MDI Related Potential Design Changes

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Outline

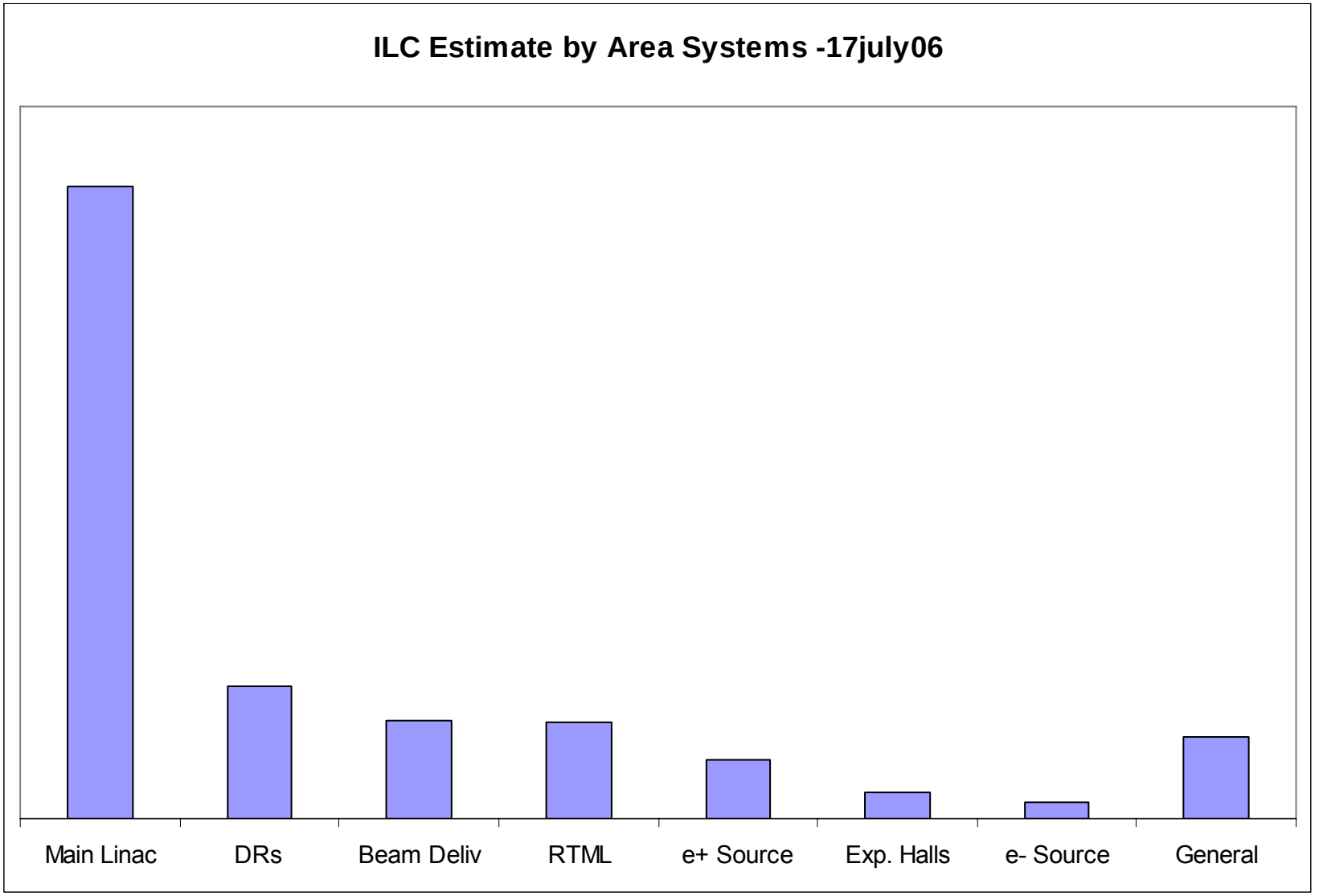
- Context of Design Changes under Consideration
- Changes Accepted
  - **2x20 mr → 14x14mr**
  - **Surface Detector Assembly**
  - **Reduced Muon Shield**
- Changes being Considered
  - **Reduce # Bunches by 2**
  - **Single IR with Push-Pull Detectors**
- Timescale & Plans for RDR
- Comment on Longer Term Issues and Plans

