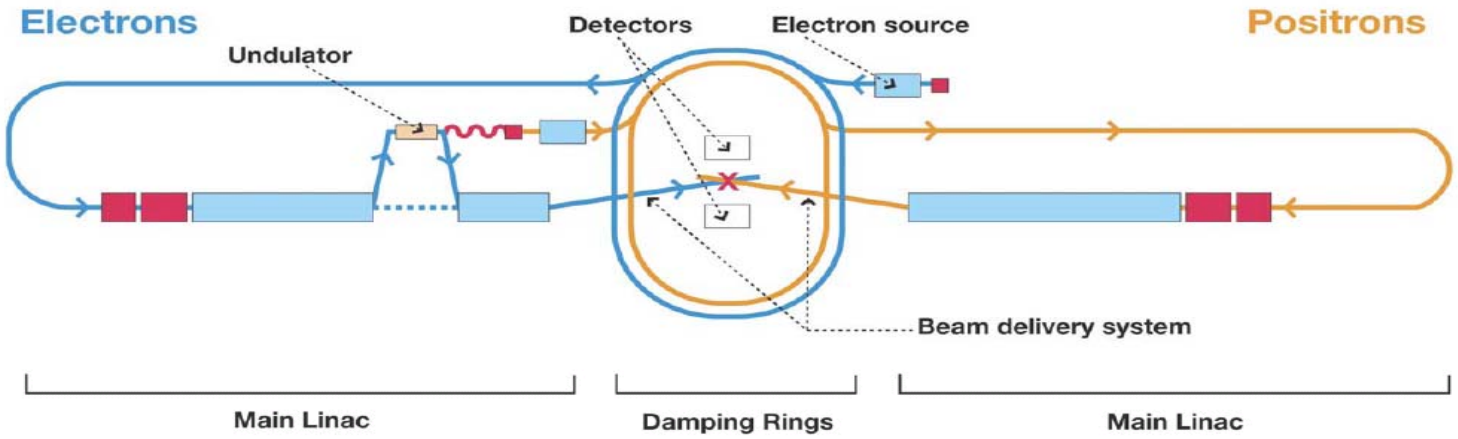
A Vision of the Future

RDR to ILC



Barry Barish

LCWS DESY

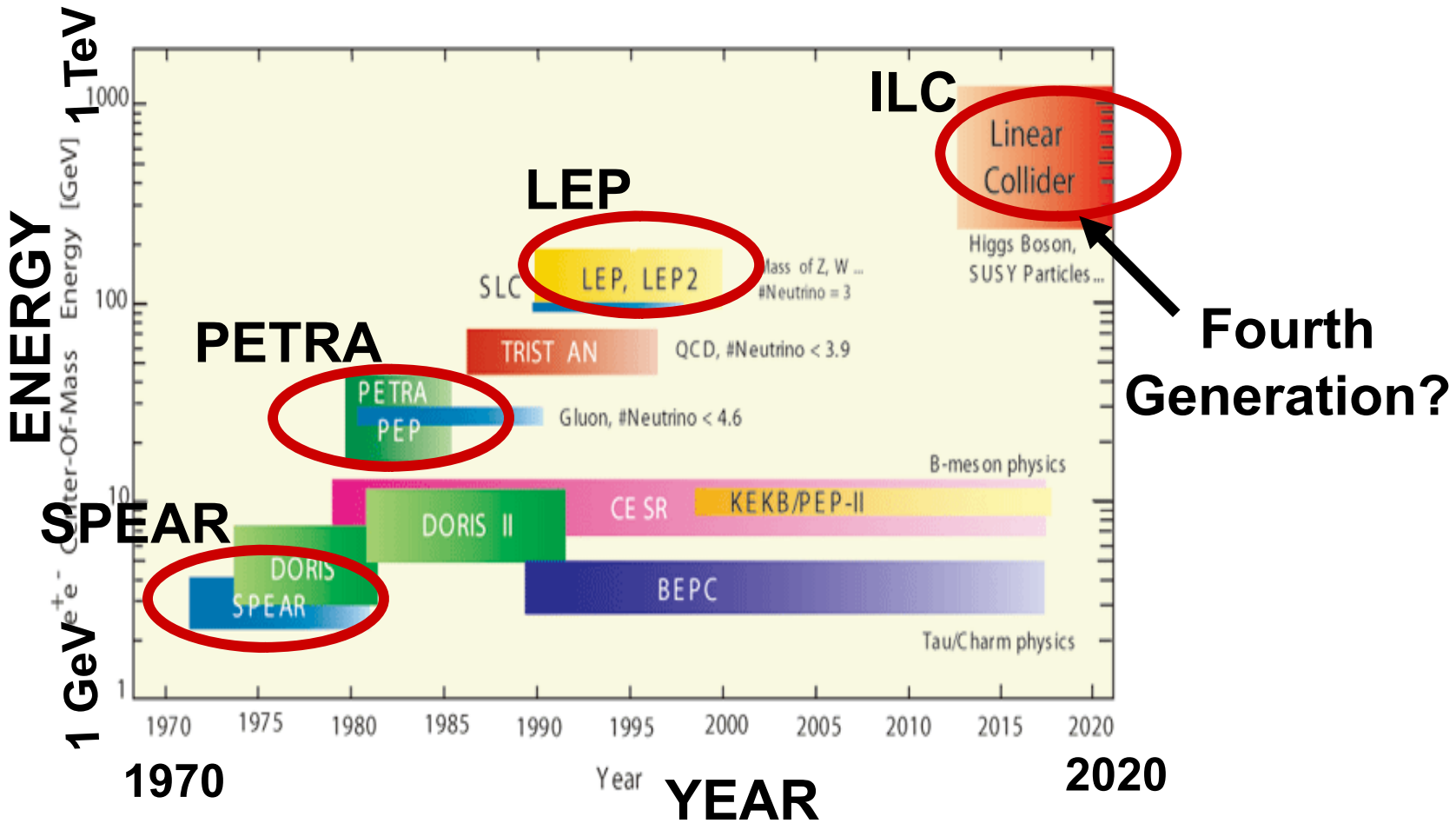
30-May-07

The Plan

- A little history
- The GDE first milestones
  - **Create Baseline Configuration (BCD)**
  - **Develop a Reference Design (RDR)**
- Description and assessment of the RDR
- Plans for the next step – Engineering Design
- Making the ILC a reality

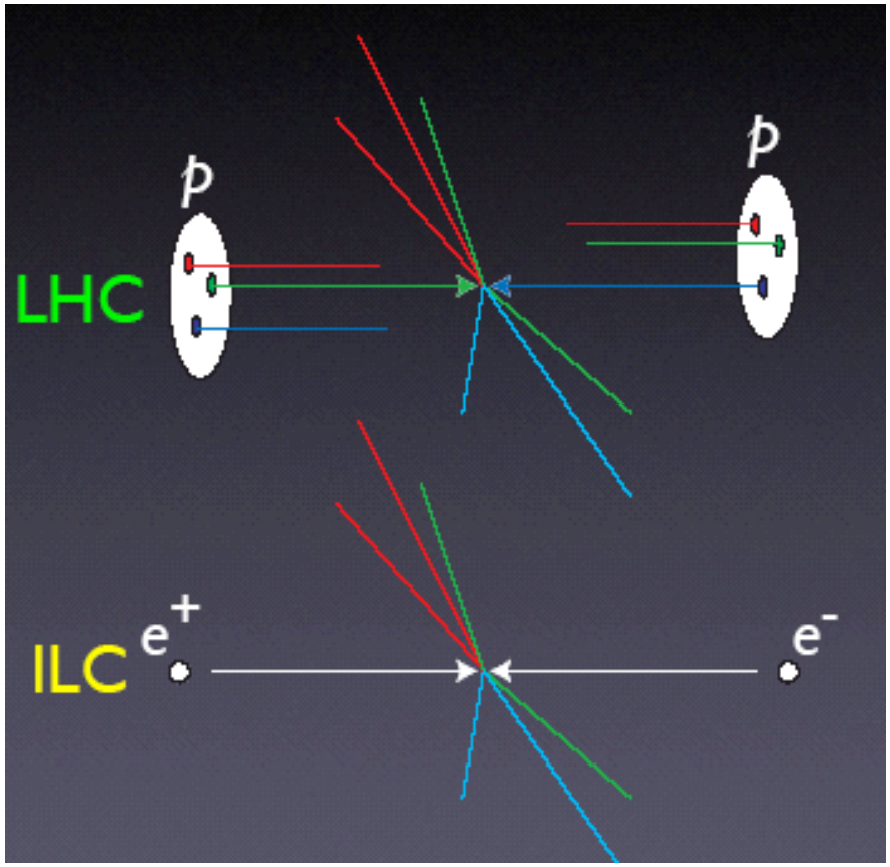
Three Generations of e^+e^- Colliders

The Energy Frontier



Precision Physics at the Terascale

- elementary particles
- well-defined
  - **energy,**
  - **angular momentum**
- uses full COM energy
- produces particles democratically
- can mostly fully reconstruct events



