September 19, 2006

To: **Distribution**
From: **GDE Change Control Board**
Subject: **Response to the Change Request (August 4, 2006) for the BCD Damping Ring Section**

Preamble

This is the CCB response to the proposed changes to apply to the Damping Ring section of the June 2006 version of GDE ILC Baseline Configuration Document [1]. CCB received the change configuration request (CCR) from A.Wolski on August 3, 2006 and CCB forwarded it to GDE the next day [2]. This Change

Request was treated as Class-2. D.Schulte, K.Kubo, M.Kuriki and N.Toge were assigned as the CCB reviewers. CCB requested remarks from the GDE Cost Engineers concerning cost implications, whose responses is attached in the Appendix. CCB hearing on the cost implications of this change request was held via phone and webex on Sep. 8, 2006 [15].

Summary

Requester proposed:

1. To eliminate the second positron damping ring, so that the damping rings system would consist simply of two rings with circumferences roughly 6.7km (one ring for electrons, and one for positrons) and the associated injection and extraction lines. All other specifications would remain the same..

2. To simplify the text of the Damping Ring section of BCD. Only the initial summary, updated to reflect changes from the original baseline configuration, has been retained. Instead of the detailed discussion and justification for the configuration choices, a reference is given to the report form which the text was originally taken.

Item 1 in this change request, according to the requesters, is expected to reduce the construction and operation cost of ILC substantially. The requesters also stated that technical benefits from the simplification of the injection and extraction systems are expected. The requesters noted that with the notion of technical risks associated with the removal of one positron ring, in connection with the electron cloud effect, this new baseline does not preclude a later upgrade to the two-ring configuration. The requesters emphasized that R&D into mitigation techniques for electron cloud effects must be continued as a very high priority.

CCB response:

1. **CCB agrees that the cost change (in this case, reduction) expected from this change request is substantial, such that it qualifies as Class-2. Consequently, CCB assumes that its role concerning this change request is to assess its merits and make a recommendation to EC, rather than to make a final configuration**

change decision.

2. **CCB recommends EC to adopt this change request as is, for reasons detailed below in the Discussion section.**
3. **CCB will encourage the relevant parties, and will work with them, to update the "Parameters and Layout" section of BCD in accordance with the updated damping ring population.**
4. **CCB notes the need for conducting systematic R&D associated with the vacuum chamber system, simulation and validation of all mitigation techniques for electron cloud effects. CCB recognizes that the GDE R&D board is currently in the process of evaluating, organizing and facilitating these research programs. CCB recommends that the GDE Executive Committee create an effective review process by which the progress of such R&D efforts can be evaluated so as to reconfirm the adequacy of the baseline design at appropriate intervals. This applies equally to other design development issues with the damping ring baseline, such as the 650MHz RF and fast kickers, as well as to other systems such as high-gradient SRF cavities or extraction magnets in the beam delivery sections.**

Discussion:

Beam Dynamics Issues:

1. The two-ring configuration was previously chosen for the baseline to address the concerns over electron cloud [3, 4] effects at the positron damping ring.
2. Findings from recent studies are as follows. New results on electron cloud effects, including simulation and experimental studies were discussed at the Vancouver GDE meeting [17]. Two new techniques for reducing the electron cloud density in the vacuum chambers have been studied:
   - Use of grooved chamber surfaces: Secondary electron yield was found to be significantly reduced with grooved chamber surfaces [5, 6, 7, 8] in field-free conditions in laboratory environments, and simulations indicate promising prospects for environments inside magnets. Tests in an accelerator environment are planned at PEP-II [9]. Impedance of vacuum chambers with grooved surfaces have also been examined [9].
   - Use of cleaning electrodes: Simulation studies have been performed [8] and possible designs of electrodes have been considered [8, 10, 11], which are also expected to significantly reduce the electron cloud density. Issues with the RF heating of electrodes in the presence of beam, additional impedance that can arise from the electrodes, and generation (or absorption) of high-order modes [12] are noted.
3. CCB assessment
   - CCB agrees that theoretical studies so far, together with simulations with simple models, show that the techniques based on grooved chambers or cleaning electrodes will reduce the electron cloud density to the level acceptable for a single positron ring configuration at ILC, if they function as expected. CCB understands that an increase of the resistive wall impedance is at an acceptable level.
   - CCB notes that the experimental validation of the proposed techniques are, however, yet to

be established in a accelerator ring environment that resembles that of ILC damping rings.

