2019 Activity Report

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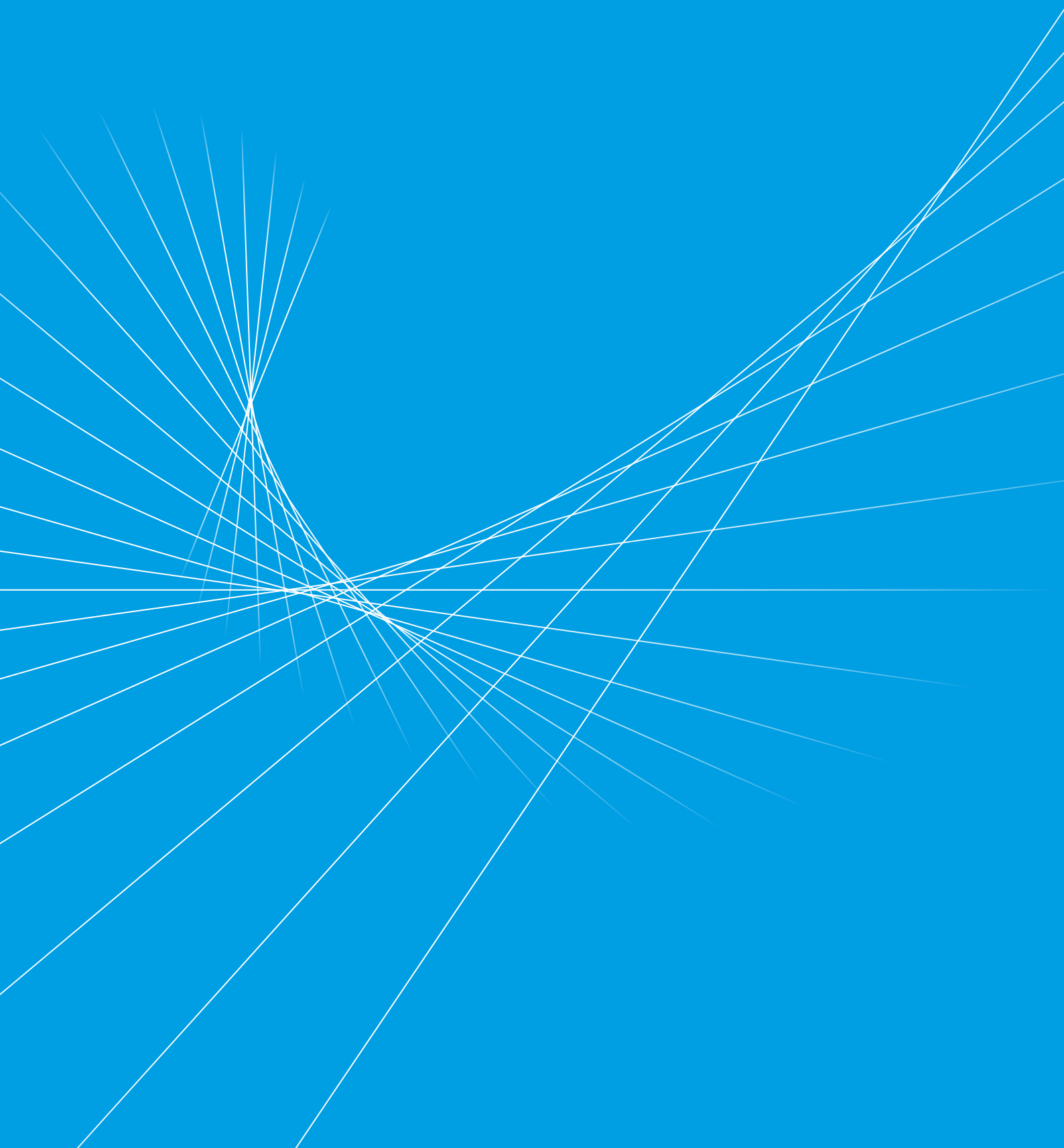
Content



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Were you there, glued to your TV set, in 1969, to see a human first set foot on the moon? Or were you there in 2019, as the world gathered again to celebrate the 50th anniversary – not of one man's small step, but of one of the greatest collective efforts ever under-taken? During a year when we at ESS transitioned towards increasingly integrated efforts, that anniversary was a vivid reminder that we can achieve world-changing things by working together as a team.

First Science in 2023 is our next big goal at ESS. Perhaps not as epic as putting the first human on the moon, but a challenging goal that takes an extraordinary team effort. Without most of us even realising it, ESS's culture naturally shifted in 2019: people now see more clearly how their own individual efforts contribute to the whole. With components arriving on site and buildings handed over with increasing speed, we see the vast jigsaw puzzle coming together before our eyes.

Integrating the whole

To transition from a focus on design to one on installation and integration, we completed an organisational restructuring in 2019 – building up new teams with responsibility for integration and commissioning, to test each component step by step and move us towards a complete, working ESS.

In this integration stage, we've made great strides with installation work in a much larger number of buildings across the site.

by the Director General

Natural transition towards First Science

We inaugurated the Long Instrument Hall – its huge scale a reminder of the sheer size of the scientific instruments that will be here at ESS. Installation also began on the first pieces of the target where neutrons will be generated, and the first section of the particle accelerator is now working at the level we require for ESS.

The only constant is change

Of course, when you're delivering something totally new, it's no surprise to be surprised. Our biggest challenges are the unforeseen, which is why we need to be agile as an organisation – able to redeploy our resources and adjust our thinking as we go.

We've set aside money in our planning to deal with unforeseen challenges and we'll continue to adjust our organisational mix, with another transition again as we approach operations. We expect to be changing for decades, and there's a great deal of enthusiasm and commitment here, as people continue to step up to the task. We know a scientific facility that's not changing is one that's no longer delivering innovative science. Change is a measure of success here.

Changing the way science is done

Yet, it's not simply operational change we need. We hope to change the way science is done – both with the dramatically new capabilities ESS offers and also with what we offer for scientific data. Having recently inaugurated our Data Centre in Copenhagen, we'll be the first facility of our kind that's built from the ground up to make the data from all experiments publicly available after it's used by the scientists who experiment here.

Traditionally, the output of a scientific facility is publications – journal articles that capture the results. ESS scientists will continue this, of course, but we'll also produce petabytes of raw data from our instruments that can be reanalysed and reused by others as the basis of new experiments.

Instead of publishing, which is the legacy of Gutenberg and the printing press, it's more like the legacy of Berners-Lee and the World Wide Web – making all information available so that any scientists, even those who've never been to ESS, can make world-changing breakthroughs with the data.

Application and industry-driven science

At ESS, we want to give every opportunity to enable not only Nobel prize-winning impacts in fundamental research, but also society-changing breakthroughs that can come to application quickly. Industrial users can also take advantage of ESS in new ways, as we'll have the opportunity here to put test-scale industrial equipment into the neutron beams and observe not just very small samples, but whole working systems where a battery is discharged or where a chemical reaction takes place over days. Those kinds of things may not end up published in a scientific paper, but may find their way into your house, car or other areas where industrial research can benefit people and the planet.

The journey starts with First Science

Just like the Apollo programme was only the start of decades more space exploration, we know that delivering science to European users beginning in 2023 is just the start of a much bigger journey.

Yet how can anyone guarantee success for something that's never been done? I believe it's through one well-planned and well-executed step at a time. We have 36,000 steps already planned for our journey in our detailed schedule plan, and what's driving us all forward is that First Science achievement. I'm confident that the commitment, enthusiasm and skill of our staff, partners and suppliers is our success. Everyone who is here has chosen to come here, and all our sights are set now on delivering First Science. 2019 was a key transition year towards that goal, and our organisation is ready.

W. J. Womersley

JOHN WOMERSLEY
ESS DIRECTOR GENERAL

The world rushes to find more sustainable ways forward, focusing on circular solutions. Circular economy features strongly in the European Green Deal, and major actors are stepping up to contribute across sectors, including Tetra Pak – global leader in food processing and packaging solutions. Having worked with these challenges already for years, Tetra Pak sees the trifecta of industry, academia and large-scale research infrastructure such as ESS to be a powerful collaborative force to help solve sustainability challenges.

“We have a phrase we use in Tetra Pak from our founder that a package should save more than it costs,” shares Eva Gustavsson, Vice President D&E Materials & Package at Tetra Pak. “This has served us well over the years and continues to do so as circular economy has become one of the most important challenges to solve in the world right now.”

In contrast to the traditional make-use-dispose model of a linear economy, a circular economy aims to extend the life of what’s already made and prioritise renewable and reusable resources in new products, as well as enable more sharing and repair to sustain a healthy loop. For their packaging, Tetra Pak works according to four innovation objectives:

1. Sustainable openings
2. Renewable materials
3. Promote recycling
4. Recycled content

“This is quite a big challenge,” explains Gustavsson, “because our packages should protect the nutritional value and quality of the food for several months in ambient temperature. Our vision is to make food safe and available everywhere, and that comes with high demands on barriers, for example. We need to transform some of our materials into new ones, still providing all these values to keep food safe.”

Collaboration is key for circular economy

Tetra Pak works cross-functionally from an early stage with internal competence networks where specialists share knowledge and create joint value. The company also has ongoing relationships with a number of universities and research facilities and is now looking forward to expanding that collaboration with ESS.

“We believe, and it’s a shared view among other external stakeholders, that collaboration between companies, universities and facilities like ESS is powerful,” says Mats Qvarford, Strategic Partnership Manager at Tetra Pak responsible for external partnerships within D&E Materials & Package. “We need to share challenges and work in parallel, where we as an industry stand for the application, universities provide the foundational research, and ESS offers the opportunities with neutrons, for example.”

ESS recently had the opportunity to present at Tetra Pak’s joint seminar series with Lund University, called Science and Innovation Talks. The popularity of these seminars through the years is a clear reflection of the eagerness to learn and collaborate across disciplines, and attendees expressed a growing interest for what can be done with neutrons after ESS’s presentation.

MATS QVARFORD
STRATEGIC PARTNERSHIP MANAGER
AT TETRA PAK

"The reason our seminars are booked so quickly is because learning is energising," says Gustavsson, "and both learning and energy are vital for the value we need to deliver. Early collaboration in research to fully understand phenomena and alternatives adds speed in development, ensures higher accuracy, and means shorter time to market."

New ways to characterise materials with ESS

The types of advanced characterisation methods that ESS will offer can be of value early in the development process for companies when there are a lot of uncertainties and a need to explore properties and behaviours of new materials.

"One of the keys to innovating and solving challenges fast is being able to characterise the materials and processes," says Gustavsson. "For example, with new barrier materials, we need to create new sealing processes. To study how these materials behave and interact during the forming and sealing processes are good examples of how we can really benefit from ESS and what can be studied there."

"What we find very appealing with ESS is that there are opportunities to see light elements inside metals, polymers or cellulous fibres, for instance, which can add to our existing work with x-ray methods," explains Qvarford. "Also, characterising while things are moving – in operandi – could open up new opportunities for us to study what happens in manufacturing processes. For example, what happens in our filling machines when we do polymer welding to make our packages tight, moulding of caps and closures, etc. We need to understand even better how it works with today's materials and how we can optimise new sustainable materials for the future.

"This characterisation power of ESS is also highly relevant to study food inside our food production equipment during process steps such as mixing, heat treatment, and homogenisation," continues Qvarford. "This will support food technology and application developments, such as those related to plant-based beverages and new protein sources."

Interpreting the knowledge gap

Yet, it's important to recognise that there is a knowledge gap in industry when it comes to understanding ways to use neutrons and the instruments available at ESS. "X-ray methods, for example, are well established and many within industry have some ideas how to use them for their applications, but fewer people have experience with neutron research," notes Qvarford.

"Asking us 'What do you want to do?' would simply not work," says Gustavsson. "Our expertise is around applications. It's not so easy in the case of such a complicated area as neutron-based research for us to understand both the fundamental research and all the new opportunities with ESS. Therefore, we need to work in a new way. To conclude what we can actually do, we need help to bridge the gap between the deep understanding of neutrons and the application knowledge. We need an interpreter."

Industry partnership for a brighter future

The importance for ESS to engage in new kinds of collaboration with industry and academia towards goals such as circular economy is clear – both in supporting specific applications and in educating on neutron findings for innovation needs applicable across industry sectors.

"We believe many more actors will now gather around the vision of fully renewable, fully recyclable, and increased use of recycled content, not just in the packaging industry but in other areas such as textiles," affirms Gustavsson. "So there is an opportunity to build more knowledge within these areas among non-competing actors, where academia and ESS could play a role in understanding those phenomena."

Qvarford represents Tetra Pak on the board of Treesearch, for example – Sweden's largest research collaboration platform in the field of new sustainable materials from forest resources – where industrial partners from all across the forest sector in Sweden participate. Tetra Pak is also a member of LINX (Linking Industry to Neutrons & X-rays) in Denmark.

"The key for achieving success through collaborations is to be open and understand each other's challenges and expertise," says Gustavsson. "That's when knowledge meets knowledge and becomes not just doubled but tripled. What we hope to gain from ESS is help in building the fundamental understanding of material properties and food processes for developing our new sustainable solutions. We want to build knowledge that contributes to a better society. We do that by developing sustainable solutions that protect food to make it safe for people while meeting changing demands, trends, and needs from consumers and society."

"With beam on target, everything changes: a cascade is coming."

ANDREAS SCHREYER
DIRECTOR FOR SCIENCE, ESS

Preparing to test drive ESS

What's the first thing you do when you buy a new car? The test drive. First, you take it to a road you already know to feel how the car performs. Then, once you've figured out its new capabilities, you take it down new roads. It's the first test drive of the ESS facility that the organisation is gearing up for now, as 2019 began the transition from design and blueprints to fully functioning machine.

First Science in 2023 is the next momentous goal everyone at ESS is working towards. Yet, it's important to understand "First Science" on the bigger timeline, including all the science "firsts" it takes to get there.

"In simplest terms," explains Prof. Andreas Schreyer, Director for Science at ESS, "First Science happens during the commissioning of instruments. Part of commissioning the instruments is testing and doing the first demonstration experiments to show that we get good data using samples compared with those measured in existing facilities. Only after that do we begin first experiments on samples which have not been measured elsewhere. We need to be sure that everything runs reliably with no bugs when we get to the science user stage."

Reality set in during 2019

The reality of that impending test drive set in during 2019 with the handover and inauguration of the first instrument hall. The 140-metre wide and 13-metre high Long Instrument Hall will house eight instruments that will completely fill the building. With this and the next instrument hall becoming available later in 2020, as well as instrument components beginning to arrive for installation, ESS is beginning preparations to commission the first instruments.

The first instruments are chosen to be relatively familiar and easy to get up to speed with right away. As Prof. Schreyer shares, "ESS must be a place people know they can come and get their data quickly and efficiently so new discoveries can be made. Excellence in science is to have the brightest ideas, gather the brightest team, and be first to come up with the explanation for some challenge or phenomenon to drive your field forward. As we move from a construction project to an operating science facility, we must work hard to generate such an environment."

Within the commissioning plan, ESS has anticipated risks so that if one instrument is delayed, the next is on deck so the organisation can adjust to get back on schedule relatively quickly. A user office function also started up in 2019 to ensure that ESS has everything in place to receive proposals, conduct external expert review, and select the first experiments.

First hints of science

Yet while preparing for First Science, there's already science happening at ESS. The ESS Deuteration and Macromolecular Crystallisation lab (DEMAX) began initial operations in 2019 to gradually establish a system that runs smoothly in time for the First Science milestone. The service provides unique samples only a few institutes in the world can do. The complex process exchanges hydrogen atoms with deuterium, which interacts with the neutrons to mark certain parts of the molecule and is widely used in neutron research within life sciences and with soft matter. Such samples are specifically tailored for use with the first instruments coming online at ESS, and are being measured at other facilities now as a dry run.

Towards the tipping point

The organisational readiness initiative during 2019 was a key step in transitioning ESS from design and construction to a scientific outfit as we rapidly approach the tipping point for First Science – the moment the first proton beam hits the target in 2022.

"Once we have beam on target," says Prof. Schreyer, "the cascade of activities will be quite fast. About nine months after that, we expect First Science, and another nine months after that, we start user operations. So beam on target is when everything changes, because that's when people will expect data and results. And it's only two-and-a-half years away."

