SLAC
NATIONAL ACCELERATOR LABORATORY

SLAC Responses to the Committee Charge for the Linac Ops Review

February 18-20, 2009

1) Present facility

i. Brief description of the facility.

The Linac Coherent Light Source (LCLS) provides laser in the x-ray region of the spectrum that is 10 billion times greater in peak brightness than any existing coherent x-ray light source, providing more than 10^{11} x-ray photons/pulse in a duration of less than 230 femtoseconds. These characteristics of the LCLS will open new realms of scientific research in the chemical, material, and biological sciences. The LCLS will provide the first demonstration of an x-ray Free Electron Laser (FEL) in the 1.5–15 Angstrom range and will apply these extraordinary, high-brightness x-rays to an initial set of scientific problems. The LCLS is the world's first such facility.

The LCLS is based on the existing SLAC linac. The SLAC linac can accelerate electrons or positrons to 50 GeV for colliding beam experiments and for nuclear and high-energy physics experiments on fixed targets. The LCLS uses the last one third of the linac to produce high-brightness 5–15 GeV electron bunches up to a 120 Hertz repetition rate. When traveling through the new 120 meter long LCLS undulator, electron bunches are emit x-ray radiation to produce an intense, coherent x-ray beam for scientific research.

The LCLS makes use of technologies developed for SLAC and the next generation of linear colliders, as well as progress in the production of intense electron beams with radiofrequency photocathode guns. These advances in the creation, compression, transport, and monitoring of bright electron beams make it possible to base this next generation of x-ray synchrotron radiation sources on linear accelerators rather than on storage rings.

The LCLS utilizes a 135 MeV injector at Sector 20 of the 30-sector SLAC linac to create the electron beam required for the x-ray FEL. The linac has been modified by adding two magnetic bunch compressors. Most of the remaining linac and its infrastructure remain unchanged. Beyond the Linac, the LCLS includes an undulator, associated x-ray optics and photon diagnostics, and two experimental halls, the Near Experimental Hall and the Far Experimental Hall.

The LCLS experimental program is expected to support experimentation in a variety of areas such as: fundamental studies of the interaction of intense x-ray pulses with simple atomic systems; the study of materials in extreme environments; structural studies on single nanoscale particles and biomolecules; ultrafast dynamics in chemistry and solid-state physics; and studies of nanoscale structure and dynamics in condensed matter. Five LCLS instruments are presently under construction:

- Atomic, Molecular, Optical (AMO) Instrument (commence operations in FY09)
- Soft X-ray (SXR) Instrument (commence operations in FY09)
- X-ray Pump Probe (XPP) Instrument (commence operations in FY10)
- Coherent X-ray Imaging (CXI) Instrument (commence operations in FY11)
- X-Ray Correlation Spectroscopy (XCS) Instrument (commence operations in FY12)

Also included in the LCLS are the instrumentation and infrastructure necessary to support research at the LCLS, such as experiment hutches and associated safety systems; computers for data collection and data analysis; devices for attenuation and collimation of the x-ray beam; optics for manipulation of the intense x-ray beam; and synchronized pump lasers.

SLAC's Magnetic Measurement Facility supports the assembly, alignment and calibration of LCLS undulators and undulator infrastructure. In addition, LCLS maintains core SLAC competencies and capabilities needed to ensure a sustainable technical infrastructure focused on the LCLS Mission that provides a foundation for Accelerator Science and Technology at SLAC. These core competencies and capabilities include SLAC facilities and infrastructure which support the development of klystron fabrication, control systems, power conversion, scientific computing and precision metrology, as well as minimum maintenance of the first two thirds of the SLAC linear accelerator and related facilities.

Transition of SLAC Stewardship

Beginning in FY06, with initiation of LCLS construction, funding to partially support Linac operations has come from the DOE Office of Basic Energy Sciences. The fraction of funding to support Linac operations from BES has increased through FY07 and FY08 as programmatic ownership for SLAC Linac operations shifted from HEP to BES as the LCLS project progressed. In FY09, BES fully supports Linac operations and its related infrastructure. Initially, LCLS will operate the last kilometer of the 3 km SLAC Linac. Future expansion of the LCLS complex will take full advantage of the entire linear accelerator: as LCLS grows, the entire Linac will be available to support an expanded program.

