into a new category of users of neutron sources. In order to unlock this potential, ESS needs to bridge the gap between RIs and industry, and reach out to companies through research and academic institutions that have already established collaboration with industry on R&D projects. This set of outreach activities should target user offices at RIs, industrial liaison officers (ILOs), innovation actors, academic departments, and research groups.

Strategic objective for ESS: Build capacity in collaborative R&D

3. 4 Engagement with Industry Group 3: Potential Users of RIs

This section provides information about potential industrial users of RIs, including potential users of neutron sources. The main observations are supported by quotations from the individual reports prepared by BrightnESS regional hubs.

3.4.1 Description

In many of the countries and regions in which the assessments were conducted, some companies showed a level of awareness of the industrial use of neutron, and, in some cases, of X-ray sources, too low to allow for an informed decision to integrate these techniques into their R&D activities.

3.4.2 Input

The assessments conducted in Spain, Hungary, France, Switzerland, and Sweden saw the participation of companies with limited or no experience at neutron sources. The companies expressed the need for more effective communication regarding the use of neutron sources, the advantages neutrons present with respect to other techniques, and a list of R&D challenges that could be solved by using neutrons. The suggested ways to raise awareness about the use of neutron and X-ray facilities among potential industrial users are as follows:

- Outreach initiatives to *"explain what neutrons can do in comparison with standard technologies and X-rays (Gallia Hub)",*
- *"Dedicated workshops for industry to show the benefits of large RIs (Iberia Hub)",*
- Series of meetings *"with more technical information (Southeast Hub)"* related to specific R&D needs.

As a state-of-the-art research facility and a pan-European organisation, ESS is expected to play an active role in raising awareness on the societal benefits of neutron sources by deploying campaigns at regional level through dedicated channels, and to increase the awareness of the positive societal impact of neutron sources in Europe.

Recommendation

ESS should engage in outreach activities aimed at increasing the awareness of the benefits stemming from the industrial use of neutron sources. The goal of the outreach campaign should be to explain the added value of neutrons in comparison with other research techniques, and to demonstrate the benefits of industrial research at large-scale research facilities in general.

Strategic objective for ESS: Raise awareness

3.5 Reports from BrightnESS Regional Hubs

3.5.1 Gallia Hub (France)

General Information about Focus Group
Date: 22nd June 2016
Place: Paris, France
Moderator(s): Marie-Hélène Mathon (MENESR & LLB)

General Information about Participants
Number of participating companies: 5
Field of expertise/sector: nuclear industry, metallurgy, ophthalmic industry, microelectronics, characterisation of materials and control of products of processes
Number of participants from academia: 6
Names: Fabrice Cousin (LLB), Antoine Daël involved in BrightnESS (MENESR & CEA), Arnaud Desmedt (Bordeaux University), Marie-Hélène Mathon (MENESR & LLB), Alain Menelle (LLB), Florence RAGON involved in BrightnESS (CEA)

Summary of Key Discussion Points/Outcomes
Comprised of representatives from companies that have a varying degree of experience with neutron research and come from different fields, the Gallia focus group for industrial users was a well-balanced representative group. Participants foresee a strong interest in employing neutron science because of neutrons' high sensitivity to light elements, their high sensitivity to isotopic contrasts, their high penetration, and their non-destructive nature. However, companies which are not familiar with neutron science expressed the important need to understand more precisely what the benefits are of using neutron scattering in comparison with others techniques, and how to identify that neutron scattering is a good technique to use to solve a specific problem.

Participants have distinguished two ways of doing research at large infrastructures with different timeframes and needs:

- Exploratory investigations involving collaboration with universities, and where a much longer time scale is involved.
- Routine investigations intended for more direct and commercial applications, as well as to solve a specific problem, where fast and easy access has been pointed out as being essential for routine investigations (one week is considered an acceptable time lag).

Due to the increasing demand of neutron research, a strategy has to be implemented to increase the productivity of the neutron scattering instruments at ESS. It was suggested that an effective way of optimising the beamtime would be to create a dedicated service (internal or external) in charge of performing routine investigations, in particular with the development of an automatic sample changer. Combining this dedicated service to a mail system is an option, however problems of border crossing would have to be considered.

Focus Group Minutes

Past Experiences

Which companies have used RIs for research in the past five years?

Companies participating in the focus group had a varying degree of experience with RIs. Two are regular users of synchrotron and neutron facilities respectively. One conducts synchrotron experiments on a weekly basis, whereas another company conducts neutron experiments several times per year. Two companies have been involved in research projects using neutron sciences in collaboration with academia and others companies. One company has not yet used neutron sciences for their R&D but has, however, already performed preliminary tests with a neutron facility.

How did they learn which RI was relevant to them?

Generally speaking, the companies participating learnt which RI was relevant to them through networking and feedbacks from previous users of RIs. Usually, they also have good contact with scientists working at an RI.

Did they use RIs outside their home country? If so, why? If not, why?

Companies participating reported different factors when determining what research facility to use:

- The fast and easy access: Some companies expressed the need for a facility open all year round, with a short time lag between asking for beamtime and actually performing the experiments.
- The geographical proximity: One company reported performing lots of experiments at synchrotron facilities in France (ESRF and SOLEIL) because of the geographical proximity.
- The cost: Generally speaking, participants agree that the cost to perform experiments at RIs are high. One company is considering the possibility of performing such experiments abroad because of the cost at the existing facilities in France.
- The specificity of the RIs: One of the companies used RIs outside France most of the time as the testing of microelectronic parts requires essentially fast neutrons irradiations, and at present the neutron facilities proposing a beamline with fast neutrons are rare and outside France (TSL in Uppsala, Sweden, Triumf in Vancouver, Canada, and LANSCE in Los Alamos in New Mexico, USA).

