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

11/12 November 2010; Eugene, OR, USA

Committee: Jean-Eudes Augustin, Paris; Jon Bagger, Johns Hopkins (ILCSC Chair—ex officio); Lyn Evans, CERN (Chair); Stuart Henderson, Fermilab; Steve Holmes, Fermilab; Akira Masaike, Kyoto; Robert Orr, Toronto; Roy Rubinstein, Fermilab (Secretary); Masakazu Yoshioka, KEK.

Apologies: Katsunobu Oide, KEK; Raj Pillay, TIFR

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 fifth meeting of the PAC took place on 11/12 November 2010 at the University of Oregon, Eugene, OR, USA. The PAC is very grateful to the University of Oregon staff for their excellent hospitality which made this meeting possible. The meeting consisted of two days of presentations on the ILC detectors status and plans and on the status and plans for the ILC accelerator. The presenters and the leadership of the ILC accelerator and detector efforts were thanked by the PAC for all of their work 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. Detector Reports Presented to the PAC Meeting

A. Research Director Sakue Yamada reviewed the status of the two ILC detectors, noting that the purpose of the 2012 Detailed Baseline Designs was to show that the detectors can be built and can produce the desired physics. There is good progress on detector component R&D, but the budget situation is unstable, and reducing. Engineering support is also insufficient or missing, and no response has yet been received on the request to ILCSC and the major labs for additional engineering assistance. In addition, the available human resources are also diminishing, due to funding reductions. With reduced resources, some of the work will consequently have to be reduced.

Yamada described the activities of the Common Task Groups. On MDI, he noted that CLIC has now adopted the push-pull scheme, and Yamada hopes that there will be a common push-pull solution for both ILD and SiD. There will be a draft Interim Report to ILCSC's February 2011 meeting, which will also be made available to the community. The detector community is asking what will happen after 2012 to the detector R&D and to the whole ILC project. The CPDG document is welcomed, and the two detector groups are planning to organize comments on it. Yamada's presentation is in Attachment I.

In answer to questions, Yamada said that many experimentalists are working on both CLIC and ILIC detectors, but this dual activity isn't always possible for students, and people on LHC experiments do not have extra time at present for ILC activities. He also reminded the PAC that all ILC detector activity is voluntary.

B. The status of ILD was presented by Graham Wilson (Attachment II). He gave the collaboration's goals through 2012, and the detector funding status in the three regions; manpower is critical for all parts of the detector. The goal is to make sure that there is at least one feasible/ready option for each detector component by the 2012 report. Wilson reported that particle flow is now well-established (especially through the ongoing CALICE work), and is of interest to other parts of the particle physics community.

Following PAC questions, Wilson noted that the collaboration with CLIC is very positive. The BCD will describe a feasible detector, but R&D will still be required after 2012.

C. Andy White gave the status of SiD. There are very limited resources available for the needed work. SiD is developing a relationship with CLIC_SiD; CLIC wanted to start detector work quickly, and took over much of the SiD design. White described the status of each SiD subsystem. He said that the SiD DBD is still being defined, and the collaboration is very interested in what will happen after 2012. White's report is in Attachment III.

D. The IDAG report (Attachment IV) was given by Michel Davier via speakerphone. IDAG is monitoring the activities of the Common Task Groups, the progress of both detectors, and the detector R&D progress. Davier gave the DBD guidelines, and said that the report of each detector should not exceed 150 pages. He said that IDAG recommended that the detector costing use common methods and common unit costs for both detectors; he noted that the Research Director has now set up a common costing group. Davier then described the status of each detector and the status of detector collaboration with CLIC. The CLIC detector concepts are based on ILD and SiD, and there is CERN engineering help on hall layout and push-pull design. IDAG felt that CLIC and ILC detectors need to benchmark 1 TeV simulations. Overall, the collaboration with CLIC is positive.

