CMB-S4 Project-Focused Workshop Intro

May 1, 2025

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Outline

- Workshop Goals
- Project Status and Plans – See my talk at the Collaboration Meeting a month ago.
- Funding Agency Situation
- Summary and conclusions

Objective and Plan for the Workshop

Overall Objective

Develop key aspects of the project to the level required for a successful NSF Conceptual Design Review, or at least to a level at which the path to finalization is clear and finite.

Overall Plan

Day 1: Interfaces between DOE and NSF scope and interfaces between NSF subsystems.

Day 2: Select engineering topics that apply to several subsystems and review site-specific topics.

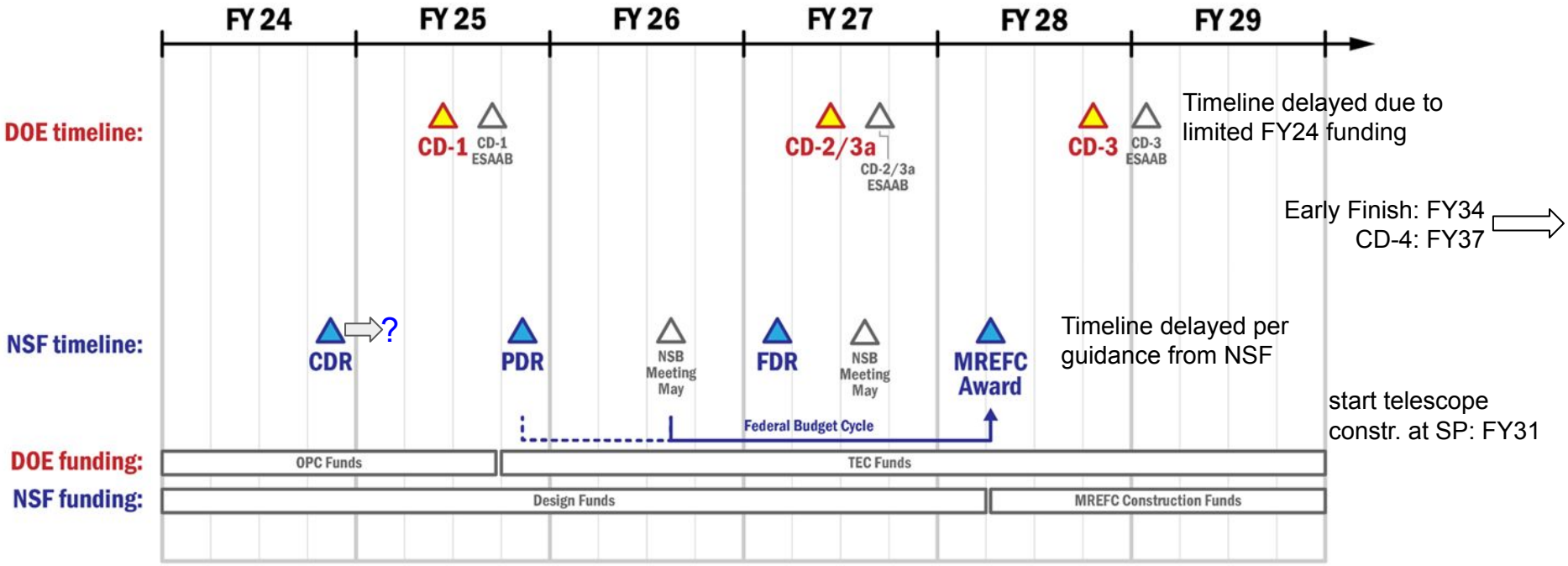
Day 3: Schedule, Risks, AoA and Wrap-Up.

Format

This is a *work*shop. Plenty of discussion and Q&A is encouraged. We should try to accomplish things together.

Updated Milestone Timeline

Based on actual FY24 funding; *"technically limited"* schedule starting FY25



- We have the resources to fully prepare for a CDR in 2024 (FY or CY).
  It is critical that we be prepared to successfully pass a CDR whenever it is scheduled.
- Expected funding limitations in FY25 will likely cause subsequent milestones to be delayed.
- Estimated increase in the total cost (DOE+NSF) for each year's delay is $40M - $60M.

