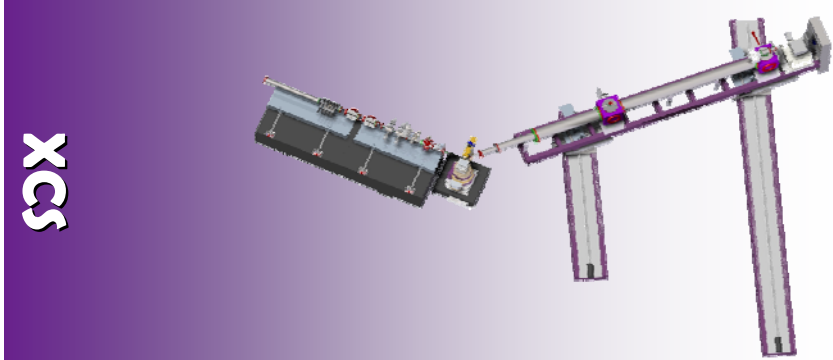
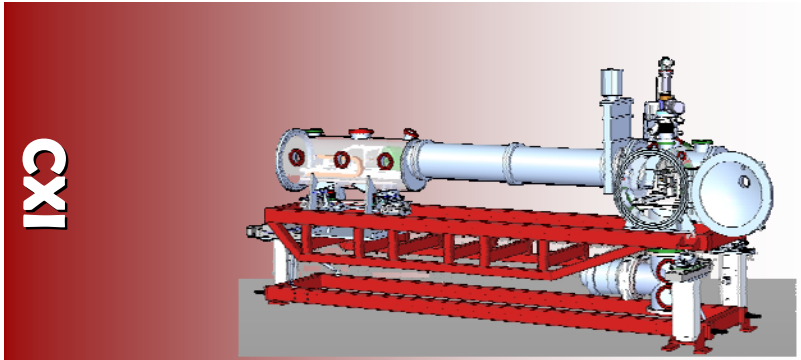
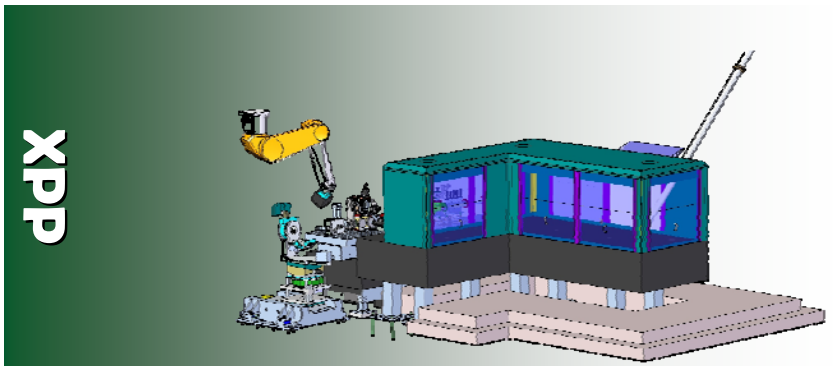


## LCLS Ultrafast Science Instruments Monthly Report April 2009



# Contents

WBS 1.1 and 2.1 Project Management.....	3
WBS 1.2 X-ray Pump Probe (XPP) Instrument.....	4
WBS 1.3 Coherent X-ray Imaging (CXI) Instrument.....	5
WBS 1.4 X-ray Correlation Spectroscopy (XCS) Instrument.....	7
WBS 1.5 Diagnostics and Common Optics (DCO).....	9
WBS 1.6 Controls and Data Acquisition (CDA).....	11
LUSI Cost and Schedule Performance- December 2008.....	12
LEVEL 1 & 2 MILESTONES.....	15
GLOSSARY .....	16

## WBS 1.1 and 2.1 Project Management

- Management and Safety

LUSI received \$33.6M from the American Recovery and Re-investment Act (RA) in April. Total Project Cost is still \$60M. April is the first month with ARRA actual costs. An Interim Baseline Change Request (BCR) was processed for April business to incorporate ARRA accounts. Some schedule changes were also included in this BCR, but the major schedule changes will be included in the schedule next month.