Vancouver Cost Data

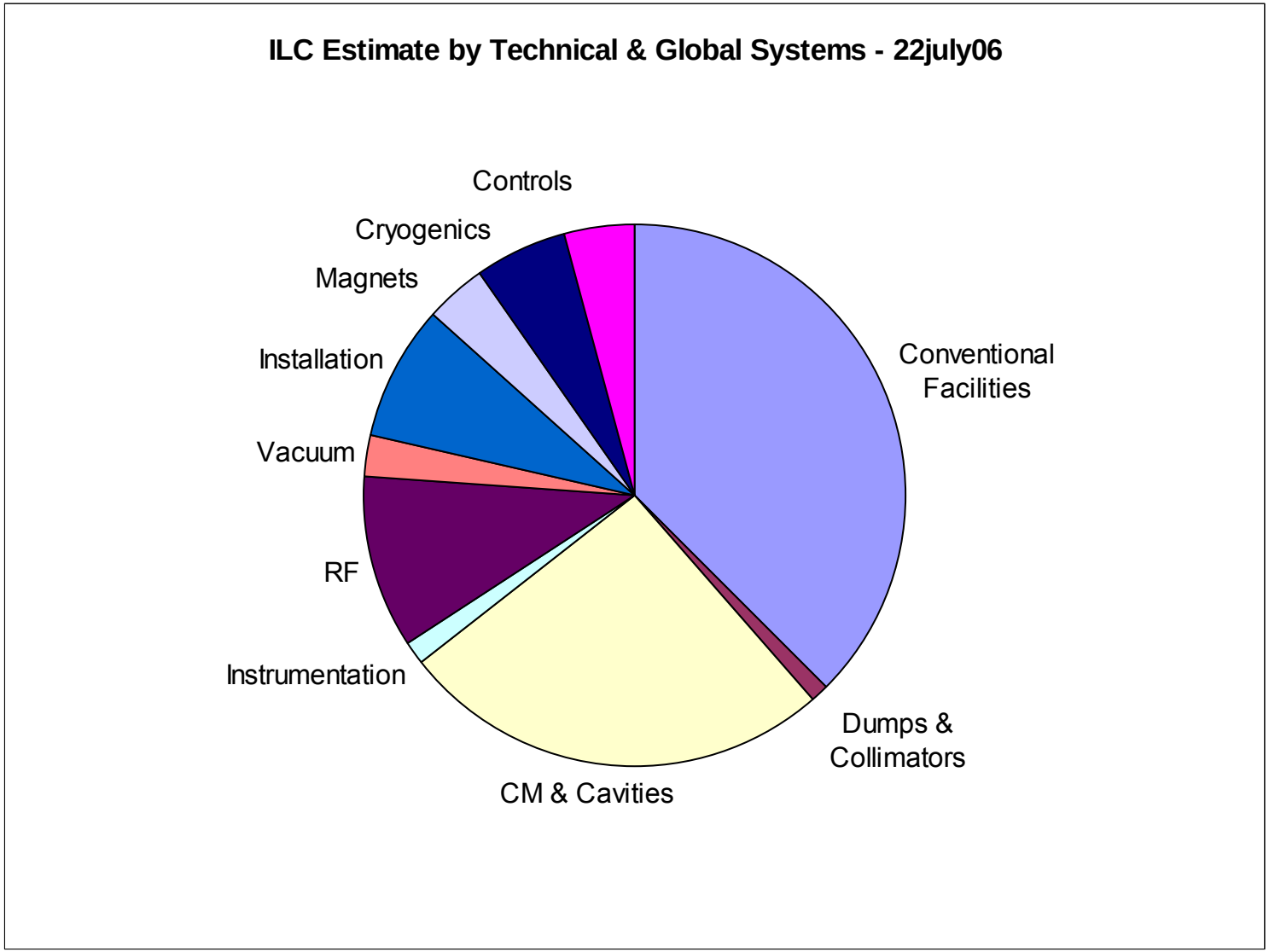
System description	July 18, 2006 - Cost Estimates received for								Regional		
	common	e-	e+	DR	RTML	ML	BDS	Exp	Am	Asia	Eur
e- Source		√									
e+ Source			√								
DR				√							
RTML					√						
Main Linac											
BDS							√				
Com, Op, Reliab											
Control System	√	√	√	√	√	√	√				
Cryogenics		√	√	√ *	√	√	√ *				
Convent. Facilities	√	√	√	√	√	√	√ *	√	√	√	√
Installation	√	√	√	√	√	√	√				
Instrumentation	√	√	√	√	√	√	√				
Cavities				√					√		√
Cryomodules		√	√		√	√			√	√	√
RF	√	√	√	√	√	√			√	√	√
Magnets & PS				√ *			√ *				
Dumps & Collim		√	√	√	√		√				
Vacuum		√	√	√	√	√	√				
Accel Phys											

√ = complete, √ * = almost complete, missing something minor

Costs by Area System



Costs by Technical & Global System



Vancouver → Valencia

Cost are too high !

Cost Reduction

- Design Scope
- Component Costs
- Physics Scope

No big ticket items!

Just lots of ≤1% effects

Design Changes Under Consideration

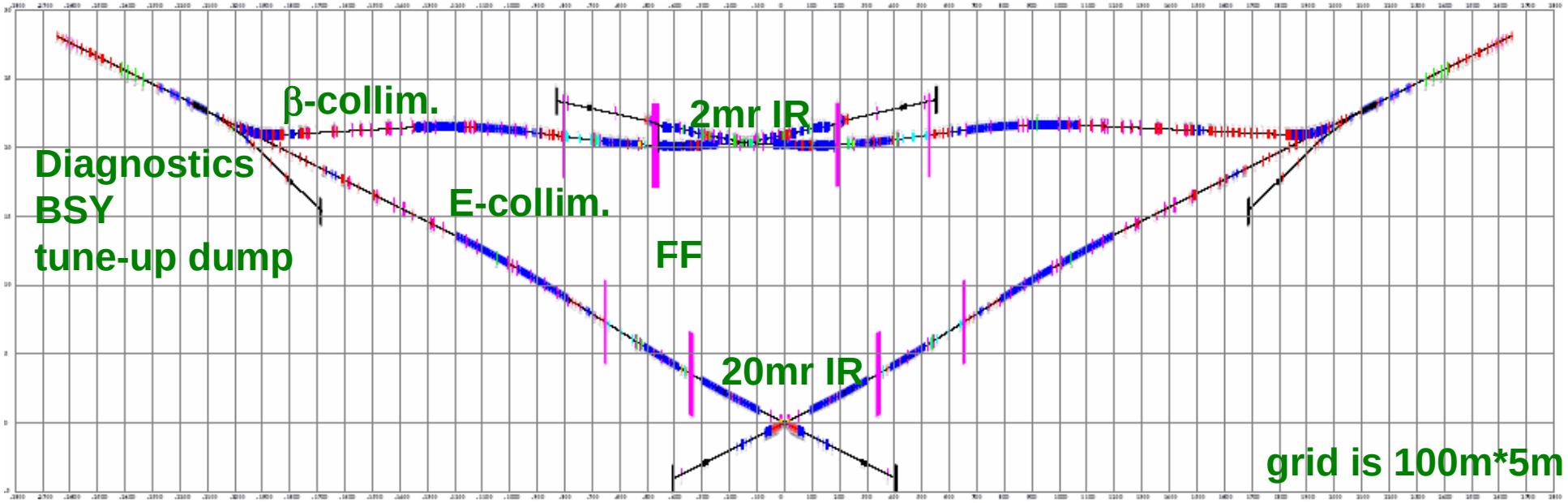
	RDR MB	CCB
2×14mr IRs	supported	✓
central injectors	supported	✓
Removal of service tunnel	rejected	
conventional e+ source	rejected	
RF unit modifications (24 → 26 cav/klys)	supported	submitted
reduced RF in DR (6 → 9mm σ_z)	supported	in prep
DR race-track lattice (CFS)	supported	in prep
reduced static 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)**
  - **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**

