

Linac Coherent Light Source Monthly Report February 2009



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Project Overview and Assessment

Highlights:

- Cover Page (LCLS Front End Enclosure) – Workers are installing the X-ray attenuator and the pulse intensity monitoring system into the LCLS Front End Enclosure. These are the first pieces of X-ray diagnostic equipment, designed and constructed at LLNL and recently delivered to SLAC. The project is on schedule to begin the commissioning the LCLS X-ray beam in the May-June timeframe. The Front End attenuator and diagnostics will be used to optimize the operation of LCLS in preparation for first X-ray science experiments starting in the fall of 2009.
- Seventeen undulator magnets are ready for installation (RFI). They are stored in the Undulator hall and are scheduled for installation during a 3-week shutdown in March.
- Soft X-Ray Material (SXR) Instrument -
 - The Memorandum of Understanding between DESY, the University of Hamburg, and SLAC has been signed. Details of how to transfer the funds from Germany to SLAC are being worked out among the financial departments of the participating institutions.
 - The SXR installation schedule is being integrated into the overall LCLS schedule.
- Turner Construction Co.-managed activities are complete with the exception of punch list items and demobilization of construction trailers.
 - Overall progress is over 99% complete.
 - Field Change Orders on the order of \$3,777K have been negotiated and approved. This remains at <5% of field construction change orders.

Assessment and Issues:

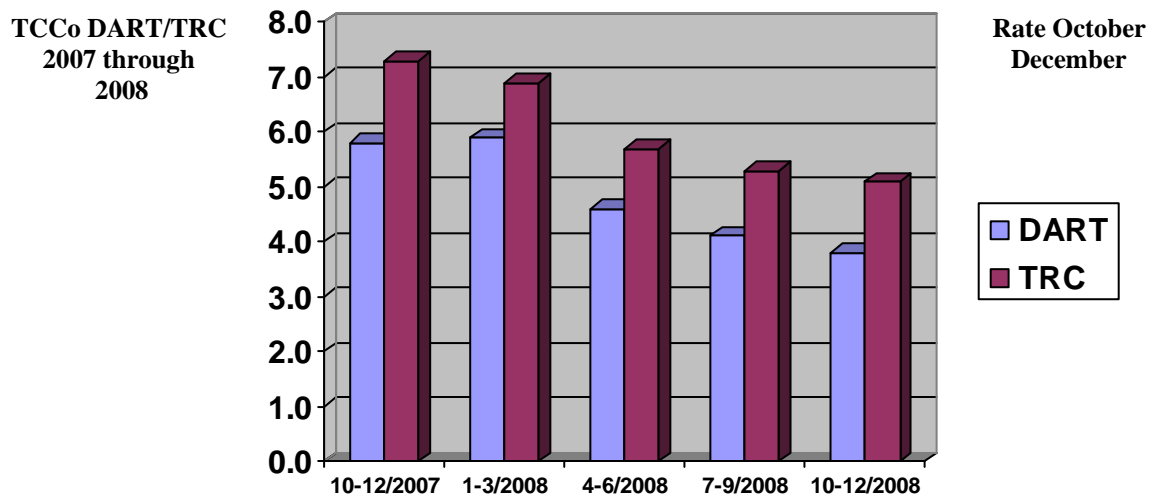
- The February 2009 Cost Performance Report is the 60th month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$364,137K. Cost and schedule indices are 1.00 and 0.97, respectively.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status –
 - The project has worked 226 days without a restricted or lost time injury and 140 days without a recordable injury. Total project hours are 2.14M comprised of 1,546K collaboration hours and 594K subcontracted hours.
 - The project DART rate for construction is currently 3.0¹, as compared to the general industry rate of 3.2. The total project DART rate is 1.0; this includes construction and collaboration hours.
 - The chart below shows the day's away/restricted time (DART) and total recordable case (TRC) rates for the Turner Construction managed work on the LCLS project for approximately the last year. The rates were unacceptable at the beginning of the period and declined over the duration of the period with project intervention. The decline was associated with:
 - improvements in TCCo oversight,
 - improvements in the subcontractor work planning and control process (WPC),
 - weekly teleconferences between TCCo executives and project executives to specifically discuss safety,
 - addition of two project technical field representatives whose primary focus was safety and WPC oversight,
 - partnering with the Labs ES&H construction safety subject matter experts,
 - partnering with the DOE Stanford Site Office in field oversight.



