EUROPEAN
SPALLATION
SOURCE

ACTIVITY REPORT 2017

1 January – 31 December 2017
European Spallation Source ERIC
Org.nr. 768200-0018

Contents

Foreword by the Director General

The construction of the European Spallation Source advanced by nearly 20% over the course of 2017. The project is now 43% complete and we are maintaining the project's fast pace and momentum. Several major construction, technical and project milestones were achieved throughout the year, keeping the project on track. For this, all of us at ESS are rightfully very proud.

Challenges to keeping that schedule have also arisen in 2017, mostly related to strengthened civil construction regulatory requirements but also potential delays to some in-kind deliverables. This has made it necessary to re-baseline the project in 2018 in order to minimise the impact on the most important milestones: beginning initial operations in 2019 and the start of our scientific user programme in 2023.

A project-wide focus on the early scientific success of the facility is guiding ESS and its member states as we work to make fundamental scheduling and funding decisions in 2018. Planning for the 2019 transition to initial operations advanced considerably in 2017, representing major work throughout the organisation in response to Council's leadership. The ESS Council has committed to finding funding solutions in 2018 for both initial operations and the completion of construction.

Another significant move forward has also been accompanied by a new challenge. On the final day of 2017, the Spanish government declared its intention to become a full ERIC member, but also indicated that it would have to reduce its contribution to the project. At the same time, engagement with non-European nations, including Canada and South Africa, has demonstrated the potential for new models for participation.

What has been most inspiring about the project in 2017 are the clear signs of how the big picture for ESS is successfully coming together on the site in Lund.

The unrelenting pace of work on the massive Target Station throughout 2017 has significantly advanced the demanding civil construction of the Target's Active Cells and Monolith structures.

Major in-kind contributions of machine hardware and systems from Italy, the United Kingdom, France, Spain, Germany and other partners are in different stages of installation, delivery, manufacturing, prototyping and testing.

Meanwhile, several buildings were handed over from construction partner Skanska to ESS throughout 2017, and, in October, ESS cleared a major milestone in the stepwise licensing of the facility by Swedish authorities. Together, these successes have allowed critical accelerator installations, including the Ion Source and RF test stand, to proceed on schedule.

The intensely collaborative process of instrument construction also advanced rapidly in 2017. The budget and scope for the instruments were approved by Council at the very end of 2016, and only a year later nearly all 15 instruments in construction have moved past their preliminary design review. Some front-runners are already well into detailed design, with procurement, manufacturing and installation planning the next order of business.

The big picture for ESS, however, is not simply the completion of the facility. The hard work making this possible contributes at the same time to embedding ESS in the worldwide materials science community, including researchers, students and Industry. In the course of hosting 6,000 visitors to the site in 2017, ESS also signed major agreements with Institut Laue-Langevin, the Japan Proton Research Accelerator Complex (J-PARC), Sweden's Max IV Laboratory, Science Village Scandinavia, and a consortium of Danish universities and government. These both reinforce existing collaborations and establish a framework for working together for decades to come.

The world is watching us, and ESS is delivering. What will define our success as a flagship Big Science facility is ESS' ability to deliver excellent science that takes direct aim at solving the grand challenges our society is facing over the next century. The accomplishments in the books for 2017 are another bold step toward that bright future.

W. J. W

JOHN WOMERSLEY
ESS DIRECTOR GENERAL

Participants in the December 2016 ESS Council meeting in Bilbao, Spain

1

Steady Governance Maintains Project Momentum Through 2017

In the busiest year to date for the European Spallation Source, member states began to plan for the transition from construction to initial operations. The ESS Council Chair was re-elected, while a new Vice Chair was brought in to add valuable experience in large research infrastructure projects. Excellent progress was made in construction and on-site installation, while new measures were implemented to ensure adherence to strengthened Swedish safety and security regulations.

1.1 Council Drives the Project Forward

At the end of 2016, the European Spallation Source ERIC (ESS) Council settled a number of key forward-looking decisions that set the stage for 2017, the busiest year of the project to date. This included ratifying nearly €200 million of in-kind contributions and approving the construction plan for the first 15 scientific instruments.

The ESS Council met next in February 2017 to take an early look at the transition from construction to operations, potential models for membership in the ERIC for new partner nations, as well as optimisation of the remaining parts of the construction project. Council also agreed on the conditions that will have to be met by the remaining Founding Observer countries for accession to the ERIC.

At the June Council meeting, the group made a unanimous choice for continuity, re-electing Sweden's Lars Börjesson as Chair. In addition, Beatrix Vierkorn-Rudolph of Germany was selected as the successor to outgoing Vice Chair Caterina Petrillo.

A new Chair and a new Vice Chair were approved by Council in 2017 for the Scientific Advisory Committee: Michael Preuss of Manchester University and Catherine Pappas of the Delft University of Technology, respectively.

At the end of 2017, construction of the European Spallation Source stood at 43% complete.

Lars Börjesson, ESS Council Chair

Beatrix Vierkorn-Rudolph, ESS Council Vice Chair

Beatrix Vierkorn-Rudolph is former Deputy-Director General for Large Research Infrastructure at the German Federal Ministry of Education and Research (BMBF), where she oversaw five Helmholtz Research Centres, XFEL, FAIR, CTA and ELI, as well as German involvement in ESS. Vierkorn-Rudolph is responsible for nuclear fusion research in Germany and sits on the CERN Council. Since 2006 she has been a German representative in the European Strategy Forum for Research Infrastructure (ESFRI), which she chaired from 2010-2013. Both the Chair and Vice-Chair were elected unanimously for two-year terms.

"This solidifies our stakeholder leadership at a critical stage in the project. She [Vierkorn-Rudolph] is a European expert when it comes to large research infrastructure projects, and will be a strong complement to the Chair."

John Womersley, ESS Director General

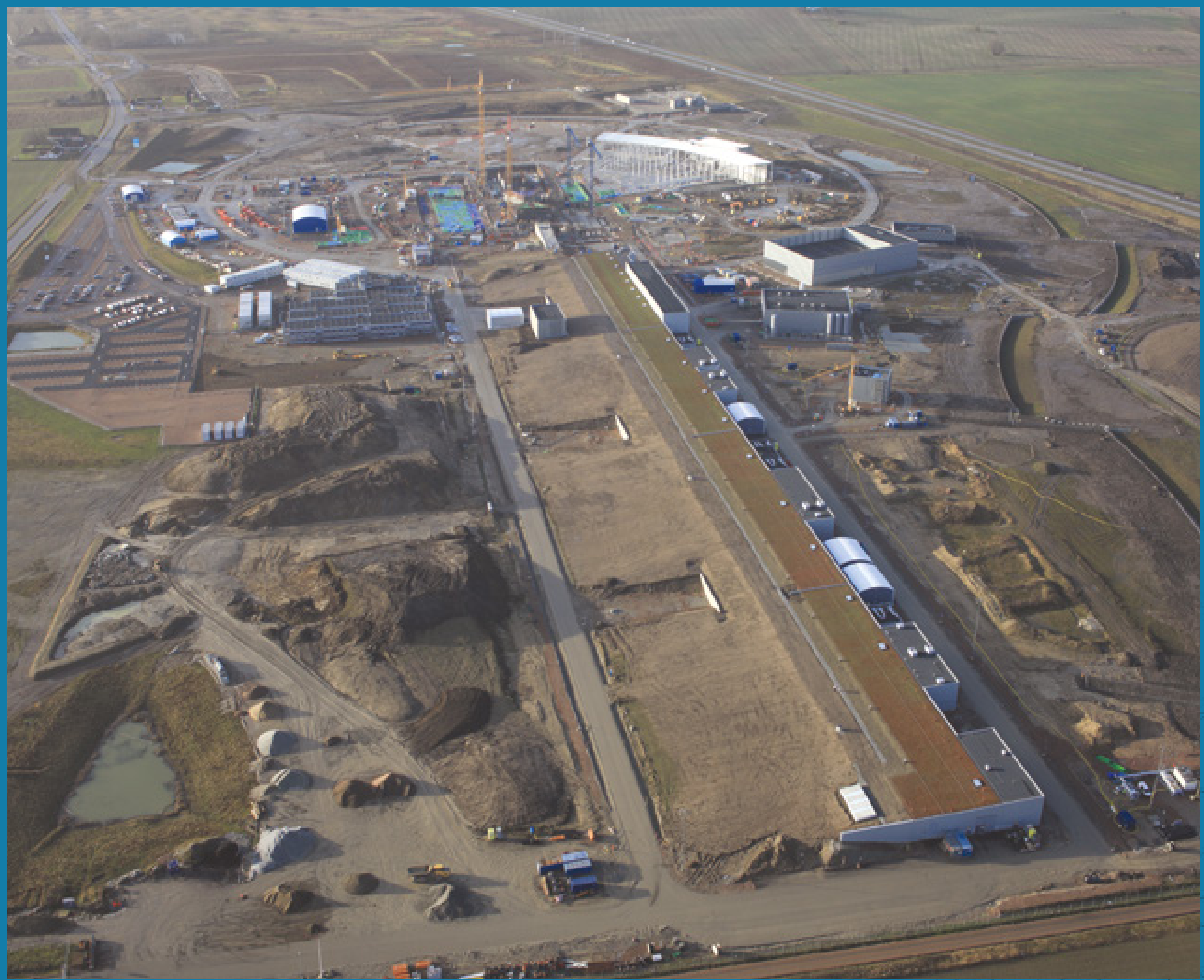
Graphic visualisation of completed ESS facility, including Max IV Laboratory and Science Village

1.2 Planning for Transition Into Initial Operations Advances

Mid-year, ESS management was tasked by Council to develop multiple scenarios on how to manage the transition from the construction phase to the initial operations phase.

ESS undertook a project-wide assessment of the operations requirements and costs for the initial operations phase from 2019-2025. Within this period, ESS installation will be completed, the facility will be commissioned and the scientific user program will begin. Deferred scope items that have been delayed from the construction phase may be added.

The ESS scenarios for the transition were examined in October by the Annual Review committee, a panel of 12 external reviewers chaired by Austin Ball of CERN. The committee commended the work and provided feedback that was incorporated into the December Council review of the management reports. Initial operations funding for the facility will start in 2019 as previously foreseen, and development of a detailed plan for the transition will take place 2018.



ESS, December 2017

1.3 Combining Excellent Science with Stronger Standards for Safety

The challenges that have arisen around the strict implementation of stronger safety measures, adopted in Sweden and around the world in the aftermath of Fukushima and amid increased concern over antagonistic threats, were acknowledged by Council in their December 2017 meeting.

These increased safety measures mainly concern the construction of the Target Station, which must withstand extremely unlikely events, such as severe earthquakes. This has inevitably led to extra construction costs for the ESS project.

Stronger Standards Lead to New Challenges

The impact of new regulations affecting ESS became clear only well after the construction started, so the additional costs were not included in the original construction budget.

The final costs for implementing these safety measures are not yet determined, but are estimated by ESS management to be around €135 million. An independent assessment will be carried out in 2018.

The uprated safety standards, together with potential delays to some in-kind deliverables, gave rise to new pressures on the schedule in 2017. The European Spallation Source will therefore develop a re-baselined schedule during the first half of 2018 with the goal of minimising any slippage in the high-level milestones.

New Technologies Lead to New Opportunities

Council also took the opportunity in December to recognise the excellent performance of the ESS moderator design, which will have significant positive implications for science at ESS and will enable a key cost-saving measure during the initial operations phase.

The 2015 baseline design of the ESS low-dimensional moderator was validated to increase neutron brightness by a factor of around two and a half. This allows ESS to produce nearly as many neutrons at 2 MW accelerator power as at the full 5 MW specified in the 2013 Technical Design Report (TDR).

The working assumption is now that ESS will begin operations at 2 MW, while retaining the design and intention to go up to 5 MW in due course.

ESS Council delegates agreed to aim to settle a plan for both the completion of construction and for initial operations by the end of 2018.

"Safety is always a priority at ESS and we need to deliver it at the same time as excellent science. We will always follow all safety regulations to the letter. This research facility will deliver world-leading science for several decades, so it is important that it is built to operate as safely and sustainably as required."

John Womersley, ESS Director General

1.4 Vision, Mission and Values

Vision:	Our vision is to build and operate the world's most powerful neutron source, enabling scientific breakthroughs in research related to materials, energy, health and the environment, and addressing some of the most important societal challenges of our time.

Mission:

To do this, we commit to deliver ESS as a facility that:

- Is built safely, on time and on budget
- Produces research outputs that are best-in-class both in terms of scientific quality and in terms of socioeconomic impact
- Supports and develops its user community, fosters a scientific culture of excellence and acts as an international scientific hub
- Operates safely, efficiently and economically, and responds to the needs of its stakeholders, its host states and member states
- Develops innovative ways of working, new technologies, and upgrades to capabilities needed to remain at the cutting edge

Core Values:

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.

1.5 The European Spallation Source ERIC

The European Spallation Source is organised as a European Research Infrastructure Consortium, or ERIC, under the European Commission's ERIC legal framework.

The European Spallation Source ERIC is governed by the European Spallation Source ERIC Council, which is bound by the Statutes ratified by the ERIC Member Countries.

The Director General of European Spallation Source ERIC is John Womersley. The Chair of the European Spallation Source ERIC Council is Lars Börjesson of Sweden and the Vice Chair is Beatrix Vierkorn-Rudolph of Germany.

Founding Members 2017		
Czech Republic	Germany	Poland
Denmark	Hungary	Sweden
Estonia	Italy	Switzerland
France	Norway	United Kingdom

Founding Observers 2017
Belgium
The Netherlands
Spain

Timeline

- ESFRI Roadmap entry: 2006
- Preparation phase: 2008-2010
- Pre-construction phase: 2010-2012
- Construction phase: 2013-2025
- Legal entity establishment: ERIC, 2015
- Operation phase: 2019-

Estimated Cost

Capital value: 1 843 M€

Headquarters

European Spallation Source ERIC (ESS)
PO BOX 176
SE-221 00 Lund
Sweden

Website

https://europeanspallationsource.se

1.6 Governance, Management and Advisory Committees

Delegates to the ESS Council

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

Lars Börjesson (Chair)
Chalmers University of Technology
Sweden

Beatrix Vierkorn-Rudolph (Vice Chair)
German Federal Ministry of Education & Research (ret.)
Germany

Laurent Ghys
Belgian Science Policy Office - BELSPO
Belgium

Eric van Walle
Belgian Nuclear Research Centre - SCK•CEN
Belgium

Ivan Wilhelm
Ministry of Education, Youth and Sport - MEYS
Czech Republic

Petr Lukáš
Nuclear Physics Institute
Czech Republic

Bo Smith
Danish Ministry of Higher Education & Research
Denmark

Niels Christian Nielsen
Aarhus University
Denmark

Italian delegates Eugenio Nappi and Salvatore La Rosa

Council delegates, from left, Joël Mesot, Brian Bowsher and Andrew Taylor

Toivo Räim
Ministry of Education & Research
Estonia

Priit Tamm
Estonian Research Council
Estonia

Amina Taleb-Ibrahimi
Institute of Physics - CNRS
France

Patricia Roussel-Chomaz
French Alternative Energies and Atomic Energy Commission - CEA
France

Oda Keppler
Federal Ministry of Education & Research
Germany

Sebastian Schmidt
Research Centre GmbH Jülich
Germany

László Rosta
MTA Wigner Research Centre for Physics
Hungary

Eugenio Nappi
National Institute of Nuclear Physics - INFN
Italy

Salvatore La Rosa
Ministry of Education, Universities & Research
Italy

Nico Kos
Netherlands Organisation of Scientific Research
The Netherlands

H.T. (Bert) Wolterbeek
Delft University of Technology
The Netherlands

Odd Ivar Eriksen
Research Council of Norway
Norway

Marek Jezabek
The Henryk Niewodniczanski Institute of Nuclear Physics
Poland

Mateusz Gaczyński
Ministry of Science & Higher Education
Poland

Inmaculada R. Figueroa
Ministry of Economy and Competitiveness
Spain

Adolfo Morais
Basque Ministry of Universities & Research
Spain

David Edvardsson
Ministry of Education & Research
Sweden

Sven Stafström
The Swedish Research Council
Sweden

Martin Kern
State Secretariat for Education, Research and Innovation - SERI
Switzerland

Joël Mesot
Paul Scherrer Institute
Switzerland

Andrew Taylor
Science and Technology Facilities Council
United Kingdom

Claire Durkin
UK Government Department for Business, Energy and Industrial Strategy
United Kingdom

"The council is an extremely good gathering of people. Knowledgeable, interested and enthusiastic about this project. Discussions are constructive. It's really nice to be there and for us as a host nation to have this kind of support from all ESS members."

Sven Stafström, Director General of the Swedish Research Council

ESS Executive Management Team (EMT)

〉EXECUTIVE MANAGEMENT TEAM (EMT)

Director General	John Womersley
Technical Director	Roland Garoby
Project Manager	John Haines
Head of Conventional Facilities Division	Kent Hedin
Head of Relations with Host States	Pia Kinhult
Director for Project Support & Administration	Agneta Nestenborg
Director for Science	Andreas Schreyer
Associate Director for Environment, Safety & Health, and Quality	Ralf Trant
Head of Communications, External Relations & In-Kind Management (2017)	Allen Weeks
Senior Executive Assistant	Karin Hélène

〉ADMINISTRATIVE & FINANCE COMMITTEE (AFC)

France	Bernard Dormy (Chair)
United Kingdom	Neil Pratt (Vice Chair)
France	Aurelie Eray (Vice Chair)
Belgium	Christian Legrain
Czech Republic	Petr Ventluka
Czech Republic	Naděžda Witzanyová
Denmark	Morten Scharff
Denmark	Victoria Fuglsang-Damgaard
Estonia	Priit Tamm
France	Tobias Afadjigla
Germany	Andrea Risse
Germany	Oda Keppler
Hungary	Balázs Kápli
Italy	Roberto Pellegrini
Italy	Ileana Gimmillaro
The Netherlands	Nico Kos
Norway	Odd Ivar Eriksen
Poland	Michal Rybinski
Poland	Zbigniew Golebiewski
Spain	Guadalupe Córdoba Lasuncion
Sweden	Johan Holmberg
Switzerland	Patrice Soom
Switzerland	Xavier Reymond
United Kingdom	Maggie Collick

〉SCIENTIFIC ADVISORY COMMITTEE (SAC)

Michael Preuss (Chair)	Manchester University
Catherine Pappas (Co-chair)	Delft University of Technology
Muhammad Arif	NIST Center for Neutron Research
Monika Budayova-Spano	Université Grenoble Alpes
Sabrina Disch	University of Köln
Richard Dronskowski	RWTH Aachen University
Bela Farago	University of Grenoble
Giovanna Fragneto	Institut Laue-Langevin
Thomas Hellweg	Bielefeld University
Steve Hull	ISIS Neutron and Muon Source
Klaus Kirch	Paul Scherrer Institute
Sine Larsen	University of Copenhagen
Martin Månsson	KTH Royal Institute of Technology
Kell Mortensen	Niels Bohr Institute
Marie Plazanet	Université Grenoble-Alpes / CNRS
Roger Pynn	Indiana University
Regine Willumeit-Römer	Helmholtz-Zentrum Geesthacht / University of Kiel

〉TECHNICAL ADVISORY COMMITTEE (TAC)

Alberto Facco (Chair)	INFN Legnaro
Frank Gerigk (Co-chair, Accelerator)	CERN
Mark Heron (Co-chair, Controls)	Diamond Light Source
Phillip Ferguson (Co-chair, Target)	Spallation Neutron Source
Maude Baylac	CNRS
Cyrille Berthe	GANIL
Tim Broome	ISIS Neutron and Muon Source (ret.)
Michael Butzek	Forschungszentrum Jülich
Francisco Martin Fuertes	CIEMAT
Masatoshi Futakawa	Japan Atomic Energy Agency
Shane Koscielniak	TRIUMF
Roland Mueller	Helmholtz-Zentrum Berlin
Jurgen Neuhaus	Technical University of Munich
Bernd Petersen	DESY
Michael A. Plum	Spallation Neutron Source
Igor Syratchev	CERN
Szabina Török	Hungarian Academy of Sciences Centre for Energy Research
Hans Weise	DESY
Jörg Welte	Paul Scherrer Institute
Karen White	Spallation Neutron Source

〉IN-KIND REVIEW COMMITTEE (IKRC)

Norway	Bjørn Christian Hauback (Chair)
Hungary	Daniel Csanády (Vice Chair)
Belgium	Hamid Aït Abderrahim
Czech Republic	Petr Šittner
Denmark	Søren Schmidt
Estonia	Heisi Kurig
France	Jean-Luc Biarrotte
Germany	Ulrich Breuer
Italy	Paolo Michelato
The Netherlands	Guy Luijckx
Norway	Erik Wahlström
Poland	Adam Maj
Spain	Pedro González
Sweden	Björgvin Hjörvarsson
Switzerland	Peter Allenspach
United Kingdom	Robert McGreevy

〉CONVENTIONAL FACILITIES ADVISORY COMMITTEE (CFAC)

Martin Fallier (Chair)	Brookhaven National Laboratory
Olof Ehrlén	Svevia / Instalco Intressenter AB / FSN Capital
Sven Landelius	Sven Landelius Consulting AB
Peter Lundhus	DYWIK INFRA ApS
Kristian Lyk-Jensen	Danish Building and Property Agency
Observers	
Kjell Arefjäll	Swedish Research Council
Leif Eriksson	Swedish Research Council
Johan Holmberg	Swedish Research Council
Kjell Möller	Swedish Research Council
Morten Scharff	Danish Ministry of Higher Education and Science
Bo Smith	Danish Ministry of Higher Education and Science

〉ENVIRONMENT, SAFETY & HEALTH ADVISORY COMMITTEE (ESHAC)

