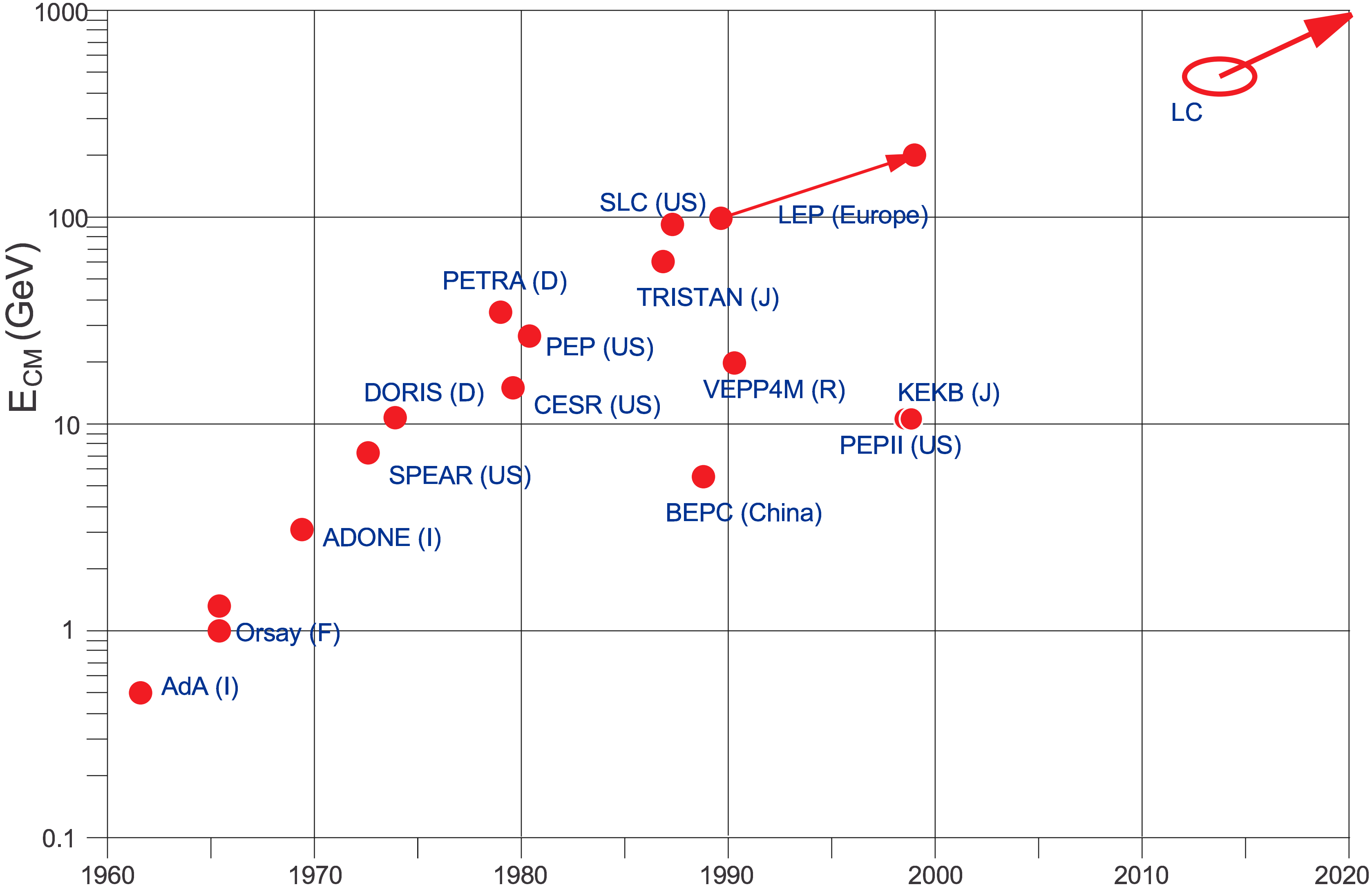
Status of the ILC project:
after release of the Reference Design Report

Collider and Astroparticle Physics
2006/2007

A.F.Żarnecki
28-02-2007

e^+e^- Colliders



Lepton Colliders

- Ring collider is impossible beyond LEP200
  - (Though, some still propose e^+e^- rings in VLHC tunnel)
- Linear Colliders have been persued for $\gtrsim$20 years as the only candidate after LEP
  - Obviously, higher gradient is better for higher energy reach
  - Numerous exotic acceleration methods proposed: Wakefield accelerator, Inverse Cerenkov, Inverse FEL, Laser-Grating, Plasma accelerator, etc
  - Only conventional microwave methods survived for the next (SLC is the 1st) and 2nd next generation LC

High luminosity could be "easily" reached at the circular collider.

Ruled out by:

- construction costs
- power consumption

"LEP 1000"

2 TeV in Center-of-Mass

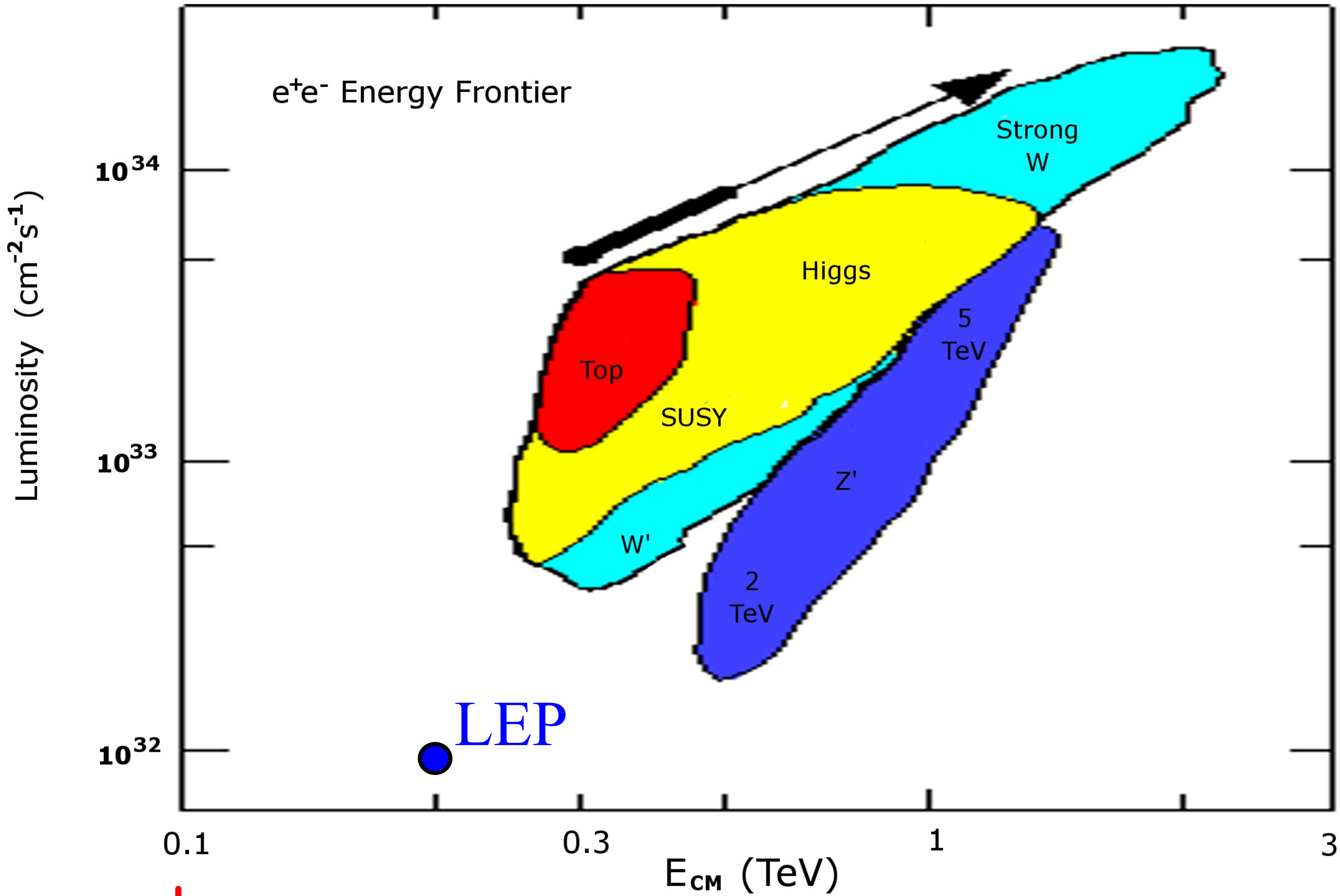
Diameter ≈ 900 km

Linear Collider at 50 MeV/m

Length = 40 km →–←

Why LEP 1000 gave way to the idea of linear colliders

The energy and luminosity challenges for a future e+e- linear collider:

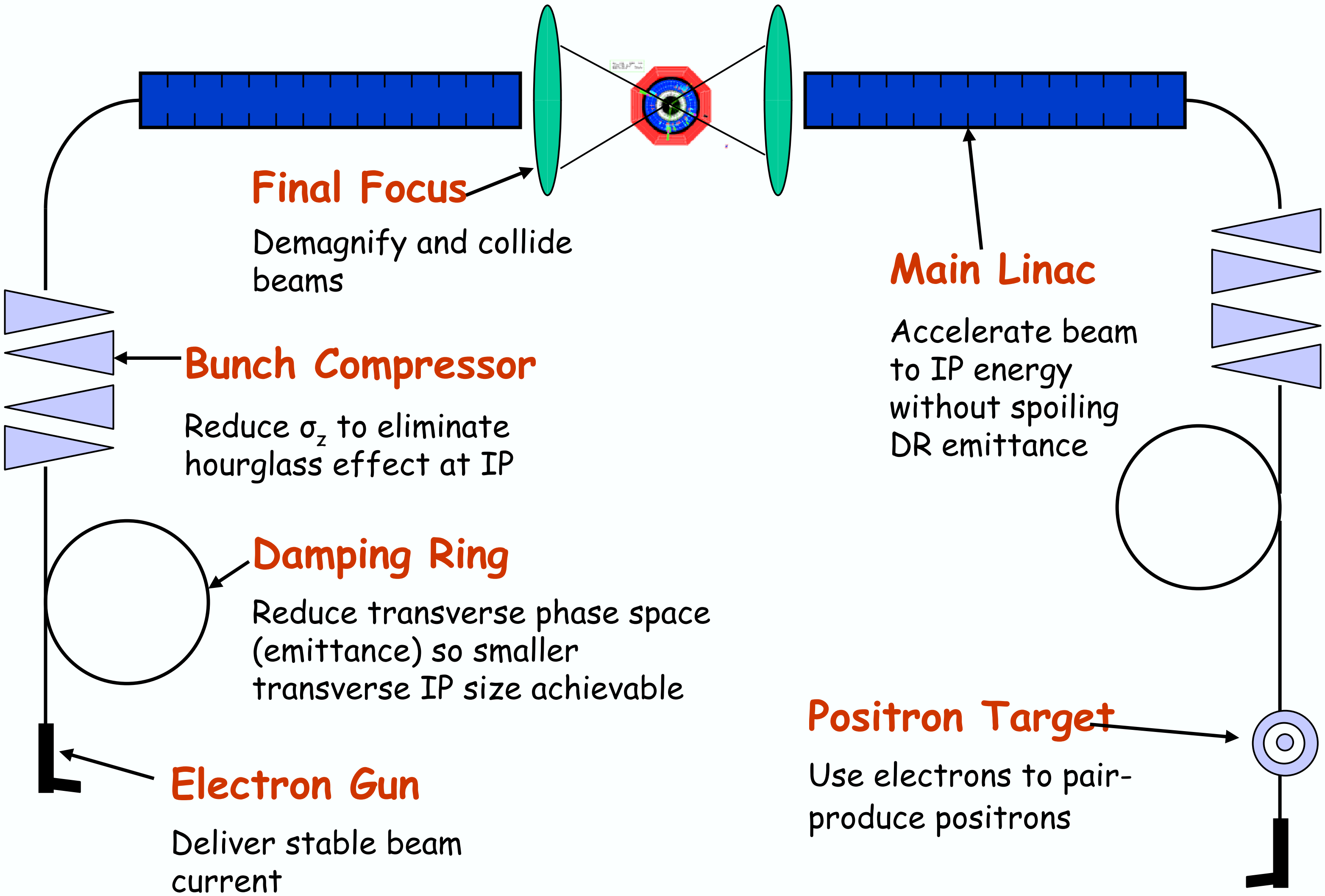


SLC

Luminosity: four orders of magnitude from the SLC

TESLA

LC conceptual scheme



Brief ILC History

- Late 1980s and 1990s:
  - Next Linear Collider:
    - SLAC/KEK warm RF designs
    - NLC detector group
  - TESLA:
    - European superconducting RF design
    - ECFA-DESY physics/detector studies →
      - **1st ECFA/DESY study: 1996/97**
      - **2nd ECFA/DESY study: 1998/2000**
      - **Extended Joint ECFA/DESY study: 2001/2003**
      - **ECFA study: 2003/2005**

  \+ World-Wide Study of Physics & Detectors

  → **International Linear Collider Workshops organized starting 1991**

- 2000s:
  - Snowmass 2001
  - HEPAP recomendation 2002
  - **"Understanding Matter, Energy, Space and Time: The Case for the e+e- Linear Collider" 2003**

TESLA TDR: 2001

GLC Project Report: 2003

500 *(→ 800)* GeV e+e- Linear Collider

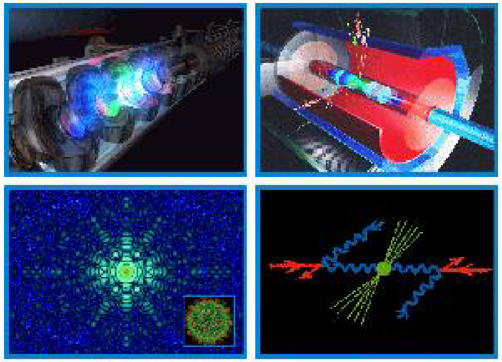
Based on superconducting linac technology

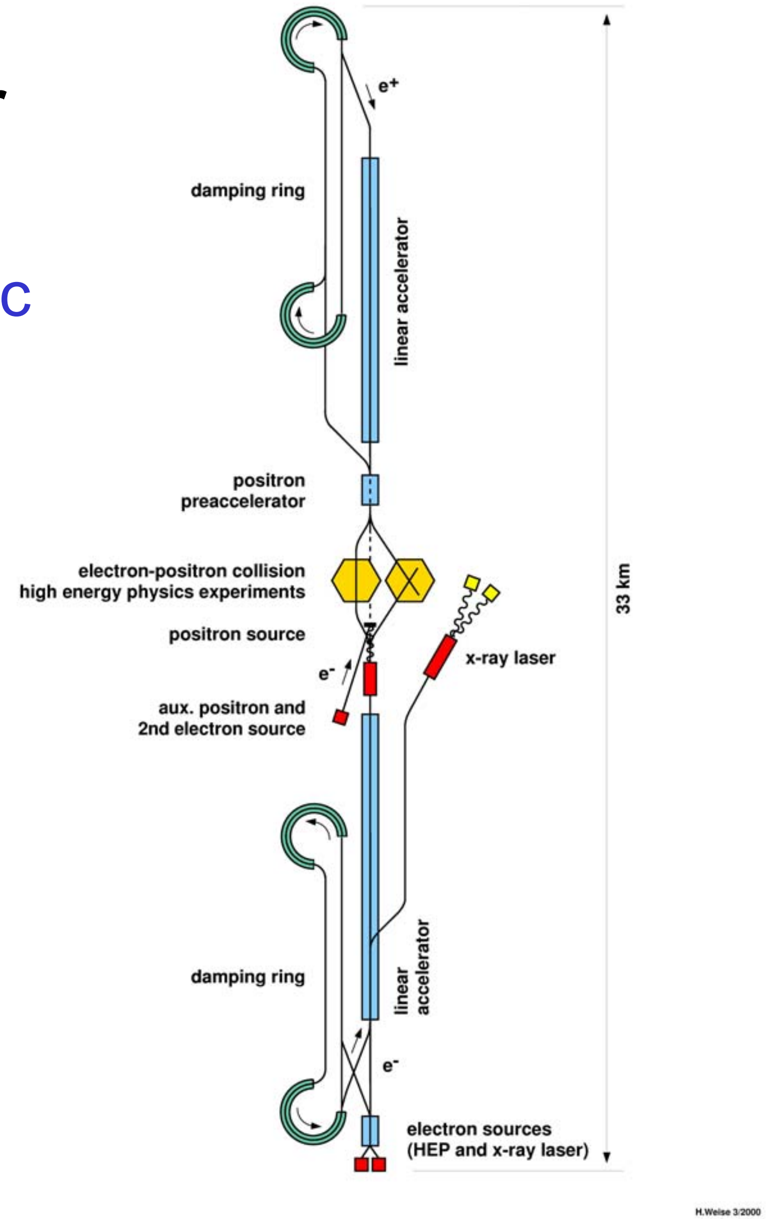
TESLA

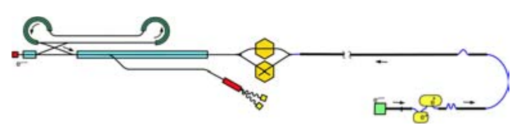
The Superconducting Electron-Positron Linear Collider

