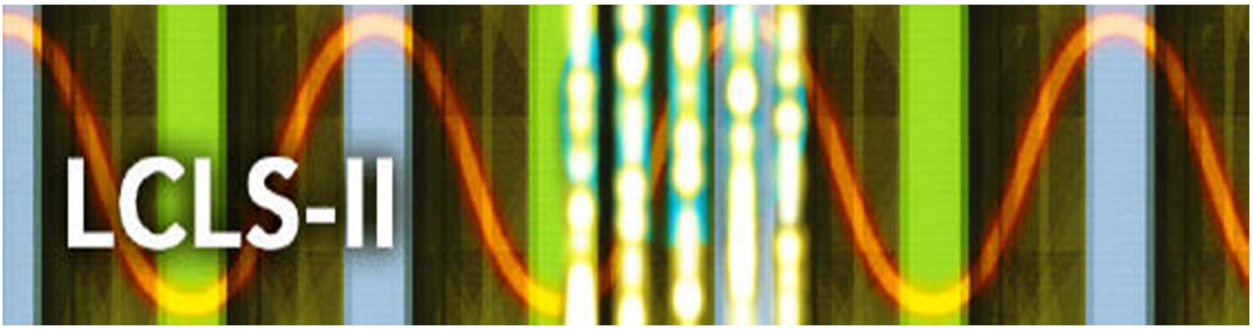
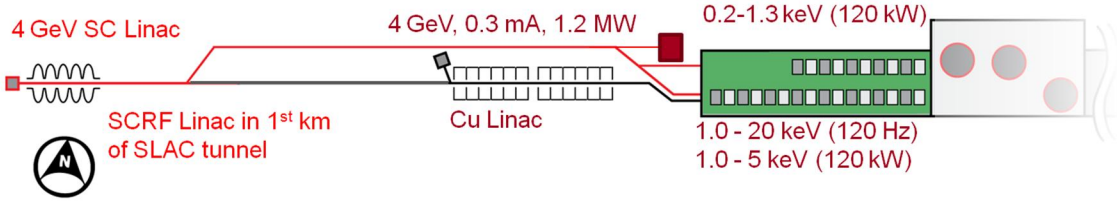
Linac Coherent Light Source – II (LCLS-II)

PROJECT PROGRESS REPORT

AUGUST 2014





Schematic of the LCLS-II facility with the new SCRF linac and two new undulators, along with the existing copper (*Cu*) linac, undulator and experimental halls. The "Cu Linac" is in the 3rd km of the SLAC tunnel

Report Issue Date: October 7, 2014

Project Director: John Galayda

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

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Overall Assessment

On August 22, 2014, the LCLS-II Project received CD-1 approval from the Acting Acquisition Executive, Dr. Michael Knotek, Deputy Under Secretary for Science and Energy. The CD-1 Preliminary Project Execution Plan (PPEP) also provided planning guidance which raised the LCLS-II Project Total Project Cost (TPC) from $895M to $965M. The overall cost range for the LCLS-II project remains unchanged at $750M - $1,200M. The additional funding was provided in FY18 and FY19 and will be applied to scope related to the removal of existing linac equipment, utility and equipment upgrades and increased contingency to reduce risk. In response to this new planning guidance, LCLS-II has added this scope to the preliminary baseline. In addition, the project has approved a change to Solid-State Amplifiers (SSAs) versus the earlier RF system which used klystrons. This reduces a substantial technical risk to the project.

A SLAC Director's Review was conducted on August 19-21, 2014 in preparation for the upcoming IPR in September at JLAB. In general, the Director's Review committee found that the project has made good progess in its preparation for CD-2 and CD-3 in 3QFY15, however overall design maturity remains a concern. The project has continued its development of a detailed "CD-2 Quality" performance baseline in preparation for a CD-2 and CD-3 review in 3Q15. The preliminary baseline now includes approximately 22,000 detailed activitities, resource-loaded and logically-linked. The initial cost scrubbing (and value-engineering) has now been completed and the project is holding ~32% contingency on remaining work. The project is now optimizing the critical path and cryomodule supply chain and is on track to set its internal baseline at the end of October 2014. The project's Risk Registry has been updated to reflect the current baseline and will continue to be actively managed by the LCLS-II senior management team.

Highlights

- SLAC Director's Review Aug 19-21, 2014
- Cryo System PDR Aug 13-15, 2014
- LCLS-II CD-1 Approval Aug 22, 2014

Scheduled Events 2014

Cryobuilding A/E Award	September 2014
DOE Status Review	Sep 30-Oct 2, 2014
Niobium Material Award	October 31, 2014

WBS 1.0 Project Management

Management and Safety

August 2014 is the 35th reporting month for the Project and the 12th report since the directed project re-scope. LCLS-II has $107.9M in total costs through August and month-end commitments of $14.3M.

There have been no first aid or DART injuries on the LCLS-II project to date.

General

The LCLS-II procurement cell lead for SLAC has arrived and is being on-boarded with SLAC Supply Chain Management Division. Applications have been received for LCLS-II procurement-cell buyer positions, and a first candidate was interviewed.

The project received bids from A/E firms to design the Cryogenic Building at SLAC. Vendor responses are being evaluated with award expected in September. The project received bids from niobium foundries to produce the niobium raw material for the LCLS-II cavities. This procurement, as well as the niobium QA/QC is being managed through Fermilab.

