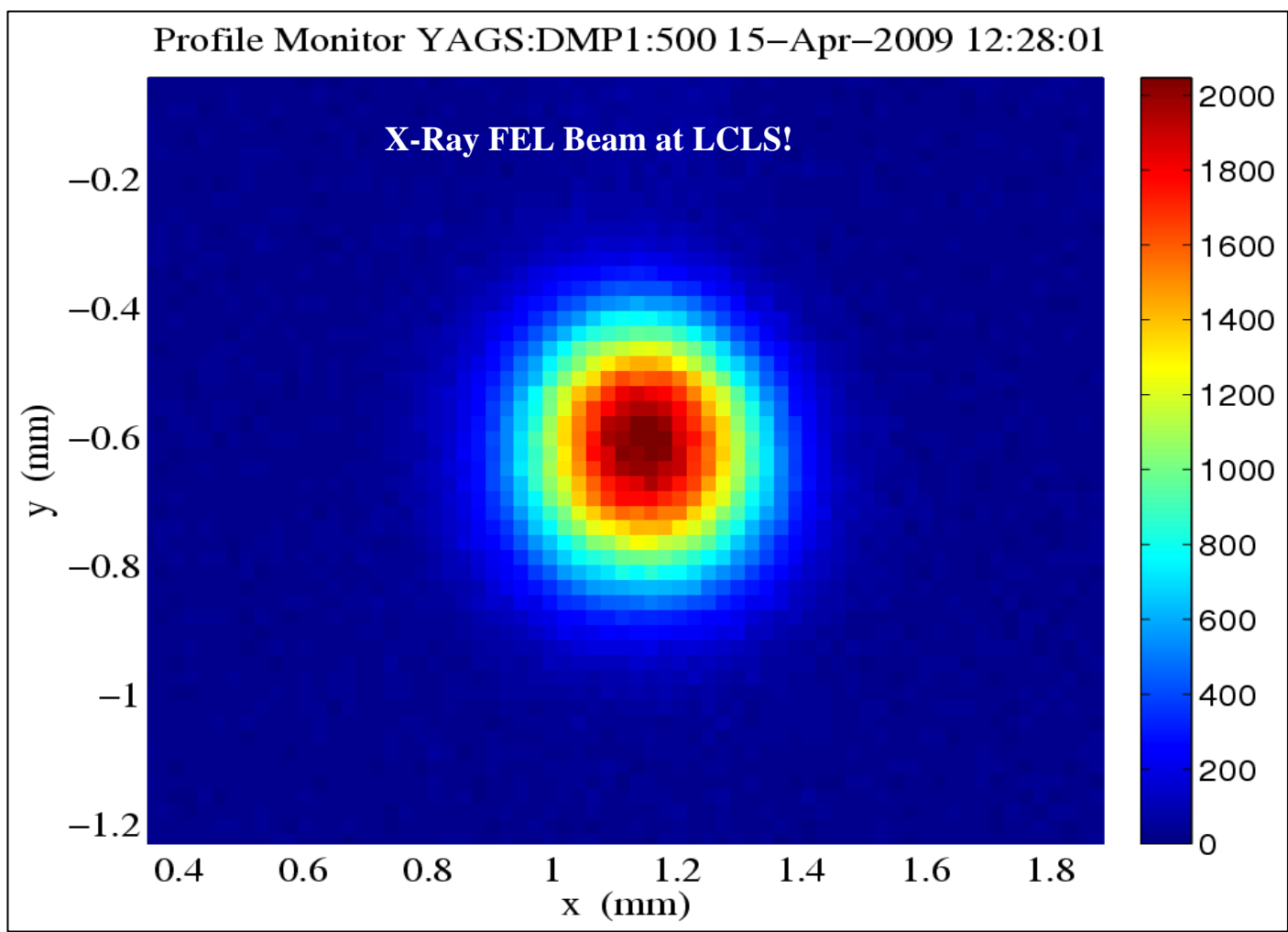


Linac Coherent Light Source

Monthly Report

April 2009



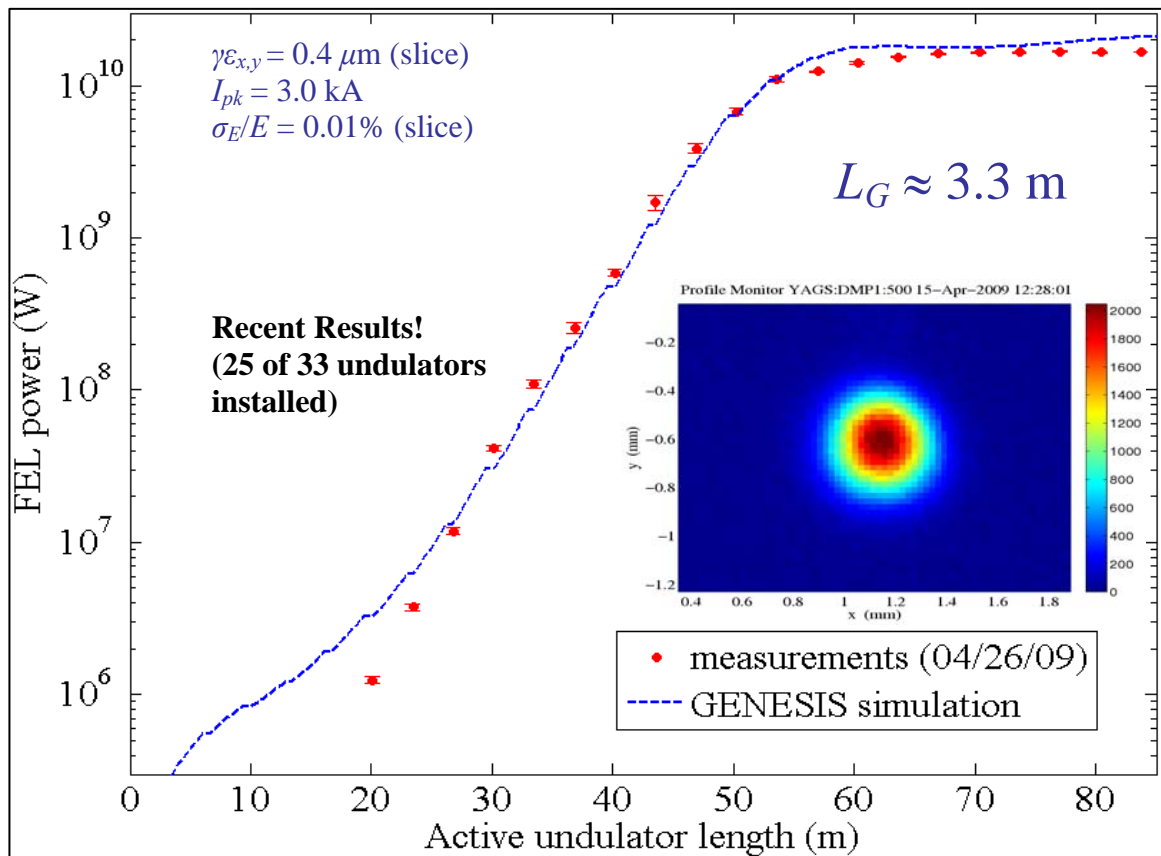
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Project Overview and Assessment

Highlights:

- Cover Page (The first x-ray FEL beam at LCLS) – The first x-ray FEL beam at LCLS as detected on a YAG screen indicating the LCLS FEL beam is ~100micron radius.
- In the figure below, the red data points show the laser power as the active undulator length is increased. The blue line is a simulation which matches the measured data well. The simulation shows that the LCLS is at or above its design parameters. Both the simulation and the data show FEL saturation above a 55m active undulator length.



Assessment and Issues:

- The April 2009 Cost Performance Report is the 62nd month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$375,165K. Cost and schedule indices are 0.99 and 0.98, respectively.

