DESY Tuesday Seminar

DESY, Hamburg, 21 October 2003

Overview of Linear Collider Status and Perspectives

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INFN Milano and DESY

On leave of absence from University of Milano

Talk Outline

- The e+ e- TeV Collider must be linear
- What happened recently
- First ILC-TRC and Test Facilities
- Competing designs
- Second ILC-TRC recommendations
- International organizations for LC
- The Linear Collider and DESY
- Conclusions

Linear vs Circular

- Historically: circular colliders were the “easier” machine of choice in HEP
- **But** not at ultra-high energy for electrons! SR scaling law for electrons:

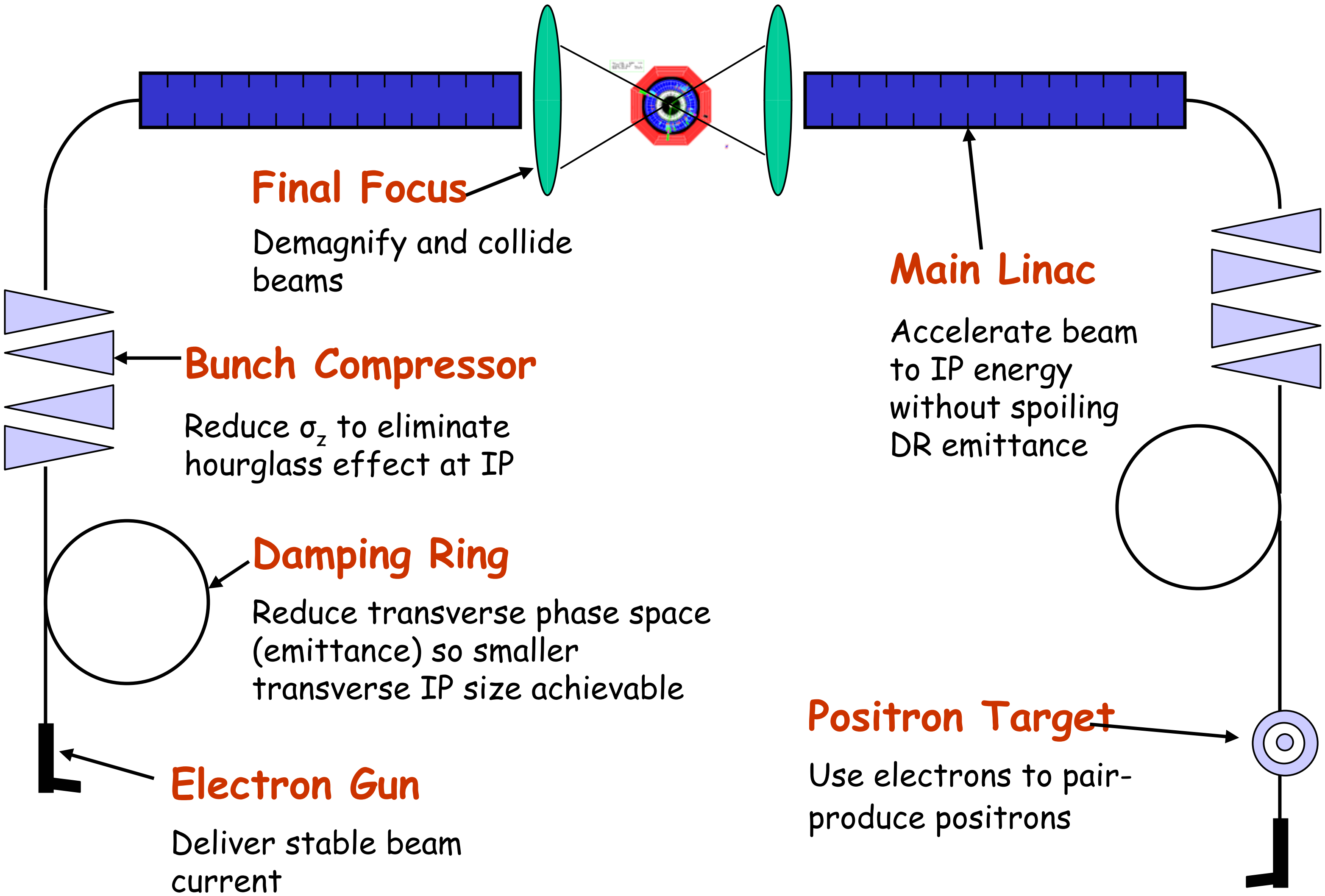
$$U_{SR}\ [\mathrm{GeV/turn}] = 8.85 \times 10^{-5}\ E^4\ [\mathrm{GeV}]\ /\ r\ [\mathrm{m}]$$

- Ring RF system must replace this loss
- Balance length costs vs RF system costs
  - r scales approximately as E^2
  - LEP @ 100 GeV/beam: 27 km around, 2 GeV/turn lost
  - Scale to 500 GeV/beam:
    - 675 km around
    - 51 GeV/turn lost!

U_{SR}	=	energy loss per turn
E	=	beam energy
r	=	machine radius

- Consider also the luminosity
  - For a luminosity of ~ 10^{34}/cm^2/second, rings use ~ amperes of beam current
  - 50 GeV/turn x 2 amperes = 100 GW RF power!
  - For scale: the state of California consumes ~ 45 GW in the summer
- Both the size and the power needs of a circular collider @ 1 TeV CM, L = 10^{34}/cm^2/second, seem excessive

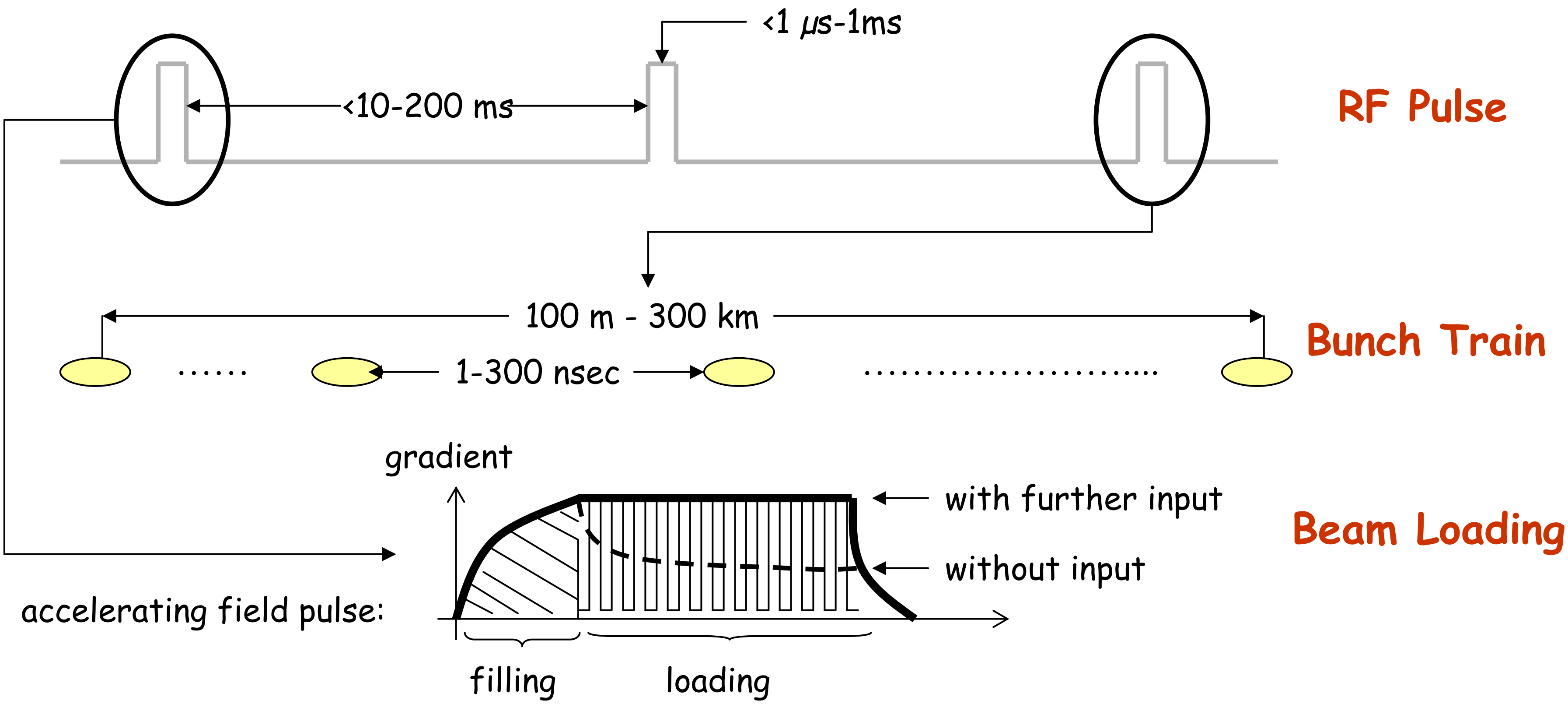
LC conceptual scheme



Linear Colliders are pulsed

LCs are pulsed machines to improve efficiency. As a result:

- duty factors are small
- pulse peak powers can be very large



LC: What happened recently

- ACFA, ECFA, HEPAP scientific recommendations
- TESLA TDR in March 2001
- OECD Global Science Forum (2002 and continuing)
- JLC Road Map in February 2003
- 2nd International Technical Review – ILC-TRC (2003)
- ILCSG and regional steering groups
- Discussion among funding agencies
- Discussion in CERN Council about CERNs role in a LC
- WGs on organizational matters
- GAN workshops
- US studies for technology and cost comparison
- Etc.

ILCSC

International Linear Collider Steerng Committee

Membership of the ILCSC

H. Chen (IHEP, Beijing)
J. Dorfan (SLAC)
B. Foster (Bristol, UK)
C. Garcia Canal (La Plata, Argentina)
P. Grannis (Stony Brook, US)
S. Komamiya (Tokyo)
L. Maiani (CERN)
D. Miller (UCL, UK)
W. Namkung (POSTECH, Korea)
A. Skrinsky (BINP)
H. Sugawara (KEK)
M. Tigner (Cornell) – Chair
Y. Totsuka (Tokyo)
A. Wagner (DESY)
M. Witherell (Fermilab)

First proposed on Feb. 2002 (J. Dorfan), very active since Aug. 2002

Extract from the mandate of the ILCSC

- Engage in outreach, explaining the intrinsic scientific and technological importance of the project.
- Based upon the extensive work already done in Asia, Europe and N. America, engage in defining the scientific roadmap, the scope and primary parameters for machine and detector.
- Monitor the machine R&D activities and make recommendations on the coordination and sharing of R&D tasks as appropriate.
- Identify models of the organizational structure, based on international partnerships, adequate for constructing the LC facility.
- Carry out such other tasks as may be approved or directed by ICFA.

The Scientific Case

Linear Collider Report from World-wide Study Group - 9 April 2003

~ 2000 signatures

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

~ 2000 signatures

- A world-wide consensus has formed for a baseline LC project in which *positrons* (e+) collide with *electrons* (e-) 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.

. . . .

- In summary:
  - *We know enough now to predict with very high confidence that the linear collider, operating at energies up to 500 GeV, will be needed to understand how forces are related and the way mass is given to all particles.*
  - *We are confident that the new physics that we expect beyond the standard model will be illuminated by measurements at both the LHC and the LC, through an intimate interplay of results from the two accelerators.*
  - *The physics investigations envisioned at the LC are very broad and fundamental, and will require a leading edge program of research for many years.*

ILC-TRC (Greg Loew Panel)

International LC Technical Review Committee

- International Collaboration for R&D toward TeV-Scale e^+e^- LC asked for first ILC-TRC in June 1994
- ILC-TRC produced first report end of 1995
- 2001: ICFA requests that ILC-TRC reconvene to produce a second report with the following charge:
  - To assess the present technology status of the four LC designs at hand, and their potential for meeting the advertised parameters at 500 GeV c.m.
  - Use common criteria, definitions, computer codes, etc., for the assessments
  - To assess the potential of each design for reaching higher energies above 500 GeV c.m.
  - To establish, for each design, the R&D work that remains to be done in the next few years
  - To suggest future areas of collaboration
- ILC-TRC produced second report January 2003

  http://www.slac.stanford.edu/xorg/ilc-trc/2002/2002/report/03rep.htm

LC status at first ILC-TRC

End 1995 E_{cm} = 500 GeV

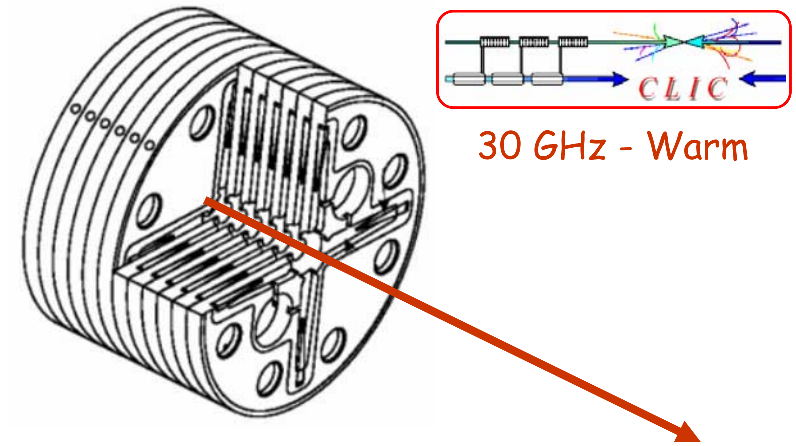
	TESLA	SBLC	JLC-S	JLC-C	JLC-X	NLC	VLEPP	CLIC
f [GHz]	1.3	3.0	2.8	5.7	11.4	11.4	14.0	30.0
$\mathcal{L}\times 10^{33}$ [$cm^{-2}s^{-1}$]	6	4	4	9	5	7	9	1-5
P_{beam} [MW]	16.5	7.3	1.3	4.3	3.2	4.2	2.4	1-4
P_{AC} [MW]	164	139	118	209	114	103	57	100
$\gamma\varepsilon_y$ [$\times 10^{-8}$m]	100	50	4.8	4.8	4.8	5	7.5	15
σ_y^* [nm]	64	28	3	3	3	3.2	4	7.4

