



Status of New Project Baseline Development

Matthaeus Leitner
(he/him)

CMB-S4 Collaboration Meeting
April 3-6, 2023

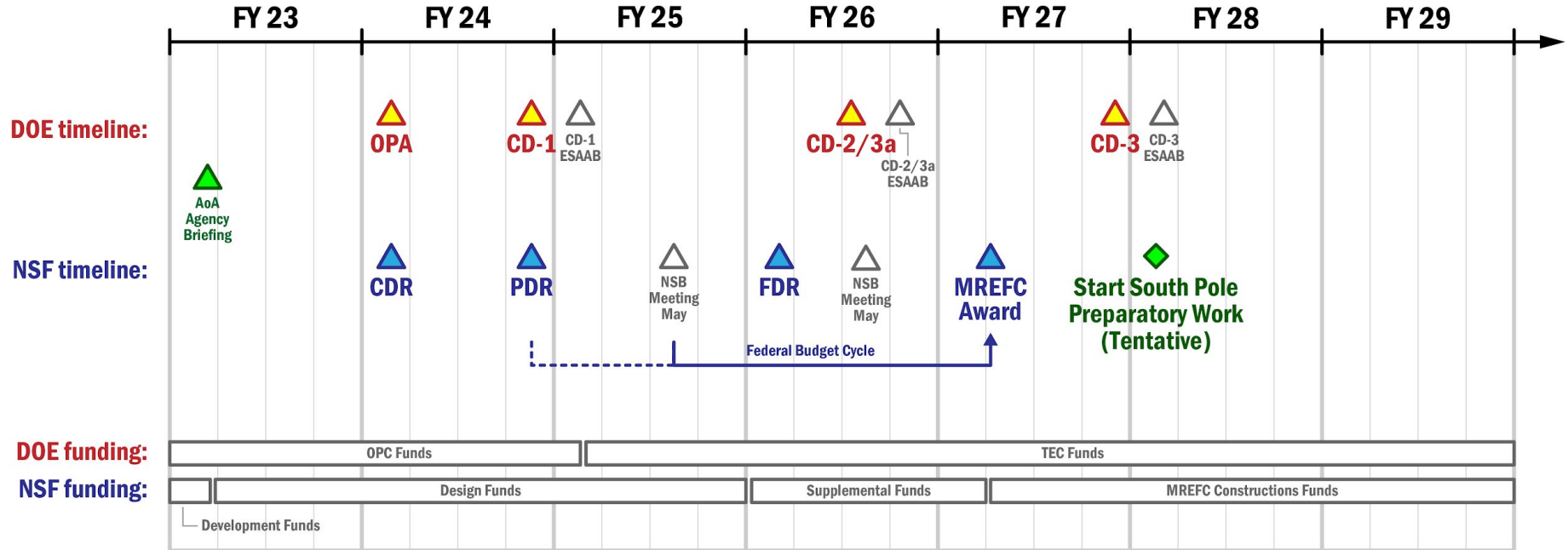




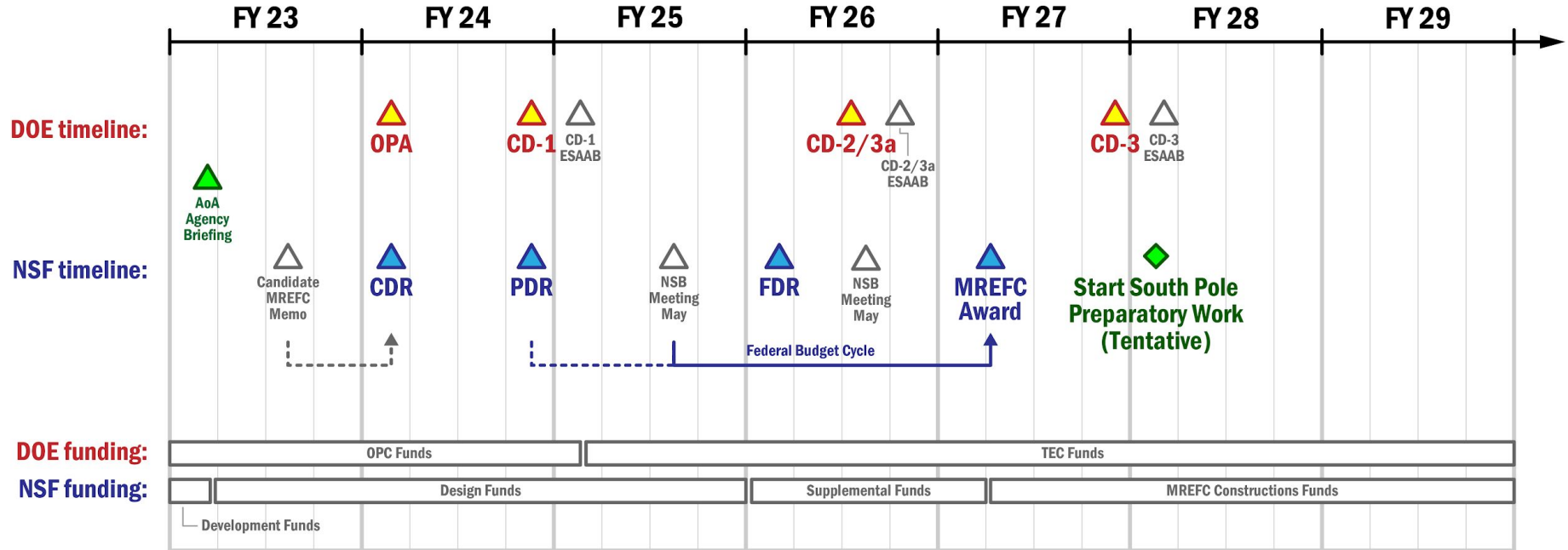
Outline

- Top Level Project Planning Assumptions
- Recent Major Project Baseline Developments
- Upcoming Near-Term Activities
- Other Updates (Communications, Project Infrastructure)
- Summary