with an Integrated X-Ray Laser Laboratory

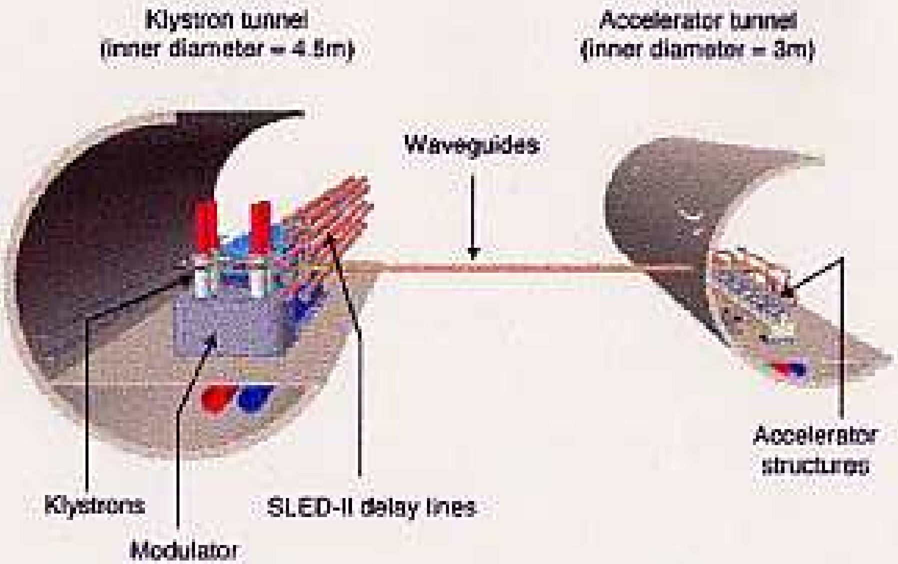
Technical Design Report

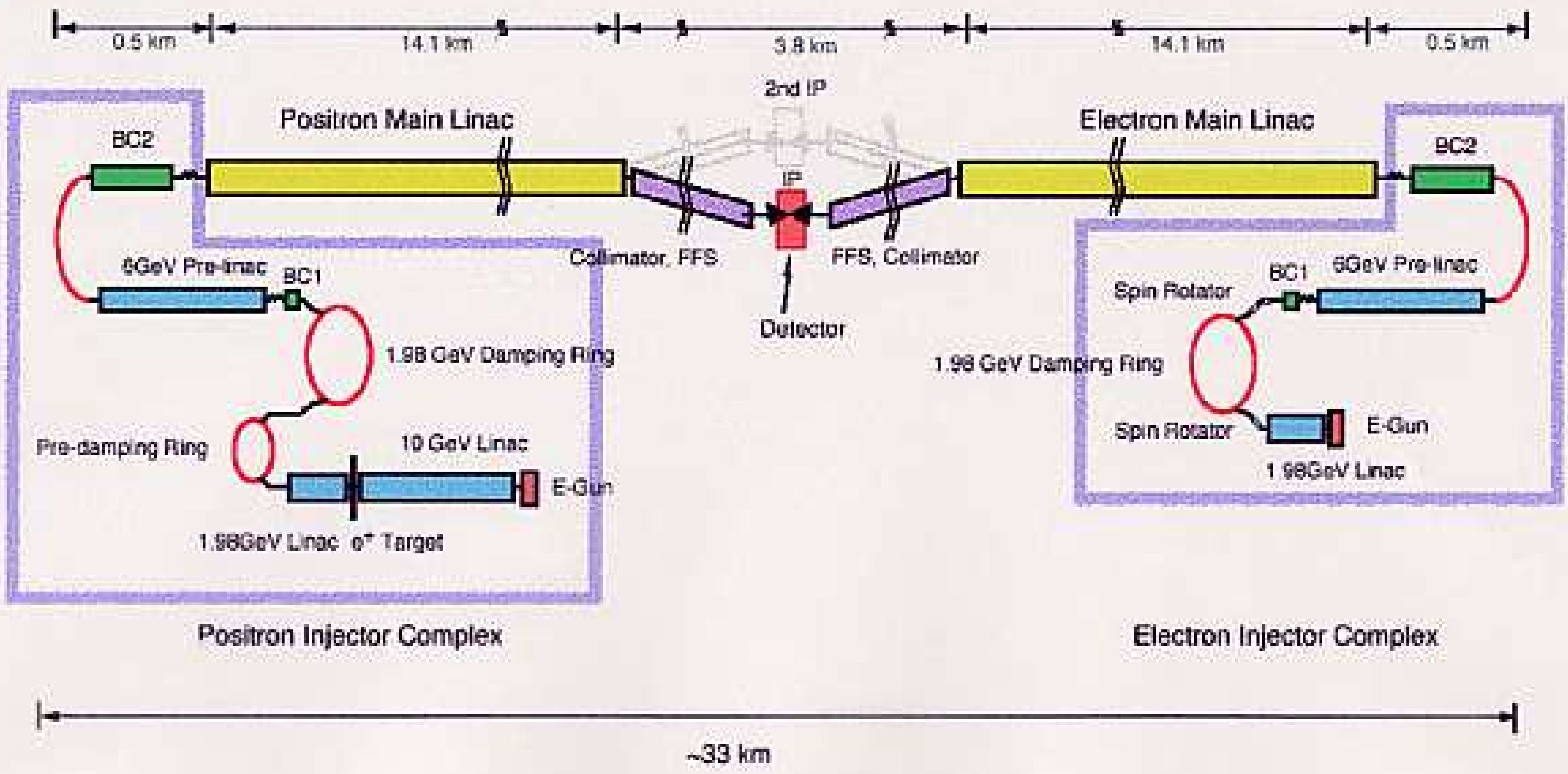






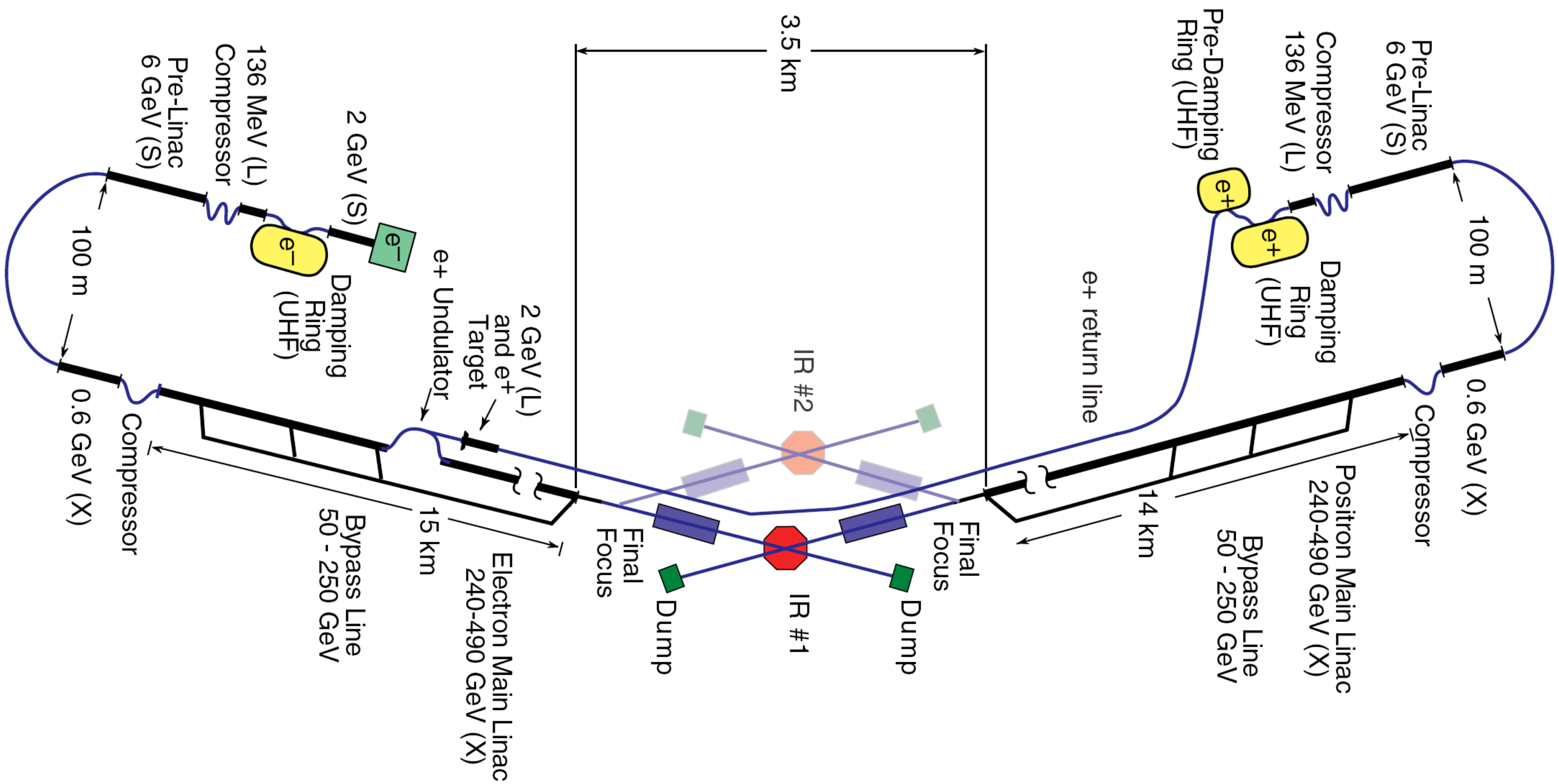
JLC/NLC Linear Collider Warm RF, 11.4 GHz, Loaded gradient=50 MV/m, site ~33 km=>E_{max}(cm)=1.0-1.3 TeV



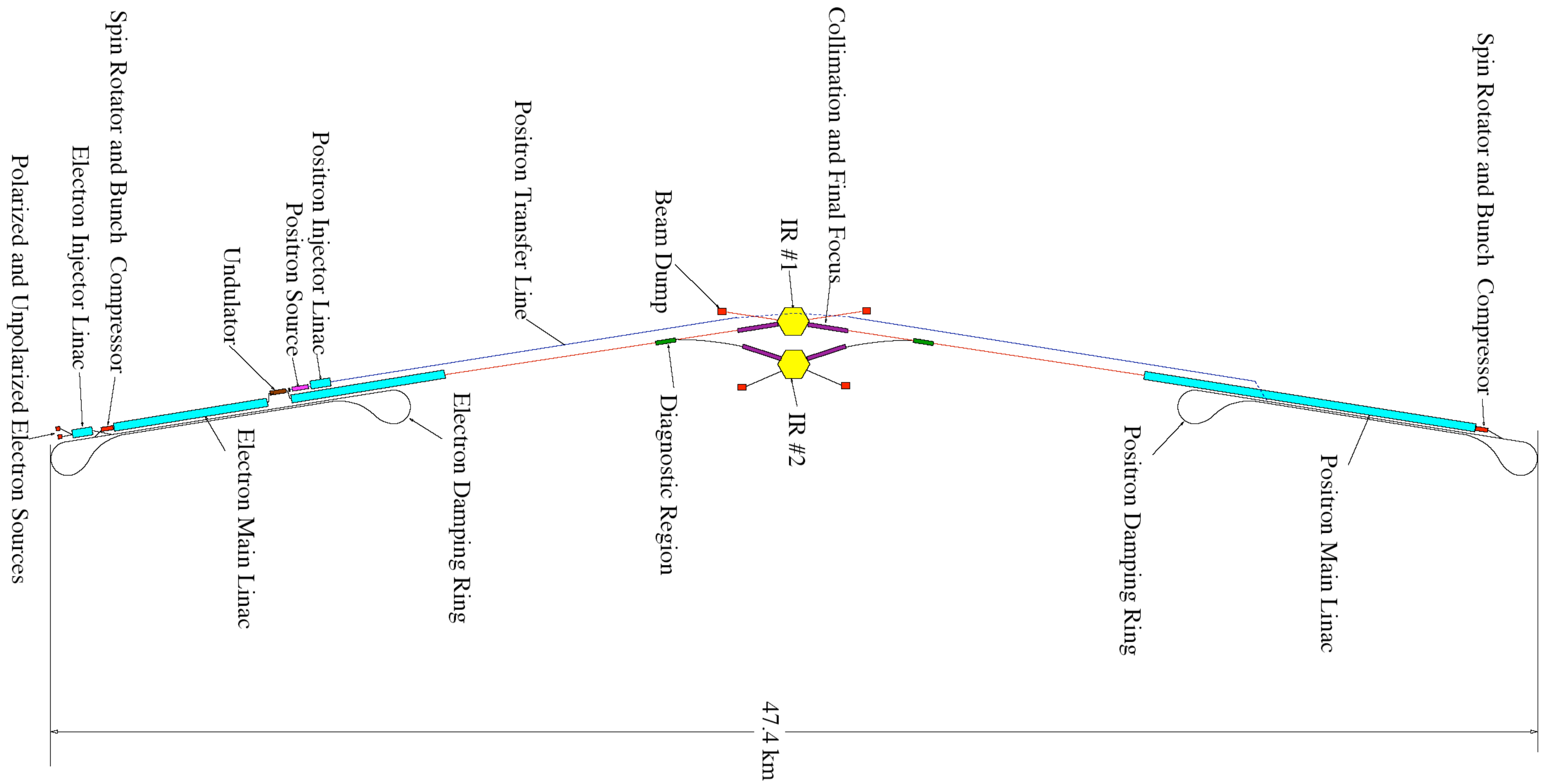


X-band Reference Design

X-band reference = 2003 NLC configuration with undulator e+ source



L-band Reference Design



ICFA and the Linear Collider

- ICFA has been helping guide international cooperation on the Linear Collider since the mid 1990's.
- Reason: World-wide consensus that 500 GeV e+e- linear collider (upgradeable to ~1 TeV) is next major accelerator following LHC

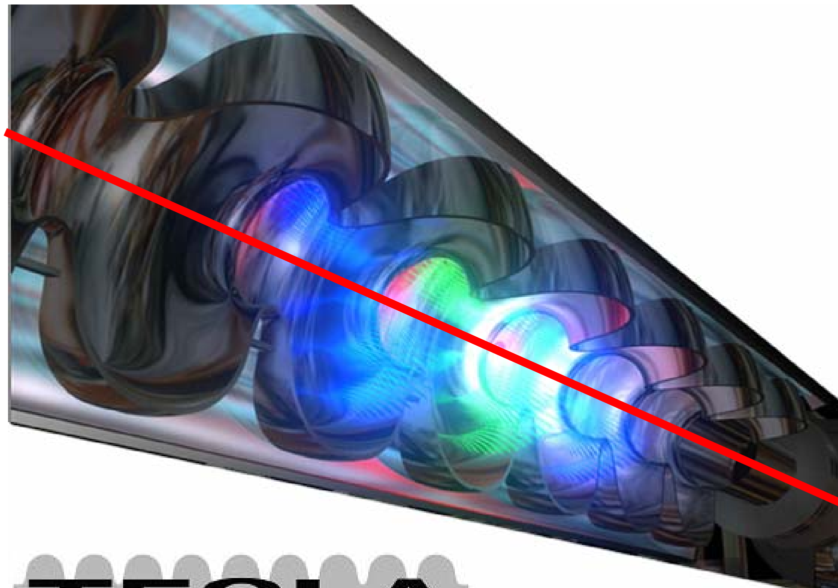
1995: First ILC TRC Report, under Greg Loew as Chair

1999: ICFA Statement on Linear Collider

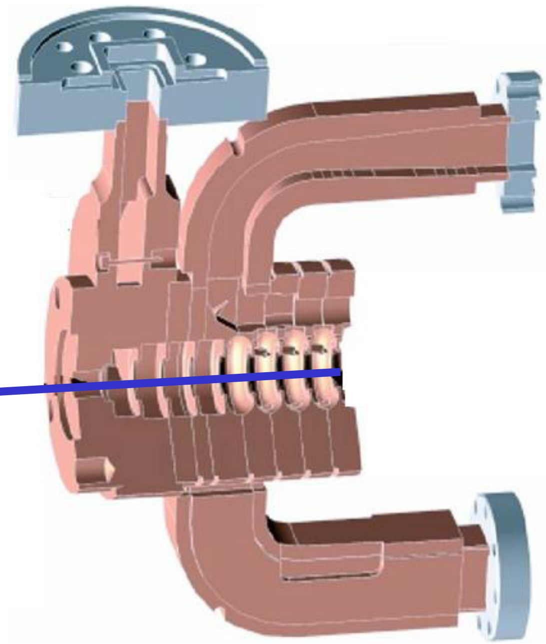
2002: ICFA commissioned the second ILC TRC Report, under Greg Loew as Chair

2002: ICFA establishes the International Linear Collider Steering Group (ILCSC) with Maury Tigner as Chair

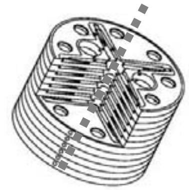
Competing technologies



1.3 GHz - Cold



11.4 GHz - Warm

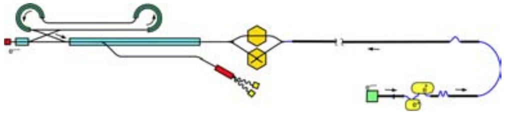


30 GHz-Warm

Linear Collider Parameter Overview

	NLC/JLC	TESLA	CLIC	SLC
f / GHz	11.4	1.3	30	2.9
E-cms / GeV	500 – 1000	500 – 800	3000 – 5000	100
g / MV/m	50	23 – 35	150	~20
Lumi / 10^{34}	2 – 3	3.4 – 5.8	~10	.0003
Power p. beam / MW	6.9 – 13.8	11.2 – 17	~15	0.04
σ_y at IP / nm	2.7 – 2.1	5 – 2.8	1	500
Beamstrahlung δB / %	3.2 – 4.3	3.4 – 7.5	21	<0.1
Site length / km	30	33	~35	3.5
Site power / MW	195 – 350	140 – 200	~400	
Cost§ (stage-I)	~3.5B$	3.14B€+7k p.y.		?

§ numbers quoted at Snowmass 2001, no pre-operation, escalation and contingency included



Accelerator designs

Parameters for the Linear Collider

September 30, 2003

- BASELINE MACHINE
  - E_{CM} of operation 200-500 GeV
  - Luminosity and reliability for 500 fb^{-1} in 4 years
  - Energy scan capability with <10% downtime
  - Beam energy precision and stability below about 0.1%
  - Electron polarization of > 80%
  - Two IRs with detectors
  - E_{CM} down to 90Gev for calibration
- UPGRADES
  - E_{CM} about 1 TeV
  - Allow for ~1 ab^{-1} in about 3-4 years
- OPTIONS
  - Extend to 1 ab^{-1} at 500 GeV in ~ 2 years
  - e^-e^-, $\gamma\gamma$, $e^-\gamma$, positron polarization
  - Giga-Z, WW threshold

http://www.fnal.gov/directorate/icfa/LC_parameters.pdf

The Charge to the International Technology Recommendation Panel

General Considerations

The International Technology Recommendation Panel (the Panel) should recommend a Linear Collider (LC) technology to the International Linear Collider Steering Committee (ILCSC).

On the assumption that a linear collider construction commences before 2010 and given the assessment by the ITRC that both TESLA and JLC-X/NLC have rather mature conceptual designs, the choice should be between these two designs. If necessary, a solution incorporating C-band technology should be evaluated.

Note -- We have interpreted our charge as being to recommend a technology, rather than choose a design

The Recommendation

- We recommend that the linear collider be based on superconducting rf technology (from Exec. Summary)
  - This recommendation is made with the understanding that we are recommending a technology, not a design. We expect the final design to be developed by a team drawn from the combined warm and cold linear collider communities, taking full advantage of the experience and expertise of both (from the Executive Summary).
  - We submit the Executive Summary today to ILCSC & ICFA
  - Details of the assessment will be presented in the body of the ITRP report to be published around mid September
  - The superconducting technology has features that tipped the balance in its favor. They follow in part from the low rf frequency.

Why superconducting?

- High efficiency AC→beam (>20%, ~10% normal c.)

- Low frequency:
  - Long pulses with low RF peak power
  - Small beam perturbations from wakefields
  - Intra-train feedback on beam orbit, energy, luminosity…

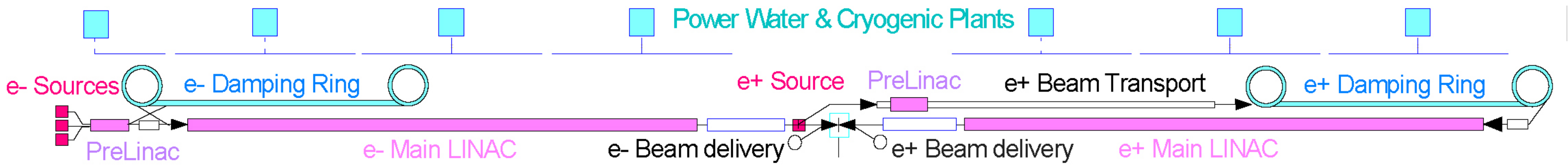
- First proposed in 1960s (M. Tigner)… show stopper was too low acc. Gradient, too high cost

Note -- **"We have interpreted our charge as being to recommend a technology, rather than choose a design..."**

Can TESLA be the baseline?

Still many alternatives remain after the SC/NC decision

- Accelerating gradient: 35MV/m or higher ?
- Tunnel: Single or double (or triple) ?
- Damping ring: dogbone or small ?
- Positron production: undulator or conventional ?
- Crossing angle: zero or small or large ?



