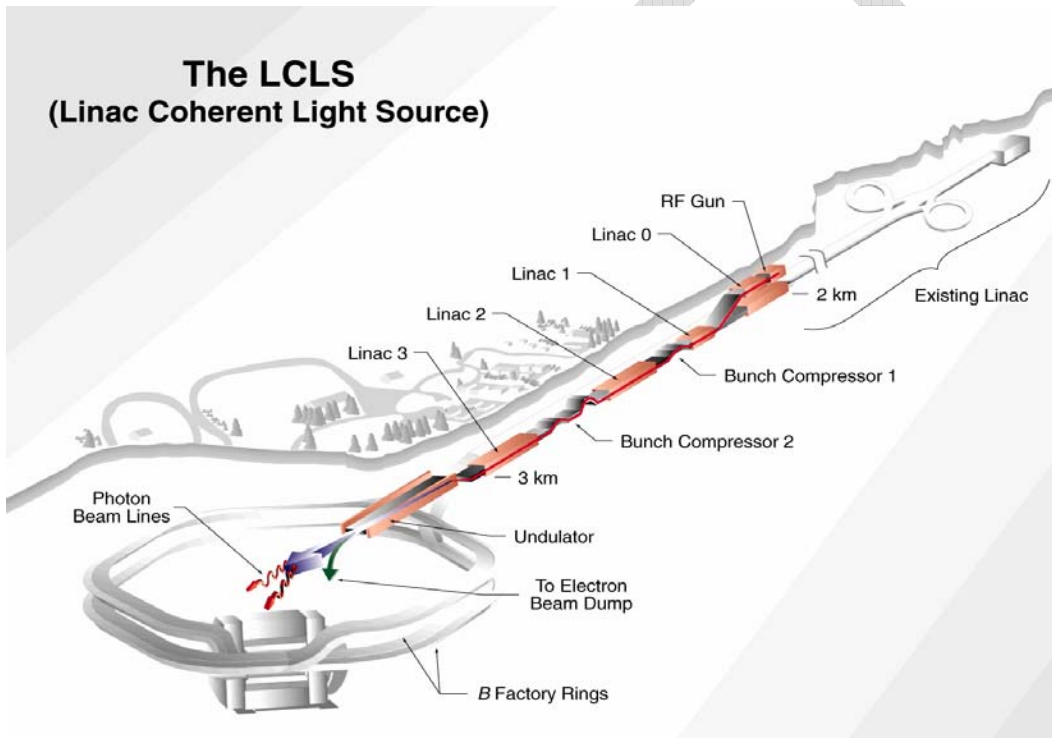


Linac Coherent Light Source (LCLS)

An X-Ray Free Electron Laser



Project Management Plan

May 2004

Prepared for the US Department of Energy under contract numbers:

SLAC	DE-AC03-76SF00515
ANL	W-31-109-ENG-38
LLNL	W-7405-ENG-48

Submission and Approval

This Project Management Plan (PMP) defines the plans, organization and systems for managing the Linac Coherent Light Source (LCLS) Project at the Stanford Linear Accelerator Center (SLAC). The LCLS PMP is in accordance with the Department of Energy (DOE) Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*, and subject to the requirements specified for projects with a Total Project Cost (TPC) of less than \$400 million.

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List of Acronyms

<u>Abbreviation</u>	<u>Definition</u>
ACWP	Actual Cost of Work Performed
ANL	Argonne National Laboratory
AY	Actual Year
BCE	Baseline Cost Estimate
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
BES	DOE Basic Energy Sciences
CPR	Cost Performance Report
DOE	U.S. Department Of Energy
EAC	Estimate at Completion
ES&H	Environment, Safety, and Health
ESAAB	Energy Systems Acquisition Advisory Board
FAC	Facilities Advisory Committee
ILCC	Inter-Laboratory Coordinating Committee
IPS	Integrated Project Schedule
LCLS	Linac Coherent Light Source
LLNL	Lawrence Livermore National Laboratory
M&O	Managing and Operating
OPC	Other Project Cost
PMCS	Project Management Control System
PMP	Project Management Plan
QA	Quality Assurance
R&D	Research & Development
RMP	Risk Management Plan
SAC	Scientific Advisory Committee
SASE	Self-Amplified Spontaneous Emission
SLAC	Stanford Linear Accelerator Center
SSO	DOE Stanford Site Office
TEC	Total Estimated Cost
TPC	Total Project Cost
XFEL	X-Ray Free Electron Laser
WBS	Work Breakdown Structure

Section I – Introduction

Purpose of this Project Management Plan

This Project Management Plan (PMP) defines the plans, organization, responsibilities and systems for managing the Linac Coherent Light Source Project (hereafter referred to as LCLS) to be constructed at the Stanford Linear Accelerator Center (SLAC). The PMP is a field-level plan documenting agreements between the Department of Energy (DOE) Stanford Site Office and SLAC on the execution of the LCLS project. The PMP supplements the DOE Project Execution Plan.

Additional information on the LCLS may be found at: <http://www-ssrl.slac.stanford.edu/lcls/>.