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

- LCLS Procurements Status –
 - Construction Procurements (Turner) –
 - One modification was issued during February (Modification 079 with three CORs). One Field Change Order was issued during February to add SWPPP to the restored former trailer site.
 - A total of 494 Field Change Order (FCOs) and Change Order Requests (CORs) have been settled, through negotiation or agreement, with issuance of Modifications.
 - Technical Procurements –
 - Orders continued to be placed for several AMO technical instruments and assembly parts throughout the month.
 - A Blanket Purchase Order agreement for misc. small construction jobs was drafted to decrease procurement time for miscellaneous small construction projects associated with LCLS start up.
 - CUP structural engineering and analysis project was completed.
 - FEH Hutch #6 design contract awarded.
 - Cable Plant Phase 6 awarded completion scheduled for June 2009.
 - Roll-up doors for Hutches 1-3 ordered.
 - Draft bids developed for fabrication and installation of Structural Steel mezzanine in the FEH commenced.

Assessment and Issues:

- None.

Electron Beam Systems

WBS 1.1,1.2,1.3,1.4,2.2,2.3,2.4 Injector, Linac and Undulator Systems

Highlights:

- Management and Safety –
 - Electron beam commissioning continues to make excellent progress. An undulator magnet was installed on the beamline to test for any unforeseen beam effects and to check for magnet degradation due to radiation effects.
 - Efforts to close out the post-start action items from the Undulator Complex ARR continue. This is in preparation for authorization to transport the x-ray beam out of the electron dump area and into the Front End Enclosure (FEE).
- BTH – NEH Controls Installation –
 - The FEE Personnel Protection System chassis has been built and installed. Also, work has commenced on the PILZ programming chains A & B, the audio message chassis, and the Allen/Bradley I/O. The PPS EPICS hardware was installed, the stoppers wired and tested, and the preset and reset boxes built.
 - The Hutch PPS Panel Final Design Review was successfully completed.
- Undulator Assembly and Measurement (SLAC) –
 - Work continues on the installation drawings for two phase cavities in the dump line. Detail drawings are finished and parts are ordered.
 - Preliminary work has commenced for installation of two new wire scanners, one in the Dump and one in the BTHW.
 - 17 undulator magnets are RFI and are scheduled for installation in March. One magnet was installed at station U-25 as a test for any unforeseen beam effects. Initial results indicate that the undulator sub-micron position control is working well and the measured field integrals compare very favorably with Hall probe measurements conducted in the MMF. Also, the radiation dose on the magnet was measured indicating a very low dose (<500 mrem) accumulated over 4 weeks with an electron beam.
 - An aperture restriction was investigated in the X-ray line. The BYD vacuum chamber was aligned to improve the situation and confirm the location. A bellows with a small ID was replaced. More effort will be expended to get the stay-clear completely within spec in March.

Assessments and Issues:

- None.

Photon Beam Systems

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

Highlights:

- Management and Safety – Schedule variances were reduced in most areas of XTOD during February, though the installation schedule slipped due to a delay in funds transfer from SLAC to LLNL. Since most components are now complete at LLNL and about to be shipped to SLAC, significant installation progress is expected in March. Readiness for first light in May should be achieved, on schedule. In addition, all remaining work is being scrutinized to make sure that cost estimates are accurate.

- Mechanical & Vacuum –
 - The Wall 1 Beam Tube Support and Isolation Valve Support have been ordered and are due the week of 3/16/09.
 - All drawings for all of the collimators have been released or are in check. The orders for the tungsten and B₄C are being prepared. The vendor estimates a 6-8 week delivery date for the tungsten and a 9 week delivery for the B₄C. IGES/STEP files for the tungsten and B₄C holder were sent to SLAC for fabrication.
 - The Wall 2 vertical plate rail location layout was sent to SLAC. LLNL is waiting for survey data, which is critical for making sure the holes in the shielding are in the correct locations.

- XTOD Design & Production Status –
 - *K*-monochromator – 55 of 56 drawings have been finalized and released to the ERC. The stand and vessel have been received and the other parts are on order except for the reticules and diode mounting hardware.
 - Fixed Mask and Slit - The Fixed Mask and Slit are at SLAC awaiting bakeout. After bakeout, the Slit blocks need to be reassembled and measured prior to installation in the FEE.
 - Gas/Solid/Attenuator – The Gas / Solid Attenuator has been shipped to SLAC. It was discovered that the seismic anchors in FEE have been buried too deep, leaving insufficient rod length to mount the Gas Attenuator at the correct height. The anchors will be extended as soon as a new seismic analysis can be completed.
 - Direct Imager – The Direct Imager was disassembled for bakeout. The vessel and scintillator carriage were baked out. The AR coated optical windows will be baked out at a lower temperature. After bakeout, the unit will be reassembled for shipment to SLAC. The image-analysis algorithms were re-coded in C as EPICS genSub records for increased speed.

