No.	Risk Title	Date Submitted	Submitted By	Date Last Revised	Owner	If	Then	**Risk Timeframe** Which phase could this event occur? Design, Construction, and/or Commissioning	**Probability of Event** (percentage)	**Current Cost Impact Estimates** (use $k) O: Optimistic, ML: most likely, P: pessimistic			**Schedule Impact** (use time in months) O: Optimistic, ML: most likely, P: pessimistic			Overview of Risk Handling Plan	**Risk Handling Approach** Avoid, Mitigation, Transfer, Accept	Steps for Handling the Plan	**Risk Retired -** Mark "X" for Yes and date
										O	ML	P	O	ML	P				
1.1	**Management**																		
R1.1-001	Change Control	5/52004	Mark Reichanadter	3/14/2005	Mark Reichanadter	If a baseline change control process is not effective,	Then change could get implemented without proper review and approval.	Design, Construction	**5**	**10**	**50**	**150**	**0**	**1**	**2**	Implement change control system and review cost, schedule and scope against baseline on a monthly basis.	Mitigate	7/04 - Set baseline process. 8/04 thru CD-4 - Review cost, schedule and contingency status monthly.	
R1.1-002	Basis of Cost Estimate is not documented	5/52004	Mark Reichanadter	3/14/2005	Mark Reichanadter	If analysis supporting design decisions isn't documented, and supported by experts,	Then the real costs of the scope of work is unknown, and the project may be at risks that cannot be covered by the estimated cost and schedule contingency.	Design, Construction	**5**	**0**	**0**	**1000**	**0**	**6**	**12**	Ensure that Basis of Estimate documentation is provided for all design decisions, procurements and subcontracts, to support the basaeline cost of the LCLS. Ensure also that estimators are experienced in cost estimating and that they understand the full scope of work	Mitigate	Establish a Basis of Estimate at the CD-2 timeframe. Continue to update the WBS Dictionary thorugh the BCR process. Use experienced estimators and/or vendors to provide estimates. Plan an updated Cost-to-Complete at the 20-25% completion point.	
R-1.1-003	Project Schedule Validity	5/52004	Mark Reichanadter	3/14/2005	Mark Reichanadter	If the project schedule is invalid due to incomplete "subsystem" elements or schedule logic errors or ommisions,	Then the comprehensive schedule may be invalid.	Design, Construction, Commissioning	**15**	**0**	**1000**	**2000**	**0**	**3**	**6**	Include schedule contingency and evaluate schedule.	Accept, Mitigate	Understand the critical path, optimize areas of float, use experts to 'value engineer' the overall construction schedule. Monitor float with respect to L2 and L3 milestones and CD-4.	
R1.1-006	Personnel	5/52004	Mark Reichanadter	3/14/2005	Mark Reichanadter	If there is a change in management personnel, or the project cannot draw high-quality personnel to key positions	Then overall project knowledge may be lost, and/or the ability for the project to respond to problems may be reduced.	Design, Construction, Commissioning	**20**	**0**	**>1000**	**>5000**	**0**	**3**	**12**	Communicate regularly with Lab management on the resource needs of the project, proactively recruit key personnel for upper management and engineering positions on the project	Mitigate	Constant communication on the project status and issues to Lab management. Seek and retain high-quality project personnel through salary, bonus, incentive and benefit pacakges.	
R1.1-007	Integration of SLC Control system Alpha to EPICS IOCs	5/9/2004	L.R. Dalesio	5/9/2004	L.R. Dalesio	IF we fail to implement Alpha functions 1-simple polled data transfer 2-Timed acquisition for beam synchronous data 3-Buffered acquisition of beam synchronous data	THEN the applications developed within the SLC controls system will not Function for linac sectors 20-30. This Will slow LCLS commissioning and Hinder or prevent operation of the linac in traditional modes.	Construction, Commissioning	**<5**	**0**	**0**	**0**	**3**	**6**	**6**	Assign adequate manpower to assess the relevant tasks and carry them out. 3 FTE per year are assigned to mitigation of this risk.	Mitigate	1-identify all SLC-micro message types 2-write message emulators for EPICS IOCs	
R1.1-008	LCLS Timing System	5/9/2004	L.R. Dalesio	5/9/2004	L.R. Dalesio	IF there is a delay in implementation or technical deficiency in the following three new designs: PNET receiverfor EPICS Master Pattern Generator for EPICS Event Receiver for EPICS	Integration of the existing SLC Controls System and the LCLS EPICS controls Will not be integrated, preventing the Operation of LCLS from the MCC and Rendering useless many essential SLC controls functions in the LCLS	Construction, Commissioning	**<5**	**400**	**1000**	**2000**	**3**	**4**	**6**	Adapt Timing pulse generator design from the Swiss Light Source For LCLS use. This module has 20 nsec resolution and at this time it is Not clear that the SLS design meets all LCLS specifications.	Accept	1-Develop and test three LCLS timing Modules in 2005-2006 2-Investigate alternative solutions in 2007 if necessary 3-Implement alternative solution in 2008, continue work on preferred solution	
R-1.1-009	Serious Accident on the SLAC Site	1/3/2005	Mark Reichanadter	3/14/2005	Mark Reichanadter	IF there is a serious accident on the SLAC site by SLAC employee, contractor or visitor	Then a work stappage of all LCLS activities regardless of the accident cause or effect could occur	Design, construction, commissioning., operations	**< 5**	**400**	**4000**	**10,000**	**3**	**4**	**6**	Implement an Integrated Safety Management System (ISMS) for the LCLS Division and Project. Ensure that LCLS upper-level management supports the ISMS and that ES&H issues are given the highest priority. Ensure that adequate ES&H resources (both technical and construction) are devoted to maintaining a safe working environment for LCLS staff.	Mitigate	Constant communication and regular training for LCLS staff that ES&H and ISMS is the highest priority for the LCLS. Initiate monthly ISMS meetings for the LCLS Division.	

