European Spallation Source ERIC

Project Progress Report

Q4 Report 2015

Aerial photo of the ESS construction site December 2015

Report due date:
January 2016

James Yeck
Director General European Spallation Source ERIC

Director General Overview

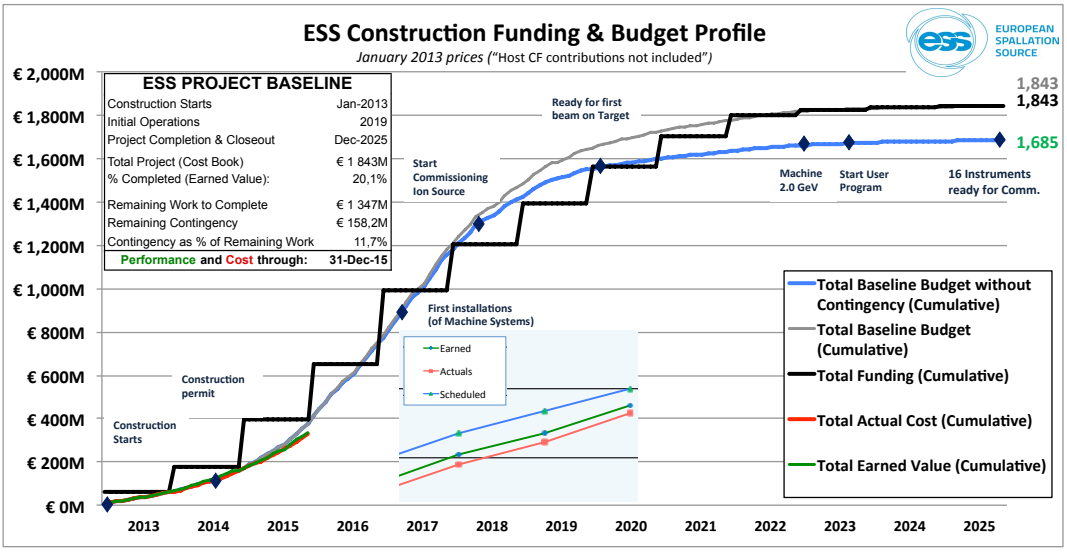
Construction progress is excellent, with Conventional Facilities continuing to set the overall pace for the project. The Accelerator and Target Systems are completing final design and protoyping activities, and transitioning into production activities. The Integrated Control System (ICS) completed a bottom-up replan, under the direction of the new Project Leader, and is seeking additional In-kind partners. The Neutron Scattering Systems project also completed a major revision to their plans, moving to a delivery model where In-kind partners serve as prime contractors for the instruments. All of the projects are now properly positioned for construction, and well advanced in securing the necessary In-kind partners.

ESS transitioned into the European Spallation Source ERIC on 1st October 2015, placing ESS on a solid European legal foundation for the long term. A continued effort will be required to ensure that the legal statutes, rules, and implemention procedures are matched to the mission and needs of the organisation.

Numerous technical and administrative achivements are reported, demonstrating that ESS is no longer only defined by future plans but by hard facts and real physical progress. The major achievement in 2015 was the progress in anchoring In-kind partners with the delivery schedule. Partners are supporting the ESS schedule objectives and are working through administrative and financial challenges to get their In-kind packages launched. In collaboration with partners we are moving forward with Heads of Agreements, contracts for long lead items, side agreements, and the Technical Annexes and In-Kind Agreements necessary to keep on schedule.

One critical issue is the need to prioritise preparation of a quality application to the Swedish regulatory authority for an “Installation Permit”, due May 2016. The permit will cover installation of technical components and commissioning of the warm Linac. Another critical risk mitigation activity underway is to improve the quality and visibility of the integrated schedule. This work will be assessed at the Annual Review in April 2016 and progress reported to Council in June and December.

The chart below provides a status against the construction baseline. A comparison of the resource-loaded schedule to member funding plans indicates a liquidity gap, beginning in late 2016. ESS is pursuing short-term financing to cover this period.



Technical Director Overview

Achievements

- The 12th Technical Advisory Committee (TAC) meeting took place on 14th-16th October, with the TAC Chair reporting to the Council on 22nd October.
- The internal Task Force reviewing the goals and the resources required for the ESS Product Lifecycle Management System (CHESS) reported its conclusions to the ESS Technical Board on 23rd November. The recommendations were submitted to the ESS Management Team (EMT) for a decision on 30th November.
- Standardisation is being improved with the creation of a central reference document. The In-Kind Review Committee (IKRC) was asked for its support, especially given the distributed procurement of components across the partners.

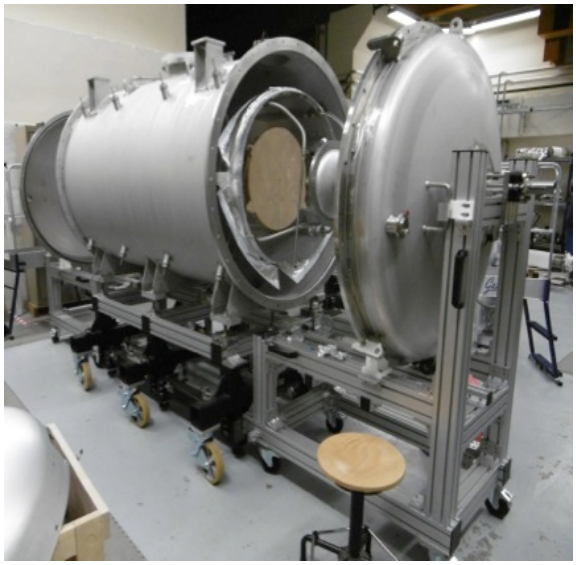
Main issues

- A number of in-kind work packages are on the critical path and must start immediately. Approval and prompt financial support by the concerned ministries is crucial. Finalisation/implementation of procedures for VAT-exemption may also cause delays. 'Ad hoc' solutions, using the ESS cash budget, are being used whenever required to avoid impact on the project schedule.
- Preparation for the "Installation Permit," which includes commissioning of the room temperature part of the linac, from the Swedish regulatory authority is a high priority across ESS and requires significant support and resources.
- Standardisation with multiple in-kind partners is complex. The understanding and support of the partners is essential.
- The decision to reduce the maximum temperature of cooling-water down to 55-60^{o} requires an evaluation of the approach to waste heat recycling. CF will prepare a revised design before the end of 2016.

Accelerator Systems

Achievements

- The new organisation of the Accelerator Division is now operational. All the linac work package leaders and lead engineers now belong to a single linac group, and a dedicated safety group was created.



Blank assembly of the Spokes cryomodule is ongoing

- The dedicated ESS test facility in Uppsala, FREIA, is now fully operational and successfully bench-marked with a CNRS spoke cavity prototype. High-power testing, which can only be done at FREIA, will now begin, and the test of the first spoke cavity cryomodule will start in spring 2016.
- The ESS RF integration test facility at the Lund University is taking shape, with equipment such as a modulator, a klystron and an interlock system on loan from CERN. The equipment is being assembled and a license to operate the klystrons was submitted. The facility will be operational in March, following a safety review.

- All elements of the ESS modulator design were tested successfully; with excellent results for flicker, grid compensation and pulse stability. A complete module capable of driving one klystron will be ready for testing in February 2016. The last remaining part, a tank with 6 HF transformers with rectifiers and filters, is now being assembled. Tendering of the first ESS designed modulators for the normal conducting linac will be launched by ESS-Bilbao in early 2016.
- The order for the Test & Instruments Cryoplant (TICP) and associated equipment was placed at a significantly lower cost than budgeted. There is strong interest from bidders in the three ESS cryoplants (accelerator, test & instruments, and target).
- The first klystron prototype from Toshiba will be tested in early February at the factory, and the test of the first IOT tube from L3 is also planned for February.
- The successful completion of the RFQ CDR2, in December 2015, enabled procurement and manufacturing of the RFQ components to begin.
- The CF team was able to advance the schedule for access to the Front End Building and Gallery, reducing the installation schedule risk for the accelerator.
- Additional staff was added to assist in the writing of the numerous Technical Appendices (TAs) with in-kind partners. A total of 21 TAs are completed, 19 are in progress, and two more are in the pipeline. Two IK Agreements, eight HoAs and seven contracts are signed.

