Report of the 13 October 2004 Meeting of the LCLS Facility Advisory Committee

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1.0 General

Introduction and Charge

The Linear Coherent Light Source Facility Advisory Committee (FAC) met with the LCLS project team on 12, 13 October 2004. J. Galayda specifically charged the Committee to advise SLAC, SSRL, and LCLS management on the development of the LCLS Project throughout its several phases and on systems:

- Accelerator systems design and construction
- Undulator systems design and construction
- X-ray transport, optics and diagnostics design and construction
- Experiment station systems design and construction
- Convential facilities design and construction
- Planning and execution of commissioning and early operations.

The Committee was divided into four subgroups: the Electrons Subgroup that covered the accelerator and undulator systems design and construction, the X-Ray Subgroup that covered x-ray transport, optics, diagnostics and experiment station systems design and construction, the Controls Subgroup, and the Conventional Facilities Subgroup. Appendix A is a listing of the members of the Facilities Advisory Committee that were present at this meeting and their respective subgroup assignments. Appendix B is the agenda of the 12, 13 October 2004 meeting of the LCLS FAC.

The following sections address the specific points of the charge through the summary reports of the subgroups. General comments and recommendations precede these summary reports.

General Comments and Recommendations

The project is making good continued progress. There is apparent progress in all areas of the project. The project is actively addressing all of the DOE review concerns. The project has also shown a sensitivity to advice received from advisory sources (including the FAC) and this is also evidenced in all areas

The FY2005 continuing resolution could be a blessing in disguise for the project. The FAC feels that this is likely the case as the project was matching costs while falling behind schedule at the end of FY 2004. Also, the project most likely would not be able to accommodate the steep ramp-up it had in the plan presented to the Committee. The project should actually exploit the *opportunity* presented by a continuing resolution to make a slightly gentler staffing ramp-up and adjust budgets and funding profiles.

Risk management is an important part of successful project management and the Committee encourages the LCLS to pursue it aggressively. Risk management is not merely a series of paperwork exercises that allow the project to have a successful External Independent Review (EIR). At the time of this advisory meeting, the risk registry did not reflect a strong global risk management approach. Risk management is as much for scientific and technical issues as well as project management, funding, and conventional facilities. For example, two risks identified during the course of the FAC meeting should be included in the risk registry until they are resolved: ac conductivity, and the very real possibility of extensive continuing resolutions in both FY2005 and FY2006. It has been said that "*If you manage the risks of a project, you will manage the project.*" The FAC recommends that the risk registry be used as a tool and that it be updated at least monthly.

Global systems integration and trades should be actively addressed as the evidence is not strong that this is being pursued aggressively. For example, the conventional facilities tunnel specifications and the undulator stability error budget needs to be addressed. Overall value engineering and the integration between the conventional facilities and the lasers also deserve attention.

2.0 Accelerator Systems Subgroup Summary

J. Corlett, W. Leemans, P.G. O'Shea, J. Pflueger, J. Rossbach,

(i) Injector

RF photocathode gun: Design of the 120 Hz rf gun is near completion, the proposed modifications to the rf gun design – dual feed to balance the field asymmetry, changes in coupling holes to reduce localized power density and heating, racetrack full cell geometry, and solenoid design - are welcomed improvements. Additional studies of mode-0 effects, higher mode distributions introduced by the laser ports, and possibilities for compensation of some effects by using beamline tuning were reported. At the time of the review, the implementation of a load-lock cathode replacement system had been deferred.

The design changes, however, emphasize the need to perform rf testing, as early as possible. The committee recommends that two guns be ordered simultaneously, and a plan developed for a gun test facility to allow for development of gun and cathode concepts. An rf gun test stand including full laser system and rf system (not necessarily at SLAC, but somewhere) is strongly recommended as a requirement for system integration tests, reliability studies, further improvements, and as a source of spare parts should the need arise. The GTF gun may be considered a fallback, but operates at only 10 Hz. Consideration of a load-lock cathode system should be revisited, as the ability to change cathodes could be a useful capability.

Photocathode laser system: Temporal control of the photocathode laser pulse, using a Dazzler, is under investigation at Brookhaven National Laboratory using a Dazzler on loan from Italy. Study of the operation of this system, including details of pulse deterioration resulting from frequency conversion processes, is welcome and encouraged to continue, with experiments on both optical and electron pulses at the DUV FEL. UV transport optics design was presented, with some remaining questions concerning the use of aspheric optics, which produce an intense waist. The committee supports the plans to continue design studies for the UV optics.