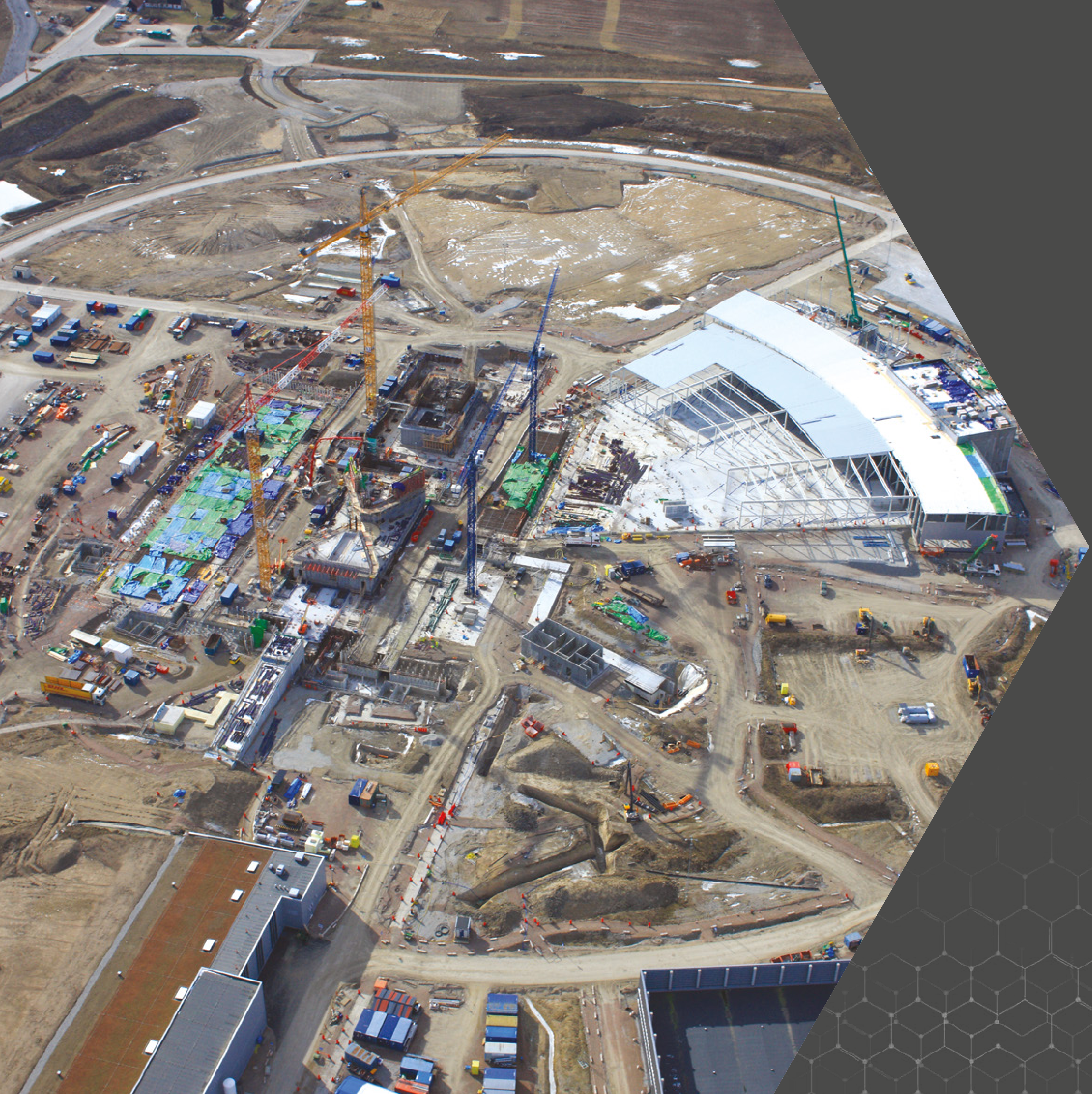
Paul Berkvens (Chair)	European Synchrotron Radiation Facility
John Anderson	FermiLab
Enrico Cennini	CERN
Doris Forkel-Wirth	CERN
Sam Jackson	United Kingdom Atomic Energy Authority
Frank Kornegay	Spallation Neutron Source (ret.)
Sigrid Kozielski	European XFEL
Stefan Roesler	CERN
Steven Wakefield	ISIS Neutron and Muon Source

〉COMMITTEE ON EMPLOYMENT CONDITIONS (CEC)

Chair	Lars Börjesson
Member	José Luís Martinez
Member	Patricia Roussel-Chomaz
Host State Denmark	Bo Smith
Host State Sweden	Katarina Bjelke

〉CHAIR'S COMMITTEE (CC)

Chair	Lars Börjesson
Member	Beatrix Vierkorn-Rudolph
Member	Marek Jezabek
Member	Andrew Taylor
Member	Bo Smith
Member	David Edvardsson
Ex-officio	John Womersley
Ex-officio	Florian Weissbach



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Key Milestones: In-Kind, Membership, Civil Construction and Licensing

The European Spallation Source hit a number of significant project milestones in 2017 critical to maintain the project schedule:

- In-kind delivery of the LINAC's Ion Source from Italy
- Handover of several buildings on site
- Critical authorisation to install Accelerator and Target equipment
- Commitment from Spain to become a full ERIC member in 2018

2.1 From Sicily to Sweden: Ion Source Delivered

The first European Spallation Source machine components were lowered into the Accelerator Tunnel in December 2017 as ESS took delivery of the LINAC's Ion Source and Low-Energy Beam Transport Line (LEBT) systems.

These are the first major machine installations for the facility, and are an in-kind contribution from the Italian National Institute for Nuclear Physics' National Laboratory of the South (INFN-LNS) in Catania, Sicily.

The delivery was tracked on social media using the hashtag #IonSourceAdventure, which followed the loading of the truck carriages in Sicily through the week-long journey across Italy, Austria, Germany, Denmark and over the Öresund Bridge to Sweden.

The Ion Source and LEBT were installed in early 2018.

Ion Source being lowered into the Accelerator Tunnel, December 2017

The ESS high-intensity proton source and LEBT line at INFN-Catania, where it was designed and commissioned

2.2 Spain Moves Towards Full ERIC Membership

On the last working day of 2017, the Spanish government gave the authorisation needed for accession to full membership in the European Spallation Source ERIC.

Spain is expected to conclude the formal membership process in 2018, but unfortunately the Spanish contribution is proposed to be reduced from 5% to 3%.

Spain was one of the earliest supporters of the ESS project and is home to ESS Bilbao, a critical in-kind partner for the target, accelerator and instrument sub-projects.

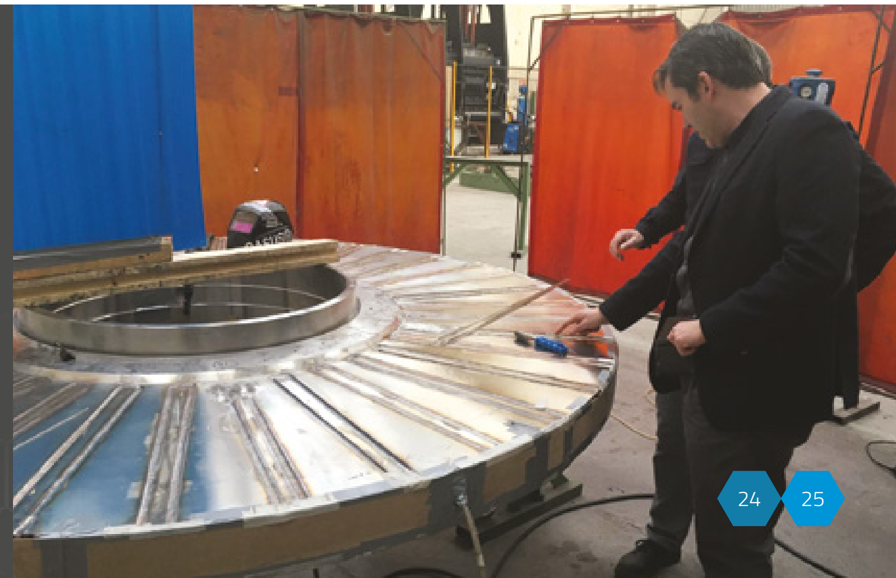
2.3 €550 million of In-Kind Contributions in the Works

The European Spallation Source is a Greenfield Big Science project pioneering a uniquely complex in-kind model. There are currently 38 European institutions making direct in-kind contributions to the project.

Leveraging the scientific, technical and industrial capacity of its 15 member and observer states, at least 30% of the €1.843 million project is being funded through their in-kind contributions. In particular, significant parts of the scientific instruments, the Target Station, and the Accelerator will be delivered as in-kind.

ESS ended 2017 with nearly €330 million in signed in-kind agreements, and an additional €220 million in contributions at various stages of agreement. The total of €550 million represents more than 230 contracts with more than 40 partner institutions.

ESS Bilbao Target Division leader Fernando Sordo with the ESS target wheel full-scale prototype under development in Spain



2.4 The Target Station Building, Revised

The last two months of 2017 saw 12 marathon concrete pours for the ESS Target Station's Active Cells Handling Facility, parts of which are designed to operate for 40 years without intervention. This concrete work was the culmination of a year's worth of reinforcement, formwork and through-wall technical installations and signalled the completion of the first six vertical metres of the concrete structure.

The 1.3-metre-thick walls included 42 tonnes of steel rebar, placed, bent and secured into a staggering density of 500 kg of reinforcement per cubic metre of concrete.

By the end of the year, more than 10,000 cubic metres of concrete had been cast for the Target Station. This concrete, some of which is infused with iron ore, is supported by a remarkably dense latticework of steel reinforcement in the base slabs and walls. This structure is in turn supported by massive concrete and steel-core pilings that reach to the Skåne bedrock.

Re-engineered and retrofitted to meet uprated seismic and security standards, the ESS Target Station, which will house the facility's one-of-a-kind rotating tungsten target system and a remote handling facility for activated material, will meet the strictest global standards to date for safety and security.

The ESS response to the enhanced regulations has come at a cost, introducing new pressures on the schedule and budget. This will require ESS management and governance to develop a re-baselined schedule in 2018 designed to minimise any slippage in high-level milestones, particularly the start of the user programme.

Construction crew marking the completion of the reinforcement work for the Target Station's active cells handling area walls

2.5 Building Handovers Allow for Early Installations

A good marker of progress on the construction of ESS is the on-schedule handover of buildings from construction partner Skanska to ESS. These handovers serve as the first indication that ESS is ready to receive deliveries of the corresponding technical equipment and machine infrastructure and to begin to install it. Key handovers in 2017 included:

March Electrical distribution substations H05 and H06, which allowed for the commissioning of some power systems.

April The Test Stand 2 area in the Klystron Gallery, followed by the wiring of high-voltage systems and the testing and commissioning of several Gallery Building systems.

May The Cryo-Compressor Building and Coldbox Hall, which allowed for full-speed-ahead installation of the ESS cryo-plant.

May The full Accelerator Tunnel was handed over on schedule, allowing for the very first LINAC installations to begin over the summer.

September The Accelerator's Front End Building, allowing ESS to prepare for receipt and installation of the LINAC's ion source and low-energy beam transport line components from in-kind partner INFN-LNS.

Kent Hedin, ESS Head of Conventional Facilities

2.6 New Construction

The construction of new buildings began in 2017 as well. The sight of the long-range instrument hall, science labs and beamline gallery superstructure rising on the site's western horizon over the last four months of the year was particularly exciting.

These buildings will be made weather-tight in 2018 in preparation for the first signs of installation work on the ESS scientific instruments.

Construction of the nine-metre-high Sprinkler Building began and was substantially completed. The building contains two large water storage tanks and a pumping system to power the facility's fire sprinkler system.

A welcome sign of progress at ESS in 2017 was the first major landscaping works: the facility's Green roof and reinforced earthen slope along the length of the 600-metre-long Accelerator and Gallery buildings. Planted atop the 66,000 cubic metres of clay and topsoil, the first grass seeds have already sprouted this winter introducing new greens, browns and purples to the landscape. In December, the very first pine saplings were planted on the perimeter of the site.

2.7 Swedish Radiation Safety Authority Grants Installation Permit for Accelerator and Target

In June, ESS received its conditional installation permit from the Swedish Radiation Safety Authority (Strålsäkerhetsmyndigheten, or SSM), allowing installation processes to move forward in the Klystron Gallery Building, the Accelerator Tunnel and the Target Station. The permit was granted in October.

The SSM's licensing of ESS is a four-stage process, and the October permit gives the go-ahead for installation of equipment that could generate ionising radiation. When producing neutrons, ionising radiation and radioactive substances are generated in parts of the research facility. This means that ESS must follow the rigorous requirements of the Swedish Radiation Protection Act.

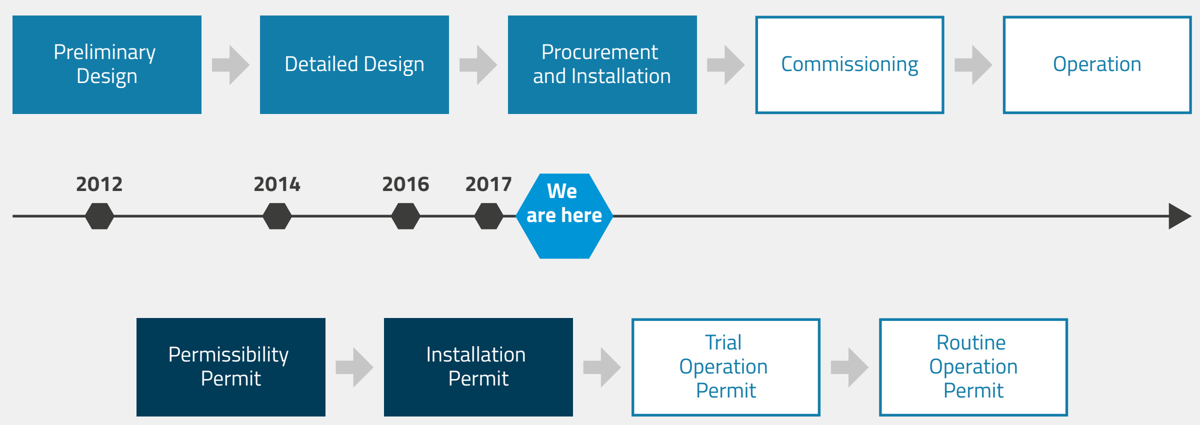
In order for ESS to fulfil the conditions received in June and start installation, ESS provided SSM with additional information, including a framework for safety classification of "Systems, Structures and Components" relevant to radiation safety.

The correct and timely application of the classification rules is instrumental for the next and most exciting stage in the licensing process: the application for trial operation of the first part of the Accelerator, the normal-conducting LINAC. This will signal the beginning of operations at ESS, and a turning point in the history of the project.

"This is an important step in the licensing process as it gives ESS permission to start installation as planned."

Johan Waldeck, Licensing Project Manager

SSM Licensing Overview and Status



2.8 Safety Objectives Set for 2018

The ESS Environment, Safety & Health and Quality divisions (ESH&Q) have established safety objectives for 2018 as part of the process to make ESS a safe work environment and also to meet regulatory compliance in the licensing process with the Swedish Radiation Safety Authority, SSM.

ESH&Q works with all divisions at ESS, focusing on people's health, respect for the environment and the safe and reliable operation of the facility. It is therefore important that all ESS staff, in-kind partners and future scientific users adopt a shared culture of safety at ESS. To that end, ESH&Q developed the following safety objectives for 2018:

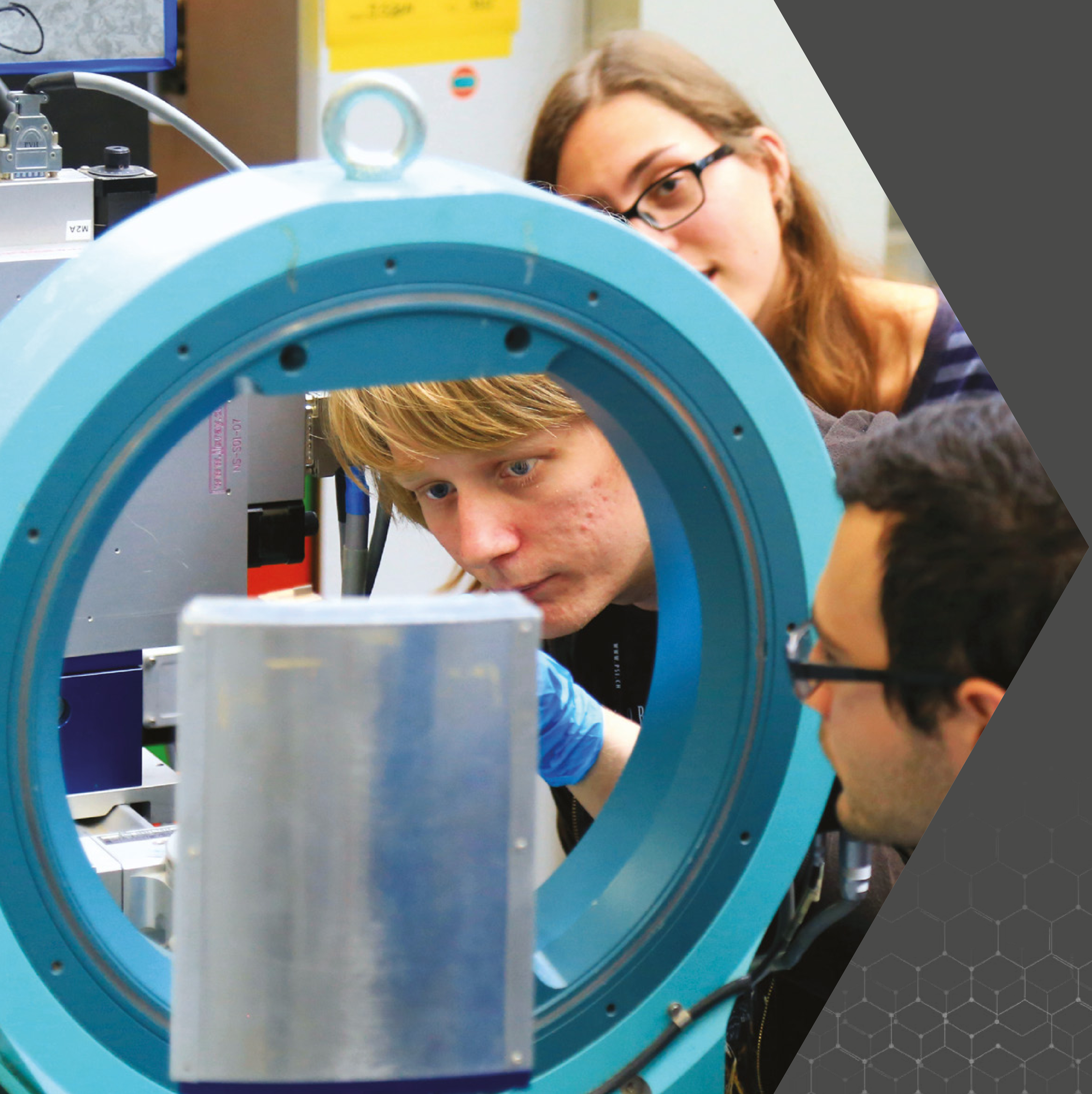
These primary safety objectives are strictly linked to ESS key milestones for 2018: the application to SSM to start trial operation of the warm LINAC, and the move of the full ESS staff to the site.

Participants in the October ES&H Advisory Committee (ESHAC) meeting

2.9 The Road Ahead

Some project and civil construction milestones anticipated for 2018 include:

- All ESS staff will be relocated to temporary offices on the construction site by the end of June 2018.
- Work will begin to ramp up on the long-range instrument hall and other E-buildings, including mechanical, electrical and plumbing works in some buildings.
- All 15 scientific instruments are expected to progress through detailed design to the procurement phase.
- The Target Monolith's High Bay Vault should be completed by the end of the year.
- Completion of the base slab for the D04 lab building in Experimental Hall 2 should be completed in September.
- ESS will submit its application to the Swedish Radiation Authority for trial operation of the warm LINAC.
- Completion of the Cryoplant is planned, as well as the start of commissioning of the Accelerator's ion source and low-energy beam transport line.
- Construction is scheduled to begin on the ESS Campus Project before the end of 2018.
- Council and management will work together towards the creation of a detailed plan for the first two years of initial operations.



3

Next-Generation Science and Industry Looking To ESS

The European Spallation Source is rapidly becoming the centre of gravity for the world's next generation of neutron scientists. ESS maintains a deep engagement with the global neutron science community while working to build regional capacity and to support PhD and postdoc researchers. Various initiatives and research programs already showcase the impact the facility is having on the broad spectrum of potential users across academia and industry.

3.1 Graduate Schools Build Capacity for Early Science at ESS

With the array of scientific instruments to be built at ESS, it is vital that future researchers have the skills to exploit them. The Nordic and Baltic states have come together to increase competence in neutron scattering among young researchers, and raise the number of neutron users in the region.

The Nordic Neutron Science Program (NNSP) and Swedish Neutron Education for Science & Society (SwedNess), aim to educate and connect young academics so that their research may take full advantage of the world-leading Big Science facility on their doorstep.

NNSP is funded by the Nordic research board, NordForsk, with additional contributions from the Swedish, Danish and Norwegian governments. The European Spallation Source and its partners collaborate with NNSP through the EU-funded BrightnESS project. SwedNess is a graduate school in neutron scattering implemented by a consortium of six Swedish universities and is funded by the Swedish Foundation for Strategic Research (SSF).

A collaboration between the two programs resulted in the first Swedish-Nordic-Baltic Summer School on Neutron Scattering, which took place in Tartu, Estonia, over two weeks in September. The program introduced around 45 PhD students to neutron scattering and demonstrated the application of neutron research in areas like life science, energy, quantum materials, as well as engineering and industrial R&D.

Through NNSP, 49 departments at 31 different universities in the Nordics and Baltics will work side by side to train students and early-career academics in the specifics of how to do research with neutrons. In the future, such programs will be made available to the entire Nordic and Baltic research communities, including future ESS users from industry.

"To take full advantage of ESS in the future, Sweden and the Nordic and Baltic countries must collaborate to establish a new generation of scientists with knowledge and experience in neutron scattering."

