

*Department of Energy
Review Committee Report*

on the

Technical, Cost, Schedule, and
Management Review

of the

**LCLS ULTRAFAST
SCIENCE INSTRUMENTS
(LUSI) PROJECT**

April 2009

EXECUTIVE SUMMARY

A Department of Energy (DOE) Office of Science review of the Linac Coherent Light Source (LCLS) Ultrafast Science Instruments (LUSI) project, to be located at the SLAC National Accelerator Facility, was conducted at SLAC in Menlo Park, California on April 20-22, 2009. The review was conducted at the request of the Office of Basic Energy Sciences (BES) and chaired by Mr. Daniel Lehman, Office of Project Assessment. The purpose of the review was to assess all aspects of the project—technical, cost, schedule, management, and environment, safety and health (ES&H). The LUSI project has been the recipient of funds from the 2009 American Recovery and Reinvestment Act (ARRA/Recovery Act). With this Recovery Act funding, the LUSI project is fully funded and the project team can accelerate much of the design, procurement, and integrated assembly activities.

The Committee concluded that the project is proceeding well towards a Recovery Act accelerated goal of achieving Critical Decision (CD) 3, Approve Start of Construction, later in 2009. The Committee expressed concern about the need for additional planning and resources for the execution of a significant quantity of procurement actions.

The project constructs three specialized instrument stations that will complement the initial instrument included in the LCLS construction. The three LUSI instrument stations are X-ray Pump Probe Diffraction (XPP), Coherent X-Ray Imaging (CXI), and X-Ray Photon Correlation Spectroscopy (XCS). Each instrument station is designed to support scientific studies of a certain type, and was identified as a high-priority need by the scientific community, as documented in the LUSI Mission Needs Statement, CD-0, approved in August 2005. These instrument stations are designed to use “hard” X-rays (i.e., those at the shorter wavelengths, or higher energies of the LCLS output spectrum, specifically between 4-25 keV).

The Total Project Cost is \$60.0 million with a Total Estimated Cost of \$55.1 million, which includes a total contingency of \$12.3 million. Other Project Costs are \$4.9 million.

The overall schedule for LUSI is approximately seven years, starting with CD-0 and ending with CD-4, Approve Start of Operations, scheduled for August 2012. This CD-4 date includes 100 days of schedule contingency. Upon approval of a Baseline Change to incorporate Recovery Act funding, the schedule contingency would increase to 160 days.

The status of design completion in each of the technical areas is as follows:

1. XPP Instrument Design is CD-3 ready
2. CXI Instrument design review scheduled for June (75 percent CD-3 ready now)
 - Instrument configuration is solid
3. XCS Instrument design review scheduled for June (90 percent CD-3 ready now)
 - Instrument configuration is solid
4. Diagnostics and Common Optics Design (90 percent CD-3 ready now)
 - Harmonic Rejection Mirror design review scheduled for June
5. Controls and Data Acquisition (85 percent CD-3 ready now)
 - Inherited Designs from LCLS comprise many items

Based on this design status, the project team requested a tailored CD-3 project review in the July/August time-frame in anticipation for a CD-3 approval by October 2009. The Committee acknowledged the design progress and supported the goal of CD-3 by October. Overall, the Committee made 31 technical recommendations.

The Committee observed that the project team is effectively managing the project budget, schedule, and project risks. The Committee commented that the proposed Recovery Act schedule is reasonable and should be adopted as the schedule performance baseline as soon as possible to maintain accurate project reporting and avoid unnecessary variances. There were five Committee cost and schedule recommendations.

The Committee commented that all ES&H requirements per DOE Order 413.3A have been met.

The risk registry is regularly updated and actively managed. The project has a prioritized contingency draw-down list.

Procurement was a concern to all of the Committee members. The schedule includes one week for SLAC approval and one week for DOE approval on all procurements. This may be inadequate due to the large volume of procurements that need to be placed and additional time needed for review of Recovery Act funded procurements. Opportunities should be explored to request additional early procurement approval to allow for early completion of work activities, take advantage of the current favorable market conditions, and avoid a spike in procurement requests following approval of CD-3. Additional resources and detailed procurement plans may be in order. There were three management recommendations from the Committee.

CONTENTS

Executive Summary	i
1. Introduction	1
2. Technical Systems Evaluations	5
2.1 X-ray Pump Probe Diffraction Instrument (WBS 1.2).....	5
2.2 Coherent X-ray Imaging Instrument (WBS 1.3).....	8
2.3 X-ray Photon Correlation Spectroscopy Instrument (WBS 1.4).....	9
2.4 Diagnostics and Common Optics (WBS 1.5).....	13
2.5 Controls/Data Acquisition System (WBS 1.6).....	14
3. Environment, Safety and Health.....	17
4. Cost and Schedule	19
5. Project Management (WBS 1.1).....	23

Appendices

- A. Charge Memorandum
- B. Review Participants
- C. Review Agenda
- D. Cost Tables
- E. Schedule Charts
- F. Management Table

1. INTRODUCTION

1.1 Background

Now under construction at the SLAC National Accelerator Facility, the Linear Coherent Light Source (LCLS) is designed to be the world's first hard X-ray Free Electron Laser (FEL). Its goal is to produce intense, ultrashort, coherent laser pulses of X-rays with wavelengths between 15 and 1.5 Angstroms. The technical approach is to inject the energetic electron beam from the SLAC LINear ACcelerator (LINAC) into a 170m long arrays of undulator magnets in order to generate synchrotron radiation of two types—spontaneous emission, as well as “Self Amplified Spontaneous Emission” (SASE) X-rays. When fully operational, the LCLS will be a scientific user facility to enable researchers in the United States and abroad to apply this new X-ray tool to the study of phenomena in ultrafast chemical reaction dynamics, precision imaging of macromolecules, novel physical effects (of atoms, molecules, and condensed matter), and other material systems.

Current plans call for this X-ray beam to be delivered to several experimental endstations that will contain instrumentation to enable experiments of different types to be performed. To maximize the use of LCLS for scientific studies, it is desirable to develop these specialized instrument stations in a timely manner—by constructing them over the next several years, for use as soon as practicable when the LCLS X-ray beam becomes available.

The LCLS Ultrafast Science Instruments (LUSI) project constructs three such specialized instrument stations as its scope. Each instrument station is designed to support scientific studies of a certain type, and has been identified as a high-priority need by the scientific community, as documented in the LUSI Mission Needs Statement (and references therein) that was approved in August 2005 as Critical Decision (CD) 0. These instrument stations are designed to use hard X-rays (i.e., those at the shorter wavelengths, or higher energies, of the LCLS output spectrum, specifically between 4-25 keV).

