international linear collider

ILC-Americas
FY06 Work Package
Technical Progress Report

Work scope period: 10/1/05 to 10/1/06

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WBS Number: 1.4
ILC Public Relations — Judy Jackson

1. **Technical progress.**

During the work scope period, the Fermilab Office of Public Affairs has made significant progress in communication for the International Linear Collider. We launched the Fermilab Envoy Program of forming connections between Fermilab staff members and key stakeholders in the community. We took significant steps toward forming the ILC Citizens' Task Force to bring key community members into the process of planning and decision-making for a bid to host the ILC at Fermilab.

With the help of the Perspectives Group, we recruited some 30 Fermilab staff members to initiate and maintain longstanding personal connections with key federal, state and local officials, business leaders, environmentalists, educators and other civic leaders. The Envoy Program launched with a training session on September 8. Each envoy selected two community members and agreed to meet with them, explain the envoy program, and become those stakeholders' principal connection to the laboratory, providing ongoing information about Fermilab and the ILC and responding to questions and concerns. Most envoys have now met at least once with their stakeholders. A dedicated data base stores information about the contacts between stakeholders and envoys.

A key early objective of the Envoy Program was to seek nominations for the new ILC Citizens' Task Force at Fermilab. Through the envoys' efforts, a press release, several local news stories and Fermilab Today articles, as of this writing we have received nearly 100 nominations for membership in the task force. A selection committee consisting of three envoys and three members of the Fermilab Community Task Force will make selection recommendations. The new ILC Citizens' Task Force is expected to hold its first meeting in mid-January.

A brochure highlighting the role of the ILC in Fermilab's future will be ready for print early in January. The head of the Fermilab Office of Public Affairs held an all-day meeting in late November with the chair of the LCSGA and the ILC-Americas communicator to coordinate Fermilab and national communication activities, including the formation of a national envoy program modeled on the local Fermilab program.

2. **Goals and plans for FY07**

Major goals and plans for FY07 include the convening of the ILC Citizens' Task Force in January. The Task Force is expected to complete its work, including a report containing its recommendations, by Fall 2007. We will complete the new Fermilab brochure, as well as a series of publications and Web pages on related ILC topics, such as economic benefits of hosting the new accelerator in Illinois.

A continuing task of the Fermilab Office of Public Affairs will involve its informal role in coordinating and supporting communication efforts by the LCSGA, the GDE, the InterAction Collaboration, users' groups and others. The Fermilab Office of Public Affairs will support the national Particle Physics Envoy program now being organized by the LCSGA.

WBS Number: 2.5.2
Damping Ring Accelerator Physics Panagiotis Spentzouris

1. **Technical progress.**

During the period 10/1/05 to 2/1/06 the DR Accelerator Physics effort at FNAL was lead by Mike Church. During this period, a study of potential DR related experimental activities was conducted. The results of the study were presented at an FNAL ILC meeting, and a report was written.

During the period 2/1/06 to 7/1/06 we focused on developing the necessary infrastructure for large-scale, multi-physics, simulations of the DR:

1. We used $50k M&S funds to expand our tightly coupled parallel cluster by purchasing twenty-one dual CPU commodity PC's. Twenty of the PC's were used to populate an existing fast networking switch (Myrinet) with existing NICs (thus leveraging FNAL CD resources), and one was added as a head node.

2. We extended our parallel framework, Synergia, to include electrons (and positrons). Synergia allows us to run 3D parallel simulations including multi-particle effects. We began studying the dynamic aperture of the baseline DR lattice and ran simulations, including space charge. We also recently began working closely with the ANL DR design group, in order to coordinate efforts and share resources.

During the period 7/1/06 to 10/1/06 we performed simulations of the DR using CHEF (single-particle optics) and Synergia (3D space-charge). The results of our initial simulations of the ring were discussed in our joint meetings with the ANL DR group. We also continued work on extending Synergia to:

1. incorporate a CSR model (working with the ANL group)
2. include impedance modeling capabilities.

In addition, we participated in discussions and attended workshops on the planning for the development of a DR test facility. We have begun to study the proposed lattice for the Cornell test facility, to help define appropriate code validation tests.

2. Goals and plans for FY07 and beyond

During FY07 we will continue using the 3D parallel code Synergia to study potential emittance growth and halo creation for different operational parameters of the baseline design. For example, we will study how close to different resonances we can run. Three-dimensional, self-consistent space-charge codes, such as Synergia are necessary to study halo generation and emittance dilution. We will continue developing our CSR module, with the objective to add such effects in the model and repeat a subset of the studies. We will also include realistic wiggler maps and impedance effects, as soon as calculations of the machine's impedance become available. In addition, we will participate in the effort to develop self-consistent electron cloud modeling, including cloud generation and cloud effects on beam dynamics.

WBS Number: 2.7.3
Main Linac Accelerator Physics Nikolay Solyak

1. Technical progress.

Fermilab is actively involved in the Main Linac accelerator physics studies. Our accomplishments for FY06 are as follows:

Static Tuning: Results presented in Snowmass-2005:

After the technology choice decision in Aug. 2004, we started carrying out static tuning simulations on the US Cold LC Technology option Lattice. We know that conventional survey and alignment techniques will not be sufficient to meet the required emittance dilution budget for the ILC and hence new and improved beam based alignment techniques need to be understood. To facilitate that, we compared the performance of the two different beam based steering algorithms: Dispersion Free Steering (DFS) and the Flat (or one-to-one) steering in terms of the emittance dilution. We performed the comparison of the various lattices with different quad configurations. We parameterized the emittance dilution as a function of number of quads in the lattice design. In the same line, we also compared the results of the TESLA lattice with the US Cold LC lattice.

After ILC BCD (Work from Dec. 2005 onwards):

Main Linac engineering lattice design: We are working on finalizing the main linac lattice. It includes working on the specifications of different beamline components, their positions in the linac, specifications of cold and warm drift spaces, matching of the main linac sections with ring-to-main-linac, undulator, and beam delivery system lattices, locations of diagnostic sections, and integrating the final lattice in generalized XSIF or/and MAD format. This lattice will be used as the final main linac lattice for the RDR. Fermilab based simulation program OPTIM, along with MAD have been used for the matching purposes. Deliverables: ML lattice is completed and posted on ILC Wiki page.

- **Progress in fourth FY06 quarter:** Matched LET lattice, including Ring-to-Main Linac (RTML), Main Linac (ML), Undulator, and Beam Delivery System (BDS), has been updated to include the changes occurred since Vancouver workshop. ML lattice is also matched to Undulator, RTML and BDS. MAD is modified to include the earth curvature effect so that the final lattice doesn't need to include any arbitrary element not present in MAD, like GKICK. Before MAD was updated, curved ML was also generated with the other method involving SBEND instead of GKICK. Latest version of the lattice is checked in terms of emittance dilution.

Development of the Simulation Tools for Accelerator Physics:

1. Package CHEF for Low Emittance Transport Simulation: We are working on extending the capability of a Fermilab based simulation package CHEF to the requirements of the ILC low emittance transport (LET) simulation. This code can be used to perform the complete start-to-end static as well as dynamic tuning simulations. To this end, the simulation code has already been benchmarked against other simulation codes in terms of tracking, and work is being going on to add static tuning algorithms in this package.

- **Progress in fourth FY06 quarter:** CHEF has been benchmarked against other simulation packages performing ILC simulation, as part of the benchmarking exercise undertaken in Snowmass 2005. Different versions of dispersion free steering and one-to-one steering have also been implemented and checked. CHEF doesn't require any commercial software to run on Grid computer. Model of the ground motion and vibration was implemented in CHEF. Element movers have also been implemented which allows for robustness in simulation.

2. Modifications in the Simulations Code LIAR: It is envisaged in the ILC BCD that the main linac of the ILC machine will follow the curvature of the earth instead of being laser-straight. Simulation code LIAR did not have the capability to simulate the curved linac system. We worked on the implementation of an arbitrary "dispersion free" element, called GKICK (or geometrical kick), which places beamline elements on the earth curvature by changing the reference trajectory. In LIAR, dispersion could not be used as the initial condition and there was no provision for propagating it through the Linac. We also added this feature. The matched dispersion condition at the beginning of the linac can now be artificially introduced into the initial beam.

- **Progress in fourth FY06 quarter:** The code is modified to include proper dispersion propagation for SBEND based ML lattice. Emittance dilution for the new ML lattice is also checked.

3. Lucretia as a tool for beam dynamic studies: This code is developed at SLAC and used for RTML, undulator studies. Code is based on C++/MatLab and includes features not available at LIAR (solenoids, synchrotron losses, etc.). We suppose to use this code for beam dynamic simulations and for DR-to-IP simulations.

- **Progress in fourth quarter FY06:** Lucretia has been installed, benchmarked and cross-checked for the static simulation. against MatLiar. Good agreement for straight linac. Few serious bugs were found in code in case of curved linac simulations. We are working with SLAC to fix problems.

4. Simulation Codes comparison: During the Snowmass meeting in August 05, it was observed that there were some disagreements in the results among the various software codes used for the emittance dilution studies. Hence, it was generally felt necessary by the LET community to perform a cross-checking of the various codes. We also participated in these cross-checking studies.

- **Progress in fourth quarter FY06:** CHEF has been benchmarked against other simulation programs, and new code, Lucretia has also been cross-checked for the static simulation.

Developing computing capabilities for Accelerator Physics simulations:

Beam dynamic simulations are very time consuming, especially dynamic tuning simulations. Goal of this task to develop computer capabilities and software for simulation beam dynamics on the multiprocessor machines

- **Progress in fourth quarter FY06:** We bought 20 nodes for the Fermilab grid computer upgrade for Acc.Physics simulations. Additional to that we bought two powerful servers to support HOM calculations, BPM design and other RF simulations for ILC cavity.

