

8 JULY 2012

## MANDATE OF THE LINEAR COLLIDER BOARD

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### **Purpose**

1. The Linear Collider Board (LCB), as a sub-panel of ICFA, will promote the construction of an electron-positron linear collider and its detectors as a world-wide collaborative project. It will facilitate advanced R&D, engineering design and project execution plans for a linear collider, consistent with LHC and other relevant physics data, and prepare for a linear collider proposal that has the strong support of the community.
2. The LCB will be responsible for the science, technology, outreach and organization in pursuit of the linear collider project. The LCB will have a three-year term. The term is renewable and the mandate is subject to review and update when the term is renewed.

### **Mission**

3. The LCB will establish a Linear Collider Directorate, headed by a Linear Collider Director, to coordinate and direct the global effort towards realizing a linear collider.
4. The LCB, representing ICFA, will provide oversight to the Linear Collider Directorate.
5. The LCB will work with the Funding Agencies for Large Colliders (FALC) and other national and international agencies, to obtain the resources necessary to advance the linear collider project. In addition, the LCB will assess and endorse budget requests for the common fund that the Linear Collider Director will then present to FALC. The common fund is necessary to support the Directorate and other essential activities normally associated with a host laboratory.
6. The LCB will set up a Project Advisory Committee (PAC) to report to it on linear collider project, accelerator, and detector issues. The PAC Chair will be appointed by the LCB. The PAC members will be appointed by the LCB for three-year terms, with advice from the Director.

7. The LCB will monitor the progress of the linear collider activities through reports by the Linear Collider Director and the PAC Chair. It will also be informed by other experts as needed, such as the World-Wide Study.

8. The LCB will monitor the outreach activities of the Linear Collider Directorate, regional groups, and others, aimed at explaining the scientific and technological importance of the project to the scientific community, to industry, to government officials, and to the public.

9. The LCB will carry out such other tasks as may be approved or directed by ICFA.

### **Linear Collider Directorate**

10. The Linear Collider Director will be appointed by ICFA for a three-year term, in consultation with the LCB and with recommendations from the regions. He/she will directly report to the LCB and be responsible to the LCB for leading the organization to fulfill its responsibilities. He/she will represent the linear collider to the world.

11. The Linear Collider Director will appoint the members of the Linear Collider Directorate, with advice and concurrence from the LCB. Initially, it is envisaged to include three Associate Directors leading divisions that will carry forward design and R&D on (i) an SCRF linear collider, (ii) a room-temperature two-beam linear collider, and (iii) the physics and detectors for these machines. There will also be three coordinators as liaisons to each of the three regions

12. The activities of the three divisions under the Linear Collider Directorate will evolve with time, but at the beginning they will be essentially those of the ILC Global Design Effort, the CLIC Collaboration, and the physics and detector activities associated with CLIC and the ILC Research Directorate.

### **Subcommittees**

13. In carrying out its work, the LCB will appoint subcommittees as needed, with members selected for their particular expertise. Membership will be chosen by consensus of the LCB.

## **Membership**

### 14. LCB Membership

a) The LCB will consist of 16 people appointed by ICFA, five from each region, plus one Chair. Each region will recommend its members according to its own processes, for three-year terms. The members should represent all major stakeholders in the program, with appropriate balance within each region. The members should include the directors of the major particle physics laboratories, as well as at least one community representative from each region.

There will be a Board secretary.

b) The LCB Chair will be chosen by ICFA. The Chair should not be one of the laboratory directors as identified in (a) above.

## **Reporting to ICFA**

15. The LCB Chair will report regularly to ICFA about the state of the linear collider program, and progress towards its goals.

## **Revision of Mandate**

16. The mandate and goals of the LCB shall be reviewed by ICFA on a regular basis to determine if the purpose is being properly served and remains appropriate, or if the activity should be modified or terminated.

