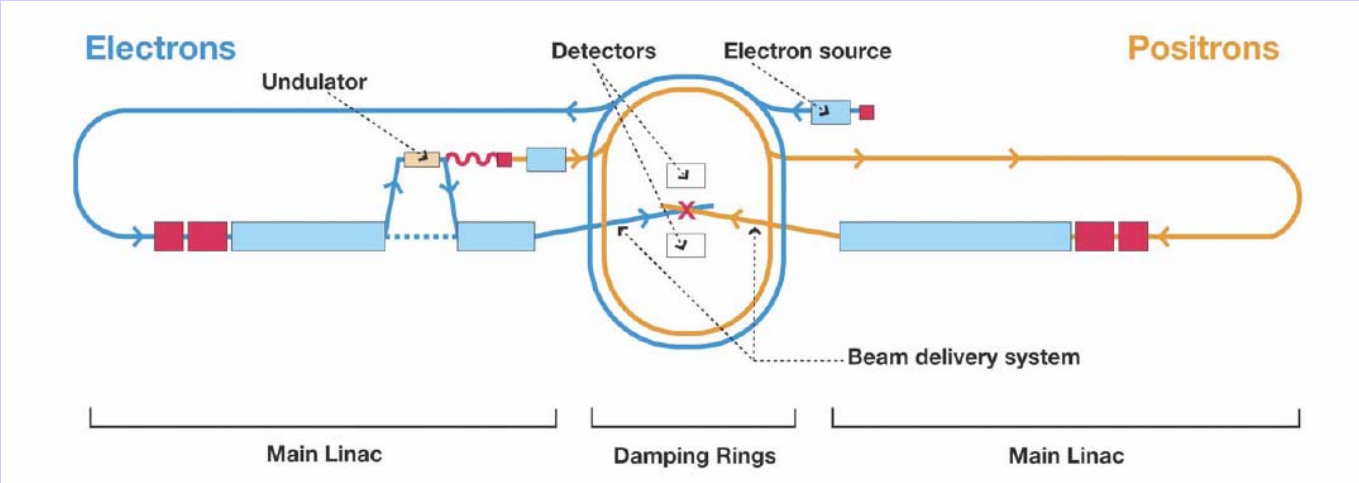
International Linear Collider



Barry Barish
Global Design Effort
1-May-07

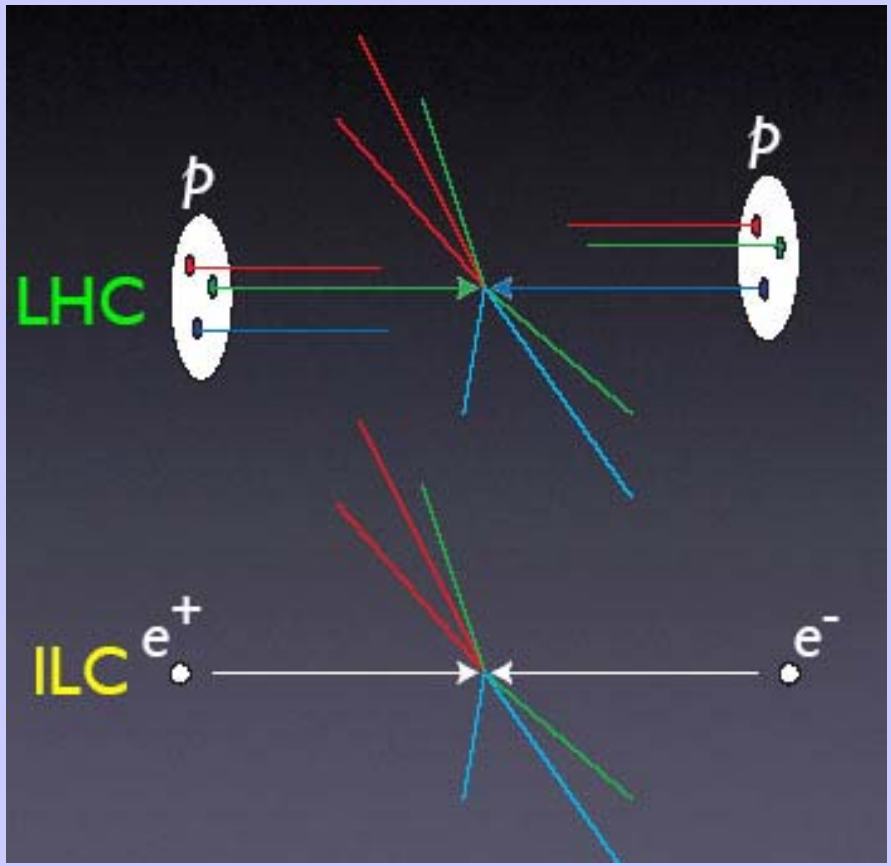
Particle Physics
Inquiry Based Science

1. **Are there undiscovered principles of nature:**
   New symmetries, new physical laws?
2. **How can we solve the mystery of dark energy?**
3. **Are there extra dimensions of space?**
