

WBS NUMBER					TITLE	DESCRIPTION
1	2	3	4	5		
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, experimental chambers, synchronized laser systems, and prototype detectors that will be used by most of the foreseeable LCLS experiments. It also includes additional sample handling equipment needed for the first studies of FEL-atom interactions (Atomic Physics experiments).
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	01	02		SSRL Physics Support	Receive advice and physics support from SSRL Physicists for X-Ray Endstation systems.
1	06	02			Controls Subsystem	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		Cabling	Design, procure, and test the cabling required for the control systems.
1	06	02	01	01	Front End Enclosure Cable	Design, procure, and test the cabling for the Front End Enclosure cabling.
1	06	02	01	02	Near Hall Cable	Design, procure, and test the cabling for the Near Hall cabling.
1	06	02	01	03	Tunnel Cable	Design, procure, and test the cabling for the Tunnel cabling.
1	06	02	01	04	Far Hall Cable	Design, procure, and test the cabling for the Far Hall cabling.
1	06	02	02		Network	Design, procure, and test the hardware and software required for computer network support for LCLS experiments.
1	06	02	03		PC Support	Design, procure, and test the hardware and software needed for experimental station computer systems and associated computer systems used by experimenters at LCLS.
1	06	02	04		Beamline Controls	Design, procure, and test the hardware and software needed to control equipment installed at the experimental stations, including precision motion equipment, sample manipulation and monitoring equipment, and detectors.
1	06	02	05		X-Ray PPS	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	05	01	FEE X-Ray PPS	Design, procure, and test the X-Ray PPS for the Front End Enclosure.
1	06	02	05	02	Near Hall X-Ray PPS	Design, procure, and test the X-Ray PPS for the Near Hall.
1	06	02	05	03	Tunnel X-Ray PPS	Design, procure, and test the X-Ray PPS for the Tunnel.
1	06	02	05	04	Far Hall X-Ray PPS	Design, procure, and test the X-Ray PPS for the Far Hall.
1	06	02	06		X-Ray MPS	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	06	01	FEE X-Ray MPS	Design, procure, and test the X-Ray MPS for the Front End Enclosure.
1	06	02	06	02	Near Hall X-Ray MPS	Design, procure, and test the X-Ray MPS for the Near Hall.
1	06	02	06	03	Tunnel X-Ray MPS	Design, procure, and test the X-Ray MPS for the Tunnel.
1	06	02	06	04	Far Hall X-Ray MPS	Design, procure, and test the X-Ray MPS for the Far Hall.
1	06	02	07		Laser PPS	Design, procure, and test the hardware and software needed for the personnel protection system that will ensure laser safety in the Near Experimental Hall and Far Experimental Hall.
1	06	02	07	01	Near Hall Laser PPS	Design, procure, and test the Laser PPS for the Near Hall.
1	06	02	07	02	Far Hall Laser PPS	Design, procure, and test the Laser PPS for the Far Hall.

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1	06	02	08		User Safeguards	Design, procure, and test the hardware and software needed for the personnel protection system that will guard against experiment-specific hazards in the experimental stations in the Near Experimental Hall and Far Experimental Hall (i.e., special chemical hazards, oxygen deficiency hazards, etc).
1	06	02	08	01	Near Hall User Safeguards	Design, procure, and test the User Safeguards for the Near Hall.
1	06	02	08	02	Far Hall User Safeguards	Design, procure, and test the User Safeguards for the Far Hall.
1	06	03			Mechanical/Vacuum Subsystem	Design, procure, and test the mechanical supports and vacuum components associated with experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	01		Chamber Support Tables - Mech/Vac	Design, procure, and test the mechanical supports (which may involve motorized degrees of motion) for experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	02		Vacuum Components - Mech/Vac	Design, procure, and test the valves, pumps, gauges, and other vacuum components associated with experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	02	01	Valves - Vacuum	Design, procure, and test the valves for the experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	02	02	Hardware - Vacuum	Design, procure, and test hardware for the experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	02	03	Ion Pump - Vacuum	Design, procure, and test the ion pumps for the experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	02	04	Turbo Pump - Vacuum	Design, procure, and test the turbo pumps for the experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	02	05	Gauges - Vacuum	Design, procure, and test the gauges for the experimental chambers in the Near Experimental Hall and Far Experimental Hall.
1	06	03	03		Experimental Chambers	Design, procure, and test an experimental chamber to be used in the Near Experimental Hall, and a chamber to be used in the Far Experimental Hall. The chambers will accommodate initial LCLS experiments of the types described in the LCLS First Experiments document.
1	06	03	03	01	Near Hall Experimental Chamber	Design, procure, and test the chambers in the Near Experimental Hall.
1	06	03	03	02	Far Hall Experimental Chamber	Design, procure, and test the chambers in the Far Experimental Hall.
1	06	04			Laser Subsystem	Design, procure, and test the ultrafast laser systems that will be installed in the Near Experimental Hall and Far Experimental Hall, and the timing system that will synchronize these lasers to the LCLS x-ray pulses.
1	06	04	01		Oscillator Laser & Pump	Specify, procure, and test the pump laser and Ti:sapphire ultrafast laser oscillator that will be installed in the Front Experimental Hall, and the similar laser system that will be installed in the Far Experimental Hall.
1	06	04	01	01	Near Hall Oscillator Laser & Pump	Design, procure, and test the oscillator laser and pump in the Near Experimental Hall.
1	06	04	01	02	Far Hall Oscillator Laser & Pump	Design, procure, and test the oscillator laser and pump in the Far Experimental Hall.
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 systems in the Near Experimental Hall and Far Experimental Hall.
1	06	04	03		Laser Supplies & Optical Transport	Specify and procure the optical tables, mirrors, lenses, etc. required for operation of the ultrafast laser systems in the NEH and FEH, and design, procure, and test the optical transport system for transporting the ultrashort laser pulses to each of the experimental hutches.

