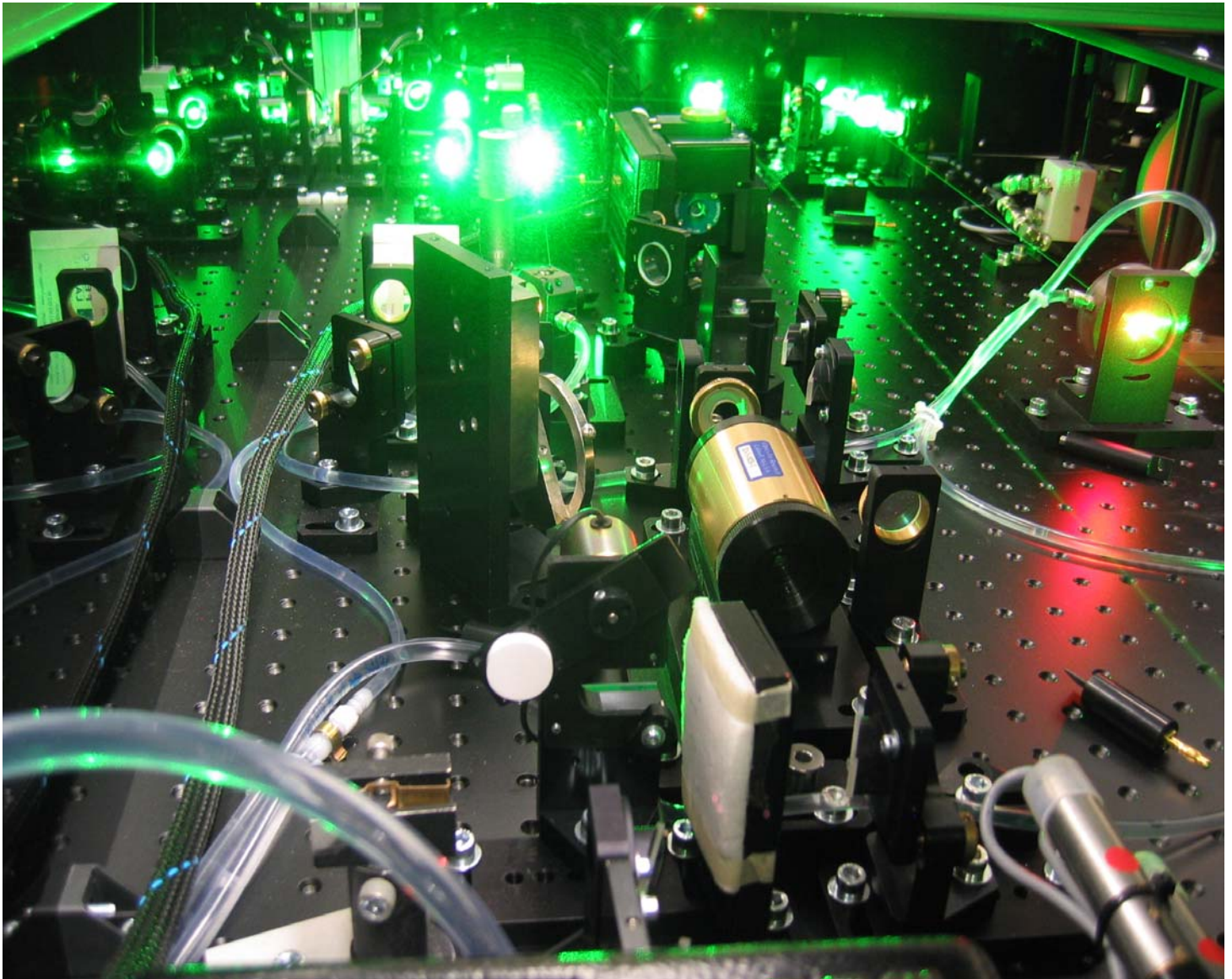


# Linac Coherent Light Source Monthly Report February 2007



# CONTENTS

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PROJECT OVERVIEW AND ASSESSMENT	3
TECHNICAL AND PROGRAMMATIC PROGRESS	
<u>LCLS Project Office &amp; Support</u>	
WBS 1.1, 2.1    Project Planning, Management & Administration	5
<u>Electron Beam Systems</u>	
WBS 1.1.3, 1.X.3 Global Controls	7
WBS 1.2, 2.2    Injector	8
WBS 1.3, 2.3    Linac	9
WBS 1.4, 2.4    Undulator	10
<u>Photon Beam Systems</u>	
WBS 1.5, 2.5    X-Ray Transport & Diagnostics	12
WBS 1.6, 2.6    X-Ray Endstations	13
<u>Conventional Facilities</u>	
WBS 1.9, 2.9    Conventional Facilities	14
COST PERFORMANCE REPORT	
-Cost/Schedule Performance	15
-Cost/Schedule Assessment	
-Milestone Performance	
GLOSSARY	18

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## Project Overview and Assessment

### Highlights:

- The LCLS Detector Advisory Committee meeting (LDAC) was conducted in the first week of February, reviewing all the LCLS detector projects. The Cornell effort received favorable marks. Cornell is preparing a full-lot submission for silicon wafer fabrication for early March. All design changes and improvements have been incorporated. The design of the detector diode array nears completion.
- The construction phase for the LCLS major civil activities began with the on-site mobilization of heavy equipment on Sept 09, 2006. This work is being managed by the Turner Construction (TCCo). To date, construction is ~13% complete. Field Change Orders to date are ~6.9% of work accomplished.
- LCLS is continuing with the driver laser commissioning (cover page – green “pump” lasers are a subsystem of the laser dedicated to the LCLS injector linac). The optical transport system has been commissioned and meets all specs. The virtual cathode, energy monitor, and pointing stability loops are all calibrated and perform as expected. Commissioning of the 135 MeV injector accelerator (laser on RF Gun cathode) is planned for late March.