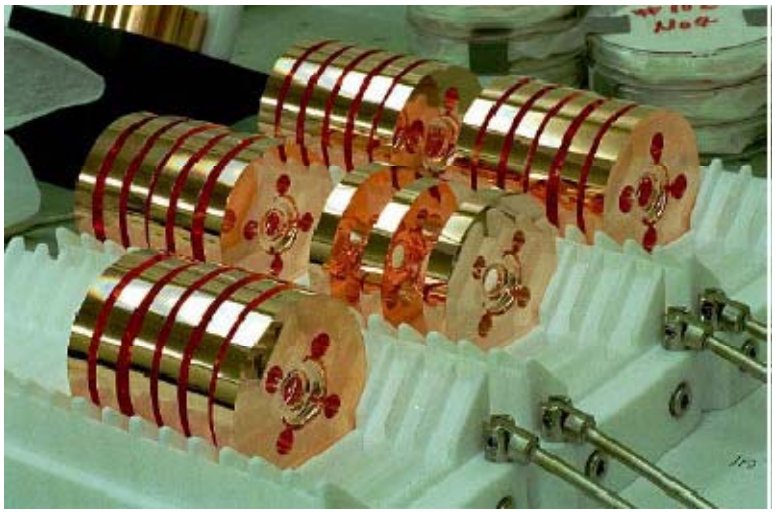
Exploring the Terascale
the tools

- The LHC
  - **It will lead the way and has large reach**
  - **Quark-quark, quark-gluon and gluon-gluon collisions at 0.5 - 5 TeV**
  - **Broadband initial state**
- The ILC
  - **A second view with high precision**
  - **Electron-positron collisions with fixed energies, adjustable between 0.1 and 1.0 TeV**
  - **Well defined initial state**
- Together, these are our tools for the terascale

Underlying Technology
a decade of R&D

- Room temperature copper structures

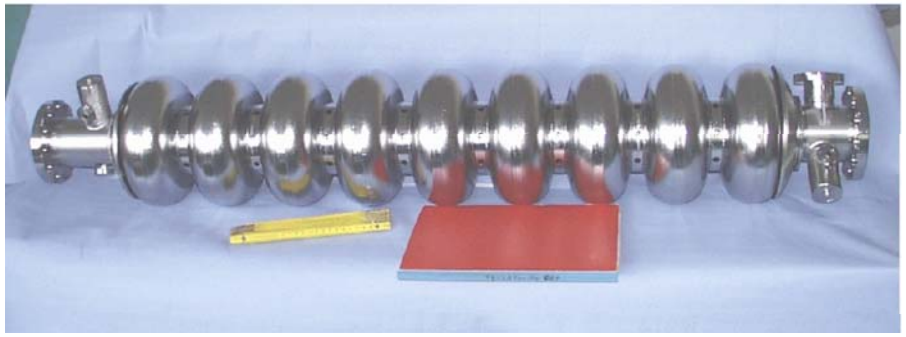
  (KEK & SLAC)



OR

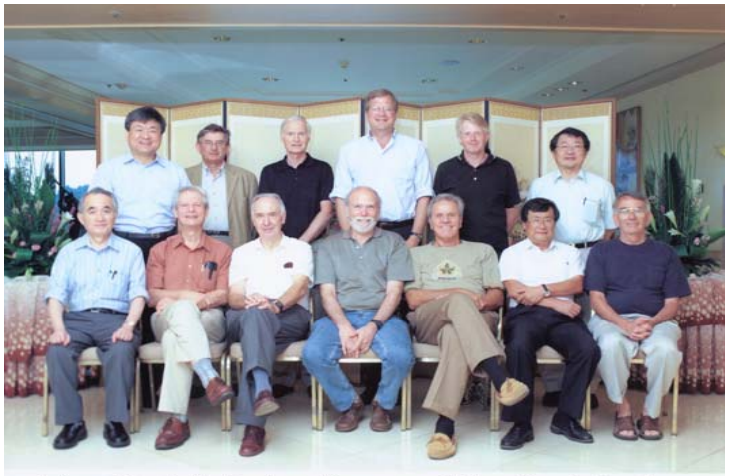
- Superconducting RF cavities

  (DESY)



SCRF Technology – A Global Decision

- The recommendation of ITRP was presented to ILCSC & ICFA on August 19, 2004 in a joint meeting in Beijing.



International Technology Recommendation Panel Meeting
August 11 ~ 13, 2004, Republic of Korea

- ICFA unanimously endorsed the ITRP's recommendation on August 20, 2004

The Community Self-Organized

Nov 13-15, 2004

~ 220 participants from 3 regions, most of them accelerator experts

15

Global Effort on ILC Design & R&D

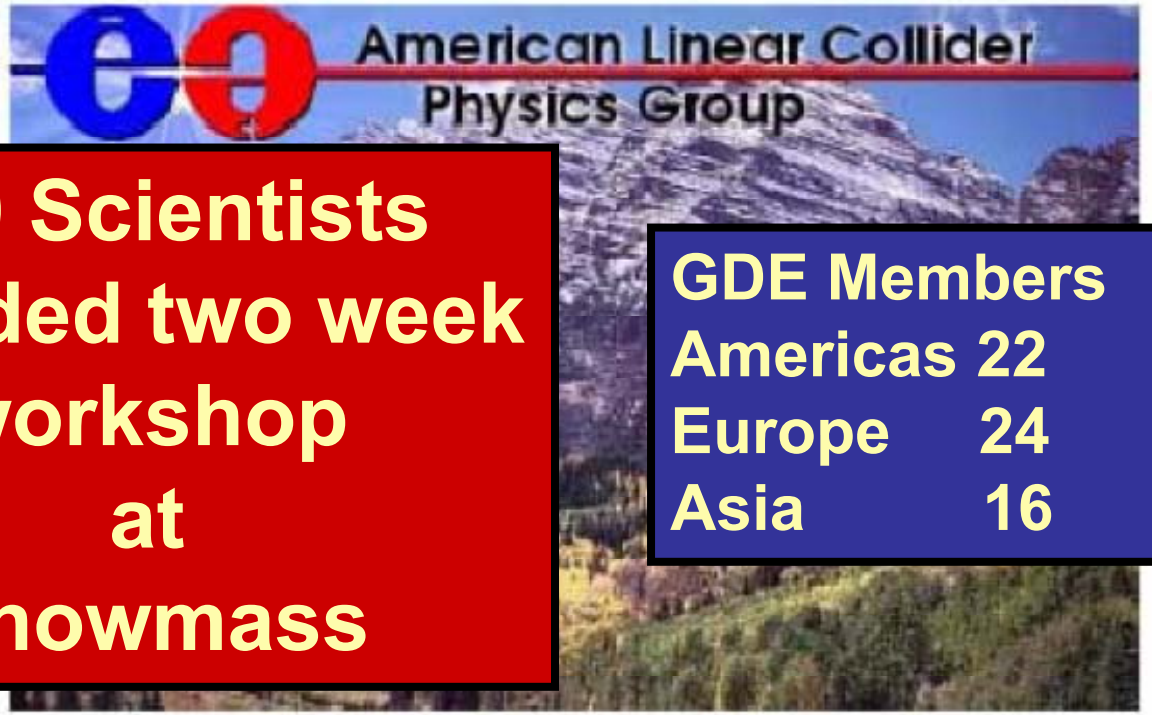
Joint Design, Implementation, Operations, Management
Host Country Provides Conventional Facilities

GDE – Mission Statement

- Produce a design for the ILC that includes a detailed design concept, performance assessments, reliable international costing, an industrialization plan , siting analysis, as well as detector concepts and scope.

- Coordinate worldwide prioritized proposal driven R & D efforts (to demonstrate and improve the performance, reduce the costs, attain the required reliability, etc.)

