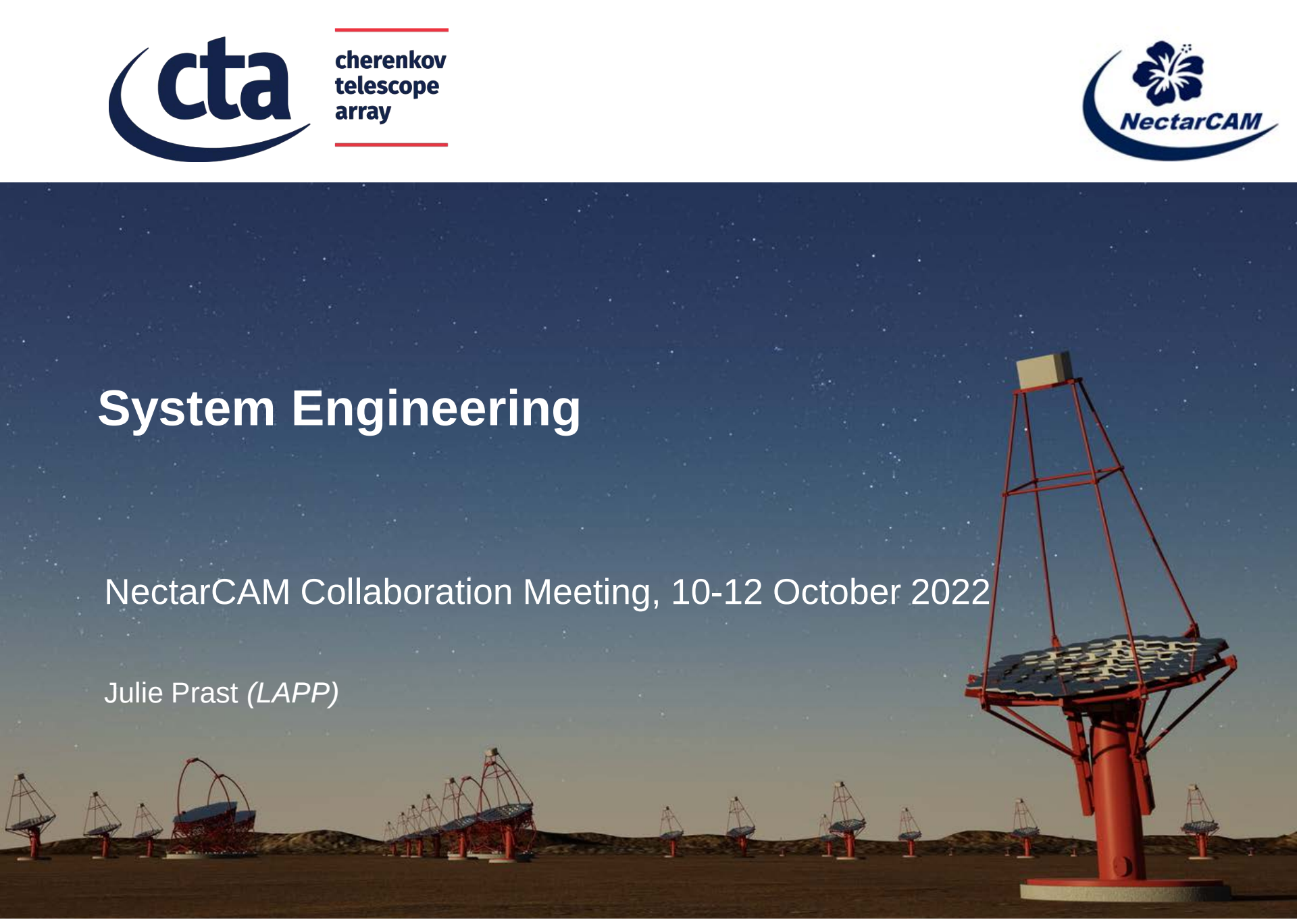
System Engineering

NectarCAM Collaboration Meeting, 10-12 October 2022

Julie Prast *(LAPP)*



System Engineering: Agenda

- Meeting Organization Overview
- Interfaces News
- Design Verification
- Status of CDMR RIXes