By that time, ESS will have the first instruments ready to take the beam – what's called "hot commissioning" – and begin safety checks, first experiments, etc.

Together for a brighter future

Anticipation picked up across the whole neutron community in 2019. With a neutron gap inevitable after the decommissioning of three older, reactor-based sources in Germany, France, and Norway, the League of Advanced Neutron Sources (LENS) kicked off activities to promote collaboration on neutron usage, advocate for the user community, and strengthen European neutron science.

Prof. Schreyer is helping lead the LENS development of a key landscape paper to define a vision and collaboration for strengthening European neutron science, as well as kicking off other practical collaborations such as a joint science colloquium with MAX IV.

"Our joint programmes are very well attended," he shares, "and there's an eagerness to develop more together. With the EU changing its science focus to more mission-based priorities, the whole science community needs to rearrange itself. As neutron sources, we must show how we can collaborate on a high level, providing key contributions to society not possible otherwise. Our excitement for that future is building right along with the ESS facility."

Top highlights of 2019

1 In a ceremony including in-kind partners from around the world, Skanska handed over the Long Instrument Hall, or E Hall, which will house eight instruments – more than 160 metres long – specialised to support a range of research areas, such as biological molecules, fuel cells, battery research, and new computing materials.

2 The League of European Neutron Sources (LENS) officially got underway in March 2019 to support and strengthen European neutron science by creating an effective, collaborating eco-system of neutron facilities.

3 The Deuteration and Macromolecular Crystallisation lab (DEMAX), which supports neutron users in soft matter, biology, life sciences and chemistry research, entered initial operations and has already accepted proposals and begun practicing procedures in preparation for First Science.

Award-winning innovation

Innovation is at the very core of the ESS project, from the way the buildings are designed to the science the state-of-the-art instruments will facilitate. In November 2019 this innovation was recognised, as ESS was awarded first prize in the 'Building Design, Large Projects' category in the international AEC Excellence Awards.

The event was held in Las Vegas, USA, and is a celebration of innovation and excellence in the fields of architecture, engineering and construction. Judges look at a number of factors, including infrastructure design, building design and overall construction, as well as aspects like sustainability, complexity and use of emerging technology. Winning first prize in this prestigious competition is an achievement to be proud of for all of the parties involved in the ESS project.

ESS is one of the largest scientific and technological infrastructure projects being built today, and the design, planning and project management are the results of a successful collaboration between Skanska and Sweco Architects, ÅF Pöyry (now AFRY). When it's complete and operational, which is expected to be in 2023, it will be the most modern and sustainable science facility of its kind in the world.

"ESS is a fantastic project with many very competent employees and as BIM Lead, I am very proud of what my group has managed to achieve," says Martin Hörestrand, Skanska's digital leader at ESS. "It is also fun that a construction project in Sweden holds world class. A big thank you to everyone who has been involved in BIM and the design work during these years"

ESS Council names new Chair and Vice Chair

At the 15th ESS Council meeting, Dr. Beatrix Vierkorn-Rudolph and Prof. Dr. Kurt Clausen were elected as the new Chair and Vice Chair of the ESS Council. Dr. Vierkorn-Rudolph had served as Vice Chair of the ESS Council for two years before being elected as Chair, and prior to that was one of the German delegates since the foundation of the European Spallation Source ERIC.

Dr. Klausen recently retired from a long career in scientific facilities, and is now Professor Emeritus at Danish Technological University. He has been involved with the ESS project since 1993, and participated in many of the early proposals for the facility.

Both Dr. Klausen and Dr. Vierkorn-Rudolph have a wealth of experience in this field, and have long been attached in some way to the ESS project. Their appointments will help ensure that everything remains on schedule and set for success.

Following the new appointments, the ESS Council also concluded that the project was progressing well as they discussed the thoughtful recommendations from the 2018 annual review. More than 20 international experts were brought to Lund to assess the progress so far, and they were also able to offer valuable advice on the coming phases and associated challenges.

Stepping towards the green light

Being first is always a challenge, especially when it comes to building pioneering scientific research facilities with capabilities beyond anything seen before. This challenge only increases when the facility in question is being built entirely from scratch, and this only begins to cover the complexity of the ESS project.

It's one of the biggest infrastructure projects in Europe, involving 13 member countries as well as a number of organisations and institutions contributing in different ways. The nature and complexity of the project means that regulatory activities are essential, as it's important to ensure that everything is as safe, secure and sustainable as possible.

The Swedish Radiation Safety Authority (SSM) are the body which specify the requirements and grant licenses as proof of these considerations, so everything needs to comply with their standards.

SSM supervises a vast array of activities in a wide range of areas, from magnetic fields around power lines to radiation in health. ESS will be regulated as a 'complex non-nuclear facility', which means an incremental licensing process is applied, with the first application from ESS being submitted as early as 2012. The review process is then carried out in several steps, and is a continuous activity until ESS is complete. When it is complete, SSM can grant the permission to begin routine operation.

"ESS has a regular and constructive dialogue with the Swedish Radiation Safety Authority," says Ralf Trant, Associate Director, Environment, Safety, Health & Quality at ESS. "Progress is good and proceeding according to plan, with the last of three complementary submissions, which were requested by SSM, submitted in December 2019. This means they can continue their in-depth review."

ESS Scientist Melissa Sharp part of the team to be awarded prestigious grant

Melissa Sharp is not only an Instrument Scientist at ESS, she is also a member of an international research team which is investigating the cell biology of photosynthetic cyanobacteria and algae, and how these organisms can be used to produce industrial chemicals. This team, led by David Lea-Smith, will receive the USD 1.2 million over three years from the prestigious Human Frontier Science Program (HFSP).

The HFSP research grants support innovative basic research into fundamental biological problems, and it tends to look for novel and interdisciplinary approaches. The research area of the team, combined with the fact that they're spread across the world, contributed to them being awarded this grant.

Alongside Melissa and David, the team includes Oscar Ces, Professor in Chemistry at Imperial College London and Jane Allison, Associate Professor at the University of Auckland. The grant will be shared between them all, as they use their expertise to investigate the cellular role of hydrocarbons produced by cyanobacteria and some algal species. This information could also contribute to a better understanding of how to use microbes for biofuel production and how to use them for oil spill clean-up, which could have a real positive impact on the environment in the years to come.

Packed with knowledge

MARK REICHANADTER
FORMER PROJECT MANAGER, LCLS II PROJECT AT SLAC NATIONAL ACCELERATOR LABORATORY, STANFORD UNIVERSITY, USA
CHAIR ESS PROJECT ADVISORY COMMITTEE

Large science facilities like ESS are huge, complex projects which take the dedication of hundreds, if not thousands of people to complete. ESS is also unique in many ways as there are two host countries and a large number of in-kind contributors involved. To keep the project on track, the ESS Council has appointed an external Project Advisory Committee, or PAC, dedicated to offering constructive advice and recommendations based upon experience from other facilities.

With any project, it always helps to get an external perspective from experts who have built similar facilities. Getting a view from the outside often leads to new insights, new ways of thinking and, ultimately, new solutions to challenges.

The ESS Council recognises this and has formed various advisory committees, made up from experts in their respective fields, for different aspects of the ESS project. One of these crucial committees is the PAC.

"The role of the PAC is advisory," says Mark Reichanadter, chair of the PAC. "The PAC membership has extensive experience in construction and operations of large science facilities in both Europe and the US, and we do our best to bring that into the ESS project in a positive way. We focus on the construction phase and the transition into an operating neutron science facility, and between us we have experience from similar facilities like DESY, Brookhaven and CERN."

The PAC was formed at the beginning of 2019, with the primary goal of offering advice and guidance on the ESS management team's execution plans, and how to keep the project as close to its schedule as possible. The committee and the ESS Council have an open, transparent dialogue, and meet three times each year.

The PAC also serves as an independent audit or assurance to the Council, which is especially useful for a big, complex project like ESS. The Council can ask the

PAC to look at specific areas where it feels more focus is required, and the PAC can provide its independent observations and recommendations for improvement. The key to the relationship is open and candid discussion of the issues between the ESS management team and the PAC.

Unique challenges

ESS is one of many large scientific facilities constructed around the world, so there are many lessons to be learned from both the failures and successes of those that have been built before. However, it's not only the fact that ESS will be the most powerful neutron research facility in the world that makes it unique.

"ESS isn't affiliated with a large (host) institution, like the Large Hadron Collider (LHC) is affiliate with CERN, for example," explains Mark. "so ESS doesn't have existing support structure and processes to rely on – everything is being built from scratch in what is sometimes called a "greenfield" project. This presents many new challenges, as it's not only the construction and laboratory projects that you need to consider, but everything that goes with running a facility. Financial, HR and Legal policies need to be established, and in addition, ESS relies heavily on in-kind contributions from its many European partners."

The in-kind contributions and partnerships were the first area of focus for the PAC, as so much of the project relies on these deliveries being made in a timely, efficient way. In-kind deliveries come from all over the world and can account for anything from specific parts to entire instruments, so effective management and coordination is critical.

"ESS is a European partnership, and relies heavily on its in-kind contributions," adds Mark. "My experience from working with the LHC construction taught me the importance of effectively coordinating these contributions. ESS management must be very active and visit sites regularly to make sure everything is going as planned. There must be a lot of interaction between ESS and the in-kind partner. The ESS team was already doing this, but the PAC recommended more emphasis on in-kind following our first meetings."

As a result of these initial meetings, the PAC also recommended that ESS focus more on the construction side of the project, and staying to the planned schedule. This was primarily because schedule delays can be extremely costly.

"Construction projects like ESS are huge investments," says Mark. "Because delays can be so costly, we made significant recommendations to recognise and prioritise the ESS construction work leading up to First Science (neutrons on the ESS Target and Instruments). These recommendations were accepted by the ESS Council, and we have seen great progress since, with many buildings being turned over."

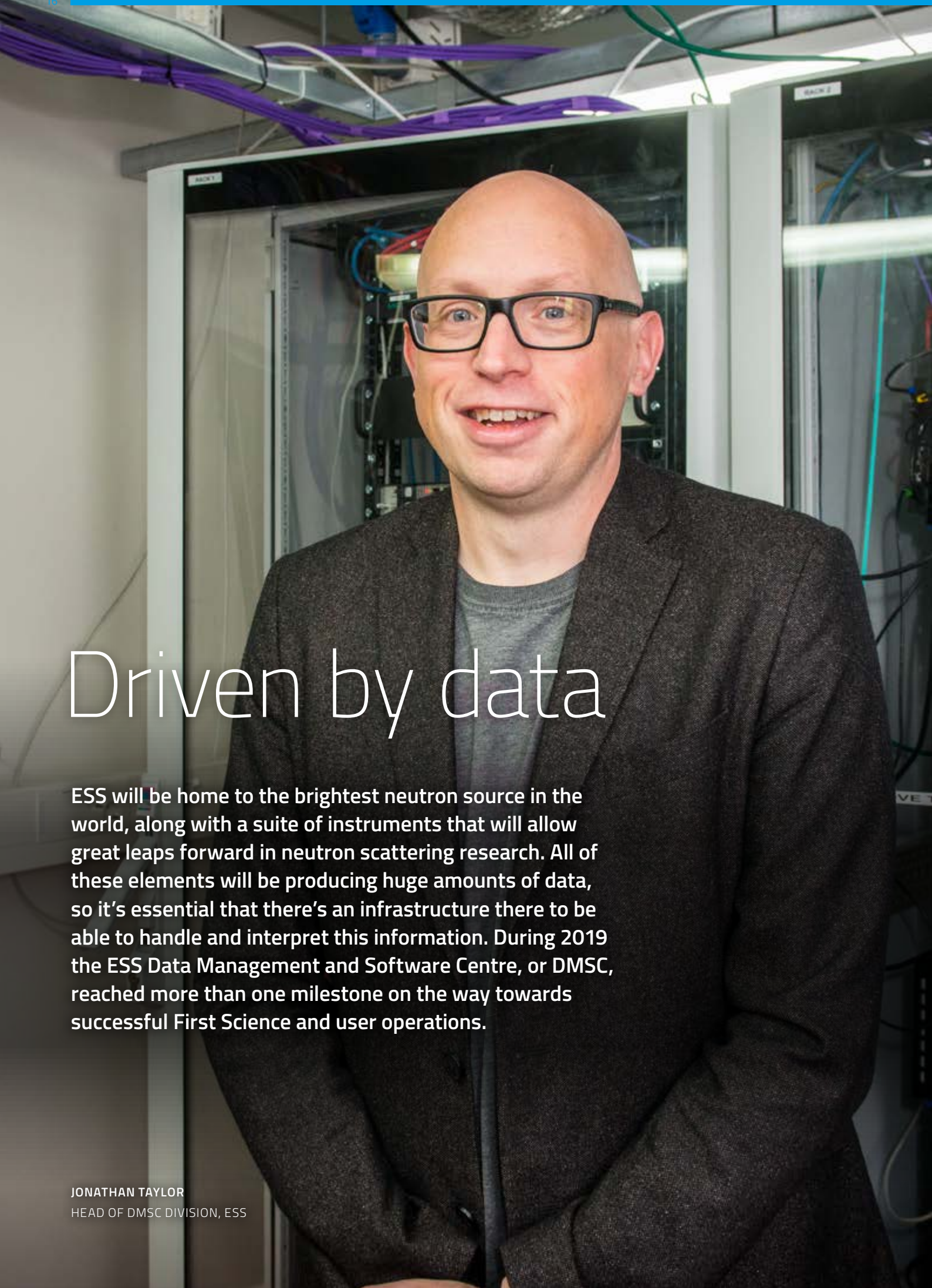
A positive force

Although the PAC tries to identify where improvements can be made, the PAC is very much dedicated to operating as a positive, helpful presence in the ESS project.

Mark says. "The PAC is here to help, and the whole committee is dedicated to offering constructive, helpful feedback and well-informed recommendations. We can be very tough in some instances, but ultimately, we want to help improve overall project performance, and get to First Science as soon as possible. In this respect, the PAC is strongly aligned with the ESS Council and ESS management team."

There are always new challenges to address and difficult decisions to be made, and the PAC will continue to play an important role in this regard. The external perspectives of the committee have already helped streamline and optimise the project in a number of areas, and the goal is to continue on the same path which will result in the ground-breaking science anticipated around the world.

"The scale, scope and complexity of ESS is very ambitious." Mark concludes, "and with in-kind equipment from many different countries, and a distributed and diverse work force, ESS is expected to have some challenges on its way to becoming the world's most powerful neutron science. The PAC is committed to helping make ESS a success."



Driven by data

ESS will be home to the brightest neutron source in the world, along with a suite of instruments that will allow great leaps forward in neutron scattering research. All of these elements will be producing huge amounts of data, so it's essential that there's an infrastructure there to be able to handle and interpret this information. During 2019 the ESS Data Management and Software Centre, or DMSC, reached more than one milestone on the way towards successful First Science and user operations.

JONATHAN TAYLOR
HEAD OF DMSC DIVISION, ESS

The ESS facility, and the researchers that visit, will be relying on the data gathered directly from the instruments in use, and the DMSC made great strides of progress during 2019. The team are responsible for delivering the scientific computing applications and infrastructure required, including developing software from the ground up that's specifically suited to ESS.

"The neutrons from the beamline have computing requirements, whether that's for controlling the experiments themselves or acquiring, processing and analysing data," says Jonathan Taylor, Head of DMSC Division. "Basically, the raw data counts the neutrons which get scattered from a sample in a unit called time of flight. This arrives as a time stamp, but we need to convert this data into useful science units, and it's a considerable amount of effort to get this to work. Thanks to our fantastic team, and collaborations with other experts around the world, we now have technology that's more than capable of the task at hand."

This software has been designed and modified throughout the construction phase, which reached completion in 2019. This period also saw the development of the core technologies for the various beamlines as well as software for a number of different types of neutron research. In addition to these developments, ESS also opened a data centre in Copenhagen which is equipped to store all data, and make it accessible to those who need it.

"In the construction phase we developed software for all these different areas and instruments," Jonathan continues, "and we also developed our own skill set and skill base. When we started, there were five of us. Now there are 28, and we always try to make sure we have the right people in the right place, working on the right things. Then we also opened the data centre, which was another big step towards First Science from the data management side."

