Report of the Engineering Design Planning Task Force

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1 Executive summary

The Engineering Design Planning task force was created by the ILC Executive Committee in March 2007 to assist it in adapting the organization of the GDE to support the creation of an Engineering Design Report (EDR).

Our major conclusions are summarized in the following bullets.

- That the Engineering Design effort and the process of creating an Engineering Design Report can and should be executed with appropriate, formal controls and reporting, i.e. a line-management organization
- That the line-management organization for the Engineering Design effort above is viable through cooperation between the GDE management and the regional basis of resource support.
- That the Conventional Facilities and Siting efforts will naturally be divided into those that support development of a specific host site (regional) and those that support development of site-independent features. We believe that it is possible and practical to link these and manage them together, through the EDR Project organization.

2 Goals and Charge

The purpose of the EDR Task Force is to advise the ILC Executive Committee on the formation of the ILC Engineering Design Project Management Organization. The Task Force was asked to study a technical project structure with a central management team.

It is paramount that the ILC EDR be produced through a truly international activity in which each major participant can contribute effectively and in turn receives meaningful benefits from their contribution. At least initially, the EDR Project Management Organization will not be a ‘traditional project management’ structure, in which control of funding and technical strategy are the responsibility of a central team. Thus the work of the Task Force is important since it represents the evaluation of an entirely new and somewhat clumsy kind of management structure. To enable this process, the Task Force membership has strong representation from each region. The Task Force membership includes the Executive Committee.

The Task Force Charge and Comments on the Charge (March 2007) are reproduced in Appendix A.

To accomplish its purpose, the Task Force developed the following agenda:

- Discuss and refine the purpose and scope of the Engineering Design Activity
- Devise criteria which could be applied to the Project Management Organization to compare it to typical Project Management structures.
- Evaluate the requirement for a written Engineering Design Report taking into account the needs of each region
- Devise and develop mechanisms for collecting input concerning the formation of the EDR Project Management Organization from the GDE Boards, RDR Area, Technical and Global System Leadership and the Community at Large.
- For selected branches of the proposed Work Breakdown Structure, develop and link Work Packages in such a way as to illustrate the process of linking and ranking Work Packages so as to formulate a Work Breakdown Structure.

The EDR Task Force met weekly from April 3, 2007 until August 7, 2007. The Task Force also met during the ILC 2007 Workshop held at DESY and gave an interim report at the Workshop Plenary.

During this period, the GDE leadership appointed a Project Management Team and asked the Team to develop a Management Plan. As expected, the material produced and collected by the Task Force is an important resource for the Plan development. The Task Force believes that their report, an advisory document produced almost concurrently with the Plan, may not be entirely consistent with the EDR Project Management Plan produced by the GDE Project Management Team.

The charge given to the EDR Task Force includes a specific request to examine a 'Work Breakdown Structure' for the EDR Project subject to general considerations of the global nature of the project and the necessity to rely on regional funding sources, at least during the initial stage of the Engineering Design Activity.

The goal of the EDR Task Force was to assemble and analyze advice from each of the major EDR stakeholders on how the EDR could be accomplished. To this end, the Task Force Chair and some of the membership traveled to and met with ILC staff members at key institutions. Unfortunately, due to time constraints, not all ILC – related institutions were visited. In these cases, discussions at the DESY ILC 2007 Workshop were substituted.

The advice received by the Task Force feel broadly into two categories: 1) how to develop an effective organization which can address the priorities of the ED phase and which includes a clear decision making process for covering the choices necessary for the EDR and 2) how to balance the mandate to establish a truly international project with the need to rely on regional funding sources. In neither of these two does a single specific solution meet the needs of the ED Project. The primary goal, therefore, of the Task Force, was to pick four primary branches of the ED Project WBS and attempt to carry them through as examples with enough detail to illustrate key characteristics of each one. We chose:

- the Damping Area System because this system has some of the most challenging accelerator physics challenges and because the community is especially diverse and has a strong global basis.
- the Main Linac – especially the cryomodule development and production sub-branch – Area System because the creation of a plan for the production of high-technology SCRF components is one of the top deliverables of the ED Activity.
- the Beam Delivery Area System because this system includes a substantial technical interface with the Detector groups, both through the development of the IR Hall and through the development of beamline systems for use by the Detector groups. For this section, we requested a contribution from Andrei Seryi, not originally named to the Task Force.
- the Conventional Facilities and Siting (CF/S) Global Area System because the ED Activity deliverables for this group, namely site development and creation of a construction plan, represent top deliverables of the ED Activity.

Thus the Task Force did not evaluate a WBS for the entire ED Activity. Controls, Positron, RTML, Electron, etc, WBS branches were omitted due to lack of time. Also, for each of the above examples, the Task Force did not have enough time to produce a comprehensive, fully developed, WBS.

The agenda of each meeting can be found in:
http://ilcagenda.linearcollider.org/categoryDisplay.py?categId=102 .

3 Engineering Design in General

3.1 Expected Output of Engineering Design

The primary goal of the Engineering Design phase is to complete and document a fully integrated engineering design of the accelerator. This design must satisfy the energy, luminosity, and availability goals outlined in the ILC Reference Design Report. It must include a more complete and accurate value estimate and an implementation plan. Specific requirements include:

- demonstrate through the ILC R&D program that all major accelerator components can be engineered to meet the required ILC performance specifications;
- provide an overall design such that machine construction could start within two to three years if the project is approved and funded;
- mitigate technical risks by providing viable documented fallback solutions with estimates of their costs;
- contain a detailed project execution plan including an achievable project schedule and plan for competitive industrialization of high-volume components across the regions;
- limit options, where technical decisions are not yet final, to focus R&D and industrialization efforts on these issues;
- design the conventional construction and site-specific infrastructure in enough detail to provide the information needed to allow potential host regions to estimate the technical and financial risks of hosting the machine, including local impact, required host infrastructure, and surface and underground footprints;
- provide a complete value cost estimate for the machine, except for the details not yet completed in the site-specific designs, which includes a funding profile consistent with the project schedule proposed.
- Begin the transition to a project management model for activities in the ILC collaboration in preparation for an ILC construction project.

The **primary deliverable** of the ED phase will be a written report (Engineering Design Report - EDR).

The goal of the EDR is to provide countries with all required information such that a decision to proceed can be made.

It will document:

- the baseline design, including detailed engineering to the extent possible with available resources;

- updated value estimate and basis, including industrial quotes where applicable;
- construction schedule and associated resource profile;
- demonstration of key technology components;
- justification of baseline design decisions;
- scope of remaining engineering work leading to construction (including associated value estimate);
- project implementation plan.

The combined effort to do the design and development work and to write and deliver the EDR are henceforth in this document referred to as the *ED Project* and the organizational structure to support it is referred to as the *ED Project Organization*.

3.2 Timelines

The established time scale results from the international agreement to review initial LHC physics results and the status of the ILC design and other accelerator R&D around 2010, implying a 2010 completion date for the EDR. It should be noted that the engineering and R&D resources available during this period are limited and set the ultimate scope of what can be accomplished. Additional engineering beyond the EDR will be required and can be accomplished, both prior to and during the construction phase of ILC.

3.3 Desirable Operational Principles of Project Structure

The task force has discussed and agreed upon the general properties desirable for the ED project organization. These are described below:

Keys to a successful EDR and R&D program:

1) Clear EDR objectives and timescale

Mission statement of what you hope to accomplish & when

Identification of key R&D objectives and decision points

2) Clear definition of project management terminology (i.e. WBS, PMP)

3) A clear enumeration of the tasks to be performed (i.e. WBS)

Realistic estimates of the required effort ($ and labor) to carry out the tasks

“Success” and deliverables are defined and agreed to at the start of project

Bottoms up schedules with measurable milestones to track progress

4) Preparation for interactions with funding agencies on overall scope of the effort

Organization Issues

1) Clear lines of responsibility and authority

2) Integration of the organizations that carry out the machine design vs. the R&D program

Mechanism to balance use of resources

3) Ownership of program objectives by entities expected to provide resources

4) Representation in management structure by key entities providing resources

5) Representation in management by technical experts

6) Effective, Open, Transparent Processes

Technical reviews (recommend only… don't design by committee)

Financial reporting and budget

Effective decision making process

Mechanisms to monitor progress (track milestones)

Effective integration group

Good documentation system

Good communication and coordination

R&D board to control scope creep but allow new ideas to develop

7) Good reporting mechanisms and structures

Recognition of Laboratory and International issues

1) National or laboratory constraints on funding

2) Laboratory constraints because of other projects (e.g. XFEL, Run II)

3) Taking advantage of shared technical objectives with other projects (ERL, Project X, STF III, etc)

4) Competition for site vs. cooperation

5) Efficiency in use of resources vs. national or laboratory priorities

6) Coordination of geographically separated activities on the same task

7) Industrialization issues by region

8) ILC timelines vs. region

9) Coordination with various international planning bodies

4 Specifics of Engineering Design Efforts

We discuss specific issues of ED group organization and ED work package organization of representative area/global systems.

4.1 Damping Rings

We give a general description of an appropriate organizational structure for the damping rings area system. More details, including a list of potential Work Packages, and an outline of the work plan for the engineering design phase, are given in Appendix B.

