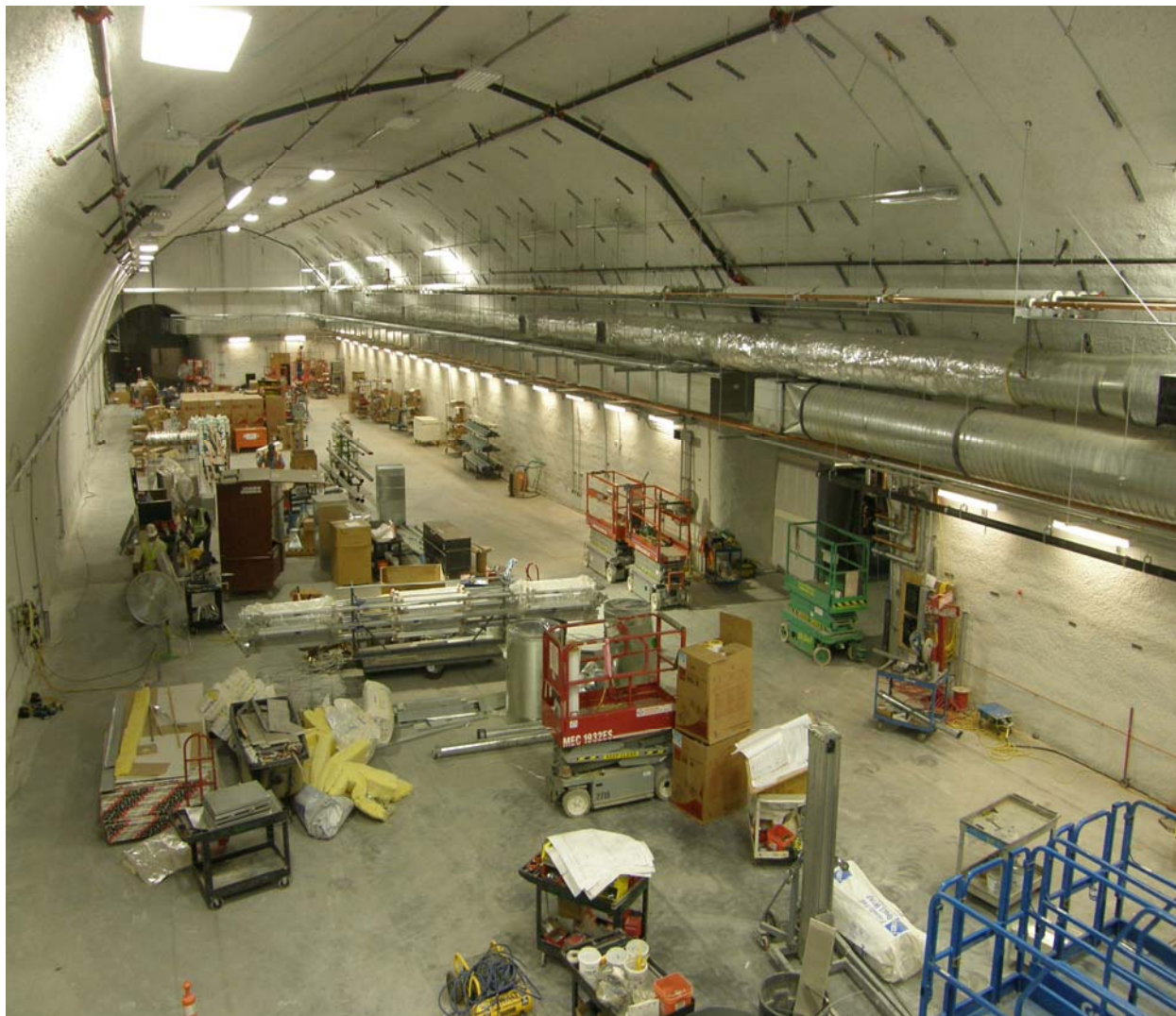


Linac Coherent Light Source Monthly Report September 2008



CONTENTS

PROJECT OVERVIEW AND ASSESSMENT	3
TECHNICAL AND PROGRAMMATIC PROGRESS	
<u>LCLS Project Office & Support</u>	
WBS 1.1, 2.1	Project Management and Administration 4
<u>Electron Beam Systems</u>	
WBS 1.1.3, 1.x.2	Global Controls 5
WBS 1.2, 2.2, 1.3, 2.3	Injector and Linac 6
WBS 1.4, 2.4	Undulator 7
<u>Photon Beam Systems</u>	
WBS 1.5, 2.5	X-Ray Transport & Diagnostics 8
WBS 1.6, 2.6	X-Ray Endstations 10
<u>Conventional Facilities</u>	
WBS 1.9, 2.9	Conventional Facilities 11
COST PERFORMANCE REPORT	
-Cost/Schedule Performance	12
-Cost/Schedule Assessment	
-Milestone Performance	
GLOSSARY	15

