Closeout Report

on the

Department of Energy
Review Committee

for the

Technical, Cost, Schedule, and
Management Review

of the

LINAC COHERENT LIGHT SOURCE (LCLS) PROJECT

April 25, 2002

DOE F 1325.8
(08-93)

United States Government **Department of Energy**

memorandum

DATE: February 7, 2002

REPLY TO ATTN OF: SC-13

SUBJECT: Office of Science Conceptual Design Review

TO: Daniel R. Lehman, Director, SC-81

I would like to request that you organize and lead an Office of Science (SC) Conceptual Design Review of the Linac Coherent Light Source (LCLS) project at the Stanford Linear Accelerator Center during April 23 – 25, 2002. The purpose of this review is to assess all aspects of the project's conceptual design and associated plans -- technical, cost, schedule, management, and ES&H. This information will subsequently help SC evaluate its readiness for Critical Decision 1 (CD-1, Approve Preliminary Baseline Range), which is a prerequisite for design work to proceed in FY 2003 using Project Engineering Design funds.

In carrying out its charge, the review committee should respond to the following questions:

1. Is the conceptual design sound and likely to meet the technical performance requirements?

2. Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?

3. Are the cost and schedule estimates credible and realistic for this stage of the project? Do they include adequate contingency margins?

4. Is the project being managed (i.e., properly organized, adequately staffed) as needed to begin Title I design?

5. Are ES&H aspects being properly addressed given the project's current stage of development?

In addition to the above, it would also be helpful if the committee would evaluate drafts of the prerequisite documentation for CD-1 (e.g., Acquisition Execution Plan, Preliminary Project Execution Plan, Preliminary Hazard Analysis Report).

The LCLS Program Manager, Jeff Hoy, on my staff will work closely with you as necessary to plan and carry out this review. I would appreciate receiving your Committee's report within 60 days of the review's conclusion.

Patricia M. Dehmer
Associate Director
Office of Basic Energy Sciences

cc:
J. Hoy, SC-13
E. Rohlfing, SC-13
P. Montano, SC-13
P. Debenham, SC-22
J. Carney, SC-81
H. Lee, OAK/SSO
K. Hodgson, SLAC
J. Galayda, SLAC
J. Hastings, SLAC

Department of Energy Review
of the
Linac Coherent Light Source (LCLS) Project
April 23-25, 2002

Daniel R. Lehman, DOE/SC, Chairperson
James R. Carney, DOE/SC, Assistant Chairperson

SC1
Accelerator Physics

* Sam Krinsky, BNL
[Pascal Elleaume, ESRF]

SC2
Injector/Linac

* Richard Sheffield, LANL
George Neil, TJNAF

SC3
Undulator

* Kem Robinson, LBNL
Pascal Elleaume, ESRF

SC4
Photon Beam Handling Systems

* Steve Leone, U of Colorado
Dennis Mills, ANL

SC5
Control Systems

* Dave Gurd, ORNL

SC6
Conventional Facilities

* Valerie Roberts, LLNL
Jim Lawson, ORNL

SC7
Cost and Schedule

* John Dalzell, PNNL

SC8
Project Management Procurement/Pre-Ops

* Jay Marx, LBNL
Gene DeSaulnier, Consultant
Ben Feinberg, LBNL

SC9
ES&H

* Frank Kornegay, ORNL
Clarence Hickey, DOE/SC

Observers

Pat Dehmer, DOE/SP	Pedro Montano, DOE/SC
Iran Thomas, DOE/SP	Bill Oosterhuis, DOE/SC
Jeff Hoy, DOE/SP	Hanley Lee, DOE/SSO
Eric Rohlfing, DOE/SC	John Muhlestein, DOE/SSO

LEGEND

SC Subcommittee
* Chairperson
[ ] Part-time Subcom. Member

Count: 18 (excluding observers)

Department of Energy Review
of the
Linac Coherent Light Source (LCLS) Project

CONTENTS

Samuel Krinsky

April 24, 2002

2.1 Accelerator Physics

Findings

The work of the team carrying out the analysis of the accelerator physics for the LCLS is of the highest quality, and indicates that the conceptual design of the accelerator systems is sound and is likely to meet the technical performance requirements.

Recommendations

1. Continue to give high priority to experimental benchmarking of the computer codes used to model the photo-injector.
2. Pursue the experimental investigation of bunch compression and its comparison to theory.
3. Continue to develop tolerance budgets and optimize performance by use of start-to-end simulations.
4. Study SASE output versus electron bunch charge to investigate the possibility that LCLS performance goals can be achieved for charges lower than 1 nC.