Tasks to be addressed

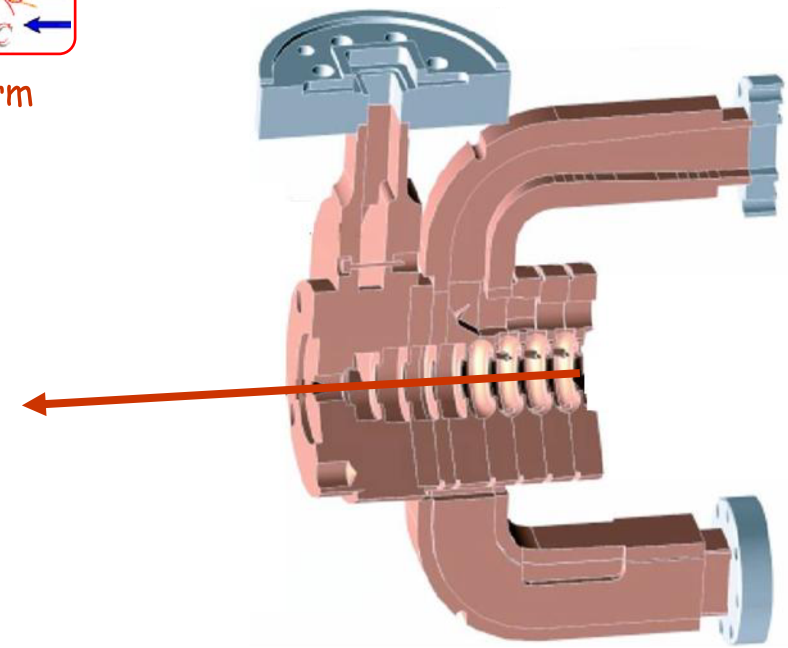
Baseline c.m. Energy stays at 500 GeV

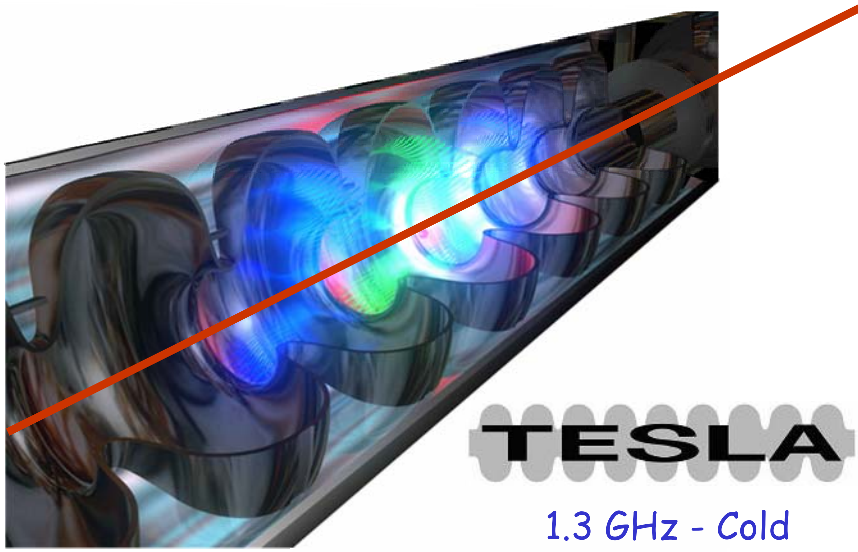
- **Push Luminosity to the maximum value**
- **Technology:**
  - Demonstrate that the proposed technology can be pushed to the limits required for a Linear Collider
  - Demonstrate that the proposed technology can be produced in large scale by industry with high reliability and reasonable cost
  - Find solution for all critical items
- **Design issues:**
  - Demonstrate that very small spot sizes ($\sigma_x \cdot \sigma_y < 1\ \mu m^2$) are possible
  - Investigate all beam physics critical issues
  - Support all design features with cross-checked simulations
  - Address reliability and availability issues
- **Roadmap for energy upgrade**
- **Test Facilities**

Competing technologies



30 GHz - Warm





1.3 GHz - Cold

11.4 GHz - Warm

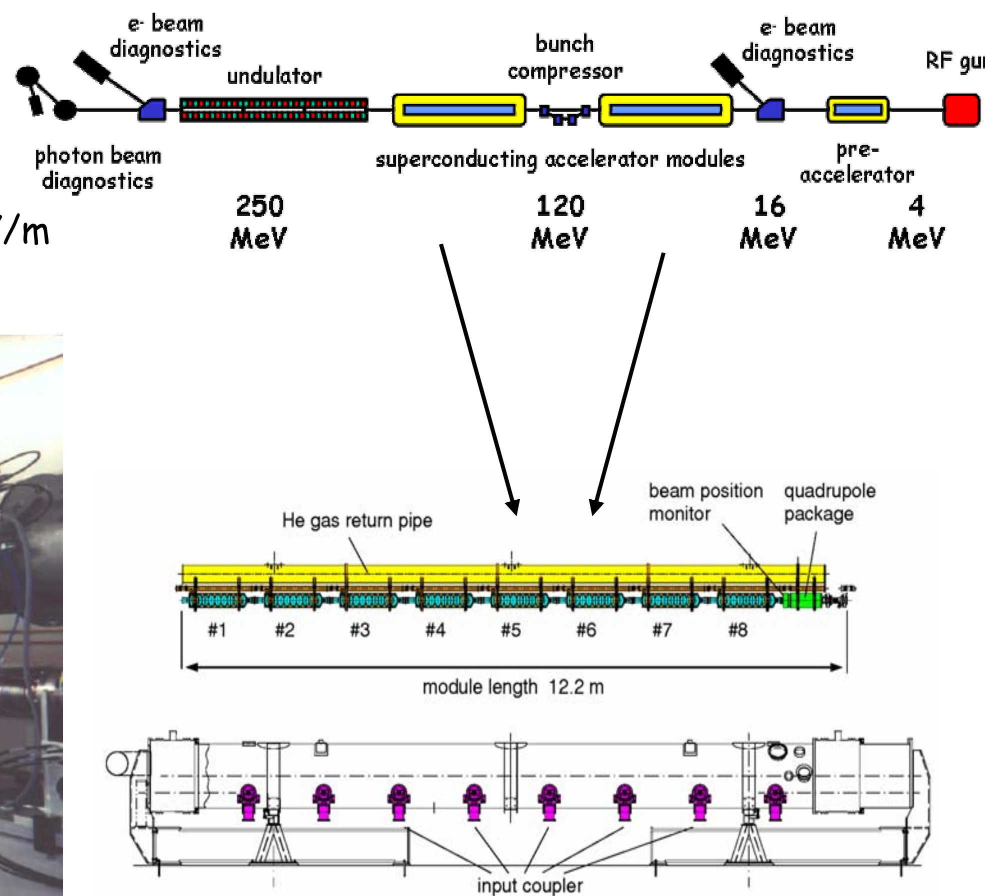
TTF for TESLA

TTF = TESLA Test Facility

TTF Goals:

- Demonstrate that Superconducting RF technology is suitable for LC
- Operate TTF at $E_{acc} > 15$ MV/m
- Develop cavity technology for Eacc > 25 MV/m

TTF as operated for SASE FEL

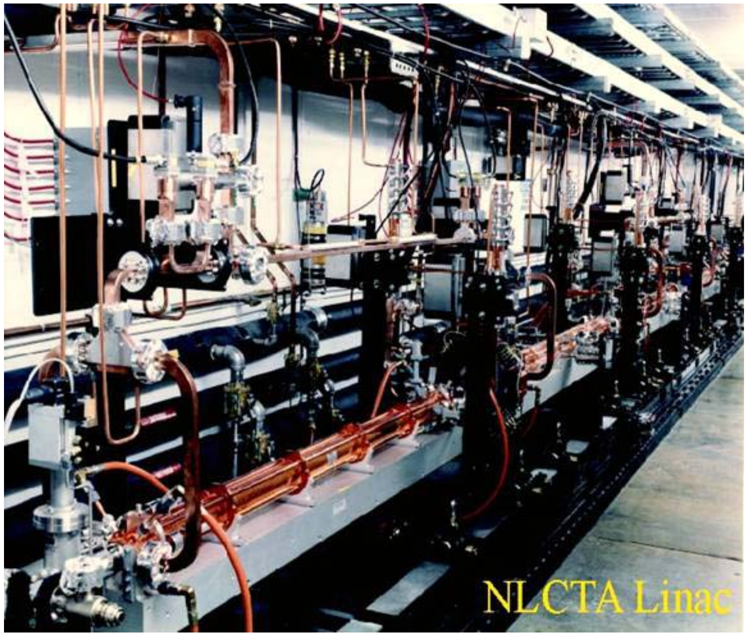


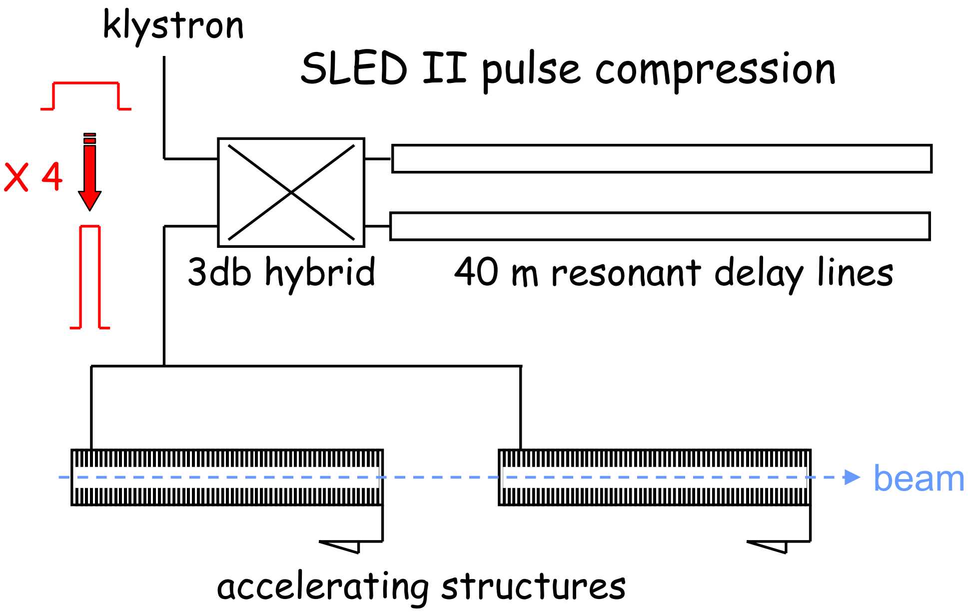
NLCTA for NLC

NLCTA = NLC Test Accelerator

NLCTA Goals:

- RF system integration test of a NLC linac section
- Test efficient, stable and uniform acceleration of a NLC-like bunch train





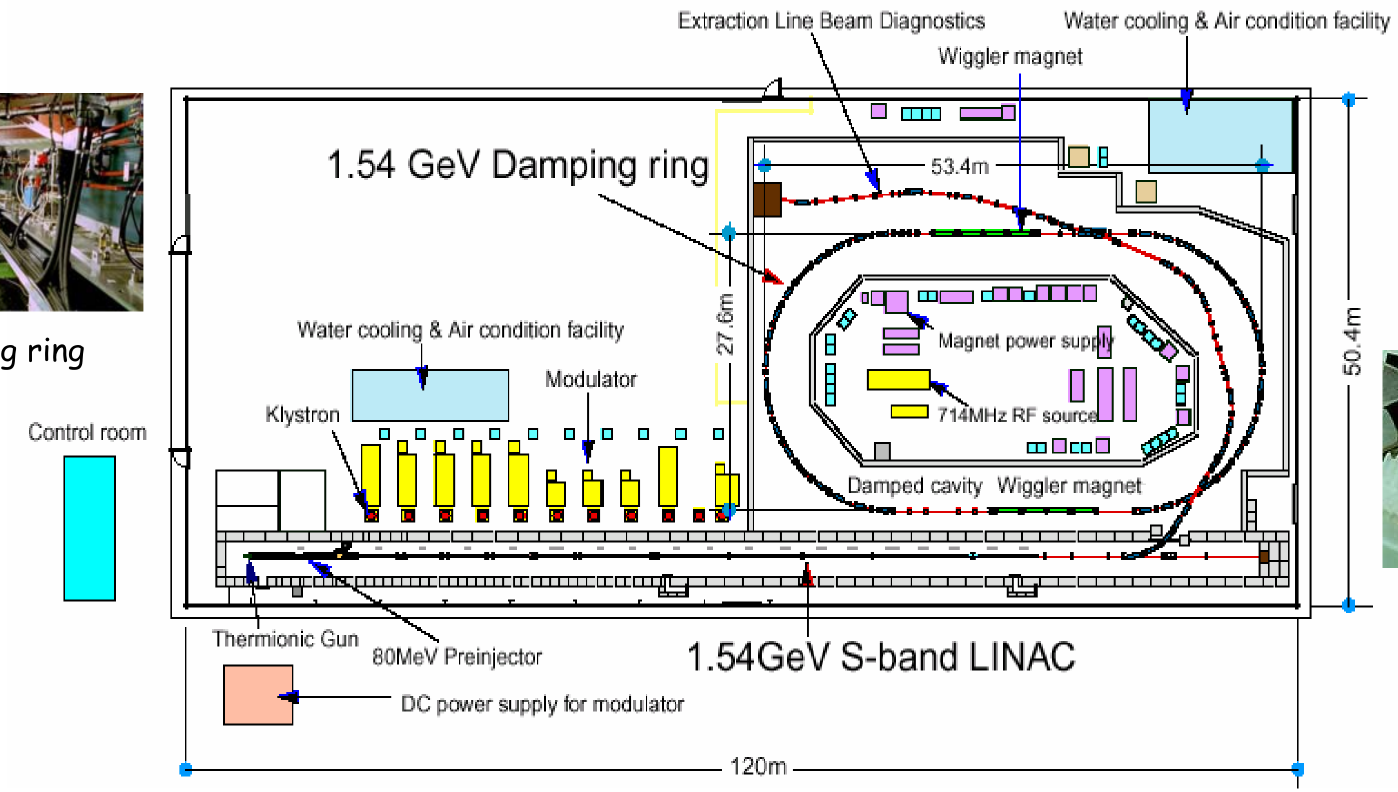
ATF for JLC

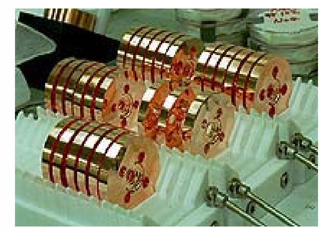
ATF = Accelerator Test Facility

ATF Goals:

- Demonstrate very low beam emittance
- Develop RF technology

Damping ring





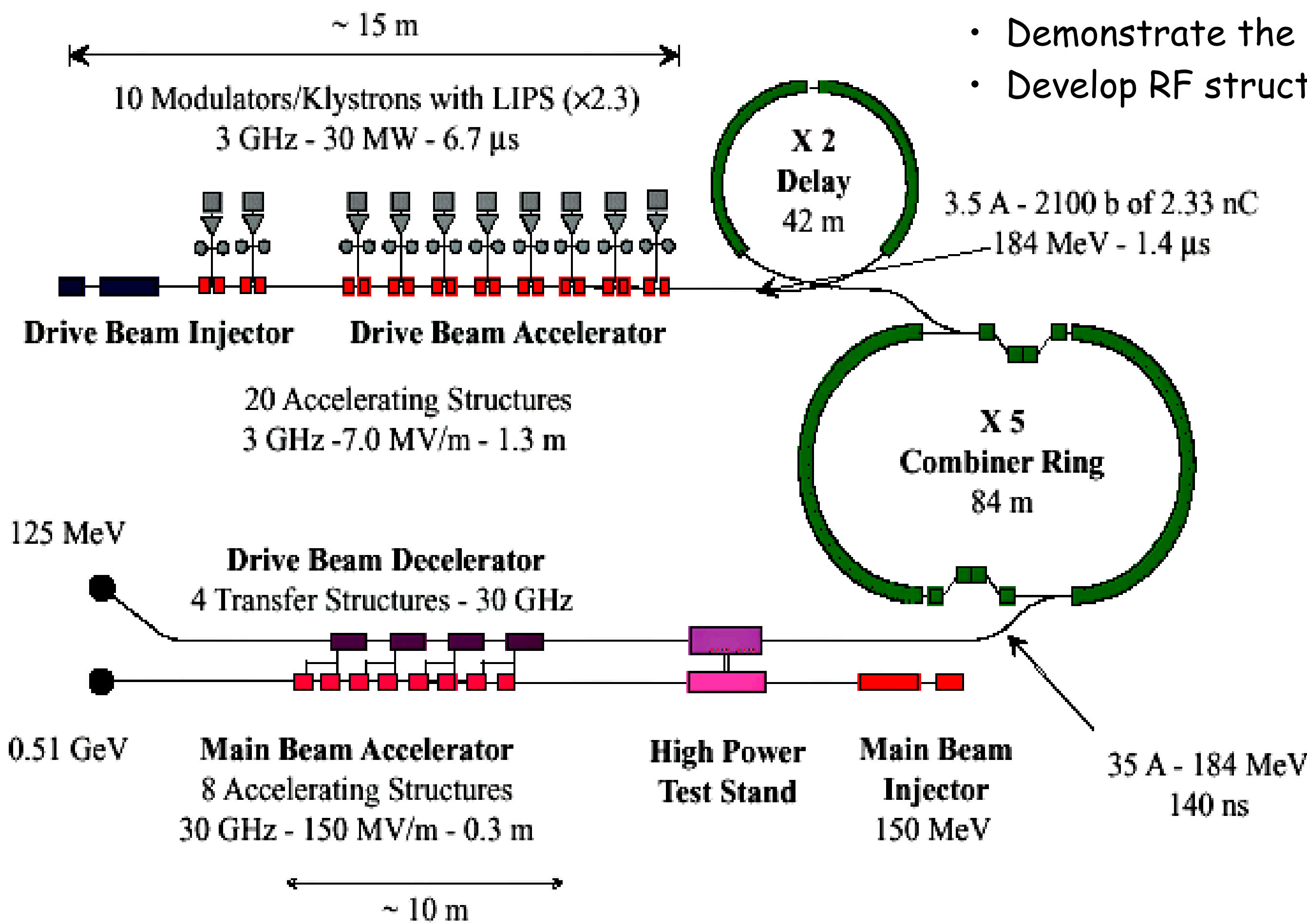
Cavity Production

CTF for CLIC

CTF3 = CLIC Test Facility #3 (Under construction after CTF1 and CTF2)

