U.S. DEPARTMENT OF ENERGY | Office of Science

Project Execution Plan for the Large Synoptic Survey Telescope Camera (LSSTCAM)

Project ID: SC-25-11-LSST (MIE 11 WB)

at

SLAC National Accelerator Laboratory

Office of High Energy Physics
Office of Science
U.S. Department of Energy

Date Approved:
JAN 0 7 2015

Month/Year

Submitted by:

Nadine Kurita

Nadine Kurita, Project Manager, SLAC

Date: 12-1-2014

Steven M. Kahn

Steven Kahn, Project Director, SLAC

Date: 12/1/2014

D MacFarlane

David MacFarlane, Associate Laboratory Director, SLAC

Date: 12/03/2014

Chi-Chang Kao, Laboratory Director, SLAC

Date: 12/3/14

Hannibal Joma, Federal Project Director, SLAC Site Office, DOE

Date: 12/1/2014

Hanley Lee

for Paul Golan, Manager, SLAC Site Office, DOE

Date: 12/3/14

for Helmut Marsiske, Program Manager
Office of High Energy Physics, Office of Science, DOE

Date: 12/18/14

James Siegrist

James Siegrist, Associate Director
Office of High Energy Physics, Office of Science, DOE

Date: 12/18/14

Concurrence:

Stephen Meador

Stephen Meador, Director
Office of Project Assessment, Office of Science, DOE

Date: 12/22/14

Approval:

Patricia M. Dehmer

Patricia M. Dehmer, Acting Director,
Office of Science, DOE

Date: 1/7/2015

Project Execution Plan for the
Large Synoptic Survey Telescope Camera (LSSTCAM) Project at the
SLAC National Accelerator Laboratory

Change Log

Revision History		
Rev.	**Date**	**Reason**
A	Sep. 19, 2014	Final Draft for CD-2 Director's Review. Updated TPC and funding profile, DOE milestones. Adjustments to WBS elements.
B	Sep. 30, 2014	Final Draft for ICE Review. Revised L2 milestone on Integrated Cryostat.
C	Oct. 5, 2014	Final Draft for CD-2 Review. Revised KPPs for better consistency with the minimum requirements of the LSST Science Requirements Document. Minor edits
D	Nov. 24, 2014	CD-2 Baseline, revised L2 milestones, cost table and baseline change control board.

Project Execution Plan for the
Large Synoptic Survey Telescope Camera Project at the
SLAC National Accelerator Laboratory

Table of Contents

Project Execution Plan for the
Project Name LSSTCAM Project at the
SLAC National Accelerator Laboratory

Acronym List

AE	Acquisition Executive
AURA	Association of Universities for Research in Astronomy
BCCB	Baseline Change Control Board
BNL	Brookhaven National Laboratory
CCB	Change Control Board
CD	Critical Decision
CPR	Cost Performance Report
CR	Continuing Resolution
CX	Categorical Exclusion (a NEPA determination)
DOE	U.S. Department Of Energy
EAC	Estimate at Completion
EIR	External Independent Review
EIS	Environmental Impact Statement
ES&H	Environment, Safety, and Health
EVMS	Earned Value Management System
HEPAC	High Energy Physics Advisory Committee
FNAL	Fermi National Accelerator Laboratory
FPD	Federal Project Director
HEP	DOE Office of High Energy Physics
HQ	Headquarters
IN2P3	Institute National de Physique Nucleaire and de Physique des Particules
IPS	Integrated Project Schedule
IPT	Integrated Project Team
ISEMS	Integrated Safety and Environmental Management System
KPP	Key Performance Parameter
LLNL	Lawrence Livermore National Laboratory
LLP	Long Lead Procurement
LSST	Large Synoptic Survey Telescope

LSSTCAM	LSST Camera
LSSTC	LSST Corporation
M&O	Managing and Operating
MIE	Major Item of Equipment
MNS	Mission Need Statement (CD-0 pre-requisite)
NEPA	National Environmental Policy Act
NSF	National Science Foundation
OECM	Office of Engineering and Construction Management
OPC	Other Project Cost
PARS II	Project Assessment and Reporting System II
PB	Performance Baseline
PEP	Project Execution Plan
PMCS	Project Management Control System
PMOG	Project Management Oversight Group
PMP	Project Management Plan
PHAR	Preliminary Hazard Assessment Report
QA	Quality Assurance
R&D	Research and Development
RMP	Risk Management Plan
SC	Office of Science
SC-2	Deputy Director for Science Programs, Office of Science
SLAC	SLAC National Accelerator Laboratory
SSO	DOE SLAC Site Office
TEC	Total Estimated Cost
TPC	Total Project Cost
VM	Value Management
WBS	Work Breakdown Structure

1. INTRODUCTION

This Project Execution Plan (PEP) describes the management and project execution processes that are used to ensure that the Large Synoptic Survey Telescope Camera (LSSTCAM) Project scope is completed on time and within budget. This document defines the project baseline (scope, cost, and schedule); describes the organizational framework and overall management systems for the project; and identifies roles and responsibilities of the project participants. It also describes the formal change control process by which the project scope, cost, and schedule as well as the PEP may be revised. This PEP is aligned with the Large Synoptic Survey Telescope (LSST) PEP, LPM -54.

1.1 Project Background

The construction and operation of the LSST is planned to be a joint initiative of the National Science Foundation (NSF), U.S. Department of Energy (DOE) Office of High Energy Physics (HEP), and the LSST Corporation, a non-profit 501C (3) corporation located in Tucson, AZ. LSST will be situated on the El Penon peak of Cerra Pachon in Chile, at a site managed by the AURA. HEP has named SLAC National Accelerator Laboratory as the lead DOE contractor to host the HEP LSST Project Office. All current DOE funded LSST engineering efforts and future fabrication and operations efforts, as well as related "off-project" efforts required for the success of the LSST experiment, will be coordinated and managed by the SLAC LSST Project Office. Major collaborators include the Brookhaven National Laboratory, the Lawrence Livermore National Laboratory, a consortium of U.S. based Universities, and the Institute National de Physique Nucleaire and de Physique des Particules in France.

