A TECHNICAL ADDENDUM F

to the

MEMORANDUM OF UNDERSTANDING

between the

STANFORD LINEAR ACCELERATOR CENTER

and the

LAWRENCE LIVERMORE NATIONAL LABORATORY

for the period

October 01, 2005 – September 30, 2006

September 30, 2005

I. Introduction

This Technical Addendum F constitutes the Statement of Work to be performed by the Lawrence Livermore National Laboratory (LLNL) on behalf of the Linac Coherent Light Source (LCLS) Project. The Stanford Linear Accelerator Center (SLAC) is a signatory as part of its role in LCLS management oversight. This Statement of Work may be amended as required by the written agreement of both parties.

The work to be performed detailed in this document falls within the scope of the Memorandum of Understanding (MOU) between SLAC and LLNL dated August 10, 2002. The terms of agreement under which the work will be carried out are found within the MOU and continue to be in force.

The Appendix to this document contains a detailed description of work, and total estimated cost for the current period organized by Work Breakdown Structure (WBS) for each area in which LLNL is involved. When manpower resources are required, every effort will be made to identify specific individuals assigned to the LCLS project.

Budgeted funds for the current period covered in this Technical Addendum are $5,481,350, which consists of $1,448,400 Project Engineering and Design (PED),

$3,849,587 Construction (CONS), and $183,363 Long Lead Procurement (LLP). Long Lead Procurement carryover from FY05 will be used to fund the FY06 LLP activities. To the extent that carryover funds are insufficient to cover the total cost of these activities in FY06, additional funding requests (BCR's) will be submitted.

II. Approval

The undersigned concur with this Technical Addendum F to the SLAC / LLNL Memorandum of Understanding dated August 10, 2002.:

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John Galayda / Date

SLAC LCLS Project Director

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Richard Bionta / Date

LLNL LCLS Project Head

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Jonathan Dorfan / Date

Director, SLAC

_____

J. Brase/ Date

I-Division Leader, LLNL

_____

W. Goldstein/ Date

PAT Associate Director, LLNL

_____

M. Anastasio / Date

Director, LLNL

III. Appendix

This Appendix consists of the detailed Statement of Work (SOW) and associate budget and milestones for the work agreed to between the Stanford Linear Accelerator Center (SLAC) and the Lawrence Livermore National Laboratory (LLNL) with regard to the Linac Coherent Light Source (LCLS) Project.

LCLS WBS, Estimated Cost/Funding and Deliverable

The overall technical goal for the LLNL LCLS work for FY06 is to prepare detailed specifications, hazard analysis, engineering designs and procurement planning for selected WBS elements in preparation for procurement, fabrication and installation activities anticipated to begin in FY07. The work in FY06 will emphasize the diagnostics, mechanics, and optical systems necessary for the commissioning of the LCLS.

Estimated Cost/Funding ($000's)

	CONS	PED	LLP
1.02.03 Drive Laser Support			183.4
1.05.01 System Management & Integration	516.0		
1.05.02 Controls	85.3	275.8	
1.05.03 Mechanical & Vacuum Subsystem	249.1	62.5	
1.05.04 Optical Subsystem	1,751.2	220.5	
1.05.05 Diagnostics Systems	1,248.0	889.6	____
	$3,849.6	$ 1,448.4	$ 183.4

Total Budget	$ 5,481.4
Total Funding	$ 5,298.0

Note: The FY06 funding request does not include the Long Lead Procurement activities in 1.02.03 Drive Laser Support ($183,363). Long Lead Procurement carryover from FY05 will be used to fund the FY06 LLP activities. To the extent that carryover funds are insufficient to cover the total cost of these activities in FY06, additional funding requests (BCR's) will be submitted.

Effort to be Performed this Period

1.2.3.1.2 - Drive Laser LLP - Work will continue on the diagnostics for measuring and understanding the required ultraviolet pulse temporal shape. These results will be used in the analysis of the nonlinear propagation / frequency conversion code. Spectral amplitude and phase control will be used for the desired pulse shape. LLNL will continue to support beam steering stabilization and drive laser testing and integration.

1.5.1.1 System Management– This WBS element supports the management, control, financial and administrative effort at LLNL's Physics and Advanced Technologies Division in support of the LCLS X-Ray, Optics and Diagnostics (XTOD) System. This includes generating monthly reports on the progress of activities at LLNL, attending management meetings at SLAC, and coordinating the LLNL staff to meet the needs of the LCLS project. A major part of this effort involves monitoring the overall integrated safety plan for performing this work, maintaining and updating the resource-loaded schedule and budget system; maintaining the project risk registry; generating required documentation; and preparing for, documenting, and attending programmatic reviews.