GDE Began at Snowmass

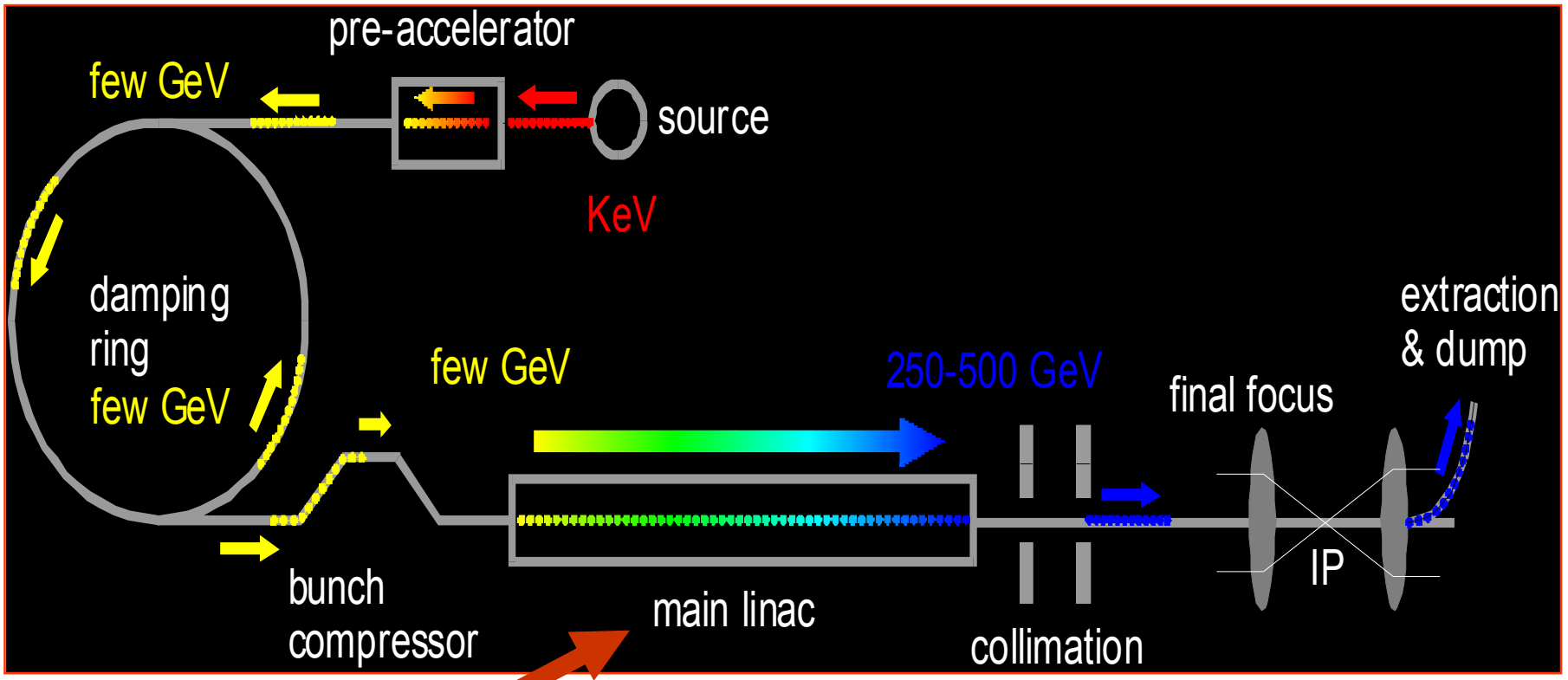


670 Scientists attended two week workshop at Snowmass

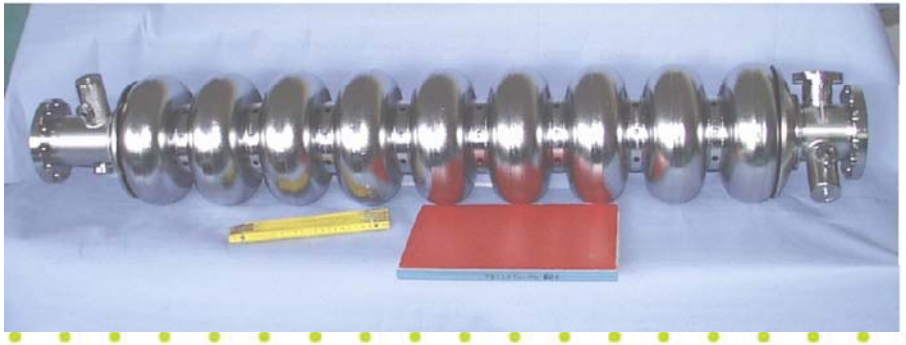
GDE Members
Americas 22
Europe 24
Asia 16

2005 International Linear Collider Physics and Detector Workshop
and Second ILC Accelerator Workshop
Snowmass, Colorado, August 14-27, 2005

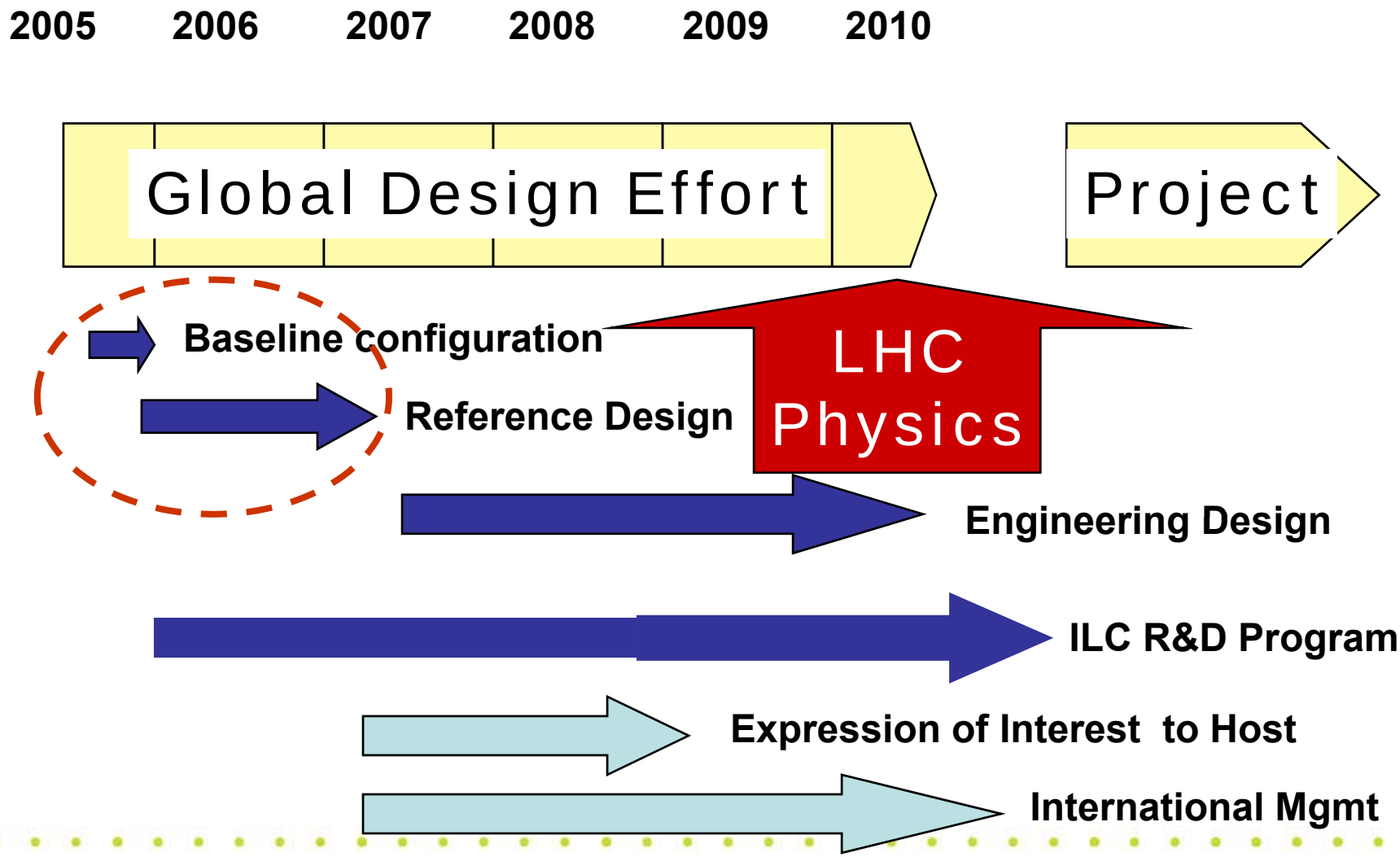
GDE -- Designing a Linear Collider



Superconducting RF Main Linac



ILC – Global Design Phase



How the physics defines the ILC

Parameters for the Linear Collider

September 30, 2003

Asia: Sachio Komamiya, Dongchul Son
Europe : Rolf Heuer (chair), Francois Richard
North America: Paul Grannis, Mark Oreglia

