Alberto Facco 4/11/2018

Report of the 18th Meeting of the ESS Technical Advisory Committee
Lund, 17-19 October 2018

1. Introduction

The 18th meeting of the ESS Technical Advisory Committee (ESS-TAC) took place in Lund on 17-19 October 2018.

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 closeout session on 19 October 2018. The report constitutes section 3 of this document.

2. Participants in TAC

Present:

Maud Baylac (CNRS, France)
Cyrille Berthe (GANIL, France)
Tim Broome (ISIS, UK-retired)
Michael Butzek (FZJ, Germany)
Alberto Facco (INFN-LNL, Italy) *[chair]*
Phillip Ferguson (SNS, USA) *[co-chair]*
Masatoshi Futakawa (JAEA, Japan)
Frank Gerigk (CERN, Switzerland) *[co-chair]*
Mark Heron (Diamond, UK) *[co-chair]*
Shane Koscielniak (TRIUMF, Canada)
Roland Mueller (HZB, Germany)
Graeme Murdoch (SNS, USA)
Bernd Petersen (DESY, Germany)
Michael Plum (SNS, USA)
Igor Syratchev (CERN, Switzerland)
Szabina Török (MTA EK, Hungary)
Hans Weise (DESY, Germany)
Jörg Welte (PSI, Switzerland)
Karen White (SNS, USA)

Excused: Francisco Martin Fuertes (CIEMAT, Spain), Jurgen Neuhaus (TUM, Germany).

3. Report of TAC18

ESS Technical Advisory Committee
Closeout Report of the 18th Meeting
Lund, 17-19 October 2018

A. Facco for the ESS-TAC

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General TAC18 - Meeting

- The Committee thanks ESS for the the excellent organization and hospitality
- Charges to Committee were clearly set
- Very good quality of presentations, in the ESS style. Prompt response to the Committee request of additional presentations not in agenda
- All relevant meeting documents have been made available to Committee in advance. Answers and comments to recommendations of the previous TAC were given before the meeting.
- Information about test results of superconducting cavities was minimal. A more comprehensive update of the still evolving status of these critical components would be appreciated in the next TAC.
- An account to TAC members so that they can access CHESS documentation would be highly valuable
- *The whole TAC is grateful to Tim Broome, Phil Ferguson, Hans Weise and Karen White, who are leaving the Committee after many years, for their outstanding contribution to the Committee work.*

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General TAC18 - Project status

- The project is in its peak of construction activities, showing a steady advancement and an increased maturity. Major technical issues and open questions which appeared in earlier phases of the project have been addressed successfully.
  - No real technical showstoppers appear at present.
  - Main risks for the project are generated by schedule delays.
- Continuous progress can be seen in the conventional facilities.
  - The construction site gives an excellent impression of efficency and good safety management.
  - The transfer of all the staff on site was completed in the last few months.
- Installation and commissioning of in-kind components has started.
  - Many important aspects have been experienced and digested, like the importance of infrastructure readiness before installation of the components.
  - Lessons learned in the Ion source and LEBT are expected to improve the process for all future installation and commissioning activities.

General TAC18 -Project status

- Progress observed in the test facilities construction
  - operational capability not yet fully reached
- ICS Division has made good progress since the last TAC on a number of fronts.
  - These include operation of the Ion Source and Cryo plant through the control system and operation of the first Personnel Safety System.
- Significant progress achieved in the bunker design and target building construction.
- A modification of the Accelerator Division structure in view of the future testing and commissioning phase was presented
- Recruitment of experienced senior staff has continued
- A satisfactory strategy procedure for licensing has been set up
- The proposed re-baselining of the project has been approved by the ESS Council.
  - A prompt follow up in fulfilling the new funding profile will be very important to prevent cash flow problems.

General concerns from the Committee

- The remarkable progress in the ESS construction is endangered by the persistence of schedule slippage
  - The recently modified baseline schedule, based on input from in-kind contributors and on past ESS experience, is already delayed by a significant amount.
- Among possible causes of friction in the system:
  - IK contributors excess of confidence in their schedule estimation
  - As already pointed out in past TAC meetings, the absence of float in the planning makes it very prone to be heavily perturbed by minimal delays of single subtasks.
  - In the presence of one delayed task (e.g. from IK) other tasks running in parallel tend to change their priorities and delay their delivery as well. This can cause a generalized slippage with no clearly defined responsibility, and should be avoided especially on the ESS side.

General concerns from the Committee

- An excellent work was done in improving documentation, project management tools, detailed planning updates and design activities. The risk of overdoing it should be avoided, focusing more on practical realizations - installation, testing, commissioning,… - and moving resources accordingly.
- Controls support for accelerator, target, and instruments continues to be an issue. Controls will soon define the critical path for the project unless a solution is found. Staff turnover is still at a level that it is causing problems for the ICS Division.

General recommendations from the Committee

- **Schedule slippage appears in several tasks in parallel, as in the case of a systemic problem. Root causes must be identified and addressed**
- **Installations & readiness should have first priority. The accelerator part of building is available to the project. This time should be used as much as possible for installation of services, cabling and preparation for arrival of equipment.**
- **The ESS TSS (Target Safety System) is a critical system for the facility. Given its importance, then a dedicated review of the TSS with experts who have built and operated such systems is recommended.**

General charge question

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

Proposed topics for future TAC meetings

- Update on the cavity and cryomodule prototyping progress and test results.
  - The project is near 50% completion and critical prototyping is still ongoing. Although their critical functionality is already demonstrated, finalization of details for production may have a significant impact on the project and must be constantly monitored.
- Update in neutron instrumentation progress
  - There might be conflict in the sharing of resources
- Update in accelerator-target interface

Report of a-TAC18
17-19 Oct 2018

Maud Baylac, Frank Gerigk (Chair), Shane Koscielniak, Bernd Petersen, Mike Plum, Igor Syratchev, Hans Weise

Main Findings

- **General:** The Council approval of the new baseline schedule and the budget definition of initial operations in 2019 and 2020 puts the project on a much more realistic footing.
- There is impressive progress on civil engineering (e.g. target building).
- The management intervenes on items with high schedule risk. E.g. finding solutions for Cu plating of the DTL tanks, putting pressure to increase priorities within institutes to deliver ESS contributions, etc. This is commendable and should be continued.
- **Testing:** Valuable experience was gained in during the Ion-Source/LEBT installation and beam commissioning. The lessons learnt will much improve the procedures for the upcoming activities. Infrastructure availability is mandatory for testing and commissioning the accelerator components. High level organisation for installation, test, and commissioning procedures and the related management were planned and implemented.
- **Operation with target:** Some important things still need definition: How to determine that beam is hitting the right part of the target? What is the plan if the target imaging system is not working? What is the plan if it is decided not to deliver beam to certain target sectors?
- **Readiness:** The vacuum commissioning, documentation and testing was a good example for others to follow. Equipment handover and release forms, also beam permit and revocation forms were successfully introduced.

