Linac Coherent Light Source Monthly Report

October 2007

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

CONTENTS

PROJECT OVERVIEW AND ASSESSMENT 3

TECHNICAL AND PROGRAMMATIC PROGRESS

LCLS Project Office & Support

WBS 1.1, 2.1 Project Management and Administration 4

Electron Beam Systems

WBS 1.1.3, 1.X.3 Global Controls 6

WBS 1.2, 2.2, 1.3, 2.3 Injector and Linac 7

WBS 1.4, 2.4 Undulator 8

Photon Beam Systems

WBS 1.5, 2.5 X-Ray Transport & Diagnostics 9

WBS 1.6, 2.6 X-Ray Endstations 10

Conventional Facilities

WBS 1.9, 2.9 Conventional Facilities 11

COST PERFORMANCE REPORT
-Cost/Schedule Performance 13
-Cost/Schedule Assessment
-Milestone Performance

GLOSSARY 16

Project Overview and Assessment

Highlights:

- Cover Page – Far Experimental Hall excavation showing the removal of the top heading and bench #1 (mid-section). Steel girders, shotcrete and rock bolts are shown which form the initial support liner. An additional eight feet will be excavated in bench #2 (bottom section). The Far Experimental Hall cross-section is 46 feet which will house three experimental hutches for LCLS science.

- LCLS project presented its revised cost and schedule baseline in an External Independent Review (EIR) to DOE's Office of Engineering and Construction Management on October 9-11, 2007. The EIR committee found some items that needed correction but endorsed the project's new baseline. A Corrective Action Plan (CAP) will be prepared to address the necessary corrections.

- The eighth meeting of the LCLS Facilities Advisory Committee was held at SLAC on October 29-31, 2007. The committee noted good progress in all fronts, but also expressed concern with construction safety, installation readiness and the undulator integration. A full report is due in December.

- During acceptance testing, a dipole magnet for Bunch Compressor #2 (BC-2) was found to have a manufacturing defect. Replacement coils necessary for repair will not be ready for installation until mid-December which is after the end of SLAC's scheduled shutdown. Arrangements are being made to have the repaired dipole installed at the first available Repair Opportunity Day (ROD). No impact to LCLS commissioning is foreseen. Other than this item, all installation plans have been completed or are on schedule to be completed during the shutdown period.

- The construction phase for the LCLS major civil activities is being managed by the Turner Construction (TCCo). Overall construction is ~67% complete. To date, $1,517K Field Change Orders have been negotiated and approved, which is less than 3% of construction progress to date.

Assessment and Issues:

- The October 2007 Cost Performance Report is the 44th month reporting earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are $273,031K. The LCLS cost and schedule indices are 0.91 and 0.88, 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 147 days without a lost time injury (Days Away) and 20 days without a DART (Restricted Time). Total project hours are 1.40 M comprised of 1.1 M collaboration hours and 322 K subcontracted work hours.
  - The LCLS project lost time injury rate is currently 3.70[1], as compared favorably to general industry rate of 3.2 and DOE rate of 0.6 for similar work. The total project DART rate is 1.1; this includes construction and laboratory hours.
  - Safety Training Metrics –
    - Mandatory safety training = 89% (goal = 93%). Corrective actions will be completed by month-ending November.
    - Supervisor required safety training = 97% (goal = 93%)
    - Compliance for training assessments = 98% (goal = 92%).
    - Medical exams for affected employees = 100% (goal = 90%)
  - DOE Stanford Site Office (SSO) Construction Project Walkthroughs – Due to an increased trend in safety incidents on the LCLS construction site, the SSO is planning on increased field presence on project construction sites in the form of daily walkthroughs. The projects safety group in conjunction with CF will develop a process that has been used with the ES&H division and the SSO construction engineer and will present the process to the SSO for consideration.
  - Construction Safety (Turner Construction) –
    - Air Monitoring – The September air monitoring test that indicated levels above the Permissible Exposure Limit (PEL) was performed incorrectly. The sample was retested following the correct method and the reading was below the regulatory limit.
    - Work Planning – Construction planning look-ahead schedules continues to be reviewed for higher risk activities, particularly those with new subcontractors to ensure they understand site requirements. Work planning documents utilized in the field (JSA, Daily Pre-Task, permits, etc) are discussed in the weekly superintendents meeting and twice monthly Safety Committee meeting lead by TCCo and attended by the subcontractors.

