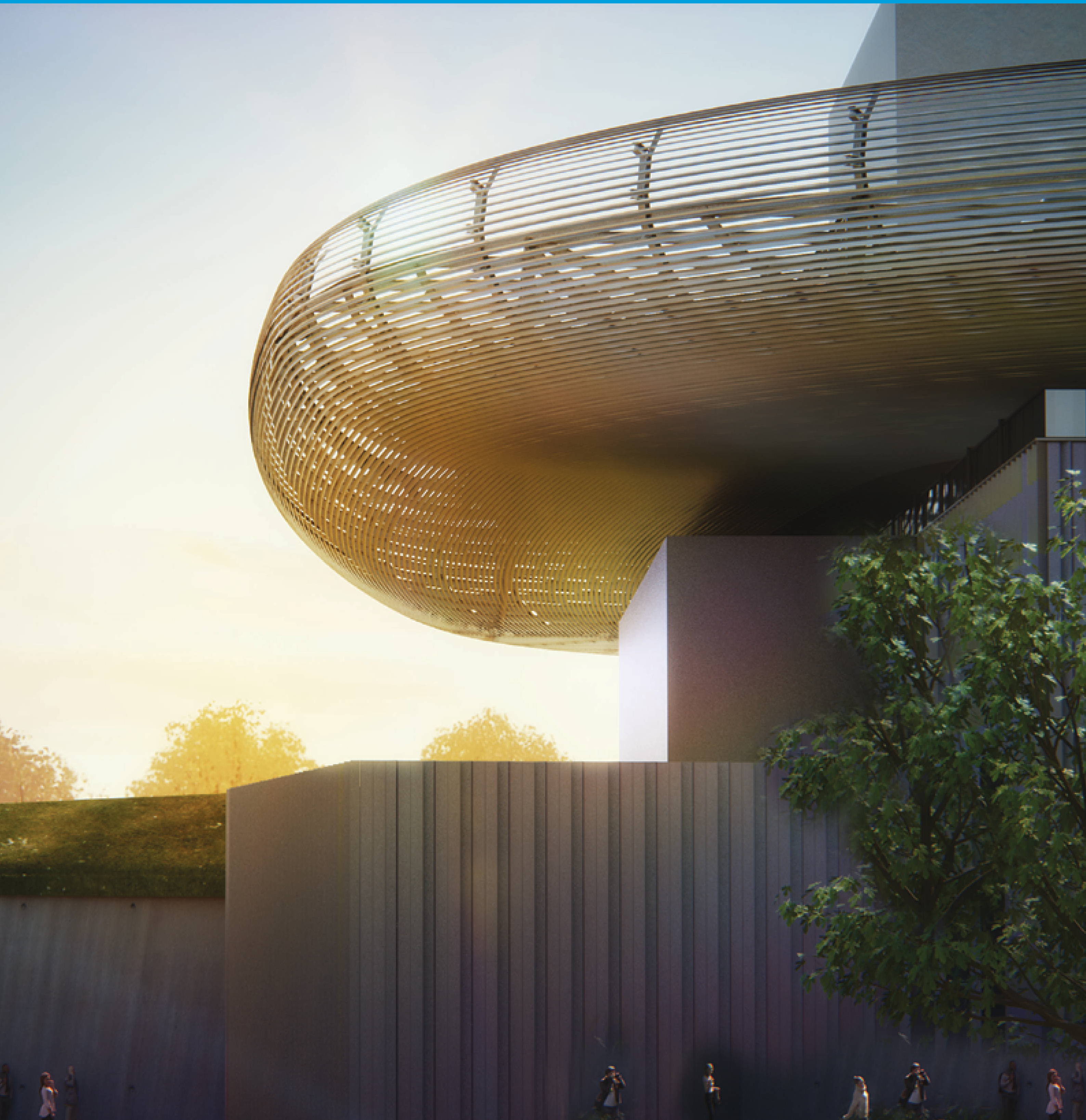
EUROPEAN SPALLATION SOURCE

ACTIVITY REPORT 2015



EUROPEAN
SPALLATION
SOURCE

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FOREWORD FROM THE DIRECTOR GENERAL

Looking back on the founding year of the European Spallation Source ERIC (ESS), the organisation and our supporters around Europe made a strong statement with the successful start of construction and with the establishment of the governance for the future.

With strong support from our stakeholders, ESS completed the transition to an international organisation and became a European Research Infrastructure Consortium. The Member countries are now jointly responsible for building and operating the world's leading research facility using neutrons for scientific research and industrial development.

The construction phase kicked-off following completion of the Technical Design Report in 2012. In 2013, we established collaborations with potential In-kind Partners and secured essential funding commitments from Member countries to begin construction in Lund, Sweden in 2014.

In 2015, there was a dramatic advance in facility construction with over 20% of the facility completed by the end of the year. We also built up the organisation, recruiting new directors for administration and science, while increasing staffing to over 350 employees. We completed over 20 design reviews of technical systems and interfaces, while building and testing prototypes of key accelerator and target equipment.

The ESS is happening all over Europe. In-kind Partners responsible for the delivery of technical systems are already in the execution phase of their respective work packages. In 2015, a collaboration of institutions responsible for the delivery of the instrument programme was formed. By the end of the year, ESS signed a Memorandum of Understanding (MoU) with the United Kingdom's Science and Technology Facilities Council for the delivery of two instruments, LOKI and FREIA.

In 2015, our organisation also conducted a comprehensive assessment of progress, the ESS Annual Review. Within the time frame this document is published, we will have already performed the Annual Review for 2016. These reviews focus the entire organisation and our Partners on key priorities for the year and on the delivery of the facility in line with expectations.

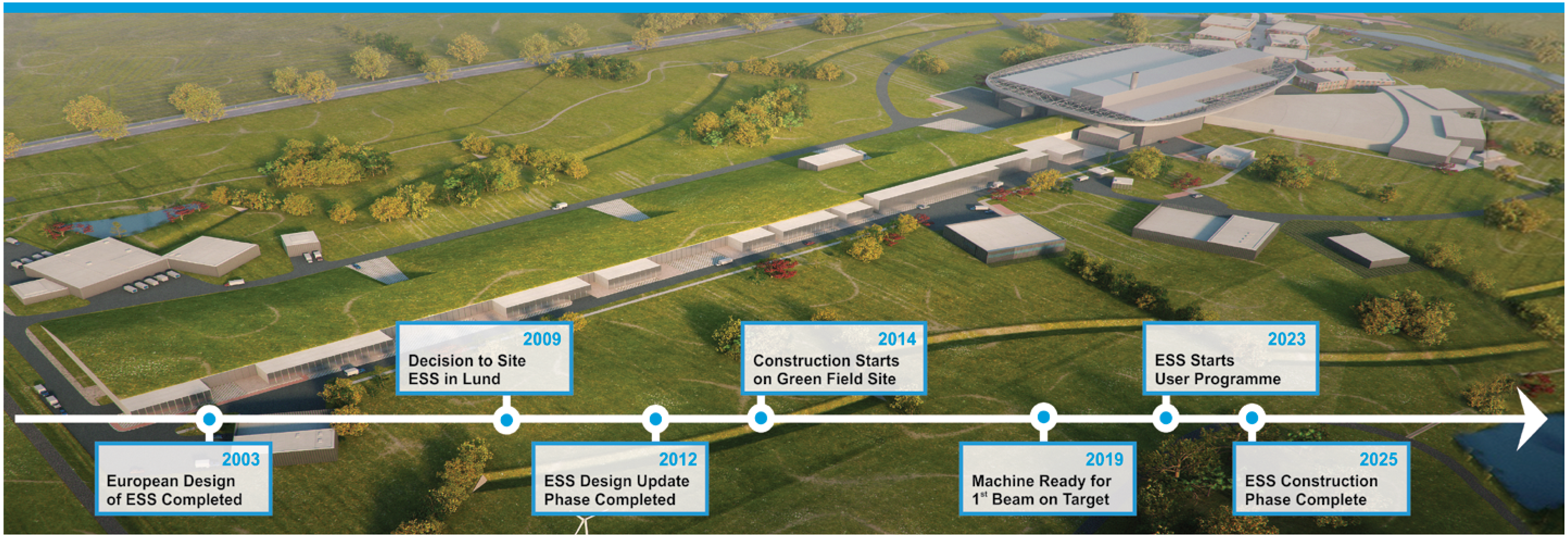
In this, our first annual Activity Report as an ERIC, are examples of our progress and pictures of the ESS people and Partners that are committed to making ESS a reality. Throughout this process we continue to embrace our core values of Excellence, Openness, Collaboration, and Sustainability.

I am proud of the progress we have made, and even more proud of the fact that we confront our many challenges together as a team. There is a shared commitment by the Council, Member countries, the Host countries, collaborating institutions, and all our stakeholders to move ESS forward on schedule, with the goal of an active user programme beginning in 2023.

James H. Yeck
ESS Director General

ABOUT ESS

NEUTRON BEAMS FOR SCIENCE



A USER FACILITY TO ENABLE SCIENCE

A New Facility

The European Spallation Source (ESS) is the ambitious story of a new facility being built on an established vision. Daily progress on the construction site and in the development of the technical components make it clear that ESS is, after 20 years in the making, is becoming a reality.

The entire research infrastructure of ESS is committed to the goal of building and operating the world's leading facility for research using neutrons. The ESS will deliver a neutron peak brightness of at least 30 times greater than the current state-of-the-art. Generating neutron beams for science will add value to a broad range of research, from life science and engineering materials, to heritage conservation and magnetism. This collaborative multinational project is also one of the largest science infrastructure projects being built in Europe today.

The ESS facility officially became a European Research Infrastructure Consortium or (ERIC) in October 2015, with Member countries throughout Europe. This next-generation research facility is being built through the collective effort of hundreds of scientists and engineers. Together, they have developed and specified the facility's technical design, which includes the Accelerator, the Target station, and instrument concepts. The construction of ESS formally began with the Groundbreaking ceremony on 2 September 2014.

Essential Elements

The facility design includes a 5 MW linear proton Accelerator, a rotating tungsten Target station, 16 state-of-the-art neutron instruments, a suite of laboratories, and a super-computing data management and software centre. The facility is being constructed on the outskirts of Lund. The Data Management & Software Centre (DMSC) is in nearby Copenhagen. Once fully operational, it is anticipated that two to three thousand guest researchers from universities, institutes and industry will participate in the ESS user programme each year, making use of the facility's broad range of neutron instruments to answer their specific scientific questions.

Neutron scattering encompasses a diverse range of experimental methods. Depending on how a neutron instrument is built, it can extract various kinds of information and answer different questions. The ESS organisation will collaborate with the international research community in order to ensure that the instrument suite meets the needs of science, enables the breakthroughs of tomorrow, and makes this this a facility built by scientists, for scientists.

The ESS project's foreseen milestones include: first on-site Accelerator installations in 2016, readiness of the Machine for beam on Target at the end of 2019, Machine installation for 2.0 GeV performance in 2022, the start of the user programme in 2023, and the completion of instrument construction in 2025.

Approved Instruments

A total of 16 instruments will be built during the construction phase to serve the neutron user community, with more instruments built during the operations phase. The ESS instrument suite will provide a 10-100-fold improvement over current performance, enabling scientists to utilise neutron methods to study real-world samples under real-world conditions.

The Neutron Scattering Systems (NSS) project at ESS is responsible for the development and coordination of state-of-the-art instrument concepts for ESS, in collaboration with international Partners. Almost 40 concepts were developed and evaluated. Of those, 16 concepts have now been selected and approved by the ESS Council for construction.

Collaboration

Even before the anticipated global-scale scientific impact can be realised during operations, ESS has a direct economic impact. The project generates economic growth and jobs, advances development, and fuels innovation potential in the Öresund region and across Europe. With the ESS being built as a collaborative project, the growth effect will be shared between the Host countries, Sweden and Denmark, and all of the ERIC Partners and collaborations Partners.

The realisation of ESS enables access to frontier technology, experienced technical and scientific staff, as well as unique production facilities and technologies, which would otherwise be unattainable.

The ESS will be an attractive and environmentally sustainable compound with research and laboratory buildings and office space designed to make make an impact on the world stage.

THE ESS PROJECT

The European Spallation Source is one of the largest science infrastructure projects being built in Europe today. The ESS facility will be the world's leading neutron source for the study of life and materials sciences, soft condensed matter, magnetic and electronic phenomena, energy, engineering materials and geo-sciences, archaeology and heritage conservation and fundamental and particle physics. The ESS source will be a key instrument for addressing the grand challenges which society faces today by making it possible to access novel insights on matter at the molecular and atomic levels and applications to energy, carbon sequestration methods, health issues at the biological level, as well as drug development and delivery strategies, plant water-uptake processes of relevance for agriculture, new data storage materials, and much more.

SCIENCE TO SOLVE GRAND CHALLENGES

The research needs of the neutron science community will play a role in addressing and solving some of the grand challenges that society faces today. Research will have impacts on areas such as: energy, materials and life sciences, magnetics and electronics, fundamental physics, and cultural heritage.

Scientific Impact

To meet the challenges of our age and uncover the fundamental secrets of nature, we are increasingly dependent on the properties and behaviour of matter at the atomic and molecular level. The number of required techniques to probe matter is also increasing to keep up with the growing demands of society as well as the new matter complexities being uncovered and designed. Progress depends on the clarity provided by continually advancing techniques, and methods that constitute this unique science tool kit using neutrons to study nature.

Neutrons have wavelengths and energies allowing us to obtain information on structural patterns without the effects of beam-damage caused by electron or X-ray probes. However, despite the power of neutron beams, they also have relatively low brightness compared to modern X-ray and electron sources. Most neutron sources are based on nuclear reactors, but this technology has reached its limit in producing maximum beam brilliance. The method of Spallation, the effect of essentially boiling off neutrons from high atomic-number elements, is 10 times more efficient than fission, and has the potential of providing much more effective scientific capabilities for research.

The ESS source will deliver a peak brightness that is at least 30 times greater than any other neutron source in the world, providing a quality of vision of the inner working of matter that will be at least that much greater. The uniquely long-pulse time structure of ESS will enable measurements over a wider temporal and spatial dynamic range, providing distinct advantages over present neutron instrumentation. Thus, ESS is a truly novel facility with the capability to transform the way we use neutrons.

Soft Matter

The ESS facility will surpass the limits of current neutron to better understand soft matter substances known as polymers and colloids, which are the foundations of blossoming technologies such as pharmaceuticals, detergents, cosmetics, and batteries that impact our everyday lives.

Chemistry of Materials

Society needs better catalysts, improved construction materials, more efficient energy materials, and more effective pharmaceuticals. The ESS facility will enable better exploration of material complexity, the issues associated with predicting behaviours, and the challenges of measuring both structure and dynamics as a function of time.

The ESS user community will make breakthroughs in materials chemistry by looking at materials in operando in catalytic converters, batteries and fuel cells. Research at ESS will track the evolution of dynamics, atomic structure, and important changes in microstructure in action for the first time. This record of materials chemistry in realistic conditions with unmatched clarity will allow progress in material design and development.

Novel Quantum States

Novel quantum states in magnetic and electronic materials are new and exciting scientific frontiers. They challenge our understanding of the states of matter, and will be at the core of future functional devices that will furnish our households, offices, and factories.

Understanding the magnetic order and excitations of these novel phases is uniquely accessible by neutrons. Here the magnetic order is either short-ranged or exhibits very long periodicity, making it challenging for resonant X-ray magnetic scattering methods. At ESS, all relevant energy and length scales required to understand such materials will be measured simultaneously for the first time.

SCIENCE FOR TOMORROW
ESS engages in a wide range of scientific activities, thus ensuring that the development of the facility is driven by research needs that will serve tomorrow's scientific community.

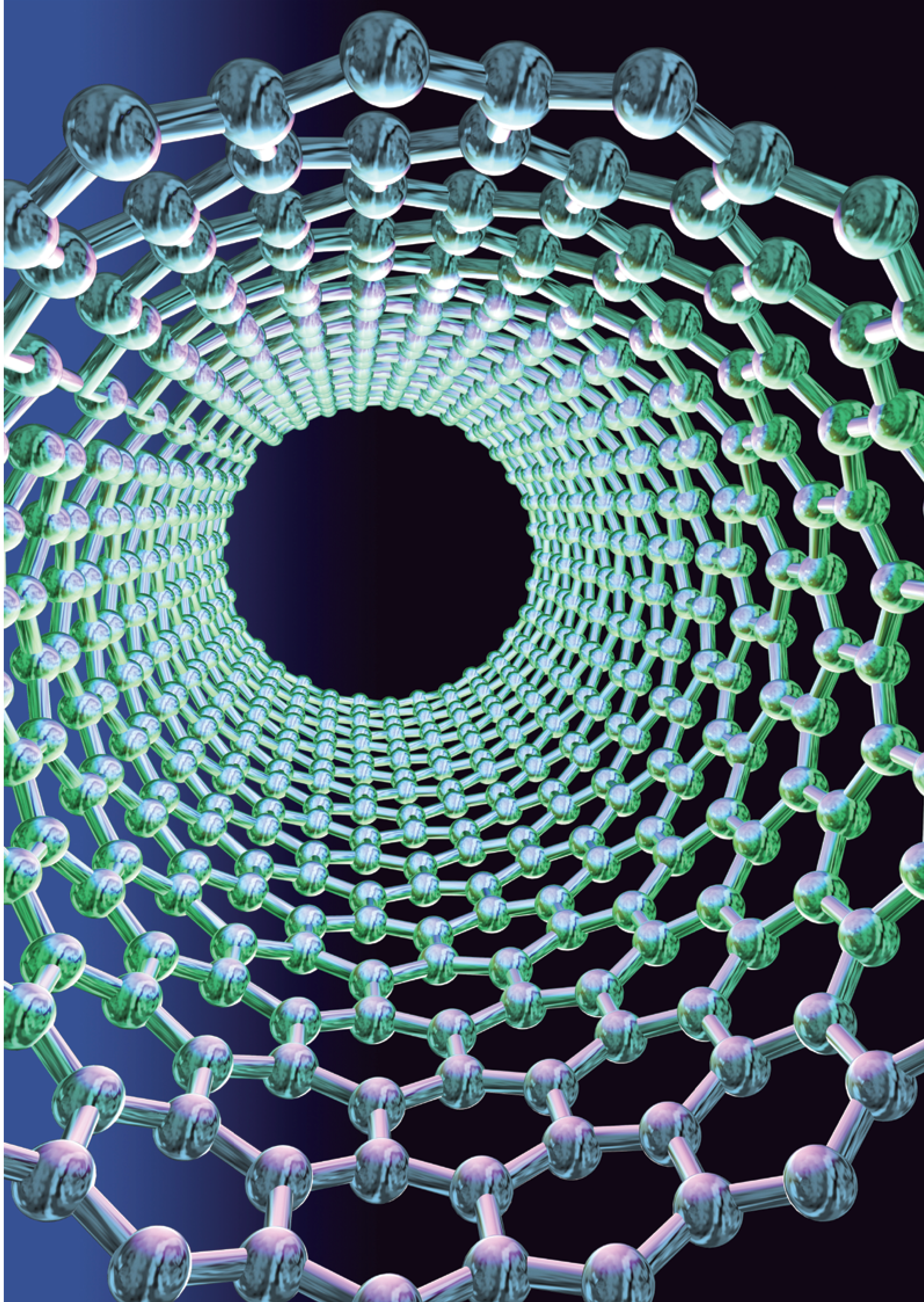
Life Science

The untapped potential of neutron sources will significantly impact life science research. The use of neutrons for studying biological systems is growing, and ESS will edge closer to the level where neutron experiments can be made in a timely manner without the concern of radiation damage.

The ESS facility will enable investigations of rare biological samples in small quantities, both crystallised and in solution. Unlike X-rays, the non-invasive properties of neutrons leave the sample undamaged, enabling single-sample, time-resolved investigations. The brightness of ESS will also increase the throughput and enable more comprehensive systematic parameter analyses, which are in high demand from the pharmaceutical industry. The ESS will unleash the unique investigative power of neutrons on the chemistry of life.

Current trends in biomedical research reveal a need to understand greater complexity. The higher neutron brightness of the ESS will allow better examination of the structure and dynamics of of complex macromolecules in dilute concentrations.

The ESS facility will modernise neutron research methods, opening up new possibilities for studying smaller, more complex samples and recording of processes under real- world conditions in a wide range of scientific fields.



OUR MISSION AND CORE VALUES

Mission

To design, build, and operate the world's leading research facility using neutrons for science and innovation.

Excellence

We provide the world's leading neutron science facility and world-class support for the science community. We advance the use of neutrons in science and technology by supporting and developing instrumentation and tools for the highest quality application of neutrons in research. We always aim for scientific, technical, and operational excellence in the safest environment.

Collaboration

We are an integral member of European society and we engage with the scientific and industrial communities to help build and operate ESS. In our everyday work and all our interactions, we seek to build and maintain relationships that create a shared sense of ownership among our stakeholders. Internally and externally we are committed to act and speak with one voice, as one ESS.

Openness

We perform our work in an open and transparent manner. In this way we build trust with our partners, our stakeholders, and with each other. We are willing to collectively and directly address challenges, and celebrate success. We demonstrate on all levels, internally and externally, that we stand for what we say in the way we act.

Sustainability

We act and make decisions with a long-term perspective and strive to safely and responsibly use natural, human, and monetary resources. We take the full life cycle of ESS into account, and view sustainability from environmental, social, and economic perspectives.

A EUROPEAN RESEARCH INFRASTRUCTURE CONSORTIUM (ERIC)

The European Spallation Source is the first ERIC established in Scandinavia and the 11th in Europe. The designation grants the ESS legal status in all of the Member countries, enabling them to participate in the governance and directly contribute to the financing of ESS.

