ECFA Study

Physics and Detectors for a Linear Collider

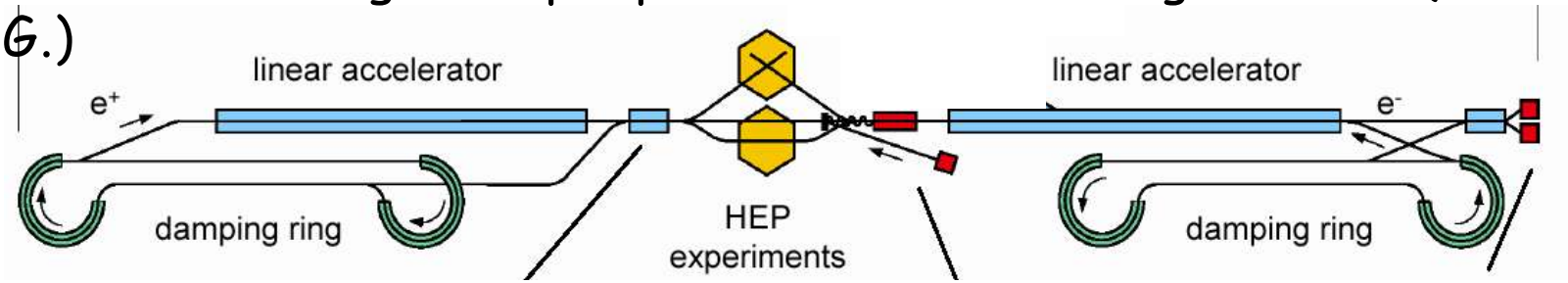
TESLA and the international LC

Impressed by work and further deepening of understanding

It continues to reflect enormous scientific potential &

Important year behind us and in front of us

"We are facing wise people and need wise arguments" (Eilam G.)



Why we need a decision on a LC soon

Why we are sure we are ready to go

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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.

Substantial overlap in running with LHC recommended

Agreed list of parameters for an international LC exisits

The consensus document is presently being signed by scientists all around the world. http://www-flc.desy.de/lcsurvey/

1953 signatures as of 12 November 2003

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My strictly personal view

Members of the TESLA Collaboration

CANDLE, Yerevan

Yerevan Physics Institute, Yerevan

Institute for High Energy Physics (IHEP), Academia Sinica, Beijing

Tsinghua University, Beijing

Peking University

Institute of Physics, Helsinki

CEA/DSM DAPNIA, CE-Saclay, Gif-sur-Yvette

Laboratoire de l'Accélérateur Linéaire (LAL), IN2P3, Orsay

Institut de Physique Nucléaire (IPN), Orsay

Rheinisch-Westfälische Technische Hochschule, Aachen

Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung, BESSY, Berlin

Hahn-Meitner Institut Berlin

Max-Born-Institut, Berlin

Technische Universität Berlin

Technische Universität Darmstadt

Technische Universität Dresden

Universität Frankfurt

GKSS-Forschungszentrum Geesthacht

Deutsches Elektronen-Synchrotron DESY in der Helmholtz-Gemeinschaft, Hamburg und Zeuthen

Universität Hamburg

Forschungszentrum Karlsruhe

Universität Rostock

Bergische Universität-GH Wuppertal

CCLRC-Daresbury and Rutherford Appleton Laboratory, Cheshire

Royal Holloway, University of London (RHUL)

Queen Mary, University of London (QMUL)

University College London (UCL)

University of Oxford

Laboratori Nazionali di Frascati, INFN, Frascati

Istituto Nazionale di Fisica Nucleare (INFN), Legnaro

Istituto Nazionale di Fisica Nucleare (INFN), Milan

Istituto Nazionale di Fisica Nucleare (INFN), Rome II

Sincrotrone Trieste

Institute of Nuclear Physics, Cracow

University of Mining and Metallurgy, Cracow

Soltan Institute for Nuclear Studies, Otwock-Swierk

High Pressure Research Center, Polish Academy of Science, Warsaw

Institute of Physics, Polish Academy of Science, Warsaw

Polish Atomic Energy Agency, Warsaw

Faculty of Physics, University of Warsaw

Moscow Engineering and Physics Institute, Moscow

Institute for Theoretical and Experimental Physics (ITEP), Moscow

Budker Institute for Nuclear Physics (BINP), Novosibirsk

Budker Institute for Nuclear Physics (BINP), Protvino

Institute for High Energy Physics (IHEP), Protvino

Institute for Nuclear Research (INR) Russian Academy of Sciences, Troitsk

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Madrid

Paul-Scherrer-Institut (PSI), Villigen

Argonne National Laboratory (ANL), Argonne IL

Fermi National Accelerator Laboratory (FNAL), Batavia IL

Cornell University, Ithaca NJ

University of California, Los Angeles CA

Jefferson Lab, Newport News VA

Joint Institute for Nuclear Research (JINR), Dubna

The TESLA Collaboration

- The TESLA Collaboration:

- at present 54 Institutes in 12 countries

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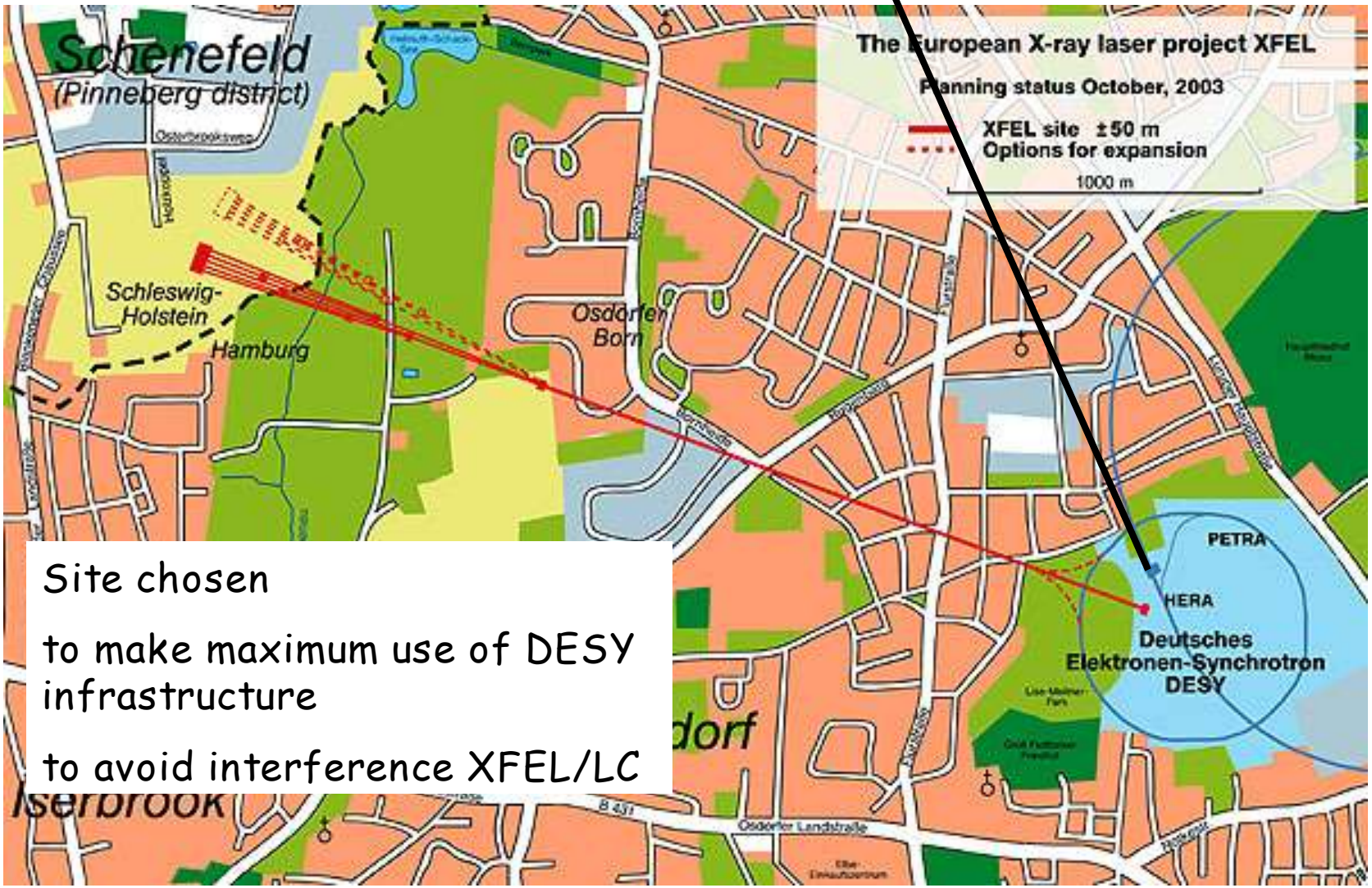
XFEL Site Proposal

