Linac Coherent Light Source Monthly Report

February 2008

Stanford Linear Accelerator Center
LLNL
UCLA
Los Alamos NATIONAL LABORATORY
Argonne NATIONAL LABORATORY
BROOKHAVEN NATIONAL LABORATORY

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Project Overview and Assessment

Highlights:

- Cover Page (Beam Transport Hall looking west) – The Beam Transport Hall (BTH) is nearing its completion date. Beneficial Occupancy, the formal transfer of the facility from Turner Construction to SLAC, is scheduled for late May 2008. Magnet stands are being installed in the BTH prior to Beneficial Occupancy to maintain schedule.

- An Installation Readiness Review for the LTU-Dump System, including technical components, controls, safety systems and cabling, was held on February 26, 2008. In general, the committee found the installation plans well-organized and sufficient to meet the installation schedule. The committee made some recommendations, particularly in the safety systems that will be followed up by the LCLS team.

- The current accelerator commissioning run started December 17, 2007. This is the second phase of LCLS commissioning, and includes accelerating the electron beam from LCLS Injector into the Linac and through the Linac to Sector 30. Components which were installed during the 2007 accelerator downtime are now being tested, such as the Bunch Compressor 2 (BC2) and the Transverse RF deflecting cavity. To date, progress toward achieving specified beam quality, including pulse compression from BC2, has been very good.

- Civil construction (Turner-managed) is approximately 85% complete. About $2,521K in Field Change Orders have been negotiated and approved, which is <4% of construction progress to date.

Assessment and Issues:

- The February 2008 Cost Performance Report is the 48th month of reported earned-value on the LCLS. This is also the 2nd month reporting against the revised baseline which addressed the FY07 Continuing Resolution and subsequent funding reduction. The revised baseline approved a TPC of $420M and CD-4 of July 2010. To date, TPC cumulative obligations (actual costs + open commitments) are $300,573K. Cost and schedule indices are 1.00 and 1.00, respectively. Civil construction is on track for its Beneficial Occupancy dates.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status –
  - LCLS worked 268 days without a lost time injury and 43 days without an injury involving days of restricted work or job transfer. Total project hours are 1.67 M comprised of 1.24 M collaboration hours and 429 K subcontracted work hours.
  - The LCLS project DART rate for construction is currently 3.7[1], 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 1.2; this includes construction and laboratory hours.
  - Safety Training Metrics –
    - Mandatory safety training = 96% (goal = 93%).
    - Supervisor required safety training = 94% (goal = 93%)
    - Compliance for training assessments = 98% (goal = 92%).
    - Medical exams for affected employees = 100% (goal = 90%)
  - Turner Construction –
    - First Aid Case – On February 27, a subcontractor working in the Front End Enclosure was attempting to bend a corner of a sheet metal duct with a hammer. He struck his thumb with the hammer and sought medical attention. The worker was wearing gloves and the injury was soothed with the application of ice. The worker returned to work with no restrictions and no lost time.
    - Fall Protection – SLAC field inspections of the Turner construction site have recently observed unsafe practice of individuals working at heights without appropriate fall protection measures. LCLS has written a formal Safety Notice to Turner Construction requesting immediate corrective action and provide an analysis why these violations continue to re-occur and develop a corrective action plan to eliminate the violations.

- LCLS Procurements Status –
  - The LCLS Procurement Department experienced moderate level of activity in February 2008, including 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) – A draft no-cost modification extending the performance period through August 2008 was sent to Jacobs. A meeting

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

to negotiate remaining open issues with Jacobs is scheduled for March 2008.