ERIC Plate Ceremony with Danish Minister Esben Lunde Larsen, Robert-Jan Smits, Jim Yeck, Lars Börjesson and Swedish Minister Helene Hellmark Knutsson

Founding Members and Observers

The Founding Members are the Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Norway, Poland, Sweden, Switzerland and the United Kingdom. Belgium, the Netherlands and Spain, joined as Founding Observer countries and plan to become Members in the near future.

The European Spallation Source ERIC is governed by statutes adopted by its Member countries, which concern governance and operational guidelines, membership, funding, and contribution to the organisation, as well as the rights and obligations of the Members. The ESS organisation has adopted its own procurement rules, based on transparency, non-discrimination, and competition.

Appointed Leadership

The Director General of the European Spallation Source ERIC is James H. Yeck and the Chair of the European Spallation Source ERIC Council is Professor Lars Börjesson.

Committees

The committees established by the ERIC Council serve as advisors to the Council. These include the Administration and Finance Committee (AFC), Scientific Advisory Committee (SAC) and Technical Advisory Committee (TAC), In-Kind Review Committee (IKRC), Committee on Employment Conditions (ECC), Environmental Safety & Health Advisory Committee (ESHAC), Conventional Facilities Advisory Committee (CFAC) and the Annual Review.

The Transition to ERIC

The European Spallation Source ESS AB was set up as a limited liability company in 2010, and the staff of ESS Scandinavia were transferred from the University of Lund their initial hub of operations. To build and develop ESS, many of the critical skills needed to be imported through In-kind Contributions (IKC) from participating institutes and companies in the Member countries. To establish a legal framework for this, the European Spallation Source ESS AB completed a transfer of assets, obligations, and personnel to the European Spallation Source ERIC on 1 October 2015. The ESS AB will be dissolved after 2015.

A European Research Infrastructure Consortium (ERIC) is a type of legal entity created by the European Commission for governing international research facilities. On 8 September ESS officially became an ERIC. The European Commission's Director-General for Research and Innovation, Robert-Jan Smits handed over the official 'plate' of the ERIC from the Commission to ESS during of a ceremony on the construction site.

"The European Spallation Source is one of the most impressive European Research Infrastructures and has obtained the prestigious ERIC status," said Smits "The timely completion of ESS enables Europe to maintain its position as the leader in neutron-based research and provides a multidisciplinary centre for innovation and competitiveness."

The new facility will be the world's leading facility for research using neutrons and one of the highest priority research infrastructure projects in Europe. The EU has approved projects for the ESS under its Horizon 2020 programme for more than €20 million, including the project BrightnESS project up of 18 European institutes and universities from 11 countries and spans over 36 months.

Lars Börjesson, Council Chairman

ORGANISATIONAL GROWTH

The construction of the material research facility ESS is not the only thing progressing rapidly at the construction site on the outskirts of Lund. In order to realise the world's leading facility for research using neutrons, ESS staff has grown at a steady pace and attracting talent from all over the world.

ESS staff

Growing Staff

Earlier in the year, ESS celebrated the hiring of its 300th employee and the 40th nationality represented by ESS staff members. ESS has come a long way from the time when the Swedish government established the ESS-Scandinavia Secretariat in 2007, with only seven employees. By the end of 2015, ESS reached a total of 353 staff representing 46 countries. This development with a growing number of employees means that there is a lot of in-house competence which is further enriched through external collaborations with Partners.

The ESS project evolved rapidly following the 2009 decision to build the facility in Lund, and continues to expand. ESS added a third of its workforce in 2014, growing by 111 employees. Altogether ESS will have approximately 500 employees when the material research facility delivers the first neutrons by the end of the decade. In an effort to find the best talent, ESS strives to recruit employees from all over the world.

YOUNG PROFESSIONALS

The ESS is also very proud of their continuing commitment to developing young professionals, with the Spanish Junior Professional Programme. Fifteen young graduates from Spain have gained valuable work experience as trainees, holding positions within different divisions, and making important contributions to the ESS project. Most participants have chosen to extend their trainee programme for an additional half year, with three staying even longer and becoming ESS employees.

Spanish Young Professionals

New Management at ESS

The past year saw significant changes for ESS management. Agneta Nestenborg took charge of the ESS Project Support & Administration Directorate on 1 September. Her job is to ensure that the strategic planning, development, and implementation of processes and procedures are on-schedule for the ramp-up to cold commissioning at the end of 2019.

As the former Head of Project Sponsors Nuclear Operations at the Swedish energy utility, Vattenfall, she comes to ESS with experience in R&D, management, operations and governance across a wide range of industries that include science, construction, consulting, nuclear technology and others.

Agneta's experience and extensive network within the Swedish industry and authority communities will be very valuable for the organisation as it transitions into the ERIC, facing a variety of challenges and opportunities.

The ESS Director General and Project Directors.

"I have had the benefit of working in many different areas. I hope to make good use of everything I've done, as the new Administration Director for ESS." – Agneta Nestenborg

Another important addition at the end of 2015 was the naming of Andreas Schreyer as the new Director for Science at ESS. Schreyer, A career neutron scientist and former Director at HZG's Institute for Materials Research, Schreyer has long been active in the ESS collaboration in his role spearheading the German contribution to the project. His management experience at large scale neutron and synchrotron facilities and his strong history and interest in supporting collaboration on instruments make Andreas an asset for the ESS Executive Management Team.

ANNUAL REVIEW

The 2nd Annual ESS Project Review took place over 4 days in April and provided a deep look to measure how progress on the technical and managerial aspects of the project match up to the commendable pace of the civil construction. The two must be closely coordinated to avoid delays.

Marzio Nessi, Chairman Annual Review

A Comprehensive Assessment

The review covered nine core project areas – from technical and scientific, to managerial and financial – and took in the analysis and recommendations of more than 30 external experts. The overall evaluation by the 2015 committee was positive, describing ESS as a "rolling machine that will reach its target."

"The project is ballistic. It went from the initial phase of defining itself, to now it's in execution." -Marzio Nessi

The committee singled out the rapid personnel growth, and the "impressive" development of the project's unique In-kind model. They also highlighted the resilience of the ESS technical design and the aggressive schedule. An action plan was developed to address the recommendations made by the committee.

ESS Technically Sound

Technical obstacles did not figure prominently in the recommendations, and the committee made the observation that there were no "showstoppers" in this area. As the first facility installations on the schedule, progress on Accelerator systems was placed in the spotlight. Expediting the formal design review process and strengthening the on-site technical review of In-kind work packages were highlighted as key recommendations for moving collaborations forward.

"I think [the review process] is fundamental," said the review committee chair, Professor Dr. Marzio Nessi of CERN, summarising the four-day regimen. "This is part of our culture, of scientific culture, where international peer reviewing is the fundamental basis to make sure that everything is justified. It is now part of all scientific projects on the planet."

Ramping Up for 2016

The earned value of the ESS project is being tracked using 20,000 individual activity parameters, and reveals, among other things, that the project was about 11% complete relative to its estimated 2025 closeout cost by the time of the review. The next two years will see a sharp rise in completion of these activities, and this number is expected to rise to around 50%. Additionally, it is anticipated that more than half of all In-kind Agreements – 120 Technical Annexes totalling around €400 M – will be signed by the end of 2015.

The year 2016 will see the reach of the ESS project extend deeply into the Partner countries, with returns in the form of component optimisation, development, and installation on the Accelerator, Target, Integrated Control System (ICS), and Neutron Scattering Systems (NSS) projects in 2016 and 2017.

The general impression from the Review was:

- Very positive, impressive progress. We now have a real project.
- ESS is now a rolling machine, which will reach its target.
- ESS is defining how to deal with In-kind. A very impressive progress in this area.
- Schedule is very tight, but not impossible
- More than 100 people have joined ESS in 12 months
- Technical problems are finding solutions
- We are seeing an increase in the amount of detail to deal with.
- Operation begins to be an integral part of the overall project.

RECOMMENDATIONS

The results of the 2nd Annual Project Review singled out impressive development and found no "major technical problems."

The nine sub-committees emphasised the need to firm up the high-level integration between the project areas, while at the same time defining the mechanisms for operational-level integration.

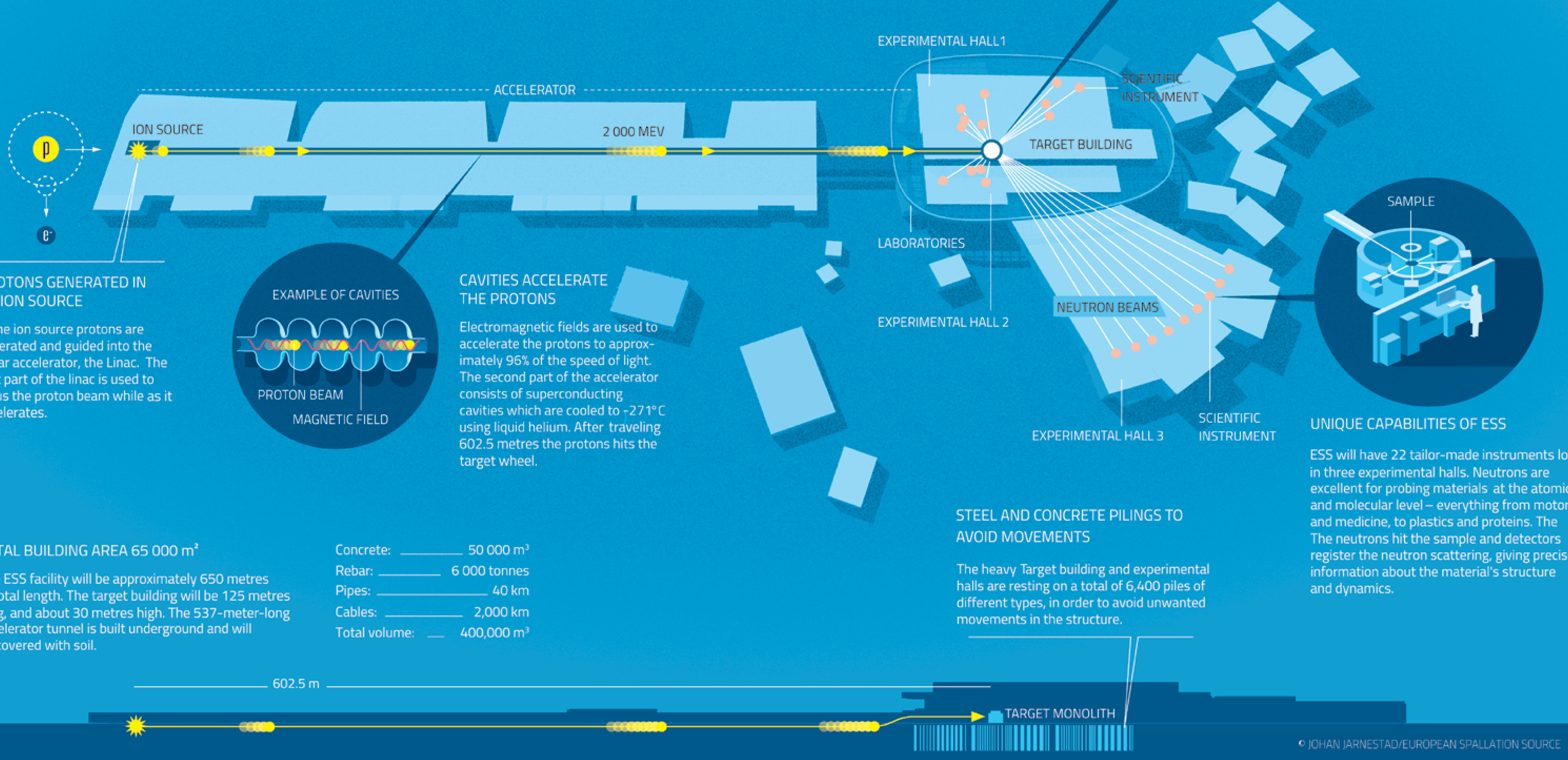
The committee recommended constructive actions including: aggressive personnel recruitment and training in engineering areas, using cross-functional personnel, and further clarification and leveraging of the In-kind model.

The European Spallation Source

The European Spallation Source (ESS) is a multi-disciplinary research centre based on the world's most powerful neutron source. ESS will give give scientists new possibilities in a broad range of research, from life science and engineering materials, to heritage conservation to magnetism. ESS is a pan-European project, with Sweden and Denmark seving as host countries. The main research facility is being built in Lund, Sweden, and the Data Management and Software Centre (DMSC) is located in Copenhagen, Denmark.

THE TARGET IS THE NEUTRON SOURCE

When the accelerated protons hit the rotating tungsten Target wheel spallation occurs and neutrons are scattered from the tungsten nucleus. The more neutrons produced and collected in the Target, the "brighter" the neutron source. The neutrons are directed through moderators and neutron guides to the scientific instruments where they are used for experiments. The Target monolith consists of the Target wheel, modera-tors, a cooling system, and shielding, and weighs approximately 3,000 tonnes.



PROTONS GENERATED IN AN ION SOURCE

In the ion source protons are generated and guided into the linear accelerator, the Linac. The first part of the linac is used to focus the proton beam while as it accelerates.

CAVITIES ACCELERATE THE PROTONS

Electromagnetic fields are used to accelerate the protons to approx-imately 96% of the speed of light. The second part of the accelerator consists of superconducting cavities which are cooled to -271°C using liquid helium. After traveling 602.5 metres the protons hits the target wheel.

UNIQUE CAPABILITIES OF ESS

ESS will have 22 tailor-made instruments located in three experimental halls. Neutrons are excellent for probing materials at the atomic and molecular level – everything from motors and medicine, to plastics and proteins. The The neutrons hit the sample and detectors register the neutron scattering, giving precise information about the material's structure and dynamics.

TOTAL BUILDING AREA 65 000 m²

The ESS facility will be approximately 650 metres in total length. The target building will be 125 metres long, and about 30 metres high. The 537-meter-long accelerator tunnel is built underground and will be covered with soil.

Concrete:	50 000 m³
Rebar:	6 000 tonnes
Pipes:	40 km
Cables:	2,000 km
Total volume:	400,000 m³

STEEL AND CONCRETE PILINGS TO AVOID MOVEMENTS

The heavy Target building and experimental halls are resting on a total of 6,400 piles of different types, in order to avoid unwanted movements in the structure.

CONSTRUCTION

MOVING FORWARD

CONSTRUCTION PROGRESS

ESS Site Development

The ESS civil construction project broke ground in 2014 as one of the largest research infrastructure projects in Europe. There has been much progress with the Accelerator tunnel nearing completion, and the complex foundation work for the Target station well advanced. The completion of these works will make way for focus to shift onto technical installations.

Conventional Facilities Activities

Conventional Facilities (CF) at the European Spallation Source refers to the spaces required to house research equipment, machines, instruments, and people. CF are also responsible for the mechanical and electrical services necessary for the proper functioning of the facility.

The overall goal of the CF project is to deliver the physical space for a research facility in a sustainable way, on-budget, on-schedule, and with the proper function and quality.
Over the last two years, the work in CF has been marked by the following major activities:

- The licensing process,
- Building design,
- Procurement of the construction contract,
- Site investigations,
- Construction works, and
- Development of the energy concept.

Construction Update

The physical change of the ESS construction site over the last 12 months has been dramatic. The flat brown landscape of earthworks and concrete reinforcement has morphed to a buzzing, three-dimensional hive that now includes a power and drainage installation, interior finishing and roofing, and the continual work of foundation piling, concrete casting, and new excavation.

By the end of 2015, nearly 14,000 cubic meters of concrete have been put in place for the Accelerator tunnel alone. More than 4,000 concrete, steel core, or bored piles have been sunk for the Target station and Experimental Halls foundations. Construction on almost half of the buildings has commenced and the base slab of the tunnel is almost complete. The project's on-site workforce grows rapidly, having nearly tripled in the last 12 months. There are now approximately 340 on-site workers representing 15 nationalities, including nearly 200 construction workers, among others from companies based in the UK, Sweden, Poland, Estonia, and Lithuania.

"It's always uplifting to see how fast progress at the construction site is going." -James H. Yeck

Director General of ESS, James H. Yeck puts strong emphasis on the development of the construction work. By the end of 2015, the ESS project had reached more than 20% completion. "What is more difficult to see is the momentum across the project as a whole," he went on to say, "This is absolute progress and it's apparent that the pace is picking up. That energises us here in Lund and our Partners working across Europe."

The project's critical path dictates early focus on the Accelerator tunnel and adjacent areas. This is followed closely by the Target area, including buildings, installation tunnels, and the demanding monolith and hot cell foundations. Very critical will be the bunker interface between the Target and the Experimental Halls. The Experimental Halls, the instrument Beamline Galleries, and then the laboratory and campus buildings will be the last structures to complete.

Front End Building Casting

Building the Accelerator Tunnel

The finished 537-meter-long Accelerator tunnel will come and go from sight quickly, as it will be buried under five to six meters of earth. Completion of the vault is anticipated for early 2016, with backfill and topfill already underway. The tunnel walls have been completed, extending from the Front End Building to the Target Station beam dump. Interior work has also been ongoing for several months, including interior painting and floor polishing.

The large Klystron Gallery Building is being built in stages. It runs alongside the tunnel for most of the tunnel's length and the two are connected by 27 two-storey concrete "stubs". Construction of large areas of the Gallery Building, including the four-storey 'cold box' section, have progressed to interior and roofing works. Mechanical, electrical and plumbing (MEP) works will begin in the tunnel and the gallery in spring 2016. That's an important shift in the type of work being done on a large portion of the site infrastructure.

Construction Partner Skanska and its sub-contractors have worked at a steady pace casting the tunnel's base slab and erecting the walls and vaults section-by-section to complete the roughly 700 m of the main and auxiliary tunnels. The total length of the main Accelerator tunnel will be 537 m.

The Accelerator tunnel taking shape

Early Access for Installations

The Conventional Facilities Division will work closely with the Accelerator Division to make some buildings and facilities available for early access. "The Accelerator Division will have partial access to their buildings in autumn 2016," said Kent Hedin, Head of the ESS Conventional Facilities Division. "We are on track, and looking forward to the handover so the Accelerator teams can begin their installations and begin to build the Accelerator." Full access to the Linac tunnel and Front End Building is expected in spring of 2017. This includes the infra-structure, electrical, and otherwise, that are required to begin installation work. The primary electrical substation building, H05, will be the first to be completed.

Morale is High

The successful completion of several milestones in a row, all on time, has instilled the project with an optimistic and cooperative environment.

"There is a good work culture of helping each other, where no one is left to solve problems by themselves." - Magnus Jacobsson

Progress Based on Collaboration

The collaboration agreement between the two companies is a multiple stage contract which provides flexibility and control for each phase of the complex construction project. Separate agreements are settled at the beginning of each stage. The project management team set up to lead and develop the work, is made up of employees from both ESS and Skanska. This method of working is both integrated and efficient.

Piling work for the Target building

COLLABORATION WITH SKANSKA

ESS and Skanska signed a collabor-ation agreement for the entire pro-ject in February 2014. The collabor-ation is divided into several stages and separate agreements will be settled for each stage with a spe-cific scope and target cost.

The second phase of the agree-ment worth 1.2 B SEK was con-tracted in May 2015. This contract covers installations in a number of buildings, substations and trans-formers, ground works including piling, landscape works, and con-crete works on the Target station and Experimental Halls. The con-tract with Skanska also focuses on detailed planning and preparations for the civil works construction, and developing the organisation, com-mon goals, and working methods for a successful joint delivery of the full project.

Skanska and ESS: second phase contract

Focus Moving to Target Station

As the Accelerator tunnel construction is near completion, work is ramping up on the Target area. Construction there has included the challenging and time-consuming steel core and concrete piling work. By the end of the year, approxi-mately 63% of the 6,000 concrete piles and 46% of the 356 steel core piles were brought to the bedrock.

"We will start concrete work for the Target building foundation in the Monolith area in early 2016. That's a major milestone for the project," says Magnus Jakobsson, Construction Section Leader for the ESS Conventional Facilities Division who works on-site with Skanska.

Piling works for the Target

Target and Building Works

The Target area has been excavated and building works will begin in early 2016. Plumbing, electrical, concrete, road works, operational planning and procurement are ongoing in anticipa-tion of the first ESS buildings being completed. The primary electrical substation (H05) and the distribution substation (H06), serving the Central Utility Building (CUB), will be the first major permanent buildings to go up on site. The large Gallery Building (G02) will follow close behind. The Gallery Building runs nearly the length of the Accelerator and includes the Cold Box and Test Facility areas.

In November, site workers celebrated the successful installation of the first of 63 large-diameter bored piles for the Monolith foundation. These piles are each 1.6 metres across and require a special pile-driver that had to be shipped from the UK in October. Once drilled, the piles are cast in place using a special procedure. The first casting followed several years of design work to meet requirements for earthquake proofing. Twenty-three have been set. The first Target installations are sched-uled for late 2017.

The CF and Target Divisions are working on documentation for The Swedish Radiation Safety Authority (SSM). Approval from SSM is key to maintaining the project's construction schedule and cost planning.

"We're working extremely hard now, to gather information and give our input for the ESS SSM application that is due in May 2016." - Kent Hedin

Kent Hedin, Head of Conventional Facilities

MULTI-PHASE LICENSING PROCESS

To build and operate ESS, licenses from the Land & Environment Court and the Swedish Radiation Safety Authority (SSM) are needed. ESS was granted permission to build, but final approval for operation of the facility will be handled in 2017. The application process is carried out stepwise, aligned with the design and construction process of ESS. The ESS facility design will meet the highest standards of safety that are expected by its users and its personnel.

