ADDENDUM

to a

MEMORANDUM OF UNDERSTANDING

between the

INTERNATIONAL LINEAR COLLIDER
GLOBAL DESIGN EFFORT

and

The Lawrence Livermore National Laboratory

for the period

October 1, 2005 to September 30, 2006

1. *Introduction*

This Addendum constitutes the Statement of Work to be performed by the Lawrence Livermore National Laboratory (LLNL) in support of the International Linear Collider (ILC) for the period of October 1, 2005 to September 30, 2006. During this time period it is anticipated that the baseline design for the ILC will be derived under the auspices of the GDE and a reference design report and cost estimate will be started. It is conceivable that during the time period of this Addendum more emphasis and thus more resources may be allocated to the R&D efforts described in this Addendum. Alternatively it is possible that more emphasis will be placed on the reference design report and cost estimate. Such decisions are expected to be made jointly by the GDE and LLNL within the context of the international collaborative R&D program.

The activities detailed in this document falls within the scope of the Memorandum of Understanding (MoU) between the GDE and LLNL dated Nov, 23 2005. The terms and conditions under which the work will be carried out are found within the MoU and are in force for the duration of time covered by this Addendum.

Work at LLNL for the period covered by this Addendum will primarily involve: design of a target for the positron source, engineering for the development of a Marx generator, development of fast kicker technology for the damping ring kicker, development of a coupler test stand at SLAC and beam instrumentation at ATF. A detailed description of the work to be performed will be developed by LLNL and the GDE as one of the first FY06 tasks. This description will include a summary of the manpower and costs as-

signed to each task. Funds at the level of $1M for ILC R&D will be established at LLNL in FY06 by transfer from the DOE as recommended by the GDE-Americas Region Director.

2. *Statements of Work*

This Section contains the Statements of Work to be done at LNLL during the period of time covered by this Addendum.

Statements of costs and commitments incurred for each work package will be submitted at the end of each fiscal year quarter to the GDE-Americas Regional Office.

Semi-annual technical progress reports for each work package will be submitted at the mid-point and close of the fiscal year to the GDE-Americas Regional Office. These reports will contain descriptions of technical progress, statements of goals for the next reporting period, and indications of long-range plans.

Within two months following the end of the fiscal year, a final technical report for each work package will be submitted, in which the actual work accomplished will be compared with the scope defined in the work package in this MoU.

2.1 ILC-Americas WBS

The ILC-Americas WBS categories are listed below. The work packages defined in the next section are numbered according to this WBS.

WBS	Description
1	Program direction and administration
2	Accelerator design, including RDR
2.1	Management
2.2	Global systems
2.3	Electron sources
2.4	Positron sources
2.5	Damping rings
2.6	Ring to Main Linac
2.7	Main Linacs: Optics, beam dynamics, instrumentation
2.8	Main Linacs: RF systems
2.9	Main Linacs: Cavities and Cryomodules
2.10	Beam delivery system
2.11	Conventional facilities
3	Research and development
3.1	Management
3.2	Global systems

- 3.3 Electron sources
- 3.4 Positron sources
- 3.5 Damping rings
- 3.6 Ring to Main Linac
- 3.7 Main Linacs: Optics, beam dynamics, instrumentation
- 3.8 Main Linacs: RF systems
- 3.9 Main Linacs: Cavities and Cryomodules
- 3.10 Beam delivery system

4 Engineering and cost estimation in support of RDR
- 4.1 Management, technical and engineering services
- 4.2 Global systems
- 4.3 Electron sources
- 4.4 Positron sources
- 4.5 Damping rings
- 4.6 Ring to Main Linac
- 4.7 Main Linacs: Optics, beam dynamics, instrumentation
- 4.8 Main Linacs: RF systems
- 4.9 Main Linacs: Cavities and Cryomodules
- 4.10 Beam delivery system
- 4.11 Conventional facilities

5 Infrastructure and test facilities
- 5.1 Management
- 5.2 Global systems
- 5.3 Electron sources
- 5.4 Positron sources
- 5.5 Damping rings
- 5.6 Ring to Main Linac
- 5.7 Main Linacs: Optics, beam dynamics, instrumentation
- 5.8 Main Linacs: RF systems
- 5.9 Main Linacs: Cavities and Cryomodules
- 5.10 Beam delivery system
- 5.11 Conventional facilities

6 Reserve

2.2 ***Scope of Work***

WBS 3.2.1.1 Development of a fast kicker for the damping ring injection/extraction

Motivation: The creation of a fast kicker is critical to the choice of damping ring size. A faster kicker enables a smaller ring with concomitant improvements in cost and reliability.

Description: An initial prototype was created and tested at the ATF in FY05. Work in this year will be to design and test new circuits for improved performance with the goal of updating the prototype.

Milestone and Deliverable:

FY06
Complete fast switch evaluation
Design and build second prototype with upgraded switches
Test new model at ATF

FY07
Build 3rd prototype, evaluate control system with two units
Test dual units at ATF

Collaboration with Other Institutes: This work is to be funded under contract with SLAC and performed in collaboration with the SLAC pulsed-power group.

Key Personel: Ed Cook, Craig Brooksby

Cost Summary:

Labor (K$)	**M&S (K$)**	**Indirect cost (K$)**	**Total cost (K$)**
90	50	60	200

Expectations for FY07 and beyond:
This work is expected to continue into FY07 at the same level.