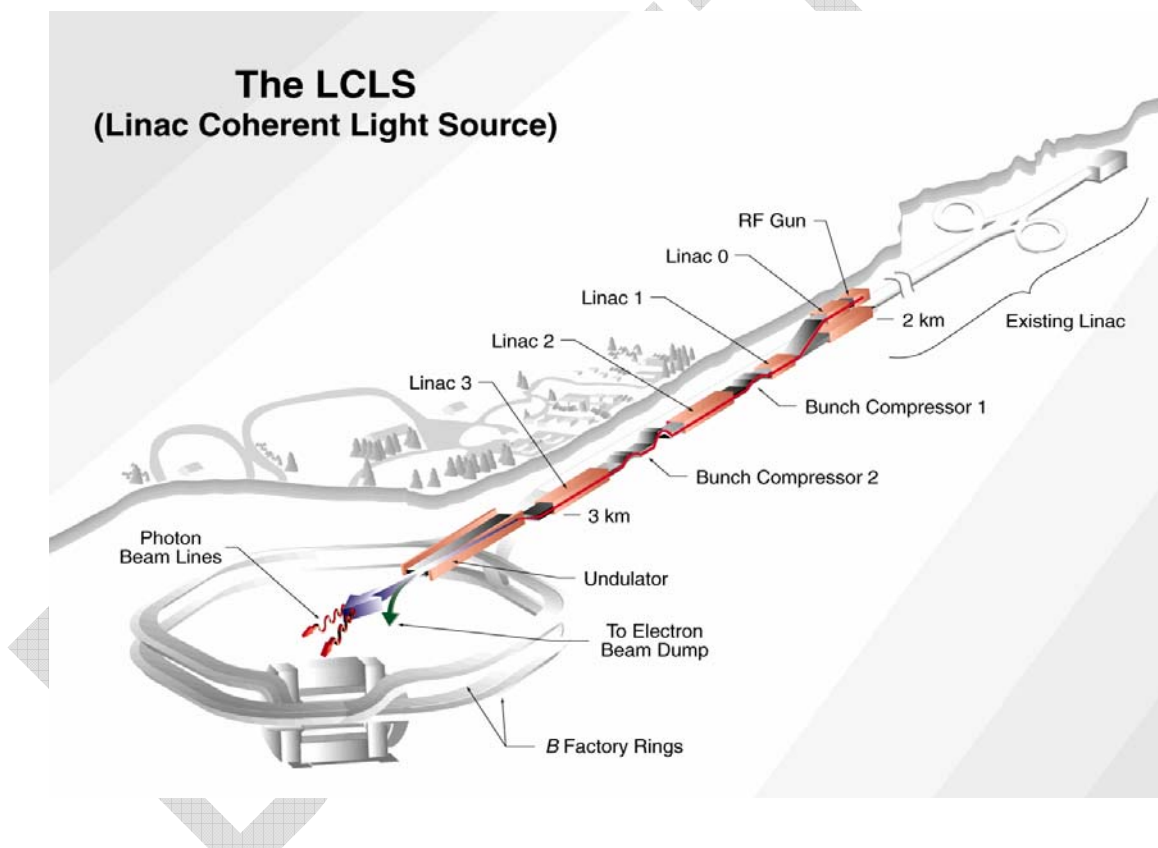
Purpose and Scope of the LCLS Project

The primary purpose of the LCLS Project is to create a world class research facility delivering coherent laser radiation in the x-ray region of the spectrum ten billion times greater in peak power and peak brightness than any existing x-ray light source. Utilizing the principles of Self-Amplified Spontaneous Emission (SASE), the LCLS will provide the world's first demonstration of an x-ray free-electron-laser (XFEL), operating in the 1.5–15 Angstrom (Å) range and utilize the extraordinary, high-brightness x-ray pulses as a powerful tool for research spanning such areas in the physical and life sciences as:

- Atomic physics
- Plasma physics
- Structural studies on single particles and bio-molecules
- Femtosecond chemistry
- Studies of nanoscale dynamics in condensed matter physics
- X-ray laser physics

Given the short duration of the LCLS pulse (230 femtosecond and shorter), the LCLS will provide an opportunity to observe the ultra-fast processes of atomic transition, chemical bond formation and breaking, and transitions in condensed matter structures. With a sufficiently short pulse the LCLS can, in effect, function as a stroboscopic flash for freeze-frame photography of atomic, molecular and nanoscale structures as they evolve.

The LCLS will be located within the SLAC complex as shown below:



The Linac Coherent Light Source (LCLS) at SLAC

The specific goal for the LCLS project is to produce a coherent x-ray pulse with a 0.15 nm wavelength and a subpicosecond pulse length. In order to achieve this goal, the project proposes to build an XFEL Facility on the SLAC site. This will require a new 135 MeV injector constructed at Sector 20 of the 30-sector SLAC Linac to create the high brightness electron beam required for the XFEL. The last one-third of the linac will be modified by adding two magnetic bunch

compressors. Most of the linac, and its infrastructure, will not be changed. The existing components in the Final Focus Test Beam tunnel will be removed and replaced by a transfer line across the SLAC Research Yard. An undulator tunnel passing through the berm east of the research yard will house a 120-meter undulator and associated equipment. Two experimental halls will be constructed. A Near Hall will be constructed approximately forty meters downstream of the undulator and a Far Hall will be constructed approximately two hundred fifty meters downstream of the Near Hall. Provisions will be made for x-ray endstation enclosures, as well as instrumentation and controls for identifying and characterizing the x-ray beam. A research center, currently titled the LCLS Central Lab Office (CLO) Complex, will be constructed to facilitate the operations and research of the LCLS program.

The SLAC site has been selected for the LCLS because it makes use of the last kilometer of the SLAC linac as a source of a high-quality electron beam for the LCLS FEL. In addition, the experienced SLAC support staff and existing infrastructure provide the optimum location for LCLS construction and operations.

The LCLS operational plan calls for a simultaneous use of the Linac by the PEP-II High-Energy Physics Experimental Program. At least 75% of the annual operating schedule for the last third of the SLAC linac will be dedicated to the LCLS. The remaining 25% of operation time may be scheduled for test beams and fixed-target experiments requiring up to 50 GeV beams. LCLS has been designed to switch from LCLS operations to 50 GeV operations in 24 hours. For injection, LCLS has no impact on PEP-II.

Participants/Contracts

The LCLS Collaboration consists of a team of scientists and engineers from the Brookhaven National Laboratory (BNL), Argonne National Laboratory (ANL), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), SLAC and the University of California at Los Angeles (UCLA).

During the design and construction phase, the LCLS project is organized as a three-laboratory partnership, led by SLAC in collaboration with ANL and LLNL. This partnership allows each laboratory to bring their unique technical strengths: SLAC – accelerators; ANL – undulators; and LLNL – x-ray beam transfer optics to the LCLS project thus reducing the need to duplicate core competencies and support staff. SLAC, as the Host Laboratory for the LCLS, will use existing personnel and proven systems and procedures to manage the project.

The LCLS project is sponsored by the DOE Office of Science. Work for the LCLS will be performed under the following DOE contracts:

SLAC	DE-AC03-76SF00515
ANL	W-31-109-ENG-38
LLNL	W-7405-ENG-48

Overall DOE management responsibilities for the LCLS are detailed in the *Project Execution Plan for the Linac Coherent Light Source* (hereafter referred to as the LCLS PEP). An update to the LCLS PEP will include the construction start-up phases of LCLS. In accordance with DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*, the Director of Office of Science, SC-1, is the Acquisition Executive (AE) for the LCLS project. The DOE's Stanford Site Office (SSO) reports to the Office of Science and administers the Managing and Operating (M&O) contract for SLAC with Stanford University, which includes the day-to-day oversight of SLAC. The SSO Director delegates responsibility and authority for execution of the LCLS project to the LCLS Federal Project Director. A complete description of the roles and responsibilities within the LCLS project as they apply to the DOE, SLAC and its partner labs, ANL and LLNL, is described in Section III.

Other Important Documents

Acquisition Execution Plan (AEP)

The Acquisition Execution Plan (October 2002) has been prepared by the DOE Stanford Site Office within the DOE Office of Science. The AEP describes the

mission need and initial pre-planning strategies and key decisions for the LCLS project from the DOE perspective.

Conceptual Design Report (CDR)

The LCLS Conceptual Design Report (April 2002) provides the detailed overall systems requirements and defines the technical criteria for each of the major systems for the project.