Static Tuning: We performed the simulation study of single bunch emittance dilution for the ILC main linac following the earth curvature, and also the implications of curved geometry on the beam based alignment methods, mainly one-to-one and dispersion free steering using the modified LIAR code. We compared the emittance dilution performance of the curved and the laser-straight geometry. We also investigated the sensitivity of these steering algorithms by taking into account the effect of various static misalignments on the emittance dilution performance of the ILC main linac. The contributions of the various sources of emittance dilution, like quadrupole or structure misalignments, structure pitches, quadrupole rotation etc., to the total emittance dilution were also studied. The sensitivity of the emittance dilution for both the steering techniques is compared for the conditions different from the nominal ones. These studies are particularly important as they provide information on the requirement of stringency of a given tolerance, as well as to understand the sensitivity of an algorithm to the various systematic effects. We have investigated the robustness of the DFS algorithm to failed

BPMs and correctors. Also, we studied the effect of incoming beam and quadrupole jitter, the effect of adding extra BPMs in the Lattice, and the effect of dispersion bumps on the emittance dilution performance. We are also working on developing new, and modifying existing, tuning algorithms. Deliverables: Static tuning studies for the ML are completed to the level needed for RDR document.

- **Progress in fourth FY06 quarter:** Effect of BPM scale errors has been studied in LIAR and also had a first look at the wake bumps. There has also been a conceptual understanding of the wake-bumps to be used for emittance preservation. However, because of some limitations and limited support for LIAR, and keeping Start-to-End simulation in consideration, we have also started working on a new, more robust simulation code, ***Lucretia***. The code has been used, elsewhere, for RTML design and dynamic steering in BDS. Lucretia has been tested against the earlier benchmark of the simulation codes and steering algorithms have also been implemented. The results of the steering algorithm implementation, both one-to-one and dispersion free steering, have also been checked against LIAR results and two are in very good agreement.

Dynamic Steering and Start-to-End simulation

- **Progress in fourth FY06 quarter*:*** We have already studied the effect of incoming beam jitter, and quadrupole vibration jitter on emittance performance in LIAR. Simulation codes are being modified to include the dynamic steering. DFS with beam jitter and ground motion will soon be implemented in CHEF.

Ground Motion:

- **Progress in fourth FY06 quarter:** Ground motion (GM) data at PW, Fermilab, 1999 has been analyzed and incorporated in GM model. A numerical simulation tool has been developed to analyze the effect of GM, and a steering solution is worked upon to suppress its effect on the ML performance. An adaptive alignment algorithm was incorporated and studied in the presence of GM and vibration in a few models. It was shown that AA methods is stable and keeps the linac aligned on the scale of few minutes (limited by calculation time)

HOM studies: Preliminary results of the multi-bunch emittance dilution studies show that although the effect of random frequency errors in cavities is extremely beneficial, we also need to pay attention to trapped modes in cavities. We are investigating the effect of R/Q and Q_{ext} for a few first pass bands in the real model, Q_{ext} scattering due to cavity imperfections and inter-cavity spacing, and optimizing the design of the HOM coupler.

- **Progress in Last quarter of FY06:** The new approach to calculate wakefields HOM properties and HOM dumping in string of the cavities is under developing. This is S-matrix decomposition method**,** which allows build s-matrix of the complex RF device from the calculated matrixes of sub-components. Method was applied to 3rd harmonic cavity for simulation of the first two dipole bands, results are in a good agreement with measured data.

Beam instrumentation issues:

- **Progress in Last quarter of FY06:** We start design of the L-band cavity BPM with sub-micron resolution. It is cleanable design with with Q~600 which allows to measure position of the each bunch in train. A Copper model with ceramic windows is in production. Analysis of production tolerances, errors and specs for signal processing is underway.

2. Goals and plans for FY07

Fermilab will continue with its efforts in FY07. The goals for FY07 are as follows:

Main Linac engineering lattice design: We will continue work on ML linac design by changing optics according to engineering drawings, cryogenic requirements, quadrupole magnet and corrector designs, beam diagnostics etc, when they are available. Fermilab will continue to be responsible for maintaining this lattice on the Wiki page.

Static tuning – We will continue with our present studies on the static misalignment issues of the ILC main linac. We will keep working on the design of the realistic main linac lattice, carry out the emittance dilution studies, continue with the understanding of steering algorithms in the presence of static misalignments, and participate in setting the tolerances on the various beam-line components. So far, we have been working on simulation codes LIAR and MERLIN to perform most of these simulations. However, we are also working on the development of a robust simulation code, CHEF, for the emittance preservation studies and will continue with this effort. We will also keep working on the wakefield calculations for different RF cavities. Lucretia will also be further used to perform static simulations. We will also address the remaining issues in Dispersion Free Steering, like using RTML to perform DFS in launch region, and optimization of emittance bumps.

Dynamic tuning – Once the alignment tolerances on the linac components is set (on the basis of static tuning studies), it is important to understand how well those tolerances can be maintained over time in the presence of component vibration and ground motion. We will carry out beam-based feedback (intra-train, train-by-train, interaction point, etc.) studies, which will be essential to maintain the (a) gold orbit established by initial tuning and (b) desired luminosity in the presence of the vibrating components. Based on the various ground motion models, long term stability issues (time scale of hours to months) will also be studied.

Integrated (Start-to-End) simulation – We will carry out full Low-Emittance Transport (LET) studies from the damping ring exit to the interaction point with a particular emphasis on the tuning algorithms, alignment issues, tolerances on beam line elements, and operational concerns. This study is particularly important to understand the final luminosity performance.

<u>Development of the Simulation Tools for Accelerator Physics</u>: - Continue development of the CHEF program for dynamic simulations. Incorporate Adaptive alignment method and Kick minimization alignment. Complete benchmarking CHEF against other codes.
Continue benchmarking and development of Lucretia in collaboration with PT,SLAC.

<u>Developing computing capabilities for Accelerator Physics simulations</u>
We will continue develop necessary software and installation CHEF, MatLiar and Lucretia on grid machine with the goal to start dynamic simulations in FY07. We need to buy a matlab compiler.

<u>MPS design</u> – It is necessary to understand full specifications on the components, procedures, and algorithm logic required for MPS to assure that each bunch can be transported safely to a beam dump without causing hazards (like heating the non-dump components).

<u>Beam instrumentation issues</u> – We will continue with our efforts to further understand and address the beam instrumentation concerns. For example, we will study the number of diagnostic sections in the linac and the required BPM resolution to achieve the desired emittance budget.

<u>Cold BPM design</u> <u>(0.3um resolution, clean technology)</u> - In ILC linacs, each quad has an associated BPM with resolution 0.3-1um. This is a 78mm aperture BPM working in the cold environment. No existing devices can provide all these requirements. Together with the Beam Instrumentation group, the Accelerator Physics Group will develop a cavity type BPM to fulfill the ILC requirements. We are planning to finalize tolerances analysis, build and test copper prototype and start final design to be installed and tested with the beam in cryomodule in NML.

WBS Number: 2.11.1/2.11.2
Conventional Facility Design F. Asiri/V. Kuchler

1. **Technical progress.**

Personnel at SLAC and FNAL work in close conjunction to perform the work described in this Work Package. For that reason, progress reporting for both WBS 2.11.1 (SLAC) and 2.11.2 (FNAL) will be described in this single report.

During FY06, efforts by the SLAC/FNAL ILC Conventional Facilities Group were primarily devoted toward two specific milestones. The first milestone was to finalize the Conventional Facilities contribution to the ILC Baseline Configuration Document (BCD). The second milestone is to develop a credible cost estimate for ILC Conventional Facilities that will be incorporated into the overall ILC cost estimate for the Reference

Design Report (RDR). These milestones remained unchanged throughout FY06 and were achieved.

As noted in the previous progress report, the Conventional Facilities contribution to the BCD was completed in December, 2005. Subsequent to the completion of the BCD, conceptual design drawings and associated cost estimates were developed for the ILC Conventional Facilities. These efforts not only included the development of many 3-D visualization drawings which facilitated the top level assessment of various design alternatives, but also included a set of concept design drawings that provide a cost effective and safe design solution for both underground and surface facilities.

In July, 2006, the first complete cost estimate and associated conceptual drawings were completed in time for the GDE Meeting in Vancouver, B.C. After the initial review of the Vancouver cost estimate, it was determined by the GDE RDR Management Group to extend the schedule for the completion of the RDR until February, 2007. This added time was intended to be used to review the existing costs and explore various options for cost reduction.

To that end, the SLAC/FNAL ILC Conventional Facilities Group devoted all effort in the fourth quarter of FY 06 toward the review of the existing cost estimate. First, this review consisted of an internal CFS review to insure consistency and accuracy across all regional cost estimates. The majority of the work however, was devoted to review and analysis of proposed options developed by the various area systems to determine feasibility and the potential for cost reduction. During the course of the review process, the CFS Group identified several opportunities for cost reduction as well. Several alternatives were considered and a complete review of all options for cost reduction for the CFS Group was formally conducted at the RDR Meeting at CALTECH in October, 2006.

The SLAC/FNAL Conventional Facilities Group also continues to coordinate efforts with the other CFS Regional Teams to complete all required work in a consistent manner.

2. Goals and plans for FY 07

The first quarter of FY 07 will be devoted to the refinement of the Conventional Facilities conceptual drawings and cost estimates, across all regions, for eventual inclusion into the ILC RDR. Further, revisions to the configuration and conceptual drawings as well as associated cost estimate are anticipated in response to various reviews and scope changes from area system managers for the optimization of the overall ILC cost. In addition, necessary text will be written to complete the Conventional Facilities portion of the RDR. The first draft of the RDR is due to be completed in December, 2006 with the final text and cost estimate due in February, 2007 Refining the cost estimate will continue to include the verification of currently identified criteria, quantities and respective unit costs as well as the investigation of alternative configurations for possible cost savings or other efficiencies. It should be noted that proposed alternatives will, in most cases, affect area and technical systems beyond the Conventional Facilities.

Other goals for FY 07 will include an independent review of underground unit costs and the beginning of the effort to define and develop the Engineering Design Report.

WBS Number: 2.1.2
Reference Design Report Shekhar Mishra

1. **Technical Progress.**

The Reference Design Report (RDR) will be a key document for defining the scope of the ILC project, the R&D program, and the project cost. Fermilab's objective in these activities is to both secure approval and funding of the ILC as an international project and to develop an Illinois site near or at Fermilab as the preferred site.