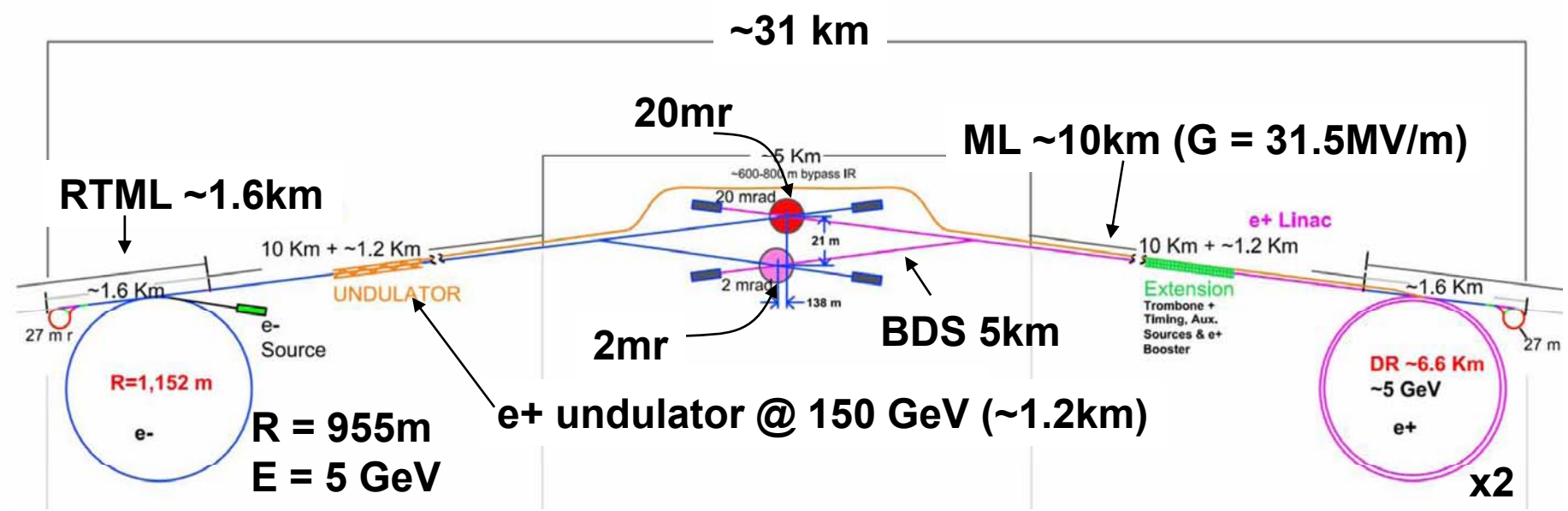
ILC Physics Goals

- E_{cm} adjustable from 200 – 500 GeV
- Luminosity → $\int L dt$ = 500 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 Reference Design meets the goals of the ICFA- ILCSC parameters study

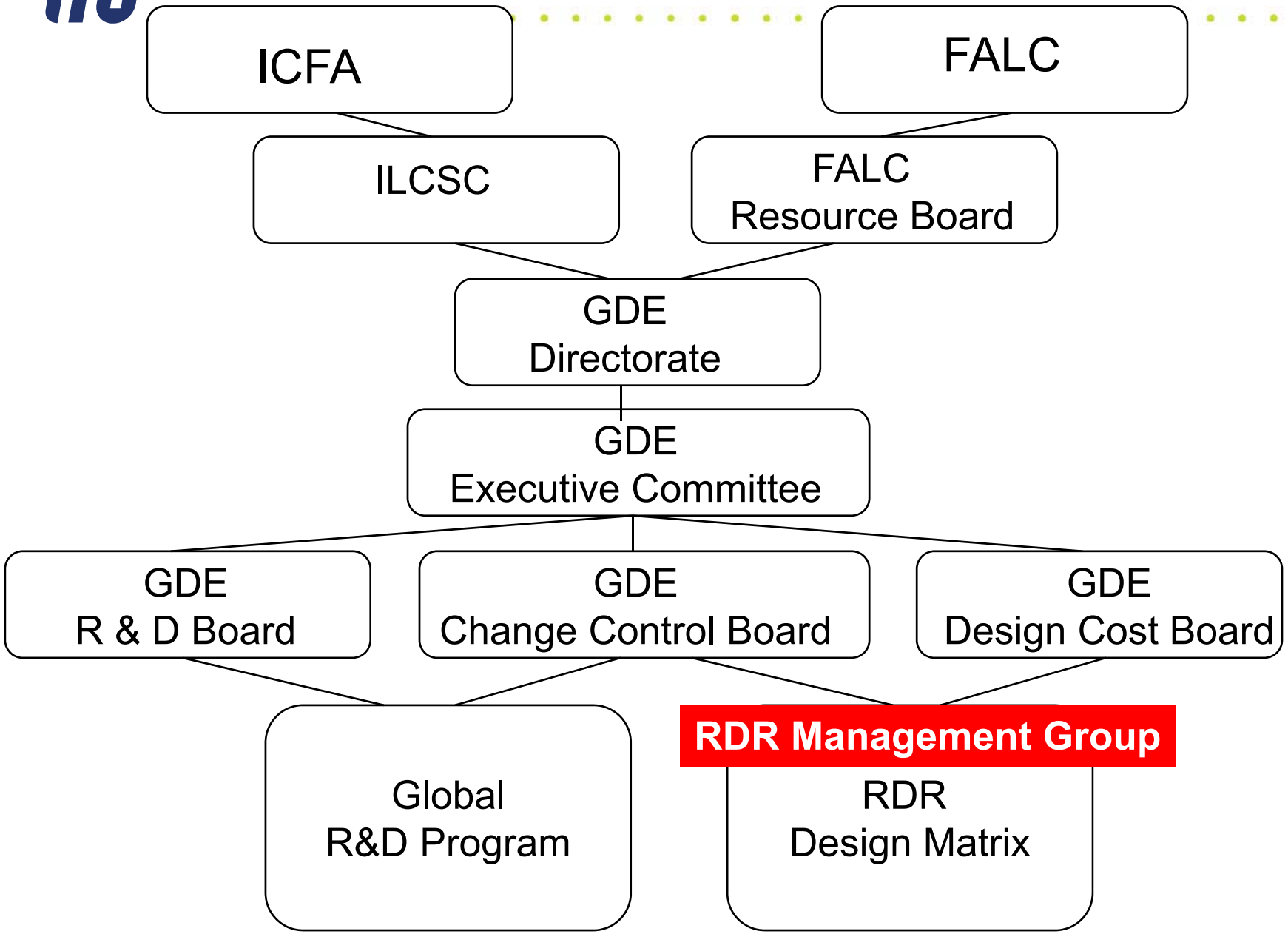
The Baseline Machine (500GeV)