The upstream 2/3 of the SLAC linac served as the injector for the PEP-II B-Factory, an international user facility supported by the Office of High Energy Physics (HEP) until it turned off in April 2008. Since then, the SLAC Linac has been supporting LCLS commissioning activities using the last third of the Linac. Operational improvements to the LCLS FEL will continue throughout the remainder of the construction phase and into operations.

Core Linac Accelerator Operations

For nearly 50 years, operation of the 3-km long SLAC Linac has been a central component of the Laboratory's high energy physics accelerator-based experimental program. With the coming of LCLS beginning operations in 2009, the last third of the Linac will serve as the dedicated LCLS injector.

At the end of FY08, the Accelerator Systems Division (ASD) transitioned from SLAC's Particle Physics and Astrophysics Directorate (PPA) to the LCLS Directorate. ASD is primarily responsible for the Linac operations and coordinating accelerator physics, maintenance, and safety of the accelerator complex. ASD is authorized through the LCLS Directorate to operate the LCLS Injector, the LCLS Beam Transport, the LCLS Undulator, and LCLS Photon Transport. ASD will also maintain, in a minimum maintenance state, the first 2/3 of the linac and related infrastructure. ASD will coordinate maintenance and upgrades of these beam lines with most work accomplished by supporting technical departments and will also define R&D and accelerator upgrade needs, plans and manage operations and accelerator improvement installations.

During this reorganization of LCLS, the Engineering and Physics Division (EPD) was also created. EPD consolidated most of the engineering and physics staff to create a common support organization which can matrix out staff as necessary to the LCLS Accelerator Systems Division, LCLS Experimental Facilities Division, and the LCLS Strategic Projects Division. EPD provides a more efficient use of staff across the entire Directorate and ensures that common engineering, physics and work planning and controls processes and procedures are applied consistently across the organization.

LCLS Experimental Operations

LCLS will commence experimental operations in the Near Experimental Hall in September 2009. Initially, the LCLS experiments, determined by an evaluation of submitted proposals, will be focused on atomic, molecular and optical science. As additional experiments come on-line in FY10 – FY12, LCLS experiments will expand into other scientific thrust areas, diffraction studies of stimulated dynamics, coherent scattering of nano-scale fluctuations, and coherent imaging of non-periodic, nano-scale objects. With all experiments on-line, operations will expand to support ~5000 hours of photon science experiments annually. LCLS Experimental Operations will ramp-up dramatically to support operations, with new hires as well as staff transitioning from construction and commissioning activities into operations. LCLS Experimental Operations will plan and manage user administration, experimental support and photon operations, as well as scientific computing and detector research and development.

ii. Provide a FY08 budget table for operating. AIP, and capital equipment as they were allocated for salary, non-salary and power. Provide the power cost for 200 days of operation.

Power Cost for 200 Days of Operation per Year

The table below lists the expected electric power costs for the LCLS facility for FY09, FY10, and FY11. The plan for each year includes time allocated for down-time installation work, maintenance, start-up time, and machine studies, with a net yield of at least 200 days of beam delivered to the primary program each year. When the machine is in full operation, the normal weekly schedule will include fifteen shifts of beam to users and six shifts for maintenance and machine studies. The linac is currently operating at 30 Hz to support a commissioning and machine development program, but will increase to 60 Hz in FY10 and to 120 Hz in FY11. The power rates for FY09 and FY10 are not likely to change significantly, because much of this power has already been procured through long-term contracts. The FY11 rate is an estimate provided by Exeter Associates, assuming no significant increases due to market fluctuations or new regulatory requirements.

