SST Programme:

Telescope Concept of Operations

SST-PRO-ODP-001
Version 1c

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1.1 Scope & Purpose

This document provides a preliminary description of the operations concept across the operational phases of the telescope.

1.2 Applicable Documents

[AD1] SST Programme: Telescope Architecture and Design Summary Report, Doc. No. SST-PRO-DSR-002, Version 1b, 2022.11.8

[AD2] SST Programme: Telescope Technical Requirements Specification, Doc. No. SST-PRO-SPE-001, Version 1b, 2022.11.8

1.3 Reference Documents

[RD1] SST Programme: Programme Management Plan, Doc. No. SST-PRO-PLA-001, 2022.11.9

[RD2] CTA Generic Telescope State Machine, Doc. No. CTA-SPE-TEL-000000-0001, Issue 2, Rev. h, 2021.11.11

[RD3] Interface Control Document for ACADA – Generic Telescope Control, Doc. No. CTA-ICD-SEI000000-0002, Issue 2, Rev.: h, 2020.4.30

[RD4] ASTRI Mini-Array: Calibration Plan for the Cherenkov Telescopes, Doc. No. ASTRI-INAF-PLA-2600-001, Issue 1.1, 2021.4.27

[RD5] SST Camera: Design Report, Doc. No. SST-CAM-DSR-001, Version 2.a, 2022.11.23

[RD6] SST Mechanical Structure: Design Report, Doc. No. SST-MEC-DSR-001, Version 2a, 2022.11.30

[RD7] SST Optics Design Report, Doc. No. SST-OPT-DSR-001, Version 1a, 2022.11.25

[RD8] Generic Telescope Use Cases, Doc. No. CTA-TRE-SEI-000000-0015, Issue 2, Rev.: i, 4.12.2019

[RD9] Requirement Specification for Array Control and Data Acquisition System, Doc. No. CTA-SPE-COM-303000-0001, Issue 2, Rev. i, 28.5.2021

[RD10] SST Mechanical Structure: Subsystem Technical Requirements Specification, Doc. No. SST-MEC-SPE-002, Version 2a, 2022.11.30

[RD11] CTA North Operations Concept, Doc. No. CTA-TRE-SEI-30000-0012, Issue 1, Rev. C, 29.10.2019

[RD12] SST Programme: Verification Plan, Doc. No. SST-PRO-PLA_013, Version 1a, 2022.11.22

[RD13] SST Mechanical Structure: On-site Maintenance Plan, Doc. No. SST-MEC-PLA-015, Version 2a, 2022.11.30

[RD14] SST Camera Maintenance Concept, Doc. No. SSTER-CAM07-MC

[RD15] ACADA – Array Elements Configuration ICD, Doc. No. CTA-INS-SEI-000000-00XX-1 DRAFT01, 2022.06.30

[RD16] SST Programme: Telescope Technical Requirements Specification, Doc. No. SST-PRO-SPE-001, Version 1b,2022.11.8
[RD17] ICD Between IPS and Telescopes, Doc. No. CTA-ICD-SEI-000000-0027- Draft 1c, 2022.03.11
[RD18] CTAO System Control Concept, Doc. No: CTA-TRE-SEI-000000-0016-1a, Issue 1, Rev. a, 2022.10.05

1.4 Definition of Terms and Abbreviations

ACADA	Array Control and Data Acquisition System
ACS	ALMA Common Software
ASTRI	Astrophysics with Italian Replicating Technology Mirrors
CDR	Critical Design Review
CoG	Centre of Gravity
CTA	Cherenkov Telescope Array
FDIR	Fault, Detection, Isolation and Recovery
HMI	Human Machine Interface
HW	Hardware
ICD	Interface Control Document
IPS	Integrated Protection System
PDE	Photon Detection Efficiency
PSF	Point Spread Function
PI	Principal Investigator
SST-CAM	SST Camera
SST-STR	SST Structure
SW	Software
TBC	To be confirmed
TBD	To be determined
TCS	Telescope Control System
WPD	Work Package Description

Table 1 - Glossary of main terms used in the SST project.

