Export from Jama of 1.08 DAQ

CMBS4-doc-783

Export Date: 07/14/2023 10:18 AM Pacific Time

Exported From Jama Project: CMB-S4

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1 DAQ Subsystem Requirements (Level 2)

1.1 Core Functionality

CTRL-0001: Control System

DAQ shall provide an Observatory Control System (OCS). It shall coordinate the delivery of high quality data from scan sequencing by providing the relevant hardware devices continuous set-points and the operator and other DAQ subsystems with the necessary feedback to efficiently and safely control the system operation. It shall also support diagnostic and calibration operations of observatory hardware. It shall be designed to allow experts from other subsystems to contribute code to integrate their devices into the OCS.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	The acquisition of science data must be coordinated among all observatory components.
#Parents / #Children	8 / 22
Parent(s)	SYS-SAT-070: Calibration SYS-SPL-070: Calibration SYS-CHL-070: Calibration SYS-SAT-050: Observing Efficiency SYS-SPL-050: Observing Efficiency SYS-CHL-050: Observing Efficiency SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0001: Data Acquisition

DAQ shall acquire all required housekeeping data, including metadata, needed for the scientific analysis of the survey data as well as, at a minimum, the following: health of operating systems, interlock statuses, temperatures, pressures, loads, status, rate, weather.

Status:	Draft
Verification Method:	Demonstration, Analysis
Verification Description:	
Basis/Rationale:	DAQ needs to support both the production of science data products by DM by providing them with the data and metadata required, but also has a responsibility to the other subsystems to provide access to the data to allow for data quality monitoring, calibration, and debugging of those systems. The enumeration of

	the required data will be contained in ICDs with the subsystems that either require or produce those data.
#Parents / #Children	9 / 19
Parent(s)	SYS-SAT-070: Calibration SYS-SPL-070: Calibration SYS-CHL-070: Calibration SYS-PRJ-110: Data: Non-Transient Science SYS-PRJ-100: Data: Quality Assurance SYS-PRJ-090: Data: Transients SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0060: Health & Monitoring

DAQ shall provide monitoring of housekeeping and diagnostic data, including detector statistics. This monitoring shall allow visualization of temporal changes in monitored quantities. Live (near real-time) access and sparsified views over the entire history shall be supported. Access shall be provided by a browser based GUI.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	To ensure the quality of data acquired, the stability of operating conditions, and aid the diagnosis of problems, performance of observatory hardware components must be monitored.
#Parents / #Children	5 / 14
Parent(s)	SYS-SAT-050: Observing Efficiency SYS-SPL-050: Observing Efficiency SYS-CHL-050: Observing Efficiency SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0080: Alarms

DAQ shall provide an alarm system based on housekeeping data and detector statistics acquired by the monitoring system.

Status:	Draft

Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	As the large number of acquired housekeeping quantities preclude human monitoring, automated range checking can alert operators to changes in conditions.
#Parents / #Children	6 / 9
Parent(s)	SYS-PRJ-020: Design lifetime SYS-SAT-050: Observing Efficiency SYS-SPL-050: Observing Efficiency SYS-CHL-050: Observing Efficiency SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0180: Test Stand Support

DAQ and Controls shall provide software to operate on subsystem test stands. (e.g. Detector Modules, LAT, SAT, Readourt (TBR))

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	Early integration of DAQ with other subsystems will benefit both by reducing the risk that software developed in isolation will prove incompatible.
#Parents / #Children	2 / 9
Parent(s)	SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0040: Timing and Synchronization

DAQ shall provide absolute timing and any required clocks for synchronization to all systems. Signals shall be sent via network to each telescope platform and arrive within the timing phase noise jitter requirements specified by the detector readout system. The timing breakout at each telescope may include IRIG, 10MHz, PPS as needed by the subsystem. If required a synchronous pulse may be distributed to each telescope platform. DAQ shall use existing standards to distribute time, these may include PTP and/or Synchronous Ethernet.

Status:	Draft
Verification Method:	Test

Verification Description:	
Basis/Rationale:	All data acquired asynchronously will require absolute timestamps and systems may need to be be clocked synchronously for noise or other considerations. The specific requirements will need to come from ICDs with other subsystems or L1 requirements.
#Parents / #Children	5 / 2
Parent(s)	SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole SYS-SAT-060: Systematics SYS-SPL-060: Systematics SYS-CHL-060: Systematics

: Network Design

DAQ shall provide a network design which provides sufficient connectivity and bandwidth between components that will provide data to or receive commands from the DAQ or OCS. The design shall be 10Gb Ethernet based. DAQ may provide or prescribe specific network hardware to implement this design.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	DAQ will provide the network connecting the OCS and Data Acquisition to the instruments and their support equipment. Requirements on any devices which connect to the network will be specified in ICDs. Similarly, any networking equipment provided by other subsystems will be specified in ICDs.
#Parents / #Children	5 / 4
Parent(s)	SYS-PRJ-110: Data: Non-Transient Science SYS-PRJ-100: Data: Quality Assurance SYS-PRJ-090: Data: Transients SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0100: Logging Facility

