Road to Beijing and Beyond

Barry Barish

Caltech / GDE

10-Nov-06

Outline

- What did we accomplish at Valencia ?
- The Next Steps in Design / Costing
  - **Make all final design changes, freeze for RDR**
  - **Conduct an internal cost review**
  - **Present to MAC / ILCSC / MAC**
  - **Brief the Governments**
- Producing the RDR
- Develop the RDB Task Force Plans
  - **I note this important advance, but will not cover today**

In Memory of Mike Ronan

Plans until Beijing (Feb. '07)

- By the end of this workshop we must have
  - **consolidated design**

Design Changes Under Consideration

	RDR MB	CCB
2×14mr IRs	supported	✓
central injectors	supported	✓
Removal of service tunnel	rejected	
conventional e+ source	rejected	
RF unit modifications (24 → 26 cav/klys)	supported	submitted
reduced RF in DR (6 → 9mm σ_z)	supported	in prep
DR race-track lattice (CFS)	supported	in prep
reduced static cryo overhead	supported	in prep
removal linac RF overhead	supported	in prep
single-stage bunch compressor	rejected	
e- source: common pre-accelerator	supported	in prep

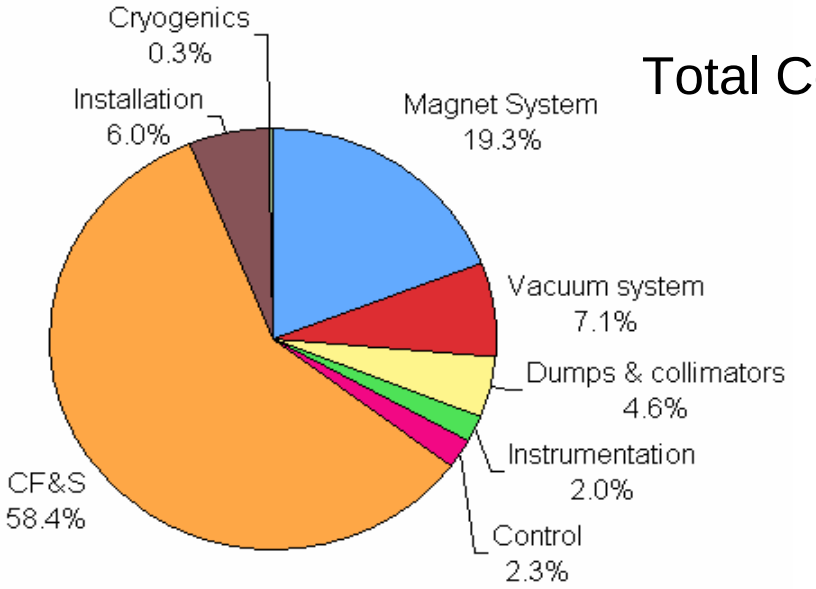
MDI Related Design Changes

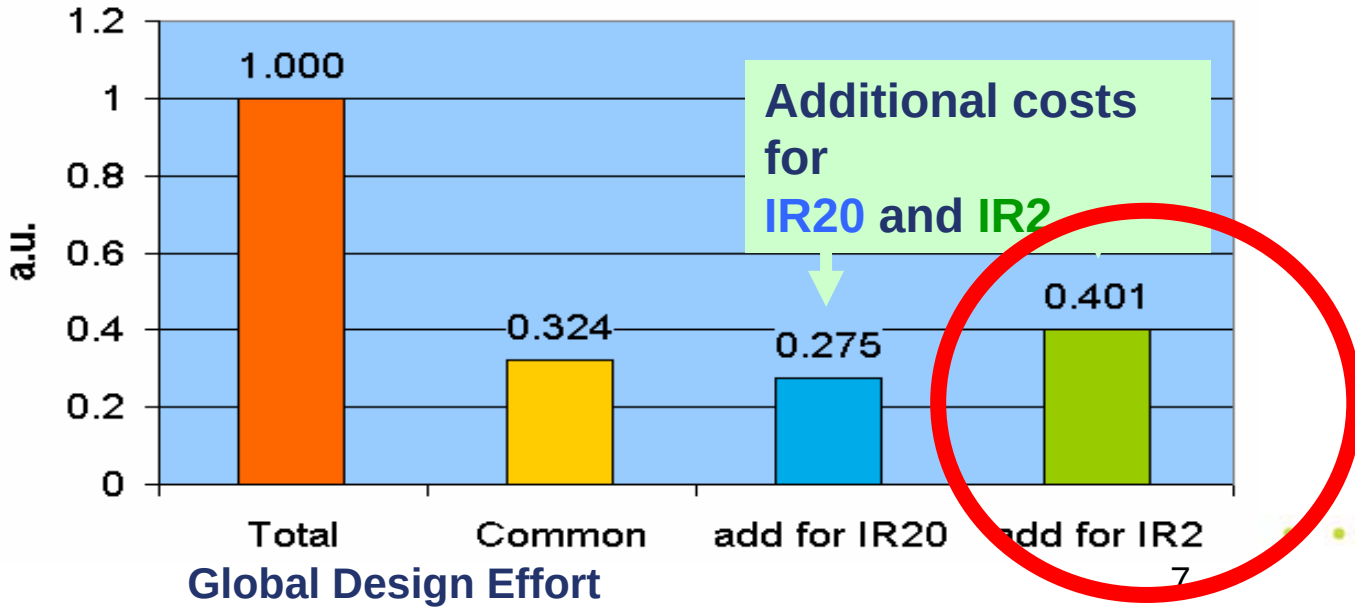
- Some cost / performance design changes would affect physics performance or reach. We are trying to pick items without major impact or are reversible changes
  - **Two detectors preserved; but no small crossing angle beam; (immature design, high cost, small physics loss)**
  - **Reduced Muon Shield; (add later, if needed)**
  - **Detector Mounting on Surface; (has schedule benefits)**

- These are being fully discussed and coordinated with the Physics Community
  - **MDI Panel; WWS; Physics Parameter Group**

Vancouver Costs for BDS

- Cost drivers
  - CF&S
  - Magnet system
  - Vacuum system
  - Installation
  - Dumps & Collimators





2/20 mrad → 14/14 mrad

- Motivation
  - **Reduce costs**
    - 2 mrad beam line expensive, risky, especially extraction line
    - Common collider hall
  - **Advantages**
    - Improved radiation conditions in the extraction lines
    - Better performance of downstream diagnostics
    - Easier design and operation of extraction optics and magnets
    - Reduced back scattering from extraction line elements
  - **Disadvantages**
    - Impact on physics (appears minor at present).
    - Simpler incoming beam optics
- R&D on small crossing angles will continue as alternative