TERM	DEFINITION
SST Programme	The overall SST organisational structure containing the SST-STR and SST Cam projects.
SST-STR	The SST Structure, consisting of elements under the control of the SST-STR Project.
SST-CAM	The SST Camera, consisting of elements under the control of the SST-CAM Project.

Central Facilities	Used as a catch-all in this document for on-site facilities not located at the Telescope Unit.
On-site Data Centre Farm	The central computing and storage facility on which all data is stored and all software installed.
Clock Distribution	The part of the central facility responsible for the provision and distribution of clocks for the precise timetagging of images recorded by the Camera Unit.
Central Power Distribution	The part of the central facility responsible for distributing power to each Telescope Unit.
Central Site Safety System	The part of the central facility responsible for human safety, coordinating and acting upon safety information from all telescopes and other devices.
SST Software	All SW installed on the Farm that is under the responsibility of the SST Programme.
Telescope Manager	Part of the SST SW dealing with the high-level control interface to ACADA.
Camera Manager & DAQ	The SST SW dealing with the control of the Camera Unit and Camera Support Systems. Part of SST-CAM.
Structure Manager	The SST SW dealing with the control of the Structure. Part of the SST-STR.
Telescope Unit	All elements of a telescope located locally at that telescope.
Foundation	The physical foundation on which the Telescope Structure is mounted. Part of the Telescope Unit.
Interface Cabinet	The CTAO-controlled interface for power, network and timing connection to the telescope.
Telescope Structure	The telescope mechanical structure drives and optics.
Telescope Network Distribution System	The interface point from the Network Interface Cabinet to the telescope. Includes any patch panels, switches, associated mounting / housing and any fiber or copper cables routed about the Telescope Structure.
Telescope Control System	The control system for the telescope drives and any other active elements.
Telescope Safety System	Elements of the telescope explicitly for human safety, such as limit switches and access switches.
Telescope Power System	The interface point from the Power Interface Cabinet to the telescope. Includes any required hardware, associated mounting / housing and any cables routed about the Telescope Structure to other telescope elements.
Camera Unit	The physical camera as attached to the telescope structure.
Camera Support Systems	All support items required at the telescope to operate the Camera Unit, including the camera chiller, pipes.

2 SST Telescope Overview

When a VHE gamma-ray interacts with the atoms and ions in the upper levels of the atmosphere, it induces a cascade of secondary particles which propagate over many kilometres at nearly the speed of light through the atmosphere. These particles emit Cherenkov light, forward-beamed with an opening angle of about one degree. A Cherenkov light event consists of a time-correlated multi-photon image with a typical timescale of ~10 ns. Cascades originate at an altitude of ~10 km above ground and create a light pool on the ground of ~120 m radius. Telescopes placed on the ground, containing large reflectors, focus the light to and imaging camera. Such Cherenkov cameras must be highly pixelated, cover a large field of view, and be able to detect UV/blue light down to the single photon levels with exposure times of approximately a billionth of a second. To provide a high imaging sensitivity over an extensive energy range, from a few tens of GeV up to a few hundreds of TeV, the Cherenkov Telescope Array Observatory (CTAO, see web page link at https://www.cta-observatory.org) will be made of subarrays with three different types of telescopes: large-sized (LST, 23 m diameter), medium-sized (MST, 12 m diameter) and small-sized (SST, 4 m diameter) telescopes. They are distributed in two observing sites, the Northern one in La Palma, the Canary Islands, and the Southern one in the Chilean Andes in the Paranal area. The CTA South "Alpha Configuration" would include LSTs, MSTs and SSTs. In particular, it envisages the construction and installation of 42 SSTs (a number that could increase up to 70 in future upgrades).

The SSTs are developed by an international consortium of institutes that will provide them as an in-kind contribution to CTAO. The SSTs rely on a Schwarzschild-Couder-like dual-mirror polynomial optical design, with a primary mirror of 4 m diameter, and are equipped with a focal plane camera based on SiPM detectors covering a field of view of ~9°. They are sensitive in the band from ~0.5 TeV up to ~300 TeV, providing the Observatory with sensitivity to the highest energies. The current SST concept has been validated by developing the prototype dual-mirror ASTRI-Horn Cherenkov telescope and the CHEC-S Cherenkov camera.

