
# Linac Coherent Light Source II High Energy (LCLS-II-HE)

## PROJECT MONTHLY REPORT

## JANUARY 2021

Report Issue Date: **February 26, 2021**

SLAC NATIONAL ACCELERATOR LABORATORY • 2575 SAND HILL ROAD • MENLO PARK • CALIFORNIA • 94025 • USA
OPERATED BY STANFORD UNIVERSITY FOR THE U.S. DEPARTMENT OF ENERGY

# OVERALL ASSESSMENT

The project began the new year with a focus on five initiatives: 1. filling the remaining open staff positions, 2. developing a plan to integrate the additional project scope (presented at the December OPA status review) into the project, 3. advancing the engineering and design effort, 4. executing the remaining CD-3A long lead procurements (LLPs), and 5. assembly of the verification cryomodule.

System managers and CAMs began the new year working on the development and incorporation of updated cost and schedule estimates that support the new project scope additions. Requirements documentation and technical specifications, as well as surveys of existing equipment configurations, were advanced in parallel.

January brought several new staff members to the project including a new PMCS team led by Craig Bracket. Craig has been involved with several large projects at the laboratory, as well as private industry, and will be working to streamline key PMCS processes and bring the project's new scope into the preliminary baseline plan. Rob Coy was selected as the new System Manager for the Low Emittance Injector with an official start date of February 1st. Jennifer Aral was selected as the new Supply Chain Director and will transition to full time project support on February 16th.

A Partnering Session was conducted at the end of the month between the four partnering laboratories to: welcome LBNL to the collaboration, discuss current issues and lessons learned, and to promote team cohesion. The session featured LCLS-II Project veterans, who were invited to share their respective lessons learned with the team. The lessons learned provoked important discussion and collaboration within the group. The session also provided an opportunity to review and revise the PMP and MOA, which now define LBNL's role as a Partner Lab and include the Low Emittance Injector and Endstation scope additions.

The RFI for the design and build of a prototype Low Emittance Injector yielded proposals from two multi-laboratory collaborations. The proposals will be evaluated by an independent review committee, selected by the project. In addition, an RFP was initiated for a geotechnical survey of several low emittance injector tunnel (LEIT) locations and alignment options. Results of the survey will inform the down selection of the tunnel's final configuration and construction method.

# PROJECT MANAGEMENT

The FPC and cavity string bellows subcontractors have reported delays in component deliveries due to employee COVID infections and temporary shutdowns of material suppliers. The project is monitoring the situation though does not currently anticipate that these delays will impact the project's critical path.

The team resumed monthly status updates to the SLAC Project Management Assessment Group (PMAG) in January. Along with overall project status, the results from the December DOE Status Review were presented, as well as the plan to integrate the new scope into the project by June of this year. Committee feedback was generally positive, though the committee did recommend that the project present a progress report on the SLAC/HE MOU, which identifies laboratory's commitment to infrastructure investments required to support LCLS-II-HE in February.

By the end of the month, 94% of the CD-3A LLPs were awarded. An initial request for information was posted for the SXU pole material while the technical and procurement packages are finalized.

The vCM is now at WS3 at FNAL where it is being outfitted with magnetic shielding and other components. Prior to advancing to WS3, two vacuum leaks in the helium circuit were identified. Investigation determined that the root cause was an undocumented weld repair by the cavity vendor. After an in-situ repair plan was developed, and successfully conducted, inspection activities resumed. Upon arrival at WS3, Cavity 1 required adjustment to bring its frequency into specification. Discrepancy reports, root cause analysis and off normal work procedures were produced to address both discrepancies. The delays to address and repair the leak are not expected to delay vCM testing, which is still anticipated to begin in mid-March.

# TECHNICAL PROGRESS

*Technical Integration – Electron Systems*

The LCLS-II-HE cryoplant availability is under evaluation and is modeled after the budget plan developed at the start of the LCLS-II project. Several key criteria have been settled, most notably the requirement to keep the superconducting linac cold as long as possible and to minimize warm-up cycles. This requirement, taken with the need to maximize the cryoplant operating margin, by making the CDS as efficient as practical, has led to a proposed interface that includes modifications to the existing (LCLS-II) interface. The proposed modifications will be presented to SLAC management next month.