January 2006



not to scale

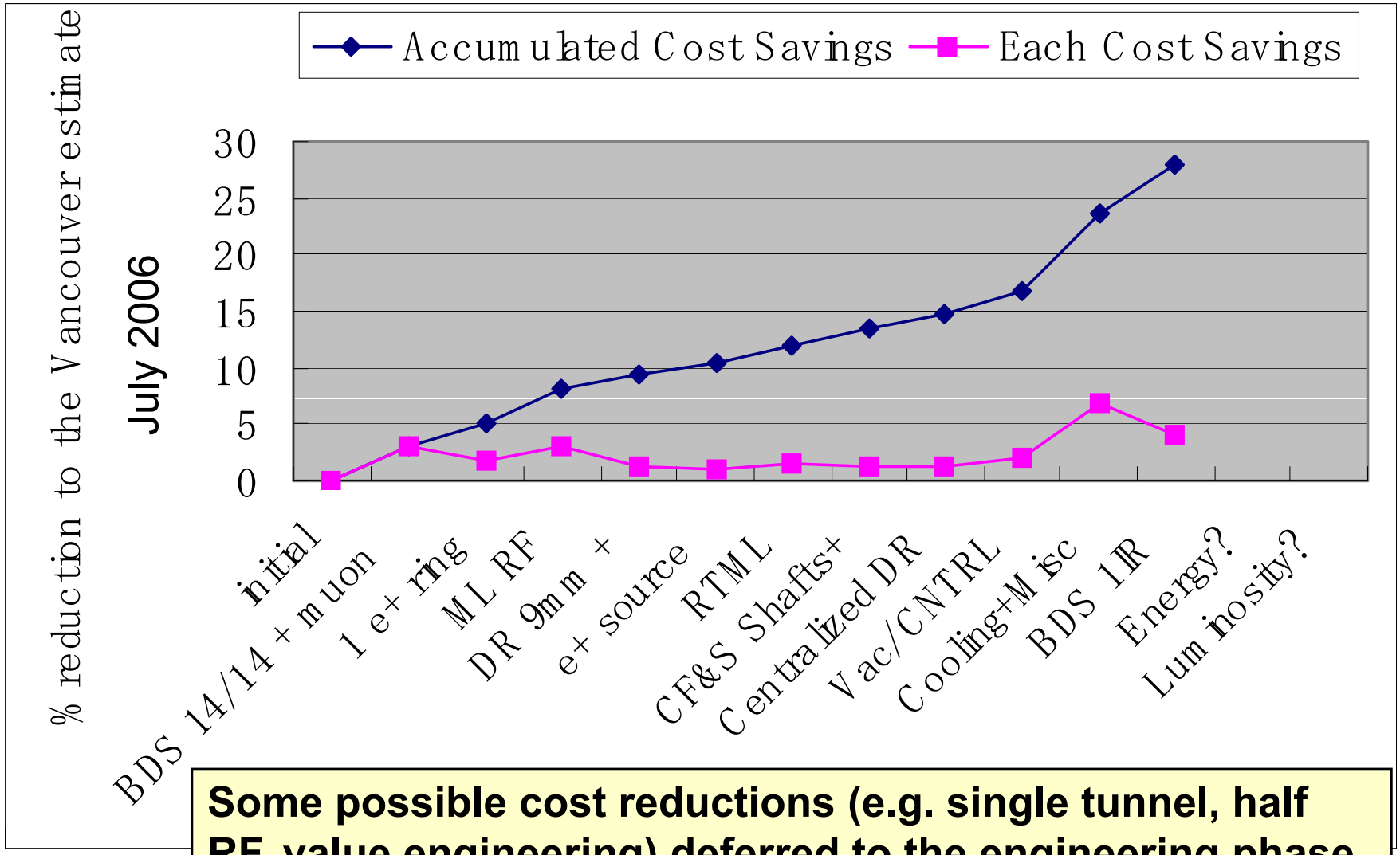
GDE RDR / R&D Organization



RDR Cost Estimating

- Value Costing is intended to represent a common basis for costing, that needs to be converted to actual costs for work performed in a given region.
- "Value" Costing System: International costing for International Project
  - **Provides basic "value" costs agreed to among regions**
  - **Provides estimate of "explicit" labor (man-hr)]**
- Based on a call for world-wide tender:
  lowest reasonable price for required quality
  - **So far only industrial nations, opportunity for reductions**
- 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)**

Evolving Design → Cost Reductions



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

Parameters Report Revisited

- **The ILCSC Parameters Group has given updated selected clarification on accelerator requirements, based on achieving ILC science goals:**
  - **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.**

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 = 6.62 B ILC Units

Summary
RDR "Value" Costs

Total Value Cost (FY07)

4.80 B ILC Units Shared

+

1.82 B Units Site Specific

+

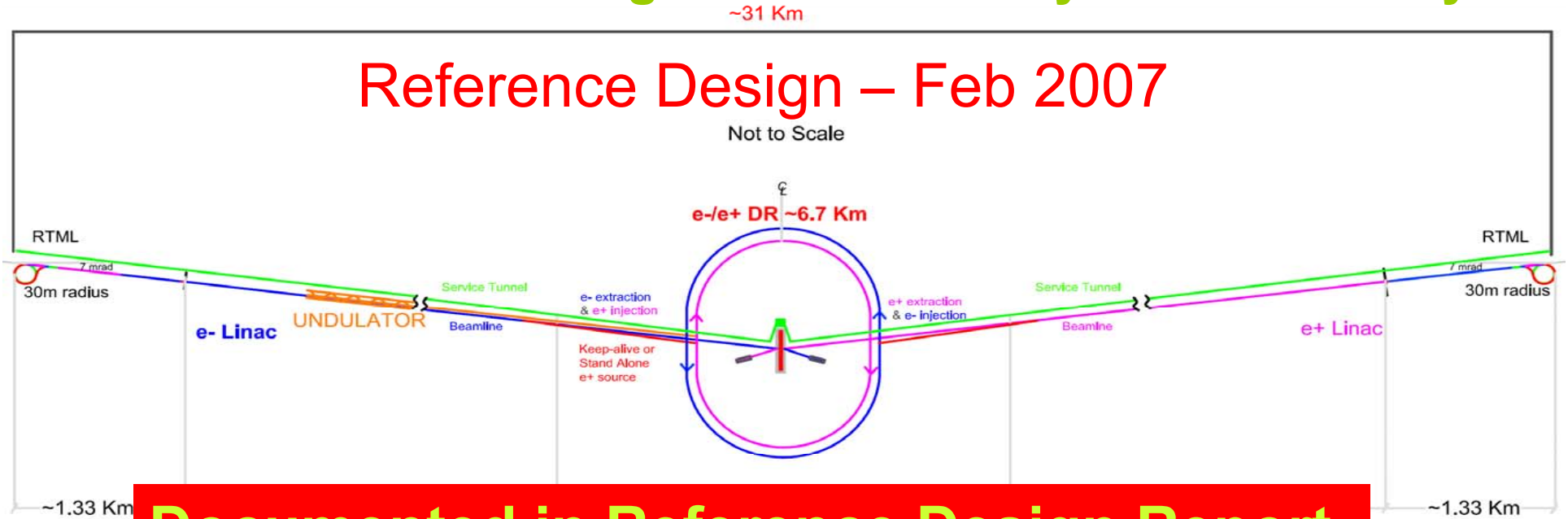
14.1 K person-years

("explicit" labor = 24.0 M person-hrs @ 1,700 hrs/yr)

1 ILC Unit = $ 1 (2007)

ILC Reference Design

- 11km SC linacs operating at 31.5 MV/m for 500 GeV
- Centralized injector
  - Circular damping rings for electrons and positrons
  - Undulator-based positron source
- Single IR with 14 mrad crossing angle
- Dual tunnel configuration for safety and availability