- Construction Procurements –
  - Field Change Orders and Change Order Requests (FCOs/CORs)–
    - A total of 272 FCOs and CORs have been settled through negotiation or agreement.
    - 111 FCOs and CORs are open in technical review, fact finding, or negotiation.
  - Off-site Gas line – PG&E issued an addendum to exhibit B of the contract updating the new gas meter numbers, meter service gas type, pressure and estimated monthly usage.
  - PG&E work on the installation of the new gas meter was completed in February, pending final gas valve lock removal by PG&E in late March.
  - Linac Electric Upgrade – Effort complete. Punch list items still to be completed.
  - Electrical S522 Substation Construction – SLAC responded to issues concerning temporary and permanent battery power; however remaining issues still need to be resolved at the end of March.
- Technical Procurements –
  - Cable Plant Installation Phase 3 (BC2/BSY) – Changes made by SLAC required the completion date to be extended into March.
  - Cable Plant Installation Phase 4 Awarded. Notice to proceed to commence in March.
  - Cable Plant Installation Phase 5 IFB was sent out to bid in February with an award pending in March.
  - Quad Stands – Complete. Vendor will store the items pending SLAC request for JIT delivery.
  - Intermediate Power Supplies – Supplier relocated and balance of order delayed until mid February 2008. Several power supplies have been delivered.
  - Power Supply Racks version 3 – Award made, delivery planned for mid to late April.
  - LTU – Award was made in February for the installation of the LTU stands and grout.

Assessment and Issues:

- None.

Electron Beam Systems

WBS 1.1.3, 1.x.2 Controls System

Highlights:

- Injector Controls Commissioning – Complete. All goals met.

- Linac Controls Commissioning – Installation complete. Commissioning efforts continued in the Linac through the second bunch compressor.

- Preparation for BTH – NEH Installation –
  - The contract was awarded for the cable plant installation for the LTU, Undulator, e-Dump regions (Phase 4 cable plant installation). This work involves the installation of 250,000 feet of cables, electronics racks for the control system and the magnet power supplies, cable termination, testing, tagging, etc. The work will start April 1, 2008 and will be completed by the end of October 2008. Over 90% of all the required cable material for phase 4 installation has been ordered and 30% is on hand.
  - The contract was awarded for the rack systems for the above regions. About 1/2 of the required racks are on hand and are being loaded with electronics and tested in the controls high bay area. The remainder will be shipped by the vendor in two installments, on April 4 and 22, 2008.
  - The contract was awarded for the electronic crates which house the field control system. The entire order will be shipped on April 11, 2008. Over 90% of all of the electronics modules and major procurements for the remainder of electron control system have been placed.
  - The control system for the magnet power supplies for the LTU and the undulator is almost fully loaded in the racks in the high bay area and is undergoing testing.
  - The electronics for several Beam Position Monitors (BPM) around the BC2 chicane were upgraded so that the BPMs are available from the EPICS control system. This will allow the physicists to develop applications software for feedback and orbit correction using these BPMs.

Assessment and Issues:

- None.

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

Highlights:

- Injector Commissioning - Complete. All goals met.

- Linac Commissioning – Installation complete. Commissioning efforts continued in the Linac through the second bunch compressor.

- Linac-To-Undulator (LTU) Design and Procurement Progress –
  - The radiation shielding for single beam dump and undulator dump have been ordered.
  - The LTU design was completed in February.
  - The major sub-assemblies for the LTU and Dump areas are being completed and staged in end station "A" for installation
  - Drilling has commenced on the LTU floor for the installation of support stands, and the supports are expected to be installed in March.
  - Wire alignment measurements were finished between the UH, the dump and the FEE through the muon wall. Five laser tracker stations were left in the tunnel: 2 in the UH, 1 in the dump and 2 in the FEE.
  - The Injector Heater Undulator layout was completed and the detail drawings are being generated.

Assessment and Issues:

- None

WBS 1.4, 2.4 Undulator System

Highlights:

- Undulator Components & System Integration –
  - Good progress was made on the BPM window-to-transition braze joint. In parallel, work began on the step braze joint to the BPM body with a lower temperature braze material.
  - 28 Undulator Support Mover (SM) Systems are now delivered to ANL/SLAC. A published list of agreed SM system quality issues with SLAC has been resolved.
  - Five production Undulator vacuum chambers were shipped to SLAC.
  - The Controls Draft UCMI Statement of work is complete - revisions are expected. The design of UCPS is 90% complete; the front panel layout still needs to be addressed.
  - The test procedure for translation stage interlocks is complete and awaiting approval. A Controls handoff plan is under development that will determine how SLAC wants to receive components.

