CHANGE MANAGEMENT AT THE INTERNATIONAL LINEAR COLLIDER ILC

B. List†, L. Hagge, N. J. Walker, DESY, Hamburg, Germany

Abstract

The Linear Collider Collaboration has introduced a change management process to ensure that changes to the ILC baseline design are properly reviewed and implemented in an orderly fashion. A change management board oversees the process, establishes the review procedure based on the overall impact of the proposed change, decides, and monitors the implementation. This change management process has become an important factor that gives structure and direction to the ongoing design activities around the world.

The change process ensures that all stakeholders are part of the review and decision process from the beginning and contribute to a design change acceptable to all parties involved.

INTRODUCTION

The International Linear Collider (ILC) is currently in a pre-preparation phase, awaiting a political decision. As a result of the Global Design Effort, the baseline design of the accelerator has been defined, and the technical feasibility has been demonstrated. Until the next project phase commences, resources are limited to further evolve the baseline design. Nonetheless, under the guidance of the global Linear Collider Collaboration (LCC), activities are on going to study critical systems in more detail and adapt the design to the preferred site in Japan.

In order to preserve the completeness and consistency of the technical baseline design, a formal Change Management process was set up to assure that further design work proceeds in a coordinated fashion and preserves the coherence and integrity of the design. This design is described in detail in the Technical Design Report (TDR) of 2013 [1] and the Technical Design Documentation (TDD) stored in DESY's Engineering Data Management System (EDMS).

A NEW CHANGE MANAGEMENT PROCESS FOR THE ILC

Following an initiative started at DESY, a Change Management process that was suitable for the ILC accelerator design in its current phase was developed. The goal was to define a process that involved minimal bureaucracy, respected the culture of the community, reached out to all ILC collaborators around the world, and was feasible given the global distribution of the participants.

The resulting Change Management Process for the ILC [2] consists of four steps: proposal of a change, review, decision, and implementation. The central body of the process is the Change Management Board (CMB), which is chaired by the LCC director for the ILC, and comprises the members of the Technical Board (TB), plus a civil engineering expert, a site expert, two representatives of the physics and detectors community, and a change administrator who organizes the meetings and takes care of the paperwork.

Change requests can be submitted by TB members, work package coordinators, and the representatives of the physics and detectors community. They are listed in a central register, published on a web site [3] and distributed to all stakeholders as soon as they are officially submitted. The CMB considers the request; complicated CRs can be deferred to a dedicated Change Review Panel of experts, who are charged to review the proposal and make a recommendation whether to accept, modify, or outright reject the proposed change. For large impact changes, the review process can involve dedicated sessions at the regular international or regional linear collider workshops, or even special workshops. This respects the community's culture to discuss momentous issues at workshops and arrive at a consensus, but adds structure to the discussions and makes sure that the consensus also involves those who had to miss a particular workshop because of limited travel funds. After the review phase, the CMB chair takes a decision. Implementation of an approved change request involves correcting or adding design documents to the Technical Design Documentation, and can be tasked to a dedicated Change Implementation Team (CIT), which reports back to the CMB.

This process, depicted in Fig. 1, is flexible enough to be applicable to the wide range in scope of the changes that are currently under discussion.

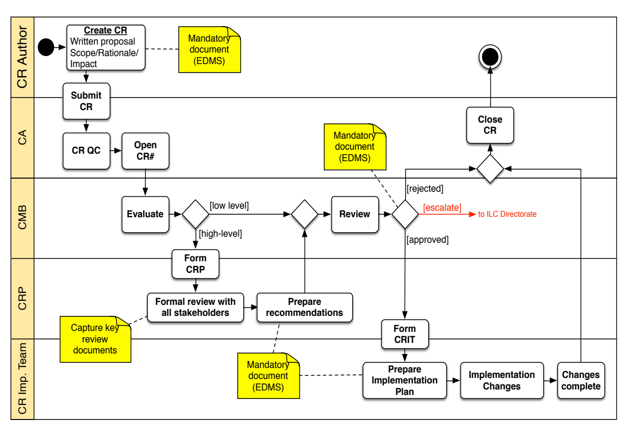

Figure 1: The Change Management process for ILC [2].