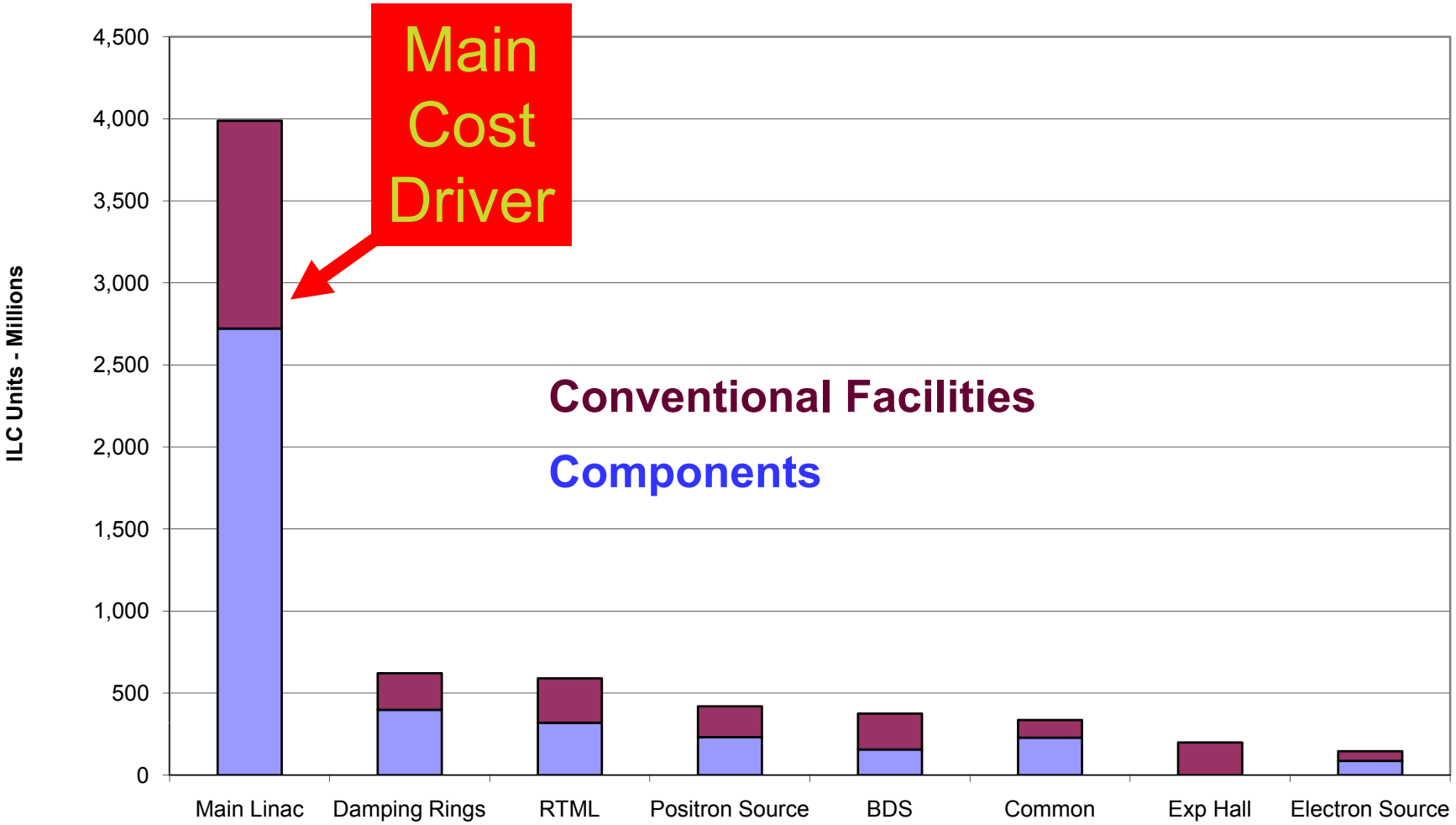


Documented in Reference Design Report

RDR Design Parameters

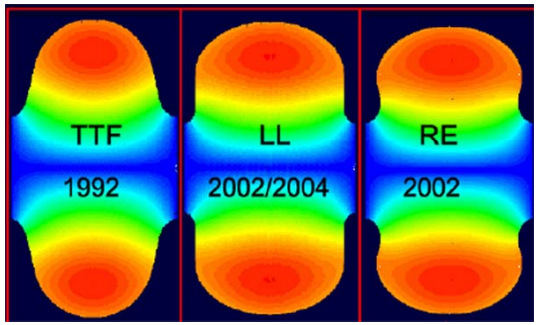
Max. Center-of-mass energy	500	GeV
Peak Luminosity	~2×10^{34}	$1/cm^2 s$
Beam Current	9.0	mA
Repetition rate	5	Hz
Average accelerating gradient	31.5	MV/m
Beam pulse length	0.95	ms
Total Site Length	31	km
Total AC Power Consumption	~230	MW

ILC Value – by Area Systems



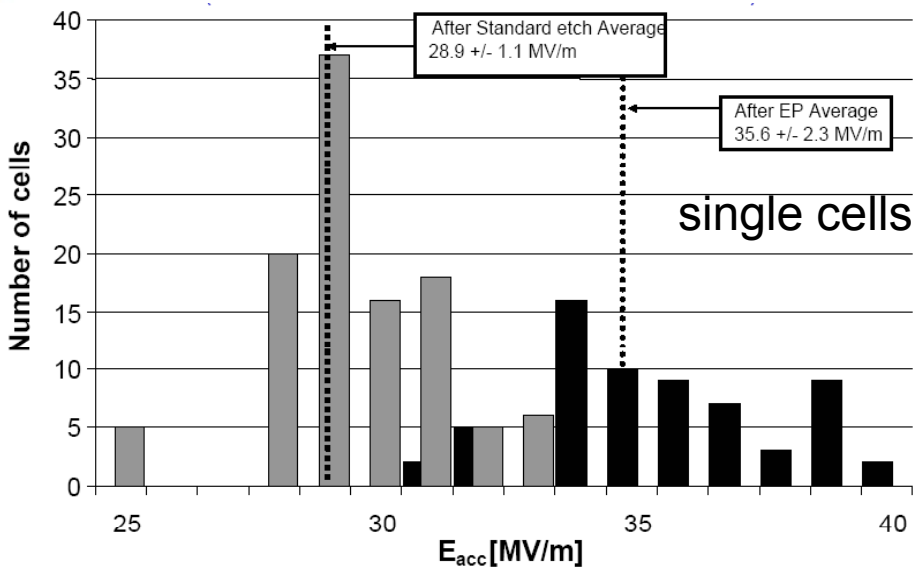
ILC Reference Design and Plan

Producing Cavities



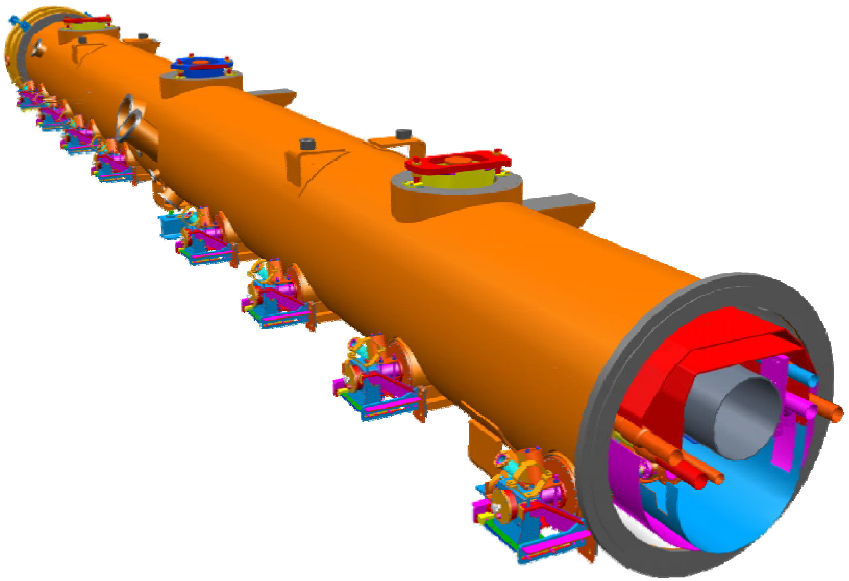
Cavity Shape

Obtaining Gradient



Cryomodules

TESLA cryomodule



4th generation prototype ILC cryomodule

The Main Linac

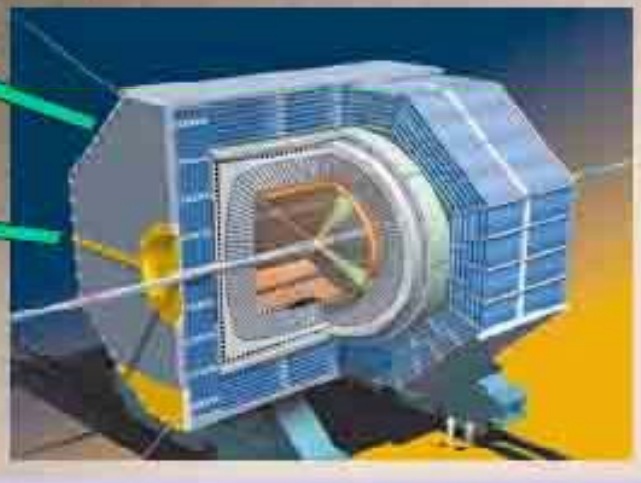
Subdivision	Length (m)	Number
Cavities (9 cells + ends)	1.326	14,560
Cryomodule (9 cavities or 8 cavities + quad)	12.652	1,680
RF unit (3 cryomodules)	37.956	560
Cryo-string of 4 RF units (3 RF units)	154.3 (116.4)	71 (6)
Cryogenic unit with 10 to 16 strings	1,546 to 2,472	10
Electron (positron) linac	10,917 (10,770)	1 (1)

- Costs have been estimated regionally and can be compared.
  - **Understanding differences require detail comparisons – industrial experience, differences in design or technical specifications, labor rates, assumptions regarding quantity discounts, etc.**