1.5.1.2 LLNL Project Support – These WBS elements supports the LLNL LCLS safety officer and Project Engineer, both on a part-time basis.

1.5.2.2 Slow Controls – This WBS element supports the design of the integrated control system for the XTOD instrumentation and vacuum components using the EPICS architecture and toolkit. The scope of the FY06 work is to complete the detailed controls plan for the XTOD system consisting of equipment lists, manpower effort, cable diagrams, rack layouts, cable to-from lists, and to have all software drivers (excluding cameras) running compatibly with the SLAC LCLS control system.

1.5.2.3 Fast Controls – This WBS element supports the design efforts for EPICS controls for the 120 Hz instrumentation.

1.5.2.3 Fast Controls – This WBS element supports design efforts for EPICS instrumentation controls having sub picosecond resolution.

1.5.3.2 Mechanical & Vacuum Front End This WBS element supports the mechanical design of the FEE (Front End Enclosure)

1.5.3.3.1 NEH Hutch 1, This WBS element supports the specifications and design of the mechanical systems (beam pipes and vacuum tanks) for the commissioning diagnostics apparatus located in hutch 1.

1.5.3.3.2 NEH Hutch 2, This WBS elements supports the specifications and design for the mechanical systems of the beam pipes, vacuum system and PPS interface in hutch 2.

1.5.3.3.3 NEH Hutch 3, This WBS elements supports the specifications and design of the mechanical systems for the beam pipes, vacuum system and PPS interface in hutch 3.

1.5.4.2.3 Slit/Collimator – This WBS element supports the design of the Slit in the Beam Dump. The scope of work in FY06 will develop a complete mechanical design package for the slit and initiate procurements.

1.5.4.2.4 Flipper/Mirror – This WBS element supports the design and engineering of the Flipper Mirror System. The scope of work in FY06 is to develop a complete mechanical design package for the Flipper Mirror and initiate procurements.

1.5.4.2.5 Gas Attenuator – This WBS element supports the design of the Gas Attenuator in the FEE. The scope of work in FY06 is to present the design of the gas attenuator, procure, assemble, and test a prototype of one half of the gas attenuator, and the complete mechanical design package for the FEE gas attenuator.

1.5.4.2.6 TTF Damage Experiment – This WBS element supports testing the response of candidate materials critical to the LCLS XTOD for susceptibility to damage in intense photon beams. The scope of work in FY06 is to test materials at the TTF VUV FEL Facility in DESY (Hamburg/Germany) in October 2005 and analyze the results. In

addition the scope includes the evaluation and development of additional testing at longer wavelengths to provide data on long-term thermal effects.

1.5.4.2.7 FEL Offset Mirror System – This WBS element supports the development of the FEL offset mirror system consisting of 2 pairs of offset mirrors to offset the FEL radiation from the spontaneous beam prior to delivery into the experimental hutches. The scope of the FY06 effort consists of the design and specification for the mirror systems and mounting scheme, and qualifying vendors for the mirrors.

1.5.4.2.8 Solid Attenuator – This WBS element supports work on the solid attenuator in the FEE. The scope of work in FY06 is to develop a complete mechanical design package for the solid attenuator supported by vendor quotations for the Be parts.

1.5.4.4.2 System Monochrometer – This WBS element supports the specification and design of a system monochrometer. The scope of work in FY06 is to develop the mechanical design package for the Monochrometer.

1.5.4.4.2 Pulse-Split and Delay – This WBS element supports the specification and design of a Pulse-Split and Delay system that allow users to split the LCLS beam into two pulses separated by a selectable time interval. The scope of work in FY06 is to develop a mechanical design package for the Pulse-Split and Delay system.

1.5.5.2.1 Wave Modeling – This WBS element supports modeling and simulation efforts other than the Monte-Carlo and/or calculations used as input data to the Monte Carlo. The scope of the work in FY06 includes modeling the energy deposition and heat flow in the layers of the Total Energy Measurement System, calculating single and multiple undulator cumulative spectral distributions to be used as input to the spectrometer models, updating and maintaining the beamline component database, updating and release of beam visualization software, performing Kirkoff and parabolic beam propagations to evaluate spectrometer candidates, and modeling imager response to FEL signals in the presence of background spontaneous radiation for selected scintillators and optics.