Requirements are also under development for the cryogenic system needed to support the new injector system, especially the cryomodule and single cavity buncher system. It is expected that simply adding this additional equipment to the existing C1/C2 cryoplants will reduce the operating margin unacceptably.

Full-scale implementation of the requirements management tool, 'Visure', is underway. This is expected to facilitate requirement reviews and configuration management.

*Technical Integration – Photon Systems*

The process to assign a quality level to X-ray Endstation scope elements was initiated. As defined in the LCLS-II-HE quality assurance plan, the quality level is assigned using a risk based graded approach. Quality requirements, such as the types of design reviews and documentation, are determined based upon the scope element quality level. A tool was created to assign quality levels based upon the factors described in the quality assurance plan. This tool is being refined and first assessments are expected next month for XES.

*Accelerator Physics*

Work continued the physics design of the new Low Emittance Injector during the month of January. Various options are being explored to ensure the flexibility of the configuration. The team has determined that a significant range in operating parameters can be optimized by an additional buncher and by extending the length of the system slightly. These issues will be explored further before selecting which configuration the project chooses to pursue. In parallel, the team conducted discussions of the photon beamline protection systems and the maximal x-ray pulses that could be expected. The FEL performance PRD is being updated to reflect the new results. In addition, the Electron Beam Dump Rastering PRD was

presented at the Accelerator Physics meeting and then sent to formal review as was the Radiation Physics Overview PRD. To date, 58 of 92, PRD have been approved.

*Cryogenic Systems*

Cryogenic Systems continued to support EVM, support LLP awards, address review recommendations and process technical change requests via the change management Smartsheet tool. Progress continued dispositioning cryogenic system risks. Final preparations for next month's Verification Cryomodule (vCM) Acceptance Criteria and Test Plan Review were completed.

JLab continues to operate under MEDCON5 regulations. The team submitted monthly EVMS reports and completed December progress reporting. Cost estimates including cost sharing for the cleanroom N2 purge system were accepted for further development by project management. Evaluation of a possible isolation valve box for LERF testing, as well as the installation of additional magnetic shielding for VTA dewars 5, 7, and 8 is ongoing. The team continues to update the JLab Director and site office on project activity. The engineering and design team continues to develop receipt and inspection travelers for cryomodule components as well as plans and estimates for infrastructure improvements. Other activities include support of general EVMS activities and ongoing technical support for procurement reviews and awards. The procurement team continues to support ongoing receipt and evaluation of initial cryomodule component deliveries. The look-ahead for next month includes receipt, and evaluation of, proposals for the Tuner frames procurement, award of the Tuner frames subcontract, and participation in the vCM review.

FNAL remains in limited operation phase with ongoing support for EVMS activities and processing of award BCRs. Assembly of the vCM was paused at WS2 when leaks were detected on the helium vessel of CAVR005 (the third cavity in the eight-cavity string). The team developed an off-normal Work Planning and Control (WPC) document including a repair procedure. Following review and approval, the repairs were successfully completed. *(Figure1 and Figure2)*. After discussion with the vendor and investigation of the weld documentation, a nonconformance report was issued by the vendor and transmitted to the project for inclusion as an addendum to the cavity Engineering Note along with a FNAL Repair Report. The vCM assembly was moved to Workstation 3 on January 27.

**Figure 1 and 2: Repaired helium tank leaks at Workstation 2.**

The disassembly of cryomodule F12 is complete and the FPCs and gate valves are ready for return to the vendors for refurbishment. Preparations for accelerated life test of the extended-range tuner continue, with approval of the cavity engineering note. Assembly of the cavity into the Horizontal Test Stand (HTS) is complete and ready for cool down. The SSA changeover at the Cryomodule Test Stand (CMTS) is complete and testing of the LCLS-II F1.3-06 cryomodule is underway. Procurement activities are progressing well. The BPM contract was awarded and the required customer-supplied equipment for the upper cold masses (flex hoses and associated parts) have been shipped to the vendor. First shipments of vacuum vessels and upper cold masses are anticipated in March.

*Cavity Research & Development*

Development and qualification work continues to progress at Zanon. Zanon's furnace has been repaired to resolve an issue with the heating elements. Two single-cell cavities have been sent to Zanon to qualify their furnace for continued doping operations. The results from these single-cells, expected in February, will determine if work can move forward on retreatment of 10 9-cell cavities.