Main Comments

- **Schedule:** 5 months after the re-baselining, 3 months of delays have been accumulated for IK accelerator equipment. In the past delays were mostly caused by administrational, political, legal issues. Now the issues are technical.
- Reasonable compromises between formal procedures and the need for 'improvised' activities have to be set up, to deal with delays and non-conformities of components. Intense cooperation between ESS owners and In-kind partners is mandatory in advance of installation and testing at ESS.
- **Installations:** Qualifications for ESS staff to do certain electrical and mechanical work would speed up the installation process.
- **Readiness reviews:** Beside the formalities, basic technical issues may have been missed.

Summary of Recommendations

1. **General:** Streamline the effort spent on planning to free resources for installation and commissioning. Find pragmatic compromises between detailed planning and the tracking of critical milestones, which have impact on interfaces between activities. Detailed planning should be left to the equipment responsible and installation managers. Where possible, reduce formal procedures and documentation to a reasonable level to free resources.
2. **Infrastructure:** Installations & infrastructure readiness must have first priority.
3. **In-Kind partners:** Continue using / improving the direct involvement of ESS system owners in the external IK activities to prepare for later successful testing, installation and commissioning. The system owner has the ultimate responsibility to get his systems delivered and has to adapt his follow-up to the different IK partners.
4. **Operation:** During commissioning there has to be enough staff to operate and write instructions for operation. One 8 hr shift per day may prove inadequate; 2 shifts can provide an opportunity for catch up on the AD schedule. Means must be provided to facilitate conditioning of RF components for long periods when beam is not present.

Summary of Recommendations

5. **Integrated Operation:** Finalise use cases and probable fault modes. Work with the science/instrument specialists and those knowledgeable of target damage scenarios.
6. **Biasing of RF couplers:** We support the installation of the HV cables for all couplers and purchase a limited number of HV supplies. For the spoke couplers we recommend to pursue the biased version with the same approach as for the medium beta couplers.
7. **Readiness:** In the readiness reviews make sure that the process documents focus on the readiness of infrastructure and controls. The new HOTC and the installation and commissioning managers must be strongly involved in the preparation for these reviews, and be confident that rapid turn-on will be achieved.

General status & accelerator

Findings

- First planning of licensing established and ESS works closely with the authorities to keep the schedule for installation and commissioning.
- The RF stations of the CM test stand are installed and operational.
- **The management intervenes on items with high schedule risk. E.g. finding solutions for Cu plating of the DTL tanks, putting pressure to increase priorities within institutes to deliver ESS contributions, etc. This is commendable and should be continued.**

Comments

- **5 months after the re-baselining, 3 months of delays have been accumulated for IK accelerator equipment. In the past delays were mostly caused by administrational, political, legal issues. Now the issues are technical.**
- Since then substantial resources have been put into updating the P6 planning. Yet the update has still not finished.
- Many more changes in planning will have to be accommodated when the installation tsunami gains speed.

Recommendations

1. **Streamline the effort spent on planning to free resources for installation and commissioning. Find pragmatic compromises between detailed planning and the tracking of critical milestones, which have impact on interfaces between activities. Detailed planning should be left to the equipment responsible and installation managers. Where possible, reduce formal procedures and documentation to a reasonable level to free resources.**

Installation

Findings

- **Valuable experience was gained in during the Ion-Source/LEBT installation and beam commissioning. The lessons learnt will much improve the procedures for the upcoming activities. Infrastructure availability is mandatory for testing and commissioning the accelerator components. High level organisation for installation, test, and commissioning procedures and the related management were planned and implemented.**

Comments

- **Reasonable compromises between formal procedures and the need for 'improvised' activities have to be set up, to deal with delays and non-conformities of components. Intense cooperation between ESS owners and In-kind partners is mandatory in advance of installation and testing at ESS.**

Recommendations

1. **Installations & infrastructure readiness must have first priority.**

Testing

Findings

- Proposal for a "good enough" approach to test equipment.
- Very first beam at ESS!➔ important milestone.
- Lessons learnt from IS+LEBT testing/commissioning extremely challenging, but valuable.

Comments

- The arrival of HOTC should improve coordinating activities between divisions including testing. Responsibilities and contact with authorities seem well established ➔ positive feedback from a-TAC 17.
- Importance of HOTC role: global view and good knowledge of individual systems, decision making capacity, communication skills and leadership, make sure ICS ready on time
- a-TAC appreciates "good enough" approach, as long as it does not add additional work later on (re-testing, …) and the new core team has enough expertise to follow this approach.
- IS+LEBT : installation was efficient, but not the testing & commissioning phases: major issues (energizing, absence of operational limits, grounding) caused large delay for infrastructure readiness.
- Ensure sufficient time for hardware testing, before delivery and at ESS, and early coordination with ICS.

Recommendations (included in R2 & 3)

- **Ensuring infrastructure readiness on time to test equipment should be 1st priority possibly requiring increase of human resources.**
- **Increase technical overlap between IK partners /ESS staff for knowledge transfer.**

Commissioning

Findings

- Ion source commissioning has started. First beam on Sept. 19. Congratulations!
- The ion source commissioning is expected to continue for another few months. At the moment not all beam diagnostics are available (e.g. no cameras or Allison scanners), but they are expected soon. It is good that the lack of a full instrumentation suite did not delay the start of commissioning.
- The a-TAC committee is pleased that a new role of Testing and Commissioning Manager for the Accelerator (HOTC) has been defined. Specific persons responsible for planning/coordination of testing and of commissioning have been identified. Each technical system now has an owner.
- Many lessons have been learned from the ion source installation and commissioning that can be and will be applied to the rest of the accelerator.
- Main risks identified are: i) insufficient accelerator and ICS coordination, ii) under-estimate of installation complexity, iii) lack of spares when needed.

Comments

- a-TAC fully supports the new HOTC position.