An Independent Project Review by the DOE Office of Project Assessment took place April 20-22. The emphasis of this review was to assess the LUSI plans to utilize the RA funding.

The Review Team generally felt that the proposed schedule, which included an “Early Science” version of the X-ray Correlation Spectroscopy Instrument, was reasonable. The reviewers felt that a baseline change to establish the ARRA schedule as the new schedule performance baseline should be submitted by the end of May. It was felt that the current CD-4 date of August 2012 should be maintained. The Project should be managed to the level-two early finish milestones for instrument readiness reviews.

Procurements were a concern during the review. We need to ensure adequate schedule time is provided for SLAC and DOE approvals on procurements, especially those over \$500k. It was recommended that the Project team should consider requesting early procurement approval for additional schedule critical items. Also, the project should assess schedule impacts of ARRA procurements for LUSI considering roles and responsibilities of LUSI, SLAC and DOE partners no later than the Middle of June 2009.

Also, LUSI staff continues to participate in the FEH Hutch 4 and 5 design reviews and coordination. This is an on-going effort and significant LUSI interaction will continue through construction of the hutches. We anticipate that the “Issued for Construction” drawings will be available in May.

- Assessment and Issues:

The April 2009 Cost Performance Report is the 7<sup>th</sup> month of reported earned-value on LUSI. MIE cumulative obligations to date (actual costs + open commitments) are \$7,915K. Schedule and cost indices for the MIE are 0.98 and 1.04 respectively.

WBS 1.1 cumulative obligations to date (actual costs + open commitments) are \$2,265K. Schedule and cost indices for WBS 1.1 are 1.00 and 1.04, respectively.

All planned OPC (WBS 2) work has been completed. OPC cumulative actual costs to date are \$4,852K.

## WBS 1.2 X-ray Pump Probe (XPP) Instrument

- Management and Safety

WBS 1.2 cumulative obligations to date (actual costs + open commitments) are \$2,066K. Schedule and cost indices for WBS 1.2 are 0.96 and 1.01 respectively.

- General

An offer was extended to the top candidate for the XPP 2<sup>nd</sup> Scientist position. A response is expected next month.

A standing meeting has been organized to discuss the XPP installation efforts with the installation manager (Ben Poling).

- Design

The preliminary design of the robot support base was completed. A design review will be held next month.

A draft robotic software statement of work was prepared. This document will be released next month and a purchase requisition will be entered for this work.

Hole-drilling for the Hutch 3 supports will occur next month. This work is being coordinated with the LCLS hole-drilling work for the X-ray Transport Tunnel. All of the necessary documentation and drawings were completed to accomplish this task.

### Detector

The LCLS Detector Advisory Committee meeting is scheduled for May 7-8.

- Procurement

Purchase orders for the XPP sample goniometer, XPP robotic detector mover, laser enclosure, X-ray optics support tables, laser optical tables, hutch workbenches and tool storage were awarded.

- Component Status

There are currently no manufactured components at this time.

- Assessment and Issues:

None.

## WBS 1.3 Coherent X-ray Imaging (CXI) Instrument

- Management and Safety

WBS 1.3 cumulative obligations to date (actual costs + open commitments) are \$1,041K. Schedule and cost indices for WBS 1.3 are 1.00 and 1.20, respectively. The large positive cost variance is partly due to planned engineering work being accomplished by the Instrument Scientist as a part of his level of effort activities. In addition, many of the engineering staff have been working additional hours to prepare for the status review. Both of these items led to accomplishment of work with no additional charges.

The CXI team presented the status of the CXI instrument at the LUSI DOE status review on April 20-22.

- General

None.

- Design

The design efforts on CXI are ramping up due to the recent increase in staffing. Work is now progressing on all major CXI components.

Work continued on the CXI layout to optimize the use of space while allowing flexibility.

- Detector

Progress on the CXI detector, which falls under the LCLS construction project, is sufficient to meet the CXI schedule. Communication is ongoing between the CXI team and the group working on the mechanical design of the detector. Specifically, the interface between the detector and the CXI Detector Stage was finalized allowing the design of the Detector Stage to move forward.