Project Office and Support

WBS 1.1, 2.1 Project Planning, Management and Administration

Highlights:

- LCLS Environmental, Safety & Health Status –
 - The project has worked 270 days without a restricted or lost time injury and 184 days without a recordable injury. Total project hours are 2.19M comprised of 1,589K collaboration hours and 599K subcontracted hours.
 - The project DART rate for construction is currently 3.0¹, as compared to the general industry rate of 3.2. The total project DART rate is 1.0; this includes construction and collaboration hours.
 - Installations continue in the FEE, NEH Basement and Subbasement, Laser Hall and now the XRT. The work is comprised of installing laser safety systems in the laser hall and hutch 1, termination and dressing of cables and activation of network lines. Hardware from LLNL continues to be installed by LLNL technicians. Work is being performed by SLAC shops, collaborators and subcontractors and is scheduled and reviewed at Work Planning & Control meetings held every morning at 7AM in B751.

- Procurements Status –
 - Construction Procurements (Turner) –
 - Two modifications, Modification Nos. 080 and 081 were issued during April. Modification 080 incorporated 6 CORs and 5 FCOs, decreased the subcontract value of two of the bid packages due to unused allowances, and deobligated the FCO budget. Modification No. 081 incorporated 17 CORs.
 - A total of 522 FCOs and CORs have been settled, through negotiation or agreement, with issuance of Modifications.
 - Technical Procurements –
 - Orders continued to be placed and expedited for several AMO technical instruments and assembly parts throughout the month.
 - The LCLS Office Space Building RFP was issued with a due date of May 6, 2009.
 - Cable Plant Phase 6 awarded completion scheduled for June 2009.
 - An award was made to fabricate and install the Structural Steel in the FEH on 4/03/2009 with a completion date of July 3, 2009.

Assessment and Issues:

- None.

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

Electron Beam Systems

Injector, Linac, Undulator and E-Beam Controls Systems

Highlights:

- Management and Safety –
 - In March electron beam commissioning was suspended to install undulator magnets. Twenty-one undulator magnets were installed on undulator girders U13-U33. In April the beam was brought back on. Following beam tuning through the undulator-complex line, the undulator magnets were brought onto the beam. On April 10, as the number of magnets on line was increased, a clear signal of FEL operation was observed and grew as the number of magnets increased. Tests over the following days confirmed that the LCLS FEL was operating.
 - Work is continuing to characterize the machine. It appears that the gain length of the undulator is shorter (better) than expected, and the undulator appears to be outputting saturated beam with approximately half of the undulators engaged.

- BTH – NEH Controls Installation –
 - EPICS IOC reliability tests were performed for all systems.
 - All magnets and wire scanners were upgraded to RTEMS 4.9.1.
 - Stress tests were performed on the BPM system to understand performance limits.
 - The FEE Final Design Review was successfully completed.
 - The FEE cold checkout was completed.

- Undulator Assembly and Measurement (SLAC) –
 - The installation of the X-Ray Diagnostics in the ST0 Chamber was completed.
 - The BTMQUE stand and drift support were installed.
 - The IMBCS4 replacement toroid was installed.
 - A FEL beam was produced in the Undulator Complex on April 10th.
 - 25 undulator magnets are now installed and operational.

Assessments and Issues:

- None.

Photon Beam Systems

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

Highlights:

- Management and Safety – Schedule and cost variances remain high in XTOD through April, although the schedule variance trend is improving and cost variance trend is stabilizing. Efforts are underway to reduce the ultimate cost variance by finalizing all designs, simplifying some remaining tasks, and transferring some work from LLNL to SLAC. In addition, all remaining work is being scrutinized to make sure that cost estimates are accurate.
- Mechanical & Vacuum –
 - The wiring of the triple bay rack was completed except for ~5 cables with confused or missing labels. Termination of the external cables of the 4 instrument racks was also completed.
 - All of the collimator drawings were released, and all parts are on order. The Tungsten Heavy Alloy and B4C for collimators C1 and C3 were shipped to LLNL by the vendors. The stands for C1 and C3 have been shipped by the vendor. The collimators C1 and C3 are in partial assembly. The isolation valve and temporary beam stop were baked out.
 - The Seismic Anchor Templates for the FEE early beam configuration, and parts of the remaining FEE, were fabricated and sent to SLAC. The Seismic Anchor Templates for the remainder of the FEE should be finished by the end of May.
- XTOD Design & Production Status –
 - Fixed Mask and Slit - The Fixed Mask was installed into the FEE. The Slit is being reassembled after baking. SLAC was unable to fix the Slit bellows that sprang a leak during bakeout. A new one has been ordered.
 - Gas/Solid/Attenuator – Wiring of the Gas Attenuator and Gas Detectors was completed. The HEPA filters for the exhaust arrived at LLNL.
 - Direct Imager – The Direct Imager vacuum system and stand were installed into the FEE, and wiring was completed.
 - SOMS – The SOMS mirror tanks were leak-checked and the mirrors mounted inside the vessels. SOMS M1 and M2 will be ready for delivery by May 1st. SOMS M3 and M4 await the arrival of the B4C chin guard which had to be redesigned after the raytrace.
 - Total Energy Thermal Sensor - The Total Energy monitor was installed into the FEE, and wiring was completed.

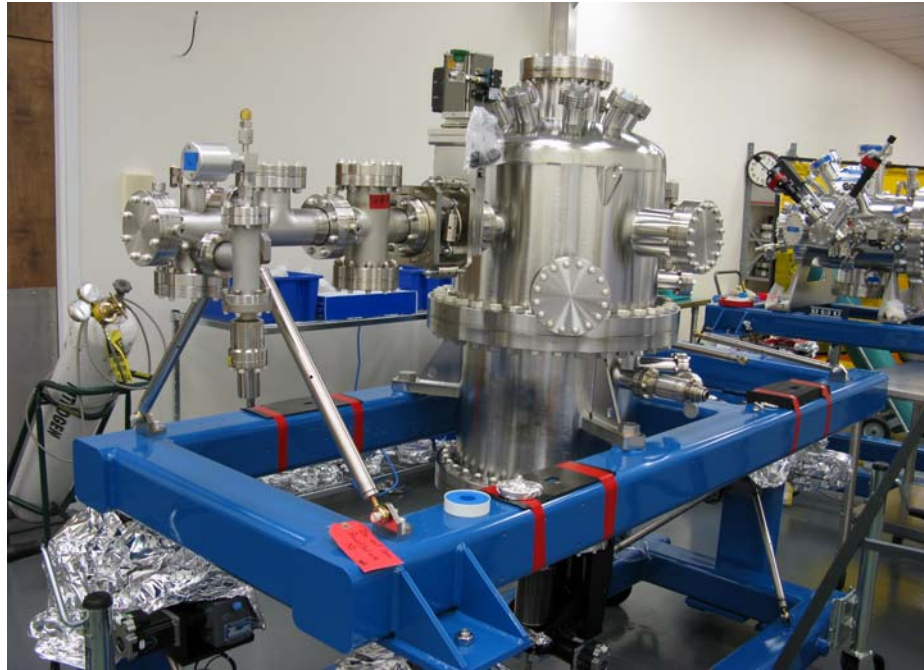
Assessment and Issues:

- None.