planned LC

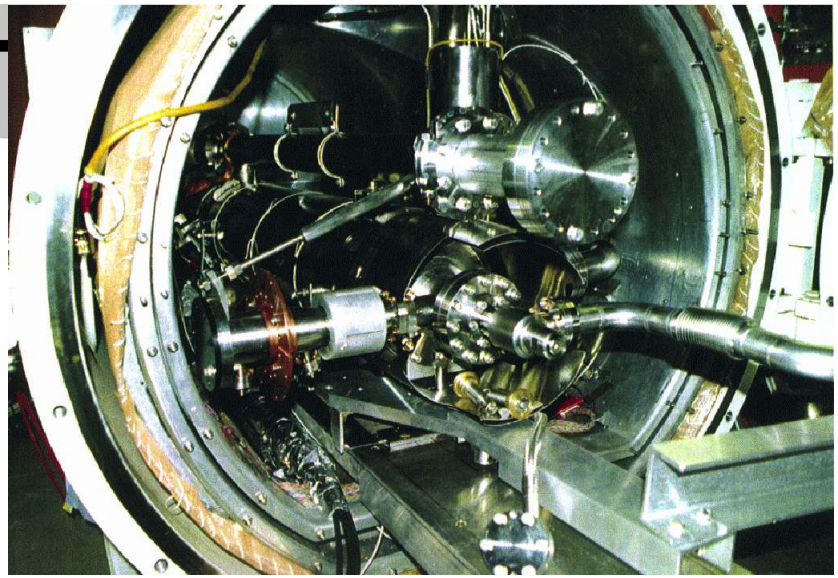


Site chosen

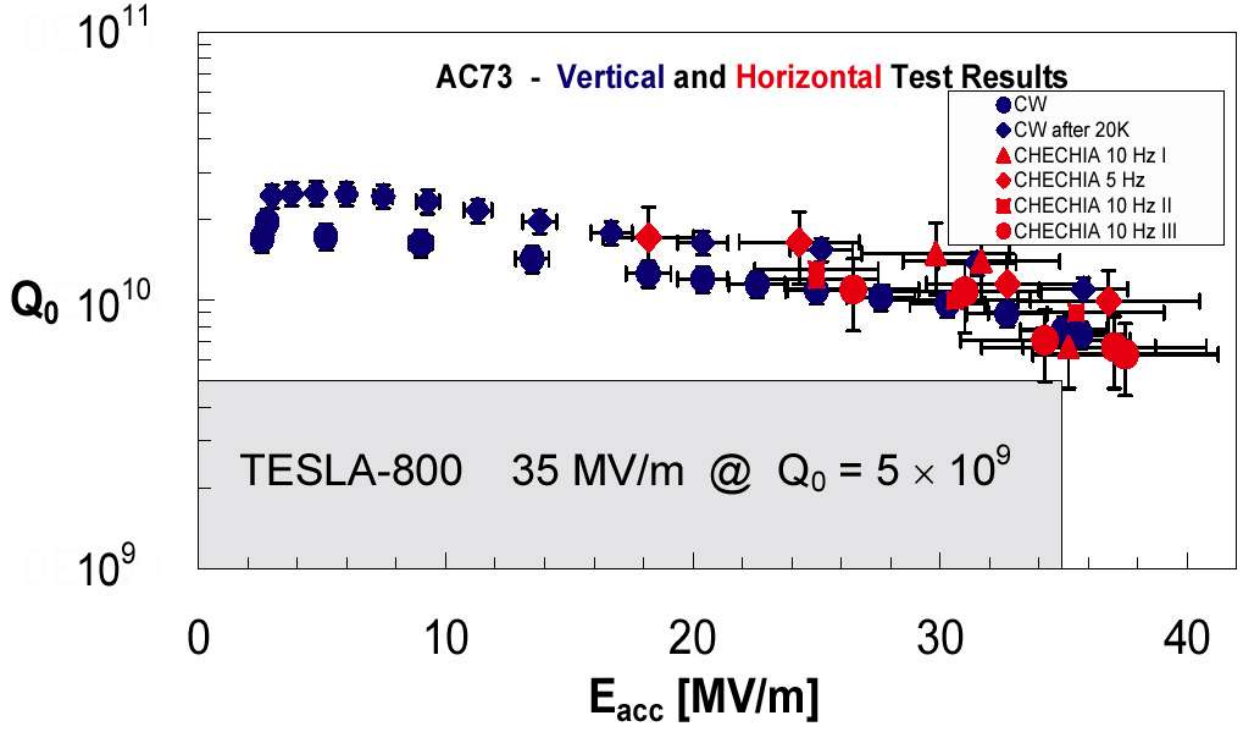
to make maximum use of DESY infrastructure

