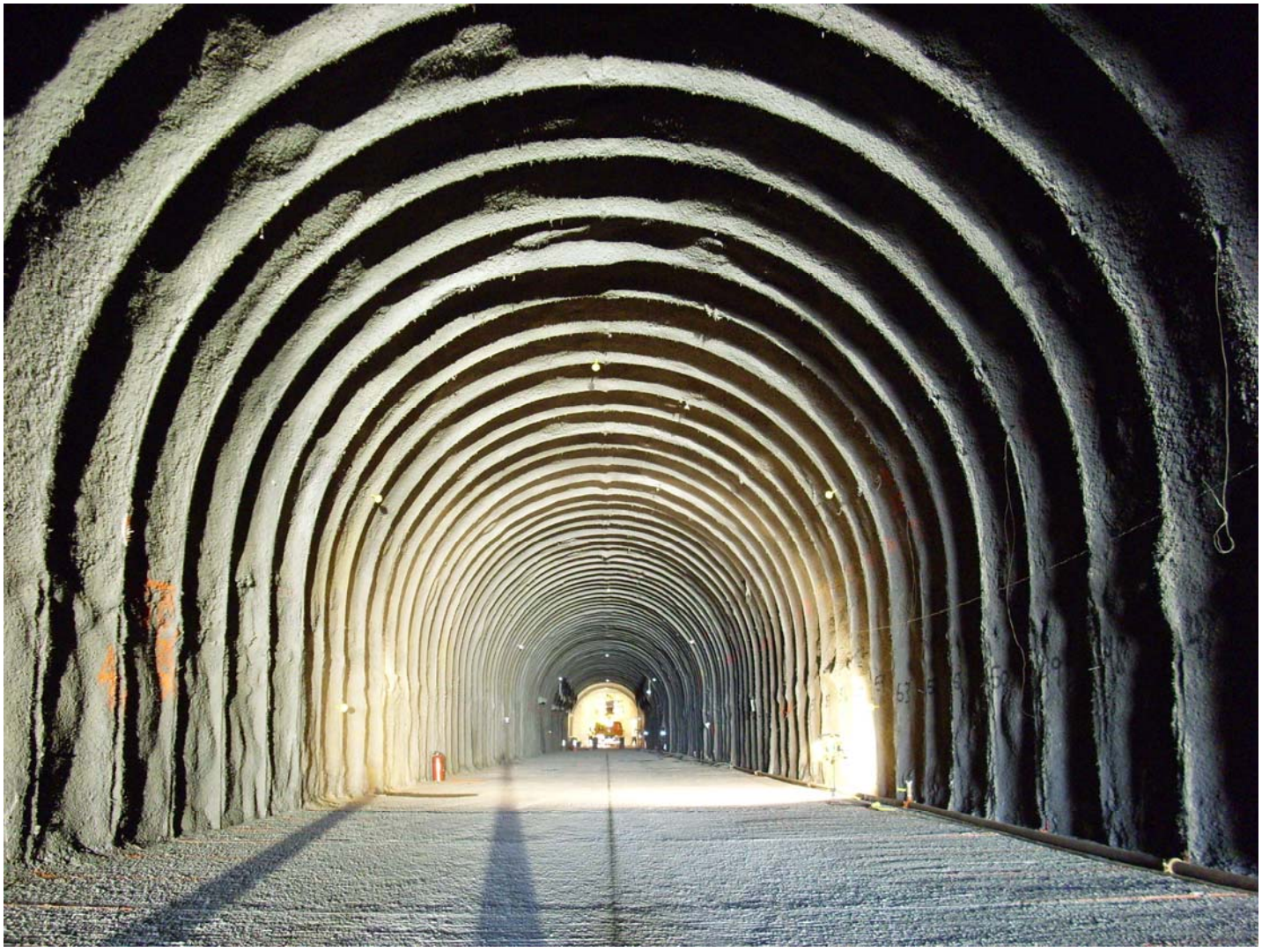
LCLS

Stanford Linear Accelerator Center

Linac Coherent Light Source Monthly Report

July 2007



Stanford Linear Accelerator Center

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Project Overview and Assessment

Highlights:

- Cover Page – LCLS Undulator Hall Tunnel (looking east) fully excavated. Top heading and lower bench excavations at 100%. Initial liner and steel girders are installed. The final liner and concrete invert will begin installation during the next reporting period. Ground conditions proved to be favorable and met or exceeded the initial expectations.

