Overview of Linear Collider Test Facilities and Results

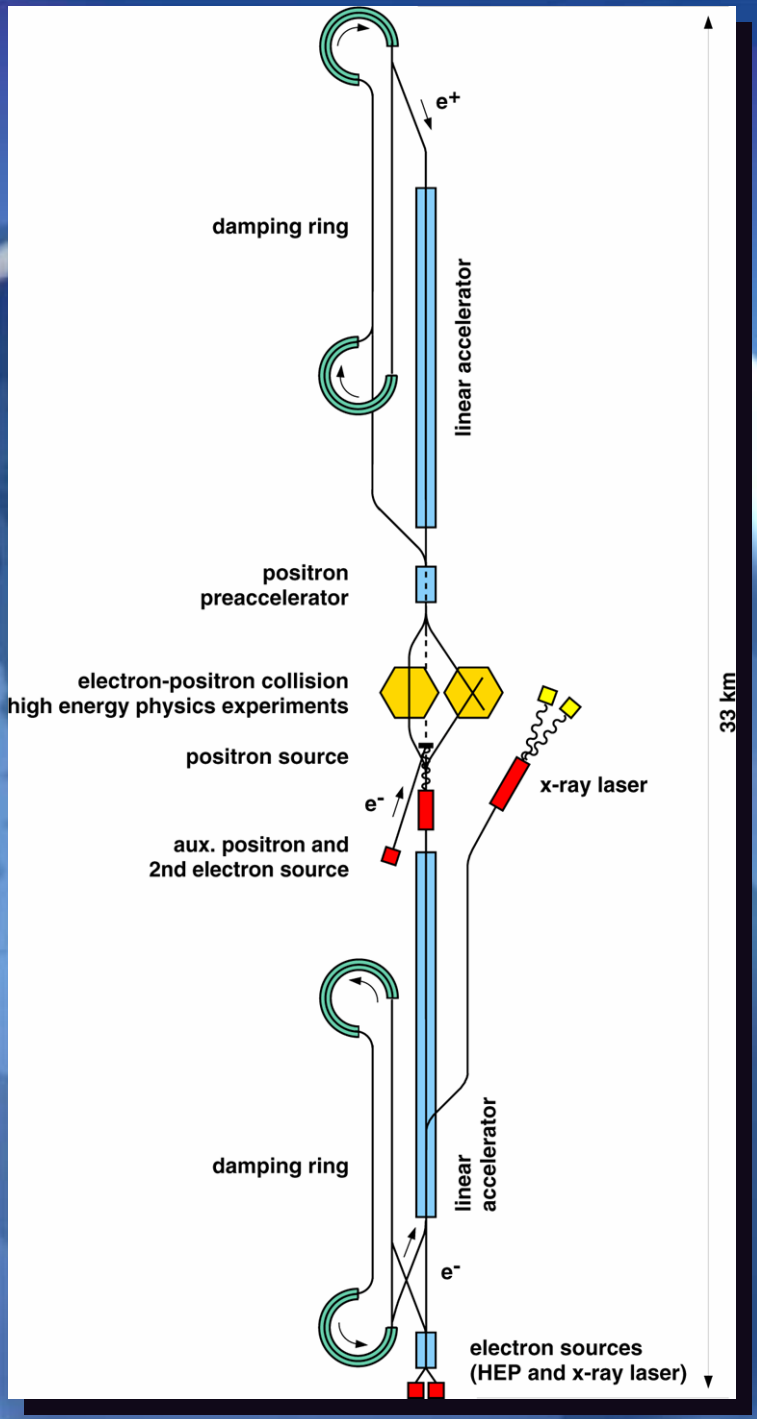
H. Hayano (KEK)

TTF at DESY

NLCTA at SLAC

ATF&GLCTA at KEK

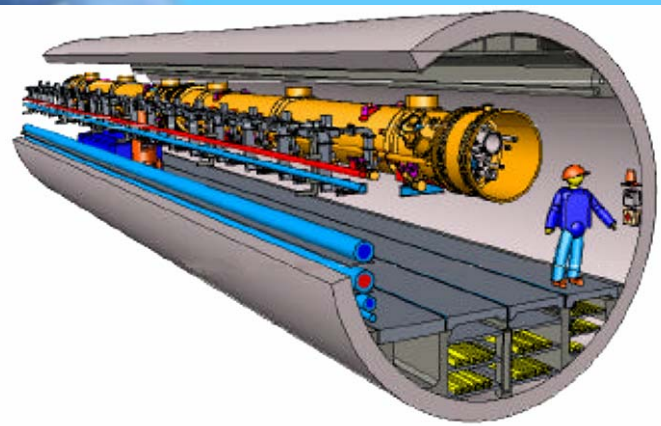
CTF at CERN



TESLA

TESLA project

- *1.3GHz superconducting cavity main linac*
- *23.8MV/m(500GeV), 35MV/m(800GeV)*
- *Long & sparse bunch train*
  (-> long damping ring)



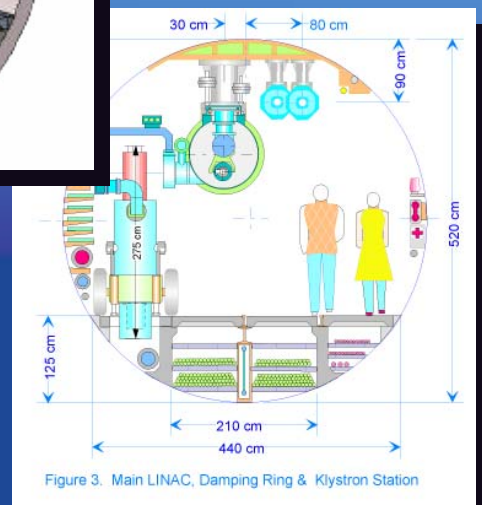
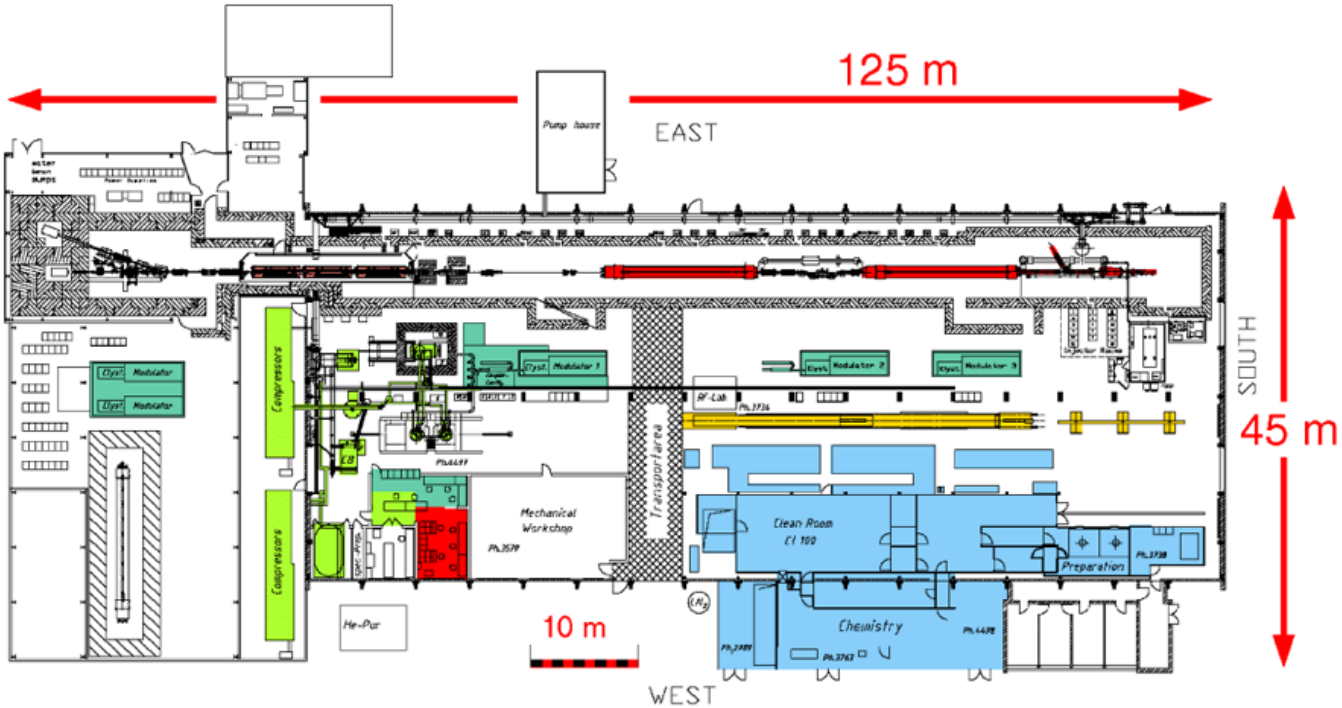


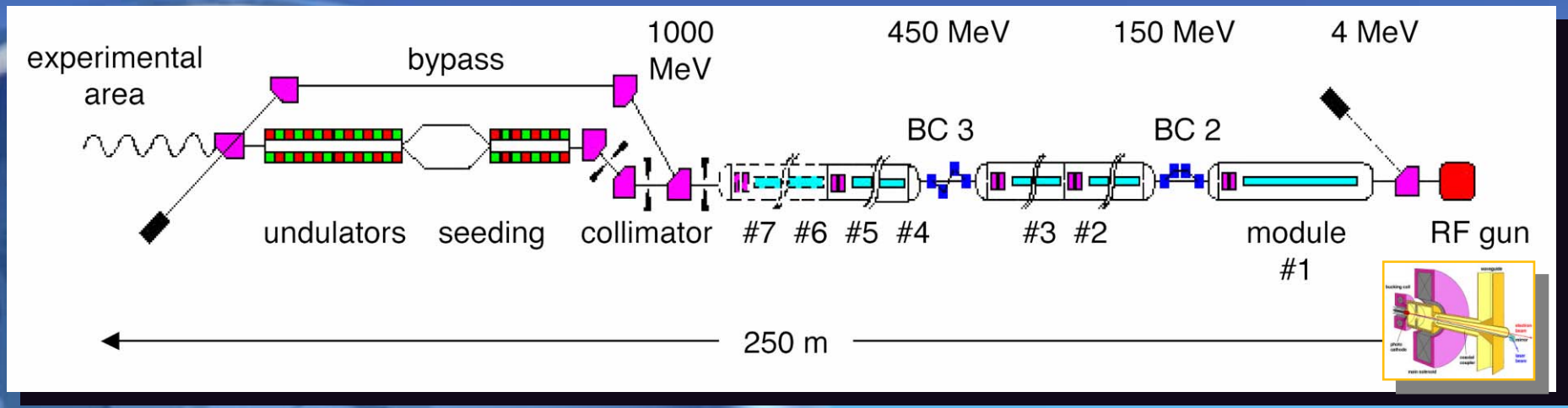
Figure 3. Main LINAC, Damping Ring & Klystron Station

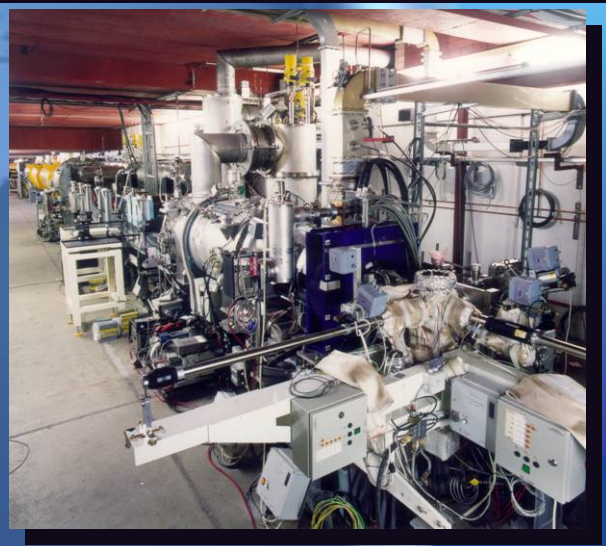
TTF (TESLA Test Facility)

TESLA TEST FACILITY (HALL 3)



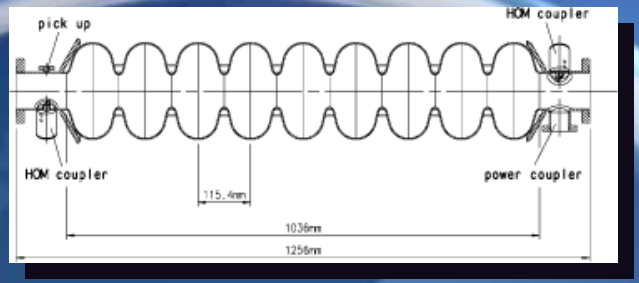
TTF2 Linac





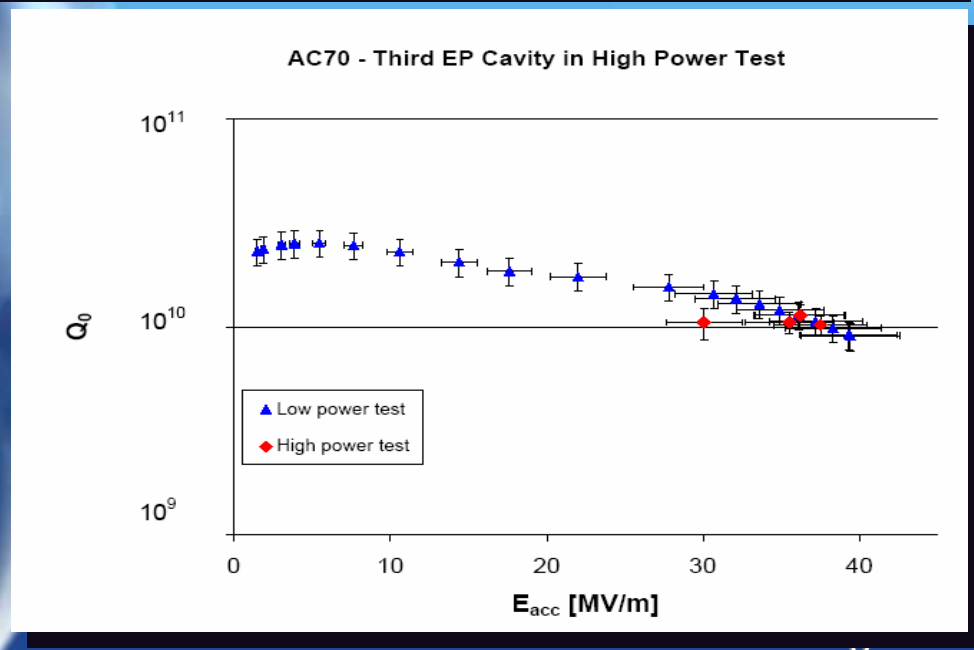
TESLA like beam by RF gun.
Average 25MV/m.
5 accelerating module(2004)
35MV/m #6 module(2006)
50μm by bunch compressor
27m Undulator