DOE has determined that SLAC will manage the acquisition of the LSSTCAM under the existing DOE M&O contract (DE-AC02-76-SF00515). OHEP is funding the LSSTCAM design and fabrication as a Major Item of Equipment (MIE) project.

In March 2011, pre-CD-0, this project was initially named Dark Energy Stage IV Experiment (DE-IV). This is one of the options covered by the mission need statement (MNS). The mission of the project was for the support of a new, next-generation, state of the art (dubbed "Stage IV") ground-based dark energy experiment. The HEP program office has decided to proceed with option 1, which is based on a collaborative effort between DOE and NSF, as the lead funding agencies, to advance the first Astro2010 priority, the construction and operation of LSST.

1.2 Justification of Mission Need

As addressed in the approved Mission Need Statement, the LSSTCAM project is in support of a new, next generation, state-of-the-art ground-based dark energy "experiment". This initiative within the DOE HEP program is to determine the nature of dark energy, which is causing the acceleration of the expansion of the universe.

In physical cosmology, dark energy is the name given to a putative energy field that permeates all of space and causes an increase in the rate of expansion of the universe. The existence of dark energy is the most accepted explanation of recent observations and experiments that show that the universe is expanding at an accelerating rate. In the current standard model of cosmology, dark energy accounts for 73% of the total mass-energy of the universe; however its fundamental nature remains a mystery.

To date there are no compelling theoretical explanations for the existence of dark energy. Understanding the nature of dark energy will provide exciting new discoveries that will change the way we view the universe and have profound implications for fundamental physics. The U.S. is presently a leader in the exploration of the Cosmic Frontier. This area investigates fundamental properties of matter, energy, space and time that are best studied using data from astrophysical sources, such as cosmic rays, electromagnetic radiation, and neutrinos. Such investigations reveal phenomena and information about the makeup of the universe that cannot be observed with particle accelerators. Experiments to study the nature of dark energy offer new insights and a deeper understanding of fundamental physics and the makeup and ultimate fate of the universe.

2 PROJECT BASELINE

This section documents the project's Performance Baseline (PB), which consists of the scope, cost, schedule, required funding profile, and other information related to the PB. Lower tier documents capture all the details and plans required for project execution, tracking and control. The project is established as a MIE.

2.1 Scope Baseline

In order to achieve the LSST overarching science requirements, as part of the baseline scope, the LSSTCAM Project will deliver a 3.2 Gigapixel capable camera including the following major sub-systems and components:

- Array of CCD science sensors
- Guide sensors and wave-front sensors at four locations on the focal plane
- Refractive optics
- Optical filters
- Filter exchange system
- Shutter system
- Utility Trunk
- Cryostat with cryogenic system
- Control system and DAQ
- Camera ground support equipment

In order to mitigate the LSST schedule risk associated with commissioning of the Camera on the summit, an interim *'commissioning camera'* comprised of a single raft fitted with engineering grade sensors, a Dewar, and related control systems and DAQ will be assembled for delivery to the summit about a year ahead of the Camera scheduled shipment.

The 'threshold' Key Performance Parameters (KPPs) are the minimum parameters required for CD-4 meeting the DOE HEP DE-IV objectives as described in the approved MNS. The 'objective' KPPs describe the ultimate technical goals of the project. Project completion and achievement of these parameters will be verified as part of the integration and test phase processes. The project plans to deliver a camera for LSST meeting the objective KPPs.

Table 1 – Threshold and Objective KPPs

Description of Scope	Threshold KPP	Objective KPP
Field of view coverage (square degrees)	9.3	9.6
Pixel size	0.2 arcsec	0.2 arcsec
Number of pixels	2.6 Gigapixels	3.2 Gigapixels
Array readout time	3 seconds	2 seconds
Sensitivity range	320-1050 nm	320-1050 nm
Shutter minimum exposure time	2 seconds	1 second
Readout electronic noise, single exposure	13 electrons	9 electrons

The Camera 'project' will be completed at SLAC when the KPPs are achieved. The shipment of the camera to Chile, installation on the telescope and commissioning are outside of the project scope to be supported by HEP program funds.

2.2 Cost Baseline

The Total Project Cost (TPC) is set at $168M. TPC includes $150.3M of TEC and $17.7M of OPC funds. This includes the contingency of $33.4M. The TPC breakdown, segregated by major WBS project elements, is provided in Table 2. The cost baseline includes actual costs and commitments to-date (since CD-0) and estimate of remaining work based on the completed preliminary design of all sub-systems, sensors final design (CD-3a), bids in-hand and updated vendor quotes.

Table 2 –Cost Baseline

WBS[1] Title	Cost ($M)
3.01 Management	9.6
3.02 Systems Integration	6.4
3.03 Science Sensors	25.6
3.04 Science & Corner Raft Systems	15.3
3.05 Optics	24.8
3.06 Camera Body, Mechanisms, Cryostat	14.1
3.07 Control System, DAQ, Aux Electronics	10.0
3.08 Integration and Test	11.6
TEC	117.4
TEC Contingency	32.9
TEC Total	**150.3**
OPC	17.2
OPC Contingency	0.5
OPC Total	**17.7**
TPC Total	**168.0**

1) *LSSTCam is @ WBS level 3.0 of the LSST Project.*

2.3 Schedule Baseline

The project master schedule forms the baseline for performance milestones and successful delivery of the Camera. The schedule is consistent with the WBS and includes project activities, Critical Decision approval dates, major procurements approval dates and milestones. The DOE Level I and Level II project milestones are shown in Table 3. Major milestones are the DOE Critical Decisions dates and these are shown as Level 1; these milestones are controlled at the DOE Program Secretarial Offices. The significant procurements, contract awards, and completion milestones for each sub-system are controlled by the DOE Federal Project Director (FPD) shown as Level 2. Level 3 milestones are managed and controlled by the SLAC project manager. These milestones are included in the resource loaded schedule. Status of milestones is included in the monthly Earned Value Management System (EVMS) updates. The schedule includes 23 months of float to CD-4.