CDMR: Critical Design and Manufacturing Readiness Review
CTAO: CTA Office
ICD: Interface Control Document
IPS: Integrated Protection System
RIX: Review Item comment or question
SE: System Engineering
TRR: Test Readiness Review
WP: Work Package

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Meeting Organization

SE Meeting Organization Overview

- Interactions with MST teams : MST Technical Coordination Group (MST TCG)
  - Every Monday at 10 am
  - MST Structure (Markus & Alex), FlashCAM (German, Miquel) and NectarCAM (Philippe & myself)
  - + relevant experts when necessary
  - Agree on common ICD (MST Structure – Camera ICD), common objects (chiller specifications, UPS)
  - Share common issues (high wind resistance), prepare interactions with CTAO…
- Interaction with CTAO SE team: CTAO – MST SE meeting
  - Once a month
  - Common meeting within MST Structure, FlashCAM and NectarCAM teams
  - Discuss telescope interfaces, telescope requirements, telescope reviews, maintenance issues, technical workshops ...
- Specific meetings with CTAO on dedicated subjects
  - Interfaces (software, IPS…), requirements, CTA standards…
  - With relevant experts on each side
- Technical Follow up meetings within NectarCAM
  - Monitor progress of the implementation of changes, ensure requirement flow down, discuss technical issues
  - Fred, Philippe G., François T. and me as permanent members + relevant experts

NectarCAM Technical Follow up Meetings

- Meeting with IJC Lab hold on Sept 27
  - Feedback on the white target installation with respect with camera front door
  - Motor Control Box power supply
  - Adlershöf Flat Field Calibration Box non conformity
  - Maintenance tools update
- Focal Plane Module production (IRAP) hold on Sept 28th
  - Follow up procedures with Microtec and associated planning
  - Call for tenders for production
- NectarCAM documentation system hold with Dirk on Sept 29th
  - Data recovery
  - Possible NectarCAM site on office365-online Sharepoint in the same way than the CTAO Document Repository
- Camera front (LP2I) hold on Sept 30
  - Feedback on camera front door installation
  - Shutter status and agenda
  - Shutter control, shutter flatness
  - Window production

To come:
- Embedded Camera Controller
- Digital Trigger Crate
- NectarCAM Module Controller
- Event Builder
- Quality Control
- PSB/PDB call for tenders
- ….

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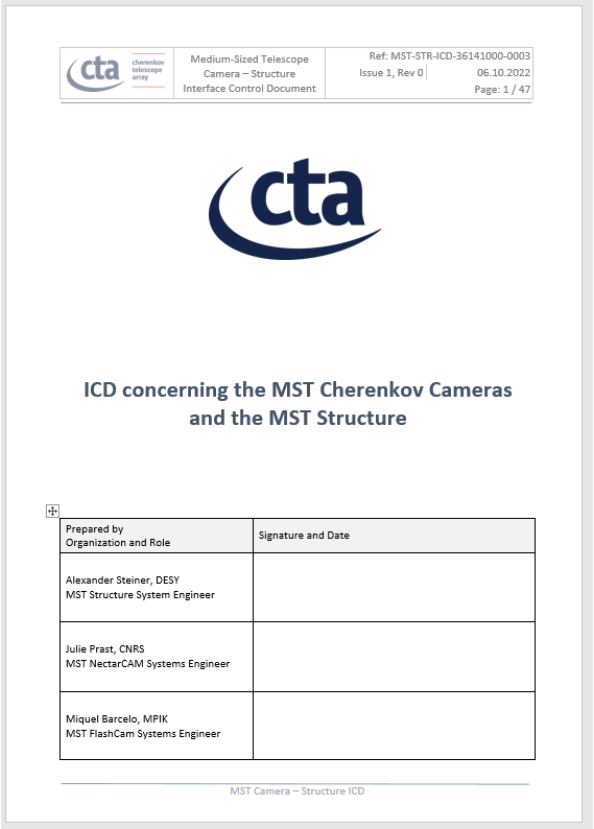
Interface News

