January 23, 2007

To: **Distribution**
From: **GDE Change Control Board**
Subject: **Response to the Change Request (January 3, 2007) for the BCD Main Linac (ML) Section – CCR#24**

Preamble

This is the CCB response to the proposed changes to apply to the Main Linac (ML) section of the December 1, 2006 version of GDE ILC Baseline Configuration Document [1]. CCB received the first communication on what became the change configuration request (CCR#24) from T. Raubenheimer on December 18, 2006 [2]. Essential supporting documentation (revisions to the BCD) was transmitted by the requester on January 1, 2007 and CCB forwarded it to GDE on January 3, 2007. It was classified as Class-2 based on its near identity in scope with CCR #20 [3]. C. Pagani, W. Funk and S. Mishra were assigned as the CCB reviewers.

Summary

Requester proposed:

To apply nearly the same three changes in the ML design baseline as were proposed in CCR #20, but supported by changes in the ILC parameters to address concerns raised in the CCB response to CCR #20 (to maintain maximum correspondence to CCR#20 for ease of discussion, the proposed changes to the baseline parameter set will be identified as CCR#24d, but they will be addressed first, since they provide the basis for some of the following changes):

CCR#24d: To modify the baseline parameters as given in Table 1 below (changes are bolded). Operation with these parameters would result in a luminosity of 2.1×10^{34}, in spite of a small reduction in total charge and average current, through reduction of horizontal β^* at the IP.

		Has been	Would become	
Electrons/bunch	N	2	**2.04**	10^{10}
Number of bunches	n_b	2820	**2670**	
Linac bunch interval	t_{sep}	337	**363**	ns
Bunch train length	T_{beam}	950	**969**	μs
Average current (in the pulse)	I_{ave}	9.5	**9.0**	mA
Bunch length	σ_z	300	300	μm
Vertical emittance	$\gamma\varepsilon_y$	0.04	0.04	mm.mrad
Horizontal emittance	$\gamma\varepsilon_x$	10	10	mm.mrad
IP beta (500GeV)	β_x	21	**20**	mm
	β_y	0.4	0.4	mm

Table 1. Proposed revisions to apply to ILC baseline parameters.

CCR#24a: Change of the cryomodule (CM) layout driven by each of the 10MW klystron RF unit. Previously, the basic linac cryomodule ‘cell’ consisted of two 8-cavity cryomodules without a magnet and one 8-cavity cryomodule with a magnet (8-8-8). Implementation of this change request will result in a cell of two 9-cavity CM without a magnet and one 8-cavity with a magnet (9-8-9). Thus, 26 cavities are to be driven by one 10MW klystron rather than the previous 24.

CCR#24b: Elimination of RF unit overhead. Previously, 3.5%. Now, 0%. Thus, maximum beam energy 250GeV is available only if all RF units are in operation. However, one difference from CCR#20b is that the conventional facilities, including the tunnels, are to be maintained to accommodate the missing 3.5% worth of RF systems if/when determined needed.

CCR#24c: Elimination of the uncertainty factor in the cryogenic static heat load. Previously, 50%. Now, 0%. This allows lowering the cryogenic capacity by 13%.

CCB response:

1. **CCB found that CCR#24d has no directly associated cost impacts, since in and of itself it proposes no changes of equipment or layout.**

   During consideration of CCR#24, CCB learned that the cost impact of the three changes CCR#24a, b and c amounts to a total 3% reduction of the construction cost of the ML, including that of related conventional facilities. CCB understands that the cost impacts of the matching components of CCR#24 will be identical to what they were for CCR#20.

   If individually looked at, only CCR#24b qualifies as Class-2 (CCR#24a and CCR#24c each are Class-1). In the light of the important coupling among all four changes, however, CCB has decided to consider them jointly, and to only make recommendations to the EC.

2. **CCB recommends that the EC:**

   A. **To accept CCR#24a.**
   B. **To accept CCR#24b.**
   C. **To reject CCR#24c.**
   D. **To accept CCR#24d.**

3. **CCB finds that to proceed further on design development of ML system, together with design and development of other systems that rely on hardware derived from ML, clarifications in the BCD text are urgently required in two areas. Thus, CCB recommends that the EC:**

   E. **Instruct relevant parties to introduce a place holder for clear and**

unmistakable definition of the energy reach and luminosity reach of ILC phase-1 in the BCD and to introduce descriptive entries there. (This repeats a recommendation in response to CCR #20.)