Cooperation is key

The DMSC and the new data centre are located in Copenhagen, Denmark, which requires a high-performance network connection between the facility in Lund and the data management and software centre side. Once operations begin, there will be vast amounts of information travelling between these two cities, sparking ideas and inspiration on both sides of the border, in both host countries. This collaborative spirit has run through every part of the DMSC project, and of the ESS project as a whole.

"DMSC was reliant on in-kind contributions, and key parts were developed by our partners," explains Jonathan. "One of the benefits of the software development community is that you can naturally work remotely, so collaboration is already seamless. When you develop alongside other neutron facilities, like we did, everyone benefits. We don't have to rebuild things that already exist, and other developers benefit from their software being built upon."

In-keeping with this approach, DMSC, just like the European Union itself, is a major proponent of FAIR (Findable, Accessible, Interoperable and Reusable) and open data. This means that, after a specified embargo has passed, anyone can access the research data and use it as a foundation for further research a deeper understanding. In addition to open data, the new data centre will be able to offer users a cloud resource for neutron science. This means rather than having to buy and build huge computers, scientists can remotely access the compute they need in the ESS data centre.

"This open data will contribute to the European Open Science Cloud," says Jonathan. "This is a big group of projects making open data viable for the European research community. To make data open, it also needs to be findable, accessible, interoperable and reusable. This requires a lot of effort and thought, but once it's done it's a huge benefit to everyone."

Prepared for a bright future

The DMSC decided that as a significant milestone, it would show that the software worked on an actual beamline. The tests were carried out in Berlin at the BER II reactor, and the test conditions replicated what will be seen when ESS is open for science.

"We wanted to show that we could do neutron scattering as we needed to," explains Jonathan. "Our job is to tie all the technology and instrumentation together with a usable system, and a lot of effort went into this integration. The test highlighted things to be fixed and improved, but it also shows that the core software was more than suitable for ESS."

All the hard work during this construction phase has paid off, as DMSC now has a fully operational data centre alongside a state-of-the-art, bespoke software stack built to make the most of the world-leading technology in place at ESS. This is all thanks to collaboration between experts in the DMSC working alongside many other teams from the science and technical directorate at ESS.

"Building scientific software is like science in general," Jonathan says. "There's more than one way to do things, and occasionally things will go wrong, so collaboration is essential. You need the right people in the right places who are able to offer the guidance you need. Science is only right because it's collaborative."

KEN ANDERSEN
NEUTRON INSTRUMENTS DIVISION, ESS

An instrumental role

As First Science fast approaches, the 15 instruments will be in focus for scientists all over the world. Each one is designed for a specific, unique purpose, and all of them are capable of contributing to groundbreaking research and discoveries.

The instruments at ESS will be as crucial as the beam itself when it comes to making advances in our knowledge of the world around us, and the materials within it. They were carefully selected based not only on the technical capability, but also the science cases behind each one. Each of the 15 instruments will facilitate research and analysis that previously wouldn't have been possible, so the decision and design stages were crucial parts of the ESS project.

"The interplay between the design of the source and the design of the instruments is something to be proud of, and something that hasn't been done before," says Ken Andersen from the Neutron Instruments Division at ESS. "We went our own way, against a lot of conventional knowledge."

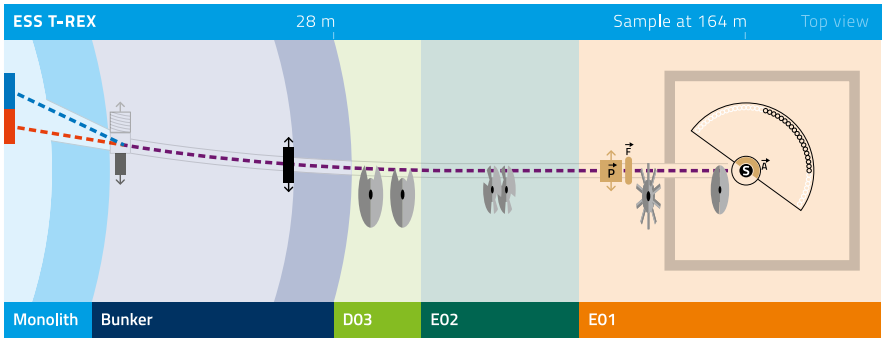
This unique, innovative way of working was essential from the very beginning of the project too, as soon after it began, ESS found itself with instrument suggestions from partners all over the world. There was no way to include every suggestion, so ESS needed to find a way to make the process fair while also ensuring that ESS would be able to take advantage of the unique capabilities afforded by the powerful neutron beam.

A world of ideas

As is the case with any new innovation or technology, there was no shortage of ideas for the best instruments for advancing neutron research, based on the proposed, powerful beam. All in-kind partners had scientists eager to suggest potential instruments, but with only a finite amount of time and space at ESS, the selection had to be carefully considered.

"For us, it was important to choose instruments and concepts that would work within our overall concept," adds Ken. "At the same time, we wanted to encourage ideas and benefit from a wide range of viewpoints, so we set up a process where scientists could submit fully formed instrumentation ideas, backed up with scientific cases on how they could advance the field. From there, we put the proposals through peer-review, and selected the 15 most suitable. The scientists and contributors could see that this was a good and fair way to work together, and it went really well in the end."

During the process, ESS worked on the crucial coordination which would ensure that all the relevant fields were covered by the instruments, and would have the potential to not only expand on existing knowledge, but to facilitate leaps into the unknown.



Graphical visualisation of one of the long ESS instruments: T-REX.

Transformative science

All 15 instruments were analysed and reviewed thoroughly before the designs were finalised, but the intensive process will pay off when it comes to the work which will be done in the future. Because each of them had a clear science case, and because the design stage has been so closely linked with the overall design of ESS, it's likely that there will be significant leaps forward in a variety of scientific fields.

"All the instruments will facilitate science on scales we've never seen before," explains Ken, "but there are two instruments which, to me, stand out as truly transformative – BIFROST and ESTIA. BIFROST will likely be the instrument that helps discover a new superconductor, which could potentially make a huge difference when it comes to energy efficiency and sustainability.

"If we can find a room temperature super conductor, for example, we could transmit power with no loss through heat. This could mean getting power from a windfarm in northern Europe to a town thousands of kilometres away without any loss whatsoever. Or it could help with levitating trains, or cheaper MRI machines. The potential would be almost limitless, and if anyone does discover this superconductor, BIFROST at ESS is the place to do it.

"ESTIA is interesting because it will allow us to measure surfaces and interfaces much more quickly and over smaller sizes. Neutron scattering information was instrumental in the development of the physics behind hard disks. With ESTIA we could see this science branch into many more applications and be applied to more complex surfaces. Thin film systems which aren't restricted to flat surfaces could be really exciting."

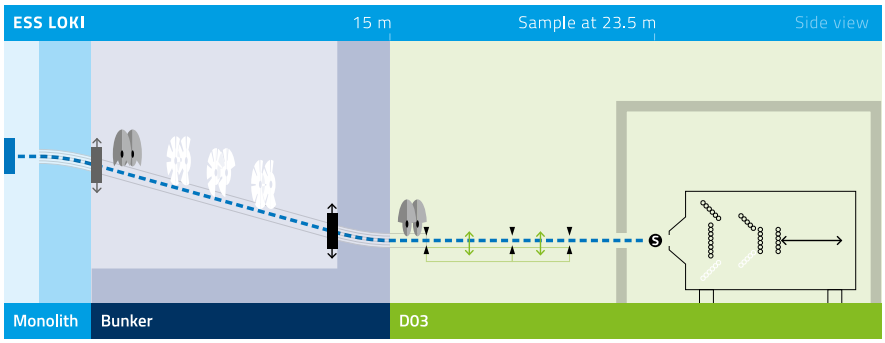
There are a number of other potential application areas for the instruments at ESS, including healthcare and fuel cells, and even though each instrument has a science case it's impossible to accurately predict what discoveries will be made in the future. ESS, and the groundbreaking science, will be driven by scientists looking to answer questions.

"ESS, and neutron scattering, isn't about answering one big question, it's a tool that can help answer thousands," says Ken.

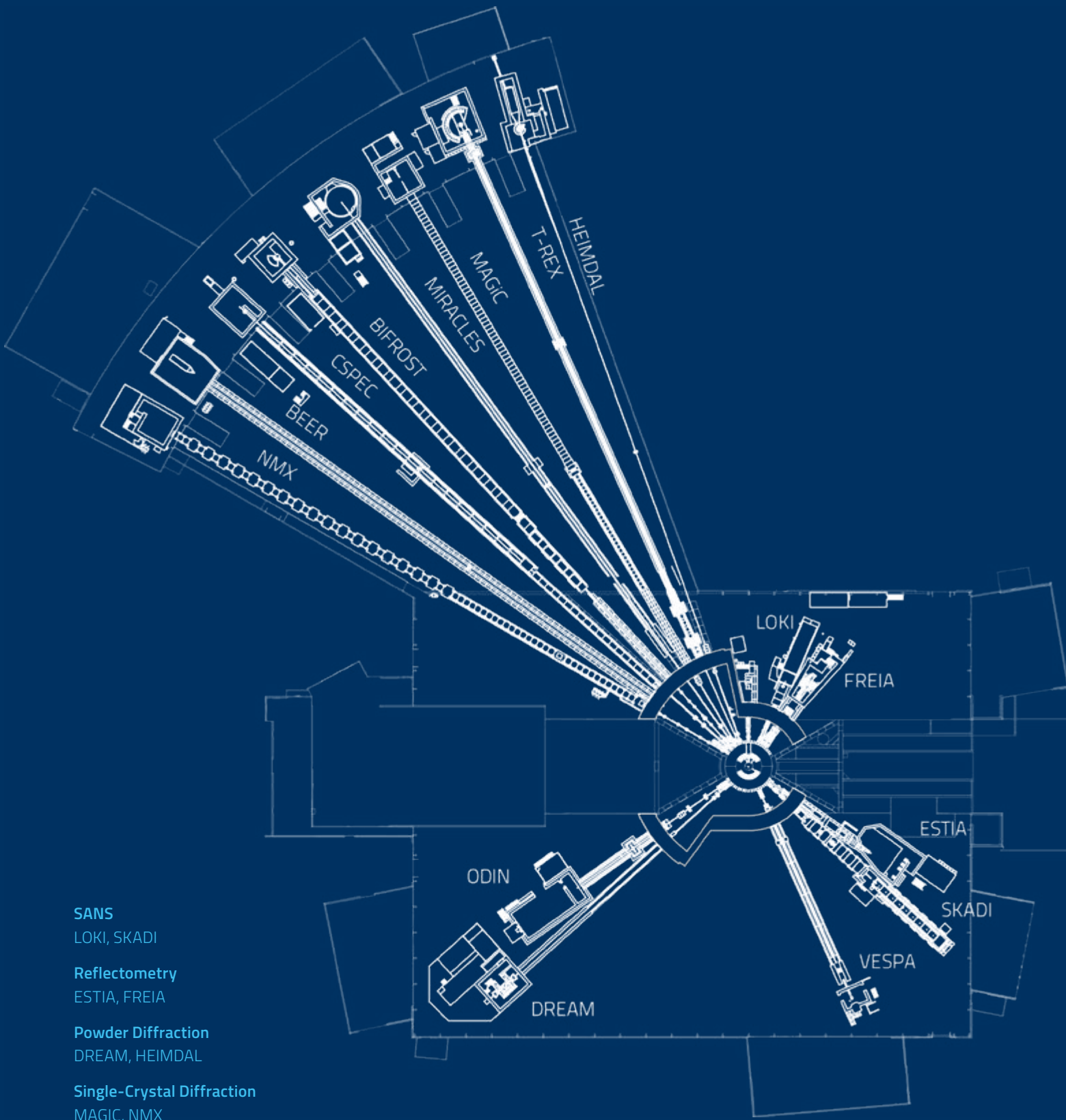
Looking to the future

The user programme for the first 15 instruments is currently scheduled to open in 2023, and looking further ahead, the suite is likely to expand to 22 instruments. This was already considered in the design process too, so the next instruments will be as well-implemented with the beam line and infrastructure.

"I'm really proud of the interplay between the design of the source and the design of the instruments," concludes Ken. "We were able to achieve integrated optimisation of the whole facility which is really unique, and I didn't expect that to happen when we started. I'm really proud that we were able to develop this global optimum by going our own way."



Graphical visualisation of one of the short ESS instruments: LOKI.



SANS
LOKI, SKADI

Reflectometry
ESTIA, FREIA

Powder Diffraction
DREAM, HEIMDAL

Single-Crystal Diffraction
MAGIC, NMX

Imaging & Engineering
ODIN, BEER

Direct-Geometry Spectroscopy
CSPEC, T-REX

Indirect-Geometry Spectroscopy
BIFROST, MIRACLES, VESPA

Building more than meets the eye

Looking back on the anniversary of the moon landing, who were the heroes? Armstrong and Aldrin were justifiably famous for taking great personal risk. But what about the Saturn V rocket, the computer systems, the administration, the janitorial services? The people behind those are equally heroes for enabling that milestone. Just as they did, every person at ESS is eager to enable great science – especially now as we see our own massive machine taking shape.

"We had a lot of visible changes in the field last year," says Mark Anthony, Project Director for ESS. "If you walked out there in January 2019, you saw a lot of empty space. We're proud to say that if you went out in January 2020, you saw tremendous changes that happened in just a year. All of these accomplishments didn't just happen because they were listed on a piece of paper, but because of all the people involved – from individual contributors to work package managers and in-kind partners."

The ESS construction project was 65% complete at the end of 2019 and has entered the initial operations phase. This is when testing and commissioning start on subsystems. ESS is also getting a lot of the infrastructure in place and hardware to install. During 2019, ESS was active in all three major areas – target, accelerator, and NSS instruments. As Anthony says, "Now it truly starts to look like a whole research facility and everyone feels involved."

What you see is not all you get

Yet even as the massive facility takes shape in a way that anyone can now recognise, there is more being constructed behind the scenes than most people could imagine. In the beam drift room for example, between the end of the accelerator and the target, the team put in over 100 tonnes of steel shielding. In the klystron gallery, accelerator tunnel and connection passages, the RF team alone installed nearly 5,000 pieces of equipment.

"One of the most complicated parts is generating the power that adds energy to the particles," explains Kevin Jones, Technical Director for ESS. "That requires installation of wave guides that carry power from the hardware in the gallery into the tunnel and couple it to the accelerating structures. There we've already installed 3,600 pieces of wave guide – all carefully bolted together and torqued and tested."

"There's a lot of work happening on a project like this that never gets a spotlight," says Anthony. "It's down in the end of a tunnel, through a cave, at the back, behind a wall. It's not all about the big, shiny components; it's equally about the behind-the-scenes work, where supervisors and their teams installed components during the night in the rain. There are hundreds of unsung heroes doing that work every day, and without them we would not be successful."

Progress in parallel

The reorganisation in 2019 enabled a more central view of the project to help sync the high levels of collaboration needed as thousands upon thousands of parts are now being installed. Since re-baselining the project due to additional requirements on the civil construction works, ESS has maintained the major milestones. The way the organisation is able to do this is to be more efficient by doing more work in parallel.

"Through a cave, behind a wall, are the unsung heroes."

MARK ANTHONY
PROJECT DIRECTOR, ESS

It takes enormous effort to constantly look ahead, develop contingency plans, and have something else to work on if one thing is delayed so the project doesn't skip a beat towards the milestone of First Science in 2023.

"There have been a lot of benefits already," affirms Anthony. "Simply co-locating the whole project installation organisation together has improved communications threefold. It also means we can do things using the same standards across subprojects and be safer. Last year we had zero working days lost due to accident or illness, and that hinges on communication and caring, paying attention to how each person's work affects others."

Stewarding a brighter future

A key word for the project in 2019 was learning, and that is certainly at the heart of everything at ESS. Right now, we are learning to build a facility unlike any other together with our in-kind partners and their decades of experience on how to design, manufacture and develop the key pieces of hardware. And learning will also be the daily purpose and legacy of what we're building once in full operation.