DAQ shall provide and use a common system to record logs and trace errors. Subsystems shall be provided an interface which allows them to enter messages in the log. It shall include keeping a history of messages and methods for searching and filtering the contents of the log.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	A central logging facility enables the monitoring of the operation of the system as well as tracking, explanation, and resolution of anomalies.
#Parents / #Children	6 / 1
Parent(s)	SYS-PRJ-020: Design lifetime SYS-SAT-050: Observing Efficiency SYS-SPL-050: Observing Efficiency SYS-CHL-050: Observing Efficiency SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0030: Data format

DAQ shall specify the format of data products and will provide data in that format through its interfaces. DAQ systems should use this representation of the data internally where appropriate.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	Using a common data format will enable the correlation of data from various sources. Gratuitous translation of data between formats, internal or external to DAQ incurs performance penalties and increases the risk of data corruption. The data formats will be defined in ICDs.
#Parents / #Children	7 / 2
Parent(s)	SYS-PRJ-110: Data: Non-Transient Science SYS-PRJ-100: Data: Quality Assurance SYS-PRJ-090: Data: Transients SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole SYS-PRJ-070: Time Standard

: Data Latency

The DAQ shall produce its data products within the time allotted to it in the latency budget (TBR).

Status:	Draft
Verification Method:	Test
Verification Description:	
Basis/Rationale:	In order for the observatory to produce its science data products in a timely manner, DAQ and Controls must produce its data products within their allowed latency budget.
#Parents / #Children	3 / 2
Parent(s)	SYS-PRJ-110: Data: Non-Transient Science SYS-PRJ-100: Data: Quality Assurance SYS-PRJ-090: Data: Transients

: Observatory Time Standard

Any timestamped data in DAQ subsystems, either at rest or transmitted, shall be stored or transmitted with timestamps in the observatory time standard UTC.

Status:	Draft
Verification Method:	Demonstration, Inspection
Verification Description:	
Basis/Rationale:	To reduce the possibility of error translating timezones, whenever data is stored or transmitted, it should use the observatory time standard.
#Parents / #Children	1 / 4
Parent(s)	SYS-PRJ-070: Time Standard

CTRL-0230: Availability

The DAQ and Controls system shall not cause more than 0.1% (TBR) loss of data from downtime.

Status:	Draft
Verification Method:	Test, Analysis
Verification Description:	
Basis/Rationale:	The expectation is that DAQ should not materially contribute to downtime. This should also be related to the appropriate performance requirement/budget.
#Parents / #Children	5 / 0

Parent(s)	SYS-SAT-050: Observing Efficiency SYS-SPL-050: Observing Efficiency SYS-CHL-050: Observing Efficiency SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

1.2 Design Principles

CTRL-0080: Scalability

DAQ and Controls systems shall work at a variety of scales: single object, lab, testing, receiver, and full observatory. Further, in the full observatory, DAQ and Controls systems shall be capable of being configured to operate with arbitrary combinations of telescopes.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	Early integration of DAQ with other subsystems is critical to ensuring provided functionality is sufficient, and provide opportunities to verify requirements and interfaces prior to observatory integration. Allowing arbitrary combinations of telescopes is critical to continuing to operate if some number of telescopes are taken offline or if the compliment of telescopes in the observatory changes.
#Parents / #Children	2 / 5
Parent(s)	SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0090: Commonality

DAQ shall provide the same software systems to Chile, South Pole, and labs. These software systems shall be adapted to each environment through runtime configuration.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	Though there may be DAQ software components which are specific to the various environments, the system should be designed to be configurable by the end users for their specific needs.

#Parents / #Children	2 / 3
Parent(s)	SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0120: Hardware compatibility

DAQ software shall be written so it can be used on any commodity lab computer, with compatible OS, package manager, compiler/library version, etc on the native system.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	DAQ will not be providing computer hardware to subsystems. To ensure the early integration with DAQ software, that software should be capable of running at the lab scale on commodity hardware. Any minimum requirements that could not be reasonably expected to be satisfied by such a machine (e.g. 10GbE NIC) should be specified in ICDs.
#Parents / #Children	3 / 4
Parent(s)	SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0130: Open source

The DAQ and Controls software shall be open source with no dependencies on licensed libraries, packages, etc. to the greatest extent possible.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	Relying on proprietary software frameworks and libraries introduces risks over the lifetime of the system. At the least, the availability of support for such resources may not be reliable over the term of the project and operations. Open source software, at the very least, will allow maintaining our own copy of any such software products if it becomes unsupported.
#Parents / #Children	3 / 4
Parent(s)	SYS-PRJ-020: Design lifetime

SYS-PRJ-050: Siting at Chile
SYS-PRJ-060: Siting at South Pole

CTRL-0140: Distributions

The DAQ and Controls sofware shall be versioned and use tools which allow collaborative development, issue tracking, and code reviews.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	We are expecting experts from other subsystems to participate in DAQ development by implementing code to manage the devices they produce. To facilitate this development, DAQ will need to use collaborative software development tools and processes.
#Parents / #Children	3 / 2
Parent(s)	SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0150: Programming Languages