2.2 Injector and Linac

Findings and Comments

1) Is the conceptual design sound and likely to meet the technical performance requirements?

Yes. It meets a satisfactory level for CD1.

2) Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?

Yes, but there are some items that are not completely covered at this time. The overall performance specification for project deliverables are not fully defined.
They do not yet have a resource loaded schedule.
In our estimation the resources are insufficient to meet CD2 in less than a year.

3) Are the cost and schedule estimates credible and realistic for this stage of the project? Do they include adequate contingency margins?

The contingency is adequate but it is unclear that personnel for the commissioning process have been completely included. Some prototyping efforts are lacking in the plan.
There is no funding for running the gun test stand.
It is not obvious where funding is allocated for support of the injector crew during commissioning and pre-ops.
Cost for necessary process spare components were not included in all estimates.

4) Is the project being managed (i.e., properly organized, adequately staffed) as needed to begin Title I design?

Yes

5) Are ES&H aspects being properly addressed given the project's current stage of development?
Yes

2.2 Injector and Linac

Recommendations

1) Establish a resource loaded schedule for the PED. By September 02.
2) Establish a realistic spares list and include in Other Costs or other appropriate area. By September 02.
3) Include support for the required injector scientist activity in the commissioning plan. By September 02.
4) Move forward with laser prototyping as early as budget permits. Include in planning by next review.
5) Move forward with prototyping the gun as early as budget permits. Include in planning by next review.
6) Perform prototyping and design validation tests on the GTF test stand, integrating as many of the injector components as possible before final integration on the injector linac. Include in the TPC. FY02-FY03

Kem Robinson
Pascal Elleaume

Version 4
4/25/2002 8:50 AM

2.3 UNDULATOR

Findings

- The Undulator subsystem includes 33 undulator magnetic structures, the vacuum chamber, permanent magnet quadrupoles, electron beam diagnostics and x-ray diagnostics that are deployed within the undulator length.

- The Undulator system is at, or beyond, a CD-1 level and the conceptual design is complete as stands.

- The conceptual design is sound and work to date has either demonstrated or will likely demonstrate the technical performance requirements.

- A full-length prototype has been partially assembled and has provided verification of tuning stub range, field strength, and a test of the passive thermal compensation.

- The scope and specifications of the undulator systems are sufficiently defined to support preliminary cost and schedule estimates.

- The cost estimate appears credible and realistic for this stage of the project.

- Active temperature stabilization, which was not part of the original concept, has not been costed.

- As presented, the schedule for the design is aggressive and there are not enough resources at APS to accomplish CD-2 by March 2003. The PED estimates require ~16 FTEs and available resources constitute only 3-4 FTEs.

- The contingency margins assigned to this section have been properly assessed based on the tools provided by the central project office.

- The undulator system has been well managed during the conceptual design phase the organization and staff necessary to start Title I (PED) is not yet defined.

- The ES&H aspects of the undulator are being properly addressed given the project's current stage of development.

- The passive thermal compensation of the magnetic field by counteracting materials with differing coefficients of expansion has been judged as insufficient by APS to avoid some other means of field strength control.

Comments

- The level and breadth of the conceptual design report is commendable. It is a very comprehensive work. All of the contributors of the undulator system section should be proud of their efforts. The project is very challenging and exciting.

- A number of diverse technologies must be successfully implemented in the undulator system to achieve success. APS and SLAC have a good grasp of what these technologies entail.

- The application of beam based alignment evidences a good collaboration between the LCLS and the Next Linear Collider (NLC) groups. This is very encouraging. The energy scanning of beam-based alignment to a SASE FEL system is innovative and exciting.

- APS should procure all of the magnets to be used in the undulators and drop ship them at the undulator subcontractor site.

- If the procurement choice is to use high-level industry involvement in the undulator system, prospective suppliers need to be involved early enough through letters of interest/intent. Necessary actions should be initiated to allow full value engineering and production optimization.

- If there is goal to go with industry there should be multiple first article suppliers with the option to pick a single or multiple suppliers for the final deliveries. Care should be exercised to ensure that competition is maintained for as long as possible.

- Develop a long-term assessment of the stability of the undulator magnetic fields by characterizing the undulator sections of LEUTL when removed and compare with initial measurements

- Clarify the need and benefit for temperature stabilization of each segment.

- Determine the preferred approach for phase adjustment of successive undulator sections, PZT, vertical alignment or thermal control. Develop a means to follow the long-term magnetic field stability in each undulator segment in the tunnel.

- Both prototype electron BPM and X-ray diagnostics should be tested with beam as soon as possible.

