

Linac Coherent Light Source Monthly Report September 2007



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Project Overview and Assessment

Highlights:

- Cover Page – SLAC Accelerator enclosure during the 2007 Linac shutdown. The shutdown began on September 4th and is scheduled to end on December 7th, 2007. Here, a sub-contractor is drilling anchor holes for supports for the second LCLS Bunch Compressor center table. During the first two weeks, SLAC technicians removed accelerators and diagnostics components in sector 24 (as shown on the picture) to make room for the second LCLS Bunch Compressor.
- The construction phase for the LCLS major civil activities is being managed by the Turner Construction (TCCo). Overall construction is ~59% complete. To date, \$1,273K Field Change Orders have been negotiated and approved, which is less than 3% of construction progress to date.
- The LCLS project presented its revised cost and schedule baseline to DOE's Office of Science a mini-(Lehman) review on September 18.
 - The Committee found that the project had addressed the recommendations from the July 10-12, and that its revised baseline was sound.
 - The Committee expressed concern that the Project Office staff was still too thin and requested that a management staffing plan to augment the management team be developed and implemented prior to rebaseline.
 - The project team is now preparing to present its revised cost and schedule baseline to an OECM External Independent Review (EIR) on October 9-12, 2007 to validate the revised cost and schedule baseline.

Assessment and Issues:

- The September 2007 Cost Performance Report is the 43rd month reporting earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$258,245K. The LCLS cost and schedule indices are 0.95 and 0.87, respectively. The SPI ('yellow' on the PARS threshold) is primarily driven by CR impacts (which are unrecoverable and require replanning) and delays in civil construction. The civil construction effort continues to show a schedule delay but is projected to recover to near its original schedule over the next few months.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status –
 - LCLS worked 7 days without a lost time injury at SLAC [9/21 DART]. Total project hours are 1.38 M comprised of 1.1 M collaboration hours and 280 K subcontracted work hours.
 - The LCLS project lost time injury rate is currently 2.90¹, as compared to the general industry rate of 3.2 and DOE rate of 0.6 for similar work. The total project lost time injury rate is 0.9; this includes construction and laboratory hours.
 - Safety Training Metrics –
 - Mandatory safety training = 96% (goal = 93%)
 - Supervisor required safety training = 98% (goal = 93%)
 - Compliance for training assessments = 98% (goal = 92%).
 - Medical exams for affected employees = 100% (goal = 90%)
 - DOE SSO/Oakridge Electrical Safety Review –
 - The SSO with the support of ORO subject matter experts performed an Electrical Safety Assessment of the laboratory. For LCLS construction work the assessment was of Turner construction and of the Electron Beam Systems linac work.
 - The assessment consisted of meetings with the program managers to discuss the work in progress, document review related to electrical safety followed by worksite inspections.
 - Construction Safety (Turner Construction) –
 - Possible Worker Exposure – A tunnel subcontractor monitoring of air borne asbestos resulted in a reading above the regulatory limit. This information was transmitted to the project on 21 September; an investigation was immediately initiated.
 - The investigation has shown that similar samples since March 2007 are below regulatory permissible levels. Further, it has been learned that the sample may have been compromised prior to testing and an incorrect test method was performed. Several corrective actions are implemented.
 - DART Case – On September 21, a worker strained his back while handling materials. The worker was examined, prescribed medication and assigned restricted duty. This case represents the fourth DART in six months under Turner's management. The Project is alarmed by the safety trend and has formally convened