4.1.1 Transition from present organization into the engineering design phase

R&D activities for the damping rings have a wide global distribution, with each participating institution typically providing effort at the level of one or two FTEs (though the number of different people involved at each institution may be significantly larger). Organization and coordination of activities for the engineering design phase would be significantly simplified if it was possible to identify a small number of coherent Work Packages, each of which could be the responsibility of a single institution. However, this would require a significant reorganization of resource allocation. In general, institutions are working collaboratively to provide the necessary skills for particular activities. A reorganization that would require individual institutions to provide all the specialized effort for a single Work Package would be highly disruptive and would face significant practical obstacles. This kind of reorganization may be contemplated for the period following the engineering design phase; the engineering design phase itself could provide the opportunity for an "adiabatic" transition to such a structure.

An organizational model that gives the greatest chance of achieving the EDR goals will build on the existing structure, by formalizing the roles of participating institutions, facilitating communication between institutions, and establishing accountability and clear procedures for reporting and reviewing progress. This will benefit the project by allowing institutions to take advantage of the time and effort they have already invested in damping rings R&D.

4.1.2 Organizational structure: roles and responsibilities

Accountability may be supported by defining deliverables for the engineering design phase, with each deliverable being the responsibility of a single institution. Related deliverables may be grouped into Work Packages. Each Work Package would involve a single institution or a small number of collaborating institutions; the activities within a Work Package would be coordinated by a Work Package Manager. Each institution could take responsibility for one or more deliverables, including deliverables outside the damping rings area. Where an institution has responsibility for a number of deliverables, it would be appropriate for that institution to appoint an Institutional Manager. Work

Package Managers would report to the Damping Rings Manager, who would report in turn to the Accelerator Project Manager. The Institutional Managers would report to the appropriate Regional Director. Technical issues, reporting and reviews would be the responsibility of the Work Package Managers and Damping Rings Manager. Resource issues would be the responsibility of the Institutional Managers and Regional Directors. This model is illustrated in Figure 1.

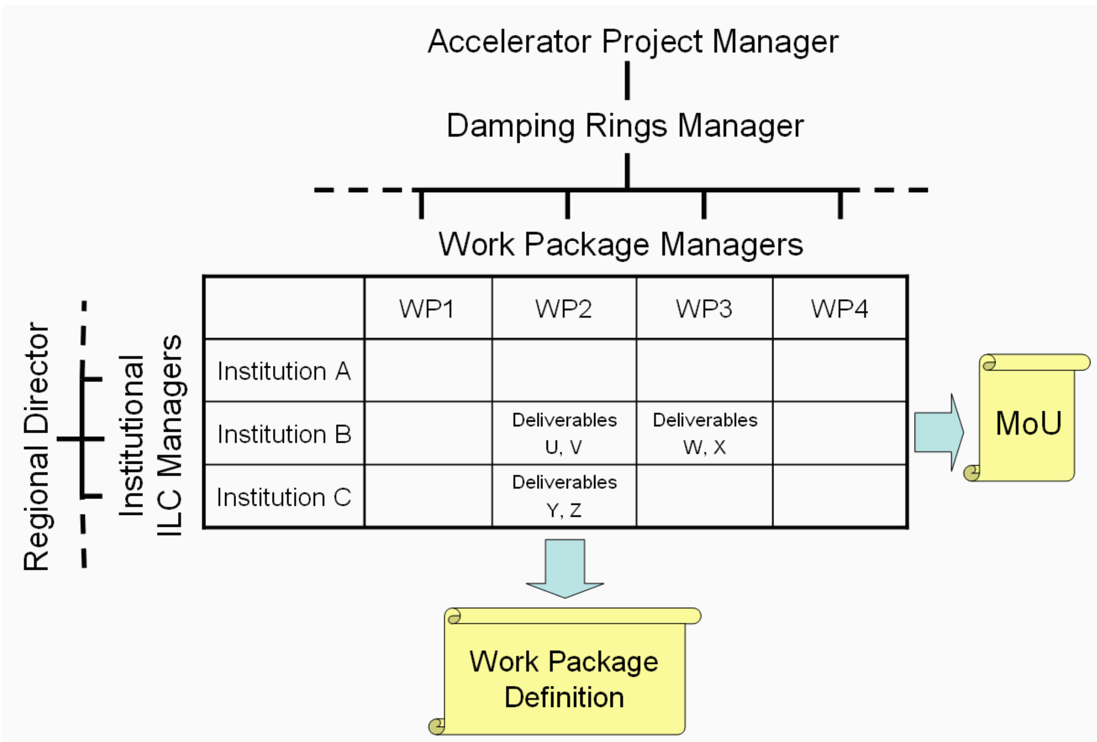


Figure 1. A possible model for damping rings organization during the engineering design phase.

The responsibilities of each institution would be described in a Memorandum of Understanding signed between the institution and the GDE management. The MoU would define the deliverables, with completion dates.

4.1.3 Work Package Managers will play a critical role in communication and coordination

It is envisaged that activities for the Damping Rings Area System would be grouped into roughly a dozen different Work Packages. Examples include: lattice design; electron cloud; vacuum system; injection and extraction systems. It will be critical for Work Package Managers to spend (close to) 100% of their time on coordination and communication in support of the activities within their Work Package.

One of the first responsibilities of the Work Package Managers will be review and complete the plans for the activities within their work package, including more precise specification of the deliverables. Work Package Managers will need to be identified before the organization can start to operate effectively.

The nature of the damping rings means that however the Work Packages are defined, there will be many interdependencies between them. Regular meetings between the Work Package Managers (or at least between sub-groups of them) at weekly or fortnightly intervals will be essential for effective coordination, and to ensure consistency across the design. While phone/web or video meetings can be useful for keeping in touch, regular face-to-face meetings will be important for effective communication.

4.1.4 Global systems and interfaces with other area systems

The Accelerator Project Manager and the Global Systems Project Manager will coordinate the development of Global Systems Work Packages which cover topics which serve all Accelerator Areas. Examples of such Work Packages would include CF/S underground area design development and the controls system design development and would be coordinated by Work Package Managers who are experts in such topics. Specifying Damping Rings requirements and providing these as input to the Global Systems Work Package Managers would be the responsibility of the Damping Rings Manager.

Interfaces with Global Systems and with adjoining Area Systems, such as the RTML and the Sources (e+/ e-), must be coordinated and documented. In some cases, these interfaces will be quite complex, and may require the participation of a third, neutral, party experienced in negotiating and delineating these boundaries. Providing this assistance will be the responsibility of the System Integration Scientist.

4.1.5 Progress reviews

The Damping Rings Manager will be responsible, with the support of the Work Package Managers, for continuous monitoring of technical progress with damping ring research, development and design activities. Formal reviews of technical progress will be necessary, and could be organized in a number of different ways; however, it will be important that the implemented system has sufficient flexibility to serve a useful function for activities ranging from research and development (for example, on electron cloud beam dynamics, or fast injection/extraction kickers), to design work (e.g. magnets and power supplies), with different kinds of activities following different time scales.

One possibility would be to set up a Damping Rings Review Committee, with a standing charge to meet twice a year to report on progress with different parts of the damping rings research, development and design program. The Accelerator Project Manager and Damping Rings Manager would be responsible for setting the review schedule, and the scope and charge for each review. Reviews should not be so frequent as to place an undue burden on investigators, and coordination will be necessary with reviews covering overall ILC machine development.

4.2 Main Linacs

4.2.1 Introduction

The main linacs are based on SCRF technology, the most cost effective and efficient accelerator technology to deliver the high beam power required by ILC. The main linacs also represent the largest and most expensive high technology system in the ILC. The Reference Design Report outlines the overall design elements of the main linacs. However, the engineering details of the cryomodules, cryogenics, RF power source and beam line components are far from complete. Considerable R&D and design work will be required during the EDR phase: to demonstrate the performance of key main linac components; to reduce the ML cost; and to arrive at overall systems designs that are ready for construction.

In planning the work packages for the EDR it is important to recognize that although SCRF knowledge and capability in Europe is advanced and will become more so with the construction of the XFEL at DESY, the other two regions, Americas and Asia, lack experience. The EDR R&D organization and work packages should be considered very carefully and must recognize that development of the required SCRF experience base in all 3 regions is an important deliverable.

First operation of cryomodules similar to ILC will occur at FNAL and KEK in 2007-2008. As experience is gained we expect both regions to engage more heavily in detailed engineering discussions and design as part of EDR phase.

4.2.2 Issues and Tasks in EDR phase

The task description of issues to be resolved by R&D during EDR phase are listed below. This list was created during discussions in the main linac group during GDE meetings in Beijing and in DESY.

A: Cavity:

1. Demonstration of S0 goal, that is, 35MV/m with >85% yield by the first process and vertical qualification test.
2. Review and final selection of the ILC operating gradient.

B: Cavity ACD down selection:

1. Cavity shape down selection.
2. Cavity material down selection: Large grain vs. fine grain Nb.
3. Coupler selection.
4. Tuner selection.
5. Hydro-formed cavity vs. welded cavities.
6. EBW vs. TIG welded end group.

