IRD Revisiting Event

Project Deliverable Information Sheet

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Abbreviations:

ESS – European Spallation Source ERIC
HZG - Helmholtz-Zentrum Geesthacht – Centre for Materials and Coastal Research
HEREON - Helmholtz-Zentrum hereon GmbH
DMSC – Data Management and Software Centre
ERIC – European Research Infrastructure Consortium
RE – Representing Entity
RI – Research Infrastructure(s)
LINX – Linking Industry to Neutrons and X-Ray
SotA – State of the Art

Executive Summary

Under the task 3.4, CERIC-ERIC, the European Spallation Source ERIC (ESS), and Hereon (formerly Helmholtz Zentrum Geesthacht) engaged in delivering a series of events with an aim to build capacity between the Research Infrastructures around Europe and Industry. This activity was principally aimed at researchers already positioned within Industry, who would act as a bridge between the Research Infrastructures' capabilities and Industry needs. The events were organized both before and after the COVID-19 pandemic hit. As a result, some of the Partners involved in the task had to change the initially planned format of the events, while other partners were unable to organize the events.

The events that have been organized were well attended and garnered solid discussions. The pre-pandemic events saw more than 140 attendees visit the 8 separate events that CERIC-ERIC organized in Barcelona, in years 2018 and 2019. These events offered CERIC-ERIC an excellent opportunity to network with the Industrial Researchers, and expand the number of stakeholders aware of, and engaged in CERIC-ERIC member institutes and research facilities.

ESS organized its events under the duress of the COVID-19 Pandemic. As a result, ESS could not invite Industrial Researchers to visit the project in construction, and an alternative solution was sought. A series of 4 webinars were held, with the Instrument Class Coordinators (people responsible of coordinating all of the activities related to the construction of Instruments at ESS in one of the four classes) giving talks to the participants on the remarkable scientific potential that ESS Instruments will offer to the researchers, once the facility will be built and fully operational.

Due to logistical and personnel difficulties stemming from the ongoing pandemic, Hereon has decided to not hold the events under the Task 3.4

Task 3.4 clearly demonstrated that there is still a strong need to build and strengthen capacity between the Industry and Research Institutes and Facilities around Europe. Scientists and Researchers, both in Research and Industry, are often siloed from one another. There is a lack of recognition and understanding that more often than not Research Institutes and Industry can use one another in a better way, fostering innovative solutions to problems of today, but also of tomorrow.

The key takeaway of the tasks described in this deliverable is that more work is needed to strengthen the relationships between Industry and Research Facilities. Reaching industry is still quite difficult, even when the events are organized around the idea of leveraging direct relationships with researchers and scientists in the private sector. Therefore, the improvement of relationships and communication between Industry and Research Infrastructures needs to be done in a meaningful way, with networking and capacity building exercises that demonstrate clear value and opportunities for them.

1 Introduction and Purpose

One of the purposes of the Accelerate Project's Work Package 3 is to bridge the gap between Industry and Research Infrastructures in Europe. To do this, Work Package 3 has been divided into 4 tasks which tackle different topics, covering commercial access to Research Infrastructures, building and maintaining Industrial Networks, better understanding of Technology Transfer Human Resources needs and evolutions, and finally, strengthening the bond between the Industrial R&D staff with State-of-the-Art Instrumentation and other scientific capabilities in Research Infrastructures around Europe. This deliverable will focus primarily on the latter, Task 3.4.

The tasks associated to this deliverable have been conducted by three Accelerate Project Partners – European Spallation Source ERIC, CERIC-ERIC, and HEREON (former HZG).

The European Spallation Source (ESS) ERIC is an international, multidisciplinary research facility building the world's most powerful neutron source. The ESS aims to advance the use of neutrons in scientific discovery, enable access to state-of-the-art instrumentation, and provide world-class support to the scientific community. The facility's unique capabilities will both greatly exceed and complement those of today's leading neutron sources, enabling new opportunities for researchers across the spectrum of scientific discovery, including materials and life sciences, energy, environmental technology, cultural heritage, and fundamental physics. The facility is under construction in Lund, Sweden, with its Data Management and Software Centre (DMSC) located in Copenhagen, Denmark. In 2015, ESS became the first European Research Infrastructure Consortium (ERIC) established in Scandinavia.