DAQ software should be written in a limited number of well-known languages including C++, python or javascript, where appropriate. Where software is expected to be contributed by other subsystems, DAQ shall provide at least a python API.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	The DAQ system will likely be maintained by a series of individuals over the life of the experiment. To facilitate this long-lived common languages should be used for implementation unless they are precluded by technical reasons. Specifically, it is expected that users/collaborators will mostly wish to use Python to interface with DAQ systems.
#Parents / #Children	3 / 3
Parent(s)	SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0190: Firmware-free

DAQ and Controls shall not provide firmware.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	Keeping DAQ systems in the software domain will allow development and testing on commodity compute and network hardware. By excluding firmware, the DAQ group will not require staff with firmware experience.
#Parents / #Children	3 / 3
Parent(s)	SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

CTRL-0210: Digital Hardware Interfaces

DAQ interfaces to all hardware shall be digital.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	Keeping DAQ systems in the digital domain will allow development and testing on commodity compute and network hardware.
#Parents / #Children	3 / 3
Parent(s)	SYS-PRJ-020: Design lifetime SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

DAQ-0140: Asynchronous Data Collection

The software architecture shall support asychronous data collection of all data types.

Status:	Draft
Verification Method:	Demonstration

Verification Description:	
Basis/Rationale:	There should be no assumption that data provided to DAQ occurs synchronously or that data from one source implies the presence of data from another source. This will allow the most flexibility for components to operate in isolation and in various modes.
#Parents / #Children	12 / 3
Parent(s)	SYS-SAT-070: Calibration SYS-SPL-070: Calibration SYS-CHL-070: Calibration SYS-PRJ-110: Data: Non-Transient Science SYS-PRJ-100: Data: Quality Assurance SYS-PRJ-090: Data: Transients SYS-PRJ-020: Design lifetime SYS-SAT-050: Observing Efficiency SYS-SPL-050: Observing Efficiency SYS-CHL-050: Observing Efficiency SYS-PRJ-050: Siting at Chile SYS-PRJ-060: Siting at South Pole

2 DAQ Subsystem Current Best Estimates

3 DAQ Level 3

3.1 Level 3 Requirements

3.1.1 1.08.02 Observatory Control System

3.1.1.1 Core Functionality

CTRL-0110: Scheduling

The OCS shall support the execution of observations which consist of ordered operations.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	A demonstration of the ability to schedule a sequence of observations through the OCS will be sufficient to verify this requirement. Emulated components are acceptable for this demonstration.
Basis/Rationale:	OCS is responsible for coordinating the operation of observatory components during observations. These observations will consist of sequences of actions specified by the user. Examples of such

	operations are move to a location, tune detectors, begin a scan pattern, etc. The interface for specifying these sequences will be documented in the appropriate ICD.
#Parents / #Children	1 / 0
Parent(s)	CTRL-0001: Control System

: Logging Facility

OCS shall provide and use a common system to record logs and error tracing.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	To verify this requirement, it will be sufficient to demonstrate the use of the logging facility.
Basis/Rationale:	A central logging facility is critical to the efficient debugging of issues.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System DAQ-0100: Logging Facility

CTRL-0040: Operating Modes

The OCS shall be designed and constructed to support the following operational modes: fully automated, calibration, manual observing, engineering and maintenance

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Demonstration of operations in each of these modes will be sufficient to verify this requirement. Emulated components will be allowed for this demonstration.
Basis/Rationale:	Depending on the situation, different operating modes will be necessary.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0180: Test Stand Support

CTRL-0050: Receiver commanding

The OCS shall be capable of executing commands to receiver's bolometer readout crate, such as calibration, tuning, fast cadence modes, and data acquisition.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	This requirement will be verified by using OCS to configure and command the readout of a receiver's readout crate. This can be done in at lab scale.
Basis/Rationale:	OCS is responsible for providing the command/user interface to the receivers.
#Parents / #Children	3 / 0
Parent(s)	CTRL-0001: Control System DAQ-0001: Data Acquisition CTRL-0180: Test Stand Support

CTRL-0070: Refrigerator commanding

DAQ and Controls shall provide a carefully considered plan for command of the refrigerators, with equipment safety made a particularly high priority, and in consultation with the needs of the collaboration and the refrigerator vendor.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	experience, CONOPS
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0180: Test Stand Support

CTRL-0060: Auxiliary hardware commanding

The OCS shall support commanding other components, including but not limited to: calibration equipment, heaters, compressors, hardware configuration.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	For each hardware component described in an ICD, OCS will demonstrate that it supports the required interface. Doing so in a lab environment in isolation will be sufficient.
Basis/Rationale:	The set of hardware to be commanded will be captured in the ICDs with other subsystems.