DOE Project Execution Plan (PEP)

The DOE Project Execution Plan for the LCLS (May 2004) has been prepared by the DOE Stanford Site Office within the DOE's Office of Science. This Project Plan includes a Project Charter and describes LCLS management, organization, and roles and responsibilities from the DOE perspective.

Environmental Assessment for the LCLS Experimental Facility

The Environmental Assessment for the LCLS Experimental Facility (December 2002) provides an evaluation and summary of potential environmental effects of the LCLS project on the SLAC site. A finding of No Significant Impact was issued in February 2003.

LCLS Global Requirements Document

The LCLS Global Requirements Document specifies the performance requirements for the LCLS x-ray free-electron laser to be constructed at the Stanford Linear Accelerator Center (SLAC).

Preliminary Hazards Analysis Document

A Preliminary Hazards Analysis Document was completed by SLAC and approved by DOE/SSO in June 2002. This document provides an early evaluation of potential hazards that may impact the construction phase of the LCLS.

Risk Assessment and Management Plan

A Risk Assessment and Management Plan identifies and quantifies key risks to the LCLS project. This document provides an early assessment of the potential risks to the LCLS project and formulates mitigation strategies and funds to address the risks to the LCLS.

Copies of all documents can be obtained in the LCLS Project Office. Additional Information on the LCLS project and its scientific program can be found on the LCLS website at <http://www-ssrl.slac.stanford.edu/lcls>.

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Section II – Objectives

The primary objective of the LCLS project is to construct the world's first x-ray free electron laser (XFEL) that will serve as a facility for the application of XFEL radiation to experimental science and a research and development center for XFEL physics in the hard x-ray regime. This objective will be accomplished within the cost and schedule requirements accepted by the DOE and the LCLS Project.

Technical Objectives for the LCLS

The primary technical objective of the LCLS is to provide coherent radiation of extraordinary brightness with greater than 10^{11} photons per pulse in a 0.2%-0.4% energy bandpass with a pulse duration of 230 femtosecond or less. The LCLS facility will include two experimental halls, with associated office and laboratory space, where the x-ray beam will be utilized for research in physics, chemistry and biology. The Key Design Operating Parameters List for the LCLS are defined in the LCLS Global Requirement Document (GRD 1.1-001), which can be found on the LCLS website.

Project Schedule Objectives

The LCLS project formally began in Fiscal Year (FY) 2002 with DOE funding for Research & Development activities. Project Engineering and Design (PED) funds were available in FY2003 with completion of PED scheduled for the fourth quarter of FY2006. LCLS construction is planned to begin in the first quarter of FY2006 to be followed by a staggered commissioning phase. LCLS operations are scheduled to begin in the first quarter of 2009. The LCLS Project Level 1 and Level 2 milestones, which form the basis of the LCLS schedule baseline, are provided in Appendix A.

Project Cost Objectives

The Total Estimated Cost (TEC) for the LCLS project is \$273.0 Million Actual-Year (AY) dollars and the Total Project Cost (TPC) is 315.0 Million Actual-Year dollars.

The TEC and TPC profiles for the LCLS project, along with projections of DOE funding are shown in Appendix B.

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Section III – Management Organization and Responsibilities

Department of Energy

The roles, responsibilities, and authorities of the U.S. DOE Office of Science participants are described below. Appendix C depicts the relationships between the DOE and the partner laboratories as they apply to the LCLS project.

Office of Science

The Director of the Office of Science (SC-1) is the Program Secretarial Officer Acquisition Executive (AE) for the LCLS project. SC-1 has full responsibility for project planning and execution, and for establishing broad policies and requirements for achieving project goals. Specific responsibilities for the LCLS project include:

- Chair the ESAAB Equivalent Board.
- Approve Critical Decisions and Level 1 baseline changes.
- Approve the Project Execution Plan.
- Delegate approval authority for Level 2 baseline changes to the Federal Project Director.
- Conduct Quarterly Project Reviews.
- Ensure independent project reviews are conducted.
- Recommend approval of the Acquisition Execution Plan to the Undersecretary.

Office of Basic Energy Sciences

Within DOE's Basic Energy Sciences Division (BES), the Materials Sciences and Engineering Division (SC-13) has direct responsibility for providing funding, and programmatic guidance to the LCLS project. The LCLS Program Manager in SC-13 will be the primary point of contact for DOE Headquarters (HQ) with responsibilities that include:

- Oversee development of project definition, scope and budget.
- Prepare, defend, and provide project budget with support from the field organizations.
- Review and provide recommendations to the Acquisition Executive of Level 0 and 1 change control proposals.
- Monitor Level 2 technical, cost, and schedule milestones.
- Participate in Quarterly Project Reviews, ESAAB Equivalent Board meetings, and formal project reviews.
- Ensure ES&H requirements are implemented by the project.
- Coordinates with other HQ offices such as the SC Construction Management Support Division (SC-81), SC ES&H Division (SC-83), and the Office of Engineering and Construction Management (OECM).

DOE Stanford Site Office (SSO)

The SSO reports to the Office of Science and administers the M&O contract for SLAC with Stanford University, which includes day-to-day oversight of SLAC. The SSO Director delegates responsibility and authority for execution of the LCLS project to the LCLS Federal Project Director whose specific responsibilities include:

- Monitor, review, evaluate, and report on the performance of the project against established technical, cost, and schedule performance baselines.
- Ensure environment, safety and health is integrated into the project.
- Lead the Integrated Project Team.
- Approve Level 2 change control proposals as delegated by the AE. Review and provide recommendations to the AE for Level 0 and 1 change control proposals.
- Monitor Level 3 change control proposals.

- Authorize use of project contingency in accordance with the levels described in this PMP.
- Participate in Quarterly Project Reviews, ESAAB Equivalent Board meetings, Critical Decisions and project reviews conducted by the LCLS project and DOE HQ.
- Conduct management meetings to monitor and review status of project activities.
- Keep SC management informed of progress and problems in a timely manner.
- Maintain project data current in the DOE Project Assessment and Reporting System (PARS).
- Issue Project Directive Authorizations for disbursement of funds and work authorizations.
- Prepare project documents such as the Project Execution Plan, Acquisition Execution Plan and Project Quarterly Report.
- Coordinate matrix support from the SC or NNSA Service Centers

SLAC, ANL and LLNL Project Management, and Advisory Committees

Appendix D provides an organizational chart illustrating the relationships (for the purposes of this project) between SLAC, ANL and LLNL laboratory management; LCLS Project Management; and various advisory committees. An explanation of the responsibilities of key managers, are provided below:

SLAC Director

The SLAC Director has the ultimate responsibility for designing and constructing the LCLS Project in keeping with the requirements of the SLAC DOE contract DE-AC03-76SF00515. The Director has delegated the authority to manage and execute the LCLS project to the LCLS Project Director, and will

ensure that the LCLS Project Director has priority access to all of SLAC's resources for that purpose.

