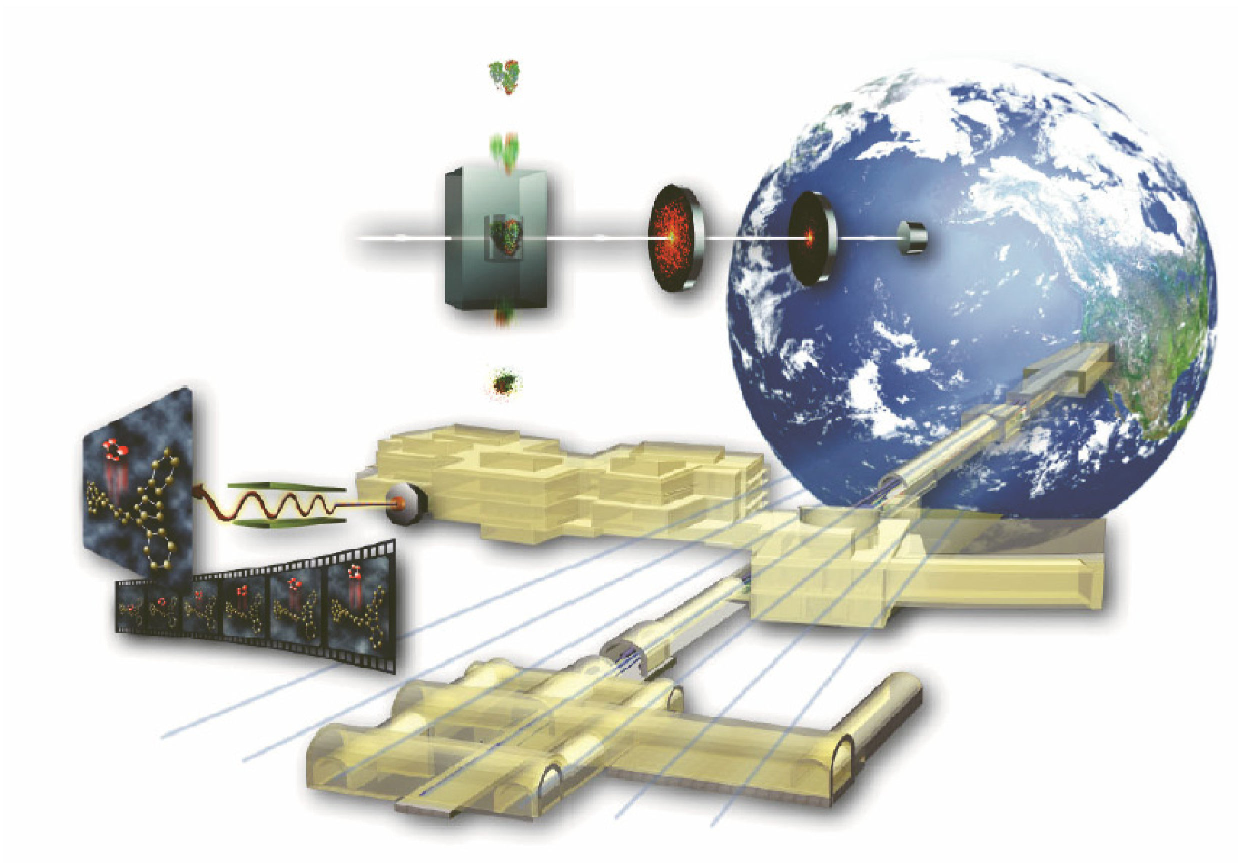
Project Execution Plan for the Linac Coherent Light Source



Stanford Linear Accelerator Center
for the Department of Energy

Approval

Department of Energy

Hanley W. Lee — 4/6/05
Hanley W. Lee Date
Federal Project Director
Stanford Site Office

Nancy N. Sanchez — 4/6/05
Nancy N. Sanchez Date
Site Manager
Stanford Site Office

Jeffrey C. Hoy — 4/7/05
Jeffrey C. Hoy Date
LCLS Program Manager
Office of Basic Energy Sciences

Patricia M. Dehmer — 4/8/05
Patricia M. Dehmer Date
Director
Office of Basic Energy Sciences

D R Lehman — 4/7/05
Daniel R. Lehman Date
Director
Office of Project Assessment

Stanford Linear Accelerator Center

John Galayda — 4/6/05
John Galayda Date
LCLS Project Director
Stanford Linear Accelerator Center

Jonathan Dorfan — April 6, 2005
Jonathan Dorfan Date
Director
Stanford Linear Accelerator Center

Approved:

Raymond L. Orbach — April 11, 2005
Raymond L. Orbach Date
Director
Office of Science

Revision Record

	Description	Date
Revision 0	Preliminary Project Execution Plan for Approval of Preliminary Baseline (CD-1)	September 2002
Update	Updated PPEP for Approval of Long Lead Procurement Budget (CD-2a)	June 2003
Revision 1	Revised Project Execution Plan for Approval of Performance Baseline (CD-2b)	March 2005

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Overview

The purpose of the Linac Coherent Light Source (LCLS) Project is to provide laser-like radiation in the x-ray region of the spectrum that is 10 billion times greater in peak brightness than any existing coherent x-ray light source. This advance in brightness is similar to that of a synchrotron over a 1960's laboratory x-ray tube. Synchrotrons revolutionized science across disciplines ranging from atomic physics to structural biology. Advances from the LCLS are expected to be equally dramatic. The LCLS Project will provide the first demonstration of an x-ray Free Electron Laser (XFEL) in the 1.5 - 15 Ångstrom range and will apply these extraordinary, high-brightness x-rays to scientific problems. The LCLS experimental program will commence with: measurements of the x-ray beam characteristics and tests of the capabilities of x-ray optics; instrumentation; and techniques required for full exploitation of the scientific potential of the facility. This will be the world's first such facility.

A separate Major Item of Equipment project, the Photon Instrumentation for X-ray Experiments at LCLS (PIXEL), will design and fabricate additional instrumentation to capitalize on the unique capabilities of the LCLS to further the experimental program.

The LCLS is based on the existing Stanford Linear Accelerator Center (SLAC) linac. The SLAC linac can accelerate electrons or positrons to 50 GeV for colliding beam experiments and for nuclear and high-energy physics experiments on fixed targets. At present, the first two-thirds of the linac is being used to inject electrons and positrons into PEP-II, and the entire linac is used for fixed target experiments. When the LCLS is completed, the latter activity will be limited to 25 percent of the available beam time and the last one-third of the linac will be available for the LCLS a minimum of 75 percent of the available beam time. For the LCLS, the linac will produce high-brightness 4 - 14 GeV electron bunches at a 120 Hertz repetition rate. When traveling through the new 120 meter long LCLS undulator tunnel, the electron bunches will amplify the emitted x-ray radiation to produce an intense, coherent x-ray beam for scientific research.

The LCLS makes use of technologies developed for SLAC and the next generation of linear colliders, as well as the progress in the production of intense electron beams with radiofrequency photocathode guns. These advances in the creation, compression, transport, and monitoring of bright electron beams make it possible to base this next generation of x-ray synchrotron radiation sources on linear accelerators rather than on storage rings.

The LCLS will have properties vastly exceeding those of current x-ray sources (both synchrotron radiation light sources and so-called "table-top" x-ray lasers) in three key areas: peak brightness, coherence (i.e., laser-like properties), and ultra-short pulses. The peak brightness of the LCLS is 10 billion times greater than current synchrotrons, providing 10^{11} x-ray photons in a pulse with duration of less than 230 femtoseconds. These characteristics of the LCLS will open new realms of scientific application in the chemical, material, and biological sciences.

The LCLS project is organized as a three-laboratory partnership, led by SLAC that includes Argonne and Lawrence Livermore National Laboratories (ANL and LLNL). This will capitalize on each laboratory's technical strengths: SLAC – accelerators; ANL – undulators; and LLNL – x-ray optics.

1.2 Purpose

The LCLS Project Execution Plan (PEP) provides an overview of the roles, responsibilities, authorities and management interactions between the Department of Energy (DOE) and the Stanford Linear Accelerator Center in executing the LCLS project. The PEP was prepared in accordance with DOE Manual 413.3-1, *Project Management for the Acquisition of Capital Assets.* In accordance with DOE Manual 413.3-1, the LCLS is subject to the requirements specified for "Other Projects". The Director, Office of Science (SC-1) is the Acquisition Executive (AE) as delegated in memorandum from the Under Secretary to the Director, Office of Science, dated April 11, 2003.

This PEP documents plans for the design, fabrication, construction and pre-operational phases of the project. It establishes the underlying principles for managing LCLS, provides details related to project authority, approval and funding; as well as the details of management structure, organization and project baselines for cost, schedule, and technical scope.

1.3 Approval and Revisions

Approval of the PEP occurs as an element of Critical Decision 2b (CD-2b), Approval of Performance Baseline. As the AE, SC-1 is the approval authority for the PEP. The PEP will be reviewed annually and updated to incorporate changes, as required.

2. MISSION NEED AND JUSTIFICATION

The mission of the Department's Office of Science (SC) is "To advance basic research and the instruments of science that are the foundations for DOE's applied missions, a base for U.S. technology innovation, and a source of remarkable insights into our physical and biological world and the nature of matter and energy." In turn, SC's Office of Basic Energy Sciences (BES) is charged with planning, constructing, and operating user facilities to provide special scientific and research capabilities to serve the needs of U.S. universities, industry, and Federal laboratories.

The mission of SLAC is to advance the understanding of the fundamental nature of matter and energy by providing leadership and resources for qualified researchers to probe the structure of matter at the atomic scale with x-rays and at much smaller scales with electron and positron beams. The B-factory utilizes the first two thirds of the linear accelerator to provide electron and positron beams for collisions in the BaBar detector to study the imbalance between matter and anti-matter. This program is supported by SC's Office of High Energy Physics.

The Stanford Synchrotron Radiation Laboratory (SSRL), a division of SLAC, provides synchrotron radiation from the SPEAR storage ring as well as ancillary equipment. The facility, which comprises 24 experimental stations, is used each year by over one thousand researchers from industry, other government laboratories, and universities including astronomers, biologists, chemical engineers, chemists, electrical engineers, environmental scientists, geologists, material scientists, and physicists. The LCLS project will expand the capabilities at SSRL.

2.1 Mission Need

The LCLS will serve as a research and development center for XFEL physics in the hard x-ray regime and as a scientific user facility for the application of XFEL radiation to experimental science. The LCLS is a high priority for the Office of Science as described in the "*Facilities for the Future of Science: A Twenty-Year Outlook" (November 2003)*. The LCLS ranked third in near term priorities. A full description of how the LCLS project furthers the mission of SLAC and the mission of the DOE Office of Science is found in the LCLS Justification of Mission Need (CD-0) document approved in June 2001, the *"Facilities for the Future of Science: A Twenty-Year Outlook",* and the Office of Science Strategic Plan (February 2004).

2.2 Project Goals

The LCLS will be located within the SLAC complex as shown in Figure 1. Figure 2 shows the below grade conventional facilities and figures 3 and 4 shows a conceptual drawing of the Central Laboratory and Office (CLO) building. The specific operational goal for the LCLS project is to produce coherent x-ray pulses with a 1.5 Ångstrom wavelength and a pulse length of less than 230 femtoseconds (10^{-15} seconds).