Recent Milestones

Reviews of work package are being replanned, and the finalisation of a number of Technical Annexes is slower than expected. This is without consequence to the 'end of 2019' milestone, ready for beam on target, which is a major ESS project milestone.

The main, planned design reviews were completed. No significant technical issues were found. Recommendations are being followed up by ESS, the responsible in-kind collaborators, and vendors. These were:

- Preliminary Design Review for the Linac Warm Units (LWUs),
- Critical Design Review for the Beam Delivery System
- Second Preliminary Design Review for the Accelerator Cryoplant (ACCP),
- Critical Design Review for the Toshiba klystron prototype,
- Contract Detailed Design Reviews for the L3 and CPI-Thales IOT prototypes,
- Second Critical Design review for the RFQ from CEA-IRFU.

Recent and upcoming milestones

Name	Current Forecast	Delay (W.Days)
LEVEL2. Spoke cryomodule prototype available for Uppsala test stand (Freia)	**01.01.16**	**-21**
LEVEL2. LEBT assembly starts	**07.01.16**	**-60**
LEVEL2. Cryo-Distribution System Elliptical production starts	**22.02.16**	**-24**
LEVEL5. Thales Klystron Prototype Delivered	21.03.16	0
LEVEL5. Successful tests of a cavity + coupler in (HNOSS)	01.04.16	0
LEVEL5. Toshiba Klystron Prototype Delivered	19.05.16	0
LEVEL2. RFQ machining starts	**25.05.16**	**0**
LEVEL5. CPI Klystron Prototype Delivered	01.06.16	0
LEVEL5. Prototype Spoke valve box design validated	01.07.16	0
LEVEL5. Medium Beta Cavity design frozen	15.09.16	0
LEVEL2. CPI/Thales and L3 IOT prototypes delivery	**09.09.16**	**0**
LEVEL2. Ready For Installation (RFI) SPK High Power Amplifier - 1st unit	**24.11.16**	**0**
LEVEL2. Spoke & MB CM production launched.	**23.12.16**	**0**

[The finalisation and agreement on the content of the Technical Annexes with the in-kind partners will result in modifications to various intermediate milestones, with the goal of avoiding any impact on final delivery dates of the accelerator project components. The "delays" presented are only indicative.]

This official list of milestones is reassuring, however, there are many risks, which are commented on below as "issues". The latest news from L3 is that the IOT prototype will be available four months early and the current forecast from CPI-Thales is that their prototype device will be one month late.

Main issues

- There is a risk of delays in critical path work packages if in-kind partners do not receive adequate funding on time (e.g. cryogenic distribution line from Poland, DTL fabrication and High Power Amplifiers from Italy). Until now, the necessary design and prototyping work has continued under existing contracts or in advance of final signed agreements and released funds by national governments. However, as we move into 2016, high-value procurements will need to be made.
- A solution for VAT-exemption must be found quickly to avoid delaying work packages on the critical path (e.g. RFQ).

Target Station

Achievements

- Three additional partners were secured for in-kind packages [Primary Water Cooling System (CZ), Secondary Water Cooling Systems (CZ), Ventilation & Confinement (CZ)]. Partners are now selected for 16 of the 22 work packages.
- A Collaboration Agreement was signed with DTU (DK) for the Tungsten Release Factor Experiment, and work on this task is proceeding according to schedule.
- Joint work is actively taking place with partners - ESS-Bilbao for manufacturing tests of the target wheel vessel and kick-off meeting for the monolith vessel, and FZJ for prototype manufacturing of the moderators.
- Orders were placed for the Target Safety System test stand hardware.

- The analysis of a bounding accident scenario, stopped ventilation in active cell, is complete and the analyses for other bounding accident scenarios are under way.
- The first Critical Design Review for the Target Project – Part 1 of Active Cells was conducted, and procurements were placed for concrete embedments.

Recent and upcoming milestones

Name	Current Forecast	Delay (W.Days)
CDR Active Cells embedded parts	09.10.15	0
PDR Monolith Vessel	12.11.15	-160
Delivery on Site - Embedments in Active Cells Floor	27.04.16	-17
Award Helium Cryoplant Contract	27.04.16	-48
Award contract for tungsten spallation material	19.10.16	-16
Delivery on Site – Stainless Steel Liner Plates	01.02.17	0

Hardware to be embedded in the concrete floor of the Active Cells located within the Target Building will is scheduled for delivery to the site by 27th April 2016. The Critical Design Review for these early procurements was held on 9th October, and the forecast date for delivery of these components on site shows a 17-day delay, but this does not negatively impact the CF schedule. The helium cryoplant shows a 2-month delay in the forecast date, but this does not place this activity on the critical path. The monolith vessel Preliminary Design Review was six months behind schedule, due to our limited engineering design resources being assigned to higher priority systems. This delay does not significantly impact forecast dates for higher-level milestones.

Main issues

- High priority is given to the completion of the Design Basis Accident analyses to provide the documents and information necessary in time for the next ESS permit application to SSM.
- FZJ will soon be forced to pause or delay some of its work on the Modulator and Reflector due to a lack of funding. ESS and FZJ developed mitigation measures to allow FZJ to continue working and avoid a delay in the Target Project schedule, as this work package is on the ESS critical path.
- There is a risk of schedule slippage due to the complicated interface between Target Building construction and the installation of Target System components. Mitigation efforts include integrating and refining the CF and Target schedules.

Integrated Control System

Achievements

- The Integrated Control System (ICS) project continued to strengthen the project organisation during the quarter. A deputy project manager and a software group leader were recruited and are now active. In addition, a long awaited specialised safety engineer was recruited and will start in February 2016. The operational model for the division was defined and communicated, which will help overall understanding of responsibility, mandate and prioritisation in the project.
- A comprehensive replanning and coordination effort progressed, under the leadership of the new deputy project manager. In particular, the ICS software scope, currently more than 40% of the ICS budget, is being intensely scrutinised.
- The first actual in-kind agreement for ICS was signed with Norway in October.

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

Main issues

- The definition of the full implementation plan for the ICS project is a priority, and crucial for establishing a roadmap and other decision-supporting documents.
- The in-kind goals and implementation are a challenge for ICS, and efforts are underway to improve the in-kind opportunities.

Engineering and Integration Support

Achievements

- Increased focus on common goals related to ESS-wide strategies for technical processes and standardisation. A clear path forward is set for the ESS Project Information Management and its related tools (CHESS-based PLM), and is reflected in delivery milestones for 2016.
- Strategies related to ESS standardisation are agreed across ESS and a detailed project-plan is underway, using the annual review in 2016 as leverage. A number of handbooks, guidelines and templates already exist or are well advanced.

Main issues

- The largest concern is the timeline to fully integrate the requirements from the Swedish radiation safety authority into the technical discipline handbooks.

System Engineering

Achievements

Major efforts continue to be invested in the preparation of the application for the "Installation Permit" in spring 2016:

- The planning of the remaining radiation safety studies will soon be completed.
- The structure of the permit application and the supporting documents, e.g., the ALARA procedure, were finalised in collaboration with the ES&H division.
- The approach for classifying radiation safety important components is defined.