Superconducting Cavity development



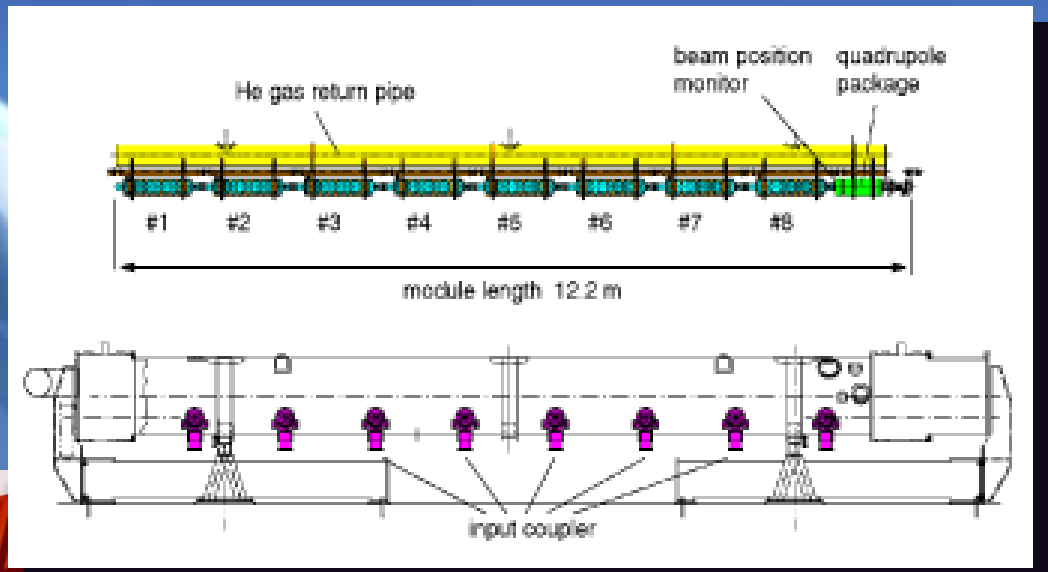
Process of cavity:

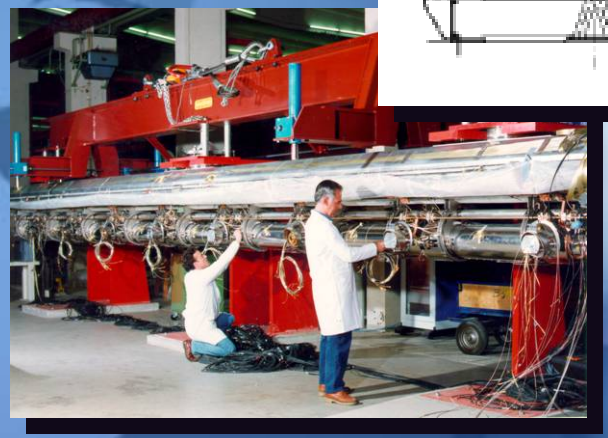
- ***form 9-cell from high purity Nb sheet,***
- ***800deg annealing,***
- ***1400deg heat treat (option),***
- ***chemical etching / electropolishing(EP),***
- ***High pressure water rinsing.***

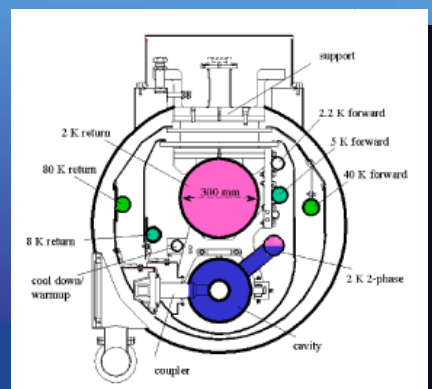


AC72 35MV/m cavity was installed in ACC1 cryomodule

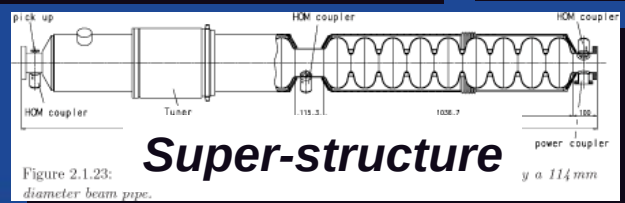
Cryomodule







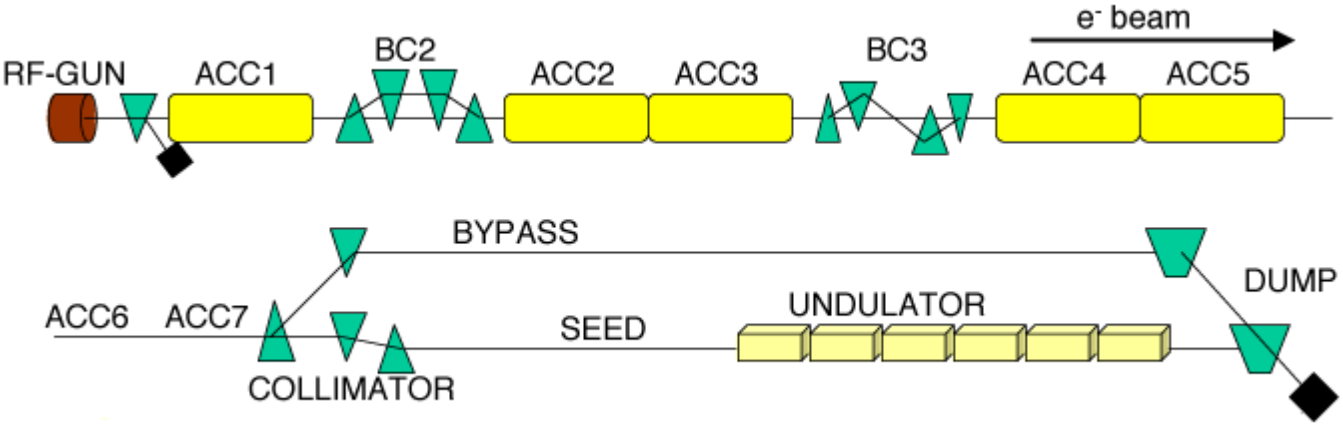
8 of 9-cell cavities and Quad, BPM are installed in Cryomodule. Super-structure was also tested.



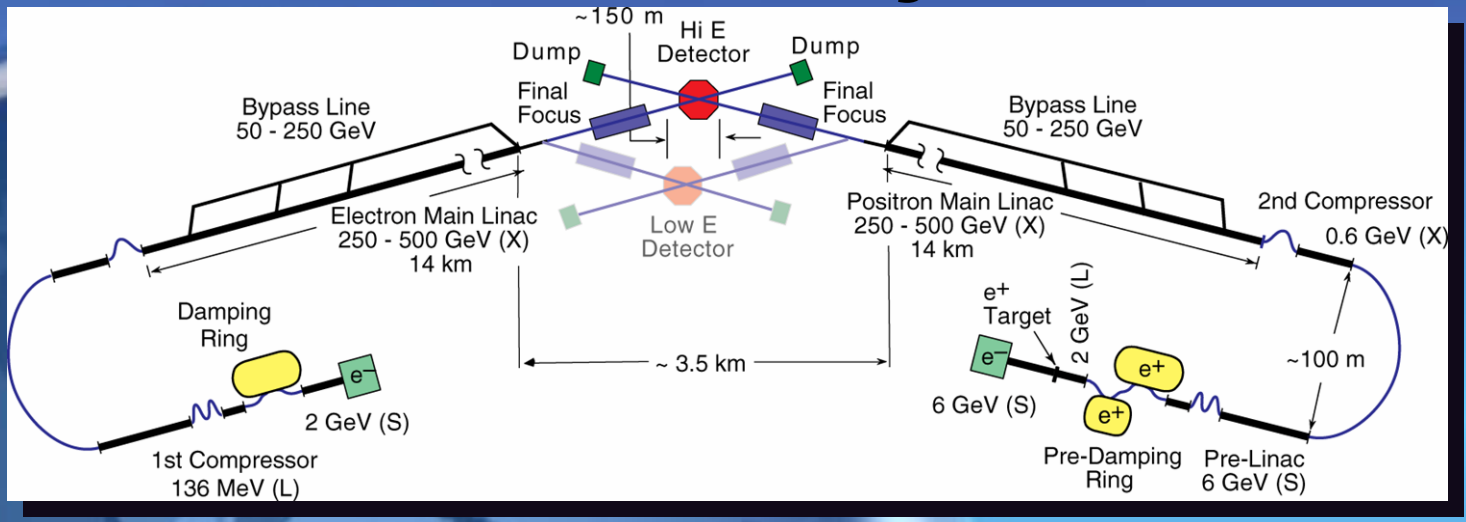
Super-structure

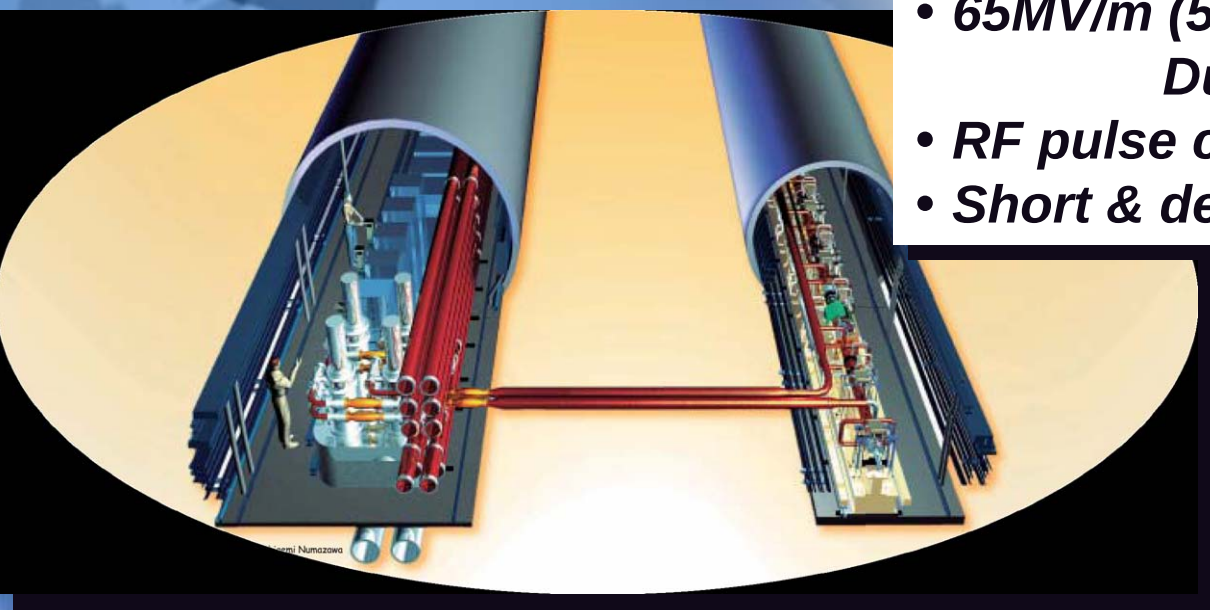
6 ~ 30nm SASE-FEL at TTF2

TTF2 Injector (up to BC2) comm.	*Jun. 2004*
0.8GeV TTF2 commissioning	*Aug. 2004*
Saturation 30-120 nm	*July 2005*
Operation with full beam current	*Dec. 2005*
3rd Harmonic RF & ACC6 installed	*Feb. 2006*
1 GeV beam energy	*April 2006*
Saturation 6 nm	*June 2006*