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R-1.1-010	Co-Location of Core LCLS Staff	1/3/2005	Mark Reichanadter	1/3/2005	Mark Reichanadter	If the core team of managers, scientists, engineers, and designers cannot be co-located at its three partner labs	Then, a loss of coordination and communication will be realized within the LCLS project	Design, construction, commissioning, operations	**30**	**400**	**2000**	**4000**	**3**	**4**	**6**	Discuss regularly with Lab management the need for co-located space for the LCLS teams.	Avoid, mitigate	In general, LCLS will communicate regularly with Lab management at SLAC to facilitate the co-location of the central design group in B280. In particular, LCLS has an agreement to co-locate at the following rate; 7 offices on Feb1, '05 (complete), 5 offices in Mar15 '05 (complete), 14 office Apr15 '05 (complete), 14 offices July 1 '05 (planned), and 8 office Sep 1 '05 (planned). In general, ANL and LLNL have similar plans in place to co-locate their staff.	
R-1.1-011	Equipment Storage and Staging Area	1/3/2005	Mark Reichanadter	1/3/2005	Mark Reichanadter	IFthe LCLS cannot obtain secure storage space for equipment and deliverables prior to installation	THEN there is the potential for loss or damage to the LCLS deliverables	Construction, commissioning, operations	**10**	**400**	**1000**	**2000**	**3**	**4**	**6**	Develop staging plan with estimates on space needs and timing. Describe security and access requirements and any special equipment reauirements and work with SLAC to ensure adequate space is available when needed	Avoid, mitigate	In general, LCLS will communicate regularly with SLAC management to obtain the necessary warehouse space to ensure LCLS deliverables are stored properly prior to installation in the LCLS conventional facilities. In particular, LCLS has formally requested temporary and permanent space in B750 (CEH) to serve as a staging area for the LCLS.	
R-1.1-012	Funding Shortfall due to FY06 Continuing Resolution	3/14/2005	Mark Reichanadter	3/14/2005	Mark Reichanadter	IFthe U.S. Congress does not approve the FY06 budget in a timely manner	THEN there is the potential for loss of funding to maintain staff, obligate procurements and prepare for the start of construction	PED, LLP, Construction	**50 Probability based upon a 3-mo CR**	**400**	**1000**	**4000**	**3**	**4**	**6**	Will work closely with DOE (SSO and BES) to mitigate impact to the LCLS. Risk Handling Plan assumes a 3-mo CR.	Avoid, mitigate	1/12 of PED, LLP and OPC funds will not be adequate to maintain staffing or procurements. Under this scenario, LCLS will still need FY05 carryover (~$13M) to maintain continuity of project. Mar06 start date is at lesser risk than maintaining staffing and coherence of the project.	
R-1.1-013	Lack of formally approved specfications (PRD's, ESD's, ICD's)	4/18/2005	Mark Reichanadter	4/18/2005	Mark Reichanadter	IF the LCLS specifications are not well-defined and documented in a formal manner	THEN there is a potential for loss of project coordination/communication and a risk to the schedule and technical quality of the LCLS project.	PED, LLP, Construction	**33**	**200**	**1000**	**2000**	**1**	**3**	**6**	Hire the LCLS Quality Assurance Manager as quickly as possible. Charge him/her as one of their first assignments to assess the use or non-use of the LCLS specifications as the technical definition of the project.	Avoid, mitigate	Put together metrics for distribution in the weekly LCLS Physics meetings. # of PRD's/ESD's/ICD's/system. How many approved/week/month? Plot trends.	
R-1.1-014	PLC PPS Design Evaluation	3/31/2005	L.R. Dalesio	3/31/2005	L.R. Dalesio	IF										Get review for use of PLC in personnel progectin through the citizen review committee in early 2005.	Mitigate	1. Complete review in early 2005 (Schedule for the steps: 6/2005 - complete citizen review) 2. Go to hardwired alternative if the review is not successful (Schedule for the steps: 9/2005 - Complete prototype system) COMMENTS: Many other laboratories have used PLCs for personnel safety, but it has never been done at SLAC. One previous attempt to use PLCs did not pass. It was some years ago. (total est costs: 4 weeks for the PPS for the injector)	

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1.2	**Injector System**																		
R-1.2-001	Laser Beam Temporal Shaping	5/4/2004	S. Gilevich	3/8/2005	Sasha Gilevich	If we are unable to procure or preserve the laser pulse flattop temporal shape (set by the pulse shaper) during amplification and UV conversion	Then the laser pulse on the cathode will not meet the temporal profile requirements and the emittance of the electron beam leaving the gun will be too large. And the optical components down the line could be damaged by the spikes in the amplified pulse shape	Design, Construction	**30**	**50**	**400**	**500**	**3**	**3**	**6**	Conduct R&D in collaboration with LLNL. The work will be performed mainly at LLNL with SLAC particiation. The work will be coordinated by SLAC.	Mitigate	• Modeling of the UV conversion process of the temporal shaped pulses (Schedule for steps: Mar-June 2005). • Development of the temporal pulse shape diagnostics. (Schedule for steps: Mar-Aug 2005) • Testing and optimizing of the pulse shaping technique.(Schedule for steps: June-Dec 2005)	
R-1.2-002	Dual Feed L0-1 Structure	5/7/2004	Eric Bong	3/8/2005	Eric Bong	IF there are problems with the design or fabrication of the dual feed for the L0-1 structure	THEN the L0-1 structure will not be ready installation and commissioning	Design, Construction	**20**	**0**	**50**	**100**	**3**	**3**	**6**	Design and build structures in-house. Finish design early, fabricate with plenty of float. Use a single feed L0 strucrures if dual feed structures are not ready for installation	Mitigate	• Start the design early. (Schedule for steps: done) • Fabricate ASAP. (Schedule for steps: 5-1-05) • Prep single feed structures, if required. (Schedule for steps: 10-1-05)	
