



# Project Needs

**Matthaeus Leitner**

2024 Spring Collaboration Meeting  
March 25, 2024



# Outline

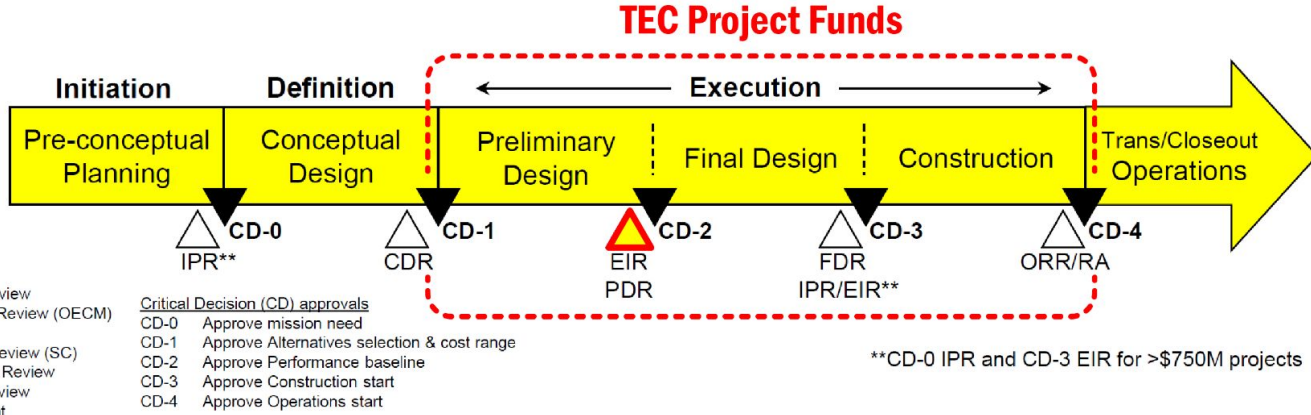
- Readiness for Agency Gateway Reviews
- Recent Project Plan Updates
- Ongoing Activities In Preparation for NSF CDR and DOE CD-1
  - EHS
  - Requirements & Interfaces
  - Analysis of Alternatives
  - Quality Assurance
  - Transition To Operations Planning
- Next Steps Towards An NSF CDR and DOE CD-1
- Outlook and Summary

# Agency Gateway Reviews



**DOE-SC**  
Ref: DOE O 413.3A

- CDR Conceptual Design Review
- EIR External Independent Review (OECM)
- FDR Final Design Review
- IPR Independent Project Review (SC)
- ORR Operations Readiness Review
- PDR Preliminary Design Review
- RA Readiness Assessment

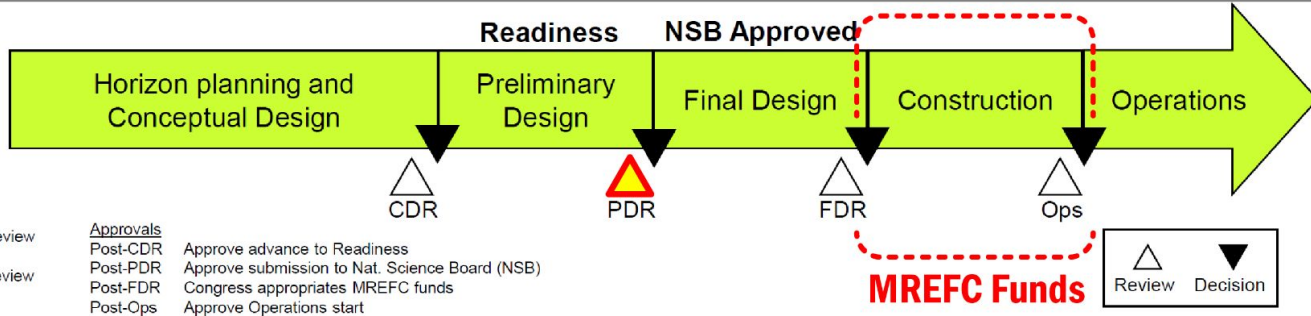


- Critical Decision (CD) approvals
- CD-0 Approve mission need
  - CD-1 Approve Alternatives selection & cost range
  - CD-2 Approve Performance baseline
  - CD-3 Approve Construction start
  - CD-4 Approve Operations start