Table 3—Key Milestones

Level I Baseline Milestones[1]	Schedule
CD-0, Approve Mission Need	6/20/11 (Actual)
CD-1, Approve Alternative Selection and Cost Range	4/11/12 (Actual)
CD-3a, Approve Start of Long Lead Procurements	6/5/2014 (Actual)
CD-2, Approve Performance Baseline	2015 January
CD-3, Start of Construction	2016 January
CD-4, Approve Project Completion	2022 March
Level II Baseline Milestones[2]	**Schedule**
Conceptual Design Complete (Ready for CD-1)	11/30/2011 (Actual)
Prototype Science Sensors Received	1/3/2012 (Actual)
Vertical Slice Test - Phase 1	5/16/2013 (Actual)
Sensor Final Design Complete (Ready for CD-3a)	3/31/2014 (Actual)
First Article Sensor Contract (Ready for Award)	4/24/2014 (Actual)
Performance Baseline Established (Ready for CD-2)	10/16/2014 (Actual)
Award L3 Assembly Phase 1 Contract	2015 July
Camera Design Complete (Ready for CD-3)	2015 September
L1-L2 Assembly Phase 2 Complete	2016 February
First Sensor Tested	2016 February
Start ASIC production (IN2P3)	2016 March
Award Sensor Lot 2	2016 May
Receive First Article Wavefront Sensor	2016 December
First RTM Ready for Integration	2017 May
Cryostat Assembly Ready for Integration	2017 September
Cryostat Refrigeration System Ready for Integration	2017 September
L1 & L2 Pre-Coating Metrology, Phase 4b Complete	2017 October
Sensor Production is 50% Complete	2018 February
L3 Assembly Ready for Integration	2018 July
Filter Exchange System Ready for Integration (IN2P3)	2019 January
Sensor Production Complete	2019 March
Commissioning Camera Ready to Ship for Testing	2019 May
1st Filter Coated and Ready for Integration	2019 August
L1/L2 Assembly Ready for Integration	2019 October
Early Hardware & Software Ready for Summit	2019 October
Loaded Cryostat Ready for Integration	2019 November
Camera Fully Integrated & Ready for Verification Testing	2020 June
PSR/ORR - Camera Pre-Ship/Operations Readiness Review Complete	2020 November
KPPs achieved (Ready for CD-4)	2021 October

[1] Controlled by the DOE Office of Science (SC HQ)

[2] Controlled by DOE Federal Project Director (FPD)

2.4 Work Breakdown Structure (WBS)

The project work is organized as shown in the following table.

Table 4—WBS Structure

WBS Number	WBS Name	WBS Description
3.01	Management	Labor, materials, travel and fixed costs associated with operations of the LSSTCAM Project Office, including environment, safety and health.
3.02 *3.02.01* *3.02.02*	Systems Integration *System Engineering* *System Integration Analysis*	Labor, materials, travel and fixed costs associated with camera-wide system engineering effort for the LSSTCAM. It includes requirement management, external and internal interface management, risk management, quality assurance, configuration management and document control.
3.03 *3.03.01* *3.03.02* *3.03.03*	Science Sensors *Science Sensors* *Science Sensors Devices* *Science Sensors Test Stands*	Labor, materials, travel and procurement necessary to acquire, qualify and test the focal plane science sensors. It includes the design, labor, materials, fabrication and procurement of the sensor test fixtures.
3.04 *3.04.01* *3.04.02*	Science and Corner Raft *Science Raft System* *Corner Raft System*	Labor, materials, travel and procurement necessary to design, acquire, fabricate, qualify and test the readout electronics and thermal and structural modules supporting the focal plane sensors. It includes the design, labor, materials, fabrication and procurement of the test fixtures.
3.05 *3.05.01* *3.05.02* *3.05.03* *3.05.04*	Optics *Optics Integration & Mgmt* *Filter Assemblies* *L1-L2 Assembly* *L3 Assembly*	Labor, materials, travel and procurement necessary to design, acquire, fabricate, qualify and test the LSSTCAM refractive optics (including filters) and their opto-mechanical mounts. It includes the design, labor, materials, fabrication and procurement of the test fixtures
3.06 *3.06.01* *3.06.02* *3.06.03* *3.06.04* *3.06.05*	Camera Body, Mechanisms, Cryostat *Camera Body* *Shutter* *Exchange system* *Cryostat* *Utility Trunk*	Labor, materials, travel and procurement necessary to design, acquire, fabricate, qualify and test the LSSTCAM body housing, filter exchange mechanism (without the actual filters), shutter cryostat, refrigeration system and utility trunk. It includes the design, labor, materials, fabrication and procurement of the control units and test fixtures.
3.07 *3.07.01* *3.07.02* *3.07.03*	Control System, Data Acquisition System and Auxiliary Electronics *Camera Control system* *Data Acquisition (DAQ)* *Auxiliary Electronics*	Labor, materials, travel and procurement necessary to design, acquire, fabricate, qualify and test the LSSTCAM control system which manages, monitors, and controls all Camera subsystem operations as well as the LSSTCAM Data Acquisition system. It includes the design, labor, materials, fabrication and procurement of the camera power management system and camera protection system.

WBS Number	WBS Name	WBS Description
3.08	Integration and Test	Labor, materials, travel and procurement necessary to assemble, integrate, align, qualify, verify KPPs and make the Camera ready for shipment to the summit (CD-4). It includes the design, labor, materials, fabrication and procurement of the test facility, test fixtures, and the interim *Commissioning Camera* unit test and shipment to a pre-designated test facility in U.S. The *Commissioning Camera* scope includes a single raft fitted with engineering grade sensors, a Dewar, and related control systems, DAQ and software.
3.08.01	*I&T Integration & Mgmt*	
3.08.02	*Verification Test Systems*	
3.08.03	*Cryostat I&T*	
3.08.04	*Camera I&T*	
3.08.05	*Transportation & Storage Equip*	
3.08.06	*Commissioning Camera*	

2.5 Funding Profile

The PB described in this document conforms to the revised funding profile issued by HEP in September 2014.