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1	06	04	04		Laser Timing	Design, procure, and test the hardware and software required to synchronize the ultrafast laser systems in the NEH and FEH to the LCLS x-ray pulses. Synchronization with the linac master oscillator to better than 100 fs is required. In addition, trigger signals from the linac and correlation detectors in the experimental hutches will be used to identify the precise arrival time of the x-ray pulses, to which the laser pulses will be synchronized. The timing system must be able to record information from x-ray/laser correlation detectors on a shot-by-shot basis, to be used for experimental data analysis.
1	06	04	05		Laser Amplifiers	Specify, procure, and test the pump lasers and Ti:sapphire laser amplifiers required to boost the intensity of the laser oscillator pulses, for the laser systems in the NEH and FEH. An output pulse rate of about 1 kHz is required, with pulse energy of about 1 mJ.
1	06	04	05	01	Near Hall Laser Amplifier	Design, procure, and test the laser amplifier in the Near Experimental Hall.
1	06	04	05	02	Far Hall Laser Amplifier	Design, procure, and test the laser amplifier in the Far Experimental Hall.
1	06	05			X-Ray Detectors	Specify, procure, and test prototype detectors that will be needed for the types of experiments described in the LCLS First Experiments document. Development of advanced detector concepts that are essential to LCLS will be included as R&D.
1	06	05	01		Beam Imaging	Specify, procure, and test a detector capable of imaging the LCLS x-ray beam in any of the experimental stations with better than 10 micron resolution and 120 Hz image collection rate.
1	06	05	02		2-D X-Ray Detector	Specify, procure, and test a detector suitable for x-ray diffraction experiments at LCLS, studying diffuse or sharp scattering features. An active area of at least 1000x1000 100- $\mu$ m pixels is needed, and an image collection rate of 120 Hz is required.
1	06	05	03		Beam Intensity	Specify, procure, and test a detector for measuring the LCLS x-ray beam intensity with 1% accuracy on a shot-by-shot basis.
1	06	05	04		Streak Camera	Specify, procure, and test a detector for LCLS x-rays with single-shot time resolution of better than 500 fs.
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, experimental chambers and their vacuum components, laser systems, x-ray detectors and infrastructure for atomic physics experiments. This also includes the integration of the X-Ray Endstation system with other components of the LCLS source, such as the LCLS timing system, beam diagnostics and conventional facilities.
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, network and safety systems. This also includes the integration of the X-Ray Endstation system with other components of the LCLS source, such as the LCLS timing system, beam diagnostics and conventional facilities.
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, experimental chambers and their vacuum components, laser systems, x-ray detectors and infrastructure for atomic physics experiments. This also includes the integration of the X-Ray Endstation system with other components of the LCLS source, such as the LCLS timing system, beam diagnostics and conventional facilities.
1	06	06	02	01	Near Hall Install Controls	This element covers all controls system installation, testing and integration in the Near Hall.