The project team will design, construct and commission this facility, which is described in detail in the Conceptual Design Report and other technical design reports. Scheduling and budgetary goals are to complete construction and commissioning by the end of March 2009 for a Total Estimated Cost (TEC) of $315 million and a Total Project Cost (TPC) of $379 million.

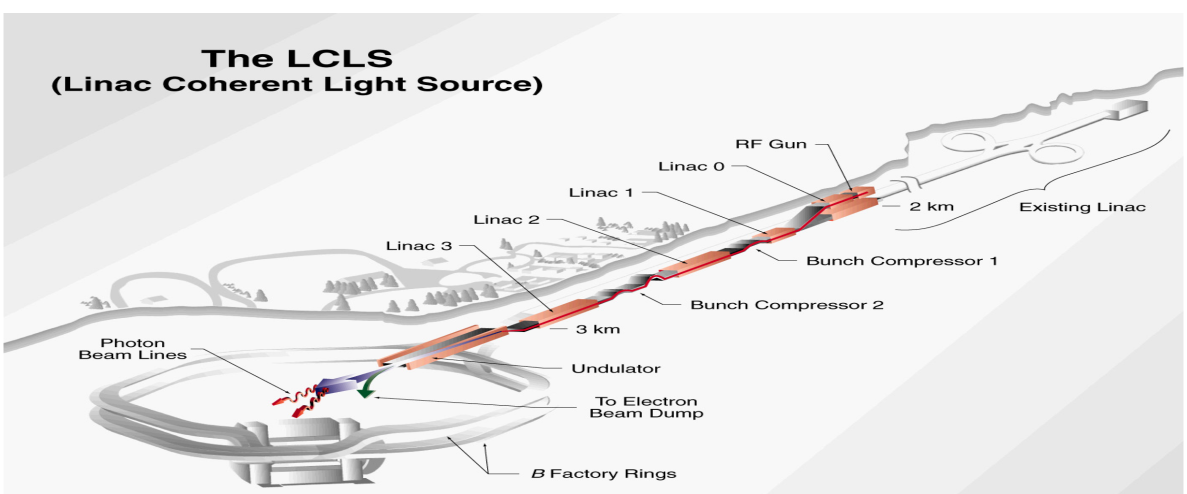


Figure 1 - *LCLS Facility*

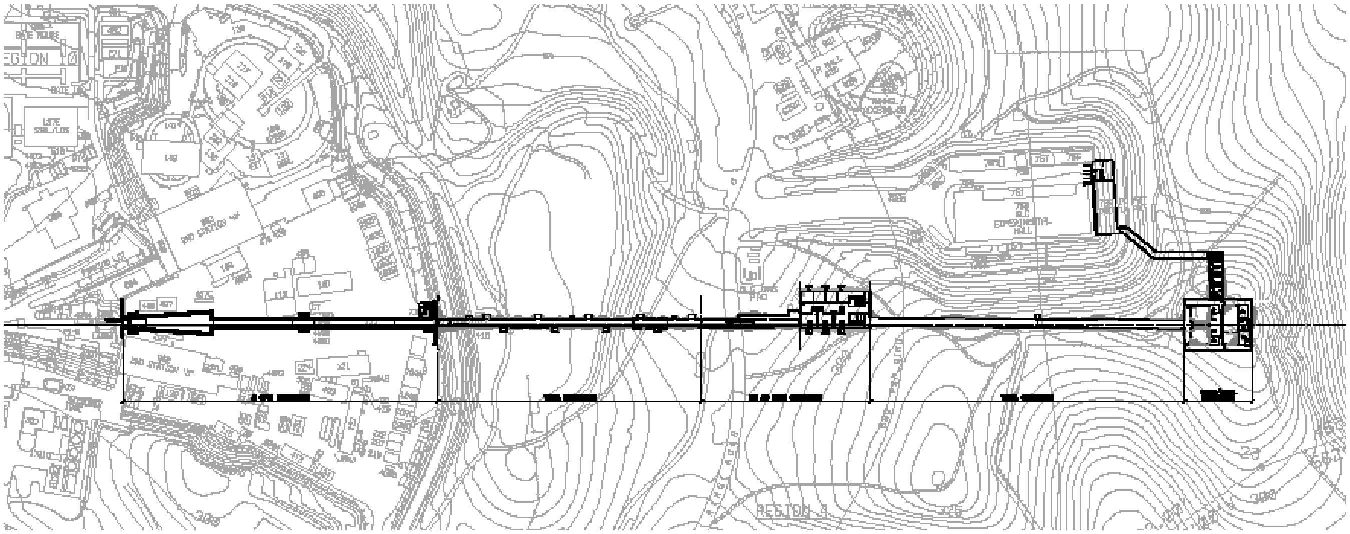


Figure 2
Below Grade Conventional Facilities

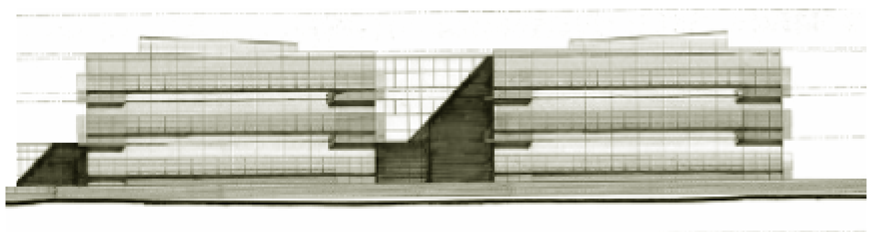


Figure 3
Central Laboratory and Office Building
Front View (West Elevation)

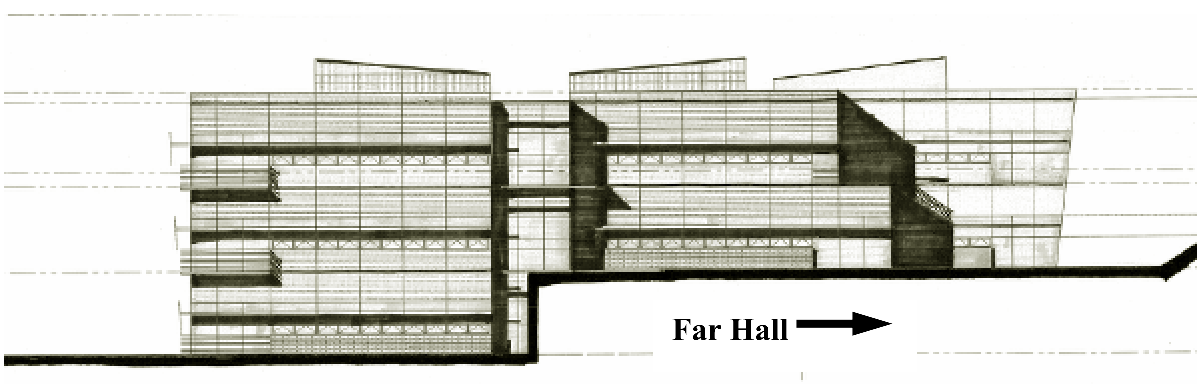


Figure 4
Central Laboratory and Office Building
Side View (South Elevation)

3. PROJECT DESCRIPTION

The LCLS Project requires a 135 MeV injector to be built at Sector 20 of the 30-sector SLAC linac to create the electron beam required for the x-ray FEL. The last one-third of the linac will be modified by adding two magnetic bunch compressors. Most of the linac and its infrastructure will remain unchanged. The existing components in the Final Focus Test Beam tunnel will be removed and replaced by a Beam Transfer Hall (BTH). The undulator system will be installed in a below grade tunnel with associated equipment. Provision will be made for x-ray endstation enclosures, as well as instrumentation and controls for identifying and characterizing the x-ray beam. Two experimental halls will be constructed. A Near Experimental Hall (NEH) will be constructed near the PEP ring road and a Far Experimental Hall (FEH) will be constructed further east. A CLO building will be constructed at the NEH site to provide laboratory and office space for LCLS users and serve as a center of excellence for basic research in x-ray physics and ultra-fast science.

The project has been organized into a Work Breakdown Structure (WBS) for purposes of planning, managing and reporting project activities. The project WBS is shown in Table 1. Work elements are defined consistent with discrete increments of project work and the planned method of accomplishment.

Table 1
LCLS Work Breakdown Structure

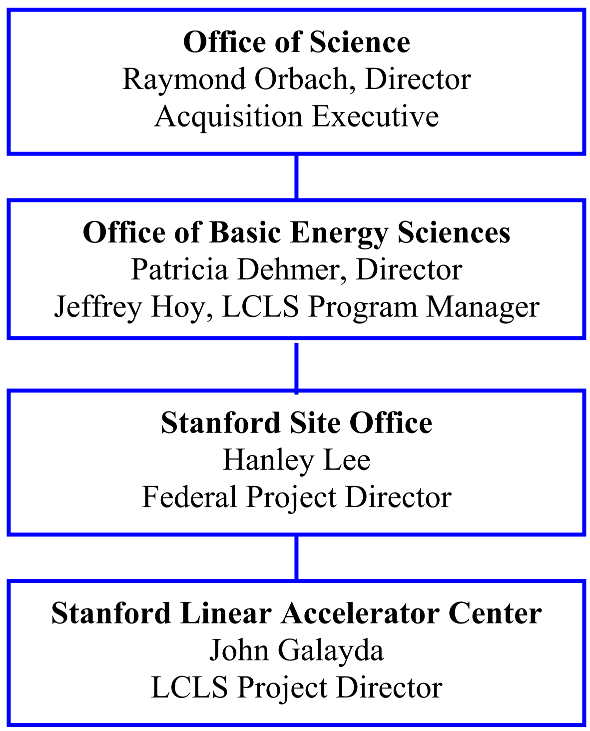
1.0 LCLS Construction Project (Total Estimated Cost)
- 1.1 Project Management, Planning and Administration
- 1.2 Injector System
- 1.3 Linac System
- 1.4 Undulator System
- 1.5 X-ray Transport and Diagnostic System
- 1.6 X-ray End Station System
- 1.7 Unused
- 1.8 Unused
- 1.9 Conventional Facilities

2.0 LCLS R&D, Spares, Commissioning (Other Project Costs)
- 2.1 Project Management, Planning and Administration
- 2.2 Injector System
- 2.3 Linac System
- 2.4 Undulator System
- 2.5 X-ray Transport and Diagnostic System
- 2.6 X-ray End Station System

4. ORGANIZATION AND RESPONSIBILITIES

SC is the DOE program office responsible for the LCLS project, and SC's Office of Basic Energy Sciences (BES) provides funding for the LCLS project directly to SLAC via approved financial plans. As the Management and Operating (M&O) contractor for SLAC, Stanford University will be responsible to DOE for carrying out the LCLS project. The University has delegated to SLAC responsibility for the research and development, design, construction, and operation of the LCLS. The organizational lines of authority and accountability for the LCLS project are shown in Figure 5. The roles, responsibilities, and authorities of the relevant managers are described below.

Figure 5
Linac Coherent Light Source
Project Management Organization



4.1 Department of Energy

Office of Science

The Director of the Office of Science (SC-1) is the Program Secretarial Officer Acquisition Executive (AE) for the LCLS project. As such, 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:

- Chairs the ESAAB Equivalent Board.
- Approves Critical Decisions and Level 1 baseline changes.
- Approves the Project Execution Plan.
- Delegates approval authority for Level 2 baseline changes to the Federal Project Director.

