



# **WBS 1.08: DAQ/Control Management Overview**

**L2 Lead - Laura Newburgh**

**L2 Deputy - Nathan Whitehorn**

**L2 Control Account Manager - John Joseph**

# Presenter Introduction

Name: John Joseph

Role: L2 CAM for Detectors

Institution: LBNL, Staff Engineer and Electronics Systems Group Leader

## Previous experience

- 20+ years of electrical engineering experience on DOE projects
- GRETA (L2 CAM for Electronics Systems)
- X-Ray & Electron Microscopy Camera Developments for BES User Facilities
- LBNL Superconducting Magnet Test Facility Management
- IceCube (DOM Main Board production, Chief Engineer)
- CMB-The Early Days (1st gen fMux Electronics board design and fabrication)
- ATLAS Silicon Readout Drivers Electronics Board development and production.



# Outline

- WBS Tree & Dictionary
- Interfaces
- Risk Management
- Safety / Hazards Analysis
- Quality Assurance
- Cost/Schedule Summary
- Response to Previous Review Recommendations
- Focus through the rest of CY2021
- Conclusion

# WBS tree and dictionary captured in the Dash360 tool; defined to level 4 for development areas, level 3 for support and deployment areas

**WBS Tree**  
Estimating / WBS Tree  
Project: CMB-S4 WBS: 1.08

- Work Breakdown Structure: CMB-S4
  - 1.08 - Observatory Control and Data Acquisition System (DAQ)
    - 1.08.01 - DAQ Management
      - 1.08.01.01 - DAQ Management
      - 1.08.01.02 - DAQ System Design Engineering
      - 1.08.01.03 - DAQ Reviews
      - 1.08.01.04 - Interface Documentation
    - 1.08.02 - Observatory Control System
      - 1.08.02.01 - Bolometer Readout Control
      - 1.08.02.02 - Telescope Platform Control - SP, Chile, LAT, SAT
      - 1.08.02.03 - Cryogenic Control
      - 1.08.02.04 - Housekeeping Control
      - 1.08.02.05 - Observatory Subsystem Control
      - 1.08.02.06 - Observation Scheduling
      - 1.08.02.07 - Control Framework
    - 1.08.03 - Observatory Data Acquisition
      - 1.08.03.01 - Bolometer Readout
      - 1.08.03.02 - Telescope Readout Data Acquisition
      - 1.08.03.03 - Housekeeping Data Acquisition
      - 1.08.03.04 - Observatory DAQ Network Design
      - 1.08.03.05 - Hardware Procurement
      - 1.08.03.06 - Timing
      - 1.08.03.07 - DAQ Build/Distribution
      - 1.08.03.08 - File Format Specification
    - 1.08.04 - Monitoring and Alarms
      - 1.08.04.01 - Remote Monitoring Capability of Telescope, Housekeeping Subsystems
      - 1.08.04.02 - Remote Monitoring and Real-Time Statistics Gathering
      - 1.08.04.03 - Non-Critical Alarms based on Bolometer + HK Monitors
      - 1.08.04.04 - Personnel and Equipment Protection Interfaces Propagated to Alarms
    - 1.08.05 - (Lab) Subsystem Development and Support
      - 1.08.05.01 - (Lab) Subsystem Development and Support
    - 1.08.06 - Integration, Test, and Deployment of DAQ and OCS
      - 1.08.06.01 - Integration, Test, and Deployment of DAQ and OCS

**WBS Dictionary**  
Estimating / Work Breakdown Structure Report  
Project: CMB-S4 WBS: 1.08 Observatory Control and Data Acquisition System (DAQ) WBS Level: 3

<b>1.08 Observatory Control and Data Acquisition System (DAQ)</b>
<b>Sponsor</b> DOE
<b>Responsible Manager</b> Newburgh_L
<b>Summary/Description</b> Design, commissioning and testing of Observatory Control and Data Acquisition Systems for the CMB-S4 Project
<b>Acceptance Criteria</b> Delivery computing hardware and software to provide Observatory Control and Data Acquisition for the CMB-S4 project
<b>Final Product</b> Computing hardware and software that will provide Observatory Control and Data Acquisition for the CMB-S4 project

<b>1.08.01 DAQ Management</b>
<b>Sponsor</b> DOE
<b>Responsible Manager</b> Joseph_J
<b>Summary/Description</b> Project Management of the design, commissioning and testing of Observatory Control and Data Acquisition Systems for the CMB-S4 Project
<b>Acceptance Criteria</b> Provide management and oversight for the Observatory Control and Data Acquisition Systems in the CMB-S4 project
<b>Final Product</b> (* Management and oversight, (*) Guidance on software version controls, (*) Review planning, (*) System engineering, (*) Travel.