Laser heater: Requirements for the laser heater have been determined from convincing simulations studies. The IR pulse will be taken from the photocathode laser, before frequency conversion, to obtain a good mode profile. Modulation of the laser power may provide a useful diagnostic in facilitating FEL output detection with a lock-in detector tuned to the modulation frequency. Possibilities for testing concepts for this technique may be explored at the Brookhaven DUV FEL.

Laser systems in general: The Committee felt some concern about the availability of required laser and optical systems expertise in general for the facility, and recommends the building up of a strong in-house laser group to address laser systems design issues across the whole facility (injector laser, laser heater, near hall and far hall laser systems, synchronization issues, etc.). The hiring of a "laser jock" to provide oversight of integrated activities on laser systems is recommended, to also work in coordination with conventional facilities to address temperature and vibrational stability issues (e.g. upstairs / downstairs differences for the photocathode laser). The planned involvement of a scientific institute with extensive laser expertise, for example LLNL, is welcome.

Diagnostics: Injector diagnostics tools have been designed, and modeled in simulation codes, verifying capabilities in slice emittance and longitudinal phase space measurements, and the impact of degraded performance has been assessed. In addition, an alternate operating point of 0.2 nC and 5 ps bunch length has been explored with attractive results. Commissioning plans are yet to be developed and the committee recommends pursuing these, including exploration of techniques to automate feedback from electron bunch measurement to photocathode laser pulse manipulation, for optimization of electron bunch properties.

(ii) Linac

Bunch length control: A technique for bunch length control through feedback was presented, based on bunch length determination from power emitted from CSR in the THz regime, fed back to the S-band systems phase and amplitude control. Such control of bunch length will be required for stable operations, and the committee recommends continued development of THz detection techniques

(for example at the SPPS), and considerations of schemes to modulate the X-band section phase to discriminate effects arising from this linearizing cavity.
The x-band system is a small sub-system but important to the successful operations of the facility, and this device has the tightest phase tolerance in the facility. Expertise in this X-band technology should be nurtured.

Current-enhanced SASE: A proposal to energy-modulate the 4 GeV electron beam with a laser pulse interacting with a bunch in a wiggler magnet, followed by a dispersive section before the FEL undulator, resulting in increasing peak current density, has interesting possibilities in reducing the gain length of the FEL, and in allowing for precise synchronization with the modulating laser. Optimization of the technique requires changes in the undulator focusing lattice. The committee feels this to be a very promising technique and encourages development of schemes.

(iii) Electron beam diagnostics

BPMs: Development plans for BPM pick-ups were presented, based on ceramic-chamber striplines (for the linac) and C-band cavity structures (for the undulator), as well as 45° wire scanners in the undulator. The committee feels that absolute position measurement in the undulator will be valuable and recommends x-y (horizontal-vertical) wire scanners for more accurate absolute position determination, with the installation of 5 horizontally and 5 vertically. The wire position may then be referred to external fiducial marks and to a stretched wire system determining a straight line.

(iv) Timing and synchronization

Difficulties in determining the accelerating field experienced by a bunch in the linac structures requires measurement of multiple parameters for each linac section – at a minimum, the input and output rf phase and amplitude and temperature of each accelerating structure – and development of an algorithm to determine the coincident field conditions inside the structure. Beam-based measurements and feedback systems will likely be required (see for example bunch length control above), to accurately determine the timing of electron bunches and thus x-ray pulses. Electro-optical sampling techniques are under development at SPPS to allow determination of timing using post-processed data.

Low-level rf systems are based on existing SLAC linac phase and timing systems, and compatibility with these is required for full implementation of linac operations. The committee recommends that options for alternate timing systems dedicated to the needs of the LCLS facility be investigated, possibly with alternate master oscillator and stabilized distribution systems.

(v) Undulator particle physics

Strong longitudinal resistive wall wakefields in the undulator vacuum chamber were presented as potentially introducing a strong correlated energy spread along very short electron bunches in the FEL. The resulting modulation in energy appears to be sufficient to put some parts of the electron bunch out of the FEL resonance condition. The wakefield is sensitive to geometry, dimensions, and materials of the vacuum chamber. Changes in vacuum chamber dimensions may impact the undulator design, and the schedule for construction of the undulator. The committee recommends that the Project pursue calculations, modeling, and measurements of materials properties at relevant frequencies, and to follow a plan to reach a decision on undulator design by the end of January 2005.

