December 23, 2006

To: **Distribution**

From: **GDE Change Control Board**

Subject: **Response to the Change Request (November 29, 2006) for the BCD Beam Delivery (BDS) Section – CCR#23**

Preamble

This is the CCB response to the proposed changes to apply to the Beam Delivery (BDS) section of the December 1, 2006 version of GDE ILC Baseline Configuration Document [1]. CCB received the change configuration request (CCR#23) from A.Seryi on November 29, 2006 [2], and CCB forwarded it to GDE the same day. It was initially classified as Class-2 and it was confirmed as such at the CCB hearing that was held on December 15, 2006 [3]. T.Markiewicz, G.Blair and K.Kubo were assigned as the CCB reviewers. In response to CCB inquiry (Appendix A), WWS, MDI and representatives of four detector concept groups delivered their remarks concerning this CCR.

Summary

Requester proposed:

To modify the BDS to a single IR 14mrad configuration with push-pull arrangement for two complementary detectors. The CCR also specifies the details of the optics and layout; in particular, the BDS optics will be compatible to 1TeV upgrade in the same layout. Savings from the suggested change amounts to approximately one third of the BDS construction cost.

CCB response:

1. **CCB agrees that the cost impact of this CCR (change configuration request), as described by the requesters, is substantial and it qualifies as Class-2. Consequently, CCB assumes that its role with respect to this CCR is to make recommendation to EC (GDE Executive Committee) rather than to make a decision.**
2. **CCB recommends EC, on the basis of its review as detailed in the "Discussion" section, to accept CCR#23, whereby incorporating the "1IR with two detectors push-pull" as Baseline Configuration.**
3. **CCB recommends EC to maintain the previous Baseline with "2IR, single hall, two detectors" as part of Alternative Configuration.**
4. **CCB recommends EC to reinforce a taskforce on Machine-Detector-Interface issues. The taskforce should be specifically charged, and be recognized as such, by *both* the GDE and WWS, to facilitate pertinent design development efforts and discussions on relevant executive matters.**

Discussion:

Statements contributed by relevant parties: Full Statements are in Appendix A.

1. Requester gave the following statements:
   - In CCR [2] the requesters said the BDS optics will be compatible to a 1TeV upgrade in the same layout. The time taken for the changeover will be somewhere between 0.5 and 3 days; further detailed study including cost optimization is needed to clarify this.
   - In response to CCR inquiry [3], the requesters noted that a calibration at the Z-pole would most likely be needed both for the push-pull scenario and for a switch over between 2 IRs (the current baseline). A long case scenario with a mature system for the time for a switch-over, including detector recalibration and machine tuning, is quoted to be about 2 weeks. Beam tuning will be more rapid in the push-pull scenario, because only the final doublets are changed whereas, in the 2-IR case, the entire BDS may have to be retuned depending on the duration of the hibernation time.
   - Cost impact is a reduction of approximately 31% of the BDS cost. Hardware to accomplish rapid switch-over of two detectors would incur some cost increase, currently estimated to be below 10% of the savings.

2. Statements by Detector Concept Groups are included in full in Appendix A. All groups insist that, if the push-pull scenario is adopted, frequent and quick exchanges of the detectors are essential in order to avoid loss of luminosity and to ensure fair and equal treatment.
   - LDC identified technical challenges in the push-pull scheme but noted that they probably have engineering solutions given the resources. They stated that 2IR solution must continue to be studied, and in particular, priced, and that both 2IR and 1IR prices should be made available at the time the RDR is published.
   - SiD accepts the rationale for considering push-pull, is optimistic about its technical feasibility, and expects that further exploration of this idea and its alternatives can provide the technical conviction needed for a decisive position.
   - GLD does not yet have solutions they feel comfortable for the critical issues specific to the push-pull scheme. They hope that the decision to adopt the push-pull scheme, which may be critical to the physics potential of ILC, is postponed until the feasibility is proven with some confidence.
   - 4th Detector Concept does not see any show-stoppers in a properly engineered realization of push-pull.

3. MDI (Appendix A) expressed grave concern about the risk of losing the 2-detector scenario in its entirety, triggered by this CCR. There was also concern that the push-pull option for 2 detectors at a single IR has not been investigated sufficiently thoroughly to allow a sound technical basis for its acceptance as the baseline. They request that the 2 IR option should also be explicitly included in the RDR as an ‘alternative configuration’, with a cost estimate. In addition, MDI stated that they urge the GDE and the WWS to give a new charge to the push-pull task force to continue to study of the technical implementation

of the push-pull option.

