Philippe Lebrun 9/5/2016

Report of the 13th Meeting of the ESS Technical Advisory Committee Lund, 6-8 April 2016

1. Introduction

The 13th meeting of the ESS Technical Advisory Committee (ESS-TAC) took place in Lund on 6-8 April 2016.

The meeting followed the agenda given in Annex 1. The Committee was given a specific charge (Annex 2), addressed in the meeting and answered in the oral report presented in the close-out session on 8 April 2016. The report proper constitutes section 3 of this document.

2. Participants in TAC

Present: Bertrand Blau (PSI), Michael Borden (LANL), Tim Broome (ISIS), Michael Butzek (FZJ), Alberto Facco (INFN), Philip Ferguson (ORNL-SNS) [t-TAC chair], Matasoshi Futukawa (J-PARC), John Galambos (ORNL-SNS) [a-TAC chair], Frank Gerigk (CERN), Mark Heron (DIAMOND), Philippe Lebrun (CERN) [TAC chair], Alessandra Lombardi (CERN), Alban Mosnier (CEA), Ralph Pasquinelli (Fermilab), Manuel Perlado (UPM), Robert Stieglitz (KIT), Szabina Török (MTA), Hans Weise (DESY), Karen White (ORNL-SNS), Michael Wohlmuther (PSI)

Excused: Anton Mösslang (KIT)

3. Report of TAC13

ESS Technical Advisory Committee
Summary Report of the 13th Meeting
Lund, 6-8 April 2016

Ph. Lebrun for the ESS-TAC

General TAC13

- Well-prepared meeting
  - Topical presentations addressing the questions of the charge to the Committee
  - General information on aspects of the project outside the strict domain of TAC
    - Civil construction
    - Neutron instruments
  - Documents made available on the INDICO site in advance of the meeting
  - Commented responses to the recommendations of TAC12
  - Excellent hospitality of ESS
- Advancement of the project
  - No major change in top-level organization
  - Earned value ~20% of total, mostly in civil construction
  - 367 staff, growing but still below steady-state target of 450
  - 60 partner institutes
  - Progress in identification and technical definition of IK contributions, although few IK agreements are formally signed
    - Work can start on the basis of HoA and Technical Annexes
    - Still, differential of some 140 MEUR between total IK goal and planned contributions would eventually have to be covered by additional cash contributions

Civil construction

- Impressive progress
  - 570 people working on well-maintained construction site
  - Accelerator tunnel completed
  - First building completed in May 2016
  - Some delay in target building (large number and size of piles)
- Concurrent engineering definition of civil works
  - Demanding approach requiring frequent communication with future users, and timely decisions often taken under pressure
  - Originally considered prone to bring a cost and schedule risk, however seems to work reasonably well up to now

Neutron instruments

- Decision on first 16 instruments (out of 22)
  - Based on science case
  - Within total budget of 350 MEUR (ring-fenced)
  - In-kind target 65 %
  - Schedule ensuring early science success, within resources and partner capabilities
- Milestones revisited
  - Instruments prioritized for start of science in August 2023
  - *Ad hoc* test beam line to meet the June 2019 goal of first protons on target
- Proposal to be made in December 2016 to Council

General charge question

- Have the recommendations and concerns expressed by TAC been addressed adequately?
  - Yes

General concerns from the Committee [1/2]

- The ESS project is getting closer to launching major procurements, with multiple stakeholders intervening in series or parallel. This requires
  - Management of multiple interfaces
  - Clear definition of respective responsibilities to achieve conformity, performance, target cost and in-time schedule
  - Enforcement of standards and QA procedures throughout project
  - Continued team spirit among ESS and IK contributors
- Timely licensing by the nuclear safety authorities is an essential condition to meet the project schedule
  - Next milestone: installation permit, to be instructed in May 2016
- The desire to achieve the ambitions IK goals brings the risk of taking technically sub-optimal decisions
  - WP allocation not to most experienced partners
  - Excessive splitting of procurement, beyond technical or commercial rationality

General concerns from the Committee [2/2]

- The project rests on advanced technology, pushed beyond the present state-of-the-art. The increasingly aggressive schedule brings the risk of technically unsound shortcuts
  - Quality and performance should have priority over schedule
- Consideration should be given to the timely establishment of start-up working groups for accelerator, target and ICS. These working groups should closely interact to address interface issues

