

GDE Internal Review

ILC Reference Design Costing



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Caltech / GDE

14-Dec-06



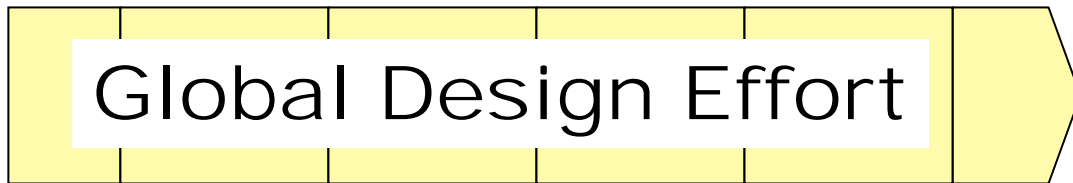
Objectives of this Review

- Begin validation process for the RDR Costing
- This is an “internal review,” operating under cost confidentiality rules.
 - **It is the first exposure of costing beyond those doing the costing a their particular area; only the cost engineers and myself have seen totals.**
 - **Both “internal” and “external reviewers” – internal to give depth to the review, and external to provide outside perspective on our approach, methodology and initial costing**
- First some context, mainly for external reviewers



ILC Overall Timeline

2005 2006 2007 2008 2009 2010



➔ **Baseline configuration**

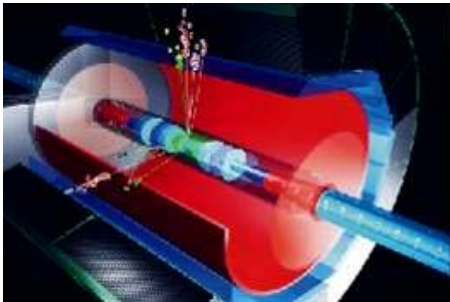
➔ **Reference Design**

..... ➔ **Technical Design**

➔ **ILC R&D Program**

➔ **Expression of Interest to Host**

➔ **International Mgmt**



Global Design Effort



Parameters for the ILC

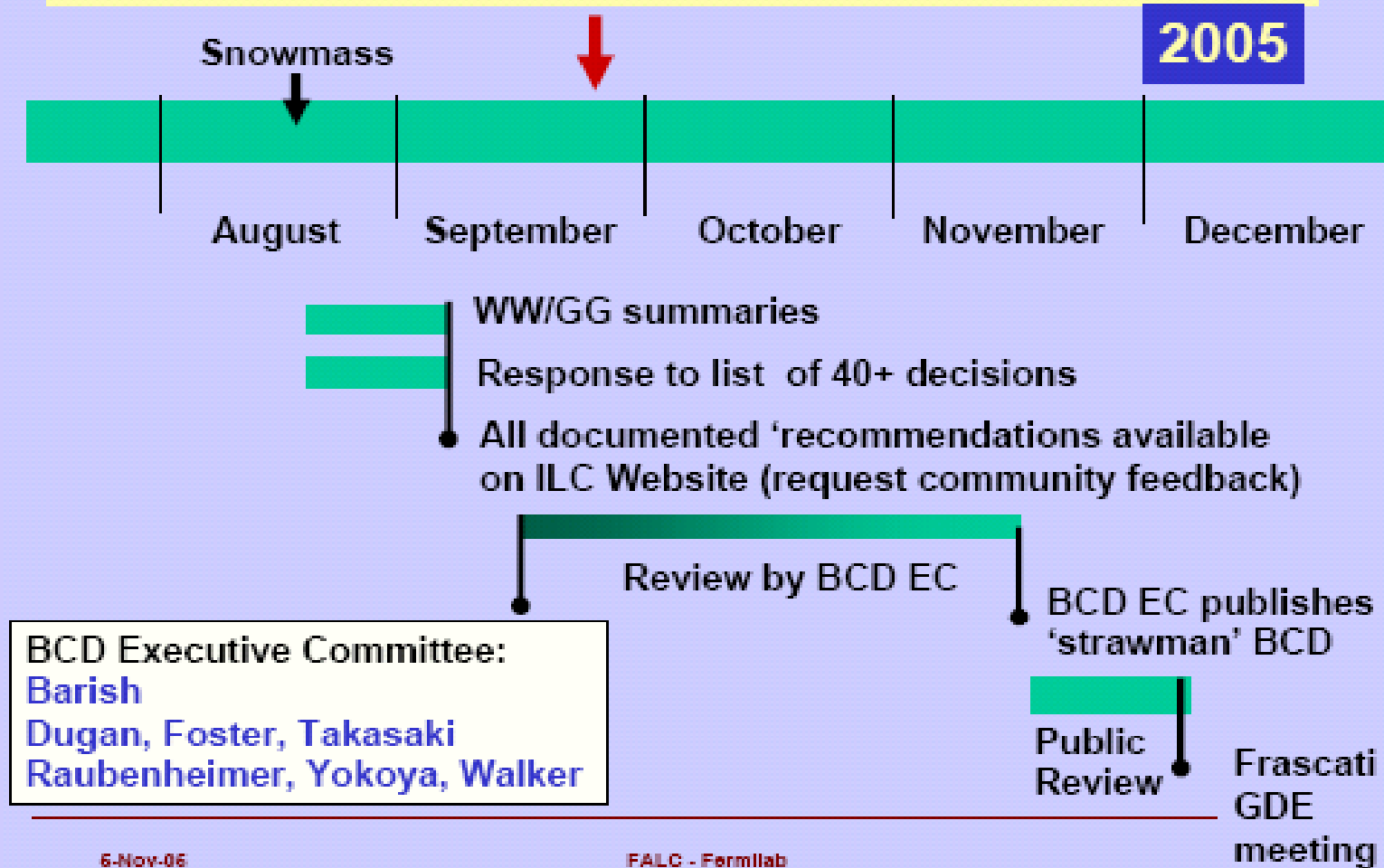
- E_{cm} adjustable from 200 – 500 GeV
- Luminosity $\rightarrow \int L dt = 500 \text{ fb}^{-1}$ in 4 years
- Ability to scan between 200 and 500 GeV
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%