4. **Do all the forces become one?**
5. **Why are there so many kinds of particles?**
6. **What is dark matter?**
   How can we make it in the laboratory?
7. **What are neutrinos telling us?**
8. **How did the universe come to be?**
9. **What happened to the antimatter?**

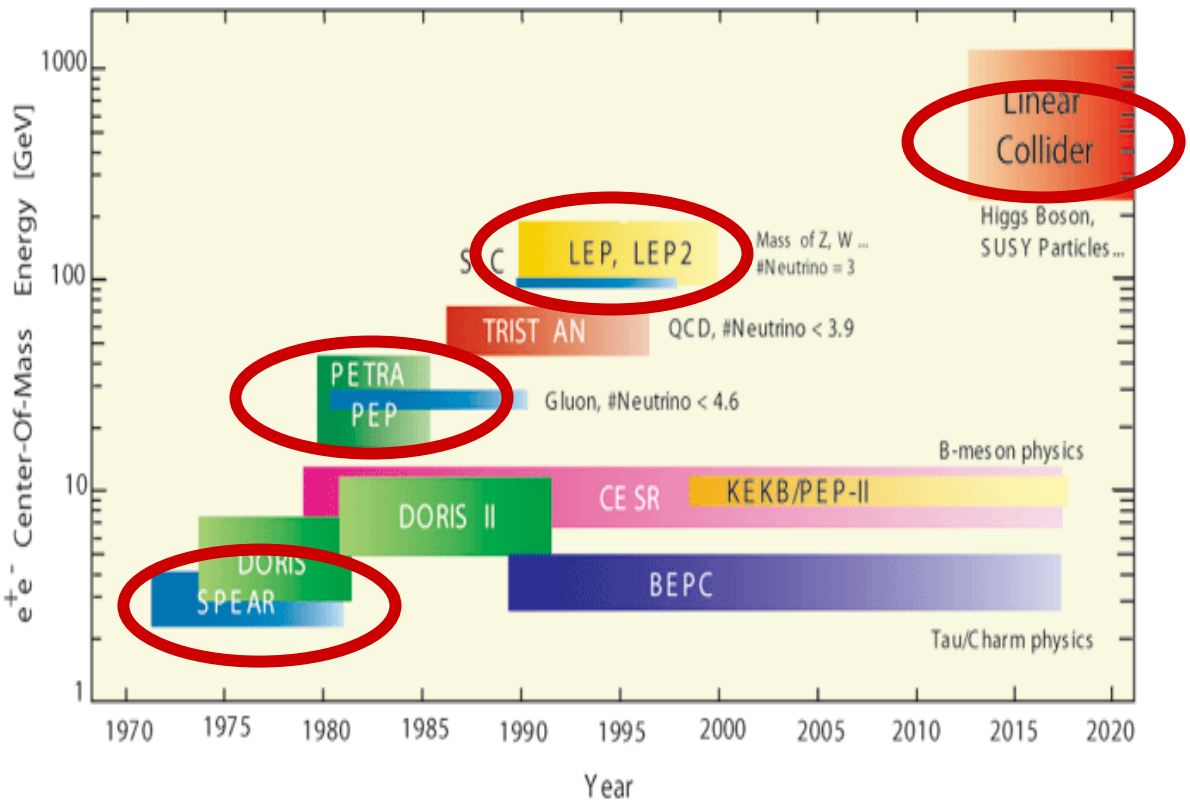
from the Quantum Universe

Why e^+e^- Collisions ?

