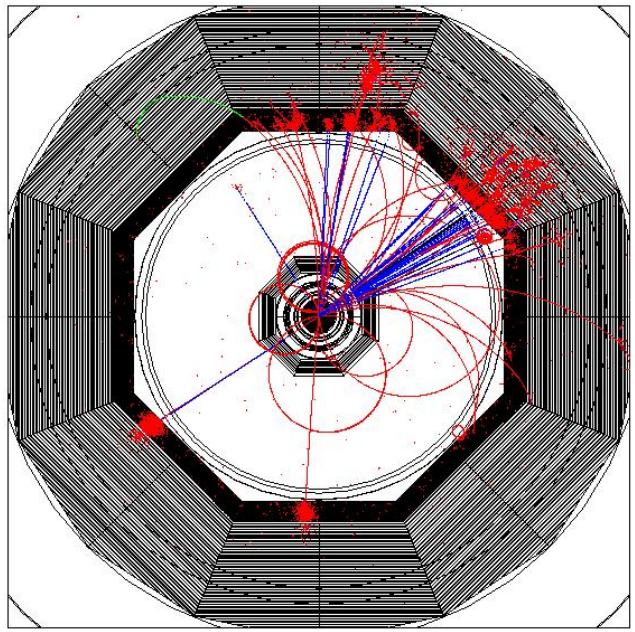
Global Science Projects
Accelerator Based Particle Physics

- Past
- Future
- Challenges



Albrecht Wagner
DESY and Hamburg University

HERA

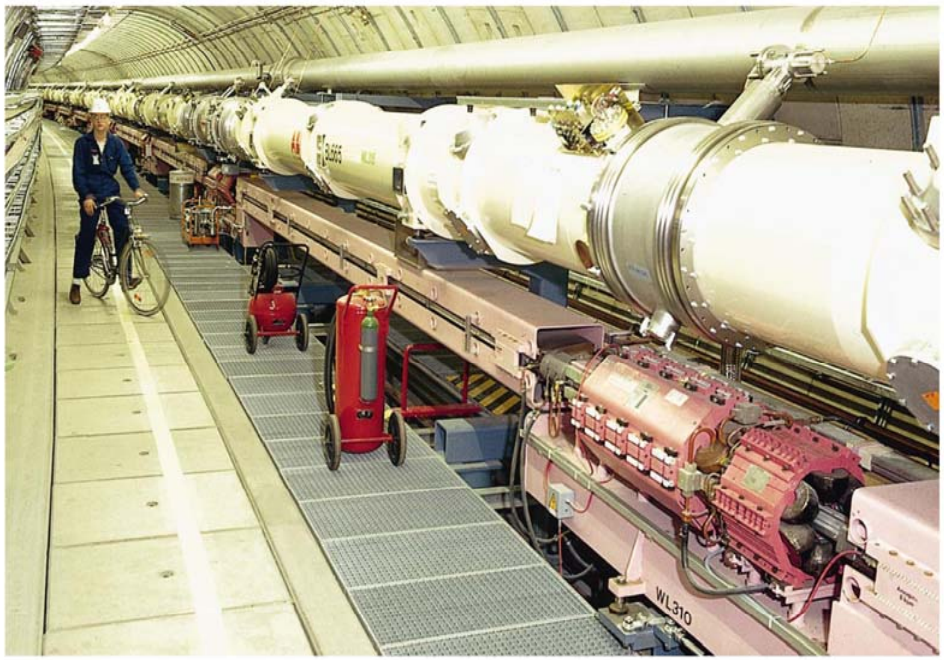
Accelerator was built with help (manpower) and contributions (hardware) of Italy, France, Poland, China

Operation is paid by Germany

Became known as ‚HERA model'

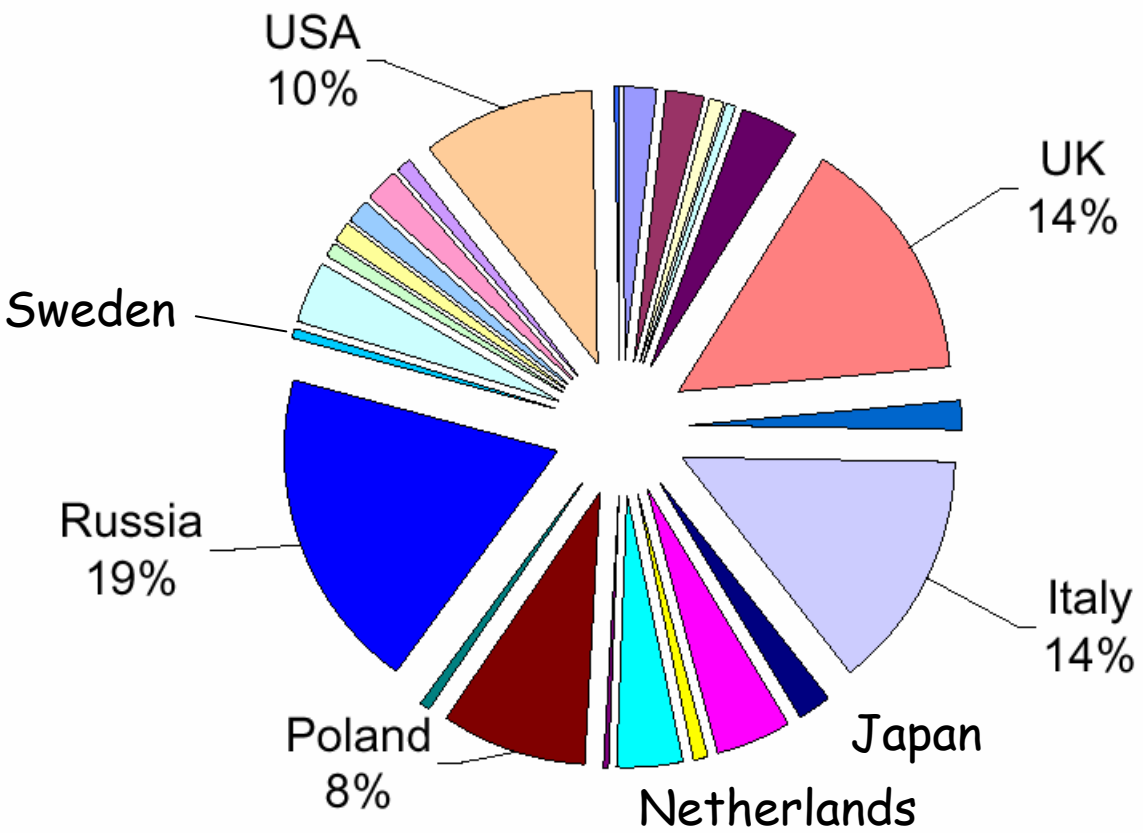
Experiments were build by large international collaboration