- The construction phase for the LCLS major civil activities is being managed by the Turner Construction (TCCo). Overall construction is ~37% complete. Field Change Orders to date are ~3.5% of work accomplished.

- A DOE Office of Science (Lehman) Review of the LCLS Project was conducted on July 10-12, 2007. The committee found the project had made good progress, in particular, commissioning of the injector and in civil construction. The Committee believed the project provided sufficient justification on the impacts of the 2007 Continuing Resolution, but had not yet adequately developed the revised baseline to ensure sufficient confidence in completing the project at the new cost and schedule. An Action Item was generated for the project to develop a complete bottoms-up cost and schedule in the earliest timeframe, and to present a revised baseline to DOE Office of Project Assessment.

- The LCLS Injector continues to show good progress on meeting its commissioning goals. Early measurements indicate the Injector is capable of delivering horizontal and vertical normalized emittance values below one micron at 135 MeV. This is below the 1.2-micron goal for a 1 nC bunch charge, and this transverse beam brightness, if preserved through the linac, is expected to be adequate to drive the 1.5-Angstron LCLS SASE Free-Electron Laser.

Assessment and Issues:

- The July 2007 Cost Performance Report is the 41st month reporting earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are $252,528K. The LCLS cost and schedule indices are 0.92 and 0.85, respectively. The SPI is primarily driven by CR impacts (hold on procurements and project management evaluating reduced funding scenarios) and delays in civil construction.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status –
  - LCLS worked 35 days without a lost time injury. Total project hours are 1.2 M comprised of 1.0 M collaboration hours and 226 K subcontracted work hours.
  - The LCLS project lost time injury rate is currently 2.70[1], which compares favorably to the general industry rate of 6.0 for similar work. The total project lost time injury rate is 0.8; this includes construction and laboratory hours.
  - Safety Training Metrics –
    - Mandatory safety training = 99% (goal = 93%)
    - Supervisor required safety training = 96% (goal = 93%)
    - Compliance for training assessments = 94% (goal = 92%).
    - Medical exams for affected employees = 100% (goal = 90%)
  - Stanford Site Office Oversight – In response to a SSO memo raising concern on a recent increase in construction safety incidents, LCLS project management responded by performing an assessment of incidents beginning with TCCo's mobilization to SLAC. The assessment identified causal factors common to the safety incidents on the project, specifically, lack of TCCo field personnel awareness of roles and responsibilities, lack of familiarity of Site Safety regulations and weak communication of lessons learned among the subcontractors. LCLS management worked with TCCo to develop a corrective action plan (CAP) to mitigate the causal factors identified. The CAP was initiated in July and is expected to last throughout the life of the project.
  - DOE-BES Construction Safety Review – Coinciding with the July 10-12 DOE-BES review, an independent team conducted an assessment of the construction safety program between July 9-12. The construction safety assessment was comprised of field observations of the construction site including earth movement, concrete form work and tunneling. In addition review of paper work, safety plans and interviews was performed. In general the observations of work performed had no findings; the job safety analysis supported the work being performed. During interviews with the TCCo Project Manager, Senior Superintendent and Safety Manager there were conflicting statements regarding the understanding of and implementation of the TCCo Safety Plan. In addition, a review of the TCCo Safety Plan revealed several

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

program elements that are not being implemented. A recommendation of the assessment is for TCCo to correct these identified conflicts.

