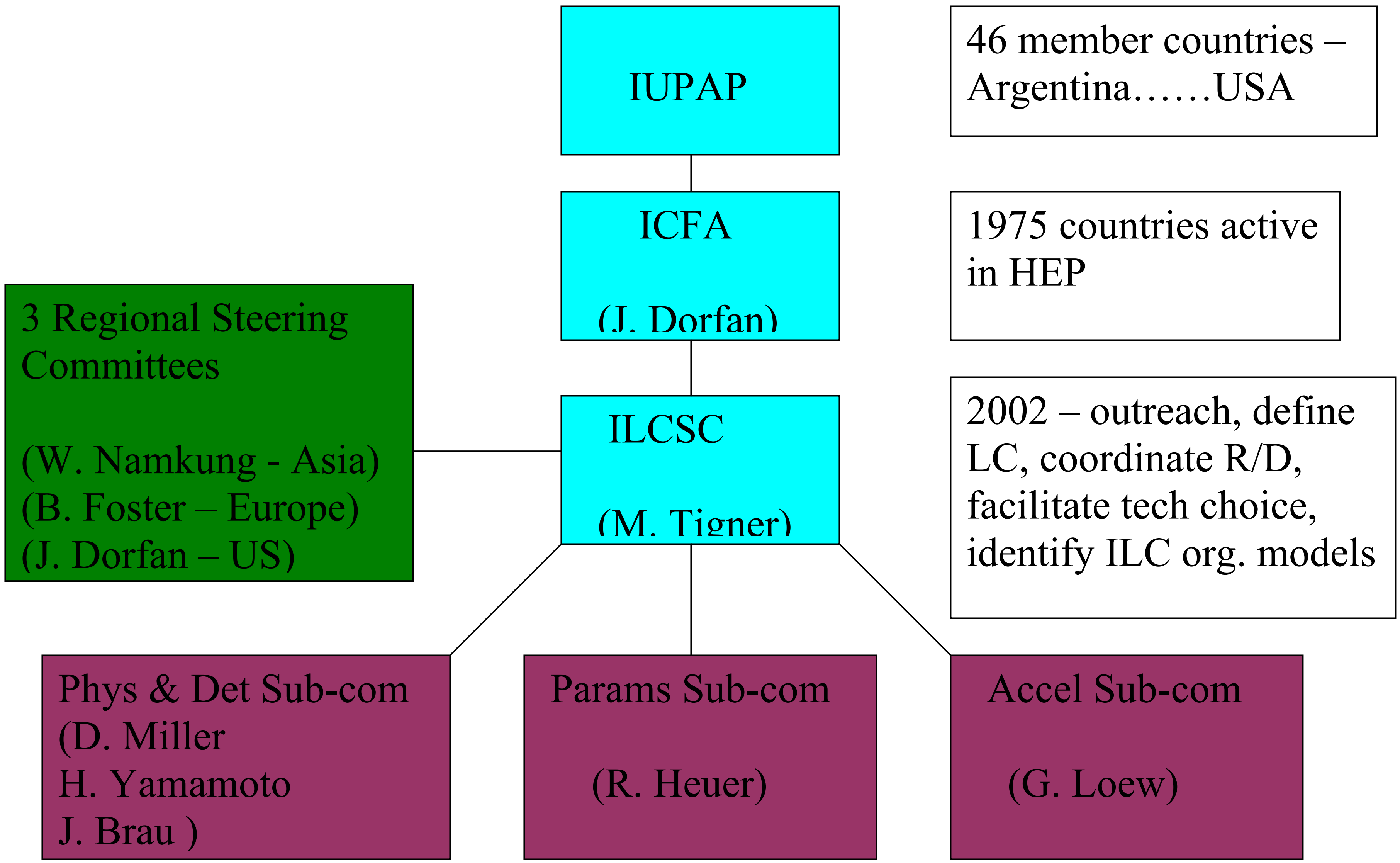
LP2003

Aug. 16

LINEAR COLLIDER OPTIONS: STATUS OF THE R&D AND PLANS FOR TECHNOLOGY SELECTION

1. Some background
2. TRC report
3. R&D status of the options
4. Plans for a recommendation


IUPAP
46 member countries – Argentina……USA
ICFA
(J. Dorfan)
1975 countries active in HEP
3 Regional Steering Committees
(W. Namkung - Asia)
(B. Foster – Europe)
(J. Dorfan – US)
ILCSC
(M. Tigner)
2002 – outreach, define LC, coordinate R/D, facilitate tech choice, identify ILC org. models
Phys & Det Sub-com
(D. Miller
H. Yamamoto
J. Brau)
Params Sub-com
(R. Heuer)
Accel Sub-com
(G. Loew)

- 1994 Inter-laboratory Collaboration for R&D Towards a Linear Collider creates an ILC – TRC with Greg Loew as Chair : document status of R&D of the then 8 e+e- collider concepts. Report in 1995

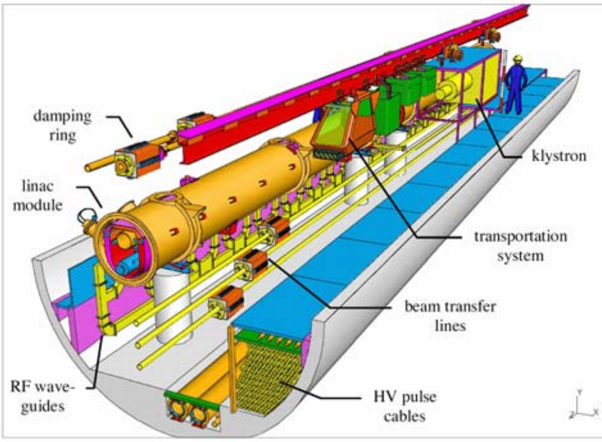
- 2001 ICFA reconvenes the ILC – TRC, again under Greg Loew. Steering Committee: R. Brinkmann DESY, K. Yokoya KEK, T. Raubenheimer SLAC, Gilbert Guignard CERN. + Working Groups: 37 members – enormous task

- Reviewed R&D status of the now 4 options: TESLA, JLC-C, JLC-X/NLC, CLIC

- Report delivered in 2003 – defines and ranks R&D needed for choosing technology to go forward with: ranges from R&D needed for feasibility assessment to R&D needed for design and cost optimization i.e. R1 – R4

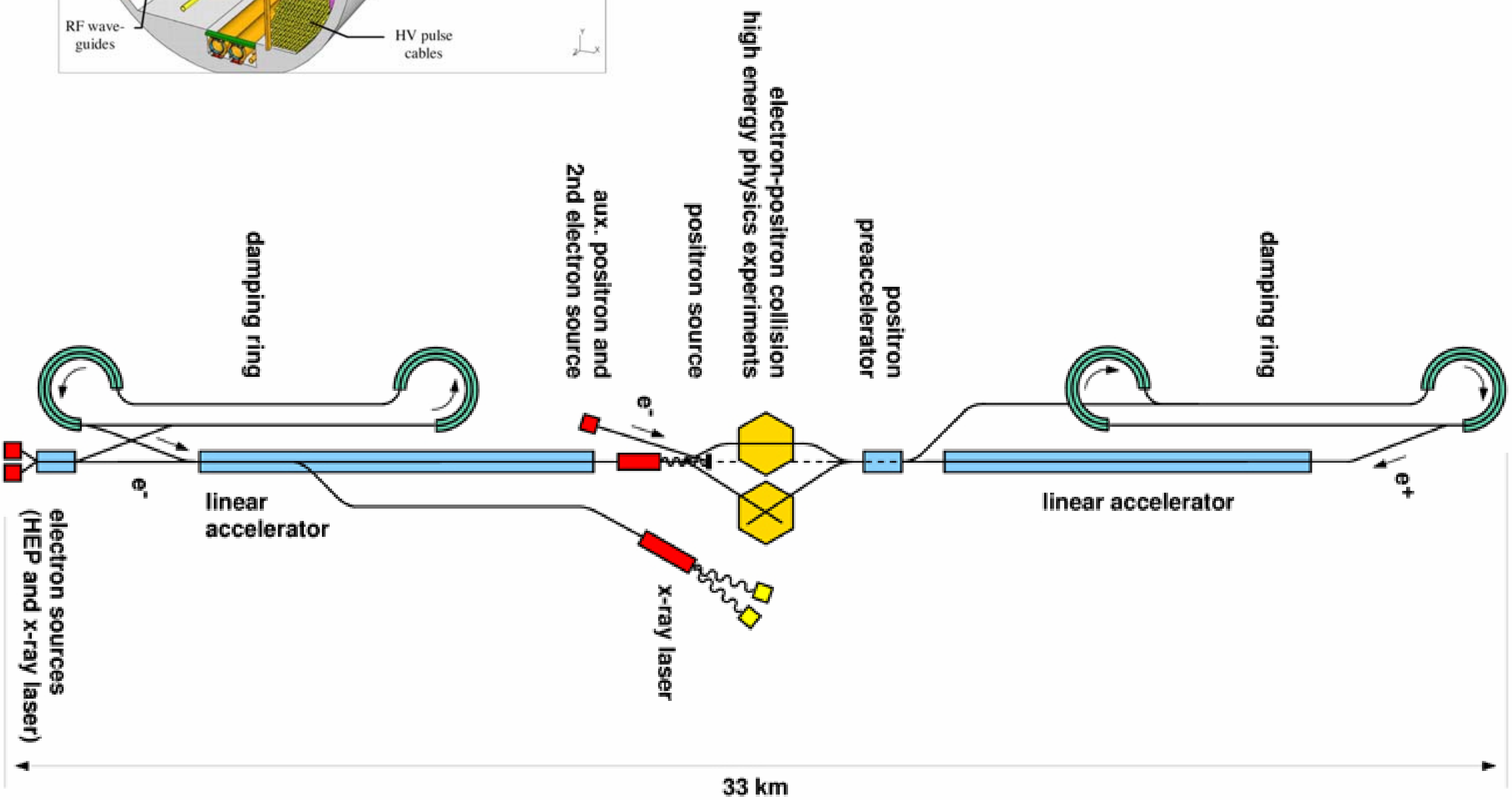
- Most "press" focused on gradients but many other things are of prime importance e.g. E(ILC)/E(SLC) 5 – 10 x where as L(ILC)/L(SLC) ~ 10^4