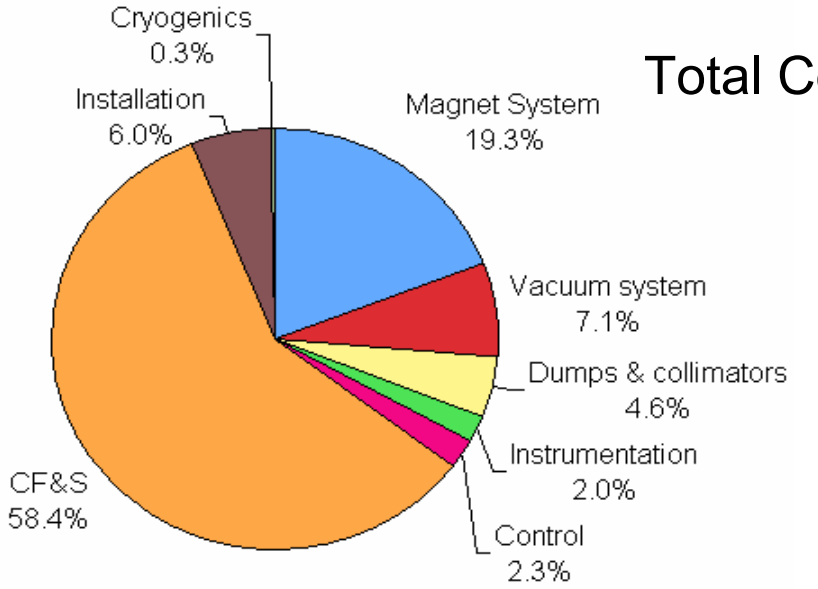
Vancouver Baseline

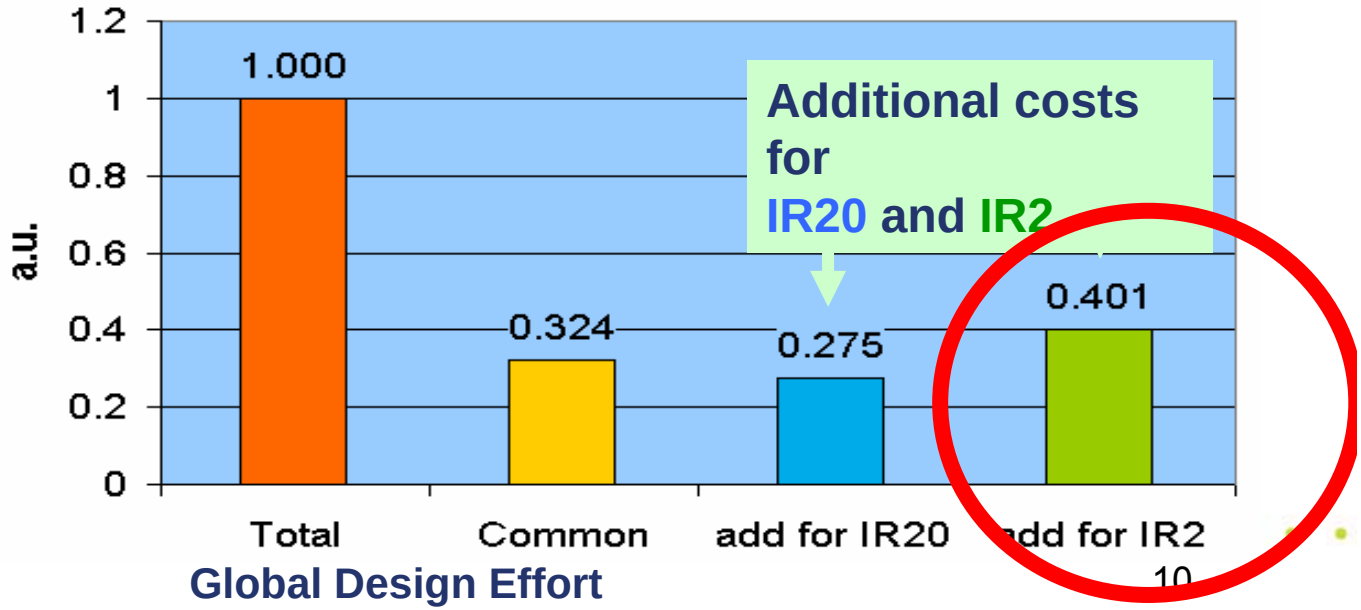


- Two IRs with 20mrad and 2mrad crossing angle
- Two collider halls separated longitudinally by 138m

