R&D Funding Request

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Fermilab Meeting

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R&D Activity Plans Fall 2018

- 3J's called for R&D activity plans in Fall 2018. This resulted in a funding request to DOE summarized on next slides.
- R&D is focused on pushing development of promising technologies to the level required for S4.
- As we move through the approval process we need to document the technical options and choices, demonstrate that the ones we choose meet the project requirements and represent a cost effective approach.
- Flow-down of science requirements to technical requirements and specifications will inform this process.

Funding Request April 2019 - September 2021

Activity Plans were combined into one document. Detailed plans are on the S4 Wiki: https://cmb-s4.org/wiki/index.php/Activity_Plans

Request was submitted in Feb. 2019
Progress and spending will be tracked as project funds

Table 2. DOE Funding Request ($M)

	2nd Half FY2019	FY2020	1st Half FY2021	2nd Half FY2021
R&D Activities	**2.97**	**8.08**	**5.12**	**8.00**
Detectors and Readout	1.90	6.10	4.20	7.00
Data Management	0.28	0.55	0.28	
Ground Pickup, Sidelobes, Beam Systematics	0.26	0.52	0.27	
Cold Optical Elements	0.21	0.42	0.21	
Large Aperture Telescope Cryostat Design	0.12	0.26	0.17	
Small Aperture Telescope Cryogenics	0.20	0.20	0.0	

R&D Request April 2019 - Sept. 2021: Detectors and Readout 14.2M$ addresses highest risk to the project

- Detectors and readout are the project critical path, and were identified in the Dec. Review as the highest risk to the project
- Funding request included Milestones for tracking progress

Critical R&D Milestones included in R&D request

- Oct. 2019 Comparison of RF coupling schemes
- April 2020 Prototype Design S4 90/150 pixel/wafer
- April 2020 Multiplexing options (fMUX and uMUX) demonstrated on S3 wafers
- Oct. 2020 Characterize prototype S4 module (S4 wafer and components)
- April 2021
  - Compare fMUX and uMUX readout on S4 wafer
  - Demonstrate Fab throughput on four modules

DSR Review (Dec 2018) Schedule: The Cost and Schedule driver for the project is the Detector Fabrication

End date came out to be Feb. 2028. We are looking for ways to speed it up

Project Milestones	Now – April 2021 Pre-conceptual R&D and Design Dev	
MS000	Directors Review - Washington Dec	11-Dec-18*
MS001	R&D Proposal to DOE & CDR Proposal to NSF	21-Dec-18*
MS002	Initial Input to the Decadel Survey	29-Mar-19*
MS003	L1 - CD0 Approval	01-Apr-19*
MS004	NSF CDR Review	30-Sep-19*
M0007	L2 D&R - Detector and Readouts Preproduction START	01-Apr-21
MS006	L1 - CD1/3A/ NSF PDR Approval	01-Apr-21*
MS008	L1 - CD2/3B NSF FDR Approval	31-Mar-22*
MS009	L2 LAT - LG Telescopes Design Complete	13-Jul-22
MS010	L2 D&R - Detector and Readouts Production START	15-Feb-23
MS011	L1 - CD3 Approval	29-Sep-23*
MS012	L2 Sites - South Pole logistics base ready for telescope commissioning	01-Nov-23
MS014	L2 LAT - Pre-ship review complete ready for LG Tele 1 to SHIP to Pole	19-Mar-24
MS013	L2 Sites - Chile permission for major construction granted	01-May-24
MS016	L2 LAT - LG Telescope #2 to SHIP to Chile	10-Sep-24
MS015	L2 Sites - Chile ready for telescope installation	24-Oct-24
MS017	L2 Sites - Accept LG Tel #1 from contractor	09-Jan-25
MS019	L2 LAT - LG Telescope #3 to SHIP to Chile	07-Mar-25
MS020	L2 D&R - Detector and Readouts Production Complete	23-Dec-25
MS018	L2 SAT - First SAT 1 Ready to Ship	06-Feb-26
MS021	L2 LAT - Accept Cam #1 in US Complete	19-Feb-26
MS022	L2 Sites - Camera #2 Arrives at Pole	06-May-26
MS023	L2 I &C - LG Telescope #1/Camera #2 Commissioning Complete at Pole	29-Jan-27
MS024	L2 DM - Challenge Milestones Complete	13-Sep-27
MS025	L2 I&C - LG Telescope #3/Camera #3 Commissioning Complete - Chile	10-Feb-28
MS026	L1 - CD4 Approval, Start of Operations	26-Jan-29

~2 years

~2 years pre-production

~3 years production

~2 years assembly, test, deploy

R&D request (cont.) : DM 1.1M$, Beams 1M$, Cold Optics 0.8M$, LAT Design 0.9M$, SAT cryo 0.4M$

Goal is to inform design choices for S4 Baseline prior to CD-1

- **Data Management R&D** will develop simulations of the instrument systematics to inform design choices and provide and initial demonstration of data processing at scale
- **Ground pickup, Sidelobes and Beam systematics R&D** will optimize the optical design, baffling and shielding and develop technical specifications using simulations tools from the DM R&D
- **Cold Optical Element R&D** will determine the most promising technologies and provide a production plan to reduce cost and schedule uncertainty
- **Large Aperture Cryostat Design R&D** will optimize pixel spacing, optics tube diameter and detector wafer configuration
- **SAT Cryo R&D** will test the capacity of the proposed S4 cryocooling system

Next Steps

- Work with DOE to motivate funding the R&D request
- Once we receive funding we will likely need to re-evaluate priorities and schedule
- Continue to encourage development of requirements: how we decide R&D is complete = ready to go into production
- Meanwhile some Detector R&D is in progress with other funds (LDRD, Early Career, etc.)
  - Plan to meet monthly to discuss progress
  - Tentative date April 4th Thursday 11-12 Central

https://fnal.zoom.us/j/7478573072 (brennazoom)