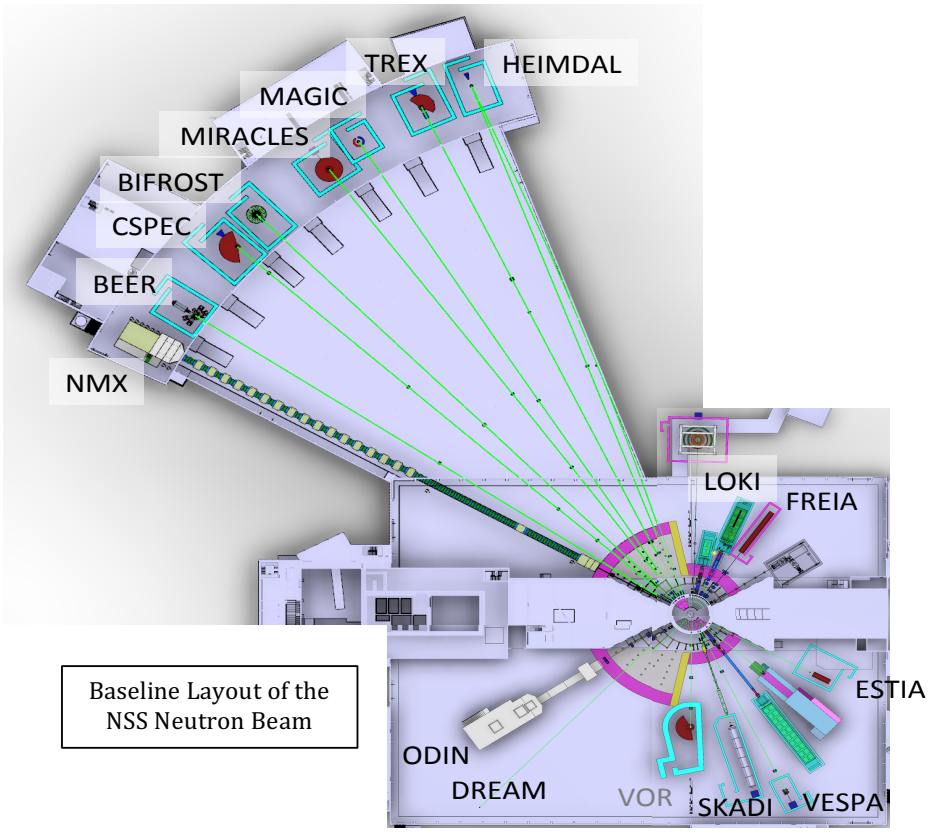
User needs related to requirements, verification, and PBS management were collected and handed over to the PLM system implementation team.

Science Director Overview

Building on the decisions for the first 16 instruments, taken by the Council in October, the NSS Project is now focusing on getting additional instrument projects into the preliminary engineering design phase (Phase 1). Progress in Phase 1 will provide the basis for decisions on the budget allocation for each instrument, as well as on the sequence and timeline of their construction. In parallel, intense work is being conducted to finalise the beam-port allocation of the 16 instruments, and to integrate the software of all partners into a common approach. A number of external grants help to take some pressure off the NSS budget by mitigating technology and software development risks.

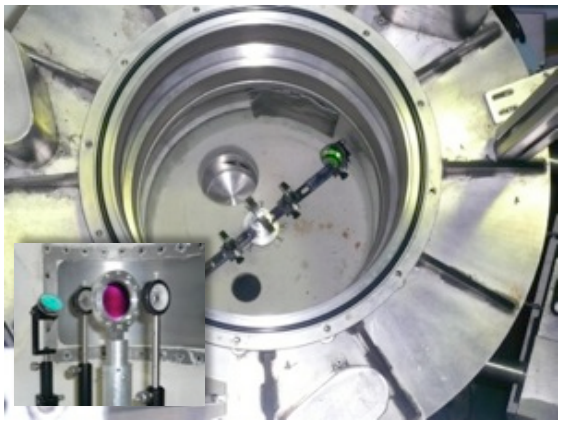
Neutron Scattering Systems

In October 2015 the European Spallation Source Council endorsed the initial 16-instrument suite that had been developed through years of joint efforts with the community. The general plan for sequencing these instruments was discussed with the Science Advisory Committee (SAC) in September and also endorsed by the Council.



Baseline Layout of the NSS Neutron Beam

With the suite defined, the NSS project team, our instrument build partners and other ESS staff worked together to establish an instrument lay-out for the facility with the main priority to provide the best outcome in terms of performance and operability for instruments 1-15, and the two options for instrument 16. The benefits of the proposed layout are brought by having fewer mechanical interference areas, which reduce both complexity and cost during construction phase, and associated costs in the operational phase during maintenance. At the same time, the number of useable beamports for future instruments is maximised in balance with the performance of the suite. The beam-port allocation enables us to move forward into more detailed planning of the experimental halls and the bunker design.



The University of Tartu in-kind sample-environment for photosynthesis research is being tested at the ILL instrument IN5. The sample (purple) is activated by double pulses while in the neutron beam.

A comprehensive coordinating effort was conducted in preparation for entering several instrument projects into Phase 1 (Preliminary Engineering Design) during 2016. This involves the Instrument Technologies, Science Support Systems (SSS), and DMSC teams, who are liaising with the instrument teams in order to support the upcoming activities. SSS is prioritising the development of reliable and useful sample environment for the first instruments, and are establishing workspaces for prototyping and testing. Meanwhile, the work of identifying in-kind partners and establishing technical annexes for NSS continues.

The ESS Integration Project was set up by DMSC with the Integrated Control Systems (ICS), SSS, the Motion Control and Automation and Chopper groups. The goal is to set up a test laboratory in Lund for software integration between ICS (the ESS timing and EPICS networks), the EPICS Input-Output Controller software developed by the technical groups and their in-kind partners, and the software developed by DMSC and their in-kind partners.

NSS is benefiting from a number of external grants, covering some deuteration and mechatronics activities at SSS (SINE grant), some detector work (BrightnESS and SoNDE grants), and DMSC projects (SINE and BrightnESS). These programmes involve collaborations with other facilities across Europe; such as ISIS, ILL, MLZ, SINQ, LLB, PSI and Elettra.

Conventional Facilities Overview

Schedule and cost

The schedule emphasis in Q4 2015 was the integration of the Conventional Facilities schedule with the Target Station schedule for the works in Target Building. An integrated construction/installation schedule will be presented in the beginning of February 2016. Also, the access milestones for the Cryo Building for Accelerator Systems was defined and agreed. Conventional Facilities requested a contingency budget in Q4, due mainly to unforeseen costs for piling due to higher stability requirements for earthquake demands. Actual expenditures in Q4, and for 2015 in total, were lower than planned, in part due to rescheduling work to accommodate delays in establishing the final piling requirements.

Design – Baseline Team

The Baseline Team programme for Target & Experimental halls was changed in order to be able to capture SSM-related requirements (Strålsäkerhetsmyndigheten, Swedish Radiation Safety Authority). However, there is still a large risk that new SSM-related requirements could result in additional changes.

For the Accelerator buildings, the focus is on preparing the format for agreements with our stakeholders. Much effort was placed on structuring the security work, in order to improve Baseline Team programme efficiency and collaboration with Environment, Safety & Health Division.

Design – Detailed Design Team

A detailed design for the Logistics building has started: structural and architectural designs for the Cryo and the Central Utilitity Building (CUB) buildings are finished. The Mechanical, Electrical and Plumbing (MEP) services were released from "on hold" for the Accelerator buildings. A detailed design for the foundations, superstructure and roof of Target and Experimental Hall buildings is continuing on these critical path items. A design for the foundation of the Experimental Hall is finished, and piling of the foundation has started.

Construction

Progress on the Linac tunnel, as well as the HEBT loading bay and Front End building, was good, and the scheduled completion of the concrete works by March will be achieved.
The installation of Large Diameter Bore piles for the monolith commenced in November. During November and December 18 of the 42 Large Diameter Borde piles for the monolith were completed, making it possible to start the concrete works for the monolith by April 2016.

The concrete piling for the Experimental Halls has made good progress, with more than 3,000 piles have been installed, which is >50% of the total piles.

Campus Offices and Labs

The offices and laboratories located in the campus area on the ESS site are not included in the Conventional Facilities construction budget and are planned to be leased facilities. An annual lease budget of 4 M€ is included in the ESS annual operating cost of 140 M€ (2013 pricing). Crucial progress was made on the Campus project, both concerning the final scope and space distribution for the control room, lab and workshops, and office layout, and in the preparation of the next step in the design process with the main architect. There is also progress concerning possible financial models and sourcing. The final decision concerning the financing will be made in June 2016, and the procurement process of the design/construct contract will need to be adjusted to accommodate the final financing model.