### Assessment and Issues:

- The February 2007 Cost Performance Report is the 36<sup>th</sup> month reporting earned-value on the LCLS. For month-ending February 2007, the LCLS cost and schedule indices are 0.93 and 0.91, respectively. Declines in the CPI and SPI (and increase to the EAC) are primarily driven by delays in civil construction and by procurements delayed by uncertainty in the FY2007 LCLS budget due to the Continuing Resolution (see below). TPC cumulative obligations to date (actual costs + open commitments) are \$173,402K.
- Uncertainties related to the Continuing Resolution and full FY2007 funding are impacting the cost and schedule performance of the LCLS. All major procurements at SLAC, ANL and LLNL have been put on hold by the LCLS Project Office. In addition, a portion of the project staff has been redirected to evaluate plans and strategies under reduced funding to minimize the impact to LCLS science. The cost of redirected staff is roughly estimated at \$875K over the past three months. After the conclusion of the Continuing Resolution, the FY2007 appropriation resulted in \$8M less than anticipated funding for LCLS. FY07 was the peak funding year for construction. The procurement delays caused by the CR and the shortfall in funding resulted in 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.

- Civil construction schedule performance is 4-6 weeks behind its early finish milestones. The delays are due to unforeseen and undocumented utilities, inclement weather and general contractor Turner Construction (TC) coordination problems with meeting electrical safety requirements. The CF group will coordinate with TC to develop a recovery plan for these areas to ensure completion of scheduled milestones.

