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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 1.1
Work Package Title: SLAC Program Management
Work Package Leader: Tor Raubenheimer
Laboratory: SLAC
Date: 01-Aug-2006

1. Technical progress.

This work package covers the management of the SLAC ILC effort. It includes the program director, office and computing support, ES&H compliance, and travel. In FY06, the SLAC ILC group played a major role in developing and documenting the BCD, in design and costing for the RDR, and in several critical RDR efforts. SLAC has 9 GDE members, 1 on the CCB and 2 each on the RDB and DCB. SLAC physicists are Area System leaders on 6 of the 7 areas, and Americas leaders of several Technical and Global groups. Markiewicz also heads the EDMS group and Raubenheimer is the Americas Accelerator Physicist.

2. Goals and plans for the remainder of FY06 and beyond

Work on the RDR will continue for the remainder of FY06 and into FY07. The expectation is that this will carry over into TDR work in FY07 and beyond.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.1.1
Work Package Title: Accelerator Design Management
Work Package Leader: Nan Phinney
Laboratory: SLAC
Date: 01-Aug-2006

1. Technical progress.

This work package covers the management of the SLAC accelerator design effort. SLAC is contributing to the BCD and RDR designs for the electron and positron sources, damping rings, bunch compressors, main linac optics, beam delivery system, conventional facilities, operations, availability and controls. The two milestones were:

Dec 05	BCD Document complete
Dec 06	RDR Document complete

The first milestone was met by the end of 2005. The designs for the electron and positron sources, bunch compressors, beam delivery system, operations, and availability were led by Area Systems leaders in the SLAC ILC group. This group also contributed to the damping ring, main linac and conventional facilities designs. Designs and preliminary cost estimates for all systems were delivered in Vancouver in preparation for the RDR.

2. Goals and plans for the remainder of FY06 and beyond

Work on the RDR designs, costing and documentation will continue for the remainder of FY06 and at least the first quarter of FY07. A major deliverable is the RDR document at the end of CY06, where the WP leader is acting as lead author. Post-RDR work will continue to refine designs for the TDR.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.2.1
Work Package Title: Global Systems Design
Work Package Leader: Tom Himel
Laboratory: SLAC
Date: 8/1/06

1. Technical progress.

First let me note that the Commissioning Operations and Reliability group divided the work for the RDR up by region. Each region had primary responsibility for different aspects of our work. Europe took MPS, commissioning, and tuning/feedbacks; Asia took PPS, BCS, and radiation safety; and the US took availability. While we regularly communicate and have helped each other, these have been the prime responsibilities. This report will concentrate on the work done in the US with only brief mention of work done in the other regions.

Many memos and talks can be found on our wiki page at http://www.linearcollider.org/wiki/doku.php?id=rdr:rdr_gs:commissioning_operations_reliability_wiki_pages.

We had two milestones.

1. "Complete MPS conceptual design, reviewed by the collaboration." This milestone was achieved and is represented by the MPS chapter in the BCD. Since the BCD, my European collaborators have been the primary parties responsible for the MPS development. There have been some fault-analysis-studies done that have been presented at GDE meetings and published. I must confess that I had expected the MPS conceptual design to be further advanced after the BCD version, but that has not happened.

2. "Memo on diagnostic (and other) needs in excess of those already specified by other groups." This milestone has not been achieved. While our operations group has been in

communication with the area groups and know that diagnostics have not been completely forgotten, we have not done any careful cross checks.

A lot of work has been done that did not have explicit milestones as we responded to the needs of the time. This includes

- The reliability of cavity tuner motors was investigated along with an analysis of the effects of their failure. There is a memo on our wiki page
- The radiation exposure rules in the regions have been compared and summarized for use in the beam containment system design. This is summarized in a talk given in Bangalore. More work is still needed on this subject.
- The availability simulation was updated several times to match the changes in the ILC design. This will be an ongoing activity.
- Checks were done with PEP data to see the relation between downtime and recovery time. This validated the model we have been using. We are continuing this work to improve the statistics.
- The effects of alternative designs on availability were investigated. This included location of the keep-alive source, the possibility of putting all 3 DRs in a single tunnel, reducing the number of PPS regions, and the ever popular question of 1 vs. 2 tunnels.
- Location and power requirements of dumps for MPS, operations, and commissioning were evaluated and shared with the area leaders.

2. Goals and plans for the remainder of FY06 and beyond

We will be doing more work to evaluate the tradeoffs between possible cost savings and their effects on operations. The availability model will get updated with new component counts as they become available. The most important one that has not been updated is the number of magnet power supplies.

A milestone is the writing of our section of the RDR. Early drafts are due this fiscal year and final drafts next FY.
In FY07 we will continue our activities developing the more detailed analyses and designs that are needed for the TDR.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.2.2, 3.2.1, 3.2.2, 3.2.3, 3.2.4
Work Package Titles: Control System Design, High Availability Power Supplies, High Availability Kicker, Diagnostic Processor for Power Supply, High Availability Control System & Standard Instrument Modules
Work Package Leader: Ray Larsen
Laboratory: SLAC
Date: August 13, 2006

2.2.2 Control system design

This task includes design of the basic architecture of the control system, cost estimating and RDR reporting. The BCD design for controls has been declared a High Availability design. A basic architecture with redundant networks for data and timing and redundant node switches and power supplies has been selected as a model. The Advanced Telecom Standard known as ATCA has been selected for cost modeling. Both hardware and software estimates are based on the HA design approach. First level cost estimates are complete. ANL is providing team leadership along with FNAL for LLRF. SLAC is contributing to all system technical discussions and providing cost modeling guidance. The level of effort is continuing.

Milestones and deliverables:

Dec 05 BCD Document complete
The general BCD architectures and conceptual designs were agreed and documented.
Dec 06 RDR Document complete
RDR documentation will get underway when the new cost reduction studies and inevitable BCD revisions settle down.

3.2.1 High Availability (HA) Power Supplies

This task has two main components: The demonstration of successful cost effective HA designs for magnet systems, and the demonstration of a working ~40-unit system in collaboration with KEK for the ATF system. Both goals have made excellent progress. A single unit of an N+1 system was demonstrated for auto-failover performance and met

specifications. Further progress has been made in demonstrating a redundant bulk system and in designing a redundant controller. Commercial companies are being engaged to provide components. KEK has agreed to the specifications for the system demonstration. The following is the milestone summary to date:

1. Technical progress.

Milestone	Date	Status
Design prototype HA power supply	Apr 2006	Complete
Build one power supply system	Jun 2006	Complete

2. Goals and plans for the remainder of FY06 and beyond

Milestone	Date	Status
Final design of HA supplies	Jan 2007	On schedule
Installation at ATF2	Nov 2007	

3.2.2 High Availability Kicker

This task covers only the SLAC-LLNL kicker development collaboration and not related SLAC support activities at ATF. The goal is demonstration of a high availability architecture kicker system. The two components are a basic induction stack kicker pulser that meets requirements and a system of two or more units to demonstrate system calibration and stable, high availability operation.. SLAC personnel are evaluating two kicker switches, the MOSFET induction switch and the Drift Step Recovery Diode (DSRD). Both switches show high promise. The original induction stack has been modified for higher voltage and re-tested at KEK. Meanwhile a new bidirectional MOSFET switch has been developed and achieves an acceptable full width pulse. The long range goal is demonstration of switches in FY06 and a full specification operational unit and system in FY07-8. Performance vs. FY06 milestones is as follows:

1. Technical progress.

i. Procure silicon switch and integrated driver on same substrate (LLNL)
LLNL procured the substrate-mounted silicon switch and driver. The performance of the device was not up to expectations.

ii. Complete fast switch evaluation (LLNL)
LLNL developed bipolar switch. The evaluation of this switch is in progress.

iii. Design, build 2nd Prototype w/ faster switches, lab test (LLNL)
This task is in progress and scheduled for completion in FY2007.

2. Goals and plans for the remainder of FY06 and beyond

iv. Complete switch evaluation and 2nd prototype
Discussed above.

v. Begin simulations full systems model of n+1 units (SLAC)
This work was delayed to FY2007 by the departure of a key employee.

vi. Model full system availability (SLAC-LLNL)
Delayed until FY2007.

vii. Test new model at ATF. (SLAC-LLNL-KEK)
Delayed until FY2007

viii. FY07-08 tasks:
Develop full system model, perform simulations, thermal analysis, circuit drifts in amplitude, timing, Z matching issues (SLAC-LLNL)
Design fast timing and control system for n+1 units (SLAC-LLNL)
Build 3rd prototype, evaluate control system with two units. (LLNL)
Test dual units at ATF (SLAC-LLNL)

3.2.3 Diagnostic Processor for Power Supply

This task includes an original collaborative development with Pohang, a directed effort of a special design for the new Marx cells, and a new program aimed specifically at N+1 power supplies as mentioned above in 3.2.1. The goal is a general purpose diagnostic module for power devices that can report performance to the control room and eventually be taught to take evasive actions on its own. The most fundamental function is to identify a malfunctioning module in an N+1 system, safely remove it from operation without interrupting machine operation, and signal for a hot-swap or opportunistic non-interrupting replacement by maintenance technicians. The Pohang board is quite large and has both fast and slow waveform capture as well as triggering and trigger width and delay functions. The Marx version is very low power consumption and smaller size to be able to operate off the Marx floating power supply on each cell. The HA power supply version will take advantage of special commercial DSP chips developed for a new family of intelligent HA power supplies. A milestone summary follows:

1. Technical progress.

Milestone	Date	Status
i. Detailed design of Diagnostic controller card (PLS Collaboration) work done by PAL	2005	Complete
ii. Construct diagnostic tester controller PAL completed this task in March 2006.	2006	Complete

iii. Test with prototype Diagnostic controller card 2006 Complete, under evaluation

PAL completed this task in July. SLAC is awaiting the PAL test report, expected in September 2006. Additional development of the PAL Diagnostic Board is on hold, pending evaluation of a SLAC-designed Marx Diagnostic Controller.

iv. Test on single Marx cell 2006 Complete

SLAC designed a fiber optic Diagnostic Control Board for the Marx Modulator, which is now in operation on a single Marx Cell.

v. Construct set of modules for full Marx prototype (16) 2006 Complete

SLAC fabricated a full complement of 16 modules that is being installed on cells as they are completed.