Interfaces News: MST Structure Camera ICD

- Updated version of the MST Structure –Camera ICD V1.0
  - Address points from CTAO reviews (most of them by Stefano)
  - General cleaning of the document after interface items got better defined
  - Align the document concerning terms and layout to CTAO standards
  - Mainly motivated by approaching MST Structure CDMR
  - No major modification for cameras, except
    - Max camera weight increased to 2,5T
    - Specification for shutter flatness (under discussion)



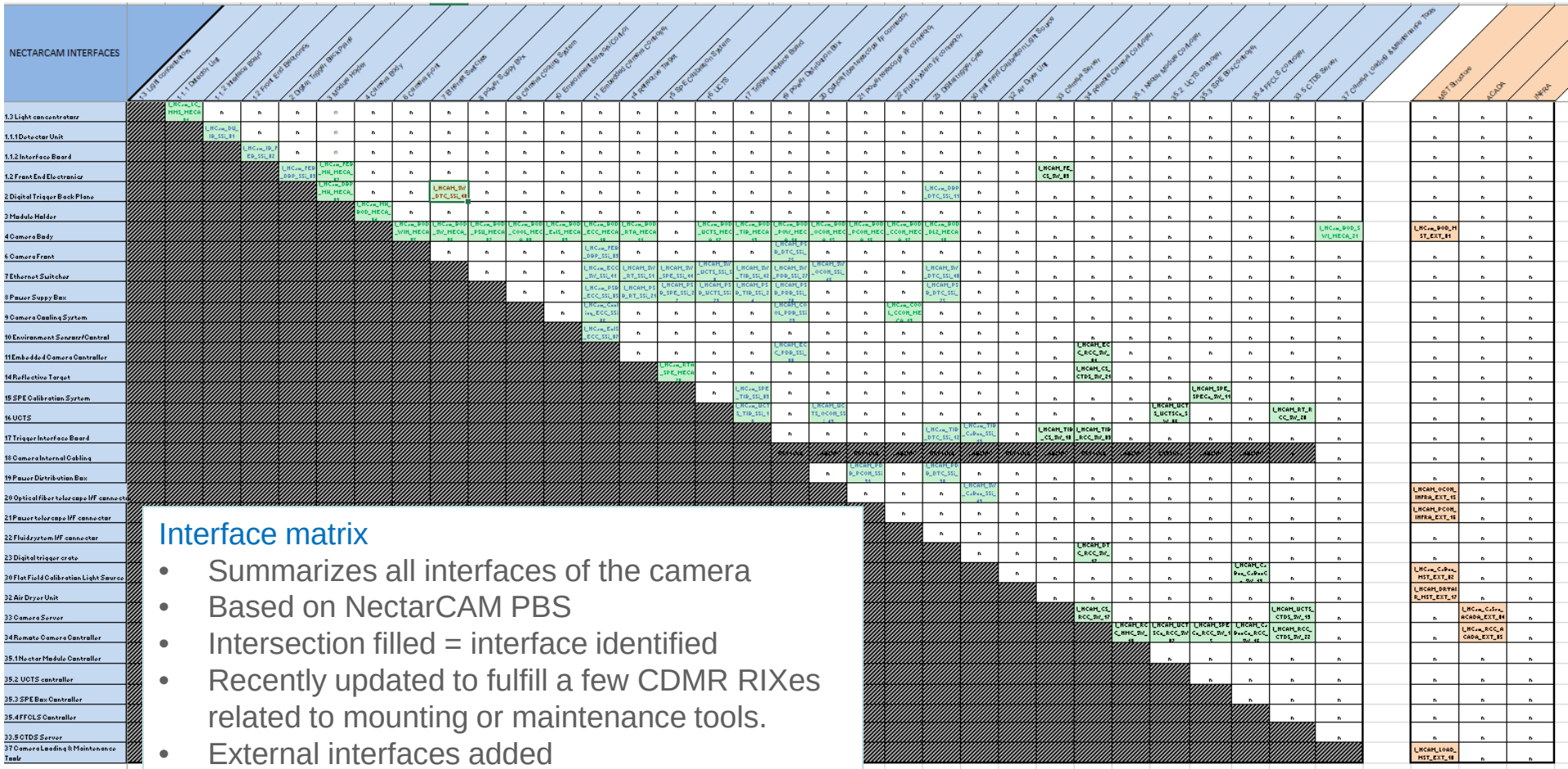
Interfaces News : New CTAO documents

- CTAO System Control documents
  - CTAO System Control Concept
  - CTAO System Control Standards
  - CTAO System Control Development guidelines
  - CTAO Alarm System (for information)
  - Received in April for review
  - Most of the NectarCAM comments given by Patrick & me
  - Each of the MST comments was discussed, clarified and finally agreed in September
  - The good news is that all these documents are not retroactive, neither mandatory and should be used as possible guidelines for future developments. We pick up what we can !

- CTAO Timing Standards
  - Quite general document distributed early September for review
  - NectarCAM comments given by Michael & Dirk
  - More detailed documents are expected in October
  - Dedicated timing workshop is planned during the CTA consortium at Napoli on Nov 14

- IPS concept and interface documents in preparation
  - Integrated Protection System of the array network
  - Based on identified hardware and digital IO + transmission by dedicated fibre optics
  - ICD proposal should be distributed in the coming days
  - Possible impact on the telescope design to be clarified

Interfaces News: NectarCAM Interface Matrix



Interface matrix

- Summarizes all interfaces of the camera
- Based on NectarCAM PBS
- Intersection filled = interface identified
- Recently updated to fulfill a few CDMR RIXes related to mounting or maintenance tools.
- External interfaces added
- Internal interfaces are all documented and validated.

Internal Interfaces

External Interfaces

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Design Verification

Compliance Matrix & Verification Plan: a Long Process

- Key elements in the verification process of the camera.