In addition, the wakefield budget for the entire machine should be re-assessed in light of recent findings, and detailed FEL modeling including wakefields should be pursued.

The Committee would like to see simulations of the collimator design, including shower calculations.

Undulator System

The undulator concept now seems to be sound and moving. Most of the FAC April recommendations have been followed:

1. Canted poles together with the controlled roll out option allows for a much better control of the performance of the undulator system:
    - K-tapering
    - Temperature compensation – if required
    - Switching off undulator segments
    - Much improved optical diagnostic techniques similar to the photon beam based alignment techniques developed for the X-FEL

2. Quadrupoles are now decoupled from the undulator. The fact that they still share the same basis on the cradle may be a benefit for the whole system

3. EM quadrupoles offer better adjustability for electron beam based alignment techniques.

Questions and concerns

1. There should be some attention paid to the cradle/support/traction system, particularly with respect to the trade off with the girder and the tunnel stability requirements. With the pushing of requirements and performance so hard on the tunnel stability, it isn't prudent to leave consideration of principal interface too long.

2. In H.D. Nuhn’s presentation the adjustment of the K-parameter using the canted poles was proposed for compensation of temperature changes. LCLS should now consider the question: What are now the requirements and specifications on the temperature stability and what is the strategy to compensate for temperature variations?

3. The choice was made not to pursue a coordinating single contractor as previously recommended. The reason for not pursuing this option should consciously be understood and have full top-level project concurrence. The way the procurement was started seems to not follow this line. It is now planned to procure magnets, poles strongbacks etc. separately and look for vendors to do the assembly. LCLS needs to answer and be satisfied with the following questions: What are the reasons to do so? What about liability logistics, etc. Who is assuming the risks?

Frequency dependent wakefields: The impact at the moment is not fully understood of frequency dependent wakefields, but LCLS management is well aware of the issue. Activities in this area are already started. A full range of solutions are being examined including enlarging the vacuum gap and changing the undulator gap. If it is necessary to adjust the period/gap it is not necessary to prototype the change in the magnetic structure.

4.0 X-Ray Subgroup Summary

Roger Falcone, Paul Fuoss, Tom Rabedeau, Pete Siddons, Thomas Tschentscher

Presentations to the Committee

The x-ray sub-group heard presentations from three members of the LCLS management team on six different topics including 1) the physical infrastructure for experimental operations, 2) the MIE approach to experimental funding, 3) LLNL design of x-ray transport components, LLNL simulations of spontaneous synchrotron radiation patterns, 4) LCLS 2-D detector efforts, 5) x-ray optics specifications, and 6) progress on SPPS. Each of these areas will be summarized below.

In combined session, John Arthur described in detail the organization of the x-ray experimental facilities, the different areas that must be supported in order to perform experiments using the LCLS, and proposed funding levels for each of the major efforts. The plan currently has 9 FTE on controls, 2 FTE on mechanical and vacuum, 2 FTE on lasers, 1 FTE on detectors, 2 FTE on the initial atomic physics experiments and 2 FTE coordinating the entire program. It is expected that this construction level of staffing will have to grow in order to support LCLS operations. In FY05 the plan is to grow the program from the current level of 2 FTE to 6 FTE with the hiring of group leaders for each of the major areas. However, this plan is being delayed by the continuing resolution for DOE funding. In the breakout session the conventional facilities were discussed in more detail. However, it was generally concluded by the committee that there was insufficient detail regarding the experimental programs to modify the current end station plans.

Jerry Hastings described the new approach to the organization and funding of the experimental effort at LCLS. Until recently, the approach had been that LCLS would solicit proposals from various groups; the LCLS SAC would review each proposal, proposals that were approved by the SAC then be submitted for funding by the experimental group to an appropriate funding agency. The new plan has all experimental work being funded by a single Major Item of Equipment proposal to the Department of Energy. To achieve this goal, the SAC has combined all of the proposals it received for experimental work into five thrust areas. This combined effort is being submitted to obtain a CD0 for the MIE proposal. As the project moves forward, there will be a staggered start to each of the five thrust areas (the order of starting has not yet been established).

Richard Bionta described LLNL efforts to specify and design the x-ray transport components from the undulator to the experimental areas. This effort has been greatly slowed by the continuing resolution and by the consequential lack of funding. Currently, LLNL is working sequentially on individual transport components as funding permits, and has 1) completed preliminary design of the solid and gas attenuators and 2) tested a beam imaging camera which will be used to detect FEL gain.