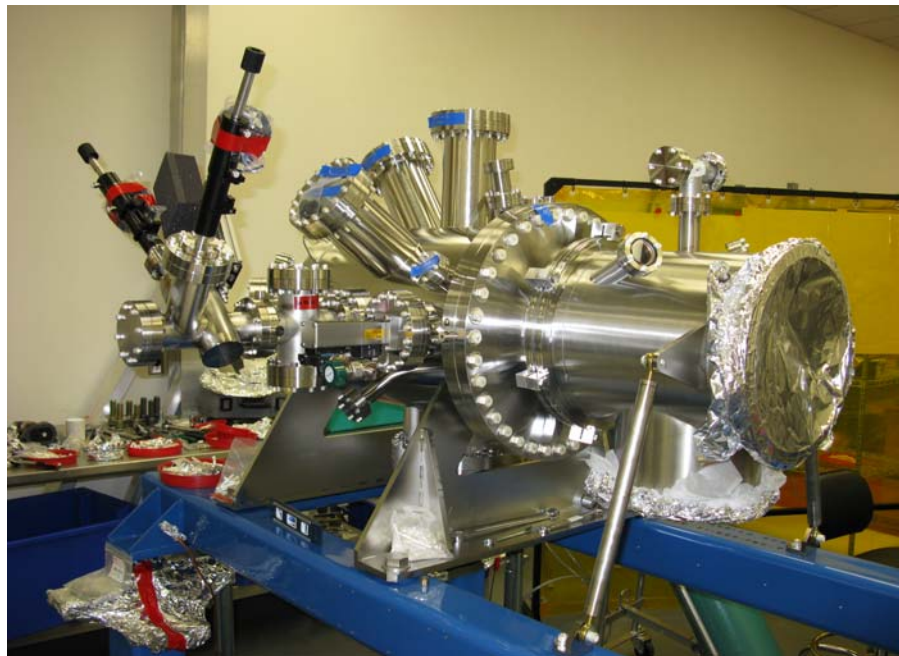
WBS 1.6, 2.6 X-Ray Endstation Systems (XES)

Highlights:

- Management and Safety – The performance metrics for cost and schedule for WBS 1.6 are similar to last month. Cost and schedule variances in installation and mechanical systems are due to delays in stopper fabrication. This is being monitored very closely as the installation dates are approaching. Positive cost variances exist in the Commissioning and X-ray Detector sections, due to changes in the planned schedule. These variances will be corrected in the upcoming months.
- Mechanical Systems -
 - The fabrication of the hutch stoppers for the X-ray tunnel and the Far Experimental hutches is progressing with a projected completion date at the end of July. Shielding requirements have been reviewed and incorporated into some of the stopper tank designs.
 - Contracts for installing utilities in the Near Hall such as piping for exhaust systems, AC for experimental racks, and PPS and laser doors have been placed and installation has begun. Completion is expected at the beginning of June.
- LCLS Detector Contract with Cornell University - The 2D detector project at Cornell is preparing for the 8th LCLS Detector Advisory Committee Review meeting on May 7-8. A visit to the bump-bonding vendor was organized to plan the next bump-bond run of the ASIC and detector chips. Testing of the digital board with a full readout system is ongoing with progress on the programming of the FPGA. Testing of the prototype with X-rays will occur soon.
- XES Laser System – The Photon Controls Group began installation of the hardware components for the laser hall laser safety system (LSS). Additionally the Standard Operating Procedures (SOP) for the Safe Use of Lasers in the NEH Laser Hall was revised and updated to include changes to the laser architecture and the laser safety system. The LSS certification and approval to operate in the laser hall is expected during June.
- Atomic, Molecular and Optics (AMO) Instrument –
 - Both the High-Field Physics Chamber and the Diagnostics Chamber are more than 90% complete (see attached photos).
 - Some long-lead components such as the ITOF detector are being monitored for on-time delivery. Special attention is given to the vacuum treatment of some components such as the single pulse shutter, where outgassing issues require special baking prior to completing this assembly.



Diagnostic Chamber in staging area



High Field Physics Chamber in staging area

- XES Controls and Data Systems – The instrument controls for the AMO components are being tested by system in the Photon System Controls Lab. The bellows protection system that links the chambers has been added to this test set

- up. The AMO Control room equipment layout has been designed and a contract was awarded to begin this work. Work also progresses on the data acquisition software for the ATCA control and data readout and processing electronics.
- Soft X-Ray Material (SXR) Instrument - The external funds have been made available which allows starting the procurement of the hardware. Bids for the monochromator were evaluated, a vendor was selected, and the order was placed. The required delivery date in mid-November was confirmed. The monochromator mirror and grating have been ordered with delivery dates consistent with the monochromator fabrication schedule. A request for proposals has been issued for mirrors M2 and M3. The request for proposals for the Exit Slit system has also been released.