<b>1.08.01.01 DAQ Management</b>
<b>Sponsor</b> DOE
<b>Responsible Manager</b> Joseph_J
<b>Summary/Description</b> This item covers labor costs for the Level 2 Manager, two Level 3 managers, systems engineering support over the life of the construction project. It also organizes

# Project-Level Interfaces are identified and being developed for DAQ

CQ2

**CMBS4-doc-469-v7: N-squared interface matrix**

WBS 1.04 Readout	WBS 1.05 Module Assembly & Testing	WBS 1.06 Large Aperture Telescopes	WBS 1.07 Small Aperture Telescopes	WBS 1.08 Data Acquisition & Control	WBS 1.09 Data Management	WBS 1.10 Chile Site Infrastructure/I&C	WBS 1.11 South Pole Site Infrastructure/I&C	← L2 Elements ↓
E, T (339)	M, E, T (463)	X	X	X	X	X	X	WBS 1.03 Detectors
	M, E, T (321)	M, E, T (318)	M, E, T (354)	E (324)	X	M, E, T (718)	M, E, T (719)	WBS 1.04 Readout
		M, T, O (345)	M, T, O (342)	X	X	M, E (721)	M, E (720)	WBS 1.05 Module Assembly & Testing
			X	M, E, T (333)	X	M, E, T (336)	M, E, T (330)	WBS 1.06 Large Aperture Telescopes
				M, E (351)	X	X	M, E, T (348)	WBS 1.07 Small Aperture Telescopes
					E (327)	M, E, T (417)	M, E, T (423)	WBS 1.08 Data Acquisition & Control
						M, E, T (426)	M, E, T (432)	WBS 1.09 Data Management
							X	WBS 1.10 Chile Site Infrastructure/I&C

(XXX) in cell indicates docdb number

**Interface type key**  
M mechanical  
E electrical, data, control, telem  
T thermal  
O optical

**ICD maturity phase color coding**  
X no interface exists, no ICD req'd  
doc drafted, general xface params named  
more specific naming of xface params & boundaries  
most scope, boundaries, responsibilities defined  
Phase 1 scope, boundaries, responsibilities defined  
Phase 2 design-driven refinements  
Phase 3 ICD complete