- LCLS Procurements Status –

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

- The LCLS Procurement Department experienced a heavy level of activity in October 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) –
  - A proposal was received for the On-site Contract Administration Manager on October 31 and forwarded to CF management for review and direction.
  - The DCN / Request for Equitable Adjustment received from Jacobs regarding out of scope work (mainly third submittal reviews) in September, is still undergoing technical evaluation as of the end of October.

- 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 175 FCOs and CORs have been settled through negotiation or agreement.
    - 67 FCOs and CORs are open in technical review, fact finding, or negotiation.
  - PG&E on-site Gas Meter installation – Planned award by the DOE did not take place during the month of October; however, issues are being addressed with assistance from the LCLS Procurement Manager and award is expected sometime in November. Schedule to be determined post award.
  - Electrical S522 Substation construction – Additional work may have modest impact on cost and scheduled completion date of November 30, 2007.
- Technical Procurements –
  - Cable Plant Installation Phase 3 (BC2/BSY) – Shutdown related. Two change orders were issued mid October. The completion date remains at the end of November 2007; however, depending on number and scope of additional changes being defined, the completion date may need to be extended.
  - 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 –
  - All Linac cables were installed in the BSY, BTHW, MCC, and B105 from racks to tray in the tunnel. More than 70% of electronics for BC2 have been installed in the field.
  - All network cables from Linac to MCC have been installed. Sector 24 networks are scheduled to be online beginning of November. The cable infrastructure in Sector 24 and 28 are now installed.

- Controls Design and Procurement Progress –
  - Over 90% of the LTU/UND/EDMP required cable plant has been identified and documented in the CAPTAR database.
  - The Gigabit switches for MPS network and the Fiber cables delivery and rack profiles are received. The software for the MPS Link Processor communication has been written and partially tested. We now have a preliminary design for the Beam loss monitor.
  - The bandwidth and dynamic range problems associated with the design of a filter/preamp to improve linac BPM resolution at low charge was studied and potential components identified.
  - The Solid State Sub-Booster Trigger Chassis cables were installed and existing cables modified to accommodate the design of a new SSSB Trigger Chassis.

- Controls Software Support – The Software Requirements Document for phase II MATLAB Feedback was completed and reviewed. An EPICS interface has been developed for the Feedback system and added feedback alarms with additional error messages logged. The phase I version of the EPICS save & restore software has been completed, including the underlying Oracle database and the user interface.

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. To date, all Linac components have been installed per the planned 2007 downtime schedule. In November earthquake restraining supports and radiation shielding for the BC2 center table will be installed and grouted.

- Linac-To-Undulator (LTU) Design and Procurement Progress – The purchase requisition for core drilling the LTU is in the signature cycle. We will need to modify the purchase order because anchors which are specified in the statement of work do not meet current specification.

Assessment and Issues:

- In September, the Linac group found both coils of the fourth BC2 dipole magnet to be out of specification. Arrangements were made with the vendor to replace the damaged coils however the magnet will not be ready for installation until mid-December which is after the end of the planned shutdown. Arrangements are being made to have the repaired BC2 dipole installed at the first available Repair Opportunity Day (ROD). A generous commissioning schedule had been planned; therefore no impact to BC2 commissioning is foreseen.