In July 2104, the SSM granted con-ditional approval for ESS, which al-lows construction to proceed. John Haines, ESS Interim Associate Dir-ector of Environment, Safety, Health & Quality is preparing the applica-tion to SSM for the license to install equipment in the Accelerator tunnel and other parts of the facility.

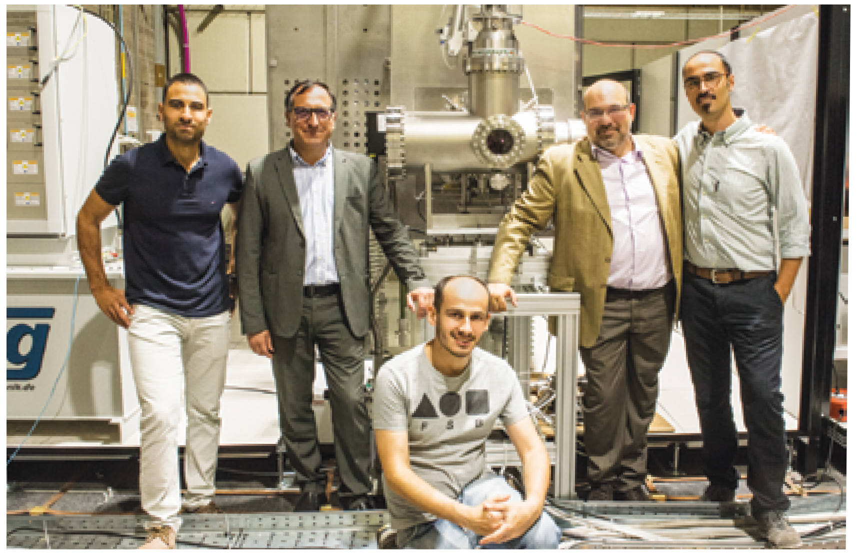
John Haines, Interim Associate Director of ES&H and Q

IN-KIND AND COLLABORATION PARTNERS

A WINNING TEAM

IN-KIND CONTRIBUTIONS

The success of the ESS mission relies in great parts on the expertise of its international Partners, a network across many disciplines and all the Member countries. Our Partners bring their knowledge, personnel, and experience to the construction in the in the form of In-kind Contributions (IKC), or non-cash contributions.



IKC Partners from INFN, Catania in front of the Ion Source at Laboratori Nazionali del Sud, Italy

Coordinated Effort for a Common Goal

Building a state-of-the-art facility is challenging in many respects, even more so when being built from the ground up, on a Greenfield site. In order to successfully construct ESS in the required time frame, experts, scientists and engineers from all over Europe are mobilising their knowledge and experience. The coordination of such an effort can be challenging, but the rewards are tremendous as well. This collaboration of more than 40 institutions, working together in parallel with one goal, enables the power of European science to deliver an unprecedented facility in a relatively short time frame.

In order to make this effort work, a framework has been created and Partners have systematically matched their skills and expertise with the needs of the project. An IKC may cover technical components as well as personnel needed to perform testing, installation, and integration.

In-kind Contributions may also include R&D work needed during the Construction Phase. Other products or services relevant for the completion of the ESS facility may be included as well, as long as it is a planned part of the construction project and agreed between ESS, the Partner institution and the Member country.

In addition to the advantage for the ESS project, there are also important benefits that the Member countries will realise as a result of their contributions. It allows Partner institutions to have focused networking possibilities with international Partners, and at the same increase local know-how. Working on a large-scale research infrastructure creates unique employment opportunities in the Member countries, contributes to national economic growth and fosters the growth region of regional economies in high-value technological and specialised industries. It also allows the Partner institutions direct access to ESS research into cutting-edge technologies.

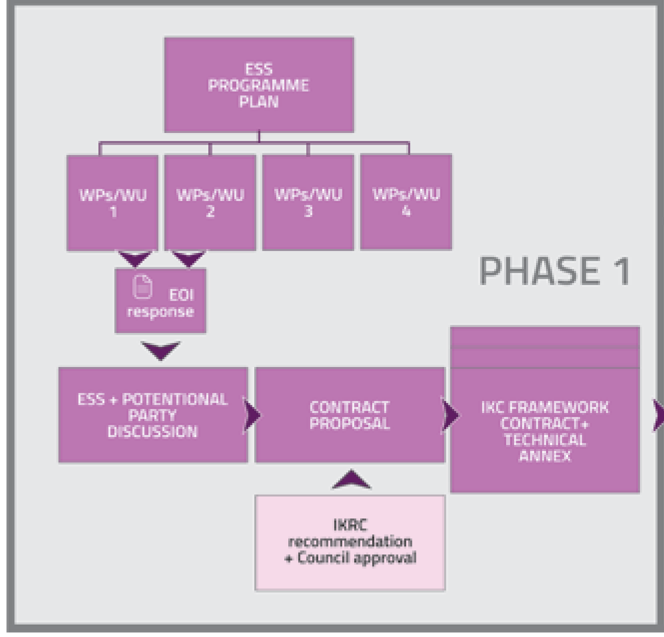
The In-kind Contribution Process

The ESS IKC process can be separated into three fundamental phases.

1. Preparation: managing expressions of interest and contracting with Partner institutions.

2. Implementation: tracking the delivery of the contracted solutions, services, materials etc.

3. Conclusion: IKC value crediting process is approved, applied and the closeout of a contribution is conducted.



Progress Securing In-Kind Contributions

Work and activities relative to establishing In-kind Contributions have been on-going since 2011 and are making tremendous progress. These contributions are expected to finance more than €645 million, or 35% of the total €1.843 billion (2013) construction costs.

Overall, ESS has identified a project scope with a potential value of €664 million, equal to 61% of the ESS technical work scope. The total current value of IKC work packages with Partners is €312 million, nearly half the estimated potential value. That value will continue to rise. The Partner facilities and ESS project teams continue to identify work that may be done by IKC Partners. There are important decisions still pending on the distribution of IKC relative to Neutron Scattering Systems, Instruments and Integrated Control Systems. This is expected to raise the total planned IKC close to the goal of 35% of the project value.

IKC from Start to Finish

The process of identifying an IKC Partner begins with the ESS project teams. They are responsible for defining the work in their respective projects that can potentially be done as an In-kind Contribution. The value for contributions must be based on the overall ESS budget and project budgets as defined in the cost book. After the work has been defined and a value determined, ESS solicits proposals from potential Partners in the Member countries.

Potential Partner institutions evaluate those In-kind packages and when they see a potential package that is of interest, they can respond with an Expressions of Interest. This begins a discussion between the potential Partner and ESS to reach an agreement on the scope, schedule and cost.

Each Agreement follows a pre-defined structure. The delivering party, in agreement with ESS, is wholly responsible for the contribution including the technical, financial, and commercial aspects. The In-kind Review Committee (IKRC) evaluates all In-kind Agreement proposals that are reached and signed, and decides to endorse them or not. Finally, the ESS Council approves all the IKRC-endorsed In-kind Agreements.

Once Agreements are in place, funding can be released to the Partner and work can begin. Once work does begin, the Partner and ESS project teams continuously monitor progress of the package and other related packages, going through several key milestones. When work is completed, the ESS staff creates a final report for the contribution; Based on the final evaluation, the Member country receives credit for the value of the In-kind Contribution according the ESS Cost Book.

THE FIRST DELIVERED IKC
An Estonian Success Story

The University of Tartu designed, set up, and tested a set up for laser pump probe neutron scattering experiments as an Estonian IKC. The final delivery and acceptance test took place in 2015. The equipment will be used on time-of-flight spectrometers and small-angle neutron scattering (SANS) instruments. This opens up a wide range of possible applications in biophysics, including photo-induced functional processes, temperature jump experiments, and thermal unfolding.

Jörg Pieper and the first credited In-kind Contribution to ESS

IN-KIND AND COLLABORATION PARTNERS

ESS is working together with partners from all across Europe and the world.
In-kind Collaboration Partners are indicated in bold.

Aarhus Universitet - AU

A.V. Shubnikov Institute of Crystallography Russian

Academy of Sciences -IUCr

Australian Nuclear Science and Technology Organisation - ANSTO

Bilbao Bizkaia Kutxa - BBK

Brookhaven National Lab - BNL

Budker Institute of Nuclear Physics of SB RAS - INP SB RAS

Centre National de la Recherch Scientifique - CNRS

Chalmers Tekniska Högskola - CTH

Cockcroft Institute

Commissariat a l'Energie Atomique et aus Energies Alternatives - CEA

Consejo Superior De Invest-igaciones Cientificas - CSIC

Consiglio Nazionale delle Ricerche - CNR

Consorcio ESS Bilbao - ESS Bilbao

Consorzio Interuniversitario Risonanze Magnetiche di Meallo Proteine - CIRMMP

Danmarks Tekniske Universitet - DTU

Darsbury Laboratory

Deutsches Elektronen -Sychrotron - DESY

Diamond Light Source

École Polytechnique Fédérale de Lausanne - EPFL

Elettra Sincrotrone Trieste S.C.p.A.

Eötvös Loránd Tudomanyegytem - ELTE

European Molecular Biology Laboratory - EMBL

European Organisation for Nuclear Research - CERN

European Synchrotron Radiation Facility - ESRF

European X-Ray Free-Electron Laser Facility GmbH - European XFEL

Extreme Light Infrastructure Delivery Consortium - ELI DC

Facility for Antiproton and Ion Research in Europe GmbH - FAIR

Foschungszentrum Jülich GmbH - FZJ

Goethe Universitaet Frankfurt Am Main

GSI Helmholtzzentrum für Schwerionenforschung GmbH - GSI

Helmholtz-Zentrum Berlin für Materialien und Energie GmbH - HZB

Helmoltz Zentrum Geesthacht - HZG

Hongik University, Seoul

Huddersfield University

Indiana University

Institut Laue-Langevin - ILL

Institute of Accelerator Technologies of Ankara University - IAT-AU

Institute of Applied Physics of the Russian Academy of Sciences - IAP RAS

Instituto de Tecnologia Quím-ica e Biológica, Universidade Nova de Lisboa - ITQB NOVA

Institutt for Energiteknikk - IFE

Instruct Integrating Biology - Instruct

Instytut Fizyki Jądrowej Henryka Niewodniczańskiego Polskiej Akademii Nauk - IFJ PAN

Integrated Detector Electronics AS - IDEAS

ISIS Neutron Source Facility

Istituto Nazionale di Fisica Nucleare - INFN (Catania, Legnaro, Milano)

Japan Proton Accelerator Research Complex - J-PARC

Joint Institute for Nuclear Research - JINR

Karlsruher Institut für Technologie - KIT

Kobenhavns Universitet - KU

Kungliga Tekniska högskolan - KTH

Laboratoire Léon Brilouin - LLB

Laboratório De Instrumentação e Física Experimental de Partículas - LIP

Latvijas Universitāte - LU

Leibnitz-Instituit für Molekulare Pharma - FMP

Linköpings Universitet

Lund University - LU

Magyar Tudományos Akadémia Atommagkutató Intézet - MTA Atomki

Magyar Tudományos Akadémia Energiatudományi Kutatóközpont - MTA EK

Magyar Tudományos Akadémia Wigner Fizikai Kutatóközpont - MTA Wigner

Masarykova Univerzita - MUNI

Mittuniversitetet - MiUN

Narodowe Centrum Badán Jądrowych - NCBJ

National Research Center Kurchatov Institute - NTI

Nederlands Kanker Instituut - NKI

Norges teknisk-naturvitenskapelige universitet - NTNU

Oak Ridge National Laboratory - ORNL

Oulun Yliopisto - OULU

Paul Sherrer Institut -PSI

Politechnika Warszawska

Politechnika Wrocławska

Polska Grupa Energetyczna - PGE

Roskilde Universitet

Science and Technology Facilities Council - STFC

Source Optimisée de Lumière d'Energie Intermédiaire du LURE - SOLEIL

Stanford University National Accelerator Laboratory - SLAC

Stockholms universitet

Tallinna Tehnikaülikool - TUT

Tartu Ülikool - UT

Technische Universität Chemnitz - TU Chemnitz

Technische Universität München - TUM

Technische Universiteit Delft - TU Delft

Teknologisk Institut - DTI

Thomas Jefferson National Accelerator Facility - Jefferson Lab

United Kingdom Atomic Energy Authority

Universidade da Coruña

Università degli Studi di Brescia

Université Laval

Universiteit Leiden

Universiteit Utrecht

Universitetet I Bergen

Universitetet i Oslo

University of Bath

University of Manchester - UoM

University of Patras - UPAT

Uppsala Universitet

Ústav technické a experimentální fyziky, České vysoké učení technické v Praze - ÚTEF ČVUT

Vilniaus universitetas

Weizmann Institute of Science

Zürcher Hochschule für Angewandte Wissenschaft - ZHAW

GRANTS FOSTERING COLLABORATION

ESS is actively using European Union and national grants to facilitate partnership building with the scientific community and In-kind Collaboration Partners. Grants help to maximise scientific impact and productivity, and increase resources during the construction phase and into operations.

BrightnESS Kick-off meeting in Lund, September 2015

Building Capacity

Last year, ESS put in place a grants policy which confirms its commitment to playing a role in the wider European Infrastructure community and its approach to becoming a world-renowned facility for external neutron users. Central to the policy are the Open Innovation and Open Access paradigms, which allow knowledge to be shared with partner organisations. ESS has proven to be very successful in this approach using European Framework 7 and Horizon 2020 research grants as well as several national and regional grants. External funding is used to support - among others - collaborative technological advances on detector resolution and large area detectors using Boron-10 isotope, the design of an advanced liquid hydrogen moderator, chemical deuteration for studying a range of advanced materials with neutron scattering, and data treatment software (capture, streaming, analysis). This support helps to build and extend capacity within the future ESS user base in Europe and also to support outreach activities for science, innovation and collaboration with industry during the construction phase of ESS.

Simply constructing the most powerful spallation neutron source will not, by itself, ensure maximum scientific or technological impact. The diversity in funded collaborative projects is enabling ESS to build and extend a broad network for the exchange of best practices and enhance mobility of staff and knowledge. Through several grants in which ESS has been participating since 2012, both as coordinator and as a partner, a smooth transition from the initial planning stages to the implementation stage and subsequent operation is being supported.

The number of funding applications by ESS staff increased significantly over the past two years. With only three submissions recorded every year in 2012 and 2013, ESS grants participation increased to 14 submissions in 2014 and 22 in 2015. Currently, ESS proposals have shown a success rate of 30%, a significant achievement in 2015 relative to the general Horizon 2020 success rate of below 15%. ESS is now involved in the implementation of 14 grants (two are about to be closed) from the following funding agencies: European Commission, Tillväxtverket, Vinnova, and Vetenskapsrådet.

In order to further increase the number and quality of funding proposals, ESS is working on an additional support scheme for scientists which will allow them to insource professional review capacity of draft proposals as well as writing support. Furthermore, ESS is creating modular proposal text blocks which can be used as starting points by the scientists and tailored to individual needs. This will help to reduce the time-burden of writing proposals (e.g. not 'reinventing the wheel') as well as increase consistency between proposals relative to the ESS overall policies on topics such as intellectual property, safety & security, project management structure and project impact.

Horizon 2020 implements the Innovation Union, a Europe 2020 initiative to create an innovation-friendly environment to tackle societal challenges, based on scientific excellence, by coupling research and innovation.

BrightnESS seminar on IKC

BrightnESS and SINE2020 are two strategic European Union funded projects for ESS, which bring together major European research infrastructures of the present and the future, world-class national facilities and several smaller national facilities. Collectively they offer high quality services and an efficient research environment for almost 9,000 scientists in Europe – by far the biggest user community of its kind in the world.

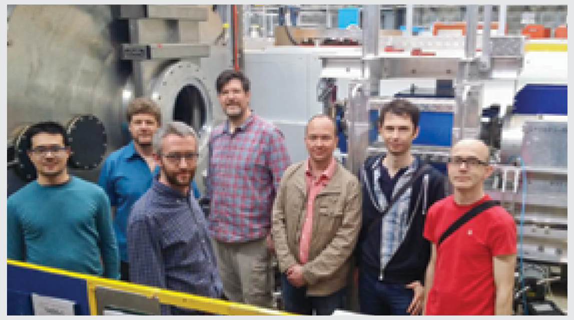
brightness – Building a research infrastructure and synergies for highest scientific impact on the ESS

BrightnESS is a 3-year EU-funded project within the European Commission's Horizon 2020 Research and Innovation programme under the INFRADEV-3 call. It's a partnership of 18 European institutes and universities from 11 countries with a total budget of €20 million. BrightnESS helps to ensure that key challenges during the construction phase of the ESS are met, so that ESS can deliver high impact scientific and technological knowledge to its academic and industry user communities.

The overall aim of the project is to support the construction of the ESS in key technical areas, IKC and risk management. The grant provides resources to help move ESS from its planning phase to the implementation phase, as well as to keep physical construction of the site and development and delivery of vital equipment and components by its In-Kind Partner institutes aligned.

BrightnESS' key deliverables are to ensure that (A) the knowledge and skills of European companies and institutes are best deployed in form of In-Kind Contributions to ESS for its construction and operation, (B) technology transfer both to and from the ESS to European institutions and companies is optimised and (C) maximum technical performance is obtained from the ESS Target, Moderators and Detectors.

ESS is currently defining the metrics through which to measure its own contribution toward increased scientific knowledge and technological solutions for societal challenges. Part of the BrightnESS scope is to define indicators on ESS knowledge transfer to industry and job creation during the IKC. The project also measures the effects of the ESS collaboration on participation by 'Low research-performing countries' (LRPC) in neutrons research, which is an indicator for strengthening of the overall European Research Area. Lastly, BrightnESS monitors capacity building and Research Infrastructure human capital development by measuring research staffing at institutes in existing as well as prospective ESS Member countries.



Real time data management – Work Package 5 Kick-off at PSI

Through these activities, BrightnESS provides a vital support framework for ESS so that Europe can deliver upon its Smart Growth strategy toward a more resource efficient and competitive economy.

SINE 2020 – EU supports the neutron science community: SINE2020 funded through Horizon 2020

SINE2020 Kick-off meeting in Copenhagen, October 2015

ESS is a partner in the strategic project called SINE2020 – world class Science and Innovation with Neutrons in Europe for 2020. This €12 million European grant is focussed on broadening the academic and industrial user base of neutron science in Europe. It is being coordinated by the Institut Laue-Langevin neutron source in Grenoble and implemented with 17 partners.

SINE2020 will expand the innovation potential of neutron scattering at large-scale facilities by developing new and improved services for academic and industry users through a holistic approach, including outreach and education, samples, instrumentation, and software. Furthermore, the project will also prepare Europe for the unique opportunities that the ESS, as an ESFRI Roadmap facility, will bring to the different communities through the creation of synergies and complementary solutions. SINE2020 is also instrumental in creating the foundations for a significant increase in direct facility-industry collaborations.

OUTREACH ACTIVITIES

ESS outreach activities are a vital part of communication with our partners and potential industry users. The construction site is one source of those activities, and this kind of frequent contact with collaborators and future users ensures their continued support and commitment.

Press Conference with Spanish State Secretary Carmen Vela in Bilbao, April 2015

Partner Days

ESS Partner and Industry Days are unique events organised in cooperation with ESS Partners which provide overview information about ESS in general, in addition to in depth updates on the status of each project. These events provide an occasion to connect to and interact with the local industry and scientific community in the respective ESS Partner country, with the aim to identify potential collaboration opportunities. Furthermore, the Partners already contributing to ESS have a chance to present their work.


ESS Partner and Industry Day in Bilbao, April 2015

ESS-Bilbao and ESS hosted a Partner and Industry Day in Bilbao on 16 April, 2015. The event began with a press conference featuring Carmen Vela, the Spanish State Secretary for Research, Development, & Innovation; Cristina Uriarte from the Basque Government Research & Education Ministry; Executive Director of ESS-Bilbao José Luis Martinez; and ESS Director General James Yeck. Nearly 90 participants from 46 companies and organisations attended the event, opening a dialogue to generate business opportunities for Spanish companies. The companies participating in the Partner and Industry Day represented a variety of competences, including engineering firms and fabricators.

This is just one example of the more than 20 such events that have been held reaching over than 2,000 interested stakeholders since 2013.

Organising events in the Partner countries is one approach, but ESS also invited Partners and many guests to visit the site in Lund.

On 7 May 2015, the Lithuanian Minister for Science and Education, Prof. Dainius Pavalkis visited the ESS construction site, together with a delegation of 13 representatives from leading academic positions in Lithuania to discuss the possibilities of neutron scattering for life sciences, to get the current status of the project, and address opportunities for future collaborations between ESS and Lithuania.


Visit of Lithuanian Minister Dainius Pavalkis to ESS, May 2015

Interacting with Collaborators

Organising these numerous outreach and networking activities every year helps ESS interact with its various target groups, that include: prominent members from academia like university groups, research labs, and institutes; stakeholders from governmental ministries and funding agencies; and industrial suppliers and future industrial users.


ESS Industry Day in Prague organised by Technology Centre ASCR, June 2015

The ESS-sponsored Science Symposia harvested input from a wide range of scientific disciplines and expands the neutron user base. The symposium resulted in reports which help feed into the ESS science strategy. Conferences and workshops organised by our Partners may include: the participation of ESS speakers at lectures on ESS, neutron and material science, research infrastructure and procurements, and 'how to do business with ESS'. All of these events have expanded the interest in our project in the Partner countries and even potential new Partner countries. This helps to grow the stakeholder base for potential resources.

ESS welcomed more than 2,200 visitors in 2015. Most visited the construction site to see the progress either by taking a guided walking tour, a bus tour, or for a viewing from the site offices. All activities were organised in close collaboration between ESS and Skanska.