A newly hired mechanical engineer has joined the Cryogenic Systems organization. He comes with experience commissioning and operating cryogenic refrigeration systems.

ACCELERATOR SYSTEM

INJECTOR SOURCE

Minor adjustments to the Injector Source schedule were made in August to update the detailed work plan, and add separate deliverables by date and category at the end of the Injector Source project. These deliverables were tied into the project level schedule.

The Injector Source design was presented at the August 9-11 Director's Review. No issues or concerns with the current progress and plans for the Injector Source were identified by the review committee.

A meeting was held at SLAC on August 21st to discuss plans for developing the controls and instrumentation system for the Injector Source. The primary topic was the establishment of the scope of work and interfaces between SLAC and LBNL.

Another meeting was held on August 28th between LBNL, SLAC and FNAL to review the integration issues associated with the Injector Source beamline, the support stand for the first cryomodule, and the UV laser table. Several interference issues were identified and action items assigned to initiate the development of solutions.

The Physics Requirement Document (PRD) for the Injector dark current sweeper was reviewed and officially released. The PRD for the buncher had been previously submitted and is still under review prior to release.

Additional beam dynamics runs were carried out at 10, 20 and 100 pC bunch charges in addition to the nominal 300 pC. A script was developed to carry out dark current Monte Carlo simulations for the injector. Simulations were performed to determine the dark current dependence on gun energy using the baseline injector layout. Beamline optimizations were also carried out for the APEX Phase II configuration using 20, 100 and 300 pC bunch charges. Variables used in the optimization included: gun phase, buncher phase and gradient, solenoid fields, cavity phases and gradients, and spot size and bunch length at the cathode. The paper titled "RF INJECTOR BEAM DYNAMICS OPTIMIZATION FOR LCLS-II" was submitted for publication in the FEL2014 proceedings.

The final set of buncher cavity fabrication drawings were being developed in August along with an assessment of fabrication and assembly schemes. The LBNL mechanical engineering team members visited California Brazing on August 18th to discuss the design of the buncher cavity braze joints. LBNL will place a contract with California Brazing to review and assess the fabrication drawings in preparation for initiating the cavity machining. An LBNL internal review of the detailed design of both the cavity and the coupler that was originally planned for September 3rd has been delayed until September 12th due to the effort on the APEX repair and to allow the completion of the klystron/modulator acceptance tests.

INJECTOR

During August, the project team incorporated schedule links to milestones from other WBS schedules, including those of the partner labs. As SLAC will be installing all systems with the exception of the Cryogenic Distribution System (CDS), the main focus of this effort has been the installation schedule. Request for Information (RFI) packages have been sent to vendors for magnets, beam position monitors (BPMs), wire scanners, collimators and stands.

Design and engineering of systems continues. A technical note for the LCLS-II Accelerator Vacuum System Safety Plan is in draft form. Particle free requirements have been collected from other superconducting labs, from which specifications for LCLS-II will be established. Infrastructure requirements such as power, water and air are being collected for inclusion in Room Data Sheets (RDSs). Magnet functional requirements, such as

size envelope, are being collected. Work on general purpose drawings has started, including anchor hole bolt placement and stand installation drawings. Areas of mechanical interferences, such as the solenoid drives, cryogenic distribution stand and laser table are being identified and addressed with partner labs (see Figure 1 below).

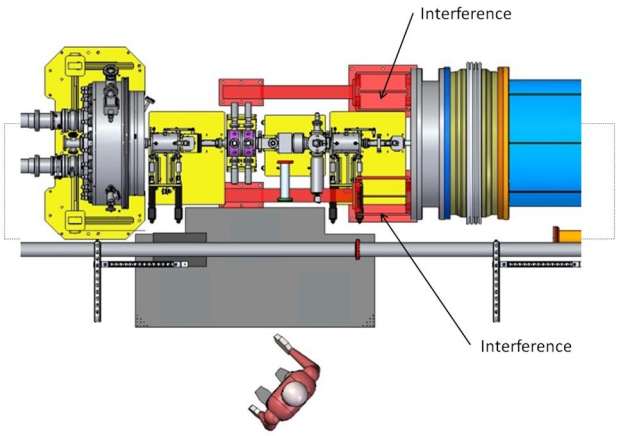


Figure 1. Areas of Mechanical Interference at Injector Source

Block diagrams (see Figure 2 below) and preliminary layouts for the LCLS-II laser systems have been created.

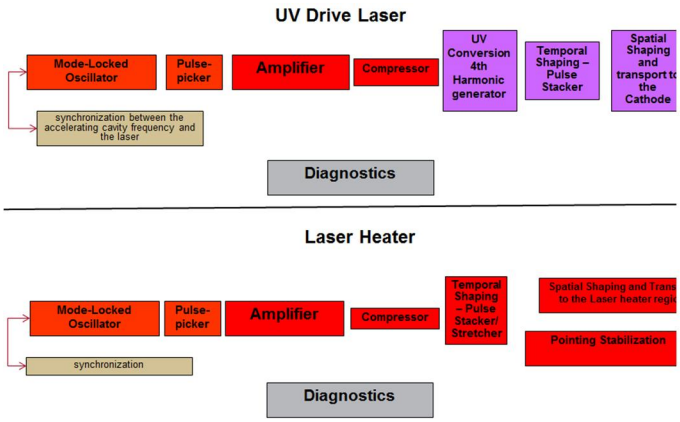


Figure 2. Laser Systems Block Diagrams

General coordination with partner labs continues. A SLAC/LBNL controls scope collaboration meeting was held, and a schedule for subsystem-specific discussions will be established. Current areas of focus include discussions regarding the cryomodule exterior components, cryomodule insulating and CDS pumping requirements, and gaining understanding of the cryomdoule and CDS installation sequence.