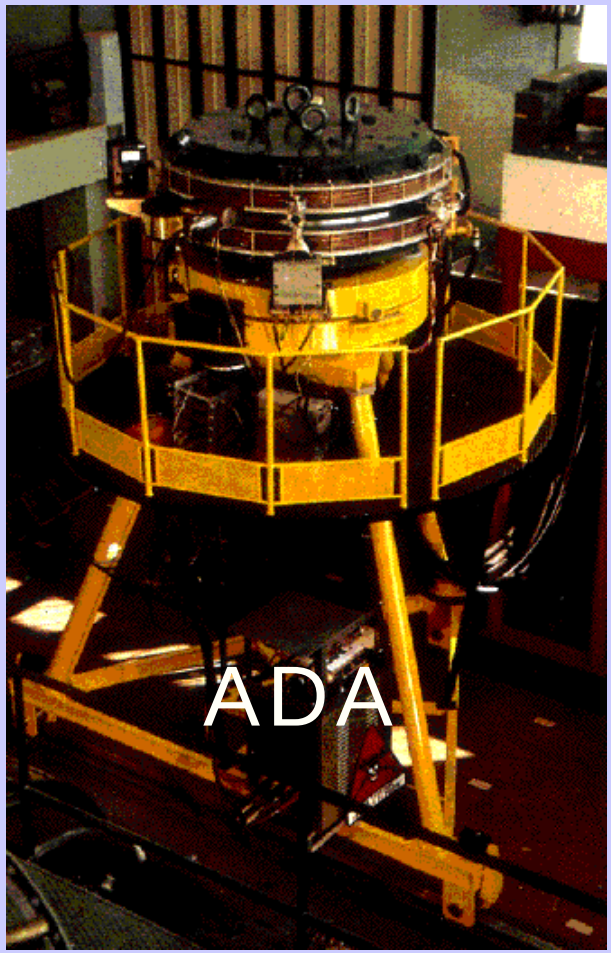
- elementary particles
- well-defined
  - energy,
  - angular momentum
- uses full COM energy
- produces particles democratically
- can mostly fully reconstruct events



Electron Positron Colliders
The Energy Frontier



Electron-Positron Colliders

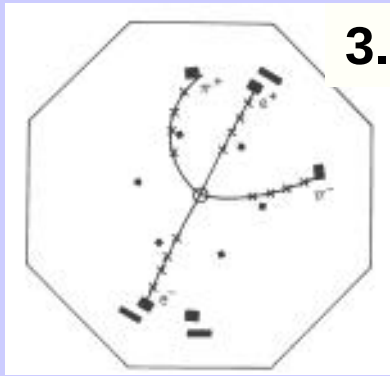


Bruno Touschek built the first successful electron-positron collider at Frascati, Italy (1960)

Eventually, went up to 3 GeV

But, not quite high enough energy ....