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

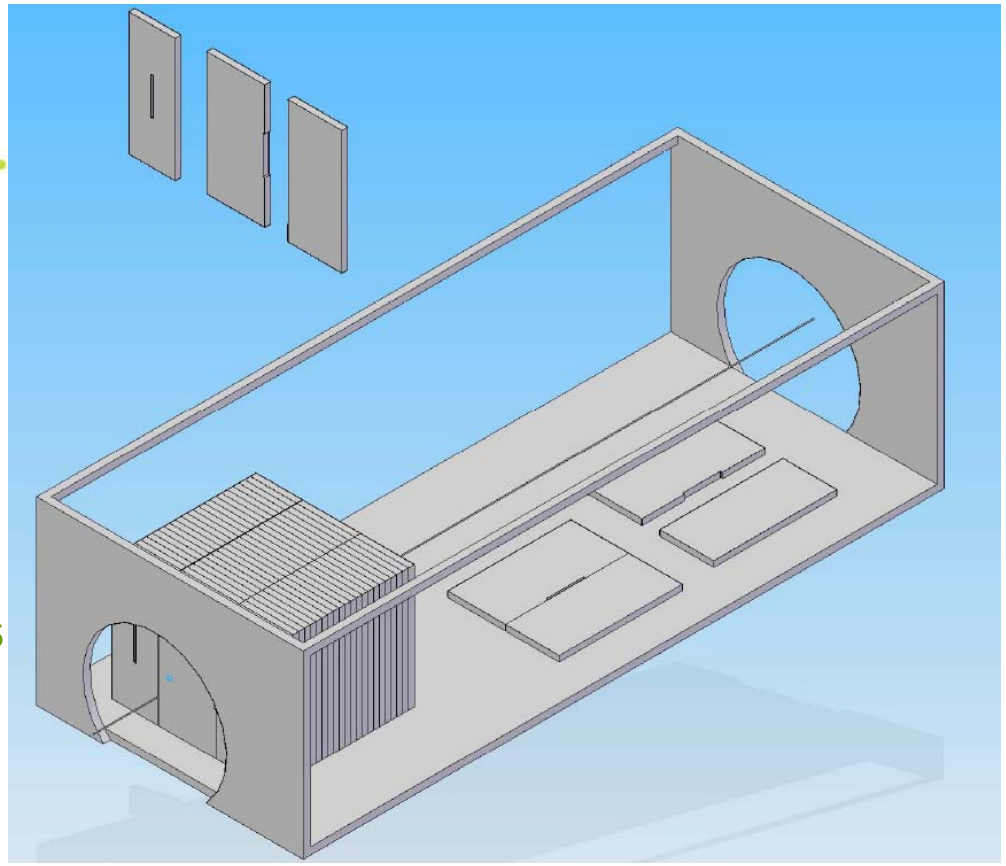
2/20 mrad → 14/14 mrad

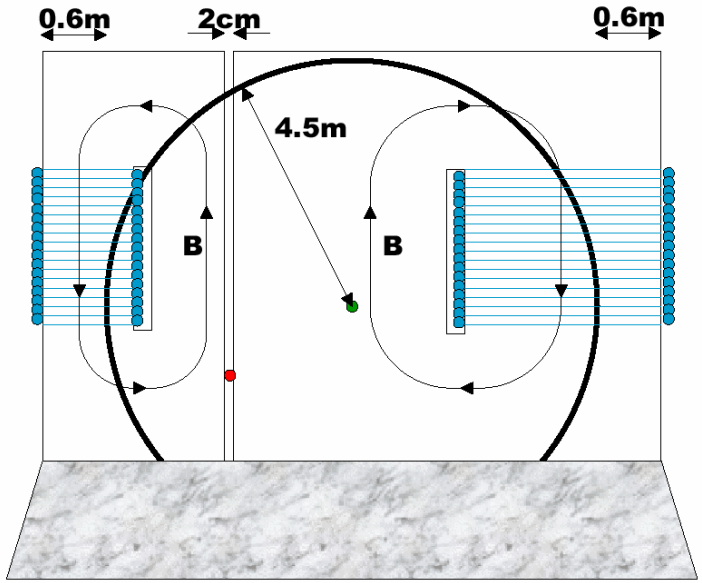
- Design & cost of 14/14 with common collider hall & z=0
  - **Design of 14mr beamline is similar to 20mrad**
  - **The cost reduction in this configuration is ~16%**