Assessment and Issues:

- None.

Conventional Facilities (CF)

WBS 1.9, 2.9 Conventional Facilities (CF)

Highlights:

- Construction Progress –
 - All areas (BTH thru FEH) – all field activities including punch list items and red-lined markups have been submitted and are now 100% complete.
- Far Experimental Hall Hutches – The construction documents have been submitted to proposed General Contractors for bidding purposes. Bids are due during the month of May.
- Design Office Space Alternative –
 - The Office Space Alternative project was sent to 7 potential bidders. The proposals are for a Guaranteed Maximum Price, design/build contract. Bids are due May 5, 2009.
 - Building 028 and Building 751 remodeling: HDR-CUH2A is advancing towards the 90% design submittal. The IFB documents are due first week of June, 2009.
 - The selection of LCLS office space alternative will be made by June 1, 2009.

Assessment and Issues:

- The structural steel fabrication drawings (columns, beams, stairs and metal decking) for the FEH hutches will be submitted to both SLAC and the Engineer of Record for approval prior to commencement of fabrication. The FEH Hutch project will be managed directly by the LCLS CF group.



LCLS Cost and Schedule Performance – April 2009

LCLS Cost/Schedule Status Report								30-Apr-09		
WBS	Cumulative to Date (\$K)							Budget At Complete (\$K)	Estimate At Complete (\$K)	Variance At Complete (\$K)
	Budgeted Cost		Actual Cost Work Performed	Variance		Performance Indices				
	Work Scheduled	Work Performed		Schedule	Cost	SPI	CPI			
1.1 Project Management	21,292	21,299	20,592	7	708	1.00	1.03	22,599	21,891	708
1.2 Injector	20,239	20,239	20,240	0	0	1.00	1.00	20,239	20,240	0
1.3 Linac	27,948	27,948	28,023	0	-75	1.00	1.00	27,948	28,023	-75
1.4 Undulator	45,830	45,737	45,906	-92	-168	1.00	1.00	46,030	45,984	46
1.5 X-ray Transport	28,045	25,606	28,428	-2,439	-2,822	0.91	0.90	28,858	31,680	-2,822
1.6 X-ray Endstations	7,878	7,390	8,045	-487	-655	0.94	0.92	10,669	11,524	-855
1.9 Conventional Facilities	131,377	127,965	129,271	-3,413	-1,306	0.97	0.99	142,794	144,100	-1,306
1.X LCLS Controls	39,140	38,144	38,891	-996	-747	0.97	0.98	41,937	42,684	-747
1 LCLS Total Base Cost	321,749	314,329	319,396	-7,420	-5,067	0.98	0.98	341,073	346,126	-5,053
								LCLS Total Estimated Cost		352,000
								Contingency		10,927
								% Contingency on ETC		40.9%
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	20,213	20,214	19,373	1	841	1.00	1.04	24,438	23,598	841
2.2 Injector (OPC)	5,892	5,892	6,199	0	-308	1.00	0.95	5,892	6,200	-308
2.3 Linac (OPC)	2,143	2,140	2,244	-3	-104	1.00	0.95	2,334	2,843	-509
2.4 Undulator (OPC)	9,266	8,269	7,777	-997	491	0.89	1.06	10,169	9,927	241
2.5 X-ray Transport (OPC)	3,061	3,085	3,306	24	-221	1.01	0.93	4,185	4,406	-221
2.6 X-ray Endstations (OPC)	5,859	5,750	3,781	-109	1,969	0.98	1.52	10,408	9,239	1,169
2.9 Conventional Facilities (OPC)	1,651	1,555	1,462	-96	93	0.94	1.06	2,688	2,595	93
2.X LCLS Controls (OPC)	3,178	2,616	2,375	-563	240	0.82	1.10	3,541	3,301	240
2 LCLS Total Other Project Cost	51,263	49,520	46,518	-1,743	3,001	0.97	1.06	63,656	62,110	1,546
								LCLS Other Project Cost		68,000
								Management Reserve		4,344
								% Management Reserve on ETC		30.7%
LCLS Total Project Cost	373,012	363,848	365,914	-9,163	-2,066	0.98	0.99	420,000	90%	