The life cycle of the facility is divided into several phases. The Construction Phase started in 2013, when the ground-breaking ceremony took place in September 2014. It is currently running in parallel to the Initial Operations Phase (2019-2025).

CERIC is a European Research Infrastructure Consortium (ERIC) integrating and providing open access to some of the best facilities in Europe, to help science and industry advance in all fields of materials, biomaterials and nanotechnology. With a single-entry point to some of the leading national research infrastructures in 8 European countries, it enables the delivery of innovative solutions to societal challenges in the fields of energy, health, food, cultural heritage and more.

Each Member country appoints one Representing Entity (RE), and contributes to CERIC by making available and supporting a high-quality Partner Facility. The Partner Facilities are strongly complementary to each other, allowing the integrated use of analytical and modification techniques based on microscopic probes for nano-level science and technology. Available methods include NMR, X-ray electron spectroscopy and light scattering, ion beam analysis, high-resolution electron microscopy, X-ray electron spectroscopy, materials' analysis using synchrotron radiation and neutron beams.

Access to the facilities is open to researchers from all over the world through the submission of single- or multi-technique proposals to the two calls for proposals launched every year. A peer review evaluation system guarantees a competitive free access to the over 50 multi-probe techniques available. The only condition for free open access is publication of the results of the experiments and the data, after an embargo period of three years. Commercial users can also request access to CERIC, which is granted on market-based conditions.

The Helmholtz-Zentrum Hereon conducts international cutting-edge research for a changing world: approximately 1,100 employees generate knowledge and innovation toward more resilience and sustainability. The Hereon's scientific spectrum encompasses high-performance materials, processes and environmentally friendly technologies for mobility and new energy systems. Furthermore, research is conducted on biomaterials for medicine and for increasing the quality of life. Through research and consulting, the Hereon addresses the challenges of climate change in a solution-oriented manner and facilitates sustainable management as well as the protection of the coasts and marine environment through comprehensive scientific understanding. From basic understanding to practical applications – the interdisciplinary research center covers a unique spectrum.

As part of an international network and as a member of the Helmholtz Association, the Hereon supports political, economic and societal institutions in shaping the future through the transfer of its expertise. Founded in 1956, the center is the largest non-university research institution in Schleswig-Holstein. In addition to its main location in Geesthacht and its site in Teltow near Berlin, the Hereon has branches in Hamburg, Kiel, Berlin and Garching bei München. The research center has an annual budget of approximately 100 million Euros.

2 Task 3.4: Industrial R&D staff re-connecting with State of the Art (SotA) science – Key Activities

The grant agreement of the Accelerate Project stipulates the following for the Task 3.4:

The RI partners (CERIC, ESS and HZG) will organize events for selected R&D staff for industrial companies of matching domains. These re-visiting events (1.5 days each) will comprise of these modules:

- Interactive excursions to RI's SotA instrumentation relevant in the focus domain of the event,
- Seminar with frontal presentations of cutting-edge research undertaken on those instruments including a discussion of the possible measurements relevant to industry.

The goal of the Task 3.4 was to support capacity building between Industry and Research Infrastructures through interactive, face-to-face exchanges and networking activities. The choice of researchers and scientists who are currently engaged with the private sector was to support capacity building activities, serving as the bridge between the worlds of research and industry.

As with most other activities, the onset of the COVID-19 pandemic has created challenges that needed to be circumvented in order to deliver the task and capture the value that was aimed with its formulation. As a result, the in-person interactions and networking events that were originally planned prior to the pandemic had to be replaced by webinars and online lectures instead.

2.1 Pre COVID Events

CERIC-ERIC seized the opportunity to enlarge the activities stipulated in the grant agreement, and potentially capture a wider audience than initially planned. Instead of 2 reconnecting events, CERIC-ERIC organized 8, expanding the reach of the project by 300%. Each event involved around 10-20 industrial PhD researchers. CERIC partner facilities' opportunities and techniques were presented, together with the ideas on how to maximize the relationship between RI and industry.