Table 2 reports main properties of the Small-Sized telescope (SST).

Table 2 - Small-sized telescope main properties.

Small-Sized telescope (SST) main properties:	
Optical Design	modified Schwarzschild-Couder
Primary reflector diameter	4.3 m
Secondary reflector diameter	1.8 m
Effective mirror area (including shadowing)	>5 m^2
Focal length	2.15 m
Total weight	17.5 t
Field of view	>8.8 deg

Number of pixels in SST Camera	2048
Pixel size (imaging)	0.16 deg
Photodetector type	SiPM
Telescope data rates (before array trigger)	>600 Hz
Telescope data rates (readout of all pixels; before array trigger)	2.6 Gb/s
Positioning time to any point in the sky (>30° elevation)	90s
Pointing Precision	< 7 arcsecs

More details about the SST Telescope design are described in [RD5, RD6, RD7].

3 Telescope Operations Concept

3.1 Telescope Operative Modes and States

The SST allows users to monitor and control its subsystems – Structure, Cherenkov Camera – either in remote or local mode. In local mode, only commands issued locally will be taken in charge by the Telescope, ignoring any remote commands: any remote control is fully detached.

The local mode is used for installation, some calibration activities during commissioning and above all maintenance operations. When in local mode, it is expected that technicians and engineers will be present in the area strictly surrounding the Telescope structure. In local mode, staff on site can directly control the Telescope subsystems using tools such as the Engineering HMI.

The Telescope Control System (TCS) implements a state machine, allowing the CTA Array SCADA system (ACADA) to monitor the telescope state and issue transitions. Furthermore, the state machine paradigm extends also to the Structure and Camera subsystems.

The states of the SST Telescope, Structure and Camera subsystems are: On, Off, Maintenance. The On state has the following substates: *Initializing*, *Initialized*, *Standby*, *Ready*, *Observing*, *Fault*. The SST Telescope state machine has an additional *Technical* state, which is attained whenever the substates of Structure and Camera differ. These states and the transitions between them are defined in the Generic Telescope State Machine document [RD2].

When the SST is in remote mode, ACADA operates it via remote procedure calls defined in the ACADA to Telescope Element ICD [RD3]; this is the operational mode for regular scientific observations, remote testing, and regular calibration activities. Lastly, the remote stand-alone engineering mode is needed to perform technical operation of a single instrument from remote. In this case the ACADA monitoring operations are active, while its control actions are fully detached. Further details are given in the document CTAO System Control Concept [RD18].