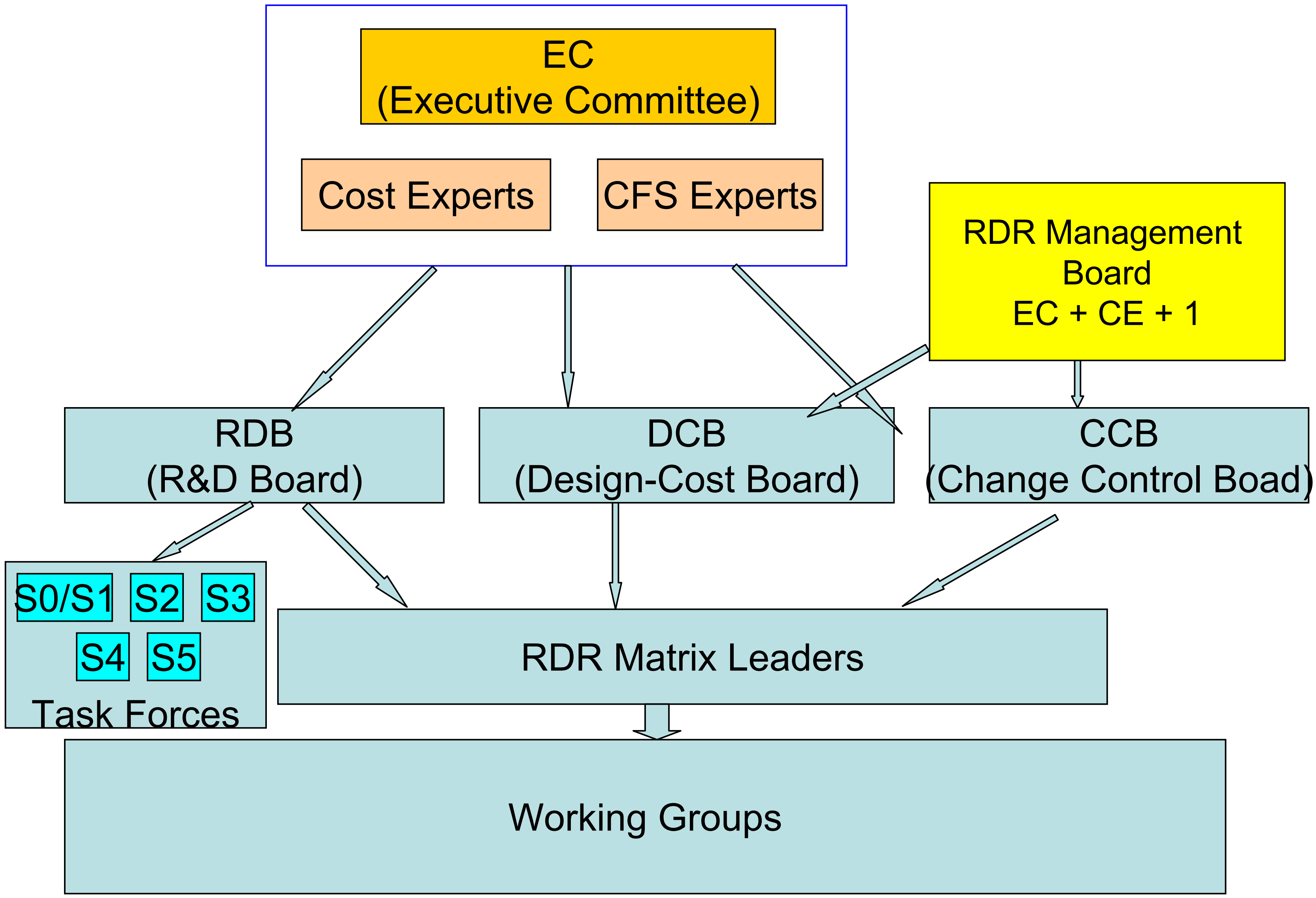
ILC Milestones

- 2004 Aug. ICFA Decision of SC Technology (ICHEP at Beijing)
- 2005 Aug. Formation of GDE (Snowmass Workshop)
- 2005 Dec. BCD (Baseline Configulation Document) completed (Frascati Workshop)
- 2007 Feb. Draft of RDR (Reference Design Report) with Cost to be open to public (Beijing GDE Workshop)

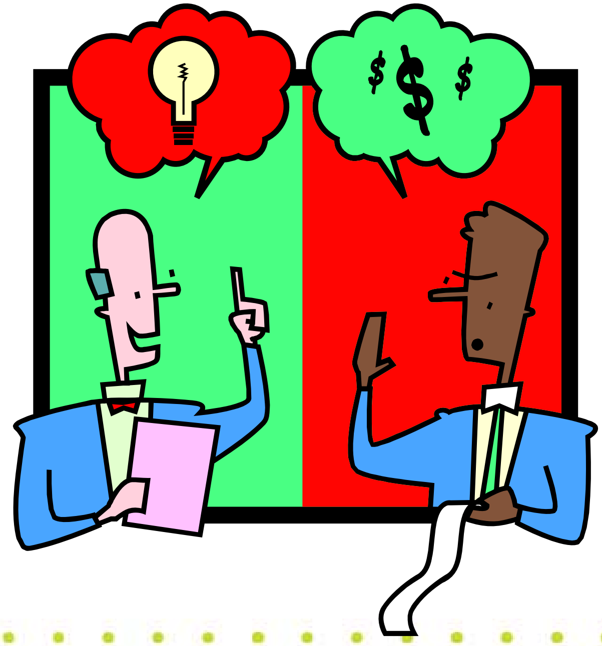
  We came to this point today,

  Then,
- EDR (Engineering Design Report), Site Selection, Approval, Construction...

GDE Structure



GDE:
Producing the Design and Cost Estimate



Costing Rules

One common estimate of the “value” and labor including site dependent cost is made. The definition of the “value” is:

1. Cost estimate of the construction cost but no preparation cost.
2. Cost estimate on the basis of a world wide call for tender, i.e. the value of an item is the world market price if it exists.
3. The selection criterion is the best price for the best quality. value is world market price if exists
4. One vender supplies the total number of deliverables. Two vendors for the same package could be chosen for risk minimization. Then the parts depend on the bids.
5. If necessary parametric cost estimate is used for scaling of the cost, i.e. for cost improvement. The cost improvement is defined by the following equation:

   $P = P_1 N^a$ $P = P_1 N^a$, where P is the total price of N units

   where P is the total price of N units, P_1 is the first unit price and a the slope of the curve related to learning. The slope a is for large N also the ratio of the last unit price PN and the average unit price $<P>$.
6. No tax is included.
7. No escalation is used. The fixed date is January 2, 2007.
8. No contingency is calculated. The risk will be analyzed separately.
9. One currency with fixed exchange rates is used. The fixed exchange rates are:

   1 M€ = 1.2 M$ = 1.4 Oku¥.   1 M€ = 1.2 M$ = 1.4 Oku¥

10. Fixed raw material prices, i.e. for copper, steel and niobium, and fixed prices for power are used. The fixed prices are:
    Electrical work C/W = $ 0.1/kWh (incl. supply cost),
    Copper C/m = $ 1000/100 kg (up to factor three higher for degassed copper),
    Black steel C/m = $ 0.6 /kg (for stainless and magnet steel up to factor three higher).
11. The external labor is included in the value.
12. Internal (institute) labor will be estimated in person hours (1 person year = 1700 person hours).
13. The EDIA[1] is included in the item cost.

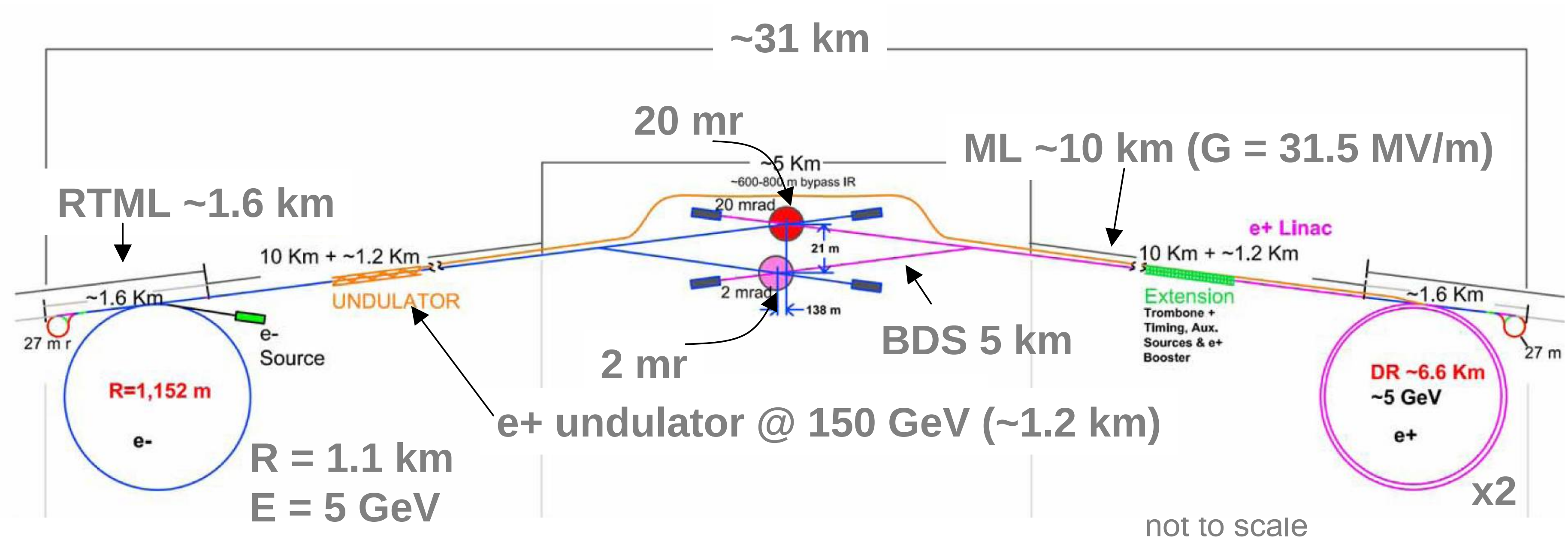
[1] In the U.S. EDIA is the acronym for Engineering, Design, Inspection and Administration. Industry calls this non-recurring engineering (NRE).

Steps in the Last 1 Year

- Bangalore GDE Meeting Mar.9-14
  - **Design temporarily frozen**
  - **Established costing methodology**
  - **Cost estimation started**
  - **ILCSC-MAC1 Apr. @FNAL**
- Vancouver GDE Meeting Jul.19-22
  - **1st stage cost sum**
  - **Identified cost driver**
  - **Cost reduction work started (target: 30%) Restart of changing design**
  - **ILCSC-MAC2 Sep.@KEK**
- Valencia GDE Meeting Nov.6-10
  - **2nd stage sum**
  - **Internal review Dec. @SLAC)**
  - **ILCSC-MAC3 Jan. @Daresbury)**

The Status at Vancouver (July '06)

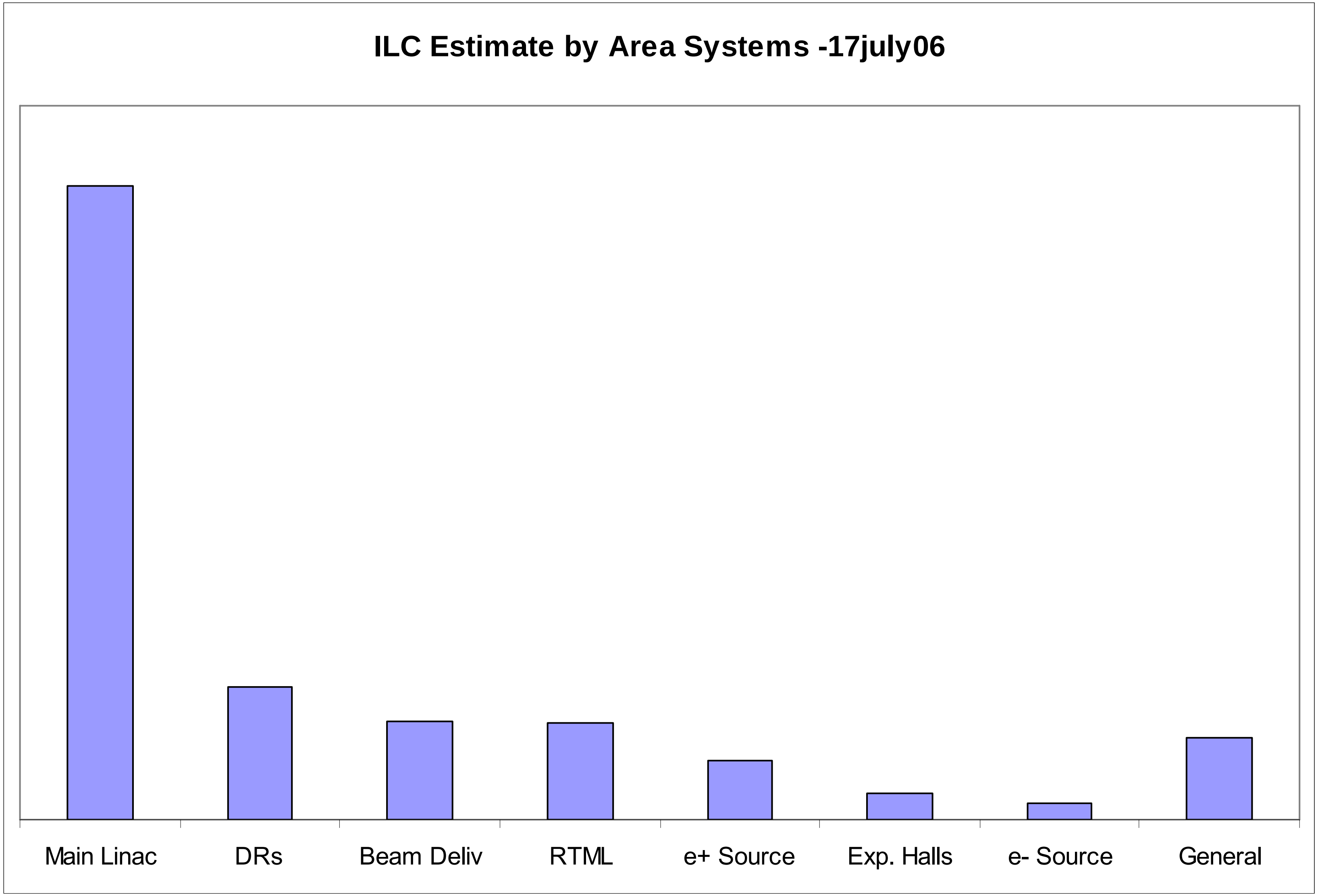
Baseline Configuration



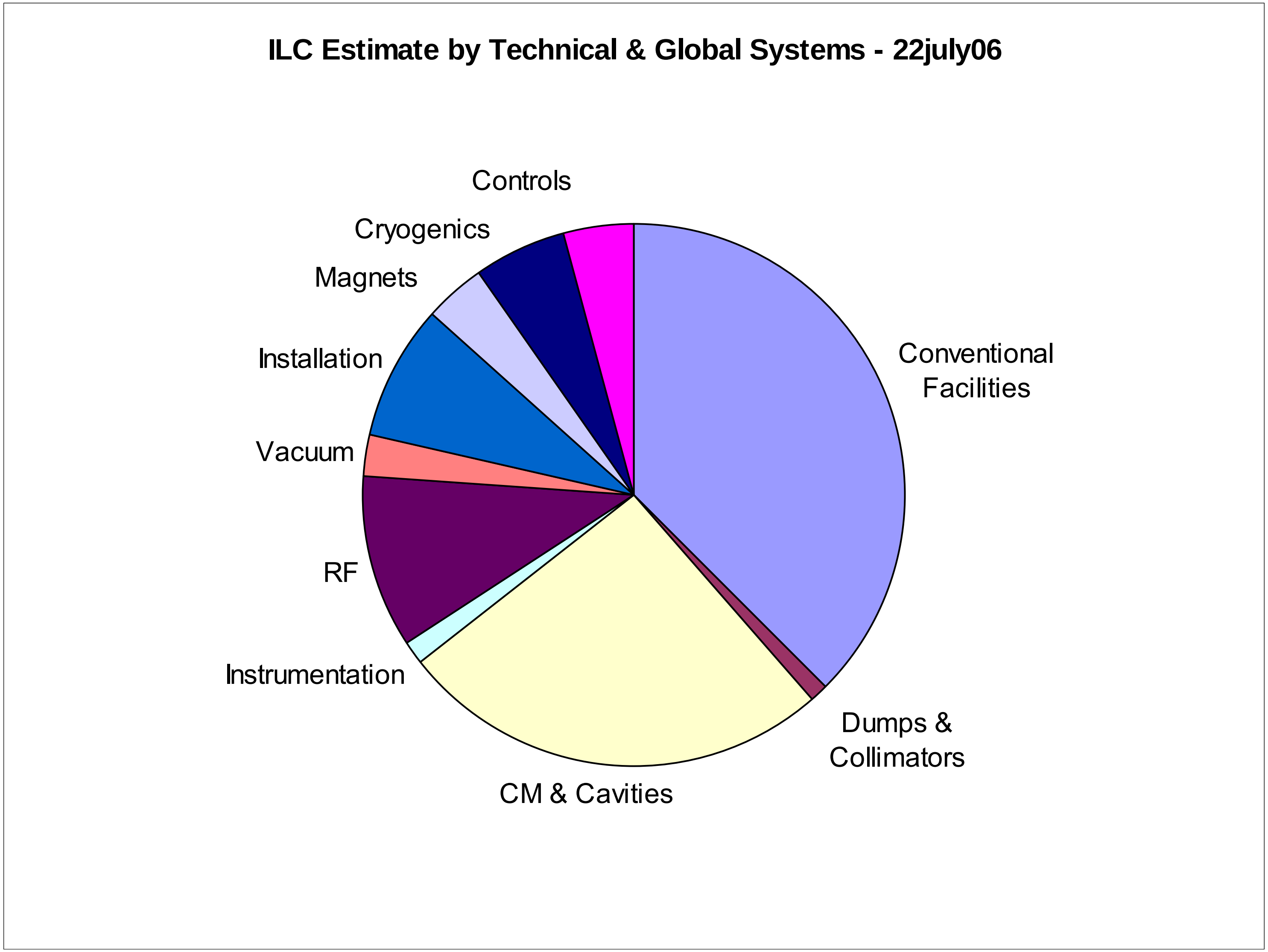
Configuration used for Vancouver cost estimate

fundamentally no different from Frascati BC, but much more detail design work

Costs by Area System



Costs by Technical & Global System



Result of Vancouver

- Initial rough cost estimate ...

Result of Vancouver

Not! to scale!

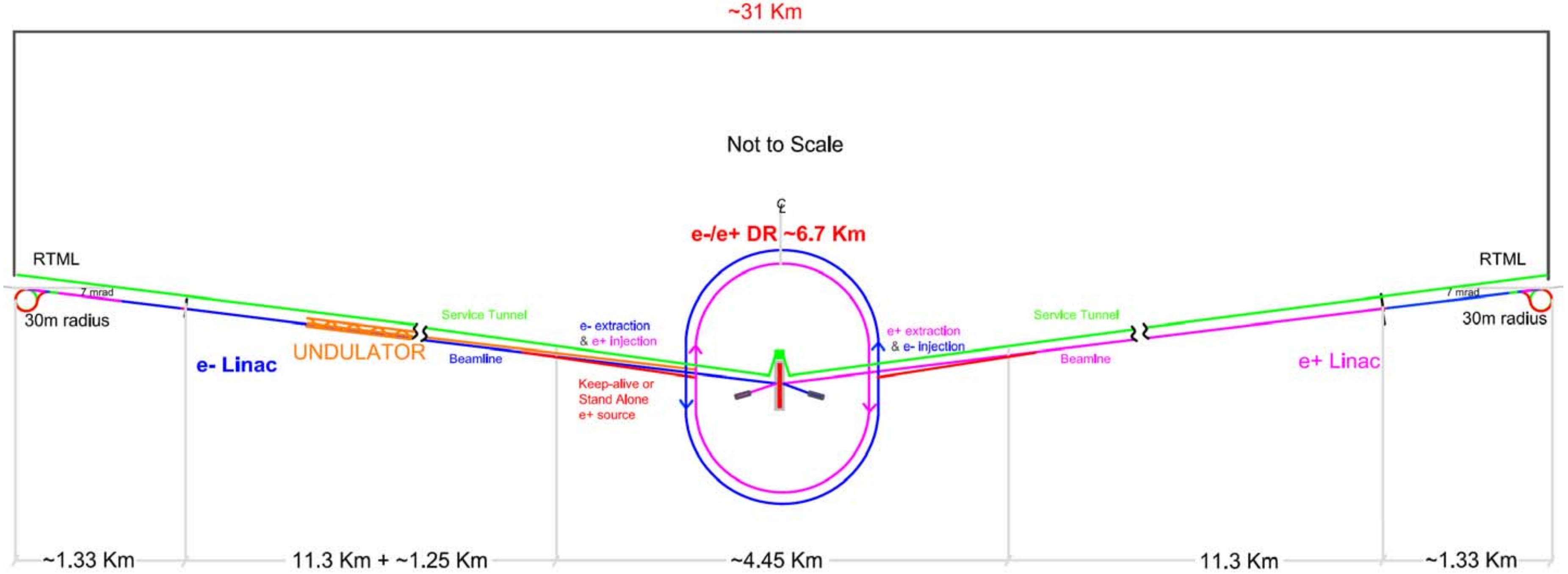
- Initial rough cost estimate too high
  - **Not too surprised**
- Begin design and cost iteration
  - **Identify cost drivers**
- Cost estimate not as ‘mature’ as hoped
  - **Clear than more time will be needed to push back on costs**
- ~3 month delay to schedule
  - **Draft RDR+cost to be published at Beijing Feb. 07**

From Vancouver to Valencia:

Saving Money

How Does ILC Look Like Now ?

