

LARGE SYNOPTIC SURVEY TELESCOPE

NSF Monthly Progress Report

May 2019

For the period of performance April 1-30, 2019

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Submitted by: Association of Universities for Research in Astronomy (AURA) 1212 New York Avenue NW Suite 450 Washington, DC 20005 Technical Contact:

> Victor Krabbendam, Project Manager vkrabbendam@lsst.org (520) 318-8482 (520) 881-2627

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Report-676

Table of Contents

In	troduc	tion	3
1	Pro	ject Status	3
	Ove	erview	3
	Saf	ety	4
	Qu	ality and Compliance	4
	Site	e Activity	4
	Do	ne Activity	4
	Tel	escope and Site Subsystem	5
	Dat	a Management Subsystem	5
	Car	nera Subsystem	5
	Edu	Ication and Public Outreach	6
	Ne	ar Term Events and Meetings	6
2	Cui	rent Photos	8
3	Pro	ject Integrated Schedule1	1
	3.1	Critical Path1	2
4	Fin	ancial Summary and Projections1	3
	4.1	Brief Narrative1	3
	4.2	Funding Profile Table1	3
	4.3	Top Level Earned Value Management (EVM) Data Table and "S" Curve	3
	EV	Summary of the Project Down to Level 2 of the Work Breakdown Structure (WBS)1	5
	4.4	WBS Sub-System Level EVM1	5
	4.5	Schedule Variance (SV) and Cost Variance (CV) Trend Graph1	6
	4.6	Discussion of Variances and Corrective Actions1	7
	4.7	Obligations as of 28 February 2019 2	8
5	Ris	k Management	0
	5.1	Brief Narrative	0
	5.2	Liens on Budget Contingency	1



	5.3	Budget Contingency Allocations	
6	Crit	cal Path Plots	Error! Bookmark not defined.
7	Det	ailed Project Progress Status	
	Proj	ect Office	
	Syst	ems Engineering (SE) and Commissioning	
	Tele	scope and Site (T&S)	
	Can	nera	
	Data	a Management (DM)	
	Edu	cation and Public Outreach (EPO)	



Introduction

This technical progress report summarizes LSST activities for April 2019 accomplished with National Science Foundation (NSF) funding under Cooperative Support Agreement (CSA) award number AST-1202910 for construction of the Large Synoptic Survey Telescope (LSST) under the NSF Major Research Equipment and Facilities Construction (MREFC) account. The governing Cooperative Agreement (CA) for this effort is 1258333. This report is focused on the NSF construction effort but includes descriptions of work completed with Department of Energy (DOE) funding through contract DE-AC02-76-SF00515 with Stanford University. LSST is managed as a single coordinated effort. Descriptions of work completed with DOE funding are noted in *italics*, but no DOE-funded work is included in the report's financial data.

Document references in the text below indicate the documents' "handles" in the Project document archive, DocuShare. LSST's NSF Program Officer has access to the web-based, password-protected repository. Others may obtain access by contacting the LSST Project Manager.

1 Project Status

Overview

Project earned value (EV) toward the MREFC effort rose \$2.7 million this month to a calculated \$304.5 million. The cost variance (CV) changed -\$1.8 million this month to -\$7.9 million, and the cost performance index (CPI) dropped to 0.97. The schedule variance (SV) changed by -\$2.6 million to -\$5.0 million, which equates to a schedule performance index (SPI) of 0.98. There were 15 project controls change requests (LCRs) implemented this month; 11 had an impact on cost or schedule, resulting in a net contingency draw of \$1,162,866. As of the end of the month, the Project has allocated 64% of the total contingency to the baseline through the change control process. The remaining contingency of \$29.6 million is 22% of ETCl¹ (ETCl=BAC-BCWP²) and 21% of ETCII (November 2018 bottom up).

There are 48 control accounts beyond the plus/minus \$100,000 reporting threshold contributing to the cost variance. The Dome Fabrication contract is the current largest cost variance at -\$2.2 million. The variance increased by approximately \$750,000 this month as payment was made on a change order for which contingency has yet to be applied. The change order covered the cost of requirements changes for louvers and related structures. Also contributing to the overall CV are the expenses being paid directly by LSST to onsite vendors, principally crane vendor SIMAQ and erection labor support from MILL. There are 18 control accounts with a reportable schedule variance. The primary contributor is the 1.02C.08.03 Long-Haul Networks work breakdown structure (WBS) element at \$3.9 million. This large schedule variance is due to the early delivery of the 100G ring operating at 98% availability with the Miami to Boca Raton diverse fiber path and spectrum link from Sao Paolo to Boca Raton. These payments were planned in fiscal year 2019 (FY19) and will be corrected via an LCR to keep this positive schedule from skewing cumulative earned value metrics.

LSST management and AURA continue to address Dome and Telescope Mount Assembly (TMA) schedule issues. Even with the recent schedule adjustment made through LCR-1623, the TMA schedule is now

¹ Estimate to complete

² Budgeted cost of work performed



Report-676

forecasting 58 days later than recently baselined due to disassembly delays. The Project is working constantly with the vendors to improve the delivery efforts and has sketched out full system integration plans that will keep the overall schedule within the prescribed construction period with contingency but many details are being finalized so baseline changes can be proposed.

Safety

LSST Safety activities focused on oversight at work sites, in particular the summit, the hotel expansion and the base facility. LSST Safety personnel also prepared for safe delivery of M1M3 (Primary-Tertiary Mirror) from the Port of Coquimbo to the Summit Site. In addition to ongoing safety orientation for LSST and contractor employees, the Safety team instituted a new Safety Rules campaign. Safety Rules are intended to provide a guide for regulations and project standards in areas of critical risk. The first Safety Rule regarding assembly, disassembly and modification of scaffolds was disseminated over two weeks. English and Spanish language versions of the rules are archived in LSST's document repository. Two accidents were reported in April. An LSST employee lost control of his vehicle while driving to the summit site and went over the berm and down the slope. He was uninjured. Another accident happened with the Camera work in France. See Camera section below for details.

Quality and Compliance

The Compliance and Quality Administrator (CQA) continued collaboration with the Information Security Officer (ISO) on a draft update to the LSST Information Classification Policy (LPM-122). A change request will be submitted in May. A procedure to supplement the updated changes is in progress. In addition, the CQA provided guidance on travel, information classification and personally identifiable information (PII) compliance.

Site Activity

The project sent the final signed contract termination documentation to Summit Facility general contractor Besalco, and the balance of the remaining retention was sent 30 April, officially ending this effort. The Besalco work was completed earlier this year, but this final administrative step followed months of LSST staff completing a comprehensive review of all delivered documentation. Other summit site efforts this month resulted in completion of welding activities, completion of the Pflow contract, substantial completion of the summit warehouse to receive M1M3 and continuation of the Pachón hotel addition. The team successfully completed Pflow vertical lift system final acceptance testing, including software debugging and carriage load testing at 25%, 60% and 100% (i.e. 85,600 kg) payload mass. Five repetition cycles were performed with the Pflow field service technician, including interfacing to the movable roof and testing of emergency stops. This is a major milestone. By the end of April, the summit warehouse was sufficiently completed for arrival and storage of M1M3 (Primary-Tertiary Mirror), which is in transit and due in early May. The seismic anchoring system design was completed. It will utilize concrete anchors and strapping to secure the transport box. The team anticipates the Pachón hotel fourroom addition will be completed in July. A change order for additional excavation and concrete foundation work was approved.

Dome Activity

Five members of the Telescope and Site (T&S) hardware and software teams met with Dome vendor European Industrial Engineering's (EIE) senior engineers and management. The objective was to review

LARGE SYNOPTIC SURVEY TELESCOPE

Report-676

the overall assembly sequence, to assess the level of dome control system development, to review the current logistics and shipping plans, and to visit and inspect the status of supply chain fabrication. LSST and EIE negotiated and completed a final round of change requests to incorporate design changes and to assist with timely acquisition of remaining hardware components. These negotiations should stabilize EIE cash flow and resume remaining supply chain activities. In Chile, an additional summit engineer was hired to assist the on-site team with work planning and steel assembly sequence preparation. Chilean vendor Faremin has fabricated and delivered all the remaining roof steel and missing purlin pieces. They are ready for EIE to install. This month EIE continued to focus on remaining structural steel, adjustment of the main support columns and erection of pieces for the main dome platform. Nearly all the vertical purlins were installed around the dome. Cladding is scheduled to begin in May. The project continues to seek ways to advance scheduled work on the summit, but approaching winter weather conditions, i.e. high winds, present challenges for the schedule.

Telescope and Site Subsystem

LSST and TMA vendor representatives met in Chile to hold an onsite assembly, integration and test plan review. LSST also met with the crane vendor's technical agents to understand the requirements for all staging and critical lifts. Minor summit platform modifications will be made to increase laydown area and support crane staging. TMA system packaging continued in Spain. The oil supply system was loaded and shipped in April. Three shipping containers with the two mirror carts and mirror cover components arrived in Chile, were unloaded and stored at the AURA property gate. The overall TMA disassembly and shipping schedule is slipping, which will negatively affect the overall assembly integration and verification (AIV) workflow schedule. Updated schedules are due in May to assess this impact. LSST management is watching this closely as more delays will require further adjustment to the AIV workflow and activities. The TMA software review has been rescheduled for early June to accommodate LSST participation and to enable additional development progress.

Data Management Subsystem

The Data Management (DM) team held a successful LSST Science Platform (LSP) review with a nine-person panel representing a cross-section of LSST stakeholders. DM team members provided presentations and demonstrations, which were well received by the committee. The reviewers made a number of valuable recommendations.

A number of critical updates to DM software and services were released. In particular, the Firefly system has been updated to behave properly when a VOTable with International Virtual Observatory Alliance (IVOA) Observation Data Model Core Components (ObsCore) information is displayed, enabling image display if the correct metadata is included in the VOTable table entry. Important upgrades also were made to the Science Pipelines. Critical among these is the across-the-codebase adoption of the modernized, spatially-variant "PhotCalib" system for representing photometric calibration information. Lastly, having received telemetry data from the M1M3 subsystem simulator, the team was able to benchmark the DM engineering facilities database (DM-EFD) implementation. The results show the team is very close to achieving the level of performance that will be required on the summit.

Camera Subsystem

A serious injury accident 11 April at Laboratoire de Physique Nucleaire et des Hautes Energies (LPNHE) has delayed integration of the carousel with the Camera back flange. Carousel work is on hold while the





Report-676

incident is investigated and corrective actions taken. The injured individual required arm surgery but is recovering rapidly. The project expects the incident will impact the carousel schedule by about two months; however, the carousel delay is not expected to impact Camera early delivery.

While attaching the L1 lens to the L1-L2 assembly, the Optics team discovered a minor non-conformance on the L1 radius of curvature due to a gravity sag sign error at time of initial acceptance. After investigation, the project confirmed the issue can be fully addressed with no performance impact by adjusting the distance between the L1-L2 assembly and the L3 lens.

Phased-delivery of refurbished Raft Tower Modules (RTMs) to SLAC continued with five having been delivered by mid-April. Re-verification revealed issues with three of them, but those issues are being resolved. Corner RTM (CRTM) acceptance testing has begun and is expected to be completed on-schedule in July. Thales SESO (TSESO) completed polishing of the i-band filter glass, which was shipped to Lawrence Livermore National Laboratory (LLNL) for evaluation and test-fitting in its mount. Materion completed coating the r-band filter and expects to begin qualification testing soon. Early results have confirmed that the filter coating was successful. The Filter Exchange team in France continued construction of production components. The first units of the two loaders and two auto-changers have been completed, and testing is underway. The Camera body shroud has been delivered. Assembly of the production shutter will be delayed due to long lead time for delivery of the shutter blade guides, which are custom made by a vendor in Japan. The shutter delay will not impact Camera schedule or cost.

The Integration and Test (I&T) team completed initial testing of the bench for optical testing (BOT) electrooptical (EO) instrumentation. The testing showed that cold-system and cryo-system refrigeration circuits supported by the first I&T heat exchanger vacuum canister attached to the BOT meet design requirements. A second I&T heat exchanger canister was attached to the BOT but kept offline. It will support the additional cryo-system refrigeration circuits required for BOT EO final testing, which I&T expects to begin in early May. Successful completion of final EO testing clears the way for the integration of production RTMs with the cryostat, which I&T expects to begin in the second quarter of 2019.

Education and Public Outreach

The Education and Public Outreach (EPO) team held several educator user testing sessions to support ongoing development of formal education investigations. The team continued to transcribe the StoryTime Domain videos collected at the LSST2018 Project and Community Workshop and began planning a video with the clips. The team also began initial phases of planning for Alert Stream web displays.

Near Term Events and Meetings

A formal list of Level 1 milestones is provided in Section 3. Below is a list of key items on the Project Manager's watch list for the next few reporting periods.

- AURA Member Representatives Meeting 30 April-2 May
- Community Broker Workshop 19-21 May
- LSST@Asia 20-24 May
- American Astronomical Society (AAS) Meeting 9-13 June
- Director's Review for NSF/DOE Joint Status Review (JSR) 6-9 August
- LSST2019 Project and Community Workshop 12-16 August



Report-676

• NSF/DOE JSR – 27-30 August



Report-676

2 Current Photos



The team successfully completed Pflow vertical lift system final acceptance testing, including software debugging and carriage load testing at 25%, 60% and 100% (i.e. 85,600 kg) payload mass. Five repetition cycles were performed with the Pflow field service technician, including interfacing to the movable roof and testing of emergency stops. This major milestone completes the Pflow contract.



Dome vendor European Industrial Engineering (EIE) has installed nearly all the vertical purlins around the dome. Cladding is scheduled to begin in May.



Report-676



The Primary-Tertiary Mirror (M1M3), the M1M3 vacuum lift and other support materials were loaded onto the BBC Manitoba 2 April in Houston, Texas. The BBC Manitoba left Houston on 7 April. The voyage to Chile is expected to take four to five weeks.



Vendor REOSC successively completed broadband anti-reflective (BBAR) coating of the LSST camera's L3 lens and returned L3 to Thales SESO (TSESO) for inspection. The Optics team determined the lens meets project requirements.



Report-676



The previous two photos provide recent views of the SLAC IR2 cleanroom facility where the LSST camera will be assembled. The top photo shows the bench for optical testing (BOT) in the foreground, behind the work platform. The two Integration and Test (I&T) heat exchanger canisters installed on the BOT are identified with callouts. The heat exchanger canisters support cooling of cold- and cryo-system refrigeration circuits. Cold-system circuits cool raft electronics; cryo-system circuits cool the Camera focal plane. From the opposite angle, the bottom photo shows the cryostat housing in the foreground, sitting on an assembly work bench. Beyond that, technicians work on assembly of the Camera integration stand, which will cradle the Camera during construction.



Report-676

3 Project Integrated Schedule

Efforts toward the two remaining Level 1 milestones this year are progressing well. The M1M3 segment will be on site in May and the cell in June or July depending on ship schedules and local road permitting in Chile. LCR-1729 was implemented this month to update the M1M3 cell shipment dates. As a result of this LCR, the M1M3 On site baseline date changed to 17-Jul-19, a 17 day delta from the previously baselined date. As discussed previously, the notion of Software Release 9.1 was changed when Data Management was replanned, but these milestones names have not been changed. The software capability for the pipelines is in-keeping with the hardware need dates, so this formal Level 1 milestone is functionally on schedule.

Level 1 Milestones

FY2015	FY2016	FY2017	FY2018	FY201	19	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025
FQ4 FQ1 FQ2 FQ3	3 FQ4 FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 F	Q3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4	FQ1 FQ2 FQ3 FQ4
🎗 Nominal	Start of NSF M	REFC Fundi	ng								
\$	Dome Contract	Start									
	Mountain - Ba	se Network	Functional	1 Gbps	5			•			
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									Start of FL	III Science (perations

Level 1 Milestone Change Tracking

Activity Name	Baseline Finish	Previous Month Finish	Forecast / Actual Finish	Delta From Baseline	Delta From Previous Month	Total Float
Nominal Start of NSF MREFC Funding	1-Aug-14	01-Aug-14 A	01-Aug-14 A	0	0	0
Dome Contract Start	4-May-15	04-May-15 A	04-May-15 A	0	0	0
Mountain - Base Network Functional 1 Gbps	2-Jun-15	01-Jun-15 A	01-Jun-15 A	-1	0	0
Archive Site Ready for Equipment Configuration	29-Sep-15	01-Oct-15 A	01-Oct-15 A	2	0	0



Report-676

OCS Scheduler Available	24-Feb-16	15-Feb-16 A	15-Feb-16 A	-7	0	0
Coating Plant Contract Start	1-Mar-16	01-Mar-16 A	01-Mar-16 A	0	0	0
Lower Enclosure Ready for Dome	5-Oct-16	14-Oct-16 A	14-Oct-16 A	7	0	0
Award Base Facility Contract	17-Jan-17	20-Mar-17 A	20-Mar-17 A	43	0	0
EPO Acceptance Review	29-Sep-17	28-Sep-17 A	28-Sep-17 A	-1	0	0
Summit Facility Full Occupancy	13-Nov-17	01-Mar-18 A	01-Mar-18 A	72	0	0
Mountain - Base Network Functional 2 x 100 Gbps	27-Mar-18	02-Apr-18 A	02-Apr-18 A	2	0	0
LSST Software Release 8.1 Complete, Ready for Commissioning Camera	31-Aug-18	12-Jul-18 A	12-Jul-18 A	-37	0	0
M2 on Site	18-Oct-18	23-Dec-18 A	23-Dec-18 A	47	0	0
ComCam Optics & Filters Ready for Integration in Tucson	9-Jul-18	1-Feb-19 A	1-Feb-19 A	143	0	0
Base Center Ready for Occupancy	7-May-19	29-Mar-19 A	29-Mar-19 A	-28	-161	0
M1M3 on Site	17-Jul-19	17-Jun-19	9-Aug-19	17	38	112
LSST Software Release 9.1 Complete, Ready for Full Camera	3-Sep-19	3-Sep-19	3-Sep-19	0	0	208
Telescope Mount Fab Contract Complete	7-Aug-20	28-Sep-20	28-Oct-20	57	22	-58
Base Center Integration Complete	13-May-20	30-Jul-20	3-Jul-20	35	-19	45
3-Mirror Optical System Ready for Testing	24-Aug-20	13-Oct-20	12-Nov-20	57	22	-40
Telescope Subsystem Development Complete	5-Nov-20	29-Dec-20	1-Feb-21	57	22	80
Engineering First Light w/ComCam	7-Dec-20	29-Jan-21	2-Mar-21	57	21	-25
Archive Center Integration Complete	7-Aug-20	28-Oct-20	28-Oct-20	57	0	280
COMP: Camera Pre-Ship Review at SLAC	19-Nov-20	19-Nov-20	19-Nov-20	0	1	14
Camera Ready for I&T at Summit Facility	13-May-21	1-Jul-21	30-Jul-21	56	21	89
System First Light	16-Jul-21	2-Sep-21	1-Oct-21	54	20	126
System Integration Test Complete	16-Jul-21	2-Sep-21	1-Oct-21	54	20	126
Science Verification Complete	1-Apr-22	20-May-22	21-Jun-22	57	22	-58
Start of Full Science Operations	3-0ct-22	3-Oct-22	3-Oct-22	0	0	0

3.1 Critical Path

See Section 6 for the critical path plots. The schedule continues to be the same significant challenge reported last month. The baseline schedule continues to be in jeopardy due to a further forecasted 58-day delay caused by TMA and Dome schedule issues. The Project continues to develop new integration sequences that adapt to the new delivery timelines and endeavours to find the most efficient system integration sequences for the evolving conditions. There is a high probability that some of the new forecast delays can be recovered through a new sequence, but continued delays with the TMA will push the critical path and require additional baseline changes. LSST management is engaging with the vendor to inject priority into the TMA disassembly and packing efforts and to look for opportunities to recover schedule in the final assembly on site. In-person meetings are scheduled with both the TMA and Dome vendors in early June to get better schedule definition.