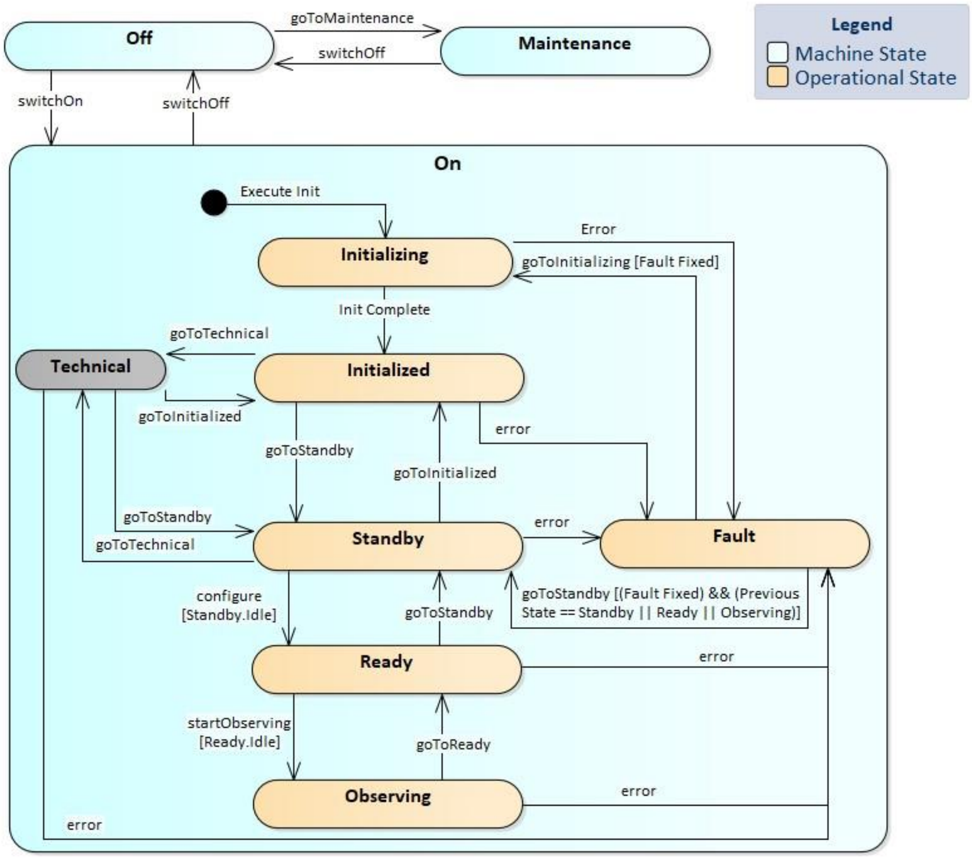

Figure 1 - Finite-state machine scheme of the SST system [RD2].

3.2 Telescope Configuration

The configuration of the SST and its subsystems is performed during the transition to a given state, this way, the configuration of the SST in any state and substate is always well-defined. The storage, retrieval and modification of Telescope or Subsystem configurations happens following the ACADA – Array Elements Configuration ICD document [RD15].

Upon switching from the Off to the On state, the telescope enters automatically in the Initializing state, during which the individual subsystems are powered on and thermalized. When this procedure is completed, the telescope transitions automatically to the Initialized State.

In the Initialized State, the SST is configured to survive in harsh environmental conditions with minimum consumption of electrical power. These survival conditions and the power budget are defined in the Telescope Technical Requirement Specification document [RD16]. Normally, the telescope stays in Initialized state during the day. The telescope hardware settings in the Initialized state may therefore change according to the season, or the environmental conditions.

The Standby State is the state immediately after Initialized. In this state, all subsystems are turned on and ready to be controlled. The Telescope configuration is the default one, with minimal risks to the subsystems.

The Telescope configuration of the Ready and Observing states depends on which type of activity it is going to take place, for example:

- Cherenkov shower acquisition;
- Camera calibration;
- Pointing calibration.

3.3 Fault Detection, Isolation, and Recovery

Telescope hardware and software components faults can be detected by the Telescope Resource Manager (a software system part of the TCS) and communicated to ACADA via its alarm notification system. The Telescope Control Software and the local control systems of the individual subsystems can perform actions to isolate the fault and try recover the subsystem that raised the alarm.

In terms of Telescope operational states, if the scenario of the observation phase of the Telescope is considered, this implies a transition from Observing to Fault state as shown in Figure 1. More precisely, when either the Camera or the Structure subsystem experience a failure, they transition to Fault state of the relative faulty subsystem: this then results in the transition of the entire Telescope system to Fault state.

Then, the faulty subsystem transitions to the Fault-Fixing substate, as shown in Figure 2 relatively to the SST Structure subsystem state machine, where it tries first to fix itself. If it is successful in doing so, it transitions to Standby state, after which normal operations may start again. In case the fixing procedure is not successful, the subsystem transitions to Initializing state instead, where each of its component is restarted until the whole system is initialized again and ultimately arrives to the Initialized state. Then, the Telescope system is made available for normal operations again. In general, the CouldNotFix substate of the SST Structure is reached if a special command is issued to SST TCS to terminate the automatic recovery procedure. This implies the entire Telescope remains in the Fault state. If a recovery is not possible even after re-initialising, the TCS communicates this to ACADA as a critical failure/alarm and delegates to the ACADA operators to manage it, with ad-hoc troubleshooting procedures. In case that even such manual recovery procedure fails, ACADA can isolate and exclude the faulty Telescope from observations, to allow array operations to continue without it.