2. Goals and plans for the remainder of FY06 and beyond

vii. Install and test Marx system 2006 In progress

SLAC will test the Marx Cell Diagnostic Boards in the first prototype system by the end of FY2006. Installation in a fully operational unit will follow.

viii. Design N+1 HA DC power supply prototype 2006-7 In Progress

ix. FY07-08 Tasks

Develop commercial specification hardware & software	2007
Develop commercial suppliers	2007
Order prototypes	2007
Evaluate samples	2008

3.2.4 High Availability Control System & Standard Instrument Modules

This task focuses on detailed evaluations of HA instrument components and architectures. Emphasis is on evaluating the Telecom open architecture called ATCA for use with both computing systems and instruments. The components are: Crates (Shelves), shelf manager system, redundant power supplies, analog and digital instruments, software support, high speed networks and timing, test systems, racks and cooling. In Q1 FY06 SLAC procured the first components but aside from examining the hardware could not mount the hardware and software evaluation efforts due to lack of manpower. As a result a collaboration was formed with University of Illinois at Urbana Champaign (UIUC) to take on the evaluation tests. This equipment has been sent and the MOU and SOW's signed so work is getting underway, funded by SLAC for the remainder of FY06 and planned to continue through FY 07-08. However, additional evaluations of the suitability of ATCA for analog-digital instruments are already underway at FNAL and DESY. The following is a summary of original milestones and progress to date:

1. Technical progress.

Milestone	Date	Status

i. Complete FE prototype testing 2006 Not started

The intent was to test a front end module for analog performance. This effort is finally getting underway at UIUC.

ii. Conduct HA workshops/seminars/vendor contacts & events 2006 Ongoing

Several vendor visits were arranged and are ongoing. Subjects included racks, power supplies and ATCA modules and turnkey starter systems. SLAC is evaluating options for a commercial turnkey starter system based on ATCA. A problem exists with limited internal engineering support for this effort.

iii. Assign SLAC personnel to GDE Controls team 2006 Started

The UIUC collaboration is the first real testing effort aside from conceptual design and management level cost modeling.

iv. Bring up HA test station, tools for high performance hardware, software evaluation 2006 Started

This is the main goal of the UIUC effort. Initial startup is making good progress but is behind the original planned schedule.

v. Map BPM design to new HA platform module to advance cost model 2007 Started

An effort was intended for SLAC but manpower limitations prevented it. We are now looking to UIUC and FNAL to produce initial evaluations of analog-digital performance.

vi. Contribute to Collaboration activities: 2006 In progress

- Baseline, Alternate Configuration Design (BCD, ACD)
- Baseline HA software configuration design
- Overall plan for software development tasks
- Complete RDR modeling and cost analysis

This effort overlaps with controls and LLRF. The team has made excellent progress toward the RDR cost modeling on all fronts.

2. Goals and plans for the remainder of FY06 and beyond

vii. Investigate robotics modular replacement system (w/LLNL) 2006-7 Postponed

This goal has been given a very low priority to date since the BCD has been assuming a second tunnel for access. With new studies of a single tunnel solution it may be revived in FY07.

viii. Within Controls Collaboration:

- Identify commercial, custom module sources for (a) controls, (b) FE systems
- Build development systems for hardware, software collaboration
- Develop commercial version of FE module mechanics

These are all viable goals for 2007 and beyond. Good progress has been made in FY2006 in identifying important commercial products and complete hardware-software development systems and the effort is continuing. A feature ILC electronics overview was published in the commercial journal of the ATCA group based on a talk given at a major industry workshop.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.3.1, 3.3.1
Work Package Title: Electron Source Design and R&D
Work Package Leader: Axel Brachmann
Laboratory: SLAC
Date: 8/10/06

1. Technical progress based on FY06 milestones:

Source lab upgrade

The upgrade of the source laser lab has progressed slowly throughout FY06. The remaining work (electrical upgrade, laser safety system, HVAC installation) is expected to be completed by the end of August ’06.

Simulations

Major progress has been made simulating the electron beam transport from gun to damping ring injection. Simulations include the low energy part of the injector (gun through bunching system), NC and SC acceleration and transport through the linac to damping ring transfer beamline (eLTR). The eLTR includes spin rotation using a superconducting solenoid and an RF energy compression system to ensure the appropriate energy spread for injection of the beam into the damping ring ($\Delta E/E = \pm 0.5\%$).

ILC source laser development

The ILC source laser development has not been started yet due to delayed preparation of the laser lab (see above). Additional hardware needed to generate the bunch train structure has been acquired and is ready to use upon completion of the lab infrastructure.

Gun development (Simulations and Engineering)

This work is in progress. Initial simulations are being carried out to optimize the SLC gun design according to ILC specifications. More progress is expected as additional personnel becomes available.

New gun materials R&D

No personnel is currently available for this project. In FY07 we expect to acquire additional physicists to work on new gun materials.

Gridded photocathode R&D

Polarized photocathode R&D is in progress with a goal of achieving higher than 90% polarization. We investigate de-polarization processes, for example internal charge scattering, that prevents P>90% in GaAs-type cathodes through an SBIR collaboration with Saxet, Inc.. This R&D is aimed at forward-biasing the emitting layer to reduce the electron drift time using grids of various materials (Tungsten, Gold) deposited on the cathode surface. It has been found that a forward bias enhances quantum efficiency and the degree of polarization of emitted electrons.

InGaP/GaAs superlattice R&D

The investigation of InGaP/ GaAs strained-superlattice structure is ongoing. The goal is to explore these superlattice materials to find alternative materials to GaAs/GaAsP with a lower spin relaxation rate.

2. Goals and plans for the remainder of FY06 and beyond

ILC Source Laser Development

The main goal for the remainder of FY06 is to complete the necessary installations in the Injector Test Facility to allow the ILC source laser development work. Most of the installation work in the actual room is completed. The laser safety system is installed and approved by the SLAC PPS (Personnel Protection System) group. As of now (8/9/06) the HVAC installation and remaining electrical upgrade work packages are awarded to respective contractors. Although the overall progress of this project has been extremely slow, we expect completion of the work by the end of August ’06. During FY07, initial results of pulse train amplification will become available.

Beam transport simulations

Simulations of beam line transport system are now sufficient for the RDR. The work will continue on a more sophisticated level, e.g. multi-particle transport simulations will be carried out for most of the sources systems. An important aspect of this work is to connect the source and damping ring beam lines. The current design will be reviewed from an engineering standpoint, including investigation of cost savings options.

Gun development

Although the SLC gun is the baseline for the ILC, an engineering effort is necessary as appropriate documentation is currently not available. This will give the opportunity to incorporate state of the art technologies, such as electrode materials into the design. As additional manpower becomes available in FY07, a detailed R&D plan will be developed and work towards an improved gun design is anticipated.

Photocathode R&D

The R&D program described in this work package will continue for the remainder of FY06 and in FY07. An SBIR collaboration with SVT Associates is starting up to develop robust photocathodes based on GaN for polarized DC and RF gun applications.

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FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.4.1
Work Package Title: Positron Source
Work Package Leader: John Sheppard
Laboratory: SLAC
Date: August 3, 2006

1. Technical progress.

The bulk of the progress made since the beginning of FY06 has been to develop and document the Positron System BCD and then to develop, refine, document, and distribute the layout of the RDR and to coordinate the costing activities associated with the positron aspects of the RDR. A preliminary optics design for the full positron production system has been made in association with the RDR layout. Initial investigations have begun into the feasibility of spinning the conversion targets in a strong axial magnetic field. R&D plans in support of the TDR have been developed and have been submitted for budget and resource approval. The status of milestones and deliverables are noted below.

Milestones and deliverables:

Nov, 2005	– Positron Source Recommendation:	Done
Dec, 2005	– Positron Source Decision (BCD):	Done
Jan, 2006	– Layout (draft version):	Done
Mar, 2006	– Layout:	Done
Apr, 2006	– Parts list:	Done
May, 2006	– Draft RDR text:	Deferred until Sept, 2006
Sep, 2006	– Text deliverable	Deferred until Oct, 2006

2. Goals and plans for the remainder of FY06 and beyond

The remainder of the FY06 activities is centered on the further refinement and documentation of the RDR configuration and associated cost estimate. This activity will continue into FY07. Planning and coordination for TDR R&D will continue on a secondary basis until the RDR effort is completed. Milestones and deliverables for the continuing work are noted below.

Milestones and deliverables:

Sept, 2006	– Draft RDR text
Oct, 2006	– Text deliverable
Nov, 2006	– RDR integration
Nov, 2006-Sept,2007	– TDR Activities

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FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.5.1
Work Package Title: Damping Ring Design
Work Package Leader: Yunhai Cai
Laboratory: SLAC
Date: August 8, 2006

1. Technical progress.

The 2.5.1 Damping Ring Design is part of the 2.5 Damping Ring Design package. The 2.5 package covers SLAC work on the damping ring design, including optics studies, evaluation of dynamic acceptance, space charge effects and classical instabilities, simulations of electron cloud and fast ion instabilities, and design of pre-ring energy and bunch length compressors.