Did they have a clear understanding about what the RI could do for them (e.g. did they have a research project which fitted with the instruments that were available) or did they make use of an intermediary (commercial or academic) to translate their research problem into a researchable project for the RI?

The approach chosen has been dependent on the type of experiments. For routine investigations, companies conducted research with the help of their in-house experts that have acquired knowledge with the experience. For first time/new experiments, the project would usually be drawn up with academic collaboration and in close relation with the beamline scientist.

Were the companies able to tell the RI clearly how much beamtime they expected to need for the research? If not, how was the beamtime duration ultimately calculated (by whom, how)?

Again, this has been dependent on the type of experiments. If the measurement has already been performed, a good estimation of the beamtime expected can be made. Companies already have good knowledge of the time needed to calibrate the instrument, to set up and change a sample, to do a specific measurement, etc. However, for exploratory experiments, the estimation can be more difficult and an upward estimation is made in order to anticipate possible problems. Usually, with research performed with academia, the beamtime attributed is spread over the year giving more flexibility.

What was the time lag between asking for beamtime and getting beamtime? Was this too long or sufficient?

The time lag has been dependent on the access modes chosen and the facility used. Some RIs are proposing an option providing rapid access on a commercial basis. This type of access is expensive but ensures rapid access and IP rights to commercial exploitation. The process of peer-review selection involves a much longer timescale, with a few months between the proposal submission and the beamtime allocation, and few more months between the beamtime allocation and actually performing the experiments. Furthermore, there are usually only one or two rounds per year.

Were they able to take the results and perform the analysis themselves, or did they have others to do this for them?

The approach adopted by the participating companies varies. Those most experienced performed the analysis themselves as they already had good knowledge of the beamlines used. This is especially true when there is a need to perform similar measurements over time. Some collaborate with universities and with scientists working at the facility. One participant expressed the need for support with the interpretation of data and to "translate" these results in order to convince the management of the benefits of the measurement.

Would they use an RI again in the future (e.g. cost/benefit of using the RI)?

The participating companies were planning to use RIs again in the future, but it was pointed out that large-scale facilities were expensive, at around 10,000 Euros per day of experiment and around 500 Euros per sample (including analysis in both cases). The cost-benefit ratio of doing research was therefore fairly high. Generally speaking, there is an increasing demand for analytical imaging techniques, such as tomography.

Future Expectations

Do the companies expect to use an RI (again) within the next five years?

All participating companies are planning to use RIs within the next five years. For two companies, RIs are an essential tool for their activities. One of them is even conducting synchrotron experiments on a weekly basis. Both companies will therefore continue to use RIs on a regular basis. The other of the two is also considering using neutron facilities in the future to address demands in neutrography. Another company is currently involved in an RFCS (Research Fund for Coal and Steel) European Project. Within this project, six days of beamtime at the FRM II facility (Münich, Germany) have been obtained, four of which are still to be scheduled. One of the companies in the focus group has highlighted that neutrons are interesting for them both for surface and bulk material characterisations. Another participating company would be interested in using an RI in the near future. One of the participants pointed out some of the challenges related to research and where neutrons could help:

1. Understanding the surface-environment interaction (e.g. aging mechanism of surface coating)
2. Understanding the interface-environment interaction (e.g. water diffusion in multi-layered materials)

However, the need to understand more precisely what the benefits of using neutron scattering are in comparison with others techniques was expressed. In this context, one of the academic participants explained some of the benefits of neutron research:

- High sensitivity to light elements, such as hydrogen and lithium
- High sensitivity to isotopic contrast
- High penetration
- Non-destructive nature

What are the 'lessons learnt' from previous experience (if applicable)?

One participant highlighted that beamline accessibility has to be all year round.

What is an acceptable time lag between asking for RI research time (beamtime) and actually performing the research?

Participants have distinguished two levels with different timeframes:

1. R&D experiments with unknown materials and/or problems requiring the help of an instrumentalist to set up and perform the experiment, as well as to analyse the data: In this case, three to six months is an acceptable time lag.
2. Routine investigations requiring a well-known set up of a particular instrument where the industrial is already familiar with the experiment and the data analysis: In that case fast access is essential, one week is considered an acceptable time lag.

Do the companies feel that they are better able to define their research questions in terms that the RI can work with, or would they prefer an intermediary (this may also be a researcher from the RI itself) 'rephrase' the company's research question into an RI project?

With regard well-known established analyses, companies don't necessarily need additional help. Furthermore, the increasing development of data processing software is making data analysis easier. However, when companies have a new problem, two needs have been pointed out:

1. Support to understand more precisely what the benefits are of using neutron scattering in comparison with others techniques, and how to identify that neutron scattering is a good technique to use to solve the specific problem. In this case, discussion with a researcher from the RI itself seems essential.
2. Support for the analysis and interpretation of data that isn't always straightforward.

Do the companies feel that the services offered by the RI are well communicated, or should the RI work in pre-defined 'service packages' (e.g. "doing X will cost Y beamtime at Z price", "analysis of results will cost A" etc.)? What would be business-oriented service packages (what are the elements in such packages)?

In order for ESS to ensure effective communication with industry, as well as to optimise the ratio of beamtime used over the beamtime provided, they suggested the following:

- Raise awareness and explain what neutrons can do in comparison with standard technologies and X-rays; Create a dedicated service (internal or external) in charge of performing routine analysis, in particular with the development of an automatic sample changer, giving the possibility for industrials to send their sample;
- Associate a mail system with the dedicated service (the problem of border crossing would have to be consider);
- Clarify the management of the intellectual property.

<u>Learning Opportunities (Online/On-Site Course)</u>

What kind(s) of support in the preparation of your research project would companies like to receive from the RI when preparing their research question for the RI-research activity? Consultancy time in re-defining/re-phrasing the research question in the context of the RI offering? Consultancy time in establishing required beam-time duration?