#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0180: Test Stand Support

CTRL-0010: Local or remote control

The OCS shall support both local and remote user interaction with the telescopes, receivers, and other hardware.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	A demonstration of remote access to the OCS is sufficient to verify this requirement.
Basis/Rationale:	It will be necessary for remote experts to have access to their systems in all phases of the project not limited to commissioning and debugging.
#Parents / #Children	1 / 0
Parent(s)	CTRL-0001: Control System

CTRL-0020: Observer or scheduled commands

The OCS shall allow control of each telescope, receiver, and associated hardware either directly by a telescope operator or through a scripted set of commands

Status:	Draft
Verification Method:	Demonstration
Verification Description:	A demonstration of both interactive and scripted control of an observation will be sufficient to verify this requirement. Emulated components are acceptable for this demonstration.
Basis/Rationale:	There will be cases where interactive control of telescope systems will be required, but it is expected that scripted commanding will be nominal method for performing observations.
#Parents / #Children	1 / 0
Parent(s)	CTRL-0001: Control System

CTRL-0200: Telescope interface

The OCS will interface with the telescopes at a high-level, e.g. at the level of az/el itinerary delivered by network or serial communication.

Status:	Draft
Verification Method:	Inspection
Verification Description:	Inspection of the interface between OCS and the telescopes will be sufficient to satisfy this requirement.
Basis/Rationale:	This will be specified in the ICDs with the appropriate subsystems.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0210: Digital Hardware Interfaces

CTRL-0160: Control authorization

The OCS shall manage and prioritize access to observatory control by users so that conflicting commands will not be possible. OCS may allow observatory systems to be partitioned to allow separate control authorization during some operating modes.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Demonstration of this functionality will be sufficient to verify this requirement.
Basis/Rationale:	Multiple users commanding the same hardware could lead to unexpected operation. OCS should control access to command authority over hardware.
#Parents / #Children	1 / 0
Parent(s)	CTRL-0001: Control System

: Observatory Time Standard

Any timestamped data in OCS subsystems, either at rest or transmitted, shall be stored or transmitted with timestamps in the observatory time standard UTC. OCS may choose to allow the user to view the timestamps in an arbitrary time zone provided it is clearly labeled as such.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the codebase to show timestamps are recorded in the observatory time standard.
Basis/Rationale:	Though it is imperative to record all data with a consistent time base, it may be helpful to the user to view times in a local timezone.
#Parents / #Children	1 / 0

Parent(s) : Observatory Time Standard

3.1.1.2 Design Principles

CTRL-0100: User friendly

The OCS shall provide a software framework and support that allows any qualified collaboration member to contrubute software to allow the control and monitoring of, and acquisition from, new components.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	experience, CONOPS
#Parents / #Children	1 / 0
Parent(s)	CTRL-0001: Control System

CTRL-0170: Modularity

The OCS shall allow configuration of DAQ and Control objects per lab which are changeable by the user.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	
Basis/Rationale:	experience, CONOPS
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0180: Test Stand Support

: Scalability

The OCS shall work at a variety of scales: single object, lab, testing, receiver, and full observatory.

Status:	Draft
Verification Method:	Demonstration

Verification Description:	Demonstration of scalability will be completed by demonstration at scales up to and including the full observatory. Particularly for large scale demonstrations, emulated or simulated data producers will be sufficient.
Basis/Rationale:	Early integration of OCS with other subsystems is critical to ensuring provided functionality is sufficient, and provide opportunities to verify requirements and interfaces prior to observatory integration.
#Parents / #Children	3 / 0
Parent(s)	CTRL-0001: Control System CTRL-0080: Scalability CTRL-0180: Test Stand Support

CTRL-0220: Messaging layer

The OCS messaging and routing layer for the control architecture should be commercial and designed for distributed systems.

Status:	Draft
Verification Method:	Inspection
Verification Description:	Code inspection will be sufficient to verify this requirement.
Basis/Rationale:	Writing performant middleware from scratch is not a good use of project resources any more than building a custom network switch.
#Parents / #Children	1 / 0
Parent(s)	CTRL-0001: Control System

: Commonality

OCS shall provide the same software systems to Chile, South Pole, and labs. These software systems shall be adapted to each environment through runtime configuration.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the documentation.
Basis/Rationale:	Though there may be OCS software components which are specific to the various environments, the system should be designed to be configurable by the end users for their specific needs.
#Parents / #Children	2 / 0

Parent(s)	CTRL-0090: Commonality CTRL-0001: Control System

: Hardware compatibility

OCS software shall be written so it can be used on a commodity lab computer, with compatible OS, package manager, compiler/library version, etc on the native system.

Status:	Draft
Verification Method:	Inspection
Verification Description:	It will be sufficient to inspect the minimum hardware requirements for a lab installation of the OCS software systems to verify this requirement.
Basis/Rationale:	OCS will not be providing computer hardware to subsystems. To ensure the early integration with OCS software, that software should be capable of running at the lab scale on commodity hardware. Any minimum requirements that could not be reasonably expected to be satisfied by such a machine (e.g. 10GbE NIC) should be specified in ICDs.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0120: Hardware compatibility

: Open source

The OCS software should be open source with no dependencies on licensed libraries, packages, etc.