R-1.2-003	'04 Linac Downtime Work	5/7/2004	Richard F. Boyce	5/7/2004	Lynn Bentson	If the shield wall is not complete during the Linac downtime	Then work in the Sector 20 Alcove to prepare for installation cannot proceed	Construction	**30**	**0**	**50**	**100**	**6**	**6**	**12**	Prepare the work in detail in advance. Work two shifts during the '04 downtime. Complete the work during the '04 winter 2 week break. Complete the work during the '05 linac downtime.	Mitigate	Schedule for the Steps: 04-06/2004 07-08/2004 12/2004 07-08/2005	**x 3-9-05**
R-1.2-004	'05 Linac Downtime Work	5/7/2004	Richard F. Boyce	3/8/2005	Eric Bong	IF the October '05 installation activities are not completed in '05	THEN the start of injector commissioning may be delayed to excessive work in '06.	Construction	**30**	**0**	**50**	**100**	**6**	**6**	**12**	• Prepare the work in detail in advance. • Work two shifts during the '05 downtime. • Complete the work during the '05 winter 2 week break. • Complete the work during the '06 linac downtime.	Mitigate	• Prepare the work in advance. (Schedule for steps: Apr-June 2005) • Work two shifts during the '05 downtime. (Schedule for steps: Oct 2005) • Work during '05 winter break. (Schedule for steps: Dec 2005) • Work during '06 linac downtime. (Schedule for steps: Aug-Nov 2006)	
R-1.2-005	'06 Linac Downtime Work	5/7/2004	Richard F. Boyce	5/7/2004	Lynn Bentson	If the DL and SAB beamlines are not installed before the Linac downtime is over	Then the injector cannot inject the beam into the linac or complete commissioning to the SAB dump	Construction	**30**	**0**	**50**	**100**	**6**	**6**	**12**	Prepare the work in detail in advance. Work two shifts during the '06 downtime. Complete the work during the '06 winter 2 week break. Complete the work during the '07 linac downtime.	Mitigate	Prepare work in advance Work two shifts during '06 down Work during '06 winter break Work during '07 linac downtime	
R-1.2-006	RF Gun at 120 hertz	5/7/2004	Richard F. Boyce	3/8/2005	Eric Bong	IF the RF gun changes shape due the increased heat load of 120 hertz operations	THEN the RF gun will not resonant with the klystron and will not accelerate the electron beam properly	Commissioning	**10**	**50**	**100**	**150**	**3**	**3**	**6**	Design the gun in-house to coordinate the RF and mechanical analysis and incorporate into the mechanical design. Fabricate gun in house with in-process testing. Fabricate two sets of parts. Test first assembly of parts at 120 Hz as early as possible. Use test data to modify second set of parts to correct any design defect. Incorporate push-pull tuning cells into the RF gun design.	Mitigate	• Design gun. (Schedule for steps: Mar-Aug 2005) • Fabricate gun. (Sept 2005 – May 2006) • Test Gun (May 2006)	
R-1.2-007	FY05 Shutdown	1/4/2005	Eric Bong	1/4/2005	Eric Bong	IF the FY05 shutdown signifcantly moes earlier in time, decreases in duration or is eliminated	THEN the components scheduled for installation during the FY05 shutdown will not be installed in the beamline during FY05.	Commissioning, operations	**> 25**	**0**	**< 1000**	**< 1000**	**3**	**3**	**>3**	Mitigate risk of failure to install beamline components during FY05 downtime by establishing whether downtime will occur, and the duration if it occurs. Re-schedule installation work that will not happen in FY05 into FY06 and extend the FY06 downtime to accommodte work.	Accept	1. Define FY05 downtime existence and parameters with SLAC laboratory management. 2. Re-schedule downtime installation work. 3. Re-optimize engineering and fabricationschedules to new installation schedule.	

LCLS Risk Registry
LCLS_risk_registry_March_05-r1.xls

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R-1.2-008	Insufficient Charge	1/5/2005	Eric Bong/Dave Dowell	3/8/2005	Cecile Limborg	IF the gun does not produce the specified charge	THEN the FEL will not produce the required 10^12 photons per pulse	Commissioning	**50**	**< 100**	**< 1000**	**> 5000**	**0**	**3**	**12**	The beam charge is determined by the drive laser energy and the cathode quantum efficiency. The approach should be to first determine which of these subsystems is not meeting its specification, then correct that one. Mitigate using R&D on non linear conversion. Develop gun load lock as upgrade. In parallel, investige possibility of lower charge operation that will satisfy LCLS program goals.	Mitigate	• Run low charge, 0.2nC, that meets LCLS program goals. Low charge solution also mitigates AC conductivity risk. (Schedule for steps: Perform low charge operating point start-to-end simulations in FY05-FY06.) • Drive laser UV energy is low: Put more resources into the non-linear conversion system via the LLNL SOW plan. (Schedule for steps: The LLNL laser work is expected to last for ~1 year, or during the construction phase of the drive laser. FY05-FY06.) • Cathode QE is low: Implement the load lock and use plasma discharge cleaning to improve QE. Also, improve gun vacuum. (Schedule for steps: The priority for the cathode load lock needs to be raised. The load lock design needs to start soon and so it can be tested before it's needed. This will take the next year. FY05-FY06.)	
R-1.2-009	Emittance Specification	1/5/2005	Eric Bong/Dave Dowell	1/5/2005	Cecile Limborg	IF emittance from injector does not meet specification	THEN the FEL will not perform to its specifications	Commissioning	**< 25**	**100**	**500**	**1000**	**0**	**3**	**>3**	The injector emittance is determined by drive laser shaping and the cathode quality. The best approach to improving the emittance is to put more effort into the drive laser system and to implement better cathodes with the load lock.	Mitigate	1. Improve the drive laser by proceeding with the R&D at LLNL. 2. Build and incorporate the load lock and the load lock room.	
R-1.2-010	Cabling Code Uncertainty	1/4/2005	Eric Bong	1/4/2005	Eric Bong	IF the cabling code requirement at SLAC changes before the cable plant is accepted and the incorrect cable is purchased or installed	THEN new cable will have to be purchased and/or installed to meet the new code requirement. Removing and reinstalling new cable would delay CD4.	Construction	**> 25**	**< 1000**	**< 1000**	**> 5000**	**0**	**0**	**>3**	Accept risk of changing cable code requirements and purchase cable meeting or exceeding the standard that will certainly be adopted.	Accept	1. Purchase the cable appropriate to the new code. 2. Adjust the injector plan to reflect the increase in cable cost.	
