



ILC VALUE ESTIMATE and METHODOLGY

(confidential details removed)

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Fermilab

ILC-Global Design Effort

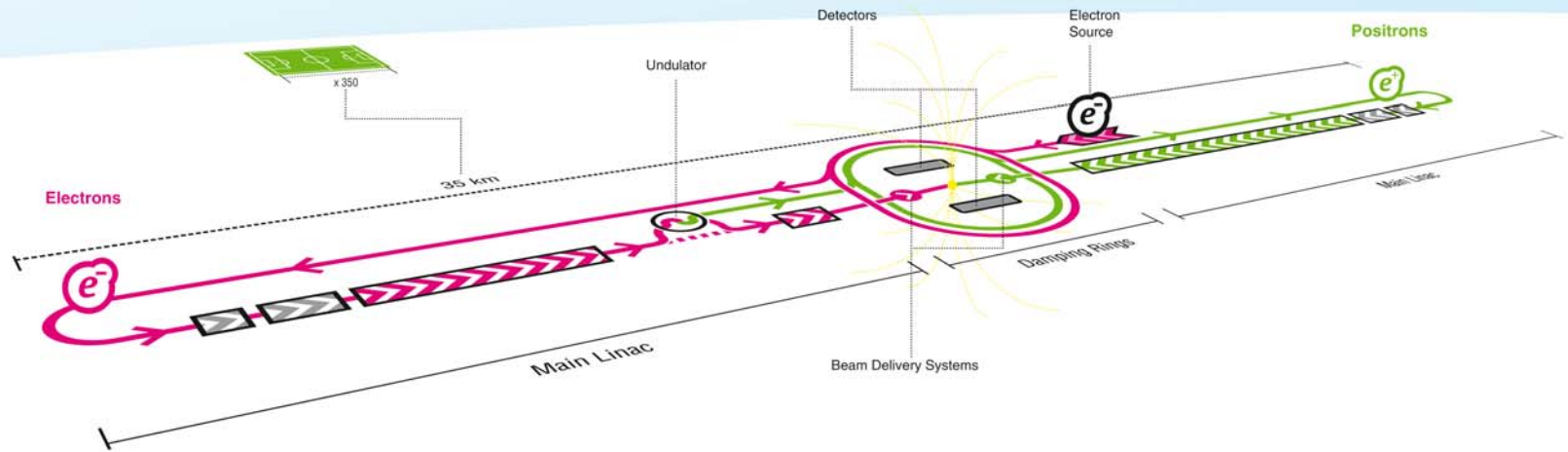


Outline

- **draft** RDR and **preliminary** value estimate
- URLs – how to find
- I will not discuss the technical aspects except where they affect estimate
- Barry Barish will present at ILC-FEST on Wed., March 7
- Marc Ross and I will follow-up Friday, March 9
- Confidentiality – still!
- International Value Estimate – what's in? what's out?
- Organization, instructions, and standards
- Process & Optimization
- Examples of Basis of Estimate
- Preliminary Value Estimate
- Characteristics of the Estimate
- Still to do...
- Lots of time for **discussion**



The International Linear Collider



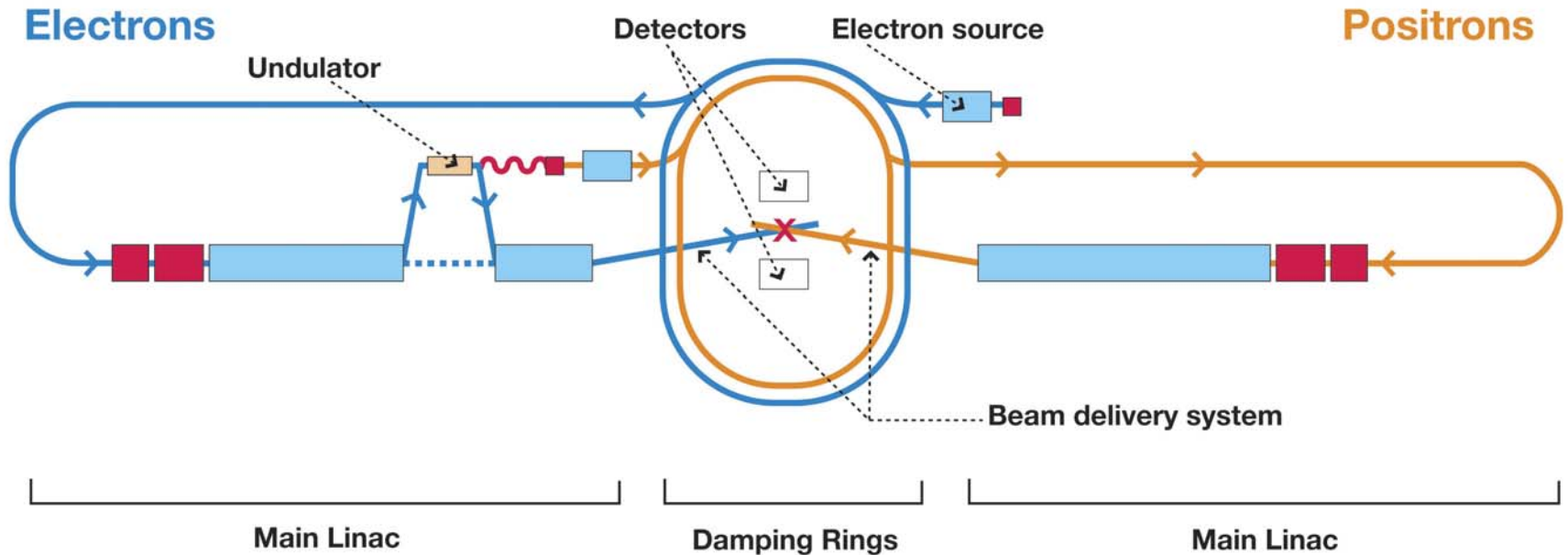
draft (still missing sections) Reference Design Report (RDR) including **preliminary** Value and Explicit Labor Estimates was made public in Beijing, Thursday, February 8, 2007

The screenshot shows the ILC website homepage. At the top left is the 'ilc' logo. Below it is a navigation bar with links for 'FOR COLLABORATORS', 'FOR THE PRESS', 'FOR COMMUNICATORS', and 'FOR STUDENTS AND EDUCATORS'. A search bar is on the right. A large banner image shows the Great Wall of China with the caption 'Beijing ILC Workshop 2007, 4-7 February (Image Courtesy IHEP)'. The main content area is divided into 'Current News' and 'Features'. The 'Current News' section has three items: one from 'itWire' dated 11 February 2007, one from 'Zeit online' dated 10 February 2007, and one from 'Le Figaro' dated 10 February 2007. The 'Features' section has one item: 'Draft Reference Design Report Released' with a list of links to various documents. A red circle highlights this 'Features' section, and a red arrow points from the text 'Report, Companion Document, Graphics, and more...' to it. On the left side of the page is a vertical menu with links like 'What is the ILC?', 'Global Design Effort', 'ILC Document Server/ILC Agenda Server', 'Talks', 'Reports and Statements', 'ILC Jobs', 'ILC in the News', 'Images & Graphics', 'Around the World', 'Calendar', 'Glossary', and 'Contacts'. At the bottom left is the 'ilc NewsLine' section with links for 'View Current Issue', 'View NewsLine Archives', 'Japanese Version', 'Search NewsLine', 'NewsLine via RSS', and 'Subscribe to ILC NewsLine'.

Report,
Companion
Document,
Graphics,
and more...



ILCSC Parameters Reports (R. Heuer)



E_{cm} adjustable (scan) from 200 – 500 GeV

Peak Luminosity $2 \times 10^{34} \text{ cm}^{-2}\text{sec}^{-1}$

$\rightarrow \int L dt = 500 \text{ fb}^{-1}$ in 4 years

Energy stability and precision below 0.1%

Electron polarization of at least 80%

The machine must be upgradeable to 1 TeV

Removing safety margins in the energy reach is acceptable but should be recoverable without extra construction. The max luminosity is not needed at the top energy (500 GeV), however

The interaction region (IR) should allow for two experiments the two experiments could share a common IR, provided that the detector changeover can be accomplished in approximately 1 week.