C: Cryomodules:

1. Demonstration of S1 goal, that is, one single cryomodule operating at 31.5MV/m average gradient.
2. Design, build and test a cryomodule suitable for ILC (Type IV).
3. Regional CM difference: Decision on an interface specification and level of compatibility.
4. Re-evaluate quad position and adjust the design.
5. Decide the material to be used for He vessel: Ti vs. stainless-steel
6. Location of magnetic shield of the cavity.
7. Improved cavity interconnect seals.
8. Re-engineering of module interconnect, such as HOM absorber, pipe connects, assembly time, leak check.
9. Movable quad for beam-based-alignment.
10. Elimination of 5K shield.
11. Design, build and test a value engineered ILC cryomodule (Type V).
12. Demonstration of S2 phase 1.1-1.4, that is, 1 RF unit operation (FLASH,ILCTA-NM, STF).
13. Demonstration of S2 phase 2, that is, several ILC RF units operation.
14. XFEL module prototyping.
15. XFEL pre-series production.
16. Testing of XFEL series production.
17. ILC-cryomodules pre-series production.
18. Validation of pre-series ILC-cryomodules.
19. Mass-production of ILC-cryomodules.

D: HLRF

1. Mass-production of the baseline modulator in XFEL.
2. 2000 hours test of Marx modulator (ACD).
3. DFM design of Marx modulator (ACD).
4. 1000 hours test of horizontal MBK in XFEL.
5. Vertical tube test in SLAC,KEK.
6. More horizontal tube test.
7. Sheet-beam klystron (ACD).
8. Super-multibeam klystron (ACD).
9. Non-circulator distribution test (ACD).

10. Variable tap-off test (ACD).
11. Integrated design of RF distribution.
12. Build and demonstrate 26 cavity LLRF system.
13. IF mixture front-end for cost down (ACD).

E: Cryogenic system

1. Heat load estimation and measurements on cryomodules, transfer system.
2. He liquid control for long string of two-phase line.
3. Thermal performance optimization of cryomodules.
4. Compliance with engineering standards.

F: Machine design

1. End to end simulation of final machine including ML

4.2.3 Work package organization

Given the distributed nature of the engineering resources available for the EDR it is important that each work package (WP) defined for the EDR be broad enough and have well defined interfaces so that regional design teams can work effectively within that package with minimal interaction and overlap with other systems. It is important to recognize that an important WP will be ML integration. This package should develop the detailed interface and requirements of each component. A well organized and communicated work package will be much more effective narrow work packages with confined technology choice, such as tuner WP or coupler WP, etc.. The following packages are possible candidates;

Work Package Candidates:

1. Bare Cavity WP

Tasks: Cavity Material, Cavity Fabrication methods, welding and Machining details surface treatment, accelerating mode tuning, end group design and HOM damping performance, Vertical testing detail, cavity fabrication and test database, bare cavity gradient performance.

2 Dressed Cavity WP

Tasks: He vessel design, Nb to Ti or SS transitions, slow and fast tuner design and test, coupler design, Cavity handling and dressing procedures, investigation of HPR and EP of dressed cavities, shipping of dressed cavities, HTS testing

2. Cryomodule WP

Tasks: Cryostat design and performance including piping, cabling, pumping and sensors, cavity system including tuner, coupler, magnetic shield, and jacket, vacuum seal, Quad magnet, BPM, beam pipe design, HOM absorber, gate valves, alignment technology, mechanical vibration, testing procedure, assembly technology, carry-in technology into tunnel, transport technology from Lab to tunnel, etc.

3. Power source WP

Tasks : Klystron development and test, Modulator development and test, power distribution system design and test, power distribution adjustment, phase adjustment, cavity coupling adjustment (Q adjustment), Tunnel layout of AC cabling, cooling water, waveguides, RF cabling, LLRF control, phase reference line interface, timing reference line interface, Quad &collector magnet power and cabling, etc. Specifications and requirements for other systems.

4. Cryogenics WP

Tasks: Refrigerator specification, design of cryogenic distribution system, definition of cooling strings, cryogenic control systems including valve and end boxes, schemes for , flow control, pressure control, He level control, control of mechanical vibration, cool down sequence, warm up sequence, repair scenarios, system assembly and leak check technology, installation procedure, maintenance procedure, etc.

Since these activities are likely to be shared across all three regions the organization of each of these broad work packages should consist a work package leaders from each of the 3 regions with one of these serving as the chair + WP participants world-wide.

The charge of the WP leaders will be;

1. Create and carry out an R&D plan to support the baseline design, and for alternate designs consistent with anticipated resources. The plan should contain milestones and decision points

2. Provide technical information to provide the basis for a down selection process to be defined by the PM and EC.

3. Provide regular WP technical progress reports to the project management team.

4. Provide WP budget, schedule, and milestone information to management so that regional funding requests can be made and if necessary WP or task priorities adjusted.

5. Complete baseline engineering design of each component,

The WP meeting should be held by a tele-conference and via regular face-to-face Meetings.

4.2.4 Technology down selection

- WP leaders should work with the PM to establish the condition an ACD technology must satisfy in order to be selected.
- WP leaders and the PM will establish the required timeline or deadline for ACD down selection.

- The PM will establish a transparent process of decision making and down selection.

4.2.5 Cryomodule design policy

The PM will establish a process to set the compatibility requirements for ILC CM designed or manufactured in the 3 regions. Possible outcomes:

- Identical
- Plug compatible (with definition)
- Regional contributions that are functional equivalents in large blocks

WP leaders will work with integration team and PM to establish: the sharing of design work, the physical boundary of cryostat, interfaces, cryogenic requirements, power source and overall linac integration.

4.2.6 Industrialization policy

Industrialization is recognized as a regional issue. However overall coordination within the project is desirable. The PM will establish a suitable forum for the exchange of information on this issue. The forum should attempt to codify rules for the use of drawings, exchange of information, management of intellectual property rights, etc. The goal is to insure that technical improvements or cost savings demonstrated by industry can be shared in all three regions.

4.2.7 Plans and schedules of Main Linac Test Facilities

- Test facilities are recognized and supported as part of regional aspirations to host the ILC.
- Plans and schedules of XFEL, ILCTA-NML Project X, STF2 and STF3 should be developed
- The PM should establish a body to encourage coordination and collaboration among the regions. The goal is to share knowledge and if appropriate equipment in a way that advances both the ILC project and advances regional aspirations

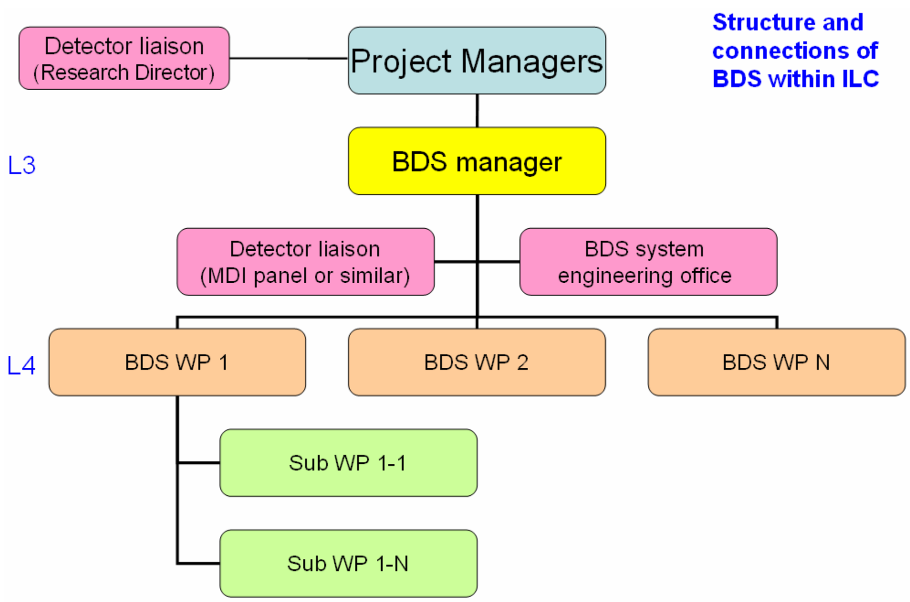
4.2.8 Main Linac technology integration

It is recognized that this is an important task for the EDR phase and that suitable WP leaders must be found early in the EDR phase to insure this activity receives adequate attention.

4.3 Beam Delivery Systems

The BDS EDR structure of organization and efforts is optimized to meet the goals common with other systems, e.g. to cover the critical R&D planned for EDR phase that ensures performance risk reduction, perform engineering design involving value management and optimization, producing updated cost estimate and a project execution plan; and in addition to meet the goals specific for BDS, in particular to have the clear connection to detector team for efficient organization of interaction region and detector design.

To have an efficient streamlined structure, the BDS manager, who is reporting to the Project Managers, has in its assistance the BDS system engineering office and is also assisted by a detector liaison which may be organized in a way similar as MDI panel done now[1]. The working connection to detectors also performed via the work-packages as discussed below. The BDS system engineering office is chaired by BDS System Engineer who is also a deputy of the BDS manager. Both the BDS manager and System Engineer are located at SLAC.



The BDS work-package leaders (L4 leaders) are directly reporting to BDS manager. In order to preserve maximally the existing financial connections, and to streamline communication, the "chair-deputy" scheme is used for L4, where a deputy may typically be from SLAC or American region when the chair is from other regions.

There are nine work-packages on the L4 level as follows:

- ATF2 Construction, Commissioning and Operation
- Accelerator and physics requirements and design integration

[1] Connection to the Detector collaboration also exists on the level of GDE Director and PMs, via the Research Director.