## Project Office and Support

### WBS 1.1, 2.1 Project Planning, Management and Administration

#### Highlights:

- LCLS Environmental, Safety & Health Status – February 2007
  - Safety Performance – LCLS worked 149 days without a recordable injury at SLAC. The project sustained one injury to an employee in June of 2005 and one injury to a subcontractor in October of 2006. The LCLS project recordable incident rate is currently 0.64<sup>1</sup>, which compares favorably to general industry rates of 6.8 and that of the Department of Energy which is 2.1 for similar work.
  - Safety Training Compliance Metrics –
    - Mandatory safety training = 97% (goal = 93%)
    - Supervisor required safety training = 92% (goal = 93%)
    - Compliance for training assessments = 96% (goal = 92%)
    - Medical exams for affected employees = 100% (goal = 90%)
  - DOE Stanford Site Office (SSO) Inspections – The DOE-SSO is conducting once per week inspections of LCLS activities at S20 and the Turner construction site. The weekly inspections of S20 began approximately December 2006, while the construction inspections started in 2005. The construction safety inspections covered the active Near Experimental Hall (NEH) site as well as the Research Yard and Sector 20. No major safety issues/observations were noted. Several “Noteworthy Practices” were observed including effective prevention measures related to slip/trips/falls, rebar dislocation; as well as other noteworthy practices such as crane inspections, secondary containments for generators, and pipe welding operations.
- LCLS Procurement Status – February 2007
  - The LCLS Procurement Department continued with heavy activity in February 2007, mainly due to issues arising with subcontracts for the A/E (Jacobs) and CM/GC (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 –
    - Settlement on several issues was reached in February that resulted in contract modifications 25 & 26 for additional funding for Trade Subcontractors, final authorization for Pre-Purchased Equipment.
    - Modification 27 was prepared for unilateral reduction in CM/GC Fees due to the CLOC De-scope. Modification 28 adjusts two

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



trade subcontracts for sales tax that was excluded from the bid packages. These Modifications will be released in early March.

- Open Change Order Request (COR) Status – 22 CORs are in technical review, fact finding, or negotiation. Total estimated value \$1.26M
  
- Technical Procurements –
  - Injector Laser Heater Chicane Dipole Magnets – Subcontract awarded. The ship has slipped but no impact to the project will result.
  - BC2 Chicane Dipole Magnets – Subcontract awarded. Due June 2007.
  - LTU Quadrupole 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.

#### **Assessment and Issues:**

- LCLS conducted its quarterly surveillance audit of its Earned-Value Measurement System on February 12, 2007. The LCLS Surveillance Officer is Jerry O'Hearn from Lawrence Berkeley National Lab. In general, the surveillance officer's assessment is that the LCLS Corrective Action Plan has addressed the findings of the 27-31 March 2006 LCLS EVMS OECM Certification, however documentation of cost and schedule variances and their corrective actions is identified as an area needing improvement.

## Electron Beam Systems

### WBS 1.1, 1.x.2 Controls System

#### Highlights:

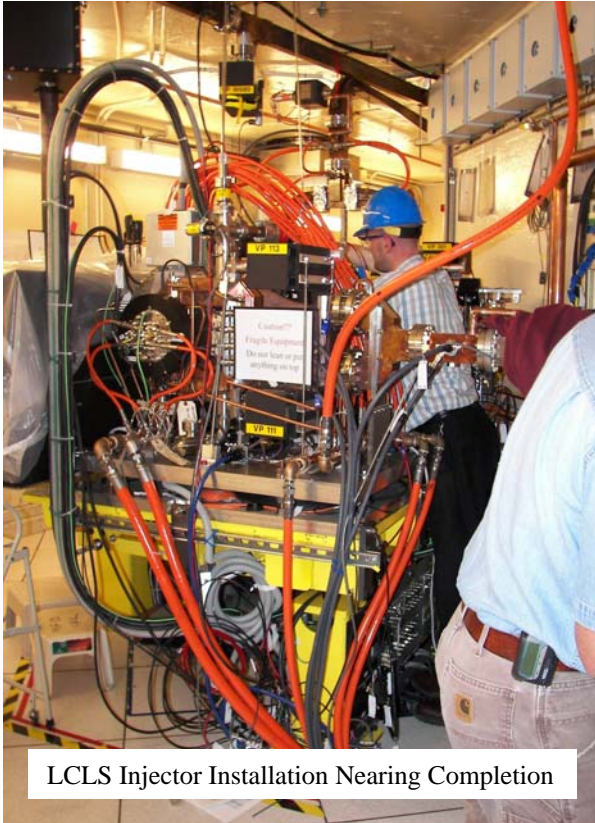
- Controls Installation –
  - Installation of all cable plant in the injector vault is complete.
  - The laser safety system was certified and delivered to operations.
  - The installation of the LCLS PPS system is complete.
  - The hardware and software for the laser launch control was completely installed.
  
