CTA-SST Engineering Review Panel Report

Prepared by: Rodolphe Clédassou & CTA SST engineering review panel

Approved by: Wolfgang Wild Digitally signed by Wolfgang Wild Date: 2020.09.03 16:37:06 +02'00'

Wolfgang Wild, CTAO Project Manager

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Federico Ferrini, CTAO Managing Director

Change Log

Issue	Revision	Date	Section/Page affected	Reason/ Remarks / Initiation Documents
1	0	31/07/2020	All	First draft of the document
1	1	21/08/2020	All	Update taking into account panel members comments and remarks.
2	0	01/09/2020	All	Update after final verifications and last comments.

Table of Contents

1 Introduction

This report summarises the findings obtained during the CTA-SST engineering review and assesses the achievement of the review charges.

2 Documents of the review

2.1 Applicable documents

Document Title	Document number
CTA SST Engineering Review Plan	CTA-PLA-SST-305000-0001 Version 1.1
RIX Procedure and Guidelines for the SST Engineering Review	CTA-PRO-SST-305000-0001_1a Issue 1
CTA System-Level Science Performance Requirements	CTA-SPE-SCI-00000-0001, Issue 1.0
Critical SST Requirements	CTA-SPE-SST-40000-0001, Issue 1.0

2.2 Reference document

Document Title	Document number
SST Programme Proposal [RD01]	n/a (under revision) Version V1.0 (11-11-2019)
An SST-2M Implementation Concept [RD02]	n/a. Version 1.2 (31-10-2018)
CTA System-Level Science Performance Requirements	CTA-SPE-SCI-00000-0001
SST Critical Requirements	CTA-SPE-SST-40000-0001

2.3 Documents submitted to the review

See appendix.

3 Scope of the panel and review objectives

3.1 Review purpose and expected outcome

The SST Design and Value Engineering Review (hereinafter-called SST-ER) was held to assess the current prototypes designs of the SST structure and camera with the aim of (a) further industrialization and (b) further optimization for cost and maintenance. In this respect, also an evolution of the telescope design starting from the ASTRI prototype and improved in terms of reliability, has been considered, along with industrialization and maintenance. This will be achieved via implementing all or part of the findings of the review, which was carried out by an external and independent review committee with the composition, procedures and charges proposed by CTAO and agreed by the CTA-SST Consortium and the CTAO Council.

The outcome of the review panel work is a series of action items and recommendations concerning design optimizations, in response to the panel charges in Section 3.2. These recommendations will be submitted to the Decision-Making Authority. Based on the recommendations adopted by the Decision-Making Authority, the SST Executing Steering Committee will finalise the design to be used for the manufacturing of the SSTs after successfully passing the SST Critical Design Review.

3.2 Review panel charges

The following charges to the SST Engineering Review Panel have been agreed between the SST Consortium and CTAO and approved by the CTAO Council. The Panel was asked to address these charges in the review meeting and this report.

Charge 1 – Advise the SST Consortium and CTAO Management on possibilities, options and design modifications to optimize the existing ASTRI telescope structure design and CHEC camera design regarding the cost for production and maintenance as well as ease of maintenance.

Charge 2 – Advise the SST Consortium and CTAO Management on possibilities, options and design modifications to optimize the existing ASTRI telescope structure design and CHEC camera design for further industrialization.

Charge 3 – Advise the SST Consortium and CTAO Management about any further possibilities to reduce the production and operations cost of the ASTRI structure and CHEC camera.

The review panel submits this report to the CTA Project Manager and Chair and Vice-Chair of the ad interim SST Executing Steering Committee.

4 Panel proceedings

The review was carried out by one single panel, whose competences were covering the overall SST engineering review technical fields.

4.1 Panel composition

The Review Panel composition was the following:

Name	Affiliation and position
Rodolphe Clédassou (Chair)	CNRS IN2P3 (France) Directeur Adjoint Technique
Giulio Ballio	Politecnico di Milano (Italy) Rector (emer.)
Matthias Kleifges	Karlsruhe Institute of Technology (Germany) Deputy Head of Institute for Data Processing and Electronics
Max Kraus	European Southern Observatory (IGO) Mechanical Engineer
Silvio Rossi	European Southern Observatory (IGO) Head of ALMA Technical Team
Wilco Vink	NIKHEF – National Institute for Subatomic Physics (Netherlands) Electronic Technology Dept., Electronics Engineer
Roberta Zanin	Cherenkov Telescope Array Observatory (Germany, Italy) CTA Project Scientist
Kjetil Dohlen	Laboratoire d'Astrophysique de Marseille – LAM (France) Head of the Optics Department

4.2 Meeting dates and participants

Participants list is given in appendix. Below are the review milestones.

