

Office of Project Assessment – Project Review Report

DOE Review of CD-3 for the LCLS Ultrafast Science Instruments (LUSI) Project

DATE: July 15, 2009
LOCATION: Rockville, Maryland
COMMITTEE: Committee (7); Observers (6)

1. SUMMARY

Based on the favorable assessments from the April 2009 DOE/SC review, a tailored DOE review of the LCLS Ultrafast Science Instruments (LUSI) project was conducted on July 15, 2009 to evaluate the project's readiness for Critical Decision (CD) 3, Approve Start of Fabrication. The project scope includes three fully operational instruments (XPP, CXI, and XCS), all the associated Diagnostics and Common Optics, and the required Controls and Data Acquisition systems. The LUSI project has been the recipient of funds from the 2009 American Recovery and Reinvestment Act (ARRA). With this funding, the LUSI project is fully funded and the project team plans to accelerate much of the design, procurement, and integrated assembly activities. The Committee concluded that the technical design is at the CD-3 level. Project planning and documents have been updated to reflect the impacts of the ARRA funding. It was particularly noteworthy that final installation and readiness of each instrument is indeed being pulled forward.

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

1. The X-ray Pump Probe (XPP) design was ready for CD-3 at the April 2009 review. Advance procurements were approved and some items have been ordered.
2. The Coherent X-ray Imaging (CXI) and X-ray Photon Correlation Spectroscopy (XCS) Instrument Designs are now complete and CD-3 ready.
3. Diagnostics and Common Optics preliminary design complete and is CD-3 ready.
4. Controls and Data Acquisition preliminary design complete and is CD-3 ready.

The Committee recommended frequent vendor contacts to ensure timely deliveries, particularly the two detectors at BNL. The project presented a potential scope enhancement plan should funds become available. Some items (e.g., 0.1 micron mirrors) will require decisions very soon.

Cost and schedule contingency is adequate for this stage of the project. The schedule has been updated to reflect receipt of the ARRA funding. The April 2009 committee expressed concern about schedule delays caused by ARRA procurement process. Experience to-date indicates that there is not a problem; however, the Committee recommended that this concern continue to be monitored. Early science availability dates have been advanced.

ES&H and Management areas were covered in the April 2009 DOE/SC review. The project was responsive to the April review recommendations. There were no action items resulting from the July review.

2. TECHNICAL

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

This 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-ray pulses (i.e., on systems for which X-ray scattering constitutes a useful and informative signal) following a laser pump pulse that initiates the process. In this setup, an ultrashort optical laser pump pulse creates excitations in a sample, which is then probed by an X-ray pulse, at different time delays from the pump pulse on time scales much faster than the dynamic process of interest. The timing between the optical laser pulse and the X-ray probe pulse is experimentally varied and measured as a parameter. The X-ray probe pulse incident upon the sample generates scattered X-rays that are detected in order to measure transient properties of the excited system and its dynamical evolution. Use of the ultrashort intense LCLS X-ray pulses with the 120-Hz repetition rate enables images of the scattered X-ray intensity pattern from each individual pulses being collected with sub-picosecond time resolution.

The XPP Instrument Scientist representative gave a very clear presentation of the current status of the project. The team has made careful plans on most aspects of the instrumentation on schedule or ahead of schedule. Their plan has been integrated with the rest of the X-ray optics and experimental facilities in the front station, as well as the laser systems installed in the second floor. CD-3 procurements were approved in March 2009 and some major items have been purchased and acquired. The technical scope of the XPP project is consistent with the budget and schedule as dictated by CD-3 and CD-4 milestones. The scheduled procurements for laser components is enabled by the ARRA funding, which will allow the XPP to meet an accelerated schedule to provide for early science in July 2010.

Present 'critical path' items for XPP are: 1) Sample Goniometer; 2) two-dimensional detector; 3) Common Optics and Diagnostics; 4) Installation; and 5) user sample environment designs. The first four items have been identified during prior recent reviews in August 2008 (DOE/SC), March 2009 (FIDR), and April 2009 (DOE/SC).