4. Members of WWS, in addition to WWSOC statement reproduced in Appendix A, contributed the following remarks [3]:
   - The goal of the engineering and design efforts pertaining to the 1 IR scheme ought to be to achieve less than 1 week switch-over, with less than 10% of the integrated luminosity lost.
   - It is essential that the 2IR option be kept alive for a transition period, to allow for a fall back solution in case the push-pull scheme appears impractical.
   - There is a serious risk in eliminating the 2nd IR unless the viability of the push-pull option can be convincingly proven because two detectors are vital to secure the necessary support for the ILC from the worldwide HEP community. A 2 IR option must be maintained as a back-up in the RDR until the details of the push-pull scenario have been studied more and a higher level of confidence achieved.

5. M.Breidenbach contributed a detailed statement, as included in Appendix A. The cost of two detectors can be kept to about 10% of the cost of the machine; push-pull may save about half of this cost. Breidenbach stated that the Push-Pull is technically feasible and could be performed rapidly.

6. A.Yamamoto (Appendix A, [4]) stated that the Push-Pull system for the detector solenoid, final doublets, and related cryogenics should be feasible provided a set of boundary conditions, he identified, are satisfied. His current estimate for the switch-over is approximately 1 week, not including the beam tuning time, with the assumption that warming up the coldbox and disconnecting room-temperature lines are necessary.

7. V. Telnov stated that one IP will be a big mistake for the ILC because it greatly increases the risk to an already difficult project. The implementations of the $\gamma\gamma$ and γe options for the push-pull scheme have not been worked out, although these options are required by physics community, in his opinion.

CCB Observations:

8. CCB finds that all technical issues conceivable on the accelerator design to date have been identified in the areas of: detector roll-in/out, detector solenoids, final doublets and cryogenics. Possible solution scenarios have been presented, although all of them at this moment still require substantial amount of engineering studies.

9. CCB finds that most critical regulatory issues have been identified, although solutions to apply in all regions in the world have not yet been fully worked out.

10. CCB finds that in the current state of engineering discussion, the GDE, as a whole, still sees differences of opinions on, or ambiguities over the estimates for, the achievable speed of detector switch-over.

11. CCB observes that Detector Concept Groups currently possess differences of opinions concerning the engineering feasibility and impacts on the physics research concerning the detector switch-over.

CCB Assessment

- CCB heard that the expected switch-over time is somewhere between 1 day and 1 week and if one includes the time for beam tuning and calibration, it can amount to 2 weeks or even longer. CCB realizes that there are considerable ambiguities to this estimate which can be only resolved after systematic and organized engineering survey. There will be “learning-curve” effects, too, when this switch-over system is actually commissioned at ILC.

- CCB understands that the nature of BC selection at this moment (December, 2006) is to define an assumption for a scheme that is believed to lead to a workable ILC design, so as to facilitate rapid design development and rapid identification of critical engineering difficulties by the GDE team and by the relevant parties whom the GDE team works with. In that sense CCB finds that this CCR does not fail to qualify as BC (*i.e*., it does qualify as BC).

- CCB acknowledges the concerns by MDI on technical feasibility of fast switch-over. However, the expected cost reduction is quite substantial that CCB feels that this CCR is worth an organized and coordinated effort by all who are concerned. CCB feels that it is not unreasonable for GDE to ask the relevant detector groups’ cooperation in pursuing this new CR towards the point where the team (GDE and detector groups) as a whole sees if this 1IR push-pull could actually be made to work to satisfaction of all.

- The evaluations above lead CCB to recommend adoption of this CCR by EC.

- As for the MDI panel’s request for costing both 1IR and 2IR in RDR (Reference Design Report), first, CCB finds that it is not unreasonable to maintain 2IR as part of Alternative Configuration (AC) in the name of a fall-back scheme, given the quite early stage of engineering evaluation of 1IR. Request by WWS to maintain 2IR as back-up in RDR can be met by this same measure.

- If the 2IR scheme is maintained as an AC, how its costing discussion be made part of RDR is an issue for the RDR Management to work under EC. CCB notes that approximate cost comparisons have been already done as of now, to the level reasonably achieved prior to RDR authoring, and CCB feels that the work done so far actually is sufficient for purposes of making costing comparisons between 1IR and 2IR in RDR, if EC and RDR Management choose to do so.

- As for recommendation by the MDI panel to include provisions in the Baseline design to facilitate a change to the 2IR design in case of needs, CCB feels that this MDI request is not specific enough. CCB, however, understands that the present CCR does not preclude the possibility, for instance, of introducing big bend sections at the upstream ends of BDS and in that sense is not entirely incompatible with reverting to 2IR. Thus, CCB recommends relevant parties to discuss on the issues pertaining to “restore smoother transition between 1IR and 2IR” and submit a specific CCR, if determined suitable. CCB points out that since the present CCR intends to support two detectors already at one IR, considering yet one more IR could mean support of potentially up to three detectors. CCB, however, assumes that first examinations of its implications and other aspects of such an additional CCR belong to the charter of BDS Area Group, not to CCB.