F. **Instruct relevant parties to redraft a specification table as part of BCD for the main linac RF unit, together with cavities and cryomodule, on the basis of a firm consensus of all subgroups who are involved such as: parameters, high-level RF, low-level RF, cavities, cryomodules, cryogenics, commissioning, operation and availability. This specification table has to allocate reasonable provisions for absorbing the current technical ambiguities, has to be internally consistent, and has to be consistent with respect to the definition of the "energy reach" above.**

Discussion:

Readers are referred to the CCB report on CCR#20 [3] for details and background on components a, b and c. Material presented there will, in general, not be repeated here.

CCR#24d

The requester stated that the updated set of 'nominal' beam parameters provided above, with an average current of 9.0 mA, exceed the design luminosity of 2×10^{34}, and that these parameters are consistent with the operating ranges in the sources, damping rings, bunch compressors and beam delivery systems.

Statements contributed by relevant parties:

The leaders of RTML (Ring-to-Main Linac), BDS (Beam Delivery System), Positron Sources and DR (Damping Ring) area systems responded to inquiry by the CCB, concerning potential impacts of this CCR on their system designs. None pointed out fundamental technical obstacles. M.Kuriki of Positron Sources, however, responded that the SHB frequencies, presently assumed to be 108MHz and 433MHz in BC, need to be revised to restore consistency with the new linac bunch spacing.

CCB Discussion:

Fairly simple arithmetic confirms that the parameters have been modified in a way that reduces average beam current (9.5mA → 9.0mA, with reduction of number of bunches to accelerate per pulse), while maintaining luminosity (with reduction at β_x* at the interaction point).

CCB Assessment

CCB finds that the proposed parameter set, being consistent and acceptable, as a reasonable working assumption, and thus concurs that CCR#24d qualifies as a new baseline definition.

CCR#24a

Statements contributed by relevant parties:

1. Requester gave the following statements:
    - As pointed out during the review of CCR#20, the HLRF system probably does not provide sufficient overhead if the peak gradient is 33.5 MV/m and the average current is 9.5 mA. Accordingly, the proposal redefines "the linac parameters to have a peak gradient of 33 MV/m at an average current of 9.0 mA. In this case, the RF power required at the cavities of an RF unit is 8.02 MW which is halfway between the maximum required (8.28 MW) assuming that the LLRF losses add linearly and maximum RF power required (7.80 MW) assuming that the LLRF losses add quadratically – see the CCB estimate for 9-8-9 (20061123) Appendix A1 in the response to CCR #20." "It is expected that this rf overhead will prove sufficient."
    - "During the EDR, experiments at the linac test facilities will demonstrate the capabilities and limitations of the RF distribution and LLRF systems. At the same time, detailed simulations of the collider energy gain need to be performed where the peak RF power is limited and which use realistic parameters for the cavities, LLRF, and RF losses. These experiments and calculations will provide better estimates of the RF power requirements. If the rf power is too low to provide 33MV/m, it is expected that a small reduction in the average current will be sufficient to restore the peak acceleration gradient and any luminosity impact can be recovered with a corresponding reduction in the horizontal beta function at the IP."
    - "The main linac had been designed with for an average beam current of 9.5 mA and a beam pulse length of 1.0 ms. Decreasing the average current from 9.5 to 9.0 mA causes the RF fill time to increase by ~6% or ~30 μs. The beam pulse length will be reduced to keep the RF pulse length constant which keeps the heat and cryo-loads roughly constant."
    - "The maximum RF unit gradient of 33 MV/m still allows for variation in the maximum achievable cavity gradient while still maintaining an average gradient of 31.5 MV/m within a 2.5 km cryogenic system as well as the main linac."

