WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1					LCLS PROJECT - PED & CONSTRUCTION	This summary WBS covers the Total Estimated Cost (TEC) Estimate for the LCLS Project being constructed at SLAC. The LCLS TEC is supported through Project Engineering and Design (PED) and Construction funds by the U.S. Department of Energy.		
1	01				LCLS PROJECT MGMT, PLANNING & ADMIN (TEC)	This summary WBS covers the project management, planning and organization function of the PED and construction phases (TEC) of the LCLS Project.		
1	01	01			Environment, Safety & Health	This summary WBS describes the ES&H support for the LCLS project at SLAC.		
1	01	01	01		Radiation Physics	This WBS supports radiation physics experts/consultants to facilitate the LCLS shielding and enclosure designs and in conducting periodic radiation safety reviews on the LCLS project.		
1	01	01	02		ESH Management & Coordination	This WBS supports ES&H staff/consultants who provide support to the line management for the LCLS Integrated Safety Management System (ISMS)		
1	01	02			Project Management	This summary WBS describes the project management function for the LCLS project at SLAC.		
1	01	02	01		Project Management Office	This summary WBS describes the LCLS Project Office at SLAC.		
1	01	02	01	01	Project Office - General	This WBS provides for the management function of the LCLS Project Office based upon the approved LCLS Organization Chart. This includes a Project Director, Deputy Project Director and 2 Associate Project Directors, 2 full-time Technical System Managers (E-Beam and Photon System Managers), 1 full-time Financial Analyst (Budget/Finance Manager), and 4 full-time Administrative Aides. In total,11 FTE's. The 11 FTEs are phased between TEC and OPC to reflect the average fraction of effort spent on construction and R&D/Pre-Operations/Operations.		
1	01	02	01	02	Project Support	This WBS provides for the support function of the LCLS Project Office, which includes: The LCLS Project Management Control System (PMCS) supported by a team of cost/schedule analysts that will establish and maintain a PMCS to track the planning, performance and resource allocation during the LCLS construction project. Additional collective duties include maintaining the Work Breakdown Structure (WBS), tracking and maintaining the cost and schedule baseline and documenting the Baseline Change Proposal (BCP) System.). Primavera is used as the primary scheduling tool and COBRA is used for cost analysis.		
1	01	02	01	02	Project Support (continued)	Website support for the LCLS project is provided by the Database Manager and includes maintaining the LCLS website as the primary repository of project information. The LCLS website will include a general area of information about LCLS (education, outreach, LCLS applications and future directions), technical areas for LCLS groups to disseminate information, and sensitive LCLS management information on costs, budgets, PMCS data (earned-value, change control). This area also includes a quality control manager as well as consulting support for the LCLS procurement activities.		
1	01	02	01	03	Project Office M&S	This WBS provides for the Materials & Supplies (M&S) for the LCLS Project Office, which includes: Miscellaneous M&S to operate the LCLS project on a day-to-day basis which includes all office supplies, binders, etc. to support the LCLS team. All M&S costs necessary to support the LCLS project during reviews (Management, Physics, Safety, Engineering, etc.) is included in this WBS. Tele/videoconferencing equipment (polycoms, monitors, phones, modems) and projector costs for the LCLS project, including setup labor. All PC + software costs for the LCLS group. Miscellaneous shipping or storage of general LCLS items at SLAC.		
1	01	03			Technical Integration	This summary WBS describes the technical integration effort for the LCLS Project. These integration tasks are technical activities or tasks that support the global effort for the LCLS, such as Lasers, Controls and Alignment systems which integrate specific geographical LCLS systems into a fully functional LCLS.		
1	01	03	03		System Integration	This WBS describes the technical integration effort to support LCLS installation coordination and planning.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	01	03	05		Global Controls	This is all non-recurring development for the first instance of each subsystem solution.		
1	01	03	05	05	Laser Heater Controls	Development of the laser heater system.		
1	01	03	05	09	Power Supply Controls	Development of the first power supply system.		
1	01	03	05	12	Global Controls Management	Management support		
1	02				INJECTOR SYSTEM	The injector generates the electron beam and accelerates it to 135 MeV. This system includes the laser, optical transport, the electron gun, the accelerator sections, the solenoids and other magnets, the diagnostics including a diagnostic section at the end of the injector, the LCLS timing system, and the laser room. The interface to the Linac is at the downstream end of Dog Leg 1 (DL1), ending at the valve at the entrance to linac section L1.		
1	02	02			Injector Controls Subsystem	The injector controls system is to be an EPICS – Experimental Physics and Industrial Control System. The Injector control system must interface with the existing linear accelerator (LINAC) timing system. Local system control, at Sector 20, will be used for development through the commissioning phase of the project. Operational control will reside in the LCLS Main Control Center (MCC).		
1	02	02	13		Laser Heater Controls	The laser heater controls system consists of control modules, cables and software to do on/off control of two laser shutters - one in beam conditioning optics, one at launch table. Steer the IR beam by controlling two motorized mirror stages on the launch table. Modifying the OTR control, if necessary, for the laser heater. Transmit the IR joulemeter signal from IR diagnostics to MCC. There are 4 analog signals which need to get to PEP via an ADC. There might be 0.5 months software work here, too. Transmit the IR timing diode signal to an oscilloscope near diagnostics port. Transmit the Spiricon camera image on the diagnostic table to MCC and receive controls from MCC. Transmit the electron beam energy spread data from OTR and to MCC. A PC might be needed here for the spectrometer. Reduce the data for the laser and the e-beam (the previous two items). Control the Undulator by stepping the motor and reading the position from LVDT sensors and the limit switches.		
1	02	03			Injector Lasers	The drive laser system provides ultraviolet (UV) irradiation to the cathode of the LCLS RF photoinjector. The drive laser utilizes a standard chirped pulse amplification (CPA) design beginning with a mode-locked infrared (ir) oscillator. Oscillator pulses are temporally shaped and stretched before entering the IR amplifier chain. This chain amplifies the single pulse energy in two sections (i) the preamplifier and (ii) the final amplifier Ir pulse energies of order 10's of millijoules are obtained during the final amplification where the repetition rate is also reduced to 120 Hz, the RF photoinjector design repetition rate. Following amplification and repetition rate reduction, a portion of the IR pulse energy is converted to UV irradiation via third harmonic generation in nonlinear media. UV pulse energies of a few millijoules are generated, conditioned, and transported to the photocathode.		
1	02	03	03		Drive Laser Diagnostics	The drive laser diagnostics includes several diagnostics clusters for each stage of the system: oscillator, preamplifier, final amplifier and UV conversion. Special ultra-fast high resolution diagnostics for the waveform (temporal shape) measurements will be designed by LLNL. The oscillator diagnostic cluster is intended to monitor the intrinsic oscillator output as well as the results of temporal pulse shaping and stretching. The diagnostic cluster includes a spatial profile imaging system, a fast photodiode, an average power sensor, a time-integrated spectrometer for monitoring bandwidth as well as mode-locked operation, and broadband time-resolved diagnostics for monitoring temporal pulse-width and shape (using techniques such as scanning autocorrelation and frequency-resolved optical-gating (FROG) detection). Where possible, diagnostics require only a sample of the oscillator pulse energy.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	02	03	03		Drive Laser Diagnostics (Continued)	The preamplifier diagnostic cluster is intended to monitor the preamplifier output. It includes fast photodiode detection, a pulse energy/power meter, spatial profile imaging, and broadband single pulse detection (as would be provided, for example, by polarization-gated frequency-resolved optical-gating detection (PG-FROG)). This single pulse broadband time-resolved detection monitors the temporal pulse shape (envelope) that is established between the preamplifier and the oscillator		
1	02	03	03		Drive Laser Diagnostics (Continued)	Final amplifier diagnostics is used to monitor the final amplifier output prior to UV conversion. It includes fast diode detection, a time-integrating spectrometer, spatial profile imaging, energy/power sensors, and broadband time-resolved single pulse diagnostics, with potential to add a single-pass oscillator probe beam. As with the preamplifier, single pulse broadband detection is used to monitor the established temporal pulse shape (envelope) with all amplifier effects included.		
1	02	03	03		Drive Laser Diagnostics (Continued)	The UV diagnostic cluster is located at the harmonic generation unit and monitors the UV pulse features prior to transport to the photocathode in the tunnel. It includes a fast photodiode, a pulse energy/power monitor, a time-integrated spectrometer, spatial profile imaging, and single pulse broadband time-resolved UV pulse detection (which will include a streak camera).		
1	02	17			Injector System Installation	System Summary for installation of beamline components, controls hardware and cabling.		
1	02	17	15		Laser Heater Installation	This section accounts for the specific tasks associated with the field installation of the specific Injector section.		
1	03				LINAC SYSTEM	The Linac accelerates the electron beam while preserving the transverse emittance and compressing the longitudinal size. This element includes modifications to the last third of the existing SLAC linac, Bunch Compressor 1 (BC1), Bunch Compressor 2 (BC2), beam transport to the Undulator (LTU), beam transport after the undulator, bend magnets and beam dump, the bypass system for transporting test beams to end station A, and diagnostics including characterizing both the electron and x-ray beams as they pass through the undulator. The interface with the undulator is a vacuum flange at each end of the undulator. This element includes the common beam line beyond the undulator for the electrons and x-rays until the electrons are deflected enough for an interface to the x-ray beam line.		
1	03	01			System Management & Integration	The Linac is made up of a number of individual devices and systems. These devices and systems must be integrated into functional blocks. In consecutive order with respect to the electron beam the functional blocks or areas are: Linac 1 (L01), Bunch Compressor Chicane 1 (BC1), Linac 2 (L02), Bunch Compressor Chicane 2 (BC2), Linac 3 (L03), Linac-to-Undulator Transport Line (LTU), and Main Electron Dump (E-Dump).		
1	03	01	01		Linac Mechanical Integration	Linac Mechanical Integration defines a physical envelope for the LCLS modifications in the Accelerator Housing and Klystron Gallery. Mechanical Integration also ensures that existing Linac systems are, once modified by LCLS, returned to an acceptable level of function along with complete documentation.		
1	03	01	01	04	BC2 System Integration	BC2 applies second stage bunch compression to the electron beam. Representing an LCLS Linac functional block, it is here where the functional requirements for systems and components are presented, reviewed, and documented. The mechanical top assembly of this functional area is completed here.		
1	03	01	01	05	L03 System Integration	L3 accelerates the electron beam to a final energy of 14 Gev. Representing an LCLS Linac functional block, it is here where the functional requirements for systems and components are presented, reviewed, and documented. The mechanical top assembly of this functional area is completed here.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	03	01	01	06	LTU System Integration	LTU transports the electron beam to the FEL Undulator. The system includes bend magnets that support energy and emittance diagnostics. Representing an LCLS Linac functional block, it is here where the functional requirements for systems and components are presented, reviewed, and documented. The mechanical top assembly of this functional area is completed here		
1	03	01	01	07	E-Dump System Integration	The Electron Dump receives the electron beam from the FEL Undulator and terminates the electron stream. It is a high radiation area with possibly some beam diagnostic capabilities. Representing an LCLS Linac functional block, it is here where the functional requirements for systems and components are presented, reviewed, and documented. The mechanical top assembly of this functional area is completed here		
1	03	01	03		Travel	Linac group project-related travel expenditures.		
1	03	01	04		Linac Management	Linac group costs related to management; administration, personal computers, productivity software, as well as simulation and modeling software.		
1	03	02			Linac Controls & Power Conversion Subsystem	Provide an EPICS based control system for the portions of the linac that are modified for LCLS use.		
1	03	02	01		Personnel Protection System (PPS)	This system creates a physical barrier that subtends the LCLS for the purpose of personnel protection from radiation, electrical, and other present or imagined hazards. An LCLS area may use or combine with other SLAC control areas. The PPS system will include monitoring of radiation shielding integrity, barriers, area status annunciators, and multiple interlocked control gates for access to a safe machine space.		
1	03	02	02		Beam Containment System (BCS)	The BCS includes components like stoppers and dumps that along with shielding provide a safe way to contain radiation that is generated under all LCLS operating conditions. This system also includes active instruments (beam shut off ion chambers - BSOIC's) that will disable operations if elevated levels of radiation (Neutron & Gamma) are detected outside of the PPS control area.		
1	03	02	03		Machine Protection System (MPS)	This is a system of sensors (i.e. water flow switches, thermocouples) supplied as Digital and/or Analog signals which are interlocked, that will in turn shut off the beam if conditions exist/persist that will cause damage to machine hardware or other protection systems.		
1	03	02	04		Linac Power Conversion Subsystem	The power supplies for the LCLS Linac will, for the most part, be a standard design and are used throughout the SLAC accelerator. This Linac WBS Power Supply subsystem has been divided into three types, Dipole, Quadruple and Trim and are described below. The WBS unit will not provide for Fabrication or Installation activities. In addition, the design of the magnet power supply systems assumes that all magnets will have their magnet electrical connections covered such that the powered systems comply with SLAC, National Electric Code and OSHA regulations. There is no provision for interlocking the magnet power supplies for magnet safety.		
1	03	02	04	01	Beamline Power Supplies - (Dipole Type)	The Dipole Power Supplies provide power to dipole magnets. These units cover the LINAC, BSY and the LTU. There are 7 units, which are: BXH11-14, BXH 21-26, BXH 31-34, BY1, KICKER (BYBKIK), BYW, and the Dump Bend.		