- As for request by MDI to give a new charge to the push-pull taskforce to continue the study of the technical implementation of the push-pull design, CCB feels that this proposal is worth a positive thought. CCB also feels that EC might as well take this opportunity to reconsider the title, charge, membership, report chain, relation to GDE and to WWS; however, obviously, those specifics are an issue which goes well beyond the charter of CCB.

- As for concerns by WWS stating “bypassing normal CC process with CCR#23”, CCB does not find that it is warranted. CCB does not consider itself being bypassed in any of the change configuration processes.

Overall CCB Assessment:

1. CCB finds that this CCR brings in a very attractive cost reduction. CCB finds that it is not technically problematic enough to be rejected, either, since no fundamental “show-stopper” issues in the technical area have been identified at this moment. Therefore, CCB recommends EC to accept this CCR as the new baseline.
2. On the other hand, CCB notes that obviously not all engineering details have been worked out to their fullest at this moment. Consequently, CCB recognizes that some engineering and operational issues in the future might make the 1IR less attractive than how it is conceived today. Therefore, CCB recommends EC to adopt the 2IR scheme as an alternative configuration.
3. CCB notes the complexity of the technical issues related to this CCR, which demands organized and focused engineering efforts by all concerned, particularly by members of the detector groups many of whom reside outside the organization of GDE. CCB notes the critical importance of maintaining close cooperation with members of detector groups on numerous technical issues in this regard. CCB also notes the critical importance of maintaining a thick channel between the GDE and detector groups on more executive matters such as project cost optimization, planning of commissioning and operational scenarios for the accelerator and detectors as a whole, and others. Therefore, CCB recommends EC to reinforce a taskforce on issues related to Machine-Detector-Interface . This taskforce should be specifically charged, and be recognized as such, by *both* the GDE and WWS, to facilitate pertinent design development efforts and discussion on relevant executive matters.

E N D

References

[1] http://www.linearcollider.org/wiki/doku.php?id=bcd:bcd_home .

[2] A.Seryi : http://lcdev.kek.jp/ML/PubCCB/msg00130.html and http://lcdev.kek.jp/ML/PubCCB/msg00133.html .

[3] Minutes of CCB Hearing, December 15, 2006 and references therein: http://www.linearcollider.org/wiki/lib/exe/fetch.php?cache=cache&media=bcd:ccr23hearingbds.pdf .

[4] A.Yamamoto, December 12, 2006 : http://www.linearcollider.org/wiki/lib/exe/fetch.php?cache=cache&media=bcd:ilc-det-pushpull.pdf .

Appendix A: Input from the Community Members

MDI Panel

The MDI panel had a meeting on Dec. 8 and discussed the push-pull option. There were reports from the three concept studies and the WWS about their respective statements.

In general there was grave concern about the risk of losing the 2-detector scenario in its entirety. There was also concern that the push-pull option for 2 detectors at a single IR has not been investigated sufficiently thoroughly to allow a sound technical basis for its acceptance as the baseline.

The fact that the primary motivation for the push-pull model is to save on the cost of the accelerator has caused considerable misunderstanding within the detector community, which does not enjoy the same level of cost-consciousness as the GDE. We thus suggest that there be efforts both by GDE and WWS/Concepts to share and communicate the overall cost reduction strategy, possible trade-offs, and its implementation.

Regarding CCR#23, we recommend that, if the push-pull option be included as the baseline, then the 2 IR option be also explicitly included in RDR as an 'alternative configuration', with a cost estimate. We understand that such a cost estimate may, by necessity, be less complete than the baseline cost. In addition, provisions should be included in the baseline design to facilitate a change to the 2 IR design in the event of either:

a) the push-pull model proving unfeasible, or
b) additional funding being secured for a second BDS and IR.

Finally, we urge the GDE and the WWS to give a new charge to the push-pull task force to continue the study of the technical implementation of the push-pull option.

WWS

The WWS thinks it is fundamental for the scientific program of the ILC to have two complementary detectors which create the support of a large HEP community in the world. Without such support the ILC project would not be funded. We therefore believe that there is a serious risk in eliminating the 2nd IR unless the viability of the push-pull option can be convincingly proven.

The concept studies have not found any show stoppers for the push-pull option, but the depth of the studies so far is not sufficient to place a high level of confidence on this conclusion. Since we cannot conclude with certainty that the push-pull option can meet the requirements of engineering and physics, if the push-pull approach is implemented in the reference design we think a two IR option must be maintained as a back-up in the RDR until the details have been studied more, and a higher level of confidence has been achieved.

The ideal scheme for the HEP community which was intended in the 2 IR scheme was a fast and frequent switching between two experiments where there is little need for re-tuning of the beamlines so that there is no significant loss of luminosity. We wonder if sufficient resources have been used toward realizing such a scenario.

We acknowledge that the push-pull scheme for two detectors would reduce the cost considerably. A large amount of efforts from the concept studies went into this direction with however insufficient time to fully prove the feasibility. They are willing to actively continue their effort.