Operation cost are shared



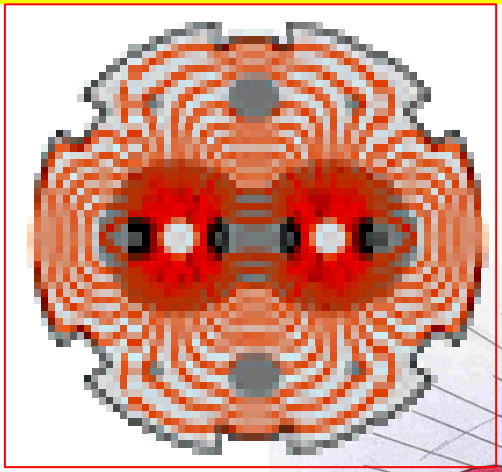
International use of HERA

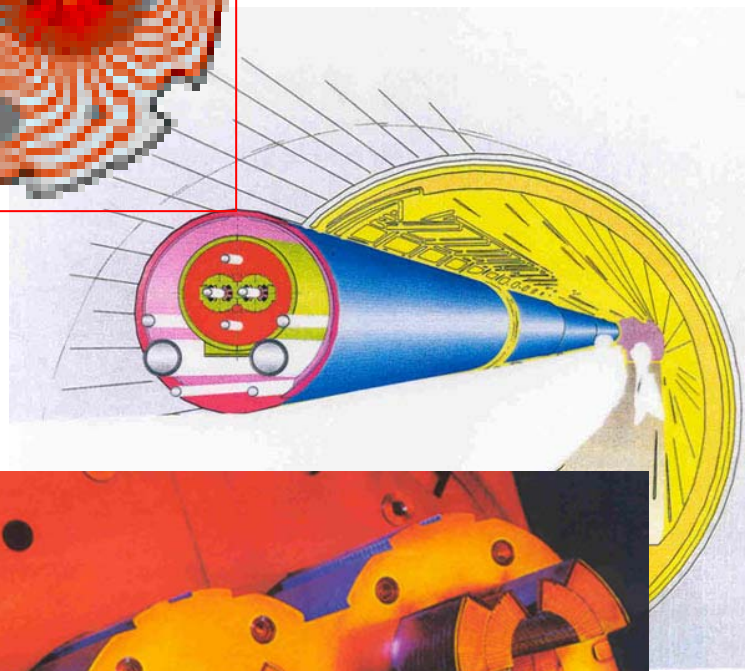
Particle physics experiments at DESY
711 scientists from abroad

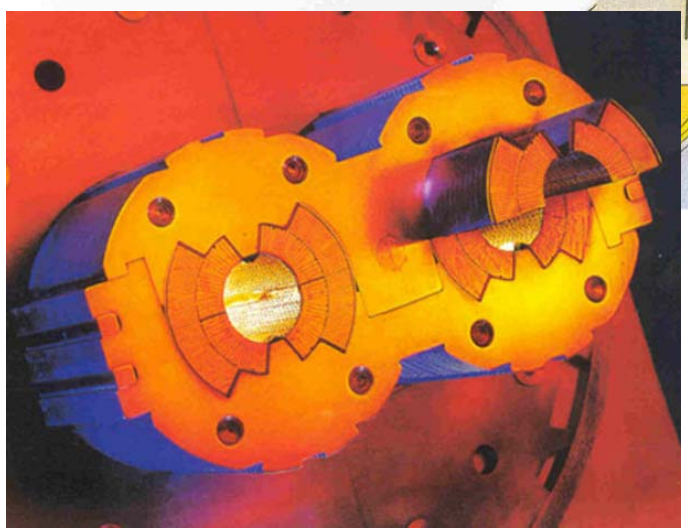


- Armenia
- Belgium
- China
- Danmark
- France
- UK
- Israel
- Italy
- Japan
- Canada
- Korea
- Netherlands
- Norway
- Poland
- Portugal
- Russia
- Sweden
- Switzerland
- Slovakia
- Slovenia
- Spain
- Czech Republic
- Ukraine
- USA
- White Russia

The Large Hadron Collider







proton-proton collider, under construction in the LEP tunnel

(27 km circumference)

first luminosity in 2007

Accelerator and experiments built with substantial international contributions, well beyond CERN member states