No specific demands or anticipations have been expressed concerning these specific points.

3.5.2 Northwest Hub (United Kingdom, Netherlands)

General Information about Focus Group

Regional Hub: Northwest

Report: Laura Sewell (STFC, UK); Jeroen Plomp, and Toon Verhoeven (RID, Netherlands)

In the Northwest hub it was decided to hold a series of individual interviews with companies rather than a focus group; the interviews were arranged and conducted either by STFC (UK) or RID (Netherlands). Below is a summary of the interviews and key discussion points/outcomes.

General Information about Participants

Number of participants: 7

Industrial participants (sectors): Oil (STFC), Chemicals (STFC), NXUS project (STFC), Steel (RID), Food and Beverages (RID)

Summary of Key Discussion Points/Outcomes

Of the companies interviewed, there was a balance of experienced and more recent neutrons users providing a variety of viewpoints. The Industry Liaison Manager of ISIS was also interviewed for a general perspective. Industry views neutrons as complementary to X-rays, although it was noted that there is a lack of awareness about neutrons and their potential applications within industry in general. Within the companies that do utilise neutrons, capability is often limited with only one person able to perform experiments. Suggestions to improve industrial knowledge of neutrons included short hands-on courses for industry on techniques and data analysis, and symposia, in particular thematic areas, to allow industry to see the potential applications of neutrons. Data analysis was regarded as a possible barrier for industry participation, and the interviewees were in agreement that assistance with data interpretation was useful, even for experienced users: most relied on assistance from the instrument scientists or academics. The interviewees had utilised neutrons for a variety of different projects, from short-term projects impacting on current products to much longer-term projects, some in collaboration with academics and some by themselves. Industry utilise the full range of access methods (commercial, peer-review, mail service, ICRD - ISIS' Collaborative R&D Programme) and valued having multiple options, as speed of access and/or confidentiality may be important factors depending on the project and the stage of the research. Confidentiality and intellectual property were regarded as of high importance to industry. While the cost of beamtime is a factor, it is not considered a large obstacle if there is a demonstrable benefit for the company.

Facilities were chosen for a variety of reasons: location, cost, familiarity with the facility and its staff, and the type of project to be carried out. While some interviewees had used facilities outside their home country due to cost or availability, some strongly favoured their local facility but might consider using another facility should it have a unique capability. A point of contact was essential for both general logistical questions and technical questions; instrument scientists were the preferred point of contact.

Many companies see SINE2020 as an interesting way of becoming familiar with performing experiments with neutrons, although, for the more experienced companies, the direct costs are not seen as a decisive issue.

Summary of Interviews

Past Experiences

Research Background

The interviewees had a range of experience with neutrons: some are experienced users of neutrons and the interviewees had utilised neutrons during their PhDs, while others are relatively recent users of neutrons. It should be noted that NXUS is not a company but a project to promote the industrial use of neutrons and X-rays through collaborations with academics. ISIS's Industry Liaison Manager was also interviewed to gain a general perspective of industrial use at ISIS.

Neutrons were seen as complementary to X-rays, with the two main selling points of neutrons being their ability to provide non-destructive testing and their ability to see hydrogen. The interviewees had used neutrons for a variety of reasons including understanding the structure of their nano-sized products, studying the formation processes, assessment of multiscale food structure, diffusion measurements, and phase transformations in metals allowing them to gain information that couldn't be obtained with other techniques, such as X-rays. Some were now actively expanding their use of neutrons and utilising other methodologies.

Research Infrastructure

Companies expressed a variety of reasons for choosing a particular facility: location, familiarity with beamlines and scientists, experiments which can only be done at a particular beamline, cost, and availability. Several had used facilities outside of their home country, with their reasons for going abroad including cost and availability. Those who hadn't would consider it if they were unable to access their home facility within a reasonable time frame, or if a particular capability was only available there.

Users either contacted the instrument scientists directly, or the industry liaison manager, depending largely on their familiarity with the facility.

Companies had utilised the full range of mechanisms to access the facilities, including public funding schemes ,with the access method dependent on the project and its commercial relevance.

Some companies noted that as X-rays are easier to use than neutrons (e.g. as some companies have in-house X-ray devices), X-ray facilities, such as the ESRF, have a greater number of industrial users and therefore can offer extended services, making it easier for companies.

Beamtime Access

Industry use a range of mechanisms to access the facility: peer reviewed academic process; commercial route; ISIS's Collaborative R&D Programme (ICRD); or quick look express routes, such as the SANSXpress (ISIS). Companies valued having a range of access methods, as speed of access/confidentiality may all be important factors depending on the project and the stage of the research. Access via the ICRD programme or the peer-reviewed route helps to reduce the risk for the company when the output for the company from the experiment is unknown, although these routes are only suitable for non-commercially sensitive work. It was commented that a potential issue with ICRD is that you have to decide your experiment in advance; this might vary depending on whether the results will be published or kept confidential.

Depending on the access mechanism, it can take from two weeks to six months to obtain beamtime; this can also be dependent on whether contact was made before or after beamtime had been scheduled. This was broadly acceptable to the companies, although the possibility to mail-in samples for "standard analysis" with a short turnaround time was valued. Contract negotiations can take some time, depending on the IP arrangements.

None of the interviewees used external service providers, with the work being done in house or in collaboration with academics, although the NXUS project is itself an external service provider. It was noted that most companies only had one employee with sufficient expertise to run the experiments and analyse the data. One was keen to expand the capabilities within their company and transfer the knowledge in-house. ISIS's ILM noted that when trying to promote neutrons to industry, a lack of knowledge regarding neutrons is often encountered. The use of an unknown technique increases the perceived risk in costs and outcome of the experiment to a company.