The technical objective of the LUSI project is to design, build, and install at LCLS three X-ray instruments that will complement the initial instrument included in the LCLS construction. This initial LCLS instrument is designed for atomic, molecular, and optical physics studies. The three LUSI instrument stations are X-ray Pump Probe Diffraction, Coherent X-Ray Imaging, and X-Ray Photon Correlation Spectroscopy. The purposes, functions, technical performance parameters, and fuller descriptions of each of these LUSI stations are described in the Conceptual Design Report (CDR) and other project documents. Below is a brief summary of each LUSI instrument station.

X-ray Pump Probe Diffraction Instrument

This X-ray Pump Probe (XPP) station is designed to probe dynamics of a sample system at ultrafast timescales (e.g., reactions or relaxation processes with subpicosecond time constants) using X-rays (i.e., on systems for which X-ray scattering constitutes a useful and informative signal). In this setup, a short pulse of an optical laser creates excitations in a sample, which is then probed by an X-ray pulse, at time scales much faster than annihilation of the sample, that interrogates the sample as it evolves over time after the initial laser excitation. The timing between the optical laser pulse and the X-ray probe pulse is experimentally measured and tuned as a parameter that can be varied. The X-ray pump probe incident upon the sample generates scattered X-rays that are detected in order to measure properties of the excited, transient system and its dynamical evolution. Use of the ultrashort intense LCLS X-ray pulse enables a separate image of the system to be created via the scattered X-ray intensity pattern from each pulse, with sub-picosecond time resolution.

Coherent X-Ray Imaging Instrument

This Coherent X-Ray Imaging (CXI) station is designed to conduct experiments that use the X-ray beam to image a) molecules that are free-standing targets (e.g., not periodic or bound in a lattice), and/or b) systems that are susceptible to radiation damage (because the scattered signal from each pulse is generated prior to any sample degradation from the X-ray power). In this setup, an intense X-ray pulse is incident upon a sample molecule (e.g., a large protein), to create a detectable diffraction pattern that is dependent upon the molecule's structure and spatial orientation. This process is repeated several times, with successive X-ray pulses incident upon molecules of varying orientations, each time producing a diffraction pattern with features that depend upon the sample's molecular structure and orientation. All of these diffraction images, produced by the same molecule but with different orientations, are then analyzed with computational algorithms to calculate a three-dimensional structural image of the sample molecule. The brightness, energy, and coherence of LCLS X-ray pulses could create images of single molecules at close to atomic resolution.

X-Ray Photon Correlation Spectroscopy Instrument

This X-Ray Photon Correlation Spectroscopy Instrument (XCS) station is designed to conduct correlation spectroscopy using coherent hard X-rays. In this setup, an X-ray pulse is directed onto a sample depositing a precisely known amount of energy and creating a scattered intensity pattern characteristic of the location of scattering centers within the sample. After an experimentally controlled time delay, a second X-ray pulse re-interrogates the 'excited' sample, creating a second scattered intensity pattern. The difference in the two scattered intensity patterns is telling of time

scales of motions within the sample. The two intensity patterns are compared quantitatively by calculating the degree of correlation (e.g., the contrast in intensity in each detector pixel, for long time delays that are greater than the detector resolution time; for times shorter than this, each detector pixel collects an intensity sum that can be compared to the single shot intensity pattern). These intensity correlations are measured as a function of the time delay in order to map characteristic time scales at which disorder occurs in the sample. Using the short, intense, and coherent LCLS X-ray pulses, X-ray correlation spectroscopy can be applied to several scientific problems, and in particular can probe condensed matter sample dynamics in regimes of imparted energy and momentum transfer that other experimental techniques cannot attain.

All of these experiments require X-ray optics to guide the beam, X-ray beam diagnostics to measure beam properties, control systems, two-dimensional pixilated highly specialized detectors with fast read-out capability, a data acquisition architecture that includes fast signal processing algorithms, and significant ‘local’ data storage and handling requirements. Therefore, these technical features are also part of the project scope. Note: the LUSI project will create the ability to sample and store diagnostic data collected on pulse-by-pulse X-ray beam properties (e.g., wavefront and intensity profiles), but software development for reconstruction of shot-by-shot beam characteristics, and the use of this information in experimental data analysis, are outside the LUSI project scope.

The LUSI is a Major Item of Equipment (MIE) project of the U.S. Department of Energy (DOE) Office of Science (SC). The Project Execution Plan (PEP) shows each instrument to be a deliverable that is organized and managed as a separate element of the project’s Work Breakdown Structure (WBS). The PEP shows the project’s \$60 million Total Project Cost (TPC), in as-spent dollars, through FY 2012. Technical staff at SLAC conduct extensive design work in consultation with members of the scientific user community for each instrument. To this end, each Instrument Scientist has an advisory “Instrument Team” composed of active researchers outside the project, and the Instrument Team Leader approves the Physics Requirement Document (PRD) that captures the technical requirements of the instrument to be built. The Instrument Scientist, Lead Engineer, Design Engineers, and other SLAC staff plan to finish the engineering design by tapping relevant technical expertise elsewhere as needed. The SLAC staff will procure individual components and subsystems that will be assembled into complete instrument stations in the hutches of the Near and Far Experimental Halls (buildings that are nearing completion as part of LCLS construction).

1.2 Charge to the DOE Review Committee

In a March 3, 2009 memorandum (see Appendix A), Dr. Harriet Kung, then the Associate Director of the Office of Science for the Office of Basic Energy Sciences, requested that Daniel

R. Lehman, Director of the Office of Project Assessment (OPA), organize and conduct a review to assess several aspects of the LUSI project—including technical, cost, schedule, management, and environment, safety, and health (ES&H) issues.

1.3 Membership of the Committee

The OPA formed a Committee composed of members (see Appendix B) selected based on their independence from the project, as well as for their technical and management expertise, and experience with building large, complex, and highly specialized scientific instruments. Daniel Lehman, Director OPA, chaired the Committee.

1.4 The Review Process

The LUSI team provided project documents (e.g., the PEP, basis of cost estimates, PRDs, and preliminary design reviews of the three instruments) to the Committee as downloadable read-aheads prior to the review. The review was conducted at SLAC in Menlo Park, CA, during April 20-22, 2009. Representatives from SLAC, the DOE/SLAC Site Office (SSO), DOE/SC, and the DOE/OPA jointly developed the meeting agenda (see Appendix C). The Review process began with the ‘Plenary’ Talks addressing the major topics at high level followed by more detailed and specific ‘Break-Out sessions’ conducted in parallel.

The first day of the review consisted of presentations given by SLAC staff and discussions to address detailed questions from the Committee. The LCLS and LUSI project managers and other principals overviewed LUSI information and the context offered by LCLS. Each LUSI instrument scientist then presented more detailed material on each subproject instrument, including its major components, specific plans, schedules, and cost estimates, in order to status the design work to date for that instrument. In the late afternoon, the Committee toured the LCLS facility including the Near Experimental Hall (experimental Hutches 1-3), the X-ray Transport Tunnel, and the Far Experimental Hall (experimental Hutches 4-6). Breakout sessions began in the afternoon of the first day to discuss various follow-up questions and issues of interest to the Committee. The late afternoon of the second day and the morning of the third day were devoted to Committee deliberations, report writing, and drafting a closeout report. Preliminary results were discussed with LUSI and LCLS staff at a closeout session on the third day of the review.

