LCLS

Stanford Linear Accelerator Center

Linac Coherent Light Source Monthly Report

April 2007

Stanford Linear Accelerator Center

LLNL

UCLA

Los Alamos NATIONAL LABORATORY

Argonne NATIONAL LABORATORY

BROOKHAVEN NATIONAL LABORATORY

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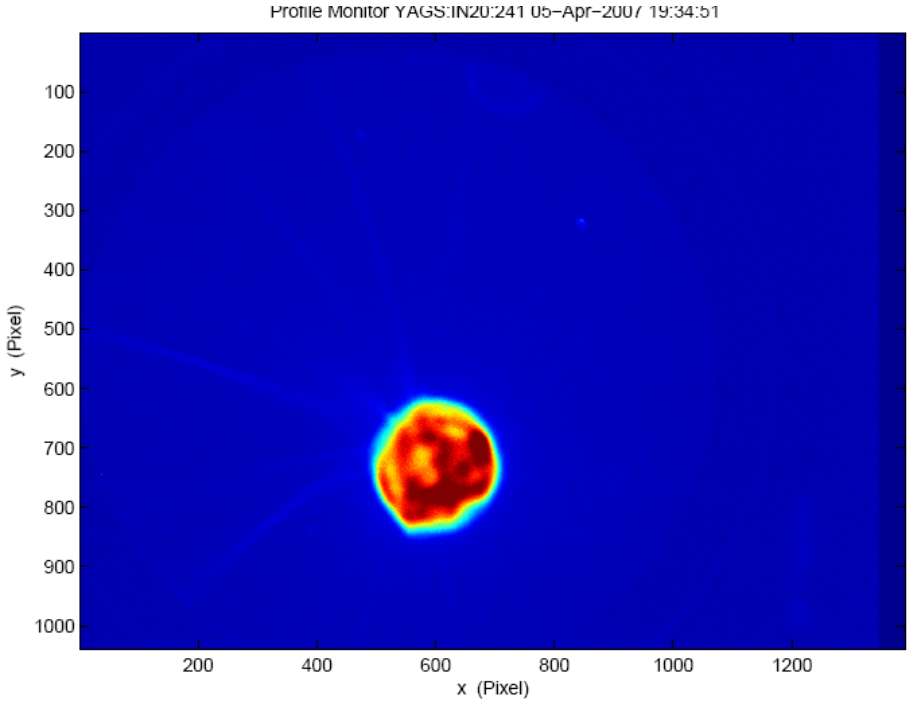
Project Overview and Assessment

Highlights:



- The first photo-electron beam produced by the LCLS injector occurred on April 5, 2007. The above image shows the beam on a diagnostic viewer approximately 80 cm from the LCLS RF gun. Beam energy is 5.5MeV, pulse length is 6ps (full width half max), laser pulse energy was 50 mJ producing a charge of 60pC.

- The construction phase for the LCLS major civil activities is being managed by the Turner Construction (TCCo). Roadheader excavation for the FEH Access Tunnel (shown on cover page) has advanced a distance of 192 feet. A second heading in the Undulator tunnel has advanced to 56 feet. Civil construction is ~22% complete. Field Change Orders to date are ~4% of work accomplished.

- The seventh meeting of the LCLS Facilities Advisory Committee was held at SLAC on April 16-17, 2007. The committee noted good progress in all fronts, but also pointed to upcoming challenges; recovering momentum from the FY07 Continuing Resolution (CR), installation readiness and the LCLS/LUSI integration. A full report is due in June.

Assessment and Issues:

- The April 2007 Cost Performance Report is the 38th month reporting earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open

commitments) are $194,168K. The LCLS cost and schedule performance indices are 0.93 and 0.88, respectively. The SPI of 0.88 is primarily driven by CR impacts (the Project management enacted a "hold" on procurements and directed the effort of senior managers and CAMs to evaluating reduced funding scenarios) and delays in civil construction.

- Over the past six months, uncertainties related to the Continuing Resolution and full FY2007 funding has impacted LCLS cost and schedule performance. With the outcome of the Continuing Resolution and FY 2007 funding now known, LCLS has released available funding for procurements. The delays and shortfall in FY2007 funding require a Directed Change to re-baseline the project. An Office of Science review is scheduled for July 10-12, 2007 to evaluate the re-baseline. The Office of Engineering and Construction Management (OECM) will also conduct a limited External Independent Review to validate the LCLS revised baseline.