Cost and Schedule Performance (con't)

<u>April 2009 Project Performance</u>	AYK\$
Total Project Cost (TPC)	\$420,000
Planned % Complete	92.2%
Actual % Complete	89.9%
Total Estimated Cost (TEC)	\$352,000
Cost and Commitments to Date	\$325,094
Estimate at Complete	\$346,126
Work Remaining	\$26,731
Outstanding Phase-Funded Awards	\$6,037
Remaining Contingency (Based on EAC)	\$5,874
% Contingency on uncommitted work remaining	26.0%

Overall Cost and Schedule Assessment

The LCLS cost and schedule are consistent with the approved baseline with a Total Estimated Cost (TEC) of \$352M and a Total Project Cost (TPC) of \$420M. The CD-4 milestone is July 2010. All costs are in actual-year dollars and out-year costs are escalated.

The April 2009 Cost Performance Report is the 62nd month of reported earned-value on the LCLS. TPC cumulative obligations to date (actual costs + open commitments) are \$375,165K. Cost and schedule indices are 0.99 and 0.98, respectively.

The critical path to meet CD-4 technical performance runs through the scheduled Linac shutdown, then FEL commissioning and has 76 working days (~5 months) of float. Near critical path activities are the FEH PPS and FEE installation activities. The critical path to meet CD-4 overall performance runs through the LCLS space renovation has 80 working days.

The Estimate at Complete (EAC) provides the most current estimate of the TEC projected final cost. Contingency on EAC is considered adequate for this stage of the project. LCLS is evaluating possible enhanced capabilities to the baseline. Any added capabilities will be presented to the Change Control Board for approval prior to being added to the baseline.

DOE (Level 2) Milestones

Activity Description	Base Date	Base vs Curr	Current Date	Fiscal Year							
				FY04	FY05	FY06	FY07	FY08	FY09	FY10	
DOE Milestone - Level 2											
Preliminary Safety Assessment (PSAD) Doc Comp	04/30/04	0	04/30/04A	●							
DOE External Independent Review (EIR) Complete	06/15/04	0	06/15/04A	●							
Fire Hazard Analysis Approved	06/30/05	-31	08/15/05A		●						
Preliminary Safety Assessment (PSAD) Doc Appvd	02/28/06	0	02/28/06A			●					
Delivery of Undulator 1st Articles to MMF	07/03/06	12	06/15/06A			●					
Sector 20 Alcove Beneficial Occupancy	07/21/06	58	04/14/06A			●					
MMF Qualified & Ready to Measure Prod Undulators	08/28/06	0	08/28/06A			●					
Research Yards Mods Beneficial Occupancy	10/20/06	35	08/30/06A			●					
Start Injector Commissioning (Drive Laser)	01/29/07	19	12/15/06A			●					
Injector Laser Commissioning Review Complete	01/31/07	31	12/01/06A			●					
Injector Accelerator Readiness Review (ARR) Comp	01/31/07	-41	03/30/07A			●					
Start Injector Commissioning(UV Beam to Cathode)	04/09/07	2	04/05/07A			●					
Linac Water/Power Available	07/11/07	72	03/29/07A			●					
Linac (L120-L130) Ready for Commissioning	12/01/07	0	12/01/07A					●			
Start Installation of Undulator Facility	05/16/08	-62	08/14/08A				●				
Beam Transport Hall Beneficial Occupancy	07/21/08	-18	08/14/08A	●							
Undulator Facility Beneficial Occupancy	07/21/08	-18	08/14/08A		●						
Front End Enclosure Beneficial Occupancy	07/21/08	-21	08/19/08A	●							
Near Experimental Hall Beneficial Occupancy	07/21/08	-19	08/15/08A					●			
Central Utility Plant Beneficial Occupancy	07/21/08	-19	08/15/08A	●							
Linac (L120-L130) Commissioning Complete	07/30/08	84	04/01/08A					●			
Safety Analysis Document (SAD) Approved	08/29/08	-19	09/28/08A	●							
Start Installation of Beam Transport Hall	09/26/08	-2	09/30/08A		●						
X-Ray Transport Beneficial Occupancy	10/22/08	-18	11/17/08A		●						
Far Experimental Hall Beneficial Occupancy	10/22/08	-17	11/16/08A	●							
XT Start FEE Installation	01/13/09	-40	03/12/09A					●			
Beam Path Project Close Out	02/13/09	53	11/17/08A					●			
LCLS ARR Complete (BTH thru FEH)	04/17/09	13	03/31/09A					●			
Start Linac-to-Undulator (LTU) Commissioning	04/20/09	82	12/12/08A				●				
XT Start Tunnel Installation	05/27/09	0	05/27/09*					●			
Start Undulator Commissioning (1st Light)	07/06/09	0	07/06/09*					●			
XE Start Installation in NEH	07/24/09	35	06/04/09*					●			
Start FEE Commissioning with Beam	08/06/09	0	08/06/09*					●			
First X-Rays into NEH, ready to start Exptl Ops	09/10/09	0	09/10/09*					●			
XE Start Installation in FEH	09/17/09	0	09/17/09*					●			
2-D Detector Shipped to SLAC	02/26/10	0	02/26/10*						●		
First X-Rays into FEH	02/26/10	0	02/26/10*						●		
SXR Instrument Installed	03/01/10	0	03/01/10*							●	