The seminars took place in Barcelona, under the International Business Build-up module organized by Consorci de Serveis Universitaris de Catalunya – CSUC. The first four seminars took place in 2018, while the latter four took place one year later.

The courses were planned in an interactive way: a presentation of CERIC, the facilities and techniques and research opportunities on material research and results and the different access modes. This presentation was made in order to raise interest about the facilities and the possibilities a researcher can have in collaborating with them. A practical /exercise part was developed where the researchers brainstorm good practices on creating a successful collaborating environment among research infrastructures and industry.

This particular format of the courses has been chosen due to the fact that the industrial PhD researchers are the ones that are developing their career in the industrial environment so as a result they were the right target audience with whom CERIC-ERIC wanted to raise the awareness about RIs, SotA instrumentation and possibilities of access. As industrial research managers and long-course researchers were already targeted by other type of events among other WP 3 tasks, the strategic focus on industrial young researchers was considered the more appropriate to insure a proper holistic strategy.

HEREON had planned to organize a "reconnecting event" initially, but this concept was quickly adapted into an academic course aimed predominately at BA students in order to build capacity for the future. Originally, the idea was to offer students theoretical and practical insight into the topics of residual stress analysis with synchrotron radiation. Students would have had an opportunity to learn about the world of Research Infrastructures, but also practice working on real synchrotron measurement data. Contact had been established with a professor from a German University, and a general consensus was reached on how to proceed.

The onset of COVID-19 pandemic combined with the departure of key personnel from HEREON involved in the planning of the event created numerous obstacles to its execution.

Firstly, the event was postponed numerous times, all in hope of eventually hosting it in person should the pandemic secede. This never happened. Secondly, the contact established with the German Professor was severely weakened by the departure of the principal organiser of the event, as well as a growing workload the professor in question was under due to the impact of the pandemic. Finally, repositioning the event to an online sphere proved to be a futile exercise since it did not allow students to engage in the practical element of the exercise.

Once it became clear that the event could not proceed as initially envisaged, HEREON tried to introduce a series of webinars on a topic of measurements of one of the most frequently used sample environments. However, due to such short notice, all of the HEREON staff who are working on the device in question were busy with user service or fixing severe unforeseen technical problems at HEREON instruments.
As a result of many unforeseen circumstances, exacerbated by the COVID-19 Pandemic, HEREON was unable to organize the Reconnecting Event as initially planned.

2.1.1 Outcomes

The events took place in Barcelona, under the International Business Build-up module organized by Consorci de Serveis Universitaris de Catalunya – CSUC, on the following dates:
On the 2018:

- 13th of April
- 1st of June
- 14th of September
- 5th of November

On the 2019:

- 31st of May
- 5th of July
- 27th of September
- 15th of November

Each course involved between 13 and 23 industrial PhD researchers each, the activity could reach 145 PhDs researchers that are developing their research with a company.
In the following table the number of participants for each seminar is presented

Date of the Seminar	Number of partcipants
13th April 2018	19
1st June 2018	18
14th September 2018	13
5th November 2018	12
31st May 2019	22
5th July 2019	23
27th September 2019	20
15th November 2019	16

Regarding the sectors targeted, according to the data received, as not all the data can be provided for confidentiality reasons by CSUC, the percentage distribution is presented in the following figure:

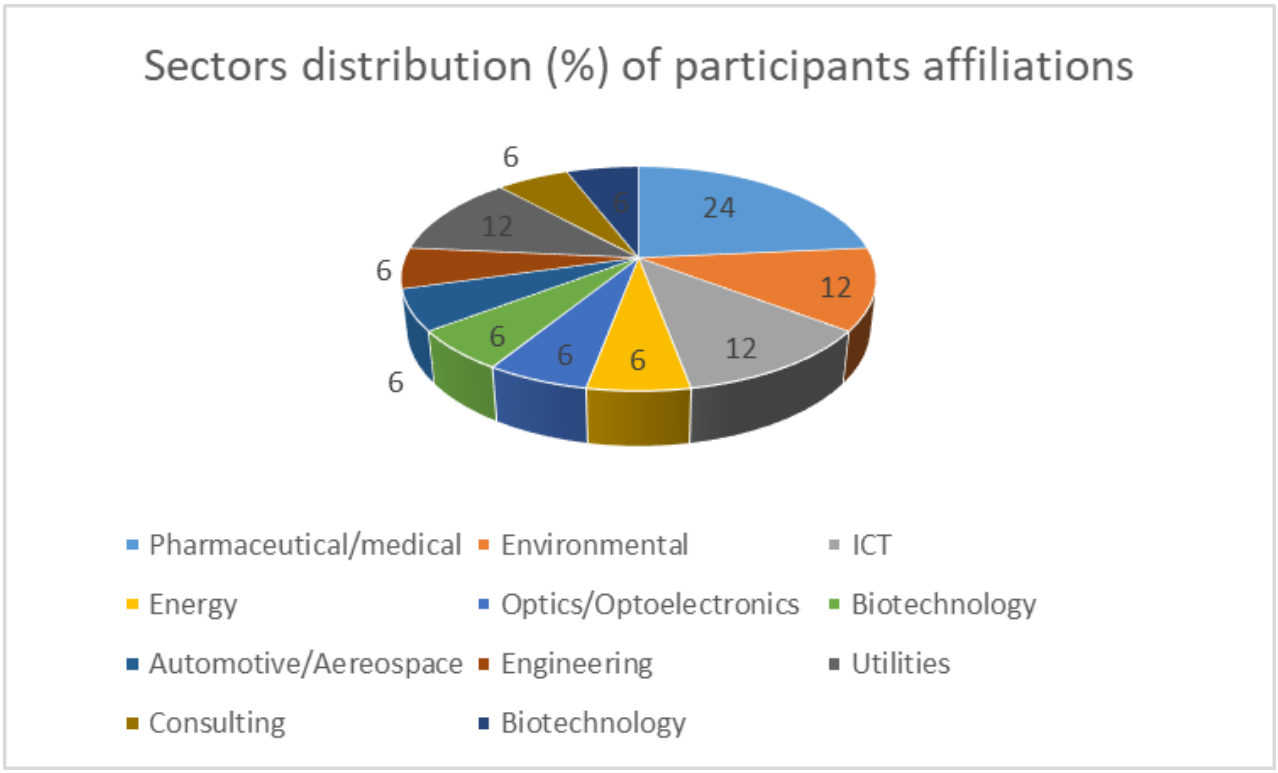

Fig. 1- Percentage of participants according to sectors

The diversification of sectors can be considered very positive, as one of the common issues for Research infrastructures is that their technical strengths are usually known as applicable by few sectors and most of researchers are not aware of the potential usage of RIs: participants, even knowing the kind of Research Infrastructures presented, did not know about the potential industrial applications of the SotA Techniques of CERIC neither the possibility of accessing them via Open Access or Commercial Access (the main procedures for accessing CERIC RIs).

2.2 Post COVID Events

ESS decided to organize a revisiting SoTA event in early Spring 2020. Since ESS has not yet become operational, it was impossible to reconnect with researchers who have been using the facility prior to their move to Industry. A reverse method has been planned instead, ESS was to reach out to Industrial R&D staff who might use the facility once it is operational in the future. A decision was made to primarily invite R&D Staff from regional industries. Some of these companies include, but are not limited to Novo Nordisk (Pharmaceuticals), ARLA (Food), Volvo (Car Manufacturing), and others.

The planned number of invitees was not to exceed 10, with ESS organizing front-facing speeches about instrument capabilities of the facility, coupled with a detailed tour of the Accelerator Tunnel (in construction) and the Instrument Hall (in construction). The initial plan was to invite the Industrial R&D Representatives only, with an exception for a potential invitation to an ecosystem cluster representative (Medicon Village Alliance / LINX), as well as a potential invitation to a MAX IV Industry Relations Officer.

Unfortunately, the plans have been grounded to a halt once the COVID-19 pandemic hit Europe in March 2020. It was difficult to assess what the extent of the pandemic measures would have been. The differences between approaches taken by different countries proved to be another obstacle in planning the event which was regional in its essence. Once the border between Denmark and Sweden closed, it became clear that the idea of postponing the event to a later date would have been infeasible.