R-1.2-011	Reliability of the Injector Drive Laser System	6/4/2004	Sasha Gilevich	3/31/2005	Sasha Gilevich	IF any of the drive laser system components fails (for example, due to optics damage or due to diode laser failure)	THEN the whole LCLS will be shut down for a certain period of time required to find and fix the problem and realign and check the laser system. This downtime period can be significant due to the complexity of the system and to the fact that the main components will be built by the outside vendor and could be fixed only by its manufacturer.	Operations	**<30**	**350**	**500**	**1000**	**0.5**	**0.5**	**1**	Plan the laser bay to have the space and utilities to accommodate the second laser system. Request the Project Office to allocate FY07 funds towards procurement of the second laser system.	Accept	Re-evaluate the risk based on the preformance of the first laser system (Schedule for steps: 10/2006)	
R-1.2-012	Laser Beam Spatial Shaping	3/8/2005	Sasha Gilevich	3/8/2005	Sasha Gilevich	IF we are unable to produce and preserve the UV laser pulse round flattop spatial shape (set by the reshaper) during the transport of the beam to the cathode	THEN only small transverse fraction of the beam will have small enough emission to lase. And the tuning for emittance preservation will be very difficult.	Design, Construction	**30**	**50**	**60**	**100**	**3**	**3**	**6**	Conduct R&D in collaboration with ANL. The work will be performed mainly at ANL with SLAC participation. The work will be coordinated by SLAC.	Mitigate	• Testing of the UV conversion process of the spatially shaped pulses (Schedule for steps: Mar-July 2005) • Imaging of the spatially shaped UV pulses and optimization of the optical system (Schedule for steps: Aug-Oct 2005)	
R-1.2-013	Sector 20 Beneficial Occupancy	1/4/2005	Eric Bong	3/8/2005	Eric Bong	If the beneficial occupancy of Linac Sector 20 is delayed	THEN the components scheduled for installation in the laser alcove and the injector vault will be delayed	Construction	**< 25**	**0**	**0**	**< 1000**	**0**	**1**	**3**	Accept risk of delay to install beamline components due to Li20 Beneficial Occupancy delay and minimize impact by regular inquiry into LI20 construction progress and revising installation schedule to accommodate	Accept	1. Regularly review Li20 conventional construction progress. 2. RE-schedule installation work.	

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1.3	**Linac System**																		
R-1.3-001	Linac RF Stability	5/6/2004	Eric Bong	5/6/2004	Eric Bong	If the following RF stability is not achieved… L1: φ1: 0.1° S; ΔV1/V1: 0.10% LX: φX: 0.1° X; ΔVX/VX: 0.25% L2: φ2: 0.1° X; ΔV2/V2: 0.25% L3: φ3: 0.1° X; ΔV3/V3: 0.25%	The electron bunch length will vary with phase instability and the electron energy will vary with the amplitude instability. This will cause fluctuations in the SASE FEL pulse length and peak brightness.	Commissioning, Operations	**> 25**	**0**	**0**	**750**	**0**	**3**	**>3**	Mitigate risk of failure to achieve RF stability requirements by instituting R&D efforts to develop an appropriate signal to use as feedback to establish RF stability. Investigate multiple feedback signal sources in case one source fails to meet criteria. Model feedback effectiveness. Test feedback on Linac klystron using EPICS control mockup in Linac Sector 21.	Mitigate	1. Perform bunch length measurements w/ EO and OTR/THz signals with test beam. 2. Build LLRF prototype and install in Linac. 3. Build EPICS test stand in Linac. 4. Write RF feedback software. 5. Instrument Linac klystron and rest feedback.	
R1.3-002	FY05 Shutdown	1/4/2005	Eric Bong	1/4/2005	Eric Bong	IF the FY05 shutdown significantly moes earlier in time, decreases in duration or is eliminated	THEN the components scheduled for installation during the FY05 shutdown will not be installed in the beamline during FY05.	Commissioning, operations	**> 25**	**0**	**< 1000**	**< 1000**	**3**	**3**	**>3**	Mitigate risk of failure to install beamline components during FY05 downtime by establishing whether downtime will occur, and the duration if it occurs. Re-schedule installation work that will not happen in FY05 into FY06 and extend the FY06 downtime to accommodte work.	Accept	1. Define FY05 downtime existence and parameters with SLAC laboratory management. 2. Re-schedule downtime installation work. 3. Re-optimize engineering and fabricationschedules to new installation schedule.	**X 3-8-05**
R-1.3-004	Linac Legacy Issues	1/5/2005	Eric Bong	3/8/2005	Eric Bong	IF the condition of the existing SLAC Linac infrastructure does not support LCLS requirements	THEN the LCLS will not be able to operate the new beamlie components required to meet electron beam delivery parameters	Design, Construction	**> 25**	**< 1000**	**< 5000**	**> 5000**	**0**	**3**	**12**	Mitigate risk by upgrading SLAC Linac infrastrucure prior to commissioning Linac	Mitigate	1. Specify utilities requirements to Conventional Facilities. (Schedule for steps: DONE) 2. Check Conventional Facilities plan to verify utilities requirements will be met. (Schedule for steps: FY05) 3. Monitor implementation of CF plan. (Schedule for steps: FY06) 4. Verify utilities capacities prior to component installation. (Schedule for steps: FY06 for Li21; FY07 for Li24) 5. Perform independent assessment. (Schedule for steps: FY05)	
R-1.3-005	Cabling Code Uncertainty	1/4/2005	Eric Bong	1/4/2005	Eric Bong	IF the cabling code requirement at SLAC changes before the cable plant is accepted and the incorrect cable is purchased or installed	THEN new cable will have to be purchased and/or installed to meet the new code requirement. Removing and reinstalling new cable would delay CD4.	Construction	**> 25**	**< 1000**	**< 1000**	**> 5000**	**0**	**0**	**>3**	Accept risk of changing cable code requirements and purchase cable meeting or exceeding the standard that will certainly be adopted.	Accept	1. Purchase the cable appropriate to the new code. 2. Adjust the linac paln to reflect the increase in cable cost.	
1.4	**Undulator System**																		
R-1.4-002	Magnetic Measurements	5/7/2004	Robert Ruland	3/8/2005	Robert Ruland	IF the measurements and tuning takes too long	THEN, we will fall behind schedule	Construction, Commissioning	**< 25**	**<1000**	**<1000**	**<1000**	**0**	**0**	**6**	Time estimates are based on measurements on the undulator prototype at APS. If production undulator segments are more difficult and more time consuming to tune, we can add additional staff to run swing or even night shifts	Mitigate	Loan from other departments or hire additional staff (Schedule for steps: 9-1-06)	
R-1.4-003	Fixed Support Design Specification	5/9/2004	Steve Milton	5/9/2004	Steve Milton	If the fixed supports are not stable over time	Then beam-based alignment need to be performed too often to achieve availability and stability functional goals	Design	**< 25**	**50**	**100**	**100**	**3**	**5**	**6**	Get more design and engineering support on this.	Avoid	Cost of an additional engineer and designer for 3 months.	