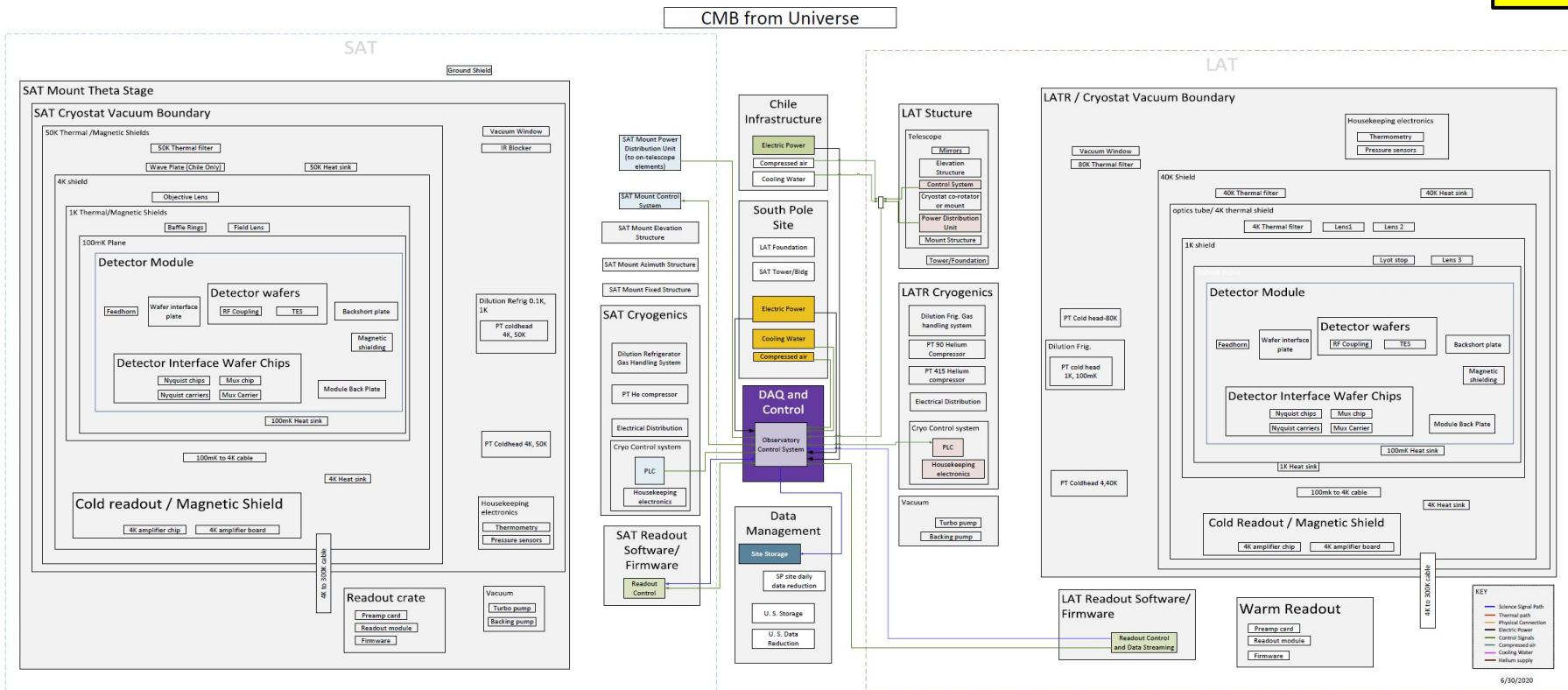
DAQ contains interfaces to six WBS areas

- 1.04 Readout
- 1.06 LAT
- 1.07 SAT
- 1.09 Data Management (DM)
- 1.10 Chile Site Infrastructure
- 1.11 South Pole Site Infrastructure

DAQ to DM is a key driving interface as there are multiple handoffs and deliverables to define and track

# Schematic of DAQ and Control Interfaces with other L2's

CQ2



Collaboration Science Analysis (off-project)

