Addendum to the
Memorandum of Understanding
between
The Fermilab National Accelerator Laboratory (Fermilab)
and
The Deutsches Elektronen-Synchrotron Laboratory (DESY)
concerning the TESLA Technology Collaboration

Addendum II: Development of a 1.3 GHz Superconducting Radio Frequency Module

June 30, 2005

1. Introduction

The purpose of this Addendum is to define areas of responsibility of Fermilab and DESY in the fabrication, installation, and commissioning of an eight cavity, 1.3 GHz, superconducting radio frequency module and associated systems at the SMTF facility at Fermilab.

The work detailed in this document falls within the scope of the Memorandum of Understanding (MOU) between Fermilab and the TESLA Technology Collaboration (TTC) dated May 15, 2005. General terms and conditions under which work will be carried out are found within the TTC MOU.

Specifically covered by this MOU are:

1. A complete set of subassemblies for an 8 cavity TESLA module ("DESY/Fermilab Module") will be fabricated at DESY and sent to Fermilab. Subassemblies will be assembled into a complete cryomodule by Fermilab and subsequently installed into the SMTF.

2. Individual cavities will be provided by DESY for commissioning of processing facilities in the U.S.

3. A higher gradient Capture Cavity (type III, ~ 25-30MV/m) will be sent by DESY to Fermilab for installation at A0 or SMTF.

4. LLRF and associated controls development and implementation for both the Capture Cavity and DESY/Fermilab modules will be undertaken as a collaborative effort between DESY and Fermilab.

2. Institutional Responsibilities

2.1 DESY/Fermilab Module

DESY will be responsible for providing a complete set of cavity subassemblies for assembly at Fermilab into an 8 cavity cryomodule to be incorporated into the SMTF facility. The DESY/Fermilab cryomodule was discussed at the Dec 6-7, 2004 TTC Meeting. This module will be of type TTFIII+. It will be selected from within the group of modules ACC 8-10 currently being planned. Assembly at Fermilab is expected in the mid-2006 to early-2007 time frame, dependent on the relative priority of this module within the TTF production line and the readiness of Fermilab to accept the module and its subcomponents. Fermilab's current expectation is that it would be ready to accept subcomponents for assembly on the Fermilab site in June 2006. The most probable assembly model is for individual Chechia tested cavities to be sent to Fermilab for assembly into a Fermilab (or possibly INFN) provided cold mass-module. String assembly would take place at Fermilab and would require appropriate cleanroom facilities.

Specific DESY deliverables include:

- 8 complete cavities with tuners (mechanical and piezo), couplers, and magnetic sheilding, mounted in their He vessels (Some cavities may be supplied at an early time without attached He vessels or other "dressing" components. These will be supplied separately. See Section 2.2)
- Associated components for string assembly including bellows, gatevalves, beam position monitors, and quadurpoles. The BPM-quad will be of the TTF type. (tentatively)
- Cavities consistent with type III+ cryomodule design
- Processing of all cavities by the standard "35 MV/m" procedures
- Horizontal testing of cavities prior to shipment
- The expectation is that the 8 cavities will average >24 MV/m at $Q_0 \geq 5\ 10^9$

Final agreement as to the shipping configuration will be worked out in the future.

Specific Fermilab responsibilities include:

- All cryomodule components beyond those provided by DESY (as described above)
- Tooling and cleanroom facilities necessary to assemble a complete cryomodule
- Assembly of DESY provided cavities and associated components into an 8 cavity string, and subsequent integration into a complete cryomodule
- Development of all electrical, rf sources and distribution, mechanical mounting, and controls infrastructure necessary to power a complete 8 cavity cryomodule in the SMTF.

Cryomodule assembly will occur on the Fermilab site. Fermilab intends to provide an electron beam source for testing with beam subsequent to commissioning with rf.

2.2 Individual Cavities

In order to begin to work toward the DESY/Fermilab module and to give Fermilab and collaborators experience with TESLA cavities, four cavities and one prototype without end groups will be made available to be shipped to Fermilab in the summer of 2005 after planned tests have been completed at DESY. At present these cavities include:

- Cavities Z84 and P2 would be used for commission of the JLab ep facility.
- Cavities S33 and D38 would be used for setting up processing, testing and measurements at Cornell and Fermilab.
- AC 68 is a candidate for utilization in Capture Cavity #2 (see below).

Fermilab may add helium vessels to these cavities and dress for horizontal testing. Cavities may be shipped directly to JLab or Cornell at the request of Fermilab. It is proposed that, if possible, three of these cavivite may be candidates for the eight cavity module.