- Procurement

A preferred bid was selected by a panel of experts for the 1 micron KB System. SLAC procurement is conducting vendor negotiations and other necessary actions leading up to award of the Purchase Order.

- Component Status

- **1 micron Sample Chamber**

The Sample Chamber door design was modified slightly based on conversations with potential users so that it could be replaced with a fully UHV compatible flange if necessary. Thermal analysis of the internal components of the chamber was started.

- **0.1 micron KB/Sample Chamber System**

Design work on the 0.1 micron KB/Sample Chamber System will begin once the option on the KB contract is officially picked up.

- **Precision Stands**

Two options for mounting the Detector Stage upstream of the Sample Chamber were modeled and are being investigated.

The seismic analysis of the 1 micron Instrument Stand was completed and revealed that a widening of the vertical support structure was needed. The necessary modifications are being made to the model.

Conversations with stage vendors revealed that with the use of one of their standard adapters, we should be able to utilize the IMS smart motors to drive the motions of the stand.

- **Detector Stage**

Issues encountered by the Pegasus Design Company during the design phase led them to suggest modifications to the back plate interface of the detector. These suggested modifications were communicated to the SLAC group working on the detector. The proposed changes were easily integrated in the design of the detector. The modifications will allow the use of smaller and more flexible cooling lines.

- **Particle Injector**

The interface flange of the Particle Injector in the Sample Chamber was modified from a 6 inch to an 8 inch flange. The modification will allow a re-entrant bellows design which will bring the injector nozzle into the interaction region. Previously, the closest point of approach was roughly 6 inches; with this modification the point of approach is now 2.2 inches. A re-entrant bellows design was completed. This re-entrant bellows will be included in a custom made manipulator that will position the Particle Injector.

The Particle Injector Engineering Specifications Document was completed and released.

- **KB Mirrors**

The technical evaluation of the proposals has been completed and a preferred vendor was selected.

- **Ion Time-Of-Flight**

The Engineering Specifications document was released.

- **Reference Laser**

The revised optical system for the Reference Laser was updated to respond to the Preliminary Design review comments. In particular, a different laser with lower power and a class 2 rating was selected. The Reference Laser model was checked and corrected when necessary in order to prepare for drafting the parts.

- Assessment and Issues:

None.

## WBS 1.4 X-ray Correlation Spectroscopy (XCS) Instrument

- Management and Safety

WBS 1.4 cumulative obligations to date (actual costs + open commitments) are \$836K. Schedule and cost indices for WBS 1.4 are 0.90 and 0.98, respectively. The schedule variance is expected to improve in May once preparations for the Final Instrument Design Review are completed and the revisions needed to complete the Advance Procurement Review are finished.

The MoU between SLAC National Accelerator Laboratory and the Deutsches Elektronen Synchrotron laboratory (DESY, Hamburg, Germany) related to the Split and Delay prototype is now signed by the management of each laboratory. The Split and Delay unit will provide the unique scientific opportunity to probe ultrafast dynamics of condensed matter systems on the XCS instrument. The details of the MoU can be obtained from LCLS management.

- General

The XCS Instrument Integrated Team prepared for and participated in the LUSI DOE Status Review (April 20-22). In addition the instrument team was primarily responsible for preparations for the Advanced Procurement Review of the XCS instrument long-lead components (April 23).

The LUSI Project received \$33.6M of ARRA funding in April. This allowed the XCS Instrument Team work intensively on the design of the instrument components in order to expeditiously bring the XCS instrument to the CD-3 level. The current progress was recognized as very positive by the Review Committee during the LUSI DOE Status Review (April 20-22).

The XCS Instrument Integrated Team conducted an Advanced Procurement Review for its long-lead items: the XCS diffractometer, the XCS Large Angle Detector Mover and the XCS Large Offset Monochromator. The review was held on April 23. The report was received on April 30. The XCS instrument team is now moving forward to start the procurement of these 3 critical items.

The XCS Instrument Team is getting ready for the Final Instrument Design Review of the XCS instrument, which is a precursor for CD3. The FIDR is tentatively scheduled for June 2009.