Richard Bionta also described simulations of the patterns of spontaneous synchrotron radiation from the LCLS undulator. It was speculated at the last FAC meeting that these patterns could be useful for understanding the performance of the undulator sub-units. This presentation demonstrated that the patterns would be significantly modified by internal reflections from the polished beam pipe. Since these modifications are extremely sensitive to even small misalignments of the beam pipe, it’s unlikely that the spontaneous light patterns can be effectively used to characterize the undulator performance.

John Arthur described the x-ray detector requirements for the LCLS experiments. Detectors do not currently exist that will meet the LCLS experimental demands and, thus, LCLS is planning on supporting development of new detectors. To support this effort, LCLS has created a Detector Advisory Committee to give them technical and strategic advice about detector development. LCLS is also close to completing a Memorandum of Understanding with Prof. Gruner from Cornell University to help fund the development of his pixel detectors. A detailed discussion of why this was the most promising technology was not presented to the committee and, since they haven’t met yet, it has clearly also not been presented to the committee.

John Arthur presented a high level description of the x-ray optics required to support the x-ray end stations. There is still considerable uncertainty in what components will be included in the LCLS project. For example, there was originally supposed to be an x-ray streak camera to generate coarse timing information. This was then dropped from the project, but, since it appears crucial to laser operation and EO timing, measurements may be added back into the project.

Finally, Jerry Hastings provided an update on the SPPS project. There has been considerable progress on the EO measurements of pulse arrival time and pulse duration. In addition, "melting" studies of InSb with 100 fs time resolution have been performed and are being analyzed. There should be several high-impact publications coming out of the science efforts on SPPS. For LCLS, detector technologies and experimental techniques are being developed that should greatly simplify the startup of LCLS experimental programs. The program going forward this fall will focus on integrating the EO timing measurements into laser pump/x-ray probe experiments.

Concerns of the Committee

The main concern of the committee continues to be the lack of detail concerning specifications and needs arising from a comprehensive analysis of the proposed experiments. This lack of information is primarily due to a fairly late start of the experimental program (Letters of Intent for proposals were only received this summer). However, there are a series of workshops in the near future that should add a great deal of information to the experimental plan. It is crucial that this information be incorporated into the LCLS plan as quickly as possible.

The committee is particularly concerned that there are no conceptual solutions to the non-destructive characterization of each pulse of the FEL. Since it is expected that both the nominal photon energy and the total energy per pulse will vary significantly from pulse-to-pulse, such characterization may be crucial to the scientific program of the LCLS. Such measurements are unique to FELs, and it is difficult to extrapolate existing synchrotron technologies for their solution. Correlation of these non-destructive characterizations with the experimental data may also be challenging and should be examined as soon as possible. The x-ray subgroup would welcome a presentation concentrating on non-destructive photon beam characterization at the next FAC meeting.

Stability of optics, particularly the optics to steer the beam between the far experimental hall experiments, is a large concern. The FEL beam is fairly small (< 1 mm) and the lever arms (250 m) are very long resulting in stability requirements of less than one microradian on the optics. On most synchrotrons, feedback is used to stabilize components with such demanding tolerances. However, it is not clear whether such feedback systems will be effective on low-repetition rate sources such as FELs. Since the program depends on this technology working, a detailed engineering study should be done as soon as possible.

Detectors, data correlation, and data visualization are clearly going to be very important to the success of experimental programs on the LCLS. LCLS is correct to be concerned about detector development and the creation of a Detector Advisory Committee is a very positive step. However, it is crucial that detector development be driven by specifications coming from the MIE proposals. There should be a robust mechanism for communication between the MIE communities and the DAC.

The x-ray sub-group was asked to comment on the appropriateness of the conventional facilities layout, particularly the size of the FEH experimental areas. Without detailed input from the experimental proposals, all that can be argued is that the areas should be as large as possible. This guideline may add unnecessary cost to the project and should be revisited by 1) providing a mockup (either real or virtual) of the experimental area to the MIE teams and 2) asking them for detailed layouts based on the current plans.

