REPORT OF THE EIGHTH MEETING OF THE ILC PROJECT ADVISORY COMMITTEE (PAC)

15/16 May 2012; Fermilab

Committee: Jon Bagger, Johns Hopkins; Jia-Er Chen, Beijing; Lyn Evans, CERN (Chair); Stuart Henderson, Fermilab; Katsunobu Oide, KEK; Roy Rubinstein, Fermilab (Secretary); John Seeman, SLAC

Apologies: Enrique Fernandez, Barcelona; Robert Orr, Toronto; Raj Pillay, TIFR; Hans Weise, DESY

1. Introduction

The ILC Project Advisory Committee (PAC) was formed in 2008 to assist the International Linear Collider Steering Committee (ILCSC) in the ILCSC's oversight of the ILC accelerator and detector designs. The PAC mandate is given in Appendix I.

The eighth meeting of the PAC took place on 15/16 May 2012 at Fermilab, and attendees were welcomed by Fermilab's director Pier Oddone. The PAC was very grateful to its hosts for their hospitality which made this meeting possible, enjoyable and productive. The meeting consisted of two days of presentations on the ILC accelerator status and plans and on the status and plans for the ILC detectors. The PAC thanked the leadership and the presenters of the ILC accelerator and detector organizations for all of their efforts which allowed this evaluation of their activities. The meeting agenda is given in Appendix II, and the presentations to the Committee are in Appendix III.

2. Accelerator Reports

A. Barry Barish noted that cavity yield at 35MV/m is now 70%, to be compared with 46% in 2008/9; 80% is expected by the end of 2012. The vertical test acceptance figure is 35 MV/m +-20%, with operation at 31.5 MV/m +-20%. FLASH test achievements are approaching those needed for the ILC, and the report on CesrTA tests is close to completion. Barish noted the new tunnel configuration in the recent Japanese ILC studies. Changes initiated by SB2009 should reduce costs of the changed systems by ~11% from the RDR estimates; Purchasing Power Parity (PPP) will be used to account for varying currency exchange rates in the TDR cost estimate.

Barish described the documents that will make up the TDR; the GDE will remain in existence during the TDR review process, until mid-2013. Post-2012, work will be needed for studies on

extending the ILC energy; further SCRF R&D; and system tests. The GDE is not introducing anything in the design that will preclude an upgrade to 1 TeV. A complete draft of the TDR will be available in December 2012 for cost and technical reviews, and the final version will be submitted to ILCSC at its June 2013 meeting. GDE will speak for the ILC until its successor organization is in place. Barish's presentation is in Attachment I.

B. Nick Walker (Attachment II) gave more details of the TDR contents, and also discussed the accelerator design changes made over the past few years, and the technical reviews that followed. The traveling focus scheme has been abandoned due to technical difficulties and risk; other improvements have gained back most of the same parameters. The BDS will have a reduced beta*; the number of bunches will be increased; and more klystrons will be added. For 1 TeV, two possibilities are under study, differing in the amounts of beamstrahlung. The site power has been capped at 300 MW. The DRFS klystron scheme has been dropped from the baseline design. The Marx modulator has been chosen. There is now a complete damping ring design, which includes full electron-cloud mitigation.

Walker said that the BDS and MDI designs will be compatible with later upgrading to 1 TeV. The detector halls will use CMS-type assembly for a flat site, while a mountain site will use ATLAS-type assembly. Walker noted that everything is on schedule for a draft TDR to be available for the December 2012 PAC meeting, with formal publication by the June 2013 Lepton-Photon Symposium and ILCSC meeting.

C. The sites under consideration were described by Marc Ross (Attachment III). The CERN site is similar to that discussed in the RDR; the Dubna site is cut and cover; Japan sites are in mountain regions. The Japan sites have a single-tunnel with a 3.5 meter heavy concrete divider. Ross noted in a discussion of RF systems that cavity gradient prediction is still not reliable for ~ 20% of the cavities, and single cavity control will be needed; more work is needed on this. Total site power will be 178 MW in the TDR, using the Klystron Cluster RF System. Ross said that the TDR will integrate the basic technical design, the flat topography design, and the mountain topography design.

D. Akira Yamamoto described SCRF industrial studies. The current cavity yield at 28 MV/m (20% below the operational 31.5 MV/m) is ~ 80%. Yamamoto gave the recent progress in cavity R&D. The KEK-00 has all but 1 cell over 40 MV/m. Solutions to tuner problems have been found, and the blade tuner has been selected. Yamamoto described communications with industry on SCRF cavities; 16 companies were visited, and 6 were selected (with contracts) to provide more detailed information. Some confidential cost estimates have been obtained from manufacturers. Work still needed includes cavity input coupler costs; assembly and test plans for cryomodules; and guidelines for mass production, including the use of single or multiple vendors. Yamamoto's presentation is in Attachment IV.