The SLAC Director will establish a separate LCLS Division during the PED and construction phase of the LCLS project. The reorganization creating a separate LCLS Division will establish the LCLS Project Director as an Associate Director of SLAC reporting directly to the SLAC Director. (See Appendix E for additional details.) Key personnel currently matrixed from other SLAC divisions will migrate into the LCLS Division establishing a direct line management organization to support the activities of the LCLS project.

ANL/LLNL Directors

The ANL and LLNL Directors ensure that the appropriate resources for their laboratories are applied to support the project in keeping with their DOE contracts. The Directors jointly review with the SLAC Director the findings of the Machine Advisory Committee, and initiate adjustments in program direction as needed. The ANL and LLNL Directors will appoint representatives to the Inter-Laboratory Coordinating Council (ILCC). The Directors will ensure that issues raised by the ILCC are addressed in a timely manner.

The ANL Director and LLNL Director have worked with the SLAC Director to approve Memoranda of Understanding (MOU's), which describe the terms of agreement with respect to their laboratories' participation in the LCLS project. Each year, a Technical Addendum to the MOU is written between SLAC and its partner laboratories to define the annual scope of work, resources and schedule requirements for the LCLS. An example of the Technical Addendum between SLAC and ANL/LLNL is shown in Appendix F.

Facilities Advisory Committee

The Facilities Advisory Committee (FAC) is a standing committee appointed by the LCLS Project Director, with concurrence from the SLAC, ANL and LLNL Directors, to provide advice on the progress of LCLS construction. Members of this group will be selected from the international scientific

community with expertise in the project areas of interest. The FAC not only advises the three laboratory Directors, but has a primary role in providing guidance and feedback to the Project Director and his management team. The FAC meets and publishes a status report on the LCLS project biannually.

Scientific Advisory Committee

The Scientific Advisory Committee (SAC) is a standing committee appointed by the LCLS Project Director, with concurrence from the SLAC, ANL and LLNL Directors, to provide guidance on the LCLS scientific research program. Members of this group will be selected from throughout the scientific user community with expertise in atomic, plasma and laser physics, femtosecond chemistry and biology, and nanoscale physics and will provide advice and recommendations on the initial direction of LCLS programmatic research. The SAC meets and publishes a status report on the LCLS scientific program biannually.

Inter-Laboratory Coordinating Council

The purpose of the Inter-Laboratory Coordinating Council (ILCC) is to address issues affecting resource allocation to the LCLS project at the partner laboratories, optimization of LCLS Project resources with other laboratory activities, and coordination of partner laboratories' LCLS activities. Each laboratory Director shall appoint a representative to the ILCC with line responsibility for resource allocation to the LCLS Project. The ILCC is chaired by the LCLS Project Director and will meet once per month, or spontaneously should an immediate need arise. The Federal Project Director will be invited to attend ILCC meetings.

LCLS Management

Appendix G provides an overview of the organization chart for the LCLS Project. The roles and responsibilities of the LCLS Project Management organization are described below:

LCLS Project Director

The LCLS Project Director reports to the SLAC Director and is responsible for the direction of LCLS design and construction activities and the research and development program to support the LCLS, including coordination of SLAC, ANL, and LLNL personnel assigned to the project. The LCLS Project Director is responsible for approving the selection of staff for the design, construction, commissioning, and initial operation of the LCLS facility. Specific responsibilities include:

- Day-to-day management and overall direction of the LCLS project.
- Ensuring that ES&H responsibilities and requirements are integrated into the project.
- Establishing technical and administrative controls to ensure project is executed within approved cost, schedule and technical scope.
- Directing and coordinating supporting R&D and commissioning activities with construction activities
- Representing the project in interactions with the DOE and other laboratories. Participating in management meetings with DOE and communicates project status and issues.
- Chairing the Configuration Control Board
- Chairing the Inter-Laboratory Coordinating Council
- Chairing the Change Control Board.
- Approving Level 3 change control proposals. Preparing and providing recommendations to the Federal Project Director for Level 0, 1, and 2 change control proposals, as required.
- Identifying and managing project risks.
- Member of the Integrated Project Team.

LCLS Chief Engineer

The LCLS Chief Engineer reports to the Project Director and has the following responsibilities:

- Carrying out the LCLS Project Director functions when the LCLS Project Director is unavailable.
- Providing support for all the functions performed by the LCLS Project Director.
- Facilitating and overseeing interlaboratory coordination.
- Serving as the Configuration Manager of the Configuration Control Board.
- Coordinating engineering work for the entire project.
- Directing project planning, scheduling, and budgeting and overseeing the Project Management Control System.
- Defining estimating rules, practices, and procedures and managing periodic project re-estimates.
- Establishing, maintaining, documenting, and enforcing engineering standards.
- Establishing technical definitions of all project procurements.
- Member of Integrated Project Team.

System Managers (*Injector, Linac, Undulator, etc.*)

The LCLS System Managers report to the LCLS Project Director and have the following responsibilities:

- Planning and managing the design, construction, installation, and commissioning of their respective LCLS system.
- Serving as the Cost Account Managers for all cost accounts in their LCLS system.

- Participating in project planning, scheduling and cost estimating for their LCLS system.
- Ensuring that work in their respective LCLS system is planned and executed in accordance with SLAC ES&H policy.
- Serving as members of the Configuration Control Board.

System Physicists (*Injector, Linac, Undulator, etc.*)

The LCLS System Physicists report to the LCLS Project Director and have the following responsibilities:

- Acting as a liaison for the respective LCLS System Manager with SLAC operational infrastructure and personnel.
- Ensuring that the physics performance of the respective LCLS system will meet the operational requirements of the LCLS and the SLAC Linac.
- Establishing and documenting performance specifications and physics parameters of their respective LCLS system.
- Establishing and documenting specifications for operational and controls parameters of their respective LCLS system.
- Developing commissioning goals and procedures and optimize the physics performance of the LCLS.

LCLS Project ES&H Officer

The LCLS Project ES&H Officer reports to the LCLS Project Director and is responsible for:

- Providing all levels of LCLS management with advice, information and other resources appropriate to the LCLS project safety oversight.

- Assisting line management in writing environment, safety, and health documents, or authoring these documents as assigned by the LCLS Project Director.
- Reviewing proposed designs, procedures, and practices for environment, safety, and health considerations.
- Acting as a liaison for the LCLS Project in dealings with the SLAC Environment, Safety, and Health (ES&H) Division and the SLAC Safety Oversight Committee (SOC) to ensure that laboratory-wide environment, safety, and health policies are followed.
- Coordinating with the SLAC ES&H Division on training requirements for LCLS Project members.
- Acting as LCLS Project liaison in environment, safety, and health audits conducted by the DOE or the ES&H Division.
- Supporting of line management's activities to determine if environment, safety, and health requirements are being followed.
- Advising LCLS management on progress toward completion or monitoring of project schedules of environment-, safety-, and health-sensitive milestones.
- Recommending to the LCLS Project Director corrective action for situations where environment, safety, or health conditions pose an imminent danger or significant environmental harm.
- Serving as a member of the Configuration Control Board.
- Stopping work authority for unsafe activities.