Recommendations

3. **Continue using / improving the direct involvement of ESS system owners in the external IK activities to prepare for later successful testing, installation and commissioning. The system owner has the ultimate responsibility to get his systems delivered and has to adapt his follow-up to the different IK partners.**

Operation: Accelerator operation

Findings:

- Valuable experience and lessons learned with the installation, integration, and commissioning of the ion source.
- The roles, responsibilities, the methodologies, the software tools, etc, proposed are all good and should work.
- The daily coordination meetings are essential, as is dissemination of the plan to all persons who may be accessing the spaces.
- The plan is to hire the first two operators next year.

Comments

- This is the correct time for operator recruitment**.** Operators must have the full cooperation of service providers, particularly ICS, and equipment owners (RF, vacuum, diagnostics, infrastructure) to resolve (minor) faults as they occur or are encountered.
- Work Orders are a natural means to track worker locations and perform coordination.

Recommendations

4. **During commissioning there has to be enough staff to operate and write instructions for operation. One 8 hr shift per day may prove inadequate; 2 shifts can provide an opportunity for catch up on the AD schedule. Means must be provided to facilitate conditioning of RF components for long periods when beam is not present.**

Operation: Integrated operation of Accelerator and Target

Findings:

- The concepts being introduced (beam modes, destinations, pattern) are useful. Extending/refining the definition of "destination" to particular target sectors will prove useful. An early understanding of the timing/synchronization needs will also benefit the project.
- The operating scenarios are still being defined (e.g. how to do the initial alignment of target with probe beam, how to operate the accelerator/target interface in production).
- Some important things still need definition: How to determine that beam is hitting the right part of the target? What is the plan if the target imaging system is not working? What is the plan if it is decided not to deliver beam to certain target sectors?

Comments

- The parameters (upper and lower thresholds) for the Target Safety System (TSS), and whether any should depend on beam power, are still being defined. These should be specified and clarified.

Recommendations

5. **Finalise use cases and probable fault modes. Work with the science/instrument specialists and those knowledgeable of target damage scenarios.**

Biasing of SRF couplers at ESS

Findings

- It is foreseen that all the SRF couplers (spokes (26) and elliptical cavities (120)) will be equipped with HV bias option. The coupler processing to full power (warm/cold; SW/TW) will be done without bias voltage to enable the best surface cleaning procedure. The HV cables will be installed for all the couplers 'now' and purchasing of reduced set of HVPS (30%) is budgeted.
- The biased version of the spoke coupler will only be validated 02.2019, followed by 14 weeks for the prototypes to be ready and the last 'series' coupler arrival 04.2020. That is on a critical (yet feasible) path for the components installation in the tunnel.

Comments

- The HV biasing of SRF couplers is well proven technology. It certainly shall be implemented for all types of SRF cavities in the accelerator.

Recommendations

6. **We support the installation of the HV cables for all couplers and purchase a limited number of HV supplies. For the spoke couplers we recommend to pursue the biased version with the same approach as for the medium beta couplers.**

Readiness: High level Readiness

Findings

- A system of reviews is used to manage the test and commissioning process; viz the Installation Readiness Reviews (IRRs), Test Readiness Reviews (TRRs), Safety (i.e. Accelerator) Readiness Reviews (SRRs).
- The high level reviews are very complete in a formal way.
- The process exists and is being used extensively.

Comments

- Beside the formalities, basic technical issues may have been missed.

Recommendations

7. **In the readiness reviews make sure that the process documents focus on the readiness of infrastructure and controls. The new HOTC and the installation and commissioning managers must be strongly involved in the preparation for these reviews, and be confident that rapid turn-on will be achieved.**

Readiness: Lessons from the 1st Safety Readiness Review

Findings

- The vacuum commissioning, documentation and testing was a good example for others to follow. Equipment handover and release forms, also beam permit and revocation forms were successfully introduced.
- The SSR is convened by EH&S.

Comments

- The key thing is the first equipment was installed and tested, whether the outcome was good or poor.
- It brings a sense of accomplishment and realism to the ESS project which has so long been concerned with planning and design.
- Firmly include "beam readiness" in the review scope.

Have the recommendations and concerns expressed by a-TAC17 been addressed adequately?

- ESS AD responded very favourably to the a-TAC17 recommendations, instituting many of them. In particular, the identification of the installation and testing manager and head of testing and commissioning will bring the necessary urgency, focus and coherence to the integration effort that appears to have been missing for the ion source and LEBT.
- The a-TAC is very appreciative that the request from TAC17 to cover "Readiness Reviews, Commissioning Leaders, Hardware and Beam Commissioning Status and Results" was complied with at TAC18. As hoped, this turns out to be timely and opportune.

A-TAC18 answer to charges

a1) Is the planned organization for installation, testing and commissioning likely to result in an operating accelerator that meets its requirements in a timely manner? - Yes

- The planned high level organization seems appropriate, making it likely to reach requirements within reasonable time.
- The project should now put maximum support on installation/testing/commissioning. Consider re-allocating staff towards these activities, while reducing effort on planning and paperwork. Now is the time to be pragmatic and take charge of equipment.

a2) Are there any suggestions for improving the schedule performance of in-kind partners?

- Increase the commitment of IK lab management by having regular high-level directorate interactions. Offer technical support to the IK partners, when needed (as it was done for the Cu plating).
- Increase the technical participation to testing equipment (developing "ownership") at IK partners' labs. This should increase visibility of project and boost activity.

A-TAC18 answer to charges

a3) Are the schedules for accelerator and utilities installation reasonable? Are there any reasonable strategies for reducing the schedule? -- Yes

- With reference to the information shown, the schedules seem to be reasonable, even though further delays are likely to happen, which will need extra resources for follow-up. We note that there is no or only little float.
- There is a risk that the lack of utilities in the tunnel is delaying the installation & commissioning of accelerator equipment, as happened for the ion source/LEBT (5 months). Priority must be to have the necessary infrastructure ready. Consider 2 shifts if needed.
- Introduce pragmatism across the AD projects. Look into opportunities to move resources away from paperwork and schedule updating and into the field to work on installation and integration.
- Ensure electrical training to some ESS staff so that they can do cabling on their own without need for Skanska.

A-TAC18 answer to charges

a4) Are the presented testing and commissioning plans appropriate?

- Yes, on the basis of the information provided for TAC. Assuming utilities are ready and equipment is tested sufficiently before arrival at ESS, the commissioning periods may even be shorter.
- Early coordination with ICS must be in place to ensure readiness of ICS for testing.

a5) Is the strategy for high level readiness reviews reasonable?