1	03	02	04	02	Beamline Power Supplies - (Quad Type)	The Quadruple Section power supplies power quadruple magnets which provide power to the focusing elements in the transport system. This section has the largest number of units and there will be 31 units which are: SEC-23 (2KW), SEC-24(2KW), SEC-25 (2KW), SEC-26 (2KW), SEC-27 (2KW), SEC-28 (2KW), SEC-29 (2KW), Q24701, QM21, Q24901, QM22, QVM1, QVM2, QVM3, QVM4, QVB1, QDL1, QE31, QEM1, QEM2, QEM3, QEM4, Qtm1, Qtm2, QUM1, QUM2, QUM3, QUM4, QDMP, QUE1 and QUE2.		
1	03	02	04	03	Beamline Power Supplies - (Trim Type)	The last type is the Trim Type and these power supplies power magnets that operate at low currents and make minor orbit corrections to the beam. There will be 10 new units, which are: MCOR_1, MCOR_2, MCOR_3, MCOR_4, MCOR_LTU1, MCOR_LTU2, MCOR_LTU3, MCOR_LTU4, MCOR_LTU5, MCOR_LTU6.		

WBS NUMBER L1	L2	L3	L4	L5	TITLE	DESCRIPTION		
1	03	02	04	04	Controls & Power Supply	This section covers the costs associated with the packaging (integration of systems equipment) and testing of electrical equipment racks for the Power Conversion and Control Systems. Rack infrastructure i.e. AC power distribution, plugstrips, utility outlets, cooling fans and mounting brackets are integrated prior to the integration of previously procured rack and crate mounted equipment from the various sections. Cableplant installation design of Trays and Long-Haul cables (Using CAPTAR database) to be installed into the various areas, resulting in an award of contract, takes place here.		
1	03	02	05		Controls - LLRF	LLRF is a system for the amplitude and phase control of the electron beam. It includes a new master oscillator and the distribution of the 2856 MHz RF and the machine timing signals. It also includes the RF control system around individual klystrons for stabilizing (low noise, low drift) and monitoring of their operation. A preponderance of design and procurement resides within the RF Section budget leaving controls with a engineering supporting role. This equipment also provides the means of avoiding Main Drive Line phase jumps when operating PEPII.		
1	03	02	06		Controls - E-Beam Diagnostic	Diagnostic devices measure salient beam parameters such as beam size, position, phase, bunch length, beam current etc. for the purposes of setting and tuning the various machine parameters such as the strength of magnets and the amplitude and phase of klystrons. The diagnostic signals provide a monitoring function and in some case a direct feedback for closed-loop control of the accelerator hardware.		
1	03	02	06	01	Controls - Wire Scanners	Wire scanners are beam profile monitors used to provide accurate measurements of beam size and position in all three planes (vertical, horizontal and 45 degrees) for beam measurement systems and beam tuning procedures. Components include wires capable of being moved precisely through the path of a beam, and a detector which can accurately measure the amount of charge striking a wire. When in use, a wire is scanned across the path of a beam using stepper motors, and a plot of wire position versus beam intensity is generated that represents the beam profile.		
1	03	02	06	02	Controls - BPMs	Beam Position Monitor. A device including four electrodes located inside the beam pipe, and the associated electronics necessary to locate the position of the centroid of the beam. The electrodes are usually located about 90 degrees apart inside the vacuum chamber, far enough away from the beam's path not to interfere with it, but close enough to feel the electric charge of the beam's passing. A device called an RF cavity BPM uses resonant cavities in place of electrodes to detect the electric charge of the beam.		
1	03	02	06	03	Controls - Toroids	The Toroid is an average beam current (charge) monitor (CM) which uses transformer action to measure the intensity of a beam pulse. A lead shielded pre-amplifier is usually placed near and connected to the wire wound ferrites. The amplified signal is then cabled to an electronic module external to the shielded housing. Comparisons can be made between Toroid installations as a way of determining beam losses between two points.		
1	03	02	06	04	Controls - Stoppers	A Personnel Protection System device used to stop the beam, usually by allowing a heavy metal slug to pivot into the beam's path. The de-energized default is in the beam path as a fail-safe. This is removed from the path by means of air solenoids. This device, as all PPS devices rely on redundant parallel limit switches to supply status prior to allowing entry into beamline areas.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	03	02	06	05	Controls - Profile Monitors	A screen inserted is inserted into a beam transport line to view the beam cross section via a remote camera focused through a glass viewing port. The screen can be made from a variety of materials suited to the beam energy at that location. The visible emission picture is captured on a digital video camera, triggered to look a specific beam pulse. Profile monitor screens can be inserted and removed remotely by the machine operators. Position status is determined by limit switches. Cameras can be remotely triggered, iris controlled, zoom activated, lamp intensity varied via electronic modules connected to a two channel Profile Monitor chassis.		
1	03	02	06	07	Controls - Bunch Length Monitors	The bunch length monitor, BLM, is used to measure the length of the bunch after each longitudinal compression stage in the accelerator. The measurement is done on a pulse-by-pulse basis so that the information can be transmitted to a feedback loop for control and stabilization of the bunch length. The BLM device senses the coherent radiation from the bunch, where the spectral power is proportional to the peak current in the bunch and so is able to detect relative changes in bunch length. For calibration purposes this measurement is compared to measurements made with the RF transverse deflecting cavities.		
1	03	02	06	09	Controls - Single Beam Dump	The single bunch beam dumper, SBBD, consists of a fast-acting pulsed magnet that is able to selectively deflect a bunch toward a beam stopper on a pulse-by-pulse basis. The purpose of this is to control the rate at which beam is sent to the downstream undulator beam line which contains sensitive equipment. If a fault condition occurs such as a beam loss in the undulator then the SBBD is able to prevent the next beam pulse from being sent down the beam line and potentially causing damage. The fault conditions are passed to the SBBD from the Machine Protection System, MPS. The SBBD is able to stop the full-rate 120 Hz beam from the linac upstream and selectively allow single shots, 1 Hz, 10 Hz or an arbitrary rate to be sent downstream, thereby facilitating tune up of the beam without risking damage to the beam line.		
1	03	02	06	12	Controls - Movable Collimator	This system provides control and monitoring of two-axis beam intercepting blades which can be used as a diagnostic in the LTU front end and further downstream for beam clean-up. Stepper-motors are used for movement which is read back with transducers (LVDT's) for positional information.		
1	03	02	08		Controls - Timing	This system includes the synchronization of pulsed accelerator devices with generating the beam and the acquisition of beam measurements for use in feedback and timing.		
1	03	02	09		Controls - Vacuum	This system includes the monitoring and control of gages, pumps, and valves. This system includes interlocks for the protection of the machine during maintenance and against a catastrophic change in pressure.		
1	03	02	09	01	Controls - Vacuum Instrumentation & Interlocks	This system collects and displays the operating state of vacuum system in discrete areas of the accelerator. It uses this information to control beam operation as well as the state of isolation valves and vacuum pump power supplies.		
1	03	02	10		Software & Controls Infrastructure	The controls infrastructure provides the interconnection between various parts of the control system. It performs supervisory function for the control network. It includes the software tools and applications for the real time programming of the control modules as well as the tools for supporting the database structure.		
1	03	02	10	04	Data Communications	Gigabit networking has been costed to connect 5 locations to MCC. The locations are: Bldg 406, sector 24, sector 30, support bldg at near end and the end of the LTU. One gigabit switch has been allocated per location except at the end station, where two have been allocated because of the high quantity of cameras at this location. Wireless network access points (to the visitor network) are also included.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	03	02	10	05	Computers	This is actually "Computers and crates". VME crates with Power PC controllers and VxWorks run-time licenses have been costed for all systems. The cables and the modules that go in the crates are distributed across the systems (in the rest of the controls WBS) that use/need them. No workstations have been costed for the Linac controls.		
1	03	03			Linac Magnets & Supports	This system may include permanent and electromagnetic elements (dipoles, quadrupoles, sextupoles, and correctors) for the manipulation and direction of charged beams. The structure and systems to locate and accurately position these elements are included in the system.		
1	03	03	02		Bend Magnet (BX3_LTU)	This is an existing bend magnet design for use in the LTU. Five existing bend magnets will be recycled from SLAC / FFTB. One of the five will become the first bend in the dump line in front of the BYD bend magnets.		
1	03	03	03		Bend Magnet (BX2_BC2)	This is a new bend magnet design for use in BC1. It is direct current string of four magnets powered to bend the electron beam into and out of the BC2 chicane. The final alignment stage for each magnet and support stand for the entire BC2 system have been cost with these components.		
1	03	03	04		Bend Magnet (BY_LTU)	This is a new bend magnet design for use in the LTU. It is a direct current powered to bend the electron beam in a vertical plane in the LTU		
1	03	03	05		Quad Magnet (Quad_LTU)	These magnets are an existing design. Fifteen additional units will have to be fabricated to augment the lot of existing refurbished units that will be removed from FFTB.		
1	03	03	08		Corrector Magnet (Type 4)	This is an existing linac design for a weak (iron core) bend magnet. Its large appeture allows for installation over the accelerating structure. They provide bend correction for the electron beam. A single design can be installed in either a vertical or horizontal orientation. The majority of these magnetic elements exists in the current linac and will assume new position and control for LCLS.		
1	03	03	09		Bend Magnet (BYD_DUMP)	This is a new direct current electromagnetic dipole that bends the bends the spent electron beam after the Undulator and directs it to the main dump. Along with other magnetic elements, this magnet is part of a spectrometer that analyzes the energy distribution of the discarded electrons that reach the dump.		
1	03	03	10		Quad Magnet (QA)	This is an existing linac Quadrupole magnet for focusing or defocusing of the electron beam. They are usually found at linac intergirder and or drift locations. The majority of these magnetic elements already exists in the current linac and will assume new position and control for LCLS.		
1	03	03	11		Bend Magnet (BYPM_LTU)	This is a new system of permanent dipole magnets located immediately after the dump bend magnet that directs the electron beam into a safe shielding zone in the event of a failure of the Dump Bend Magnet.		
1	03	03	12		Bend Magnet (BYKIK_LTU)	This is a new pulsed magnet in the LTU that limits the rate of beam bunches into the Undulator by deflecting unwanted bunches out of the forward Beamline into the Single Beam Dump.		
1	03	03	14		BXKIK LINAC TCAV Screen Kicker	This WBS section identifies and collects the resources and costs associated with the BXKIK LINAC TCAV Screen Kicker.		
1	03	04			Linac Vacuum Subsystem	Section Summary		
1	03	04	02		Linac Beamline Vacuum System	This section represents all of the interconnecting vacuum parts between accelerating, magnetic, or diagnostic components for the identified LCLS system. It includes, but is not limited too, drifts, tees, pumps, gauges, pumps, and manifolds. Gauge controllers and ion pump controllers are not included in this section. They are estimated under WBS 1.3.2.9. Cutting and re-assembly of accelerator structures are not covered under this WBS number. Those activities are covered under WBS 1.3.6.2.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	03	04	04		BC2 Vacuum System	This section represents all of the interconnecting vacuum parts between accelerating, magnetic, or diagnostic components for the identified LCLS system. It includes, but is not limited to, drifts, tees, pumps, gauges, pumps, and manifolds. Gauge controllers and ion pump controllers are not included in this section. They are estimated under WBS 1.3.2.9. Since the vacuum supports are an integral part of the BC2 magnet support system those items are covered under WBS 1.3.3.3.		
1	03	04	05		Linac to Undulator (LTU) Vacuum System	This section represents all of the interconnecting vacuum parts between accelerating, magnetic, or diagnostic components for the identified LCLS system. It includes, but is not limited to, drifts, tees, pumps, gauges, pumps, vacuum supports and manifolds. Gauge controllers and ion pump controllers are not included in this section. They are estimated under WBS 1.3.2.9		
1	03	04	06		Dumpline Vacuum System	This section represents all of the interconnecting vacuum parts between accelerating, magnetic, or diagnostic components for the identified LCLS system. It includes, but is not limited to, drifts, tees, pumps, gauges, pumps, vacuum supports and manifolds. Gauge controllers and ion pump controllers are not included in this section. They are estimated under WBS 1.3.2.9		
1	03	04	07		Vacuum System Undulator Interface	Specification of the vacuum system requirements at the entrance and exit to the undulator system.		
1	03	04	07	01	Entrance Section Assembly	Specification of the vacuum system requirements at the entrance to the undulator system.		
1	03	04	07	02	Exit Section Assembly	Specification of the vacuum system requirements at the exit to the undulator system.		
1	03	04	08		LTU/BSY& Cold Trap Vacuum System	This section represents all of the interconnecting vacuum parts between accelerating, magnetic, or diagnostic components for the identified LCLS system. It includes, but is not limited to, drifts, tees, pumps, gauges, pumps, vacuum supports and manifolds. Gauge controllers and ion pump controllers are not included in this section. They are estimated under WBS 1.3.2.9		
1	03	05			Linac Electron Diagnostics Summary	System Summary		
1	03	05	01		Wire Scanners (7) Summary	Wire Scanners are used to measure beam size in order to determine Beam Emittance and Energy Spread. They consist of at least one set of wires orthogonal to the beam Z-axis that are moved through the electron beam. The resulting radiation is measured by a photon detector.		