Gee Whiz (all pushing industry):

16,088 SC Cavities: 9 cell, 1.3 GHz

1848 CryoModules: 2/3 containing 9 cavities,
1/3 with 8 cavities + Quad/Correctors/BPM

613 RF Units: 10 MW klystron, modulator, RF distribution

72.5 km tunnels ~ 100-150 meters underground

13 major shafts \geq 9 meter diameter

443 K cu. m. underground excavation: caverns, alcoves, halls

10 Cryogenic plants, 20 KW @ 4.5° K each

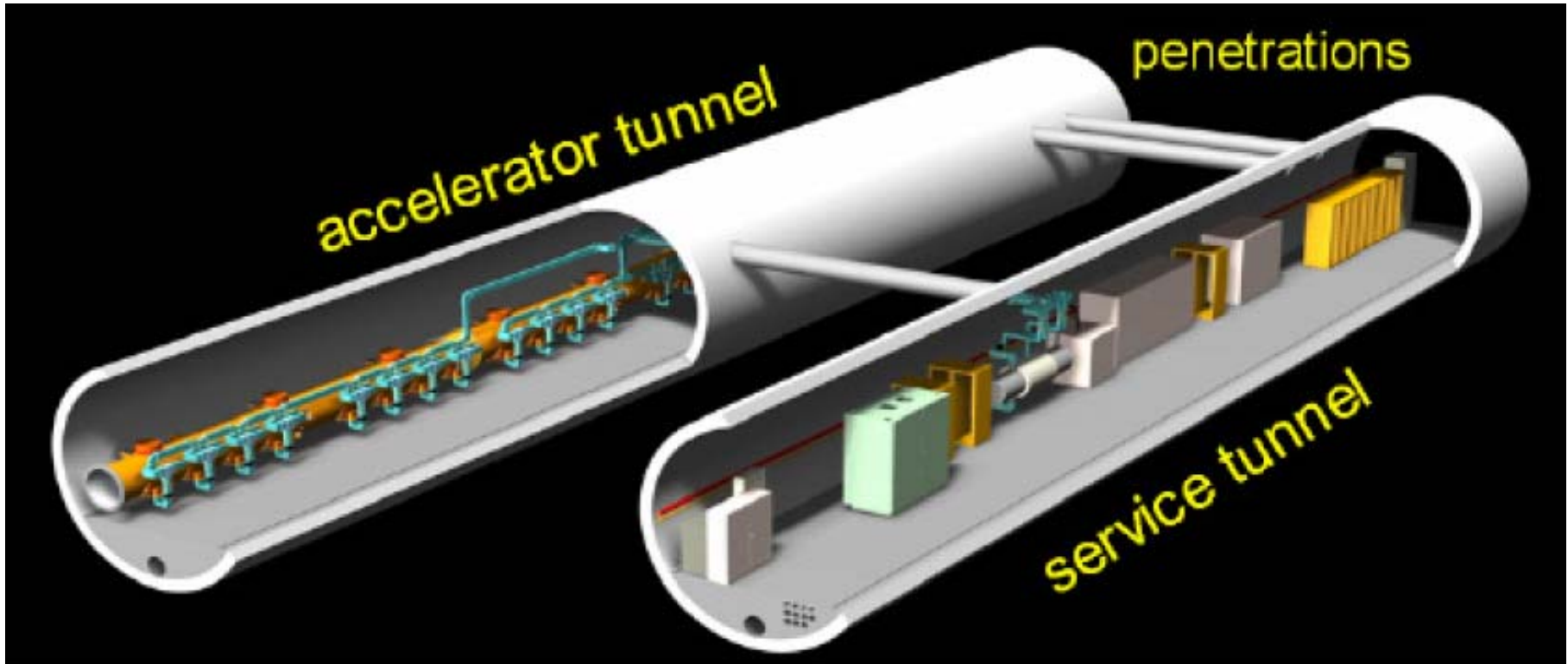
plus smaller cryo plants for e-/e+ (1 each), DR (2), BDS (1)

92 surface “buildings” (for Americas’ site), 52.7 K sq. meters

240 M Watts connected power, 345 MW installed capacity

13,200 magnets – 18% superconducting

Main Linac Double Tunnel



- Three RF/cable penetrations every rf unit
- Safety crossovers every 500 m
- 34 kV power distribution



Abbreviated RDR Timeline

- Beijing – August 04 – ITRP recommends “cold”
- Snowmass - August 05
 - prepare Baseline Configuration Document
- Frascati - December 05 – accept BCD
- Bangalore – March 06 – Design/Cost Methodology
- Vancouver – July 06 – Review Initial Cost Estimates
 - cost/performance optimization & tradeoff studies***
- Valencia – November 06 – Review Final Estimates
- Beijing – February 07 – release preliminary RDR
 - begin Engineering Design phase***



The GDE Plan and Schedule

2005

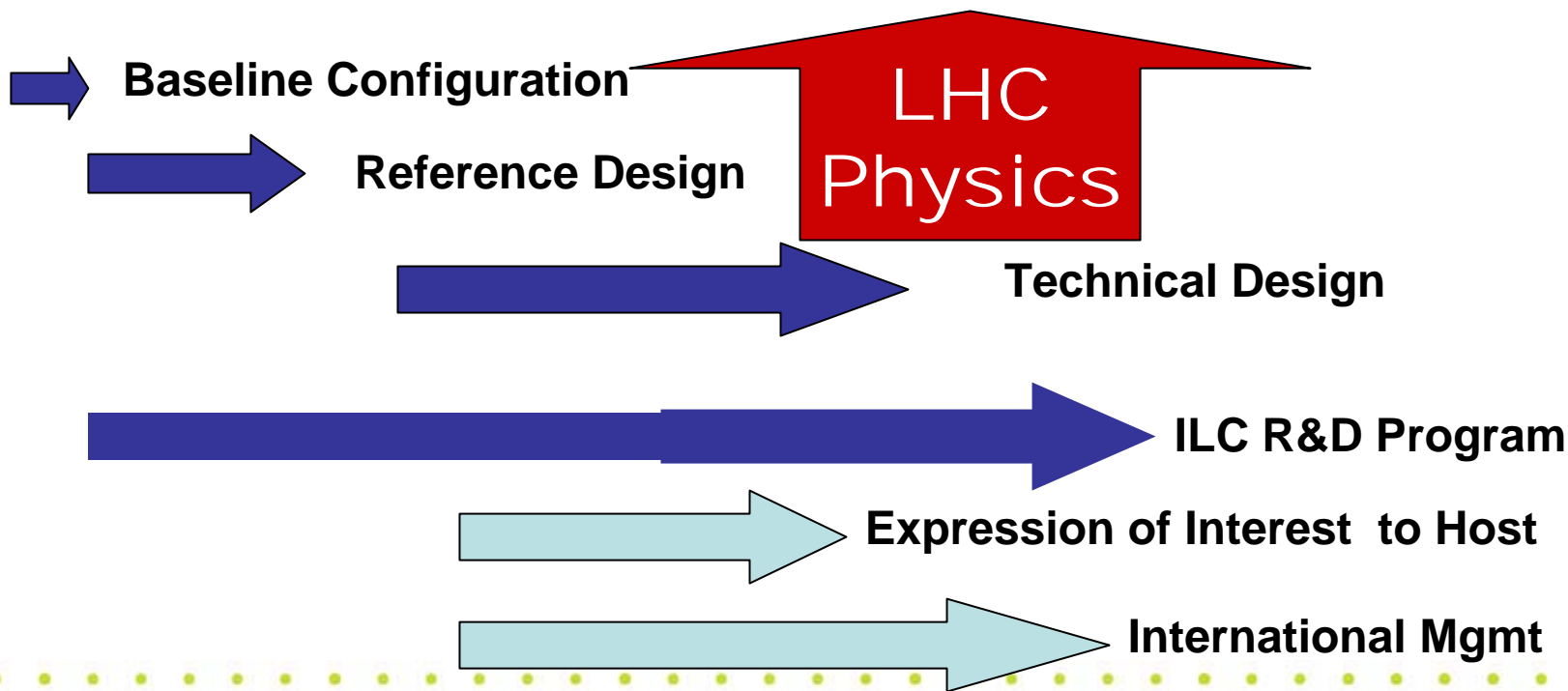
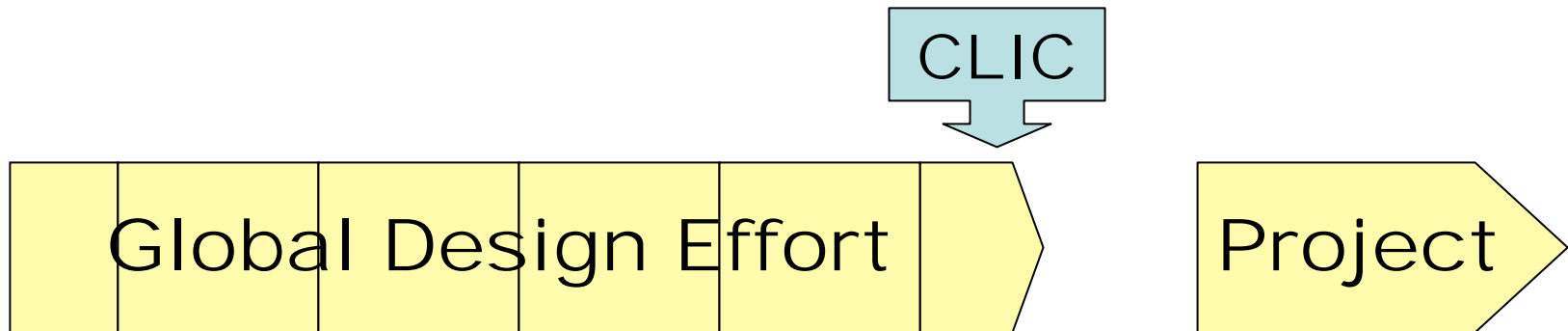
2006