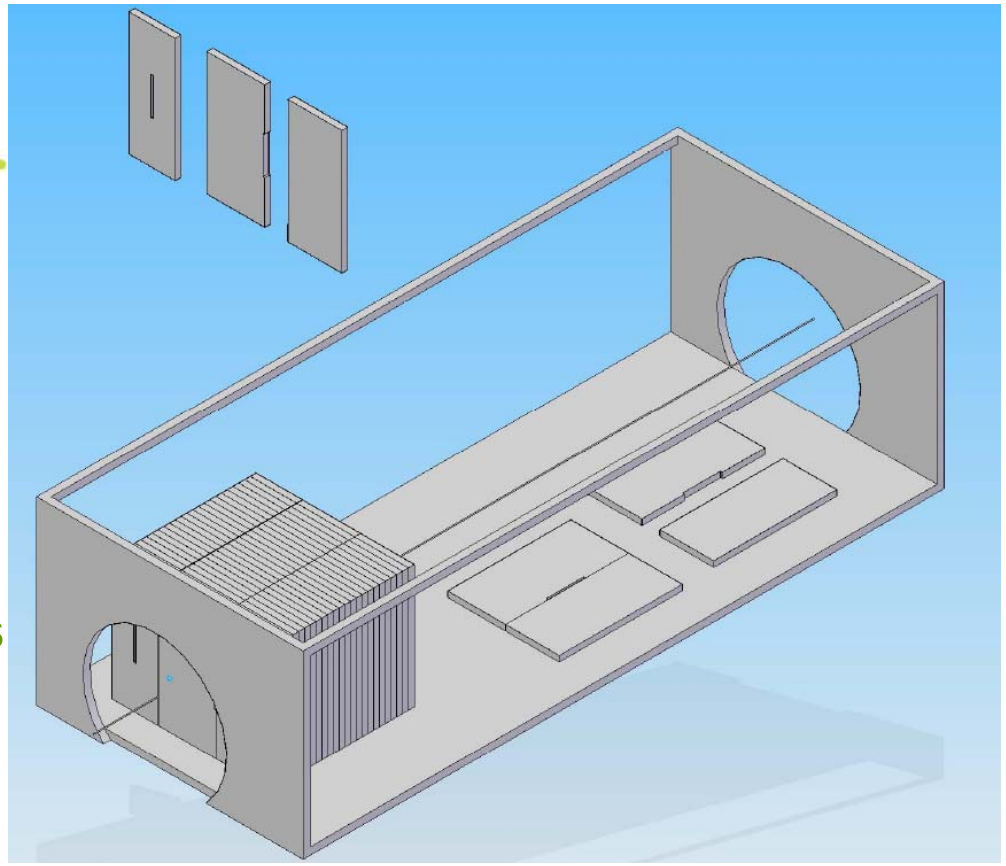
2/20 mrad → 14/14 mrad

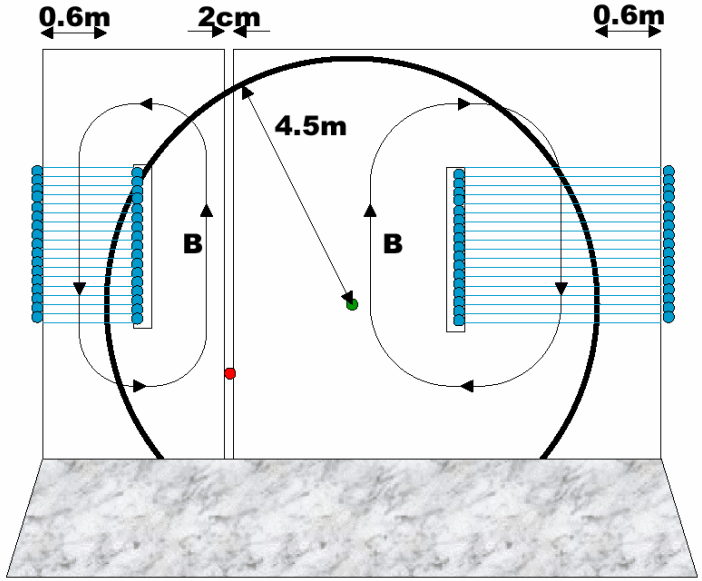
- Design & cost of 14/14 with common collider hall & z=0
  - **Design of 14mr beamline is similar to 20mrad**
  - **The cost reduction in this configuration is ~16%**

- Physics/Detector Community (MDI – WWS)
  - ***"With this limited information, the MDI panel thinks that the 14mrad is acceptable as the baseline at this time. However, we would like to stress that the 2mrad crossing angle is clearly desirable than larger crossing angles for the slepton search, and R&Ds related to 2mrad should be encouraged."***

Muon walls

- Purpose:
  - **Personnel Protection: Limit dose rates in one IR from other IR**
  - **Physics: Reduce the muon background in the detectors**





Scheme of a muon wall installed in a tunnel widening which provide passage around the wall

Baseline configuration:
18m and 9m walls in each beamline

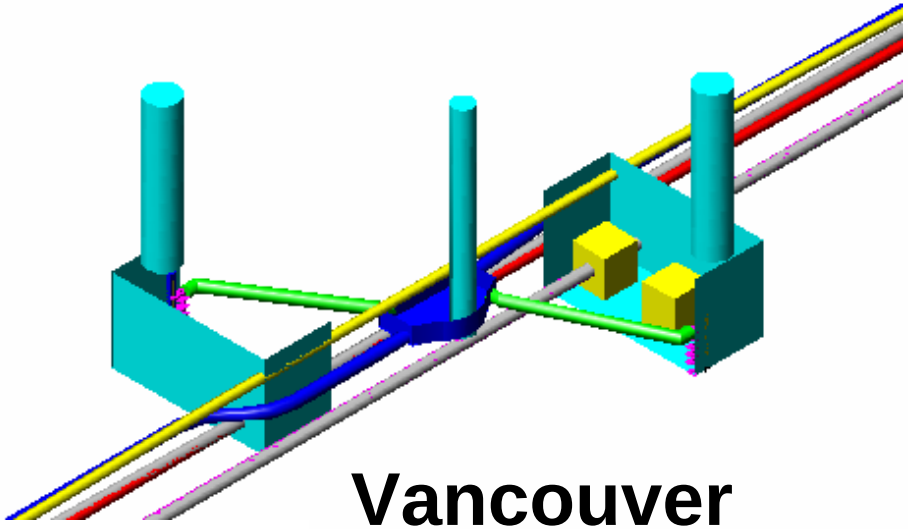
Reduced Muon Walls

- Considerations
  - **The estimation of 0.1% beam halo population is conservative and not supported by any simulations**
  - **The min muon wall for personnel protection is 5m**
  - **Detector can tolerate higher muon flux.**
  - **Cost of long muon spoilers is substantial, dominated by material cost**
  - **Alternatives – muon spoilers need study**

- The caverns will be built for full length walls, allowing upgrade if higher muons flux would be measured

- MDI panel accepted this change.