The XCS instrument has one job opening for a Second Scientist position, provided by the Experimental Facility Division of LCLS. Action is taken to identify qualified candidates.

The XCS Instrument Scientist, Dr. A. Robert, is part of the collaboration regarding the Split and Delay development from DESY. The DESY team has submitted a scientific article to *Optical Letters* (describing the performances of the prototype) in which the XCS instrument scientist is co-author. A more detailed technical paper on the split and delay is under preparation for submittal to *Journal of Synchrotron Radiation*, later this year.

- Design

The XCS Instrument Team continued to interact intensively with LCLS Conventional Facility staff regarding the design effort for the hutches located in the Far Experimental Hall. The XCS Instrument Team reviewed the FEH Issued For Bid hutch drawings. A list of comments was generated.

The XCS Instrument Team intensified the design effort, for the main components contained in its own WBS structure (i.e. the diffractometer, the support tables for the optical elements and the large angle detector mover) as well as the Large Offset Monochromator. These critical long lead items were reviewed as part of an Advanced Procurement Review (April 23<sup>rd</sup>).

- Detector

The suggested update of the requirement for the pixel size (i.e. 55 $\mu$ m) of the XCS detector developed by BNL will be presented during the upcoming LDAC Review (May 7-8, 2009).

As a result of full funding of the LUSI project, XCS can be completed to begin early experiments in advance of CD-4. However, since the XCS specialized detector cannot be available for the early science milestone; the Instrument Scientist is evaluating (in consultation with the team leaders) the option for the delivery of an interim XCS detector for early science. The possibility of obtaining a duplicate of the XPP detector to satisfy the XCS Early Science milestone (thus allowing the commissioning of the XCS instrument but also providing early science) is discussed with N. van Bakel, LUSI Detector Physicist, and BNL Detector Team. This solution is supported by the team leaders and by the LUSI Lehman Status Review committee.

- Procurement

There are no ongoing procurements for the XCS instrument. However, after completion of the XCS Advanced Procurement review (held on April 23), the procurement of the three XCS long-lead items will start in May 2009:

- XCS Diffractometer
- XCS Large Angle Detector Mover
- XCS Large Offset Monochromator

- Component Status

There is no specific status to report on any XCS component.

- Assessment and Issues:

None.



## WBS 1.5 Diagnostics and Common Optics (DCO)

- Management and Safety

WBS 1.5 cumulative obligations to date (actual costs + open commitments) are \$1,191K. Schedule and cost indices for WBS 1.5 are 0.99 and 1.01, respectively

- General

During the month of April the focus was the execution of the monitors and the Attenuator/Pulse picker final design reviews. These reviews were scheduled for the middle of April. The uncertainties with the Pulse picker continued to divert attention from other issues.

- Design

- **Monitors:**

A final design review for the IPM, PIM and PM was held on April 17. This was an important accomplishment prior to the DOE review on April 20-22.

A detailed finite element analysis effort was performed on the chamber monitor assemblies with the six degree of freedom alignment stand in preparation for the FDR. Report results were presented at the FDR.

No major concerns were raised during the review. Based on this, the team is moving forward with building the first articles to confirm performance requirements. Details on the items procured for this effort are outlined in the Procurement section below.

- **X-Ray Lenses:**

The lens holder assembly drawing package is in work. A first article holder assembly will be made once the drawing package is finished.

- **Slits:**

No design changes have occurred. Stand and assembly drawings have been started based on the most suitable slit design available.

- **Attenuator/Pulse Picker:**

Efforts were concentrated on finishing the Pulse picker in-vacuum tests. The results were presented at the Attenuator/Pulse picker Final Design Review, which was held on April 16.

The FDR committee recommended moving forward with detail design but acknowledged the fact that there is more testing needed to alleviate the concerns surrounding the Pulse Picker performance. The FDR report states “The review committee feels the biggest risk in proceeding comes from the modified, Azsol, in-vacuum shutter assembly which is the centerpiece of the pulse picker design. Preliminary testing has shown that there is technical risk as to whether this device can perform reliably and meet the requirements of the ESD. For this reason, the reviewers have listed this as an action item. However, the design team presented a detailed plan to improve the shutter performance and mitigate this risk”.