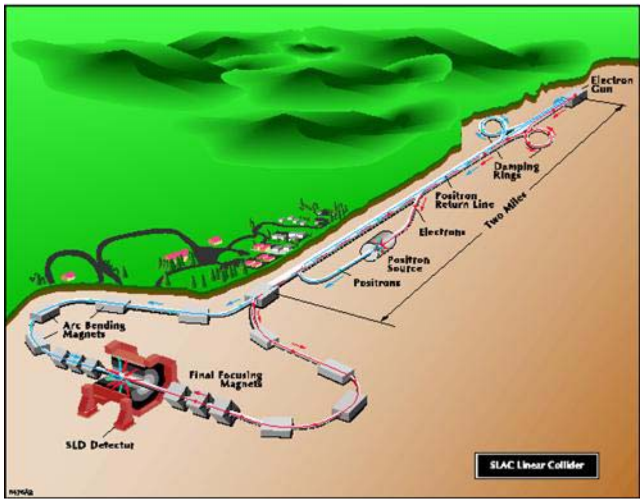
CTF3 Goals:

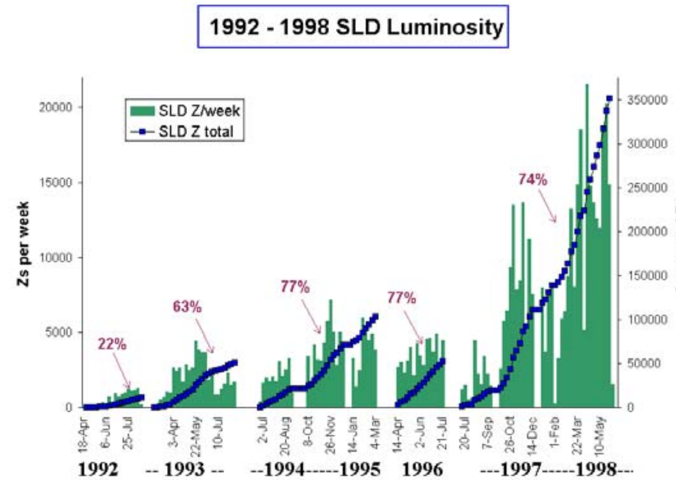
- Demonstrate the drive beam scheme
- Develop RF structures and technology

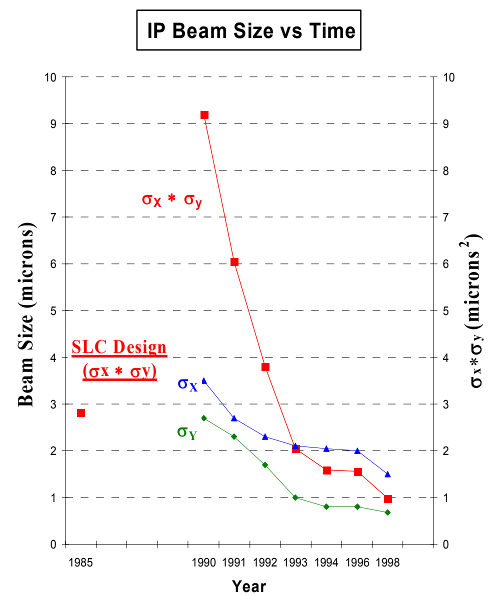


Lessons from the SLC

SLC = SLAC Linear Collider





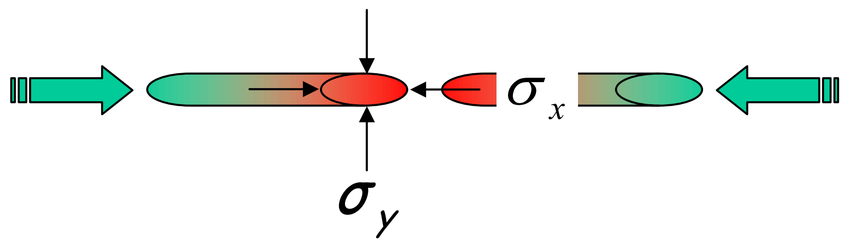


New Territory in Accelerator Design and Operation

- Sophisticated on-line modeling of non-linear beam physics.
- Correction techniques (trajectory and emittance), from hands-on by operators to fully automated control.
- Slow/fast feedback theory and practice.

All you need is... Luminosity

$$L \propto \frac{N_e^2}{\sigma_x \sigma_y}$$



$$L \propto n_b \times f_{rep}$$

L = Luminosity

N_e = # of electron per bunch

$\sigma_{x,y}$ = beam sizes at IP

IP = interaction point

$$L \propto \frac{P_b}{E_{c.m.}} \times \frac{N_e}{\sigma_x \sigma_y}$$

N_b = # of bunches per pulse

F_{rep} = pulse repetition rate

P_b = beam power

$E_{c.m.}$ = center pf mass energy

Parameters to play with

- ↓ Reduce beam emittance ($\varepsilon_x \cdot \varepsilon_y$) for smaller beam size ($\sigma_x \cdot \sigma_y$)
- ↑ Increase bunch population (N_e)
- ↑ Increase beam power ($P_b = N_e \cdot n_b \cdot f_{rep}$)
- ↑ Increase beam to-plug power efficiency for cost

LC status at second ILC-TRC

January 2003 E_{cm} = 500 GeV

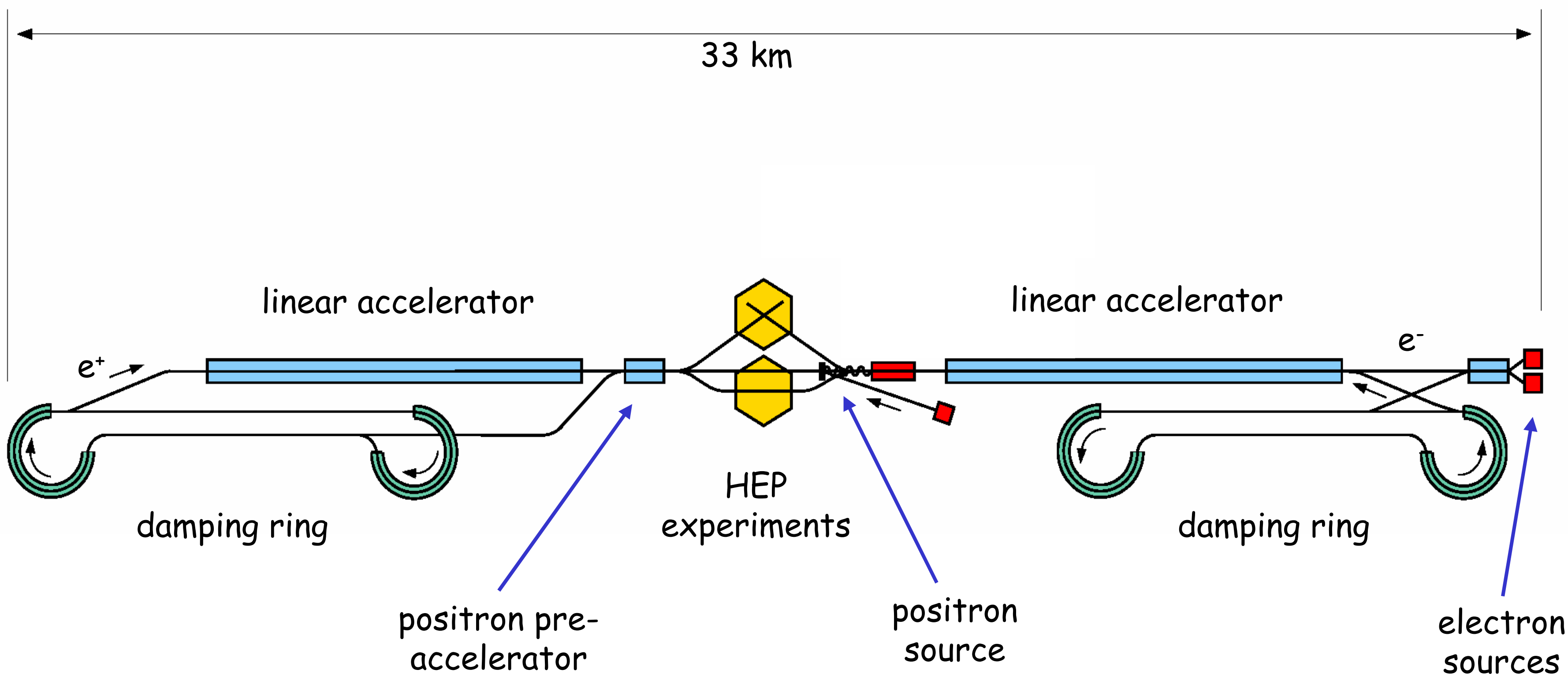
	TESLA	SBLC	JLC-S	JLC-C	JLC-X/NLC	VLEPP	CLIC
f [GHz]	1.3			5.7	11.4		30.0
$\mathcal{L}\times10^{33}$ [$cm^{-2}s^{-1}$]	34			14	20		21
P_{beam} [MW]	11.3			5.8	6.9		4.9
P_{AC} [MW]	140			233	195		175
$\gamma\varepsilon_y$ [$\times10^{-8}$m]	3			4	4		1
σ_y^* [nm]	5			4	3		1.2

Second to first ILC-TRC Comparison

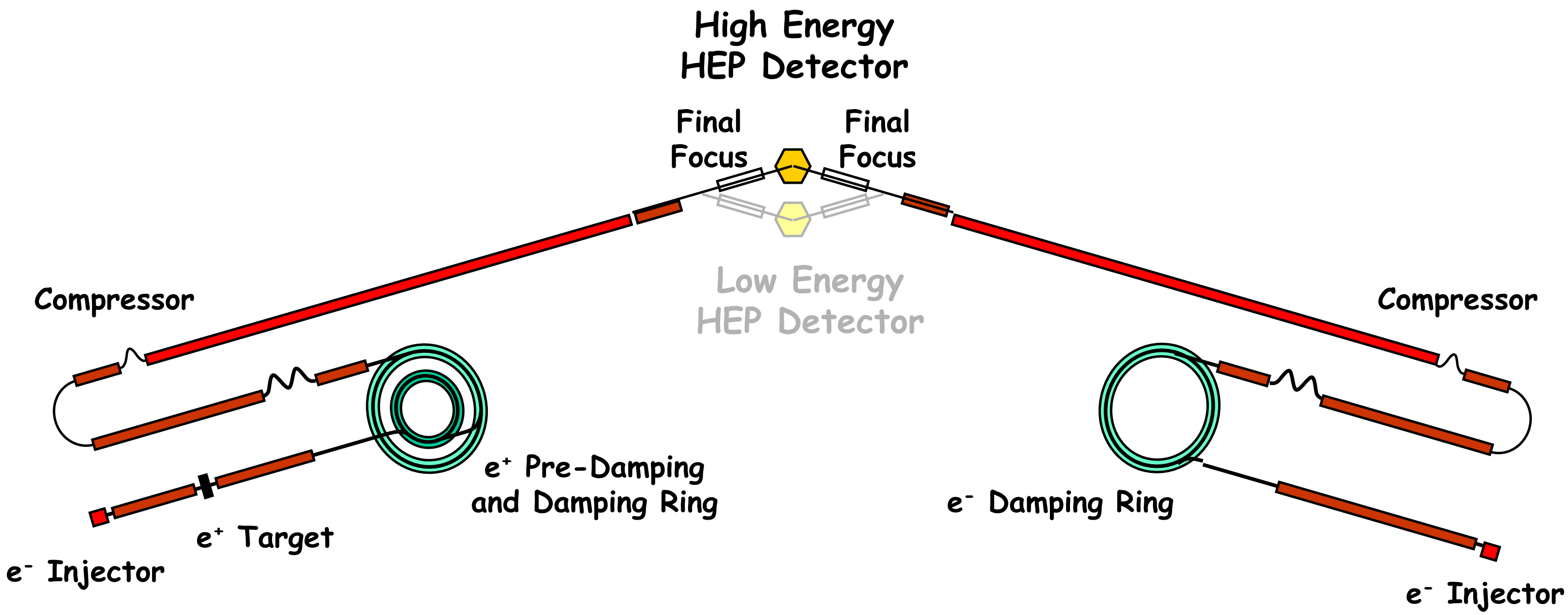
2003 vs. 1995 E_{cm}= 500 GeV

	TESLA 2003	TESLA 1994	JLC/NLC 2003	<JLC/NLC> 1994	CLIC 2003	CLIC 1994
f [GHz]	1.3	1.3	11.4	11.4	30.0	30.0
$\mathcal{L}\times10^{33}$ [$cm^{-2}s^{-1}$]	34	6	20	6	21	1-5
P_{beam} [MW]	11.3	16.5	6.9	3.7	4.9	1-4
P_{AC} [MW]	140	164	195	110	175	100
$\gamma\varepsilon_y$ [$\times10^{-8}$m]	3	100	4	5	1	15
σ_y^* [nm]	5	64	3	3	1.2	7.5

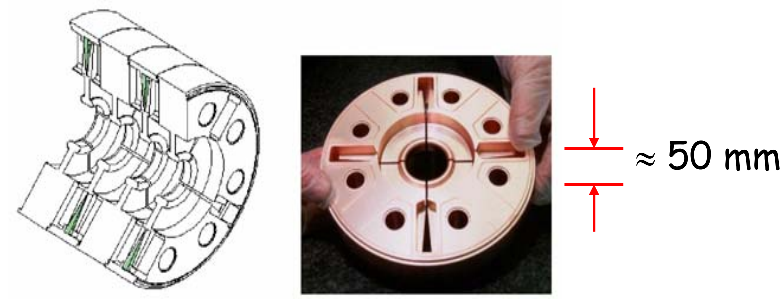
TESLA 0.5 - 0.8 TeV c.m.



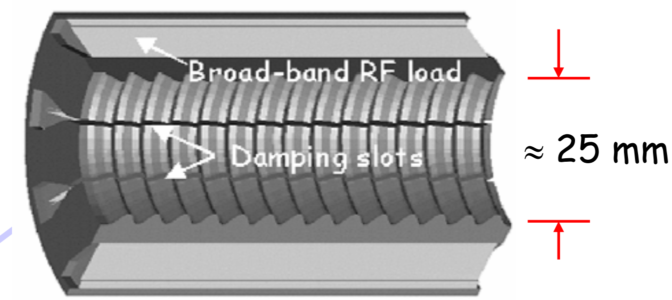
NLC/JLC 0.5 – 1.0 TeV c.m.