- The framework of reviews (IRR, TRR, SRR) is reasonable, but the emphasis has to be adjusted from process engineering documents towards infrastructure and controls "present and complete". Management should ensure that excessive formalities are avoided.

A-TAC18 answer to charges

a6) Please comment on the experience so far from the ion source and LEBT commissioning and operations. Does this experience and the lessons learned bode well for future linac operations?

- The arrival of the first linac component at ESS marks a turning point, and must be celebrated. The preparations took much longer and were much more difficult than anticipated. This provided an excellent opportunity and motivation to adjust processes toward rapid turn-on. DTL installation will prove success.

a7) Have we missed anything?

- The connections to the ICS are very strong. Functioning beam diagnostics will speed commissioning; and functioning MPS will prevent lost time. So both must join the "integration" band wagon.

Proposed topics for TAC19

- Transportation of cryomodules
- Status of cavities & cryomodules
- ICS support for beam diagnostics
- Mechanical integration - Alignment ?
- Please provide an account to TAC members so we can access CHESS documentation
- Operations planning & staffing model.
- Progress on the target/accelerator interface.

cTAC Report on ICS at TAC18
17th -19th Oct 2018

Cyrille Berthe, Roland Mueller, Karen White and
Mark Heron (Co-Chair)

cTAC ICS Overall

Findings:

- ICS has made substantial progress since the last TAC, including operational control systems for the Ion Source and Cryo plant; and operation of the first phase of the PSS.
- Current scope of the ICS Division is clear in terms of software, electronics, infrastructure and integration, and support for Accelerators, Target, NSS and CF.
- Since TAC17 ICS staff and contractors have increased from 47 and 12 to 47 and 17 plus 5 more temporary employees; with 6 unfilled positions.
- There remains great demand from other divisions for ICS support.
- ICS is proactive in leading µTCA adoption and supporting EPICS 7 development.
- Infrastructure is available and functional and a cybersecurity firewall is in place, but authentication is the next step.
- Support of accelerator commissioning with beam is on a good track.
- Physics group supports accelerator, ICS has an eye on presence in the control room gaining understanding of the stakeholders needs.

cTAC ICS Overall

Comments:

- ICS staff are highly commended on their achievements.
- ICS Division has done very well to develop processes, support a wider range of subsystem developments.
- Development of the ICS Division is a major achievement and now has appropriate structure, and numbers. However they may have to focus more effort on Hardware Integration to meet the needs of customer groups.
- Developing and deploying the control systems on the accelerator in the coming years will put increased demands on ICS Division, while this needs to be planned for and the plans adhered to, there will be demands that will have to be addressed in a pragmatic way to support here-and-now project objectives.
- Cost increases from re-baselining are reasonable and to be expected.
- Constant development of the interface to technical groups is of mutual benefit, e.g. conditioning of the cavities will be scripted by RF experts using ICS tools.
- Resources in hardware, software and support should be available early, to help support the installation phase.
- Machine learning is new in the ICS portfolio and is commended, as it has to be considered these days, but not at the expense of priority tasks.

cTAC ICS Overall

Recommendations:

- ICS Management should give greater emphasis on the coordination with stakeholders beyond the accelerator to target and Neutron Scattering System (NSS). The role of an embedded ICS person in these Divisions could help improve understanding and trust.

cTAC Target Safety System (Operational Aspects)

Findings:

- Initial definition of the TSS safety functionality, logic, and operation was presented.

Comments

- The definition of TSS functionality was based on an abnormal condition switching off the beam. A better practice is to define the logic as the TSS enabling operation of the beam. In such a definition the failure modes of the TSS should be clearer and this helps understand and design a system that fails safe.
- The project proposes setting the trip limits for the TSS sensors to values based on a model for 5 MW operation. However the Target systems and sensors will not be qualified at such power for a number of years. Setting trip values should be based on the qualified operating experience of the target systems.

cTAC Target Safety System (Operational Aspects)

- The project may need to be prepared to go back to the Swedish Radiation Safety Authority (SSM) with changes in the operating envelope as the power is ramped up. This would enable redefining TSS thresholds appropriate to the increasing operating power.
- cTAC advises against provision for hot swapping a failed sensor during neutron production; it is more practical to have a policy or procedure that allows high level approval to authorize bypassing a single sensor (1 out of 3)
- The design appear at an early level with no details presented of required reliability, choice of technology or processes for managing design changes during the lifecycle. These are all critical to successful operation of the facility.

Recommendations

- The ESS TSS is a critical system for the facility. Given its importance, a dedicated review of the TSS with experts who have built and operated such systems would seem appropriate.

cTAC Integrated Operation of Accelerator and Target

Findings:

- The project presented a credible outline of many topics that need to be addressed in order to properly operate the ESS as an integrated facility.

Comments

- While some operations planning work was done in the past, many details must now be worked out.
- It seems to be the right time to form an interdivisional team to decide and document the details concerning operations parameters, beam modes and operating scenarios.
- Procedures need to be developed and should be in place now for systems that are already operating and require a response to off-normal conditions even during non-business hours. (e.g. Oxygen Deficiency Hazard, ODH)

cTAC Accelerator Operation

Findings:

- Role and responsibilities of the proposed operations crew is well perceived. Even long term perspectives are considered, e.g. utilize presence on site for emergency handling.
- Baseline operational tools are already available.

Comments

- Incredible opportunities are available, from the Python ecosystem of tools, which the project should look to leverage.
- In the early installation phase technical groups should be heavily involved in commissioning. This will help to establish and define a good operations model.

cTAC ICS New Baseline of the ICS project

Findings:

- Following re-planning, the ICS budget for completion is well understood, but the new cost estimate is more than 10% above the ICS allocation.
- Schedule is very detailed, generally resource loaded and follows very high level project milestones.

Comments

- Schedule, including intermediate activities to meet high level milestones, should be broadly communicated to staff and partners.
- To make the best use of limited resources, deliverables should be prioritized as absolutely required (Must) and those that could be deferred (Should) until later.
- Required deliverables should be addressed with a sense of urgency.
- Metrics are valuable tools, but need to be well aligned to actual business needs.