A plan has been developed to remediate the failed cavities from LCLS-II. Currently, 72 cavities could be requalified through various amounts of rework. This rework is planned to begin in February, starting with cavities that require the least amount of processing. Rework will consist of a simple re-rinse and re-tests for some cavities; light EP and tuning for others. The initial work is expected to yield approximately 18 qualified cavities. Beyond the initial work, the team will evaluate the possibility of reworking cavities that will require de-tanking and re-doping.

*Accelerator Systems*

After the winter break, the Accelerator Systems team resumed remote work activities, focusing on implementation of all approved pending Baseline Change Requests (BCRs) which were presented at the DOE Status Review in December 2020. Under the guidance of a new, dedicated Project Controls Team, a strategy was laid out as to how the revised cost and schedule will be developed and integrated into the Project P6 schedule within the next six-months. The team successfully completed two BCRs by the end of the month.

The Cryogenic Distribution System (CDS) team carried out meetings with Project Office members, to discuss the strategy on how to implement a high-level requirement that addresses the ability to maintain the superconducting accelerator operating with a single cryoplant. At the end of the month a draft of the Global Requirements Document (GRD), which included the single cryoplant operation as a new requirement, was circulated for comment.

As previously reported, the Accelerator Systems team initiated an external search for a Cryogenics Mechanical Engineer to join the project. A final candidate selection was performed. By the end of the month, all

documentation and recommendation letters were collected and submitted to the chair of the Directorate Appointment and Promotion Committee (DAPC).

Undulator system work continued on the procurement package for the SXU pole material LLP and the pre-production and production magnet modules. The team completed drafts of all the necessary procurement package documents, with the expectation to finalize these documents in mid-February. Work is progressing on the fabrication drawings of the magnet modules and subcomponents, with approximately 80% being ready for review. The drawing package is expected to be complete by mid to late February.

The technical team completed a draft of the magnetic design report, which documents the periodic and end section design optimization, as well as an analysis of the tuning methods. This document is a deliverable to the preliminary design review (PDR) of the magnetic system, which is scheduled to be held in March. Progress continued by prototyping tests for the pole mounting and locking mechanism. Parts were fabricated, assembled, and have started the lifecycle test that simulates the cyclic force on the poles due to gap cycles over the life of the undulator. The lifecycle test results for the pole mounting mechanism are expected in February.

Finally, at the end of the month, the System Manager and LBNL STL participated in the two-day LCLS-II-HE Partnering Session.

*Experimental Systems (XES)*

The XES team kicked off the year eager to advance the scope planning and design. To this effect, requirement documentation writing, review, and release moved at a steady pace. The DXS endstation PRD and DXS offset mirror PRD were released. Another 8 documents are under review and are expected to be released next month.

The engineering and design efforts picked up. A meeting series for the common components was initiated to review the designs and documentation. The meeting series was kicked off with the Intensity Position Monitor. The team has started to evaluate the Laser transport and laser table layouts in the hutches. The staff performed 3D scans of all instruments and X-ray Transport Tunnel (XRT). Hutch environmental measurements were performed to assess how to achieve the stability requirements imposed on the DXS instrument. The MFX staff is evaluating the use of KB mirrors instead of focusing lenses. Preliminary evaluations of the LCLS-II-HE FEL beam revealed a higher average power on the PPS stopper. Further analysis will help determine operational limits.

Resource needs continue to be addressed. A new engineer has been assigned to work on the XPP LODCM. The team continues to work to fill gaps for the crystal optics on the DXS. The DXS lead scientist formed a collaboration to work on optics simulations. The outcome of these simulations will help address the optics recommendations received at the December DOE review.

The CAM and Lead Engineers continue detailing the scope plans. Recurring meetings have been scheduled to coordinate the transfer of information as they tackle integrating the scope additions into P6.

*Controls Systems*

An updated Work Breakdown Structure (WBS) for Controls & Safety Systems was developed to better reflect the activity logic and the organization of the technical teams, to increase

the visibility of critical subsystems, and to allow for more efficient management. The proposed WBS divides Accelerator Controls into five new L3 subsystems: RF & Power Systems, High Performance Systems & Diagnostics, Industrial & Infrastructure Systems, Safety Systems, and Rack & Cable Plant. In preparation for the development of the full project cost estimate, a standardized cost estimation worksheet is under development to streamline the replan process.