2. TECHNICAL SYSTEMS EVALUATIONS

2.1 X-ray Pump Probe Diffraction Instrument (WBS 1.2)

2.1.1 Findings

The XPP Instrument Scientist and Engineer made very clear presentations of project organization, plans, and present status. The technical scope of the XPP project is consistent with the budget and schedule as dictated by CD-3 and CD-4 milestones (see Table 2-1 below). The CD-4 baseline date remains August 2012, and there is considerable schedule contingency in the schedule to meet this. Importantly, the XPP project is being effectively managed to meet an accelerated schedule to provide for early science in July 2010, while mitigating risk.

Table 2-1. XPP WBS Scope

WBS 1.2.1	XPP System Integration and Design
WBS 1.2.2	XPP X-ray Optics and Diagnostics Support Tables
WBS 1.2.3	XPP Ultrafast Laser System
WBS 1.2.4	XPP 2D Detector from BNL by MOU
WBS 1.2.5	XPP Sample Goniometer
WBS 1.2.5	XPP Detector Mover
WBS 1.2.6	XPP Hutch Facilities
WBS 1.2.7	XPP Vacuum System
WBS 1.2.8	XPP Installation

Other Related WBS

WBS 1.5	Diagnostics and Common Optics
WBS 1.6	Controls and Data Acquisition

Present “critical path” items for XPP are: 1) Sample Goniometer; 2) 2D Detector; 3) Common Optics and Diagnostics; and 4) Installation.

XPP has been through numerous recent reviews, including an August 2008 DOE/SC review, and most recently, in March 2009, a thorough Final Instrument Design Review (FIDR), which resulted in a recommendation for some advanced procurement approval. While the Laser Amplifier and Optical Parametric Amplifier (OPA) were recommended for procurement

approval for “early science” by the FIDR Review Committee, DOE authorization for this advanced procurement was not received.

Timely procurement is becoming a significant issue for the XPP project, with numerous procurements either in the system, or anticipated in the next few months. The procurement problem appears to be more than just a lack of manpower. The procurement system appears to be quite cumbersome and inefficient—requiring substantial attention from the Instrument Scientist and Engineer to insure that requisitions make their way through the system. This is likely to be further complicated with Recovery Act funding with additional rules/restrictions that are poorly determined.

2.1.2 Comments

The overall project is in very good shape, and both the Instrument Scientist and Engineer should be commended for their strong performance in organizing and leading this project. At this stage, the project is essentially CD-3 ready. However, it should be noted that XPP is not limited by CD-3 as it is very effectively using ‘advanced procurement’ approval and is targeting a much more ambitious goal of providing for early science in July 2010. The Committee was very encouraged by this.

The LUSI project has ample contingency for this stage of the project. Moreover, the elimination of funding-profile constraints with the availability of ARRA funds may provide for additional cost savings. The Committee strongly supports the ongoing efforts to establish priorities for restoring scope that had previously been eliminated from the project. In particular, we strongly support restoring the large-offset monochromator and agree that this should be the highest priority for XPP scope restoration.

An important component of the XPP instrument is the 2D detector being developed by Brookhaven National Laboratory (BNL) and managed as part of XPP (WBS 1.2.4) by the LCLS/LUSI detector Control Account Managers (CAM), and supported by the LCLS Detector Advisory Committee (LDAC). Given the R&D associated with this detector, the contingency appears to be too low. A convincing justification for the present contingency level was not provided.

The omission of the Laser Amplifier and OPA in the DOE letter authorizing advanced approval may be a result of miscommunication or misunderstanding of the recommendation from the FIDR Committee in March 2009.

Effective back-up plans for the Sample Goniometer and 2D detector have been developed in the event that these items are delayed. This largely mitigates the risk of these two items on the critical path. The Committee encourages the XPP team to communicate these back-up plans to the user community and to future review committees. Common Optics and Diagnostics and Installation thus become more important in determining the critical path for “early science” in July 2010.

The Committee strongly supports the accommodation of other sample environments (particularly vacuum chamber and cryostat) and encouraged the XPP team to consider providing these as funds permit, and to communicate the options for other sample environments to the user community. A similar suggestion was made in the August 2008 DOE/SC review. This appears to provide a significant enhancement of scientific capability at relatively modest cost compared to the investment in a sample environment based solely on the goniometer.

As noted in the August 2008 DOE/SC Review, integration of the Scientific Team Leaders is critical to LUSI/LCLS success. There is evidence of progress in improving this integration through meetings between Instrument Scientists, Engineers, and Scientific Team Leaders. The Committee strongly encouraged these efforts and advised a continued focus on this issue.

2.1.3 Recommendations

1. Secure DOE procurement approval for both the Laser Amplifier and the OPA, or determine the remaining requirements must be met to secure approval by May 2009.
2. Re-evaluate the contingency on the 2D detector being developed at BNL or provide better a better justification for the present contingency level by June 2009.
3. Develop an installation schedule (e.g., for equipment, cabling, vacuum components, utilities, etc.) to avoid any delay in the delivery of ‘early science’ by June 2009.
4. Develop a plan for testing and commissioning of the XPP instrument (even without X-ray beam) in order to meet ‘early science’ goals October 2009.
5. Secure ES&H approval *in advance* for XPP components that present a novel hazard, particularly the detector robot and the optical parametric amplifier. This is essential for timely acceptance testing and operation once these instruments are delivered (prior to payment of invoice) and to avoid any delay in the delivery of ‘early science’ by October 2009.

6. Implement other sample environments (e.g., vacuum chamber, cryo) that are cost-effective as soon as funding permits by October 2009.

2.2 Coherent X-ray Imaging Instrument (WBS 1.3)

2.2.1 Findings

The overall prospects for new science results are very exciting. The plans and preparations for the CXI instrument appear to be in good shape.

Several vendors responded to the requests for proposals for the KB mirrors and for the mirror manipulators for both 1 micron and 0.1 micron mirror systems.

Plans for the detector development in conjunction with Cornell appear to be adequate.

The collaboration with FLASH has been very helpful.

2.2.2 Comments

The CXI particle injector is very far from optimum. R&D could be facilitated by adding staff to a laboratory for an “injector” specialist now at PULSE. This may possibly be facilitated in Human Resources.

Science users will be implementing algorithms to invert to real space, and an additional scientist on the CXI team that can concentrate on implementing algorithms should improve early and full productivity for the exciting CXI instrument.