EU Commissioner Carlos Moedas and Swedish Minister Helene Hellmark Knutsson visit ESS, December 2015

Distinguished Guests

ESS values the presence and input of high-level guests, such as the Swedish, Danish, and Lithuanian Ministers of Research, EU Commissioner Carlos Moedas, European Commission Director General Robert-Jan Smits, and Bill Stirling, Director General of the Institut Laue-Langevin.

Partners and Stakeholders

Swedish Minister for Higher Education and Research Helene Hellmark Knutsson visited the ESS several times in 2015. On her first visit she discussed the transition from a Swedish Aktiebolag (limited company) to a European Research Infrastructure Consortium (ERIC). The Research Minister was also given an overview of the ongoing construction and the progress of the project as a whole.


First time at ESS, Helene Hellmark Knutsson, May

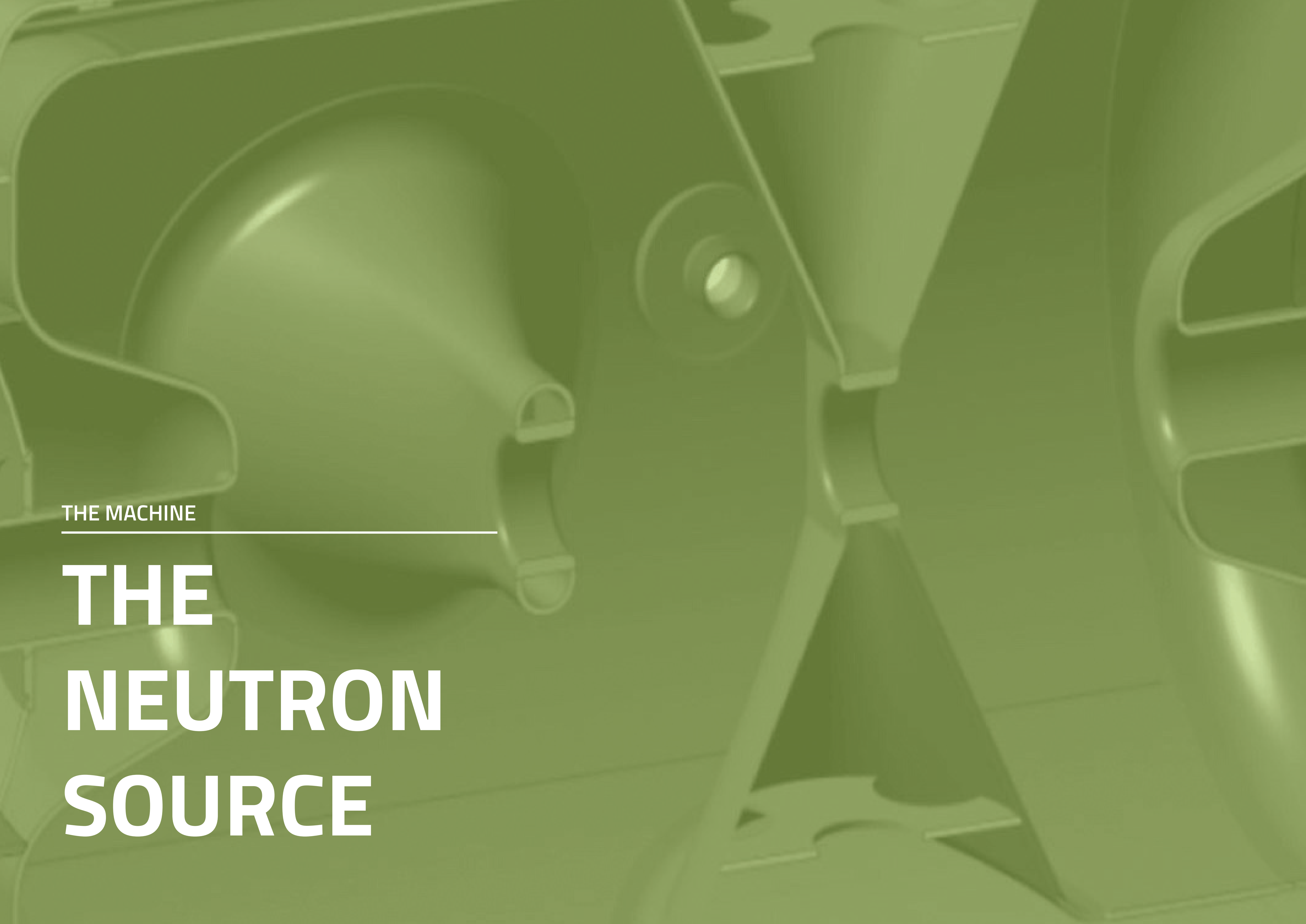
On 8 September, the ESS marked an important milestone. On that day the organisation became a European Research Infrastructure Consortium (ERIC), a type of legal entity created by the European Commission for governing international research facilities. The European Commission Director General for Research and Innovation, Robert-Jan Smits visited the construction site and handed over the official 'plate' of the ERIC from the Commission to ESS.

The year ended with a visit from Carlos Moedas, EU Commissioner for Research, Innovation, and Science to discuss the various opportunities and challenges a collaborative project such as ESS brings with it. His visit was a clear sign of the support and encouragement ESS has received from the European Commission and important stakeholders across Europe.


ILL Director General Bill Stirling at ESS, January 2015

"My meetings with your staff, have confirmed the enthusiasm that exists here and at ILL for deepened cooperation between our two organisations." -Bill Stirling


Danish Minister Esben Lunde Larsen and EC Director General Robert-Jan Smit

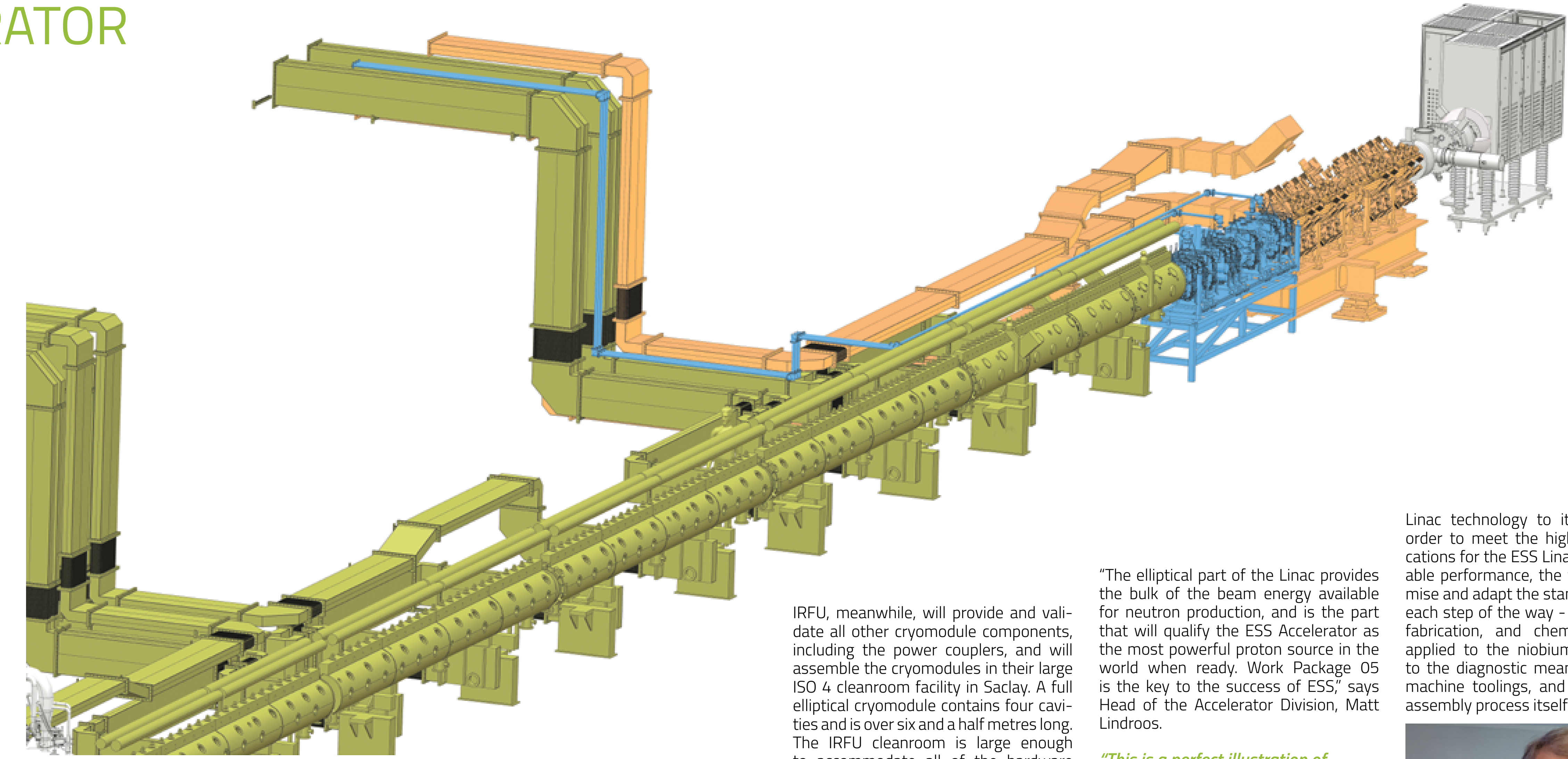


THE MACHINE

THE NEUTRON SOURCE

THE ACCELERATOR

ESS is an accelerator-driven neutron spallation source. The linear Accelerator, or Linac, is thus a critical component. The role of the Accelerator is straightforward. It creates protons at the ion source, accelerates them to an appropriate energy, and steers them onto the Target to create neutrons via the spallation process for use by a suite of research instruments. Building the ESS Accelerator requires the expertise of more than 25 Partner institutions executing 17 Work Packages across Europe.



The Most Advanced Linac

The ESS Accelerator is the most powerful linear proton Accelerator ever built by a factor of five. It will also be the first Linac to use spoke cavity technology for the acceleration of protons.

Pushing Accelerator Technology to its Limits

In the final and major stages of acceleration before contact with the Target, the proton beam energy of the ESS Accelerator will reach 2.0 GeV. France's national Atomic and Alternative Energies Commission, CEA, is guiding the design, production, and testing of the superconducting radio-frequency cryomodules that make this possible. One of the largest of these Work Packages includes nearly half the length of the linear Accelerator five institutions in four European countries, and 20 percent of the Accelerator construction budget. This is Accelerator Systems Work Package 5 (WP05).

Working in close collaboration with one another, the members of WP05 have the responsibility to produce nine medium-beta and 21 high-beta superconducting radio-frequency (SRF) elliptical cryomodules for installation in the ESS Accelerator tunnel. Once installed in-line the cryomodules will run 256 meters and provide nearly 90 percent of the beam acceleration. First installations are scheduled for September 2016.

The work is distributed as In-kind Contributions (IKCs) to ESS from the national institutes on behalf of France, Italy, and the UK. The prototypes for both cryomodule types, high-beta and medium-beta, are being fully developed and tested by CEA Saclay and IPNO (Institut de Physique Nucléaire d'Orsay). IRFU – the French National Institute for Research on the Fundamental Laws of the Universe – will provide all cryomodule components except the cavities, and will include the final assembly of the full cryomodule units in a clean room. LASA (Laboratorio Acceleratori e Superconduttività applicata of the National Institute for Nuclear Physics (INFN) in Italy will provide the medium-beta cavities of the series, with Daresbury Laboratory in the UK providing the high-beta cavities. Finally, ESS will perform the crucial radio frequency (RF) power tests of the cryomodules before installation.

Collaborative Production of 120 Cavities

Once performance and quality specifications are achieved by the cavity and cryomodule prototypes, series production of the cavities will move to INFN-LASA and Daresbury, who will contract with private companies for fabrication. LASA will produce the 36 medium-beta cavities and Daresbury the 84 high-beta cavities, and these labs will perform the acceptance testing, including radio frequency (RF) tests in cryogenic conditions.

IRFU, meanwhile, will provide and validate all other cryomodule components, including the power couplers, and will assemble the cryomodules in their large ISO 4 cleanroom facility in Saclay. A full elliptical cryomodule contains four cavities and is over six and a half metres long. The IRFU cleanroom is large enough to accommodate all of the hardware and personnel involved in the complex assembly procedure.

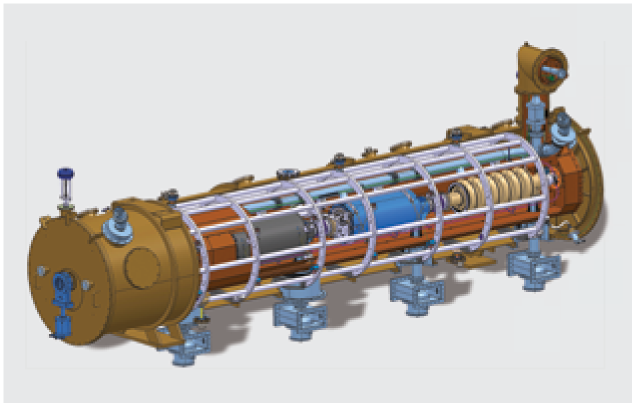
All testing necessary to move forward with series production of the cavities, as well as power testing of a full cryomodule assembly, is expected to be complete by the end of 2016.

"The elliptical part of the Linac provides the bulk of the beam energy available for neutron production, and is the part that will qualify the ESS Accelerator as the most powerful proton source in the world when ready. Work Package 05 is the key to the success of ESS," says Head of the Accelerator Division, Matt Lindroos.

"This is a perfect illustration of the state-of-the-art competencies available all across Europe and how powerful they can be when they come together in a project like ESS."
-Roland Garoby

Aside from the large coordination effort, the real challenge is to take the existing Linac technology to its upper-limit in order to meet the high-power specifications for the ESS Linac. To ensure reliable performance, the team must optimise and adapt the standard technology each step of the way - from the design, fabrication, and chemical treatments applied to the niobium metal cavities, to the diagnostic means and methods, machine toolings, and the cryomodule assembly process itself.

Roland Garoby, Technical Director

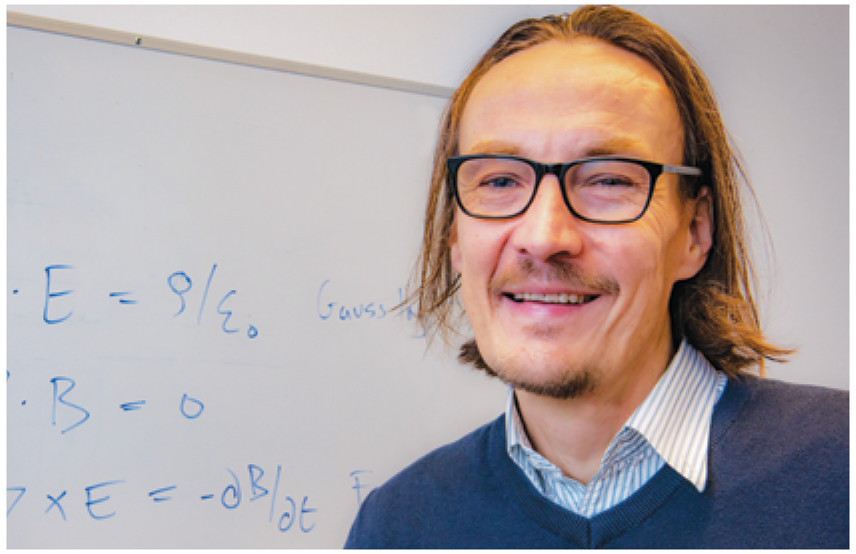


Design model of the SRF Elliptical Cryomodule for ESS

A high-beta cavity assembly in the ISO 5 cleanroom at IRFU in Saclay, France.

DEVELOPMENT OF RF SYSTEMS

The Radio Frequency (RF) system for the ESS Linac is defined as the system that converts alternating-current (AC) line power to RF power. The Accelerator division saw many collaborations come together and received its first In-kind deliverable, a vacuum systems test facility from Daresbury.



Mats Lindroos, Head of the Accelerator Division

Supplying the Power

The Radio Frequency (RF) system for the ESS Linac is defined as the system that converts alternating-current (AC) line power to RF power at either 352 or 704 MHz to be supplied to the RF accelerating cavity couplers. The AC conventional power lines on one side, and the waveguide power couplers on the accelerating cavities on the other side, bound the RF system.

LLRF - Low-Level Radio Frequency Control System

The FREIA Laboratory at Uppsala University was outfitted with a Low-Level Radio Frequency control system (LLRF), delivered by ESS and Lund University. This laboratory will be used to test Accelerator components in the months and years to come. More specifically, the LLRF will be used to regulate the superconducting radio frequency (SRF) spoke cavities, and the cryomodules that contain them. The LLRF control generates an input signal to the RF amplifier that sets the unique phase and amplitude for each cavity. Set in series, the 26 spoke cavities work together with the LLRF to accelerate the ESS proton beam to progressively higher speeds.

> *"This is not only an important step in the development and test of the RF systems, it is also an example of a successful cooperation between different institutes around Europe." -Anders Johansson, Associate Professor at Lund University*

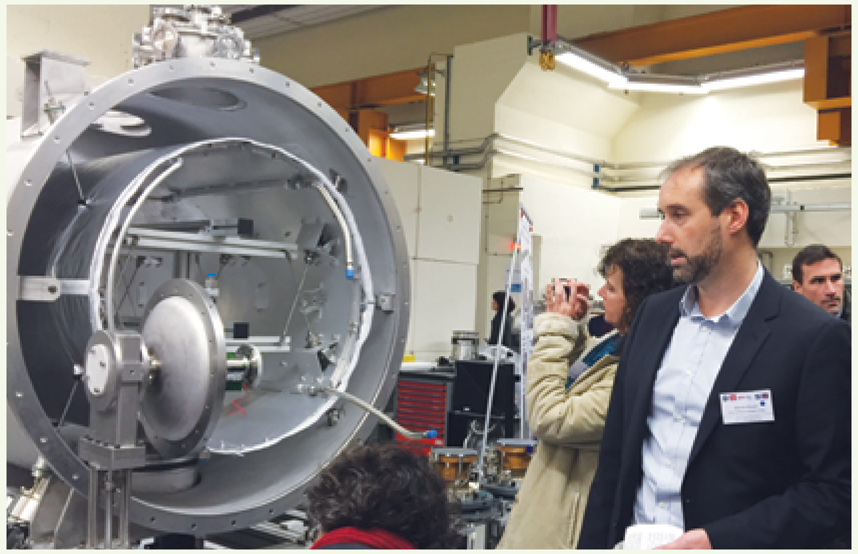
The LLRF system is being integrated into the Experimental Physics and Industrial Control System (EPICS) in close cooperation between the ESS RF Group and the ESS Integrated Control System (ICS) Division, in dialogue with the users at Uppsala University and the developers of the RF cavity and cryomodule in Orsay.

An ESS niobium cavity prototype being prepared for testing in the lab at IRFU

Personnel from ESS, CNRS, and Uppsala University's FREIA Lab in front of the HNOSS cryostat in Uppsala, Sweden

FIRST CAVITIES GO INTO PRODUCTION

ESS Partner IPN-Orsay, completed its landmark testing of the innovative spoke cavity cryomodule design, the first critical step in the superconducting stage of the Accelerator, for the ESS Linac. The test in June validated that the prototypes are ready to move into production.



Sébastien Bousson, Head of Accelerator Division at IPN-Orsay

Spoke Cavities Prototypes

This novel design will introduce spoke cavity technology to a linear proton Accelerator for the first time in history, making the ESS Accelerator more efficient and flexible.

IPN-Orsay's (IPNO) Accelerator Division is developing and building this technology as part of and In-kind Contribution to ESS of nearly €20 million. IPNO is a division of CNRS, the French National Centre for Scientific Research, which has long been a key partner in the ESS Accelerator project.

The French lab will design, produce and deliver the Accelerator's 13 spoke cavity cryomodules. These cryomodules, each of which will contain two spoke cavities, two power couplers, and be fitted with a custom designed ESS Cold Tuning System, will run end-to-end, constituting around 56 meters of the roughly 600-meter-long ESS Linac.

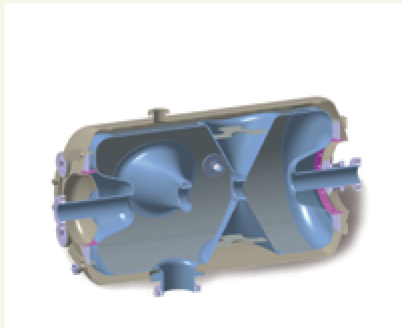
Validation of Tests

The test performed in June, in conjunction with similar tests performed in January, February, and March, has provided the final validation that the spoke cavity prototypes designed by IPN-Orsay and manufactured by two different vendors—Zanon in Italy and SDMS in France—are ready to move into production. More than this, the June test confirmed that the lab's new chemical surface treatment of the niobium cavity's metallic surface allows ESS ever larger margins on measures of both quality and acceleration speed—an added assurance that the technology will perform as required following production, assembly, and installation.

A First for Linac Design

The use of spoke cavity technology to accelerate protons has been achieved in laboratories, but the ESS Linac will be the first to integrate it on a large scale. The technology makes it possible that the Accelerator will enter into its superconducting stage at a lower energy than any existing Linac, with 97% of the proton beam acceleration speed achieved in a superconducting environment. The next step for IPN-Orsay is to integrate the RF power coupler with the cavity and confirm that they will function as a unit at high RF power. Following that, the assembly will be tested at the FREIA Laboratory.