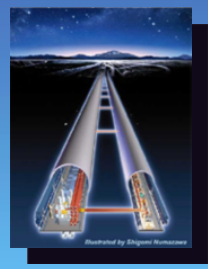
NLC/GLC Project





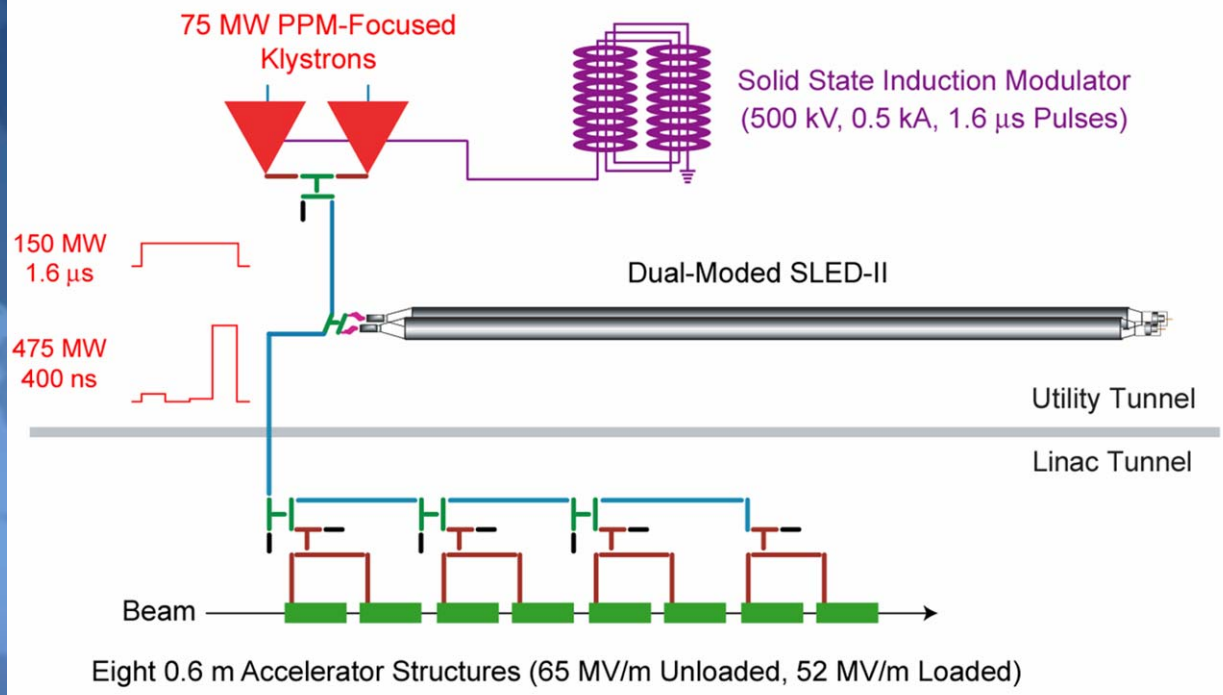
- *11.4GHz main linac*
- *65MV/m (52MV/m loaded)*
  Dumped Detuned Structure
- *RF pulse compression for H.G.*
- *Short & dense bunch train*

Main Linac Unit



NLC/GLC Linac RF Unit

(One of ~ 2000 at 500 GeV cms, One of ~ 4000 at 1 TeV cms)



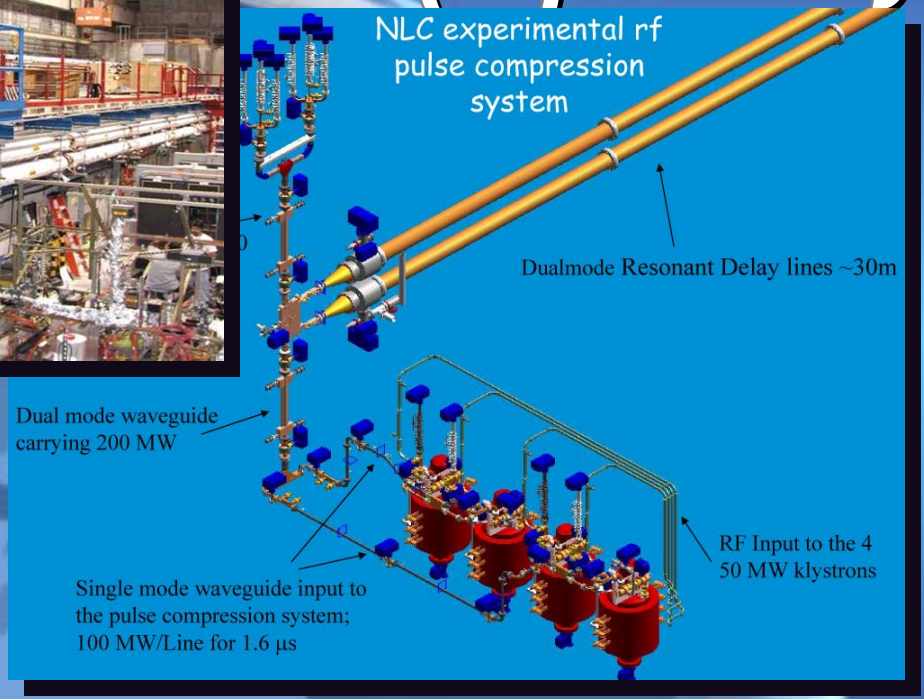
Eight 0.6 m Accelerator Structures (65 MV/m Unloaded, 52 MV/m Loaded)

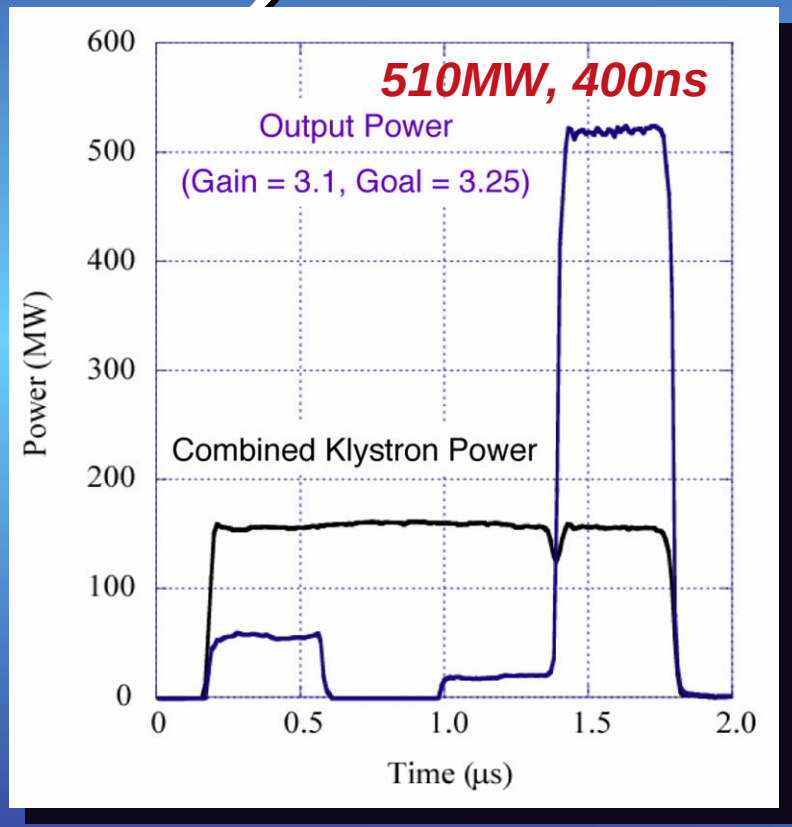
Periodic Permanent Magnet focused Klystron

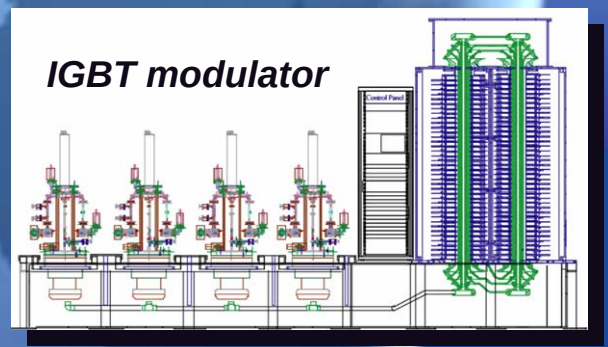
- ***75MW, 1.6μs PPM Klystron***
- ***500kV IGBT Modulator***
- ***475MW,400ns RF Pulse compression***
- ***65MV/m, 400ns Structure***

75MW, 1.6μs, 120Hz Operational

RF Power generation (8-pack system)

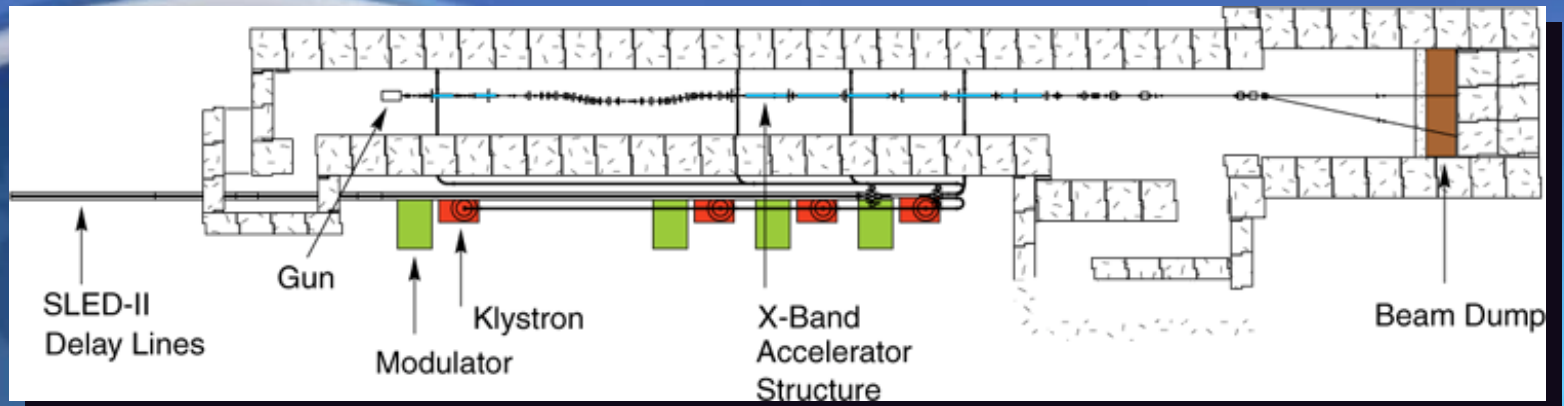






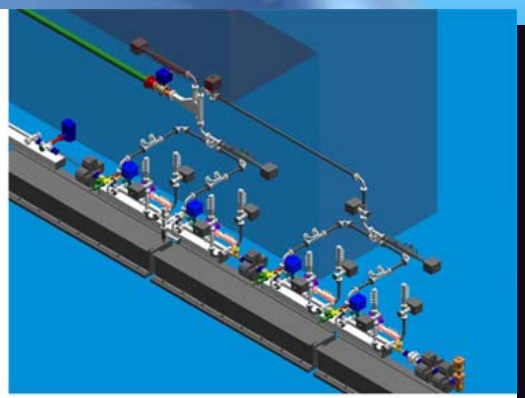
Four 50MW Solenoid Klystron run by IGBT modulator, Dual mode SLED II

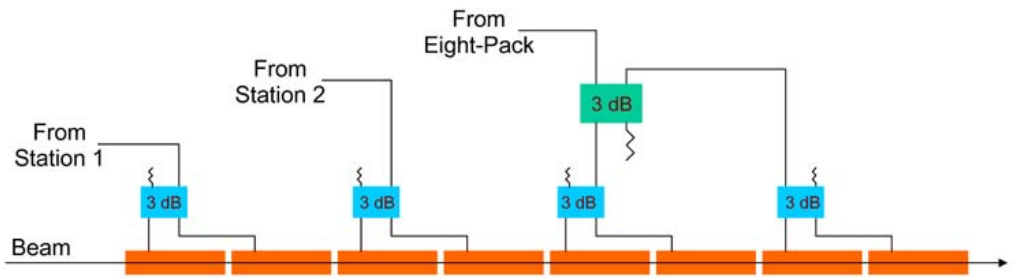
NLCTA (NLC Test Accelerator)



RF Unit Test: Phase II
(In Progress)

Power Eight Accelerator Structures in NLCTA (TRC R2 Requirement)

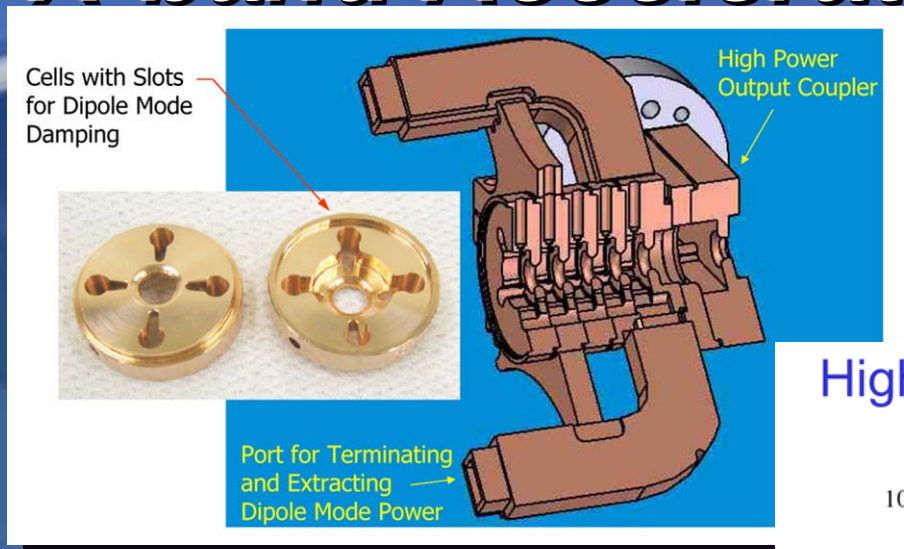


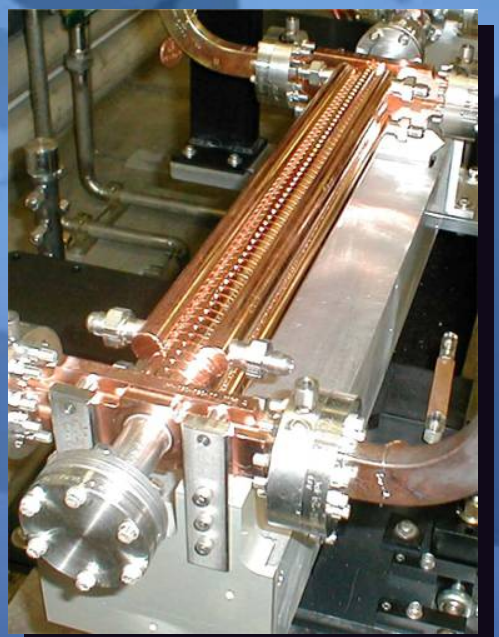


Operate Eight, 60 cm Long Structures at 65 MV/m, 400 ns Pulses

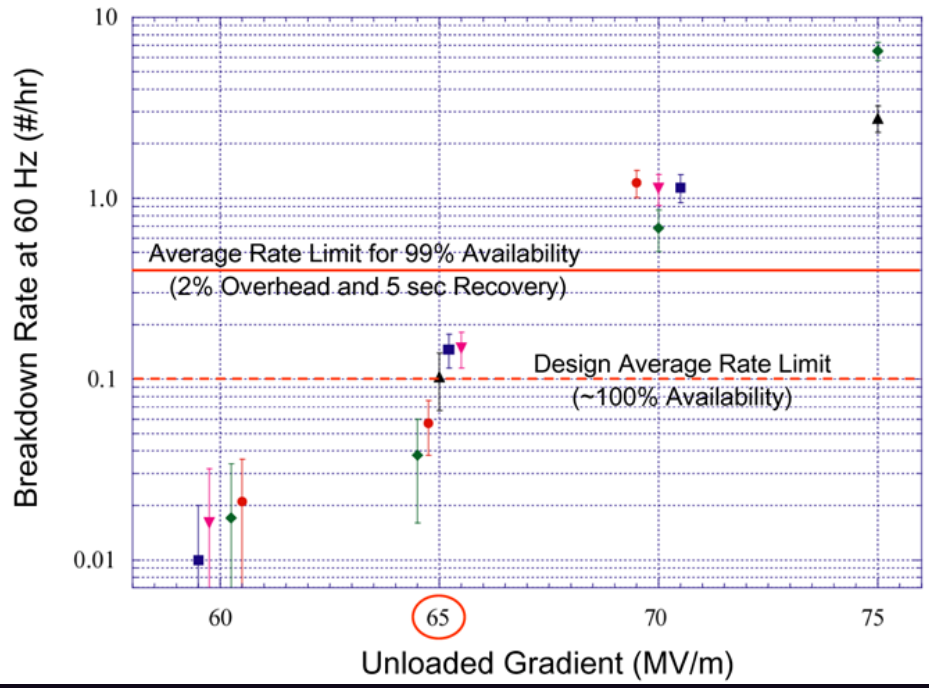
Beam supply
by DC gun & buncher
2 SLED II RF station
for structure HG test
1 8-pack system
for high power
& for system integration