There is very long lead time for the mirrors, and there is not a good reason to delay procurement of either the 1 micron or the 0.1 micron KB mirror pairs. A vendor has been selected for 1 micron mirror manipulator, vacuum system, and stand. Vendor selection on the corresponding 0.1 micron system has not been made. A successful speed-up in schedule for 0.1 micron system necessarily entails an additional mechanical designer.

Contingency looks reasonable even if a damaged mirror needs to be replaced.

An Memorandum of Understanding (MOU) between SLAC and Lawrence Livermore National Laboratory (LLNL) is planned for mirror metrology (including test coupons) and coatings.

2.2.3 Recommendations

1. Procure mirrors for 0.1 micron KB system.
2. Have manipulator and vacuum system for 0.1 micron system evaluated by several experts as soon as possible.
3. An additional mechanical designer should be added to implement both KB systems.
4. Expedite the SLAC/LLNL MOU for metrology and coating.
5. Facilitate R&D on the particle injector.
6. Improve coupling to the science users on software with an additional CXI X-ray scientist.

2.3 X-ray Photon Correlation Spectroscopy Instrument (WBS 1.4)

2.3.1 Findings

Due to the outstanding efforts of the beamline personnel, substantial progress has been made on the XCS beamline so that XCS is nearly CD-3 ready.

The confluence of 1) achieving laser action at 8 keV by LCLS; 2) ARRA funding, permitting schedule acceleration for XCS; 3) the success of the DESY-designed, split-and-delay (S&D) unit; and 4) the mature design of XCS has created an extraordinary opportunity to carry out innovative hard X-ray science several months ahead of schedule.

One of the critical components of XCS is the S&D system, which is the subject of a recently-signed MOU with DESY. The DESY S&D unit is built and successfully tested and, according to the MOU, will be at SLAC for an initial period of three years, starting in summer 2009 or when agreed. DESY will provide a scientist to be on-site at SLAC and work with the S&D unit. The DESY S&D unit operates at a single energy. After three years, there is the possibility/likelihood that the S&D unit MOU may be renewed.

Another critical aspect of XCS is the XCS detector, which is to be designed and built by BNL. The design process at BNL was recently initiated. The XCS detector is subject to detailed

LDAC review twice per year. At the current early stage of design, a detector with 56 micron pixels is deemed feasible/optimal. By contrast, a detector with 35 micron pixels was the original specification. The possible change from 35 microns to 56 microns is expected to reduce the XCS contrast by a factor 2.5, but will NOT adversely affect the XCS signal-to-noise ratio.

A tremendous increase in scientific productivity is possible by, instead of a detector employing 1 chip, employing a detector or detectors that deploy 10 or 100 chips.

Software to permit data reduction to intensity autocorrelation functions in near-real time is planned to be provided by LUSI to general users.

The XCS detector will not be ready in time for XCS commissioning.

Community involvement via XCS Team Leaders has improved and is proving valuable for XCS staff.

A successful scientific workshop on XCS science was held at SLAC last fall.

Currently, there is a single scientist pursuing XCS research at LCLS/LUSI and across the Stanford campus. A second XCS scientist position has been advertized.

Design risk for the remaining well-understood XCS components (slits, focusing lenses, etc.). All indications are that the performance of these components determined elsewhere will be satisfactory for XCS at LCLS.

There seems to be an unusually protracted procurement process at LUSI/SLAC. Future procurement delays and delays caused by duplicative reviews of low-risk items (post-monochromator from APS, diagnostics, etc. from XPP) are the principle risks associated with the XCS schedule.

2.3.2 Comments

The potential now exists at XCS to transform the paradigm of X-ray correlation spectroscopy and also very high-resolution inelastic X-ray scattering, conceived in the time domain, but there is a need to move in a timely fashion.

Coherence preservation by the S&D system has been shown experimentally to be satisfactory. This device at LCLS running at 8 keV will be transformative for XCS and sub-meV inelastic X-ray scattering in the time domain. A manuscript describing the S&D system and its characterization for XCS experiments is submitted for publication. The S&D technology is on-track. However, development of local (LUSI/LCLS) expertise in a S&D system should be a high priority for LCLS.

The Committee concurred that a detector with pixels of 56 microns is acceptable, and overall the optimum compromise among pixel size, performance, and delivery date should be reached, with delivery date a key consideration.

Multiplying the number of pixels used for data acquisition will permit previous LCLS data to be acquired 10 or 100 times faster, with an enormous savings in time and increase in productivity of XCS. The incremental cost of additional chips/detectors, once the first has been built is likely modest. The Committee also noted that gaps in continuous coverage of reciprocal space are perfectly acceptable in XCS experiments.

Because the XCS detector will not yet be completed at the time that XCS starts commissioning, the XCS team proposes to acquire an additional XPP detector for initial commissioning. Then, once the XCS detector is delivered, this XPP detector will be transferred to XPP. The XCS detector will not be available until the end of FY 2011, so this proposal is a win-win for XCS and XPP, which desires a second detector.

Appropriate data reduction is extremely important for creating a user-friendly and therefore scientifically-productive facility. The Committee applauded plans to provide user-friendly XCS data reduction software.

Opening a second beamline scientist position is important and laudable. Nevertheless, the Committee judged that the level of scientific commitment to hard X-ray correlation spectroscopy from the laboratory/LCLS/LUSI should be further strengthened.

2.3.3 Recommendations

1. Plan to design a LUSI S&D system incorporating the possibility of tuning the energy, and avoiding attenuation in air.
2. Evaluate the level of environmental control needed for S&D to maximize stability.

3. Construct and deploy an XCS detector with 56 micron or smaller pixels as soon as possible.
4. Plan to deploy multiple XCS detectors at XCS simultaneously (i.e., an effectively tiled detector) in order to correspondingly multiply the data acquisition rate.
5. Follow the strategy proposed above in order to expedite early XCS commissioning using a second XPP detector.
6. Ensure that the planned user software is indeed available as soon as it is needed.
7. SLAC, LCLS, and LUSI management should do their utmost to exploit the tremendous opportunity for XCS that now presents itself.
8. SLAC, LCLS, and LUSI management should initiate early planning for how to accommodate operations and General Users at XCS.
9. Broaden further community participation and awareness of LUSI XCS (including to the inelastic X-ray scattering community).
10. Increase outreach via further workshops, seminar series, etc.
11. Laboratory management should augment the experimental facilities scientific leadership within LUSI/LCLS and across the Stanford Campus.
12. Laboratory management should strength its scientific commitment to hard X-ray correlation spectroscopy.
13. LUSI management should expedite the procurement cycle and manage the review process.
14. LUSI management should exploit any procurement efficiencies (and savings) that may be possible by placing combined orders for items common to more than one beamline (e.g., refractive optics).
15. Proceed to CD-3 as soon as possible, pending successful completion of final instrument design review.