On the push-pull issue, Davier said that it was important that the two detectors reach convergence, so that GDE planning can proceed. On detector R&D, he noted the very impressive work done by the R&D collaborations, although the ongoing situation is worrying because of the decreasing level of funding. In many areas, there are applications of ILC detector R&D outside ILC, and a document describing this would be very valuable. It is essential to convince funding

agencies that long-term detector R&D support is essential for the field, and also provides very valuable spin-offs.

3. **Accelerator Reports Presented to the PAC Meeting**

A. Barry Barish gave the GDE project status (Attachment V). He first showed a 2009-2012 resource table, noting that most funding and FTEs were allocated to SCRF. The 2012 TDR should be as close as possible to "construction project ready", and the goal is for cost containment to compensate for cost growth since the RDR. The goal of demonstrating 50% cavity yield by 2010 has been achieved. He briefly described the achievements of the accelerator tests on FLASH, ATF, and CesrTA.

Barish discussed the change control process now in place, and distributed two reports (Attachments VI and VII) on change control approvals for the operating gradient and the single tunnel. For the single tunnel, there are 2 proposed RF systems, with a backup RDR-like rf system applicable for a single tunnel.

By the end of 2012, there will be the TDR and a Project Implementation Plan. The TDR will have an updated value estimate with optimized cost/performance/risk, and a supporting R&D program. The goal is to be ready to propose a "Construction Project" to governments at any time after 2012.

After publication and reviews of the TDR in 2012/13, the GDE will have completed its mandate; after that, there will still be SCRF system tests, mass production, value engineering, 1TeV, positron source and other issues to still consider; also ongoing R&D could lead to major technical advances. Whatever organization for ILC comes into being after 2012, GDE-like global decision-making and coordination must be preserved. GDE will give a formal response to the CPDG proposals soon.

Barish summarized by saying that production of the TDR, accompanied by a PIP, is on track for the end of 2012; there is broad collaboration with CLIC; and planning for after 2012 is crucial, as it will be difficult to keep support for the project in the period after 2012 until a decision on construction is made.

During questions following Barish's presentation, it was commented that having a central GDE team after 2012 is crucial. There will be an interim GDE report in the next 6 months.

B. A report on SCRF progress since the previous PAC meeting was given by Akira Yamamoto; he noted that the 600-cavity production order for the XFEL had been placed. Yamamoto said that the Fermilab NML CM1 cryomodule cooldown was about to start, and MHI-12 at KEK reached 37.5 MV/m on the first pass. The goal of 50% yield at 35 MV/m has been reached; JLab has had an 81% yield, and 9 out of 10 ACCEL/RI cavities have exceeded 35 MV/m. Yamamoto described the S1 global test, where eight 9-cell cavities in the S1 global

cryomodule reached an average field gradient of 28 MV/m. A field gradient reduction of 7% has been observed in comparison with the 30 MV/m average individual vertical test results previously obtained at DESY, Fermilab and KEK. DRFS will be demonstrated in the S1 global test.

With a vertical cavity gradient of 35 MV/m, and a 28-42 MV/m allowed spread, this should give an operational 31.5 MV/m average, and a spread of 25-38 MV/m. Yamamoto gave the RF capacity requirements to accommodate this spread. His presentation is in Attachment VIII.

C. Eckhard Elsen gave an update on the XFEL status (Attachment IX). There will be 640 accelerating cavities, expected to operate at a conservative 24.3 MV/m, which sets the linac length; individual cavity performance limits are expected to exceed this. The cavities will be fed by 20 RF stations of 5.2 MW each. Cavity production will be in industry, following detailed instructions and with no performance guarantees. There are 2 schemes for final surface treatment—final EP and flash BCP; some tooling and the Nb/NbTi will come from DESY. Each of the two companies will produce 8 pre-series cavities and 280 XFEL cavities. An additional 80 cavities will be subsequently ordered as an option. Each of the initial contracts is almost 25 MEuros. XFEL cryostats will be produced by 3 vendors. Elsen said that performance specifications as a vendor requirement for the cavities were abandoned because of the high cost. He described the additional procedures that will be needed for ILC-quality cavities.