LINAC SECTORS 1-10

In August, the linac team completed cost reduction opportunities and links and resource leveling in the Project schedule in preparation for internal baseline.

Final design review for Fundamental Power Couplers was held on August 29th. A draft of recommendations from committee members were received, the design team with the cryo-system manager have reviewed and answered the recommendations. Also, comments have been incorporated into an Engineering Specifications Document (ESD) which was submitted for approval. Interface Control Document (ICD) and Statement of Work (SOW) are in draft with expected completion next month.

Linac team scheduled a final design review (FDR) for the solid state amplifiers (SSA) on September 23rd, 2014. The ESD is complete and is in review for approval. The Project has adopted all 1.3 GHz SSAs sources for cavities (added to the preliminary baseline). We have retired the risk of vector sum and R&D for testing single source to multi cavities is no longer needed. Our current plan is to place an initial order of 20 SSAs for testing prototype cryomodules and award the remaining 260 SSAs at CD3 approval.

TRANSFER AND DUMP LINE

In August, the team updated cost estimates to reflect hardware for several magnets and beam position monitors that can be repurposed rather than purchased new. Design activities in the schedule were adjusted to level resources and to align with the accelerator system design review plan. Links were made in the schedule between systems for common items such as magnets, stands, and vacuum chambers to facilitate more efficient procurements by combining orders.

Designs continue to mature as the team incorporates the August 7th MAD deck into the

models. Several items were identified in the new deck that has been included in the current cost estimates. We are working with Physics to determine what can be removed or deferred. In the area of the Electron Beam Dump, a thermal simulation model was started for predicting the temperature rise of the dump slug. Shielding design concepts were also investigated focusing on ways to disassemble the shielding for dump maintenance. Figure 3 shows a cut away view of the soft beam line dump.

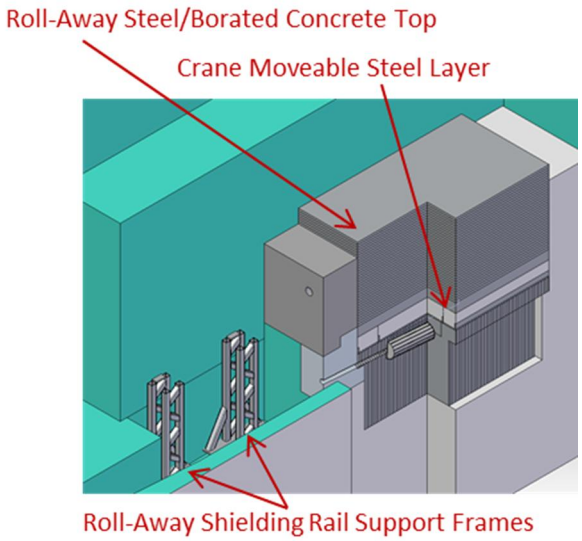


Figure 3. EBD Shielding Roll-Away Concept

The LTU to Infrastructure ICD was released which completed all of the planned ICDs for the Transfer Lines and Dump.

CONTROLS

The Controls team continued schedule development adding critical links to external control activities and incorporating scope changes. In addition to activity linking, detailed installation planning continued with mechanical groups.

A meeting was held at SLAC with APEX physicists and engineers from LBNL to discuss control system designs and APEX integration with the rest of the LCLS-II control system. Focusing on value engineering and optimization of effort, the collaborative teams have begun reviewing designs for each component.

The Low Level RF (LLRF) team produced a detailed R&D plan including SOW for the development of the Single Source Single Cavity (SSSC) model in collaboration with partner labs. The LCLS-II partner labs will participate heavily in the LLRF design. The following areas will support the design of the LLRF system.

1. Cavity Model and Simulation
2. Single Cavity Tests
3. CW Cryomodule Tests
4. RF Station R&D
5. Piezo Controls

The Controls team continued Interface Control Document (ICD) development, specifying how each systems interface to other accelerator systems. System diagrams for each subsystem detailing each interface are under development and being reviewed for value engineering in hopes to make uses of common architecture where appropriate, see Figure 4 for an example.