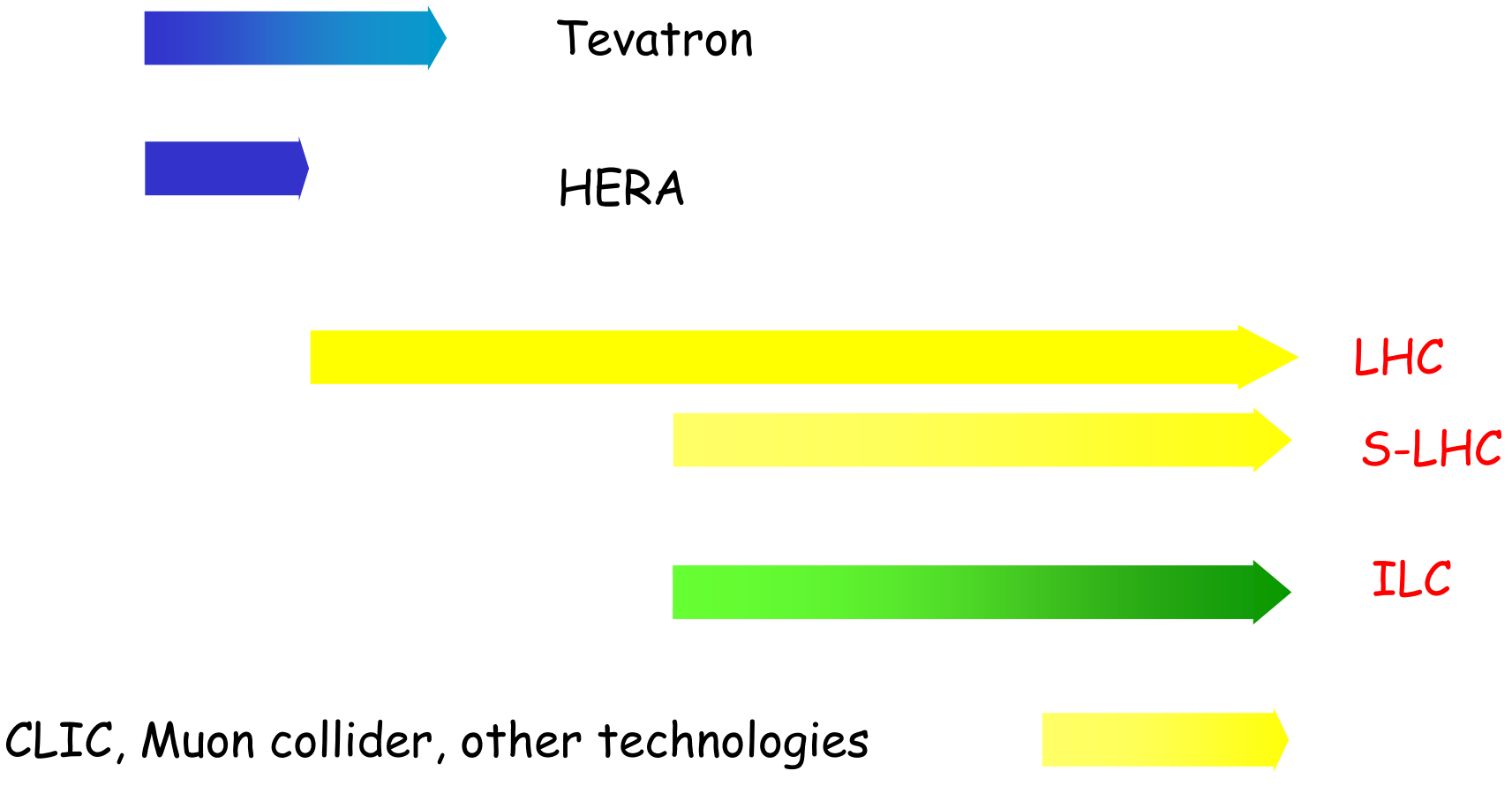
CERN as host is an international organisation

The International Linear Collider

- Many reasons speak for a truly global project:
  - Necessary funding
  - Scientific challenges
  - Political climate concerning basic research
  - Big time gaps between new projects

- Many steps have been taken in this direction:
  - Scientific consensus
  - Technology choice
  - World-wide organisation of accelerator work
  - World-wide organisation of detector work
  - OECD
  - Funding agencies

A Road Map for the Energy Frontier



The Scientific Case for a LC

Understanding Matter, Energy, Space and Time :
The Case for the e^+e^- Linear Collider

A world-wide consensus has formed for a baseline LC project in which *positrons* collide with *electrons* at energies up to 500 GeV, with *luminosity* above 10^{34} $cm^{-2}s^{-1}$.

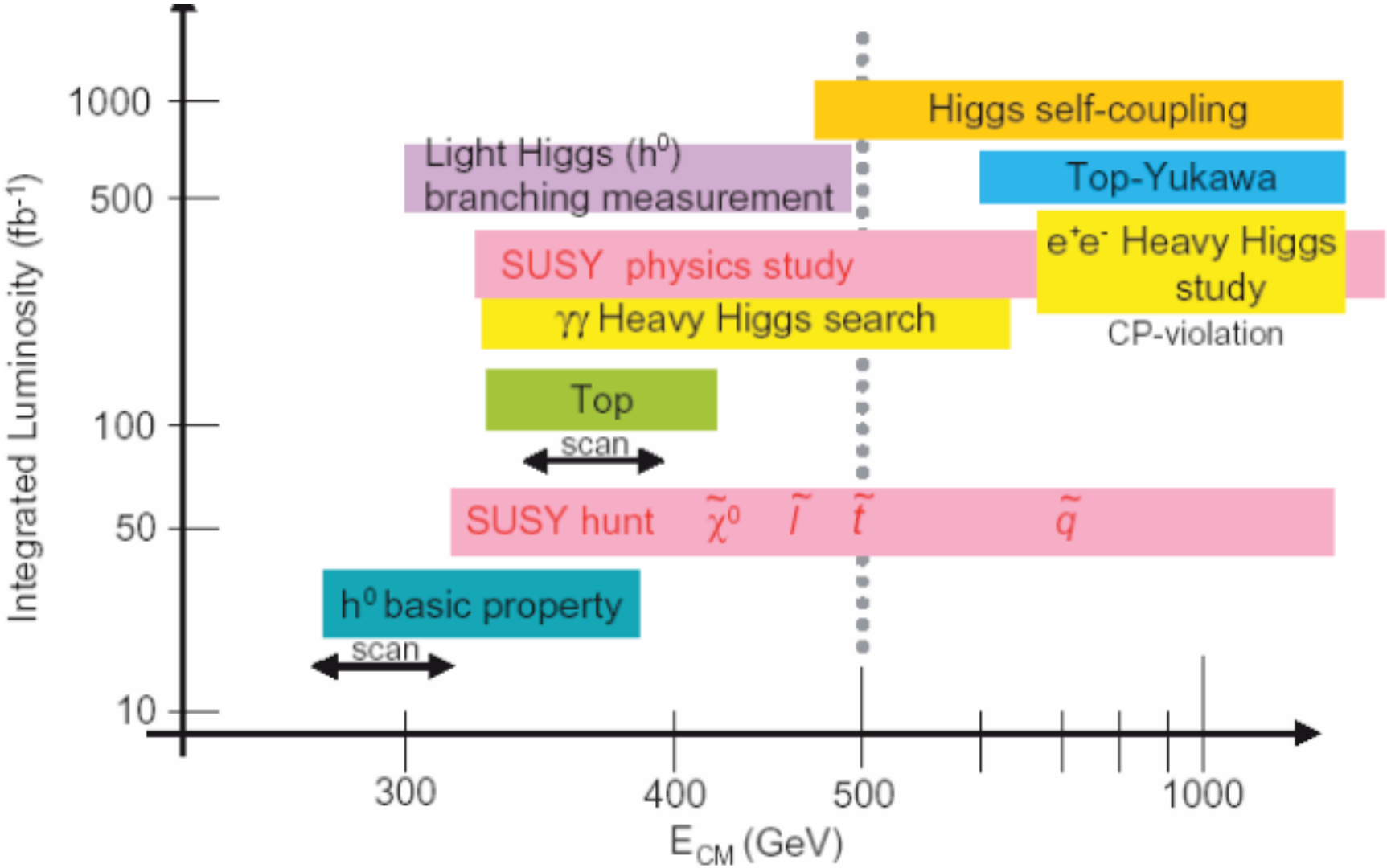
The energy should be upgradable to about 1 TeV.