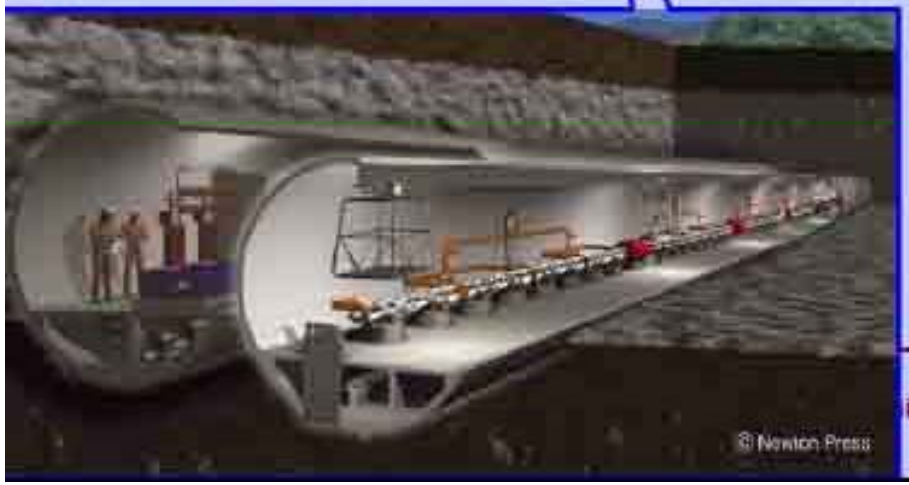
Linear Collider Facility

Main Research Center

Particle Detector



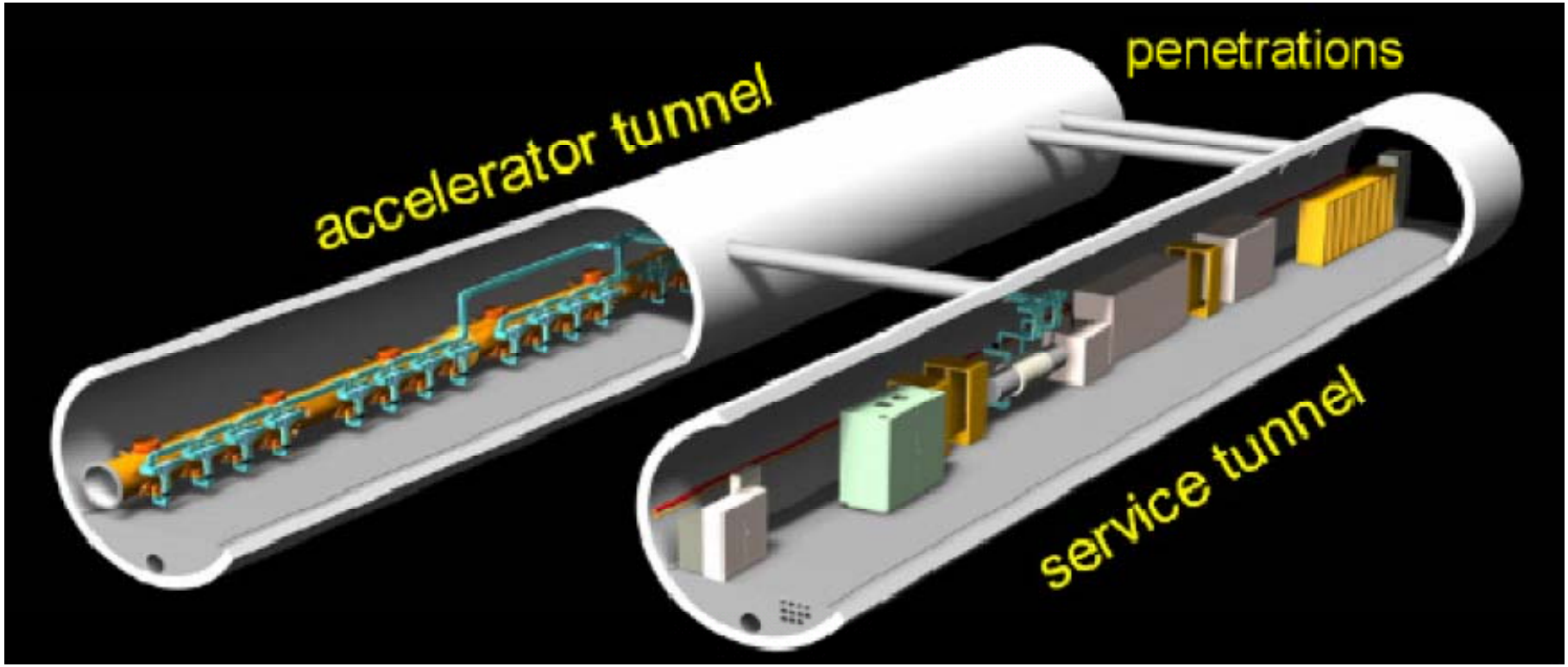
~30 km long tunnel



Two tunnels

- accelerator units
- other for services - RF power

Main Linac Double Tunnel



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

Conventional Facilities

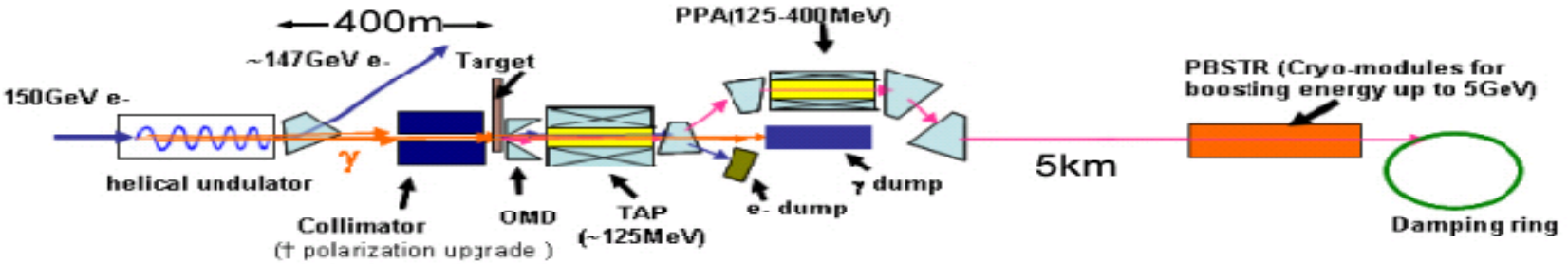
72.5 km tunnels ~ 100-150 meters underground

13 major shafts ≥ 9 meter diameter

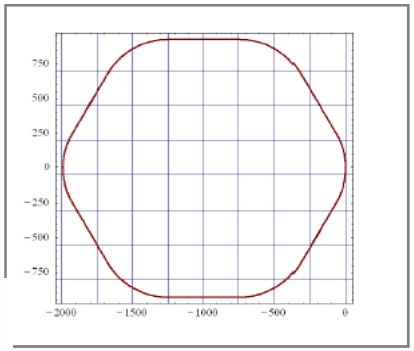
443 K cu. m. underground excavation: caverns, alcoves, halls

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

ILC Reference Design and Plan

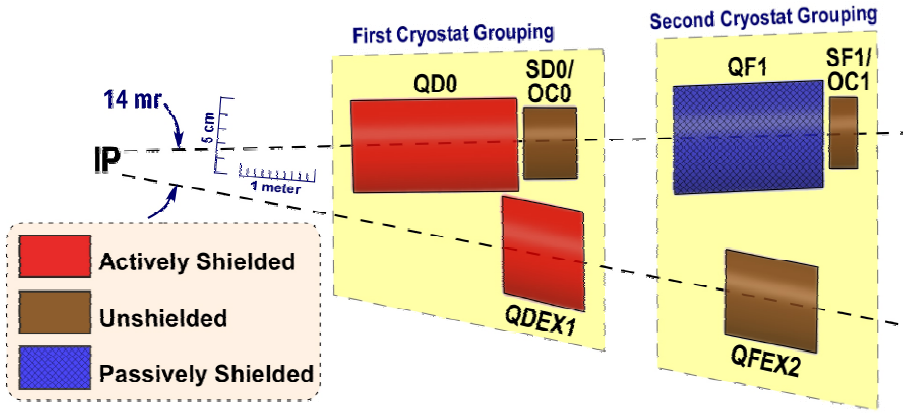


Making Positrons



6km
Damping
Ring

10MW
Klystrons



Beam Delivery and Interaction Point

Assessing the RDR

- **ILCSC Machine Advisory Committee (4 reviews)**
  - **The Design:** "The MAC applauds that considerable evolution of the design was achieved which was made possible by strong leadership and guidance by the GDE. Together these have resulted in a successful reduction of the total project cost as compared to the status of summer 2006. The numerous design changes that provide considerable cost reductions as compared to the baseline configuration are clear evidence that the performance driven baseline configuration was successfully converted into a cost conscious design."
  - **The R&D Plan:** "The committee endorses the approach of collecting R&D items as proposed by the collaborators, categorizing them, prioritizing them, and seeking contact with funding agencies to provide guidelines for funding. This appears to be the right way to start coordination of the R&D effort. The committee acknowledges that this approach is working and success is now starting to show."

Completing the RDR

- **International Cost Review (Orsay) 23-25 May**
  - Report by FALC
  - Closeout by Lyn Evans (chair) supported the costing methodology; considering the costing conservative in that they identify opportunities for cost savings; etc.

- **Final Steps**
  - The final versions of Executive Summary, Reference Design Report and Companion Document will be submitted to FALC (July), ILCSC and ICFA (August).
  - A series of "internal" technical reviews of the reference design will be carried out by GDE, in order to assess the detailed design and then to establish the new ILC baseline. (see Ross)

Nice, but what about Orbach?