WBS 1.4, 2.4 Undulator System

Highlights:

- Undulator Components & System Integration –
  - Support Systems – All parts for the production of support and motion systems are in full production. There presently exists one Support & Motion System at ANL, eight at SLAC and Hi-Tech is preparing to ship four more in November. The remaining twenty five Support & Motion Systems are in production at the vendors.
  - RF Beam Position Monitors (BPMs) – Cavity BPM machining contracts were placed with parts expected in November. Two vendors will provide a single machined First Article production BPM for evaluation.
  - Beam Finder Wire – The first article validation of the Beam Finder Wire frame assembly was completed and vacuum tests of the 1st Article frame assembly proved successful.
  - Vacuum Chamber – All vacuum chamber extrusions were prepared and sent to the polishing vendor. The ends of the extrusions were machined to accept the mating flange for extrude honing. Control samples of the first 54 un-polished extrusions were cut and sent for surface finish analysis.

- Undulator Assembly & Measurement (SLAC) –
  - Eight additional sets of pedestals and girders were received this month. One set has been installed in Building 750. One girder is presently in MMF for mechanical inspection. QA has found: 1) the two linear slides are not co-planer and this issue is being addressed with ANL to face-off top plate; 2) slide gearbox caps are leaking oil, ANL will be sending gearbox manufacturer to SLAC to repair all 26 gearboxes.
  - Production tuning of the undulators continued (completed 17th undulator and the 18th are being measured. The first article undulator feet were received from the vendor and successfully installed on an undulator.
  - Shielding for the Tune-Up Dump has been preliminary approved by Radiation Physics (RP).
  - The SLAC Fire Marshall has approved undulator egress under the girder for installation.

Assessments and Issues:

- Undulator Quadrupoles – The original quadrupole 1st articles that were marginally low in field were rejected. Two new replacement Quad first articles are now in production and will be delivered to ANL the first week of November; we have negotiated with Everson Tesla to speed up the rest of the schedule and bring us back on track.

Photon Beam Systems

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

Highlights:

- Management and Safety –
  - XTOD management attended and participated in the DOE External Independent Review of the new baseline. October was the month of peak XTOD spending, including $400K in commitments.
  - Cost and schedule variances are being accrued in all areas against the current, approved performance baseline. Measured progress against the new (proposed) performance baseline is good.

- XTOD Design & Production Status –
  - Fixed Mask / Slit - The fixed mask is in production and near completion. The Tungsten Heavy Alloy and the Boron Carbide pieces for the slit blocks are in brazing and will be shipped to the vendor for final polish.
  - Gas Detector – The Gas Detector Final Design Review was held October 15, and procurement and fabrication of the devices has begun. Dmitri Ryutov submitted LCLS note LCLS-TN-07-11 containing his analysis of space charge effects in the gas detector.
  - Direct Imager – Work continued on preparing for the Direct Imager calibration run at SPEAR on November 6-8. Software has been written to control the camera through the PVCam library on a windows platform. All of the parts necessary for an end-to-end measurement of the Direct Imager optical system are at LLNL.
  - Soft X-ray Offset Mirror System (SOMS) – Three 2" diameter silicon flat polished coupons have been delivered to LLNL from InSync. These are made of the same material as the SOMS mirrors and have been polished using the same process to be used for the SOMS mirrors. These coupons will be used for testing the B_4C coating process.
  - Hard X-ray Offset Mirror System (HOMS) – Measurements of the pointing stability of the prototype HOMS mirror mount have been started. Over a period of 3 ½ days, the pointing seems to follow a cyclical pattern, similar to the pattern of room temperature variation, varying by about ± 250 nrad. The pointing was seen to vary by about 50 nr/0.1 °C. This is acceptable for the SOMS, but not for the HOMS.

Assessment and Issues:

- None

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

Highlights:

- Management and Safety –
  - The XES group has completed a detailed Basis of Estimate (BOE) of our new plan. The BOE was presented at the External Independent Review (EIR) on October 9-11. The reviewed area, 2D X-ray detector, received overall good marks. We are evaluating the few comments that we have received. XES participated in the LCLS October FAC meeting.
  - Cost and schedule variances are being accrued in all areas against the current, approved performance baseline. Measured progress against the new (proposed) performance baseline is good.

- XES Design & Production Status – The bidding process for the PPS hutch door fabrication for Near Hall hutches is ongoing. Vendor bids are under evaluation.