A staffing plan was developed and agreed upon for the engineering & design phase of accelerator systems (RF & Power systems, High Performance Systems & Diagnostics, Industrial & Infrastructure Systems, and Rack & Cable plant). An experienced team from SLAC's Electrical Engineering Division (EED) and Technology Innovation Directorate (TID) is assigned based upon their specific individual skill sets and expertise. Several team members are new hires or junior staff; in each case, they will be overseen by an experienced member of the LCLS-II-HE team.

A Statement of Work covering the design effort was agreed to by LCLS-II-HE and EED/TID management, and work will begin the first week of February. Similar staffing plans for X-ray & Experimental Systems and Safety Systems are expected to be developed in March 2021.

Design work for the Rack & Cable Plant was kicked off in January, beginning with initial 2D layouts duplicating the LCLS-II designs in Sectors 6-10. These layouts, along with field trips to the Klystron Gallery, are being used to preliminarily identify and resolve any potential interferences and space conflicts. In parallel, the cable plant team is working to develop 3D design tools and an associated model that can be integrated with the mechanical and building systems. A working group of experienced technical staff from LCLS-II and other recent cable plant projects will meet the first week of February to identify other specific, actionable process improvements based on recent lessons learned.

Build-out of the JLab test stand cryomodule control and power supply racks are largely complete, with a few minor items expected to be finalized by February. The Low-Level RF (LLRF) components have been delayed, due to an issue with warped printed circuit boards (PCBs) received from a vendor, though it has been resolved by a minor process change. Chassis assembly is now underway and the full build of the LLRF racks is expected to be completed by the end of March 2021.

*Infrastructure Systems*

The Infrastructure Systems team began further development of Low Emittance Injector Tunnel (LEIT) scope. A Request for Proposal (RFP) was initiated to perform a Geotechnical Investigation to help plan on the design and location of the proposed tunnel. In parallel, the Infrastructure Team has been working with Project Controls to flesh out a schedule in P6 to be integrated with the rest of the project.

With the potential LEIT scope on the horizon, the team continues discussions with SLAC Resource Managers to identify a candidate to fill the CAM role for the Injector construction scope. Three interviews have been conducted, and the team anticipates filling the position by March 2021.

The team has made significant progress in the development of the Room Data Sheets (RDS). The S0-10 Housing and Gallery areas are expected to be completed by the end of

February, while the Injector and Experimental areas are tracking to be a month behind that. It was a priority to finish S0-10 to better understand the possibility of bringing the construction effort forward to take advantage of summer downtimes to minimize impacts to technical installation in FY25 and FY26.

A meeting with the SLAC Communications Group has been initiated to socialize the plan for the LEIT as it may impact the surrounding community. The Infrastructure Systems team continues to work with project management to further develop the Memorandum of Understanding (MOU) with SLAC.

*Injector Systems*

The project has identified the System Manager for Injector Systems. Rob Coy, current SLAC and LCLS-II employee, will join the project in February. All System Manager roles have now been filled.

## SCHEDULED EVENTS

- vCM Acceptance Criteria and Test Plan Review: Feb 4, 2021
- SRF Gun R&D Proposal Review: Feb 9, 2021
- Risk Workshop: Feb 17, 2021

# CD-3A LONG LEAD PROCUREMENTS

| Procurement | LAB | APP | TPRR | PRR | RFP | Bids Recd | PCR | Award | Status |
|---|---|---|---|---|---|---|---|---|---|
| Cavity Fabrication | SLAC | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Cavity Nb Material | JLAB | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| FPCs | JLAB | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Cold Mass Assys | FNAL | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Vac Vessels | FNAL | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Magnets | FNAL | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Gate Valves | JLAB | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Temperature Sensors | FNAL | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Cavity String Bellows | JLAB | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Magnetic Shielding | FNAL | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Tuner - Piezos | JLAB | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Tuner - Motors | JLAB | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Tuner - Frames | JLAB | 100% | 100% | 100% | 100% | 0% | 0% | 0% | |