1st Stage: 500 GeV



Schematic Layout of the 500 GeV Machine

Basic Global Parameters

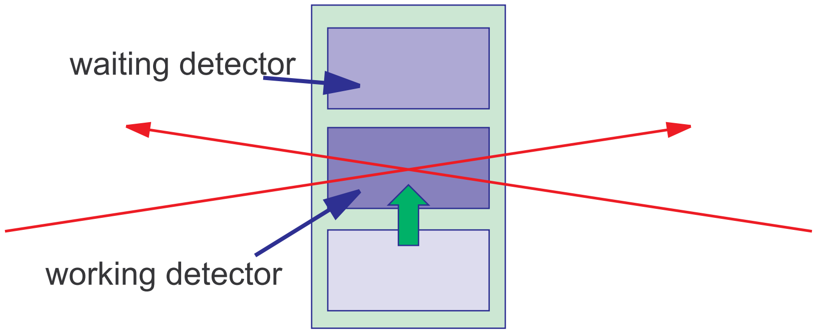
Max. Center-of-mass energy	500	GeV
Peek Luminosity	~$2x10^{34}$	$1/cm^2s$
Beam Current	9.0	mA
Repetition rate	5	Hz
Average accelerating gradient	31.5	MV/m
Beam pulse length	0.95	ms
Total Site Length	31	km
Total AC Power Consumption	~230	MW

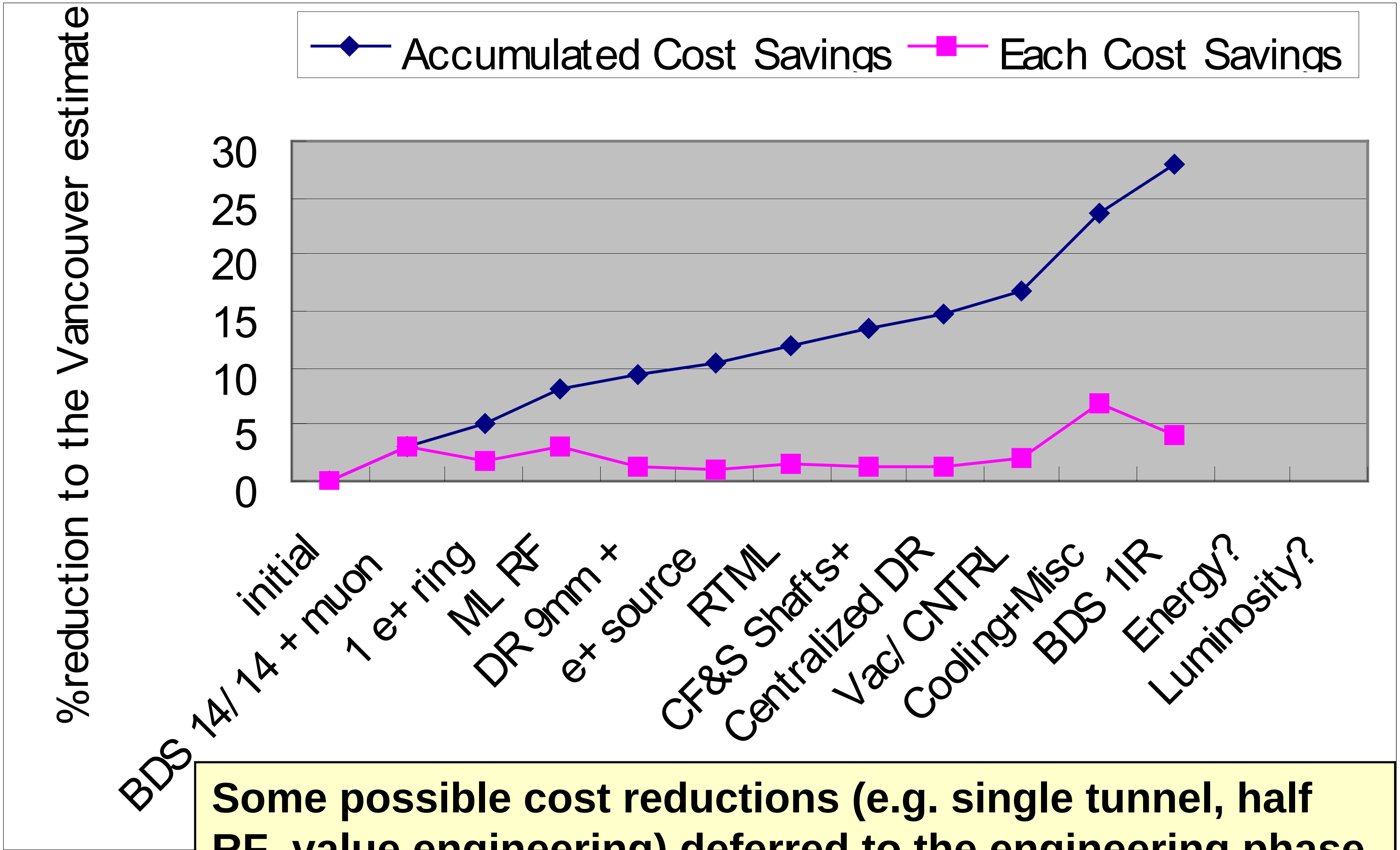
Range of Parameters

	min	-	nominal	-	max	
Number of particles	1	-	2	-	2	10^{10}
Number of bunches	1320	-	2625	-	5120	
Linac bunch interval	189	-	369	-	480	ns
DR bunch interval	3.08	-	6.15	-	12.3	ns
Bunch length	200	-	300	-	500	μm
Vertical emittance	0.03	-	0.04	-	0.08	μm
Beta at IP (x)	11	-	11	-	20	mm
Beta at IP (y)	0.2	-	0.4	-	0.6	mm

Design Changes Since Vancouver

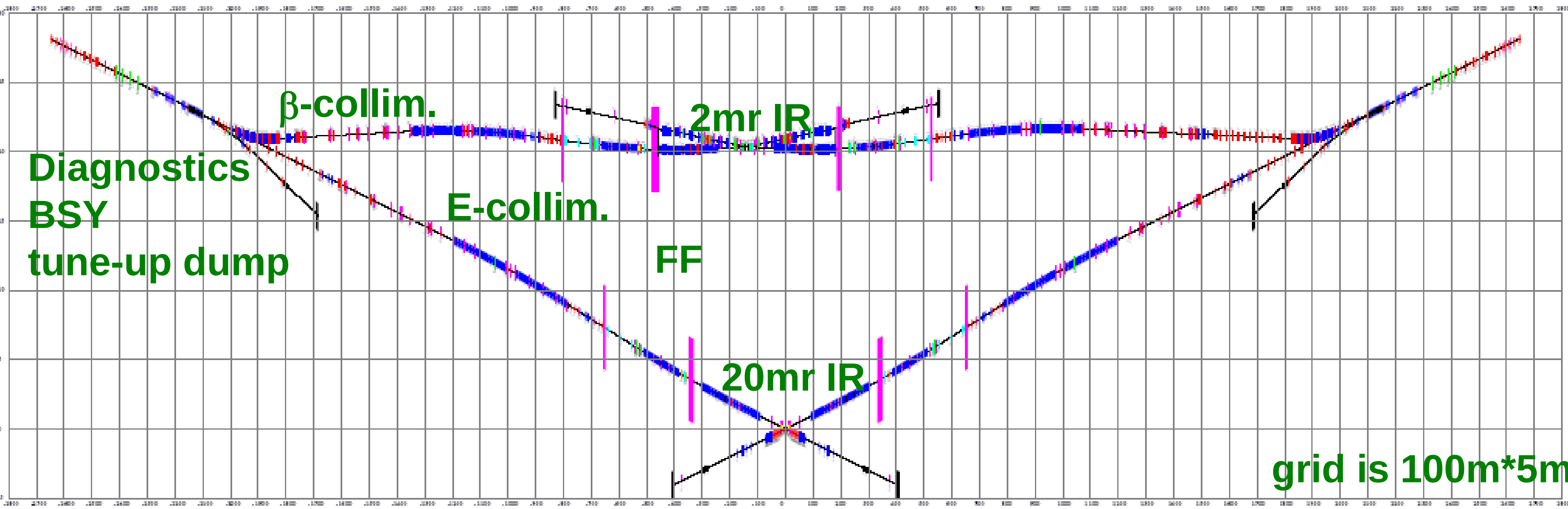
- 2IP (2mard+20mrad)
  → 2IP (14mrad+14mrad)
  → 1IP (14mrad + push-pull)
- 3DRs (1e-, 2e+), 2 tunnels
  → 2DR (1e-,1e+), 2 tunnels
  → 2DR (1e-,1e+), 1 tunnel
- Central injector complex
- Reduce number of shafts and sizes of caverns
- And numerous small ones
  - Larger RF unit (reduce power sources)
  - Muon wall 9m+18m → 5m
  - Reduce positron target redundancy
  - Reduce RF unit overhead
  - Surface detector assembly
  - Tunnel diameter 5m → 4.5m





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

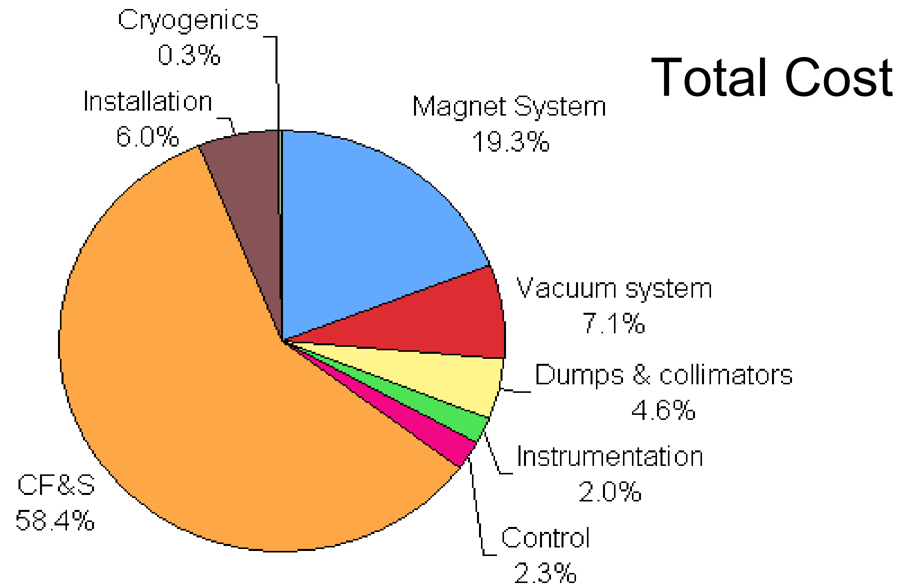
Vancouver Baseline

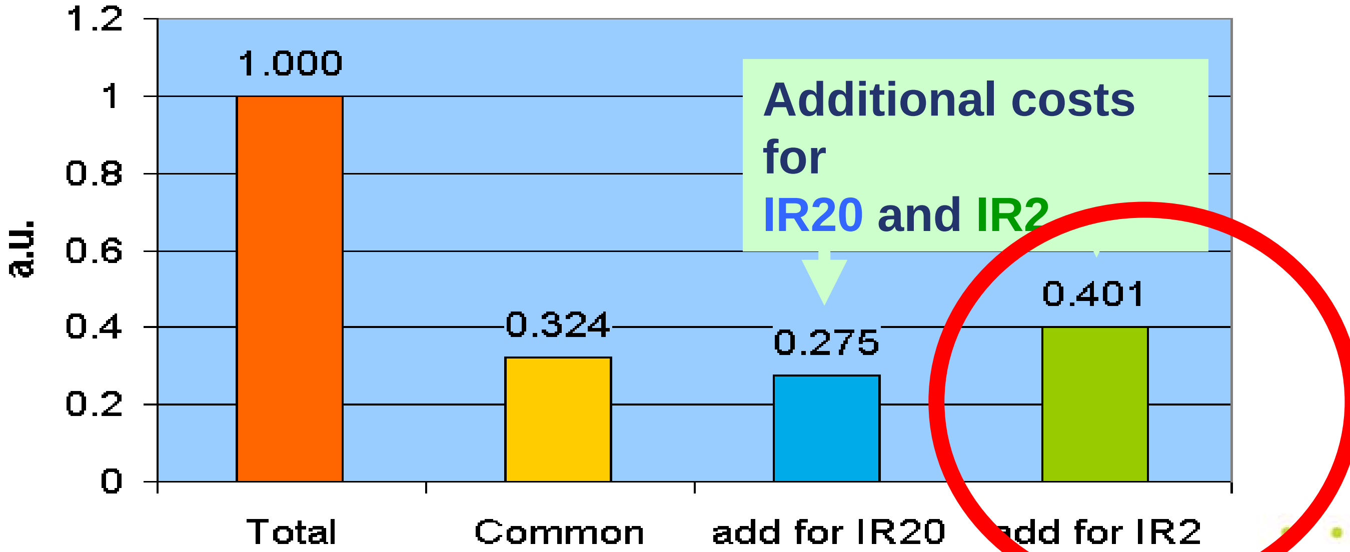


- **Two IRs with 20mrad and 2mrad crossing angle**
- **Two collider halls separated longitudinally by 138m**

Vancouver Costs for BDS

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

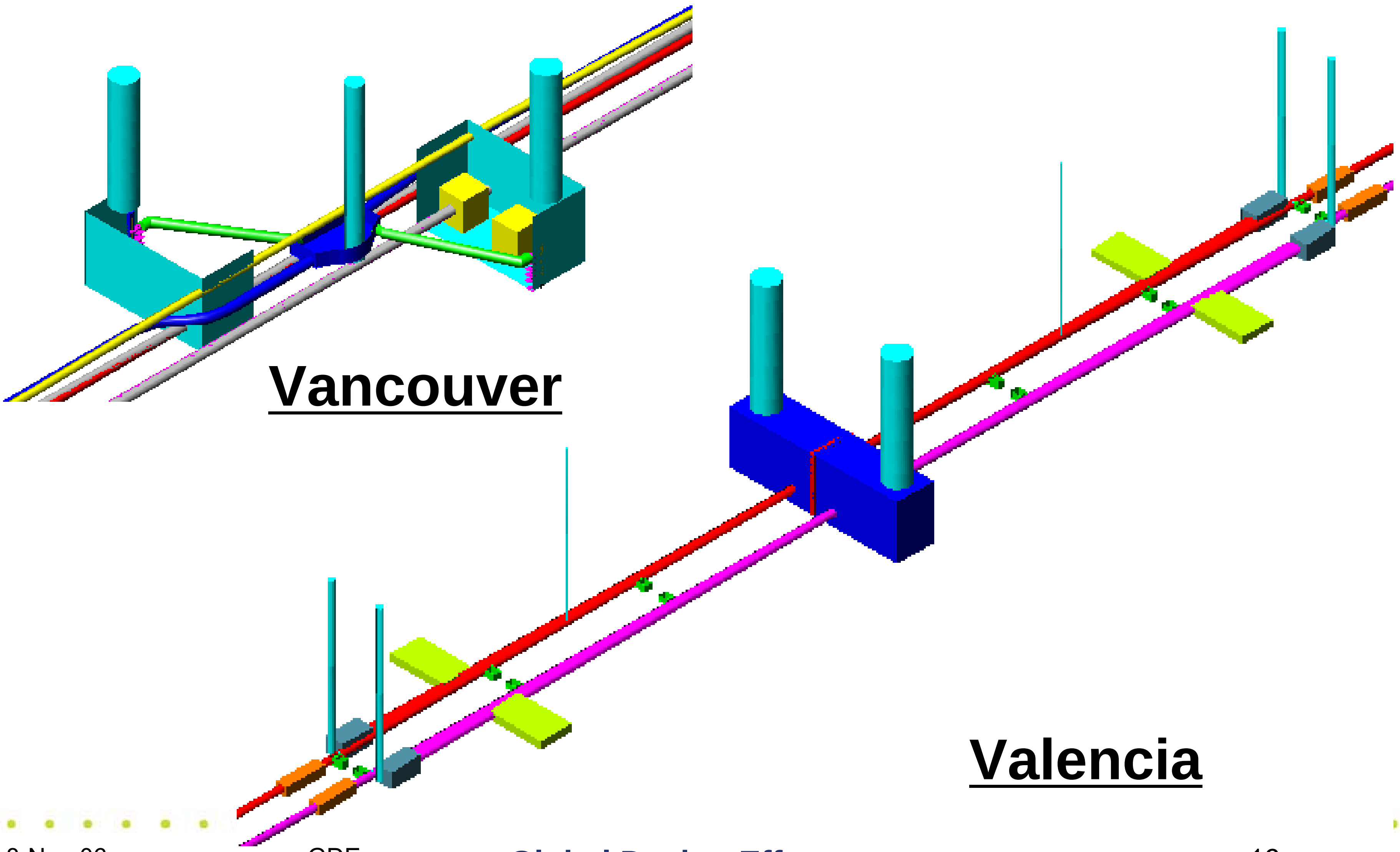




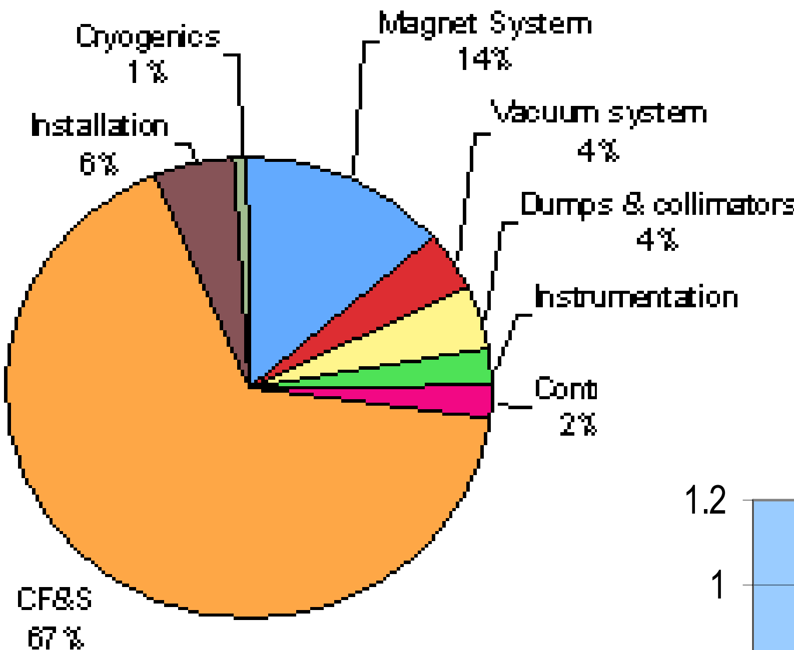
2/20 mrad → 14/14 mrad

- 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

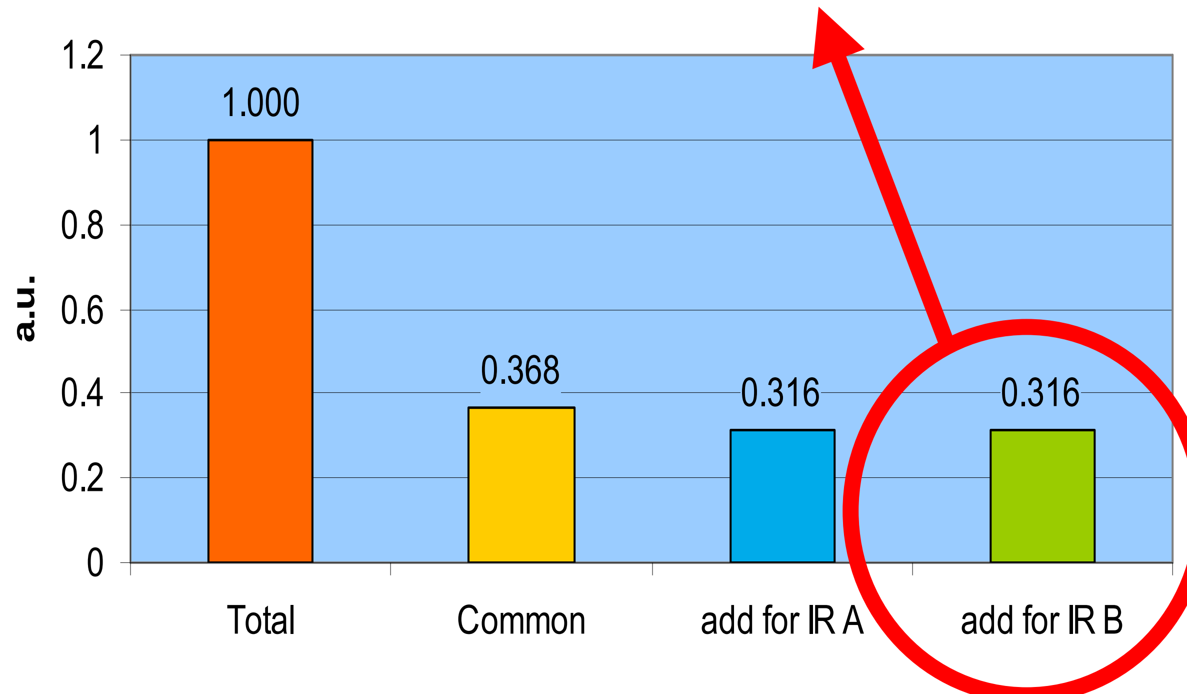
Hall Designs for two IRs



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

Would 1 IR lead to 1 Detector?