Proposed topics and remarks for TAC14

- The Committee welcomes the proposal *to return to RF systems and services, as well as integration and installation issues*
- Additionally, the Committee would like to receive information on specific topics detailed in the Subcommittee reports. At the general level:
  - Survey and alignement
  - Progress in licensing
  - Energy efficiency and waste heat recovery
  - Actions for QA enforcement at IK contributors
  - Plan for concurrent pre-operation, installation and commissioning in 2020-2023
- Agenda
  - Schedule question time in presentation agenda
  - Ensure number of slides is consistent with allotted presentation time
  - Maintain discussion time for the Committee in days 2 and 3

Report of a-TAC13
6-8 April 2016

Alberto Facco, John Galambos (Chair), Frank Gerigk,
Alessandra Lombardi, Alban Mosnier,
Ralph Pasquinelli, Hans Weise

General ATAC Comments

- Seeing the impressive progress of civil construction is inspiring!
- Bravo!!! to the RF/modulator/power supply test station.
  - The dream of an integrated « blinky light» test facility in Lund is demonstrated!
  - Test station team is encouraged to work with ICS group with ICS standards
- ATAC encourages an explicit understanding of who will take the ultimate responsibility for « re-finishing » of IK delivered equipment
- The overall WP construction schedule is tight. No time contingency was allocated and any problem is going to delay delivery

a1) The AD staff plan

The AD staff plan (In short, AD is responsible for ion source, accelerator, RF systems, local cooling circuits, cryogenics for all of ESS and vacuum for all of ESS):

The "green field" nature of ESS means that all AD staff is newly recruited starting from 2010. The pace of recruitment has been set by several parameters such as internal AD project needs, available candidates, budget availability at ESS, ESS HR capability to support recruitment etc. Does the TAC have general recommendations on this process and the priorities set?

Comments

- Support re-organization to be better aligned with the work packages
- Staff dedicated to supporting IK teams installing equipment at ESS is weak

Recommendations

- Have ESS central team staff spend more time at IK facilities (especially during key demonstrations) to be able to take ownership of these components
- Trained technicians will be required – have people spend extended time at IK labs (> 3 weeks)
- Assign to a cental ESS team individual reponsibility for each linac system (source, DTL, spokes,…) – including IK oversight, integration, beam commissioning planning,…

a1) The AD staff plan

There are limited possibilities for short term contracts in Swedish labor law. To avoid "hire and fire" AD is using contracted staff and IK staff contributions. Does the TAC have recommendations on this?

Comments

- The IK model seems to be a good solution here (e.g. secondment)
- Sub-contracted staff from companies and scientific institutions may be possible
- Ensure the right experience is made available

The ambition is to have recruited staff for both the project and operation phase (excluding operators) by 2018, does the TAC have recommendations regarding the competences and numbers of different staff categories in the present staff plan?

Comments

- a-TAC supports the proposal to operate with existing staff for the first years of commissioning. As the project matures, a more hands-on technical orientation will evolve
- It is not obvious from the material provided whether survey & alignment and magnet power supplies are supported

a2) Accelerating structures

The TAC proposed at the last meeting to review the linac accelerating structures. Does the TAC have recommendations on the systems presented:

- *Regarding the design and early prototyping?*
- *Regarding the proposed procurements and assembly, which mostly is done at IK partners?*
- *For the proposed testing?*

- This question is addressed for the different accelerating structures in the following slides

a2) Accelerating structures: RFQ

Comments

- Water passages and vacuum integrity should be established at CEA for each of the modules. Resources at ESS to fix leaks may be limited. The schedule has little to no contingency for repair work
- The assembly and testing of the RFQ will take place in the ESS tunnel. Adequate « clean » space needs to be provided with ample room for bead pull aparatus
- The CEA design team of the RFQ should be present at ESS for the duration of assembly, tuning and commissioning
- The tuning slugs are threaded devices with an O-ring seal and have significant travel (many turns)

Recommendations

- Start RFQ LLRF/Resonance control modeling
  - The mixing valve for the water tuning system should be installed as close to the RFQ as possible (i.e. 1-2 meters) to reduce system delay and allow for increased closed-loop gain
  - Personnel responsible for the LLRF and resonance control (water) should be very tightly coupled
  - CEA should execute a system model of the RFQ to predict thermal tuning constants of Hz/degree C. Both common-mode and differential (loop-to-body) thermal frequency and time constants are desirable. The LLRF/resonance control team will use this estimate in their modeling of the control loops for optimum performance.
- Ensure the movable RFQ tuning system meets vacuum requirements

a2) MEBT

Findings

- The quadrupoles with the integrated steerers and the bunchers are well defined, and the path for procurement is clear
- The chopper, dump and instrumentation are not yet fully defined
- It is not clear whether the chopper is a necessary element from the very beginning

Comments

- The MEBT is compact and includes many interconnected elements which have to be accurately aligned. A simple approach, which will save installation time at ESS Lund, is to mount and align all elements on a single girder and ship it as a whole
- The fast chopper is a challenging system