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

- a SLAC/TCCo team to investigate the incidents, develop corrective actions and an implementation plan.
- TRC Case – On September 12 a worker was using a hammer drill overhead and liberated concrete dust and particles that penetrated behind the workers safety glasses causing eye irritation. The work performed is very common on the project and its hazards are being reevaluated based on this incident. In particular, face and eye protection methods will be reviewed for adequacy.
 - Safety Observation Process – The construction planning look-ahead is reviewed for tasks high-lighted with safety flags. Safety concerns center around new subcontractors beginning work and ensuring they understand site expectations and work that is at height or with hazardous materials. In addition attention is applied to the field work planning documents.
- LCLS Procurements in September 2007 –
 - The LCLS Procurement Department experienced a heavy level of activity in September 2007, due to managing new and on-going issues with the Turner subcontract, as well as issuing and negotiating several Field Change Orders (FCOs) and Change Order Requests (CORs).
 - A/E Design (Jacobs) – Subcontract Mod 27 to incorporate two minor design change requirements was executed.
 - Construction Procurements –
 - SLAC and TCCO attorneys/staff continued to meet in an effort to settle claims disputes outside of arbitration. Weekly OAC meetings continue to be held and are very productive.
 - FCOs/CORs–
 - A total of 155 FCOs and CORs have been settled through negotiation or agreement.
 - 47 FCOs and CORs are open in technical review, fact finding, or negotiation.
 - PG&E on-site Gas Meter installation – Planned for DOE award. This procurement requires significant support from SLAC procurement and CF personnel with several issues outstanding.
 - Technical Procurements –
 - Cable Plant Installation Phase 3 (BC2/BSY) – Shutdown related. Completion date remains at the end of November 2007; however, potential changes may extend completion date.
 - Intermediate Power Supplies – Split procurement with July and September deliveries. July delivery delayed due to back orders with sub-vendors. Initial power supplies have been delivered with the remainder due in January. No impact to project schedule.

Assessment and Issues:

- None

Electron Beam Systems

WBS 1.1, 1.x.2 Controls System

Highlights:

- Injector Controls Commissioning – Complete. All goals met.
- 2007 Shutdown Installation Progress –
 - Delivery of cabling for the Linac/BC2 installation is complete. The installation of all cable trays in the linac is complete. The installation of the cable plant for the linac BPM upgrade in sectors 21-30 is complete.
 - The Controls group received all the required electronics modules for BC2 installation including the timing system components from Finland.
- Controls Design and Procurement Progress –
 - During the Undulator week at ANL, Controls organized a dedicated session to review the details of the undulator beam loss monitor. This resulted in the adoption of a simplified design that would fit the tight budget and schedule restraints for the BLMs. The meeting also resulted in developing a Controls rack layout for the undulator hall, including the motion control and WPM racks.
 - Design of the cable plant and the tray layout for the LTU/Undulator/E-Dump is making progress. Over 75% of the required cable plant has been documented in the CAPTAR database.
 - The DL2 bends (BX30's) and BYD bends will be operated from the same power supply in order to simplify the Beam Dump PPS system. An additional boost power supply will be utilized to balance the strengths of the two magnet strings.
- Controls Software Support –
 - Major progress was made in developing an online accelerator modeling software. This is based on the XAL system from SNS and now provides optics model for the injector beam line.
 - As requested by LCLS Physics, work was started on a new configuration control and saves & restores facility for the EPICS control system. This will replace the old software provided by the legacy SCP system. The first version will be ready for BC2 commissioning.
 - The online Oracle database project is proceeding well, and now includes the entire LCLS beam line. This will be used as the foundation for online modeling, configuration control, cable plant documentation, etc.

Assessment and Issues:

- None

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

Highlights:

- Injector Commissioning – Complete. All goals met.
- 2007 Shutdown Installation Progress –
 - The 2007 installation period started on September 4th. MFD technicians removed all components from sector 24-7, 8 and 9 in preparation for BC2 installation, and penetrations were cleared for cable installation. L3 installation is also underway.
 - Three out of the four BC2 dipole magnets were magnetic measured and are ready for installation. However, both coils of the fourth magnet are out of specification. Arrangements have been made for Everson Tesla to replace the damaged coils.
- Linac-To-Undulator (LTU) Design and Procurement Progress – The Statement of Work (SOW) for installation of the LTU support stands has been generated and approved by the building inspection office. Installation drawings are being generated and are expected to be complete by December 2007.