Project Support and Administration Director Overview

During the fourth quarter, the transition from ESS AB into the European Spallation Source ERIC was successfully executed.

The Council approved the proposed annual budgets for 2015 (in October 2015) and 2016 (in December 2016). The long-term financing of the project and corresponding construction plans and delivery schedules require a solution to the forecasted liquidity gap arising in Q4 2016. Construction income is expected to exceed expenditures again in 2019, and the liquidity gap is expected to be eliminated by 2023. Different options for addressing the issues related to the liquidity gap are being explored, and preparations are being made to present a proposal to the Council in Q2 2016.

The Council decided to establish a Committee for Employee Conditions, replacing the former Remuneration Committee under the former ESS AB. The committee will report to the ESS Council, with the remit to advise on employment and compensation related issues. The long-term goal is to ensure that ESS labour costs are consistent with the needs of the organisation and supported by the Council.

End of the year negotiations were initiated with SKB, the Swedish Nuclear Fuel and Waste Management Company, to find a sustainable solution for the handling of radioactive waste.

During December, the first phase of the workplace design project for ESS Campus Offices and labs was concluded with user cases, a survey, and focus group interviews. The work of further detailing the requirements will continue during Q1 2016, and will be the basis for the preliminary design of the future buildings.

In October, General Services developed a business case for the short-term office planning. Since the decision is that ESS' offices will remain in the current location for now, it was decided to further expand the current offices to ensure enough space before parts of the organisation are ready to start moving to the site. In parallel, the work of finding a long-term solution for the DMSC future offices started, and a request for tender was launched before the end of the year.

The Supply, Procurement and Logistics Division at present deals with >100 new procurement requests per month for goods, services and consultants, and this is constantly ramping up.

External Grants summary

The Policy for EU and National Grants that was introduced in spring of 2015 defines the objectives for the involvement of ESS in grants. This policy was complemented by Grant Management Procedures, which define the principles that need to be respected when applying for and implementing grants.

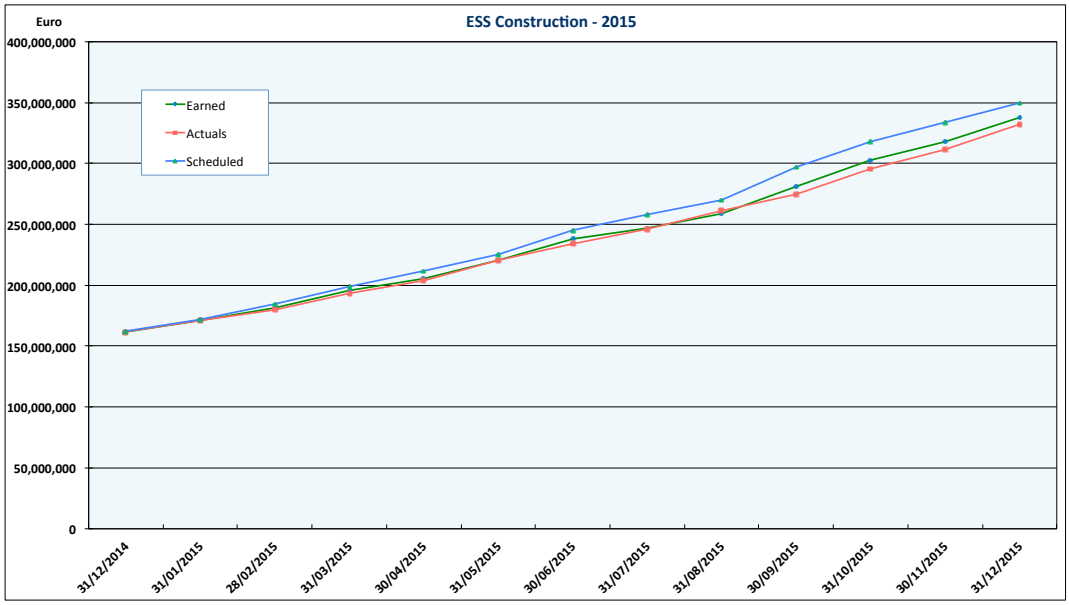
ESS is currently involved in 14 international or national grants (nine European grants, two regional grants and three national grants) with a total volume of approximately 13.6 M€, including ESS co-funding of 495 k€. A detailed overview of all current international and national grants is provided below.

The funding schemes include the EU Framework Programmes for Research and Innovation 7th Framework Programme (FP7) and Horizon 2020, Interreg activities, as well as support from the Swedish funding agencies VR and Vinnova. The FP7 grants with ESS involvement started in 2011 and will finish in the next few months. Approximately 120 partners are included in all grants. The largest project, led by ESS, is BrightnESS; a partnership of 18 partners with a total budget of 19 941 M€ (ESS Budget 9.8 M€). An overview of all external grants can be found in Annex 4.

Cost/Performance Overview

Current trends in earned value measurement (EVM) indicate that ESS is slightly behind schedule and that the activities performed overall are costing somewhat less than planned. There is no question that some work is behind schedule, and the priority is to avoid delays in critical path activities that might jeopardise the overall ESS delivery schedule. It is unlikely that the positive cost performance will result in substantial savings, as most of the measured difference between the budgeted cost and the actual cost of work performed is a consequence of delays in invoices and payments on contracts. The EVM performance is reviewed in the projects, and for all the projects combined every month after the close of the previous month's accounting.

Activities to mitigate potential delays and seek cost savings are being pursued. The external delivery milestones and the total construction budget remain valid.



Annex 1 provides more detailed information on Cost Performance Status, Risk and Contingency status, Cost Baseline change log, level 2 Baseline Budget Status and Contingency as % of remaining work.

Upcoming Events January 2016 – March 2016

Swedish Research Council Reference Group on ESS, Lund	20th January
Accelerator Technical Board, Lund	28th January
French Accelerator Kick-off Meeting, Paris	3rd February
Partner and Industry Day, Paris	4th & 5th February
European Spallation Source ERIC Council Meeting, Malmö	12th February
IKON 10 Collaboration Meeting, Düsseldorf	16th - 18th February
In-Kind Review Committee Meeting, Kastrup	18th February
Visit by Belgium SCK/ŸCEN Board to ESS, Lund	3rd March
Instrument Collaboration Board, Cph.	7th March
6th Industrial Liaison Officers Meeting, Lund	8th March
Publication of new ESFRI Roadmap, Amsterdam	10th March
Target Technical Board, Cph	16th March
Accelerator Technical Board, Lund	17th March

Annex 1: Cost/Performance Status

The construction budget is 1 843 M€ in 2013 prices. The indexed budget is 2 013 M€ (n.b. In-kind not indexed). All cost and schedule performance data using earned value management (EVM) is based on indexed values.

The project is 20.1% complete versus the plan of 22.5% complete, measured using earned value techniques. Remaining contingency is 166.8 M€, and the contingency as a percentage of remaining work is 11.7%. There were no changes to the original construction contingency budget during the initial construction years; 2013, 2014, and 2015. As part of the 2016 budget process, ESS proposed allocation of appoximatly 15.4 M€. The contingency at 166.8 M€ is above 10% of the cost of the remaining work – current level 10.6%. A project management objective is to keep the contingency budget above 10% of the remaing work budget, in support of the overall goal of completing the ESS construction project within the approved cost baseline.

The Cost-Schedule Status Report (CSSR) for the ESS Construction Project through December 2015 is shown below.