Fermilab scientific and engineering staff has been working with the ILC GDE on the development of the Reference Design Report.

The Snowmass workshop (Aug 05) began the definition of the ILC baseline configuration document with the baseline and alternate configuration recommendations. The Working Groups, Global Groups and GDE finalized the Baseline Configuration Document (BCD) in Dec. 2005 at the Frascati Meeting. The ILC baseline configuration is now under Configuration Control Board (CCB) and we are using it to develop the ILC Reference Design Report (RDR) by early 2007. The RDR activity is supported by Area Systems, Technical and Global Groups, R&D, Cost and Schedule, and Change Control Boards. Fermilab has key roles in many of these groups and boards. Several members of the Fermilab Staff are working on the technical development of the RDR and also participate in GDE boards that assist in the RDR development.

Fermilab's primary participation is in the Main Linac, Site and Conventional facility, Magnet and cost and schedule development. The details of the design and technical progress made to date are described in other sections of this document. Fermilab is managing cost studies for the Main Linac, Cryogenics, Magnet and conventional facility development. These cost studies are also described in the other sections of this document. We are also playing a secondary role in Damping Ring, Beam Delivery System, Controls, Instrumentation and feedback development.

Fermilab is also working on developing a Conceptual design and cost estimation of magnet systems in support of the RDR. We are also at the planning stage of working on detailed designs for magnets to better understand parameter space and physical dimensions

2. **Goals and plans for FY07 and beyond**

This work is expected to continue and evolve into a much larger effort on the ILC Engineering Design in FY07 and beyond. We expect that the Reference Design Report activities will slowly transform into the Technical Design Report work. Fermilab's activity in the area is expected to triple to above 100 FTE.

WBS Number: 3.9.2
Cavity Fabrication — Michael Foley

1. **Technical progress.**

The initial ILC cavity fabrication effort began in FY05 using the DESY Tesla TTF design (Type III+) with asymmetric beam tubes. Four Type III+ cavities were purchased from ACCEL and have been delivered. Four additional Type III+ cavities were ordered from AES. The DESY drawings were converted to US standards and transferred to AES. All end groups for these cavities have been successfully completed, and hydroforming of all the half-cells for the four AES cavities was completed. Scheduled completion date for these fine grain niobium cavities remains January-February 2007.

In a collaborative effort (FNAL/Jlab MOU Addendum II), Jlab is in the process of building two Type IV (symmetric beam tubes) cavities using large grain niobium. These cavities have an estimated completion date of January 2007. Jlab is also in the process of fabricating two Type III+ cavities using fine grain niobium supplied by Fermilab. Estimated completion date for these two cavities is April 2007.

Two purchase orders were awarded to industry for fourteen additional Type IV cavities at the close of FY06. The first P.O. for six cavities was sole-sourced to AES. The second P.O. was an open bid and was awarded to Accel. All fourteen cavities will be fabricated using fine grain niobium.

2. **Goals and plans for FY07 and beyond**

A purchase requisition is in preparation for material required to replenish our stock of fine grain niobium and niobium-titanium. The plan is to maintain a reserve on site sufficient to fabricate approximately twelve ILC cavities. PR's to purchase four large grain niobium ingots are also being prepared.

Fermilab and Jlab will continue collaborative efforts to develop additional US vendors for cavity fabrication.

In FY07 it is expected that requisitions will be issued for 24-36 ILC cavities. Possibly half of these cavities may be fabricated from large/single grain niobium, with the remainder constructed from fine grain material. The selected vendors will supply material.

Over the next several years Fermilab will acquire a large pool of ILC cavities. The establishment of a Cavity Fabrication and Processing Facility (CFPF) at Fermilab has been proposed. The CFPF will include capabilities for RF testing, ultrasonic cleaning, chemical (BCP) etching, high pressure rinsing, and electropolishing. It will also include a properly sized and configured electron-beam welding machine. The purpose of the CFPF will be to develop a robust cavity processing methodology with the goal of reliably achieving the highest attainable operating gradients for those cavities. The CFPF will also serve as a site for cavity fabrication R&D (e.g., exploring new cavity shapes, alternative materials, or developing improved construction methods). Knowledge gained will be transferred to US industry to aid in the ILC industrialization effort.

WBS Number: 3.9.2.1
Two Large Grain Cavities — P. Kneisel

1. **Technical progress.**

Monthly progress reports on this work package have been submitted to Helen Edwards as the FNAL representative for the MOU with Jlab.

- All raw cavity parts have been fabricated.
- All dumbbells have been welded with stiffening rings.
- Frequency measurements on the dumbbells are presently being done and subsequently, the dumbbells will be trimmed to the appropriate dimensions and frequency.
- End groups are in fabrication, some weld parameters for some components (e.g. HOM cans) are being developed.
- 30 raw end groups have been ordered from W. C. Heraeus with a delivery in September. Six cans have been loaned from DESY and need to be replaced.
- Fabrication of the two large grain cavities is almost complete. It is projected that these cavities will be ready for processing and testing early in January 2007. The status of the three helium vessels that DESY has offered to purchase is not known at this time, but is being investigated. These helium vessels will be welded onto the 9-cell cavities at JLab after successful vertical testing of the cavities.

2. **Goals and plans for FY07**

- The cavities will be tuned, hydrogen degassed, buffered chemical polished, then tested at 2K.
- During BCP, a stirrer for the acid will be used to achieve uniform material removal; this system has been delivered.
- DESY has offered to purchase three helium vessels as a "tag-on" to their presently placed PO; these helium vessels will be delivered soon.
- Helium vessels will be welded onto the 9-cell cavities, followed by an additional cold test.

WBS Number: 3.9.2.1
Fabrication of two TESLA 9-cell cavities from polycrystalline niobium — Peter Kneisel

1. **Technical progress.**

   - Fabrication of all the component parts for the two fine grain cavities is in progress.

2. **Goals and plans for FY07**

   - It is estimated that these cavities will be ready for processing and testing early in April 2007.

WBS Number: 3.9.3
Cavity Processing (BCP) — Allan Rowe

1. **Technical progress.**

A safety review of the Joint Superconducting Surface Processing Facility (SCSPF), located in Bldg. 208, Rm. 101 at Argonne National Laboratory (ANL), was conducted. This review was performed under the auspices of the ANL Physics Division safety office. The scope of the review encompassed the overall operation of the SCSPF as well as operation of the electropolishing (EP) facility located in the ANL chemical processing room. The safety review, begun in January 2006, was formally completed in July 2006. Beneficial occupancy of Bldg. 208, Rm. 101 for chemical processing is pending the implementation of egress related improvements, which will be completed in August

2006. This safety review did not include the Fermilab BCP System other than that its operation falls within the general operation requirements of the SCSPF.

Fermilab is developing preliminary safety and procedural documentation for the pending FNAL BCP System safety review to be scheduled following the 1.3 GHz cavity reconfiguration. The documentation presented during the successful ANL safety review will be used as a model for the Fermilab documentation.

A BCP (Buffered Chemical Polishing) system, designed for processing 3.9 GHz cavities, was assembled at ANL in Bldg. 208 Rm. 101. All mechanical and controls modifications requested by the Fermilab BCP System technical review committee were implemented. During the water commissioning phase, several BCP system characteristics were discovered that made processing 3.9 GHz cavities impractical. It was determined that the time required to implement the modifications to the BCP system for 3.9 GHz processing overlapped with the 1.3 GHz cavity processing schedule. Therefore, it was decided that Rm. G150 in Bldg. 203 will remain as the sole BCP processing location for the Fermilab 3.9 GHz cavity program. By forgoing the modifications for 3.9 GHz cavities, reconfiguration of the BCP system for 1.3 GHz processing can begin in earnest.

A large ultra pure water (UPW) plant and distribution system was installed and commissioned as part of the overall SCSPF infrastructure. An unaffiliated analytical laboratory verified the UPW quality met required specifications. The UPW infrastructure services the entire SCSPF including both the ANL and Fermilab chemistry and cleanrooms. ANL also plans to use UPW for high pressure rinsing electropolished resonators.

A safety review of the Joint Superconducting Surface Processing Facility (SCSPF), located in Bldg. 208, Rm. 101 at Argonne National Laboratory (ANL), was conducted. This review was performed under the auspices of the ANL Physics Division safety office. The scope of the review encompassed the overall operation of the SCSPF as well as operation of the electropolishing (EP) facility located in the ANL chemical processing room. Beneficial occupancy of Bldg. 208, Rm. 101 for chemical processing is anticipated by the end of CY06. The safety review did not include the Fermilab BCP System specifically, but the common facility elements and the general operating requirements for the entire facility were reviewed and approved.

The reconfiguration of the FNAL BCP system installed at ANL Bldg. 208, Rm. 101 that began in June 2006 continued through the end of FY06. This effort will continue well into FY07.

2. Goals and plans for FY07

The reconfigured BCP System will be commissioned with water in the beginning of FY07. Complete system testing with water will be used to verify process controls and operational procedures.

Cavity handling and manipulation occurs through the use of rather complicated hardware, all of which must be designed, developed, and fabricated or purchased. To quicken the pace of this hardware development, Fermilab will consult with other Laboratories (DESY, JLab, Cornell) who have experience handling ILC style cavities. This effort, already underway, will continue into FY07.

A formal safety review of the Fermilab BCP system will be conducted following the water commissioning phase of the reconfigured BCP system. Prior to the safety review, Fermilab must develop significant procedural and safety documentation. The safety review will likely occur in the beginning of calendar year 2007.

Following a successful safety review, ANL Physics Division will grant the approval to perform chemical procedures with the Fermilab BCP system. Fermilab plans to chemically polish both the inside and outside surfaces of 1.3 GHz ILC style cavities soon after approval is granted.

As part of the formal operation of the SCSPF, anyone working on chemical processes must receive formal training in chemical hygiene, emergency and processing procedures, and SCSPF operations. This training will begin in the last quarter of FY06 and continue into FY07.