4 Financial Summary and Projections

4.1 Brief Narrative

To date the Project has received \$372.5 million of MREFC funding and has incurred approximately \$312.4 million in actual costs (30 April 2019). EV is calculated at \$304.5 million with details presented in Section 4.4. Using Monte-Carlo risk-based methods, LSST has calculated that a total contingency of \$82.4 million dollars is necessary for 90% confidence in completing the project; this has been agreed with NSF. A net total of \$51.7 million in contingency has been allocated to the distributed budget through the change control process with a current BAC of \$440.5 million.

For the MREFC project, the CV is -\$7.9 million (3%), and the SV is -\$5.0 million (2%). This equates to a CPI of 0.97 and an SPI of 0.98.

In April 2018, the integrated Monte Carlo assessment using the resource loaded schedule and risk register impacts determined the project had an 88% confidence in completing within the available contingency. A revised analysis will be completed in June 2019.

4.2 Funding Profile Table

		L	SST MREFC Fu	nding Profile	(CSA Update 1	.2-Feb-2019)				
	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	Grand Total
Approved Budget	\$21,139,502	\$71,055,610	\$78,323,209	\$59,986,864	\$44,774,121	\$39,535,210	\$41,681,902	\$32,261,258	\$0	\$388,757,676
Approved Contingency	\$6,360,498	\$8,584,440	\$21,346,718	\$7,318,744	\$12,256,014	\$9,012,017	\$4,383,062	\$8,239,703	\$4,891,803	\$82,392,999
Management Fee	\$0	\$0	\$12,837	\$191,949	\$284,662	\$284,662	\$284,662	\$284,662	\$0	\$1,343,434
Total	\$27,500,000	\$79,640,050	\$99,682,764	\$67,497,557	\$57,314,797	\$48,831,889	\$46,349,626	\$40,785,623	\$4,891,803	\$472,494,109
Authorized Budget	\$21,400,000	\$70,795,062	\$78,323,209	\$59,986,864	\$44,774,121	\$39,535,260	\$0	\$0	\$0	\$314,814,516
Authorized Contingency	\$6,100,000	\$8,844,938	\$14,633,954	\$0	\$21,641,187	\$5,646,335	\$0	\$0	\$0	\$56,866,414
Authorized Management Fee	\$0	\$0	\$12,837	\$191,949	\$284,662	\$284,662	\$0	\$0	\$0	\$774,110
Total	\$27,500,000	\$79,640,000	\$92,970,000	\$60,178,813	\$66,699,970	\$45,466,257	\$0	\$0	\$0	\$372,455,040

Note: The funding table has been updated to reflect the NSF-approved management fee proposal (1758427). The NSF determined a fee of \$284,662 for fiscal year 2018 (FY18) and each of the subsequent years remaining under the CSA, with the exception of the final year, which is to be renegotiated for approval under the LSST Operations award.

4.3 Top Level Earned Value Management (EVM) Data Table and "S" Curve

	\$M	
EVM Reporting Date	Apr-19	
Total Project Cost (TPC - \$M) (Includes Mgmt fee)	472.5	
Estimate At Completion (EACI - \$M)	449.4	EACI=ACWP+BAC-BCWP
Estimate At Completion Bottom Up (EACII - \$M)	453.3	
Budget at Completion (BAC - \$M)	441.5	
Budgeted Cost of Work Scheduled (BCWS - \$M)	309.5	
Budgeted Cost of Work Performed (BCWP - \$M)	304.5	
Actual Cost of Work Performed (ACWP - \$M)	312.4	
Remaining Contingency	29.6	
Remaining Contingency, % of ETCI	22%	



Report-676

Remaining Contingency, % of ETCII	21%	
% complete	70%	
	Actual	69%
%\$	Percent Spent	71%
Cost Variance (CV)		-7.9
Schedule Variance (SV)		-5.0
Actuals + Commitments (Appro	360.0	
Cumulative NSF funding to dat	372.5	

Note: The EACII is based on the November 2018 Estimate at Completion (EAC).





Report-676



EV Summary of the Project Down to Level 2 of the Work Breakdown Structure (WBS).

The following EV summary table now contains columns to show SPI and CPI indices for each WBS. New this month is the last column, which indicates the WBS element's percent complete.

		CPR REPORT MONTH ENDING 4/30/2019 (ALL VALUES IN \$K)																
		CURRENT PERIOD						CUMULATIVE TO DATE					AT COMPLETE					
	PLANNED	EARNED	ACTUAL	SV	C۷	SPI	CPI	PLANNED	EARNED	ACTUAL	sv	C۷	SPI	CPI	BAC	EAC	VAC	PCT COMP
1 LSST Construction Baseline	5,241	2,700	4,471	-2,541	-1,771	0.52	0.60	309,478	304,485	312,416	-4,993	-7,931	0.98	0.97	441,460	449,391	-7,931	69.0 %
1.01C Project Management Office Construction	490	487	501	-3	-15	0.99	0.97	34,067	34,067	35,642	0	-1,575	1.00	0.96	47,595	49,170	-1,575	71.6 %
1.02C Data Management Construction	1,716	715	1,153	-1,000	-438	0.42	0.62	82,352	84,005	83,701	1,653	303	1.02	1.00	147,274	146,970	303	57.0 %
1.04C Telescope and Site Construction	2,735	1,164	2,590	-1,571	-1,427	0.43	0.45	179,548	173,055	180,381	-6,493	-7,326	0.96	0.96	204,550	211,876	-7,326	84.6 %
1.05C Education and Public Outreach Construction	77	62	76	-15	-15	0.80	0.81	4,046	3,960	3,879	-86	80	0.98	1.02	9,216	9,136	80	43.0 %
1.06C Systems Engineering and Commissioning	224	273	150	49	124	1.22	1.83	9,465	9,398	8,812	-67	586	0.99	1.07	32,825	32,239	586	28.6 %

4.4 WBS Sub-System Level EVM

		CPR REPORT MONTH ENDING 4/30/2019 (ALL VALUES IN \$K)																
		CL	IRRENT P	ERIOD				CUMULATIVE TO DATE						AT COMPLETE				
	PLANNED	EARNED	ACTUAL	SV	C۷	SPI	CPI	PLANNED	EARNED	ACTUAL	SV	CV	SPI	CPI	BAC	EAC	VAC	PCT COMP
1.01C.01 LSST Project Office	318	315	242	-3	73	0.99	1.30	19,233	19,233	19,583	0	-350	1.00	0.98	27,460	27,810	-350	70.0 %
1.01C.02 Site Office	47	47	58	0	-11	1.00	0.81	2,980	2,980	3,897	0	-917	1.00	0.76	4,476	5,394	-917	66.6 %
1.01C.03 Safety and Environmental Assurance	19	19	29	0	-10	1.00	0.66	1,535	1,535	1,455	0	79	1.00	1.05	2,418	2,339	79	63.5 %
1.01C.04 Facility and Staff Administration	31	31	57	0	- 26	1.00	0.55	3,385	3,385	3,756	0	-372	1.00	0.90	4,392	4,764	-372	77.1 %
1.01C.05 AURA	75	75	116	0	-41	1.00	0.64	6,935	6,935	6,950	0	-15	1.00	1.00	8,848	8,863	-15	78.4 %
1.02C.01 System Management	73	73	113	0	-40	1.00	0.65	5,130	5,130	4,998	0	132	1.00	1.03	6,938	6,806	132	73.9 %
1.02C.02 System Engineering	151	151	176	0	-25	1.00	0.86	5,882	5,882	6,155	0	-273	1.00	0.96	9,496	9,769	-273	61.9 %
1.02C.03 Alert Production	145	-61	131	- 20 6	-192	-0.42	-0.46	6,018	5,864	5,992	-154	-128	0.97	0.98	11,495	11,623	-128	51.0 %
1.02C.04 Data Release Production	208	93	144	-114	-51	0.45	0.65	7,987	7,390	6,846	-596	544	0.93	1.08	17,493	16,949	544	42.2 %
1.02C.05 Science User Interface and Analysis Tools	115	141	95	26	46	1.22	1.49	7,603	7,434	7,262	-169	173	0.98	1.02	8,667	8,494	173	85.8 %
1.02C.06 Science Data Archive and Application Services	176	114	217	-61	-102	0.65	0.53	9,233	8,551	8,791	-682	-240	0.93	0.97	13,052	13,293	-240	65.5 %
1.02C.07 Processing Control and Site Infrastructure	712	174	50	-538	124	0.24	3.47	18,012	17,544	17,417	-469	127	0.97	1.01	42,177	42,050	127	41.6 %



Report-676

1.02C.08 International Communications and Base Site	58	102	128	44	- 2 6	1.75	0.80	19,197	22,994	23,103	3,797	-109	1.20	1.00	30,487	30,596	-109	75.4 %
1.02C.09 Data Management System Integration and Test	0	0	0	0	0	0	0	0	0	3	0	-3	0	0	815	817	-3	0.0 %
1.02C.10 Science Quality and Reliability Engineering	77	-73	99	-150	-172	-0.94	-0.74	3,288	3,215	3,136	-73	80	0.98	1.03	6,654	6,574	80	48.3 %
1.04C.01 Telescope System Management	312	318	374	6	-56	1.02	0.85	8,417	8,423	8,701	6	-277	1.00	0.97	16,302	16,579	-277	51.7 %
1.04C.02 Telescope System Engineering	0	0	0	0	0	0	0	1,533	1,533	1,624	0	-91	1.00	0.94	1,533	1,624	-91	100.0 %
1.04C.03 Summit Facilities and Infrastructure	68	111	50	43	61	1.63	2.23	36,112	36,106	36,222	-6	-116	1.00	1.00	36,584	36,701	-116	98.7 %
1.04C.04 Dome	932	352	897	-580	-546	0.38	0.39	15,057	14,260	16,815	-797	-2,555	0.95	0.85	16,546	19,101	-2,555	86.2 %
1.04C.05 Telescope Mount	0	0	0	0	0	0	0	36,556	36,556	36,730	0	-174	1.00	1.00	39,083	39,258	-174	93.5 %
1.04C.06 Mirror Systems	15	242	318	228	-75	16.48	0.76	28,191	27,816	29,321	-376	-1,505	0.99	0.95	28,191	29,697	-1,505	98.7 %
1.04C.07 Wavefront and Alignment Sensing	0	0	0	0	0	0	0	605	605	557	0	48	1.00	1.09	605	557	48	100.0 %
1.04C.08 Calibration System	61	87	85	26	2	1.42	1.02	4,496	4,389	4,295	-107	95	0.98	1.02	5,908	5,814	95	74.3 %
1.04C.09 Reflective Coating System	2,489	20	12	-2,470	8	0.01	1.67	18,887	16,408	16,623	-2,479	-215	0.87	0.99	19,157	19,372	-215	85.7 %
1.04C.10 Observatory Control System	-699	156	0	855	156	-0.22	0	4,038	4,038	4,190	0	-151	1.00	0.96	4,038	4,190	-151	100.0 %
1.04C.11 Telescope Control System	-1,406	-287	0	1,119	-287	0.20	0	2,704	2,704	2,796	0	-92	1.00	0.97	2,704	2,796	-92	100.0 %
1.04C.12 Utilities and Support Equipment	511	210	407	-301	-197	0.41	0.52	9,035	7,841	8,268	-1,193	-427	0.87	0.95	10,768	11,195	-427	72.8 %
1.04C.13 Base Facility and Infrastructure	18	18	162	0	-145	1.00	0.11	8,926	8,671	10,157	-255	-1,486	0.97	0.85	9,159	10,645	-1,486	94.7 %
1.04C.14 Telescope Integration and Test	236	-87	216	-323	-303	-0.37	-0.40	4,116	3,034	3,610	-1,082	-576	0.74	0.84	9,106	9,682	-576	33.3 %
1.04C.15 Telescope and Site software	197	25	69	-173	-44	0.13	0.36	875	671	472	-204	199	0.77	1.42	4,865	4,666	199	13.8 %
1.05C.01 System Management	26	26	33	0	-7	1.00	0.80	1,964	1,964	1,856	0	109	1.00	1.06	3,322	3,214	109	59.1 %
1.05C.02 EPO Database and Data Access Services	16	0	0	-16	0	0	0	474	422	468	-53	-46	0.89	0.90	715	761	-46	59.0 %
1.05C.03 Infrastructure for Citizen Science	0	0	0	0	0	0	0	125	124	117	-1	8	0.99	1.06	282	274	8	44.0 %
1.05C.04 Classroom / Online Research Toolkit	18	35	27	17	8	1.98	1.31	548	550	461	2	89	1.00	1.19	2,029	1,940	89	27.1 %
1.05C.05 Visualization including Science Museums	15	0	0	-15	0	0	0	445	410	488	-35	-78	0.92	0.84	856	934	-78	47.9 %
1.05C.06 User Interfaces	1	0	16	-1	-16	0	0	489	489	490	0	-1	1.00	1.00	2,012	2,013	-1	24.3 %
1.06C.01 Systems Engineering Management	73	114	68	41	46	1.56	1.67	6,875	6,867	6,766	-8	101	1.00	1.01	10,058	9,957	101	68.3 %
1.06C.02 Commissioning	152	160	82	8	78	1.05	1.95	2,590	2,531	2,046	-58	485	0.98	1.24	22,767	22,282	485	11.1 %

4.5 Schedule Variance (SV) and Cost Variance (CV) Trend Graph

Project financial data are provided through 30 April. The trend graphs for the last 12 months of the project duration are provided below. See sections 4.1, above, and 4.6, below, for narratives on variances and recovery plans. The first graph provides cost and schedule variances as percentages; the second graph shows the same variance data in dollars.





Report-676



4.6 Discussion of Variances and Corrective Actions

The following is provided at the WBS level of the data reported in Section 4.4.

		CUM	ULATIVE TO	DATE (K	\$)	
	PLANNED	EARNED	ACTUAL	SV	CV	BAC
1.01C.01.02 Chief Scientist Support	1,076	1,076	1,236	0	-159	1,835
Explanation: The Cost variance changed from underestimating the effort the Chief Scientist	-\$180k to -\$ in FY18.	159k. This o	cost variand	ce is the r	esult of	
Corrective Action: We assessed the past incre EAC exercise and we believe that the remaining for this work package.	ased level of ng budget w	f effort requ ill be appro	uired to sup priate to su	port LSST pport the	in our fir e remainir	st FY19 ng work
1.01C.01.05 LSST Project Science	1,758	1,758	1,910	0	-152	1,899
Explanation: The cost variance under LSST Provide variance is attributed to the promotion of Zel	oject Science iko Ivezic to	has a cumu the deputy	ulative cost director.	variance	of -152k.	The cost
Corrective Action: Additional budget will be a	dded to this	work packa	nge in an up	coming L	CR.	
1.01C.02.01 Site Office	2,980	2,980	3,897	0	-917	4,476
Explanation: The negative cost variance of -91 to fund the additional road improvements at	7K has beer LSST entry to	caused by the summ	underestin it.	nating the	e available	budget
Corrective Action: Additional budget will need improvement effort.	l to be draw	n from cont	tingency to	fund the	remainin	g road
1.01C.04.01 Facility	2,745	2,745	2,994	0	-249	3,752
Explanation: The cost variance continues to w building lease budget was underestimated for software staff from budget (50% increase). Th based on projections we are underbudgeted b	rorsen by -20 FY18, main Ie FY19 budg Dy 225K in FV	OK a month ly due to th get assumes (19.	and is now e large incr a ramp do	at -249K ease of te wn of Tuo	cumulativ elescope a cson lease	ve. The and staff staff but



Report-676

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Corrective Action: With the transition of staff expect these facility costs to better match the better estimate of budget needed for FY19.	to Chile and FY19 budge	planned sta t. We are ru	aff reductic unning proj	ons in som jections o	ne subsyst f staffing	ems we to get a			
1.01C.04.02 Staff Administration	640	640	763	0	-123	640			
Explanation: This Staff Administration and Recruiting Professional Services account was slightly under budgeted by 123K leading to the negative cost variance. This account is in the process of being closed. A few more charges will appear in the February EVMS data, so we now expect to close this account in March. As future recruitment and recruiting should be charged to individual subsystems.									
Corrective Action: This Staff Administration ar budgeted by 122K leading to the negative cos recruitment and relocation will now be charge	nd Recruiting t variance. T ed to individ	g Profession his account ual subsyste	al Services has closed ems.	account i in March	was slight 2018. Fu	ly under ture			
1.02C.02.01 Data Management Science	2,458	2,458	2,625	0	-166	3,812			
Explanation: The LOE budget for KLM20201A.PROC remains under-budgeted for two University of Washington Project Science Analysts who have been assigned to this work package.									
Corrective Action: An LCR will be submitted no	ext month (J	une).							
1.02C.02.02 Data Management Architecture	3,424	3,424	3,530	0	- 10 6	5,684			
Explanation: This variance has now stabilized and the 106K needs to be addressed.									
Corrective Action: An LCR will be submitted to use future fund to rectify this shortfall.									
1.02C.03.05 Tools for Science Pipelines	972	948	804	-23	145	1,796			
Explanation: The accumulated cost variance in this account is due to lower than expected effort required to address emergent issues during late calendar 2018 and early 2019.									
Corrective Action: Savings here will be offset against future emergent issues. Note that this variance is burning down (it is \$80k lower in ME 19-04 than in ME 19-03).									
1.02C.03.07 Transform Fitting on Stacks of Images	124	114	231	-10	-117	738			
Explanation: Cumulative cost variance in this element is due to higher than anticipated integration costs of the Jointcal photometric calibration system. This was hampered by failures of the algorithm when applied to data from precursor facilities, and required greater than anticipated effort to overcome. Note that this cost variance is now contained. The minor increase in this month is due to two activities (DM-12384 and DM-17596) which were completed but properly credited as work performed in this WBS element.									
Corrective Action: Photometric Jointcal integr work. The difficulties encountered with Jointc Calibration Method (FGCM), an alternative ter Initial work with FGCM has progressed smoot Jointcal use cases at a lower development cos to address astrometric calibration only, reduc updated to properly account for earned value	ation is now al are being chnique whi- hly, and we t than using ing the over which has n	complete; mitigated b ch can addr expect it to Jointcal itse all load on t ot been cre	no further by exploitin ress broadly address re elf. Jointcal chis accoun edited.	cost is exp g the Forv the same maining p developr t. The acc	pected for ward Glob e problem whotometr nent will ount will	r this al domain. ric continue be			
1.02C.03.08 Integration	244	244	369	0	-125	578			



Explanation: No work was performed in this WBS element during April. We continue to carry a cost variance from some early integration activities charged to this account last year								
Corrective Action: The early integration activit later activities will progress with lower than p	ties will pay reviously est	off when sc imated cos	heduled wo ts, recoveri	ork in this ing the va	element riance.	starts;		
1.02C.04.02 Calibration Products	777	686	467	-91	219	1,903		
Explanation: Schedule variance here is due to 16686, which were all due for end of March inadvertently omitted from the plan, leading t	: - Late closu Successor a this planning	re of activit ctivities of p package to	ties DM-128 planning pa pappear lat	316, DM-: ickage DR :e.	16685, an P-PP-CPP	d DM- -04 were		
Corrective Action: - All of DM-12816, DM-166 distributes funds from DRP-PP-CPP-04 to furth bring it to a timely conclusion.	85, and DM- ner activities	16686 are e (DM-18003	expected to 3, DM-1800	o close in 7 05, DM-18	April LC 3006) whie	R-1756 ch will		
1.02C.04.07 Maintenance, Quality & Documentation	615	503	265	-112	238	1,514		
Explanation: There are a number of reasons for variances in this WBS element: - Effort has been diverted to service "Generation 3" middleware development. This has driven late delivery of DM-14568 Development of DM-12863 has been placed on hold due to other activities being judged a higher priority A smaller number than expected of emergent issues in late 2018, together with effort being diverted to middleware development on WBS 02C.04.01, drive the positive cost variance.								
Corrective Action: - DM-14568 development is not part of the critical path. It is expected to be addressed early in summer 2019 DM-12863 is not on the critical path. It will remain on hold for the immediate future Emergent issues will continue to be serviced as they arise, ultimately burning down the positive cost variance.								
1.02C.06.02 Data Access Services	5,273	4,678	5,064	-595	-386	6,872		
Explanation: Jira epics for several significant packages were mistakenly not marked as started, even though significant work in those packages has in fact been logged (for example, DM-16796 LSP K8S Tooling, and DM-2129 Qserv Improve Query Coverage). This has been corrected in Jira, and should be reflected in the next PMCS upload.								
Corrective Action: Continue to monitor Jira carefully for any further "missed starts". Variances for previously missed starts should continue to recover, as value has now been "earned ahead" in these packages so they should come in ahead of their current BAC/EAC. Additional recoveries are anticipated over the next periods as we approach the end of the 6-month planning cycle (many packages contingent on just a few remaining tasks are expected to conclude.)								
1.02C.06.03 Task Framework	140	138	0	-1	138	1,119		
Explanation: Value required in this WBS was somewhat over-estimated, so it is coming in under budgeted cost. This positive cost variance fortunately helps offset the negative cost variance in WBS 1.02C.06.02.								
Corrective Action: Continue to improve basis of	of estimatio	า.						
Corrective Action: Continue to Improve basis of estimation.1.02C.07.00 Processing Control and Site Infrastructure Management Engineering and Integration3,6643,6643,48401813,664								