Finally, even though we understand the tight schedule of GDE, we are concerned that the push-pull option is already included in the IWA (Interim Working Assumption) upon which future design efforts will be based. The normal change control process seems to be bypassed for this issue, and we worry that it might disturb the change control process in future.

LDC Detector Concept

Preliminary LDC position on a possible PUSH-PULL
detector configuration at the ILC
Version 2.0
07.12.2006
The LDC detector concept group in this document formulates a position on the question whether or not a push-pull arrangement for the ILC detectors is feasible. The position summarised in this note is mostly the result of the work of the LDC members in the push-pull task force, Norbert Meyners, Karsten Büsser, Henri Videau, and the LDC contact people. It has been circulated in the LDC community, and contains the feedback from the community.

We like to stress that we can only give a very preliminary assessment of the push-pull configuration at this moment. The shortness of time available prevented us from a serious in-depth engineering study, as would be appropriate for this topic.

The LDC concept group stresses that we are convinced that two detectors at the ILC are of very high importance. We are convinced that two detectors, designed towards the same general physics questions, but realised in complementary technologies and designed and operated independently of each other, offer a significant advantage and, in the end, will significantly increase the scientific output and return from this machine. Any technical considerations should take into account that both detectors should be operated on an equal footing, that nothing is done which jeopardizes the operation of one or both detectors, and that the construction and operation of both detectors remains equally attractive for the community.

We have studied the feasibility of a push-pull configuration in a very superficial and preliminary manner. We have identified a number of areas of serious concern, which need significant study and engineering work to understand their impact on the design of LDC and on the eventual performance of a push-pull scheme. These areas include the design and size of the cavern, the mechanical overall design of the detector, its scheme to open and to move around in the cavern, and the designs of most of the different sub-systems, all of which will be affected by a decision to move to a push-pull scheme. We in particular are not convinced that a fast switchover between detectors is possible without loosing significant time for a re-calibration of the detectors. Many of these problems can probably be solved by a dedicated engineering effort, and if enough resources and money are spent on their solution. At this stage however we feel that we do not understand the tradeoffs between decreasing costs by eliminating one beam line, and increasing costs and risks by additional complexities for the detectors.

A possible push-pull scenario will present a significant challenge to the community to operate it in a way that both detectors are treated on an equal footing. We repeat that an equal treatment of both experiments is of utmost importance. For this a solution where a fast switching between the experiments is possible is obviously the best. Such a solution is clearly excluded in a push pull scheme. We nevertheless think however that a solution can be found to guarantee an equal treatment of both experiments also in the case of a push-pull scheme. We request that any decision for or against push-pull should be taken under the condition that the other solution is continued to be studied in detail. We request that should the push-pull scheme become the baseline, as prepared in the recent Change Control Request, the two-beam line solution is continued to be studied, and in particular, priced, and that both prices are made available at the time the RDR is published.

In summary the LDC group is very concerned that no fast and irreversible decision is taken in favour of a push-pull scenario, in the absence of any serious study and information on the additional costs and risks such a solution implies. We do not fundamentally oppose a push-pull decision, but insist that a decision at this time can only be preliminary, and has to include the non-push pull solution as a backup.

GLD Detector Concept

View on the proposed push-pull scheme of ILC detectors

22 November 2006

GLD detector concept study group

In this document, we try to express our view on the proposed push-pull scheme of the ILC detectors. The contents are based on the discussions made within GLD members and with outside experts. Frequent and quick switch-over of two detectors is essential for the push-pull scheme in order to avoid loss of luminosity and to ensure fair and equal treatment of the two detectors. The push-pull task force, which was formed to address relevant technical issues, has presented its first report at the Valencia workshop. Many technical studies have been carried out by the task force and we very much appreciate their effort. However, we do not think that a convincing scenario for the push-pull scheme has been presented yet, due to the lack of time for sufficient engineering study.

As for the GLD concept, we do not have solutions yet for the critical issues specific to the push-pull scheme such as the support structure for the final quadrupole magnet compatible with nano-meter level stability, re-alignment of the sub-detectors, plumbing method for the “movable” cryogenic system for the super-conducting solenoid, etc. Furthermore, legal issues associated with the push-pull scheme, such as disconnection of the cryogenic system, will have to be clarified. The additional costs required for the push-pull scheme might not be negligible. These will include costs for a realistic design of the experimental hall, the apparatus for the detector movement, and the impact on the cost of the detector itself. These additional costs need to be estimated. In addition, the switching of detectors would be a complicated operation involving a large number of groups working together, and the scheduling issues need to be considered in detail.

Thus at present, we do not think we have enough knowledge to judge with confidence whether the push-pull scheme is feasible or not. We are willing to actively participate in the studies to make the push-pull scheme work. We are afraid, however, that accepting the push-pull scheme now, where its feasibility is not yet demonstrated with sufficient credibility, might later force us into a situation which is far from what we anticipate. We hope that the decision to adopt the push-pull scheme, which may be critical to the physics potential of ILC, is postponed until the feasibility is proven with some confidence.