Recommendations

- Ensure each staff member and partner understands the intermediate activities needed to meet milestone and their role in the overall project success.

cTAC ICS Platforms for Beam Instrumentation (1)

Findings:

- Three hardware platforms have been selected based on required data rate. With high data rate option being MCTA for reasons of longevity, interoperability and maintainability.
- These standards are now documented and a process has been defined for augmenting the list of supported components based on need.
- MTCA components include a range of crates, carrier hubs, AMC cards, FMC modules and an Event Receiver.
- The project has settled on two FPGA development frameworks: the TOSCA Framework and the BI Framework.

cTAC ICS Platforms for Beam Instrumentation (2)

Comments

- The solutions presented are well thought out and provide a platform to realise a very powerful ESS control system.
- There are now two FPGA development frameworks one for the IOXOS and one for the Struck AMC modules. Such an approach provides a degree of mitigation against a single supplier failing and enables existing work to be built upon.
- There are approximately 12 different types of FPGA based systems to be built on the MTCA platform. The level of support required for this should be carefully considered.

Recommendations

- ICS should maintain sufficient stock of standard PLC, EtherCat and MTCA components above and beyond what is scheduled such that they are available to issue to their customers when they need them. Even when not expected.

cTAC ICS ESS Machine Protection System (1)

Findings:

- MPS implementation follows the international functional safety standard EN61508.
- The MPS is based on two systems, a slow one based on a Safety PLC and a fast one based on MTCA and FPGAs with the S-Link communication standard.
- The MPS team is performing extensive analysis of the MPS SOS equipment, verifying the reliability of the MPS equipment, which is very resource heavy to produce engineering process documents.

Comments

- Good progress has been made on system analysis to define MPS functional requirements
- Such analysis, in line with EN61508, is resource intensive. As the system does not fulfill a personnel protection function, a margin can be taken in strict compliance with the standard.

cTAC ICS ESS Machine Protection System (2)

Comments

- A balance in priorities must be such that system design, build and realisation is in line with project needs even if this mean systems analysis follows on afterwards.
- The hardware choices are made: safety PLC plus FPGA (Micro TCA), they are well adapted to the needs.
- The first results of average frequency of dangerous failure are good and encouraging.
- Equipment sub-systems should look after themselves (self-safe) in all matters except beam. MPS analysts should restrict analysis to those equipment failures that can cause beam damage.

Recommendations

- Bring more focus to the near term integration of the MPS with the linac. Less immediate emphasis on the reliability studies. Management should provide a compromise on the overly demanding documentation requirements.

cTAC ICS Automation of Control System Configuration

Findings:

- ICS will automate generation of Control System configuration.
- ICS were well aware of benefit and possible pitfalls due to systematic errors, intermediate graphical tools and importance of the sanity checking of the CCDB.
- IOC configuration is already maturing, PLC factory provided functionalities are appealing.
- Possible problems arising from change management of PLC code are already addressed.

Comments

- cTAC endorses this approach which is powerful and offers efficiency gains and consistency of definitions across layers of the Control System.
- Other facilities, e.g. ITER tried similar with varying success. To exploit full potential it could be mutually beneficial to share experiences.

cTAC Charge Questions (1)

c1) Concerning the ICS construction and initial operations activities:

• Are the presented strategies for ensuring the quality of the control system appropriate?

In general, yes.

• Are the principles for prioritizing and allocating resources to stakeholder activities adequate, what alternatives exist?

Customers and ICS report resource shortages for integration work although it seems the overall staff assigned to ICS should be enough.

• Have we missed anything - are there any particular difficulties that we could expect?

*Consider how ICS staff is allocated between the groups and work to supplement integration staff. Consider allocating all 6 open positions **initially** to integration.*

cTAC Charge Questions (2)

c2) Concerning the operational aspects of ICS:

- *Are the plans for machine modes and timing integration appropriate and complete enough?*

  Early idea for machine modes and timing was apparent, but work on realisation needs to begin in earnest.

- *Please comment on any weaknesses in the planned integration and interaction of machine subsystems with ICS?*

  ICS should engage in a very proactive manner with other divisions and in-kind partners. In person cross divisional communication should be improved. Strong consideration needs to given to overall automation of the facility.

cTAC Charge Questions (3)

c3) Concerning the new baseline for the ICS construction project plan:

- *Is the new baseline for the construction project plan appropriate - do you find any particular weaknesses?*

  Yes, the plan is appropriate, likely needs to be better communicated and resources clearly focused on intermediate goals.

- *Is the planning methodology, including planning quality objectives, sufficient and relevant?*

  Yes. Be careful about the use of metrics.

cTAC Charge Questions (4)

c4) Concerning the ICS platforms for beam instrumentation:

- *Are the use cases for using the ICS technical platforms sufficiently developed? Has anything been missed?*

  The ICS platforms are well developed. The two AMC solutions are reasonable and allow the project to move forward.

- *Do you have comments to the plan for deploying the ICS platforms for beam instrumentation?*

  Beam Instrumentation is critical and can be time consuming to develop. Consider taking an end to end solution for BPMs and BLMs and testing at another facility.

cTAC Charge Questions (5)

c5) Concerning the ESS machine protection system of systems

- *Is the analysis method and integration strategy appropriate for implementing machine protection into the complex accelerator and target systems?*

  Analysis is appropriate but should not be at the expense of early availability of hardware.

- *Is the verification and validation strategy for the fast beam interlock system (FBIS) appropriate? What are the issues?*

  Yes.

- *Is the integration of machine protection strategies into operations likely to be successful?*

  Yes provided the distinction between SOS and system of interlock is recognised.

cTAC Charge Questions (6)

c6) Concerning the automation of control system configuration:

•Is the concept for automation of control system configuration valid from an operational/practical point of view?

Yes.

•Please comment on any potential issues with the presented automation of control system configuration?

Seems very promising. Many have tried and the committee endorses this approach.

Suggested Presentations for cTAC 19

- Report on the Control System plans and development of the NSS
- Report on Integration Activities for system to be delivered in the coming 12 months from the TAC meeting
- Update on Target Safety
- Report on the MPS management interface: the plans, functionalities, prototypes and implementation status
- Report on how integration work is organised and managed with in-kind partners.

Report of t-TAC18
17-19 October 2018

Tim Broome, Michael Butzek, Phillip Ferguson (Chair), Masatoshi Futakawa, Graeme Murdoch, Szabina Török, Jörg Welte

t-TAC general

- Support and preparations have been, as usual, exceptional. Thank you!
- Significant progress has been made since TAC 17.
- Exchanging the site visit for more time in discussion was very fruitful.

Have the recommendations and concerns expressed by t-TAC17 been addressed adequately?

Yes, except for increased ICS support for Target and NSS, the t-TAC17 recommendations have been addressed adequately.