"ESS presents enormous opportunity for us to learn things we don't know that we don't know," says Jones. "For example, where we might make an enormous difference is in moderator technology. The fraction of neutrons that facilities today make which can actually be used is tiny, maybe just 1%. We already have a brighter moderator design compared to other facilities, but if over the next decades we could continue developing technology to increase the number of usable neutrons by a factor of 10 or so, wow, that would be a huge impact on future science."

"There's a word I learned some time ago that I think is crucial for facilities like ESS," continues Jones, "and that word is stewardship. This consortium of European nations has entrusted the ESS organisation with a significant amount of money. It's our responsibility to make sure that investment is positioned to work sustainably and maximise the effectiveness of every neutron we make, enabling scientists to make ground breaking contributions for the next 40–60 years and beyond. If you take good care of them, accelerators will live almost forever. Our stewardship today must serve the future generations."

"If accelerators live almost forever, we're stewarding generations here."

KEVIN JONES
TECHNICAL DIRECTOR, ESS

Top highlights of 2019

Project

1 ESS has 22 buildings in Total Scope, and civil construction partner Skanska made excellent progress during 2019, handing over seven buildings for a total of 14 handed over to date.

2 We inaugurated the ESS Data Centre (at DMSC*) in Copenhagen, which will provide analysis and modelling software that enables researchers to transform experimental data into scientific results.

3 In June 2019, ESS submitted the application to test and operate the normal conducting linac. A lot of effort went into putting together our preliminary safety report (about 400 pages) on time and on schedule, which is the first step in the six to nine-month long application process.

Technical

1 In the autumn, ESS received the Radio Frequency Quadrupole (RFQ) from our in-kind partner in France and installed it in the tunnel. The RFQ is a key component in the 600-metre-long linear accelerator, which focuses, bunches and accelerates the proton beam.

2 Our cryogenic plant that makes liquid helium – the lifeblood of the facility – is up and running and we've installed a substantial amount of the cryogenic distribution system that will cool down the accelerator to help it work in an energy-efficient way.

3 During 2019, we built and commissioned our test stands which are essential for us to test all equipment before we install it in the accelerator.

* DMSC = Data Management and Software Centre

Long Instrument Hall in landmark handover

The handover of the Long Instrument Hall from Skanska, the construction partner, to ESS represents an important scientific milestone. It also marks a major shift in the construction process, from focusing on the buildings themselves to installing the instruments. To mark the occasion, more than 200 of the scientists and engineers involved in the design and construction of ESS's world-leading instruments took part in a handover ceremony.

The Long Instrument Hall itself is a unique development, built specifically to house the long instruments, which need to be placed further from the Target Station to achieve the highest possible level of detail in research results. The building is bow-formed with a width of 140 metres to accommodate the eight instruments side-by-side. Once these long instruments are installed, they will completely fill the building.

"For me personally this is a very special moment as, before joining ESS, I participated in the development of the engineering instrument BEER, which will be located in this very hall, " said Andreas Schreyer, ESS Director for Science. "Standing here today I envisage the experimental halls at ESS filled with state-of-the-art instruments and top scientists, delivering world-class research."

Changing landscape for Europe's neutron science community

During 2019, three European neutron research reactors shut down. Significant steps have been taken to make up for these closures and try to keep Europe's leading position in neutron science. ESS is well on its way, while the remaining major European sources have invested heavily into upgrading their capacities and capabilities.

Image by: FRM II

Half of all neutron science publications across the world can be attributed to European researchers from academia and industry, working at European neutron sources.

Helmut Schober, LENS (League of advanced European Neutron Sources) chair and director of the ILL (Institut Laue-Langevin) said, "European neutron science owes its outstanding performance over the last 50 years largely to the close-knit network of facilities available to scientists. The three reactors closed in 2019 were all vital pillars of this network, in particular, BER II and Orphée, which both ran extensive international user programmes."

Before the closure of BER II at the Helmholtz-Zentrum Berlin, the reactor played a part in the testing of equipment for ESS instruments.

According to Schober, Europe can expect to retain its world-leading position, "provided we can maintain the proper level of support".

ESS celebrates the 10th anniversary of the site decision

At a meeting in Brussels on 28 May 2009, European research ministers agreed that the materials research facility European Spallation Source would be built in Lund, Sweden, with its Data Management and Software Centre in Copenhagen, Denmark.

It was a historic decision; for the first time, a major international science facility would be built and operated on Swedish soil. And now, ten years later, the decision was commemorated at a meeting in Stockholm.

Among the speakers was Allan Larsson, former finance minister and Sweden's chief negotiator for ESS in 2009. He described to the audience how his team, through hard work and many small steps in the negotiation process with the other European nations, gained support for Lund being the right place for ESS.

In conjunction with the site decision in 2009, extensive work was set in motion to define ESS's advanced technical design, and to secure support and funding from the member states. This includes financial contributions, technical equipment developed and produced at research institutes around Europe, designing and determining the instrument suite, and commencing the construction of the 23 buildings that make up the research facility.

As part of the 10th anniversary of the site decision, ESS also welcomed some of the early pioneers and contributors that helped make ESS in Lund a reality.

Years in the making

LARS BÖRJESSON
PROFESSOR, DEPARTMENT OF PHYSICS,
CHALMERS UNIVERSITY OF TECHNOLOGY, SWEDEN

With First Science on the horizon, it's natural to focus on the next steps, but it's important to look at the past as well. Everything is a result of years of dedication, commitment and bold ideas. The origins of ESS can be traced all the way back to the early 90s, and it went through a number of iterations before becoming what it is today and what it will be in the years to come. However, the vision has always been the same – to create a truly next generation neutron research facility.

Neutron research has been carried out since the 1930s, and there have been a number of leaps forward since. Whether it has been through more advanced instruments or brighter beamlines, it is a field that has been evolving consistently since its inception. This evolution is often driven by scientists reaching the limits of current equipment and thinking of ways to expand the capability in a meaningful way.

"I started work on this project back in 1993," says Lars Börjesson, who has been involved in ESS in a variety of roles and is currently one of two Swedish delegates on the ESS Council. "I was using the neutron scattering technique at the time, and I was pushing the limits in pursuit of the best possible material science research, so I wanted to push for the next possibilities."

This desire quickly led to analysing what could be done. Lars and his colleagues realised quickly that it would be a large, complex project which would require the cooperation of laboratories and the scientific community all around Europe.

"We needed to organise at national and European levels," continues Lars, "so we started the European Neutron Scattering Association (ENSA) which was built from the bottom up. I helped set this up back in 1994, and this helped create more impetus around advancing neutron research."

Finding the right host

The steps that followed involved the initial stages of conceptual design, as well as the formation of various collaborations to help advance the case for a new neutron facility in Europe.

"Early in the 2000s, we were already working across borders," adds Lars.

"The Nordic countries were all working together, and we started to talk about support for the European Spallation Source. As a result, we formed ESS Scandinavia, with the aim of supporting ESS wherever it was to be built, but we also wanted to look at the possibility of hosting here in Scandinavia."

This group gathered momentum quickly, and were joined by institutes and universities across Scandinavia. As a result, the potential for ESS being built in Scandinavia was clear, so they started working on a proposal. This was presented in 2002, but at that time Europe was not yet ready.

"We did a lot of work, but then everyone realised that we needed to bring it to the political level to get it moving," explains Lars. "After a while, we managed to get that attention, and in 2008 a number of international site evaluations were carried out. Sweden and Denmark came out on top here, so the site was decided and confirmed. This was a huge step forward!"

Throughout this process, it was important to show how important ESS would be to the potential host, as well as making it clear what the countries offer in terms of infrastructure, existing scientific community and innovation. After collaboration with a number of experts and interested parties, Lars and his team had succeeded, which in turn paved the way for the project to start in earnest.

Approaching the finish line

"After all the years of planning and preparation, construction finally started in 2014," Lars says. "I learned so much in this project. I was collaborating with people all over the world, and not just with scientists but with political bodies and industrial companies. There are so many things to consider – the role of the facility, what it will be driving, the innovation it will lead to. We had to find the answers to all of these to be able to get the funding and approval we needed."

As a result of all of this hard work, ESS is now close to completion and the scientific community is on the edge of being able to conduct research that will change the world. Whether that's with advances in renewable energy, or innovative new ways to develop cures, ESS will be home to a wide range of exciting discoveries, and it all started as ideas on a page.

"Thinking back, it's exciting that these concepts from PowerPoint presentations are now concrete in the ground," Lars concludes. "It can be hard to take in after seeing it on a screen for so long. I'm so proud that it's being built, and that it's European. We have the support of so many people, and so many collaborated, all for the benefit of science."

Next shift in the highway to science

If your goal is to go where no one's travelled before, your heroes are those who smooth the way so you can get to the unknown's edge faster, smarter and safer. For a scientific facility, the technical term for that work is preparing for operations. At PS&A, it is called "highway to science."

"Not only is it about getting to First Science in 2023," says Agneta Nestenborg, Director for Project Support and Administration (PS&A) for ESS, "but it's about continuing after that to pave the way for every scientist, every day, to do excellent science and achieve groundbreaking results."

"We are not doing this for ourselves," affirms Ralf Trant, Associate Director for Environment, Safety, Health & Quality (ESH&Q) at ESS. "We are a service organisation. We are here to enable great science. Licensing, safety, quality – indeed everything we do here as a whole team – is about caring for the scientists and for their results."

Organisational readiness

In October 2019, ESS implemented a large organisational restructuring, moving towards a cross-functional project orientation. This was a planned shift in operational rhythm, specifically to empower the transition towards First Science in 2023.

Both PS&A and ESH&Q are already in full operation and, as Nestenborg explains, "More parts of the organisation transitioned from the construction project into initial operations during 2019, and it's our task to put systems and processes in place to make it easy as more people transition at different times over the next years. As the culture is becoming more operational, more and more people get involved in everything that happens in the facility, and that's our future."

"At ESS, we know it's vital to consider interconnectedness – to understand how everything works together and how one's own actions and contributions impact others," says Trant. "That mindset can even lead to out-of-the-box ideas for helping within the organisation." During 2019, for example, ESS established a volunteer first responder team made up of ESS colleagues who have experience as volunteer firefighters in private life. They've also now undergone a full week of professional training at a fire brigade centre and are set up to handle minor incidents. If bigger incidents arise, they help prepare so the fire brigade can act faster and more efficiently when they arrive.

Quality ambitions

The extraordinary levels of collaboration that go into preparing for operations are vital to ensure ESS will not only be the safest facility, but also leading-edge when it comes to quality.

"Quality is about providing support to have the best possible performance with the least possible downtime so scientists don't miss a moment of beam time and get excellent results," says Trant. "We set the framework for the quality-control programme in a collaborative way with our other ESS divisions, as well as our in-kind partners.

*"Highway is paved.
Rearview mirrors are checked.
Now we accelerate."*

AGNETA NESTENBORG
DIRECTOR FOR PROJECT SUPPORT AND ADMINISTRATION, ESS

A proactive quality approach in which we reach out to our partners is important because if there are quality issues, you want to discover and fix those as early as possible, ideally before equipment is delivered."

Progress with digitalisation

The progressive ambitions at ESS also include digitalisation – everything from an easy app to book meeting rooms to a Learning Management System for efficient training and tracking. During 2019, ESS also took into operation the first three radiation monitors, as well as Dosiserv personal dosimeter monitors. While only a small number overall, it's a major step because now ESS can test the whole radiation monitoring system with real data, and continue to scale it up over the next two years.

"We want to be a world-leading facility when it comes to science, but also in how we work to digitalise functions, processes and activities to make life easy and safe for both our users and staff to keep focused on what matters most for them," says Nestenborg.

Reflecting back to move forward

ESS is in a good position now to pick up speed. Yet, there's value in pausing at each new year to get our bearings. "For us in administration," shares Nestenborg, "we've started 2020 by reflecting on where we are and making sure we have the right understanding of where the organisation expects us to be when we get to steady-state operations. With the reorganisation in mind from 2019, I think 2020's challenge is to fulfil the ambition of why we changed – to make quicker decisions, to have the mandates in the right places in the organisation to make those decisions, and to make sure we can deliver First Science in 2023."

Nestenborg is clear, though, that the reflective pause won't be long as the whole organisation is eager to move forward towards First Science. "We're delivering something over time and it's a really long wait, during which you prepare and prepare," she describes. "Now as we get closer to operations, we get more and more excited."

"Interconnected, out-of-the-box thinking puts out fires before they begin."

RALF TRANT
ASSOCIATE DIRECTOR FOR ENVIRONMENT, SAFETY, HEALTH & QUALITY, ESS

Top highlights of 2019

Project Support and Administration

1 Multiple teams worked to establish more organisational flexibility with workforce planning, flexible workspaces, a commuter survey to ensure the right amount of parking and bike spaces for our new Campus, as well as digitalisation tools, such as an app to book meeting rooms.

2 During 2019, we began work on a new integrated service management strategy to develop services to the organisation, and also gave everyone a foretaste of what's to come with a mini exhibition visualising the new ESS campus, which will be ready next year.

3 A big moment was the handover of our logistics building. It's the first building we've started to operate fully and with all goods coming in there now, logistics works much smoother.

Environment, Safety, Health and Quality

1 In collaboration with local quality representatives in the technical and science divisions, and them involving our in-kind partners, we made significant progress in quality control during 2019 as we move into increased deliveries and installations.

2 We established a volunteer first responder team, made up of seven ESS colleagues with experience as volunteer firefighters, who have now also undergone professional training at a fire brigade centre and are ready to serve.

3 With the first radiation monitors and personal dosimeters in operation, ESS now has all parts of the complete radiation monitoring system up and running for those first monitors, which we will continue to test and scale up over the next two years.

Collaboration is the lifeblood of ESS

There's a proverb that says, "If you want to go fast, go alone. If you want to go far, go together." Collaboration is the lifeblood of ESS – not only for conceiving and constructing such an enormous undertaking, but for sustaining the long-term mission of enabling science to see further, investigate further, and progress further than ever.

"We are building something together that will be significant for global research, is enormous on a physical scale, and is also complex in terms of cooperation," says Sharon Cosgrove, Associate Director for Strategy for ESS. "Normally, facilities like this take about 10 to 20 years in gestation and a similar amount of time to build and optimise to ensure that they are truly world-leading. It takes a large, strong consortium of members and in-kind partners like we have to even dream of undertaking such a venture."

As ESS begins the intensive ramp-up towards First Science, the need for collaboration also continues to increase. The Strategy Directorate was created in 2019 to work closely with key stakeholders vital to the future of ESS. This work reaches across many domains within and beyond ESS, from relationships with host nations and the political sphere to strengthening relationships with in-kind partners, maintaining project governance, supporting our Science Directorate in partnering with peer facilities, and working with educators to excite the next generation of scientists and engineers.

"This new directorate plays a key role in securing the future," explains Cosgrove. "As you can imagine, there is never a dull moment. We have lots of ideas and tasks to juggle in order to sustain the information flow, while keeping up engagement and energy for this project. With such a diverse list of responsibilities, it's especially important to have a talented, committed team that understands stakeholder interests, meets their needs, and serves the project. That is what the Strategy team is all about."

Moving into the phase of initial operations, the immediate work is to secure sustainable funding to support the facility. All of the consortium members have shown great engagement in this process and have detailed a timeline together with ESS to secure this objective by December of 2020. Our deliverables for the year included:

- Securing the 2020 initial operations budget plus additional construction funding to strengthen security arrangements
- Obtaining support from AFC, PAC, Council for ESS's Initial Operations Plan
- Launching a multi-million euro Horizon 2020 grant portfolio to support peer facility, neutron user and in-kind community-building and awareness-raising activities.

The next chapter will be equally important. For ESS member states, in-kind partners and the global neutron science community, seeing their individual investments and contributions coming together into an operational science facility should bring a palpable increase in energy and a renewed motivation to work together to achieve the shared scientific and societal missions.

"Scientists want to be at the heart of excellent science wherever it happens," shares Cosgrove, "and as ESS becomes operational, it will start contributing to our shared vision to enable excellent science. This, in turn, will support Europe's global leadership in research delivered with neutrons, which has brought amazing benefits in terms of discovery. Whether it's new drug delivery systems, innovative materials, better batteries, or clean energy technologies, we're hoping that really exciting things – those key links that can really change the world – will come from research undertaken here, but we have a lot to do before that can happen."

"We're a new directorate helping to secure the future."