- Undulator Assembly & Measurement (SLAC) –
  - A test to verify the structural integrity of the X Translation Stage of the undulator support stand in earthquake accelerations was determined to be unnecessary.
  - Five vacuum chambers were received from ANL. Chambers and supports were assembled and aligned at SLAC.
  - Nine additional Undulator magnets require measurement and fiducialization. The current plan is to complete these measurements by May. Then the re-fiducialization of the previously measured Undulator magnets will begin.

Assessments and Issues:

- No quads were delivered to ANL/SLAC this month. There are some issues with the positional accuracy of fiducials. This is being addressed with the vendor. There are at least 8 approved quads on hold at the vendor. Quad magnetic performance meets all specifications.
- The BPM production schedule continues to be a problem. There is substantial effort at ANL to address the problems.
- The Undulator Hall was measured by the alignment crew and the floor elevation was found to be out of specification. CF is planning to grind the Undulator floor to the nominal height.

Photon Beam Systems

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

Highlights:

- Management and Safety – The new baseline for LCLS was approved at the end of January. There are no significant variances for schedule and cost.

- XTOD Design & Production Status –
  - Mechanical & Vacuum –
    - The design concepts for the X-ray collimators (which are PPS safety items) are being finalized in consultation with SLAC Radiation Physics and LCLS Conventional Facilities. The designs are roughly 80% complete.
    - The details of the penetration through Wall 1 (steel and concrete shielding between Electron Dump and FEE) are being updated. This penetration is complicated by the rough edges on existing holes in the steel plates. The penetration through Wall 2 (between FEE and NEH) is clean and will support the original plan.
    - For the initial layout of the X-ray beamline, the XVTS (Tunnel) hardware will be used to transport the beam through Hutch 2 and 3 then into the XVTS.
  - Attenuator – The Gas Attenuator will not be assembled until the post-Final Design Review change has been implemented. The design modification (which will reduce the chance of twisting and breaking a vacuum bellows) requires that 8 new parts be fabricated (ten week estimate) and 8 additional parts be purchased (6 week delivery.)
  - Soft X-ray Offset Mirror System (SOMS) – Two of the 5 SOMS mirrors have been delivered to LLNL and are undergoing detailed measurements of the figure and roughness.
  - Controls –
    - The problem with the Hytech motor controllers has been traced to non-standard modifications to the VME back-planes requested by CERN and implemented in the Wiener 9-slot VME crates. Discussions are underway with SLAC, Hytech, and Wiener.
    - The triple-bay rack for the FEE vacuum instrumentation and Gas Detector/Attenuator gas supply is being loaded with equipment prior to wiring.

Assessment and Issues:

- None.

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

Highlights:

- Management and Safety – The new baseline for LCLS was approved at the end of January. There are no significant variances for schedule and cost.

- Mechanical Systems –
  - The hutch stopper parts fabrication and hutch door parts fabrication continued through February. Both items are on schedule for predicted completion dates. The photon/electron stopper drawings ST1&2 were completed, released and submitted to MFD for fabrication.

- Detector Project at Cornell –
  - Test and performance optimization with X-rays of the bump-bonded chips are being carried out. Characterization of the diodes indicates that leakage currents are within specification. Nine bump bonded single modules (1x1) have been received, and are being wire-bonded and tested. An additional 13 bump bonded single modules are being wire bonded, and 12 additional bump-bonded 2x1 modules have been received. Testing is proceeding along the program suggested by the LCLS Detector Advisory Committee (LDAC).