1.5.5.2.2 Monte-Carlo Modeling - this WBS element supports Monte Carlo modeling and simulation efforts in support of the detailed engineering designs for the XTOD instrumentation. The Monte Carlo is a photon ray-tracing code including the additional physics relevant to the LCLS beam. The work in FY06 will include simulations of the beam transport through the electron dump (emergency dump collimators, fixed mask, and slit) whose primary purpose is to set the fixed mask aperture and to set alignment tolerances on the slit blocks. Similarly, the beam will be simulated through the Gas and solid attenuators to estimate scattering and to specify the tolerances on the alignment scheme for the 3 mm apertures in the gas attenuator. Simulations of the diagnostics package will follow these efforts in parallel with simulations of the FEL offset mirror system.

1.5.5.2.3 Beam Simulation - this WBS element supports the translation of UCLA files to Pradox format and releasing codes for viewing.

1.5.5.3.1 Direct Imager - This WBS element supports the specification and design of the Direct Imager Systems, which are high spatial resolution camera systems having calibrated response to x-ray radiation that will be used during commissioning to characterize the LCLS beam. In FY06 we will select scintillator, optics, and CCD sensors for two direct imager sensors, one located in Hutch 2 of the Near Hall and the other located in the FEE. Since the Fields-of-View are different for the two cameras, the imagers will be evaluated separately for sensitivity and response to the FEL and spontaneous background. The team will develop the mechanical and electrical design for the two direct imagers and their tanks, mounts, and enclosures and update the cost estimate and project Engineering Requirements Documents.

1.5.5.3.2 Indirect Imager - This WBS element supports the specification and design of the Indirect Imager Systems, which utilize a survivable multilayer to reflect a calibrated fraction of the FEL radiation into a camera. In FY05 we identified several SiC/B4C multilayers that would work at 2400, 8000, and 24000 eV and fabricated a 40 layer pair test structure of that material. In FY06 we will fabricate and test a full scale SiC/B4C and identify and fabricate test samples of survivable systems that work at 800 eV.

1.5.5.4.2 Total Energy Measurement System – This WBS element supports the design specification of the Total Energy Measurement System. In FY06 we will measure Resistivity vs Temperature curves for a series of CMR sensors which measure the temperature of the LCLS beam. We will then incorporate the optimized sensor recipe into the total energy sensor and test their performance with a long wavelength laser.

1.5.5.4.4 Spectral Measurement Systems – This WBS element supports the development of spectrometers to measure the wavelength spectra of the FEL and Spontaneous radiation at all energies. The FY06 work includes evaluating the design for the spectrometer and the FEE diagnostic package.

Personnel

The following LLNL personnel are identified as participating in the LCLS Program during this period of performance;

Name	Areas of Responsibility
Richard Bionta	Project Management & Senior Physicist
Donn McMahon	Project Engineer
Richard Beale	Safety Officer
Cindy Kelley-Clark	Administration
Rodney Victorine	Resource Manager
Linda Ott Kirby Fong	Applications Programmer
Steve Lewis Keith Kishiama	Controls Engineering
Eldon Ables	Electrical Engineering
John Trent Patrick Duffy Mark McKernan Stewart Shen Louann Tung Marty Roeben	Mechanical Engineering
Stephan Friedrich Richard London Dmitri Ryutov Michael Pivovaroff Stephan Hau-Riege Brent Stuart	Physicist

Reporting and Procurement Authorization

The person responsible for the LCLS effort at LLNL is the LCLS X-Ray Transport, Optics and Diagnostics System Manager and LCLS LLNL Project Head, Dr. Richard Bionta. The LCLS group at LLNL agrees to furnish complete documentation for all deliverables supplied to the LCLS project as well as quality control, design and performance checks carried out in the performance of this work

The LCLS Group at LLNL will report monthly on or before the tenth working day of the following calendar month to the LCLS Project Office. All LCLS-related materials and services, travel and labor charges will be reported according to Work Breakdown Structure (WBS) category at the lowest WBS level. Major procurements (currently >50k) must, in addition, have the written authorization of the LCLS Project Director. Procurements of control hardware shall be with the approval of the LCLS Controls WBS Manager. During this period of performance the LCLS Group at LLNL agrees to supply the above deliverables at a cost not to exceed the estimated base cost given in the LCLS WBS.

A high-level monthly report will also be generated by the LCLS LLNL Project Director and provided to the LCLS Project Engineer by the tenth working day of the subsequent month. This report will describe major highlights on technical progress, an overall assessment of the project's status and should emphasize any problems or issues that require attention.

Schedule and Milestones

The LCLS group at LLNL will make every effort to carry out their institutional responsibilities consistent with the overall LCLS schedule. In this Statement of Work the project milestones for this period of performance relevant to the LCLS group at LLNL are shown in the table below:

Milestone ID	Milestone	Milestone Date
MS3_XT035	Design Package - Spectral Measurement	07JUN06
MS3_XT015	Flipper Mirror Design Review Complete	05JUL06