Table 5—Funding Profile

Fiscal Year	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Total (M)
OPC[1]	1.9	5.5	8.0	2.3					17.7
TEC[2]				19.7	35.0	40.8	45.0	9.8	150.3
TPC[3]	1.9	5.5	8.0	22.0	35.0	40.8	45.0	9.8	168.0

[1] *Other Project Costs (OPC) includes Conceptual Design, R&D, prototypes and Pre-Operations.*
[2] *Total Estimated Cost (TEC) Construction includes Preliminary and Final Designs, construction/fabrications, project management, other cost not captured in OPC.*
[3] *Total Project Cost (TPC) includes TEC and OPC.*

3 LIFE CYCLE COST

The project TPC is estimated to be $168M in as-spent dollars from August 2011 to November 2020 ('early date' for Camera delivery). Start of operations is defined as the start of scientific operations in October of 2022. The Camera operating costs are the DOE's contribution of $9M per year for the 10 year lifetime in FY14 dollars. Factoring in a 3% escalation rate, the as-spent dollars for the Observatory operations from October 2022 to September 2032 is approximately $135M. The project has estimated that $49.5M of operating funds, in as-spent dollars from June 2018 to September 2022, will be needed for shipping, re-verification, integration and commissioning of the camera at the observatory. The camera project does not have a physical facility construction component; as a result, the decommissioning costs are limited to dismantlement of the camera components for salvage. At this early stage, the dismantlement cost is estimated to be approximately $8M or about 10% of the Camera fabrication/assembly cost (direct TEC less design cost). It is assumed that a reasonable portion of the camera dismantlement cost will be recovered by the component salvage value.

4 ACQUISITION APPROACH

DOE HEP has determined that SLAC, as the M&O contractor, will manage and execute the LSSTCAM acquisition. The engineering and design for the technical equipment will be performed by SLAC and collaborating DOE institutions as they possess the expertise in this area. The collaboration consists of Brookhaven National Laboratory, Lawrence Livermore National Laboratory and several DOE supported institutions.

Advance Procurement Plans (APP) are prepared for procurements greater than $250K at least 12 months in advance at each collaborating laboratory. The APP sets internal deadlines and identifies specific buyer(s) and CAMs, type of subcontracts, and the appropriate acquisition approach. Procurement strategies are chosen to obtain the best value based on the assessment of technical and cost risks on a case-by-case basis. A combination of various business transactions including Memorandum Purchase Orders (MPO), Financial Plans and Financial Plan Transfers with other DOE National Laboratories, University Sub-Contracts, and direct fixed price purchases with vendors will be utilized.

Refer to the Acquisition Strategy document for more details.

5 TAILORING STRATEGY

Tailoring is necessary for efficient delivery of LSSTCAM project. To minimize risk, optimize processes, and gain efficiency, tailoring principles are applied. As a major risk mitigation strategy, the project received CD-3A approval on June 5, 2014 for the long-lead procurements of the camera sensors. The project was authorized to initiate the long-lead procurement of production sensors, for an amount not to exceed $13M, prior to the approval of CD-3.

Sensors are on the critical path driving the Camera schedule; early procurement of production sensors will enable successful and timely transition into the full production phase. To further mitigate the schedule risk associated with production yield, the approved Sensor Acquisition Plan is based on acquiring the services of two (2) qualified vendors for the delivery of first articles and the first production lot. Table 6 shows the cost estimate and planned schedule of exercising the 'option' for the first lot of production sensors.

Table 6 – Long Lead Procurement (CD-3A, June 2014)

WBS	Long Lead Procurement Description	Schedule	Estimate ($M)
3.03	Science Raft System – sensors, 1st Lot, Vendor 1	<15 Months after award of Option 1 (Science Production CCDs)	5.9
3.03	Science Raft System – sensors, 1st Lot, Vendor 2	<15 Months after award of Option 1 (Science Production CCDs)	4.0
		Contingency	3.1
		Total	13.0

6 BASELINE CHANGE CONTROL

The LSSTCAM project controls changes in functional and physical requirements and evaluates the impact of changes on cost and schedule through a baseline change control process. The essential elements of configuration control are a well-defined baseline, and an effective method of communicating, evaluating, and documenting changes to that baseline. The process promotes orderly evolution of the baseline design, and ensures that the effect of changes on cost, schedule, and technical scope performance are properly evaluated and documented by project management. A Baseline Change Request (BCR) must be initiated when there will be an impact on any of the cost, schedule, or scope baselines. Thresholds for determining the BCR approval level during project execution are delineated in Table 7.

A Change Control Board (CCB) consisting of members of the LSSTCAM project team has been established. The board includes the LSSTCAM Project Director, LSSTCAM Project Manager (who also acts as chairman of the board), LSSTCAM Project Scientist, a change control manager, and other board members. The board members review the technical, cost and schedule implications of changes and advise the Chairman. All BCR actions are maintained in a change control log. The LSST Camera Project Director is the LSST Project Director.

A Baseline Change Control Board (BCCB) will be convened for BCRs that are above Level 3 thresholds. The BCCB members are the CCB members, the FPD, and appropriate SC Program Managers. DOE approves BCRs above Level 3.

A baseline change control framework has been established and includes applicable change management processes, threshold requirements, and the change control board charter. A summary table of baseline change control thresholds; and approval authority for scope, schedule, and cost is shown in Table 7.

Since NSF and DOE follow agency-specific project management, procurement, and financial rules and policies, any 'proposed' change that triggers cost and schedule impacts across the DOE/NSF interface(s) will be managed jointly with the LSST Project Director, LSST Project Manager, LSST Camera Project Manager and, as appropriate, the DOE FPD.