- LCLS Procurements in July 2007 –
  - A/E Design – Subcontract Modification 26 to incorporate three minor design change requirements identified by Jacobs as Design Change Notices were settled in July. Additional work took place in July to extend the on-site contract support services put in place previously.
  - Construction Procurements –
    - SLAC and TCCO attorneys/staff met to discuss claims disputes outside of arbitration. No significant progress thus far.
    - SLAC/Turner Modification No. 35 was approved which incorporated 5 fully negotiated FCOs into the Subcontract, settled 3 CORs, implemented a Safety Violation Penalty, and made some administrative changes.
    - Alpine Road/Gate Natural Gas Line Design/Construction – Responsibility for the installation of the gas meter to the SLAC property line was transferred to the DOE SSO per the terms and conditions of the lease. SLAC will proceed with a bid to install a new gas line for the new gas meter to the CUP. All required gas metering installation Information has been provided to the DOE Stanford Site Office for implementation and establishment of contract with P G & E. Final outcome status is pending.
  - Technical Procurements –
    - Linac Electrical Upgrade – IFB issued with bids received in June. Award made in July with a completion date of 10-29-07. Submittals are on schedule.
    - BC2 Chicane Dipole Magnets – One magnet arrive on July 3 and testing went well. The balance is due late July or early August.
    - LTU Quadrupole Magnets – June delivery slipping due to material delays with current expectations of mid August for two each and the end of August for the balance.
    - Intermediate Power Supplies – Awarded with split delivery of the end of July and the end of September, 2007. The July deliveries have been delayed to late August and LCLS is working with the supplier to expedite the delivery.
    - Laser JEDIs (Spares) – Awarded with late August, 2007 due date.

Assessment and Issues:

- None

Electron Beam Systems

WBS 1.1, 1.x.2 Controls System

Highlights:

- Injector Controls Commissioning – The beam charge toroids for the Injector were calibrated and commissioned online. This resulted in the realization that the gun was generating 40% more charge than was previously measured.

- 2007 Shutdown Installation Readiness –
  - All Controls sub-systems are on course for the 2007 Downtime installation, with the completion expected by the beginning of December 2007. All system wiring diagrams and rack profiles are complete.
    - Cable orders are nearly complete and over 80% have been delivered. All the required connectors have been ordered and most have been delivered and ready for installation. Phase 3 Cable Plant (S21 to BTH W) contract has been awarded with the installation start in August.
    - Most BC-2 controls hardware is on-site with the remainder expected in early August.
    - Data acquisition electronics for the BC2 toroids have been fabricated and will be tested in August. All cameras and electronics for the beam profile systems and these are being tested.
    - Fabrication of five LION High Voltage Power Supply chassis was completed. The chassis were bench tested and are ready for installation.
  - The LCLS installation work authorization control form is signed and approved by Safety Personnel and LCLS management.

- 2008 Shutdown Planning – Design and documentation is proceeding for the installation of the 2008 cable plant. The Davis-Bacon bid package will be ready in November 2007, with the bid to be awarded in February 2008 and installation starting in March 2008.

- The vacuum system ESD for the LTU/Undulator/E-Dump was completed and it is being reviewed.

Assessment and Issues:

- None

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

Highlights:

- Shutdown Installation Readiness –
  - Plans for 2007 installation shutdown are in place. In the first two weeks of the down, SLAC's Manufacturing Department will be taking out accelerators in sector 24 to make room for Bunch Length Compressor 2, clearing penetrations for cables and removing accelerators in L3 area for re-configuration of the Linac.
  - Over 90% of hardware is available for installation. MFD is collecting parts in kit form for installation. Daily tailgate meetings will start on August 24th.
  - The BC2 center table and arms are being assembled in buildings 25 and 26 to verify their functionality. The BX2 magnets are in magnetic measurements.

- Design and Procurement Progress –
  - Modifications to LTU stands did affect cost and delivery schedule. Deliveries of stands will start in October, the supplier is willing to store them in their facility until SLAC is ready to install. SOW's for the LTU stand installation have been submitted.
  - All correctors for the LTU installation have been received.

Assessment and Issues:

- The 2007 downtime installation is very short, and the budget may not be sufficient to perform all downtime tasks. A Pending BCR has been added to update the cost estimate once the installation contract prices are known.

- The 2007 Continuing Resolution led to delays in final design and procurement of the Linac system, which is reflected in poor schedule performance against the baseline. These variances will persist until the new plan becomes official. A revised cost and schedule is being prepared that will take into account the CR.

WBS 1.4, 2.4 Undulator System

Highlights:

- Undulator Production Magnets – All 40 of the main magnetic structures have all been assembled and delivered. Thirty-nine production undulators have been delivered to SLAC and one remains at Argonne National Laboratory (ANL) for long term testing and development.

- Undulator Components & System Integration –
  - Undulator Support Movers – Both vendors (Components-Metalex, Integration-Hi-Tech) are progressing on the support motion systems. The first-article girder was accepted at Metalex, with four girders complete and ready for shipment to Hi-Tech. Completion of the first article assemblies at Hi-Tech is delayed due to late arrival of some ANL long-lead components (gearboxes and translation slides).
  - Undulator Quadrupoles – First article quadrupoles were tested at Argonne and tests were started at SLAC. Initial testing indicates that the magnetic center stability is well within specifications, but magnetic length is below specification. This will be addressed at the vendor by increasing the number of laminations within the designated length.