Recommendations

- Define a minimally acceptable baseline MEBT (possibly w/o chopper) to meet the beam test requirements for 2018
- Clarify the specifications and function of the chopper
  - Do not use the chopper as a required machine protection device

a2) DTL

Findings

- The design is based on the Linac4 DTL, which has been verified in recent beam commissioning. Some changes and improvements were made and are being tested on prototypes. The FODO scheme allows BPMs and steerers in every second drift tube, significantly reducing losses
- The tanks will be assembled in Lund by INFN staff with support from ESS. For this purpose a DTL assembly lab will be set up in Lund under the control of INFN. This is planned to be ready in the beginning of 2017

Comments

- PMQs are made with 16 segments. CERN's experience shows that 8 segments give the same field quality, which may be a savings opportunity
- The CDR took place in 6/2015 but the tendering will only start in 6/2016. Counting a 9-month tendering period, construction can only start in 3/2017. Given the tight tolerances it is likely that a qualification period of 6-12 months is needed for machining procedures, which means that the planned installation date of the first tanks (3,4) in March 2018 is not very realistic
- For Linac4, CERN disqualified 10 companies for the production of the girders. 3 years were needed between start of construction and installation of the first tank in the tunnel

a2) DTL

Recommendation

- Find means to reduce the tendering period and concentrate on companies which are known to have experience with the fabrication of similar cavities. This will come at a price but it will reduce long qualification periods
- The use of temporary diagnostics plates is suggested by INFN to aid the beam commissioning process but needs to be agreed to by ESS. This suggestion should be based on a commissioning plan

a2) Spoke cavity/cryo-modules

Findings

- Work package activities in general are proceeding according to plans. All important aspects are well addressed. Validation of critical subsystems is not yet completed
- Cavity development is completed with prototypes successfully tested. Design and processing are validated. Two vendors are qualified
- The Forward Power Coupler is prototyped, but first testing at high power on test bench caused a failure of the ceramic window at 100 kW (the goal is 400 kW) for reasons which were not clearly pointed out. Tests are ongoing with other prototypes
- A new version of the FPC with DC bias is being developed as mitigation to the risk of heavy multipacting in the baseline coupler in the real cavity. No extra time is allocated

Comments

- Excellent results have been achieved with prototype cavities
- Low T baking is planned to be tested, but not expected to improve performance significantly
- Integrated test of cavity with final coupler and tuner at full power will be the important milestone before launching production of couplers and tuners; risk of delays is substantial before that validation
- 3 spare cavities in addition to the 26 required appear to be an adequate safety margin

a2) Spoke cavity/cryo-modules

Recommendations

- Clarify in detail the causes of the failure at 100 kW of the first FCP to eliminate this risk
- Continue bias coupler development

a2) Medium-beta cavities

Comments

- There are two medium beta cavity approaches. The minor modifications between these cavities will likely not have a meaningful interface impact, but there is some impact on possible coupler geometry and tuning

Recommendation

- Pursuing the large-grain Nb for ESS applications appears too risky

a2) Medium-beta cavities/cryomodules (prototyping)

Findings

- From the INFN presentation: INFN feels there is only a very small risk that their medium-beta design will not be workable in the CEA cryo-module. INFN claims that all interfaces are identical ("plug-compatible"). Changes are proposed for the cavity shape only, without impact on the external connections. The new INFN shape will be tested vertically late summer 2016, though the date of the test of the INFN cavity with He tank was not reported. If the INFN design does show a problem, the fall-back position is to use the CEA cavity design. INFN suggests to start the tendering procedure based on the INFN design, with the CEA design being an option. Thus longer delays or sophisticated contract changes can be avoided
- INFN prefers to not launch the procurement until a full test of the CEA cryomodule prototype is done. INFN does not want to accept the risk of launching cavity production before the CEA tests are complete. If prototype cavities integrated in the cryomodule do not turn out as expected, INFN does not want to bear additional expenditure
- CEA proposed to test at least one INFN cavity in the four-cavity string in the cryomodule prototype, in order to limit the risks before launching the series cavities
- CEA has built 6 medium-beta cavity prototypes, but not demonstrated sufficient performance (believed to be H contamination, solvable by processing, but not yet demonstrated)

a2) Medium-beta cavities/cryomodules (prototyping)

Comments

- The standard approach is to await prototype tests before launching series production. Deviation from this approach should not be taken lightly
- Integrated testing of cavities in the cryomodule with all subsystems in operation is advisable to verify installation procedures, interface compliance and system performance achievement before launching production
- It is difficult to make an informed judgement on bypassing this usual process, based on material presented in the review