Even though the pulse picker tests diverted attention from other issues, there was significant progress made on the design of the Attenuator/Pulse picker assembly. The attenuator inspection mirror concept was finalized and drawings were made to create a prototype for concept verification. The six degree of freedom alignment stand drawings were created and will be put in check after the stands made for the monitors are verified. Drawing release and order of the stand will be done shortly after the stands are tested in house. The Pulse picker inspection camera and lens were finalized. Chamber model detailing was done and drawings have been started. Dialogue continues with the vendor of the attenuator actuator to detail our geometry requirements.

- **Harmonic Rejection Mirrors:**

Design efforts started on the HRMs. The current approach is to have a design where there would not be a need to break vacuum to change mirror configurations. This might mean in-vacuum stages PDR will have to be scheduled prior to the Final Instrument Design Review for XCS.

- Procurement

- Slides for IPM prototype are due early May.
- 2 chambers for monitor first articles will be made by the Klystron group. Material procurement was started.
- Ordered and received dampening materials for pulse picker test.
- Ordered and received connectors, cables and feed-thru flanges for the PIM, and IPM first articles.
- Responses to RFP 2611 were received from ADC and JJ X-ray.
- A request for quotation for the Be lenses was sent to Aachen University.
- The SLAC procurement process for the Be lenses was started by posting a source posting on FedBiz.

- Component Status

- Attenuator/Pulse picker final design review performed on April 16.
- IPM, PIM, and PM final design review was performed on April 17.

- Assessment and Issues:

Pulse Picker performance continues to be in question. Questions were raised about the performance requirements imposed on the device. It seems that the requirements could be relaxed without adverse impact to the LUSI science capabilities. The scientific staff is evaluating this and will rule on it early next month.

## WBS 1.6 Controls and Data Acquisition (CDA)

- Management and Safety

WBS 1.6 cumulative obligations to date (actual costs + open commitments) are \$515K. Schedule and cost indices for WBS 1.6 are 0.98 and 0.98, respectively.

- Design

The CXI and XCS Controls and Data Systems Preliminary Design Reviews were held on May 11. Material and the review report are posted at:

[https://confluence.slac.stanford.edu/display/PCDS/CXI\\_XCS-PDR](https://confluence.slac.stanford.edu/display/PCDS/CXI_XCS-PDR)

There were no major findings during the review.

Work on off-line data management continued this month. The work concentrated on defining the data-format translator to convert on-line data formats to HDF5 data formats. We also started to investigate an electronic logbook, see:

<https://confluence.slac.stanford.edu/display/PSDM/Electronic+Logbook>

Controls personnel are continuing the discussions with LUSI scientists regarding data processing. A draft of the Engineering Specification Document for the common portion of the data processing system for the three instruments was prepared.

- Detector

We are continuing to perform noise measurements on the XPP detector readout integrated circuit at SLAC. We also continue to interact with BNL to bring up their test setup which also has one of the circuits.

The layout of the next application specific integrated circuit (ASIC) planned for fabrication was finished. This ASIC was submitted to design-rule and layout-versus-schematic verification. The ASIC came back without issues and is now awaiting fabrication. ASIC fabrication is expected to take about 6 weeks.

- Procurement

We are continuing to order the control hardware for the XPP instrument.

- Assessment and Issues:

None.