**Figure 3: CD 3A Long Lead Procurement Award Status**

# PRELIMINARY FUNDING PROFILE ($M)

**Notional Project Funding Profile** [1]

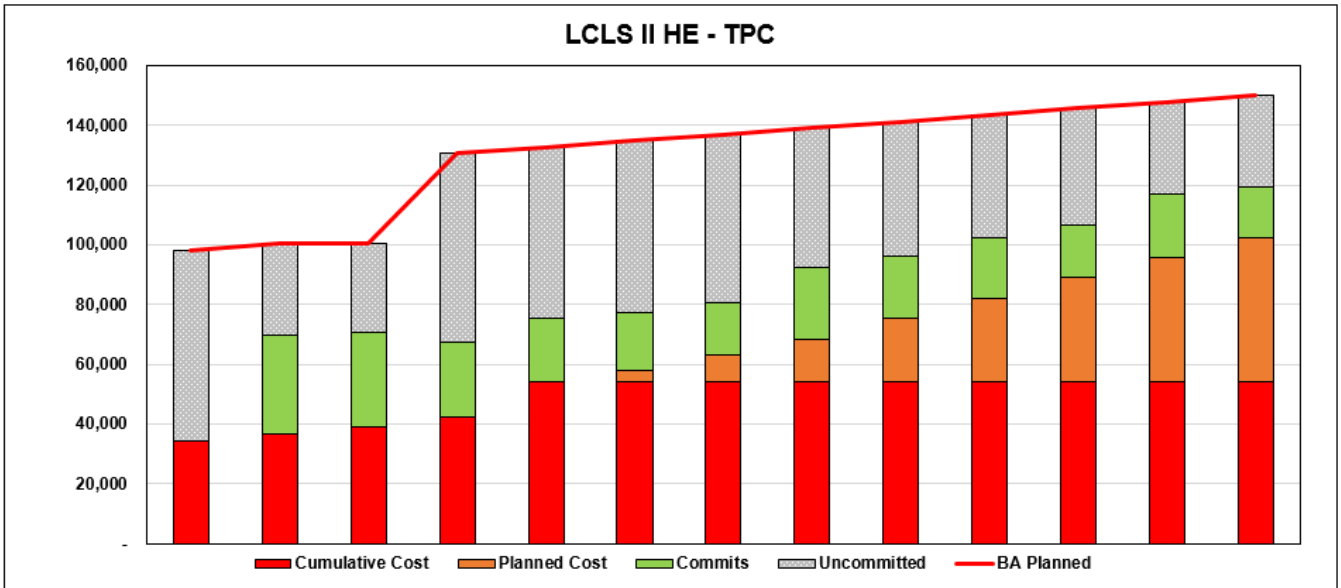
| | FY18 [2] | FY19 [2] | FY20 [2] | FY21 [3] | FY22 | FY23 | FY24 | FY25 | FY26 | Total ($M) |
|---|---|---|---|---|---|---|---|---|---|---|
| OPC | $ 2.0 | $ 6.0 | $ 4.0 | $ 2.0 | $ 7.0 | | | $ 6.0 | $ 5.0 | $ 32.0 |
| TEC | $ 8.0 | $ 28.0 | $ 50.0 | $ 70.0 | $ 80.0 | $ 100.0 | $ 100.0 | $ 94.0 | $ 78.0 | $ 608.0 |
| TPC | $ 10.0 | $ 34.0 | $ 54.0 | $ 72.0 | $ 87.0 | $ 100.0 | $ 100.0 | $ 100.0 | $ 83.0 | $ 640.0 |

1. Project formulated notional profile for planning and analysis; DOE/BES guidance is pending
2. Congressional appropriations
3. FY21 House Mark (FY21 Senate Mark is $54M)

**Figure 4: Preliminary Funding Profile**

# COSTS and FUNDING TO DATE

To date in FY21, the project has been appropriated $34.7M, which is 67%, of the $52M expected for the current fiscal year. Considering appropriations between FY18 and FY20, the cumulative to date TPC funding for the project increased this month to $132.7M as shown in Figure 5.




| ($k) | CTD | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cumulative Cost | 34,217 | 36,881 | 39,024 | 42,195 | 54,053 | 54,053 | 54,053 | 54,053 | 54,053 | 54,053 | 54,053 | 54,053 | 54,053 |
| Planned Cost | - | - | - | - | - | 4,094 | 9,165 | 14,399 | 21,562 | 27,755 | 35,124 | 41,836 | 48,258 |
| Commits | - | 32,695 | 31,796 | 25,201 | 21,315 | 19,011 | 17,473 | 24,107 | 20,779 | 20,403 | 17,487 | 21,063 | 16,877 |
| Uncommitted | 63,783 | 31,081 | 29,837 | 63,261 | 57,289 | 57,666 | 56,302 | 46,601 | 44,935 | 41,285 | 39,000 | 30,881 | 30,811 |
| BA Planned | 98,000 | 100,657 | 100,657 | 130,657 | 132,657 | 134,825 | 136,993 | 139,161 | 141,329 | 143,497 | 145,665 | 147,833 | 150,000 |