The Laser Amplifier and Optical Parametric Amplifier (OPA) was recommended for procurement and is still in a decision making process to secure the vendor. The Sample Goniometer from Huber is now in a process of negotiation with the company for a proper interface with the diffractometer platform at the XPP experimental station. The instrument scientist has paid visit to Huber in Germany to have face-to-face discussions with the vendor. The order for core XPP detector from BNL has been placed and the initial evaluation of the dynamic range was completed by the BNL detector team for the 512 by 512 pixel version, equivalent to one quarter of the detector. Therefore, the technology has been proven feasible. The delivery schedule will need to be closely followed.

The Committee encouraged the XPP team to communicate back-up plans to the user community and to future review committees. This communication is very important to keep future users 'heads up' for 'early science' in July 2010.

Similar to the April 2009 DOE/SC review, the Committee strongly supported the accommodation of other sample environments (liquid circulating, vacuum chamber, and cryostat). Although these capabilities are from 'matured' technologies, the sample environment is the key for the success of the early science. The communicating users' needs to the engineering design, as well as designated funding is critical to ensure the progress. This modest cost can generate significant enhancement for the early science.

Pre-LCLS experiments using the laser experimental capability at the station enabled by multiplexing 1-kHz laser pulses is critical capability to ensure the sample stability and the detailed procedure for sample handling.

XPP is ready for CD-3 approval.

Recommendations:

1. Complete the procurement for the Laser Amplifier and the OPA, making sure of the pump laser power compatibility with the future OPA system.
2. Make frequent contacts with vendors to ensure the ordered items, such as Huber and the BNL detector, are to be delivered on schedule or there is a manageable mitigation plan for backup. Re-evaluate the contingency on the 2D detector being developed at BNL or provide a better justification for the present contingency level by September 2009.
3. Implement designs and setups for different sample environments.
4. Develop pre-LCLS experiments using the laser experimental capability at the station enabled by multiplexing 1-kHz laser pulses is critical to ensure the sample stability and the detailed procedure for sample handling.
5. Develop an installation schedule (e.g., for equipment, cabling, vacuum components, utilities, etc.) to avoid any delay in the delivery of 'early science'.
6. 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.
7. 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.

2.2 Coherent X-ray Imaging Instrument (WBS 1.3)

CXI designs are mature. Reviews have done adequately. One of the key components that requires a very long lead time, the 1 μm KB mirror pair, was ordered. The 0.1 μm KB mirrors are ready to be ordered.

A second scientist is being hired to improve coupling to the science users. A mechanical designer is being hired to implement both KB mirror systems.

The possible delayed delivery of the Cornell detector does not affect CXI. Another key component, the CXI particle injector is still far from optimum.

CXI is ready for CD-3 approval.

Recommendations:

1. Keep finding ways to improve the particle injector.
2. Seek special permission to order the 0.1 μm KB mirrors before the August 31 deadline.
3. Request sole source ARRA purchase.

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

The XCS beamline design is ready to proceed to CD-3 as a result of the outstanding efforts of the beamline personnel.

Design risk for the remaining well-understood XCS components (slits, focusing lenses, etc.) is very low.

The detailed beamline designs and procurement plans for the XCS beamline components are appropriate both for early science operations and final operations, and will meet the requirements for CD-4 with high likelihood.

Delays in the procurement system constitute one potential risk for the XCS beamline. DOE should move rapidly to CD-3 approval. In addition, LUSI management should continue to work to expedite the procurement cycle.