## LUSI Cost and Schedule Performance- April 2009

SLAC Linear Accelerator Center Menlo Park, California	LUSI Cost/Schedule Status Report (April 2009)							Date:	6/1/2009	
Performance Data										
WBS[2]	Cumulative to Date					At Completion			Indices	
	Budgeted Cost		Actual Cost Work Performed	Variance		Budgeted	Latest Revised Estimate	Variance	SPI	CPI
	Work Scheduled	Work Performed		Schedule	Cost					
1.1 PROJECT MANAGEMENT	2,353,987	2,353,987	2,265,241	0	88,746	4,955,382	4,896,892	58,490	1.00	1.04
1.2 X-RAY PUMP PROBE (XPP)	2,167,147	2,078,757	2,066,028	-88,390	12,729	5,728,269	5,680,774	47,495	0.96	1.01
1.3 COHERENT X-RAY IMAGING (CXI)	1,249,718	1,246,825	1,041,390	-2,893	205,435	9,890,267	9,913,328	-23,061	1.00	1.20
1.4 X-RAY CORRELATION SPECTROSCOPY (XCS)	911,719	819,441	836,065	-92,278	-16,624	6,995,690	7,056,112	-60,422	0.90	0.98
1.5 DIAGNOSTICS & COMMON OPTICS	1,213,822	1,203,493	1,191,269	-10,329	12,224	8,311,095	8,541,527	-230,433	0.99	1.01
1.6 CONTROLS AND DATA ACQUISITION	516,891	504,095	514,934	-12,796	-10,839	7,223,124	7,259,346	-36,223	0.98	0.98
Gen. and Admin.	0	0	0	0	0	0	0	0		
Undist. Budget						0	0	0		
Sub Total	8,413,284	8,206,598	7,914,927	-206,685	291,671	43,103,826	43,347,980	-244,154		
Management Resrv. (MIE)						11,996,174	11,752,020	244,154		
Total MIE	8,413,284	8,206,598	7,914,927	-206,685	291,671	55,100,000	55,100,000	0	0.98	1.04
2.0 Other Project Costs (OPC)	4,851,861	4,851,861	4,851,861	0	0	4,851,861	4,851,861	0		
Management Resrv. (OPC)						48,139	48,139	0		
Total OPC	4,851,861	4,851,861	4,851,861	0	0	4,900,000	4,900,000	0		
Sub Total (MIE+OPC)	13,265,145	13,058,459	12,766,788	-206,685	291,671	47,955,687	48,199,841	-244,154		
Total Management Reserve						12,044,313	11,800,159	244,154		
Total Project Cost (TPC)	13,265,145	13,058,459	12,766,788	-206,685	291,671	60,000,000	60,000,000	0		

## LUSI ACTUAL COSTS – April 2009

LUSI MIE Project			
WBS Level 2	Actual Cost of Work Performed		
	Non-ARRA	ARRA	Total
1.1 PROJECT MANAGEMENT	\$2,237,907	\$27,334	\$2,265,241
1.2 X-RAY PUMP PROBE (XPP)	\$2,056,925	\$9,103	\$2,066,028
1.3 COHERENT X-RAY IMAGING (CXI)	\$954,315	\$87,074	\$1,041,390
1.4 X-RAY CORRELATION SPECTROSCOPY (XCS)	\$784,255	\$51,810	\$836,065
1.5 DIAGNOSTICS & COMMON OPTICS	\$1,169,522	\$21,748	\$1,191,269
1.6 CONTROLS AND DATA ACQUISITION	\$486,563	\$28,371	\$514,934
<b>Total</b>	<b>\$7,689,488</b>	<b>\$225,440</b>	<b>\$7,914,927</b>

<b>April 2009 Performance</b>	<b>AYK\$</b>
Total Project Cost (TPC)	\$60,000
Planned % Complete (MIE)	19.4%
Actual % Complete (MIE)	18.1%
Total Estimated Cost (MIE)	\$43,108
Cost and Commitments to Date (MIE)	\$7,915
Estimate at Complete (MIE)	\$43,348
Work Remaining (MIE)	\$35,433
MIE Remaining Management Reserve (Based on EAC)	\$11,752
% Contingency on Uncommitted Work Remaining (MIE)	33.2%

The LUSI cost and schedule are consistent with the approved baseline with a Total Estimated Cost (TEC) of \$42.7M and a Total Project Cost (TPC) of \$60M. The CD-4 milestone is August 2012. All costs are in actual-year dollars and out-year costs are escalated.

The April 2009 Cost Performance Report is the seventh month of reported earned-value on LUSI. Schedule and cost indices are 0.98 and 1.04, respectively.

The projected Estimate at Complete (EAC) provides the most current estimate of the TEC final cost. Contingency on EAC is considered adequate for this stage of the project. LUSI is evaluating possible scope changes to the approved baseline. Scope changes will be presented to the LUSI Technical Configuration Control Committee (TCCC) and the LCLS Change Control Board for approval prior to being added to the baseline.