- On March 29, Insituform Technologies, announced plans to seek buyers for its tunneling business and assets. Insituform is the parent company of Affolder, Inc., tunneling subcontractor for the LCLS tunnels and Far Experimental Hall.
    - Turner Construction, who holds the contract with Affolder, and LCLS management have been in contact with Affolder senior management to understand and assess the impact to the LCLS project. Affolder management stated that it intends to honor contractual agreements for the LCLS project and has offered retention bonuses for key staff.
    - Although it appears to be a remote possibility at this time, a Payment and Performance Bond is in place should a default situation transpire.
    - Turner and LCLS management plan continued discussions with Affolder as the details of the liquidation unfold.

- To address a ~7-8 weeks schedule delay in civil construction, Turner Construction has provided a plan re-sequencing construction activities to minimize the schedule impact in the BTH and Undulator Hall. The re-sequencing plan provides for LCLS early occupancy of the BTH through the NEH in December 2007 (roughly on the baseline schedule). Coordination between the conventional facilities and equipment installation will be critical to maintaining progress.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status – April 2007
  - The LCLS Project worked 502 days without a lost time injury at SLAC. Total project hours are 1.04M, which is comprised of 881K collaboration hours and 162K subcontracted hours. The project has sustained one lost time injury to an employee in June 2005 and two recordable injuries [no lost time] to subcontractors (10/06, 03/07). The LCLS project lost time injury rate is currently 0.38[1], which compares favorably to general industry rates of 6.2 and that of the Department of Energy which is 0.6 for similar work.
  - Safety Training Metrics –
    - Mandatory safety training = 96% (goal = 93%)
    - Supervisor required safety training = 88% (goal = 93%)
    - Compliance for training assessments = 69% (goal = 92%).
    - Medical exams for affected employees = 100% (goal = 90%)

    Most annual training requirements at SLAC expire in April

- LCLS Safe Performance Observation (SPO) process - The LCLS SPO process, which has been in place for approximately six months, focuses on observing people and talking with them about ways to work safely. The SPO process emphasizes managers performing regular area walkthroughs to positively modify work behavior by making effective, meaningful observations and discussing them with their employees in the moment. The objective is to help reduce injuries through modification of employee behavior by reinforcing safe work practices and eliminating at-risk behavior. The process raises overall safety awareness and communicates management's commitment to safety.

- DOE Stanford Site Office (SSO) Walkthroughs – The SSO continued with its once per week inspections of LCLS civil construction activities. For the month of April, safety process observations identified several noteworthy practices including expeditious handling of PEP Utility Relocation Water Leak, Fall Protection implementation during work in NEH, Access Tunnel Entry Control using Brass-Tag Board, dust control at Access Tunnel, and effective Hoisting & Rigging procedures during work in RSY and NEH. Inspections also resulted in identification of several improper procedures and worker practices including lack of re-bar End-Caps to avert potential impalement/abrasion hazard, use of job built ladder without slip-hazard mitigation, use of out-of-date (i.e., un-inspected) fire extinguisher at Access Tunnel portal, and missing portable eyewash bottle at

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

the eye wash station. Most safety observations of improper activities/procedures were corrected real-time by SLAC ES&H and Turner Co.

- LCLS Procurement Status – April 2007
  - The LCLS Procurement Department continued with heavy activity in April 2007, mainly due to issues arising with Turner subcontracts since the project is now in Phase 2 and the primary construction effort is underway.
  - A/E Design – Current emphasis has been placed on handling submittals and providing rapid response to subcontractors' requests for information.
  - CM/GC –
    - Contract Modification 33 added staff for the second shift tunnel excavation for the Undulator Hall tunnel.
    - Open Change Order Request (COR) Status – 32 CORs are in technical review, fact finding, or negotiation. Total estimated value $1.1M.
  - Technical Procurements –
    - Injector Laser Heater Chicane Dipole Magnets – Subcontract awarded. Estimated arrival is May 07. No schedule impact.
    - BC–2 Chicane Dipole Magnets – RFP Addendum issued with 1 month extension provided. Bids were received on March 20 and a technical evaluation was completed on April 21. Award was made in May to Everson Tesla with a due date of June 2007.
    - LTU Quadrupole Magnets – Subcontract awarded. Estimated arrival is June 2007. No schedule impact.