Martin Månsson, Director of Studies, SwedNess

PhD students with lecturer Mark Telling (black t-shirt) of the UK's ISIS Neutron and Muon Source at the Swedish-Nordic-Baltic summer school in Tartu, Estonia. Previous pages: SwedNess Graduate School participants receiving hands-on training at the Swiss Spallation Neutron Source, SINQ, a facility at the Paul Scherrer Institute (PSI), an ESS partner

3.2 In Preparation for ESS, Denmark's World-Leading Universities and Industries Coordinate Research Efforts

Interdisciplinary materials science research is key to finding the solutions to society's grand challenges. With huge potential in commercial applications to expand the industrial user base for neutron science, more than 30 materials science research groups in Aarhus, Denmark, have begun to work together to leverage the scientific opportunities ESS will provide.

iMAT

Aarhus University's Centre for Integrated Materials Research (iMAT) was inaugurated in August with the goal to coordinate the link between Danish industry and academia in preparation for new Big Science facilities like ESS, MAX IV and European XFEL.

"The real game changer will be the possibility to do experiments that are currently out of reach. This is especially true for in operando studies," said iMAT Director Bo Brummerstedt Iversen. "In ESS we will be able to see the processes taking place in a battery, a thermo-electric module, or a fuel cell during normal operation, and often without modifications. For instance, we can keep the casing around a battery on, as the neutron beams will just penetrate. This is not possible with X-rays."

LINX

A related collaboration, the LINX Association, puts Danish companies together with groups at Aarhus University, the University of Copenhagen and the Technical University of Denmark (DTU) to bridge the gap between science and industry.

Industry leaders Danish Power Systems and Grundfos are among the companies that have identified neutrons as a key part of R&D. With the brightest neutron source in the world at ESS, these companies will be able to observe processes important to developing new products and improving existing ones.

"An interesting feature for the new large-scale facilities such as ESS is the possibility to study entire systems, not just samples. This promises to bridge the traditional materials research with the integration perspective, which is so important to us," said Allan Holm, Lead Materials Specialist at Grundfos.

"We are keen to have experiments done, once ESS opens. In general, I am confident that industry will get on board research at ESS through joint projects with university groups."

Hans Aage Hjuler, CEO of Danish Power Systems

3.3 Scientists from Canada and Japan Open New Initiatives with ESS in 2017

Seven of Canada's leading researchers using neutrons visited ESS for a three-day science workshop as part of the Canadian Neutron Initiative (CNI), while a Japanese delegation visited ESS early in the year to prepare the Swedish-Japanese MIRAI collaboration.

CNI at ESS

Canada is facing a decrease in capacity for neutron science and has shown a keen interest in ESS as both a user facility and a model for a potential future Canadian neutron source.

The delegation was led by John Root, Director of the Canadian Neutron Beam Centre and Executive Director of the Sylvia Fedoruk Centre for Nuclear Innovation, and Thad Harroun, President of the Canadian Institute for Neutron Scattering (CINS) and associate professor of physics at Brock University.

Canadian researchers took part in a call-and-response scientific forum, held on November 21-23 at the ESS construction site. The Canadian scientists presented their research, while ESS peers responded with the new possibilities instruments in construction at ESS could bring to these projects.

The European Spallation Source has become a key option for Canadian neutron science research as the country's own National Research Universal reactor in Chalk River Ontario is scheduled to shut down in May 2018.

The delegation of scientists from Canada represented a wide range of priority research areas for the country, with experts in energy, health, advanced manufacturing and quantum materials. As such, the discussions explored how new materials and a deeper understanding could lead to science-based solutions for society's grand challenges across these fields.

With the powerful capabilities ESS brings, the workshop touched on potential new research in quantum materials, how new techniques could be investigated in the fight against Alzheimer's disease, and the development of metal hydrides to address the grand challenge of hydrogen storage, among many others.

Top: Canadian neutron scientists Bruce Gaulin (l), Thad Harroun and John Root at ESS; Bottom: Gaulin and Barbara Friskin (c) on a site tour with ESS scientists Sindra Petersson-Årsköld (l) and Andrew Jackson (r)

MIRAI

A delegation of scientists from the robust Japanese neutron science community visited ESS in January. The visit's focus was on the MIRAI initiative, a collaboration effort between Swedish and Japanese universities to increase capacity for neutron science.

Lund University is the Swedish coordinator for the MIRAI project, with counterpart Nagoya University in Japan. Fourteen universities across the two nations will participate in MIRAI, which will connect Swedish and Japanese universities through research, education and innovation.

MIRAI is specifically directed at researchers at an early stage of their career to lead future joint activities between universities in the two countries. The topic and focus of the project will be within the broader contexts of large-scale research facilities, life sciences, sustainability, ICT, and innovation processes.

Canadian scientific delegation with ESS Head of External Relations Ute Gunsenheimer (r) in Copenhagen

"Canadian neutron scientists have long enjoyed the collaboration and hospitality of neutron sources around the world. We are looking forward to continued meaningful work with our friends in Europe."

Professor Bruce Gaulin, Director of the Brockhouse Institute for Materials Research, McMaster University

Discussion of future Swedish-Japanese collaboration at ESS in January 2017. Clockwise from left: Masatoshi Arai (ESS), Takashi Kobayashi (J-PARC), Naohito Saito (J-PARC), John Womersley (ESS) and Olov Sterner (Lund University)

3.4 Swebeams Initiates Research Agenda for Swedish Stakeholders

Swebeams is an initiative led by Fredrik Hörstedt, Vice Rector at Chalmers University of Technology, in cooperation with Lund's Big Science neighbours, ESS and the MAX IV synchrotron. The goal of Swebeams is to create a forum to set the agenda for the two facilities relative to the research and innovation arena in Sweden.

The first Swebeams workshop was held in Stockholm in November 2017 with more than 100 participants.

The Swedish Research Council (Vetenskapsrådet) and the Swedish innovation agency, Vinnova, have supported and funded Swebeams with the ambition to make a national appeal and raise interest in both facilities from academia and industry. Based on collaboration, Swebeams hopes to see cross-scientific work, new industrial cooperation and the construction of a Swedish-led instrument at ESS. Three more workshops distributed throughout Sweden will be held during the spring of 2018.

Sweden's latest major research infrastructure to go online is MAX IV Laboratory, the brightest synchrotron source in the world, and ESS' neighbour to the west. Between MAX IV and ESS (seen rising in the background) is a planned development project known as Science Village that will provide common infrastructure for researchers visiting Lund to use the two facilities.

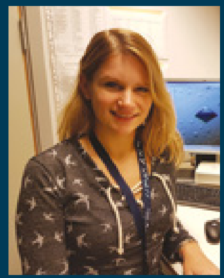
3.5 EU Funds Young Researchers in Support of ESS: MAX4ESSFUN and RAMP

As one of the focal points of the global neutron science community, ESS is preparing the next generation of neutron researchers to maximise its impact.

In cooperation with ESS and MAX IV Laboratory, the EU Interreg program MAX4ESSFUN has continued to build user capacity by directly financing experiments, and providing training and supervision for PhD and postdoc researchers.

The €13.6 million project enables 1,000 months of training and 500 months of learning with senior researchers.

The European Spallation Source is also a beneficiary of the EU's RAMP (RAtionalising Membrane Protein crystallization) project under the highly competitive Marie Skłodowska-Curie Actions Innovative Training Network (ITN) call in the Horizon 2020 Framework Programme for Research and Innovation. The Marie Skłodowska-Curie Actions train early-stage researchers (ESRs) across Europe, building the careers of tomorrow's leaders in research and industry.



Researcher: Janina Sprenger, Lund University

Program: MAX4ESSFUN

Experiment: Trapped in the crystal: Towards a new method to obtain structural information of small proteins through X-ray crystallography

Supervisor: Sara Snogerup Linse, Lund University

Co-supervisor: Marjolein Thunnissen, Max IV Laboratory

Janina Sprenger is a German postdoc working with researchers at the MAX IV Laboratory and Lund University to develop a new method for probing protein structures with x-rays and neutrons.

With the unique ability of neutrons to identify Hydrogen atoms in a molecular structure, Sprenger is looking to use the high neutron flux at ESS to study samples that are currently too small to be analysed at existing neutron facilities. Her research could impact medical and life science research, as it helps us to better understand the functions in the cell and how to cure diseases like Alzheimer's.

As Sprenger's work is multi-disciplinary, she has drawn on the complementary skills of experts from Lund University and MAX IV to develop a crystal host system to better realise the structures of proteins.

Sprenger said, "Due to the cross-border setup between Lund University and MAX IV, I was able to get input on the crystallography part of our project and advice on how to conduct and evaluate the experiments. I also get insights into the status of the BioMAX beamline at MAX IV and can follow the process."

Researcher: Mads Bertelsen, University of Copenhagen

Program: MAX4ESSFUN

Experiment: Better background correction: Modelling multiple scattering and background from neutron sample environment by simulation and experiment

Supervisor: Kell Mortensen, University of Copenhagen

Co-supervisor: Alexander Holmes, ESS

University of Copenhagen postdoc Mads Bertelsen, in coordination with the MAX4ESSFUN Interreg project, is working to help develop the neutron instrument simulation program McStas.

This will be a critical tool for both the ESS instruments in Sweden and for data modelling work conducted at the ESS Data Management and Software Centre (DMSC) in Denmark.

The software package will provide better background corrections during simulations of neutron scattering experiments, reducing the impact of background noise. This is a key challenge in every aspect of an instrument's design, with so many neutrons scattering off a sample.

As soon as Bertelsen's software is complete, and he trusts it, he is ready to share it with other researchers to help them with their experiments and analyse their trials with them. Through the project, Bertelsen has been able to develop a host of contacts across the Öresund in Sweden.

Bertelsen said, "It is enormously rewarding to be allowed to be in a position to help push people's questions forward as I've become an expert in the problems, the sources of the problems, and the annoying aspects, instead of focusing on the aspects that more easily generate headlines. My goal as a researcher is not to perform science itself, but to improve the possibility for others to do so."

Researcher: Josefine Eilsø Nielsen, University of Oslo

Program: MAX4ESSFUN

Experiment: Mapping out the interactions of antimicrobial peptides with model lipid membranes using neutron reflectometry

Supervisor: Reidar Lund, University of Oslo

Co-supervisor: Marité Cárdenas, Malmö University

Josefine Eilsø Nielsen is a first-year PhD student at the Department of Chemistry at the University of Oslo (UiO). She works in a group focused on the interaction of antimicrobial peptides with lipid model membranes. Better understanding this system can help unlock new options for antibiotics, as growing resistance represents a major challenge for modern medicine.

At part of the MAX4ESSFUN project, Nielson had the opportunity to collaborate with Cárdenas, a member of the ESS Science Focus Team for Life Science & Soft Condensed Matter, allowing the project to access expertise on a variety of techniques.

Nielson said, "They are really experts in lipids and neutron reflectometry, while our group in Oslo mainly have specialised in small-angle scattering techniques. When combining these two methods we can hopefully both get an understanding of how the peptides interact with the surface on the membrane and the cell (lipid vesicle) in bulk.

Researcher: Swati Aggerwal, ESS PhD student

Program: RAMP

Experiment: Elucidating the function of proton pumps with neutron crystallography

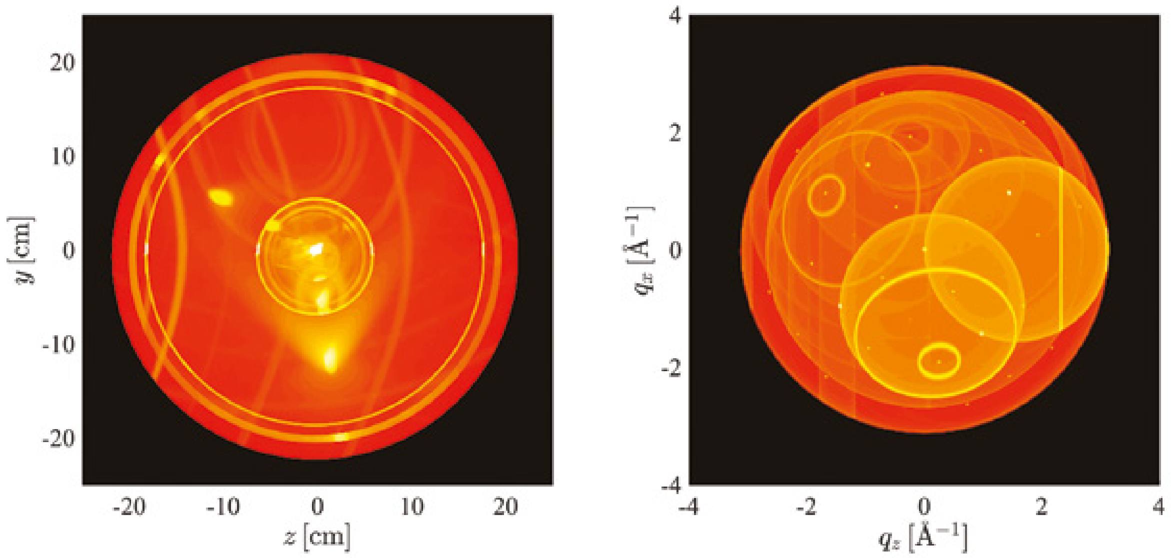
Supervisor: Esko Oksanen, ESS

The European Spallation Source is working to optimise crystallisation techniques to maximise the potential of the NMX macromolecular diffractometer under construction for the facility. This groundbreaking instrument is designed to identify the positions of hydrogen atoms in molecules that have never been probed with neutrons before.

By optimising crystallisation methods for large, complex molecules like proteins and enzymes, ESS can enable researchers to gain a better understanding of the basic biological processes in cells, in turn supporting critical developments like those for drug therapies.

The European Union's RAMP program supports ESS PhD student Swati Aggerwal's work in this field. Aggerwal's project is to understand the basic biological processes of proton pumps. She is supervised by ESS instrument scientist Esko Oksanen, originator and lead scientist for the NMX instrument.

Aggarwal said, "Proteins are responsible for about 15% of the average mass of a human body. They are the building blocks of the body and major constituents of muscles, ligaments and hair. We are interested in membrane proteins that reside on the cell membrane and perform vital functions like transducing signals and energy across the membrane. Hydrogen plays an important role in the function of proton pumps, and thus it becomes really important to study the hydrogen positions by determining their structure. But the challenging part is the requirement of larger and well-defined crystals formed with a robust process."



Images from Mads Bertelsen's MAX4ESSFUN project showing simulated experiment results derived from McStas data. At left, the position of scattered intensity from a cryostat with a single crystal sample from above, and at right, the corresponding scattering intensity in reciprocal space. Both images illustrate the importance of multiple scattering.

King Carl XVI Gustaf of Sweden at ESS, February 2017

4

A European Science Project with Global Reach: In-Kind, MoUs, Grants and Outreach

Through its collaboration model, ESS continues to work with leading scientists and research organisations around the world while strengthening ties to host countries Sweden and Denmark. From its involvement and leadership in several European grant programmes, to its diverse and broad outreach activities, to formalising global collaborations new and old, ESS is working hard to establish a strong strategic foundation for its future as a world-leading Big Science facility.

In-Kind and Collaboration Partners

Nearly 40 European institutions work directly on construction of the European Spallation Source as in-kind contributors. An additional cohort of more than 120 institutions across the world contribute to the project through either grant consortiums or other research collaborations. ESS in-kind partners are indicated in bold type.

Partner	Acronym	Collaboration	Grants	Country
A.V. Shubnikov Institute of Crystallography Russian Academy of Sciences	IUCr	Grant	Cremlin	RU
Aarhus University	**AU**	**IKC / Grant**	**Ramp,iNext**	**DK**
AGH University of Science and Technology	AGH/AGH-UST	Grant	ESSnuSB	PL
ALBA Synchrotron Light Facility	ALBA-CELLS	Grant	ARIES	ES
Association of Instituto Superior Técnico for Research and Development	IST-ID	Grant	ARIES	PT
ATHENA Research and Innovation Center	ARC	Grant	EoscPilot	GR
Australian Nuclear Science and Technology Organisation	ANSTO	Collaboration		AU
Autonomous University of Madrid	UAM	Grant	ESSnuSB	ES
B.P. Konstantinov Petersburg Nuclear Physics Institute		Grant	Cremlin	RU
Barcelona Supercomputing Center	BSC	Grant	EoscPilot	ES
Biobanks and Biomulecular Research Infrastructure Consortium	BBMRI	Grant	EoscPilot	AU
Brookhaven National Lab	BNL	Collaboration		USA
Budker Institute of Nuclear Physics of SB RAS	BINP	Grant	Cremlin	RU
Central European Research Infrastructure Consortium	CERIC-ERIC	Grant	Accelerate	IT
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	CIEMAT	Grant	ARIES	ES
Chalmers University of Technology	CTH	Collaboration		SE
Charles University		Grant	Accelerate	CZ
Chemnitz University of Technology	TU Chemnitz	Collaboration		DE
Cockcroft Institute	**CI**	**IKC**		**UK**
Consiglio Nazionale Ingegneri	CNI	Grant	ARIES	IT
Consortium of universities CINECA	CINECA	Grant	EoscPilot	IT
Consorzio Interuniversitario Risonanze Magnetiche di Metallo Proteine	CIRMMP	Grant	iNext	IT
Cosylab	COSYLAB	Grant	ARIES	SI
CSC - IT Center for Science	CSC	Grant	EoscPilot	FI
Çukurova University	CU	Grant	ESSnuSB	TR
Danish Technological Institute	DTI	Grant	BrightnESS	DK
Daresbury Laboratory (STFC)	**Daresbury**	**IKC**		**UK**
Delft University of Technology	TU DELFT	Grant	BrightnESS	NL
Deutshes Elektronen-Synchrotron DESY	DESY	Grant	ARIES, EoscPilot	DE
Diamond Light Source	DLS	Grant	iNext	UK
Durham University	UDUR	Grant	ESSnuSB	UK
Ecrin European Clinical Research Infrastructure Network	ECRIN	Grant	EoscPilot	
EGI Foundation	EGI	Grant	EoscPilot	NL
Elettra - Sincontrone Trieste SCPA	**ELETTRA**	**IKC / Grant**	**BrightnESS, Accelerate**	**IT**
ESP Central	ESP	Grant	Accelerate	UK
ESS Bilbao		**IKC / Grant**	**BrightnESS**	**ES**
European Molecular Biology Laboratory	EMBL	Grant	iNext, EoscPilot	DE
European Organisation for Nuclear Research	CERN	Grant	ESSnuSB, Cremlin, BrightnESS, ARIES	CH
European Synchrotron Radiation Facility	ESRF	Grant	iNext, Cremlin	FR
European X-Ray Free-Electron Laser Facility GmbH	XFEL	Grant	EoscPilot, Cremlin	DE
Extreme Light Infrastructure Delivery Consortium	ELI DC	Grant	Cremlin, Accelerate	RO/HU/CZ
Eötvös Loránd University	ELTE	Grant	iNext	HU

Partner	Acronym	Collaboration	Grants	Country
Facility for Antiproton and Ion Research in Europe GmbH	FAIR	Grant	Cremlin	DE
Forschungsverbund Berlin E.V.	FVB	Grant	iNext	DE
Forschungszentrum Jülich GmbH	**FZJ**	**IKC / Grant**	**Sonde, Cremlin, BrightnESS**	**DE**
Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V.		Grant	ARIES	DE
Friedrich-Alexander-Universität Erlangen-Nürnberg	FAU	Grant	ARIES	DE
GÉANT	GEANT	Grant	EoscPilot	NL
Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts	UGOE	Grant	EoscPilot	DE
GSI Helmholtz Centre for Heavy Ion Research	GSI	Grant	ARIES	DE
Heidelberger Ionenstrahl-therapiezentrum	HIT	Grant	ARIES	DE
Helmholtz Centre for Materials and Coastal Research	**HZG**	**IKC / Grant**	**Accelerate, Cremlin**	**DE**
Helmholtz-Zentrum Berlin for Materials and Energy	HZB	Grant	ARIES	DE
Horia Hulubei National Institute of Physics and Nuclear Engineering	ELI-NP	Grant	ARIES	RO
Huddersfield University	**HU**	**IKC / Grant**	**ARIES**	**UK**
Hungarian Academy of Sciences - Centre for Energy Research	**MTA EK (CER)**	**IKC**		**HU**
Hungarian Academy of Sciences - Institute for Nuclear Research	**MTA Atomki**	**IKC**		**HU**
Hungarian Academy of Sciences - Wigner Research Centre for Physics	**MTA Wigner**	**IKC**		**HU**
Imperial College of Science, Technology and Medicine	IMP	Grant	Ramp	UK
Institut Laue-Langevin	ILL	Grant	BrightnESS, Cremlin	FR
Institute for Energy Technology	**IFE**	**IKC**		**NO**
Institute of Accelerator Technologies of Ankara University	IAT-AU	Collaboration		TR
Institute of Applied Physics of the Russian Academy of Sciences	IAP RAS	Grant	Cremlin	RU
Institute of Elelctrical Engineering, Slovak Academy of Sciences	IEE	Grant	ARIES	SK
Institute of High Energy Physics of the Chinese Academy of Sciences	IHEP	Collaboration		CN
Institute of Modern Physics of the Chinese Academy of Sciences	IMP	Collaboration		CN
Institute of Nuclear Chemistry and Technology	ICTJ	Grant	ARIES	PL
Instituto de Tecnologia Quimica e Biologica - Universidade Nova de Lisboa	ITQB NOVA	Grant	iNext	PT
Instituto Superior Tecnico	IST	Grant	ARIES	PT
Instruct Integrating Biology	Instruct ERIC	Grant	iNext	UK
Integrated Carbon Observation System	ICOS	Grant	EoscPilot	FI
Integrated Detector Electronics AS	IDEAS	Grant	Sonde	NO
Ion Beam Applications S.A.	IBA	Grant	ARIES	BE
ISIS Neutron Source Facility (STFC)	**ISIS**	**IKC**		**UK**
Japan Proton Accelerator Research Complex	J-PARC	Collaboration		JP
Jisc Lbg	JISC	Grant	EoscPilot	UK
Johan Wolfgang Goethe Universitaet Frankfurt am Main		Grant	iNext, ARIES	DE
Johannes Gutenberg-Universität Mainz	JGU	Grant	ARIES	DE
Joint Institute for Nuclear Research	JINR	Grant	Cremlin	RU
Karlsruhe Institute of Technology	KIT	Grant	EoscPilot, ARIES,	DE
Laboratoire Léon Brillouin	**LLB**	**IKC**		**FR**
Laval University		Collaboration		CA
Leibniz-Institute for Molecular Pharmacology	FMP	Grant	iNext	DE
Leiden University		Grant	iNext	NL