2.4 Diagnostics and Common Optics (WBS 1.5)

2.4.1 Findings

The X-ray pulses from the LCLS FEL exhibit intrinsic fluctuations. Diagnostic beamline components are required to capture the transverse intensity profile, determine the incident beam intensity distribution, beam position, and pointing changes, to aid in the alignment of X-ray optics, function as beam diagnostic devices and are required to obtain quantitative measurement of the beam for wavefront determination. Common optical components are required for beam size definition, attenuation, pulse selection, reduction in harmonic content, beam focusing, and monochromatization. The LUSI staff made excellent progress in the design, review and procurement of Diagnostics and Common Optics (DCO) components in a very short time. With the exception of the Large-Offset Monochromator, and Harmonic Rejection Mirrors all components have reached the final design review stage of development and are ready for procurement. Reviews of the monochromator and mirror system are scheduled for the near future.

2.4.2 Comments

The Committee judged that the final designs for all of the diagnostic components are technically sound and meets the requirements for the accurate beam delivery and monitoring for the LUSI experimental stations. The cost, schedule, and contingency for these components are reasonable with the accelerated procurement schedule presented provides delivery with adequate time for testing and assembly.

The design presented for the harmonic rejection mirrors is less mature. The concepts for manipulation of two flat mirrors to provide three modes of beam transport are undeveloped and need careful value engineering (see recommendations). Care has to be taken with the technical specifications for the surface roughness and the slope errors for the mirrors since over-specification can lead to greatly increased costs and long delivery times, while under-specification could affect performance. Given the level of design at this time, the amount of contingency allocated is reasonable.

Although the management of the Large-Offset Monochromator was moved to the XCS team, costs for this component are still accounted as part of DCO. Details of the physics requirements, engineering specifications, and schedule were not presented to the Committee. The funding allocated for this component appears to be reasonable compared to a similar monochromator to be deployed at the Advanced Photon Source. The delivery date of August 9,

/2010 (found in the XCS documentation) is reasonable given the design review schedule for the monochromator but will require expedited engineering and procurement to remain achievable. Details such as crystal motions selected, energy ranges, choice of monochromator, crystals and crystal cut are critical for device performance and should be available to future reviewers.

2.4.3 Recommendations

1. Mirror procurements have long lead times: early specification and procurement of DCO mirrors is recommended.
2. The accelerated procurement schedule for DCO components puts nearly all procurements into the late 2009—early 2010 time window. Vendor selection should be carefully examined so that timely delivery for early science is assured.
3. The use of a rotation for the second mirror in the Harmonic Rejection mirror system is a complicated engineering solution. Replacement of this motion with a third mirror and translation system is recommended.
4. The CDO is ready for CD-3.

2.5 Controls/Data Acquisition System (WBS 1.6)

2.5.1 Findings

The controls and data acquisition (DAQ) system (WBS 1.6) covers the Controls for the LUSI instruments CXI, XPP, XCS and DCO. The Controls group made a comprehensive presentation about the LUSI Controls/DAQ needs.

The LUSI controls are modeled after the LCLS controls and are Experimental Physics and Industrial Control System (EPICS) based. Widgets and utilities developed for LCLS will be used in LUSI. The hardware for the LUSI instruments will be standardized and use similar or same as the LCLS Atomic, Molecular, and Optics (AMO); Soft X-ray Science (SXR); and the Fusion End Station (FES) equipments.

The Controls/DAQ systems group has been meeting on a regular basis with the LUSI instrument teams to coordinate the designs. The controls and DAQ team developed all the Engineering Specification Documents (ESD) based on the Physics Requirement documents that

were generated by various LUSI instrument teams. In addition the Interface Control Documents (ICD) have also been completed. Most of the ESDs and ICDs have already been released.

The Controls and DAQ design team has extensive experience in handling large volume of data at a fast rate. The project team's experience in handling High Energy Physics experimental data will be very beneficial for LUSI. The DAQ systems for the LUSI detectors are also well developed. The devices are scalable with the detector developments.

The Controls/DAQ system is making good progress to proceed to CD-3.

2.5.2 Comments

The Controls/DAQ system have been making steady progress and are at the right stage in the LUSI project timeline.

The Controls group has the expertise in handling the massive data challenge from the LUSI experiments.

The LUSI Controls staff has to interface to different 2D detectors being developed and procured from Cornell and BNL. The Controls staff has generated a common DAQ interface and has made excellent progress in testing and integrating into the EPICS controls.

The Controls group and the various instrument teams are working very closely together. The combination of the professionalism of the Controls group and their experience handling data for high energy physics, together with the very well defined project focus of the various instrument teams will lead to efficient implementation of the systems required for operation of the LUSI instrumentation as it is currently defined.

The LUSI project has received the rest of the funding to complete the project under the Recovery Act. This will help the project to achieve early science prior to the original CD-4 timeline of August 2012. The acceleration of the project will impose additional pressure on the Controls group. The Controls group is ready to handle the increased demand for both staffing as well as speeding up the procurements of hardware.

2.5.3 Recommendation

1. The Controls/DAQ staff should now begin to work with typical synchrotron users. The efficient implementation of the systems required for initial operation of the LUSI instrumentation seems assured, LUSI systems should also provide flexible interfacing for special equipment brought later by general users. Interacting now with experiment groups from the synchrotron community will help the Controls staff to plan for the needs of LUSI users in the future. Typical LUSI user needs may be rather different from that of High Energy Physics experimenters.

3. ENVIRONMENT, SAFETY and HEALTH

3.1 Findings

The LUSI Project ES&H staff are experienced and capable. LCLS/LUSI ES&H staff performed several benchmarking visits with other DOE accelerator facilities, that have been very helpful for the staff in broadening awareness of other operations and best practices. In addition, the ES&H staff have fostered a strong interface with the LCLS project.

All required documents are in place or properly planned, with an updated LUSI Hazards Analysis Report (HAR) and DOE approval of CD-2. This update did not impact the LCLS Safety Analysis Document. The LUSI HAR appears to be ready and supportive of the project being ready for CD-3.

Safety performance on the LUSI project has achieved approximately 72,000 hours worked without an incident.

All recommendations from prior review have been addressed. Relative to ES&H, the project utilizes a sound approach and is performing well.

3.2 Comments

Construction support for LUSI end stations and hutches has been appropriately considered. Flow-down of ES&H requirements is addressed, with the process for selection of sub-contractors benefiting from other LCLS project lessons learned.

System and process interfaces with LCLS (e.g., PPS, laser interlocks) are appropriately planned. During the tour of the experiment hall the infrastructure for these systems was addressed and plans for integration into the experimental equipment operation was discussed.

ES&H staffing support, other than the ES&H Coordinator for the project, as per agreements with SLAC, are overhead-funded support. ES&H management support is accounted for in LUSI WBS 1.1.1.

A LCLS Experimental Safety Review Process that will cover LUSI experimental equipment is in development, with planning for integration of safety into design and operations

of proposed experiments being considered and addressed during this process. The format for this process was a direct outcome of benchmarking activities.