1	03	05	02		Beam Position Monitors	Beam Position Monitors (BPM) identify the local position of the electron beam relative to a known mechanical and magnetic reference (quadrupole magnet magnetic center relative to physical references). The LCLS linac has two BPM design types; electrode and RF. The stripline electrode BPM generates a signal proportional to the dimensional offset between the electron bunch center and the BPM center. The RF BPM is an RF resonant cavity that measures the bunch position based on the amplitude and phase shift of the RF pulse proportional to the electron bunch. BPM and magnet data can be used to automatically tune the electron beam position.		
1	03	05	02	03	BPM - FFTB (12) Summary	This electrode type FFTB BPM is an established design. Existing units in the SLAC FFTB will be refurbished and used in the LTU. The balance of the required FFTB type BPMs (~30%) will be a revised design modeled on the historical design.		
1	03	05	03		Toroid Beam Current Monitor (10) Summary	Toroids measure both discrete local and integrated system level electron beam current. As a local device, a Toroid measures beam current by producing a signal proportional to the electron bunch current. Measurements by two or more Toroids in a system can be made to indicate average current per bunch. A system of Toroids can also be used to indicate beam losses by comparing bunch current at multiple locations.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	03	05	04		Beam Stoppers (4) Summary	Beam stoppers are water cooled diagnostic/protection devices that are inserted into the electron path to stop the beam. They are designed to absorb the electron beam power. Beam stoppers may be designed for a reduced electron bunch rate to minimize heat load and radiation effects. Stoppers are placed in the beam path to tune the upbeam electron beam path while the stopper is protecting personnel and downbeam radiation sensitive devices.		
1	03	05	05		Profile Monitors (7 OTR-3 PHOSPHOR SCREEN-1 YAG)	Profile monitors are beam emittance and energy spread diagnostic devices. They characterize beam shape, size, and position. Profile monitor designs consist of a fluorescent screen or metal foil that interacts with the electron beam and produces secondary radiation that is monitored by detectors and/ or cameras.		
1	03	05	07		CSR/OTR/CTR Bunch Length Monitors (5) Summary	This device generates a signal proportional to the bunch length by measuring terahertz and synchrotron radiation produced as the electron beam passes through a thin foil.		
1	03	05	09		Single Beam Dump (1) Summary	The single beam dump is an electron beam stopper designed to absorb the full beam energy. This dump is designed for system tuning and to provide protection for the undulator system in concert with a pulsed bend magnet.		
1	03	05	10		Electron Beam Dump (1) Summary	The electron beam dump is the endpoint for the electron beam in the LCLS system after the beam passes through the undulator system.		
1	03	05	11		Protection Collimators (5) Summary	Protection collimators are designed to limit the beam cross sectional dimensions in X and Y to prevent damage to devices downbeam from the collimator.		
1	03	05	12		Movable Collimators (7x,3y) Summary	Movable collimators are designed to tune the electron beam characteristics by limiting the beam dimension in either the X or Y axes.		
1	03	05	13		Safety Electron Dump (1) Summary	The safety electron dump is a redundant system designed to remove the electron beam in the event of a system failure mode.		
1	03	07			Linac Installation & Alignment	This WBS section covers the reception of parts, components, and sub assemblies from either a Post Processing & Testing or a Rack Integration activity. Installation begins at beneficial occupancy or at a planned SLAC Linac downtime and completes all necessary activities prior to the start of commissioning. These activities are, but not limited to, mechanical installation of beam line components, installation of vacuum components, alignment, vacuum pump down, vacuum leak checking and functional testing of components and all of their respective control systems. Management of project installation activities are not covered in this section. Those activities are covered under WBS 1.3.1, System Management & Integration. This WBS section also covers the removal and/or relocation of existing SLAC Linac beam line components to make room for new LCLS Linac components such as magnets, vacuum components, RF components and diagnostic instruments.		
1	03	07	03		Linac L02 System Installation & Alignment	This WBS section identifies and collects the resources and costs associated with the removal and/or relocation of SLAC Linac beam line components and the installation of all LCLS Linac beam line components in accordance with the activity description above.		
1	03	07	04		Linac BC2 System Installation & Alignment	This WBS section identifies and collects the resources and costs associated with the removal of SLAC Linac beam line components and the installation of all BC2 components in accordance with the activity description above.		
1	03	07	05		Linac L03 System Installation & Alignment	This WBS section identifies and collects the resources and costs associated with the removal and/or relocation of SLAC Linac beam line components and the installation of all LCLS Linac beam line components in accordance with the activity description above.		
1	03	07	06		Linac LTU System Installation & Alignment	This WBS section identifies and collects the resources and costs associated with the removal and/or relocation of SLAC FFTB beam line components and the installation of all LCLS Linac beam line components in accordance with the activity description above.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	03	07	07		Linac E-Dump System Installation & Alignment	This WBS section identifies and collects the resources and costs associated with the removal and/or relocation of SLAC FFTB beam line components and the installation of all LCLS Linac beam line components in accordance with the activity description above.		
1	03	07	20		LINAC Installation 2007 Shut Down	This WBS section covers the FY2007 Shut Down effort for the reception of parts, components, and sub assemblies from either a Post Processing & Testing or a Rack Integration activity. Installation begins at beneficial occupancy or at a planned SLAC Linac downtime and completes all necessary activities prior to the start of commissioning. These activities are, but not limited to, mechanical installation of beam line components, installation of vacuum components, alignment, vacuum pump down, vacuum leak checking and functional testing of components and all of their respective control systems. Management of project installation activities are not covered in this section. Those activities are covered under WBS 1.3.1, System Management & Integration. This WBS section also covers the removal and/or relocation of existing SLAC Linac beam line components to make room for new LCLS Linac components such as magnets, vacuum components, RF components and diagnostic instruments.		
1	03	07	20	01	Beamline Equip Removal L02, L03 and BC2	This WBS section identifies and collects the resources and costs associated with the removal of SLAC Linac beam line components of all L01, L02 through BC2 components in accordance with the activity description above.		
1	03	07	20	02	Beamline Equip Installation L02, L03 and BC2	This WBS section identifies and collects the resources and costs associated with the installation of all Gallery Waveguide components in accordance with the activity description above.		
1	03	07	20	03	2007 Linac Controlls Install and Checkout	This WBS section identifies and collects the resources and costs associated with the installation and checkout of all 2007 Linac Controls in accordance with the activity description above.		
1	03	07	20	04	Linac Undulator Interface	This WBS section identifies and collects the resources and costs associated with the installation of all Undulator Interface with Linac in accordance with the activity description above.		
1	04				UNDULATOR SYSTEM	The LCLS Undulator System Project Costs, including undulator magnets and supports, undulator diagnostics, vacuum systems, and controls for the undulator equipment are included herein. Integration and installation are also included within this area. Total cost for the LCLS undulator system planning, project management, design, construction, and installation are summed at this level.		
1	04	01			Undulator System Management & Integration	All project management and engineering integration oversight is covered by this element. Total cost of all project management and project integration tasks required to design, construct, test and install an operationally complete undulator system for the LCLS: Undulator System Management; ANL Project Support; Undulator System M&S – General; Undulator System Reviews and Workshops.		
1	04	01	01		Undulator System Management	Oversee project management details and delivery of a completely operational undulator system for the LCLS. This section includes all project management and project integration tasks required to design, construct, test and install an operationally complete undulator system for the LCLS: Undulator System Management-Technical; ANL Project Support-General.		
1	04	01	01	01	Undulator System Management - Technical	Oversee the technical project management details and delivery of a completely operational undulator system for the LCLS. Technical management and oversight cost of all project management and project integration tasks required to design, construct, test and install an operationally complete undulator system for the LCLS. It also include SLAC indirect costs generated as a part of doing business with ANL.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	04	01	01	02	ANL Project Support	Provide all necessary administrative, PMCS, budget, schedule, and contract monitoring, website and other basic sundry support required for the delivery of a completely operational undulator system for the LCLS. This section includes direct and indirect ANL LCLS project support costs required to design, construct, test, and install an operationally complete undulator system for the LCLS.		
1	04	01	02		Undulator System Materials & Supplies	This section covers the total M&S cost of the ANL LCLS project office required during the design, construction, testing and installation of an operationally complete undulator system for the LCLS.		
1	04	01	02	01	Undulator System M&S - General	Basic M&S cost excluding travel of the ANL LCLS project office required during the design, construction, testing and installation of an operationally complete undulator system for the LCLS: Office supplies and miscellaneous materials; Tele/video conferencing; CPUs and Software; Shipping and Storage.		
1	04	01	02	02	Undulator System Travel	Basic M&S cost of travel for the ANL LCLS project required during the design, construction, testing and installation of an operationally complete undulator system for the LCLS.		
1	04	01	03		Undulator System Reviews and Workshops	This section provides the necessary support for all reviews of the undulator system or required workshops. It includes all costs required to cover all semiannual reviews and occasional workshops focused on the needs of the LCLS undulator system: Organization and management of all LCLS undulator system reviews and related workshops; Travel for reviewers or necessary workshop attendees; Miscellaneous items required during the reviews and workshops.		
1	04	02			Controls	Overall undulator controls task covers all controls issues involved with the LCLS undulator. This includes the costs involved with the entire controls section of the LCLS undulator. It also consists of the specification, design, procurement, assembly and testing of all controls components of the LCLS undulator.		
1	04	02	08		Undulator Magnet Power Supplies	This element covers design of the power supply controls software, documentation, construction of the computer interface, and integration. It also covers all costs of purchasing the power supplies and controls for them.		
1	04	02	10		Undulator Control Module	This is the cost center for the effort to design and procure the undulator control module. It includes the design and purchase of the components.		
1	04	02	12		Rack and Cable	This is the cost center for the specification and purchase of the intra-undulator racks and cables for the in-tunnel equipment.		
1	04	02	13		BPM	This is the cost center used to support the design and development of the RF Cavity BPM. It includes engineering effort for software design used to charaterize the BPM electronics.		
1	04	02	14		Long Term Test Prep	This is the cost center used to design and deploy the cabling and controls electronics for the long-term test fixture at APS.		
1	04	02	17		Undulator Conrols - Management	This is the const center used to cover effort and expenses associated with the management of the undulator controls effort.		
1	04	02	20		Undulator MPS	Machine Protection System for the undulator installed and tested.		
1	04	02	21		Undulator Controls - Timing	The timing system providing the rates and triggers installed and tested.		
1	04	02	22		Undulator Controls - BPM	The beam position monitor data acquisition electronics and software installed.		
1	04	02	23		Undulator Controls - Vacuum	The vacuum controls and monitoring hardware and software installed.		
1	04	02	24		Undulator Controls - ADS System	The undulator diagnostics including WPM and HLS installed and tested.		
1	04	03			Undulator Magnet & Support	This element covers the LCLS undulator magnets and supports, including calibration, assembly, and integration.		
1	04	03	03		1st Article Undulators & Long Lead Procurements	Procurement of the long lead items, Titanium Strongbacks, Magnet Blocks, and Magnet Poles is in this area. The first articles from each vendor of the production undulators are also contained herein.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	04	03	03	01	Ti Strongback (LLP)	Procurement of Long Lead Items: Titanium Strongbacks. This covers the labor and materials for 33 production devices. Additionally, there are 7 operational spares, located in WBS 2.4.3.4. This cost includes effort for design, procurement, testing and receiving of these units.		
1	04	03	03	02	Magnet Blocks (LLP)	Magnet blocks for the 33 installed undulators, plus 5% extra construction/assembly spares. Blocks for the 7 operational spare undulators are located in WBS 2.4.3.4. This covers the labor and materials for enough magnet blocks to fabricate 33 production undulators, and includes 5% spares to cover those that are likely to be broken during assembly. Additionally, there are enough blocks for 7 operational spare undulators, without the 5% spare count, located in WBS 2.4.3.4. This cost includes effort for design, procurement, testing and receiving of these units.		
1	04	03	03	03	Magnet Poles (LLP)	Magnet poles for the 33 installed undulators, plus 5% extra construction/assembly spares. Poles for the 7 operational spare undulators are located in WBS 2.4.3.4.		
1	04	03	03	04	Magnet Assembly & Supports - 1st Articles	Assembly of the first article undulators from each vendor is included within this WBS area.		
1	04	03	03	05	Magnetic Measurement (ANL)	Magnetic measurement and tuning of first article undulators from each vendor is included within this WBS area. First articles will be shipped to the MMF.		
1	04	03	03	06	Integrated Single-Undulator Module Test	This WBS includes preparation for and execution of a single-undulator module test at ANL.		
1	04	03	04		Production Undulator Magnet Assembly & Supports	Procurement, magnetic measurement, and tuning of 33 production undulator assemblies and support/movers are included in this area.		
1	04	03	04	01	Production Undulator Assembly - Vendor A	Assembly by Vendor A of 17 production undulators (Assembly of the 7 operational Spare Units is listed under WBS 2.4.3.4.1).		
1	04	03	04	03	Production Support/Mover Fabrication/Assembly	This WBS area contains the fabrication and assembly of 33 support/mover systems.		
1	04	03	05		Quadrupole Focusing Magnets	Design and procure 33 quadrupole focusing magnets, power supplies, stages and stands, and cables. Procurement of four spares is in 2.4.3.5.		
1	04	03	05	01	Quadrupole Magnets	Design and procure 33 quadrupole foscusing magnets. Procurement of four spares is in 2.4.3.5.		
1	04	03	05	03	Quadrupole Stages & Stands	Design and fabrication of the stages and stands that support the quadrupole magnet on the cradle and allow it to be mechanically positioned for initial alignment are included herein.		