Recommendations

1. Designate a senior team leader for the LCLS Undulator system from within APS whose primary responsibility is to carry forward to successful completion of the system before September 2002.

2. Develop a resource-staffing plan prior to expenditure of PED funds to meet requirements during the PED design phase by July 2002.

3. Decide upon the Undulator procurement approach by September 2002. This must include who, national lab or industry, will be responsible for what portions of the design, fabrications, measurements, etc. The approach during the preliminary design phase is different depending upon the approach.

4. Complete a thorough value engineering and production analysis of the undulator mechanical design. Trade offs on the choice of strongback materials, thermal compensation and phasing control, physical tolerances, and relationship between stringent tolerances and post assembly tuning must be completed. This is to be completed prior to submitting for bid any long lead procurement.

5. Focus the second undulator prototype on addressing mass production issues. The design and technical approaches are sufficiently advanced that production issues are the most urgent. If a second prototype is pursued, this recommendation must be completed prior to CD-3.If industrial production is selected, the second prototype should be produced in industry.

6. Build and field a complete prototype subsystem consisting of an undulator (the existing prototype is adequate), vacuum chamber, a short diagnostic/focus section, and a long diagnostic/focus section. This should include the electron beam diagnostics and x-ray beam diagnostics. This is to be completed prior to CD-3.

7. Assess and ensure that the allocation of the total impedance budget throughout the undulator is complete before CD-2. Specifically, the cavity BPM, x-ray diagnostics, and Cerenkov detector disruptions will impact the allocated impedance of the system.

2.4 Installation and Alignment

Findings and Comments:

1) Is the conceptual design sound and likely to meet the technical performance requirements?

Yes. It meets a satisfactory level for CD1.

2) Are the project's scope and specifications sufficiently defined to support preliminary cost and schedule estimates?

Yes but they do not yet have a resource loaded schedule. The details of how the installation schedule will be incorporated into linac operations are yet to be fully established but the plan is adequate for cost and schedule estimates.

3) Are the cost and schedule estimates credible and realistic for this stage of the project? Do they include adequate contingency margins?

Yes. This area includes reasonable contingency because the experience base is well established.

4) Is the project being managed (i.e., properly organized, adequately staffed) as needed to begin Title I design?

Yes

5) Are ES&H aspects being properly addressed given the project's current stage of development?

Yes. There will be Personnel Safety System aspects involved in the installation and alignment activities of the injector and linac systems in the side tunnel. The team is aware of this and will incorporate the requirements in the safety system.

2.4 Installation and Alignment

Recommendations

1) Continue to optimize the approach for minimizing installation interference with linac operations for other programs. Incorporate plan for injector commissioning with installation of other subsystems. By next review.

Stephen Leone
Dennis Mills

LCLS report

Section 2.5

Photon Beam Handling Systems

Findings

The diagnostics and end stations component of this project will be implemented at a later time than many of the other subassemblies of the LCLS. Given this point in time, the conceptual design is at a reasonable level and likely to meet the required technical performance. The LLNL and SLSC staff members have done a very thorough job to date exploring a variety of possible avenues and approaches to solve the extremely challenging technical problems associated with the XFEL. Excellent progress has been made by the team to define what will be needed for the photon handling and how to develop the necessary optics and diagnostic tools. The partnership between Livermore and Stanford is effective and productive, and many excellent people are working on this part of the project.

Clearly one of the more interesting challenges is the survivability of optical components placed in the direct beam. The team members working in this area are well aware that this is a critical, and largely unexplored, area and have already begun to put resources in this direction. Work is essential on both theoretical and experimental aspects of materials damage by the FEL beam.

For the CD-1, the scope, conceptual design, timeline, management plan, and costing are all satisfactory for this subsection, with a few reservations concerning the costing and timeline for some R&D and procurement noted in specific places. This subarea is also on track for the CD-2 in March 2003. The costing was thorough and often based on recent experience. In some cases the cost analysis arrived at a reasonable total for a particular component, but with more for engineering and less for procurement than past experience suggests.

Implementing the diagnostics and photon beam aspects does represent a very challenging and crucial aspect. This is because very little is known about how the intense, short pulse x-ray radiation will interact with materials, for example, whether there will be unforeseen damage mechanisms or multiphoton processes. There are many challenging questions that remain with regard to the materials that will be used for the optics, apertures, and slits, although much is now satisfactorily worked out. Also it is not known how short the pulses from the LCLS will be or how to measure such short pulses, although some new ideas are being considered. A careful assessment of how the PED funds are distributed and whether it is possible to reallocate some of these resources to address some of these issues may be desirable.