Meetings and dates	Duration	Start	Finish
SST-ER Arrangements			
Review Plan released	0 days	2020-05-08 Fri	2020-05-08 Fri
Review website preparation	5 days	2020-05-11 Mon	2020-05-15 Fri
SST-ER Preparation			
Review documentation preparation	21 days	2020-05-08 Fri	2020-06-05 Fri
Review panel 1st Meeting	1 hour	2020-05-19 Tue	2020-05-19 Tue
Review documentation released	0 days	2020-06-05 Fri	2020-06-05 Fri
Documentation review by the Panel	15 days	2020-06-05 Fri	2020-06-25 Thu
Review Panel Kick-Off meeting	3 hours	2020-06-10 Wed	2020-06-10 Wed
RIX submission deadline	1 day	2020-06-25 Thu	2020-06-25 Thu
RIX consolidation by panel chair	1 day	2020-06-26 Fri	2020-06-26 Fri
SST team responds to RIXs	5 days	2020-06-29 Mon	2020-07-03 Fri
Panel reviews RIX responses	5 days	2020-07-06 Mon	2020-07-10 Fri
Prepare meeting & presentations	5 days	2020-07-13 Mon	2020-07-17 Fri
SST-ER Session			
Review meeting	2 days	2020-07-20 Mon	2020-07-21 Tue
Panel draft report	7 days	2020-07-22 Thu	2020-07-30 Thu
Draft report in revision / final report	19 days	2020-08-28 Fri	2020-08-28 Fri
Final report released	0 days	2020-09-01 Tue	2020-09-01 Tue

4.3 RIX / Action Items statistics

RIX (Review Item discrepancies) have been managed using the RedMine platform with access limited to the review participants:

https://forge.in2p3.fr/projects/sst-engineering-review/issues

They were generated by the panel through examination of the documentation delivered at: https://forge.in2p3.fr/projects/sst-engineering-review/documents in due time by the project team.

An overall consolidation was done by June 26th which led to the following RIX overview:

RIX	Created	Rejected	Withdrawn	Accepted			
				Low	Normal	High	Total
SST System	17	0	0	0	14	3	17
SST Structure	55	0	0	3	51	1	55
SST Camera	15	0	0	1	14	0	15
SST Subsystem	1	0	0	0	1	0	1
Total	**88**	**0**	**0**	**4**	**80**	**4**	**88**

The project team answered by July 6th online to the RIX and the panel analysed the answers. This culminated in a global consolidation of their status by the panel on July 10th.

Following this meeting 66 RIX have been closed (40 with an action or a recommendation) and 22 have been kept for discussion at the review meeting. In preparation of the review meeting, the panel asked the project team to prepare a short presentation as reply for the remaining RIX.

Hence, the review meeting occurred on the 20th and the 21st July by videoconference. This permitted to address the remaining opened topics and to close the remaining RIX.

The current RIX closure status is the following:

RIX	Low	Normal	High	Total
Closed with action	1	51	4	56
Closed	3	29	0	32
Still open	0	0	0	0
Total	**4**	**80**	**4**	**88**

Several action items (AI) and recommendations (REC) have been generated through the analysis of the RIX. These AI & REC are due for different project milestones to come.

It is understood by the panel that after the closure of the SST engineering review, a bridging phase will begin. This bridging phase will start by a bridging phase Kick-Off (BKO) and end by a proposed design review (PDR). Then the programme will enter its Design Consolidation Phase for which system critical design review (CDR) is a major milestone prior to start production.

The panel also identified the following milestones for completion of the AI & REC:

- Before bridging phase kick-off (< BKO)
- Before proposed design review (< PDR)
- Before critical design review (< CDR)

37 action items and 9 recommendations have been generated.

The following table gives an overview of the statistics of AI with respect to the due dates:

Due date	Number of AIs
< BKO	13
< PDR	19
< CDR	5

5 Main findings

We give hereafter the panel findings on the different aspects of the project. The general discussions below are reflected within the action items that have been generated. Beyond these action items, the panel gives its conviction on the general philosophy that should be pursued for the project development.