- 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

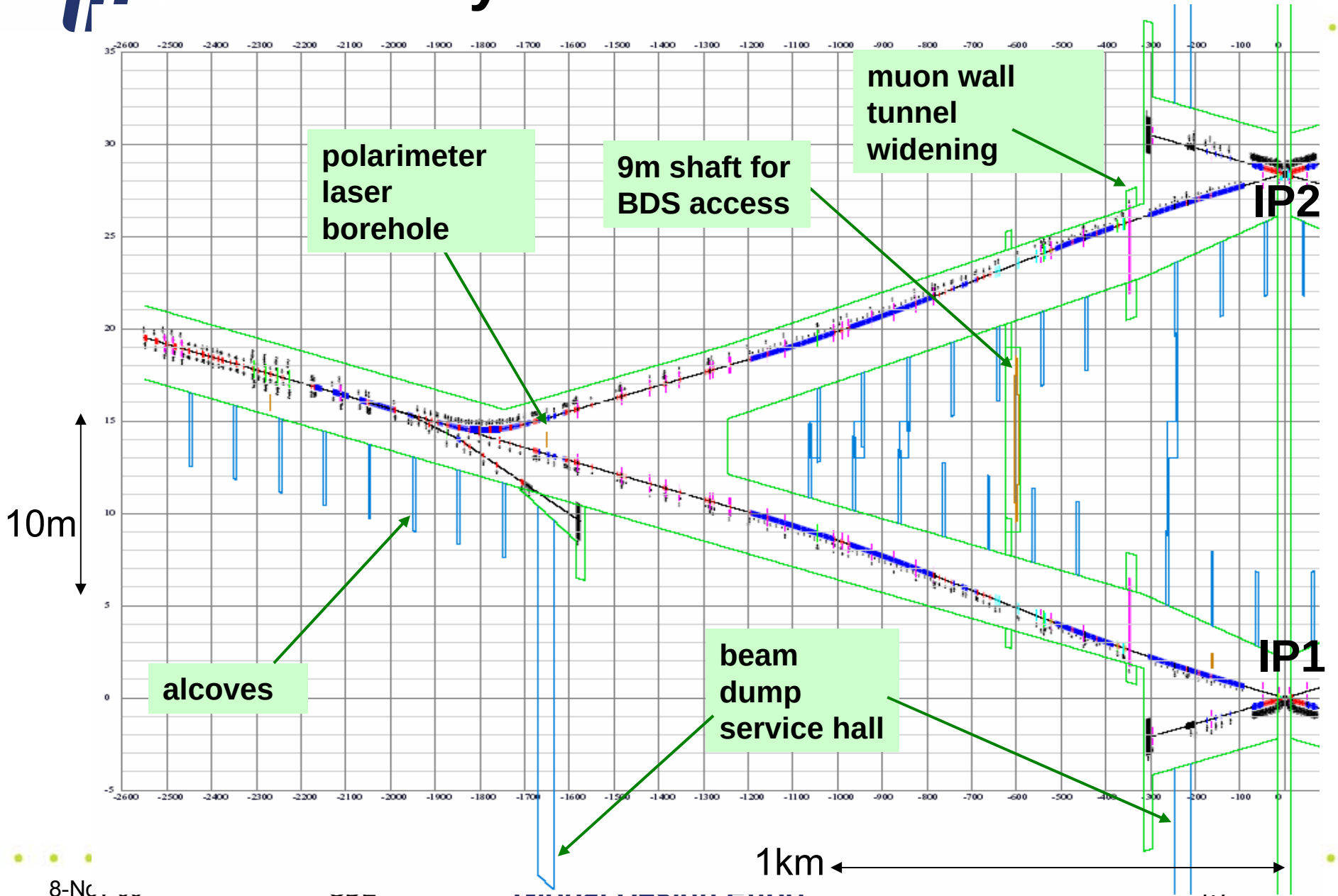
Reduced Muon Walls

- 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**

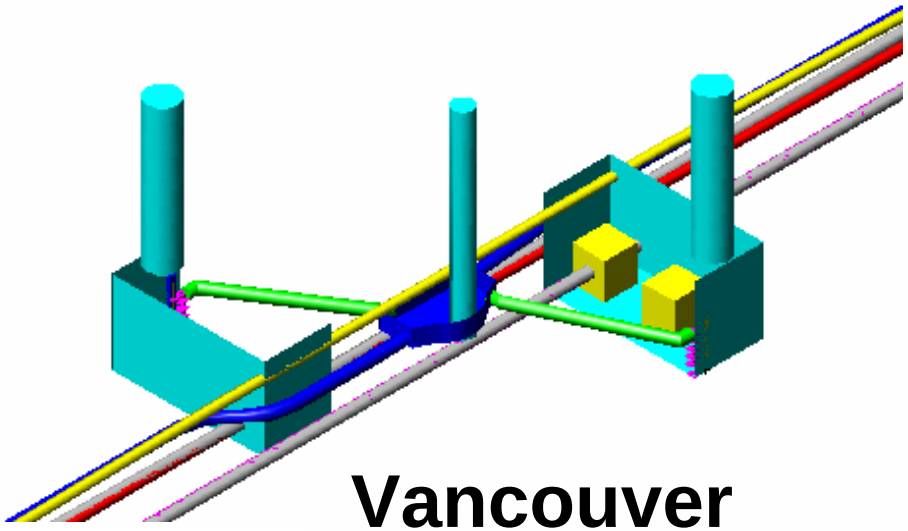
- The caverns will be built for full length walls, allowing upgrade if higher muons flux would be measured

- MDI panel accepted this change.

BDS Layout for New Baseline



Hall Designs for two IRs



Vancouver

Valencia

On-surface Detector Assembly

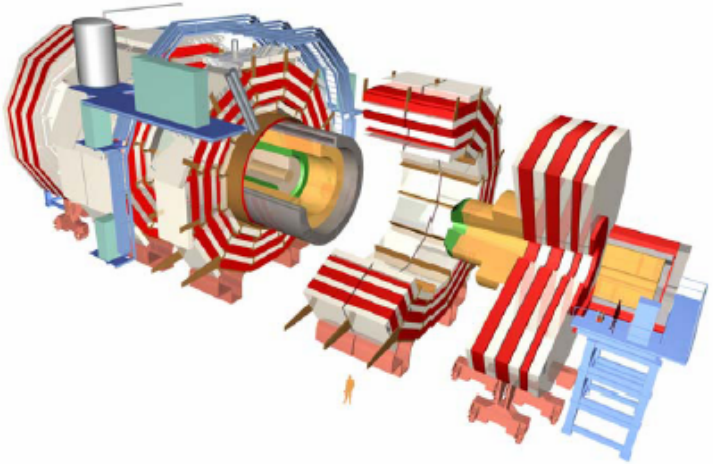
- Vancouver WBS considered the underground halls sized at 32m (W) x 72m (L) each to allow underground assembly of the largest considered detector.