3.3 Recommendation

1. The LUSI project ES&H support should maintain a strong interface within and external to the project, supporting timely achievement of project milestones and deliverables. An example of this interface would be with SLAC safety committees (i.e., the Hazardous Experiment Equipment review committee) that will review and provide recommendations on LUSI equipment and experimental apparatus. These committees need to provide timely and actionable feedback that supports the LUSI project baseline, and appropriate support to issue resolution for any items identified during these reviews that could negatively impact the project or its milestones.

4. COST and SCHEDULE

4.1 Findings

The LUSI Mission Need Statement/CD-0 was approved in August 2005. The project's technical goal, as stated in the Mission Need, was to augment the LCLS construction project with a suite of four X-ray instruments, to be built over a period of six fiscal years. At CD-0 the preliminary range for the Total Project Cost (TPC) was set at \$50-60 million, and CD-4, Approve Start of Operations, was planned to be phased from 2010-2012.

The initial cost estimate provided by the project for this scope in August 2006 significantly exceeded the cost range set at CD-0. As a result, at the January 2007 DOE/SC review, the project proposed a revised scope that would meet the CD-0 cost range target, but only deliver two instruments (the XPP and CXI) and beam delivery for the other two instruments (the XCS and Soft X-ray Scattering). The details for a \$60 million maximum cost were presented with a proposed Total Estimated Cost (TEC) of \$43.0 million, \$3.6 million of Other Project Cost (OPC), and a contingency of \$13.4 million (31.2 percent on TEC and 28.8 percent on TPC). Escalation rates were based on the published DOE rates. Numerous recommendations were made by the review committee and documented in that report.

In March 2007, as directed by DOE/BES, another plan was put forth that committed LUSI to produce science when LCLS becomes operational and included three instruments with priority given to CXI. In July 2007, the project proposed a CD-1 scope that consisted of a TEC of \$55.10 million (including a contingency of \$13.18 million). The OPC of \$4.9 million resulted in a TPC of \$60.0 million. CD-1 was approved by DOE in September 2007.

In the August 2008, CD-2 Independent Project Review the project presented technical, cost and schedule details as part of their application for a CD-2, Approve Performance Baseline. The project team presented a project scope that will deliver three instruments (the XPP, CXI and XCS). Two of these instruments (XPP and CXI) were scheduled to be ready to produce science when the LCLS is operational in 2010. The XCS followed a later schedule due to a constrained funding profile. The TEC of \$55.1 million included a contingency of \$12.98 million. The OPC of \$4.9 million is then added to result in a TPC of \$60.0 million. Project completion was defined as August 2012.

A change in project funding, including the receipt of \$33.6 million in Recovery Act funding, preceded this review. The Recovery Act funding, along with receipt of the FY 2009

funding of \$15 million, will result in a fully funded project this fiscal year. A plan to integrate Recovery Act funding into the project has been developed including provision for separate reporting on the use of these funds. The TEC overall completion is currently 16 percent and TPC overall completion is 24 percent. The project cost contingency is \$12.73 million, which is 34 percent of the Estimate to Complete.

The accelerated funding profile has removed the project funding schedule constraints. A proposed revision to the baseline schedule has been prepared that reflects changes due to Recovery Act funding. This schedule shows the Final Instrument Readiness Review approximately three months earlier than the current baseline, but retains the current CD-4 date of August 2012. The project has a resource loaded P3 schedule with milestones indicated. The schedule consists of over 4,100 tasks with 5,900 relationships. The proposed revision to the schedule increases the schedule contingency to CD-4 from approximately 100 days in the baseline schedule to approximately 160 days. Cobra software is being used as the cost processor to support earned value management reporting, the project currently has a Cost Performance Index of 1.03 and a Schedule Performance Index of .98.

4.2 Comments

The LUSI project plan assumed a Continuing Resolution in FY2009 through March, therefore, this incremental receipt of funding has not had a significant impact on the project schedule. The project team quickly responded to the revised funding plan, which moves FY 2010, FY 2011 and FY 2012 funding into this fiscal year. A proposed revision to the baseline schedule has been prepared by removing the funding constraints, thereby moving schedule activities forward. The Committee examined this schedule and it appears overall to be a reasonable schedule. One area of concern is the time allowed for SLAC approval and DOE approval for procurements. The schedule includes one week for SLAC approval and one week for DOE approval on all procurements. This may be inadequate due to the large volume of procurements that need to be placed and the additional time that may be necessary for review of foreign procurements and the Recovery Act funded procurements. The Committee judged that this schedule should be submitted through the baseline change process and adopted as the new performance baseline. This change would be best accomplished as soon as possible to maintain accurate project reporting and to avoid unnecessary variances.

The project team used approvals for early procurement effectively to order the XPP Goniometer in March and XPP Robot in April. Timely placement of procurements for additional equipment is critical to the success of the project; however, the project team is currently limited

to ordering items that were specified in the early procurement approvals. Approval of CD-3 would allow the team to move forward with all procurements, but the baseline schedule has CD-3 review in April 2010 and the proposed revised schedule calls for CD-3 in October 2009. Since this approval is currently several months away, the project team should consider requesting approval for early procurement of additional items to allow the work to proceed in a timely manner. Equipment and material procurements are the critical work activity needed to allow work to proceed on schedule. Additional early procurement approval would allow for early completion of work activities, take advantage of the current favorable market conditions, and avoid a spike in procurement requests following approval of CD-3.

The level of detail and basis behind the cost estimate are very good. The cost estimate is well detailed to WBS Levels 4 or 5 with Project Engineering Design funds, construction labor, and material costs shown for all items. Appropriate burdens have been applied and are shown in the estimate at the task level and quotes have been obtained for procurements.

The project contingency has been calculated at each task level of the cost estimate by using the risk registry. Risks are well defined using technical, cost, and schedule categories. Risks have been appropriately weighted based on design or manufacturing requirements, material and labor cost certainty, and schedule impact. The overall project contingency of \$12.73 million is approximately 34 percent of the estimate to complete, which is more than adequate for this stage of the project. The project team identified potential scope contingency items (including a large offset monochromator and the 0.1 micron KB mirror system) that should be considered in planning for contingency use.

The project team satisfactorily responded to the cost and schedule comments from the August 2008 DOE/SC review—there were no recommendations needing response. The project team is effectively managing the project budget, schedule, and project risks.

4.3 Recommendations

1. A baseline change to establish the Recovery Act schedule as the new schedule performance baseline should be submitted by the end of May.
2. Maintain the current CD-4 date of August 2012. The project should be managed to the Level 2 early finish milestones for instrument readiness reviews.

3. Ensure adequate schedule time is provided for SLAC and DOE approvals on procurements, especially those over \$500K.
4. The project team should consider requesting early procurement approval for additional schedule critical items.
5. The project cost contingency appears more than adequate for this stage of the project. Continue to update the contingency to reflect project risks and perform additional planning for contingency use.