Recommendations of the Committee

1. Efforts of the LCLS x-ray group should focus on problems which are unique to LCLS. Items which are common to most synchrotron and/or laser experiments should be left to the experimental groups. Experimental challenges which appear to be both unique to LCLS and extremely important include:
    - Shot by shot non-destructive diagnostics
    - Data flow issues (huge quantities of data will be generated)
    - Synchronization and merging of data streams
    - Development (and avoidance) of feedback systems appropriate for low repetition rate operation
    - Coherence preservation and measurement
2. The DAC should oversee detector development for both LCLS and MIE programs and ensure coordination between both efforts. It is important that sub-critical detector efforts shouldn’t be supported because those would lead programs down non-viable paths. Communication between the DAC and the MIE teams should be facilitated.
3. Identification and communication of critical issues to the MIE teams should be a priority. Also, mechanisms to facilitate communication between the MIE teams should be implemented.

The MIE teams should be encouraged to develop and commit to specifications for conventional facilities as soon as possible so that the appropriateness of those facilities can be determined..

5.0 Controls Subgroup Summary

Tom Himel, Karen White

Background

Since we met in April 2004, the LCLS Controls group has made good progress. People have been added to the design and prototyping tasks and management is prepared to hire quickly once funds are available. Because the control system for the LCLS is being developed as a collaborative effort by the partner labs, SLAC, ANL and LLNL, and the work is largely distributed among the various WBS elements, it is important to establish project standards and guidelines as well as a central database for static information as soon as possible. Regardless of where the controls are developed, they must be integrated into a coherent system. The controls group faces the further challenge of ensuring the LCLS control system is integrated with the SLC control system.

Standardization

The Controls Group continues to take steps towards the necessary standardization to ensure consistency in the delivered control system. They have identified the preferred set of EPICS tools for the project. This effort needs to continue to complete the software standards and to choose standard hardware where appropriate. The Controls Group must ensure the standards are followed throughout the project.

Organization

The controls design work for the Injector and Linac has been moved to the Global Controls WBS. It warms our hearts to see you follow our advice. This will help ensure design decisions that are consistent with the integrated control system, and we would encourage the same type of allocation for other areas. Now that a global controls effort has been clearly identified and is apparently growing, it seems appropriate to add it to the organization chart.

Database

It is well known that a project-wide database is needed to manage static information, but this effort has not yet begun. While such a database is generally a good idea, it becomes more critical for this project due to the need to configure, maintain and run two dynamic databases, one for the SLC controls and one for the EPICS controls. An additional complication will arise from the need to keep these two dynamic databases synchronized during machine operations and recover gracefully from exceptions and interruptions to various parts of the control system. We recommend hiring the initial database programmer and proceeding with this work as quickly as possible. If it waits much longer many parts of the team will start using their own spreadsheets or databases and will be nearly impossible to get them to use the central database. Note that the central database is a project-wide responsibility of which controls is simply major user.

SLC aware IOC

A major concern from the last review was the risk associated with the SLC aware IOC. Good progress has been made on prototyping the communications needed for this project. Unfortunately, no functional requirements and top level design documents have been written yet. The team indicated that the full project would be completed before the next FAC meeting. It is imperative that at least the requirements and design documents be written and **reviewed** by that time.

Design

The definition of the needed hardware and software components is proceeding well, considering the small number of people funded to work on this project so far. There has been good progress on the SLC-aware IOC, BPMs, Timing System. During the last meeting, we noted that the X-ray beamline controls were yet well defined. This still appears to be the case, as no additional information was presented at this time. It may be helpful to move this design effort to Global Controls, as has been done for the Injector and Linac.

Processes

In at least a couple of cases, it appears that hardware and software prototyping and/or implementation activities are proceeding, in advance of, developing written requirements and designs that are reviewed by the hardware and software experts. While this may appear to speed progress, it is a false economy, sure to cause problems later. We strongly urge the controls developers to adopt and use standard, good engineering practices, including appropriate documents and reviews throughout the life cycle of the project.

BPMs

The following issues were raised with regard to the BPM system in our last report:

- The BPM electronics in the linac are being designed to handle e+ and e- beams on the same pulse 60 ns apart. This complicates the design considerably. Management should assess the need for this capability (it is not for LCLS, but rather for the 3 months a year when LCLS doesn't run). This issue has been addressed and the new BPMs will not need to handle e+ and e- on the same pulse. If this functionality is needed, the old BPMs may be used.
- Consider putting BPM immediately next to and attached to quad as is usually done, to have them solidly locked together for beam-based alignment. This issue has not been addressed.
- The initial alignment, plus electrical offset specification of 100 microns for the undulator BPMS, is very tight. Is there really data to support this requirement? Can the beam based alignment process be improved to ease this tolerance? This question has not been addressed. Consider putting the quads on movers, instead of using correctors to ease the alignment tolerances even more.