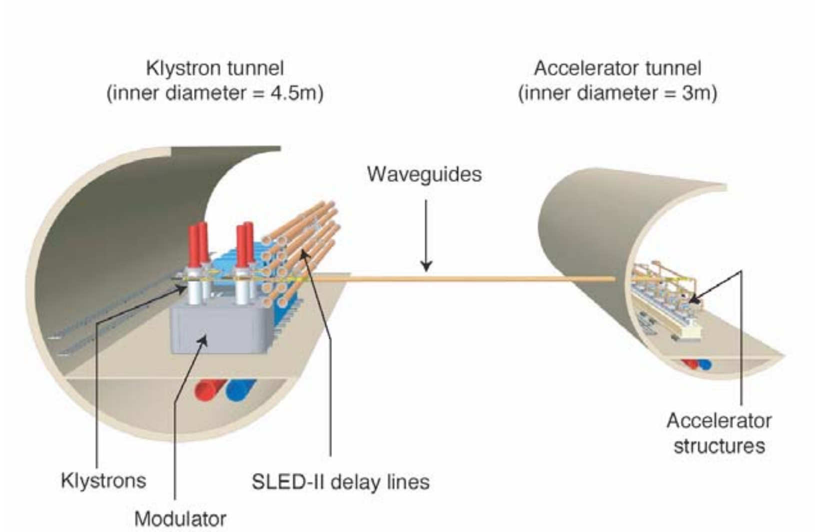
- The ILCSC has not produced a final high level parameter and scope document yet (due Sept.) but the regional SG's have converged generally on something like 500 GeV CM to start, extendable to ~ 1 TeV, L~ 2 x 10^{34}, 2 IR