	Linac Rate Hz	Energy GW•hrs	Power Rate $/MW•hr	Total Cost $K
FY09	30	86.6	66.0	5712
FY10	60	97.2	68.2	6632
FY11	120	122.5	73.9	9056

iii. Provide a table that breaks down all LCLS accelerator-related scientific and technical staff (permanent, part-time, and temporary) by their assignments [list personnel (FTEs) and budget allocation for each assignment]. Show the number of FTEs associated with infrastructure support by general categories (mechanical, electrical, cryogenics, vacuum, physical plant, ES&H, etc).

The following tables provide details on the Linac-related scientific and technical staff:

<u>Table 1a – Detail of FTEs by Performing Organization</u>

Breakdown of FTEs by their home organization and type of worker.

Table 1a
Detail of FTEs by Performing Organization

org	Admin	Engineer	IT Prof	Manager	Scientific	Technical	Total
1.SSRL	0.7	0.3			0.4		1.4
2.PPA ARD		2.4			7.5	1.0	10.8
2.PPA ENG		0.3					0.3
3.LCLS ASD	3.0	8.5		7.3	4.0	15.0	37.8
3.LCLS DIR	2.9		1.1	6.2			10.3
3.LCLS EPD		13.1	1.9	1.5	16.4		32.9
3.LCLS SP				0.9			0.9
3.LCLS XFD		0.3			6.3		6.6
4.OPS ESH	0.5			0.5	1.7		2.7
4.OPS FAC	2.3	15.4		3.9		27.1	48.7
4.OPS SCCS	0.9		21.1	0.5			22.4
4.OPS TIS	1.6			0.5		0.3	2.3
9.1.ETS ADM	2.2	0.5		1.4			4.1
9.2.ETS CTL	2.2	28.6	2.3	3.0		17.1	53.2
9.3.ETS KLY	2.0	8.2		1.4		17.1	28.7
9.4.ETS MD	5.7	4.4		1.0		1.8	12.8
9.5.ETS MFD		10.5		0.2		10.7	21.3
9.6.ETS MET	1.0	11.3		1.0		5.5	18.8
9.7.ETS PCD	1.0	19.5		2.0		22.3	44.9
Total	25.9	123.1	26.4	31.2	36.2	117.9	360.7

Table 1b – Detail of Labor Budget in K$ by Performing Organization

Breakdown of labor budget by home organizations and type of worker.

Table 1b
Detail of Labor K$ by Performing Organization

org	Admin	Engineer	IT Prof	Manager	Scientific	Technical	Total
1.SSRL	76	42			69		187
2.PPA ARD		376			1,119	95	1,590
2.PPA ENG		42					42
3.LCLS ASD	216	1,120		1,097	558	1,521	4,512
3.LCLS DIR	263		199	1,089			1,551
3.LCLS EPD		1,974	278	277	2,484		5,012
3.LCLS SP				232			232
3.LCLS XFD		38			1,056		1,094
4.OPS ESH	36			81	265		382
4.OPS FAC	204	2,381		549		3,237	6,370
4.OPS SCCS	92		2,997	118			3,207
4.OPS TIS	142			57		25	224
9.1.ETS ADM	275	90		329			694
9.2.ETS CTL	221	4,319	296	600		1,829	7,265
9.3.ETS KLY	216	1,276		227		2,161	3,880
9.4.ETS MD	754	640		162		184	1,740
9.5.ETS MFD		1,552		30		1,158	2,740
9.6.ETS MET	103	1,709		252		687	2,751
9.7.ETS PCD	108	3,056		450		2,264	5,878
Total	2,705	18,615	3,771	5,550	5,550	13,161	$49,352

Table 2a – Detail of FTEs by WBS and Performing Organization

Breakdown of FTEs by level 1 of the WBS, their home organization and type of worker. Lower levels of the WBS are available on request.

