ADDENDUM

to a

MEMORANDUM OF UNDERSTANDING

between the

INTERNATIONAL LINEAR COLLIDER
GLOBAL DESIGN EFFORT

and the

Thomas Jefferson National Accelerator Facility

for the period

October 1, 2005 to September 30, 2006

1. *Introduction*

This Addendum constitutes the Statement of Work to be performed by the Thomas Jefferson National Accelerator Facility (hereinafter Jefferson Lab) 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 Jefferson Lab 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 Jefferson Lab dated TBD, 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 Jefferson Lab for the period covered by this Addendum will primarily involve the fabrication and testing of several nine-cell, 1.3 GHz superconducting accelerating cavities of the types being considered for use in the ILC. A detailed description of the work to be performed will be developed by Jefferson Lab and the GDE as one of the first FY06 tasks. This description will include a summary of the manpower and costs assigned to each task. Funds at the level of $300,000 for ILC R&D will be established at Jefferson Lab 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 Jefferson Lab during the period of time covered by this Addendum.

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

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***

Category 3.9

WBS 3.9.5: Fabrication of test ILC cavities using large-grain/single-crystal niobium.

Description:

This work package addresses the International Linear Collider cryomodule development efforts. In particular it proposes the use of large-grain/single-crystal high purity niobium for the fabrication of cavities based on the low loss shape and the original TESLA shape, which then will be combined into a superstructure (SST). Both the large –grain and single-crystal niobium and the SST based on the low loss cavity shape or the TESLA shape promise an opportunity for significant cost savings for the ILC .The choice of the cavity shape for the superstructure is depending on simulation calculations of higher order mode damping and possible trapped modes.

Motivation:

Recent encouraging test results at Jefferson Lab with cavities made from large-grain or single-crystal high purity niobium indicate that significant cost savings for the ILC might be realized, if the technology for this material could be developed to the state of development of polycrystalline niobium . At the recent ILC workshop at Snowmass this material was recognized as a high potential alternative to the BCD material, fine-grain or polycrystalline niobium. In addition, the combination of two cavities into superstructures – a concept, which has successfully been demonstrated at DESY by J. Sekutowicz and co-workers (J. Sekutowicz et al., "Superconducting Superstructure for the TESLA Collider; A Concept", PR-ST AB,1999; J. Sekutowicz et al, PAC2003, paper ROAA 003) - will further result in significant cost reductions due to reduction of the number of components such as power couplers, rf directional couplers, low level rf systems and beam pipe shortening (the length of ILC would be shortened by ~ 1,8 km).

Collaboration with other institutions:

The development of a superstructure initially needs plenty of electromagnetic field and HOM damping calculations to optimize a design with respect to number of cells/cavity, damping requirements for HOMs, location of dampers, inter-cavity coupling requirements, field flatness requirements, etc. This work can start immediately and we intend to involve the SLAC computational group under Kwok Ko into this work. J. Sekutowicz, who invented the superstructure at DESY, is one of the principle investigators and will closely work with the SLAC group on the electromagnetic design.

For demonstration of the superstructure concept at DESY, a special tuning system ("plate tuners") has been developed. We believe that this system can be adopted or borrowed for the superstructure test of the proposed development. Also, much of the engineering and design from the DESY test can be incorporated into this development, reducing the required engineering at Jefferson Lab.

As has been pointed out in the past, one of the draw-backs of the superstructure concept is the need for fundamental input couplers with twice the power carrying capability of single cavity couplers. However, already there presently exist power coupler designs and prototypes which fulfill these requirements. Nevertheless, more work, especially in the direction of reliability, needs to be done. This development work however is presently not part of the 2 years proposal as outlined in this document. Nevertheless, W.D. Moeller of DESY has strongly indicated his interest in these developments even within the 2 year time frame of this proposal and most likely a coupler of the TTF 3 design is available for these tests. Couplers have to be available for a demonstration with beam; but the non-availability does not prevent cryomodule testing of a superstructure.

Colleagues from other institutions (FNAL- N. Solyak- and KEK – K. Saito) have indicated their interest and willingness to participate in these developments.

A close collaboration with the niobium producing industry (CBMM in Brazil, Ningxia in China, Wah Chang in the US and W. C. Heraeus in Germany) is also essential for developing single crystal niobium of the size required for ILC cavities at 1300 MHz.

<u>Milestones and deliverables:</u>

We plan to deliver the following items in FY06:

April 1, 2006:	several single cell and at least one multi-cell cavity of the LL design, made from large grain/single crystal niobium
July 1, 2006:	an improved buffered chemical polishing system for producing very smooth rf surfaces on large grain/single crystal material
April 1, 2006:	a test cavity for superconducting rf joint investigations
Sept. 30, 2006:	results from these investigations with the goal to incorporate the most promising design into the superstructure
Sept. 30, 2006:	an optimization study of the superstructure configuration based on the Low Loss cavity or TESLA cavity design with emphasis on number of cells/subunit, HOM damping requirements, interconnection coupling requirements and field flatness requirements

<u>Key personnel:</u>

Peter Kneisel	25%
Gianluigi, Ciovati	10%
Ganapati Rao Myneni	5%

<u>Cost summary:</u>

Provide a cost estimate for the work. Indicate specifically, in a footnote to the table, the nature and purpose of any single M&S expenditures in excess of $75K.

Labor (K$)	M&S (K$)	Indirect cost (K$)	Total cost (K$)
170	*50.6*	*79.4*	*300*

If this is a collaborative effort within the Americas region, indicate the costs to be expended at the collaborating institutions in a separate table.

<u>Expectations for FY07 and beyond:</u>

In FY07, proposed deliverables are:

1. two low loss cavities suitable to be combined into a superstructure
2. an engineering package for the completion of a superstructure assembly ready for cold tests

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	hh, Jefferson Lab ILC Program Leader
________________________	________________________
Date	Date