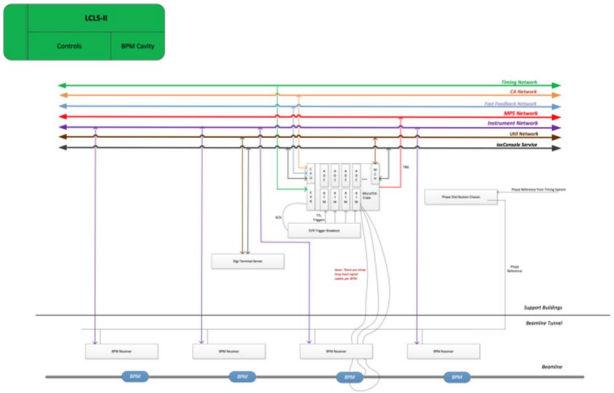


Figure 4. LCLS-II Cavity BPM Controls

CRYOGENIC SYSTEMS

Jefferson Lab hosted the Cryogenics Systems Preliminary Design Review and Integrated Safety Review (PDR/ISR) on August 13-15. Presentation preparation included Process Design, ODH Mitigation in Design, Cryoplant Failure Analysis, Cryoplant Physics and Functional Requirements, and Cryoplant Production and Procurement Plan. The Fermilab team participated in that Review and in the SLAC

Director's Review August 19-21, 2014, making several key presentations on cryomodule design, cryogenic distribution, Q0 R&D and preservation, as well as component design verification.

The PDR / ISR report is available through the LCLS-II Project Office.

RELATIONSHIP WITH DESY / E-XFEL

DESY, SLAC and the Department of Energy have signed a Cooperative Research and Development Agreement aimed at promoting FEL accelerator technology-related cooperation.

The Jefferson Lab Supplemental Quality Assurance Plan for the LCLS-II project has been approved and released to Jefferson Lab. The SOW was reviewed from a quality perspective for the cryomodule testing end caps.

Work continued on the schedule, linkages, accruals and development of our FY15 SOW and funding request. A revised top level FY15 SOW has been accepted. The cavity and cold box procurement documentation is advancing as needed for the planned PRRs in September. At present, the coldbox procurement is on hold pending resolution of technical specification issues though other documentation is proceeding. DESY has indicated there would be no issues with us using the DESY IP for the cavity procurement.

Fermilab assembled the detailed resource loaded schedule for the 1.3 GHz and 3.9 GHz Cryomodules and for the Cryogenic Distribution System. The next step is to methodically go through the schedule and cost estimate to refine the numbers and resource level the work. Linkages between work packages will be checked and a critical path for the FNAL Scope of Work established. A joint cost reduction exercise was carried out and the team assembled a list of items that approached the cost reduction goal. This set of changes to the cryomodule scope of work increases the project risk.

CRYOMODULES

Designers continue to work on JLab tooling and infrastructure used for cold mass assembly and cryomodule assembly. The FRS for assembly tooling is being updated based on comments from reviewers. Work continued on the JLab CM end caps – the focus is design of internal components on the bayonet boxes. The end cap design specification is in the approval process. Production cavity specifications and the contents of the package for the production cavity procurement are in review. Preparations for the Procurement Readiness Review (25-Sep) and Vendor Outreach Day (8-Oct at JLAb) are underway. We are reviewing the detailed schedule to verify logic, links to partner lab schedules and consistency with the overall project plan.

The Fermilab/JLab niobium procurement team focused on the plan for Nb QC. The statement of work has been iterated several times and is nearing a final version. A meeting with SLAC procurement and QA/QC personnel resulted in the plan to present a Baseline Change Request to the Change Control Board to restore 100% niobium sheet inspection. The RFP is under development. The Acceptance Criteria Strategy for all the niobium and related materials QC was drafted. The niobium bids were received from the vendors, with additional questions posed and answered, and they are under study by the Technical Evaluation Team.

The cryomodule design advanced in several ways. Two FNAL tuner prototypes were received and assembled at FNAL for bench tests. The XFEL BPM design requirements were iterated and updated with SLAC, with final requirements almost ready. An ILC carbon-steel vacuum vessel was successfully demagnetized. Magnetic shielding measurements were completed and written up. A conceptual cryomodule fast cool down strategy was developed.

CRYOPLANT

Engineering effort continued for completing the 4.5K cold box documentation for review in mid-September and the warm helium compressor

procurement documentation to follow shortly after. The 4.5K Cold Box specification is in preparation. The project will review these in light of comments from the Director's review.

CRYOGENIC DISTRIBUTION SYSTEM (CDS)

CDS design work continued on the 3-D model of the end cap subcomponents, the horizontal transfer line and the feed cap/half bypass area. CDS work is progressing well towards acheiving remaining design milestones. It is estimated that the preliminary reference design for surface and tunnel components is at 80% complete including completion of the P&ID, valve and instrument lists, valve sizes, flexibility analysis for feed and end caps, thermal and hydraulic analysis, What-if and FMEA analysis. The Interface Control Document is approved and released.

Work with the JLab Cryoplant Group continues and is directed towards an upgraded cryo plant capacity and reduced system cost. The 12GeV cryo plant was designed for 237 g/sec of cold compressor flow. Hence, to upgrade its capacity from 4 kW @2K to approximately 5 kW@2K, with the required shield and intercept flows, would require some minor changes to the plant design, namely increased turbine sizes. The team also agreed with PDR/ISR and Director's Status Review recommendations on combining the 2K cold box and the Distribution Box into a single vacuum vessel. Combining these components will result in a substantial cost saving with no effect on the devices' functional, technical or reliability performance. A Request for Information (RFI) seeking input on cost, delivery schedule and equipment size was submitted to industry. Responses from at least two manufacturers are expected by September 15th, 2014. Detailed work on the scope, cost and BOE is in progress.