- SLAC Main Control Center (MCC) –
  - EPICS interfaces to all safety systems including BCS, MPS and PPS were developed, and the BCS EPICS displays were in use in the Main Control Center.
  - Operator consoles for LCLS in MCC were completely setup and are now operational. The necessary software including MATLAB, data archiving and browsing facility, etc. have also been installed.
  - All motion control software (BC1, Collimator, Wire scanner) were installed in the MCC, awaiting tests with hardware.
  - Software for the support of EPICS controlled klystrons from the legacy system (SCP) was completed and is now being tested.
  
- Testing of the strip-line BPM analog and digital electronics boards continued. The software for operating the boards is complete and we are proceeding with system debugging and integration
  
- The LLRF software package including integration with the new LCLS timing system was completed. It is now being tested in L1-s. RF processing on 21-1 started.

#### Assessment and Issues:

- The Controls effort at SLAC was reorganized by combining the LCLS and the SLAC Controls Departments. A Deputy Controls Manager for LCLS will be hired to replace Hamid Shoaee who has taken over the leadership of SLAC's Controls Department.
  
- Controls Cost/Schedule Performance (CPI=0.89, SPI=0.78) – Controls has experienced considerable schedule slippage due to uncertainty in funding due to the CR. There are significant procurements, both at SLAC and at ANL, which have been held up due to funding issues. As the CR has now been resolved these purchases can go forward, but it will be difficult to recover from the late start.

## WBS 1.2, 2.2 Injector System

### Highlights:



LCLS Injector Installation Nearing Completion

- Drive Laser Commissioning – The laser system is complete and met all specs except temporal shape. The current temporal shape is close to spec and is acceptable for injector commissioning. LCLS has discussed possible solutions with the drive laser vendor (Thales) to improve the temporal shape. The optical transport system has been commissioned and meets all specs. The virtual cathode, energy monitor, and pointing stability loops are all calibrated and perform as expected.
- Injector Installation – The Gun-to-Linac (GTL) section was installed and aligned onto the RF gun table in the injector vault. This allowed laser group to align the “mock cathode” to virtual the cathode.

- Injector RF Gun – The RF gun will be installed next month when virtual cathode testing is complete. All waveguides are leak tight and under vacuum with ion pumps turned on. All waveguides were checked for coolant leaks in preparation for RF processing of L0A and L0B.

### Assessment and Issues:

- Injector Cost Performance (CPI=0.80) – The Injector cost overrun is chiefly due to high power RF fabrication and installation design. The engineering and fabrication of the RF gun and of the first accelerator structures took longer than planned as extra care was taken for these new and innovative designs. This work is complete and testing proved very successful and profitable. The Injector area is very congested and the design of the area proved to be more difficult than anticipated. Installation will conclude in March and Injector accounts will be closed (many are already being closed).



## **WBS 1.3, 2.3 Linac System**

### **Highlights:**

- L2 Beamline – All beamline components and supports are in SLAC's Manufacturing Facilities Department (MFD) for fabrication. The L2 design package is 90% complete.
- Bunch Compressor 2 (BC-2) – All BC-2 vacuum chambers are in MFD for fabrication. Support designs are in the design check cycle. We will be ordering the supports next month.
- Linac-to-Undulator Beamline (LTU) – The LTU support structure final design review was completed. The review was focused on the mechanical support structures for the quadrupole and dipole magnets along the LTU beamline. The final design review was approved by the committee (chair person Paul Emma) with few actions. Support drawings were sent out for quotation.
- The waveguide design for transverse cavity was completed. Most waveguides were fabricated last year with the exception of a few bends which will be submitting to MFD for fabrication.

### **Assessment and Issues:**

- The design for the TD23 stopper blocks used in the e-beam dump and stopper ST1 indicated that the thermal issues were more severe than anticipated. A design for this area is being evaluated.
- The Beam Transport Hall (BTH) floor (sump pit) is still not resolved. A consultant was hired to evaluate several structural support designs to see which would meet the stringent vibration requirements. Support is needed from CF to provide floor support for the Quad stands.
- The supplier for the BC-2 bend magnets has not finalized the drawing package. This makes integration into the BC2 Installation drawing difficult. The supplier will be visited to solve specification and delivery issues.
- Linac Cost Performance (CPI=0.83) – The Linac cost overrun is driven by the design of diagnostic instruments. The design of profile monitors, bunch length monitors, beam position monitors and movable collimators was underestimated. These designs are now complete. The installation of L1 and BC1 was more difficult than anticipated and more costly. This installation will conclude in March and those Linac accounts will be closed.