A critical aspect of XCS is the XCS detector, which is to be designed and built by Brookhaven National Laboratory (BNL). The principal risk to the XCS beamline is that the delivery date of the XCS detector could be delayed. The design process at BNL was recently initiated (February 2009) and therefore the details of detector design are still in an early stage. However, in order to maintain the XCS schedule, it is essential to come to a clear conclusion about the path forward within the next few months. The XCS detector is subject to rigorous LCLS Detector Advisory Committee (LDAC) review twice per year and it is important that by the next LDAC review in the fall that the detailed detector design concepts will have been settled. The

Committee noted that 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. Because the XCS detector will not yet be completed at the time that XCS starts commissioning, the XCS team will acquire an additional XPP detector for Early Science experiments. Another critical component of XCS is the DESY split-and-delay (S&D) system. The DESY S&D unit is built, and will be at SLAC for an initial period of three years, starting when agreed. Nevertheless, it would be valuable for LUSI to initiate conceptual design work for a LUSI S&D system incorporating the possibility of tuning the energy, and avoiding attenuation in air.

It is gratifying that laboratory management has indeed followed up on the recommendation of the April review to augment the scientific leadership within LUSI/LCLS via the appointment of Jo Stohr as Assistant Laboratory Director for LCLS. It is also highly laudable that a second XCS scientist position has been hired.

Recommendation:

1. Closely monitor the progress of the XCS detector and ensure that its schedule is satisfactory.

2.4 *Diagnostics and Common Optics (WBS 1.5)*

The X-ray pulses from the LCLS FEL exhibit intrinsic fluctuations in spatial and temporal extents. Diagnostic beamline components are therefore very important for the capture of the transverse intensity profile, to determine the incident beam intensity distribution, for determination of beam position and pointing changes, to aid in the alignment of X-ray optics, to 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. Even in the short time since the April 2009 review the LUSI staff has made excellent progress in the design, review and procurement of Diagnostics and Common Optics components. The Large-offset Monochromator, and Harmonic Rejection Mirrors are the only components that have not reached the final design review stage of development. All other diagnostic and common optical components are in procurement. Initial reviews of the monochromator and mirror system are complete. The large offset monochromator will be procured as a design-build project. The mirror system design is in process. This component uses proven designs and should be in procurement soon.

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

The design 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.

The Large Offset Monochromator is also a Common Optics component. A design review has been held for this component and the subcommittee judged that the conceptual design and choice of a design-build option are reasonable for this component. The funding and contingency allocated for this component appear to be reasonable compared to a similar monochromator to be deployed at the Advanced Photon Source (APS). The projected delivery date for the monochromator is reasonable for installation on schedule.

The Diagnostics and Common Optics are ready for CD-3.

2.5 Controls/Data Acquisition System (WBS 1.6)

The controls/DAQ system group gave a comprehensive presentation about LUSI controls/DAQ needs.

The controls/DAQ system team has extensive experience in handling a large volume of data at a high rate. The risk is low particularly since many of the LUSI devices and much of the software was used at the LCLS earlier photon sections, XTOD and Atomic, Molecular, and Optics (AMO). XTOD is being commissioned; AMO will follow in August 2009.

Data system concept and architecture are well developed. The test of interfaces between LUSI DAQ system and readout electronics for LUSI BNL detectors are at an advanced stage.

Engineering Specification Documents (ESD) and Interface Control Documents (ICD) are released to clear what needs to be done, where the interface is, and who is responsible for what.

The controls/DAQ system group has been meeting on a regular basis with the LUSI instrument teams. The controls for robot safety are in progress.

The Committee was very pleased to see the following:

- The controls/DAQ system group has made steady progress and has meet or is ahead of the project timeline. The control and data system design is technically sound.
- The controls group has the expertise and manpower needed to handle the LUSI control and DAQ project.
- The design team is taking advantage of established designs from existing XTOD and AMO tasks.
- ESD and ISD documents are released and kept current.
- The controls and instrumentation teams are working very closely together.

The controls/DAQ system is ready for CD-3.

Recommendations:

1. Expand contact with user groups for early user operations to prepare user instruments and user software to be interfaced with LUSI standard controls/DAQ standards.
2. Establish software quality control mechanisms for user programs.
3. Continue the strong technical linkage between controls/DAQ group and LUSI instrument group to ensure system safety integration.