Assessment and Issues:

- Potable Water Line Breach – On April 3rd a section of an existing potable water line, north of a recent LCLS related line modification, failed. The cause of the failure appears to be abrasion of the pipe due to earth compaction. The volume of water released was such that some portion of it left the SLAC site, resulting in a County notification.

- Turner Construction ORPS Near Miss (Grounding Rod Penetration) – On April 18th, SLAC discovered a Turner Construction subcontractor had driven a grounding rod into an existing utility tunnel that contains high voltage power. This event will be classified as a Near Miss in the ORPS.
  - SLAC's Initial Steps – Following this discovery, all excavations and penetrations by Turner or its subcontractors was halted without expressed permission of the SLAC-LCLS field manager. An independent SLAC ES&H investigation team's initial findings indicated two deficiencies: 1– subcontractor working out of the scope of their Job Safety Analysis and approved permit, 2–work scope planning was not walked-down by the Turner/subcontractor as required by approved procedures.

- Corrective Action – SLAC issued a deficiency notice to Turner citing process gaps and requesting a corrective action plan (Turner's General Superintendent has since been removed from the job site). Turner subcontractor, Cupertino Electric, was notified of the deficiency and fined. Following a full investigation and corrective action, SLAC plans a construction site stand-down to ensure that the seriousness of the incident is understood and the necessary corrective actions are implemented.

Electron Beam Systems

WBS 1.1, 1.x.2 Controls System

Highlights:

- Management and Safety – A comprehensive plan for the installation of BC2 in sectors 24-25 was developed. The plan includes detailed schedules for cable plant installation, magnet power supplies and controls, mover systems including wire scanners, collimators, and BC2 motion control, MPS and BCS, LLRF, the vacuum system, and profile monitors.

- Injector Controls Commissioning –
  - All BC1 control system were systematically brought online and commissioned. The beam was put through BC1 and the BC1 X-mover was scanned with beam on. The system was functional on the first try.
  - The gun LCW temp feedback system was turned on and is operating now at 30 Hz. This interfaced the conventional facilities water control to EPICS controls.
  - A new timing system for the SLAC Linac, with interfaces to the diagnostics and LLRF systems, was commissioned.
  - The laser system image acquisition and steering feedback loops were turned on ands commissioned. The image acquisition system was commissioned with MATLAB. Beam images on the Gun spectrometer YAG Profile Monitor Screen were also acquired.
  - The Gun RF feedback system was put into operation, closing the loop between the PAD (Phase and Amplitude Detectors) and the PAC (Phase and Amplitude Corrector).
  - The new LCLS BPM electronics were commissioned. The system resolution was measured to be less than 7 microns, exceeding the design goal of 10 microns.
  - The SLC-Aware IOC software was released into production which allowed Asynchronous Beam Acquisition via SCP (e.g. Gun charge vs. laser power)
  - All commissioning logs are available through a new electronic logbook for LCLS.

Assessment and Issues:

- Controls Cost and Schedule Variances (SPI = 0.77, CPI = 0.88) – In Controls there has been a considerable schedule slippage due to uncertainty in funding brought on by the Continuing Resolution. There are significant procurements, both at SLAC and at ANL,

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

Highlights:

- Injector Commissioning – Approval for the beginning of Injector commissioning was given by the DOE Site Office and SLAC Directorate on April 4, 2007. Commissioning proceeded immediately afterward with good progress in meeting the Injector commissioning goals and milestones.

- FY07 Shutdown Planning – Installation planning for the next shutdown are underway. Nominal dates for the shutdown are Sep 01 through Dec 01, 2007. LCLS has prepared an integrated schedule with SLAC's Manufacturing Department and LCLS engineering. A review is scheduled for May 16 with the LCLS PMOG to assess LCLS readiness and finalize the shutdown duration.

- Bunch Compressor #2 (BC-2) – The BC-2 center table support is in final design and will be completed in May. The remaining supports were submitted to SLAC Manufacturing Department for fabrication.

- The FDR on the remaining three types of supports for LTU area was completed. A purchase request for all support stands was submitted. Installation drawings for the first section in the BTH west area will be completed next month.

- The LCLS Beam Dump Magnets are in detailed design. Strong consideration s being given to utilize a collaborative agreement to fabricate these large magnets.

Assessment and Issues:

- The 2007 downtime installation is very short, and the budget may not be sufficient to perform all downtime tasks.