Partner	Acronym	Collaboration	Grants	Country
Linköping University		Collaboration		SE
Lund University	**LU**	**IKC / Grant**	**BrightnESS, ESSnuSB, iNext, Sonde, ARIES**	**SE**
Masaryk University	MENI / CEITEC	Grant	iNext	CZ
MAX IV Laboratory	MAX IV	Grant	Cremlin	SE
Max Planck Society	MPG	Grant	EoscPilot	DE
Maynooth University	NUIM	Grant	Ramp	IR
Mid Sweden University	MiU	Grant	BrightnESS	SE
National Center for Scientific Research "Demokritos"	DEMOKRITOS	Grant	ESSnuSB	GR
National Institute for Nuclear Physics	**INFN**	**IKC / Grant**	**ARIES, ESSnuSB, BrightnESS, EoscPilot**	**IT**
National Institute of Geophysics and Volcanology	INGV	Grant	EoscPilot	IT
National Research Centre "Kurchatov Institute"	PNPI (NRC KI)	Grant	Cremlin	RU
National Research Council of Italy	**CNR**	**IKC / Grant**	**EoscPilot**	**IT**
Natural Environment Research Council	BGS	Grant	EoscPilot	UK
Netherlands Cancer Institute	NKI	Grant	iNext	NL
Norwegian University of Science and Technology	NTNU	Collaboration		NO
Nuclear Physics Institute of the CAS	**UJF CAS (ASCR)**	**IKC**		**CZ**
Oak Ridge National Laboratory	ORNL	Collaboration		USA
Partnership for Advanced Computingin Europe Aisbl	PRACE	Grant	EoscPilot	BE
Paul Scherrer Institut	**PSI**	**IKC / Grant**	**BrightnESS, ARIES**	**CH**
Polish Energy Group	**PGE**	**IKC**		**PL**
Polytechnic University of Milan	POLIMI	Grant	ARIES	IT
Polytechnic University of Turin	POLITO	Grant	ARIES	IT
RHP-Technology GmbH	RHP	Grant	ARIES	AT
Riga Technical University	RTU	Grant	ARIES	LV
Roskilde University	**RU**	**IKC**		**DK**
Royal Institute of Technology	KTH	Grant	ESSnuSB	SE
Royal Netherlands Academy of Arts and Sciences	KNAW-RI	Grant	Accelerate, EoscPilot	NL
Ruđer Bošković Institute	RBI	Grant	ESSnuSB	HR
Science and Technology Facilities Council	**STFC**	**IKC / Grant**	**ARIES, BrightnESS, EoscPilot**	**UK**
Sofia University	UniSofia	Grant	ESSnuSB	BG
Spanish National Research Council	CSIC	Grant	iNext	ES
Stanford University National Accelerator Laboratory	SLAC	Collaboration		USA
Stichting Liber	LIBER	Grant	EoscPilot	NL
Stockholm University	SU	Collaboration		SE
SURFsara	SURFsara	Grant	EoscPilot	NL
Swiss Center for Electronics and Microtechnology	CSEM			CH
Swiss Federal Institute of Technology in Lausanne	EPFL			CH
Synchroton SOLEIL	SOLEIL	Grant	ARIES, iNext	FR
Tallinn University of Technology	**TTU**	**IKC**		**EE**
Technical University of Denmark	**DTU**	**IKC / Grant**	**BrightnESS**	**DK**

Partner	Acronym	Collaboration	Grants	Country
Technical University of Munich	**TUM**	**IKC / Grant**	**Cremlin, Accelerate**	**DE**
The Chancellor, Masters and Scholars of the University of Oxford	UOXF	Grant	ARIES	UK
The French Alternative Energies and Atomic Energy Commission	**CEA**	**IKC / Grant**	**BrightnESS, EoscPilot, Cremlin, ARIES, Sonde**	**FR**
The Henryk NiewodniInstitute of Nuclear Physics	**IFJ-PAN**	**IKC**		**PL**
The Institute of Experimental and Applied Physics	IEAP CTU	Grant	BrightnESS	CZ
The National Center for Nuclear Research	**NCBJ**	**IKC**		**PL**
The National Center for Scientific Research	**CNRS**	**IKC / Grant**	**EoscPilot, ARIES, ESSnuSB,iNext**	**FR**
Thomas Jefferson National Accelerator Facility - Jefferson Lab	JLAB	Collaboration		USA
Trinity College Dublin	TCD	Grant	Ramp	IE
United Kingdom Atomic Energy Authority	**UKAEA**	**IKC**		**UK**
Université Grenoble Alpes	UGA	Grant	Ramp	FR
University of A Coruña		Collaboration		ES
University of Bath		Collaboration		UK
University of Bergen	**UiB**	**IKC**		**NO**
University of Brescia		Collaboration		IT
University of Copenhagen	**KU**	**IKC / Grant**	**BrightnESS**	**DK**
University of Edinburgh	UEDIN	Grant	EoscPilot	UK
University of Florence	PIN	Grant	EoscPilot	IT
University of Geneva	UNIGE	Grant	ESSnuSB, ARIES	CH
University of Hamburg	UHAM	Grant	Ramp	DE
University of Latvia		Collaboration		LV
University of Leeds	UoL	Grant	Ramp	UK
University of Malta	UoM	Grant	ARIES	MT
University of Manchester	UMAN	Grant	EoscPilot	UK
University of Oslo	**UiO**	**IKC**		**NO**
University of Oulun	UO	Grant	iNext	FI
University of Patras	UPAT	Grant	iNext	GR
University of Siegen	USIEGEN	Grant	ARIES	DE
University of Surrey	SURREY	Grant	Ramp	UK
University of Tartu	**UT**	**IKC**		**EE**
University of Twente		Grant	ARIES	Nl
Uppsala University	**UU**	**IKC / Grant**	**ESSnuSB, ARIES**	**SE**
Utrecht University		Grant	iNext	NL
Uzhhorod National University	UNU	Grant	Accelerate	UA
Vilnius University		Collaboration		LT
Warsaw University of Technology	**WUT**	**IKC / Grant**	**ARIES**	**PL**
Weizmann Institute of Science		Grant	iNext	IS
Wroclaw University of Science and Technology	**PWR**	**IKC**		**PL**
ZHAW Zurich University of Applied Sciences	**ZHAW**	**IKC**		**CH**

4.1 ESS In-Kind Model Reaches Maturity

Thirty percent of the €1 843 million ESS construction project is now established to be in-kind contributions from more than 40 partner institutions across Europe. This amounts to €550 million in signed or planned agreements.

In 2017, €54 million in new contracts were endorsed by the ESS In-Kind Review Committee (IKRC), a group of ESS member state delegates who evaluate in-kind contribution agreements and make recommendations to the ESS Council. In a new sign of maturity for the in-kind process, the IKRC endorsed final reports for 25 completed in-kind agreements this year.

The 20 new technical annexes endorsed by the Committee in 2017 included a €25 million agreement with the United Kingdom's Science and Technology Facilities Council for their Daresbury Laboratory to fabricate and test the Accelerator's 84 high-beta elliptical cavities.

Another major in-kind milestone in 2017 was the signing of the first Phase IV instrument agreement for the development of ESTIA at Switzerland's Paul Scherrer Institute. Meanwhile, ESS Bilbao sponsored two large agreements on behalf of Spain, including the LINAC's Medium Energy Beam Transport line (MEBT) and the radio frequency (RF) systems for the warm LINAC.

ESS LINAC cryomodule under development at CEA-IRFU in France

4.2 Cooperation Between ESS and ILL Vital to Europe's Scientific Community

The European Spallation Source and Institut Laue-Langevin (ILL) signed a Memorandum of Understanding in June 2017 to cooperate on instrument and software development.

The two facilities, which are both structured as consortiums including more than a dozen European nations, are fully committed to combining their forces in the interests of science, the neutron user community, and their stakeholders. Together, ILL, which has long been the world's leading neutron science facility, and ESS, the discipline's future global centre, aim to reinforce Europe's leading position in neutron research and technology by optimising the use of available resources.

The MoU provides the framework required for enhanced cooperation between ESS and ILL, particularly in the fields of neutron-scattering instrumentation and beam components. It also addresses strategic issues such as the organisations' relations with their stakeholders.

Progress in neutron science depends on the continuous development of methods at the frontier of technical possibilities. The MoU will facilitate the exchange of experience and technical expertise accumulated at ESS and ILL in order to generate such new capabilities.

"Good cooperation between ESS and ILL is critical for the future of Europe's neutron community. We have the same stakeholders and the same users, so we have to work closely together to come to optimal opportunities for the future of science and researchers using advanced neutron techniques."

Lars Börjesson, ESS Council Chair

ESS DG John Womersley (l) and ILL Director Helmut Schober signing the MoU in June 2017. Standing, from left, are ILL Steering Committee Chair Grahame Blair of the UK's STFC, and Steering Committee members Maria Faury of France's CEA and Sebastian Schmidt of Germany's Forschungszentrum Jülich.

4.3 Canadian Engagement Brings King Carl XVI Gustaf to ESS

The European Spallation Source welcomed large delegations from Canada on two occasions in 2017. In February, the Governor General of Canada, David Johnston, joined King Carl XVI Gustaf of Sweden and the research ministers of the two nations for a roundtable focused on collaboration between Canada's and Sweden's science, industry and research infrastructures.

The event was part of a four-day Canadian state visit to Sweden, where current and future collaboration possibilities between the countries were discussed. The roundtable was led by ESS Director General John Womersley and included the Swedish Minister for Higher Education and Research, Helene Hellmark Knutsson, and the Canadian Minister of Science, Kirsty Duncan, as well as Canadian scientist Arthur B. McDonald, Professor Emeritus at Queen's University and 2015 Physics Nobel Laureate, among several others.

The discussion focused on cross-disciplinary research as a vital driver for sectors such as life science, clean technology, forestry and communications technology, and the central role that large research infrastructures play in enabling global collaborations.

Science Delegation Comes to ESS in Search of Neutrons

A second high-level delegation from Canada made a three-day visit to ESS in November, following up on an ESS visit to the Canadian Institute for Neutron Scattering's (CINS) annual meeting in 2016. Seven of Canada's leading researchers using neutrons, joined by Canada's ambassador to Sweden, visited Lund and Copenhagen for three days of meetings and exchanges concerning opportunities for cooperation with ESS.

Through their Canadian Neutron Initiative, the group has shown a keen interest in ESS as both a user facility and a model for a potential future Canadian neutron source.

ESS DG John Womersley greeting the royal motorcade at the ESS construction site

We can imagine participating in this visionary international endeavour, both now, in building it, and in the future, through access to the world-class facility. Participation in ESS could present Canadians with unique opportunities for impact at the leading edge of science and technology in coming decades, and would reap many benefits for society in health, clean energy, security and our environment."

John Root, Director of the Canadian Neutron Beam Centre and Executive Director of the Sylvia Fedoruk Centre for Nuclear Innovation

From left, Swedish Minister of Higher Education and Research Helene Hellmark Knutsson, King Carl XVI Gustaf of Sweden, Canada's Governor General David Johnston and Canadian Minister of Science Kirsty Duncan at the Canadian State Visit to the ESS Construction Site

4.4 Danish Government and Academia Come Together to Advance ESS Strategic Partnerships

The representatives for six Danish universities and the Danish Agency for Science and Higher Education gathered at the ESS construction site in November to sign a Memorandum of Understanding with ESS. The cooperative strategies defined in the agreement will extend through the construction and operations phases of the project.

Denmark, together with Sweden, is an ESS Host State and is contributing 15% of the facility's construction costs. At the beginning of 2017, more than 30 scientists, politicians and business representatives from Denmark visited ESS, led by the country's Minister for Higher Education and Science, Søren Pind, and including the Danish parliament's Standing Committee for Education and Research.

The activities outlined in the agreement aim to establish an open and internationally attractive environment for the Danish scientific, technical and academic communities that are at the heart of the ESS scientific programme. An additional aim is to further integrate these communities into the activities of the ESS Data Management and Software Centre (DMSC), based in Copenhagen, and the ESS neutron instruments programme.

The MoU also allows for direct staff exchanges between ESS and participating Danish universities, enabling freedom of movement and an open exchange of knowledge not only between institutions, but across borders. Party to the agreement are the Danish Agency for Science and Higher Education (DAFSHE), Aarhus University, Aalborg University, Roskilde University, the Technical University of Denmark, the University of Copenhagen and the University of Southern Denmark, and the agreement remains open to accession by other Danish universities.

Richard Larsen of Dansk Industri and Katrine Krogh Andersen of DTU

MoU signing in November, from left, Thomas Bjørnholm (UCPH), Katrine Krogh Andersen (DTU), Niels Christian Beier (Danish Ministry for Higher Education and Science), John Womersley (ESS), Henrik Bindslev (University of Southern Denmark), Niels Christian Nielsen (Aarhus University)

4.5 ESS and MAX IV: Collaboration and Coordination for Better Science

Neighbours ESS and MAX IV Laboratory signed a Memorandum of Understanding in May that will underpin several collaborations over the course of a decade.

While there has been cooperation between ESS and MAX IV before, the new MoU aims to identify and formalise areas of institutional-level cooperation both in the short and long term in various areas including scientific proposals, user coordination and facilities management.

The MoU has three main goals:

- To establish scientific collaboration in materials and life science, exploiting complementarity between x-rays and neutrons.
- To exploit synergies in building, operating, and maintaining large research infrastructures.
- To coordinate activities to meet users' needs concerning reception, transportation, lodging, education and training, safety, publications, etc.

"Our common opportunities and challenges provide a good foundation for the long-term coordination of activities. This will benefit not only the facilities but, more importantly, will benefit the scientists using MAX IV and ESS when doing outstanding science, and will eventually benefit society as it takes advantage of all the knowledge created."

Christoph Quitmann, Director of MAX IV Laboratory

Director of MAX IV Laboratory Christoph Quitmann (l), and ESS DG John Womersley signing the MoU, May 2017

Director of J-PARC Naohito Saito (l) and Chair of the ESS Council Lars Börjesson exchange the Memorandum of Collaboration between the two institutions. Looking on are prime ministers Abe and Löfven.

4.6 Technical Collaboration with J-PARC Strengthened Through New Agreement

A Memorandum of Collaboration was signed in July between ESS and the Japan Proton Accelerator Research Complex (J-PARC), in a ceremony that included the prime ministers of both Japan and Sweden.

The agreement between ESS and J-PARC establishes a framework to foster research and development for neutron science and technology. It covers cooperation in areas such as accelerator technology, neutron source development, instrument development, neutron technologies, testing and safety, and includes mechanisms for the transfer of knowledge, technology and staff.

The Materials & Life Science Facility spallation source at J-PARC has long served as a benchmark for ESS, and the two facilities have been collaborating from the early days of the ESS Design Phase. In April 2015, a joint effort by physicists from the ESS Target Division and J-PARC resulted in a set of experiments at J-PARC that validated the physics behind the breakthrough design of a low-dimensional moderator for ESS.

"As we continue to find solutions to the many challenges of such a large and technically advanced project, the example of our colleagues at J-PARC – who faced similar challenges only a decade ago – will continue to be invaluable."

Lars Börjesson, ESS Council Chair

4.7 Nearly 6,000 visit ESS in 2017

ESS welcomed nearly 6,000 visitors to the construction site in Lund this year.

This included not only the King of Sweden, ministers and ambassadors from Brazil, Canada, the European Commission and several ESS member states, high-level delegations from J-PARC, the European Synchrotron Radiation Facility (ESRF) and Copenhagen University, but also university students, local school groups and a wide range of scientists and politicians from around the world, including China, Greece, India and Russia.

These visits are in high demand and are an essential outreach activity providing a first-hand experience of the facility while it is under construction.

In comparison to 2016, the number of visits increased by 30%, with an average of 24 visitors per weekday touring the site either on foot, by bus or via the site office viewing platform.

ESS Visits Coordinator Alexandra Schmidli leading a tour by representatives from the Nordic Investment Bank

Site walk as part of a two-day workshop with a high-level J-PARC delegation

4.8 BrightnESS Enters Its Third Year

BrightnESS is a €20 million three-year project led by ESS and funded by the EU within the European Commission's Horizon 2020 Research and Innovation Programme. Launched in 2015, BrightnESS helps to ensure that key challenges are met in order to build a facility that can deliver high-impact scientific and technological knowledge, while having a long-term impact on ESS and the wider research community.

In 2017, the BrightnESS project's key results included the following:

- Set up a network of Field Coordinators to enhance communication between ESS and its partners.
- Helped to secure more than 230 in-kind contributions contracts with more than 40 institutes for a total value of €550 million.
- Improved the flow of knowledge sharing between partners through best practice exchange and networking activities.
- Helped ESS to gain a better understanding of VAT issues in each ESS Member State and facilitated appropriate solutions.
- Engaged with partners to build capacity in the Technology Transfer Office and established an innovation framework to help ESS build capacity for early engagement with industry.
- Enabled the development, testing and optimisation of new, state-of-the-art technology for neutron detectors.
- Supported progress in technical areas such as moderator physics and moderator design.
- Created innovative software infrastructure to make the experimental data available as a live stream.
- Conducted and published a European-wide survey to analyse key target groups for ESS to support informed policy making and establish trustful relations with future academic and industrial users.
- Raised awareness about ESS and reached out to future users across Europe through various collaboration, networking and outreach activities.

2017 BrightnESS General Assembly at the ESS construction site

4.9 Grant Collaborations

CREMLIN

The aim of CREMLIN is to strengthen the relations and networks between European and Russian research infrastructures both at a scientific and a research policy level. Through its partnership, ESS was involved in two main activities in 2017:

Press Trip to Russia

Six leading science journalists from across Europe visited Russia during the 10th meeting of the Group of Senior Officials on Global Research Infrastructures (GSO) in October. The reporters visited large-scale research infrastructures sites in Moscow, Dubna and Gatchina. The press trip was designed to help the reporters learn about current and future European-Russian research partnerships.

CREMLIN Innovation Workshop

Experts from European, Russian and international platforms and initiatives gathered with representatives from the Russian and European Megascience facilities participating in the CREMLIN project in October 2017. The workshop was designed to help share best practice around the challenges of managing innovation to improve the impact of research.

European Journalists visiting Moscow

RAMP

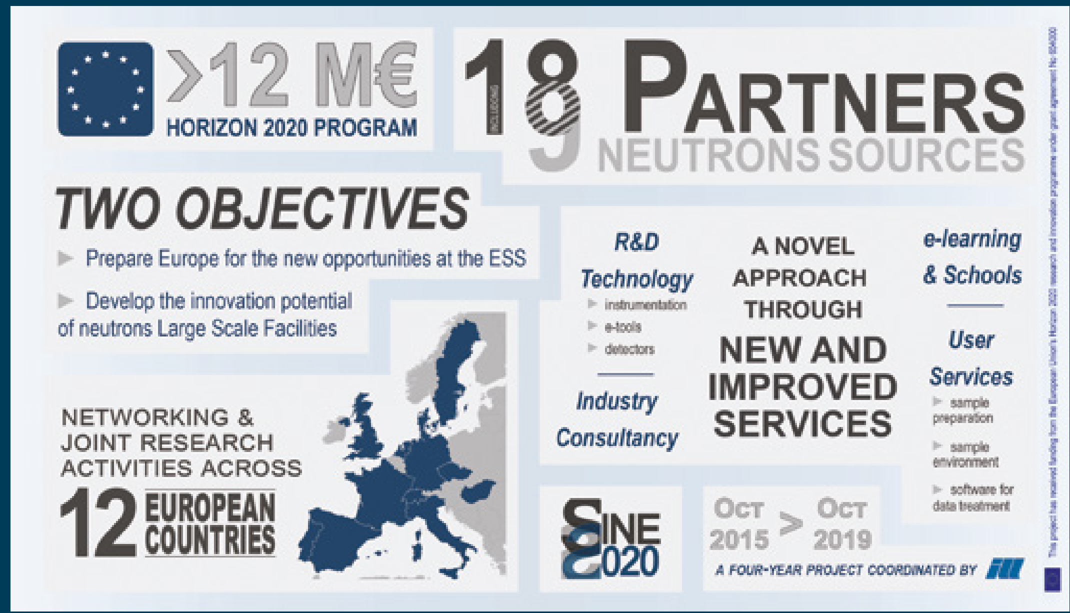
The European Spallation Source is part of the EC-sponsored, Grenoble University-led RAtionalising Membrane Protein Crystallisation (RAMP) project under the highly competitive Marie Skłodowska-Curie Actions Innovative Training Network (ITN). RAMP is a consortium of organisations from academia and industry who will support the research and training of 12 early-stage researchers over a four-year period.

"As the name suggests, ITN, innovative training network, is the best example of brain-storming, where people with distinct expertise join at the same platform for a common cause. Most importantly, we get a chance to interact and know people from different cultures across the world. Being in this network, we not only gain technical knowledge while working on our projects, but also develop professional skills to make a difference in industry or academia in the near future."

Swati Aggerwal, RAMP Early-Stage Researcher and ESS PhD student

SINE2020

The European Spallation Source is a partner in the strategic project SINE2020 – world class Science and Innovation with Neutrons in Europe for 2020, which is coordinated by Institut Laue-Langevin.



SINE2020

EOSCpilot

The European Spallation Source is part of an initiative to support the first development phase of the European Open Science Cloud (EOSC), which has received €9.9 million in funding through the European Commission's Horizon 2020 programme. The two-year EOSCpilot project connects 33 partner organisations from 11 countries to establish the foundations of the EOSC. The project launched in January 2017, and will run for two years.

SREss

Spatial Research Excellence by ESS (SREss) is a project at ESS funded by the European Union as part of its regional investment policy through the European Regional Development Fund.