SPEAR at SLAC

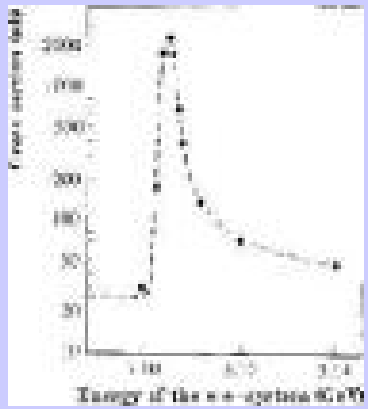


3.1 GeV

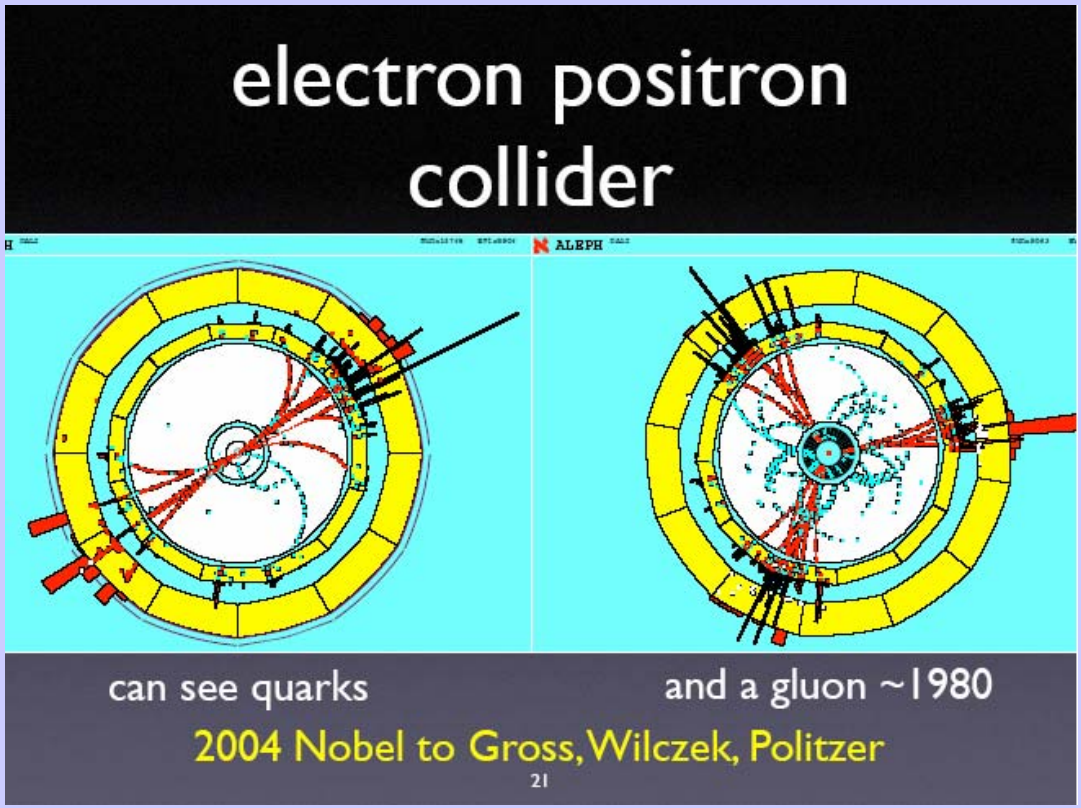
Burt Richter
Nobel Prize

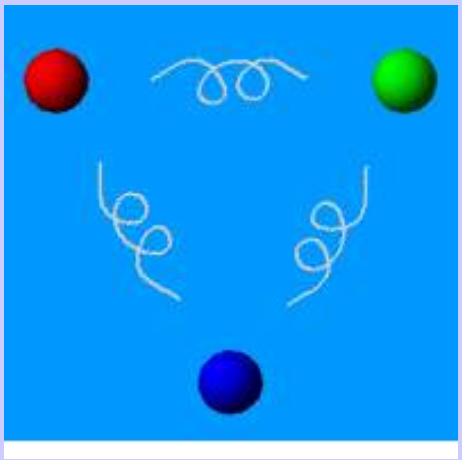
and

Discovery Of Charm Particles



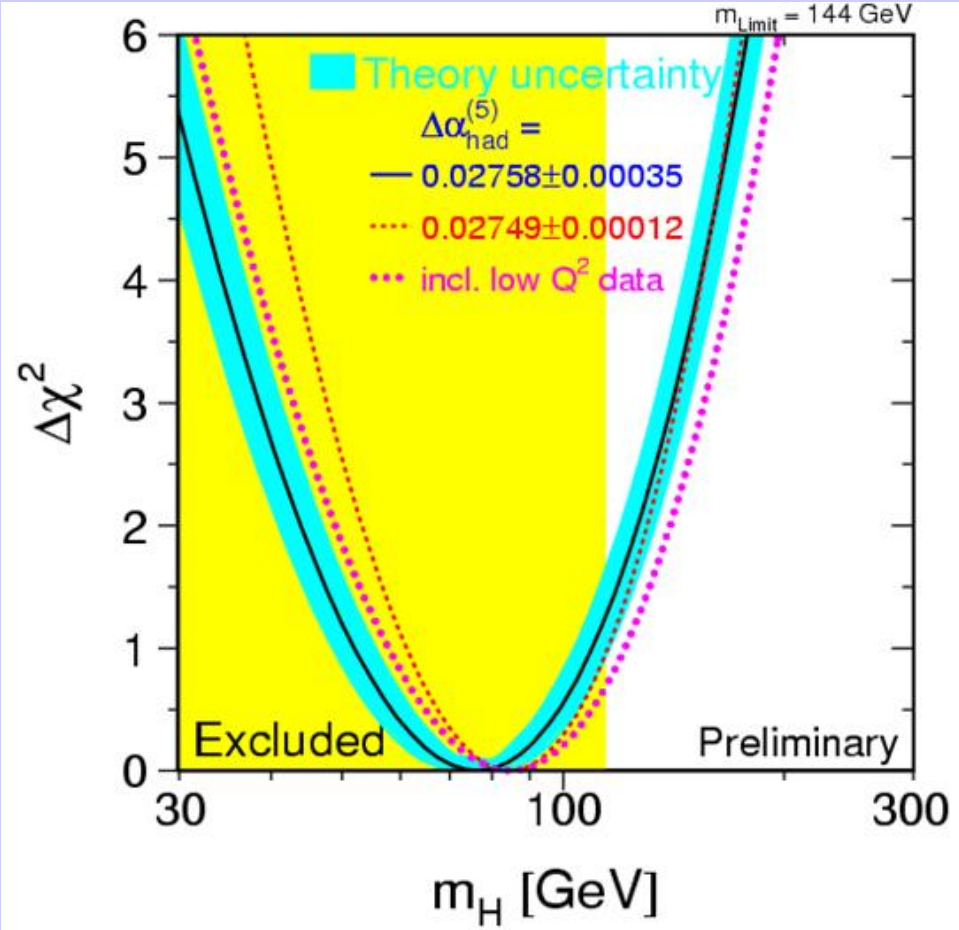
The rich history for e^+e^- continued as higher energies were achieved …