- **The machine must be upgradeable to 1 TeV**



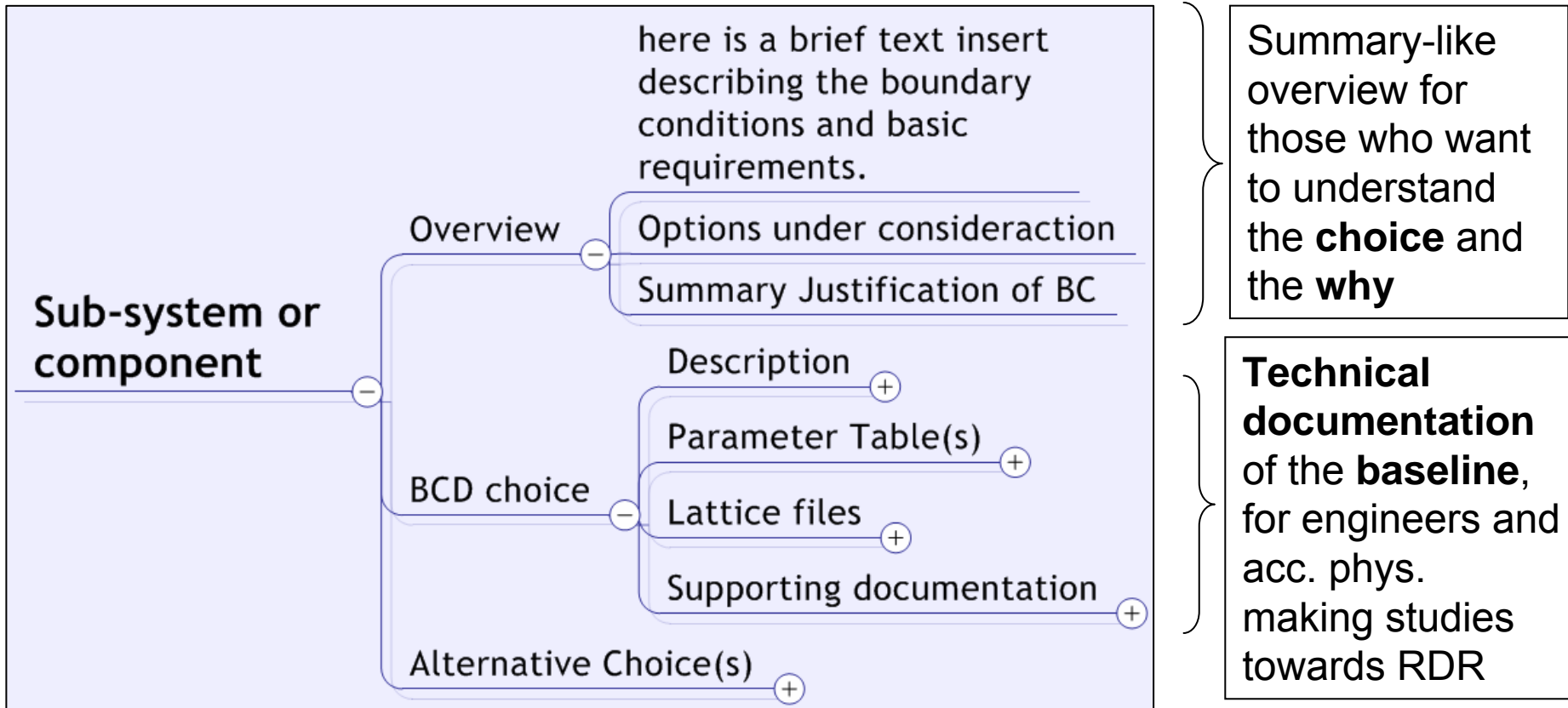
The First Step – Create a Baseline

From Snowmass to a Baseline





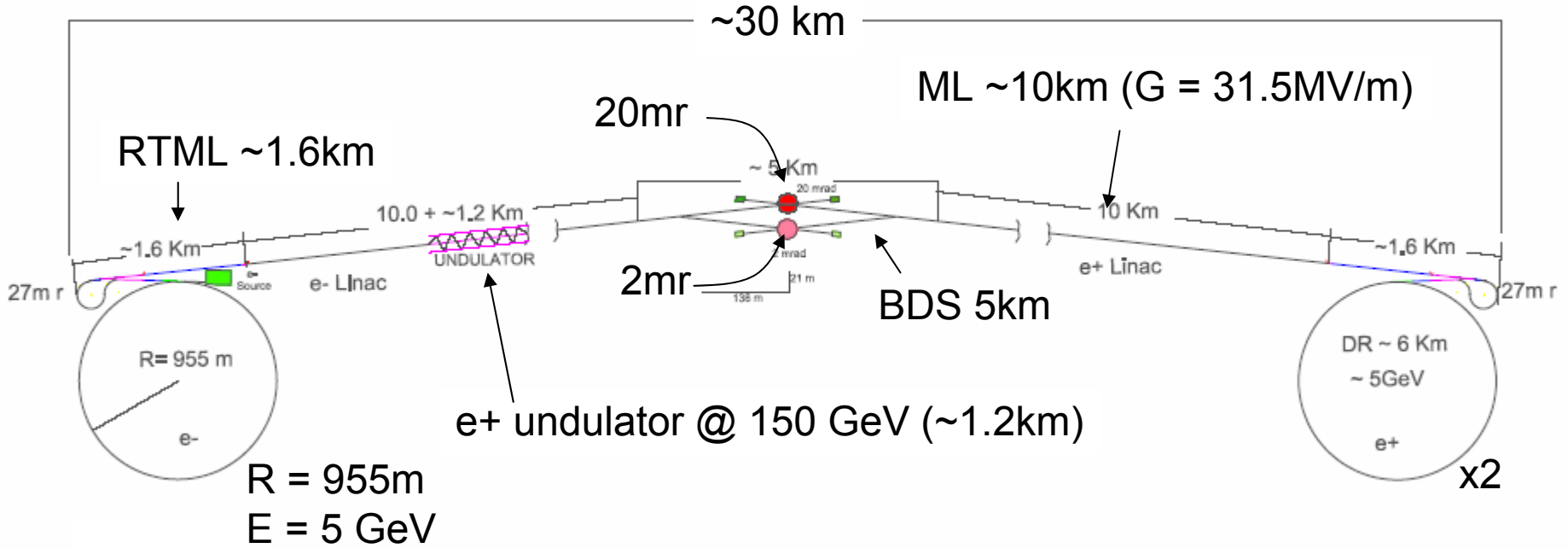
The Baseline Configuration Document





The Baseline Machine (500GeV)