The CDR presents many sound and clever ideas about how to measure the pulses and to perform post processing for timing jitter. The depth of planning was apparent throughout the breakout session, where many more details were presented and new ideas discussed. The plans to provide diagnostics for several aspects of the pulse on a pulse-to-pulse basis are excellent. This includes pulse energy, shape and centroid. In separate experiments, bandwidth, coherence, and temporal information will be obtained. It may be possible to obtain pulse chirp information through some of the newer atomic physics methods of temporal pulse measurement being considered. In addition, the current planning of the user halls and endstation areas provides a flexible and thorough base for future work by users as well as for the diagnostics effort. The detector development contained in the plan is crucial and must be maintained. This is the one area where the timeline is critical for this group to develop the high repetition rate 2-dimensional acquisition.

The LCLS will become a unique coupling of lasers and accelerator physics, which will ultimately be crucial for many of the diagnostics and endstation work. None of the planned diagnostics presently consider the merger of short pulse lasers with the LCLS beam. While much laser expertise resides in Livermore, by the time of commissioning it will be desirable to have additional in house staff with expertise and interest in short pulsed lasers at SLAC. Similarly, the machine advisory committee should be constituted with a more general name, such as facility advisory committee, and should have a strong component of laser experts as an integral part.

The gas attenuator appears to be relatively complex and costly. It would be valuable to check the designs of other gas filters implemented at synchrotrons before finalizing the design of the gas attenuator.

All end stations seem to be of a "generic" design, which is appropriate at this time. Shielding seems excessive on the walls of the end stations, and additional calculations are needed to ensure there can be no radiation issues on the connecting tubes.

The level of contingency did not seem commensurate with the level of technical risk/difficulty. Optics under the extreme conditions of the LCLS x-ray beam will be in a completely new regime of incident instantaneous power density and the contingency for these components seemed low. Budgets should be configured to include special process spare items for some of the crucial optical elements because of the potential for damage by the high power beam.

Comments

Several broad areas will require more understanding of important physics. These include the topics of coherence preservation on optics, multiphoton processes in materials as they relate to possible damage, and pulse duration and timing measurements. By the time of commissioning, it will be necessary to obtain better synchronization of the LCLS pulses with short pulse laser sources. These are discussed further below.

Although the current effort by LLNL has focused primarily on the issue of damage, optical performance is really the bottom line. For example, coherence/brilliance preservation of the beam is critical for many experiments. With a radiation opening angle of 1 microradian, mirror slope errors need to be a small fraction of this to not dilute the brilliance. This requirement is at the state-of-the art for polishers and metrology. Developing partnerships and collaborations with existing synchrotron radiation facilities, in particular with the 3rd generations sources who already require such specifications, is a good approach, to gain expertise in this important area.

Multiphoton processes are largely unknown, but would afford an excellent means of obtaining autocorrelations of two x-ray pulses. More theoretical work in this area would be valuable.

Synchronization with short pulse lasers, pulse timing and pulse duration measurements are going to be the key areas for future experiments. Several new methods are being considered and others have been suggested. Split pulse methods together with frequency downconversion methods in gaseous or solid media may provide temporally linked pulses with much smaller timing jitter than currently contemplated. Additional methods to measure chirp may be possible and necessary in the future, using processes in atoms. These should be pursued vigorously.

The committee is pleased to see that the team seems to be taking advantage of established designs from existing synchrotron radiation sources and not starting from scratch in the design of components. Considerable effort and expense has gone into optical component development and fabrication at existing facilities, and the team should take advantage of this expertise.

Concerning suitable materials for optical components, it should be pointed out that the authors stated that continued R&D into x-ray photon-materials interactions should be further explored. The committee commends this action.

Recommendations

Increase R&D in the damage area as much in advance as possible before experiments take place. At the same time calculations of optical component performance must also be pursued.

Increase communication with undulator x-ray diagnostics group.

Increase R&D to measure temporal resolution, achieve pulse timing, and measure pulse chirp.

Ramp up additional staff with laser expertise on the project at SLAC for commissioning.

Include laser specialists and experienced synchrotron radiation users/beamline designer as an integral part of the advisory committee. Consider renaming the Machine Advisory Committee to Facility Advisory Committee.

Integrate the Scientific Advisory Committee and potential users immediately with the Optical Systems team in the design of the end stations to ensure compatibility of end stations with planned experiments. If necessary, a specific liaison should be appointed.

Evaluate the shielding requirements for the connecting tubes and other elements.

Assess contingencies based on individual component risk analysis.

Incorporate lessons learned from 3rd generation light sources for developing optical component specifications and beamline component design.