Recommendations

- Provide an informed framework from which to decide whether launching INFN cavity series production prior to completion of cavity and cryomodule tests is a reasonable risk:
  - Quickly convene a technical review on the potential impacts of cavity, cavity accessory (e.g. tuner, He vessel ...) or cryomodule rework, resulting from integrated testing
    - Include technical experts from INFN, CEA, and an independent institute with experience in cavity and cryomodule fabrication and operation
    - Create a systematic list of the potential cavity rework issues, their impacts, and likelihood
  - Estimate the impact on the project if a delay is realized, due to rework needs
- It is advisable to fully test at least one INFN cavity in the cryomodule test, in order to fully qualify one RF unit (cavity with He tank and all plugs+tuner+coupler), before launching the series production
- ESS, CEA and INFN should have a well-defined agreement of who bears cost impacts if production is launched before prototype tests are complete, and a problem arises

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a2) Accelerating structures: high-beta

Recommendation

- The niobium procurement for the elliptical cavities should be started as soon as possible. As proposed, all upcoming CFTs related to the elliptical cavities / modules should be prepared now. Use the SRF community's expertise by inviting selected experts to the specification reviews

High-beta cavities

Comments

- There is remarkable progress in the infrastructure preparation / procurement, i.e STFC is working hard to be prepared for the cavity procurement and testing
- STFC doesn't see an advantage in common Nb procurement; nevertheless the TAC sees the need for a common strategy especially w.r.t. QA
- In case of low cavity performance, there is a need to distinguish between cavity vendor mistakes and STFC mistakes
  - E.g., use a qualified cavity for infrastructure commissioning
  - Take care of all details in the cavity specifications; QA, documentation and acceptance levels are to be defined; invite SRF experts for Production Readiness Reviews (final editing of specifications)
- The most up-to-date specifications for Nb and cavity production should be handed over from CEA to STFC and INFN

Elliptical cryomodules

Comments

- There is great progress at CEA Irfu, but at least half-a-year delay in the prototype, resulting in an absolutely success-oriented schedule w/o any margin for problems and iterations
  - The 2 months scheduled for assembly (last cavity available for string assembly in November 2016 only) is too agressive
- Preparation of series assembly takes advantage of European X-FEL experience; material presented gives a hint to the involvement of X-FEL experienced colleagues
- The cavities are not yet successfully tested; hydrogen due to chemistry is quite likely limiting the performance but testing asap is a must!
- Modifications of the power couplers sound plausible but results are required; couplers are critical in many (almost all?) accelerator projects
- A full module test with all four cavities independently powered will only be possible in the ESS tunnel; how can one assure stable operation?
  - Even if the module is not yet tested, the impact on the cavity specifications seems to be small enough; most likely all necessary changes can be done on the module itself

a3) ...risk of not reaching the specified gradients...

The risk of not reaching the specified gradients in a fraction of the superconducting cavities is non negligible. Does TAC have recommendations on:

What failure rate we should expect, i.e. what fraction of the cavities will not reach full gradient during tests, allowing additional HPR if needed but not rework (incl. BCP) at the factory?

- For spoke cavities, < 10% rejection is considered safe
- For X-FEL elliptical cavities only 2/3 of the cavities can be used after initial surface treatment, i.e. w/o a performance guarantee from the vendors a respective retreatment and re-testing need to be included in the schedules. In almost all cases High-Pressure Rinsing is sufficient, i.e. the cavity performance suffers from bad assembly / field emission. Only some few cavities will need BCP
- With X-FEL-like procedures and QA, statistics indicate that ~2% of the cavities will not reach the specifications, even after retreatment. Make sure that the linac design can live with one or two low-performing modules, i.e. other modules should be above specifications

a3) …risk of not reaching the specified gradients…

Whether eddy-current scanning of the niobium sheets should be performed, taking into account cost, schedule and the possibility to mitigate by ordering spare cavities?

- Yes: 100% for elliptical, and samples for spoke cavities
  - Scanning alone is not sufficient. The niobium vendors should be forced to present a well-defined QA plan, and the contractor needs to supervise / control the niobium suppliers. Use help of experts. Ask them to join company visits. Metallurgy experts (or vendor) should check RRR and hardness, do a gas/element analysis and profilometry
- Comment
  - The QA for vendor qualification should be consistent for all elliptical cavities

What number of extra cavities should be ordered?

- For spoke cavities, 3 extra, with the option of more (out of ~30) is sufficient
- Some few extra medium-beta and high-beta cavities should be assumed, which should be accounted for in the initial Nb order

a3) …risk of not reaching the specified gradients…

Does the TAC have specific recommendations regarding the 84 high-beta cavities, for which the TAC had a more extensive presentation?