E. Siting studies were discussed by Vic Kuchler (Attachment V). For the RDR, there were sample sites without site-specific geology investigations. Currently, the European and Americas sample sites are still being used, and now there are two candidate Asian sites. The Klystron Cluster System is still the HLRF choice for the European and Americas sites (klystrons and

cryogenics on the surface, with vertical shafts), while the Distributed Klystron System is the choice for the Asian mountain topography sites (klystrons in the main linac tunnel, and cryogenic equipment in caverns adjacent to the tunnel; access tunnels are horizontal downwardly inclined). For the Japan sites, there is a single access tunnel to damping rings and detectors, and minimal surface building presence except for the detector assembly hall.

F. The current status of accelerator costing was given by Gerry Dugan. TDR costs will be in 2012 ILCUs where 1 ILCU will be equal to 1 US$ on 1 January 2012; this will be related to other currencies using PPP conversions. About 70% of the TDR cost estimate will be new, with the rest based upon RDR costs. Dugan gave the changes to the RDR costs for various accelerator systems, and some comparisons between conventional facility costs in the three regions. For the cryomodule costs, new information is expected by early summer 2012. Manpower estimates are expected to be similar to those of the RDR. Dugan felt that the cost estimate was well underway for completion in the TDR; there will be a major cost reduction in conventional facilities from the RDR estimate.

G. Jim Kerby (Attachment VI) discussed Main Linac SCRF R&D. He said that 2nd pass yields are now over 80%, so far with chemical polishing, but mechanical polishing is now being studied more. A new world record peak surface magnetic field (2127 Oe) was achieved at KEK in a 2-cell cavity which reached 50 MV/m. Kerby gave the issues to be overcome in reaching 45 MV/m in post-TDR R&D.

Kerby described cryomodule system tests in the 3 regions, including details of the tuner problems in the S1 Global test, and the post-mortem on the Fermilab CM1 tests. In answers to questions he said that all CM2 cavities have exceeded 35 MV/m vertical and 31.5 MV/m horizontal. More powerful motors are being studied for blade tuners.

H. The status of FLASH tests was given by John Carwardine. He discussed the topics, machine conditions and key results from the 1 week of studies in February 2012. All cavity gradients were flat to +-0.3%, and cavities were run with beam 5-10% from quench. There are 2 proposals for how to ramp to full current and full pulse length without quenching. Carwardine said that 6 mA 800 microseconds was demonstrated, while 9 mA 800 microseconds was marginally achieved. Pulse stability better than 0.02% was achieved. Other achievements were average gradient of 29 MV/m; flat gradient to +-0.3%; klystron operation with beam within 7% of saturation; and Lorenz force compensation on all cavities simultaneously. Carwardine said that there will be another study period in September 2012. His presentation is in Attachment VII.

I. Toshiaki Tauchi gave an update on the ATF2 status (Attachment VIII), including the achievements up to now and the goals for 2012 and 2013. In the February 2012 run, the vertical beam size at the IP was reduced to 165 nm, with the goal still 35 nm; Tauchi discussed the other modifications to equipment made at that time. There will be another dedicated beam tuning period in October, November and December 2012.

J. The CesrTA final report was given by Mark Palmer. He gave the major results on electron-cloud studies; low-emittance operation; and electron-cloud-induced beam dynamics at ultra-low emittance. Palmer noted that this work has been incorporated into the damping ring conceptual design. A report on CesrTA Phase I is close to completion. Palmer gave a list of electron-cloud mitigations for different machine elements, together with simulations, comparisons of simulations and data, and recommendations for damping ring beam chambers. High-power ILC operation is under study, with the goal to avoid needing a second positron damping ring. The three-year CesrTA Phase II program is now underway. Palmer's presentation is in Attachment IX.

3. **Detector Reports**

A. Sakue Yamada gave the Research Director's report (Attachment X), with emphasis on the plans and status of the DBD; an interim report was completed in 2011, and provided many lessons for the DBD. The DBD target date is still the end of 2012. The DBD will have two volumes: a physics case for the ILC, and a detector and simulation volume; expected readers will be particle physicists and members of related fields. Each detector group will write its own detector description, R&D activities, and cost estimate. IDAG is monitoring DBD preparations by both detector groups and the Common Task groups. The DBD will show that present technology can be used to build the detectors and do the physics; the primary goal will be to achieve a robust design for 500 GeV physics, and then present results from the study of the new 1 TeV benchmarks.

Yamada commented on the post-2012 linear collider organization where the Physics and Detector section will include current ILC and CLIC activities. The detectors for the two machines are different in energy range, R&D stage, and other requirements necessitated by the accelerator differences, and Yamada raised the question of how rapidly the two activities could be merged. He also commented that it would be valuable for the new organization to have some common funds.

In the following discussion, it was noted that the ILC and CLIC detector groups have been cooperating on MDI; the MDI group is strong, and will work on the write-up of the IR for the TDR.

B. A report on the SiD detector was given by Marty Breidenbach. The current cost estimate is ~ US$400M for materials and services, including contingency. Breidenbach described, for each detector subsystem, the critical R&D still needed for it, the R&D timeline, the R&D results expected to be in the DBD, and the participating institutions. He noted the lack sufficient funding for R&D. Breidenbach's presentation is in Attachment XI.

