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TO: John Galayda, LCLS Project Director
Hanley Lee, Federal Project Director

FROM: Mark Reichanadter, LCLS Chief Engineer

SUBJECT: Value Engineering for the LCLS Project

As the LCLS, the world's first x-ray laser, prepares to enter the CD-2 phase of the project, it is perhaps prudent to note the value that the LCLS management and engineering teams have added to the LCLS project. This effort, mostly applied over the past year has been applied to reduce risk in the LCLS project by addressing specific technical issues, optimizing physics performance and incorporating engineering enhancements into the LCLS baseline.

It is anticipated that these recent improvements and efficiencies added to the LCLS project will allow the project to advance safely and efficiently through the CD-2, CD-3 and CD-4 phases of the project within its TPC and on or ahead of schedule. And while the LCLS team recognizes that value engineering is a "journey" and an inherent process in any well-run project, please note to date the following efforts to reduce risk and add value to the LCLS project.

Technical Design Reviews (TDR's) – Each LCLS system conducted an in-depth review of its overall system design to ensure that the current scope of the system meets the needs of the LCLS physics performance requirements. These integrated system reviews have helped to ensure that each overall LCLS system is complete and that its scope is mature enough to support a baseline estimate of its cost and schedule. The reviews for each TDR were as follows;

- Injector System TDR – November 2003
- Linac System TDR – December 2003
- Undulator System TDR – March 2004
- X-Ray Transport, Optics and Diagnostics System TDR – March 2004
- X-Ray Endstations TDR – December 2004

The following charge was presented to a committee of experts for each LCLS system;

- Will the current design meet the LCLS physics requirements?
- Are the current plans for design and construction reasonable?
- Where are the areas of high technical (performance & construction) risk?
 - Identify any technical issues not addressed in the current design.

- Identify the areas of high risk and make suggestions to mitigate the risks
- Identify areas where LCLS should continue parallel R&D efforts to reduce future risk.

Each TDR has a written report and the LCLS teams have addressed and/or incorporated the recommendations of the review committees into their current design.

Facilities Advisory Committee (FAC) Review – In addition to system-wide TDR's, the LCLS has also conducted its first LCLS-wide integrated technical review by its standing Facilities Advisory Committee (FAC) in April 2004 with the following charge;

- Consider the LCLS as an Integrated Facility;
 - Will it support the range of possibilities for the presently envisioned experiments?
 - Are we making design choices that foreclose important potential capabilities?
- Consider the LCLS commissioning challenges;
 - Does the design and commissioning strategy properly address the challenges of commissioning?

While the final report of the FAC is still in draft, the LCLS team is beginning to address some of the recommendations of the FAC.

Targeted Reviews and/or Workshops – On specific areas, the LCLS team has conducted targeted reviews using expert peer review to address particularly complex areas of the LCLS. Examples of these targeted reviews are;

- Undulator Parameters Workshop (October 2003) – A workshop, conducted at SLAC, specifically called to settle on the optimum set of undulator performance requirements for the undulator magnets. With a long list of variable undulator parameters, such as material, gap, canted poles, roll-away, “K” value, temperature, and diagnostics positioning this review allowed the LCLS team to carefully evaluate the best set of parameters to meet the needs of the LCLS.
- Undulator Magnet Review (November 2003) – A two-day review of the LCLS Undulator Magnet, conducted at ANL, to evaluate and optimize the magnet for production and magnetic measurements. Based upon this review, a number of production features were added to the LCLS magnet to facilitate the ability to use commercial vendors.
- Undulator Commissioning Workshop (January 2004) – A two-day workshop, conducted at UCLA, specifically investigated inter-undulator x-ray diagnostics used in the Undulator System. Based upon this workshop, it was determined that the inter-undulator diagnostics would not function properly over the full wavelength range of the LCLS. As a result, the inter-undulator diagnostics were descoped from the LCLS in order to invest in a full suite of diagnostics downstream of the undulator.
- Injector Laser Review (January 2004) – For the LCLS Long-Lead Procurements, an Injector review was conducted to evaluate the performance of the LCLS Drive

- Laser and its ability to deliver the high quality electron beam necessary for the LCLS Free-Electron Laser (FEL). A number of improvements to the earlier design, particularly in the areas of the laser and RF Gun were incorporated based upon the recommendations of the Laser Review committee.
- Injector “Heater” Review (February 2004) – For the LCLS Long-Lead Procurements, an Injector review was conducted to evaluate the performance of a laser heater in the Injector rather than the super-conducting wiggler in the Linac. An expert review committee endorsed the heater over the wiggler, thus providing improved physics performance and saving ~\$1M.
 - Injector – Linac Cost Review (March 2004) – Conducted as a cost and schedule assessment of common components used in both the LCLS Injector and LCLS Linac, this one day review at SLAC drew upon experienced engineering talent at SLAC to advise LCLS management on “make versus buy” decisions and opportunities to exploit economies of scale in LCLS procurements.
 - LCLS-wide Controls Review (April 2004) – Conducted as an integrated technical, cost and schedule review, this one-day review at SLAC, helped to assess the controls needs of the LCLS project and to ensure that the EPIC’s design will meet the needs of the LCLS as well as the SLAC SLC system.

Conventional Facilities Value Engineering – For LCLS Conventional Facilities, the Architect/Engineer, Jacobs Engineering, facilitated a targeted value engineering session in March 2004 which resulted in a savings of ~\$4M while maintaining the full functionality of the LCLS baseline design. In addition, LCLS management has requested that Jacobs evaluate the current construction schedule for the LCLS to ensure that all current assumptions are reasonable and that the work is organized in a logical and efficient manner. We will continue to evaluate and look for improving the schedule for the LCLS conventional facilities, as it is the critical path for the LCLS.

Scientific Advisory Committee (SAC) Meetings – To ensure that the LCLS properly addresses the needs of the FEL scientific community, the LCLS held the following meetings with the LCLS Scientific Advisory Committee (standing);

- Experimental Hall Layout/Functionality (September 2004) – In this one-day review at SLAC, LCLS management reviewed the layout and design of the LCLS experimental hutches and incorporated many features suggested by the SAC.
- SAC Winter Meeting (December 2003) – This meeting of the SAC reviewed the present concepts of the LCLS to ensure that the requirements of the FEL community are being addressed.

Reports of all reviews and/or meetings pertaining to value engineering on the LCLS project can be obtained in the LCLS Project Office.

As noted earlier, the process of value engineering will continue throughout the LCLS construction phase in order to optimize the LCLS design and work plan and reduce risk. Future examples of this process can be seen in the Project Management Cost & Schedule



(PMCS) review scheduled for July 2004 as well as a Title II value engineering session scheduled in the fall of 2004.

Though there is significant road ahead for the LCLS, the noteworthy efforts to add value to the LCLS recently can make us look forward to a successful project. Please join me in commending the LCLS team for their conscientious effort for a job (currently) well done.