**NSF**  
Ref: NSF 21107

- CDR Conceptual Design Review
- FDR Final Design Review
- PDR Preliminary Design Review
- Ops Operations Review

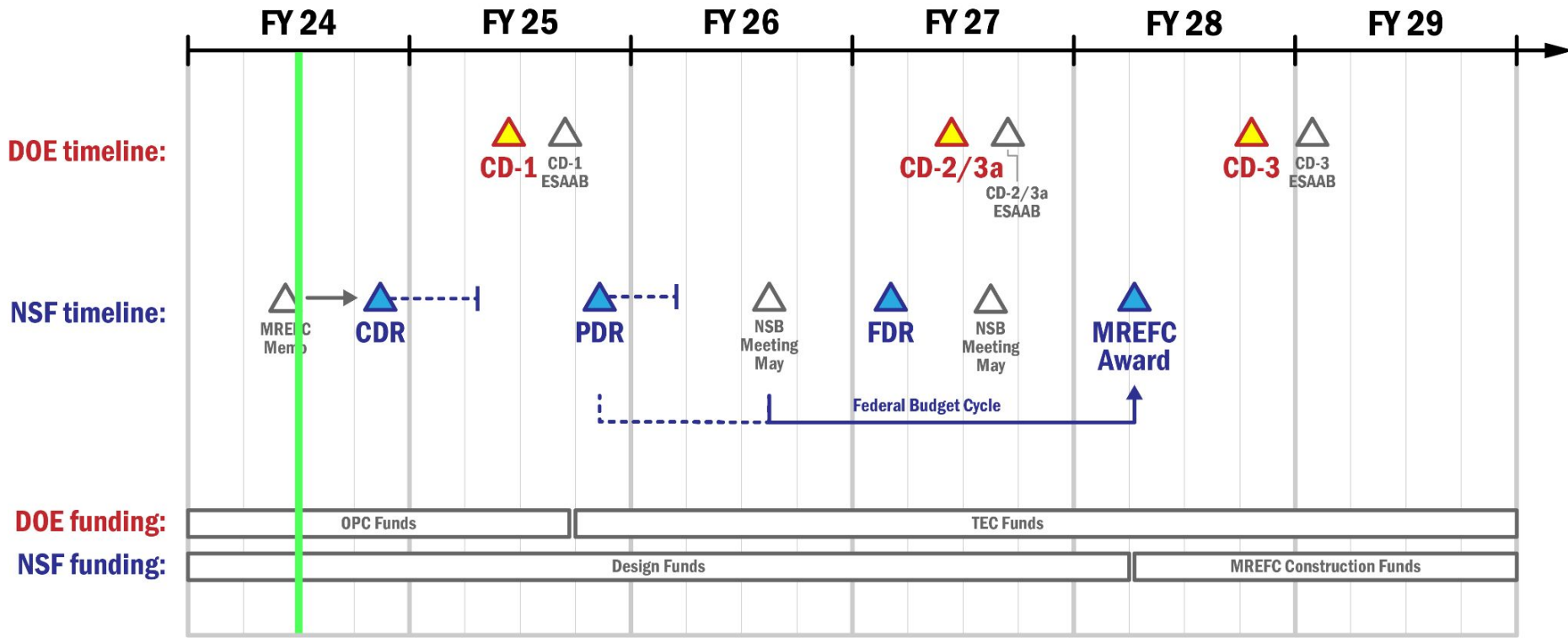


- Approvals
- Post-CDR Approve advance to Readiness
  - Post-PDR Approve submission to Nat. Science Board (NSB)
  - Post-FDR Congress appropriates MREFC funds
  - Post-Ops Approve Operations start