Project Overview and Assessment

Highlights:

- Cover Page (LCLS Far Experimental Hall looking west) – Most of the remaining civil construction being managed by Turner Construction is in the Far Experimental Hall. With the tunneling and concrete work mostly complete, the main effort is installing electrical switchgear, heating and ventilation equipment and mechanical and plumbing. All Turner managed work is scheduled to be complete by the end of November.
- LCLS technical equipment installation in the Linac-To-Undulator (LTU), Undulator Hall, and Electron Beam Dump continues to make steady progress. 95% of the drift tubes have been installed in the Beam Transport Hall (BTH), aligned and pumped down. E-dump pit steel installation is complete and the magnet installation is underway. In addition, all 33 undulator girders have been installed.
- Construction (Turner) is approximately 96% complete. To date, \$3,812K Field Change Orders have been negotiated and approved, <5% of construction cost to date.

Assessment and Issues:

- The September 2008 Cost Performance Report is the 55th month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$332,750K. Cost and schedule indices are 1.00 and 0.99, respectively.
- Civil construction activities continue to lag the target schedule for Beneficial Occupancy of the FEH facilities. However there was a substantial improvement in schedule variance during this month. SLAC is continuing its early installation of technical equipment, so as to maintain the overall schedule float to CD-4.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status –
 - LCLS has worked 123 days without a lost time injury (days away) and 37 days without a recordable injury. Total project hours are 2.004M comprised of 1.441M collaboration hours and 563K subcontracted hours.
 - The LCLS project DART rate for construction is currently 3.2¹, as compared to the general industry rate of 3.2 and the Department of Energy rate of 0.6. The total project DART rate is 1; this includes construction and laboratory hours.

- LCLS Procurements Status –
 - Construction Procurements (Turner) –
 - Three modifications were issued during September (Modifications 064 for three CORs, 065 for six FCOs, and 066 for incremental funding of the Trades).
 - A total of 351 FCOs and CORs have been settled, through negotiation or agreement, with issuance of a Modification.
 - 77 FCOs/CORs are in tech review, fact finding or negotiation.
 - Technical Procurements –
 - Magnetic blocks awarded with a delivery expected in October.
 - Service Building Racks Power installation contract was completed and awaiting as built drawings.
 - Dump – Magnet Assembly – The device for lifting the magnets had to be modified. Completed work moved to October.
 - BCS Gas Line Distribution project awarded with a completion date in October.
 - FEH Hutch # 4 and #5 design contract awarded with a completion date of December 10th.

Assessment and Issues:

- None.

¹ The number of injuries sustained by an average work crew of 100 individuals over a year.

Electron Beam Systems

WBS 1.1, 1.x.2 Controls System

Highlights:

- Management and Safety – To close out the fiscal year without over running the funded accounts required a cut back of all non-essential (to production) effort at ANL for September. The September effort was focused on finishing the Beam Finder Wire units and the electro-mechanical aspects of BPM production. All work finalizing drawings and documentation has been re-planned for October and November.
- BTH – NEH Installation –
 - All Control Racks are AC powered.
 - The PPS Electrical Interconnect and Wiring Diagram drawings were revised to include the interface to MCC and the BSOIC and BTM chassis. The battery charger installation and EEIP is complete. The lighting contactor panels are fabricated and 50% are installed. The BSOIC electrometer power was installed and the cables were terminated.
 - Four BCS PIC HV Chassis were bench tested and calibrated. The Gas System installation started.
 - The MPS device state changes were demonstrated to log in the history server. Progress continues on the MPS System and Database.
 - The Network is operational in B910, B911, B912, B913 and enabled to the undulator racks. The intra-rack cables to EPICS in B912 are installed. The wireless network is online in B921.
 - The B105 vacuum pumps and gauges are online and accessible from EPICS. All Pirani gauges are now operating. All ion pump HV cables are terminated thru the LTU. The PLCs are online in B912 and B921.
 - The Shop has assembled all Linac BPM Preamp chassis and all chassis needed for Phase 4 are complete. All PLL Chassis are installed in the Cavity BPM Racks. All IOCs, EVRs, DIOs, and VME-ADCs are installed in the Cavity BPM VME Crates. The BPM to LH jumper cables are installed and tested and the Cavity BPM signal jumper cables are constructed.
 - The Undulator IOCs 25-16, 14 and 13 are booted and completely connected. The first round of check out has started to make sure all motors can be moved. All Undulator racks are installed and AC powered and all control cables from ANL are available.
 - The MCOR magnet PS in the BSY and BTHW are powered and checked out from B005. Hi-pot testing of all BSY and LTU magnets is underway.