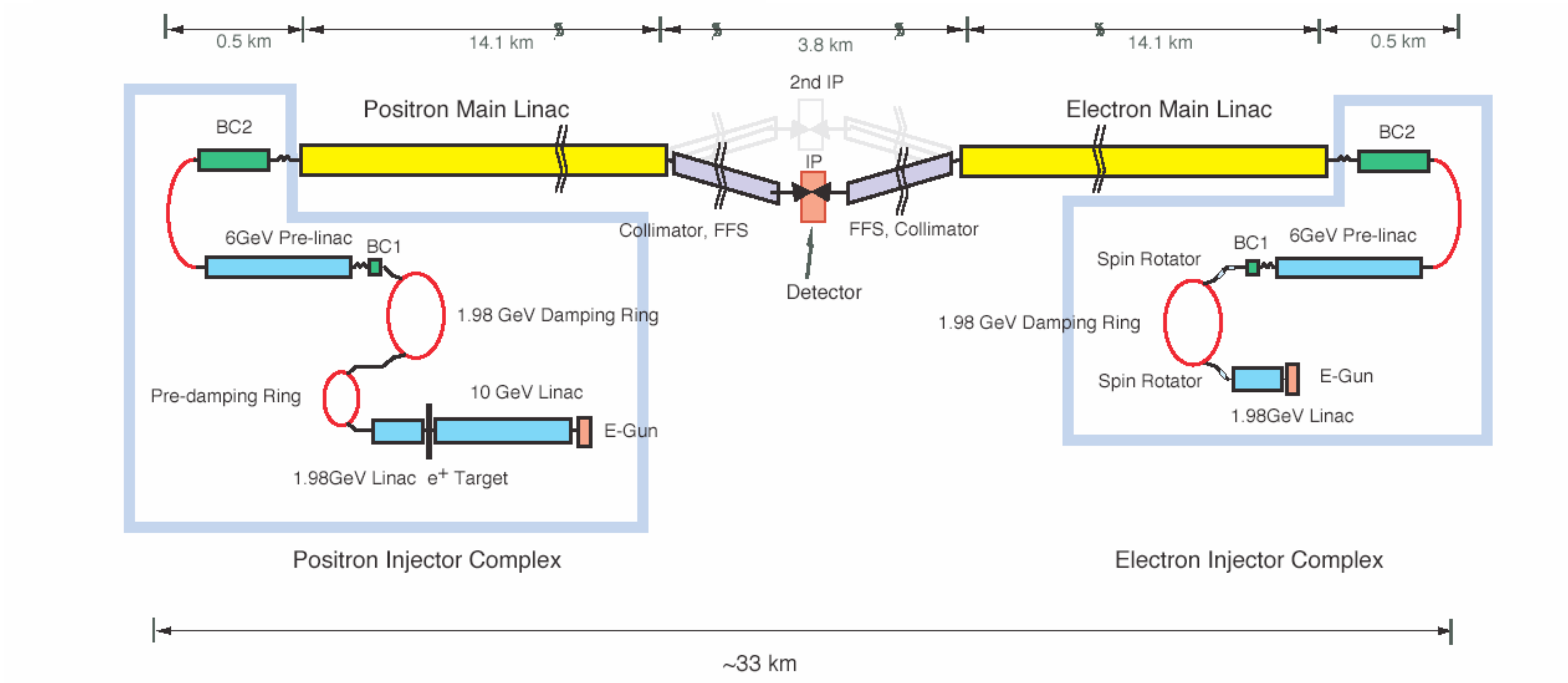
TESLA Linear Collider

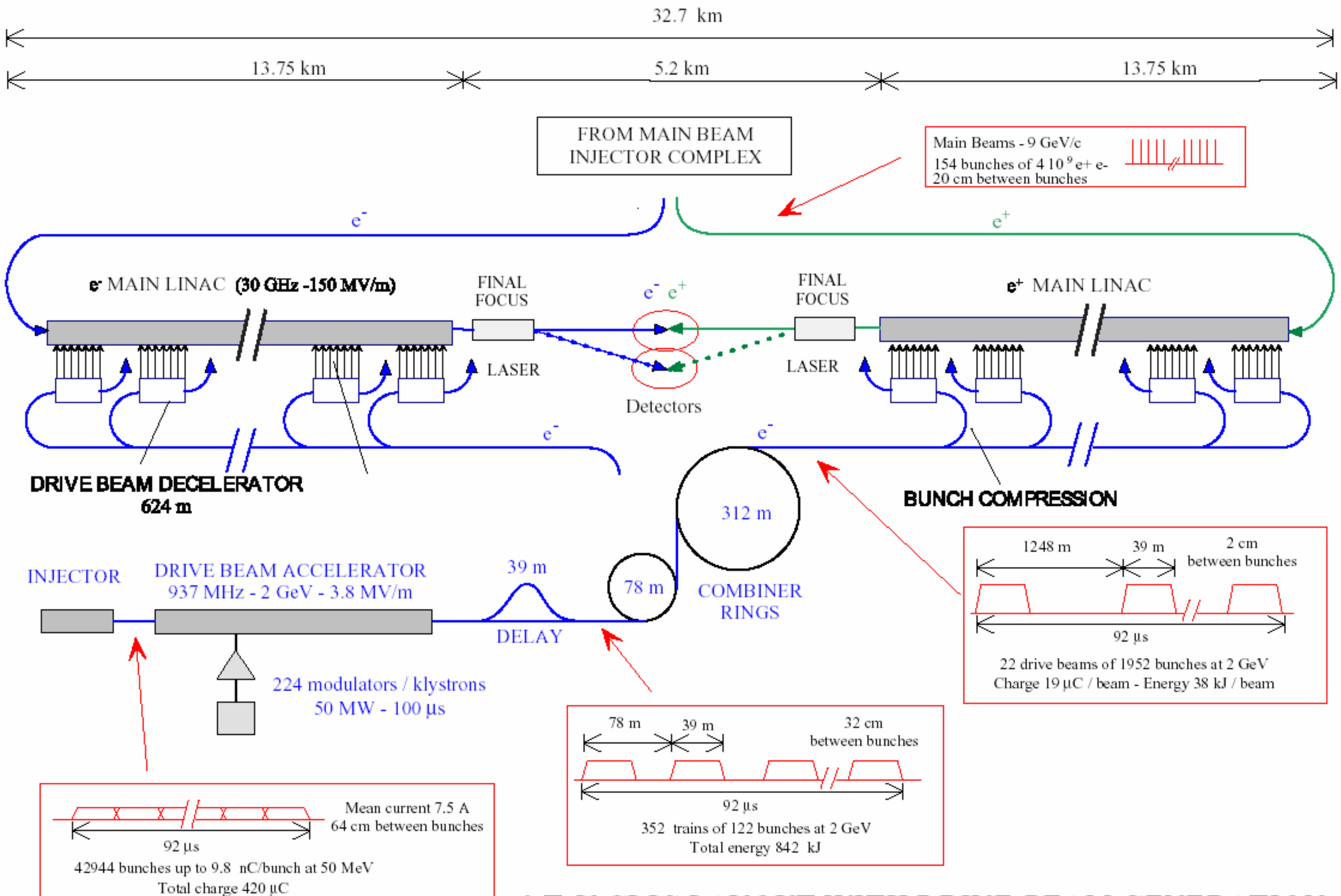
Superconducting RF, 1.3 GHz, loaded gradient=35 MV/m, site~33 km=>Emax(cm)=0.8 TeV



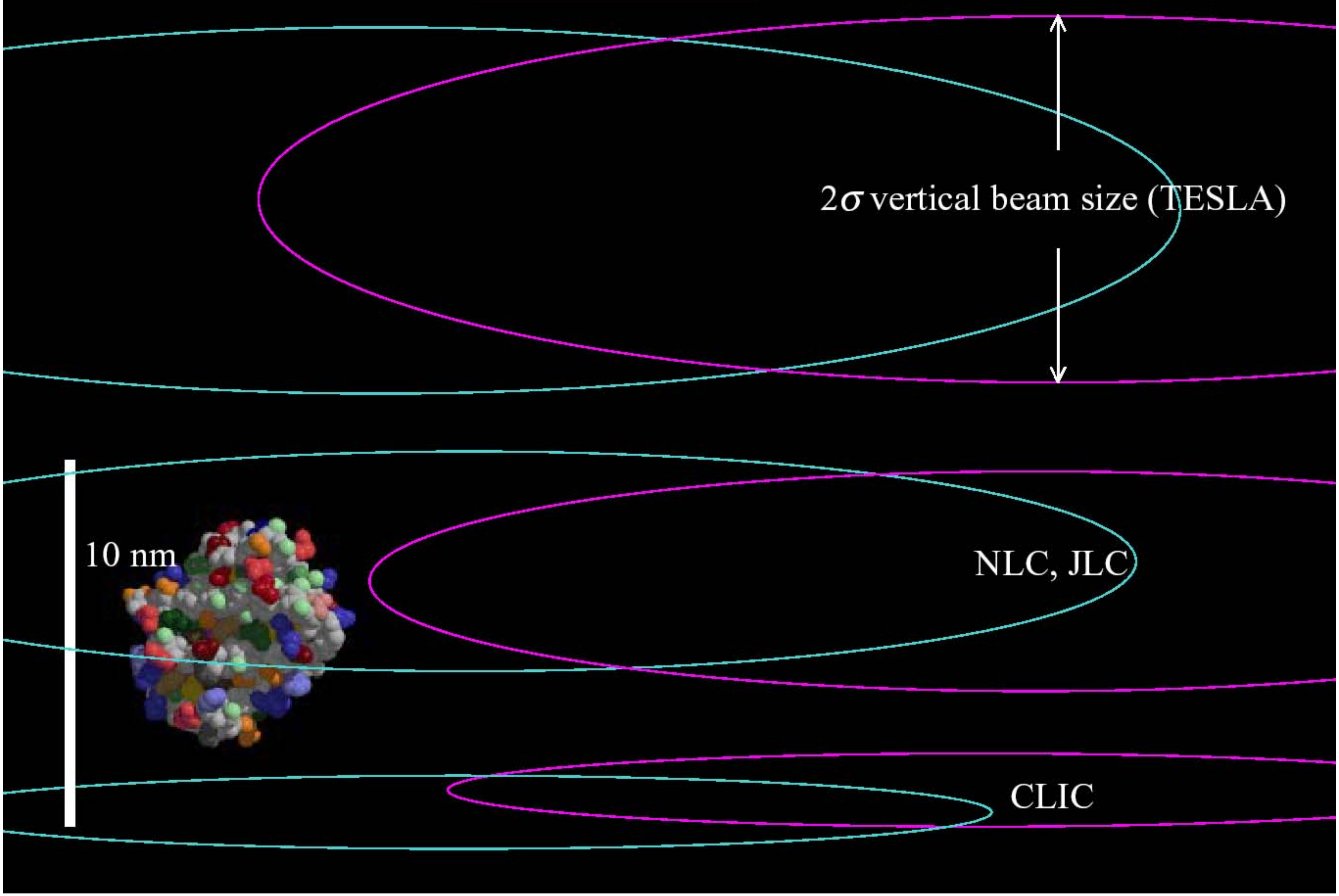


JLC/NLC Linear Collider
Warm RF, 11.4 GHz,
Loaded gradient=50 MV/m, site ~33 km=>E_{max}(cm)=1.0-1.3 TeV



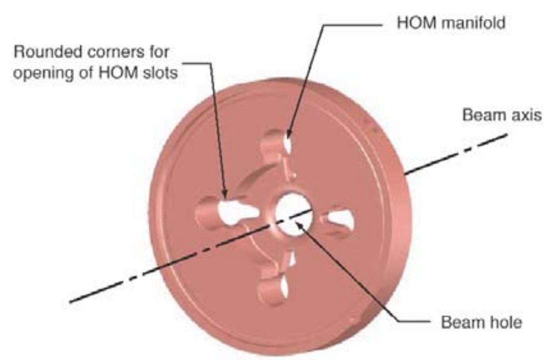


3 TeV CLIC LAYOUT WITH DRIVE-BEAM GENERATION

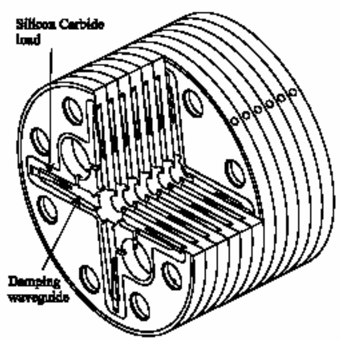

2σ vertical beam size (TESLA)
10 nm
NLC, JLC
CLIC

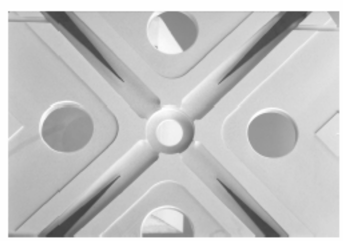
Accelerating structure components

TESLA 9-cell L-band
Pure Nb cavity,
Iris diameter 70 mm



JLC/NLC DDS X-band
Copper cell,
Iris diameter 9 mm





CLIC TDS W-band
Copper cell, Iris
diameter 4 mm

R1: R&D Needed for a Feasibility Demonstration of the Machine

R1 'Score Card': Is a Feasibility Demonstration Required* ?