Evaluation of acceptance:

Since the configuration study, we have continued the evaluation of the dynamic aperture of the newly designed 6km damping ring to ensure that the ring acceptance was large enough for the injected beams. A simple and nonlinear model of wiggler and realistic magnetic errors based on PEP-II and SPEAR3 measured magnets were included in the simulation. These results were an important part of the evaluation of the baseline lattice. A deliverable should be the specification of magnetic errors for all magnets in the baseline lattice, including wigglers.

Impedance enhancement due to grooved surface:

In the ILC it was envisioned to have two positron damping rings of 6km in circumference each. Two rings were necessary to keep the bunches far enough apart to avoid the electron cloud instability. Without this effect, one ring would suffice, which would represent a significant saving in cost for the project. One mitigation measure proposed is to use beam pipe chambers with small longitudinal grooves in the bend regions: according to simulations, the grooves reduce the secondary emission coefficient and solve the electron cloud problem. The grooved chambers, however, will have an increased resistive wall wakefield.

Using an analytical Schwartz-Kristoffel calculation and also a numerical approach we quantified the increase in resistive wall wake. The two calculation results agree and yield a ~**1.5 factor increase** (for the geometry under consideration) in resistive wall wake compared to the case of a smooth beam pipe.

Choice of material for vacuum chamber:

Resistive wall instability is one the main instabilities in the damping rings. It is related to the choice of aperture and material (vacuum). The wiggler sections have smaller aperture 16mm, which is the main source of impedance. The resistive-wall instability has been simulated in various conditions: different aperture, different material, and also bunch-by-bunch feedback. Stainless steel has lower outgassing rate, but a larger impedance. Al has the opposite effect: larger outgassing rate but a small impedance. We proposed copper-coated stainless steel, which has both the advantages: lower outgassing rate and impedance. Therefore, a small chamber aperture can be used in the wiggler sections. The results were presented at EPAC06. A beam study on multi-bunch instability is planning at KEK-ATF.

Code development of single-bunch longitudinal instability:

It is well known that the microwave instability in the damping ring was one of important limitations in the performance of SLC. For the ILC, it strongly determines how large the momentum compaction factor has to be for the damping rings. Since the compaction factor is one of main parameters in the rings, it is very important to understand precisely what the threshold of the instability is. For this reason, we are developing a computer code for analysis of the single bunch longitudinal instability. There has been a discussion on the ILC DR email list of the need to benchmark existing computer codes and compare with experimental data, to make sure that we can confidently predict the stability of the ILCDR. In our view, most of the existing codes are not accurate enough for this job.

We developed a new algorithm for calculation of the longitudinal stability of the ring. The code is now implemented as a Mathematica notebook. In preliminary tests, the results of the calculations with the new code show a good agreement with previous calculations.

Fast-ion instability:

A numerical program based on weak-strong model has been developed to simulate the ion effects. It allows us to calculate the ion instability with more realistic parameters: realistic optics (tracking ions and beam through the whole ring), realistic vacuum (mixed gas species possible), beam fill pattern and feedback, etc. Multi-train is proposed as a main remedy to mitigate the ion effects by effectively reducing the ion density near the beam. This idea was demonstrated by recent simulations. The growth time is longer than 20 turns for the present 6km ring with multi-train fill patterns and 1nTorr vacuum. Likely, **the fast ion instabilities will not be a limitation of the design of the electron ring**. The results were presented at EPAC06. We continue to simulate the fast ion instability at injection and some beam study is planned at KEK-ATF.

Electron cloud instability:

Electron cloud is one of the key issues for the positron damping ring. In the configuration study, we have carefully simulated how the electron cloud develops under various vacuum chamber conditions and estimated the threshold of single- and coupled-bunch instabilities. As a result of our study, two 6km positron rings were chosen as the baseline configuration. Since then, simulation studies of electron cloud suppression in the damping rings have continued. In particular, two new techniques have been the focus of attention: a grooved chamber surface and clearing electrodes to reduce the electron cloud inside magnets and wigglers. Simulations performed in 2006 show that both techniques would be excellent to suppress the electron cloud in the ILC DR.

The results of these studies, including simulation and experimental results were presented and discussed at VLCW06 during which the following decisions were made:

- The baseline configuration should be changed to specify a single positron damping ring, as opposed to the pair of positron damping rings presently in the baseline.
- The design of the damping rings systems should not preclude later installation of a second positron ring, which will provide a possible solution if electron cloud effects turn out to limit performance.
- R&D on the full range of electron cloud mitigation techniques, including experimental demonstration in test facilities, must be a very high priority for the ILC Damping Rings program.

2. Goals and plans for the remainder of FY06 and beyond

We will continue the work outlined in the work package:

- Finalize a realistic specification of magnetic errors for all magnets and wigglers in the damping ring to ensure an adequate acceptance and dynamic aperture.
- Develop a solid impedance budget and specify feedback systems to control the conventional instabilities in the damping rings.
- Continue to simulate the effects of electron cloud in the positron ring and specify the essential properties of the vacuum pipe to mitigate the instabilities caused by the electron cloud.
- Develop a faster, reliable computer program to simulate the fast ion effects in the electron ring and specify a proper vacuum system to control the instability.

Beyond FY07:

We will continue the work of this year. Given a single positron damping ring, it is vital to double the R&D effort to reduce electron cloud inside the magnets. We plan to test both grooved vacuum chamber and clearing electrode in the positron ring of PEP-II. Significant manpower is required to support the design and testing of hardware.

Key personnel:
Yunhai Cai, Mauro Pivi, Lanfa Wang, Karl Bane, Sam Heifits, Gennady Stupakov

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.6.1
Work Package Title: Ring to Main Linac (RTML)
Work Package Leader: Peter Tenenbaum
Laboratory: SLAC
Date: 01-Aug-2006

1. **Technical progress.**

A complete optical design and layout for the RTML has been completed, and lattice files have been made available to the public. The necessary information for cost estimation has been compiled from the lattice files and transmitted to the RDR Technical and Global Systems leaders; in almost all cases, complete cost estimates have been developed by those Systems groups and "rolled up" by the RTML Area Systems group. The following milestones for the FY2006 plan are complete:

- Optimize the layout of the BCD 2-stage compressor (due Nov 2005)
- Complete BCD Documentation (due Dec 2005)
- Complete comparative study of different 2-stage BC designs (due Jan 06)
- Develop a complete set of lattices for the entire RTML (due Jun 06).

In addition, some progress has been made on two other milestones:

- Complete tuning studies of the BCs and spin rotation (due Jun 06)
- Complete tuning studies of the full RTML (due Sep 06).

The deliverables which have been produced are: the Baseline Configuration Document (BCD) section on the RTML; the RTML lattice files; the technical data on all components which was submitted to the Technical and Global Systems for costing purposes. In addition, the RTML leaders have received the cost estimates from these System leaders.

2. Goals and plans for the remainder of FY06 and beyond

Work for the remainder of FY2006 will be focused on cost reduction, production of the Reference Design Report (RDR), and associated documentation. This work is expected to continue past the end of FY2006, most likely until the end of CY2006. At that time, the additional deliverables will be the following:

- A final set of lattice files for the RDR design of the RTML, possibly including WBS tracking numbers for all components
- A final cost estimate for the RDR design of the RTML, plus any required supporting documentation including cost-performance tradeoff studies of various design options
- The RTML section of the RDR accelerator chapter
- A completed WBS for the RTML suitable for incorporation into the overall ILC WBS; if time and resources permit, the WBS numbers will be incorporated directly into the lattice files to improve our ability to check the consistency of the WBS and the lattice files.

In the remainder of FY2007 (Q2 through Q4), the RTML design effort will turn from its current focus on design and costing to study the tuning and performance optimization of the RTML. The tuning and performance studies have lagged in FY2006 relative to our original plans; this was a consequence of redirecting efforts from tuning and performance into the higher-priority design and costing / cost reduction efforts. Thus in FY2007 we anticipate rebalancing our efforts back in the direction of tuning and performance studies and endeavoring to “catch up” with our baseline in these areas.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.7.1
Work Package Title: Linac Beamline Design
Work Package Leader: Peter Tenenbaum
Laboratory: SLAC
Date: 8/9/06

1. Technical progress.

Note that, although it is given the title of "Main Linac Design," WBS2.7.1 has also been used as the work package for LET studies, and it is expected that the main activities under 2.7.1 in FY2007 and beyond will be more tied to LET work than linac design as such.

Main Linac Lattice: a number of key decisions were made in the first 3 quarters of FY2006. Most notably, the overall linac configuration has been chosen: 1 quad and 1 RF station per 3 cryomodules, a vertically curved linac to allow the entire linac to lie roughly on a gravitational equipotential, with 1.2 km insertions for the positron undulator on the electron side and for the timing adjustment system on the positron side. There are several lattice files currently in circulation, each of which incorporates some but not all of the final design choices. High priority activities for the remainder of FY2006 and into 2007 are: wrap up the last few decisions required for the production linac lattices (mainly related to dispersion matching and other details); produce final production versions of the electron and positron linac lattices; and transition the LET work to the production lattices (at this time, a 1 Q / 4 CM lattice from early in FY2006 is the main lattice used for LET work, owing to the absence heretofore of universally-accepted production lattices).

Low Emittance Transport: An LET workshop was held early in FY2006. At that time, the aforementioned vertically curved lattice was adopted for main linac studies, and agreement was reached on a set of simulation tests which would be used to "certify" the basic beam dynamics properties of a code before it was accepted for use in linac studies. All of the codes currently in use have been certified in this manner.