"Completing the R&D and engineering design, negotiating an international structure, selecting a site, obtaining firm financial commitments, and building a machine could take us well into the mid-2020s, if not later,"

- **Our technically driven time-scale is**
  - **Construction proposal in 2010**
  - **Construction start in 2012**
  - **Construction complete in 2019**
- **What do we need to do to achieve our schedule?**

Prepare to Propose ILC Construction

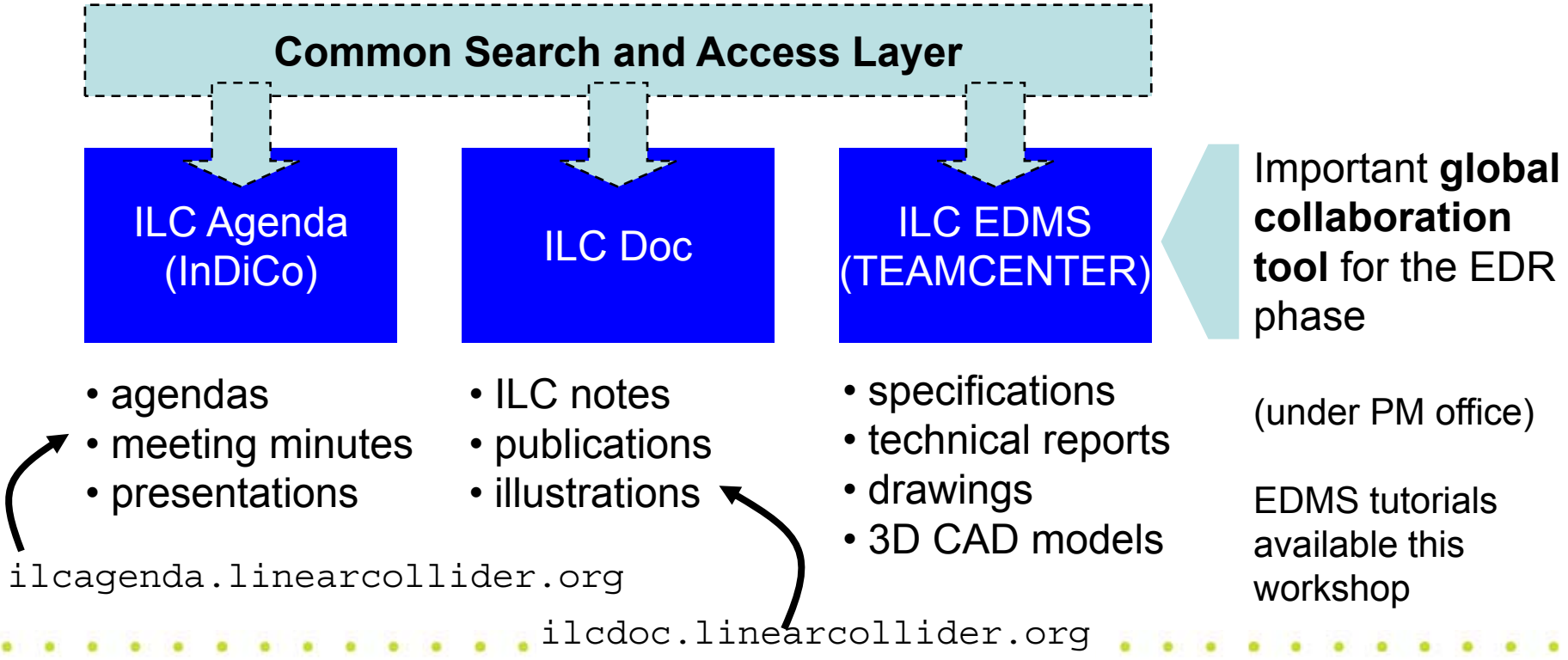
- **ILC Engineering Design**
  - We have a solid design concept in the reference design, but it is immature and needs engineering designs, value engineering, supporting R&D and industrialization.
- **GDE will be reorganized around a Project Management Office to reach this goal (Ross talk)**
  - Mark Ross, N. Walker and A Yamimoto
  - Central management will have authority to set priorities and direct the work
  - Resources for the engineering design and associated R&D appears feasible
  - Investments toward Industrialization and siting
  - Anticipate LHC results by about 2010. We must be ready!

Prepare to Propose ILC Construction

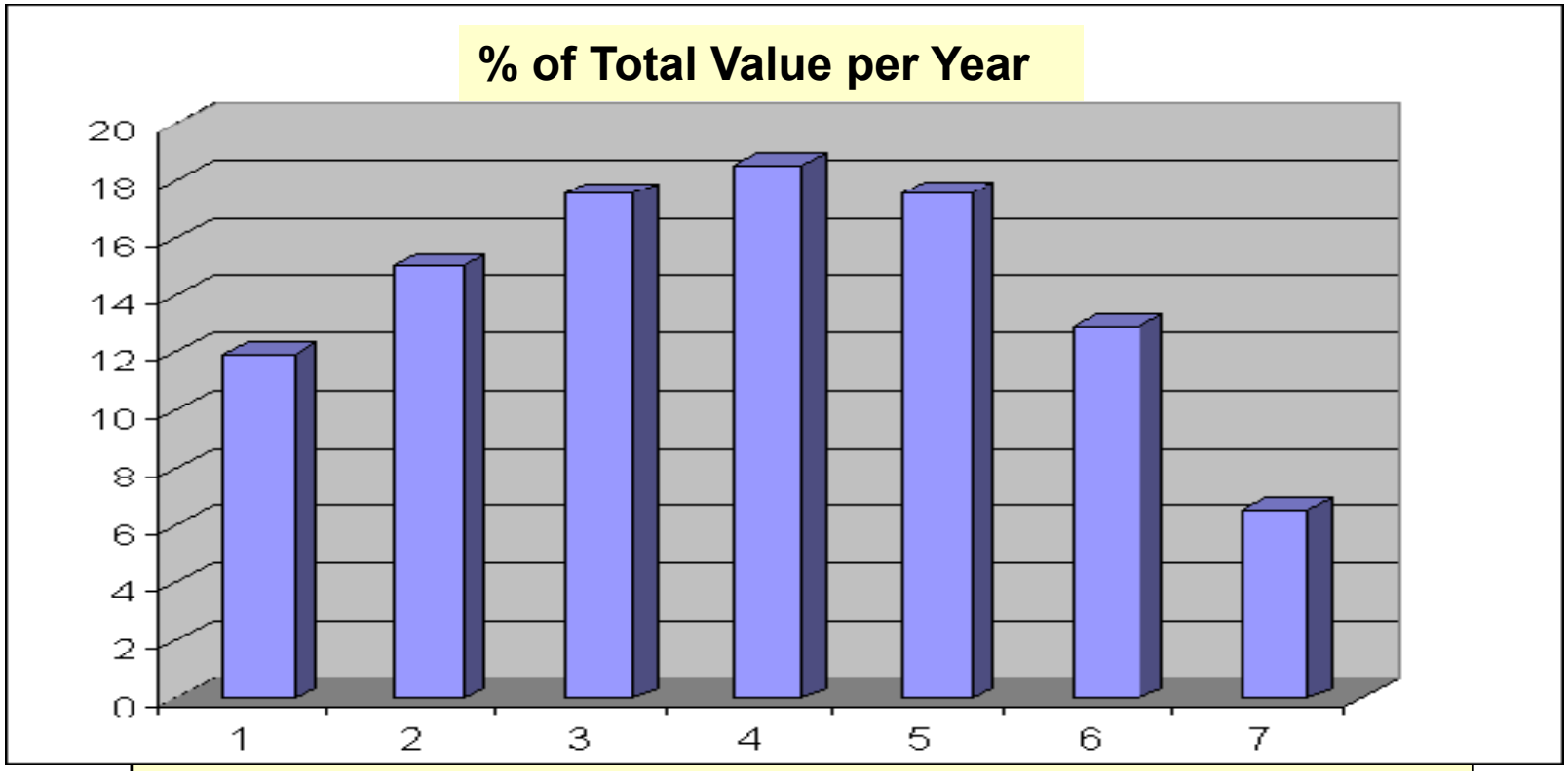
- **Supporting R&D Program**
  - Organized around task forces to achieve milestones linked to EDR schedule
  - S0 task force - globally coordinated program to demonstrate gradient for EDR by 2009
  - S2 task force – RF unit test and string tests by construction
  - S3 task force – Electron Cloud tests to establish mitigation and verify one damping ring is sufficient.
- **Costing Tools**
  - Primivera and other costing tools will be implemented
  - An earned value system will be employed during EDR

E-Document Systems at ILC

- Recommendations from EDMS committee have been implemented (job completed --- THANKS!!!)
- Status: ILC Agenda and ILC Doc in operation, ILC EDMS launched at this workshop, tools for common access to be added subsequently



Value Funding Profile



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

Other Pieces of the Puzzle

- **Detector Roadmap**
  - Proposals to appoint Research Director; ILCSC Advisory Committee and convergence to develop two detector EDRs on comparable time scale
- **Engage the Funding Agencies**
  - Steps to international governance
- **Siting of the ILC**
  - Identify candidate sites and perform site studies
- **Establish Funding, Responsibilities & Schedule**

Making our Schedule a Reality

- **Build on Successes of GDE, RDR and DCR**
  - **Be ready with solid funding proposal when exciting results begin to emerge from LHC**
- **Gain Support of the broad Scientific Community**
  - **We need pro-active scientific outreach.**
- **Gain Political and Public Support**
  - **We need active outreach from our community**
- **The ILC is a great scientific project being developed by a unique global effort. It is up to us to sell it!!**