1 January 2016

**Membership of the Linear Collider Board**

Chair

Sachio Komamiya

Americas

Jonathan Bagger

The Fermilab Director (currently Nigel Lockyer)

David MacFarlane

Lia Merminga

Hugh Montgomery

Asia

Jie Gao

Rohini Godbole

Sunkee Kim

Masanori Yamauchi

Yifang Wang

Europe

The CERN Director-General (currently Fabiola Gianotti)

The DESY Director of Particle Physics (currently Joachim Mnich)

Francois Le Diberder

The JINR Director (currently Victor Matveev)

Lenny Rivkin

(Secretary: Roy Rubinstein)

## ILCSC/LCB Meeting

21 February 2013

TRIUMF

This was a combined final meeting of the ILCSC together with the first meeting of the new Linear Collider Board (LCB). A summary of the whole meeting is given here.

### 1. GDE Report

Barry Barish reported that an average cavity gradient of 37 MV/m has been achieved in vertical tests, surpassing the 35 MV/m goal. He discussed what will and will not be included in the TDR cost estimate. The official TDR completion will be on 12 June 2013 (“ILC Day”), and this will end the GDE mission. Barish said that the ILC is now ready for selection of a host country and site, and the formation of an international project.

### 2. Research Director’s Report

The Detailed Baseline Design (DBD) of the ILC detectors was described by Sakue Yamada; the ability of the detectors to study the properties of the 125 GeV Higgs-like particle will be included. Yamada said that both detectors are feasible and have demonstrated their capability to produce the desired physics with good accuracy, although more detailed engineering studies will still be needed.

### 3. TDR Cost Review

In early February 2013, a cost review of the TDR was held, and the review conclusions were summarized by its Chair, Norbert Holtkamp. He said that the TDR quality and costs are sufficient to begin negotiations among partners and governments; the costing methods are reasonable for a global project of this scale, and are similar to those of ITER, LHC, etc. Holtkamp listed several steps, not included in the TDR, needed before construction starts, and mentioned other items, including elements in the cost estimate, that still need to be refined.

### 4. “ILC Event”

The “ILC Event” will be held on 12 June 2013, in all three regions, to celebrate TDR completion, to highlight the ILC progress and future, and to expose a wider community to the ILC goals. Plans for the event were described by Brian Foster.

5. General Issues Working Group

Activities of the CLIC-ILC General Issues Working Group were discussed by Mike Harrison. The major emphasis has been on a comparison of the two approaches to a linear collider, particularly 500 GeV versions of each. CLIC has a lower slope of cost/GeV at higher energy, with the two costs approximately equal at 500 GeV.

6. Linear Collider Collaboration

The LCB approved Linear Collider Director Lyn Evans' choice of Hitoshi Murayama as Deputy Director, Mike Harrison as Associate Director for ILC, Steinar Stapnes as Associate Director for CLIC, and Hitoshi Yamamoto as Associate Director for Physics and Detectors. Each of the Associate Directors gave some initial thoughts on their roles and future goals.

7. Project Design Guidelines

Atsuto Suzuki reported on a study which describes a management model for the pre-ILC lab, and how to proceed towards the goal of an ILC lab.

## LCB Meeting

26 June 2013  
San Francisco

### 1. Linear Collider Overview

Linear Collider Director Lyn Evans discussed the Linear Collider Collaboration (LCC) organization; Brian Foster and Harry Weerts have joined as Regional Directors, and a search is underway for an Asian Regional Director. Among the LCC goals are to support construction of a staged ILC in Japan, to pursue CLIC R&D for a potential future multi-TeV machine, and to exploit the synergy between ILC and CLIC. Evans felt that his March 2013 meetings with the Japanese Prime Minister and other officials were very positive.

### 2. ILC Status

ILC activities were described by Mike Harrison. An ILC resource plan is currently being produced, and Harrison discussed the significant regional activities which relate to the ILC program. An important technical issue still remaining is the positron production system.

### 3. CLIC Status

Steinar Stapnes noted that the European Strategy listed CLIC as an option for a future energy frontier machine. Over the next few years, machine optimization studies will be carried out at 0.375, 1.5 and 3.0 TeV.

### 4. Linear Collider Detectors Status

The Linear Collider Physics and Detectors organization was described by Hitoshi Yamamoto; he commented that not all positions on the Executive Board are yet filled. Yamamoto is setting up a Physics and Detectors Advisory Panel, which would be somewhat analogous to the GDE-era IDAG.