X-band Accelerating structure



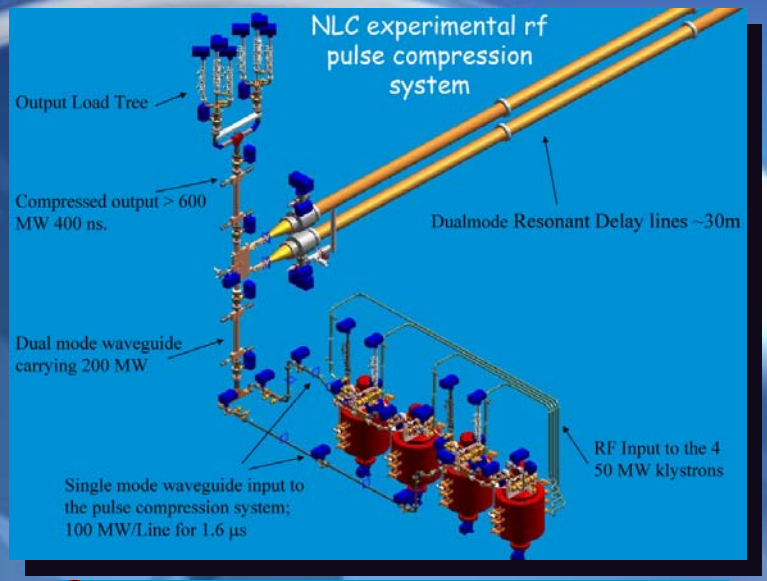


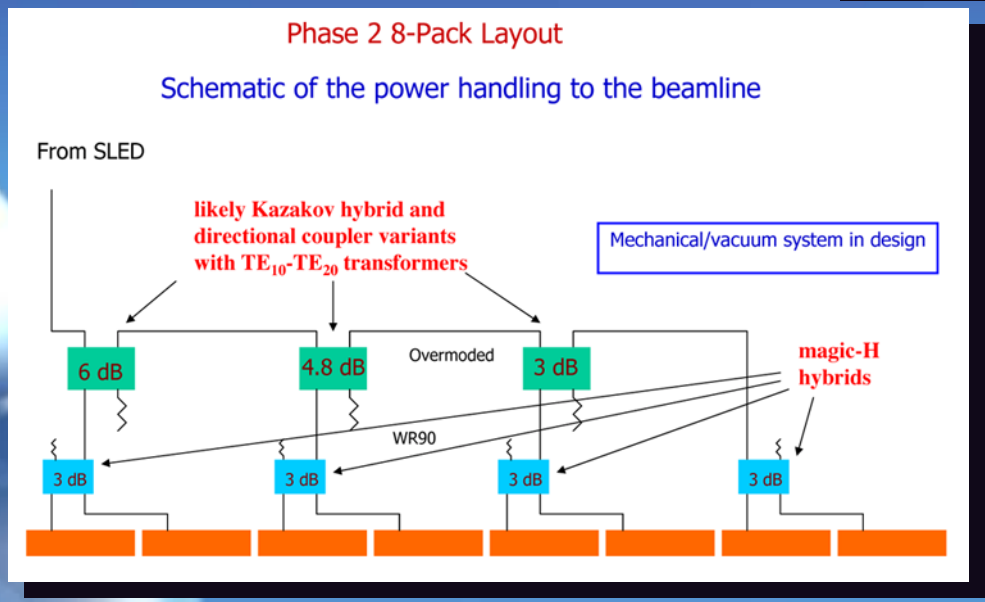
High Gradient Performance of Five Recent NLC/GLC Structures

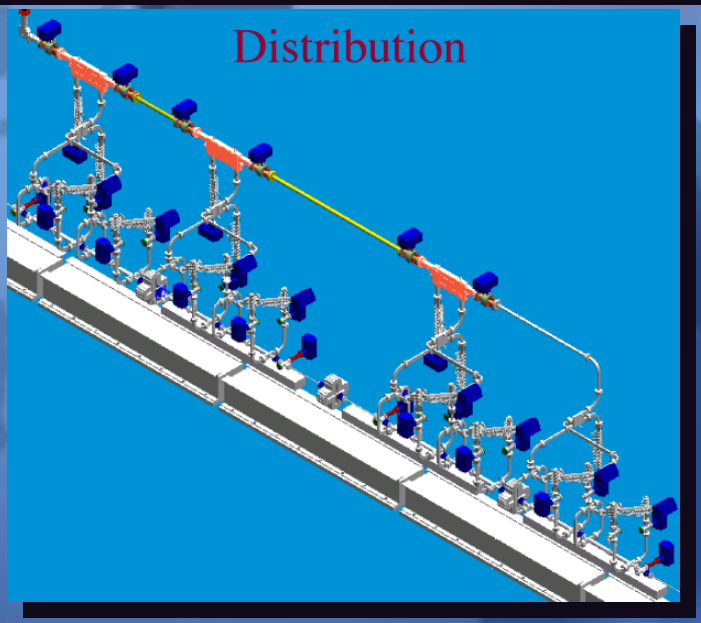


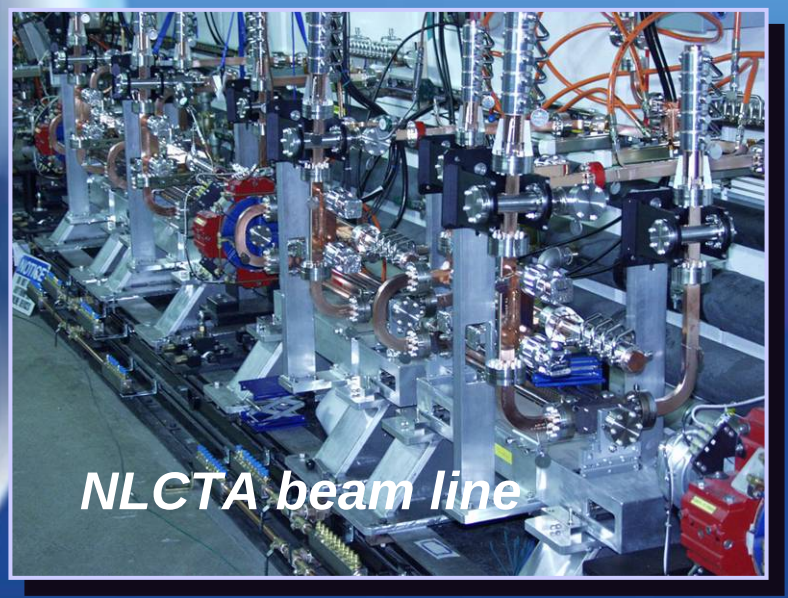
65MV/m : < 0.1 BD/hour at 60Hz

Accelerating unit integration

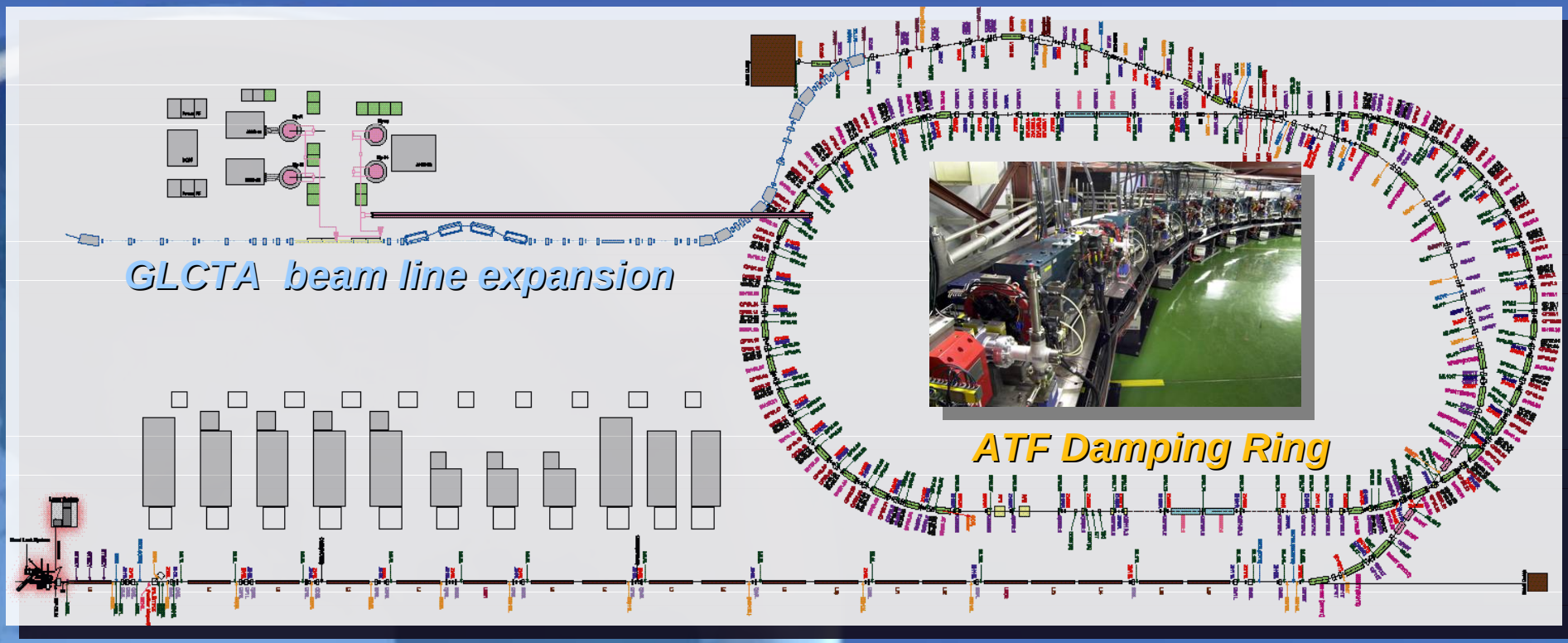


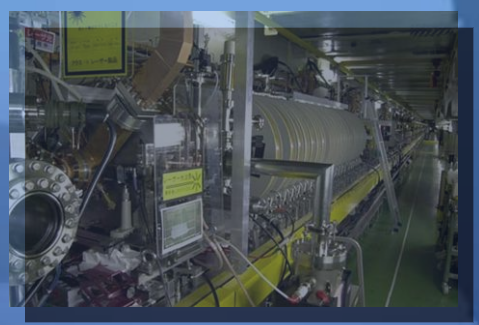






ATF & GLCTA





Test Facility of
LC low emittance beam

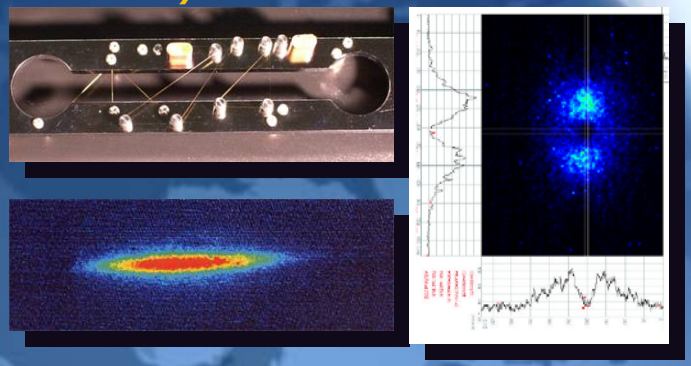
Half scale DR realization

E=1.28GeV
Ne=1x10^{10} e-/bunch
1 ~ 20 bunches
Rep=1.5Hz
X emit=2.5E-6(at 0 int.)
Y emit=2.5E-8(at 0 int.)