SHARON COSGROVE
ASSOCIATE DIRECTOR
FOR STRATEGY, ESS

MARTIN SJÖSTRAND
HEAD OF COMMUNICATIONS, ESS

Achieving the right balance

With First Science on the horizon, development of ESS as a facility continues at a swift pace. More buildings are being finished and more of the instruments are being assembled and installed. In conjunction with these steps towards Operational Readiness, ESS continues to achieve significant milestones on the way to Organisational Readiness. Working on both in parallel is essential, and achieving the right balance between the two will ensure an optimal user experience when the doors open after First Science in 2023.

"We have our initial operations concept, which is all about getting the facility and organisation trimmed up to be running well in time for inauguration," says Martin Sjöstrand, Head of Communications at ESS, "this includes making sure all the right people and processes are in place. To achieve this we try to focus on both Operational Readiness and Organisational Readiness in parallel, as they are equally important to the success of this research facility."

Operational and organisational readiness complement each other, and steps forward in one area contribute to progress in the other. "You can compare it to putting a ship to sea," adds Martin. "It doesn't make sense to only look for a crew, and train the crew, after you finish building the ship. You do both at the same time."

Many milestones were met in terms of operational and organisational readiness during 2019. On the operational side, there was a lot of progress with the buildings and the infrastructure, as well as significant progress with the instruments and beamline. The organisational side also saw significant strides towards readiness, with many pieces of the puzzle being put into place well in advance of First Science.

"We did a lot of things during 2019 to prepare for organisational readiness," confirms Martin. "We strengthened the user office to ensure we have people and processes ready to help when researchers arrive. We launched our new identity, giving a clearer idea of who we are and how we work, and showing that we're ready to go into business. We now have a first responder team in place to ensure we can run operations in a safe and efficient way. Our deuteration lab, DEMAX, is already working with users who will hopefully come to ESS in the future."

As ESS is a true greenfield project, there were no existing structures and processes to bring in, and everything has been built from the ground up. While this is challenging, it also offers a great opportunity.

"Existing structures are great," Martin adds, "but we have the opportunity to build a truly modern research facility for the coming generations of scientists. We can take knowledge and experience from elsewhere, and we have a blank page to work with. It's a fantastic and unique opportunity, and allows us to build something which we can all be truly proud of."

The approach to placing equal priority on the organisational and operational sides of the project continues to work well, and keeps ESS on track for the various goals on the way to opening in 2023.

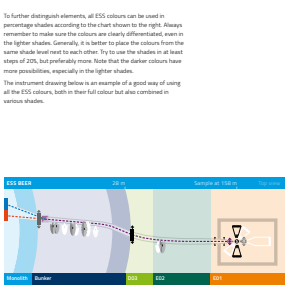
"It's all how we balance the work," Martin concludes. "We need to balance organisational and operational readiness closely and cleverly. If we don't have the right equipment, we can't offer the users the experience they expect. Equally, if we have the perfect facility but without the people and processes we need, we can't live up to the standards that we're aiming for. It's all about the balance."

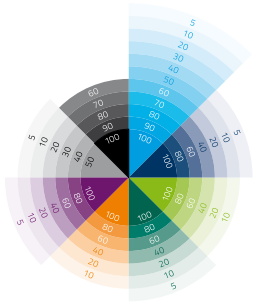
2.7 BASIC ELEMENTS

Shades of ESS

To further distinguish elements, all ESS colours can be used in percentage shades according to the chart shown to the right. Always remember to make sure the colours are clearly differentiated, even in the lighter shades. Generally, it is better to place the colours from the same shade level next to each other. Try to use the shades in at least steps of 20%, but preferably more. Note that the darker colours have more possibilities, especially in the lighter shades.

The instrument drawing below is an example of a good way of using all the ESS colours, both in their full colour but also combined in various shades.



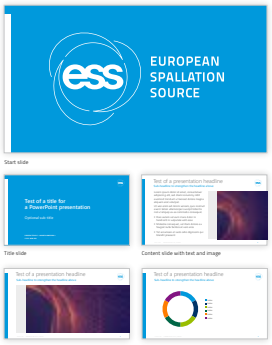


3.8 APPLICATIONS

Presentations

In our PowerPoint template, you can find a great number of different layout possibilities. Please stay within these guidelines and avoid creating new layout solutions.

Segoe is used for all text throughout the presentations.



3.4 APPLICATIONS

Business card

ESS business cards are printed on both sides. If a second language/writing system is required, the cardholder information should be printed on both sides, with one language/writing system on each. Business cards are an example of small but important branding material that use the alternative version of the open bar, which is on the opposite side from the ESS symbol.

Card front
All cardholder information is written in blue, with the open bar to the left and the ESS symbol in the top right.

Card back
Blue background with logotype and brand statement.

New look, same vision

The ESS facility will soon be setting the standard in the field of neutron research, so it's only fitting that the branding reflects this ambition as well. As the project moves on from the construction phase, it was the perfect opportunity to revisit the brand and visual identity, to ensure that everything was in place, ready to represent everything that ESS stands for in the years and decades to come.

"How the world experiences us is one of the keys to our success," says Martin Sjöstrand, Head of Communications for ESS. "We want to be perceived as professional, attractive and trustworthy, and we want to be admired and respected for what we help scientists achieve. This is all encapsulated in our brand."

The timing was important as now most of the construction work is complete. Whether on building façades, or printed on the flooring, the ESS visual identity will be everywhere, so ensuring that it was world class before this work began was crucial.

"We're in a phase where we're transforming from construction to research facility," adds Martin. "So how we present and use our identity is changing, as everything is literally being carved in stone and metal. This is why we chose to set the new identity now, and we believe we have a brand and visual style that we can take pride in for many years to come."

The new visual identity will play an important role in how ESS is perceived by the global audiences that the ground-breaking research will inevitably attract.

"Our overall goal is to help mitigate the social challenges of our time," explains Martin. "With such an ambitious vision, we need to look the part as well. We need to come across as a leading global organisation. We need an identity that is welcoming and open, but also one that represents quality, leading-edge technology, and progress."

As First Science approaches, it was important to set a consistent approach to style and branding which more fully represents ESS and everything it stands for. All of this will help ESS to build global support and recognition, and the visual platform will constantly develop and evolve alongside the organisation, and the research itself.

"It all comes together to symbolise connection, harmony, balance and hope," Martin concludes. "These factors will also play a big part in the science we hope to see at ESS in the future, whether that's through discoveries that help connect people, or research that leads to the hope of a brighter, more sustainable future. These are the things we want the ESS brand to encapsulate."

An inspirational welcome

ESS will soon be home to research and science on levels never seen before, and this home needs a welcome that befits the ambition of such a facility. The Campus is a group of buildings designed to attract, encourage and inspire all visitors to ESS. Each part has been carefully considered to ensure that every person knows that when they arrive at ESS, they have arrived somewhere special.

When ESS is open for science, it will be welcoming thousands of guests each and every year. It's important that these guests feel that they have arrived at a forward-thinking and state-of-the-art facility, and the ESS Campus is set to play a central role in creating that feeling. The Campus broke ground in December 2018, and is set to be completed by the end of 2020 thanks to all the effective work done during the pre-construction phase.

It consists of three buildings – the entrance building, the main office building and the laboratories/workshops building which are in addition to the main instrument labs. The Campus project also includes the outside space that connects these buildings, with everything designed to come together in an attractive, inspirational way.

"When starting the workplace design for the Campus, we really wanted to capture the needs of all the different stakeholders," says Therése Welander, Head of Strategic Projects and Campus Stakeholder Manager. "We listened to representatives from every division, and from there we knew that the building design should inspire and facilitate collaboration. It was also clear that the organisation will change over time, so we want these spaces to be flexible and suitable for a variety of purposes."

Diversity is also a priority, as people work in so many different ways. The Campus will account for that through a range of different offices, open areas, focus rooms, and collaborative spaces. This runs all the way through to the kinds of catering available, with one communal space for those who choose to buy food on the premises or to bring their own. This allows diversity and collaboration to go hand-in-hand. There is one other over-arching philosophy that runs through every part of the Campus – attractiveness.

"The Campus, and particularly the entrance building, is the first thing people will see," continues Therése. "Many people will be spending much of their time in our offices, labs and workshops, so we want to make this as attractive a working environment as possible. This is not only to create a positive feeling, but also to help us keep and attract competence, and to make people from all over the world want to come here. Our vision is that we want everyone to see ESS as 'the place to be'. It's bold, but if we want to be a state-of-the-art facility, we have to dare to be bold!"

Form meets function

While making the Campus appealing, it was equally important to ensure that every part of it would fit its purpose in the best possible way. Whether that's an auditorium equipped with the latest audio-visual technology, or an atrium that can be used for practical purposes, everything has been carefully considered.

"Everything with regards to building placement, design and function has been done in a way that will give the best results possible," explains Therése. "Take the atrium in the office building, for example. In most buildings, atria are spaces which aren't used for anything, they just exist to give light into the building. With the Campus atrium, the first thing people will see is what we call 'the iceberg', which is best described as a bold, modern installation with large screens which will show information about ESS, and can show different things to different parts of the room. This means it can be used in a practical way by holding exhibitions or presentations, while people will be able to gather around the balconies to observe and discuss."

In addition to meticulously planned interiors, the building placements and the external areas have also been planned down to every last detail.

Since the conceptual phase, the plan has remained the same, but there have been a number of tweaks and improvements along the way.

"As well as trying to meet the demands of the various stakeholders, we also made adjustments based on the environment around ESS," adds Therése. "For example, we studied sunlight and wind, and the rotation and placement of the buildings are made to avoid creating wind tunnels in the outdoor spaces. We want people to be able to sit and enjoy being outside our facility as well."

Where everything comes together

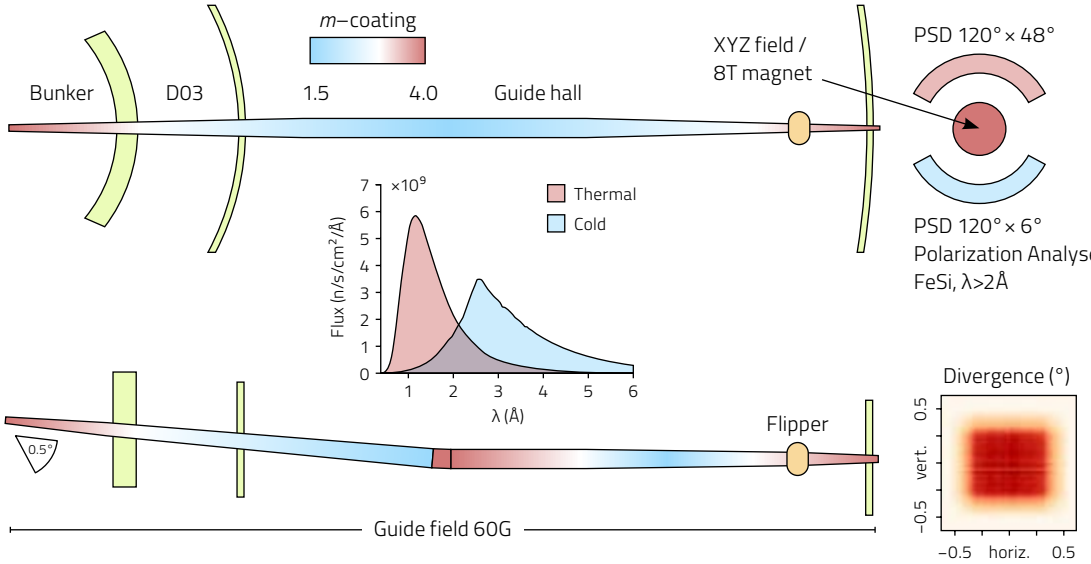
Encouraging collaboration and inspiring new ideas are pillars of the Campus project. Each area flows into the next, with the idea being that it's simple for people to move and communicate, and to find spaces where they will be able to think and create. In addition, with ESS being a beacon for the future of science, the surroundings need to inspire each and every visitor.

"Through the eight meter high glass windows in the canteen, people will get a clear view of the target building, which I think will offer a great perspective of the scale of our facility, and of the scientific possibilities," continues Therése. "We want to encourage collaboration and inspiration more than anything else. In the future, when we're open, I hope to see a lot of people, and a lot of talking. It would be great to see people having deep, interesting conversations, or making drawings together based on a spark of an idea. I want a Campus that's full of life!"

Collaboration and inspiration are long-term goals, but they have also played a big part of the design and construction process. With so many teams and stakeholders, it's clearly a complex project. Teams from ESS and Skanska, the contractor in charge of the construction, have worked in a positive, pro-active way, and are on schedule to deliver a Campus that will help make ESS stand out.

"Our decisions have been made based on experience, and on input from the various teams," concludes Therése. "I think the end result is something special. We want people to feel like they're in the place to be, and to feel like we're part of the future. We want to show that ESS is a modern, state-of-the-art facility, and I hope that will be emphasised when the Campus opens its doors."

THERÉSE WELANDER
HEAD OF STRATEGIC PROJECTS, ESS CAMPUS
STAKEHOLDER MANAGER



Instrument MAGiC layout. *Top:* top view of the instrument across the multiple buildings. *Bottom:* side view of the instrument with simulated divergence profile at the sample position. *Inset:* neutron flux at the sample position as a function of wavelength.

Technical annexes endorsed

The In-Kind Review Committee (IKRC) is responsible for evaluating the in-kind proposals and making recommendations to the ESS Council, and each of the member countries has one delegate in the IKRC. During 2019, the IKRC endorsed new technical annexes for four of the instruments (ODIN, DREAM, C-SPEC and MAGIC), along with an in-kind contribution agreement with the Laboratoire Léon Brillouin (LLB), which is co-owned by CEA/CNRS.

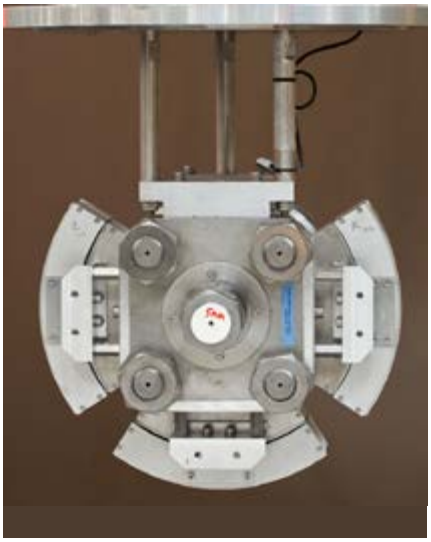
This brings the number of signed technical annexes up to eight in total, with partners in Germany (Forschungszentrum Jülich and Technical University Munich), France (Laboratoire Léon Brillouin) and Switzerland (Paul Scherrer Institut). It also represents a significant step forward, as the number of the first tranche of instruments has increased to eight, with signed instrument agreements growing from two to six (with the first two being for LOKI and ESTIA).

Front cover news

Mara Capon, a student at the University of Edinburgh, is co-funded by ESS and ISIS through an ISIS Facility Development Student Grant. Her study into perovskites, an important class of materials, has been highlighted on the front page of Physica Status Solidi A.

In her study, Mara focused on the magnetic material $LaCoO_3$, observing it at up to 60,000 times atmospheric pressure. The idea was to observe how the structure of the matter would change at this kind of pressure, and the PEARL diffractometer at the ISIS Neutron Facility was designed to measure these changes at atomic level.

The electronic properties of $LaCoO_3$ are governed by subtle distortions of the atomic octahedra that build up the structure, and Mara was able to measure these with greater precision than ever before. This revealed behaviour that completely contrasted with earlier x-ray work, which is far less sensitive to the position of oxygen atoms. Her research has completely changed our understanding of the material's electronic properties.



She will now build on this work by developing a new pressure device called a diamond-anvil cell, which has the potential to extend these studies to far greater pressures than currently achievable. This new device will be able to achieve pressures exceeding 1,000,000 times atmospheric pressure, so measuring changes at these levels will offer insights on a whole new level.

Front cover of Physica Status Solidi A issue No.6, 2019.
Photo: onlinelibrary.wiley.com

Logistics Centre ready for operation

The Logistics Centre will be a vital part of the ESS facility, as all researchers will need to send their own materials and equipment for the experiments being carried out. Having a dedicated Logistics Centre ensures that everything can be handled appropriately and ensures that the process of carrying out research runs smoothly.