- Atomic, Molecular and Optics (AMO) Instrument –
  - Final design efforts are underway for the AMO project. Decisions remain to be made regarding exact dimensions and particularly materials for the vacuum chamber and electron Time of Flight spectrometers (TOF's). It is critical that magnetic fields be maintained at extremely low levels in the interaction region.
  - ESD's for the AMO controls and data acquisition system were developed in preparation for an upcoming Preliminary Design Review of the control system.
  - A one-day workshop was held by the PULSE group to explore ways in which they could assist with the commissioning of the LCLS-AMO and LUSI instrumentation, and help launch a successful scientific program at the LCLS. The workshop has spawned a pair of working groups for further discussions of soft X-ray and hard X-ray scientific opportunities.

- XES Controls and Data Systems –
  - The Preliminary Design Review for the PPS for FEE and NEH was held. A draft for the network security plan was created and forwarded to SCCS network security. Meetings were held with SCCS to discuss manpower and tasks for the near future.
  - The PDR for the LBL femto-second timing systems was held, and results of the tests of the 1 mile tunnel fiber and the 1 mile klystron fibers were

discussed. The timing system is going back to LBL for some modifications to allow for larger temperature swings, and to make it less sensitive to humidity changes.
    - Progress was made on the data acquisition for the Cornell detector.

- XES Laser System –
    - The Physics Requirement Document for the XES Laser System is being drafted. The ESD for the XES Laser transport is being prepared, describing the laser beam transport from the laser room into the X-ray hutches downstairs. The XES Laser group has begun to specify components.

Assessment and Issues:

- None.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)

CUP and NEH with site work for Future parking lot in the forefront

BTH with 3 service buildings

Highlights:

- Construction Progress –
  - Construction is approximately 85% complete. To date, $2,521K Field Change Orders have been negotiated and approved, which is <4% of construction progress to date.
  - Central Utility Plant - Continued progress included interior construction, fire protection sprinkler system installation, seismic bracing, and exterior underground CTW piping.
  - Beam Transport Hall - Permanent power has been provided to Service Buildings (SB) #2.1 and #2.2. Continued progress on SB #2.3. Roof coating, exterior stairs, and the setting of air handling units for the SB #2.1 and #2.2, ductwork supports, mechanical connections have been completed.
  - Near Experimental Hall - Continued progress for MEP in basement and sub-basement floors, interior finishes, and seismic installations, have commenced. Final phase of site-work activities have commenced; underground storm drain, domestic water and final grading at parking lot.
  - 12 KV Substation - Building and switchgear installation complete. Testing complete. Permanent DC Battery System on schedule for delivery in March. See Issues and Assessments.
  - Far Experimental Hall - Cavern excavation complete. Begin installation of reinforcing steel for shotcrete.
  - X-Ray Tunnel - Mud slab pours continue through the month, preparations for installation of the final shotcrete liner.
  - Undulator Hall Tunnel - Continued progress on MEP installations, interior door frames and thermal barrier walls.

Issues and Assessments

- The BTH West project constructed by Rushford Construction and managed directly by the LCLS in-house CF staff has safely reached substantial completion on schedule and within budget. These modifications to the down-stream end of the existing linac housing allows for the transition from the existing accelerator to the new LCLS facilities. Modifications included lighting, power, LCW, fire protection, steel, cable tray and concrete work.

- NEH roof continues to leak into the facility. Contractor is reviewing the issue and consulting with manufacturer representatives to review the installation process and the material specified. Currently this does not have any impact to the completion of the project.

- The Natural Gas line project is essentially complete. Remaining activities include calibration of meter and valves. The remaining work is to be performed by PG&E and will be in time for final connection to the Central Utility Plant for final commissioning.

- Safety – the LCLS CF staff has substantially increased its Safety Observations to 181 observations for this reporting month.