  - Verification plan lists all the NectarCAM applicable requirements. For each requirement, the verification methods at each project phase, and the testing procedures are given
  - Compliance Matrix gives compliance status photography of the camera at a given time

- History:
- CTAO was contacted several times prior the NectarCAM CDMR to agree on the compliance matrix format (starting from Feb 2019). No answer was received
- During the CDMR (Feb 21), reviewers said that the verification plan needs to be released (#42850) and the design compliance demonstrated in an updated verification matrix (#42745)
- To clarify the expectations, several meetings were organized in spring & summer 2021 with Vanessa Montes but no agreement was reached
- September 2021 : Stefano, as CTA Telescope manager was put in the loop

- End of November 21: F2F meeting with Stefano & Nick @ Saclay
  - Verification Plan & Compliance Matrix formats agreed with CTAO
  - Request for an update of the compliance documents to reach an “acceptable state for the CDMR closure, with the promise they will be improved for the preshipment and acceptance reviews
  - Verification procedures delayed to the Test Readiness Review

Compliance Matrix : a Long Process (2)

- 2021-12-02: agreement presented in NectarCAM PC
- Matrix content filled through dedicated calls organized with the WPs in Dec (verification methods for each project phase, test applicability)
- Update of some compliance documents to include clarifications or missing information (configuration, testbench description, accessible references, compliance status …)

- 2022-03-17 : Exchange with Stefano: “A very significant progress has been done”
- 2022-03-23 Work submitted through the RIX 42745 update
- 2022-06-21 Meeting with Nick, Stefano, JF, PG, JP related to critical RIXes (architecture document and verification and compliance matrices)

- 2022-07-04 RIX 42745 is closed by Nick
  - The requested compliance matrix and verification plan have been provided and reviewed. Therefore, this action is closed. It was not possible to check the linked reports and procedures due to the non-availability of the old SharePoint directories. This will be checked as normal work when a replacement repository is available. We agreed CTAO will support the generation of the verification and inspection procedures and any updates of the verification plan in preparation for the TRR which is targeted for the end of 2022.