Cavity	gradient	Helium vessel	Status	Needed/ available
AC 68	27.5	Type 3	Needs Chechia HOM test	June 1 for assembly at DESY
S 33	25	Type 3	Needed for HOM pick up test	Expected available end July 05
D38	21.7	no	?	Release when required
Z84	23	no	Needs 1400T, retest	Wait for results To be used for JLab commissioning of ep
P2	?	No, no coupler ports	?	Guinea pig for JLab ep Release when required

2.3 Capture Cavity #2

The Capture Cavity assembly from TTFI has been shipped to Fermilab with an old cavity. DESY will supply a new cavity with a gradient in the range 25-30 MV/m. Fermilab is responsible for redesigning the mounting of the cavity in the vacuum vessel. This redesign includes the beam-pipe with gate valves and the support modifications for the type III helium vessel. Fermilab will procure/fabricate and ship to DESY the required parts for assembly (beam pipes, gate valves, input coupler). DESY will assemble the cavity within a type III helium vessel. Other “dressed” cavity components will be supplied by DESY (coupler, tuner, motor, piezo, magnetic shielding).

An appropriate cavity will be selected and the complete assembly shipped to Fermilab for installation into the vacuum vessel. It is planned that this activity be completed by summer 2005

for operation at Fermilab prior to Oct 1, 2005. The selected cavity planned for this installation is AC68. It must be tested in Chechia prior to shipping. Fermilab will assemble the DESY supplied dressed cavity into its cryostat for subsequent testing and integration into either the A0 photoinjector or SMTF.

2.4 Low Level RF (llrf)

Continued collaboration between DESY and Fermilab on llrf and associated controls is critical to progress at Fermilab for the operation of SRF cavities. DESY expertise in this area will be important to assembling llrf systems for the Capture Cavity#2, SMTF modules, and new injector configurations. This collaborative activity could include personnel exchanges, sharing of knowledge, software and hardware developed for TTF and the XFEL, and consultation on new design configurations required at Fermilab. Working visits and exchanges to participate in mutually beneficial efforts would be part of this activity. Support, by way of information, design, hardware/software, and collaboration from the Rehlich and Simrock groups at DESY will be key to successful and rapid operation of these cavity rf systems. Details of collaboration on and exchange of hardware and software will be documented in a separate Addendum III.

3. Schedule

3.1 DESY/Fermilab Module

Fermilab is planning to have all infrastructure and tooling required for cryomodule assembly in place in the MP-9 building at the end of May 2006. At this time Fermilab will be ready to initiate assembly of a complete cryomodule. As such Fermilab desires that cavity subassemblies from DESY be available by June 1, 2006. DESY will proceed on a best effort basis to meet this schedule.

<u>Schedule Milestones</u>

These milestones will be used to judge the progress of the activity and the likelihood of achieving the needed delivery and installation dates. DESY and Fermilab will proceed on a best effort basis to meet these milestones. Milestones will be updated as required.

Finalization of the type III+ cryomodule design (Fermilab)	July 2005
Review of CM design	July 2005
Initiation of vacuum vessel and cold mass procurements (Fermilab)	July 2005
Review of (dressed) cavity design	July 2005
Identification of potential cavities for the DESY/Fermilab Module	December 2005
Final vertical test results from all DESY/Fermilab cavities	February 2006
Horizontal test results from DESY/Fermilab cavities	April 2006
Acceptance for shipment by Fermilab	May 2006
Complete cavity shipment	May 2006

Complete CM assembly tooling and infrastructure at Fermilab	May 2006
Receive cavities at Fermilab, initiate CM assembly	June 2006
Complete assembly DESY/Fermilab CM	December 2006

3.2 Cavities

Fermilab and its collaborators will be ready in mid-summer 2005 to accept cavities for use in commissioning of chemical processing and vertical testing facilities in the United States. Five cavities have been provisionally designated as described above. It would be most efficient if these cavities were available for shipment to the U.S. over the period July 1-September 1, 2005. DESY will proceed on a best effort basis to meet this schedule.

Schedule Milestones

These milestones will be used to judge the progress of the activity and the likelihood of achieving the needed delivery dates. DESY, Fermilab, and collaborators will proceed on a best effort basis to meet these milestones. Milestones will be updated as required.

Identification of cavities to be shipped to the U.S.	July 2005
Initiation of shipments	July 2005
Processing facilities available at JLab, Cornell, Fermilab/ANL	August 2005
Shipments complete	September 2005

3.3 Capture Cavity#2

Fermilab is desirous of installing capture cavity#2 into the photoinjector at A0 in the fall of 2005. Meeting this schedule is dependent upon delivery of a complete module assembly by October 1, 2005. DESY will proceed on a best effort basis to meet this schedule.

Schedule reviews and milestones

These milestones will be used to judge the progress of the activity and the likelihood of achieving the needed delivery and installation dates. DESY and Fermilab will proceed on a best effort basis to meet these milestones. Milestones will be updated as required.

Dressed cavity assembly shipped to Fermilab	July 2005
Assembled Capture Cavity Module#2 to Meson Lab	August 2005
Begin cryo commissioning	September 2005

4.1 Effective Date

This MOU shall become effective upon the date of final signature. It shall remain in effect until superseded or suspended by agreement of Fermilab and DESY.

3.2 Approval

The following concur in the contents of this Memorandum of Understanding:

Fermilab ILC Program Leader	Hans Weise, DESY
Date	Date
Harry Carter Fermilab ILC Lead Engineer	
Date	
Stephen D. Holmes, Fermilab Associate Director, Accelerators	Dieter Trines, DESY Director for Accelerators
Date	Date