- Interaction Region and IR integration
- Crab cavity system
- Beam Dump system
- Collimation system
- BDS magnet & PS
- BDS instrumentation
- BDS Vacuum system

The names of WP chairs and deputies were suggested and presented to the EDR task force. All names are known at the moment except for the name of System Engineer and a deputy responsible for Vacuum.

The first work-package, the ATF2, is of special kind, because it contains similar branches as BDS area itself and is in large parallel to BDS structure.

The second work-package, the "Accelerator and physics requirements and design integration" is a crucial place where system optimization and interfaces to CF/S and detector will be done. On the following level, this work will include sub-work-packages for Optics, tolerances, tuning & feedback (apertures & magnet types standardization; setting specifications for all sub-systems); Backgrounds, other detector requirements (field homogeneity, IR apertures, alignment, etc.); CF/S interfaces & optimization (air, water T, stability, vibration, tunnel & cavern sizes, penetrations, etc.); Installation model for BDS (magnet sizes, shafts, elevators, detector & machine interference, etc.); Design study of alternatives (0&2mrad designs, gamma-gamma, e-e-, entrance intra-train feedback; etc.).

The third work-package, Interaction Region and IR integration, is the one very tightly connected to detector hardware design. It includes, on the sub-WP level, the IR system engineering and integration, IR magnet design and its prototypes, IR cryogenics, IR shielding design, Detector moving system, stability study of IR magnets, alternative magnet solutions for IR, etc. Leaders of this sub-work-package will work closely with representatives of two emerging detector proto-collaboration to create an optimal IR design.

The next work-package, Crab cavity system, will include optimization of RF design of cavity & couplers, development of phase stable RF power system, designing the cryostat for crab cavity, prototyping the crab cavity and couplers, studying the phase stability with two cells, prepare crab cavity beam tests and performing them.

The next work-package, Beam Dump system, will include designing widow & remote replacement mechanism, engineering of the beam dump radiation water system, engineering the beam dump shielding, designing the beam dump vessel, performing irradiation tests of dump window prototype, optimizing physical design of beam dump, prototyping beam dump window, building the window remote replacement front-end, etc.

The Collimation system sub-work-package will include optical, physical and engineering design of collimators, performing beam damage tests of collimators, verifying collimator wakefields in beam measurements, etc.

The Magnet and Power Supply sub-work-package will include conceptual design of DC magnets and more detailed design of pulsed systems, as well as deign of power supply system, design of BDS specialties the muon walls, magnet movers, and beam sweepers, septa and kickers, design and prototyping of low field dipoles, design and optimization of DC power supply system, development and possible prototyping of HS power supply module, in particular the bipolar one.

The Instrumentation System work-package For Instrumentation, the EDR work would mostly focus on defining specifications, sizes, apertures, interfaces, etc. The Development part will focus on E-spectrometers, feedback hardware, laser wires and large aperture BPMs.

The Vacuum System work-package would include developing the general layouts with locations of ports, bellows, valves, gauges; the conceptual schemes of RF shields, chambers in moderately complicated areas such as laser wires and Y-s (BSY); and more detailed schemes of chambers in very complicated areas such as IR. The work will also include optimization of vacuum chamber aperture, pressure; physical design of vacuum system in terms of SR, beam-gas, desorption and impedances; engineering integrated design of vacuum system; and detailed design of IR vacuum chamber.

For the allocation of WP, there is no universal rule. In some cases some new labs are expressing interest and in most cases, connections already exist, and they need to be adjusted for the EDR phase. In some cases, still need to search for the interested labs.

The charge for BDS WP chairs and deputies is to form, in interaction with BDS manager, the detailed sub-work-packages for EDR phase, suggest sub-WP leaders, perform the coordinating role of the work and also personally drive the design work as appropriate.

The work flow in BDS will be of course similar to the flow in other systems. It is assumed that the Project Manager will have weekly or so meetings with BDS manager and his deputy, to hear about progress and issues. The BDS manager and his deputy will hear reports from L4 managers and their deputies approximately twice per week. The L4 managers and deputies will have daily interaction with sub-WP managers. And each L4 WP will have reviews approximately twice per year where external experts would be participating.

4.4 Conventional Facilities and Siting (CF/S)

4.4.1 Introduction

This section summarizes an analysis that has been attempted by the Taskforce on issues related to Conventional Facilities and Siting (CF/S) in the Engineering Design phase (EDR phase).

The Reference Design Report, in its EDR section, gives a following description: “Design shared conventional systems and site-specific infrastructure, and provide necessary information, to the level required for host regions to estimate the cost, technical and financial risks to host the machine, including local impact, required host infrastructure, and surface and underground footprints.”

Thus, the EDR CF/S efforts are poised to substantially refine its engineering design details in conjunction with all other area and global systems within ILC. The goal is to ensure that the machine design, as a result, from the CF perspectives, is fully build-able, operable, maintainable, cost-optimal, and be adequately documented as such.

Another important aspect of the CF/S efforts is to start refining the relevant site-specific engineering solutions for building ILC. The goal from this context is to ensure that such site-specific CF/S solutions are: consistent with internationally agreed-upon ILC specifications, something that are useful for the subsequent site-selection process, and something that are supportable by experts of other regions when one site is chosen.

These two facets – global and regional aspects – are the two important attributes that characterize the - nature of CF/S activities to keep in mind during the EDR phase.

4.4.2 Inputs for and Outputs from Site Selection

The "full engineering design" of CF/S (e.g. a set of construction drawings and spec sheets for the contractors to abide by) for ILC cannot be completed, in a normal sense of a civil construction project, unless a construction site is determined. And unless the site selection sees a very rapid progress, we cannot hold the "full engineering design of the whole ILC CF/S" as a realistic target to achieve during the EDR phase that is expected to expire in the year 2010.

However, it would be reasonable to request the experts to lay down the type of preparation tasks that should be completed before formal initiation of the site selection process. Likewise, it should be possible to lay down the series of tasks to carry out once the site selection is done. Identification and time-organization of these tasks are one of the first issues to be tackled by the CF/S group in an early stage of the EDR phase.

In relation to the work towards site selection, the Taskforce wishes to point out that development of a suitably documented set of "ILC Site Criteria" will be of critical importance..

4.4.3 Global and Regional Aspects

Since the original charge of GDE is focused on "global development" of the ILC design, some aspects of CF/S activities to perform in the EDR phase, in particular, site-specific design efforts, might be called outside the GDE scope. However, irrespective of the strict language in the official GDE charter, the majority of the Taskforce members feel that the GDE and the CF/S team in it should assume certain responsibilities in ensuring the coherence of the world efforts and their outcome in the area of CF/S, whether the specifics of the subjects are "global" or "regional".

Thus, the taskforce wishes to draw attention of the GDE EC and Project Managers to the following points as desirable features to maintain:

- The work breakup structure (WBS) for CF/S to include region-specific (or site-specific) tasks.
- CF/S group to establish the EDR phase goals that are clear and feasible in both "global" and "regional" contexts.

- CF/S group to be organized under the Project Manager in ways ensuring smooth connection between “global” and “regional” activities.
- GDE to develop a high-level oversight mechanism which is suitable for reviewing and managing both “global” and “regional” activities.

4.4.4 Work-Package (WP) Organization

The Taskforce feels that it is best to leave the matter of laying out specifics of the Work-package (WP) organization for experts in the existing CF/S group (and its possible future expansion). This can be done, based on the results of the past work, in particular, their comprehensive work breakup sheet (WBS) dictionary, their accumulated knowledge and guidance from the GDE EC and Project Manager(s).

One comment, however, that the taskforce wishes to offer is that it may be worth introducing a labeling scheme where regional and global natures of each of the work-package items can be easily identified. A possible labeling might be:

A. WPs that are related to specifications or solutions which are common to all regions.

B. WPs that are related to developing solutions which are either region-specific or site-specific.

This may be useful for making the global and regional natures of WPs more explicitly visible, and for helping visualize the inter-dependences of many WPs for CF/S. This scheme, if adopted, will have to be seamlessly integrated with the present CF/S WBS dictionary and its expansion.

4.4.5 Work-Group (WG) Organization

In the light of dual natures (i.e. “global” and “regional”) of CF/S efforts in the EDR phase, a question may arise as to how to optimally organize the CF/S groups.

During the RDR phase of GDE, while the CF/S group (one of the global-system groups, then) had one unique point of contact with respect to the RDR management, the actual work group was organized under representatives from three regions (Americas, Europe and Asia) who had an excellent working relationship. This group model (one CF/S group with one POC, now, to report to the Project Manager(s)) could be continually adopted for the EDR phase. In this case, an important prerequisite for its success would be to ensure that “regional CF/S activities” are treated with adequate respect, independence and mutual cooperation. However, observations on the past performance of the CF/S group indicate that it is very likely to be possible.

Another possible group model is to explicitly establish three regional CF/S groups that are responsible for reporting directly to the Project Manager(s). In this case, a “global CF/S coordination group” (or workgroup forum) will have to be made active and effective, so as to ensure that region-independent aspects of CF/S efforts are coordinated seamlessly, and all the relevant information are shared across all three regions. This will be also possible, while some conscious efforts might be necessary.