**Figure 5: TPC expenditures and funding for FY21 in $k**

# Preliminary Cost, Schedule Performance

Note: CD-3A was approved in May 2020 and baselined WBS 1.20.

## Total Project and CD-3A Performance to Date ($K)

| LCLS-II-HE Earned Value Performance - Level 2 ($k) | | | | | | | | Jan 2021 |
|---|---|---|---|---|---|---|---|---|
| System | BCWS | BCWP | ACWP | SV | CV | BAC | SPI | CPI |
| 1.01 Project Management | $12,316 | $12,316 | $12,499 | $0 | -$182 | $43,499 | 1.00 | 0.99 |
| 1.02 Cryogenic Systems | $9,530 | $8,985 | $8,899 | -$545 | $86 | $23,218 | 0.94 | 1.01 |
| 1.03 Accelerator Systems | $4,902 | $3,148 | $3,128 | -$1,754 | $21 | $77,460 | 0.64 | 1.01 |
| 1.04 Experimental Systems | $1,325 | $339 | $498 | -$986 | -$159 | $30,931 | 0.26 | 0.68 |
| 1.05 Controls and Safety Systems | $2,515 | $955 | $860 | -$1,560 | $95 | $31,995 | 0.38 | 1.11 |
| 1.06 Infrastructure Systems | $506 | $279 | $213 | -$227 | $66 | $21,227 | 0.55 | 1.31 |
| 1.08 CD, R&D & Commissioning | $9,031 | $8,263 | $8,058 | -$768 | $206 | $15,238 | 0.91 | 1.03 |
| 1.20 CD-3A Package | $21,281 | $20,866 | $19,899 | -$415 | $967 | $83,451 | 0.98 | 1.05 |
| Subtotal | $61,408 | $55,152 | $54,053 | -$6,255 | $1,099 | $327,020 | 0.90 | 1.02 |

| LCLS-II-HE Project Performance ($k) | |
|---|---|
| Total Project Cost* | $428,000 |
| Project BAC | $327,020 |
| Total Contingency (TPC-BAC) | $100,980 |
| Work Complete (BCWP/BAC) | 17% |
| Work Remaining (BAC-BCWP) | $271,868 |
| Contingency(% of work remaining) | 37% |

| LCLS-II-HE CD3A Performance ($k) | |
|---|---|
| Total Estimated Cost | $98,000 |
| CD3A BAC | $83,451 |
| Total Contingency (TEC-BAC) | $14,549 |
| Work Complete (BCWP/BAC) | 25% |
| Work Remaining (BAC-BCWP) | $62,585 |
| Contingency(% of work remaining) | 23% |

**Figure 6: Project & CD-3A Cost and Schedule Performance Data**

**The above performance data is based upon the October point estimate of $428M. The project will begin reporting performance on the revised point estimate of $640M in February 2021.*