	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

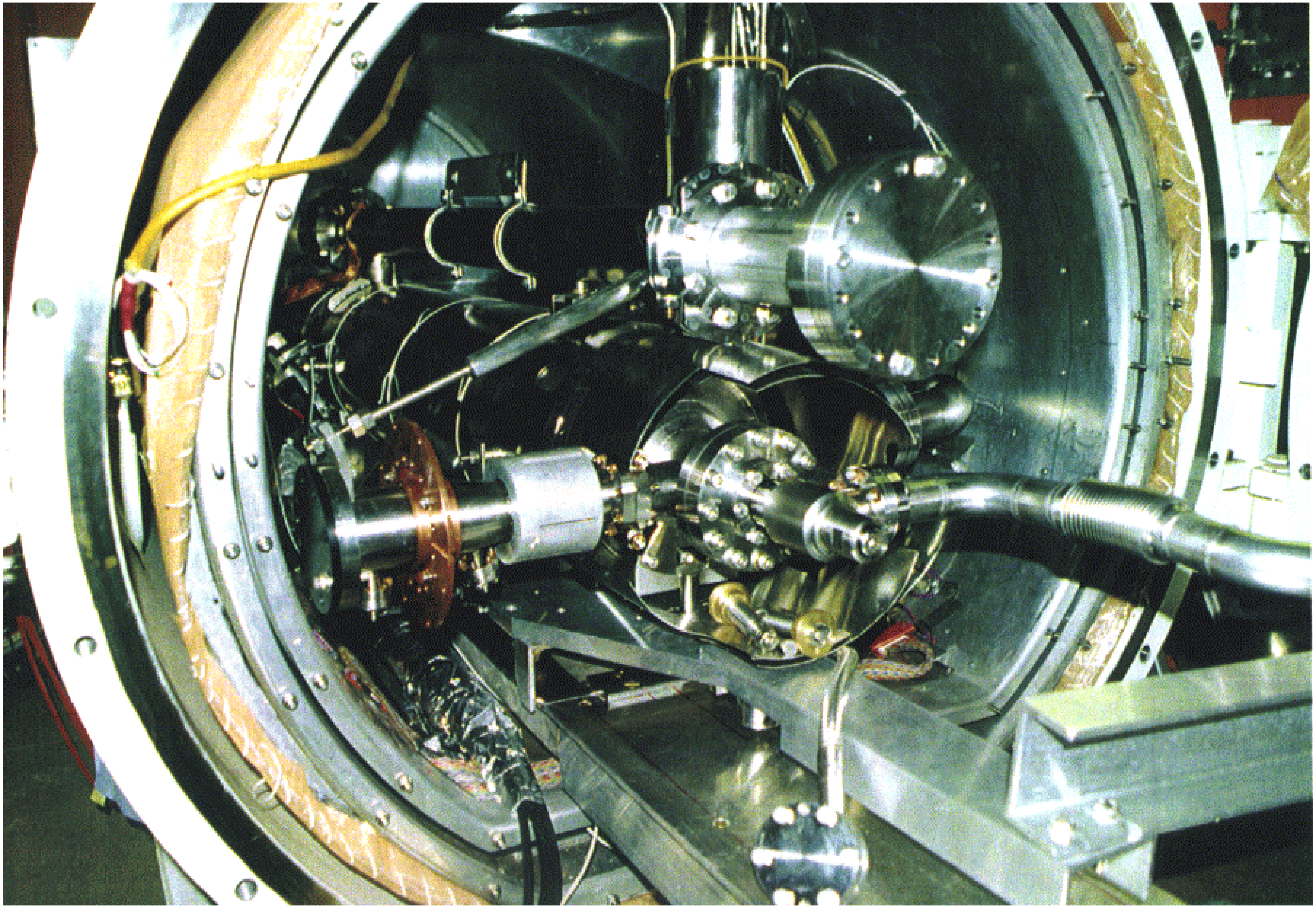
Key Challenges-
High gradient L-band superconducting cavities

- Extensive R&D at DESY, KEK and Cornell over the past decade, in
  - cavity design (to reduce peak magnetic fields),
  - Nb material specification,
  - cavity fabrication, cleaning and processing techniques

has led to the production of a substantial number of L-band cavities capable of gradients in excess of 24 MV/m.

- The latest development in cavity processing (electropolishing) has yielded a “fully-dressed” 9-cell cavity capable of exceeding 35 MV/m
- More such cavities need to be made, to demonstrate the reproducibility of the process, and tested for dark current performance.

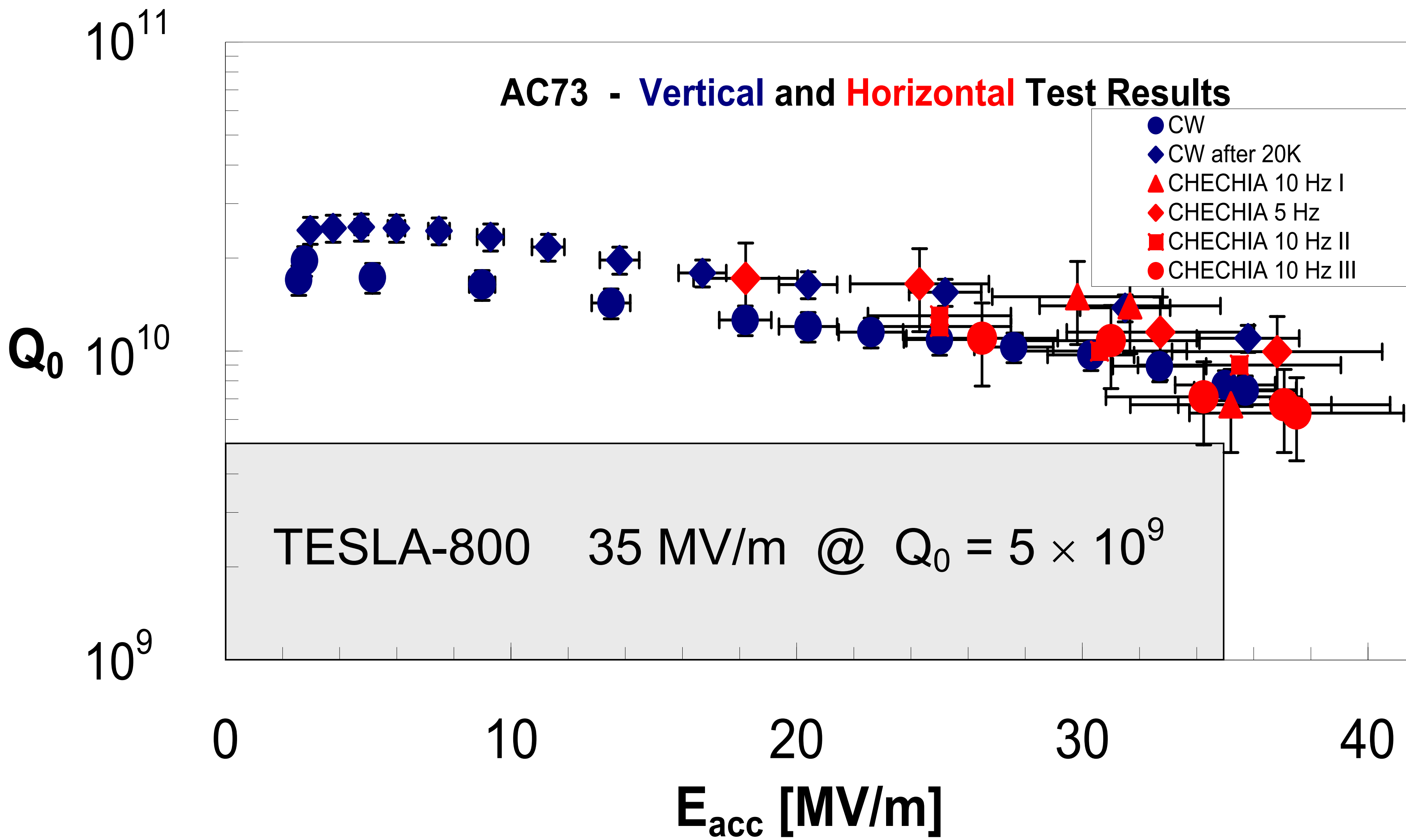
Test of complete accelerator modules in the TTF linac at DESY (>13,000h beam operation 1997 - 2003)