4.4.6 Oversight

While certain independence of activities of regional CF/S teams will be helpful for expeditiously pursuing region-specific studies of CF/S issues, mutual reviews on the scope and progress of such efforts will be equally beneficial for the entire GDE. Depending on the nature of the topic and on the progress of preparation towards the site-selection process, a semi-regular high-level review forum (GDE Project Managers, Executive Committee, the Director or above) on the CF/S issues might become worthwhile.

4.4.7 Information Flow

Outputs from efforts in the area of CF/S have large impacts on the ILC project cost as well as the considerations on the construction schedule and commissioning, which are all major topics of the EDR phase activities. These efforts, naturally, require detailed layout and other specifications from each of the area systems. However, delivery of sufficiently detailed technical descriptions of individual area groups tends to be late, because of the inherent work orders within these groups. The Taskforce wishes to point out that some sort of a special enforcement group may be worth creating, for ensuring smooth and timely flows of information from area groups to the CF/S group and vice versa. Exact implementation of such an enforcement group is something to be determined by the Project Manger(s), in consultation with adequate parties including the CF/S leader(s).

At a minimum, points of contact (POC's) need to be established, or maintained, between each area system group and the CF&S group. These POC's should have the support of the L3 system leaders in representing an area system, not just a sub-system, in discussions of design/cost tradeoff's with CF&S. They will be a necessary part of the CF&S Activity planning described below in 6.4.8. A.

4.4.8 Activity Planning for CF/S

Specific planning of CF/S activities in the EDR phase is to be developed by the CF/S leaders, and be determined under guidance of the Project Manager(s) and the higher management. While fully recognizing this managerial framework, the Taskforce wishes to offer here some remarks which may be of some use for this activity planning.

In an early preparatory stage for EDR efforts, the issues to address by the CF/S group may be logically organized in the following four subject groups:

A) Establish the detailed specifications for the CF/S to satisfy, irrespective of the regions. Primary inputs for this work are to come from area groups and other global or technical groups. Naturally this will be a long, interactive and continuing process. However, at an early stage of the EDR phase, a reasonably clear and commonly-agreed-upon starting point needs to be defined, and any ambiguities in the present RDR (or BCD) be resolved to the extent maximally possible.

B) Establish the consensus over a few key subjects related to region-specific (site-specific) aspects of CF/S activities. Representative subjects of this category include the following three: (1) an acceptable magnitude of regional variations in the implementation of CF/S, (2) specifics of the activities to carry out prior to site selection, (3) specifics of the activities to carry out during site selection.

C) Develop and share a good understanding of region-specific concerns and their variations over CF/S. The subject matters include: (1) legal issues to note in major construction projects, (2) magnitude of environmental impact studies to carry out as the project proceeds, (3) safety regulations and others.

D) Last but not least, organize the CF/S group structure and Work-package structure.

It may be that the work in the area A) is more straightforward and immediately necessary in establishing a base design than the one in B) or C). In that case the CF/S group might as well choose to focus first on A), move on to B) and C), then try D).

The Taskforce also recognizes that there are a few other important issues to address, besides the four subject groups above, namely

E) How to make a transition from RDR's studies on "sample sites" towards studies on "site candidates".

F) Examination of shallow-tunnel cases at flat-land sites, which were not completed as or RDR.

However, while repeating that the managerial decisions belong to their own layer in the GDE,, some Taskforce members feel that it would be more beneficial to focus first on the subject groups A) through D) and that would not compromise the quality of work to conduct in E) and F).

Appendix A : Charge

CHARGE

•To study two or more possible technical project structures (WBS) for the EDR phase of the ILC.

•The WBS models should be orientated around a central project management structure, lead by a single project manager.

•The WBS should break down into individual Work Packages, suitable for distribution to interested parties, who would then take on responsibility for the deliverables of that Work Package.

•The WBS models must have clear lines of responsibility and reporting, up to the top-level management.

•The WBS should naturally support (and drive) the ILC R&D program, which must be an integral part of the project.

COMMENTS

Some considerations are of particular importance for the task force to consider are the global nature of the project and therefore consider how well does the WBS/WP structure map onto a geographically distributed project, and how will it function . Secondly, you should consider the existing programs, funding, as well as regional/institutional stated interests, but you should not necessarily be constrained by them. The study should solicit and take note of input from the current RDR leaders (Area, Technical and Global System leaders) as well as the R&D boards as to possible Work Packages, milestones, R&D etc. . Finally, the study should attempt to find flexible solutions, which allow the structure to naturally evolve during the work package allocation, and will support (and encourage) new groups to join at a possible later stage.

Appendix B: Damping Rings Organizational Structure, Work Packages, and Work Plan

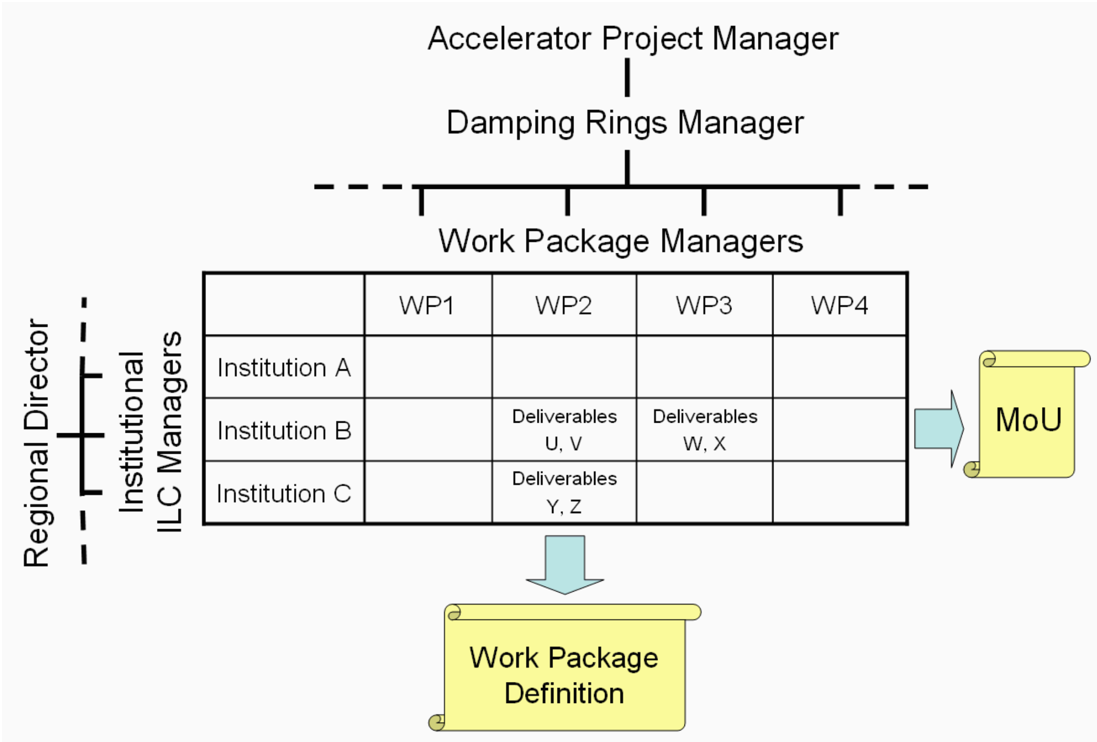
We develop the description of the damping rings organizational structure given in Section 6.1, to include further details of the organizational structure, potential Work Packages, roles and responsibilities, and outline work plan.

B.0. Introduction and Summary

Damping rings research, development and design (RD&D) activities during the engineering design phase should be based on a set of Deliverables. Closely-related Deliverables will be grouped into Work Packages. Responsibility for completing Deliverables by defined dates will lie with Principal Institutions, with assistance from Supporting Institutions. The agreement for a given Principal Institution to take responsibility for a set of Deliverables (possibly from different Work Packages and different areas of the ILC) will be recorded in a Memorandum of Understanding between the Institution and the GDE [*Executive Committee?*].

Each Work Package will have a Manager, responsible for management of technical activities within that Work Package. The Work Package Managers report to a Damping Rings Manager who has overall responsibility for management of damping rings RD&D. The Damping Rings Manager reports to the Accelerator Project Manager.

Each Institution will have a Manager, responsible for provision and coordination of resources for ILC RD&D at that Institution. The Institutional Managers report to the respective Regional Directors.



B.1. Damping Rings Work Packages.

RD&D activities for the damping rings during the engineering design phase will be grouped into Work Packages, each with a set of defined deliverables. The following lists the proposed Work Packages for the damping rings:

- WP1: Lattice design
- WP2: Impedance and impedance-driven instabilities
- WP3: Electron cloud
- WP4: Ion effects
- WP5: Other collective effects
- WP6: Acceptance
- WP7: Orbit, optics and coupling correction
- WP8: Vacuum system
- WP9: Magnets and supports (including wiggler)
- WP10: Power systems
- WP11: 650 MHz RF system
- WP12: Injection and extraction systems
- WP13: Fast feedback systems
- WP14: Abort systems
- WP15: Instrumentation and diagnostics
- WP16: Systems integration and availability

B.2. Deliverables.

Work Package descriptions will include a set of Deliverables, to be completed by specified dates. Deliverables and completion dates will initially be defined by the Damping Rings Manager, in consultation with the Work Package Managers and the Accelerator Project Manager.

B.3. Principal Institutions.