Since the LET workshop, studies of the main linac have demonstrated that there is an incremental penalty in emittance dilution for the use of a vertically-curved linac as compared to a laser-straight version. This penalty is sufficiently small that the vertically-curved version has been accepted as the baseline configuration. For the first time, a simulation result produced by one group was reproduced, in full detail, by a separate group with a completely independent simulation codebase.

Preliminary work has commenced on emittance preservation in the RTML section upstream of BC1 (the skew correction, collimation, turnaround, and spin rotator sections), and progress has

been made on the alignment and tuning of the BDS (although this effort is mainly funded out of WBS 2.10.1).

2. Goals and plans for the remainder of FY06 and beyond

In FY2007 work will continue in all these areas, both area-by-area and in an integrated approach. The goals of the effort will be: to demonstrate with 90% confidence that the emittance budget of the ILC can be achieved; to demonstrate multiple steering and alignment algorithms which can be used in each area; and to have at least 1 independent verification of each simulation result before it is accepted as a valid demonstration for these purposes.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.7.2
Work Package Title: Linac Wakefields
Work Package Leader: Chris Adolphsen
Laboratory: SLAC
Date: 8/8/06

1. Technical progress.

Physicists from the Advanced Computing Department (ACD) and Beam Physics Group at SLAC have made a good start at understanding a number of issues related to wakefields in the ILC linac cavities, and multipactoring in the high power cavity couplers. They have used both analytical models and computer simulations to study the characteristics of the cavity dipole modes (e.g. their external Q values, polarization, frequency spread and mode splitting), and the severity of multipacting in the TTF3 coupler bellows. The cavity simulations show that elliptical dipole modes will be generated with purely symmetrical cavity cells, although they are unlikely to be present in the ILC linacs due to the azimuthal asymmetries introduced during the cavity manufacturing process. An analytical model was developed to characterize these modes, and the results are summarized in Slac-Pub-11860. The ACD work on cavity and coupler simulations was recently presented in an invited talk at EPAC06 – see paper THXFI01.

2. Goals and plans for the remainder of FY06 and beyond

The main goals for the remainder of FY06 and beyond are to (1) develop a model of the cavity shape distortions that will explain the variations observed in the lowest-band dipole mode properties, (2) use this model to verify that the spectrum of (R/Q)*Qext for lowest band modes will not produce significant beam breakup in the ILC Linacs, (3) extend this analysis to trapped modes over multiple cavities for frequencies up to ~ 8 GHz, which will require massively parallel computer processing and (4) complete the multipacting evaluation of the TTF-3 coupler and suggest design changes to reduce this phenomenon.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.8.1
Work Package Title: RF Design
Work Package Leader: Chris Adolphsen
Laboratory: SLAC
Date: 8/9/06

1. Technical progress.

WBS 2.8.1 covers the linac rf system design, where the main focus in FY06 has been on the rf distribution system.

Four changes to the baseline rf distribution design are being considered. The circulators would be eliminated as they are a big cost item, and the cavities would instead be powered in pairs using 3-dB hybrids. This would still isolate the cavities, but would allow some power (< 1%) to return to the klystron in the event of an rf fault in a single cavity or coupler, which should be benign. A second change would be to use a variable tap-off system to feed the cavity pairs. One proposal is to have rotatable, polarized TE11 circular waveguide sections between the cavities whose orientation would be adjusted (one time only) after the relative cavity performance was measured. Another cost cutting measure is to replace the 3-stub tuner with a simpler phase shifter that would be adjusted once the system is set up, and would not require further changes. Finally, with the large number of waveguide flanges, a means of welding the waveguides together is being sought to reduce cost and improve reliability. At present, an rf design for a variable tap-off system has been completed and some initial waveguide welding tests have been done.

WBS 2.8.1 also covers my work with the GDE to design and cost the ILC Linacs (I am the head Area System Leader for the Main Linacs). It has been a very intense past year to complete the Baseline Configuration Design (BCD) and to work with the Technical and Global System groups to finalize and cost the Main Linac design for the Reference Design Report (RDR). During the past quarter, Mike Neubauer joined this effort full time and works with me on the HLRF system design, and helps organize the configuration and cost information that will be incorporated in the RDR.

2. Goals and plans for the remainder of FY06 and beyond

Design work on an improved and less expensive rf distribution system will continue and prototypes of an adjustable tap-off and phase shifter will be built and tested in FY07 (under a different WBS category). Based on the results, an eight cavity distribution system will be built for the first cryomodule at FNAL. Work will also continue to finalize the Main Linac design, document it for the RDR and to assemble a defendable cost estimate.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/31/06
Work Package WBS Numbers: 2.10.1, 5.10.1
Work Package Titles:
Beam Delivery system accelerator design;
BD test facilities (optics design and fabrication of magnets for ATF2)
Work Package Leader: Andrei Seryi
Laboratory: SLAC
Date: 08/10/06

2.10.1 Beam Delivery system accelerator design

1. Technical progress.

During this period the accelerator design of beam delivery system continued within the international collaboration. The following milestones have been met, and deliverables produced, according to the original plan:

- The BDS BCD has been completed in December of 2005;
- Following the BCD decisions, the BDS optics design was completed in April 2006, which included design of the tune-up extraction lines, diagnostics sections, etc.
- This BDS optics design was then used to determine CF&S layout of BDS; engineering specification of the components; performance evaluation of the beamlines, etc., during May-June 2006;
- The first version of the cost estimate of the BDS was produced at the end of July 2006.

Here is more detailed yet incomplete list of the technical design studies and performance evaluations that were performed [1]:

- Performance of downstream diagnostics for both 20mr and 2mr beamlines
- Studies of beam losses and SR losses in extraction lines
- Study background due to backscattering in extraction lines
- Magnets and power supply specifications for all beamlines
- Specifications of beam dump systems and its enclosures
- Radiation safety and required shielding in the collider hall
- Detailed design of crab cavities and analysis of low and high order modes and specifications for couplers
- Studies of BDS tuning and feedbacks
- Determine specifications for BDS diagnostics
- Study vacuum chamber material effect on wakes

In addition to this technical work, efforts were directed into coordination of the work done in other labs and regions.

2. Goals and plans for the remainder of FY06 and beyond

The project goals and work plans for the remainder of FY06 continue to be the detailed evaluation of the design and cost. Following the July 2006 GDE meeting, an additional goal has been set – to find a reasonable way to reduce the cost of BDS. The final version of BDS design and cost is needed to be produced at the end of the calendar year 2006, as well as the BDS section of RDR. The work will continue in 2007, with the emphasis on engineering aspects of the design and on TDR work.

5.10.1 BD test facilities (optics design and fabrication of magnets for ATF2

1. Technical progress.

During this period the ATF2 optics design and fabrication of magnets proceeded *mostly* according to plan, however, several design decisions taken in January 2006 at the ATF2 Project Meeting [2] resulted in corrections of the initial plan. First, the collaboration decided to eliminate the chicane in the ATF2 optics, which was supposed to help in extracting the laser wire signal, and instead to detect the laser wire photons after the first bend in the Final Focus. Second, it was decided that a completely new extraction optics would be adopted, which allows reduction of dispersion in the extraction line of about a factor of four, from 2.4m to about 0.6m. This is expected to facilitate extraction of low emittance beam from the ATF ring. The extraction line will include all existing magnets, but the layout is somewhat different which will require modification of the beamline. As a result of these two and several other smaller decisions, a new goal was set – to complete the ATF2 optics by the end of June 2006, after that the civil engineering layout for the shielding enclosure and floor modification will proceed. This milestone was met – the final ATF2 optics was produced shortly after the Second ATF2 Project Meeting [3]. At the same meeting the requirements for the design of FF bends and Final Doublet (aperture, length) were finalized. After that, design of bends and FD has started. For the FD bends, existing FFTB quads were identified whose aperture need to be increased by re-machining the poles. Design of FD quads is ready for production. Design of FF bends and FD sextupoles is being produced now.

2. Goals and plans for the remainder of FY06 and beyond

In the remaining part of FY06 and in 2007 the optics design work will concentrate on studies of tuning methods and integration with diagnostics. The design of magnets and there manufacturing will be completed.

References

[1] BDS design progress is documented in the minutes of the meeting
http://www-project.slac.stanford.edu/lc/bdir/meetings_beamdelivery.asp
and more recently also here
http://ilcagenda.cern.ch/categoryDisplay.py?categId=9
[2] First ATF2 project meeting, January 2006, SLAC
http://www-project.slac.stanford.edu/ilc/meetings/workshops/ATF2/feb2006/
[3] Second ATF2 project meeting, May 2006, KEK
http://acfahep.kek.jp/subg/ir/bds/atf2/meeting/2nd-project/index.htm

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 2.11.1
Work Package Title: Conventional Facility Design
Work Package Leader: Fred Asiri
Laboratory: SLAC
Date: 8/8/06

1. WBS 2.11.1 and WBS 2.2.3: Conventional Facility Design and Installation Efforts

SLAC Conventional Facilities (CF) partnering with the FNAL-CF engineers identified several potential locations for the ILC alignment in northeast Illinois. They then assessed each location considering not only cost of the construction and installation phase of the project, but the environmental impacts as well as any eventual impact on the long term operations of the ILC. Results were analyzed, reviewed, and amended into the global site assessment matrix. As results of this effort, a Sample Site for the Americas region in northeast Illinois was identified at the end of 2005.

In collaboration with Fermilab, Japanese, European engineers, and Area System managers the baseline configuration layout as well as a complete description for the CF portion of the ILC was developed. In addition to baseline choices, alternate configurations were also established that may have cost benefits. These efforts were complete in time for inclusion into the Baseline Configuration Document (BCD) in December, 2005.