SiD Detector Concept

The SiD Concept has been asked to record its viewpoint on "push-pull", the scheme whereby two ILC detectors would share a single ILC interaction region, alternately moving on and off beamline to take luminosity. Representatives from SiD have actively participated in the Push-Pull discussions organized by Andrei Seryi for the GDE. The tentative opinions expressed below have been discussed within the SiD management, but time pressure has not allowed more thorough discussion throughout the SiD Collaboration. Many of these points follow from an earlier position paper distributed by Marty Breidenbach to the Seryi Panel.

For the following discussion we assume that an ILC with two IP's can realistically only deliver beam to one IP for an extended period of time (weeks), and that switchovers on a much shorter time scale are simply not possible. We note at the outset that from the point of view of the detector and the physics, having the detector permanently positioned on beamline and equitably sharing luminosity on as short a timescale as possible, is ideal. It will stabilize data taking and simplify calibrations and alignment, and offer the stability required to do precision physics.

That said, SiD accepts that push-pull will remove the considerable cost of one beam delivery system, enhance the likelihood of having two detectors at the beginning of ILC running, provide these two detectors equal access to the luminosity, and may even increase the net luminosity each detector will integrate compared to the two-IP scenario.

SiD is deeply concerned about the formidable sociological issues surrounding how and when swaps are scheduled. Procedures must be devised that share machine luminosity equitably, that put the burden of detector readiness on the detector which has moved onto the beamline, that are acceptable to both detector collaborations, and that are seen as fair. We note, however, that these problems are not fundamentally different from those which would arise in the two beamline scenario, regarding when to swap beamtime.

SiD believes that push-pull is most easily accomplished with self shielding detectors, and that self shielding is technically feasible. SiD believes that the online detector must be shielded so as to allow full accessibility to the offline detector, and that keep-alive data-taking on cosmic rays will be needed to maintain detector operability.
Obviously, the mechanisms used to move detectors on and off beamline must not reduce experimental acceptance.

SiD believes that the period between detector swaps be about one month, to assure that neither detector receives a significant luminosity advantage in a single data taking period. It obviously follows that it is imperative that the period between stopping data taking with one detector and restoring luminosity for the other, is very small compared to the period of the run cycle.

There are number of technical issues with push-pull that, while not having well-defined or engineered solutions, SiD expects will not pose insurmountable problems. In particular, SiD expects a cost effective detector moving system to be feasible, and it expects to be able to engineer a system to precisely align the captured beamline components, independently of the overall detector position. Nevertheless, there are certainly technical questions regarding the viability of push-pull which have not yet received adequate answers. They include the following:

A. After moving a detector out, then in, will the magnetic field map remain effectively unchanged? Can it be engineered to remain so?

B. Can tracking chamber alignment be restored/redetermined without time consuming calibration runs?

C. Can a detector in the out position remain fully operable without the constant influx of data?

D. Can the swap time, including the time to restore luminosity, be made short enough?

In sum, SiD accepts the rationale for considering push-pull, is optimistic about its technical feasibility, and expects that further exploration of this idea and its alternatives can provide the technical conviction needed for a decisive position.

4th Detector Concept

4th Concept statement on the proposed push-pull detector configuration at the ILC

A.Mikhailichenko and J. Hauptman

December 13, 2006

Abstract

The 4th Concept detector is modular and light-weight by virtue of the dual solenoid flux return that allows for an iron-free detector. The only mass of any importance in the detector is the calorimeter mass, about 10 interaction lengths equivalent of brass over 4π starting at a radius of $r \approx 1.5$ meters. We do not see any show-stoppers in a properly engineered realization of push-pull for the 4th concept. The level of confidence can be high with engineering foresight. The final quadrupoles will be supported by the detector itself to greatly decrease the incoherent beam motion due to ground motion and vibration, and for near-IP control of the final beam aim and focus. Active tuning, mechanical and electromagnetic correction coils, would allow for a quick restoration of luminosity. The detector itself will have a modest number of channels in the triple-readout calorimeter, about 20K, and we anticipate on-detector electronics to compress the final cable count of the pixel vertex and TPC detectors. We do not believe that this will be easy, and the caution expressed by the GLD and LDC groups is warranted in the absence demonstrated feasibility with sufficient confidence. In addition to the move time, the Z0-calibration running time after each move is essentially a luminosity loss.

Specific considerations

We list here several specific considerations for the 4th concept detector and some more general assumptions and suggestions for all concept detectors.