2007

2008

2009

2010



Global Design Effort



RDR Cost Estimating

- “Value” Costing System:
International costing for International Project
 - Provides basic agreed to “value” costs
 - Provides estimate of “explicit” labor (man-hr)]
- Based on a call for world-wide tender:
lowest reasonable price for required quality
- Classes of items in cost estimate:
 - **Site-Specific:** separate estimate for each sample site
 - **Conventional:** global capability (single world estimate)
 - **High Tech:** cavities, cryomodules (regional estimates)
- Value is the **least-common denominator** among all parties, in that it is the **barest** cost estimate that **any** of their funding agencies expect. It needs translation into cost, by region.



Major Components of Cost Estimate:

- Three Site Dependent Estimates for Civil Construction, HV Electrical Power Distribution, Primary Cooling Water
 - CERN, Japan, Fermilab (**an estimate for each site**)
- Other conventional facilities estimates
 - electrical, HVAC, cooling, fire protection, hoisting, safety
 - site-independent
 - each estimated by **single region**, then apply globally
- Technical Cost Drivers: Cavities, Cryomodules, RF
 - independent estimates from **each of 3 regions**
 - based on Industrial Studies (not yet US for Cavities/CM, US Cavities/CM estimate is an engineering model)
 - choose estimate derived from TESLA for VALUE
- Other items have **single** engineering level estimates
 - based on world-market (lowest cost) estimates
 - often based on prior purchasing experiences



Scope of the Estimate

What is Included:

500 GeV machine include
sizing to enable 1 TeV, e.g.
beam dumps, BDS tunnels
tooling-up industry,
final engineering designs,
construction management
construction of all conventional
facilities, tunnels, bldgs, etc.
construction of detector hall,
shafts, assembly building, etc.
explicit labor including
management & administration

What is *Not* Included:

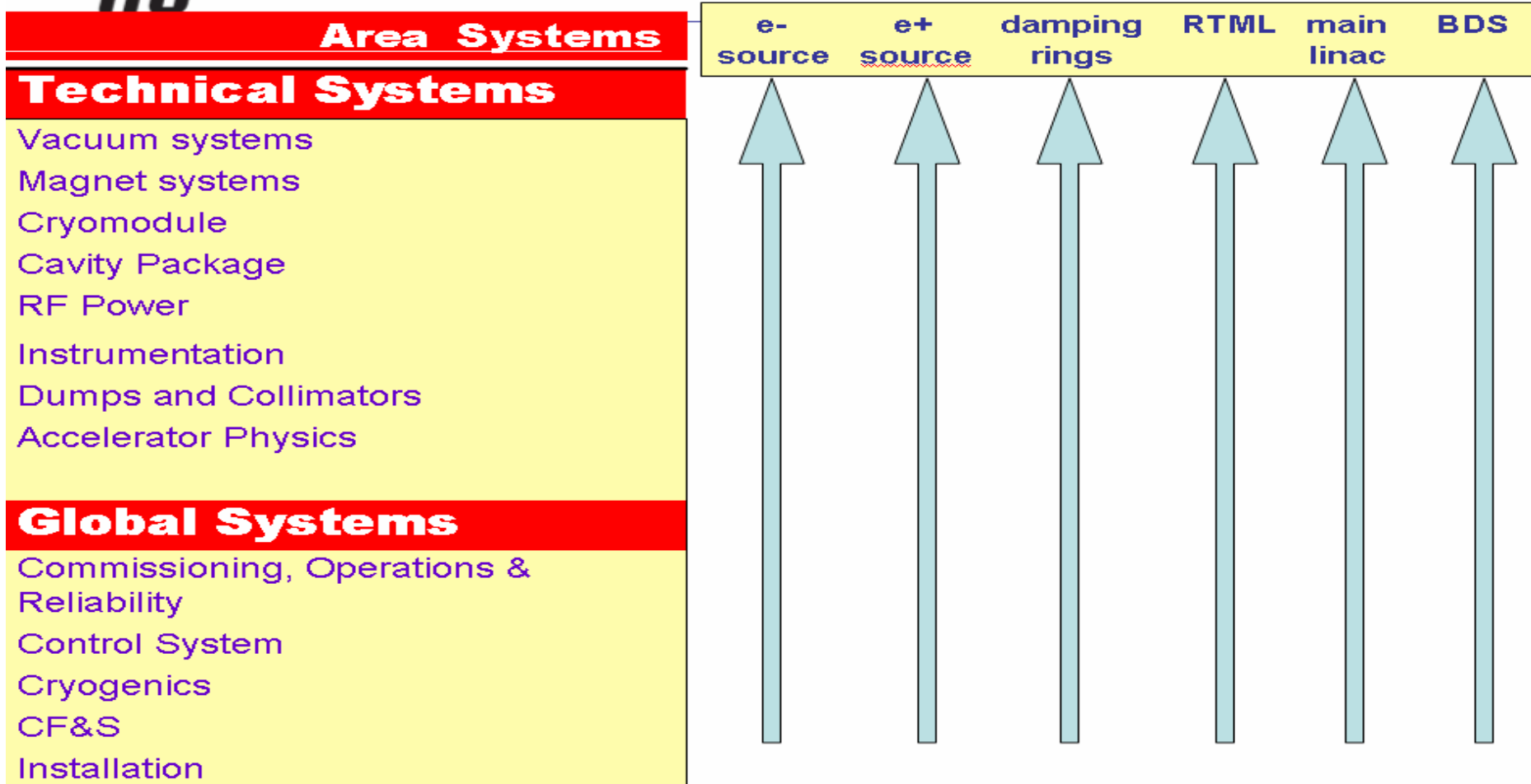
2007 estimate, no escalation
Research & Development
prototype system tests
contingency, taxes
engineering & design that
can be accomplished
before construction start
surface land or underground
easement costs
experimental detectors
commissioning, operations,
decommissioning



matrix of team & responsibilities



Cost Roll-ups





Instructions for the RDR Cost Estimate produced by Design & Cost Board

Cost Estimating Guidelines – Bangalore, March 06

http://www-ilcdcb.fnal.gov/RDR_costing_guidelines.pdf

more detailed Cost Estimating instructions – May 06

http://www-ilcdcb.fnal.gov/RDR_Cost_Estimating_Instructions_23may06.pdf



Examples of Basis of Estimate

- Cavities and Cryomodules:
industrial studies:
scaled TESLA, Asia + KEK experience
Americas industrial study – in process
engineering studies & hybrid models
- RF Power – (SLAC developed) factory model,
industrial vendor quotes in Asia & Europe
- Cryogenics – CERN LHC plant cost model
recent experience (FNAL quotation),
awaiting Cornell ERL budgetary quotes