Progress on the bunker has been excellent. *The team performed very well under significant pressure. There are still items to address during the final design and manufacturing process, but nothing out of the ordinary.*

t-TAC17 recommendations

1. In light of the rebaselining activity, some thought needs to be given to appropriate resource levels with Target and ICS
2. Given the level of staffing, controls support for NSS must be increased as soon as possible
3. Increase integration of controls in mechanical hardware and cooling/utility process systems detailed design process as early as possible
4. The committee recommends that the bridge beam guide be retained
5. Explore reducing the thickness of the BBG windows
6. Engineering controls, including cables, locks, etc., should be used for the access system in the bunker
7. The committee recommends that a workshop be organized quickly where relevant experts from existing facilities (e.g., JPARC, SNS, and PSI) can meet with ESS and RACE staff to share their experiences and provide feedback on cell designs
8. There will be active handling activities in accelerator, target station and NSS. The committee recommends that an 'Active Handling' working group be set up at appropriate time to coordinate active handling activities and promote a common approach both in methods and equipment.

t-TAC18 answer to charges

t1) Concerning "Update on Target Station Accident Analyses":

- *Does the design philosophy and the methodology for dose calculations provide a solid basis for licensing of the Target Station? We also ask the committee to advice on how to improve the efficiency of the procedure for dose calculations.*

t2) Concerning "Monolith inner (water-cooled) shielding":

- *Will the presented technical solution, for the inner water-cooled monolith shielding, be a reasonable compromise to conflicting and challenging requirements?*

t3) Concerning "Scheme for beam lines alignment":

- *Will the envisioned installation scheme, in the end, provide satisfactory alignment precision for the neutron science instrument in cold and hot conditions?*

t4) Concerning "Update on waste management":

- *Will the pursued technical solutions for waste management of filters and contaminated water assure safe, efficient and reliable maintenance work within the Target Station? Proper ALARA?*

t5) Concerning interplay between Controls, MPS, TSS and Control Room:

- *Is the philosophy presented sound and appropriate for a safe and reliable operation of the ESS machine? Operations, Asset Protection and Safety.*

Concerning "Update on Target Station Accident Analyses": Does the design philosophy and the methodology for dose calculations provide a solid basis for licensing of the Target Station?

- **Findings**
  - Accident Analysis cases for consideration were already reduced from ~350 to 22 bounding cases
  - There are no "quick" ways to reduce to fewer bounding cases
  - Calculating all possible scenarios for these 22 cases produces a big work load
- **Comments**
  - ***The design philosophy and the methodology used for dose calculations provides a solid basis for licensing***
  - Search for additional bounding cases
  - Searching for methods to reduce the workload is understood by the committee but might not be possible
  - Ask existing facilities how they dealt with the problem of facility accident analysis. They may have methods, codes, etc. that can help.
- **Recommendations**
  - None

Concerning "Monolith inner (water-cooled) shielding": Will the presented technical solution, for the inner water-cooled monolith shielding, be a reasonable compromise to conflicting and challenging requirements?

- **Findings**
  - Maximum leakage 1g water/h for a minimum of 40 years of operation
  - Maximum thermal stresses have been calculated
  - Scoping LEFM calculation has also been carried out & indicates crack propagation not expected to be an issue
  - Cooling channel design path is complicated to satisfy the maximum cooling water temperature requirements
  - Significant testing is proposed to mitigate the chance of a leak:
    - Prototypes & mock ups
    - Material testing e.g. volumetric, ultrasonic corrosion, etc.
    - In-process weld testing, e.g. root pass, borescope, mock-ups etc.
    - Pressure and helium leak testing
  - An installation sequence as well as design for the water cooled shielding blocks inside the monolith vessel was presented.
  - Water channels in the blocks are realized by milled channels covered by a metal plate welded on. This results in ~ 2 km of weld seam for one block.
  - Redundant water channels were not possible for the blocks close to the target because of the high heat load.
  - The first block under the target can be replaced in case of a leakage. No others can.

Concerning "Monolith inner (water-cooled) shielding": Will the presented technical solution, for the inner water-cooled monolith shielding, be a reasonable compromise to conflicting and challenging requirements?

- **Comments**
  - ***A leak in the monolith inner shielding could potentially shutdown (end of life) the facility. Therefore it's imperative that the best possible design and fabrication solution is sought.***
  - All water systems will leak sooner or later
  - Proposed design for sealing cooling paths is challenging from a fabrication standpoint
  - The committee has concerns regarding what could be done if there is in fact a water leak during operation
  - Stainless steel is expensive. Using carbon steel bulk shielding (improved thermal conductivity) with stainless cooling pipes is a possibility
  - Relief grooves along the weld length could reduce the residual stresses
  - The cooling channel design path is complicated and the cover plate to seal the channels requires kilometres of seal welds.
    - This technical issue has been addressed in other similar facilities; design options that could improve the chance of success may be available
  - Weld inspection will be time consuming and somewhat difficult
  - In FEM calculation to evaluate the stress concentration, take account of a sort of notch shape effect around welded parts between block and lid plate.
  - Consider irradiation effect to evaluate the fracture toughness and fatigue strength on the welding; IASCC.

Concerning "Monolith inner (water-cooled) shielding": Will the presented technical solution, for the inner water-cooled monolith shielding, be a reasonable compromise to conflicting and challenging requirements?

- **Recommendations**
  - Consider other possible design options for the cooling channels and cover plates
  - Prepare for leakage of water systems inside the monolith and work on mitigation plans (repair or replacement) in case it happens

Concerning "Scheme for beam lines alignment": Will the envisioned installation scheme, in the end, provide satisfactory alignment precision for the neutron science instrument in cold and hot conditions?

- **Findings**
  - A scheme for aligning the monolith components as well as the beam lines was presented.
  - All possible sources of misalignment like settlement, elastic and plastic deformations and thermal expansion was considered over 170 m and 4 buildings
- **Comments**
  - With the existing design of the port block and neutron beam inserts the ***alignment scheme is complex but seems feasible*** and well thought through
  - The system is complex and the committee is concerned that the time taken to perform survey and alignment present a significant schedule risk.
  - Welding of the port block to the monolith vessel appears to be difficult as proposed
  - Continue to think about realignment scenarios, especially as the bunker continues to become more crowded
- **Recommendations**
  - Be aware of the number of alignment tasks and the impact on schedule

Concerning "Update on waste management": Will the pursued technical solutions for waste management of filters and contaminated water assure safe, efficient and reliable maintenance work within the Target Station? Proper ALARA?