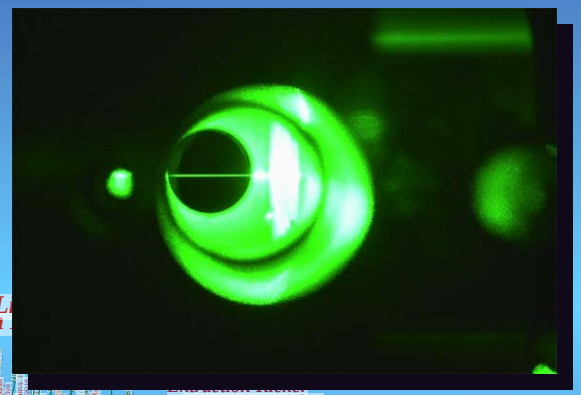
Multibunch Photo-cathode RF gun,
Δf-ECS S-band Linac

ATF emittance monitors

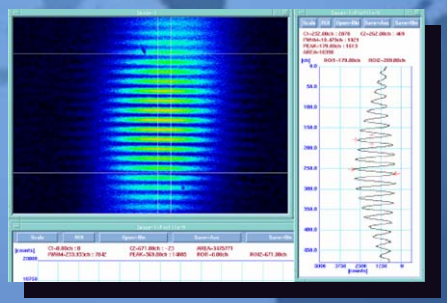
Tungsten Wire Scanner
OTR, ODR Monitor



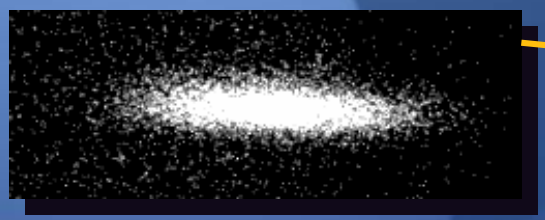
Laser Wire Scanner

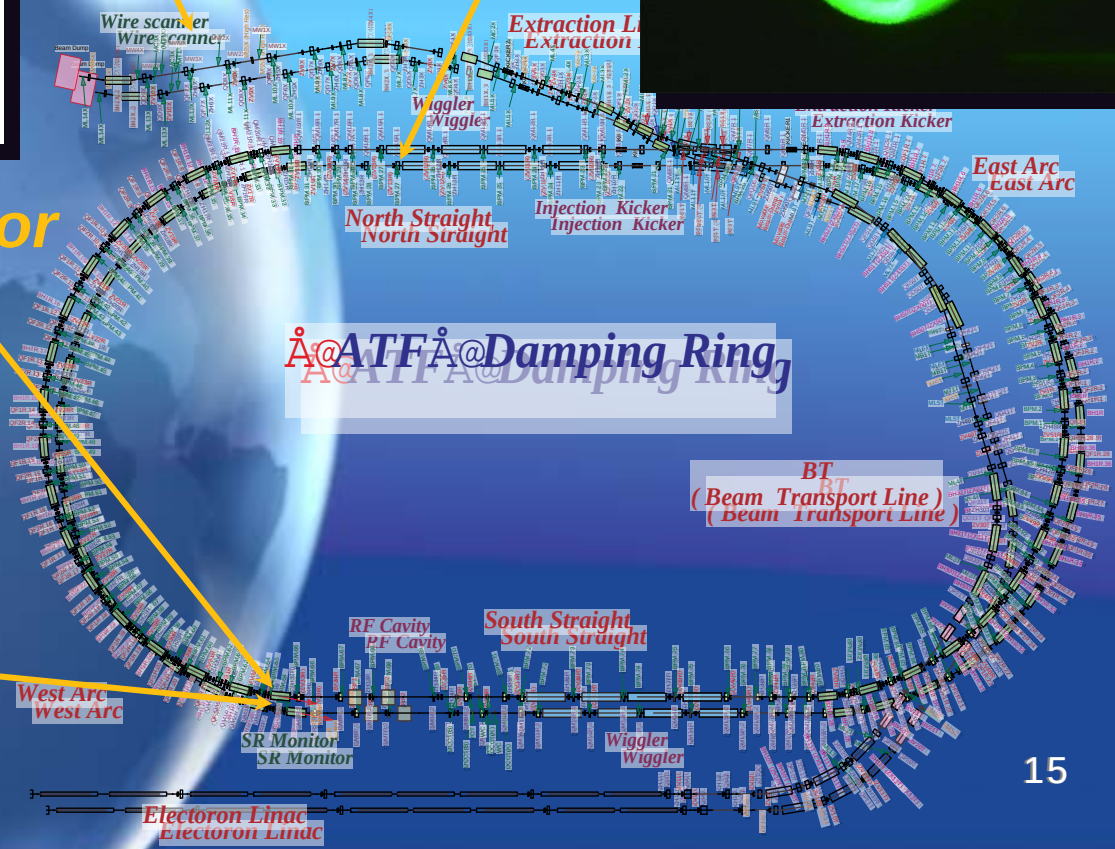


SR Interference Monitor



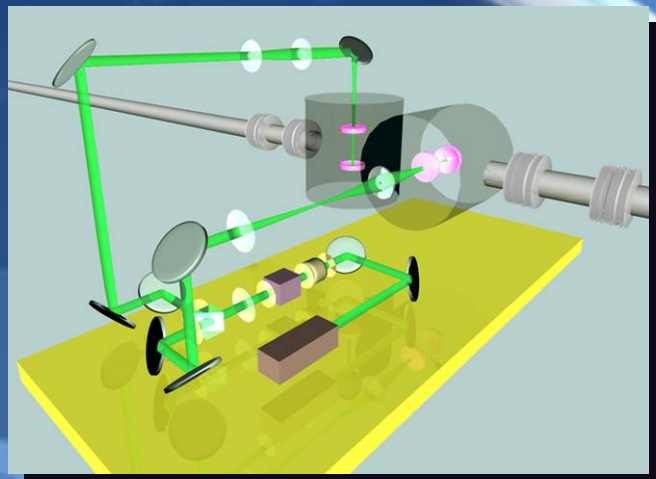
X-ray SR Monitor

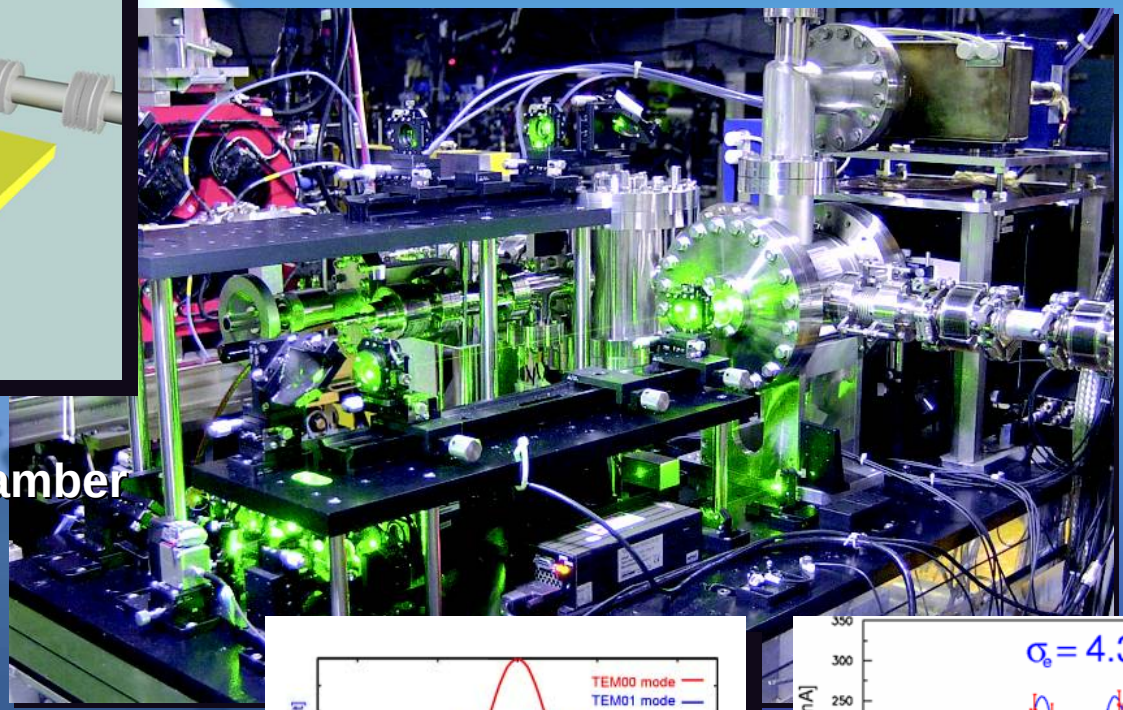




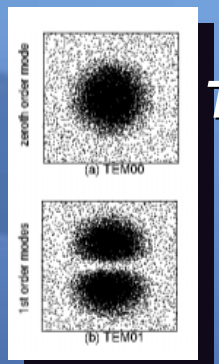
Laser wire scanner in DR

for X & Y scan, for single/multi-bunch



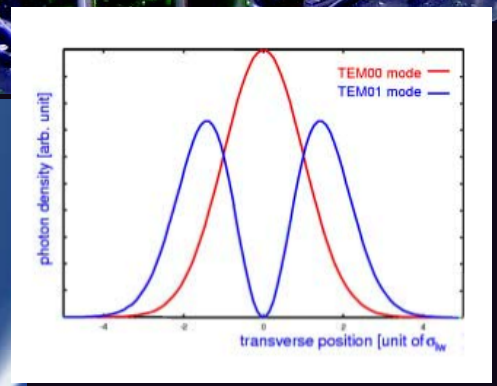


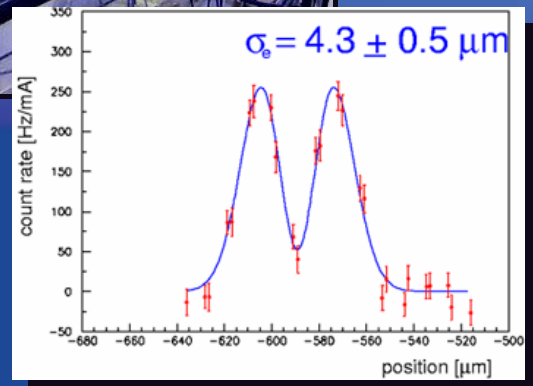
Two optical cavity chamber
For X-wire and Y-wire