D. Cavity industrialization options were described by Akira Yamamoto. The plug-compatibility concept is now in use in the R&D phase, and how this can be accommodated in the construction phase is now under consideration. In preparing for industrialization, GDE is learning from TESLA and XFEL. Yamamoto gave details of the KEK pilot plant for industrialization R&D. GDE personnel have made visits to manufacturers, and will prepare ILC cavity and cryomodule specs before asking for responses from vendors.

A possible production scale for a vendor could be 4000 to 8000 cavities (i.e. 25-50% of the total), with a time scale of 2 years (pre-series) and 5-6 years (main production). The industrialization study should determine what part of the industrialization will be the responsibility of the vendors and what will be lab responsibility. Yamamoto gave some possible models of industrialization, assuming a construction period ~twice that of XFEL. Yamamoto's report is in Attachment X.

During the discussion after Yamamoto's presentation, it was commented that the cost of the XFEL cavities is very high compared to the cost of equipment of equivalent complexity in the LHC. It was suggested that the industrialization model developed for the LHC be studied and a new cost estimate made for cavities built according to this model.

E. Wei Gai described undulator-based ILC positron source performance (Attachment XI), using a SC helical undulator and a 0.4 radiation length Ti target; the goal is to achieve 1.5 positrons per electron. The target prototype design and testing was completed at Cockcroft. Gai said that the study predicted yields, polarization and energy deposition as functions of the undulator length and strength, and with capture by a flux concentrator or by a quarter wave

transformer. For polarization, a key is collimation technology development. For SB2009, with the low-energy option, a new undulator may simplify the system.

F. Positron source technology was discussed by Jeff Gronberg. A 4 metre undulator unit (0.86T) has been designed and prototyped, and the prototype has been operating very well. A prototype target has also been a success, and a photon collimator has been designed. LLNL is designing and building a prototype II target including flux concentrator, and Gronberg gave the prototyping plan. Alternate positron sources, using different targets, different undulators and different types of source are also under consideration. Gronberg's presentation is in Attachment XII.

G. Marc Ross (Attachment XIII) described the ongoing R&D programs at FLASH, ATF and CesrTA; he gave the goals of each and said that enough R&D will be carried out to demonstrate the needed technical features.

The tests at FLASH have demonstrated 0.5% peak to peak energy deviation within a pulse, and 0.13% pulse to pulse. Ross described the accomplishments so far, and what additional work needs to be done during the next ~ 1 year.

On CesrTA, studies have been made of the development of an electron cloud, the interaction between the beam and the cloud, and the beam instability and emittance growth characteristics; Ross described the results so far. 100 days of studies have been requested for FY11 and FY12,

At ATF2, a vertical emmittance of 12 pm has been achieved, which should give a sigma-y* of 110 nm, although 310+-30 nm has been achieved so far. Ross felt that there is good progress towards 35 nm sigma-y* in 2011. There is some uncertainty about the future of ATF past 2013.

3. **Presentations on Common Detector/Accelerator Issues**

A. The SB2009 proposals viewed from the accelerator were discussed by Nick Walker. He reviewed the major proposals, and noted the major potential physics impacts, which were due to the reduced beam power and the move of the positron source. The single tunnel and the accelerating gradient were discussed at BAW-1 in September 2010, and the reduced bunch number and the positron source location will be discussed at BAW-2 in January 2011. Walker noted the two RF possibilities for the single tunnel (DRFS and KCS), and described their current status; he also noted the backup RF system, which is similar to that described in the RDR and also is similar to the XFEL system.

Walker said that the luminosity reduction caused by the reduction in the number of bunches could be regained by stronger IP focusing. He noted that GDE is working with the physics/detector groups on all SB2009 issues, and more attention is being paid to the low energy parameters. Walker's report is given in Attachment XIV.