to avoid interference XFEL/LC

High Power Test of a Complete EP nine-cell Cavity



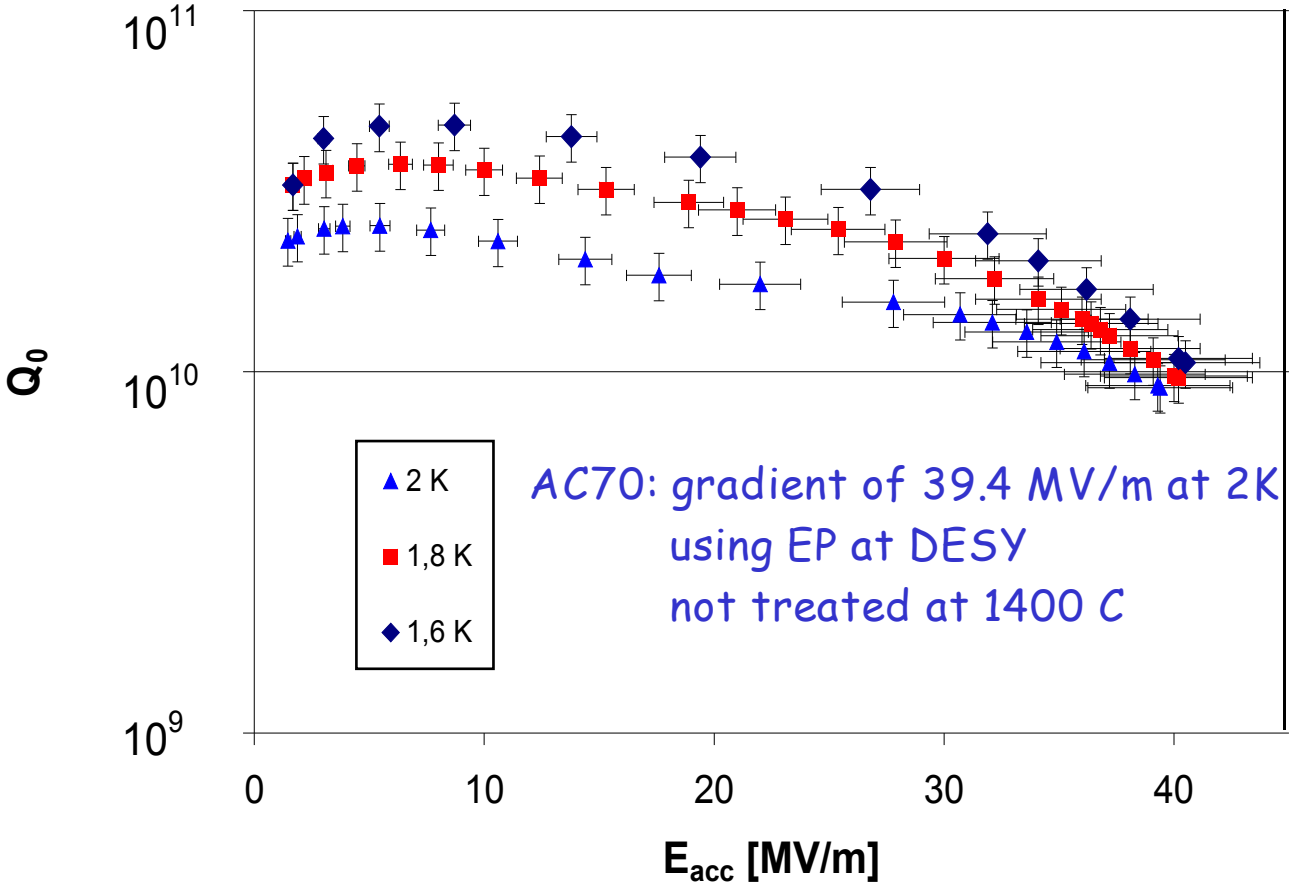
Several single cell cavities reached > 40 MV/m



- 1/8th of a TESLA cryomodule
- 5 Hz, 500 μs fill, 800 μs flat-top
- 33-> >35 MV/m with no interruption related to cavity-coupler-klystron for more than 1000 hours
- > 50 h at 36 MV/m
- No field emission

Two cavities tested

AC70: EP at DESY



High gradients is a high priority item at DESY and in TESLA collab.

Dedicated group working on it

Other Projects referencing to the TESLA technology

- High Energy Physics
  - TESLA
  - Neutrino Factories and Muon Colliders
  - Kaon Beam Separation at FNAL
  - New TEVATRON Injector
- Nuclear Physics
  - RIA
  - EURISOL
  - CEBAF Upgrade
- High Power Proton Linacs for Spallation
  - SNS, Joint-Project, Korea, ESS
  - ADS for Waste Transmutation
- New Generation Light Sources
  - Recirculating Linacs (Energy Recovery)
  - SASE FELs

XFEL Project Group: 38 work packages

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1. RF System
2. Low Level RF (LLRF)
3. Accelerator Modules
4. S.C. Cavities
5. Power Coupler
6. HOM Coupler / Pick-Up
7. Frequency Tuner
8. Cavity Flanges / Cold Vacuum (incl.warm injector section)
9. Cavity String Assembly / Clean Room Quality Assurance

10. Module Test Facility
11. Cold Magnets
12. Warm Magnets
13. Cryogenics

14. Injector
15. Bunch Compression and Start-to-End Simulation
16. Lattice Design and Beam Optics/Dynamics
17. Standard Beam Diagnostics
18. Special Beam Diagnostics
19. Vacuum system (warm)
20. Beam Dumps
21. Undulators

accelerator modules

module test / magnets / cryogenics

linac components (injector, bunch compressors, diagnostics, dumps)

Photons

FEL concepts

Controls / Operability

Infrastructure (site, civil construction, survey, tunnel layout, utilities)

Safety

Organisation

Note synergy!

22. Generic Hard Photon Beam Line
23. Generic Medium Energy Photon
24. Photon Diagnostics
25. Experimental Areas
26. Detector Development

27. FEL Concepts

28. Control Systems
29. Operability/Failure Handling

30. Ground Motion and Mechanical Stability
31. Site and Civil Construction
32. Survey and Alignment
33. Tunnel installation
34. Utilities

35. Radiation Safety
36. General Safety

37. Construction Plan Approval Procedure
38. Overall Project Progress Tracking

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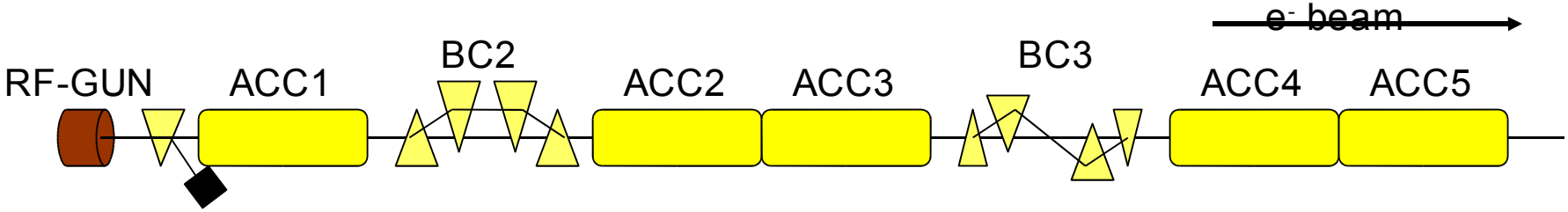
TTF2 VUV FEL