- 2022-07-12 CTA PC : 2 templates documents given as models for other teams

Verification Plan

- Lists all the NectarCAM applicable requirements. For each requirement, the verification methods at each project phase, and the testing procedures are given

Environmental Requirements — Automatic JAMA extract on: 26/11/2018

Requirement Information		Camera Applicability	NectarCAM WP applibility		Project Phase D=Design Phase, P=Preshipment Phase, Acpt=Acceptance phase			Verification Method A=Analysis, D=Demonstration, R=Review of design, I=Inspection, T=Test, C=Certification						Test Applicability	
Requirement Identifier & Name	Requirement Description	Y=Yes, N=No, Shared w... Structu	WP Applicability	Verification level	Design	P	Acpt	A	D	R	I	T	C	Unit #	Test / Inspection Proc
B-ENV-0135 Atmospheric Pressure	Performance requirements must be met in the atmospheric pressure range of 770 +/- 50 mbar.	Y	ALL	System Engineering	X		X	X				X		1-N	
B-ENV-0210 Observation Temperature	Performance requirements for observations must be met within the ambient temperature range -5°C to 25°C	Y	Mech&Cooling	AIV	X	X		X				X		1-N	
B-ENV-0220 Survival Temperature	Damage must not occur due to ambient temperatures within the range -15°C to 35°C when in the Safe State	Y	Mech&Cooling	AIV	X	X		X				X		1-N	
B-ENV-0225 Survival Temperature Without Power	Damage must not occur due to ambient temperatures within the range -10°C to 30°C when no power is available.	Y	ALL	AIV	X	X		X				X		1	
B-ENV-0230 Temperature Gradient	Performance requirements for observations must be met during air temperature gradients of less than 7.5°C/h	Y	Mech&Cooling	AIV	X	X		X				X		1	

Compliance Matrix

- Gives compliance status photography of the camera at a given time. V 3.0 gives the compliance status photography at the CDMR closure.
- One compliance matrix will be issued for each project review and all camera units

Environmental Requirements

Automatic JAMA extract on: 26/11/2018

Requirement Information		Camera Applicability	NectarCAM WP applibility		Project Milestone C=CDMR, P=Preshipment Acceptance, A=Acceptance			Verification Method A=Analysis, D=Demonstration, R=Review of design, I=Inspection, T=Test, C=Certification						Reference(s)		
Requirement Identifier & Name	Requirement Description	Y=Yes, N=No, Shared with Structu	WP Applicability	Verification level	Cdmr	P	Acrv	A	D	R	I	T	C	Compliance document	Compliance status @ CDMR	
B-ENV-0310 Observation Humidity	Performance requirements for observations must be met within the relative humidity range 2% to 90%, provided the condition for operation with un-misted mirrors (B-ENV-0330) is met.	Y	Mech&Cooling	AIV	X		X	X				X		CTA-LLR-TN-031: NectarCAM Mechanical and ThermalPerformance Verification	Compliant	The camera is camera. controller.T humidity level air mana
B-ENV-0320 Survival humidity	Damage must not occur due to relative humidity within the range 2% to 100% when in the Safe State or when no power is available.	Y	Mech&Cooling	AIV	X	X		X				X		CTA-LLR-TN-031: NectarCAM Mechanical and ThermalPerformance Verification	Compliant	The camera is camera. controller.T humidity lev camera sealin doors is n
B-ENV-0410 Rain in 24 hours	Damage must not occur due to rain precipitation of up to 200mm in 24 hours.	Y	Mech&Cooling	AIV	X	X						X		MST-CAM-TN-0400-IRFU_NectarCAM Test etanchéité	Compliant	The camera ho ingress protec note CTA- protection I NectarCAM Q Tests results ingress were f At Adleshop Waterproo
B-ENV-0420 Rain in 1 hour	Damage must not occur due to rain precipitation of up to 70mm in 1 hour.	Y	Mech&Cooling	AIV	X	X						X		MST-CAM-TN-0400-IRFU_NectarCAM Test etanchéité	Compliant	The camera ho ingress protec note CTA- protection I NectarCAM Q
B-ENV-0430 Rain wind speed	Damage beyond the Serviceability Limit State must not occur due to precipitation in the form of rain, snow or hail for (10 minute average) wind speeds of up to 90km/h.	Y	Mech&Cooling	AIV	X	X						X		MST-CAM-TN-0400-IRFU_NectarCAM Test etanchéité	Compliant	The camera ho ingress protec note CTA- protection I NectarCAM Q
B-ENV-0460 Rain during transition	During transitions, damage must not occur due to rainfall of up to 2 mm/hour.	Y	Mech&Cooling	AIV	X	X						X		MST-CAM-TN-0400-IRFU_NectarCAM Test etanchéité	Compliant	The camera ho ingress protec note CTA- protection I NectarCAM Q
B-ENV-0520 Survival snow load (North)	Damage beyond the Serviceability Limit State must not occur on the CTA-N site whilst in the Safe State due to snow loads of up to 200kg / m^2	Y	Mech&Cooling	Mech&Cooling	X			X						CTA-LLR-TN-0021 Camera Structural Analysis	Compliant	The strength as well as the