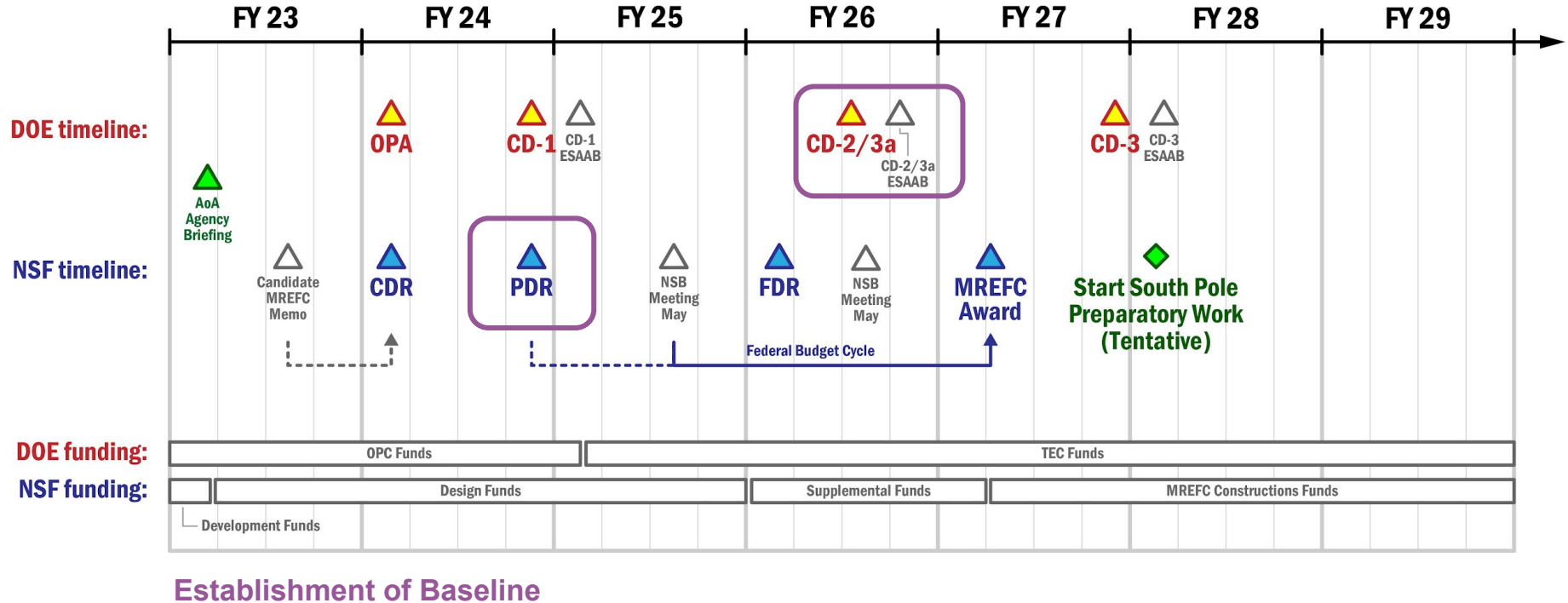
Top-Level Project Planning Assumptions



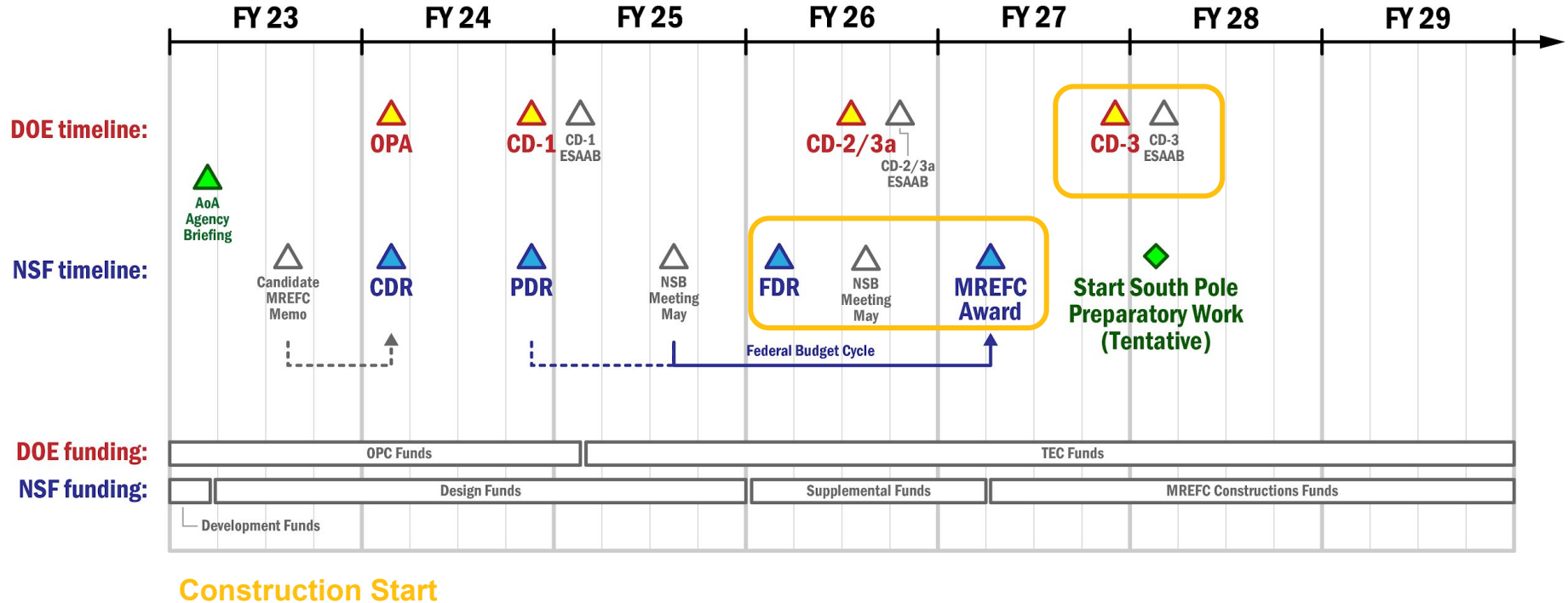
Top-Level Project Planning Assumptions



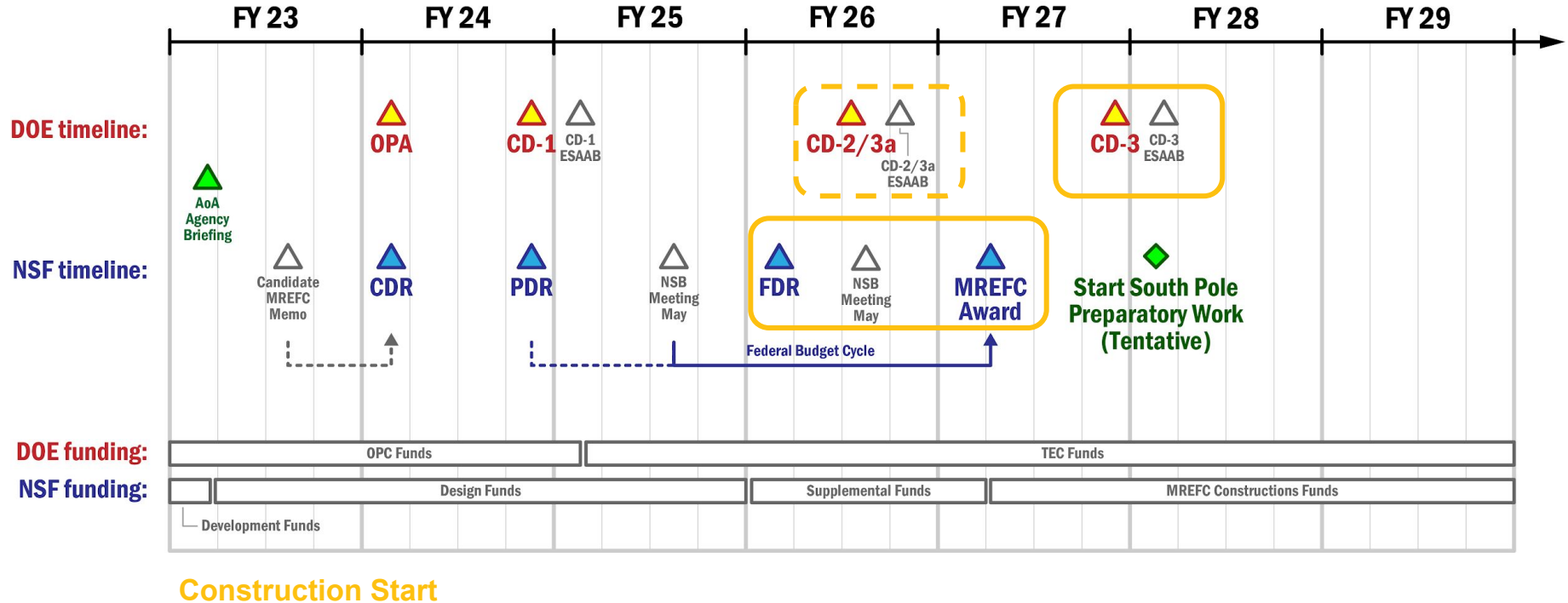
Top-Level Project Planning Assumptions



Top-Level Project Planning Assumptions



Top-Level Project Planning Assumptions



A Major Update To The CMB-S4 Project Plan Has Been Successfully Implemented To Prepare For Upcoming Reviews

Scope



- Analysis of Alternatives Completed
- Alternative 1 Point Design Freeze Completed
- Included Project Scope Contingency and Systems Engineering Labor
- Site Scope Changes According To Alternative 1
- Pending PBDR Update
- Pending Requirements and Interfaces Release

Schedule



- Major DRM Production Workflow Update
- Realistic Yield and Module Rework Schedule
- Streamlined Module To Telescope Hand-offs
- Site Changes Reflecting Alternative 1 Scope