R.1-4-004	Chamber Roughness Specification	5/9/2004	Dean Walters	3/31/2005	Steve Milton	If the surface roughness of the chambers is too high	Then it is very likely that there will be significant reduction in total power delivered or no lasing at all.	Design	**< 25**	**50**	**100**	**120**	**3**	**5**	**6**	Prototyping of various chamber configurations will be performed and the results of the prototype chambers measured roughness will be given to a theorist to determine if it meets the performance specifications. Methods of reducing the surface roughness of the chambers will also be tested.	Avoid	Prototyping of various chamber configurations will be performed and the results of the prototype chambers measured roughness will be given to a theorist to determine if it meets the performance specifications. Methods of reducing the surface roughness of the chambers will also be tested.	
R-1.4-005	Machine Protection System	5/9/2004	Josh Stein	3/31/2005	Steve Milton	If beam strikes the undulators do to unwitnessed steering errors,	Then the magnet blocks in the undulator may be damaged.	Design, Commissioning	**< 25**	**20**	**25**	**50**	**<1**	**1**	**2**	The Machine Protection System within the undulator section will be designed with different system inputs in mind, but will be based on beam loss monitors. If it is determined at a later date that the beam position information is a required input into the system, that capability will be added as another system input to the global MPS.	Mitigate, Accept	The beam position may be monitored via: 1) The existing RFBPM systems – this requires active EPICS participation, but reduces the impact on new electronics designs (see below) and adds minimal software effort 2) Some type of Beam Position Limit Detectors may be designed to signal when the beam has exceeded vertical or horizontal limits.	

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										O	ML	P	O	ML	P				
R-1.4-006	RFBPM – Timing Interface	5/9/2004	Josh Stein	2/9/2005	Steve Milton	If the timing interface to the existing SLAC timing system is not correlated with the RF BPM's	Without accurate and reliable timing information, the data acquired from the RFBPM, a system critical component, becomes meaningless.	Design, Commissioning, Operations	**> 25**	**20**	**25**	**50**	**<1**	**1**	**2**	The design of the EPICS aware timing module will depend almost directly on the amount of effort expended – with this in mind, the primary method of handling this risk is by assigning multiple and redundant engineers to the design effort.	Avoid	Assist in the design of the SLC aware IOC and event receiver modules when necessary. Integrate these components with the BPM acquisition system to provide correlated data.	
R-1.4-007	Magnet Block Radiation Damage	5/9/2004	Marion White	5/9/2004	Stephen V. Milton	If the high-energy electron beam strikes any of the undulator magnet blocks,	Then it is very likely that some amount of radiation damage will occur, resulting in partial demagnetization of individual magnets within the undulator.	Commissioning, Operations	**> 25**	**20**	**25**	**50**	**<1**	**1**	**2**	There is risk that one or more undulators will be damaged in part or in total by radiation as a result of commissioning or operational beam strikes.	Mitigate, Accept	The risk handling plan is: 1) Collimators are installed to protect the undulators 2) Equipment protection devices, including radiation sensors will not allow beam operation under conditions known to be dangerous to the undulators. 3) Seven (7) spare undulators are being purchased. 4) All undulator magnets are made of a new higher coercivity material which is less sensitive to radiation damage. 5) ANL-APS is carrying out studies with the intent of better understanding the actual damage mechanism and helping to determine safe operating dose levels. 6) Undulators can be rolled out of the beam to do beam tuneup studies. 7) Commissioning procedures developed with undulator protection as one of the prime goals.	
R-1.4-008	Undulator Vacuum Chamber AC Conductivity	12/4/2004	Dean R. Walters	3/31/2005	Stephen Milton	IF the Undulator Vacuum Chamber necessitates a change in material due to the AC Conductivity of the chamber wall material.	THEN there will have to be a redesign to the Undulator Vacuum chamber design. With a change of chamber design also brings about a change in construction method.	Design	**> 25**	**300**	**500**	**800**	**3**	**6**	**12**	Analyze impact of material and cross section choice on performance. Change vacuum chamber design to use better suited material (Cu -> Al) and chamber cross section (circular -> oblong). Optimize FEL gain through micro-tapering. Reduce bunch charge in combination with increased linac bunch compression.	Mitigate, Accept	Technical stucy of AC conductivity. Complete construction methodologies study.	**X 3-31-05**
R-1.4-009	Lack of final performance specificiations of focusing and corrector magnets: schedule, and cost implications of delayed decision on specs	12/1/2004	Marion White	3/31/2005	Stephen V. Milton	IF there is a delay in finalizing the strength specificiation and alignment tolerance of the quadrupole and/or corrector magnets	THEN it is very likely that there will be schedule and cost implecations; design and integration effort are delayed	Design, construction, commissioning, operations	**> 25**	**100**	**100**	**100**	**< 1**	**<1**	**2**	There is a risk that the present quadrupole and corrector magnet strength and alignment tolerance will be changed again due to incompletely developed commissioning and oeprating plans. There is also risk in that a prolonged delay in making the required decisions on magnet strengths and alignments tolerance will cause significant schedule delay and thus cost growth. The magnet is an integrated part of the undulator line, and changing it requires changes or perhaps loss of nearby components. The risk handling plan is: 1. The new PRD will be sidned off by 18 Feb 2005.	Mitigate, Accept	See handling plan	**X 3-31-05**

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R-1.4-010	Undulator period and aperture change due to AC impedance issues; performance, schedule, and cost implications, including delayed decision	12/1/2004	Marion M. White	12/1/2004	Stephen V. Milton	IF the undulator period, aperture, and quantity change due to mitigation of AC impedance issues, and if there is a delay in deciding on a course of action	THEN it is very likely that there could be performance, schedule, and/or cost implications.	Design, construction, commissioning, operations	**> 25**	**< 100**	**<1000**	**>1000**	**< 1**	**>1**	**6**	There is risk that the present undulator design will cause degraded FEL performance due to possible wakefield enhancement by AC contributions to the impedance. There is risk that a prolonged delay in making a decision on the required undulator gap and period will cuase significant schedule delay and thus cost growth.	Mitigate, Accept	1. A task force was set up t o make calculations, simulations, and measurements, and to propose a solution to Project Management by mid-January 2005. 2. The decision will be made and a revised PRD will be ;issued by 18 February 2005. If there are no or only minor design changes to the undulator, the baseline schedule can be met. 4. If significant design changes are required to miitgate the wakefield problems and ensure FEL performance, a redesign will be done as rapidly as possible. 5. If additional undultaors are qrequired to compensate for increased gap, the production schedule and plan may need adjustment.	**X 2-9-05**
R-1.4-011	End of Undulator Diagnostics Suite	12/1/2004	Dean R. Walters	12/1/2004	Stephen V. Milton	IF the goals and role of the End of Undulator Diagnostics are not detailed	THEN the organization and schedule of the End of Undulator will be in flux	Design, construction, commissioning	**> 25**	**<1000**	**<1000**	**5000**	**0**	**3**	**6**	Conduct discussions and R&D together with SLAC and LLNL. Develop plan for technical study followed by a listing of responsibility of equipment design, construction, and installation.	Mitigate	Complete Technical Study of End of Undulator Diagnostics. Assignment of responsibility.	