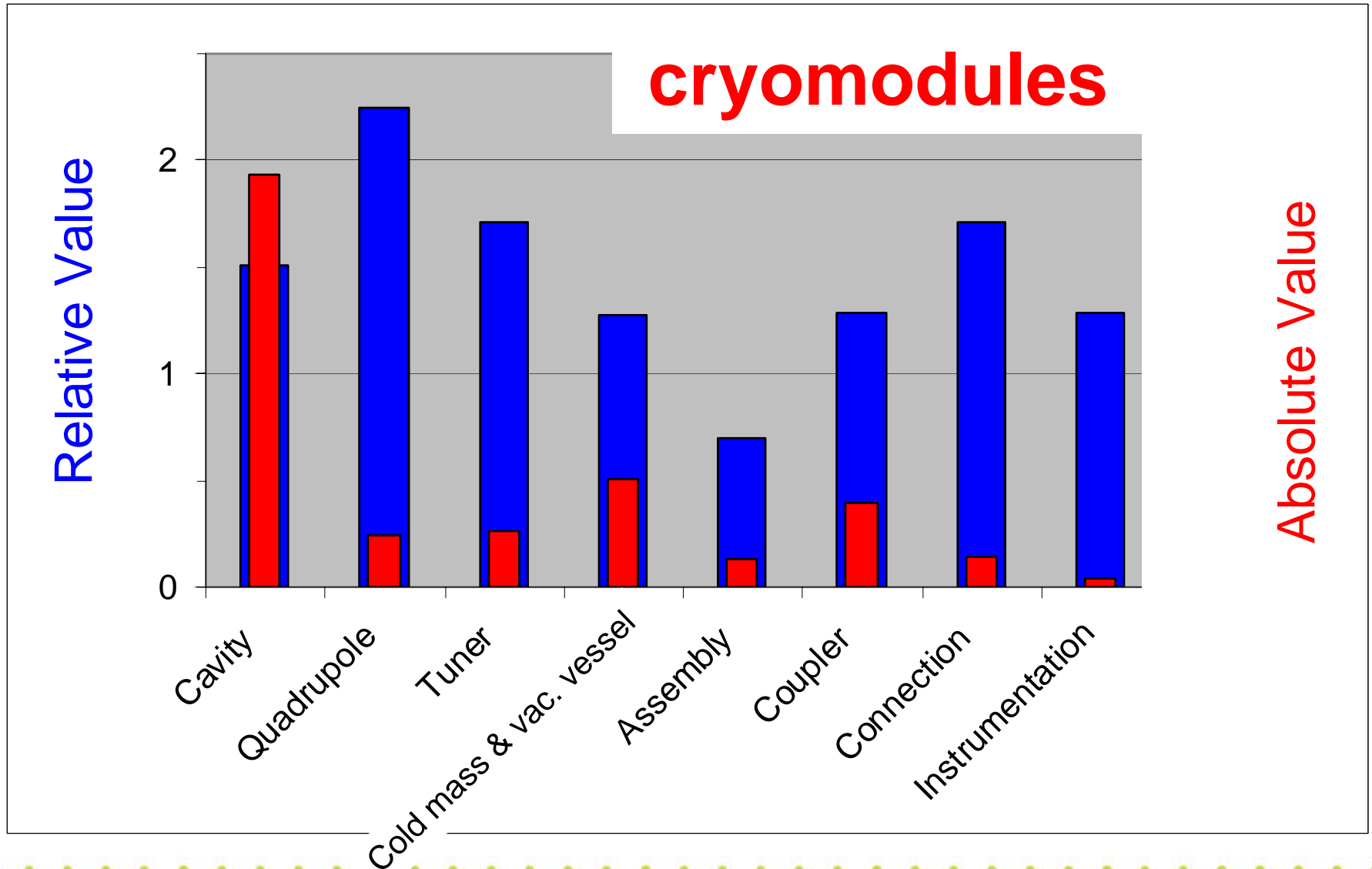


Examples of Basis of Estimate (2)

- Damping Ring RF
 - scaling KEK-B cavities & CryoModule costs
 - discussions with vendor on costs
 - for extrapolating current 500 MHz klystrons to production of 650 MHz klystrons
- Conventional Magnets
 - checked eng. cost estimates for a quad series w 3 vendors (all non-US) – agree to ~ a few %
- XFEL bids will be coming in 1-1.5 years from now

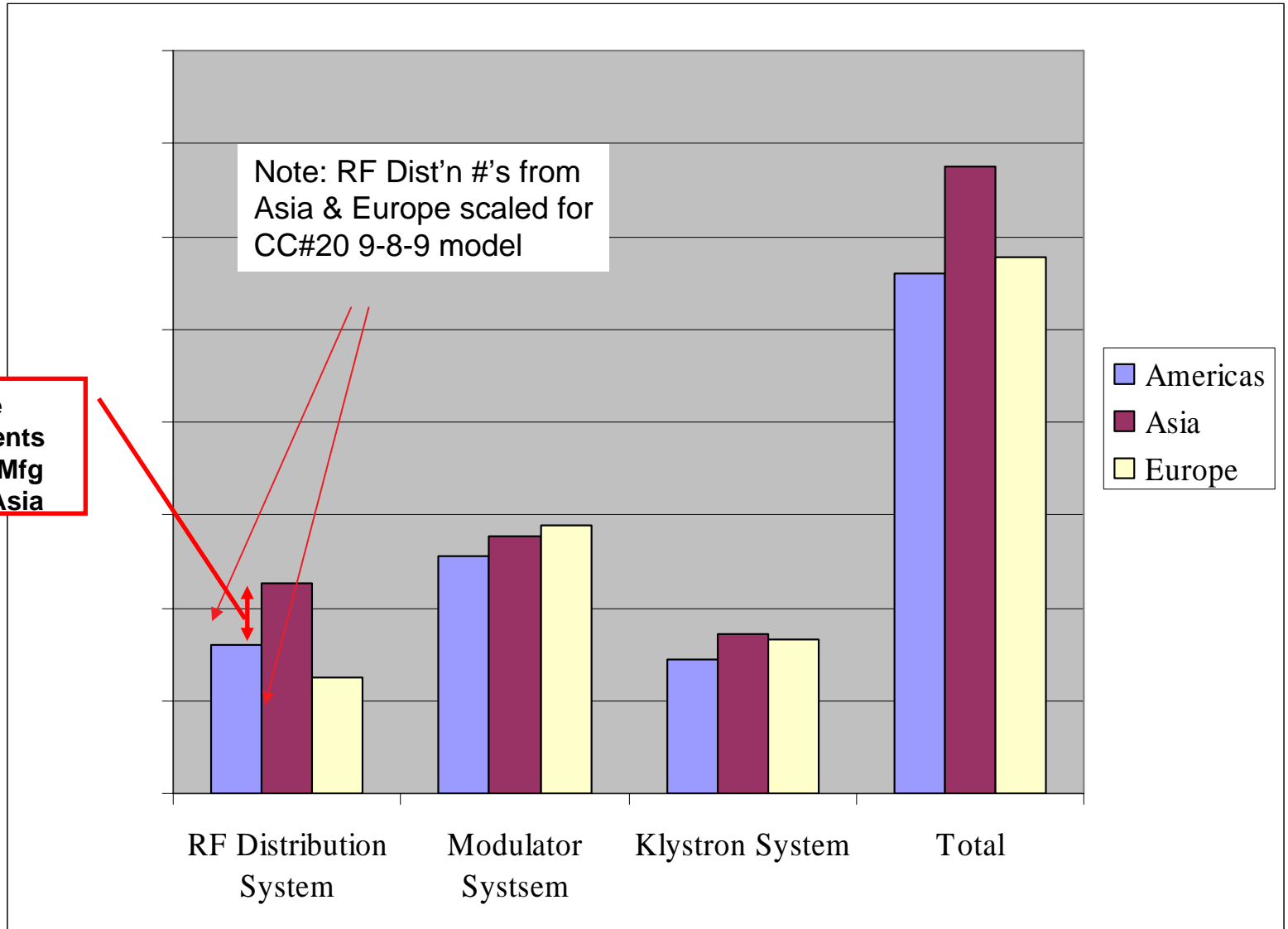


American vs. European Estimate





Cost of High Level RF by Region





Confidentiality...still

Although the draft RDR with preliminary estimates have just been released, additional backup explicit estimate data remain confidential since they are either proprietary from industrial sources or could influence upcoming procurements (XFEL) I will be able to show, but not give, some of this data. They will be marked as ***confidential*** and be removed from any copies of this presentation