As a result, ESS decided to evolve the event model into a series of Webinars. The Webinars were to take place in Autumn 2020, and were to offer the same front-facing lectures on the capabilities of ESS to deliver cutting-edge research potential to researchers around the world. The changed format of the lectures meant the following:

- The scope shifted from a single lecture and a tour of the facility to 4 separate webinars on 4 separate topics, each with a somewhat separate audience.
- The scope shift also meant that the audience invited could be much wider.
- The communication policy changed. It went from personal contact between ESS and Industrial R&D Staff to the use of official communication channels to identify and target various groups, including, but not limited to Industrial R&D Staff, current R&D Staff in other research facilities, PhD Students, Post-Docs, as well as generally interested public.
- The duration of webinars had to be adjusted. Instead of a single day filled with lectures, the Webinars were split between two-weeks periods, allowing the proper identification and communication plans to be put in place for each of the talks.

In total, four webinars took place. Their titles and synopsis, as well as the links to the publicly available recordings are available in annex 1 of this document. The activity was carried out in collaboration with CERIC that was involved in the shaping and organization of the events. CERIC wanted to improve some of its capabilities on how to present the potential of RIs to researchers that work or collaborate with industry.
It was tested how niche content, instead of a larger general presentation of a whole infrastructure, makes possible warm leads because attendees who tune in are genuinely interested, as experienced in the development of Research to Business events related to Taks 3.2.

CERIC worked together with ESS also to understand better how to relate webinars presenting different solutions offered by a Neutron facility, in order to create a series facing different topics but with a common thread. The first webinar was more focused on an overview on why studying materials with neutrons and what types of measurements are possible. This first webinar served

to attract those researchers less familiar with Neutron research facility in order they can profit and be attracted to follow the next webinars that were more specific. Meanwhile, researchers with a better knowledge of such type of Research Infrastructures could directly benefit from the more specific content of the last three webinars. The last three webinars were chosen to highlight the potential of Neutrons techniques in industry fields of interest for CERIC: Pharmaceutical, Food and Packaging, and Engineering applied to fuel cells and batteries too.

2.2.1 Outcomes

The four webinars had different levels of attendance. This can be attributed to the scope of the topics presented. As a result, the first webinar, which served as the introduction to the series, but also to the use of Neutron Methods at ESS drew the largest audience of some 41 people. Interestingly, several participants to the first webinar were internal ESS staff members. Their feedback was very positive, and each of them remarked that webinars like this are extremely useful to showcase the amazing scientific potential of the facility to general population, including ESS non-scientific Staff. This is a perfect example of a HORIZON 2020 Project benefits trickle-down effect in practice.

The other three webinars also attracted a varied crowd, albeit a bit more focused given the topics discussed. Still, in total, the webinars attracted 81 unique participants, from more than 19 countries, working in more than 20 companies/scientific institutes. The detail on the online outreach will be included in the D6.5 Communication management.