Table 2a
Detail of FTEs by WBS and Performing Organization

wbs-1	org	Admin	Engineer	IT Prof	Manager	Scientific	Technical	Total
1.Mgmt and Admin	1.SSRL					0.4		0.4
	3.LCLS DIR	1.7		0.4	6.2			8.3
	3.LCLS EPD				0.3	0.3		0.5
	3.LCLS XFD					0.4		0.4
	4.OPS SCCS			1.8				1.8
1.Mgmt and Admin Total		1.7		2.2	6.5	1.0		11.3
2.Accelerator Operations	2.PPA ARD		2.0			2.4	1.0	5.3
	3.LCLS ASD	3.0	8.5		7.3	3.7	15.0	37.5
	3.LCLS EPD		3.4	0.9	0.3	10.9		15.4
	4.OPS ESH					1.2		1.2
	4.OPS FAC		4.8				7.1	11.8
	9.1.ETS ADM				0.1			0.1
	9.2.ETS CTL		27.5	2.3			17.1	46.9
	9.3.ETS KLY		5.8				12.1	18.0
	9.4.ETS MD		2.1				1.8	3.9
	9.5.ETS MFD		10.5				10.3	20.7
	9.6.ETS MET		6.4				3.2	9.5
	9.7.ETS PCD		17.5				12.1	29.7
2.Accelerator Operations Total		3.0	88.4	3.2	7.7	18.1	79.5	199.9
3.Eng & Physics Operations	1.SSRL		0.3					0.3
	2.PPA ARD					2.0		2.0
	2.PPA ENG		0.3					0.3
	3.LCLS ASD					0.2		0.2
	3.LCLS DIR	0.8		0.7				1.5
	3.LCLS EPD		9.2	1.0	1.0	4.1		15.3
	4.OPS SCCS			0.3				0.3
	9.3.ETS KLY		0.4					0.4
	9.4.ETS MD		0.8					0.8
	9.5.ETS MFD						0.4	0.4
3.Eng & Physics Operations Total		0.8	10.9	2.0	1.0	6.3	0.4	21.4
4.Experimental Facilities	1.SSRL	0.7				0.0		0.7
	3.LCLS EPD					0.4		0.4
	3.LCLS XFD		0.3			5.9		6.2
	9.2.ETS CTL		0.3					0.3
	9.4.ETS MD		0.0					0.0
	9.5.ETS MFD						0.0	0.0
	9.6.ETS MET		0.1					0.1
	9.7.ETS PCD						0.1	0.1
4.Experimental Facilities Total		0.7	0.6			6.3	0.1	7.6
5.Strategic Projects	2.PPA ARD		0.5			3.1		3.6
	3.LCLS ASD					0.1		0.1
	3.LCLS DIR	0.5						0.5
	3.LCLS EPD		0.6			0.8		1.3
	3.LCLS SP				0.9			0.9
	9.4.ETS MD		1.5					1.5
5.Strategic Projects Total		0.5	2.5		0.9	4.0		7.9
8.Operations	4.OPS ESH	0.5			0.5	0.5		1.5
	4.OPS FAC	2.3	10.6		3.9		20.1	36.8
	4.OPS SCCS	0.9		19.0	0.5			20.3
	4.OPS TIS	1.6			0.5		0.3	2.3
8.Operations Total		5.2	10.6	19.0	5.4	0.5	20.3	60.9
9.ETS	9.1.ETS ADM	2.2	0.5		1.3			4.0
	9.2.ETS CTL	2.2	0.8		3.0		0.1	6.1
	9.3.ETS KLY	2.0	2.0		1.4		4.9	10.4
	9.4.ETS MD	5.7			1.0			6.7
	9.5.ETS MFD				0.2			0.2
	9.6.ETS MET	1.0	4.9		1.0		2.4	9.3
	9.7.ETS PCD	1.0	2.0		2.0		10.1	15.1
9.ETS Total		14.1	10.2		9.8		17.5	51.7
Total		25.9	123.1	26.4	31.2	36.2	117.9	360.7

Table 2b – Detail of Labor Budget in K$ by WBS and Performing Organization
Breakdown of labor budget by level 1 of the WBS, home organizations, and type of worker.