At ISIS, besides confidentiality arrangements, companies receive the same service as academics, with the service dependent on the user's experience. Industry appreciated the well-equipped labs, as well as the help of the instrument scientists for setting up the experiment, dealing with issues, or helping with data analysis. The facility at RID, the Reactor Institute in Delft, is not strictly a user facility, and therefore no specific arrangements are standardised for industrial users.

Methodology, Samples, and Data Interpretation

ISIS's ILM noted that the main methodologies that companies use at ISIS are engineering strain measurements and small angle scattering; the value of both of these has been clearly established in industry. In line with this, several of the interviewees had mainly used SANS, although they were open to other methodologies if needed, and some were actively looking for other methodologies that they could use.

None of the interviewees needed assistance with sample preparation and mostly brought their samples with them, although the ability to ship samples was useful for trials and standard samples after performing full experiments. Help with sample environment or sample conditioning from the instrument scientists was often needed, as well as much appreciated. At ISIS, discussions are held with the users regarding the experiment and what is feasible before the start of any experiment. The importance for industry of having workhorse beamlines that can work at various temperatures and pressures was noted.

All commented that the data was easy to obtain, but sometimes assistance was needed with interpretation. Due to a capacity issue, ISIS does not provide large-scale data analysis and report writing for companies, which could be a barrier for some, or for new industry engagement. A possible solution to this is the use of academics, either through consultancy work or collaborations. At RID, companies have had the help of RID academic staff for setting up experiments and analysis of the data.

Impact of Measurements

The measurements have been beneficial to the companies interviewed. With regards to increasing their competitiveness, answers varied between interviewees, however most agreed that this had been the case, due to the deeper knowledge the measurements provide placing them in a stronger position to produce better products.

Proprietary Research

All agreed that confidentiality and a mechanism to protect the data are important for industrial research, at least until the company has determined the commercial relevance of their results. For most, management initially required some convincing on the benefits of using neutrons, but less justification is required once a track record is established. Although the cost is important, the wider benefit to the company/people is also important. One interviewee commented that their case to management was aided by the following: publications from another company in the same sector that have used the technique, having an experienced user in the company to reduce the risk, and the ability to quickly generate some trial data to demonstrate that the method worked on their systems.

Services

All agreed that a point of contact is extremely useful, both for general logistical questions and for more detailed discussions regarding the design of the experiment, beamtime required, sample environment, etc. Instrument scientists were favoured by several interviewees as their preferred contact.

Data analysis was regarded as a possible barrier for industry participation, and all interviewees were in agreement that assistance with data interpretation was useful, even for experienced users. Most relied on assistance from the instrument scientists at the facility or academics.

Courses

ISIS does not currently provide any specific courses for industry, and the week-long neutron training course is mainly attended by academics. The main training provided to industry users is hands-on training from the instrument scientists during the experiment.

Most interviewees favoured multiple, short online courses/webinars where they could participate in relevant sections. Longer on-site courses are more difficult to get permission for, but a focused course of one or two days would be beneficial for industry, potentially including some hands-on training. Another suggestion was focused symposia around particular thematic areas, to introduce industry to neutrons and the different techniques and their potential applications.

In terms of content, the suggestions of general information about techniques and which problems they address, theoretical background, and data analysis were all considered positive. Additional suggestions included experiment design and the limitations of the facility.

3.5.3 Southeast Hub (Italy, Hungary)

General Information about Focus Group no. 1 in Italy
Date: 14th October 2016
Place: Elettra Sincrotrone Trieste premises
Regional Hub: Southeast
Moderator: Marco Peloi, Head of Industrial Liaison Office at Elettra Sincrotrone Trieste

General Information about Participants
Number of participating companies: 1
Sectors: Foundry industry

Summary of Key Discussion Points/Outcomes
The company is familiar with Research & Development Projects under Horizon 2020 initiatives and nationally funded projects. It is also becoming familiar with X-ray sources. The company is interested in all kinds of collaborations; i.e. funded projects, co-developments, R&D projects, etc.

Confidentiality is important, as most of the company's business is based on proprietary technologies. Awareness of the available technologies has been raised through a dedicated visit to their facilities by Elettra representatives. Potential collaboration with Elettra is under discussion. Currently, the company collaborates mostly with universities and research centres in Italy.

The company is not able to estimate the beamtime needed. It needs support with data interpretation and analysis. The expected time lag is two months. A service package was not requested, but the company asked for general information on range of prices for long-term collaborations, such as R&D Projects, for 1-3 years.

Concerning the opportunities of using neutron sources, the technique of most interest for its industry area is neutron reflectometry. With reference to the teqnique, an example of application in its industry area was shown.

General Information about Focus Group no. 2 in Italy
Date: 25th October 2016
Place: The event was held in AREA Science Park campus, Padriciano 99 Trieste Centro Congressi, and was organised jointly with OPEN LAB, a national project that brings together industry and research centres to develop industrial applications. The event was promoted through AREA Science Park's website, and invitations were sent to around 150 companies, including current customers of Elettra- Sincrotrone Trieste.
Regional Hub: Southeast
Moderator: Marco Peloi, Head of Industrial Liaison Office at Elettra Sincrotrone Trieste

General Information about participants:
Number of participating companies: 5
Sectors: Metallurgy, Photometry, Diagnostics, Polymers, Electronics for Steel Industry

Summary of Key Discussion Points/Outcomes

The companies are familiar with nationally funded projects and are also becoming familiar with X-ray sources. Apart from a couple of companies which were very keen on starting R&D collaborations, and who were also familiar with X-ray sources, companies participating in the event were interested in short-term collaborations; i.e. a few measurements, focused on a maximum of one or two techniques. Confidentiality is important, as most of the companies' businesses are based on proprietary technologies. Current collaborations involve mostly universities and research centres in Italy. The companies cannot estimate the beamtime needed. The companies need support for data interpretation and analysis. The time lag expected is two months. A service package was not requested, only general information on the range of prices for long-term collaborations, such as R&D Projects, for 1-3 years.