**Only WBS 1.20 "1.20 CD-3A Package" (highlighted above) is baselined to date.*

# PRELIMINARY PROJECT SCHEDULE

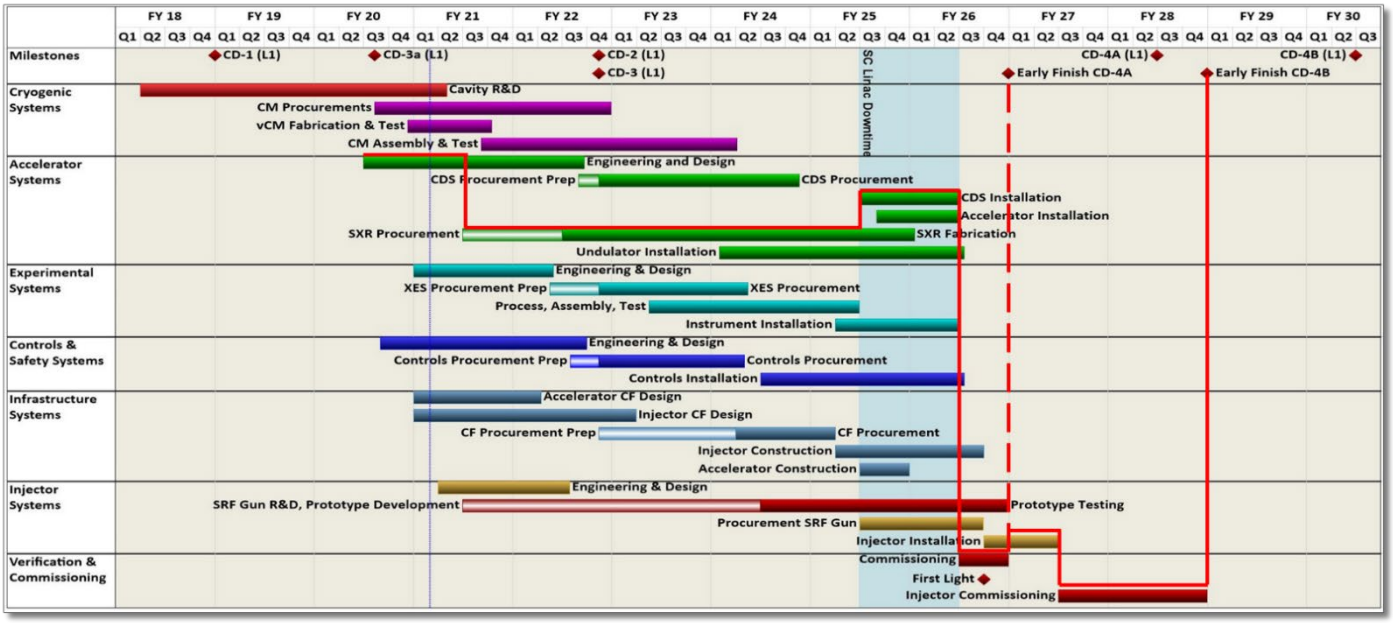



**Figure 7: Project Summary Schedule**

# LEVEL 2 MILESTONES – 12 MONTH OUTLOOK

| L2 Milestones | Date |
|---|---|
| CD-3A Approval | 5/12/2020 A |
| vCM Cryomodule Assembly Complete | 5/4/2021 |
| vCM R&D Complete | 6/24/2021 |
| vCM Shipped from PL to SLAC | 11/10/2021 |
| FNAL CM Production Readiness Review | 8/24/2021 |
| JLAB CM Production Readiness Review | 10/12/2021 |

**Figure 8: Level Two Milestones – 12 Month Outlook**

# KEY PERSONNEL

| Title | Name | Email | Phone |
|---|---|---|---|
| LCLS-II-HE Federal Project Director | Hanley Lee | hanley.lee@science.doe.gov | 650-926-3207 |
| LCLS-II-HE Project Director | Greg Hays | haysgr@slac.stanford.edu | 650-926-3201 |

**Figure 9: Project Key Personnel**

# ACRONYMS

| | |
|---|---|
| ACWP | Actual Cost of Work Performed |
| BA | Budget Authority |
| BAC | Budget at Completion |
| BCR | Baseline Change Request |
| BCWS | Budgeted Cost of Work Scheduled |
| BCWP | Budgeted Cost of Work Performed |
| BES | Basic Energy Sciences |
| BOE | Basis of Estimate |
| CAM | Control Account Manager |
| CD | Critical Decision |
| CDS | Cryogenic Distribution System |
| CM | Cryomodule |
| CMTF | JLAB Cryomodule Test Facility |
| CMTS | Fermilab Cryomodule Test Stand |
| CV | Cost Variance |
| CVS | Concurrent Version System |
| CXI | Coherent X-ray Imaging Experimental Hutch |
| DXS | Dynamic X-ray Scattering Experimental Hutch |
| EAC | Estimate at Completion |
| ES&H | Environment, Safety, and Health |
| EVMS | Earned Value Management System |
| FAC | Facility Advisory Committee |
| FDR | Final Design Review |
| FEE | Front End Enclosure |
| FEH | Far Experimental Hall |
| FEL | Free Electron Laser |
| FERMI | Fermi National Accelerator Laboratory |
| FRS | Functional Requirement Specification |
| FPC | Fundamental Power Coupler |
| FPD | Federal Project Director |
| FY | Fiscal Year |
| HXR | Hard X-Ray |
| HR | Human Resources |
| IPR | Independent Project Review |
| IPT | Integrated Project Team |
| ISEMS | Integrated Safety and Env. Mgmt. Sys. |
| JLAB | Jefferson National Laboratory |
| ICD | Interface Control Document |
| LERF | Low Energy Recirculating Facility |
| LEX | Low Energy Extraction |