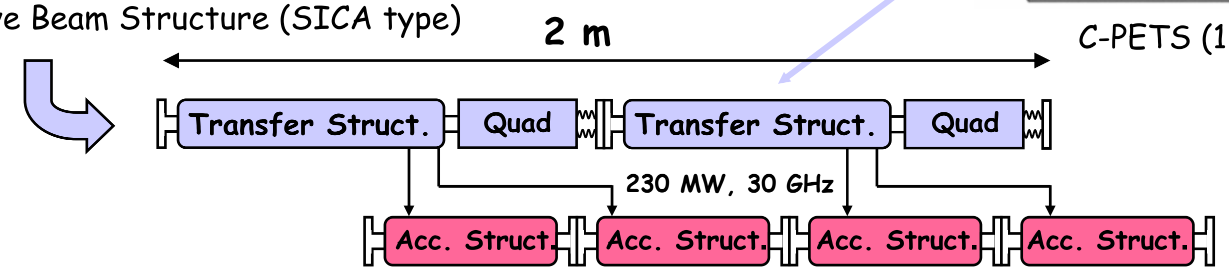
The CLIC Idea

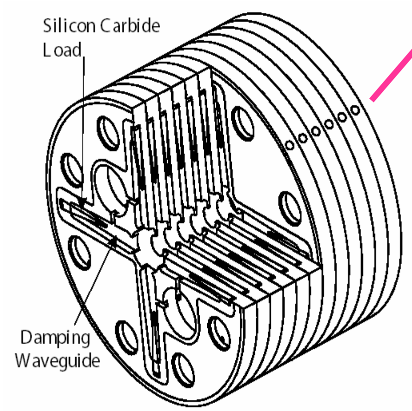


CLIC Drive Beam Structure (SICA type)

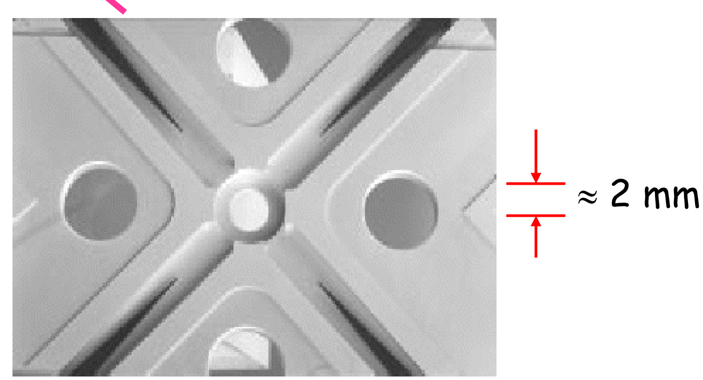


C-PETS (12 damping slots)

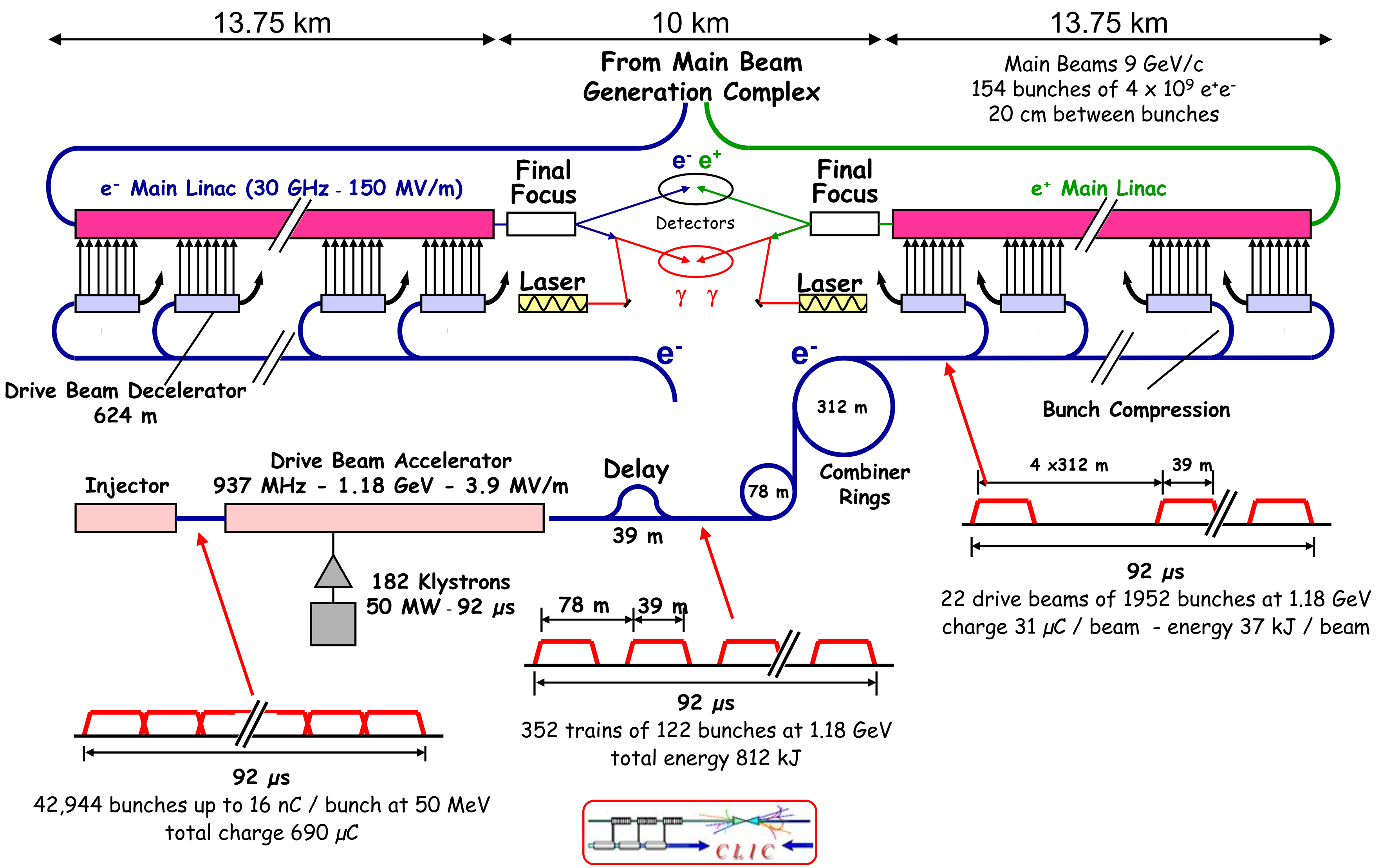




Tapered-Damped Structure (30 GHz)



CLIC 3 GeV c.m. Layout

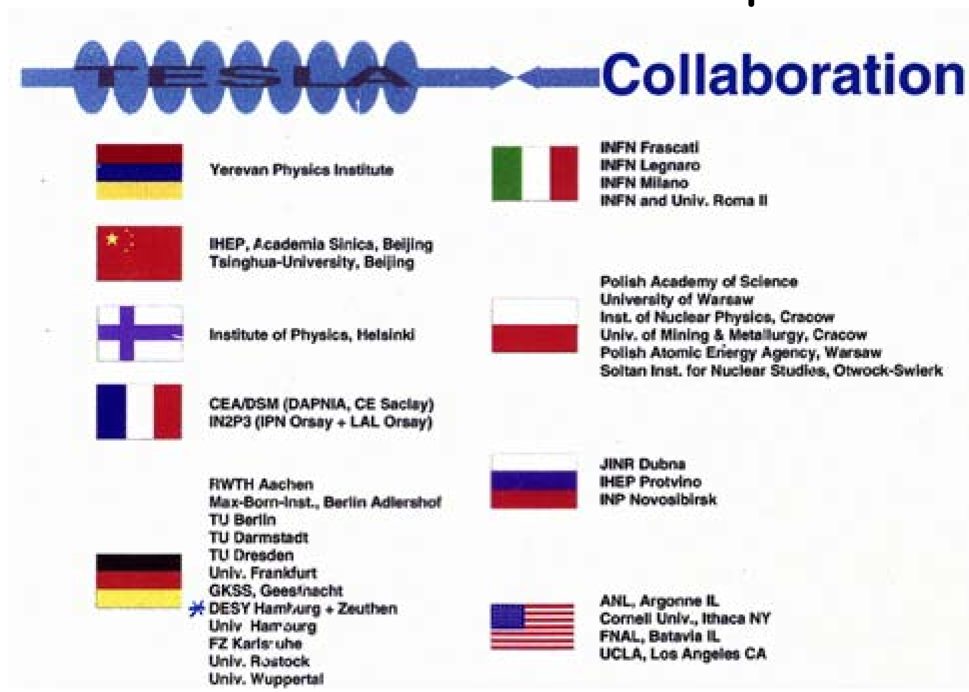


The TESLA challenge

Physical limit at 50 MV/m → **≥25 MV/m should be possible**

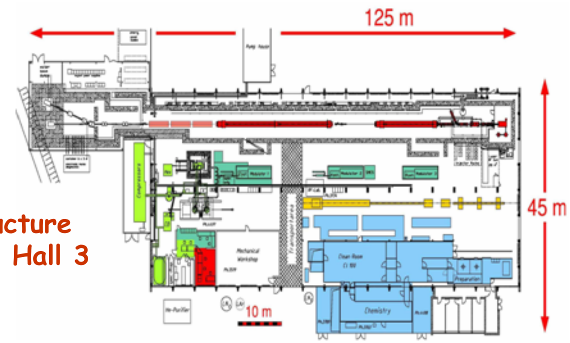
→ **Common R&D effort for TESLA**
- Higher conversion efficiency
- Smaller emittance dilution

1992 - TESLA Collaboration set up at DESY



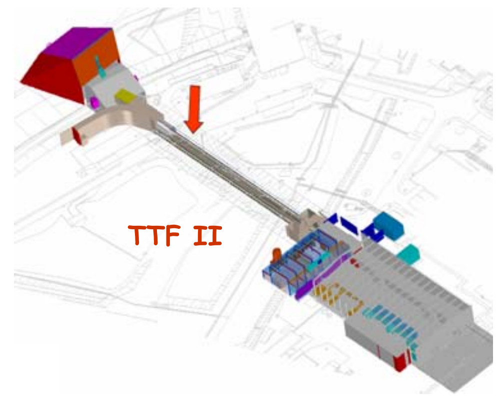
TESLA Milestones

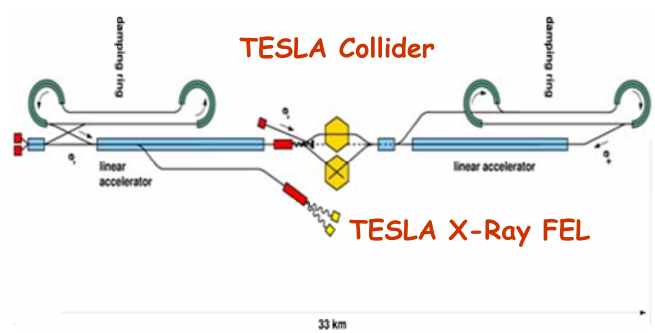
- 23-26 July 1990 – 1° International TESLA Workshop @ Cornell University
- 7-9 August 1991 – 1° Meeting on SC Cavities and TESLA @ DESY
- February 1992 – 1° TESLA Collaboration Board Meeting @ DESY
- March 1993 - "A Proposal to Construct and Test Prototype Superconducting RF Structures for Linear Colliders"
- March 1995 -TESLA Test Facility Linac Design Report-A VUV Free Electron Laser at the TESLA Test Facility at DESY
- May 1996 – First beam at TTF
- March 2001 – First SASE-FEL Saturation
- March 2001 – TESLA Technical Design Report
- February 2003 – Positive news from German Government



Infrastructure @ DESY in Hall 3

TTF I





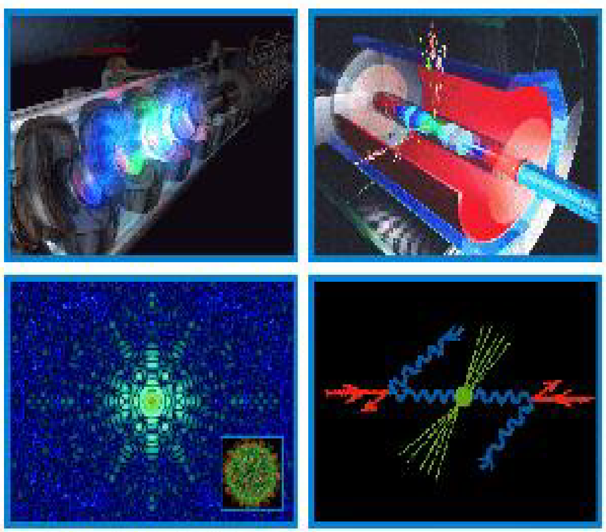
The TESLA TDR

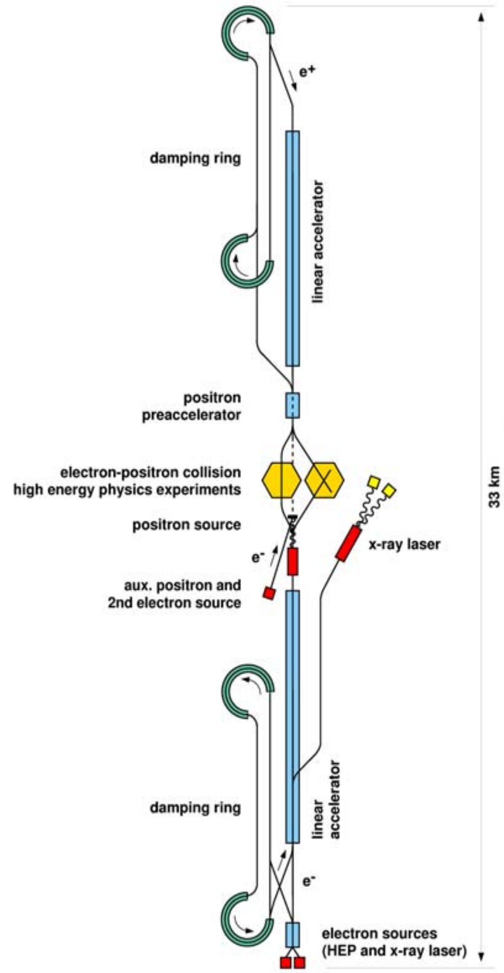
TESLA

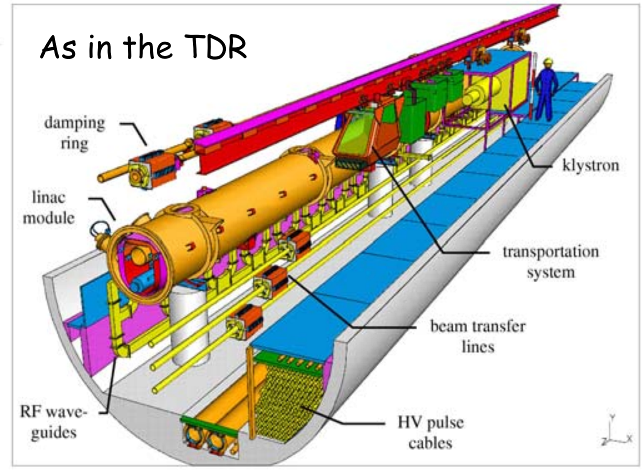
The Superconducting Electron-Positron Linear Collider

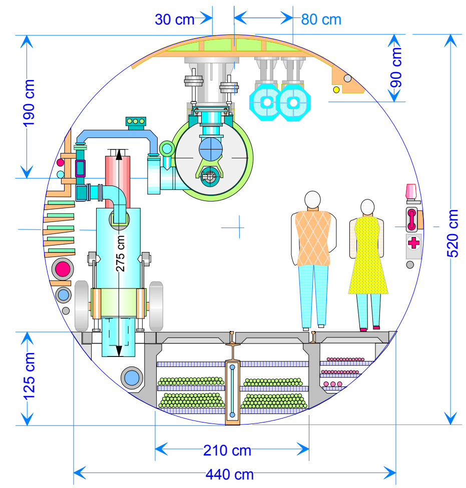
with an Integrated X-Ray Laser Laboratory