**“Thank You” to the
Project Team and
Project Controls**

Cost



- New Time-phased Cost Roll-up Developed
- Inflation Impacts Included
- Scope Contingency Added
- Yearly Spending Profile Requires Further Tweaks
- Cost Scrubbing Review Required
- CD-3a Plan

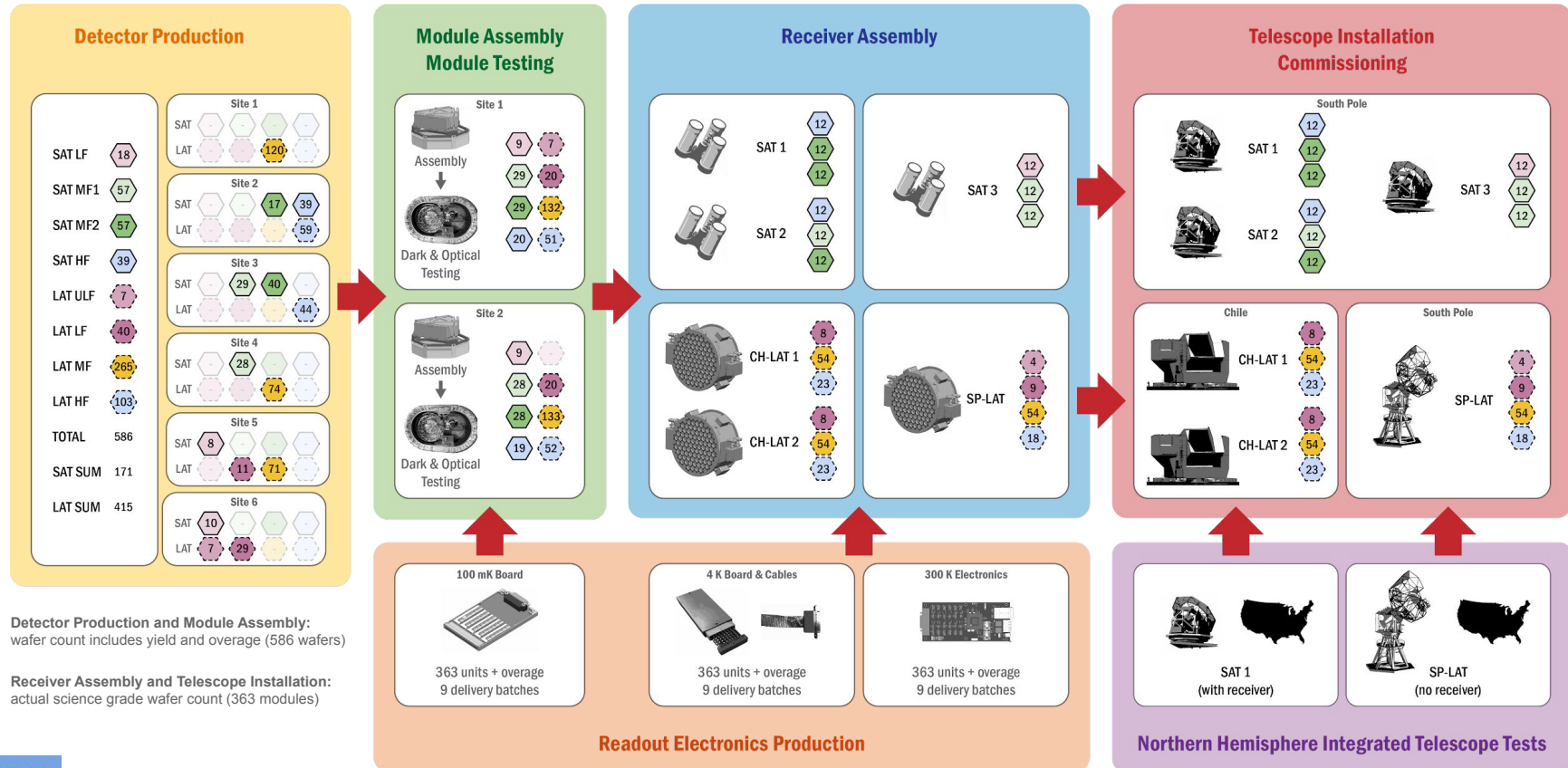
ICDs and Requirements Will Be Officially Released In JAMA

See B. Besuner Talk

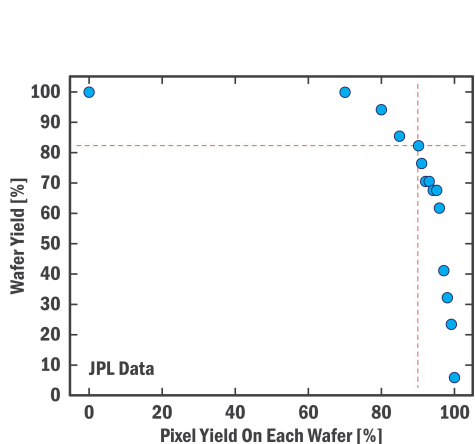
A Major Step In Demonstrating Project Maturity And Readiness

External ID	ID	Name	Subsystem	Status	Description	Basis / Rationale	Verifica
	CMB54-TXT-6	Preamble					
	CMB54-TXT-5	Revision History			Version Revision Date (MM/DD/YYYY) Notes		
	CMB54-TXT-7	Summary			NET is the instantaneous sensitivity. It is affected by: 1. Dark NEP (detector + readout) evaluated at the planned observing optical load 2. Photo...		
	LATULF-0070	CMB54-DET-471	Calibration TES Saturation Power (Psat)	Detector	Draft	The Calibration TES Bolometer saturation power, P _{sat} , defines the dynamic range of the detector by identifying the maximum optical power the ...	Minimum Cal...
	LATULF-0080	CMB54-DET-472	Noise Equivalent Temperature	Detector	Draft	The Noise Equivalent Temperature will be measured looking at a cold load a the appropriate T to set optical loading (each band is different). Me...	NET is the inst...
	LATULF-0010	CMB54-DET-478	Band Edge Placement	Detector	Draft	The Band Edge requirements define the band edges of the RF filters on the LAT-LF detector wafer. The Band Edges are defined as the frequ...	Optimizing sig...
	LATLF-0020	CMB54-DET-448	In Band Optical Efficiency	Detector	Draft	The sensitivity is the product of the optical efficiency and bandwidth. The important parameter is the noise-weighted average of the wafer. LAT...	Determined b...
	LATLF-0030	CMB54-DET-449	Out of Band Rejection	Detector	Draft	Rejection of optical signal outside of intended passband (dB)	Science & NE...
	LATLF-0040	CMB54-DET-450	Science TES Saturation Power (Psat)	Detector	Draft	The Science TES Bolometer saturation power, P _{sat} , defines the dynamic range of the detector by identifying the maximum optical power the det...	Nominal Psat i...
	LATLF-0050	CMB54-DET-451	Noise Equivalent Power	Detector	Draft	Photon NEP is driven by optics, photon load and optical efficiency. The average NEP over a detector wafer in the LAT-LF_1 Passband shall be ...	Places a limit ...
	LATLF-0060	CMB54-DET-452	Time Constant in Transition	Detector	Draft	Detector optical time constant (tau) defines the response time of a detector Minimum tau for the detectors in the LAT_LF_1 passband shall be s...	Fast enough t...
	LATLF-0070	CMB54-DET-453	Calibration TES Saturation Power (Psat)	Detector	Draft	The Calibration TES Bolometer saturation power, P _{sat} , defines the dynamic range of the detector by identifying the maximum optical power the ...	Minimum Cal...
	LATLF-0080	CMB54-DET-454	Noise Equivalent Temperature	Detector	Draft	The Noise Equivalent Temperature will be measured looking at a cold load a the appropriate T to set optical loading (each band is different). Me...	NET is the inst...
		CMB54-FLD-66	1.03.1.3 DET LAT-MF				