TTF1 is being extended to reach 1 GeV in 2003

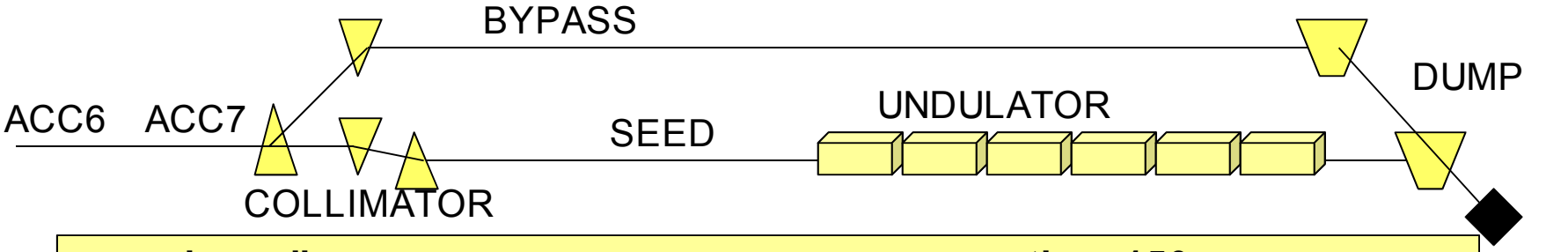
and becomes a user facility in 2004

TTF1

TTF2 Installation



• a new RF Gun	
• a new injector concept	Injector 3
• three new accelerator modules and later this year another two	ACC3 to ACC5 (3*, 4, 5) ACC1 and ACC2 (2*, 1*)
• another bunch compressor	BC3



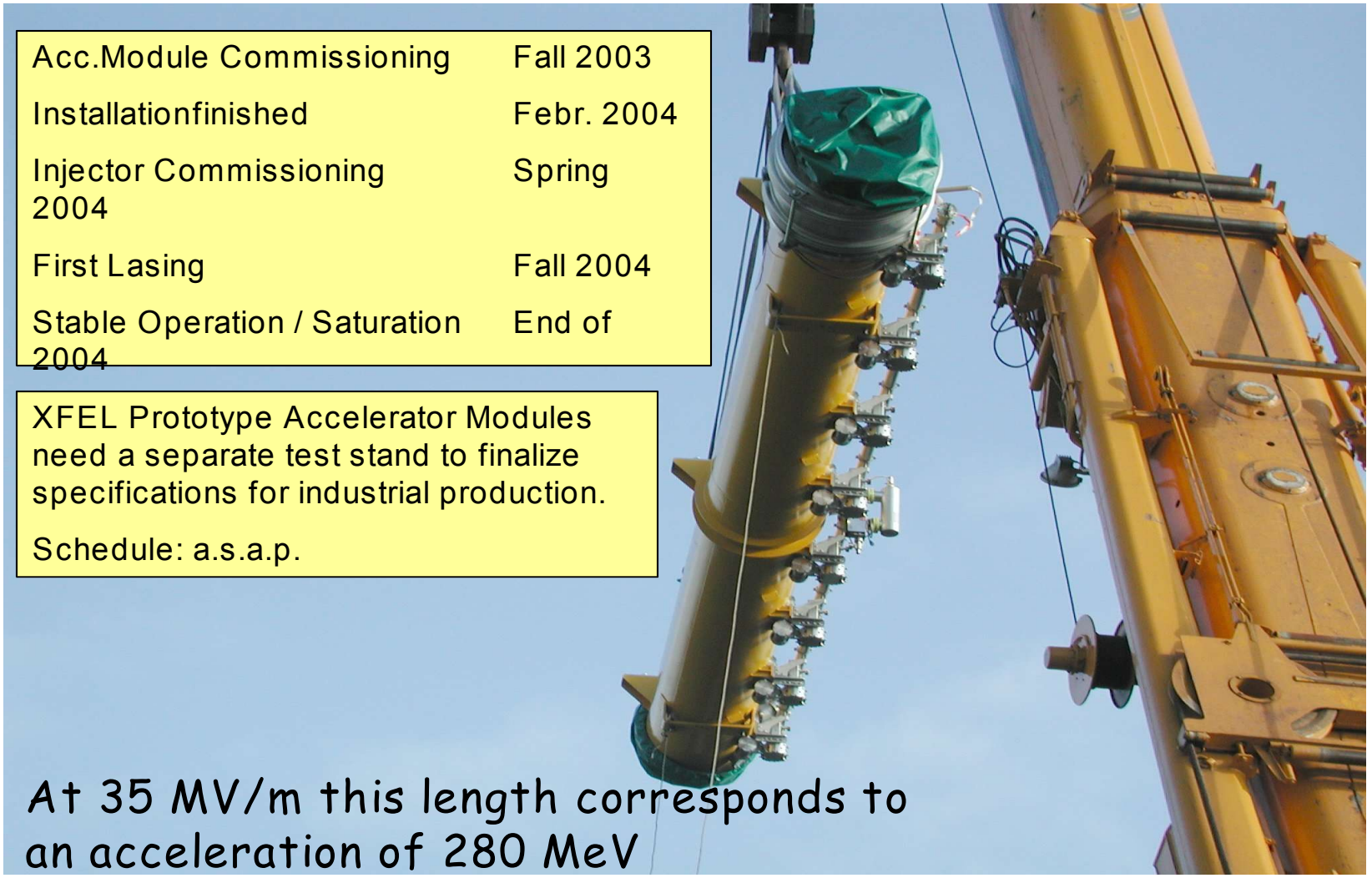
• new beamlines	more than 150 m
• a new collimator concept	transv. and energy collim.
• a long undulator	6 modules, 30 m
• a long bypass and a spectrometer line	

TTF2 Installation - Acc.Module #5

Acc.Module Commissioning	Fall 2003
Installationfinished	Febr. 2004
Injector Commissioning 2004	Spring
First Lasing	Fall 2004
Stable Operation / Saturation 2004	End of

XFEL Prototype Accelerator Modules need a separate test stand to finalize specifications for industrial production.

Schedule: a.s.a.p.



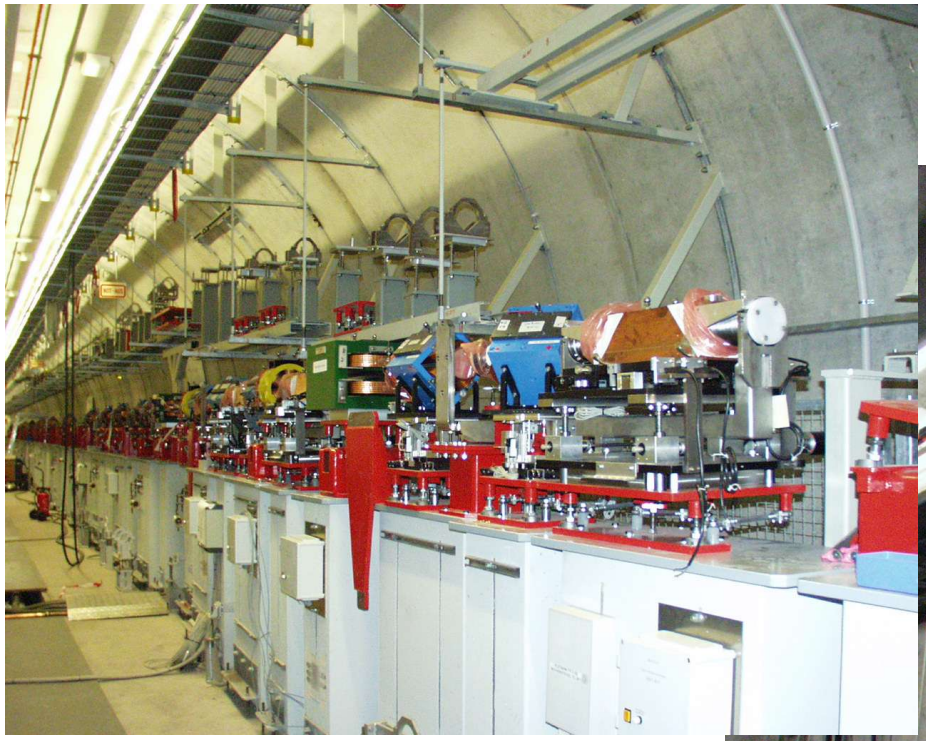
At 35 MV/m this length corresponds to an acceleration of 280 MeV

TTF2 Installation - BC3

BC3 vacuum chambers

creative break...