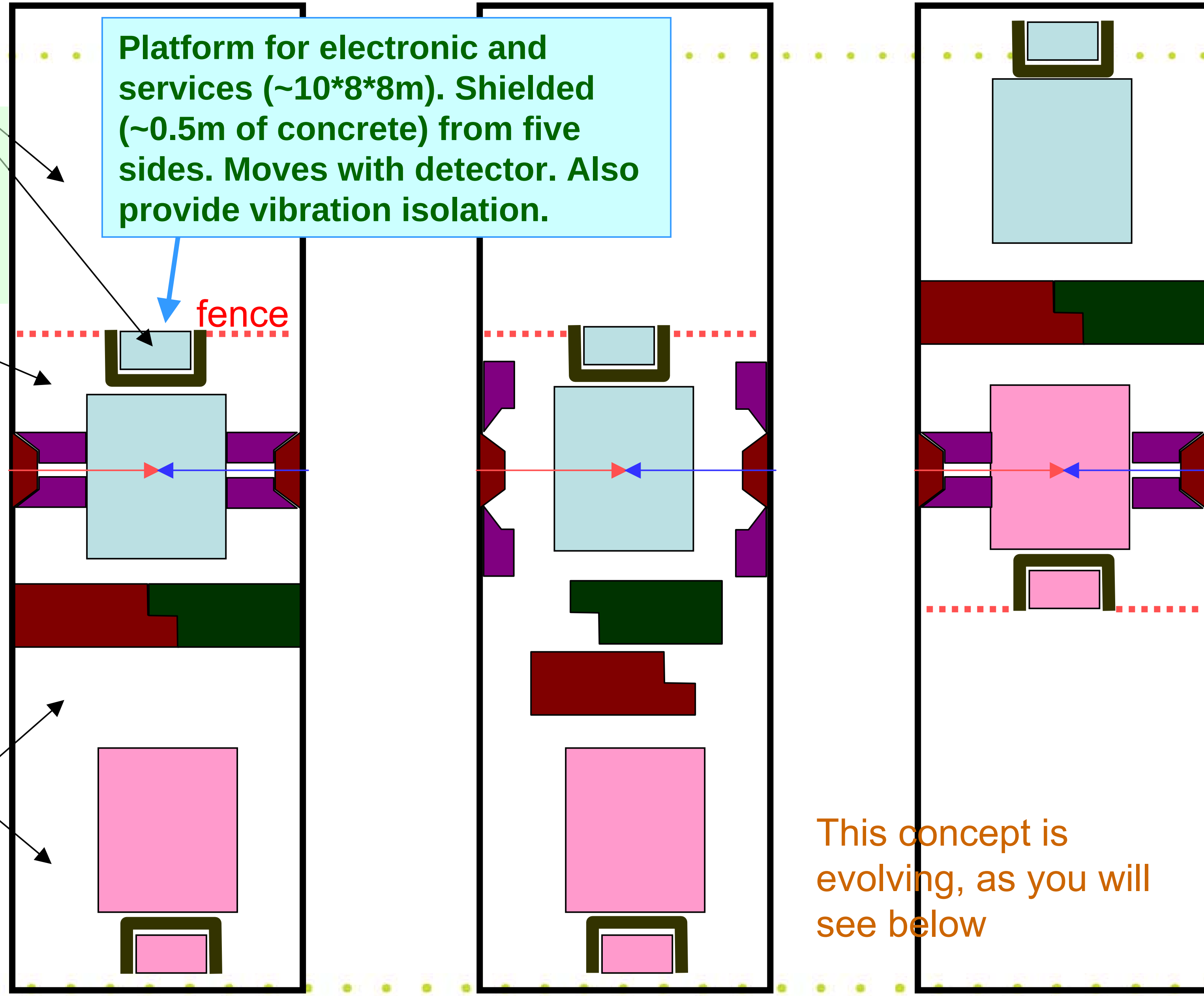
- NO! We have no intention of going to one detector.
- In my opinion, the case for two detectors is much stronger, if it does not require a second expensive beam line
- However, it the burden on the detector community is to develop two **complementary** detectors.

Concept which does not rely on self-shielding detector

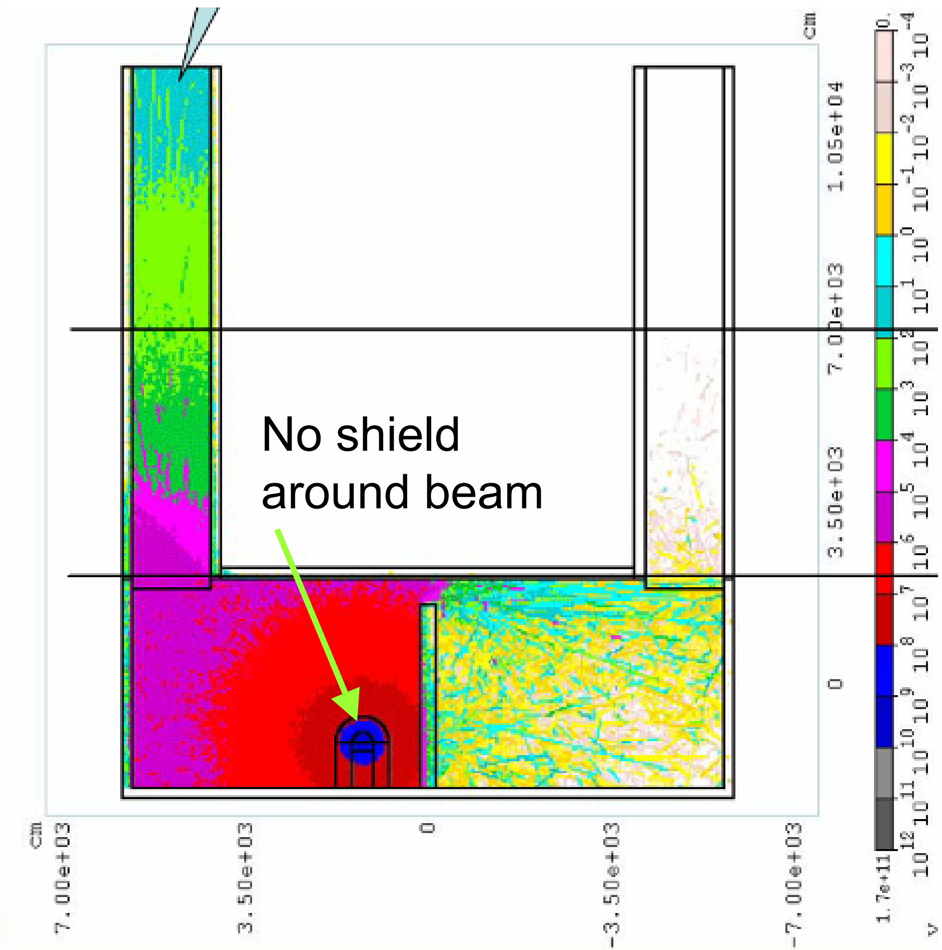
accessible during run (radiation worker)

not accessible during run

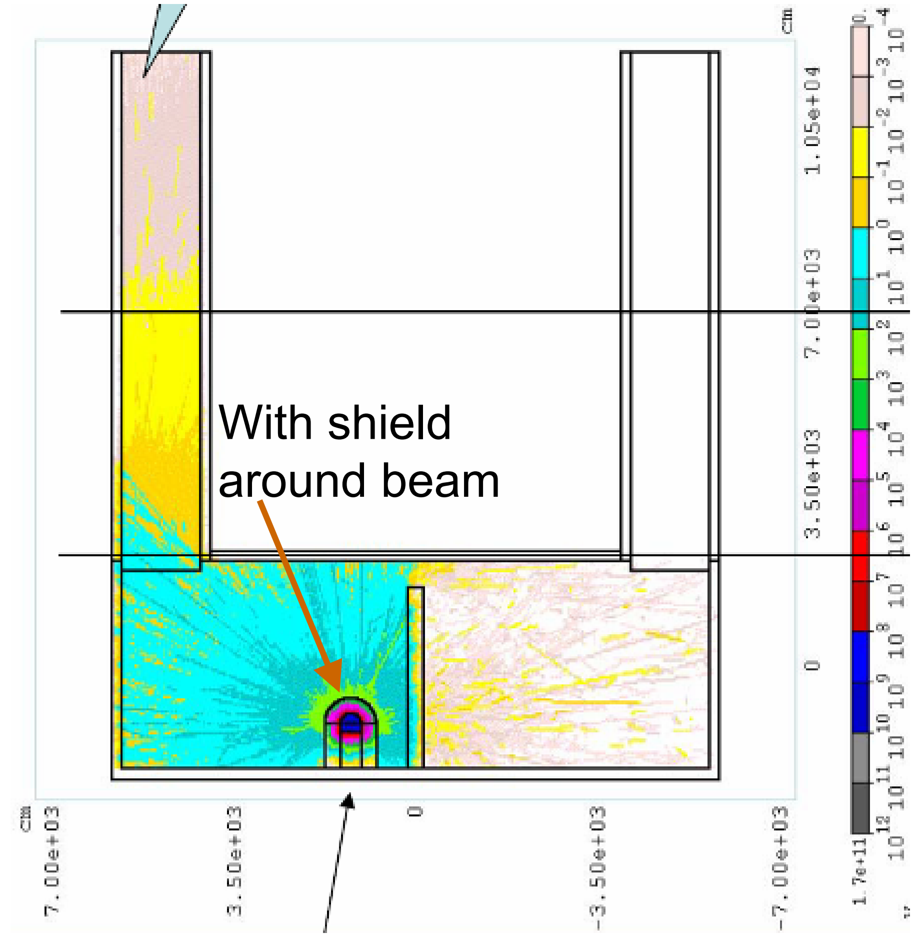
accessible during run (general personnel)



IR hall with shielding wall



May need additional curtain wall on top of main wall. May need shaft cover.



Do not need full height wall. The height could be decrease from what shown.

RP T.Sanami and A.Fasso

2006年9月19日

Air-pads at CMS

Single air-pad capacity ~385tons (for the first end-cap disk which weighs 1400 tons). Each of air-pads equipped with hydraulic jack for fine adjustment in height, also allowing exchange of air pad if needed. Lift is ~8mm for 385t units. Cracks in the floor should be avoided, to prevent damage of the floor by compressed air (up to 50bars) – use steel plates (4cm thick). Inclination of ~1% of LHC hall floor is not a problem. Last 10cm of motion in CMS is performed on grease pads to avoid any vertical movements. [Alain Herve, et al.]

Photo from the talk by Y.Sugimoto, http://ilcphys.kek.jp/meeting/lcdds/archives/2006-10-03/

14kton ILC detector would require ~36 such air-pads

Luminosity sharing & efficiency

- Assumptions in the two IR baseline:
  - machine is designed to allow switch between detectors on the timescale of weeks-months
  - estimated switch-over time, for realignment of BDS beamlines and their retuning, is 3-4 days
    - the pulse-to-pulse switch-over, which is sometime mentioned, is not supported by hardware of present ILC baseline
- Considerations for single IR
  - it may be argued that recovery of full luminosity in a BDS that was OFF only for a day, should be rapid

Schedule considerations

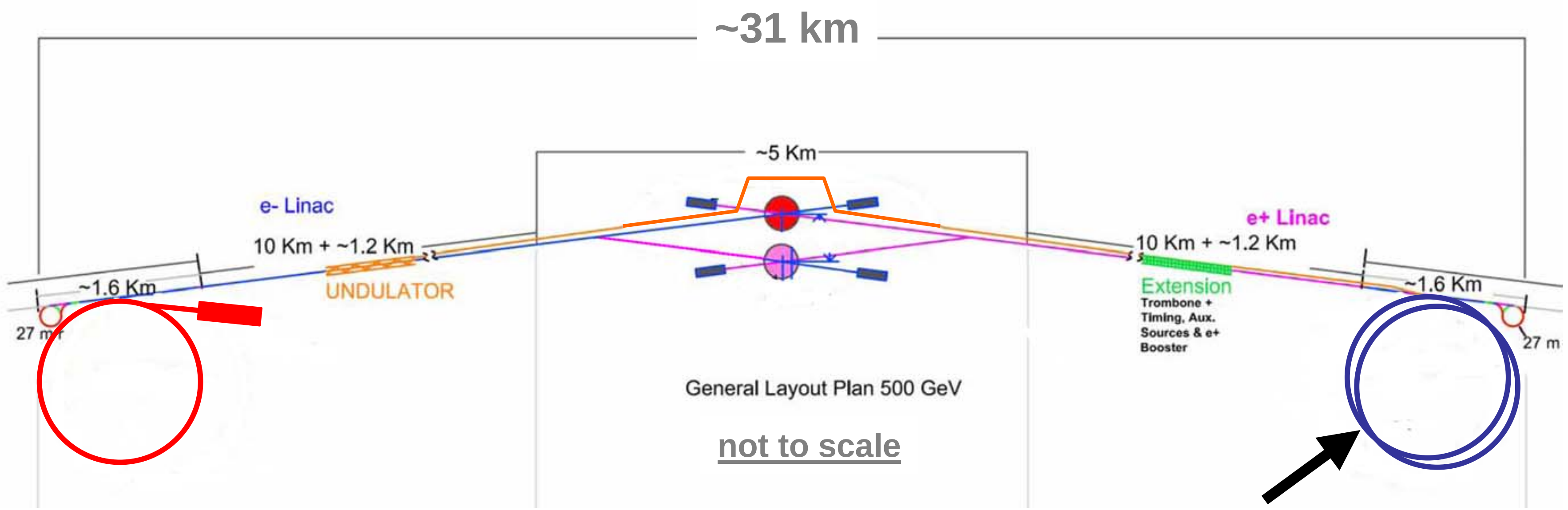
- Consider design goal for subsystems 0.5-1 day for detector exchange operation
- Depending on the mode of operation, the desired frequency and duration of exchange may vary
  - **in precision scan, longer intervals and switch-over may be fine**
  - **in discovery mode, rapid exchanges are more essential**
- Switching over in ~3 days (to full luminosity) would also be sufficiently fast
- Further detailed study, including cost optimization, would clarify where in the range of ~0.5-3 days the design goal should be placed

Single IR with Push-Pull Detectors

- Large cost savings compared with 2 IR
  - **~200M$ compared with 2IR with crossing angles 14+14mrad**
- Push-pull detectors
  - **Task force from WWS and GDE formed**
  - **Quick conclusion is**
    - No show-stoppers
    - But need careful design and R&D works
    - 2IR should be left as an `Alternative’

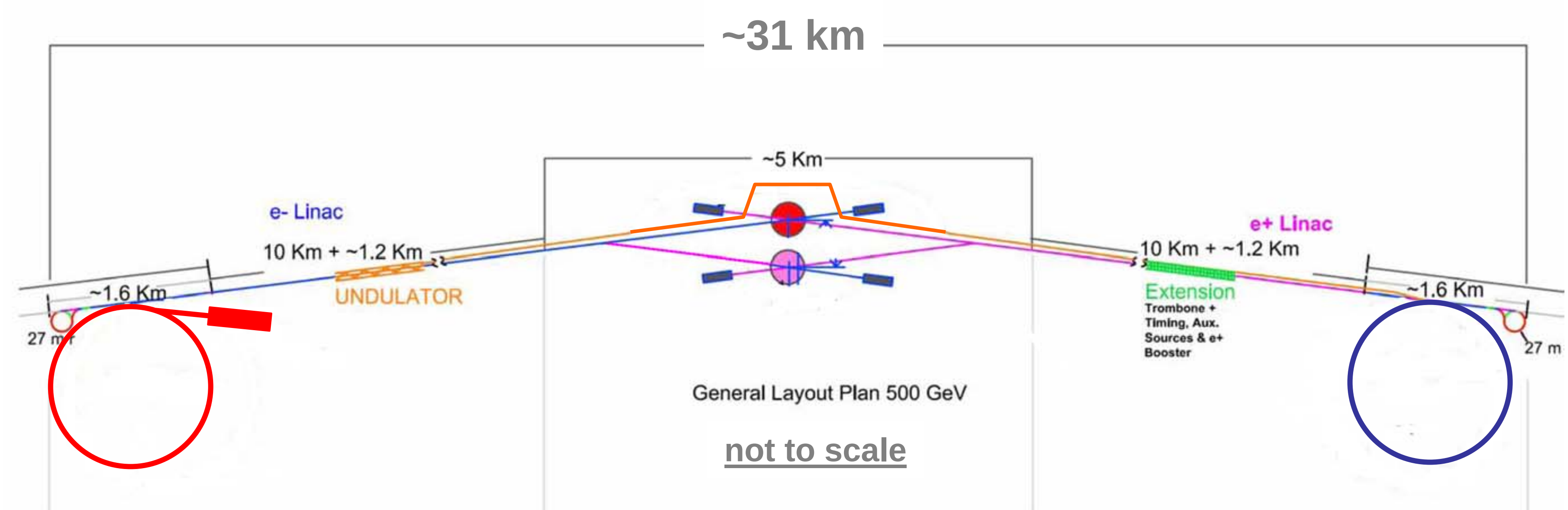
Damping Ring

Baseline Configuration



Removal of second e+ ring

Baseline Configuration



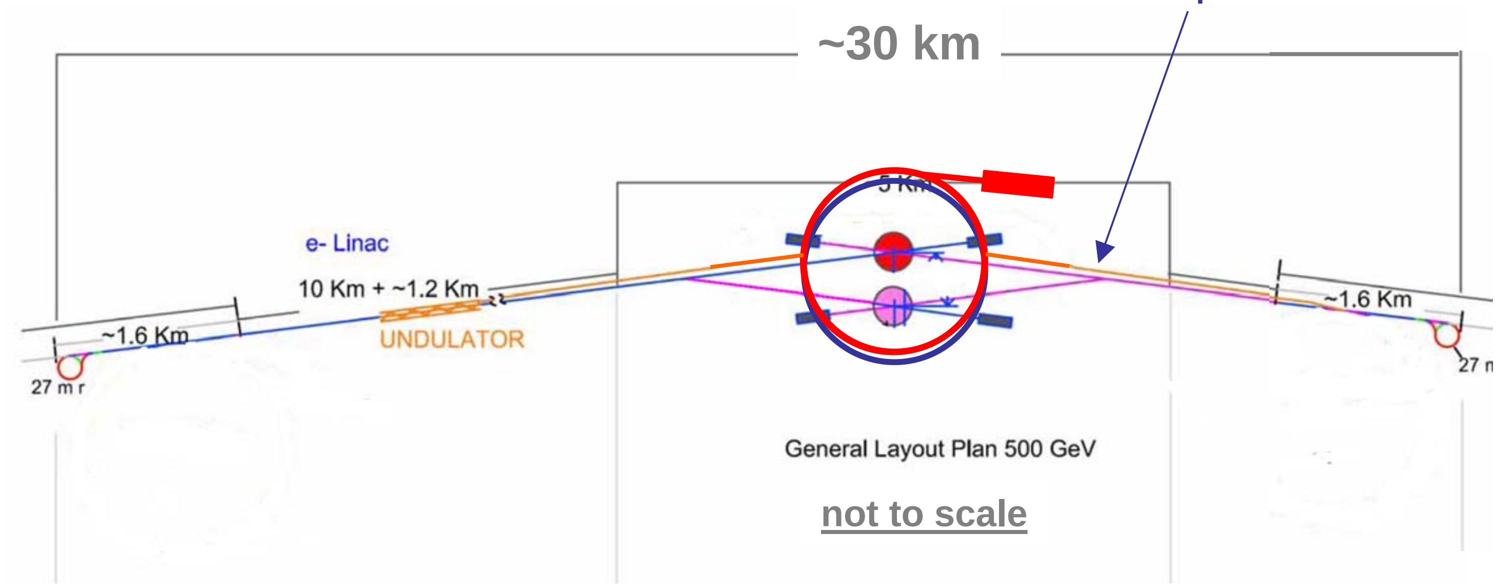
Removal of second e+ ring

simulations of effect of clearing electrodes on **Electron Cloud** instability suggests that a **single e+ ring** will be sufficient