## **WBS 1.4, 2.4 Undulator System**

### **Highlights:**

- Undulator Vacuum Chamber – The LCLS Project Office requested an evaluation review of the baseline undulator vacuum chamber design (4-weld stainless steel) as well as the alternative design (aluminum clamshell) with the intent of selecting a single production design. The review took place at ANL-Advanced Photon Source on February 22, 2007. Although the review committee found both designs met the LCLS performance requirements, the LCLS Project Office determined that the best design choice was to continue with the development and full production of the Stainless Steel, “4-weld design”.
  - Chamber Production Status – The first, two full length prototype vacuum chambers (chamber components only) were vacuum-tested, initial problems with some of the welds were seen but after some re-work the chambers were made vacuum tight. Results from the Aluminum chamber coating process look very encouraging.
  
- Undulator Magnets – Undulator #33 was accepted on 15 February 2007. Thirty-three undulators are now complete. Enough Undulators have been manufactured to complete the required amount of undulators to be installed in the LCLS tunnel.
  
- Undulator Magnet Measurement –
  - The MMF facility continues to perform well. The first magnet has completed tuning and fiducialization. The rough tuning of undulators continues at a sub-optimal pace due to limitations in available wedge spacers and 100 um peak field shims.
  - The development of the undulator fine tuning process continued with the only significant remaining issue of hall probe calibration. This issue is expected to be conquered in March.
  - The long coil stage is up, running and performing within specification.
  - The undulator fiducialization process is developed and has been implemented on the first tuned undulator.
  - Mu-metal shields were received but did not meet requirements and will be reworked.
  
- QA documentation packages are complete for all of next month’s undulator assemblies that are planned to be shipped to SLAC. Significant QA effort has been put into organizing the documentation required for the “ASK” information and integration tool. The tool will have limited capability by mid April and on line by May/June.
  
- The major components of the Beam Finder Wire have been prioritized in a zero funded requisition. The req has been entered into the PARIS procurement

system. Because of a schedule delay in the design of the wire card it has been agreed that the main BFW assembly may possibly be assembled without it. The card could be fitted at SLAC before BFW to girder alignment takes place.

### Assessments and Issues:

- Due to the current state of the Continuing Resolution (CR) and budget uncertainties all ANL purchases and requisitions were put on hold at the beginning of February. A priority purchasing list was initiated. Long lead and low value items were initiated and processed to a “Stop at Award” point. These items are planned to be funded first if small incremental funding becomes available before the CR is resolved. Large value production items are being held until significant funds arrive. Schedule delays due to these budget constraints are inevitable.
- Vacuum leaks around some of the welds on both the prototype stainless steel vacuum chambers were found to come from a “3 stage pass” laser welding process. ANL held talks with the Laser welding company in regard to the repairs and what caused the leaks. The leaks were quickly repaired, lessons were learned and a single continuous weld is now planned. Both prototypes were cleaned, coated, and baked. Results from the coating of Proto A showed that the end samples have an average of 520 nm of aluminum coating on them. A vacuum string test of the two prototypes and two half chambers is planned in March. This test will confirm real pump down and sequence times.
- RF BPMs – Due to funding limitations, Altair, the brazing vendor is still waiting for a verbal go ahead or new requisition before brazing the first BPM unit. The three other BPM bodies are being tested and processed at ANL, then prepared for brazing and will get sent to Altair. We are still waiting to place the order for the new end cap and transitions for the third unit.
- The “RFI: Undulator Magnet 01” milestone has slipped due to delays in delivery of mounting hardware, shimming procedures, and assembly drawings from ANL. The overall delay in MMF magnet production is ~two weeks. There is no impact to the critical path since there is adequate float in the phased installation plan.
- Undulator Cost Performance (CPI=0.89) – The Undulator cost overrun is driven by the setup of the Undulator Magnetic Measurement Facility. Commissioning the sensitive hardware that is used to make these critical measurements proved far more difficult than planned, leading to schedule delays and cost overruns. The MMF is now operational and the precision tuning and fiducialization of the Undulator magnets is proceeding.