- CCB, therefore, feels that from a technical standpoint adoption of the proposed configuration change, if it is to be approved, is critically contingent upon the following two conditions:
  - To carry out R&D and experimental validation, with clear timelines, of the techniques for reducing the electron cloud densities.
  - To maintain the provisions for reverting to the dual positron ring system in the baseline configuration.

Additional System Issues:

1. The DR configuration in the current BCD[1] has been designed to cure possible beam instability issues, and in order to bring the positron side design on a safe side, it ended up with an asymmetric layout of one-electron plus two-positron rings. Since the two positron DRs in the present BC are assumed to be *always* operational, this poses a certain additional demand on the system availability for the entire DR system, both in terms of hardware operation of the rings as well as injection and extraction systems. The proposed CCR lessens this burden substantially.
2. This CCR does not make any additional constraints on the global operation synchronization issue, which was discussed by a task force earlier in 2006 [3]. The only technical revision to take place with regards to the timing issue is that of the kicker drive frequency. In the two-positron DR case, the extraction and injection kickers are driven in maximum 3 MHz repetition. It will now become maximum 6 MHz for the single-positron DR. This increment, however, is not a difficulty that adds to the presently identified technical issues, since the kicker system for the electron DR is assumed to be driven at maximum 6 MHz. While the positron DR will deploy a larger number of kicker pulsers and stripline kicker electrodes because of the larger beam clearance during injection, the specifications for these individual kicker elements are assumed identical for the electron and positron DRs.
3. The same situation applies to the bunch fill pattern, since the fill pattern in the single positron DR will be identical to that of the electron DR. If the DRs could not be filled with bunches with a spacing of 3.08 ns for some reason, the low-Q parameter set will have to be compromised and the bunch spacing of 4.62 ns or 6.16 ns will have to be used.

Cost Issues:

1. According to the DR Area Group Leaders [Appendix 1, 15] this change request is estimated to reduce the construction cost of the damping ring system by 17.3% with an uncertainty of 1-10%. This cost reduction comprises the elimination of the beamline components of the second positron damping ring hardware. The tunnel construction is assumed to remain the same on both the electron and positron sides for which up to two rings can actually be built. While elimination of the second e+ damping ring will allow us to simplify the magnet support systems and not install some part of the beam injection and extraction hardware the present cost study does not fully account for that type of details. Likewise, while implementation of the grooved vacuum chambers and/or sweeping electrodes would lead to some cost increases, they are not accounted for in the present cost studies.
2. CCB assesses that despite some uncertainties mentioned in 1, this change request safely falls within the category of Class-2.

New BCD Text:

1. A proposal has been made to replace the DR section of BCD with the new text found as dr.04aug2006.doc at https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/ConfigStudy .
2. The new text is substantially more compact than the previous version while maintaining all the detailed technical discussion as references to be quoted from the main text. CCB finds this arrangement as nice improvement and to be fully acceptable.

Overall CCB Assessment:

1. CCB finds that this CCR brings in a substantial cost reduction while maintaining a good likelihood of achieving a workable ILC design, if adequate and coordinated technical development efforts are made in the area of vacuum systems.
2. In the spirit of present definition of BCD, which reads "A forward looking configuration which we are reasonably confident can achieve the required performance *and* can be used to give a reasonably accurate cost estimate by mid-end 2006 in a 'Reference Design Report.'", CCB finds that this CCR acceptable, and recommends EC to adopt it, as is.
3. CCB, however, emphasizes the need for conducting systematic R&Ds on the vacuum chamber system, together with simulation and validation of the entire mitigation technique for electron cloud effects. CCB recognizes that GDE R&D board is currently in the process of evaluating, organizing and facilitating numerous research programs towards fully establishing the technical health of the ILC design. CCB recommends the GDE Executive Committee create an effective review process by which the progress of such R&D efforts is evaluated so as to reconfirm the adequacy of the baseline design at reasonable intervals. This applies equally to other design development issues with the damping ring baseline, such as the fast kickers and RF systems, as well as to other area systems such as high-gradient SRF cavities, undulators for positron production or extraction magnets in the beam delivery sections.

Additional Notes:

Handling of Cost-Related Information:

1. The "Hearing" on the cost impacts was held via Webex and telephone connection on September 8, 2006. The minutes of the hearing are available at [16]. However, as announced by GDE EC and reported at the Vancouver GDE meeting all public communication from CCB will have all "raw" cost numbers withheld (replaced by fractional numbers wherever possible and adequate).