ESS PROJECT PERFORMANCE REPORT

WORK BREAKDOWN STRUCTURE

PROJECT	FROM 2015-10-01	TO 2015-12-31

PERFORMANCE DATA

Total Project.EPS	CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
	BUDGETED COST		ACTUAL	VARIANCE		BUDGETED COST		ACTUAL	VARIANCE		BUDGETED	ESTIMATED	VARIANCE
ITEM	WORK SCHEDULED (Planned Value)	WORK PERFORMED (Earn Value)	COST WORK PERFORMED (Actual Cost)	SCHEDULE (=EV-PV)	COST (=EV-AC)	WORK SCHEDULED (Planned Value)	WORK PERFORMED (Earned Value)	COST WORK PERFORMED (Actual Cost)	SCHEDULE (=EV-PV)	COST (=EV-AC)	(Planned Value)	(EAC)	(Cost Variance)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)
Project Support & Administration	4 921 855	4 639 827	5 184 776	-282 027	-544 949	54 968 697	54 985 699	55 909 952	17 002	-924 253	138 343 112	139 301 054	-957 941
Conventional Facilities	24 311 104	25 581 175	28 155 439	1 270 070	-2 574 264	136 851 233	133 618 363	130 553 778	-3 232 870	3 064 586	558 897 020	557 303 468	1 593 551
Accelerator Systems	11 490 742	16 423 840	13 928 094	4 933 098	2 495 746	75 152 899	72 196 114	68 654 258	-2 956 785	3 541 856	511 898 470	508 458 018	3 440 452
Target Station	3 000 188	2 510 840	2 925 733	-489 349	-414 894	17 807 510	15 891 916	17 893 753	-1 915 594	-2 001 837	161 965 286	164 155 253	-2 189 967
Integrated Control Systems	1 585 931	1 225 094	1 463 474	-360 837	-238 380	12 137 412	11 067 385	11 807 100	-1 070 027	-739 714	79 573 885	80 915 942	-1 342 057
Technical Management & Services	2 299 856	2 172 904	1 783 237	-126 951	389 668	17 283 703	17 155 826	14 792 319	-127 877	2 363 507	39 526 618	37 171 659	2 354 958
Neutron Scattering Systems	4 847 841	4 212 734	3 923 573	-635 108	289 161	35 254 873	33 135 500	32 260 096	-2 119 373	875 404	361 907 243	357 812 331	4 094 912
TOTAL	**52 457 517**	**56 766 413**	**57 364 324**	**4 308 896**	**-597 911**	**349 456 327**	**338 050 804**	**331 871 255**	**-11 405 523**	**6 179 550**	**1 852 111 633**	**1 845 117 726**	**6 993 908**

Schedule Variance (BCWS-BCWP): The trend for the accumulated schedule variance is improving, and the accumulated schedule variance at the end of December 2015 is -11 405 k€ compared to -19 135 k€ in September. The meaning of the negative schedule variance is that the Budgeted Cost for Work Performed (BCWP) is lower than Budgeted Cost for Work Scheduled (BCWS), indicating that less work is being performed than planned. The implication of this, should this trend continue, could lead to a schedule delay

.

The variance is related to Conventional Facilities (-3 233 k€), Accelerator Systems (-2 957 k€), Neutron Scattering Systems (-2 119 k€), Target Station (-1 916 k€), Integrated Control System (-1 070 k€) and Technical Management & Services (-128 k€). Project Support & Administration has a minor positive schedule variance (+17 k€).

There is a schedule variance for Conventional Facilities and Target Station that could correspond to a delay of up to five months. However, ESS still believes that it is possible to recover these delays and replanning and optimisation of the schedule is ongoing. The current expectation is that there will be no slippage in the final Conventional Facilities delivery date, or the date when the target will be ready for beam milestones.

Cost Variance (BCWP-ACWP): The accumulated earned value cost variance at the end of December 2015 is +6 180 k€, which is more or less inline with the accumulated cost variance in September of +6 961 k€. The meaning of the positive cost variance is that Budgeted Cost for Work Performed (BCWP) is higher than the Actual Cost for Work Performed (ACWP), indicating that the work performed costs less than planned. The implication of this, should this trend continue, could lead to a lower total cost.

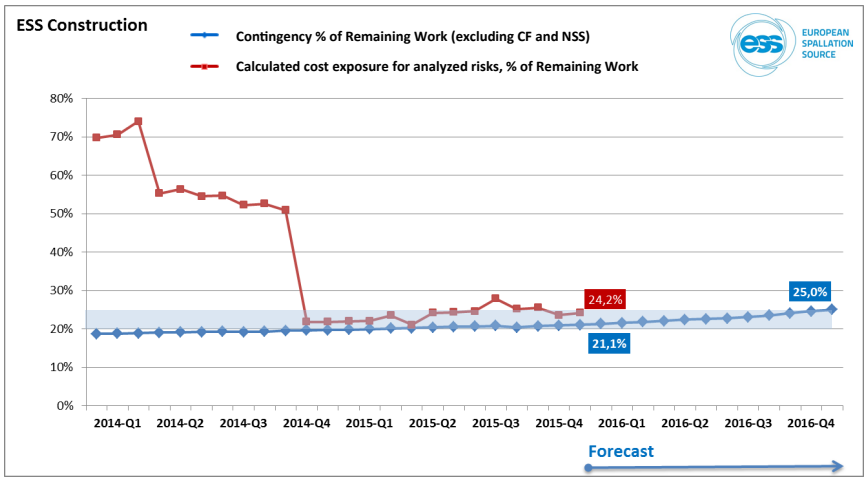
The positive cost variance is mainly related to Accelerator Systems (+3 542 k€), Conventional Facilities (+3 065 k€), Technical Management & Services (+2 364 k€) and Neutron Scattering Systems (+875 k€). There is also a negative cost variance for Target Station (-2 002 k€), Project Support & Administration (-924 k€) and Integrated Control System (-739 k€).

There is a positive cost variance, and if the trend continues this could lead to a lower total project cost. It should, however, be noted that the work for Target was at higher cost and most of the negative Cost Variance in this areas is unrecoverable. This is most likely also true for Project Support & Administration and Integrated Control System. Cost savings will be sought in all areas, either through value engineering efforts or through cost scrubbing to hold the baseline budget.

Risk and Contingency Status

The graph below shows the calculated risk exposure for identified and analysed risks, together with the contingency as a percentage of remaining work budgeted, excluding the Conventional Facilities (CF) and Neutron Scattering Systems (NSS) projects (CF risk is assumed as a contribution of the Host Countries and the NSS budget is ring-fenced with risk and contingency managed within the fixed budet). The current contingency budget, excluding CF & NSS, is 21.1% of the remaining work budgeted. The goal is to stay within the calculated risk exposure range of 20-25%. The current risk exposure is calculated at 24.2%.

The drop in calculated risk exposure in 2014 is a consequence of the successful approval of construction permits and finalized work to define interface descriptions and specifications. Calculated cost exposure does not include risk of delays in external delivery milestones and/or funding for initial operations.



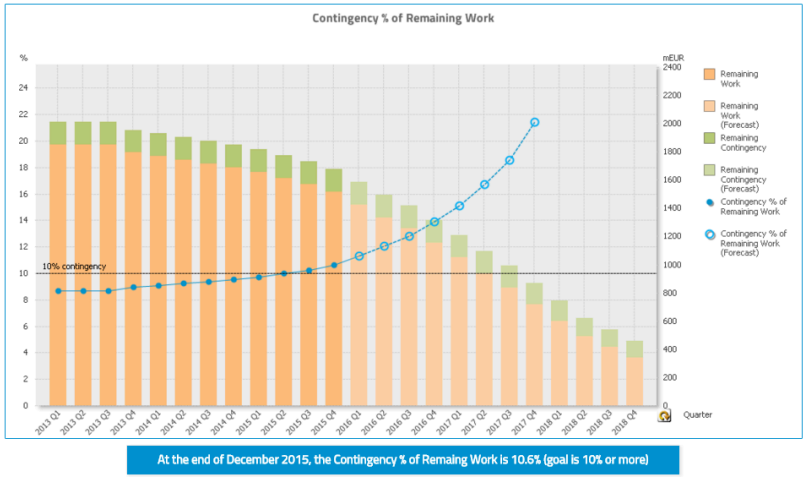
Change Log – ESS Total Project Budget Baseline (k€) - 31st December 2015