5.1 SST-Project Office

The long competition between different concepts supported by intense prototyping has become a real point of strength of the project. It permitted to reach a very good maturity with regard to the scientific performances that one could expect for the whole observatory. This is illustrated by the overall good documentation that has been submitted to the review.

Considering this maturity and facing the challenges to produce, test and install 50 telescopes in a tight schedule and in an adverse environment, **the panel thinks that the project should be managed by costs & schedule** (referring to the triangle of virtue Cost / Schedule / Performances).

Consequently, although good work has already been done in that direction, reinforcement of the overall management structure and process during the upcoming months is certainly a priority. More consistency will be needed in the everyday work, insuring smooth flux of information, adhesion to the overall objectives, and enhanced team spirit. To this end several action shall be taken, among them are:

- Consolidation of the management plan
- Setting a detailed costs management plan (with sufficient margin)
- Setting a strong schedule management with ample margin (a person dedicated to the overall schedule consolidation would be an asset)
- Put in place a centralized product assurance & quality management
- Initiating configuration & documentation control

5.2 SST-Camera-Project Office

The SST-Camera project was found in a good state with a strong and sound organization. It raised a small amount of questions and AIs. Among them was the fear of a project management that would be too disconnected from the overall SST programme. Although these fears have been erased by discussions, there is a point of alertness remaining.

Apart from technical points here and there that led to a few AIs, some recommendations are issued and will be discussed in the related chapter.

Apart from that, the panel thinks that there is still some leeway to optimize the Camera production plan. This should be worked out and presented at PDR.

5.3 SST-Structure-Project Office

The SST-structure design was found mature and undisputed. This is due to the huge work done to build the telescope prototype that is currently being operated in Sicily. This is also coherent with the preparation of the contract for the upcoming mini-array.

Nevertheless, this has a drawback, which is reflected in a number of questions raised by the panel. The telescope structure documentation is actually build relying on the prototype. This prevented the project team to specify the design by the needs rather than by the experience obtained through prototype building, testing and operations.

The panel thinks that some work has to be done during the next phase, to step back, make use of the results from the prototype and revisit requirements and selected hardware in view of design optimization and simplicity wherever possible. This work shall be done with the aim to enhance robustness, safety, maintenance and operations.

The mini-array subject raised a question on the availability of personals with respect to the CTA-SST program. Although the development of the telescopes composing the mini-array will be made by industry, the amount of work needed on the customer side will be huge especially during its deployment and early operations. The fear is that the mini-array project may jeopardize the CTA-SST programme schedule by lack of adequate manpower. Appropriate risk moderation should be made and may be a review on the work force needed for the two projects should be scheduled.

5.4 SST-STR-Optics

The optics design is based on existing technology with a strong feedback. This explains that the information given is sometimes less driven by requirements than by expertise. This may be a weakness in the project development (requirements & performances control, tests plans, etc.). Many RIX raised were then directed towards having better explanations. They point towards having more details in the technical description and expressing more rigorously the requirements.

The action items assigned to this part show this.

5.5 SST-STR-Structure

Prototyping the entire structure and having a model in operations in Sicily has reinforced the confidence in the performances of the structural concept. However, this advantage has not been entirely used. It could permit to crosscheck dynamic models (simulation and computation) to actual results, both in factory and on site. The panel suggests some actions in that direction.

In addition, the panel supposes that the current design has ample structural margin and that some of the subsystem solutions implemented are sometimes oversized for the real needs. Thanks to a more detailed analysis of the current loads on the prototype and a consolidation of the models, it should be possible to carefully update the requirements on the equipment. After that, some of the selected solution can be revised to better fit the updated performances needs.

5.6 SST-Camera-Electronics

Exchanges on the topic between the project team and the panel persuaded the panel that the development of this part of the camera is well mastered. Nevertheless, the panel pointed out to some action items that will permit **to decrease the workload once on site**.

In that field, the panel suggests to enhance strongly the tests coverage on embedded software.

Similarly, the implementation (internally to the camera collaboration) of systematic design reviews for boards and schematic is deemed a common good practice and the panel encourages it. These reviews should not be limited to the boards or schematics that will change from the prototyping phase to the production one.