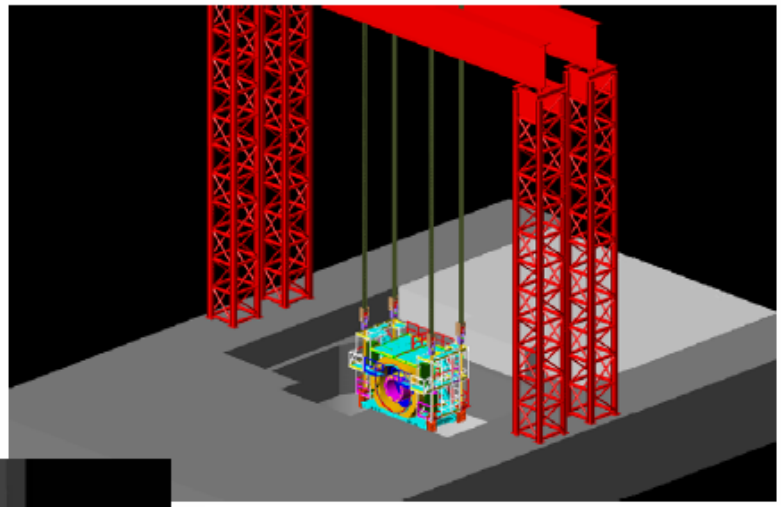
- Conventional Facilities Schedule gives detector hall is ready for detector assembly 5 yrs from project start
  - **If so, cannot fit our goal of "7years until first beam" and "8years until physics run"**

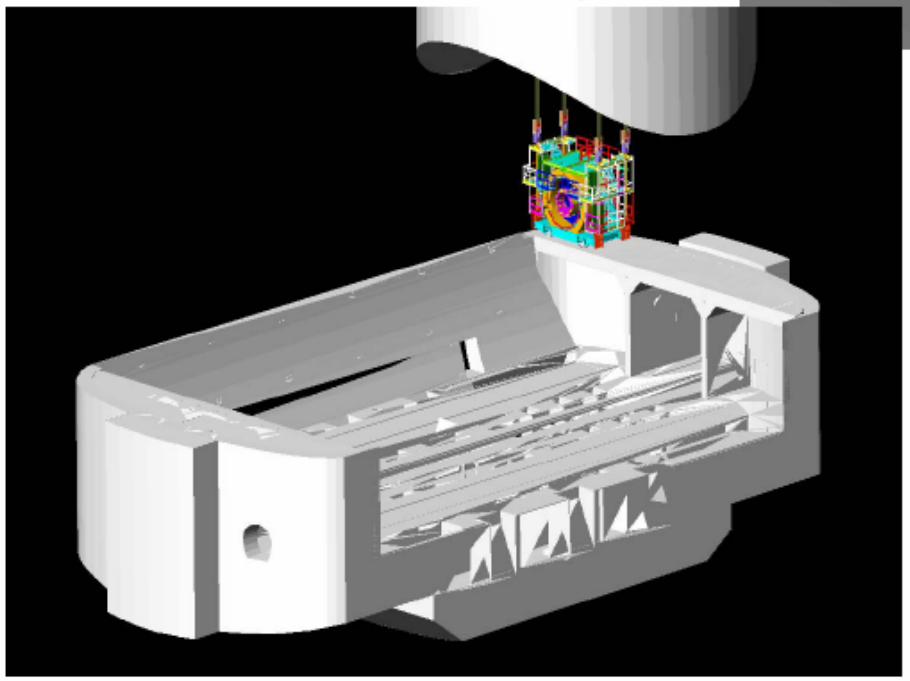
- Surface assembly allows to save 2-2.5 years and allows to fit into this goal
  - **The collider hall size may be smaller (~40-50%) in this case**
  - **A building on surface is needed, but savings may be still substantial**