WBS NUMBER					TITLE	DESCRIPTION
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1	06	06	02	02	Near Hall Install Mech/Vac	This element covers all mechanical and vacuum system installation, testing and integration in the Near Hall.
1	06	06	02	03	Near Hall Install Detectors	This element covers all detectors installation, testing and integration in the Near Hall.
1	06	06	02	04	Near Hall Install Atomic Physics	This element covers all Atomic Physics system installation, testing and integration in the Near Hall.
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, safety systems. This also includes the integration of the X-Ray Endstation system with other components of the LCLS source, such as the LCLS timing system, beam diagnostics and conventional facilities.
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, experimental chambers and their vacuum components, laser systems, x-ray detectors and infrastructure for atomic physics experiments. This also includes the integration of the X-Ray Endstation system with other components of the LCLS source, such as the LCLS timing system, beam diagnostics and conventional facilities.
1	06	06	04	01	Far Hall Install Controls	This element covers all controls system installation, testing and integration in the Far Hall.
1	06	06	04	02	Far Hall Install Mech/Vac	This element covers all mechanical and vacuum system installation, testing and integration in the Far Hall.
1	06	06	04	03	Far Hall Install Laser	This element covers all detectors installation, testing and integration in the Far Hall.
1	06	06	04	04	Far Hall Install Detectors	This element covers all Atomic Physics system installation, testing and integration in the Far Hall.
2	06				X-RAY END STATION SYSTEMS (OPC)	The element for the X-Ray Endstations System includes time and material costs associated with R&D, Spares, and Commissioning.
2	06	01			System Management & Integration	The structure provides management support for X-Ray Endstations System R&D and commissioning work.
2	06	01	01		Management	The structure provides management support for X-Ray Endstations System R&D and commissioning work.
2	06	02			Controls Subsystem	This element covers the effort associated with commissioning of the Controls.
2	06	02	01		Cabling	This element covers the effort associated with commissioning Cabling in the X-Ray End Station functional area.
2	06	02	02		Network	This element covers the effort associated with commissioning the Network.
2	06	02	03		PC Support	This element covers the effort associated with commissioning PC Support.
2	06	02	04		Beamline Controls	This element covers the effort associated with commissioning Beamline Controls.
2	06	02	05		X-Ray PPS	This element covers the effort associated with commissioning X-Ray PPS in the X-Ray End Station functional area.
2	06	02	06		X-Ray MPS	This element covers the effort associated with commissioning X-Ray MPS in the X-Ray End Station functional area.
2	06	02	07		Laser PPS	This element covers the effort associated with commissioning Laser PPS in the X-Ray End Station functional area.
2	06	02	08		User Safeguards	This element covers the effort associated with commissioning User Safeguards in the X-Ray End Station functional area.
2	06	03			Mechanical/Vacuum Subsystem	This element covers the effort associated with commissioning of the mechanical and vacuum systems.
2	06	03	01		Chamber Support Tables - Mech/Vac	This element covers the effort associated with commissioning of the chamber support tables.
2	06	03	02		Vacuum Components - Mech/Vac	This element covers the effort associated with commissioning Vacuum Components.

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2	06	03	03		Experimental Chambers	This element covers the effort associated with commissioning Experimental Chambers in the X-Ray End Station functional area.
2	06	04			Laser Subsystem	This element covers the effort associated with commissioning the components of the Laser system.
2	06	04	01		Oscillator Laser & Pump	This element covers the effort associated with commissioning the Oscillator and Pump Laser in the X-Ray End Station functional area.
2	06	04	02		Laser Diagnostics	This element covers the effort associated with commissioning Laser Diagnostics.
2	06	04	03		Laser Supplies & Optical Transport	This element covers the effort associated with commissioning Laser Supplies and Optical Transport.
2	06	04	04		Laser Timing	This element covers the effort associated with commissioning Laser Timing.
2	06	04	05		Laser Amplifiers	This element covers the effort associated with commissioning the Laser Amplifiers in the X-Ray End Station functional area.
2	06	05			X-Ray Detectors	This element covers the effort associated with commissioning the X-Ray Detectors.
2	06	05	01		Beam Imaging	This element covers the effort associated with commissioning the Beam Imaging Detector.
2	06	05	02		2-D X-Ray Detector	This element covers the effort associated with commissioning the 2-D-X-Ray Detector.
2	06	05	03		Beam Intensity	This element covers the effort associated with commissioning the Beam Intensity Detector.
2	06	05	04		Streak Camera	This element covers the effort associated with commissioning the Streak Camera.
2	06	07			Atomic Physics	This element covers the R&D costs to specify, design, procure and test the hardware and software needed in the areas of samples, diagnostics, data analysis, and detectors for initial LCLS Atomic Physics experiments as recommended by the Atomic Physics advisory group. This includes also specific sample handling equipment and its control and diagnostics.
2	06	07	01		Atomic Physics Samples	This number covers the R&D costs to specify, design, procure, and test the hardware and software needed to handle the Atomic Physics samples. This includes offline sample characterization equipment and special laser equipment needed to create the required sample state.
2	06	07	02		Atomic Physics Diagnostics	This number covers the R&D costs to specify, design, procure, and test the hardware and software needed for checking the operation of the Atomic Physics experiments, including x-ray and laser beam characterization, online sample characterization, and timing characterization.
2	06	07	03		Atomic Physics Data Analysis	This number covers the R&D costs to specify, design, procure, and test the hardware and software needed for analysis of the Atomic Physics experimental data.
2	06	07	04		Atomic Physics Detectors	This number covers the R&D costs to specify, design, procure, and test the hardware and software needed for detection of the Atomic Physics experimental data. This may include modification of other LCLS detectors, or development of specialized detectors.