CCB Discussion:

2. This change addresses the CCB concerns raised with respect to the corresponding component of CCR#20 effectively and completely. Appendix B presents a CCB summary of RF-power accounting with new proposed parameters, in the same format as Appendices A1 and A2 of previous CCB response to CCR#20. It indicates that if the LLRF overhead is considered to contribute in quadratic sum, an RF unit with 26 cavities (9-8-9 configuration) can be still said to maintain reasonable headroom for operation at an accelerating gradient of 33MV/m with a beam current of 9mA.
3. The bullet 1 in the requester's remark above has slightly wrong numerical statements. If the 9-8-9 configuration is to be adopted the RF power available for cavities would be 8.10MW if the LLRF losses add quadratically. It would be 7.63MW if the LLRF losses add linearly. However, these do not affect the fundamentals of the CCB assessment that follows.
4. As for bullet 3 in the requester's remark above, the bunch train length with CCR#24d will be 969μs, 19μs longer than present baseline of 950μs. This is in addition to the increase of the fill time by ~30μs. However, since the calculations of the heat-load and cryo-load in the present baseline have been done with an assumption of the bunch train length being 1ms,

the integrity of the design logic is still maintained. Therefore, it does not affect the fundamentals of the CCB assessment that follows.

5. The CCB concurs with the need for more elaborate and detailed simulation of RF system performance under realistic conditions. We are also convinced that modest changes to the IP optics can correct any residual deficiencies. CCB notes the fact that relatively small changes of beam parameters allowed us to restore the design integrity and consistency. This is indicative of the situation that some aspects of our design consistency rely on rather delicate balancing of these parameters.

CCB Assessment

- CCB finds that in the present accounting of RF power, the case 9-8-9 as proposed with CCR#24a should be able to support operation of 31.5MV/m gradient on average. Therefore, CCB finds CCR#24a acceptable as a new baseline.
- CCB, however, notes that it is important to understand in future design analysis how the individual elements in the LLRF loss factors are to be added in actual operation.
- CCB also notes that it is important to understand the ranges of beam parameters, together with their inter-dependence and constraints, so that the overall operability of ILC becomes more thoroughly understood by all who are involved in the design and development efforts.
- CCB wishes to urge all area groups to adequately update their baseline system descriptions, without excessive delay. Possible subjects include descriptions of: bunchers and subharmonic bunchers of electron sources, RF system layout for particle sources and RTML, beam parameters and timing specifications in general.

CCR#24b

Statements contributed by relevant parties:

1. Requester noted the following:
   - "Change request #20b reduced the RF overhead from 3.5% to 0%. This essentially is a redefinition of the operating energy of the ILC, since the 3.5% energy overhead was thought necessary to always (>99% of the time) achieve the design CMS energy of 500 GeV and also provide energy feedback. Without the 3.5% energy overhead the full CMS energy of 500 GeV could only be achieved when all RF units were operational. The routine CMS energy is difficult to define because it depends on the detailed operating and repair scenarios. However, simple availability models, similar to those discussed by the CCB, would suggest that a CMS energy within 0.5% of 500 GeV could be achieved more than 50% of the time. Furthermore, the full 500 GeV CMS energy could be achieved when necessary given the extra effort to get all RF units operational. Finally, it should be noted that space had been left in the main linac tunnel so that the 3.5% additional RF units could be installed to recover the possibility of always operating at 500 GeV cms as requested by the WWS (see Appendix B2 in the response to CCR #20)."
   - "This change request has the largest cost impact but, as discussed, it is difficult to analyze in absolute terms. The EC believes that this change request is an effective cost savings and feels comfortable with the redefinition of the linac energy reach; the WWS appeared to feel similarly. A more detailed understanding of the energy reach, overhead, and linac operation will be calculated during the EDR."

CCB Discussion:

2. A new report on the Parameters for ILC by the Parameter Subcommittee under ILCSC, dated November 20, 2006, has been made publicly available on December 7, 2006 [4] as http://www.linearcollider.org/newsline/pdfs/20061207_LC_Parameters_Novfinal.pdf . While the exact binding power of this document with respect to GDE's design efforts may require clarification and refinement, it is a fact that the previous version of this document (http://www.fnal.gov/directorate/icfa/LC_parametrs.pdf) has been heavily referred to in determining the ILC parameters as of Snowmass 2005 . Therefore, CCB feels that it is not unreasonable to refer to a statement concerning the energy reach of ILC in the new Subcommittee report which reads as follows:

   > "The maximum centre-of-mass energy should be 500 GeV. Removing safety margins in the energy reach is acceptable but should be recoverable without extra construction. The maximum luminosity is not needed at the top energy (500 GeV), however, 500 GeV should be reachable assuming nominal gradient. The machine should allow for an energy range for physics between 200 GeV and 500 GeV, with operation at any energy value as dictated by the physics (e.g. at the maximum of the Higgs production cross section)."