General Information about Focus Group in Hungary

Date: 27th January 2016

Presentations:

Szabina Török: Presentation of ESS

László Rosta: Presentation of BrightnESS

Margit Fábián: Methods and possibilities at ESS

Area of Expertise/Sector of Participating Companies

Surface chemistry/Catalysts, Engineering, Biotechnology, Energy and Engineering, Biological Systems, Material Science, Pharmaceutics, Metallurgy, Manufacture.

Round Table Discussion

An interactive discussion followed the presentations: The moderator was Laszló Rosta. Two main points raised by the participants during the discussion were:

1. Methodological and professional issues
2. Financing possibilities

The present situation concerning planned instrumentation developments at ESS was explained. It became clear that the organisations participating in the focus group have their own equipment and instrumentations for basic and dedicated problems; e.g. laboratory X-ray diffractometer, chromatography, Nuclear Magnetic Resonance, Raman spectroscopy, etc. They also have a strong relationship with universities and, in cooperation with academia, aim to carry out various experiments using large infrastructures like ESRF or the forthcoming ESS. However, neutron methods and possibilities were new to most of the participants.

One of the participants is a well-known theoretical chemist and structural biologist. He emphasised that this new infrastructure with high-performance neutron methods and innovative instruments can provide a large boost to dedicated biological research. He mentioned that it was important to identify the needs of users from industry and academia. It is necessary to be able to service special needs related to, for example, sample environment and measurement conditions, such as variable temperature, pressure, or humidity.

Another participant noted that the potential of ESS in stimulating scientific fields, encouraging new cooperation, solving particular problems, and supporting economic growth is well recognised. He pointed out the importance of using neutron methods together with X-rays, as well as taking advantage of their complementarity in modern experimental evaluation. He often performs measurements at ESRF synchrotron radiation facilities.

Yet another participant was interested in non-destructive methods. Currently, the company he represents is interested in performing an analysis of special 15H2MFA steels and aluminium-alloys. The importance of financial aspects related to ESS usage was raised. While the company would be willing to pay for the measuring time, he underlined the importance of having guarantees that the source at ESS will be in stable operation and on time. Other questions of interest included: What will be the reliability of ESS? What will be the operational costs per beamtime/per instrument?

Another participant came from the pharmaceutical sector. His group was interested in using ESS and in exploring possibilities for in-vivo cell tests and molecular studies. He asked whether tenders would be similar for both parties; i.e. research institutes and companies. Other questions raised included: What is the response to special sample installation requests? Is it possible to use own equipment? Who will be responsible for measurements – the staff or the users? What is the plan for the scientific/industrial user rate?

One of the participants was from the energy sector and mentioned the need for a very strong and well-defined industrial property legislation. He was interested in studying special, new heat storage PCM-materials, and stated it would be beneficial if beamline staff could support the acquisition of neutron data and assist with general data analysis. He was also interested in beam reports and in details about economic development.

Recommendations

- There was a strong consensus that a well-designed and determined approach is necessary to achieve the full potential of ESS,
- Important factors of a successful collaboration between ESS and industrial partners include timescale, steady quality, and well-written agreements,
- There is a need for a well-defined policy, strategy, and action plan to boost the development of an ESS Industrial User Society,
- Stronger collaboration between scientists and industry is needed,
- Participants hoped and recommended that these meetings continue when more technical information became available,
- Participants proposed creating platforms to exchange experience between different groups interested in the same field or topic,
- Many participants required the support of staff/human resources,
- All participants agreed on the need to create an effective ICT network for all kinds of activities, including dissemination of information, networking, tender submission, booking of accommodation, etc.

The importance of using neutrons and developing the potential of industrial partners to become decisive factors in the success of ESS was highlighted at the close of the discussion.

3.5.4 Central Hub (Switzerland)

General Information about Focus Group

Date: 21st April 2016
Place: PSI, Switzerland
Regional Hub: Central
Moderator(s): K. Thomsen, PSI
Report: K. Thomsen, PSI

General Information about the Format of the Meeting

Intentionally, the declared prime focus of the meeting was on specific questions on metallurgy, for which neutrons can deliver unique insights not accessible via other means of investigation. Thereby, high-ranking representatives of Swiss industry could be attracted who have the overview of current issues and are in the position to provide valuable information on current and anticipated needs and boundary conditions. Although only two participants from industry might seem low, quality is decisive, and, due to their rather different business types, a fair coverage of the field has been achieved. The points raised and reported below can therefore be taken as representative for Swiss (European) industry, and also match general PSI experience accrued in decades of cooperation with industrial partners.

The split into presentations and ample time for discussion fostered a rather informal and friendly climate, resulting in a very open exchange of ideas and sharing of problems. The basics of several new potential collaborations have been started.

General Information About Participants

Number of participating companies: 2
Sectors: Steel, High-Tech Cast Components

Summary of Key Discussion Points/Outcomes

There is a strong interest within the Swiss steel-casting industry in employing neutrons, which can fall under the common title of process optimisation and quality assurance. For standard investigations, a response time of a maximum of four weeks is mandatory. The potential for conflicts is seen between dedicated industrial research and open access to the obtained results.

Focus Group Minutes

Past Experiences

There was limited experience with neutrons, and in only one of the two companies. Use of other (large-scale) research facilities and collaborations with various research institutes is common practice. One company "had just not come across neutrons".

Future Expectations

Strong interest in novel approaches and new means of analysis has been expressed by both industry representatives.