## Photon Beam Systems

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

#### Highlights:

- Management and Safety – An updated work plan was developed to address the effects of the Continuing Resolution. This plan will allow all front-end and Near Hall x-ray hardware and instrumentation to be operational in time for first light at the end of FY2008. In FY2009, the x-ray hardware for the transport tunnel and Far Hall would be purchased and installed.
- Attenuator – The Engineering Specification Document has been signed and work has begun on the final drawings, in preparation for a Final Design Review planned for late April.
- Gas Detector – Detailed calculations of the interactions of x-ray photons with the N<sub>2</sub> gas were performed. Weak x-ray scattering effects such as Compton scattering and elastic scattering may be able to generate annoying background signals in the photo-detectors. This will be studied in tests of the prototype detector, planned for early May at SSRL.
- Soft-x-ray Offset Mirror System (SOMS) – A summary of specifications for the mirrors was sent to vendors for comment. Four out of five vendors responded. One of the vendors will send a formal quote for the SOMS mirrors and some sample coupons. Another vendor promised to send sample coupons for evaluation as well. Two of the vendors responded with a letter of interest. It is expected that a vendor will be selected and that the mirrors will be ordered later this spring.
- Hard-x-ray Offset Mirror System (HOMS) – The baseline design for the HOMS includes meter-long mirrors made from SiC or silicon substrates coated with a thin layer of SiC. Mirrors of this length will be very expensive and require a long lead time, particularly if made from of pure SiC. Several concepts are being studied which would reduce the length of each mirror to approximately 0.5 m, using Si substrates which could be coated in existing LLNL facilities.

#### Assessment and Issues:

- With the current state of the CR and budget at LLNL, not all purchases can proceed on schedule. Scheduled procurements, except for parts to finish key prototypes, have been halted pending resolution of the FY07. Schedule delays, due to the funding constraint, may be recoverable due to adequate float in the XTOD schedule. A careful evaluation will be performed once the details of the CR are known.





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

### **Highlights:**

- Management and Safety –
  - XES has drafted a plan in response to the proposed LCLS funding profile. The recent changes will have a significant impact on the XES schedule. XES will be working in the next month to phase the schedule to the new milestone completion dates while staying within the new budget limits.
  - Personnel Protection System (PPS) – The Physics Requirement Document of the PPS has been completed and is being reviewed. Design on the photon stoppers is progressing gradually. The requirements for the stoppers in the electron dump area are still being defined. Shielding calculations by the Radiation Physics group are underway to define any shielding requirements.
- The LCLS Detector Advisory Committee meeting (LDAC) was conducted in the first week of February, reviewing all the LCLS detector projects. The Cornell effort received favorable marks. Cornell is preparing a full-lot submission for silicon wafer fabrication for early March. All design changes and improvements have been incorporated. The design of the detector diode array nears completion.
- Atomic Molecular and Optics (AMO) Instrument: A draft of a Physics Requirement Document (PRD) describing the controls and data acquisition needs of the AMO instrumentation was completed and distributed for comments. Preliminary design of the AMO instrumentation was initiated.
- XES Controls: The draft of the overall controls architecture for the experimental areas is being reviewed. A detailed schedule is being developed and reviewed as well. Progress was made on defining a data acquisition interface standard.

### **Assessment and Issues:**

- The new LCLS baseline guidelines have impacted the XES schedule significantly. Cost and schedule plans are being revised to respond to these recent changes.