Chechia – horizontal test cryostat

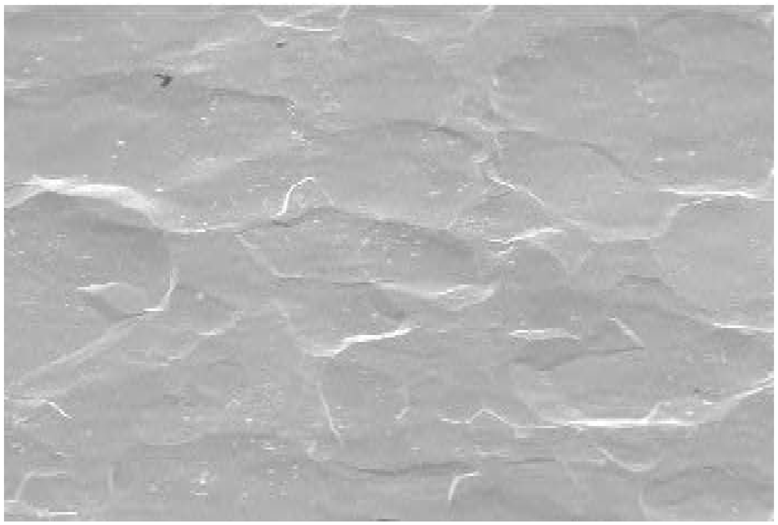
More than 35 MV/m in CHECHIA

i.e. high power test and 1/8th of a TTF Linac module



Improvement of Nb surface quality with electropolishing

(pioneering work done at KEK)



BCP

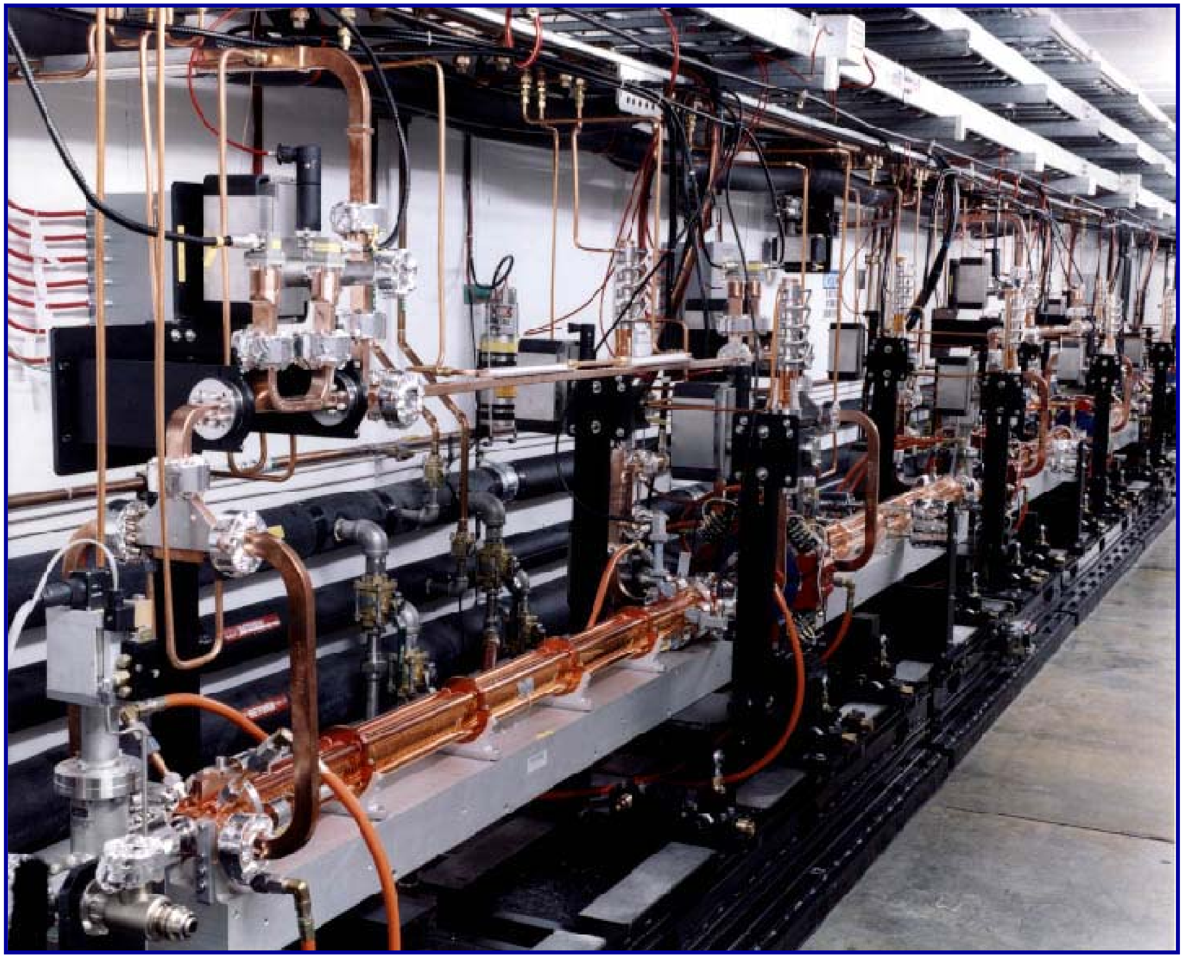
EP

- Several single cell cavities at g> 40 MV/m
- 4 nine-cell cavities at ~ 35 MV/m

Key challenges:
high-gradient normal conducting cavities

- Extensive R&D on X-band cavities at SLAC and KEK have yielded a substantial number of 1.8 m structures capable of gradients in the 40-45 MV/m range.
- Efforts to push to higher gradients have required careful attention to minimize the stored energy (through reduced group velocity) and limit regions of high pulsed heating, while maintaining acceptable transverse impedance.
- The latest prototype 60 cm structure has demonstrated close to the required breakdown performance at 65 MV/m.
- 8 similar structures will be made and tested to demonstrate performance of the basic main linac rf unit.
- 30 GHz structure development at CERN for CLIC has focused on designs to minimize peak electric field and introduce refractory metal for the iris material.

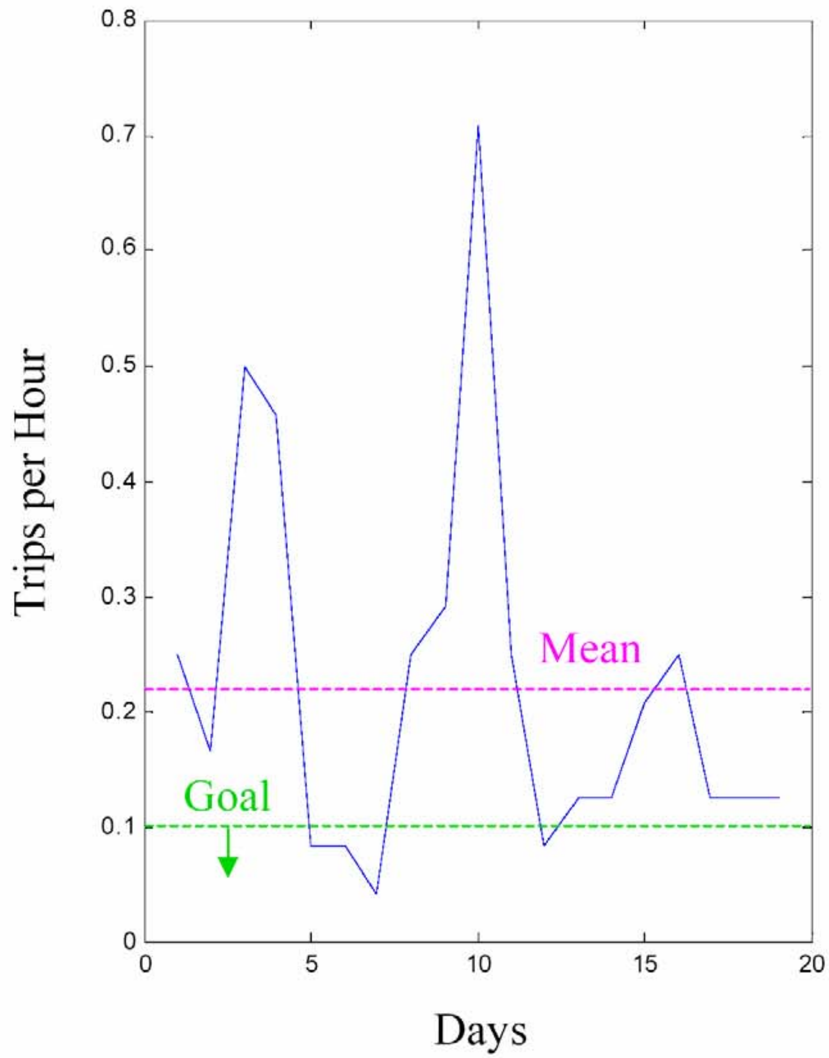
The NLCTA with 1.8 m accelerator structures (ca 1997).