F. Asiri/SLAC 11-29-2005

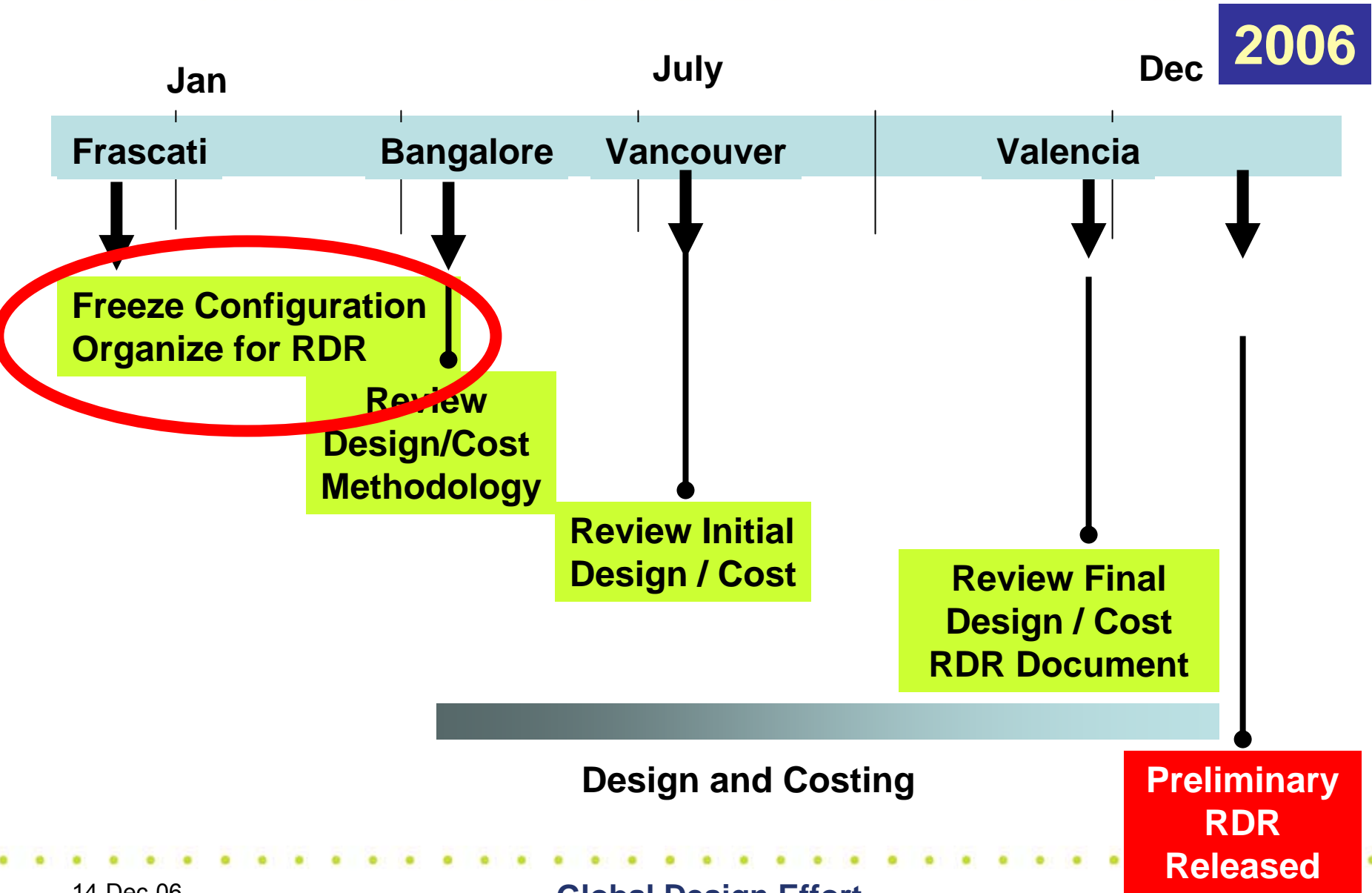


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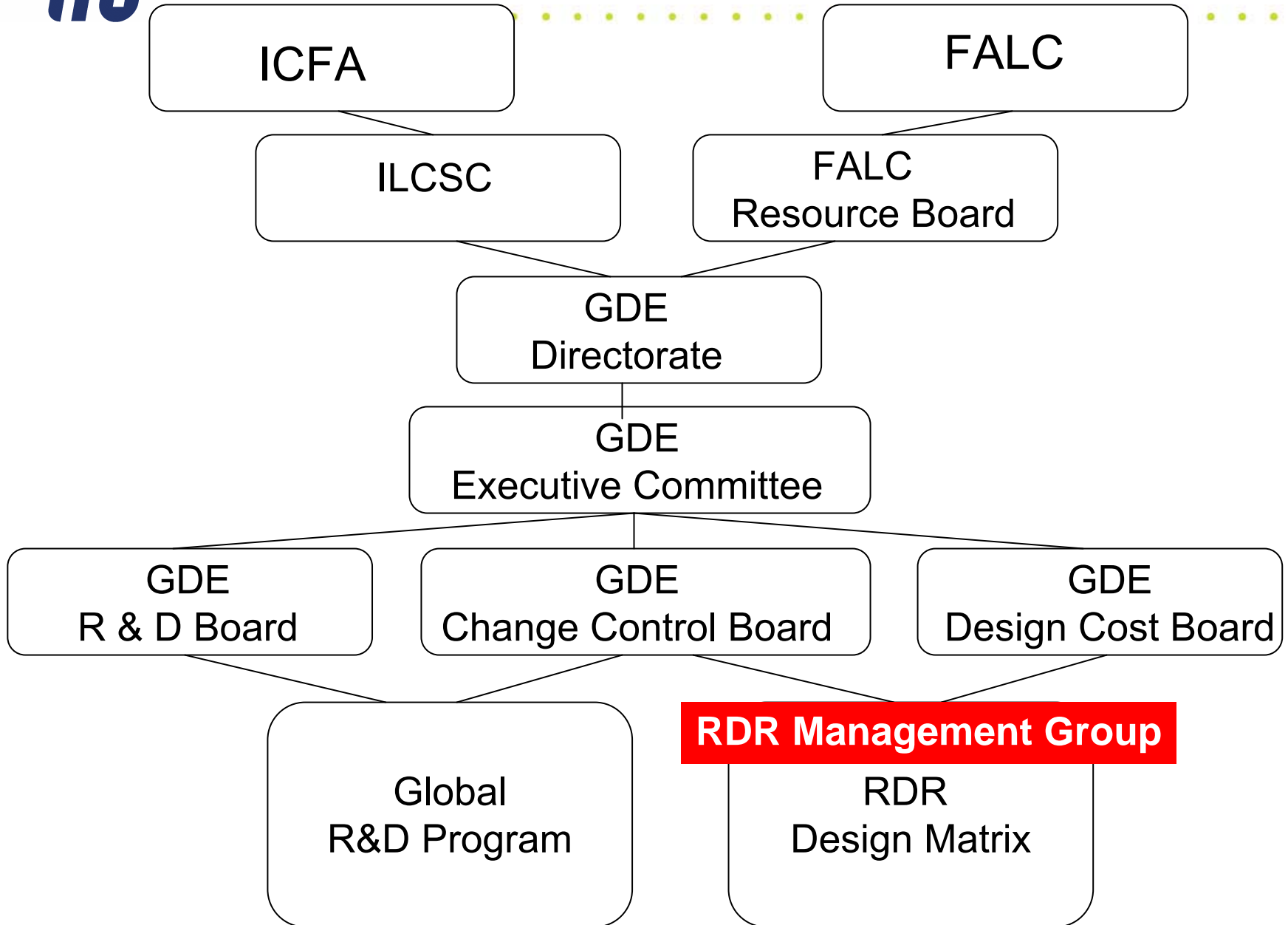
Baseline to a RDR

2006



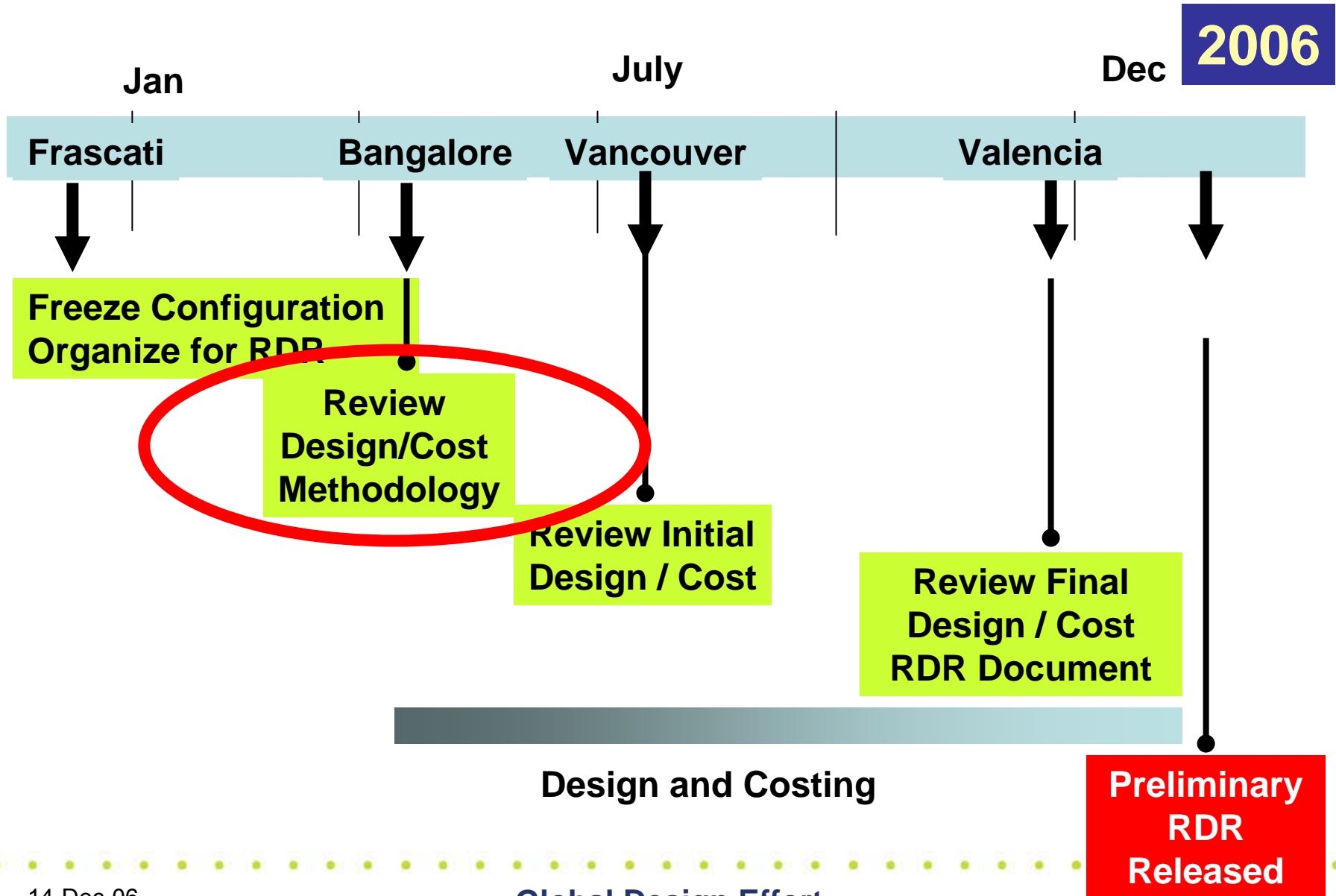


GDE RDR / R&D Organization





Baseline to a RDR





RDR Cost Estimating

- 500 GeV BCD machine + “essentials” for 1 TeV
- Follow ITER “Value” & CERN “CORE” model for International Projects
 - Provides basic agreed to costs [common “value” + in-house labor (man-hr)]
- RDR will provide information for translation into any country’s cost estimating metric, e.g. Basis of Estimate => contingency estimate, in-house labor, G&A, escalation, R&D, pre-construction, commissioning, etc.
- Assumes a **7 year** construction phase