- SOMS – The coated mirrors, mounts, and vacuum vessels were baked out individually. The mirrors will soon be installed in the vessels, and the assemblies will be baked again at 80 C. Wiring of the SOMS racks is in progress.
- HOMS – SiC coating of test pieces with uniformity of 0.36 nm rms across the 385 mm HOMS clear aperture was demonstrated, meeting the 1 nm rms specification. Coating of the HOMS mirrors is about to commence.
- Total Energy Thermal Sensor - The Pulse Tube cold head has been brought to SLAC so that it can be returned to the vendor to have the Lemo feedthrough connector replaced with a UHV compatible metal plug, and to have the o-rings in the high-pressure helium section replaced with viton o-rings to allow the unit to be baked to 125 C.
- Pop-ins –
 - All cameras, scintillator, and lenses have been received. The order for the linear feedthroughs was released and delivery is expected in 8-10 weeks. The order for the Alpha Pop-In Monitor mirrors was released with an expected delivery in 4 weeks.
 - The drawings for the Alpha Pop-In Camera mechanical parts are complete and as soon as they are checked we will have the first article/prototype parts manufactured.

Assessment and Issues:

- None.

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

Highlights:

- Management and Safety – The cost and schedule performance indicators for WBS 1.6 are steadily improving as the procurements for AMO and other sections are catching up with our baseline plan. The delivery and installation dates continue to be monitored very closely. Further improvement of the SPI variance is expected in the coming months.
- Mechanical Systems -
 - The hutch stoppers for the NEH hutches are ready for installation. Fabrication of the second set of stoppers for the Far Hall hutches has started. The design of the shielding requirements of the upstream stopper in the x-ray tunnel has been completed and submitted for fabrication.
 - The PPS and laser hutch door installation contracts for the Near Hall hutches are nearly finalized. It was recently decided to add an overhead crane in hutch one of the Near Hall (a scope increase in the Conventional Facilities area). This contract is expected to be released next month.
- LCLS Detector Contract with Cornell University - Several boards (carrier and analog type) have been fabricated at SLAC and sent to Cornell to be tested for building up a complete prototype detector. A vacuum test setup is available at Cornell for outgassing tests of the first article detector module. These two 2x1 modules on carrier-board and strong-back are planned to be available in the coming month. SLAC has allocated a clean room for module assembly. An interface drawing is being developed for the CXI instrument, in order to specify the final integration. Close collaboration between SLAC and Cornell is continuing in weekly meetings.
- XES Laser System – The laser group activities for the NEH laser system during February included installation of the laser table enclosures in the NEH laser hall and continued laser component procurements. A temporary laser Standard Operating Procedure (SOP) was created for the NEH Laser Hall to allow for acceptance testing of the lasers by the vendors.
- Atomic, Molecular and Optics (AMO) Instrument –
 - The design phase of the AMO instrument is being finalized. A design review for the slit system was completed and drawings are being drafted. Long-lead materials for the slit system are in procurement and the fabrication job is being submitted at SLAC.
 - All the main AMO chambers have been received from the vendors. These chambers were inspected and are undergoing cleaning and hydrogen firing processes.
 - Sub-assemblies of the AMO instrument have started at the Mechanical Fabrication Department (MFD) at SLAC. Completion of several

assemblies will be possible soon as parts are being expected from suppliers in the coming weeks. The procurement phase is being monitored closely and expediting of critical purchased parts has been requested.

- Top frame assemblies for the instruments have been assembled with temporally fixed jacks and will be replaced with movable jacks when they become available. A work order has been submitted to MFD for fabrication and all purchase parts have been ordered for the jacks.
 - The remaining design reviews for the Optics Focusing System (built at Lawrence Berkeley Lab) and the Magnetic Bottle Spectrometer (built at Ohio State University) are planned for March.
- XES Controls and Data Systems – The Laser Safety system installation in the NEH Laser Room is nearly complete, and laser control equipment is being assembled. Servers and data-caches in the NEH server room are being installed. Procurement of the SXR controls equipment was started, and there is continued progress on the data acquisition software for the ATCA control and data readout and processing electronics.
 - Soft X-Ray Material (SXR) Instrument -
 - The Memorandum of Understanding between DESY, the University of Hamburg, and SLAC has been signed. Details of how to transfer the funds from Germany to SLAC are being worked out among the financial departments of the participating institutions.
 - The SXR installation schedule is being integrated into the overall LCLS schedule.