- Detector Project at Cornell –
  - The diode wafer shipment from SINTEF was received at Cornell, and four detector wafers were sent for initial bump-bonding. During processing a full wafer it was noticed that there was a mismatch of the pitch between the ASIC and the mask which was corrected.
  - Integration efforts and testing are ongoing for the FPGA and ASIC data acquisition system. The full chip imaging has not been confirmed yet. The FPGA data acquisition system is being duplicated for further testing.

- Atomic, Molecular and Optics (AMO) Instrument –
  - The AMO instrument design is progressing towards a preliminary design review planned for the end of November.
  - Laser optics mounting platforms were added to the design of the high field physics and diagnostics chambers, to provide support for the last optical elements which send the laser beam into the chamber.

- XES Controls and Data Systems –
  - The final design of the fiber trunks has been completed so they can be part of the "phase 4" installation contract.
  - The MPS architecture for the XTOD and XES areas was redesigned, the number of MPS boxes has been reduced and the system was simplified.

Assessment and Issues:

- None.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)

BTH areas #7 and #8 with concrete and rebar

Front-End Enclosure concrete roof deck

Highlights:

- Construction Progress –
  - Construction is approximately 67% complete. To date, $1,517K Field Change Orders have been negotiated and approved, which is <3% of construction progress.
  - Beam Transport Hall (BTH) – Final concrete pours for walls and concrete slabs complete. Utility installation effort is on schedule.
  - Undulator Hall (UH) – Installation of final liner has begun with concrete floor slab complete.
  - Near Experimental Hall (NEH) – MEP utility installations on schedule. ~90% complete.
  - Far Experimental Hall (FEH) – Top heading excavation > 100% complete. Favorable ground conditions continue to be encountered during the tunneling operations.
  - X-Ray Tunnel – Temporary adit tunnel is complete. ~360' excavation has advanced into the X-Ray tunnel. Similar ground conditions as noted in Far Experimental Hall.

Issues and Assessments

- Civil Construction Schedule – 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.

- Natural Gas Line Project – This is a non-Turner awarded project managed by the LCLS CF group. Multiple coordination meetings with PG&E (gas utility company) and the DOE continue to take place. However no progress has been made related to final contract negotiations to commence work by PG&E. The LCLS CF group is making provisions for alternative solutions for gas requirements in order to commission the boiler system for the Central Utility Plant.

- Recycling – Thru October the project has diverted and recycled roughly 273 tons or 86% of material of a total of 315 tons generated during the construction phase of the project. This exceeds the project's 66% landfill diversion goal.

LCLS Cost and Schedule Performance – October 2007

LCLS Cost/Schedule Status Report									31-Oct-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	16,587	16,567	17,671	-20	-1,104	1.00	0.94	18,013	92%
1.2 Injector	16,747	16,633	20,204	-114	-3,571	0.99	0.82	16,760	99%
1.3 Linac	17,223	14,591	19,411	-2,631	-4,820	0.85	0.75	19,940	73%
1.4 Undulator	33,898	27,522	33,153	-6,376	-5,631	0.81	0.83	37,398	74%
1.5 X-ray Transport	20,300	13,813	17,555	-6,487	-3,742	0.68	0.79	22,803	61%
1.6 X-ray Endstations	4,060	2,143	2,129	-1,918	14	0.53	1.01	8,735	25%
1.9 Conventional Facilities	94,616	90,863	92,720	-3,753	-1,858	0.96	0.98	128,987	70%
1.X LCLS Controls	27,758	18,763	22,336	-8,995	-3,574	0.68	0.84	32,366	58%
1 LCLS Total Base Cost	**231,189**	**200,894**	**225,180**	**-30,295**	**-24,286**	**0.87**	**0.89**	**285,002**	**70%**
					LCLS Total Estimated Cost			**315,000**	
					Contingency			**29,998**	
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	12,852	13,119	12,290	267	829	1.02	1.07	30,195	43%
2.2 Injector (OPC)	4,196	3,045	4,980	-1,151	-1,935	0.73	0.61	5,317	57%
2.3 Linac (OPC)	742	422	540	-320	-118	0.57	0.78	3,232	13%
2.4 Undulator (OPC)	3,697	4,317	2,630	619	1,687	1.17	1.64	6,852	63%
2.5 X-ray Transport (OPC)	1,236	1,179	1,074	-57	105	0.95	1.10	4,544	26%
2.6 X-ray Endstations (OPC)	2,214	1,822	1,143	-393	679	0.82	1.59	5,559	33%
2.9 Conventional Facilities (OPC)	31	0	0	-31	0	0	0	683	0%
2.X LCLS Controls (OPC)	747	343	213	-404	130	0.46	1.61	1,129	30%
2 LCLS Total Other Project Cost	**25,716**	**24,247**	**22,870**	**-1,469**	**1,377**	**0.94**	**1.06**	**57,511**	**42%**
					LCLS Other Project Cost			**64,000**	
					Management Reserve			**6,489**	
LCLS Total Project Cost	**256,906**	**225,141**	**248,051**	**-31,764**	**-22,909**	**0.88**	**0.91**	**379,000**	**66%**