Dave Gurd

April 24, 2002

Section 2.6 Control Systems

Findings:

1. Considerable effort by an experienced and professional team has gone into the preparation of the controls part of the CDR, and excellent technical presentations were made during the breakout session.

2. Controls for major LCLS subsystems are to be delivered with those subsystems and the controls effort is distributed around the WBS (and the partner institutions) with those subsystems.

3. The control systems will use a combination of SLAC controls and EPICS, with EPICS used where practical constraints do not dictate otherwise. The SLAC team knows how to do this, based upon experience at PEPII.

4. Cost data has been assembled from the various distributed WBS elements into one comprehensive cost book that supports the estimates. The cost estimates have been developed by experienced people, and appear credible. Risk (and therefore contingency) has been reasonably estimated – the highest risk is in the integration of subsystems.

5. The major technical concern has to do with subsystem integration. "Global" systems, such as timing, machine protection and network must be common and should follow the SLAC model. Hardware and software standards should be established where appropriate. Feedback between subsystems will be facilitated if the control systems are standardized. (And there will be cost savings.) A standard naming convention should be imposed and a common technical database used.

6. Following the organizational model of PEPII, a controls project manager will be appointed in the SLAC LCLS Division. The Controls System manager's scope should include control over all controls WBS elements. This should be the mechanism for addressing the integration issues noted above.

7. The control system design appears to be at the CD-1 level now, and although much work is required to bring the design to CD-2 level this should be achievable by March 2003 with available resources.

Recommendations:

Independent of where they are designed, all LCLS subsystems must be tightly integrated and be operated from the SLAC control room. There can be one and only one timing system, naming convention, MPS system, database schema, etc. With this in mind, the committee makes the following recommendations:

1. Consolidate the controls effort under one organizational entity within the LCLS Division. Consider consolidation of the controls WBS elements as well.

2. Centralize at SLAC the design and development of the "global" systems, including timing, Machine Protection System and network. Establish standards for naming, technical database and appropriate hardware and software to be applied across the project.

3. Initiate discussions with LLNL to understand interface requirements between the x-ray control systems and the accelerator control systems. (Communication with the Undulator controls team at Argonne has already been initiated.)

Valerie Roberts
James Lawson

Version 3
April 24, 2002

3.0 – Conventional Facilities

Findings
Assessment of technical, cost, schedule and management

- The conceptual design is not fully developed at this time. System Design Requirements have not been developed to adequately define the scope of the CF project. Detailed shielding requirements for the hutches and beam dump have not been developed.
- The cost estimate was developed using detailed quantity take-offs taken from sketches. The basis of the estimate is variable in detail and is in some cases difficult to substantiate. The basis by which engineering was estimated is not clear.
- Contingency estimated (19.3%) for the CF work is low given the lack of: System Design Requirements, detailed shielding requirements, and geotechnical/ biotechnical reports
- The proposed schedule and funding profile delays Title I design of Conventional Facilities until FY'04. The project will have neither adequate CF design information nor a conceptual estimate in order to baseline the costs for CD-2 in March '03

Comments
- The team as currently assembled is dedicated and conscientious; however, they would benefit from experience managing a CF project in the $35-$50M range
- The geotechnical/biotechnical report is scheduled for preparation in FY'03. The required information for the foundation designs, soils remediation and cost estimates of the CF may be late as a result of this schedule; additionally, NEPA documentation could also be impacted
- Means and methods for the tunnel construction as well as risk assessment for this work needs to be reviewed and managed by individuals with specific experience in this area; utilize resources that exist here at SLAC from prior projects to augment this activity wherever possible
- Timing of shut-downs for critical path activities on the front-end of the CF schedule should be carefully managed to ensure there are no impacts to the overall schedule. The IPS must reflect the inter-relationships of the CF schedule with the special equipment installation

Recommendations

1. Develop, document and control the top level System Design Requirements for the CF to ensure that the Conceptual Design Report and estimate are adequate by July 1, 2002.
2. Further define System Design Requirements by the completion of Title I.
3. Augment the CF team with more experienced individuals; assign the CF team directly to the LCLS Project Team prior to the start of Title I development. Engage additional consultants as required to augment the CF Project Manager to develop cost estimates, schedules, and other plans during Title I.
4. Develop a Procurement Plan for the CF work and identify approaches and schedules for civil construction facilities prior to Title I
5. Perform the geotechnical/biotechnical survey now, with the final report due no later than 9/1/02
6. Revise the project schedule to perform Title I design of the CF in concert with the rest of the project, but not later than CD2.
7. Revise the allocation of contingency to approximately 30%; this is due to the lack of detail in the CDR. As more detail is developed, the contingency should be reduced commensurately.