3. COST, SCHEDULE, and FUNDING

The LUSI Mission Need (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 Committee and documented in that report.

In March 2007, as directed by the Office of Basic Energy Sciences, 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 in September 2007.

At the August 2008 DOE/SC review (for CD-2), 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 review was held in April 2009, which was preceded by a change in project funding, including the receipt of \$33.6 million in ARRA funding. The ARRA funding, along with receipt of the FY 2009 funding of \$15 million, resulted in a fully funded project. A plan to integrate ARRA funding into the project was developed including provision for separate reporting on the use of these funds.

At that time, the process for ARRA procurements was under development and there was concern expressed that the many small procurements necessary (under \$25K) for the project would become mired in reviews. It was recommended that the project exercise the ARRA procurement system as much as possible to gain experience that could inform revisions of the schedule ahead of a CD-3 decision (this review). This has been accomplished and is reflected in a revised project schedule. Other key project documents including the PEP have also been revised and are ready for approval.

The ARRA modified project schedule pulls the early science milestones for the XPP and CXI instruments forward by a year or more, and advances the XCS installation complete by three months. Overall the project milestones presented at this review show five months of schedule contingency from the final instrument readiness review (March 30, 2012) to CD-4 (August 31, 2012).

Based on the May 2009 data reported at this review the project TEC is \$55.1 million with a baseline at completion (BAC) of \$43.4 million leaving a contingency of \$11.6 million, which is 33 percent of the \$34.9 million of remaining work to go against the BAC. Including the OPC for the project of \$4.9 million the TPC is \$60 million. With a total of \$13.3 million spent to date, the project is at 22 percent complete against the TPC. Based on the costs of the work to date, the project currently has a Cost Performance Index of 1.05 and a Schedule Performance Index of .98.

The project team satisfactorily responded to the cost and schedule comments from the April 2009 review. The LUSI project is positioned to take advantage of their new funding situation and is effectively managing the project budget, schedule, and project risks. It was clear from this review that the technical work is largely on track and certainly mature at the CD-3 level. Project documents have been updated to reflect the impacts of the ARRA funding. It is particularly noteworthy that the early science is indeed being pulled forward although the CD-4 date remains at the CD-2 baseline of August of 2012.

ARRA procurements remain a concern for the LUSI project because there are so many, and although they are small (most below \$25K) there seems to be a high level of scrutiny that outside of ARRA program desires, would only be appropriate for rather large (\$100K and up) scale procurements. The situation needs to be monitored to make sure the acceleration intended by the ARRA funding does not become a drag on the schedule induced by the magnitude of the required oversight.

The project presented a prioritized list of possible future scope enhancements. Many have decisions that must be made in the very near future if they are to be pursued. This includes some investments (such as engineering studies) that would need to be made now, but that for technical or schedule reasons, might not result in a scope enhancement that would be taken as part of the project. These issues should be discussed with DOE to understand the potential benefits and the consequences for the time phased contingency drawdown for the project.

Issues related to transition to operations were discussed, at least tangentially, in this review. Looking beyond a CD-3 decision, the project needs to start elevating the level of discussion and activity that will lead to a smooth transition from the construction of LUSI into the operation experimental program. Support for users who are not yet associated with the project and its instruments should be considered as part of the planning. Assuring continuity of knowledge

moving from construction into operations and development beyond the project will be particularly important for instruments at this level of sophistication.

Recommendations:

1. Review potential scope enhancement plans with DOE by September 2009.
2. Immediately seek relief from full ARRA procurement process requirements that are actually imposing schedule risks to the project, particularly Fed Biz Ops cycle, for procurements below \$25K.
3. Authorize CD-3, Approve Start of Fabrication.