WBS Number: 3.9.3
Cavity Processing (EP) Cristian Boffo

1. **Technical progress.**

At Fermilab, during the mentioned time period between October 2005 and October 2006, several new activities focused on EP have been started, while ongoing tasks have been pursued further.

The main accomplishment was the establishment of a close collaboration between FNAL, ANL, J-Lab and LANL with the goal of exploring the EP input variables and defining the proper set of working parameters to allow consistent control of the process. This task is still ongoing, mainly at J-Lab where it is possible to perform EP on 9-cell cavities.

Within a wider collaborative effort, during the SMTF (FNAL) and TTC (Frascati) meetings, a preliminary specification document aimed at the standardization of the EP parameters was created. During the STF (KEK) meeting in September 2006 this document was further discussed.

A joint ANL/FNAL panel generated a scenario describing the path toward EP industrialization by 2009, which was discussed by the SMTF R&D board and led to the funding of an R&D EP unit to be installed at the ANL/FNAL joint facility. At the moment, while waiting for full operational approval at ANL, the FNAL group is working on the fluid-dynamic optimization of the cathode and is testing a number of components that might simplify the setup.

In order to gain in-house experience on EP, a 1-cell setup has been designed at FNAL. Due to the present limited acid handling capabilities, initially this unit will only be able to electropolish 3.9 GHz cavities, but the design allows a full upgrade to 1.3 GHz, envisioned in 2007. This setup, which incorporates several technological solutions that can be later transferred to the ANL unit, will be operational by the end of August 2006.

In order to introduce Niobium EP to US industry, both local and national companies have been contacted. The initial goal of this activity is to establish a collaborative effort with possible developers of EP units and possible companies that can reliably run the process.

In parallel with the facility activities, a collaboration with Udine University (Italy) has been established and a Laurea student is now applying a numerical approach to the modeling of the EP process. The initial goal of defining the proper system of equations that describe the process has been completed.

Since KEK has achieved the goal gradients with 1-cell cavities where tumbling was adopted as pre-treatment, a pilot small sample tumbling program has been established at FNAL. An experimental device has been designed and shall be operational by the end of this calendar year.

The collaboration between FNAL, ANL, JLab and LANL with the goal of exploring the EP input variables and defining the proper set of working parameters to allow consistent control of the process is in place and functioning. This majority of the effort for this task remains at JLab where EP studies have begun on 9-cell cavities.

The 3.9GHz, 1-cell setup designed at FNAL has been completed but not yet tested. Due to the administrative hold on all HF operations at Fermilab, it is unlikely that this system will be tested before March 2007. In the meantime, all etching operations are being conducted at Argonne.

Three of the planned six 1-cell 3.9 GHz cavities produced with material purchased from 2 different suppliers have been completed and are available for testing.

During the STF (KEK) meeting in September 2006, a preliminary specification document aimed at the standardization of the EP parameters was discussed.

The Udine University (Italy) Laurea student completed his numerical approach to the modeling of the EP process.

A pilot small sample tumbling program has been established at FNAL. An experimental device has been constructed and will be operational by the end of this calendar year. It is planned to develop a 1.3GHz single cell cavity tumbling machine as the next step in this program.

2. Goals and plans for FY07

Continue the collaboration with the other US institutions. Visit J-Lab and support the ongoing activities. If possible intensify the permanence at J-Lab during FY07.

Discuss the standardization of EP parameter specification document at the KEK STF meeting in September and when in agreement, proceed to the identification of the proper industrial partners capable of producing the unit.

The primary goal for FY07 is to keep testing small cavities, allowing collection of useful information to complement the data acquired at J-Lab. At the same time, this unit shall allow testing of additional technical solutions for implementation into the ANL unit. During FY07, this setup shall be scaled up to handle 1.3 GHz 1-cell cavities and support the newly established FNAL 1-cell program.

The effort to introduce US industry to Niobium EP shall continue and will be integrated with the Process Standardization being developed.

The fundamental understanding of EP and the exploration of new acid mixtures, acid aging and F- concentration control shall be intensified during FY07 by increasing the number of small sample tests.

WBS Number: 3.9.3.2
EP Processing at JLab J. Mammosser

1. Technical progress.

Monthly progress reports on this work package have been submitted to Helen Edwards as the FNAL representative for the MOU with Jlab.

Adapt Production Tooling to 9 Cell Cavity

- All tooling for processing 9-cell cavity has been completed, several development runs were completed and starting on production runs for first production cavity.
- All tooling for testing a single 9 cell cavity has been completed, a second setup is still needed to meet ILC R&D tight loop planning.

Develop Production Procedures

- Five assemblies and vertical tests have been completed.

- Integrated particulate monitoring and video taping has been completed (reference starting point).
- Started development on improved assembly techniques, which includes monitoring and tooling for hands free assembly.
- Demonstrated that quenches reached on cavities in vertical is multipacting barrier.

Develop EP Procedures

- Investigations on rotation speed, flow rates have been completed.
- Investigations on anode contact point are underway (processing with helium vessel).
- Investigation on HF monitoring has started.
- The system is operational and many improvements have been completed.
- Final electropolish on S35 has been completed.

Process, Qualify & Turnover 8 Cavities to FNAL for String Assembly

- A-7 Bulk electropolish has been completed.

Electropolish Development

- Single cell cavity process cabinet was moved into place.
- Single cell facilities and hardware underway.
- Last four of the five assemblies show no field emission up to multipacting barriers.

Electropolishing Progress

- The electropolishing effort at JLab was temporarily halted during the last quarter of FY06 due to lack of supporting funds. Prior to this interruption, the bulk processing of the Fermilab A-7 cavity (fabricated by Accel) was completed.

2. Goals and plans for FY07

- Complete the processing on the 7 nine cell cavities for FNAL.
- Develop procedures and weld helium vessels to all eight cavities.
- Deliver cavities to FNAL.

Jefferson Lab is just getting started with the electropolishing of nine cell cavities and has not yet demonstrated ILC gradients. Therefore, it is most important to determine if the processes and facilities at JLab are capable of meeting the gradient requirements. The focus of FY07 will be, to determine what problems will be encountered and to quickly overcome them by adapting processes and procedures as necessary to achieve gradient and Q-value goals as outlined. Throughout this process, an understanding of performance variability at JLab and the parameters that affect it will be the focus of our efforts. This understanding will be approached by several methods as follows:

- Single cell cavity processing and testing focused on reaching high gradients as well as identifying the reason for Q-disease in some cavity tests.

- 9-Cell cavity assembly performance improvement through reduced field emission by applying specialized tooling to reduce assembly errors and particulates.
- Improving process understanding and monitoring with focus on the following:
  - HF loss and its monitoring
  - Better understanding of the chemistry and QC of the electrolyte mixture
  - Reduction of sulfur residues by applying appropriate cleaning methods after electropolish procedures are completed without damaging cavity performance

This work will be carried out in a collaboration of international efforts as well as focused at Jefferson Lab with involvement of local Universities.

WBS Number: 3.9.4
ILC Cryomodule Design — Tom Peterson

1. **Technical progress.**

DESY type III drawing details were not all converted into Fermilab/US drawing. Due to manpower limitations, it was decided to move ahead with the type IV design effort.

The Type IV Cryomodule design effort continues with five contract designers and three senior staff -- Don Mitchell, Youri Orlov, and Chuck Grimm – all working on module design. The total module design effort is currently about 5 FTEs. The Type IV cryomodule features remain: closer cavity spacing, 8 cavities per module, magnet/BPM package under the center post, and magnets cooled at 2 K.

During the work period, we held two international design meetings. The first was held at CERN on 16 – 17 January 2006. The module workshop agenda and talks are posted at http://indico.cern.ch/sessionDisplay.py?sessionId=0&confId=671
There was agreement regarding technical topics needing attention, but following this meeting, work was delayed in all three regions due to other commitments.

A second international design meeting was held at Fermilab on 13 - 14 July 2006. Much of this second meeting focused on the formats for CAD data exchange among the laboratories. Both INFN-Pisa and Fermilab have IDEAS CAD models of the cryomodule under development, as well as finite element models under development for vibrational studies. Another emphasis, in this July meeting, was on what module test measurements should be done and how to instrument modules. Accelerometers and wire position monitors will be key items in these R&D modules.

A meeting was held at INFN-Pisa in September for the designers and engineers working directly with the CAD model packages. Meanwhile, work continued in detailing the type IV design and on the vibrational analysis of the design

2. Goals and plans for FY07

Work will continue in detailing the type IV design. This design effort is likely to go through the third quarter of FY07. The next international design collaboration meeting is tentatively planned for January, 2007, in Milan.

Among the topics which will receive attention as part of this type IV design effort over the next year will be: quadrupole/corrector/BPM package details and supports, magnet current lead and integration into the module, magnetic shielding, inter-cavity connection details, inter-module connection details, tuner details, module instrumentation, module pipe sizing, and module mechanical vibration analyses.

As time permits, there is significant interest among many people to explore a separate quad cryostat for ILC, as opposed to the position within the center of the module.

WBS Number: 3.10.6
Beam Delivery System-Collimators Nikolai Mokhov

1. Technical progress.

A realistic front-end STRUCT-MARS15-GEANT4 model of the Beam Delivery System (BDS), interaction region and extraction beam line has been created and tested for 2 and 20-mrad crossing angles, and partially for a 14-mrad crossing angle. The model based on the corresponding layouts, includes all the beam elements in that region with their detailed 3-D geometry, materials and magnetic field distributions, collimators and masks, tunnel and the SID collider detector. Detailed simulations have been performed on effects of synchrotron radiation with respect to performance of collimation and extraction systems and on radiation loads to the BDS and extraction components (two Beams-docs). Simulations and benchmarking of results on collimation system performance are done with the BDSIM, MARS15 and STRUCT codes (EPAC paper). Various configurations of absorbers, synchrotron radiation masks, and water and liquid sodium beam dumps in the extraction beam lines have been studied. Comprehensive modeling of BDS-induced backgrounds in the SiD detector with respect to those generated in collisions has been performed for various configurations of the tunnel magnetic walls and different time windows of all the SiD sub-detectors (*FN-790)*. Comprehensive verification of source terms in the BDS was performed jointly with SLAC colleagues. Comparative studies were performed on muon flux suppression efficiency for the original two magnetic wall configuration, proposed one-wall scheme and the doughnut-type magnetic spoilers around the beam line requested by Barry Barish. Optimization studies on handling synchrotron radiation in the BDS and extraction lines for 2 and 20-mrad crossing angles were done.