Hall Designs for two IRs



Vancouver

Valencia

On-surface Detector Assembly

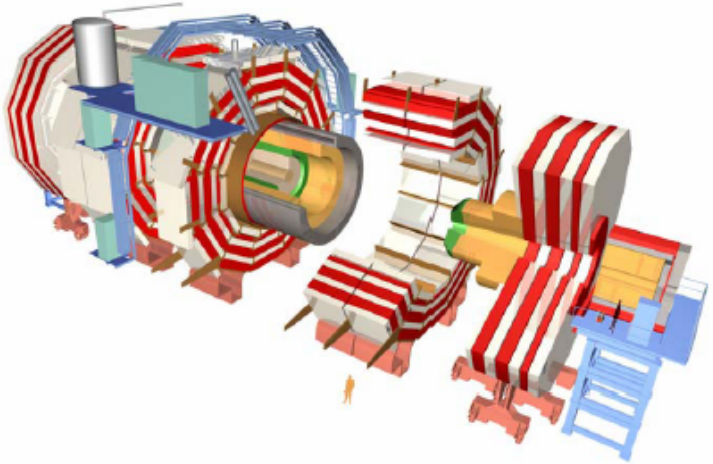
- Vancouver WBS considered the underground halls sized at 32m (W) x 72m (L) each to allow underground assembly of the largest considered detector.

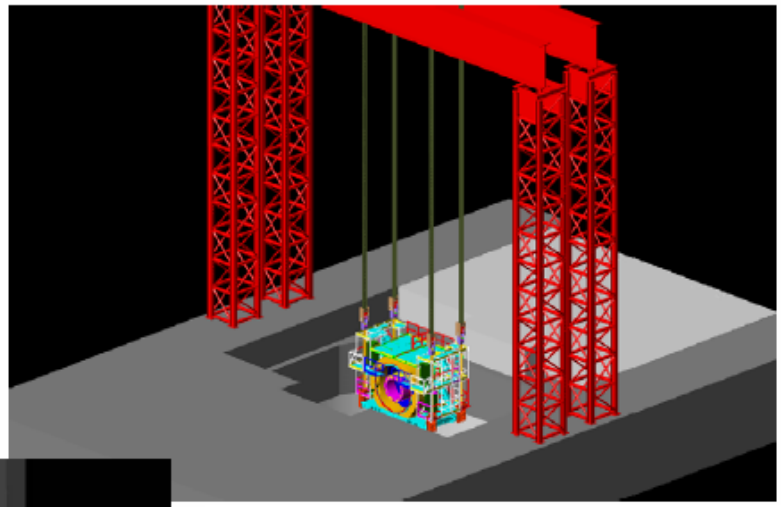
- Conventional Facilities Schedule gives detector hall is ready for detector assembly 5 yrs from project start
  - **If so, cannot fit our goal of "7years until first beam" and "8years until physics run"**

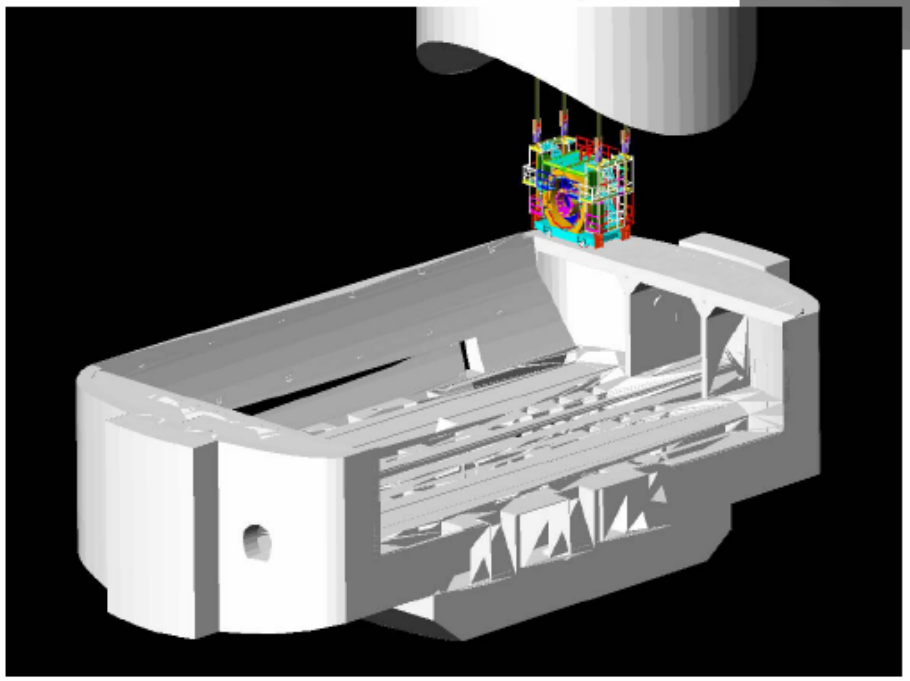
- Surface assembly allows to save 2-2.5 years and allows to fit into this goal
  - **The collider hall size may be smaller (~40-50%) in this case**
  - **A building on surface is needed, but savings may be still substantial**