# CMB-S4 Is Well Positioned For NSF CDR And DOE CD-1

- Held a successful Director's Review last November
- Committee concluded:
  - "... The project is **on track** to be ready for an NSF CDR in spring 2024 and on track for a DOE CD-1 review later in 2024."
  - "... The science-driven technical design has **advanced to or beyond the conceptual design stage** for most of the project and the management structure, documentation and planning is also very advanced for this stage. **R&D has progressed well to support the design** and understanding and mitigation of technical risks, and the **management team is strong** and experienced."
- Since December the project team has started responding to (technical as well as project management) review recommendations in preparation for a NSF CDR and DOE CD-1

# NSF And DOE Need To Schedule Gateway Reviews



# Gateway Reviews Require A Well Developed And Comprehensive Project Definition - Areas Of Ongoing Effort:

- Construction Project Definition (Scope, Budget and Schedule)
  - Initial Risk Analysis
  - Initial Acquisition Plans
  - Environmental and Safety Impacts
  - Preliminary Project Execution Plans
- } Project Plan Updates
- Conceptual Design Report
  - Technical Requirements
  - System-Level Design (Interfaces, Design and Verification Plans)
  - Quality Assurance Plans
  - Analysis of Alternatives
- } Design Updates
- Concept of Operations (incl. Commissioning Plans)
  - Educational Outreach and Broader Societal Impact
- } Important Additional Plans

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# Recent Project Plan Update Absorbs Agency Delays But Significantly Improves And Refines Near-Term Planning

- We moved the project schedule by one year due to ongoing delays in receiving the NSF MREFC memo and reduced DOE funding for FY24
- We are substantially refining near-term DRM<sup>(\*)</sup> prototyping and pre-production plans
  - Transition from prototyping to pre-production better aligns with fabrication site practices
  - High-throughput cryostat fabrication will provide two early units for full detector wafer qualification
- We added:
  - Missing quality assurance / component screening activities in DRM and LAT
  - Prototyping activities during detector production (when sites switch frequency)
  - Added coupling wafers for full production (accounting for rework)
  - Added electronics for a prototype SAT
- We completely reworked the DOE work breakdown structure to align DOE and NSF control accounts on Level 4