Cut-away of a double-spoke cryomodule model



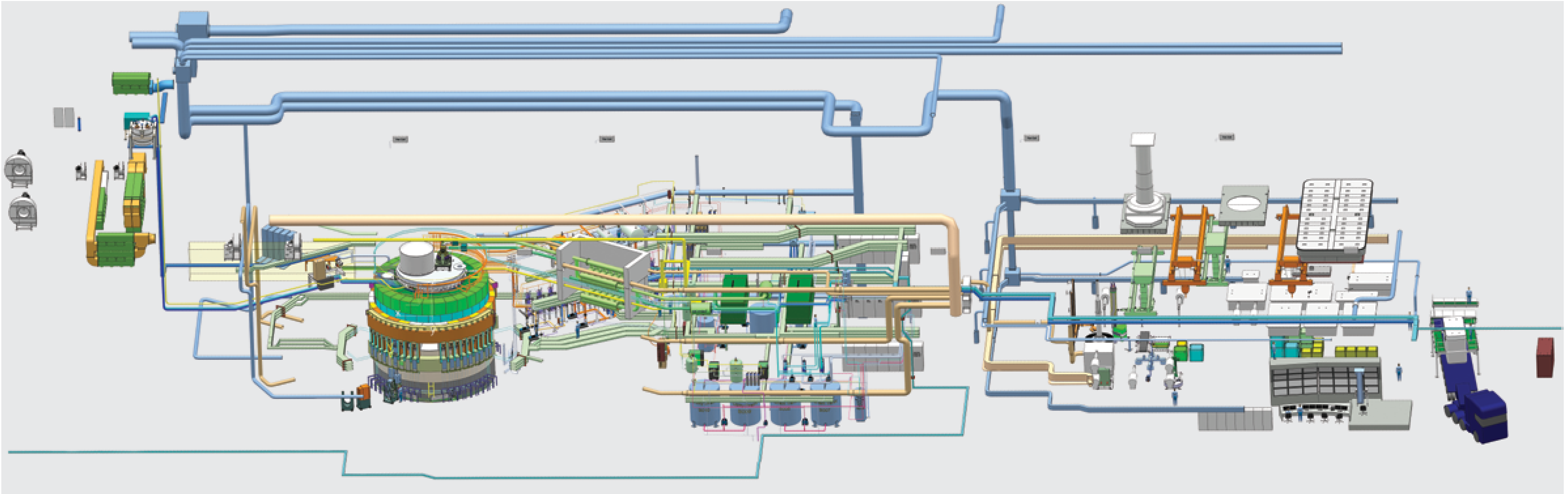
Cross-section of a niobium spoke cavity model

A spoke cavity is a metal enclosure—like a barrel, though a barrel of a very particular shape—into which a powerful radio frequency electromagnetic wave is introduced at the very precise frequency of 352.21 MHz. The shape, temperature, and material composition of the cavity, along with other factors, ensure that the RF waves will propel the protons from one cavity to the next at ever-increasing speeds.

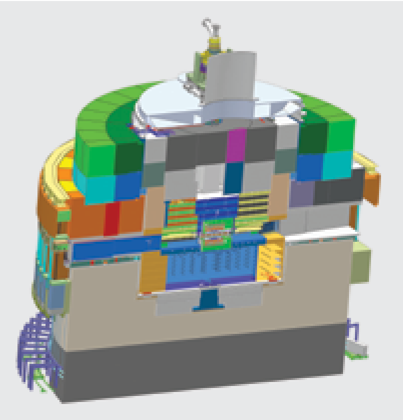
"The spoke is very interesting just because the structure itself is mechanically very stiff," explained Sébastien Bousson, Director of the Accelerator Division at IPN-Orsay who is responsible for the CNRS contribution to the ESS Accelerator. "It means the cavity is not affected by a lot of things that can cause troubles in its operation—vibrations, the variation of the pressure of the helium bath—that can affect the behaviour of the cavity and the capability to accelerate. The second advantage is that it can reach a very high accelerating gradient that with standard cavity geometries you cannot reach."

THE TARGET

The neutrons that scientists need to study materials and molecules are produced in the Target Station. It is here that the spallation process takes place when protons from the accelerator hit the Target, a 3-tonne helium-cooled tungsten wheel. The design of the Target has a direct impact on the number of neutrons that can be generated, and is therefore of utmost importance for the future scientific capabilities of ESS.



The complete Target system



Cut-away of the Target monolith

Producing Neutrons

Spallation is the process for producing neutrons by means of a particle Accelerator and a heavy metal Target. Protons derived from hydrogen gas are drawn through a linear Accelerator to a velocity just below the speed of light, at which point they collide with the nuclei of the Target metal, tungsten. The collision of protons and the nuclei of the Target metal, tungsten, throws off, or scatters, a collection of high-energy neutrons, which, once moderated, in turn are assembled into beams that are directed toward an array of scientific instruments. It is in the design and operation of these tools that the experimental science at ESS takes place.

The more neutrons produced in the Target collision, the more neutrons pass through the moderator-reflector systems. Each individual neutron plays its part in revealing the properties of the sample placed in its path, either by colliding with the sample's atoms, passing through it completely, or by interacting with whatever magnetic forces are already present in the material resulting in a higher resolution image.

The Target station is where the neutron beams are produced for experiments. The fast, high-energy neutrons, which are released in the spallation process, are slowed down to energies that are suitable for different types of experiments, and then delivered to the instruments through beam ports leading to neutron guides.

In the Target station, fast, high-energy neutrons are released by spallation from the Target consisting of neutron-rich material, the heavy metal tungsten, when a high-energy beam of protons from the Accelerator impinges on it. The neutrons, which are travelling at 10 percent of the speed of light, are then slowed down to roughly the speed of sound, using moderators and reflectors, to provide intense pulses of neutrons at velocities and energies that are useful for experiments. Once moderated, the neutrons are delivered to the instruments through beam ports radiating from the Target station.

Key features of the Target station are the Target, the neutron moderator, pre-moderator and reflector system, the beam-extraction system, and the shielding. The Target station also incorporates a powerful helium-based cooling system able to dissipate the heat generated by the powerful 5 MW proton beam hitting the Target. Radioactive isotopes and radiation is generated by the spallation process and by general activation of components. The Target will therefore be surrounded by steel shielding in the form of the cylindrical, 3,000-tonne Target station monolith to prevent unwanted ionising radiation from escaping.

In 2015 the Target system completed the final design and prototyping stages and transitioned over to production activities. Major design choices, including the moderator, reflector concept, and neutron beam extraction configuration were settled.

System Optimisation in Spain

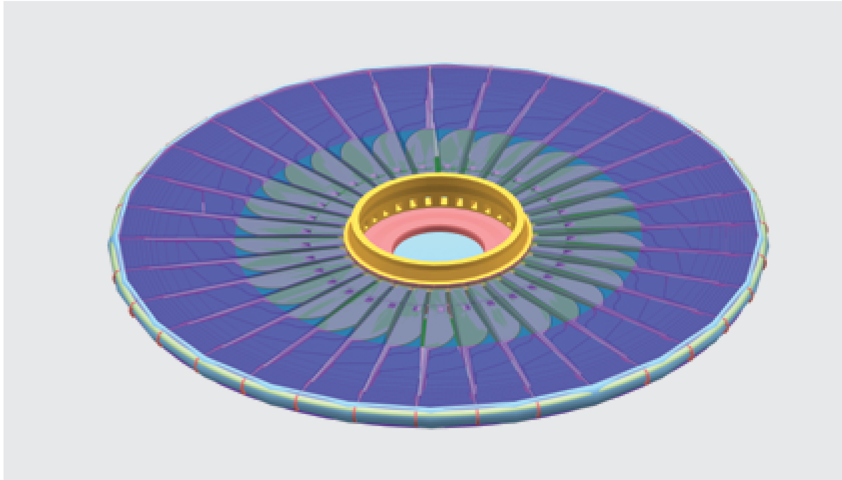
Spain was one of the first countries to send a Letter of Intent committing to ESS, and in November 2014 ESS-Bilbao was chosen as the In-kind Partner for the ESS Target system, including the novel rotating tungsten Target wheel, the Target shaft assembly, the drive motor and support bearing, is being optimised, prototyped, tested, and ultimately will be delivered by ESS-Bilbao in Spain.

Fernando Sordo and his team at ESS Bilbao

Fernando Sordo, lead engineer of the Target wheel at ESS-Bilbao and his team are currently in the process of modifying the Target system proposal to achieve a design that can be manufactured more easily. "Focusing on design efficiency now will make it easier to meet the challenge of manufacturing and testing later," said Sordo. The current ESS-Bilbao proposal has specifically modified the geometric arrangement of the tungsten bricks such that protons will not cross the Target without a spallation interaction.

The Tungsten Wheel Concept

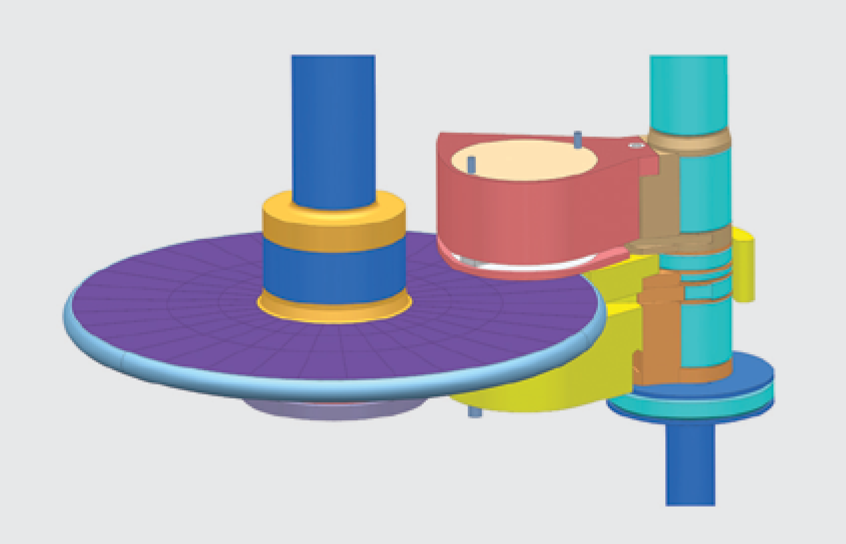
The Target wheel will measure 2.5 meters in diameter, is estimated to weigh 3 tonnes, and is divided into 36 radial sectors. The heart of the Target station is the roughly 7,000 tungsten bricks set into the sectors of the wheel. "The ESS Target wheel will feature a novel design of the rotating tungsten Target making it possible to distribute the heat over a larger volume than what is irradiated by the proton beam at one moment," explained Ulf Odén, ESS's lead engineer for the Target wheel. "Together with the helium coolant, this design can produce a Target with a long lifetime of approximately five years."



The Target Wheel

THE TARGET SYSTEMS

The ESS facility's centre of gravity is the 3,000-tonne Target Station monolith: the high density, high-energy interface between the linear proton Accelerator and scientific instruments. The Target baseline design was developed after the site decision in 2009.



Target Wheel and Pancake Moderator

Target Partner Collaborations

"We have had a great start to the collaboration with ESS-Bilbao," noted John Haines, former Head of the Target Division. "They started fast. They hosted the Target wheel, shaft, and drive unit kick-off meeting at the end of January, and have already submitted a modified design proposal for the Target wheel, that is much easier to manufacture and is more robust."

Haines went on to say "Working with ESS-Bilbao gives us access to the experience and capabilities of the Spanish nuclear industry. Beyond that, ESS-Bilbao has a focus just like our own, namely, making ESS a reality. Their dedication to the project is very valuable to us."

Neutron Technologies in Spain

ESS-Bilbao is an internationally renowned strategic center for neutron technologies that leads the Spanish In-kind Contributions to ESS. The work performed will in turn foster collaborations between Spanish academia and industry, as suppliers will be hired to manufacture and test the designs, which will fuel the Spanish national innovation potential by building capacity and supporting job growth.

"Building the highest powered spallation target in the world will position the Spanish engineering industry in the field of neutron science."
-Jose Luis Martinez,
Executive Director of ESS-Bilbao

The Target Station Monolith

The tungsten Target and moderator-reflector are surrounded by a radiation shielding system of 3,000 tonnes of steel in order to contain the extreme level of highly penetrating gamma and fast neutron radiations created in the Target and its vicinity. The beam extraction system provides intense slow neutron beams through beam tubes going across the target shielding. At the surface of the shielding, the neutrons are delivered to be used at the neutron scattering instruments. The proton beam window separates the high vacuum in the Accelerator from the inert helium gas. All of these systems sit inside a large vessel. Together they form the Target station monolith, a large cylinder 8 m high and 6 m across.

Target Wheel

A rotating tungsten wheel is the baseline option for the Target, which distributes the irradiation over a large volume of Target material. Tungsten is a rare metal of high density that is commonly used at existing spallation sources. What is unique to the ESS application is the high power of the ESS Accelerator. This energy, which manifests in the tungsten as heat, must be dissipated rapidly and efficiently. To this end, the Target wheel rotation is timed such that each of its 36 sectors receives a single pulse from the beam per revolution.

Moderators

The ESS Target Station will contain two liquid-hydrogen moderators with a volume of approximately one litre each, partially surrounded by water pre-moderators of comparable volume. The moderators are placed inside an inner reflector of about half a cubic metre of beryllium. These components will be kept at their desired operational temperature by dedicated cooling systems which will not emit significant after-heat.

Beam Extraction

The beam-extraction system will consist of more than 40 beam tubes arranged in four sectors with about 60° horizontal angular spread. Each beam tube will be equipped with a beam shutter within the Target monolith to assure that the residual radiation escaping through the closed beam line when the Target station is not in operation is reduced to safe working levels at the wall of the Target monolith. This monolith will be surrounded by a combination of integrated and individual radiation shielding for each beam line, which guarantees safe working access to the areas outside of these shielding structures all the time, including during full power operation.

Target Handling and Fluid Systems

Providing adequate cooling for the Target at the 5 MW power level of ESS requires distributing the heat over a much larger volume than the few litres instantaneously irradiated by the proton beam. In addition, the amount of radioactivity created in the spallation process must be safely contained both in normal operation and in the case of accidents.

Containment of Radioactivity

The Target monolith will provide two barrier layers of containment against the escape of volatile and airborne radioactive materials, both at normal operation and in case of incidents, and will be continuously vented and filtered.

The Cooling System

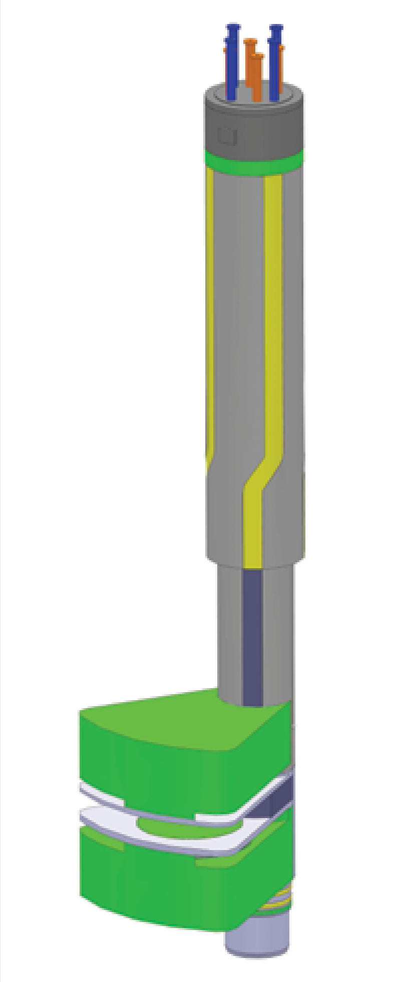
When the 5 MW proton beam hits the Target wheel, the Helium circuit cycles the heat up through the shaft and away from the Target, then returns it at a lower temperature, similar to how a radiator functions in an automobile. the Target Helium Cooling System will keep the temperature below 500°C both in the structural material of the wheel and on the surface of the spallation material. Keeping the tungsten surface temperature below 500°C will avoid oxidation of the tungsten in the event that air infiltrates the Target Vessel. Oxidation of the spallation material is the main driver for contamination of the Target System and in turn the radiological threat to workers and public. The Nuclear Physics Institute of the Czech Republic (UJF) has committed to deliver the Target Helium Cooling System for ESS.

OPTIMISED FOR BRIGHTNESS

The "Pancake" Moderator becomes a "Butterfly"

The Target division conducted test that preliminarily validated the physics behind the "flat" moderator which has been developed for the ESS long pulse. The measurements appear to give preliminary empirical confirmation that ESS's optimisation of its 2013 baseline moderator design will improve the performance for those instruments at ESS able to exploit this brightness by about 2.5-3 times. The new design is a major step forward in neutron moderator design, and has large implications for neutron science at ESS.

The optimised design established in 2014, which became known as the "pancake" moderator, was developed in a series of iterations over the last two years. It is referred to as "2-dimensional" because the vertical dimension is flattened to a slim 3 cm, from the original 13 cm height. The result is a "flat" moderator that releases more neutrons in an evenly distributed pattern across a smaller area than the earlier design. Aside from the possibility of more efficient neutron extraction, the new geometry of the ESS moderator will require smaller beamline penetrations—an additional factor behind the increased brightness for the facility.



The Pancake Moderator

Over the last several months the concept underwent further design optimisation by Target division engineers and physicists, in close consultation with ESS instrument scientists, resulting in the 2015 baseline design. Due to the innovative shape of the para-hydrogen and water canisters in the interior of the flat moderator, it is now often referred to as the "butterfly" moderator. In the words of the new Head of the ESS Target division Eric Pitcher, "Our pancake has become a butterfly."

Since it was impractical in terms of both cost and time to perform a full mock-up of the butterfly moderator, the Neutronics group experimentally confirmed the effectiveness of the designs, by indirectly using the existing moderator at J-PARC .

Impact on Instrument Performance

The new design is expected to raise instrument performance at ESS relative to other spallation sources. The moderator optimisation will not benefit every instrument at ESS to a corresponding degree, though it will result in increased flux across a wide range of instrument classes and experiment types. Work continues on neutron extraction techniques and instrument beam guides that will also help determine to what degree the instruments are able to exploit the additional flux. For those instruments better served by a volume moderator, the ESS design includes a second, 6 cm high moderator situated beneath the Target wheel.

"An experiment that can be done at ESS in one day can also be done at the other neutrons sources in a bit longer time, but still can be done. What can be done at ESS in one week or two weeks cannot be done anywhere else. This is where the new science is." -Ferenc Mezei

ESS Technical Coordinator Ferenc Mezei emphasised that this increase in brightness goes to the heart of the ESS mission.

Ferenc Mezei, spiritus rector of the pancake moderator

THE INTEGRATED CONTROL SYSTEM (ICS)

The Integrated Control System (ICS) covers the whole ESS machine and facility. A unified approach keeps the costs of development, maintenance, and support relatively low. ESS selected a standardised controls framework, the Experimental Physics and Industrial Control System (EPICS)

EPICS

The selection of EPICS is based on best practices and experience from similar facilities regarding platform standardisation, control system development, and device integration and commissioning. The controls framework was originally developed jointly by Argonne and Los Alamos National Laboratories in the U.S The components of ICS include the control system core, the control boxes, the database management system, and the human-machine interface.

PSS Test Stand

The control system core is a set of systems and tools that make it possible for the control system to provide required data, information, and services to engineers, operators, physicists, and the facility itself. The core components are the timing system that makes possible clock synchronisation across the facility, the machine protection system (MPS) that helps avoid damage to the machine's equipment due to beam losses, the personnel protection system (PPS) that prevents harm due to radiological risks, and a set of control system services that help with maintenance and operations. An estimated 1.5 million control points will be needed to ensure that complex machine and corresponding equipment work in synchronization.

Control boxes are servers that control a collection of equipment (e.g. a radio frequency cavity). ICS will include many control boxes, each of which can be assigned to one supplier, such as an internal team, a collaborating institute, or a commercial vendor. This approach facilitates a clear division of respon-sibilities and makes integration much easier.

The central data management system is called 'BLED' (Beam Line Element Databases), which is a set of databases, tools, and services used to store, manage, and access data. The set of tools that access BLED will be tailored to the needs of different categories of users, such as staff physicists, engineers, and operators, external partner laboratories and visiting experimental instrument users.

Building the Main Control Room (MCR)

The Institute for Energy Technology (IFE) in Norway signed the first In-kind Agreement for ICS in October to build the ESS Main Control Room. This milestone is the first phase of a three-stage process for the ergonomic design of the MCR. The support of operators using the complex control system will maintain a reliable beam with a high output and operational availability, while maintaining the highest possible safety standard. This project is led by Stephen Glenn Collier at IFE and Remy Mudingay at ESS."

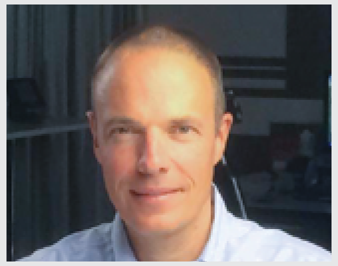
IKC Progress

The majority of value within ICS's scope during the construction phase is represented as manual labor. This leaves many opportunities for contributions from In-kind Partners or suppliers.

Continued progress was made in defining In-kind Agreements with Switzerland. Two contracts, amounting to more than 10% of the ICS In-kind goal, are scheduled to be completed in Q1 2016. Technical Annexes with existing In-kind Partners in France and Spain have advanced, and new opportunities were identified with Estonia and Poland for potential agreements during the first half of 2016.

NEW DIVISION LEADERSHIP LEADS TO, RESTRUCTURING

The ICS division gained new leadership this summer with the appointment of Henrik Carling as Head of Division. Additionally, seven new team members have been hired this year. Considering ICS was one of the smaller divisions at ESS, this was a significant expansion.

