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Target and Dump Proton Beam Imaging Systems CDR

Project adaptation to updated ESS accelerator schedule

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1. SCOPE

This document summarizes the schedule for the various subsystems of the target and tuning dump imaging systems with respect to the updated ESS accelerator schedule. The impact on the planned contractual milestones of the Oslo-ESS in-kind contract [ESS-0044049] is discussed. Possible ways to adapt the project to the updated ESS schedule are outlined.

This document should be considered "first thoughts" on the subject, and not as a description of final options for project adjustments.

2. INTRODUCTION

2.1. Project Schedule and Key Milestones

The following table includes the contractual milestones from [ESS-0044049]. The contract between Oslo and ESS runs from 01.01.2016 **until 31.12.2019**. The contract discusses that the final acceptance of the imaging system is done with beam. However, a clause was entered at the time of writing to formally allow for contractual acceptance of the system without beam.

#MS	Milestone WBS	Short description	Planned/Baseline date	Responsible	Location	Comment	EV [%] See 5.1.5
1	WBS 11.7.10	Kick-off meeting Start of Preliminary Design Stage	29 Feb, 2016	Univ. of Oslo	ESS	Start of Preliminary Design Stage	0%
2	WBS 11.7.10	Imaging PDR: Preliminary Design delivered and Review Closed Out	30 Sept 2016	Univ. of Oslo	Univ. of Oslo	Marks completion of the Preliminary Design phase	10%
3	WBS 11.7.10	Imaging optical performance achieved in simulations	31 March 2017	Univ. of Oslo	Univ. of Oslo	Performance of the 3 optical systems verified with detailed simulations.	15%
4	WBS 11.7.10	Imaging CDR: Detailed Design delivered and Review Closed Out	29 Sep, 2017	Univ. of Oslo	Univ. of Oslo	Marks completion of the Detailed Design phase and the start of major procurements	20%
5	WBS 11.7.10	Delivery of critical imaging components complete	18 May, 2018	Univ. of Oslo	ESS	SAR-1, Deliveries of the system components required for phase 1 integration	30%
6	WBS 11.7.10	All imaging components delivered and accepted.	18 Dec, 2019	Univ. of Oslo	ESS	SAR-2 (Final System Acceptance Review)[1]. [1] If no beam has been available by the project End Date, an	25%

						alternative acceptance review, not requiring commissioning with beam, will be held to mark completion of this milestone.	
	Total:						100%

In 2017 a significant re-scheduling of ESS accelerator installation and commissioning has taken place, with the result that the first beam on both the tuning beam dump and on target is now scheduled for October 2020.

The Oslo in-kind contribution consists of both manpower and hardware. The budget was at the start of the project made for the planned four-year period ending December 2019. Although hardware expenses can be delayed, possibly with future value adjustment, the Oslo hired manpower can in practice neither be delayed nor reduced in percentage or salary. This means that in order for Oslo to complete its deliveries on budget (zero additional cost), the deliveries must still be made by the December 2019 deadline. In this case ESS in agreement with Oslo must define acceptance criteria without beam.

Alternatively, in order to profit from the delayed ESS accelerator schedule to do more technical developments, likely to lead to even better performing imaging systems, Oslo could consider following the project all the way to commissioning with beam. However, in this case, a new contract as well as funding to cover manpower (and eventually future value adjustments to hardware) is required for the period beyond 2019.

After discussing the overall schedule for the projects we describe these two scenarios in some more detail.

3. OVERALL SCHEDULE CONSIDERATIONS

3.1. Tuning beam dump imaging systems

Installation and commissioning without beam

A preliminary high-level schedule for the tuning beam dump imaging system development is found [ESS-0150756], section 9. With the current planning for the dump and the dump vacuum vessel and beam line itself [ESS-0150756], it would appear feasible to deliver, install and test all imaging system components in situ, without beam, before the end-2019. It is highly unlikely to achieve in situ tests with beam by this date.

Commissioning with beam

As one of the design challenges for the dump system is the radiation environment of the tuning beam dump and the effect on electronics, it is important that the imaging system is commissioned by system experts. The system will not be ready for handing over to normal operation before a certain integrated beam power has been sent to the dump, including full ESS beam pulses. While individual components, like screens with coated or sintered chromox, may be tested with test beams, a realistic full system test with beam

cannot be done in existing test beam facilities due to the lower beam power and/or different geometry than the ESS beam dump.

3.2. Target imaging optical systems

Installation and commissioning with beam

Four of the mirrors, M1-M4, for each optical system, must be installed and aligned in the PBIP. This is described in [ESS-0153500], including a schedule (see Section 5) compatible with the present PBIP schedule. This schedule foresees that final installation and alignment of M1-M4 in the PBIP in the mock-up by the end of 2019. The final step, moving the PBIP from the mock-up to the final position is highly unlikely to happen by end 2019. Inspection of the imaging system after installation in final position is an important part of the system verification plan [ESS-0153500], and would require expert knowledge of the system. The installation schedule of the rest of the mirrors, M5-M7, in the high bay / connection cell, is pending more information about this part of the ESS construction, but might well only be possible after 2019. It is crucial [ESS-0153500] that the mirrors M5-M7 are aligned based on the final positioning of the PBIB in the monolith. This alignment would require expert knowledge of the system.