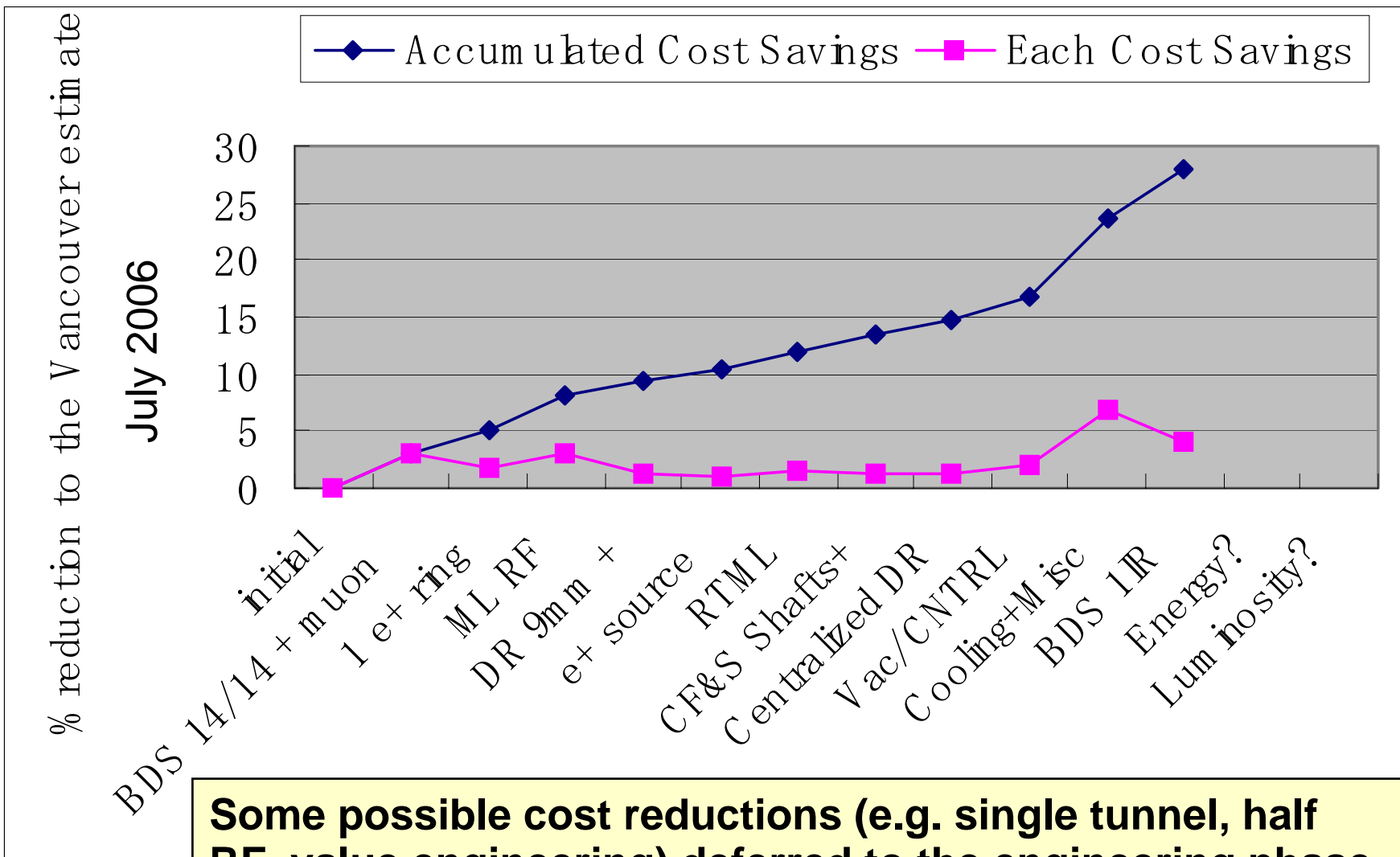
Cost-Driven Design Changes

confidential

Area		RDR MB	CCR	CCB	approx. Δ\$
BDS	Two 14mr IRs	supported	14	YES	
	Single IR with push-pull detector	supported	23	YES	
	Removal of 2nd muon wall	supported	16	YES	
ML	Removal of service tunnel	rejected			
	RF unit modifications (24 @ 26 cav/klys)	supported	20	YES	
	Reduced static cryo overhead	supported			
	Removal linac RF overhead	supported			
	Adoption of Marx modulator (alternate)	rejected			
RTML	Single-stage bunch compressor	rejected			
	Miscellaneous cost reduction modifications	supported	19	YES	
Sources	Conventional e+ source	rejected			
	Single e+ target	supported	<i>in prep</i>		
	e- source common pre-accelerator	supported	22	YES	
DR	Single e+ ring	supported	15	YES	
	Reduced RF in DR (6 → 9mm σ_z)	supported	<i>in prep</i>		
	DR consolidated lattice (CFS)	supported	<i>in prep</i>		
General	Central injector complex	supported	18(19)	YES	



Evolving Design → Cost Reductions



Some possible cost reductions (e.g. single tunnel, half RF, value engineering) deferred to the engineering phase



explicit labor (person-hours)

- Implicit labor for producing components, civil construction, etc., is included in the purchase price.
- Explicit labor is estimated separately from component costs. It may be provided by the ILC collaborators as in-kind contributions, drawn from existing laboratories with their own personnel and budgets (e.g. design, testing, supervision, etc.) , or may be purchased from industrial firms (e.g. trades people: riggers, millwrights, electricians, etc. for installation).



RDR Design & “Value” Costs

The reference design was “frozen” as of 1-Dec-06 for the purpose of producing the RDR, including costs.

It is important to recognize this is a snapshot and the design will continue to evolve, due to results of the R&D, accelerator studies and value engineering

The value costs have already been reviewed twice

- 3 day “internal review” in Dec
- ILCSC MAC review in Jan

Σ Value = 6.65 B ILC Units

Summary

RDR “Value” Costs

Total Value Cost (FY07)
4.87B ILC Units Shared

+

1.78B Units Site Specific

+

13.0K person-years

(“explicit” labor = 22.2 M person-hrs
@ 1,700 hrs/yr)

1 ILC Unit = \$ 1 (2007)



**1 ILC Unit of Value =
\$ 1 = 0.833 € = 117 ¥
January 1, 2007**

Remember:

VALUE \neq COST



for comparison

ILC: 6.7 B ILC Units (2007\$) + 13,000 person-years

TESLA: 3.1 B €(2000) + 6,900 person-years

	TESLA TDR / M€	Scaled TESLA TDR / M\$	ILC RDR / M\$	Difference / M\$
Total Cost	3136	5018	~6500	~1500
Civil Facilities	676	1082	2437	1355
Underground Buildings	383	613	1070	457
Surface Buildings	44	70	168	98
Consultant Engineering	10	16	160	144
Power Distribution	34	54	275	221
Water Cooling	70	112	374	262
Cryogenic System	162	200	567	307
Cryo Plant*	12 x 11	12 x 17	10 x 34.3	139

*TESLA: 6 x 4.3 kW @ 2 K

ILC: 10 x 3.5 kW @ 2 K

XFEL: 2.45 kW @

The difference is primarily in conventional facilities



VALUE Estimate Summary – ILC Units

VALUE	site-specific	shared	total
Asia	1.6 B	4.9 B	6.5 B
Americas	1.9 B	4.9 B	6.8 B
Europe	1.8 B	4.9 B	6.7 B
Average	1.8 B	4.9 B	6.7 B

not too different!



