2006/11/21

To: Files
From: Nobu Toge
Subject: Minutes of the CCB Hearing on RTML CCR (CCR#19) Cost Implications

Date: Wednesday, 2006/11/08
Venue: ADEIT Sala profesores, Valencia, Spain
Time: 08:00-09:00 EST
Present: N.Toge, W.Funk, T.Markiewicz, P.Garbincius, T.Shidara, W.Bialowons, L.Lilje, D.Schulte, K.Kubo, G.Blair, K.Yokoya, S.Mishra, C.Pagani, T.Raubenheimer, N.Walker, J.M.Paterson

1. Opening
   - Toge welcomed the participants, and noted that the purpose of this hearing is for CCB to understand the costing implications and the current status of design development concerning the RTML baseline configuration change request (CCR#19) that was submitted on 2006/10/24.
   - Garbincius confirmed that all present at the hearing had signed up on the GDE costing NDA in the past.

2. Presentation by P.Tenenbaum
   - Tenenbaum's presentation file has been distributed separately (For CCB's internal archive, it is [CCB-857] at http://lcdev.kek.jp/ML/CCB/msg00880.html , and is attached to this memo (Appendix A).
   - Presentation described the technical specifics of the elements within this change request, namely, the changes needed for consistency with CCR#18 and the changes proposed to reduce the cost of the BCD RTML. The presenter noted that the intention of this CCR is to bring the changes "conceptually into production", and another CCR which finalizes the parts counts etc will be submitted in the future.
   - Change proposals to maintain consistency with CCR#18 are described in slide 4.
   - Change proposals for cost reduction of RTML are described in slides 5 and 6.

3. Cost impacts
   - Tenenbaum explained the breakup of the cost changes associated with this CCR.
     a) Changes to maintain consistency with CCR#18 incur a cost increase, dominated by the expenses needed to introduce new beamlines, including the 5GeV transport.
     b) Changes to reduce the RTML cost, naturally, brings a cost reduction.

     The absolute magnitude of the latter is approximately x1.5 of the former.
   - CCB noted that the point a) above has been already accounted for in review of CCR#18. CCB, therefore, determined that only the portion corresponding to b) is to be considered as the cost impact associated with CCR#19.
   - GDE Cost Engineers reported that the relative magnitude of the cost impact of CCR#19 b) is approximately 18% of the RTML construction cost (Appendix B). The largest cost reduction is brought by reduction of part of conventional facilities, followed by reduction of cavities in BC2.
   - Based on the magnitude of the cost impacts, CCB determined that this CCR is to be classified as Class-2.

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4. Discussion
   - C (Toge): It is desirable to have a topology diagram of the RTML beamline illustrating its subsystems.

- C (Toge): The CF/S section of BCD should be eventually updated so that the type of cost reduction items in the area of CF/S with this CCR is brought under suitable configuration control.
- C (Kubo, Toge): We understand that while 2 out of 6 laserwires are not to be implemented in the initial installation, their installation slots are to be maintained. This appears to be a suitable arrangement.
- Q (Kubo, Schulte): Is the RTML in the revised design capable of producing the output bunch length of 0.3mm even with 9mm bunch length from the damping rings?
- A (Tenenbaum): Yes.
- Q (Funk): What if the field gradient in BC turns out to be lower than the original specifications?
- A (Tenenbaum): See Appendix C for details.

E N D

Appendix A

The presentation material used by P.Tenenbaum during the CCB hearing on CCR#19 is reproduced in the following 9 pages.

Changes to the RTML in Change Control Request 19

PT

SLAC

Introduction

- CCR # 19 contains two sets of changes
  - **Changes needed for consistency with CCR # 18 (Central DR)**
    - A long transfer line from the DR to the RTML turnaround, with all appropriate geometry adjustments, diagnostics, etc.
  - **Changes needed to reduce the cost of the BCD RTML**
    - We identified possible reductions totalling 19.7%
    - GDE Management approved all but 1 of them
    - The ones they approved are in CCR # 19

Important Note

- At this time, lattice files for the “post CCR” RTML are not complete
- Thus, all component counts are *approximate*
- We thought it important to get the changes at least conceptually “into production” as soon as possible
- So we put in a CCR now.
- When the changes are complete we will submit another CCR which finalizes the parts counts, etc., in the BCD
  - **May also need to respond to some other CCRs which are working their way through the system**

Changes for CCR 18 Consistency

- These were included in the CCR 18 hearing materials
  - **A long, straight transfer line at DR elevation including**
    - Skew correction
      - Correct coupling at DRX
    - Emittance measurement
    - Pulsed extraction / PPS Segmentation
    - Collimation
  - **A vertical dogleg ("escalator") to linac elevation**
  - **A very long horizontal transfer line at the elevation of the ceiling in the linac tunnel**
    - Needs to follow the earth's curvature
  - **Second collimation section in front of the turnaround**
  - **Second SKEW section between the BCD RTML SPIN and EMIT sections**
    - Correct coupling from SPIN

Cost Saving Changes

- Many changes addressed systems which are not currently captured in the RTML BCD
  - **CFS, vacuum, cryo, for example**
- CCR 19 is a subset of the full suite of changes

- How to handle this I do not know!