During 2019, the building became the first to be officially handed over from the construction partner, Skanska, to ESS. This was also the first building to become fully operational, so all goods to and from ESS now go through the Logistics Centre before further distribution.

The Logistics team has already moved to this new, permanent workplace, soon to be followed by the Quality Control and Radiation Protection teams. This represents yet another important step towards completion.

Medium energy beam transport ready for installation

ESS relies on its in-kind partners to deliver various crucial parts of the facility and the instruments within. During 2019, the medium energy beam transport (MEBT) was delivered to ESS in Lund after being designed and manufactured in Spain by ESS Bilbao. ESS Bilbao also manages Spain's in-kind contributions, which are helping to make the ambition of ESS a reality.

The MEBT is an elemental accelerator component and is a machine section in the normal conducting accelerator. This equipment will diagnose and optimise the proton beam for further acceleration on its way from the ion source to the super-conducting stages of the accelerator. The MEBT is packed with hundreds of sub-systems designed to shape the proton beam, as well as cleaning it from unwanted particles, and it forms an essential part of the early stages of acceleration.

This is just one of many in-kind contributions that ESS Bilbao has been involved with, with its other projects including the design, manufacture and delivery of several other key components, like RF systems, Target systems and the instrument MIRACLES.

"The highly qualified and competent ESS Bilbao team has from the very beginning worked very hard to assure a timely delivery of the MEBT, in spite of many challenges," says Mats Lindroos, Head of the ESS Accelerator Division.

ESS Support Laboratory calls for first scientific proposals

The main ESS facility is fast approaching completion, but there are some parts of ESS which are already fully operational. The ESS support laboratory for deuteration and macromolecular crystallisation, known as DEMAX, issued its first pilot call for proposals at the beginning of 2019, and has been providing materials for scientists all over the world since.

ZOË FISHER
GROUP LEADER DEUTERATION AND MACROMOLECULAR CRYSTALLISATION PLATFORM, ESS

The initial call for proposals marked a significant step forward for ESS, as the DEMAX support lab was officially complete and ready for initial operations. The support lab provides researchers with deuterated materials and services which are required for neutron scattering, and the work that's being done now will help prepare more efficient processes for when ESS is open for business.

"We're practicing the methods now, while growing our lab and the team. This means we can make sure we have the right equipment and systems in place before we start to work with ESS neutron experiments," says Zoë Fisher, Group Leader for Deuteration and Macromolecular Crystallisation Platform. "We're test-running things like the ESS user portal which will be used for people applying for beam time in the future as well, so everything we're doing now will help ESS in the long term. It's really interesting to define what we need from the bottom up."

Once DEMAX made the call for proposals, researchers from all over the world started to send in their plans and applications. There was a wide range of proposals with varying levels of complexity and viability, so a thorough review process has been put in place.

"First and foremost, we make sure the materials will be used for neutron research," confirms Zoë, "as this is important to our development. Then we analyse them in terms of safety, feasibility and whether there's a precedent. Then the proposals which pass this are reviewed externally, and they look at the potential scientific impact – is it interesting enough, and will it represent a leap forward in understanding?"

Building for the future

The systems and procedures that the team at DEMAX are helping to define now will be extremely useful for ESS in the long term, but the initial work being done here is helping in other vital ways. First, the proposal calls are activating the scientific community, and helping to create a bond between ESS and researchers around the world who are interested in neutron scattering. Second, it's helping to advance the scientific reputation of ESS itself through collaborations and scientific publications.

"The materials we have produced based on the first round of proposals are already making their way into published research," confirms Zoë. "It's exciting to see the materials we made here go on to be used for beam time experiments at other neutron facilities around the world, which will then be published or contribute to an exciting PhD. All of this early scientific output associated with ESS helps establish us in the community before First Science."

This community has already proposed a wide range of interesting research areas, with everything from drug delivery to cost effective measures to incorporate deuterium in proteins are covered. It's all science that is 100% applicable to ESS, and the next round of proposals will be based on producing materials for hot commissioning of instruments at ESS itself, helping to support First Science.

Advanced support

With First Science around the corner, the team at DEMAX are already preparing for the proposals on how scientists want to use deuterated materials on any of the first eight instruments.

"We're giving a longer execution time for this phase," explains Zoë. "This is partly because some materials can take up to two years to properly produce, but also because we want to give ourselves time to do more challenging things. We'd like some high-impact First Science, and some research that will make a real splash!"

The advanced instruments of ESS, together with the brightest neutron beam in the world, will allow major leaps in the way materials can be studied. It's already possible to predict that a machine like NMX will be able to do measurements in one day that would previously take four weeks, and there are even more potential breakthroughs that are impossible to foresee.

"Many facilities are limited in the sizes of proteins they can study," Zoë says. "Bigger proteins, protein complexes, and disease-relevant systems can't be studied today because there are no instruments suited for that. NMX is more flexible and can measure a much wider range of protein crystals than any instrument in operation today. I think this will lead to a much deeper understanding of human membrane proteins involved with disease, enable us to do systematic studies in normal neutron-sized crystals, and the study of complicated systems in small protein crystals."

With DEMAX already optimising essential processes, and with the life science and soft matter part of the scientific community already activated well in advance of First Science, it's clear that exciting, ground-breaking research will be carried out from the very beginning.

"It's great that we are doing something today for our future users," Zoë concludes, "and we take support seriously when it comes to our community. ESS as a whole represents a massive leap forward in neutron scattering, and I can't wait to see the performance and the kinds of science possible."

Highlights 2019

Q1

Seven buildings handed over to ESS, including Substation D05 which will support buildings D03, D04, part of D02 and H09 through its electrical switchgear, transformers, central sprinkler and other infrastructure

Swedish Minister for Higher Education and Research announces Swedish ESS Office to help research and industry accomplish groundbreaking discoveries

Campus interior design project plan starts, aimed at ensuring the best fit for all the building's various activities

Arrival of the first medium beta cryomodule prototype, designed and built jointly by IPN Orsay, CEA Saclay, and INFN LASA Milano, to be set up in test stand 2

Q2

Joint ESS – MAX IV Science Colloquia launches to highlight neutron and synchrotron radiation science for local science community

Newly established ESS Project Advisory Committee (PAC) convenes

MEBT (medium energy beam transport) arrives at ESS from in-kind partner ESS Bilbao in Spain

Ten-year anniversary of European Research Ministers' decision to build ESS in Lund and Copenhagen

Definition of the new ESS First Science milestone agreed as three instruments available for expert teams with first results publishable in peer-reviewed journals

This timeline reflects key events according to the current baseline.

Q3

Logistics Centre is first building to become fully operational

Safety Readiness review of Test Stand 2 done and application for trial operation permit for Normal Conducting Linac submitted to SSM

Installation begins for first instrument hardware (neutron guides) in the long beamlines

Swedish Liberal party leader, Nyamko Sabuni, tours ESS

Waveguide installation in the medium beta stubs completed

Radio-Frequency Quadrupole (RFQ) accelerating structure assembled and installed in accelerator tunnel

Delivery of first modulator for the warm linac from ESS Bilbao in Spain

Official handover of keycard for the long instrument hall

Q4

New organisational structure in place to facilitate ongoing activities and prepare for steady-state operations

Council approves Initial Operations plan for 2020–2025 and Initial Operations budget for 2020

ESS Data Centre in Copenhagen handed over to ESS

Tuning Beam Dump delivered to ESS

First radiation monitoring equipment installed and made operational in Test stand 2

Full paper on the first 15 instruments submitted

DMAX introduces system for preparing deuterated samples at ESS

ESS First Responder team appointed and trained

Four buildings handed over to ESS

Statutory Report

European Spallation Source ERIC
Org. no. 768200-0018


SKANSKA
SKANSKA
SKANSKA

ESS Expenditures Reach Across Europe

The following shows the expenditures (cash basis) at ESS during 2019 for ESS founding member and observer countries and other countries. The data is based on invoices paid for the period January – December 2019. The data includes all payments by ESS, including, but not limited to, commercial contracts, including construction costs related to the construction contract with Skanska, rental agreements, collaboration agreements, and travel.

SUPPLIERS 2019 BY COUNTRY		
	KSEK	KEUR
Austria	4	0
Belgium	189	21
Bosnia	504	56
Canada	606	67
China	152	17
Czech	2,891	321
Denmark	43,975	4,886
Estonia	7,240	804
Finland	9,809	1,090
France	111,016	12,335
Germany	85,319	9,480
Greece	22	2
Hungary	15,991	1,777
Ireland	80	9
Italy	7,289	810
Japan	28,722	3,191
Latvia	1	0
Luxembourg	7	1
Netherlands	399	44
Norway	210	23
Poland	2,435	271
Russia	584	65
Slovenia	622	69
South Africa	8	1
Spain	70,836	7,871
Sweden	1,386,394	154,044
Switzerland	5,143	571
United Kingdom	36,147	4,016
USA	6,986	776
TOTAL	**1,823,578**	**202,620**

Exchange rate: 1 EUR = 9 SEK

Governance, Management and Advisory Committees

Delegates to the ESS Council

The European Spallation Source ERIC Council is composed of up to two delegates from each Member Country in addition to a Chair and Vice Chair appointed by the Council.

Beatrix Vierkorn-Rudolph (Chair)

Kurt Clausen (Vice Chair)

Lukáš Levák
CZECH REPUBLIC

Petr Lukáš
CZECH REPUBLIC

Bo Smith
DENMARK

Jane Hvolbæk Nielsen
DENMARK

Toivo Räim
ESTONIA

Priit Tamm
ESTONIA

Emmanuelle Lacaze
FRANCE

Pascal Debu
FRANCE

Andrea Fischer
GERMANY

Sebastian Schmidt
GERMANY

László Rosta
HUNGARY

Balázs Kápli
HUNGARY

Eugenio Nappi
ITALY

Salvatore La Rosa
ITALY

Odd Ivar Eriksen
NORWAY

H.T. (Bert) Wolterbeek
THE NETHERLANDS

Erik van Aert
THE NETHERLANDS

Marek Jeżabek
POLAND

Mateusz Gaczyński
POLAND

Inmaculada Figueroa Rojas
SPAIN

Adolfo Morais Ezquerro
SPAIN

David Edvardsson
SWEDEN

Sven Stafström
SWEDEN

Martin Kern
SWITZERLAND

Christian Rüegg
SWITZERLAND

Mark Thomson
UNITED KINGDOM

James Partington
UNITED KINGDOM

ESS EXECUTIVE TEAM (EET)

Director General	**John Womersley**
Director for Project Support & Administration	**Agneta Nestenborg**
Director for Science	**Andreas Schreyer**
Technical Director	**Kevin Jones**
Associate Director for Environment, Safety & Health, and Quality	**Ralf Trant**
Associate Director for Strategy	**Sharon Cosgrove**
Project Director	**Mark Anthony**
Head of Operations Planning	**Dimitri Argyriou**
Head of Communications	**Martin Sjöstrand**
Senior Executive Assistant	**Karin Hélène**

ADMINISTRATIVE & FINANCE COMMITTEE (AFC)

(Chair)	**Neil Pratt**
(Vice Chair)	**Stéphanie Lê Vàn**
Czech Republic	**Ondřej Svoboda**
Denmark	**Morten Scharff**
Denmark	**Victoria Fuglsang-Damgaard**
Estonia	**Priit Tamm**
France	**Claire Lechevalier**
Germany	**Ingo Pfeil**
Germany	**Johanna Brandenburg**
Hungary	**Balázs Kápli**
Italy	**Ileana Gimmilaro**
Italy	**Antonella Tajani**
Norway	**Odd Ivar Eriksen**
Poland	**Michal Rybiński**
Poland	**Michal Wójtowicz**
Spain	**Guadalupe Córdoba Lasuncion**
Spain	**Javier Losada**
Sweden	**Johan Holmberg**
Sweden	**Leif Eriksson**
Switzerland	**Patrice Soom**
Switzerland	**Xavier Reymond**
United Kingdom	**Philippa Kingston**
United Kingdom	**Laura Sewell**

TECHNICAL ADVISORY COMMITTEE (TAC)

Chair **Alberto Facco**

TAC TARGET

Co-Chair	**Graeme Murdoch**
Delegate	**Eric Pitcher**
Delegate	**Masatoshi Futakawa**
Delegate	**Michel Butzek**
Delegate	**Francisco Martin Fuertes**
Delegate	**Jörg Welte**
Delegate	**Jürgen Neuhaus**
Delegate	**Szabina Török**

ICS

Co-Chair	**Mark Heron**
Delegate	**Eugenia Hatziangeli**
Delegate	**Roland Muller**
Delegate	**Cyrille Berthe**

Accelerator

Co-Chair	**Frank Gerigk**
Delegate	**Stéphane Chel**
Delegate	**Michael Plum**
Delegate	**Maud Baylac**
Delegate	**Igor Syratchev**
Delegate	**Shane Koscielniak**
Delegate	**Bernd Pedersen**

SCIENTIFIC ADVISORY COMMITTEE (SAC)

Chair	**Michael Preuss**
Delegate	**Sabrina Disch**
Delegate	**Kell Mortensen**
Delegate	**Fred E. Wietfeldt**
Delegate	**Monika Budayova-Spano**
Delegate	**Bela Farago**
Delegate	**Thomas Hellweg**
Delegate	**Regine Willumeit-Römer**
Delegate	**Bill Stirling**
Delegate	**Stephen Hull**
Delegate	**Martin Månsson**
Delegate	**Marie Plazanet**
Delegate	**Juan Colmenero de Leon**
Delegate	**Bella Lake**
Delegate	**Richard Dronskowski**
Delegate	**Giovanna Fragneto**

IN-KIND REVIEW COMMITTEE (IKRC)

(Chair)	Bjørn Christian Hauback
(Vice Chair)	Daniel Csanády
Czech Republic	Petr Šittner
Denmark	Søren Schmidt
Estonia	Rasmus Palm
France	Jean-Luc Biarrotte
Germany	Ulrich Breuer
Hungary	Daniel Csanády
Italy	Paolo Michelato
The Netherlands	Guy Luijckx
Norway	Erik Wahlstrøm
Poland	Adam Maj
Spain	Fiamma Garcia-Toriello
Sweden	Björgvin Hjörvarsson
Switzerland	Peter Michael Allenspach
United Kingdom	Robert McGreevy

PROJECT ADVISORY COMMITTEE (PAC)

Chair	Mark Reichanadter
Delegate	Diane Hatton
Delegate	Reinhard Brinkmann
Delegate	Christiane Alba-Simionesco
Delegate	Winfried Petry
Delegate	Stuart Henderson
Delegate	Lina Rodriguez Rodrigo
Delegate	Pedro Fernandes Tavares

COMMITTEE ON EMPLOYMENT CONDITIONS (CEC)

Chair	Beatrix Vierkorn-Rudolph
Delegate	Sebastian Schmidt
Delegate	Lukáš Levák
Host State Observer	Bo Smith
Host State Observer	Katarina Bjelke

ENVIRONMENT, SAFETY & HEALTH ADVISORY COMMITTEE (ESHAC)

Chair	**Paul Berkvens**
Delegate	**John Anderson**
Delegate	**Enrico Cennini**
Delegate	**Doris Forkel-Wirth**
Delegate	**Sam Jackson**
Delegate	**Frank Kornegay**
Delegate	**Katarina Norén**
Delegate	**Stefan Roesler**
Delegate	**Steven Wakefield**

CHAIR'S COMMITTEE (CC)

Chair	**Beatrix Vierkorn-Rudolph**
Vice Chair	**Kurt Clausen**
Delegate	**Salvatore La Rosa**
Delegate	**Odd Ivar Eriksen**
Host State Observer	**Bo Smith**
Host State Observer	**David Edvardsson**
Ex-officio	**John Womersley**
Ex-officio	**Florian Weissbach**

Statutory Administration Report

The Director General of European Spallation Source ERIC (Organisation Number 768200-0018), with its registered office in Lund, hereby submits the Annual Report for the financial year 1 January to 31 December 2019.

General information on the company

European Spallation Source (ESS) is an ERIC, a legal form of organisation which the European Commission has developed to facilitate major European research facilities. Through the establishment of European Spallation Source ERIC, ESS has acquired a legal status in all Member States and observer countries, enabling the countries to participate in decision-making and directly contribute to the funding. See also Notes, note 2.