- Conducts Quarterly Project Reviews.
- Ensures independent project reviews are conducted.

Office of Basic Energy Sciences

Under the Energy Policy Act of 1992, SC's Director for Basic Energy Sciences (SC-22) is responsible for planning, constructing, and operating user facilities to provide special scientific and research capabilities to serve the needs of U.S. universities, industry, and private and Federal laboratories. Within BES, the Scientific User Facilities Division (SC-22.3) has direct responsibility for providing funding, and programmatic guidance to the LCLS project. The LCLS Program Manager, in SC-22.3, is the primary point of contact with the following responsibilities:

- Oversees development of project definition, scope and budget.
- Prepares, defends, and provides project budget with support from the field organizations.
- Reviews and provides recommendations to the AE on Level 0 and 1 baseline changes.
- Monitors Level 1 and 2 technical, cost, and schedule milestones.
- Participates in Quarterly Reviews, ESAAB Equivalent Board meetings, and project reviews.
- Ensures ES&H requirements are implemented by the project.
- Coordinates with other SC Staff offices, HQ program offices and the OECM.

Stanford Site Office (SSO)

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

- Day-to-day oversight of the project and provides direction to ensure its timely execution.
- Monitors, reviews, evaluates, and reports on the performance of the project against established technical, cost, and schedule performance baselines.
- Ensures environment, safety and health (ES&H) is integrated into the project.
- Leads the Integrated Project Team.
- Approves 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.
- Authorizes use of project contingency in accordance with the levels described in this PEP.
- Participates in Quarterly Project Reviews, ESAAB Equivalent Board meetings, and project reviews conducted by the LCLS project and DOE HQ.
- Conducts management meetings to monitor and review status of project activities.
- Maintains project data in the DOE Project Assessment and Reporting System (PARS).
- Issues Project Directive Authorizations for disbursement of funds and work authorizations.
- Prepares project documents such as the Project Execution Plan, Acquisition Strategy (formerly the Acquisition Execution Plan) and Project Quarterly Reports.
- Coordinates matrix support from the SC Integrated Support Centers.
- Prepares and submits budget and funding documents to the BES program manager. (e.g. Congressional Project Data Sheet)

4.2 Stanford Linear Accelerator Center

<u>SLAC Director</u>

The SLAC Director is responsible for managing all activities at the SLAC site. This includes assuring that all laboratory programs meet the requirements of the Stanford University - DOE Contract DE-AC02-76SFO0515. The Director has delegated the authority to manage and execute the LCLS project to the LCLS Project Director, and will ensure that the latter has priority access to all of SLAC's resources for that purpose.

<u>LCLS Project Director</u>

The LCLS project is organized as a Division of SLAC. The LCLS Project Director, as well as being the Associate Director of the Division, will be responsible to the Director of SLAC for managing the design, fabrication, installation, and commissioning of the LCLS as well as the supporting R&D efforts. He is also responsible for the LCLS organization and staff selection at SLAC and at the other institutions collaborating in the LCLS project. The LCLS organization chart is shown in figure 6. Specific responsibilities include:

- Manages day-to-day execution of the project at SLAC and at collaborating institutions.
- Establishes technical and administrative controls to ensure project is executed within approved cost, schedule and technical scope.
- Ensures that project activities are conducted in a safe and environmentally sound manner.
- Ensures ES&H responsibilities and requirements are integrated into the project.
- Directs overall project planning.
- Oversees R&D program, design, fabrication, installation, construction and commissioning.
- Represents the project in interactions with the DOE. Participates in management meetings with DOE and communicates project status and issues.
- Chairs the Change Control Board.
- Approves Level 3 change control proposals. Prepares and provides recommendations to the Federal Project Director for Level 0, 1, and 2 change control proposals.
- Identifies and manages project risks.

4.3 Collaborating Institutions

The LCLS project is a collaboration between SLAC, ANL, and LLNL. ANL will be responsible for the Undulator System and LLNL will be responsible for the X-ray Transport and Diagnostics System. The scope of work of these two collaborating laboratories is controlled by Memoranda of Understanding (see Appendix A).

4.4 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 quarter, or immediately when the need arises. The Federal Project Director will be invited to attend ILCC meetings.

4.5 LCLS Advisory Committees

The Facilities Advisory Committee (FAC) is a standing committee reporting to the SLAC Director and to the LCLS Project Director to provide advice on technical, strategic/planning and safety issues important to the success of LCLS construction. The FAC meets and publishes a status report on the LCLS project biannually.

The Scientific Advisory Committee (SAC) is a standing committee reporting to the SSRL Director and the LCLS Project Director. It provides advice as needed for planning the LCLS scientific research program. The SAC meets and publishes a status report on the LCLS scientific program biannually.

The Conventional Facilities Advisory Committee (CFAC) is a standing committee appointed by the LCLS Project Director to provide guidance on the LCLS conventional facilities aspect of the project. The CFAC meets on an as needed basis depending on the progress of the conventional facilities. A report is published after meetings.

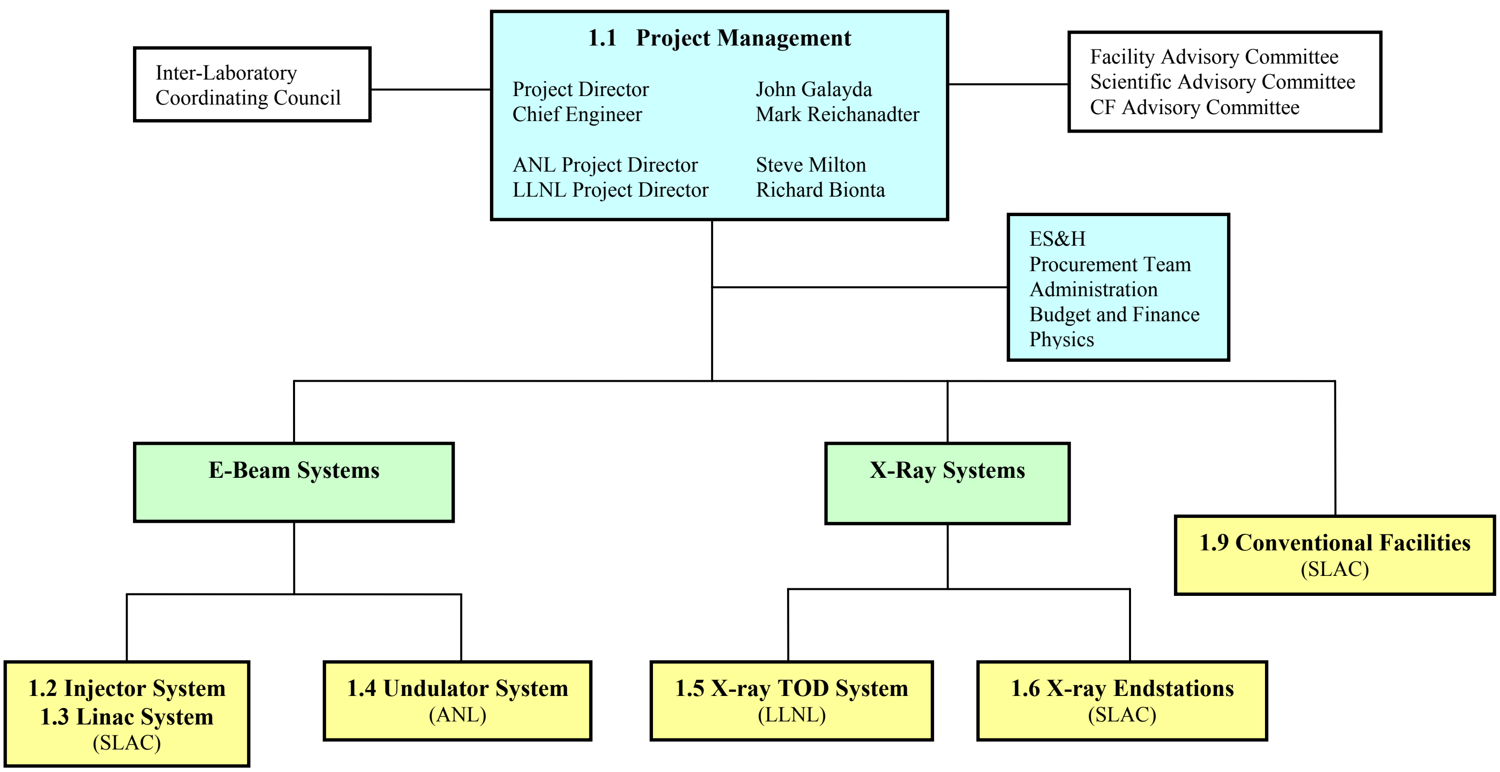


Figure 6 - *LCLS Organization*

4.6 Integrated Project Team

The LCLS Integrated Project Team (IPT) supports the Federal Project Director to ensure successful execution of the project. The IPT will draw upon functional specialists as members when needed. Team membership will vary depending on the deliverables required during each phase of the project life-cycle. An important role of the IPT is to ensure open and timely communications of project progress and concerns with all levels of management. Core members of the IPT and their roles and responsibilities are as follows.

DOE-SSO Federal Project Director. The Federal Project Director provides overall project management oversight, leads the IPT, issues work authorizations, provides necessary funds, submits key project documents to support critical decisions, reports project progress, and assesses LCLS project execution performance.

DOE-BES LCLS Program Manager. The Program Manager has responsibility for the day-to-day program management of the LCLS project.

DOE-SSO Contracting Officer. The Contracting Officer provides oversight of the M&O contract with Stanford University.

SLAC-LCLS Project Director. The Project Director has overall authority and responsibility to DOE for project execution.

SLAC-LCLS Chief Engineer. The Chief Engineer has overall responsibilities for all aspects of the engineering effort for the project.

ANL-LCLS Project Director. The ANL LCLS Project Director is responsible for the Undulator system.

LLNL-LCLS Project Director. The LLNL LCLS Project Director is responsible for the X-ray Transport, Optics and Diagnostics system.

SLAC-LCLS Procurement Officer. The LCLS Procurement Officer has overall authority and responsibility for LCLS procurements and coordinates with the SLAC Procurement Officer.

Additional support will be provided by SLAC, SSO and the SC Integrated Support Center staff in all functional areas (e.g., legal, budget, finance, ES&H, public affairs).

5. <u>RESOURCE REQUIREMENTS</u>

5.1 Budget Authority

The baseline budget authority (BA) funding requirements for the LCLS project were established in the FY2006 Congressional Project Data Sheet and are shown in Table 2 below. The TEC is $315 million and Other Project Cost (OPC) is $64 million, which includes R&D, pre-operations, and spares. The TEC and OPC total to the TPC of $379 million. The baseline LCLS project schedule and milestone dates are dependent upon receiving project funds in accordance with the BA funding profile in Table 2.

Table 2

Linac Coherent Light Source BA Funding Profile ($K)									
	FY02	**FY03**	**FY04**	**FY05**	**FY06**	**FY07**	**FY08**	**FY09**	**Total**
TEC	0	5,925	7,456	49,674[1]	85,544	105,901	50,500	10,000	315,000
OPC	1,500	0	2,000	4,000	3,500	16,000	15,500	21,500	64,000
TPC	1,500	5,925	9,456	53,674	89,044	121,901	66,000	31,500	379,000

[1] *FY2005 TEC funding includes $29,760,000 for long lead procurements.*

5.2 Work Breakdown Structure

All work required for completion of the LCLS project is included in the WBS shown in Table 1, beginning with the first year of funding in FY 2002 and continuing through project completion (CD-4). The WBS contains a complete definition of the project's scope and forms the basis for planning, execution, and control. A LCLS WBS Dictionary is contained in Appendix B.