Revised P6 DRM Production Schedule Is Aligned With A Strawperson Detector Fabrication Plan And Includes Realistic Yield And Overage Assumptions



Revised P6 DRM Production Schedule Is Aligned With A Strawperson Detector Fabrication Plan And Includes Realistic Yield And Overage Assumptions

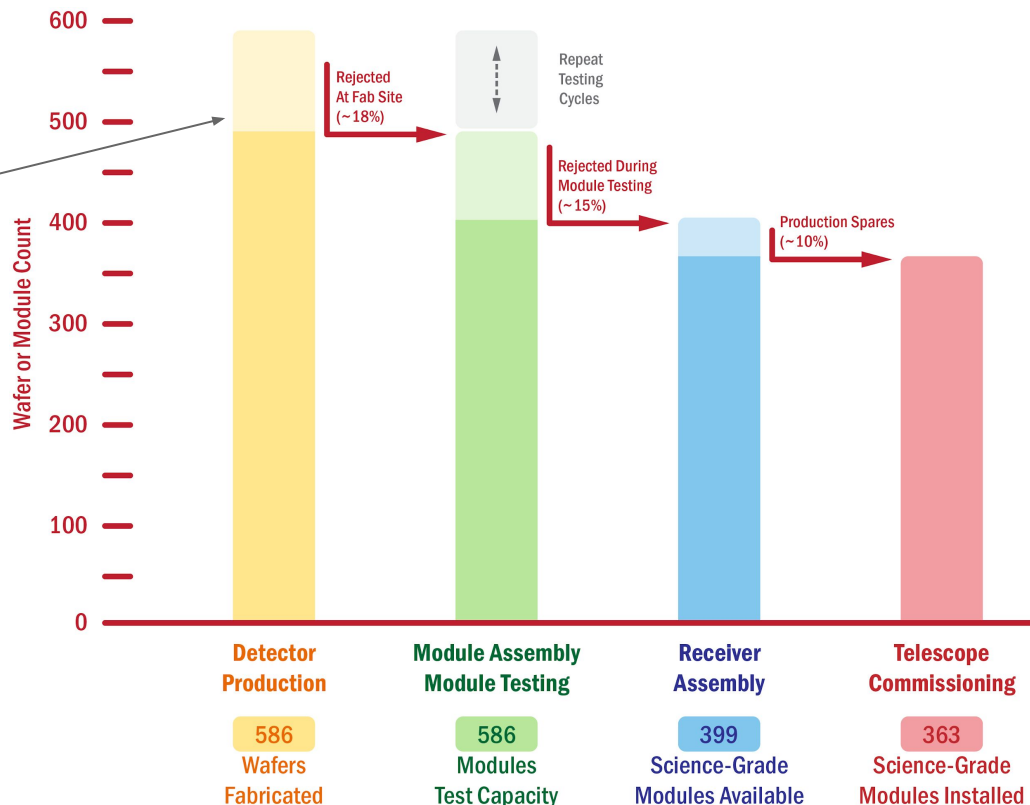


CMB-S4 will require unambiguous QA acceptance criteria to maintain DRM production schedule.

Next Step:
Develop Detector QA Plan

DRM plan developed by
B. Flaugher and S. Nelson

Assumption:
~1/3 wafers will not achieve science-grade rating

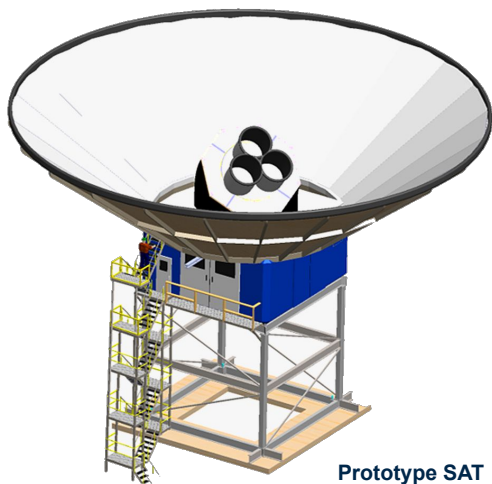


Revised P6 DRM Production Schedule Is Aligned With A Strawperson Detector Fabrication Plan And Includes Realistic Yield And Overage Assumptions



Additional Project Plan Updates

- Module to telescope handoffs streamlined
- Sites and telescope WBS areas have been reworked
- Current inflation environment is now included in cost projections
- Systems and manufacturing engineering plus procurement oversight labor added
- 4th SAT (prototype) added - North America test facility for risk reduction
- Ongoing alternative energy plant development (not yet in project plan)



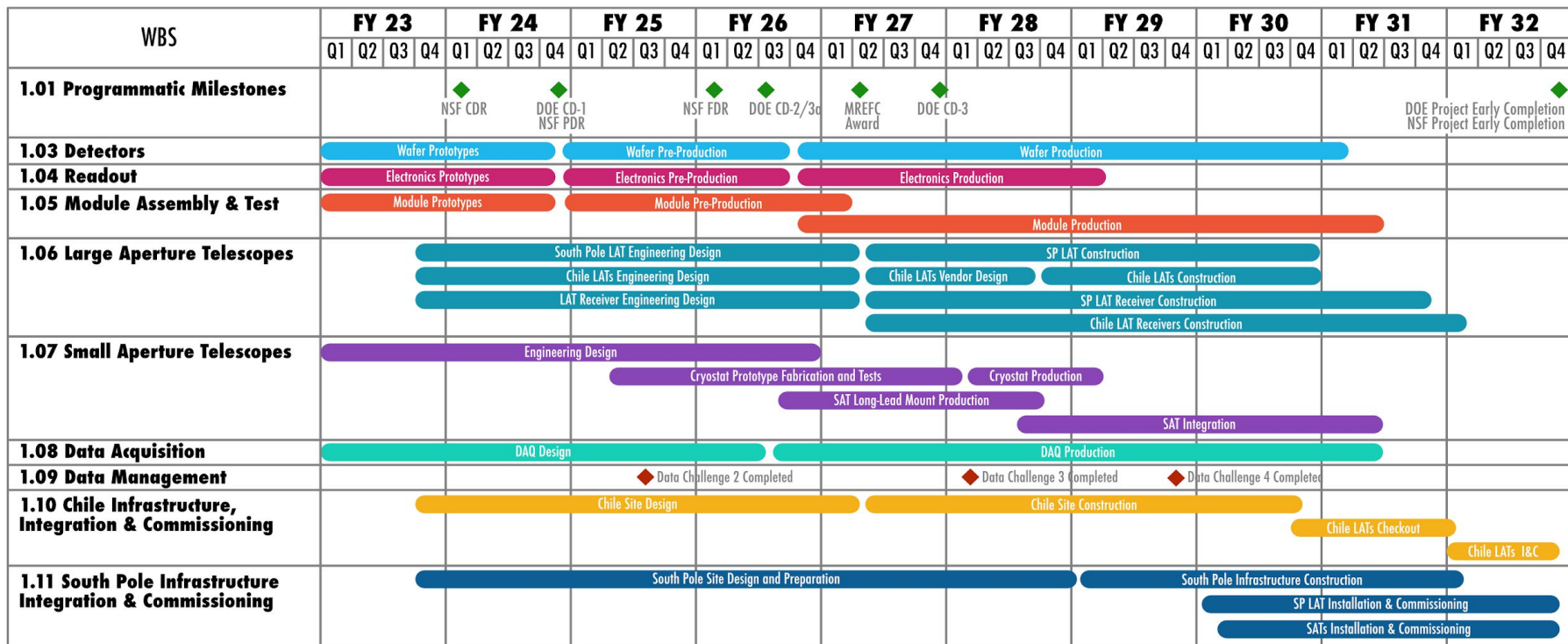
Prototype SAT

PROJECT SPECIFIC NON Labor		
Fiscal Year	Period Rate	Factor
START	0.0%	1.0000
2023	0.0%	1.0000
2024	6.8%	1.0680
2025	4.4%	1.1150
2026	2.1%	1.1384
2027	2.1%	1.1623
2028	2.1%	1.1867
2029	2.1%	1.2116
2030	2.1%	1.2371
2031	2.1%	1.2631
2032	2.1%	1.2896
2033	2.1%	1.3167
2034	2.1%	1.3443
2035	2.1%	1.3726
2036	2.1%	1.4014
2037	2.1%	1.4308
2038	2.1%	1.4609
2039	2.1%	1.4915
2040	2.1%	1.5229
2041	2.1%	1.5548
2042	2.1%	1.5875