- The higher-energy linac portion is flexible w.r.t. accommodating low-performing cavities at the expense of output energy. The high-beta elliptical section should be able to accelerate beam with under-performing cavities, and allowing for swapping cryomodules, perhaps even some of the medium-beta section. Simulations could support this
  - Allowing the introduction of poor-performing structures into the linac, for schedule expedience, will introduce longer term gradient recovery needs
    - For example, ESS will need some SRF processing equipment to accomodate energy recovery. A comprehensive « gradient recovery » plan (e.g. share resources with another lab) should be prepared, if this option is taken
  - Also attention to ongoing efforts in in-situ surface processing gradient recovery efforts should be followed, to ensure that the design will accomodate such methods

Report on ICS at TAC13
6-8 April 2016

Mark Heron, Karen White

Findings

- The new ICS management team is in place and is having a positive impact within the division by improving communication and increasing ICS alignment with ESS project goals
- The broadly defined scope of the ICS software is under evaluation to ensure all essential services are available in accordance with the ESS project schedule and additional features are phased in later
- Significant questions remain regarding the scope/value of some planned CCDB functions
- ICS has made good progress with IKC but there remains considerable work in this area to meet the allocated ICS goal
- Three hardware standards (PLC, Ethercat and MTCA) have been selected, which are aligned to the required range of signal data rates. PLC and EtherCat solutions are available, while the MTCA common digital platform is under develop as an IKC
- A project-wide control room is being designed and realised against best practice as an IKC. Scope for a data centre is well established and requirements for network infrastructure, shared with business IT and DMSC, are established
- The Integration Group is working on development of interface documents and controls for early systems with in-kind partners
- Re-planning the ICS work and development of a detailed schedule is not complete, but significant progress has been made. The ICS schedule is integrated with the master ESS schedule

Comments

- Good progress has been made with recommendations from TAC12
- ICS should increasingly look to reach out and improve partnerships with other ESS divisions and their IK partners
- Use of the standard ICS architecture and solutions, as technical systems are developed and tested, is essential to overall project success
- Significant effort on requirements analysis, schedule and governance continues, but ICS must also be providing their standard solutions for early equipment, test stands and prototyping efforts to ensure there is time to work out any issues well in advance of beam delivery
- Effort must be focused to ensure delivery of the prototype of the MTCA common high-speed digital platform in Oct 2016, otherwise this will become critical for a number of systems
- Providing an application development process for the MTCA common digital platform before the hardware becomes available will help minimise the time to deploying applications on the new hardware
- The current size of the Integration Group is not adequate for the work scope required and the group lacks depth in some critical areas
- The ICS network should be capable of running in isolation mode to support operations independent of the site network in case of cyber disruptions

Recommendations

1. Design out dependencies on network services (e.g. LDAP or Active Directory) outside the operational ICS network to enable the machine to operate without an external network connection
2. ICS should promote ICS solutions and standards within ESS and to IK partners
3. Strengthen the ICS Integration Group, by adding a few **senior** engineers, in order to meet the overall ESS project schedule
4. ESS senior management should support the enforcement of standards from ICS across the project. Failure to do so will incur technical debt and introduce unnecessary risk to the project.

Charge questions (1)

c1) Is the software scope correctly timed/prioritized for the ICS/ESS context?

Software scope is currently being revisited to align it to available resources and overall project schedule, as part of updating the ICS programme

c2) Have the risks of the hardware choices been properly estimated? Have any viable alternatives been left out?

The main risk is associated with the MTCA common digital platform development schedule. This is understood, and is being mitigated by the undertaking early development on the functionally compatible VME version of the board.

c3) Are the management strategies and plans for accelerator integration appropriate? Are there major issues that need to be addressed/prioritized in order to ramp up with the integration work?

Yes, the development of interface definition documents is appropriate; but need input from both ICS and AD staff, to be successful

c4) Is the planning method appropriate? Is the connection to the ESS schedule strong enough?

The planning is currently being updated, but to the first order appears appropriate

c5) Are the design choice conclusions for infrastructure appropriate? Is the action plan for the MCR appropriate?