- Optimization needs to be done

On-surface assembly



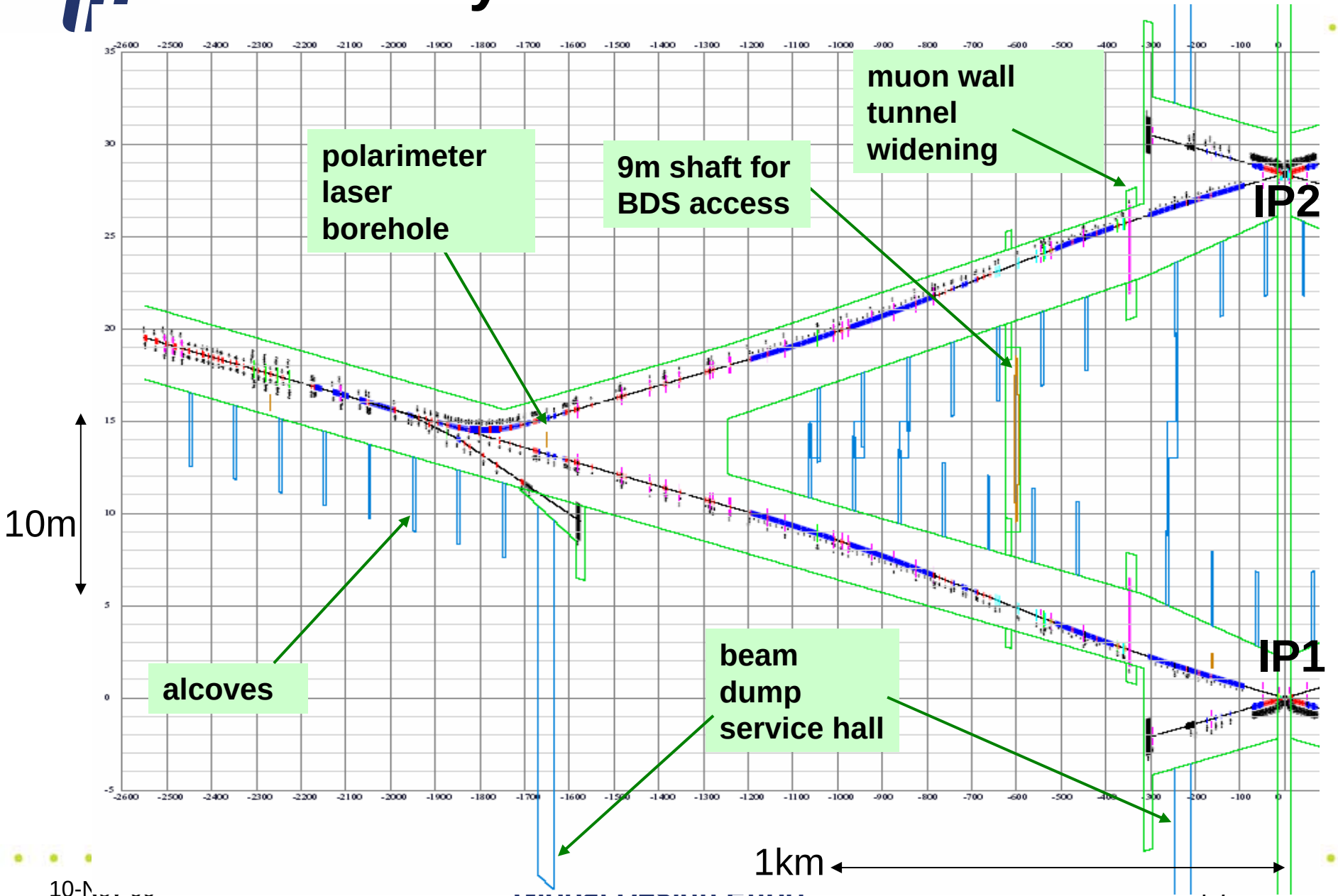




CMS assembly approach

- **Assembled on the surface in parallel with underground work**
- **Allows pre-commissioning before lowering**
- **Lowering using dedicated heavy lifting equipment**
- **Potential for big time saving**
- **Reduce size of underground hall required**

BDS Layout for New Baseline



Plans until Beijing (Feb. '07)

- By the end of this workshop we must have
  - **consolidated design**
  - **new cost estimate**

Valencia Reviews

- Wednesday: Area System
  - **Main Linac**
  - **BDS**
  - **RTML**
  - **DR**
  - **e+e- sources**
- Thursday: Technical
  - **RF Power**
  - **Instrumentation**
  - **Cavities / CM**
  - **Vacuum**
  - **Metrology**

Focus on completeness of design and cost status

Focus on component cost estimates, cost reduction and ‘quality/basis’ of estimate

Dumps & Collimators
Magnets / Power Supplies
Controls (LLRF)
Installation
Cryogenics

Initial (Management) Feedback

- Very impressed by standard of presentations
  - **and amount of work done!**
- We need a little more time (~week) to consolidate and review cost savings
  - **synchronise area system – technical groups – cost engineers cost information**
  - **check for 'double counting effects' etc.**
- The **cost** of the machine is **significantly less** at the **End of the Workshop** than **at the Beginning**

Findings

- Significant cost reductions for many groups
- Good progress in completing estimates, WBS dictionary and Basis of Estimate
- watch out for double counting the savings, easy for both Area Systems and CF&S to take credit
- Still missing much institutional labor estimates, but found some “hidden” labor as costs some confusion on labor – need guidance

Cost Reductions Found (unvetted)

0.35% e- source: elim 1 NC beam, lasers to surface

0.14% e+ source: < # correctors, BPM, 2nd target sta.

0.20% RF: fast ACD charging PS for modulators

1.21% Controls: Front End electronics, cable plant, ATCA, network infrastructure, LLRF changes

1.80% Installation (in contract labor) new basis of est: scale time & motion to task, bottom-up est.