# Risks are compiled and analyzed in JIRA Risk Registry

CQ4

DAQ currently monitoring 15 risks

Key	WBS L2	Agency	Summary	Status	Cost Impact	Schedule Impact	Performance Impact	Probability	Risk Score Value	Risk Ranking ↑
RISK-283	1.08 - DAQ	DOE	Staffing	PROPOSED	High - >= 1M and < 6M	Critical - SS > 6mo	Moderate - Impact on L2 system requirements	Likely 25-67%	16	High
RISK-282	1.08 - DAQ	DOE	Hardware emulators not provided	PROPOSED	Moderate - >= 250K and < 1M	High - SS < 6mo	Moderate - Impact on L2 system requirements	Highly Probable >67%	17	High
RISK-281	1.08 - DAQ	DOE	Hardware to Controls	PROPOSED	Moderate - >= 250K and < 1M	Critical - SS > 6mo	Minor - Impact on component level requirements	Highly Probable >67%	17	High
RISK-280	1.08 - DAQ	DOE	Controls Test Stands	PROPOSED	High - >= 1M and < 6M	High - SS < 6mo	Minor - Impact on component level requirements	Highly Probable >67%	17	High
RISK-279	1.08 - DAQ	DOE	Framework Downselect	PROPOSED	High - >= 1M and < 6M	Critical - SS > 6mo	High - Impact on more than one L2 system requirements	Likely 25-67%	17	High
RISK-278	1.08 - DAQ	DOE	Interface Definitions	PROPOSED	Moderate - >= 250K and < 1M	Critical - SS > 6mo	Moderate - Impact on L2 system requirements	Highly Probable >67%	18	High
RISK-277	1.08 - DAQ	DOE	DAQ Test Stands	PROPOSED	Moderate - >= 250K and < 1M	Critical - SS > 6mo	Moderate - Impact on L2 system requirements	Highly Probable >67%	18	High
RISK-285	1.08 - DAQ	DOE	R&D Funding	PROPOSED	Minor - >= 50K and < 250K	Minor - SS < 1mo	Moderate - Impact on L2 system requirements	Highly Probable >67%	12	Moderate
RISK-284	1.08 - DAQ	DOE	Hardware to DAQ	PROPOSED	Minor - >= 50K and < 250K	High - SS < 6mo	Minor - Impact on component level requirements	Highly Probable >67%	13	Moderate
RISK-290	1.08 - DAQ	DOE	Telescope Interface	PROPOSED	Moderate - >= 250K and < 1M	Critical - SS > 6mo	Moderate - Impact on L2 system requirements	Unlikely 1-10%	7	Minor
RISK-288	1.08 - DAQ	DOE	Testing	PROPOSED	Moderate - >= 250K and < 1M	Minor - SS < 1mo	Moderate - Impact on L2 system requirements	Possible 10-25%	8	Minor
RISK-287	1.08 - DAQ	DOE	Timing Downselect	PROPOSED	Minor - >= 50K and < 250K	Moderate - SS < 3mo	Moderate - Impact on L2 system requirements	Possible 10-25%	8	Minor
RISK-286	1.08 - DAQ	DOE	Early R&D DAQ Test Stands	PROPOSED	Minor - >= 50K and < 250K	Insignificant - SS level no impact	Moderate - Impact on L2 system requirements	Highly Probable >67%	10	Minor
RISK-76	1.08 - DAQ	DOE	DAQ Design	PROPOSED	Moderate - >= 250K and < 1M	High - SS < 6mo	Insignificant - Negligible technical impact	Possible 10-25%	8	Minor
RISK-291	1.08 - DAQ	DOE	Simulated Data	PROPOSED	Insignificant - <50K	Minor - SS < 1mo	Insignificant - Negligible technical impact	Unlikely 1-10%	3	Insignificant

1-15 of 15

# Risks are compiled and analyzed in JIRA Risk Registry

CQ4

DAQ currently monitoring 15 risks

Key	WBS L2	Agency	Summary	Status	Cost Impact	Schedule Impact	Performance Impact	Probability	Risk Score Value	Risk Ranking ↑
RISK-283	1.08 - DAQ	DOE	Staffing Moving to Project	PROPOSED	High - >= 1M and < 6M	Critical - SS > 6mo	Moderate - Impact on L2 system requirements	Likely 25-67%	16	High
RISK-282	1.08 - DAQ	DOE	Hardware emulators not provided	PROPOSED	Moderate - >= 250K and < 1M	High - SS < 6mo	Moderate - Impact on L2 system requirements	Highly Probable >67%	17	High
RISK-281	1.08 - DAQ	DOE	Hardware to Controls	PROPOSED	Moderate - >= 250K and < 1M	Critical - SS > 6mo	Minor - Impact on component level requirements	Highly Probable >67%	17	High
RISK-280	1.08 - DAQ	DOE	Controls Test Stands	PROPOSED	High - >= 1M and < 6M	High - SS < 6mo	Minor - Impact on component level requirements	Highly Probable >67%	17	High
RISK-279	1.08 - DAQ	DOE	Framework Downselect	PROPOSED	High - >= 1M and < 6M	Critical - SS > 6mo	High - Impact on more than one L2 system requirements	Likely 25-67%	17	High
RISK-278	1.08 - DAQ	DOE	Interface Definitions	PROPOSED	Moderate - >= 250K and < 1M	Critical - SS > 6mo	Moderate - Impact on L2 system requirements	Highly Probable >67%	18	High

- Risk-279 Framework Downselect: Completed and ready to be reduced or retired
- Risk-280 Controls Test Stand: Integration and interoperability testing does not happen, creating risks of integration failure and later delays and cost increases
- Risk-282 Hardware emulators not provided: Significant hazard that DAQ for hardware is delayed or does not function correctly, including late identification of problematic interfaces once baked into hardware



# Safety / Hazards Analysis

CQ9

- Hazards to personnel, the environment, and the equipment have been identified in coordination with L3 leads and the CMB-S4 Safety Coordinator, per the Project Hazard Analysis Process Document [CMBS4-doc-711](#).
- Next steps are to analyze impacts and probabilities of identified safety risks and define mitigations and populate the WBS 1.08 table in the [Hazard Identification/Analysis Workbook](#).