Laser Controls

The requests for information and proposals for the laser system were written to include the vendor delivery of EPICS controls. The vendor responses are less than favorable for this scenario. One vendor suggested producing a Labview/EPICS solution to meet this requirement, which would introduce an additional, undesired maintenance load on the Controls Group. Furthermore, exactly what must be controlled for the laser appears to be undefined. The Controls Group, Laser Group and vendor must work together to resolve this issue and define an interface that will produce the desired result.

Cabling

There was discussion of a possible new cabling code requiring low smoke, non-halogenated cable. It is not clear where this requirement may come from; however, the Controls Group should investigate and adjust the budget, if needed.

X-band Phase Feedback

It is not yet clear how to design the feedback to control x-band phase. This phase has the tightest tolerances in the whole accelerator, yet what to measure to determine if it is incorrect, is not clear. Please consider dithering the phase and measuring the high frequency component of the longitudinal beam density as a possibility for this. If a diagnostic can be developed to directly measure the longitudinal beam density, this would help a great deal. While there were no ideas for a nondestructive diagnostic of this type, it may be reasonable to kick out 1% of the bunches into a destructive diagnostic (e.g. transverse RF cavity and profile monitor) for this purpose.

Free x-band stuff?

With the change of direction for the NLC project, it may be possible to get x-band klystrons and waveguides, for free, from the NLCTA. Investigate the possibility.

6.0 Conventional Facilities Subgroup Summary

H. Carter, A. Chargin, G. Kugler, K. Schuh

Technical

General Comments

Physics criteria integrator assigned. This is good!

Physics criteria exist. This is good. Whether or not the criteria are reasonably achievable is a point for future discussion within the LCLS team.

It appears that the Conventional Facilities team (CF), by itself, has no workable solution to meet undulator tunnel physics criteria. We expect that part of the solution may be in an active alignment system for the machine. We derive this comment from the data presented on the existing SLAC tunnel settlement for similar soils over a 17-year period.

There is no calculation prediction of the foundation system deflection for near term or long term creep. There is a lot of very nice work on effects of ground motion due to all types of effects: temperature, vibration, atmospheric pressure, tides, and long term soil effect. Given the available geotechnical data at the site and the proposed structural design, the deflection calculations and resulting plots should be produced.

It would appear, at least during the commissioning period, the proposed CF design will not meet the needed physics criteria as currently defined. Nor do we see a better design on the horizon. Some system integration thinking is required here to see if there is an active support system possible that would help meet the stated physics requirements.

Geotechnical

Much historical data exist as well as 11 new project specific borings. This is good! There is very good record of the SLAC tunnel motion over 17 years. All of this can be incorporated to make relevant predictions of the ground motion of the undulator tunnel. While the presentation on historical SLAC data was not explicit on the soil composition supporting the tunnel, it appears the worst settlement may be on fill. That needs to be checked. Further geotechnical review may demonstrate that these worst SLAC tunnel motions may not occur in the LCLS tunnel. If this were to be true, then the actual settlement would be much closer to the stated physics criteria.

Civil

We believe there has been a cost tradeoff done among various options of building tunnels, i.e. tunneling vs. cut and fill. However, we didn't see the data. It might have been useful to see it, if for no other reason, than to see how the AE/LCLS team approaches cost issues in CF design.

Structural

No presentations were made. By the time the FAC meets again, there may be issues. We were told that the building code the project adopted is UBC1997. This should be checked with DOE in order to get an early approval of building codes to use for the duration of the project. We believe there are later codes that DOE may wish the project to adopt. Specifically the structural steel welding requirements were updated significantly after the recent earthquakes in California and resulting weld failures.

Circular tunnel shape is not the theoretically moment-free structure. Since the tunnel is excavated and not bored, it may not be necessary to maintain the circular geometry allowing for a better structural configuration with possible reduction in excavation quantities while maintaining the useable space size.

HVAC

This is a high cost item, although there were no specific cost estimate presentations made. Through questions we found the HVAC in the undulator area to be critical because of very tight limits on temperature fluctuation. The design solutions presented are innovative. The cross ventilation scheme may be a good idea. In addition, for the same tunnel, it may be possible to heat the tunnel wall electrically to eliminate the temperature gradient at the inner surface of the wall. The heaters could be imbedded in shotcrete with the structural mesh.