Assessment and Issues:

- None.

WBS 1.2, 1.3, 2.2, 2.3 Injector and Linac Systems

Highlights:

- Linac-To-Undulator (LTU) Design, Procurement and Installation Progress –
 - More than 98% of the drift tubes have been installed in the BTH, aligned and pumped down. The remaining installation in the BTH involve the single beam dump, TDUND, RFBPM and a few missing drift tubes which are in fabrication.
 - The E-dump pit steel installation was completed with Radiation Physics approval. All dump magnets were installed except three permanent magnets which will be installed in October along with the main dump.
 - Welding and cleaning of the LTU bellows has been completed at ANL. They are expected to be delivered early October.

Assessment and Issues:

- None.

WBS 1.4, 2.4 Undulator System

Highlights:

- Undulator Components and System Integration –
 - The additional (6) quad spool units (in addition to the spares) were completed and shipped to SLAC at the end of September.
 - The girder extension support for the first RFBPM arrived was fitted to the LTT at ANL. A small number of holes had to be cleaned out in the machine shop. It will be shipped to SLAC first week of October.
 - Four RFBPM Units were shipped this month. This completes the quantity at SLAC to 36 for production and provides 2 of the 4 required spares. Two spares will be supplied in October. By the end of September, the 36 electronic systems for production were all delivered. The 4 spare electronic units are still being produced at Miteq. It appears Miteq has a parts shortage and are delaying delivery until the end of October.
 - SLAC now has 35 Beam Finder Wire units, 33 are needed for the tunnel installation. The last unit is at ANL in the LTT. It is waiting for some repair work to one of the feed-throughs. This work cannot start until testing is complete.
 - Full BLM Prototype testing was performed at ANL. The results look very promising. A second prototype system consisting of the detector, pmts and interface electronics was sent to SLAC. Production components are in manufacture and are scheduled for delivery to SLAC in November.

- Undulator Assembly and Measurement (SLAC) –
 - 26 girder assemblies are installed and the remaining seven girder assemblies are completed and in MMF for inspection. Installation of all 33 girders will be complete by mid-October.
 - The vacuum shop is installing and leak checking ion pumps on the installed girders.
 - The metrology group is aligning the undulator girders in preparation for installation of the interconnecting vacuum chambers.
 - The Controls group has started connecting cables to the undulator racks.

Assessments and Issues:

- None.

Photon Beam Systems

WBS 1.5, 2.5 X-ray Transport, Optics and Diagnostics (XTOD)

Highlights:

- Management and Safety – The cumulative SPI and CPI for XTOD construction activities are 0.96 and 0.94, respectively. The most significant variance is a delay in initial installation, due mostly to delays in conventional construction. A plan has been formed to recoup the schedule over the next 4 months, so that the installation completion dates should not be affected.
- Mechanical and Vacuum –
 - SLAC has requested that the anchor studs in the NEH, Tunnel, and FEH be replaced by threaded insert anchors. This will require modifications to the drawings and a review of the seismic safety calculations.
 - The FEE template drawings were completed and released by the Engineering Records Center (ERC.) Purchase orders for the Seismic Anchor Templates, Hilti anchors, and hardware for the first half of the FEE were written but were placed on hold pending funding.
 - Analysis and draft seismic safety notes for both the Wall 1 and Wall 2 shielding have been completed.
- XTOD Design & Production Status –
 - K-monochromator –
 - The design of the fixturing for testing the K-Mono system at SSRL was completed. Purchase orders have been written for the parts needed at SSRL but are on hold pending funding.
 - The full set of crystals has been shipped from the vendor.
 - Total Energy (Thermal Sensor) –
 - The stand and vessel arrived at Livermore on schedule. The stand was bolted down and assembly of the vessel begun. The copper parts have arrived as well. The laser safety enclosure is delayed until mid October.
 - Six of the 9 high-resistance thermal sensors have been fabricated, and the others are in process. The 3 low-resistance sensors will be fabricated in October.
 - Soft x-ray Offset Mirror System (SOMS) – SOMS mirrors 1, 2, and 4 were successfully coated with B₄C. The vendor requested more time to complete and evaluate the last two SOMS mirrors, #3 and 5.