Assessment and Issues:

- None.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)

Highlights:

- Construction Progress –
 - All areas (BTH thru FEH) – continued progress on final five punch-list items, and close-out of all bid packages and trade subcontractors.
 - Field Change Orders on the order of \$3,777K have been negotiated and approved. This remains at <5% of field construction change orders.
- Design For Experimental Hall Hutches – FEH design was awarded. FEH design has commenced and successfully reached the 90% completion milestone.
- Design Office Space Alternative –
 - Conceptual Design for the Office Space Alternative was awarded. This fast-track design effort will develop the Conceptual Design Report for a new building. The final CDR is due at the end of March, 2009.
 - Building 028 and Building 751 remodeling: the completion and preparation of the Issue-for-Bid documents were awarded to HDR-CUH2A. The IFB documents are due end of April, 2009.
 - The final selection of LCLS office space will be made by May 15th, 2009.

Assessment and Issues:

- The scheduled 90% submittal for the FEH hutches was received but lacked several QC elements. Therefore the 90% submittal was rejected and returned to the A/E for revision and re-submittal. A meeting was held with the A/E and their engineering consultants to ensure the A/E and their consultants will provide a high quality design package on this second iteration.
- The structural steel design for the FEH has been advanced to nearly 100%. LCLS will make provisions to allow the structural steel to be bid separately from the remaining work. It is predicted that the advantages to this approach will include a savings to cost, schedule and safety as the effort will be managed directly by the LCLS CF group.
- Red-lined mark-ups by TCCo and the subcontractors are a part of the close-out phase and are roughly 50% complete during this reporting period.



LCLS Cost and Schedule Performance – February 2009

LCLS Cost/Schedule Status Report										28-Feb-09	
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	21,005	21,015	20,355	10	660	1.00	1.03	22,599	21,939	660	
1.2 Injector	20,239	20,239	20,240	0	0	1.00	1.00	20,239	20,240	0	
1.3 Linac	27,948	27,948	27,965	0	-18	1.00	1.00	27,948	27,965	-18	
1.4 Undulator	45,795	45,702	45,734	-93	-32	1.00	1.00	46,030	45,848	182	
1.5 X-ray Transport	27,349	24,346	26,863	-3,003	-2,518	0.89	0.91	28,708	31,276	-2,568	
1.6 X-ray Endstations	6,898	5,634	5,764	-1,264	-129	0.82	0.98	10,569	10,899	-329	
1.9 Conventional Facilities	130,847	127,398	128,236	-3,448	-838	0.97	0.99	139,849	140,687	-838	
1.X LCLS Controls	37,488	36,700	36,893	-788	-192	0.98	0.99	41,937	42,130	-192	
1 LCLS Total Base Cost	317,569	308,982	312,050	-8,587	-3,068	0.97	0.99	337,879	340,983	-3,104	
								LCLS Total Estimated Cost	352,000		
								Contingency	14,121		
								% Contingency on ETC	48.9%		
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	19,365	19,366	18,528	1	839	1.00	1.05	24,438	23,600	839	
2.2 Injector (OPC)	5,890	5,891	6,199	1	-309	1.00	0.95	5,892	6,201	-309	
2.3 Linac (OPC)	2,094	2,094	2,184	0	-90	1.00	0.96	2,334	2,424	-90	
2.4 Undulator (OPC)	8,356	7,642	7,251	-714	391	0.91	1.05	10,169	10,028	141	
2.5 X-ray Transport (OPC)	3,015	3,034	3,259	19	-225	1.01	0.93	4,185	4,411	-225	
2.6 X-ray Endstations (OPC)	4,653	4,179	2,936	-475	1,242	0.90	1.42	10,408	9,165	1,242	
2.9 Conventional Facilities (OPC)	1,229	1,220	1,241	-9	-21	0.99	0.98	2,632	2,653	-21	
2.X LCLS Controls (OPC)	2,812	2,371	2,113	-441	258	0.84	1.12	3,541	3,283	258	
2 LCLS Total Other Project Cost	47,414	45,796	43,711	-1,618	2,085	0.97	1.05	63,599	61,764	1,835	
								LCLS Other Project Cost	68,000		
								Management Reserve	4,401		
								% Management Reserve on ETC	24.7%		
LCLS Total Project Cost	364,983	354,778	355,761	-10,205	-983	0.97	1.00	420,000	88%		

Cost and Schedule Performance (con't)

Overall Cost and Schedule Assessment

<u>February 2009 Project Performance</u>	AYK\$
Total Project Cost (TPC)	\$420,000
Planned % Complete	90.9%
Actual % Complete	88.4%
Total Estimated Cost (TEC)	\$352,000
Cost and Commitments to Date	\$317,049
Estimate at Complete	\$340,983
Work Remaining	\$28,933
Outstanding Phase-Funded Awards	\$5,361
Remaining Contingency (Based on EAC)	\$11,017
% Contingency on uncommitted work remaining	45.0%

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 February 2009 Cost Performance Report is the 60th month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$364,137K. Cost and schedule indices are 1.00 and 0.97, respectively.