It is clear that both companies would not apply for beamtime right now. The natural next/first step appears to be to start with some dedicated common project, taking advantage of funding support from diverse sources (EU, national). The first steps, involving quick looks at samples to check the principal suitability of the available techniques to current questions, have been outlined. Some cooperation in compiling proposals for EU and Swiss funded projects has been agreed upon. Industry highlighted their requirement for quick results when employing standard processes and analysis methods; four weeks as a maximum turnaround time was deemed acceptable. Of course, (common) research projects involve a much longer timescale.

Industry is hesitant concerning their engagement in common research projects because of issues with intellectual property rights. They see the employment of (not only) neutron-based techniques in an open research environment as potentially conflicting with their primary aims of optimising their products and production procedures in order to gain an edge over their competitors.

Learning Opportunities

No specific demands or anticipations have been articulated. For the envisaged common projects, a stepwise approach will be followed; i.e. firstly checking the principal suitability of the available methodologies for the actual demands with specifically prepared specimens and later, where applicable, the elaboration of common projects.

Next Steps

A large number of companies, both in Switzerland and in Germany, had been directly contacted and invited to take part in the meeting at PSI on 21st April. Several key staff from the steel and aluminium industry declared a strong interest but, for various reasons, were unable to take part on that particular date. It was agreed that these companies would be contacted after the event for continued discussions.

The very initial steps towards common projects with, potentially, both companies have already been taken. They are, of course, focused on existing PSI infrastructure and experience. For the two companies interviewed, ESS is (still too) far away.

3.5.5 Iberia Hub (Spain)

General Information

Date: May-June 2016

Place: Valencia, Barcelona (through Alba users), Madrid, Zamudio (Vizcaya), Beasain (Guipuzcoa)

Regional Hub: Iberia

Report(s): Sira Cordón

General Information about Participants

Field of expertise/sector: Agriculture, Food and Beverage, Aerospace, Railways, Pharmaceutical.

Summary of Key Discussion Points/Outcomes

- Industry in Spain has a lack of experience with, and lack of knowledge of, the use of large RIs,
- There is a big gap between industry and academic research centres that possess information related to the use of RIs. This points to the need to increase collaboration between industry and academia, or industry and other intermediaries,
- Common point: There is a need to raise awareness, through a communications campaign, in order to increase the knowledge of industry on the added value of neutron research carried out at large RIs,
- There is a need to develop case studies and concrete examples outlining the benefits of neutron research,
- There is a need to explain in detail the cost and time needed to obtain results that would benefit companies.

Past Experiences

- Stronger collaboration throughout the whole experiment; i.e. from designing the experiment to data analysis,
- Better performance capabilities of RI analysis with respect to the laboratory equipment,
- Reasonable costs of using neutrons and quick results.

Future Expectations

- Close the gap between research centres and industry in order to facilitate access to large RIs and reduce the costs of beamtime,
- Help industry to identify needs that could be met by using neutron techniques,
- Industry needs quick results and also help with data interpretation,
- Reasonable price for the usage of a large RI: Good balance between costs and benefits.

Next Steps

- Follow-up meetings to provide information on the added value of neutron research,
- Foster collaboration between industry and academia and other research centres,
- Raise awareness through workshops for industry and demonstrate the benefits of large RIs,
- Create a document with cases studies in neutron research and explanations of the added value of neutron techniques.

3.5.6 Nordic Hub (Sweden, Denmark)

General Information about Focus Group

Date: 14th March 2016
Place: Lund, Sweden
Regional Hub: Nordic
Moderator(s): Axel Steuwer (Invest in Skåne), Roy Pennings (ESS)
Report: Lenka Petkova (ESS), Axel Steuwer (Invest in Skåne), Roy Pennings (ESS)

General Information about Participants

Number of participating companies: 6
Field of expertise/sector: Electric Power, Chemical, Metallurgy, Pharmaceutical, Nuclear industry.

Summary of Key Discussion Points/Outcomes

Comprised of senior representatives from companies that have a varying degree of experience with neutron and synchrotron research, the Nordic focus group for industrial users was a well-balanced representative group. Participants agreed that research at large infrastructures is mainly an optimisation tool for industry, and serves to improve and upgrade products that are already on the market rather than to develop new ones. Reasons for this are the relatively long time lag to be able to perform experiments, the investment cost, and the uncertainty about possible results. In this regard, it was noted that smaller facilities, i.e. not the latest generation, usually provide a better service, and their robust and standard beamlines are better fitted for industrial use. As a consequence, these facilities play an essential role in routine investigations and long-term collaboration. The participants suggested that service at research facilities in general could be improved, for example by:
providing stronger support during experiments;

- providing standardised data formats and liaising with fast data analysis;
- easing the administrative burden and initiating standardised administration across different facilities;
- improving communication by providing more information about the value proposition and cost-benefit of neutron research;
- featuring case studies, with timeframes and costs, on the facilities' websites.

In addition to providing a better service, it was suggested that an effective way of making neutron research and ESS more attractive to industry would be to establish industry-specific scientific centres of excellence around ESS. These centres could be based at universities and would conduct world-class research and stimulate industrial collaboration. Furthermore, education and raising awareness on what neutrons can do in comparison with standard technologies and X-rays is also needed, as the preparation and execution of neutron experiments is currently beyond the internal expertise of many companies.

In some cases, collaboration with academia was seen as beneficial because of the willingness of academic partners to take over the administrative burden associated with research experiments. However, participants also stressed that collaboration with academia could, at times, be rather difficult because of the question of Intellectual Property (IP) and confidentiality, and the overall slow nature of such partnerships. Industry values flexibility and the possibility to choose from a few collaborative options; i.e. to collaborate with academia, collaborate with an intermediary company, or use the research facility directly.