Subsequent to the adaptation of the BCD, the CF group developed a concept design and associated cost estimate for the ILC Conventional Construction. This effort included the development of many 3-D visualization drawings which facilitated the top-level assessment of the major choices, as well as a set of concept designs that provide cost effective, safe underground and surface facilities. This initial design and cost estimate was completed in time for discussion at VLCW06 and will form the basis for the Reference Design Report planned for completion by the end of 2006.

In addition, SLAC has devoted a major effort in initiating, organizing and setting-up a complete and comprehensive cost model plan for the ILC Installation Global System in collaboration with the Asian and European representatives. The SLAC Installation group being also partner in the Conventional Facilities Group has tried to coordinate and to integrate the installation effort with the CF work as well as with the other Regional Technical and Area Teams. An intermediate milestone was established that would provide a first cut cost estimate for this effort by mid July. This milestone was met and the Installation Cost Estimate was delivered to the ILC Design and Cost Board for VLCW06

2. Goals and plans for the remainder of FY06 and beyond

The remainder of FY06 will be devoted to the refinement of the Installation and Conventional Facilities cost estimates for eventual inclusion into the ILC RDR. In addition, necessary text will be written to complete the Conventional Facilities and Installation sections of the RDR. Refining the cost estimate will include the verification of currently identified scope, boundaries, treaty points, 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. These will not only result in adjustments to the cost estimate, but will likely affect other aspects of the project that are not as easily quantifiable, such as installation efficiency, machine maintenance, reliability and impacts to other aspects of the baseline configuration. A comprehensive approach to proposed alternatives will require careful attention to all potential impacts. This effort will extend through the end of FY06 and well into the coming fiscal year.

The RDR is currently scheduled for completion in November, 2006, however refinement of the cost estimate and text may continue after the scheduled completion date and evolve into detailed engineering studies for the TDR.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.1.1
Work Package Title: R&D Management
Work Package Leader: Tom Markiewicz
Laboratory: SLAC
Date: 01-Aug-2006

1. Technical progress.

This work package covers the management of the SLAC R&D effort. SLAC is contributing R&D in support of the both the baseline design and alternate configurations in the areas of high availability power supplies, kickers, and control system architecture, polarized electron source cathodes, gun and lasers, positron source capture structure, electron cloud effect amelioration devices and measurements, bpm design and bpm electronics, linac quad stability under shunting, rf coupler development, HOM monitors, and End Station A facilities to beam test various of these and other devices. The two milestones were:

Dec 05	BCD Document complete
Dec 06	RDR Document complete

The first milestone was met by the end of 2005. The results of this R&D program figured prominently in discussion of the configuration, changes to the configuration, and cost of all areas of the ILC at the July 2006 Vancouver GDE meeting in preparation for the RDR.

2. Goals and plans for the remainder of FY06 and beyond

With few exceptions (completion and dismantling of E166) the SLAC ILC R&D program is expected to continue for the remainder of FY06 and beyond. Results will continue to be incorporated into baseline design, through the change control board, where the WP leader is a contributing member and documented in the electronic document management system, with which the WP leader is intimately involved. Post-RDR work will continue in an effort to increase reliability and reduce the cost and risk of the devices investigated.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.4.1
Work Package Title: NC Positron Capture Structure
Work Package Leader: Chris Adolphsen
Laboratory: SLAC
Date: 8/9/06

1. Technical progress.

The positron capture cavity design was completed in FY05 and fabrication of the cells began last November. Since then, a full set of drawings (over 100) was generated for the five-cell cavity, surrounding solenoid magnet, high power rf vacuum windows, supports and cooling system. The solenoid was acquired from Boeing this summer as a gift to Stanford. The magnet was made by Thales for L-band klystrons, and could be used with our klystrons if needed (it took over a year of emails and phone calls to get this exchange approved, but it saved 50 k$). The fabrication of the cavity has been very slow due to the low priority of ILC work in the Klystron Shop relative to work on klystrons for PEP II and an rf gun for LCLS. So far, the inner half cells have been machined, brazed in pairs and re-machined: they still require tuning before they are assembled with the end cells, which are still being machined.

2. Goals and plans for the remainder of FY06 and beyond

By the end of FY06, the rf vacuum windows should be completed and at least two of them high power tested (four are being built: one for the structure, one spare and two for the coupler test stand). The cooling system should be assembled and tested at the required 100 gpm flow rate with 45 degC temperature-regulated water (a preliminary test was done at 50 gpm earlier in the year). The 5 MW rf power source (all components from the LLRF system to the connecting waveguide) should also be in place and ready for operation (this is discussed in the WBS 5.7.1 progress report). Unfortunately, the structure itself will probably not be available for test until December. After it is installed, it will be processed to 15 MV/m with 1 msec pulses at 5 Hz, and the absolute gradient and its uniformity during the pulse measured by accelerating a single bunch from the NLCTA injector at different times relative to the rf pulse. The cavity will also be operated in a 0.5 T solenoidal magnetic field, as required in the ILC, to see if its performance is affected.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.4.2
Work Package Title: E-166 Positron Polarization Experiment
Work Package Leader: John Sheppard
Laboratory: SLAC
Date: August 3, 2006

1. Technical progress.

The data taking for E-166 was completed at the beginning of October, 2005. Preliminary data analysis shows that a successful demonstration of undulator based polarized positron production has been made. The analysis is largely being conducted at DESY Zeuthen for positron polarization while the effort on the photon analysis is being conducted at the University of Tennessee. Some post-experiment calibrations have been done. Two collaboration meetings have been held to discuss the results and analyses.

Milestones and deliverables:

Oct, 2005	– Complete second experimental run:	Done
Nov, 2005	– Collaboration Meeting, DESY Zeuthen:	Done
Mar, 2006	– Disassemble experiment apparatus:	Done
May, 2006	– Collaboration Meeting, Princeton:	Done
Aug, 2006	– Return equipment:	Ongoing

2. Goals and plans for the remainder of FY06 and beyond

Equipment is being returned to the collaborating institutions. Journal articles are being developed and are expected to be submitted for publication towards the end of 2006. A third collaboration meeting is being planned for the beginning of November, 2006 to finalize an initial pair of publications.

Milestones and deliverables:

Oct, 2006	– Complete equipment return
Nov, 2005	– Collaboration Meeting, DESY Hamburg (?)
Dec, 2006	– Submit articles for publication

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.5.1
Work Package Title: Electron cloud measurements and PEP-II studies
Work Package Leader: Mauro Pivi
Laboratory: SLAC
Date: Aug 3, 2006

1. Technical progress.

The 3.5.1 Electron cloud measurements and PEP-II studies Working Packages program is to study mitigation techniques and their feasibility to ultimately reduce and stabilize the surface secondary electron yield (SEY) below the threshold for the onset of the electron cloud in the positron damping ring.

Motivation:

At the recent Vancouver meeting, a decision has been taken to eliminate the second positron ring. This would place new emphasis and urgency on R&D aimed at suppressing the electron cloud. While the various suppression techniques look sufficiently promising to justify the change in the baseline configuration, there are still technical problems to be overcome and demonstrations to be made. While there remains uncertainty regarding the impact of electron cloud on the positron damping ring, a configuration with two positron damping rings should remain an alternative, and a potential upgrade.
Possible cures in wiggler and dipole regions such as rectangular grooves and clearing electrodes although very promising need a full demonstration and a stronger R&D program is urged.

Summary of FY06 work:

At SLAC, a dedicated laboratory system is setup to measure the Secondary Electron Yield (SEY) of vacuum chamber materials. This system is unique amongst High Energy Physics laboratories. During FY06, we performed SEY measurements of promising grooved profile, novel Ti alloys and tested the effect of ion bombardment conditioning. Note: F. Le Pimpec from PSI, came in November 2005 for a non-profit period at SLAC to work on SEY measurements. The R&D program for FY06 includes a series of projects for installation of dedicated chambers in an accelerator beam line to test various electron cloud mitigation effects:

- Project 1: Installation of chambers with rectangular longitudinal fins (grooves). ILC, PEP-II collaboration.

- Project 2: Installation of dedicated test chambers in PEP-II to test the effect of conditioning *in situ*. ILC, PEP-II collaboration.
- Project 3: Design of dedicated test chambers with clearing electrodes.
- Laboratory measurements of the SEY and surface analysis.
- Developing new material alloys.
- Measurements of electron trapping mechanism in a quadrupole field. In collaboration with PSR LANL.
- Fabrication of samples with rectangular μm size grooves.
- Install a dedicated electron diagnostic in the Dafne positron ring, Frascati. In collaboration with Frascati.

We performed laboratory measurements of rectangular grooved surfaces that resulted in a low promising SEY ≤ 0.7. We successfully tested the effect of ion bombardment and conditioning. We also built 4 aluminum vacuum chambers by extrusion with longitudinal fins that will replace an 8 meter long section in the PEP-II low energy ring (LER). We will compare the effect of the fin chambers with reference no-fin chambers. Those are scheduled to be installed earlier in FY07. We completed the construction of a dedicated chamber to test the effect of photon and electron conditioning *in situ*. The chamber will host TiN and TiZrV-NEG coated samples, which after a period of conditioning, will be extracted and transferred to the SLAC laboratory for SEY measurements. The chamber is scheduled to be installed in PEP-II LER earlier in FY07 together with the fin chambers.

Since the DR recommendation in November 2005, simulation studies of electron cloud suppression in the damping rings have continued. In particular, two new techniques have been the focus of attention:

- Use of grooved chamber surface.
- Use of clearing electrodes.