- **Considered two topics: target cooling He-filters, facility waste water**

- **Findings**
  - The updated target cooling system with a new semi-manual handling of filter extraction was presented
  - Total activity of filters assumed 10 g of eroded W particles
  - An alternative to waste water piping was presented. Instead of the pipeline connecting different buildings to the waste management building the water will be stored in a local tank and transported by truck to either the waste management building or to the municipal drain water system depending on the activation/contamination.

Concerning "Update on waste management": Will the pursued technical solutions for waste management of filters and contaminated water assure safe, efficient and reliable maintenance work within the Target Station? Proper ALARA?

- **Comments**
  - Dose rate from the He filters is hard to estimate, but may be high
  - The filter pack replacement process may impose unnecessary dose to personnel. Technology can reduce the time (quick release flanges, etc.).
  - Current design of the change process requires opening the loop to change the filters, potentially resulting in particulate contamination.
  - Duplicate filters with a valve could allow cool down time before changing a filter.
  - Procedures/equipment to control the spread of contamination from the He filters should be developed
  - Waste water transport by pipes has been re-assessed; transport tank(s) will be used instead. This is good for multiple reasons.
  - This philosophy for the waste water is also implemented at J-PARC & ISIS.
  - Storing waste water locally avoids mixing low activity water with high activity and allows segregation into separate waste streams
  - Consider tritium treatment, which will be released unexpectedly from everywhere once contaminated.

Concerning "Update on waste management": Will the pursued technical solutions for waste management of filters and contaminated water assure safe, efficient and reliable maintenance work within the Target Station? Proper ALARA?

- **Recommendations**
  - ***Consider building a second filter system for alternate operation, allowing decay time for used filters.***
  - Look at changing the entire cartridge and not just the filter, avoiding opening the vessel until the filter has decayed, and open it in an area where you can control contamination, etc.
  - ***Proceed with the design to remove waste water piping***.

Concerning interplay between Controls, MPS, TSS and Control Room: Is the philosophy presented sound and appropriate for a safe and reliable operation of the ESS machine? Operations, Asset Protection and Safety

- **Findings**
  - The function of TSS is to ensure that a target incident which might compromise public safety is prevented
  - A TSS trip requires SSM to be notified
  - TSS trip levels will be set at values appropriate to prevent accidents (5 MW operations)
  - There is triple redundancy of the target system TSS sensors, with two out of three voting; TSS is the 3rd line (last line) of defense. Defense in depth.
  - Complex possible beam modes were presented
  - Current concepts for the Controls, MPS, TSS were presented.
- **Comments**
  - The TSS can be viewed as the equivalent of a rupture disk in a pressure system
  - Setting TSS trip levels at safety level values means that any systems which cannot reach the performance required will prevent accelerator operation. (e.g. problems with the helium blowers that limits the helium flow rate)
  - The responsibility for setting the TSS trip levels was not clear. They will have to be set without any significant operational experience.

Concerning interplay between Controls, MPS, TSS and Control Room: Is the philosophy presented sound and appropriate for a safe and reliable operation of the ESS machine? Operations, Asset Protection and Safety

- **Comments**
  - Complex synchronization between the accelerator and particular sectors of the target does not seem to be necessary.
  - Setting TSS limits for true safety cases seems to be reasonable in order to not tamper with a system that acts as "last line of defense"
  - For example: during commissioning it could be necessary to operate the helium blower at low flow in order to get temperature readings on the target at the kW level. For these conditions it may be required to over ride the TSS if you really need that data.
  - Review the requirements for data which needs to be shared between Controls, MPS, TSS and the Control Room and only implement those which are essential for commissioning and early operations. More functionality can be added later as needed.
  - Keep TSS as simple and slim as possible but talk to SSM to determine if override mode during commissioning is possible to allow learning about system behavior at very low beam power level. Maybe this requires hardware interlock to not allow higher beam power.
- **Recommendations**
  - Establish who is responsible for authorizing the TSS trip levels.

Suggestions for t-TAC19

- An update on delivery of key components, such as the target and the reflector, would be good
- Follow up on the inner shielding, including the selected design and progress, would be useful
- An update on the plant areas (water cooling plant, filter areas, etc.) and the active handling would be useful

Annex 1

Agenda TAC#18 October 17-19, 2018
ESS Office, Odarslövsvägen 113, Lund

	17 Oktober -18
11:45	Shuttle from Hotel
12:00	Light Lunch - TAC Members only
	TAC Closed Session
	Meeting room Saturn
13:00	TAC Initial working session - TAC Members only
	Plenary Session
	Meeting room Saturn
13:30	Welcome and overall status of ESS -R Garoby
14:00	Charge and Organization of meeting -R Garoby
14:10	Accelerator - M Lindroos
14:55	*Coffee*
15:20	Target - M Anthony
16:05	ICS - H Carling
16:50	TAC Working session - TAC Members only
18:30	Transportation to Dinner
19:00	*Social Dinner - *By invitation only* - Bryggan Cafe*
21:30	Walk to Hotel

	18 Oktober -18		
	Joint session: Concerning interplay between Controls, MPS, TSS and Control Room		
	Meeting room Saturn		
08:00	Target Safety System (operational aspects) - M. Olsson		
08:20	Integrated operation of accelerator and Target - T. Korhonen		
08:40	Accelerator Operation - M. Munoz		
	Joint, and parallel sessions		
	Accelerator	**ICS - Aries**	**Target - Tellus**
	Saturn	**Aries**	**Tellus**
09:00	Organization for accelerator installation, testing and commissioning - M. Lindroos	New baseline of the ICS project - H. Novella	Source to sample - F. Rey, I. Sutton, T. Lexholm
09:20	Accelerator installation schedule - C.		
09:40	Accelerator installation plan - P. Gustavsson		
10:10	*Coffee*		
10:30	Testing planning - I. Alonso	ICS platforms for Beam Instrumentation - S. Farina	Handling of waste water - L. Stenman
10:50	Commissioning planning - R. Miyamoto		
11:00			Helium filter design and handling - U. Oden
11:10	High Level Readiness Reviews - J. Weisend	ESS Machine Protection System - A. Nordt	
11:30	Results and lessons from the 1st Safety Readiness Review - L. Tchelidze		Monolith inner (water cooled) shielding - U. Oden
11:50	Results and lessons from Ion Source and LEBT testing and commissioning - H.	Automation of Control System configuration - K. Vestin	
12:10	Biasing of SRF couplers at ESS		
12:30	*Lunch*		
	Joint, and parallel sessions		
	Accelerator	**ICS**	**Target**
	Saturn		**Tellus**
13:30	Safety induction followed by Site visit - H. Fröderberg		Update on Target Station Accident analysis - P. Nilsson
14:15			**TAC Working session**
15:00	VR Room	*Coffee*	
	Accelerator	**ICS**	**Target**
	Saturn	**Aries**	**Tellus**
15:30	*Coffee*	**cTAC Working session**	**tTAC Working session**
15:50	**aTAC Working session**		
19:00	Shuttle to hotel - TAC Members only		
19:30	TAC Dinner at hotel - TAC Members only		