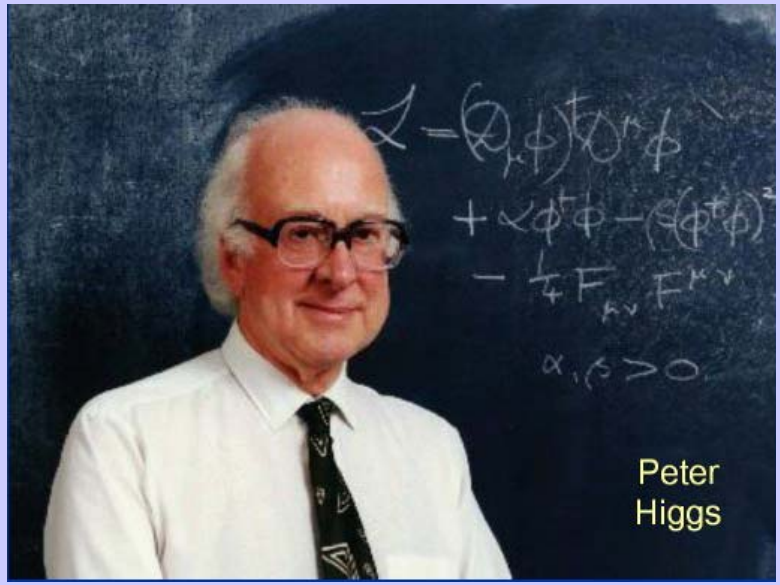
DESY PETRA Collider

Precision Measurements at LEP



What causes mass??

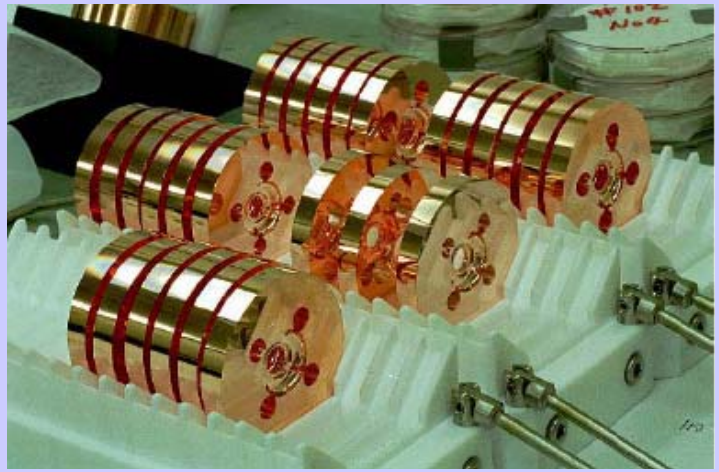
The mechanism – Higgs or alternative appears around the corner



ILC – The Underlying Technology

- **Room temperature copper structures**

  (KEK & SLAC)