C. Graham Wilson discussed the ILD detector (Attachment XII), and the recent progress on each subsystem, together with the remaining subsystem options. He noted the common issue of power pulsing, which is essential for many sub-detectors. Work on costing is still ongoing, with

a current estimate of ~ 470 MILCU. Wilson said that the ILD part of the DBD will be produced on time.

D. Detector collaboration with CLIC was covered by Juan Fuster. The CLIC versions of ILD and SiD are similar to the ILC versions, modified for the CLIC higher energy, different bunch spacing, and different backgrounds; the tracking and EM calorimeters are unchanged. There was collaboration on the 2011 CLIC CDR, and now collaboration on the DBD (some CLIC detector people are editors of the DBD). Fuster noted the ongoing discussions on the post-2012 linear collider organization; there needs to be flexibility to allow for the needs each of the ILC and CLIC groups, and there needs to be a solution acceptable to the majority of the community even if it is not perfect. Fuster's presentation is in Attachment XIII.

5. **PAC Summary and Recommendations**

Accelerator

1. The PAC feels that the GDE work is progressing well, and will lead to a valuable, high quality, TDR; keeping up the momentum afterwards is recognized as being significantly more difficult.
2. The R&D still needed is in general aligned with the needs of the major labs, particularly DESY and Fermilab. A concern is that R&D on high-gradient cavities, particularly in the US, may not be supported at the ILC-needed level.
3. Currently, the cavity yield at goal gradient is ~ 80%, rather than the desired 90%. The PAC encourages continued R&D on this after submission of the TDR.
4. The Committee is concerned that cavity tuners have not reached the ultra-high level of reliability required for the ILC; the PAC recommends more study and a focused program to achieve the necessary reliability.
5. The need to work on design for a mountainous topography site as well as a relatively flat site is being handled by the GDE as well as can be expected, and needs to continue to TDR completion.
6. It is important to maintain the DESY cavity database, and the Committee appreciates DESY's support of this.
7. The FLASH and CesrTA studies have been of very high quality, and are essential to the design of the ILC.
8. The PAC is impressed with the costing effort, which appears to be using all available information. Based upon LHC experience, the Committee advises not to use a single vendor for any large production order, even if the single-vendor price is lower than using multiple vendors.

Detectors

1. The PAC is pleased that both detector collaborations are on track to produce the DBD by the end of 2012. The Committee heard of some concerns by these collaborations about the future linear collider organization, and recommends that ILCSC take note of this.

6. **Next PAC Meeting**

The next PAC meeting will be take place at KEK on 13/14 December 2012.

Appendix I

ILC Project Advisory Committee (PAC) Mandate

1. The International Linear Collider Steering Committee (ILCSC) is responsible for the oversight of the Global Design Effort (GDE) activities and of the ILC experimental program.

2. PAC will assist ILCSC in this function and report to the ILCSC.

3. PAC will review the GDE accelerator activities and, in addition, the ILC detector activities.

4. In its review activity, PAC will examine the overall consistency and realism of the project, in relation to physics, technical design, cost, and schedule.

5. PAC shall comprise about nine members, appointed by the ILCSC for terms of two or three years, and will meet a few times per year until the completion of the Technical Design Phases I and II.

6. The PAC Chair will be appointed by the ILCSC, normally for a two-year term.

Appendix II

PAC Review

Fermilab
15/16 May 2012

Tuesday 15 May

08:30	Executive Session	(30)	
09:00	GDE Director's Report	(25+5)	B. Barish
09:30	TDR Baseline Reviews and Decisions	(50+20)	N. Walker/M. Ross
10:40	Break	(15)	
10:55	Accelerator Costing	(40+15)	G. Dugan
11:50	Executive Session	(70)	
13:00	Lunch	(60)	
14:00	SRF Industrial Studies	(25+10)	A. Yamamoto
14:35	SRF RD Summary	(20+5)	J. Kerby
15:00	SRF System Tests	(20+5)	J. Carwardine
15:25	Break	(15)	
15:40	CFS Siting Studies	(15+5)	V. Kuchler
16:00	ATF2 update	(15+5)	T. Tauchi
16:20	CesrTA Final Report	(20+5)	M. Palmer
16:45	Executive Session	(105)	
18:30	Dinner		

Wednesday 16 May

09:00	Research Director's Report	(50+10)	S. Yamada
10:00	SiD	(40+10)	M. Breidenbach
10:50	Break	(15)	
11:05	ILD	(40+10)	G. Wilson
11:55	Detector Collaboration with CLIC	(20+5)	J. Fuster
12:20	Lunch	(60)	
13:20	Executive Session	(60)	
14:20	Closeout	(45)	
15:05	End		

Appendix III

The Attachments are available at
http://www.fnal.gov/directorate/ILCPAC/May2012/Attachments.html