Safety

No presentation was made on life safety requirements. There should be early specific consideration of critical design features impacting configuration in this technical area. How will earthquake design criteria affect design? DOE should have an opportunity to agree with the design criteria early in the process. Same is true for the radiation protection issue. A responsible fire engineer needs to be brought onboard at this stage of the design. For example, the cable system design needs to be checked by the fire engineer to reduce the risk of redoing a lot of work later. Also there should be an ES&H professional involved in the Title II design.

CLO

While we did not see the specific design, the planned housing of 300 people in 90,000 sq ft may not be a world class type looking facility. We would like a breakdown on area assigned per professional office person, per technician, and per graduate student, in order to make a more meaningful evaluation of the space planned.

Management

Cost

No presentations were made on the cost of the CF subsystem and there was no charge to the committee to evaluate this issue. Nevertheless the CF Subcommittee feels there are cost optimizations that could be studied for possible savings thereby increasing contingency while retaining the desired functionality.

Procurement strategy

The construction procurement strategy is still in development. The project schedule requires two buildings (S20 and MMF) to be started - before the acquisition strategy is fully developed. This may not be a problem. However, if the eventually chosen strategy involves using a CM contractor, at least initially the CM responsibility will be split.

In the planning stages, consideration should be given to possibly following the SNS model of establishing commodity prices in bulk, and offering them to the General Contractor as unit price sources. This involves several types of procurements. There may be CM furnished equipment (CMFE) such as substations, which may be a long lead item and the procurement can be placed as soon as the specification is known, and before the General Contract for a building is placed. The second type of procurement is a Directed Procurement, i.e. the CM may bid commodities such as concrete, structural steel and reinforcing steel on a unit basis. These unit prices would be provided to General Contractors (GC) to use in their bid submittals. In other words, the GC would not have to shop around for a good price, the supplier of the commodity would be pre-identified, but the procurement contract is still between the GC and the supplier. The third type of procurement would be of the general hardware variety. The suppliers would bid to a CM issued RFP on thousands of small commodity types, mechanical and electrical. This may be wall switches, cables, pumps, seals, nuts and bolts. These suppliers and their catalogue items at the pre-agreed price would be provided to the GCs by the CM. A discussion with the SNS/CF management, as well as the CM management may provide insight to advantages and disadvantages of the approach to assure the best outcome.

Construction Management

A number of possible management models have been considered.
The self-perform model of construction management performed by the SLAC staff has been rejected for lack of appropriate staff, and no continuing need for career CM personnel at SLAC. The option of SLAC hiring temporary CM staff was not discussed; however it may be a viable option.

Another model has the General Contractor and Construction Manager contained in one entity with minimal SLAC overview. While this model reduces apparent costs early on, in the long run it is like the fox guarding the hen house. This approach reduces checks and balances, so the eventual costs may end up being vastly greater than the initially projected savings. We would not recommend this approach, unless SLAC adds more direct staff with CM skills.

Given the overall constraints of the overall project circumstances, the separation of the CM and GC functions is the most likely choice. In competing for the CM contract, there should be no preference given one way or the other to the current AE. Either contractual arrangement, AE/CM or AE separate from CM. can be successfully managed.

Once selected, the CM would conduct the procurement process and administer the construction safety program. If the project chooses the contracted CM approach, we recommend that the CM selection proceed at the expeditious pace. As it is, the first construction contracts are scheduled to be placed before the CM is onboard. This may divide the CM responsibility, unless the execution of the already placed contracts is reassigned to the CM. This should be spelled out in the CM solicitation.

Construction contractor

There may be a desire by the LCLS Project to have a single GC doing the work, an unnecessary constraint. The likelihood of having many GCs is small, since those that win the initial contracts have a distinct cost advantage in competing in additional contracts. However, the benefits of competition are still there and no contractor would be likely to exceed market prices. A strategy of using the initial awards to qualify a limited number of contractors for subsequent construction should be considered.

Schedule

While we did not see a detailed presentation on schedule, other than the one overall viewgraph, it would appear that the proposed 27-month schedule is quite tight. There are inherent risks of underground construction and risks of construction work in partially or fully occupied facilities. We agree with the principle of adding critical path schedule contingency at the project level; however, we did not evaluate the schedule contingency assigned to individual CF activities.

LCLS CF management staff

The LCLS management staff should include a construction procurement professional to monitor and consent to the CM negotiated construction contracts. The management staff should also include a safety professional to interface with the CM safety program. There needs to be a QA professional function included as well. There may be more than one staff model that could satisfy these needs.