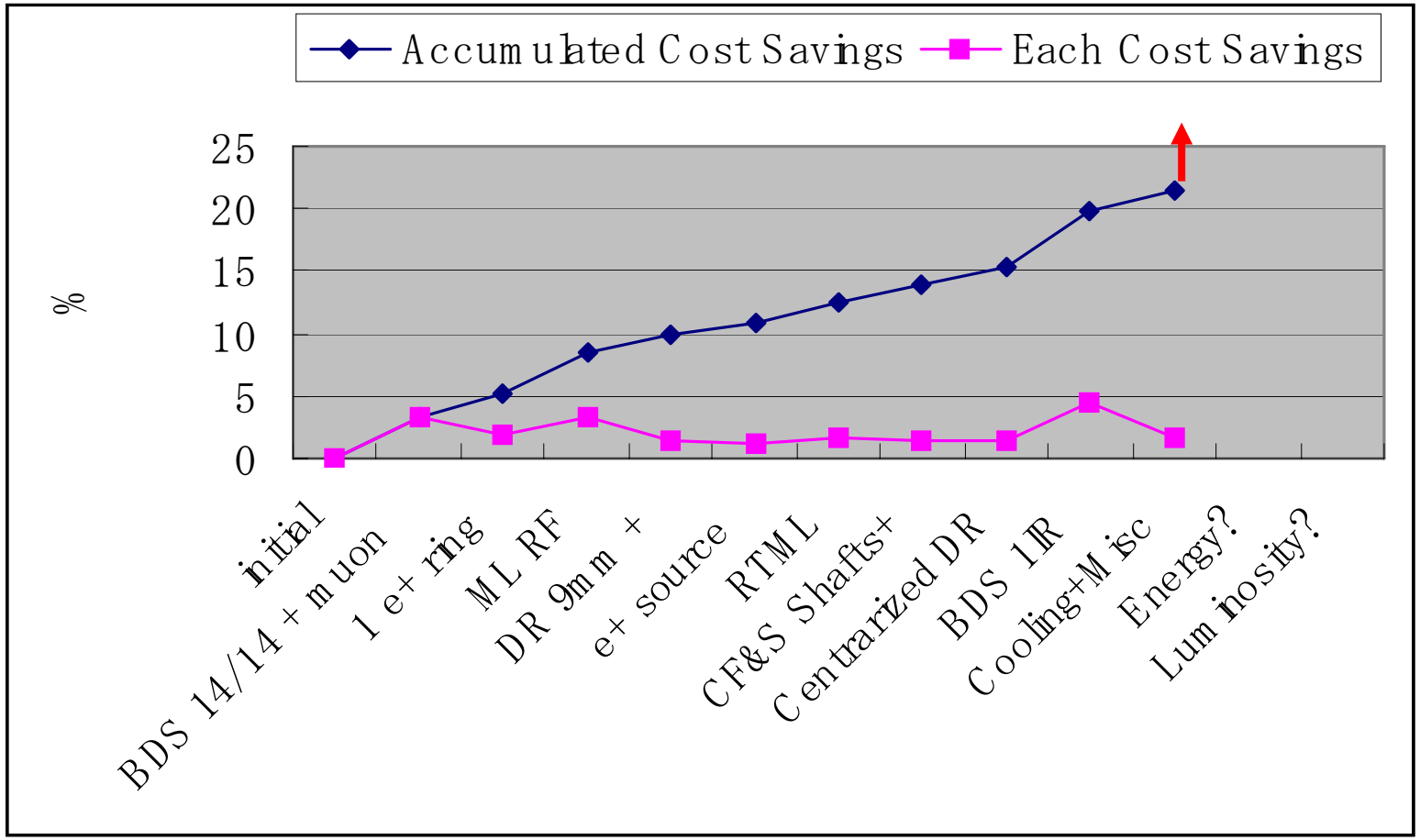
0.91% PS engineering optimization

0.29% Cold Vacuum: remove fast acting valves and

4.91% total 15/16 of Turbo Molecular Pumps

On Tuesday, Tetsuo showed:

Our efforts at Valencia identified another **4.91%!**



Plans until Beijing (Feb. '07)

- By the end of this workshop we must have
  - **consolidated design**
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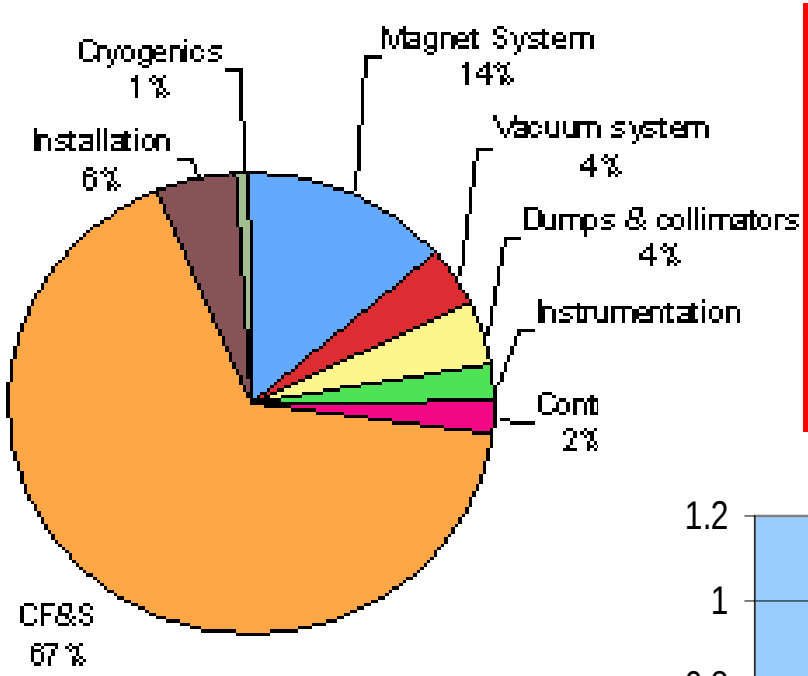
  - **prioritized plans for addressing remaining (cost-driven) issues**