Explanation: We believe that the cost variance is due to difference in past planning cycle budget being set higher because of escalation rates that automatically inflate budgeted costs, which was greater than our actual costs that would be charged. Corrective Action: no corrective action. This control account is now closed with a positive cost variance of \$181k. 1.02C.07.01 Processing Control 1,503 1,503 1,355 0 148 1,503 Explanation: We believe that the cost variance is due to difference in past planning cycle budget being set higher because of escalation rates that automatically inflate budgeted costs, which was greater than our actual costs that would be charged. Corrective Action: We have re-evaluated our planned costs to correct in future cycles. We implemented a new salary planning structure to better reflect the staff salaries that are working on the project to avoid having unnecessary cost variances in the future. 1.02C.07.04 Site Infrastructure 4,216 4,216 4,386 0 -170 4,216 Explanation: There is one outstanding epic to reorganize file systems that has taken additional effort than what was planned. This epic is nearing completion and will soon be complete, the cost variance across all the pre-re-plan WBS areas has not exceeded the budget. Corrective Action: We are monitoring the overall cost variance for these old WBS elements to ensure that the outstanding work does not exceed our budget in the 02C.07.00 to 02C.07.04 WBS areas. There is minimal work remaining in these WBS elements and this epic will be completed at the end of October. 1.02C.07.08 LDF Service Software 1,639 1,400 1,466 -239 -66 3,811 Explanation: The schedule variance of is due to a delay in progress for several tasks with dependencies on other Data Management teams and LSST subsystems. The primary drivers are AuxTel testing and integration and dependencies on Gen3 middleware for Batch Production and Data Backbone Services. Corrective Action: We are closely tracking developments in these areas, providing support and making progress where possible. We are prepared to complete the necessary work once external subsystem dependencies are met during the remainder of 2019. 1.02C.08.00 International Communications 503 859 0 -356 653 and Base Site Management Engineering and 503 Integration Explanation: Negative cost variance in 1.02C.08.00 is due to higher than anticipated labor costs associated with supporting on boarding, training, and labor in setting up Information Technology (IT) team in La Serena, which has grown to 5 staff. In addition, the repatriation relocation to Canada of the former team lead, Ron Lambert, created the need for distributing some of his responsibilities to other staff in La Serena and requiring them to charge to this account. The original plan had only budgeted for the TCAM, but other team members are also charging this account for these items. Corrective Action: None, this will continue to be a variance until the team is fully staffed at the start of operations. 1.02C.08.01 Base Center 1,012 873 752 -139 120 1,671



Report-676

Explanation: The negative schedule variance in 1.02C.08.01 is due to delays in the construction of the Summit and Base Facilities, and the corresponding delay in access to the Base Data Center for this work. It is currently anticipated that the Base Data Center full occupancy with stable power, cooling, and access control will not occur until end of May 2019. The positive cost variance in 1.02C.08.01 is due to partitioning of Base LAN into multiple annual acquisitions. Instead of procuring all the years at one time, there will be an FY19 - FY20 acquisitions for part of the LAN equipment.

Corrective Action: Submit LCR to move remaining purchases to FY20 and FY21. LCR will be submitted in September 2019.

1.02C.08.03 Long-Haul Networks	17,683	21,619	21,488	3,936	131	28,164
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Explanation: The positive schedule variance in 1.02C.08.03 is due to early delivery of 100G Ring Operating at 98% availability and Miami - Boca Raton Diverse Fiber Path and Spectrum link from Sao Paolo to Boca Raton. The equipment has been installed and tested. We expect activation (announcement of the ability to use the link) in May 2019. The positive cost variance is due to lower than anticipated labor costs in managing the Chilean National segment contracts.

Corrective Action: None, the schedule variance will continue until the scheduled dates, the cost variance will remain until start of operations.

	1.04C.01.02 Summit Office	3,470	3,470	3,764	0	-294	8,458
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Explanation: This CV of \$273k has increased approximately \$80k from last month and is due to increased meals at the casino for both LSST/vendors and the German team working on the coating plant as well as increased professional services (temporary Adecco electrical support). In addition, operational expenses for fuel, water, and power are increasing with the full functionality of the facility. The Adecco work has continued to support the clean room, Pflow, AuxTel, and the casino this month.

Corrective Action: LCR-1718 Recharge Summit Non-Labor Resource Budget (Meals) #2 has been submitted and approved. It will be implemented in the Apr 2019 baseline to address these expenses and funds in a future planning package will be moved so there is no overall cost or schedule impact associated with this LCR. Additional Funds will be added to Work Packages KLM40102A, B, and C to cover increased meals and lodging costs. A total of \$296k was moved from the planning package to fund the remainder of FY19.

1.04C.03.01 Summit Construction	2 270	2 260	2 /101	٥	222	2 270
Management	2,275	2,209	2,491	-9	-222	2,215

Explanation: In WBS 1.04C.03.01, Summit Construction Management, the negative Cost Variance (CV) of \$221,681 is up 8% from last month. The continuing incremental increase in this CV results from the longer than expected duration of the Summit Facility construction project and related costs, mainly administration and LSST management.

Corrective Action: As the Summit Facility Construction contract with Besalco is now closed, and the Pflow lift contract is expected to be closed very soon as well, all remaining Summit Facility work management will be transferred to Post Construction accounts. When that transfer is finalized, the application of contingency will be considered by Project Management and Controls to offset the CV in in this account.

1.04C.03.03 Summit Support Facility	30,202	30,157	30,290	-45	-133	30,562

Explanation: The remaining cost variance of -133k is due to costs in excess of the original plan for the PFLOW contract and summit facility utility lines.



Report-676

Corrective Action: No corrective action as the	se accounts	will close w	ith a slight	negative	cost varia	nce.	
1.04C.03.04 Summit Lodging and Dining	467	470	198	3	272	535	
Explanation: In WBS 1.04C.03.04, Summit Lod up 42% from last month. This increasing CV is contractor in Chile and their posting on CASN contractor Project is conservatively less than the under-reporting of progress is due to dela conditions.	ging Additio caused by ty ET North, an the advance tys in the fou	n, the posit wo factors: d the progr reported by ndation wo	ive Cost Va there is a la ess estimat / the LSST i rk caused l	riance (C ^V ag betwee tion and in managem by unexpe	V) of \$272 en payme nvoicing b ent team ected soil	2,280 is nts to the by the . Part of	
Corrective Action: As this project remains well and budget, the reporting issues resulting in t LSST management reporting will be better syn the variance. The additional foundation costs	l managed b he positive (nched to the (~\$12,500 U	y the contra CV do not re contractors SD) are sub	actor and c quire any s invoicing ject to a pe	lose to th significant to avoid f ending ch	e original correctiv urther inc ange orde	schedule ve action. crease in er.	
1.04C.04.01 Dome System Management	939	939	1,061	0	-122	939	
Explanation: In WBS 1.04C.04.01 Dome System Management the \$121,542 negative cost variance increased 3% from last month due to a slight increase in management labor charges to this account. Oversight of the EIE contract remains a high priority requiring time and travel by multiple members of the Telescope and Site management team.							
Corrective Action: The corrective action, to be the coming months, will be to close out this m labor costs to the AIV WBS 4.12 series	e implemente nanagement	ed by proje account an	ct controls d charge su	at the ap ubsequen	oropriate t manage	time in ment	
1.04C.04.02 Dome Fabrication Contract	13,889	12,982	15,187	- 907	-2,204	15,002	
Explanation: In WBS 1.04C.04.01 Dome Fabrication Contract the Schedule Variance (SV) of \$906,701 reflects the previously reported and well-known lateness in the delivery of the dome to the site and its on-site erection process. The increase in the SV indicates that originally defined milestones – principally batch deliveries to the site of fabricated components have not been met. The Cost Variance (CV) of \$2,204,426 in this account has increased by ~\$750K this month as payment was made on a change order for which contingency has not yet been applied. That CO was to cover the cost of changes in the requirements for louvers and related structures. Also contributing to the overall CV are the expenses being paid directly by LSST to onsite vendors, principally the crane vendor (SIMAQ) and erection labor support (MILL).							
Corrective Action: The corrective actions for t recovery plan. These include the direct manag well as rigorous technical and managerial ove and Site team. EIE has recently submitted a re Project Controls to enhance tracking going for cost impacts due to increased seismic require (referenced above), and to provide improved	he SV and CV gement and rsight of the evised sched rward. LCRs ments, rede safe access.	/ in this con contracting EIE work as ule that is ir are in proce sign of louv	tract are p of key on-: a high-lev review an ss to provi ers to com	art of a co site work el priority d will be de contin ply with fa	ompreher by AURA/ for the T incorpora gency to o acility ICD	nsive (LSST as elescope ted into cover s	
1.04C.04.03 Calibration Screen Fabrication	229	339	568	109	-229	605	
Explanation: As described in last month's narr month since EIE has performed work against	ative the 22	9k negative	cost variar	nce has in	proved fi	rom last	

January. The variance will continue to erode as progress continues. The positive schedule variance results



from taking partial credit on the payment milestone, which is not scheduled until next month, which is when the positive schedule variance will be resolved.

Corrective Action: The recovery plan for the Dome and Calibration screen cost variance was implemented in January, the variance continues to erode as work is completed therefore no corrective action is necessary. The positive schedule variance will be mitigated next month with the payment milestone coming due. This milestone was moved as part of LCR-1793 therefore no further action is required.

1.04C.05.01 Mount System Management	1,223	1,223	1,344	0	-122	1,223

Explanation: KLM40501A.TMS: During the factory acceptance we required additional LSST resources for the review. This was not budgeted. The account is closed No additional charge to this account are expected.

Corrective Action: The account is closed No a	dditional charg	ge to this a	account are	e expected	1.

1.04C.06.01 Mirror System Team	555	555	660	0	-106	555
Management	555		000	v	-100	

Explanation: Once again this month, there exists a negative \$106k cost variance in the Mirror System Team Management WBS. Labor charging to this WBS account has been closed. The minor overspend on planned work was due to slightly additional efforts on the M1M3 and M2 efforts. In March the M1M3 mirror was successfully packaged and delivered to Houston for ship loading for its trip to Chile.

Corrective Action: As reported during last month's period, this account has been closed to labor charging as work planned is now budgeted in other WBS elements as the material has been delivered to Chile. Remaining mirror work in Tucson for M1M3 is planned and budgeted under WBS 4.6.4 and will not impact this current cost variance

1.04C.06.03 M1M3 Cell	13,359	12,983	14,126	-376	-1,143	13,359
1.040.00.03 MITMIS CEI	13,333	12,505	14,120	-370	-1,143	13,333

Explanation: The negative \$376k SV has improved from \$603k last month (a \$66k improvement from the previous month). This improvement was largely driven by missing status on several activities in the plan. The new Control account manager found and corrected the activities with missing status and continues to conduct weekly meetings with the team to review status and to go work.

Corrective Action: While significant unanticipated reduction in available resources created difficulties in making progress on any further development in the M1M3 system, most of the tasks for March were the responsibility of contractors/vendors. Based on the current milestones, progress should remain healthy throughout shipping, but there is significant risk to the cost/schedule of M1M3 if steps are not taken to plan resources for upcoming summit tasks. We will implement an LCR soon to correct the to go budget for the M1M3 SOML testing effort.

1.04C.06.04 Secondary Mirror M2 Contract	13,941	13,941	14,182	0	-241	13,941
Explanation: The negative CV of \$240k represented by the second s	ents underes	stimating LS	SST labor ch	narges sup	oporting t	he M2
contract						

Corrective Action: This account is closed. \$239k charges is static; it hasn't changed in several months. Account has no impending charges; all future charges are directed to new accounts. No action required.

1.04C.09.01 Coating System Mgmt &	760	760	001	0	121	760
Engineering	700	700	001	U	-121	700



Report-676

Explanation: This negative \$121k CV has increased slightly from last month and is due to slight overcharging of labor and travel expense in support of the coating system. Currently the labor support is budgeted down in WBS 4.14 to cover the oversight of the vendor efforts on site to commission and perform final acceptance testing (completion scheduled for June 2019). Corrective Action: There is no specific corrective action as we are moving to close this labor account as part of the transition of support to the AIV area in WBS 4.14. Charges and accounting will be checked to make sure this variance does not grow. This will be an action for this reporting period. 1.04C.09.02 Coating Chamber System 18.127 15.648 15.742 -2.479 -94 18.142 Explanation: The -2.5M schedule variance is due to the late completion of the Final Acceptance Review. At the time of writing this narrative in May we have accomplished FAR and will close out this activity in the May reporting cycle. Corrective Action: None. This activity has now been completed and will be closed out in the May report.

There is no overall schedule impact as a result of this late closeout.

1.04C.10.01 OCS System Mgmt and	1 692	1 692	1 001	0	110	1 692
Engineering	1,085	1,005	1,801	U	-110	1,005

Explanation: The negative cost variance of -\$118k is due to sick leave being accrued on the old management. these charges should have been redirected to the new management account 1.04c.15.01

Corrective Action: We are working with accounting to make sure these old OCS/TCS accounts are closed and all home accounts are moved to their new charge numbers.

1.04C.10.07 OCS Monitor	119	119	308	0	-189	119

Explanation: The negative cost variance of -\$189k is due to INRIA charges being recorded under the old account instead of 1.04C.15.07. This negative entry is offset by a positive CV under 1.04C.15.07 where the work is budgeted.

Corrective Action: We are working with accounting to rectify all of the mischarges caused by moving telescope software to a new WBS structure.

1.04C.12.02 Safety Systems	797	654	576	-144	78	797

Explanation: KLM41202A.PROC: The SV of 143,511 is from the installation of the Global interlock system being delayed by the delay in the TMA shipping. These installations will be performed by Tekniker. All hardware has been procured and tested and will be reviewed at Tekiniker on June 6. I will get an updated schedule for installation then.

Corrective Action: KLM41202A.PROC: The Global interlock system (GIS) is not needed until the telescope mount comes online. The estimated schedule for completion of the TMA interlock system is October 2020. The GIS should be completed shortly after the telescope interlock system is checked out.

1.04C.12.05 Summit Network System	1,043	992	1,390	-52	-398	1,160
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Explanation: The negative cost variance in 1.04C.12.5: Due to delays in the summit facility construction schedule and late information from Telescope subsystem vendors regarding network connectivity, extra labor has been expended, and activities that were scheduled serially in the baseline are now being done in parallel to recover schedule. Staff that were planned 50% on 1.04C.12.5 and 50% on KLM20803 have been primarily on the former.



Corrective Action: Cost variance is unrecovera Continue schedule recovery activities through date of 3/1/19. Three temporary electrical en trays, and cables. In addition, the high load of and 5 floors), auxiliary telescope, auxiliary insi common areas) will require hiring a full-time of and Base networks operating to an implied SL out the rest of the observatory, and we are er aligning the replacement and job requisitions	able if we are FY19. An IT gineers were coordinatin truments, ar T manager i A, we need nlisting IT res and descrip	e to deliver Infrastructo e hired to po g activities a nd Base Faci n La Serena additional s sources in T tions to refl	without im ure Enginee erform wor across Sum ility (compu . Also, due ystem/serv ucson to as ect this div	pacting p er was hir k installir mit Facilir uter room to the ne vice suppo ssist more ision of re	roject crit ed, with t ng conduit ty (compu , offices a ed to kee ort while w e in this. W esponsibil	ical path. he start s, cable uter room nd p Summit ve build Ve are ities.	
1.04C.12.06 Tools and Equipment	1,574	1,525	1,250	-48	275	1,574	
Explanation: The positive cost variance of \$275K is the sum of the accomplishment of milestones achieved before being invoiced by CAID (\$122K) and for equipment procurement received before accounted for (\$153K)							
Corrective Action: no corrective action require	ed						
1.04C.12.07 Vehicles and Transportation	502	387	355	-115	32	502	
Explanation: The \$116K negative schedule variance is due to a lower rate of expenses for maintenance as previously planned.							
Corrective Action: no corrective action required							
1.04C.12.08 Shipping and Logistics	1,619	1,163	1,630	-456	-467	2,631	
Explanation: The \$456K negative schedule var .PROC and .TMS KLM41208A accounts. It is lin cost variance is mainly due to an accounting o linked to the TMA shipment being delayed.	riance is mai iked to the T lifference be	nly due to a MA shipme tween .PRC	in accounti int being de DC and .TM	ng differe elayed. Th S KLM412	nce betw ne negativ 208A acco	een e \$466K unts. It is	
Corrective Action: Contingency fund will be ad	dded to this	account					
1.04C.12.10 M2 Equipment	123	18	53	-105	-35	134	
Explanation: The \$105K negative schedule van resources in Tucson	iance is due	to delayed	activities fo	or the M2	baffle by	lack of	
Corrective Action: Resources will be allocated	when availa	ble to finis	n the M2 ba	affle activ	ities		
1.04C.12.13 Coating Optical Equipment	180	180	22	0	158	180	
Explanation: KLM41213A.TMS: That is actually the total cost of the Cary5000 Spectrophotometer, which one was received in Tucson las week and properly checked. Right now, the instrument is traveling to Chile for it final installation on site.							
Corrective Action: The final invoice for the Cary5000 Spectrophotometer has not yet been received. We are electing not to enter an estimated actual to stay on top of the invoicing process. We expect this invoice to be processed in the very near future.							
1.04C.12.18 Environmental Awareness System	144	27	1	-117	26	277	



Explanation: Still approximately 3 months behind schedule due to previous unplanned shifting of resources to higher priority subsystems. HVAC contract is now processed and waiting to be executed.

Corrective Action: Have identified contractor to fab custom components. Plan to prioritize finishing design work to proceed with this.

1.04C.13.03 Base Construction	222	222	479	0	147	565
Management	552	552	475	U	-14/	505

Explanation: In WBS 1.04C.13.03, Base Facility Construction Management, the negative CV of \$147,289 is down 5% from the last reporting period. The continuing incremental decrease results from the inspection and management team billing less time to this part of the LSST project. In general, the CV is due to the extended period of LSST management labor and related costs. The project for remodeling and construction has exceeded its schedule mainly due to change orders during Phase 1 remodeling and Phase 2 new building construction taking longer than planned, due in part to contractor inefficiencies.

Corrective Action: To avoid further increasing this CV, the conclusion of the project is being expedited to the extent possible. The new building construction is now expected to finish in mid-June – a one month slip since last reporting. That will be followed by the final Phase of the remodeling, which is expected to require less management oversight, helping to mitigate this CV.

1.04C.13.04 Base Site Preparation	1,696	1,506	2,051	-189	-544	1,696
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Explanation: In WBS 1.04C.13.04, Base Facility Site Prep and Remodeling (Phase 1), the negative Schedule Variance (SV) of \$189,220 is the same as last month, as the remodeling project continues in hiatus. The delay reflected in this SV was mainly generated by change-order work during site preparation and the 4 stages of completed remodeling. Stage 5 remodeling will convert the existing computer rooms to meeting spaces, after the computing equipment is moved to the new Data Center. The Cost Variance (CV) of \$544,163 is substantially unchanged from last month. This CV represents the LSST share of change orders and other project support costs during the remodeling work.

Corrective Action: No corrective action is required for the SV at this point. When the Stage 5 remodeling project is initiated, the schedule will be updated for appropriate tracking to completion. The final cost delta, based on the portion of remodeling change-order work charged to LSST, will be less than the current CV, since the LSST share of the remodeling work is lower than the amount being assigned via the partner shares applied during construction to simplify accounting.