plus **13 K person-years of explicit labor**

(~ 2,000 persons/year over 7 years constructio

(= 22 M person-hrs @ 1,700 hrs/yr)

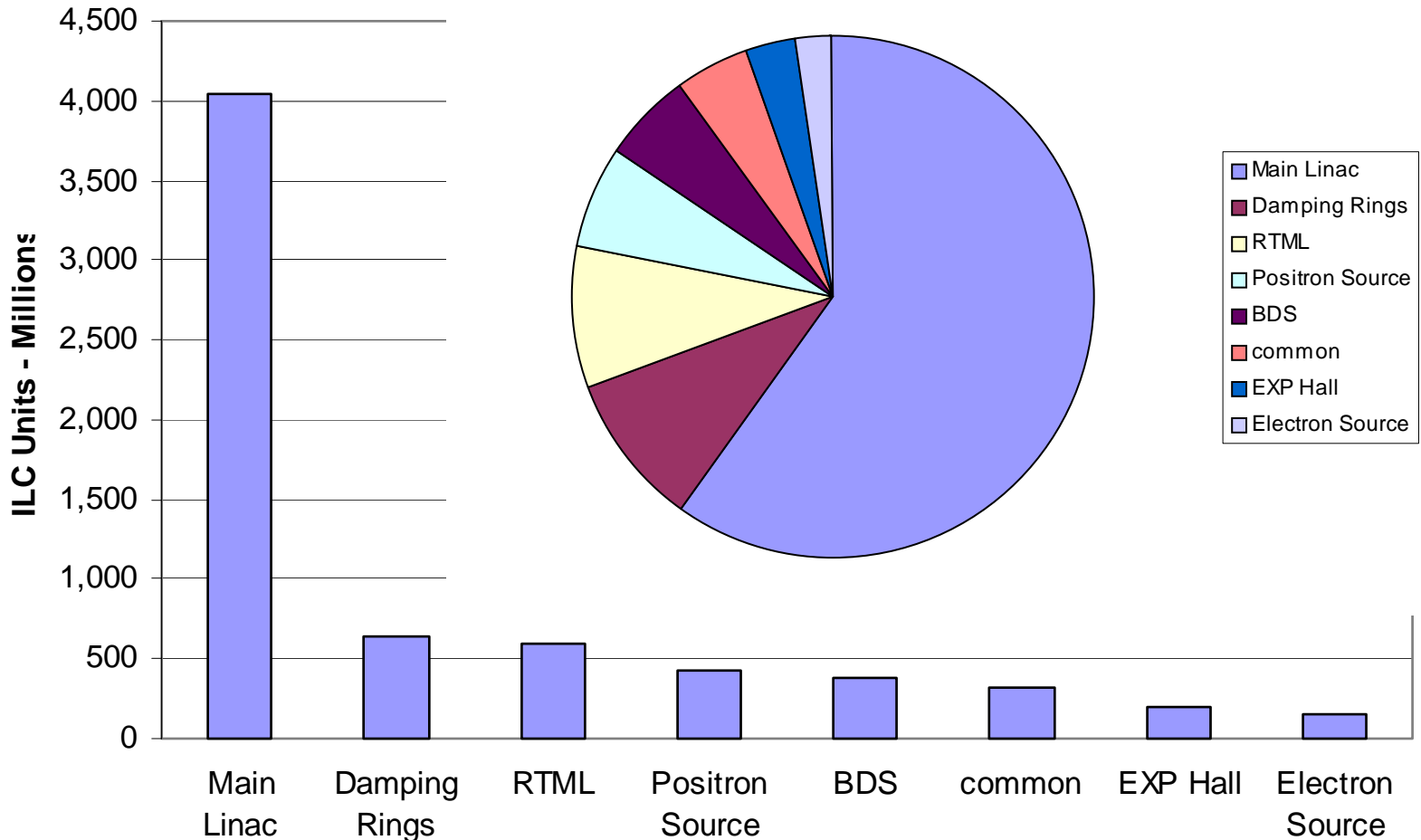
site-specific: civil engineering, HV electrical power, and primary cooling water systems.

(use Americas' estimates in illustrations below)