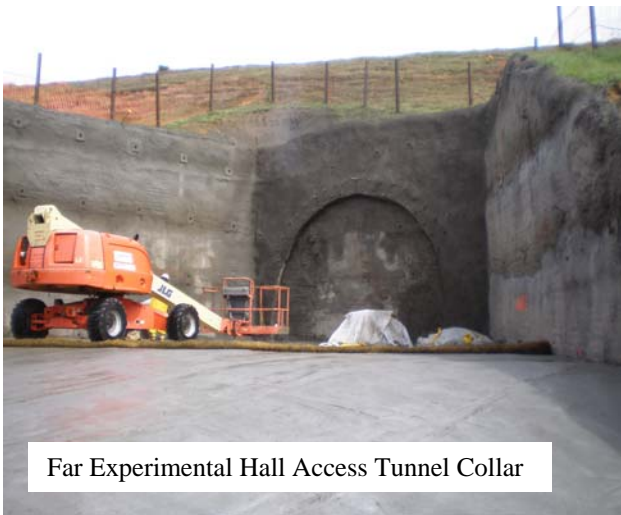
## Conventional Facilities (CF)

### WBS 1.9, 2.9 Conventional Facilities (CF)

#### Highlights:



Delivery of Roadheader ATM50



Far Experimental Hall Access Tunnel Collar

- Construction Progress - (Mobilization commenced on Sept 11, 06)
  - Civil construction is ~13% complete.
  - Major activities for this reporting period include NEH underground electrical and plumbing for sub-basement level, rebar and pouring of 12,000sf mud slab in preparation of upcoming concrete pour. Underground site utilities in the Research Yard continued with some delays due to unforeseen and undocumented electrical lines. Preparations for tunnel portals continued.
  - First road header was delivered to the SLAC site.
  - During this reporting period, three (3) Field Change Orders were initiated for a total negotiated amount of \$231,000. Since the start of construction thru the month of February \$727,754 has been generated in Field Change Orders.  $\$727,754 \text{ (FCO's)} / \$10,439,424 \text{ (BCWP)} = 6.9\%$

#### Issues and Assessments

- Civil construction schedule performance is overall 4-6 weeks behind its early finish milestones. The delays are due to unforeseen and undocumented utilities, inclement weather and TCCo coordination problems with meeting electrical safety requirements. CF will coordinate with TCCo to develop a recovery plan for these areas to ensure completion of scheduled milestones.
- A Field Change Order (FCO) was generated to reroute (5) five major site utilities. These utilities conflicted with the roof deck of the Electron Beam Dump. This work is scheduled with a planned shutdown for BaBar operations to minimize impact to the lab.



## LCLS Cost and Schedule Performance – February 2007

LCLS Cost/Schedule Status Report								28-Feb-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	14,432	14,432	15,277	0	-844	1.00	0.94	18,013	80%
1.2 Injector	16,546	16,196	20,171	-351	-3,976	0.98	0.80	16,760	97%
1.3 Linac	10,612	9,783	11,841	-829	-2,058	0.92	0.83	17,932	55%
1.4 Undulator	24,822	23,712	26,647	-1,111	-2,936	0.96	0.89	37,833	63%
1.5 X-ray Transport	12,391	10,776	11,726	-1,616	-950	0.87	0.92	22,531	48%
1.6 X-ray Endstations	1,908	1,665	1,464	-244	201	0.87	1.14	9,580	17%
1.9 Conventional Facilities	45,248	39,572	39,497	-5,676	75	0.87	1.00	125,535	32%
1.X LCLS Controls	16,976	13,263	14,870	-3,713	-1,606	0.78	0.89	30,865	43%
<b>1 LCLS Total Base Cost</b>	<b>142,936</b>	<b>129,398</b>	<b>141,493</b>	<b>-13,538</b>	<b>-12,095</b>	<b>0.91</b>	<b>0.91</b>	<b>279,049</b>	<b>46%</b>
								<b>LCLS Total Estimated Cost</b>	<b>315,000</b>
								<b>Contingency</b>	<b>35,951</b>
2.1 LCLS Project Mgmt, Planning & Admn (OPC)	8,427	8,413	8,595	-13	-182	1.00	0.98	27,626	30%
2.2 Injector (OPC)	1,416	1,025	1,004	-392	21	0.72	1.02	4,272	24%
2.3 Linac (OPC)	56	24	196	-31	-172	0.44	0.12	1,730	1%
2.4 Undulator (OPC)	1,746	1,942	784	196	1,158	1.11	2.48	6,637	29%
2.5 X-ray Transport (OPC)	814	757	729	-57	28	0.93	1.04	4,544	17%
2.6 X-ray Endstations (OPC)	1,169	1,059	586	-110	473	0.91	1.81	5,559	19%
2.9 Conventional Facilities (OPC)	0	0	0	0	0	0	0	683	0%
2.X LCLS Controls (OPC)	1,455	585	419	-871	166	0.40	1.40	5,638	10%
<b>2 LCLS Total Other Project Cost</b>	<b>15,083</b>	<b>13,805</b>	<b>12,314</b>	<b>-1,277</b>	<b>1,492</b>	<b>0.92</b>	<b>1.12</b>	<b>56,689</b>	<b>24%</b>
								<b>LCLS Other Project Cost</b>	<b>64,000</b>
								<b>Management Reserve</b>	<b>7,311</b>
<b>LCLS Total Project Cost</b>	<b>158,019</b>	<b>143,203</b>	<b>153,806</b>	<b>-14,816</b>	<b>-10,603</b>	<b>0.91</b>	<b>0.93</b>	<b>379,000</b>	<b>43%</b>