Damping Ring

Baseline Configuration

Long 5GeV low-emittance transport lines now required



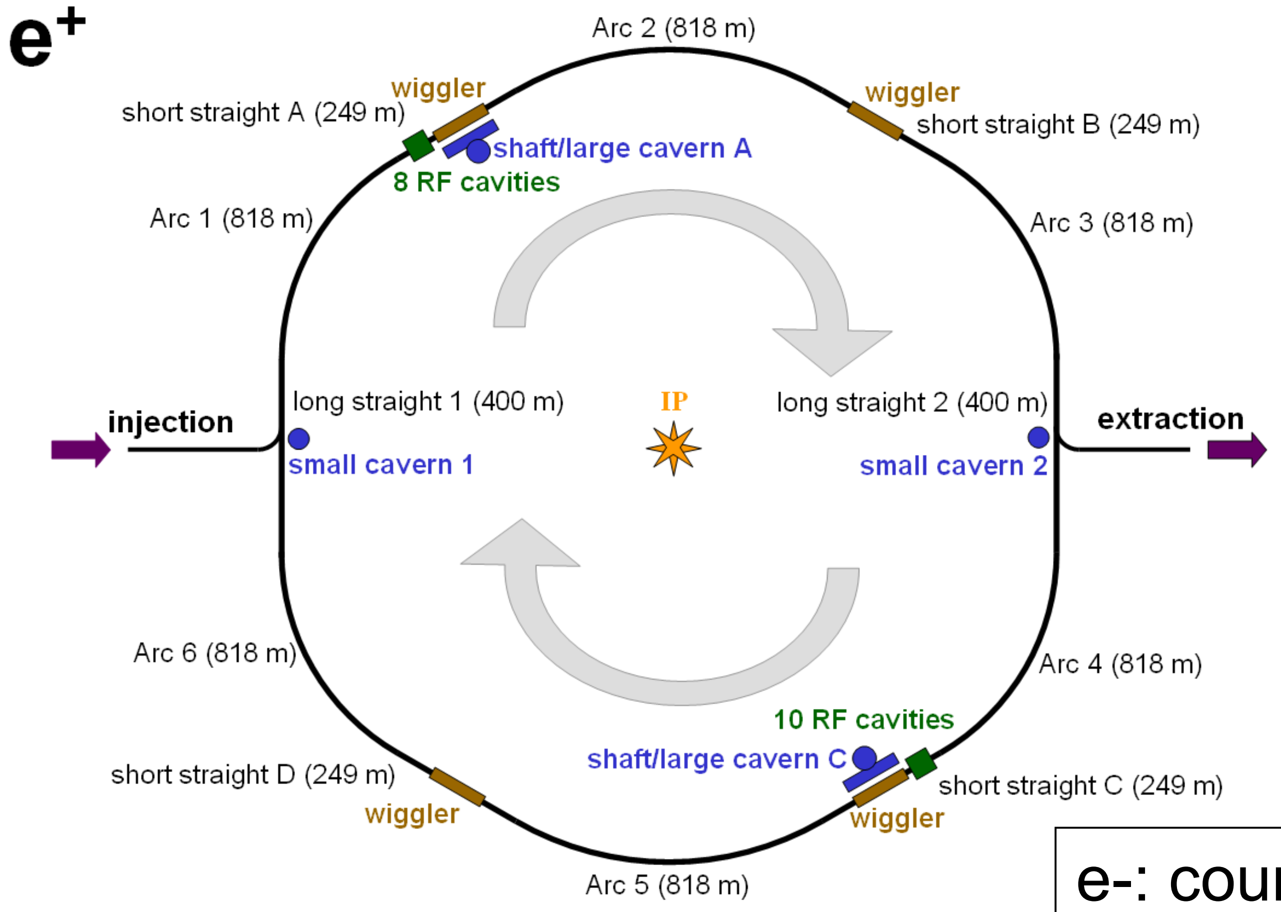
Centralised injectors

Place both e+ and e- ring in single centralized tunnel

Adjust timing (remove timing insert in e+ linac)

Remove BDS e+ bypass

Schematic Layout



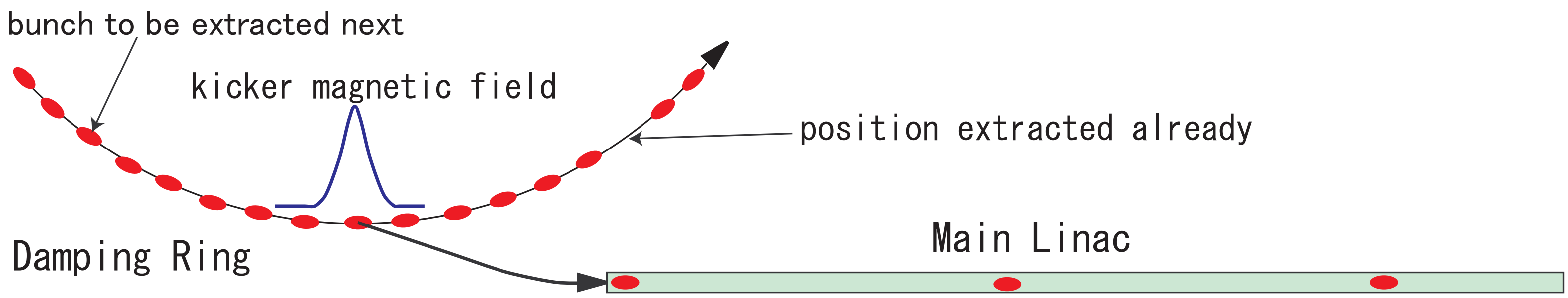
e-: counter-clockwise

2 vertical shafts

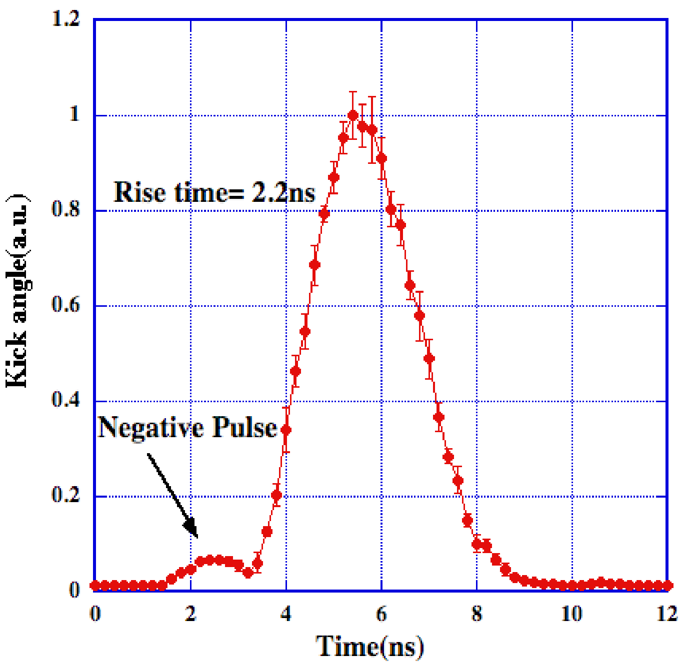
A. Wolski

Kicker System

- Must extract bunches one-by-one

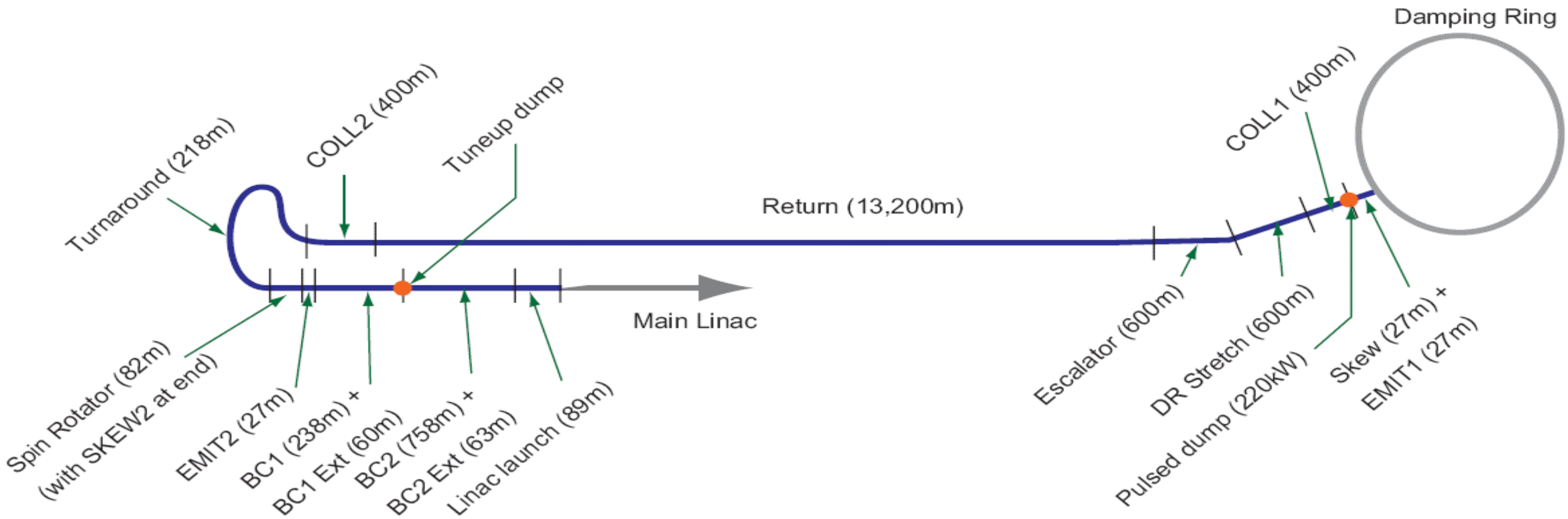


- Specification
  - rise, fall time < 3ns
  - rep.rate 5.5MHz
  - pulse length 1ms
  - stability < 0.1%
    (can be relaxed by feedforward)
- Fast kicker needed
  - A system with fast pulser and stripline developed at KEK. Unit test done.



RTML (Ring To Main Linac)

- ~14 km long transport
- Turn-around
- Spin Rotator
- Bunch compressor (2 stages)
  9mm→300μm (nominal param)
  9mm →200μm possible (Low Q param)
- Diagnostics and collimators



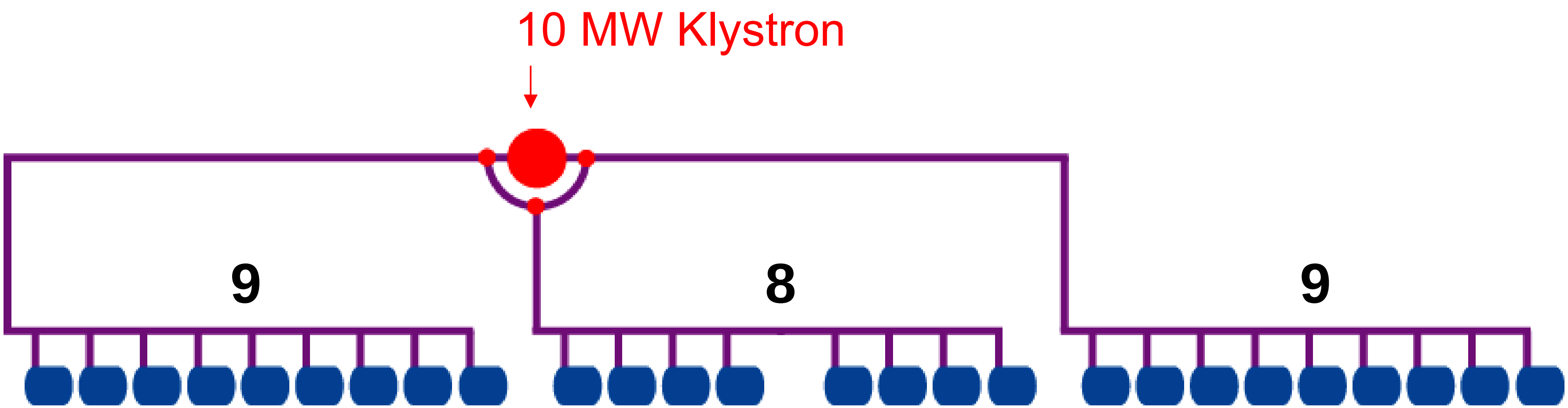
Proposed Cost Cutting Changes to Main Linac Design

- Lower rf power requirement for rf unit so maximum gradient is 33.5 MV/m instead of 35.0 MV/m
  - **One 10 MW klystron would then feed two 9-cavity cryomodules and one 8-cavity cryomodule (instead of three 8-cavity cryomodules).**
  - **Number of rf units reduced by 1/10, as is the AC power and cooling capacity to first order.**

  (408m shorter length for each linac.)

RF Distribution Math

(for 33.5 MV/m Max Operation)



33.5 MV/m * 9.5 mA * 1.038 m = 330.3 kW (Cavity Input Power)

× 26 Cavities

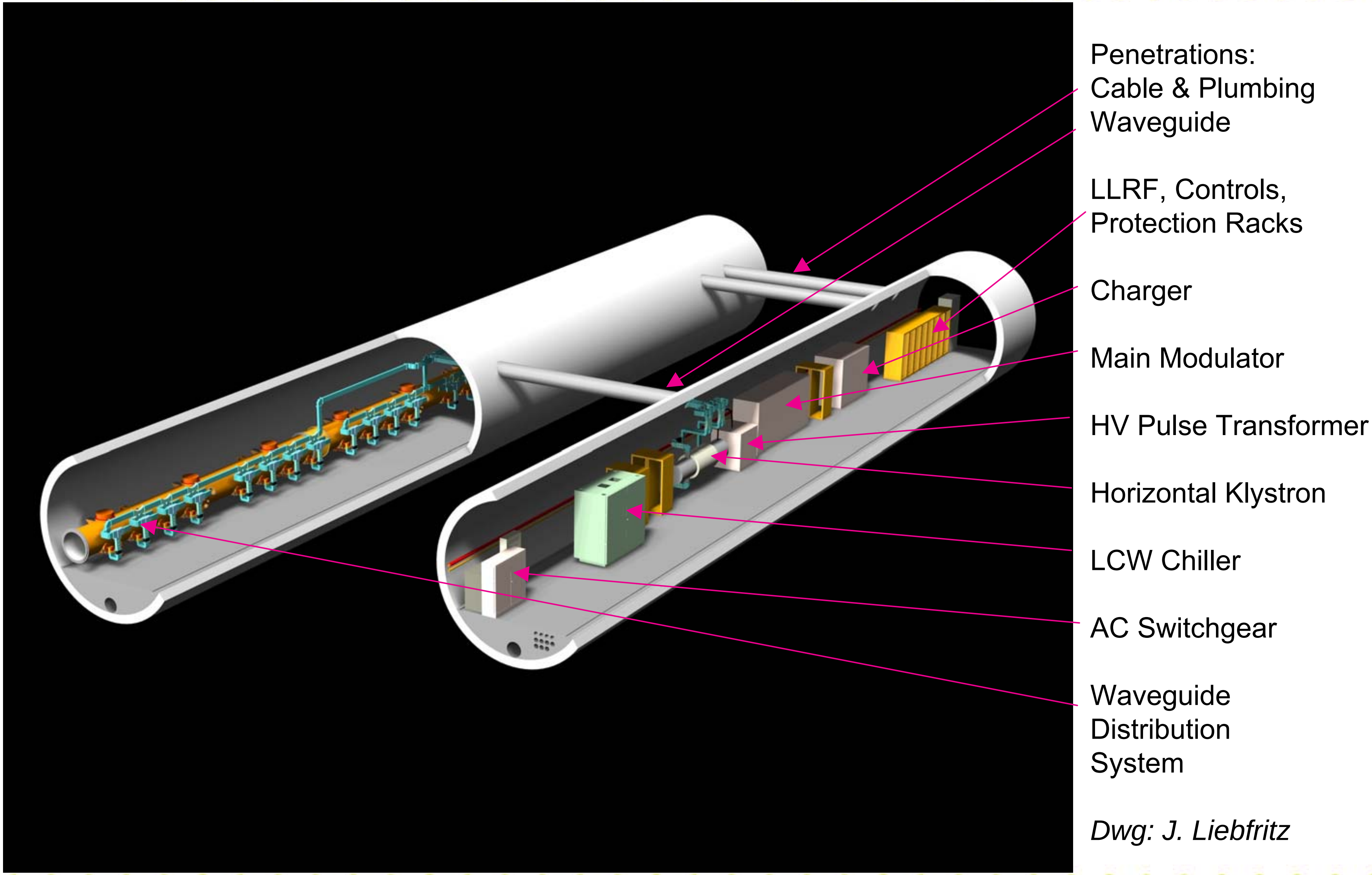
× 1 / 0.95 (Distribution Losses)

× 1 / 0.90 (Tuning Overhead)

= 10.0 MW

(for 31.5MV/m, transferred power to beam is 8.0MW.)

10 MW Linac Stations



Dwg: J. Liebfritz

On-surface Detector Assembly

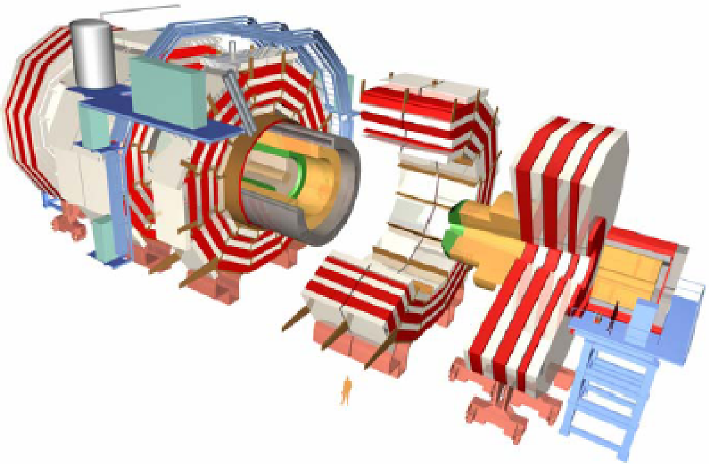
- Vancouver WBS considered the underground halls sized at 32m (W) x 72m (L) each to allow underground assembly of the largest considered detector.