Participants agreed that ownership of IP was crucial for industrial research, especially if related to processes, due to the long development time invested in projects. Also, the current process for contracting with research infrastructures was considered (too) slow and often bureaucratic. One favoured solution was to have framework agreements in place and then set up specific project agreements with dedicated IP arrangements. Nevertheless, companies evaluate the question of IP on a case by case basis, and are often willing to share IP and publish results in case of basic research, or if the processes in question are used by all of their customers. Industrial companies would be willing to invest in beamlines, either through one-off investment costs in infrastructure or towards operation (even up to sharing costs for beamline-scientists) as long as they provided a clear benefit to industrial use. All agreed that the current grading and career system for beamline scientists is not really conducive toward increasing industry use of research infrastructures, as the career system focuses on the production of publications rather than on service delivery based on industry specifications and within a competitive industrial context (ownership of data, IP etc.). In addition, the high turnover rate of staff on short-term contracts was a hindrance to the repeated use of facilities, as staff had to be trained in several cases because of the lack of experience in the field.

Focus Group Minutes

Past Experiences

Which companies have used RIs for research in the past five years?

Companies participating in the focus group had a varying degree of experience with RIs. One of the companies has been conducting synchrotron research since the 1980s, and has also been using neutrons for quite some time. Another company started conducting synchrotron research in 2007, and is at the moment relying on contract researchers. Another company participating in the focus group, a regular user of synchrotrons, has recently made its first try-outs with research using neutrons, but the administrative burden associated with the process made the experience rather difficult and costly. Yet another company in the focus group had direct experience with conducting research at RIs. In addition, there were two companies that have both gained indirect experience by carrying out research in collaboration with academia.

How did they learn about which RI was relevant to them?

Participants pointed out that state-of-the-art beamlines, which are available at some research facilities, were not necessarily of interest to industry as they were often too narrow for industrial use. Industry looks for standards and robust beamlines. Such beamlines are especially important in case of long-term research, when companies need to perform the same measurements with the same samples over several years. The lack of coordination among research facilities in Europe whenever beamtime in any of them becomes unavailable was mentioned, but participants did not see this as a major problem. The group agreed that websites of RIs do not currently provide information that could help industrial users to understand what RIs have to offer, or what problems could be solved using the specific instruments; i.e. there is lack of product-oriented information, and case studies do not provide background on the timeframe and costs associated with the research in question.

Did they use RIs outside their home country? If so, why? If not, why not?

Geographical proximity does not play a major role when companies decide which research facility to use. Some of the participants in the focus group have carried out research at facilities based not only in Europe but also in the USA and Japan. They generally agreed that, when choosing between different research infrastructures, they sometimes tend to opt for the one that offers the best service, even if this is not the most cost-effective option. They emphasised the need for proper 24/7 support from the experimental staff (more than one person), consulting services, fast data analysis, continuity of staff at the facility, and the option of service packages: 1) A 'solution' for standard analysis with the possibility to mail samples in and get results back; and 2) A solution for in-situ studies where an industry representative can be at the facility when measurements are done. Industry also values flexibility; i.e. having the option to collaborate with an intermediary company, collaborate with academia, or use research facility directly.

Did they have a clear understanding of what the RI could do for them (e.g. did they have a research project which fitted with the instruments that were available) or did they make use of an intermediary (commercial or academic) to translate their research problem into a researchable project for the RI?

While each of the participating companies has had a slightly different approach to carrying out research, all of them have collaborated with universities before. The benefit of such collaboration was that universities were willing to take care of the administrative burden associated with research at facilities and to support industry with data interpretation. On the other hand, participants pointed out that collaboration with academia could often be challenging because of issues related to IP, the question of confidentiality and, last but not least, the overall slow pace. Some of the companies in the focus group conduct research with the help of their in-house PhDs and experts, or with the help of commercial intermediaries. In addition, one participant shared that their research was completely outsourced. Projects co-funded by government and industy are seen as the natural way of collaborating, providing the opportunity for companies to train their own staff. There was a general agreement that RIs were not sufficiently industry-oriented when it comes to topics they address, and also the way they present information on their websites. One of the participants also noted that when buying beam time, companies sometimes do not know what they are paying for; e.g. there may be a need to calibrate the beamline, and the calibration would be included in the paid beamtime, etc.

Were the companies able to tell the RI clearly how much beamtime they expected to need for the research? If not, how was the beam-time duration ultimately calculated (by whom, how)?

Depending on the problem and company, the beamtime estimates were either done internally or via intermediaries (CRO, Academics). Standard experiments, such as MX, are well established and known to industry, but targeted experiments with complicated in-situ set-ups need to be discussed with the beamline scientists, and a balance between feasibility, time, and budget has to be established.

What was the time lag between asking for beamtime and getting beamtime? Was this too long or sufficient?

Participants shared that bureaucracy generally slows research projects down, and as a consequence discourages them from using research facilities. They would therefore prefer to have standardised administration across different facilities, or to have the option of buying themselves out of the administrative burden. It was mentioned that whenever a project involves IP negotiations, these take three months on average, and as such slow the project even further.

Were they able to take the results and perform the analysis themselves, or did they have others to do this for them?

The approach adopted by the participating companies varies. While some outsource the whole research process, others collaborate with universities in order to receive support with data interpretation, or use intermediary companies. The question of reliability of data interpretation was brought up, and the importance of being able to track data and analysis backwards in time, especially in the case of long-term projects, was underlined. Generally speaking, the participants expressed the need for support in carrying out experiments, and also with the interpretation of data.

Would they use an RI again in the future (e.g. cost/benefit of using the RI)?

The participating companies were planning to use RIs again in the future, but it was pointed out that large-scale facilities were costly, and the cost-benefit ratio of doing research there was rather high. Generally speaking, industry uses large facilities as an optimisation tool and not as a development tool; i.e. not to introduce new products to the market, but rather to develop the second or the third generation of products for which they already have customers. On the other hand, it was emphasised that industrial R&D should not be underestimated, and that they would find the solution to a particular problem if it included neutrons. It was mentioned that smaller facilities, i.e. not the latest generation, usually provide a better service, and are essential for routine investigations and longer collaboration.