Assessment and Issues:

- Both coils of the fourth BC2 dipole magnet are out of specification. Arrangements have been made for Everson Tesla to replace the damaged coils. The installation of this magnet during this installation period is in doubt.

WBS 1.4, 2.4 Undulator System

Highlights:

- Management & Safety –
 - The ANL Integration Engineering position has been filled with Bill Berg from ANL-APS. This is an important step in improving the quality of components delivered to SLAC. The SLAC Undulator group was reorganized to focus manpower on production, integration and installation.
 - ANL hosted an “LCLS Undulator Week” with a significant number of the Undulator team in attendance. They discussed issues, deliveries and exchanged engineering ideas to improve system coordination. It is planned to hold another “Undulator Week” in January at SLAC.

- Undulator Components & System Integration –
 - Support Movers – Three first-article Support and Motion Systems units were delivered to SLAC with all known issues corrected. Work is proceeding to identify any additional changes and implement them in all remaining Support and Motion Systems.
 - Beam Position Monitors – The RF BPM team worked on all aspects of component procurements for the BPM. Variations in response quotes from the vendors for the BPM body made the selection very difficult. Re-quotes are being evaluated now.
 - Vacuum Chamber – The vacuum chamber production schedule is being worked to meet the delivery schedule: First chambers by January 26, all vacuum chambers deliveries by the end of April. Polishing will be accelerated by paying an OT premium.

- Undulator Assembly & Measurement –
 - Three sets of pedestals and girders were received. One set has been installed in building 750 and one girder sent for inspection. Preparations continue in building 750 for girders assembly activities.
 - Production tuning of the undulators continued. The 14th undulator was completed and the 15th is being measured.
 - All 140 wire monitors were received from RWI and mechanically inspected. All aluminum post and strongbacks for wire tube supports plates are complete. All six wire monitor system computers were received and tested.

Assessments and Issues:

- Considerable effort is being applied to the revision of the P3 resource-loaded schedule and budget, particularly in updating the Undulator cost estimates and schedule revisions due to the effects of the FY07 CR.

Photon Beam Systems

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

Highlights:

- Management and Safety – The Basis of Estimate data for the XTOD systems was assembled into a common electronic document in preparation for the EIR.
- XTOD Design Status and Progress –
 - Gas Attenuator – Purchase orders for the actuators for the 6-strut system supporting the Gas Attenuator differential system have been written.
 - Solid Attenuator – The order for slicing and polishing the attenuators from a block of O-30-H Be has been placed.
 - Total Energy monitor – As recommended by the FAC, an alternative sensor configuration has been developed as backup to the high-speed, single-pulse sensor design. Rather than examine each X-ray pulse, the alternative sensor would measure the average energy deposited by a series of pulses. This avoids possible systematic effects that might reduce accuracy for the high-speed sensor.
 - Soft x-ray Offset Mirror System (SOMS) – The vendor received the contract modifications for the 5 complete mirrors and 1 “dummy” mirror. The finished mirrors are expected in February 2008.
 - Hard x-ray Offset Mirror System (HOMS) – A Preliminary Design Review (PDR) of the HOMS was conducted on September 20. Tom McCarville showed the results of interferometer measurements of the change in figure induced in a surrogate (Pyrex) mirror mounted in the prototype HOMS bender.
 - Gas Detector – Conditions under which the gas detector signal will be strictly linear with FEL pulse energy, over the total range of pulse energies, has been determined to be 0.1 to 2.5 mJ. In the linear regime, where space charge effects are not important, the detector will only require a single calibration of the scale factor. The detector could also be operated in regimes where space charge effects are important, but might require separate calibration of each operating condition. See LCLS note at <http://www-ssrl.slac.stanford.edu/lcls/technotes/lcls-tn-07-11.pdf>.