Finally, the panel suggests the implementation of a common timing board for the different CTA cameras. Actually, it has many advantages among which are knowledge and disposability.

5.7 SST-AIV

The panel found the AIV project the weakest part of the overall programme. Two recommendations are made to enhance the maturity of the overall SST array AIV concept. They are described in chapter 7.

Here we point out to two action items that are essential for the consolidation of the deployment schedule:

- The CTA-SST AIV schedule seems very aggressive. It is embedded within the overall CTA deployment schedule. The panel fears that slips in the CTA-SST deployment could jeopardize the overall CTA deployment schedule (with extensive delays and costs). The only way to master this is to allocate adequate margin to CTA-SST AIV and that its schedule fits within the CTA big picture. The number of telescopes to build on site is certainly a key parameter of optimization here.
- The installation of the camera is certainly one of the most delicate part of an SST construction. It will drive the AIV, the maintenance and the safety. The project team

shall describe it in detail and at short time, so that it can become a priority to be taken into account in the structure optimization.

5.8 SST-Operation & Maintenance

Operations & maintenance will be challenging, and the operation & maintenance concept shall be considered very early. Wherever possible, it shall become mandatory for the telescopes design.

The panel emits a recommendation on that topic in chapter 7.

More specifically, some topics need to be addressed as part of an overall effort to consolidate this part:

- The project shall develop and implement an SST programme safety plan (including SST projects levels) derived from the completion of the overall Safety Plan by CTAO. The associated requirements will be derived from telescopes design.
- The mirror coating, de-coating and re-coating problematics can be an area that drives maintenance costs and schedule. Some technical work shall be done to understand the needs better. Then the project will be able to agree on the associated trade-off (re-coating on site or off site, no re-coating, buy additional spare mirrors …) with respect to schedule and costs.

6 Issues brought to the attention of CTAO

The panel suggests two areas where CTAO should take actions for helping the SST project consolidation:

- The flow-down of requirements has been found a weak point. Although some documents exist in the field, they are incomplete and need to be revisited in view of verifying the completeness of their coverage. In that respect, the SST top-level requirements need to be updated on a short timeline and matched against the SST documentation.
- Maintenance will be of utmost importance for the observatory smooth functioning with mastered costs. In that respect, CTAO shall derive top-level requirements that may affect the telescopes design. Such a high-level document needs to be issued rapidly.

The panel address these two points in **AI-SST-ER-08 and AI-SST-ER-09.**

7 Recommendations brought to the attention of the board

SST-AIV:

Experience feedback on previous projects shows that the work and difficulties related to AIV on site are very often underestimated. This is particularly true when the site is located in an adverse environment. At the same time, there is a natural tendency to trade the on-site operations costs in favor of a decrease of the ones on the production line and of the transport.

The panel thinks that alternate assembly strategies should be investigated (for instance, one based on shipments of large parts using general cargo instead of containerized shipments). This could result in reduced assembly and test effort on-site against increased transport cost.

REC-SST-ER #01
Trade and optimize the assembly strategy in view of reduced assembly and test effort on-site against increased transport cost. This shall be done before SST-PDR.

The AIV project definition has been found the weakest part of the overall SST program. Its maturity is deemed insufficient at this stage and a strong effort has to be done in the coming month and during the bridging phase to bring it to the appropriate level. Discussions with the project team have shown that many good ideas are "in the air" but this shall be reflected in the definition of activities to be done for the AIV and the commissioning of the telescopes.

Hence, the panel proposes the two following recommendations:

REC-SST-ER #02
Considering the amount of work to be done and the current maturity of the project, the panel strongly recommends to appoint an experienced AIV project manager, fully dedicated to this task. This person shall join the project team for BKO at the latest.

REC-SST-ER #03
A global work shall be done to consolidate the AIV & Commissioning phases with respect to schedule, human resources & needed facilities on site (both with industry and laboratories resources), and to verify that the cost of these activities is commensurate with available expected funds. SST-PO shall establish a dedicated interface document between the "SST-Program" and the "on-site construction program" that will describe the facilities, tools, logistic and services needed. This work shall be completed by SST PDR.

SST-STR production:

It is understood that the overall production specification will be documented for the future STR production and AIV contract. This will be done once the design will have been frozen (i.e. after PDR). However, this relies on a clear definition of the in-kind contributions (IKC) provision which are undefined today and which will be confirmed with the ERIC official birth. Moreover, due to local institutional constraints, IKC may have a dramatic impact on the production schedule and in consequence to the overall project. These uncertainties prevent to build a consolidated and realistic schedule with the needed margins.