Status:	Draft
Verification Method:	Inspection
Verification Description:	It is sufficient to verify this requirement by inspection of the codebase.
Basis/Rationale:	
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0130: Open source

: Distributions

The OCS software shall be versioned and use tools which allow collaborative development, issue tracking, and code reviews.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the code repositories and documentation.
Basis/Rationale:	We are expecting experts from other subsystems to participate in OCS development by implementing code to manage the devices they produce. To facilitate this development, OCS will need to use collaborative software development tools and processes.
#Parents / #Children	3 / 0
Parent(s)	CTRL-0001: Control System CTRL-0140: Distributions CTRL-0180: Test Stand Support

: Programming Languages

OCS software should be written in a limited number of well-known languages including C++ or python where appropriate. Where software is expected to be contributed by other subsystems, DAQ shall provide at least a python API.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the code repository.
Basis/Rationale:	The OCS system will likely be maintained by a series of individuals over the life of the experiment. To facilitate this long-lived common languages should be used for implementation unless they are precluded by technical reasons. Specifically, it is expected that users/collaborators will mostly wish to use Python to interface with OCS systems.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0150: Programming Languages

: Firmware-free

OCS shall not provide firmware.

Status:	Draft
Verification Method:	Inspection
Verification Description:	For verification of this requirement, it will be sufficient to inspect the code base.
Basis/Rationale:	Keeping OCS in the software domain will allow development and testing on commodity compute and network hardware. By excluding firmware, the OCS group will not require staff with firmware experience.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0190: Firmware-free

: Digital Hardware Interfaces

OCS interfaces to all hardware shall be digital.

Status:	Draft
Verification Method:	Inspection
Verification Description:	For verification of this requirement, it will be sufficient to inspect the code base.
Basis/Rationale:	Keeping OCS systems in the digital domain will allow development and testing on commodity compute and network hardware.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0001: Control System CTRL-0210: Digital Hardware Interfaces

: Asynchronous Data Collection

The software architecture shall support asychronous data collection of all data types.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Verification of this requirement will take the form of a demonstration of multiple components operating asynchronously.
Basis/Rationale:	There should be no assumption that data provided to OCS occurs synchronously or that data from one source implies the presence of data from another source. This will allow the most flexibility for components to operate in isolation and in various modes.

#Parents / #Children	2 / 0
Parent(s)	DAQ-0140: Asynchronous Data Collection CTRL-0001: Control System

3.1.2 1.08.03 Observatory DAQ

3.1.2.1 Core Functionality

: Bolometer Data

DAQ shall acquire the fast bolometer data from the Readout system, and provide it to Data Management.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	For verification of this requirement, it will be sufficient to demonstrate the ability to acquire data from a representative readout emulation and produce the appropriate data products.
Basis/Rationale:	DAQ will process the fast data stream from the readout crates, and produce intermediate data products in accordance with the DAQ/DM ICD.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition DAQ-0030: Data format

DAQ-0200: Meta-data

DAQ shall record appropriate meta-data with its associated data. (e.g. bolometer tuning results)

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Verification of this requirement will be by a demonstration of acquisition of bolometer data and production of data products in accordance with the DAQ/DM ICD.
Basis/Rationale:	Metadata is data required in order to process the bolometer data into useful science data products. The metadata to be recorded with the data will be described in the DAQ/DM ICD.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition DAQ-0030: Data format

: Data Latency

The DAQ shall produce its data products within the time allotted to it in the latency budget (TBR).

Status:	Draft
Verification Method:	Test
Verification Description:	To verify this requirement, the DAQ subsystem must be shown to produce their data products within the latency budget. Emulated data producers will be allowed in performance of this test.
Basis/Rationale:	In order for the observatory to produce its science data products in a timely manner, DAQ and Controls must produce its data products within their allowed latency budget.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition : Data Latency

DAQ-0110: Network Physical Layer

The DAQ shall provide a network design based on 10 Gigabit Ethernet between telescopes to the recording computers.

Status:	Draft
Verification Method:	Inspection
Verification Description:	Simple inspection of the design will be sufficient to verify this requirement.
Basis/Rationale:	10 Gigabit Ethernet components are commonplace and provide ample bandwidth for communication among observatory components. DAQ will specify network compatibility requirements in the appropriate ICDs for subsystems wishing to communicate on the DAQ network.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0001: Data Acquisition : Network Design DAQ-0040: Timing and Synchronization

DAQ-0120: Network Protocol

The network shall support IP based protocols.

Status:	Draft
Verification Method:	Inspection
Verification Description:	Inspection of the specifications of the network components will verify that they support IP based protocols.
Basis/Rationale:	Virtually all network capable devices will be capable of communicating with IP over Ethernet making this a natural standard.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0120: Hardware compatibility : Network Design

DAQ-0130: Network Partitioning

The domains for high speed and low-speed DAQ may be segregated physically or virtually.

Status:	Draft
Verification Method:	Inspection
Verification Description:	
Basis/Rationale:	It may become necessary to isolate the high-speed DAQ connections in order to maintain performance.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0001: Data Acquisition : Data Latency : Network Design

: Timing and Synchronization

DAQ shall provide absolute timing and any required clocks for synchronization to all systems. Signals should be sent via network to each telescope platform and arrive within the timing phase noise jitter requirements specified by the detector readout system. The timing breakout at each telescope may include IRIG, 10MHz, PPS as needed by the subsystem. If required a synchronous pulse may be distributed to each telescope platform. DAQ shall use existing standards to distribute time, these may include PTP and/or Synchronous Ethernet.