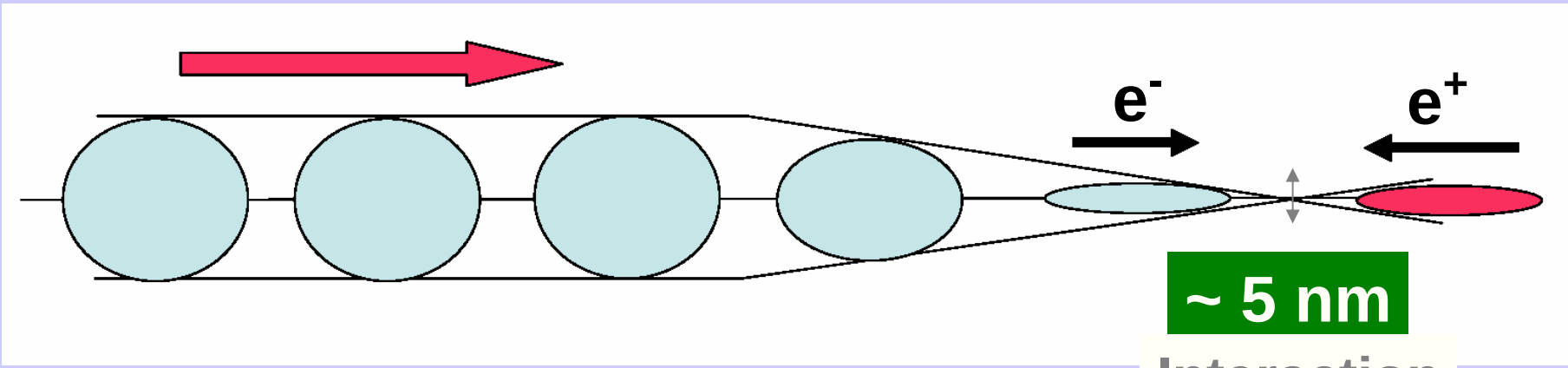
OR

- **Superconducting RF cavities**

  (DESY)

Achieving High Luminosity

- **Low emittance machine optics**
- **Contain emittance growth**
- **Squeeze the beam as small as possible**



Global Effort on Design / R&D for ILC

<u>Joint</u> Design, Implementation, Operations, Management
Host Country Provides Conventional Facilities

The Role of ICFA

ICFA, the International Committee for Future Accelerators, was created to facilitate international collaboration in the construction and use of accelerators for high energy physics. It was created in 1976 by the International Union of Pure and Applied Physics.

Its purpose, as stated in 1985, are as follows:

- **To promote international collaboration in all phases of the construction and exploitation of very high energy accelerators**
- **To organize regularly world-inclusive meetings for the exchange of information on future plans for regional facilities and for the formulation of advice on joint studies and uses**
- **To organize workshops for the study of problems related to super high-energy accelerator complexes and their international exploitation and to foster research and development of necessary technology**

Global Planning
A Must for HEP

- **Never before has a field of science attempted to globalize itself as extensively as HEP has done recently. It is a challenging task, but one that must be accomplished. *Indeed the long-term health of the field depends critically on truly global cooperation***

- **The necessity for global coordination was formalized by ICFA in its May 1993 ICFA Statement entitled "International Collaboration in the Construction of Future Large Accelerator Projects".**

- **ICFA's role was crucial for the ultimate realization of a *global* LHC and is crucial for launching the ILC**

International Technology Review Panel

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

The ITRP Recommendation

- **We recommend that the linear collider be based on superconducting rf technology**