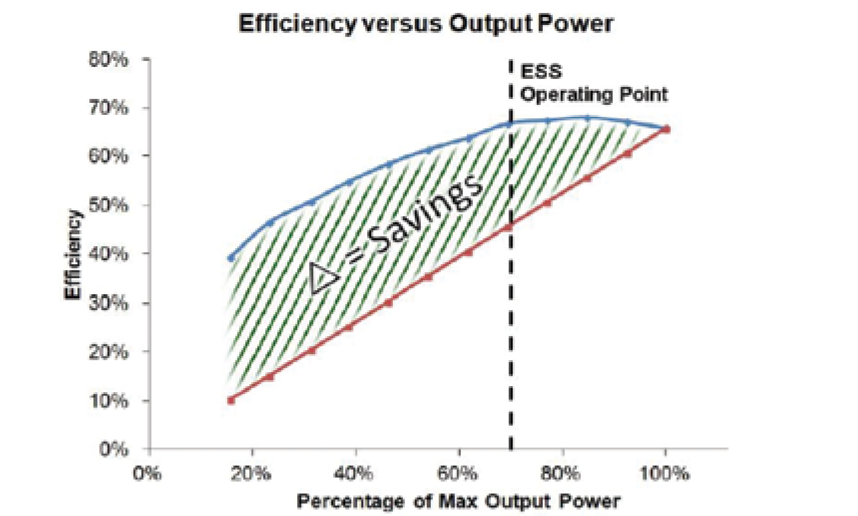


Henrik Carling, Head of ICS Division

Furthermore, the division went through some restructuring, including its Work Package configuration, and In-kind activities were developed. The operational model for the division was defined and communicated, which will help overall understanding of responsibility, mandate and prioritisation in the project. A comprehensive replanning and coordination effort also progressed. In particular, the ICS software scope, currently more than 40% of the ICS budget, is being intensely scrutinised.

MAKING "RESPONSIBLE, RENEWABLE, AND RECYCLABLE" A REALITY

ESS abides by its commitment to create sustainable science in the interest of society with minimal environmental impact. The sustainability goals for ESS have impacted design, construction, and planning, and will come to bear on preparations for how the facility will serve the research community from 2023 onward.



An indication of how the improved efficiency of MB-IOTs (blue) translates into a reduction in the energy used to operate them compared to equivalent klystrons (red).

Path to Sustainability

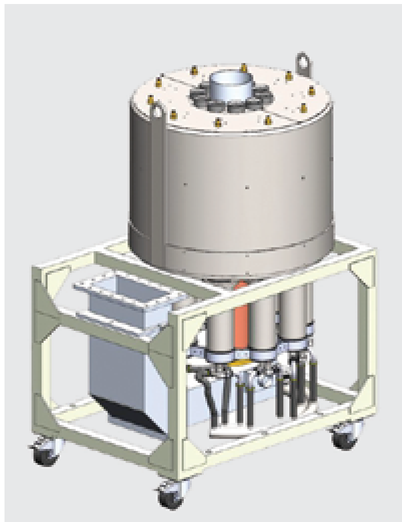
Recent work during the ESS Construction Phase has resulted in notable gains for the project's Responsibility commitment, which refers to responsible energy management.

"ESS has reduced its needs quite a bit with respect to the initial goals for electricity use. That's a winning case, because what you don't use in power means less power lost. There's also less energy to recover." -Roland Garoby

Green Priorities for Big Energy Systems

The power required to run the linear proton Accelerator (Linac) at ESS will account for greater than half of the facility's roughly 270 GWh annual energy needs. Increasing the efficiency of energy consumption for the Linac and its component systems is an important goal of the ESS Accelerator Division and its Partners, including the French national organisations CEA and CNRS, who are working on the efficient superconducting Linac.

"To increase energy efficiency, we consider every single system. We think about how to design smart, technical solutions," said Mats Lindroos, Head of the ESS Accelerator Division. "We are also developing the software, the control algorithms, to make these devices smarter."



MB-IOT prototype version in development for ESS by industrial supplier

An important investment ESS has made over the last few years is research into Multi-Beam Inductive Output Tubes (MB-IOT), a type of power-efficient Radio Frequency (RF) source for the Linac. The MB-IOTs are projected to deliver typical power savings of 2 to 3 MW of the 19 MW of power required to drive the Accelerator.

MB-IOTs, as well as klystrons—another type of RF source that will power the Linac—use powerful radio waves to push the proton beam to increasing speeds as it shoots toward the Target.

"We must look at every percentage to be more efficient, and maintain this mentality. It can definitely be done," said Lindroos. "In essence, it's an obligation. If politicians invest so much money in neutrons it's because we are going to develop technology for a sustainable society and help save the world from the impacts of climate change indirectly through such technology."

ESS is currently exploring methods for how to best recycle the waste heat, which will be output as wastewater ranging in temperature from 30-60° C. The reduction from earlier estimates of wastewater temperatures as high as 80° C may prove to be an advantage as the lower temperature water can be used directly for some applications without the need for cooling. A number of uses are possible for the waste heat, including applications for farming, greenhouse and other food production, and to directly augment the district heating system for the 40,000 people expected to inhabit new developments in Lund's Brunnshög community.

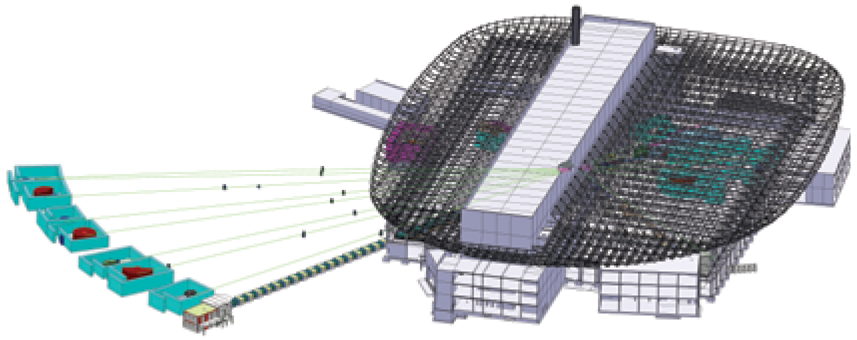
"The most important thing is that the waste heat does not end up in the natural environment, in the atmosphere or aquatic ecosystems," said Lennart Stenman, Design Lead for the ESS Conventional Facilities division. "We want a commercial buyer, such as an energy supplier, to purchase the heat and make good use of it for society."

SCIENCE

THE PATH TO DISCOVERY

SCIENCE AND INSTRUMENTS

The development of ESS is driven by science and the requirements of research to put a foundation in place for tomorrow's scientific community. The scientists and engineers at ESS and its Partners are working together to ensure a world leading facility.



Experimental Hall

The Neutron Toolkit

Neutron scattering can be applied to a range of scientific questions, spanning the realms of physics, chemistry, geology, biology, medicine and other disciplines. With a neutron tool kit, it is possible to probe the structure and dynamics of materials over a wide range of length- and time-scales. Neutron scattering encompasses a diverse range of experimental methods. Depending on how a neutron instrument is built, it can extract different kinds of information and answer different questions.

The neutrons that scientists at ESS will use to study materials at the molecular level are produced by a process known as spallation. That process takes place when protons from the Accelerator hit the Target, a 3-tonne helium-cooled tungsten wheel. That source of neutrons aims to have the highest peak and time-averaged brightness of any source of neutrons in the world when it is built. Today, ESS scientists and Partners from all over Europe are working hard to develop instruments that can harness the potential of this state-of-the-art instrument.

Schreyer Named New Science Director

A key addition to the ESS management in 2015 was the naming of Andreas Schreyer as the new ESS Director for Science. The major goal for Schreyer and the entire ESS management team during the coming year will be to deliver a firm schedule to the ESS Council for the engineering design, construction, and commissioning of the first 16 instruments to be built at ESS.

"I've been involved with the ESS project from the outside so far, and I've seen it grow and seen very good work and very important decisions on the instrument suite being taken," Schreyer added. "We're actually now in a state where we know what we want to build and what the instrument suite is supposed to be."

Andreas Schreyer, Director for Science, then HZG Director

Defining Instruments

A key achievement of 2015 was the Neutron Scattering Systems' (NSS) efforts to define the ESS suite of 16 instruments. These instruments are being built in a massive collaborative effort with Partners from all the Members countries. This milestone has driven discussions with In-kind Partners to defining their contributions to ESS.

In 2013, ESS began a process of selecting instruments based on proposals. Those proposals were then developed into concrete plans for instruments that were presented to the Scientific Advisory Committee (SAC). Several instrument proposals were merged together. According to Schreyer, despite being long, it was an important process to go through because it helped involve all the Partners from Europe, which is needed to make the ESS In-kind model work.

In October 2015 the European Spallation Source ERIC Council endorsed the initial 16-instrument suite that is the result of years of joint efforts within the neutron community. The general plan for sequencing these instruments was discussed with the SAC in September prior to being endorsed by the Council.

The instruments in this series will be the core tools of the ESS user program and expected to enter use by 2023. They will bring unprecedented capabilities to scientists studying matter with neutrons. Importantly, the ESS user community defined the suite of instruments to address the needs of that community.

"By the end of the 2016 we should be able to make a concise proposal that is aligned with our In-kind Partners as to how we do it and which instruments should be finished and by when," said Schreyer.

"By the end of the 2016 we should be able to make a concise proposal that is aligned with our In-kind Partners as to how we do it and which instruments should be finished and by when." -Andreas Schreyer

Detector Developments

In addition to instruments, ESS teams and Partners are working hard to develop the support infrastructure and technologies necessary to operate the instruments. Detector technology will play an important role in future instruments and ESS has been leading the way along with Partners at the The Institut Laue-Langevin and Linköping University demonstrating and building new materials for the next generation of detectors.

ESS Instruments

The table presents and overview of the approved instruments and the corresponding lead partner institutes. There are four different instrument classes with eight different use areas.

Instrument Class	Instrument	Lead Partner(s)	Icons
Large Scale Structures	SKADI General-Purpose SANS	FZJ (DE)	
	LOKI Broadband SANS	ISIS (UK)	
	FREIA Horizontal Reflectometer	ISIS (UK)	
	ESTIA Vertical Reflectometer	PSI (CH)	
Diffraction	HEIMDAL Thermal Powder Diffractometer	AU (DK)	
	DREAM Bispectral Powder Diffractometer	FZJ (DE)	
	MAGIC Single-Crystal Magnetism Diffractometer	LLB (FR)	
	NMX Macromolecular Diffractometer	ESS	
Engineering	ODIN Multi-Purpose Imaging	TUM (DE) + PSI (CH)	
	BEER Materials Science Diffractometer	HZG (DE) + NPI (CZ)	
Spectroscopy	C-SPEC Cold Direct Geometry Spectrometer	TUM (DE)	
	T-REX Bispectral Direct Geometry Spectrometer	FZJ (DE)	
	BIFROST Cold Crystal-Analyser Spectrometer	DTU (DK)	
	VESPA Vibrational Spectrometer	CNR (IT)	
	MIRACLES Backscattering Spectrometer	ESS Bilbao (ES)	
	16th Instrument (VOR or NSE)* Decision in 2018		

Icons legend

life sciences · superconductivity · soft condensed matter · engineering & geo-sciences · chemistry of materials · arheology & heritage conservation · energy research · fundamental & particle physics

Support infrastructure

ESS is also taking shape as a user facility. The first successful ESS user experiment done in collaboration with researchers from the Lund University demonstrates the importance of neutrons to the life sciences, and shows the way forward for ESS.

The team studied protein:carbohydrate binding interactions of a domain (carbohydrate binding module CBM) of a bacterial enzyme. Analysis of these samples with X-Rays and Neutrons makes it possible to better understand the basis of these interactions which have broad application in biotechnology applications, such as biofuel production and biore-

DR. SHANE KENNEDY JOINS AS ESS DEPUTY SCIENCE DIRECTOR

Dr. Shane Kennedy serves jointly as the ESS Deputy Science Director and NSS Project Leader. As the former Technical Director of the Bragg Institute at the Australian Nuclear Science and Technology Organisation in Sydney, Australia he led much of the effort to build the suite of instruments at the Opal reactor which came on line in 2007.

"It's clear what the goal is and what we need to do - deliver 16 world-class instruments by the end of 2025." -Shane Kennedy

Kennedy began at ESS in the spring of 2015, but he had already been involved in the first ESS Annual Project Review in 2013. One of his first priorities has been defining the strategy for the NSS Project to leverage the resources and expertise of European

Shane Kennedy, Technical Coordinator of the Instruments

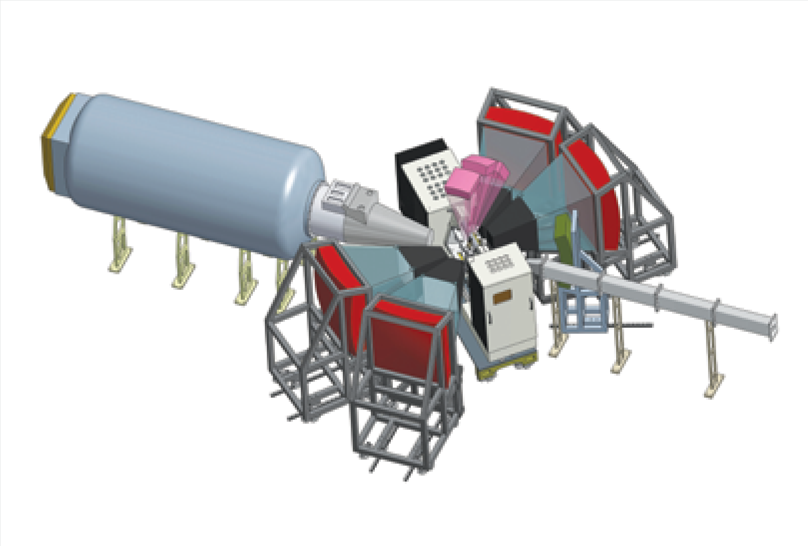
facilities. "The ESS In-kind model is a massive challenge and a great asset," said Kennedy. "As a Greenfield site with no history of neutron scattering in the area, the only way to build ESS is to have the best of the neutron scattering community help us."

Kennedy and the NSS team have been busy defining the tasks between In-kind Partners and ESS. Their immediate goal is to secure signed In-kind Commitments from the Partners.

EUROPE'S NEXT FLAGSHIP ENGINEERING DIFFRACTOMETER

Developing instruments to make use of the unique brightness of ESS and the pulsed structure of the beam is a key challenge. A collaboration between Czech and German labs has resulted in the design of a novel diffractometer. This new instrument aims to be an important tool in European efforts to create 21st Century materials.

"BEER will have the greatest impact by enabling the use of structural materials that are incredibly important for transportation and energy."
– Dr. Michael Preuss



Digital drawing of BEER

The Beamline for European Engineering Materials Research (BEER) is the realisation of Dr. Petr Lukáš' research group at the Nuclear Physics Institute (NPI) and the Institute of Physics in the Czech Republic, and Prof. Dr. Andreas Schreyer's research group – together with an innovative chopper design by Dr. Reinhard Kampmann – at Helmholtz-Zentrum Geesthacht (HZG) in Germany. The concept evolved from two separate proposals previously under development for ESS: the Complex-Environment Engineering Diffractometer (CEED) from the Czech labs, and the Structured Pulse Engineering Diffractometer (SPEED) from the German laboratory. It was not long before CEED and SPEED became BEER.

The design of BEER's enables simultaneous obtain Small Angle Neutron Scattering (SANS) and neutron imaging measurements, while working as a diffractometer. This solution provides nanoscale data for kinetic processes, and detects sample inhomogeneity during structural transformations.

"When we realised the two former instrument concepts could actually be merged into a single concept from which both groups could profit," explained Schreyer, "it became clear we could deliver an instrument concept able to combine the possibilities of worldwide existing instruments with novel concepts for an engineering diffractometer."

Neutron diffraction obtains a pattern of the atomic structure of a material. It is used for characterising materials stress, textures, and deformation. The aim with BEER is to allow more flexibility in sample analysis and increase the usable beam intensity by at least one order of magnitude more than existing neutron diffractometers. That gives more possibilities to investigate samples in situ, but also in operando, or in operation, such as batteries while they are in use.

The advances BEER offers to researchers have broad implications for society and industry. Dr. Michael Preuss is professor of metallurgy at the University of Manchester chaired the panel for Materials and Engineering Diffraction. He said materials such as advanced engineering steel, and super-alloys like titanium alloy, are at the limit of what we can do with them. BEER will have the greatest impact by enabling the use of structural materials that are incredibly important for transportation and energy," said Preuss. "These materials are needed for aircraft engines, power stations, nuclear reactors, deep hole drilling of oil wells and more."

Petr Lukáš, Nuclear Physics Institute in Prague

Engineering materials are critical in technology breakthroughs that improve our modern standard of living. Magnesium and aluminium alloys make possible lightweight, fuel-efficient vehicles and aircraft wings. Titanium alloys mean better consumer electronics. Shape memory alloys (SMA) are essential for the development of device sensors and super elastic, nickel-free biomedical components.

finery processes. They can also be used for probe design that can recognize specific sugars in a complex sample.

The organization and management of the partnership for the experiment is a preview of the large-scale user program that ESS will become over the next decade. It is also helping to spread the word in life sciences circles that ESS is already supporting user's research in life sciences and biology.

The Copenhagen Campus – The ESS Data Management Software Centre

The ESS Data Management Software Centre is an integral part of the ESS Science Directorate, located in Copenhagen with nearly 20 people employed. Mark Hagen, Head of the Centre's Division, leads the work. He previously worked on the construction of both ISIS in the UK, and the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory in Tennessee, USA.

"We are completely focused towards supporting the scientific research programme of ESS," stated Hagen. "In the near term we are very much focused on enabling the instruments to operate."

The team there is developing control, data reduction, and initial data analysis software. In the longer term they are dedicated to ensuring that the data analysis and modelling software is able to extract the maximum amount of scientific information from the experimental data.

Britain's Science and Technology Facilities Council is lead Partner for two instruments. The ESS critical milestone to define the 16-instrument project scope has catalysed discussions with In-kind Partners to agree on their contributions to ESS.

Robert McGreevy and Dimitri Argyriou signing the first instrument MoU

The UK Takes the First Step

A Memorandum of Understanding (MoU) was signed between ESS and the UK's Science & Technology Facilities Council (STFC) in the autumn of 2015. That means that the STFC's ISIS neutron science facility will become the lead Partner for the ESS instruments FREIA and LoKI.

The ISIS neutron science facility at the UK's Rutherford Appleton Laboratory has been a world-leading centre for research with neutrons in the physical and life sciences for nearly three decades. As Europe's only pulsed spallation source it serves as the foundation for ESS, also a pulsed spallation neutron source. The facility's Director, Robert McGreevy, is a member of the ESS Instrument Collaboration Board (ICB) and was on-hand to sign the Agreement.

"To support neutron scattering you need a whole range of capacity and capability, you need a range of experience and knowledge and inputs – this is how science works," said McGreevy. "LoKI and FREIA are good for us, we know how to do these things and we have a user community who are interested in using them, and in using all of the instruments at ESS."

"This is great news for the project. This Partner has a strong tradition of excellence in neutron scattering and instrument building, which is needed to ensure success with ESS."
–Dimitri Argyriou, Former Director for Science at ESS

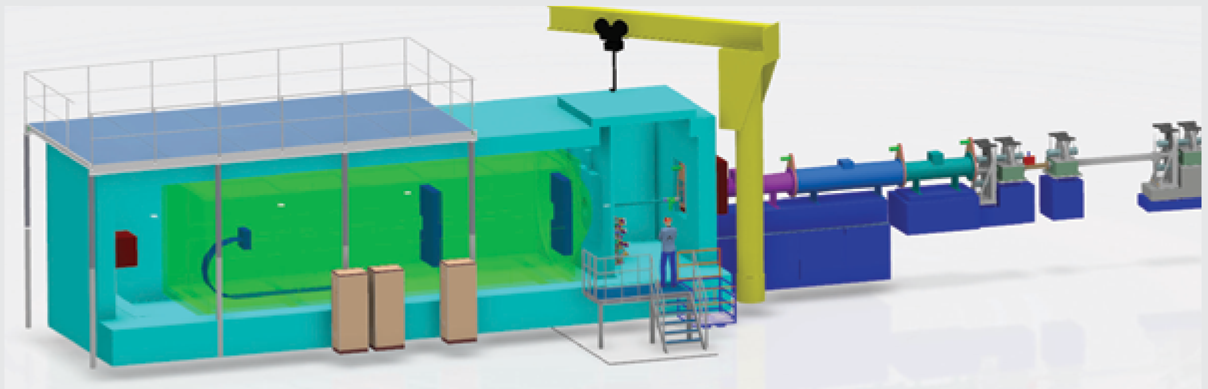
FREIA and LoKI were developed and proposed by instrument scientists at ESS. Both instruments, combined with the high flux and unique pulse structure of the ESS neutron source, are expected to have a major impact across a wide range of materials and life science studies.

LoKI

The instrument LoKI was one of the first selected for ESS and is expected to be a world-leading small-angle neutron scattering (SANS) instrument when construction is complete.

Small angle neutron scattering is a technique that is applied across a spectrum of scientific disciplines, with users from chemistry, physics, biology, materials science, engineering, and geoscience. LoKI is designed primarily with the needs of the soft matter, biophysics, and materials science communities in mind, and the trend in all of these fields is towards complexity and heterogeneity.