CDR Requirements "Scorecard"
Essentially All The Required CDR Documentation Is Ready

Slide from Director's Review

see SC-8: Zivick

Research Infrastructure Guide, Section 2.3.1.1

Elements to be considered in an NSF CDR	How does CMB-S4 satify the requirement	Review Presentations
Technical requirements needed to meet the science that flow down from the science requirements.	CMB-S4 Design Report 2023[1] Chapters 1 and 2 and Appendix A; Requirements Database[2]	Plenary: Carlstrom, Ruhl, Besuner SC-1: All presenations
System-level design, including definition of all functional requirements and major systems	Design Report[1]; Requirements Database; Interface Control Documents[3], internal CDRs[4]	Plenary: Carlstrom, Strait, Leitner, Niemack, Arnold, Bender, Borrill SC-2: Crawford, Petravick SC-3: Emerson, Niemack, Nagy, Benson
Concept of operations including an estimate of annual operations and maintenance costs, staffing levels, and other activities	CMB-S4 Concept of Operations [5]	Zivick SC-8
Initial risk analysis and mitigation strategy, identifying enabling technologies, high-risk or long-lead items, and R&D needed to reduce project risk to acceptable levels	CMB-S4 Risk Management Plan [6] CMB-S4 Risk Register [7], Monte Carlo Contingency Simulations	Zivick SC-8
Initial acquisition plans, addressing unique project specific considerations, risks and uncertainties or R&D and design efforts that continue in the Construction Stage	Design Report[1], subsystem design documents. *Needs more work and better understanding of what is required.*	
Potential environmental and safety impacts to be considered in site selection.	Design Report[1]; Integrated Safety Management Plan[8]; Chile Site HS&E Plan[9]; Chile Site Environmental Impact Evaluation Report [10]; South Pole Safety and Health Plan [11]. *South Pole Environmental Evaluation not started.*	Plenary: Arnold, Bender, Peterson
Proposed construction project definition (scope of work, budget and schedule) needed to evaluate readiness and continue planning in preparation for the Preliminary Design Phase.	Design Report [1]; NSF Project Execution Plan [13]; P6 Resource Loaded Schedule; WBS Dictionary, Cost Book, and BOEs[12]	SC7: Jacobs SC-8: Leitner, Zivick
Description of proposed Educational Outreach and Broader Societal Impact, included in the proposed scope of work, budget & schedule.	Scope defined in NSF Continuing Design Proposal; *schedule for broader impacts to be developed*.	Zivick SC-8

CDR Requirements "Scorecard"
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Research Infrastructure Guide, Section 2.3.1.4

The AD will submit a memorandum to the Facilities Readiness Panel ... that explains ... how it satisfies the following criteria:	How does CMB-S4 satify the requirement	Review Presentations
The science program addresses one or more science objectives, clearly demonstrating a compelling need for the project;	P5 (2014) [14]; CMB S4 Science Case [15]; Astro 2020 [16]	Plenary: Carlstrom
The project has been reviewed by the research community and by NSF, in consultation with Directorate Advisory Committees, and has been assigned a high priority;	P5 (2014) [14]; A Strategic Vision for NSF Investments in Antarctic and Southern Ocean Research [17]; Astro 2020 [16]; Snowmass 2021 [18]; AAAC Annual Report 2023 [19]	Plenary: Carlstrom
The project's CDR indicates that:		
(1) the design and construction plans are defined at the conceptual design level and the management plans and budget estimates development, construction and operation are reasonable;	Design Report [1]; NSF Project Execution Plan [13]; P6 Resource Loaded Schedule; WBS Dictionary, Cost Book, and BOEs[12]; CMB-S4 Concept of Operations [5]	Plenary: Strait, Leitner SC7: Jacobs SC8: Leitner, Zivick
(2) the sponsoring Directorate endorses the Internal Management Plan (IMP) and Project Development Plan2 (PDP);	*Internal NSF process*	*Internal NSF process*
(3) the technology to create the facility exists or can exist shortly, and can be used without excessive risk;	CMB-S4 Technology Book [20]; Design Report [1]	All technical talks in the plenary and breakout sessions
(4) other risks to development are satisfactorily defined and minimized or otherwise addressed in the IMP,	CMB-S4 Risk Management Plan [6]; CMB-S4 Risk Register [7]	SC8: Zivick; All technical talks in the plenary and breakout sessions
(5) there are no better alternatives	Analysis of Alternatives [20]; CMB-S4 Study to Support the Alternatives Analysis and Selection [21]	Plenary: Carlstrom, Strait