- Undulator Assembly & Measurement – Production tuning of undulators continues. Travelers for all undulators in MMF have been generated and put with the actual magnets. All CMM tooling is complete and integrated into the automated inspection program. The quadrupole fiducialization system was commissioned.

Assessments and Issues:

- Undulator Vacuum Chamber – The stainless steel vacuum chamber has been dropped from the baseline after failing to meet performance specifications on magnetic permeability. Due to previous prototype R&D there are three alternate designs already partly developed. They are:
  - Extruded Aluminum Chamber – Results from extrusion development effort are promising. ANL will perform surface roughness measurements to ensure it meets requirements.
  - Aluminum Clamshell – Requires further development. SLAC is pursuing polishing techniques to ensure it meets roughness requirements.
  - Copper Chamber – Simple design requiring minimal development.

- The addition of the ANL Integration engineer is imminent. This is an important step in improving the quality of components delivered to SLAC.

Photon Beam Systems

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

Highlights:

- Management and Safety – The XTOD group prepared for and presented status reports at the Lehman review in July. The controls schedule is being updated under the guidance of G. Haller who has assumed CAM responsibilities for Photon Systems Controls.

- XTOD Design Status and Progress –
  - Version 54 of the XTOD configuration drawing has been released with all interface points updated to match the Jacobs Engineering construction drawings. The LUSI Treaty Flanges for NEH Hutch 3 are identified.
  - Water cooling requirements for the attenuator turbo-pumps and the total energy cryo-pump were forwarded to SLAC for the purposes of sizing the NEH water system which will supply the cooling water to the FEE.
  - The Soft X-ray Imager PRD is in circulation for comment. The concept calls for directing the soft X-ray spontaneous radiation from one or more undulators onto a multilayer mirror with reflectivity of around 8%. The reflected light strikes a bare CCD, which records the distribution of the radiation. The 1% bandwidth of the multilayer reflects only the core of the fundamental and does not reflect the diffuse spontaneous background produced by reflections in the undulator vacuum chamber.
  - The Pop-in camera design is converging towards a configuration centering on the Pulnix TM-4200 CL camera and the Navitar Platinum 50 lens, viewing a 1 mm thick YAG:Ce crystal. This gives up to a 60 x 60 mm FOV and a 15 Hz readout rate. The Pop-ins will be used for mirror alignment.

- Attenuator – All of the commercial components of the attenuator have been ordered. The final drawings of the attenuator have been signed and entered into the repository. The request for quotes on the attenuator vessels has gone out.

Assessment and Issues:

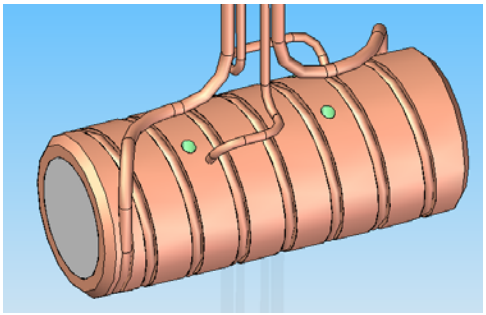
- The 2007 Continuing Resolution led to delays in final design and procurement of most XTOD systems, which is reflected in poor schedule performance against the baseline. These variances will persist until the new plan becomes official. Cost variances are much smaller. They are generally due both to CR effects and to extended design work which is expected to yield savings during the procurement phase.

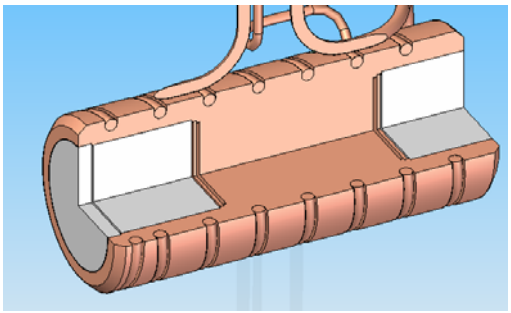
WBS 1.6, 2.6 X-Ray Endstation Systems (XES)

Highlights:

- Management and Safety – The XES group presented a new re-baseline schedule at the DOE Review in July. The recommendation for LCLS following this review has had a significant impact on the XES system plan, which is currently being addressed.