Q0

The JLab effort is proceeding with the mini-production run of six 9-cell cavities that is the culmination of the 2014 JLab High Q0 R&D. AES034 was tested - 2.7e10 @ 11.4 MV/m quench. Temperature, magnetic field and doping look good but the cavity has a localized defect. JLab prepared a LINAC2014 conference paper and poster on analysis of N-doping process and performance for contribution next week.

Fermilab VTS3 commissioning is in progress. Liquid transfer between dewars was successfully completed. All dewars passed the radiation shielding tests.

Dressed cavity TB9AES011 was shipped to Cornell for additional testing in HTC.

Several cavities were vertically tested at Fermilab in August.

- TB9AES015 was retested. The final performance of this cavity after reprocessing is a Q0 = 3.5E10 at 16 MV/m and a quench field of 24 MV/m.
- TB9AES027 was reset using a combination of barrel polishing, electropolishing, and the high Q0 heat treatment. The cavity qualified with a Q0 = 3.5E10 at 16 MV/m, but testing was stopped administratively at 18 MV/m due to induced radiation. This cavity will be re-rinsed and tested again.
- TB9AES028, initially had a Q0 above 3.5E10 but had Q-switch behavior with quench at 14.5 MV/m. The defect was removed after resetting the surface with barrel polishing, electropolishing and subsequent nitrogen doping. The cavity qualified with a Q0= 4.0E10 at 16 MV/m and a quench field of 25.5 MV/m. This cavity is now qualified for the FNAL prototype cryomodule.
- TB9AES021 was tested twice using the ILC baseline process as part of an ARRA vendor qualification for bulk electropolishing project. This cavity had two successive small vacuum leaks at an undetermined location. The cavity will be tested a third time after swapping in a completely new set of hardware. In the last test, the cavity exhibited high radiation and exhibited field discharge above 25MV/m. Ultimate performance of this cavity is not yet known.

PHOTON SYSTEM

UNDULATOR SYSTEMS

Efforts for the month of August focused primarily on the interspace length investigation. Magnetic measurements completed the preliminary investigation of phase shifter – undulator separation. The drive motor was remounted on the phase shifter (Figure 5), and testing will continue, focusing on quadrupole proximity (Figure 6) and phase shifter magnetic shield effects.

Figure 5. Phase shifter with mounted drive motor

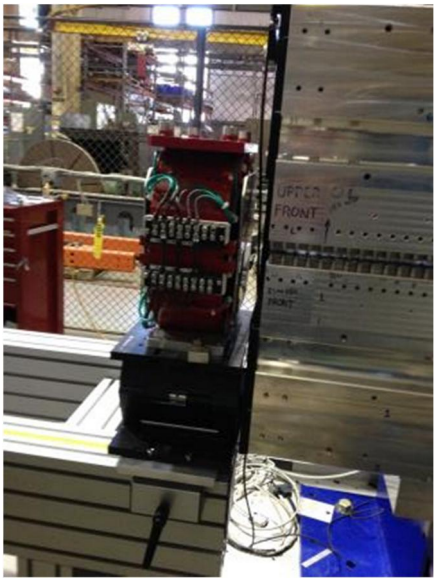


Figure 6. Quadrupole proximity testing

Other activities this month included: The Interspace Vacuum prototype progressed in August. All prototype drawings have been released. Materials for the prototype have been ordered, and initial polishing efforts are underway in preparation for plating. ANL engineers are preparing for a PDR of the undulator vacuum chamber in September. The phase shifter prototype requisition was submitted to SLAC procurement to start the bidding process. The project is on target to have this procurement placed with an outside vendor by the end of September. The undulator system team participated in the DOE Director's Review. The presentation focused on design and prototype progress in RFBPM, Phase Shifter, Interspace Length, and Radiation Monitoring areas.

LBNL – UNDULATORS

The HXU-32 prototype undulator has been disassembled to allow reassembly of a new drive system, see Figure 7. The new setup will include several significant enhancements:

- The original drive system roller guide assembly will be replaced with commercially available linear bearings. This change reduces cost and improves performance as the new linear bearings provide increased stiffness.
- The new setup also includes modified flexure plates, which connect the undulator strongback to the drive system. These flexure plates have been optimized to withstand significant stress occurring during storage of the undulators within a large temperature range of ±15°C.

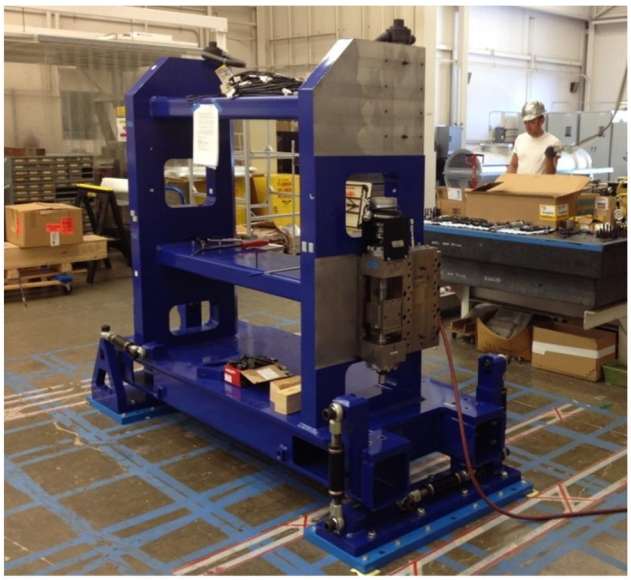


Figure 7. HXU-32 undulator frame with the old drive systems partially removed.