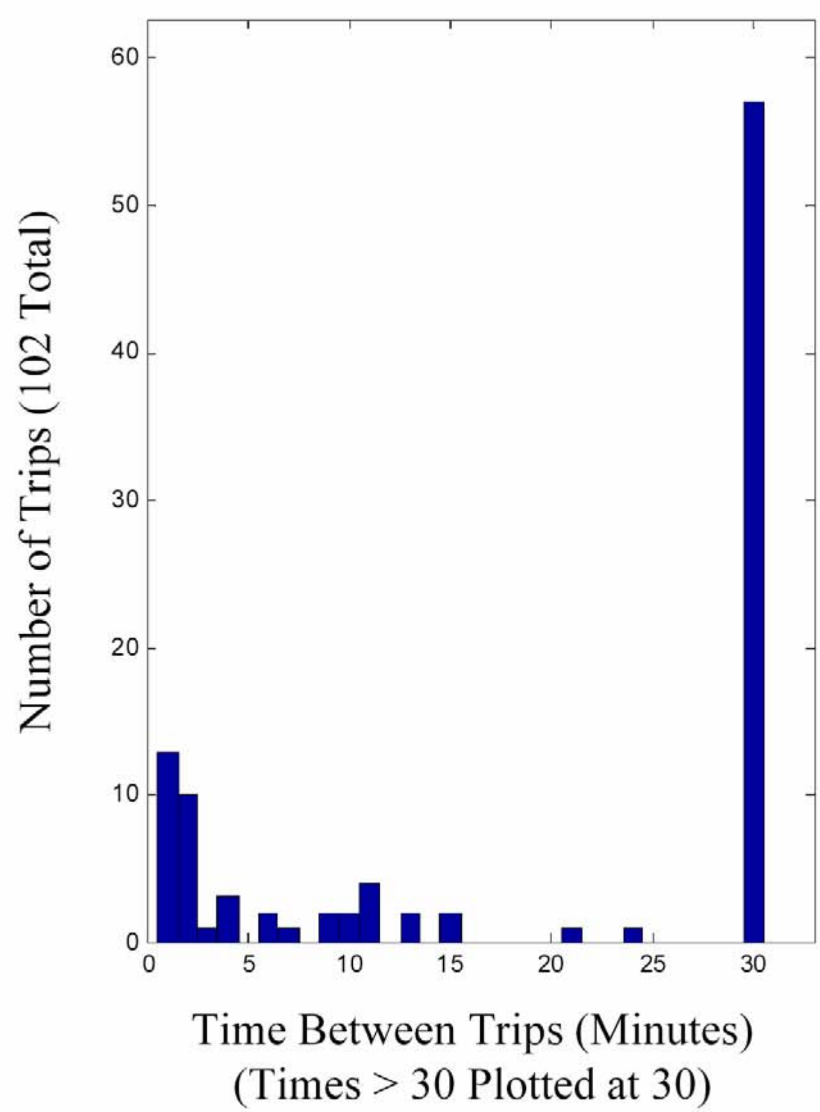


Demonstration of X-band concept, wakefield control, beamloading compensation,…

<u>But:</u> acc. Gradient limited < 40 MV/m

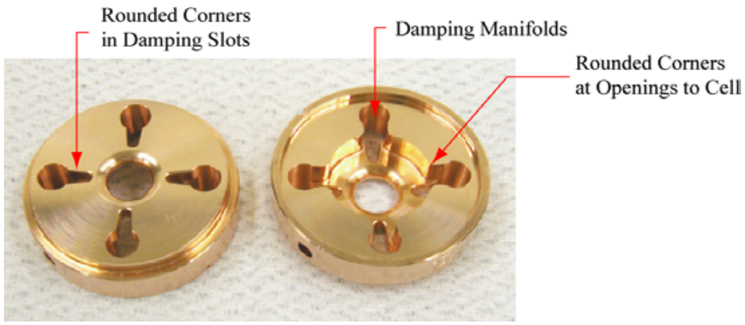
Breakdown Statistics for H60VG3(6C) at 65 MV/m, 400 ns





JLC/NLC Structures

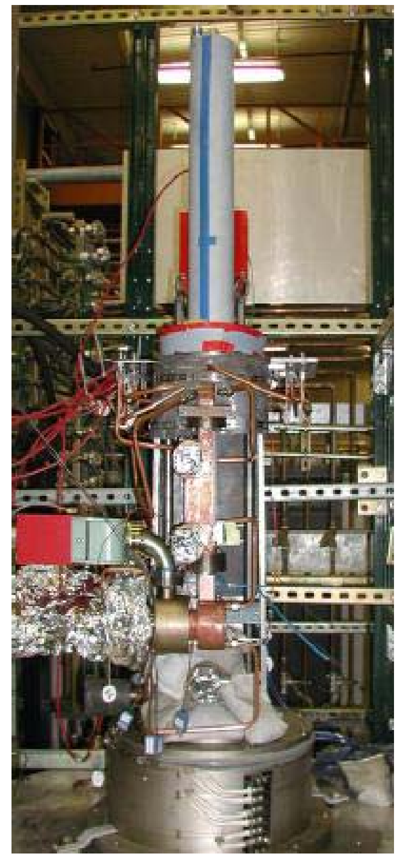
- Structures with <a/λ> = 0.17- 0.18 and with full damping and detuning features.



Tests of 60 cm structures reach 65 MV/m, but with little overhead (previous slide).

Designs with higher shunt impedance now in fabrication for test this Fall.