Cost and Schedule Performance (con't)

Overall Cost and Schedule Assessment

October 2007 Project Performance	AYK$
Total Project Cost (TPC)	**$379,000**
% Planned (Cumulative)	75.0%
% Complete (Cumulative)	65.7%
Total Estimated Cost (TEC)	**$315,000**
Cost and Commitments to Date	$248,719
Estimate at Complete (EAC)	$311,517
Work Remaining	$86,337
Outstanding Phase-Funded Awards	$35,792

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.

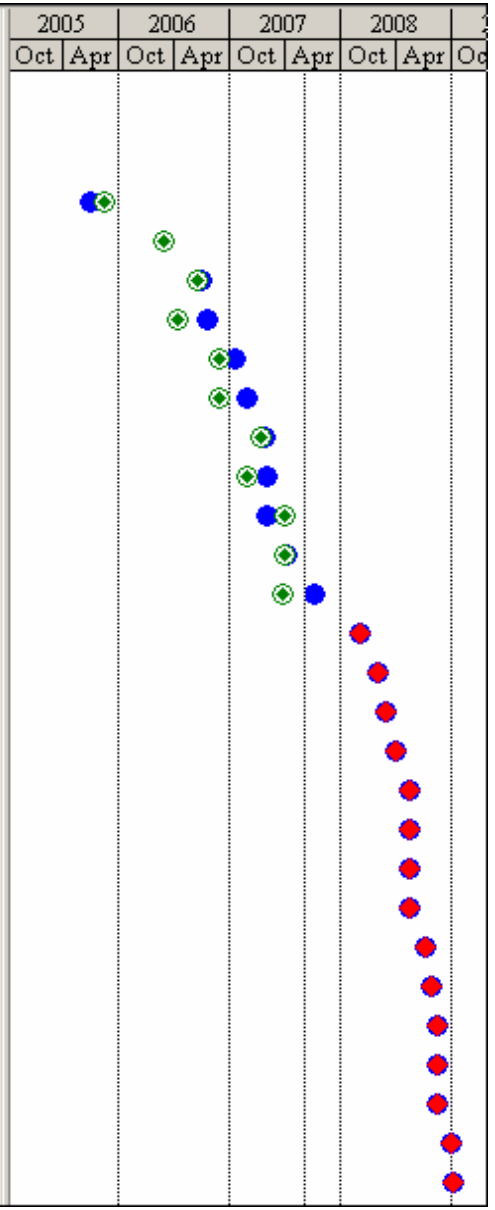
The October 2007 Cost Performance Report is the 44th month reporting earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are $273,031K. The LCLS cost and schedule indices are 0.91 and 0.88, respectively. The SPI ('yellow' on the PARS threshold) is primarily 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.

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.

DOE (Level 2) Milestones

System	Level	Milestone	Baseline	Projected	Variance
		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. % 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