References: CDR requirements "Scorecard"

[1] CMBS4-doc-716
[2] https://cmb-s4.jamacloud.com/perspective.req#/containers/17039?projectId=61 *
[3] https://docdb.cmb-s4.org/cgi-bin/private/ListBy?topicid=120 *
[4] https://indico.cmb-s4.org/category/5/ *
[5] CMBS4-doc-303
[6] CMBS4-doc-505
[7] https://cmb-s4.atlassian.net/jira/dashboards/10002 *
[8] CMBS4-doc-728
[9] CMBS4-doc-687
[10] CMBS4-doc-699
[11] CMBS4-doc-705
[12] https://cmb-s4.dash360.com/ *
[13] CMBS4-doc-608
[14] https://www.usparticlephysics.org/wp-content/uploads/2018/03/FINAL_P5_Report_053014.pdf
[15] arXiv 1907.04473
[16] http://nap.nationalacademies.org/26141
[17] http://nap.nationalacademies.org/21741
[18] arXiv:2211.09978
[19] https://www.nsf.gov/mps/ast/aaac/reports/annual/aaac_2023_report.pdf
[20] CMBS4-doc-1005
[21] CMBS4-doc-1004

*CMB-S4 login required

Interactions with NSF

Challenges remain, e.g.,

- OPP not yet engaged with CMB-S4 on South Pole logistical planning.
- Polar Journal article, which paints an extremely negative picture of the Antarctic infrastructure situation, continues to be used as an excuse to delay science.
- Challenging NSF FY 2024 budget means the 2nd year of our Continuing Design Cooperative Agreement will likely be less than the full proposed amount.
    - The NSF Research and Related Activities funding for all Science Directorates is down 6% in the FY 2024 appropriation.
    - We may not know the funding level for CMB-S4 for another 1-2 months.

Interactions with NSF

But there are some positive movements:

- New Acting Director of OPP: Jean Cottam. She was the Deputy Head of Physics and has strong background in astroparticle science.
- OPP has asked BICEP to plan for initiation of the construction of BART at the South Pole and a related plan to raise the MAPO laboratory building.
- Internal NSF Memo to enter CMB-S4 into the MF Design Stage is being actively iterated among MPS, GEO and the Director's Office (CORF). Once approved, a CDR can be scheduled. We are expecting CDR by end of CY24.
- There is pressure to recapitalize the LC-130 fleet:
  - Authorization legislation passed – but not appropriations yet.
  - Letter from Senators Schumer and Gillibrand to the Secretary of the Air Force: "we urge you to prioritize the recapitalization of the LC-130 fleet."
  - "Dear colleague" letter circulating in the House also supports recapitalizing the LC-130 fleet.

Interactions with DOE

DOE leadership (Gina Rameika, head of HEP, and Harriet Kung, Acting head of the Office of Science) continue to support CMB-S4.

- Gina met with Denise Caldwell (acting head of NSF/MPS) last week to work on moving CMB-S4 forward.
- DOE is looking for confirmation that NSF is on board, particularly regarding access to the South Pole.
- However, they are being cautious about investing in CMB-S4 until they are convinced that NSF will move forward with them.
- We will brief Gina Rameika and Mike Procario tomorrow on a schedule option that could allow us to start to deliver science as early as possible, with a light initial logistical footprint at the South Pole, and that keeps us on track to deliver the full CMB-S4 configuration and science capability.