Table 2b
Detail of Labor K$ by WBS and Performing Organization

wbs-1	org	Admin	Engineer	IT Prof	Manager	Scientific	Technical	Total
1.Mgmt and Admin	1.SSRL					69		69
	3.LCLS DIR	146		71	1,089			1,305
	3.LCLS EPD				41	50		90
	3.LCLS XFD					79		79
	4.OPS SCCS			196				196
1.Mgmt and Admin Total		146		267	1,129	198		1,740
2.Accelerator Operations	2.PPA ARD		307			361	95	763
	3.LCLS ASD	216	1,120		1,097	512	1,521	4,466
	3.LCLS EPD		523	113	29	1,611		2,277
	4.OPS ESH					188		188
	4.OPS FAC		684				757	1,441
	9.1.ETS ADM				16			16
	9.2.ETS CTL		4,190	296			1,814	6,300
	9.3.ETS KLY		907				1,490	2,397
	9.4.ETS MD		311				184	494
	9.5.ETS MFD		1,552				1,108	2,660
	9.6.ETS MET		1,003				333	1,337
	9.7.ETS PCD		2,750				1,363	4,113
2.Accelerator Operations Total		216	13,347	410	1,143	2,672	8,665	26,451
3.Eng & Physics Operations	1.SSRL		42					42
	2.PPA ARD					284		284
	2.PPA ENG		42					42
	3.LCLS ASD					31		31
	3.LCLS DIR	81		129				210
	3.LCLS EPD		1,366	165	207	643		2,381
	4.OPS SCCS			45				45
	9.3.ETS KLY		61					61
	9.4.ETS MD		99					99
	9.5.ETS MFD						50	50
3.Eng & Physics Operations Total		81	1,610	339	207	957	50	3,244
4.Experimental Facilities	1.SSRL	76				0		76
	3.LCLS EPD					66		66
	3.LCLS XFD		38			977		1,015
	9.2.ETS CTL		32					32
	9.4.ETS MD		0					0
	9.5.ETS MFD						0	0
	9.6.ETS MET		6					6
	9.7.ETS PCD						6	6
4.Experimental Facilities Total		76	76			1,043	6	1,200
5.Strategic Projects	2.PPA ARD		69			474		543
	3.LCLS ASD					15		15
	3.LCLS DIR	36						36
	3.LCLS EPD		84			115		199
	3.LCLS SP				232			232
	9.4.ETS MD		231					231
5.Strategic Projects Total		36	384		232	604		1,256
8.Operations	4.OPS ESH	36			81	77		194
	4.OPS FAC	204	1,697		549		2,479	4,929
	4.OPS SCCS	92		2,756	118			2,966
	4.OPS TIS	142			57		25	224
8.Operations Total		474	1,697	2,756	806	77	2,504	8,313
9.ETS	9.1.ETS ADM	275	90		313			678
	9.2.ETS CTL	221	98		600		15	934
	9.3.ETS KLY	216	308		227		672	1,422
	9.4.ETS MD	754			162			916
	9.5.ETS MFD				30			30
	9.6.ETS MET	103	699		252		354	1,408
	9.7.ETS PCD	108	306		450		895	1,759
9.ETS Total		1,677	1,501		2,034		1,936	7,147
Total		2,705	18,615	3,771	5,550	5,550	13,161	$49,352

iv. Provide a detailed organization chart that includes the names of all SLAC employees associated directly or indirectly with the LCLS operation. Describe the function of each major organizational unit and of the groups within these units.

Detailed Organization Charts are included in Dale Knutson's presentation, as well as a full print-out in the backup documentation.

v. Describe the ongoing R&D activities at the facility related to operational improvements. Include accelerator physics activities. How are these activities now supported? How will they be supported in the future?

The LCLS Linac, Linac-to-Undulator Transport, Undulator and e-Dump are being commissioned at the present moment. A beam has been successfully transported through the entire complex with good beam qualities. Daily machine development sessions are carried out to improve the beam characteristics. The list of detailed tests contains numerous items. The undulator magnets are due to be installed in March 2009 and will be commissioned shortly thereafter. The Front End Enclosure is due to be finished in April 2009 and will then be commissioned. Users in Hutch 1 are expected in July 2009.

