Road to down-select: Process & Timeline

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Overarching Goal: Get to CD1

CD-1 is in April 2021

Baseline Design Document → Conceptual Design Report

- Detailed design of end-to-end system
  - Mechanical, electrical, thermal
- Key system parameters & their requirements

Will need significant **community involvement** to complete this (much more detail than the DSR).

CD-1 – Approve Alternative Selection and Cost Range

What is the function of CD-1?

CD-1 serves as a determination that the selected alternative and approach is optimized to meet the mission need defined at CD-0. Key elements of the evaluation are the project's conceptual design, cost and schedule range, and general acquisition approach. The cost range allows for uncertainty in the estimates and scope options such as a range of capabilities.

What is a project expected to prepare for CD-1 approval?

- An analysis demonstrating that the proposed alternative is the correct one.
- A complete and independently reviewed conceptual design of a chosen alternative and associated cost and schedule range estimates. Typically the design is described in a Conceptual Design Report (CDR) and cost and schedule are supported by a resource loaded schedule and a collection of supporting information called "Basis of Estimate" (BOE) documents.
- A funding profile (time phased funding plan) that is compatible with the project's expected spending over time.
- Management plans including an Acquisition Strategy, Preliminary Project Execution Plan, Preliminary Hazard Analysis Report, Quality Assurance, Risk Management Plan, and a Risk Assessment.
- National Environmental Policy Act (NEPA) strategy and determination, i.e. whether a formal environmental assessment or impact statement is appropriate.

What impacts does CD-1 approval have on a project?

CD-1 allows for release of Project Engineering and Design (PED) funds, if available, for large projects and may allow for long lead procurements if specifically approved. Projects begin the next phases of design (preliminary design and perhaps final design for some elements) and development of a detailed resource loaded schedule. R&D and prototyping continue.

Experiences of others

"Down-selects are never easy as someone always loses. One can try to make it based on performance, but generally we are good at designing well to meet specifications. XX was a technical/schedule decision, YY has dragged on and on, and ZZ was largely political".

"First and foremost, all contenders must demonstrate that they can satisfy science requirements. This is blindingly obvious but should be checked off item by item if for no other reason than to document the margins. And we shouldn't forget about stretch goals, not only in obvious things like resolution but also external conditions."

"XX vs YY was a down-select where management overruled the [collaboration] "wise people" [committee]. It could have fractured the community but luckily did not. Choose your wise people wisely if the collaboration already has a strong inclination where it wants to go."

"Our solution set a long-term cultural approach which stuck with the collaboration throughout its lifetime: an internal independent "wise-person" committee was formed by the Technical Board to conduct a review process looking at the merits, physics performance and risks of each of these systems… this process had sufficient integrity that the collaboration as a whole bought into the outcome, and the proponents of Option A stayed with the experiment and joined the Option B effort in a way that significantly enhanced the successful completion of the instrument."

We went through CD1 without making a decision...

"In projects I have been involved with, there was never a formal down select process. Basically the L2 made the choice."

"Sometimes, having control over resources can be crucial to the decision. I have seen cases where someone basically said "There is money in my wallet to build X, but I will go home if you choose Y". If there is any chance of this, some really really wise men and women have a lot of work to do before any technical down-select can proceed."

Different Methods for Decision Making

Voting

Consensus

Can we reach technically-backed consensus?

Smoke-filled back room

Framing the Question

What is at stake?

- Quality of scientific data collected (instrument sensitivity & systematics).
- Functionality of the instruments (can it get cold, is it easy to work with)
- Cost and schedule
- Intellectual engagement of the community

Who are the stakeholders?

- Scientific collaboration
- Project
- Agencies
- Taxpayer

What are the different perspectives when looking at the down-select?

- Science outcome driven
- Technology outcome driven
- Project (planning) driven

Tools & Process

Tools:

- Weighted-metric evaluation

Reviews:

- December assessment
- Detectors, Readout, & Testing Advisory Committee Meeting
- Down-select (internal) & Presentation to external review

Tools: December Assessment

Proposed Charge:

1) Evaluate whether a complete and sufficient process for metric based down select exists and make recommendations for modification as necessary
    a) Are the chosen metrics adequate to defend future down-select choice in a CD-1 level design review.
2) Can projected performance at the scale of CMB-S4 be reasonably assessed at this stage? Are any required extrapolations well motivated? Are there any areas where significant R&D would drastically change the performance or readiness of any of the three technologies?
3) Does the current R&D plan sufficiently capture the effort required to get to CD1 once a decision has been made?
4) Does the cost and schedule have sufficient contingency for the current risks?

Proposed Format:

- Primarily internal panel with a couple of external experts?

Down-select Decision

Metric	**Value/measure**	**Margin/error bar/risk**	**Weight**
Performance (Science requirements)			Highest weight
Performance (Engineering)			
Cost			Less weight than performance
Schedule			Less weight than performance
Execution			

Performance (Science Requirements)

Metric	**Value/Measure**	**Margin/error bar/risk**	**Weight**
White noise level			
Low-frequency noise level (0.1-1 Hz)			
Electrical crosstalk between channels			

Performance (engineering)

Metric	Value/Measure	Margin/error bar/risk	Weight
Cryogenic heat loads	Mux factor could in principle go here, but should be able to easily engineer away		
Room temp electronics power			Unless significantly prohibitive, should encourage sites to meet needs

Cost

Metric	Value/Measure	Margin/error bar/risk	Weight
Screening Yield: (how many components do you have to pre-screen to fill the required number)	Based on a simple accept/reject for entire chip.		
Operable yield Yield: For monolithic components that that connect to multiple detectors (accepted after pre-screening), how many are operable	How much does yield have to be reduced to have realistic amount of fabrication & pre-screening?		
Mux multiplier			
Total Readiness Level (TRL)			

Schedule

Metric	Value/Measure	Margin/error bar/risk	Weight
Component fab times			
Screening Yield			
Operable Yield			
Mux Multiplier			
Total Readiness Level			

Execution

Metric	**Value/Measure**	**Margin/error bar/risk**	**Weight**
Fall-back option development?	If a backup is needed, how much $$ is needed to develop it to be reasonably advanced option?		
Programmatic alignment?	Does CMB-S4 derive value from other programs		

Additional information for readout input

(Relevant audio frequencies)--> scan speed of telescopes

Detector time constants

What are the currently assumed fab tolerances on Tc, Rn, time constants?

Systematics:

- In standard noise picture, is readout noise sufficiently gaussian and averages down as expected? What level of non-gaussianity impacts r measurement? Are there other sources of irreducible noise?

Proposed Timelines

- Readout assessment December 2019
- Detectors & readout annual status review: April 2020 (recommendation from detector fab review)
- Down-select decision: June 2020
- External review: July 2020
- CD1: April 2021

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