Additionally, radiation studies for SC RF vertical Test Facility were done (*TM-2350)*. A detailed MARS model was built for the ILC Test Area, and beam dumps with their shielding have been designed for an 800-MeV 50-kW electron beam; optimization MARS/ANSYS calculations were performed for the beam window; optimization calculations were continued on a new shielding configuration in the hall. A detailed MARS model was built for the main ILC RF structure, and first test runs were performed on radiation loads induced by dark current and beam halo particle loss. Radiation environment in the NIU Beam Diagnostics Lab with its 6-20 MeV microtron for coherent light source has been calculated with the MARS15 code.

2. **Goals for FY07**

Perform studies on handling synchrotron radiation in the BDS and extraction lines for a 14-mrad crossing angle layout (01/31/07). Rebuild the STRUCT-MARS15-GEANT4 model of the BDS, interaction region and extraction beam line with the current 14-mrad crossing angle layout, agreed with other collaborators apertures of the magnetic elements and collimators, and start implementation of engineering details of the machine-detector interface for the current push-pull experimental hall and detector configuration (12/31/06). For this new model, perform calculation studies of radiation loads, prompt and residual radiation levels in BDS, IR and extraction line components, and impact on environment and a detector garage hall: thorough tests and preliminary runs for BDS – 12/15/06, modeling for BDS and IR – 03/31/07, modeling for extraction lines – 05/15/07, reports – 06/30/07). For the new model, calculation studies of machine-induced backgrounds in the SiD detector in comparison with those from the IP, with further optimization of protective measures: tunnel magnetic wall, collimators, synchrotron radiation masks, tunnel plug and walls between the detector and garage halls (thorough tests – 03/15/07, modeling – 06/30/07, reports – 09/30/07). Energy deposition and radiation simulation support for the ILCTA and the main linac design as needed.

WBS Number: 4.3.1
Magnet Systems: Engineering and Cost Estimation
J. Tompkins

1. **Technical progress.**

Effort was organized and began on this work package roughly halfway through FY2006 in support of the RDR Magnet System Group effort, led by J. Tompkins. A team of magnet design engineers as well as power system and controls experts was assembled from Fermilab, SLAC, and other major laboratories and universities around the world. The primary goal of this work was to develop magnet designs suitable for very preliminary cost estimates as part of the overall ILC cost study. The first steps were to work with Area Leaders to define the requirements for the large number and varieties of magnets needed. Once the requirements were determined, work began on conceptual designs to form the basis for cost estimates. Work carried out at Fermilab during this period included: estimates of magnet designs and costs for the RTML system, the Main Linac, and the Positron Source. Conceptual designs were developed for key components, such as the superconducting quadrupole magnets and correction dipoles in the Main Linac, and the conventional quadrupoles in the positron source transfer line (~1600 magnets). A design package was created for use in obtaining cost estimates from outside vendors. Modifications of the existing LHC quadrupole design were used as a basis for the estimate of superconducting magnets in the BDS 2 mrad beam line final focus region. Fermilab personnel also worked on developing the controls system quench protection requirements for superconducting magnets as well as instrumentation and controls interfaces for conventional and superconducting magnets.

Fermilab scientists and engineers participated in numerous ILC meetings and workshops in carrying out this work, including Magnet Systems Group meetings at SLAC and Fermilab, and the ILC Meeting at the Vancouver Linear Collider Workshop in July. In addition, weekly teleconferences have been held since June to discuss ongoing efforts. Despite the very compressed schedule and limited resources, a nearly complete, very preliminary, estimate of the magnet system cost was assembled for the Vancouver meeting. Importantly, this work revealed technical difficulties and associated higher equipment and operating costs in some areas.

The preliminary cost estimate was completed and reviewed for completeness and consistency. The task of writing the magnet portions of the RDR began during the last quarter of FY06.

Effort began on detailed design of the Main Linac superconducting quadrupole and associated dipole and skew quadrupole correctors. This effort will continue beyond the end of FY06 with prototype development occurring in FY07.

2. Goals and plans for FY07

The goals for FY07 are to complete the preliminary cost estimate and to review it for completeness and consistency, given the very short time in which it was developed. The number of magnet designs or "styles" will be reviewed across the different Area Systems along with the cost estimates to ensure that consistent design and cost methods have been employed. Estimates for a small selection of larger quantity magnets will be obtained from industry for purposes of comparison to internal estimates and to get feedback on cost drivers (e.g., specifications) as well as savings on large quantity orders.

The task of writing the magnet portions of the RDR will continue into FY07.

Effort will begin on detailed design of the Main Linac superconducting quadrupole and associate dipole and skew quadrupole correctors. This effort will continue beyond the end of FY06 with prototype development occurring in FY07, if sufficient funding is available.

Effort will continue on the design of the e^+ source transfer line, low gradient, large bore quadrupoles with the intent of building a prototype in FY07 if resources are available.

Precision measurements of quadrupole axes are critical to determining magnetic field stability. Fermilab plans to develop an improved stretched wire measurement system with thermal and vibration damping, based on its long experience with axis measurements for the LHC quadrupole program and precision measurements of quadrupole axis stability for NLC final focus permanent magnets.

Finally, extremely low fringe fields from quadrupoles near superconducting RF cavities are required to avoid degrading cavity performance. Procurement of magnetoresistive sensors and development of a very low field measurement system for initial studies at room temperatures is planned as part of the FY07 program.

WBS Number: 4.10.1
Industrial Studies: Engineering and Cost Estimation
P. A. Pfund

1. **Technical progress.**

A contract was placed with Advanced Energy Systems (AES) to lead a team of Linear Collider of America (LCFoA) companies to conduct an industrial study. The goal of this study was to define the cost to construct the first RF unit and production lots of 250 and 750 RF Units of the ILC main linac. An RF Unit is defined as a total of 24 superconducting cavities within 3 cryomodules powered by a common RF system. The center cryomodule contains a magnetic element that provides beam-focusing and steering correction.

The study will include detailed costs of all major components and subsystems by WBS, along with a schedule showing critical paths of the construction program. It is assumed that a facility capable of providing the equipment and space for superconducting cavity processing and integration, as well as checkout of the RF Units, will be available at a location near the ILC site. The cost of the setup and operation of this facility is not part of this study.

The study will included the cost of the superconducting cavities and processing (Buffered Chemical Processing, Electro Polishing, High Pressure Water Rinsing, Radio Frequency Testing), helium vessels, cavity tuners, magnetic shields, required cryomodule instrumentation, beamline string support systems, thermal shields, vacuum vessels, cryomodule support stands, internal cryogen piping, and major RF system components (such as the couplers), RF distribution, circulators, klystrons, modulators and low level RF.

The industrial team members will generate component and subsystem cost estimates in each of their areas of responsibility via internal estimating methods and, where appropriate, by solicitation of US manufacturers that have had previous experience in this technical area. The team members will develop component fabrication plans only to the level necessary to enable them to estimate the manufacturing cost of their respective components and provide appropriate quotations. The costs associated with acquisition and set up of new equipment (i.e. e-beam welders, BCP systems, etc.) for high rate production is not included. Tooling for integration and assembly of the RF units is also not included, since it is assumed that this is part of the government furnished facility. Each solicited manufacturer will be asked to provide quotations for the number of components in a single ILC RF Unit and budgetary quotations for the quantities associated with up to 250 and 750 RF Units. Each manufacturer will be given the opportunity to provide input on cost reduction ideas, utilize learning curves to extrapolate low quantity costs to full ILC quantities where applicable, and utilize their expertise to validate vendor quotations.

The industrial study to define the cost to construct the first RF unit and production lots of 250 and 750 RF Units of the ILC main linac was well underway by the end of FY06, with a preliminary estimate scheduled for delivery prior to the Valencia ILC GDE meeting in November.

2. Goals and plans for FY07

The RF Unit Cost Study is expected to be completed in the second quarter of FY07. Their final report is expected to include:

- Estimated labor and material costs by WBS.
- Commentary as appropriate to explain the above costing information, including cost model characteristics such as QC overhead, process efficiencies and expected rework.
- Identification of key suppliers with a summary of their respective cost proposals.
- An overall project plan with a rough staffing profile keyed to schedule requirements.
- Top-level requirements for government furnished support facilities for processing, testing, and assembly.

WBS Number: 4.10.2
Industrial Studies: Civil Design Vic Kuchler

1. Technical progress.

During FY 06, the verification of unit costs for underground construction was identified as a topic appropriate for investigation by independent private sector consultants. The Conventional Facilities Group worked with the Linear Collider Forum of the Americas (LCFOA) to identify a firm with the experience necessary to complete this review. Unit costs for underground construction had been developed initially through a combination of in-house experience and supporting consultant input. This study would provide an independent "second opinion" based only on the experience of the newly selected consulting firm, with the benefit of previously collected data. The unit costs requested would be based on specifically defined underground construction activities required by the ILC Project including: cost per unit length of excavated tunnel for various tunnel diameters using tunnel boring machines, shaft construction, general underground excavation, tunnel invert installation, cross tunnel penetrations and personnel access enclosures. In an effort to maintain global consistency, the definitions for underground construction activities and respective unit costs were also used in consulting agreements developed in the European and Asian Regions for similar unit costs.

The current status of this effort is as follows. The initial Request for Proposal was sent through the LCFOA to the Parsons Consulting Group in July 2006. A proposal was received and after a brief period of negotiation, a final proposal was developed and accepted. The final contract was signed in August, 2006. The first draft report is expected to be provided to Fermilab in December, 2006, with a final report due in January, 2007. Although it is anticipated that additional topics for independent consultant review will be forthcoming, no further work was initiated in the final quarter of FY 06.