5.3 Acquisition Strategy

The acquisition of the LCLS will be conducted through Stanford University, the SLAC M&O contractor. The project makes extensive use of existing SLAC facilities including the last one-third of the linear accelerator. The installation must be carefully coordinated with other research activities at the laboratory. Therefore, it is not feasible for DOE to have a separate subcontract with another organization to manage this project. SLAC has the resources to manage and direct this project and the resources, with the collaborating laboratories, to execute the project.

The LCLS Project Director is responsible for accomplishing the project under the terms of Stanford University's contract with DOE. SLAC will execute those parts of the project associated with conventional facilities, the acceleration and control of the electrons, and the endstations as well as overall system integration and management. ANL's Advanced Photon Source Division will design and fabricate the undulator and associated systems, and LLNL's Physics and Advanced Technologies Directorate will design, fabricate, qualify, and commission the x-ray transport optics and diagnostics. The LCLS Project Director at SLAC using the Memoranda of Understanding in Appendix A and project reporting tools will control work at these laboratories.

Project activities will be accomplished to the extent feasible using fixed-priced subcontractors selected on the basis of best value, price and other factors. Details can be found in the LCLS Acquisition Execution Plan (currently known as the Acquisition Strategy), approved by the DOE Under Secretary on October 16, 2002, and the LCLS Advance Procurement Plan.

Construction of the LCLS major conventional facilities will be accomplished by a fixed priced incentivized contract. The procurement will be a combined construction manager/general contractor (CM/GC) agreement. This relationship structure is similar to the American Institute of Architects A121/CMc contract delivery method. The successful offerer will be the construction manager who will solicit and award subcontracts to perform the conventional facilities construction work. Actual cost will be determined by competitive bid from subcontractors. The CM/GC will award all contracts after review and approval by the SLAC LCLS Project and SLAC Procurement. Subcontract bid award amounts are added to the CM/GC contract.

5.4 Work Authorization

DOE Manual 413.3-1 defines five Critical Decisions that are formal determinations or decision points in a project lifecycle that allows the project to proceed to the next phase and commit resources. Each decision constitutes a work authorization for a specific phase of the project's existence. This section describes the basis of each Critical Decision for the LCLS project and specifies the DOE authority required for approval of each decision.

As described below, Critical Decisions 2 and 3 are phased for long lead procurements (LLP) that consist of the injector, undulator, accelerator components, undulator measurement system and modification of existing facilities at SLAC for testing of the LLP equipment. This will reduce the technical and schedule risks for the project. With CD-2a approval, LCLS LLP budget was included as part of the President's FY 2005 Budget Request. CD-3a approval authorized the expenditure of FY 2005 funds for LLP. CD-2b approval established the project scope, cost and schedule baseline.

<u>Critical Decision 0: Approve Mission Need</u>
Authority: Director, Office of Science
The Acting Director, Office of Science approved the Mission Need Statement and CD-0 for the LCLS project, on June 13, 2001.

<u>Critical Decision 1: Approve Alternative Selection and Preliminary Baseline Range</u>
Authority: Director, Office of Science
Approval of CD-1 authorized the expenditure of Project Engineering and Design funds to proceed with Title I (preliminary) and Title II (final) design. The Director, Office of Science approved CD-1 on October 16, 2002.

<u>Critical Decision 2a: Approve Long Lead Procurement Budget</u>
Authority: Director, Office of Science
Approval of CD-2a enabled submission of the FY 2005 budget request for the LLP. The Deputy Director, Office of Science approved CD-2a on July 2, 2003.

<u>Critical Decision 2b: Approve Performance Baseline</u>
Authority: Director, Office of Science
Approval of CD-2b established the technical, schedule and cost performance baselines for the project. The Director, Office of Science approved CD-2b on April 11, 2005.

Critical Decision 3a: Approve Start of Long Lead Procurement
Authority: Director, Office of Science
Approval of CD-3a authorized the start of long lead procurement activities in FY 2005. The Deputy Director, Office of Science approved CD-3a on December 10, 2004.

Critical Decision 3b: Approve Start of Construction
Authority: Director, Office of Science
Approval of CD-3b will authorize the project to start full-scale construction of the LCLS.

Critical Decision 4: Approve Start of Operations
Authority: Director, Office of Science
Project completion (CD-4) will be accomplished when the commissioning goals have been achieved. Prior to operations, a period of commissioning and performance testing for the LCLS will be completed as technical systems and facilities are installed. A Commissioning Plan will be prepared to define goals that ensure LCLS systems are integrated and functioning as designed. The commissioning goals are to produce a single-pulse x-ray spectral flux density of at least 10^6 photons/(mm^2 ·0.1%BW) at 1.5 Ångstrom wavelength, measured in the NEH or just upstream in the Front End Enclosure; and to detect x-rays in the FEH to confirm the x-ray transport system to the endstations is functional. Achieving the commissioning goals will demonstrate that the LCLS facility was designed, fabricated, and installed satisfactorily; systems are functioning as designed; and that the facility is capable of functioning as an XFEL producing intense, coherent x-ray pulses.

Office of Science projects are scientific state-of-the-art facilities that require operational experience to achieve design operating parameters. Therefore, the commissioning goals are the performance requirements for project completion and closure of the line item construction project. Following commissioning, experience gained operating the LCLS will allow SLAC to optimize the facility to achieve project design operating parameters.

5.5 Life Cycle Cost

A preliminary estimate for operating costs of the LCLS, including power and maintenance but excluding programmatic research costs, is about $50 million per year in FY 2009 dollars. It is expected that the facility will have a useful operating life of about 30 years.

5.6 Contingency Management

In developing the project's performance baseline cost estimate, the contingency associated with each system was estimated based on an assessment of risk and on experience with similar systems.

All contingency for the project will be held under the central control of the Federal Project Director and LCLS Project Director as governed by the Baseline Change Control process in section 7.2. An increase above the threshold in a WBS Level 3 Estimate-at-Completion (EAC) will require submitting a Baseline Change Proposal (BCP) to the LCLS Change Control Board

(CCB). The BCP will include the reason for the change and the implications for cost, schedule, technical scope and system interfaces.

BCP approval levels are based on the Baseline Change Control Thresholds. The LCLS Project Director approves Level 3 changes, the Federal Project Director approves Level 2 changes and the SC Acquisition Executive approves Level 1 changes. Level 0 changes are approved at the Secretarial level. Approval of the BCP will increase the baseline cost estimate(s) for that WBS element, and unless there are any offsets, it will reduce the available contingency by an equal amount. Given that the project performance baselines have been approved at CD-2b, the LCLS Project Director will make every effort to find offsets within the project, without impacting the technical performance baseline, to minimize use of contingency. A change control log will be maintained by the project to document all approved BCPs.

6. PROJECT BASELINES

The project technical scope, cost and schedule performance baselines were established and approved at CD-2b. The project will be measured against these baselines during execution to ensure successful completion. The following sections describe the baselines.

6.1 Technical Scope

The scope baseline of the LCLS project consists of a 135 MeV injector to be built at Sector 20 of the 30-sector SLAC linac to create the electron beam required for the XFEL. Portions of the last one-third of the linac will be modified by adding two magnetic bunch compressors. Most of the linac and its infrastructure will remain unchanged. The existing components in the Final Focus Test Beam tunnel will be removed and will be replaced with a BTH. After the BTH, an Undulator Hall (UH) tunnel and associated equipment will be installed. Two new below grade experimental halls will be constructed. The NEH and the FEH will be built approximately 70 meters and 400 meters downstream of the UH, respectively. The NEH and the FEH will be connected by a tunnel that transports the x-ray beam. The instrumentation for the Atomic, Molecular, and Optical Physics (AMOP) experiment will be fabricated as part of the project. The CLO building will be constructed at the NEH site. At the completion of preliminary design, the size of the NEH is 25,000 square feet, the FEH is 10,700 square feet, and the CLO building is 74,000 square feet.

Key design operating parameters to be attained during routine operations, after CD-4, are:
0.8 – 8 KeV Self-Amplified Spontaneous Emission (SASE) Free Electron Laser
Electron Beam Energy 4.5 – 14.3 GeV, from SLAC Linac
Peak Power in SASE bandwidth 8 GW
Peak Brightness 1 x 10^{33} photons/s (mm^2 $mrad^2$ 0.1%BW)
Pulse Duration 230 femtoseconds
Pulse Repetition Rate 120 Hz

6.2 Cost

The Level 1 cost baseline was determined after preliminary (Title 1) design. The Total Estimated Cost is $315 million and the Total Project Cost is $379 million. The following chart shows the project TEC and OPC budget at WBS Level 2.

WBS	System	Budget ($K)
1.1	Project Management	29,294
1.2	Injector System	18,435
1.3	Linac System	26,751
1.4	Undulator System	48,242
1.5	X-Ray Transport and Diagnostics	26,595
1.6	X-Ray Endstations	14,956
1.9	Conventional Facilities	76,754
	Total Base Budget	**241,027**
	Contingency	**73,973**
	TEC	**315,000**
2.1	Project Management	33,199
2.2	Injector System	6,089
2.3	Linac System	2,552
2.4	Undulator System	7,269
2.5	X-Ray Transport and Diagnostics	4,342
2.6	X-Ray Endstations	3,546
	Total Base Budget	**56,998**
	Management Reserve	**7,002**
	OPC	**64,000**
	Total Project Cost (TEC + OPC)	**379,000**