1	04	03	06		Undulator Magnetic Measurement Facility (SLAC)	This element covers the setup of the MMF at SLAC, the magnetic measurements, fiducialization and assembly of the undulator system components, and the design and construction of the position monitoring systems.		
1	04	03	06	02	Fiducialization and Magnetic Measurements (F/MM)	This element covers the magnetic measurements, fiducialization and assembly of the undulator system components.		
1	04	03	06	03	Undulator Monitoring	This element covers the design and construction of the stretched wire monitoring system and the hydrostatic leveling system.		
1	04	03	08		Fixed Supports	This system provides an ultra-stable non-adjustable support platform for the majority of the undulator system components.		
1	04	03	08	02	Fixed Support Design	Design the undulator system fixed supports and purchase fixed supports.		
1	04	03	08	05	Thermometry	This category refers to thermometry monitoring the temperature of parts of the girder.		
1	04	03	08	07	Earthquake Bracing	Simple SLAC style restaint system built into the girder and undulator assemblies that will contain the undulator system in the event of a major earthquake.		
1	04	04			Vacuum System	This is the Total Center for Vacuum System in the Undulator System to deliver a functional vacuum system for the Undulator System within LCLS. The Vacuum System and related equipment includes the effort required for procuring the technical equipment, including specification review, oversight of the bid process, issue of purchase requests, and billing. This center includes all vacuum components from the upstream treaty valve to the downstream treaty valve.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	04	04	02		Undulator Vacuum Chamber Assembly	Total Center for Undulator Chamber Assembly in the Vacuum System in the Undulator System. The Undulator Vacuum Chamber is an assembly that resides within the Undulator Magnet. It is designed to contain the electron beam and the produced x-ray beam under vacuum within its walls with little interaction to the beam. Undulator Vacuum Chamber Assembly and related equipment includes the effort required for procuring the technical equipment, including specification review, design, oversight of the bid process, issue of purchase requests, and billing.		
1	04	04	02	02	Production Chamber Weldment	Total cost of (34) Production Undulator Vacuum Chambers including: design, procurement, quality assurance, and testing. This element includes material and labor charges. Production Chamber Weldment and related equipment includes the effort required for procuring the technical equipment, including specification review, design, oversight of the bid process, issue of purchase requests, and billing. The chambers will be in a state ready for installation when they are shipped from ANL to SLAC.		
1	04	04	02	03	Prototype Aluminum Chamber	Total cost of (2) Prototype Aluminum Chambers that includes: design, procurement, quality assurance, and testing. This element includes material and labor charges. Prototype Aluminum Chamber and related equipment includes the effort required for procuring the technical equipment, including specification review, oversight of the bid process, issue of purchase requests, and billing. The (2) prototypes will be used to qualify both the design and the materials selection for the Production Vacuum Chamber.		
1	04	04	03		Beam-line Bellows Module Assembly	Total Center for Bellows Assembly in the Vacuum System in the Undulator System. The Beam-line Bellows are placed in the spaces between the undulators. The Bellows assembly contains both a barrier for vacuum and a liner (channel) for the beam to follow. Beam-line Bellows Module Assembly and related equipment includes the effort required for procuring the technical equipment, including specification review, oversight of the bid process, issue of purchase requests, and billing.		
1	04	04	03	02	Production Bellows Module	Total cost of (47) Production Bellows Modules including: design, procurement, quality assurance, and testing. This element includes material and labor charges. The (47) Production Bellows Modules will be used in the Short and Long Diagnostics Breaks along with the Entrance and Exit Sections.		
1	04	04	04		Single Undulator Test (SUT) Vacuum	Total cost of Vacuum Components to be used in the Single Undulator Test including: design, procurement, and quality assurance. This element includes material and labor charges. These are the temporary units that will be used until actual units are available.		
1	04	04	05		Short Diagnostic Break (SDB) Assembly	Total Center for (23) Short Diagnostic Break Assembly in the Vacuum System in the Undulator System. This center includes: design, procurement, quality assurance, and testing. This element includes material and labor charges. The Short Diagnostics Break is that set of vacuum components that reside within the smaller breaks between the undulator magnets. This is also the assembly that includes both diagnostics devices and vacuum components, although the costing of these items will be found in other places in the WBS.		
1	04	04	06		Long Diagnostic Break (LDB) Assembly	Total Center for (11) Long Diagnostic Break Assembly in the Vacuum System in the Undulator System. The Long Diagnostics Break is that set of vacuum components that reside within the larger breaks between the undulator magnets.		
1	04	04	09		Baking System	Total Center for Baking System in the Vacuum System in the Undulator System. This element covers the labor and materials for the baking system for vacuum components going into the undulator vacuum system. This includes effort for design, procurement, and receiving of these units. Baking System and related equipment includes the effort required for procuring the technical equipment, including specification review, oversight of the bid process, issue of purchase requests, and billing.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	04	05			Diagnostics	Deliver a functional Diagnostics for the Undulator System within LCLS. This center includes all diagnostics devices from the upstream treaty valve to the downstream treaty valve.		
1	04	05	05		RFBPM	The RFBPM will be used to precisely measure the position of the electron beam in all the breaks between the undulators. Total Center for RFBPM Diagnostics for the Undulator System.		
1	04	05	05	01	X-Band Cavity BPM Development	The X Band Cavity BPM is the sensor installed in the beam line that will be used to precisely measure the position of the electron beam in all the breaks between the undulators. Total Center for RFBPM Diagnostics for the Undulator System. This element covers the labor and materials for (5) prototypes: (1) non-vacuum bench unit, (1) ITS beam test unit, and (3) for single shot test. This includes effort for design, procurement, testing and receiving of the units.		
1	04	05	05	03	X-Band BPM Production	This element represents the production of the RFBPM system. It incompasses the production of the cavities, receivers, waveguides and supports. This element covers the labor and materials for (8) units going into the LTU and a group of (35) devices going into the Undulator System. This includes effort for design, procurement, testing and receiving of the units.		
1	04	05	06		Beam Finder Wire	The Beam Finder Wire will be used to precisely measure the position of the electron beam in all the breaks between the undulators. Total Center for Beam Finder Wire Diagnostics for the Undulator System. This element covers the labor and materials for prototype effort and a group of (33) production devices. This includes effort for design, procurement, testing and receiving of the units.		
1	04	05	08		Beam Loss Monitoring	This element cover the design and materials costs for the beam loss monitor system installed in the undulator system and used to protect it from significant radiation doses.		
1	04	06			Undulator System Installation and Alignment	This element covers all the M&S and effort, management oversight, technical and other labor, required for the LCLS undulator system installation, basic checkout, and alignment tasks. Following beneficial occupancy (BO) of the LCLS Undulator Hall all technical equipment, fixed supports, undulators and quadrupole magnets, diagnostics, vacuum systems, and controls system, will be moved into the undulator hall, installed, checked out, and aligned to the required position and accuracy.		
1	04	06	06		2008 Undulator System Installation	This element is the total cost center for all M&S and effort, management oversight, technical and other labor, required for the LCLS undulator system installation, basic checkout, and alignment tasks. Following beneficial occupancy (BO) of the LCLS Undulator Hall all technical equipment, fixed supports, undulators and quadrupole magnets, diagnostics, vacuum systems, and controls system, will be moved into the undulator hall, installed, checked out, and aligned to the required position and accuracy.		
1	05				X-RAY TRANSPORT & DIAGNOSTICS SYSTEMS	XTOD includes mechanical and vacuum systems for the x-ray beam path, attenuators, x-ray optics and x-ray diagnostics required for manipulation and characterization of the x-ray beam downstream of the undulator. “Manipulation” includes collimation, attenuation, turning, and monochromatizing. “Characterization” includes measurement of x-ray beam properties as necessary for commissioning and operation of the LCLS.		
1	05	01			System Management & Integration	This element provides overall management for XTOD.		
1	05	01	01		Management	This element provides overall management for XTOD safety, conceptualization, R&D, design, construction, testing, installation, integration, and commissioning.		
1	05	01	01	01	XTOD Management - Technical	This covers a full time manager.		
1	05	01	01	02	LLNL Project Support	This covers a half time administrator, and funding for programmatic travel to attend weekly staff meetings, recruit project staff prepare monthly reports, prepare reviews, and other required project documentation.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	05	02			Controls	Controls captures upper-level work required to interface and integrate the LCLS system-wide control systems to the XTOD primitive controls and to provide remote access to the instrumentation in the Front End Enclosure (FEE), the Near Experimental Hall (NEH), the Tunnel, and the Far Experimental Hall (FEH).		
1	05	02	01		Controls	This element covers the development and delivery of the EPICS control system for XTOD. This will include the development of high level application programming to support the physics application and software programs for all XTOD diagnosics and instruments. The control system will interface to a variety of devices including cameras, sensor electronics, valves, motors, and gas flow and pressure controllers.		
1	05	03			Mechanical & Vacuum Subsystem	Design pumps, pipes and stands for interconnecting the experimental tanks in the FEE, Near Hall, Tunnel and Far Hall.		
1	05	03	01		Vacuum Systems Engineering	This covers the management for the Mechanical and Vacuum work.		
1	05	03	02		Mech/Vac Front End	This covers the mechanical and vacuum specification, design, and procurement for the FEE.		
1	05	03	03		Mech/Vac Near Hall	This covers the mechanical and vacuum specification, design, and procurement for the Near Hall.		
1	05	03	03	01	Mech/Vac Near Hall	This covers the mechanical and vacuum specification, design, and procurement for the Near Hall.		
1	05	03	04		Mech/Vac Tunnel	This covers the mechanical and vacuum specification, design, and procurement for the Tunnel.		
1	05	03	05		Mech/Vac Far Hall	This covers the mechanical and vacuum specification, design, and procurement for the Far Hall.		
1	05	04			Optical Subsystem	All elements used to manipulate the X-Ray beam.		
1	05	04	02		Facility Optics	This WBS element will provide specification, design, procurement, install and testing for the fixed masks, the slits and collimators, the mirrors, the gas attenuator, and the solid attenuator.		
1	05	04	02	01	Fast Valve	This WBS element supports the design, procurement, fabrication, assembly, testing, and shipping, of the Fast Valve, its sensor and its controller. The Fast Valve is located in the electron beam dump area and the sensor is located in the FEE.		
1	05	04	02	02	Fixed Mask	The Fixed Masks insure that all radiation allowed downstream is confined to within a very small angular region.		
1	05	04	02	03	Slit	Slit consists of a two movable jaws defining an adjustable horizontal aperture, and two movable jaws defining an adjustable vertical aperture. The purpose of the slit is to allow the users to remove the halo of spontaneous radiation surrounding the FEL.		
1	05	04	02	05	Gas/Solid Attenuator	This element includes both the solid and gas attenuators. The gas attenuator is a section of pipe filled with gas whose purpose is to attenuate the FEL beam at low photon energies.		
1	05	04	02	05	Gas/Solid Attenuator (Cont.)	The solid attenuators reside in one of the gas attenuator cells. The attenuators are mounted on inserters allowing various combinations of attenuators to be selected.		
1	05	04	02	06	TTF Damage Experiment	This WBS element covers the planning, procurement, running, analysis, and documentation of a series of measurements at the TTF VUVFEL facility. The purpose of these measurements is to measure damage thresholds of materials used at the LCLS under the conditions of high brightness and short times.		
1	05	04	02	07	FEL Offset Mirrors	This WBS element covers the specification, design and procurement of FEL Offset Mirrors located in the Front End Enclosure. This purpose of this device is to filter the spontaneous energy.		
1	05	05			Diagnostics Subsystem	Provide diagnostics to characterize and measure beam performance for the users and the facility.		
1	05	05	03		Facility Diagnostics	This WBS element will provide specification, design, procurement, prototype, install and testing for the Direct Imager, Indirect Imager, Pulsed Ion Chamber, Gas Mixing System, FEE Diagnostic Tanks, Ion Pump Diagnostic Tanks.		
1	05	05	03	01	Direct Imager	The Direct Imager is an insertable, high-resolution scintillator viewed by CCD cameras for measuring spatial distributions and for alignment and focusing of optical elements.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	05	05	03	06	Gas Detector	There are two Gas Detectors located upstream and downstream of the attenuators which provide a non-intrusive measure of the FEL pulse energy, in real-time, on a pulse-by-pulse basis.		
1	05	05	04		Commissioning Diagnostics	This WBS element will provide specification, design, procurement, prototype, install and testing for the Total Energy Measurement, and Spatial Shape & Centroid Measurement.		
1	05	05	04	02	Total Energy Measurement	The Total Energy Measurement System is located downstream of the Attenuator and provides an accurate, although intrusive, measure of the FEL pulse energy based on the temperature rise produced in a known quantity of matter after interaction with an FEL pulse.		
1	05	05	04	04	Soft X-Ray Imager	The commissioning diagnostic tank is converted into a spectrometer by adding a multilayer optic at 0.8 keV. The optic disperses the radiation onto an x-ray sensitive region of a fast readout position-sensitive detector.		
1	05	05	04	05	Popup Cameras	This WBS element supports the design, procurement, fabrication, assembly, testing, and shipping of the Popup Alignment System. The Popup Alignment System is a series of stations consisting of cameras viewing scintillators that normally are not in the beam path but when required can be inserted into the beam path. The Popup camera systems are located at various positions before, after, and between the mirrors of the FEL offset systems to provide information on the position of the main and reflected beams. This information will be used to align the FEL offset systems.		