Table 7 - Change Control

	Acquisition Executive[1], Deputy Director for Science (Level 0)	Associate Director for HEP (Level 1)	Federal Project Director* (Level 2)	LSSTCAM Project Director/ Project Manager (Level 3)
Scope	Any change degrading the Threshold KPP, or any change in scope and/or performance that affect the ability to satisfy the mission need or are not in conformance with the Section 2.1 of the approved PEP.	Any major changes in scope at WBS Level 1 or changes requiring coordination with the National Science Foundation.	Any changes in scope and deliverables at WBS Level 2 as described in the PEP and the WBS Dictionary.	Changes in scope at WBS Level 3.
Schedule	Any delay in CD-4, project completion date as stated in Table 3.	Any changes to Level 1 milestones as stated in Table 3 with the exception of CD-4.	Any changes to Level 2 milestones as stated in Table 3.	Any changes to milestones below Level 2.
Cost	Any increase in TPC of the project as stated in Table 2.	Cumulative contingency usage of $10M or larger	The smaller cumulative change** of greater than 30% or $1M to Level 2 WBS element as stated in Table 2.	Any increase >5% of Level 3 WBS elements**
Funding	Any changes to funding profile as shown in Section 2.5 that negatively impacts the Performance Baseline			

[1] *Deputy Director for Science acts as the AE post CD-1.*

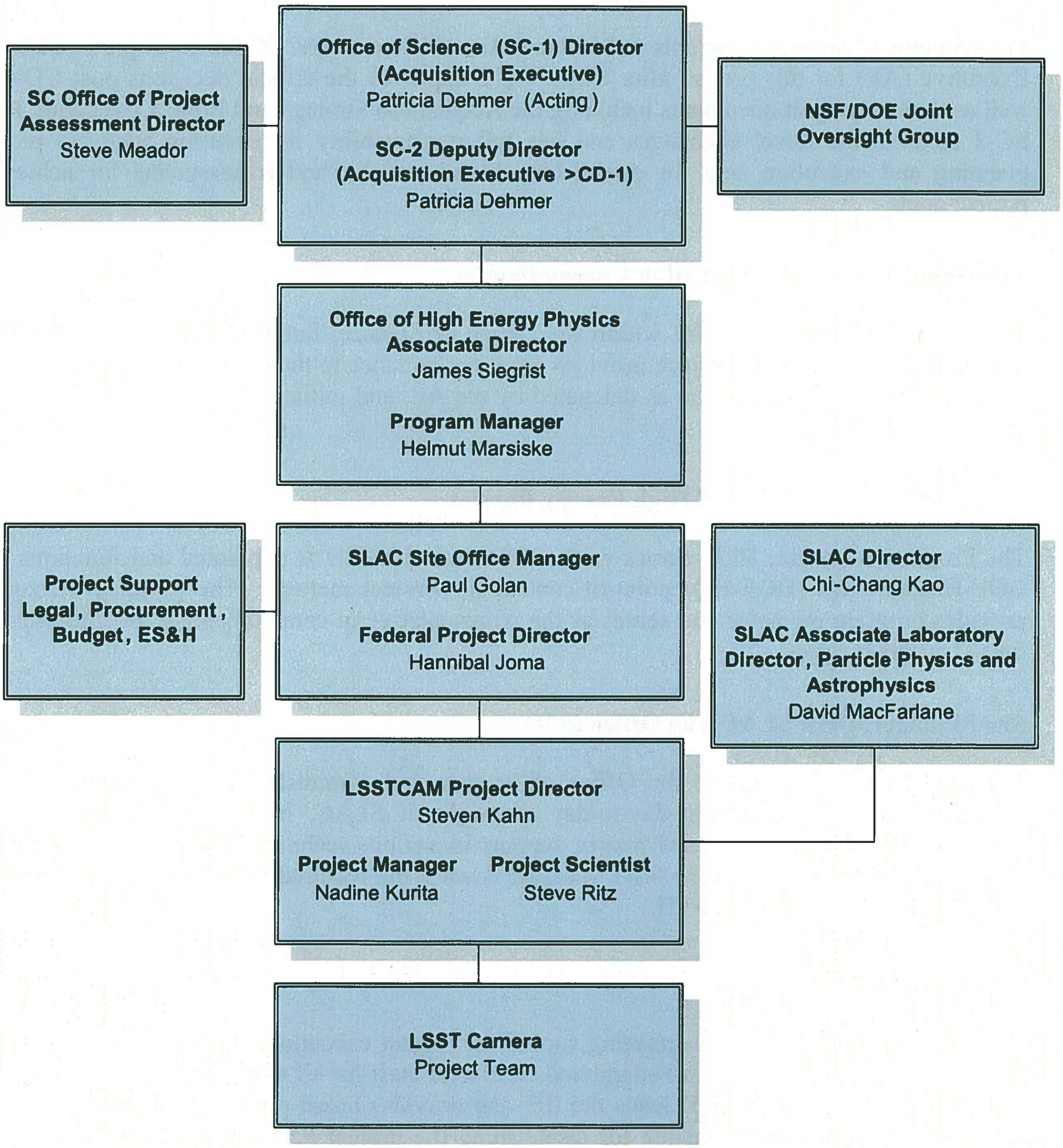
**Any contingency usage will require the approval by the FPD.*
***After the cumulative threshold has been reached and the next higher change authority has been notified and has approved the changes, the cumulative cost thresholds will reset.*

7 MANAGEMENT STRUCTURE and INTEGRATED PROJECT TEAM

Figure 1 is the management structure for the LSSTCAM Project. An "Integrated Project Team" is established for providing support to the FPD and the LSSTCAM Project Director and Project Manager. The Integrated Project Team (IPT) is organized and led by the FPD, and consists of members from both DOE and the project team. The FPD will work closely with the DOE program manager in HEP to ensure that the project execution is consistent with program goals and objectives and to ensure the Acquisition Executive and appropriate DOE Headquarters personnel are apprised of the project status. This will be accomplished through routine conference calls, site visits, reviews, and other formal and informal communications.

The IPT membership will change as the project progresses from initiation to closeout to ensure the necessary skills are represented to meet the project's needs. The IPT structure, membership and details of roles and responsibilities are defined in the LSSTCAM IPT Charter presented in Appendix A. Key LSSTCAM management roles, responsibilities, and authorities are described in Figure 1.

Figure 1 – Management Structure



U.S. Department of Energy

Director, Office of Science

The Director of the Office of Science (SC-1) approves the CD-0 and CD-1 for the LSSTCAM project. The director also appoints the FPD.

Deputy Director, Office of Science

The Director of Science Programs within the Office of Science (SC-2) serves as the Acquisition Executive (AE) for this project after CD-1. SC-2 approves the critical decisions post CD-1 as well as the key project documents including the Acquisition Strategy and Project Execution Plan. SC-2 controls the Level 0 changes and has full responsibility for ensuring adequate project planning and execution, and for establishing broad policies and requirements for achieving project goals.