  - **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).**

SCRF Technology Recommendation

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

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

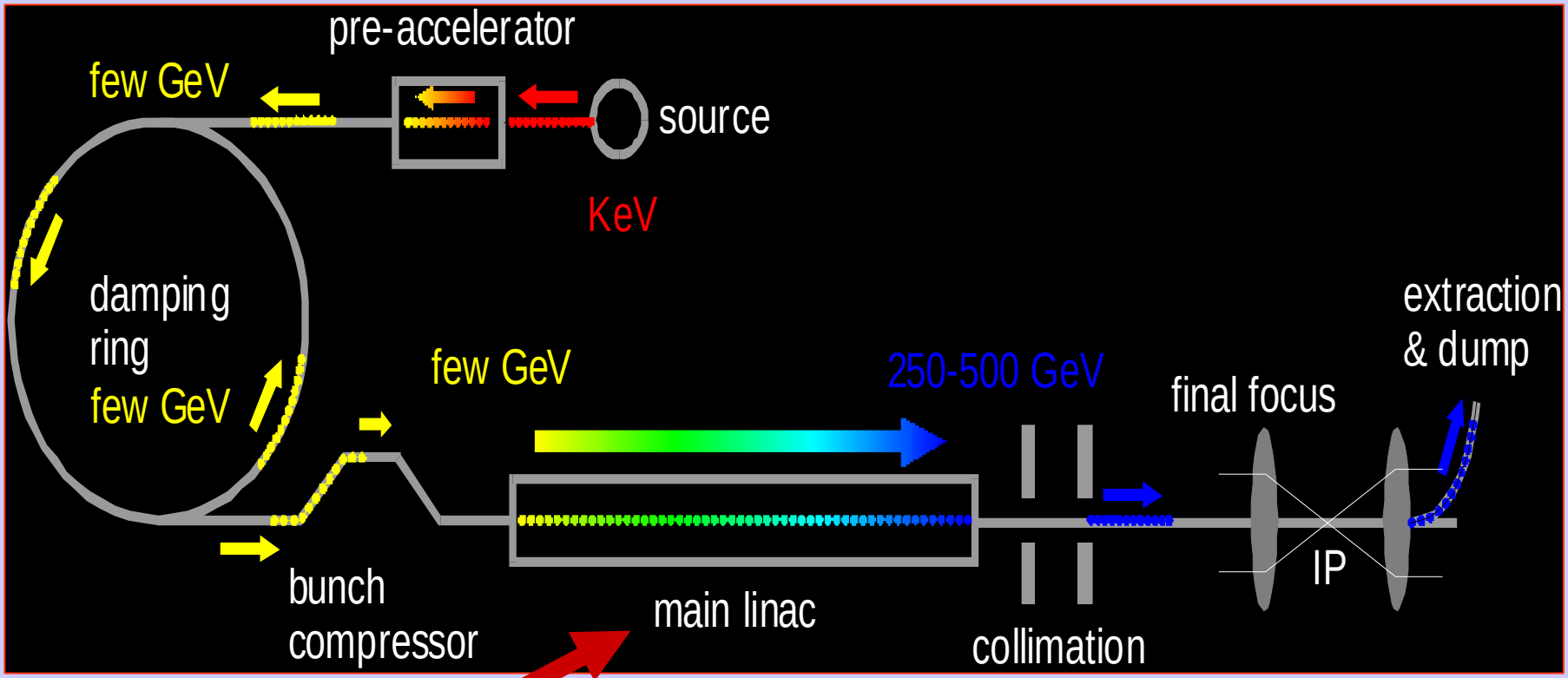
ICFA (2002): ILC Organizational Structure

The Role of Governments

- **Governments are the key – they will make the decisions that lead to the establishment of an ILC project**

- **The scientific community, through ICFA, are maintaining close contact with the key government agencies**
  - **The main forum is the Funding Agencies for Large Colliders (FALC), which meets about twice a year. Major strategy steps (like ITRP, GDE etc) are discussed with FALC to ensure acceptance by the governments of ICFA's actions**