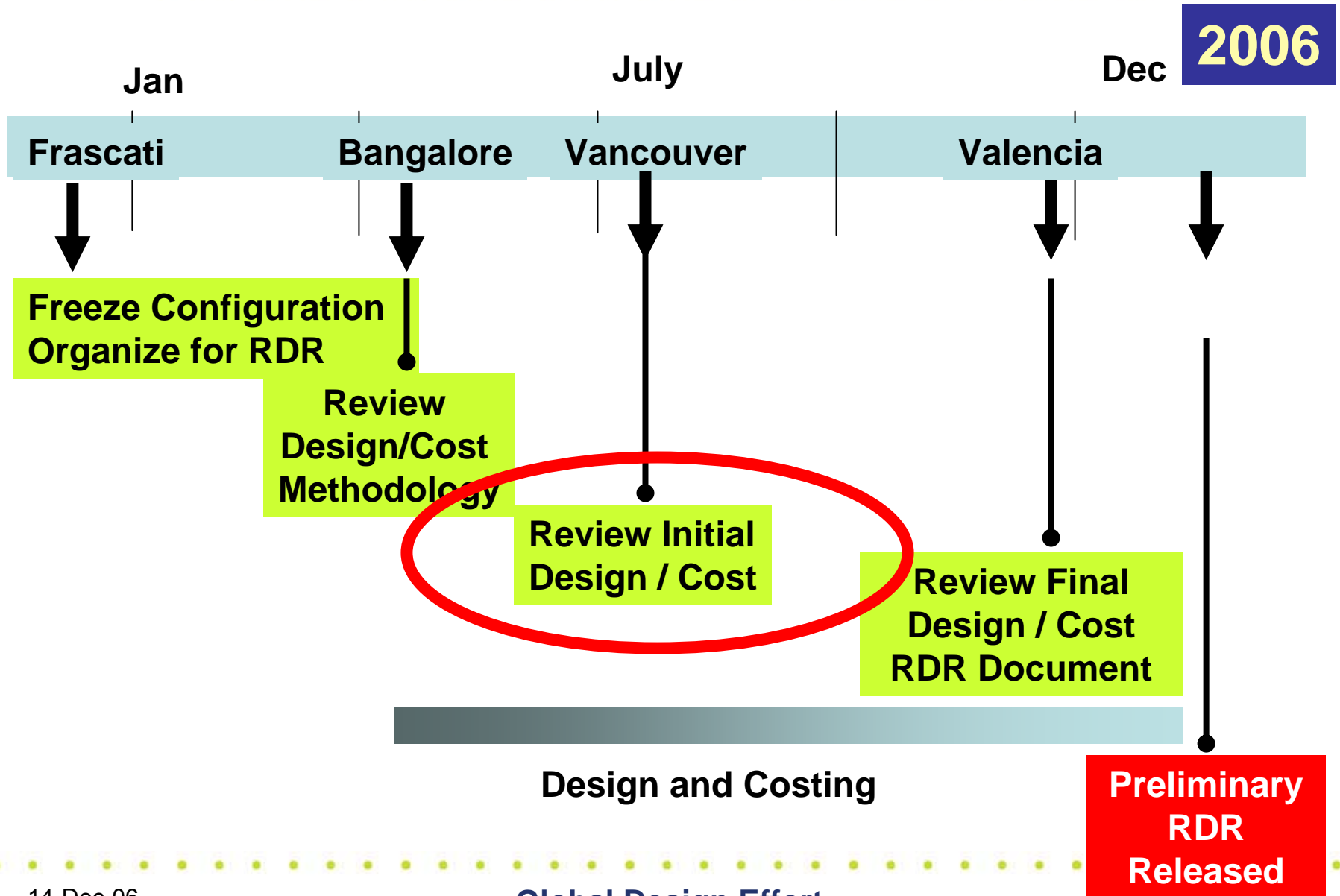


ILC Cost Estimate

- Based on a call for world-wide tender:
 - lowest reasonable price for required quality
- Classes of items in cost estimate:
 - **Site-Specific (separate estimates for each site)**
 - **Conventional – global capability (single world est.)**
 - High Tech – cavities, cryomodules, regional estimates**
- Cost Engineers determine how to combine and present multiple estimates
- WBS ; WBS Dictionary; Costing Guidelines are mature enough – RDR cost estimating