# Quality Assurance Implementation

CQ7,8

QA throughout the project governed by the CMB-S4 Project QA Plan, [CMBS4-doc-602](#)

- Project QA Manager: Creates, maintains, and oversees implementation of the QA Plan
- L2 Manager: Executes and oversees CMB-S4 QA within their L2 subsystem, using a graded approach per the Project QA Plan

# QA Documentation

CQ7,8

- The QA documents that will be generated in DAQ 1.08 and shall adhere to the Project QA Plan (CMBS4-doc-602):
  - Software test plan
  - Software acceptance criteria
  - Workflow and software flow documentation
  - Version Control
  - Adherence to professional coding standards
- Vendor procurements will include requirements for QA/acceptance packages as deliverables
  - Having complete procurement packages and well-defined acceptance criteria up front
- DAQ will have a well-defined subsystem acceptance documentation package as a deliverable to the Project, demonstrating that the L2 meets its requirements

# Current Costs by L3 and rolled up to L2 are maturing in P6

CQ5&6

The resource loading for DAQ is in process of getting updated. The estimates in the table assume 7 FTE/year throughout the duration of the project and ~\$300k for high performance DAQ hardware

WBS	Direct \$			Indirect\$	Total\$
	Labor	Non-Labor	Total		
1.08.01 - DAQ Management	\$4,916,421	\$2,317,529	\$7,233,950	\$2,068,377	\$9,302,327
1.08.02 - Observatory Control System		\$3,460,526	\$3,460,526	\$534,582	\$3,995,108
1.08.03 - Observatory Data Acquisition System		\$3,742,500	\$3,742,500	\$578,141	\$4,320,641
1.08.04 - Monitoring and Alarms		\$3,567,500	\$3,567,500	\$551,107	\$4,118,607
1.08.05 - Subsystem Development and Support		\$1,858,750	\$1,858,750	\$287,140	\$2,145,890
1.08.06 - Integration & Test - Moving to Site I&C		\$0	\$0	\$0	\$0
<b>Total</b>	<b>\$4,916,421</b>	<b>\$14,946,805</b>	<b>\$19,863,226</b>	<b>\$4,019,347</b>	<b>\$23,882,573</b>

- **Key labor cost drivers:** The DAQ WBS is dominated by labor. The drivers for this area is in the development of a well defined software base and constant communication with interface WBS areas
- **Procurements:** The DAQ procurements are primarily Commercial Off The Shelf items such as standard computing equipment and networking hardware and the process to purchase these items is known to straightforward.

# Current Schedule maintained in P6

CQ6

Working File Baseline 07 2020 Update - Cosmic Microwave Background - Stage 4 CD-1 Planning