B. A report on the SB2009 proposals viewed from the detectors was given by Jim Brau (Attachment XV). He noted that the RDR accelerator design met the ILCSC physics requirements, while there were difficulties in meeting these requirements with the original SB2009 proposals. New ILC accelerator parameters were recently made available, and their impact has been under study by the detector organization. Brau said that the recent accelerator design changes have significantly restored the ILC physics potential relative to the original SB2009 proposal, and with the assumption of a traveling focus the Higgs mass and cross section are improved even over the RDR. This arises from improved luminosity and reduced beam energy spread at 250 GeV relative to the RDR. The impact of the luminosity reduction at the highest energies is still under study, although a traveling focus could alleviate the reduction.

Brau reviewed the physics case for positron polarization, noting that it is important for cm energies below 500 GeV. He said that the detector community was pleased with their recent interactions with the GDE on SB2009 and the resulting feedback.

Following Brau's presentation, it was commented that positron polarization was initially considered a byproduct by the GDE; if it is essential, then more effort needs to put on the undulator and collimator design.

C. Karsten Buesser described the current status of the Machine-Detector Interface (MDI); his presentation is in Attachment XVI. He said that a detailed study needs ~ 14.5 FTEs, while only ~ 9.25 are currently available. One important question is how to combine the requirements of ILD (platform-based design) and SiD (rollers on rails); a decision will need to be taken in 2011. The final ILC site will impact the collision hall design (e.g. vertical or horizontal access to the IR). Buesser noted that MDI and push-pull work is also ongoing at CLIC, with obvious synergies.

D. Accelerator collaboration with CLIC was discussed by Mike Harrison. He described the working groups set up in 2008, which are now mature and functioning well, and noted that the amount of interaction on a specific topic depends on the technical overlap on the topic between the two projects. A survey of the collaboration working groups resulted in all saying that the collaboration was positive. Harrison said that there would probably be too many compromises needed to stage from a 500 GeV ILC to a 3 TeV CLIC. Cost comparisons between ILC and CLIC should be carried out by the joint Cost and Schedule Working Group. In the future there should be one linear collider community supporting a well-conceived global project; with the reorganization of GDE after 2012, there is the possibility of realigning the global linear collider program. Harrison's report is in Attachment XVII.

E. Francois Richard discussed detector collaboration with CLIC (Attachment XVIII). Collaborations between detector physicists on both projects take place spontaneously. CERN is encouraging creation of a common CLIC-ILC project to facilitate strategy driven by LHC/Tevatron results. Currently, there is a large participation by ILC detector experts in the CLIC CDR, and ILC would like to see the flow reverse after the CDR, with CLIC participation in the ILC detector DBDs. So far CLIC is benefitting from the ILC, but this weakens the ILC effort towards the DBDs, and IDAG has noted this problem.

Richard said that it would be possible to build detectors for ILC that would be CLIC compatible, but they would be larger and more costly than needed for ILC alone.

F. Physics issues for the ILC were presented by Michael Peskin, and given in Attachment XIX. He described the basic elements of the ILC physics program, with a key question being what energy e+e- collider is needed to follow up on LHC discoveries. A tight focus on 500 GeV could be a disadvantage, as the question will always arise about eventually going to higher energies. Nevertheless, even if LHC discoveries come only after 2013, and involve new particles of mass greater than 1 TeV, Peskin felt that the ILC program will be very rich and will address questions raised by the LHC.

4. PAC Summary and Recommendations

A. General

1. The PAC is very impressed by the progress made in both accelerator and detector areas since the previous PAC meeting; the Committee thanked the speakers for the high quality of their presentations.
2. It is important that consideration be given by ILCSC, GDE and RD to maintaining global coherence of the ILC accelerator and detector R&D efforts past the 2012 design report.
3. The ILC-CLIC collaborative activities in both the accelerator and detectors are growing, and the PAC views this positively.