† Benno.List@desy.de

ISBN 978-3-95450-147-2

RECENT CHANGE REQUESTS

Twelve change requests have been submitted so far, ranging from the insertion of a 10cm long beam position monitor into the experiments to the extension of the main linac tunnel by 3km. Two of the first CRs involved negotiations between the accelerator and the detector design teams: the accelerator side asked for a harmonization of the free space around the IP (L*, see below) between the detectors that share the interaction zone alternatingly, and the detector groups asked for a vertical access shaft to the experimental hall that completely changed the requirements for the experimental hall location. These two CRs also the flexibility of the process: While the former was submitted at an early stage and was then extensively studied during the review process, as intended by the change management process, the latter was thoroughly prepared by a task force comprising all relevant stake holders, so that it could be adopted quickly when finally submitted.

*Common L**

ILC-CR-0002, the second change request ever submitted to the CMB called for a harmonization of the final focus magnet distance to the interaction point (the so-called L^*) between the two detector concepts SiD and ILD. Fig 2 shows the ILD detector, with L^* highlighted. As the final focus magnet sits inside the detector and defines the free space available for instrumentation, this is one of the major design constraints for each detector and goes to the heart of the detector concept, Changing it requires significant engineering work, preceded by careful physics studies. On the other hand, the final focus optics is one of the most delicate parts of the accelerator design, and supporting two different final focus lengths requires compromises that are less than optimal for both solutions. This change request triggered an extensive review phase. Over the course of one year, a series of workshops with detector and accelerator experts was conducted to evaluate the feasibility and ramifications of the proposed change. The studies included detailed simulations of the accelerator performance in the old and new configurations, and the impact on detector design and performance. Finally, a solution was found that suited all parties, the accelerator and both experiments, with a common L^* value of 4.1m.

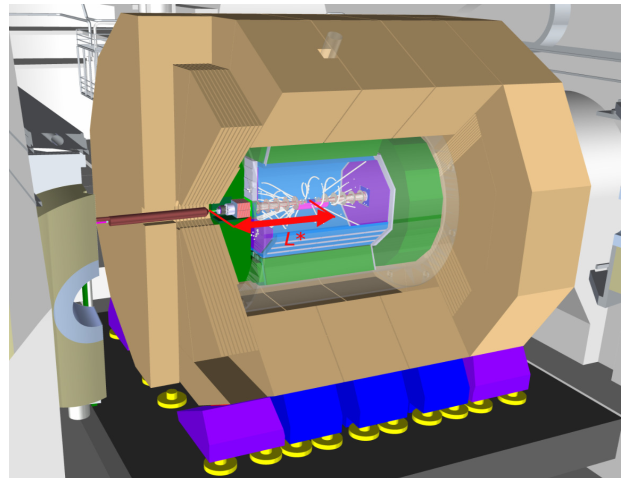

Figure 2: Schematic view of the ILD detector [4] with a Higgs event: L^*, the distance from the last accelerator magnet to the interaction point, has been harmonized for both ILC detector concepts.