PROJECT SPECIFIC Labor		
Fiscal Year	Period Rate	Factor
START	0.0%	1.0000
2023	0.0%	1.0000
2024	5.0%	1.0500
2025	3.5%	1.0868
2026	3.5%	1.1248
2027	3.5%	1.1642
2028	3.5%	1.2049
2029	3.5%	1.2471
2030	3.5%	1.2907
2031	3.5%	1.3359
2032	3.5%	1.3826
2033	3.5%	1.4310
2034	3.5%	1.4811
2035	3.5%	1.5330
2036	3.5%	1.5866
2037	3.5%	1.6422
2038	3.5%	1.6996
2039	3.5%	1.7591
2040	3.5%	1.8207
2041	3.5%	1.8844
2042	3.5%	1.9504

Escalation Updates

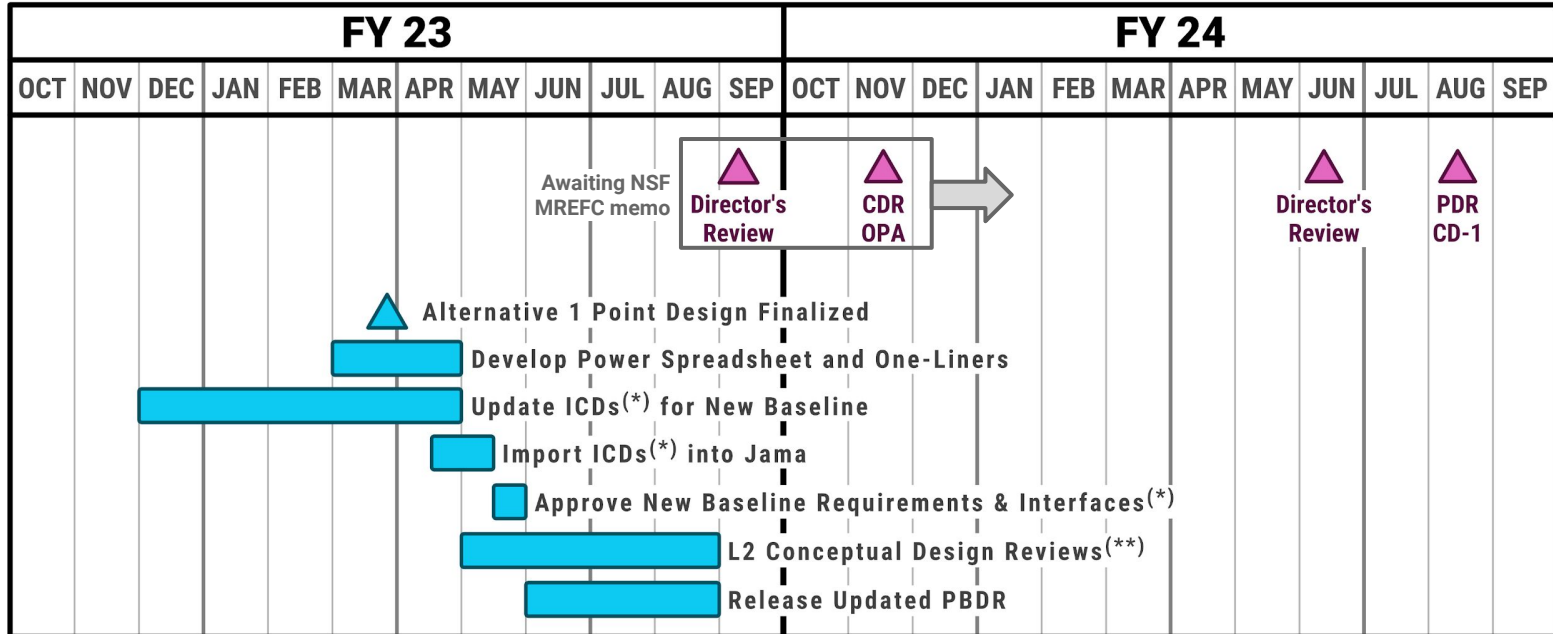
Draft Updated CMB-S4 Summary Schedule (*)



(*) The shown summary schedule is a working version until finalized before the next review cycle. We will continue to optimize subsystem handoffs.

Upcoming Near-Term Activities

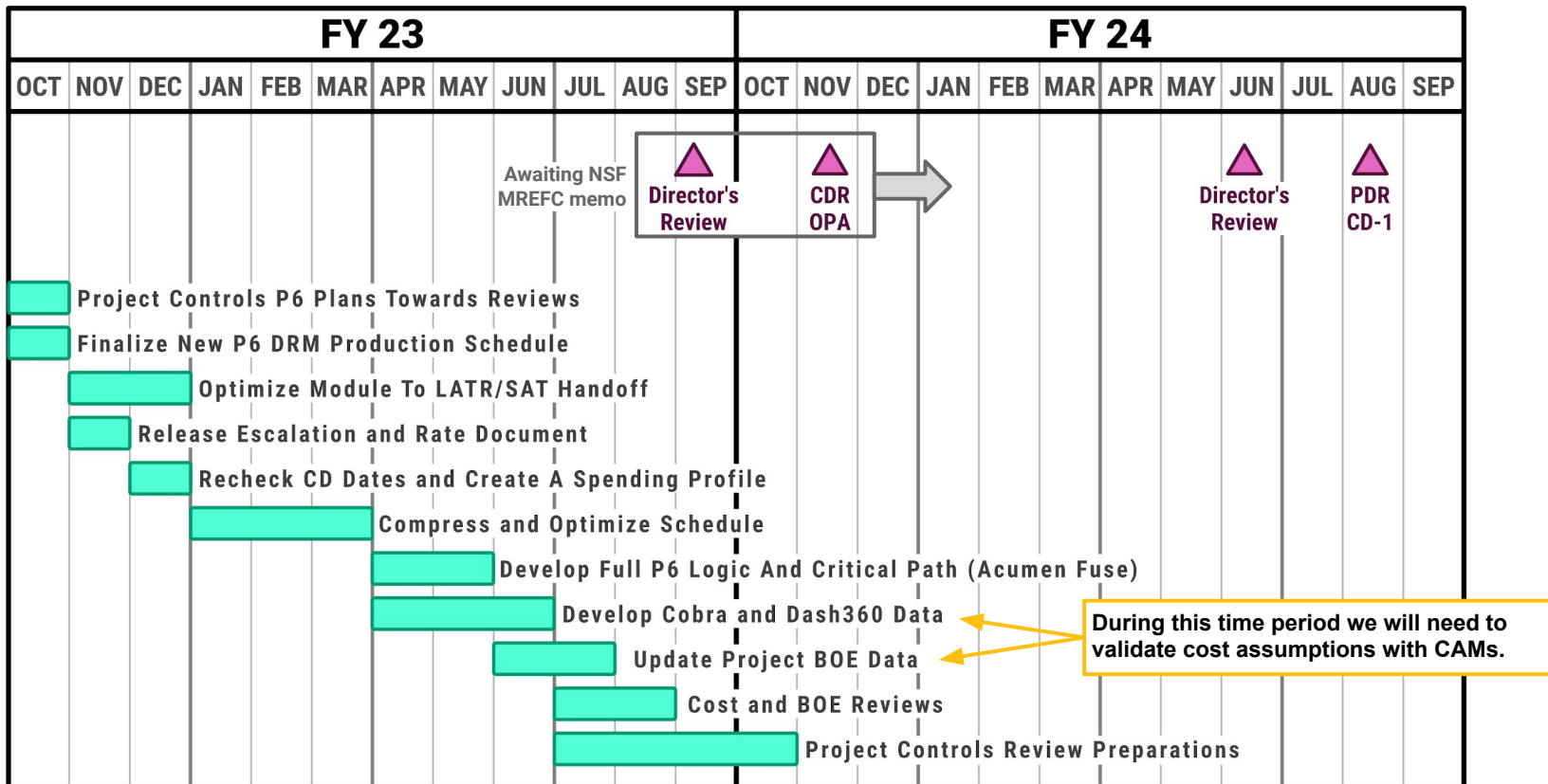
Near-Term Systems Engineering Activities