## LEVEL 1 & 2 MILESTONES

MILESTONE DESCRIPTION	Baseline	Projected	Variance		CY 2008	CY 2009	CY 2010	CY 2011	CY 2012
<b>LUSI - Project Management</b>									
<b>Level 1 DOE HQ Milestones</b>									
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						▼
<b>Level 2 - DOE Local Milestones</b>									
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 - ▼

## GLOSSARY

**Cost of Work Performed (ACWP)** – Actual cost reported through the LCLS cost accounting systems, plus any accruals, for a specific WBS#, subproject, or project.

**Budget Authority (BA)** – Cumulative funds currently allocated and authorized by the Department of Energy that may be committed and spent by LUSI for project-related activities.

**Budget at Completion (BAC)** – The total budgeted cost at completion for a given WBS, subproject, or project. BAC is the budgeted cost of the project excluding contingency.

**Budgeted Cost of Work Performed (BCWP)** – Budgeted value of planned work for a WBS#, subproject, or project physically accomplished.

**Budgeted Cost of Work Scheduled (BCWS)** – Budgeted value of planned work time-phased to the schedule for a specific WBS#, subproject, or project.

**Commitments** – Funds allocated to subcontractors where work has been authorized but not yet expensed.

**Cost Performance Index (CPI)** – The ratio of the value of the work performed to actual cost;  $CPI = BCWP/ACWP$ . Values less than 1.0 represent “cost overrun” condition, and values greater than 1.0 represent “cost underrun” condition.

**Cost Variance (CV)** – Difference between the estimated value of the physical work performed and the actual cost expended for a specific WBS#, subproject, or project.  $CV = BCWP - ACWP$ . A negative result is unfavorable and indicates the potential for a cost overrun.

**Estimate at Completion** – Forecast of the final cost for a specific WBS#, subproject, or project based on the current ACWP plus a management assessment of the cost to complete the remaining scope of work.

**Estimate to Complete (ETC)** – A realistic appraisal of the cost to complete the remaining scope of work.

**Major Item of Equipment (MIE)** - Capital equipment or automated information system components with a total estimated purchase value of \$2,000,000 or more, including costs that are capitalized and not related to construction.

**Other Project Cost (OPC)** – LUSI “supporting” costs not directly contributing to the construction project. OPC costs generally include research and development and pre-operation (start-up) activities.

**Percent Complete** – The ratio of the work accomplished (earned-value) to the Budget at Completion for any WBS#, subproject, or project.  $\% \text{ Complete} = BCWP/BAC$ .

**Percent Contingency Remaining** – The ratio of remaining contingency dollars to remaining line item (TEC) work calculated as follows: the numerator is equal to the contingency available (after consideration of the EAC) less 5% of outstanding technical phase-funded awards and less 10% of outstanding conventional facilities phase-funded awards. The denominator is the EAC less ACWP less outstanding phase-funded awards.

**Percent Planned** – The ratio of the current plan to the Budget at Completion.  $\% \text{ Planned} = BCWS/BAC$ .

**Project Engineering and Design (PED)** – Funding used to support the engineering and design effort for LUSI.

**Schedule Performance Index (SPI)** – The ratio of the value of work performed to work scheduled,  $SPI = BCWP/BCWS$ . Values less than 1.0 represent a “behind schedule” condition, and values greater than 1.0 represent “ahead of schedule” condition.

**Schedule Variance (SV)** – Difference between the value of the physical work performed and the value of the work planned (scheduled).  $SV = BCWP - BCWS$ . A negative result is unfavorable and indicates a behind schedule condition.

**Total Estimated Cost (TEC)** – The total MIE budget authorized for the LUSI project for the construction phase of the project. TEC includes contingency but does not include OPC.

**Total Project Cost (TPC)** – The total budget authorized for the LUSI project, including MIE and OPC.

**WBS (Work Breakdown Structure)** – A method of hierarchically numbering tasks in a traditional outline numbering format. The WBS provides a basis for the LUSI work plan which is used to track all resources, schedules, and cost.