The logical recovery procedure described above is similar if the Telescope experiences a failure while it operates in the Standby or Ready operational state too.

A similar logical recovery procedure is designed to recover the SST Camera subsystem when it eventually experiences a failure. For completeness, states and substates of the machine state of the SST Camera are reported in [RD2].

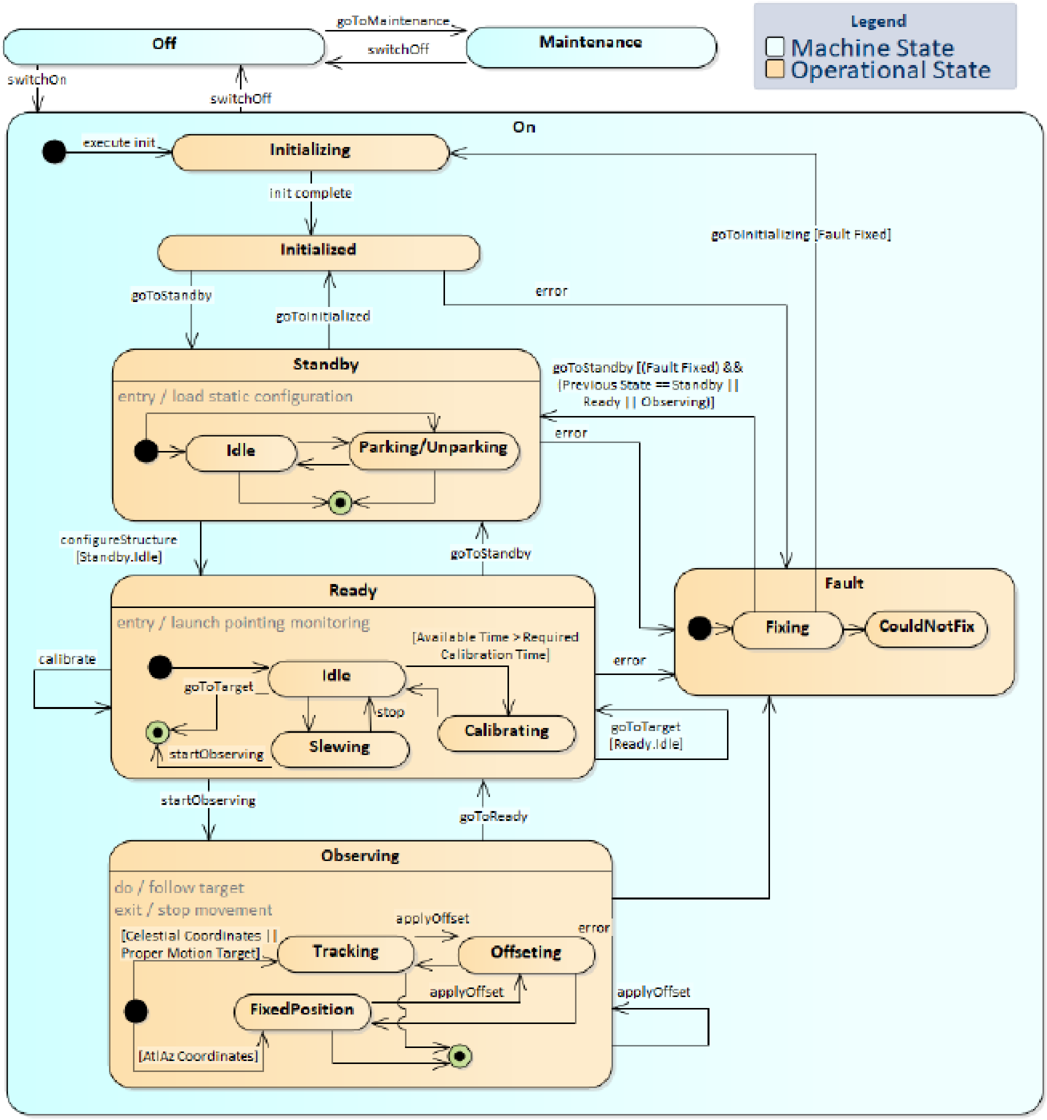

Figure 2 - States and sub-states of the SST Structure subsystem state machine [RD2].