1.04C.13.05 La Serena Base Facility Construction	6,739	6,673	7,434	-66	-761	6,739
Explanation: In WBS 1.04C.13.05, Phase 2 Bas \$761,405 has increased 24% from the last rep orders that have been approved and enacted, The total CV primarily reflects the LSST share months of construction, approximately 8% ov	e Facility Co oorting. The i , but have no of all change er the origin	nstruction, ncrease is c ot yet been orders tha al contract	the negativ due to cont covered by t have been amount.	/e Cost Va inued billi / requeste n enacted	iriance (S ing for ch ed conting I over the	V) of ange gency. 16
Corrective Action: The anticipated corrective a increase will be applied when the contract is a change orders is determined.	action of a re completed a	equest for c nd a final ac	contingency	/ to cover of the LSS	the accu I share of	mulated the

1.04C.14.02 Integration Tooling and Equipment	1,793	1,454	1,635	-339	-181	2,073
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Report-676

Explanation: Delays of different activities are the origin of the \$339K negative schedule variance. These include delays for ComCam (\$106K), for Image Quality Diagnostics (\$150k), the camera mass simulator (\$51k) and for the laser tracker interface phase 2 (\$45K). The \$181K negative cost variance is mainly due to overspending labor for ComCam (\$162K). Corrective Action: Progress with Comcam and SHWFS in the coming months will mitigate the schedule variance. Overspending will be corrected by allocating contingency funds 1.04C.14.03 Major Equipment Leasing and 268 379 471 -92 549 111 Rental Explanation: The \$111K positive schedule variance is due to additional rental expenses to support the construction of the dome. Corrective Action: No corrective action required

1.04C.14.04 Subsystem Integration and Test	1,381	527	840	-854	-313	4,511

Explanation: The negative schedule variance of \$854K is due to EIE dome construction delayed (\$128k), coating plant preparation for M1M3 surrogate delayed (\$324k), software deployment activities (\$127K), camera rooms preparation (\$85k) and TMA preparation (\$100K). The negative cost variance of \$313K is driven mainly by delayed activities related to coating plant (\$105k), Platform Lift test (\$40K), camera rooms preparation (\$60k) and TMA (\$95K).

Corrective Action: The variance will be reduced as the PFlow platform lift testing is completed and the camera rooms are almost ready. The coating plant is also basically ready for M2 coating.

1.04C.15.01 Telescope and Site Software	175	175	12	0	162	E14
Management	1/5	1/5	12	U	105	514

Explanation: Exp: The large positive cost variance under 1.04C.15.01 is due to the Laboor Recharge (Vacation and sick balances). when home account of KLM41501A is charging out to another account. This is a relatively new account and once the team begins taking holiday/vacation those charges will accrue under 1.04C.15.01; reducing the positive cost variance. Corrective action: none at this time. Since the team is large and dynamic (charging multiple charge numbers) it is very difficult to move their home accounts around to where the majority of their effort is being concentrated. Once people begin using their Vacation/Sick balances this positive variance will begin to decrease

1.05C.01.01 System Management	1,964	1,964	1,856	0	109	3,322	
Explanation: The cost variance of \$109K has decreased from \$115K last month. A change request with							

improved labor rates was implemented in the March 2019 baseline and is the cause of the decline in the cost variance.

Corrective Action: No further action is needed, and the cost variance is expected to decrease below the threshold in coming months.

1.06C.01.02 Simulation & Analytic Tools Management	2,738	2,739	2,596	0	143	2,739

Explanation: The overall cost variance use being caused by latency in invoicing from several contracts. The \$143K positive cost variance is lower from \$153K last month due to a \$10K payment to Intercax.



Report-676

Corrective Action: Going forward, we will be paying another \$45K to Intercax, and final Purdue invoices have not been paid yet, so that should bring this cost variance under the \$100K threshold over the next quarter.

1.06C.02.01 Commissioning Management	1,307	1,307	1,189	0	118	6,828
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Explanation: The \$118K positive cost variance is being driven by reduced labor costs - personnel who were planned full time are now splitting their time to other cost accounts due to changes in need and responsibilities. Some of this cost variance is being offset by work at UC Davis which is being executed earlier than planned. The expected international travel for commissioning has also been delayed due to overall project schedule slips.

Corrective Action: A change request submittal is in progress which will bring the budgeted amount into closer alignment with actuals.

1.06C.02.02 Commissioning Planning,	1 282	1 22/	857	-58	367	2 401
Preparation, Tooling, & Simulations	1,205	1,224	0.57	-30	307	2,401

Explanation: The \$367K positive cost variance has increased from \$294K in March in this control account. The primary issue is a delay in hiring commissioning support scientists with a positive CV of \$319K up from \$285 in March for KLM60202A.LABOR. In KLM60202F.PROC, the Univ. of Washington caught up status reporting from prior periods, but the invoices lag the effort so that accounts for \$27K of the increase in CV. Finally, delayed purchases of equipment account for \$16K of the increase in KLM60202D.TMS

Corrective Action: A change request submittal is in progress which will bring the budgeted amount into closer alignment with actuals. Hiring campaign for support scientist position will conclude before the end of FY19. The change request will allocate the support scientist budget to FY20 for future hires.

4.7 Obligations as of 30 April 2019

Vendor	Description	Amount
Aerotek Professional Services, Inc.	LSST Staffing contracts	\$145,309
AGILENT TECHNOLOGIES INC.	Cary7000 Spectrophotometer Final ship	\$118,035
Amazon Web Services	Cloud resources for web hosting and prototyping	\$32,619
Astelco Systems GmhB	Differential Image Motion Monitor (DIMM)	\$186,760
Aston Carter	Information Technology and Communications (ITC) Contracted Services	\$97,668
Astronomical Consultants & Equipment, Inc.	Auxiliary Telescope and Dome Refurbishment	\$20,182
AURA	Base Site Preparation	\$621,571
BBC Chartering USA, LLC	Coating Chamber and TMA Freight	\$618,273
BellDex	Belldex IT Support	\$48,960
CAID Industries, Inc.	M1M3 Mirror Cell Weldment	\$65,000
Caltech	DM Science User interface and Analysis Services FY19	\$3,410,513
Centre National de la Recherche Scientifique	IN2P3	\$80,698
D4D Consulting Ltd.	DM Calibration support	\$62,292
European Industrial Engineering, Srl	Dome Fab Contract Vendor NRE	\$26,860
Facilities Engineering	Vacuum Lifting Pads	\$77,868
Florida International University	Network Provider for US Chile link	\$148,871
Harvard University	Atmospheric Calibration Support	\$64,164
Hislop, Richard	Safety Support	\$26,700



Report-676

Hoes, Charles	Safety Support	\$30,296
Hofstadter Analytical Services, LLC	M1M3 Static support isolator analysis and design engineering	\$24,906
IGUS Inc.	Optical Fiber Cables	\$33,213
Imagine Optic	hack-Hartmann Wavefront Sensor System	\$112,618
INRIA	INRIA OCS User Interfaces	\$56,645
Intercax	Syndeia MagicDraw to JIRA plugin	\$45,000
JDP Metrology Consulting, LLC.	Laser Tracker Metrology Consulting	\$42,000
Kuehne & Nagel	Global container logisitics	\$409,743
Lawrence Livermore National Lab	LLNL work for DM (Pipelines) Fy19	\$25,850
Longhorn Industries	Project Controls Consulting	\$683,199
Marsh USA	"all risk" transportation insurance	\$300,000
New River Kinematics	Spatial Analyzer	\$58,750
Observatory Sciences Ltd.	Pointing Component	\$219,360
Office of Finance and Treasury	Data Management MREFC Agreement for Princeton University	\$4,609,587
Optical Data Associates, LLC	ComCam Optics Contract	\$29,364
Phase Motion Control S.p.A	Dome Phase Motion Control System	\$457,930
Precision Heavy Haul, Inc.	LSST Heavy Haul Transportation	\$83,059
Regents of the Univ of CA	UC Davis LSST Support Contract	\$326,935
Sozen, Inc.	FY19 deblending work for DM	\$121,667
Stanford University	Science Data Archive and Application Services	\$4,401,448
Union Temporal de Empressas LSST TMA	LSST Telescope Mount Assembly Design and Fabrication	\$3,633,856
University of Arizona	UoA Richard F. Caris Mirror Lab	\$527,453
University of Florida	FY19 DM Network Support	\$72,024
University of Illinois	NCSA MREFC Subaward	\$13,758,427
University of Oxford	Zooniverse citizen science	\$37,750
University of Pittsburgh	Support to Science Quality and Reliability Engineering	\$29,979
University of Washington	LSST System Scientist and DM Alert Production Services	\$6,568,392
VON ARDENNE GMbH	LSST Coating Plant Contract	\$2,096,130
Miscellaneous 1	\$10K < X < \$20K	\$504,359
Miscellaneous 2	<\$10K	\$900,338
LSST US Subtotal		\$46,052,618
ANA MARIA ZAVALA TAPIA	LSST Casino contract	\$73,479
ARCADIS CHILE S.P.A.	A&E support	\$36,995
AUTOMATICA Y REGULACION SA	Light Removal for M1M3 mirror transportation to the summit	\$25,611
Large Crane Rental	Large Cranes Rental for TMA construction	\$1,016,997
Carlos Leyton Vega E.I.R.L.	Mechanical Contractor support	\$24,918
Dimension Data Chile S.A.	Network hardware for the base datacenter	\$118,517
Empresa Nacional de Energia Enex S. A.	Petrol for LSST Summit Facilities	\$66,218
Enter Comunicaciones Spa	AURA network Fiber repair	\$77,355
FUNDACION INRIA CHILE	LSST Operator Visualization Environment LOVE	\$188,358
IMOPAC LTDA	LSST Improvement of Access Roads	\$98.903
ING. DE TRANSP. JAVIER CORTES SOC. LTDA.	Ground transportation from Coquimbo Harbor to LSST Summit	\$553,502
JACQUES SEBAG,	Removal of Road Obstacles for LSST Coating Chamber Transportation	\$59,568
MAESTRANZA FAREMIN LTDA.	Dome roof - 2 node pieces fabrication	\$118,237



Report-676

MILL MONTAJES INDUSTRIALES LLANQUITRUF LIMITADA	Steel erection crew construction of LSST Dome	\$135,106
PINO Y LABARCA LIMITADA	Lease and maintenance of Chemical toilets	\$30,110
PREMIUM INGENIEROS SPA	Piping for Coating dedicate Chiller	\$27,764
PROYECT CONSTRUCTORA E INMOBILIARIA LTDA.	LSST casino remodeling	\$247,887
RED UNIVERSITARIA NACIONAL	REUNA	\$1,405,360
SERVICIOS SYR SPA	Warehouse construction at the LSST summit	\$49,403
SIMAQ LTDA.	On Site Crane Services for LSST Dome Erection	\$38,542
SK RENTAL S.A	Scaffold rental	\$22,400
SOC.DE INVERSIONES LAS VEGAS LTDA.	LSST Minibus Driver to the Summit	\$22,229
Miscellaneous 1	\$10K < X < \$20K	\$155,558
Miscellaneous 2	<\$10K	\$317,874
Chilean Subtotal (Estimated)		\$4,910,893
Total		\$50,963,511

5 Risk Management

5.1 Brief Narrative

The JIRA tool functionality was further expanded with additional scripts and dashboards for more streamlined management. By expanding the tool and providing training on its usage, subsystems will have an increased ability to view, analyse and manage their risks. Therefore, the tool will lead to an increased visibility on risk exposure at various project levels. In addition to risks and opportunities, this has allowed us to focus on discrete mitigating actions, an estimate of how these actions will reduce our current exposure levels, and capturing anticipated completion dates of these mitigating actions. As these mitigating actions are completed, the exposure of the associated risks is re-evaluated against this estimate. We now also have the ability with our Monte Carlo script to report what our probability weighted cost exposure (PWCE) would be after the final mitigations are completed.

The R&O register contains 176 active risks and 12 active opportunities. This is unchanged this month, but the last monthly report has an error, reporting the number as 116. There were limited changes in exposure updates this month. Many of the highest exposure risks were not updated. The recent baseline change (LCR-1623) adding 2.5 months and \$3.5 million to the plans will eventually impact the risk exposure. There is a natural lag in the process even if the risks are promptly reviewed. However, in this case, the Dome and TMA efforts have not yet shown steady progress to the new schedule, so the risk exposure will continue for a few monthly review cycles. The overall PWCE decreased from \$34.8 million to \$34.46 millin.

There were 15 project controls LCRs implemented; 11 had an impact on cost or schedule, resulting in a net contingency draw of \$1,062,866. As of the end of the month, the Project has allocated 64% of the total contingency to the baseline through the change control process. The remaining contingency of \$29.6 million is 22% of ETCI (ETCI=BAC-BCWP) and 21% of ETCII (November 2018 bottom up).

There was no change in the baseline finish date leaving 6 months of contingency between early and late finish. The schedule issues and forecast dates detailed in Section 3 above point to an increasing schedule risk exposure, but the Project is actively addressing mitigations.

There were no changes in the technical requirements or performance predictions. Technical margins



Report-676

remain unchanged, and 32 scope options, as listed in the LSST Scope Options document (LPM-72), remain available at an estimated value of \$27.2 million.

Together, the cost, schedule and scope contingency indicate the Project will be completed within budget and on schedule.

5.2 Liens on Budget Contingency

The table below is the Project Manager's Lien List used to assess the project's contingency status. The table summarizes the processed and pending change requests and the cumulative cost variance from the earned value report. It also provides a forecast of potential contingency liens from the Risk and Opportunity register and a separate detailed list of items under careful watch by the Project Manager.

Project Manager Lien List April 2019

Lien ID	Description	Value (\$)	Contingency Balance (\$)
N/A	Initial Agreed Contingency	82,392,999	82,392,999
L1	Processed Change Requests	(52,767,224)	29,625,775
L2	Cumulative Cost Variance	(7,931,078)	21,694,697
L3	Pending LCR Estimates	(280,000)	21,414,697
L6	Cost of Schedule Contingency (reserve for team labor)	-	21,414,697
L7	Project Manager Watch list Subtotal	-	21,414,697
L8	BCWR - EACII	(3,449,994)	17,964,703

The following LCRs have entered the "Implemented" or "Pending" state and have been removed from L8 this month.

LCR #	Description	Amount
LCR-1808	Additional Budget for Dome Construction Crane	-\$180,000
	Total	-\$180,000

The following two tables contain the top risks and opportunities as evaluated by the R&O register PWCE. The Opportunities table contains the top 10 items; the Risk table includes the top 10 items plus the critical risks from the 5x5 matrix, even if they are not in the top 10. The top risks are tracked closely as they are considered to have the largest potential contingency impact. Note that the risk IDs have changed with the new R&O tool. The mapping of ID numbers from the old system to the new system is available on the LSST R&O website.

	Top Risks List						
Sort #	Risk ID #	Subsystem	WBS	Risk Title	Probability Weighted Cost Exposure (\$K)		
1	RM-886	РМО	01C	Subsystem Milestone Execution	4,347		
2	RM-888	РМО	01C	Multi-agency coordination - Camera Delivery	2,268		



3	RM-773	Data Management	02C.04	Computing power required for Data Release Production exceeds estimates by large factor	1,348
4	RM-817	Telescope & Site	4.5	Mount Late Delivery	1,332
5	RM-887	РМО	01C	Institutional Overhead Rates	1,260
6	RM-814	Telescope & Site	4.4	Dome Late Delivery	1,221
7	RM-775	Data Management	02C.04.06	Unanticipated characteristics of real data result in poor MultiFit performance (computational)	962
8	RM-733	Systems Engineering	06C.02	Discontinuity between subsystem I&T and Commissioning staffing levels	888
9	RM-815	Telescope & Site	4.14	Telescope and Site Integration activities underestimated	851
10	RM-723	Data Management	02C.04	Object counts exceed expectations, leading to insufficient compute	823
Date:		5/6/2019		Top Ten Total:	15,300

Top 10 List - Opportunities							
Sort #	Opp ID #	Subsystem	WBS	Title	Probability Weighted Cost Exposure (\$K)		
1	RM-628	РМО	1.01C.01	Favorable Chilean Currency Exchange Rate Factor	1,480		
2	RM-629	PMO	1.01C	Favorable Personnel Costs	442		
3	RM-630	РМО	1.01C	Favorable Material Estimate Uncertainty	340		
4	RM-785	Systems Engineering	1.06C.05	Commissioning Finishes Early	113		
5	RM-631	PMO	1.01C	Favorable Institutional Overhead Rates	60		
6	RM-627	Data Management	02C.10	New or different technology provides saving in hardware/effort.	30		
7	RM-786	Systems Engineering	1.06C	Standardizing Common Hardware Across Subsystems	30		
8	RM-624	Data Management	02C.04.06	Exceptional MultiFit Performance	25		
9	RM-787	Systems Engineering	1.06C.05	Camera Verification On Summit Finishes Early	23		



Report-676

10	RM-632	РМО	1.01C	Purchase Forward Planned Hardware	3
				Sooner with Favorable Exchange Rates	
	Date: 5/6/2019		Top Ten Total:	2,544	

The 5x5 probability vs. impact matrix below clearly shows the severity of the highest LSST Risks.

	50%-100%	4	2	1	2	
	25%-50%	10	6	5	2	
Probability	10%-25%	22	15	9	3	
	5%-10%	35	16	10	1	
	0%-5%	21	5	1		
		< 0.5	0.5 - 1.0	1.0 - 3.0	3.0 - 8.0	>8.0
			Cost Im	pact (\$M)		

Updated: 3 days ago 11:11 PM (RM-746) | Issues:170 | Red issues:5 | Yellow issues:55 | Green issues:110

The risks in the critical range are described in the following table.

JIRA ID	Subsystem	WBS	Summary	PWE (\$K)	Proposed Management Response
RM-886	РМО	01C	Subsystem Milestone Execution	4347	Schedule and contingency will be used along with reworking the integrated plan to deal with subsystem delays
RM-888	РМО	01C	Multi-agency coordination - Camera Delivery	2268	At this time the Telescope and Site's TMA is on the critical path and the Camera has roughly 1 month of float. This risk focuses on the Camera late delivery but as float develops the risk reduces. ComCam continues to progress and will be on site and available for further valuable use if the main Camera should be delayed.
RM-817	Telescope & Site	4.5	Mount Late Delivery	1332	The TMA delivery is currently the critical path. Delays in early 2019 caused a 2.5 month delay in the early delivery of LSST. There are signs the vendor is maintaining the current schedule and has engaged in



Report-676

					discussions on optimizing the site integration but this risk remains critical.
RM-887	РМО	01C	Institutional Overhead Rates	1260	AURA was chosen as the basis because very little can be done in response to a rate change. AURA centers, including NOAO are subject to NSF approval so changes are well understood and will come with significant advanced warning.
RM-814	Telescope & Site	4.4	Dome Late Delivery	1221	The Dome vendor has had significant contract issues in completing the site integration. LSST is deeply engaged with the site work and is working weekly with the vendor to establish a plan to complete the dome. Progress is being made but past performance and an approaching winter keep this delivery risk critical. Further delays are being managed to focus on TMA priorities.

5.3 Budget Contingency Allocations

The first chart below plots the actual contingency usage (red line) against the "algorithmic" contingency model (blue bars) and the risk-based contingency annual amounts agreed with NSF (green background). The purple line tracks the total authorized contingency. A new data point has been added to the chart that shows the estimated dates for items maintained in the liens list. In this chart, the project is processing the DM replan LCRs that were pending NSF approval and additional contingency authorization in the January 2018 baseline, which explains the large jump in that period. The second chart below provides a more detailed view of the actual cumulative contingency allocated to the baseline budget. The cumulative cost variance has been added to the plot to better reflect what is in the liens list.



Report-676



The table on the following pages identifies the LSST Change Control items approved during the period that had a cost or schedule impact. It lists each applicable LCR and includes the NSF approval date for those changes whose amount thresholds required prior agency authorization. In addition to this table of cost and schedule related LCRs, Section 7 provides a complete list of LCR activity for the reporting period.