Status:	Draft
Verification Method:	Test
Verification Description:	To verify this requirement, we should set up a test with representative cable lengths, switches, and/or fan-outs and show that we provide an absolute timestamp within

	specification and meet the phase jitter requirements at a representative endpoint.
Basis/Rationale:	All data acquired asynchronously will require absolute timestamps and systems may need to be be clocked synchronously for noise or other considerations. The specific requirements will need to come from ICDs with other subsystems or L1 requirements.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0001: Data Acquisition : Observatory Time Standard DAQ-0040: Timing and Synchronization

DAQ-0010: Data Rate

The DAQ shall support data rates no less than 4 (TBR) Gbits/s per site.

Status:	Draft
Verification Method:	Test
Verification Description:	This requirement can be verified by a site-level scale test. It will be acceptable to use emulators to produce the data.
Basis/Rationale:	The minimum required bandwidth that DAQ will need to support from each telescope is dominated by the maximum number of detector channels that it is possible to readout. This number should flow from L1 as a CBE of maximum extant detector channels. The current estimate is derived from the Preliminary Baseline Design Instrument Description spreadsheet.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0080: Scalability

DAQ-0020: Data Loss

Data loss within the DAQ (due to corruption, packet loss, bookkeeping errors, etc.) shall be less than 0.001% (TBR) per observation.

Status:	Draft
Verification Method:	Test
Verification Description:	To verify this requirement, a site-scale test of the DAQ will take place of a duration sufficient to demonstrate losses within acceptable limits. The use of emulated data sources will be allowed.

Basis/Rationale:	The intent is for the data loss due to DAQ be insignificantly small. The value of acceptable data loss should be derived from a L1 budget of downtime or sensitivity. (TBD)
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition
	: Network Design

: Observatory Time Standard

Any timestamped data in the DAQ, either at rest or transmitted, shall be stored or transmitted with timestamps in the observatory time standard UTC.

Status:	Draft
Verification Method:	Demonstration, Inspection
Verification Description:	To verify this requirement it will be sufficient to demonstrate that data products are produced with timebases in the observatory time standard and to inspect the codebase to ensure there is no gratuitous translations of timebases.
Basis/Rationale:	To reduce the possibility of error translating timezones, whenever data is stored or transmitted, it should use the observatory time standard.
#Parents / #Children	1 / 0
Parent(s)	: Observatory Time Standard

3.1.2.2 Design Principles

: Scalability

The DAQ shall work at a variety of scales: single object, lab, testing, receiver, and full observatory.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Demonstration of scalability will be completed by demonstration at scales up to and including the full observatory. Particularly for large scale demonstrations, emulated or simulated data producers will be sufficient.
Basis/Rationale:	Early integration of DAQ with other subsystems is critical to ensuring provided functionality is sufficient, and provide opportunities to verify requirements and interfaces prior to observatory integration.
#Parents / #Children	3 / 0

Parent(s)	DAQ-0001: Data Acquisition CTRL-0080: Scalability CTRL-0180: Test Stand Support

: Commonality

DAQ shall provide the same software systems to Chile, South Pole, and labs. These software systems shall be adapted to each environment through runtime configuration.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the documentation.
Basis/Rationale:	Though there may be DAQ software components which are specific to the various environments, the system should be designed to be configurable by the end users for their specific needs.
#Parents / #Children	2 / 0
Parent(s)	CTRL-0090: Commonality DAQ-0001: Data Acquisition

: Hardware compatibility

DAQ software shall be written so it can be used on a commodity lab computer, with compatible OS, package manager, compiler/library version, etc on the native system.

Status:	Draft
Verification Method:	Inspection
Verification Description:	It will be sufficient to inspect the minimum hardware requirements for a lab installation of the DAQ software systems to verify this requirement.
Basis/Rationale:	DAQ will not be providing computer hardware to subsystems. To ensure the early integration with DAQ software, that software should be capable of running at the lab scale on commodity hardware. Any minimum requirements that could not be reasonably expected to be satisfied by such a machine (e.g. 10GbE NIC) should be specified in ICDs.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0120: Hardware compatibility

: Open source

The DAQ software should be open source with no dependencies on licensed libraries, packages, etc.

Status:	Draft
Verification Method:	Inspection
Verification Description:	It is sufficient to verify this requirement by inspection of the codebase.
Basis/Rationale:	
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0130: Open source

: Distributions

The DAQ software shall be versioned and use tools which allow collaborative development, issue tracking, and code reviews.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the code repositories and documentation.
Basis/Rationale:	We are expecting experts from Readout to interface with DAQ libraries. To facilitate this development, DAQ will need to use collaborative software development tools and processes.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0130: Open source

: Programming Languages

DAQ software should be written in a limited number of well-known languages including C++ or python where appropriate. Where software is expected to be contributed by other subsystems, DAQ shall provide at least a python API.