5. PROJECT MANAGEMENT (WBS 1.1)

The LCLS very recently achieved X-ray lasing and has in place a substantial backlog of proposals to use the experimental stations constructed as part of the facility. The LUSI project is poised to significantly expand the scientific capability of the facility by providing three additional experimental end stations. It has been structured to allow staged execution of the instruments, making some available for “early science” before the full instrument capability has been installed. The LUSI project is slated to receive the balance of its baseline funding under the Recovery Act, removing available budget authority as a constraint on the project. The project decided to use this funding to enhance the early science capability where practical, while holding to the baseline CD-4 completion date. It is notable that this review was dominated by understanding the issues associated with utilizing the Recovery Act funding, rather than the maturity of the designs or the ability of the project to execute and manage them under normal boundary conditions.

5.1 Findings

The Committee was impressed with the project’s state of technical readiness and the maturity of the suite of management tools in use. The project was responsive to previous review recommendations and has in place most of the staff it requires to complete the project. The few remaining openings are in areas for which is reasonable to expect that capable people can be found and hired. The project has a risk registry in place and a prioritized contingency draw-down list has been prepared that includes decision dates for exercising scope additions.

The CD-3 date in the current baseline is planned for April 2010. Using Recovery Act funding to add engineering and designer support, the project plans to seek CD-3 approval in October 2009, thereby accelerating this milestone by six months.

With the receipt of Recovery Act funding, the project will be fully funded in 2009. This event retires a previously identified risk arising from limited funding for several years and the possibility of continuing resolutions. The project has been actively developing a revised schedule that would use these funds to advance (or create) early science milestones for the LUSI instruments while maintaining the baseline CD-4 date (August 2012). An additional benefit identified by the project of the availability of these funds is a potential increase in ‘buying power’ of \$1.4 million due to reduced escalation costs as compared to the baseline spending profile.

Early procurements have been authorized for the XPP instrument, which are currently getting underway in earnest. The project showed a procurement plan that would expend roughly

\$730K between April and June of 2009. Among the 49 planned procurement actions three are foreign procurements worth approximately \$380K, with 46 procurement actions accounting for approximately \$350K that would be readily eligible for Recovery Act funding. Among these only one procurement is above \$25K.

The provision of full budget authority for the balance of the project through Recovery Act funding removes any limitations on the quantity of procurement actions due to limited funds. However, this will result in a potentially large number of procurement actions being released in near proximity of time. The project is working with the SLAC procurement division to address this possibility. The procurement division has requisitioned for and obtained additional personnel to handle the workload from this and other Recovery Act funded efforts at SLAC. In addition, the SLAC site office is working on preparing for a significant number of actions requiring approval and/or other added requirements specific to Recovery Act funded work.

5.2 Comments

The Committee judged that mature project management systems and tools are in place that are being actively utilized to inform the decision-making process within the project. Judging from the status reporting and discussions with the technical subcommittees the technical work of the LUSI project is generally on track. There was some level of concern expressed regarding the rigor of technical review required for apparently modest technical changes. The project should consider its “settings” for the graded approach to design reviews to ensure that important changes have adequate scrutiny yet not create an impediment to progress by requiring exhaustive reviews for changes that are modest, or not strongly coupled to other technical systems.

To achieve the projected early CD-3 approval, the project needs to revise the baseline schedule factoring in early experience on the Recovery Act procurement preparation and approval process durations that will be acquired through LUSI and other SLAC procurements in April and May 2009 and immediately add planned engineering support resources to achieve the required design maturity.

It was not apparently clear that all partners in the process (LUSI/SLAC/DOE) are adequately poised to execute the upcoming procurement actions. There is an effort in progress to determine the quantity and timing of actions, as well as clarify the added Recovery Act requirements. Completion of this effort and communication of the requirements to both SLAC procurement division and the site office should help prepare for planning the workload. The site office workload will likely increase without the ability to acquire additional personnel.

5.3 Recommendations

1. Identify, introduce, and manage the risks associated with Recovery Act into the risk registry by the mid-May 2009.
2. Establish a realistic date for CD-3 review by the end of May 2009.

Intentionally Blank

APPENDIX A

CHARGE MEMORANDUM

United States Government

Department of Energy

memorandum

DATE: March 3, 2009

REPLY TO

ATTN OF: Office of Basic Energy Sciences, SC-22

SUBJECT:

DOE REVIEW OF THE LINAC COHERENT LIGHT SOURCE (LCLS) ULTRAFAST SCIENCE INSTRUMENTS (LUSI) PROJECT

TO:

Daniel R. Lehman, Director, SC-28

This memorandum slightly revises the content of the previous request for this review that was dated February 10, 2009. I request that your office organize and conduct an Office of Science (SC) status review of the LUSI Major Item of Equipment (MIE) project at the Stanford Linear Accelerator Center (SLAC) National Accelerator Laboratory in Menlo Park, California, during April 20-22, 2009. The purpose of this review is to evaluate the project's status in all aspects - technical, cost, schedule, management, and environment, safety and health (ES&H).

The LUSI project expands upon the initial scientific capability of the LCLS by building three instruments that will use the LCLS X-ray beam for research. The LUSI instruments are the X-ray Pump Probe Diffraction (XPP), Coherent X-Ray Imaging (CXI), and X-Ray Photon Correlation Spectroscopy (XCS) stations whose capabilities, technical performance parameters, and fuller descriptions are contained in project documents to be available prior to the review.

The project achieved its Critical Decision-2 (CD-2) milestone, Approve Performance Baseline, on October 22, 2008. The milestones represented in the Project Execution Plan (PEP) show the LUSI instruments to be designed and built in a phased approach, with completion of some capability for early science in Fiscal Year (FY) 2011, and all instruments completed by FY 2012. The project has a Total Project Cost of \$60 million projected through FY 2012. The most recent SC review of this project was an Independent Project Review on August 19-21, 2008.

The LUSI project has been the recipient of funds from the American Recovery and Reinvestment Act of 2009. These funds provide sufficient funding to fully complete the LUSI project and should allow the project team to accelerator much of the design, procurement, and integrated assembly activities.

In carrying out its charge, the committee is requested to consider the following questions:

1. Technical Scope: Are accomplishments to date and planned future activities adequate to meet baseline objectives? Is it reasonably likely that the instruments will meet the CD-4 criteria (e.g., Key Performance Parameters and required hardware) that are specified in the PEP? Have appropriate plans been made for each instrument's procurements, integrated assembly, and transition to operations?