Simulations performed in 2006 show that both techniques would be excellent to suppress the electron cloud in the ILC DR magnets as dipoles and wigglers. We are studying the feasibility and use of those techniques in accelerator vacuum pipes.

We fabricated and measured the secondary electron yield of a novel TiCN alloy.

We have fabricated OFE Cu samples with rectangular micron size grooves to be used for suppression in magnets.

Finally, we have an ongoing collaboration since two years with R. Macek at LANL to install special electron cloud diagnostic in PSR quadrupoles, to be able to measure the electron trapping mechanism. The installation is expected for the end of FY06.

2. Goals and plans for the remainder of FY06 and beyond

We expect to install the fin chambers and SEY test chamber later in FY06 and run the SEY experiments through FY07.

During FY07, we will design a dedicated experiment to test the very promising electron cloud mitigation techniques for magnets including clearing electrodes and triangular grooves. We are projecting to build a dedicated 4-bend chicane and test chambers to be arranged on purpose in PEP-II LER. We are collaborating with M. Palmer at Cornell to run similar experiments in the CESRC wigglers chambers later in FY08. There are potential risks associated with novel cures that may limit their technical feasibility. Concerns include the possible RF over-heating of the electrodes from the beam, the additional impedance that may come from the electrodes and the generation of higher order modes. If these concerns can be addressed, then the use of clearing electrodes could be an effective technique for preventing electron-cloud build up inside strong magnetic fields. Furthermore, we will follow the installation of the electron cloud diagnostic in

the PSR quadrupole at LANL and the installation of dedicated electron cloud diagnostic in the Dafne ring. We will collaborate with KEK measurements of dedicated Cu chambers and will also collaborate with CERN at the start of the LHC in FY07, where an electron cloud is expected.

Milestones and Deliverables: Date

Project 1. Grooved chamber installation in PEP-II drift ready for tests 10/06

Project 2. SEY test chamber installation in PEP-II drift ready for tests 10/06

Project 3: Build prototype clearing electrode chamber and PEP-II chicane 06/07
Clearing electrode chamber installation in the PEP-II LER Summer 07
Triangular groove stripes chamber installation in PEP-II LER Summer 08
Clearing electrode chamber installation in the CESRC wiggler Summer 08
Installation of dedicated diagnostic in PSR LANL and Dafne Frascati Fall 06
Measure SEY micron grooved profile samples by electroforming 11/06

Expectations for FY07 and beyond:

Studies will continue as needed to support the RDR and TDR.

Note: although, much has been done in the past years, the R&D on electron cloud at SLAC urges considerable increase in work forces. In particular, since F. le Pimpec left SLAC ~one year ago, we are left with limited FTE key personnel time to work on the experimental program. In view of the new emphasis and urgency on R&D aimed at suppressing the electron cloud, we ask to implement the FTE effort at SLAC to be able to get to the Technical Design Report TDR document, due by 2008, with solid information and knowledge on suppressing techniques needed to mitigate the electron cloud effect in the damping ring.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.5.2
Work Package Title: ATF Ring BPM Electronics
Work Package Leader: Marc Ross
Laboratory: SLAC
Date: August 8, 2006

1. Technical progress.

The ATF Ring BPM electronics system was tested at ATF in February 2006. The pilot system (~10% of the ring) performed as expected and results were presented at the DOE – ART review in early April. This project was supported in part by US-Japan funds. The KEK US-Japan fund managers decided not to support further work in JFY 2006, which began in April 2006. No work has been done since then. The pilot system was left intact and was used during the remainder of the 2005-2006 ATF operations cycle.

The primary USFY06 deliverable, the 10% project system was completed February 26, 2006.

2. Goals and plans for the remainder of FY06 and beyond

We expect US-Japan support for the remainder of the system in JFY2007, although the details have not been finalized. Fermilab instrumentation engineers have joined the effort, in the meanwhile, and will participate in further pilot system tests and software development in December 2006. Fermilab has a lot of experience with digital receiver technology following its application to most of the complex (Tevatron, recycler, main injector and NUMI transport). We also expect this system to be critical in the tune up of ultra-low emittance beams at ATF. Such beams will be needed in early 2008.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.7.6
Work Package Title: TTF2 HOM Monitor
Work Package Leader: Marc Ross
Laboratory: SLAC
Date: August 8, 2006

1. Technical progress.

The complete TTF2 HOM monitor system was completed and delivered to DESY in November 2005. It has been in use for tuning the FEL beam since then. In mid FY-2006 we assigned a post-doc to the study of HOM signals for checking and understanding three-dimensional higher order modes in the SCRF cavities. Such modes have been calculated by the SLAC RF modeling group and may have an impact on the operation of ILC. Experiments to understand these modes were started in May 2006.

2. Goals and plans for the remainder of FY06 and beyond

We expect tests of these modes to be carried out by both DESY and SLAC staff over the next year. The cost of this effort is limited to the travel costs of the student and assisting staff.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.8.3
Work Package Title: ATF2 Cavity BPM Electronics
Work Package Leader: Marc Ross
Laboratory: SLAC
Date: August 8, 2006

1. Technical progress.

Prototype electronics have been beam and bench tested in December 2005 and April 2006. In April, we decided to re-schedule the delivery of the electronics to September 2006 in order to have time for a better packaging design and installation/testing plan. This plan is now complete. All (40 each) printed circuit cards have been produced and are in loading and testing. One fourth of the delivery will be taken to KEK on August 24 for bench testing. The complement will be shipped in early September. This constitutes the primary deliverable for USFY06.

The system performance, per bench tests, exceeds the required 100 nm resolution. X-y channel coupling is also within specification, but this has not been tested in the final configuration. Beam tests with older 'legacy' cavities showed poorer performance than expected (140 nm resolution), but further analysis of the data is required in order to evaluate this result. It is important to note that this is the first high frequency (>2GHz) such printed circuit board produced by the group and accepted for use.

2. Goals and plans for the remainder of FY06 and beyond

The goal for the remainder of FY06 and for the preparation period leading up to initial commissioning of ATF2 is the preparation of this BPM system for use. We expect the system to be available for 'first pulse' operation, something new for large cavity BPM systems. This will require a-priori estimates of the relative phase difference between the cavity signal and the local oscillator with a precision of 180 degrees (about 80ps).

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 5.5.3
Work Package Title: ATF Beam Dynamics and Instrumentation Studies
Work Package Leader: Marc Ross
Laboratory: SLAC
Date: August 8, 2006

1. Technical progress.

There are 7 sub-projects in this work package: 1) ultra-high resolution cavity BPM's, 2) emission of coherent synchrotron radiation, 3) laser-based beam profile monitors (laserwire), 4) fast feedback, 5) optical stabilization, 6) generation of low emittance beams using precision BPMs and correction procedures and 7) development of fast pulse kickers.

1) work on ultra-high resolution cavity BPM's, a collaboration between SLAC, UCB, UK and KEK groups, moved to a new phase this year with the installation of the carbon fiber 'metrology' frame against which the positions of the cavities can be compared. The metrology frame, developed and fabricated at LLNL, is made from carbon fiber reinforced plastic and should have a small (compared to the space frame within which the BPM's are mounted) thermal expansion coefficient. Studies with the frame and the position sensors attached to it have just begun.
2) Together with KEK and the LBNL group, tests have been done to search for signs of micro-bunching instability in the stored ATF beam using emitted millimeter-wave radiation. These tests have been done with a liquid helium bolometer and a ~ 100 GHz detector diode. So far, no coherent stored-beam signals have been seen.
3) Laserwire work is led by the Grahame Blair's group based at the John Addams Institute in the UK. Our participation has been in a consultative, reviewing capacity. The group achieved a major milestone this June with their first scan of the extracted ATF beam.
4) The fast feedback work, led by Philip Burrows of the 'FONT' collaboration, also based in the UK, began this year to test systems optimized for the ILC bunch spacing. As with the laserwire, the SLAC group provides advice and help with ATF infrastructure.
5) The purpose of the optical stabilization in the ATF extraction line is to determine component motion over long 'thermal' time scales. This work is led by David Urner

of Oxford University. SLAC's role is to facilitate the installation of a practical system at ATF. During FY06, the groups' focus has been on lab tests.

6) The group had hoped to use the pilot project precision BPM's (WP 3.5.2) to demonstrate improved emittance tuning. Tests were done in February 2006 and will be repeated later this year, in December.
7) Fast kicker work has been headed by the KEK group under Takashi Naito. During FY06, the LLNL group completed a very high power (+/- 9KV, 3 MHz) bipolar inductive adder pulser which was delivered to KEK in June and has been used for beam tests. This device does not satisfy the rise / fall time requirements of the ILC but it is powerful enough to extract the beam from the ATF and we expect extraction testing in late 2007.