- Optimization needs to be done

On-surface assembly



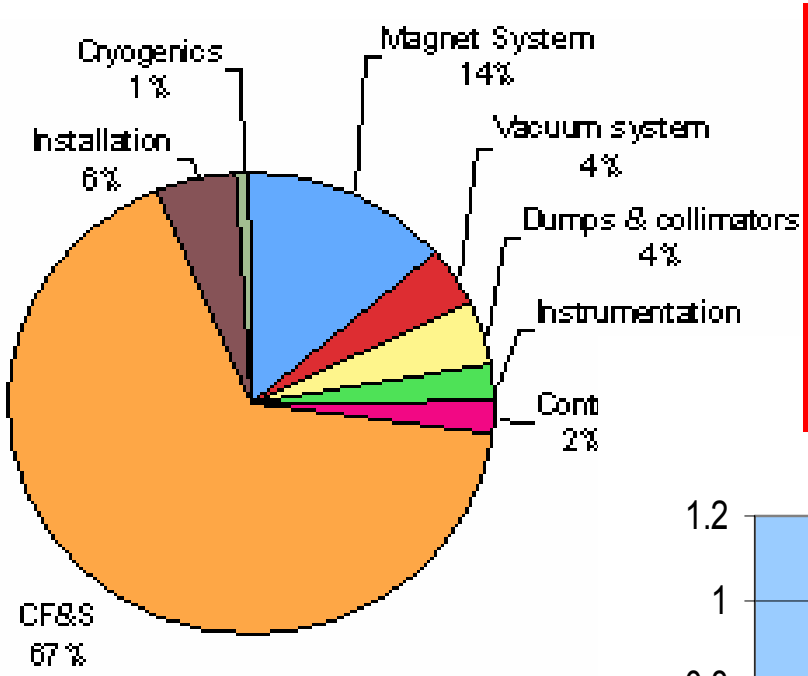




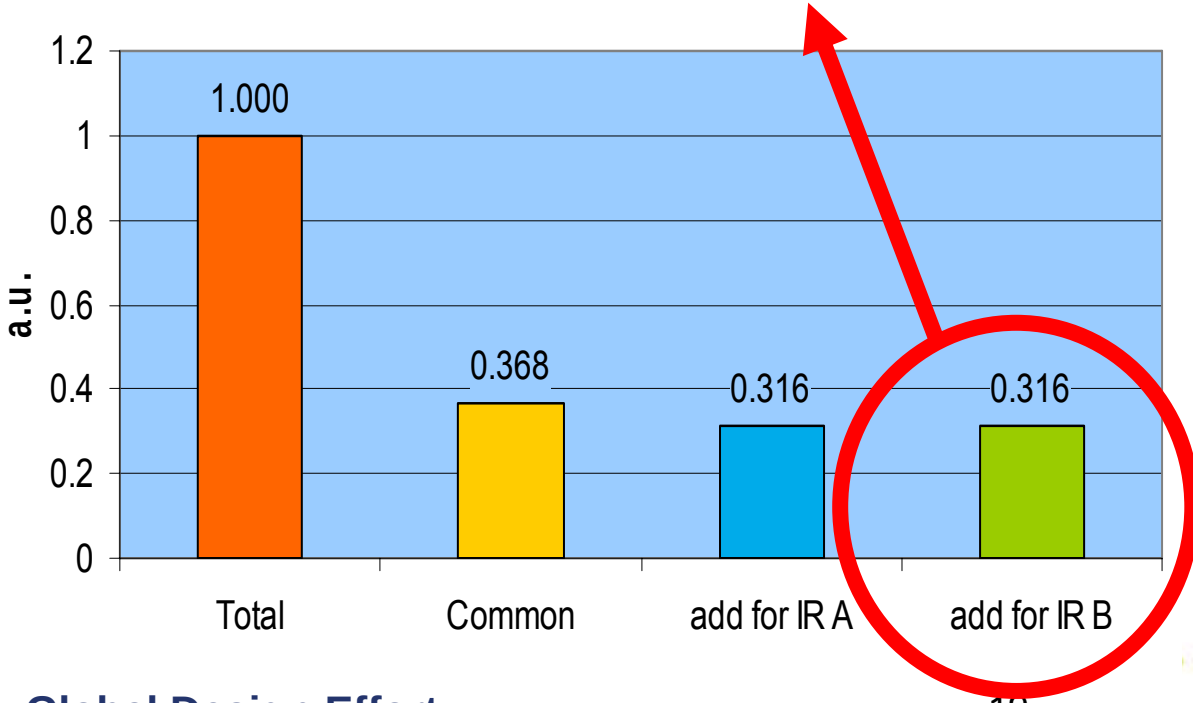
CMS assembly approach

- **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**

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

Would 1 IR lead to 1 Detector?

- NO! We have no intention of going to one detector.
- In my opinion, the case for two detectors is much stronger, if it does not require a second expensive beam line
- However, it the burden on the detector community is to develop two **complementary** detectors.

Seryi - Some Questions

- *Is there, in the beamline, a natural breaking point?*
- *Do we need to redesign the beamline to optimize location of breaking point?*
- *Is part of beamline (part of FD) remains in detector when it moves?*
- *What vacuum connections are needed in breaking point?*
- *Do we have to use the same L* for either detector or it can be different?*
- *How the connections of electrical, cryo, water, gas, etc, systems are arranged?*

Seryi - Some Questions

- *Is there, in the beamline, a natural breaking point?*
  - yes, it can be arranged, between QD0 and QF1
- *Do we need to redesign the beamline to optimize location of breaking point?*
  - yes and a first version of optics already produced
- *Is part of beamline (part of FD) remains in detector when it moves?*
  - yes, this seems to be the most optimal way
- *What vacuum connections are needed in breaking point?*
  - two vacuum valves with RF-shield, details are being worked out
- *Do we have to use the same L* for either detector or it can be different?*
  - Different L* is possible, but same L* gives benefits and may save time
- *How the connections of electrical, cryo, water, gas, etc, systems are arranged?*
  - Part of electronics and services can be placed on a platform which moves with detector. Flexible connections to stationary systems needed.

Seryi - More Questions

- *What is the suitable way to move (rails, air-pads) the detector?*
- *For quick change-over, do we need to make detector self shielding?*
- *What are the design changes needed to make the detector self shielded?*
- *If there is a need in shielding wall between detectors, what is the method of its removal and assembly?*
- *What arrangements or reinforcements (such as imbedded steel) are needed for the floor of the collider hall?*
- *Is there a need to open detector when it is on the beamline, or it would be only opened in the off-beamline position?*