- Photon Stoppers – A preliminary design review was held for both hutch photon stoppers and the photon/electron stoppers in the beam dump area. A few changes were requested in the photon/electron stopper design to improve ease of manufacture (see figure), which consists of brazing a copper sheet to the copper body to form pressurized gas volumes.





- LCLS Detector Development – Preliminary testing began of the first full lot ASIC (190 x 190 pixels). Some of the functionality of the high-level architecture was verified (e.g. addressing shift registers) and initial tests showed that the pixels are responsive. Work on the FPGA readout has continued and will be used to interface the ASIC when full functionality of the ASIC is confirmed. The ASIC wafers were sent to RTI for processing.

- Atomic Molecular and Optics (AMO) Instrument – The design of the AMO instrumentation continues to progress in anticipation of a preliminary design review. Following discussions at the ICPEAC meeting in Germany, however, it was decided that the configuration of the instrumentation on the high field physics chamber should be changed to accommodate a longer flight path for the sample injector.

Assessment and Issues:

- The LCLS baseline schedule presented at the DOE review in July has significant impact on the XES schedule, especially on the delivery of the AMO instrument. Further requests to modify the XES schedule and budget will likely impact the performance in the XES section due diverting resources away from their actual tasks.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)

Highlights:

FEE and EBD looking west (upstream)

Central Utility Plant (CUP) underground utilities

- Construction Progress –
  - Construction is ~37% complete. To date, $991K Field Change Orders have been negotiated and approved, which is ~3.5% of construction progress to date.
  - Near Experimental Hall (NEH) – The NEH is 100% erected: all concrete floors, walls and ceiling decks are installed. Mechanical, electrical and plumbing utilities are roughed-in. NEH is 4 weeks ahead of schedule.
  - Beam Transport Hall (BTH) – The concrete structure (at grade) is ~85% complete. Resequencing of activities has recovered schedule and the facility is currently on schedule.
  - Electron Beam Dump/Front End Enclosure – The sitework has been completed. Rebar layout and installation is 50% complete during this reporting period.
  - FEH Cavern – The initial 20' of advance (10% overall) has been completed. Ground conditions have proven to be favorable thus far.

Issues and Assessments

- Overall, civil construction lags behind its baseline schedule (early occupancy in early December 2007) by 3-4 weeks. Most critical areas are in the E-Beam Dump and Front-End Enclosure. A plan is in place to recover schedule.

- The tunneling subcontractor (Affolder) has submitted a no cost proposal for a new adit to lead to the X-Ray Tunnel. This proposal may gain to up to two months of schedule savings for the tunneling effort and is viewed as a "means and method" request. LCLS will review the option for safety and liability impacts to the SLAC site.

LCLS Cost and Schedule Performance – July 2007

LCLS Cost/Schedule Status Report									31-Jul-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	15,895	15,895	16,972	0	-1,077	1.00	0.94	18,013	88%
1.2 Injector	16,708	16,615	20,073	-93	-3,458	0.99	0.83	16,760	99%
1.3 Linac	14,310	12,244	15,941	-2,066	-3,697	0.86	0.77	19,940	61%
1.4 Undulator	30,209	25,789	30,336	-4,421	-4,547	0.85	0.85	37,398	69%
1.5 X-ray Transport	18,423	12,285	14,532	-6,138	-2,247	0.67	0.85	22,803	54%
1.6 X-ray Endstations	3,078	1,968	1,857	-1,110	111	0.64	1.06	8,735	23%
1.9 Conventional Facilities	69,510	62,266	63,080	-7,244	-814	0.90	0.99	127,338	49%
1.X LCLS Controls	24,533	16,749	19,016	-7,784	-2,267	0.68	0.88	32,366	52%
1 LCLS Total Base Cost	**192,666**	**163,810**	**181,806**	**-28,856**	**-17,996**	**0.85**	**0.90**	**283,353**	**58%**
					LCLS Total Estimated Cost			**315,000**	
					Contingency			**31,647**	
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	11,227	11,222	11,499	-6	-277	1.00	0.98	30,195	37%
2.2 Injector (OPC)	3,686	2,314	3,524	-1,372	-1,210	0.63	0.66	5,317	44%
2.3 Linac (OPC)	694	319	481	-375	-162	0.46	0.66	3,232	10%
2.4 Undulator (OPC)	2,956	2,712	727	-244	1,985	0.92	3.73	6,852	40%
2.5 X-ray Transport (OPC)	1,095	1,038	974	-57	64	0.95	1.07	4,544	23%
2.6 X-ray Endstations (OPC)	1,908	1,635	919	-273	716	0.86	1.78	5,559	29%
2.9 Conventional Facilities (OPC)	185	0	0	-185	0	0	0	683	0%
2.X LCLS Controls (OPC)	588	68	114	-520	-46	0.12	0.60	1,129	6%
2 LCLS Total Other Project Cost	**22,339**	**19,307**	**18,237**	**-3,032**	**1,070**	**0.86**	**1.06**	**57,511**	**34%**
					LCLS Other Project Cost			**64,000**	
					Management Reserve			**6,489**	
LCLS Total Project Cost	**215,006**	**183,118**	**200,043**	**-31,888**	**-16,925**	**0.85**	**0.92**	**379,000**	**54%**