Yes

ICS topics for TAC 14

- Progress on Machine Protection System
- Progress on Personnel Safety Systems
- Progress on integration
- Status of ICS standards
- Update on Software scope
- Progress on common high speed digital platform

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Philip Ferguson (Chair), Masatoshi Futakawa, Manuel Perlado,
Robert Stieglitz, Szabina Török, Michael Wohlmuther

Comments

- The response to the t-TAC12 recommendations was thorough, and we could see our recommendations had an impact on the project.
- Good progress on the safety analysis. This is on the right track and moving forward.
- The postulated reliability criteria for the target system appear unrealistic and should be reformulated in the light of existing facility experiences
- Gaining additional early access to the target building will be critical to meeting schedule for the target installation. CF is working on this, and we encourage them to come up with a solution
- It is good to see the task force tackling difficult problems for the facility, including the bunkers. An update on the neutron guide insert was presented and is progressing well. The operations are complex and will benefit from planned mock-ups. Analysis of dose rates during operations is essential
- For the next t-TAC, the committee would like to see:
  - An update on the target installation plan integrated with CF access/occupancy plans
  - An update on the design of the bunkers, the critical interface between the target and the instruments
  - Monolith vessel & target instrumentation plug updates, when available

Are the hazard analyses and accident analyses being evaluated using a sound approach and are reasonable and appropriate safety-classified mitigation measures being properly identified?

- The methodological part of the safety analysis has substantially improved. It shows a logic structure and addresses the key topics. Both qualitative and quantitative analysis are on a reasonable track matching best practice guidelines
- A common perception of safety culture has been established across the project
- The strategy to rely on passive safety features wherever possible is appreciated and supported
- As part of the safety analysis, establish which critical safety-related equipment requires an uninterruptable power supply (e.g., battery, diesel generators, etc.)
- Similar evaluation procedures could be established to evaluate zoning concepts
- Other European labs have lower dose rate limits. Consider this when re-evaluating the ESS dose rate limit

Open issues

- Experimental validation of assumptions and computations of unique fluid systems will improve confidence in performance. (e.g. failure of flow path in target, leaking gas into the monolith, etc.). Consider options to reduce uncertainty by adequate prototyping (e.g. hydraulics tests of sectors to validate computations, identification of early failure features, etc.), or scaled demonstration experiments

- Assessment of thermal-hydraulic & mechanical integrity of the rotating target during operation should be considered to give an early indication of problems
- Independent train description for redundant/diverse systems (cabling, physical) should be clearly described and communicated to project participants

Operational safety

- Management of tritium in cooling water needs further assessment in terms of operational procedures and dose to personnel
- Location of active components should be analyzed with respect to dose rate of working personnel
- Consider generating a handbook on operational procedures (four eyes-principle, personnel protection, etc.)

Is the design approach for the Primary Water Systems sensible and likely to meet system requirements? Does it represent a reasonable balance between performance, manufacturability, operability, maintainability, cost, schedule?

- The primary water system design is similar to existing systems and is reasonable
- Delay tanks of 90 seconds may be longer than necessary. Check half-lives of anticipated radionuclides and see if reduced times may be acceptable
- Seeking expertise from other spallation sources and not reinventing the wheel is smart. We encourage you to do this when appropriate
- Look at tritium build-up. Replacing the water now and then might pose fewer radiological/waste problems
- If you don't have one, consider adding a drain pipe at lowest point of the monolith
- Monitoring oxygen in the water should be considered to reduce corrosion rate
- Carefully consider water quality issues impacting radiological and corrosion issues. Bad water chemistry can result in high corrosion rate, down time, and high cost
- Access to components (e.g. ion exchangers) for maintenance seems not to be considered in all cases
- Is shielding of the ion exchangers, piping and delay tank sufficient?
- Is the standard procedure used in Swedish nuclear power plants, exchanging the resin rather than ion exchange column, applicable for the activity conditions anticipated for ESS?

Is the approach to developing a plan to integrate the civil construction of the Target Station Building with the installation of Target Station systems sound? Do you see opportunities for compressing the schedule further?

- Integrating the civil construction of the target building with the target system installation is critical to meeting the beam-on-target schedule. Concurrent activities (early access) seems to be the only way to meet schedule, and we encourage efforts to make this happen
- Finding an in-kind partner for the monolith vessel is needed to keep the envisioned schedule (may already be in process)
- One method for improving schedule would be to work two shifts on the building construction. This has advantages and disadvantages, but can improve schedule
- A delegate of the Target Division has been identified to increase communication with CF. This will have (is having) a positive impact on the schedule
- Pre-installation testing of portions of the target station might have the advantage of checking procedures, completeness and functionality of these components. Additionally errors could be identified early and save time, compacting the schedule. However, additional space and manpower is needed for such an approach.

Does the concept of maintaining an evacuated atmosphere in the monolith vessel during operation seem sound, and is the proposed design approach reasonable? Is it reasonable to preserve the design option of operating with 1 bar helium?