Baseline to a RDR





Cost Roll-ups

Area Systems

Technical Systems

Vacuum systems

Magnet systems

Cryomodule

Cavity Package

RF Power

Instrumentation

Dumps and Collimators

Accelerator Physics

Global Systems

Commissioning, Operations & Reliability

Control System

Cryogenics

CF&S

Installation

e-
source

e+
source

damping
rings

RTML

main
linac

BDS





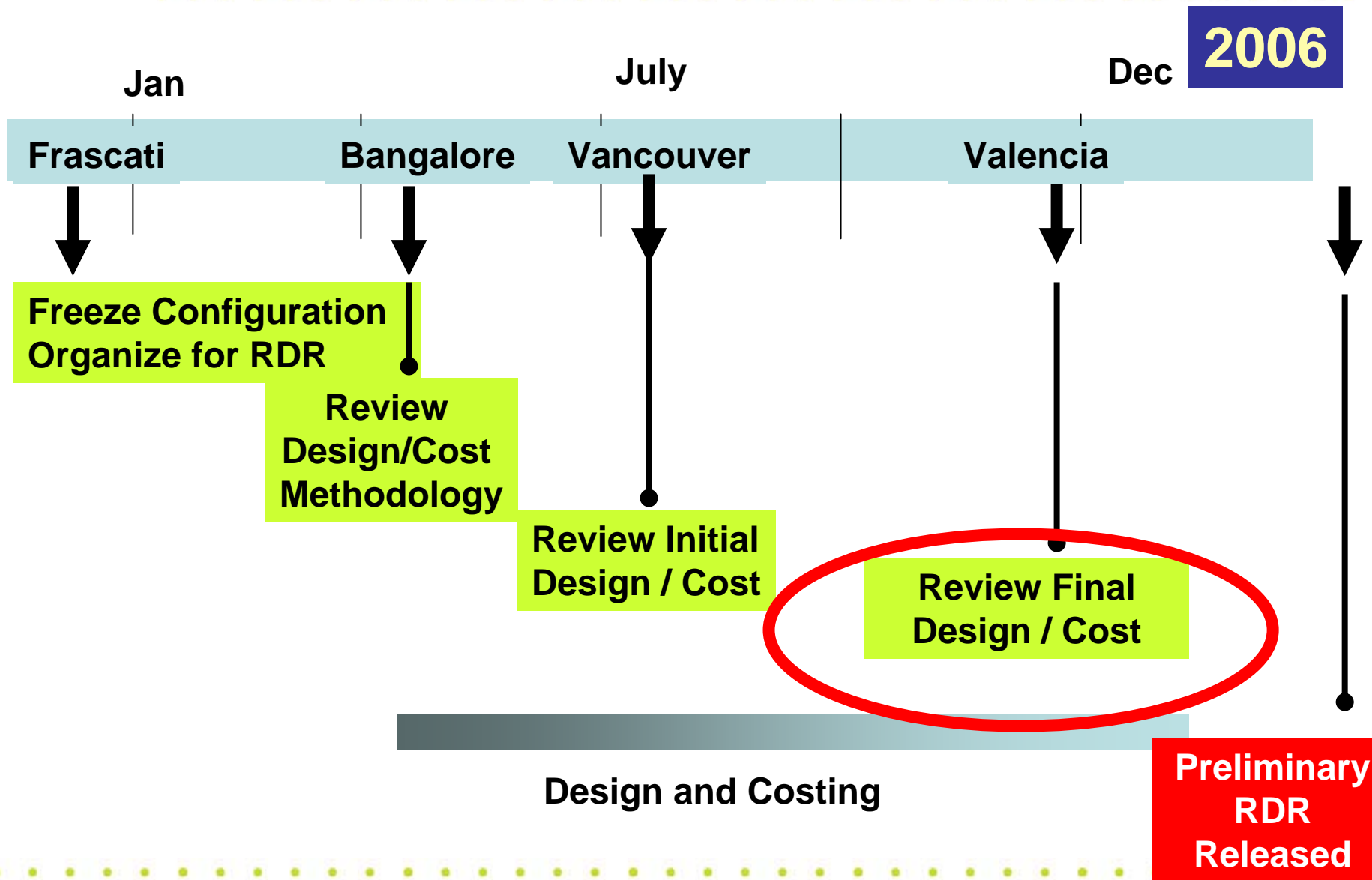
Vancouver Cost Data

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



Baseline to a RDR



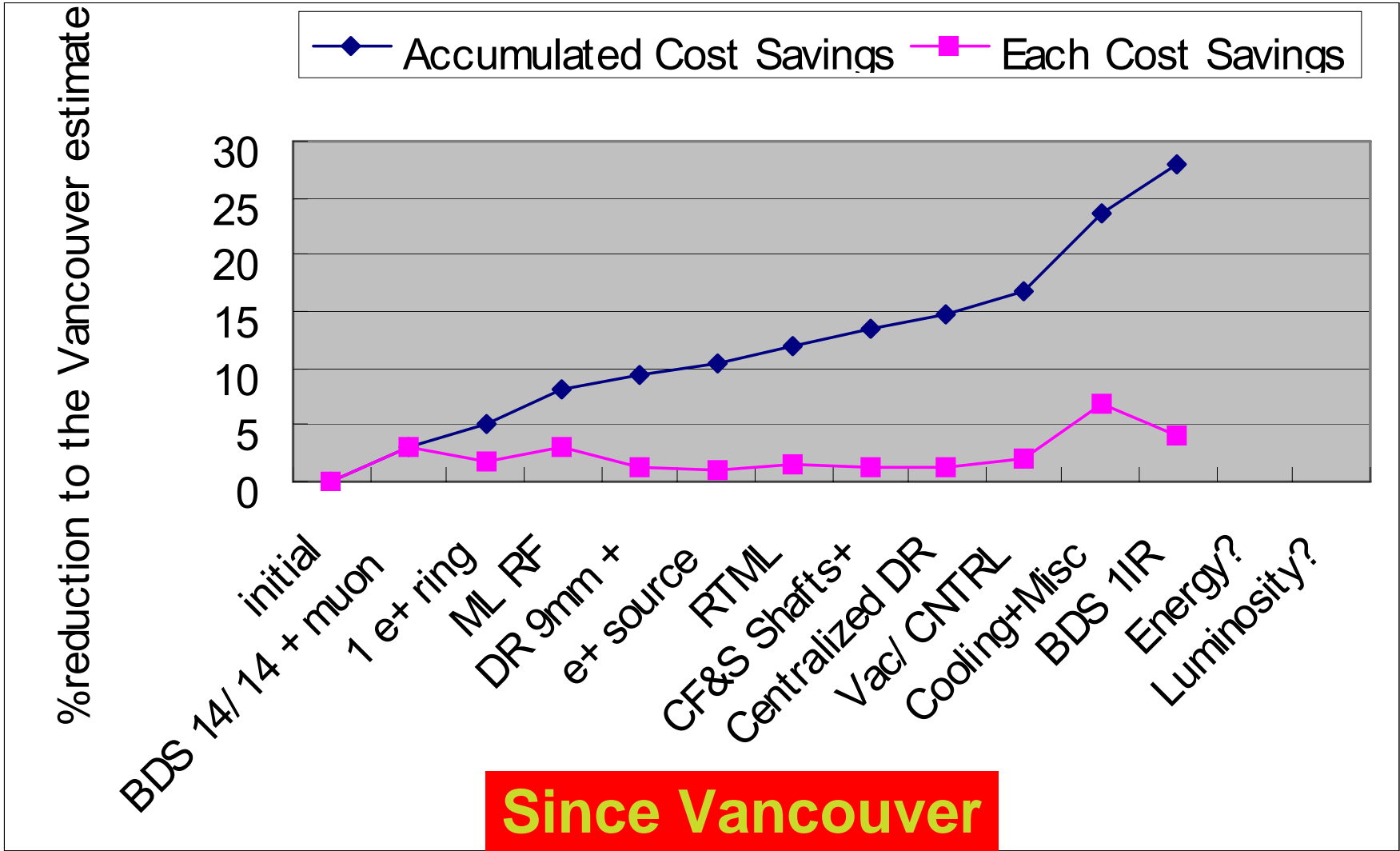


Optimizing Cost to Performance

	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



Evolving Design → Cost Reductions

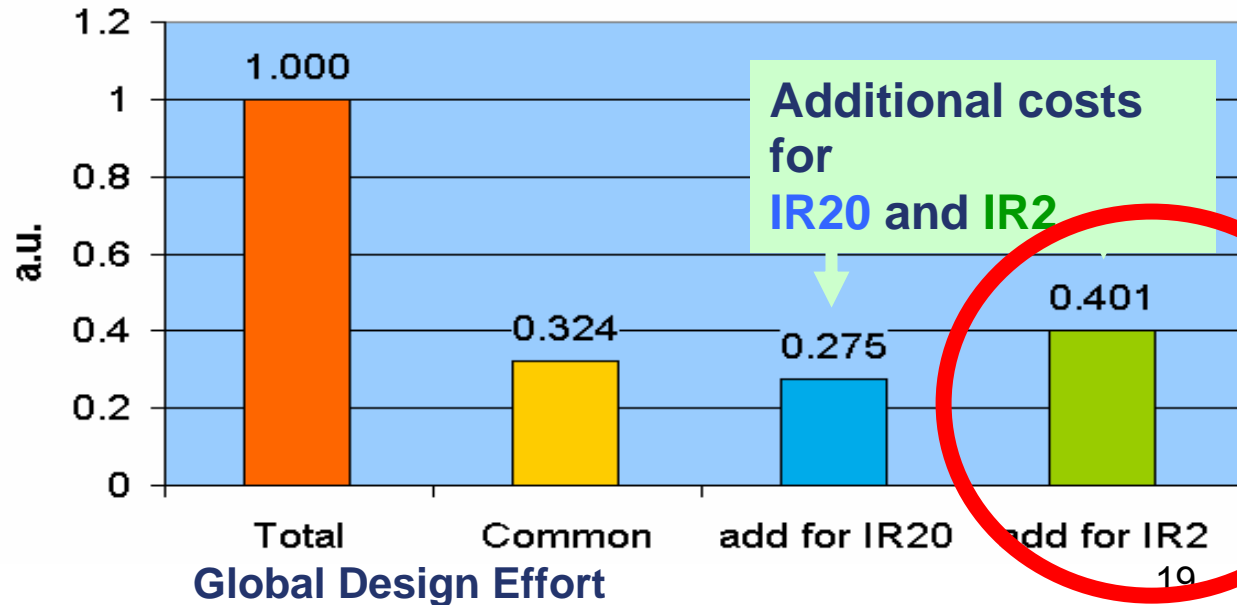
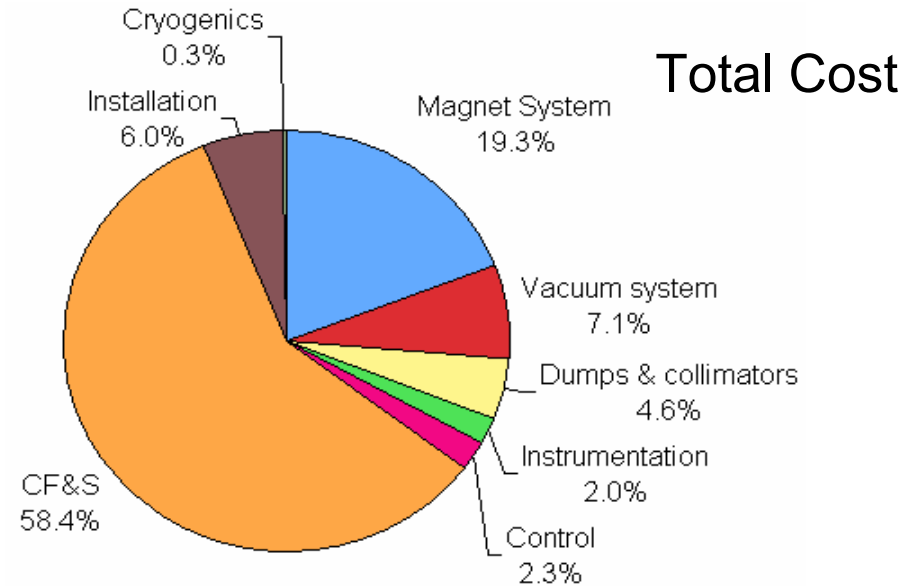




