

cherenkov telescope array

CTAO Perspective on Calibration: Architecture, Requirements, Interfaces, Use Cases

Alison Mitchell, 04/10/17

CTA Calibration Meeting, Barcelona





- Current CCF work is greatly appreciated by CTAO and crucial for the success of the Observatory
- However, expect changes with respect to the Critical Design Review (CDR):
 - CDR was a general endorsement of CTA plans
 - PPRR and OIR are needed for a firm final plan (see the Business Plan)
- CTAC plans to set up a calibration group under ASWG
 - Bridge the transition between construction and operation
 - Facilitate development of new ideas and algorithms
 - Coordination of open-ended tasks
- Exact CTAO / CTAC division remains to be defined

CTA Restructuring



- CTAO is currently restructuring work packages
- Top-Level Architecture process used to identify systems
 - See talks by Matthias Füßling at recent Project Committee meetings
- Upcoming decisions on:
 - Which items / systems should be packaged as a single IKC agreement
 - Which items can be directly implemented / bought by CTAO



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Architecture

CTA Architecture



- System Architecture: Use Cases and processes as input
 - Develop a system model for how CTA will work in the operations phase
 - Understand and model all information flow and system interactions
- Comprehensive documentation (~80 pages) to be distributed in the near future

CTA Architecture: CTA context





CTA Architecture: CTAO System





CTA Architecture: Auxiliary Instruments







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Requirements

New Requirements Scheme



Under development in Jama, based around CTA architecture







- For passing the next reviews and for device acceptance, it must be demonstrated that the relevant requirements are met
- They ensure that the required level of performance / functionality is reached
- Requirements should capture everything absolutely needed
- Requirements do not contain the solution
 - Details of the proposed solution are specifications
 - Requirement Verification Statements explain how a given set of specifications meets a requirement

Environmental Requirements



- Recently adjusted to account for data obtained by T. Bulik and measurements at the chosen sites
- All CTA Products on-site must be able to deliver the required performance (for a given state) under the environmental ranges given in the requirements.
- States:
 - Harshest environmental conditions \rightarrow Safe state
 - Normal environmental conditions → Operational / Observing state

Calibration Requirements



- Fall roughly into three categories:
 - Performance requirements on final uncertainties (mostly existed)
 - Requirements that measurements are possible (mostly missing)
 - Requirements on behaviour of calibration devices (mostly missing)
- A lot of work to be done to make the requirements complete

Performance Requirements



- High-Level requirements on derivable quantities
- PROG-0100 Systematic Energy Uncertainty: Systematic errors or biases in the energy of reconstructed gamma-ray photons must be < 10% at energies between 50 GeV and 300 TeV (at 90% confidence level)
- Uncertainty budgets were allocated with help of "calibration strategy" document and propagated to the next level
- A-PERF-2050 Absolute Throughput Error:

The systematic error on the measurement of the absolute intensity (i.e. photons per square metre) of the Cherenkov light (post-calibration) at the position of each telescope must be < 8%

Measurement Capability Requirements



- Requirements that justify the existence of calibration devices
- A-GEN-3060 Environmental Alarms

It must be possible for environmental monitoring systems within CTA to raise environmental alarms, as well as for CTA to receive and respond to externally generated environmental alarms

• B-CSI-xxx External Illuminating Device:

A device capable of externally illuminating the telescope at multiple wavelengths (within the sensitive range of the telescopes) and at multiple intensities, known to better than 5% accuracy, must be provided for calibration purposes

• E.g. Illuminator could be an IKC solution to this requirement

Calibration Device Requirements



• Requirements on the behaviour of calibration equipment

• Light Pollution:

Array Elements must not produce light with an isotropic equivalent flux greater than 3x10⁶ photons ns⁻¹ at source in the wavelength range 300-550 nm in the absence of specific calibration instructions from OES.