TEM00 wire

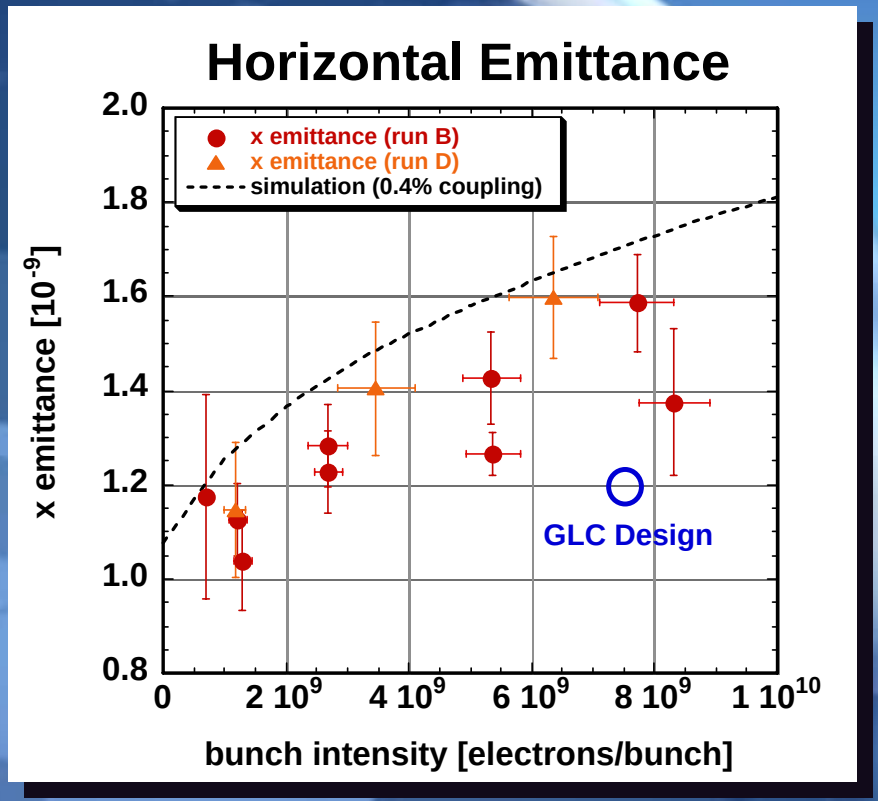
TEM01 wire

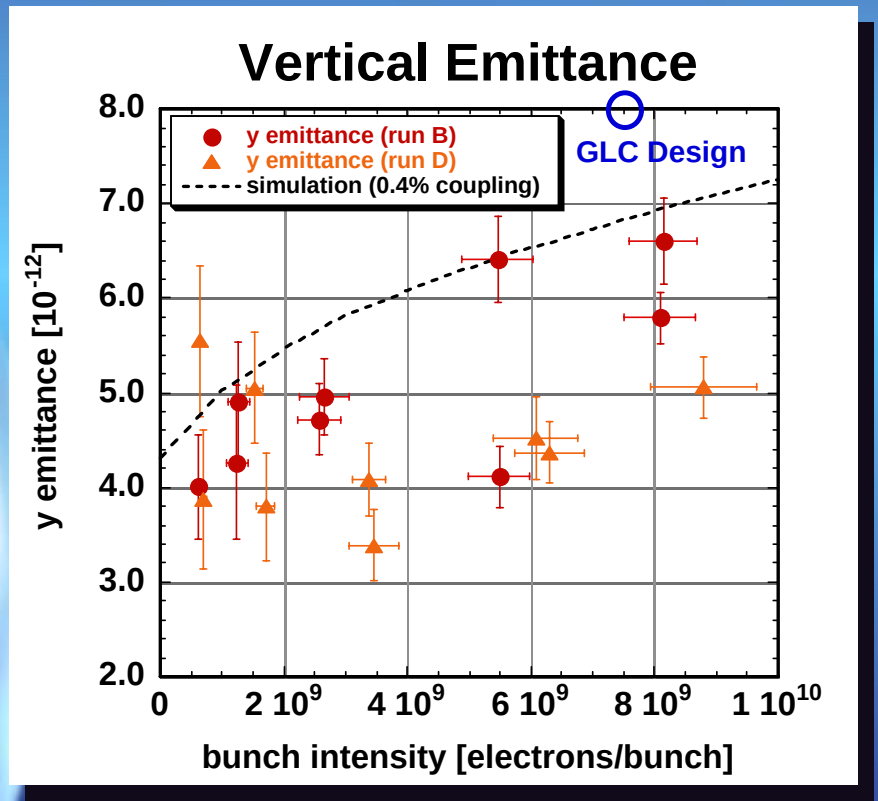




Single bunch Transverse Emittance

by Laser wire

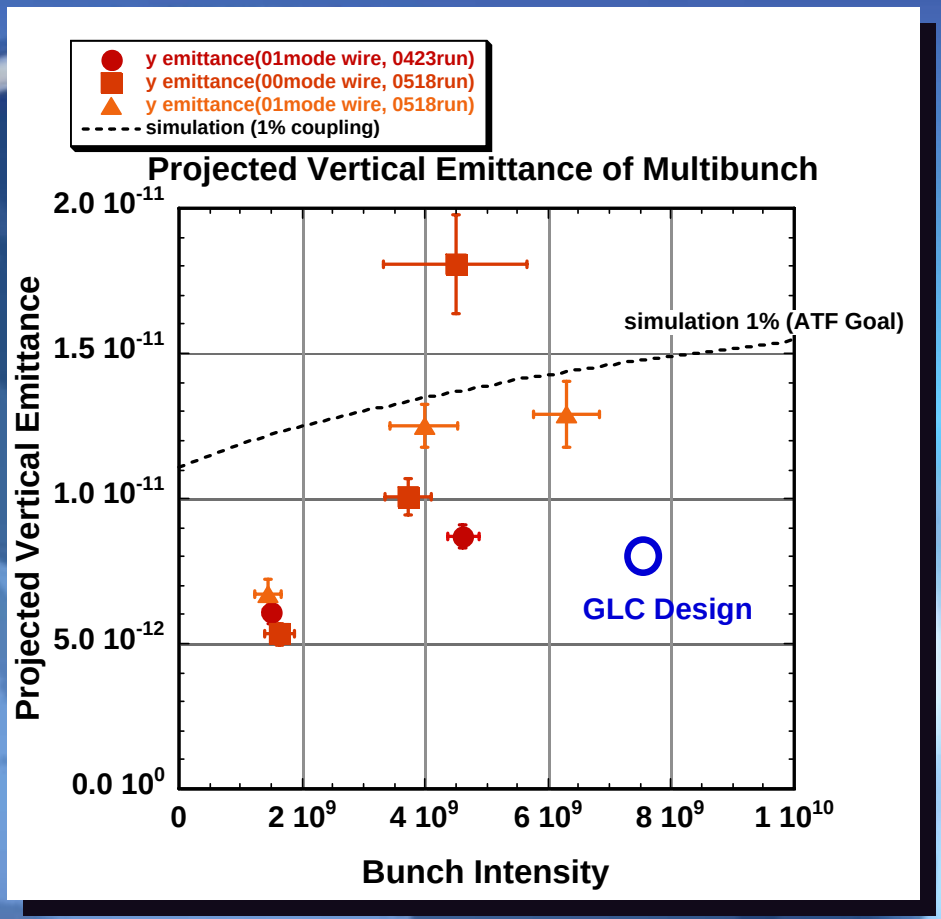


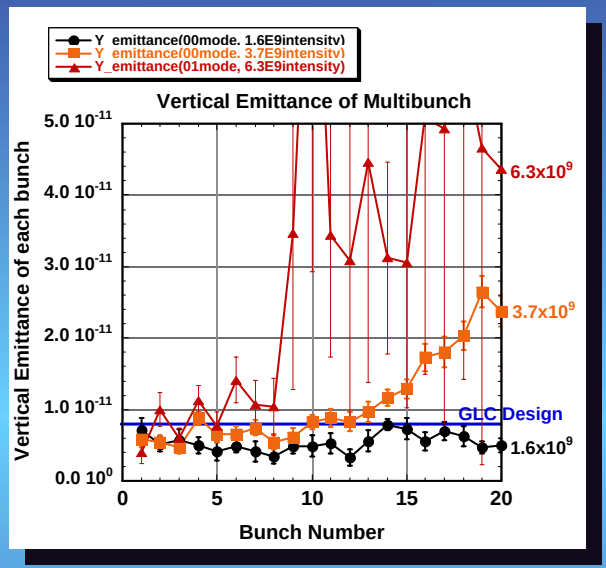


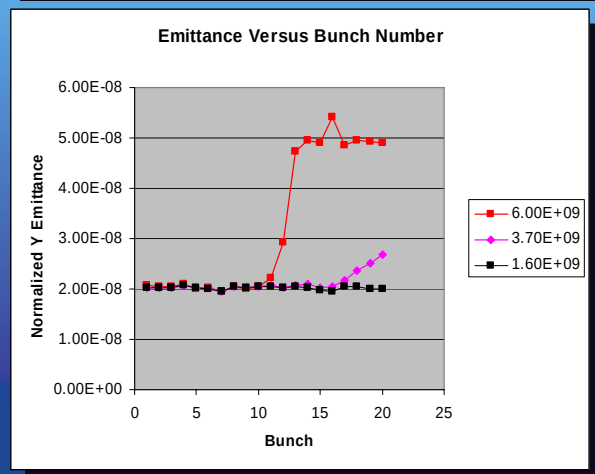
X emittance determined by Ring Design. Measured data points are fit to simulation.

Y emittance =6.5pm at GLC intensity, is below GLC design.

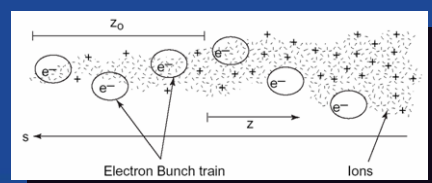
Multibunch Vertical Emittance





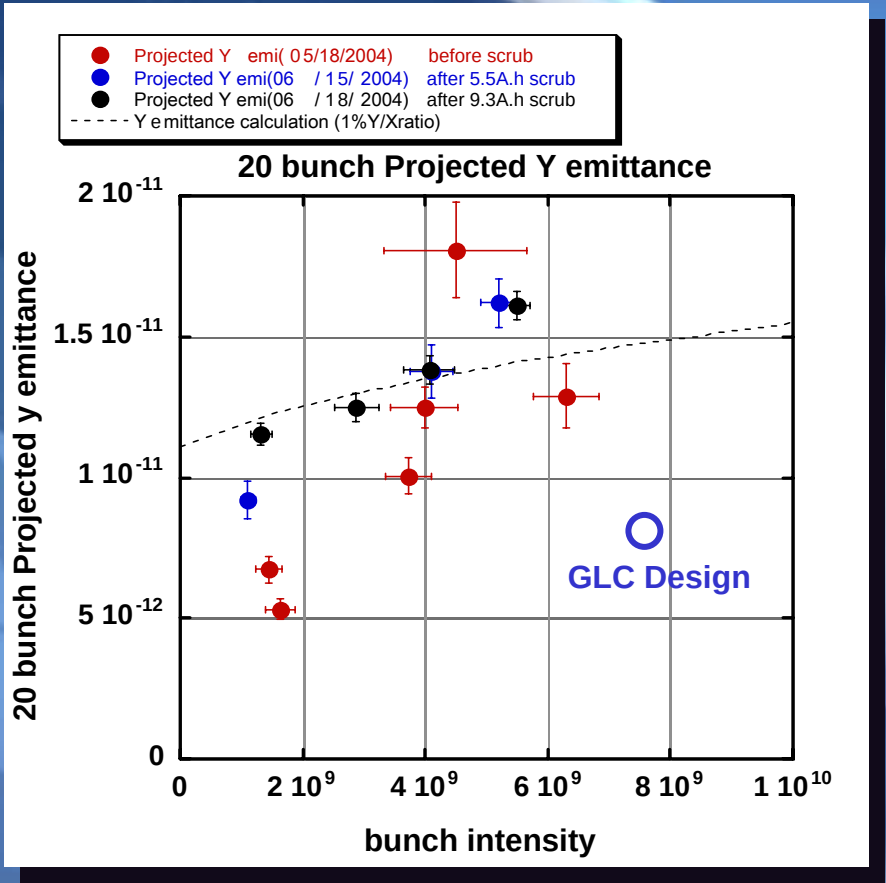


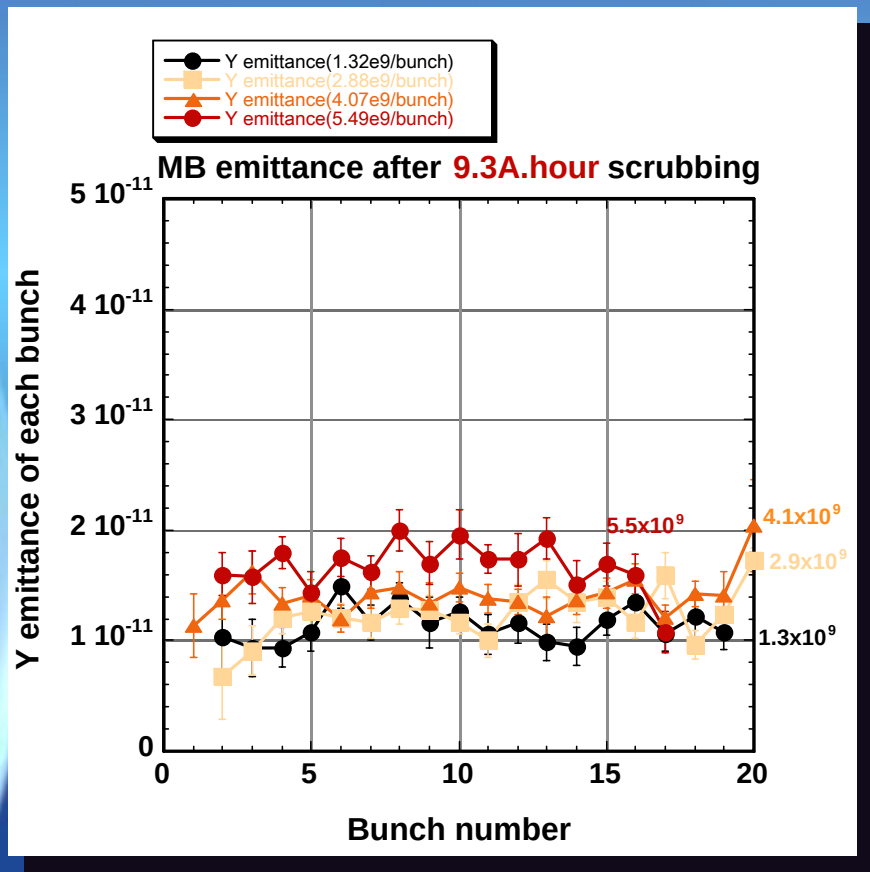
Blowup at tail bunch is seen.



Multibunch Vertical Emittance

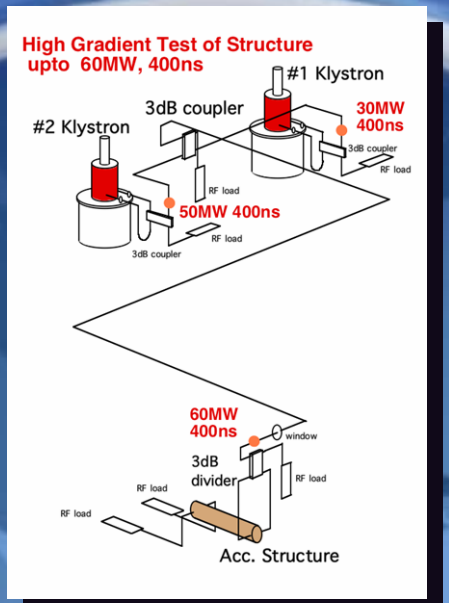
after 9.3 A.hours scrubbing

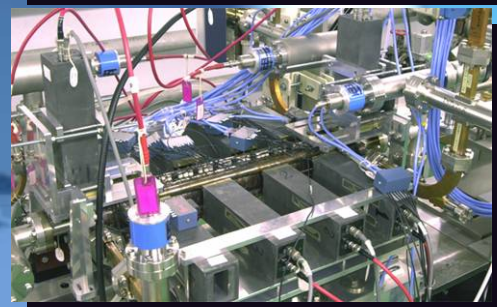




Projected Y emittance *is around 1% from X,*
However, insufficient tuning of Y emittance.