TTF2 Installation - Beamlines

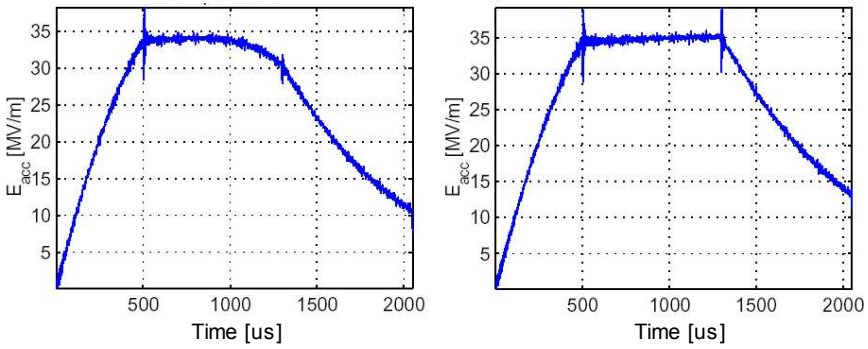


collimator

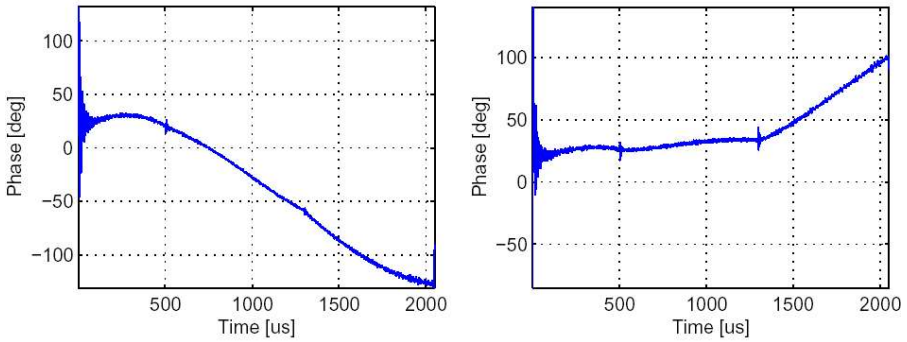
spectrometer

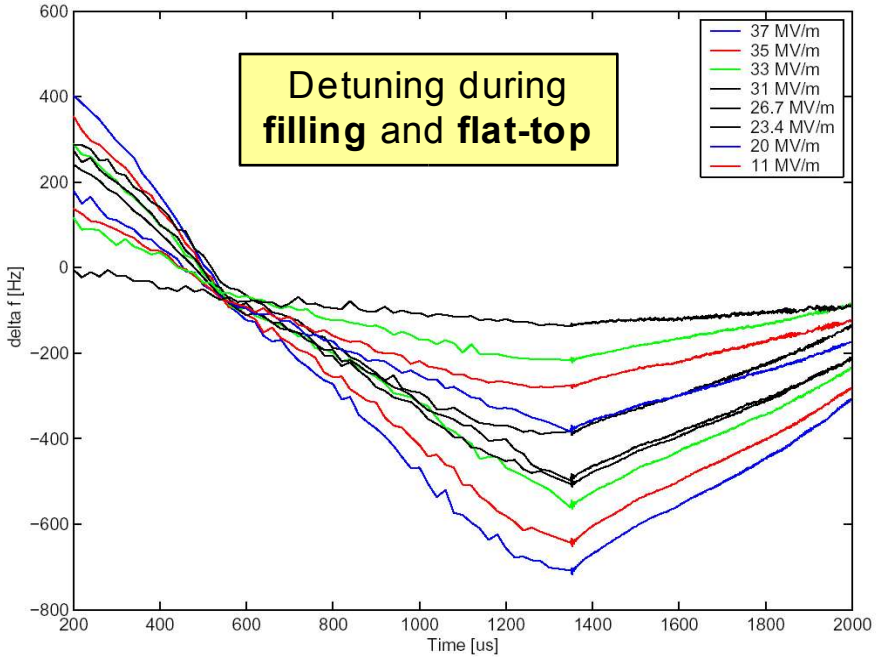
Lorentz Force Compensation at 35 MV/m using a piezo-electric tuner