A SOMS mirror newly coated with boron carbide.

- Hard x-ray Offset Mirror System (HOMS) – The figure of HOMS mirror 1 was measured in the mid and high spatial frequency regimes. The measured high spatial frequency roughness averaged 0.15 nm, better than our specification of 0.4 nm. The measured mid spatial frequency roughness also averaged 0.15 nm, better than our specification of 0.25 nm.
- Fixed Mask and Slit - CS Patel completed the calculations for the new anchor size for the Fixed Mask and Slit and will update the seismic safety document.
- Gas/Solid/Attenuator/Detector -
 - The attenuator carriage rails were received and installed on the differential pumping sections. All spools and B₄C apertures on the upstream differential pumping section were installed and aligned.
 - The 2nd Gas Detector, having completed all electronic tests, was installed into the downstream differential pumping section. The two B₄C apertures on either side of the Gas Detector were installed and aligned.
- Direct Imager –
 - The stand for the Direct Imager arrived and was bolted down. The vessel and structural parts are slated for delivery in October.
 - Modifications to the beryllium parts of the scintillator assembly were completed and the drawings checked released by the ERC.

Assessment and Issues:

- None.

WBS 1.6, 2.6 X-Ray Endstation Systems (XES)

Highlights:

- Management and Safety – Cost and schedule performance have slightly degraded from last's month: 0.89 for SPI and 0.88 for CPI. Most variances are due to slight delays in procurements, and are expected to disappear soon. However, the AMO design work is expected to take longer than planned. This is not expected to impact milestones for early science, but it is being monitored closely.
- Mechanical Systems –
 - The electron dump stopper fabrication was delayed due to a fabrication error which has been corrected. Completion is projected by mid of October.
 - The shielding design for the collimator C6 on the upstream end of the X-ray transport tunnel is being integrated with the rest of the components at this location, which are provided by the XTOD group. An overall configuration drawing is being released soon which will serve as the reference for these designs.
- Detector Project at Cornell – Characterizing and testing of the prototype detector modules is continuing for the 2D Cornell detector. The work is on track for delivering a fully-working detector chip by the end of calendar year 2008. Design is progressing for a second submission of an improved ASIC chip. Regular meetings continue to take place between the LCLS controls group and Cornell University for integration of the entire detector package.
- Atomic, Molecular and Optics (AMO) Instrument – A design review for the beam path components was prepared and planned for early in October. This review includes many smaller components that make up the AMO instrument: differential pumping, beam viewing screens, laser mirrors, beam confinement apertures, focus verification, and several other components. A cross section cut of the beam path components is shown below.
- XES Controls and Data Systems – Timing tests were performed on the femto-second laser timing system by the LBNL group. The updated prototype system was moved from LBNL to SLAC and tests were performed using the gallery fibers to analyze whether the modified system can now handle the range variation due to temperature changes. The system performed well.

Assessment and Issues:

- None.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)



Beam Transport Hall



BTH with 3 Service Buildings

Issues and Assessments

- The Boiler start-up experienced some minor mechanical issues related to the gas regulator. This is not expected to impact the final completion date but will continue to be monitored.

Highlights:

- Construction Progress –
 - Construction (Turner) is approximately 96% complete. To date, \$3,812K Field Change Orders have been negotiated and approved, <5% of construction progress to date.
 - Central Utility Plant – All major equipment has been tested. Final commissioning is well underway. Training has commenced for SLAC maintenance technicians for operation of equipment.
 - Beam Transport Hall – The final punch-list items are in process of being closed out. Over 50% of punch-list items are complete.
 - Near Experimental Hall – Continued progress on elevator installation. Final paving and striping complete. Punch list has commenced.
 - Far Experimental Hall – Continued work on ductwork, domestic water, and sanitary sewer installation, chilled water rough in, compressed air rough in, installation of feeders and branch circuits, lighting, rough in for restrooms, installation of handrails on the Make-up Air Unit platform.
 - X-Ray Tunnel – Continued progress on MEP final installations.
 - Undulator Hall Tunnel – Continued verification of punch-list items in preparation for Substantial Completion.