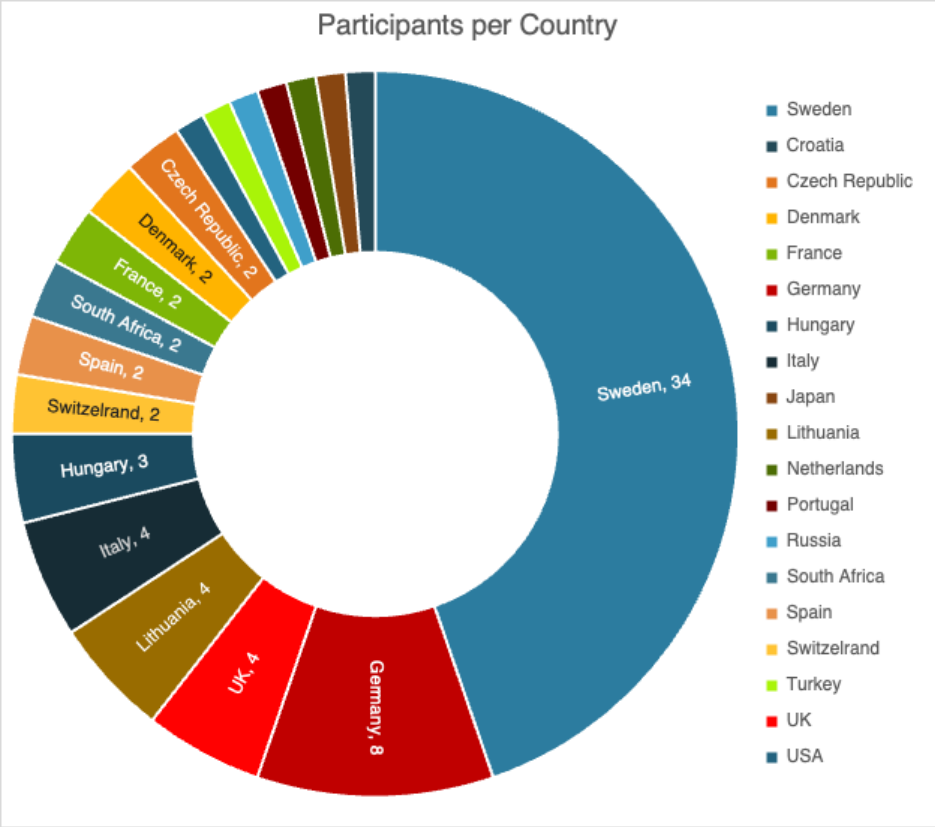

Figure 2-Participants per country

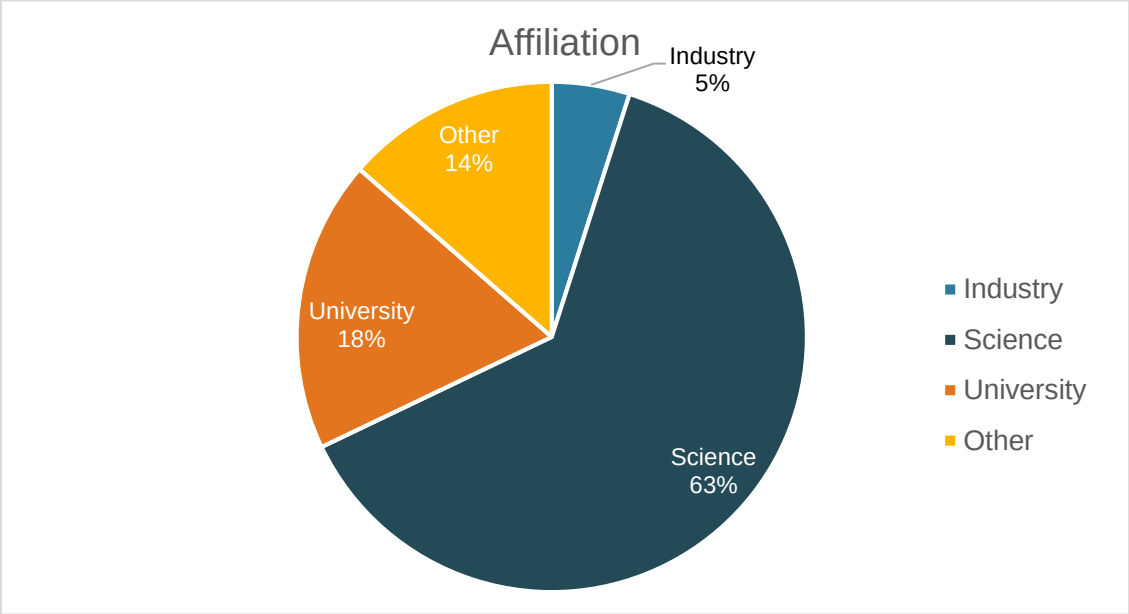

Figure 3 – Affiliation Breakdown

3 Lessons learned

Both the pre-pandemic and post-pandemic events showed a clear pattern in industry to research interactions. There is a systematic need for a more intense engagement between researchers in industry and researchers in scientific labs and Research Infrastructures. Apart from this general remark, there are three key takeaways that are interconnected.

- The public, and with it the Industry is often not aware of the capabilities that the Research Infrastructures possess. This leads to many missed opportunities, since tighter collaboration between Industry and Research Infrastructures could lead to increased use of Research Infrastructures capacity, more advanced research, and increased innovation potential in Europe.
- The Industry as well as the Research sector seem to have problems communicating with one another in a pertinent way. There seems to be a silo effect which is further exacerbated by European Academic cultural norms which are often very critical of any for-profit activities. As a result, researchers in Research Infrastructures do not engage with their industrial peers so often (and vice-versa), which in turn diminishes remarkable potential for growth and innovation.
- Both sectors need to be better in advertising to the public why the work they are doing is important. This communication needs to be clear, understandable, and approachable on all levels.