MDI Related Design Changes

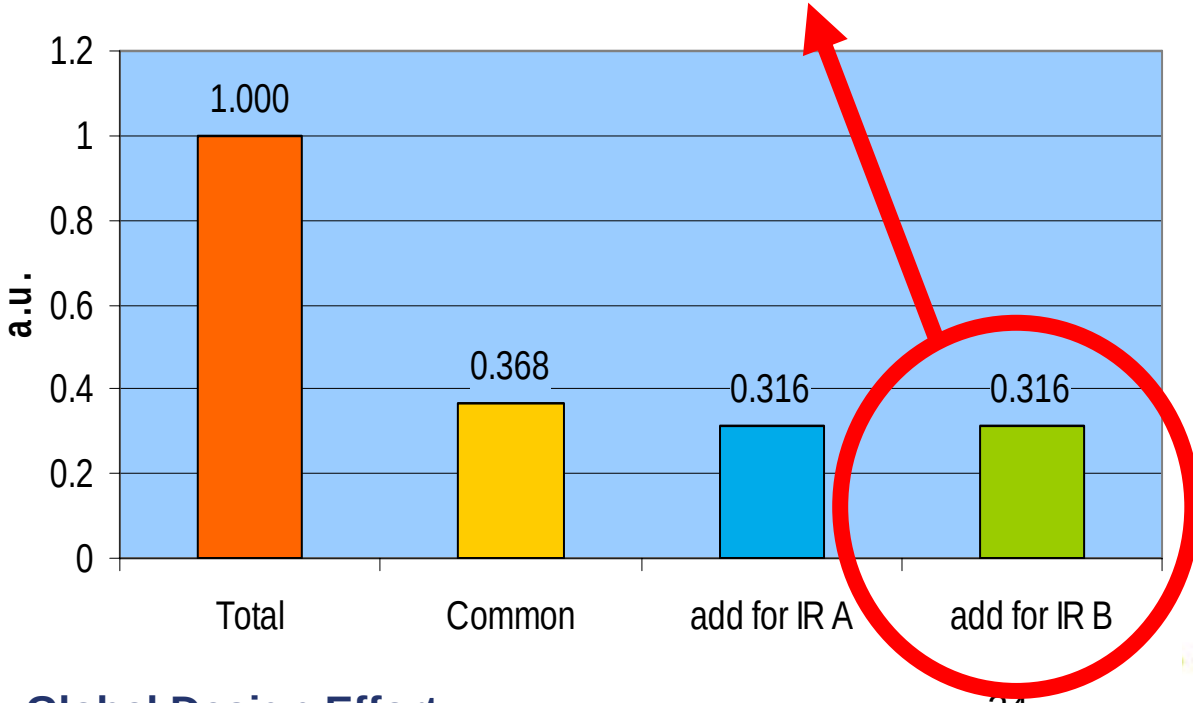
- Some cost / performance design changes would affect physics performance or reach. We are trying to pick items without major impact or are reversible changes
  - **Energy reach: maintain 500 GeV (but redefine performance at that energy)**
  - **Peak Luminosity; (reduce for initial running; but, upgradeable)**
  - **Two detectors preserved, but one beam line + push-pull**

- These are being fully discussed and coordinated with the Physics Community
  - **MDI Panel; WWS; Physics Parameter Group**

Cost details of new 14/14 baseline



Should we go to a single IR and push pull system and save 30% of BCD costs?



Updates from CF&S
Magnets to be included

Push-Pull Evaluation

- Initiated by GDE & WWS at the end of September
- Detailed list of questions to be studied developed:

http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/push-pull/

- Large group of accelerator and detector colleagues, from ILC and other projects, is participating in design and discussion of these question
- The task force of detector experts was formed to contribute to detailed evaluation of the whole set of technical issues

Reduced # Bunches

Impact of ILC operation with a reduced number of bunches

Introduction

As a possible cost reduction option, a proposal to operate with half the number of bunches (approximately 1330 bunches) over the same train length (one ms) is being considered. Because of a factor of two reduction in the size of the RF system, this modification will result in a net savings of 2-3% of the total project cost. Although the peak luminosity of the machine will be reduced by a factor of two, a relatively straightforward upgrade of the RF system can fully restore the machine's luminosity performance to that of the current baseline.

Luminosity Model – ½ RF Scenario

tor

Full rf system

year	peak L	avail	% peak	lum/yr	int lum
1	2.00E+33	10%	80%	3.57E+39	3.57E+39
2	6.00E+33	30%	80%	3.22E+40	3.57E+40
3	1.30E+34	70%	80%	1.63E+41	1.98E+41
4	2.00E+34	80%	80%	2.86E+41	4.84E+41

Half rf system

year	peak L	avail	% peak	lum/yr	int lum
1	2.00E+33	10%	80%	3.57E+39	3.57E+39
2	6.00E+33	30%	80%	3.22E+40	3.57E+40
3	1.00E+34	70%	80%	1.25E+41	1.61E+41
4	1.10E+34	80%	80%	1.57E+41	3.18E+41
5	1.20E+34	80%	80%	1.72E+41	4.90E+41

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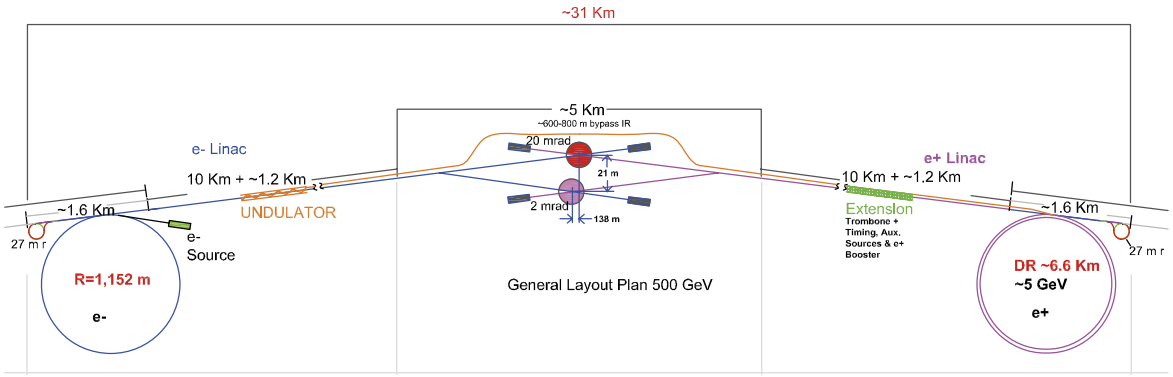
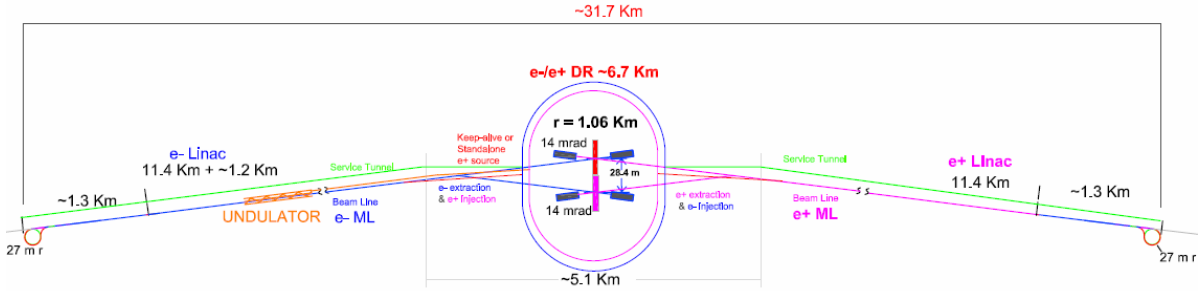
  - **prioritized plans for addressing remaining (cost-driven) issues**
  - **schedule for CCB**