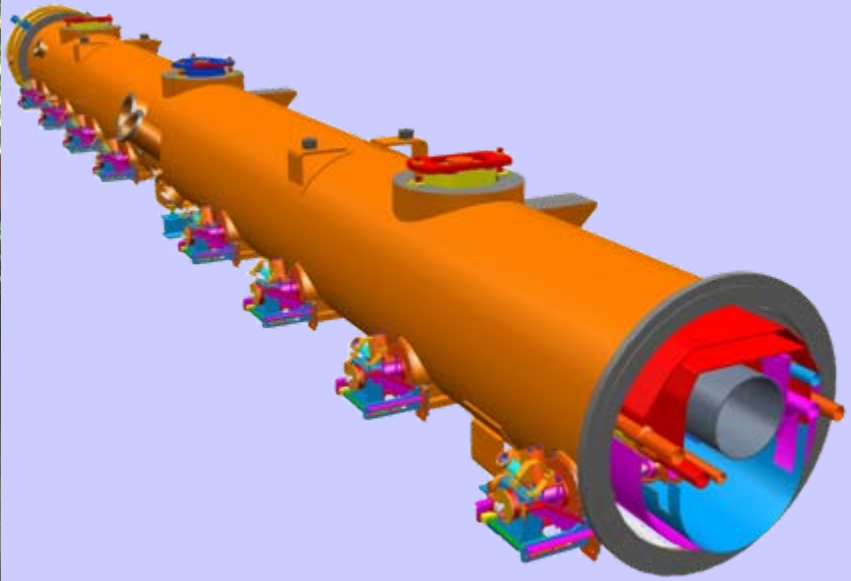
Designing a Linear Collider



Superconducting RF Main Linac

Cryomodules

TESLA cryomodule



4th generation prototype ILC cryomodule

The Main Linac

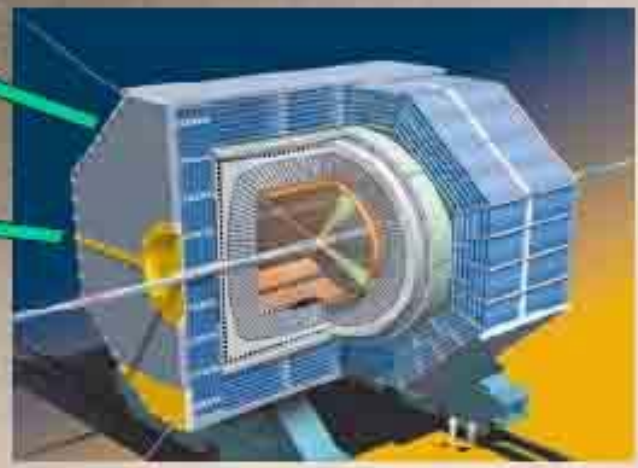
Subdivision	Length (m)	Number
Cavities (9 cells + ends)	1.326	14,560
Cryomodule (9 cavities or 8 cavities + quad)	12.652	1,680
RF unit (3 cryomodules)	37.956	560
Cryo-string of 4 RF units (3 RF units)	154.3 (116.4)	71 (6)
Cryogenic unit with 10 to 16 strings	1,546 to 2,472	10
Electron (positron) linac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

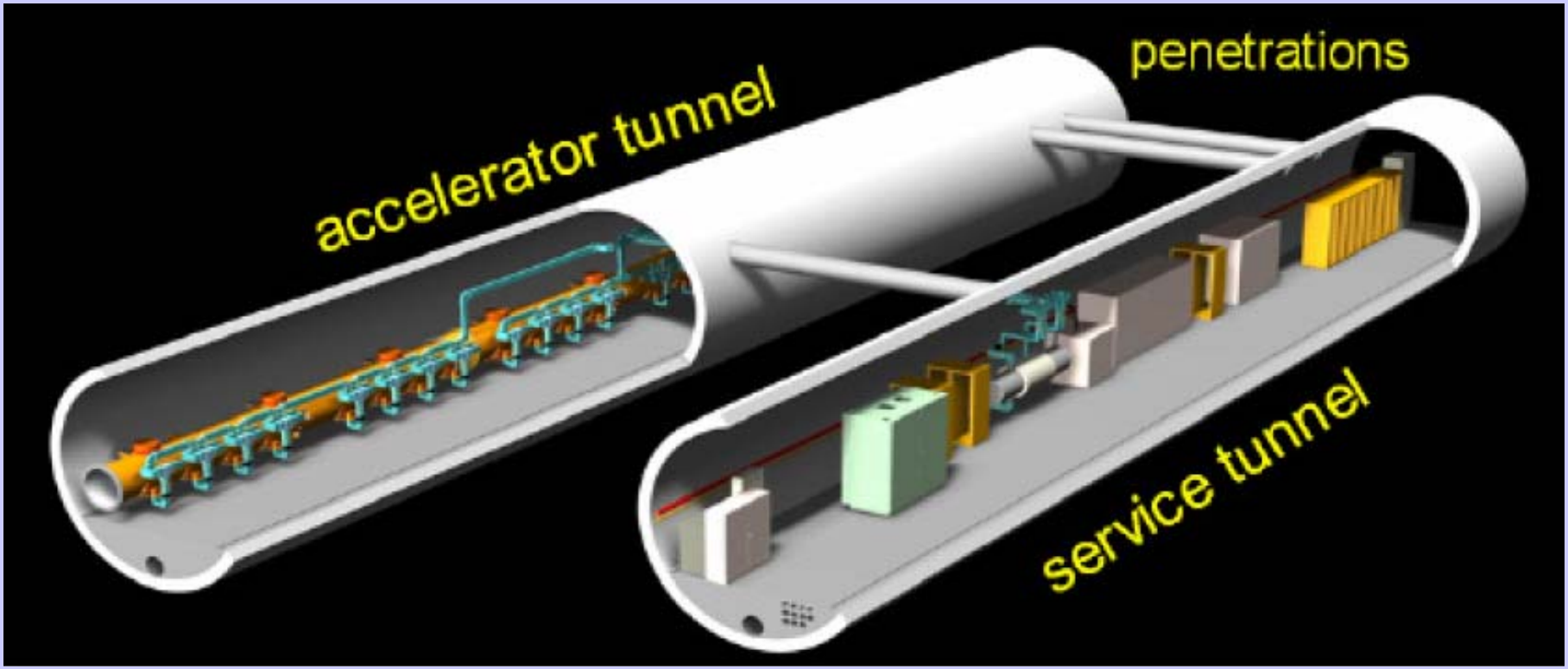


~30 km long tunnel

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 $\geq$ 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

The GDE Plan and Schedule