Vancouver Costs for BDS

- Cost drivers

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





2/20 mrad \rightarrow 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

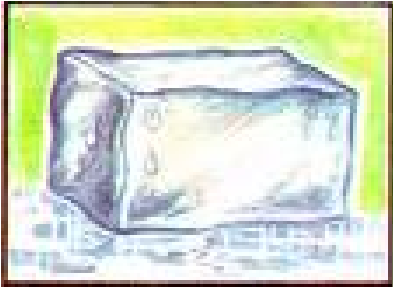


Plans until Beijing (Feb. '07)





Freeze the Design



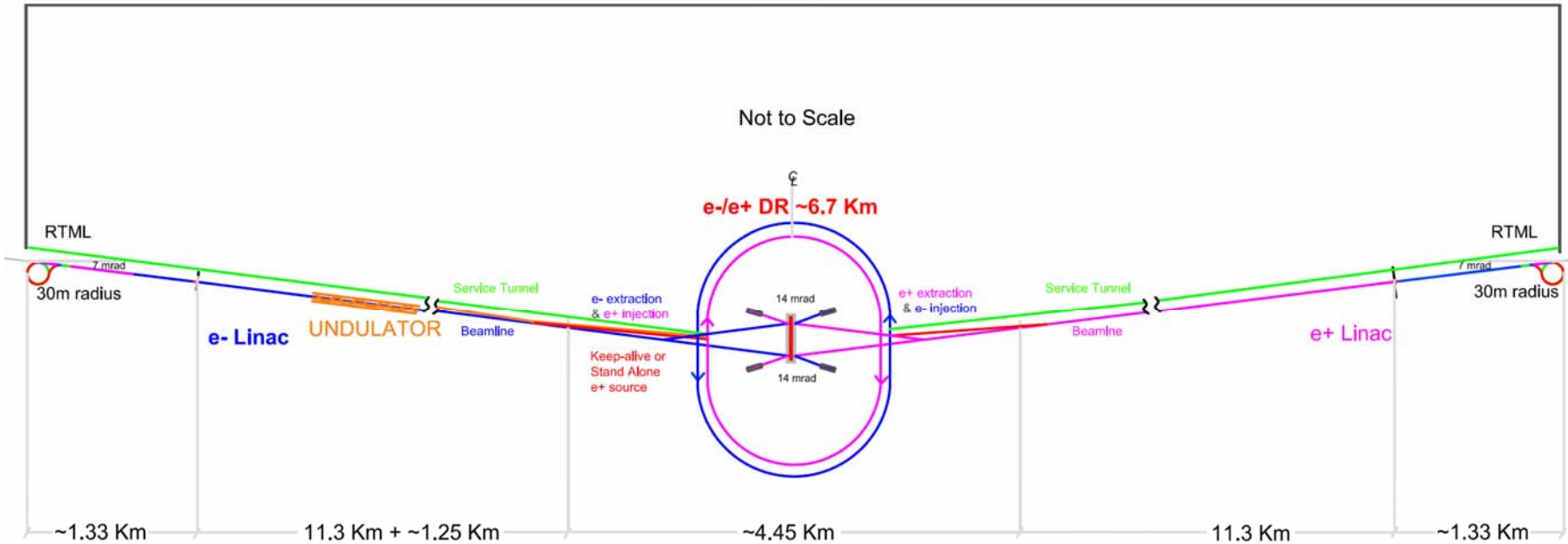
RDR Design Freeze

Summary RDR Costs

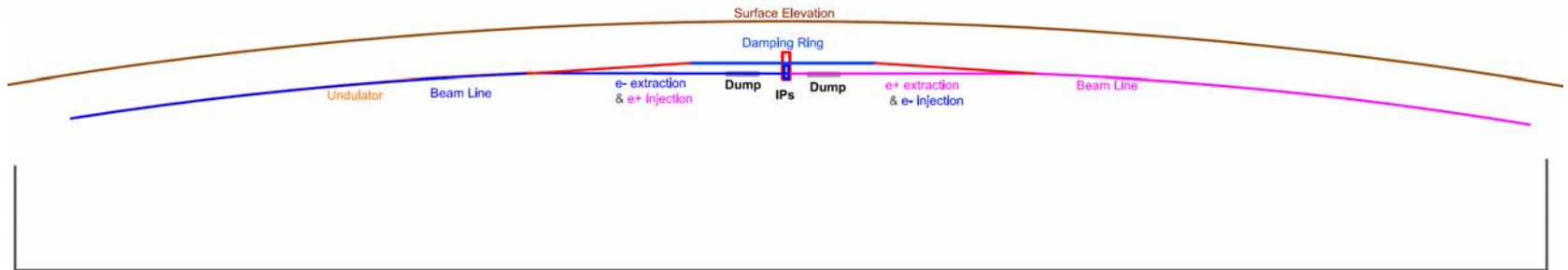
Total Value Cost
\$4.65B Shared
+
\$1.67B Host
+
17 10⁶ manhours
(in-house labor)

ILC 14/14 mr

~31 Km



Schematic Layout - Plan View of the 500 GeV Machine



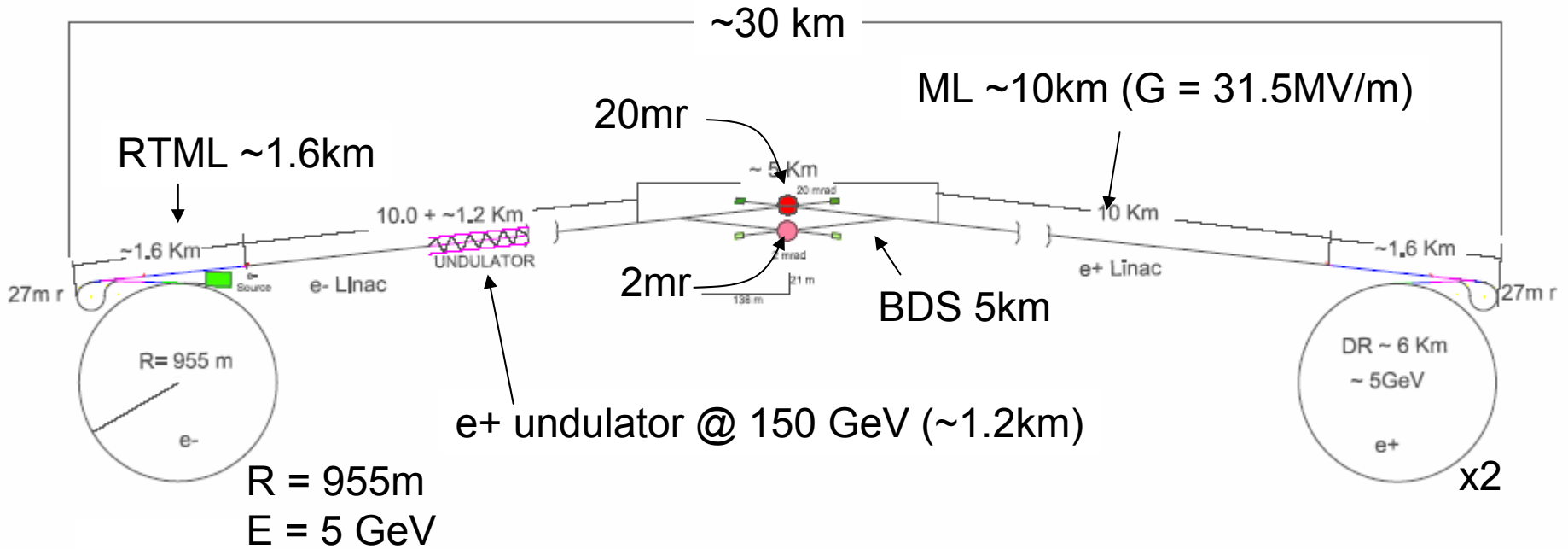
500 GeV Machine

General Elevation View



The Baseline Machine (500GeV)