"This means that we can move forward and actually start to build it," said ESS Instrument Scientist Andrew Jackson, lead proposer and lead scientist for LoKI. "The next step is, we start on the detailed design work, and they (ISIS) have an engineer ready to go." LoKI is currently undergoing preliminary engineering design.



Digital drawing of LoKI

IKON

The semi-annual IKON meetings on in-kind contributions focus on neutron instrumentation, technologies and science that ESS will engage in. IKON8 and IKON9 took place in the UK and Lund, respectively with over 100 people from the ESS Partners.

Some of the IKON8 participants assembled for a photograph outside the Milton Hill House in Oxfordshire, England, February 2015

Shared Project Culture among Partners – The IKON Meetings

IKON8

The 8th meeting in February covered a lot of ground concerning progress made on instrument engineering and design. The instruments LoKI and NMX received a lot of attention, as did the development and optimisation of their associated technologies. The ca.150 participants, travelled from all parts of the globe. They were also briefed on significant recent developments in ESS Partner countries, Germany, Switzerland, and the UK.

The Director of ISIS, Robert McGreevy, greeted the assembly with a whirlwind presentation on top-level lessons learned over his two and a half years directing the Target station 2 Upgrade at ISIS. McGreevy placed special emphasis on involving people with operational experience in the design and construction of instruments, a particular challenge in a Greenfield project like ESS. He also emphasised early-phase activities such as the target-moderator-reflector optimisation, planning for adequate space in which to both stage and operate the facility, and instrument software development, which McGreevy cautioned should begin "yesterday." "Formal project management," stated McGreevy, "is absolutely necessary –with formal change control."

IKON9

The comprehensive two-day event was held in Lund in September, and attended by more than 160 people from the NSS Partner sphere. IKON9 featured nearly 100 presentations on ongoing work for the ESS instrument project. "Now is the exciting time to build ESS and the instruments, even as we look forward to producing the ground-breaking science." said Dimitri Argyriou former Science Director.

The overall impression of the meeting was that the instrument collaboration teams have found their Partners, and taken off. Argyriou said he expected the discussion on aligning instruments with Partners to continue. That include finalising the instrument suite and its resource configuration; signing Agreements for all 16 instruments as well as bringing ODIN to Phase 2, where it will join LoKI and NMX and moving the next wave of instruments into Phase 1, Engineering Design.

The traditional IKON meeting group photo, taken in Lund on September 21, 2015

WORLD-CLASS DETECTORS

EU support through the BrightnESS project is delivering critical results for the development of such detectors at the European Spallation Source. One such development, in collaboration with Partners, is a Boron-based detector called a Multi-Blade Detector.

Francesco Piscitelli, Richard Hall-Wilton and team including the Partners from Wigner

The Intensity Frontier: Developing World-Class Detectors Using Boron

The first attempts to use Boron-10 for neutron detection were made in the 1930s. Due to the high neutron flux expected at ESS and the economics of the Helium-3 crisis, Boron is experiencing a comeback for detector applications.

In combination with novel instrument and optics designs that will maximise the transport of neutrons from the source to the sample, the instantaneous neutron flux on detectors at ESS will be without precedent. Dubbed "The Intensity Frontier," Task 4.2 of the BrightnESS project at ESS aims to realise detectors optimised for these high rates of neutrons.

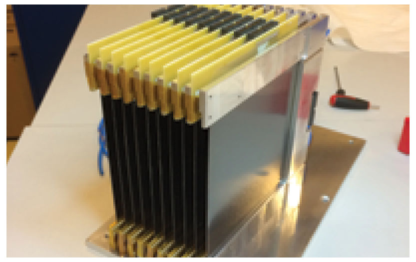
"We established that we needed to reach a neutron count rate factor of 300 greater than state-of-the-art," said Richard Hall-Wilton, Deputy Head of Instrument Technologies and Detector Group Leader at ESS. "We hope to be able to achieve this by 2017."

The project takes as its point of departure the use of Boron-10 as the detector's converter rather than the standard Helium-3 gas used for most neutron detector applications worldwide. ESS researcher in neutron detection Francesco Piscitelli, is the lead developer of the Multi-Blade technology and was a part of the original team at ILL. Piscitelli has completed the design and assembly of a new demonstrator model of the Multi-Blade that is being pre-tested at Lund University and fully tested on beamlines at the Budapest Neutron Centre (BNC), a facility operated jointly by Hungary's Centre for Energy Research and the Wigner Centre.

"Neutrons are not easy to detect, and Mother Nature has given us only a few ways. You need to transform a neutral particle, a neutron, into a charged particle, because we can only detect particles that are charged." -Francesco Piscitelli

Piscitelli went on to say, "So you need a nuclear reaction. Helium-3 reacts, Boron-10 reacts, and Lithium-6 reacts. There are other possibilities as well, but they are too 'dangerous', costly or complicated to use."

Other neutron facilities in both Europe and the US are cooperating with ESS and keeping a close eye on the development of the Multi-Blade Detector.



The nine-cassette technology demonstrator

Francesco Piscitelli, is the lead developer of the Multi-Blade technology at ESS

DATA MANAGEMENT AND SOFTWARE CENTER (DMSC)

From the moment the first neutrons produced by the European Spallation Source register their existence on a detector, the raw experiment data will flow from Lund, Sweden, to Copenhagen, Denmark, and then onto the ESS scientific user community throughout Europe.

Mark Hagen and the DMSC team

The Experiment Data

The ESS Data Management and Software Centre is an integrated part of the design and construction of the ESS instrument suite and a key driver in the development of the facility's user program. Constructing and operating this comprehensive data workflow is the core function of the DMSC.

The Data Management and Software Centre is the Division of the ESS Science Directorate that is responsible for providing the scientific software for the ESS neutron beam instruments. Its scope of work ranges from instrument control and data acquisition software to data analysis, modelling, and simulation. In order to do this, the DMSC will be working in close collaboration with various groups from the ESS Partner countries to develop this all important software suite.

"DMSC is an integral part of the ESS Science Directorate. Our work is completely focused towards supporting the scientific research programme of ESS." -Mark Hagen, Head of DMSC

Data Management

An experiment or sequence of experiments result in a large number of documents, simulation results, measurement data, analysis results, and scientific papers. All of this has to be stored in a structured way so it is easily accessed. Eventually all these data are going to be organised in a data management system that will be developed and hosted at the DMSC.

The data management system will be based on both disk and tape to ensure permanent storage for all data and fast access to frequently-used data. The high-performance cluster also hosted at the DMSC will be directly interfaced to ensure that data can be accessed with the highest bandwidth during reduction and analysis.

FROM LUND TO COPENHAGEN, AND BACK AGAIN

This is a typical data flow for a neutron scattering experiment. Each numbered element corresponds to a key area of scope within the DMSC.

1. Experiment Control: The team of users configure the components of the instrument and sample environment using an experiment control system that interfaces with the neutron instrument components through the ESS EPICS network;

2. Stream: Data are taken in the event mode whereby the individual detector counts are tagged with useful experimental metadata to create a dataset. The list of events and metadata are aggregated in software and broadcast over a network in a continuous stream of data that external software systems can utilise;

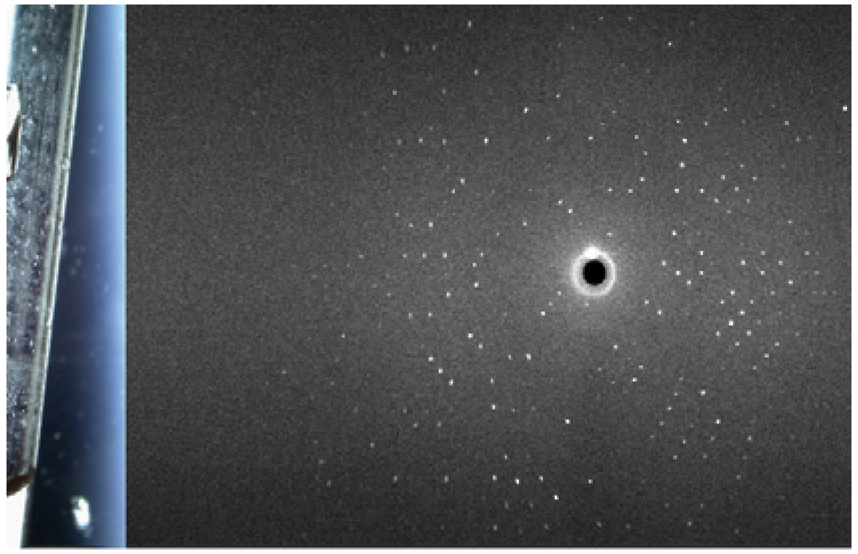
3. Reduce: The raw data are transformed and corrected from the base unit of the instrument to a data type that is scientifically useful and valid. One of the key objectives of ESS is to take the large volumes of data and process them in as near to real time as possible;

4. Visualise: The representation to the beamline users of a scientifically meaningful display of the corrected data; and finally

5. Analyse: A scientific model is generated in order to scientifically interpret the experimental data.

SUPPORT LABS AND FACILITIES

The performance gain of ESS will enable experiments on more challenging samples in an adequate (extreme) environment. Support laboratories and facilities are being established at ESS which will assist the success of user experiments.



Photograph (left) of a large, single crystal of X-2 L110F in complex with XXXG mounted in a quartz capillary undergoing H/D exchange (dimensions are ~1.3 x 1.2 x 1.0 mm; 1.6 mm3); and (right) a representative monochromatic neutron diffraction image collected using BIODIFF at FRM-II.

Facilitating Successful Experiments

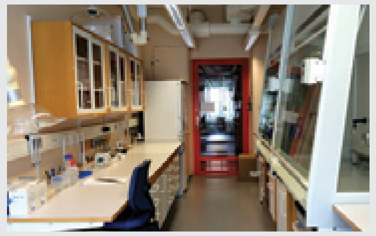
For an efficient and successful use of beam time, many samples will have to be prepared or conditioned on-site using. The technical support required prior to, and during a user visit is related to a specific experiment. For this, mechanical workshops and technical capabilities are required close to the instruments. to prepare items in a timely manner. The necessary lab facilities in the controlled areas will provide the possibility to condition the samples promptly before the experiment. Such facilities include sample handling, preparation, and storage. Temporary storage of samples in adequate conditions will be provided.

"It is an added value to have scientific support labs here in Lund, to offer an expert workflow for future ESS users," says Prof. Arno Hiess, Head of the ESS Scientific Activities Division. ESS plans to provide access to a number of on- and off-site labs that will serve to facilitate users throughout the life cycle of their sample—its preparation, testing environment, handling, and disposal. "We will be able to follow up or provide expert support, we can keep bench and beam time allocation efficient," explains Hiess. "We are here to enable the user through interwoven access modes, bearing in mind also that MAX-lab is there. Co-hosting allows us to achieve critical mass in competence and resources, that also gives a scale advantage."

FIRST LAB SUCCESSES

The first successful user experiment at ESS began in the autumn of 2015 in collaboration with researchers from the Lund University. A team of researchers led by Prof. Mats Ohlin studied protein-carbohydrate binding as part of a larger effort to expand knowledge of the role carbohydrates play in our immune systems. Dr. Zoë Fisher, a deuteration and crystallization specialist at ESS, became involved when the group started looking at the possibilities of using neutrons for this experiment.

Neutrons have the power to discern the exact locations of protons in large molecular complexes, information that is key to understanding molecular functional mechanisms in biology. However, in order to obtain this information, samples often have to be deuterated and crystallized, which poses some challenges. In order to facilitate life science studies at ESS, a biocrystallization support lab is being established as able to produce large crystals (1.6 mm3 in volume) that were then zapped with X-rays at MAX-lab and bombarded with neutrons on the BIODIFF instrument at the FRM II facility in Munich. The combination of these two high-resolution diffraction experiments in a very precise 3D model of the protein structure.



Biocrystallisation lab

The ESS Biocrystallisation Lab already serves to provide services for users in need of assistance with biological samples to be analysed at existing neutron and X-ray sources. The ESS lab has established close ties to Lund University and collaborates with their Lund Protein Production Platform (LP3), which provides a range of complimentary services to produce, purify, and analyse protein samples that will be used in spectroscopy and diffractions experiments.

Working together, these facilities are establishing an efficient administrative and scientific workflow that will be essential to making the best use of precious ESS beam time once the facility is commissioned.

GOVERNANCE

IN CHARGE AT ESS

GOVERNANCE

The European Spallation Source ERIC Council is the governing body of the European Spallation Source ERIC. The Council is made of representatives from the Member countries. It appoints the Director General and Chairperson, and approves the budget and technical scope of the facility.

European Spallation Source ERIC Council

The European Spallation Source ERIC Council

The European Spallation Source ERIC Council is bound by the Statutes ratified by the ERIC Member countries. The constituting European Spallation Source ERIC Council Meeting was held July 2-3, 2015, where the leadership was appointed, the Council Rules of Procedure were adopted, and the Terms of Reference for all advisory committees were adopted by the Council. James H. Yeck was appointed the Director General of European Spallation Source ERIC and Prof. Lars Börjesson was appointed the Chair of the European Spallation Source ERIC Council. In October 2015, Prof. Dr. Caterina Petrillo was unanimously elected as the governing body's Vice Chair. The European Commission's establishment of ESS as an ERIC occurred on August 31, 2015, and the transition of ESS from a Swedish limited partnership to an ERIC was completed as of October 1, 2015.

ESS Committees

The ESS project is supported by a number of independent advisory committees. Recommendations by each committee advances ESS along the critical path to completion. The committees consist of delegates representing the Member countries or experts which evaluate and advise the progress of the ESS.

ERIC COUNCIL LEADERSHIP

CHAIR

Professor Lars Börjesson Chairs the European Spallation Source ERIC Council. He was previously the Chair of the ESS Steering Committee, and also one of the founders and the first Chair of ESS-Scandinavia in 2000.

Prof. Börjesson is Vice President of Chalmers University of Technology and Professor of Condensed Matter Physics, and is Vice Chair of the European XFEL free electron laser facility. He has served as Chair of the MAX IV Laboratory until 2013, Vice Chair of ESFRI until 2012, and Secretary General of the Swedish Council for Research Infrastructures until 2010. Throughout the years he has served in many boards of directors and international committees for research and research

Caterina Petrillo, Vice Chair and Lars Börjesson, Chair

infrastructures. Prof. Börjesson has published around 300 scientific papers in international journals.

VICE CHAIR

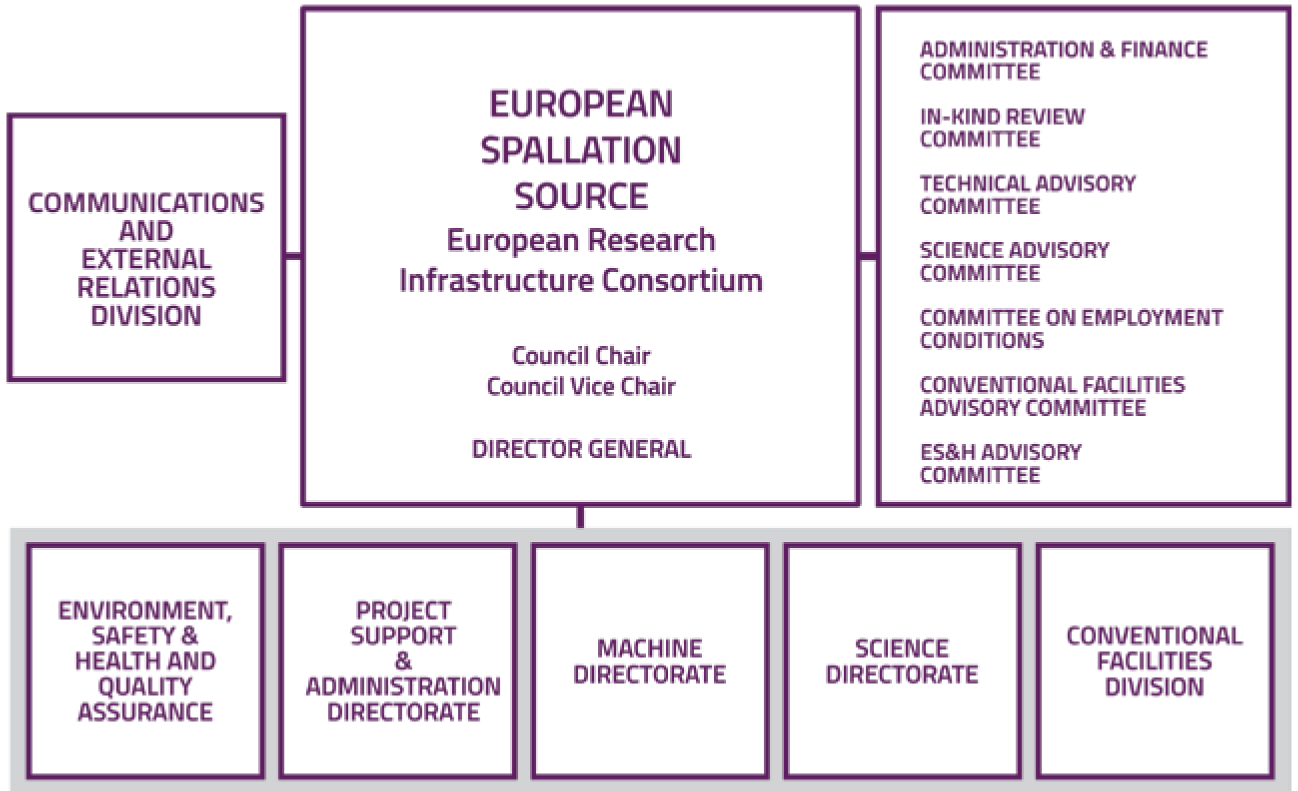
Professor Dr. Caterina Petrillo serves as the governing body's Vice Chair. Petrillo is a physicist and Director of the Physics and Earth Science Department at the University of Perugia, where she has built a standout career in research, higher education, and governance. She has been an important participant in the collective European scientific community for three decades.

"I believe the ESS project is a great opportunity for Europe and European science and scientists, which we should nurture to our best ability, starting with the responsible and inclusive work of our international council." -Caterina Petrillo

Petrillo has been actively engaged in the planning and delivery of ESS since 2007, when she became a Member of the Lund Round Table. She also served as an Italian delegate to the ESS Steering Committee from 2011 to 2015.

ORGANISATION

The organisational chart of the ESS including the ERIC Council, the related advisory committees and the project directorates.



ESS ADVISORY COMMITTEES

Administration and Finance Committee (AFC)

Two delegates from each Member country, the AFC advises the Council on all matters of administrative and legal issues and of financial management.

In-kind Review Committee (IKRC)

The IKRC is charged with the general responsibility of evaluating the In-kind Contribution proposals and making recommendations thereupon to the Council. The Council approves all In-kind contracts based on these recommendations. Each country participating in the Council is represented in the IKRC by one delegate.

Scientific Advisory Committee (SAC)

The SAC consists of outstanding scientists not employed by or otherwise immediately connected with ESS, and advises the Council in scientific matters and other matters of importance for ESS.

Technical Advisory Committee (TAC)

The TAC consists of outstanding experts not employed by or otherwise immediately connected with ESS, and advises the Council in technical matters and other matters of importance for ESS.

Conventional Facilities Advisory Committee (CFAC)

The CFAC is a small group of experts within large-scale infrastructure, assisting and advising ESS with construction planning.

Environment, Safety & Health Committee (ES&HC)

The ES&HC is a small group of experts within Environment, Safety &Health assisting and advising ESS in planning with regard to Environment, Safety &Health.

Committee on Employment Conditions (ECC)

The ECC is a committee of representatives from the governance and host countries assisting and advising ESS in all matters related to Employment Conditions.