Status:	Draft

Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the code repository.
Basis/Rationale:	The DAQ system will likely be maintained by a series of individuals over the life of the experiment. To facilitate this long-lived common languages should be used for implementation unless they are precluded by technical reasons. Specifically, it is expected that users/collaborators will mostly wish to use Python to interface with DAQ systems.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0150: Programming Languages

: Firmware-free

DAQ shall not provide firmware.

Status:	Draft
Verification Method:	Inspection
Verification Description:	For verification of this requirement, it will be sufficient to inspect the code base.
Basis/Rationale:	Keeping DAQ in the software domain will allow development and testing on commodity compute and network hardware. By excluding firmware, the DAQ group will not require staff with firmware experience.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0001: Data Acquisition CTRL-0190: Firmware-free

: Digital Hardware Interfaces

DAQ interfaces to all hardware shall be digital.

Status:	Draft
Verification Method:	Inspection
Verification Description:	For verification of this requirement, it will be sufficient to inspect the code base.
Basis/Rationale:	Keeping DAQ systems in the digital domain will allow development and testing on commodity compute and network hardware.
#Parents / #Children	2 / 0

Parent(s)	DAQ-0001: Data Acquisition CTRL-0210: Digital Hardware Interfaces

: Asynchronous Data Collection

The software architecture shall support asychronous data collection of all data types.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Verification of this requirement will take the form of a demonstration of multiple components operating asynchronously.
Basis/Rationale:	There should be no assumption that data provided to DAQ occurs synchronously or that data from one source implies the presence of data from another source. This will allow the most flexibility for components to operate in isolation and in various modes.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0140: Asynchronous Data Collection DAQ-0001: Data Acquisition

3.1.3 1.08.04 Monitoring and Alarms

3.1.3.1 Core Functionality

DAQ-0150: Live Health and Monitoring

The monitor shall support near real-time data display with update periods of no longer than 5s.

Status:	Draft
Verification Method:	Test
Verification Description:	To verify this requirement, it will be sufficient to simulate a site-scale system and verifying that data are displayed within the 5s limit.
Basis/Rationale:	Live monitoring will be important for determining the proper functioning of the observatory systems and debugging them when there are issues.
#Parents / #Children	1 / 0
Parent(s)	DAQ-0060: Health & Monitoring

DAQ-0190: Monitoring Interface

The graphical monitoring software must be easily configurable for lab, observatory, and testing from the browser itself

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the documentation of the monitoring system.
Basis/Rationale:	As the monitoring system will be browser-based and used by non-experts, it is important that configuration of that system also be browser-based.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0060: Health & Monitoring CTRL-0180: Test Stand Support

DAQ-0170: Health and Monitoring Bandwidth

The monitor shall support monitoring quantities of up to 100,000 fields/sec (TBR).

Status:	Draft
Verification Method:	Test
Verification Description:	To verify this requirement, it will be sufficient to show that the monitoring system can sustain the required input bandwidth. The use of artificial data sources will be allowed for this test.
Basis/Rationale:	The intent is that the monitoring system will support the collection, storage, and display, of all quantities useful for determining the proper functioning of the observatory systems and when necessary debugging them. The current estimate of the bandwidth is based on experience, but it may be necessary to generate this quantity from the requisite subsystems.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0060: Health & Monitoring CTRL-0080: Scalability

DAQ-0090: Alarm Hierarchy

Alarm notifications shall be heirarchical depending on the severity of the alarm, and site dependent based on notification systems already in place.

Status:	Draft

Verification Method:	Demonstration
Verification Description:	To verify this requirement, it will be sufficient to demonstrate the ability to set limits and generate alarms of appropriate severity. Use of simulated data will be allowed.
Basis/Rationale:	Users will be able to configure limits on monitored quantities which will generate alarms. These alarms should have a hierarchy of severity which can engage a site notification system if appropriate.
#Parents / #Children	1 / 0
Parent(s)	DAQ-0080: Alarms

DAQ-0070: Remote Monitoring

The system shall support remote monitoring by authorized personnel using a web browser on a compliant device, including but not limited to smart phones, laptops, and tablets.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	To verify this requirement, it will be sufficient to demonstrate the ability of a device on a remote network (not on the local observatory network) to interact with the monitoring system.
Basis/Rationale:	It will be critical to allow remote experts to remotely monitor the observatory systems to diagnose problems ensure the quality of operations. A browser-based monitoring system which is largely agnostic to platform/device will best facilitate these activities.
#Parents / #Children	1 / 0
Parent(s)	DAQ-0060: Health & Monitoring

DAQ-0160: Historical Health and Monitoring

The monitor shall support storage and retrieval of historical data. All data recorded shall remain available for no less than 1 week. After 1 week, the monitor may choose to store only decimated data.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	To verify this requirement, it will be sufficient to demonstrate the ability to retrieve stored monitored quantities. Demonstration of the decimation function will also be necessary.
Basis/Rationale:	The retention of historical monitored values will enable the trending of the performance of observatory systems. High frequency data which are of the most use for

	debugging are only required for the short term, and to relieve pressure on storage and retrieval mechanisms, data older than 1 week may be decimated.
#Parents / #Children	1 / 0
Parent(s)	DAQ-0060: Health & Monitoring