Therefore, the panel emits the following recommendations:

REC-SST-ER #04
CTAO shall freeze as soon as possible the technical perimeter of the IKC such that the production scheme and schedule of the STR can be consolidated and frozen.

REC-SST-ER #05
SST-PO shall establish with the partners a potential IKC list and build coherently a consolidated production scheme and schedule for the STR (several options can be addressed). This schedule shall encompass ample margin.

Consolidation of the SST-STR current design:

Until recently, several concepts of the SST-STR were in competition. The panel acknowledges the decision taken to choose one of them (namely the ASTRI concept). Since then, the SST-STR project has begun a design optimization phase that could possibly benefit from the skills and ideas of the teams that were involved in the alternate concepts. The panel thinks that it is important at this stage to finalize this work before BKO.

Concerning design option #2 proposed by Observatoire de Paris, the panel recognize that the Serrurier-like concept could be a good enhancement for the SST telescope. However mixing this concept with the current ASTRI design would correspond to a new structure concept. Adopting it for the production w/o having built a prototype would be an additional risk to the overall program. At least a complete design iteration loop would be needed. The current schedule is already too tight to allow performing these activities.

REC-SST-ER #06
The panel recommends not to investigate further the Serrurier-like concept.

The design option #3 proposed by Observatoire de Paris, - a M1 mirror dish modification using a beam structure - seems to bring enhancement to the current ASTRI concept. Therefore, the panel recommendation is:

REC-SST-ER #07
The panel recommends to further study the feasibility of modifying the M1 mirror dish structure using a beam structure, pending that the current overall structure design is kept unchanged (as an example: similar displacement & loads at interfaces with the overall structure).

Consolidation of the SST-CAM project:

Overall, the panel considers the SST-CAM project on a good track as it has already been said. Nevertheless, the panel wants to rise one recommendation to the attention of the board.

Concerning the ASIC qualification, the SST-CAM project has chosen not to test ASICs with a probe station before having them packaged and soldered on PCBs. This is unusual with respect to common practices (especially for analog ASICs). This certainly permits to save time and costs. However, common experience shows that a lack of ASIC tests before soldering it on PCBs in the production is very often paid by time, costs and even performances during the ultimate phases of production and commissioning.

Therefore, the panel emits the following recommendation

REC-SST-ER #08
Reopen a trade-off (time, costs, risks, etc.) between the implementation of testing ASICs before having them packaged and provisioning a sufficient number of fully integrated spare boards (with ASICs) to compensate production losses that may arise.

Maintenance & Operations:

One charge of the panel is to see if qualified solutions can be implemented in view to reduce maintenance & operations cost and to see if there are ways to ease as much as possible these activities. One particular aspect related to this is the safety insurance. In addition, the commissioning phase of the overall array of 50 telescopes will certainly be challenging, as it is a period where problems arise with the potential implication of many interventions on the telescopes (especially the cabinet). Moreover, the panel noted that there are extensive structural margins within the current design that would permit to accommodate access to the SST. Even if reduction of weight is a priority, the panel think that one part of the structure can be dedicated to this.

REC-SST-ER #09
The panel recommends improving the overall access concept of the SST in view to enhance its maintainability. To this end, the following actions are suggested:

- *Review the overall access concept (especially the cabinet access).*
- *Perform a hazard analysis to enhance the safety of operations.*
- *Take into account experience feedback from multi telescope projects (example: ALMA) but also from the SST-prototype.*
- *Make use of the prototype to challenge the updated access concept*

8 Achievement of review charges

Although the panel thinks that the evaluation of its work would be a duty of CTAO, the feeling was that the three charges awarded were treated.

9 Conclusion and panel overall evaluation

The panel acquired the conviction that the SST project is on a good path. The overall design is mature, sound and solid with good design and performances margins. The project is now at a point when it is necessary to consolidate and optimize it (design, management, AIV…). There is time for this if the decisions on the proposed AI & REC are not delayed.

As showed in the recommendations, different actions may be taken in order to optimize costs and workload. The careful trade of production costs against on site AIV, test, operations and maintenance is definitely an important aspect, with the number of telescopes being a key parameter.