2. Project Management: Is the LUSI project being properly managed for its successful execution? Is the management approach, including interactions among the project team, Instrument Team members, and other stakeholders, effective? Are issues identified and resolved in a timely manner? Are there opportunities for improvement?
3. Resources and Risks: Are adequate resources being applied to effectively execute the remaining LUSI project scope? Have the most major risks been identified and addressed? How well are remaining risks and uncertainties being managed? Is the contingency (cost and schedule) being managed well to address the remaining risks? Have the American Recovery and Reinvestment Act funds been properly integrated into the project and schedule baselines?
4. ES&H: Are ES&H aspects being properly addressed? Are Integrated Safety Management Principles being followed?
5. Prior Reviews: Has the project responded appropriately to previous reviews?

Thomas E. Kiess, the LUSI Program Manager, will serve as the Basic Energy Sciences point of contact for this review. I would appreciate receiving your committee's report within 60 days of the review's conclusion.

// signature//
 Harriet Kung
 Associate Director of Science
 for the Office of Basic Energy Sciences

cc:

P. Golan, SSO
 H. Lee, SSO
 H. Joma, SSO
 D. Knutson, SLAC
 J. Galayda, SLAC
 P. Montano, DOE/SC-22.3
 T. Kiess, DOE/SC-22.3
 T. Brown, DOE/SC-22.3
 L. Cerrone, DOE/SC-22.3
 R. Meneses, DOE/SC-22.3
 S. Tkaczyk, DOE/SC-28
 C. Clark, DOE/SC-28

APPENDIX B

REVIEW PARTICIPANTS

**Department of Energy Review of the
LCLS Ultrafast Science Instruments (LUSI) Project
April 20-22, 2009**

Daniel R. Lehman, DOE/SC, Chairperson

SC-1	SC-2	SC-3	SC-4
<u>XPP Instrument (WBS 1.2)</u>	<u>CXI Instrument (WBS 1.3)</u>	<u>Diagnostics & Common Optics (WBS 1.5)</u>	<u>Controls/Data Acquisition Systems (WBS 1.6)</u>
* Robert Schoenlein, LBNL Eckhart Foerster, U. of Jena	* Al Macrander, ANL Zenghu Chang, KSU	* Mark Beno, ANL Jorge Rocca, Colorado State Peter Takacs, BNL	* Mohan Ramanathan, ANL Deming Shu, ANL Tony Warwick, LBNL
SC-5	SC-6	SC-7	SC-8
<u>XPCS Instrument (WBS 1.4)</u>	<u>Cost and Schedule</u>	<u>Project Management</u>	<u>ES&H</u>
* Simon Mochrie, Yale Ali Khounsary, ANL	* Richard Stanton, LBNL Ray Won, DOE/SC	* Erik Johnson, BNL John Haines, ORNL Steve Tkaczyk, DOE/SC	* Hans Vogel, PPPL

<u>Observers</u>	
Pedro Montano, DOE/SC	Hannibal Joma, DOE/SSO
Thomas Brown, DOE/SC	Hanley Lee, DOE/SSO
Greg Pitonak, DOE/PSO	Brian Huizenga, OECM
Tony Guadagni, BNL	

LEGEND

* Chairperson

Count: 19 (excluding observers)

APPENDIX C

REVIEW AGENDA

**Department of Energy Review of the
LCLS Ultrafast Science Instruments (LUSI) Project**

AGENDA

Monday, April 20, 2009—Redwood Room, Building 48

10:00 am	Tour of LCLS (optional)	
1:00 pm	Executive Session and Start of Review	D. Lehman
1:30 pm	Welcome	P. Drell/D. Knutson
1:45 pm	LCLS Project Status Update and Charge to the Committee	J. Galayda
2:10 pm	LUSI Project Overview.....	T. Fornek
3:00 pm	LUSI Plans for ARRA Funds	T. Fornek
3:45 pm	Break	
4:00 pm	Subcommittee Breakout Sessions	
5:00 pm	Executive Session	
6:00 pm	Adjourn	

Tuesday, April 21, 2009

8:00 am	Diagnostics and Common Optics.....	Y. Feng
8:30 am	Controls and Data Systems	G. Haller
9:00 am	Detectors	N. van Bakel
9:30 am	ES&H.....	M. Scharfenstein
9:50 am	Break	
10:15 am	Subcommittee Breakout Sessions	
12:15 pm	Lunch	
1:15 pm	Subcommittee Breakout Sessions	
3:00 pm	Executive Session— Redwood A	

Wednesday, April 22, 2009

7:30 am	Executive Session Closeout Dry Run— Redwood A	
9:00 am	Closeout Briefing	
10:00 am	Adjourn	

APPENDIX D

COST TABLE

LUSI Cost Baseline

	Baseline Oct 2008	February 2009
Base Cost (BCWS)	\$42.10 M	\$42.37 M
Contingency	\$13.00 M	\$12.73 M
TEC	\$55.10 M	\$55.10 M
OPC	\$4.90 M	\$4.90 M
TPC	\$60.00 M	\$60.00 M

APPENDIX E

SCHEDULE CHART

LUSI Project Summary Schedule

MILESTONE DESCRIPTION	Baseline	Projected	Variance		CY 2008	CY 2009	CY 2010	CY 2011	CY 2012
LUSI - Project Management									
Level 1 DOE HQ Milestones									
CD-0 MISSION NEED APPROVAL	08/10/05A	08/10/05A	0 days	▼					
APPROVED: CD-1 COST RANGE	09/27/07A	09/27/07A	0 days						
APPROVED: CD-2 PERFORMANCE BASELINE	10/22/08A	10/22/08A	0 days		▼				
APPROVED: CD-3 FABRICATION START	4/12/10	10/12/09	120 days				▼	▼	
APPROVED: CD-4 START OF OPERATIONS	8/31/12	8/31/12	0 days						
Level 2 - DOE Local Milestones									
COMPLETE: CD-2 REQUIREMENTS - XPP / CXI / XCS	08/18/08A	08/18/08A	0 days		▼				
APPROVED: ADVANCE PROCUREMENT-XPP&CXI	01/30/09	12/19/08A	20 days (A)			▼			
APPROVED: FAB START - XPP	05/07/09	3/12/2009A	37 days (A)			▼	▼		
APPROVED: ADVANCE PROCUREMENT-XCS&DCO	08/03/09	06/03/09	40 days			▼	▼		
COMPLETE: CD-3 REQUIREMENTS	01/15/10	09/24/09	72 days			▼	▼		
COMPLETE: XPP PHASE 1 INSTL-START EARLY SCIENCE	10/20/10	10/20/10	0 days				▼		
COMPLETE: CXI PHASE 1 INSTL-START EARLY SCIENCE	08/05/11	08/05/11	0 days					▼	
APPROVED: FINAL INSTRUMENT READINESS REVIEW	07/06/12	07/06/12	0 days						▼

BASELINE - ▼
 PROJECTED (Early) - ▼
 PROJECTED (Late) - ▼
 ACTUAL - ▼

Early Dates Reflect ARRA
 Facilitated Schedule Advancement

APPENDIX F

MANAGEMENT TABLE

LUSI Integrated Project Team