ILC Value – by Area Systems

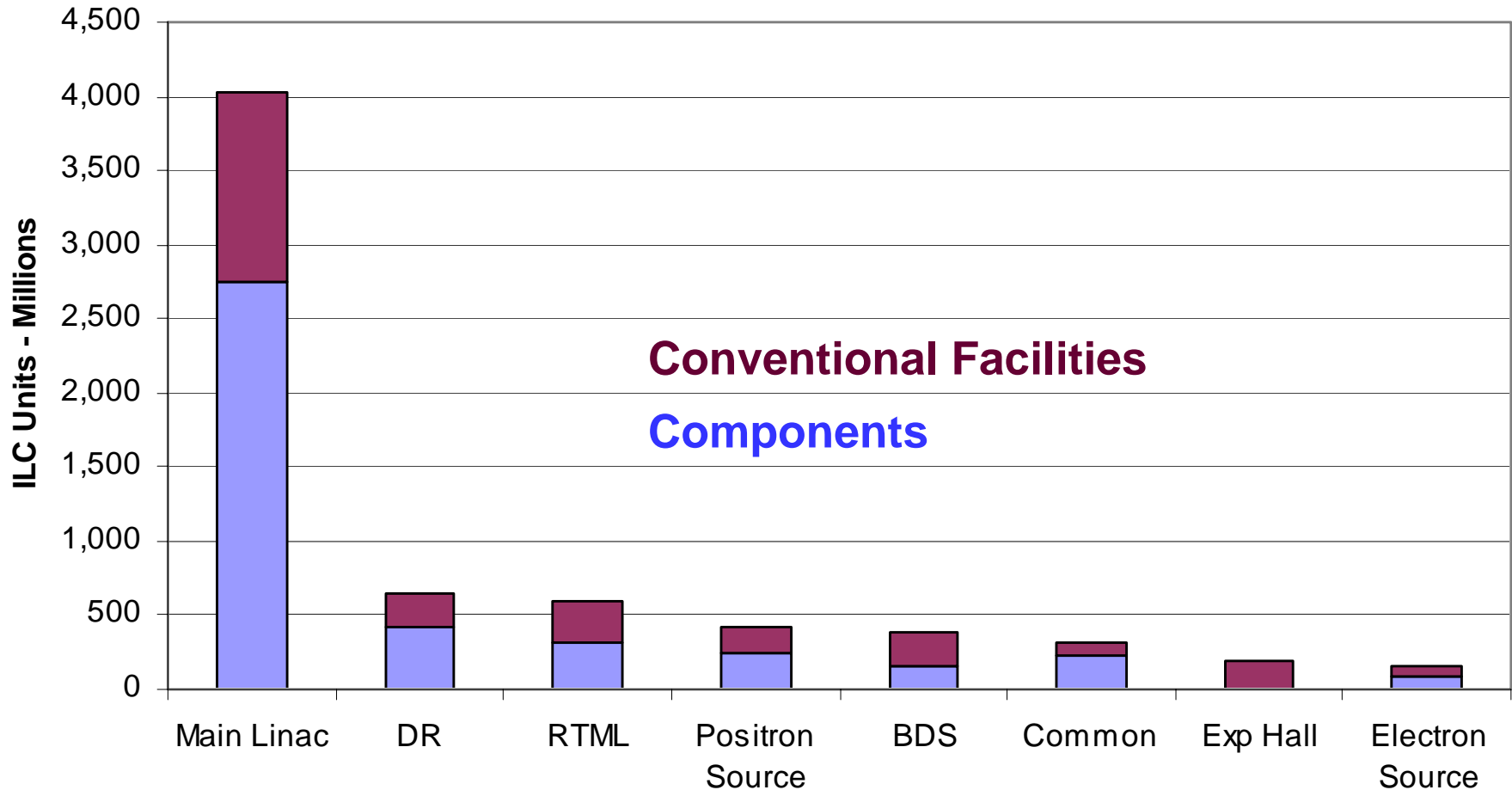
includes CF&S in each AS total



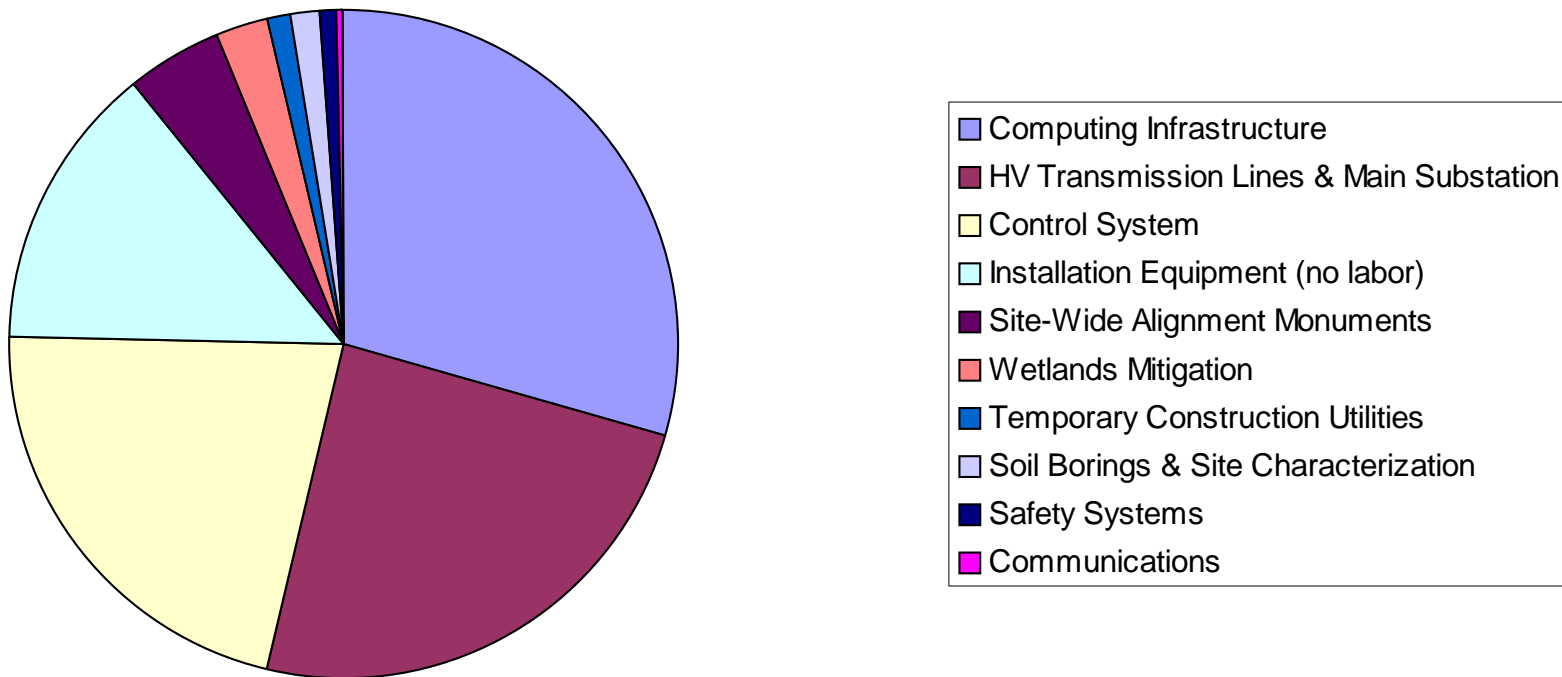
see next page for definition of “common”



ILC Value – by Area Systems

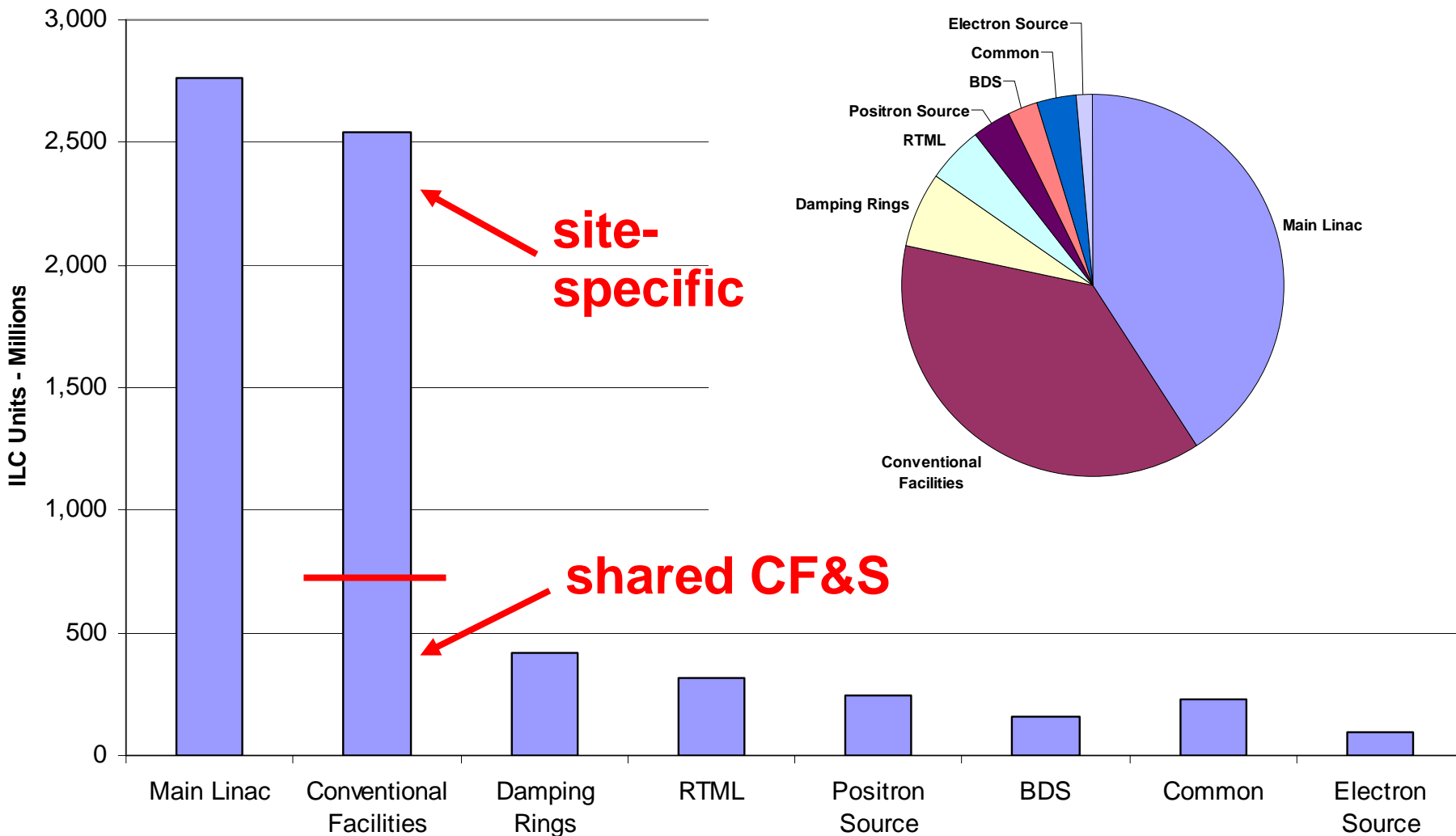


“common” includes:





Value – CF&S + AS (non-CF&S)





ILC Value – by Global & Technical Systems

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Installation counted mostly as in-house labor





Area vs. Global/Technical Systems

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What's in Conventional Facilities?