Commissioning with beam

Eventual system tests with test beam outside ESS will not be representative for the ESS target environment, due to the strong neutron flux and the thermo-mechanical characteristics of the PBIP. The PBIP characteristics have been a major driver in the optical system design, tolerancing and alignment strategies. It is important that expert knowledge is retained for the commissioning with beam when the PBIP gets heated in order to survey whether the deformations of the system are as expected. Furthermore, the interpretation of fiducials, verification of the motion deblur, investigation of noise level, are all commissioning items that require access to system experts.

3.3. Target imaging luminescent coating

The proton beam window, the target and possibly the tuning beam dump will be thermal sprayed with luminescent coating, the baseline being a $Cr:Al_2O_3$ coating as used at SNS. At the present state of discussions with target, the coating of the target should take place at latest mid-2019, and the proton beam window well before this. This information is based on oral communication and is not official at the present state of writing. This schedule means that the industrial process development for the $Cr:Al_2O_3$ must be completed by mid-2019. We remind that a SNS-based $Cr:Al_2O_3$ coating is not expected to perform sufficiently well to ensure imaging for ESS full power operation (production). In order to arrive at coating solution for the ESS production mode, it is important that the research and development for new coatings, currently part of the Oslo-ESS in-kind work, continue also after 2019.

3.4. Electronics and software

The imaging system images will be analyzed using FPGA and software based on ESS ICS standards. The task of Oslo is to develop top level algorithms, analysis software, and user

panels [ESS-0044049]. While much of this work can in theory take place ahead of or in parallel with the installation of the hardware, prototypes of the final software and hardware framework must be available to complete this work. As present such framework is far from being ready [ESS-0150753] and with the current progress it is likely that complementary FPGA and software development will have to take place after 2019. During commissioning with beam it is also likely that modifications of delivered software and firmware will be necessary. Such modification will profit from access to experts who have developed the software.

4. PROJECT COMPLETION AT ZERO ADDITIONAL IN-KIND COST

In order to complete the Oslo in-kind project at zero additional in-kind cost all deliverables need to be completed by December 2019. Final acceptance reviews needs to be done without beam. Acceptance criteria should be defined by ESS and agreed upon by Oslo. A large part of the final installation and alignment of the systems, in the PBIP and tuning beam dump especially, may have been successfully completed by December 2019 with the help of Oslo, according to present schedules. Final alignment of the target systems, and final verification with beam will take place after the contact.

With the updates ESS schedule it is likely that both parties (Oslo and ESS) will prefer to move milestone 5, SAR-1, forward in time to allow more time for component procurement and testing in Oslo before delivery to ESS, typically towards end 2018. Milestone 6, SAR-2, can not be moved any further, beyond the contract period.

In-kind personnel still with Oslo will be happy to answer questions and communicate with ESS after the end of the in-kind contract, in order to maximize the success of the project. However, the bulk of the man-hours in the project are being done by temporary Oslo employees, employed with in-kind money. It is possible that they will go on to new jobs when the in-kind contract ends. In this case having access to answers on detailed technical questions cannot be guaranteed, and for example travel to ESS by former experts in new jobs is unlikely to be possible.

5. PROJECT COMPLETION BY ACCEPTANCE TESTS WITH BEAM

In order to complete the Oslo in-kind project as foreseen, the project should continue until acceptance tests with beam have been completed. Hardware costs can be delayed. Key project manpower must be extended until the new project end. As minimum a full time project engineer, 25% of a research engineer, some allocations for electronics and mechanical workshops, and some travel cost, should be covered by a contract extension. Oslo could possibly contribute with project manager at no cost, infrastructure, some co-funding of workshop labor and compensation for future value adjustment of hardware.

Even if a contract extension is agreed upon, Oslo will require that the updated schedule allows for completion of all milestones and payments, as originally agreed. If not, there could be considerable juridical issues to deal with, since the Oslo administration will notice a discrepancy between contract and payments (this is the project managers

personal opinion, no dialogue with Oslo lawyers on this subject has started). The new contract, on the other hand, could for example define a final system acceptance with beam ("SAR-3") as condition for payments related to the new contract.

6. CONCLUSION

Oslo is open to either delivering imaging system components at the original delivery date, at no extra cost, or considering an extension to the in-kind contract to keep Oslo manpower and support ESS until the final system commissioning with beam has taken place. In both cases, it is important that the milestone payments for the original contract are done before the end of the original contract.

Glossary

See: https://ess-ics.atlassian.net/wiki/display/BIG/Abbreviations

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	CDR	Erik Adli	2017-10-10