Above this firm baseline, several options are envisioned whose priority will depend upon the nature of the discoveries made at the LHC and in the initial LC operation.

The consensus document has been signed by > 2700 scientists from all around the world.

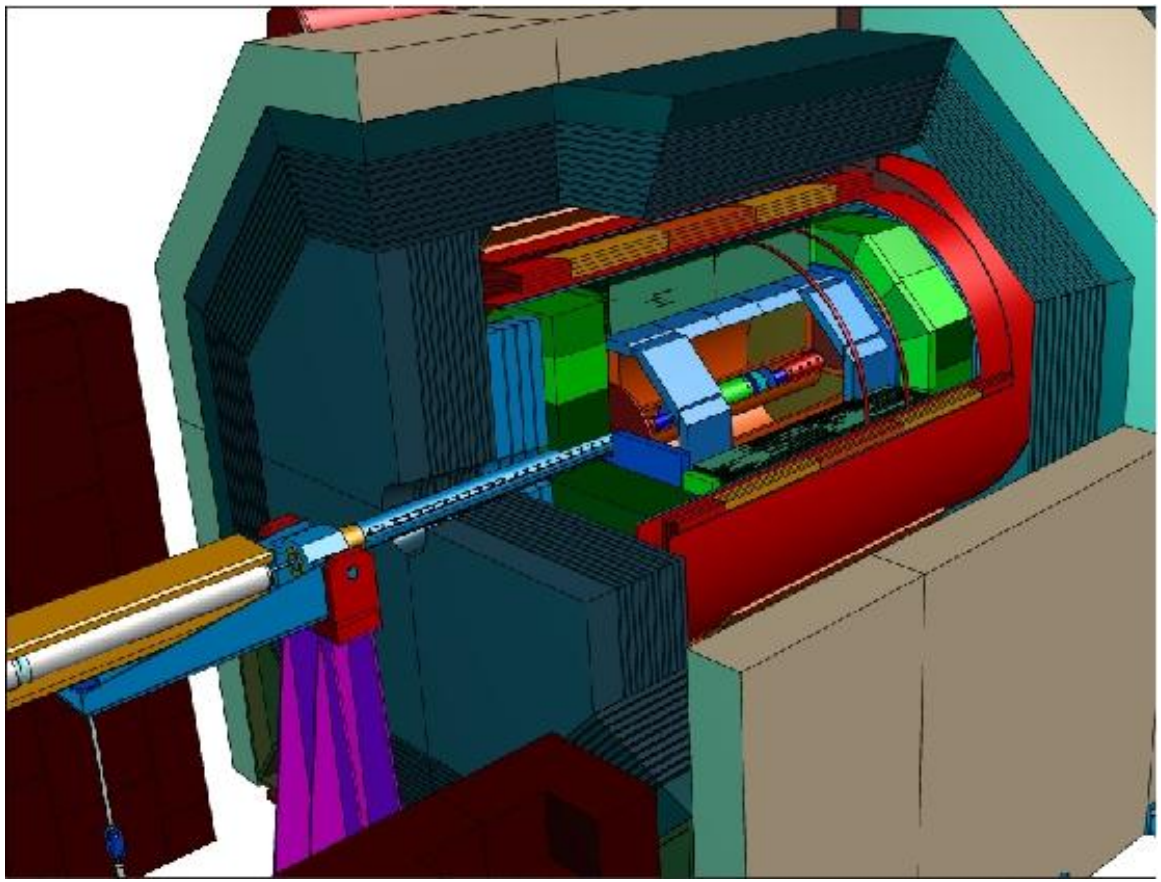
Substantial overlap in running with LHC recommended

ILC Physics Reach



Albrecht Wagner, Aspen 0205

Detector



physics case studied with realistic assumptions for a LC detector

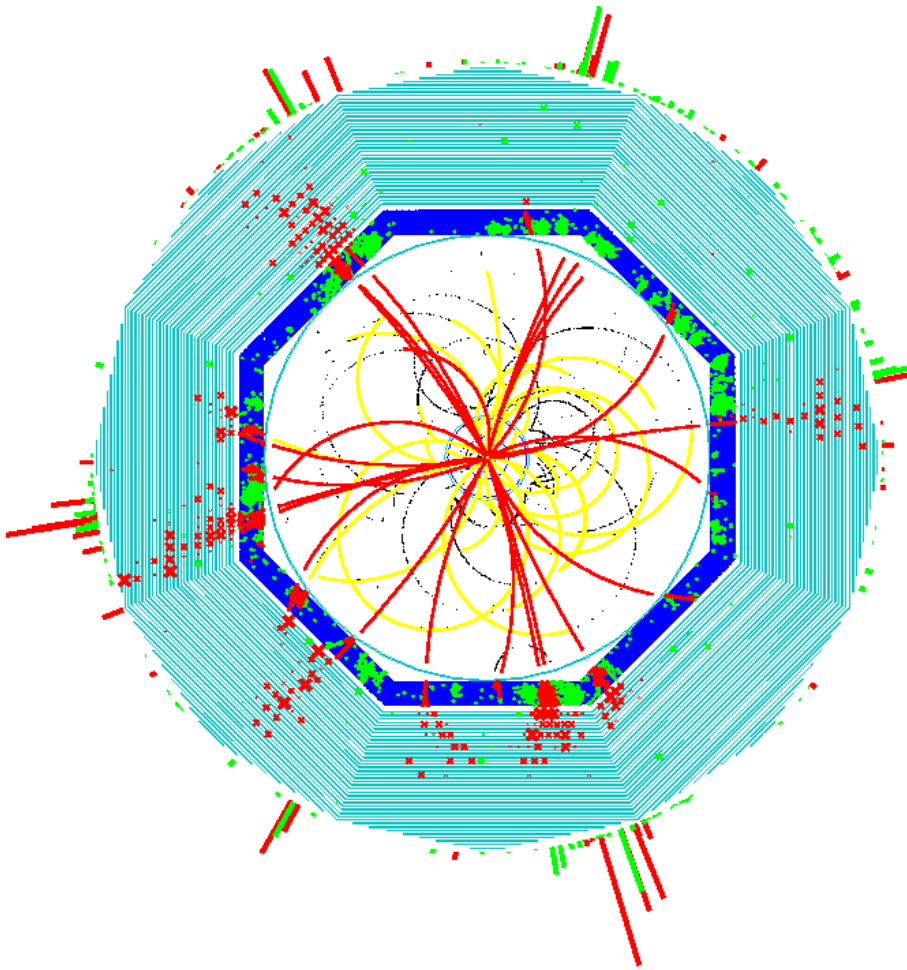
detector design is challenging!

high statistical power of LC has to be met by high detector resolution (limit systematics)

⇨ a "standard" LEP detector will not be sufficient!