4 Key Takeaways

The key takeaway from all of the events organized is that both the researchers from Industry, as well as those from the Research sector itself very much welcome the increased interactions between one another. As mentioned in the previous section, the silo effect that exists in both branches presents an obstacle to an increased collaboration that can be very fruitful for both the Industry and the Research Sector in the long run.

As a result, it is important to put continuous, extended effort into bridging the activities of the two sectors through increased interaction and networking opportunities, not only at a management and commercial level (that was tackled by the activity of task 3.2 of Accelerate project) but also via a bottom-up approach continuously targeting the young researchers that works in an industrial environment or in projects collaborating with industry. Concretely, the European Research Community and Industry should put a special emphasis in joining activities for researchers such as:

- Webinars and face-to-face presentations where capabilities will be presented, tested, and verified.
- Field Excursions and Lab Visits
- Increased mobility of Research Staff between the two branches
- Increased availability of Research Facilities to Industry from a bottom-up approach
- Collaboration on bleeding edge technological and research developments through Horizon Europe and other funding streams

Another thought to consider is stronger involvement of regional and local actors in bridging the gap between Industry and the Research Facilities. Regional and Local governments are excellently positioned to support the strengthening of the relationships through investments into cluster ecosystems, regional development events, and public showcases of the benefits or collaboration between the two sectors. This was the case of the seminars conducted by CERIC in collaboration with a local government, and CERIC will pursue this strategy in the future trying to involve regional and local administrations in similar activities. Only through committed engagement by the politicians and other decision makers can the Researchers from both ends really harvest the immense potential made available to them.

5 Annex 1: Webinar Descriptions

1st webinar: Neutrons: A Natural Tool for Industrial Research

Date and time: 15 October 2020 at 15:00 (CET)
Speaker: Dr. Andrew Jackson, Acting Head Neutron Instruments Division, Group Leader Instrument Scientists (European Spallation Source)

Overview
Neutron beams are highly penetrating, non-destructive, and sensitive to light elements and magnetic structures. As such neutron scattering, imaging and spectroscopy form a family of methods that provide unique insight into structure, dynamics and kinetics from the atomic to macroscopic scale.

Whilst neutrons have played a key role in many fields of academic research, the special characteristics of neutrons, and the maturity of many of the techniques, lend themselves to application in industrial R&D. Neutron methods have been successfully employed in areas ranging from formulations and personal care products, through to understanding strains in aircraft wings.

This talk gave an overview of why we choose to study materials with neutrons, how we generate neutron beams, and what types of measurements are possible. Examples of applications from a broad spectrum of industrial research will be presented, with a view to both giving an opportunity for discussion and as an introduction to the rest of the seminars in the series.

2nd webinar: Nanoscale to Microscale Structural Analysis with Neutrons

Date and time: 4 November 2020 at 15:00 (CET)
Speaker: Dr. Judith Houston, Instrument Scientist for LoKI (European Spallation Source)

Overview
The interactions and assembly behaviour of a product's components in the nano-range, such as the colloidal building blocks in milk, or the polymer chains in plastic thin film coverings, determine not only the structure of the material at the nanoscale, but also directly influence that materials' structure, rheology and functional properties at the macroscopic scale. Therefore, when designing new products, such as food, drug formulations or packaging, it is increasingly important to understand the relationship between the structural and functional properties of that material's constituent components.