Each Deliverable should have a Principal Institution responsible for its completion by a specified date. The Deliverables and completion dates will be formally agreed between the Principal Institution and the GDE [*Executive Committee?*] and recorded in a Memorandum of Understanding.

B.4. Supporting Institutions.

Institutions other than the Principal Institution may contribute to any given Deliverable by providing resources to support the activities of the Principal Institution. The role and contribution of a Supporting Institution should be recorded in an informal agreement between the Principal Institution and the Supporting Institution (each represented by their Institutional ILC Managers), in consultation with the Damping Rings Manager and appropriate Work Package Manager.

B.5. Damping Rings Manager.

Overall coordination and management of damping rings research, development and design (RD&D) will be the responsibility of the Damping Rings Manager. The Damping Rings Manager reports to the ILC Accelerator Project Manager. The Damping Rings Manager has specific responsibilities including:

- initial definition of the Deliverables to be completed during the Engineering Design Phase, with the support of the Work Package Managers;
- participation in the selection of Principal and Supporting Laboratories for the various Deliverables;
- leading the negotiations of Memoranda of Understanding between the Principal Laboratories and the GDE.

B.6. Work Package Managers.

RD&D activities for the damping rings will be grouped into Work Packages, each with a set of defined deliverables. Coordination and management of each Work Package will be the responsibility of a Work Package Manager. The Work Package Managers report to the Damping Rings Manager. The Work Package Managers have specific responsibilities including:

- initial definition of the Deliverables within their Work Package to be completed during the Engineering Design Phase;
- participation in the selection of Principal and Supporting Laboratories for the Deliverables within their Work Package;
- participation in the negotiations of Memoranda of Understanding between the Principal Laboratories and the GDE, where such MoU’s include Deliverables within their Work Package;
- coordination and management of activities within the work package, including monitoring progress, facilitating communication, etc.

B.7. Institutional ILC/Damping Rings Managers.

Provision and coordination of resources within an Institution will be the responsibility of an Institutional ILC Manager. The Institutional ILC Managers report to the appropriate ILC Regional Director. The Institutional ILC Managers have specific responsibilities including:

- provision and coordination of resources at their Institution, as needed to complete the Deliverables specified in the Memorandum of Understanding by the specified dates;
- reporting Institutional RD&D activities for reviews and as otherwise required by the respective Regional Director and/or the Executive Committee.

A given Institution may take responsibility for deliverables from several different Work Packages, possibly including Work Packages for systems other than the damping rings. [*Subject to "global" ILC organisation:*] Each Institution should have a single Institutional ILC Manager. Any Institutional ILC Manager may, at the discretion of the Institution, appoint one or more deputies with responsibilities for specific areas of ILC activity.

B.8. Selecting Principal and Supporting Institutions.

After initial definition of the Deliverables and completion dates, Work Package Descriptions will be published, and Institutions asked to submit brief proposals for each Deliverable, or group of Deliverables. Joint proposals (identifying the Principal Institution and one or more Supporting Institutions) will be encouraged. The brief proposals should indicate the capability of the Institution (or collaboration) to complete the Deliverable on time, by reference to the availability of necessary resources. The Damping Rings Manager may, with agreement from the Work Package Managers, Accelerator Project Manager, and Regional Directors, informally invite proposals from particular Institutions or collaborations.

Following submission of the proposals, recommendations for the choice of Principal Institution (and Supporting Institutions) for each Deliverable will be drawn up by a committee formed of:

- the Damping Rings Manager,
- the Work Package Managers,
- the Regional Directors,
- the Accelerator Project Manager.

The recommended choices for the Principal/Supporting Institutions will be submitted to the Executive Committee, who will then decide on the Principal/Supporting Institutions for each Deliverable.

B.9. Memoranda of Understanding

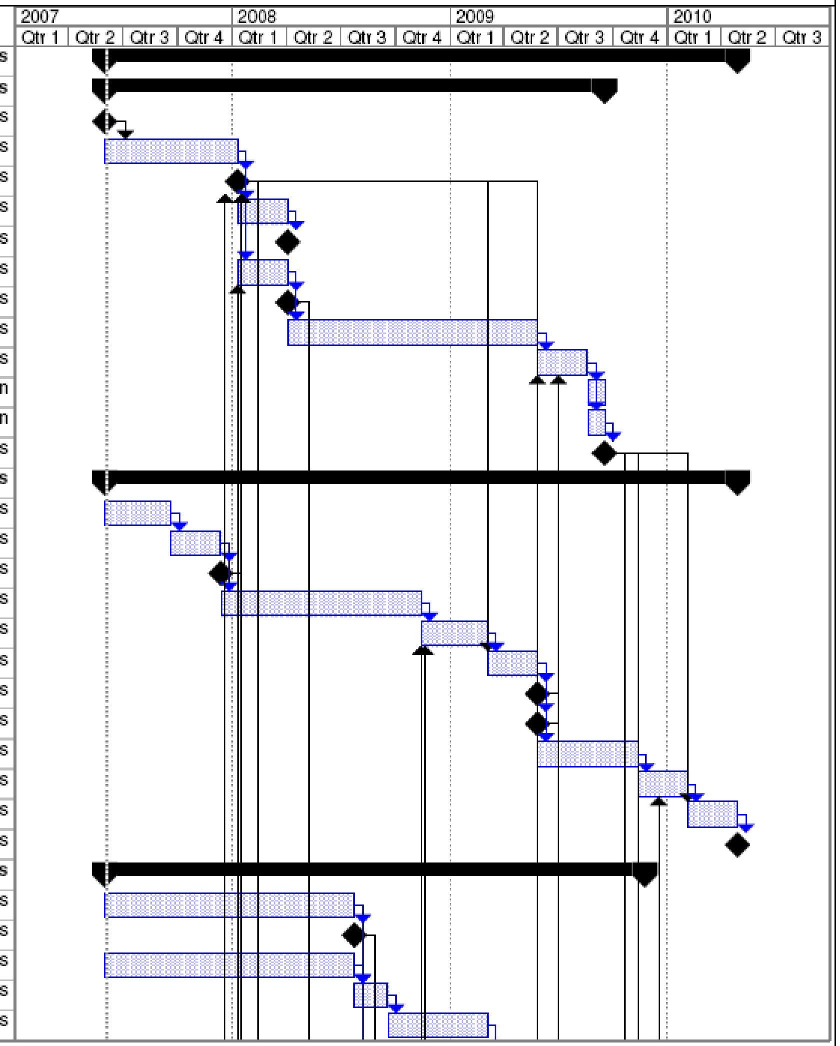
The responsibilities of each Principal Institution will be formalised by a Memorandum of Understanding between the Principal Institution and the "GDE" [*Executive Committee?*]. The MoU shall list the Deliverables that the Principal Institution undertakes to complete by specified due dates. The final definition of each Deliverable that will appear in the MoU, and the completion dates, will be agreed by negotiation between:

- the Damping Rings Manager,
- the appropriate Work Package Managers,
- the appropriate Institutional ILC Managers,
- the appropriate Regional Director,
- the Accelerator Project Manager,
- the GDE Executive Committee.

The Damping Rings Manager should have the leading role in the negotiations of the various Memoranda of Understanding.

ILC Damping Rings - DRAFT EDR Gantt Chart - Version 2007-06-03

ID	Task Name	Duration
1	**Optics and beam dynamics**	**760 days**
2	**Lattice design**	**600 days**
3	Set lattice specifications	0 days
4	Develop damping rings lattice designs	8 mons
5	Select and "freeze" baseline lattice design	0 days
6	Develop baseline design of injection/extraction lines	3 mons
7	"Freeze" baseline design of injection/extraction lines	0 days
8	Develop baseline design of abort line	3 mons
9	"Freeze" baseline design of abort line	0 days
10	Explore optimisations and operational flexibility	15 mons
11	Make necessary changes to lattice design	3 mons
12	Make necessary changes to injection/extraction lines	1 mon
13	Make necessary changes to abort line	1 mon
14	Lattice designs finalised and documented	0 days
15	**Impedance and impedance-driven instabilities**	**760 days**
16	Construct impedance model from scaled component designs	4 mons
17	Model instabilities using preliminary impedance model	3 mons
18	Make instability estimates based on preliminary impedance model	0 days
19	Refine and improve impedance models and instability calculations	12 mons
20	Construct impedance model using real technical designs	4 mons
21	Understand impact of single-bunch and coupled-bunch instabilities, and inj	3 mons
22	Estimates of coupled-bunch instability growth rates	0 days
23	Specify improvements to lattice and vacuum designs	0 days
24	Refine and improve impedance models and instability calculations	6 mons
25	Finalise impedance model	3 mons
26	Characterise instabilities using detailed impedance model	3 mons
27	Predict instability characteristics and thresholds	0 days
28	**Electron cloud**	**648 days**
29	Evaluate electron cloud mitigation techniques	15 mons
30	Specify baseline ecloud mitigation techniques	0 days
31	Start construction of test dipole chamber	15 mons
32	Finalise construction of test dipole chamber	2 mons
33	Test ecloud mitigation techniques in dipole chamber	6 mons