B. Detectors

1. IDAG is performing a very important function, reporting on the status of the detectors and also pressing for coherence between the two detector collaborations. The Committee was pleased to hear in the IDAG report that both collaborations are on track to produce Detailed Baseline Detector Designs in 2012.
2. The examples given by IDAG of applications derived from ILC detector R&D to other fields are impressive, and should documented for wider distribution.
3. The loss of personnel working on detector R&D and design to other projects is a cause for serious concern.
4. The PAC is concerned that no reply has yet been received from CERN to the request to coordinate among labs additional engineering help for the detector designs and the push-pull system.

C. Accelerator

1. The PAC is very pleased to note that the GDE's approach to cavity production in the ILC construction phase intends to follow the successful example of the LHC in the industrialization of complex superconducting components, rather than that of the much smaller-scale XFEL project.
2. The PAC is very impressed by the recent progress on SCRF cavity gradients; 9 out of 10 cavities from one manufacturer meeting the nominal ILC gradient requirement is an outstanding achievement.
3. There is a need to pay attention to the issue of field emission in the SCRF cavities.
4. The Committee is impressed with the progress made so far on the R&D programs at existing accelerator facilities.

a) The FLASH 9 ma experiment is a good demonstration that the ILC accelerator parameter goals are realistic. The PAC recommends that ILCSC make efforts to ensure that the needed future FLASH beam time becomes available.
b) ATF has achieved success with the fast kicker performance reaching ILC requirements; the small beam size goal is still to be achieved.
c) The CesrTA program on electron cloud studies is excellent, and is also very valuable for accelerators other than the ILC. It is essential that simulation codes are benchmarked against experimental data before the end of this program.

5. The PAC endorses the methodology for GDE design change control which is now in place, and which appears to be working well. The Committee also notes positively the membership of a detector physicist on the GDE Change Evaluation Panel.
6. The PAC sees significant progress in addressing the issues raised by the SB2009 proposals, including progress towards resolution of several hardware questions following from the proposals. The Committee is gratified to observe the greatly improved collaboration with the detector community in SB2009 discussions.
7. At the previous PAC meeting, the Committee was concerned with the lack of progress on positron source issues, but is pleased that this lacuna now appears to be well covered. There seems to be increased interest within the detector community in the additional physics that can be realized with polarization of the ILC positron beam.

5. **Next PAC Meeting**

The next PAC meeting will be take place at Academia Sinica, Taipei, Taiwan, on 19/20 May 2011.

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

Eugene, OR, USA
11/12 November 2010

Thursday 11 November

08:00	Executive Session			
08:45	Research Director's Report		(45+15)	S. Yamada
09:45	ILD		(30+10)	G. Wilson
10:25	Break			
10:45	SiD		(30+10)	A. White
11:25	IDAG		(30+10)	M. Davier
12:05	Executive Session			
13:00	Lunch			
14:00	GDE Director's Report		(45+15)	B. Barish
15:00	SCRF R&D		(45+15)	A. Yamamoto
16:00	Break			
16:15	XFEL Update		(20+10)	E. Elsen
16:45	Cavity Industrialization Options		(30+10)	A. Yamamoto
17:25	Positron Source---Technology R&D		(20+10)	J. Gronberg
17:55	Positron Source---System Performance		(20+10)	W. Gai
18:25	Executive Session			
19:45	Dinner			

Friday 12 November

08:00	R&D Programs at FLASH, ATF, CesrTA		(45+15)	M. Ross
09:00	SB2009	a) Accelerator	(20+10)	N. Walker
		b) Detectors	(20+10)	J. Brau
10:00	Break			
10:15	MDI		(35+10)	K. Buesser
11:00	Collaboration with CLIC	a) Accelerator	(20+10)	M. Harrison
		b) Detectors	(20+10)	F. Richard
12:00	ILC Physics Prospects		(30+10)	M. Peskin
12:40	Lunch			
13:30	Executive Session			
14:30	Closeout			
15:15	End			

Appendix III

The Attachments, including the presentations made to the PAC, are available at
http://www.fnal.gov/directorate/ILCPAC/ILCPACNov2010/AttachmentsILCPACNov2010.htm