Building on that, with a strong managerial structure, the project may be developed successfully with a management by costs and schedule.

10 Proposals to CTAO for lessons learned

Fully remote review:

Although a fully remote review is less friendly than a collocated one, the impression of the panel was that its management was smooth and efficient. This is certainly something that could be generalized or at least encouraged for future reviews.

Additionally, a remote review cannot be led as a collocated one (calendar, nature of presentations, duration of the sessions …). This is why considering the elaboration of standard procedure for remote reviews could be valuable to CTAO.

11 Appendix

11.1 Documents submitted to the review

Document Title	Document number
SST Subsystem Documentation	
SST end-to-end Prototype performance	SSTER-SST02-E2E (V 1.0)
SST-STR/SST-CAM and SST-CTA System Interfaces (draft document)	SSTER-SST03-IS (V 0.6)
Management Plan and Schedule (draft)	SST-INAF-PLA-002 (V 1.a)
Quality Plan	SSTER-SST05-QP (V 1.1)
On-Site AIV Plan	SSTER-SST06-AIV (V 0.8)
SST Telescope Structure Documentation	
SST-STR Requirements Specification	SSTER-CAM01-RS (V 1.1)
SST-STR Design Compliance Matrix	n/a
SST-STR Prototype Design Report (Mechanical Design)	ASTRI-DES-GEC-3100-011c
SST-STR Prototype Design Report (Optical Design)	ASTRI-DES-OAB-3500-002 (V 1.1)
SST-STR Prototype Design Report (Structure Design)	ASTRI-TR-GEC-3100-016e
SST-STR Prototype Design Report (Performances & lessons learned)	SSTER-STR03-PDR-04 (V 1.0)
SST-STR Description of the intended final design (Mechanical Design)	ASTRI-DES-EIE-3100-027c
SST-STR Description of the intended final design (Electrical Design)	ASTRI-DES-EIE-3100-029c
SST-STR Description of the intended final design (Finite Element Analysis)	ASTRI-DES-EIE-3100-030c
SST-STR Description of the intended final design (Dynamic Simulation)	ASTRI-DES-EIE-3100-031b
SST-STR Description of the intended final design (Optical Design)	SSTER-STR04-DIFD-05 (V 1.0)
SST-STR Description of the intended final design (Design Options)	SSTER-STR-DIFD-06 (V 1.0)
SST-STR Management Plan (including schedule)	SSTER-STR05-PMP (V. 1.0)
SST-STR Production Plan	n/a
SST-STR Maintenance Concept	n/a
SST-STR Series production cost	SSTER-STR08-PC (V 0.2)
SST Camera Documentation	
SST-CAM Requirements Specification	SSTER-CAM01-RS (V 1.1)
SST-CAM Design Compliance Matrix	n/a
SST-CAM Prototype Design Report	SSTER-CAM03-PDR (V 1.1)
SST-STR Description of the intended final design (including design options)	SSTER-CAM04-DIFD (V 1.2)
SST-CAM Management Plan (including schedule)	SSTER-CAM05-PMP (V 0.3)
SST-CAM Production Plan	SSTER-CAM06-PP (V 0.4)
SST-CAM Maintenance Concept	SSTER-CAM07-MC (V 1.0)

SST-CAM Series production cost	SSTER-CAM08-SPC (V 1.0)

11.2 Review attendance

Participants name	Affiliation
OBSERVERS	
Angelo Antonelli	INAF, Member of the ad interim SST Executive Steering Committee
Elisabete de Gouveia Dal Pino	University of Sao Paulo
Federico Ferrini	CTAO, Managing Director
Stefan Funk	Univ. of Erlangen, Vice-Chair of the ad interim SST Executive Steering Committee
Volker Heinz	CTAO, CTA-South Site Manager
Giovanni Pareschi	INAF, Chair of the ad interim SST Executive Steering Committee
Helene Sol	Observatoire de Paris-Meudon
Karl Tegel	CTAO, Product Safety Engineer
Nick Whyborn	CTAO, Lead Systems Engineer
Wolfgang Wild	CTAO, Project Manager
PROJECT TEAM	
Primo Attinà	INAF, SST Programme Manager and ad interim AIV Manager
Salvatore Scuderi	INAF, SST-STR Project Manager
Enrico Giro	INAF, SST-STR Systems Engineer
Nicola La Palombara	INAF, SST-STR Product Assurance Coordinator
Giorgia Sironi	INAF, Responsible for the ASTRI Optical System
Rachele Millul	INAF, Scientific Secretary of the ad interim ESC
Jean-Laurent Dournaux	Observ. de Paris/Meudon, Member of the SST-STR team
Emma Rebert	Observ. de Paris/Meudon, Member of the SST-STR team
Richard White	MPIK, SST-CAM Project Manager
Gianluca Giavitto	DESY, SST-CAM Systems Engineer

11.3 RIX status summary

All RIX have been handled and resolved within the RedMine platform.