### 5. "ILC Event"

Brian Foster reported on the very successful “ILC Event” held in Tokyo, CERN and Fermilab on 12 June 2013 to mark the completion of the ILC TDR.

6. LCC MOUs

There was a discussion on the MOUs needed for the LCC and for the common fund (provided by FALC) for LCC activities.



## LCB MEETING

20 February 2014

DESY

### ILC Activities

Lyn Evans reported that an independent international review of the candidate Japanese ILC site was held in July 2013, with the conclusion that the site was totally acceptable.

Mike Harrison described the organization of the ILC part of the Linear Collider Collaboration (LCC), and also the organization of the ILC Project Office at KEK led by Akira Yamamoto; these two parallel organizations will work together. The GDE baseline design will be maintained at present, with configuration control. There are no current plans for a cost update.

The implications of an energy-phased ILC were discussed by Harrison. The current LCC scenario is to start with a 250 GeV Higgs factory (integrating  $\sim 250 \text{ fb}^{-1}$ ), with later upgrades to 500 GeV in stages; technical extendibility to  $\sim 1 \text{ TeV}$  will be maintained. The tunnel will be built for 500 GeV.

### ILC Detector Activities

Hitoshi Yamamoto gave a possible detector timeline: assuming a “green light” in 2016, the 9-year ILC construction could start in 2018; the detectors would be ready for commissioning in 2027. Paul Grannis has been selected as Chair of the Physics and Detector Advisory Panel.

The LCC Physics and Detector organization has a working group on ILC parameters; it is discussing a scenario of 250 GeV running followed by 350 GeV then 550 GeV (there is significantly increased  $\text{ttH}$  yield at 550 GeV compared to 500 GeV).

### LCB Subcommittees

Two new LCB subcommittees will be set up, reported Sachio Komamiya. The first will be to produce recommendations for the ILC Lab structure, including such items as governance, project management, etc. The second Subcommittee is to propose an international agreement for the ILC Project; it will be a forum for the exchange of political information, and for consideration of the specific issues in each region/country.

Members of the ILC Project Advisory Committee (PAC) have been selected, but meetings will not be held until there is significant progress in the ILC design.

## LCB MEETING

6 July 2014  
Valencia, Spain

### 1. Linear Collider Overview

Lyn Evans gave an overview of the Linear Collider status. ATF2 has achieved a 45 nm beam; average maximum cavity gradients are 32.8 +- 4.9 MV/m, with average useable gradients of 29.3 +- 5.1 MV/m; there has been a breakthrough at Fermilab on Q0. Evans said that LCB needs to discuss the issue of ILC energy-staging. The Japan Science Council has requested a study of the ILC's scientific and economic impact, and the LCC will provide information through KEK. Evans said current LCC planning was to build the initial ILC tunnel for 500 GeV, and with the reference design of 500 GeV.

### 2. ILC Status

The KEK ILC project office is now operating. LCC is studying the tunnel layout as given in the TDR, and making site-specific modifications and modifications to meet Japanese regulations as well as also the regulations of visitors from other labs and countries.

### 3. CLIC Status

A plan for staged implementation of CLIC will be developed taking LHC results into consideration. A cost versus bunch charge relation will be produced for 360 GeV; a current estimate is 7-8 BSF for a 0.5 TeV CLIC. There is increasing interest in applications of CLIC technology to other fields such as light sources, and commercial 12 GHz klystron systems are becoming available.

### 4. Linear Collider Detector Status

The ILC Parameters Joint Working Group, which now includes ILC accelerator members, is preparing information on ILC parameters and several options for staging up to 500 GeV. A Physics and Detector Advisory Panel is being formed, with Paul Grannis as Chair.

### 5. Discussion on Current ILC Activities in Japan

MEXT has established an "Expert Committee" of 13 members to have meetings open to the public and to produce a report by 31 March 2016. This group will study total ILC cost, human resources, the Japanese domestic ILC organization, and the social and economic impact of the ILC in Japan. Good communication among LCC/LCB, the KEK ILC project office, and MEXT is essential for progress on a Japan-hosted ILC.