The critical path to meet CD-4 technical performance runs through the Soft X-ray Offset Mirrors and has 108 working days (~5 months) of float. Near critical path activities are the XES PPS and XTOD Pop-Up Cameras. The critical path to meet CD-4 overall performance runs through the LCLS space renovation has 83 working days.

The Estimate at Complete (EAC) provides the most current estimate of the TEC projected final cost. Contingency on EAC is considered adequate for this stage of the project. LCLS is evaluating possible enhanced capabilities to the baseline. Any added capabilities will be presented to the Change Control Board for approval prior to being added to the baseline.

DOE (Level 2) Milestones

Activity Description	Base Date	Base vs Curr	Current Date	Fiscal Year							
				FY04	FY05	FY06	FY07	FY08	FY09	FY10	
DOE Milestone - Level 2											
Preliminary Safety Assessment (PSAD) Doc Comp	04/30/04	0	04/30/04A								
DOE External Independent Review (EIR) Complete	06/15/04	0	06/15/04A								
Fire Hazard Analysis Approved	06/30/05	-31	08/15/05A								
Preliminary Safety Assessment (PSAD) Doc Appvd	02/28/06	0	02/28/06A								
Delivery of Undulator 1st Articles to MMF	07/03/06	12	06/15/06A								
Sector 20 Alcove Beneficial Occupancy	07/21/06	68	04/14/06A								
MMF Qualified & Ready to Measure Prod Undulators	08/28/06	0	08/28/06A								
Research Yards Mods Beneficial Occupancy	10/20/06	36	08/30/06A								
Start Injector Commissioning (Drive Laser)	01/29/07	19	12/15/06A								
Injector Laser Commissioning Review Complete	01/31/07	31	12/01/06A								
Injector Accelerator Readiness Review (ARR) Comp	01/31/07	-41	03/30/07A								
Start Injector Commissioning(UV Beam to Cathode)	04/09/07	2	04/05/07A								
Linac Water/Power Available	07/11/07	72	03/29/07A								
Linac (LI20-LI30) Ready for Commissioning	12/01/07	0	12/01/07A								
Start Installation of Undulator Facility	05/16/08	-62	08/14/08A								
Beam Transport Hall Beneficial Occupancy	07/21/08	-18	08/14/08A								
Undulator Facility Beneficial Occupancy	07/21/08	-18	08/14/08A								
Front End Enclosure Beneficial Occupancy	07/21/08	-21	08/19/08A								
Near Experimental Hall Beneficial Occupancy	07/21/08	-19	08/15/08A								
Central Utility Plant Beneficial Occupancy	07/21/08	-19	08/15/08A								
Linac (LI20-LI30) Commissioning Complete	07/30/08	84	04/01/08A								
Safety Analysis Document (SAD) Approved	08/29/08	-19	09/28/08A								
Start Installation of Beam Transport Hall	09/26/08	-2	09/30/08A								
X-Ray Transport Beneficial Occupancy	10/22/08	-18	11/17/08A								
Far Experimental Hall Beneficial Occupancy	10/22/08	-17	11/16/08A								
XT Start FEE Installation	01/13/09	-39	03/11/09								
Beam Path Project Close Out	02/13/09	-154	09/18/09								
LCLS ARR Complete (BTH thru FEH)	04/17/09	0	04/17/09*								
Start Linac-to-Undulator (LTU) Commissioning	04/20/09	0	04/20/09*								
XT Start Tunnel Installation	05/27/09	0	05/27/09*								
Start Undulator Commissioning (1st Light)	07/06/09	0	07/06/09*								
XE Start Installation in NEH	07/24/09	35	06/04/09*								
Start FEE Commissioning with Beam	08/06/09	0	08/06/09*								
First X-Rays into NEH, ready to start Expt'l Ops	09/10/09	0	09/10/09*								
XE Start Installation in FEH	09/17/09	0	09/17/09*								
2-D Detector Shipped to SLAC	02/26/10	0	02/26/10*								
First X-Rays into FEH	02/26/10	0	02/26/10*								

Start Date	07/19/06	FBP_Level 2 Milestones	LCLS PROJECT Milestone Level 2
Finish Date	09/17/10		
Data Date	03/01/09		
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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 under run” 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.