**Most of the project plan updates are also in response to Director's Review recommendations**

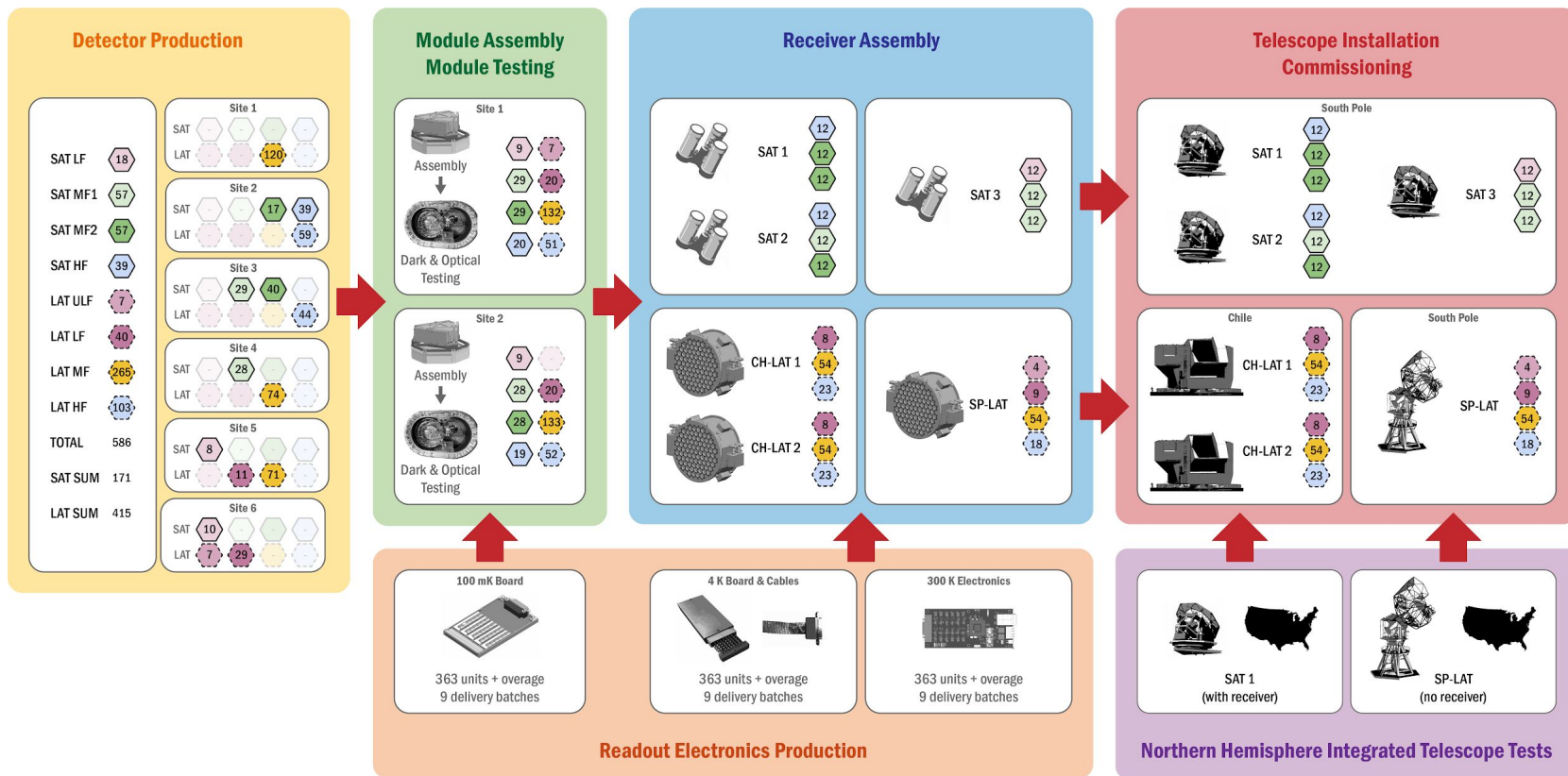
(\*) DRM ... Detector, Readout, Module Assembly and Testing



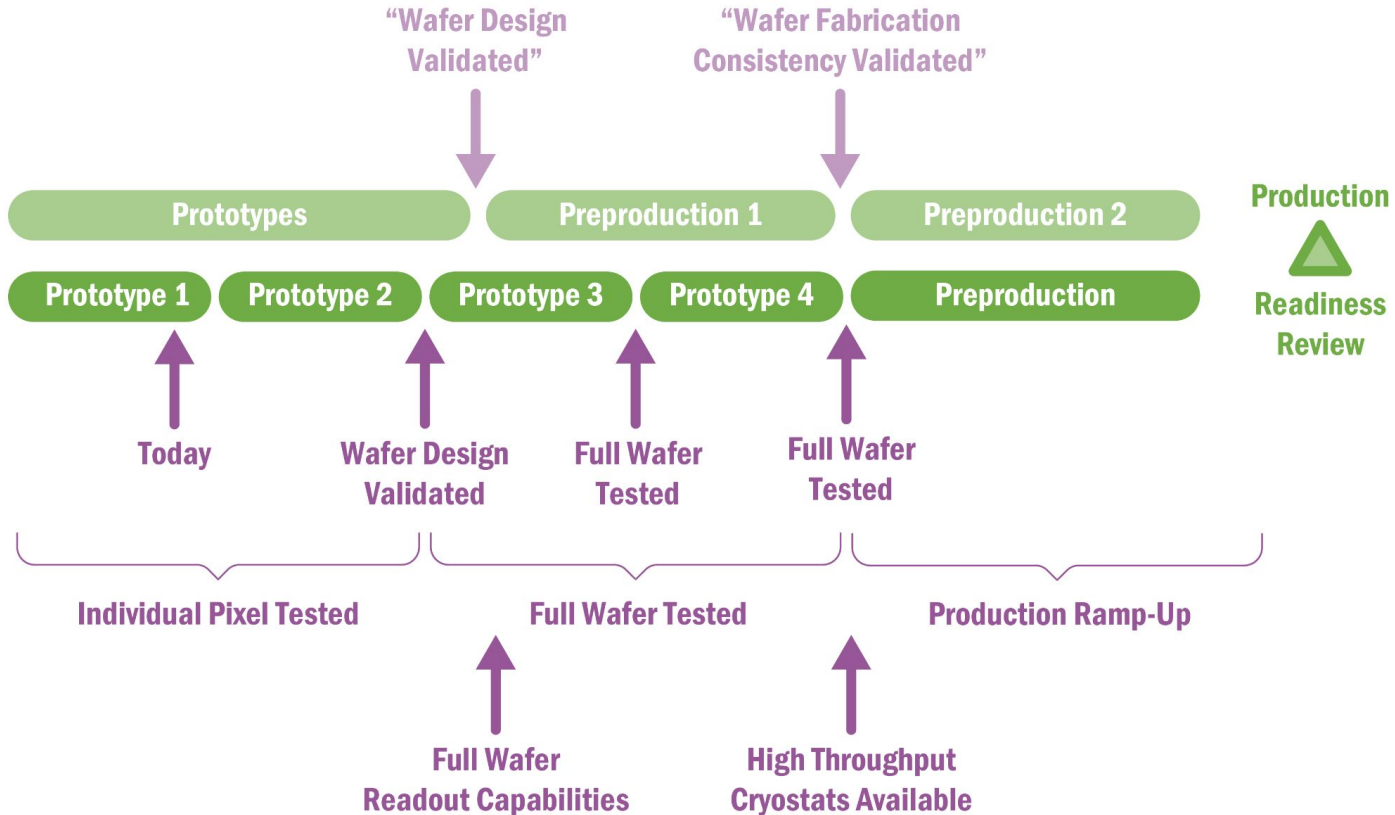
# We Started Tracking And Analysis Of Project Plan Changes