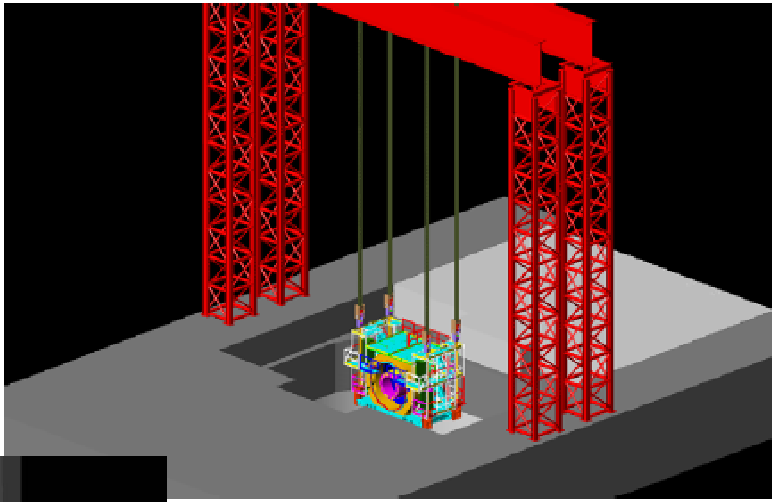
- Conventional Facilities Schedule gives detector hall is ready for detector assembly 5 yrs from project start
  - **If so, cannot fit our goal of "7years until first beam" and "8years until physics run"**

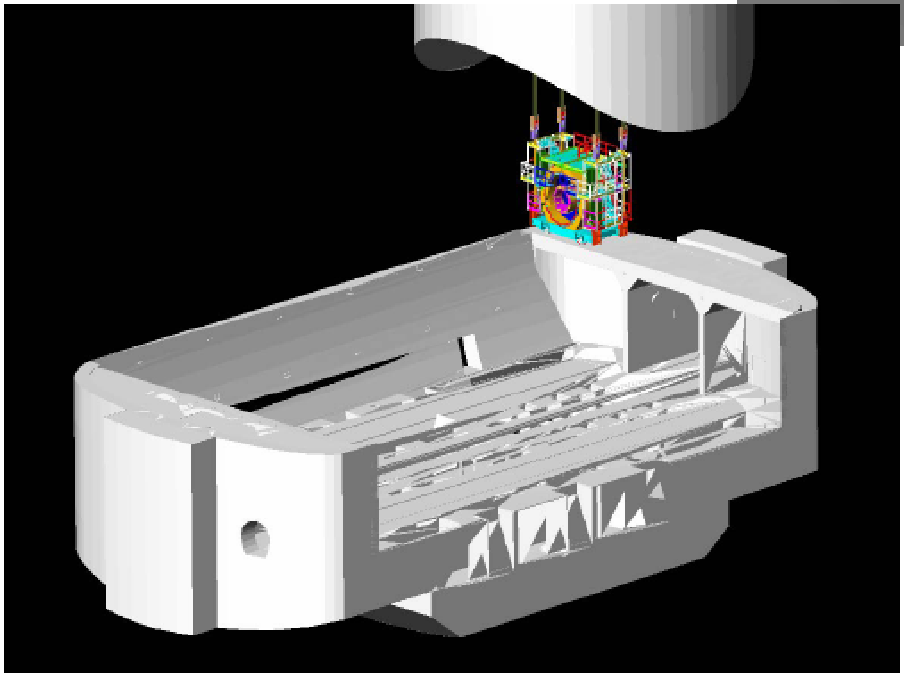
- Surface assembly allows to save 2-2.5 years and allows to fit into this goal
  - **The collider hall size may be smaller (~40-50%) in this case**
  - **A building on surface is needed, but savings may be still substantial**

- Optimization needs to be done

On-surface assembly





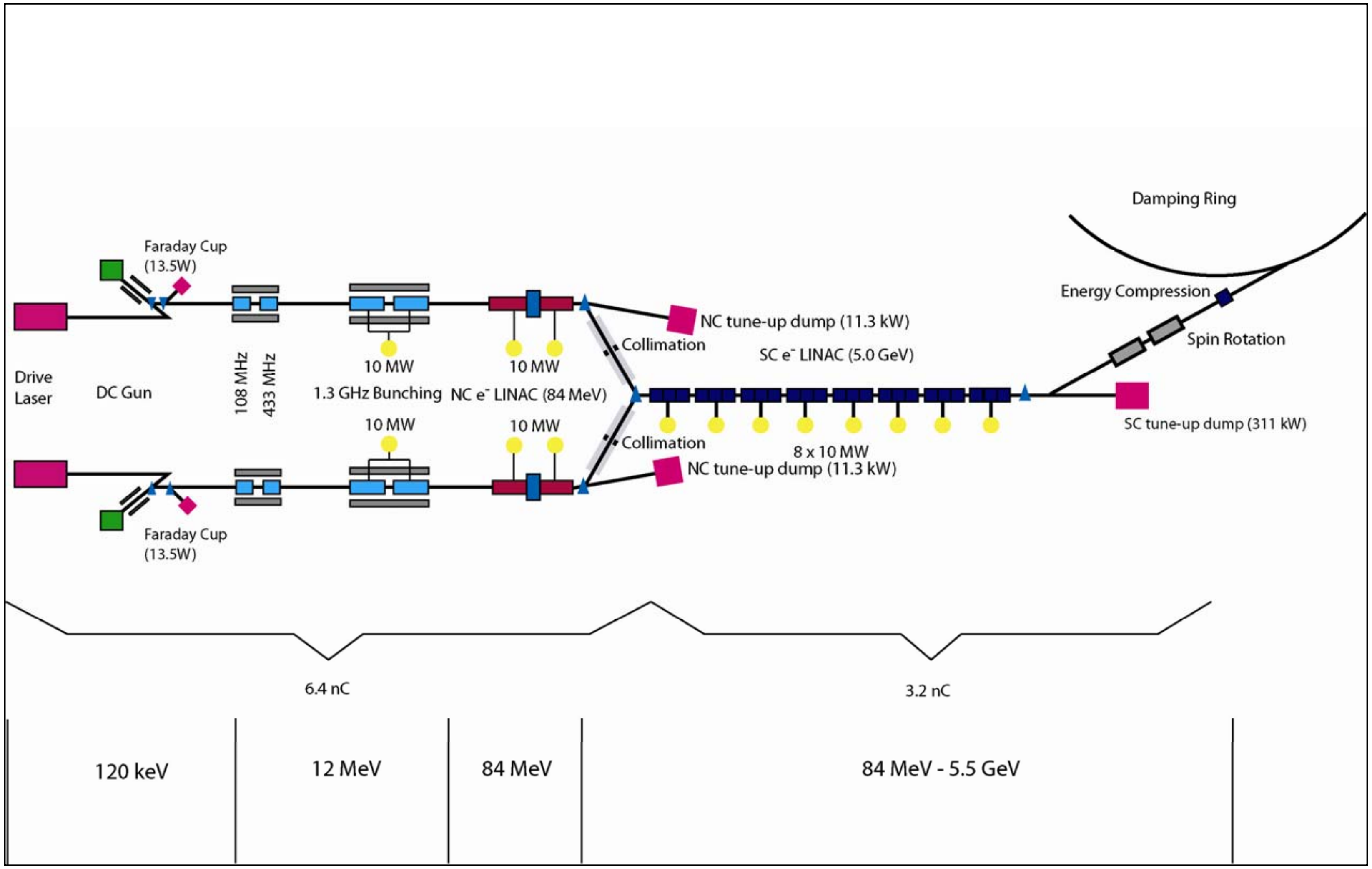


CMS assembly approach

- **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**

electron source

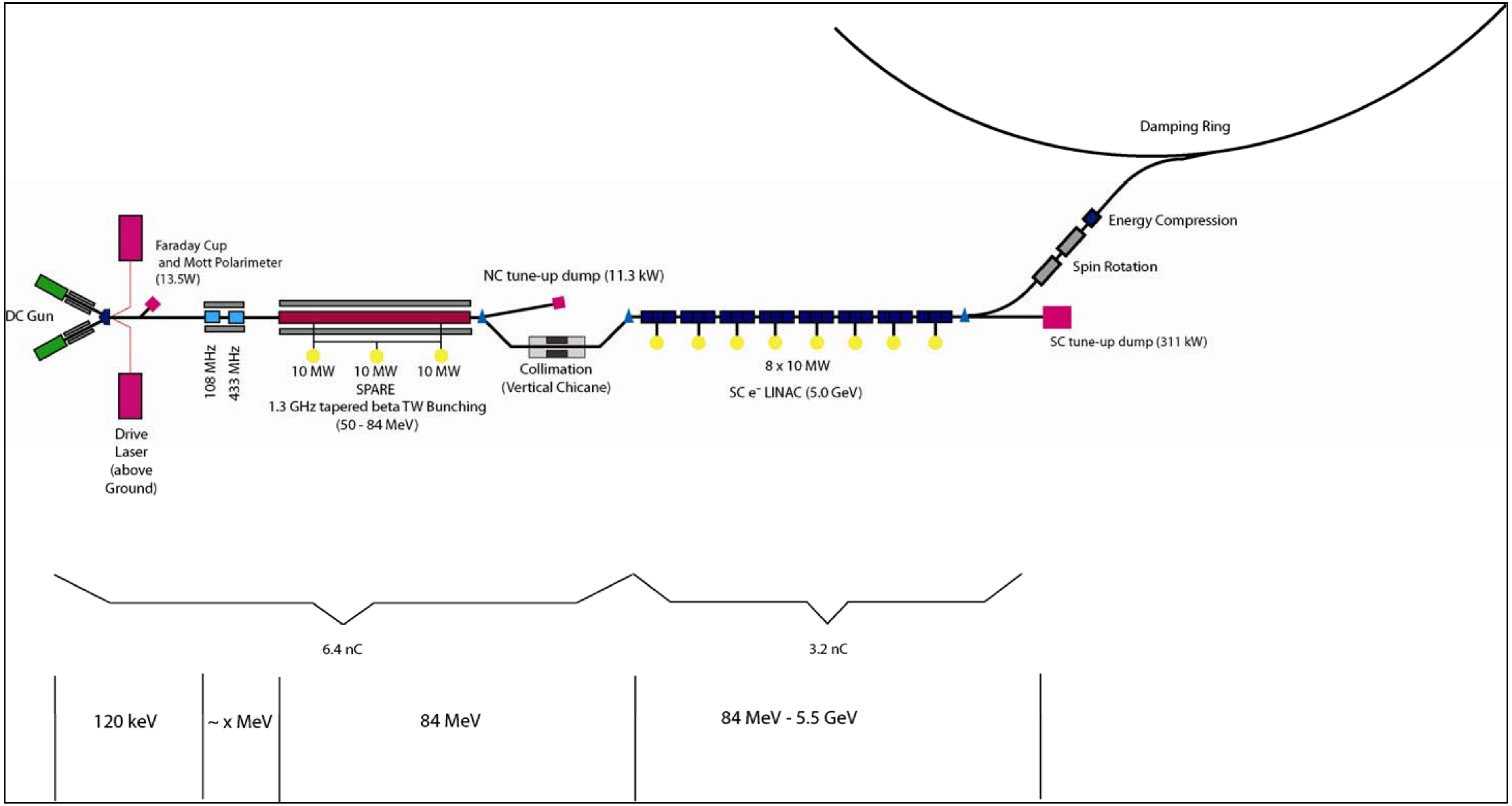
Vancouver Layout



Design Changes Driven by Cost Savings Motivation

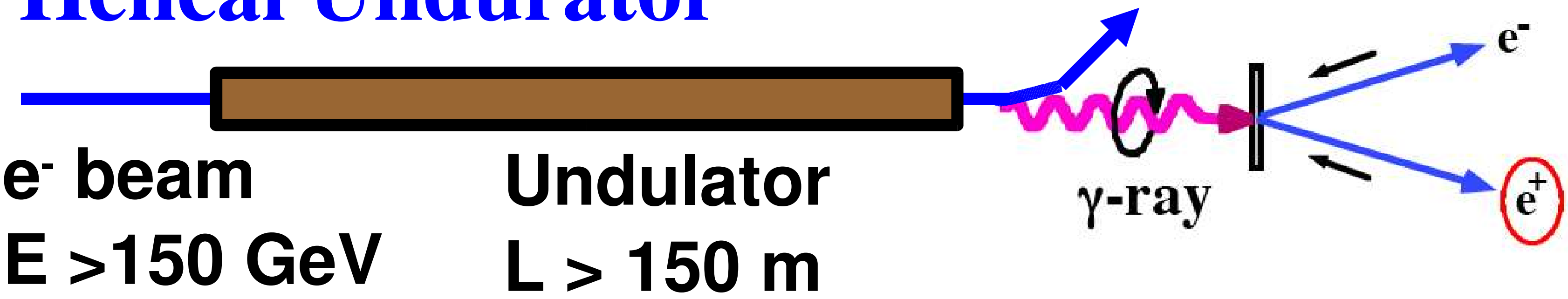
1. Elimination of 1 Normal Conducting Beam Line saves:
   - Bunching system (2 SHB’s, 2 L-Band Bunchers)
   - NC acceleration
   - RF Power
   - Associated CF&S (tunnel and facilities)
2. Installation of Source Laser System above ground saves:
   - Large 50 m x 10 m cavern
   - No extra shielding between laser system and beam line
3. These measures save about 25 % of overall cost for e- source

Modified Beam Line Layout

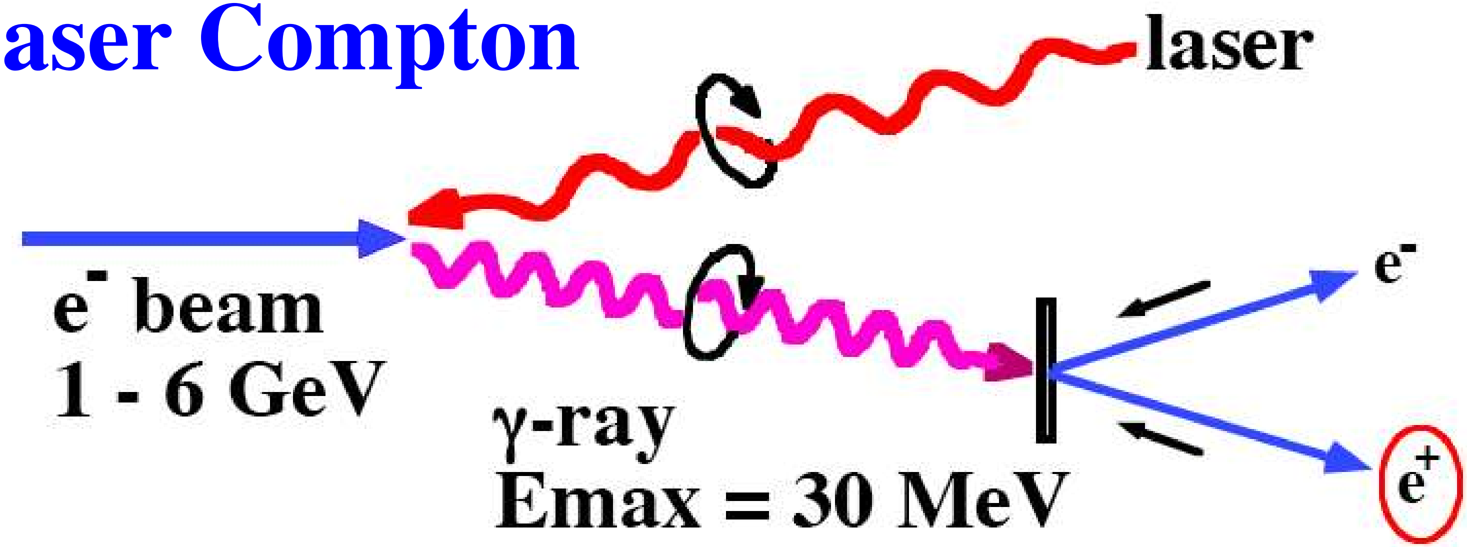


Two ways to get pol. e^+

(1) Helical Undurator

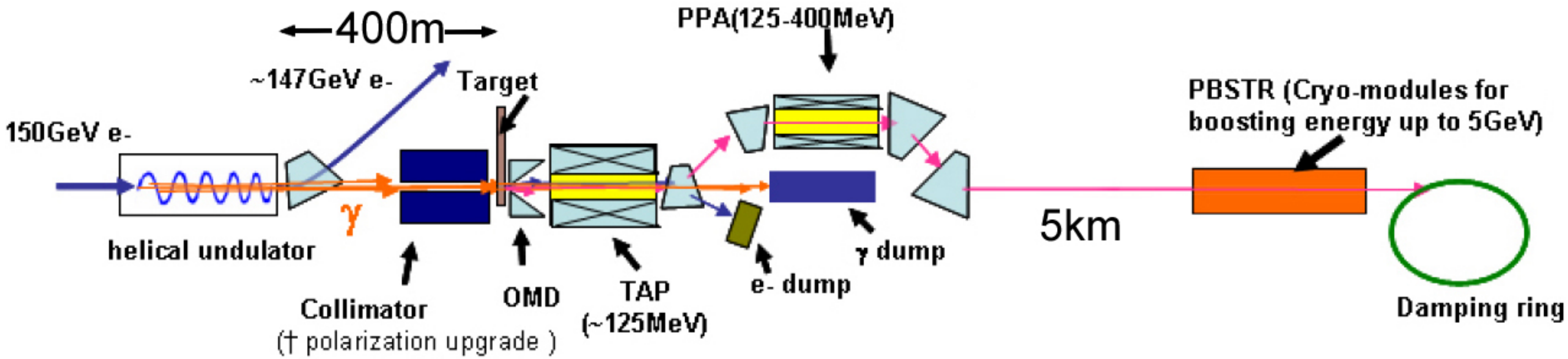


(2) Laser Compton



Positron Source

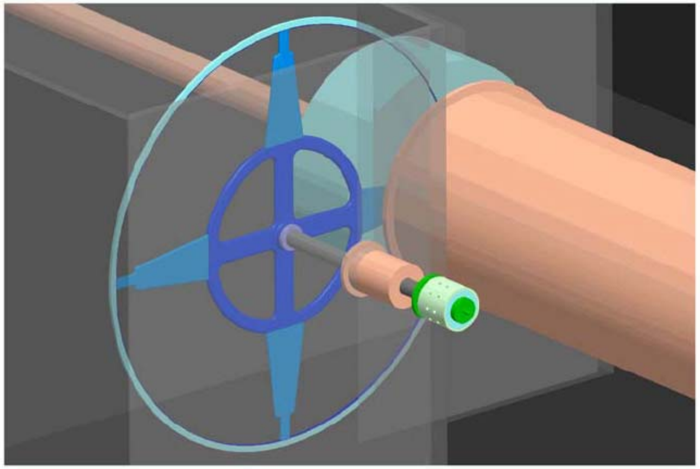
- Undulator scheme
  - **Electron beam at 150GeV**



  - **Undulator**
    - Helical, superconducting
    - length ~100m (~200m for polarized e+)
    - K=0.92, λ=1.15cm, (B=0.86T)
  - **Needs `keep-alive source'**
    - 10% intensity
    - Share 5GeV linac

R&D items

- Undulator fabrication (SC, pitch 1cm, 1.6T)
- Target (titanium alloy, diam.1m, 1.4cm think, rotating at 100m/s)
- Target region design



LC ILC e^+ Source Status

- RLC (Ring based Laser Compton): Electron Storage Ring + Mode-lock medium power laser
  - **Laser and electron beam are effectively recycled.**
  - **Beam in CR is hard to control.**
  - **Yield at one collision is limited.**
- LLC (Linac based Laser Compton): Linac + CO_2 high power laser
  - **Yield at one collision is relatively large.**
  - **Need a high brightness electron injector.**
  - **Laser repetition is limited.**

International Linear Collider Reference Design Report 2007

February 7, 2007

What's RDR

- Conceptual design
- With first-stage cost estimation
- Engineering details not yet contained

But what is published today is not RDR but Draft of RDR

- Not yet the final official version
- There are still many numerical inconsistencies
- There can be small changes in the next couple of months.
- But their cost impact will not be large.