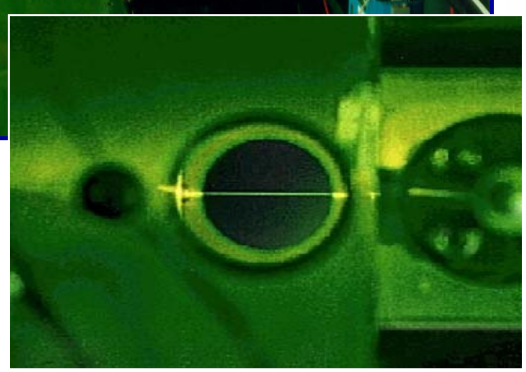
Permanent Magnet Klystrons



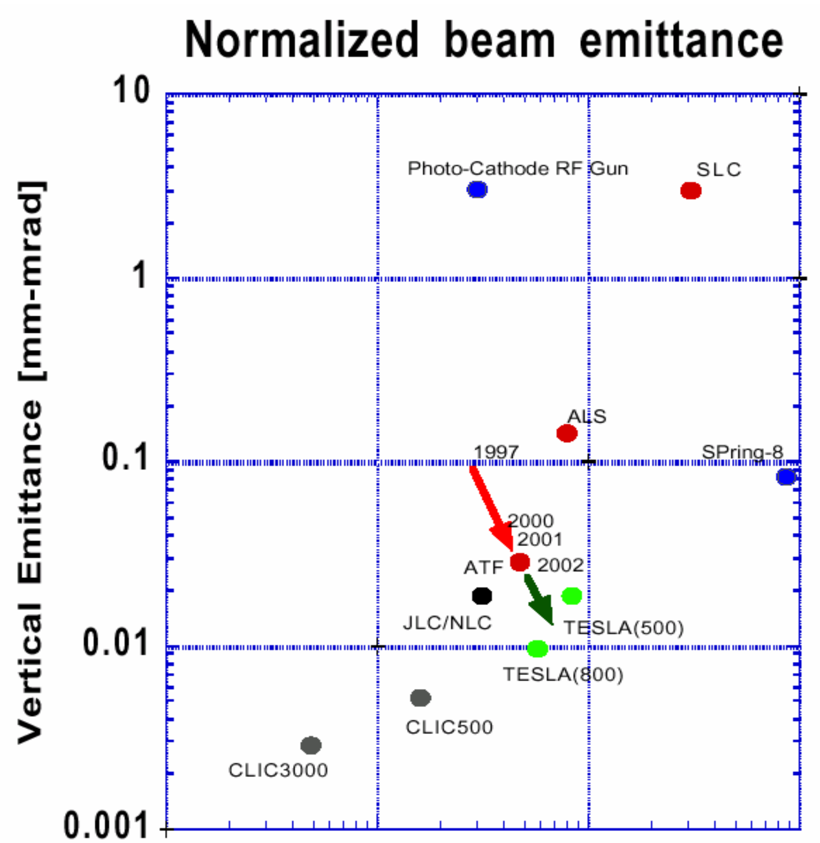
SLAC XP3-3

Met full power specifications of 75 MW pulses 1.6 µsec duration at 120 Hz repetition rate.

ATF Damping Ring at KEK



"Laser Wire"



→ Factor two better than needed.

C-band Main Linac R&D: Summary 2002~2003

X-ray FEL

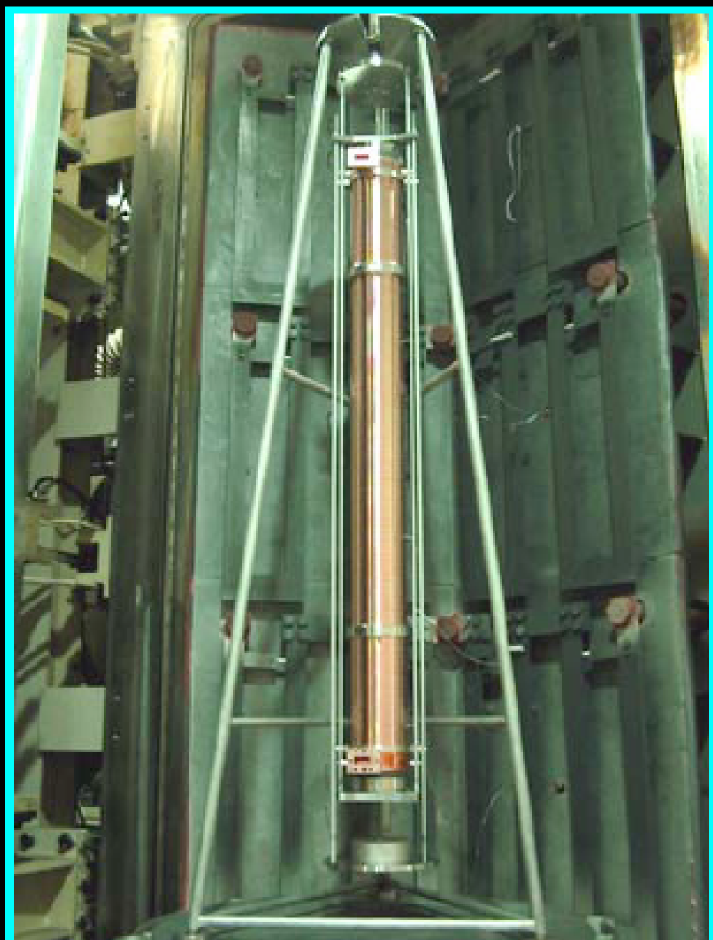
T. Shintake and H. Matsumoto

- Collaboration
  KEK and RIKEN/SPring8 Collaborating on C-band main linac in SCSS X-FEL project.
- Klystron Modulator
  Newly developed for 50 MW klystron, closed type insulating oil filled.
  Currently running to drive 50 MW klystron and 500 kV electron gun.
- Inverter HV power supply (50 kV, 35 kW)
  Newly developed to drive 50 MW klystron modulator.
  Currently running for high power testing at SPring8.
- RF Pulse Compressor (3-cell SLED-III)
  Temperature stabilized cavity using invar metal.
  High Power Testing at KEK. Processed up to 105 MW output (target 160 MW)
- Accelerating Structure (Choke Mode Cavity)
  Structure Ver 2.0 has been fabricated.
  Trapped mode (found in ASSET test 1998) as solved by tuning the cavity dimensions (disk thickness 3 --> 4 mm).
  High power test is scheduled in Autumn 2003.