World-wide studies are taking place, three detector concepts are emerging

LC Detector R&D



High precision measurements demand fundamentally new approach to the reconstruction:

- particle flow
  (i.e. reconstruction of ALL individual particles)

requires

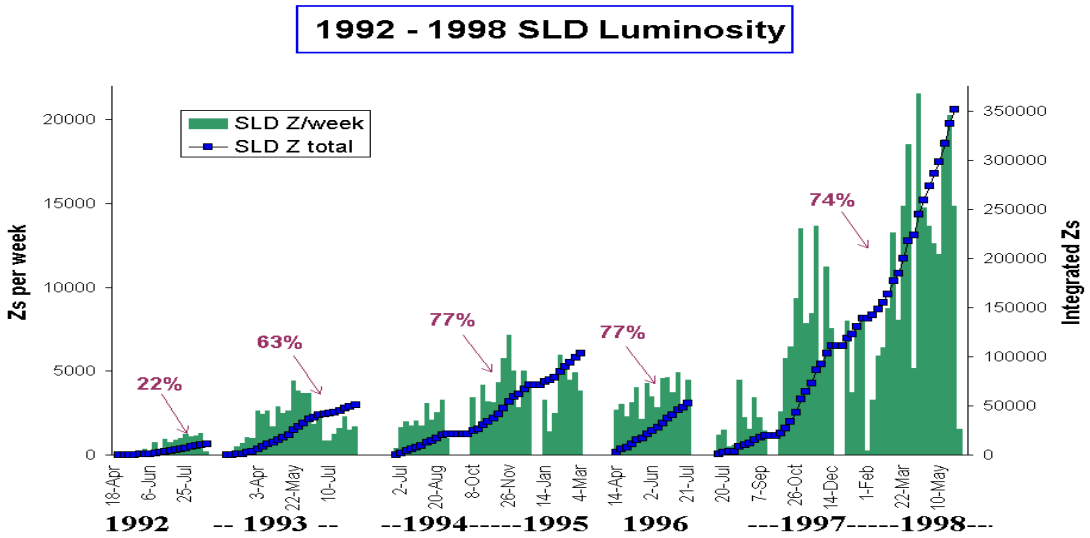
- unprecedented granularity

in three dimensions

R&D needed for key components

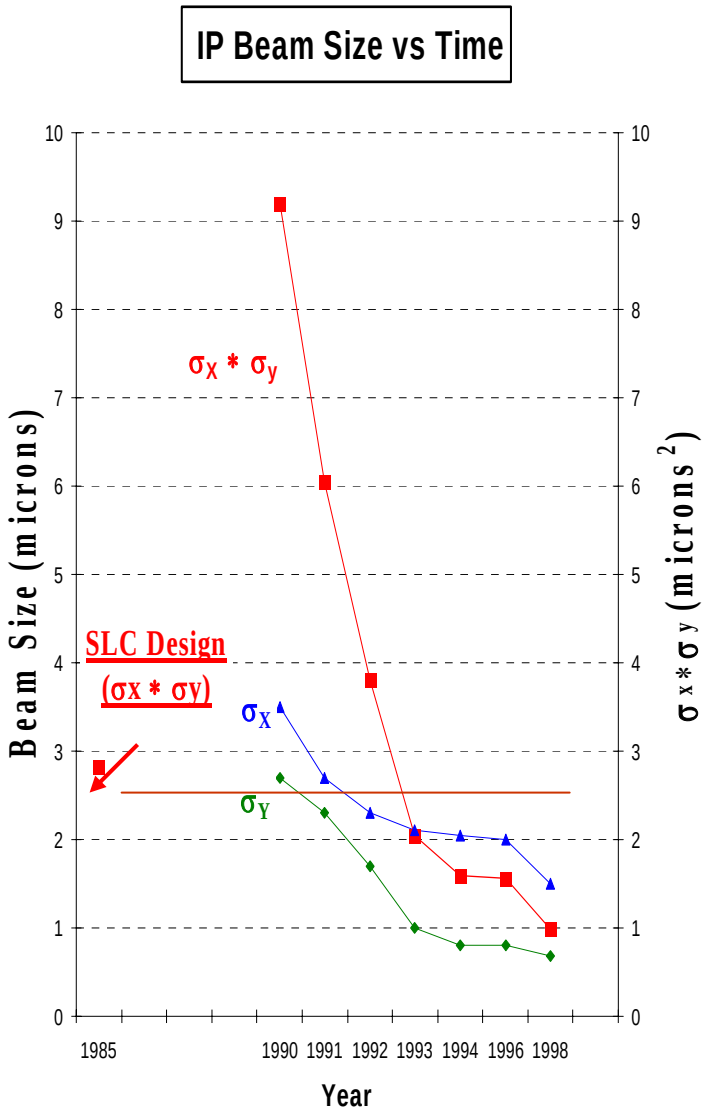
- vertex
- tracking
- calorimeter

Proof of principle: SLC



New Territory in Accelerator Design and Operation

- Sophisticated on-line modeling of non-linear physics.
- Techniques expanded from *trajectory* to *emittance* corrections, and from hands-on to fully automated control.