There are working groups formed to study the expansion of LCLS to include a second Undulator in ESA to provide light at lower wavelengths compatible with LCLS operation. This group is also studying the possibility to use the first 2 km of the linac with a new gun and undulator to produce a world class light source using 28 GeV e-beams.

vi. Provide a description of the space allocated to LCLS staff and LCLS accelerator-related R&D staff (buildings, laboratories, offices) with the associated square footage.

LCLS PROJECT GROSS SQUARE FOOTAGES		
Building Number	Building Name	Sq. Footage
B002	Sector 20 Injector Facility	2,402
B081	Building 081 Magnetic Measurement Facility	6,250
B009	Beam Transport Hall (BTH) West	4,200
B910	Beam Transport Hall (BTH)	23,532
B911	BTH Service Building 2.1	1,134
B912	BTH Service Building 2.2	972
B913	BTH Service Building 2.3	2,322
B920	Undulator Hall	11,865
B921	Undulator Hall Service Building 3.1	2,000
B930	Electron Beam Dump	4,465
B940	Front End Enclosure	3,415
B950	Near Experimental Hall/Central Utility Plant	38,473
B960	X-Ray Tunnel	12,920
B999	Far Experimental Hall (including Access Tunnel)	17,865
B522	Substation 522	1,050
B028	Building 28 Office Upgrades	8,523
B751	Building 751 Office upgrades (first and second floors)	9,600
	Total Gross Square Footage	150,988

2) Future

i. Describe existing legacy problems (physical plant, ES&H, technical, etc.) that need to be addressed.

ES&H:

- Environmental contamination and needed restoration: DOE Moratorium on not releasing materials that are potentially activated from accelerator operations has resulted in stockpiling of significant shield block, iron and instrumentations from previous operations.

- SLAC is under a Site Cleanup Requirements Order, from the California Regional Water Quality Control Board San Francisco Bay Region, for the investigation and remediation of impacted soil and groundwater resulting from historical spills and leaks that have occurred during the course of operations.
    - Receive both EM and SC funding for this effort

Facilities: <u>(Presented in COO's G&A talk)</u>

- Current Deferred Maintenance (DM) Backlog: $26.8M
- Mitigation: SLAC has an ongoing plan to reduce DM
- Additional funding from SLI Project and the stimulus proposal submitted in January, 2009

SLAC Computing Services: <u>(Presented in COO's G&A talk)</u>

- Data Center building power and cooling limitations
- Mitigation:
    - Replacing old power-inefficient equipment with more power efficient equipment
    - Investigating temporary and permanent expansion options in and beyond the current data center building.
    - Scientific Research Computing Facilities (SRCF) is possible long-term solution

Technical: Technical legacy items presenting potential operational problems for the LCLS Linac and Undulator complex are primarily in the Linac infrastructure arena that are 40+ years old. Although these items are even now very reliable, over time they will become less so. There is an ongoing effort to replace these items as money and priorities allow. We have made significant progress with these items over the past year but much work remains. The items include the k-substation power distribution system, the variable voltage power sources, and the high voltage distribution cables.

ii. Briefly describe plans for facility upgrades for LCLS operation.

The LCLS accelerator will have to perform better each coming year to follow the demands of its user community. Improvements to the linac facility are envisioned with a well defined time frame to complete. Below is the present list of Accelerator Improvement Projects that will be used to improve the capabilities of the LCLS complex over the next 4 years. Given funding levels, these projects will be completed as rapidly as possible.