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 under run” condition.

Cost Variance (CV) – Difference between the estimated value of the physical work performed and the actual cost expended for a specific WBS#, subproject, or project. $CV = BCWP - ACWP$. A negative result is unfavorable and indicates the potential for a cost overrun.

Estimate at Completion – Forecast of the final cost for a specific WBS#, subproject, or project based on the current ACWP plus a management assessment of the cost to complete the remaining scope of work.

Estimate to Complete (ETC) – A realistic appraisal of the cost to complete the remaining scope of work.

Other Project Cost (OPC) – LCLS “supporting” costs not directly contributing to the construction project. OPC costs generally include research and development and pre-operation (start-up) activities.

Percent Complete – The ratio of the work accomplished (earned-value) to the Budget at Completion for any WBS#, subproject, or project. $\% \text{ Complete} = BCWP/BAC$.

Percent Contingency Remaining – The ratio of remaining contingency dollars to remaining line item (TEC) work calculated as follows: the numerator is equal to the contingency available (after consideration of the EAC) less 5% of outstanding technical phase-funded awards and less 10% of outstanding conventional facilities phase-funded awards. The denominator is the EAC less ACWP less outstanding phase-funded awards.

Percent Planned – The ratio of the current plan to the Budget at Completion. $\% \text{ Planned} = BCWS/BAC$.

Project Engineering and Design (PED) – Funding used to support the engineering and design effort for the LCLS.

Schedule Performance Index (SPI) – The ratio of the value of work performed to work scheduled, $SPI = BCWP/BCWS$. Values less than 1.0 represent a “behind schedule” condition, and values greater than 1.0 represent “ahead of schedule” condition.

Schedule Variance (SV) – Difference between the value of the physical work performed and the value of the work planned (scheduled). $SV = BCWP - BCWS$. A negative result is unfavorable and indicates a behind schedule condition.

Total Estimated Cost (TEC) – The total capital budget authorized for the LCLS project for the construction phase of the project. TEC includes contingency but does not include OPC.

Total Project Cost (TPC) – The total capital budget authorized for the LCLS project, including TEC and OPC.

WBS (Work Breakdown Structure) – A method of hierarchically numbering tasks in a traditional outline numbering format. The WBS provides a basis for the LCLS work plan which is used to track all resources, schedules, and cost.