LCLS Cost and Schedule Performance – September 2008

LCLS Cost/Schedule Status Report								30-Sep-08		
WBS	Cumulative to Date (\$K)							Budget At Complete (\$K)	Estimate At Complete (\$K)	Variance At Complete (\$K)
	Budgeted Cost		Actual Cost Work Performed	Variance		Performance Indices				
	Work Scheduled	Work Performed		Schedule	Cost	SPI	CPI			
1.1 Project Management	20,251	20,251	19,979	0	271	1.00	1.01	22,822	22,745	76
1.2 Injector	20,239	20,239	20,240	0	0	1.00	1.00	20,239	20,240	0
1.3 Linac	27,376	27,274	26,782	-102	492	1.00	1.02	28,257	27,765	492
1.4 Undulator	44,824	44,994	44,788	170	205	1.00	1.00	46,065	45,860	205
1.5 X-ray Transport	23,220	22,372	23,870	-848	-1,498	0.96	0.94	28,134	29,632	-1,498
1.6 X-ray Endstations	3,817	3,407	3,854	-410	-448	0.89	0.88	9,482	11,999	-2,518
1.9 Conventional Facilities	123,657	121,374	120,718	-2,282	656	0.98	1.01	137,915	139,259	-1,344
1.X LCLS Controls	33,478	33,382	32,647	-95	736	1.00	1.02	41,362	40,626	736
1 LCLS Total Base Cost	296,861	293,293	292,879	-3,568	414	0.99	1.00	334,277	338,127	-3,851
								LCLS Total Estimated Cost	352,000	
								Contingency	17,723	
								% Contingency on ETC	43.2%	
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	17,393	17,393	16,970	0	423	1.00	1.02	24,246	23,823	423
2.2 Injector (OPC)	5,705	5,663	5,923	-42	-260	0.99	0.96	5,789	6,166	-377
2.3 Linac (OPC)	1,933	2,027	2,134	94	-107	1.05	0.95	2,027	2,134	-107
2.4 Undulator (OPC)	6,162	6,057	5,599	-105	458	0.98	1.08	9,904	9,686	218
2.5 X-ray Transport (OPC)	2,860	2,765	2,950	-95	-185	0.97	0.94	4,039	4,224	-185
2.6 X-ray Endstations (OPC)	2,714	2,313	2,255	-401	58	0.85	1.03	8,314	10,256	-1,942
2.9 Conventional Facilities (OPC)	856	817	719	-39	99	0.95	1.14	1,865	1,767	99
2.X LCLS Controls (OPC)	1,868	1,654	1,500	-214	154	0.89	1.10	2,940	2,786	154
2 LCLS Total Other Project Cost	39,491	38,689	38,050	-802	639	0.98	1.02	59,123	60,841	-1,718
								LCLS Other Project Cost	68,000	
								Management Reserve	8,877	
								% Management Reserve on ETC	43.4%	
LCLS Total Project Cost	336,352	331,982	330,928	-4,370	1,054	0.99	1.00	420,000	84%	

Cost and Schedule Performance (con't)

Overall Cost and Schedule Assessment

<u>September 2008 Project Performance</u>	AYK\$
Total Project Cost (TPC)	\$420,000
Planned % Complete	85.5%
Actual % Complete	84.4%
Total Estimated Cost (TEC)	\$352,000
Cost and Commitments to Date	\$297,943
Estimate at Complete	\$338,127
Work Remaining	\$45,248
Outstanding Phase-Funded Awards	\$3,109
Remaining Contingency (Based on EAC)	\$13,873
% Contingency on uncommitted work remaining	32.3%

The LCLS cost and schedule are consistent with the approved baseline with a Total Estimated Cost (TEC) of \$352M and a Total Project Cost (TPC) of \$420M. The CD-4 milestone is July 2010. All costs are in actual-year dollars and out-year costs are escalated.

The September 2008 Cost Performance Report is the 55th month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$332,750K. Cost and schedule indices are 1.00 and 0.99, respectively.

The project critical path runs through the Soft X-ray Offset Mirrors and has 108 working days (~5 months) of float to CD-4. Near critical path activities are the XES PPS and XTOD Pop-Up Cameras.