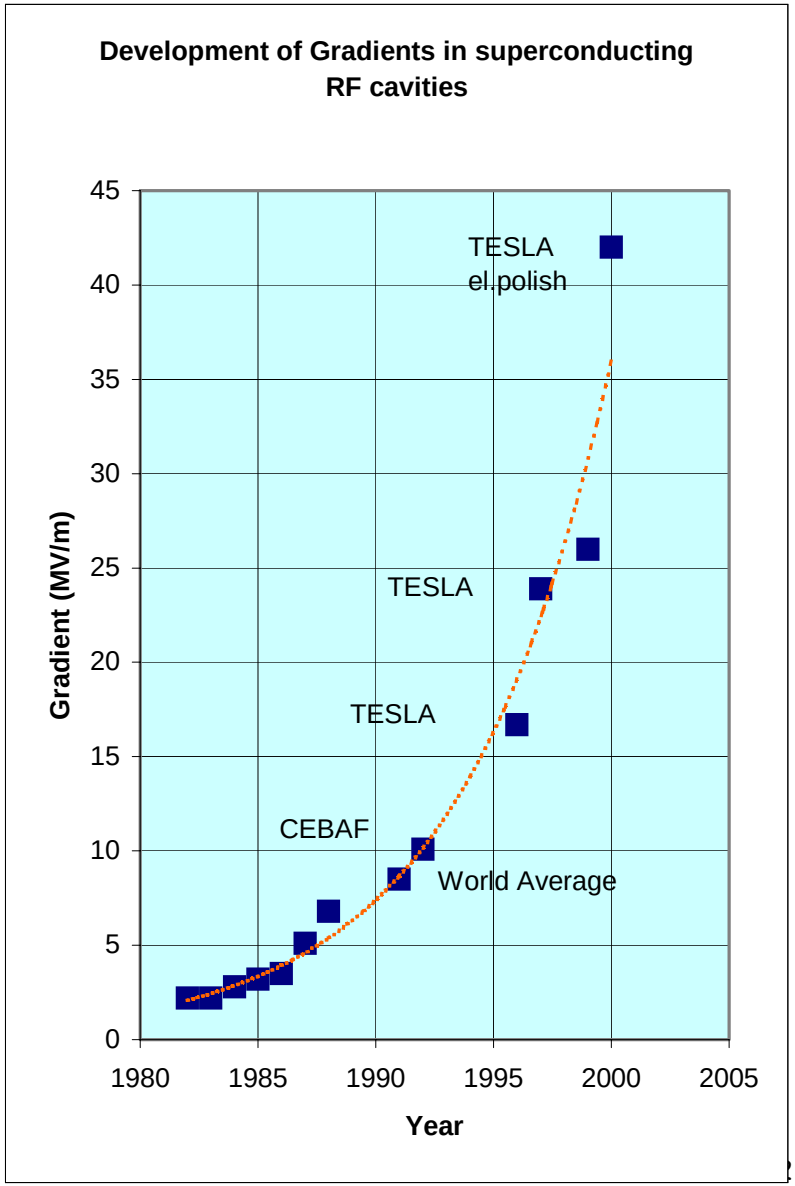
The Improvement of SC Cavities

SC RF structures for accelerators were developed in many countries

The TESLA collaboration, centred at DESY combined ~ all the world expertise in SC, thus leading to major progress:

>25-fold improvement in performance/cost in 10 years

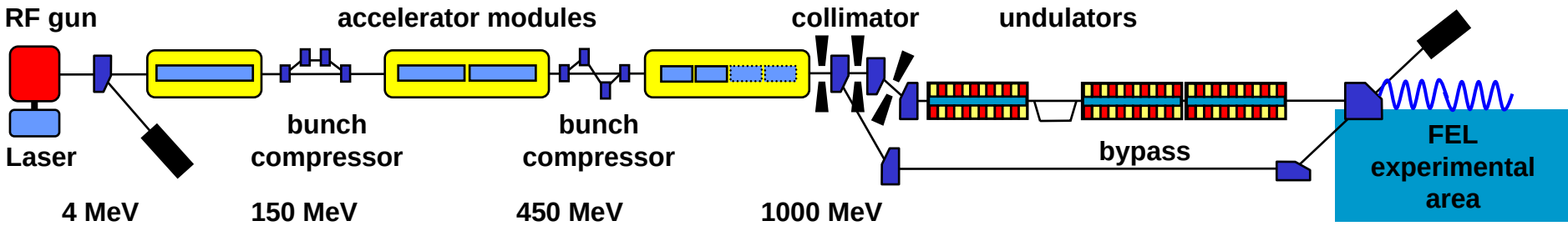
Major impact on next generation light sources (XFEL, ERL) , proton accelerators etc



The VUV-FEL as Prototype for the XFEL

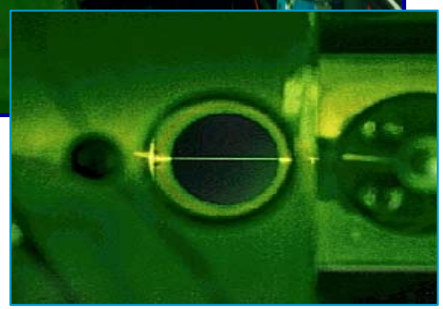
Built with substantial international contributions, in operation since 1996