Cost and Schedule Performance (con't)

July 2007 Project Performance	AYK$
Total Project Cost (TPC)	**$379,000**
% Planned (Cumulative)	63.1%
% Complete (Cumulative)	53.7%
Total Estimated Cost (TEC)	**$315,000**
Cost and Commitments to Date	$230,988
Estimate at Complete (EAC)	$304,436
Work Remaining	$122,630
Outstanding Phase-Funded Awards	$62,086
Remaining Contingency Based on EAC	$10,564
	8.3%

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 July 2007 Cost Performance Report is the 41st month reporting earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are $252,528K. The LCLS cost and schedule indices are 0.92 and 0.85, 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 is improving and is projected to recover most of its schedule delay.

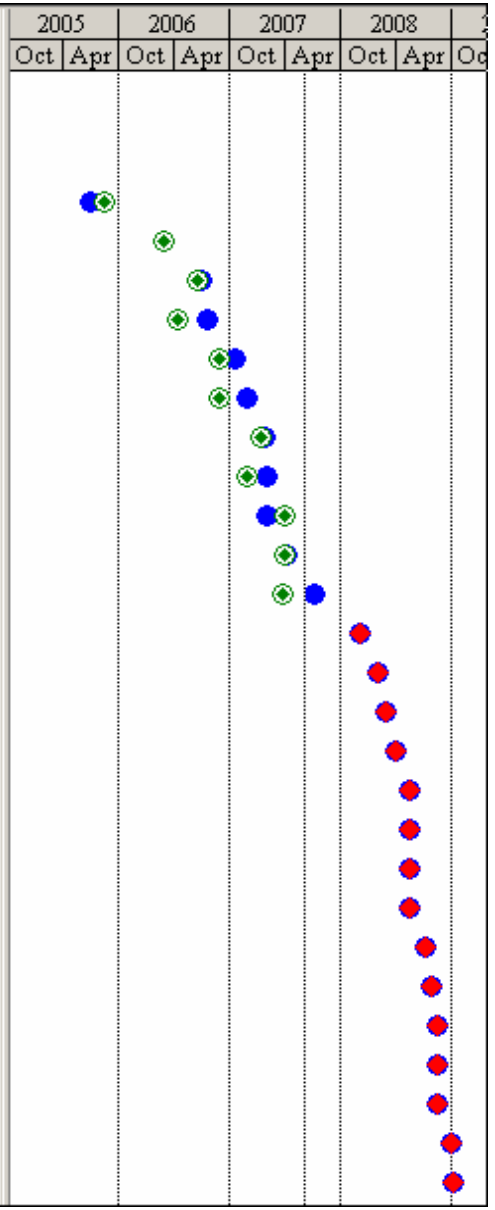
The project critical path runs through the Undulator Facility Co-(early) Occupancy followed by installation of undulators followed by FEL beam commissioning and finally photons in the FEH. The rebaseline exercise will also require a replanning of the project critical path.

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

To date, remaining contingency on EAC is less than ideal for this phase of the project. Contingency reserves on civil construction are 10% on committed but uncosted work, comparing favorably with 3.5% actual contingency usage. 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