1. The 4th concept mass is about 900t, less than an iron-based large detector at about 13,000t. Therefore, initial considerations for rapid detector movements at an interaction point, such as floor deformations, are minimal and many other issues of strengths and supports during motion are

alleviated;
2. The FF lenses delivering low-β at the IP are carried by the detector, and therefore the compensation of the movement of the beam-delivery system elements are not a large problem for the 4th concept;
3. Beam-based alignment includes electrical and mechanical adjustment of FF optics attached to detector and this procedure is an intrinsic element of functioning of 4th;
4. the 4th detector does not provide the necessary radiation shielding of personnel, however the 10 λ_{int} calorimeter in combination with movable concrete walls, as has been suggested by the push-pull study group, may be sufficient;
5. All power, water, cryogenics, and data cables are attached to the detector so that easy motion is possible without reconnection;
6. Vibration isolation and protection are arranged by attaching the final beam telescope to the detector, so a push-pull scenario does not affect it at all;
7. It is assumed that each detector has its own set of final focus elements, and that a common point can be found to break the beam lines.
8. It is assumed that the beam line is broken at common points for the detectors by valve pairs and pump outs. The design of the beam delivery optics will allow one to break the beam delivery channel practically at any point and the design of a low loss connection is not a problem;
9. We anticipate that dump resistors and other apparatus associated with the superconducting magnets are carried by the detectors;
10. We suggest that, to keep open the possibility for operation of two detectors simultaneously at some time in the future, the service tunnel must be located far enough from the main beam tunnel, so that if a decision for simultaneous operation is made, the service tunnel could be filled with focusing elements for the second beam delivery line with minimal cost.

General comments

The large iron-blanketted detectors GLD, LDS, SiD were designed, as was 4th, without consideration of frequent detector movement, and therefore new and unfamiliar ideas might be required for a comfortable solution to push-pull such as already outlined in the note “The Meaning of Push-Pull”. In addition, the newest ideas about design of the FF beam delivery lines may bring the length and cost of the lines down to an acceptable level compared with the expenses associated with frequent motion of heavy (~13000t) but delicate equipment, especially since the costly FF lenses belong to the detector.

Summary

We will continue to study this question, and rethink the construction and maintenance of each detector subsystem, but at the present time we are comfortable with the proposed push-pull scheme.

M. Breidenbach

To: SiD Executive Committee
From: M. Breidenbach
Subject: SiD Position on Push-Pull
Date: 15 November 2006

SiD Opinion on Push-Pull

Push Pull can be an approach for ILC to remove the cost of one Beam Delivery System while giving two detectors equal access to the luminosity and possibly increasing the luminosity each would have in a two-IP scenario. We believe that this option is technically feasible.

There appears to be a community impression that in the two IP ILC, the luminosity would be delivered to both on alternate trains. While this is possibly feasible, the machine designers appear to assume an illumination switch cycle of about once per month. The time required to recover full luminosity in a BDS that has been down for a month is unknown, but it is likely to be a substantial fraction of the down time. With a single BDS and a swap time of less than a day, luminosity recovery should be rapid. [1]

There are valid concerns that a detector will do better in long uninterrupted runs (years) than running for about a month at a time. This is likely quite true, but it does not appear to be an option for a two detector ILC. Perhaps the real contrast of two IP's versus Push-Pull is the actual damage that is done to the detector by moving. We believe this unlikely to be an issue in a properly designed and engineered detector, and that the additional costs are quite small compared to the cost of a beamline.

We believe that equal access to the luminosity means that neither detector should be able to get a significant luminosity advantage in a single cycle, and also that the mechanics of the detector interchange cause negligible overall luminosity loss. This implies that the detector swaps should occur on a rigid (calendar, not delivered luminosity) schedule of perhaps once every 35 days. An additional reason for ~35 days is that the detectors will tend to need some recommissioning, mostly due to small "improvements". This interval is an estimate for a time that would permit a rapid return to data taking. Of course, we assume that the detector is exercised in the off beamline position by some combination of cosmic rays and calibration systems.

There have been a set of technical issues outlined in a note by Richter and Breidenbach. Perhaps the key issue is that the set of disconnections and reconnections be so small that the swap time is dominated by the actual move. While the beamline will need common warm sections with valve pairs and pumpouts[2], it seems likely that all other connections to the detector can be maintained.

[1] The machine reliability studies tend to assume that the recovery time is a fixed fraction of the downtime for complex systems. This factor could be 1.

[2] The BDS group has proposed a warm section in between cryostats for the final quads. This space would be used for the beam position feedback system and for disconnects. It appears that this scheme could accommodate different L*. We envision the disconnect being a beamline valve pair (designed not to disturb the beam) separated by <0.5m. This region would have a removable drift (~10 cm), as well as an upstream tee to a fixed pump and purge system. The removable drift provides generous clearance as the detectors are moved. It is assumed that this region can be purged with dry N2 when it is open, and that

This seems relatively easy if the detector is self-shielded to permit personnel access during luminosity operation; more difficult if the detector is only shielded enough to protect the apparatus; and perhaps challenging if the connections need to be long and flexible. Related to this is the scale of the electronics required to service the detector – there may be a significant difference in experiences for the three concepts. Based on SLC experience, SiD expects that the electronics could be easily carried on the detector[3], but there may be disagreement here.