Technical Design Report







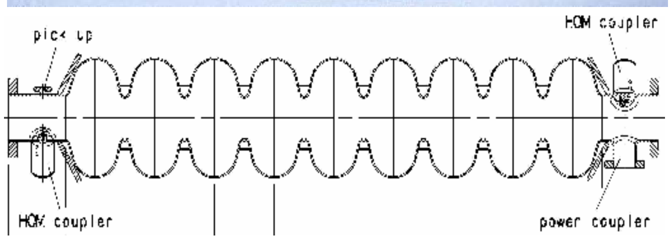


Updated tunnel cross section

The 9-cell TESLA cavity

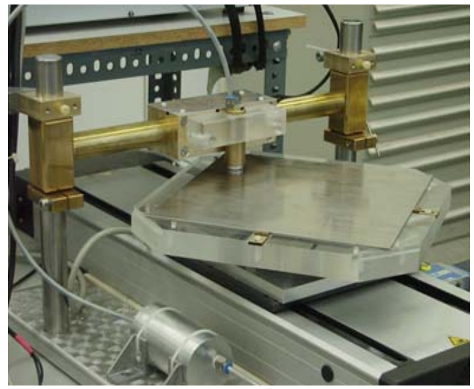
Major contributions from: CERN, Cornell, DESY, CEA-Saclay

- **9-cell, 1.3 GHz**



TESLA cavity parameters

R/Q	1036	Ω
E_{peak}/E_{acc}	2.0	
B_{peak}/E_{acc}	4.26	mT/(MV/m)
$\Delta f/\Delta l$	315	kHz/mm
$K_{Lorentz}$	≈ -1	$Hz/(MV/m)^2$


Eddy-current scanning system for niobium sheets


Cleanroom handling of niobium cavities

Preparation Sequence

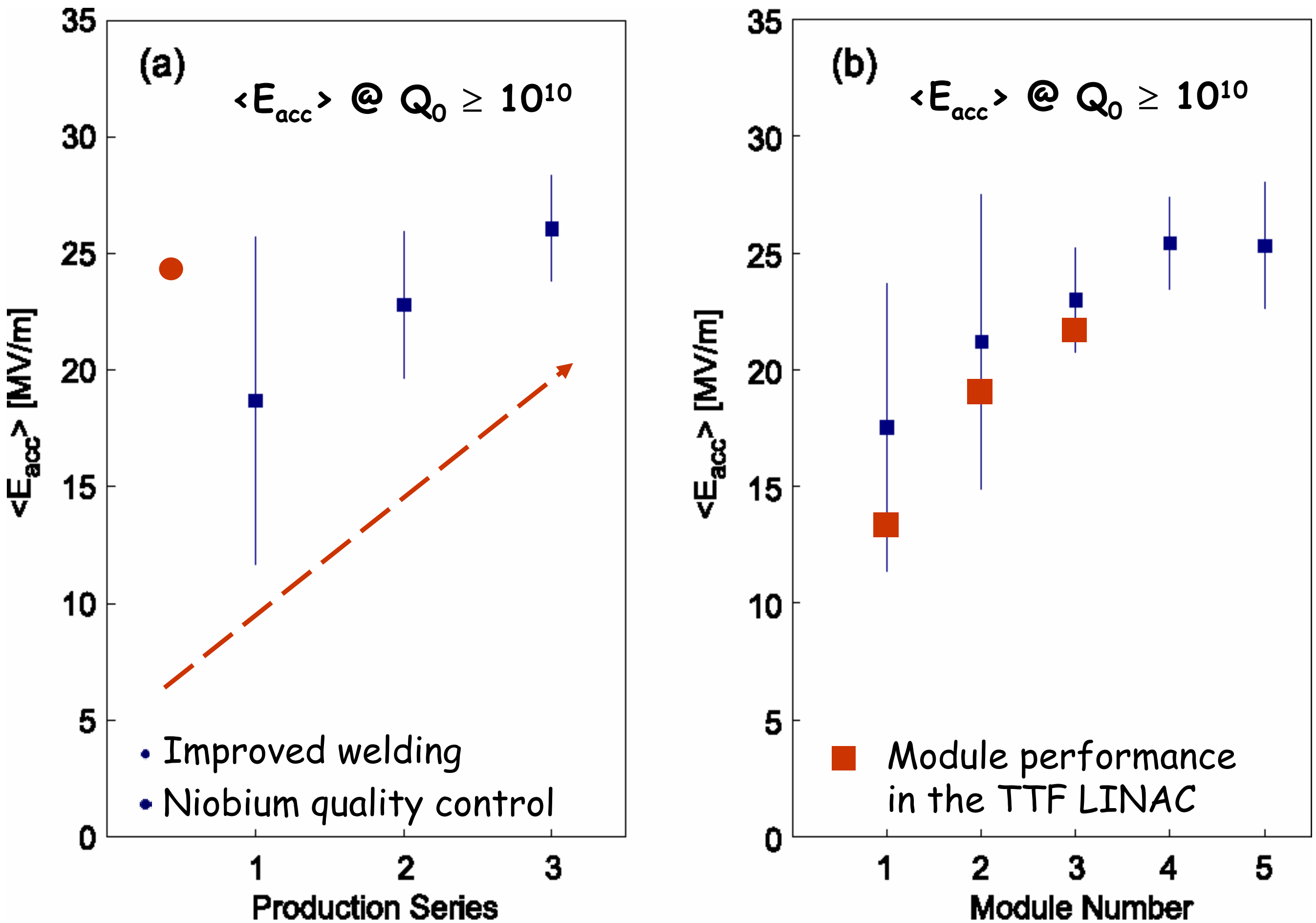
- Niobium sheets (RRR=300) are scanned by eddy-currents to detect avoid foreign material inclusions like tantalum and iron
- Industrial production of full nine-cell cavities:
  - Deep-drawing of subunits (half-cells, etc.) from niobium sheets
  - Chemical preparation for welding, cleanroom preparation
  - Electron-beam welding according to detailed specification
- 800 °C high temperature heat treatment to stress anneal the Nb and to remove hydrogen from the Nb
- 1400 °C high temperature heat treatment with titanium getter layer to increase the thermal conductivity (RRR=500)
- Cleanroom handling:
  - Chemical etching to remove damage layer and titanium getter layer
  - High pressure water rinsing as final treatment to avoid particle contamination

Learning curve till 2000

3 cavity productions from 4 European industries: Accel, Cerca, Dornier, Zanon

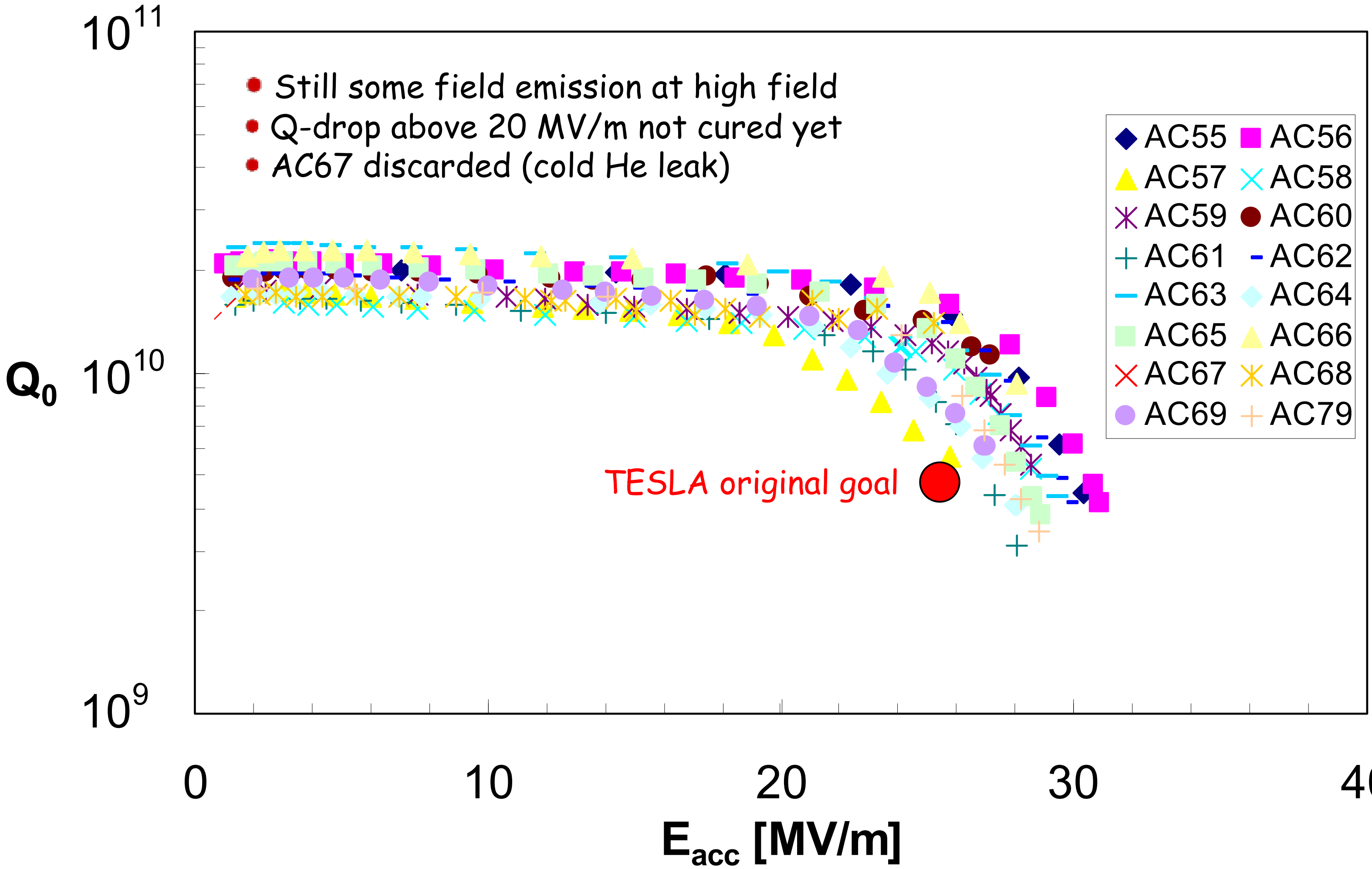
Cornell 1995

5-cell



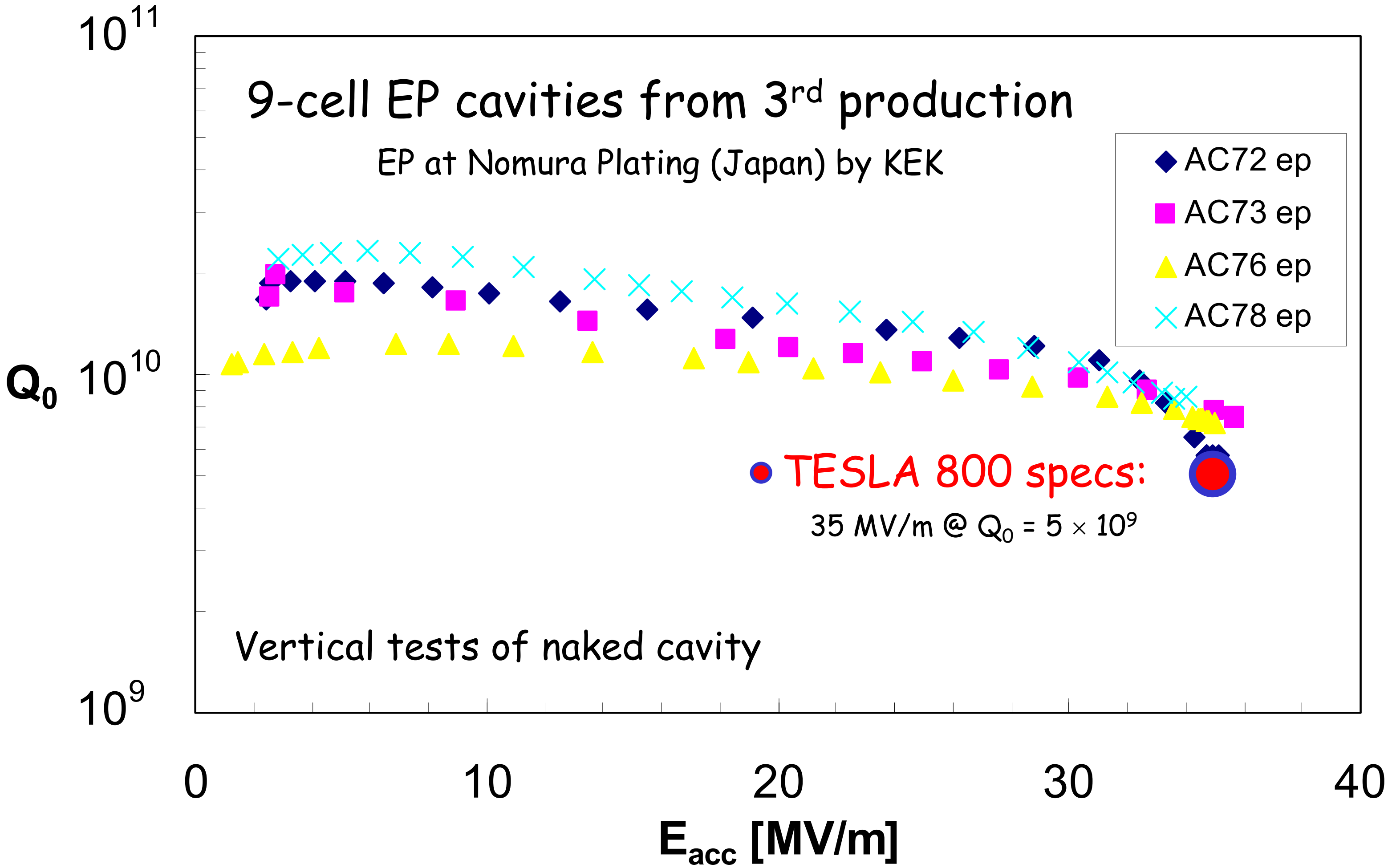
3rd cavity production with BCP

BCP = Buffered Chemical Polishing



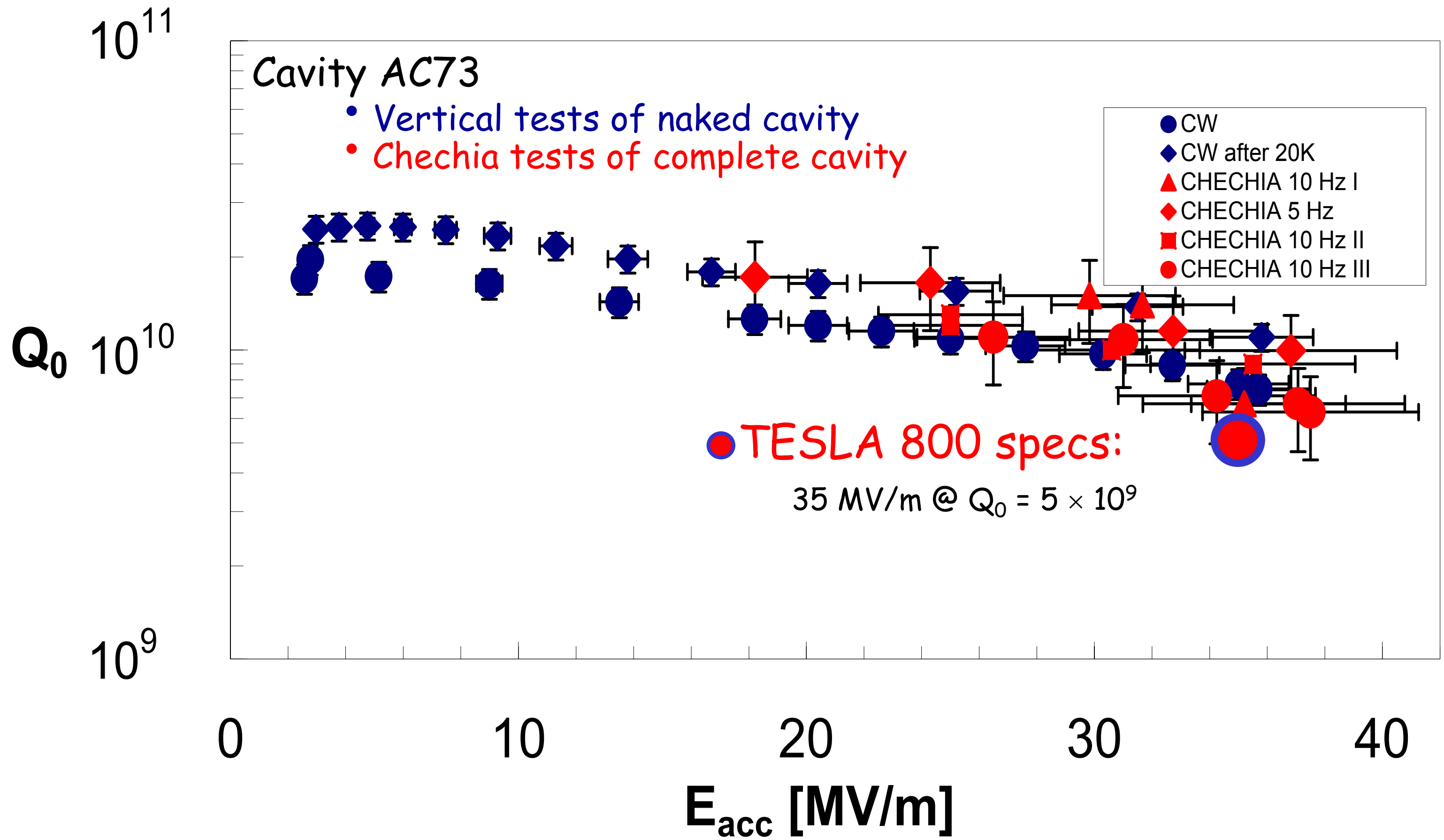
TESLA 800 Performances with EP

EP (Electro-Polishing) developed at KEK by Kenji Saito (originally by Siemens)
Coordinated R&D effort: DESY, KEK, CERN and Saclay