- We concur that the concept for monolith vacuum operation is sound
- Preserving the design option for operating at 1 bar helium atmosphere is an essential risk-avoidance strategy. The helium option may allow continued beam operation in presence of significant leaks
- Pump emissions should be captured and monitored. Residual gas analysis mass spectrometers allow early leak detection and species identification
- Fast gate valves mitigate risk and rigid surveillance testing is required
- Insure beam multiple-scattering optics are understood for downstream components as a function of gas pressure, particularly with regard to beamline components requiring hands-on maintenance
- Careful consideration of vacuum gauge selection is needed for each pressure region
- We recommend evaluating leak testing procedure of the monolith penetrations and welds during installation and after operations begin
- Vacuum pumps will become tritium contaminated; controls will be needed to deal with contamination
- Avoid oil sealed pumps

Annex 1

30/03/2016 (HF) v09

Agenda of 13th TAC meeting

Wednesday 6, April 2016
ESS Construction site

TAC closed Session (13h00 – 13h15)

13h00	TAC initial working session

Plenary Sessions (13h15 – 17h30)

13h15	Welcome and overall status of ESS – J. Yeck/R. Garoby (25'+5')
13h45	Plans for instruments – A. Schreyer (25'+5')
14h15	Status of Conventional facilities – K. Hedin (10')
14h25	Site view from panoramic room Tornado – K. Hedin (20') **TAC Only**

14h45: Coffee

15h00	Accelerator overview – M. Lindroos (40'+10')
15h50	Target overview – E. Pitcher (40'+10')
16h40	ICS overview – H. Carling (40'+10')

TAC closed Session (17h30 – 18h00)

17h30	TAC working session

19h00: Social Dinner (Gastro Gaspari, Flyinge)

Thursday 7, April 2016
ESS, Tunavägen 24

Parallel Sessions (8h30 – 12h30)

	Accelerator
8h30	Accelerator staff plan – M. Lindroos/J. Weisend (15'+5') Linac design overview – H. Danared / S. Molloy (20'+5') RFQ – A. France (CEA) (20'+5') MEBT – I. Bustinduy (ESS Bilbao) (15'+5')
10h00	*Coffee*
10h30	DTL – A. Pisent (INFN Legnaro) (15'+5') Elliptical cavities cryomodules – P. Bosland, F. Ardellier (15'+5') Spokes cavities and cryomodules – S. Bousson (15'+5') High and Medium beta prototypes at CEA – F. Peauger (CEA) (15'+5') High beta series manufacturing and testing– P. Mcintosh, (STFC Daresbury) (15'+5') Medium beta series Manufacturing and testing – P. Michelato, (INFN) (15'+5')

	ICS
9h10	Control software scope – S. Regnell (30'+10') Hardware choices – T. Korhonen (20'+10')
10h20	*Coffee*
10h50	Progress in integration – D. Piso-Fernandez (20'+10') Infrastructure and MCR – R. Mudingay (20'+10') ICS project replanning – H. Novella (30'+10')

	Target
8h30	Responses to recommendations from TAC12 – E. Pitcher (15'+5') Hazards Analysis and Safety Classification Process – L. Coney (30'+10') Bounding Event: Loss of dynamic confinement in Active Cells – P. Nilsson (20'+10')
10h00	*Coffee*
10h30	Bounding Event: Stopped Wheel – P. Nilsson (20'+10') Installation Plan – (20'+10') T. Lexholm Design of the Primary Water Systems – H. Carlsson (20'+10') Operating the Monolith Vessel in Vacuum – R. Linander (20'+10')

12h30: Lunch at Ljusgården

Parallel Session (13h30 – 15h00)

	Accelerator
13h30	Visit to RF and modulator test stand – D. McGinnis/C. Martins

TAC sessions (13h30 – 18h30) with additional interviews on TAC request
~16h00 Coffee

19h00: TAC Dinner (Hotel Planetstaden)

Friday 8, April 2016
ESS, Tunavägen 24

TAC sessions (8h30 – 12h00) with additional interviews on TAC request
~10h30 Coffee

12h00 -13h15: Lunch at Inspira

Close outs (13h15 – 14h30)
13h15: Close out with DG and Technical Director - (if necessary)
13h45: Close out (open session)
14h30: End of meeting

14h45: Transport to Site
15h00: Tunnel topping out ceremony

Annex 2

7/03/2016

Charge to the TAC for its 13th meeting
on April 6-8, 2016

1. Introduction

Since the last TAC meeting which took place on October 14-16 the ESS project has progressed and it is now close to 20% complete:

- Construction on site is well advanced.
- Additional work packages have been allocated as in-kind and technical work is actively progressing at the partners' premises as well as in Lund, as TAC will learn during its 13th meeting.