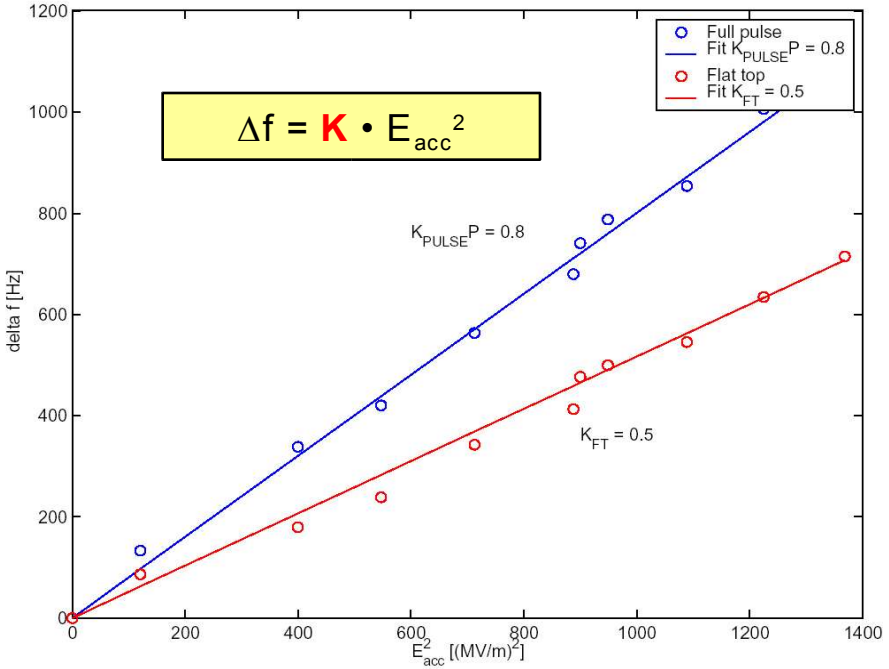
uncompensated **gradient** compensated



uncompensated **phase** compensated

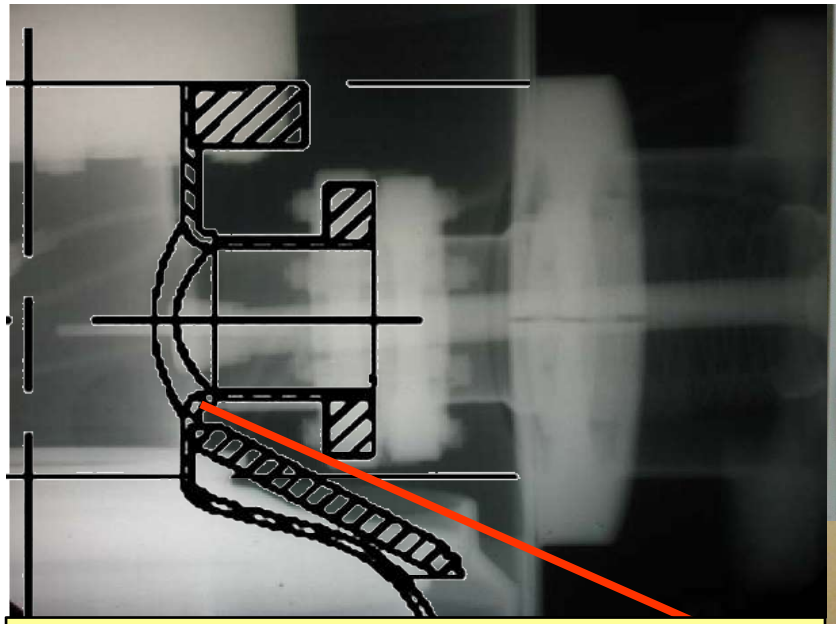


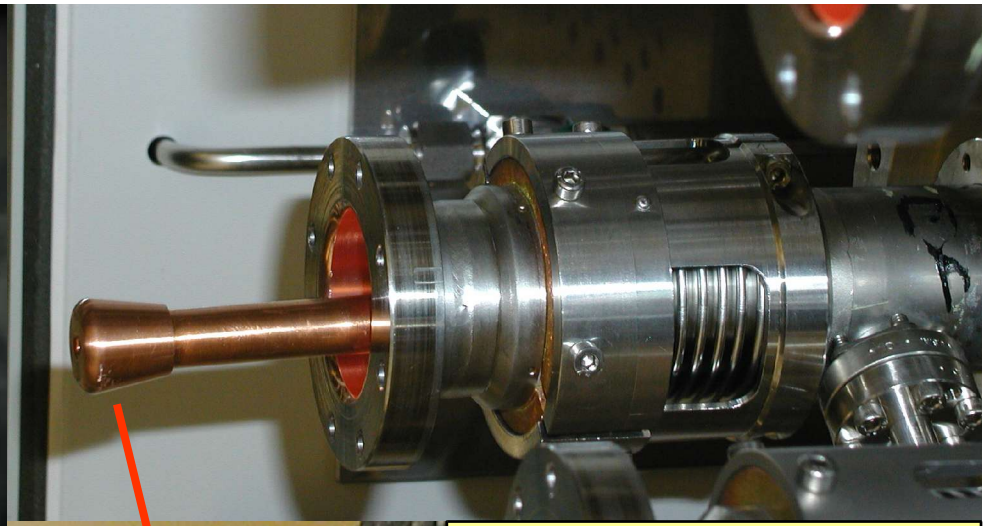


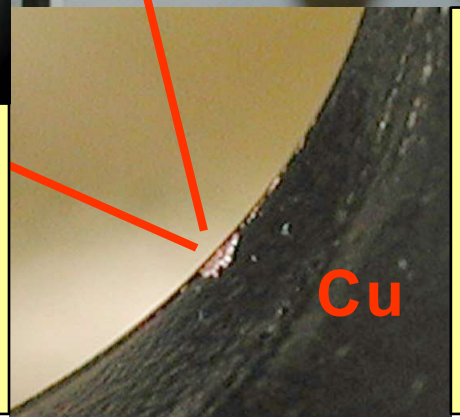


Results from S. Simrock / L. Lilje

RF Main Power Coupler Assembly Problems







Problems discovered and identified during the disassenbly of **module 3***

Strong hint on similar problems with **cavities 2 and 6 of module 1***

RF Main Coupler

- Inner conductor made from Cu
- Soft due to additional soldering
- bent / misaligned

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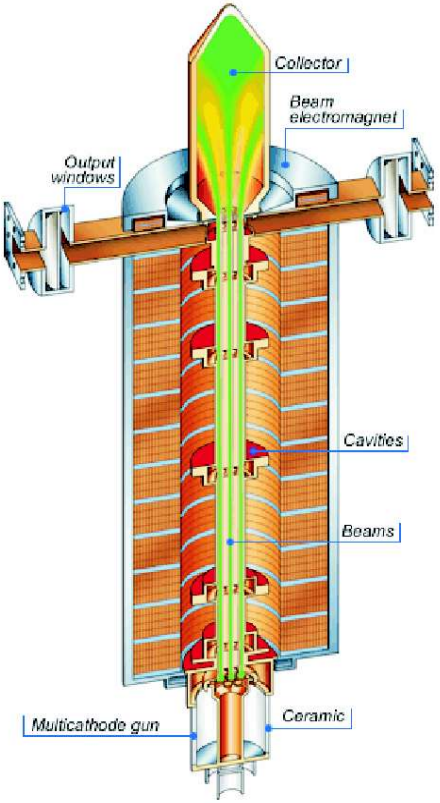
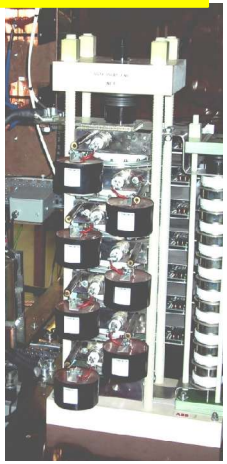
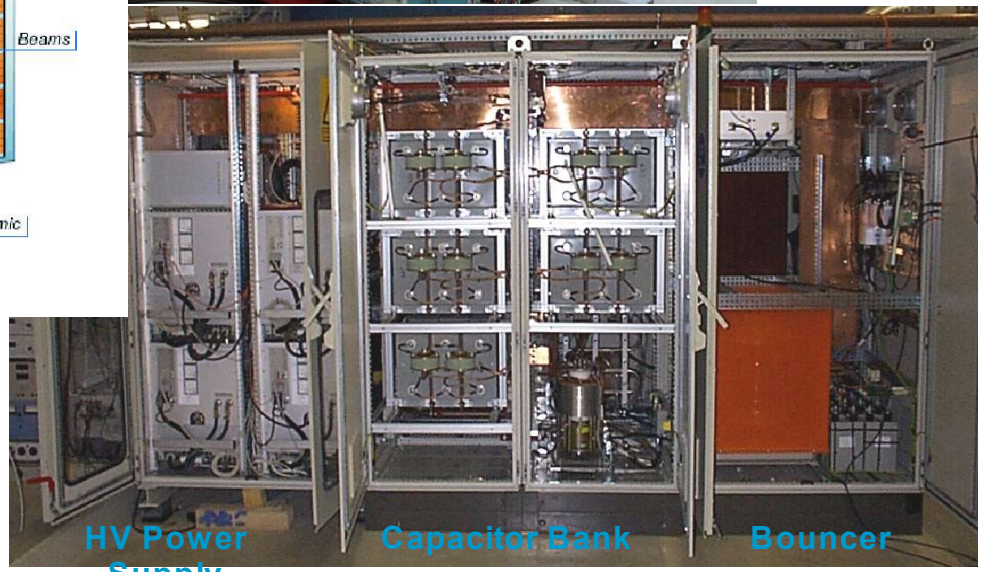
High Power RF for TTF / XFEL / TESLA



TH1801
Multi-Beam
Klystron



IGCT Stack



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End of my strictly personal view

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What has Happened since April 2003?