## Cost and Schedule Performance (con't)

<u>February 2007 Project Performance</u>	AYK\$
<b>Total Project Cost (TPC)</b>	<b>\$379,000</b>
% Planned (Cumulative)	47.1%
% Complete (Cumulative)	42.7%
<b>Total Estimated Cost (TEC)</b>	<b>\$315,000</b>
Cost and Commitments to Date	\$159,971
Estimate at Complete (EAC)	\$292,476
Work Remaining	\$150,983
Outstanding Phase-Funded Awards	\$81,696
Remaining Contingency Based on EAC	\$22,524
	17.1%

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 February 2007 Cost Performance Report is the 36<sup>th</sup> month reporting earned-value on the LCLS. The LCLS cost and schedule indices are 0.93 and 0.91, respectively. TPC cumulative obligations to date (actual costs + open commitments) are \$173,402K.

### Overall Cost/Schedule Assessment

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. % contingency on uncommitted work dropped in February, primarily due to slower than planned progress in civil construction and delayed procurements and redirected staff related to the Continuing Resolution and reduction in FY07 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. Total float with respect to CD-4 is 131 working days.

### Project Status

### DOE (Level 2) Milestones

System	Level	Milestone	Baseline	Projected	Variance	2004		2005		2006		2007		2008		C
						Oct	Apr	Oct	Apr	Oct	Apr	Oct	Apr	Oct	Apr	
		<input type="checkbox"/> <b>Level 2 DOE (SSO) Milestones</b>	<b>8/29/08</b>	<b>10/8/08</b>	<b>28 days</b>											
PM	ML2	Prelim Safety Assessment (PSAD) Doc Complete	4/30/04	4/30/04	0 days	●										
PM	ML2	DOE External Independent Review (EIF) 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	3/6/07	24 days											●
IJ	ML2	Start Injector Commissioning(UV Beam to Cathode)	4/9/07	4/9/07	0 days											●
CF	ML2	Linac Water/Power Available	7/11/07	7/11/07	0 days											●
XE	ML2	2-D Pixel Detector Production Start	12/5/07	12/5/07	0 days											●
CF	ML2	Start Installation of Front End Enclosure	12/17/07	12/17/07	0 days											●
CF	ML2	Start Installation of Undulator Facility	12/31/07	12/31/07	0 days											●
CF	ML2	Start Installation of Beam Transport Hall	1/17/08	1/17/08	0 days											●
LN	ML2	Linac ARR (Li20-Li30) Complete	1/31/08	1/31/08	0 days											●
CF	ML2	Start Installation of X-Ray Transport	2/19/08	2/19/08	0 days											●
CF	ML2	Start Installation of Near Experimental Hall	2/21/08	2/21/08	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 Far Experimental Hall	5/1/08	5/1/08	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											●
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.  $\% \text{ Complete} = BCWP/BAC$ .

**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 15% 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