DOE F 1325.8
(08-93)

United States Government

Department of Energy

memorandum

DATE: May 29, 2009

REPLY TO

ATTN OF: TBrown:SC-22.3:3-6827

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

TO: Daniel R. Lehman, Director, Office of Project Assessment

I request that your office organize and conduct an Office of Science (SC) Independent Project Review of the LUSI Major Item of Equipment (MIE) Project to be conducted at the Hilton Washington DC/Rockville Executive Meeting Center, 1750 Rockville Pike, Rockville, Maryland 20852 on July 15, 2009. The Scientific User Facility Division will manage the meeting site logistics. Based on the favorable assessments from the review in April 2009, the purpose of this tailored review is to evaluate the project's readiness for Critical Decision 3 (CD-3), "Approve Start of Fabrication."

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.

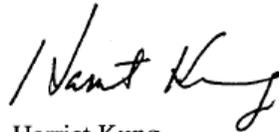
The project achieved its CD-2 milestone, "Approve Performance Baseline," on October 22, 2008. Also, since CD-2 the project has received approvals for advance procurement of long-lead components for the CXI and XPP instruments including the related diagnostics. An advance procurement package for XCS diffractometer system and large offset monochromator is also pending DOE approval. The milestones represented in the Project Execution Plan 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 a status review on April 20-22, 2009. During the April 2009 review, among other topics, management and environmental safety and health (ES&H) were assessed in detail and no issues were identified; therefore, limited discussions on these topics will occur.

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 accelerate 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 XPP, CXI, and XCS integrated instruments designs (including diagnostics and common optics, controls/data acquisition systems and detectors) ready to proceed to CD-3? Are the procurement plans and related specifications for the remaining components adequate? Is it reasonably likely that the instruments will meet the CD-4 criteria?
2. Project Management: Is the management team ready to proceed to CD-3? Have the responses to the April 2009 review been adequate to ensure a successful execution of the project?
3. Resources and Risks: Is the revised performance baseline appropriate given the advanced funding made possible by the American Recovery and Reinvestment Act of 2009? Are the procurement specific risks identified and effectively addressed? Have contingencies (scope/cost/schedule) been revised to address the remaining risks?
4. ES&H: Are ES&H aspects being properly addressed? Are integrated safety management principles being followed?

Thomas M. Brown, LUSI Program Manager, will serve as the Office of 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.



Harriet Kung
Associate Director of Science
for 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
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C. Clark, DOE/SC-28

Appendix B:
Review Committee

Department of Energy Review of the
LCLS Ultrafast Science Instruments (LUSI) Project
July 15, 2009

Steve Tkaczyk, DOE/SC, Chairperson

SC-1 XPP Instrument (WBS 1.2) * Lin Chen, ANL	SC-2 CXI Instrument (WBS 1.3) * Zenghu Chang, KSU	SC-3 XPCS Instrument (WBS 1.4) * Simon Mochrie, Yale
SC-4 Diagnostics/Common Optics (WBS 1.5) Controls/DAQ Systems (WBS 1.6) * Mark Beno, ANL Deming Shu, ANL	SC-5 Cost and Schedule (L2 Baseline Change/RA accel.) * Erik Johnson, BNL	Project Management and ES&H Addressed During April 2009 DOE/SC Review

Observers
Pedro Montano, DOE/SC
Thomas Brown, DOE/SC
John Tapia, DOE/SC
Hannibal Joma, DOE/SSO
Brian Huizenga, DOE/OECM

LEGEND
* Chairperson

Count: 7 (excluding observers)