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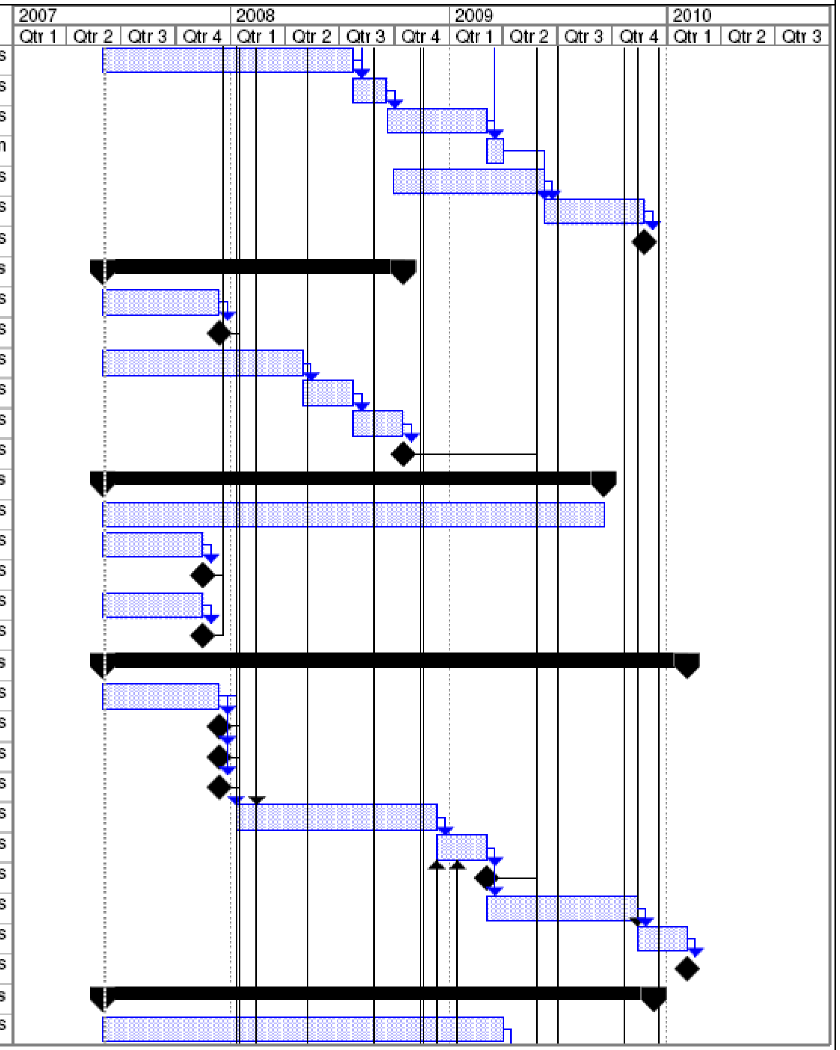
ILC Damping Rings - DRAFT EDR Gantt Chart - Version 2007-06-03

ID	Task Name	Duration
34	Start construction of test wiggler chamber	15 mons
35	Finalise construction of test wiggler chamber	2 mons
36	Test ecloud mitigation techniques in wiggler chamber	6 mons
37	Model ecloud build-up with baseline mitigation techniques	1 mon
38	Benchmark electron cloud instability codes	9 mons
39	Model electron cloud instabilities	6 mons
40	Validate design for ecloud mitigation, and predict ecloud instability safety m	0 days
41	**Ion effects**	**360 days**
42	Use existing models to estimate ion effects under various fill/vacuum condi	7 mons
43	Make initial specification of vacuum conditions to mitigate fast ion instabilit	0 days
44	Collect experimental data on fast ion instability	12 mons
45	Benchmark fast ion instability modelling codes	3 mons
46	Run simulations of fast ion instability for various vacuum and operational c	3 mons
47	Specify vacuum conditions and fast feedback systems performance to avo	0 days
48	**Other collective effects**	**600 days**
49	Placeholder for space-charge studies	30 mons
50	Initial estimates of intrabeam scattering	6 mons
51	Initial estimates of intrabeam scattering	0 days
52	initial estimates of Touschek lifetime	6 mons
53	Initial estimates of Touschek lifetime	0 days
54	**Acceptance**	**700 days**
55	Make preliminary estimates of dynamic aperture	7 mons
56	Preliminary estimates of dynamic aperture	0 days
57	Specify magnet field quality	0 days
58	Specify physical apertures	0 days
59	Explore dynamic aperture limitations and possible improvement techniques	12 mons
60	Characterise acceptance using technical designs of magnets	3 mons
61	Understand acceptance limitations using technical designs of magnets	0 days
62	Explore dynamic aperture limitations and possible improvement techniques	9 mons
63	Complete studies of acceptance	3 mons
64	Confirm acceptance margin on injected beam	0 days
65	**Orbit, optics and coupling correction**	**660 days**
66	Experimental studies of orbit and coupling correction	24 mons



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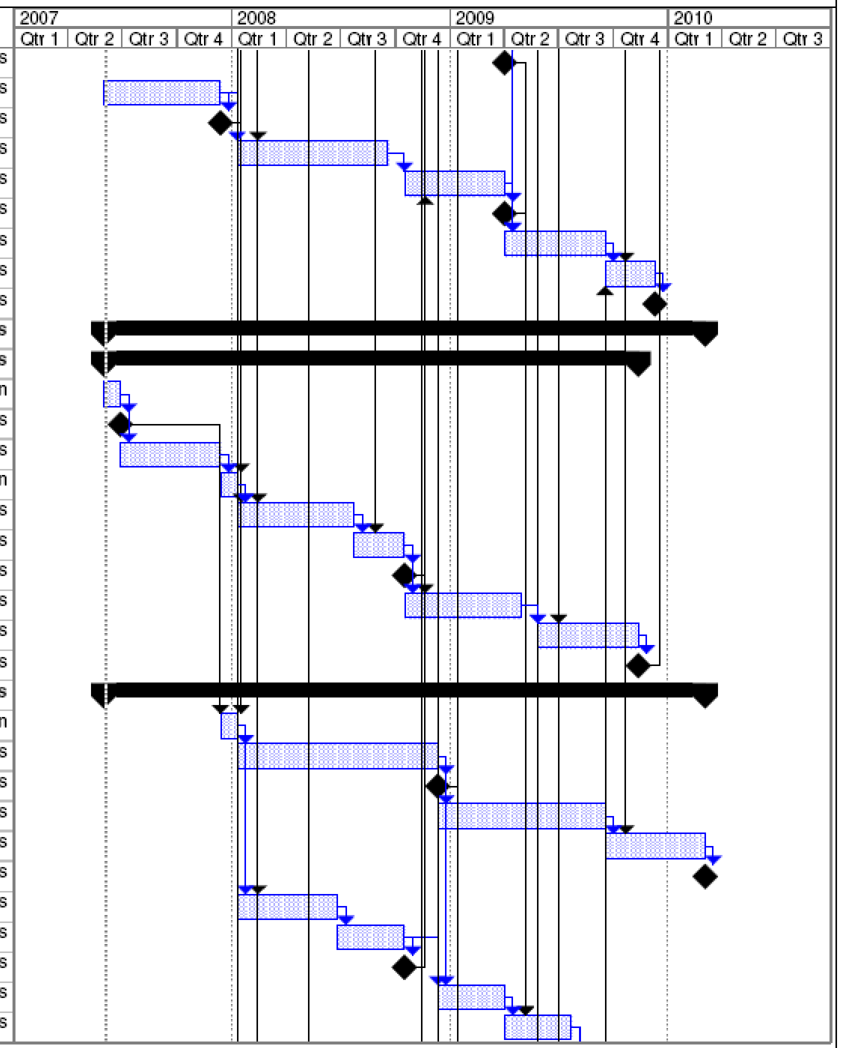
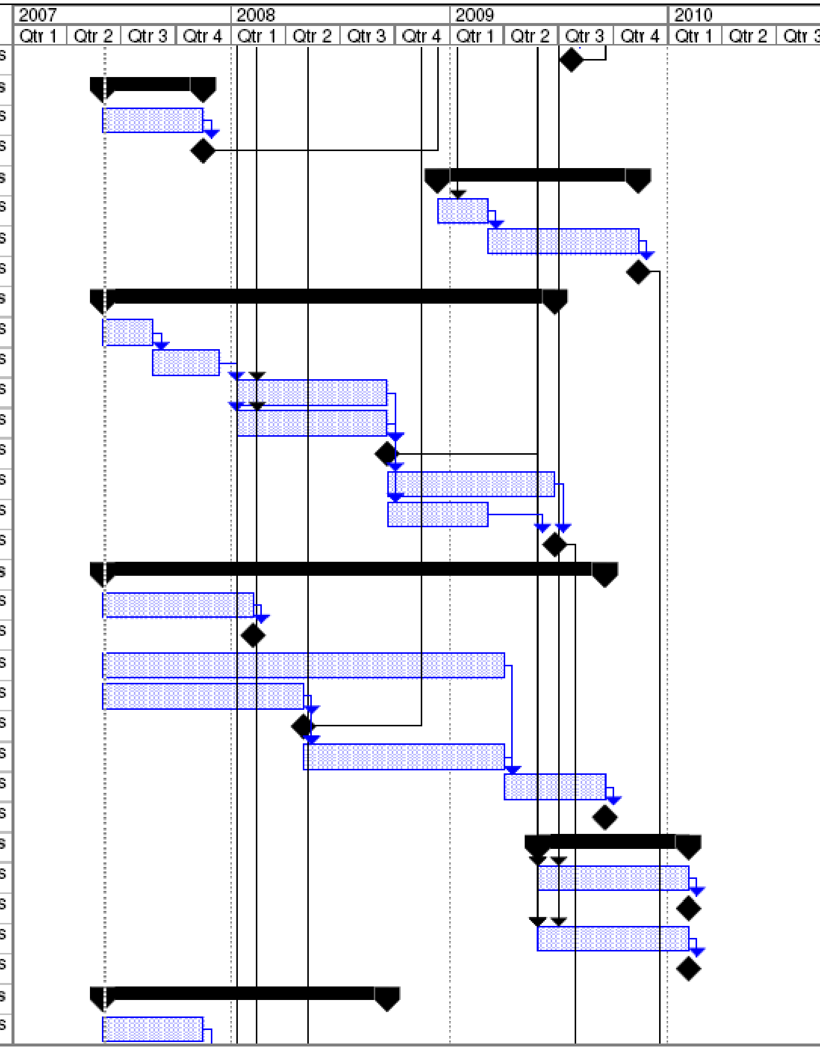
ILC Damping Rings - DRAFT EDR Gantt Chart - Version 2007-06-03