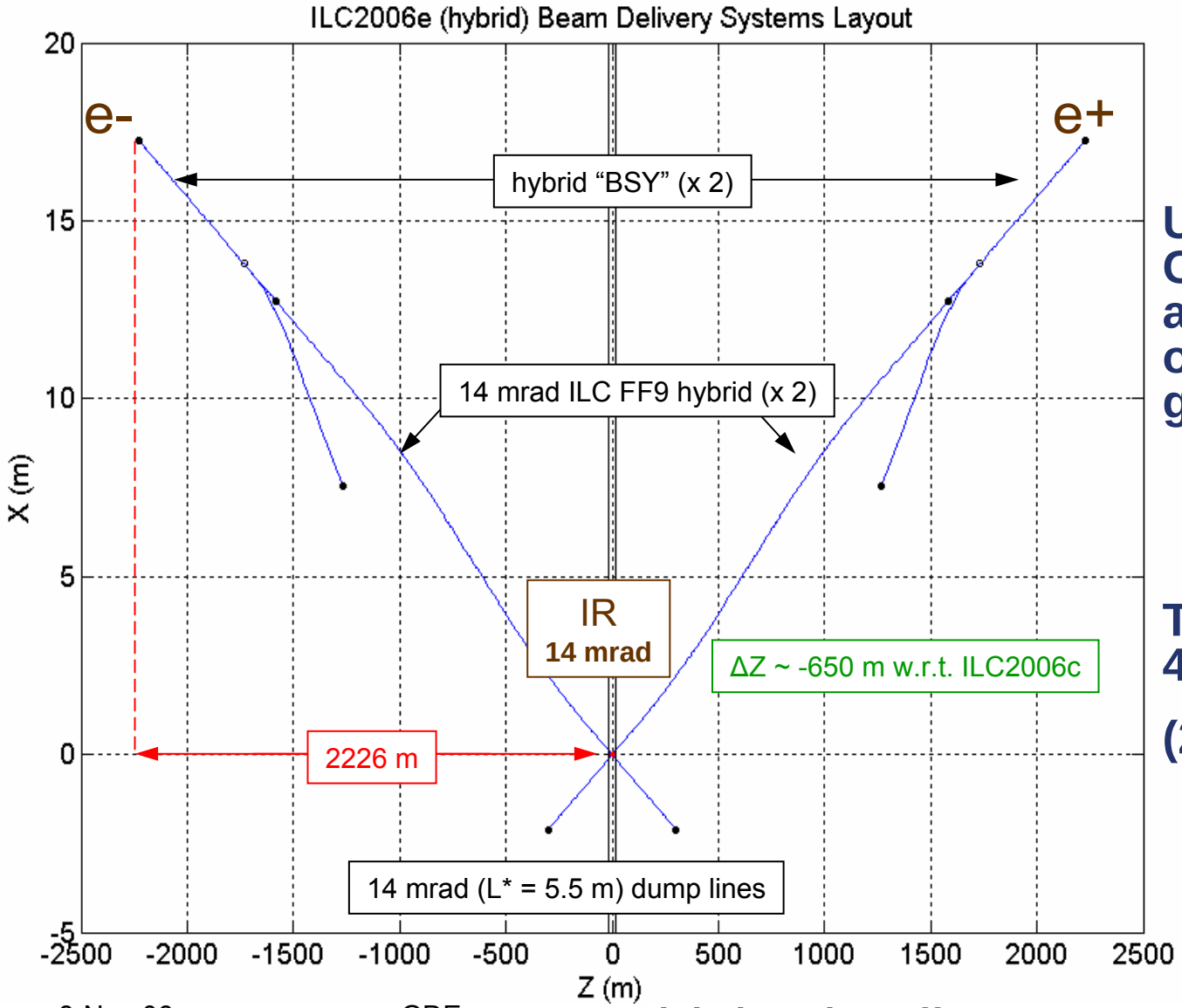
http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/push-pull/

Seryi - More Questions

- *What is the suitable way to move (rails, air-pads) the detector?*
  - **air-pads seems as a possibility**
- *For quick change-over, do we need to make detector self shielding?*
  - **It would help, but self-shielding is not absolutely required for quick change-over**
- *What are the design changes needed to make the detector self shielded?*
  - **For GLD/SiD/LDC, self-shielding has been shown in simulations. For the fourth detector concept (double solenoid with no iron), implementing self-shielding may be difficult**
- *If there is a need in shielding wall between detectors, what is the method of its removal and assembly?*
  - **The shielding wall, if needed, can consist of two parts and move on air-pads in hours**
- *What arrangements or reinforcements (such as imbedded steel) are needed for the floor of the collider hall?*
  - **Steel plates (~5cm thick, welded) to cover the collider hall floor**
- *Is there a need to open detector when it is on the beamline, or it would be only opened in the off-beamline position?*
  - **Opening one beamline desirable, certain design optimization needed**

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

Single IR BDS Configuration



Upgrade to 1 TeV COM involves adding magnets only … no geometry changes

Total Z-length is 4452 m

(2 IRs: 5100m)

Seryi (Joint BDIR/GDE/WWS/MDI)

Summary

- At the end of September 2006, technical evaluation of push-pull option started by an extended task force, which included detector and accelerator experts in ILC community and beyond. More than 60 people were involved.
- Many technical questions have tentative answers
- Detailed studies and engineering design are needed, which surely could not be done in such short time scale
- Fundamentally, the push-pull option should be feasible, provided careful design and sufficient R&D resources

Sep 21-Nov 2, 06 Global Design Effort push-pull: 57

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.

Reduced Bunches – WWS Questions

- The technical merits of the reduced number of bunches: We understand there are several merits to the reduced number of bunches. We would like to know how critical they actually are. Are they something we do not have solutions now which are solved by halving the number of bunches? Could you indicate the level of current difficulties? E.g. :
  - **ECE in the dumping ring, extraction kicker, and multi-bunch instabilities.**
  - **Positron source target**
  - **Other possible merits**

A reduction of the number of bunches does certainly relax several technical challenges for other parts of the machine, most notably the damping rings (instabilities, kickers etc.), the positron target and the main power dumps. But we would like to stress that our current scenario still maintains the specification at the original full current, so we assume these problems would be solved at some point.

More Questions from WWS

- The RF upgrade to recover the 'full luminosity'
  - **Required hardware**
  - **Amount of work needed to install them**
  - **Realistic upgrade schedule**
  - **Changes required elsewhere of the machine associated with the upgrade**
  - **Cost needed for the upgrade, and how it compares to installing the 'full RF' as the baseline from the start**
  - **Realistic scenario after the start of the baseline machine when the upgrade is proposed, approved, funded, and the upgrade work can begin.**

Discussed at GDE RDR Management meeting and preliminary replies given to WWS

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

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**
  - **Design will evolve through value engineering and R&D program,**
  - **Some potential changes will effect MDI and we will need to continue close collaboration**
  - **General Goal is to have Construction Proposal ready by 2010**

Conclusions

- The ILC design must be systematically studied for cost vs performance to determine RDR design, **and to defended it**
- For the RDR, we have selected a dozen or so potential changes that can result in cost savings of 1% or more.
- Other changes need more time or engineering details to pursue and have been deferred until after the RDR
- Some changes effect physics or detectors and we are working those with the MDI and WWS.