**Department of Energy CD-3 Review of the
LCLS Ultrafast Science Instruments (LUSI) Project
July 15, 2009**

DRAFT AGENDA

Wednesday, July 15, 2009—Hilton, Washington, DC, Regency Room

7:30 am	Executive Session and Start of Review	D. Lehman
8:00 am	LUSI Project Overview/the Revised Baseline	T. Fornek
8:30 am	Procurement Plan	T. Fornek
9:00 am	Controls and Data Systems	G. Haller
9:30 am	XPP Integrated Instrument.....	D. Fritz
10:00 am	Break	
10:15 am	CXI Integrated Instrument	S. Boutet
11:00 am	XCX Integrated Instrument.....	A. Robert
12:00 pm	Working Lunch	T. Fornek
1:00 pm	Subcommittee Breakout Sessions (see schedule below)	
3:00 pm	Executive Session Dry Run	
4:30 pm	Closeout Presentation	
5:30 pm	Adjourn	

BREAKOUT SESSIONS

-  Risks, Cost and Schedule (Revised Baseline/RA Schedule acceleration)
 -  XPP (Integrated final instrument): D. Fritz
 -  CXI (Integrated final instrument): S. Boutet
 -  XCS (Integrated final instrument): A. Robert
 -  CDA/DCO (One Sub Committee): G. Haller & Instrument Scientists
- CDA: Controls/Data Acquisition*
DCO: Diagnostics/Common Optics

Project Completion

LUSI Baseline Performance - May 2009 (AYK\$)				
WBS		Work Accomplished	% Complete	Total Budget at Complete
1.1	Project Management	\$2,332	47%	\$4,955
1.2	X-ray Pump Probe Instrument (XPP)	\$2,202	38%	\$5,728
1.3	Coherent X-ray Imaging Instrument (CXI)	\$1,147	12%	\$9,527
1.4	X-ray Coherent Scattering Instrument (XCS)	\$923	13%	\$7,170
1.5	Diagnostics and Common Optics (DCO)	\$1,319	15%	\$8,888
1.6	Controls and Data Acquisition (CDA)	\$577	8%	\$7,223
	Total MIE	\$8,500	20%	\$43,491
LUSI Total Estimated Cost (TEC)				\$55,100
Available Management Reserve (MIE)				\$11,609
% Management Reserve on Estimate to Complete				33%
2.0	LUSI Other Project Costs	\$4,852	100%	\$4,852
LUSI Total Other Project Cost (TPC)				\$4,900
Available Management Reserve (OPC)				\$48
LUSI Total Project Cost		\$13,352	22%	\$60,000

LUSI Project Summary Schedule

MILESTONE DESCRIPTION	Baseline	Projected	Variance		CY2008	CY2009	CY2010	CY2011	CY2012
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	6/15/2009A	32 days (A)			▼			
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	08/30/11	08/30/11	0 days					▼	
COMPLETE: XCS PHASE 1 INSTL-START EARLY SCIENCE	08/05/11	08/05/11	0 days					▼	
APPROVED: FINAL INSTRUMENT READINESS REVIEW	03/30/12	03/30/12	0 days						▼

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

Early Milestone Completion Dates Reflect RA Facilitated Schedule Advancement

LUSI Funding Profile

RA Modified Profile Moves FY10-FY12 Funds into FY09

<i>LUSI Funding Profile (AYM\$) With RA Funds</i>								
	<i>Prior Yrs</i>	<i>FY07</i>	<i>FY08</i>	<i>FY09</i>	<i>FY10</i>	<i>FY11</i>	<i>FY12</i>	<i>Total</i>
<i>Pre RA</i>		<i>0.50</i>	<i>6.00</i>	<i>15.00</i>	<i>15.00</i>	<i>13.50</i>	<i>5.10</i>	<i>55.10</i>
<i>MIE (Non-RA)</i>		<i>0.50</i>	<i>6.00</i>	<i>15.00</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>21.50</i>
<i>MIE (RA)</i>				<i>33.60</i>				<i>33.60</i>
<i>OPC</i>	<i>3.40</i>	<i>1.50</i>						<i>4.90</i>
<i>Total</i>	<i>3.40</i>	<i>2.00</i>	<i>6.00</i>	<i>48.60</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>60.00</i>

All remaining LUSI funding has been received

LUSI Integrated Project Team

No change since April