    - Cost and Schedule Variances (Injector TEC Accounts are closed) –
    - Linac System (SPI = 0.84, CPI = 0.77)
        - The fabrication of magnets and diagnostics are the main drivers to the schedule variance. This is primarily due to uncertainty in the FY07 budget and the CR issue. There is now significant effort on diagnostics design and close communication with the fabrication vendor in an effort to catch up with the overall schedule.
        - The cost overrun is driven by design of diagnostic instruments; profile monitors, bunch length monitors, beam position monitors and movable collimators were underestimated. Designs are now complete.

WBS 1.4, 2.4 Undulator System

Highlights:

- Management & Safety – The bids for the Support Mover fabrication contract were received and the review process has begun.

- Undulator Magnet Production – Undulator magnets through the SN-35 have been accepted from the vendor. The remaining five undulator magnets will be accepted in May.

- Undulator Components & System Integration –
  - Undulator hardware delivery schedules were revised to reflect delays due to the impact of the continuing resolution.
  - The 1st article quadrupole stage was received. Production quadrupole stages are due in May.
  - The first prototype RF BPM was accepted for hot tests. Progress was made on LEUTL setup for RF BPM testing.

- Undulator Assembly & Measurement –
  - Assembly and measurement progress is four weeks behind its baseline schedule due to start-up delays in hardware deliveries and field variations during the measurement process.
  - Six undulator magnets are tuned/fiducialized (completed three in April).
  - The MMF Group requested 2 months to assemble and commission the Quadrupole Fiducialization Fixture. Due to delays in placing the final hardware procurements (CR issue), the 2 months will not be available. The delay in fiducializing the first article Quadrupole will be minimized by performing the magnetic measurements and the fiducialization commissioning in parallel to the extent possible.

Assessments and Issues:

- The difficulty with the production RFBPM brazing process continued. To minimize delay, the development of the SOW and production drawings are being developed in parallel with improvements to the brazing process.

- The SN-06 undulator magnet was set aside to have its nonconforming magnets replaced at a later time, allowing current efforts to be directed to production tuning.

- The first article Quadrupole expected delivery to SLAC has slipped to July from June. No schedule impact is anticipated as the quadrupoles are not critical path.

Photon Beam Systems

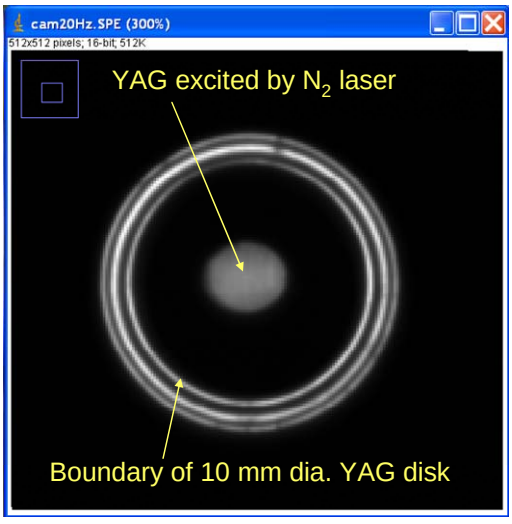
WBS 1.5, 2.5 X-ray Transport, Optics & Diagnostics (XTOD)

Highlights:

- Management and Safety – A BCR for the wall penetrations was approved this month. There was a safety walk-through of the LCLS activities in the B141 laboratory at LLNL. The XTOD group prepared for and participated in the FAC meeting.

- Gas Detector – The parts for the SSRL test of the gas detector were purchased and/or fabricated at LLNL. An experimental plan for the May 10-14 SSRL run was developed. Since the walls of the LCLS Gas Detector chamber need to be lined with a material that will not emit light when struck by x rays (which would overwhelm the small signal from the gas) the SSRL experiment will include a test of candidate wall materials for x-ray-induced photoemission. For the test, the samples will be mounted on a holder and placed directly into the x-ray beam in the field-of-view of the photomultiplier detector.

- Total Energy – Data obtained using a pulsed 532nm calibration laser was analyzed and compared to a finite difference model of the diffusion of thermal energy through the sensor. After the initial non-thermal fast transient signal, the sensor response is very close to the signal level predicted by the finite difference thermal model



- Direct Imager – Images of YAG emission have been obtained with the Cascade camera in the Wide-Field-Of-View configuration at 20Hz (see picture at left). The YAG was excited by 337nm pulses from a N_2 laser. The partial image shows the 3.3mm spot from the laser in the center of the YAG. Light exiting out of the edges of the YAG disk and reflecting off of the recess in the brass mount produce the rings.