LCLS Project Quality Assurance Officer

The LCLS Project Quality Assurance (QA) Officer reports to the LCLS Project Director and is responsible for:

- Advising LCLS management as to conformance with project-specific quality-control procedures and practices.
- Providing advice to System Managers for the implementation of QA-related activities (for example the QA Officer may provide guidance on developing inspection plans or developing vendor control programs).
- Providing or coordinating project-specific QA training for LCLS Project members.
- Reviewing completion of QA-related milestones as provided in project schedules.
- Providing advice to all levels of the project line management to ensure the completion of critical planned QA activities are not compromised due to cost, schedule, or other constraints.
- Performing QA audits as requested by the LCLS Project Director.
- Participating individually or as part of a team in vendor surveys, vendor qualifications, and source inspections.
- Serving as a member of the Configuration Control Board.

LCLS Project Budget Officer

The LCLS Project Budget Officer reports to the LCLS Project Director and is responsible for:

- Acting as the primary office of communication between LCLS and other financial offices of SLAC, ANL and LLNL including Accounting, the Business Office, and the Budget Office.
- Acting as the primary contact between LCLS and Procurement in tracking requisitions and purchase orders and expediting issues related to purchase orders.
- Providing monthly summaries of budgets, costs, open commitments and obligations in a format useful to the LCLS management team.

- Maintaining original and electronic copies of MOU's and SOW's for the LCLS project.
- Providing gate-keeping oversight to the requisition process. Approve requisitions on-line for off-line signatories. Supervise administrative staff in work related to requisition preparation.
- Tracking the overhead on individual requisitions and ensuring that adequate funds are set aside for indirect costs.
- Tracking labor effort on the LCLS project and providing reports to management indicating time and cost charged as compared to labor profile estimates.
- Tracking costs against SLAC credit cards used for LCLS business and ensure that transfers are being made to the appropriate cost account.

LCLS Project Cost & Schedule Manager

The LCLS Project Cost & Schedule Manager heads the Project Management and Control System (PMCS) Group, consisting of coordinators for the major LCLS systems. The LCLS Project Cost and Schedule Manager reports to the LCLS Chief Engineer and is responsible for:

- Maintaining the baseline cost estimate and baseline schedule.
- Establishing and maintaining the Project Management and Control System (PMCS).
- Establishing, coordinating and updating all reporting of project earned values measurements, including costs and schedule variances.
- Collecting monthly all actual costs for the LCLS project.
- Producing the monthly LCLS Cost and Schedule Status Report.
- Analyzing actual cost reports from the participating laboratories for correctness of charges.

- Assisting the Project Director, Chief Engineer and System Managers in forecasting budgets.
- Training and supervising the project's technical and administrative staff in the use of the costs and schedule system.

LCLS Database Manager

The LCLS Database Manager reports to the LCLS Chief Engineer and is responsible for designing, developing, maintaining, and qualifying the major databases that support the project including:

- Providing definitions of the appropriate hardware and software for administrative and machine design purposes.
- Maintaining Oracle and Windows-based cost, schedule, drawing, and configuration control systems for the LCLS Project.
- Maintaining a system to track purchase order progress against MOU's and SOW's.
- Establishing and maintaining an LCLS document control system that can be utilized as the central repository to ensure that all relevant documents are maintained in an accurate and logical hierarchical system.
- Installation of the appropriate hardware and implementing software, including the parameter list, to support the LCLS Project.

Section IV – Work Plan

To build an XFEL Facility at SLAC, the LCLS project proposes to construct the following main elements:

- a) A photoinjector and a short linac, at Sector 20 of the 30-sector SLAC Linac, where a bright electron beam is generated and accelerated to 135 MeV,
- b) Modification to the last kilometer of the 3-kilometer SLAC Linac, where the electron bunch is compressed and accelerated to 14.3 GeV,
- c) Removal of the Final Focus Test Beam tunnel and construction of a transport system to the undulator,
- d) An undulator, ~120m in length, where the electrons emit FEL and spontaneous radiation,
- e) The undulator-to-experimental area transport line,
- f) A Near Experimental Hall, ~40 meters downstream of the undulator, will include three enclosures for x-ray diagnostics equipment,
- g) A photon beam transport line connecting the Near Experimental Hall to the Far Experimental Hall.
- h) A Far Experimental Hall, ~250 meters downstream of the Near Experimental Hall and constructed as an underground cavern, will include three enclosures for x-ray diagnostics equipment,
- i) The LCLS Central Laboratory Office (CLO) Complex, constructed on grade near the Experimental Halls, to accommodate LCLS users and scientific and operations staff. Parking will be provided adjacent to the LCLS CLO.

Work Breakdown Structure

The detailed activities to design, fabricate, construct, install and commission the LCLS project are described in its Work Breakdown Structure (WBS). Each

element (activity) of the WBS has cost, manpower, and schedule associated with it and is the key element (activity) for planning and controlling cost and schedule.

Organization of the WBS

The levels of the WBS reflect a logical breakdown of the work by major system. Each lower level breaks down the previous level by subsystem and task. Level 1 defines the total LCLS project as follows:

1	LCLS Total Estimated Cost (TEC)	Includes all Project Engineering and Design (PED) and construction effort for this project.
2	LCLS Other Project Cost (OPC)	Includes all research and development (R&D), commissioning (pre-operations) and spares for this project.

The LCLS Total Project Cost is defined at any time as the sum of the TEC and OPC. WBS Level 2 defines the major LCLS systems organized according to geography. Each LCLS system's WBS captures their respective TEC and OPC as follows:

WBS#	LCLS System
1.1, 2.1	Project Management, Administration & Integration
1.2, 2.2	Injector System
1.3, 2.3	Linac (Accelerator) System
1.4, 2.4	Undulator System
1.5, 2.5	X-Ray Transport, Optics & Diagnostics System
1.6, 2.6	X-Ray Endstations System
1.9, 2.9	Conventional Facilities

Each system includes related common tasks and activities such as controls, alignment and installation, such that it is a fully integrated system that captures all costs, resources, tasks and activities necessary to complete each LCLS system.

Each system contains progressively lower levels to further define the sub-elements down to the lowest WBS.

The WBS Dictionary

A WBS Dictionary has been established to define the WBS scope. An index for the LCLS WBS and WBS Dictionary for each element through Level 2 is provided in Appendix H. A copy of the complete WBS and the WBS Dictionary is available in the LCLS Project Office.