More in general, FDIR can be triggered by SW and HW by dedicated tasks. The SW task will act on the basis of the parameters values retrieved by the subsystems monitored. The HW Task will be implemented on the subsystem by the provider (i.e. motors).

When an HW/SW FDIR task raises an alarm, the local software manages it, moving the machine state to a safer state called "fault state". The recovery action will be selected on the basis of the severity of the error (alarm/warning). In the case of the FDIR SW task, the rules and parameters will be configurable (i.e., an alarm will be triggered only if a parameter value exceeds some limits for several samples). In the case of the FDIR HW task, the rules and parameters will be not configurable, but we will discuss a strategy with all the providers to manage false positives (i.e. persistence in the monitoring). Alarm conditions will be sent to ACADA.

3.4 Telescope Survival/Operative Environmental Conditions

The Telescope survival and some science operation performances are guaranteed also under specific unfavorable environmental conditions.

Design requirements make the Telescope system surviving in the temperature range from -15° C to +35° C, with air temperature gradients of up to 0.5°C/min for 20 minutes. Damages to Telescope subsystems shall not occur due to relative humidity within the range from 2% to 100% when in the Initialized State or when no power is available. In addition, damage does not occur to components regularly exposed to direct solar radiation of up to 1200 W/m^2 (averaged over 1 hour) at a maximum ambient temperature of 35ºC.

Observations performance specified at design level, are met in the temperature range from -5° C to +25° C within the relative humidity range from 2% to 90%, provided the condition for operation with un-misted optical surfaces (dew point temperature at least 2ºC lower than the ambient temperature). In case of climatic variability, temperature gradients less than 7.5°C/h maintains observation performances again, whilst smaller temperature gradients are admissible, up to 3° C / h, to meet the precision pointing requirements.

Table 3 - Environmental requirements [AD2].

Parameter	Precision	Observation	Transition	Damage	Survival
Air Pressure	750 +- 50 mbar				
Air Temperature	-5°C < T < 25°C		T<-5°C or T>25°C	-15°C < T < 35°C	
Temperature gradient	<=3°C/h	<=7.5°C/h	>7.5°C/h	>7.5°C/h to < 0.5°C/min for 20 min	0.5°C/min for 20 min
Relative Humidity	2% < RH < 90%		RH < 2% or RH > 90%	2% < RH < 100%	
Misting	T is >2°C greater than dew point		-		
Rain	-		≤2mm in 1h	≤70mm in 1h; ≤200mm in 24h;	
Snow load	-			-	<20kg/m2
Hailstone	-			-	Ø=5mm, E=0.2J
Wind, sustained for 10 min	≤11km/h	≤36km/h	≤50 km/h	<80km/h parked	≤100 km/h parked; ≤60 km/h in transitions
Wind gusts (1 sec)	-	-	-	-	≤170 km/h
Solar radiation				1200 W/m^2 averaged over 1 hour	
Dust and sand				2.9 x 10^5 particles of ≥5µm size per m³ of air for 90% of the time at 2m above ground	
Illumination	-				≤10^6 photons ns−1 cm−2

3.5 Thermal Control

The Cherenkov Camera thermal control scheme and its operation will be reported and detailed in the next version of the document before the CDR.

3.6 Telescope Switch ON/OFF Procedures

Start-up operation consists of providing electrical power to all Telescope electrical components of the Structure and Camera subsystems. Frequency of this operation is low (less than twice per year per telescope) since it is needed after specific maintenance activities or unscheduled power-down due to external factors.

In particular, when the Power Management System provides power to Telescope, then the local control systems of the Camera and Structure subsystems start. The Telescope state at this point is OnInitialising. The Local Safety Units connects to the Integrated Protection System - which provides status of interlocks and safety elements to ACADA, see [RD17]. Meanwhile, the Telescope TCS connects to the Local Control Systems of the Camera and Structure subsystems, then sends information to ACADA that both Camera and Structure are Initialising, and updates that information when they reach the Initialized state. At this point, ACADA can pass the Telescope system state to Initialized, in which a minimal set of monitoring information are received and shown to operators, expert operator, support astronomer in the control room, such as chiller status, internal camera temperature.