R-1.4-012	Undulator Component Motion	12/1/2004	Josh Stein	12/1/2004	Stephen V. Milton	IF radiation strikes the motors used to move devices within the undulator hall.	THEN the motors may become damaged to the point where they cease to function, or function in an inappropriate manner.	Commissioning, Operations	**30%**	**50**	**500**	**500**	**1**	**1**	**3**	Determine radiation susceptibility of pertinent motors. Develop alternative motor choices and anticipate backup installation.	Mitigate	Test motors for damage in SR environment. Characterize the threshold for motor resistance. Plan on installation of "worst case" motorr choices to minimize impacet on replacint existing motors if necessary.	
R-1.4-014	Loss of Reference Positions on Undulator Cradle	1/5/2005	Robert Ruland	3/31/2005	Robert Ruland	IF the relative alignment between quad - BPM-undulator segment becomes damaged due to rough handling, extreme temperature cycles,	THEN the relative alignment cannot be re-established in the tunnel, and the machine performance will be adversely affected. A mitigation requires removing the cradle with its components from the location and reprocessing through the magnetic measurements and fiducialization sequence	Construction, Commissioning, Operations	**< 25%**	**<100**	**<100**	**<100**	**< 3**	**< 3**	**< 3**	Schedule design reviews and allow for sufficient time for testing the complete installation process and then modify the equipment if necessary following testing.	Mitigate, Accept	First tests are part of the Single Undulator Test set-up at APS using laser tracker for cradle alignment and alignment verification. Final tests will be performed in conjunction of Multiple Undulator Test using production cradle alignment procedure on MMF equipment. (Schedule for Steps: SUT Nov 2005; MUT April/May 2006)	

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R-1.4-015	Cradle Alignment Stability	1/5/2005	Steve Milton	3/31/2005	Steve Milton	The accurate relative alignment between each quadrupole - BPM - undulator segment triplet is essential for the performance of the LCLS. The alignment position is mechanically maintained by their common strong-back (cradle). IF the cradle, the individual supports or the roll-away slide is not stable enough to maintain the alighment to within the specified range of ± 2 μm over 10 hours and ± 5 μm over one month...	THEN the relative alignment between quad-BPM-undulator setment cannot be corrected in the tunnel. A mitigation would require a redesign and subsequent replacement of the cradle and reprocessing though the magnetic measurements / fiducialization sequence.	Design, Construction	**< 5%**	**< 100**	**<1000**	**>10,000**	**0**	**< 3**	**>3**	Schedule design reviews and allow for sufficient time for testing the complete integrated system and then modifying the equipment if necessary following testing	Mitigation	1. Allocate more engineering design oversight. 2. Evaluate at least two other options associated with the cradle design. 3. Execute extensive prototype testing and enhancements.	3/31/2005
1.5	**X-Ray, Transport, Optics & Diagnostics System**																		
R-1.5-001	Solid Attenuator Performance	5/8/2004	R. Bionta	5/8/2004	R. Bionta	IFsolid attenuators fail to achieve sufficient or linear attenuation due to damage or physics effects.	THEN at high photon energies, we will be unable to cross calibrate the diagnostic detectors, and we will be unable to operate the direct imagers and the spectrometer.	Commissioning	**10**	**500**	**1000**	**2000**	**3**	**6**	**12**	Make solid attenuators of the lowest Z materials. Develop plans to raise pressure in the gas attenuator and to run it with higher z gases. Plan for moving solid attenuators and detectors downstream.	Mitigate	1) Design low-z solids 2) Develop high pressure / high z gas capabilities in gas attenuator 3) Provide space for solid attenuators downstream.	
R-1.5-002	Gas Attenuator Performance	5/5/2004	R. Bionta	5/5/2004	R. Bionta	If gas attenuator fails to achieve sufficient or linear attenuation due to insufficient pressure with an opening large enough to pass the required beam footprint.	Then, at low photon energies, we will be unable to cross calibrate the diagnostic detectors, and we will be unable to operate the direct imagers and the spectrometer.	Commissioning	**10**	**500**	**1000**	**2000**	**3**	**6**	**12**	The risk of poor gas attenuator performance is handled in a 3 pronged approach. First we are investigating window technologies that allow higher pressures across bigger openings, and have provided access shafts for external gas piping into the FEE. Secondly, we have increased the length of the gas attenuator to 10 m, considerably lowering the pressure requirements and have positioned the gas attenuator so that it can be expanded into the muon shield and into the flex space if necessary. Thirdly, we have the option of moving the solid attenuator's and detectors further downstream if necessary.	Mitigate	1) Design low-z solids 2) Develop high pressure / high z gas capabilities in gas attenuator 3) Provide space for solid attenuators downstream.	