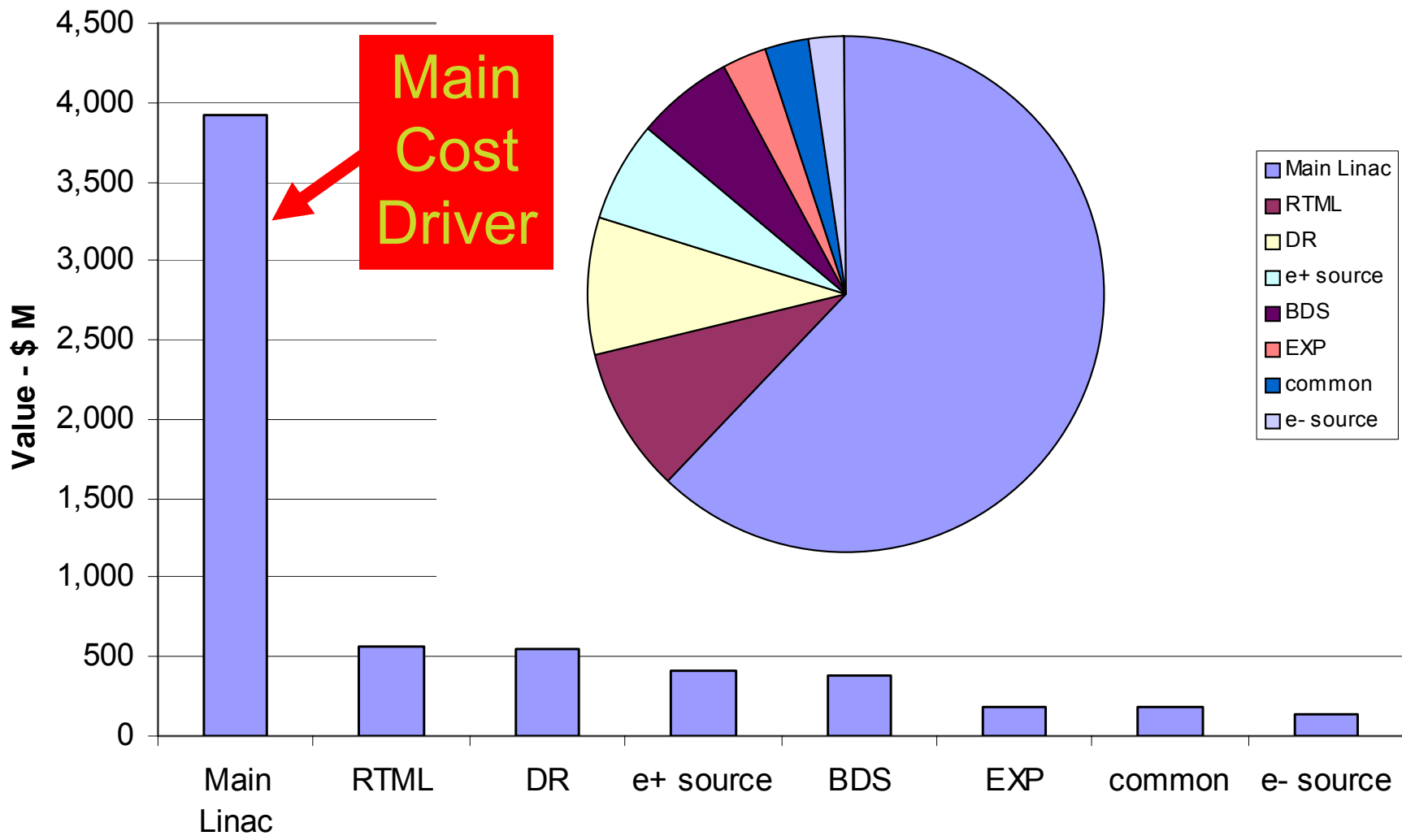
F. Asiri/SLAC 11-29-2005



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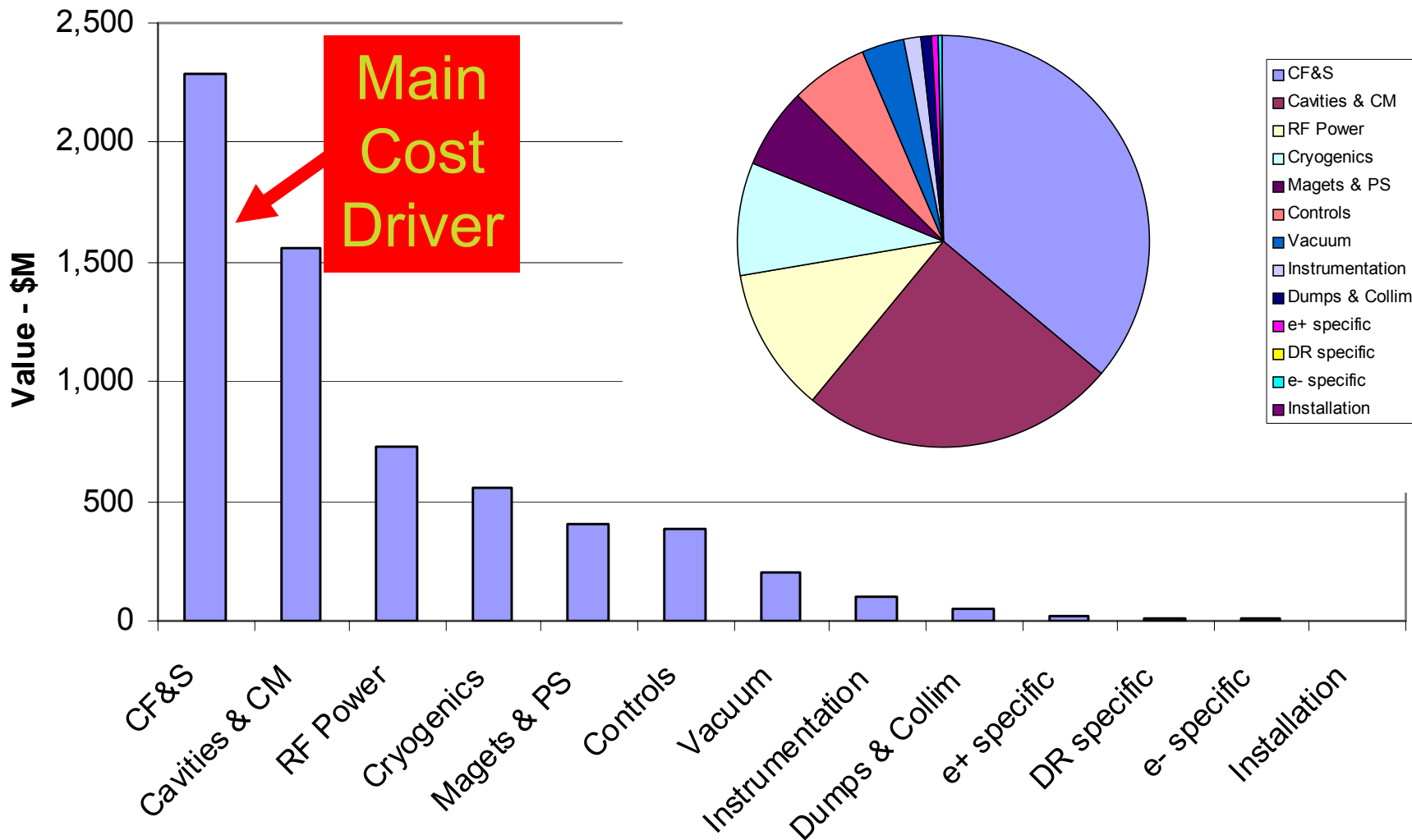