Shut down and power-off of the Telescope is carried out only when needed. Operator or support astronomer, through the HMI made available by ACADA requests to shut down the Telescope. This implies the shutdown operation of the Telescope hardware components, including the Local Control Systems. Once the expert operator verified this procedure has been successfully completed, the Power Management System is used still by expert operator to power off the whole Telescope system [RD8].

3.7 Power Budget across the Daily Phases

3.7.1 Power budget across the States

The Telescope system power budget estimation reported in the Table below will be consolidated before the CDR.

Table 4 - Power budget (Maximum Expected Value) of the Telescope System across the States.

	Initialized state [KW]	Slewing [KW]	Tracking/ Data taking [KW]
Structure	2	6,7	3,3
Camera	4,9	6,1	4,5
Telescope	6,9	12,8	7,8

3.7.2 Power Budget across the Daily Phases

The power budget across the Daily phases of the SST system will be reported in detail in the next version of the document (CDR).

3.8 Telescope Safety

The Telescope system operations include devices, automatic and manual procedures to ensure safety of the staff involved in technical and scientific operations, and to minimize damages of the Telescope components also in presence of not favorable outside factors, such as adverse climatic conditions. Indeed, one of the aims of the SST design is to minimize hardware damage to perform the scheduled science operation. Situation when damages can be repaired on-site using available spare parts and a normal level of on-site workforce does not exceed the Serviceability Limit State [RD10].

Concerning pointing operations instead, the Telescope can move to any position using the most direct route and in the fastest possible time within safety constraints, if properly instructed by ACADA.

Referring again to Telescope as state machine, Maintenance state allows to technicians and engineers corrective maintenance activities. In this scenario, SST is unavailable for scientific operations or any remote control to contribute to the safety of the staff on-site during maintenance operations.

As for staff safety, the SST drive control systems have safety interlocks that prevent injury to staff or damage to telescopes that might result from inadvertent operations, human errors, or mechanical or control system failures. The Integrated Protection System (IPS) receives the interlocks status via the Telescope safety I/O modules based on a specific CTAO IPS/SST interface and sends these data to ACADA to inform the expert operators and support astronomer via the HMI [RD9]. The same data are used internally by the TCS that eventually sends them to ACADA.

Audible and visible signals are generated for any potentially dangerous movement of the Structure for operators on-site, following standard safety rules.

More, the emergency stop function is provided to stop all moving structural elements with the fastest controllable deceleration [RD10], such that no additional risks can be eventually introduced to staff on site for maintenance operations, according to international standard rules on work safety.

A lightning protection system is provided following the corresponding standard regulation.

4 Verification Phase

4.1 Verification Activities Description

The Verification process consists of a set of activities aimed to show proof of compliance of the SST system with approved specifications, through performances resulting from an inspection, review and test. From a system engineering point of view, this phase is placed next to the whole SST system integration process for verification against system level specifications.

During this phase, we will operate the telescope locally/remotely, we will perform dedicated tests to verify technical specifications, as well as dedicated scientific acquisition to verify scientific performance and to calibrate the telescope [RD4].

Telescope technical and scientific specifications to be verified cover the following aspects:

- Mirror alignment
- Camera alignment
- SW/HW functionalities
- Pointing accuracy
- Tracking precision
- Camera Thermal Control
- Electrical interlocks and other safety aspects
- Internal and external interfaces
- Assessment the array mirror reflectivity
- Dead/noisy pixels identification
- Monitoring of the PSF
- Camera Trigger threshold determination
- PDE
- Pointing model
- Telescope Optical Throughput:
    - Using muon ring analysis
    - Using Variance data [RD4]
- Telescope (including its subsystems) scientific and functional performances
- Others (TBD).

To assure that all requirements are verified, a Verification Matrix containing results of verification for each system specification is defined and completed.