1	05	05	04	06	K Measurement System	This WBS element supports the design, procurement, fabrication, assembly, testing, and shipping of the K Measurement System excluding the channel cut crystal optical elements which are supported through WBS element 1.6.8 K Measurement Crystals. The K Measurement System is located in the FEE and contains crystal optics that can be inserted into the LCLS beam to spectrally filter the radiation.		
1	05	06			X-Ray Transport System Installation & Alignment	This covers the mechanical and vacuum installation for the Front End Enclosure, Near Hall, Tunnel and Far Hall areas in the X-Ray Transport system.		
1	05	06	01		FEE Install	This covers the mechanical and vacuum installation for the FEE.		
1	05	06	02		Near Hall Install	This covers the mechanical and vacuum installation for the NEH.		
1	05	06	03		Tunnel Install	This covers the mechanical and vacuum installation for the Tunnel.		
1	05	06	04		Far Hall Install	This covers the mechanical and vacuum installation for the FEH.		
1	05	06	05		Electron Dump Enclosure Install	This covers the mechanical and vacuum installation for the EDE.		
1	06				X-RAY END STATION SYSTEMS	This element includes the infrastructure required to integrate x-ray experiments with the LCLS source and conventional facilities. Specifically, this includes safety systems, computer and network systems, a synchronized laser system, and a prototype detector that will be used by most of the foreseeable LCLS experiments. It also includes a complete Atomic Physics Station for the first studies of FEL-atom interactions.		
1	06	01			System Management & Integration	This element provides management and integration for all design engineering and construction phases of the Project.		
1	06	01	01		Management	Attend meetings, arrange for staffing for the project, prepare reports, formulate conceptual design, and travel as required.		
1	06	02			XES Controls	Create protocols, networks, and systems needed for controlling experimental equipment and handling experimental data, and design and create safety interlock systems.		
1	06	02	01		Controls Management	Provide management for the XES Controls activities, planning and scheduling reviews, provide travel and test equipment for supporting engineering.		
1	06	02	07		AMOS Experiment Controls X1	Design the hardware and software needed to control equipment installed at the High Field Atomic Physics experimental station (X1), including precision motion equipment, sample manipulation and monitoring equipment, optics, detectors, and diagnostics.		
1	06	02	07	01	AMOS Requirements, Design, Setup	Design the hardware and software needed to control equipment installed at the Atomic Physics experimental station X1.		
1	06	02	07	07	Development Hardware & Software	Procure hardware and software for test setups to develop and test contol and DAQ components		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	06	02	07	08	Beam Viewing System for Phase 1	Design, procure, and test the beamviewing system for the initial phase of the experiment		
1	06	02	07	09	Beam Viewing System for Phase 2	Design, procure, and test the beamviewing system for the later phase of the experiment		
1	06	02	07	12	Differential Pumping	Design, procure, and test the hardware and software for the differential pumping controls		
1	06	02	07	14	Temperature Monitoring	Design, procure, and test the hutch temperature monitoring system		
1	06	02	07	15	Gas Storage & Delivery System	Design, procure, and test the gas storage and delivery system		
1	06	02	07	16	High Field Physics Chamber	Design, procure, and test the controls for the experimental chamber		
1	06	02	07	17	Diagnostics Chamber	Design, procure, and test the controls for the diagnostics chamber		
1	06	02	07	18	Total Power Measurement	Design, procure, and test the controls for the total energy measurement system		
1	06	02	08		AMOS Particle Imaging Controls	Design the hardware and software needed to control equipment installed at the Particle Imaging Atomic Physics experimental station (X2).		
1	06	02	08	01	AMOS Particle Imaging Controls	Design the hardware and software needed to control equipment installed at the Atomic Physics experimental station X2.		
1	06	02	08	02	AMOS Particle Imaging Software	Procure, and test the software needed to control the X2 Particle Imaging instrument.		
1	06	02	10		Global Controls System	Create protocols, networks, and systems needed for controlling experimental equipment and handling experimental data, and design and create safety interlock systems.		
1	06	02	10	01	Network	Design, procure, and test the hardware and software required for computer network support for LCLS experiments.		
1	06	02	10	02	Machine Protection System	Design, procure, and test the hardware and software needed for the machine protection system that will minimize the possibility of significant damage to the LCLS source due to accidents in the experimental stations and x-ray beam transport areas (front end enclosure, Near Experimental Hall, x-ray transport Tunnel, and Far Experimental Hall).		
1	06	02	10	03	Personnel Protection System	Design, procure, and test the hardware and software needed for the personnel protection system that will ensure radiological safety for the experimental stations and x-ray beam transport areas (front end enclosure, Near Experimental Hall, x-ray transport tunnel, and Far Experimental Hall).		
1	06	02	10	04	Laser Safety System (LSS)	Design, procure, and test the hardware and software needed for the personnel protection system that will ensure safe operation of the laser system for the laser laboratory, beam transport and experimental hutches in the Near Experimental Hall.		
1	06	02	10	05	User Safeguards	Design, procure, and test the hardware and software needed for user safeguard systems that will ensure safety of the users in the experimental areas (FEE, NEH, Tunnel, FEH).		
1	06	02	10	06	Timing System	Design, procure, and test the hardware and software required for a timing system to provide timing information for the experiments through the EPICS systems.		
1	06	02	10	07	Data Management	Design, procure, and test the hardware and software required for data management system supporting the data storage and processing needs of the experiments.		
1	06	02	10	08	Global Cabling & Racks	Design and procure the cabling and racks need for all the global control systems.		
1	06	02	10	09	Laser Timing	Design, procure, and test the hardware and software required for a high precision low jitter laser based timing system as a timng backbone for the LCLS including the experimental areas.		
1	06	02	10	11	Common Hutch Controls	Design, procure, and test the hardware and software required for common hutch controls as 120-Hz beam-data exchange, workstations, etc		
1	06	02	10	12	Data Acquisition (DAQ)	Design, procure, and test the hardware and software required for the data acquisition at 120Hz from the readout devices		
1	06	02	10	13	Archives	Design, procure, and test the hardware and software required to archive the 120-Hz EPICS and also science data		
1	06	02	10	14	Data Retrieval & Analysis	Design, procure, and test the hardware and software required to retrieve and analyze EPICS and also science data		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	06	02	11		Laser Controls	Design, procure, and test the hardware and software required to control the laser of the AMO experiment in the Near Hall.		
1	06	04			XES Laser System	Design, procure, and receive the ultrafast laser system, the laser diagnostics, the laser transport of the Atomic Physics Station that will be installed in the Near Experimental Hall. Specify, design and certify the laser safety system.		
1	06	04	01		XES Laser	Specify, procure, and receive the XES laser system that will be installed in the Near Experimental Hall for the Atomic Physics Station.		
1	06	04	02		Laser Diagnostics	Design, procure, and test the hardware and software that will be used to monitor the operation of the ultrafast laser system in the Near Experimental Hall.		
1	06	04	03		Laser Optical Transport	Design, procure, and test the optical transport system for transporting the ultrashort laser pulses to the experimental hutche(s) in the Near Experimental Hall.		
1	06	04	04		Laser Safety	Specify, design, review, certify and procure the Laser safety systems for the XES laser system to ensure laser operation according to SLAC Laser Safety rules.		
1	06	05			X-Ray Detectors	Specify, procure, and test prototype detectors that will be needed for the first experiments at LCLS. Development of advanced detector concepts that are essential to LCLS are included under 2.6 as R&D.		
1	06	05	04		Detector & Streak Camera	Detector Engineering activities to manage and coordinate all detector development programs for the Endstation Systems at LCLS including the R&D detector project in WBS 2.6.		
1	06	05	04	01	X-Ray Detector Management	Detector Engineering activities to manage and coordinate all detector development programs for the Endstation Systems at LCLS including the R&D detector project in WBS 2.6.		
1	06	06			System Installation & Alignment	This element provides for System Installation and Alignment in all areas of the X-Ray Endstation system (Front End Enclosure, Near Hall, Tunnel, and Far Hall). Specifically, this includes controls, computer and network systems, safety systems, laser system, x-ray detector and instrumentation and infrastructure for the atomic physics station. This also includes the integration of the X-Ray Endstation system with other components of the LCLS source, such as the LCLS timing and control system, vacuum system and conventional facilities. Initial test activities are included in this section.		
1	06	06	01		Front End Install	This element provides for System Installation and Alignment in the Front End Enclosure. Specifically, this includes controls, computer and network systems and safety systems.		
1	06	06	02		Near Hall Install	This element provides for System Installation and Alignment in the Near Hall. Specifically, this includes controls, computer and network systems, safety systems, a complete instrument of a Atomic Physics Station with its experimental chambers and their vacuum components, and the laser system and optical transport. Initial test activities of these systems are included in this section.		
1	06	06	03		Tunnel Install	This element provides for System Installation and Alignment in the Tunnel. Specifically, this includes controls, computer and network systems, and safety systems.		
1	06	06	04		Far Hall Install	This element provides for System Installation and Alignment in the Far Hall. Specifically, this includes controls, computer and network systems, safety systems, and x-ray detectors.		
1	06	06	05		Electron Dump Enclosure Install	This element provides for System Installation and Alignment in the Electron Dump Enclosure. Specifically, this includes safety systems.		
1	06	07			AMOS Experiment	This element covers specification, design, procurement and testing of the hardware needed for the AMO instruments including diagnostics and focussing needs. Management tasks for the technical and safety reviews are also included.		
1	06	07	01		AMO Exp - Management & Design	This WBS section covers the AMO management tasks of performing technical design and safety reviews, and producing documentation and plans.		
1	06	07	02		AMO Exp - High Field Physics	This element includes the procurement, assembly and testing of the AMO High Field Physics instrument (also labeled X1). This includes detectors, sample source, vacuum system and the differential pumping system.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	06	07	03		AMO Exp - Refocus Optics	This element includes the procurement, assembly,alignment and testing of the AMO refocussing optics.		
1	06	07	04		AMO Exp - Diagnostics	This element includes the procurement, assembly and testing of the AMO diagnostics.		
1	06	08			K Measurement Crystals	This element includes tasks in suppport of building the K Measurement spectrometer. The remainder of the tasks are covered in the WBS 1.5.		
1	06	08	01		K Measurement Crystals	This element includes the preparation of the Physics Requirement Document for the K Measurement spectrometer and the procurement of the crystals for this instrument.		
1	06	09			Mechanical Systems	This element covers specification, design, procurement, assembly and testing of mechanical systems which include PPS stopper hardware and PPS shielding. The safety and Radiation Physics Review process is also included.		
1	06	09	01		PPS Stoppers	This element covers specification, design, procurement, assembly and testing of the PPS stopper hardware.		
1	06	09	02		PPS Shielding	This element covers specification, design, procurement, assembly and testing of the PPS shielding.		
1	06	09	03		NEH Hutch Doors	This element covers specification, design, procurement, assembly and testing of 3 hutch doors for the NEH, one for each hutch. Doors are 44" wide, sliding doors with frames and lead lining.		
1	09				CONVENTIONAL FACILITIES	The Conventional Facilities for the Linac Coherent Light Source (LCLS) will include renovations to the existing SLAC facilities and the development of new facilities. Included will be all major systems and subsystems contained herein that will be required to support the facilities related to the LCLS programmatic requirements. The scope of the WBS will include 17 elements: Sector 20 Injector Facilities, Magnetic Measuring Facility, BTH West, Linac Upgrades, Research Yard Modifications, Beam Transport Hall, Front End Enclosure, Electron Beam Dump, Near Experimental Hall, Undulator Hall, X-Ray Transport & Diagnostics, Far Experimental Hall, BTH Service Building 2.1, 2.2, and 2.3, UH Service Building 3.1, FEH Service Building 8.1, Central Utility Plant, and SLAC Space Renovation for LCLS Ops		
1	09				CONVENTIONAL FACILITIES (Continued)	Activities within these elements include, site preparation and development (including establishment of survey monuments for site alignment), beam line housings including a beam dump, renovations to existing facilities, buildings, service buildings, utility systems (including cooling systems), fire protection systems, roads, sidewalks, landscaping, berms, fencing and parking areas.		
1	09	01			System Management & Integration	This element will provide the overall project management to implement and integrate the design, construction, commissioning, and close-out for all phases of the project related to conventional facilities.		
1	09	01	01		Management	This element will provide overall level of effort management support for conventional facilities to include development of reports and peer reviews, attendance of meetings, insure integration of other systems interfacing with conventional facilities, software acquisitions and travel as required, managing the WBS including cost, schedule and resources; coordinate Title I, Title II and Title III efforts with AE firms and in-house support staff engineers, designers and drafters; coordinate Title III with subcontractors (including architectural and engineering firms) and general contractors and construction managers, and managing the close-out of activities including commissioning and final acceptance by end users.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	01	02		CAM/CF Engineering	This element covers SLAC project management support during Title I, Title II and Title III activities throughout the WBS. The UTR will provide oversight for subcontractors (including architectural and engineering firms), labor service and in-house labor. During the construction phase (Title III), SLAC Engineering / UTR has the responsibility to monitor construction activities including safety program, tests for bolt torque, welding, concrete strength, pressure certification, fire systems and electrical testing for project compliance with technical specifications and regulatory compliance. ETC baseline redefined the Title as "Engineering / CAM" to include CF engineering support and AE engineering support for Beam-Path.		