Change to Central Damping Rings





Schematic Layout of the 500 GeV Machine

Introduction

N Toge

- CCB = Change Congrol Board
  - **C.Pagani, G.Blair, D.Schulte, T.Markiewicz, S.Mishra, W.Funk, K.Kubo, M.Kuriki, N.Toge**
- CCR = Change Configuration Request
  - **Class 0 : Minor touch-up/corrections/filling-in.**
  - **Class 1 : Moderate impacts (< 100M$).**
  - **Class 2 : Major impacts (>100M$) → EC approval needed for final decision**
- CCB chair, AG/GG leaders and RDR Integration Scientist may submit CCRs
- BCD/CCB wiki at www.linearcollider.wiki
  - **ALL relevant information is posted there for public viewing**

Technical Issues - CCR#18

N Toge

1. Fundamentals of the injector complex are not changed
   - **… so they are "neutral".**
2. It gives a certain amount of cost reduction
   - **… so that is positive.**
3. It gives a lot of new engineering design issues
   - **… so that is a question.**
4. It gives a lot of commissioning / maintenance schedule issues
   - **… so this is a question too.**
5. It introduces a long 5GeV transport …and certain beam dynamics issues need to be looked at.
   - **We must be "reasonably" confident that it works, i.e. emittance preservation, emittance ratio preservation, impacts on the ML beam dynamics have to be deemed OK. This is another important question.**

Technical Assessement

N Toge

- Q3: Design engineering issues:
  - **Engineering is an area of major additional effort: However, none fundamentally unfeasible identified. i.e. tunnel diameter, support system, alignment, etc.**
- Q4: Maintenance / Commissioning issues:
  - **Issues of temporal order of installation / maintenance work, and personnel safety interlocks … We found they belong essentially to the same category as Q3 also.**

Technical Assessement

N Toge

- Q5: Beam dynamics with 5GeV Beam Transport.
  - **Seemingly innocuous BT is something that often bites you. "Interface junction always tends to be a problem"… So this was a concern. "Care-taker" for this has been identified - RTML AG.**
  - **CCB looked for some quantitative evaluations, which was not really there in the proposal whose statements were mostly qualitative.**
  - **Some quantitative simulation results (by Kubo) became available during CCB review, supporting proponents' claim.**
- Thus all the technical questions did NOT lead to major performance threats, according to CCB evaluation that was reached through interactions with the proponents and through CCB's own analysis.

CCR#18 - Summary

N Toge

- Calendar:
  - **CCR#18 submission: Oct. 7, 2006**
  - **CCB hearing: Oct. 23, 2006**
  - **CCB report to EC: Oct. 28, 2006**
- Pipelined, parallel, no-compromise approach worked.
  - **3 weeks to get one Class-2 CCR processed by CCB**
  - **Plus 1 week for EC to give the final approval.**

CCR#18 - Summary

N Toge

- We benefited from the facts that:
  - **CCB had a pre-warning beforehand.**
  - **No major interruptions were caused by conferences and travels.**
  - **CCR, as it was submitted, turned out to be in a "good shape".**
  - **It really did not pose major, quantifiable performance threats, as CCB came to understand it.**
- Note that,
  - **It is impractical to try processing any faster.**
  - **Unlikely to be able to process Class-2 CCRs this fast all the time:**
    - **Not all CCB members can devote 100% time on CCB business all the time.**
    - **Forthcoming CCRs might incur performance risks/compromises, which complicates CCB's thought process.**

Plans until Beijing (Feb. '07)

- By the end of this workshop we must have
  - **consolidated design**
  - **new cost estimate**
  - **prioritized plans for addressing remaining (cost-driven) issues**
  - **schedule for CCB**
  - **Clear guidance and goals for writing the RDR**

ILC Documents

Phinney

- Several reports for different audiences

- Brochure – non-technical audiences, ready now
- “Quantum Universe” level booklet ~30 pages

- Executive Summary ~ 30 pages
- Physics motivation, accelerator and detectors
- RDR Report ~ 300 pages
- high level description of the accelerator
- DCR Report ~ 250 pages
- physics and detectors

RDR Report

Phinney

- RDR is a high level description of the accelerator, CFS, sites and costs
- A snapshot of what we propose to build
  - **not a history of R&D, design evolution, and alternatives**
- Editors:
  - **Nan Phinney (SLAC), Nobu Toge (KEK), Nick Walker (DESY)**
- Original schedule was complete draft now, but has been pushed back because of cost iterations

New RDR Schedule

Phinney

- Now:
  - **Document and most section outlines in hand, editors to iterate content with section authors**
- mid-Dec:
  - **1st drafts of Executive Summary and all area, technical and cost sections**
- early Jan:
  - **Complete draft for review by ILC MAC and discussions with funding agencies**
- Feb:
  - **Draft available in PDF and on web, pending final revisions before publication**
- Summer 07:
  - **Published version**

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  - **Make all final design changes, freeze for RDR**
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  - **Brief the Governments**
- Producing the RDR
- Develop the RDB Task Force Plans

Plans until Beijing (Feb. '07)

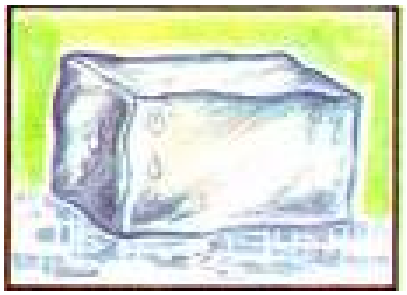
Baseline design complete

No further design modifications after this dater

Costs are consider complete

RDR Design Freeze

- The RDR is a “snapshot” of our design. We are costing it and documenting it.



- The design will continue to evolve as we enter the engineering phase and the evolution will be done through the CCB process and documented in our BCD.

Plans until Beijing (Feb. '07)

Full internal quasi-formal cost review

Including ‘external’ experts
(total 6: two from each region)

Preparation for post-RDR formal reviews

We begin to prepare for this today!