CCB Assessment:

- The original proposal, CCR#20b, had two elements that were primarily responsible for the negative decision on that component, in addition to the high-possibility of the linac RF power accounting broken at that time. These were:
  1. Clear implication of a significant softening, relative to Snowmass, of the project position with respect to the need for reliable simultaneous achievement of the two

principle ILC performance variables: energy and luminosity. Absent clear direction from the EC, the CCB felt it had no choice but to reject a proposal that clearly took significant risks in this area.

2. Removal of the tunnel that housed the additional 3.5% of linac meant that there was no realistic prospect of recovering from the change without a significant cost increase. Thus, in addition to greatly increased risk, there was no realistic way to mitigate the risk.

CCR#24b clearly and positively addresses both these points. Statements in the new report by the Parameter Committee under ILCSC are consistent with the performance and availability projection expected from CCR#24b, also. Therefore, CCB is now satisfied that this component of the proposal is acceptable as a new baseline.

CCB, however, notes that if/when physics operation at the top 500GeV is conducted in earnest, it is quite likely that some additional installation of RF units and cavities will be called for in an attempt to improve the luminosity availability at that time.

CCR#24c

Statements contributed by relevant parties:

1. Requester noted the following:
   - "The design included an overhead factor 40% and an uncertainty of 50% fot the static load and the total heat load can be written as:

     $$Q_{tot} = 1.4 \times (1.5 \times \text{static} + \text{dynamic}). \qquad \text{(Eq. 1)}$$

     The 1.5 is an uncertainty factor while the 1.4 is an overcapacity factor. Reducing the uncertainty factor to 0 reduces the cryogenic system capability by 13%.

     The main objection to the 1.5 factor is that it is a design contingency which has not been included in other items such as gradient. At the time of construction, the static, as well as the dynamic, heat loads will be known and thus there will be no uncertainty. In cases such as this, we should use our best estimate and not implicitly add contingency, which we can do in the cost estimate (as a risk factor for example)."
   - "In part, the uncertainty factor was included to provide some margin against parameter variation. The baseline parameters for the collider require that an average accelerating gradient of 31.5 MV/m be attained in the accelerator cavities to reach the cms energy of 500 GeV. Given the variation in cavity and rf power source performance, it is assumed that some rf units will operate above this average gradient and some below. However, the length scale of these variations was not specified. The uncertainty factor provided some margin against an average gradient higher than 31.5 MV/m over the full cryogenic system length of roughly 2.5 km. This is not necessary. It is entirely consistent with the ILC goals to assume an average gradient over an individual cryogenic system equal to the average gradient in the collider of 31.5 MV/m. It is believed that this new definition of the average gradient will make CCR #20c acceptable."
2. Cryogenic system experts within GDE, however, contributed statements to the contrary.
   - T.Petersen's communication is reproduced in Appendix C1. L.Tavian's communication is reproduced in Appendix C2.
   - Petersen and Tavian both stated that the uncertainty factor (1.5) accounts for our imperfect knowledge of heat loads which will not be known before production operation of the actual system. They both stated that the uncertainty factor may be foregone if the system happens to have a built-in knob (i.e. a free parameter) to adjust in ways to cope with such an uncertainty. However, in their observation, ILC does not possess such a free parameter which has been identified and agreed upon within the design team

CCB Discussion:

- Issues raised by Petersen and Tavian, concerning the nature of the uncertainty factor with the static heat load, are worth noting. CCB agrees with Petersen and Tavian in feeling that making this uncertainty factor to be zero is not a good engineering practice.
- The cost reduction expected from CCR#24c is 0.5%, smaller than those from CCR#24a and #24b.

- If the static heat load turns out to be excessive large, one way around would be to reduce the repetition rate of operation from 5 Hz to 4 Hz, and reduce the dynamic heat load, thereby reducing the total heat load. This affects the luminosity in a range of center-of-mass energies wider than CCR#24b, because of the distributed nature of cryogenic system's implementation.
- The value to assume for the uncertainty factor (1.2 or 1.3 or 1.4, etc) should be a subject of more expert discussion, however.