1	09	01	03		Construction Management & AE Support	This element will provide a support role for various construction management activities in support of the WBS. CM will support all phases of activities to include pre-construction services, bidding, field supervision, commissioning, and close-out. Particular emphasis will be given to validation of WBS schedules and estimates, value engineering and general construction support activities including Safety plan, EP site sampling analysis/characterization and disposal plans, quality control and preparing bid packages to release for construction. ETC baseline redefined the scope for this element and transferred A&E Title 3 engineering support to WBS 1.09.01.02.		
1	09	01	04		Mechanical Design (MD)	This element will provide SLAC MD drafting support and drawing research for as-builts in support of the WBS for Title I and Title II activities.		
1	09	01	04	05	Mechanical Design Title 3 Linac Facility	This element will provide MD effort directly related to the Linac in support of Title III activities.		
1	09	01	04	06	Mechanical Design Title 3 (Linac not Included)	This element will provide MD effort (excluding Linac) in support of Title III activities.		
1	09	03			Construction-T3 Conventional Facilities	This element will provide the construction phase of activities to cover the receipt, inspection, assembly of the project conventional facilities, as well as any changes that are required during construction. Included will be support of: obtaining permits, safety plan, quality control, site preparations, buildings demolition, buildings construction, tunnels, shielding blocks, control rooms, preparation areas, laser rooms, experimental hutches (NEH), cooling systems, electrical systems, cable trays, ventilation systems, HVAC systems, drainage systems and utility systems. Installation of the interiors, commissioning, testing, punchlist, furnishing, final as-built drawings, operation and maintenance manuals, on-site safety and equipment training and other documentation of the facility are also prepared as part of Title III close-out activities. At the end of Title III the project is ready for activation and operation by the operations staff. [Note: cable tray within the Linac is not included].		
1	09	03	03		BTH West	The Beam Transport Hall West commences from the end of the Muon Shield (~159.246 m) to the beginning of the BTH.		
1	09	03	03	01	BTH West - Site Preparation	This element includes the demolition and removal of existing cables and cable trays, piping, electrical conduits and wiring to allow the modification and installation of new electrical and mechanical systems and beam components.		
1	09	03	03	15	BTH West Mechanical	This element will provide the mechanical materials and construction costs for: fire protection and Low Conductivity piping, ventilation and balancing/testing of water systems. Plumbing includes a compressed air header and isolation valve and drainage piping system.		
1	09	03	03	16	BTH West - Electrical	This element will provide the installation of the project primary electrical distribution systems to the main panel source of the area. The distribution of electric power will follow downstream and will include secondary electrical panels, transformers, disconnects, panel boards, electrical system grounding for 480V, 3 phase; 208/120V, 3 phase; and 120V single phase and cable trays. This element will include the installation and modification of general lighting, welding outlets, GFCI outlets and duplex outlets for 120V electric power.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	03	20	BTH West Project Close Out	This element will cover the receipt, inspection, commissioning, testing, punchlist, and furnishing of the project facilities and equipment, as well as any approved changes that are required during construction. Included in this final phase will be the receipt of operating and maintenance manuals, testing and on-site training for maintenance personnel, as-builts, and start-up of all equipment for validation of project (specification and drawing) compliance. At the end of the close out phase, the project will be ready for activation and operation by the operations staff.		
1	09	03	04		Linac Facility Upgrade (LN)	This element will provide upgrades to existing water-cooling and electrical systems from Sector 20 to Sector 30 of the SLAC Linac. Upgrades will include additional cooling water systems to support the RF gun and new Low Conductivity Water (LCW) requirements especially in sectors 24 and 25. Modifications will include upgrade to the existing electrical distribution system and switchgears. This element includes modifications to the LCW temperature control system and Sector 24 Stairwells installation.		
1	09	03	04	16	LN - Electrical	This element will provide the installation of the project primary electrical distribution 480 volts, 3 phase systems and a new Motor Control Center (MCC). The distribution of electric power will follow downstream and will include secondary electrical panels, transformers, disconnects, panel boards, electrical system grounding for 480V, 3 phase; 208/120V, 3 phase; and 120V single phase. All power will be delivered to the vicinity of the technical system components to within 5 feet. This element will include the installation of general lighting, utility duplex outlets for 120V electric power.		
1	09	03	04	20	LN - Project Close Out	This element will cover the receipt, inspection, assembly, commissioning, testing, punchlist, and furnishing of the project facilities and hardware, as well as any approved changes that are required during construction or assembly. Included in this final phase will be the receipt of operating and maintenance manuals, testing and on-site training for maintenance personnel, as-builts, and start-up of all equipment for validation of project (specification and drawing) compliance. At the end of the close out phase, the project will be ready for activation and operation by the operations staff.		
1	09	03	05		Research Yard/B102,B211,B113 & Storage Trailers	This element will provide the various activities required by SLAC and a general contractor (GC) within the existing SLAC Research Yard. Some of the buildings that may be affected as a result of the LCLS project are building #064 Final Focus Test Beam, building #113 (hi-bay portion only) building #102, various storage containers and trailer #204. This element will also provide FFTB Removal and Preservation of Technical Equipment.		
1	09	03	05	01	RY - Site Preparation	This element will provide the site preparation and general requirements costs for: summarization of the project, work restriction, price and payment procedure, project management and coordination, construction progress and photographic documentations, submittal procedures, references, temporary facility and controls, environmental protection, product requirements, cutting and patching, selective demolition, and HVAC commissioning requirements. The site preparation includes: locate and remove existing utilities, temporary fencing, construction permits, and training.		
1	09	03	05	02	RY - FFTB/BSY & Site Construction	This element will provide the site construction materials and construction costs for: building demolition, site clearing, tree protection and trimming, dewatering, excavation support and protection, earthwork, erosion control, sanitary sewerage, sub drainage system, storm drainage, hot mix asphalt paving, portland concrete pavement, and pavement joint sealants. This element also includes the FFTB/BSY Vertical Wall, and FFTB Removal and Preservation.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	05	20	RY - Project Close Out	This element will cover the receipt, inspection, assembly, commissioning, testing, punchlist, and furnishing of the project facilities and hardware, as well as any approved changes that are required during construction or assembly. Included in this final phase will be the receipt of operating and maintenance manuals, testing and on-site training for maintenance personnel, as-builts, and start-up of all equipment for validation of project (specification and drawing) compliance. At the end of the close out phase, the project will be ready for activation and operation by the operations staff.		
1	09	03	06		Pre-Purchase Equipment for Beam Path	The element will provide the mechanical and electrical equipments for Beam Path construction and installation.		
1	09	03	06	01	PPE - General Requirements	This element will provide costs for Pre-Construction /Bid/Award , submittal release approvals, manufacture releases, equipment deliveries, and final turnover.		
1	09	03	06	11	Pre-Purchase Equipment for PPE	This element will provide the cost for mechanical and electrical equipments.		
1	09	03	07		SITEWORK, Earthwork, Site Utilities, & Survey	This element will provide construction and installation of underground utilities. This includes electrical, water, sewer and storm drain. Construction of major surface excavations. Installation of survey control and layout of items during construction and installation.		
1	09	03	07	01	SW - General Requirements	This element will cover CCIP insurance, bond, and mobilization to site for Earthwork, Site Utilities, SWPPP installation and maintenance, and Site Survey contractors		
1	09	03	07	02	SW - Earthwork, Site Utilities & Survey	This element will provide the costs for: construction and installation of underground utilities. This includes electrical, water, sewer and storm drain. Construction of major surface excavations, hot mix asphalt paving, portland concrete pavements, pavement joint sealants, and shotcrete. Installation of survey control and layout of items during construction and installation.		
1	09	03	07	16	SW - Electrical	This element will provide costs for construction and installation of the Power & Tel-Data underground, temporary power, feeder wire, under slab, and site lighting.		
1	09	03	08		Beam Transport Hall (BTH)	The new Beam Transport Hall commences from the end of the Linac to the beginning of the Undulator Hall and replaces the existing Final Focus Test Beam enclosure. The existing Linac finish floor is approximately one foot lower than the required elevation of the new facility which will be at 247.25'. The BTH will have roughly the same general footprint of the FFTB extending from the BSY wall in the direction of the beam at 227 meters (length) x 4.5 meters (width) x 3 meters (height). This element also includes the installation cost for a new BTH Switchboard which will provide power to the entire BTH area including the service buildings.		
1	09	03	08	01	BTH - Site Preparation/General Requirements	This element will cover CCIP insurance, bond, and mobilization to site.		
1	09	03	08	03	BTH - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete.		
1	09	03	08	05	BTH - Metals	This element will provide the Metals materials and construction costs for: structural steel, steel joists, steel deck, cold-formed metal framing, metal fabrications, metal stairs, gratings, railings, and architectural joint systems.		
1	09	03	08	15	BTH - Mechanical	This element will provide the Mechanical materials and construction costs for: air handlers, fans, ductwork, chilled and hot water piping, balancing/testing and temperature controls. Plumbing includes a compressed air header, a pumped waste system.		
1	09	03	08	16	BTH - Electrical	This element provide the Electrical materials and construction costs for: basic power distribution from bldg 406/407 to an MCC in each Service building. The communication cable tray runs the length of the tunnel to each service building from a SLAC provided backbone conductor. This element also includes the installation costs for anew 1600 amp, 480 volts, 3 phase, BTH Switchboard which will provide power to the BTH area.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	08	17	BTH - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	08	17	BTH - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	09		Front End Enclosure (FEE)	The Front End Enclosure (FEE) shall contain various diagnostic beam line components to separate the electron and x-ray-beams. The electron beam shall curve downward into the Beam Dump and the x-ray beam shall continue into the Near Experimental Hall and other facility components further downstream. A fire sprinkler system shall also be provided throughout the FEE. The floor elevation shall be maintained at 247.25' and will remain constant throughout the entire LCLS facilities.		
1	09	03	09	03	FEE - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete.		
1	09	03	09	05	FEE - Metals	This element will provide the Metals materials and construction costs for: structural steel, cold-formed metal framing, metal fabrications, and gratings.		
1	09	03	09	15	FEE - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	09	15	FEE - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	09	16	FEE - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	09	17	FEE - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	09	17	FEE - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	10		Electron Beam Dump (EBD)	This facility is a 132' long underground concrete cast in-place facility used to separate the electron and x-ray beams.		
1	09	03	10	01	EBD - Site Preparation/General Requirements	This element will provide the site preparation including steel modification, steel blocks storing, fabrication and installation of EBD Steel Shielding.		
1	09	03	10	03	EBD - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete.		
1	09	03	10	05	EBD - Metals	This element will provide the Metals materials and construction costs for: structural steel, cold-formed metal framing, metal fabrications, and gratings.		
1	09	03	10	15	EBD - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	10	15	EBD - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	10	16	EBD - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	10	17	EBD - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	10	17	EBD - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	11		Near Experimental Hall (NEH)	The Near Experimental Hall (NEH) is a two-story structure (below grade) that will begin downstream of the FEE and will extend approximately 33 meters in the direction of the beam. The primary function of the NEH is to house three experimental hutches. Each hutch shall have its independent PPS entry (provided by others). Adjacent to the hutches shall be floor space to accommodate Prep and Control areas. Provisions shall be made for restroom facilities and 5-ton freight elevator. The second floor shall house a Laser Bay The NEH shall be provided with heating, cooling, ventilation and smoke purge systems. Provisions shall be made for the hutches to have process exhaust fans. A fire sprinkler system shall also be provided throughout the NEH. The floor elevation shall be maintained at 247.25' and remain constant throughout the entire LCLS facilities.		
1	09	03	11	01	NEH - Site Preparation/General Requirements	This element will provide CCIP insurance, bond, and mobilization to site.		
1	09	03	11	02	NEH - Site Construction	This element will provide the installation costs for Fire Protection (Hazard Analysis).		
1	09	03	11	03	NEH - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete.		
1	09	03	11	05	NEH - Metals	This element will provide the Metals materials and construction costs for: structural steel, cold-formed metal framing, metal fabrications, and gratings.		
1	09	03	11	15	NEH - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	11	15	NEH - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	11	16	NEH - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	11	17	NEH - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	11	17	NEH - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	11	20	NEH - Project Close Out	This element will cover the cost for NEH finishing.		
1	09	03	12		Undulator Hall (UH)	The Undulator Hall (UH) shall be a tunnel commencing from the downstream end of the Beam Transport Hall thermal barrier. It shall extend 170 meters in the direction of the beam to the downstream end of the UH where it shall be enclosed by another physical thermal barrier separating the UH from the Beam Dump/Frond End Enclosure. The UH will contain 33 undulator magnets and associated equipment as it continues the electron beam to the Front End Enclosure and Beam Dump. The interior dimensions are 4.5 meters (width) by approximately 4.0 meters (height). Access into the UH will be through an entry provided from the Beam Transport Hall. The UH shall be provided with heating, cooling, and ventilation system. The floor elevation shall be maintained at 247.25' and will remain constant throughout the entire LCLS facilities.		
1	09	03	12	01	UH - Site Preparation/General Requirements	This element will provide Affholder (Tunneling Contractor) CCIP insurance, bond, and mobilization to site.		