It was recognized that the particle physics community needs to have input on ILC staging and ILC parameters, and this should be a goal of the Belgrade LCWS in October 2014. To do this, LCC needs to provide a scenario to LCB so that it can then be provided to the community for initial discussion.

**LCB MEETING**  
26 February 2015  
Newport News, USA

Linear Collider Overview

Lyn Evans reported on LCC activities. A visit to the preferred site showed that there was much local enthusiasm for the ILC. Evans described several test facilities valuable for the ILC at labs around the world, while noting that all have uncertainties on their futures. He said that until a Japanese government decision on the ILC is made, some funding is still needed for ILC activities, and funding requests for this have been made to MEXT and to DOE.

ILC Accelerator Status

Akira Yamamoto noted the significant progress since the TDR in cavity gradient and IR spot size. ASTA reached the ILC specified gradient of 31.5 MV/m. ATF2 has reached a 44 nm spot size, close to the 37 nm goal; this latter number translates to 6 nm for the ILC.

Some design changes since the TDR have been made to optimize for the preferred site: a common  $L^*$  for both detectors; vertical access to the IR; a ~ 1.5 km extension of each accelerator tunnel for timing and redundancy; and searches for cost savings are ongoing. Yamamoto discussed the anticipated facilities worldwide which could contribute to the ILC construction; he noted that LCLS II and XFEL will be completed before ILC construction starts, giving much experience and confidence. There are ongoing discussions on whether the maximum initial ILC energy should be 550 GeV rather than 500 GeV, to improve top-Yukawa studies; this would add ~ 1% to the ILC cost.

Yamamoto described the MEXT organization for studying the ILC. It has been estimated that the ILC Lab will initially need ~ 100 staff members, eventually rising to ~ 1000.

CLIC Status

Steinar Stapnes gave a possible CLIC schedule, noting that three stages are under consideration:  $\sqrt{s} = 500, 1500$  and 3000 GeV, and he gave the timescales and power consumptions for each. Although there are only limited statistics, it appears that 100 MV/m is a realistic gradient.

Stapnes described the interest in X-band facilities for XFELs, and the increasing involvement of industry in X-band activities.

### Linear Collider Detector Activities

The LCC, reported Hitoshi Yamamoto, is making the ILC physics case for MEXT. A 500 GeV ILC will produce a factor of 3-10 smaller errors on Higgs physics (except for the photon channel) than the HL LHC. Yamamoto then discussed ILC running scenarios; the ILC Parameters Joint Working Group has come up with several scenarios.

Yamamoto is setting up a Physics and Detector Advisory Panel, chaired by Paul Grannis; a charge for the Panel is under discussion.

### PAC Meeting

There will be a Project Advisory Committee (PAC) meeting on 13/14 April at LAL, Orsay; a revised charge for the meeting was approved.

### Subcommittee 1 on Linear Collider Governance

Changes in the PIP document since the TDR were presented by Brian Foster; new information has been collected, especially from ESS and ITER, and the Okinawa Institute of Science and Technology has been a useful model for an international facility in Japan. Major changes to the PIP include: a mission statement has been added; a limited liability company option has been discarded as this entity does not exist in Japan; there are more details on the Council and management structure; and the duration of the agreement has been specified (~ 8 years construction and over 20 years operation). There are clear statements on contingency and the common fund, and on host responsibilities.

**LCB MEETING**  
19 August 2015  
Ljubljana, Slovenia

ILC Progress in Japan

There was extensive LCB discussion of a recently issued report “Summary of the International Linear Collider (ILC) Advisory Panel’s Discussions to Date” by a panel advising the Japanese government’s MEXT ministry. The Panel’s recommendations include the requirement to share costs internationally; the need for a clear vision on the discovery potential for new particles; the need to monitor closely LHC Run II data; the need to mitigate project cost risk; and the need to have public and science community understanding of the project. ICFA subsequently sent a short letter thanking the Panel, with a more detailed document to clarify some of the issues raised to be submitted by the end of 2016.

MEXT has asked the Japanese company Nomura to survey the technical feasibility of the ILC accelerator, the technical issues expected in mass production of components, and possible cost reduction efforts.