Assessment and Issues:

- CPR metrics – Variances for cost and schedule continue to be accrued mainly due the effects of the Continuing Resolution and aligning the tasks more along the new baseline schedule. Delays are seen in all areas. It is expected that the variances will disappear once the new baseline schedule takes effect.

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

Highlights:

- Management and Safety – The XES group prepared for the DOE Lehman Review on September 18, where the XES Estimate to Complete (ETC) and methodology of rebaselining the project was presented. In preparation for the External Independent Review (EIR) planned for October 9-12, XES has been establishing a detailed Basis of Estimate (BOE) of our new plan.
- XES Design Status and Progress –
 - The photon hutch stopper drawings have been submitted and are being checked. Clearance for release of the drawings is expected soon.
 - The brazing sequence and heat-shrink fit process were established for the Photon/Electron Stoppers (ST1-3 & TDUND). The detailed drawings are near completion and will be submitted for checking in October.
 - The bidding process for the PPS hutch door fabrication for the Near Hall hutches has been started and is ongoing.
- LCLS Detector Development (Cornell) –
 - Progress was made on FPGA integration with the full-lot ASIC wafers. Data transfer has been demonstrated at full speed. Trouble-shooting is ongoing for the data acquisition system, including tests of the imaging capabilities of the ASIC while it is being controlled by the FPGA.
 - The diode supplier has again delayed the shipment of the diode due to equipment problems in their clean room. Expected delivery date is now October 19th. The impact of this delay is being evaluated.
- Atomic Molecular and Optics (AMO) Instrument – Preliminary design for AMO instrumentation is near complete with a few subsystems yet to be detailed. Producing the Engineering Specification Documents (ESD) for the components is progressing. A decision has been made to use dynamically bent focusing optics similar to those used at the ALS.
- XES Controls and Data Systems – The fiber routing has been investigated for network fibers (SCCS to NEH/FEH), MPS/120Hz data fibers (MCC to NEH/FEH) and laser timing fibers (Sector 20 to NEH/FEH). Sleeves are being added to create an affordable solution for the fiber routing.

Assessment and Issues:

- CPR metrics – Cost and schedule variances are being accrued in all areas due to reporting against an outdated baseline schedule. The XES group has been starting to work according to the new baseline. Therefore, once the new schedule becomes effective the variances are expected to disappear.

• Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)



BTH with rebar installation in areas #7 and #8



X-Ray Adit Tunnel with Ventilation Fan

Highlights:

- Construction Progress –
 - Construction is approximately 59% complete. To date, \$1,273K Field Change Orders have been negotiated and approved, which is <3% of construction progress to date.
 - Beam Transport Hall (BTH) – Rebar installation and walls connecting BTH to UH are underway.
 - Undulator Hall (UH) – Installation of final liner has begun with concrete floor slab in preparation.
 - Near Experimental Hall (NEH) – MEP utility installations continue for both floors.
 - Far Experimental Hall (FEH) – Top heading excavation > 70% complete. Favorable ground conditions continue to be encountered during the tunneling operations.
 - X-Ray Tunnel – Temporary adit tunnel has been completed with ~70' excavation advanced into the X-Ray tunnel. Similar ground conditions as noted in Far Experimental Hall.

Issues and Assessments

- Overall, civil construction lags behind its baseline schedule by 3-4 weeks. The most critical area is the Central Utility Plant which could impact the commissioning (not the initial installation activities). Opportunities exist for recovery during concrete and metal building stages and re-sequencing of MEP installations.

- The CF group has been informed that the planned project for the natural gas line (a non-Turner award) will need to be coordinated by the local SSO due to the Stanford University Management and Operations (M&O) contract with the DOE. This was not planned and currently has an unknown impact to cost and schedule. Early coordination meetings with PG&E (gas utility company) have been difficult. LCLS will monitor the schedule and future commitments by PG&E. CF group will coordinate temporary solutions and possible alternative scope reductions to minimize PG&E effort while maintaining scope of the project. This gas-line project is critical to the current commissioning phase of the boiler system in the Central Utility Plant.
- During this month the project safely installed over 300 tons of steel shielding. This was a successful installation due to the collaborative effort between TCCo, their subcontractors and LCLS. Originally, these two shielding walls had a combined duration of 40 working days. The actual installation was safely completed within 5 working days.
- Thru September the project has diverted and recycled roughly 233 tons or 87% of material generated during the construction phase of the project. This exceeds the project's 66% landfill diversion goal.