- OECD Global Science Forum (2002 and continuing)
- ILCSG and regional steering groups
- Discussion in CERN Council about CERN's role in a LC
- WG's on organisational matters (e.g. Kalmus et al. ESGOM)
- Parameter list has been established
- US: Facilities for the Future of Science
- Wise people panel (ITRC)
- Technology progress
- Discussion among funding agencies
- Setting up of an International Design Team and bidding for EU Design Study

Statement by the German Government on LC

Dr. H. Schunck, EPS HEP conference in Aachen, July 2003:

"The TESLA linear collider has been one of the proposals evaluated by the Wissenschaftsrat. The judgement of the Wissenschaftsrat on the scientific perspectives of the project has indeed been very positive. The Wissenschaftsrat has strongly suggested hat the linear collider should be realized as a genuine global project.

The German government has decided to follow this and as a consequence not to proceed nationally and at this moment not to propose a German site for TESLA. We have to wait for the international development. But we will continue our efforts to be able to participate in a global linear collider project. Let me underline: my government is the first one to have announced to be principally committed to participating in the project. "

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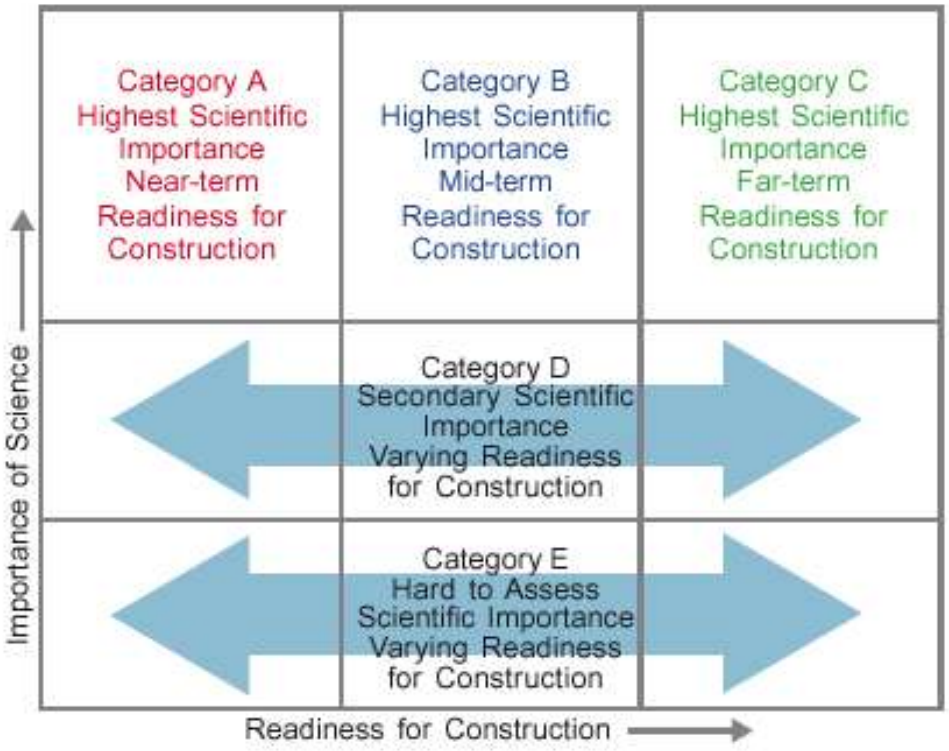
US 20-Year Outlook
Facilities for the Future of Science

Prioritisation process:



http://www.sc.doe.gov/Sub/Facilities_for_future/20-Year-Outlook-screen.pdf

The DoE Advisory Committees recommended 53 major facilities for construction, and assessed each according to two criteria:

- scientific importance and
- readiness for construction.

Of the 53 facilities initially proposed by the Advisory Committees, 28 made the list of most important facilities that will be needed over the next 20 years to support the Nation's research needs in areas that have been the traditional responsibility of the DOE.

US 20-Year Outlook
Facilities for the Future of Science

Priority

Near-Term	1	FES	ITER
	2	ASCR	UltraScale Scientific Computing Capability
	Tie for 3	HEP	Joint Dark Energy Mission
		BES	Linac Coherent Light Source
		BER	Protein Production and Tags
		NP	Rare Isotope Accelerator
	Tie for 7	BER	Characterization and Imaging
		NP	CEBAF Upgrade
		ASCR	Esnet Upgrade
		ASCR	NERSC Upgrade
		BES	Transmission Electron Achromatic Microscope
	12	HEP	BTeV

Mid-Term	13	HEP	Linear Collider
	Tie for 14	BER	Analysis and Modeling of Cellular Systems
		BES	SNS 2-4 MW Upgrade
		BES	SNS Second Target Station
		BER	Whole Proteome Analysis
	Tie for 18	NP	Double Beta Decay Underground Detector
		FES	Next Step Spherical Tokamak
		NP	RHIC II

Mid Term Readiness for construction (time line?!)

Near Term Readiness for construction

HEPAP: "The intrinsic science potential of the Linear Collider and the capability of the facility to achieve that science are absolutely central. Presently in an advanced R&D phase on an international basis, with the formation of an international design team it would enter the project engineering and design phase in 2006."

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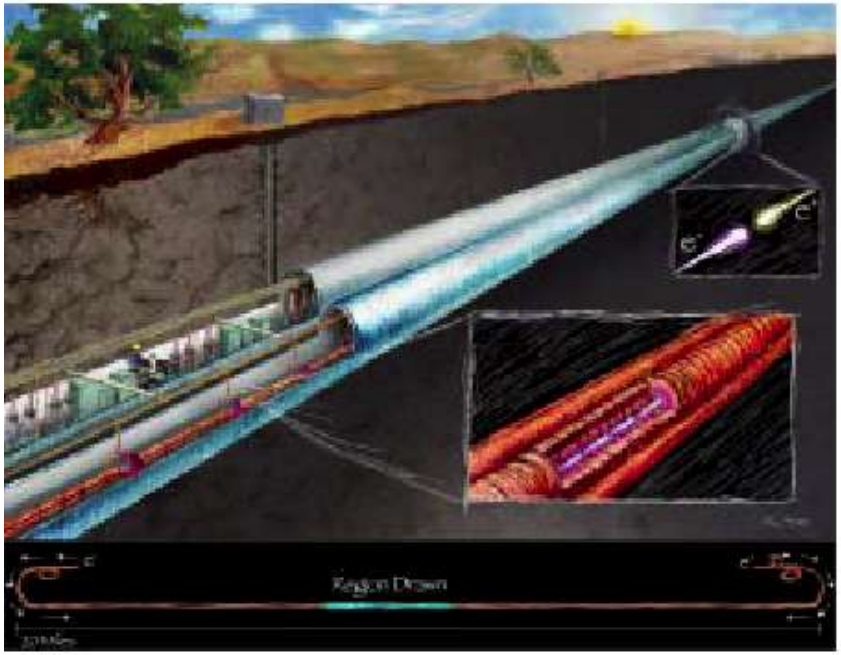
US 20-Year Outlook
Facilities for the Future of Science

Mid-Term Priorities

Priority: 13
Linear Collider



The Linear Collider is designed to extend the study of particle physics.