LCLS CDR Review
April 25, 2002

Cost and Schedule

Findings

- The project has access to good cost and schedule capabilities
- A complete project critical path schedule has not been developed
- A detail cost estimate provided to the sixth level of the WBS
    - The process used to establish the estimates seems creditable

Comments

- Absence of a critical path schedule creates questions
    - Sufficient staffing – when and where needed
    - Accurate budget profiles
- Control of contingency should be clarified in PEP
- Clarify cost account management for each WBS element
- Concern about the level of PMCS implementation during PED phase
- The committee reviewed project contingency to identify area of concern, however the committee is not recommending an increase in the TEC

Recommendations

- Cost estimates need to address committee's concerns
    - Reevaluate project contingency – especially in conventional facilities
- Develop a TPC that includes updated TEC and details OPC
    - OPC includes R&D, Capital Equipment, Commissioning, etc.
- Develop a schedule with a critical path including resources to
    - Provide support and verify assumptions
        - Staffing levels
        - Funding profiles
        - Cost estimates

DOE Review of the Linac Coherent Light Source Project

FY02 Dollars ($K)
April 23-25, 2002

		LCLS						DOE Assessment							
			Burdened, escalated $		Contingency on ETC			Burdened, escalated $			Contingency on ETC				
WBS	WBS Title	Cost & Awards thru 3/31/02	ETC 3/31/02 Forward	EAC	%	$	TEC	ETC 4/25/02 Forward (calc)	EAC	EAC Variance (calc)	%	$ (calc)	Contingency Variance (calc)	TEC (calc)	Comments
1.1	**Project Management**	-	12,183	12,183	1.6%	190	12,373	12,383	12,383	200	2.1%	256	67	12,639	
1.1.1	ES&H	-	1,908	1,908	2%	39	1,947	2,108	2,108	200	5.0%	105	67	2,213	See note 5 below
1.1.2	Construction Project Mangement	-	10,275	10,275	1%	151	10,426	10,275	10,275	-	1%	151	-	10,426	
1.2	**Electron Beam Handling Sys.**	-	79,515	79,515	27.9%	22,151	101,666	79,515	79,515	-	27.9%	22,151	-	101,666	
1.2.1	Injector	-	15,912	15,912	28%	4,498	20,410	15,912	15,912	-	28%	4,498	-	20,410	
1.2.2	Accelerator	-	18,178	18,178	27%	4,874	23,052	18,178	18,178	-	27%	4,874	-	23,052	
1.2.3	Undulator	-	39,118	39,118	28%	10,832	49,950	39,118	39,118	-	28%	10,832	-	49,950	
1.2.4	Installation and Alignment	-	6,307	6,307	31%	1,947	8,254	6,307	6,307	-	31%	1,947	-	8,254	
1.3	**Photon Bean Handling Systems**	-	35,506	35,506	25.5%	9,050	44,556	35,506	35,506	-	25.5%	9,050	-	44,556	Contin. may be low
1.3.1	X-ray Transport & Diagnostics	-	21,992	21,992	21%	4,658	26,650	21,992	21,992	-	21%	4,658	-	26,650	
1.3.2	X-ray End Station Systems	-	13,295	13,295	32%	4,316	17,611	13,295	13,295	-	32%	4,316	-	17,611	
1.3.3	Installation and Alignment	-	219	219	35%	77	296	219	219	-	35%	77	-	296	
1.4	**Conventional Facilities**	-	31,778	31,778	19.3%	6,133	37,911	31,778	31,778	-	30.0%	9,533	3,401	41,311	See note 4 below
1.4.1	Injector Facilities	-	989	989	15%	145	1,134	989	989	-		-	-		
1.4.2	Accelerator Facilities	-	972	972	23%	223	1,195	972	972	-		-	-		
1.4.3	Undulator Facilities	-	924	924	15%	142	1,066	924	924	-		-	-		
1.4.4	Near Hall	-	10,395	10,395	23%	2,442	12,837	10,395	10,395	-		-	-		
1.4.5	Tunnel	-	2,571	2,571	17%	444	3,015	2,571	2,571	-		-	-		
1.4.6	Far Hall	-	15,927	15,927	17%	2,736	18,663	15,927	15,927	-		-	-		
	Subtotals:	-	158,982	158,982	1	37,523	196,505	159,182	159,182	200	26%	40,991	3,468	200,173	
	Additional Mgmt Contingency:				0%		-				0%			-	
	Total Contingency:				24%	37,523					26%	40,991			
	Escalation:						19,271					19,271		19,271	
	Total Estimated Cost (TEC):						215,776							219,444	
	Other Project Cost (OPC):				0%	-	17,100							17,100	
	Total Project Cost (TPC):						232,876				0%	-		236,544	