Associate Director, Office of High Energy Physics

The Associate Director of HEP within the Office of Science, initiates definition of mission need and objectives of the project, provides program guidance to the project and reviews Level 1 baseline changes for approval as delegated by the AE, and initiates formal periodic reviews of the project.

Program Manager, Office of High Energy Physics

The Program Manager, HEP, serves as the FPD until the FPD is appointed and functions as DOE-Headquarters (DOE-HQ) point-of-contact for Project matters. The program manager provides program guidance and serves as the representative in communicating the interests of the SC program office.

Site Manager, DOE SLAC Site Office (SSO)

The SSO Manager reports to the Office of Science and administers the M&O contract with Stanford University, including day-to-day oversight of SLAC. In carrying out its oversight responsibilities, the SSO obtains matrix support in various technical disciplines from the SC Integrated Support Centers. The SSO Manager ensures the required DOE oversight support and resources are provided to the FPD.

Federal Project Director

The FPD is accountable for overseeing successful project execution. The FPD serves as the single point of contact between Federal and contractor staff for all matters relating to a project and its performance. The FPD leads the IPT and provides broad project guidance to the IPT members. The FPD is responsible for establishing the project Performance Baseline (scope, cost, and schedule), reviews baseline changes at Level 2 for approval, and provides support to the SC program manager and the AE concerning any Level 1 proposed changes or changes at the Deputy Director for Science (Level 0).

SLAC National Accelerator Laboratory

Laboratory Director and Associate Laboratory Director for Particle Physics and Astrophysics

SLAC Director and Associate Laboratory Director, ensure LSSTCAM receives the necessary matrix support as needed in various business and technical disciplines. SLAC directorate also enables project success by approving implementation of indirect support activities, as appropriate.

LSSTCAM Project Director, Project Manager, and Project Scientist

LSSTCAM Project Director and Project Manager work closely with the FPD and are responsible and accountable to DOE for executing the Project within scope, cost and schedule in a safe and responsible manner

LSSTCAM Project Director is the LSST Project Director and manages the overall project. The Project Director also serves as the SLAC POC with DOE on project matters. The Project Director ensures project access to laboratory/contractor resources, systems, and capabilities required to execute the Project.

LSSTCAM Project Manager reports to the LSSTCAM Project Director and is responsible for day-to-day activities, and safe and successful execution of the project in accordance with the approved performance baseline. Project Manager also interacts directly with the DOE FPD on day-to-day project matters.

LSSTCAM Project Scientist reports to the LSSTCAM Project Director and, working closely with the Project Manager, is responsible to ensure the Camera design captures the LSST flow-down science requirements including all the requirements necessary to fulfill the DOE HEP dark energy experiment objectives.

8 PROJECT MANAGEMENT/OVERSIGHT

8.1 Risk Management

The LSSTCAM Risk Management Plan, (LCA-29) describes the continuous risk management (CRM) process implemented by the project. CRM is a disciplined approach to managing project risks throughout the life cycle of the project. This plan is consistent with DOE O413.3B, "Project Management for the Acquisition of Capital Assets," and strives to incorporate "best practices" from other large-scale, first-of-a-kind science projects. The plan establishes the methods of assessing Camera project risk down to the subsystem level. Project risk is managed throughout the life of the project, from development through construction and early commissioning phases.

The primary goals to implement this system are to manage the risks associated with the development and construction of the Camera. Project risks are centrally managed, but are the result of project-wide risk assessment. The project-wide risk assessment supports management decision-making by providing integrated and quantitative assessments of risk. Current and comprehensive risk updates provide management with additional information in preparing for and reacting to contingent events and adverse outcomes to planned events. The process also provides a uniform language for tracking risk elements and communicating that information. A Risk Registry (LCA-30) documents the risk assessment, mitigation strategy, and the residual risk after mitigation. This database includes information about all identified risks within the project. The registry has incorporated lessons learned in several recent projects.

The following section provides a brief description of the current major risks, and planned or on-going mitigations:

Sensors Yield

Risk Description:

If the yield of sensors within full specifications is lower than required then the camera cost, schedule and/or performance could be impacted.

Mitigation Plans:

First Article Fabrication, Yield Runs and Raft Integration

Fabricate first-article sensors to final LSST specifications to demonstrate full fabrication capability and qualify the fabrication processes. Use these to validate the acceptance test processes and finalize test procedures and equipment.

Second Vendor

Maintain two vendors through first article and possibly through the first lot of sensor production. Consider a heterogeneous focal plane if yield is low and schedule cannot be met.

Partially Filled Focal Plan

Complete integration and test of the camera with a partially filled focal plane, meeting the threshold KPP, to maintain schedule. Complete the science sensor raft integration prior to shipment to Chile or on the summit.

Refrigeration System Performance Under Operational Conditions

Risk Description:

If refrigeration system isn't stable in varying orientations then the CCD temperature stability requirements will not be met.

Mitigation Plans:

Prototype Development

Fabricate and test prototype heat exchanger and vacuum test dewar. Test under operational conditions (e.g. camera orientations, disconnects, utility drapes).

L1-L2 Fabrication

Risk Description:

If L1-L2 fabrication is more expensive or the schedule is longer than baselined then the project may not have enough contingency to complete the work.

Mitigation Plans:

Design Fabrication Contract

Place a design contract for L1-L2 with options for fabrication prior to CD-2. This will establish the baseline cost and schedule early and reduce risk.

8.2 Project Reporting and Communication Management Plan

The LSSTCAM Project Manager submits a monthly project progress report to the FPD containing information about the overall progress of the project. After iteration and verification of data, the FPD transmits the monthly report to the HEP Program Manager. The monthly report addresses project cost and schedule performance, accomplishments, issues, and upcoming milestones. After CD-2 approval, the report will include the latest earned value data together with an explanation for any significant variances. Cost and schedule performance is evaluated and variances determined including any necessary corrective actions. In addition, the detailed Estimate at Completion (EAC) will be evaluated on at least an annual basis. On a monthly basis, the FPD and Program Manager updates the PARS II database by reviewing and certifying the monthly performance data, rating project performance based on calculated performance indices, and providing a status report on progress and issues.

The FPD holds regular meetings with the LSSTCAM Project Director and relevant staff to discuss project status, issues and current business. Additionally, there are regular conference calls by LSSTCAM management and the FPD with HEP to provide project status updates, progress and discuss issues.