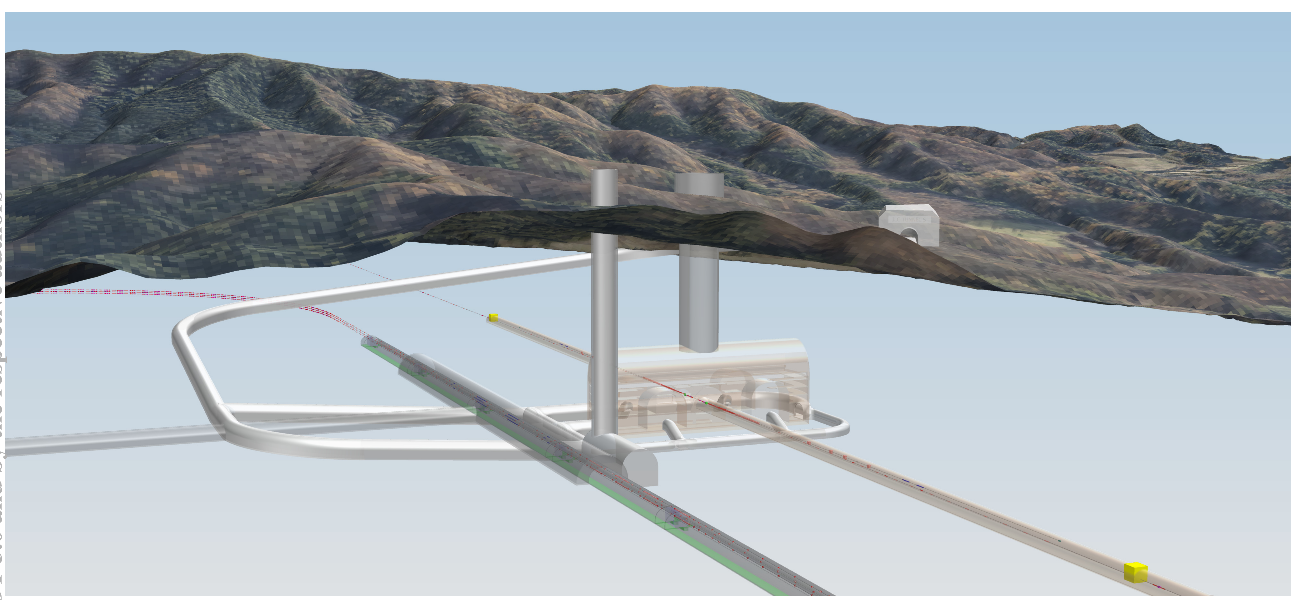

Figure 3 Illustration of the ILC accelerator complex in a fictitious mountainous area: Design evolution uses change requests to adapt the general layout of the facility to the specifics of the most probable host site. The figure shows the experimental hall with the original sloped access tunnel and the newly added vertical access shafts. The accelerator is shown to illustrate the complexity and dependencies that have to be taken into account when changing the design of any component.

ISBN 978-3-95450-147-2

Experimental Hall with Vertical Shaft Access

Conversely, the experiments approached the accelerator siting team with a change request asking for a modification of the access scheme to the experimental hall: Instead of the baseline design that foresaw access to the experi- mental hall via sloped tunnels, with detector assembly taking place underground, the CR proposed to add a ver- tical access shaft with a gantry crane to allow detector assembly in a surface hall (similar to construction of CMS) to decouple cavern and detector construction schedules and reduce schedule risk. Figure 3 shows the 3D integration model of the detector hall and adjacent tun- nels, accelerator beamlines and surface landscape that was created as part of the Change Request preparation. (The landscape shown illustrates the capability to include this information in the model, but does not correspond to any of the locations considered for the experimental hall location.)

This request meant that the interaction point at the preferred site would have to be moved to a point where the overburden was low enough to allow for such a vertical shaft. This change request also took about a year of discussions, but in this case the proposers chose to work out the details before submitting the change request. After the CMB had convinced itself that all stakeholders had been involved in the preparation and were satisfied with the solution proposed, the change request was quickly approved.

Extension of the Main Linacs

The most expensive change request so far called for an extension of the Main Linac tunnels by 1.5km each, adding 3km to the total length of the accelerator. Although the extension was triggered by a machine requirement that the round trip of the positrons from damping ring (DR) to IP has to be an integer multiple of the DR circumference, the real reason for this costly solution came from physics: at 500GeV centre-of-mass energy, the ILC operates just above the threshold for associate production of a top pair and a higgs boson, one of the key measurements to make at the ILC. Failure to reach 500GeV would jeopardize this goal, and the 1.5km additional tunnel adds space that could be equipped with additional cryomodules, should it turn out to be more economic to produce more cryomodules at a relaxed gradient rather than require the full design gradient of 31.5MV/m. The CMB accepted this CR, noting that the ensuing cost increase had to be compensated by another change that saves at least the same amount of money. Such a CR is currently being reviewed: CR-0012 proposes to reduce the shield wall thickness in the Main Linac tunnel from 3.5 to 1.5m, which would finance the longer tunnel.

SUMMARY AND CONCLUSIONS

The experience with the Change Management process is quite positive. On-going change requests serve as a crystallisation point for discussions at the linear collider workshops, even trigger dedicated meetings, and lead to coordinated and thorough studies of issues that go through the change review process.

In the current situation of limited project resources, design activities emerge bottom-up as often as top-down, and as those activities typically change the design, managing the change is almost tantamount to managing the project. The benefit for the project lies in an increased efficiency, as design activities are conducted in a transparent way. Consensus is reached and on a broad basis, so that changes are less likely to be challenged or reversed again. A documented and systematic implementation ensures that design documents are up-to-date, or at least that pending changes are known, which reduces waste of time and effort due to confusion over the current state of the design.

Clearly, the Change Management process will have to evolve once the project enters the preparation phase, which will be marked by hugely increased level of design activity, at an increased level of detail. This will necessitate a faster processing of changes, with strict control of the implementation. Such a process will likely draw from existing industry standards such as CMII [5]. It will also require establishing change control on all relevant levels, in addition to the top level change control that is in place now. The introduction of such a full-scale change process will profit from a culture of systematic change control that is being established now.

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ISBN 978-3-95450-147-2