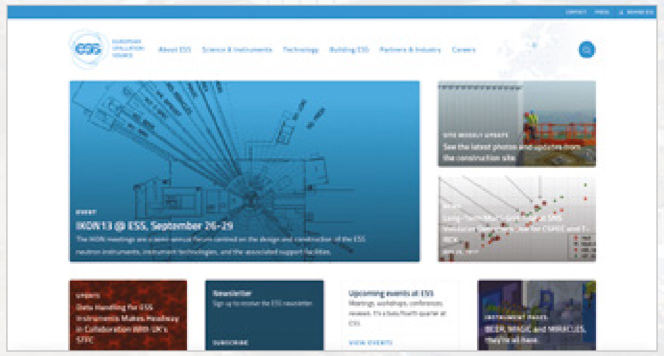
The aim of the SREss project is to secure the basic physical infrastructure of the research facility under construction in Lund, thus laying the physical basis for the future instruments. In 2017, SREss entered its third and final year.

4.10 Web-Based Initiatives Make an Impact

Two web-based initiatives launched in 2017 have improved external and intra-project communications at ESS.

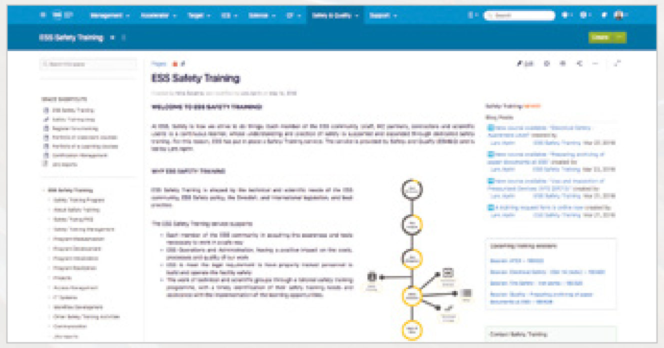
Public Website

A new ESS public website was launched in September. The fresh design and updated technology establishes a new dynamic showcase for the global reach of one of the most exciting Big Science projects on the planet.



ESS Inside and Collaboration Space

The January 2017 launch of an internally hosted platform has been a game-changer for web-based collaboration at ESS. Based on various popular tools from Atlassian, the initiative has greatly centralised daily project communication for its 2,000 users working together on the ESS project.



4.11 ESS Expenditures Reach Across Europe

The following shows the expenditures (cash basis) by ESS during 2017 for ESS founding member and observer countries and other countries. The data is based on invoices paid for the period January – December 2017. The data includes all payments by ESS, including, but not limited to, commercial contracts, including construction costs related to the construction contract with Skanska, rental agreements, collaboration agreements, and travel.

SUPPLIERS 2017 BY COUNTRY

	Amount in SEK (in '000s)	Amount in EUR (in '000s)*
Belgium	209	23
Czech Republic	63	7
Denmark	47,288	5,254
Estonia	27	3
France	22,249	2,472
Germany	121,332	13,481
Hungary	1,051	117
Italy	6,551	728
Netherlands	2,595	288
Norway	1,009	112
Poland	705	78
Spain	759	84
Sweden	1,204,334	133,815
Switzerland	16,040	1,782
United Kingdom	14,898	1,655
Other	31,480	3,498
TOTAL	**1,470,590**	**163,399**

*Based on exchange rate of 9 SEK = 1 EUR

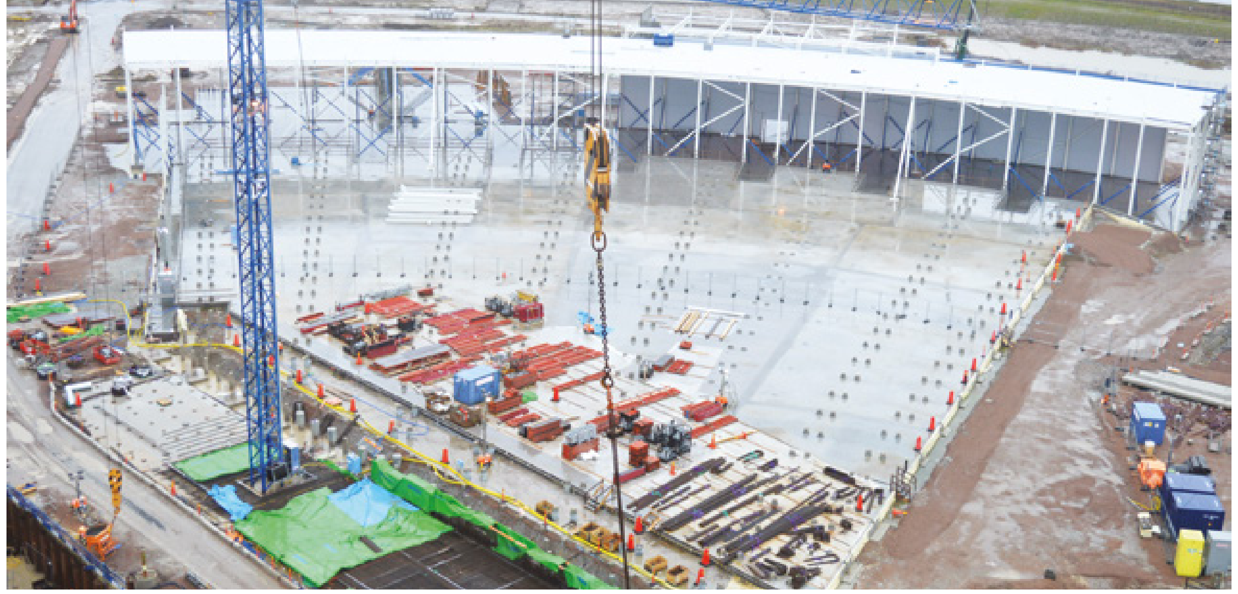
5

Science Pivots to Installation Planning and Focus on Early Experiments

In 2017, construction of the first 15 instruments for ESS turned the corner toward detailed design and installation planning. With sights set on enabling early science at ESS, scientists and engineers at more than two dozen partner labs continued to collaborate with ESS and one another to ensure the suite of world-leading instruments meets its installation milestones.

5.1 IKON Meetings Cut Path to Early Science at ESS

The European Spallation Source's semi-annual IKON meetings for in-kind collaborators on the Neutron Scattering Systems (NSS) project have become standing-room-only affairs critical to delivery of the first 15 scientific instruments at ESS.



The ESS guide hall, long-range instrument hall and support labs under construction in December 2017

Following the December 2016 ESS Council approval of the revised scope, schedule and budget allocation for NSS, 2017 was full steam ahead for the instrument teams, with nearly all of them clearing a review of their preliminary engineering design before the year was out.

Nearly 200 people participated in February's IKON12 meeting at the Paul Scherrer Institute in Switzerland, and many more at IKON13 in September in Lund. Participants in the multi-day meetings included scientists and engineers from all 15 instrument teams, many members of ESS staff and management, representatives from more than 30 partner labs, and still others from industry.

'Fantastic Communications Platform'

The purpose of the meetings as well as their most critical theme is the optimisation of communicating the vast amount of evolving project information. The timely and clear dissemination of information in both directions can impact everything from the smallest details of a design, to the larger questions of how to allocate funds over time and where to assemble and test components – impacts that in some cases can be years away.

IKON sessions include discussions and presentations on, among many other topics, installation scheduling, facility infrastructure progress, safety standards and systems, control systems, data handling and software, detector R&D, and investigations into common approaches to shared problems like shielding and guide alignment.

The NSS Integrated Project Schedule

The trickiest discussions typically concern the knowns and unknowns surrounding installation of the instruments, which is staged over some of the most dynamic years of the ESS project as a whole, featuring many overlapping contingencies. The constraints on how an instrument may be installed, where, and when, have significant bearing on the instrument's design.

These parameters become more and more fixed with each concrete pour out on the construction site, giving some urgency to communications around the issues.

Planning discussions have become increasingly focused over the course of 2017 as development of the NSS integrated project schedule became a solid fixture of the IKON meetings in September and for the foreseeable future.

Start of the User Program and Early Science

At the September meeting, NSS Project Leader Shane Kennedy noted that, with most in-kind commitments secured and all instruments soon to be through preliminary engineering design, the focus for 2018 would be on detailed design and in some cases manufacturing and procurement.

Setting the group's sights farther ahead, ESS Science Director Andreas Schreyer presented detailed scenarios for the first decade of operations at ESS. These included sliding variables for budget allocation, the instrument completion strategy, and the impact of additional instruments beyond the first 15. Schreyer also underscored the most important milestone for the project, and for ESS as a facility: the inauguration of the scientific user program.

IKON12 meeting at PSI, Villigen, Switzerland

"All of the teams know now exactly what they need to do. With all the labs collaborating, it's mainly a communications issue, and IKON is a fantastic communications platform where the instrument teams can exchange experiences."

Andreas Schreyer, ESS Science Director

5.2 Instruments in Construction

LARGE-SCALE STRUCTURES	**LoKI** - Broadband SANS	STFC (UK)	
	SKADI - General Purpose SANS	FZJ (DE)	LLB (FR)
	ESTIA - Focusing Reflectometer	PSI (CH)	
	FREIA - Liquids Reflectometer	STFC (UK)	
DIFFRACTION	**DREAM** - Bispectral Powder Diffractometer	FZJ (DE)	LLB (FR)
	HEIMDAL - Hybrid Diffractometer	Aarhus University (DK) PSI (CH)	IFE (NO)
	MAGiC - Magnetism Single-Crystal Diffractometer	LLB (FR) FZJ (DE)	PSI (CH)
	NMX - Macromolecular Diffractometer	ESS BNC-Wigner (HU) LLB (FR)	University of Bergen (NO) BRC (HU) mtaEk (HU)
ENGINEERING & INDUSTRIAL	**BEER** - Engineering Diffractometer	UJF (CZ)	HZG (DE)
	ODIN - Multi-Purpose Imaging	TUM (DE)	PSI (CH)
SPECTROSCOPY	**BIFROST** - Extreme Environment Spectrometer	DTU (DK) UCPH (DK) IFE (NO)	LLB (FR) PSI (CH)
	CSPEC - Cold Chopper Spectrometer	LLB (FR)	FRM II (DE)
	T-REX - Bispectral Chopper Spectrometer	FZJ (DE)	CNR (IT)
	VESPA - Vibrational Spectrometer	CNR (IT)	STFC (UK)
	MIRACLES - Backscattering Spectrometer	ESS Bilbao (ES) UCPH (DK)	

"Success at ESS will be judged by the ability of the facility to make progress in science areas valuable to society. To deliver on this scale requires European collaboration, the basis upon which ESS can succeed."

John Womersley, ESS Director General

5.3 Instrument Highlights: NMX and BIFROST

NMX Will Reveal Cellular Functions Fundamental to Life

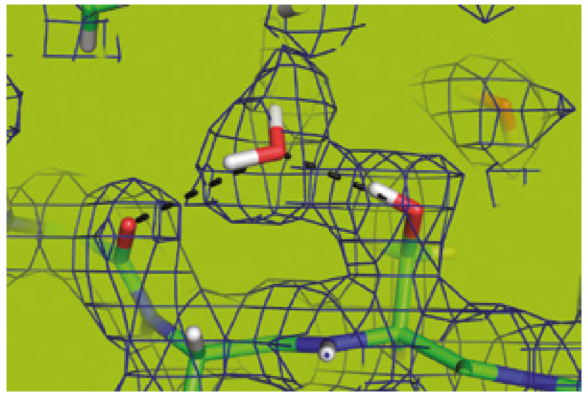
The high neutron flux generated by ESS will be a game-changer in the identification and characterisation of hydrogen atoms in complex molecular structures, like proteins and enzymes. NMX, the macromolecular crystallography instrument under construction for ESS, will be the world-leading instrument for these types of studies and will break new ground in structural biology.

Allowing for smaller crystal samples and shorter measurement times, NMX will enable researchers to identify the position of hydrogen atoms in molecules where this basic information remains a mystery.

Macromolecular crystallography is a workhorse discipline at synchrotron X-ray sources globally, and NMX is the next step of scientific discovery. Researchers will use the diffractometer to perform neutron scattering experiments to understand life processes in greater detail than ever before.

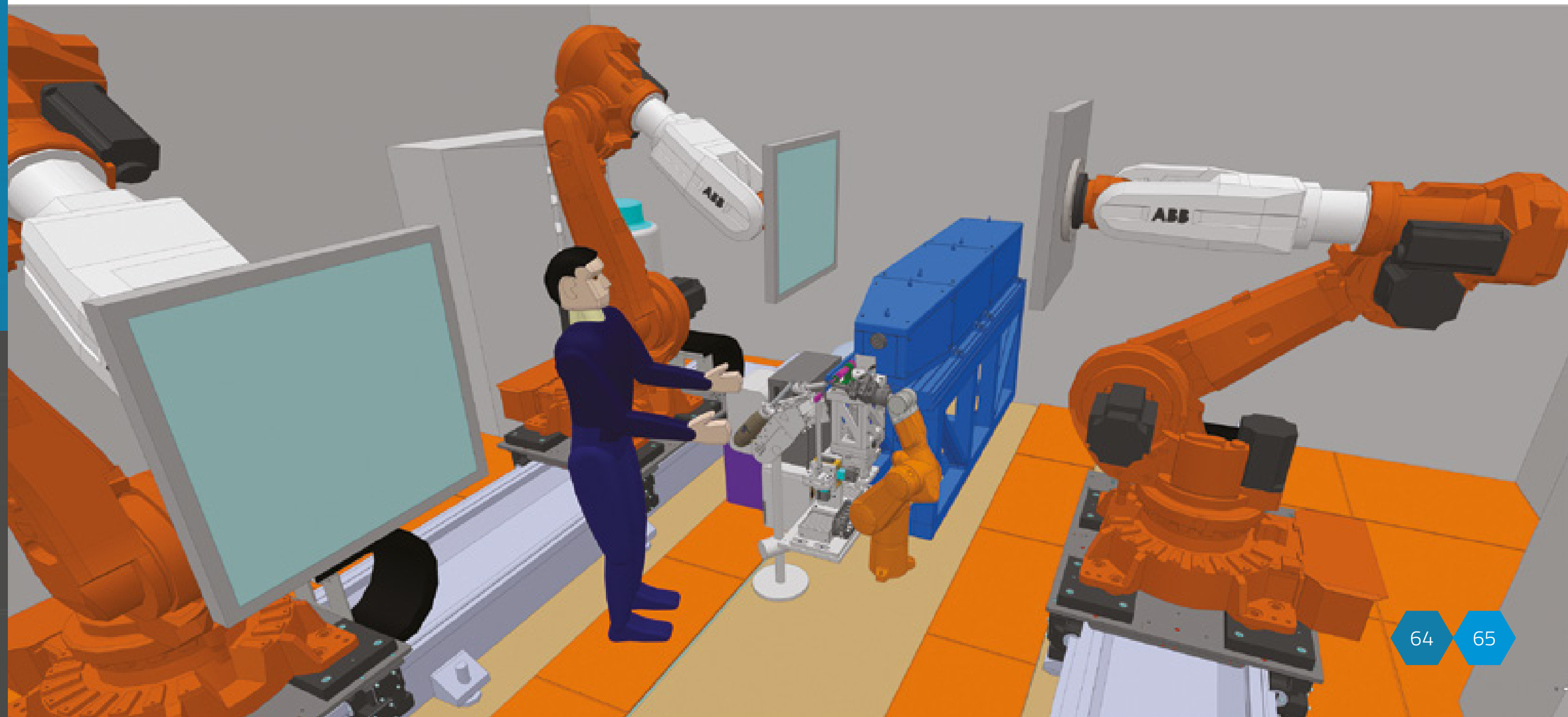
The NMX project team, led by ESS instrument scientist Esko Oksanen, has been one of the forerunners of an adaptive, ongoing design process orchestrated for the entire instrument suite of ESS. The project is currently nearing completion of the detailed engineering design phase. Following this, procurement of instrument components will begin.

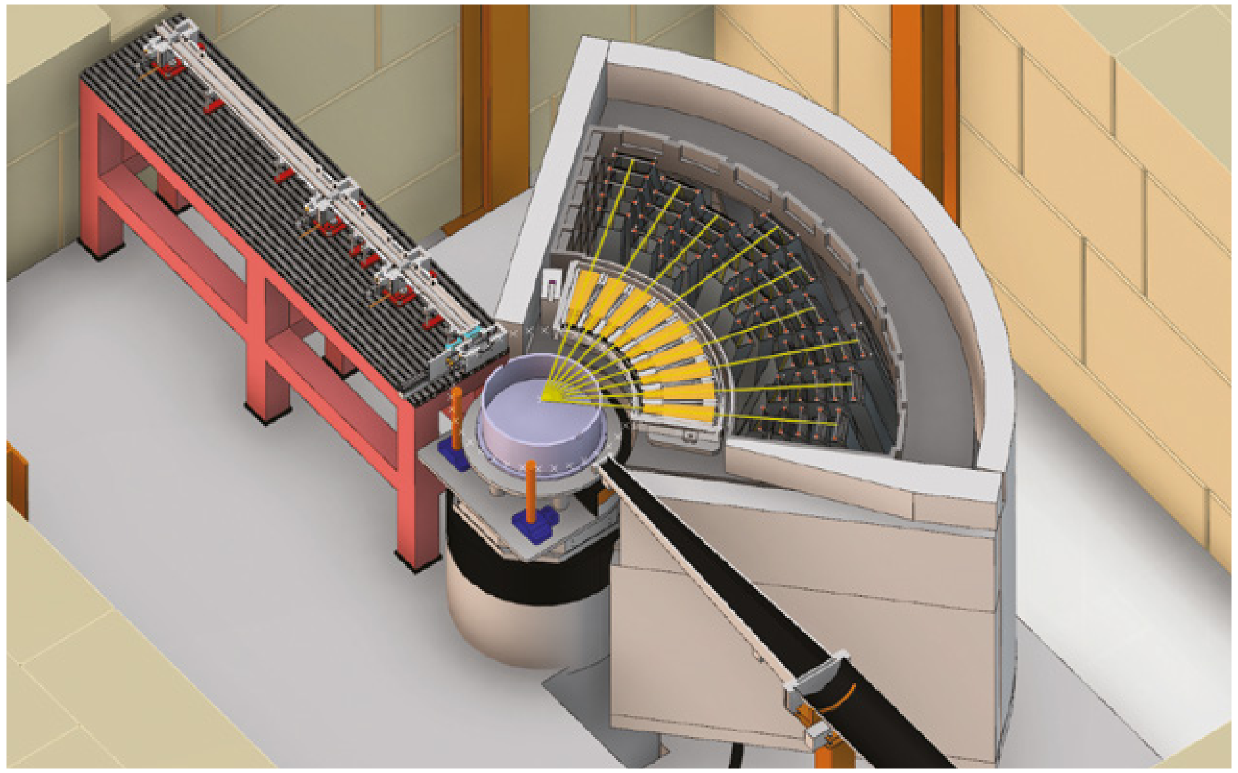
"ESS has many in-kind partners working to make NMX a success," said NMX lead scientist Esko Oksanen. "For instance, we have nice progress on the robotics from the Institute for Structural Biology (IBS) through the French Alternative Energies and Atomic Energy Commission (CEA) in Grenoble. We have our Hungarian partners at the Wigner Research Centre for Physics developing the beam delivery system optics and choppers. The Centre for Energy Research in Budapest is doing the shielding calculations and design."



Neutron crystallography allows unambiguous determination of hydrogen positions, including the ordered water hydrogens. This example shows a hydrogen bonding network from the enzyme urate oxidase. Oksanen et al. 2014

The NMX endstation, including robotic arms





BIFROST sample environment and novel prismatic analyser concept with efficient detector arrangement

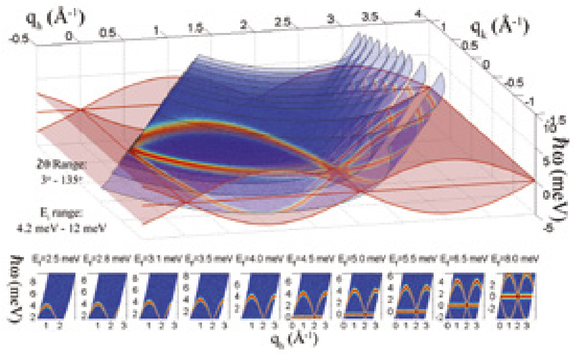
The ESS extreme environment spectrometer, BIFROST, will represent a major leap forward for our understanding of the intricate physics of magnetism and superconductivity, impacting the development and discovery of the information technology, energy and health care materials of tomorrow.

Cold neutron spectroscopy is the only tool in existence for probing such dynamics at low energies (0-40 meV), but it remains a flux-limited technique and therefore requires large sample mass for feasibility. The BIFROST beamline, coupled to the ESS machine, will increase flux on sample by an order of magnitude compared to the best options available today, allowing for smaller sample sizes and faster experiments.

Based on a design nearly 20 years in the making, which incorporates a novel prismatic analyser concept with a more efficient detector arrangement, BIFROST is engineered like no other instrument in the field. It will enable the routine investigation of samples more than 1,000 times smaller than those currently studied.

This opens the doors for exciting new research that will expand our limited understanding of magnetic phenomena as well as contribute to the discovery of new materials and new materials applications. With the potential to reveal high-temperature superconducting materials, BIFROST could, for example, support the development of more efficient and patient-friendly MRI scanners.

BIFROST's lead scientist is Rasmus Toft-Petersen at ESS and the Technical University of Denmark (DTU) and the team's lead engineer is Liam Whitelegg at DTU. Other in-kind partners include the University of Copenhagen, the Paul Scherrer Institute in Switzerland, Laboratoire Léon Brillouin in France, and the Institute for Energy Technology in Norway. BIFROST has passed its preliminary design review and the team will spend most of 2018 working on detailed design before moving into procurement and manufacturing.



Example of a magnon dispersion measured on a BIFROST indirect geometry setup. A BIFROST data-set is 3-dimensional: Two in-plane Q-coordinates and an energy transfer. Each set of analyzers effectively measures a 2-dimensional manifold in this space.