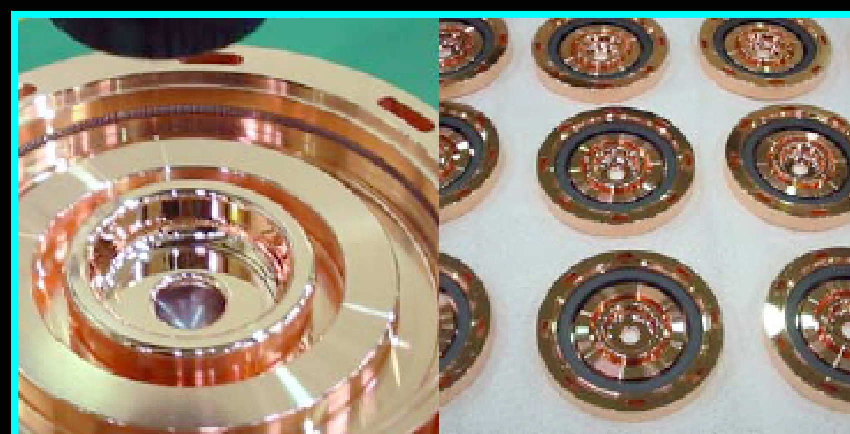
C-band Accelerating Structure for SCSS

X-ray FEL

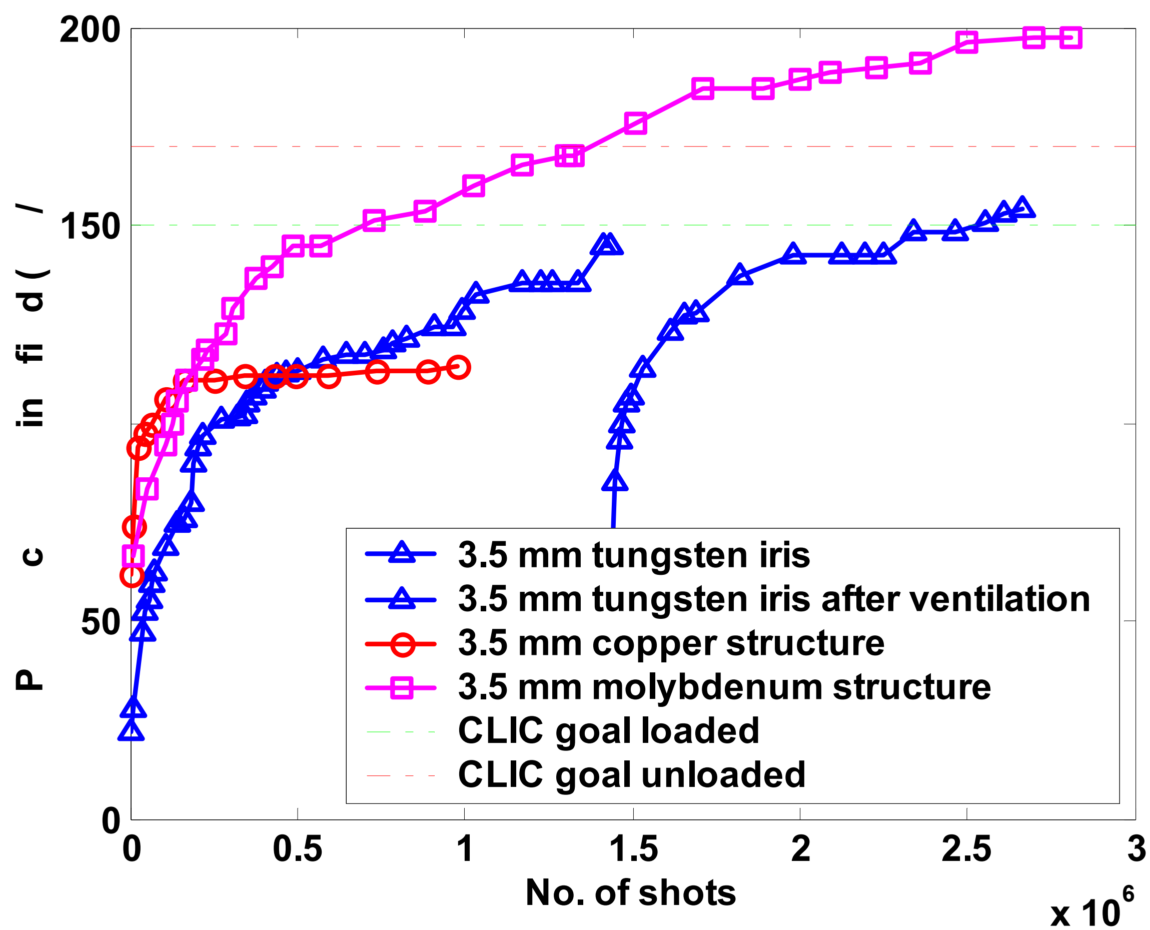
Ver. 2002



- HOM Damping by Choke-Mode Cavity
- 1.8 m long, 91 Cells, CG-structure
- 3π/4-mode
- Brazing Bonding
- SiC by Tungsten wire-spring.
- Double-feed Coupler
- High-power test will be Summer 2003



CLIC Structure high-gradient tests: 30 GHz, 15 ns pulse

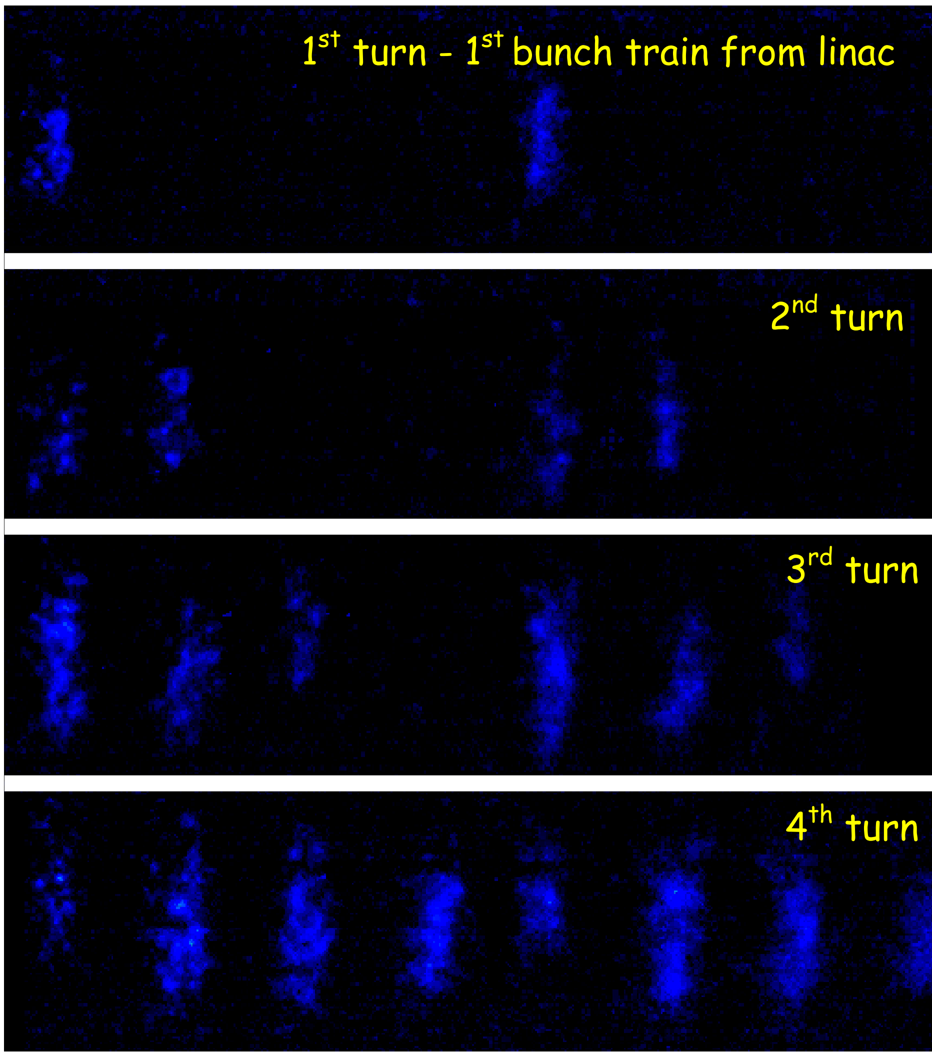


Peak accelerating gradient vs. pulse number

CTF3 (under construction)

LOW CURRENT BUNCH TRAIN COMBINATION

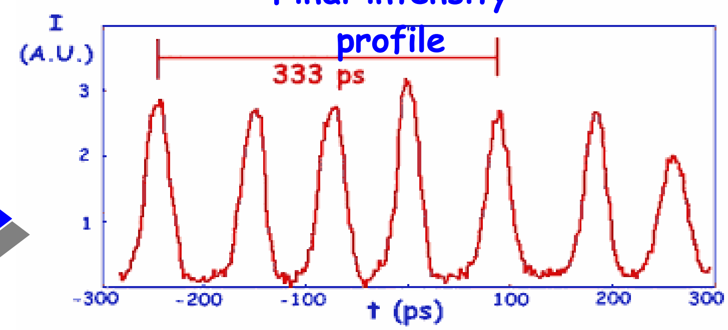
streak camera images of beam in the ring



time

- First demonstration in June 2002
- Tested combination factors 4 & 5

Final intensity profile



mbination factor 4

Where do we go from here?

ICFA has charged the ILCSC with facilitating the choice of technologies and then following up with facilitating an Internationalized design embodying that technology.

Who is the ILCSC?

Current Members

Category	Current incumbent
Directors	
KEK	Yoji Totsuka
SLAC	Jonathan Dorfan
DESY	Albrecht Wagner
CERN	Luciano Maiani
FNAL	Michael Witherell
LC Steering Group Chairs	
Asian	Won Namkung
European	Brian Foster
N. American	Jonathan Dorfan
Other	
Chair	Maury Tigner
China (IHEP Director)	Hsheng Chen
Russia (BINP Director)	Alexander Skrinsky
ICFA outside LC regions	Carlos Garcia Canal
Asia Rep.	Sachio Komamiya
Europe Rep.	David Miller
N. American Rep.	Paul Grannis

Parameters Sub Committee

R. Heuer, Chair
F. Richard
S. Komamiya
D. Son
M. Oreglia
P. Grannis

Converging well and plan to have the internationalized high level requirements for the GLC before end Sept. '03

Accelerator Sub Committee

G. Loew (Chair)
Y. Yokoya
M. Yoshioka
N. Toge
J. Urakawa
R. Brinkmann
G. Guignard
O. Napoly
G. Geshonke
G. Dugan (Deputy Chair)
T. Raubenheimer
N Solyak
A. Wolski

Will be a major resource for the technology recommendation

Technology Recommendation Plans

- Good progress to report
- Will be based on a panel of "Wise Persons": international stature, expertise in large projects desirable, experimenter (particle or non LC involved accelerator), prominent theorist
- 4 persons from each of the three regions meeting these qualifications
- ILCSC preferences for Wise Persons, Chair, charge, time frame, procedural suggestions, etc. to ICFA for their action early December (after next ILCSC, Nov. 19)
- Plan that Wise Persons can begin work in Jan. 04

Pre Global Design Group

- Good progress to report
- Idea widely accepted
- Task Force of Chairs of regional LC Steering Groups + one lab director from each region will report in November: charge, organization – taking fully into account that the major work will be done by labs and universities in the regions, deliverables, milestones
- Hope to bring ILCSC recommendations to ICFA for action at their Feb. 04 meeting.

How can I learn more and be kept up to date?

- Good question!
- I'm having trouble myself!!
- There is an ICFA web page at FNAL with ILCSC material – need to improve and include minutes of regional SG meetings too
- Easy links to LC affairs on SLAC, KEK, DESY, CERN web pages – lots and lots and lots of info. Lots of people use it too: today I was told when I visited the KEK web page that I was visitor # 559858 to the KEK LC pages!!!

THANKS