Civil construction activities remain behind schedule for Beneficial Occupancy of the FEH facilities although this month indicated a substantial improvement in schedule variance. Early installation of technical equipment will continue to be installed by SLAC to maintain the overall schedule float to CD-4.

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. LCLS is evaluating possible scope additions to the approved baseline. Any added scope will be presented to the LCLS Change Control Board for approval prior to being added to the baseline.



DOE (Level 2) Milestones

Milestone	Baseline	Projected	Variance	2006			2007			2008			2009			2010	
				Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr
Level 2 DOE (SSO) Milestones	Fri 8/29/08	Fri 2/26/10	368 days														
DOE External Independent Review (EIR) Complete	Tue 6/15/04	Tue 6/15/04	0 days														
Prelim Safety Assessment (PSAD) Doc Approved	Tue 2/28/06	Tue 2/28/06	0 days	●													
Delivery of Undulator 1st Articles to MMF	Mon 7/3/06	Thu 6/15/06	-12 days		●	●											
Sector 20/Alcove Beneficial Occupancy	Fri 7/21/06	Fri 4/14/06	-70 days	●		●											
MMF Qualified & Ready to Measure Prod Undulators	Mon 8/28/06	Mon 8/28/06	0 days			●											
Research Yards Mods Beneficial Occupancy	Fri 10/20/06	Wed 8/30/06	-37 days			●											
Start Injector Commissioning (Drive Laser)	Mon 1/29/07	Fri 12/15/06	-22 days				●	●									
Injector Laser Commissioning Review Complete	Wed 1/31/07	Fri 12/1/06	-34 days				●	●									
Injector Accelerator Readiness Review (ARR) Comp	Wed 1/31/07	Fri 3/30/07	42 days					●	●								
Start Injector Commissioning(UV Beam to Cathode)	Mon 4/9/07	Thu 4/5/07	-2 days					●	●								
Linac Water/Power Available	Wed 7/11/07	Thu 3/29/07	-74 days					●	●								
Start Installation of Undulator Facility	Fri 5/16/08	Thu 8/14/08	64 days							●	●						
BTH-UN-FEE-NEH-CUP Beneficial Occupancy	Mon 7/21/08	Thu 8/14/08	18 days							●	●						
Linac (Li20-Li30) Commissioning Complete	Wed 7/30/08	Tue 4/1/08	-86 days							●	●						
Safety Analysis Document (SAD) Approved	Fri 8/29/08	Tue 9/23/08	17 days								●	●					
Start Installation of Beam Transport Hall	Fri 9/26/08	Thu 7/31/08	-41 days								●	●					
XT-FEH Beneficial Occupancy	Wed 10/22/08	Mon 11/17/08	18 days									●	●				
XT Start FEE Installation	Tue 1/13/09	Tue 1/13/09	0 days										●	●			
Beam Path Project Close Out	Thu 2/12/09	Thu 2/12/09	0 days											●	●		
LCLS ARR Complete (BTH thru FEH)	Fri 4/17/09	Fri 4/17/09	0 days												●	●	
Start Linac-to-Undulator (LTU) Commissioning	Mon 4/20/09	Mon 4/20/09	0 days													●	
XT Start Tunnel Installation	Wed 5/27/09	Wed 5/27/09	0 days													●	
Start Undulator Commissioning (1st Light)	Mon 7/6/09	Mon 7/6/09	0 days													●	
XE Start Installation in NEH	Fri 7/24/09	Fri 7/24/09	0 days													●	
2-D Detector Shipped to SLAC	Thu 7/30/09	Thu 7/30/09	0 days													●	
Start FEE Commissioning with Beam	Thu 8/6/09	Thu 8/6/09	0 days													●	
First X-Rays into NEH, Initiate Early Operations	Thu 9/10/09	Thu 9/10/09	0 days													●	
XE Start Installation in FEH	Thu 9/17/09	Thu 9/17/09	0 days													●	
First X-Rays into FEH	Fri 2/26/10	Fri 2/26/10	0 days													●	

Baseline (Blue Circle), Projected (Red Diamond), Actual (Green Circle Diamond)

Glossary

Actual 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 LCLS 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.

Other Project Cost (OPC) – LCLS “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 the LCLS.

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 capital budget authorized for the LCLS project for the construction phase of the project. TEC includes contingency but does not include OPC.

Total Project Cost (TPC) – The total capital budget authorized for the LCLS project, including TEC 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 LCLS work plan which is used to track all resources, schedules, and cost