Tunnel Advisory Committee

Establishing such a committee is a good idea. There are continual pressures on the CF design, cost and schedule throughout the project construction lifetime; therefore, having an advisory group to evaluate issues on an as-needed and/or periodic basis will be beneficial to the project. The advisory committee concept needs to be expanded to include other aspects of CF subsystem.

Appendix A
Members of the LCLS Facility Advisory Committee present at the 13, 14 October 2004 Meeting

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Appendix B

Facility Advisory Committee (FAC) Meeting
October 12-13, 2004
Redwood Conference Rooms, ROB, Bldg 48
AGENDA

Tuesday, October 12, 2004
Plenary
Location: Redwood C/D, Building 48

7:30	Executive Session	
8:00	Welcome	J. Dorfan
8:10	Project Status Update; Charge to Committee	J. Galayda
8:20	Project Organization; Executive Status	M. Reichanadter
8:35	Injector Update	D. Dowell
9:00	Linac Update	E. Bong
9:25	Undulator Systems Update	S. Milton
9:50	X-Ray Transport / Optics / Diagnostics Overview	R. Bionta
10:15	X-Ray Endstations Update	J. Arthur
10:40	Break	
10:55	Laser Update	D. Dowell
11:20	RF, Timing	R. Akre
11:45	Conventional Facilities Update	D. Saenz
12:10	Lunch	
1:00	Breakout Sessions (see Breakout Session Agenda below)	
5:00	Executive Session (Redwood Rooms C/D)	
7:00	Dinner - Chef Chu's	Committee & Speakers

Breakout Session 1:
Accelerator Systems Design and Construction
Undulator Systems Design and Construction
Location: Redwood C/D, Bldg 48

1:00	Injector Physics / Diagnostics / Gun & Linac RF Design	C. Limborg
1:30	Modulated Laser Heater, Enhanced SASE	P. Emma
2:00	Bunch Length Feedback	J. Wu
2:15	Undulator / FEL Diagnostics	B. Yang
2:45	AC Impedance, Implications	K. Bane
3:15	Undulator Physics Update	H.-D. Nuhn
3:45	Break	
4:00	Undulator Vacuum, Mechanical	D. Walters
4:30	Undulator Prototype Status, Magnet Measurement System	M. White
5:00	Executive Session (Redwood C/D)	

Breakout Session 2:
X-Ray Transport, Optics & Diagnostics Design & Construction
Experiment Station Systems Design & Construction
Location: Redwood A/B, Bldg 48

1:00	LCLS Experiment Planning	J. Hastings
1:30	XRTOD Layout and Diagnostic Systems	R. Bionta
2:00	XRTOD Beam and Detector Simulations	R. Bionta
2:30	X-Ray Prototype Optics Specifications	J. Arthur
3:00	Break	
3:15	X-Ray Fast Detector Planning Status	J. Arthur
3:45	Experiment Facilities Walk-Thru	D. Saenz / J. Welch
4:15	SPPS Update	J. Hastings
4:45	Discussion	
5:00	Executive Session (Redwood C/D)	

Breakout Session 3:
Controls
Location: Madrone Conference Room, Bldg 48, upstairs

1:00	Controls Overview	B. Dalesio
1:30	Integration with SLC	S. Allison
2:00	Injector/Linac Controls	D. Kotturi
2:30	Undulator Controls	J. Stein
3:00	Break	
3:15	Discussion	
3:45	Physics Requirements and Technology Choices for LCLS Instrumentation & Controls Krejcik	
4:15	Discussion	
5:00	Executive Session (Redwood C/D)	

Breakout Session 4:
Conventional Facilities
Location: Alexander Room, Bldg 280, Room 206

1:00	Physics Requirements (click here for Support Documentation)	J. Welch
1:30	Construction Organization and Schedule	D. Saenz
2:15	Discussion, Jacobs Engineering Perspective	S. Hill
2:45	Site Conditions, Geotechnical Data	J. B. Folger
3:15	Break, Discussion, Site Tour	
5:00	Executive Session (Redwood C/D)	

Wednesday, October 13, 2004
Location: See listing below

7:30	Executive Session	Redwood A
8:00 -10:00	Breakout Sessions, continued (if necessary)	

Breakout 1: Redwood A
Breakout 2: Redwood B
Breakout 3: Alexander Room
Breakout 4: Babar, Bldg 280B, rm 162

10:00	Executive Session	Redwood CD
12:00	Lunch	Redwood A / Outside Patio
1:30	Executive Session	Redwood CD
4:00	Closeout - Plenary	Redwood CD