R-1.5-003	Imager noise and backgrounds	5/5/2004	R. Bionta	5/5/2004	R. Bionta	If imager noise levels are too high due to high radiation backgrounds, EMP, or high readout rates..	Then we will be limited in our abilities to measure the FEL at low intensities during commissioning.	Commissioning	**10**	**500**	**1000**	**2000**	**3**	**6**	**12**	The risk of poor gas attenuator performance is handled in a 3 pronged approach. First we are investigating window technologies that allow higher pressures across bigger openings, and have provided access shafts for external gas piping into the FEE. Secondly, we have increased the length of the gas attenuator to 10 m, considerably lowering the pressure requirements and have positioned the gas attenuator so that it can be expanded into the muon shield and into the flex space if necessary. Thirdly, we have the option of moving the solid attenuator's and detectors further downstream if necessary.	Mitigate	Provide an indirect imager which can be withdrawn in a direction transverse to the beam to lessen Compton background. Run cameras at slower readout speeds. Provide a gas ion chamber and total energy detector for alternative means of measuring beam intensity. Locate detectors in first hutch during commissioning, downstream of electron dump and muon shields.	
R-1.5-004	Small apertures may hinder commissioning	1/6/2005	Richard Bionta	1/6/2005	Richard Bionta	IF the small apertures located upstream of the Commissioning Diagnostics limit our view of the spontaneous radiation or reflections from the undulator vacuum chamber seriously distrots the spontaneous radiation pattern…	THEN, we will possible miss important information in the spontaneous beam that could aid in commissioning, and it may be difficult to convince ourselves that we are looking for the FEL in the correct place in the event that we do not see the FEL signal initially.	Commissioning	**25%**	**1000**	**1500**	**2000**	**2**	**4**	**12**	Carefully study the spontaneous radiation through modeling and simulation to determine the nature of its information content and the effects of small apertures and reflections on the expected patterns. Explore schemes allowing a wider radiation pattern in the front-end Enclosure while maintaining a restricted Aperture in the near Hall and downstream.	Mitigate	1) Calculate near field radiation patterns in the front-end Enclosure at the position of the apertures. 2) Develop Codes to calculate the effects of apertures and reflections on the expected spontaneous radiation pattern. 3) Perform radiation safety calculations with wider apertures in the front-end Enclosure. 4) Planned on providing a wide field of view camera in the front-end Enclosure to measure the spontaneous radiation pattern during Commissioning.	

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R-1.5-005	Design Immaturity	1/6/2005	Richard Bionta	1/6/2005	Richard Bionta	IF, due to the relative design immaturity of the XTOD instrumentation, large changes in scope are necessary in order for instrumentation to meet requirements…	THEN, it will be difficult to meet the wschedule and budget as specified in P3.	Design, Construction	50%	1000	1500	2000	2	4	12	Prioritize instrumentation work and R&D so that Commissioning and front-end Diagnostics plans are completed and understood first. Plan on bypassing instrumentation and user tanks with spools to allow early beam transport so delays in tank delivery will not affect CD 4.	Mitigate	1) Prioritize Instrumentation development schedule 2) Early front-end Design 3) Provide adequate contingency for immature designs	
R-1.5-006	Late changes to design due to evolving user requirements	1/6/2005	Richard Bionta	1/6/2005	Richard Bionta	If there are major changes in the scope, performance, existence or placement of XTOD instrumentation after the project is baselined due to evolving user requirements…	Then, it will be difficult to meet the schedule and budget as specified in P3, and the Commissioning and risk mitigation strategies will be ineffective.	Design, Construction, Commissioning	50%	1000	2000	5000	2	6	12	Rigorously Maintain and adhere to the BCR process. Separate user and facility instrumentation geographically, functionally, and temporary. Maintain cost estimates and low-level R&D efforts on instrumentation users are likely to request. Expend resources to investigate possible changes well before initiating BCR process.	Mitigate	1) Adhere to BCR process. 2) Place facility and Commissioning instrumentation upstream of potential users to allow Commissioning activities to proceed during installation of user instrumentation. 3) Delay design of user instrumentation. 4) Maintain cost estimates and low-level R&D efforts on possible user instrumentation such as lenses, mirrors, and pulse length/synchronization schemes. 5) Provide adequate R&D as well as management resources to consider ramifications to Commissioning strategy, risks, and safety of proposed changes before initiating BCR process. 6) Develop accurate, fast, and convenient, computer models of the beam and instrumentation to allow accurate assessment of proposed changes.	
R-1.5-007	Uncertainties in Power levels, damage thresholds, or physics mechanisms	1/6/2005	Richard Bionta	1/6/2005	Richard Bionta	IF the FEL or spontaneous parameters are significantly different than expected, or materials damage thresholds or mechanisms are significantly different than expected, or physical mechanisms such as attenuation or scintillator emission, are significantly different at FEL intensities than expected...	THEN, measurements of beam parameters may not have sufficient information to commission the FEL, and the characteristics of the beam delivered to the users may not be suitable for their purposes.	Design, Construction, Commissioning, Operations	50%	500	1000	2000	2	4	18	Provide multiple, redundant, measurement techniques for Commissioning that relies on different physical principles. Rely on techniques that minimize or eliminate optical elements upstream of the Commissioning Diagnostics.	Mitigate	1. Baseline three overlapping detection schemes: scintillator/attenuator, mirror/scintillator, and calorimeter for determining FEL parameters during commissioning. 2. Place facility and Commissioning instrumentation upstream of apertures and mirrors to minimize uncertainties in beam transport during commissioning. 3. Baseline both solid and gas attenuators for redundant reduction of FEL power levels. 4. Provide sufficient margin in instrumentation apertures and sensitivities to allow for differences in estimated and actual beam parameters. 5. Develop accurate, fast, and convenient, computer models of the beam and instrumentation response to assure that we are making full use of our current understanding of the expected beam parameters, and to allow us to recognize during commissioning differences in our expectations and the actual beam. 6. Test our models of materials damage thresholds that high intensities, but lower photon energies, at the TTF FEL facility as soon as possible. 7. Encourage users not to initially plan and build elaborate instrumentation based on unverified beam parameters, but to wait for measurements of the actual beam before proceed	
1.6	**X-Ray Endstations System**																		
R-1.6-001	Laser Timing Failure	5/7/2004	J. Arthur	3/15/2005	S. Moeller	If the desired level of synchronization is not achieved	Then the precision of experiments and diagnostics will be compromised	Operations	10	100	100	100	3	3	3	Allow plenty of time for design	Mitigate	1. Hire Control Engineer early (July 05) 2. Focus on laser timing first to identify risks (planned duration to end of FY06) 3. Provide sufficient time in the schedule to solve issues.	