Changes have taken place in the ESS management:

- Agneta Nestenborg has succeeded to Matti Tiirakari as Director for Administration,
- Andreas Schreyer has succeeded to Dimitri Argyriou as Science Director,
- John Haines has been made responsible of the Integrated ESS schedule and took over, by interim, the position of Associate Director for ES&H and Quality after the departure of Patrik Carlsson.
- Eric Pitcher succeeded to John as Leader of the Target Project.

Beyond ensuring technical progress according the schedule, the following objectives are high priority in 2016:

- Signature of more in-kind agreements and negotiation of additional in-kind contributions.
- Submission of the "Installation Permit" in May 2016 (2nd step of licensing).

The 13th meeting of the TAC is an opportunity to put our progress in perspective. I have no doubt that the discussion with TAC and the advices and recommendations of the Committee will again be very precious.

2. Charge questions

Our first question to the Committee is:

Have the recommendations and concerns expressed by TAC been properly addressed?

More specifically, we would like the ESS Technical Advisory Committee to address the following questions:

- concerning the **Accelerator**:

- *a1) The AD staff plan (In short, AD is responsible for ion source, accelerator, RF systems, local cooling circuits, Cryogenics for all of ESS and vacuum for all of ESS):*
  - *The "green field" nature of ESS means that all AD staff is newly recruited starting from 2010. The pace of recruitment has been set by several parameters such as internal AD project needs, available candidates, budget availability at ESS, ESS HR capability to support recruitment etc. Does the TAC have general recommendations on this process and the priorities set?*
  - *There are limited possibilities for short term contracts in Swedish labor law. To avoid "hire and fire" AD is using contracted staff and IK staff contributions. Does the TAC have recommendations on this?*
  - *The ambition is to have recruited staff for both the project and operation phase (excluding operators) by 2018, does the TAC have recommendations regarding the competences and numbers of different staff categories in the present staff plan.*
- *a2) The TAC proposed at the last meeting to review the linac accelerating structures. Does the TAC have recommendations on the systems presented:*
  - *Regarding the design and early prototyping?*
  - *Regarding the proposed procurements and assembly, which mostly is done at IK partners?*
  - *For the proposed testing?*
- *a3) The risk of not reaching the specified gradients in a fraction of the superconducting cavities is non negligible. Does TAC have recommendations on:*
  - *What failure rate we should expect, i.e. what fraction of the cavities will not reach full gradient during tests, allowing additional HPR if needed but not rework (incl. BCP) at the factory?*
  - *Whether eddy-current scanning of the niobium sheets should be performed, taking into account cost, schedule and the possibility to mitigate by ordering spare cavities?*
  - *What number of spare cavities should be ordered?*
  - *Does the TAC have specific recommendations regarding the 84 high-beta cavities for which the TAC had a more extensive presentation?*
- *a4) The plan is to at next TAC return to RF systems and services as well as integration and installation issues. We would be happy to have your comments on that, in particular on what we should focus on.*

- concerning the **Target**:

- *t1) Are the hazard analyses and accident analyses being evaluated using a sound approach and are reasonable and appropriate safety-classified mitigation measures being properly identified?*
- *t2) Is the design approach for the Primary Water Systems sensible and likely to meet system requirements, and does it represent a reasonable balance between performance, manufacturability, operability, maintainability, cost, and schedule?*
- *t3) Is the approach to developing a plan to integrate the civil construction of the Target Station Building with the installation of Target Station systems sound? Do you see opportunities for compressing the schedule further?*
- *t4) Does the concept of maintaining an evacuated atmosphere in the monolith vessel during operation seem sound, and is the proposed design approach reasonable? Is it reasonable to preserve the design option of operating with 1 bar of helium?*

- concerning the **Integrated Control System**:

- *c1) Is the software scope correctly timed/prioritized for the ICS/ESS context?*
- *c2) Have the risks of the hardware choices been properly estimated? Have any viable alternatives been left out?*
- *c3) Are the management strategies and plans for Accelerator integration appropriate? Are there major issues that need to be addressed/prioritized in order to ramp up with the integration work?*
- *c4) Is the planning method appropriate? Is the connection to the ESS schedule strong enough?*
- *c5) Are the design choice conclusions for infrastructure appropriate? Is the action plan for the MCR appropriate?*

The Committee is encouraged to provide also suggestions/comments and recommendations on any other subject it would find relevant.

A preliminary version of the Committee report is expected at the end of the meeting, in the afternoon of Friday 8, April. The final report is expected two weeks later. The TAC Chair will be asked to present it to the ESS Council on June 9-10.