The assembly of the new drive systems will take until mid/end October at which point load tests will continue. The plan is to quantify the structural behavior of the frame under simulated magnet loads. A subcomponent test apparatus (see Figure 8) has been developed which allows the play and distortion of the linear bearings on the bearing track to be quantified. First results show that the bearing play is minimal.

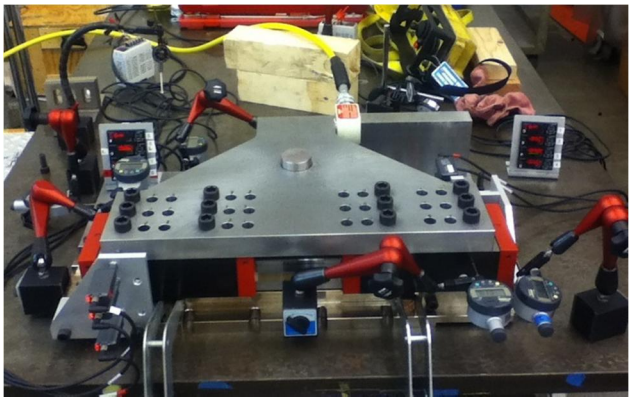


Figure 8. Subcomponent test setup to measure the bearing movement on the linear bearing track under simulated magnet loading cases. We also use the setup to quantify bearing movement for different bearing mounting options.

A test apparatus to cyclically load and unload undulator pole/flexure assemblies has been developed. Such a test simulates the fatigue loading of poles over the lifetime of the LCLS-II undulators. The setup is shown in Figure 9. Initial tests using an early pole/flexure design show no change in pole movement with over 60,000 cycles. As a next step, the test will be repeated with an actual HXU-32 pole/flexure assembly. The test will run for several days accumulating approximately 100,000 load cycles, the number of cycles expected in 20 years of operation.

Figure 9. Picture of the undulator pole/flexure fatigue test setup. A motor (foreground) moves a cantilever arm which cyclically loads and unloads the pole flexure. This simulates the load cycles during undulator gap changes.

Sort data for the HXU-32 prototype undulator was provided to the magnet vendor Vacuumschmelze utilizing the newly established 5-point magnet measurement algorithm. Using a LBNL developed magnet measurement device, Vacuumschmelze measured the field non-uniformity of each single HXU-32 magnet. These data have been fed into a LBNL computer program, which minimizes several objective functions related to the field quality of the undulators. The computer software prints out a magnet sort list for use by vendor's technicians during actual magnet installation minimizing any data transfer errors.

In preparation for a preliminary design review of the LCLS-II undulator segments, we have generated several new engineering notes, which summarize structural and thermal analysis of the final undulator design configuration. In addition, we have completed the magnetic field simulations for the production undulators. These calculations have been independently verified for accuracy.

XTES

In the month of August, design and requirements documentation efforts evolved. Passthroughs for the HVAC and cable trays from the FEE to the FEE Maze have been evaluated. A meeting with a structural engineer took place to evaluate the impact on the removal of some walls. A report is expected next month.

On the Solid Attenuators, calculations revealed that the Silicon filter, if located downstream of cooled diamond filters do not need to be cooled at the 200W maximum average FEL power. The design will accommodate upgrade for cooling, if the beam parameters are upgraded, see Figure 10. The Solid Attenuator PDR is scheduled for the end of September. Preparations for this have started.

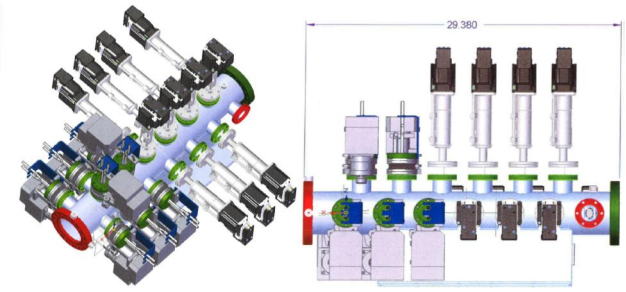


Figure 10. Solid attenuator model

Efforts on the Imager focused on the researching adhesive-free bonding between the sintilating crystal and a cooled support crystal. Vendors that specialize in optical bonding (adhesive-free bonding) for crystals have been identified and one budgetary quote was received. Some more questions need to be answered before we move forward on obtaining samples.

The team continued work on the flat mirror cooling simulations in support of the CDR which was held on August 29. The Mirror requirements document completed its formal review, comments were incorporated, and it was distributed for signature. Official release is expected early next month.

System level layout updates of the Soft X-ray, SXR, and beam line were completed. SXR beam line graphics were created and uploaded to the project site. The SXR schematic and device locations document were also updated. Sequencing of the experimental station build-out was discussed and layouts were updated to reflect the evolution plans. The SXR baseline and full build-out raytraces were reviewed. These will be presented to a more extended group for discussion early next month. Preliminary collimator aperture selection is based on updated beam size clculations. Updated apertures sizes are being used in the preliminary beam line raytraces.