LCLS Cost and Schedule Performance – September 2007

LCLS Cost/Schedule Status Report								30-Sep-07	
WBS	Cumulative to Date (\$K)							Budget At Complete (\$K)	% Complete
	Budgeted Cost		Actual Cost Work Performed	Variance		Performance Indices			
	Work Scheduled	Work Performed		Schedule	Cost	SPI	CPI		
1.1 Project Management	16,457	16,457	17,429	0	-972	1.00	0.94	18,013	91%
1.2 Injector	16,733	16,633	20,168	-100	-3,535	0.99	0.82	16,760	99%
1.3 Linac	16,141	13,964	18,116	-2,176	-4,152	0.87	0.77	19,940	70%
1.4 Undulator	32,252	26,953	32,435	-5,299	-5,482	0.84	0.83	37,398	72%
1.5 X-ray Transport	19,784	13,387	16,584	-6,397	-3,197	0.68	0.81	22,803	59%
1.6 X-ray Endstations	3,675	2,095	2,045	-1,579	50	0.57	1.02	8,735	24%
1.9 Conventional Facilities	89,031	83,594	76,869	-5,437	6,725	0.94	1.09	128,987	65%
1.X LCLS Controls	27,096	18,426	21,250	-8,669	-2,824	0.68	0.87	32,366	57%
1 LCLS Total Base Cost	221,167	191,509	204,897	-29,658	-13,388	0.87	0.93	285,002	67%
								LCLS Total Estimated Cost	315,000
								Contingency	29,998
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	12,146	12,536	11,862	390	674	1.03	1.06	30,195	42%
2.2 Injector (OPC)	4,047	2,493	4,012	-1,554	-1,518	0.62	0.62	5,317	47%
2.3 Linac (OPC)	742	318	507	-424	-189	0.43	0.63	3,232	10%
2.4 Undulator (OPC)	3,474	3,156	796	-318	2,361	0.91	3.97	6,852	46%
2.5 X-ray Transport (OPC)	1,205	1,148	1,062	-57	87	0.95	1.08	4,544	25%
2.6 X-ray Endstations (OPC)	2,027	1,755	1,084	-273	670	0.87	1.62	5,559	32%
2.9 Conventional Facilities (OPC)	380	0	0	-380	0	0	0	683	0%
2.X LCLS Controls (OPC)	701	306	180	-395	126	0.44	1.70	1,129	27%
2 LCLS Total Other Project Cost	24,723	21,713	19,503	-3,009	2,210	0.88	1.11	57,511	38%
								LCLS Other Project Cost	64,000
								Management Reserve	6,489
LCLS Total Project Cost	245,890	213,222	224,400	-32,667	-11,177	0.87	0.95	379,000	62%

Cost and Schedule Performance (con't)

<u>September 2007 Project Performance</u>	AYK\$
Total Project Cost (TPC)	\$379,000
% Planned (Cumulative)	71.8%
% Complete (Cumulative)	62.3%
Total Estimated Cost (TEC)	\$315,000
Cost and Commitments to Date	\$235,726
Estimate at Complete (EAC)	\$309,055
Work Remaining	\$104,158
Outstanding Phase-Funded Awards	\$48,129

Overall Cost and Schedule Assessment

The LCLS cost and schedule are consistent with a CD-4 milestone of March 31, 2009, a Total Estimated Cost (TEC) of \$315M and a Total Project Cost (TPC) of \$379M. All costs are in actual-year dollars and out-year costs are escalated.