2. Goals and plans for FY 07

As stated above, the contract for services to provide the independent development of unit costs for specific underground construction activities will continue into FY07 with completion expected in January, 2007. In addition, other specific topics are being considered for outside A/E Consultant work, including a formal independent review of the completed CFS Pre-conceptual Design Drawings and Cost Estimate (as included in the RDR) and a charge to provide input on the content and format of an "Expression of Regional Interest" document based on private sector experience and past example projects of similar scope. Also, the CFS Group will initiate an A/E selection process that will identify and place under contract several A/E Firms of varied experience that can be called on to supplement the in-house engineering effort for specific elements of the design process and the development of the Engineering Design Report.

Finally, some effort is expected to begin on the formal process of engaging local and state governmental bodies toward the development of an Expression of Regional Interest for the Americas Sample site. As needed, outside consultant support may be required to assist in-house staff for this effort.

WBS Number: 5.8.3
RF Power — Sergei Nagaitsev

1. Technical progress.

RF power (1.3 GHz) at Fermilab is needed in the following areas: Horizontal Test Stand (HTS) at Meson Detector Building (MDB), Vertical Test Stand (VTS) at IB1 and at beam test facility at New Muon building (NML).

At MDB – installed a rebuilt Phillips YK-1240 Klystron (300 kW) and the entire distribution system for CC2. The Klystron was tested on a dummy load and on CC2. It produced 287 kW at required operating parameters. This same setup will be used to RF power the HTS. Presently, Fermilab has a total of three rebuilt YK-1240 Klystrons: two are operating and the third one failed tests and will need to be sent to factory in FY07. Three low-power modulators are in the final stages of assembly -- two are already complete, one -- 90% finished.

High-power Klystrons: Presently have a TH2104C (1.5 y.o.) Klystron operating the RF gun at A0. A used 2104U is an operational spare for the gun. The power and efficiency of this Klystron is lower, thus there is a need to buy another 2104C. One solenoid for 2104C (or U) has been received, and one is already in use at A0.

High-power modulators: SLAC has shipped new HV parts to complete two HV switches. All Fermilab components have been received. One modulator is 95% assembled at MDB for HINS. A second modulator is scheduled to be delivered to NML in summer of 2007.

For the VTS at IB1, the RF system design review took place in August 2006, with the design finalized at the end of FY06. We have already received one 500-W solid state rf amplifier and a circulator. The amplifier was tested and met the specifications.

2. Goals and plans for FY07 and beyond

The HTS RF distribution system will be complete in Jan 2007. The detailed RF layout and distribution work has already started.

In FY07 we plan to buy a 5-MW TH2104C Klystron to power the first Cryomodule at NML. We will also buy two – 500 W drivers for 2104C.

In FY07 we will buy a pulse transformer and parts for the high-power modulator, assemble one more 1-ms 10-MW modulator, and get two more HV switches from SLAC.

The VTS RF system will be assembled and commissioned in FY07.

For the Cryomodule test at NML in the summer of 2007, Fermilab will provide an RF power source, which will consist of a new 5-MWatt klystron and a new full pulse-length modulator (to be delivered to NML in FY07). Fermilab provides all interlocks and controls for these systems and the wave guide to connect to the RF distribution waveguide. Fermilab intends to place the order for a 5 MW klystron in Feb, 2007 and to build an additional bouncer-type, full pulse width, modulator in FY 2007-08. This second modulator will be used to power the rf gun at NML.

By summer 2007, SLAC is to provide the RF distribution hardware for distributing RF to cryo module 1, containing eight 9-cell cavities. Higher Order Mode couplers (HOM) are an integral part of the cavity structure. Fermilab will need to supply the external terminations for these couplers. SLAC will provide circulators with this first distribution system. Dual directional couplers at each of the cavity inputs will also be included to monitor power flow.

WBS Number: 5.8.4
LLRF Controls

Brian Chase, Ruben Carcagno

1. **Technical progress.**

The motivation for WBS 5.8.4 (LLRF Controls) is to develop LLRF systems for ILCTA and work towards an ILC LLRF system. FY06 milestones and deliverables in the original work package are the design and fabrication of the LLRF system for the Horizontal Test Stand (HTS) in the Meson Test Area (ILCTA_MDB) by May 2006.

All milestones and deliverables have been met: A LLRF system was delivered ahead of schedule for ILCTA_MDB commissioning using the Capture Cavity 2 (CC2), and the system is ready to support the HTS when needed.

The current LLRF system delivered to ILCTA_MDB is based on the latest DESY FPGA-based LLRF controller VME card, Simcon 3.1. This LLRF system successfully supported the first CC2 test on March 2006, and it is a result of a strong collaboration with DESY which started in FY2005 and continued into FY2006. The LLRF system was first fully tested and fine-tuned using Fermilab's Capture Cavity 1 (CC1) in the A0 photoinjector area, so there was high confidence about the performance of this system to support

ILCTA_MDB commissioning with CC2. Other components delivered to ILCTA_MDB associated with the LLRF system include: a new Fermilab designed and built programmable multi-frequency, low-noise Master Oscillator (MO); a new Fermilab designed and built Downconverter and Vector Modulator; and a Fermilab built fast piezo tuner assembly instrumented with a novel method developed at Fermilab to continuously monitor piezo preload forces together with the associated electronics to monitor and control this device.

In parallel, a second LLRF system based on a modified SNS LLRF system for 1.3 GHz operation was also developed in collaboration with the SNS LLRF team and was ready as a contingency for ILCTA_MDB. This modified SNS system was also tested with the A0 photoinjector CC1. The approach of having two independent systems tested under realistic conditions with a 9-cell cavity prior to delivery to ILCTA_MDB minimized project risks and assured availability of the LLRF system when needed.

The LLRF Controls work at Fermilab is performed as a collaborative effort among divisions and other laboratories and institutions. Details of this organization are described in the document "ILC Fermilab R&D - LLRF Controls R&D Program" issued on January 19, 2006. Further details on Fermilab plans to deliver ILCTA LLRF systems can be found in the document "ILC Fermilab R&D – ILCTA LLRF Short-Term Development Project" issued on February 24, 2006.

As part of our collaborative efforts, a 3-day LLRF workshop was held at Fermilab in February 2006. This workshop included over 50 of the most active researchers in the LLRF field from around the world. In addition, five Fermilab staff members traveled to DESY for a week to participate in a LLRF software workshop and to work on collaborative projects with the DESY LLRF group. Fermilab maintains weekly LLRF videoconferencing meetings with DESY, UPenn, KEK, ANL, and SLAC collaborators.

R&D efforts towards a system capable of meeting the ILC LLRF requirements continue vigorously at Fermilab. Further LLRF development is needed in areas such as technical performance, reliability, ease of use, tight integration with the control system, and cost reduction. Fermilab's R&D efforts include noise characterization of Simcon 3.1 boards, board redesign and manufacturing to improve noise characteristics, FPGA firmware developments towards higher Intermediate Frequency (IF) capabilities, and control system integration with DOOCS and EPICS. New firmware has been successfully tested in the lab and a new printed circuit board is being laid out. With the rapid advance of commercially available FPGA-based electronic boards and higher level FPGA programming languages, Fermilab is also exploring their use and suitability for LLRF control applications. A board developed by industry (Lyrtech) has been purchased together with the associated software (Matlab/Simulink/Sysgen) for high-level FPGA programming. In addition, a Multi-channel Field Controller module is being designed that is optimized for an ILC RF Unit (Klystron plus three Cryomodules). This design incorporates lower cost and higher density technology for the high channel count of the ILC. One of our collaborators (University of Pennsylvania) is involved in the development of an ILC RF unit simulator, including a real-time version of this simulator, which is expected to be quite useful for LLRF system developments. Much additional simulation effort has gone into the control and power requirements for driving 24 cavities from a single klystron.

2. Goals and plans for FY07 and beyond

In FY07, Fermilab plans to continue working on developments associated with LLRF hardware, firmware programming, and controls interface.

In the hardware development area, Fermilab plans to complete the Simcon 3.1 board redesign to improve its noise characteristics and start manufacturing a prototype to validate design improvements. This activity will continue through FY07 with the manufacturing of several Simcon 3.1 improved boards to populate ILCTA as needed with LLRF boards and spares.

Fermilab is developing an Eight Channel Downconverter module and high density card cage to support the 94 RF signals of a RF Station. Modification to the Master Oscillator and LO distribution will support a new IF frequency.

In the firmware programming development area, Fermilab plans to make progress towards a higher Intermediate Frequency (IF) LLRF controller. The current version of the LLRF controller Simcon 3.1 operates with a rather low IF of 250 KHz. There has been recognition from some time that it would be better to increase this IF frequency to reduce the latency in the LLRF control loop and improve its performance. However, implementation of this higher IF requires substantial changes to the FPGA firmware. Delivery of this higher IF LLRF controller firmware will constitute a significant upgrade to Simcon 3.1 that is expected to benefit all members of our LLRF collaboration.

In the controls interface development area, until a decision is made of which control system (DOOCS or EPICS) will be adopted for ILCTA, Fermilab plans to support both control system interfaces to Simcon 3.1 and work on interfaces that can be easily changed from one system to another. Efforts toward LLRF automation, exception handling, and piezo control integration are expected to increase in FY07 as more funding and resources become available.

In addition to efforts related to improvements related to Simcon 3.1, Fermilab plans to integrate firmware and controls interface developments into commercially available hardware to explore the performance of electronic components produced by industry. In parallel, work on the in-house 32-channel LLRF controller optimized for an ILC RF Unit, which started in FY06 will continue in FY07. We also plan to continue supporting UPenn’s efforts to develop an ILC RF unit real-time simulator.

There are several ILCTA LLRF deliverables anticipated for FY07:

- LLRF systems for the beam source and for the first 8-cavity ILC cryomodule at ILCTA_NML
- LLRF system for 3.9 GHz Cavities and power coupler testing
- LLRF systems for the Vertical and Horizontal Test Facilities (VTS and HTS) at ILCTA_IB2

Upgrades to the ILCTA_MDB LLRF system delivered in FY06

WBS Number: 5.9.1
Cavity Horizontal Test Stand Andy Hocker

1. **Technical progress.**

At the beginning of the work scope period, the cryostat for the ILCTA_MDB Horizontal Test Stand was under design. This design was completed and the package sent out for bid. The construction contract was awarded to PHPK in Columbus, OH, and the completed cryostat was shipped from PHPK to FNAL on 12-JUL-2006. Instrumentation for the cryostat has also been procured and assembled.