NectarCAM Verification Status @ CDMR (last Spring)

	ENV	Common	MST	ON SITE	Struct	Sum	
Requirement number applicable to the camera or shared with the telescope	31	44	28	36	60	199	
Compliant	28	30	24	14	50	146	73,4%
Partially Compliant	2	0	0	0	0	2	1,0%
To be Confirmed	1	2	1	1	0	5	2,5%
Deferred to Preshipment review	0	12	3	20	8	43	21,6%
Deferred to the acceptance review	0	0	0	1	2	3	1,5%

- No particular worry that we will not be compliant with some requirements
  - 2 PC are related to South Earthquakes (not applicable, NCAM goes to North)
  - 1 TBC is now validated by tests from the supplier of the new shutter (opening/closing up to 50km/h)
  - 2 TBC are related to requirements to be clarified with CTAO
  - Most of the deferred to the preshipment review require the final software (RCC, ACADA, RTA)
  - 3 were linked to missing test facilities (laser). Validated since.
  - 4 are linked to maintenance duration or maintenance documentation
  - 3 require that all errors /alarms/ particular cases are listed and analysed
  - Those deferred to the acceptance review are linked to the cabling on the telescope or validation from data center

- Notes
  - Waterproofness of the first unit will be re-done soon with the updated camera front design
  - Thermal tests planned in the dark room in the coming weeks to validate by tests the requirements
  - ....

CTA Requirements

- CTA requirements are not yet frozen
- Some requirements are still unclear, incomplete or wrong
- CTAO intention is to prepare some generic specifications to be mentioned in the IKC agreement
- Work complicated by existing advanced designs, and possible conflicts
- Some environmental requirements should be relaxed
- Forum for revision of telescope requirements set
  - https://redmine.cta-observatory.org/projects/telescope-requirements/boards

- In the last CTAO MST SE meting, it was said that any change in the requirement will be mutually agreed by CTAO and the telescope. Changes *should* not impact the camera design

Verification : Next Steps

- Write verification and inspection procedures
- Expected for the Test Readiness Review (TRR)
- CTAO should support the generation of these documents
- Shall include
  - Test facilities description
  - Software and hardware configurations
  - Description of tests and inspections that will be performed on the camera units
  - Note that some verifications will be performed only on the first camera(s)
- The QM is the ideal place to validate the performances, calibrate the camera and prepare the associated procedures

- TRR Target: February / March 2023
- *“The basic objective of the TRR is to check whether the test item is ready for testing (including a check that there are no open change requests or action items from previous review) and whether the test program and its related facilities are fit to perform the test (i.e. test plans and procedures are available and accepted)” - CTA Management Plan 2020-05-25*