No real engineering has been done on a transport mechanism. In physicist engineering imagination, there appears to be good experience moving kiloton scale objects on air pads, but high capacity rollers running in a channel might be better for one dimensional motion. It appears the detectors could be constrained in Z by cam followers running on a guide beam attached to the floor. This beam would also have precision stops to locate the detector in X. It seems plausible that such a system could locate a detector to ~ 1mm. The final quads would have remote adjustors with this range to allow beam based alignment. Finally, it is assumed that the vertex detector and beampipe would have to be aligned to the beam to substantially better than 1 mm, and would require a motion system. We assume that when the detector moves, it carries its endcap doors.

There have been preliminary discussions on self shielding. It appears that the upstream spoilers and shielding required for normal detector operation may make the shielding required for the maximum credible accident simpler. Obviously, the dose and dose rate criteria for the maximum credible accident and the mis-steering cases need to be established. Note that the mis-steering case may be more difficult to deal with than the full power accident because it may continue for a longer time. A first look, using the accident criteria of 25 R/hr, seems promising. There may be pressure to insist on a shielding wall between the detectors, and shielding of a utility platform permanently attached to the detector as described by Seryii, but this will add to the cost.

We expect the superconducting magnets (solenoids, quadrupoles) associated with the detector to stay cold, and perhaps energized during a move. A possible exception to the no disconnect rule might be that the detectors carry an appropriately large supply of liquid helium, and that the connections to the liquefier be broken for a move.

---

recovery to adequate vacuum will be rapid.
It is obvious that the inboard cryostat will be carried by the detector. However, this is likely to be required even without push-pull.

[3] It is possible that electronics cooling air may cause vibration problems. Some study should indicate whether simple vibration isolation of the racks would be adequate, or whether vibration concerns necessitate a separate electronics building. Note, however, that there is some level of detector cooling (of the actual sensors and local electronics) that can not be moved!

A perhaps plausible move scenario could be:

ID	Start With / After ID	Operation	Required Time (A.U.)	Elapsed Time at Completion (A.U.)
1		Secure ILC Beams	1	1
2	W 1	De-energize magnets (if required)[4]	3	3
3	A 1	Open Beamline shielding (Pacmen)[5]	0.5	1.5
4	A 3	Disconnect beamlines[6]	1	2.5
5	W 1	Disconnect liquefier	1	1
6	A 1	Checkout Detector Transport System	2	3
7	A 6	Transport Detector off beamline[7] (20 m) out	4	7
8	W 7	Transport Other detector on beamline[8]	1	8
9	A 8	Connect Beamline[9]	1	9
10	A 9	Close Beamline shielding	0.5	9.5
11	A 10	Check detector alignment & adjust if needed.[10]	1	10.5
12	A 8	Energize Magnets	3	12.5
13	A 10	Safety Checks before beams	1	10.5
14	A 8	Reconnect liquefier	1	10
15	A 13	Begin Beam Based alignment[11]	-	10.5

This table should be considered no more than a plausibility argument that a properly engineered push pull transition could have the Arbitrary Units identified as hours, and the transition occur in less than a day. Optimists might see a path to substantially less than a day! Many of these times may be conservative, particularly with tested procedures and experienced crews.

Possible Problems

---

[4] Assume a 1 GJ , 10H solenoid. Then a 100 KW power supply could energize the solenoid in $1X10^4$ seconds. LdI/dt should not be a problem.

[5] If there were shielding walls, they would be opened at this time. Assuming that the wall does not interfere with access to the beamline disconnects, there appears to be no time penalty if the doors can be moved in ~ 2 hours.

[6] The beamline break may be in a warm drift between cryostats. It seems essential that there be no cold bridges across the drift.

[7] The SLD doors weighed 600 tons and moved at 200 inches/hour (5 m/hr). We assume a highly engineered motion system can at least match this velocity.

[8] Assume incoming detector follows 1 hour behind.

[9] The pumpdown continues by remote control after the beamline is reconnected.

[10] This operation is intended to correct vertical motion of the floor beyond beam based alignment or quad motion range. It is possible that the beambased alignment will need better than 1 mm alignment to start, and this should be studied.

[11] It seems likely that beam based alignment could at least begin before the solenoid is at full field, at least at the level of re-establishing beams. It is possible that the final quads might move as the solenoid ramps up. There might be a schedule advantage in being able to leave the solenoid at least partially energized. The 10.5 hours in the last column is the time for which alignment could start. Note that the vertex detector and beampipe will need to be re-aligned also.