Table of Contents

ILC Cost Reviews

- Internal Review of the Cryomodule cost
- Internal Cost Review at SLAC with the participation of an External Review Panel on December 14 to 16, 2006
  - ***"Methodology is an appropriate basis" for ILC costing***
- Machine Advisory Committee Review at Daresbury on January 10 to 12, 2007
  - ***"… performance driven baseline configuration was successfully converted into a cost conscious design."***
- DOE Briefing on January 17, 2007
- FALC Meeting at London on January 22, 2007
- International Cost Review up to mid 2007

Total ILC Value and Explicit Manpower

- Total ILC Value Cost **$ 6.65 B**

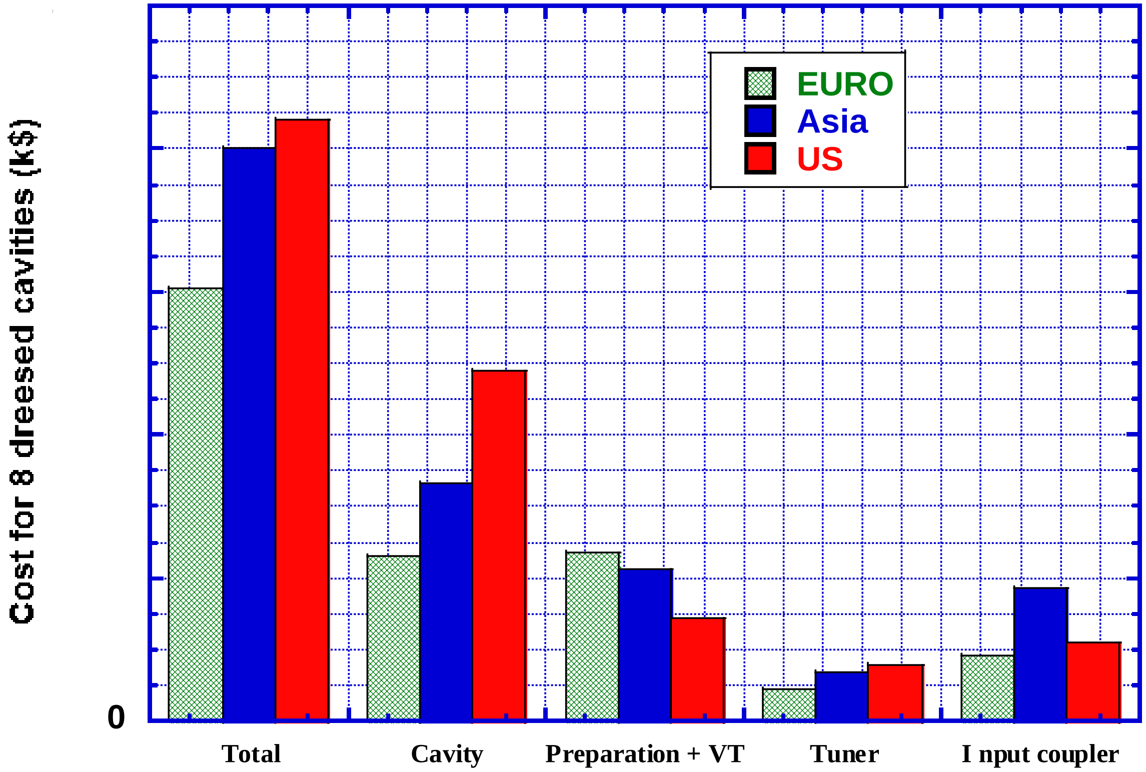
$ 4.87 B shared + **$ 1.78 B** <site specific>

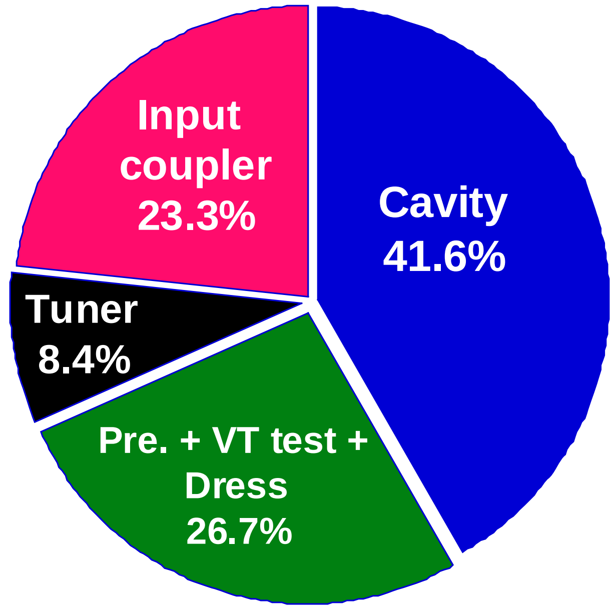
plus **13.0 K** person-years Explicit Manpower

= 22.2 M person-hours

@ 1,700 person-hr/person-yr

Cost estimation for 8 dressed cavities

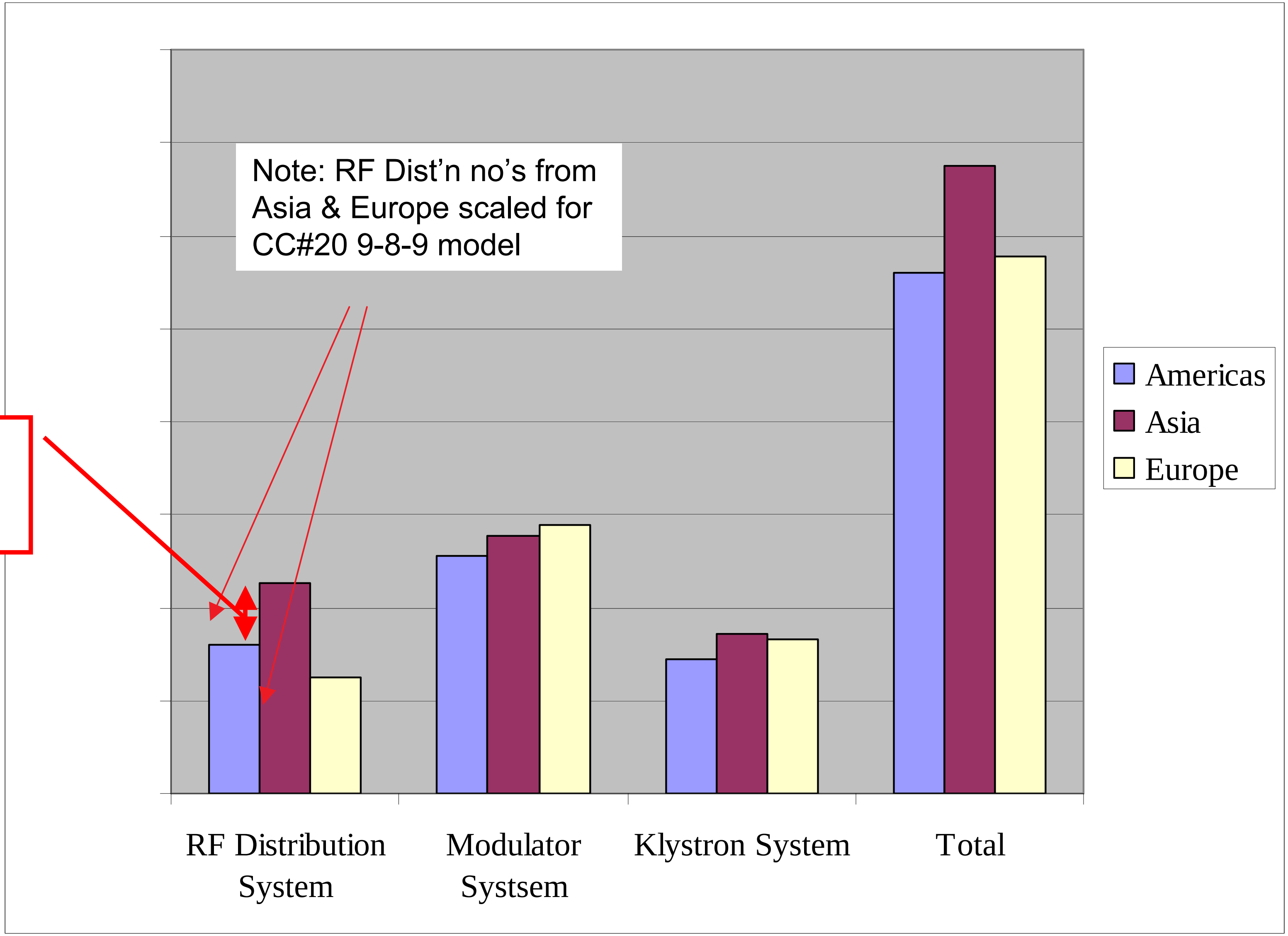




Cavity Package Cost Break in Asia

*** Include facility cost , labor cost for test, and profit (25% in Asia) but no tax.**

Cost Results for HLRF by Region



Some components have no Mfg base in Asia

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

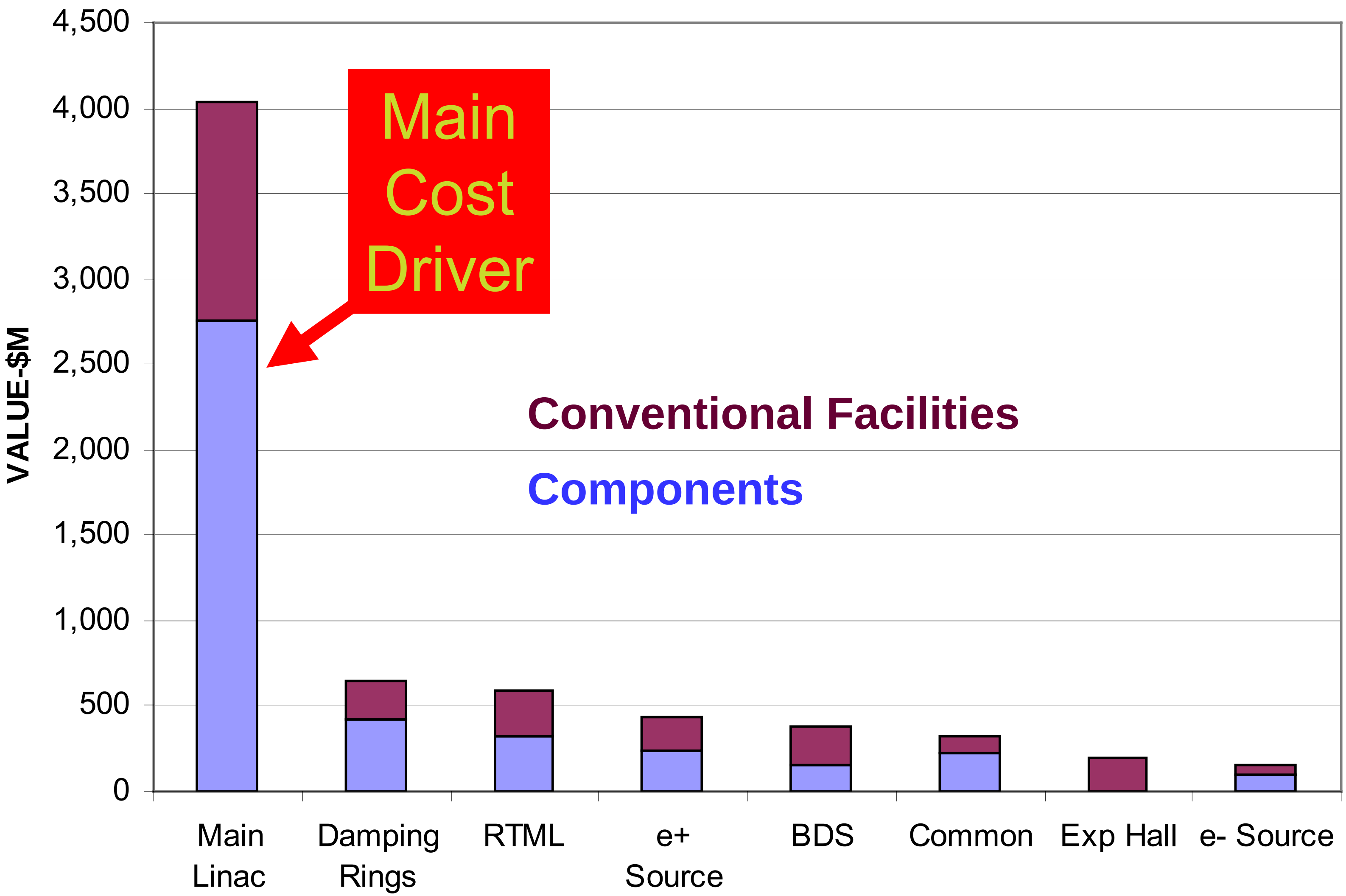
10 Cryogenic plants, 20 KW @ 4.5^{o} K each
plus smaller cryo plants for e-/e+ (1 each), DR (2), BDS (1)

92 surface "buildings", 52.7 K sq. meters = 567 K sq-ft total

240 M Watts connected power, 345 MW installed capacity

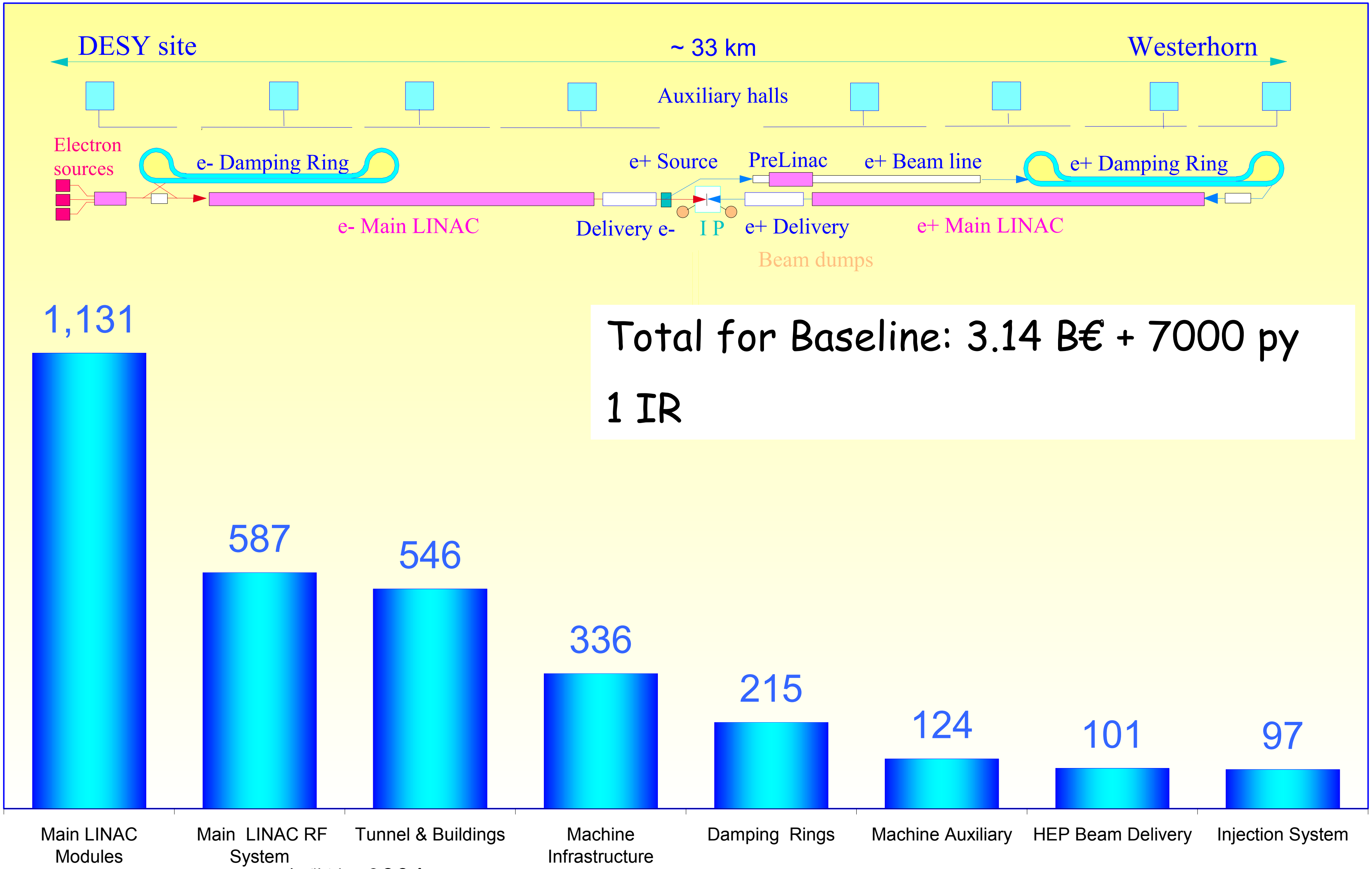
13,200 magnets – 18% superconducting

ILC Value – by Area Systems



Comparison between TESLA and ILC Cost

TESLA Cost Distribution



Gee Whiz from Peter H. Garbincius

16,088 SC Cavities: 9 cell, 1.3 GHz (TESLA: 21,024)

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

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

ML: 562 RF Units (15 to 250 GeV); TESLA 572 (5 to 250 GeV)

72.5 km tunnels ~ 100-150 meters underground (TESLA 37 km)

13 major shafts $\geq$ 9 meter diameter (TESLA 19 shafts)

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

10 Cryogenic plants, 20 KW @ 4.5^o K each (TESLA 12 x 15 kW)
plus smaller cryo plants for e-/e+ (1 each), DR (2), BDS (1)

92 surface "buildings", 52.7 k sq. meters (TESLA ~30 k m^2)

240 MW connected power, 345 MW installed capacity (145/180)

13,200 magnets – 18% superconducting

Comparison between TESLA & ILC

	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		100 %	175 %	
Surface Buildings		100 %	240 %	
Consultant Engineering		100 %	1000 %	
Power Distribution		100 %	510 %	
Water Cooling		100 %	333 %	
Cryogenic System	162	260	567	307
Cryo Plant*		12 x 100 %	10 x 200 %	

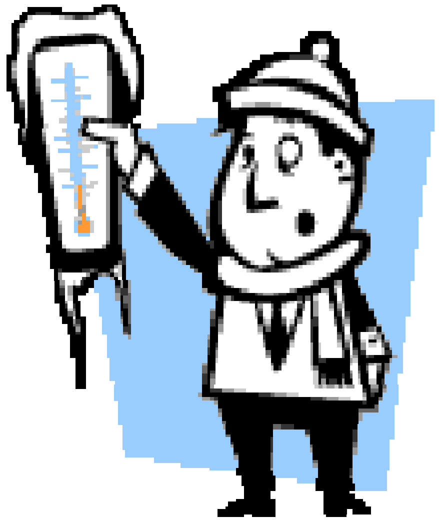
*TESLA: 12 x 2.2 kW @ 2 K

ILC: 10 x 3.5 kW @ 2 K

XFEL: 2.45 kW @ 2 K; 34.35 M€ for Cryogenic System

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.

What from now?

- Finalize RDR
  - **Check inconsistencies (still many!)**
  - **Possible final small changes**
  - **ILCSC-MAC review in ~April**
  - **Final form in summer**
- Organization of GDE for the next step
  - **Next milestone EDR (Engineering Design Report) around 2009.**
  - **Coordination of R&D essential**
  - **Engineering stage**
  - **To be decided in the next coule pf months**

Finally

- RDR Draft is going to be published
- This is the first major milestone reached by international collaboration
- First estimation of the cost will be open to public
- There still remains many R&D items, including, e.g., the establishment of the accelerating gradient 35/31.5 MV/m.
- GDE is going to coordinate the R&D
- The nest step is
  - **To finalize the RDR**
  - **And to start the work for EDR**

The International Linear Collider: By the Numbers

Collisions:	Electrons and their antiparticles, positrons, in bunches of 5 nanometres in height containing 10 billion particles and colliding 14,000 times per second
Energy:	Up to 500 GeV with an option to upgrade to 1 TeV
Collision Rate:	Bunches consisting of $2x10^{10}$ electrons and positrons each collide 14000 times per second, focused to a tiny area a few millionths of millimetres across
Acceleration Technology:	Superconducting radiofrequency using accelerating cavities made of pure niobium
Length:	Approximately 31 kilometres, plus two damping rings each with a circumference of six kilometres.
Accelerating Gradient:	31.5 megavolts per metre
Cavities:	16,000
Cryomodules:	2000
Cavity temperature:	1.8 Kelvin (-271.2 °C or -456°F).

Detectors:	2 in an interchangeable push-pull configuration
Site:	To be determined in the next phase of the project
ILC Community:	More than 100 laboratories and universities around the world involving currently about 1000 people are working on R&D programmes for the ILC
Management:	Global Design Effort, a team of approximately 60 scientists and engineers led by Barry Barish
Contact:	communicators@linearcollider.org
On the Web:	http://www.linearcollider.org/