ILC Value – by Area Systems



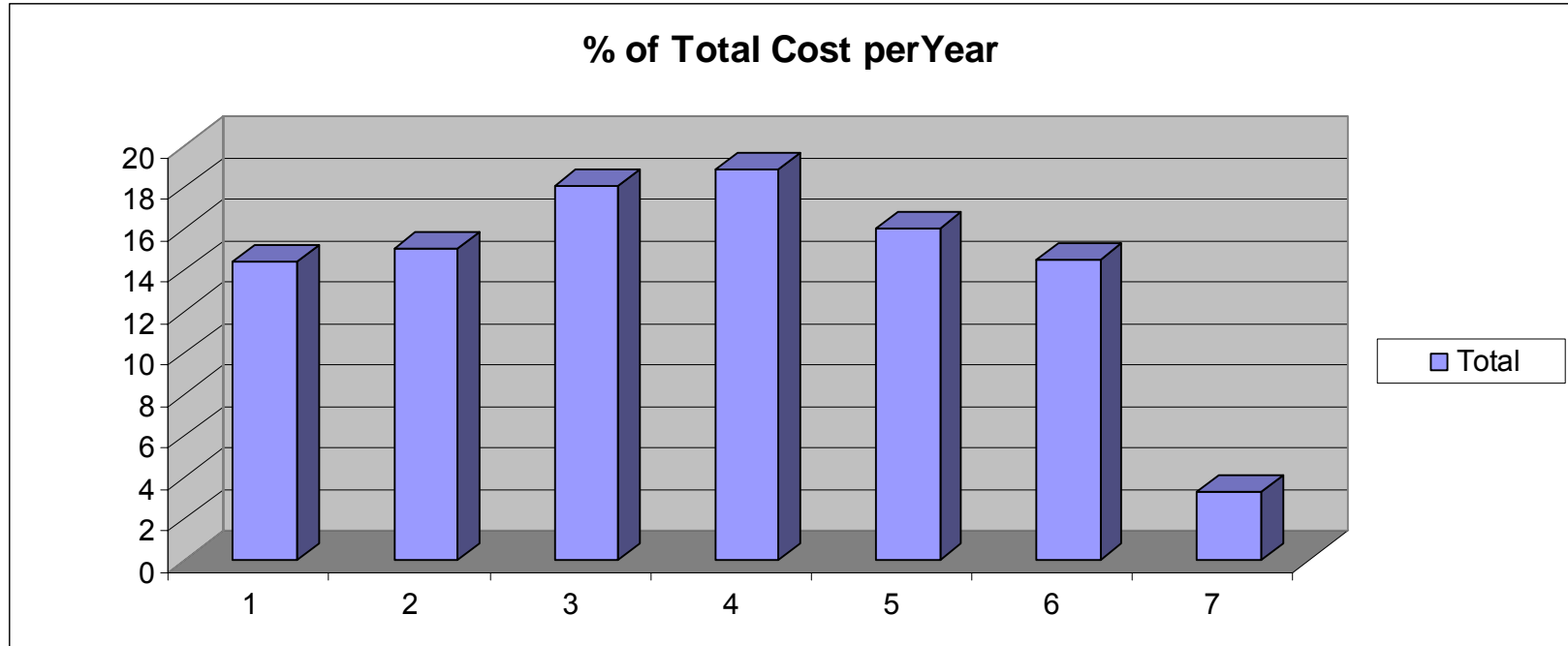


ILC Value – by Global & Technical Systems





Integrated Cost-Schedule



No integrated cost/schedule yet; but it looks feasible to develop a realistic profile



Charge for MAC Review

- On Wednesday 10, Thursday 11 and Friday 12 (until noon) January 2007, there will be an ILC MAC meeting at the Cockcroft Institute, Daresbury, UK. The major item for the meeting is the ILC cost and overall design, with specific MAC tasks:
 - Review the soundness of the overall RDR concept, identify any areas of concern, note what R&D is still needed, and comment on whether the performance parameters can be met.
 - Review the cost methodology and identify any areas of concern.
- This will be the first occasion at which costs will be presented outside of the GDE.



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**
 - **General Goal is to have Construction Proposal ready by 2010**



Proposed RDR Review Process

July 27, 2006

Dear Shin-ichi, Roberto,

The GDE expects to complete its Reference Design Report and associated value-based cost estimate at the beginning of 2007. We would like to define the process by which these documents can be reviewed and received. From the GDE perspective, the most natural mechanism would be a single international review reporting to FALC, perhaps co-chaired by persons from each of the three regions. For the US, inclusion of Dan Lehman as a co-chair would be a natural choice.

We would like to ask ILCSC and FALC to take this matter into consideration with the aim of establishing the mechanism by which the review would take place in spring 2007, with an agreed plan in place by October 2006 so that planning can proceed.

With regards,

Bang C. Basik



ILCSC Review Proposal

- The GDE is purposefully constituted as a tri-regional design team whose goal is to produce by 2009 a Technical Design Report (TDR) which will contain a detailed, engineering-based design and cost for the ILC.
- The initial step towards the TDR was to establish a Reference Design Report (RDR) which will define a self-consistent set of ILC design parameters and associated implementation scope. The RDR also contains an initial estimate of cost at the 20% level which is mostly parametric in nature. This initial cost estimate is at sufficient detail to permit a) trend analysis for cost reduction/optimization and b) give guidance for the R&D and industrialization that must accompany the engineering design process of the TDR.



ILCSC Cost Review Guideline

- An international team should be convened prior to completion of the RDR to review those aspects of the RDR cost estimate that strongly influence the TDR. Given the intermediate nature of the RDR estimate as discussed above, it would seem premature to review in detail every aspect of an ILC cost estimate. Rather this review team should:
 - **review cost trends and relative costs of sub-systems as they relate to potential scope changes to be incorporated in the TDR**
 - **review cost trends and relative costs of sub-systems and comment on their relevance to the R&D program needed to complete the TDR**
 - **review the methodology used in the estimate to ensure that it is appropriate for establishing an accurate TDR cost assessment. Evaluate that the method and format of estimation can serve the needs of regional authorities as they develop plans for potential involvement as partners in the ILC**



Summary & Final Remarks

- Status of Value Costing
 - **First costing available at Vancouver (July06)**
 - **Cost to performance optimization**
- Status & Plans for design modifications
 - **Several proposals accepted and some rejected**
 - **Changes having physics impact considered at Valencia**
 - **Complete RDR and Public Release – Beijing (Feb)**
 - **Reviews / Modifications to RDR / Costs until summer**
- Final RDR Approved by ICFA in July. Engineering Design phase (EDR) commences



Charge for this Review

- Internal Reviewers
 - Assess the level of correctness and consistency of the estimates across the groups;
 - Identify either missing information, or lack of sound basis of estimate as presented (with a view to future more formal external reviews);
 - Identify inconsistencies and errors with respect to the Area System information and cost roll-ups (Area System representative specific); • To produce an overall evaluation of the complete ILC value estimate based on the
 - Information presented and advise the Director and Cost Engineers accordingly; • To identify action items to be completed before the MAC review in January 2007.



Charge for this Review

- External Reviewers
 - Identify areas where the cost estimates appear weak or where the justification is considered insufficient for scrutiny during future formal cost reviews by funding agencies;
 - Identify costs which appear inconsistent with other projects they have been involved with (where applicable); □ critically review the standards of cost estimation; □ advise the Director and Cost Engineers of possible measures to improve both the accuracy and validity of the estimates.
- We propose the external reviewers have a closed session with the GDE Director and Cost Engineers on the last day and then an outbriefing to all involved in the review.