A shielding block cave for the Horizontal Test Stand has been constructed in the Meson Detector Building (MDB). Cryogenic transfer lines servicing this cave have been built, and the "feed can" interface between the MDB cryogenic system and the cryostat is in place. The MDB cryogenic system has been built, commissioned and used to successfully cool A0 Capture Cavity II (in a separate shielding cave) to 1.8 K.

A high-power, 1.3 GHz, RF system consisting of a modulator, charging supply, and 300 kW klystron has been installed and commissioned in MDB and has been used to power Capture Cavity II to a peak gradient of 31.3 MV/m. A low-level RF system based on the DESY SIMCON design has been deployed at MDB and has been successfully run in closed-loop mode in order to maintain a constant flat-top accelerating gradient.

A controls/display system based on EPICS has been developed for the MDB cryogenic system and has begun to be developed for RF controls.

The dressed cavity support system fabrication was completed, and a test pipe designed for HTS commissioning was designed and constructed. This test pipe will permit HTS mechanical systems commissioning without the need for a dressed cavity. An old "Type II design" dressed cavity was requested from DESY and it will be undergo high pressure rinsing and vertical testing at JLab prior to being used to facilitate commissioning the HTS in March 2007

2. **Goals and plans for FY07**

For FY07, ILCTA_MDB will be fully operational by April 2007. It is anticipated that testing the first dressed cavity will take approximately six weeks due to an initial learning curve, but that the turnaround time should steadily decrease to something like 10 days for subsequent cavities. During FY07, ILCTA_MDB will test six 3.9 GHz accelerating-mode cavities for the DESY VUV-FEL, and as many 1.3 GHz ILC cavities as possible, depending on their production schedule.

WBS Number: 5.9.2
Cavity Vertical Test Stand — Camille Ginsburg

1. **Technical progress.**

The Fermilab Cavity Vertical Test Stand (VTS) will be used to test single, bare 1.3 GHz 9-cell SRF cavities. During the work scope period of 10/1/05 – 10/1/06, the VTS project scope was defined and construction began. The subtasks in which significant progress was made in FY06 are the cryostat design, RF system design, cryogenic capacity studies, radiation shielding design, and civil construction.

The cryostat design is based on a Fermilab design for the DESY Tesla Test Facility vertical test stands, with some updates from experience at DESY. The primary improvement to the design was the addition of a phase separator, to provide a better quality of liquid helium to the cryostat. The Process & Instrumentation Diagram was completed in May 2006. A design and procurement readiness review took place in May during which the review committee assessed the technical design of the cryostat and its readiness for the procurement and fabrication process. The completed cryostat design drawings, which incorporated the recommendations from the review committee and bid evaluation criteria, were sent to the Procurement department in July 2006.

The RF system design is based on that of the Jefferson Lab vertical test stands, modified for 1.3 GHz operation. A 500 W CW RF amplifier will be used to excite the cavities. The procurement of non-design-specific and long-lead-time equipment has begun.

A systematic study of the cryogenic capacity for VTS has been performed, and the capacity was determined to be 125 W at 2 K. This cryogenic capacity is sufficient to measure Q vs. T down to about 1.5 K, and measure Q vs. E up to at least 35 MV/m at 2 K, for typical cavities.

The radiation shielding design was completed in April 2006 and satisfies the requirement that IB1 be maintained as a Controlled Area: x-rays, photo-produced neutrons, and tritiation of the ground water were considered. Data from the DESY/TTF vertical test stands were used to estimate the expected x-ray flux. The shielding consists of three parts: a plug internal to the dewar, a movable shielding lid, and the concrete walls of the pit. The tritium production rate in the surrounding groundwater will be negligible. The shielding design has been reviewed and approved by Fermilab ES&H.

Because the vertical cavity pit walls are an integral part of the radiation shielding design, the final civil construction detail drawings were finalized after the radiation shielding design was complete. The civil construction, consisting of a shaft, recessed area for top plate instrumentation, and cryogenic piping and instrumentation cabling trenches, began June 23 and was completed on July 26.

The completed milestones from the original work package description are the new cryostat design, the vertical cavity pit, and the beginning of test stand component procurement.

In September, the contract for the cryostat fabrication and assembly was awarded. The cryostat top plate and the magnetic shielding mechanical designs were also completed and the procurement process initiated. An RF system design review took place in August 2006, and that system design has been finalized.

2. Goals and plans for FY07

In FY07, the radiation shielding lid mechanical design and motion control system will be completed, parts procured, and the system assembled. The RF system assembly and commissioning will be completed. Personnel safety interlocks for the RF power and shielding lid will be designed, procured, and installed. The cryostat top plate will be fabricated "in-house." In addition, a portable clean room for top plate assembly will be designed and procured. The complete cryostat, including magnetic shielding and top plate, will be installed in March 2007, and commissioning begun.

Once the baseline VTS is complete, its functionality will be extended. The diagnostic instrumentation will be expanded, beginning with the design of a quench-location detection system. This activity will continue into FY08.

The milestones for FY07 are the completion and installation of the radiation shielding lid, RF system, cryostat and top plate, the connection of VTS to the IB1 cryogenic system, and the installation of personnel safety interlocks. The primary deliverable for FY07 is a complete, commissioned, and operational VTS.

WBS Number: 5.9.3
Cryogenics for Test Stands Jay Theilacker

1. Technical progress.

Major cryogenic accomplishments took place during the work scope period. In October 2005, the Cryogenic Test Facility (CTF) sent 4.5K helium to the Meson Detector Building (MDB). Since the Capture Cavity II (CCII) was not available as a load, a temporary dummy load was installed in order to tune control loops for stable operation. Warm return flow from the MDB was returned to the CTF after passing through the newly installed and commissioned purifier compressor and existing purifier.

During the winter of 2005/06, the large helium vacuum pumping skid to be used to cool the loads down to 1.8 K was installed and the appropriate safety documentation was prepared for the required system safety review. The pumping system was commissioned in May 2006.

Capture Cavity II was cooled to 4.5 K for initial commissioning of the RF system and for cavity performance verification in January 2006. CCII was cooled down to 1.8 K in June 2006 using the vacuum pumping system.

Transfer lines were extended in the spring of 2006 to feed cryogens to the cave which will support the Horizontal Test Stand (HTS). The feed box and low pressure pumping lines were fitted in place using a mock-up, since the horizontal test cryostat was not available. Cryogenic controls for the distribution and horizontal test cryostat were installed. We are now waiting for the cryostat to arrive in order to complete the final tie-in. Safety documentation has been written for the HTS cave and submitted to the cryogenic review panel for the facility.

The cryogenic controls for CTF and CCII utilized ACNET as the user interface and for many of the required controls functions (alarms, fast time plots, data logging and system graphics). A decision had previously been made to use EPICS as the higher level controls system. Effort has been made to duplicate the cryogenic graphics displays from ACNET to EPICS. Conversion of the higher level cryogenic controls to EPICS took place in the 4th quarter of FY06. Training of the key Cryogenic Department personnel in the use of EPICS also took place in the 4th quarter.

Operational support for cryogenics to the MDB continues. Considerable progress has been made to understand the system operation and to begin automating processes, such as pump-down of CCII to 1.8 K.

All cryogenic milestones for the MDB systems have been attained.

2. Goals and plans for FY07 and beyond

A major milestone for the beginning of FY07 will be the cool down and commissioning of the horizontal test cryostat. The schedule for the cool down is not dictated by the cryogenic system tie-in or the horizontal test cryostat installation, but by cavity production leading to a dressed cavity available for testing.

A goal is to move all higher level controls requirements for the cryogenic system from ACNET to EPICS by the end of FY07 and to work with the Controls Department to ensure that development or implementation of the required EPICS controls services takes place.

The majority of the cryogenic effort in FY07 will be applied toward cryogenic operations and migration of cryogenic controls from ACNET to EPICS.

Financial Report Rich Stanek

The financial summary (attached to the technical report) is compiled using data from the end of Fiscal Year 2006 Fermilab accounting reports. This summary incorporates the latest revision of the GDE funding distribution as agreed to by the DOE, Fermilab and the ILC Americas Regional Director. The budget totals balance exactly with the numbers contained in the 2006 Fermilab Financial Plan. In addition, the M&S budget allocation that was held temporarily in the WBS Line titled "6.3 Fermilab Reserve" has been reallocated to "3.9.2 Cavity Fabrication" where it was used to purchase additional cavities from US industry.

The financial information is presented in two ways. The standard ILC Americas report uses both "Direct and Indirect Cost" information and shows "Open Commitments", "Requisitions in Process", "Total Budget", and "Budget Balance". This gives a financial picture for the actual costs of the project to date and a look at what is "coming in the near future". However, one must be careful when looking at the "Budget Balance" column, since "Indirect" charges are not costed until the "Open Commitments" are costed. Therefore, even though the Open Commitments are taken into account, the related indirect charges are not. This column overstates the budget balance since invoices for the open commitments will eventually come in and be paid. At that time, indirect charges will be applied and the budget balance will become much smaller. This financial data is displayed in the ILC Americas WBS format for easy incorporation into an overall ILC Americas report.

The second table shows the financial data sorted by ILC Americas WBS (FNAL WBS elements only) and gives the numbers based on "Obligations" and "Requisitions in Process". The report looks only at "direct costs". Including "Requisitions in Process" creates a more forward looking view of the financial status of the project and helps the reviewer anticipate how the 2006 Fiscal Year will end and the 2007 Fiscal Year will begin. The combination of the two reports gives a clear view of not only the actual costs but the plan for spending.