- Soft Offset Mirror System (SOMS) – The System Concept Review (SCR) for the SOMS mirror system was held in April. The soft offset mirrors are a long-lead item so the work is being expedited. To speed up the process a Preliminary

Design Review (PDR) is scheduled for the end of May, covering the mirror specifications and mounting attachments only. This work will be followed by a Final Design Review (FDR) that covers the final mirror drawing. The planned schedule is to order 5 mirrors (4+1 spare) by June 2007. Characterization of the coupons supplied by the candidate vendors continues. The results will be presented at the PDR. The mirror motion control system design continues at a slower pace.

Assessment and Issues:

- XTOD Cost and Schedule Performance (SPI = 0.78, CPI = 0.88) – The low SPI is driven by the reorganization of the work plan due to the continuing resolution and reduced funding in FY2008. The activities will be re-planned as part of the revised project baseline caused by the Directed Change. This extra work (typically prototype testing) may yield value engineering savings in the production/procurement phase.

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

Highlights:

- Management and Safety –
  - The XES group has continued to work on the impact of the continuing resolution and the revised cost and schedule baseline. The AMO experiment has been defined for the initial experiments for completing the early CD4a milestone while preserving scientific capabilities.
  - Personal Protection Systems: The X-Ray Systems Operational Modes Physics Requirement Document (PRD) was signed. The SCR for the X-Ray PPS systems is scheduled for May 31st. Cable coding has begun for X-Ray PPS systems.

- LCLS Detector Project at Cornell has completed the high-level FPGA programming for the full-size detector as well as the design and layout of the CMOS-ASIC circuit board. Work has started on a prototype cryostat system for a single module detector.

- Atomic Molecular and Optics (AMO) Instrument –
  - Specifications were developed for the Kirkpatrick-Baez focusing mirrors used to focus the X-ray beam to a spot as small as 1um in the interaction region. The waist of the beam in the interaction region of the AMO end-station can be used to control the power density of the x-ray beam, with field strengths of up to 10^{18} W/cm^2 accessible at the smallest focus.
  - The focusing mirrors are formed by dynamically bending flat mirrors into the required elliptical shape to achieve the desired focus. The bender mechanism will be similar to those used at synchrotron beamlines to refocus the X-ray beams. To withstand the high peak power of the FEL beam while providing high reflectivity, the mirrors need a boron carbide (B_4C) coating with a low surface roughness. The XTOD group at LLNL has developed a method for coating optics with B_4C with acceptable surface roughness and will shortly begin a program of testing appropriate substrates for the mirrors to achieve the required specifications.

Assessment and Issues:

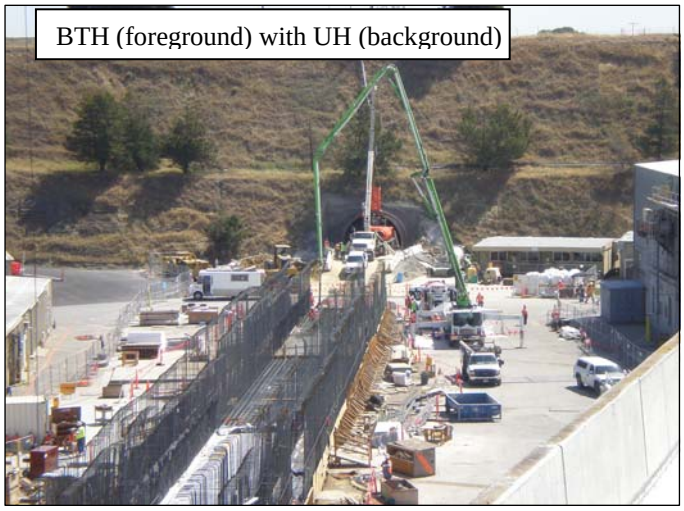
- XES Schedule Performance (SPI = 0.76) – The XES work plan is being modified due to the continuing resolution and reduced FY2008 funding. Some tasks are being moved out, and others are delayed while the revised plan is being formed. In addition, it appears that a small factor contributing to the low SPI was errors in assigning status to ongoing tasks. The latter cause is being investigated.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)

Highlights:

Beam Transport Hall Rebar Installation



BTH (foreground) with UH (background)