| | |
|---|---|
| LINAC | Linear Accelerator |
| LLP | Long Lead Procurement |
| LTU | Linac to Undulator |
| MFX | Macromolecular Femtosecond Crystallography, Experimental Hutch |
| MOU | Memorandum of Understanding |
| NEH | Near Experimental Hall |
| NXI | Nanofocus-CXI, endstation |
| OFO | Off Frequency Operation |
| OPA | DOE Office of Project Assessment |
| OPC | Other Project Costs |
| PARS | Project Assessment & Reporting System |
| PDR | Preliminary Design Review |
| PPEP | Preliminary Project Execution Plan |
| PMCS | Project Management Controls System |
| PMP | Project Management Plan |
| PRR | Procurement Readiness Review |
| QA | Quality Assurance |
| R&D | Research & Development |
| RF | Radio Frequency |
| RP | Radiation Physics Group |
| SC | Office of Science |
| SEMP | Systems Engineering Management Plan |
| SMEs | Subject Matter Experts |
| SSA | Solid-state amplifier |
| SSO | SLAC Site Office (DOE) |
| SV | Schedule Variance |
| SXR | Soft x-ray (undulator beamline, etc.) |
| SXRSS | Soft X-ray Self Seeding |
| TCCB | Technical Change Control Board |
| TEC | Total Estimated Cost |
| TPC | Total Project Cost |
| TPRR | Technical Package Readiness Review |
| VARs | Variance Analysis Report |
| vCM | Verification Cryomodule |
| WBS | Work Breakdown Structure |
| WS | Cryomodule assembly workstation |
| XPP | X-ray Pump Probe Experimental Hutch |
| XRT | X-ray Transport Tunnel |

# GLOSSARY

**2N0 -** An R&D program with goals to demonstrate high Q0 and high gradient performance from both laboratory and vendor produced cavities using the 2N0 nitrogen doping.

**3N60 -** R&D program to develop an alternative cavity nitrogen doping method that achieves the project high gradient and high Q0 performance requirements.

**Actual Cost of Work Performed (ACWP) –** Actual cost Reported through the LCLS cost accounting systems, plus any accruals, by Control Account.

**Budget Authority (BA)** – Cumulative funds currently allocated and authorized by the Department of Energy that may be committed and spent by LCLSII for project-related activities.

**Budget at Completion (BAC)** – The total authorized budget for accomplishing the scope of work. The Budget at Completion will form the Performance Baseline. BAC is the budgeted cost of the project excluding contingency.

**Budgeted Cost of Work Performed (BCWP) – Budgeted** value of work performed for an activity or a group of activities.

**Budgeted Cost of Work Scheduled (BCWS)** – Budgeted value of time-phased planned work allocated to complete an activity.

**Commitments** – Funds allocated to subcontractors where work has been authorized but not yet expensed.

**Concurrent Version System (CVS)** – documentation and software control system for monitoring releases.

**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 physical work performed and the actual cost. CV = BCWP-ACWP. A negative result is unfavorable and indicates the potential for a cost overrun.

**Estimate at Completion (EAC)** – Forecast of the final cost for a specific Control Account 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 estimate 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** – Percent complete is assessment of the percentage of work complete on that task based on objective, earned value indicators.

**Percent Contingency Remaining** – The ratio of remaining contingency to work remaining (in dollars).

**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 project for engineering, design, construction costs and cost of equipment and installation... TEC includes contingency but does not include OPC.

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

**Variance at Completion (VAC) – The difference** between the EAC and the BAC.

**Work Breakdown Structure (WBS)** – A product-oriented grouping of project elements that organizes and defines the total scope of the project into smaller manageable components. It is the structure and code that integrates and relates all project work (technical, schedule, and cost) and is used throughout the life cycle of a project to identify and track specific work scope.