ID	Task Name	Duration
67	Demonstrate 2 pm vertical emittance	0 days
68	Make initial estimates of alignment sensitivities in baseline lattice	7 mons
69	Initial estimates of alignment sensitivities	0 days
70	Specify and evaluate possible orbit and coupling correction schemes	9 mons
71	Evaluate impact of ground vibration, temperature variations and long-term	6 mons
72	Initial estimates of impact of ground vibration, temperature variations and l	0 days
73	Optimise orbit and coupling correction scheme	6 mons
74	Finalise orbit and coupling correction scheme	3 mons
75	Correction systems documented and costed	0 days
76	**Technical subsystems**	**720 days**
77	**Vacuum system**	**640 days**
78	Preliminary vacuum system specifications	1 mon
79	Set baseline specifications for vacuum system (subject to ecloud studies)	0 days
80	Prepare initial technical designs of vacuum system components	6 mons
81	Review vacuum system specifications	1 mon
82	Develop initial technical designs of vacuum system components	7 mons
83	Finalise technical designs of vacuum system components	3 mons
84	Technical designs of vacuum system components	0 days
85	Optimise vacuum system for cost and technical performance	7 mons
86	Make essential modifications to technical designs of vacuum system comp	6 mons
87	Vacuum system technical design finalised, documented and costed	0 days
88	**Magnets and supports**	**720 days**
89	Specify magnets	1 mon
90	Develop technical designs for main magnets	12 mons
91	Technical designs for main magnets	0 days
92	Optimise magnet designs for cost and performance	10 mons
93	Finalise designs of main magnets	6 mons
94	Magnet designs documented and costed	0 days
95	Develop technical designs for magnet supports	6 mons
96	Model magnet supports response to vibration and long-term stability	4 mons
97	Characterisation of magnet supports response to vibration and long-term s	0 days
98	Optimisation of design of magnet supports	4 mons
99	Finalise design of magnet supports	4 mons



ILC Damping Rings - DRAFT EDR Gantt Chart - Version 2007-06-03

ID	Task Name	Duration
100	Magnet supports documented and costed	0 days
101	**Wiggler**	**120 days**
102	Develop technical design for wigglers	6 mons
103	Wiggler design documented and costed	0 days
104	**Power systems**	**240 days**
105	Specify magnet power supplies, power distribution and cooling system	3 mons
106	Develop designs for power distribution and cooling systems	9 mons
107	Power systems documented and costed	0 days
108	**650 MHz RF system**	**540 days**
109	Initial specifications for RF system	3 mons
110	Preliminary technical design of RF system	4 mons
111	Develop technical designs for RF cavities	9 mons
112	Develop technical specifications/designs for modulators, klystrons, wavegu	9 mons
113	Technical design of RF components	0 days
114	Finalise RF system technical designs	10 mons
115	Develop technical design for low-level RF	6 mons
116	RF system documentation and costing	0 days
117	**Injection and extraction systems**	**600 days**
118	Install single-bunch extraction system in ATF	9 mons
119	Demonstrate single-bunch extraction from ATF	0 days
120	Develop fast high-power pulser meeting damping ring specifications	24 mons
121	Develop technical design for kicker striplines	12 mons
122	Technical design for kicker striplines	0 days
123	Fabricate striplines for beam tests	12 mons
124	Install and test fast injection/extraction kicker system	6 mons
125	Demonstrate injection/extraction kickers with damping ring specifications	0 days
126	**Fast feedback systems**	**180 days**
127	Develop technical design for longitudinal fast feedback system	9 mons
128	Longitudinal fast feedback systems documented and costed	0 days
129	Develop technical design for transverse fast feedback system	9 mons
130	Transverse fast feedback systems documented and costed	0 days
131	**Abort systems hardware**	**340 days**
132	Develop technical design for abort dump	6 mons



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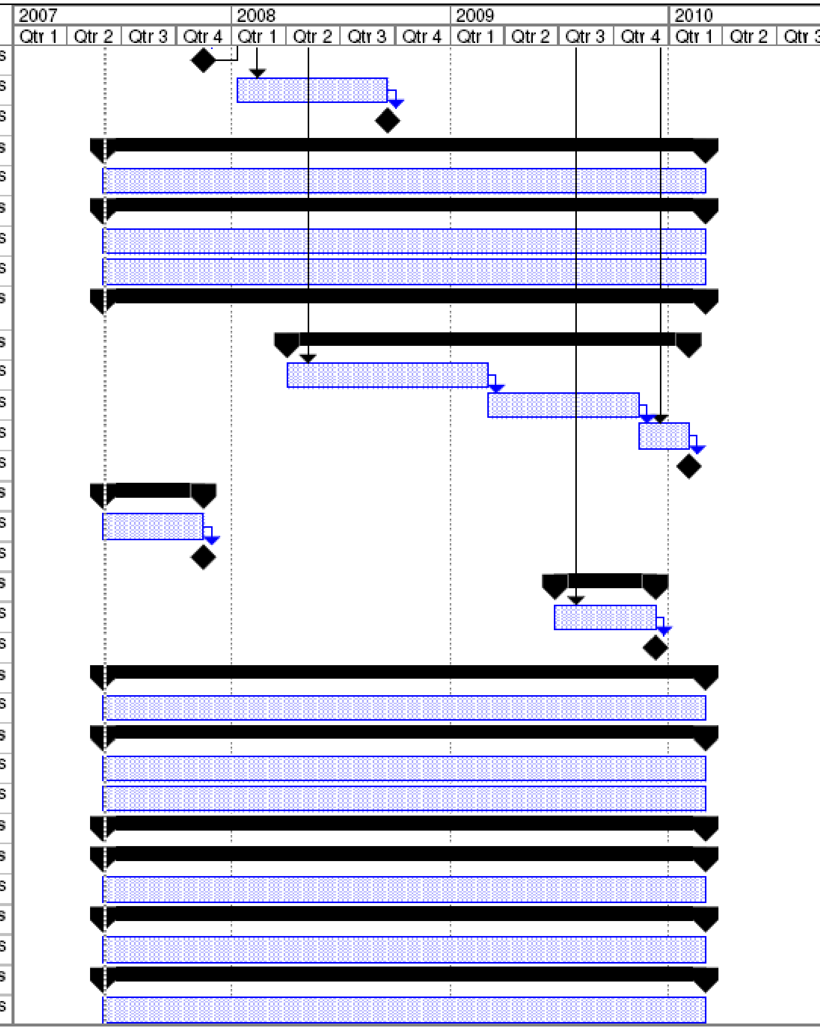
ILC Damping Rings - DRAFT EDR Gantt Chart - Version 2007-06-03

ID	Task Name	Duration
133	Technical design for abort dumpt	0 days
134	Develop technical designs for abort kickers	9 mons
135	Abort systems documented and costed	0 days
136	**Instrumentation and diagnostics**	**720 days**
137	Instrumentation and diagnostics placeholder	36 mons
138	**Systems integration and availability studies**	**720 days**
139	Systems integration tasks placeholder	36 mons
140	Systems availability tasks placeholder	36 mons
141	**Global systems: integration into the organisational structure uncertain. Mostly placeholders**	**720 days**
142	**Conventional facilities**	**480 days**
143	Design excavations (tunnels and caverns)	12 mons
144	Design air conditioning/temperature stabilisation systems	9 mons
145	Finalise conventional facilities designs	3 mons
146	Conventional facilities documented and costed	0 days
147	**Control systems**	**120 days**
148	Specify control systems	6 mons
149	Control systems documented and costed	0 days
150	**Cryogenics systems**	**120 days**
151	Specify cryogenics systems	6 mons
152	Cryogenics systems documented and costed	0 days
153	**Survey and alignment**	**720 days**
154	Survey and alignment placeholder	36 mons
155	**Installation and commissioning plan**	**720 days**
156	Installation plan placeholder	36 mons
157	Commisioning plan placeholder	36 mons
158	**Test facilities: placeholders for tasks specific to test facility development**	**720 days**
159	**ATF**	**720 days**
160	Experimental studies placeholder	36 mons
161	**CesrTA**	**720 days**
162	Experimental studies placeholder	36 mons
163	**KEKB**	**720 days**
164	Experimental studies placeholder	36 mons



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