(*) Level-2 ICDs and Requirements plus Level-3 CH-LAT, SP-LAT, and LATR ICDs and Requirements

(**) ~May: LAT, LATR, Sites / Summer: remaining WBS areas

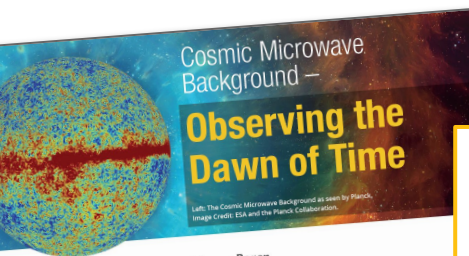
Near-Term Project Controls Activities





As Project Matures And Competes For Funding We Are Strengthening Project-Specific Outreach

- Flyer
- Newsletter Based on Monthly Report
- New Branding in development

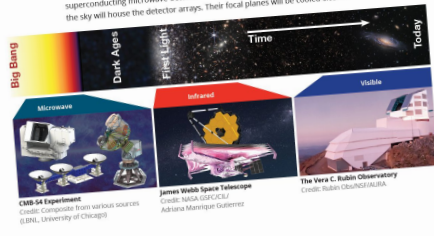


Understand How the Universe Began

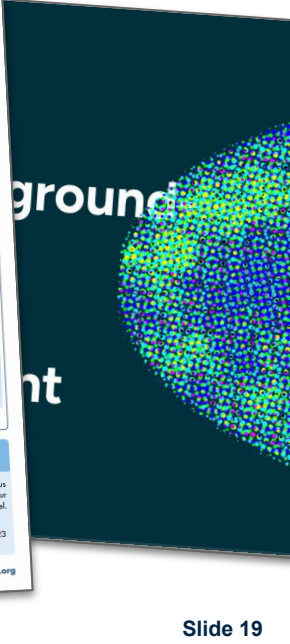
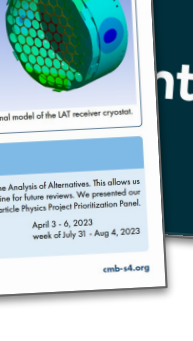
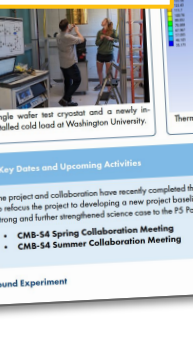
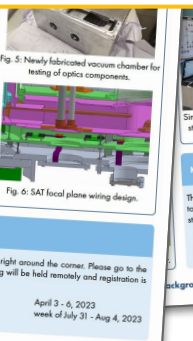
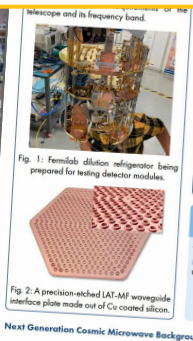
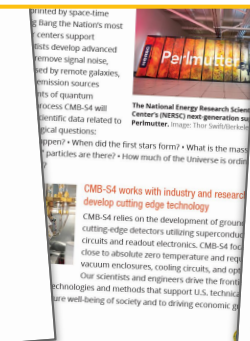
Inflation — a mysterious period during the dawn of time — describes the early Universe as it expanded to cosmic scales in a fraction of a second after the Big Bang. Tiny perturbations in the fabric of space and time during this primordial phase of the Universe would seed the later formation of the world we live in today — stars, planets, and galaxies.

A new observatory, Cosmic Microwave Background Experiment — Stage 4 (CMB-S4), supported by over 400 scientists across more than 100 institutions in 18 countries including 8 U.S. National Laboratories and 49 U.S. Universities will enable precise measurements of the earliest detectable radiation revealed after the Big Bang, a faint remnant background glow permeating our Universe. CMB-S4 is designed to reach sufficient detection sensitivity to extract the finest details from this background radiation and to uncover — for the first time — the imprints of quantum fluctuations left by the inflationary epoch.

CMB-S4 brings together a U.S. led collaboration of cosmologists, data scientists, physicists, integrated circuit designers, and engineers working on the deployment of the largest arrays of superconducting microwave detectors ever built. Ground-based telescopes continually scanning the sky will house the detector arrays. Their focal planes will be cooled close to absolute zero.



Please Provide Feedback For Continuing Improvements And New Material Topics



We Are Working On Enhancements To Project Infrastructure

- AoDoc - New Document Control System (incl. document approval capabilities, supporting Google as well as Microsoft documents, automatic ownership transfer)
- Manufacturing Database based on Jira Platform
- Change Control Board Database to collect all necessary (preliminary) project baseline change documentation
- Work on project infrastructure is progressing in the background and limited due to funding
- We hope to enroll first beta users after summer

The image displays three overlapping screenshots of the CMB-S4 Document Control Center and Google Drive interfaces.

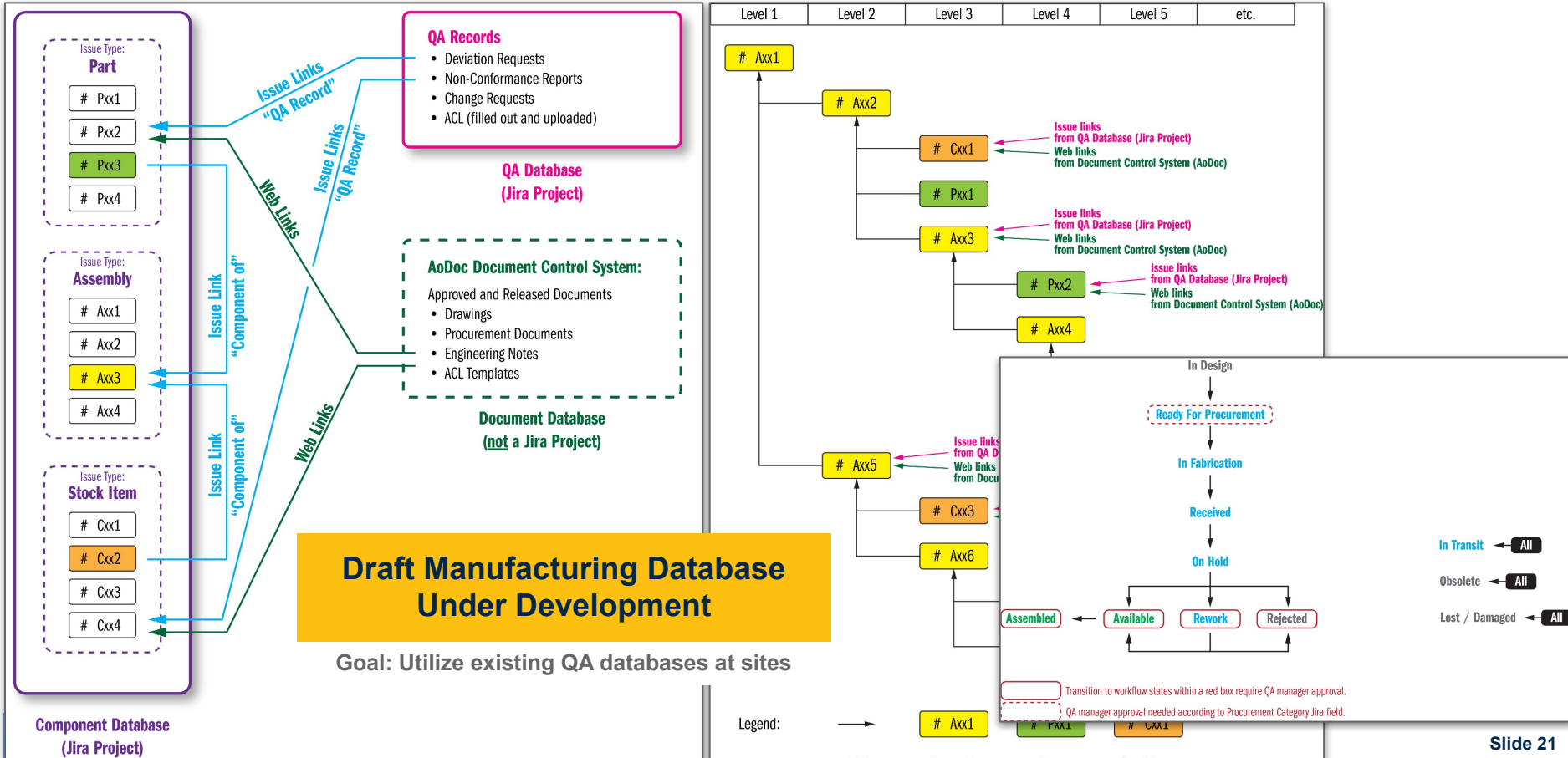
Top Screenshot (CMB-S4 Document Control Center): Shows the 'CMB-S4 AO Docs Business Requirements' document. The breadcrumb trail is 'CMB-S4 Document Control Center > Show All Documents > CMB-S4 AO Docs Business Requirements'. The document title is 'CMB-S4 AO Docs Business Requirements' with a 'Draft version' label. The document content shows a table with columns for 'Category Code', 'Title 1', 'Title 2', 'Title 3', 'Major Revision', and 'Minor Version'. The table contains the following data:

Category Code	Title 1	Title 2	Title 3	Major Revision	Minor Version
CM0101	CMB-S4 Project Management & Systems Engineering	General		A	8

Middle Screenshot (Google Drive): Shows the 'CMB-S4 Team Drive' > 'Testing' > 'Team Folder'. The 'New' menu is open, showing options like 'File upload', 'Folder upload', 'Google Docs', 'Google Sheets', 'Google Slides', 'Google Forms', 'Word', 'Excel', 'PowerPoint', and 'More'. The 'Test.xlsx' file is selected.

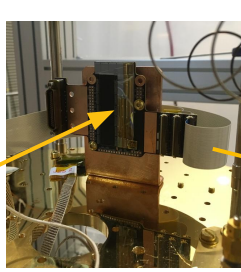
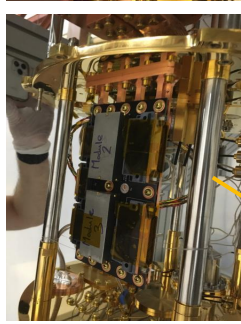

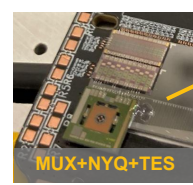

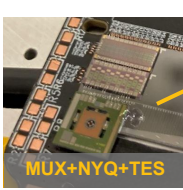

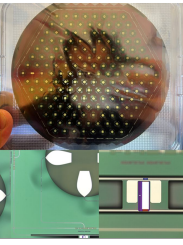
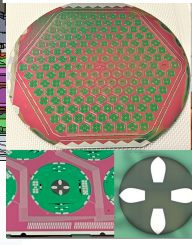

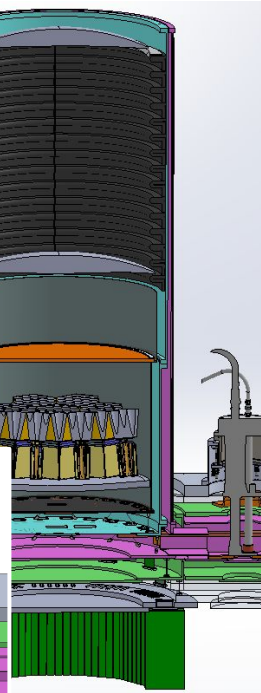
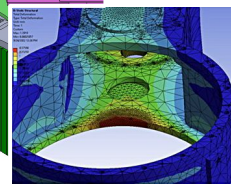
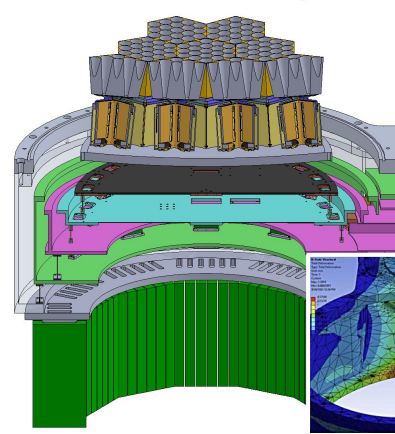
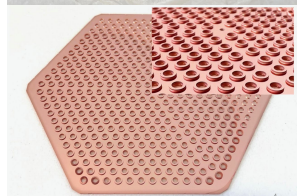
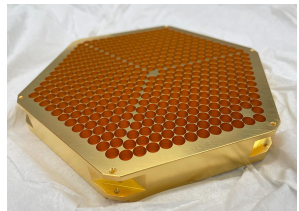
Bottom Screenshot (Google Drive): Shows the 'Test.xlsx' file selected in the 'CMB-S4 Team Drive' > 'Testing' > 'Team Folder'. The file details are shown: 'Test.xlsx' (7 KB, Last modified: Jul 12, 2022, 12:21 PM, Owner: admin AODocs). The 'Open File' button is visible.

We Are Working On Enhancements To Project Infrastructure





Technical Areas Continue To Accomplish Major Design Advancements



Wiring vacuum feedthrough

New 300K Electronics

DR frame

300K

50K

4K

4K SSA and addressing PCBs

1K

100 mK readout module

100 mK

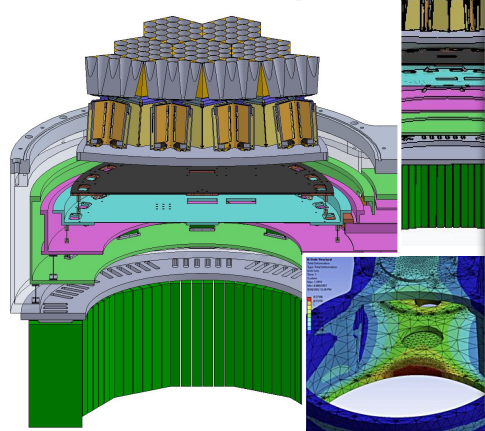
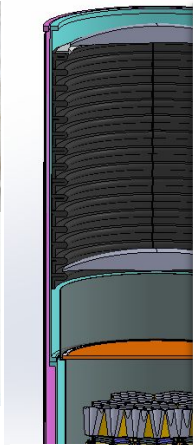
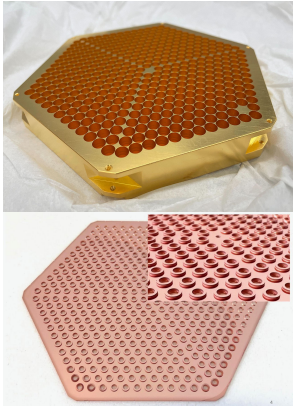
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Wiring looms