11.4 Action Items summary

AI #	Related RIX #	Description	Responsible	Deadline	Area
SST-ER-01	#40489	Elaborate an updated version of the costs that will permit to better understand if they are solid and that will permit to consolidate the total number of telescope to be built	SST-PO	< PDR	SST-PO

SST-ER-02	#40492 #40494	Consolidate of the overall management scheme prior to enter the Design Consolidation phase. In particular, reinforce the AIV project and I/F management. Update the management plan in consequence.	SST-PO	< PDR	SST-PO
SST-ER-03	#40691	For the LED illumination flashers micro-controller we strongly advise to setup a test procedure in which all-possible cases in the embedded software are covered.	SST-CAM	< PDR	CAM-electronics
SST-ER-04	#40691	For the programmable components on the GECCO motor controller boards, we strongly advise to setup a test procedure in which all possible cases in the embedded software are covered.	SST-CAM	< PDR	CAM-electronics
SST-ER-05	#40698 #40693	**PCB Design schematics** : Implement an internal design review for the schematics & all boards (PCBs)	SST-CAM	< PDR	CAM-electronics
SST-ER-06	#40690	**Thermal behavior of the electronics cooling in the camera:** Though the discussion during the review meeting permitted to better understand the problematics, the panel still consider that building a thermal model and implement it in a simulation tool would benefit to the project. It should not be a huge work to do it. We recommend testing this approach and try to implement at least a simplified airflow model.	SST-CAM	< PDR	CAM-PO
SST-ER-07	#40521	Implement the actions described by the SST-PO within its answer to the RIX	SST-PO	< CDR	SST-AIV
SST-ER-08	#40522	Write a system level maintenance concept/plan and derive potential requirements to SST-PO	CTAO	< BKO	CTA
SST-ER-09	#40564	Update the SST top level requirements document that will be delivered to the SST program as soon as it is ready	CTAO	< BKO	CTA
SST-ER-10	#40565 #40566 #40567 #40570 #40571 #40573 #40574 #40576 #40578 #40579 #40580 #40581 #40582	**SST-STR Requirements Specification (Optics):** Implement the actions described by the SST-PO within its answer to the RIXs. Update the document in consequence.	SST-STR	< BKO	STR-Optics

SST-ER-11	#40572	**SSTER-SST05-QP "SST Program Quality Plan" :** Implement the actions described by the SST-PO within its answer to the RIX	SST-PO	< PDR	SST-PO
SST-ER-12	#40612	**SSTER-CAM06-PP version0.4 "SST Camera Production Plan":** Update the document to reflect the answer given within the RIX by the SST-CAM PO	SST-CAM	< PDR	CAM-PO
SST-ER-13	#40656	**SSTER-STR05-PMP:** Build a more detailed breakdown of the PBS and WBS with a short characterization of the elements. Relate it in an update of this document.	SST-PO	< PDR	SST-PO
SST-ER-14	#40657 #40663	**SSTER-STR05-PMP:** Implement the actions described by the SST-PO within its answer to the RIXs	SST-PO	< BKO	SST-PO
SST-ER-15	#40658	Define in accordance with CTAO standards, the decision process for major CRE's	SST-PO	< PDR	SST-PO
SST-ER-16	#40659 #40670	**SSTER-STR05-PMP:** Develop and implement an SST program safety plan (including SST projects levels) derived from the completion of the overall Safety Plan by CTAO.	SST-PO	< CDR	M&O
SST-ER-17	#40665	**ASTRI-DES-EIE-3100-030c:** Implement the actions described by the SST-PO within its answer to the RIXs	SST-STR	< PDR	STR-Structure
SST-ER-18	#40669	**ASTRI-DES-EIE-3100-027c:** Describe the installation method of the camera on the structure which is essential for AIV and maintenance (This method shall be developed early so that it can become a priority in the structure optimization).	SST-STR	< BKO	SST-AIV
SST-ER-19	#40671	**SSTER-STR03-PDR-04:** Write a document describing how the lessons learned from the prototype have been implemented for the final design.	SST-PO	< PDR	SST-PO
SST-ER-20	#40678	**ASTRI-DES-EIE-3100-029c:** Define in an ICD the cabinet space foreseen/needed for camera infrastructure.	SST-STR	< CDR	STR-PO
SST-ER-21	#40681	**ASTRI-DES-EIE-3100-027c** Identify the minimum stiffness and precision requirement for the bearing/drive and adapt the selected technology to the needs, e.g. ball bearing vs crossed roller. Commercial slewing systems with integrated drives such as: https://conedrive.com/products/slew-drive-and-slew-bearing-2-2-4/slew-drive-and-slew-bearing-2-2-2-2/ https://www.frusca.com/en/industry/slewing-	SST-STR	< BKO	STR-Structure