Notes:

4/25/02 9:54

1 Project TEC/TPC Used DOE Escalation Rates - FY03 (1.021); FY04 (1.046); FY05 (1.076); FY06 (1.106); FY07 (1.135)

2 Burden Rates - ED&I Labor M&S

	ED&I	Labor	M&S
SLAC	20%	6%	6%
ANL	30%	24%	13%
LLNL	98%	98%	19%

3 Other Project Cost (OPC) Breakout - ~$6M R&D Funding FY99-02; $11.2M Pre-ops $3.5M FY06 (Injector) and $7.7M in FY07 (Injector, linac, experimental halls)
Using Draft Project Management Manual (Feb. 2002) Definition for OPC - ~$1.5M for Post CD-0 Preparations; $11.2M Pre-ops FY06-07

4 Due to lack of detail in the CDR, the contingency of 19.3% should be in the 30% range.
As more detail is developed, the contingency can be reduced commensurately

5 FTE increase needed to support CD-2 & safety/environmental documentation

Closeout- Management Subcommittee

**Jay Marx (chair), Ben Feinberg, Gene DeSaulniers,
Jeff Hoy, Jim Carney**

Recommendations and Significant Comments about:

- **Documentation- CDR Acquisition Execution Plan and Project Execution Plan**
- **Risk Assessment**
- **Commissioning and Operations**
- **Management of the Scientific Program**
- **Overall Management**

Documentation

Conceptual Design Report

The CDR is generally of high quality. The scientific and technical sections are well done and are at a level of detail needed to support a CD-1 decision. Reflecting the clear focus on technical systems, the Conventional Facilities sections require some additional detail.

Acquisition Execution Plan

The plan is a draft plan and by its nature is incomplete and needs to be flushed out with more details in the next few months.

A detailed set of things that need improvement have been flagged in the report and discussed with LCLS staff.

Project Execution Plan

Recommendation:

> Complete the preliminary Project Execution Plan in consultation with the LCLS Federal Project Manager and the LCLS Program Manager in BES. Include as appendices the Acquisition Execution Plan, FY2003 Construction Project Data Sheet, if possible the signed inter-laboratory MOU, and any additional management detail at the project's discretion. This document should be ready for SC-1 approval in July 2002.

Risk Assessment

Recommendation:

During title I, LSCS should do a more quantified risk analysis, produce a plan that describes actions that could be taking to mitigate the high level risks that have been identified and then reevaluate the contingency and schedule to take account of their potential impact and likelihood.

Commissioning and Operations

Recommendation:

1. **LCLS should begin the coordination with the Technical and Research Divisions for compatible operations of the linac for HEP and of the LCLS during commissioning and operation of the LCLS.**

Management of Science Program

Recommendations:

1. LCLS, SSRL and SLAC management need to define the advisory process for scientific input both on experimental proposals and on LCLS design by January 2003. As part of this definition, they will need to determine the reporting structure for the SAC and/or other scientific advisory committees.

2. SSRL will need to plan for the expanded range of activities involved in constructing and operating the experiments for LCLS.

Overall Management

Comments:

1. PEPII provides an excellent management model for LCLS that should be utilized.

   However, there are some aspects of the PEPII model that may not work as well for LCLS. As a result, the LCLS project must be managed with cognizance of the differences with LCLS, especially in regard to priorities within the laboratory.

2. The advisory committees described by SLAC are very appropriate to a project of this type and scale. The laboratory should consider one additional advisory committee reporting to the Laboratory Director to provide oversight and advice for the project's management activities.

3. Although there is the potential for some conflicts with the Laboratory's high energy physics program (assignment of technical personnel, access to the linac tunnel for construction, etc.). the SLAC Director's support of LCLS should ensure that this should not be a significant problem.

4. The following needs to be done in order to bring documentation to the point where it can support a CD-1 decision. The shortcomings in the Draft Acquisition Plan described in the report must be remedied. The Project Execution Plan needs some additional work as described in this report. The Conventional Facilities section of the Conceptual Design Report also needs to be fleshed out with additional detail, and the Preliminary Hazards Analysis must be completed.

5. The goal of a Critical Decision 2 in March 2003 is extremely challenging at best. It is suggested that LCLS management carefully track progress on the needed deliverables so that the

CD-2 process is planned to take place at the earliest time when it would be successful.