The Facility: The Linear Collider will allow physicists to make the world's most precise measurements of nature's most fundamental particles and forces at energies comparable to those of the Large Hadron Collider (LHC) now under construction in Switzerland.

Background: The Standard Model of particle physics, developed over the last 50 years and recognized as one of *the* great scientific achievements, has been tremendously effective in predicting the behavior of all the interactions of subatomic particles except those due to gravity, and in describing the varieties of particles that combine to make everyday matter. The next step—incorporating a theory of gravity and understanding why fundamental particles have mass—will require particle accelerators that function at the trillion-electron volt ("TeV") level.

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US 20-Year Outlook
Facilities for the Future of Science

What's New: The LHC now under construction at CERN in Switzerland will open exploration of the TeV energy level. The Linear Collider, also to be an international effort, will distinguish itself by its ability to perform unique, precise measurements at this energy because it will collide individual fundamental particles rather than complex clusters of particles. The precision afforded by the Linear Collider will enable new phenomena discovered at the LHC to be more fully explored, in addition to providing its own discoveries.

Applications: High-energy physics has always been a frontier discipline in science, driving technological innovation (the World Wide Web was created to share data from accelerator experiments, as an example) and pushing the limits of what we know in the disparate but interconnected worlds of cosmology and elementary particles. The Linear Collider could be considered the high-tech equivalent of a frontier outpost at the edge of a new world.

The Linear Collider is the highest priority facility among the mid-term priority projects

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Technology Choice

The International Linear Collider Steering Committee (ILCSC) has successfully completed the selection of the twelve members of the International Technology Recommendation Committee (ITRC), the group that will recommend to ICFA the choice of the main linac RF technology for the internationally-based linear collider project.

In addition, a chairman for the ITRC has unanimously been selected from within the twelve members.

The selection process for the members and Chair of the ITRC is exactly as agreed upon at ICFA's August 2003 meeting at Fermilab. ICFA approval scheduled for 19 November 2003.

The twelve members have been polled and it appears that the first meeting will occur in January 2004.

Aim at joint selection of one technology in 2004.

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Next Milestones towards a Global Linear Collider

1 Selection of Collider Technology (warm or cold) and setting up of an international project team with branches in America, Asia and Europe

Continuation of discussion between funding agencies

Further studies of organisation structures

5 Start of work of project teams (‚Pre GLC')

6 Completion of the project layout including costing

~2007 Decision in principle by governments to go ahead with LC

2015 Start of commissioning

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Meeting of Funding Agencies

Meeting of Funding Agencies to discuss the status and funding prospects for a linear collider of 0.5 – 1TeV.

30 July 2003, London, UK

Representatives from Canada (NSERC), CERN (President of Council and DG), France (CNRS), Germany (BMBF), Italy (INFN), UK (PPARC), and the US (DOE, NSF, OSTP).

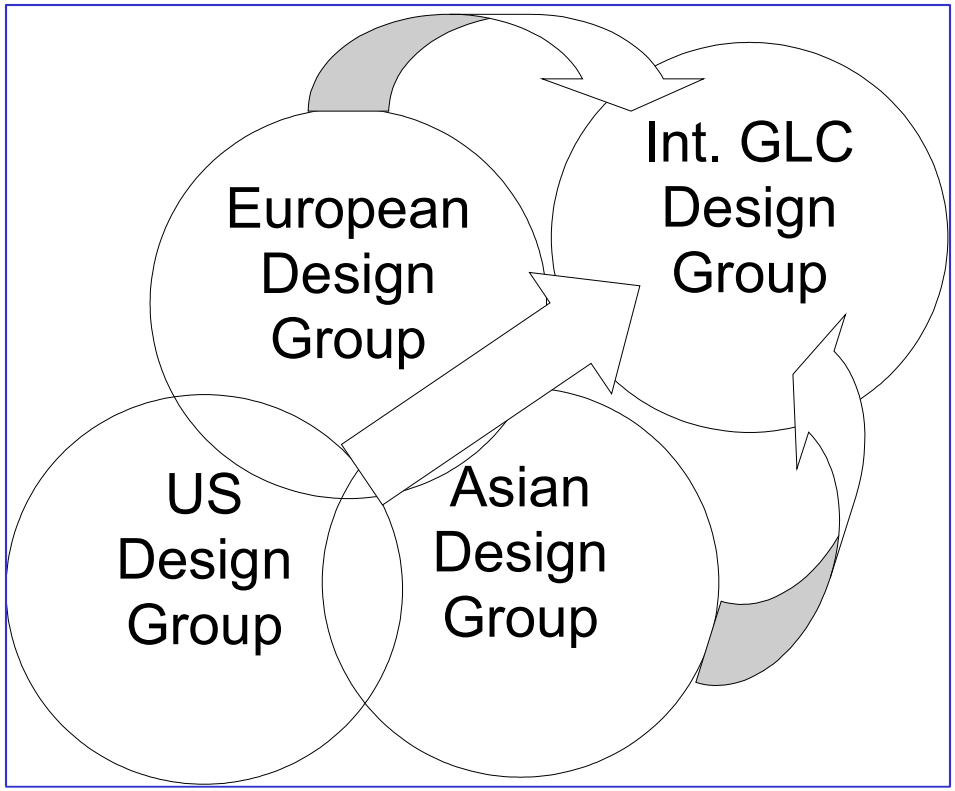
Recognised that scientific committees have established a need for future facilities of such a scale that an international forum of potential funding agencies/sponsors was needed.

The group discussed the status of current funding for a linear collider (LC) and their perceptions of the prospects for the future.

Will meet again in March 2004

Possible Structure of an International LC Design Group - The European View

From a European perspective:



Three regional <u>core</u> design groups:

- are responsible for coordinating and managing the design effort in each of the three regions
- should have representatives in them from each of the other two groups.

The three regional groups are coordinated by an international GLC Design Group, whose members are primarily (but not necessarily exclusively) made up from the team leadership of the Regional Design Groups.

- The GLC Design Group reports

Global Design Organisation

Task force is preparing a Global Design Orgnisation. Main thrust of present thinking:

- The ILC Global Design Organization (GDO) to be established as an inter-regional entity as soon as the International Technical Recommendation Committee establishes their choice of the basic technology for the LC and ICFA approves the choice.
- The first mission of the GDO is to turn the technology choice to conceptual design of the machine (parameters, layout, roadmap, R&D)
- The GDO will consist of a Central Team and three Regional Teams, representing Asia, Europe and North America.
- The GDO, in its early phase, will be established using an MOU among the participating institutions, and will be supported by funds that presently exist at the institutions.

Under discussion: Specific tasks, funding, organisation ...

Report to ICFA and LCSC

Outlook

- This meeting in Montpellier shows again, as do the meetings in the other regions: Strong world enthusiasm for a LC continues and grows
- The HEP community has demonstrated the will to join behind one technology and to build the LC jointly. It has the capability of getting organised
- The reason: „The next discoveries will have a disproportionate impact of our understanding of Nature".
- We have convinced many people outside our community, but we need to get our own community more on board
- Need to go new ways in international collaborations in order to advance science and to maintain the strong existing centres
- Most important: we need to keep focused on reaching the next milestones while looking at the same time further ahead