Sum of BAC	Column Labels						
Row Labels	11/1/23	12/1/23	1/1/24	2/1/24	3/1/24	Grand Total	
• Pend#000 (Nov23 Prelim Estimate)	670,450,423					670,450,423	
• Pend#001 (Dec23 Admin Updates)		(1,690,238)				(1,690,238)	
• Pend#003 (Module - Add coupling wafers for full production)			2,865,356			2,865,356	
• Pend#004 (Dec23 Estimate/Scope Update)		727,266				727,266	
• Pend#005 (Jan24 Admin Updates)			55,875			55,875	
• Pend#006 (Jan24 Estimate/Scope Update)			(32,525)			(32,525)	
• Pend#010 (Wafer screening in Readout)			5,098,502			5,098,502	
• Pend#011 (Prototype SAT in Readout)			2,814,640			2,814,640	
• Pend#012 (DAQ System Scale Testing)			26,822			26,822	
• Pend#013 (Add'l READ ME and QA Support)			1,661,443			1,661,443	
• Pend#014a (CA / WBS L4 Update)				(1,420)		(1,420)	
• Pend#014b (Feb24 Admin Updates)				(293,281)		(293,281)	
• Pend#025 (QA Engineer for Detectors)				2,483,120		2,483,120	
• Pend#020 (Readout Shipping Resources (product of L4 CA split))				245,586		245,586	
• Pend#016 (MAT HT Cryostat Updates)				62,364		62,364	
• Pend#015 (Feb24 Estimate/Scope Update)				64,100		64,100	
• Pend#026 (LAT Add'l QA Support)				1,863,148		1,863,148	
• Pend#027 (Add'l details for DM/DAQ installation)				(199,476)		(199,476)	
• Pend#028 (L1/L2 Milestone Update - 1 Yr Shift)					27,963,794	27,963,794	
<b>Grand Total</b>	<b>670,450,423</b>	<b>(962,972)</b>	<b>12,490,113</b>	<b>4,224,140</b>	<b>27,963,794</b>	<b>714,165,498</b>	

# Detector Prototyping and Pre-Production Planning Updates



# Detector Prototyping and Pre-Production Planning Updates



# EH&S Updates

Documentation is overall in good shape for a review. Based on recent review recommendations we are developing a few additional documents:

- Document which defines codes and standards to be implemented project-wide
  - Applies uniformly to NSF and DOE scope of work
- Equipment Acceptance Standards
  - Electrical standards and acceptance criteria
  - Fire safety standards and acceptance criteria
- Safeguard and Security Document
- NEPA strategy awaits OPP interaction

# Requirements And Systems Engineering Updates

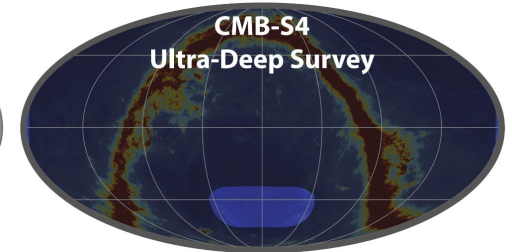
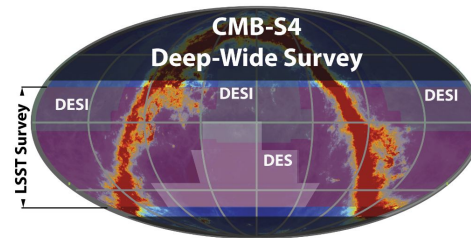
- Most important open item in preparation for a NSF review - see next talk
- Released L1 requirements
- L2 requirements and interfaces need to be developed and finalized by L2 managers
  - A lot of documents still require substantial effort
  - Import into Jama and approval in database
  - We need to develop a culture where we continually add requirements and interfaces into Jama along the way as we continue to refine our designs
- Pro-active documentation and development of requirements and interfaces is not yet at a stage where we can successfully transition into a preliminary and final design effort
  - Will need to strengthen this effort (especially in the the realm between science analysis and systems engineering)
  - Next project-focused workshop (see slide 20) will also focus on interfaces

**Important for NSF CDR - See subsequent talks**

# Analysis Of Alternatives - Science Document

- We developed a first draft “CMB-S4 Analysis of Alternatives prepared for DOE CD-1 and NSF CDR” which is a project management document
- We expect continuing scrutiny of our siting decisions, and an accompanying scientific document informing the AoA decision is under ongoing development
  - Needs to be completed before NSF CDR
  - Need comparative analysis of the r forecasts of the various alternatives including consideration of existing experiments
  - Deaggregation of the factors and data cuts that lead to achieved performance of BICEP/Keck
  - Systematics breakdown and margin definition
- In addition, we need (simplified) graphs for agency interactions plus gateway reviews

**Important for NSF CDR**  
**See subsequent talks**



# Quality Assurance Updates

- QA Program Foundation

- Roles ✓
- Tools ✓
- Document Control ✓
- Core Document Release ✓
- Requirements
- Interfaces
- Serialization



- Component Database
- QA/QC Database
- Procurement Processes

**Requirements**

Alarms [V4] - Modified 08/18/2023 04:05:56 pm

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

SUBSYSTEM:  
DAQ

Demonstration

VERIFICATION DESCRIPTION:  
A demonstration of the alarm system responding properly to excursions from configured ranges will be sufficient to verify this requirement. Emulated data are appropriate for this demonstration.

BASIS / RATIONALE:  
As the large number of acquired housekeeping quantities preclude human monitoring, automated range checking can alert operators to changes in conditions.

EXTERNAL ID:  
DAQ-CF-0004

**QA Database**

Key	Summary
CMBS4-200	1.05.03   LAT MF Wafer Optical Coupling Assembly   #1
CMBS4-209	1.01.02.01   Test One   #99
CMBS4-210	1.03.02   CDFG ANL   #18
CMBS4-198	1.05.03   Backshort Assembly   #1
CMBS4-192	1.05.03   Backshort, L/
CMBS4-197	1.05.03   Ecosorb CR11
CMBS4-196	1.05.03   WIP Choke Au Plated Assembly   #
CMBS4-195	1.05.03   WIP Choke Assembly, LAT MF Module Coupling Wafer   #
CMBS4-190	1.05.03   Choke, LAT MF Coupling Wafer   #1 • First prototype LAT MF Choke Module Wafers ordered from SeeQC
CMBS4-191	1.05.03   WIP, LAT MF Coupling Wafer   #1
CMBS4-193	1.05.03   STYCAST 2850FT BK / Catalyst 23LV CL   # • Epoxy used to bond the Choke and WIP together (CMBS4-doc-900 and -901).
CMBS4-199	1.05.03   GE Varnish (100:0 ISO)   #