- Management & Safety –
  - The Monthly Schedule update provided by Turner Construction indicates a 7-8 week delay in civil construction. (See Issues & Assessments below).
- Construction Progress –
  - Construction is ~22% complete. Since the start of construction $722K of Field Change Orders have been negotiated and approved, which is ~4.5% of the construction progress to date.
  - Poured over 1,200 cubic yards of concrete for the basement level (2nd floor) of the NEH facility. This was another successful logistical challenge with several dozens of concrete trucks over a short period of time.
  - FEH Access Tunnel (AT) continues with an advance of 192 feet at the end of April. Ground conditions are favorable and meet or exceed initial expectations for average daily advance rates.

- Undulator Hall tunneling with the use of the second road-header has commenced. Ground conditions appear to be similar to that of the AT. An advance of 56 feet has been completed.

- Concrete pouring for the invert of the Beam Transport Hall has commenced, and rebar for the walls are partially in place.

Issues and Assessments

- On March 29, Insituform Technologies, announced plans to exit the tunneling operations and to seek buyers for its tunneling business and assets. Insituform is the

parent company of Affolder, Inc., tunneling contractor for the LCLS tunnels and Far Experimental Hall.

- Turner Construction, who holds the contract with Affolder, and LCLS management have been in contact with Affolder senior management to understand and assess the impact to the LCLS project. Affolder management stated that it intends to honor contractual agreements for the LCLS project and has offered retention bonuses for key staff.
- Although it appears a remote possibility at this time, a Payment and Performance Bond is in place should a default situation transpire.
- Turner and LCLS management plan continued discussions with Affolder as the details of the liquidation unfold.

- On April 2, Turner Construction replaced its General Superintendent for the LCLS Project. This replacement of a key staff member of the Turner on-site team was at the request of the LCLS management due to poor performance on managing subcontractor coordination and safety across the construction project. LCLS views this as a positive step by Turner and anticipates improved performance on overall coordination and safety.

- To address the ~7-8 weeks schedule delay, LCLS management has requested a recovery plan. In response, Turner Construction has provided a plan re-sequencing construction activities to minimize the schedule impact in the BTH and Undulator Hall. The re-sequencing plan provides for LCLS early occupancy of the BTH through the NEH in December 2007 (roughly on the baseline schedule). The re-sequencing of activities by Turner indicates a positive approach taken by the new Project Superintendent. Coordination between the conventional facilities and equipment installation will be critical to maintaining progress.

LCLS Cost and Schedule Performance – April 2007

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	15,028	15,028	15,993	0	-965	1.00	0.94	18,013	83%
1.2 Injector	16,616	16,574	20,042	-41	-3,468	1.00	0.83	16,760	99%
1.3 Linac	12,086	10,211	13,250	-1,875	-3,039	0.84	0.77	19,940	51%
1.4 Undulator	27,154	24,699	26,868	-2,455	-2,170	0.91	0.92	37,398	66%
1.5 X-ray Transport	14,476	11,266	12,733	-3,210	-1,467	0.78	0.88	22,803	49%
1.6 X-ray Endstations	2,380	1,820	1,587	-561	233	0.76	1.15	8,735	21%
1.9 Conventional Facilities	51,777	46,927	48,034	-4,850	-1,107	0.91	0.98	126,602	37%
1.X LCLS Controls	20,467	14,222	16,272	-6,245	-2,050	0.69	0.87	32,366	44%
1 LCLS Total Base Cost	**159,984**	**140,747**	**154,780**	**-19,237**	**-14,032**	**0.88**	**0.91**	**282,617**	**50%**
					LCLS Total Estimated Cost			**315,000**	
					Contingency			**32,383**	
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	9,834	9,731	9,792	-103	-61	0.99	0.99	30,195	32%
2.2 Injector (OPC)	2,614	1,945	2,057	-669	-112	0.74	0.95	5,317	37%
2.3 Linac (OPC)	428	71	418	-358	-348	0.16	0.17	3,232	2%
2.4 Undulator (OPC)	2,231	2,181	725	-50	1,456	0.98	3.01	6,852	32%
2.5 X-ray Transport (OPC)	927	870	815	-57	56	0.94	1.07	4,544	19%
2.6 X-ray Endstations (OPC)	1,630	1,344	1,344	-286	0	0.82	1.00	5,559	24%
2.9 Conventional Facilities (OPC)	0	0	0	0	0	0	0	683	0%
2.X LCLS Controls (OPC)	404	52	111	-351	-59	0.13	0.47	1,129	5%
2 LCLS Total Other Project Cost	**18,067**	**16,193**	**15,261**	**-1,874**	**933**	**0.90**	**1.06**	**57,511**	**28%**
					LCLS Other Project Cost			**64,000**	
					Management Reserve			**6,489**	
LCLS Total Project Cost	**178,052**	**156,941**	**170,040**	**-21,111**	**-13,100**	**0.88**	**0.92**	**379,000**	**46%**