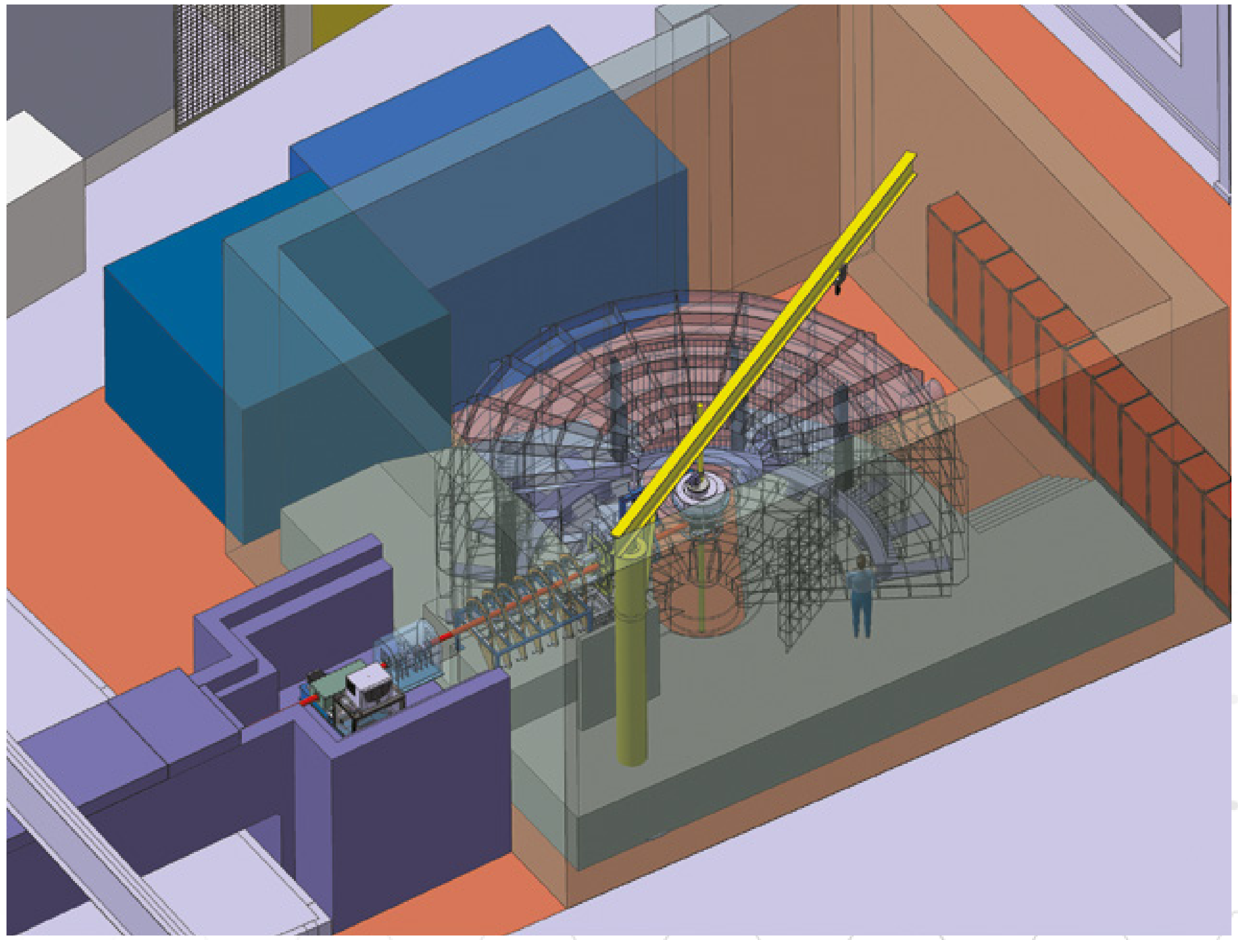
5.4 Large-Area Boron-Based Detector Improvements Validated at LLB

A team of researchers from ESS and Institut Laue-Langevin (ILL) have made improvements on the first-of-its-kind boron carbide-based large area Multi-Grid detector approved for use with ESS instruments CSPEC and T-REX.

Modifications to the construction and geometry of the MG_IN6 prototype detector have been tested on an instrument at ESS partner institute Laboratoire Léon Brillouin (LLB), near Paris. A significant improvement in detection efficiency was confirmed by the beamline tests. The improvements are attributable to an increased number of converter layers in the new grid, newly designed radial blades and an adjustment to the grid layout that eliminates dead zones.

The new developments come on the heels of a very successful long-term trial of another prototype of the detector, which for more than a year has been operating successfully on the CNCS instrument at the Spallation Neutron Source in Oak Ridge, Tennessee, adjacent to the instrument's primary detector.

T-REX: Overview of the T-REX bispectral chopper spectrometer, which will use the boron-based Multi-Grid detector developed by ESS and ILL



5.5 Instrument Technologies Development and Integration Advance at Utgård and V20 Test Beamline

Utgård Workshop

Shared between the Detector Group, the Scientific Activities Division and the Integrated Control System Division (ICS), the 790 square metre Utgård workshop and laboratory in Lund is being used to test and develop equipment and prototypes to support the construction, integration and operation of the scientific instruments at ESS.

The groups have been developing detectors, sample environments and laboratories, and a complex network of hardware, software and configuration databases.

Development and integration work at the Utgård workshop in Lund

ESS V20 Test Beamline

The ESS V20 Test Beamline has provided real-world conditions for ESS and its partners to test engineering and scientific concepts in the development of instruments and their associated neutron technologies.

Constructed at the Berlin Experimental Reactor (BER) II at Helmholtz-Zentrum Berlin (HZB), the beamline serves as a general-use test bench for the development of novel experimental methods and components for ESS instrument scientists and neutron technology groups working with optics, detectors, choppers, electrical engineering and other associated technologies. For this reason, the beamline's design features an elaborate chopper system that mimics the unique long-pulse time structure of ESS.

Prototype: Integrating Systems for the ESS Instrument Suite

In a joint effort of the Neutron Chopper Group, the Detector Group, DMSC and the Integrated Control Systems Division, the first integration prototype test was performed at the ESS V20 test beamline at Helmholtz-Zentrum Berlin in November.

A functional ESS mock-up chopper system was installed, integrated and controlled via EPICS. This represents the first implementation of a vertical integration of ESS technologies for control of choppers, motion systems, detectors and sample environment that sees the ESS controls vision take shape.

The prototype test implementation follows on the one from the ESS Instrument Integration Project (ESSIIP) at the Utgård facility in Lund. The integration program will continue in early 2018 with more tests and detailed time-of-flight measurements, including the time-stamping of events.

5.6 Interim DMSC Leader Made Permanent

Jonathan Taylor served nearly a year as interim head of DMSC following the retirement of Mark Hagan in 2016. In September he was selected as head of the Copenhagen-based division.

Taylor came to ESS from the ISIS Neutron & Muon Source in the UK and, in addition to his interim responsibilities, has served as leader of DMSC's Instrument Data Group for several years. He will lead the effort to prepare ESS for its steep data management and software development requirements.

As chair of the Mantid Project Management Board, Taylor is also part of the leadership in the global initiative to standardise software and controls across neutron science facilities.

"There is unanimous agreement on the importance of scientific computing at large scale facilities in providing high impact science. I look forward to leading DMSC and working with our stakeholders to deliver world-leading scientific computing for neutron science at ESS."

Jonathan Taylor, Head of the ESS Data Management & Software Centre

Jon Taylor, Head of the ESS Data Management and Software Centre

5.7 In-Kind Collaboration with UK's ISIS Yields Progress for ESS Instrument Software

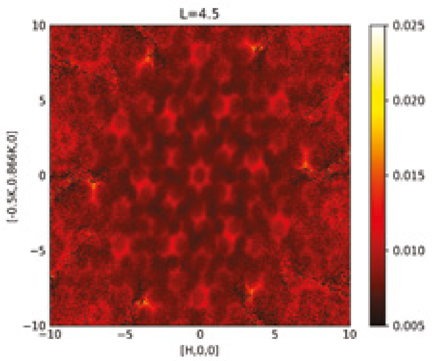
DMSC's Instrument Data Group is developing custom software based on the Mantid framework for data reduction together with STFC's ISIS Neutron & Muon Source in order to meet ESS instrument-specific requirements.

Aside from the demands of its high neutron flux and unparalleled instrument complexity, ESS will also require greater real-time capability for data reduction than has previously been attempted.

The Mantid Project is an Open Source, neutron-specific data treatment framework. It was started by ISIS in 2007 to provide a common data reduction framework for all instruments at ISIS, and has grown into an international collaboration involving many facilities.

Throughout 2017, the ISIS-ESS collaboration has made significant strides in improving the performance and flexibility of Mantid, bringing the project closer to meeting the unique requirements of the ESS instrument suite.

The group has also demonstrated that Mantid outputs can be connected to ESS live data streaming components. This is particularly important because it means this procedure, which converts raw counts from instrument detectors into scientifically useful data, can be used in real-time for the time-of-flight instruments at ESS.



Visualisation of LaNaF4 as measured on the TOPAZ neutron instrument at the Spallation Neutron Source in the US. Multiple orientations have been measured and stitched using Mantid software

"The collaboration is really important. We can call on experience from experts across different facilities for some of the hardest problems, and everyone benefits as we solve these forward-looking issues."

Owen Arnold, in-kind work package leader for STFC

Canadian scientist Arthur B. McDonald, Professor Emeritus at Queen's University and 2015 Physics Nobel Laureate (second from left) meeting with ESS scientists (from left) Valentina Santoro, Ken Andersen, Mats Lindroos and Andreas Schreyer during the Canadian state visit to Sweden

ESS DMSC staff in Lund, summer 2017

5.8 DMSC Hosts 7th SasView Code Camp

The ESS Data Management & Software Centre hosted the 7th SasView code camp in Copenhagen in the last week of October. Instrument scientists and software developers from the National Institute of Standards and Technology (NIST) in the US, Institut Laue-Langevin, and the UK facilities ISIS Neutron & Muon Source and Diamond Light Source.

The intense seven-day code camp was an excellent way to combine forces with other software developers and scientists and work for an uninterrupted period on a single area. These seven days were dedicated to development of analysis software for the SANS instruments LoKI and SKADI.

The camp is partly supported by the EU-funded SINE2020 project, which funds two developers at DMSC.

"[ESS] is fascinating for me, I'm like a kid in a candy shop... I think the sort of thing that's happening here, particularly the combination of great synchrotron light and great neutron scattering that enables you to understand materials in different ways is just the sort of thing that you need to have. I really applaud what you're doing here, and the international cooperative nature of it."

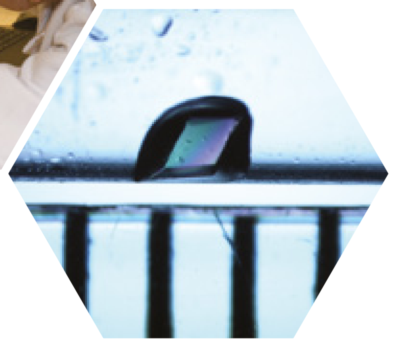
Art McDonald, 2015 Physics Nobel Laureate

5.9 Building a World-Leading Laboratory and Sample Environment Infrastructure

Civil construction of the ESS science labs moved significantly forward in 2017, with some of the buildings planned to be weather-tight in mid-2018. Meanwhile, the Scientific Activities Division continued to deliver Science Support Systems, including sample environment and user laboratories, in parallel with the instrument construction project. Standardisation efforts are well advanced and regular interactions with the instrument teams continue.

Both ESS laboratory platforms, Deuteration & Macromolecular Crystallization (DEMAX) and the Sample Handling & General Use Labs, progressed well in 2017, with the user labs moving through their Preliminary Design Review and the tendering process for laboratory fitting initiated.

ESS deuteration scientist Anna Leung in the DEMAX lab

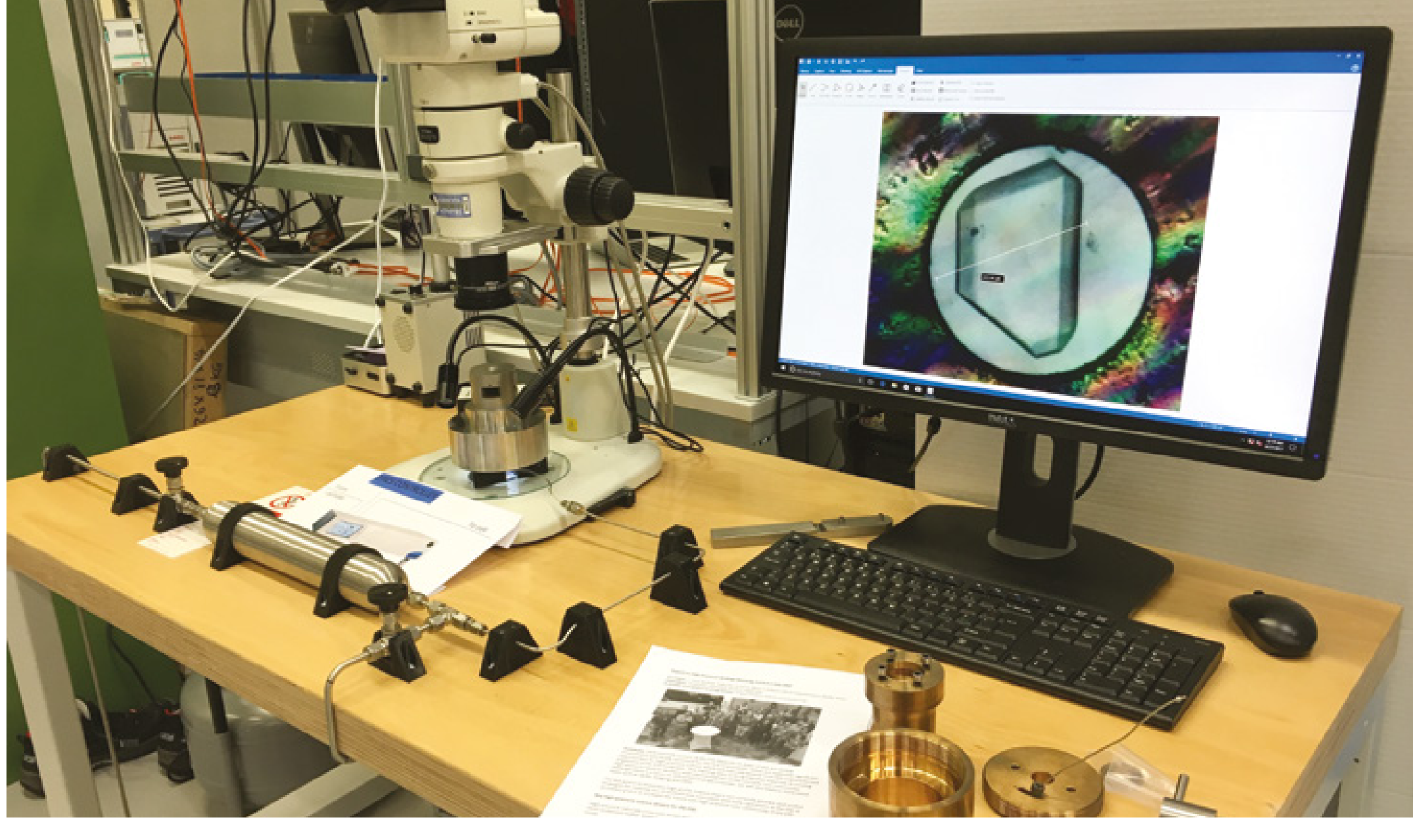


A crystal of the enzyme triose phosphate isomerase mounted in a capillary for neutron data collection

DEMAX and DEUNET

The European Spallation Source is committed to developing new and better deuteration and crystallisation methods, as well as to fostering an increase in the production of crystals and deuterated molecules for neutron analysis. This commitment is necessary to optimise the use of the new facility for life science studies. With distinguished staff scientists dedicated to such initiatives, ESS's DEMAX lab will serve as a coordination point for the development of these processes worldwide.

An important step in this direction was the inauguration of DEUNET last year, an initiative driven by ESS instrument scientist Hanna Wacklin-Knecht and supported by the EU's SINE2020 grant project. DEUNET aims to provide European neutron scattering users with access to complex deuterated small molecules, for which demand greatly outstrips supply. The network was inaugurated in mid-2017 and thus far includes ESS, the ISIS Neutron & Muon Source in the UK, the Institut Laue-Langevin in France, and Germany's Forschungszentrum Jülich, with ANSTO in Australia as an observer member.



On the monitor, a single crystal of a high-pressure ice VI with growth controlled remotely by gas pressure. On the table, components of the ESS-designed Diamond Anvil Cell made from BeCu.

Beyond Engineering: The ESS High-Pressure Sample Environment

High-pressure sample environments are one of the most exciting beneficiaries of the unparalleled brightness of the ESS neutron source.

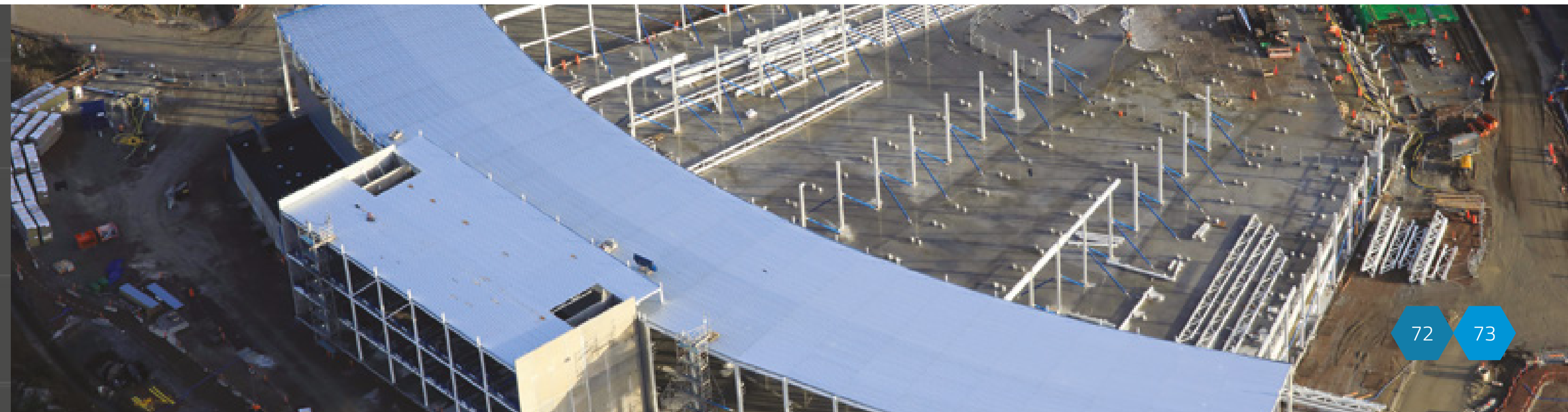
Supporting both high-pressure and engineering science, PREMP, the high pressure sample environment group at ESS, will help scientists using the world-leading instrument suite at ESS to analyse materials in high-pressure conditions from 0.1 to 100 GPa.

With hardware from classic gas and clamp cells through to new classes of diamond anvil cells capable of exceeding 100 GPa available, a broad range of environments are now possible.

The research potential with the PREMP platform goes beyond the engineering sectors, with possibilities in materials science that will aid discovery in fundamental physics, chemistry and geo-planetary sciences.

ESS will use new tools, based on large artificial diamonds, to recreate, for example, extreme extra-terrestrial environments here on Earth, and on a much larger scale than previously possible.

These high-pressure sample environments incorporated into instruments like DREAM and HEIMDAL will enable unprecedented insight into, for example, the strange atomic world of highly compressed water molecules. This exquisite new level of detail is crucial to deliver a step-change in our understanding of the far-reaching implications of water molecules and their hydrogen bonds in fields as disparate as quantum physics, biology, pharmaceuticals and volcanology.



The ESS Ion Source arriving in Lund at the end of its journey from Sicily

6

Rise of the Machine

Moving from paper to prototyping, and from building handovers to the first major machine installations, 2017 marked a critical evolution of the ESS technical project. An intense focus on design reviews and prototype manufacturing and validation has resulted in some major components moving into production, while others were delivered for installation. With installation readiness at the top of the agenda, ESS is now firmly on the path to beam-on-target.

6.1 Handover of Accelerator Tunnel and Other Buildings Launches Installations

Full access to the Accelerator Tunnel was granted to ESS in May, allowing for LINAC infrastructure and technical installations to begin on schedule.

Also in the spring, the Test Stand 2 area in the Klystron Gallery was handed over from Skanska as well as the Cryo-Compressor Building and Coldbox Hall, which were promptly filled with machinery and associated infrastructure. In September full access to the Accelerator's Front End Building was also delivered as promised, setting the stage for the 2018 installation of the Ion Source and Low-Energy Beam Transport line (LEBT).

The LINAC's Phase Reference Line was the first installation in the tunnel, performed as an in-kind contribution from Poland. The Test Stand 2 area received two klystrons to be used for site acceptance testing of LINAC components and was wired for high voltage.

Several systems across the larger Gallery Building were tested and commissioned in preparation for handover to ESS, while many dozens of electrical systems racks were received for accelerator systems. The specially engineered steel support system for the LINAC's large radio frequency (RF) distribution system, an in-kind contribution from the UK, was likewise received in the fall, followed by installation throughout the Gallery Building.

The ESS Klystron Gallery with a delivery of the wave guide support system, an in-kind delivery from STFC

6.2 Italy Delivers Ion Source

At the end of 2017, the LINAC's Ion Source and LEBT became the first major machine components to be lowered into the Accelerator Tunnel. Installation in the Front End Building was completed in early 2018.

The two systems are in-kind deliveries from Italy's National Institute for Nuclear Physics' National Laboratory of the South (INFN-LNS) in Catania, Sicily. Both were designed, built and tested in Catania and then shipped to Sweden.

The Ion Source will be the origin of the ESS proton beam. The beam begins as a plasma of protons, which is created by "boiling off" the electrons from hydrogen molecules using rapidly varying electromagnetic fields. The plasma is guided into the accelerator beamline and quickly brought nearly to the speed of light before it strikes the ESS target wheel to create neutrons to be used for scientific research.

The INFN-LNS accelerator team in Catania at the beginning of the #IonSourceAdventure

The Ion Source during installation at ESS

"This is an important moment for LNS. We really wanted to participate and drive collaboration between INFN and ESS. The realization of the Ion Source and the LEBT line are a tangible sign of the international excellence already achieved in our laboratories in the field of accelerators. It is teamwork that fundamentally has allowed the achievement of this important result."