LCLS Cost and Schedule Performance – February 2008

LCLS Cost/Schedule Status Report									29-Feb-08
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	18,726	18,726	18,752	0	-26	1.00	1.00	22,822	82%
1.2 Injector	20,239	20,239	20,236	0	3	1.00	1.00	20,239	100%
1.3 Linac	23,001	22,647	22,612	-354	35	0.98	1.00	28,257	80%
1.4 Undulator	39,001	38,724	39,006	-277	-282	0.99	0.99	45,355	85%
1.5 X-ray Transport	20,274	20,067	20,324	-207	-257	0.99	0.99	27,494	73%
1.6 X-ray Endstations	2,437	2,437	2,464	0	-27	1.00	0.99	9,115	27%
1.9 Conventional Facilities	108,591	108,575	108,519	-16	56	1.00	1.00	135,888	80%
1.X LCLS Controls	26,191	26,310	26,110	119	200	1.00	1.01	41,369	64%
1 LCLS Total Base Cost	**258,459**	**257,725**	**258,023**	**-735**	**-298**	**1.00**	**1.00**	**330,539**	**78%**
					LCLS Total Estimated Cost			**352,000**	
					Contingency			**21,461**	
					% Contingency on ETC			**29.5%**	
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	14,077	14,077	14,023	0	54	1.00	1.00	24,246	58%
2.2 Injector (OPC)	5,139	5,160	5,204	22	-43	1.00	0.99	5,802	89%
2.3 Linac (OPC)	877	877	852	0	25	1.00	1.03	2,027	43%
2.4 Undulator (OPC)	3,470	3,553	3,363	83	190	1.02	1.06	9,967	36%
2.5 X-ray Transport (OPC)	1,837	1,839	1,727	1	112	1.00	1.06	3,861	48%
2.6 X-ray Endstations (OPC)	1,375	1,663	1,650	288	13	1.21	1.01	8,089	21%
2.9 Conventional Facilities (OPC)	255	259	209	4	50	1.02	1.24	1,865	14%
2.X LCLS Controls (OPC)	643	638	562	-5	75	0.99	1.13	2,817	23%
2 LCLS Total Other Project Cost	**27,672**	**28,065**	**27,589**	**393**	**476**	**1.01**	**1.02**	**58,675**	**48%**
					LCLS Other Project Cost			**68,000**	
					Management Reserve			**9,325**	
					Management Reserve			**30.5%**	
LCLS Total Project Cost	**286,131**	**285,790**	**285,612**	**-342**	**178**	**1.00**	**1.00**	**420,000**	**73%**

Cost and Schedule Performance (con't)

February 2008 Project Performance	AYK$
Total Project Cost (TPC)	**$420,000**
% Planned (Cumulative)	73.5%
% Complete (Cumulative)	73.4%
Total Estimated Cost (TEC)	**$352,000**
TEC Cost + Commitments to Date	$270,740
Estimate at Complete (EAC)	$332,745
Work Remaining	$74,723
Work Remaining (Under Contract)	$26,378
% Contingency Based on EAC methodology	$19,255 36.0%

Overall Cost and Schedule Assessment

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 2008 Cost Performance Report is the 48th month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are $300,573K. Cost and schedule indices are 1.00 and 1.00, respectively. Civil construction is on track for its Beneficial Occupancy dates.