ESS will be the world´s next-generation neutron source, and will be one of the most powerful spallation neutron source in the world when it is completed. The facility will be used for materials research in areas such as energy, health and environment, and will be of great importance in the long-term with regard to the competitiveness of Swedish and European research and industry. The facility is under construction on the outskirts of Lund and is scheduled to be in full operation with 15 instruments in 2026. The user programme for researchers is scheduled to begin in 2023 with a smaller number of instruments. The project is one of the largest research infrastructure projects in Europe, and is prioritised by the European Strategy Forum for Research Infrastructures (ESFRI).

ESS comprises activities at the facility under construction in Lund, Sweden, and the Data Management and Software Centre (DMSC), which is based in Copenhagen, Denmark. DMSC is operated by the Swedish company with its office in Copenhagen as "udenlandsk, anden virksomhed"/"overseas, other company".

At the turn of the year, the personnel comprised 509 employees from 55 different nations.

In addition to its own activities, ESS collaborates with partners from all over Europe and other parts of the world. ESS has 13 member countries: Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Norway, Poland, Spain, Sweden, Switzerland and the United Kingdom.

When the ESS user programme is in full operation, an estimated two to three thousand researchers from around the world will conduct experiments at the facility each year.

The construction project

During 2019, work has continued on maintaining the re-baselined schedule in order to be able to complete the project within the established cost framework. By 31 December 2019, 64% of the facility was finished.

ESS adheres to the permitted noise levels regulated in the environmental ruling and has special contact routes with the local residents to inform about ongoing and future work, and to receive any complaints. No complaints have been received during the year.

During the construction phase, rain water and drainage water from excavation pits are diverted to two of the three surrounding drainage companies via a delay reservoir located on the property. One of these three drainage companies leads on to Kungsmarken, a Natura 2000 area approximately one kilometre south of the property. No emissions of significant impact have taken place at the associated drainage companies during the period.

In-kind contributions

The ESS project is based on extensive collaboration with research institutions in partner countries, to exchange knowledge, personnel, and experience. ESS is expected to be partially funded through in-kind contributions (approximately 30% of the total estimated construction cost, 1.843 B€, 2013 price level), in particular, significant parts of the instruments, the target station, and the accelerator will be delivered as in-kind. During the year, extensive work has continued to secure in-kind collaborations with partner institutions across Europe. More than 100 institutions are now actively involved in the ESS project.

ESS is currently involved in 13 projects with EU support, two with regional support, and five with national support.

Environment, Safety & Health and Quality Divisions

The Environment, Safety & Health (ESH) and Quality (Q) Divisions play a key role in ESS, and shall ensure that safety and quality requirements are implemented throughout the organisation and during the actual construction of the facility.

All suppliers who have components or tools to be installed or used at ESS must ensure that their component fulfills the EU regulations regarding CE

marking. This applies to both external suppliers and deliveries from in-kind partners.

ESH ensures ESS's safety and environmental objectives for personnel and users, as well as the surrounding area. This is done by setting requirements regarding the design, installation, and operation of the facility, among other measures. ESH has an important duty in coordinating and leading the work in order to obtain the required permits from Swedish authorities. The largest and most important task is the permit for ionising radiation, which is being handled by the Swedish Radiation Safety Authority (SSM).

In 2019, ESS was granted a permit for commissioning of the ESS test facility for cryomodules (TS2), while trial operation of the first part of the ion source, which ESS received in 2018, was completed.

Information on risks and uncertainties

Active and structured Risk Management contributes to successful execution of the ESS project and fulfilment of ESS's overall objectives. The knowledge ESS accumulates in relation to risks is used to further develop ESS's management system, personnel, and project plans.

ESS has a risk management framework, which is described in two main documents: ESS Risk Management Policy and ESS Risk Management Process. The risk management policy describes in general why and how risk management work is to be carried out. The risk management process describes processes and flow charts, as well as criteria for how risks are assessed at ESS. In addition to these two documents, the Risk Management Plan specifies roles, responsibilities, and timeframes for risk-related activities within the organisation.

Risk management objectives

ESS has established the following risk management objectives:

- Frequent and open risk communication that enables a clear and shared view of risks and uncertainties within ESS, as well as among European partners, suppliers, etc.
- A continuously updated risk register for an overview of risks, uncertainties, and risk mitigation measures
- Reduced risk exposure through rapid and active application of measures.
- Focus on risks and uncertainties through effective risk reporting, internally and externally. Risk analyses should be based on qualitative estimates as well as quantitative calculations, and decisions are made after careful consideration of the results of such analyses, in combination with an impact assessment.

Risks and uncertainties

Any potential event that may affect ESS's overall objectives poses a risk. Risk identification and risk analysis are part of ESS's daily work, and aim at contributing to effective risk management by providing increased insight into the consequences of a particular risk, as well as the probability that it might occur. Structured risk analysis enables comparisons, simplifies risk communication, and is crucial in understanding whether a risk is acceptable or not. A number of accident scenarios have been analysed, and these form the basis of the classification work on which the design of ESS's safety system is based.

Risks are judged from several different perspectives:

Risks related to personal injury

Health and accident risks are assessed for all activities performed, and also cover the management of radiation safety when ESS is in operation. This also includes managing risks related to accidents during the construction phase. Processes and rules for the work environment at ESS's construction site have been established in collaboration with our contractors. The transfer of buildings from the contractor to ESS has begun, which creates new conditions that must be handled. As such, ESS takes greater responsibility and will continuously increase the proportion of the facility controlled by ESS and its personnel. This transition is managed in a controlled manner to ensure the highest possible level of safety.

Risks related to quality and function

Risks that could potentially impair the quality and thereby the function of technical structures, systems, and components are of great importance to ESS. To handle such risks, ESS has refined existing processes for configuration work during the year, and developed a new set of rules for design and installation work. Processes and systems for quality management and governance have been continuously developed and implemented with an increasing demand, and in consultation with the ESS management team.

Since May 2016, ESS has been a member of EFQM (European Foundation for Quality Management), and, through that network, is able to ensure a world-wide analysis of best practice in the area. Significant focus has been on compliance with the European Product Safety Directives applicable to ESS, and that these are also complied with by suppliers and collaborative partners.

Risks related to the environment and the surrounding area
ESS has the ambition of becoming the world's first major research facility with energy-sustainable operations, thereby paving the way for a new way of building and operating the facilities of the future. This means, among other things, that the facility will be energy efficient, that it will be supplied with electricity from renewable energy sources, and that some of the surplus heat will be utilised in the district heating network. Implementation is based on the energy policy with the energy concept "Responsible, Renewable, Recyclable" and with the goal of consuming less than 270 GWh of electricity per year.

Risks regarding society's view of ESS
ESS is committed to providing a positive social contribution to the local community in which the organisation is located; to operate the company as a responsible social actor; to respect the laws, customs and needs regarding the countries that contribute to the development, construction and operation of the research facility; to respect internationally recognised human rights; and to act in an environmentally responsible way by minimising the environmental impact of the activities. In this way, ESS actively contributes to sustainable development. Sustainability is one of ESS's four core values: *Excellence, Openness, Collaboration, Sustainability.*

By 2014, ESS had already established a code of conduct based on the 10 principles of the UN's Global Compact relating to human rights, working conditions, the environment, and anti-corruption, as well as the International Chamber of Commerce's rules on combatting anti-corruption. As such, ESS has undertaken to comply with these principles and rules. The ESS Code of Conduct encompasses all employees and others who have ESS as their permanent or temporary workplace. ESS also requires equivalent codes of conduct of external collaboration partners.

ESS evaluates its suppliers through competitive procurement processes in accordance with Article 23 of the European Spallation Source ERIC procurement rules.

ESS may not invite any supplier to submit a bid, or award a contract, if the supplier, or its board of directors, or any other person empowered to represent, decide, or control the supplier when they:

a) have been convicted of any of the following offenses in the last three years: participation in criminal organisation, corruption, fraud, money laundering, terrorist offenses, or a crime related to terrorist activity, child labour, or other forms of illegal trafficking;

b) failed to comply with current environmental, social, or labour laws in the last three years;

c) is guilty of gross professional shortcomings, which cast doubt on the supplier's or tenderer's integrity;

d) is involved in, or in the past three years has been involved in, a secret agreement; or where the organisation has knowledge of the occurrence of any of the following circumstances:
   - an unfair advantage that may distort competition as a result of the supplier's or tenderer's previous participation in the preparation of the procurement process in accordance with Article 28.4,
   - significant previous shortcomings in the performance of previous contracts awarded by ESS,
   - serious distortion of information submitted as part of a tendering procedure, or
   - if the supplier or tenderer is in bankruptcy, or is subject to insolvency or liquidation, or is in an equivalent situation arising from a similar procedure under the laws and regulations of a state.

ESS often requests proof of quality assurance and sustainability, in accordance with ISO 9001 or ISO 14001, or equivalent.

ESS's general procurement terms include requirements on anti-corruption. The supplier shall guarantee that no offer, payment, remuneration, or benefit of any kind which constitutes an illegal or corrupt practice has been, or shall be, made, either directly or indirectly, as an inducement or reward for entering into the contract or implementing the agreement.

Risks regarding timetable
Risks related to the ESS timetable concern the processes and activities that could delay implementation of the project plan.

Risks regarding annual operational costs
In order to achieve ESS's overall objectives, a number of requirements related to the annual operational costs are required. Risks in the form of, for example, maintenance and service, energy consumption, downtime, insurance premiums, and/or loss of property have therefore been identified. Plans and cost estimates for ESS's operations

phase have been developed during the year and was presented to the ESS Council.

Risks related to finances and funding
Understanding and managing risks that may have financial consequences in terms of exceeding the project budget are central to ESS, and are managed through established processes related to the identification and analysis of uncertainties in cost estimates. Each part of the project has its own budget, and each risk of exceedance is handled individually. Such measures are handled by the management team in a well-defined process.

The activities undertaken by ESS are funded by all members contributing to the financing. The remaining funding risks connected to the construction phase relate to reaching a hundred percent commitment, and bridge financing to secure the project's liquidity needs.

Personnel
All personnel working at ESS are required to comply with the ESS Code of Conduct. It consists of rules describing responsibilities and appropriate procedures for employees at ESS. The rules define business principles, values and norms, and appropriate behaviour for ESS personnel.

The Work Environment Policy at ESS states that well-being and health are important issues for the organisation. The Health and Well-being Policy is a clarification of the promotion of health and well-being work within ESS.

The main objectives of the Health and Well-being Policy are to prevent illnesses and accidents by:

- Making it easier for employees to be better aware of their health and to increase their own welfare.
- Facilitating access to physical and social activities, and encouraging ESS personnel to participate in these.
- Being an attractive workplace where people feel good and are satisfied with their work situation.
- Identifying physical and psychological risks with the personnel through different analyses, and taking preventive measures to minimise and reduce sick leave, both in the long- and short-term.

The diversity of our employees is our strength. We want to create an inclusive work environment where each employee is valued and individual achievement is recognised.

We do not tolerate discriminatory behaviour, either in recruitment or in our daily interaction with each other. We strive to develop the full potential of our employees, regardless of external conditions. To do that, we endeavour to identify and remove obstacles in our thinking and in our processes.

The diversity of the workforce and an open and appreciative culture are important success factors in a globalised world, and with over 500 employees from a total of 55 countries, cultural diversity is a well-established part of everyday life at ESS.

Since the relocation of the offices to the construction site in June 2018, ESS has introduced a drug and alcohol policy, in order to ensure a safe and healthy workplace.

The number of sick leave cases remained low in 2019.

Significant events during the year
In January, the BrightnESS^2 project started a continuation of the BrightnESS project. The project is over three years and focuses on ESS's long-term sustainability.

Several buildings were taken over by ESS during the year. Installation of the distribution part of the cryo-system began during the second quarter. In August, the new logistics centre was put into operation and in September the hall for the long instruments was inaugurated in connection with one of the two annual IKON conferences held in Lund. At the end of October, the ESS data hall was also inaugurated in Copenhagen. By the end of the year, 14 of 24 buildings had been completed and taken over by ESS.

With the takeover of one of the instrument halls, preparatory installations for the first instruments have been able to start.

The 10th anniversary of the decision to locate ESS in Lund was celebrated at the end of May.

In October, the new organisation to further strengthen the goal of starting research in 2023 was launched.

The design work on the target station building continues, as do the preparations for the installation of the actual spallation target.

Expected future development and significant risks and uncertainties
In the coming quarters, we expect to increase the purchase of components for the instruments that will be in the facility.

Since the United Kingdom left the EU, negotiations have started on the country's future relationship with the EU and as such indirectly with the EU legislation that

forms the basis for the membership of the European Spallation Source ERIC. However, the United Kingdom has previously announced its intention to remain as a member and thereby ratify the agreements and adopt the necessary national legislation.

The development of the company's financial performance and position

Net profit for the year amounted to –1,336 MSEK (–1,387). The result includes costs for personnel and consultants, as well as the administrative and technical infrastructure during the construction phase.

Equity amounted to 3,633 MSEK (3,045).

Investments

Investments were made during the year in fixtures and fittings and ongoing new facilities totalling 1,456 MSEK (780).

Financing and liquidity

During its fiscal year 2019, ESS received contributions from member countries totalling 1,923 MSEK (1,455). Further information on the contributions received can be found in Note 18. Cash and cash equivalents amounted to 1,929 MSEK (1,710) at the end of the period.

INCOME STATEMENT		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Net turnover	-	-
Gross profit	**-**	**-**
Administration expenses (Note 5, 6)	–505,046	–460,636
Research and development expenses (Note 6)	–839,461	–977,651
Other operating income (Note 7)	31,704	65,649
Operating profit	**–1,312,803**	**–1,372,638**
Financial income (Note 8)	3	0
Financial expenses (Note 9)	–22,935	–14,376
Profit before tax	**–1,335,735**	**–1,387,014**
Tax (Note 10)	-	-
NET RESULT	**–1,335,735**	**–1,387,014**

BALANCE SHEET		
KSEK	2019-12-31	2018-12-31
ASSETS		
Non-current assets		
Buildings (Note 11)	22,688	0
Land (Note 12)	64,250	64,250
Equipment, tools and installation (Note 13)	39,830	27,787
Construction in progress (Note 14)	4,771,313	3,360,501
Total non-current assets	4,898,081	3,452,538
Current assets		
Other current receivables (Note 15)	306,110	176,587
Prepaid expenses and accrued income (Note 16)	48,512	55,089
Cash and bank	1,929,169	1,709,626
Total current assets	2,283,791	1,941,302
TOTAL ASSETS	**7,181,872**	**5,393,840**

BALANCE SHEET (CONTINUED)		
KSEK	2019-12-31	2018-12-31
EQUITY AND LIABILITIES		
Equity		
Capital contribution (Note 18)	4,968,349	4,431,912
Net result	–1,335,735	–1,387,014
Total equity	3,632,614	3,044,898
Non-current liabilities		
Interest-bearing liabilities to credit institutions (Note 19)	3,000,160	2,007,530
Current liabilities		
Account payables	292,107	154,544
Other liabilities (Note 20)	37,710	23,509
Accrued expenses and prepaid income (Note 21)	219,281	163,359
Total current liabilities	549,098	341,412
TOTAL EQUITY AND LIABILITIES	**7,181,872**	**5,393,840**

EQUITY				
KSEK	Cash contribution	Previous year result	Net result	Total equity
Opening balance 2018-01-01	5,112,920	–2,135,658	-	2,977,262
Contributions	1,454,650	-	-	1,454,650
Net result 2018	-	–1,387,014	-	–1,387,014
Opening balance 2019-01-01	6,567,570	–3,522,672	-	3,044,898
Contributions	1,923,451	-	-	1,923,451
Net result 2019	-	-	–1,335,735	–1,335,735
CLOSING BALANCE 2019-12-31	**8,491,021**	**–3,522,672**	**–1,335,735**	**3,632,614**

CASH FLOW		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Operating activities		
Income after financial items	–1,335,735	–1,387,014
Adjustment for non-cash items	10,386	7,281
Cash flow from operating activities before changes in working capital	–1,325,349	–1,379,733
Cash flow from changes in working capital		
Increases (–) / Decreases (+) in current receivables	–122,946	–25,046
Increases (+) / Decreases (–) in current liabilities	207,686	–59,852
Cash flow from operating activities	–1,240,609	–1,464,631
Investment activities		
Acquisition of tangible fixed assets (Note 12,13)	–22,238	–18,268
Acquisition of construction in progress (Note 14)	–1,433,691	–762,073
Sales of land (Note 12)	0	3,750
Cash flow from investing activities	–1,455,929	–776,591
Financing activities		
Cash contribution	1,923,451	1,454,650
Change in interest-bearing non-current liabilities	992,630	2,007,530
Cash flow from financing activities	2,916,081	3,462,180
Cash flow for the year	**219,543**	**1,220,958**
Liquid assets at the beginning of the financial year	1,709,626	488,668
Liquid assets at the end of the year	1,929,169	1,709,626

Notes

NOTE 1: NOTES WITH ACCOUNTING PRINCIPLES AND COMMENTS ON THE ACCOUNTS

The annual report has been prepared in accordance with the Annual Accounts Act (*Årsredovisningslagen*) and the Swedish Accounting Standards Board BFNAR 2012: 1 Annual report and group consolidation (K3) (*Bokföringsnämndens allmänna råd BFNAR 2012:1 Årsredovisning och koncernredovisning* (K3)).