8.3 Earned Value Management System

SLAC has a certified EVMS that complies with ANSI/EIA-748-B. This system provides the essential earned value information needed for management control of the project and maintains the database for progress reporting. The EVMS integrates the cost and schedule baselines and provides the tools to monitor project performance. The data from the EVMS is the basis for information entered into the DOE PARS II. Surveillance of the SLAC EVMS is conducted bi-annually.

The LSSTCAM EVMS has been implemented and will be consistent with SLAC EVMS description documentation and will provide an objective measure of actual costs and schedule performance against the plan.

8.4 Project Reviews

DOE SC conducts independent project reviews throughout the project life cycle; these include critical decision 'readiness' reviews as well as annual 'status' reviews. In addition, DOE Office of Acquisition and Project Management (APM) conducts (external) independent cost estimates and reviews (prior to CD-1/2). CD-3 independent cost estimate by APM may be conducted if warranted.

SLAC LSSTCAM management team implements a uniform and rigorous design review process for all the Camera sub-systems. Design reviews provide an independent assessment of the continuing ability of the project to meet its technical and programmatic commitments and provide value-added assistance to the program manager. Independent technical reviews will occur periodically throughout the life cycle of the project.

Document LCA-98 (Design Review Plan), provides the LSST technical staff with the guidelines for design reviews as discussed in the LSSTCAM Systems Engineering Plan, "LCA-38". This document provides the design review's minimum requirements for its technical and programmatic deliverables and establishes roles and responsibilities of the presenters and the review committee. It also defines what role the review process plays in authorizing the transition to the next phase of the technical deliverable. Attendance and the final report are configuration controlled documents. The action items from these reviews are tracked by the Project Office.

The objectives and salient features of major review classes are provided to guide the project team in the formulation and implementation of an integrated and comprehensive continuum of reviews. The term "integrated and comprehensive continuum" is used to emphasize that there is both a life-cycle relationship and a hierarchical relationship to these reviews. Reviews provide the opportunity to confirm the approach or offer options, if needed, and communicate progress and risks toward meeting the success criteria. The output of these reviews (i.e., assessments, options, recommendations, and decisions) affect subsequent reviews, as appropriate, to ensure alignment between providers, customers, and stakeholders, and ensure proper disposition of issues. It is the responsibility of the Project Manager or System Engineer to propose options to combine reviews, (such as those shown below in Section 8.5) provided that the objectives of each are met. The goal is to maximize the probability of mission success through added value and efficiencies.

8.5 Engineering and Technology Readiness

Engineering and technology readiness will be assessed at each phase of the project following the Design Review Plan, LCA-98. System Requirements Review (SRR).

- Conceptual Design Review (CDR) – required for CD-1 readiness
- Preliminary Design Review (PDR)
  - Required for CD-2 readiness
  - Required for design-build elements for CD-3 readiness
- Final Design Review (FDR) – required for CD-3 readiness except for design-build elements which require PDR.

- Manufacturing Readiness Review - required to initiate the assembly and test phase of the project
- Pre-Ship Review (PSR) – required to initiate the integration and verification testing phase of the project. At the camera system level required for CD-4 readiness.

8.6 Alternatives Analysis and Selection

An alternative analysis was performed as part of the Acquisition Strategy development process. The alternative selected is to build a new camera for the LSST as a cooperative interagency project with NSF. This alternative is the most viable path to be pursued to meet the mission need in a timely and cost-effective manner. The alternatives analysis is documented in the Acquisition Strategy.

8.7 Environment, Safety and Health

The LSSTCAM project work at SLAC is executed in accordance with SLAC ES&H policies to ensure hazards are identified and mitigated; work is authorized after ES&H analysis is completed; and oversight of work is conducted by LSSTCAM management and staff. The SLAC ES&H Division and designated SLAC Safety Officer provide technical support to the project and conduct independent oversight and reviews of project activities. Work at the collaborating laboratories is executed in accordance with their existing ES&H policies.

In compliance with the National Environmental Protection Act (NEPA) and its implementing regulations (10 CFR 1021 and 40 CFR 1500-1508), since the project poses no adverse environmental impacts, a determination of Categorical Exclusion was approved by DOE in July 2011.

8.8 Safeguards and Security

Safeguards and Security requirements are coordinated with the appropriate SLAC, BNL, and LLNL security officials and addressed in the approved Preliminary Security Vulnerability Assessment Report. Although no operational specific security vulnerabilities are anticipated, the report will be revised as necessary prior to project closeout and transition of the Camera to commissioning on the summit. During project execution, access requirements and procedures will be written into project subcontract documents and will be followed by all project subcontractors accessing the site.

SLAC does not conduct any DOE classified work; therefore, no Q or L clearances will be required. BNL and LLNL will follow their respective security requirements pertaining to this project.

8.9 Systems Engineering

The project will use a systems engineering approach to execute and manage the project including performing value management analysis and value engineering studies; specification and design development, verification, and reviews; risk analysis and management; and coordination of fabrication and installation of equipment and systems, and other interface management activities.

The System Engineering Management Plan (SEMP), LCA-38, describes the organization, processes, products, and methodology implemented by the Camera management team to ensure a coordinated development of the LSST Camera system. This Plan includes:

Organizational responsibilities—including relationships with the rest of the Camera management team, the LSST Corporation (LSSTC), and Camera collaborating institutions.

Processes—including requirements and interface management, and operations concept development, as well as integration and verification test planning; also involves design value management and risk management, as well as configuration control plans.

Methodology—plans for communication within the system engineering group and with the rest of the camera and LSST team; description of system engineering involvement and planning for programmatic and other external reviews, as well as the internal technical review process for the camera.

The Camera SEMP supports and is subordinate to the Camera Project Management Plan (PMP), LCA-225. The SEMP defines the technical management of the camera project, while the PMP specifies programmatic management. Furthermore, the SEMP is responsive to the LSST Observatory SEMP. The Camera SEMP provides the specific processes required to manage the system engineering effort at the Camera level of integration and lower. The Observatory SEMP provides processes required to specify and control the functionality and requirements allocated to the Camera, interfaces between the Camera and other Observatory subsystems and integration of the entire system.