Activity ID	Activity Name	Predecessors	Successors	Planned Duration	Start	BL Project Start	Finish	BL Project Finish	Year					
									FY21	FY22	FY23	FY24	FY25	FY26
Total														
CMBS4-WF Working File Baseline 07 2020 Update - Cosmic Microwave Background - Stage 4 CD-1 Planning														
CMBS4-WF.08 Observatory Control and Data Acquisition System (DAQ)														
DAQ_MS4_1500	COMP: T4 All DAQ ICD's Complete	DAQ_MS5_10	MS1_PMSE_10	0.0d	01-Oct-18	01-Oct-18	29-Sep-28	28-Jan-32						
DE_MS_1000	NEED: System Engineering: Preliminary Requirement and Interface	MS1_PMSE_1	DAQ_MGMT_13	0.0d	01-Oct-18	01-Oct-18	29-Sep-28	28-Jan-32						
MS4_OCS_0001	FND: T4 START Prototype Data Acquisition System ("Can Start as Soon as Funding Allows")		DAQ_MGMT_28	0.0d	01-Oct-21*	01-Oct-21*	29-Sep-28	28-Jan-32						
MS4_OCS_0015	FND: T4 START Prototype Cryostat Control ("Can Start as Soon as Funding Allows")		DAQ_OCS_150	0.0d	01-Oct-21*	01-Oct-21*	29-Sep-28	28-Jan-32						
MS4_OCS_1020	COMP: T4 B Preliminary Design Review - Observatory Control and Data Acquisition System	PM_8030		0.0d	01-Oct-18	01-Oct-18	21-Sep-23	01-Oct-18						
MS4_OCS_1030	COMP: T4 C Final Design Review - Observatory Control and Data Acquisition System			0.0d	01-Oct-18	01-Oct-18	01-Oct-18	01-Oct-18						
MS4_OCS_1040	COMP: T4 D Production Readiness Review - Observatory Control and Data Acquisition System			0.0d	01-Oct-18	01-Oct-18	01-Oct-18	01-Oct-18						
MS4_OCS_1045	AVAIL: T4 - ICD Development to SP Site Infrastructure	DAQ_MGMT	DAQ_MS4_1500	0.0d	01-Oct-21*	01-Oct-21*	24-Aug-21	24-Aug-21						
CMBS4-WF.08.01 DAQ Management														
CMBS4-WF.08.01.01 DAQ Management														
DAQ_MGMT_2800	L2 Manager FY22			425.0d	01-Oct-21	21-Jun-22	30-Sep-22	15-Feb-30						
DAQ_MGMT_2801	L2 Manager FY23	MS4_OCS_00	DAQ_MGMT_28	425.0d	01-Oct-21	21-Jun-22	30-Sep-22	15-Feb-30						
DAQ_MGMT_2802	L2 Manager FY24	DAQ_MGMT_28	DAQ_MGMT_28	425.0d	01-Oct-21	21-Jun-22	30-Sep-22	15-Feb-30						
CMBS4-WF.08.02 Observatory Control System														
CMBS4-WF.08.02.01 Bolometer Readout Control														
DAQ_MSS_2600	AVAIL: T5 SW for Control of Readout Electronics	DAQ_OCS_22	MS4_RO_1300	357.0d	02-May-22	16-Dec-22	23-Mar-23	07-Nov-23						
DAQ_MSS_3411	REQD: T5 Low-level Readout Control Software	READ_31001	DAQ_OCS_220	357.0d	02-May-22	16-Dec-22	23-Mar-23	07-Nov-23						
DAQ_OCS_2100*	Cost Summary: Observatory Control & Data Acquisition System (C)			357.0d	02-May-22	16-Dec-22	23-Mar-23	07-Nov-23						
DAQ_OCS_2101*	Cost Summary: Observatory Control & Data Acquisition System (C)			357.0d	02-May-22	16-Dec-22	23-Mar-23	07-Nov-23						
DAQ_OCS_2200	Develop SW for Control of Readout Electronics	DAQ_MSS_17	DAQ_MSS_2600	357.0d	02-May-22	19-Dec-22	23-Mar-23	07-Nov-23						
CMBS4-WF.08.02.02 Telescope Platform Control - SP, Chile, LAT, SAT														
DAQ_MSS_2900	AVAIL: T5 Telescope Motion Control SAT	DAQ_OCS_2F	MS3_SAT_2276	265.0d	16-Aug-22	15-Feb-23	03-Nov-25	03-Nov-25						
DAQ_MSS_3401	AVAIL: T5 Telescope Motion Control LAT	DAQ_OCS_3C	CHLAT1_FA_04	265.0d	16-Aug-22	15-Feb-23	03-Nov-25	03-Nov-25						
DAQ_MSS_3421	REQD: T5 Emulators from SAT	MS3_SAT_227	DAQ_OCS_250	265.0d	16-Aug-22	15-Feb-23	03-Nov-25	03-Nov-25						
DAQ_MSS_3431	REQD: T5 Emulators from LAT	CHLAT_0600	DAQ_OCS_300	265.0d	16-Aug-22	15-Feb-23	03-Nov-25	03-Nov-25						
DAQ_OCS_2500	Telescope Motion Control - SAT (Need Contract Award to Start)	SAT_TMA_11C	DAQ_MSS_2900	265.0d	16-Aug-22	16-Feb-23	04-Aug-23	06-Feb-24						
DAQ_OCS_3000	Telescope Motion Control - LAT	DAQ_MSS_17	DAQ_MSS_340	265.0d	13-Nov-24	13-Nov-24	03-Nov-25	03-Nov-25						
CMBS4-WF.08.02.03 Cryogenic Control														
DAQ_MSS_2001	AVAIL: T5 Cryostat Control--Thermometry, Pulse Tubes...	DAQ_OCS_1F	SAT_PROT_12E	491.0d	01-Oct-21	08-Dec-22	26-Oct-22	10-May-23						