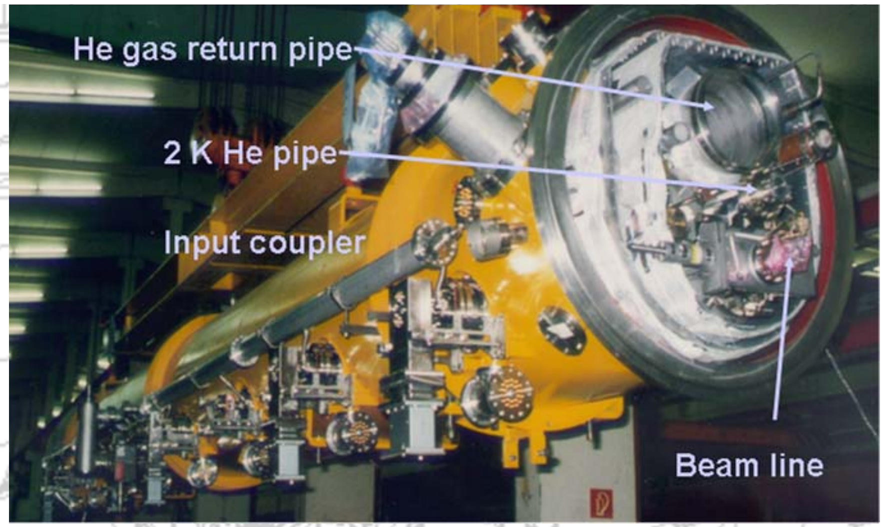
TESLA 800 in Chechia

- Long Term (> 1000 h) Horizontal Test
- In Chechia the cavity has all its ancillaries
- Chechia behaves as 1/8th (1/12th) of a TESLA cryomodule



Performing Cryomodules

Three generations of the cryomodule design, with improving simplicity and performances, while decreasing costs

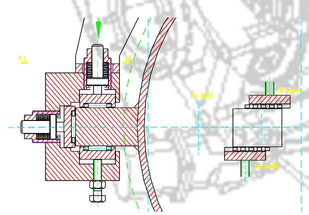


Cryomodule Characteristics

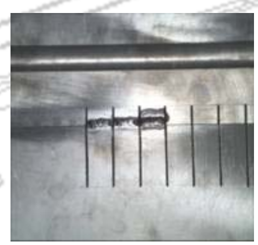
Length		12	m
# cavities		8	
# doublets		1	
Static Losses	@ 2 K	1.5	W
	@ 5 K	8	W
	@ 50 K	70	W

Required plug power < **6 kW**

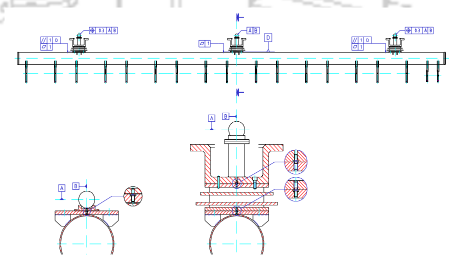
Sliding Fixtures @ 2 K



"Finger Welded" Shields

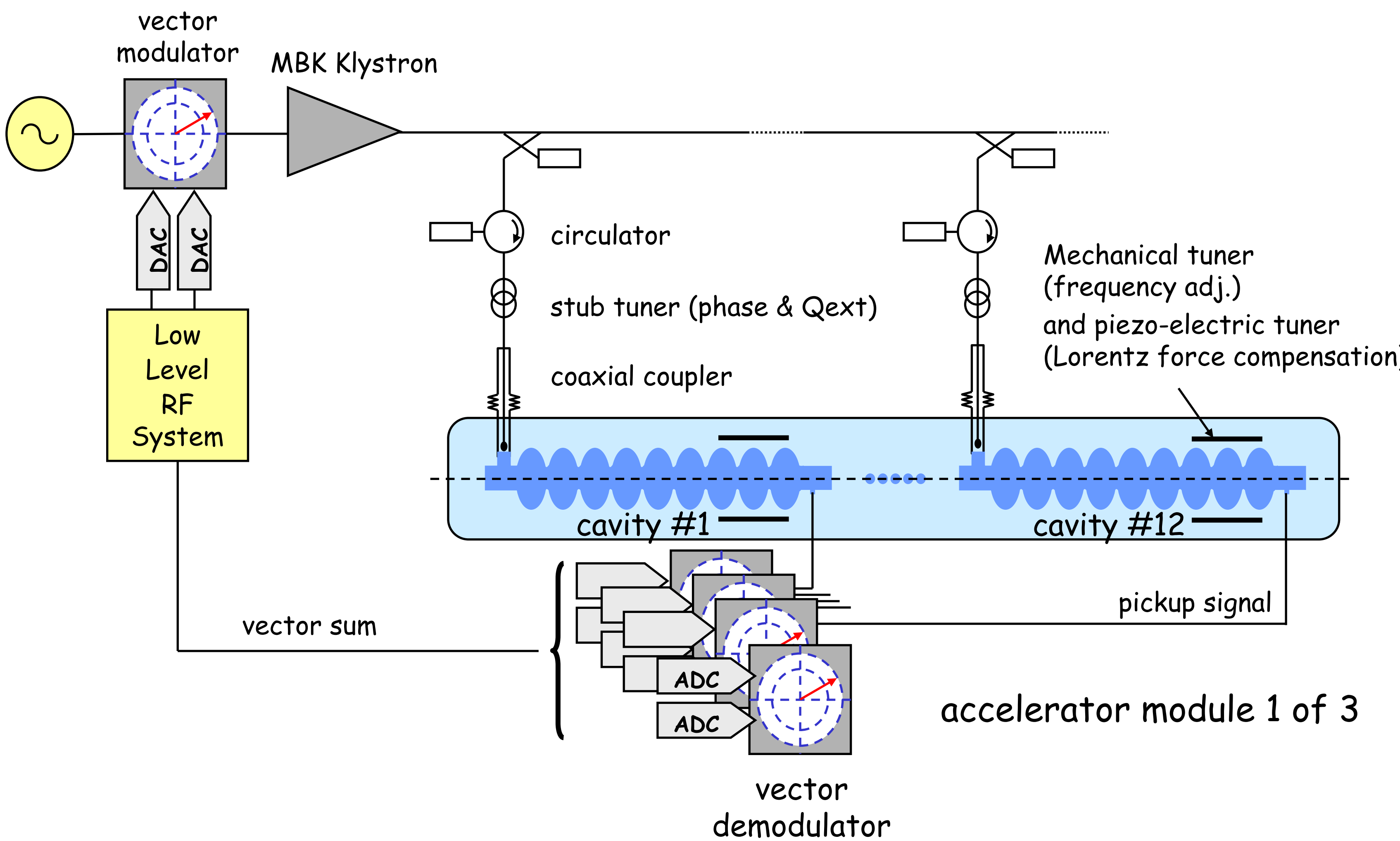


Reliable Alignment Strategy



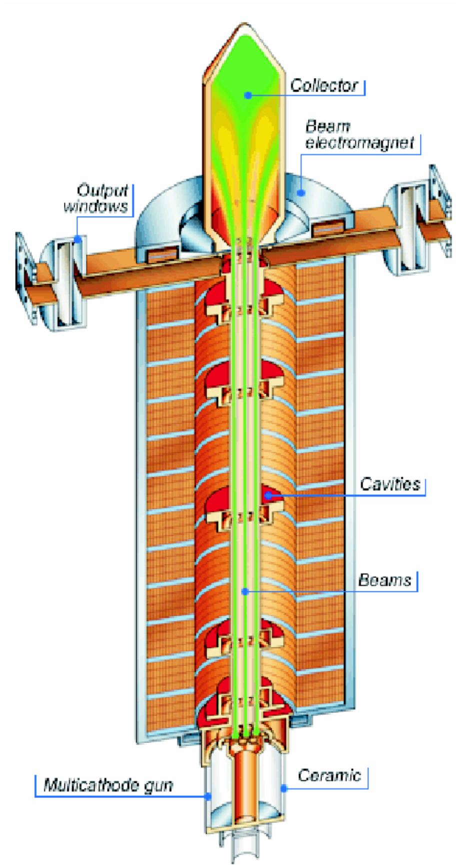
TESLA RF Unit

1 klystron for 3 accelerating modules, 12 nine-cell cavities each



TESLA Multi Beam Klystrons

Three Thales TH1801 Multi Beam Klystrons have been produced and tested



MBKs reduce HV and improve the efficiency: lower space charge.

Seven beams, 18.6 A, 110 kV, produce 10 MW with 70% eff.

Cathodes are still the weak point

Operational experience

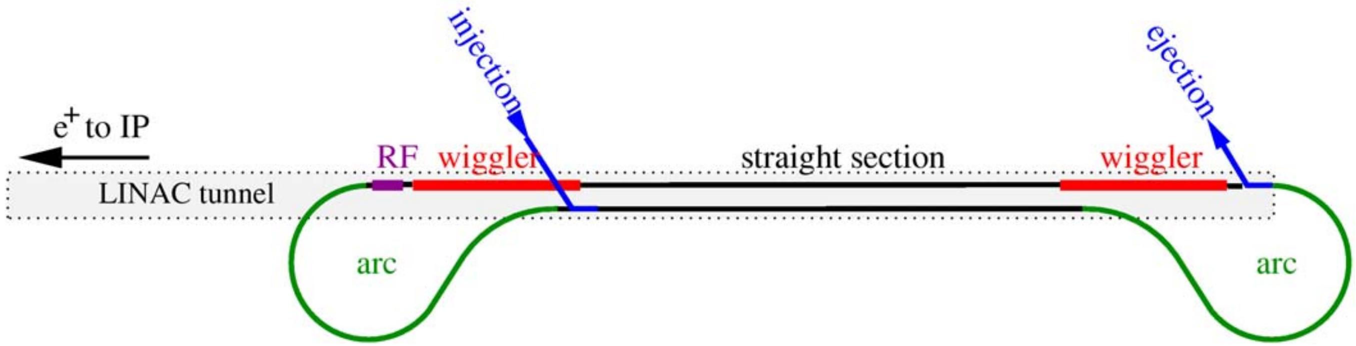
Achieved efficiency	65%
RF pulse width	1.5 ms
Repetition rate	5 Hz
Operation experience	> 5000 h

10% of operation time at full spec's

A new design proposed by Toshiba looks more robust and should reach 75% efficiency

One TESLA design problem

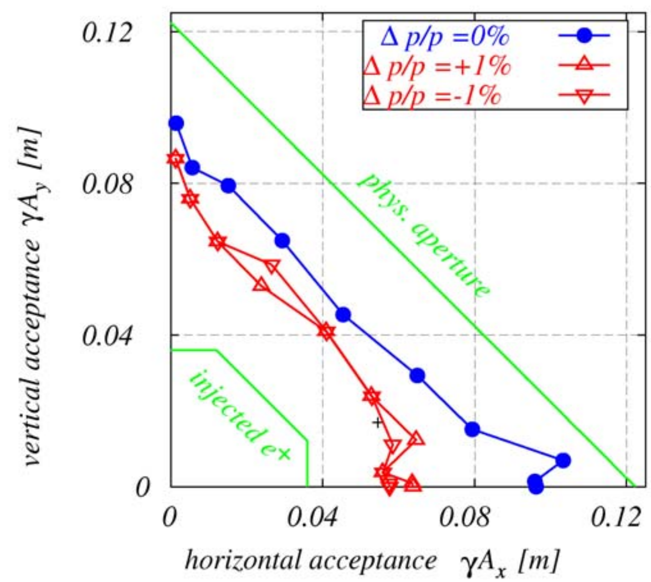
Very long damping rings: at present 17 km



Electron cloud and beam-ion instability effects:

- more simulation effort required,
- impact on vac. sys. layout?
- Problem with coupling bump?

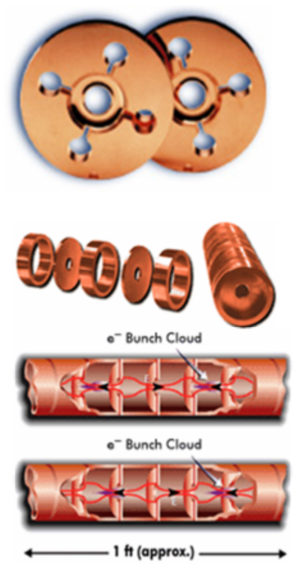
Dynamic aperture with sextupoles OK, but not yet sufficient with present wiggler model



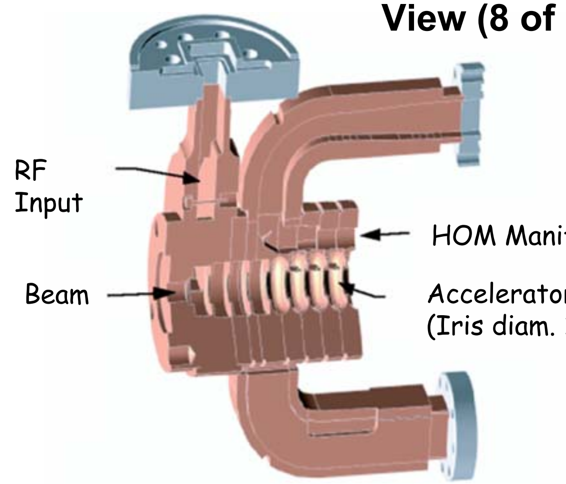
NLC/JLC RF Structures

Rounded Damped-Detuned Structure (RDDS)

Frequency	11.4	GHz
RF mode	$2\pi/3$	
Acc. Gradient	70	MV/m
Iris diameter	11.2–7.8	mm



RDDS Cutaway View (8 of 206 cells)



Made with Class 1 OFE **Copper**.