SLAC Cost Review 14-16/12

Thursday 14/12	Friday 15/12	Saturday 16/12
09:00 Introduction	08:30 SCRF	Q&A sessions
10:00 Machine Overview	*10:30 coffee*	discussions
11:00 coffee	10:30 Magnets / Power Supplies	close-out
11:30 Cost methodology	11:00 Cryogenics	
12:30 lunch	11:45 Instrumentation	
13:30 CFS	*12:30 lunch*	
15:30 coffee	13:30 Controls / LLRF	
16:00 RF Power	14:15 Dumps / Collimators	
17:00 Vacuum	15:00 installation	
	15:45 coffee	
	16:15 executive session	

Full cost review (internal GDE with 6 external experts)

Focus on Technical Systems and Basis of Estimate

Plans until Beijing (Feb. '07)

Machine Advisory Committee

- **Committee:** Takaaki Furuya, KEK; Günther Geschonke, CERN; Mike Harrison, N. Holtkamp ITER; BNL; In-Soo Ko, PAL; Shin-ichi Kurokawa, KEK (ex-officio); Philippe Lebrun, CERN; Bernd Loehr, DESY; Dave McGinnis, FNAL; Katsunobu Oide, KEK; Burt Richter, SLAC; Lenny Rivkin, PSI; Claus Rode, TJL; Roy Rubinstein, FNAL (Secretary); John Seeman, SLAC; Yuri Shatunov, BINP; Ferdinand Willeke, DESY (Chair);

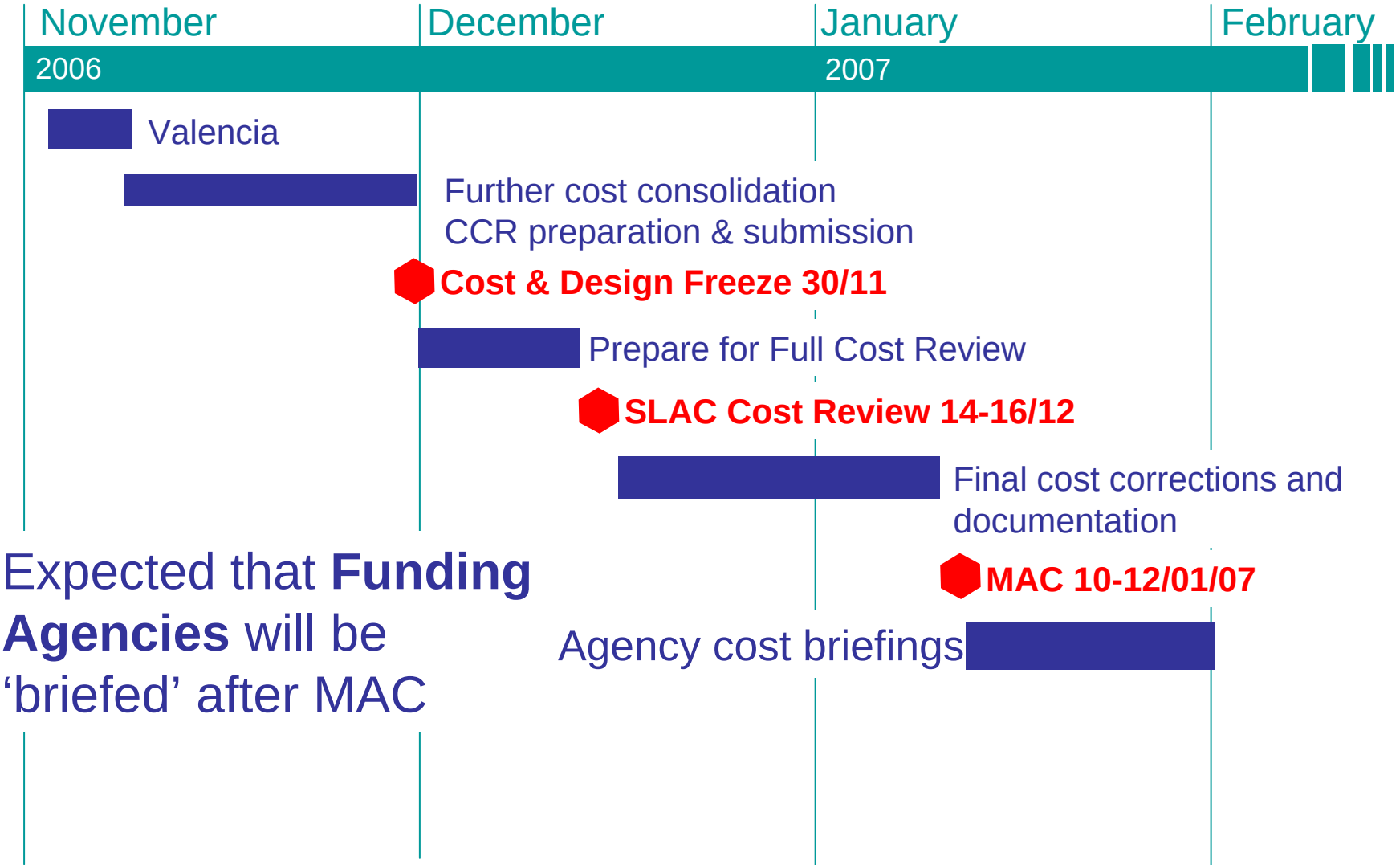
Topics to be discussed at the next MAC

Milestones of the RDR including R&D activities
Upgrade plans for 1TeV
Ring to main linac design
LINAC beam dynamics including front-to-end simulations
Absolute cost numbers
Machine detector interface
Injector and DR configurations
Bunch compressor systems

Next MAC Meeting

The next ILC-MAC meeting will be held on January 10-12 2007 at the Cockcroft Institute, Daresbury in the UK.

Plans until Beijing (Feb. '07)



Following MAC Review

- RDR / Costs will remain internal until Beijing
- This period will enable us to take into account immediate feedback from the MAC
- This period will enable us to give advance briefings to FALC, FALC Resource, ICFA members, government agencies, etc
- Final Approval by GDE at Beijing and submit to ICFA
- ICFA meetings on 8-9 Feb 07

Plans until Beijing (Feb. '07)

What Happens after Beijing?

- Public Release of Draft RDR and Preliminary Costing at Beijing
  - **Cost Reviews, etc**
  - **Finalize RDR by Summer 2007?**
- Enter into Engineering Design Phase
  - **Planning underway internally (B Foster talk)**
  - **Probably some reorganization of GDE to include stronger project management and work package responsibility.**
  - **Design will evolve through value engineering and R&D program (value engineering; R&D results; etc)**
  - **Cost of EDR will be consistent with RDR**
- General Goal is to have Construction Proposal ready by 2010

Conclusions

- Design decisions for RDR almost all in place
- We are approaching cost goals
- Writing of RDR and companion document getting underway.
- We expect to make our goal of releasing RDR and costs at Beijing
- Post Beijing planning is underway