Major schedule drivers:

- FY22 - Testing and analysis software for prototype module tests with CDFG and CMB-S4 wafers
  - Links with DRM schedule
- FY24 - Testing and analysis software for production module tests with CDFG and CMB-S4 wafers
- FY25 & to CD-4a - Main drivers are linked to DM and Observatory Site Interfaces

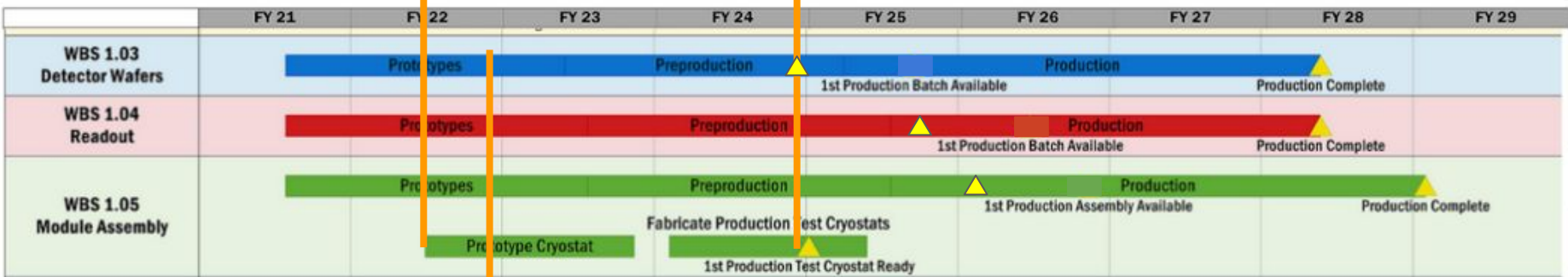
# Current Schedule indicates major drivers and constraints to other L2s

CQ6

- Key FY22 Milestones
  - Test Stand Readout, control and analysis software must be ready for the start of prototype module testing and optimized for start of Optical testing.
  - CD-1 Review Readiness.
- FY23/24 and beyond is driven by interfaces to DM (1.09) and Observatory Sites (1.10 & 1.11)

5/2022: Prototype Readout DAQ System ready for Modules assembled w/CDFG Wafers

FY24: Final software for production testing ready and deployed at MAT testing sites.



8/2022: CD-1 Review Scheduled

# Response to Previous Recommendations

CQ10

**SC5-2: Ensure that the interface definitions of DM and DAQ with other subsystems are fully integrated into the project-wide change management system. [CD-1 review]**

In progress.



CMB-S4  
Next Generation Orbital Experiment

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## Recommendation List

Key	Summary	Status	Recommendation	Response	WBS L2	Assignee	Proposed Close Date	Close Date
RT-66	Complete DAQ ICDs	ADDRESSING	DAQ: Complete the ICDs (which are currently more Interface Requirements Documents) - including requirements for a complete set of emulators. Include budget for emulator cluster. (later)	Interface Control Documents are all under continuing development and maturation. The goal is for them all to be at least at Maturity Phase 1 by the CD-1 IPR, meaning fully-defined scope boundaries and division of responsibilities between interfacing elements. This will include definition of required emulators. The emulators will be included in the project resource-loaded schedule (P6).	1.08 - DAQ	Laura Newburgh		...
RT-64	Present control software choice more clearly and identify fallbacks	CLOSED	DAQ: Present control software choice more clearly and identify fallbacks for risks that cannot be mitigated forcing a change in package choice. Identify one or two specific alternatives that you know would overcome that risk. Avoid smogashboard or random alternatives as presented. (for DOE review)	A software trade study is currently ongoing, with options based on software packages currently in use by either Stage3 experiments or telescopes at a similar scale as CMB-S4. Although we have identified no risks associated with adopting the proposed design, the results of the trade study will allow us to finalize a software package choice and fully characterize alternatives.	1.08 - DAQ	Laura Newburgh	Mar 11, 2021	...