The Collimators and Stoppers activities are focused on obtaining a concept for high average FEL power to be reviewed in September. Bremsstrahlung collimators models were prepared and coordinated with radiation physics. The apertures and overall geometry was evaluated based on latest beam parameters and layout locations (SXR and HXR).

An adjustable aperture, design, AA1, was presented to the team, Figure 11. Further development is needed to the material thicknesses and geometry. Spatial needs for this beamline component on the SXR line were discussed with the gas attenuator engineer and agreements were reached.

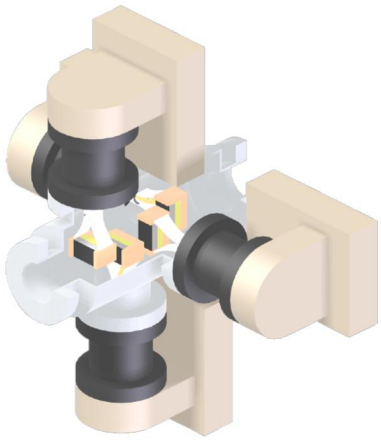


Figure 11. Adjustable Aperture One, AA1

Investigation of thermal effects continues by the gas attenuator engineering and scientific staff. Calculations and simulations are ongoing to understand thermal density changes over time through the entire energy range. Discussions with subject experts have started. The team is investigating methods to validate calculations on LCLS-I.

INFRASTRUCTURE SYSTEMS

The Cryoplant Building A&E price proposals were received and negotiations were initiated.

SLAC Metrology personnel worked with accelerator physicists to plan and measure cryoplant compressor vibration at JLab to help determine necessary stand-off distance between similar compressor equipment and the superconducting accelerator at SLAC.

Supply Chain Management issued a contract Aug. 7, 2014 for a structural engineering study to determine if removing walls in the existing FEE is feasible to accommodate needed additional rack space and access.

Infrastructure Systems added scope to include:

- Existing equipment removal in sectors 0 thru 10,
- Electrical panel upgrades in sectors 0-10,
- Electrical power distribution for the cryoplant and building,
- Cooling tower water distribution from CT1201 to the cryoplant.

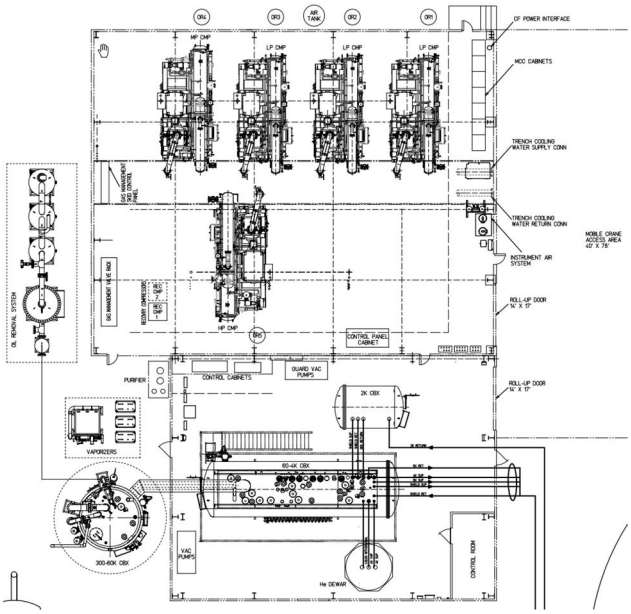


Figure 12. Preliminary Cryoplant equipment layout for building reference (Provided by Jefferson Lab)