GLCTA (GLC Test Accelerator)

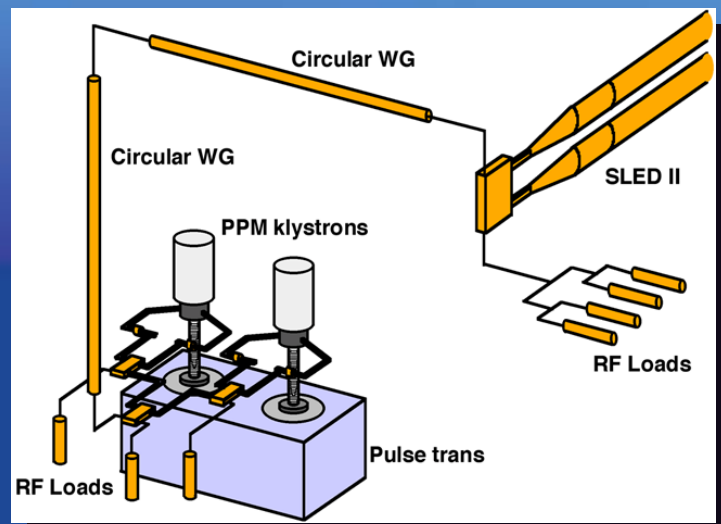




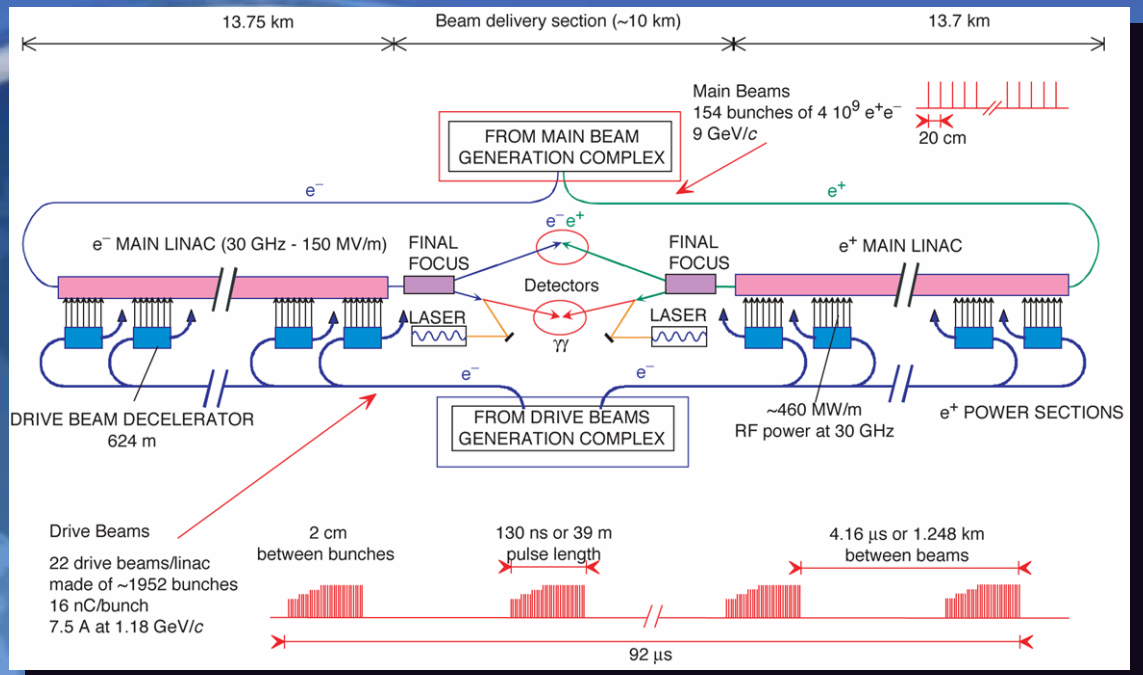
Mission:

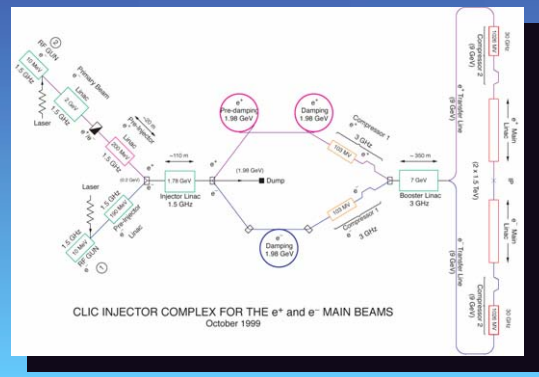
1. ***Structure High Gradient Test***
2. ***High Power Generation Test***
3. ***Main Linac System Integration***
   using ATF low emittance beam
   or using GLC intensity beam
   from RFgun

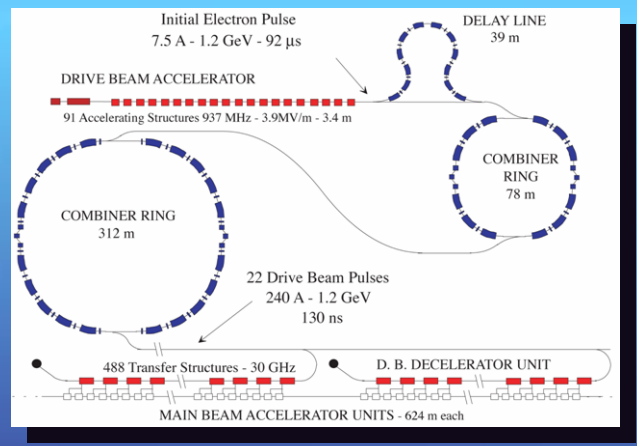
Construction: 2003 ~ 2005

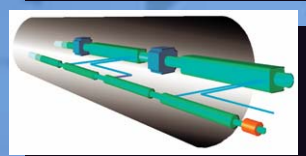


CLIC project









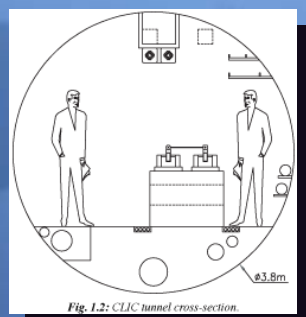
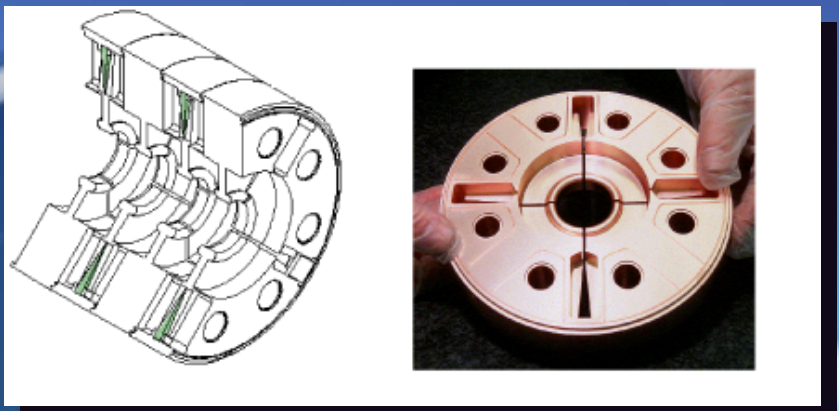


Fig. 1.2: CLIC tunnel cross-section.

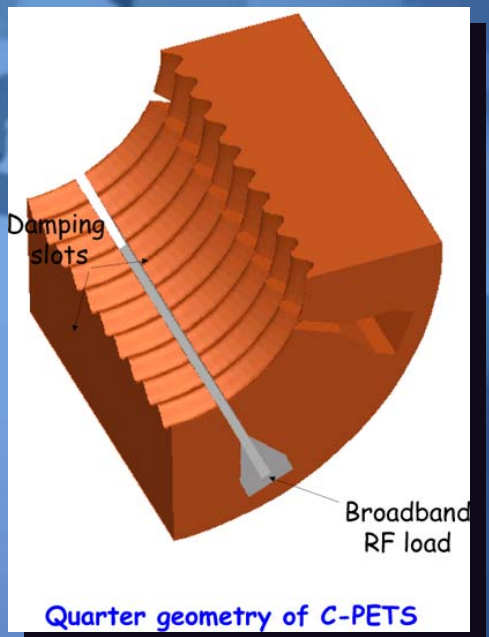
- ***Two-beam Acceleration***
- ***30GHz main linac***
- ***150MV/m Dumped Detuned Structure***
- ***High Intensity Drive Beam***
- ***Short & dense bunch train***

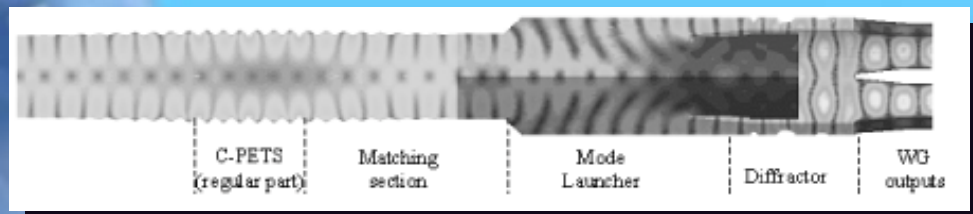
CLIC RF component



SICA (Slotted Iris Constant Aperture) Structure for Drive Beam acceleration

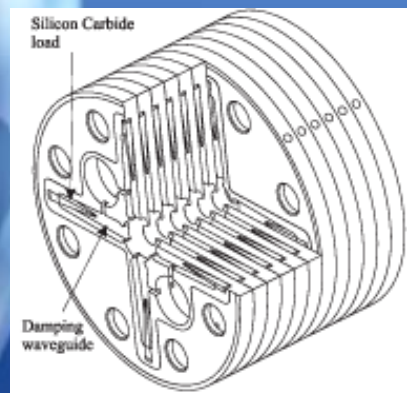
937MHz (3GHz at CTF3)

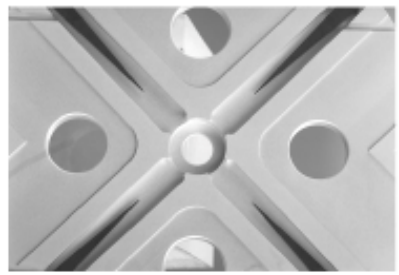




Mode converter from circular to rectangular

C-PETS :
Circular Power ExTraction Structure
Ø25mm, 512MW, 30GHz

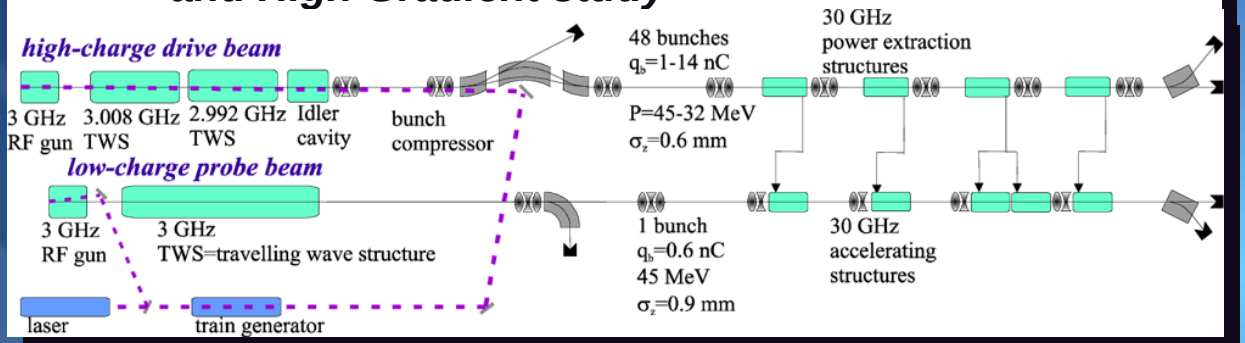




30GHz Main Beam accelerator structure

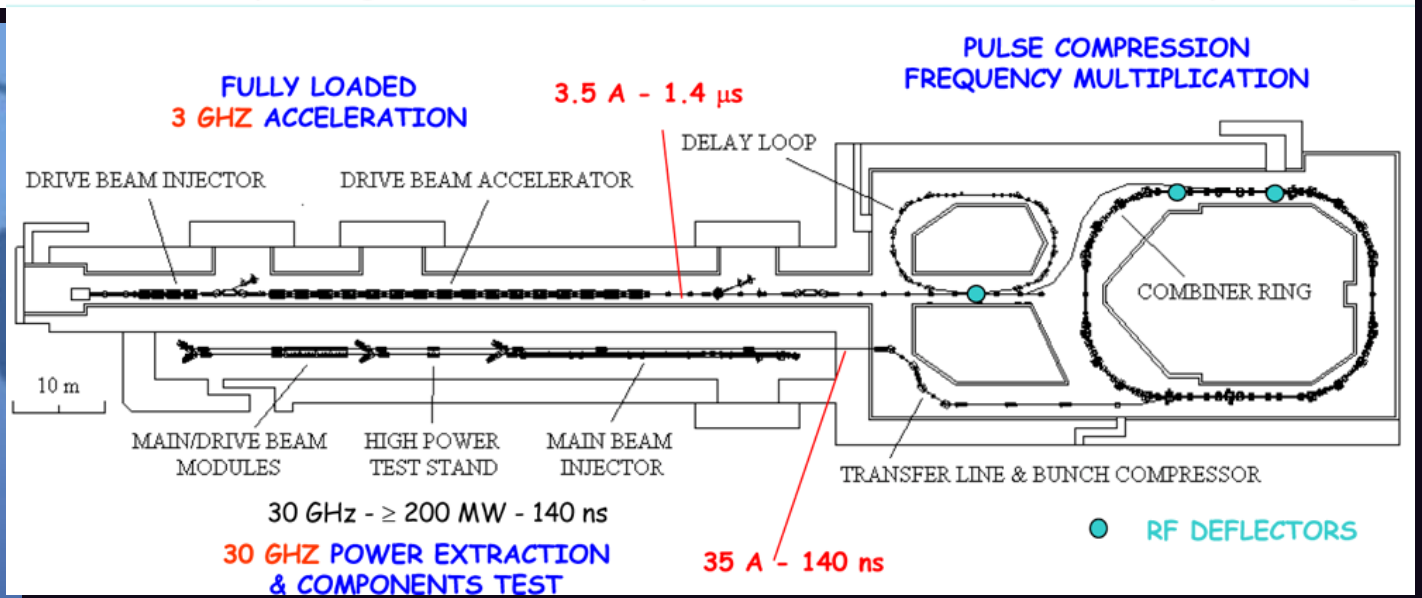
CTF3 (CLIC Test Facility)