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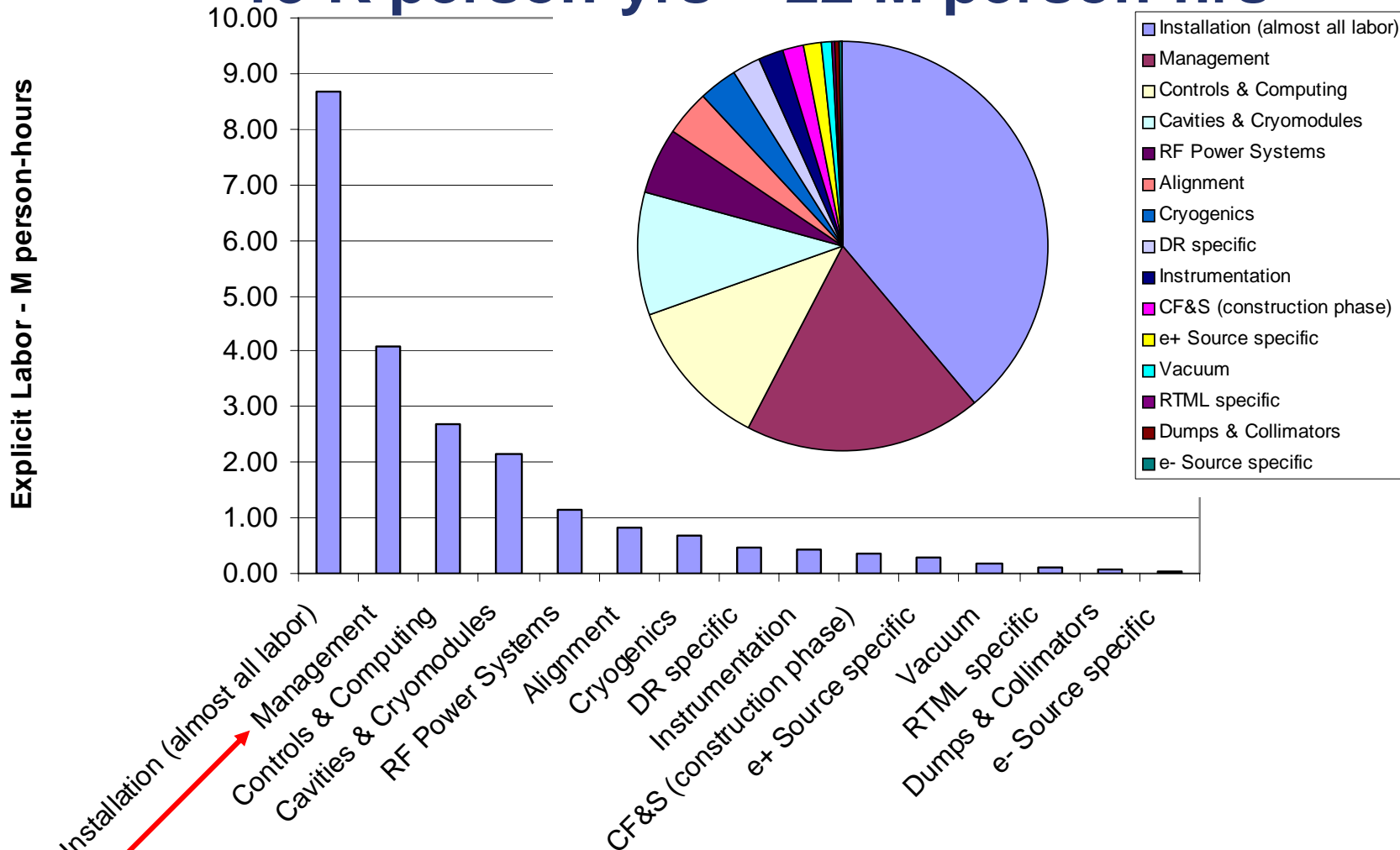
for Americas' Site
2006 Value for illustration
(not escalated)

shared

site-specific



plus Explicit Manpower = 13 K person-yrs = 22 M person-hrs

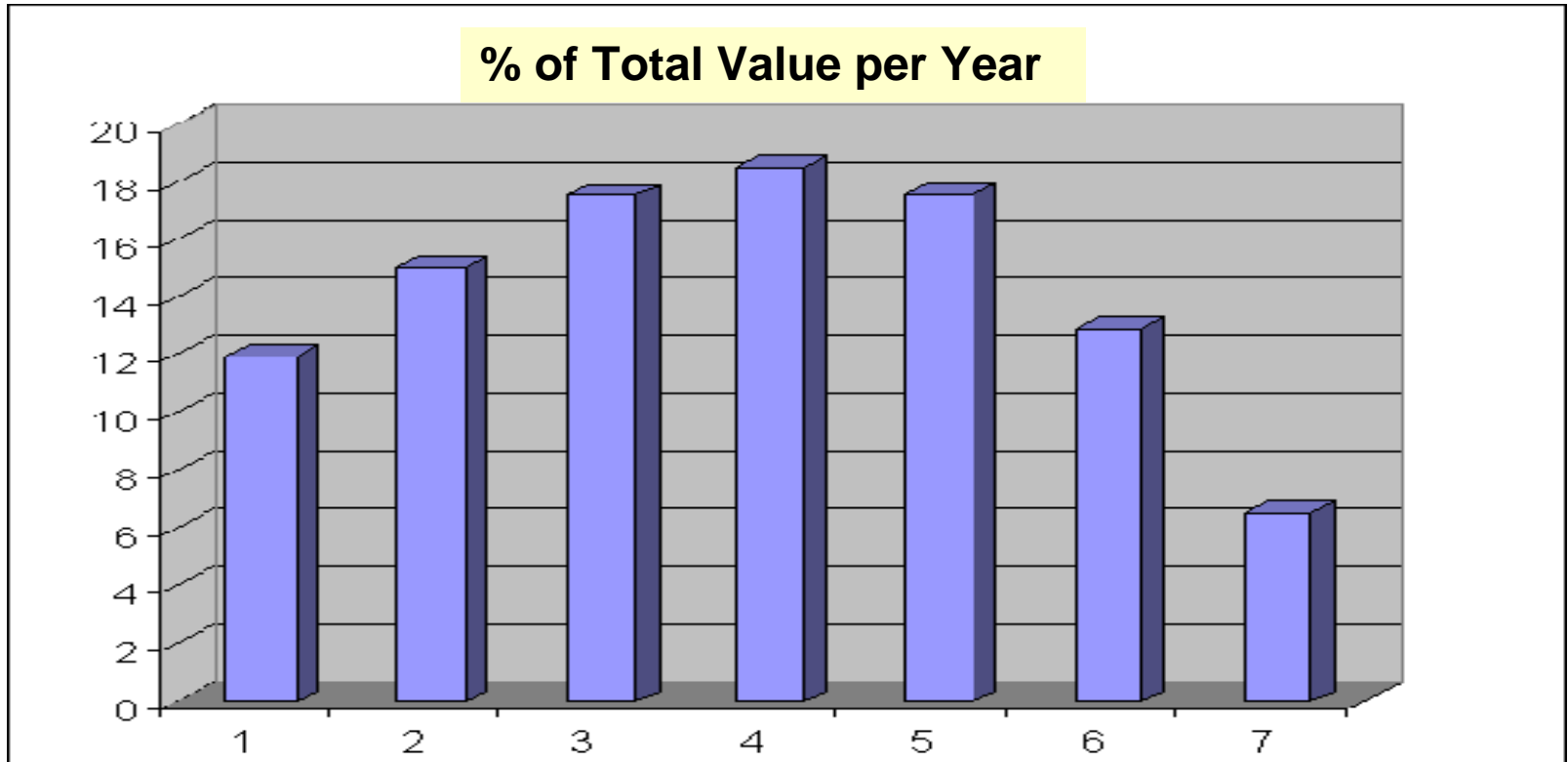


*

“management” includes personnel in “overhead sections”



Value Funding Profile



We are not using integrated cost/schedule tools yet; but it appears feasible to develop a realistic funding profile



still only a Preliminary Estimate

- need: many checks of value estimate
explicit labor is **very** preliminary => needs work
uncertainties and risk analysis:
 - uncertainties in costs and quantity discounts
 - technical risks – e.g. gradient, underground
 - futures: copper, construction, inflation, etc.
- International Review – April *or so...*
 - commissioned by FALC and ILCSC
- complete Reference Design Report & Estimate
and submit to ILCSC in July
- translate into US DOE Metrics

end of my presentation

many thanks to

**Barry Barish & Wilhelm Bialowons
from whom I appropriated many slides**

questions, comments, suggestions?