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The project critical path runs through the Undulator Facility Co-(early) Occupancy followed by installation of undulators followed by FEL beam commissioning and finally photons in the FEH. The rebaseline exercise will also require a replanning of the project critical path.

The LCLS EAC incorporates all overruns and potential BCR's into the performance baseline to provide a realistic assessment of the project's final cost. To date, remaining contingency on EAC is less than ideal for this phase of the project.

DOE (Level 2) Milestones

System	Level	Milestone	Baseline	Projected	Variance	2005		2006		2007		2008		2009
						Oct	Apr	Oct	Apr	Oct	Apr	Oct	Apr	
		<input type="checkbox"/> Level 2 DOE (SSO) Milestones	8/29/08	10/8/08	28 days									
PM	ML2	Prelim Safety Assessment (PSAD) Doc Complete	4/30/04	4/30/04	0 days									
PM	ML2	DOE External Independent Review (EIR) Complete	6/15/04	6/15/04	0 days									
PM	ML2	Fire Hazard Analysis Approved	6/30/05	8/15/05	32 days	●	●							
PM	ML2	Prelim Safety Assessment (PSAD) Doc Approved	2/28/06	2/28/06	0 days			●						
UN	ML2	Delivery of Undulator 1st Articles to MMF	7/3/06	6/15/06	-12 days			●	●					
CF	ML2	Sector 20/Alcove Beneficial Occupancy	7/21/06	4/14/06	-70 days			●	●					
CF	ML2	Research Yards Mods Beneficial Occupancy	10/20/06	8/30/06	-37 days			●	●					
UN	ML2	MMF Qualified & Ready to Measure Prod Undulators	11/27/06	8/28/06	-65 days			●	●					
IJ	ML2	Start Injector Commissioning (Drive Laser)	1/29/07	1/16/07	-9 days					●	●			
IJ	ML2	Injector Laser Commissioning Review Complete	1/31/07	12/1/06	-34 days					●	●			
IJ	ML2	Injector Accelerator Readiness Review (ARR) Comp	1/31/07	3/30/07	42 days					●	●			
IJ	ML2	Start Injector Commissioning(UV Beam to Cathode)	4/9/07	4/5/07	-2 days					●	●			
CF	ML2	Linac Water/Power Available	7/11/07	3/29/07	-74 days					●	●			
XE	ML2	2-D Pixel Detector Production Start	12/5/07	12/5/07	0 days							●		
LN	ML2	Linac ARR (Li20-Li30) Complete	1/31/08	1/31/08	0 days							●		
LN	ML2	Start Linac (Li20-Li30) Commissioning	3/3/08	3/3/08	0 days							●		
PM	ML2	Final Safety Analysis Document (FSAD) Approved	3/31/08	3/31/08	0 days							●		
CF	ML2	Start Installation of Front End Enclosure	5/20/08	5/20/08	0 days							●		
CF	ML2	Start Installation of Undulator Facility	5/20/08	5/20/08	0 days							●		
CF	ML2	Start Installation of Beam Transport Hall	5/20/08	5/20/08	0 days							●		
CF	ML2	Start Installation of Near Experimental Hall	5/20/08	5/20/08	0 days							●		
PM	ML2	LCLS ARR Complete (BTH thru FEH)	7/11/08	7/11/08	0 days							●		
LN	ML2	Start Linac-to-Undulator (LTU) Commissioning	7/31/08	7/31/08	0 days							●		
UN	ML2	Start Undulator Commissioning (1st Light)	8/18/08	8/18/08	0 days							●		
CF	ML2	Start Installation of X-Ray Transport	8/20/08	8/20/08	0 days							●		
CF	ML2	Start Installation of Far Experimental Hall	8/20/08	8/20/08	0 days							●		
XE	ML2	Start XES Commissioning	10/2/08	10/2/08	0 days							●		
XTOD	ML2	Start XTOD Commissioning	10/8/08	10/8/08	0 days							●		

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