1	09	03	12	15	UH - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	12	15	UH - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	12	16	UH - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	12	17	UH - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	12	17	UH - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	12	19	UH - Tunnel Construction	This element will provide the Access Tunnel materials and construction costs for tunneling.,		
1	09	03	13		X-Ray - Transport & Diagnostic Hall (XRTD)	The XRTD tunnel shall extend 250 meters downstream of the NEH and shall extend to the FEH. The tunnel width configuration shall accommodate the main beam (0 degree) and the splitting of the referenced beam with +/- ¾ degree beams. A 4' wide aisle shall be maintained throughout the tunnel. The XRTD tunnel shall be provided with ventilation and smoke purge systems. A fire sprinkler system shall be provided throughout the XRTD. The floor elevation shall be maintained at 247.25' and will remain constant throughout the entire LCLS facilities.		
1	09	03	13	15	XRTD - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	13	15	XRTD - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	13	16	XRTD - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	13	17	XRTD - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	13	17	XRTD - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	13	19	XRTD - Tunnel Construction	This element will provide the Access Tunnel materials and construction costs for Access Tunnel.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	14		Far Experimental Hall (FEH)	The Far Experimental Hall (FEH) shall be located 250 meters downstream of the NEH. It shall be located approximately 30 meters below grade and shall be constructed using conventional tunneling applications. The primary function of the FEH is to house experimental hutches. Each hutch shall have its independent PPS entry. Adjacent to the hutches shall be floor space to accommodate Prep and Control areas. The FEH shall be provided with heating, cooling, ventilation and smoke purge systems. Provisions shall be made for the hutches to have process exhaust fans. A fire sprinkler system shall be provided throughout the FEH. The floor elevation shall be maintained at 247.25' and will remain constant throughout the entire LCLS facilities.		
1	09	03	14	02	FEH - Site Construction	This element will provide the construction / materials / equipment costs for: 2 hutches in the FEH.		
1	09	03	14	15	FEH - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic,		
1	09	03	14	15	FEH - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	14	16	FEH - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	14	17	FEH - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	14	17	FEH - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	14	18	FEH - Access Tunnel	This element will provide the Access Tunnel materials and construction costs for Access Tunnel.		
1	09	03	14	19	FEH - Tunnel Construction	This element will provide the Access Tunnel materials and construction costs for tunneling.		
1	09	03	15		BTH Service Buildings 2.1, 2.2, and 2.3 (SB BTH)	Service Buildings 2.1, 2.2, and 2.3 are included as a pre-engineered buildings and are part of the Beam Transport Hall. The building components include the slab, metal frame, exterior cladding, HVAC and electrical.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	15	05	SB BTH - Metals	This element will provide the Metals materials and construction costs for: structural steel, steel joists, steel deck, cold-formed metal framing, metal fabrications, metal stairs, gratings, ornamental metal, ornamental railings, and architectural joint systems.		
1	09	03	15	15	SB BTH - Mechanical	This element will provide the Mechanical materials and construction costs for: air handlers, fans, ductwork, chilled and hot water piping, balancing/testing and temperature controls. Plumbing includes a compressed air header, a pumped waste system.		
1	09	03	15	16	SB BTH - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	15	17	SB BTH - Others (include Div 4, and 6 through 14	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	15	17	SB BTH - Others (include Div 4, and 6 through 14 (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	16		UH Service Building 3.1 (SB UH)	Service Buildings 3.1 included as a pre-engineered building and is part of the Undulator Hall. The building components include the slab, metal frame, exterior cladding, HVAC and Electrical.		
1	09	03	16	03	SB UH - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete and shotcrete initial and final linings.		
1	09	03	16	15	SB UH - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	16	15	SB UH - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	16	16	SB UH - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	16	17	SB UH - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	16	17	SB UH - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	17		FEH Service Building 8.1 (FEH SB)	Service Building 8.1 is included as a pre-engineered building and is part of the Far Experimental Hall. The building components include the slab, metal frame, exterior cladding, HVAC and electrical.		
1	09	03	17	03	SB FEH - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete and shotcrete initial and final linings.		
1	09	03	17	16	SB FEH - Electrical	This element provide the Electrical materials and construction costs for: basic electrical materials and methods, overcurrent protective device coordination, grounding and bonding, electrical supports and seismic restraints, electrical identification, conductors and cables, medium-voltage cables, raceways and boxes, cable trays, wiring devices, lighting control devices, variable frequency controllers, circuit breakers, enclosed controllers, switchboards, panel boards, motor control centers, dry-type transformers (600v and less), power distribution units, interior lighting, and exterior lighting.		
1	09	03	17	17	SB FEH - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	18		Central Utility Plant (CUP)	The Central Utility Plant Support (CUP) includes a single level steel structure with metal panel cladding and metal standing seam roof assembly. Interiors include light gauge metal studs and painted drywall.		
1	09	03	18	01	CUP - Site Preparation/General Requirements	This element will provide CCIP insurance, bond, and mobilization to site.		
1	09	03	18	02	CUP - Site Construction	This element will provide the cost for construction of gas line.		
1	09	03	18	03	CUP - Concrete	This element will provide the Concrete materials and installation costs for: castinplace concrete and shotcrete initial and final linings.		
1	09	03	18	05	CUP - Metals	This element will provide the Metals materials and construction costs for: structural steel, steel joists, steel deck, cold-formed metal framing, metal fabrications, metal stairs, gratings, ornamental metal, ornamental railings, and architectural joint systems.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
1	09	03	18	15	CUP - Mechanical	This element will provide the Mechanical materials and construction costs for: basic mechanical materials and methods, motors, hangers and supports, mechanical vibration and seismic controls, mechanical identification, mechanical insulation, valves, pipe expansion fittings, meters and gages, chilled water and heating water piping, piping specialties, drainage piping specialties, hydronic piping, general-sevice compressed-air piping, sump pumps, heat exchangers, breechings, and hydronic.		
1	09	03	18	15	CUP - Mechanical (continued)	air-handling units, metal ducts, duct accessories, centrifugal fans, power ventilators, air terminal units, diffusers, registers, and grilles, ventilators, air filters, HVAC instrumentation and controls, sequence of operation, testing, adjusting, and balancing.		
1	09	03	18	16	CUP - Electrical	This element provide the Electrical materials and construction costs for: 12kv construction (MH48 to CUP Substation), and underground electrical duct banks.		
1	09	03	18	17	CUP - Others (include Div 4, and 6 through 14)	This element provides the materials and construction costs for CSI divisions 4, 7, 8, 9 and 13. Div 4 - Masonry which covers unit masonry assemblies, Div 7 - Thermal and Moisture Protection which cover self-adhering, elastomeric , and thermoplastic sheet proofing, Bentonite waterproofing, traffic coatings, water repellents, building insulation, metal wall panels, thermoplastic membrane roofing, sheet metal roofing, sheet metal flashing and trim, roof expansion assemblies, roof accessories, horizontal lifeline fall protection system, sprayed fire-resistive materials, through-penetration fire stop systems, fire-resistive joint systems, and joint sealants. Div 8 - Doors and Windows which covers standard steel doors & frames, flush wood doors, access doors, overhead coiling doors, and door hardware.		
1	09	03	18	17	CUP - Others (include Div 4, and 6 through 14) (continued)	Div 9 - Finishes which covers gypsum board assemblies, gypsum board shaft-wall assemblies, resilient floor covering, acoustical wall panel, exterior and interior painting, concrete floor stain, and high-performance coatings. Div 13 - Special Construction which covers radiation, metal building systems, security access, lighting controls, fire alarm, fire-suppression piping, electric-drive, centrifugal fire pumps, and clean-agent extinguishing systems.		
1	09	03	19		SLAC Space Renovation for LCLS Ops	This element will provide for LCLS Office and Lab Space Functionality which includes B028 space improvements and CEH building remodel		
1	09	03	19	01	ED&I of SLAC Space Renovations for LCLS Ops	This element will provide the space improvements of existing SLAC Office Space at Building 028 for LCLS use. This element covers the cost of: material, labor, and installation for architectural, civil improvement to the space. Improvement to mechanical, plumbing, HVAC, controls, electrical and lighting, fire protection, furniture, and voice/data networks.		
1	09	03	19	02	Construction of SLAC Space Renovation for LCLS	This element will provide the renovation of existing SLAC Office Space at CEH Building for LCLS use. This element covers the cost of: material, labor, and installation for floors to include space conversion to offices, support function areas (no remodeling of existing shop areas), interior improvements, restrooms/shower upgraded for ADA compliance, new elevator, stair and exterior walkway.		
1	09	03	20		Construction Credits and Debits	Provide credits and debits related to trades associated with the general construction of the Research Yard thru Far Experimentla Hall activities.		
1	09	03	20	01	SC Work in Deleting CLOC	Credit for the overlap of the trades cost associated with the removal of the CLOC from the CF WBS scope of work. Trades include but are not limited to electrical, earthwork, site utilities, concrete, drywall, finishes, metal siding and waterproofing.		
1	09	03	20	02	Bulletin #2 Changes & Other Credits	Credit for the Bulletin #2 changes made to the construction drawings and specifications. Trades include but are not limited to concrete, mechanical, plumbing, electrical, site utilities, metals, painting, and roofing.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
2					LCLS PROJECT - R&D, SPARES, COMMISSIONING	This summary WBS covers the Other Project Cost (OPC) Estimate for the LCLS Project being constructed at SLAC. The LCLS OPC is supported through Research & Development (R&D), Spares and Commissioning funds by the U.S. Department of Energy.		
2	01				LCLS PROJECT MGMT, PLANNING & ADMN (OPC)	This summary WBS covers the Other Project Cost (OPC) Estimate for the LCLS Project being constructed at SLAC. The LCLS OPC is supported through Research & Development (R&D), Spares and Commissioning funds by the U.S. Department of Energy.		
2	01	01			LCLS Commissioning Mgmt & Physics Support	This summary WBS provides for physics support through the LCLS R&D and commissioning phases of the project.		
2	01	01	05		X-Ray Transport Physics	This WBS provides support for the LCLS X-Ray Transport System Physicist through the R&D and commissioning phases of the LCLS X-Ray Transport System. The X-Ray Transport System Physicist is responsible for directing the overall physics effort for the LCLS X-Ray Transport system and for providing system requirements that satisfy the global requirements of the LCLS project.		
2	01	01	06		X-Ray Physics Commissioning	This WBS provides support for the LCLS X-Ray Endstations System Physicist through the R&D and commissioning phases of the LCLS X-Ray Endstations System. The X-Ray Endstations System Physicist is responsible for directing the overall physics effort for the LCLS X-Ray Endstations system and for providing system requirements that satisfy the global requirements of the LCLS project.		
2	01	01	11		Global Controls OPC	This is all non-recurring development for the first instance of each subsystem solution.		
2	01	01	11	14	Controls - Networking and Data Comm. OPC	High Level Software application development for the LCLS project.		
2	01	01	11	15	Controls S/W Applications LOE	Network and Data Communications for the LCLS project.		
2	01	01	12		E-Beam Systems Commissioning Management	Management support for the commissioning of electron beams systems. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	01	01	13		E-Beam Systems Physics Support	Physicist support for the commissioning of electron beams systems. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	01	01	14		Laser Commissioning Management	Management support for the commissioning of laser systems. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	01	03			Project Mgmnt, Planning and Admn - M&S (OPC)	This summary WBS covers the Other Project Cost for the LCLS Project Office at SLAC.		
2	01	03	01		SLAC Project Office - General	This WBS covers a portion of the Project Office staff to manage and direct R&D, Spares and Pre-Operations activities.		
2	01	03	02		SLAC Project Support	This WBS covers a portion of the Project Support staff to manage and direct R&D, Spares and Pre-Operations activities.		
2	01	03	03		Project Mgmnt, Planning and Admn - M&S (OPC)	This WBS covers the pre-operations activities for the LCLS, which include electrical power usage, start-up costs and Linac legacy costs during the commissioning phase of the LCLS.		
2	02				Injector System (OPC)	Other Project Costs (OPC) Summary for the Injector System. It includes effort and costs associated with R&D, Spares, and Commissioning.		
2	02	02			Injector Controls Subsystem	System Summary		
2	02	02	04		Power Conv (beamline pwr supp) Spares	This element covers spares costs for this system.		
2	02	03			Injector Lasers	System Summary		
2	02	03	02		Drive Laser System	This element covers special processing spares required for this section.		
2	02	03	14		LSR HTR - Beam Conditioning Optics (Laser Bay)	This element covers special processing spares required for this section.		
2	02	04			Injector RF Subsystem	System Summary		
2	02	04	01		RF Gun & Load Lock	This element covers special processing spares required for this section.		
2	02	04	01	01	RF Gun	This element covers special processing spares required for this section.		
2	02	04	02	02	CP Load Lock	This element covers special processing spares required for this section.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
2	02	08			Injector System Emittance Enhancement	This is a system designed to add uncorrelated energy to the LCLS beam in the injector, at 150 MeV, by crossing an IR laser beam with the electron beam in an undulator. The system starts just past a dichroic beam splitter that is downstream from the drive laser doubling crystals. The IR beam that is not absorbed by the doubling crystals passes through an optics system on the drive laser table, down to the linac tunnel, into the electron beamline, along the electron beam in a chicane, and out into a diagnostic system at the end.		
2	02	08	01		Heater Integration	System Design and Optimization consists of developing the physical models for the laser beam / electron beam interaction. This category also includes an overall system design review and reviews by safety committees at SLAC. Definition of the overall parameters, (e.g. undulator length and period, laser beam power and wavelength, beam size and shape) needed to obtain the desired energy modulation. The desired energy modulation is determined from beam dynamics models for the FEL as a whole. Refinement of the parameters, and integration of the laser heater into the rest of the injector. A design review of the laser heater subsystem of the injector; with some participation outside of SLAC. This review is in addition to a separate review for the undulator proper. Safety reviews for electrical, earthquake, laser optics, radiation, and mechanical hazards. These reviews will be done by internal SLAC committees.		