On a matter separate from the discussion of static heat load, CCB understands that the dynamic heat load in the baseline is to be evaluated for 31.5MV/m *average* gradient for 9.0mA beams. If the cavity gradient is raised to 33MV/m *on average* for an as-built machine, the dynamic heat load will be increased by approximately 9.8%. This appears to be covered by the overhead factor of 1.4, in as much as other elements of overhead would not dominate the accounting. However, it should be noted that the dynamic heat load will be also increased with cavities operating at reduced Q_0 at various gradient values. For instance a reduction of 10~20% on Q_0 will result in an additional 11~25% increase of the dynamic heat load. Consequently, it is important to establish a clear definition as to under which condition (gradient and its variation, Q_0 and its variation, beam current and its variation etc) the nominal dynamic heat load should be determined for which the overhead factor 1.4 is to be added. CCB notes that the present CCR#24c is not explicit in that regard, and unless adequately qualified, it can have a risk of compromising the luminosity or energy reach of ILC.

CCB Assessment

- CCB finds that the case for this change proposal is not compelling enough in view of cost vs risk.
- CCB feels that the actual magnitude of uncertainty factor to assume for the static heat load calls for more expert discussion and consensus-forming.
- CCB feels that aside from the formula and coefficients to adopt in Eq.1, the conditions in which the baseline values of both the static and dynamic heat loads call for more expert discussion and consensus-forming.
- CCB concludes that unless the issues stated above are clearly resolved, it is not adequate to recommend approval of CCR#24c.

Costing Issues

This discussion is similar to the report on CCR#20:

- Summary of the cost impacts, normalized to the total main linac (ML) construction cost, are as follows
  - CCR#24a: 1.2% reduction
  - CCR#24b: 1.3% reduction (revised[a], since the tunnel facilities are not reduced)
  - CCR#24c: 0.5% reduction
  - CCR#24d: No identified cost impact
- The calculation of the percentage cost changes is based on a total ML cost which uses the scaled TESLA estimates for the cryomodules.

Overall CCB Assessment:

1. Since details of CCB assessments on CCR#24a, CCR#24b, CCR#24c and CCR#24d are individually presented in previous sections, they are not repeated here.
2. CCB conclusions as the result of these deliberations are as given in “CCB response” under “Summary”.
3. Several supplementary remarks, as extracted from discussion of each element of CCR#24 are reproduced below:
   - It is important to understand in future design analysis how the individual elements in the LLRF loss factors are to be added in actual operation.
   - It is important to understand the ranges of beam parameters, together with their inter-dependence and constraints, so that the overall operability of ILC becomes more thoroughly understood by all who are involved in the design and development efforts.
   - All area groups should adequately update their baseline system descriptions, without excessive delay. Possible subjects include descriptions of: bunchers and subharmonic bunchers of electron sources, RF system layout for particle sources and RTML, beam parameters and timing specifications in general.
   - The actual magnitude of uncertainty factor to assume for the static heat load calls for more expert discussion and consensus-forming.
   - Aside from the formula and coefficients to adopt in calculating the total heat load capacity of the cryogenic system, the conditions in which the baseline values of both the static and dynamic heat loads call for more expert discussion and consensus-forming.

E N D

---

[a] Communication from T.Shidara, January 19, 2007.

References

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

[2] http://lcdev.kek.jp/ML/PubCCB/msg00137.html , http://www.linearcollider.org/wiki/lib/exe/fetch.php?id=bcd_history&cache=cache&media=bcd:ccr24_proposal.pdf

[3] http://lcdev.kek.jp/ML/PubCCB/msg00129.html , http://www.linearcollider.org/wiki/lib/exe/fetch.php?cache=cache&media=bcd:ccb-com-ml20061127.pdf

[4] http://www.linearcollider.org/newsline/archive/2006/20061207.html , http://www.linearcollider.org/cms/?pid=1000352 .

Appendix A1

Reproduced below is a response from P.Tenenbaum (RTML AG leader) concerning CCR#24.

[CCB-1103] Re: CCR#24 and RTML

- *Subject*: [CCB-1103] Re: CCR#24 and RTML
- *From*: Peter Tenenbaum
- *Date*: Fri, 12 Jan 2007 09:52:23 -0800

I think that the RTML would be OK with this. We actually have an optics for the BC which uses the 9-8Q-9 RF configuration. In BC1 we would of course still like to use 8Q-8Q-8Q for now.