- Note: all CCF devices must be monitored by the OES
 - Some devices will need a control interface and well defined states
 - Some devices will need to be connected to the SAS (those with human safety implications)



Interfaces

Interfaces: Transition to Jama system



- Many System boundaries have shifted during the architecture process
 - Obvious boundaries, e.g. Infrastructure device remain
- Old sharepoint database
 - Almost only calibration had useful information
 - Exportable to excel
 - Will be replaced by Jama
 - Merge interfaces with transition to Jama

Interface Approach



- Each interface is motivated by level B requirements from each work package
- The existence of an interface must be defined by CTAO
 - Interfaces must not be defined arbitrarily!
- Interfaces describe all relevant specifications and must be agreed between affected work packages



Interface Control Document Template



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E CTA restructuring		•• I-IIN
🕀 📝 Glossary		СТА
🕀 拱 Top Level Requirer	nents	Description:
🕀 🔛 Level A Requireme	ents	
🕀 🕂 Level B Requireme	ents	
🕀 🖶 CTA Objectives		
🕀 💾 Observatory Requi	rements	
🕀 💾 System Requireme	ents	
🕀 💾 Product Requireme	ents	
🕀 🖶 RVS		
E Interface Control D	ocuments	
Interface Lists		
Interfaces		
I-INFRA-CSI	All Sky Camera	
I-INFRA-CSI	template	
I-INFRA-CSI	IFAE/LUPM/UAB	
I-INFRA-CSI	FRAM	
I-INFRA-CSI	Cellometer	
I-INFRA-CSI	Anemometer	
	Weather Station	
	Areada Lidar	
	Arcade Lidar	
	Uluminator	
	Electric Eield Mill	
	AERONET Sun P	
I-INFRA-CSI	Radiosonde	
I-INFRA-CSI	Ceilan Lidar	
I-INFRA-CSI	template	
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PEC.V	7	

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CTA_-Interface-2 · Interface CTA restructuring » Interface Control Documents » Interfaces

Description of the Item

Item Location

Item	Value

Item Safety

Item Support Structure

Item	Value

Item Maintenance

ltem	Value

Area Around Item and Access

Power Needs for the Item

Interface Applicability

This interface applies to both CTA-N and CTA-S sites.

Unassigned

INFRA

CSI

Draft

WP 1 Responsible:

Interface WP 1:

Release:

Interface WP 2:

WP 2 Responsible:

Interface Status:





- UC-CAL-ATMO and UC-CAL-ARRAY in Jama (M. Gaug and F. Cassol)
- Already quite in-depth Use Cases
 - In several cases, refer to a specific device / solution
 - One level deeper than current architecture work
- Top-Level Architecture team has not found any inconsistencies
 with CAL Use Cases so far
- Telescope Use Cases will be circulated soon (first version to PC in October) only minor implications found from CAL Use Cases

Calibration Strategy for Operations Phase



- A detailed plan / strategy for calibration during the operations phase is currently lacking
- CTAO to commence as part of a more general operations plan, in collaboration with calibration group members
- Needs to cover:
 - Which methods are safety critical, influence scheduling, primary methods, secondary methods
 - Frequency of execution and how they will be scheduled
 - How data will be analysed and at what level it will be applied (data quality cuts? Calculation of calibration coefficients?)
- Related to Use Cases, but providing the overview / context





- JAMA system: <u>https://jama.cta-observatory.org/perspective.req#/home</u>
- If you cannot login, you probably have not been added to the system yet → let me know
 (or email jama@cta-observatory.org)
- First requirements workshop for telescopes: 25th-26th October, Bologna CSI requirements to follow soon
- Calibration is vital to the success of CTA CTAO recognises this
- A lot of change underway



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Thank you for your attention

Any Questions?



Array Element:

An element of the CTAO system deployed on an array site which is needed for array operation and of sufficient complexity or with sufficient safety implications that operation via standard connections to the OES and SAS systems is required.