CR No.	Project	Description	Total Amount (k€)	2016 Amount (k€)
CR0001	ESS Project (ES&H)	Increased fees to be paid to Swedish radiation regulatory authorities.	-840	0
CR0018	Target	Changes to accommodate improved design of the moderator/reflectors in the Target.	-4 040	-1 300
CR0019	ICS	Oxygen depletion and radiation monitoring for personnel safety system.	-2 000	-250
CR0026	Target	Addition to accommodate a potential future ESS chip irradiation (ECHIR) beam line.	-125	0
CR0029*	Accelerator	Cryomodule to Cryogenic Distribution System Connections.	-750	0
CR0030*	Accelerator	Lund Cryomdule Test Stand Activities (WP10).	-1 310	0
CR0031	ICS	Budget transfer from Accelerator to ICS for IPNO work.	-2 500	0
CR0032*	Accelerator	Accelerator Cryoplant cost savings based on actual contract award.	+8 350	0
CR0033*	Accelerator	Radio Frequency (RF) integration laboratory work.	-500	0
CR0041	Design & Engineering	Scope for development, integration and implementation of Product Lifecycle Management (PLM) system.	-4 000	0
CR0044	ESS Project (Insurance)	Insurance costs covering risks associated with installation of equipment.	-1 600	0
CR0040	ESS Project (ES&H)	Additional cost for rad waste licensing (200 k€). Scope originally planned for Initial Operations in 2017-18 (1000 k€).	-1 200	0
CR0042	ESS Project Support (In-Kind)	Increased scope and level-of-effort for supporting partners and coordinating in-kind.	-594	-594
CR0045	ESS Project (Administration)	Orphan scope - Rent for DMSC office in Copenhagen during construction phase.	-1 332	0
CR0043	ESS Project (Technical/Admin)	Increased scope and level-of-effort to cover establishment of and Internal Auditor, Operations Coordinator, and Technical Coordinators.	-2 304	-360
CR0046	ESS Project (Administration)	Increased scope for Project Support & Administration due to ERIC VAT-administration and Legal support for in-kind agreements and IPR-issues.	-692	0

** Accelerator CR's already introduced in the Accelerator budget*

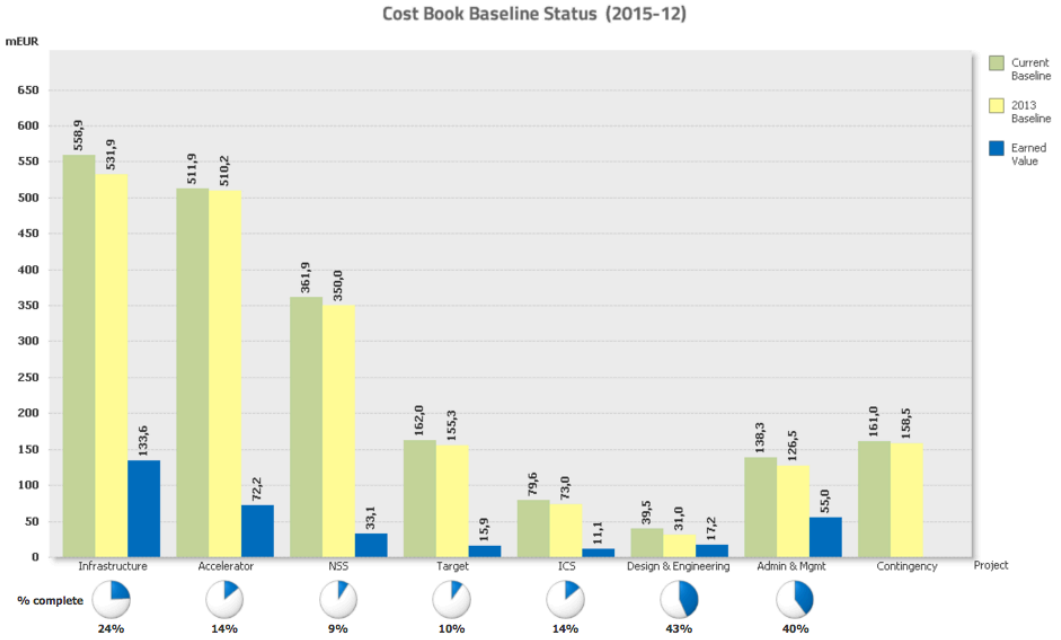
As part of the 2016 budget process ESS proposed contingency allocations as shown in the above table. After the allocation of 15 437 k€ a total budget of 166 803 k€ remains. ("As Year" budget).

The graph below compares contingency with the cost of the remaining work. The goal is to maintain the contingency above 10%. If no contingency is allocated in 2016 the level will increase to 13.9%.



Level 2 Budget Status

The chart below provides the current Level-2 budgets, including changes and indexation. Also shown is the percentage complete per project based on the Earned Value Measurement data.



Annex 2: In-kind Status

The last quarter of 2015 was a pivotal point in anchoring ESS In-Kind Contributions (IKC). The In-Kind Review Committee (IKRC) endorsed five In-kind Agreements with Technical Annexes (TAs) in November for a total value of 8.16 M€; those agreements were subsequently approved by the Council in December 2015. The IKRC endorsed 13 more TAs with a total value of 33 M€, which will be incorporated into IKC Agreements and signed by the responsible institutes before approval by the Council. This is a significant step forward in the numbers of TAs approved, as well as total value addressed by the TAs. Nevertheless, much progress remains to be made. ESS projects are still working to secure the full scope of their in-kind potential. Many partner institutions are still resolving issues blocking the signing of agreements. These issues are predominately related to clarification over internal funding, as well as uncertainties on implementing the VAT exemption.

The next IKRC (#8) will be held on 18th February. The expectation is that between 10-20 TAs worth over 30 M€ will be endorsed. The subsequent IKRC #9 will be held 25th -26th May. The endorsed agreements from these two meetings will be brought to the June Council meeting for approval.

There was good progress towards identifying additional In-kind partners for In-Kind Contributions (IKC). There are currently partners identified for 115 in-kind packages, and a further 44 packages are awaiting partners. The result is a total of 159 IKCs defined, for a total cost book value of 482 M€. There is a further 190.5 M€ of potential in-kind that is yet to be organised into individual IKCs; these are mostly concerning the instrument suite. This will become clearer in 2016 as the work associated with the instruments becomes more defined.

A number of 'Heads of Agreement' with institutes are now in place to allow work to go ahead before a TA or IKC Agreement is signed. Currently these HoAs cover 18 agreements worth over 100 M€. Additionally, there are a number of collaborations with institutes in the Host Countries, Denmark and Sweden, included in the in-kind figures (13 collaborations worth 16.5 M€).

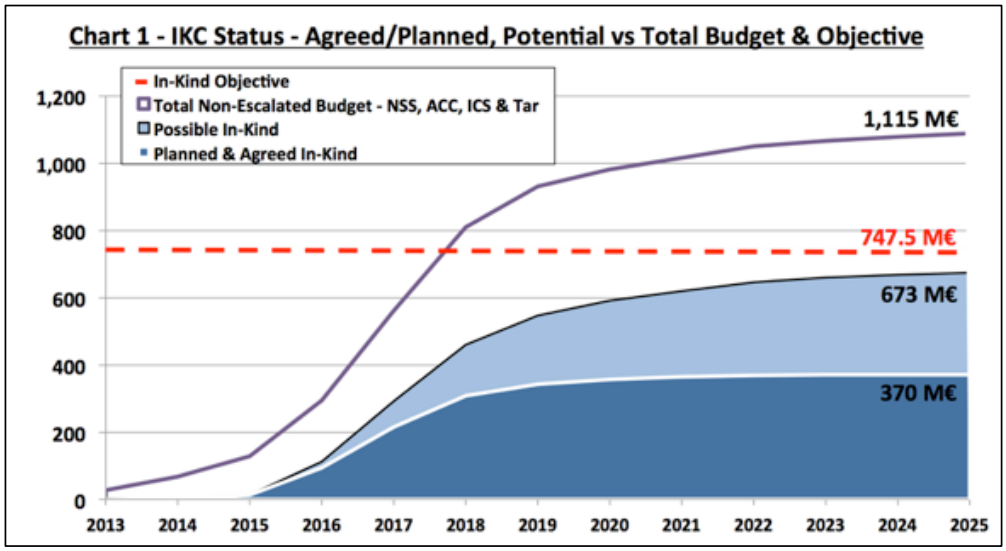
The member countries are strongly engaged in the In-kind process, but some hurdles remain. Spain is expected to join as a full ESS member in August 2016; the UK aims to become a full member before April 2016. The internal funding procedure of approving and signing IKCs in Germany is currently being put in place but is delayed. If these issues are not resolved early in 2016, delays in establishing the IKC work will start impacting the overall ESS schedule.