6.3 Schedule

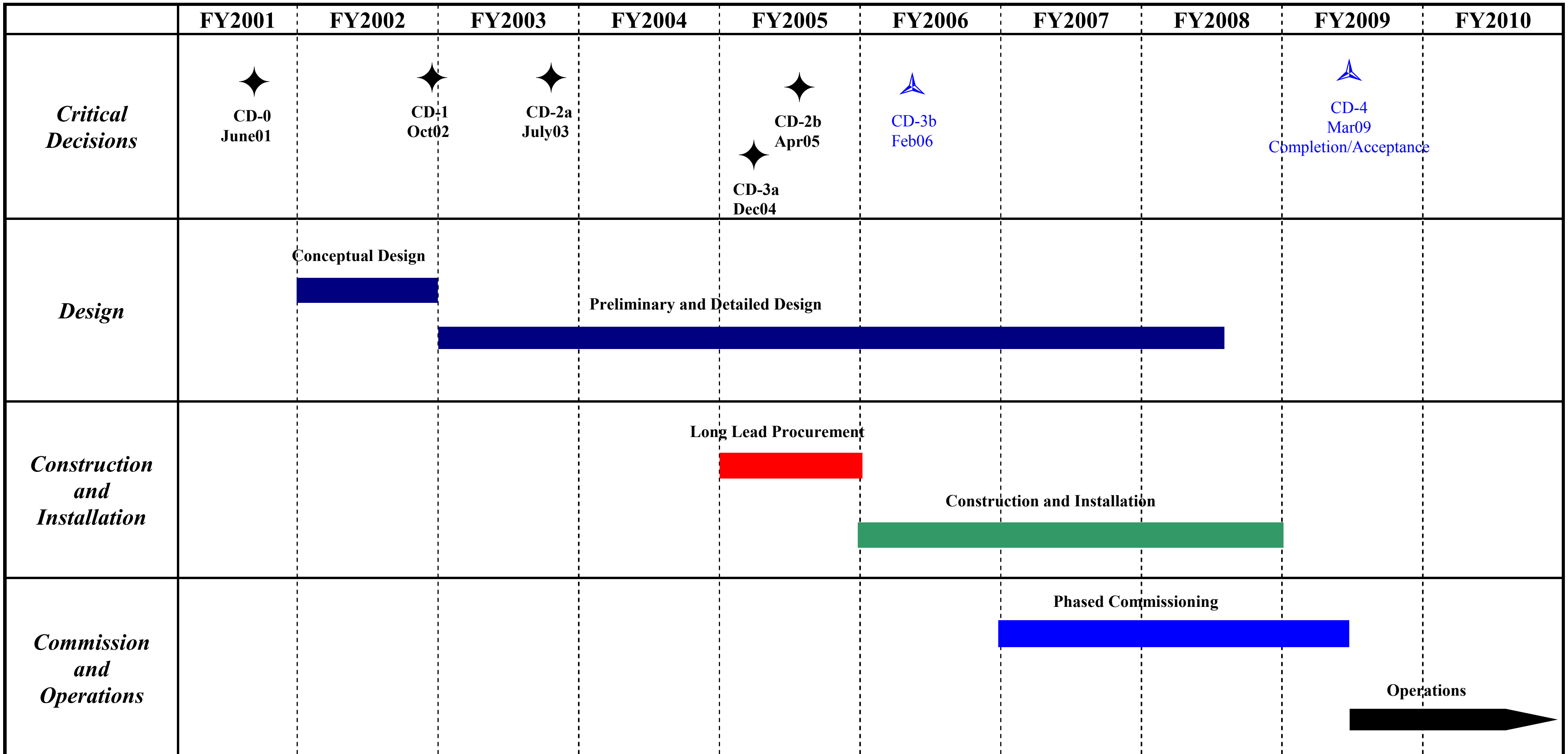
The Level 1 baseline milestones for the project are shown below. Level 2 milestones are included below and Level 3 milestones are identified in the LCLS Project Management Plan. As noted in Section 5.4, CD-2 and CD-3 are phased to permit long lead procurements to be initiated in FY 2005. The summary project schedule is shown in figure 7.

Level 1 Baseline Milestones	Scheduled Date
CD-0 Approve Mission Need	June 2001 (A)
CD-1 Approve Preliminary Baseline Range	October 2002 (A)
CD-2a Approve Long-Lead Procurement Budget	July 2003 (A)
CD-2b Approve Performance Baseline	April 2005 (A)
CD-3a Approve Start of Long-Lead Procurement	December 2004 (A)
CD-3b Approve Start of Construction	February 2006
CD-4 Approve Start of Operations	March 2009

Note: (A) indicates actual milestone completion date.

Level 2 Baseline Milestones	Scheduled Date
Draft Prelim Safety Assessment Doc (PSAD) Complete	April 2004 (A)
DOE External Independent Review (EIR) Complete	June 2004 (A)
Fire Hazard Analysis Approved	May 2005
Delivery of Undulator 1st Articles to Magnet Meas. Fac.	July 2006
Sector 20 Alcove Beneficial Occupancy	July 2006
MMF Qualified & Ready to Measure Prod Undulators	August 2006
Injector Laser Commissioning Review Complete	September 2006
Research Yards Mods Beneficial Occupancy	October 2006
Start Injector Commissioning (Drive Laser)	November 2006
Preliminary Safety Assessment Document Approved	January 2006
Injector Accelerator Readiness Review (ARR) Comp	May 2007
Near Experimental Hall Beneficial Occupancy	June 2007
Undulator Hall Beneficial Occupancy	July 2007
Linac Facility Beneficial Occupancy	July 2007
Start Injector Commissioning (UV Beam to Cathode)	July 2007
Far Experimental Hall Beneficial Occupancy	September 2007
Front End Enclosure Beneficial Occupancy	October 2007
X-Ray Transport Beneficial Occupancy	October 2007
Linac ARR (Li20-Li30) Complete	January 2008
2-D Pixel Detector Production Start	January 2008
Beam Transport Hall Beneficial Occupancy	January 2008
Start Linac (Li20-Li30) Commissioning	March 2008
Final Safety Analysis Document (FSAD) Approved	March 2008
LCLS ARR Complete (BTH thru FEH)	June 2008
Start Linac-to-Undulator (LTU) Commissioning	June 2008
Start Undulator Commissioning (1st Light)	August 2008
Start XTOD Commissioning	August 2008
Start XES Commissioning	August 2008
Central Lab Office Building Beneficial Occupancy	November 2008

Note: (A) indicates actual milestone completion date.



(✦) Completed Milestones
CD-0 Mission Need
CD-1 Preliminary Baseline
CD-2a Long Lead Procurement Budget
CD-2b Performance Baseline
CD-3a Start Long Lead Procurement
CD-3b Start of Construction (Full scale)
CD-4 Project Completion/Acceptance

Linac Coherent Light Source
Project Summary Schedule

Figure 7

7. PROJECT MANAGEMENT, CONTROL, AND REPORTING

7.1 Project Performance

The LCLS Project Director monitors, tracks, and reports project progress to the Federal Project Director. Together they evaluate variances in cost, schedule and scope and document the results on a monthly basis (see Section 7.3). The LCLS Project Director will initiate a BCP when a change in cost, schedule or scope exceeds any of the thresholds identified in Table 3.

The LCLS project has implemented a project management control system (PMCS). This system provides the essential earned value information needed for management control of the project and maintains the database for progress reporting. The PMCS integrates the cost and schedule baselines and provides the tools to monitor project performance. The data from the PMCS is the basis for information entered into the DOE Project Assessment and Reporting System (PARS).

7.2 Baseline Change Control Management

The LCLS 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 from the baseline design, and ensures the effect of changes on cost, schedule, and technical scope performance are properly evaluated and documented by project management. A BCP must be initiated when there will be an impact on any of the cost, schedule, or scope baselines. Thresholds for determining the BCP approval level during project execution are delineated in Table 3.

A Change Control Board (CCB) consisting of members of the LCLS project has been established. The board includes the Chairman (the LCLS Project Director), a change control manager, and board members. The board members review the technical, cost and schedule implications of changes and advise the Chairman. All BCP actions are maintained in a change control log.

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

Table 3 - *Baseline Change Control Thresholds*

	Secretarial Acquisition Executive (Level 0)	Acquisition Executive (SC-1) (Level 1)	Federal Project Director (Level 2)	LCLS Project Director (Level 3)
Technical	Any change in scope and/or performance that affects mission need requirements or is not in conformance with current approved Project Data Sheet	Change in siting or in the Key Design Parameters in section 6.1 that affect mission need requirements	Changes that affect ES&H requirements or changes in facilities that do not affect Key Design Parameters or greater than 10% change to the NEH, FEH or CLO building square footage	Changes in system requirements or design that do not affect Key Design Parameters
Schedule	6 months or greater increase (cumulative) in the original project completion date	≥ 3 months delay in any Level 1 milestones contained in section 6.3	Any delay in Level 1 milestones or ≥ 3 months delay in Level 2 milestones contained in section 6.3	Any delay in Level 3 milestones in the PMP or < 3 months delay in Level 2 milestones contained in section 6.3
Cost	Increase in excess of $25M or 25% (cumulative) of the baseline TEC or TPC	Any increase in the baseline TEC or TPC	Cumulative change ≥ $1M of any WBS Level 2 cost element in section 6.2	Any increase ≥ $100K of any WBS Level 2 cost element in section 6.2

7.3 Project Reporting

The LCLS Project Director submits a monthly project progress report to the Federal Project Director containing information about the overall progress of the project. The monthly report is submitted to the LCLS Program Manager. It discusses project cost and schedule performance, accomplishments, issues, and upcoming milestones. The report also includes the latest earned value data together with an explanation for any significant variances. The following data is reported: actual cost of work performed (ACWP), budgeted cost of work performed (BCWP), and budgeted cost of work scheduled (BCWS). Cost and schedule performance is evaluated and variances determined. Cost and Schedule variance thresholds used by the project are the PARS thresholds shown below at WBS level 1. The project uses these same thresholds at WBS Level 2 to give an early warning of potential variances to cost and schedule. The Federal Project Director inputs monthly progress information into PARS and discusses significant variances or any unusual parameter values.

The Federal Project Director prepares a quarterly progress report and submits it to the LCLS Program Manager. The report highlights cost, schedule and technical performance; provides status of completed milestones, and identifies completed and upcoming milestones; and discusses issues.

Cost and Schedule Performance Indices Variance Reporting Thresholds	
GREEN	if the performance index is between .90 and 1.10
YELLOW	if the performance index is between .85 and .89 or if the performance index is between 1.11 and 1.20.
RED	if the performance index is below .85 or above 1.20 (any value outside of green or yellow).

7.4 Project Meetings and Reviews

LCLS project management conducts internal project meetings and reviews. The purpose of the meetings is to provide project coordination and discuss system progress. Internal reviews are held to evaluate system and component designs.

The Federal Project Director holds weekly meetings with the LCLS Project Director and relevant staff to discuss project status, issues and current business. Additionally, there are weekly conference calls by LCLS management and the Federal Project Director with BES to provide project status updates, progress and discuss issues.

During project execution, a project progress review is held quarterly between the Federal Project Director, the LCLS Program Manager, the Director of the Office of Basic Energy Sciences and the SC Acquisition Executive. The review is based on the quarterly progress report issued by the Federal Project Director. The quarterly review is accomplished by teleconference or videoconference. The DOE Office of Engineering and Construction Management is invited to this review.

Formal DOE reviews of the project's cost, schedule, technical, ES&H, and management performance will be conducted periodically by the Office of Project Assessment, SC-1.3, at the request of SC.

8. RISK MANAGEMENT

Risk management is based on a graded approach in which levels of risk are assessed for project activities and elements. This assessment is based upon the potential consequences of activity or element failure, as well as the probability of occurrence. The level of formality of the quality assurance requirements is tied to the potential failure consequences. Risk minimization is implemented by conducting research and development activities, prototyping components, long lead procurements, and planning alternatives.

Risk assessments are conducted throughout the project lifecycle. Risks identified include technical, cost and schedule risks. The project Risk Management Plan details the process for identifying, evaluating, mitigating, and managing risks in compliance with DOE Manual 413.3-1. The project Risk Registry is reviewed and updated monthly.

9. ENVIRONMENT, SAFETY AND HEALTH

9.1 Integrated Safety Management System

Environment, safety and health (ES&H) requirements are systematically integrated into management and work practices at all levels so that the LCLS project is executed while protecting the public, the worker, and the environment. The SLAC Safety Management System document and policies make it clear that the responsibility for safety and environmental protection starts with the SLAC Director and flows through the management chain to Associate Directors, to Department Heads and Group Leaders, to line supervisors, and finally to the workers. It is the responsibility of LCLS management to ensure that staff are trained and are responsible for ES&H in their assigned areas.

The LCLS 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 LCLS management and staff. The SLAC ES&H Division and SLAC Citizen Committees 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.