Cost Saving Changes (2)

- Elimination of 9 meter shaft in e+ RTML
- Elimination of 3 RF units (out of 19) in each BC2
  - **Puts one configuration out of reach**
    - 6 mm $\rightarrow$ 0.15 mm with 180° rotation in PZ phase plane
  - **Other 3 configurations still OK**
    - 6 mm $\rightarrow$ 0.15 mm with 90° rotation
    - 6 mm $\rightarrow$ 0.3 mm with 90° or 180° rotation
- Vertical stacking of "two-way" beamline in RTML
  - **Current baseline is side-by-side beamlines**
  - **Vertical stacking allows smaller, cheaper tunnel**
  - **Also: reduction in diameter of turnaround tunnel (from 6 meters, which seems excessive)**
  - **Necessary for CCR 18 as well**
- Elimination of some unnecessary surface buildings at RTML shafts

Cost Savings Changes (3)

- Eliminate 50% of quads in turnaround
  - **Larger beta functions → more SR emit growth**
  - **Reduce this through larger phase advance per cell**
    - Go from 90° to 108°
  - **May be able to increase bend magnet packing fraction as well**
- Eliminate x correctors at D quads
  - **Typical in many accelerators**
  - **Appears to be OK from emittance POV**
- Replace 22 kW and 660 kW beam dumps with 2 x 220 kW dumps
  - **Can run full power to BC1 dump**
  - **Can only run 1/3 power to BC2 dump**
- Loosen vacuum specification from 10 nTorr to 100 nTorr
  - **Seems okay from ion and beam-gas scattering POV**

Cost Savings (4)

- Fix accidental double-counting of dipole correctors in cost roll-up
  - **No actual impact on design!**
- Eliminate 3 NC crab cavities and 2 RF stations per side
  - **Can no longer measure YZ and PyZ correlations directly**
  - **Can still measure σ_z and PZ correlations**
- Eliminate 2 wires (out of 6) from EMIT
  - **Can no longer measure normal-mode emittances and coupling parameters**
  - **Can still measure projected emittances**
- Miscellaneous Savings
  - **Assume savings on air handling, water handling, controls, installation proportional to other savings**

Comments / Questions

"Turn and face the strange…"

-David Bowie

Appendix B

Subject: cost metric for CR#19
To: Nobu Toge
From: Peter Garbincius
Date: Wed, 08 Nov 2006 08:31:08 -0600

Here is what I said at today's CR #19 CCB hearing:
CR #19/(Vancouver RTML + RTML part of CR # 18) = 18%

Peter

Appendix C

Subject: Follow-up on Today's Meeting
To: Nobu Toge
From: Peter Tenenbaum
Date: Wed, 08 Nov 2006 01:09:39 -0800

Warren asked about the results of not meeting the gradient. I took a look at the configurations. The nominal configuration requires a gradient of 29.5 MV/m in order to hit the 300 um RMS bunch length and still have 1 spare RF unit in BC2. The 300 "alternate" configuration (180 degree phase rotation) requires 30.1 MV/m, and the 150 um configuration needs 31.1 MV/m.

If the achievable gradient is lower than 31.1 MV/m, then either the highest-voltage configurations become unattainable or else the spare unit has to be turned on, in which case there is no spare. If the gradient is below 29.5 MV/m then we cannot run in the baseline configuration, and we need to lengthen the bunch and reduce the luminosity. I note that the bunch length out of BC1 is 800 um RMS, so under no circumstances do we need to lengthen the bunch beyond that. At a guess, I would say that the achievable final bunch length probably varies approximately linearly between 800 um and 300 um. So if you miss the gradient by 10%, the achievable final length is probably around 350 um.

Of course, the BC2 RF also brings the beam energy up to 15 GeV for the linac, so if you miss on the gradient you also miss on the CM energy.

Subject: Re: Minutes of CCB Hearing on CCR#19 (Draft A)
From: Peter Tenenbaum
To: N.Toge
Date: Tue, 14 Nov 2006 15:08:58 -0800

Upon further study of the problem, I would like to add something about the bunch length and the BC2 voltage.

It appears that configurations which produce 300 um RMS final bunch lengths are not too difficult to achieve, even at lower voltage. The process for finding optimal solutions is a bit tedious, but straightforward. As a result, I think that if the BC2 voltage does not meet the current specifications, we can easily find parameters which will fit within the voltage budget and achieve the desired bunch length.

There will of course be trade-offs. At lower BC2 voltage, the beam energy into the linac will be lower, so the CM energy will be lower as well. A related phenomenon is that the RMS energy spread will be higher, so there will be more emittance growth in BC2 due to errors. These are both incremental factors, which means that in real life, if BC2 does not meet its voltage specifications, then we will consider the trade-offs between longer bunches at the IP, increased emittance growth, and lower CM energy, and pick a new optimum based on those considerations.

-PT