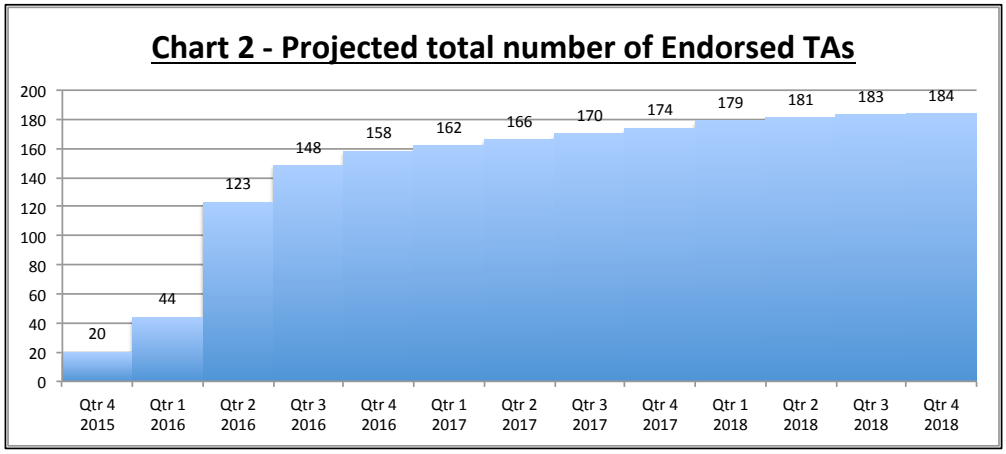
Table 1 provides the current status of in-kind across the four projects. All projects, apart from ICS, are approaching their in-kind goals. The current forecast is that the possible in-kind identified will unlikely be reached, but the high in-kind goals continue to serve as a tool for maximising the total level of in-kind that will be achieved. Chart 1 shows the planned/agreed and possible in-kind budget profile during ESS construction years, with the in-kind objective as a reference. Chart 2 shows the current predicted dates for TAs being endorsed. It highlights the large number of TAs, 79 of which are planned to be ready in the second quarter of this year.

Table 1 - Current IK totals per Project for Qtr 4 2015

Values kEUR	Qtr 4 2015 IN-KIND REPORTING									
	% IKC POTENTIAL DEC 2015									
	% AGREED & PLANNED									
PROJECT	Agreed	Planned	Planned & Agreed		Potential	Agreed, Planned & Potential		In-Kind Goal	Not In-Kind	*TOTAL
11 Accelerator Systems	14,735	252,036	266,771	52.3%	83,325	350,096	68.6%	75%	159,904	510,000
12 Target Station	5,790	71,875	77,665	50.1%	21,752	99,417	64.1%	65%	55,583	155,000
13 Neutron Scattering Systems	437	47,597	48,034	13.7%	183,030	231,064	66.0%	65%	118,936	350,000
14 Integrated Control Systems	700	3,127	3,827	5.2%	14,495	18,322	25.1%	50%	54,678	73,000
Total - All 4 projects	21,662	374,636	396,298	35.5%	302,601	698,899	62.7%		389,101	1,115,525
Total - All ESS				21.5%			37.9%	747,250		1,843,000

*From 2013 Budget





ESS Project Status

Project budgets and in-kind goals are based on the original Cost Book values from 2013 and do not include indexation. 'TAs approved' refers to TAs receiving approval at the ESS ERIC Council whereas 'endorsed' refers to endorsement at the IKRC (but without Council approval yet).

Accelerator				
510 M€ Budget	**75%** (**383** M€) In-Kind Goal **69%** (**350** M€) forecasted as In-Kind	**2** TAs approved (**2.25** M€) **1** TA endorsed (**19** M€) **12** HoAs signed (**91.7** M€) **6** Collaborations signed (**15.5** M€)	**30** TAs/HoAs in Preparation (**214** M€) **8** M€ of further In-Kind work identified	**8.61** M€ EV (*includes work on unapproved TAs and HoAs*) **9.34** M€ PV (*includes work on unapproved TAs and HoAs*)
Target				
155 M€ Budget	**65%** (**101** M€) In-Kind Goal **64%** (**99.4** M€) forecasted In-Kind	**1** TA approved (**5.6** M€) **1** TA endorsed (**8.4** M€) **4** HoAs signed (**8.5** M€) **1** Collaboration signed (**0.2** M€)	**19** TAs/HoA in preparation (**85.2** M€) **0** M€ of further In-Kind work identified	**1.58** M€ EV (*includes work on unapproved TAs and HoAs*) **2.05** M€ PV (*includes work on unapproved TAs and HoAs*)
Integrated Control Systems				
73 M€ Budget	**50%** (**36.5** M€) In-Kind Goal **25%** (**18.3** M€) forecasted In-Kind	**1** TA approved (**0.25** M€) **0** TA endorsed (**0** M€) **0** HoAs signed (**0** M€) **3** Collaborations signed (**0.45** M€)	**11** TAs In Preparation (**8.2** M€) **9.4** M€ of further In-Kind work identified	**0.09** M€ EV (*includes work on unapproved TAs and HoAs*) **0.15** M€ PV (*includes work on unapproved TAs and HoAs*)
NSS				
350 M€ Budget	**65%** (**228** M€) In-Kind Goal **66%** (**231** M€) forecasted as In-Kind	**2** TAs approved (**.27** M€) **11** TAs endorsed (**5.6** M€) **0** HoA signed (**0** M€) **1** Collaborations signed (**0.17** M€)	**70** TAs/HoAs in preparation (**41.3** M€) **183.6** M€ of further In-Kind work identified	**0.49** M€ EV (*includes work on unapproved TAs and HoAs*) **0.49** M€ PV (*includes work on unapproved TAs and HoAs*)

Accelerator: Currently, in-kind discussions are ongoing with 26 potential partners. The total value of items under discussion represents 50% of the total accelerator budget: 67% of the in-kind goal. Since schedule progress is a major consideration, ESS may need to self-perform certain work packages for lack of an in-kind partner. There are several key work packages in need of partners, mainly large commercial items, such as RF sources and power supplies. These packages have a total value of 75 M€.

Target: In-kind partners from six countries are identified for 80 M€ of the 99.4 M€ of possible in-kind scope. The Nuclear Physics Institute (CZ) recently accepted three new packages, covering water-cooling and ventilation systems. Partners are making excellent progress in the design and fabrication prototyping of components. A collaboration agreement was signed with Danish Technical University to measure tungsten release factors, and irradiation measurements are scheduled at CERN this spring.

Integrated Control Sytems: The first in-kind agreement was signed with Norway in October. There is also progress in defining in-kind agreements with Switzerland. Two contracts, with a total value of 10% of the ICS in-kind goal, will be completed in Q1 2016. Technical Annexes with existing ESS in-kind partners in France and Spain are advancing, and new opportunities were identified with Estonia and Poland for potential agreements during the first half of 2016.

Neutron Scattering Systems: Two important instrument milestones were reached at the Instrument Collaboration Board meeting on 4th December, when Dr. Robert McGreevy of STFC signed MoUs for instruments LoKI (SANS) and FREIA (Reflectometry). STFC is now the prime contractor for both instruments. LoKI already passed the Tollgate 2 Review, while FREIA will enter Phase 1. On 21st January the document describing the baseline layout of the ESS Neutron Instruments was approved and distrubted to all instrument teams. Work in the coming months will focus on the preparation of Phase 1 schedules for several instruments, together with the signing of instrument MoUs for all consortia that are ready to start Phase 1 work.

Annex 3: Major Milestones

The following table presents the status of Project Major Milestones as of December 2015.