The company's registered office etc.

European Spallation Source ERIC (ESS) is a European Research Infrastructure Consortium, which is a legal entity and has its registered office in Lund, Sweden. The head office's visiting address is Odarslövsvägen 113 in Lund, with post box address P.O. 176, 221 00 Lund, Sweden. The company's corporate identity is 768200-0018.

Classification etc.

Fixed assets, long-term liabilities and provisions consist of amounts expected to be recovered or settled after more than twelve months from the balance date. Current assets and current liabilities consist of amounts expected to be recovered or paid within twelve months from the balance date.

Valuation principles etc.

Assets, provisions and liabilities have been valued at cost, unless otherwise stated below. ESS comprises the activities with the facility under construction in Lund, Sweden, and the Data Management and Software Centre (DMSC) in Denmark. DMSC is operated by the Swedish company with its headquarters in Copenhagen as "udenlandsk, anden virksomhed"/ "overseas, second company". For DMSC, monetary items in the balance sheet are valued at the rate when closing the accounts and profit and loss items at the closing rate for each month.

Tangible fixed assets

Tangible assets are recognised as assets if it is probable that future economic benefits will accrue to the business and the cost of the asset can be measured reliably. Property plant and equipment is stated at cost less accumulated amortisation and impairment losses. The cost includes purchase price and costs directly attributable to the asset to bring it on place and condition to be utilised in accordance with the intended purpose. Other additional expenses are expensed in the period they occur. The assessment of whether a subsequent expenditure is added to cost is whether the replacement of identified components or parts is capitalised. Additional components will be added and capitalised. Values of replaced components, or parts of components will be discarded and expensed in connection with the replacement.

Depreciation according to plan

Depreciation is based on cost less estimated residual value. Depreciation is linear over the asset's estimated lifetime.

The following depreciation schedules are applied:
Buildings 40 years
IT equipment 3–5 years
Machinery and equipment 5–7 years

Impairments

The recorded value of the assets at balance date is reconciled for any indication of impairment. If any such indication exists, the asset's recoverable amount is the higher of value in use and net realisable value. Impairment loss is recognised if the recoverable amount is less than the balance value. When calculating the value in use, future cash flows at a pre-tax rate are discounted to reflect the market's assessment of risk-free interest and risk associated with the specific asset. An asset that is dependent on other assets is not considered to generate any independent cash flows. Such assets are instead attributed to the smallest cash-generating unit where the independent cash flows can be determined.

An impairment loss is reversed if there has been a change in the estimates used to determine the recoverable amount. A reversal is made only to the extent that the assets balanced amount does not exceed the amount that would have been determined, after depreciation, if no impairment loss had been recognised.

ESS operates without profit in accordance with the requirements of the EU regulation relating to ERIC. Financing the future operation of the facility is planned to be achieved through contributions that ensure full cost recovery. This means that the assessment of external and internal indicators related to impairment

review according to K3 regulations for ESS, is taking into account ESS ERIC´s specific conditions. This specific application complies in all material respects with the principles and methods as expressed in the "*Utkast till redovisningsuttalande från FAR Nedskrivningar i kommunala företag som omfattas av kommunallagens självkostnadsprincip*", which thereby is applied similarly for ESS.

Receivables

Accounts receivable are recorded to the expected value to be received after deductions for bad debts, which are assessed individually.

Receivables and liabilities in foreign currencies

Receivables and payables in foreign currencies are converted using the closing balance rate. Exchange rate differences for operating receivables and liabilities are included in operating income, while differences in financial receivables and liabilities are reported among financial items.

Short-term investments

Short-term investments are valued in accordance with Annual Accounts Act (Årsredovisningslagen) to the lower value when comparing cost and fair value.

Financial instruments

A financial asset or financial liability is entered into the balance sheet when the organisation becomes a party to the instrument's contractual terms. Accounts receivable are recorded in the balance sheet when the invoice has been sent. Accounts payable are booked when the invoice is received. A financial asset is removed from the balance sheet when the contractual rights are realised, expire or the company loses control over them. A financial liability is removed when the contractual obligation is fulfilled or otherwise concluded.

Leasing

All leases are accounted for as operating leases. Leasing fees are expensed over the term of the usage, as well as with regard to benefits paid or received at the signing of the agreement.

Liquid assets

Cash and cash equivalents, immediately available bank balances and other money market instruments with original maturities of three months or less are converted to the closing balance rate.

Accounts payable

Accounts payable have a short expected duration and are valued at nominal value.

Employee benefits

Defined contribution pensions

Operational payments for defined contribution pension plans are recognised as an expense during the period the employee performed the services covered by the fee. Consequently, no actuarial assumptions for calculating the obligation or the cost are needed and there is no possibility of any actuarial gains or losses. The obligation is calculated without discount, except in cases where they are not entirely due for payment within twelve months after the end of the period during which the employees perform the related services.

Tax

The tax consists of current tax and deferred tax. Taxes are recognised in the income statement except where the underlying transaction is recorded directly against equity, whereby the associated tax effect is recognised in equity. Current tax is tax to be paid or received for the current year. This includes adjustment of current tax with taxes from prior years. Deferred tax is calculated using the liability method for temporary differences between the booked and the tax value of the assets and the liabilities. The amounts are calculated based on how the temporary differences are expected to be settled and by applying the tax rates and tax rules adopted or announced at the balance sheet date. Temporary differences do not take into account the differences relating to investments in subsidiaries and associates, which are not expected to be taxable in the foreseeable future. Untaxed reserves are reported including deferred tax liabilities. Deferred tax assets for deductible temporary differences and loss carry forwards are only recognised to the extent that it is probable that these will entail lower tax payments in the future.

Contributions

ESS is partly financed with cash and partly with in-kind contributions (non-financial contributions) from the member countries.

Cash contributions

Received contributions from members are recognised in equity in the balance sheet. See capital contributions in note 17.

In-kind contributions

The process for approving in-kind contributions are during the construction period performed by the Committee (In-kind Review Committee). The Committee reviews underlying agreements and recommends them to the ESS Council, with delegates from the member countries, for final approval. After approval it is required in order for the in-kind contributions to be recorded, finally documented agreements between the parties regarding the value of completed deliveries and signed contribution documents from the contributors.

NOTE 2: ASSOCIATED PARTIES WITH A CONTROLLING INFLUENCE

The Council is the governing body of the organisation and is composed of up to two delegates from each member of the organisation. The delegates may be assisted by experts. Each member is entitled to the number of votes equal to its contribution relative to the construction costs. Observers are entitled to participate in the Council but have no voting rights.

NOTE 3: SIGNIFICANT EVENTS AFTER THE END OF THE FINANCIAL YEAR

Preparations for the operational phase continue with planning of organisational changes and a timetable for their implementation. The transition to operations from construction will take place gradually over the coming years.

NOTE 4: EMPLOYEES, STAFF COSTS AND FEES TO THE AUDITORS

AVERAGE NUMBER OF EMPLOYEES

SWEDEN	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Men	321	303
Women	142	137
Total	463	440
DENMARK		
Men	26	19
Women	4	5
Total	30	24
TOTAL	**493**	**464**

GENDER DISTRIBUTION IN THE MANAGEMENT

	2019-12-31	2018-12-31
Management Directors and Director General	6	4
Whereof women	17%	25%

SALARIES, OTHER REMUNERATION AND SOCIAL COSTS		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Sweden	296,867	275,187
Denmark	26,239	22,035
TOTAL	323,106	297,222
Social costs	92,853	86,072
Pension costs	40,702	37,721
TOTAL SOCIAL COSTS	133,555	123,793
Salaries and other remuneration includes:		
to Director General	2,560	2,329
to Management Directors	9,093	5,653

ALLOWANCES TO MANAGEMENT DIRECTORS 2019				
KSEK	Basic salary	Other benefits	Pension costs	Total
Director General	2,511	49	592	3,152
Management Directors (7 pers.)	9,064	30	935	10,029
TOTAL	**11,575**	**79**	**1,527**	**13,181**

ALLOWANCES TO MANAGEMENT DIRECTORS 2018				
KSEK	Basic salary	Other benefits	Pension costs	Total
Director General	2,279	50	594	2,923
Management Directors (4 pers.)	5,611	42	946	6,599
TOTAL	**7,890**	**92**	**1,540**	**9,522**

Incentive scheme

European Spallation Source ERIC has no incentive scheme.

Severance pay to senior executives

In Director General and senior executives employment agreements there are no severance payments.

FEES AND REMUNERATION TO AUDITORS		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
PWC		
Audit assignments	475	475
Other assignments	981	1,850
TOTAL	**1,456**	**2,325**

Audit assignments involve examination of the annual report and accounts, other duties that are the responsibility of the Company's auditors to perform, as well as advice or other assistance arising from observations during such examination or implementation of such duties.

NOTE 5: LEASING FEES IN RESPECT OF OPERATIONAL LEASES		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Leasing agreements where the company is the lessee:		
Minimum leasing fees	21,048	21,071
Variable fees	42	48
TOTAL LEASING COSTS	**21,090**	**21,119**
Contractual future minimum leasing fees relating to non-retractable contracts which become due for payment:		
Within one year	20,913	19,275
Between two and five years	12,531	2,344
TOTAL	**33,444**	**42,619**

NOTE 6: DEPRECIATIONS		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Depreciation according to plan by asset:		
Buildings	–191	0
Equipment, tools and installations	–10,195	–7,281
TOTAL	**–10,386**	**–7,281**
Depreciation according to plan by function:		
Administration expenses	–1,883	–1,161
Research and development expenses	–8,503	–6,120
TOTAL	**–10,386**	**–7,281**

NOTE 7: OTHER OPERATING INCOME		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Exchange rate gain on receivables/liabilities of operations	4,465	20,688
Contributions for EU-Grants	18,453	44,961
Other income	8,786	0
TOTAL	**31,704**	**65,649**

NOTE 8: FINANCIAL INCOME		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Interest income	3	0
TOTAL	**3**	**0**

NOTE 9: FINANCIAL EXPENSES		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Interest expenses	–22,935	–14,376
TOTAL	**–22,935**	**–14,376**

NOTE 10: TAX ON INCOME FOR THE YEAR		
KSEK	2019-01-01 – 2019-12-31	2018-01-01 – 2018-12-31
Current tax	0	0
Deferred tax	0	0
TOTAL	**0**	**0**

ESS currently has costs that incur ongoing losses from an income tax perspective. Uncertainty regarding the possibilities and timeframe to make use of these is the reason deferred taxes have not been accounted for.

NOTE 11: BUILDINGS		
KSEK	2019-12-31	2018-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	0	0
Transfer from Construction in progress	22,879	0
TOTAL	22,879	0
Accumulated depreciation according to plan:		
Beginning of the financial year	0	0
Depreciation according to plan	–191	0
Closing balance accumulated depreciation	–191	0
TOTAL NET VALUE	**22,688**	**0**

NOTE 12: LAND		
KSEK	2019-12-31	2018-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	64,250	68,000
Sales	0	–3,750
TOTAL	**64,250**	**64,250**

NOTE 13: EQUIPMENT, TOOLS AND INSTALLATION		
KSEK	2019-12-31	2018-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	44,588	26,320
Acquisitions	22,238	18,268
TOTAL	66,826	44,588
Accumulated depreciation according to plan:		
Beginning of the financial year	–16,801	–9,520
Depreciation according to plan	–10,195	–7,281
Closing balance accumulated depreciation	–26,996	–16,801
TOTAL NET VALUE	**39,830**	**27,787**

NOTE 14: CONSTRUCTION IN PROGRESS		
KSEK	2019-12-31	2018-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	3,360,501	2,598,428
Acquisitions	1,433,691	762,073
Transfer to Buildings	–22,879	0
TOTAL	**4,771,313**	**3,360,501**

NOTE 15: OTHER CURRENT RECEIVABLES		
KSEK	2019-12-31	2018-12-31
VAT receivables	270,285	146,371
Other tax receivables	16,182	16,012
Contribution from members	19,408	13,834
Other	235	370
TOTAL	**306,110**	**176,587**

NOTE 16: PREPAID EXPENSES AND ACCRUED INCOME

KSEK	2019-12-31	2018-12-31
Prepaid rental costs	1,530	2,305
Prepaid insurance	16,538	15,764
Accrued income EU-project	21,025	32,921
Accrued interest	155	485
Other	9,264	3,614
TOTAL	**48,512**	**55,089**

NOTE 17: FINANCIAL INSTRUMENTS AND FINANCIAL RISK MANAGEMENT

Finance policy
In view of the phase in which ESS currently operates, no financial instruments are at present being used to hedge flows or the Balance Sheet.

Liquidity risks and interest rate risks
Cash surplus are placed in bank accounts or other equivalent.

Credit risks
Credit risks are considered limited, as the company's receivables consist of minor amounts.

Exchange rate risks
Exposure to exchange rate changes has been low and the exchange rate earnings that occurred during the year relates to exchange rate differences on account payables and bank balances mainly in EUR.

NOTE 18: CAPITAL CONTRIBUTION		
KSEK	2019-12-31	2018-12-31
Czech Republic	99,625	47,059
Denmark	1,281,781	996,867
Estonia	14,380	8,884
France	178,524	64,010
Germany	1,798,192	1,259,899
Hungary	32,024	29,927
Italy	223,432	0
Norway	299,785	282,287
Poland	61,121	48,692
Spain	9,213	0
Sweden	3,030,033	2,506,033
Switzerland	246,888	179,653
United Kingdom	370,410	298,646
TOTAL	**7,645,408**	**5,721,957**

NOTE 19: INTEREST-BEARING LIABILITIES TO CREDIT INSTITUTIONS		
KSEK	2019-12-31	2018-12-31
External loans	3,000,160	2,007,530
TOTAL	**3,000,160**	**2,007,530**

NOTE 20: OTHER LIABILITIES		
KSEK	2019-12-31	2018-12-31
Other	37,710	23,509
TOTAL	**37,710**	**23,509**

NOTE 21: ACCRUED EXPENSES AND DEFERRED INCOME		
KSEK	2019-12-31	2018-12-31
Accrued vacation salary	25,057	22,364
Employee taxes and social costs	6,462	5,866
Accrued salary tax	10,350	9,543
Accrued payments for EU-projects	50,395	29,741
Cash in-kind	104,038	76,544
Accrued interest	3,353	1,310
Other accrued expenses and deferred income	19,626	17,991
TOTAL	**219,281**	**163,359**

NOTE 22: CONTINGENT LIABILITIES AND PLEDGED ASSETS		
KSEK	2019-12-31	2018-12-31
Contingent liabilities	None	None
Pledged assets	None	None

The Council of European Spallation Source ERIC will decide upon the adoption of the financial statement and Annual report.

Director General certify that, based on my best knowledge, belief and understanding, the Annual Report is prepared in accordance with applicable accounting rules, the information provided is in accordance with the facts, and nothing of significance that could affect the image of the company as a result of the Annual Report, is omitted.

JOHN WOMERSLEY
ESS DIRECTOR GENERAL

European Spallation Source ERIC
Odarslövsvägen 113, Lund, Sweden

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