The funding that comes through the ILC Americas Regional Director is split between two distinct end uses; funds for the GDE Office/Common Fund/Director Travel (also includes ILC School) and funds for ILC work packages dealing with RDR development, SRF technology and cavities & cryomodules. These are handled separately within the Fermilab system by assigning them to two different Project Numbers (19 and 18 respectively).

In regards to the GDE Office and Common Funds financial data (Project 19), the total budget (including indirect charges) was 748.4K. The sum of YTD cost + open commitments was 902.9K so that there was a negative balance of (154.5K) in those specific work packages. In fact, as shown above (in the discussion of indirect charges) the over-run will be slightly larger once all indirect charges are applied to the open commitments. The estimate of final over-run is ~183K. The assumption was that these work packages would be a zero balance at year end and that any over-runs would be made up through additional funding in FY07 and any under-runs would be "carried over" into FY07.

The remainder of this report will deal exclusively the technical work packages (Project 18). Table 1 gives a condensed view of FY06 financial data. A brief summary of the Project 18 FY06 this information is as follows:

For direct SWF, obligations are the same as costs. The total direct SWF budget was 3709K (including the funds that arrived in September for the ILC Communicator). The end-of-year obligations for Personnel Costs were equal to 3559.6K. There was a net balance of 149.4K that was not charged in FY06.

The bulk of that SWF under-charging occurred in WBS 3.9.2 Cavity Fabrication. The reason for this positive balance was that there was a delay in placing the order for new cavities until very late in the Fiscal Year. In addition, the same people who planned to charge time to Industrial Cavity Fabrication tasks were instead working (for longer than expected) on solving cavity problems on the 3.9GHz Project (something funded with internal FNAL SRF Infrastructure funds). Therefore the expected labor was not available to work on 1.3 GHz cavities. Most of the other work packages were very close to their budget estimates. The fact that some tasks are shared between ILC and the other FNAL SRF initiatives makes the exact proportioning of SWF problematic but in general the guidelines of the ILC GDE/FNAL MOU were met. A balance of 149K on a budget of 3709K represents a 4% effect which is well within acceptable standards.

For M&S, the direct budget was equal to 6768K for all of the Project 18 work packages. The direct cost was 3911.4K with open commitments of 3410.3K (total obligations equals 6754.4K). This is in very close balance to the M&S budget (0.2% difference). Requisitions in Process (RIP) totaled another 304.7K so the "plan" to spend M&S in FY06 was equal to 7059K which is more than the allocated budget. Of course it is well known that not all RIPs will become obligations due to slower than expected bidder response and delays in placing the orders. Therefore, the FNAL ILC Program Office allowed the additional requisitions to enter the system and wait for the beginning of FY07 to be obligated. It should be noted that these RIPs constitute part of the FY06 scope of work; they will be obligated in the first few months of FY07 and that on order of 300K should be added to the proposed FNAL/ILC funding plan in FY07 to account for these obligations.

Looking in detail at some specific work packages, there are several areas where M&S funding was over-obligated (some due to technical reasons and some because the scope of work expanded). These include:

WBS 2.11.2 Conventional Facilities – The conventional facilities work leading up to the RDR has proven to be much more time consuming than anticipated and the M&S budget (given the internal chargeback system that makes effort show up as M&S) was over-obligated by ~100K. This over-obligation was at the request of the GDE US Cost Engineer with the concurrence of the ILC Americas Regional Director who needed the work done in order to make progress on the RDR and ILC cost estimate. The understanding was that FNAL would be reimbursed for this work in the future.

WBS 3.9.3 Cavity Processing – The combination of a slower than anticipated progress on the Joint FNAL/ANL Processing Facility and the total sum of funds being redirected away from Fermilab to collaborating institutions under processing-related MOUs led to an over-obligation of ~120K.

WBS 3.9.4 Cryomodule Design – The collaborative effort to design the Type IV cryomodule was centered at FNAL (with participation of DESY, INFN, and KEK). Unfortunately, the current state of design work at FNAL required the use of contract designers to perform the work. This is costed as M&S since they are employed temporarily via a purchase requisition to an outside vendor. The amount of work involved in this effort is large as new ideas for cost savings and design for manufacturing concepts are incorporated. This work package was over-obligated by ~90K.

The way these budget over-runs were handled in order to stay within the budget was that the order for cavities which was issued late in FY06 (under WBS 3.9.2 Cavity Fabrication) was adjusted to accommodate the available budget. This reduction in the number of cavities ordered reflects a change in the FY06 scope of work due to the need to balance the budget in other areas.

In summary, the FY06 financial report gives a clear picture of the financial status of the ILC Program at Fermilab. The budget and accounting processes are now well established with a well defined mapping of the FNAL internal Project 18 to the ILC Americas WBS. The FY06 summary shows obligations matched to the available budget. The labor costs were well within acceptable standards and were aligned with the intentions of ILC Americas/FNAL MOU. The work packages that were over-obligated were balanced by the ability to adjust the number of cavities ordered.

Table 1 Summary of Direct-Only Budgets/Obligations for ILC Work Packages (Project 18)

GDE		Materials & Services				Personnel Costs		
Title	GDE WBS	Sum of BUDGET	Sum of YTD (OBLG)	Sum of Bud-YTD	Sum of Bud-(YTD+RIP)	Sum of BUDGET	Sum of YTD OBLG	Sum of Bud-YTD
Project Management	1.2	310.0	313.7	(3.7)	(3.7)	420.0	402.6	17.4
ILC Public Relations	1.4	74.0	75.5	(1.5)	(1.6)	78.0	79.3	(1.3)
RDR	2.1.2	91.0	78.7	12.3	(45.2)	440.0	448.2	(8.2)
Damping Ring	2.5.2	50.0	42.3	7.7	4.0	130.0	130.4	(0.4)
Main Linac Accel Physics	2.7.3	109.5	104.4	5.1	5.1	411.0	433.9	(22.9)
Conventional Facilities	2.11.2	450.0	549.1	(99.1)	(99.1)	0.0	0.8	(0.8)
Cavity Fabrication	3.9.2	1,901.5	1,701.4	200.1	(3.7)	250.0	150.1	99.9
Cavity Processing	3.9.3	944.0	1,066.0	(122.0)	(123.3)	325.0	321.9	3.1
Cryomodule Design	3.9.4	300.0	389.2	(89.2)	(89.2)	260.0	240.1	19.9
BDS Collimators	3.10.6	50.0	49.8	0.2	0.2	180.0	183.4	(3.4)
Magnet Systems	4.3.1	38.0	37.7	0.3	0.3	180.0	172.0	8.0
CM Industrial Study	4.10.1	600.0	605.2	(5.2)	(5.2)	0.0	0.0	0.0
Civil Industrial Study	4.10.2	340.0	300.0	40.0	40.0	0.0	0.0	0.0
RF Power	5.8.3	310.0	272.0	38.0	4.9	173.0	156.7	16.3
LLRF	5.8.4	200.0	184.3	15.8	13.8	230.0	223.3	6.7
HTS	5.9.1	200.0	187.4	12.6	12.6	201.0	189.1	11.9
VTS	5.9.2	400.0	371.6	28.4	28.4	201.0	200.1	0.9
Cryo for Test Stands	5.9.3	400.0	426.1	(26.1)	(29.4)	230.0	227.7	2.3
Reserve	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Grand Total	6,768.0	6,754.4	13.6	(291.1)	3,709.0	3,559.6	149.4

YTD = Year to Date
OBLG = Obligations
RIP = Requisitions in Process

WBS 1.2 Program Management R. Kephart, S Mishra

Progress

The Fermilab ILC program office was reorganized in FY06**.** The ILC R&D effort is now managed from the Fermilab Directorate. The motivation of central ILC Program management at Fermilab is to make the most efficient use of Fermilab ILC resources throughout the laboratory. The organization is a matrix management scheme with the Technical and Accelerator Divisions managing most of the accelerator R&D activities. The Computing Division will be responsible for various ILC-related computing, control, and simulation activities. The Particle Physics Division is mainly responsible for ILC Physics and Detector. The ILC program office is also responsible for all SCRF R&D and infrastructure development at FNAL allowing for overall coordination of this activity lab wide.

The ILC Program Director's office is the point of contact for the GDE, regional ILC collaborations (TTC, SMTF, SFT, ATF-II etc.) and institutions collaborating with Fermilab on the ILC. The ILC Program Director's office is responsible for developing collaborations with other institutions described in the GDE MOU. These collaborations are managed under bi-lateral MOU's between Fermilab and the collaborating institutes. At present Fermilab is has or is developing bi-lateral

MOU's with DESY, KEK, SLAC, TJNL, Cornell, INFN, LANL, MSU, UPenn, UIUC, NIU, IIT. Fermilab is also member of the TESLA Technology Collaboration (TTC). FNAL is constructing a 3.9 GHz cryomodule for DESY as part of its work on TTC and DESY in turn will supply parts to assemble a 1.3 GHz TTF cryomodule. Both activities, while not supported with ILC funds, benefit the ILC. . The ILC program office has begun to organize what is anticipated to be a large effort on the Engineering Design of the ILC. In addition Efforts have begun on Regional interest items in support of a US Bid to Host ILC at Fermilab. Fermilab is working to create political and financial support for an ILC sited in Illinois. The first tangible progress is a commitment from the State of Illinois to construct the Illinois Accelerator Research Center, a $35 M building on the FNAL site whose focus is SCRF testing, industrialization, and education.

Fermilab ILC management office has established the financial tools to track the ILC and SCRF R&D programs. We developed a full WBS and the machinery to track expenditures, requisitions in process, SWF spending and technical progress at FNAL. We use these tools for reporting to American Region Team. We have task leaders for every WBS who accept responsibility for the technical and financial goals of the task.

Goals and plans for FY07 and beyond

The goals for the rest of the year and FY07 are to continue the ILC program begun in FY06, expand our capabilities in SCRF and machine physics, continue and expand detector development including improvements to the FNAL test beams, and initiate the Engineer Design of a site specific ILC. We will also continue and expand our community outreach efforts and work to build political support for an ILC at FNAL. Considerable delays and uncertainty in our FY07 plans have resulted from the failure of congress to pass a budget in FY07.