-PT

Appendix A2

Reproduced below is a response from A.Seryi (BDS AG leader) concerning CCR#24.

[CCB-1105] RE: CCR#24 and BDS

- *Subject*: [CCB-1105] RE: CCR#24 and BDS
- *From*: Seryi, Andrei
- *Date*: Sun, 14 Jan 2007 13:13:21 -0800

Dear Nobu,

Thank you for this message! Indeed these changes are small enough and won't require significant design changes to BDS. So, this should be OK.

Best regards
Andrei for Deepa and Hitoshi

Appendix A3

Reproduced below is a response from M.Kuriki (Positron Source AG leader) concerning CCR#24.

[CCB-1106] Fw: CCR#24 and e- source / e+ source

- *Subject*: Re: CCR#24 and e- source / e+ source
- *From*: KURIKI Masao
- *Date*: Mon, 15 Jan 2007 12:01:52 +0900 (JST)

Dear Nobu,

I can remember that we had responded to the CCR #20 from the source point of view. There is no any big impacts by changing the Cryomodule assembly mentioned in CCR#20.

The variations of the CCR#24 from the CCR#20, are mainly on the RF margins and parameters. I do not consider the RF power business affect the source part. Speaking of the main parameters, the less average current (9.5 -> 9.0 mA) is always welcome. The bunch charge is increased slightly, but it is within our margin.

One concern is for bunch separation, 472 of 1.3 GHz cycle.
It is inconsistent to the SHB frequency, 108MHz and 433MHz in BCD.

Appendix A4

Reproduced below is a response from A.Wolski (Damping Rings) concerning CCR#24.

[CCB-1107] Re: CCR#24 and DR

- *Subject*: [CCB-1107] Re: CCR#24 and DR
- *From*: Andy Wolski
- *Date*: Tue, 16 Jan 2007 03:26:52 +0000

Dear Nobu,

I believe it is correct that the changes you indicate will have only very minor impact on the damping rings, and we are happy with them. We shall make sure to use the new parameters if and when the CCR is approved.

Best regards,

Andy.

Appendix B

RF power accounting with the proposed new beam parameters in cases of “8-8-8” and “9-8-9” cavity configurations.

	Case: 8-8-8 Configuration			Case: 9-8-9 Configuration		
	Voltage loss	Power loss	Available Power (MW), when no derating of	Voltage loss	Power loss	Available Power (MW), when no derating of
Power Source and High Level RF Loss Factors						
Maximum Klystron Output Power		0.0%	10.00		0.0%	10.00
De-rating of klystron for end of life time		0.0%	10.00		0.0%	10.00
Modulator Ripple Spec = 1%	1%	0.0%	10.00	1%	0.0%	10.00
Waveguide and circulator losses		8.0%	9.20		10.0%	9.00
Power loss due to cavity gradient variation		2.3%	8.99		2.3%	8.79
Parameter variation	0.5%	1.0%	8.90	0.5%	1.0%	8.71
Total HLRF Loss and Available Power		11%	**8.90**		13%	**8.71**
Low Level RF Loss Factors						
Peak power headroom	1.0%	2.0%	8.72	1.0%	2.0%	8.53
Dynamic Headroom	3.0%	5.9%	8.21	3.0%	5.9%	8.03
Beam current fluctuations of 1%		1.0%	8.12		1.0%	7.95
Detuning errors of 30 Hz	1.0%	2.0%	7.96	1.0%	2.0%	7.79
Klystron drive noise sidebands	1.0%	2.0%	7.80	1.0%	2.0%	7.63
Total LLRF Loss (linear sum) and Available Power		12.3%	7.80		12.3%	7.63
Total LLRF (square sum) and Available Power		6.9%	8.28		6.9%	8.10
9-8-9 Configuration Case						
Power (kW) Required for 9mA @ 33 MV/m			0.308286			0.308286
Power (MW) for 24 or 26 cavities			7.40			8.02
Excess Power Headroom (when linear sum of LLRF losses assumed)			0.41			(0.38)
Excess Power Headroom (when square sum of LLRF losses assumed)			0.88			0.09
Peak Gradient (MV/m) at 9mA with 24 or 26 cavities, when zero power headroom is assumed for linear-sum LLRF loss			**34.81**			**31.43**
Peak Gradient (MV/m) at 9mA with 24 or 26 cavities, when zero power headroom is assumed for square-sum LLRF loss			**36.95**			**33.36**