AIP Ongoing and Future Project List				2/3/2009		Seeman		
Project Name	**Charge Number**	**Tech Manager**	**Prior Year(s) Funding**	**FY2009**	**FY2010**	**FY2011**	**FY2012**	**Total Cost (k$)**
Ongoing Approved Projects								
Linac Timing Upgrade	67-24	Shoaee	322					322
Linac Network Upgrade	67-25	Lahey	325					325
Linac Machine Protection System Upgrade	67-26	Norum	667					667
Linac Waveguide Manifold Vacuum Controller Upgrade	67-27	O'Neal	244					244
Linac Klystron Modulator Upgrade S-28	67-28	Burkhart	441					441
Linac Quadrupole Magnet PS Upgrade Sectors 22-23	67-29	Ratkovsky	740					740
Linac control computer Upgrade Sectors 20-BSY	68-30	Shoaee	495					495
Linac PPS Upgrade	68-31	Bong	50	450	500			1000
BSY PPS Upgrade	68-32	Bong	50	550				600
Linac Quadrupole Magnet PS Upgrade Sector 30	68-33	Ratkovsky	50	90				140
Linac vibration damping Sectors 21-30	68-34	Schultz	50	550				600
Proposed New Projects								
Linac Building 136 dipole and quad upgrade		Ratkovsky		150				150
Linac Wire scanners in Sector 24 (4 units)		Schultz		300				300
Linac New VME PS controllers Sectors 20-30		Bellomo		250				250
Linac Quadrupole Magnet PS Upgrade Sectors 21+24-29		Ratkovsky		1400				1400
Linac EPIC controls upgrade Sectors 21-30		Shoaee		250				250
Linac BPM electronics upgrade Sectors 21-30		Shoaee		600				600
Linac Klystron Modulator Upgrade S-21		Burkhart		1000				1000
Linac new RF low level control unit (1 klystron)		Akre		250				250
LTU energy spread wire scanner		Iverson		100				100
New OTR screen for beam monitoring		Emma		60	100			160
Transverse x-band RF cavity after undulator		Emma			600	500		1100
Beam phase monitor after undulator		Emma			200			200
Energy spectrometer after BC2		Emma			800	700		1500
Linac Solid State Sub-boosters Sectors 21-30		Burkhart			800	700		1500
Linac New RF Low Level Controls Sectors 21-30		Akre			500	500		1000
Linac new hot swap laser		White			1000	1000		2000
Klystron Modulator Upgrades 20-30 (ex 28)		Burkhart			1300	1300		2600
Linac Magnet LCW controls upgrade Sectors 21-30		Schultz			600	600		1200
Linac Vacuum Pump Controller Upgrade Sectors 21-30		Fant			400	500		900
Linac New Klystron Solenoid PS Sectors 20-30		Bellomo			900	900		1800
Linac magnet temperature monitor upgrade Sectors 21-30		Robinson			300	900		1200
Linac FIAT Rack Power Distrib Upgrade Sector 21-30		Robinson				700		700
Linac water pump controller upgrade Sectors 21-30		Shoaee				900		900
Linac New RF Lowel Level Controls Sectors 21-30		Akre				800	400	1200
Linac 4 Crucial Klys Modulators to Solid State Sector 21		Burkhart					800	800
Linac Beam Line Fast Valve Upgrade Sectors 21-30		Shoaee					2000	2000
Linac Mechanical Alcove Motor Disribution Centers 21-30		Robinson					2000	2000
Linac Klystron Vacuum Gauge Controller Sectors 21-30		Shoaee					300	300
Linac sector air handling system upgrade		Robinson					1100	1100
Linac bunch length monitor upgrade		Emma					900	900
Bunch timing monitor upgrade		Emma					800	800
Linac upgraded undulator vacuum system		Shoaee					1200	1200
Linac water pump motor upgrade Sectors 21-30		Robinson					500	500
Totals				**6000**	**8000**	**10000**	**10000**	
Year				**FY09**	**FY10**	**FY11**	**FY12**	

iii. Identify potential problems – such as power shortages and cost, environmental contamination, etc.

Facilities:
- DM is currently based on condition assessments for FIMS report
- May increase in the future when condition assessments based on Mission Readiness

ES&H:
- Same as legacy issues until infrastructure and environmental restoration activities are done

SLAC Computing Services:
- Short lead-time scientific computing needs of LCLS.
- Successful transforming from a computing environment that supports a single-program lab to one that supports a multi-program lab.
- A mature multi-program funding model for computing to achieve optimal use of lab-wide computing facilities.