# Focus through the rest of CY 2021

1. Adapt selected control system to S4-specific goals.
2. Provide access, training, and development support for deployments in test labs (fall 2021 and on).
3. First-draft DAQ/control for prototype warm readout boards (summer/fall 2021).



# Conclusions

An experienced and capable team is in place with clear roles and lines of authority

A design that will meet requirements is well-developed to conceptual / preliminary DOE maturity

Trade studies have been completed to assess alternatives and selection Observatory Control System software

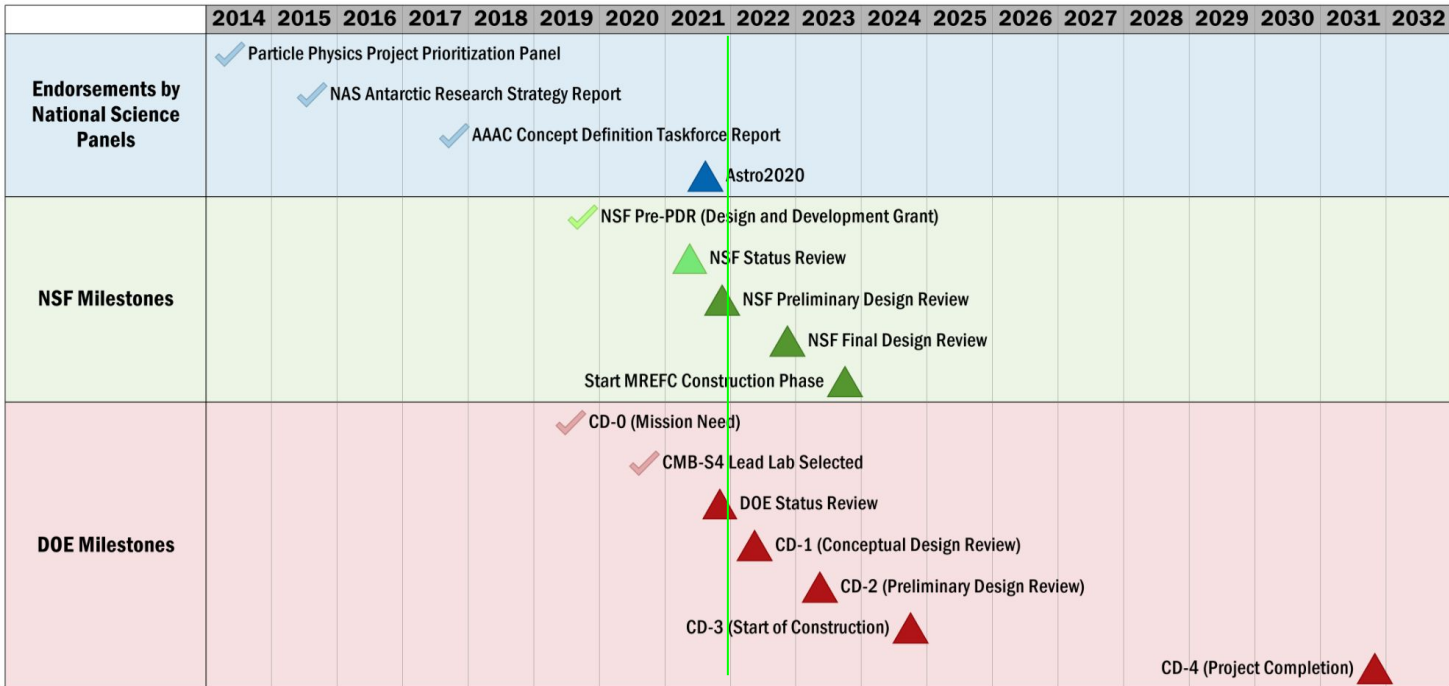
Risks and mitigations strategies have been identified

Major drivers to cost and schedule have been identified

DAQ design is sufficiently mature for conceptual design approval

# Backup Slides

# CMB-S4 Top Level Milestone Targets



- DOE/OPA Status Review Nov 2021 (scheduled)
- NSF PDR late CY21
- DOE CD-1 mid CY22
- Project Early Completion ~2030
- Project Late Completion ~2031
- Survey Completion ~2037