2	02	08	02		Heater Laser & Optics	This system includes the optics downstream from the dichroic beam separator to the first mirror in the optics transport system down to the linac tunnel. These optics will be on the drive laser table. The subsystems include a grating pair pulse compressor, a collimating telescope, a path length adjustor, and a shutter. Establishment of the optical principles required to prepare the IR beam from the drive laser and deliver it to the transport system. Establishment of all the optical parameters and requirements, and performance of modeling calculations (Zemax).		
2	02	08	03		Heater Magnets	This section accounts for the specific tasks associated with the field commissioning of the specific Injector section.		
2	02	08	03	01	Heater Dipoles	This section accounts for the specific tasks associated with the field commissioning of the specific Injector section.		
2	02	08	03	02	Heater Undulator	This section accounts for the specific tasks associated with the field commissioning of the specific Injector section.		
2	02	08	04		Heater Vacuum	This section accounts for the specific tasks associated with the field commissioning of the specific Injector section.		
2	02	08	05		Heater Diagnostics	Overall engineering design of the system that includes a power meter, a profile camera, and a timing diode, with appropriate optics on a small table downstream from the IR beam - e-beam interaction region. The system will include: Spiricon camera for beam profile monitoring. Coherent power meter for beam power monitoring. Timing diode for local timing measurements. Optics, table and enclosure at end of beamline, including shielding from e-beam radiation. Identification of commercial optics to be used for diagnostics and placement of purchase orders for them. Also, expediting, receipt, and checking of items on receipt.		
2	02	08	05		Heater Diagnostics (continued)	An imaging system that will provide transverse beam profiles to be transmitted to MCC. A joule meter capable of transmitting power information to MCC. A fast photodiode and an oscilloscope (10 GHz) to monitor temporal characteristics of the IR laser pulse. The oscilloscope will have to be placed near the diode in use, and removed during accelerator operations. A support table for the diagnostics breadboard. Spare equipment for any diagnostics optics which, if it failed, would prevent the operation of the laser heater. No items identified at present. Installation of the photon diagnostics, and testing of the optics with live beam from the beam conditioning, and transport systems.		
2	02	08	06		Heater Install & Align	This element covers the effort associated installing, aligning and commissioning with the specific Injector functional area.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
2	02	17			Injector System Commissioning	System Summary		
2	02	17	02		Drive Laser Commissioning	This element covers the effort associated commissioning with the specific Injector functional area.		
2	02	17	11		Injector Engr, Design, Maintenance Support	Maintenance support during the commissioning of Injector system. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	03				LINAC SYSTEM (OPC)	OPC Summary for the Linac System. It includes effort and costs associated with R&D, Spares, and Commissioning.		
2	03	02			Linac Controls & Power Conversion Subsystem	System Summary		
2	03	02	04		Power Conversion	This element covers special processing spares required for this section.		
2	03	02	04	01	Spare Power Supply (Dipole Type)	This element covers special processing spares required for this section.		
2	03	02	04	02	Spare Power Supply (Quad Type)	This element covers special processing spares required for this section.		
2	03	02	04	03	Spare Power Supply (Trim Type)	This element covers special processing spares required for this section.		
2	03	04			Linac Vacuum Subsystem	System Summary		
2	03	04	01		Linac Vacuum Subsystem Operations Equip	This element covers special processing spares required for this section.		
2	03	06			Linac RF Subsystem	System Summary		
2	03	06	05		X-Band High Power System	This element covers special processing spares required for this section.		
2	03	07			Linac System Commissioning	System Summary		
2	03	07	10		L2/BC2/L3 Commissioning	Maintenance support during the commissioning of Linac systems. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	04				UNDULATOR SYSTEM (OPC)	The LCLS Undulator System OPC area for spares plus any R&D and commissioning for all elements including undulator magnets and supports, undulator diagnostics, vacuum systems, and controls for the undulator equipment are included herein. Total cost for the LCLS undulator system Other Project Costs (OPC) including R&D, spares, and commissioning.		
2	04	01			Undulator System Management & Integration	All LCLS Undulator Systems project management and commissioning oversight for Other Project Costs (OPC) items is covered by this element. Total cost of all project management and commissioning oversight tasks required to perform R&D, commissioning or oversight of the acquisition of spares is included in this element.		
2	04	01	01		Undulator System Mgmt & Integration	All LCLS Undulator Systems project management and commissioning oversight for Other Project Costs (OPC) items is covered by this element. Total cost of all project management and commissioning oversight tasks required to perform R&D, commissioning or oversight of the acquisition of spares is included in this element. SLAC indirect cost that cover doing business with ANL are also included here.		
2	04	02			Controls	All controls related spares and OPC. Any spares purchased for controls are tracked underneath this element.		
2	04	02	01		Controls Management and Integration	Management and integration tasks associated with spares and OPC. Any management effort associated with control spares and OPC will be tracked within this element.		
2	04	03			Undulator Magnet & Support	Other Project Costs [OPC] are collected in this WBS area. This WBS area includes some management, integration, as well as the construction and assembly of spare undulators.		
2	04	03	01		Und Magnet & Support-Mgmt & Integration	Integration of the undulator design, construction, installation, and commissioning efforts.		
2	04	03	03		1st Article Undulators & Long Lead Procurements	Procurement of the long lead items, Titanium Strongbacks, Magnet Blocks, and Magnet Poles is in this area. The first articles from each vendor of the production undulators are also contained herein.		
2	04	03	04		Production Undulator	This area contains elements related to construction of the Production Undulators.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
2	04	03	05		Focusing Magnets	This area contains elements related to construction of the 4 spare Quadrupole Magnets.		
2	04	03	06		Undulator Magnetic Measurement Facility (SLAC)	This element covers the OPC for the setup of the MMF at SLAC, the magnetic measurements, fiducialization and assembly of the undulator system components, and the design and construction of the position monitoring systems		
2	04	03	08		Fixed Supports	This area contains elements related to construction of the Fixed Supports.		
2	04	04			Vacuum System	Total Center for the OPC Spares of the Undulator Vacuum System. This center includes all vacuum components from the upstream treaty valve to the downstream treaty valve.		
2	04	04	02		Undulator Vacuum Chamber Assembly	Total Center for the spare Undulator Vacuum Chamber and supports for the Undulator System. This element covers the labor and materials for (7) spare chambers and (4) spare supports. This includes effort for procurement and receiving of the unit.		
2	04	04	03		Beam-line Bellows Module Assembly	This element covers the labor and materials for (7) spares. This includes effort for procurement and receiving of the unit. The (7) spare Bellows Modules will be used in the Short and Long Diagnostics Breaks along with the Entrance and Exit Sections.		
2	04	04	04		Single Undulator Test(SUV) Vacuum	Total cost of Vacuum Components to be used in the Single Undulator Test including: design, procurement, and quality assurance. This element includes material and labor charges. These are the temporary units that be used until actual units are available.		
2	04	04	05		Short Diagnostic Break (SDB) Assembly	The SDB Assembly is composed of diagnostic devices and vacuum components that reside in the area of the short breaks between the undulators. SDB Assembly and related equipment includes the effort required for procuring the technical equipment including issuing of purchase requests and billing.		
2	04	04	06		Long Diagnostic Break (LDB) Assembly	The LDB Assembly is composed of diagnostic devices and vacuum components that reside in the area of the long breaks between the undulators. LDB Assembly and related equipment includes the effort required for procuring the technical equipment including issuing of purchase requests and billing.		
2	04	05			Undulator System Diagnostics [OPC]	Total Center for the OPC Spares of the Undulator System		
2	04	05	05		RFBPM	The RFBPM will be used to precisely measure the position of the electron beam in all the breaks between the undulators. Total Center for RFBPM Spares for the Undulator System. This element covers the labor and materials for (4) spares of the production devices. This includes effort for procurement and receiving of the units.		
2	04	05	06		Beam Finder Wire	The Beam Finder Wire will be used to precisely measure the position of the electron beam in all the breaks between the undulators. Total Center for Beam Finder Wire Spares for the Undulator System. This element covers the labor and materials for (4) spares of the production devices. This includes effort for procurement and receiving of the units.		
2	04	05	08		Beam Loss Monitoring	This element covers to the spares costs for the beam loss monitor system installed in the undulator system and used to protect it from significant radiation doses.		
2	04	05	10		SIngle Undulator Test (SUT)-Diagnostics	Support single undulator testing.		
2	04	06			LTU/Undulator/Dump Commissioning	Maintenance support during the commissioning of Undulator systems. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	04	06	01		LTU/Undulator/Dump Commissioning	Maintenance support during the commissioning of Undulator systems. Commissioning begins after installation and ends when commissioning goals are met and the system is operational.		
2	05				X-RAY TRANSPORT & DIAGNOSTICS SYSTEMS (OPC)	OPC Summary for the X-Ray Transport, Optics and Diagnostics System. It includes effort and costs associated with Spares, and Modeling and Simulation.		
2	05	01			System Management & Integration	This summary element covers the management and integration for the X-Ray Transport system.		
2	05	01	01		Management	This WBS element covers the management of R&D issues associated with component design and layout at the conceptual level.		

WBS NUMBER					TITLE	DESCRIPTION		
L1	L2	L3	L4	L5				
2	05	04			Optical Subsystem	This summary element covers spares for the optics subsystem of the X-Ray Transport system.		
2	05	04	01		Optical Subsystem R&D	This WBS element covers R&D into FEL induced damage of the optical and Diagnostics systems.		
2	05	05			Diagnostics Subsystem	This summary element covers spares, and modeling and simulation of the Diagnostics subsystem of the X-Ray Transport system.		
2	05	05	02		Modeling & Simulation	This WBS element covers R&D aimed at the development of practical simulations of the LCLS beam for use in developing Diagnostics and optics.		
2	05	05	03		Spares for Diagnostics Subsystem	This WBS element covers R&D aimed at the development of practical simulations of the LCLS beam for use in developing Diagnostics and optics. It also has spare parts for diagnostic equipment likely to be damaged by the FEL.		
2	06				X-RAY END STATION SYSTEMS (OPC)	The X-Ray Endstations System (OPC) section of the WBS includes labor and material costs associated with Management, R&D tasks, Spares and Commissioning of the Photon Beam Systems.		
2	06	01			XE System Mgmt & Integration	This element provides management support and travel for the Photon Beam Systems. It also includes the effort associated with integrating, testing and commissioning of all the subsystems of the Photon Beam Systems.		
2	06	02			Controls Subsystem	This element covers the controls R&D.		
2	06	02	04		LBNL Laser Timing	This element covers the controls R&D effort by LBNL for the LCLS laser timing system.		
2	06	02	08		2-D X-Ray Detector Controls	This element covers the controls effort in particular integration with data read out and display needed for the 2D x-ray detector.		
2	06	03			Commissioning	Commissioning of FEE diagnostics systems in support of undulator commissioning. Flux measurement in the FEE. Transport and characterization of photon beam into NEH, XRT, and FEH. This includes commissioning of AMO experiment. Commissioning ends when photons are detected in the Far Experimental Hall.		
2	06	03	01		Commissioning - Beamline	This includes all commissioning activities of the beamlines including its vacuum systems and associated components. Beamlines provide the LCLS beam and the vacuum to the experimental stations and extend from the Front End Enclosure to the Near Hall, the x-ray tunnel to the Far Hall.		
2	06	03	02		Commissioning - XES Laser	Commissioning of the XES Laser system includes providing laser light to the AMO experimental stations in the Near Hall and includes the laser transport and diagnostic system into the AMO hutch.		
2	06	03	03		Commissioning - AMO Experiment	Commissioning of the AMO experimental station includes demonstrating functionality of the subcomponents (high field chamber with detectors, focusing system and diagnostic chamber) and demonstrating to acquire spectra from real samples with the LCLS beam.		
2	06	03	05		Commissioning - 2D X-Ray Detector	Commissioning the X-ray Detector (Cornell) includes demonstrating functionality of the detector by illuminating its diode surface with scattered x-rays and recording and storing a scattering pattern and verifying the detectors design parameters.		
2	06	04			Spares	This element includes procurement and assembly of spare parts for the X-Ray Endstation Systems.	Open	
2	06	04	01		Spares - PPS Stoppers	This element includes procurement and assembly of spare PPS stoppers.	Open	
2	06	05			X-Ray Detectors	This element includes the R&D activites associated with delivering a novel 2D x-ray detector. All the effort in this WBs section is managed via a contract with Cornell University.	Open	
2	06	05	01		reserved			
2	06	05	02		2-D X-Ray Detector	This element includes labor and materials for the 2D x-ray detector contract with Cornell. It also covers the biannual external detector reviews by the LCLS detector advisory committee (LDAC).	Open	
2	06	05	03		deleted			
2	06	05	04		deleted			
2	09	03			Beam Path Project Commissioning	This element covers the commissioning plan, Dispute Resolution, and OPC Labor Support to Beam Path	Open	

WBS NUMBER					TITLE	DESCRIPTION	
L1	L2	L3	L4	L5			
2	09	03	05		Beam Path Project Commissioning	This element covers the commissioning plan, Dispute Resolution, and OPC Labor Support to Beam Path	Open