2. Goals and plans for the remainder of FY06 and beyond

1) The cavity BPM work will be directed by Stewart Boogert of the John Addams Institute starting in November 2006. His primary goal is the development of a precision absolute energy spectrometer. SLAC and UCB involvement in this effort is expected to complement tests in ESA. This effort is expected to take another 2 years.
2) Coherent (mm-wave) emission tests are expected to continue this year with attempts to increase the single bunch current beyond that used in previous tests. The threshold for the microwave instability is expected to be well below the achievable single bunch current.
3) The UK group will develop and test a precision f# 2 high power laser focusing optic this year. This device should be installed during FY07 and will be used for scanning tests.
4) The FONT group will test 3-ILC bunch feedback this year, and may have the opportunity to test their system with up to 20 bunches, with nominal ILC spacing, in June 2007.
5) Work on the optical stabilization system has now shifted its focus to applications involving the ATF2 IP. This system is needed for ATF2 testing in FY08. Lab testing will continue until then.
6) FY07 emittance tuning and BPM development work will involve the efforts of the Fermilab and UK groups.
7) In FY07 the DR RD groups will attempt to coordinate the global effort focused on this technology. We expect to use ATF to test prototype kicker systems developed at other labs, and to test the ATF / LLNL system at other labs. Preparations are under discussion for testing the ATF system at Cornell.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.7.3
Work Package Title: SC Linac Quad and BPM
Work Package Leader: Chris Adolphsen
Laboratory: SLAC
Date: 8/9/06

1. Technical progress.

A TELSA SC linac quad prototype was obtained (on loan) from DESY this year along with gas-filled-type leads to power it (100 A produces 60 T/m in the 0.66 m long magnet). The quad was built by the CIEMAT group in Spain and tested initially in a vertical dewar at DESY. At SLAC, the design of a warm-bore cryostat for this quad was started in FY05 and finished this spring (keeping the magnet stable vibrationally at the sub-micron level while allowing contraction of the support system during cool-down is not trivial). The cryostat is now under construction and is about 80% complete (the quad was recently inserted in the He vessel). The power supply and quench protection circuit for the magnet was assembled and the gas-filled lead assembly tested in a dewar at full current. The magnet will be tested at the SLAC Magnetic Measurement Lab using liquid He and N2 supplied by 2000 liter portable dewars. The parts for the cryogenic supply system have been purchased and are being assembled. Also, a rotating coil system was built that will allow the position of the quad magnetic center to be monitored at the sub-micron level as the magnetic field is varied (the design of this system is based on that developed for the normal-conducting NLC quads). Finally, accelerometers were purchased that will be used to monitor the vibration of the quad relative to base on which the cryostat will be supported (the measurements will be done in collaboration with FNAL).

In a parallel program, a slotted-waveguide-style, S-Band (2.9 GHz), cavity BPM was designed, and three prototypes constructed and tested at End Station A at SLAC. These BPMs have a 36 mm aperture, which is about half of the nominal ILC size. This choice makes testing this design concept simpler, and it would be advantageous to adopt this aperture size for the ILC. The BPM geometry naturally suppresses monopole mode signals, and it was carefully designed so the neighboring modes are well separated in frequency. A low cavity Qext was chosen (~ 500) to allow clean bunch-to-bunch signal separation in the ILC (the signal drops to 0.2% of its initial level after 337 ns, the nominal ILC bunch separation). The prototype BPMs preformed well in beam tests with 29 GeV, 300 micron-long single bunches of 1.5e10 electrons. Resolutions of 400-800 nm were achieved when down-mixing the signals to 73 MHz and digitizing them at 100 MHz. These resolutions are better than that required in the ILC linacs.

2. Goals and plans for the remainder of FY06 and beyond

During the last quarter of FY06, the rotating coil system will be first tested with a normal-conducting quad to verify that the desired resolution and accuracy are achievable. The cryostat assembly will be completed and first cooled down in the one of the cryogenic support buildings at SLAC. The full system will then be assembled at the Magnetic Measurements Lab, and basic measurements made of the fields generated by the quad and dipole windings. This will be followed by the main program of monitoring the magnetic center stability during field changes (the center must move by less than 5 microns with 20% field changes for quad shunting techniques to be used effectively for beam-based alignment of the ILC linac quads). Finally, the long term stability of the magnetic center will be monitored at a fixed current, and the vibrational characteristics of the support system will be measured.

The S-Band BPMs will continue to be used in beam tests in ESA. If no broad consensus is reached to reduce the large BPM apertures (80 mm) in the ILC Linacs, a triplet of full aperture, L-band (1.5 GHz) BPMs will be built (this is an FY07 proposal). As part of this program, more prototype quads of different strengths would be tested, both with a rotating coil and with beam using the prototypes BPMs to monitor changes in the beam trajectory when the quad strength is changed.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.8.1.1.
Work Package Title: Marx Modulator
Work Package Leader: Greg Leyh
Laboratory: SLAC
Date: 01-Aug-2006

1. Technical progress.

Mid FY06 Goals

• Verify 12kV solid-state switch performance
• Develop Marx bank control system
• Assemble, test prototype Marx Cell
• Assemble, test a four-cell Marx 'short stack'

Progress

Verify 12kV solid-state switch performance – The 12kV IGBT-based switches were addressed first in the cell development, as they had the highest technical risk of all the Marx Cell components. The actual prototype switch performance matched the design simulations closely, and performed to expectations during 10 weeks of accelerated testing. No design changes are needed for the 12kV switch.

Develop Marx bank control system – Jeff Olsen (Controls Group) designed both the Ground Station Control crate hardware and the individual Marx Cell Control modules. The first prototype boards were installed and successfully operated at 12kV on the Marx cell test stand. Jeff designed preliminary firmware and software control panels for the control system that allow a base level of control, suitable for initial modulator tests. Further software development is scheduled in FY07 to provide a precisely regulated pulse to the 10MW ILC klystron.

Assemble, test prototype Marx Cell – The fully integrated prototype Marx Cell experienced some problems during initial power-up and testing, detailed below. These problems have been solved and the prototype cell is currently operating at 12kV.

A) Vacuum Relays – The 15kV rated vacuum relays performed well during months of continuous tests, but apparently generated brief bursts of out-gassing when energized after being dormant for long periods. The manufacturer recommended a relay with much larger contact areas, which required mechanical changes to the Marx Cell. The new relays were installed in the prototype, and have operated so far without incident.

B) Overcurrent Protection – The circuitry that detects overcurrent faults had errors in both the comparator hardware and the firmware that calculates the fault time delays. These errors were especially challenging to solve since the detection circuitry floats at 12kV potential, requiring us to design custom diagnostic probes for isolating sources of the problems. We modified the detection circuitry and firmware, and the Marx cell now performs to spec under short-circuit fault conditions.

Assemble, test a four-cell Marx 'short stack' – In Q1 FY06 the Marx cell IGBT manufacturer (Powerex) advised us of an unplanned 18 week production delay, due to a bottleneck in their silicon irradiation process. To mitigate the impact of this delay we decided to pursue construction of the full modulator framework during the IGBT production delay period, and bypass the short stack testing stage altogether. At the end of Q2 FY06 the full modulator frame was completed. Operation of a fully stacked modulator at 120kV is now planned for Q4 FY06.

Progress Summary

Verify 12kV solid-state switch performance	Completed
Develop Marx bank control system for initial testing	Completed
Assemble, test prototype Marx Cell	Completed
Assemble, test a four-cell Marx 'short stack'	Rescheduled*

* - Short stack testing plan modified in favor of moving directly towards full modulator tests in Q4 FY04.

2. Goals and plans for the remainder of FY06 and beyond

The main goal for the remainder of FY06 is to demonstrate operation of the prototype Marx modulator at 120kV, producing a full rep-rate, full-width pulse. This demonstration, which will not include the pulse leveling regulators, will primarily test the power processing capabilities of the Marx prototype design.

In FY07 we plan to integrate the vernier regulator system and the feedforward control software, allowing the modulator to produce a leveled, +/-1/2% output pulse. The main goal for FY07 will be to demonstrate 2000 hours of stable operation into a resistive load, at nominal output power with a regulated output pulse.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.10.1.2.
Work Package Title: Collimator Wakefield Test Facility at End Station A
Work Package Leader: Peter Tenenbaum
Laboratory: SLAC
Date: 01-Aug-2006

1. Technical progress.

Both of the FY2006 milestones – commission Wakefield Test Facility in ESA and complete measurements on 8 new collimator inserts in ESA – are largely complete. Because of complications in the process of generating calibrations for the new ESA BPMs, it has not yet been possible to "close the loop" and produce results for the measured wakefield kicks for the collimators. It is hoped that the BPM commissioning for ESA will soon be completed and that results will be published shortly thereafter.

Another "milestone" of sorts is that Steve Molloy of SLAC has replaced Peter Tenenbaum as co-spokesperson for the Collimator Wakefield experiment (the other co-spokesperson is Nigel Watson).

2. Goals and plans for the remainder of FY06 and beyond

In July of 2006 there will be another ESA run and additional measurements on the 8 new collimators will be performed. At that time the FY2006 experimental program of the Collimator Wakefield experiment will be complete, with the exception of the aforementioned data analysis which is largely the responsibility of the UK CollWake group.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 5.7.1
Work Package Title: 1.3 GHz RF Power Source
Work Package Leader: Chris Adolphsen
Laboratory: SLAC
Date: 8/9/06

1. Technical progress.

To gain experience with L-band sources and rf components at SLAC, construction of an L-band test stand was started in FY05 at the Next Linear Collider Test Accelerator (NLCTA). For this facility, a 140 kV converter-style modulator was borrowed from SNS, and an SDI-legacy, 10 MW, 160 kV, short-pulse klystron was purchased from Titan. Also, a 500 W drive amplifier, WR650 waveguide, loads, directional couplers and high-power circulators were acquired, and an EPICS-based low-level rf system configured.

The modulator was first tested using a resistor load, and then used to power the klystron at 120 kV. In March, this source produced 3.3 MW, 1 msec rf pulses at 5 Hz, which is the peak power expected at this voltage. The power was used to test a high power circulator and waveguides that were pressurized (3 bar) with nitrogen (instead of SF6) to suppress rf breakdown. Arcing at the waveguide flanges was observed and has since been eliminated by machining the flange mating surfaces flatter (to < 1 mil) to reduce any gaps.