E N D

References

[1] http://www.linearcollider.org/wiki/doku.php?id=bcd:bcd_home . https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/ConfigStudy

[2] http://lcdev.kek.jp/ML/PubCCB/msg00072.html

[3] A. Wolski, J. Gao and S. Guiducci, “Configuration Studies and Recommendations for the ILC Damping Rings”, LBNL-59449, February 2006.

[4] M. Pivi, T. Raubenheimer, L. Wang, K. Ohmi, R. Wanzenberg, A. Wolski, F.Zimmermann, “Simulation of the Electron Cloud for Various Configurations of a Damping Ring for the ILC”, Proceedings of EPAC 2006, Edinburgh, 2006.

[5] M. Pivi, R. E. Kirby, T.O. Raubenheimer, F. Le Pimpec, "Suppressing electron cloud in future linear colliders", Proceedings of PAC 2005, Knoxville, USA, 2005.

[6] L. Wang, T. Raubenheimer, G. Stupakov, “Suppression of Secondary Emission in a Magnetic Field Using a Sawtooth Surface”, Proceedings of EPAC 2006, Edinburgh, 2006.

[7] L. Wang and T. Raubenheimer, “Suppression of Secondary Emission in a Magnetic Field Using a Sawtooth and Isosceles Triangle Surface”, SLAC-PUB-12001, July 2006.

[8] L. Wang, “Possible Remedies to Suppress Electron Cloud in the ILC Damping Ring”, presented at VLCW06, Vancouver, 2006.

[9] K.L.F. Bane and G. Stupakov, “Resistive Wall Wake Effect of a Grooved Vacuum Chamber”, Proceedings of EPAC 2006, Edinburgh, 2006.

[10] L. Wang, H. Fukuma, S. Kurokawa, M. Pivi, G. Xia, “A Perfect Electrode to Suppress Secondary Electrons Inside the Magnets”, Proceedings of EPAC 2006, Edinburgh, 2006.

[11] N. Diaczenko, A. Jaisle, P. McIntyre, N. Pogue, “Killing the Electron Cloud Effect in the LHC Arcs”, November 2005. http://ab-abp-rlc.web.cern.ch/ab%2Dabp%2Drlc%2Decloud/

[12] J. Seeman (SLAC), J.-M. Laurent (CERN) and S. Guiducci (LNF), private communications, July 2006.

[13] Presentations by M. Pivi, L. Wang and J.-P. Delahaye at VLCW06.

[14] A. Wolski et al., “Timing Constraints in ILC”, task force report to GDE-EC. http://www.linearcollider.org/wiki/lib/exe/fetch.php?cache=cache&media=bcd:timingrecommendations-revapril17.pdf .

[15] Minutes of the DR CCR Cost Hearing, September 8, 2006. http://www.linearcollider.org/wiki/lib/exe/fetch.php?cache=cache&media=bcd:drhearing20060908final.pdf

[16] http://ilcagenda.cern.ch/contributionDisplay.py?contribId=56&sessionId=2&confId=316 , http://www.linearcollider.org/newsline/pdfs/dc_20060831_cost-confidentiality.pdf

[17] Presentation files by Mark Palmer, Mauro Pivi, Lanfa Wang , J.-P.Delahaye and J.M.Jimenez compiled at https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/ConfigStudy

Appendix 1

To: Nobu Toge
Cc: CCB, Garbincius, Bialowons, Shidara
From: Tetsuo Shidara
Date: Thu, 24 Aug 2006 23:04:22 +0900
Sent: Tuesday, August 15, 2006 11:03 PM
Subject: [CCB-576] Re; Request for Comments: DR Change Config Request - July 29, 2006

Dear Toge-san,

Here are some comments from CEs concerning the DR change request.

Cost saving: The reduction in cost is roughly 17 %.
CCR Class: This cost saving corresponds to Class 2.

Note 1: Due to our ILC-GDE confidentiality protocols, actual cost numbers are not shown here. Since you request the so-called review-mode access to these numbers in your review process, CEs will ask DR AS leaders to present related information to CCB members under Non-Disclosure Agreement (NDA) condition.

Note 2: Assessment is based on the file prepared by the DR AS leaders, "DampingRings-RDR-CostingSummary-2006-08-22", where they halved the numbers of components necessary for positron damping ring system.

Note 3: Simplification in the design, construction and operation is expected, particularly speaking in the injection and extraction systems.

Note 4: There still remains uncertainty in the electron cloud issue. It is highly recommended to perform R&D urgently on electron cloud suppression scheme in the positron damping ring.

Tetsuo Shidara for CEs