R-1.6-006	2-D Detector Failure	5/7/2004	J. Arthur	3/11/2005	S. Moeller	If the 2-D X-Ray Detector fails to meet its technical requirements by 9/28/08	Then the goal of developing this useful instrument will not have been met	Operations	30	1000	1000	1000	0	0	0	Begin detector R&D immediately. If R&D results are not promising, pursue acquisition of alternative detector, with less aggressive specifications, in FY07.	Mitigate	1. R+D work starts early FY05 2. Review after 1st and 2nd year 3. Decision about continuation of program after 2nd year review (end of FY06) 4. In case R+D program is stopped: 5. Start with procurement of alternative detector (specifications will be determined earlier).	
R-1.6-007	Cable Code Uncertainty	3/11/2005	S. Moeller	3/11/2005	S. Moeller	IF the cabling code requirements at SLAC changes before the cable plant is accepted and the incorrect cable is purchased or installed	THEN the new cable will have to be purchased and/or installed to meet new code requirement. Removing and reinstalling new cables would delay CD4.	Construction	25%	< 200	< 500	> 800	0	0	>3	Accept risk of changing cable code requirements and purchase cable meeting or exceeding the standard that will certainly be adopted.	Accept	1. Purchase the cable appropriate to the new code 2. Adjust the endstation plan to reflect the increase in cabling costs.	

LCLS Risk Registry
LCLS_risk_registry_March_05-r1.xls

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R-1.6-008	Pricing fluctuations for procurement items	4/1/2005	S. Moeller	4/1/2005	S. Moeller	IF the prices for procurement items or the exchange rate for foreign procurements increases rapidly in the next years	THEN the actual cost for procurements will be higher than our current cost estimates	Construction	> 25%	0	1,000	>5000	0	0	0	Monitor prices of main procurement items and allow sufficient contingenty	Accept	Monitor prices of items that will be procured in the later years and especially from vendors that are the only suppliers of the items. Allow for sufficient contingency. Present changes to Project Office for possible BCRs. SCHEDULE FOR STEPS: Monitor prices beginning of FY06; For start of procurements at the end of FY06 thru mid of FY08.	
1.9	**Conventional Facilities**																		
R-1.9-002	Bay Area Labor Construction Cost	5/7/2004	David Saenz	5/7/2004	David Saenz	If the Bay area economy experiences rapid economic growth, to levels see 5-10 years ago.	Then Bay area labor force may experience an increase in demand that can result in a greater labor cost than currently estimated.	Construction	<5%	>5000	>5000	>5000	0	0	0	Monitor trends for bay area construction activities	Avoid, Accept	Review and track various resources for bay area construction activities, specifically labor costs. Develop quarterly reports and present economic trends to the LCLS Project Office	
R-1.9-004	Construction Schedule	5/7/2004	David Saenz	5/7/2004	David Saenz	If the average tunneling rate, using road header boring, is not maintained	Then the minimal tunneling advances will experience a schedule delay and impact the overall schedule of beneficial occupancy milestones	Construction, Commissioning, Operations	<25%	<5000	<5000	<5000	3	3	3	Closely monitor all major activities and proactively seek improvements to the CF schedule. Call an early review with outside experts to optimize the LCLS construction schedule.	Avoid, Accept	Review all critical patch activities, place all tunneling and excavation operations onto the critical path, increase of necessary manpower, and make provisions for additional equipment (road headers)	
R-1.9-005	Undulator Hall HVAC	5/7/2004	David Saenz	5/7/2004	David Saenz	If the environmental parameters of the tightly controlled Undulator Hall thermal requirements are not realized,	Then the specified technical requirements will not allow the 33 undulators to function properly	Commissioning, Operations	<25%	<1000	<1000	<1000	>3	>3	>3	Review and validate the design by Jacobs Engineering for the Undulator Hall HVAC system	Mitigate	Provide peer review of mechanical systems, provide adequate review of the HVAC system during upcoming VE session in Title II	
R-1.9-006	Tunneling	5/7/2004	David Saenz	5/7/2004	David Saenz	If the subsurface material is to soft	Then voids and soft surfaces will require additional reinforcement and potentially cause additional cost and potential schedule delays	Construction	<25	<1000	<1000	<1000	<3	<3	<3	Provide additional detailed geotechnical analysis of subsurface to approximately 10' below inverted tunnel floor elevation	Mitigate	Provide additional borings, develop geotechnical investigation	
R-1.9-008	Seismic activity during construction	5/7/2004	David Saenz	5/7/2004	David Saenz	If a moderate earthquake occurs during tunneling operations	Then a life/safety issue may cause possible accidents or schedule delays	Design, Construction	<25	<1000	<1000	<1000	<3	<3	<3		Mitigate	Provide construction design to peer review, submit final design to SLAC Seismic Safety committee for review and approval	
R-1.9-012	RSY Pile Locations	5/7/2004	David Saenz	5/7/2004	David Saenz	If excavation of piles results in contact with active/inactive utilities	Then major modifications to the construction plan, cost and schedule may be impacted	Construction	<25	<1000	<1000	<1000	<3	<3	<3	Manage CF scope of design effort to ensure completion within scheduled parameters.	Mitigate	Manage CF scope for requirements, manage Jacobs Engineering effort to assure timeliness of final deliverable, validate all scope changes	
R-1.9-014	Delta Between Jacobs Engineering and WDWC Cost Estimates	1/5/2005	David Saenz	1/5/2005	David Saenz	IF the WDWC report cost estimate is correct	THEN the CF budget will need to be readjusted to increase by ~ $7M	Construction	2		>5000		0	0	0	Continually review and validate the cost etimage against local contractor conditions.	Mitigate	Increased contingency assessment for the RY-CLOC construction Phase. Will RE-evaluate the estimated constrcutino cost at the o 30% and 60% T2 phase with JE as well as the CM/GC	