Interactions with DOE

- FY 2024 funding is tough:
  - Final funding for FY24 is $4.5M.
  - This is substantially less than the budget guidance of $10M that we had been given up until November 2023.
  - We carried over $5.5M into FY24 from the IRA funds, and plan to carry over $1.5M into FY25 (the minimum to assure continuity during likely CR)
  - Thus our total available funding in FY24 is $8.5M vs the original plan of $14M
- We have adjusted the project plan to fit within this reduced funding and still make progress. Focus is on CDR readiness; CD-1 readiness delayed.
  - We have informed DOE of the consequences of this reduced funding on our ability to make progress.

Interactions with DOE

- FY 2025 funding is potentially difficult.
  - The President's Budget Request for CMB-S4 is $4.5M, to which we will add $1.5M to be carried forward from FY 2024, for a total of $6M.
  - Of course, the PBR is just the start of the process; the final word comes from the Congressional appropriations bills, which we can work to influence. See below.
  - We are developing plans for how to best adapt to this FY 2025 funding level.
  - In Lab budget briefings in April, we made DOE/HEP aware of the impacts to the progress of CMB-S4 if this becomes the FY 2025 funding level.
  - We also advocated to DOE/HEP that funding of *at least* $12M in FY 2025 is needed to keep the Project moving forward.

HEPAP

- HEPAP meeting next week has a number of potentially important agenda items:
  - DOE perspectives on the P5 report - Regina Rameika (DOE/HEP)
  - NSF perspectives on the P5 report - Saul Gonzalez (NSF/MPS/PHY)
  - The South Pole Infrastructure - Jean Cottam Allen (NSF/GEO/OPP)
  - Report from the DOE Facilities Subpanel - Natalie Roe (LBNL)
- Several members of CMB-S4 leadership will be at this meeting to interact with the funding agency people and participate in the discussion sessions, particularly the one that follows Jean Cottam Allen's presentation.
- We have discussed with the Chair of HEPAP the possibility a presentation at the next meeting on South Pole issues from the viewpoint of the experiments, jointly with SPO, IceCube and perhaps others.

How are we addressing these challenges?

- Continuously remind the funding agencies of the high priority of this science – so they know why to support it and the scientific consequences if they do not.
- Continuously remind them of the advanced state of project planning.
- Make clear to the funding agencies what funding we need to keep moving forward.
- Continue to emphasize our readiness to work with OPP and the flexibility of our plans to fit within their constraints.
- We are working with our congressional delegations and institution government affairs liaisons to ensure that the challenges with South Pole Infrastructure and Logistical Support and their impact on science are understood at the highest levels.

How are we addressing these challenges?

- Periodic briefings for Congressional staff regarding CMB-S4, jointly organized by LBNL and UChicago Government Relations offices. The next set of briefings are being planned now. We will advocate for funding for CMB-S4 well above the PBR level.
- CMB-S4 participated in April APS and AAS congressional visits in April. The official APS/DPF “Ask” was to support:
  - The P5 priorities, including specifically CMB-S4;
  - $1.385B for DOE/HEP (vs. $1.200B FY24 enacted and $1.231B in the FY25 PBR);
  - $11.9B for the NSF (vs. $9.06B FY24 enacted and $10.183B in the FY25 PBR).
- Questions from congressional staff during the visits have been collected and responses are being prepared.

Summary

- CMB-S4 has made excellent technical progress, as recognized the the Director's Review.
- P5 recommends CMB-S4 as the highest priority new project for HEP.
- The Project planning puts us in an excellent position for a successful NSF CDR and later a DOE CD-1 Review.
- There is progress toward NSF placing CMB-S4 in the Design Stage, which will lead to scheduling a CDR.
- Change in leadership of OPP may lead to more effective implementation of the needed infrastructure recapitalization and to more engagement with us and other South Pole experiments.
- Federal funding is very challenging; but we are doing all we can both to manage within the constraints and at the same time to remove (or at least improve) the constraints.