CTF2 : Two beam acceleration component demonstration and High Gradient study

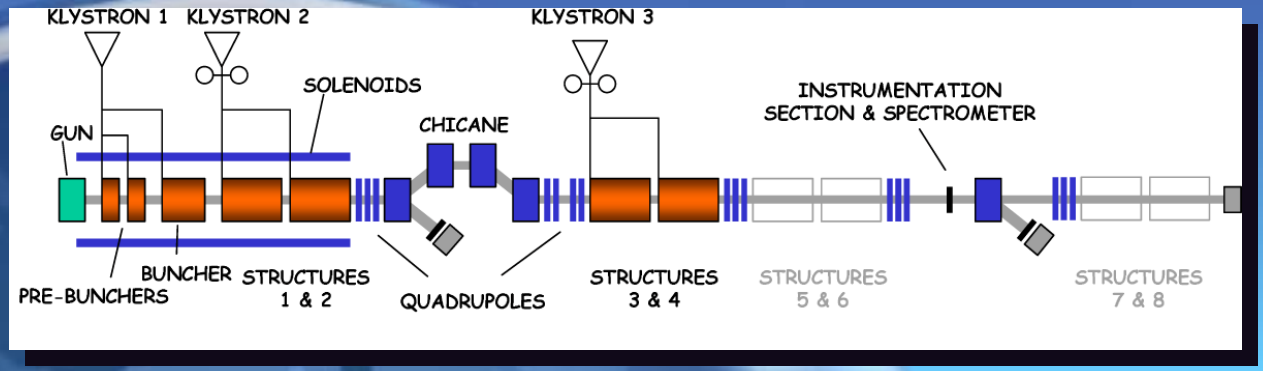


CTF3:

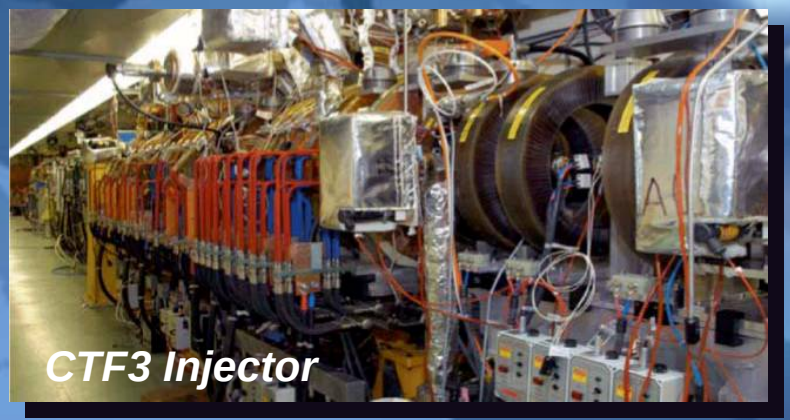
Test of Drive Beam Generation, Acceleration & RF Multiplication by a factor 10
Two Beam RF power generation & component tests with nominal fields & pulse length

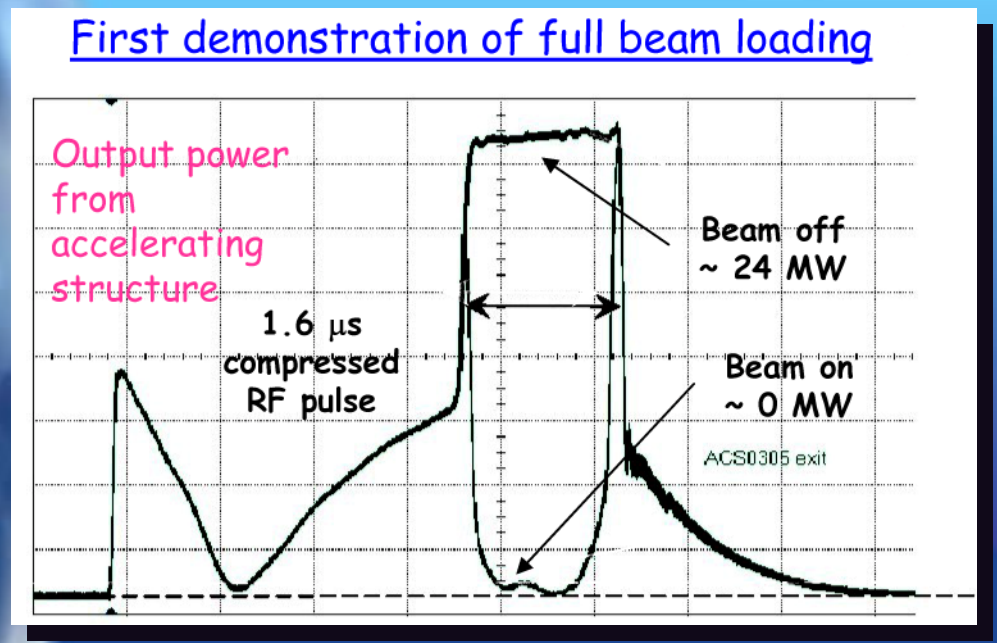


Drive Beam Generation Test

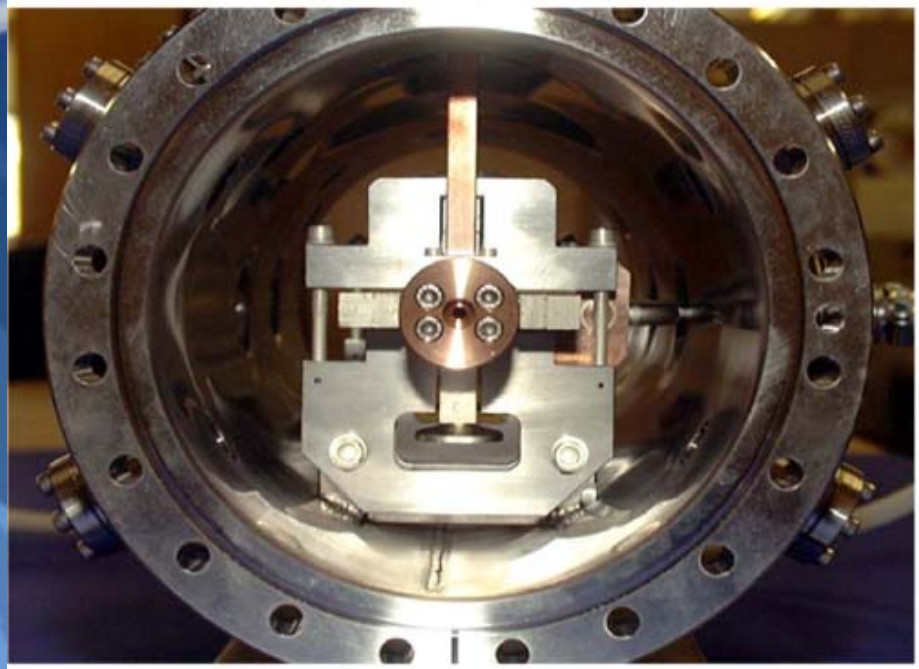


CTF3 injector commissioning

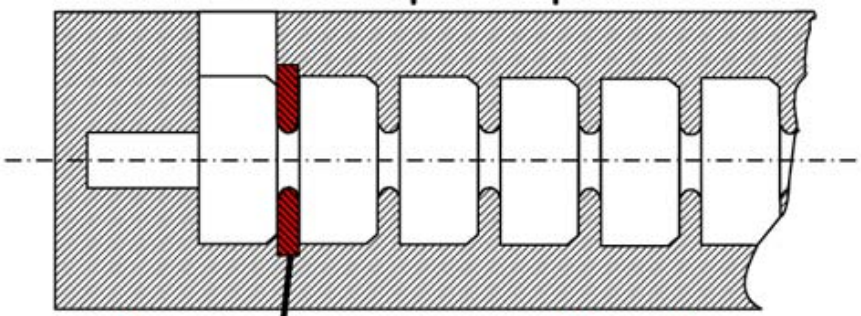




Tungsten Iris Test

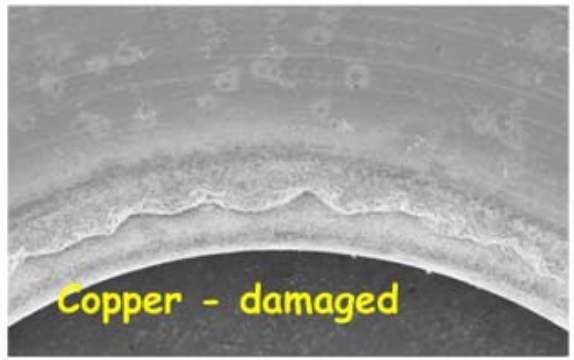


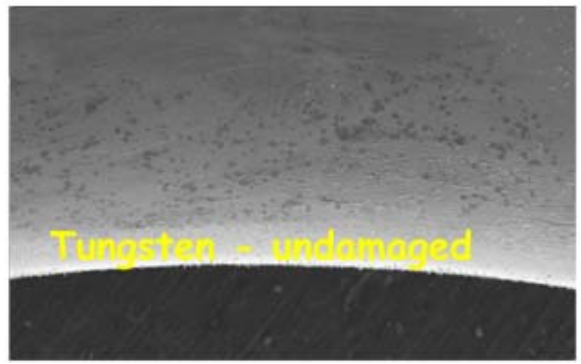
Test structure in external vacuum can, with clamped coupler cell



Copper iris replaced by Tungsten iris

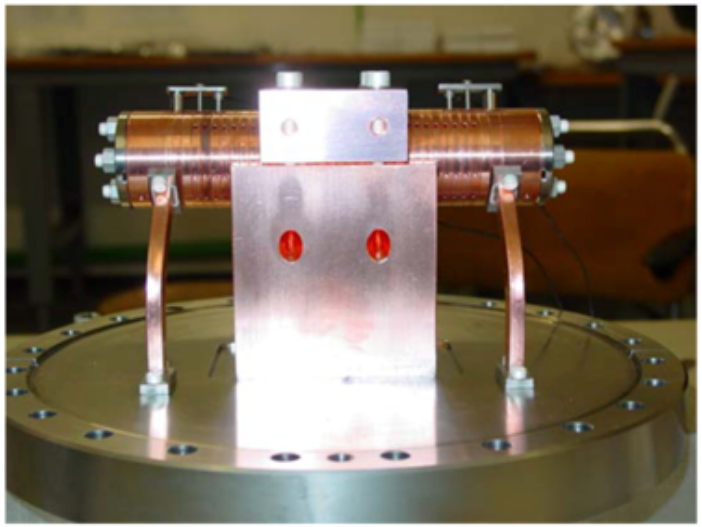
Irises after high-gradient testing to about the same field level



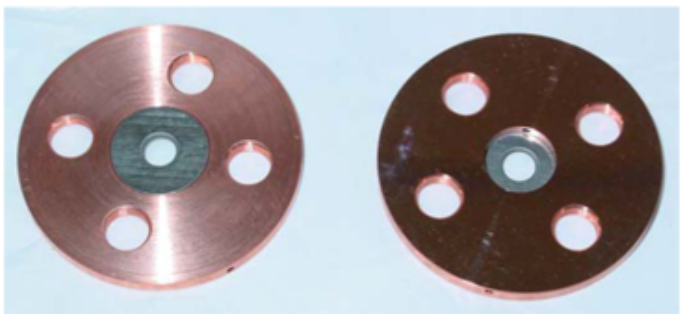


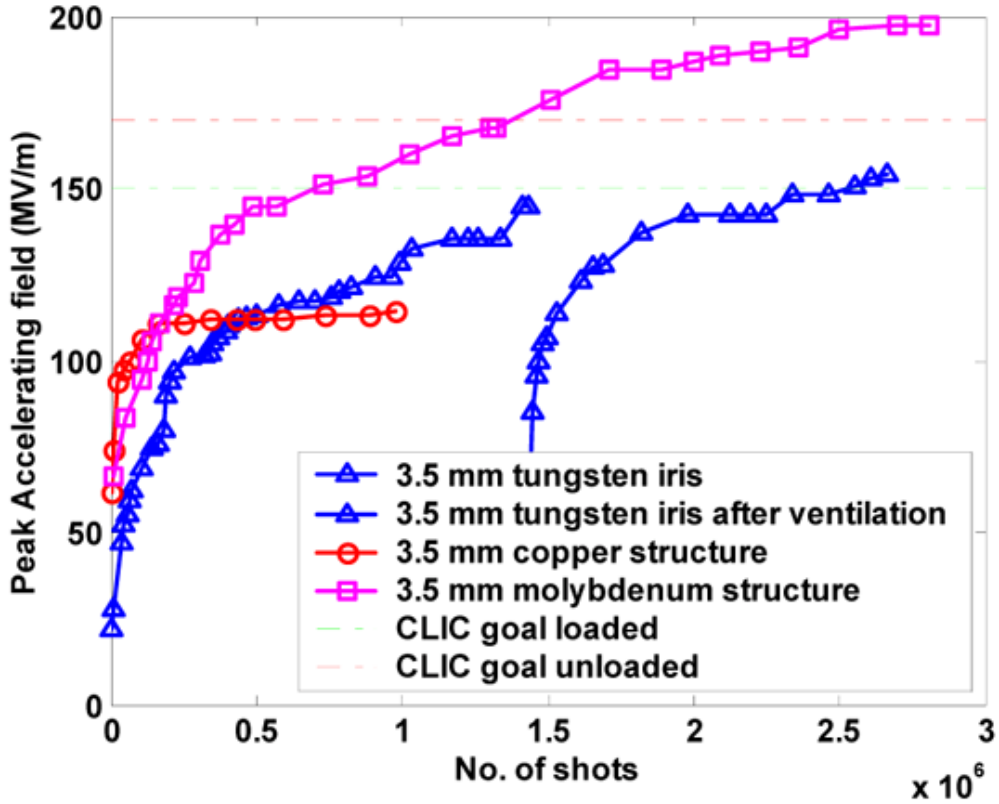
High Gradient Test

High gradient tests of new structures with molybdenum irises reached 190 MV/m peak accelerating gradient without any damage well above the nominal CLIC accelerating field of 150 MV/m but with RF pulse length of 16 ns only (nominal 100 ns)



30 cell clamped tungsten-iris structure





Test Facility Plans for 2004-2005

- **TTF2**

  Commissioning of TTF2,
  30nm SASE-FEL lasing.

- **NLCTA**

  Complete RF unit demonstration.

- **ATF/GLCTA**

  multibunch emittance, wiggler,
  Construction of complete RF unit.

- **CTF3**

  Commissioning of Drive beam,
  Construction of Delay Loop
  & Combiner Ring.

The figures and pictures are borrowed from following web-site:
DESY, SLAC, CERN, ITRP and conference papers(EPAC2004 etc.).

I would like to appreciate to all of presenter.

end