- The floor may move under the detector load, although it seems plausible to hope that the site has quite competent rock[12] for the IP region. We assume an alignment system parallel to the beamline and decoupled from the floor is available. Elastic deflections should not be a problem, but slow creep could require well engineered elevation systems for the detectors and subsequent rounds of alignment. This alignment might be required even in a one detector scenario, but two detectors are likely to complicate the floor dynamics if the deflections are inelastic.
- It is possible that the steel flux return may distort due to being moved on the floor, particularly if the elevation of each leg changes. However, it appears that SiD, LDC, and GLD all have solenoids that could be engineered to isolate the precision systems from the iron. It is likely that the solenoid would have kinematic mounts that would prevent it from being distorted by small changes in the iron. At any rate, the magnetic forces that will have to be planned for are reasonably large.

- Self shielding may be contentious. It seems straightforward to cut off a train if, for example, any of the following conditions are met:

1. Excess radiation is observed inside the detector.
2. Excess radiation is observed outside the detector.
3. The expected bunch charge does not make it to the dump.

Independent systems could:

1. Dump the DR beams.
2. Suppress the DR ejection kickers.
3. Kill the Linac RF.(Both misphase and turn off)
4. Kick beam into the Tune-Up dumps.

Thus limiting the dose rate to 25 R/hr would limit the dose to less than 1 mR. Mis-tuning of the beam, such as targeting a FF quad with a low power beam, nay be more problematic. While possibilities for effective protection collimators should be developed, it would seem that all 3 detection measures noted above should work.

- There is concern that radiation rules will continually tighten. If so, this may be an issue for shielding walls as well.
- It is unknown whether 2γ could be accommodated in the Push-Pull scenario, but it seems unlikely that it will be easier than with two IP's.
- There has been no engineering done to demonstrate the durability of a motion system. However, the SLD doors cycled perhaps 50 times with no apparent wear issues.

Comments:

The major drawback to Push-Pull appears to be sociological. There certainly is a bad history[13] to

[12] Steel plate may be needed for the air pads and for pusher anchors. However, steel may not be a good fix if the underlying rock moves.

[13] It appears that there have been few cases of repetitive interchanges of detectors. It has also been observed that these cases involved detectors of dissimilar quality. While it is expected that the ILC

Push-Pull, and many people fear it is part of a strategy towards one detector. We believe that the cost of two detectors can be kept to about 10% of the cost of the machine (assuming comparable accounting schemes!). Push-Pull may save about half of this cost.

A. Yamamoto [4]

Push-pull magnet and cryogenics system should be feasible under boundary conditions of:
– Magnet power supply and cryogenics facility is placed on the plat-form movable together with the main detector system
– The Move-in/-out time duration to be ~ 1 week.
• One day operation should not be practical without much extra effort for the fully flexible high pressure pipe line with extra space.
• Magnet can be kept cold with sealing-off the line,
• Cryogenics (cold-box) warm-up is highly recommended for safety, and for reliable cryogenics operation.

V. Telnov

Date: Sun, 17 Dec 2006 20:12:54 +0600 (NOVT)
From: Valery I. Telnov
To: Andrei Seryi, Hitoshi Yamamoto, D.Angal-Kalinin, B.Barish
Subject: Pull-push, $\gamma\gamma$

Dear Andrei, Hitoshi, Deepa and Barry,

I would like to express briefly my opinion about pull-push in general and in gg case before you made irreversible decisions.

1. One IP will be a big mistake for the ILC (irrelative of $\gamma\gamma$)! It can reduce the initial cost by several percents but experimentalist will suffer during the next 20 years. The ILC is very difficult by itself even with two independent IP. The pull-push scheme makes the project extremely risky! Money for construction of tunnels and money for conduction of experiments have different values. The former are paid to external construction workers, this work is simple, do it and forget. The latter is the work which should be done by the ILC staff, it is very difficult and need permanent attention of very high skilled personal, engineers and physicists. You can find acceptable technical decision for pull-push, but any experienced experimentalist feels by skin that it will be a disaster! It would be wise for GDE to demonstrate a common sense and give up from the pull-push idea.

2. Do not forget about $\gamma\gamma$. In pull-push case, $e+e-$ and $\gamma\gamma$ can not work in parallel. How are you imagining the transition pass from $e+e-$ to $\gamma\gamma$? It was more or less clear in the case of two 14 mrad IPs (with additional 25 mrad tunnels), but what is planned in the case of pull-push? There are no one

---

detectors would be very competitive, it is not obvious what would happen if one proved significantly superior to the other. However, it can be argued that even with 2 IP's , one would not illuminate the worse detector, so this may not be a uniquely push-pull issue.

word about this in BDS RDR. I should remind that $\gamma\gamma,\gamma e$ is required by physics community and this is confirmed in the updated parameter report.

Comparing cases of two IP and one IP with pull-push you should take into account the cost of upgrades in both cases and the required time
(no stop in the first case and several years without experiments in the second case).

Best regards

Valery