Milestone	Baseline	Actual (A) / Forecast (F)
Construction Start	01.01.13	01.01.13 (A)
ESS Programe Annual Review	22.11.13	22.11.13 (A)
EC Verdict - Legal Force (ADMIN)	01.06.14	12.06.14 (A)
Site Preparations Start (CONVFC)	16.06.14	02.06.14 (A)
ESS Programe Annual Review	21.04.15	21.04.15 (A)
SSM approval 2 (ADMIN)	01.07.16	
Early Access G04 Cryo-Compressor Bldg. (Conventional power 220V&400V) (CONVF)	09.09.16	
Early Access G02 Gallery Test Facility and Coldbox Hall (Conventional power 220V&400V) (CONVF)	07.10.16	
ICS Hardware ready for start of installation (ICS)	07.11.16	
Full Access to Accelerator Building G04 (CONVFC)	01.05.17	
Full access CUB H01 PRELIMINARY (CONVF)	02.05.17	
Full Access to Linac Tunnel & Front End Bldg. G01 (CONVF)	02.05.17	
Early Access to Target Bldg. D02 (CONVFC)	02.10.17	
Target Building Access for Monolith Installation D02 (CONVFC)	02.10.17	
Full Access to Office building (CONVFC)	30.01.18	
Early Access to Experiment Hall D01 (410) (CONVFC)	31.01.18	
Full Access to D04 Lab 2 (CONVF)	31.05.18	
Target Building D02 Access for CF Provided Utilities (CONVFC)	14.01.19	
Full Access to Target Building D02 (CONVFC)	29.01.19	
90 MeV Protons available, NC Linac ready (ACCSYS)	06.02.19	
ESS Programme TG3	01.04.19	
First Protons on Target, 570 MeV (ACCSYS)	28.06.19	
Target Commissioning (hot) ready to start (TARGET)	28.06.19	
ICS ready for superconducting linac commissioning (ICS)	28.06.19	
Full Access to Neutron Science Support Facilities (Lab. etc. Campus Area) (CONVF)	28.10.19	
Handover completed - construction project end (ICS)	18.11.19	
Handover completed - construction project end (TARGET)	17.12.19	
Handover completed - construction project end (ADMIN)	31.01.20	
Call for Initial Experiments (NSS)	30.06.21	
First call for experiments in full user programme (NSS)	30.06.22	
Capability for 2.0 GeV proton available - Handover completed - Construction project end (ACCSYS)	23.09.22	
Hand-over of last instrument - construction project end (NSS)	15.12.25	
Construction ends	15.12.25	

Annex 4: External Grants Overview

Funding Programme	Project		Total Budget	ESS Budget (in EUR)	Funding rate	Total ESS Cash Income
FP7	oPAC		€ 5 939 699,66	€ 472 645,78	100%	€ 472 645,78
	NMI3		€ 13 349 994,30	€ 132 160,00	75%	€ 99 120,00
	EuCARD-2		€ 7 979 700,00	€ 198 046,40	46%	€ 90 646,00
Erasmus+	NPAP		€ 397 345,00	€ 25 840,00	100%	€ 25 840,00
Interreg ÖKS	ESS and MAX IV	WP1: Research and Education	€ 18 976 308,00	€ 649 270,00	50%	€ 324 635,00
		WP5: International Attractivenes s		€ 11 500,00	0%	€ 0,00
		WP3: Coming to the Öresund		€ 18 975,00	0%	€ 0,00
HEPTech	External Funding		SEK120 000,00	€ 12 000,00	100%	€ 12 000,00
Vetenskapsrådet	Statistical Methods for Energy Determination in Neutron Detector Systems		SEK833 333,00	€ 71 500,00	100%	€ 71 500,00
Vetenskapsrådet / Röntgen Ångström Cluster	TT-SAS		Tbc	€ 117 500,00	100%	€ 117 500,00
Vinnova	Capacity Building in Public Procurement of Innovation at ESS		SEK1 200 000,00	€ 120 000,00	100%	€ 120 000,00
Horizon 2020/ Research Infrastructures	iNext		€ 9 999 534,25	€ 47 000,00	100%	€ 47 000,00
	CREMLIN		€ 1 696 250,00	€ 50 625,00	100%	€ 50 625,00
	SINE 2020		€ 12 080 867,00	€ 1 595 625,00	100%	€ 1 595 625,00
	BrightnESS		€ 19 941 964,00	€ 9 889 485,00	100%	€ 9 889 485,00
	SoNDe		€ 3 800 932,00	€ 201 250,00	100%	€ 201 250,00
TOTAL BUDGET				**€ 13 613 422,18**		**€ 13 117 871,78**

Annex 5: European Spallation Source Construction Project

European Spallation Source ERIC

The world's most powerful neutron source for life sciences, energy, environmental technology, cultural heritage and fundamental physics

TYPE: Single site

MEMBER COUNTRIES

Czech Republic	Denmark
Estonia	France
Germany	Hungary
Italy	Norway
Poland	Sweden
Switzerland	

OBSERVER COUNTRIES

Belgium	The Netherlands
Spain	United Kingdom

TIMELINE

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

ESTIMATED COSTS

- Capital value: 1.843 M€
- Operation: 140 M€/year

HEADQUARTERS

European Spallation Source ESS ERIC
P.O Box 176,
SE-221 00 Lund

WEB SITE

http://www.europeanspallationsource.se

DESCRIPTION

The European Spallation Source is a research infrastructure committed to the goal of building and operating the world's leading facility for research using neutrons. The ESS will deliver a neutron peak brightness at least 30 times greater than the current state-of-the-art source, thus providing the much-desired transformative capabilities for interdisciplinary research in the physical and life sciences.

ESS officially became a European Research Infrastructure Consortium (ERIC) in October 2015. The facility is under construction in Lund (Sweden), while the ESS Data Management and Software Centre (DMSC) will be located in Copenhagen (Denmark). The foreseen milestones include the beginning of the first on-site Accelerator installations (Sep 2016), facility ready for Accelerator beam on the Target (Dec 2019), the first call for user proposals (2022), the Machine installed for 2.0 GeV performance (Dec 2022), start user programme (2023), and the completion of the 16 construction phase instruments (Dec 2025).

ACTIVITY

A total of 16 instruments will be built during the construction phase to serve the neutron user community, with more instruments built during operations. The suite of ESS instruments will gain 10-100 times over current performance, enabling neutron methods to study real-world samples under real-world conditions. The Neutron Scattering Systems (NSS) Project at ESS is responsible for the development and coordination of state-of-the-art instrument concepts for ESS, in collaboration with international partners. Around 40 concepts were developed by ESS scientists and partners. Of those, 16 concepts have now been selected and approved by the ESS Steering Committee for construction within the NSS project. Our partners from the member countries will lead the construction of most of the instruments, and many will benefit from contributions from two or more participating organisations. The NSS project is coordinating the construction and installation of these instruments, and the associated support systems (such as sample environments and data processing and analysis capabilities) to ensure the highest quality outcomes for the European Community. Selection of the additional six instruments will occur once construction of the initial suite of eight instruments, of the total sixteen instruments included in construction, is approaching completion.

IMPACT

ESS will be an attractive and environmentally sustainable large compound, including industrial and laboratory buildings, office space, and guest accommodation facilities, all housed within a significant architectural design that will make an impact on the world's stage. Even before the expected world-scale scientific impact can be realised with the operation phase, the construction of ESS will have a direct economic impact, by generating growth and jobs, advance development and fuel innovation potential in the Öresund region and across the EU. With ESS being built as a collaborative project, the growth effect will be shared between the Host Countries (Sweden and Denmark) and the ESS-ERIC partners. The realisation of ESS enables access to frontier technology, experienced technical and scientific staff, as well as unique production facilities and technologies, which would otherwise be unattainable. In addition, ESS will be a key instrument for addressing the Grand Challenges, through novel insights on matter at the molecular and atomic level, and applications to energy, carbon sequestration methods, and health issues at a biological level, as well as drug development and delivery strategies, plant water-uptake processes of relevance for agriculture, novel data storage materials, and more.

Project Milestone Schedule