	19 Oktober -18		
	TAC Closed Session		
	Accelerator	**ICS**	**Target**
	Saturn	**Sirius**	**Tellus**
08:30	**TAC Working sessions**		
10:30	*Coffee*		
12:30	TAC Lunch		
13:45	Close out in Saturn - Will be streamed		
14:45	End of meeting		

Annex2

EUROPEAN SPALLATION SOURCE

Document Type	Agenda
Document Number	
Date	7
Revision	1 (1)
State	Preliminary
Confidentiality	Internal
Level	
Page	1 (4)

Charge to the TAC for its 18th meeting on October 17-19, 2018

1. Introduction

The ESS construction project is now ~ 50% complete and progress has continued at a high pace even during the summer months. Concerning Conventional Facilities, the Target station building has reached the height of the high bay floor, the long distance experimental hall and the logistics building are erected, the A2T connection between accelerator and Target is an advanced stage of construction… For Accelerator, Target and ICS, most components are now in construction, either through in-kind partners or directly in industry. Prototypes are being tested (Spoke cryomodule from IPNO in Uppsala, Elliptical cavity cryomodule in Saclay etc.). Klystrons for the Medium beta section of the linac have started arriving. The infrastructure installation organization is fully operational and it is now focusing on the first 100 meters of the klystron gallery.

Beam commissioning of the ion source and LEBT has started in the tunnel. It is managed by the operations team from the Cryogenics control room in G02. The RF Test Stand in the klystron gallery has started being used. Delivery and installation of the concrete blocks for the cryomodule bunker will begin at the end of October.

The new baseline which had been prepared during the first half of the year has successfully passed the review held in May and it has been accepted by the ESS Council. It foresees that Accelerator will be Ready for 570 MeV Beam On Target (Accelerator RBOT) by mid-2021, Target will be Ready for Beam On Target (Target RBOT) during Q1-2022, bunker and test beam line will allow Beam On Target (BOT) by mid-2022 and the Start of User Programme (SOUP) will be at the end of 2023.

A visit of the site in the afternoon of the second day will give to the TAC members the opportunity to judge the status of advancement. More details will be provided by the different subprojects during the meeting.

2. Charge questions

The following questions to the Committee address present concerns of the different subprojects:

- for the **Accelerator**:

a1) Is the planned organization for installation, testing and commissioning likely to result in an operating accelerator that meets its requirements in a timely manner?

a2) Are there any suggestions for improving the schedule performance of in-kind partners?

a3) Are the schedules for accelerator and utilities installation reasonable? Are there any reasonable strategies for reducing the schedule?

a4) Are the presented testing and commissioning plans appropriate?

a5) Is the strategy for high level readiness reviews reasonable?

a6) Please comment on the experience so far from the ion source and LEBT commissioning and operations. Does this experience and the lessons learned bode well for future linac operations?

a7) Have we missed anything?

- for the **Target**:

t1) Concerning "Update on Target Station Accident Analyses":

- *Does the design philosophy and the methodology for dose calculations provide a solid basis for licensing of the Target Station? We also ask the committee to advice on how to improve the efficiency of the procedure for dose calculations.*

t2) Concerning "Monolith inner (water-cooled) shielding":

- *Will the presented technical solution, for the inner water-cooled monolith shielding, be a reasonable compromise to conflicting and challenging requirements?*

t3) Concerning "Scheme for beam lines alignment":

- *Will the envisioned installation scheme, in the end, provide satisfactory alignment precision for the neutron science instrument in cold and hot conditions?*

t4) Concerning "Update on waste management":

- *Will the pursued technical solutions for waste management of filters and contaminated water assure safe, efficient and reliable maintenance work within the Target Station? Proper ALARA?*

t5) Concerning interplay between Controls, MPS, TSS and Control Room:

- *Is the philosophy presented sound and appropriate for a safe and reliable operation of the ESS machine? Operations, Asset Protection and Safety.*

- for the **Integrated Control System (ICS):**

c1) Concerning the ICS construction and initial operations activities:

- *Are the presented strategies for ensuring the quality of the control system appropriate?*
- *Are the principles for prioritizing and allocating resources to stakeholder activities adequate, what alternatives exist?*
- *Have we missed anything - are there any particular difficulties that we could expect?*

c2) Concerning the operational aspects of ICS:

- *Are the plans for machine modes and timing integration appropriate and complete enough?*
- *Please comment on any weaknesses in the planned integration and interaction of machine subsystems with ICS?*

c3) Concerning the new baseline for the ICS construction project plan:

- *Is the new baseline for the construction project plan appropriate - do you find any particular weaknesses?*
- *Is the planning methodology, including planning quality objectives, sufficient and relevant?*

c4) Concerning the ICS platforms for beam instrumentation:

- *Are the use cases for using the ICS technical platforms sufficiently developed? Has anything been missed?*
- *Do you have comments to the plan for deploying the ICS platforms for beam instrumentation?*

c5) Concerning the ESS machine protection system of systems

- *Is the analysis method and integration strategy appropriate for implementing machine protection into the complex accelerator and target systems?*
- *Is the verification and validation strategy for the fast beam interlock system (FBIS) appropriate? What are the issues?*
- *Is the integration of machine protection strategies into operations likely to be successful?*

c6) Concerning the automation of control system configuration:

- *Is the concept for automation of control system configuration valid from an operational/practical point of view?*
- *Please comment on any potential issues with the presented automation of control system configuration?*

The Committee is encouraged to provide also suggestions/comments and recommendations on any other subject it would find relevant. Feedback on the follow-up of former TAC recommendations is welcome.

A preliminary version of the TAC report is expected during the close-out session in the afternoon of Friday 19, October. The final report is expected before the end of October. The Chairman will orally present the TAC#18 report to the ESS Council on December 3-4.