The LCLS Cost and Schedule Manager is responsible for maintaining the current WBS and WBS Dictionary and the records of all changes. All changes must be approved by the Project Director prior to implementation.

When specified by this management plan, such changes will be forwarded to the Federal Project Director for approval after review by the Configuration Control Board. Once approved, the changes will be implemented in the WBS. A record of such changes will be maintained.

Work Execution

Engineering, Design, and Drawings

Each partner laboratory participating on LCLS agrees to furnish complete documentation of the quality control and performance checks on deliverables supplied to the LCLS project. Documentation will include all engineering drawings of equipment, full schematics of electronics, operating and maintenance specifications, 'as-built' dimensions of all deliverables, magnetic measurements, and documentation of all software. All drawings, specifications, operating and maintenance documentation will be stored on the LCLS Database at SLAC.

Make-vs-Buy Policy

The LCLS Chief Engineer will review, on a case-by-case basis, fabrication requirements and recommend whether to use in-house capabilities or buy the

item from an outside supplier. The program applies to the fabrication of hardware and services. The goals of this program are;

- a) Meet the LCLS Project mission, cost, design, and schedule requirements effectively.
- b) Comply with obligations to support small, small disadvantaged, and minority-owned business enterprises.
- c) Efficiently use and maintain the participating laboratories' capabilities according to their mission and DOE objectives.

R&D and Commissioning Activities

R&D and commissioning activities that support the construction project will be carried out primarily by employees of the participating laboratories using the facilities and resources of the laboratories. Management of the R&D work and coordination of R&D with the construction project is the responsibility of the LCLS Project Director.

Commissioning functions and activities are to be integrated into SLAC operations and are subject to all SLAC ES&H and operations policies and procedures. Should there be any conflict between SLAC ES&H and/or SLAC Operations and the LCLS PMP, SLAC's policies will take precedent.

Section V – Cost and Labor Estimates

Cost Estimates

As described previously, Appendix B provides a year-by-year summary of LCLS cost estimate (TEC, OPC), at WBS Level 2 and compared with anticipated funding plans. The LCLS cost estimate is a detailed "bottoms-up" estimate with resources loaded at the lowest activity. Resources defined in the detailed estimate are applied to the tasks established in the schedule to generate a time-phased budget. All estimates are assessed in dollars in the actual year (AY) spent.

The LCLS cost estimate has been developed using appropriate standard estimating methodologies, and integrated with the work scope definition. The cost estimate is supported and documented with the LCLS Basis of Estimate, which provides the methodology used to estimate the cost at the lowest WBS as well as the supporting documentation for the LCLS Cost Estimate. A copy of the LCLS Basis of Estimate is available in the LCLS Project Office.

Labor Estimates

The labor required for the project has been estimated by labor type and distributed by the cognizant manager to support the scope of work. Labor rates for each labor type have been developed. These labor estimates sum up to the total project labor estimate. Appendix I shows the current labor estimate required for the LCLS Project by partner laboratory per fiscal year. This labor will be provided by existing personnel at SLAC, ANL, LLNL, and where necessary, by additional contract and term appointment labor.

Section VI – Funding and Cost Management

Funding Management

Funds will be available to the DOE in support of the LCLS Project on an annual basis following the passage of legislation by the U.S. Congress. Funds for LCLS PED and construction costs shall be directed to SLAC via congressional budget line item, with LCLS R&D and commissioning funds as a modification to SLAC's M&O contract with DOE.

The financial resources required to perform the work scope at ANL and LLNL will be determined by SLAC's LCLS Project Management organization. To assure these resources are transferred in a timely manner to meet future expenditures and procurements, LCLS Project Management will prepare annual Technical Addenda to the ANL and LLNL Memoranda of Understanding (MOU) for work scope and necessary funding by August 1 of the preceding fiscal year. The addenda (see Appendix F) authorize an annual funds transfer via subcontracting agreement between SLAC and its partner labs. At mid-year and at the beginning of the fourth quarter, SLAC may request adjustments to obligations to ANL and LLNL if necessary.

The ANL and LLNL annual addenda authorize a defined scope of work and the necessary resources at the lowest level of the WBS for each Lab. Laboratory labor resources, if necessary to accomplish the work scope, will be identified explicitly in the addendum. Each partner lab will make every effort to carry out their institutional responsibilities consistent with the LCLS project schedule, which may have to be changed as the project progresses. To optimize available resources, LCLS management may transfer, modify or redefine future work scope, through modification of the addenda, to achieve the LCLS technical, cost and schedule requirements.

Cost Management

Cost Account Managers for each of the WBS level 2 systems will be responsible for ensuring that only work budgeted will be authorized and for controlling

expenditures against their accounts. The costs and commitments incurred in these accounts will be transmitted to the LCLS project office monthly and reported in the monthly Cost Performance Report.

In addition, each laboratory has a signature authority procedure to assure that only authorized personnel can approve requisitions. Signature authority is delegated by the LCLS Project Director to LCLS Cost Account Managers as follows:

LCLS Manager	Signature Authority
LCLS Project Director	\$100,000
LCLS Chief Engineer	\$15,000
LCLS System Managers (SLAC, ANL, LLNL)	\$5,000

Procurement and item purchases exceeding the delegated limit will be authorized by the LCLS Project Director in advance of obligation by the partner laboratory's Procurement Department.

Section VII – Configuration Management

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 LCLS project management will control and evaluate changes to its cost, schedule and work scope baseline through a change control process designed to promote an orderly evolution from the initial baseline design, and ensure that the effect of changes on cost, schedule, and performance are properly evaluated and documented.

Configuration Control Board

A Configuration Control Board (CCB) consisting of the key members of the LCLS Project will be established. The board will consist of a standing committee consisting of a chairman, a configuration manager, and board members. Their roles are described below:

CCB Chairman

The LCLS Project Director is the CCB Chairman. The Chairman reviews and may approve changes that come before the CCB. The Chairman will coordinate DOE approval if the impact of a change to cost, schedule, or technical performance requires DOE approval.

Configuration Manager

The Chief Engineer is the Configuration Manager, and is responsible for managing change control activities, maintaining and enforcing control procedures, organizing the agenda for change control meetings, and ensuring changes are properly evaluated and documented.

Board Members

In addition to the CCB Chairman and the Configuration Manager, the Cost and Schedule Manager, the System Managers, and representatives from QA and ES&H constitute the Configuration Control Board.

In addition to the standing CCB committee, the LCLS Federal Project Director will attend all CCB reviews requiring DOE approval, and is invited to sit in on CCB reviews below DOE approval threshold. Although any member of the LCLS project can propose a baseline change, it must be sponsored by one or more board members. The CCB members review the technical, cost, and schedule implications of changes and advise the Chairman. All System Managers must review every change to assess impact and ensure that system interfaces have been properly considered. The Cost and Schedule Manager must review every change to evaluate the impact to overall project cost and schedule.