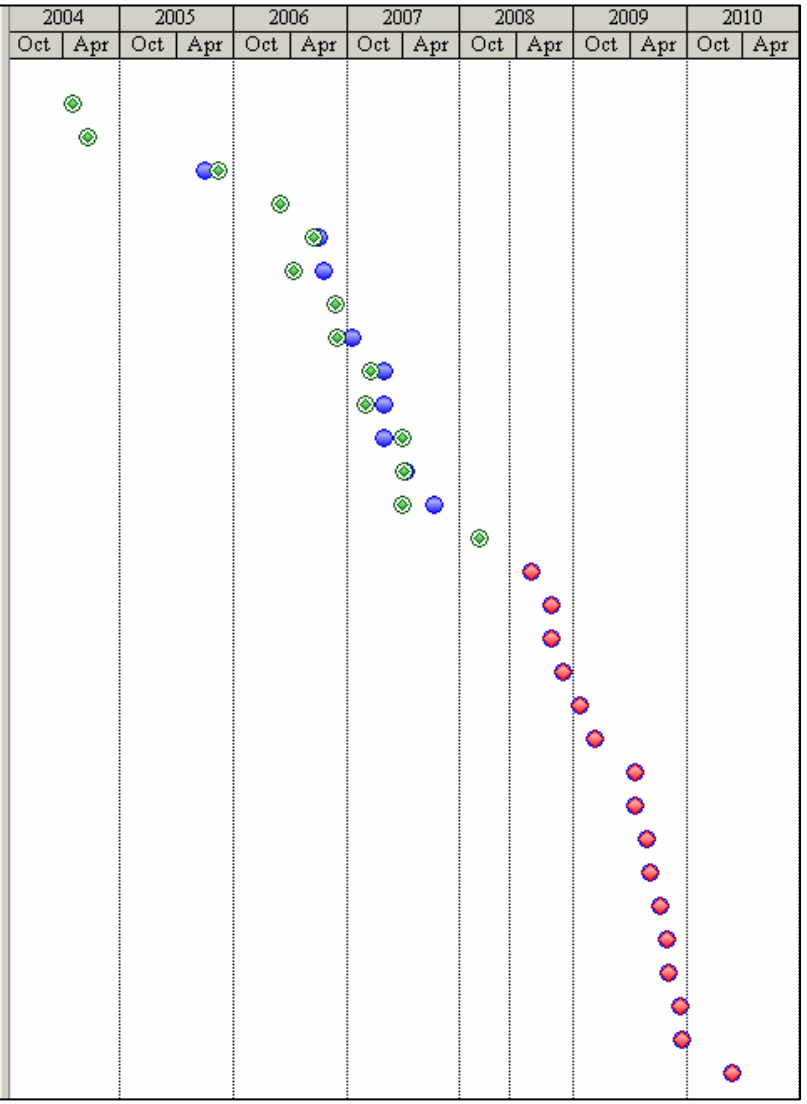
The project critical path runs through the production of FEE photon diagnostics and has 108 working days (~5 months) of float to CD-4. Near critical path activities are the SOMS Vacuum Hardware (and the assembly of the Undulator girders.

Civil construction activities are currently on its baseline schedule for Beneficial Occupancy of the BTH – NEH facilities. Early installation of technical equipment is being installed by SLAC prior to beneficial occupancy of the facilities to maintain schedule.

Overall contingency (29% on cost to go) and management reserve (30% on cost to go) are considered adequate for this stage of the project. An aggressive schedule is planned through the remainder of FY08. Contingency through FY08 remains tight and is being actively managed. Should unplanned costs (variances) be realized, non-critical path activities will be deferred until FY09.

DOE (Level 2) Milestones

Milestone	Baseline	Projected	Variance
Level 2 DOE (SSO) Milestones	**Fri 8/29/08**	**Fri 2/26/10**	**368 days**
Prelim Safety Assessment (PSAD) Doc Complete	Fri 4/30/04	Fri 4/30/04	0 days
DOE External Independent Review (EIR) Complete	Tue 6/15/04	Tue 6/15/04	0 days
Fire Hazard Analysis Approved	Thu 6/30/05	Mon 8/15/05	32 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 Undulator:	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
Linac (Li20-Li30) Ready for Commissioning	Sat 12/1/07	Sat 12/1/07	0 days
Start Installation of Undulator Facility	Fri 5/16/08	Fri 5/16/08	0 days
XT Start FEE Installation	Mon 7/21/08	Mon 7/21/08	0 days
BTH - UN - FEE - NEH - CUP Beneficial Occupancy	Mon 7/21/08	Mon 7/21/08	0 days
Safety Analysis Document (SAD) Approved	Fri 8/29/08	Fri 8/29/08	0 days
XT - FEH Beneficial Occupancy	Wed 10/22/08	Wed 10/22/08	0 days
Beam Path Project Close Out	Fri 12/12/08	Fri 12/12/08	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
XE Start Installation in NEH	Thu 6/4/09	Thu 6/4/09	0 days
Start Undulator Commissioning (1st Light)	Mon 7/6/09	Mon 7/6/09	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 Ops	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. % 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. % 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