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LSST Monthly Report CSA AST-1202910 (May 2019)

		Period:	April 2019			Alloc	ation	Running Totals			
Change Control ID	Description	NSF Approval Date	Risk ID	Affected WBS/Control Account	Schedule Impact	"Puts"	"Takes"	6 Month Jul - Dec 2018	Authorized Balance	Total Remaining Balance	
Starting C	ontingency Balance		<u>.</u>		<u>.</u>	•		(\$6,328,252)	\$5,162,055	\$30,688,640	
LCR- 1710	Calibration Screen Rear Payload Platform		RM-867	1.04C.04.03	None	\$0	(\$13,500)	(\$6,341,752)	\$5,148,555	\$30,675,140	
LCR- 1711	Update Summit and Base IT and Networks Plan		N/A	1.04C.12.05	None	\$0	(\$53)	(\$6,341,805)	\$5,148,502	\$30,675,087	
LCR- 1718	Recharge Summit Non- Labor Resource Budget (Meals) #2		N/A	1.04C.01.02	None	\$0	\$0	(\$6,341,805)	\$5,148,502	\$30,675,087	
LCR- 1726	Add Activities for M1M3 Transport Coquimbo to Pachon		RM-819	1.04C.12.08	None	\$0	(\$71,000)	(\$6,412,805)	\$5,077,502	\$30,604,087	
LCR- 1729	M1M3 Cell Shipment SOML to CAID		RM-819	1.04C.12.08	Level 1 Milestone T&SC- 0600-0200 M1M3 on Site delayed from 24-Jun-19 to 17-Jul-19	\$0	(\$11,300)	(\$6,424,105)	\$5,066,202	\$30,592,787	
LCR- 1732	Pier Safety Railing Installation		RM-841	1.04C.01.03	None	\$0	(\$30,000)	(\$6,454,105)	\$5,036,202	\$30,562,787	
LCR- 1731	Move Electrical Technicians Budget from FY20 to FY19		RM-894	1.04C.14	None	\$0	(\$5)	(\$6,454,110)	\$5,036,198	\$30,562,783	
LCR- 1730	Extra Scope Coating Chiller Piping System		RM-851	1.04C.09.02	None	\$0	(\$41,169)	(\$6,495,279)	\$4,995,029	\$30,521,614	
LCR- 1734	Integrate M2 and Coating Activities in Jira		RM-894	1.04C.09.02	None	\$0	(\$229)	(\$6,495,508)	\$4,994,799	\$30,521,384	
LCR- 1757	M1M3 System CAM Update		N/A	1.04C.06.03	None	\$0	\$0	(\$6,495,508)	\$4,994,799	\$30,521,384	
LCR- 1717	Reconcile Schedule Variance under 1.04C.10 and 1.04C.11		N/A	1.04C.10 1.04C.11 1.04C.15	None	\$0	\$0	(\$6,495,508)	\$4,994,800	\$30,521,385	
LCR- 1693	Dome Structure - Chilean Seismic Standards Impact	3/1/2019	RM-814 RM-826 RM-94	1.04C.04.02	None	\$0	(\$765,610)	(\$7,261,118)	\$4,229,190	\$29,755,775	



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LSST Monthly Report CSA AST-1202910 (May 2019)

Report-676

LCR- 1735	NCSA Cycle Planning Updates	N/A	1.02C.07	None	\$0	\$0	(\$7,261,118)	\$4,229,190	\$29,755,775
LCR- 1743	Additional Summit Road & Platform Work	RM-898	1.04C.12.17	None	\$0	(\$120,000)	(\$7,381,118)	\$4,109,190	\$29,635,775
LCR- 1753	LCR-1753 New Account for TS Consulting Services	RM-824	1.04C.01.01	None	\$0	(\$10,000)	(\$7,391,118)	\$4,099,190	\$29,625,775
Ending	Contingency Balance				\$0	(\$1,062,866)	(\$7,391,118)	\$4,099,190	\$29,625,775
			Pendir	ng LCRs with Potential PMCS Im	pact				
LCR- 1787	Minor Update to Commissioning Plan/Budget	N/A	1.06C.02.02	None	\$0	(\$0)	(\$7,391,118)	\$4,099,189	\$29,625,774
LCR- 1793	Move up Calibration Screen EIE Milestone	N/A	1.04C.08.03	None	\$0	(\$0)	(\$7,391,118)	\$4,099,189	\$29,625,774
LCR- 1786	Increase Dome Scaffolding Budget	RM-814	1.04C.14.03	None	\$0	(\$100,000)	(\$7,491,118)	\$3,999,189	\$29,525,774
LCR- 1808	Additional Budget for Dome Construction Crane	RM-814	1.04C.04.02	None	\$0	(\$180,000)	(\$7,671,118)	\$3,819,189	\$29,345,774

6 Critical Path Plots



Activity Name		BL Project Start	Start	BL Project Finish	Finish	Final	FY2019	8 F04	F01 F02	FQ3 FQ4	F91 F02 F03 F04	FQ1 FQ2	2 F03 F04	FY2023 F01
LSST April	2019 Month End E	orecast	t	- toget		- 6.00		1.00	1.41 1.42	1.45 1.64	1.41 1.46 1.42 1.58	1.41 1.42	1.00	1.40
LSST Drog	ram Timeline with Lows	1 1 Miler	tones											
MREFC Progr	reant in menne with LeVe an Complete	a i Miles	ones	01-Apr-22	21-Jun-27	-22			1		I	1	· · ·	Complete
Science Verific	cation Compilete			01-Apr-22	21-Jun-22*	-58					1		Schros Ver	Ication Comple
Telescope a	and Site Construction										1	1	۲	
ApS Lawer gut	•	15-Peb-19	15 Peb 19A	21-Peb-19	08-May 19	-36		ApS Lower guide			1			
ApS lower guid Transport in it	de final alignment In Gilón Harbour (Combiners Vers	04-Mar-19 20-Teb-19	15 Peb 19A 10 Mar 194	05 Mar-19 16 Mar-19	05-May-19 25-Jun-12	-35		ApS lower guide the	alignment De Gille Herberg (Derber	mere Viermite Second of the				
TMA Ready for	r Shipment at Port POB (Misstone)	20110212	10.000	09 Mar-18	01-May-19	-58	4 • 1	MA Ready for Ship	nert at Port FOB (Meator	nina waanna sowera araps a) - 20 Piece a				
TMA Ocean Pr	wight from Ariles to Coquimbo	12-Mar-18	01-May-19	10-May-10	10-34-19	-58	H	TMA Oce	in Preight from Avless to Co	quimbo				
Left side (beice	w azimuth ring girder)	15 Peb-19	00-May-19	20-Peb-19	07-May-19	-36	뛰	aftaide (bekw szi	muth ring girder)					
Right side (bek	kow azimuth ring girdler) anhan Dauther Distriction	21-Peb-19	05 May-19	27-Feb-19	13 May 19 25 May 19	-36		Fight side (beine s	conuch ring girder)		1			i
Side Walts - La	et side	11-Mar-19	09 May-19	23-Mar-19	25 May 19	-35		Site Walz - Left:	and constant regist table					
Left side (abov	w scinuth ring girder)	04-Mar-19	14 May-19	05-Mar-19	17-May-19	-36	4 1	Left side (above a	timuth ring girder)		i			i
Right side (abc	ow azimuth ring girder)	05 Mar-19	25 May-19	13-Mar-19	24 May 19	-36	4	Right side (above	azimuth ring girder)					
Di-partson Ape	erture Shutter Left side of side	25-Mar-19 25-Mar-19	24-May-19 24-May-19	05Apr-19 05Apr-19	05-Jun-19 05-Jun-19	-35		Di parteanApe	ture Shutter Lett side		i			i
Aperture shute	br	25 Mar-19	24 May-19	12Apr-19	13 Jun 19	-27		Aperture shut			!			!
Heavy SheiAs	sae mbly compileite	14-Mar-19	27-May-19	1		-36		Heavy She Aza	embly complete		1	1		
Side Waltz - Re	light side	25 Mar-19	27-May-19	05Apr-19	07-Jun-19	-36	1	Side Waltz - R	eht xide			1		i
Roof - Right sk	ian III.	05 Apr-19	10-Jun-19	12Agr-19	14-Jun-19	-36	E	Roof- Right a	e de					
Side Walts - Ri	light zide	06-Apr-19	10-Jun-19	29Apr-19	21-Jun-19	-33		Sicio Waltz -	Flight side					
Dome Structure	reenciced	15 Apr-19	14-Jun-19	20.0 - 10		-27	b	 Dome Structure 	reencitized					
Roof - Right sk	in de	15 Apr-19	17-Jun-19	25Ap-19	25-Jun-19	-35		Boot-Lefts	tan tuide					i I
Installation of a	temporary facilities contractor	10-May 19	24-Jun-19	04 Jun 19	15-Jul-19	-15		- Installate	n of temporary facilities co	rbacky	1	i i		
Scaftoking par	rtial damounting	25-Apr-19	25-Jun-19	05-Jun-19	05-Aug-19	-36		Scatt	king partial demounting		i			
Rich side		25-Apr-19 25-Apr-19	25-Jun-19 27-Jun-19	30Apr-19 30Apr-19	25-Jus-19 01-Jul-19	-35	li li	Bat atta	1		1	1		
Transportation	to the Sile (Containers Vescels, S	17-May 19	01-Jul-19	04 Jun 19	15 Jul 19	-32		Tanac	tation to the Sile (Containe	ra Waxaala. Several ahipme	(m)	1		
Aperture shute	br	02-May-19	09-Jul-19	06-Jun 19	06-Aug-19	-36		Apert	are shutter					
All hardware de	ense ed to LSST at Arkie port - Co on Preight from Crossingly in Pro-	21-Mars 17	11-34-15	05 May 19 25 Jun 15	10-Jul-19 20-Auro-10	-17			re delivered to LSST at Avi A Destination Provide Income	is port - Complete Iosuinto lo Summit - 20 Pe				
Power supply a	system availability	ar may 10		04 Jun 19	15-Jul-19	-15		Power at	oppy system availability	- and Photos and an and the - and Photos	T	1		i
Targets installe	ed in the Pier (By LSST)			04 Jun 19	18-Jul-19	-23		Targets	nabiled in the Pier (By LSS	in)	1	1		i
Dimensional Co	control of the pier (By LSST)			04 Jun 19	15-Jul-19	-15			mai Control of the pier (By I	.551)	1	1		i
Compressed at	ay an managany ar system arabbity			04 Jun 19	18-Jul-19	-15			cong system availability		1	1		
Plur platterns a	and stairs wady for TMA installatio			04 Jun 19	18 Jul 19	-23		P r par	orms and stairs ready for T	MA installation (By LSST)	1	1		
Plan ready for 1	TMR installation, including safety m			04 Jun 19	18-Jul-19	-23		Perma	y for TMA installation, inclu	ding astely measures	1	1		
Dimensional Co Of surply cont	Control of the machinery room (By L Instant lines through the Australian III			04 Jun 19 04 Jun 19	18 Jul 19 18 Jul 19	-15			nal Control of the machine	ry noom (By LSST)				
Dome available	ily (all doors, rotation system, upp			04 Jun 19	18-Jul-19	-15		Dom a	slabily (all doors, robiles	system, upper crane, HVA	aysism)			
Siberación a	azilary cranes, man lifs, etc. avails			04 Jun 19	18-Jul-19	-15		50.000	tion auditary cranes, man il	ts, etc.availability				j
UTE Material a	and Tools at Sile			04 Jun 19	15-Jul-19	-15		a uteres	erial and Tools at Sile					
Availability of the Donte Roor Tel	In wachinery Room for OSS install descore maintenance definers and			04 Jun 19 04 Jun 19	15-Jul-19	-15			y or the Machinery Room fo	olation and MIMI Merry	Cart Rais installed	1		
Costing Charts	ber crare and area for azimuth ring	05-Jun-19	19-3-6-19	05 Jun 19	19-Jul-19	-15		Hann	Chamber crane and area to	r azimuth ring segments to	pustorage and MIMD Mirror surrogate mass Cart Rs	de inst.		
Lift mady for us	are and MIMB Mirror Cart Rails inst			05 Jun 19	19-Jul-19	-15			for use and MIMD Mirror (Cart Rate installed		1		i
Mirror cart rails	a at Telescope Maintenance Platfor	05. hrs. 10	15.14110	05 Jun 19	19 Jul 19	-15		DATO C	ert raits at Telescope Mainte	nance Platforms installed				
Dome Substant	rines places at talk (Pirst Vessel) ritially Complete	05-345-19	19-30619	11-Jun-19 05-Jun-19	25-34-19 05 Aug-19	-31		LTHE	of the TMA pieces at Site (Substantially Complete	FEEL WALKER	1	1		i
TMA- 30 x Cor	ribaine ra	29-Jun-18	21-Aug 19	29-Jun 18	21-Aug-19	-58		241	- 30 x Containers		1			
TMA Marine Sc	avey & Cargo Inspection	09-Jul-18	29-Aug 19	17-Jul-18	06-Sep-19	-58			MAMarine Survey & Cargo	Impection	1	1		i
Telescope Mos	unt On Sile	(T.)	00.5	17-Jul-18	06-Sep-19	-55			elescope Mount On Site			1		
Installation of #	the Toppie Block (support beam and	17-Jun-19	09-Sep 19	24 Jun 19	15 Sec-12	-55			Installation of the Travel The	rabilatxib starb xk (autoort been and one	the assembly in the Pler			! I
Admuth Cable	W rap installation	18-Jun-19	09 Sep 19	20 Sep-19	12 Dec 19	-58			Azimuth Cable	Wrap installation		1		
installation of \$	the support structures (upper and i	18-Jun-19	09-Sep 19	03-Jul-19	23-Sep-19	-58			installation of the support	structures (upper and lowe	over in pier platforma	1		
Final verticato	an MIMI Mana Gammada Mara D	25-Jun-19 25-Jun-10	17-Sep 19	25 Jun 19	17-Sep-19	-33		I INH.	Pinal verfication	Description of the second	the Cardina Directory	1		; I
Installation of t	the anchor bolts on the four sectors	00-14-19	24 Sep 19	05 Jul 19	25 Sep-19	-55		1 11	installation of the anchor it	ror surrogate Mass Cart al xola on the four sectors	ne county chamber room			
Transport to the	te Dome Brough the M and Instala	08 Jul 19	25 Sep 19	09 Jul 19	27-Sep-19	-58		1 191	Transport to the Dome th	rough the lift and instalation	the four sectors over the Pler			
Low ling and a	digmet	10-Jul-19	30-Sep 19	11-Jul-19	01-Dci+19	-58			Leveling and alignmet		1			
Dollad junction Dimensional co	a between the four sectors ontrol and readiastroant	12-34-19	09-Oct-19 04-Oct-19	15 Jul 19	09-Dc8-19 07-Dc8-12	-55		"ਈ	Distance in the second	the four sectors	1	1		i
First Grouting	ana ang magan 27075	18 Jul 19	08-Oct-19	22 Jul 19	10-Oct-19	-58			First Grouting		1			
Anchorage alig	ids to the embedded boils at machi	15-Jul-19	08-Oct-19	31-Jul-19	21-Oc8-19	-45		¶-	Anchorage skids to be	e e mbedded bolts at machi	ery room	1		
Dimensional co	ontrol and the buning	25 Jul 19	11-Oct 19	24 Jul 19	14-Oc8-19	-58		#	Dimensional control an	d the turing	1	1		
Installation of P	the spinuth spisi hydrophic basels	25-34-19	15-06-19	30-Jul-19 30-Jul-19	15-06919	-56		🛍	Instabilize of the write	uth axial hydroxiatic in erice	and of firs bickness sensors over the actruth rive			
Connection to t	the oil supply and return pipes	25 Jul 19	15-Oct-19	31-Jul-19	21-Dc+19	-45		⊪⊾-	Connection to the oil :	supply and return pipes				
Installation of t	the of return collector and connecti	25-Jul-19	15-Ocl-19	03Aug-19	23-Oci-19	-56		¶-	Installation of the oil m	turn collector and connect	on with the oil return pipe	1		
Weided junction	ons to been sectors (as al weld)	25-34-19	15 Oct-19	30-Jul 19 01-Aug. 10	15-Oc8-19 23-Oc4-12	-50		P	Welded junctions betw	een aectora (aeal weld)	1	1		i
Power supply a	and signal connection	01-Aug-19	22-Oct-19	14Aug-19	04 Nov-19	-45		🖡	Power supply and s	ignal connection	1			
Piral writeato	2n	09-Aug-19	25-Oct-19	06Aug-19	25-Oc8-19	-58			Pinal writication		l	1		i
Installation of t	te simuth braie dak	05 Aug-19	24-Oct-19	07Aug-19	25 Oct 19	-56		🕈	installation of the axis	nuth brake dark				
Admuth Main D	Drives magnets (rolor)	07-Aug-19	25-0d-19 25-0d-19	09Aup-19	30-Dcl-19	-33			Atimuth Main Driver	much riedau tychostatic bas magnetic (rotar)	rings and of fim Dicipiess sensors over the astructure	-		i
Support A insta	alation over the azimuth ring and is	12-Aug-19	31-Oct-19	14Aug-19	04 Nov-19	-58		🕻	Support A installation	n over the azimuth ring and	emporary restrains	1		i
Support 5 insta	talation over the azimuth ring and to	15-Aug-19	05-Nov-19	16Aug-19	05 Nov-19	-58		🖡	Support 5 installate	n over the azimuth ring and	temporary restrains	i		i
OSS Central a	yalam	15 Aug-19	05 Nov 19	10 Sep 19	09 Dec 19	-45		111	OSS Control ay	alam in the second s		1		
Central Neel Br Installation of t	even excession (with capacitor bar the azimuth brailes calibers	12-Aug-19 20-Aug-19	05 Nov 19	25Aug-19 25Aug-19	13-Nov-19	-58		11	Installation of the s	examples (with capacitor b simultibration callmer?		İ		i
Houses from the	e grinuth cable wrap to the grinut	20 Aug-19	05 Nov 19	05 Sep-19	21-Nov-19	-39			Hoses from the a	cirruits cable wrap to the ar	muth and elevation hydrostelic pada and manifolds in	della dice		
Bolling Central	Neel Beam with SupportA and Su	21-Aug-19	11-Nov-19	27Aug-19	15-Nov-19	-58		4	Bolting Central Ne	I Dearewith SupportA and	Support 5			
Installation of B	the azimuth horizontal and vertical a	25 Aug-19	15 Nov 19	03-Sep-19	21-Nor-19	-55			Installation of the	stimute horizontal and verti	ital asiamic alopa	1		
Citode Pays are	a paper over Azmith Shuchre aA & Bover the azimuth ring and h	04 Sep-19	20-NOV-19 20-NOV-19	10-Cd5-19 09-Sep-19	27-Nor-19	-55			Circular bearry	A & B over the azimuth rive	ind bolling to Supports A& 5	1		
Cables (power	& communication) from the azimut	04 Sep-19	29-Nov 19	09 Sep 19	27-Nov-19	-39			Catha (power a	communication/ihom the a	muth cable wrap to the hydrostatic pade and manifoli	de installation		
Installation of 2	the elevation radial and axial bearing	06-Sep-19	25 Nov 19	09-Sep-19	27-Nov-19	-37			Installation of the	elevation radial and acial b	arings and oil film thickness aeroors	1		
Pintverficator	in of the Astmuth Situcture main pa	10-Sep-19 10-Sep-10	09-Dec-19 09-Dec-19	11-Sep 19 23-Sep-19	05 Dec 19	-58			First writeator	of the Azimuth Structure m	in parts azimuth cable wrap to the elevation betweek in such	and manifolds invitability		
OSS functional	dy writestors	11-Sep-19	03-Dec-19	17-Sep-19	09 Dec 19	-45			OSS functions	By vertications	and the second state of the second seco	A CHARTER AND A CONTRACT		
Installation of 2	the elevation locking pins	12-Sep-19	04 Dec-19	19 Sep-19	11-Dec-19	-58			Installation of t	te elevation locking pina	1	1		i
Cabling & pipin	ng connections over Azimuth Struct	12-Sep-19	04 Dec-19	10-Dcb-19	06-Jan-20	-58			Cabling &	piping comections over Azi	uti Stucture			
Floor support a	structure & floor (including Az. Hals be of return tray	12-Sep-19 17-Sep-10	04 Dec-19 09 Dec-19	15 Sep-19 23 Sep-19	06 Dec 19	-55			Picer supports	Buckets & Boor (IncludingA	- Halches)			
Electrical cable	ina Laydown Phase 1	17-Sep-19	09-Dec-19	25 Sep-19	17-Dec-19	-30			Electrical cat	the Laydown Phase 1	1			
First Start-up C	Oil System (Azimuth aste)	15 Sep-19	10-Dec-19	19 Sep-19	11-Dec-19	-45			PirstStarkup	Dil System (Azimuth atik)	1	1		; I
Installation of B	be MIMI Minor surrogale mass a	20 Sep-19	12-Dec-19	27-Sep-19	19-Dec-19	-58			Installation of	tes MIND Minor surrogale	mass supports (four) over the azimuth floor	Ì		i
Assembly of the Installation of a	ne en MO Meror surrogais mass o. Si drain hoses is beeen ol a bro in	20-56p-19 24-56p-19	12-Dec-19 15-Dec-19	02-04-19	24 Dec-12	-45			Assembly	of the MIMD Mirror surroga	e mass outside the Dome Indum hay / arisedb track and of others out-	1		i
Mechanical Inte	brisce with az inuth cable wrap	24 Sep-19	15 Dec-19	02-Dch 19	24 Dec-19	-55			Mechanical	interface with azimuth cabl	wrap	1		
Installation of d	oli dhain pipea ta tween eilevation azi	24 Sep-19	15 Dec-19	02-Dch-19	24 Dec-19	-50			installation of	f oli drain pipez bebeen ek	vation axis and oil return tray	1		i
Hoses from the	e grimuth cable wrap to the elevab	24-Sep-19	15 Dec-19	07-Dd+19	31-Dec-19	-39			Homes from	the samuth cable wrap to	the elevation hydroxistic pads and manifolds instellatio	1		; I
Electrical cable	as controllion Phase 1	25-Sep-19 25-Sep-10	15 Dec-19	25 0 6 19	17-Jap 20 02-Jap 20	-30			Contraction of the section	scable conscion Phase 1 ables Justices Phase 7	1			
Installation of a	supports for elevation structure inst	30 Sep-19	29 Dec-19	01-Dch 19	25 Dec-19	-55			Installation of	aupports for elevation stru	ture installation	1		
Installation of h	hard stops for MIMD Mirror surrog	09-Dch19	24 Dec-19	09-Dch-19	24 Dec-19	-58			installation of	f hard slope for MIND Min	r surrogale mass cart			
Ladders, walk	ways, field platforms and floor halo	05-Oct-19	27-Dec-19	09-Dol+19	00 Jan 20	-55			Ladders, w	aller sys, feed platforms an	Nor halphes	1	1	. I