Wiring looms



Technical Areas Continue To Accomplish Major Design Advancements

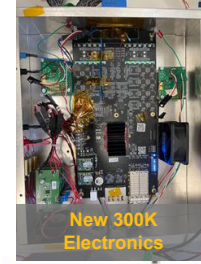
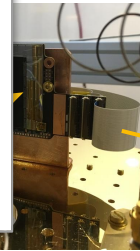
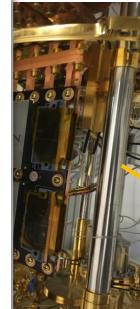


Validation of the CMB-S4 Preliminary Baseline Design
with Data Challenge 0

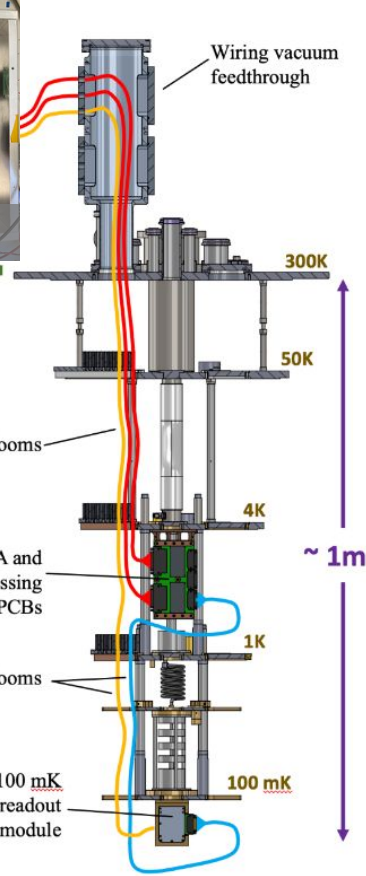
The CMB-S4 Collaboration

April 3, 2023

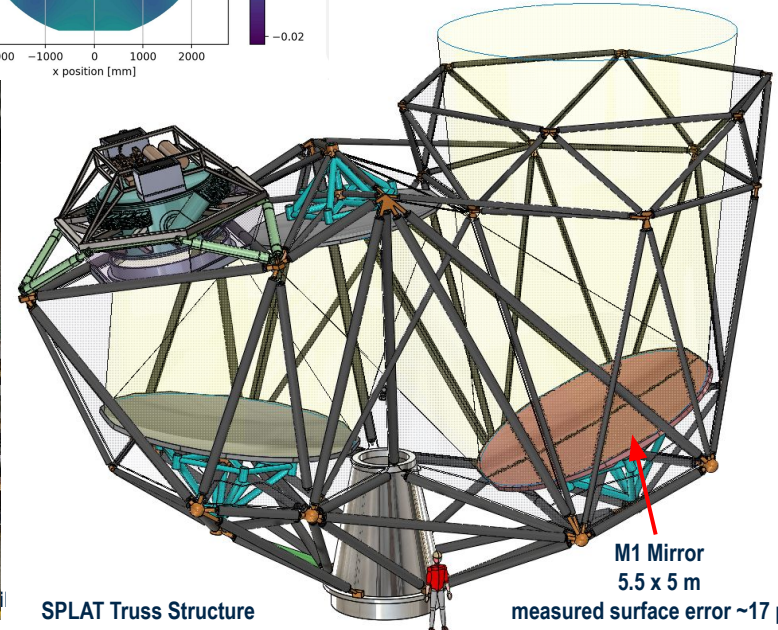
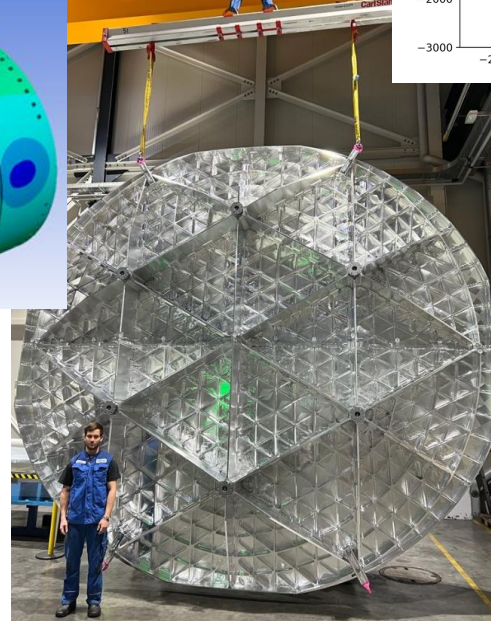
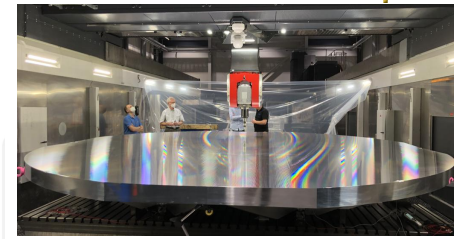
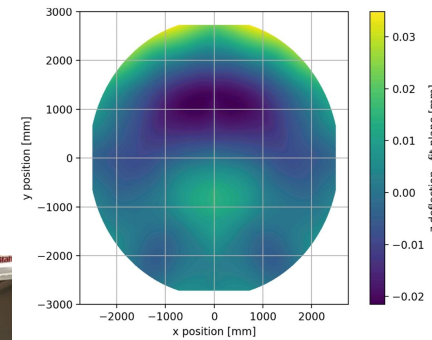
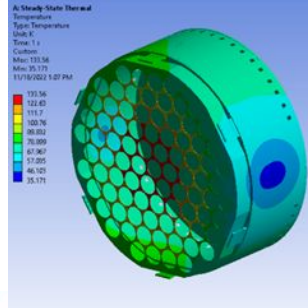
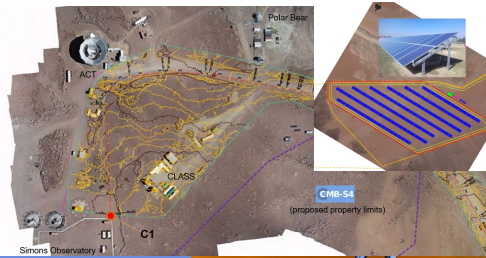
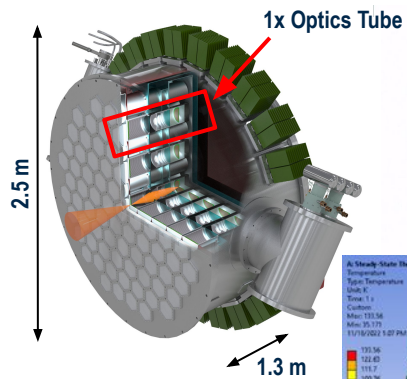
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DR frame

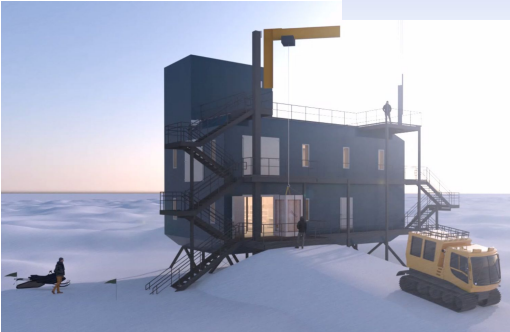


Technical Areas Continue To Accomplish Major Design Advancements



SPLAT Truss Structure

measured surface error ~17 μ m



Summary

- With major help from the Collaboration the project has generated a new proposed project baseline taking into account logistics constraints at the South Pole.
 - As a final step we still need to document the analysis of alternatives
- It is now time to transition back to a project-focused approach and prepare for a new review cycle based on funding agencies' guidance.
 - Ensure that our new project plan is sound
 - Ensure our requirements and interfaces are officially released and technically sound
 - Prepare for a new round of conceptual design reviews
- The project office utilized the AoA delay to build foundations for new project infrastructure and communication tools
 - Document control system, manufacturing database, reliability database, risk management database upgrades, new branding and newsletter
- **“Thank You” to the CMB-S4 collaboration and our dedicated project members for keeping the momentum going during uncertain times. Ongoing scientific and technical progress is essential for developing a robust project.**