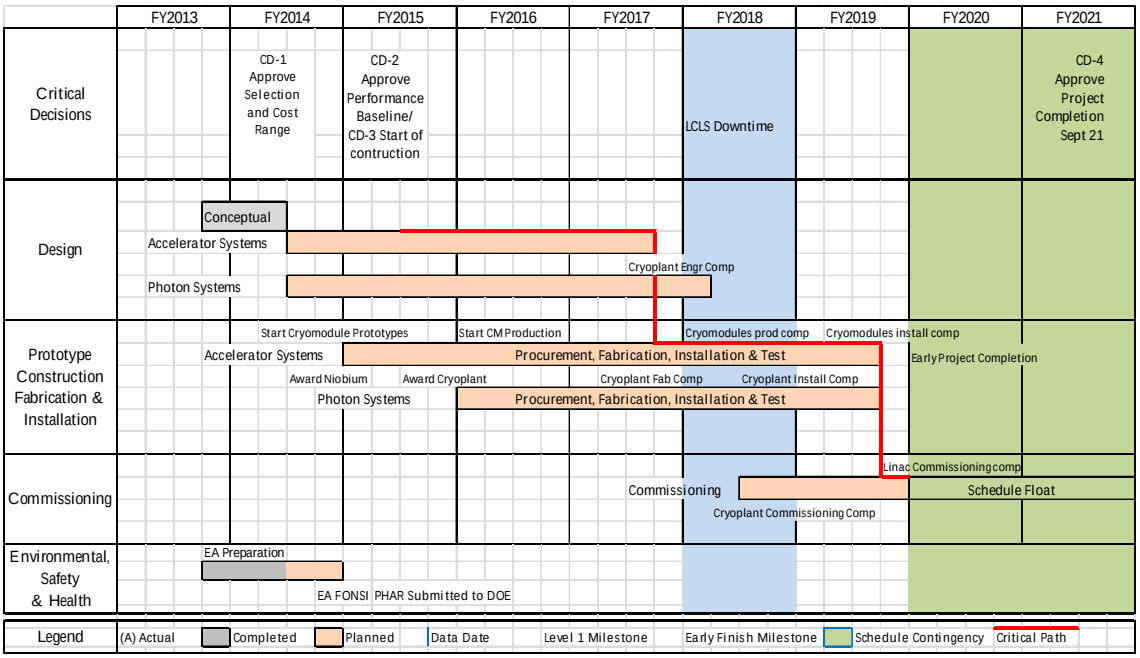
PROJECT DESCRIPTION

The SLAC National Accelerator Laboratory (SLAC) is operated by Stanford University as a contractor for the United States Department of Energy (DOE) Office of Science (SC). SLAC supports a large national and international community of scientific users performing cutting edge research in support of the Department of Energy mission. The LINAC Coherent Light Source (LCLS) Directorate operates the LCLS facility. LCLS refers to the operating experimental facility recently completed.

SLAC currently operates the world's first x-ray free electron laser light (X-FEL) source. The LCLS facility was developed with future expansion potential. The proposed LCLS-II project is the expansion of the capabilities and capacity, in terms of simultaneous experiments and users, of the LCLS facility. It is valuable for these facilities to operate 24 hours a day, seven days a week.

Planning for the LCLS-II Project (LCLS-II) began in 2009, shortly after the LCLS Project demonstrated lasing at 8 keV. Critical Decision 0 (CD-0) for LCLS-II was approved by the Office of Science in May 2010. The Project received CD-1 approval in October 2011 and completed all requirements for approval of CD-2 in August 2012. In July 2013, the Basic Energy Sciences Advisory Committee (BESAC) Subcommittee on Future X-Ray Light Sources provided recommendations to the Office of Science. The scientific needs described in the BESAC Subcommittee report were incorporated by the Office of Science in an updated LCLS-II Mission Need Statement (MNS), which was approved in September 2013, re-affirming CD-0. SLAC has responded to this revised Mission Need by proposing a new concept for LCLS-II. The reconfigured LCLS-II Project science objective Key Performance Parameters provide for a "continuous wave" (CW) 4 GeV superconducting (SC) linac and electron source, with a nominal bunch output frequency of 1 MHz; a soft x-ray variable gap undulator source (200-1,300eV) with self-seeding capability using the Cu linac; and a hard x-ray variable gap undulator capable of operating at 1,000-5,000eV using the Cu linac and 1,000-25,000eV using the Cu linac.

DOE PROJECT MILESTONE SCHEDULE



Draft Schedule – Project is pre CD-1, the schedule is preliminary

ACRONYMS

ACWP	Actual Cost of Work Performed
ANL	Argonne National Laboratory
APP	Advanced Procurement Plan
APM	Acquisition Project Management
BA	Budget Authority
BAC	Budget at Completion
BCR	Baseline Change Request
BCWS	Budgeted Cost of Work Scheduled
BCWP	Budgeted Cost of Work Performed
BESAC	Basic Energy Sciences Advisory Committee
BOE	Basis of Estimate
BPM	Beam Position Monitor
CAM	Control Account Manager
CD	Critical Decision
CDR	Conceptual Design Report
CR	Continuing Resolution
CV	Cost Variance
EAC	Estimate at Completion
ESD	Engineering Specification Documents
ES&H	Environment, Safety, and Health
ESAAB	Energy Systems Acquisition Advisory Board
FAC	Facility Advisory Committee
FDR	Final Design Review
FERMI	Fermi National Accelerator Laboratory
FPD	Federal Project Director
IPR	Independent Project Review
IPT	Integrated Project Team
ISR	Integrated Safety Review
ISEMS	Integrated Safety and Env. Mgmt Sys.
JLAB	Jefferson National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LCCA	Life Cycle Cost Analysis
ICD	Interface Control Document
LCLS	Linac Coherent Light Source
LIC	Line Item Construction
LINAC	Linear Accelerator
LLP	Long Lead Procurement
LLRF	Low Level Radio Frequency
LTU	Linac to Undulator
M&O	Management & Operation
MAD	Methodical Accelerator Design
MIE	Major Item of Equipment
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NIRSC	Nonionizing Radiation Safety Committee
OPA	Office of Project Assessment
OPC	Other Project Costs
ORNL	Oak Ridge National Laboratory
P6	Primavera Schedule
PAL	Pohang Accelerator Laboratory
PARS	Project Assessment and Reporting System
PDR	Preliminary Design Review
PEP	Project Execution Plan
PMCS	Project Management Controls System
PRD	Physics Requirements Document
QA	Quality Assurance
QIP	Quality Implementation Procedure
RF	Radio Frequency
RP	Radiation Physics
RFI	Request for Information
RFP	Request for Proposal
RFQ	Request for Qualifications
SC	Office of Science
SSO	SLAC Site Office (DOE)
SV	Schedule Variance
TEC	Total Estimated Cost
TPC	Total Project Cost
WBS	Work Breakdown Structure
XTES	X-ray Transport and Experimental Systems