More details about the verification plan are reported in [RD12].

5 Commissioning Phase

The Commissioning phase focuses on the entire SST array, and it is managed by CTAO, which will provide the relative plan as well. As SST team, we will provide support to draw up the Commissioning plan and to perform this activity both from a technical and scientific point of view. The Commissioning phase, once the Verification process at (Telescope) system integrated level is successfully completed, is the next step of the Systems Engineering framework giving as output the optimal setup for technical and scientific operations.

5.1 Engineering Commissioning

The Engineering Commissioning of the SST Telescope array regards all technical activities to integrate at SST array system level all SST Telescope technical functionalities. Main operations of this phase are focused on Cherenkov Camera system, optimal synchronization of the timing system, data acquisition performance.

The SST team will provide support for these activities.

5.2 Scientific Commissioning

The scientific commissioning activity will be performed through scientific acquisition assessment with the aim to verify high level (A) scientific requirements (CTAO responsibility). The SST team will provide support.

5.2.1 Calibration plan during Commissioning phase

The calibration plan during commissioning/SV phase includes:

- inter-calibration of all telescopes
- Array time resolution
- Map of the telescopes systematics.

and no order of execution for such calibration items is foreseen.

Moreover, calibration/monitoring procedures, already performed during the verification phase, will be executed as needed even during this phase:

- assessment the array mirror reflectivity
- Dead/Noisy pixels identification
- Pixel gain setting
- Monitoring of the PSF
- Camera Trigger threshold determination
- PDE
- Pointing model
- Telescope Optical Throughput:
    - using muon ring analysis
    - using Variance data [RD4].

6 Science Phase

6.1 Nominal Operation Cycle

6.1.1 Scientific Observations

The science operations support the execution of the SST sub-array observations during night-time, considering atmospheric and astronomical conditions, to maximize scientific run performance, which can be expressed in terms of the total amount of observation time delivered to users or volume of quality data delivered to archive users (to give some examples of performance indicators). Science operation is controlled from the control room, where operators, the expert operator and support astronomer supervise scientific data taking operation through the automatic control and monitoring system ACADA, which offer a comprehensive view of the status of the observations through HMI specifically designed. Real-time data processing and analysis is performed for immediate data quality feedback and for the science alert generations [RD11]. More refined data processing and analysis means obtaining more precise scientific results. This information is provided to the proposal PI as feedback on the status of his/her scientific observations. The high-level night-time activities flow can be summarized starting from the sub-array warm up, short schedule plan review, execution of the job (observations), then shutdown of the system array elements, lastly data and performance report of the night observations.

6.1.1.1 Calibration

Science operation includes calibration/monitoring activities. They can require specific data taking to be scheduled in the night observation plan, or part of them can be performed analysing data acquired during regular night cycle data acquisition.

Just before the regular data taking, the following two items, with the camera lids closed, will be executed (such information are directly derived from the regular data, too):

- Dead/Noisy pixels identification
- Pixel gain determination and adjustment

The analysis of the regular data will be performed for several monitoring purposes:

- PSF monitoring: during regular data taking the optical camera won't be available for dedicated calibration and the *angular resolution* stability shall be monitored with the slow signal, variance, and muon rings methods. The output from the analysis of the monitoring must be compared with the correspondent values stored in the database
- Pixel efficiency (Flat-fielding)
- Pointing accuracy and precision using slow signal and variance methods
- Telescope total optical throughput, using muon ring analysis
- M2 mirror optical throughput, using reflected flasher light.

The analysis of specific observations performed during a moon cycle will allow to monitor:

- Telescope Optical Throughput, using Variance data
- Camera Trigger threshold determination More details are reported in [RD4].

6.1.2 Activities During the Day

6.1.2.1 Telescope Status

The analysis of a reduced set of monitoring points will provide condition monitoring for the telescope and its subsystems. These include:

- Camera internal humidity and temperature
- Drive inrush current measurements (TBC)
- Drive temperatures (TBC)
- Drive vibrations (TBC).

6.1.2.2 Maintenance

Maintenance activities will be performed as defined in [RD13] and [RD14].

End of the document