WBS 3.4.3: Positron source target design

Motivation: The positron target will be required to produce two orders of magnitude more positrons than has previously been achieved. This will require the development of an advanced target that will be able to handle the average and peak power as well as the radiation damage issues. A specification of the target and the handling of spent radioactive targets is necessary for engineering, costs and layout of the positron source facility.

LLNL has played a leading role in the development of rotating target designs for both a photon and electron beam based positron target. Previously, we have worked on the analysis of radiation induced structural failure of the SLC positron target.

Description:

- Detailed engineering design of the target sufficient for the construction of prototypes.
- Simulation of heat deposition, radiation damage and activation in the target.
- Analysis of spent target handling issues

Collaboration with other Institutions: Studies within this work package will be coordinated with all other institutions working on the positron source. LLNL is presently collaborating on the positron source studies with SLAC, Daresbury and Liverpool. Work on calculations of radiation damage has been supported by contract with UC Berkeley.

Milestones and deliverables:

Mar 06: Mechanical design of the target system
Jun 06: Simulation of activation and radiation damage completed

Key Personel: Werner Stein is the target design engineer. Jeff Gronberg is the Monte Carlo simulations physicist. Jeff Gronberg is the LLNL contact person.

Cost Summary:

Labor (K$)	**M&S (K$)**	**Indirect cost (K$)**	**Total cost (K$)**
340	30	230	600

Expectations for FY07 and beyond:
The work in FY07 and beyond will focus on construction and analysis of target prototypes as well as ongoing optimization of the positron system to improve cost and reliability.

WBS 3.8.1.2: Mechanical engineering of a MARX generator modulator prototype

Motivation: A Marx generator modulator has the potential to improve the baseline for the klystron modulator systems. Compared to the current designs there is the potential for; improved availability, lower unit cost, smaller physical size and possible reduction in cable plant.

Description: Work in FY06 will be mechanical engineering in support of the creation of prototypes and associated testing hardware.

Milestone and Deliverable:

Mechanical design of a high power resistor stack for testing
Mechanical design of a full Marx modulator

Collaboration with Other Institutes: This work is in close collaboration with Greg Leyh and the SLAC pulsed power group.

Key Personel: Craig Brooksby, Ed Cook

Cost Summary:

Labor (K$)	**M&S (K$)**	**Indirect cost (K$)**	**Total cost (K$)**
42	130	28	200

Expectations for FY07 and beyond:
Work in FY07 is expected to continue at the same level with focus on design for manufacturability.

WBS 3.8.3.2 Development of a Rf coupler test stand

Motivation: By developing an understanding of which components in the coupler design lead to long conditioning times and delicate operational stability, RF coupler designs for the ILC can be developed that are more robust and less costly, both to build and to condition.

Description: Eleven coaxial sections (40 mm ID, 70 Ohms) will be prepared that vary in terms of material (SS or Cu), bellows (none or 5 or 10 folds) and windows (with and without). A general purpose waveguide (WR650) to coax adaptor will be designed to power the test sections in vacuum (one pair of adaptors will be used for all the tests). The tests will be done at the Coupler Test Stand that is being built as part of the L-band project at the NLCTA. The test sections will be instrumented to detect electron and gas activity to gauge processing performance.

Milestone and Deliverable:

Feb 06: Commission coupler test stand w/o sections
May-Aug 06: Perform measurements
Sep 06: Analyze data and write report

Collaboration with Other Institutes: This work will be performed in collaboration with SLAC.

Key Personel: Brian Rusnak

Cost Summary:

Labor (K$)	**M&S (K$)**	**Indirect cost (K$)**	**Total cost (K$)**
60	0	40	100

Expectations for FY07 and beyond:

In FY07 we will apply the experience from the test stand to the optimization of the coupler design for the ILC RF.

WBS 3.10.3 Development of a Nanometer Resolution BPM system

Motivation: The development of precision BPMs capable of resolution at the Nanometer level would allow the testing of beam stabilization schemes critical to achieving luminosity at the ILC.

Description: An alignment frame which holds the BPMs as a rigid body while allowing some position and tilt adjustment was installed and characterized in FY04. A carbon fibre metrology frame to observe the slow thermal drift of the BPM positions will complete the mechanical constraints necessary to correct for any motion of the BMPs at the nanometer level.

Milestone and Deliverable:

Dec 05: Completion and characterization of a carbon fiber metrology frame
Jan 06: Installation of the frame at KEK
Mar 06: Data taking at KEK
Aug 06: Final analysis

Collaboration with Other Institutes: This work is in collaboration primarily with SLAC but also other institutions involved with the ATF program. Including LBNL, KEK, Queen Mary, and Oxford University.

Key Personel: Sean Walston, Carl Chung

Cost Summary:

Labor (K$)	**M&S (K$)**	**Indirect cost (K$)**	**Total cost (K$)**
48	20	32	100

Expectations for FY07 and beyond: The metrology system will be completed in FY06. It is expected to remain in place and to form the basis of the STAFF project. In FY07, activities at the ATF will be refocused on the development of recirculating laser cavities for the laser wire application.

3. *Execution*

3.1 *Effective Date*

This Addendum to the Linear Collider MOU shall become effective upon the latter date of signature of the Parties. It shall remain in effect until superseded or October 1, 2006 whichever should come first.

3.2 *Approval*

The following concur in the contents of this Addendum:

_____	_____
Gerry Dugan, GDE-Americas Regional Director	Jeff Gronberg, LLNL, ILC Program Manager
_____	_____
Date	Date