# The JIRA Component Database Is Under Development And Will Have A Record Of All Components Produced And Their Current Location

Projects / Component Database / CMB54-203

1.05.03 | WIP, LAT MF Coupling Wafer | #2

Link issue Attachment Manager

General Documentation

Jessica Aguilar raised this request via Jira

WBS Number 1.05.03

Part Name WIP, LAT MF Coupling Wafer

Serial Number 2

Part Number CMB54-doc-901

Current Location FINAL

QA Manager Jessica Aguilar

L2 System Manager Bradford Benson

L2 CAM Hogan Nguyen

Description None

Linked issues

has QA record

QADB-15 NCR | WIP | 2

QADB-18 ACL | WIP, LAT MF Module C...

WBS | Component Name | Serial Number

Part Number  
Current Location

If the component is also an assembly, subcomponents will be linked:

Linked issues

Subcomponents

CMB54-196	1.05.03   WIP Choke Au Plated Assembly   #	IN DESIGN
CMB54-199	1.05.03   GE Varnish (100:0 ISO)   #	IN DESIGN
CMB54-198	1.05.03   Backshort Assembly   #1	IN DESIGN
CMB54-210	1.03.02   CDFG ANL   #18	IN DESIGN

As a next phase we will develop a few example use cases on select subsystems.