The step-up transformers and resonant circuit capacitors in the modulator were then modified to allow higher current (90 A) operation with a newly acquired 5 MW, 128 kV Thales 2104C klystron (this tube has been the ‘workhorse’ for testing at DESY and FNAL). This modification was contracted to the group at LANL that designed the modulator, and it took longer to implement and was more difficult to make work than had been anticipated (for a given configuration, modulator only works reliably within a narrow range of load impedances). Nonetheless, the upgraded modulator with the new klystron has recently produced 4.9 MW, 1 msec pulses at 5 Hz, limited only by modulator charging supply voltage (a parallel HV water load is used to fine tune the modulator load impedance). One shortcoming of the SNS modulator is that the HV droop compensation system was never made to work reliably and so is disabled. In our case, the rf power droops by 10% during a 1 msec pulse. However, when operating below saturation, the rf drive system can be used to compensate for this decrease, as is done at SNS.

2. Goals and plans for the remainder of FY06 and beyond

As configured, the L-band Test Stand will provide power to two experimental test areas. One will be used to rf process coupler sections (see WBS 3.8.3.1) and other rf components, and the other will be located in the NLCTA beam enclosure to test prototype positron accelerator cavities (see WBS 3.4.1). By the end of FY06, the waveguide transport system to these test areas should be complete and the full control system for rf processing should be commissioned. In FY07, if the new modulators that are being developed do not perform well, the SNS modulator may again be modified to allow operation of ILC prototype 10 MW klystrons (at 120 kV, 130 A).

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 5.7.2
Work Package Title: HA Modulator IGBT Switch Array
Work Package Leader: Ray Larsen
Laboratory: SLAC
Date: August 4, 2006

1. Technical progress.

Both switches have been successfully tested and the first switch was shipped to FNAL the 1st week of August. During testing, a breakdown occurred with a snubber capacitor. Higher voltage rated snubber capacitors have been ordered to improve reliability. The new capacitors are due in early September.

2. Goals and plans for the remainder of FY06 and beyond

The second switch will have the snubber capacitors replaced with the higher voltage rated type and will ship in September. It will serve as an example unit for the new capacitor installation. The capacitors in the first switch will also be replaced in September.

This job is still on track for completion in September 2006.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/1/06
Work Package WBS Number: 3.8.3.1 and 3.8.3.2
Work Package Title: Coupler Development
Work Package Leader: Chris Adolphsen (x.1) and Brian Rusnak (x.2)
Laboratory: SLAC (x.1) and LLNL (x.2)
Date: 8/9/06

1. Technical progress.

During the first three quarters of FY06, significant progress was made in developing components for the coupler test stand. Activity in the first quarter was focused on refining the experimental plan and scope, on collecting design information on the TTF-3 coupler, and on beginning design work on key components. An overall design concept was configured and an L-band waveguide-to-coaxial transition was designed that would accommodate the SLAC L-band window and the installation of components needed for the tests.

Activity in the second quarter focused on developing a detailed design of the waveguide-to-coax transition as well as designs for the coaxial impedance transitions and component mounting fixtures. As the system design developed, necessary detail was added to include all waveguide interconnect components, mounting fixtures and brackets, and tables.

In the third quarter, fabrication of the waveguide-to-coax transitions started in the SLAC shops. Detailed designs were completed for the impedance transitions and the inner coax connections. The test stand imposed significant constraints on the rf components and how they interconnect. Since the goal of the experiment is to measure gas loads during rf conditioning from individual coupler components, it is important that all rf electrical connections be robust and repeatable to avoid anomalous arcing and heating. A further complication comes from the need to reconfigure the experiment multiple times, and requires that both the inner and outer conductor connections to be easily separable, robust, and repeatable. Finally, the design of the inner conductor connections must ensure that adequate thermal conductivity is maintained. Commissioning of the test stand without components, a milestone for this period, did not occur due to delays in parts fabrication from competing priorities for resources.

2. Goals and plans for the remainder of FY06 and beyond

The work plan for the remainder of FY06 is to complete the coupler test stand parts and assemble them at the Coupler Test Area in ESB (the rf vacuum windows will be tested first without the coaxial section). Also during this period, a visit is scheduled with CPI Beverly to discuss in detail the assembly and processing steps that a typical TTF-3/XFEL coupler undergoes during manufacture so they can be duplicated for the components to be tested.

Commissioning the test stand using a straight, stainless-steel coaxial line should take place by the end of October. Afterwards, additional components will be fabricated at SLAC and purchased from CPI, and processed in the same way as DESY TTF-3 coupler components. They will be used in a series of tests to identify those features (e.g., bellows or widows) contributing to the long coupler conditioning times. After the tests are completed, the data will be analyzed to extract the evolved gas per coupler component feature or plating process. The results will also be compared with multipactoring simulations by the SLAC ACD group to see how well this phenomenon can be predicted.

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ILC-Americas
FY06 Work Package Technical Progress Report

Work scope period: 10/1/05 to 7/31/06
Work Package WBS Number: 3.10.1 and 5.10.2
Work Package Title: ESA BDS/MDI Experiments and ESA Beamline Instrumentation Upgrade
Work Package Leader: Mike Woods
Laboratory: SLAC
Date: 7/28/06

1. Technical progress to date.

The FY06 planning document for the ILC test beam program in SLAC End Station A (ESA) is given in Reference 1. The website for this program is given in Reference 2. We have had a 5-day commissioning run in January 2006, a 2-week experimental Run 1 April 24-May 8, and a 2-week experimental Run 2 July 7-20. Three papers and posters on this program were presented at EPAC 2006 in June and are listed in References 3-5. A presentation on the ILC test beam program in ESA was made at SLAC's Experimental Program Advisory Committee (EPAC) meeting in January.[6]
Brief summaries of the beam tests, milestones and deliverables in this period are given below:

i. ESA infrastructure. We have successfully installed and commissioned: 2 wire scanners; a data acquisition system for the experiments running Labview on a PC reading out VME and Camac crates; and bunch length diagnostics using high frequency diode and pyroelectric detectors. A new beamline was installed in ESA including: collimator wakefield box, 2 wire scanners, 2 rf bpm triplets, a beam containment collimator, and 4 machine protection ion chambers.

ii. T-474 BPM energy spectrometer. Two rf bpm triplets were installed and commissioned. New bpm processing electronics for these and 5 additional existing rf bpms were also installed and commissioned. One of the new rf bpm triplets, BPM3-5, uses prototype ILC Linac bpms (WBS 3.8.2).[7] For Run 2, an interferometer system was commissioned to monitor transverse motion of the

BPM3-5 triplet. We have achieved sub-micron resolution on all the bpms and are studying longer-term drifts and stability.[8]

iii. T-475 Synchrotron Stripe energy spectrometer. A prototype quartz fiber detector was installed at a synchrotron light port in the A-line and commissioning data taken.[9]

iv. T-480 Collimator wakefields. The collimator wakefield box was relocated to ESA. 8 sets of collimators were manufactured in the UK and wakefield kicks from all 8 sets have been measured.[4] The BPM system developed for T-474 is used for the BPM diagnostics. Analysis is underway.

v. T-488 IP BPM studies. This experiment studies background effects in an IR environment for the fast feedback bpms that stabilize collisions at the IP.[5] The experiment was approved in May and first data was taken in Run 2. The setup included a mockup of beamline components (material for the BEAMCAL detector, low Z absorber and downstream quad pole faces).

vi. EMI studies. We acquired broadband antennas measuring frequencies up to 7.5GHz, with signals to a 1.5GHz bandwidth scope, to characterize electro-magnetic interference (EMI) along the ESA beamline. In particular this was done near ceramic gaps that were installed to facilitate studies for bunch length diagnostics and EMI studies. In Run 2 we installed electronics from the SLD Vertex Detector that had a failure mode during SLD operation, suspected to be due to beam-induced EMI. We were able to reproduce the failure mode, demonstrate that it was due to direct beam-induced EMI pickup at the electronics board and characterize the EMI levels at which it failed.[10]

2. Goals and plans for the remainder of FY06 and beyond

We deferred installation and commissioning of the 4 chicane magnets and wiggler[1] magnet to FY07. We are starting now on this work since completion of Run 2 in July. We have to refurbish the 4 SPEAR dipoles we will use, do magnetic measurements and finalize plans for the power supply control and feedback regulation.
We are planning two 2-week runs in each of 2007 and 2008. For 2007 we plan the following experiments:

i. T-474: we will install a 4-magnet chicane between the two BPM triplets BPM3-5 and BPM9-11, and will install additional BPMs on movers at the mid-chicane location. We will continue to use the prototype ILC Linac BPM triplet (BPM3-5).

ii. T-475: a wiggler magnet will be installed in the last leg of the chicane to generate a synchrotron stripe to a quartz fiber detector further downstream.

iii. T-480: We expect that additional collimators will be built in the UK and wakefield kicks measured at SLAC.

iv. T-487: A new experiment T-487 will study and determine the longitudinal bunch profile by measuring the wavelength distribution of coherent radiation produced from the interaction of the bunch passing close to a periodic structure (Smith-Purcell radiation).

v. T-488: We plan to continue studies of the expected performance for the IP feedback bpms in a realistic IR environment.

The 2007 runs are planned to be for February (Run 3) and June (Run 4). We expect the 4 chicane magnets to be ready for Run 3 and the wiggler magnet to be ready for Run 4. In 2007, we are also studying possibilities for spoiler damage tests for FY08 running. And we are studying possibilities for continuing the ESA test beam program beyond 2008 (the end of parasitic running with PEP-II). A draft test beam proposal to bring LCLS beam to ESA in FY07 has been circulated, and we hope to do this test parasitically with LCLS commissioning in FY07.

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