ILC Accelerator Status

Mike Harrison reported that Nomura is asking for LCC help in their new study, and the LCC’s recent document “The International Linear Collider Progress Report” was produced to help Nomura.

Harrison said that the only ILC technical issue not yet demonstrated is positron production; however, a conventional source is under development as a backup, although a conventional source provides zero polarization. A list of change requests to the TDR accelerator design was presented, and the status of decisions on each of them was given.

At ATF2, the IP beam size is almost as small as the ILC specification, although this is still at low intensity.

CLIC Status

The CLIC status and plans were described by Steinar Stapnes; a possible scenario is:

2013-2018: development phase

2018-2019: decisions

Preparation phase (4-5 years)

2024: construction start

Over the past year there have been studies of a first stage CLIC of  $E_{cm} = 380$  GeV for Higgs and top physics. CTF3 will close by the end of 2016. Many labs are interested in XFELs using X-band technology.

### Linear Collider Detector Status

Hitoshi Yamamoto reported that the H20 running scenario, previously approved by the LCB, is now the standard scenario, although the actual running scenario of an operating ILC will of course depend on LHC and ILC physics results. Two documents, "ILC Operating Scenarios" and "Physics Case for the International Linear Collider", are now standard ILC references.

### Subcommittee 1 on Linear Collider Governance

The LCC's Project Implementation Planning (PIP) document on governance of a future ILC lab was approved by the LCB; it is now publically available and available to Japanese government bodies dealing with the ILC. The document again notes that it expresses the views of scientists and is not meant to pre-empt the role of governments in setting the ILC governance policies.

### Reports

Presentations were made on linear collider activities in Asia, the Americas, and Europe.

**LCB MEETING**  
25 February 2016  
J-PARC

1. Announcement

Roy Rubinstein has stepped down as ICFA Secretary after 23 years in this position. Pushpa Bhat (Fermilab) has been appointed Secretary for a five-year term.

2. ILC Progress in Japan

Masa Yamauchi reported on MEXT's new panel on the human resources needed to construct the ILC, and also on KEK's "ILC Action Plan" (which describes an evolution plan for ILC construction). Activities to increase support in Japan for the ILC were described. Yamauchi said that KEK and the Japanese HEP community hope that ICFA continues its ILC commitment past the current LCB/LCC termination date of the end of 2016. The Japanese government decision on the ILC will not be made in the next one or two years, as it will wait for 13 TeV LHC results.

3. ILC Status

There are 3 ILC design-change requests under consideration, reported Mike Harrison; they are the movement of most cryogenics from the tunnel to the surface; the creation of 1.1 km tunnel free space for a possible electron-driven positron source; and a reduction in the thickness of the tunnel shielding wall. If both the second and third changes are carried out, the net cost change would be about zero. The second change would mean that there would be no personnel access to the klystron area when there is accelerator beam.

There is an ongoing study on reducing the operating temperature of 15 XFEL cavities from 2 K to 1.8 K, to see if this can lead to increased gradient and/or a reduced cryogenics load. Final XFEL cavity data are very close to ILC specifications. The Fermilab SRF program has shown that nitrogen-doping increases Q values by  $\sim \times 4$ , which could lead to smaller cavities operating at 2.6 GHz; there are also Fermilab studies underway on Nb<sub>3</sub>Sn and Nb-coated copper cavities.

Harrison reported on the positron target work at ANL, with qualitative success so far; if the CDR-design undulator positron source proves too difficult to realize, the fallback is a conventional electron-driven positron source.



#### 4. Linear Collider Detector Status

Hitoshi Yamamoto reported that his Physics and Detector Advisory Board, composed of Paul Grannis (Chair), Junji Haba and Sandro Palestini, had their first meeting in November 2015, and subsequently published a report on ILD, SiD, the CLIC detector, and R&D groups. The Physics Working Group has provided input to the document submitted to the MEXT Advisory Panel and is updating the ILC physics case. Yamamoto described the activities of the many Working and Concept groups, and noted that it is difficult to maintain momentum without a positive ILC statement from the Japanese government.

#### 5. Reports

Reports were presented on linear collider activities in the Americas, Asia, and Europe, and also on the status of CLIC.