Cost and Schedule Performance (con't)

April 2007 Project Performance	AYK$
Total Project Cost (TPC)	**$379,000**
% Planned (Cumulative)	52.3%
% Complete (Cumulative)	46.1%
Total Estimated Cost (TEC)	**$315,000**
Cost and Commitments to Date	$176,298
Estimate at Complete (EAC)	$298,375
Work Remaining	$143,596
Outstanding Phase-Funded Awards	$76,419
Remaining Contingency Based on EAC	$16,625
	14.5%

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.

The April 2007 Cost Performance Report is the 38th 'earned-value' report on LCLS. TPC cumulative obligations to date (actual costs + open commitments) are $194,168K. The LCLS cost and schedule indices are 0.92 and 0.88, respectively. The SPI of 0.88 ('yellow' on the PARS threshold) is primarily driven by CR impacts including hold on procurements affecting future activities, postponement of work packages due funding reduction, and delays in civil construction. The project is revising the baseline as a result of the FY2007 Directed Change. The revised baseline will address the schedule slip due to impacts from the delay and shortfall in funding.

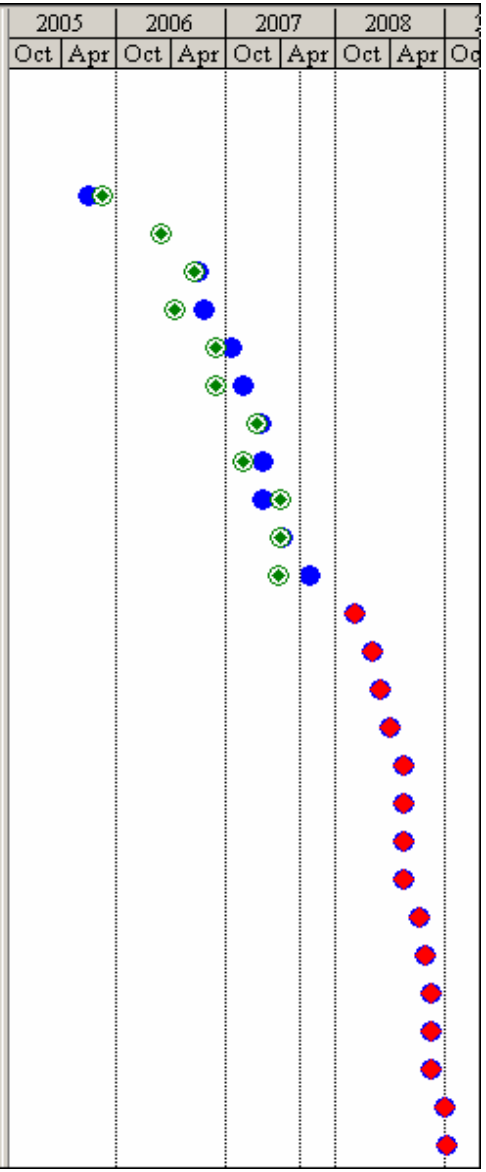
The project critical path runs through the Undulator Facility Co-(early) Occupancy followed by installation of undulators followed by FEL beam commissioning and finally photons in the FEH. Incorporating all project delays, total float with respect to CD-4 is 105 working days.

The LCLS EAC incorporates all overruns, potential BCR's and high risk issues into the performance baseline to provide a realistic assessment of the project's final cost. In April, percent contingency on EAC was reduced, primarily due to delayed procurements and redirected staff related to the Continuing Resolution and FY07 reduced funding.

To date, remaining contingency on EAC is less than ideal for this phase of the project. However, contingency reserves on civil construction are 10% on committed but uncosted work, comparing favorably with 4.4% actual contingency usage. Additionally, the potential for rain delays has now dropped significantly, and early assessments on the tunneling ground conditions are near optimal.

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