Baselines

The initial technical, cost, and schedule baseline provides the reference point from which to begin configuration control. The baseline will evolve through the configuration control process. At any time, the current baseline will be traceable to the original baseline through the records of approved changes. Approved changes may affect the LCLS parameters list, hardware or software designs, and the project WBS Dictionary, cost and schedule.

Approval of LCLS Critical Decision (CD) 2b: Approve LCLS Performance Baseline by the Director of the DOE's Office of Science, will constitute the initial technical cost, and schedule baseline. The CD-2b is accompanied by an initial cost and schedule baseline, contingency, and forecasted funding profiles, along with the approved LCLS technical performance requirements. As Configuration Manager, the Chief Engineer is responsible for maintaining and documenting the technical baseline through the configuration control process. The LCLS Cost and Schedule Manager will incorporate approved changes into the project's WBS Dictionary and cost and schedule baselines. The Cost and Schedule Manager will maintain a record of approved changes that affect cost and schedule.

Change Thresholds

The thresholds for Configuration Change Control approval are given in Appendix J. All changes for Level 0, 1, or 2 must be reviewed by the Configuration Control Board and approved by the LCLS Project Director prior to being submitted to the DOE for additional approval.

Configuration Control Process

The configuration control process will be applied to all proposed changes, including those initiated by subcontractors and suppliers, which affect technical performance, cost, or schedule of the LCLS baseline. The process proceeds as follows:

- Any member of the project can request a change proposal by informing the responsible System Manager. The technical merits and cost/schedule impact are evaluated under the direction of the System Manager.
- The System Manager submits a Baseline Change Proposal (BCP) to the Chief Engineer (Configuration Manager), complete with a concise impact statement of the technical, cost, and schedule changes related to the BCP. The proposal is added to the agenda of a future change control meeting. The BCP must be signed by the System Manager(s) proposing the change.
- The Configuration Manager will send copies of new BCP's to all members of the CCB well in advance of the CCB meeting. The new proposed changes constitute the agenda of a future Configuration Control Board meeting.
- The Configuration Manager convenes the Configuration Control Board to discuss new change proposals. Each change is discussed, and each System Manager signs the change proposals. The CCB process is designed to ensure that the technical, cost and schedule impact of changes that may affect more than one LCLS system are correctly evaluated. There is a standing meeting of the CCB scheduled monthly, which can be cancelled if no BCP's are proposed.

- As chairman of the Configuration Control Board, the Project Director approves, disapproves the proposal, or requests further information concerning each proposal.
- Approved changes are transmitted to the DOE Federal Project Director.

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Section VIII – Risk and Contingency Management

Risk Management

Managing risk is a key element of the project management process for both planning and performance phases of the LCLS. As such, the LCLS management has developed a Risk Management Plan (RMP) which identifies and quantifies risks to the LCLS Project, determines their impact and exposure to risk and develops mitigation and correction strategies to employ when risks become reality. Risks to the LCLS project are identified to be in the following categories;

- Technical
 - Design and Equipment Complexity
 - Environment, Safety & Health
 - Procurements
 - Programmatic (Scientific Mission)
 - Resources (Funding and Staffing)
- Cost (includes currency and inflation)
- Schedule

The RMP assesses and quantifies risks to the LCLS project and documents the high risk areas in the LCLS Risk Registry. The LCLS Risk Registry is a living document used throughout the life of the LCLS project and, like contingency management, is under configuration control. The LCLS RMP and Risk Registry are regularly reviewed and updated by the CCB to reflect any reassessment of risks to the LCLS project. A copy of the LCLS RMP and the current Risk Registry are available in the LCLS Project Office.

Contingency Management

Contingency funds are utilized during the LCLS project for corrective actions to technical risks realized during the project, recovering from schedule delays, and providing resources for errors and omissions in the baseline cost estimate. Contingency funds are estimated, at the lowest WBS, based on a risk assessment of; (1) design maturity of the component(s) and/or cost estimate, and (2)

judgment factors, which considers environmental factors such as beyond the state of the art technology, single vendor procurements, currency and pricing variations, etc..

At any time, the project contingency is defined as the difference between the project TEC and the sum of the current estimates at completion at Level 2 of the WBS. All contingency for the project will be held at SLAC under the control of the LCLS Federal Project Director and LCLS Project Director as governed by the Baseline Change Control process. Increases in the WBS L2 Estimate-at-Completion (EAC) above \$100K will require submitting a Baseline Change Proposal (BCP) to the LCLS Configuration Control Board (CCB). The BCP will include the basis for the change and the implications for cost, schedule, and system interfaces.

The CCB will review the request and make a recommendation to the LCLS Project Director. If the Project Director concurs, the BCP is approved unless the change thresholds require the approval of higher levels of authority. An approved cost-related BCP results in the increase of the baseline estimate for that WBS element, and unless there are offsets, will reduce the available contingency by an equal amount. After performance baselines have been established, the LCLS Project Director will make every effort to find offsets within the project, without impacting the technical performance baseline, to mitigate draws on contingency. A change control log will be maintained by the LCLS Cost and Schedule Manager to document all approved BCP's.

The principals of contingency management for the LCLS project are as follows:

- The actual allocations of contingency at any level of the WBS will be reflected in a new EAC to be updated quarterly.
- The sum of these contingency allocations may not exceed the amount in the LCLS contingency amount.
- All changes from baseline costs shall be traceable to the CD-2b Performance Baseline.

Section IX – Project Management Control System

The LCLS Project has established a Project Management Control System (PMCS) using Primavera Project Planner (P3) as a schedule planner and COBRA as a cost processor to derive earned value progress on the project. Modeled after past DOE projects at SLAC, namely the B-Factory Project (PEP-II and BaBar), GLAST-LAT Project and the SPEAR-3 Project, the LCLS PMCS is the integration for the schedule and cost baselines and provides the necessary tools to monitor cost, schedule, and technical performance on a monthly basis. The LCLS PMCS satisfies all requirements of DOE Manual 413.3-1.

The LCLS cost and schedule baseline consists of a Baseline Cost Estimate (BCE) and the Integrated Project Schedule (IPS), which uses a project-wide logic network, resource-loaded tasks, and a hierarchy of schedule milestones. Both the BCE and IPS are maintained by the LCLS Project's PMCS Group and are subject to change control under Configuration Management.

The policies and procedures for maintaining and changing the BCE and the IPS and those for reporting schedule status are set forth in Section VIII – Configuration Management of this PMP and/or the supporting PMCS documentation written and distributed by the LCLS PMCS Group. The LCLS PMCS Group is managed and operated by the LCLS Cost and Schedule Manager and reports to the LCLS Chief Engineer.