8.10 Value Management and Value Engineering

The LSSTCAM Value Management Plan, as described in this document, meets the requirements for DOE Order 413.3B (29 November 2010), "Program and Project Management for the Acquisition of Capital Assets" and Office of Management and Budget (OMB) Circular A-131 which "requires Federal Departments and Agencies to use value engineering as a management tool, where appropriate, to reduce program and acquisition costs".

The goal is to use this plan as a management tool in the execution of major project alternatives. Value management (VM) will be focused on those project development alternatives that have progressed to the level requiring serious consideration and investigation.

The VM methodology is also known as value analysis, value engineering, or value planning. VM is defined as an organized effort directed at analyzing the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions for a project at the lowest life-cycle cost consistent with required performance, quality, reliability, and safety. VM is a collaborative technique directed toward analyzing the functions of an item or process to determine “best value” or the best relationship between worth and cost. The VM Program is an integral part of the overall project delivery process and is not a separate entity designed to “second guess” the IPT or design authority. The VM process is a standard engineering practice that was chosen to be a management tool that helps meet project objectives while providing the maximum value for the entire system. Value engineering studies will be conducted throughout the preliminary and final design phase of the project.

8.11 Configuration Management/Document Control

Configuration management is the process by which the Camera project documents the functional and physical characteristics of the Camera, controls changes to those characteristics, and provides information on the state of change action. The configuration management process involves all levels of management responsibility, and consists of four ongoing stages: Configuration Identification, Configuration Change Control, Configuration Status Accounting, and Configuration Verification.

Responsibility for controlling the configuration of the Camera involves all Levels of Management in the camera project. Configuration Identification is the process by which the Camera and its subsystems are defined through drawings and documents that specify the system components in terms of functional and physical characteristics, as well as how they are manufactured and tested. The documents and records describing Camera characteristics are defined as Configuration Items (CI’s). These are listed and tracked in a Configuration Item Data List (CIDL), which is also used to assess the impact of proposed changes to CI’s. The Change Control process is the process by which proposed changes are reviewed and approved. It ensures that the performance, functional, cost, schedule, and risk impacts of a change are considered before approval is granted. Configuration Status Accounting is the means by which configuration information is tracked and relayed to key personnel in order to support management decisions and ensure that all work is performed according to the current design. The Configuration Verification process ensures that the current hardware and software configurations match the intended design by verifying the implementation of each approved change through periodic configuration audits.

Some of the key project documents, that will be configuration controlled are listed below:

- Project Execution Plan
- Preliminary and Final Hazard Analysis
- Project Management Plan
- System Engineering Management Plan
- System Safety Program Plan
- Quality Implementation Plan
- Quality Assurance Plan
- Risk Management Plan
- WBS Dictionary
- Requirements, Specifications and Interface Documents
- Drawings
- Design Review Reports

- Performance Measurement Baseline
- Approved Project Baseline Change Requests (BCRs)

8.12 Quality Assurance and Testing and Evaluation

Quality Assurance (QA) is an integral part of effective project management and is employed throughout the design, procurement, and construction of the project. The project has an approved Quality Implementation Plan (QIP) conforming to SLAC QA Program and DOE Orders 413.3B and 414.1D. In addition, national codes and standards will be followed throughout as applicable. The design and procurement documents for specific QA, Testing and Evaluation, and acceptance requirements are used. The resource-loaded schedule includes major QA and Testing and Evaluation activities as well as the durations and responsible resources.

8.13 Transition to Operations

LSSTCAM project transition to operations begins during design and continues until the camera is completed as an integrated system and verified to meet its requirements. A transition to operation plan will be developed during the preliminary design phase of the project and will evolve until the end of the project.

All transition to operations activities (personnel transition or changes, operations and maintenance manuals development, training requirements, and other activities) will be identified, resourced, assigned, and will be included in the resource-loaded schedule.

A Start-Up Test Plan will be developed, consistent with this stage of the design maturity and addressing the check-out and commissioning plans. The Start-Up Test Plan supports the development of the verification procedure, integration with the observatory, and Commissioning. The commissioning effort is not part of this MIE project and will be funded by HEP program funds (Operation).

8.14 Project Closeout

The Camera *project* will be completed at SLAC when the Camera is fully assembled, tested, and the KPPs are achieved.

A Draft Project Closeout Report will be developed and presented during the DOE CD-4 readiness review prior to CD-4 approval. The initial Project Closeout Report will be finalized within 90 days of CD-4 approval. The closeout report will contain the final cost of the project, project lessons learned, and performance achieved at project completion. Closing contractual activities requires the SLAC project manager and respective system managers to oversee final settlement of project contracts, acceptance of contract deliverables, collection of contracts documents and records (such as as-built drawings, operations and maintenance manuals, and warranties, etc.), and approval of final payments. In addition to construction completion, the Project Manager is also responsible for administrative closeout activities relative to demobilizing the project team, arranging the disposition of project records, closing of final payments, and compiling and disseminating lessons learned. The Project Manager is responsible to review and ensure the project closeout processes are completed. The LSSTCAM Project Manager will submit a project closeout report to the FPD. The FPD acceptance of the project closeout report is the official acceptance of the contractor deliverables and other reporting requirements on behalf of the DOE. Elements of the project completion report will address the following key activities:

- Confirmation that all project deliverables and completion criteria, including KPPs, were achieved satisfactorily
- Excess material and equipment identified, retrieved, and disposed of in accordance with DOE property disposition regulations
- All purchase orders closed or placed in a single account
- Outstanding obligations identified and described in the contractor's financial closeout
- Remaining project control accounts, except for outstanding obligations, closed
- Project lessons learned completed and submitted to DOE
- Level 2 Milestone approval from FPD
- CD-4 approval

After CD-4, SLAC finance will review and ensure that all project charges and costs are in proper accounts and outstanding invoices are settled. SLAC will send the cost closing statement to the FPD for authorization to close. As part of project closeout, the FPD will document the project completion in PARS II database.

The shipment of the camera to Chile, installation on the telescope and commissioning are outside of the project scope to be supported by HEP program funds.

Appendix: The IPT Charter