9.2 National Environmental Policy Act

In compliance with the National Environmental Protection Act (NEPA), a determination was made to prepare an Environmental Assessment (EA). The effects of the LCLS project on the environment were assessed in the EA. This project is executed in conformance with existing SLAC ES&H policies, systems and procedures to assure a minimum impact on the environment. The EA determined that an Environmental Impact Statement (EIS) was not needed and a Finding of No Significant Impact (FONSI) was approved in February 2002.

9.3 Safety Assessment Document

Specific ES&H hazards were identified in the LCLS Preliminary Hazards Analysis report and their mitigation are detailed in the LCLS Preliminary Safety Assessment Document (PSAD). The PSAD addresses the ES&H considerations in the design, fabrication, and installation of LCLS. The PSAD will be approved prior to authorizing start of full scale construction (i.e. prior to CD-3b). The PSAD forms the basis for the LCLS Final Safety Assessment Document (FSAD). The FSAD will evaluate the ES&H considerations for operating the LCLS. The FSAD will be approved prior to operation. An Accelerator Readiness Review will be accomplished in phases prior to LCLS commissioning and completed prior to starting operations (i.e., before CD-4).

10. TECHNICAL ANALYSES

10.1 Value Engineering

A Value Engineering (VE) Study was performed during Title I design. The study followed the traditional approach to VE. A review team evaluated alternative design approaches, evaluated the flexibility of the design for present and future research, reviewed sustainability design features, and evaluated specific energy applications. The project team and the architect-engineer design team will perform VE evaluations throughout the design of the conventional facilities portion of the LCLS project. Additionally, the project conducts VE evaluations for the technical systems.

10.2 System Engineering

System engineering principles are employed in the development of the project from conceptual design through construction and transition to operations.

10.3 Configuration Management

Documents defining the configuration of the project baseline are maintained through a formal configuration control process. Configuration definition documents for the project are identified in the LCLS Quality Implementation Plan.

10.4 Sustainable Building Design

Sustainable building design principles are being applied to the siting, design, and construction of the LCLS conventional facilities. Additionally, standard practices, including the use of recycled material, the purchase of energy-efficient and water-efficient equipment, and substitution of less hazardous input materials, are being evaluated and implemented. Project waste disposal and recycling requirements are being incorporated into the project procurement documents.

The LCLS will pursue the Leadership in Energy and Efficiency Design (LEED) certification, a voluntary national standard emphasizing state of the art strategies for sustainable site planning, water efficiency, energy efficiency and renewable energy, conservation of material and resources and indoor environmental quality.

10.5 Reliability, Maintainability, Operability and Quality Assurance

10.5.1 Reliability, Maintainability, and Operability

The conventional facilities designs are reviewed for reliability, maintainability, and operability by the LCLS Project Director, the Construction Manager and relevant staff. The primary objective of these reviews is to ensure the development of systems that are reliable, safe, easy to operate, and maintainable with minimum resources.

10.5.2 Quality Assurance

A Quality Assurance Program has been established at SLAC in accordance with DOE Order 414.1A, Quality Assurance. The SLAC Institution Quality Assurance (QA) Program Plan (SLAC I-770-0A17M-001) dated September 2000, defines the management systems for quality assurance, including the general requirements for quality on projects such as LCLS. The LCLS Project Quality Assurance Officer is responsible to implement the QA program requirements for the project, in accordance with the Quality Implementation Plan.

11. TRANSITION TO OPERATIONS

11.1 Final Inspection and Acceptance

The following items will be accomplished by the LCLS project team:

- Equipment, systems and facility checkouts
- Preliminary inspection and list of incomplete work
- Inspection walk-through and punch list
- Inspection of corrective activities and completion of punch list work
- Inventory of operations manuals, instructions, and guarantees
- Acknowledgment of completion and acceptance of work under subcontract

11.2 Transition to Operations

Once the facility is ready to produce an x-ray beam, a series of performance tests and commissioning will be undertaken to demonstrate that all components of the facility are working properly and in concert for producing x-rays. A Commissioning Plan will be prepared to test and evaluate system performance. For project completion and acceptance, the LCLS must have in place necessary capital facilities that can achieve the design peak brightness of 10^{33} photons/(sec·mm^2·mrad^2·0.1%BW) at a wavelength of 1.5 Ångstrom during routine operations.

Commissioning will produce a single-pulse x-ray spectral flux density of at least 10^6 photons/(mm^2 ·0.1%BW) at 1.5 Ångstrom wavelength, measured in the Near Experimental Hall or just upstream in the Front End Enclosure. This flux is about 1% of the expected design flux for spontaneous radiation when the LCLS is set to produce FEL radiation at 1.5 Ångstrom. Initial tests include detection of x-rays in the Far Hall to confirm the x-ray transport system to the endstations in the FEH is functional. These tests will indicate that the electron beam transport system is working properly, that the basic systems for transport of the x-ray beam are in place, that basic systems for characterization of the x-ray beam are in place and functional, that full-energy beam can be achieved during routine operations, and that the facility is capable of functioning as an XFEL producing intense, coherent x-ray pulses.

The DOE Program/Project team will conduct a Project Completion Review to meet the objective of the "operational readiness review" described in DOE Order 413.3. This review and completion of the performance tests will be documented in a Project Completion Report which will serve as the basis for requesting the Acquisition Executive approval of CD-4. Approval of CD-4 completes the construction phase of the project, and the LCLS will enter the routine operations phase for research.

11.3 Lessons Learned

During the project, instances of "what worked" and "what did not work", as well as insights into what might have been done better, will be documented. At the conclusion of the project, the LCLS Project Director will analyze these lessons learned and review them with the DOE.

12. APPENDICES

A. Memoranda of Understanding with ANL and LLNL
B. WBS Dictionary

Appendix A

Memoranda of Understanding

1. Argonne National Laboratory
2. Lawrence Livermore National Laboratory

Memorandum of Understanding

between

Stanford Linear Accelerator Center

and

Argonne National Laboratory

Date: August 10, 2002

1.0 Introduction

The Linac Coherent Light Source (LCLS) Project is to be executed as a collaboration of three laboratories: Argonne National Laboratory (ANL), Lawrence Livermore National Laboratory (LLNL), and the Stanford Linear Accelerator Center (SLAC). The Linac Coherent Light Source is a single-pass x-ray free electron laser operating in the 1.5-15 Å wavelength region, using electron beams from the SLAC linac at energies up to 15 GeV. The LCLS is a multi-year, $200M, Department of Energy (DOE) sponsored project to construct a coherent light source sited at SLAC that will produce ultra-short pulse, coherent X-rays in the wavelength range 0.8-8 keV, with peak brightness 10^{10} times higher than any currently available x-ray source in the world. The facility will produce unprecedented levels of peak and average brightness of monochromatic and spontaneous x-ray radiation for use in scientific applications that are far beyond the reach of current 3rd generation synchrotron light sources. The DOE approved CD-0 for this project in June 2001, and a SLAC/LLNL/ANL team is responsible for completing it. SLAC will serve as lead laboratory for the collaboration and the central project management will reside there.

The partner laboratories have agreed upon a division of responsibilities that makes best use of expertise and available resources. LLNL plans to work in three main areas: x-ray optics, x-ray diagnostics, and x-ray beam transport. The areas of LLNL responsibility are identifiable in the LCLS work breakdown element entitled "X-Ray Transport, Optics and Diagnostics. ANL plans to take responsibility for LCLS WBS element entitled "Undulator Systems".

This Memorandum of Understanding is between ANL and SLAC. It provides the overall framework for the business relationship between SLAC and ANL (the Parties) for portions of the design, construction, installation and commissioning of the LCLS as outlined in addenda to this MOU. It does not constitute a legal contractual obligation on the part of either of the institutions. Definition of specific work packages in these and possibly other areas will be done in consultation with the SLAC LCLS Project Office and will be described separately in semiannual Statements of Work that constitute Addenda to this Memorandum of Understanding. ANL is managed and operated by the University of Chicago under DOE Contract No. W-31-109-ENG-38. All ANL work performed will be consistent with and under the terms and conditions of this W-31-109-ENG-38 Contract.

Management of the design, fabrication, construction, installation, and commissioning of the LCLS will be subject to the guidelines of the LCLS Project Management Plan. In particular, technical review will be an integral part of design and fabrication, and the change control process will govern parameter and/or cost changes. In all cases, work will be coordinated with the cognizant system manager.

1.1 Objective

The Objective of this Memorandum of Understanding (MOU) is to document the terms of agreement between SLAC and ANL so that required LCLS project work can be performed at ANL.

1.2 Scope

This MOU covers work to be performed by ANL during the multi-year LCLS construction project. It includes design and fabrication effort the undulator and related systems. . Furthermore, ANL will be responsible and accountable to project management for the cost, schedule and technical dimensions of the level –3 element "Undulator Systems", during design and construction phases of the project.

1.3 Roles and Responsibilities

1.3.1 Linac Coherent Light Source Management

SLAC LCLS management will be responsible for the overall definition, cost, schedule, and technical dimensions of the LCLS Project Baseline, as well as for delegation of project management and project leadership responsibilities to partner laboratories. SLAC management will be responsible for overall assignment of resources as required for the successful completion of the LCLS Project. SLAC LCLS management will control interfaces of responsibility between the laboratories participating in the LCLS Project.

1.3.2 Department of Energy

The Department of Energy (DOE) will be responsible for oversight of the project.

1.3.3 Argonne National Laboratory

Argonne National Laboratory will be responsible and accountable for assigned work products.

2.0 General Provisions

2.1 Introduction

Overall executive authority for managing the LCLS Project will be vested in the SLAC Associate Director for the LCLS Division who is also the LCLS Project Director and is vested with the authority to deal directly with partner laboratory project heads on LCLS matters. The LCLS Project Director's ability to effectively control work at the partner laboratories is facilitated by the Interlaboratory Coordinating Council, described below in 2.3. Lines of authority and responsibility will follow the organization structure established by LCLS management and documented in an organization chart updated as necessary.

2.2 Project Baselines and Management

Project baselines detailing the technical scope of work, cost estimates and project schedule will be developed, reviewed and approved by the Project and relevant partner laboratories as a prerequisite to formalizing the MOU. These baselines, once approved, will be under configuration management; changes must follow the procedures outlined in the management documents described below.

The Project Execution Plan (PEP) and the Project Controls Manual (PCM) contain the project management structures and methodologies to be employed in the conduct of the project, including reporting, communication, reviews, performance metrics, change control, funding mechanism and handling of contingency.

2.3 Inter-Laboratory Coordinating Council

The ANL Director will assign a representative to the LCLS Inter-Laboratory Coordinating Council, which is chaired by the LCLS Project Director. The purpose of the Council is to address issues affecting resource allocation to the LCLS project at the partner laboratories, coordination of LCLS Project activities with other laboratory activities, and coordination of partner laboratories' LCLS activities. The ANL representative will have line authority for resource allocation to the LCLS Project appropriate to achieve the Project Baseline. As specified in the Project Management Plan, the Council will be Chaired by the LCLS Project Director and will meet once per month, or spontaneously should the need arise.

2.4 Reporting

ANL will provide all necessary data to support the DOE-approved LCLS Project Management Control System. ANL will submit monthly progress reports, including schedule status and earned value for each of its work packages. These reports will contain brief descriptions of technical progress in all major areas, organized by "work package," along with an indication of key items for resolution in the next reporting period. Incurred costs and commitments will be reported by WBS category for the total ANL effort. The report will be submitted on or before the tenth of the following calendar month to the LCLS Project Office.