Giacomo Cuttone, Director INFN-LNS

Giacomo Cuttone (l), Director of INFN-LNS, meets with ESS Head of Accelerator Division Mats Lindroos and ESS Technical Director Roland Garoby in Catania, Italy

6.3 Cryogenics Plant Progresses Quickly from Empty Buildings to Systems Testing

The largest of the three Coldbox helium cooling vessels was delivered and set inside the Gallery Building in the summer of 2017, following several years of design and manufacturing by Linde Kryotechnik in Switzerland.

The 50-tonne vessel is where the final stage of helium cooling takes place, following delivery of the compressed gas from the cryoplant. The large coldbox will deliver low-temperature helium to the superconducting cavities that accelerate the ESS proton beam. Two smaller coldboxes were also installed in the Coldbox Hall, which will service the cooling of Target Station and instrument components.

The Cryo-Compressor Building was first filled with extensive piping, followed by three large oil skids, generators, and a helium recovery and purification system, while just outside the building several nine-metre-tall helium tanks have been raised and set in position. The underground transfer line between the plant and the Accelerator and Target buildings was also installed and sealed.

Installations in progress in the Cryo-Compressor Building

The 50-tonne Accelerator coldbox for the ESS cryoplant, received in August 2017

6.4 Assembly of LINAC Warm Units Begins at Daresbury as Lab Gears Up for High-Beta Cavity Series Production

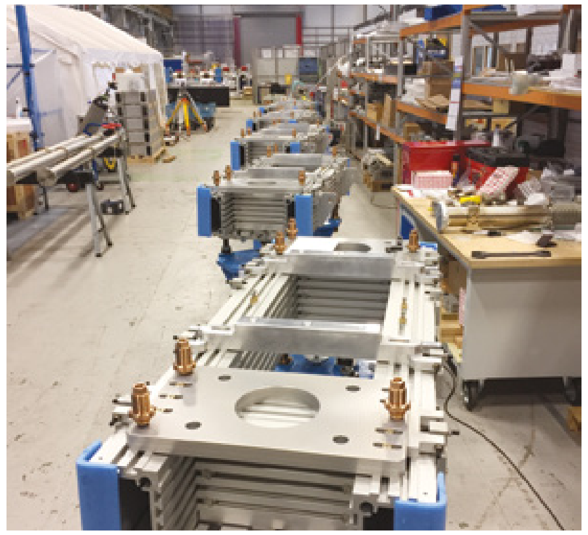
The ESS LINAC components at the low-energy end of the accelerator, where the beam is focused and steered before entering the superconducting phase, are in production at the UK's Science & Technology Facilities Council (STFC) Daresbury Laboratory. The lab is also coordinating production of the ESS Accelerator's high-beta elliptical cavities.

The lab will perform acceptance testing, including RF tests in cryogenic conditions, for the 84 elliptical cavities that will form the majority part of the ESS superconducting LINAC. The cavities must be literally spotless before they are locked away inside cryogenic tanks in Saclay, France, and delivered for installation in Lund.

France's Alternative Energies and Atomic Energy Commission (CEA) has developed and, in 2017, successfully prototyped the cryomodules that will house the cavities.

Daresbury is building a testing facility for the high-beta cavities, including a cryostat, cryoplant and an iso-4 clean room, that will soon begin operations.

The activities at Daresbury form a large portion of the UK's in-kind contribution to ESS, and in 2017 ESS secured a €25 million agreement with STFC to begin fabrication and testing of the cavities.



ESS LINAC warm units in production, an in-kind contribution from STFC Daresbury

Laboratory at STFC Daresbury

6.5 Major Machine Systems Advance at ESS Bilbao

As Spain progresses towards full ERIC membership, ESS Bilbao is producing several sub-systems for the ESS LINAC and will deliver the ESS target system, including the target wheel, its shaft and drive unit, as well as the system's enclosing vessel.

Massive RF Power and a Clean Beam

ESS Bilbao is building one of the elemental LINAC systems, the medium energy beam transport (MEBT) line. The MEBT is densely packed with hundreds of sub-systems designed to shape and characterise the proton beam, as well as clean it of unwanted particles, as it moves from the source to the superconducting stages of the Accelerator.

A second key delivery for the ESS Bilbao accelerator team will be the Radio Frequency (RF) systems used to power the normal conducting LINAC at the front end of the Accelerator. Power systems and beam tuning go hand in hand – a clean beam requires the perfectly timed delivery of clean power. ESS Bilbao will deliver a turn-key system for ESS that includes klystrons with their controls and modulators.

Target System Moves Toward Final Design

ESS Bilbao is building the ESS target system, which will generate neutrons for use in scientific experiments at a rate of 10^{18} per second, making ESS the brightest spallation source ever built.

The design and full-scale prototyping of the target system was brought nearly to completion in 2017. The construction of prototypes serves to verify the different steps of the production process, including machining, welding and inspections. This will ensure that the final construction takes place under the strictest industrial quality controls available, and will prepare Bilbao for the next step: the complete design review in 2018.

"We are extremely happy with the work Bilbao is doing. ESS and Bilbao have a good collaboration. They have today a very competent, well-trained, and very good team in Spain."

Mats Lindroos, Head of the ESS Accelerator Division

Inside the ESS Target Station Monolith

6.6 Budapest Neutron Centre Leads Optimisation of ESS Moderator

The European Spallation Source will be the first spallation neutron facility to operate a low-dimensional moderator as part of its target systems. Hungary's Wigner Research Centre at the Budapest Neutron Centre (BNC-Winger), with support from the EU's BrightnESS project, is building a prototype of the ESS moderator test beamline to optimise the novel technology.

The Budapest Neutron Centre hosts the 10 MW Budapest Research Reactor (BRR), a cold neutron facility. The prototype test beamline serves now as a testing ground both to characterise the ESS moderator as well as to develop reactor-based applications of the novel moderator concept.

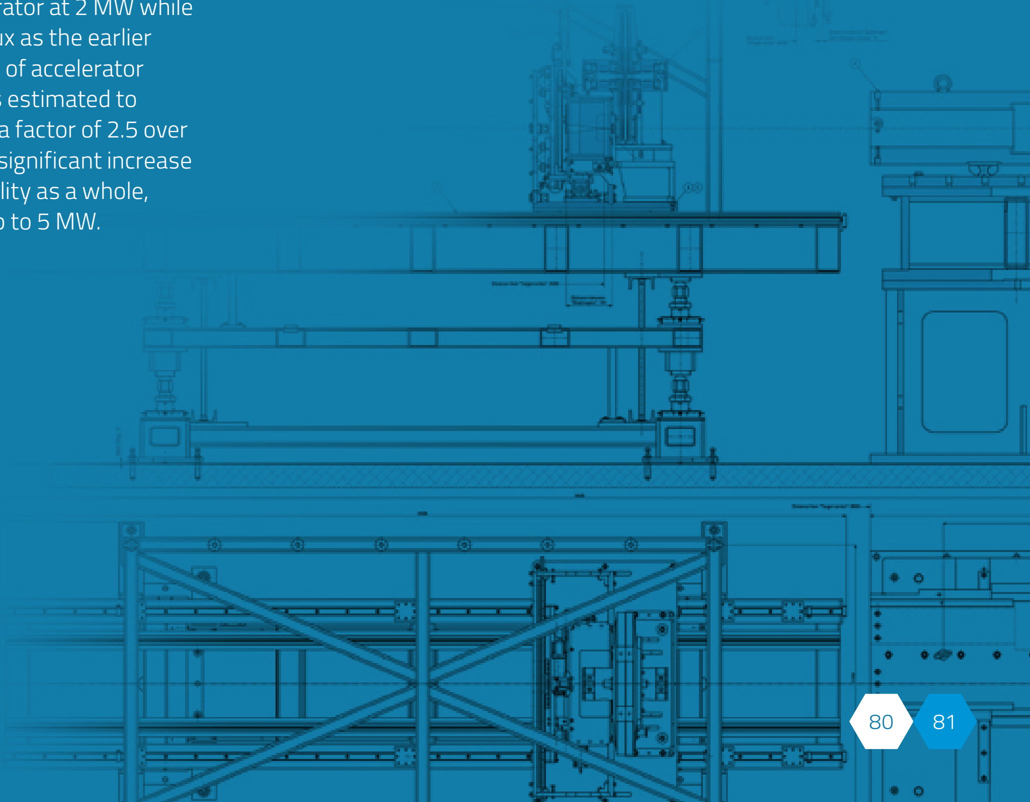
The ESS butterfly moderator will be the central point of neutron extraction for all beamlines at ESS, so its geometry, composition and operating methods must all be optimised to maximise the number of neutrons that can be used by scientists.

The test beamline will be recreated at ESS as the facility's first beamline installation. It is important that the performance of the ESS moderator is fully characterised as soon as neutron production starts at ESS.

Breakthrough improvements in moderator design have already allowed ESS to reduce its initial power consumption by operating the accelerator at 2 MW while achieving nearly the same neutron flux as the earlier design would have produced at 5 MW of accelerator power. The low-dimensional design is estimated to increase neutron flux at ESS by up to a factor of 2.5 over the original 2012 design, leading to a significant increase in the scientific capabilities of the facility as a whole, particularly when the LINAC ramps up to 5 MW.

"As a novelty, these [experimental] scenarios included the option of cooling down the moderator for a few days before the neutron source was switched on. Surprisingly, this systematically led to clearly higher moderator brightness. One of the goals in the testing of the prototype moderator test beamline is to try to understand by observing all details this curious phenomenon that might be also relevant to other neutron moderators at other sources."

Ferenc Mezei, ESS Technical Coordinator



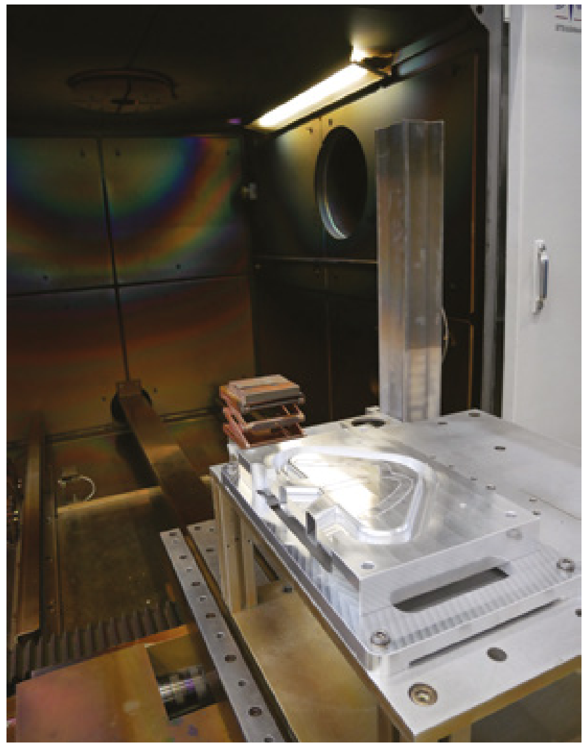
Mirrortron Ltd./BNC-Wigner

6.7 Butterfly Moderator Manufacturing Completed at Jülich

The manufacturing of all three Butterfly V2 cold moderators was completed in December 2017. The first-of-its-kind moderator design was brought to life by ESS in-kind partner Forschungszentrum Jülich (FZJ), where the project was led by Yannick Beßler.

The team at FZJ has successfully electron-beam-welded and leak-tested the three moderator vessels, making them ready for assembly in the Moderator & Reflector Plug. The moderator consists of one pair of mirrored vessels, and the third vessel will serve as a reserve in the event of a testing failure.

The complete Moderator & Reflector Assembly will be delivered as a German in-kind contribution in fall 2018.



Electron welding of the ESS low-dimensional moderator at FZJ

6.8 Twister Shaft Forged in Germany

The ESS Target Division reached a considerable milestone in October 2017 when it took delivery of the moderator twister shaft from its German manufacturer, Saarschmiede.

Designed by in-kind partner FZ Jülich, the five-metre-long, 6050-kilogram stainless steel Target Station component shields cold and thermal neutrons, and acts as a support for target station piping, the beryllium reflector, and the moderator. Beginning with 33,000 kilograms of steel, the lengthy forging and machining processes reduced the steel mass by a factor of nearly five.

The twister shaft was developed to allow replacement of moderator and reflector components as required without dismantling the target wheel. It will be installed parallel to ESS Bilbao's six-metre-long main target wheel shaft.

The twister shaft is born healthy with less than 0,05% cobalt content

6.9 ESS Joins Italian Study to Help Optimise Target Systems

The European Spallation Source is part of an Italian partnership including INFN and the University of Brescia (UniBs) that is researching the ways that intense beams of neutrons will impact some of the non-metallic materials used in the ESS Target Station.

With the unprecedented quantity of neutrons produced in the Target Station, it is critical that ESS select materials that will withstand the conditions produced inside the shielding walls. These materials can include, for example, elastomeric O-rings, lubricant oils and greases, and cable insulators. Past research into the impact of neutrons on these materials is limited.

ESS is supporting the PhD research of Matteo Ferrari at UniBs, whose studies are helping to fill these gaps in the research. This knowledge is necessary for the safe and steady operation of ESS as it will help to predict the expected lifetime of components in operation, thereby aiding ESS to choose the most reliable products.

The experimental outcomes collected so far evidence highly relevant neutron-induced structural modifications in the tested polymers, with some fluid-like compounds dubbed "target grease", referencing the ESS target systems. Some products have displayed strong neutron sensitivity and their use in ESS systems would have been a poor choice, while others clearly exhibit more stable behaviour and can be considered more reliable. In a relatively short space of time, the research teams have produced a number of valuable results. Ferrari presented his findings to the Nuclear Energy for New Europe International Conference in 2017, and the project continues into 2018.

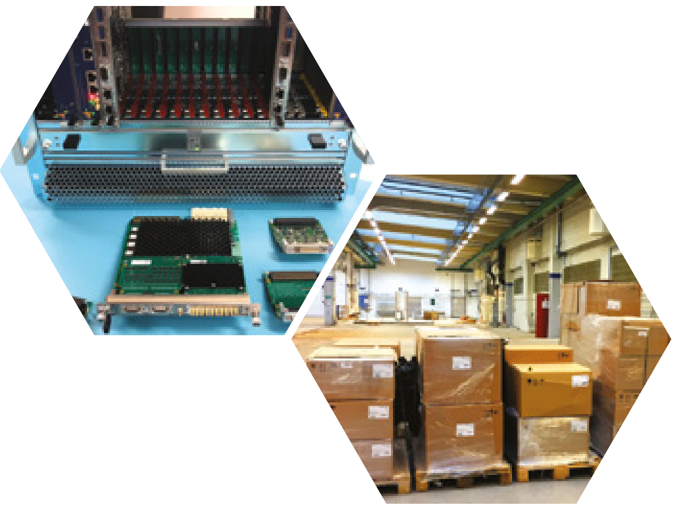
6.10 ICS Deliveries Begin to Roll In as Staff Grows to 50

In 2017, the ESS Integrated Control System (ICS) Division grew rapidly to keep pace with the many other parts of the project with which it interfaces. New recruitments brought the staff to 50 people by the end of the year, including filling the key role of Installation Coordinator.

Preparing for installation was indeed the focus at ICS in 2017 as the year culminated in a number of key deliveries that will be necessary to support machine, instrument and conventional facilities installations over the next few years.

Ethercat Slave Controller FPGA Card Prototype

This in-kind contribution from the Technical University of Talinn in Estonia arrived in November. The purpose of the module is to be able to link MicroTCA-based and EtherCAT-based systems. With the delivery of this important prototype, a phase of test and development can now start that will involve close technical collaboration between staff at ICS and the Technical University of Tallinn.



First batch of MicroTCA infrastructure equipment arriving at the ESS RATS facility in Lund

Local Control Room

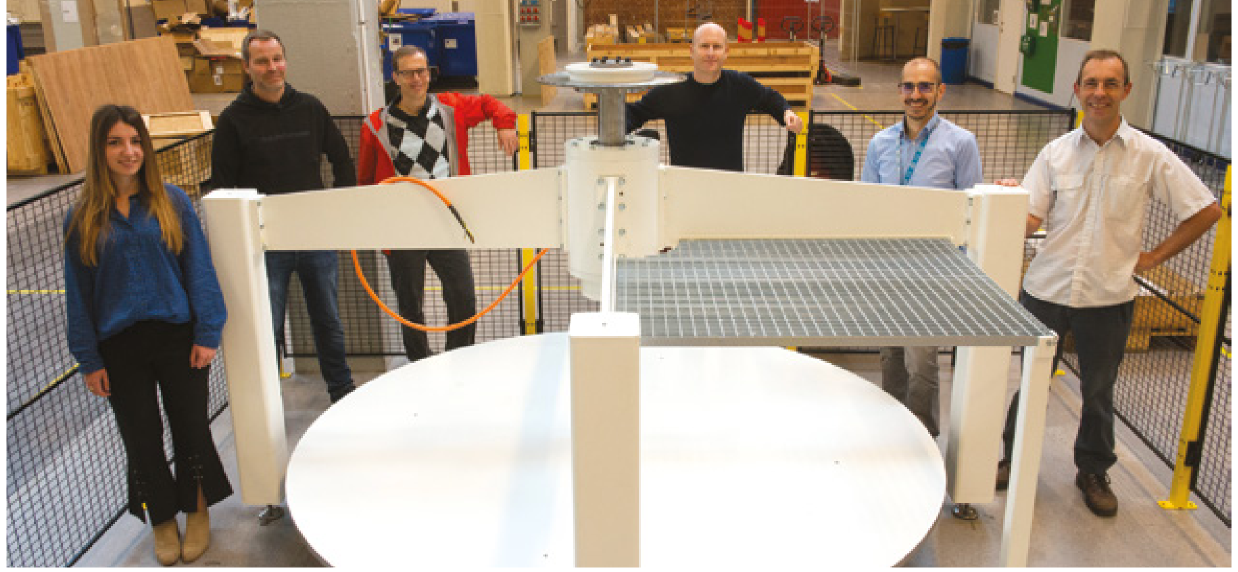
Also in November, ICS delivered the local control room to its stakeholders, in preparation for testing and commissioning of several ESS systems. The local control room will be used to control and monitor the ESS cryogenic plants, Test Stand 2, high voltage systems, and the non-superconducting sections of the LINAC. All systems will be controlled and monitored with the EPICS 7 (Experimental Physics and Industrial Control System) toolkit. The ergonomic layout and design of the room was provided by the Institute for Energy Technology (IFE) as part of the Norwegian in-kind contribution.

Standard High-Performance Controls Platform Deliveries

The first production-level results from an intensive in-kind collaboration between Switzerland's Paul Scherrer Institute and ESS are now materializing in the labs at ICS and for other parts of the facility. This large in-kind project will deliver the bulk of the standard high-performance controls platform, which consists of a MicroTCA-based Advanced Mezzanine Card (AMC) capable of carrying versatile FPGA Mezzanine Card (FMC) modules for high flexibility in control system applications.

Ion Source, LEBT and MEBT Controls

In conjunction with INFN's delivery of the Ion Source and LEBT systems for the Accelerator in December, France's CEA delivered their control systems as an in-kind contribution to the ICS project. ICS is also working closely with ESS Bilbao to develop the control system for the MEBT system.



Model of the Target Wheel, to be used for testing the Control System. From left, ESS staff members Kristina Jurisic, Anders Sandström, Kristoffer Sjögreen, Markus Larsson, Benedetto Gallese and David Brodrick.

MicroTCA Infrastructure

In December, ICS launched a long-researched procurement for MicroTCA infrastructure equipment, including crates, power modules, carrier hubs and more. The delivery, completed in early 2018, will allow for the assembly of 50 MicroTCA-based systems for distribution throughout the project for development and for deployment of already established functions. Further batches are currently being planned in order to complete around 500 MicroTCA systems for ESS.

Installation of Ion Source and Cryoplant Safety Systems

With each system that is installed at ESS, a corresponding Personnel Safety System (PSS) installation takes place. In 2017, ICS began installing such systems for both the cryogenics plant and the Ion Source and LEBT test stand areas, including an Oxygen Deficiency Hazard (ODH) detection system for the cryoplant, and high-voltage discharge switches for the test stand.

6.11 Global Particle Accelerator Community Gathers for IPAC '17

More than 1,400 members of the global particle accelerator community gathered in Copenhagen in May as ESS hosted the 8th International Particle Accelerator Conference (IPAC '17).

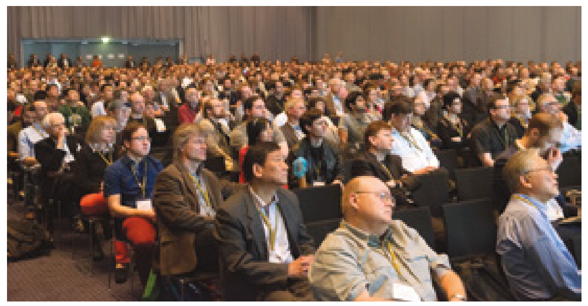
The European Spallation Source and co-hosts MAX IV Laboratory and Aarhus University (AU) welcomed a record number of delegates from 40 nations to Copenhagen's Bella Centre for a full week of programming.

The annual conference has a reputation for a high standard of excellence. At its core is a scientific programme that includes around 100 invited and contributed talks culled from more than 2,000 abstracts submitted by scientists and engineers the world over.

The ESS linear proton accelerator, which is designed to be the most powerful in the world by a factor of five, was at centre stage. Delegates had an opportunity to cross the bridge to Sweden for guided tours of the ESS construction site and neighbouring facility the MAX IV synchrotron.

"Every individual is influenced by particle accelerators, even if they don't know it."

Peter McIntosh, Deputy Director ASTeC Department, Daresbury Lab



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Annual Report 1 January – 31 December 2017

European Spallation Source ERIC
org. no. 768200-0018

Contents

Statutory Administration Report

The Director General of the European Spallation Source ERIC (Organisation Number 768200-0018), with its registered office in Lund, Sweden, hereby submits the Annual Report for the financial year 1 January to 31 December 2017.

General information on the company

The European Spallation Source (hereinafter referred to as "ESS") is an ERIC, a legal form of organisation which the EU has developed to facilitate the construction and operation of major European research facilities. Through the establishment of the European Spallation Source ERIC, ESS has a legal status in all member and observer countries, enabling them to participate in decision-making and directly contribute to the funding. See also Notes, note 2.