Small-angle neutron scattering (SANS) is an ideal technique to help us unravel complex soft matter structures on the 1-500 nm scale. The specific properties of neutrons, such as their capability to distinguish light elements and their isotopes (e.g. ^{1}H (hydrogen) and ^{2}H (deuterium)), or their negligible absorption, make them particularly useful in the field of soft matter. Firstly, by selectively deuterating components of a complex material, we can create contrast in an otherwise homogenous system without altering its physical-chemical properties. Such components can then be rendered effectively invisible in the measured scattering data when combined with judicious selection of the solvent. Therefore, this method of contrast-variation enables full structural characterisation of not only the global structure, but also its constituent components and their interaction, which cannot be obtained by light or x-ray scattering. In addition, the comparatively weak interaction between neutrons and matter, enables them to penetrate most materials. As a result, we can design relatively complex sample environments for *in situ* studies with neutrons. This has powerful implications for studying the evolution of nanoscale structures in industrial processes, without the need for overly simplified model set-ups. Finally, their non-invasive nature makes neutron perfect to study bio-relevant material without radiation damage.

This talk included numerous examples from the literature aiming to highlight the versatility of neutron scattering for industrial applications, from understanding the structure of food or packaging to demonstrating the flexibility of neutrons to study processing techniques.

3rd webinar:
Neutron protein crystallography reveals molecular details of inhibitor binding to clinical targets.

Date and time: 11 November 2020 at 15:00 (CET)
Speaker: Dr. Zöe Fisher, Group Leader Deuteration and Macromolecular Crystallisation (European Spallation Source)

Ligand binding to proteins are mediated through numerous interactions. These can include direct hydrogen bonds, water-mediated interactions, electrostatics, metal coordination, energetic changes through water displacement, aromatic ring stacking, and hydrophobic interactions.

Using X-ray crystallography as a tool for the study of protein: ligand complexes is a powerful and high throughput approach, but cannot elucidate many of the atomic details of the types of interactions involved. Neutrons can fill this knowledge gap as they have unique properties that enable us to determine the location of light atoms [^{1}H (Hydrogen), and its isotope ^{2}H (Deuterium)]. By extension then it is possible to observe hydrogen bonds and infer electrostatics based on presence or absence of a hydrogen atoms on the protein but also the ligand. This can inform the researcher on the charged state of a ligand, the involvement of water molecules, and the charged state of amino acid side chains involved in binding.

Combining the unique information from neutron crystallography with high resolution X-ray crystallography, it is then possible to obtain a complete and accurate view of the interactions that drive ligand binding. This talk included examples from the literature on where this strategy was employed to investigate novel compounds binding to a cancer metastasis marker, and clinically used protease inhibitors to HIV protease.

4th webinar:
Non-destructive testing with neutrons: Revealing (micro-) structural properties and providing unique contrast inside large samples and assembled components

Date and time: 28th November 2020 at 15:00 (CET)
Speaker: Dr. Robin Woracek, Instrument Class Coordinator for Imaging and Engineering, Instrument Scientist for Test Beamlines and Engineering (European Spallation Source)

Overview

While neutron based material characterization tools may seem exotic, they have much in common with more widely available microscopy techniques or x-ray based diffraction and computed tomography methods. Due to the high penetration power of neutrons into most materials and the unique contrast they provide, they complement the more standard tools and moreover, are invaluable for in situ and in operando investigations.

Large-scale neutron infrastructure methodology has played key roles in the innovation of engineering systems and provided insights about materials and processes that enable developments of novel and improved products. Thanks to the high contrast for elements like Hydrogen and Lithium, neutron imaging and diffraction has been used to optimize the fuel cell technology that will power our cars tomorrow, to gain insight into the operation of batteries, as well as to reveal corrosion in airplane components. The high penetration power allows probing deep inside of metallic alloys to study phase transitions, determining internal residual stresses or crystallographic texture, hence significantly expanding what can be done using electrons or x-rays.

This presentation summarized the most important neutron characterization tools for the study of engineering materials and components, and beyond that aimed to spark ideas on how neutrons can help to solve open questions and problems that currently exist in your industry.

6 Annex 2: Webinar VIMEO Links

https://vimeo.com/470545736 - 'Neutrons-A Natural Tool for Industrial Research'
https://vimeo.com/475902128 - 'Nanoscale to Microscale Structural Analysis with Neutrons'
https://vimeo.com/478953240 - 'Neutron protein crystallography reveals molecular details of inhibitor binding to clinical targets'

https://vimeo.com/511618139 - ‘Non-Destructive Testing with Neutrons: Revealing micro structural properties and providing unique contrast inside large samples and assembled components.’