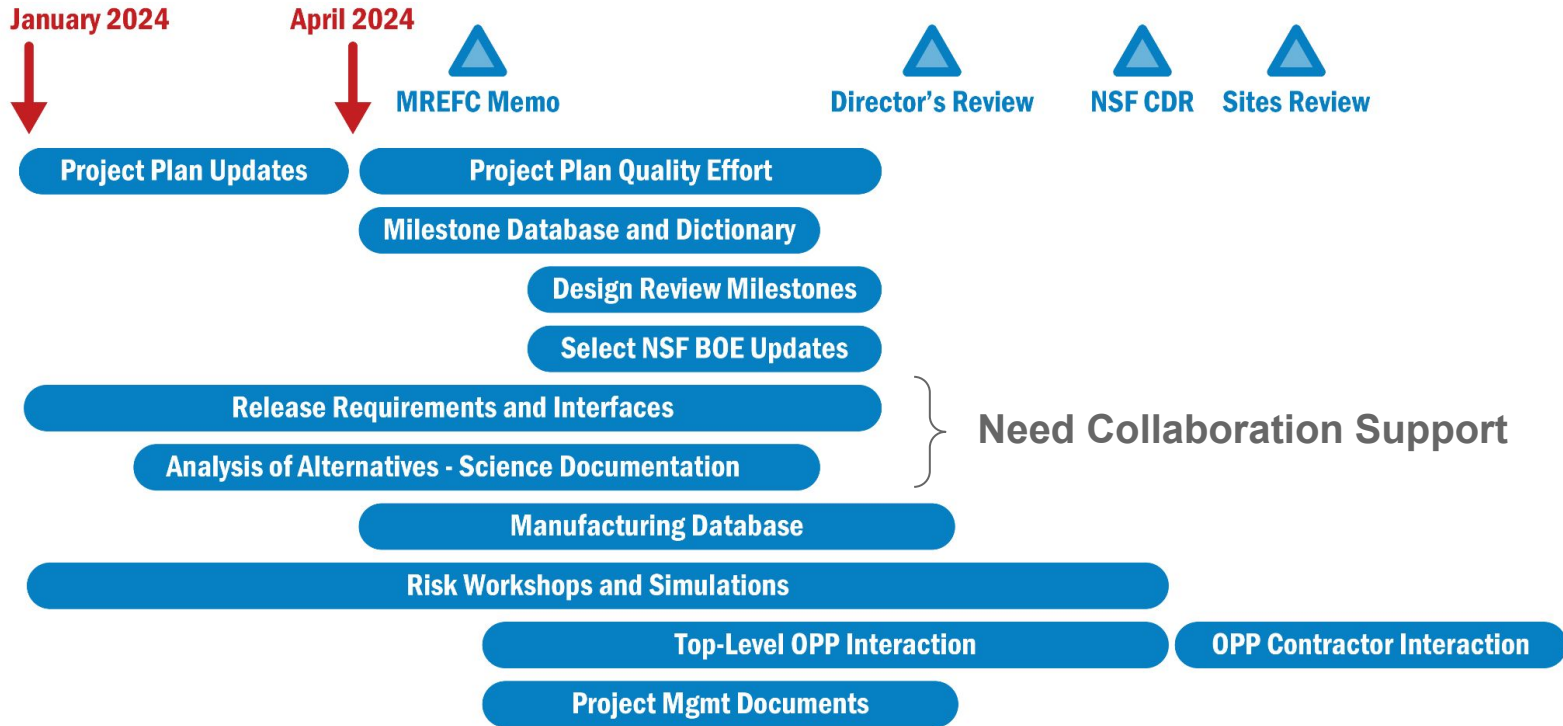
Linked QA Records



# Transition To Operations Plan Updates

- P6 project plan separates equipment **integration & verification** from **science commissioning** to reflect different objectives as well as different personnel involved
- Integration & verification is managed by site L2s and focuses on hardware hand-offs  
Split in:
  - Site activities
  - US support
- Science commissioning requires DM involvement
- We developed a draft “Concept of Operations Plan” which focuses on operations organization and costs
- **We still need to develop a Science Commissioning Plan**

# Next Steps Towards An NSF CDR



# DOE CD-1 Readiness Will Require Additional Steps



- DOE/NSF Letter of Intent
- Receive Funding Profile Guidance
- Refine SAT Schedule Details
- Develop More Detailed Prototype SAT and Pre-SAT Schedules
- Further Refine Module Rework Plans
- Finalize High Throughput Cryostat Fabrication Schedule
- Full BOE Refresh
- Procurement Plans and CD-3 Phased Funding Approach
- Ongoing Schedule Plan Maintenance
- Release All Required CD-1 Project Documentation
- Alternative Energy Conceptual Design Review
- Prototype Wafers Tested

# Project-Focused Workshop May 1 To May 3 (Remote)

Focused on:

- Finalizing requirements and interfaces between NSF and DOE scope plus inter-NSF scope
- Common engineering topics
  - LAT and SAT cryostats thermal analysis and verification
  - Magnetic and RF shielding
  - Electrical power needs
- Site Integration & Verification plus Commissioning Plans
- Analysis of Alternatives

We plan to give homework assignments so we can focus on discussing results and open items during the workshop. Will post agenda on Indico shortly after Collaboration meeting.

**Plan to hold regular project workshops in the future.** Next one likely focused on DRM.

# Outlook And Summary

- **We continue to focus on being ready for a NSF CDR in the near-term**
  - Corresponding project schedule (P6) update is almost complete and remaining work will be mostly within project controls focused on cost/schedule documentation quality.
  - Two areas still need major effort:
    - Requirements and Interfaces
    - Analysis of Alternatives Science Document
- **The timetable towards a DOE CD-1 will depend on adequate agency funding and completing a successful NSF CDR**
  - Additional steps to prepare for a DOE CD-1 are clear and we can work on advancing our project readiness as funding permits.
- **Technical progress by the project team continues to be significant. Even small advancements in the next year will be important to maintain project momentum.**
- **Key Collaboration support is needed for the project to go through the next review milestones**
  - Analysis of Alternatives, Requirements and Interfaces, Science Flowdown, Commissioning Plans
  - Science Book

# Technically-Limited Integrated Master Schedule Established Based On A Detailed DRM Production Plan Plus Comprehensive Telescope And Site Installation Plans