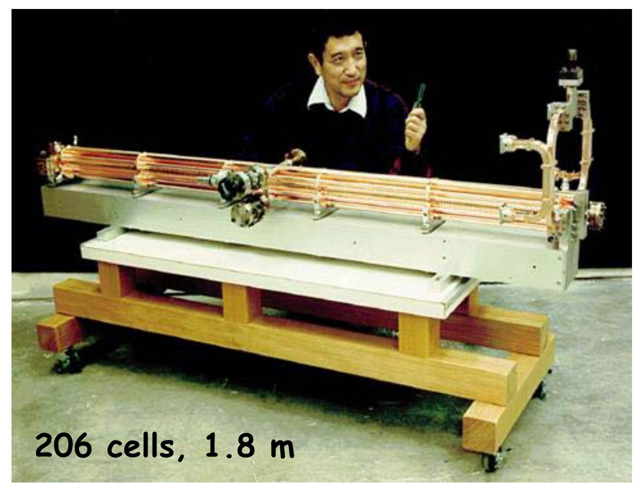
Cells are precision machined (few μm tolerances) and diffusion bonded to form structures.

Fill time ≈ attenuation time ≈ 100 ns, i.e. length 1.8 m.

Operated at 45°C with water cooling.

RF losses approx. 3 kW/m

RF ramped during filling to compensate beam loading (21%).
In steady state ~ **50% input power goes into the beam.**



Surface damage problem

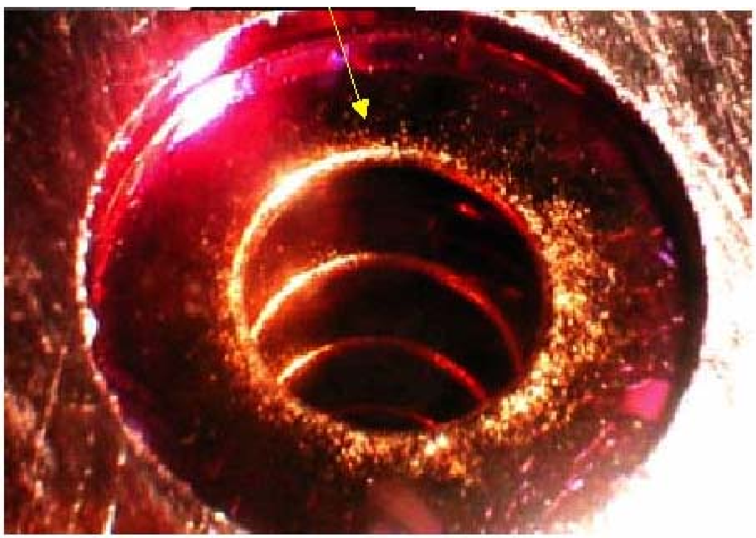
An unexpected problem...

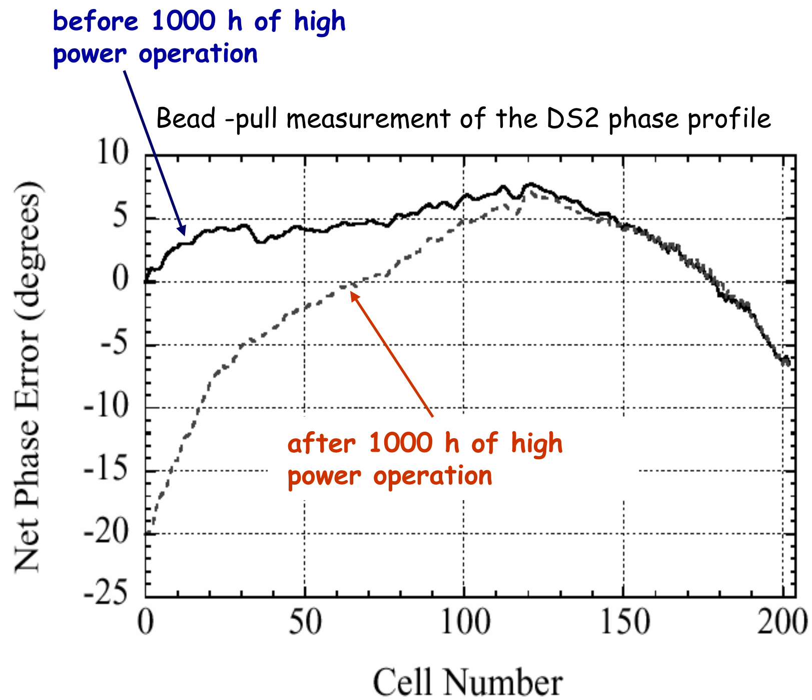
During conditioning of the first long NLC structures changes in the field profile were observed.

- surface damage due to field emission

- crater with approx. 30 μm diameter

- after 1000 h high power operation a 20 deg. phase error was measured

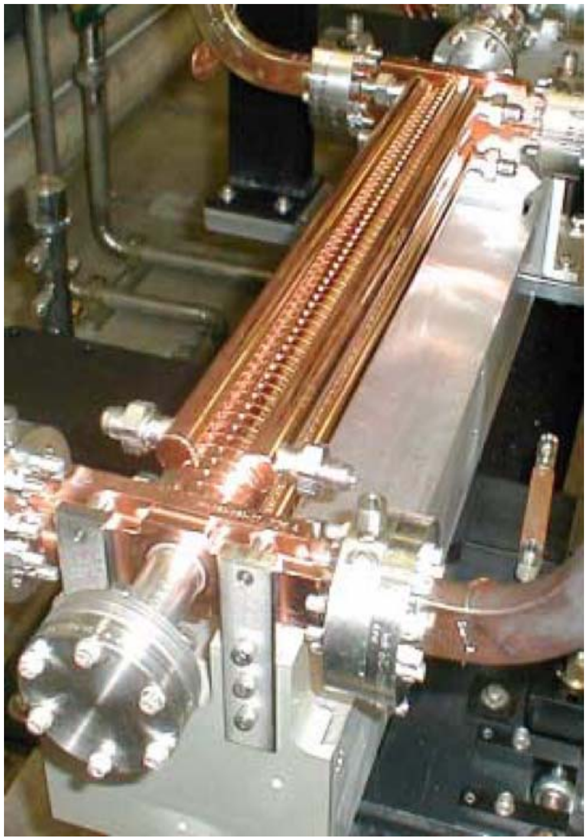




C. Adolphson et al., RF Processing of X-Band Accelerator Structures at the NLCTA, LINAC 2000 Conference

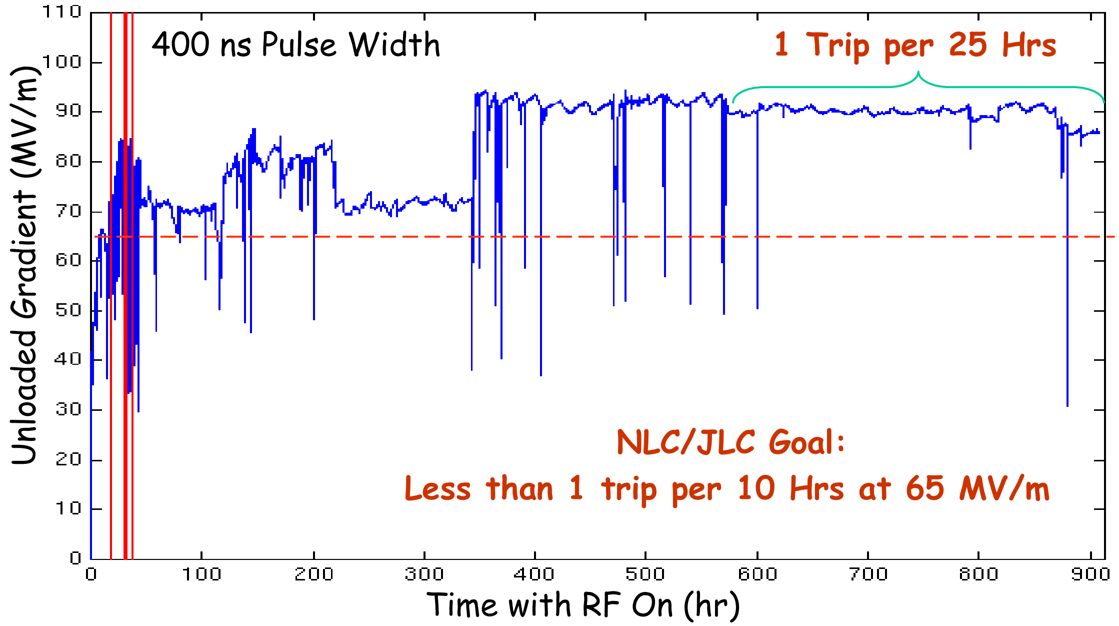
Shorter structures required

New designs with lower v_g



53 cm Traveling-Wave Structure
Group velocity 3.3% ↘ 1.6% c

Type T structure results: No Change in MW Properties



But

The T-Series design cannot be used in the NLC/JLC.

- average iris radius, <a/l> smaller (0.13) than desired (0.17-0.18),
- transverse wakefield 3 times larger than acceptable.

Structures with <a/l> = 0.17- 0.18 and with full damping.

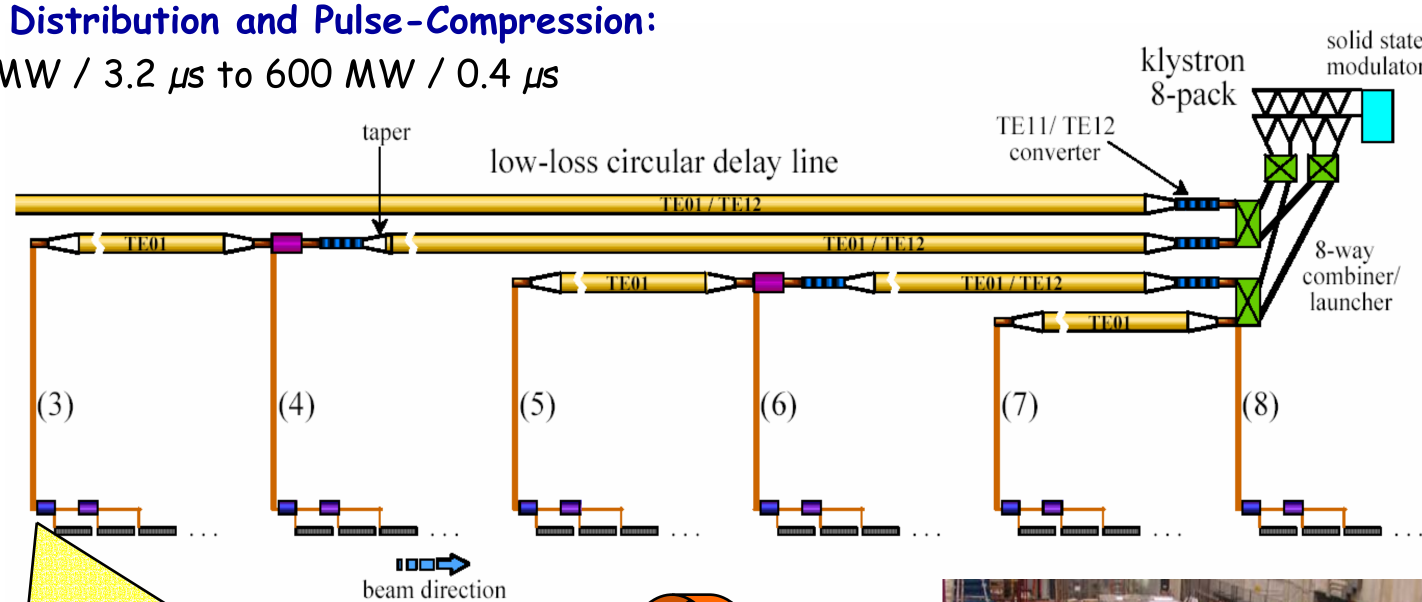
Tests of 60 cm structures reach 65 MV/m, little overhead.
Designs with higher shunt impedance in fabrication. Test in Fall.

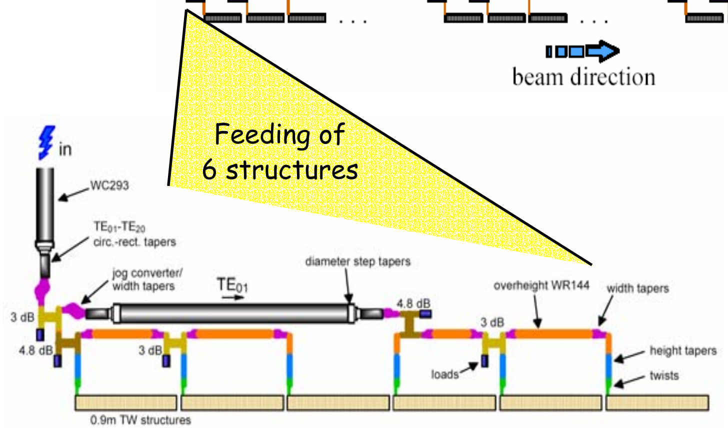
NLC/JLC RF Unit and DLDS

DLDS = Delay Line Distribution System (2 Mode, 4 Lines)

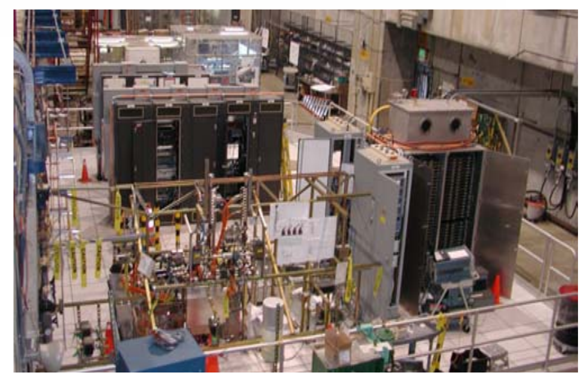
RF Power Distribution and Pulse-Compression:

from 75 MW / 3.2 μs to 600 MW / 0.4 μs





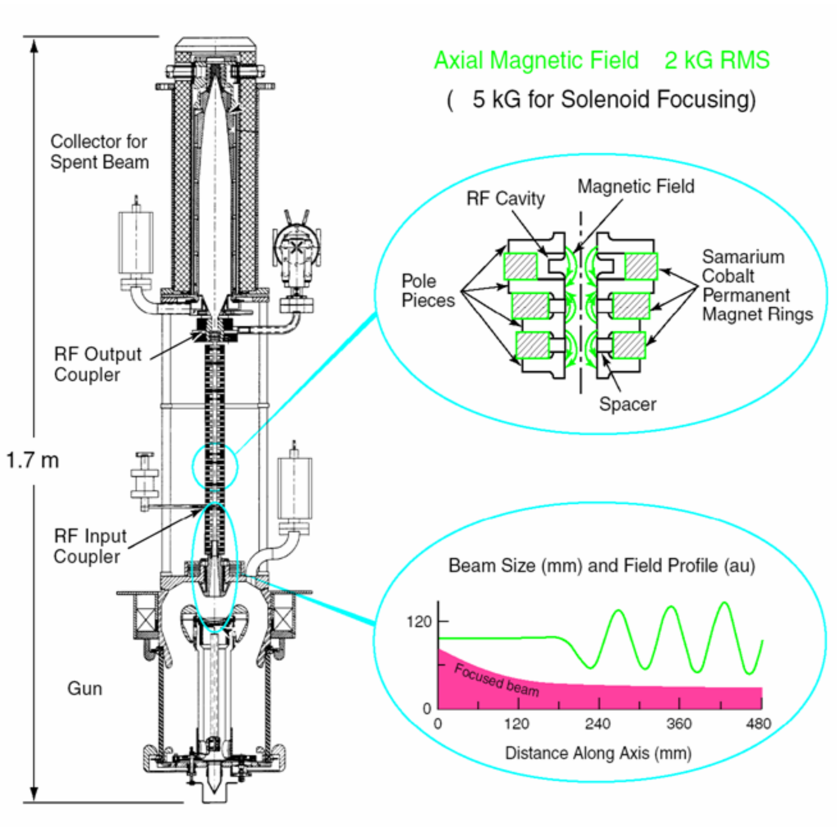
in 2004



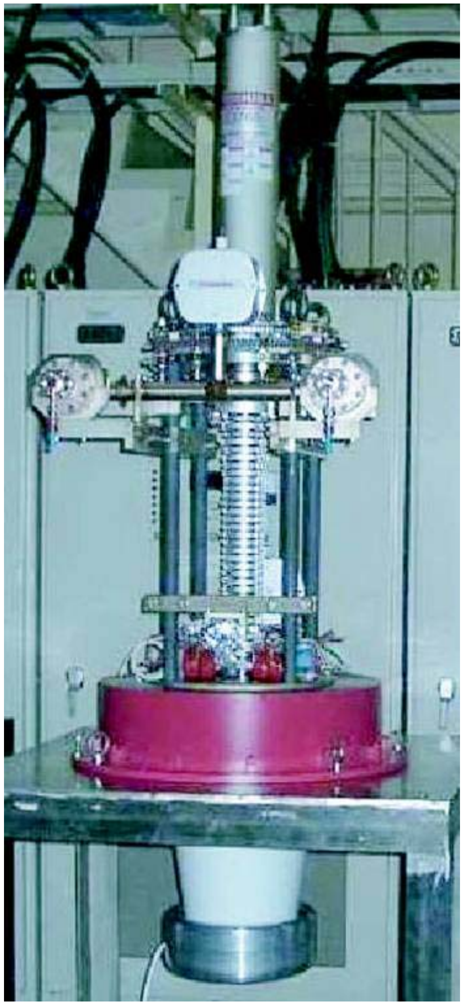
JLC-NLC TeV SLED-II Test

NLC/JLC Klystron Programs

NLC XP-Klystron



JLC PPM



Major concern is still 150 Hz repetition rate:
Insufficient average power handling for both Klystron and Modulator