Monthly performance measurement figures will be based on three quantities: schedule status submitted by the LCLS Cost Account Managers each month, actual financial status (costs and commitments) for the month, and the cost and schedule baseline.

A Cost Performance Report (CPR) will be prepared and issued monthly by the Cost and Schedule Group. Reporting will be by WBS element to the lowest element. For each element, the following data will be reported: actual cost of work performed (ACWP), budgeted cost of work performed (BCWP), and budgeted cost of work scheduled (BCWS). Cost and schedule variances, and cost and schedule performance indices, will be documented in the CPR.

A monthly report on the LCLS Project progress will be issued by the LCLS Project Office and distributed to appropriate DOE offices and other organizations outside the project. This report will provide information at WBS level 2 and higher and will discuss the overall status of the LCLS Project. A “Highlights” section will address the total project schedule overview and any significant project accomplishments. An “Assessment and Issues” section will cite any areas of concern to the project management. The LCLS monthly report will also document monthly and cumulative project cost and schedule performance at WBS level 2 and progress against DOE level 2 milestones.

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Section X – Supporting Functions

Each partner laboratory participating in the LCLS project, agrees to furnish indirect support to the project from its support departments, which may include:

- Accounting and Budgeting
- Environment, Safety and Health
- Facilities Management
- Information and Business Services
- Human Resources
- Legal
- Quality Assurance
- Procurement and Purchasing (if separate from Business Services)

All support functions will be provided through the partner laboratory's organizational lines of authority and responsibility. LCLS will direct questions of priority needs for support through normal lines of authority within the organization.

Section XI – Information and Reporting

Documents and Reports Prepared by DOE

- Accelerator Readiness Review
- Annual Project Validation Report
- Congressional Project Data Sheet
- Justification of Mission Need Statement
- Project Execution Plan
- Quarterly Project Director's Progress Report

Documents and Reports Prepared by the LCLS Project

- Advance Procurement Plan
- Conceptual Design Report
- Construction Project Data Sheet
- Environmental Assessment and Finding of No Significant Impact (FONSI)
- Final Safety Assessment Document
- Fire Hazards Analysis
- Hazards Analysis Report
- Monthly Project Report (includes Cost and Schedule Performance)
- Preliminary Safety Assessment Document
- Project Management Plan
- Quality Assurance Plan
- Risk Management Plan
- Start-Up and Commissioning Plan

Project Meetings and Reviews

Meetings and Reviews with DOE

The following meetings will be held between the DOE and the LCLS Project:

- DOE/LCLS Management Meeting (weekly). A meeting held between the DOE Federal Project Director, the LCLS Project Director and relevant LCLS staff to discuss current business and management issues.
- DOE/LCLS Status Meeting (monthly). A meeting held between the DOE BES Director, DOE LCLS Program Manager, DOE Federal Project Director, LCLS Project Director and relevant LCLS staff to review the current status of project work and to discuss outstanding issues.
- DOE/LCLS Quarterly Review (quarterly). A meeting held between the Office of Science Acquisition Executive, DOE-BES Director, DOE-LCLS Program Manager, DOE Federal Project Director, an Office of Engineering and Construction Management representative, relevant federal managers outside DOE-BES, LCLS Project Director, and relevant LCLS staff to review the current status of project work and to discuss outstanding issues.
- DOE/LCLS Project Review (semiannual). A review held by the DOE's Office of Science on the LCLS project's technical cost, schedule and management performance. Presentations by key project personnel will address issues on an agenda agreed to in advance by DOE and the LCLS Project Director. A report is issued with findings, comments, and recommendations.

Additional LCLS Project Meetings

Project reviews will be held whenever relevant to vet key decisions in the R&D and construction phases of the LCLS project. In addition, the following regular meetings will be conducted within the LCLS project:

- Inter-Laboratory Coordination Committee (ILCC) meetings (monthly), chaired by the LCLS Project Director. This meeting includes the DOE Federal Project Director, LCLS Project Director, Chief Engineer, System Manager(s) with work scope at the partner lab, and a representative from each partner lab with line authority for resource allocation to the LCLS project. This meeting will primarily focus on issues affecting resource allocation to the LCLS project at the partner laboratories and optimization and coordination of LCLS resources with all three laboratory activities. Meeting minutes will be recorded.
- LCLS Management Coordination Meeting (monthly), chaired by the LCLS Project Director. This meeting includes the DOE Federal Project Director, LCLS Project Director, Chief Engineer, the System Managers, the Integration Managers (Controls, Alignment, and Installation), the Cost and Schedule Manager, the PMCS Group, ES&H and QA officers, and a representative of the SLAC Purchasing Department. This meeting will focus on integration and coordination of the LCLS project and across functional groups within the partner laboratories. Meeting minutes will be recorded.
- LCLS Management Meeting (weekly), chaired by the LCLS Project Director. This meeting will involve the LCLS Project Director, Chief Engineer, the System Managers, the Integration Managers, the Cost and Schedule Manager, the PMCS Group, and will focus on the day-to-day management issues within the LCLS project. Meeting minutes will be recorded.
- LCLS Physics Coordination Meeting (weekly), chaired by the LCLS Project Director. This meeting will involve the Project Director, Chief Engineer, Institutional Liaisons, and System Managers, and provide the highest level of physics support and coordination for the LCLS project. This meeting will primarily focus on the R&D, liaison and commissioning support during the construction phase of the project.

- LCLS Change Control Board Meetings (monthly), chaired by the LCLS Project Director. This meeting will involve the DOE Federal Project Director, LCLS Project Director, Chief Engineer, the System Managers, the Integration Managers (Controls, Alignment, and Installation), the Cost and Schedule Manager, the PMCS Group, ES&H and QA officers, and a representative of the SLAC Procurement Department.
- LCLS Facilities Advisory Committee (FAC) Meetings (semiannual), chaired by the LCLS Project Director. The MAC is a standing committee made up of leading physicists in the scientific community charged to provide advice on the progress of LCLS construction, and to ensure that the LCLS project meets or exceeds the technical performance as defined in Appendix A.
- LCLS Scientific Advisory Committee (SAC) Meetings (semiannual), chaired by the LCLS Project Director. The SAC is a standing committee made up of leading physicists in the scientific user community charged to provide advice on the progress of LCLS scientific program, to provide guidance on the initial LCLS scientific research program.

Section XII – Project Management Plan Review and Modifications

After its adoption, this Project Management Plan shall be periodically reviewed by the DOE Federal Project Director. Proposals for its modification may be initiated by the DOE Federal Project Director, the LCLS Project Director, SLAC, ANL and LLNL Directors, or any other member of the Integrated Project Team. Significant changes to the PMP require an amended PMP and the approval of Director of the DOE's Stanford Site Office, DOE Federal Project Director, LCLS Project Director, and the Laboratory Director's at SLAC, ANL and LLNL.

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