Second stage (TTF2) just being commissioned

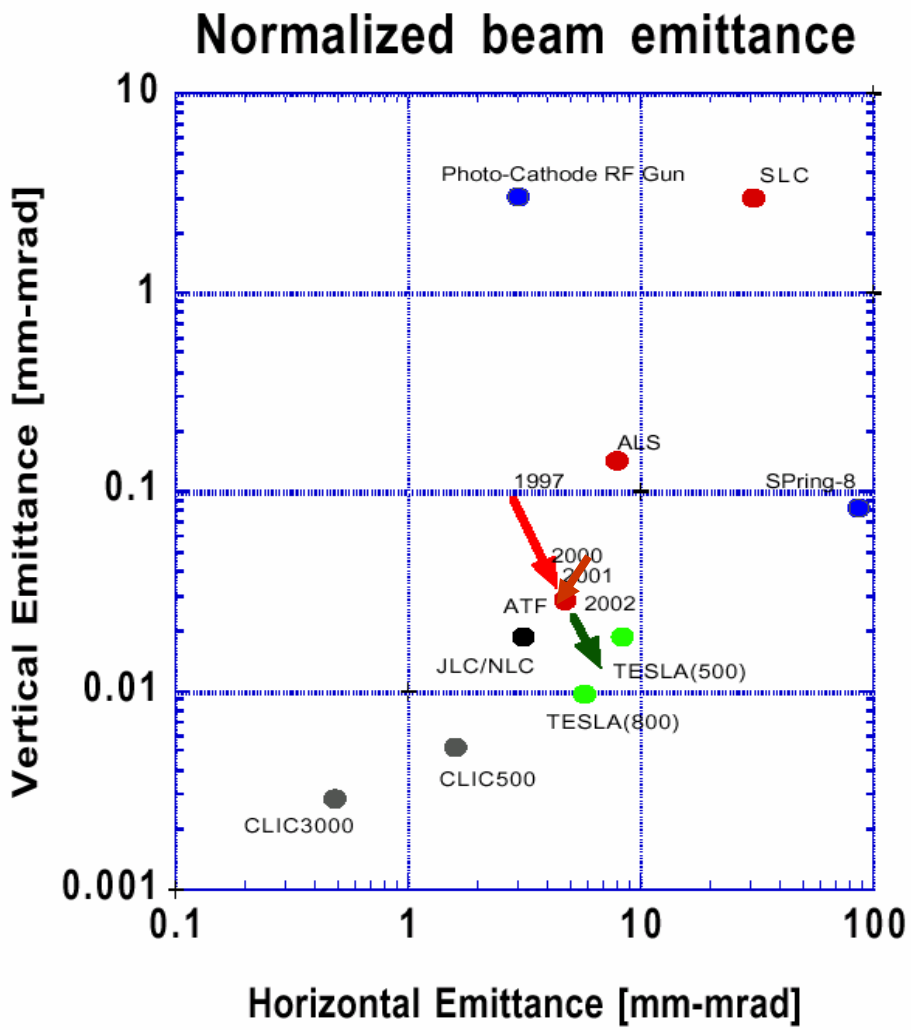


Damping Ring

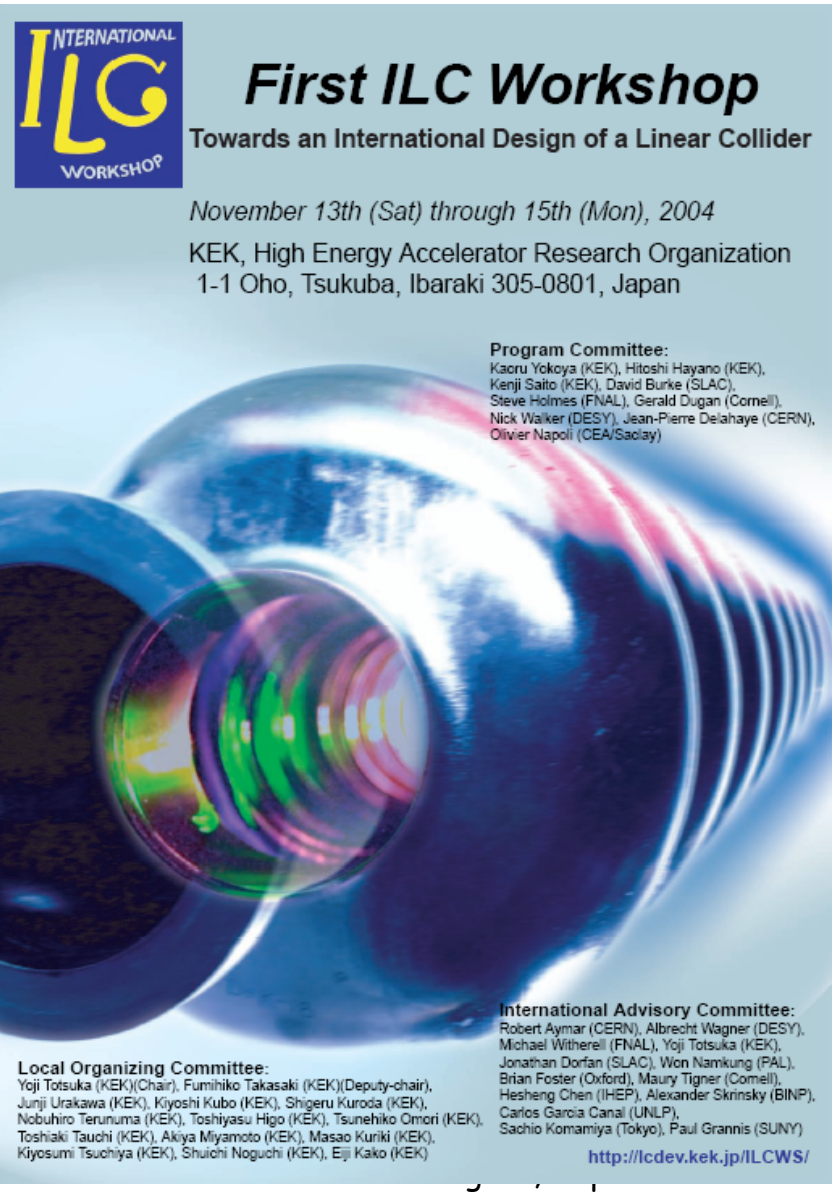
Low emittance



"Laser Wire"



Start of the Global Design Initiative



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

Result of 1. ILC Workshop

- A lot of enthusiasm, willingness to self-organise, and a strong sense of initiative
- Working Group structure was very effective
- Has helped to advance the global collaboration on well defined work packages
- One convener per region was important
- Many (not all) labs in regions have stated their interest in specific topics
- Homework as specified by workshop charge was done to various degrees of depth

- Convergence towards a common project

EU and the Global ILC Project

The European Union is thinking about a stronger role in research infrastructure

- The evaluators of the ILC design study EUROTeV emphasised the importance of the project
- EUROTeV plays the role of a focus and nucleus for the European part of the global activities which are just starting
- Europe must maintain its leading role in the SC RF technology
- Global projects represent a new challenge for European science coordination
- The ILC is one of the possible domains for the strategic road map

European Funding for ILC R&D

Structured and integrated European area in the field of accelerator research and related R&D.

3 Networking Activities and 4 Joint Research Activities.

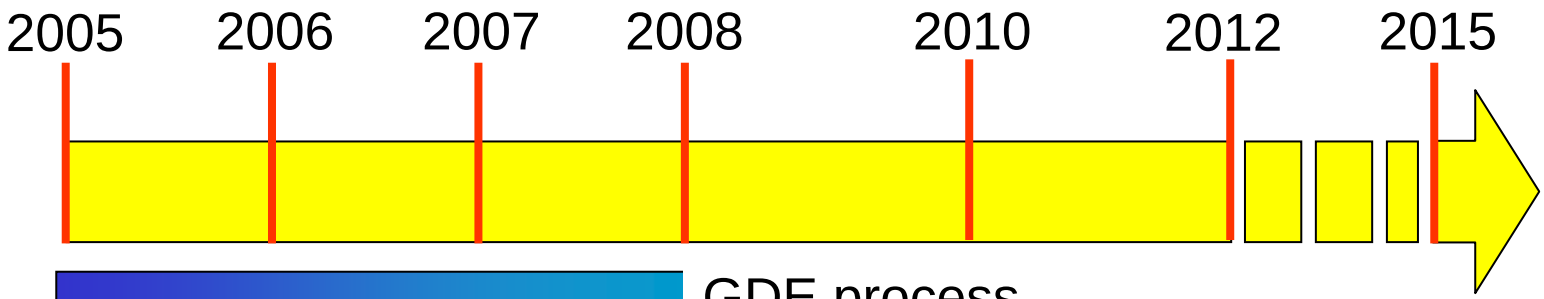
European Design Study

(27 institutions, including CERN and DESY)