mantly i		Start	our t	Finish	r mari	Ficel	F	8 6	FQ4	F01	FO	22 F09	3 FOA		F01 F02 F08 F04	FQ1 F02	F03 F04	F01
	Installation of the TENNIKER MCS cabinet	05-Dct-19	27-Dec-19	07-Och 19	31-Dec-19	-58	- r			H	Instal	distion of the 12	NNIKER MOS	5 cats	nd rate rate			
	Electrical cables Laydown Phase 3	04-Oct-19	30-Dec-19	18-Oct 19	14 Jan 20	-8				_ 411 -	De	ctical cables L	Laydown Phase	an 3				
	installation of the limit switches supports	05-Oct-19	02-Jan-20	14 Oct 19	06 Jan 20	-58			. i	ų n	inter la	tallation of the lit	mit switches au	upport			i	
	Installation of the displayable platforms (2)	10-Oct-19	05-Jan-20	10-Oct-19	05-Jan-20	-50			į	H II	Insta	alation of the d	epky able platfo	formed	2)			
	Dimensional control & inspection	15-Oct-19	09-Jan-20	22-Oct-19	15 Jan 20	-58				- W •	Die	mensional cost	tol & inspection	on i				
	Admußt structure verified over the Pier	25-Oct-19	17-Jan-20	25-Oct-19	22-Jan-20	-58					A2	attruth structure	e verfied over t	r the Fe				
	Electrical cables correction Phase 2	24-Oc819	21-Jan-20	07-Nov-19	04 Feb-20	-30					۰,	Electrical cable	at conscion Ph	Phane	2			
	Elevation Dearings adjustment	25-Ocl-19	23-Jan-20	05 Nov-19	05-Teb-20	-58					۰,	Cevelon Deari	ings adjustment	et i				
	Installation of the M1M3 Mirror surrogate mass of	04-Nov-19	30-Jan-20	05 Nov-19	05 Peb-20	-58				<u> </u>	- P -	Installation of 2	he MIMS Mirror	ror aug	ogele mass over the four supports on the spimuth for			
	Installation of Trunnion A+ Cradils + Brake dark or	07-Nov-19	04 Pab 20	05 Nov-19	05 Peb-20	-58				-	10	Installation of T	Trunnion A+ On	onda į	Drake dark over provisional supports and bearings			
	MIM3 Cover energizing	07-Nov-19	04 Peb 20	11-Nov-19	05 Peb-20	-39				- h.	12	MINE Cover e	minghing					
	Electrical cables conscion Phase 3	05-Nov-19	05 Peb 20	16 Dec-19	11-Mar-20	-30				- F-	Ηe	Electrical	cable a conscio	ction Pi	tana 3			
	Installation of Trunnion 5 + Grade + Braie dak or	12-Nov-19	07-1*eb 20	12 Nov-19	07-1*eb-20	-55				5	Ш.	Installation of 1	Trunnion B + Cr	Crade	+ Braile dak over proviational supports and bearings			
	Trunniora (Elevation axis) first alignement	13-Nov-19	10-Feb 20	15 Nov-19	12 Feb-20	-55					11.	Trunniens (C)	keration axis) fit	finial	permit			
	Installation of the Central Section Brace A + MIM	15-Nov-19	15-Feb 20	21-Nov-19	15 Peb-20	-58				- 14	11.	Installation of	fite Central Se	Sector	Brace A + MIMD Pylone + active balancing system			
	Installation of the Central Section Brace 5 + MIM	22-Nov-19	19-Feb 20	25 Nov-19	21-Feb-20	-58				- 14	1	Installation of	of the Central S	Sector	1 Brace B + M1MB Pylone			
	Central section fanges bolled.	22-Nov-19	19-Feb 20	25 Nov-19	29-Feb-20	-55				- 19	¥L .	Central and	ion fanges boli	olled				
	Prep.of the ass.of the Spider Spindle&Arms+Top	25-Nov-19	29-Feb 20	10 Dec 19	05-Mar-20	-55				- 1	t -	Prep.of the	e ass. of the Spi	ipider D	pindie Mrms+Top End Ring Battle +Offse täinlegrator2	+Carnera surrogate mass+M21	urrogate maa	
	Boling the Gradies to the Central Section	25-Nov-19	21-Feb 20	02 Dec-19	25 Feb-20	-45					H '	 Bolling the (Oracles to the O	Centr	al Section			
	Verification of the elevation locking piral and centr	05 Dec-19	02-Mar-20	05 Dec-19	02-Mar-20	-45					Ħ.	Verification	of the elevator	ton loca	ing pins and central section inmovilization			
	installation of the circular platform	05 Dec-19	00-Mar-20	05 Dec-19	05-Mar-20	-46					¥ .	Installation	of the circular	er platte				.
	Elevation and vertication and reference with autor	05-Dec-19	00-Mar-20	10 Dec-19	05-Mar-20	-46					₽.	Clevator a	pts writication.	n and	elerence with azimuth axis			
	Installation of the four Top and parts	11-Dec-19	06-Mar-20	15 000-19	10-Mar-20	-46					Þ.	Installatio	n of the four To	Topers	i piera			
	Comprisined air system installation over the TMA	11-Dec-19	05-Mar-20	29-Jan-20	29-Apr-20	-50					P	6	represented as any	ay size of	Installation over the TMA			
	Camera refigeration system over the TMA	11-Dec-19	05-Mar-20	29-389-20	29-Apr-20	-50					1	- 1	mera mitigerab	ation a	alem over the TMA			
	Dran system installation over the TMA	11-Dec-19	05-Mar-20	25-385-20	20-Apr-20	-30					P		an system insta	21112	nower the TMA			
	Cooling system instantion over the TMA	11-040-12	00 Mar 20	20 100 20	20 Apr 20	- 30					E-		oing system ins	inter Selling	on own the TMP.			
	Upper langer	12 000-12	00 Mar 20	10 000 10	10.14-20						Π.		takine cooling a	2 al y a de	nowr the TMA			.
-	Cable have and observator Research sharts and	13 Dec. 19	05 Mar. 20	72 Dec 19	20 Mar. 20	-45					E.	Cable	resource and pipers of	أست	Section shuthers			
-	Cables & sinise consultant out Placette shut	13.Dec.19	05 Mar. 20	27 Dec 19	20 Mar. 20	-45					E	Contact.	A nitition common	_	mer Realize shuthre			
-	Installation of power distribution cabine to	12 Dec-19	09-Mar-20	27 Dec-19	20-Mar-20	-45					H	Installet	ton of power da	California de	ion cabina b			
	Installation of the Mid Level Light Safe (four sect	15 Dec-19	11-Mar-20	16 Dec 19	11-Mar-20	-45			į		ų.	Installet	n of the Mid law	evel 1	tit Galle (four sectors)			
	Install of the ass, of the Spider Spindle &Arms+Ti	17-Dec-19	12-Mar-20	17 Dec-19	12-Mar-20	-45			- 1		₩.	I look at	to an of the	a Seat	Spindle & Arms+Top End Rins Ballie-Office & Intern	stor2+Carters surroo mare-M	ALTON.	
	Elevation Main Drives magnets (rotor)	17-Dec-19	12-Mar-20	25 Dec-19	15-Mar-20	-45					Щ.	Devator	Main Drives m	magn	da (rolor)		-	
	Bolling the M1MD Mirror surrogale mass to the fo	18 Dec-19	13-Mar-20	19 Dec-19	15-Mar-20	-5					H	Batting	te MIMS Mirror		gale mass to the four MIMD pylons			
	installation of the elevation brake calipera	18 Dec-19	13-Mar-20	19 Dec-19	15 Mar-20	-45			- 1		H.	Installed	on of the elevel	ntion br	ale calipera			
	Installation of provisional devices the elevation str	18 Dec-19	13-Mar-20	18 Dec-19	13 Mar-20	-8						I Installed	on of provisional		ces for elevation structure rotation			
	Installation of the M1MB Covers	19 Dec-19	15-May-20	06-Jan-20	27-Mar-20	-8			į.		9	- Installe	don of the MIN	MBC	NAL 2			
	Elevation Cable Wrap chains	29 Dec-19	17-Mar-20	24 Dec-19	19 Mar-20	-45			1		ų,	Division	n Cable Wrap o	chairs				
	Dimensional control, balancing & inspection.	27-Dec-19	20-Mar-20	31-Dec-19	24 Mar-20	-5					H.	Dimension	konal control, b	bahr	ing & inspection.			
	Hoses and cables connections	27-Dec-19	20 Mar 20	10-Jan 20	02-Apr-20	-45					- ##	Hone	and cables co	come	Bons			
	Dimensional control & inspection & Azimuth & eler	30 Dec-19	23-Mar-20	02-Jan-20	25 Mar-20	-6					-щ	Dimension	ional control &	ā iraņi	ction &Azimuth & elevation & optical ages verification			
	Admuth Main Drives abelons	07-Jap-20	30-Mar-20	13-Jan 20	03-Apr-20	-8			- i		- 4	Azinu	th Main Drives	e state				
	Elevation Main Drives stator	10-Jan-20	02-Apr-20	16-Jan 20	08-Apr-20	-45					- 4	Berger	don Main Drive	ina até	br			
	MCS & IS integration and writication	30-Jan-20	21-Apr-20	16Apr-20	06-Jui-20	-58			. i				MCS &	6 IS 6	legration and verification			
	Power supply connection	19 Feb-20	11-May-20	25 Peb-20	15 May 20	-45			i				Power supply of	y cann	ction			
	Cooling water connection	19-Feb-20	11-May 20	25 Peb-20	15-May-20	-45						- # # 1	Cooling water of	r cons	cian			
	Main drives and Capacitor Banks start up (PHAS	25-Peb-20	15-May-20	11-Mar-20	29-May 20	-45						_ 4 5 P	Main drives a	a and $\hat{\mu}$	apacitor Banka start-up (PHASE visit)			
	Aztmuth tape	12-Mar-20	01-Jun-20	12 Mar-20	01-Jun-20	-45			i			- 1	Azimuth tape	en i				
	Admuth Scienting heads	13-Mar-20	02-Jun-20	16 Mar-20	05-Jun-20	-45						~ 놀!	Azimuth Sci	kami	g heads			
	Elevation tapes	17-Mar-20	04-Jun-20	20 Mar-20	09-Jun-20	-45							Devation to	tapa n				
	Elevation Scanning Islada	23-Mar-20	10-Jun-20	24 Mar-20	11-Jun-20	-45			i			2	Devation 5	1 Scare	ing heads			i I
	Power supply connection	25-Mar-20	12-Jun-20	25 Mar-20	12-Jun-20	-45						ㅋ	Power sup	upply in	ormet ben			
	Connection to the electronic card	25 Mar-20	15-Jun-20	02Apr-20	22-Jun-20	-45			1				Connecti	ction to	the electronic card			
	Mount installation Ready for AZ MIMD Surrogate			16Apr-20	06-Jui-20	-52			i			-	Mount	nt insta	lation Ready for AZ M1MD Surrogale	i		i I
	Final TMA assembly at 5th - Complete			16 Apr-20	05-Jui-20	-52							 Pinal T 	TAA	asently at Site - Complete			
	M1M3 Gell w/Surrogate Mirror on TMA Texting	17-Apr-20	07-34-20	01-Jun-20	17-Aug-20	-42			. j				T		Cerwiserogen Mitter on TMA leading			
	Telescope balancing	17-Apr-20	07-34-20	17Apr-20	07-Jui-20	-58			i			-	Taikao	100,00 2	alancing			
	Power supply and databution system performance	17-Apr-20	07-34-20	29Apr-20	10-Jul-20	-58			1				Rower	er eug	ely and distribution system performances			
	Plat systems is adgrithese is above the TMA.	17-Apr-20	07-34-20	21-Apr-20	09-Jul-20	-50			- i			1	Fluid a	1 and to be	ra leaköphteess bats over tin TMA rei MIMI Gell af Secondala Minne on TMA Teating			
	Support M1MD Gell w/Surrogate Mirror on TMA 1	17-Apr-20	07-34-20	01-Jun-20	17-Aug-20	-49			i					. 111				
	Mount Control by stem test 1 Interfacts autobar water to best 1	25-Apr-20	15-33-20	15 May 20	27-38-20 04-8 up. 20	-50									ontrol bystem text 1			
	OSS and belowing system and the direction of each	US May 20	05 Aug 20	25 May 20	104.00.20	-42			1						CARRY BYSERIES BALL			
	Text work (Drawt Finish)	15 May 20	05 Aug 20	07400-20	25.0-120	- 22			i					U S S	The hydrostatic beamings vertication or performances	i	i	i
-	Televice and	23 May 20	Huders 20	25 May 20	13405-20	-42								-	istingors (Hogetrinan)			
-	Franks worth alter of rachemannas	25 May 20	15 Aug 20	25 May 20	154.05.20	-42			1				E L		and the state of t			
	Main Driver and recoverable brack wellington:	27. Mars 20	14.4.00.20	Ob. http://do	154.00.20	42			i				EL.	11	The standard management is been in an effective of each ere			i
	MIM3 cell and surrogate minor removal from TMP	02-Jun-20	15 Aug 20	09-Jun 20	25-Aup-20	-50							- T	MIL	E cell and surrogate mirror removal from TMA			
	Carrers assembly surrocate removal from TMA(02-Jun-20	15 Aug 20	08-Jun 20	24Aup-20	-33							- 14	Cash	are assembly surrogate removal from TMA (with cam	era cable wrap)		
	Admuts cable wrap writication of performances	02-Jun-20	20-Aug 20	05 Jun 20	25-Aug-20	-42			i				L 11	i	th cable wrap well callon of performance a		i	
	M2 Hexapod installation on TMA	09-Jun-20	25 Aug 20	15 Jun 20	31-Aug-20	-33			- 1				_ Ľ₩	M2	lexapped installation on TMA			
	M2 Safe Ready for Shipment (Misstore)			31-May-19	25-Aug-20	-50								 Most 	afte Ready for Shipment (Milastone)			
	M1M3 mirror installation into mirror cell	10-Jun-20	25 Aug 20	02 Jul 20	15 Sep-20	-50			į				_ He	🖷 İ	110 mirror installation into mirror cell	!	i	
	M2 Safe Inland Preight from Rochester, NY to U	03-Jun-19	25-Aug 20	14-Jun-19	09-5ep-20	-50		 	- 1					•	Ballie Inland Preight from Rochester, NY to US Loca	Part		
	Telescope range of movement	08-Jun-20	25-Aug 20	09-Jun-20	27-Aug-20	-42							- <u>5 (</u>)	-	cope range of movement			
	Elevation cable wraps verification of performances	10-Jun-20	25 Aug 20	10-Jun-20	25-Aug-20	-42			ļ				<u> </u>	• mi	don cable wraps writication of performances		ļ	
	Active balancing system verification of performan	11-Jun-20	31-Aug 20	11-Jun-20	31-Aug-20	-42			į.				늘비	Act	e salancing system verification of performances			
	M1M3 Cover verification of performances	12-Jun-20	01-Sep 20	15 Jun 20	09-Sep-20	-42							느님!!		ID Cover verification of performances			
	Support for M2 Hexapod installation and least on 1	16-Jun-20	01-Sep 20	23-Jun 20	08-Sep-20	-33							- I "Ħ	13	opers for Mic mecapod Installation and lexit on TMA			
	Carters cable wrap verification of performances	15-Jun-20	03-Sep 20	16-Jun-20	c8-5ep-20	-42			1				- P	9	was cable wrap writication of performances			
	unpoyable pattern verification of performances	17-349-20	04-sep 20	224 JUB 20	10 Sep 20	-42			. j				- 12	1	picyste platform verification of performances			
-	IC IV relation with cable wap and electronics	23-345-20	09-54p-20	29-309-20	15 Sep 20	-24									M2 TMA and Dome Creatives			
-	Marine Come Operations	23-345-20	40 Co 20	14Aug-20	-UP NOV-20	-30			1									
-	we calls Ucean megnt from Rochester, NY to (17-205-19	10 Sep 20	21-345-19	10 Sep 20	-50		17	1					11	a same O dean Freight from Rocheater, NY to Coquir	100 C		
	Carrier's / Mc random soliverfication of performs Mount Control Scalars (end 3	20-305-20	11-cep-20	23-345-20 05-14-20	11-cap-20	-42							t i	1	in all Cashel Bushes had 2			
	carries control of an in all 2	30-he-20	15.5co.20	72.14.00	13.0-120				1				1-1	Щ.	comerce control system start 2 comerce robotic and heavened installation on interest	no structure	i	
	Summit Manipulation DMM Environment, Tax's Children	Of Dec. 10	17-5ep 20	12.449.00	25.0-120	-26							- 11 1					
-	M2 Dath Destination Provide transmission in Chilling	24,345,115	17-See 20	15-34610	05/04/20	- 39		ΙL	. 1		-			12	M2 Baffe Destinging Posibilities Conductor In			
-	MIM3 mirror classics and coaling	05,14,00	21.5ap.20	25,14,25	09-0-6-20	- 30		I P	· 1					44	MIMD minor cleaning and coating	-		
-	Interlock salely avails milwet 2	07-34-20	25 Sen 20	15 Jul 20	05-0-4-25	-42			1				عيا ا	CT T	Interfacts autobary to a 1 2			
	Establish post-TMR Summit Pacility Performance	15 Jul 20	05 Oct-20	14Aup-20	04 Nov-20	-22							17	FT4	Establish posk TMA Summit Facility Performance	a Casteline		
	M2 Safe Marine Survey & Cargo Inspection	12-Jul-19	05-Oct-20	17-Jul 19	09-Oct-20	-50			. I						Millighte Marine Survey & Caroo Inspective			
	Telescope performances and long duration tests	17-Jul-20	07-Oct-20	29 Jul 20	07-Oct-20	-42			_				14	L.	Telescope performances and long duration leafs			
-	Mirror Integration and Coating Complete			23 Jul 20	09-Oct-20	-17							1 1	LI I	Minor Integration and Coating Complete			
-	M1M3 baffe installation	24-Jui-20	12-Oct-20	30 Jul 20	15-Oct-20	-50			- 1				- 1 P	7#	MIMI battle installation			
	M1M3 cell preparation after costing	24 Jul 20	12-Oct-20	30-Jul 20	15-Oct-20	-47			i i					₩	MIMD cell preparation after coating			
	TMA Contract Complete			07-Aug-20	25-Oct-20	-57								لليا إ	 TMA Contract Complete 			
	TMAVendor Complete			07-Aug-20	25 Oct 20	-55								🖽	 TWA Vendor Complete 			
	Text campaign completion on site - Complete			07-Aug-20	25-Oct-20	-58			i i					I P	 Test campaign completion on site - Complete 			
	Telescope Mount Pab Contract Complete			07-Aug-20	25 Oct 20	-58			1					I B	Telescope Mount Pab Contract Complete			
	M1M3 installation on TMA	10-Aug-20	29-Oct-20	21-Aug-20	11-Nov-20	-55								I I	M1M2 installation on TMA			
	Laser tracker and SMR installation and text	10-Aug-20	29-Oct-20	19Aug-20	09-Nov-20	-58			- 1						Laser tracker and SMR installation and text			
	Calibration Screen Reflector and Screen Charact	10-Aug-20	29-Oct-20	14 Sep-20	04 Dec-20	-45			1						Calbration Screen Reflector and Screen C	varacterization Hardware install	on T'MA	
	Support M1M3 installation on TMA	10-Aug-20	29-Oct-20	21-Aug-20	11-Nov-20	-55			į.					ΙĶ	Support M1MD installation on TMA			
	Install and Perform MS Horizon beiling with SHW	13-Aug-20	03-Nov 20	10-Sep-20	09-Dec-20	-58									Install and Perform MD Horizon leading with	shwirs		
	M2 Installed on Telescope	17-Aug-20	05-Nov-20			-33			1					Ц	42 Installed on Telescope	a second		
	post TWA Summit Pacility Performands Analysis	17-Aug-20	05 Nov 20	16-Sep-20	08 Dec-20	-22			. į				T		pour rescuence racey renormance An	-1		
	Telescope Ready for 3-mirror Teating			21-Aug-20	11-Nov-20	-37								-	Telescope Ready for 3-mittor Texing			
	M1M3-Cell Integrate & Facility Ready for Camera			21-Aug-20	11-Nov-20	-10								🖡	M M3-Cell Integrates' Facility Ready for Care	ra Delly		
	M1M3 Communication Text	24Aug-20	12-Nov-20	04 Sep-20	25-Nor-20	-25			- 1				I		annu communication liket			
	3-Merror Optical System Ready for Texting	24 Aug-20	12-Nov-20			-40									 Herror Optical System Ready for Testing 			
	Support MIMD Thermal Texting on TMA	24 Aug-20	12-Nov 20	02 Nov-20	27-Jan 21	-55			i					L İ	Support MIMD Thermal Testing on	1995		i I