: Observatory Time Standard

Any timestamped data in the Monitor, either at rest or transmitted, shall be stored or transmitted with timestamps in the observatory time standard UTC. The Monitor may choose to allow the user to view the timestamps in an arbitrary time zone provided it is clearly labeled as such.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the codebase to show timestamps are recorded in the observatory time standard.
Basis/Rationale:	Though it is imperative to record all data with a consistent time base, it may be helpful to the user to view times in a local timezone.
#Parents / #Children	2 / 0
Parent(s)	DAQ-0060: Health & Monitoring : Observatory Time Standard

3.1.3.2 Design Principles

: Scalability

The Monitor shall work at a variety of scales: single object, lab, testing, receiver, and full observatory.

Status:	Draft
Verification Method:	Demonstration
Verification Description:	Demonstration of scalability will be completed by demonstration at scales up to and including the full observatory. Particularly for large scale demonstrations, emulated or simulated data producers will be sufficient.
Basis/Rationale:	Early integration of the Monitor with other subsystems is critical to ensuring provided functionality is sufficient, and provide opportunities to verify requirements and interfaces prior to observatory integration.
#Parents / #Children	3 / 0

Parent(s)	DAQ-0080: Alarms DAQ-0060: Health & Monitoring CTRL-0080: Scalability

: Commonality

Monitoring shall provide the same software systems to Chile, South Pole, and labs. These software systems shall be adapted to each environment through runtime configuration.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the documentation.
Basis/Rationale:	Though there may be Monitor software components which are specific to the various environments, the system should be designed to be configurable by the end users for their specific needs.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms CTRL-0090: Commonality DAQ-0060: Health & Monitoring

: Hardware compatibility

Monitoring software shall be written so it can be used on a commodity lab computer, with compatible OS, package manager, compiler/library version, etc on the native system.

Status:	Draft
Verification Method:	Inspection
Verification Description:	It will be sufficient to inspect the minimum hardware requirements for a lab installation of the DAQ software systems to verify this requirement.
Basis/Rationale:	Monitoring will not be providing computer hardware to subsystems. To ensure the early integration with Monitor software, that software should be capable of running at the lab scale on commodity hardware. Any minimum requirements that could not be reasonably expected to be satisfied by such a machine (e.g. 10GbE NIC) should be specified in ICDs.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms CTRL-0120: Hardware compatibility

DAQ-0060: Health & Monitoring

: Open source

The Monitor software should be open source with no dependencies on licensed libraries, packages, etc.

Status:	Draft
Verification Method:	Inspection
Verification Description:	It is sufficient to verify this requirement by inspection of the codebase.
Basis/Rationale:	
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms DAQ-0060: Health & Monitoring CTRL-0130: Open source

: Distributions

The Monitoring software shall be versioned and use tools which allow collaborative development, issue tracking, and code reviews.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the code repositories and documentation.
Basis/Rationale:	Clearly versioned software will prevent confusion about what is installed, and which software features and bug fixes are present in any given installation.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms CTRL-0140: Distributions DAQ-0060: Health & Monitoring

: Programming Languages

Monitoring software should be written in a limited number of well-known languages including C++, python or javascript, where appropriate. Where software is expected to be contributed by other subsystems, DAQ shall provide at least a python API.

Status:	Draft
Verification Method:	Inspection
Verification Description:	To verify this requirement, it will be sufficient to inspect the code repository.
Basis/Rationale:	The Monitor system will likely be maintained by a series of individuals over the life of the experiment. To facilitate this long-lived common languages should be used for implementation unless they are precluded by technical reasons. Specifically, it is expected that users/collaborators will mostly wish to use Python to interface with Monitor systems.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms DAQ-0060: Health & Monitoring CTRL-0150: Programming Languages

: Firmware-free

The Monitor shall not provide firmware.

Status:	Draft
Verification Method:	Inspection
Verification Description:	For verification of this requirement, it will be sufficient to inspect the code base.
Basis/Rationale:	Keeping the Monitor in the software domain will allow development and testing on commodity compute and network hardware. By excluding firmware, the DAQ group will not require staff with firmware experience.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms CTRL-0190: Firmware-free DAQ-0060: Health & Monitoring

: Asynchronous Data Collection

The software architecture shall support asychronous data collection of all data types.

Status:	Draft
Verification Method:	Demonstration

Verification Description:	Verification of this requirement will take the form of a demonstration of multiple components operating asynchronously.
Basis/Rationale:	There should be no assumption that data provided to the Monitor occurs synchronously or that data from one source implies the presence of data from another source. This will allow the most flexibility for components to operate in isolation and in various modes.
#Parents / #Children	3 / 0
Parent(s)	DAQ-0080: Alarms DAQ-0140: Asynchronous Data Collection DAQ-0060: Health & Monitoring

3.1.4 1.08.05 Lab Subsystem Development and Support