2.5 Funding

Transfer of funds from SLAC to ANL will be via DOE Financial Plan Transfers (hereinafter referred to as LCLS project funding). Funding will typically be transferred at six-month intervals to provide timely adjustments as may be required to recognize changes in either the Scope of Work (via future Amendments to this MOU) or the definition of individual work packages (via Addenda to this MOU).

2.6 Full Cost Recovery

It is understood that ANL is operated by The University of Chicago for the Department of Energy as a full cost recovery facility. Amendments to this MOU will be issued in response to events such as major changes to the Scope of Work associated with rebaselining of the project, modifications to the project funding profile, or reassignments based on SLAC LCLS Project Office directives. Any such Amendments will be subject to the provisions of the LCLS project change control procedures. ANL will respond as quickly as possible, within DOE guidelines. However, LCLS project funding will cover all costs incurred as a result of work performed with the approval of, and on behalf of, the LCLS project.

2.7 Intellectual Property

"Intellectual Property" includes but is not limited to patents, copyrights, trademarks and maskworks. Rights to intellectual property created solely by one party under this MOU shall be retained by that party. Rights to intellectual property created jointly by the parties under this MOU shall be retained jointly by the parties and the parties shall agree among themselves as to protection and commercialization for such jointly owned property. The parties recognize that the Department of Energy has certain rights in and to any intellectual property created under this MOU by the parties.

2.8 Scientific Publication

All work covered by this MOU will be unclassified. Publications may be collaborative and either party has the right to publish information in part or in whole, independent of the other. Parties agree to secure prepublication review from each other which shall not be unreasonably withheld or delayed beyond thirty (30) days.

2.9 Amendments

This MOU may be modified or amended from time to time by written agreement of both Parties.

2.10 Overhead

Each partner laboratory shall set indirect costs charged to the LCLS project in accordance with their disclosed cost accounting practices in order to: 1) ensure the appropriate causal/beneficial relationship of indirect costs applied to the project; 2) minimize the fluctuations in the indirect cost charges over the life of the project. The accounting treatment for indirect costs will be reviewed during the annual negotiations on the projected work plans between ANL and LCLS management.

2.11 Contingency

Management and maintenance of contingency for the LCLS project is the responsibility of the SLAC LCLS Project Office and will be done in accordance with the change control process outlined in the Project Management Plan.

2.12 Equipment Ownership

All equipment items bought or fabricated using DOE-SLAC funds will be the property of DOE-SLAC and will be capitalized by SLAC. Any equipment purchased or fabricated using DOE-ANL funds, will be the property of DOE-ANL and will be capitalized by ANL. All equipment fabricated using LCLS Project funds as part of the Project technical baseline, and installed at SLAC as part of the LCLS Facility, will upon acceptance for installation become the property of DOE-SLAC and will be capitalized by SLAC.

2.13 Public Information Coordination

Subject to the Freedom of Information Act (5 U.S.C. 552), decisions on the disclosure of information to the public regarding the LCLS project shall be made by the SLAC Director and the SLAC LCLS Project Director following consultation with ANL representatives.

2.14 Project Staffing

ANL Management will select a Project Task Manager and provide a project management structure, subject to approval by LCLS Management.

3.0 MOU Implementation

3.1 Enactment

This document, when properly executed, will supersede any earlier versions of this MOU.

3.2 Effective Date

This Memorandum of Understanding shall become effective upon the latter date of signature of the parties. It shall remain in effect until superseded or until LCLS Project completion, whichever occurs first.

3.3 Approvals

The undersigned concur in the terms of this Memorandum of Understanding:

James M. Paterson, Associate Director,
SLAC Technical Division

9/12/02
Date

Efim Gluskin
ANL LCLS Project Director, Interim

11 SEPT 2002
Date

Keith Hodgson, Associate Director,
SLAC SSRL Division

9/11/02
Date

J. Murray Gibson, Associate Director,
ANL Advanced Photon Source

11 SEPT 2002
Date

Jerry Jobe, Associate Director,
SLAC Business Services Division

9/19/2002
Date

John Galayda,
SLAC LCLS Project Director

11 SEPT 2002
Date

Jonathan Dorfan
Director, SLAC

9/20/02
Date

Hermann A. Grunder
Director, ANL

Sept 11, 2002

Date

Technical Addendum A.
to the
Memorandum of Understanding
between

Stanford Linear Accelerator Center

and
Argonne National Laboratory

August 10, 2002

A.0 Specific Provisions

This addendum defines technical and management responsibilities of Argonne National Laboratory as a participant in the Linac Coherent Light Source Project.

A.1 Statement of Work

ANL will carry out design and fabrication activities in the areas of undulator systems. Particular activities and deliverables will be specified and agreed upon by the ANL LCLS Project Head, the SLAC LCLS Project Director, the ANL Director, and the SLAC Director semiannually via the Addenda to the Memorandum of Understanding. The general scope of the ANL design and construction effort is described below:

A.1.1 Technical Responsibilities

SLAC and ANL agree that ANL will carry out Project Engineering Design activities in support of LCLS
:

- Development of specifications for LCLS systems and components
- Estimation of cost for LCLS systems and components
- Activities associated with optimizing design: alternatives assessment, prototyping, etc.
- Planning and scheduling resource allocations for construction activities
- Implementation of Project Management Controls System functions required by SLAC and DOE
- Other functions as necessary for compliance of LCLS with DOE project management guidelines

SLAC and ANL expect that ANL responsibility will extend to construction activities in areas for which ANL has carried out Project Engineering Design.

A.1.2 Management Responsibilities

SLAC and ANL agree that ANL has management responsibility for the Project Engineering Design and construction of the undulator system, identified by the work breakdown structure element 1.2.3.

A.2 Work Package Definition

At this time the overall definition of the ANL scope of work for the LCLS is that described in Chapter 8 of the LCLS Conceptual Design Report, SLAC R-593, dated April 2002, and WBS 1.2.3 of the associated cost estimate of April 2002. It is understood that this working definition is subject to revision based on DOE guidance and on progress of the PED process to maturity.

Specific near-term LCLS project engineering design (PED) and construction activities to be carried out by ANL will be defined and updated at least semiannually in addenda to the SLAC-ANL Memorandum of Understanding.

Memorandum of Understanding

between

Stanford Linear Accelerator Center

and

Lawrence Livermore National Laboratory

Date: August 10, 2002

1.0 Introduction

The Linac Coherent Light Source (LCLS) Project is to be executed as a collaboration of three laboratories: Argonne National Laboratory (ANL), Lawrence Livermore National Laboratory (LLNL), and the Stanford Linear Accelerator Center (SLAC). The Linac Coherent Light Source is a single-pass x-ray free electron laser operating in the 1.5-15 Å wavelength region, using electron beams from the SLAC linac at energies up to 15 GeV. The LCLS is a multi-year, $200M, Department of Energy (DOE) sponsored project to construct a coherent light source sited at SLAC that will produce ultra-short pulse, coherent X-rays in the wavelength range 0.8-8 keV, with peak brightness 10^{10} times higher than any currently available x-ray source in the world. The facility will produce unprecedented levels of peak and average brightness of monochromatic and spontaneous x-ray radiation for use in scientific applications that are far beyond the reach of current 3rd generation synchrotron light sources. The DOE approved CD-0 for this project in June 2001, and a SLAC/LLNL/ANL team is responsible for completing it. SLAC will serve as lead laboratory for the collaboration and the central project management will reside there.

The partner laboratories have agreed upon a division of responsibilities that makes best use of expertise and available resources. LLNL plans to work in three main areas: x-ray optics, x-ray diagnostics, and x-ray beam transport. The areas of LLNL responsibility are identifiable in the LCLS work breakdown element entitled "X-Ray Transport, Optics and Diagnostics. ANL plans to take responsibility for LCLS WBS element entitled "Undulator Systems".

This Memorandum of Understanding is between LLNL and SLAC. It provides the overall framework for the business relationship between SLAC and LLNL (the Parties) for portions of the design, construction, installation and commissioning of the LCLS as outlined in addenda to this MOU. It does not constitute a legal contractual obligation on the part of either of the institutions. Definition of specific work packages in these and possibly other areas will be done in consultation with the SLAC LCLS Project Office and will be described separately in semiannual Statements of Work that constitute Addenda to this Memorandum of Understanding. LLNL is managed and operated by the University of California under DOE Contract No. W-7405-76SF00515. All LLNL work performed will be consistent with the terms and conditions of this contract.

Management of the design, fabrication, construction, installation, and commissioning of the LCLS will be subject to the guidelines of the LCLS Project Management Plan. In particular, technical review will be an integral part of design and fabrication, and the change control process will govern parameter and/or cost changes. In all cases, work will be coordinated with the cognizant system manager.

1.1 Objective

The Objective of this Memorandum of Understanding (MOU) is to document the terms of agreement between SLAC and LLNL so that required LCLS project work can be performed at LLNL.

1.2 Scope

This MOU covers work to be performed by LLNL during the multi-year LCLS construction project. It includes design and fabrication effort in the three main areas: x-ray optics, x-ray diagnostics, and x-ray beam transport. Furthermore, LLNL will be responsible and accountable to project management for the cost, schedule and technical dimensions of the level –3 element "X-ray Transport, Optics and Diagnostics", during design and construction phases of the project.

1.3 Roles and Responsibilities

1.3.1 Linac Coherent Light Source Management

SLAC LCLS management will be responsible for the overall definition, cost, schedule, and technical dimensions of the LCLS Project Baseline, as well as for delegation of project management and project leadership responsibilities to partner laboratories. SLAC management will be responsible for overall assignment of resources as required for the successful completion of the LCLS Project. SLAC LCLS management will control interfaces of responsibility between the laboratories participating in the LCLS Project.

1.3.2 Department of Energy

The Department of Energy (DOE) will be responsible for oversight of the project.

1.3.3 Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory will be responsible and accountable for assigned work products.

2.0 General Provisions

2.1 Introduction

Overall executive authority for managing the LCLS Project will be vested in the SLAC Associate Director for the LCLS Division who is also the LCLS Project Director and is vested with the authority to deal directly with partner laboratory project heads on LCLS matters. The LCLS Project Director's ability to effectively control work at the partner laboratories is facilitated by the Interlaboratory Coordinating Council, described below in 2.3. Lines of authority and responsibility will follow the organization structure established by LCLS management and documented in an organization chart updated as necessary.

2.2 Project Baselines and Management

Project baselines detailing the technical scope of work, cost estimates and project schedule will be developed, reviewed and approved by the Project and relevant partner laboratories as a prerequisite to formalizing the MOU. These baselines, once approved, will be under configuration management; changes must follow the procedures outlined in the management documents described below.

The Project Execution Plan (PEP) and the Project Controls Manual (PCM) contain the project management structures and methodologies to be employed in the conduct of the project, including reporting, communication, reviews, performance metrics, change control, funding mechanism and handling of contingency.