		drives should be investigated if they can fulfill the requirements.			
SST-ER-22	#40688	**4c SST-STR Description of the Intended Final Design (Finite Element Analysis):** Provide a document describing experimental tests finalized to compare computed values of displacements and frequencies with the measured ones.	SST-STR	< PDR	STR-Structure
SST-ER-23	#40688	**4c SST-STR Description of the Intended Final Design (Finite Element Analysis):** Improve with a specific approach the qualitative explanation given for justifying the computed over stress under severe seismic conditions.	SST-STR	< BKO	STR-Structure
SST-ER-24	#40688	**4c SST-STR Description of the Intended Final Design (Finite Element Analysis):** Produce checks of the stability of compressed elements (obviously considering also the bending moments) under the combination of severe horizontal and vertical seismic effects.	SST-STR	< PDR	STR-Structure
SST-ER-25	#40692	**PCBAs Testability/coverage:** Implement the actions described by the SST-CAM within its answer to the RIX	SST-CAM	< CDR	CAM-electronics
SST-ER-26	#40694	**Tooling:** Implement the actions described by the SST-CAM within its answer to the RIX	SST-CAM	< CDR	M&O
SST-ER-27	#40697	**Timing/White Rabbit implementation:** Implement in the design a common timing board for the different CTA cameras, to enhance knowledge and serviceability	SST-CAM	< PDR	CAM-electronics
SST-ER-28	#40701	**4d SST-STR Description of the Intended Final Design (Dynamic Simulation):** Produce the results of the simulation of the control system considering different configuration of the telescope.	SST-STR	< BKO	STR-Structure
SST-ER-29	#40701	**4d SST-STR Description of the Intended Final Design (Dynamic Simulation):** Provide a testing plan finalized to compare numerical results with the ones obtained experimentally both in the factory and in the field	SST-STR	< BKO	STR-Structure

SST-ER-30	#40640	**SST Camera design understanding:** Update the related documentation by implementing the answer in the RIX and in the presentation during the review meeting.	SST-CAM	< BKO	CAM-PO
SST-ER-31	#40664 #40680	Revisit the requirements for the encoders and look at the market to select the one that is the most suited to the telescope for the best price	SST-STR	< PDR	STR-PO
SST-ER-32	#40682	Investigate the potential suppress of the brake (if this one is not necessary) to increase the reliability of the overall system (trade-off on the risks versus cost).	SST-STR	< PDR	STR-PO
SST-ER-33	#40591 #40702	**Concerning design option #1:** More discussion is needed with EIE & SST-PO to determine whether this option enhance the current ASTRI concept	SST-STR	< BKO	STR-PO
SST-ER-34	#40583	**Error budget tree:** Relate the explanation given during the review meeting (slides presented) within the document	SST-STR	< BKO	STR-Optics
SST-ER-35	#40672	**Mirror Coating:** Clarify if the recoating is necessary and define the project baseline (recoating on site, recoating off site, new mirrors, ...). Address it in the SST maintenance plan.	SST-PO	< PDR	M&O
SST-ER-36	#40672	**Mirror Coating:** In case recoating is requested describe in a dedicated document the de-coating & recoating process.	SST-PO	< PDR	M&O
SST-ER-37	#40584	**Micro roughness:** Clarify the document in consequence to the discussion during the review meeting.	SST-STR	< BKO	STR-Optics