Future Expectations

Do the companies expect to use an RI (again) within the next five years?

The participating companies have been conducting research at RIs fairly regularly, and therefore plan to continue. Generally speaking, industry has more experience with synchrotron research than with neutron research. In this respect, participants pointed out some of the challenges related to research using neutrons:

- Synchrotron research can be carried out using routine technologies, but method development and better service to industry would be needed for neutron research, as the undertaking of experiments is beyond the internal expertise of companies;
- Neutron research is currently slow, whereas the results of synchrotron research can be made available within minutes;
- Crystals for neutron research need to be bigger than in the case of synchrotron research;
- High-level resolution would be needed in neutron research in order to compare results with synchrotron research;
- In order to sell neutron research to industry, better service, education, and PR is needed to raise awareness on what neutrons can do, and to explain what makes neutron research different from synchrotron research. In particular, the way information is currently presented on the websites of neutron facilities was deemed sub-optimal.

Some of the benefits of neutron research, as seen by the participants, were as follows:

- The possibility to see hydrogen;
- Less destructive nature of neutrons;
- Improved modeling programmes: Modeling programmes are currently based on X-ray research and thereby predictions on where hydrogen could be;
- Data that is complementary to that of synchrotron research.

Participants agreed that industry would be willing to invest in beamlines in return for beamtime, either through one-off investment costs in infrastructure or towards operation, as long as it provided a clear benefit to industrial use.

What are the 'lessons learnt' from previous experience (if applicable)?

Participants agreed that ownership of IP was crucial for industrial research, especially if related to processes, due to the long development time invested in projects. Nevertheless, companies evaluate the question of IP on a case by case basis, and are often willing to share IP and publish results in case of basic research, or if processes in question are used by all of their customers. It was, however, underlined that IP negotiations make research projects more difficult and slow them down. According to participants, the current situation with IP could be improved by: 1) Working with contract research organisations that will take care of the administrative part and ensure the retainment of IP; 2) Setting up framework agreements that would solve all IP and confidentiality questions case by case; and 3) Outsourcing the entire research to external companies.

What is an acceptable time lag between asking for RI research time (beamtime) and actually performing the research?

In relation to timeframes of research projects, participants shared that IP negotiations took three months on average. In some cases, this period expanded to up to nine months, and as such caused significant delays in research projects. Companies are interested in fast solutions to their problems, which implies fast access, fast data, and fast analysis.

Do the companies feel that they are better able to define their research questions in terms that the RI can work with, or would they prefer that an intermediary (this may also be a researcher from the RI itself) 'rephrase' the company's research question into a RI project?

Generally speaking, participants would appreciate stronger support with the interpretation of specific industrial problems into research projects that can be carried out using instruments at RIs. They suggested establishing sector-specific ILOs who would be able to understand company problems and propose solutions. Alternatively, this role could be taken on by a mediator company. Some participants have had the experience of seconding their staff to research facilities, with the aim of improving collaboration and increasing understanding. However, this form of collaboration has not been ideal, as the seconded staff were too far from the company to have a good understanding of research questions and problems that need to be solved, and lost touch with overall corporate culture. In addition, secondments have not improved "cultural" differences between academia/beamline scientists and industry, as seconded researchers tend to end up as specialised beamline scientists in facilities rather than returning to the company with their expertise.

Do the companies feel that the services offered by the RI are well communicated, or should the RI work in pre-defined 'service-packages' (e.g. "doing X will cost Y beamtime at Z price", "analysis of results will cost A" etc.)? What would be business-oriented service packages (what are the elements in such packages)?

Participants agreed that services offered by RIs are currently not communicated well. In order for ESS to ensure effective communication with industry, they suggested the following:

- Address topics that are of interest to industry, not just to academia;
- Create regional, industry/area-specific scientific centres of excellence around ESS, based at universities, to conduct world-class research and to attract industry and industrial collaboration;
- Provide information on the value proposition and cost benefits of research using neutrons;
- Provide better equipment for industrial R&D (in-situ equipment);
- Raise awareness and explain what neutrons can do in comparison with standard technologies and X-rays;
- Provide standardised data formats, as well as standardised administration, across different facilities;
- Provide product-oriented information rather than present individual instruments on the website; i.e. present case studies that would feature not only results, but also the timeframe, associated costs, etc. so that companies know what to expect, and offer similar support/product thinking when purchasing beamtime;
- Provide industry/area-specific content on the website and contact details of contact persons;
- Invite industry to join committees that operate beamlines;
- Lighten the administrative burden.

Since neutron research is complementary to synchrotron research, introduce the possibility of conducting research at ESS and MAX IV in one day; for example, a morning experiment at ESS and an afternoon experiment at MAX IV; i.e. have a coordinated experimental programme, share facilities, and provide standardised set-ups.

Learning Opportunities (Online/On-Site Course)

Participants expressed interest in having access to online lectures of high quality that would be sector-specific and easy to find, and provide general but also detailed information on how synchrotrons and neutrons work in particular case studies. Online MIT lectures were mentioned as an example, but there was a strong preference for interactive lectures that would allow the learner to, for example, follow what is happening during an experiment, etc.

What kind(s) of support in the preparation of their research projects would companies like to receive from the RI when preparing their research question for the RI-research activity? Consultancy time in re-defining/re-phrasing the research question in the context of the RI offering? Consultancy time in establishing required beam-time duration? Other?

In order to meet the scientific needs of industry, it was suggested that RIs should be more oriented on the solutions to problems industry has, as well as organise sector-specific focus groups, so that facility staff can understand the needs and demands of industry.

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