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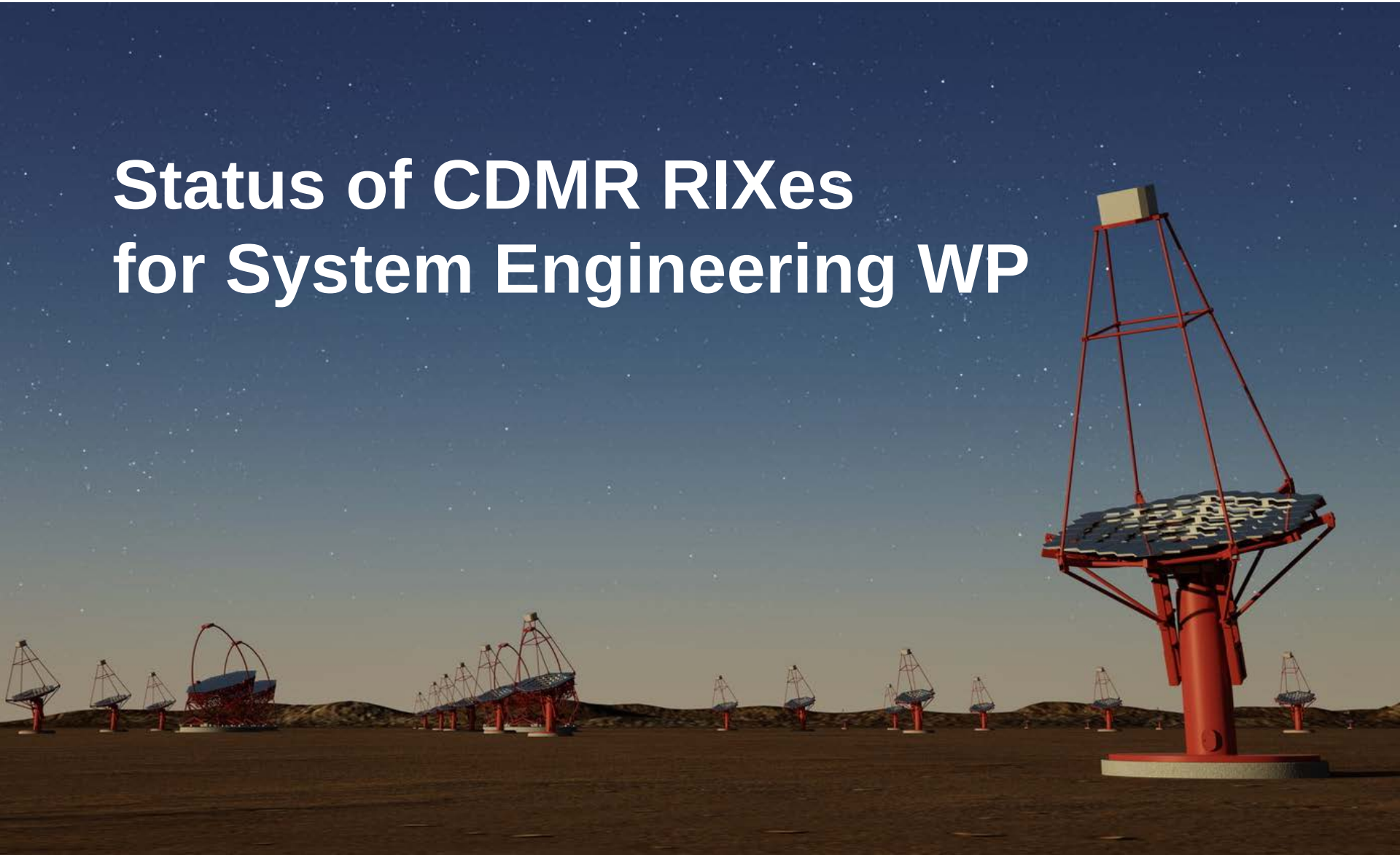
Status of CDMR RIXes for System Engineering WP



System Engineering RIXes: Status

- 27 RIXes within the category “System Engineering” (6 high priority)
  - 22 are closed
  - 4 non closed RIXes are assigned to CTAO (42381, 42336, 42629, 42511)

- 1 non closed RIX
  - RIX 41768
  - “We have discussed this topic in the monthly SE meeting between MST and CTAO in April 2021. MST agreed to provide the allocation of the MST level B requirements to the camera and structure (AI-210416-01). The allocation of requirements that are only for camera or structure exists / has been provided.“
  - **“The remaining open part of the relevant action is for the MST team to provide a breakdown (budget allocation) for those requirements that have components from both structure and camera. This is currently on hold due to other priorities.”**

Status on 2022-10-05

Questions ?