ESS GOVERNANCE COMMITTEES

	ERIC Council	Administration and Finance Committee (AFC)	In-kind Review Committee (IKRC)
Chair Vice Chair	Lars Börjesson Caterina Petrillo	Bernard Dormy Neil Pratt	Marco Marazzi Bjørn C. Hauback
Belgium	Laurent Ghys Eric van Walle	Christian Legrain	Hamid Aït Abderrahim
Czech Republic	Petr Lukáš Ivan Wilhelm	Petr Ventluka	Petr Šittner
Denmark	Robert Feidenhansel Bo Smith	Morten Scharff	Søren Schmidt
Estonia	Toivo Raïm Pritt Tamm	Pritt Tamm	Heisi Kurig
France	Patricia Roussel-Chomaz Amina Taleb-Ibrahimi	Bertrand Franel Laurent Pinon	Bernard Laune
Germany	Sebastian Schmidt Beatrix Vierkorn-Rudolph	Oda Keppler Dirk Steinbach	Ulrich Breuer
Hungary	Laszlo Rosta István Szabó	Orsolya Sárdi	Daniel Csanády
Italy	Salvatore La Rosa Eugenio Nappi	Ileana Gimmilaro Roberto Pellegrini	Paolo Michelato
The Netherlands	Louis Vertegaal Bert Wolterbeek	Nico Kos	Guy Luijckx
Norway	Bjørn Jacobsen	Bjørn Jacobsen	Bjørn C. Hauback
Poland	Mateusz Gaczyński Marek Jezabek	Michał Rybinski	Adam Maj
Spain	Inmaculada C. Figueroa Rojas José Luis Martinez	Inmaculada C. Figueroa Rojas	Frederico J. Mompean
Sweden	David Edvardsson Sven Stafström	Maud Bergkvist Johan Holmberg	Ulf Karlsson
Switzerland	Martin Kern Joël Mesot	Patrice Soom	Peter Allenspach
United Kingdom	Neil Pratt Andrew Taylor	Maggie Collick Neil Pratt	Uschi Steigenberger

ESS AB Board

Chair	Sven Landelius
Vice-Chair	Bo Smith
Denmark	Kim Graugaard
Denmark	Hans Müller Pedersen
Sweden	Katarina Bjelke
Sweden	Lars Börjesson
Sweden	Per Eriksson
Sweden	Lena Gustafsson
Employee Representative	Mikael Palade

Executive Management Team (EMT)

James H. Yeck	Director General & CEO
Andreas Schreyer	Science Director
Roland Garoby	Technical Director
Agneta Nestenborg	Director for Project Support & Administration
John Haines	Associate Director of Environment, Safety & Health and Quality Assurance
Kent Hedin	Head of Conventional Facilities Division
Allen Weeks	Head of Communications & External Relations Division
Pia Kinhult	Strategic Project Advisor

ESS ADVISORY COMMITTEES

Scientific Advisory Committee (SAC)

Andreas Meyer (Chair)
Sylvia McLain (Co-Chair)
Vladimir Sechovsky
Markus Braden
Bo Brummerstedt Iversen
Fabio Bruni
Arnaud Desmedt
Bernhard Frick
Kenneth W. Herwig
Björgvin Hjörvarsson
Herve Jobic
Klaus Stefan Kirch
Jörg F Löffler
Tomas Lundqvist
Carmen Mijangos
Kristine Niss
Catherine Pappas
Toby Perring
Roger Pynn
Helena Van Swygenhoven
Regine von Klitzing
Wojciech Zajac

Technical Advisory Committee (TAC)

Philippe LeBrun (Chair)
John Galambos (Co-Chair Accelerator)
Philip D. Ferguson (Co-Chair Target)
Alban Mosnier
Bertrand Blau
Michael Borden
Tim Broome
Michael Butzek
Alberto Facco
Masatoshi Futakawa
Frank Gerigk
Mark Heron
Alessandra Lombardi
Anton Möslang
Ralph Pasquinelli
Manuel Perlado
Robert Stieglitz
Szabina Török
Hans Weise
Karen White
Michael Wohlmuther

Environment, Safety & Health Committee (ES&HC)

Paul Berkvens (Chair)
Enrico Cennini
Doris Forkel-Wirth
Marek Jura
Frank Kornegay
Göran Larsson
Martin Luthander
Kelly Mahoney
Thomas Peterson

Conventional Facilities Advisory Committee (CFAC)

Martin Fallier (Chair)
Olle Ehrlén
Carsten Jarlov
Sven Landelius
Peter Lundhus
Gyrithe Saltrop
Tim Watson

Committee on Employment Conditions

Lars Börjesson (Chair)

José Luis Martinez
Patricia Roussel-Chomaz (Provisional)

Agneta Nestenborg
Sven Havelius (ESS Representatives)

Bo Smith
Katarina Bjelke (Ex-officio members: Host state representatives)

The ESS management can participate ex-officio.

STATUTORY ADMINISTRATION REPORT

ESS IN FIGURES

Translation of “Årsredovisning 31 augusti – 31 december 2015”:

Annual report
31 August – 31 December 2015

European Spallation Source ERIC
Org.nr. 768200-0018

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STATUTORY ADMINISTRATION REPORT

The Director General of the European Spallation Source ERIC (org.no. 768200-0018), hereby present the Annual Report for the period 31st August to 31st December 2015.

General Information

European Spallation Source is Scandinavia's first ERIC and the eleventh in Europe. ERIC is a legal framework that the EU has developed to facilitate the establishment and operation of large European research facilities. The European Spallation Source ERIC has legal personality and full legal capacity in all member and observer countries, enabling countries to participate in decision-making and contribute directly to the financing of the ESS. See also Notes, Note 2.

European Spallation Source ERIC is a consortium with the purpose of designing, constructing and operating the next generation neutron source. ESS is a European research infrastructure that will be used to conduct research on various materials and will have significant long-term impact on the competitiveness of Swedish research and industry. The site is under construction outside Lund and is scheduled to be completed in 2019. The user programme for researchers is planned to start in 2023 and the facility should be fully operational by 2025. The project is one of the largest and most high-priority research infrastructure projects in Europe.

European Spallation Source ERIC includes the facility, which is under construction in Lund, Sweden, and the Data Management and Software Centre (DMSC) in Copenhagen, Denmark. The international focus can be seen throughout the organisation. The staff now includes employees from nearly 50 different nations.

European Spallation Source ERIC has 11 member countries: Sweden, Denmark, Germany, France, Italy, Switzerland, Norway, Poland, Hungary, Czech Republic and Estonia. A number of countries are observers until the respective national decision-making processes regarding membership are completed. Observer countries are the UK, Spain, Belgium and the Netherlands.

Joint cooperation is ongoing with partners from all over Europe and also from other parts of the world. European Spallation Source ERIC has a large network of laboratories to exchange knowledge, personnel and experience, which in many cases are contributed directly to the project through In-kind contributions. In-kind contributions are expected to finance about 35 percent of the total estimated construction-cost of 1.843 billion EUR (2013 prices).

When ESS user programme starts in 2023, it is estimated that two to three thousand guest researchers annually conducting experiments in the facility. Most users will be European universities and institutes as well as industry.

Construction Project

The construction project, led by the Conventional Facilities Division, operates the work according to the schedule for the entire ESS project. The focus for the organisation is the project schedule in order to be able to complete the project on time and within the agreed budget.

At the time of the transition to the European Spallation Source ERIC 15% of the entire ESS project was already completed.

During spring the work started with the extensive land and piling works for the target station. 30% of just over 6000 piles which are to prevent the heavy impact on the target building if affected by extreme forces, was completed at the end of September.

On May 29th, ESS AB signed an agreement with Skanska to build the second phase of the research facility. The contract including installations in a number of buildings, substations, transformers and land works and piling was taken over by the European Spallation Source ERIC in the asset transfer. Work on the accelerator tunnel has continued rapidly. In early October, the entire baseplate, and 50% of the walls and ceiling of the tunnel were completed. Several adjacent buildings, including the klystron gallery (GO2) and switchgear with several support buildings, were also progressing.

In-kind Contributions

The ESS project is based on extensive collaboration with research institutions within the partner countries. The majority of the instruments, the target station and the accelerator will be delivered as In-kind. During the year, extensive work has been performed to secure in-kind collaborations with partner institutions across Europe. More than 100 partners are now actively involved in the ESS project. In 2015 ESS became an ERIC and it was a prerequisite for many of the in-kind partners to be able to sign the contracts. After the transition, several In-kind contracts were signed and more are coming.

ESH&Q

Environment, Health, Safety & Quality Division (ESH & Q) has a key role at ESS to ensure that safety requirements are implemented throughout the organisation and in the construction of the plant. Radiation Safety Authority (SSM) announced in July a revised specification of the conditions regarding radiation safety required for ESS before the plant can be commissioned. ESH & Q Division worked during the year with breaking down the SSM's updated requirements and preparing the application to be submitted to the SSM in May 2016. This is the second step of the permitting process, concerning the installation of accelerator equipment that can generate ionising radiation.

Risks and Uncertainties

Active and structured risk management contributes to the successful implementation of the ESS and that the ESS overall objectives can be met. The knowledge ESS gains regarding existing risks is used to continuously develop the ESS project plans.

ESS has a risk management framework which is described in two main documents: ESS The risk management policy and ESS Risk management process. In addition to these two documents the risk management plan specifies the responsibilities and time frames for risk-related activities of the organisation.

Risk Management Objectives

ESS has established the following goals for risk management:

- Frequent and open risk communication, which enables a clear and common understanding of risks and uncertainties within the ESS and among partners, suppliers and etc.
- Continuously updated risk overview, register of the risks, uncertainties and risk response actions
- Reduced risk exposure through rapid and proactive enforcement of measures
- Focus on risks and uncertainties through effective risk reporting, internal and external

Risk assessments should be based on both qualitative and quantitative assessments calculations and decisions are made after the results of such analysis have been duly considered.

Risks and Uncertainties

Each potential event that could affect its overall objectives implies a risk. Risk identification and risk analysis is a part of the daily work at ESS. These aims are to contribute to the effective management of risks, by providing greater insight about the consequences with a certain risk involved, and with what probability it could happen. Structured risk analysis enabling comparisons, and facilitates risk communication.

The risks are assessed from two different perspectives:

Risks Related Injuries

Health and accident risks are assessed for all activities performed and also covers the management of radiation safety when ESS is running. It includes the management of risks related to accidents during the construction phase. Processes and rules for the work of the ESS construction site has been established in cooperation with our contractors.

Risks Related to the Quality and Function

Risks that could potentially degrade the quality and function of technical structures, systems and components is of great importance for ESS. To manage these risks ESS has during the year refined the existing processes for configuration work and developed new technology systems. Processes and a quality management system has also been implemented.

Risks Related to the Environment and the Surroundings

Risks that may affect the environment and the physical environment of the ESS construction site are managed within the line organisation. Work on environmental risks are assessed in close collaboration with affected functions. Identified risks have been dealt with in accordance with the ESS risk management framework.

Risks Related to Society's View of ESS

Management of risks related to the society's view of the ESS is important because the ESS depends on collaborations with other European countries and to be able to recruit scientists, engineers, and other world class specialists to Lund in Sweden. Risks related to society's view of the ESS are handled in close cooperation between the ESS management, the human resources division and the communications division

Risks Concerning Time Schedule

Risks affecting the time schedule relates to processes and activities that could delay the implementation of the project plan. Examples of such risks which have been handled are the In-kind agreements with the partners who will deliver equipment and services to the project.

Risks Regarding the Annual Operating Cost

In order to achieve the overall goal for ESS it is required that the operating costs are met. Risks in the form of e.g. service and maintenance, energy consumption, downtime, insurance premiums and /or loss of property have been identified. Plans and cost estimates for the operational phase of the ESS have evolved over the years and after the operations transition from ESS AB to the European Spallation Source ERIC further work will be handled by a working group with representatives from the member countries, under the leadership of the Council's Vice-Chairperson.

Risks Related to Economics and Finance

To understand and manage risks that could have economic consequences in terms of exceeding the project budget is vital to ESS and managed through established processes related to the identification and analysis of uncertainties in the cost estimates. Each part of the project has its definite budget and every risk of exceeding the budget is handled individually. Such actions are handled by the management through a well-defined process.

ESS activities are financed by all member countries through contribution.

The remaining financing risks during the construction phase is about reaching one hundred percent cost coverage through commitment and being able to establish a bridge financing solution in order to secure the project's liquidity needs.

The first risk is dealt with in the ongoing negotiations with the countries that have shown strong interest to participate in ESS and the other dealt with the member countries. In 2015 it has been about moving forward some of the cash contributions and in the long term, it is about using the future contributions as security to establish a temporary bridge-financing to cover the identified gaps between the need on the one hand and on the other hand the access to cash.

Significant Events During the Year

The European Commission's decision, which took effect from 31 August 2015, to establish the European Spallation Source as an ERIC means that the activities carried out so far within the framework of the ESS AB were transferred to the ERIC. The ESS project officially transitioned to the European Spallation Source ERIC October 1, 2015.

Development of the Company's Financial Performance and Position

The net result amounted to -271 982 KSEK. The result includes costs for staff and consultants, and administrative and technical infrastructure during the construction phase.

Shareholders' equity amounted to 67 183 KSEK. During the financial year, the European Spallation Source ERIC received contributions from member countries amounting to 339 165 KSEK.

Investments

After the acquisition from ESS AB the investments in construction in progress amounts to 278 113 KSEK.

Financing and Liquidity

European Spallation Source ERIC has during the fiscal year 2015 received contributions from member countries by 339 165 KSEK. More information about received contributions, see Note 16. Cash and cash equivalents amounted to 384 062 KSEK.

Significant Events After the end of the Year

The Swedish Parliament has decided after the closing date in accordance with Prop. 2015/16: 77 that the European Spallation Source ERIC shall be exempted "from excise duties, including energy tax on electric power when the consortium for use in its own operations, makes substantial purchases of excise goods on which excise duty is included in the price. The same also applies to substantial consumption of electric power in its own operations, for which the consortium is liable for tax."

In January 2016 it was announced that James H. Yeck, Director General at the European Spallation Source ERIC, will leave his post during the year. The process of finding a replacement is ongoing.

INCOME STATEMENT

KSEK	Note	2015-08-31– 2015-12-31
Net turnover		–
Gross profit		**–**
Administration expenses		-50 944
Research and development expenses		-219 212
Other operating income	4	7 674
Other operating expenses	5	-9 465
Operating profit		-271 947
Financial income	8	4
Financial expenses	9	-39
Profit before tax		-271 982
Tax		-
NET RESULT		**-271 982**

BALANCE SHEET

KSEK	Note	2015-12-31
ASSETS		–
Non-current assets		
Tangible fixed assets		
Equipment, tools, and installation	11	8 217
Construction in progress	12	756 096
Total non-current assets		**764 313**
Current assets		
Short term receivables	13	80 965
Prepaid expenses and accrued income	14	18 495
Cash and bank		384 062
Total current assets		**483 522**
		1 247 835
EQUITY AND LIABILITIES		
Equity		
Capital contribution	16	339 165
Net result		-271 982
Total equity		**67 183**
Current liabilities		
Account payables		198 888
Other liabilities	17	857 375
Accrued expenses and prepaid income	18	124 389
Total liabilities		**1 180 652**
TOTAL EQUITY AND LIABILITIES		**1 247 835**

CONTINGENT LIABILITIES AND PLEDGED ASSETS

KSEK	2015-12-31
Contingent liabilities	None
Pledged assets	None

EQUITY

KSEK	Cash contribution	Net result	Total equity
Opening balance 2015-08-31	–	–	0
Net result	–	-271 982	-271 982
Contributions	339 165		339 165
Balance as of 2015-12-31	**339 165**	**-271 982**	**67 183**

CASHFLOW

KSEK	Note	2015-08-31– 2015-12-31
Operating activities		
Income after financial items		-271 982
Adjustments for non-cash items		656
Cash flow from operating activities before changes in working capital		**-271 326**
Cash flow from changes in working capital		
Increases (-)/decreases (+) in operating receivables		-99 460
Increases (+)/decreases (-) in operating liabilities		1 180 652
Cash flow from operating activities		**809 866**
Investing activities		
Acquisition of tangible assets	11	-8 873
Acquisition of construction in progress	12	-756 096
Cash flow from investing activities		**-764 969**
Financing activities		
Cash contribution		339 165
Cash flow from financing activities		**339 165**
Cash flow for the year		**384 062**
Liquid assets at the beginning of the financial year		0
Liquid assets at the end of the year		**384 062**

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 is a European Research Infrastructure Consortium. The organisation has its statutory seat in Lund, Sweden. The head office is situated in Tunavägen 24, 223 63 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 12 months from the balance date. Current assets and current liabilities consist of amounts expected to be recovered or paid within 12 months from the balance date.

Valuation Principles, etc.

Assets, provisions, and liabilities are valued at cost unless otherwise stated below.

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 the estimated residual value. Depreciation is linear over the asset's estimated lifetime.

The following depreciation schedules are applied:

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 ERIC, 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 thus is applied similarly for ESS ERIC.

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 (Årsredovisnings- lagen) 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 12 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

European Spallation Source ERIC 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 16.

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.

The In-kind Contribution during the preconstruction phase was included in the transfer of ESS AB to the European Spallation Source ERIC. These In-kind Contributions have not been booked since the process for reviewing and approving values, completed delivery, and agreements for these grants in ESS AB were completed when they were transferred from ESS AB to the European Spallation Source ERIC. The process to review and approve these values will continue in European Spallation Source ERIC.

NOTE 2: ASSOCIATED PARTIES WITH A CONTROLLING INFLUENCE

The Council (Rådet) 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: EMPLOYEES, STAFF COSTS, AND FEES TO THE AUDITORS

AVERAGE NUMBER OF EMPLOYEES	2015-08-31– 2015-12-31
SWEDEN	
Men	220
Women	112
Total	**332**
DENMARK	
Men	12
Women	2
Total	14
TOTAL	**346**

GENDER DISTRIBUTION IN THE MANAGEMENT	2015-12-31
Management directors and Director General	4
Where of women	25%

SALARIES, OTHER REMUNERATION AND SOCIAL COSTS, KSEK	2015-08-31– 2015-12-31
Sweden	60 602
Denmark	3 859
TOTAL	**64 461**
Social costs	17 448
Pension costs	3 023
TOTAL SOCIAL COSTS	**20 471**
Salaries and other remunerations includes	
- to Director General	606
- to Management directors	1 325

ALLOWANCES TO MANAGEMENT DIRECTORS 2015, KSEK	Total
Director General	
Management Directors (3 pers.)	
TOTAL	**2 450**

Incentive Scheme

European Spallation Source ERIC has no incentive scheme.

Severance Pay to Senior Executives

Director General and senior executives employment agreements have from 1 October 2015 been transferred from ESS AB to European Spallation Source ERIC, and there are no severance payments.

FEES AND REMUNERATION TO AUDITORS, KSEK	2015-08-31– 2015-12-31
KPMG AB	
Audit assignments	301
Other assignments	19
TOTAL	**320**

NOTE 4: OTHER INCOME

KSEK	2015-08-31– 2015-12-31
Exchange rate gain on receivables/liabilities of operations	4 191
Contributions for EU-Grants	3 404
Other income	79
TOTAL	**7 674**

NOTE 5: LEASING FEES WITH RESPECT TO OPERATIONAL LEASES

All leasing agreements have been taken over from ESS AB from 1 October 2015.

KSEK	2015-08-31– 2015-12-31
Leasing agreements where the company is the lessee:	
Minimum leasing fees	2 626
Variable fees	212
TOTAL LEASING COSTS	**2 838**

Contractual future minimum leasing fees relating to non-retractable contracts which become due for payment:

Within one year	11 352
Between two and five years	5 811
TOTAL	**17 163**

NOTE 6: OTHER EXPENSES

KSEK	2015-08-31– 2015-12-31
Exchange rate losses on receivables/liabilities of operations	-9 374
Other expenses	-91
TOTAL	**-9 465**

NOTE 7: DEPRECIATIONS

KSEK	2015-08-31– 2015-12-31
Depreciation according to plan by asset:	
Equipment, tools, and installation	-656
TOTAL	**-656**
Depreciation according to plan by function:	
Administration expenses	-89
Research and development costs	-567
TOTAL	**-656**

NOTE 8: INTEREST INCOME

KSEK	2015-08-31– 2015-12-31
Interest income	4
TOTAL	**4**

NOTE 9: INTEREST EXPENSE

KSEK	2015-08-31– 2015-12-31
Interest expense	-39
TOTAL	**-39**

NOTE 10: TAX ON INCOME FOR THE YEAR

KSEK	2015-08-31– 2015-12-31
Current tax	0
Deferred tax	0
TOTAL	**0**

European Spallation Source ERIC has currently costs generating tax losses. Uncertainty about the possibilities and the timeframe to take advantage of these is the reason for not accounting for deferred taxes.

NOTE 11: EQUIPMENT, TOOLS AND INSTALLATION

KSEK	2015-12-31
Accumulated cost of acquisitions:	
Beginning of the financial year	0
Acquisitions	8 873
TOTAL	**8 873**
Accumulated depreciation according to plan:	
Beginning of the financial year	0
Depreciation according to plan	-656
Net value in balance sheet 31 Dec 2015	**8 217**

All equipment has been transferred to European Spallation Source ERIC from ESS AB according to agreement dated 1 October 2015.

NOTE 12: CONSTRUCTION IN PROGRESS

KSEK	2015-12-31
Accumulated cost of acquisitions:	
Beginning of the financial year	0
Acquisitions	756 096
Net value in balance sheet 31 Dec 2015	**756 096**

NOTE 13: SHORT TERM RECEIVABLES

KSEK	2015-12-31
VAT receivables	73 873
Other tax receivables	4 852
Other	2 240
TOTAL	**80 965**

VAT receivables remain in the balance sheet per closing date in anticipation of the Parliamentary decision under Prop. 2015/16: 77 concerning exemption from indirect taxes.

NOTE 14: PREPAID EXPENSES AND ACCRUED INCOME

KSEK	2015-12-31
Prepaid rental costs	3 750
Prepaid insurance	9 665
Accrued income EU-project	4 407
Other	673
TOTAL	**18 495**

NOTE 15: 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 16: CAPITAL CONTRIBUTIONS

KSEK	2015-12-31
Estonia	5 230
Denmark	172 971
Switzerland	20 587
Norway	106 935
Czech republic	28 992
Hungary	4 450
TOTAL	**339 165**

NOTE 17: OTHER LIABILITIES

KSEK	2015-12-31
Liabilities to ESS AB according to transfer agreement	845 613
Other	11 762
TOTAL	**857 375**

According to shareholders meeting in ESS AB, 2016-03-18, the company's purchase price claim on the European Spallation Source ERIC will be distributed to the shareholders, Sweden, and Denmark. The liabilities to ESS AB will be converted to contribution to European Spallation Source ERIC, Prop 2015/16 1.

NOTE 18: ACCRUED EXPENSES AND DEFERRED INCOME

KSEK	2015-12-31
Accrued vacation salary	17 209
Employee taxes and social costs	4 726
Accrued salary tax	1 281
Accrued payments for EU- projects	48 309
Accrued construction- and consultancy fees	32 192
Accrued expenses CEA	10 286
Other accrued expenses and deferred income	10 386
TOTAL	**124 389**

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.

Lund 2016-04-30

James H. Yeck
Director General

Our audit report was submitted
2016-KPMG AB

Kent Lindén
Authorised Public Accountant

The European Spallation Source ERIC's mission is to design, build and operate the world's leading research facility using neutrons for science and innovation. This report is produced by The European Spallation Source ERIC with support from BrightnESS, a project funded by the European Union Framework Programme for Research and Innovation Horizon2020, under grant agreement 676548.

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