With top marks (score: 4.8/5), EU funding: ~9 M€

Kick-off meeting 1.11.2004

Project Timelines



GDE process

CDR

TDR

construction

commissioning

physics

ILC

preparation

construction

operation

EURO XFEL

EUROTeV

CARE

UK LC-ABD

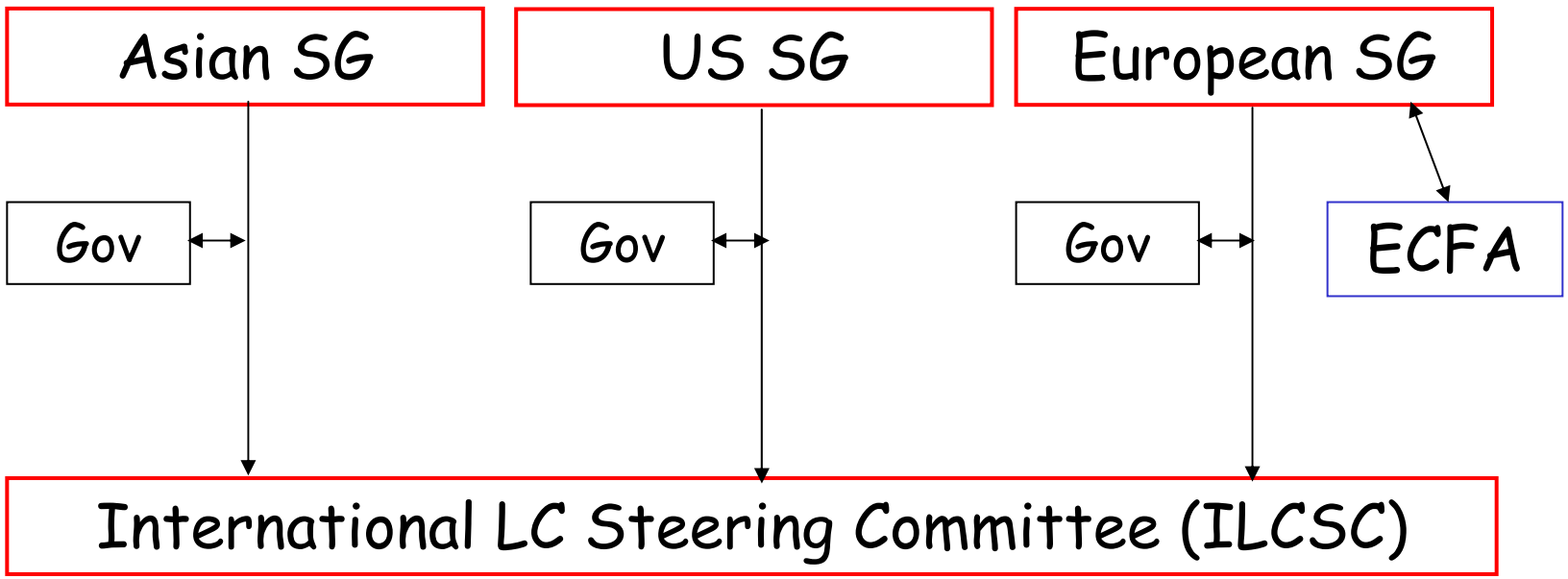
A Global Accelerator Network

- Collaboration of interested accelerator laboratories and institutes world-wide with the goal to build, operate and utilise large new accelerators
- Follows major detector collaboration in particle physics
- Partners contribute through components or subsystems
- Joint operation

Examples from science (astronomy…) and industry …

LC Steering Groups

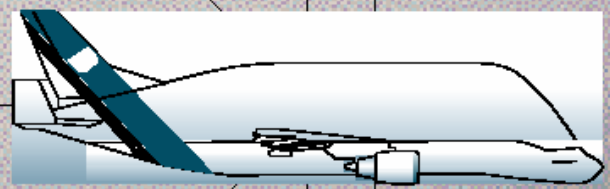
ICFA initiative:



The Airbus Example

Main Manufacturing Units

- Cabin interior — Buxtehude, Laupheim
- Fuselage (cockpit and centre) — Saint Nazaire, Nantes, Méaulte
- Fuselage (forward and aft) — Hamburg, Nordenham, Varel, Bremen
- Wing — Filton, Broughton
- Pylon, nacelle — Toulouse (Saint Eloi)
- Empennage: horizontal tailplane — Getafe, Illescas, Puerto Real
- Empennage: vertical tailplane — Stade



Airbus Transport

- Final Assembly Line A320 Family — Toulouse, Hamburg
- Final Assembly Line A300/A310 & A330/A340 — Toulouse
- Final Assembly Line A380 (under construction) — Toulouse, Hamburg

Steady Progress

- 2001 Road map discussions in the three regions
- 2001 TESLA TDR and Asian and US design documents
- 2001 Snowmass meeting
- 2002 Science Council evaluation in Germany
- 2003 Decision by the German Government to move forward on XFEL and to continue the R&D for the ILC in an international context
- ~2003 First meetings of the Funding agencies (FALC)
- 2003 Consultative group of QECD
- 2004 Ministerial Statement supporting the ILC
- 2004 ITRP process and technology decision
- 2004 First ILC workshop
- 2005 ICFA unanimously agrees on candidate for GDE director and starts negotiations

This list is incomplete, but illustrates the steady progress

Issues to be addressed

- Which is the best structure for an international projects?
- How and why should the labs which participate in the construction be involved in the operation?
- How to guarantee a long term project stability
- Does it require a international organisation with treaties?
- Understand the balance between host and non-host regions
- When and how should the site choice be made?
- What can we learn from ITER?

Summary

- The scientific case for a Linear Collider is strong and convincing, a world consensus exists on its importance and on its timing w.r.t. the LHC
- LC and LHC offer a complementary view of Nature at the energy frontier
- The SC technology for the LC is well developed
- Detector technologies to do the physics at the LC are being developed
- Politicians are following the process (technical decision, joint global design, self-organisation,..)
- 2015 is the target date for commissioning. To reach this we have to keep going at full speed.
- A lot of challenging questions lie ahead