Activity Name	BL Project Start	Start	BL Project Finish	Finish	Float	FY2019	08	F04	FQ1	F02	FQ3	FOA	+	FQ1	FY2021 F02 F03 F04	FQ1 FQ2 F	03 F04	FY2023 FQ1
Interlock Texts with M1MD system	08 Sep-20	30-Nov-20	21-Sep-20	11-Dec-20	-25									- 11	PROFESSION AND A MANAGEMENT			
installation of camera accompty with camera roba	11-Sep-20	03-Dec-20	17-Sep-20	09-Dec-20	-58									I BL	installation of carriers assembly with carr	era robabe/hexapod and SHWPS		
Verification of Calibration Screen Burnination Unit	15-Sep-20	07-Dec-20	19-Oct-20	12-Jap-21	-45										Perform 5 minute on with Schultz	enation Uniformity	1	
Final Transition Verification Dealer Deparation	10-sep-20 15-Sep-20	10-Dec-20	220420	25-389-21 15-389-21	-30				1				į.	4	Final Transfort Verification Review	a paration	i	
Interlock Text Finished	to say as	10 100 10	21-Sep-20	11-Dec-20	-25									L. #	Interlock Test Pinjahed			
Telescope on-axis IQ demonstrated			29-0:4-20	25-Jap-21	-54									~4	 Telescope on-axis IQ demonstrate 			
ComCam installed on Telescope			29-0d-20	25-Jan-21	-53									_ 4	 ComCam installed on Telescope 			
Final Transition Verification review	30-Oct-20	25-Jan-21	05-Nov-20	01-Peb-21	-58				1					Ë	Pinal Transition Verification review			
Software Integration and Text Planning Package	05-Nov-20	01-Feb 21	05-Nov-20	01-Peb-21	-58				1					- H	Software Integration and Test Pla	ning Package		
T & S Company of Common	leeleelee		05 Nov-20	01-1*eb-21	-50				1				į.		T & S Completed			
Date Inchesion Engineering and Commission	Issivining		05 Jun 13	05 Aug 10				•	Landa Balance Date	hadrended Core								
Minor Interaction Completion			25.14.20	05-Aug-19	-30		-	· Long	COLUMN TAL	CARDINGS CON	ripe aut		_ •	Marrie Int	andro Correlati			
3-mirror Telescope Ready for Optical Testing	24Aug-20	12-Nov 20			-40				1			-	°Ľ	+=	monTelescope Ready for Optical Texting			
Telescope Approved for System I&T			05-Nov-20	01-Teb-21	-58								- 11	· .	 Telescope Approved for System I 	er i	1	
Shart Early Integration and Text	06-Nov-20	02-Feb 21			-58									- 6	 Start Early Integration and Text 		1	
Begin ComCam On Sity Use	06-Nov-20	02-Feb 21			-58				1					- 5	 Begin ComCam On Silv Use 			
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Initial TCS + DAQ W PS Interface Texts (N)	29-Nov-20	15 Feb 21	07 Dec-20	02-Mar-21	-55										Highl TOS + DAQ WPS Inter	sce Texts (N)		
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ComCam Electro-Optical Texts 2 (DN)	15 Dec-20	10-Mar-21	11-Jan-21	30-Mar-21	-55										ComCam Electro Optica	Texts 2 (D/N)		
AOS DataAnatysis 1	16 Dec-20	10-Mar-21	07-Jan 21	36-Mar-21	-45				1						AOS DataAnalysis 1			
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APP: tal-Scale Pre-Recovery Photometry Texts	13 Sep-21	03-Dec-21	10-Nov-21	02-Feb-22	-37				1							APP: MAG	als Pre-Recovery Phot	ometry Texts
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Report-676

7 Detailed Project Progress Status

Project Office

- The LSST Project Office (LSSTPO) focused on coordinating Construction activities and developing additional details of the Commissioning plan.
- The LSST2019 Project and Community Workshop's organizing committee held a kick-off meeting to begin agenda planning and to set a deadline for opening workshop registration. The workshop website is https://project.lsst.org/meetings/lsst2019/.
- The Identity and Access Management (IDM) system team received the committee report from the internal review conducted in March. The team provided a response to the report.

Safety

- LSST safety coordinators continued Summit site and Base Facility construction contractor inspections. Summit inspection reports and corrective actions can be found in DocuShare Collection-4422. Base Facility inspection reports and corrective actions can be found in DocuShare Collection-4863.
- Weekly Summit site coordination meetings and the monthly Summit Safety Meeting with contractor safety personnel continued. Topics of the meetings included work coordination, vehicle over-speed observations, correct use and observance of work area safety delimitations, status of corrective actions from inspections, and review of delivery work procedures. The reports and attendance records for the meeting can be found in Collection-5642.
- Safety coordinators continued ongoing safety orientation for visitors and LSST and contractor employees. This month, visiting Chilean television channel 13 and GEMINI Observatory staff received orientation.
- The Safety team instituted a new Safety Rules campaign. Safety Rules are intended to provide a guide for regulations and project standards in areas of critical risk. The first Safety Rule regarding assembly, disassembly and modification of scaffolds was disseminated over two weeks. The rule codifies that only certified professionals are authorized to perform any assembly, disassembly or modification of scaffolding. English and Spanish language versions of the rules are archived in DocuShare.
- Two accidents were reported this month. 1) An LSST employee lost control of his vehicle while driving to the summit site and went over the berm and down the slope. He was uninjured. The employee swerved to avoid an animal in the road. The driver and others who responded to the scene initiated proper protocols, including notifying ESACH Polyclinic staff, who confirmed the driver's lack of injuries. 2) An accident happened with the Camera work in France. See the Camera section below for details.

Compliance

• The Compliance and Quality Administrator (CQA) continued collaboration with the Information Security Officer (ISO) on a draft update to the LSST Information Classification Policy (LPM-122). A change request will be submitted in May. A procedure to supplement the



Report-676

updated changes is in progress.

• In addition, the CQA provided guidance on travel, information classification and personally identifiable information (PII) compliance.

Science

- University of California Davis (UC Davis) team members continued to assist with Raft Tower Module (RTM) channel loss mitigation activities at SLAC. The team disassembled and vacuum cleaned RTMs comprised of ITL sensors then performed electro optical (EO) testing with bias and dark images. The team successfully brought several dead channels back to life.
- The UC Davis team reviewed the available ITL charge coupled device (CCD) options for replacing the Auxiliary Telescope (AuxTel) spectrometer's CCD. The team also developed a plan to upgrade the AuxTel electronics to a new wavefront readout electronics board (WREB) plus a spare power supply. The replacement is being made because the AuxTel spectrometer currently uses an early prototype ITL sensor. It is the only one of its kind in service and has yet to be made to meet all performance specifications.
- Chief Scientist T. Tyson attended the annual National Academy of Sciences (NAS) 27-30 April meeting in Washington, DC. Several discussions were relevant to LSST, including the National Research Council (NRC) Decadal Survey plans involving complementary facilities or world coordination efforts.

Communications

- The Communications team had a strong presence at the NSF Large Facilities Workshop with Communications Manager R. Gill facilitating a focussed track on Education and Public Outreach (EPO), Communications and branding. Subsequent valuable discussion resulted in creation of a network for ongoing exchange of information.
- The team documented the M1M3 mirror's departure from Houston and the M1M3 mirror cell departure from CAID Industries in Tucson. The team also communicated the system components' progress as they continue their journeys to Chile.
- The post on LSST's Facebook page with a photo of the BBC Manitoba departing Houston with the M1M3 mirror safely secured in its hold reached the most users in April (7,654). The project's Twitter post with the same content was the most popular tweet, reaching 8,112 individuals.

Social Media Statistics												
Month	Facebook Likes	Change	Twitter Followers	Change								
April 2019	5,290	310	5,419	175								
March	4,980	108	5,244	177								
February	4,872	48	5,067	127								
January	4,824	78	4,940	126								
December	4,746	51	4,814	125								
November	4,695	133	4,689	189								



Report-676

October	4,562	135	4,500	136
September	4,427	104	4,364	122
August	4,323	96	4,242	184
July	4,227	52	4,058	52
June	4,175	85	4,006	109
May	4,090	39	3,897	129
April 2018	4,051	31	3,768	112

Systems Engineering (SE) and Commissioning

- The System Integration, Test and Commissioning (SIT-Com) team continued to support systems integration, performance analysis and commissioning planning. Several team members continued their roles as product owners for various Telescope and Site (T&S) software components. Science Validation efforts have been focused on developing simulated data sets to support validation development through Python Jupyter Notebooks with LSST software stack.
- SIT-Com lead and Systems Scientist C. Claver started analysing and optimizing assembly integration and verification (AIV) and Commissioning schedules to assess planning developed during the February AIV + Commissioning workshop. This work is being done in collaboration with T&S Scientist S. Thomas. A change request was submitted to initiate the evaluation process.
- SIT-Com has begun an update to LSST Optical Design document (LSE-11) that will reflect the asbuilt properties of mirrors and lenses. As part of this effort, Deputy Systems Scientist B. Xin cleaned up the integrated Zemax model. The latest version is v3.11. All versions are documented on both Confluence and DocuShare with notes, links to reference documents and Zemax files. LSE-11 will be updated to reflect Zemax model v3.11.
- B. Xin analysed the potential performance impact of a camera L1 lens radius of curvature nonconformance. Analysis demonstrated negligible system performance impact if compensated by adjusting the distance between the L1-L2 assembly and the L3 lens.
- Senior Systems Engineer M. Rodriguez launched a new Summit Planning tool to coordinate daily Summit-based activities and to link activities to JIRA epics and Primavera budget elements. The tool allows visibility into and coordination of various JIRA projects like IT, T&S Control Software, AIV and Administration using a consolidated calendar view.
- Assistant Commissioning Scientist B. Stalder successfully completed final software and performance on-sky testing of the portable differential image motion monitor (DIMM) on Kitt Peak with direct comparison to the Observatory's facility DIMM. Subsequently, the portable DIMM was packed and shipped to Chile for deployment in early June.
- The contract with Purdue University for Photon Simulation (PhoSim) development has concluded. PhoSim has the features necessary to support active optics system (AOS) simulations as well as commissioning and system verification preparations. The final invoice will be processed in May 2019.



Telescope and Site (T&S)

- The final signed documentation of contract termination was sent to Summit Facility general contractor Besalco. The balance of the remaining retention was sent 30 April, officially ending this effort. The Besalco work was completed earlier this year, but this final administrative step followed months of LSST staff completing a comprehensive review of all delivered documentation.
- Other summit site efforts this month resulted in completion of welding activities, completion of the Pflow contract, substantial completion of the summit warehouse to receive M1M3(Primary-Tertiary Mirror), and continuation of Pachón hotel addition. The team successfully completed Pflow vertical lift system final acceptance testing, including software debugging and carriage load testing at 25%, 60% and 100% (i.e. 85,600 kg) payload mass. Five repetition cycles were performed with the Pflow field service technician, including interfacing to the movable roof and testing of emergency stops. This is a major milestone. By the end of April, the summit warehouse was sufficiently completed for arrival and storage of the M1M3, which is in transit and due in early May. The seismic anchoring system design was completed. It will utilize concrete anchors and strapping to secure the transport box. The team anticipates the Pachón hotel four-room addition will be completed in July. A change order for additional excavation and concrete foundation work was approved.
- Five members of the T&S hardware and software teams met with Dome vendor European Industrial Engineering (EIE) senior engineers and management. The objective was to review the overall assembly sequence, to assess the level of dome control system development, to review the current logistics and shipping plans, and to visit and inspect the status of supply chain fabrication. LSST and EIE negotiated and completed a final round of change requests to incorporate design changes and to assist with timely acquisition of remaining hardware components. These negotiations should stabilize EIE cash flow and resume remaining supply chain activities. In Chile, an additional summit engineer was hired to assist the on-site team with work planning and steel assembly sequence preparation. Chilean vendor Faremin has fabricated and delivered all the remaining roof steel and missing purlin pieces. They are ready for EIE to install. This month EIE continued to focus on remaining structural steel, adjustment of the main support columns and erection of pieces for the main dome platform. Nearly all the vertical purlins were installed around the dome. Cladding is scheduled to begin in May. The project continues to seek ways to advance scheduled work on the summit, but approaching winter weather conditions, i.e. high winds, present challenges for the schedule.
- LSST and Telescope Mount Assembly (TMA) vendor representatives met in Chile to hold on onsite assembly, integration and test plan review. LSST also met with the crane vendor's technical agents to understand the requirements for all staging and critical lifts. Minor summit platform modifications will be made to increase laydown area and support crane staging. TMA system packaging continued in Spain. The oil supply system was loaded and shipped in April. Three shipping containers with the two mirror carts and mirror cover components arrived in Chile, were unloaded and stored at the AURA property gate. The overall TMA disassembly and shipping schedule is slipping, which will negatively affect the overall AIV workflow schedule. Updated schedules are due in May to assess this impact. LSST management is watching this closely as more delays will require further adjustment to the AIV workflow and activities. The TMA software review has been rescheduled for early June to accommodate LSST participation and to enable



additional development progress.

- The M2 (Secondary Mirror) team successfully integrated the M2 controller and established connectivity to the cRIO device via LabVIEW running on windows to upload the necessary compiled code. M2 cell and surrogate mirror functional testing commenced using the M2 cart. Individual actuator impulse testing and closed-loop verification testing were completed. Procedures were developed and reviewed to perform removal of the M2 surrogate. It will be used by the coating team to hold witness samples as part of the M2 coating verification. The M2 surrogate will be reinstalled in early May upon completion of the coating effort.
- On 7 April, the BBC Manitoba, carrying the M1M3 mirror and 23 packages of ancillary cargo including the mirror lifting frame and two TMA Dynalene chillers, departed Houston for Chile. The vessel is anticipated at the Port of Coquimbo the first week of May. Near the end of the month, the 52-ton M1M3 cell and two mirror surrogate sections departed Tucson via heavy lift trailer for Houston with arrival due on 2 May. Plans were made to assemble the M1M3 cart inside the summit support facility next month. A consulting contract was signed with K. Harris, who was the principle controls engineer to fabricate and test the cart at CAID Industries. He will travel with LSST personnel to Chile the week of 13 May to provide onsite supervision and instruction on assembly, operation and maintenance of the cart.
- Coating Plant vendor Von Ardenne (VA) continued on schedule to complete onsite assembly and verification activities. Following successful inspection and verification, the large M1M3 washing scaffolding was disassembled, and work shifted to M2 wash stand setup and process review. The VA technical team focused on coating process optimization, confirming operation of the magnetrons with successful demonstration of sputtering and coating of witness samples. The VA team believes the M1M3 samples will be ready for performance verification in early May. The vendor will then reconfigure the chamber using the M2 surrogate to complete M2 coating process optimization. Overall, VA remains on schedule to hold the final acceptance test 20-24 May in La Serena.
- Base Facility construction progress included finalization of utility work in buildings and at exterior areas, main electrical connection by the commercial power company, initiation of utility systems final testing, finalization of interior and exterior finishes, start of Data Center IT infrastructure installation, completed installation of a diesel tank for electrical generators and completion of landscaping and exterior development work. Occupancy planning included arranging master keying and adjustments to office assignments for LSST personnel and partners.
- The AuxTel team deployed a temporary mitigation to azimuth hysteresis that will allow on-sky testing to occur until a long-term solution can be implemented. The AuxTel dome motor alignment issue also was resolved. Calibration Hardware Scientist P. Ingraham visited Chile to coordinate activities and to successfully commence two axis slewing using the pointing component and mount control system. The AuxTel M1 mirror installation procedure was updated, and a demonstration with the surrogate was performed. Additional procedures to remove all the optics and cells will be verified with surrogates next month to prepare for optics integration.



Report-676

Camera

Systems Integration

• The Systems Integration team continued work on verification and test plans and acceptance reviews for various Camera subsystems.

Sensors

• Vendors ITL and e2v have completed and delivered all sensors per contract.

Science Rafts and Corner Rafts

Phased delivery of refurbished RTMs from Brookhaven National Laboratory (BNL) to SLAC continued. Thus far, five RTMs have been delivered to the IR2 cleanroom facility. Phased delivery is expected to continue into the third quarter of 2019. At SLAC, the Integration and Test (I&T) team will re-verify refurbished RTMs and prepare them for integration within the cryostat.

EO reverification of RTM1 showed all channels that were previously identified as dead were recovered and performed as expected; however, a single sensor has developed three "glowing" segments out of 16 that were functioning properly prior to the cleaning and retrofit. Investigation by the project concluded that an electrostatic discharge event during reassembly is the likely cause. The project is reviewing potential corrective action to prevent this from recurring and has now planned to replace the sensor with a spare.

RTM11 also has all channels functioning; however, read noise unexpectedly increases below - 70°C. Investigation has identified the likely cause as a ground loop by an unexpected short circuit between a thermal strap and the thermal shield. The team plans to re-seat the thermal strap to remove the short circuit.