Superconducting Linac for LC

Advantages

- Low frequency – wakes weak, klystrons easy
- Low power loss in walls of structure
- Low input power (230 kW per structure)
- Low beam current (8 mA)
- Long bunch spacing (337 ns) so bunch-by-bunch control easy
- Standing-wave cavities have gradient uniform along length

Disadvantages

- Tight frequency tolerances, mechanical tuners needed on all cavities
- Beam instrumentation more difficult (large apertures)
- Long bunch train requires long DR (17 km around)
- Low repetition rate (5 Hz) makes train-by-train control hard
- Lower gradients

High-Frequency Linac for LC

Advantages

- Higher gradients available
- Frequency tolerance looser than SC
- High repetition rate good for train-by-train control
- Short trains good for damping ring
- Beam instrumentation easier

Disadvantages

- Strong wakefields – cavity beam based alignment required
- High power (100 MW per structure) required
- Klystrons harder
- Short bunch spacing (1.4 ns) hard for bunch-by-bunch control
- Wall losses reduce efficiency
- Gradient in front of structure higher than average gradient

2nd ILC-TRC Time-Line and Charge

Time-line

- Summer 2001: ICFA requests report
- Autumn 2001: WGs formed
- 2002 WGs meet 4 times during the year to
  - define tasks, review progress, formulate summary
- October 2002: Greg Loew formally reports at ICFA seminar
- January 2003: Published!

Charge

- To assess the present technical status of the four LC designs at hand, TESLA, NLC/JLC-X, JLC-C and CLIC and their potentials for meeting the advertised parameters at 500 GeV c.m. Use common criteria, definitions, computer codes, etc., for the assessments.
- To assess the potential of each design for reaching higher energies above 500 GeV c.m.
- To establish, for each design, the R&D work that remains to be done in the next few years.
- To suggest future areas of collaboration.

TRC Working Group Methodology

Methodology

- Review current designs and status (achievements) of R&D, particularly the test facilities
- Identify the positive aspects of the designs
- Identify those areas of 'concern' and
- identify R&D that needs to be done to address these issues
- Categorise (rank) the R&D items

Ranking Criteria

- **R1**: **R&D needed for feasibility demonstration of the machine.**
- **R2**: R&D needed to finalize design choices and ensure reliability of the machine.
- **R3**: R&D needed before starting production of systems and components.
- **R4**: R&D desirable for technical or cost optimization.

Rankings Score Sheet

	TESLA		JLC-C	JLC-X/NLC		CLIC		Common
E_{cm} [GeV]	**500**	800	500	**500**	1000	500	3000	
R1	**0**	1	2	**2**	0	5	2	0
R2	**7**	4	2	**3**	0	6	2	8
R3	**10**	3	3	**11**	0	5	0	19
R4	**1**	0	1	**2**	2	0	0	8

R1: is a feasibility demonstration required?

R1: R&D needed for feasibility demonstration of the machine.

	Modulators	Klystrons	RF Distribution	Accelerator Structures
TESLA	No	No	No	No (500 GeV) Yes (800 GeV)
NLC/JLC-X	No	No	Yes	Yes
JLC-C	No	No	Yes	Yes
CLIC	Yes	Yes	Yes	Yes

From Chris Adolphsen talk at ALCW, July 2003

R1 Comparison

TESLA

E_{cm} = 500 GeV

- No feasibility demonstration is required for TESLA 500

E_{cm} = 800 GeV

- Building and testing of a cryomodule at 35 MV/m and measurements of dark current by end 2003
  - Delayed by budget constraints
  - Very unlikely to happen before 2005!
  - In conflict with TTF as VUV FEL user facility
- What can be done with present resources till end 2004?
  - Test few cavities, fully equipped in the horizontal cryostat “Chechia”
  - Test one 35 MV/m cavity in one TTF module with beam

NLC/JLC

E_{cm} = 500 GeV & 1 TeV

- Test of complete accelerator structure at design gradient with detuning and damping, including study of breakdown and dark current
- Demonstration of SLED-II pulse compressor at full power
- Goal: end of 2003 for proof of principle tests
- Goal delayed to 2004

Common R2 Items

Common items related to all designs

- **Damping Rings**
  - Electron cloud effects
  - fast ion instabilities
  - Extraction kicker stability
  - Tuning simulations
- **LET: Low Emittance Transport**
  - Static tuning studies
  - girder/cryomodule prototypes to study stability (vibration)
  - Critical beam instrumentation
- **Reliability**
  - Detailed evaluation of critical sub-systems reliability

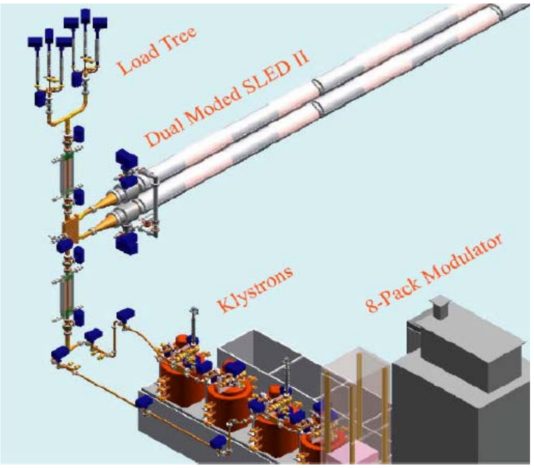
R2 Comparison

TESLA

- Test of complete main linac RF sub-unit (as in TDR) with beam
- Tests of several cryomodules running at gradient 23.4 MV/m for a prolonged period of time
  - quench rates, breakdowns, dark current
- One versus two tunnels (reliability)
- DR dynamic aperture
  - wiggler end fields
  - minimise injection losses (P_{inj}=220kW)
- DR kicker development
- Head-on versus crossing angle
  - extraction lines issues

NLC/JLC

- Test of complete X-band main linac RF sub-unit (as described in baseline design) with beam
- Full test of KEK 75 MW 1.6μs PPM klystron at 150/120 Hz
- Full test of SLAC induction modulator



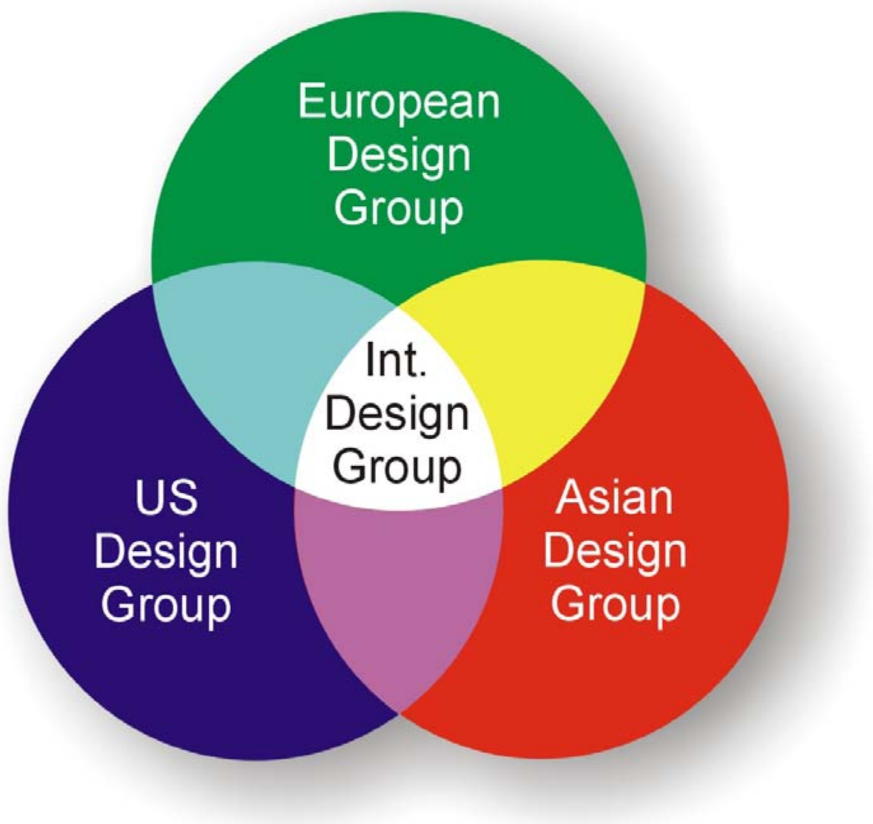
A few comments on ILC-TRC

- Rankings reflect the concerns of the working groups, but ILC-TRC overall findings were extremely positive
- "did not find any insurmountable obstacle to building TESLA, JLC-C, JLC-X/NLC within the next few years…"
- "also noted that the TESLA linac RF technology for 500 GeV c.m. is the most mature."
- Assuming the R1s are demonstrated (hopefully by the end of 2003), the RF systems of the two machines will be on an equal footing…
- The ILC-TRC is a excellent example of what we can achieve when the LC accelerator communities work together
- Attempts to maintain the 'momentum' post ILC-TRC are dwindling

LC global scenario

- Priority on LC worldwide accepted and agreement on fundamental parameters converging
- International Linear Collider Steering Group, ILCSG, and associated panels, are working
- 12 "wise men" for technology choice have been nominated
- Technology choice expected by end 2004
- Regional and international design groups are being formed
- Globally coordinated R&D and design work, on a common chosen technology, is expected from beginning 2005
- Funding should hopefully start on 2007/08
- First data on 2015
- Overlap with LHC is conceivable
- Other important activities
  - Official US Studies for comparison and costing
  - CARE has been funded by the European Community

LC design study groups

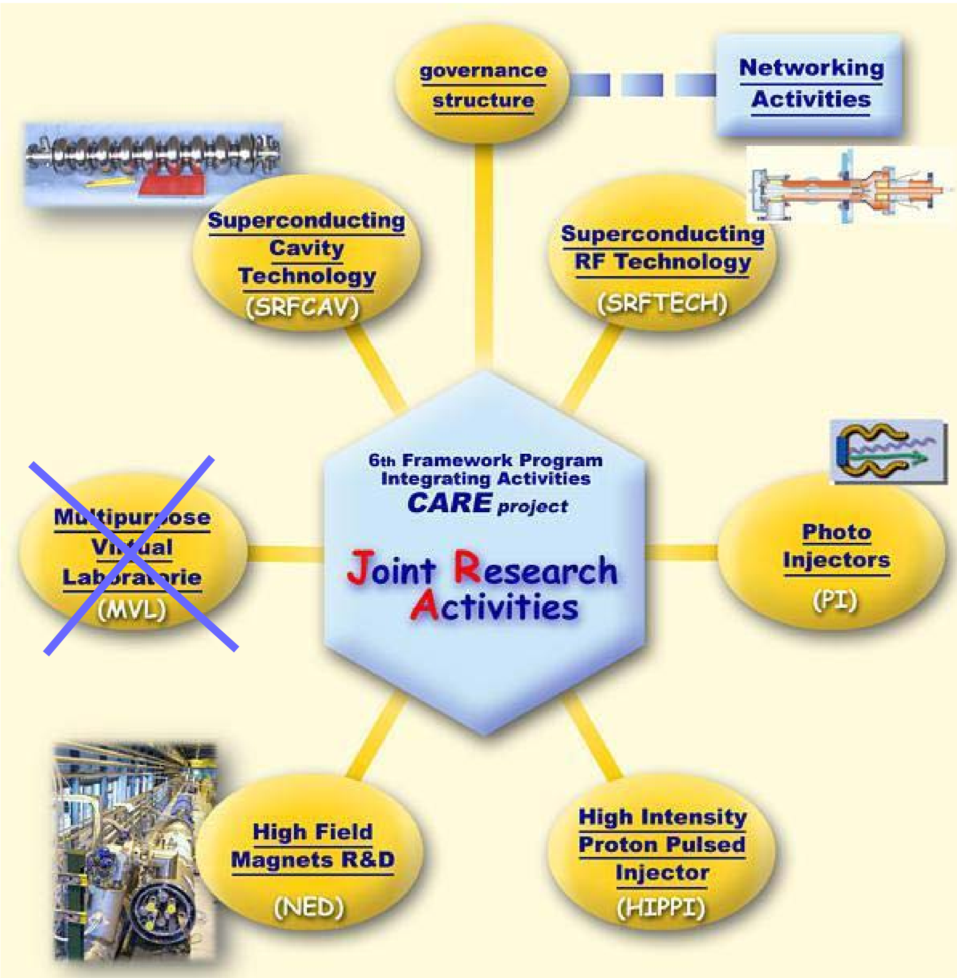


- The structuring of the Design Groups is independent of the Technology Choice, to be taken in 2004
- The European discussions should converge within a few months due to several constraints:
  - EU FP6 submission of Design Study proposals (March 2004)
  - Role of CERN and CERN Council
- Setting up of an GLC Design Group under ILCSC in 2004

CARE

Coordinated Accelerator Research in Europe

ECFA has given CARE a very high priority



- The program was considered essential to:
  - particle physics, synchrotron light sources, high intensity protons and ion beam facilities and operation of accelerators
- Network activities approved on:
  - Electron linacs, neutrino beams and proton machines
- 4 Joint Research Activities approved on:
  - Superconducting RF cavities, controls and ancillaries
  - Photo Injectors for high charge and high brightness electrons
  - High Intensity Proton Pulsed Injectors
  - Next European Dipoles

The Linear Collider and DESY

- The scientific strength of DESY is based on the combined expertise on theory, experiments and accelerators
- Together with its partners in the **TESLA Collaboration** DESY has been one of the major players in LC physics and technology R&D
- DESY's strategy is to retain this role with the aim of building the best TeV Linear Collider as a global facility
- DESY has been developing TESLA in Hamburg, but its participation will be both technology and site independent
- According to the German Government statements on its strong interest for a qualified German participation to the Global Linear Collider effort, **DESY is prepared to play in Europe a central role** for the Linear Collider design and construction

Conclusions

- **We have a convincing scientific case and a world consensus** on the importance of a LC and on its timing with respect to the LHC
- **The LC will be "the toughest collider you'll ever love"**
  - Valuable experience from numerous test facilities and SLC
  - Unprecedented simulation studies of tuning and operation have been performed and are ongoing
- **Two prospective RF technologies are available**
  - different (complementary?) strengths and weaknesses
  - by the mid of 2004 we will have a reliable idea of their capabilities
- **Technology decision by "wise men" expected by end 2004**

The future of the LC is largely in our hands
Let's make it happen