6. **LCLS experiments (e.g. crystallography) could produce megabytes/second of data. This is in the realm of forefront high energy physics experiments where computing costs are at the multi-million dollar level. DOE should be aware of the need to provide funding for this need in their downstream planning for LCLS science.**

Recommendations:

A project complete milestone should be adopted that confirms the completion of construction and the verification of the basic functionality of the facility. Therefore:

1. **LCLS should adopt a performance capability to be reached at the completion of construction that will assure that major systems operate successfully and that the underlying beam physics is proven at a level to guarantee that LCLS will ultimately achieve its required performance for science. This should be accomplished before the CD-1 decision**

Concerning the documents needed to support the CD-1 decision the LCLS should:

2. **Make improvements and corrections needed in these documents so that a CD-1 decision could be made in the July 2002 time frame.**

"Bottom Line"

The Project is in very good shape!!

SLAC has demonstrated that it can successfully accomplish projects of this scale and over many years has successfully met its commitments to DOE/BES and to its BES user community.

The project has experienced, motivated and high quality leadership and staff. The management approach being implemented will serve the project well.

There is still work to do and documentation to firm up before the various key decisions can be made. It may be that the new project requirements in DOE will result in progress towards construction at a slower pace then the Laboratory and staff would like. This should not be seen as a fundamental issue. It is up to the leadership to plan accordingly and to continue to motivate the staff and drive progress.

This project is heading in a successful direction. Keep up the good work!

Kornegay, Hickey

6.0 Environment, Safety, and Health

Findings

The Environment, Safety, and Health aspects of the LCLS Project are being properly addressed at this stage of the Project development. Line management accountability, roles and responsibilities for ES&H are in place, beginning with the Project Director. The SLAC ES&H staff is competent and capable of successfully supporting the Project, and ES&H concerns have been thoroughly integrated in the Project. Some minor refining of priorities and staffing would significantly reduce cost and schedule uncertainty in the Project. Although the LCLS will utilize or require only slight modification to SLAC environmental permits, early discussions with regulators could identify any concerns in time to adequately address the issues.

A determination to prepare an Environmental Assessment (EA) has been made by the Oakland Operations Office, and a preliminary draft EA has been prepared. The draft EA was reviewed as part of this assessment. While some additional material is required, the preliminary draft document has a reasonable probability of reaching a Finding of No Significant Impact by the Department.

Comments

The current LCLS FY 03 ES&H staffing plan cannot support the current schedule. More support for the EA, the development of a Draft Safety Assessment Document, and input to the Commissioning plan is needed.

An approved FONSI is required to support CD-2. Sufficient information exists to develop an acceptable EA. The project should proceed with modifying the preliminary draft EA and submitting the document for review by the Oakland Operations Office as quickly as possible.

Additional geotechnical studies are needed to quantify the soils and groundwater. While the EA can proceed without these analyses, the studies should commence as soon as possible to identify any unforeseen soil and groundwater issues and to quantify the amounts and types of wastes that will be generated in the tunnel construction. When the studies are complete, the EA can be modified as appropriate.

The Preliminary Hazard Analysis Report must be completed prior to CD-1.

Recommendations

Update and submit the Environmental Assessment to Oakland by October 2002.

SSO should assure that NEPA documentation is in place for the work taking place at ANL and LLNL.

Complete and submit the Preliminary Hazard Analysis Report by July 2002

Complete and evaluate the results of the geotechnical study by September 2002.

Involve the appropriate regulators in the ES&H aspects of the project as soon as possible.

Action Items from the
DOE Conceptual Design Review of the Linac Coherent Light Source
April 23 – 24, 2002

	Action	Responsibility	Due Date
1.	Provide guidance to LCLS management on the project's funding profile.	DOE/BES	May 3, 2002
2.	Provide DOE with a project schedule (that shows the critical path) based on the above guidance.	LCLS Management	July 1, 2002
3.	Complete the draft LCLS Acquisition Execution Plan in consultation with DOE and submit to BES.	LCLS Management	May 20, 2002
4.	Submit all other documentation in final form to BES required for CD-1 approval.	LCLS Management	July 1, 2002

Hanley W. Lee
LCLS Federal Project Manager
DOE Stanford Site Office

John S. Muhlstein
Manager, DOE Stanford Site Office

Daniel R. Lehman
Director, Construction Management
Support Division, Office of Science

Jeffrey C. Hoy
LCLS Program Manager, BES
Office of Science

Patricia M. Dehmer
Associate Director for Basic Energy Sciences
Office of Science

John N. Galayda
LCLS Project Director
SLAC

Keith Hodgson
Director, SSRL
SLAC

Jonathan Dorfan
Director, SLAC