One of RTM20's channels has exhibited a low gain, which could have been a pre-cursor to a glow. The team has now confirmed that it is not a glow but simply an open circuit – effectively a non-functioning channel – that is well within the required error budget. The raft has completed full EO testing and has been accepted as-is for integration into the cryostat starting mid-May.

RTM17 and RTM22, recently received from BNL, have been re-tested warm at SLAC and have showed no issues so far. The final cold EO testing planned by the end of April is expected to confirm that these rafts are ready for integration into the cryostat.

• The following table summarizes the current status of each RTM and explains the four categories of planned activity identified to address the various raft states.



Report-676

	Summary of RTMs under assembly as of March 25, 2019													
RTM	Sensors	Location	Original State ³	Plan ⁴	Current Status									
RTM1	ITL	BNL	4 dead channels	В	Refurbished at BNL, dead channels recovered; shipped to and received at SLAC <u>.</u> Testing started and showing 3 glowing channels on a single sensor caused by an ESD event. Raft has been disassembled and has been shipped to <u>BNL for replacement by end April 2019.</u>									
RTM2	e2v	SLAC	1 dead channel	С	Disassembled at SLAC. <u>Shipped to BNL.</u>									
RTM3	e2v	SLAC	0 dead channels	С	Disassembled at SLAC. <u>Shipped to BNL.</u>									
RTM4	e2v	SLAC	1 dead channel	С	Disassembled at SLAC. Waiting to be shipped to BNL.									
RTM5	e2v	SLAC	0 dead channels	С	Disassembled at SLAC. Waiting to be shipped to BNL.									
RTM6	e2v	BNL	Several shorts	A	Disassembled at BNL. <u>Cleaning completed</u> and sensor reassembled. Metrology test underway.									
RTM7	e2v	SLAC	0 dead channels	С	Awaiting start of disassembly.									
RTM8	ITL	SLAC	1 dead channel	D	Disassembled at SLAC and waiting to be cleaned.									
RTM9	e2v	BNL	1 glowing sensor (will be removed)	A	Disassembled at BNL. <u>Sensors were</u> <u>cleaned and reconstruction is underway</u> (one pre-existing missing channel <u>remains).</u>									
RTM10	ITL	BNL	3 high-noise	А	Refurbished at BNL, dead channels									

³ State prior to channel-loss mitigation

⁴ Migration plans A through D:

A. RTM to be disassembled, cleaned, retrofitted, re-assembled and qualified at BNL and then re-verified at SLAC: Applies: to 1) RTMs that were returned to BNL that require sensor replacement due to permanent damage or performance issues; and 2) incomplete RTMs at BNL that are currently on hold. There are five RTMs in this category, all of which will be re-verified at SLAC.

- B. RTM to be disassembled, cleaned, retrofitted, re-assembled at BNL, and then re-verified at SLAC: Applies to 1) RTMs that were returned to BNL that do NOT require sensor replacement; and 2) completed/tested RTMs at BNL that were never shipped to SLAC and are currently on hold at BNL. There are six RTMs in this category, all of which will be re-verified at SLAC.
- C. (e2v only) RTM to be disassembled at SLAC and the RSA will be shipped to BNL for cleaning and retrofitting, and then returned to SLAC for re-assembly and re-verification at SLAC: Applies to e2v-based RTMs currently at SLAC (e2v-based RTMs require sensor removal due to limited access to the wire bonds while installed on the RSA). There are eight RTMs in this category, all of which will be re-verified at SLAC.
- D. (ITL only) RTM to be disassembled, cleaned, retrofitted, reassembled and re-verified at SLAC: Applies to ITL-based RTMs already at SLAC. There are four RTMs in this category.



Report-676

			sensors		recovered. Expected to ship to SLAC 4/26.
RTM11	ITL	BNL	3 dead channels	В	Refurbished at BNL, dead channels recovered; shipped to and received at SLACRaft has showed high noise when cold <u>; tracked to date to a ground loop from a short between the thermal strap and the shroud. Raft is being updated.</u>
RTM12	e2v	SLAC	0 dead channels	С	Awaiting start of disassembly.
RTM13	e2v	SLAC	0 dead channels	С	Awaiting start of disassembly.
RTM14	ITL	SLAC	1 dead channel	D	Disassembled at SLAC and waiting to be cleaned.
RTM15	ITL	SLAC	1 dead channel	D	Awaiting start of disassembly.
RTM16	e2v	SLAC	0 dead channels	С	Awaiting start of disassembly.
RTM17	e2v	BNL	Complete, on hold	В	Refurbished at BNL, dead channels recovered; shipped to and received at SLAC. <u>Warm aliveness test shows all</u> <u>channels functioning within nominal</u> <u>parameters.</u>
RTM18	ITL	SLAC	0 dead channels	D	Awaiting start of disassembly.
RTM19	ITL	BNL	1 high CTE sensor	A	Refurbished at BNL, dead channels recovered, one sensor exhibited a glow that can be traced back to the fall of 3018. Sensor has been replaced.
RTM20	ITL	BNL	Complete, on hold	В	Process completed at BNL, shipped to and received at SLAC. One channel was suspect. <u>Now tracked to be a</u> <u>disconnected channel (and a glow). Has</u> <u>been accepted as is for integration into</u> <u>the cryostat.</u>
RTM21	e2v	BNL	Complete, on hold	В	Refurbished at BNL. Expected to ship to SLAC 4/26.
RTM22	e2v	BNL	Incomplete	A	Completed at BNL, shipped to and received at SLAC. <u>Warm aliveness test</u> <u>shows all channels functioning within</u> <u>nominal parameters.</u>

 The team began corner RTM (CRTM) acceptance testing at IR2. The five required CRTMs – four for the focal plane and one as a spare – were constructed in October 2018. Testing had been delayed because key personnel were diverted to work on the science raft channel loss issue.



Report-676

The team expects to complete CRTM testing in July.

Optics

- Arizona Optical Systems (AOS) completed the L1 lens and began attaching it to the L1-L2 assembly. L2 was attached last summer. During an initial check of L1-L2 alignment, the Optics team discovered a small non-conformance on the L1 radius of curvature due to a gravity sag sign error at time of initial acceptance. After investigation, the project has confirmed that the issue can be fully addressed with no performance impact by adjusting the distance between the L1-L2 assembly and the L3 lens.
- Thales SESO (TSESO) completed final inspection of the L3 lens following broadband antireflective (BBAR) coating. The lens meets requirements. TSESO also received the L3 barrel from the painting vendor and has begun integrating L3 with the barrel, which will surround the lens and provide attachment to the cryostat housing.
- TSESO completed i-band filter glass polishing and shipped the glass to Lawrence Livermore National Laboratory (LLNL) for evaluation and test-fitting in its mount. TSESO expects to finish z-band polishing later this month. Processing of the u-, g-, and y-bands continued at TSESO. Materion completed r-band filter coating and expects to begin qualification testing soon. Early results have confirmed that the filter-coating was successful.

Camera Body and Mechanisms, Shutter, and Filter Exchange

- Camera body housing bonding is in progress at IR2. The vendor completed Camera body shroud fabrication and delivered it to SLAC. Procedures for assembly of parts to the shroud have been released.
- As previously reported, production shutter assembly has begun, but the forecasted completion date was pushed back about a month due to long-lead delivery time of the shutter blade linear guides, which are custom made by a vendor in Japan. The shutter delay will not impact Camera schedule or cost. The production shutter blades and garage plates are at the painting vendor. The two garage plates are flat structures that surround the blades, providing a well-defined aperture for the shutter.
- Construction of production filter exchange components continued. As previously reported Centre de Physique des Particules de Marseille (CPPM) and Laboratory of Subatomic Physics & Cosmology (LPSC) completed assembly of the first of two auto-changers and loaders, respectively. CPPM has completed procurement of parts for its second unit, and LPSC is nearly done with parts procurement for its second unit.

At Laboratoire de Physique Nucleaire et des Hautes Energies (LPNHE) integration of the production carousel with the Camera back flange has been put on hold pending investigation of a serious injury that occurred during testing 11 April. The incident involved one person who required arm surgery. The Camera team will visit LPNHE 22-24 May to review implementation of safety corrective action and the plan forward; this is necessary, since similar verification work is planned at SLAC after delivery of the carousel from LPNHE. The incident is expected to affect carousel schedule by about two months. While this delay is not expected to impact Camera early delivery at this time, any delays beyond the estimated two months will place this element on or near critical path.





Cryostat and Refrigeration

- Initial EO testing demonstrated that the two cold-system and two cryo-system circuits supported by the first I&T canister meet design and operation requirements. In parallel with this testing, the second I&T heat exchanger canister, which will support four cryo-system circuits, was attached to the top of the bench for optical testing (BOT). Testing of the second canister is underway.
- Following installation of the final I&T refrigeration cabinets at IR2 in March, the team discovered a number of small refrigerant leaks, which are expected to be fixed in time for planned final EO testing. On-telescope system refrigeration cabinets work is progressing; however, as reported last month, some compressors had to be returned to vendor MMR to address leaks that were detected during testing at SLAC.
- The project completed wiring the four production feedthroughs for power cabling from the utility trunk to the cryostat. Three of the feedthroughs have completed residual gas analysis (RGA) testing. A fifth feedthrough will be used as a spare.
- SLAC provided the heat exchanger vendor with revised drawings for improved on-telescope, or TMA, refrigeration system heat-exchangers parts manufacturability. The contract modification was approved, and work is expected to begin shortly. Delivery is expected in July 2019. All parts for Pathfinder heat exchangers are at SLAC, and assembly is underway.

•	Following is a table that summarizes status of Camera refrigeration systems. Underlined text
	indicates updates since the last report.

Summary of Refrigeration status as of March 25, 2019					
Component(s)	System	Circuits	Status	Location	
	Camera Cryostat	2 Cold circuits	Tested successfully. Some of the RTD thermal sensors appear to be coming loose from thermal cycling and will need to be checked.	SLAC	
Evaporator		6 Cryo circuits	Two of the four circuits were tested successfully.	SLAC	
	Pathfinder Chamber	2 Cold circuits	Chamber is under final design.	Not built yet	
		2 cryo circuits	Chamber is under final design.	Not built yet	
Heat	I&T (to become Chile maintenance system	Vacuum Can 1: 2 Cold and 2 Cryo Circuits	Operating in SLAC clean room successfully.	SLAC	
Exchangers		Vacuum Can 2: 4 Cryo Circuits	Assembly completed and installation on cryostat underway.	SLAC	



Report-676

	Pathfinder	Vacuum Can 1: 2 Cold and 2 Cryo Circuits	All parts from vendor in hand. Assembly underway. One coil is being repaired.	SLAC
	On Telescope (Chile)	Vacuum Can 1: 2 Cold and 2 Cryo Circuits	Parts received at Eden. Manufacturability design improvements provided to vendor. Contract modification underway.	Eden
		Vacuum Can 2: 4 Cryo Circuits	Parts received at Eden. Manufacturability design improvements provided to vendor. Contract modification underway.	Eden
	I&T (to become Chile maintenance system)	2 Cold cabinets, each supporting 1 cold circuit	The two Cold cabinets are operating successfully at SLAC in IR2. There are several minor leaks that will need retrofitting during the next shutdown.	SLAC
Compressor Cabinets		2 Cryo cabinets, each supporting 3 cryo circuits	One Cryo cabinet is operating successfully at SLAC in IR2. There are several minor leaks that will need retrofitting during the next shutdown. The second Cryo cabinet under final testing at SLAC before delivery to the clean room.	SLAC
	On Telescope (to be used in	2 Cold cabinets, each supporting 1 cold circuit	Parts on hand. Being assembled at SLAC.	SLAC
	Pathfinder first)	2 Cryo cabinets, each supporting 3 Cryo circuits	Parts on hand. Some compressors are being repaired at MMR vendor due to some leaks. Being assembled at SLAC.	SLAC

Integration and Test (I&T)

- I&T continued RTM channel loss mitigations and preparations for RTM integration using the BOT. I&T also continued preparing the Camera integration stand and procuring fixtures to be used for positioning Camera subassemblies during construction.
- I&T successfully completed cryostat vacuum system qualification testing in March. Using a single heat exchanger canister mounted on the BOT, I&T completed initial testing of BOT EO instrumentation in early April. The single canister was sufficient to cool the two engineering test unit (ETU) rafts inside the cryostat, operating under the control of Computer Control System (CCS) software that is integrated with the BOT.



Report-676

- In mid-April, the cryostat was opened for Optical Translation Modules (OTMs) installation and feedthrough cabling. Some minor leaks were discovered on the power feedthroughs and have been addressed.
- Assembly of the Camera integration stand is underway at IR2. The stand will cradle the Camera during construction. Piers for the two sides of the stand were leveled and holes were drilled for attachment to the floor. The cradle that sits on the main weldment was assembled outside IR2 and moved into place. An interface plate that will attach the cradle to the Camera rotator was fit-checked and sent for final modifications.

Commissioning Camera (ComCam)

The team installed ComRaft in preparation for final ComCam cryostat configuration. BNL has provided ComRaft on an interim basis for ComCam testing. The final ComCam raft is expected to be one of the ETUs currently reserved by I&T for BOT testing. Currently, the ComCam preship review is scheduled to be held in July, but the team is trying to tighten the schedule to allow a May review date.

.Commissioning

 Currently, the project forecasts that the Pathfinder compressor cabinets will not be available until May 2019 at the earliest. Storage tanks for Pathfinder cryo-system refrigeration have been filled at SLAC and prepared for shipment to the summit.

Data Management (DM)

- DM held a successful LSST Science Platform (LSP) review 10-12 April with a nine-person panel representing a cross-section of LSST stakeholders. DM team members provided presentations and demonstrations, which were well received by the committee. The reviewers made a number of valuable recommendations.
- A number of critical updates to DM software and services were released. In particular, the Firefly system has been updated to behave properly when a VOTable with International Virtual Observatory Alliance (IVOA) Observation Data Model Core Components (ObsCore) information is displayed, enabling image display if the correct metadata is included in the VOTable table entry. Further, an IVOA server-side operations for data access (SODA) image cutout/stitching service was deployed.
- Important upgrades also were made to the Science Pipelines. Critical among these is the acrossthe-codebase adoption of the modernized, spatially-variant "PhotCalib" system for representing photometric calibration information. Further, the <u>autograd</u> package was integrated into the SCARLET deblender, resulting in better performance, more stable operation and higher quality outputs. Also worth noting is a significant step toward scientific validation of the DM system. The team validated that coadds can be built correctly using photometric calibration calculated using DM's Jointcal tool.
- Having received telemetry data from the M1M3 subsystem simulator, the team was able to benchmark the DM engineering facilities database (DM-EFD) implementation. The results show the team is very close to achieving the level of performance that will be required on the summit.
- National Center for Supercomputing Applications (NCSA) procured the first hardware for the Base





Data Center in La Serena. NCSA also updated the L1 test stand configurations for integration and test.

- On the summit, the AuxTel control network switch is ready for the auxiliary Instruments. Base Data Center and office building fiber installation began, and installation of the fiber connecting the existing computer room with the Base Data Center was completed. The team also completed configuration of the Summit Call Manager for the new voice-over-IP telephone system.
- A first version of the white paper resulting from the Kavli-funded "Petabytes to Science" workshop series have been published. The paper contains many contributions from DM team members. It is available from the workshop series' website <u>https://petabytestoscience.github.io/</u>. Organized by AURA, the workshops aim to identify the highest priority technologies and capabilities required for a broad-based user community to take full scientific advantage of the data-intensive astronomy opportunities being created by LSST, the Wide Field Infrared Space Telescope (WFIRST) and other massive survey facilities. The first workshop was held in July 2018; the second was held in February 2019; and next workshop will be 22-24 October in Boston.
- The team published or updated the following technical notes that describe key aspects of the DM system.
 - DMTN-094, describing the LSP authentication system
 - DMTN-106, describing the DM software release process
 - DMTN-107, discussing options for producing science alerts during the first year of operations before a complete set of deep templates has been compiled
 - DMTN-110, a proposed mechanism for handling Conda environments in support of the LSST Science Pipelines
 - DMTN-111, describing the use of DM systems in observatory operations
 - o DMTN-113, summarizing Prompt Products Database performance testing

Education and Public Outreach (EPO)

- The education team held several educator user testing sessions to support the ongoing development of formal education investigations. Education Specialist A. Herrold conducted user testing over three days at the National Science Teachers Association (NSTA) meeting in St. Louis, MO. Ardis and Chilean EPO Coordinator C. Araya lead a two-day focus group with educators in Green Bank, WV.
- Head of EPO A. Bauer presented an invited talk during a panel session at the NSF Large Facility Workshop in Austin, TX.
- The team continued to transcribe the StoryTime Domain videos collected at the LSST2018 Project and Community Workshop and began planning a video with the clips.
- The team also began initial phases of planning for Alert Stream web.

Change Request Status

This period the following change requests (LCRs) were initiated, approved or rejected.



LCR #	Title	Status
1503	LCR-1503 Parallelize Camera reverification on LSSTCam and ComCam on Telescope	Approved
1634	LCR-1634 i-band Fabrication Non-Conformance Waiver	Approved
1636	LCR-1636 WBS 4.14 Activities Update 2	Approved
1643	L3 lens BBAR Coating Non-Conformance Waiver	Approved
1654	Calibration Activity Schedule Update	Approved
1674	Replacement ITL Sensor for AuxTel Spectrometer	Approved
1696	ESnet Atlanta - Chicago Fiber Optic Network	Approved
1704	NCSA FY19 Hardware Purchase Timeline	Approved
1706	Update M2 Schedule to Include SAL Testing	Approved
1707	Dome Stairs and Walkways CR	Approved
1709	Budget for M1M3 Mirror Shipping Tucson to Summit	Approved
1710	Calibration Screen Rear Payload Platform	Approved
1711	Update Summit and Base IT and Networks Plan	Approved
1718	Recharge Summit Non-Labor Resource Budget (Meals) #2	Approved
1719	Reduce FY19 Remaining Budget on KLM10301A	Approved
1720	Reconcile DM Architecture Work Package Budget Under 1.02C.02.02	Approved
1721	Detail Plan SquaRE March-May 2019 Epics	Approved
1726	Add Activities for M1M3 Transport Coquimbo to Pachón	Approved
1729	M1M3 Cell Shipment SOML to CAID	Approved
1730	Extra Scope Coating Chiller Piping System	Approved
1731	Move Electrical Technicians Budget from FY20 to FY19	Approved
1732	Pier Safety Railing Installation	Approved
1734	Integrate M2 and Coating Activities in Jira	Approved
1756	Detail Plan AP and DRP	Approved
1758	RTM10 Non-Conformance Waiver	Approved
1366	M3 Optical Test at the Summit	Rejected
1724	Elevate LTS-836 Using a Queue for Observing to an LSE Document	Rejected
1726	Add Activities for M1M3 Transport Coquimbo to Pachón	Submitted
1727	L1-L2 Non-Conformance	Submitted



1728	Update Science Platform Vision Document LSE-319 to Current Design	Submitted
1730	Extra Scope Coating Chiller Piping System	Submitted
1731	Move Electrical Technicians Budget from FY20 to FY19	Submitted
1732	Pier Safety Railing Installation	Submitted
1733	Update of Optical Design Parameters: LSE-11	Submitted
1734	Integrate M2 and Coating Activities in Jira	Submitted
1735	NCSA Cycle Planning Updates	Submitted
1743	Additional Summit Road & Platform Work	Submitted
1753	New Account for TS Consulting Services	Submitted
1754	NCSA FY19 Hardware Budget Reallocation from ComCam	Submitted
1755	NCSA FY19 DAQ Hardware Budget Reallocation	Submitted
1756	Detail Plan AP and DRP	Submitted
1757	RTM10 Non-Conformance WaiverM1M3 System CAM Update	Submitted
1758	RTM10 Non-Conformance Waiver	Submitted
1763	Update NCSA Auxiliary Telescope Support Milestones	Submitted
1773	Budget M1M3 Cell and Surrogate Mirror Shipment to Summit	Submitted
1783	M2 Baffle and Lifting Fixture Schedule Extension	Submitted
1784	ComCam Fabrication and Shipping Update	Submitted
1785	Auxiliary Telescope Summit Labor Epics	Submitted
1786	Increase Dome Scaffolding Budget	Submitted
1787	Minor Update to Commissioning Plan/Budget	Submitted