Appendix C1

Reproduced below is a response from Tom Peterson concerning CCR#24c

[CCB-1090] Fw: CCR#24 -- cryo comments

- *Subject*: [CCB-1090] Fw: CCR#24 -- cryo comments
- *From*: N.Toge
- *Date*: Tue, 09 Jan 2007 08:10:36 +0900 (JST)

Dear CCB Colleagues,

I am forwarding a message from Tom Peterson concerning CCR#24c. He is making a case against approving CCR#24c.

Read it very carefully, and share your thoughts, please, ASAP.

- Nobu
--- *Begin Message* ---

- *Subject*: CCR#24 -- cryo comments
- *From*: Thomas J. Peterson
- *Date*: Mon, 08 Jan 2007 09:43:45 -0600

I would like to suggest that the CCB and EC reject CCR#24c, setting of the static heat load uncertainty factor to 1.0. The uncertainty factor is not "contingency" but just good engineering practice. The uncertainty factor accounts for our imperfect knowledge of heat loads in the same way as factors on stress in mechanical structures allow for our imperfect knowledge of the materials and loads.

It was I who asked for input regarding uncertainty factors, for example in my talk at Vancouver. My hope was that we could quantitatively evaluate heat load uncertainty for static and dynamic heat at each temperature level. In the absence of a quantitative evaluation of uncertainty, an overall factor of 1.4 (overcapacity) x 1.1 (uncertainty) = 1.54 is an optimistic judgement used for the current cost estimate which is about the same as the overall 1.5 factor in the TESLA TDR.

I take issue with the statement that "the actual static load would be known before construction begins". Even after components are tested, our experience is that there are indeed heat load uncertainties in cryogenic systems. Production cryomodules may differ from tested prototypes, and later production may differ from early production. After start of operation, heat loads may change. For example, insulating vacuum degradation and unforeseen dynamic effects such as the electron cloud issue in LHC (perhaps HOM or dark current issues for ILC) may develop.

If the statement in CCR#24c is a declaration of low risk -- that a slightly undersized cryogenic system is not of concern, since we have "knobs" like rep rate with which to manipulate heat loads -- then we should settle on a new cryogenic system criterion, a firm design target (e.g., 30 MV/m, or 4 Hz), and evaluate cryogenic system size per the new criteria by means of good engineering practice.

Regards,
Tom?

.

Appendix C2

Reproduced below is a response from Lorent Tavian concerning CCR#24c

[CCB-1092] CCR#24 - Comment from Laurent Tavian

- *Subject*: [CCB-1092] CCR#24 - Comment from Laurent Tavian
- *From*: N.Toge
- *Date*: Wed, 10 Jan 2007 07:20:40 +0900 (JST)

Dear CCB Colleagues,

…I am forwarding a remark from Laurent Tavian concerning CCR#24c, FYI.

- Nobu

    - *Subject*: RE?: CCR#24 -- cryo comments
    - *From*: Laurent Jean Tavian
    - *Date*: Tue, 9 Jan 2007 15:21:09 +0100

I fully agree with Tom statement. Series component test stations are not dedicated for fine heat load measurement (LHC experience return: the magnet heat load are in the background of the test equipment loads and the time to reach thermal equilibrium (MLI time constant of several days) is not compatible with the required test rate). Consequently, we will probably not know the actual level of heat loads of ILC before the construction start.
On a design target which has to be guaranteed, the cryogenic system must take uncertainty factors on heat loads.
On a design target which has some free parameters which can be adjusted to fit with the available cryogenic capacity, the need of uncertainty factor is more questionable (e.g. on Tore Supra cryogenic system, no contingency on heat load was taken into account but the time between two plasma experiments was the free parameter to adapt the cryogenic capacity to the actual loads). Are such free parameters available for ILC ?

An alternative could be to upgrade the cryogenic capacity with time (like done for the LEP2 machine). In this case some resources can be saved during the construction phase, but we have since the beginning to foresee the final required size for the distribution system including the cryomodule piping.

Regards, Laurent