ESS will be the world's next-generation neutron source, and will be the most powerful spallation neutron source in the world when it is completed. The facility will be used, among other things, for research on different materials impacting the fields of energy, health and the environment, and will be of great importance in the long-term with regards to competitiveness for European research and industry. Construction is ongoing outside Lund and is scheduled to be completed in 2025; the user programme for researchers is scheduled to begin in 2023, with the facility in full operation by 2026. The project is one of the largest and most high-profile research infrastructure projects in Europe, and is prioritised by the European Strategy Forum for Research Infrastructures (ESFRI).

ESS comprises activities at the facility under construction in Lund, Sweden, and the Data Management and Software Centre (DMSC), which is based in Copenhagen, Denmark. Personnel include employees representing 50 different nationalities.

Collaboration is ongoing with partners from all over Europe and other parts of the world. ESS has 12 member countries: the Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Norway, Poland, Sweden, Switzerland and the United Kingdom. In addition to the member states, three countries currently have observer status until the respective national decision-making process on membership has been completed. Observer countries are Belgium, Spain and the Netherlands.

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

The construction project

During 2017, focus within the Organisation was to maintain the schedule in order to complete the project within the defined cost framework. By 31 December 2017, 43% of the facility had been completed.

Construction work has changed the surrounding area for those living in proximity to the property, including heavy transportation, noise and altered landscapes. Permissible noise levels are regulated by the Environmental Court, and these have not been exceeded over the year. ESS has established specific contact pathways with the local residents to inform them on ongoing and future work, and to receive any possible complaints. No complaints have been received during the year.

During the Construction Phase, rain water and drainage water from excavation pits are diverted to two of the three surrounding drainage companies via a delay magazine located on the property. One of these three drainage companies leads on to Kungsmarken, a Natura 2000 area approximately one kilometre south of the property. This is not used during the Construction Phase. No emissions of significant impact have taken place at the associated drainage companies during the period.

In-kind contributions

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

ESS is currently involved in 19 internationally or nationally awarded contributions (14 European, one regional, and four national contributions), totalling approximately 14.6 M€, including ESS co-financing of 452 k€.

Environment, Safety & Health and Quality Divisions

The Environment, Safety & Health (ESH) and Quality (Q) Divisions play a key role in ESS, and shall assure that safety and quality requirements are implemented throughout the organisation and during the actual construction of the facility. In May, the strategic decision was taken to require CE-marking on all deliveries to ESS. This requirement applies to suppliers, internal deliveries and in-kind partners.

ES&H assures ESS's safety and environmental objectives for personnel and users, as well as the surrounding area. This is done by setting requirements regarding the design, installation, and operation of the facility, among other measures. ES&H follows up on how the requirements are implemented and provides expert support. ES&H has an important duty in coordinating and leading the work in order to obtain the required permits from Swedish authorities. The largest and most important task is the permit for ionising radiation, which is being handled by the Swedish Radiation Safety Authority (SSM). In 2017, ESS was granted a permit from SSM to begin installing equipment that can generate ionising radiation. This was the second permit in the incremental licensing process being undertaken by ESS. The next stage will be to apply for trial operation of the first part of the accelerator. The application will be submitted in 2018, with an expected permit from SSM by summer 2019..

Information on risks and uncertainties

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

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

Risk management objectives

ESS has established the following risk management objectives:

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

Risks and uncertainties

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

Risks are judged from several different perspectives:

Risks related to personal injury

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

Risks related to quality and function

Risks that could potentially impair the quality and thereby the function of technical structures, systems, and components are of great importance to ESS. To handle such risks, ESS has refined existing processes for configuration work during the year, and developed a new set of rules for design and installation work. Processes and systems for quality management and governance have been continuously developed and implemented with an increasing demand, and in consultation with the ESS management team. Since May 2016, ESS has been a member of EFQM (European Foundation for Quality Management), and, through that network, is able to ensure a world-wide analysis of best practice in the area. Significant focus has been on compliance with the European Product Safety Directives applicable to ESS, and that these are also complied with by suppliers and collaborative partners.

Risks related to the environment and the surrounding area

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

Risks regarding society's view of ESS

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

By 2014, ESS had already established a code of conduct based on the 10 principles of the UN's Global Compact relating to human rights, working conditions, the environment, and anti-corruption, as well as the International Chamber of Commerce's rules on combatting anti-corruption. As such, ESS has undertaken to comply with these principles and rules.

The ESS Code of Conduct encompasses all employees and others who have ESS as their permanent or temporary workplace. ESS also requires equivalent codes of conduct of external collaboration partners.

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

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

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

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

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

d) is involved in, or in the past three years has been involved in, a secret agreement; or where the organisation has knowledge of the occurrence of any of the following circumstances:

e) an unfair advantage that may distort competition as a result of the supplier's or tenderer's previous participation in the preparation of the procurement process in accordance with Article 28.4,

f) significant previous shortcomings in the performance of previous contracts awarded by ESS,

g) serious distortion of information submitted as part of a tendering procedure, or

h) if the supplier or tenderer is in bankruptcy, or is subject to insolvency or liquidation, or is in an equivalent situation arising from a similar procedure under the laws and regulations of a state.

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

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

Risks regarding timetable

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

Risks regarding annual operational costs

In order to achieve ESS's overall objectives, a number of requirements related to the annual operational costs are required. Risks in the form of, for example, maintenance and service, energy consumption, downtime, insurance premiums, and/or loss of property have therefore been identified. Plans and cost estimates for ESS's Operations Phase have been developed during the year and will be presented to the ESS Council in June 2018.

Risks related to finances and funding

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

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

Personnel

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

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

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

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

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

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

The diversity of the workforce and an open and appreciative culture are important success factors in a globalised world, and with 443 employees from a total of 50 countries, cultural diversity is a well-established part of everyday life at ESS.

The recruitment rate has remained high. In 2017, 167 recruitments were finalised, and at the beginning of 2018 ESS had 35 open vacancies.

A new performance and development process has been implemented for the development of personnel, and all managers have been trained within the field of handling development and salary discussions.

ESS works with a systematic work environment outlook. Training related to work environment has been completed during the year. This has also been part of the follow-up work of the employee survey carried out in autumn 2016.

The number of sick leave cases has continued to be low in 2017.

Significant events during the year

The move of the employees to the construction site started during the year, and in November a third group moved to the temporary offices established on site. The next 100 employees will move in March 2018, and the relocation of the remaining personnel, as well as technical laboratories, will take place before the end of June 2018.

Construction work with the monolith and instrument halls continues, while installation work is ongoing in the cryo-buildings and in the accelerator tunnel. The ion source has been delivered from Italy and has been installed.

In June 2017, the Council established the "Chair's Committee", which is responsible for preparing the Council's meetings and is part of ESS's governance. The Chair's Committee is not empowered to make independent decisions unless the Council has specifically given a mandate.

Also in June 2017, the Council called upon the ESS management team to deliver a report on resource needs prior to the completion of the design and launch of operational activities. The report was approved by the Council at its 11th meeting in December 2017. The Council agreed on the timeframe for its decision on these issues in 2018.

Spain is expected to become a member in April 2018.

The development of the company's financial performance and position

Net profit for the year amounted to -111 MEUR (-96). The result includes personnel and consultant costs, as well as the administrative and technical infrastructure during the Design Phase.

Shareholders' equity amounted to 331 MEUR (311).

Investments

Investments in buildings and land were made during the year totalling 7.6 MEUR (0), and investments in ongoing facilities amounted to 104 MEUR (101).

Financing and liquidity

During its fiscal year 2017, ESS received contributions from member countries totalling 130.7 MEUR (306). Further information on the contributions received can be found in Note 17. Cash and cash equivalents amounted to 54 MEUR (120) at the end of the period.

〉INCOME STATEMENT

1 EUR = 9 SEK

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Net turnover	-	-
GROSS PROFIT	-	-
Other operating income (Note 5)	6 544	3 701
Administration expenses (Note 7)	-46 364	-42 019
Research and development expenses (Note 7)	-70 743	-57 403
OPERATING PROFIT	-110 563	-95 721
Financial income (Note 8)	0	4
Financial expenses (Note 9)	-462	-332
PROFIT BEFORE TAX	-111 025	-96 049
Tax (Note 10)	-	-
NET RESULT	**-111 025**	**-96 049**

〉BALANCE SHEET

1 EUR = 9 SEK

KEUR	2017-12-31	2016-12-31
ASSETS		
NON-CURRENT ASSETS		
Tangible fixed assets		
Land (Note 11)	7 556	-
Equipment, tools and installation (Note 11)	1 867	1 972
Construction in progress (Note 13)	288 714	184 571
Total non-current assets	**298 137**	**186 543**
CURRENT ASSETS		
Short term receivables (Note 14)	19 574	34 741
Prepaid expenses and accrued income (Note 15)	3 385	2 937
Cash and bank	54 296	119 819
Total current assets	**77 255**	**157 497**
TOTAL ASSETS	**375 392**	**344 040**
EQUITY AND LIABILITIES		
Equity		
Capital contribution (Note 17)	441 832	407 183
Net result	-111 025	-96 049
Total equity	**330 807**	**311 134**
CURRENT LIABILITIES		
Account payables	21 562	22 166
Other liabilities (Note 18)	1 843	1 456
Accrued expenses and prepaid income (Note 19)	21 180	9 284
Total liabilities	**44 585**	**32 906**
TOTAL EQUITY AND LIABILITIES	**375 392**	**344 040**

〉EQUITY

1 EUR = 9 SEK

KEUR	Cash contribution	Previous year result	Net result	Total equity
Opening balance 2016-01-01	37 685	-30 220	-	7 465
Dividend from ESS AB*	93 957	-	-	93 957
Contributions	305 761	-	-	305 761
Net result 2016	-	-96 049	-	-96 049
Opening balance 2017-01-01	437 403	-126 269	-	311 134
Contributions	130 700	-	-	130 700
Net result 2017	-	-	-111 025	-111 025
CLOSING BALANCE 2017-12-31	**568 103**	**-126 269**	**-111 025**	**330 807**

*According to the minutes from the Annual General Meeting of ESS AB (556792-4096), 18th March 2016, the company's purchase price claim on the European Spallation Source ERIC will be distributed to the shareholders, and the Swedish and Danish Government. The debt to ESS AB has since been converted into contributions in the European Spallation Source ERIC, Prop. 2015/16: 1.

〉CASH FLOW

1 EUR = 9 SEK

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
OPERATING ACTIVITIES		
Income after financial items	-111 025	-96 049
Adjustment for non-cash items	600	385
Cash flow from operating activities before changes in working capital	**-110 425**	**-95 664**
CASH FLOW FROM CHANGES IN WORKING CAPITAL		
Increases (-)/Decreases (+) in operating receivables	14 719	-26 627
Increases (+)/Decreases (-) in operating liabilities	11 677	-4 320
Cash flow from operating activities	**-84 029**	**-126 611**
INVESTING ACTIVITIES		
Acquisition of tangible assets (Note 11,12)	-8 051	-1 444
Acquisition of construction in progress (Note 13)	-104 143	-100 561
Cash flow from investing activities	**-112 194**	**-102 005**
FINANCING ACTIVITIES		
Cash contribution	130 700	305 761
Cash flow from financing activities	**130 700**	**305 761**
CASH FLOW FOR THE YEAR	**-65 523**	**77 145**
Liquid assets at the beginning of the financial year	119 819	42 674
Liquid assets at the end of the year	**54 296**	**119 819**

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 annual report is reviewed by auditors in SEK. In this report, all amounts have been converted with the currency SEK 9 = 1 EUR

The company's registered office

European Spallation Source ERIC (ESS) 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

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

Valuation principles

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 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, 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.

Receivables

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

Receivables and liabilities in foreign currencies

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

Short-term investments

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

Financial instruments

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

Leasing

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

Liquid assets

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

Accounts payable

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

Employee benefits

Defined contribution pensions

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

Tax

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

Contributions

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

Cash contributions

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

In-kind contributions

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

Note 2: Associated parties with a controlling influence

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

Note 3: Significant events after the end of the financial year

Following the procurement of the construction of the ESS campus, a contract was signed on 15th February 2018.

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

AVERAGE NUMBER OF EMPLOYEES		
	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
SWEDEN		
Men	264	224
Women	130	111
Total	**394**	**335**
DENMARK		
Men	17	16
Women	5	3
Total	**22**	**19**
TOTAL	**416**	**354**

GENDER DISTRIBUTION IN THE MANAGEMENT		
	2017-12-31	2016-12-31
Management Directors and Director General	3	3
Whereof women	33%	33%

SALARIES, OTHER REMUNERATION AND SOCIAL COSTS		
KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Sweden	27 651	24 877
Denmark	2 060	1 798
TOTAL	**29 711**	**26 675**
Social costs	8 677	7 801
Pension costs	3 901	3 690
TOTAL SOCIAL COSTS	**12 578**	**11 491**
Salaries and other remunerations includes		
- to Director General	349	374
- to Management Directors	425	419

〉ALLOWANCES TO MANAGEMENT DIRECTORS 2017

KEUR	Basic salary	Other benefits	Pension costs	Total
Director General	335	14	84	433
Management Directors (3 pers.)	418	7	103	528
TOTAL	**753**	**21**	**187**	**961**

〉ALLOWANCES TO MANAGEMENT DIRECTORS 2016

KEUR	Basic salary	Other benefits	Pension costs	Total
Director General	350	24	72	446
Management Directors (3 pers.)	412	7	101	520
TOTAL	**762**	**31**	**173**	**966**

Incentive scheme
European Spallation Source ERIC has no incentive scheme.

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

〉FEES AND REMUNERATION TO AUDITORS

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
PWC		
Audit assignments	53	53
Other assignments	120	-
TOTAL	**173**	**53**

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

〉NOTE 5: OTHER INCOME

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Exchange rate gain on receivables/liabilities of operations	1 524	431
Contributions for EU-Grants	4 563	3 055
ESS AB liquidation	386	-
Other income	71	215
TOTAL	**6 544**	**3 701**

〉NOTE 6: LEASING FEES IN RESPECT OF OPERATIONAL LEASES

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Leasing agreements where the company is the lessee:		
Minimum leasing fees	2 158	1 261
Variable fees	38	14
TOTAL LEASING COSTS	**2 196**	**1 275**

CONTRACTUAL FUTURE MINIMUM LEASING FEES RELATING TO NON-RETRACTABLE CONTRACTS WHICH BECOME DUE FOR PAYMENT:		
Within one year	1 204	321
Between two and five years	437	339
TOTAL LEASING COSTS	**1 641**	**660**

〉NOTE 7: DEPRECIATIONS

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Depreciation according to plan by asset:		
Equipment, tools and installation	-600	-385
TOTAL	**-600**	**-385**
Depreciation according to plan by function:		
Administration expenses	-67	-8
Research and development expenses	-533	-377
TOTAL	**-600**	**-385**

〉NOTE 8: INTEREST INCOME

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Interest income	0	4
TOTAL	**0**	**4**

〉NOTE 9: INTEREST EXPENSE

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Interest income	-462	-332
TOTAL	**-462**	**-332**

〉NOTE 10: TAX ON INCOME FOR THE YEAR

KEUR	2017-01-01 - 2017-12-31	2016-01-01 - 2016-12-31
Current tax	0	0
Deferred tax	0	0
TOTAL	**0**	**0**

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

〉NOTE 11: LAND

KEUR	2017-12-31	2016-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	0	-
Acquisitions	7 556	-
TOTAL	**7 556**	**-**

〉NOTE 12: EQUIPMENT, TOLLS AND INSTALLATION

KEUR	2017-12-31	2016-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	2 430	986
Acquisitions	495	1 444
TOTAL	**2 925**	**2 430**
Accumulated depreciation according to plan:		
Beginning of the financial year	-458	-73
Depreciation according to plan	-600	-385
NET VALUE IN BALANCE SHEET 31 DEC 2017	**1 867**	**1 972**

〉NOTE 13: CONSTRUCTION IN PROGRESS

KEUR	2017-12-31	2016-12-31
Accumulated cost of acquisition:		
Beginning of the financial year	184 571	84 011
Acquisitions	104 143	100 560
TOTAL	**288 714**	**184 571**

〉NOTE 14: SHORT TERM RECEIVABLES

KEUR	2017-12-31	2016-12-31
VAT receivables	14 165	10 996
Other tax receivables	1 779	1 779
Contribution from members	3 008	20 949
Other	622	1 017
TOTAL	**19 574**	**34 741**

〉NOTE 15: PREPAID EXPENSES AND ACCRUED INCOME

KEUR	2017-12-31	2016-12-31
Prepaid rental costs	625	488
Prepaid insurance	1 733	1 768
Accrued income EU-project	832	482
Other	195	199
TOTAL	**3 385**	**2 937**

〉NOTE 16: 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 17: CAPITAL CONTRIBUTION

KEUR	2017-12-31	2016-12-31
Czech Republic	3 798	3 221
Denmark	80 135	49 455
Estonia	911	837
France	3 396	-
Germany	95 418	84 848
Hungary	1 576	1 034
Norway	24 266	17 969
Poland	2 643	1 336
Sweden	220 227	156 507
Switzerland	8 593	4 634
United Kingdom	33 183	23 605
TOTAL	**474 146**	**343 446**

〉NOTE 18: OTHER LIABILITIES

KEUR	2017-12-31	2016-12-31
Other	1 843	1 456
TOTAL	**1 843**	**1 456**

〉NOTE 19: ACCRUED EXPENSES AND DEFERRED INCOME

KEUR	2017-12-31	2016-12-31
Accrued vacation salary	2 271	2 119
Employee taxes and social costs	594	549
Accrued salary tax	965	883
Accrued payments for EU-projects	3 530	2 581
Accrued construction and consultancy fees	0	403
Cash in-kind	11 360	1 902
Other accrued expenses and deferred income	2 460	847
TOTAL	**21 180**	**9 284**

〉NOTE 20: CONTINGENT LIABILITIES AND PLEDGED ASSETS

KEUR	2017-12-31	2016-12-31
Contingent liabilities	None	None
Pledged assets	None	None

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

I, the 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.

W. J. W

JOHN WOMERSLEY
ESS DIRECTOR GENERAL

The European Spallation Source ERIC's mission is to build and operate the world's most powerful neutron source, enabling scientific breakthroughs in research related to materials, energy, health, and the environment, and addressing some of the most important societal challenges of our time. 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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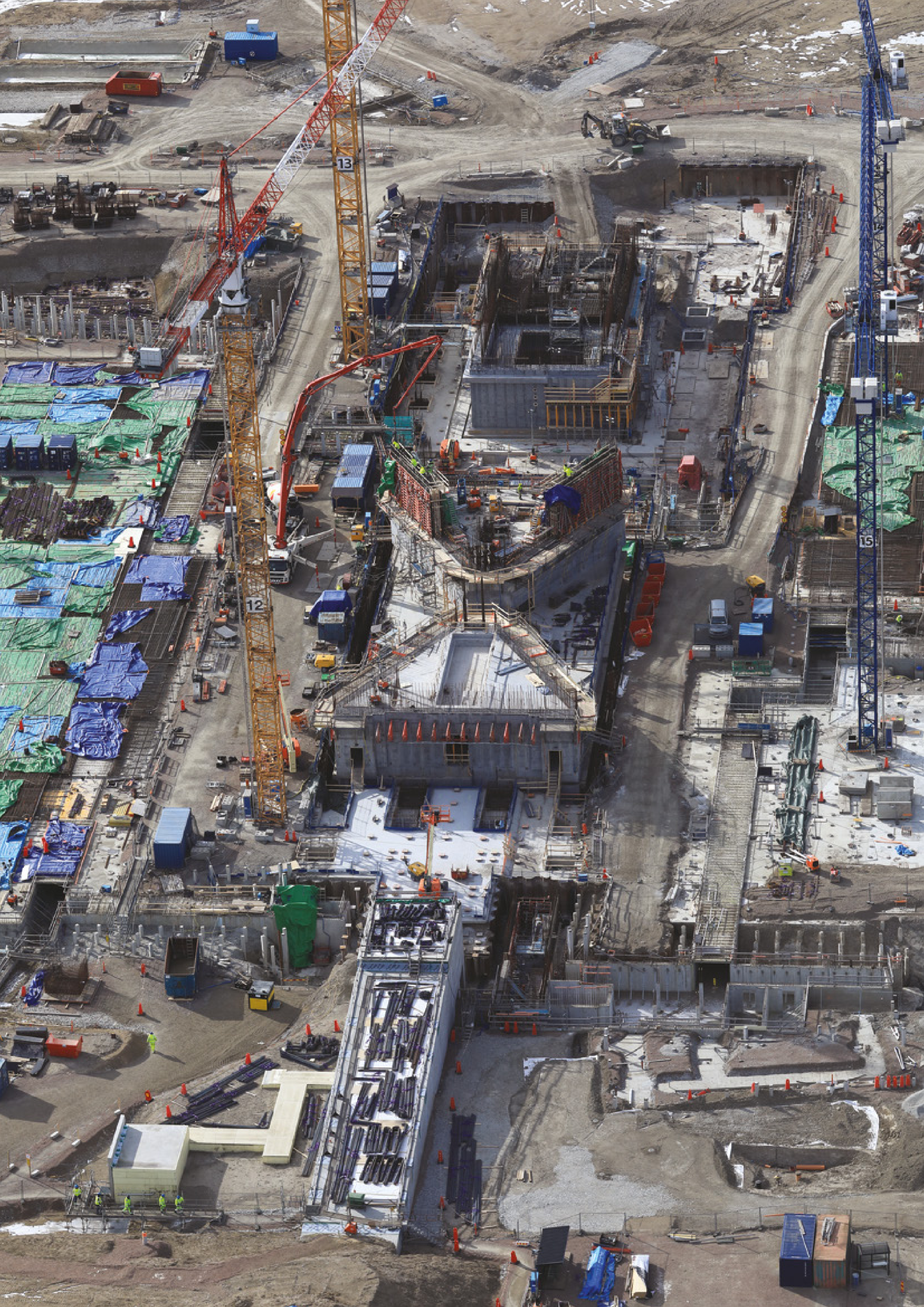
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