2.3 Inter-Laboratory Coordinating Council

The LLNL Director will assign a representative to the LCLS Inter-Laboratory Coordinating Council, which is chaired by the LCLS Project Director. The purpose of the Council is to address issues affecting resource allocation to the LCLS project at the partner laboratories, coordination of LCLS Project activities with other laboratory activities, and coordination of partner laboratories' LCLS activities. The LLNL representative will have line authority for resource allocation to the LCLS Project appropriate to achieve the Project Baseline. As specified in the Project Management Plan, the Council will be chaired by the LCLS Project Director and will meet once per month, or spontaneously should the need arise.

2.4 Reporting

LLNL will provide all necessary data to support the DOE-approved LCLS Project Management Control System. LLNL will submit monthly progress reports, including schedule status and earned value for each of its work packages. These reports will contain brief descriptions of technical progress in all major areas, organized by "work package," along with an indication of key items for resolution in the next reporting period. Incurred costs and commitments will be reported by WBS category for the total LLNL effort. The report will be submitted on or before the tenth of the following calendar month to the LCLS Project Office.

2.5 Funding

Transfer of funds from SLAC to LLNL will be via DOE Financial Plan Transfers (hereinafter referred to as LCLS project funding). Funding will typically be transferred at six-month intervals to provide timely adjustments as may be required to recognize changes in either the Scope of Work (via future Amendments to this MOU) or the definition of individual work packages (via Addenda to this MOU).

2.6 Full Cost Recovery

It is understood that LLNL is operated by the Department of Energy as a full cost recovery facility. Amendments to this MOU will be issued in response to events such as major changes to the Scope of Work associated with rebaselining of the project, modifications to the project funding profile, or reassignments based on SLAC LCLS Project Office directives. Any such Amendments will be subject to the provisions of the LCLS project change control procedures. LLNL will respond as quickly as possible, within DOE guidelines. However, LCLS project funding will cover all costs incurred as a result of work performed with the approval of, and on behalf of, the LCLS project.

2.7 Intellectual Property

Rights with regard to intellectual property are regulated, on the SLAC side, by the Trustees of Leland Stanford Junior University and the U.S. Department of Energy, and on the LLNL side, by the Regents of the University of California and the U.S. Department of Energy. “Intellectual property” includes but is not limited to inventions, technical data, and software. Intellectual property created exclusively by one party shall be exclusively the intellectual property of that party. Intellectual property created by collaboration between SLAC and LLNL shall be the joint intellectual property of both parties.

Each party hereto shall have, with regard to both intellectual property exclusively developed by the other party and intellectual property collaboratively developed, a nonexclusive, nontransferable, irrevocable, paid up (royalty free) right and license to the noncommercial use of that intellectual property in the design, construction, and operation of a free electron laser, or in such other noncommercial application(s) as may be desired by either party.

Rights with regard to commercialization of exclusively developed or created intellectual property are retained by the party that exclusively developed or created that intellectual property; commercialization of intellectual property jointly developed or created by LLNL and SLAC shall be jointly pursued. The U.S. Department of Energy has such rights in the intellectual property developed by the parties to this MOU as are separately set out in its independent contract with each party.

2.8 Scientific Publication

All work covered by this MOU will be unclassified. Publications will be collaborative, although either Party has the right to publish information in part or in whole, independent of the other. All publications and all intellectual property jointly developed under this collaboration using DOE funds will respect SLAC and LLNL procedures, Stanford University's contract DE-AC03-76-SF00515 and the Regents of the University of California's contract W-7405-ENG-48 with the U.S. Department of Energy, which requires that all publications receive prior copyright and invention review by the authors' home institution.

2.9 Amendments

This MOU may be modified or amended from time to time by written agreement of both Parties.

2.10 Overhead

Each partner laboratory shall set indirect costs charged to the LCLS project in accordance with their disclosed cost accounting practices in order to: 1) ensure the appropriate causal/beneficial relationship of indirect costs applied to the project; 2) minimize the fluctuations in the indirect cost charges over the life of the project. The accounting treatment for indirect costs will be reviewed during the annual negotiations on the projected work plans between LLNL and LCLS management.

2.11 Contingency

Management and maintenance of contingency for the LCLS project is the responsibility of the SLAC LCLS Project Office and will be done in accordance with the change control process outlined in the Project Management Plan.

2.12 Equipment Ownership

All equipment items bought or fabricated using DOE-SLAC funds will be the property of DOE-SLAC and will be capitalized by SLAC. Any equipment purchased or fabricated using DOE-LLNL funds, will be the property of DOE-LLNL and will be capitalized by LLNL. All equipment fabricated using LCLS Project funds as part of the Project technical baseline, and installed at SLAC as part of the LCLS Facility, will upon acceptance for installation become the property of DOE-SLAC and will be capitalized by SLAC.

2.13 Public Information Coordination

Subject to the Freedom of Information Act (5 U.S.C. 552), decisions on the disclosure of information to the public regarding the LCLS project shall be made by the SLAC Director and the SLAC LCLS Project Director following consultation with LLNL representatives.

2.14 Project Staffing

LLNL Management will select a Project Task Manager and provide a project management structure, subject to approval by LCLS Management.

3.0 MOU Implementation

3.1 Enactment

This document, when properly executed, will supersede any earlier versions of this MOU.

3.2 Effective Date

This Memorandum of Understanding shall become effective upon the latter date of signature of the parties. It shall remain in effect until superseded or until LCLS Project completion, whichever occurs first.

3.3 Approvals

The undersigned concur in the terms of this Memorandum of Understanding:

John Galayda
SLAC LCLS Project Director

13 SEPT 2002
Date

William H. Goldstein 9/6/02
Associate Director, LLNL
Physics and Advanced Technologies

9/6/02
Date

Jonathan Dorfan
Director, SLAC

9/22/02
Date

Michael R. Anastasio
Director, LLNL

9/9/02
Date

Technical Addendum A.
to the
Memorandum of Understanding
between

Stanford Linear Accelerator Center

and
Lawrence Livermore National Laboratory

August 10, 2002

A.0 Specific Provisions

This addendum defines technical and management responsibilities of Lawrence Livermore National Laboratory as a participant in the Linac Coherent Light Source Project.

A.1 Statement of Work

LLNL will carry out design and fabrication activities in the areas of x-ray transport, optics and diagnostics. Particular activities and deliverables will be specified and agreed upon by the LLNL LCLS Project Head, the SLAC LCLS Project Director, the LLNL Director, and the SLAC Director semiannually via the Addenda to the Memorandum of Understanding. The general scope of the LLNL design and construction effort is described below:

A.1.1 Technical Responsibilities

SLAC and LLNL agree that LLNL will carry out Project Engineering Design activities in support of LCLS
:

- Development of specifications for LCLS systems and components
- Estimation of cost for LCLS systems and components
- Activities associated with optimizing design: alternatives assessment, prototyping, etc.
- Planning and scheduling resource allocations for construction activities
- Implementation of Project Management Controls System functions required by SLAC and DOE
- Other functions as necessary for compliance of LCLS with DOE project management guidelines

SLAC and LLNL expect that LLNL responsibility will extend to construction activities in areas for which LLNL has carried out Project Engineering Design.

A.1.2 Management Responsibilities

SLAC and LLNL agree that LLNL has management responsibility for the Project Engineering Design and construction of the X-ray Transport, Optics and Diagnostics system, identified by the work breakdown structure element 1.3.1. LLNL has agreed to utilize SSRL personnel and resources to discharge its management responsibility for WBS element 1.3.1.5, entitled “Crystals and Gratings”.

A.2 Work Package Definition

At this time the overall definition of the LLNL scope of work for the LCLS is that described in Chapter 9 of the LCLS Conceptual Design Report, SLAC R-593, dated April 2002, and WBS 1.3.1 of the associated cost estimate of April 2002. It is understood that this working definition is subject to revision based on DOE guidance and on progress of the PED process to maturity.

Specific near-term LCLS project engineering design (PED) and construction activities to be carried out by LLNL will be defined and updated at least semiannually in addenda to the SLAC-LLNL Memorandum of Understanding.

Appendix B

WBS Dictionary

WBS Dictionary

1.0 LCLS CONSTRUCTION PROJECT

1.1 **Project Planning, Management and Administration.** This WBS element covers the project management, planning and organization function of the PED and construction phases (TEC) of the LCLS Project. Also, included is the coordination of project-wide technical functions such as global controls and alignment.

1.2 **Injector System.** The Injector generates the electron beam and accelerates it to 135 MeV. This system includes the laser, optical transport, electron gun, accelerator sections, solenoids and other magnets, diagnostics, and the timing system. The interface to the Linac is at the downstream end of Dog Leg 1 (DL1), ending at the valve at the entrance to linac section L1.

1.3 **Linac System.** The Linac accelerates the electron beam while preserving the transverse emittance and compressing the longitudinal size. This element includes modifications to the last third of the existing SLAC linac, Bunch Compressor 1 (BC1), Bunch Compressor 2 (BC2), beam transport to the Undulator (LTU), beam transport after the undulator, bend magnets and beam dump. The interface with the undulator is a vacuum flange at each end of the undulator.

1.4 **Undulator System.** The Undulator includes ANL-SLAC management and coordination, undulator magnets and supports, diagnostics, vacuum systems, and controls. Magnetic measurement, integration and installation of the undulators are also included within this area.

1.5 **X-ray Transport, Optics and Diagnostic (XTOD) System.** The XTOD includes LLNL-SLAC management and coordination, mechanical and vacuum systems for the x-ray beam path, attenuators, x-ray optics and x-ray diagnostics required for manipulation and characterization of the x-ray beam downstream of the undulator. “Manipulation” includes collimation, attenuation, focusing, splitting/delaying, turning, and monochromatizing. “Characterization” includes measurement of x-ray beam properties as necessary for commissioning and operation of the LCLS.

1.6 **X-ray End Station (XES) System.** The XES includes the infrastructure required to integrate x-ray experiments with the LCLS source and conventional facilities. This includes safety systems, computer and network systems, experimental chambers, synchronized laser systems, and prototype detectors that will be used by most of the foreseeable LCLS experiments. It also includes additional sample handling equipment needed for the first studies of FEL-atom interactions (Atomic Physics experiments).

1.7 Unused

1.8 Unused

1.9 **Conventional Facilities.** The Conventional Facilities includes renovations to the existing SLAC facilities and the development of new facilities. Included will be all major systems and subsystems required to support the facilities related to the LCLS programmatic requirements. This includes site preparation and development (including establishment of survey monuments for site alignment), beam line housings including a beam dump, renovations to existing facilities, buildings, tunnels, service buildings, utility systems, fire protection systems, roads, sidewalks, landscaping, fencing and parking areas.

2.0 LCLS R&D, SPARES, COMMISSIONING (OTHER PROJECT COSTS)

2.1 **Project Management, Planning and Administration.** This WBS covers the project management, planning and organization function of the R&D, Spares and Commissioning phases of the LCLS Project. Physics support, power and start-up funds, and a Management Reserve are also included.

2.2 **Injector System.** This WBS covers effort and costs associated with R&D, Spares, and Commissioning of the Injector System.

2.3 **Linac System.** This WBS covers effort and costs associated with R&D, Spares, and Commissioning of the Linac System.

2.4 **Undulator System.** This WBS covers effort and costs associated with R&D, Spares, and Commissioning of the Undulator System

2.5 **X-ray Transport and Diagnostic System.** This WBS covers effort and costs associated with R&D, Spares, and Commissioning of the XTOD System.

2.6 **X-ray End Station System.** This WBS covers effort and costs associated with R&D, Spares, and Commissioning of the X-ray End Station System.