The main potential problems concerning the LCLS complex are natural disasters and hardware failures. The most likely natural disaster is an earthquake. The LCLS was constructed with high earthquake standards and will withstand an earthquake well.

The hardware failures which could cause outages of extended time are listed in Item 2-i. These components are being upgraded as needed and money allows. However, since LCLS uses only one third of the linac, there are sufficient spare parts of even these large items to limit a potential down to LCLS to about one week at most.

Risk management for the Experimental Facilities Division (XFD) during operations will follow a process similar to that used during the construction phase: potential risks will be identified and risk mitigation strategies will be developed as a regular activity of the management team. Risks will be analyzed to assess their potential impacts on operations deliverables (the principal deliverables being useful beam time and useful instruments ready to take beam), considering both impact on schedule and costs to alleviate the risks. Some site-wide risks are managed at the Directorate or Laboratory level. Localized risks that could affect XFD operations include:

1) Equipment failure. Much of the beam transport equipment consists of standard parts that are common at SLAC, with a good supply of spares. Certain key components, such as mirrors and detectors, are unique and involve long delivery times. Replacement spares for these critical items are being procured. In addition to assuring the availability of spare parts, XFD will manage a regular program of preventative maintenance for all critical components.

2) Loss of key personnel. XFD is growing fast, giving rise to the risk that key positions may not be backed up. This risk has been recognized, and the proposed XFD hiring plan aims to provide sufficient staffing such that the operation of the LCLS would not suffer unduly through the loss of key personnel. In addition, cross training strategies within XFD and between XFD and other SLAC groups (ie, Accelerator Division and SSRL) are being pursued to provide backup for certain functions.

3) Safety or environmental violation. It is recognized that a significant safety violation or environmental contamination by either XFD employees or by LCLS scientific users would cause major disruption to LCLS operations. Therefore, a comprehensive safety program based on ISMES principles and involving both staff and users is included within XFD. The XFD safety officer reports to the XFD director, works within the LCLS and SLAC safety structure, and oversees the design and operation of XFD safety practices.

iv. Provide a projected operational schedule for FY10-FY12.
An operating schedule has been developed which covers the next three years. This schedule is attached. The goal is to deliver about 200 days of beam to the user each year with an additional about 100 days of time devoted to accelerator machine development time, maintenance, and upgrades. This schedule takes into account other activities in the laboratory to provide an overall integrated schedule.

Draft LCLS 2009-2012 General Accelerator Schedule

Fiscal year	Month	Primary Program
FY2009	October	Down
FY2009	November	Commission e-
FY2009	December	Commission e-
FY2009	January	Commission e-
FY2009	February	Commission e-
FY2009	March	Down 3 weeks
FY2009	April	Commission e-
FY2009	May	Commission photons
FY2009	June	Commission photons
FY2009	July	Commission photons
FY2009	August	Users
FY2009	September	Users
FY2010	October	Users
FY2010	November	Users
FY2010	December	Users
FY2010	January	Down

FY2010	February	Down
FY2010	March	Turn on & Users
FY2010	April	Users
FY2010	May	Users
FY2010	June	Users
FY2010	July	Users
FY2010	August	Down
FY2010	September	Turn on & Users
FY2011	October	Users
FY2011	November	Users
FY2011	December	Users
FY2011	January	Users
FY2011	February	Users
FY2011	March	Users
FY2011	April	Users
FY2011	May	Users
FY2011	June	Users
FY2011	July	Users
FY2011	August	Down
FY2011	September	Down
FY2012	October	Turn on & Users
FY2012	November	Users
FY2012	December	Users
FY2012	January	Users
FY2012	February	Users
FY2012	March	Users
FY2012	April	Users
FY2012	May	Users
FY2012	June	Users
FY2012	July	Users
FY2012	August	Down
FY2012	September	Down