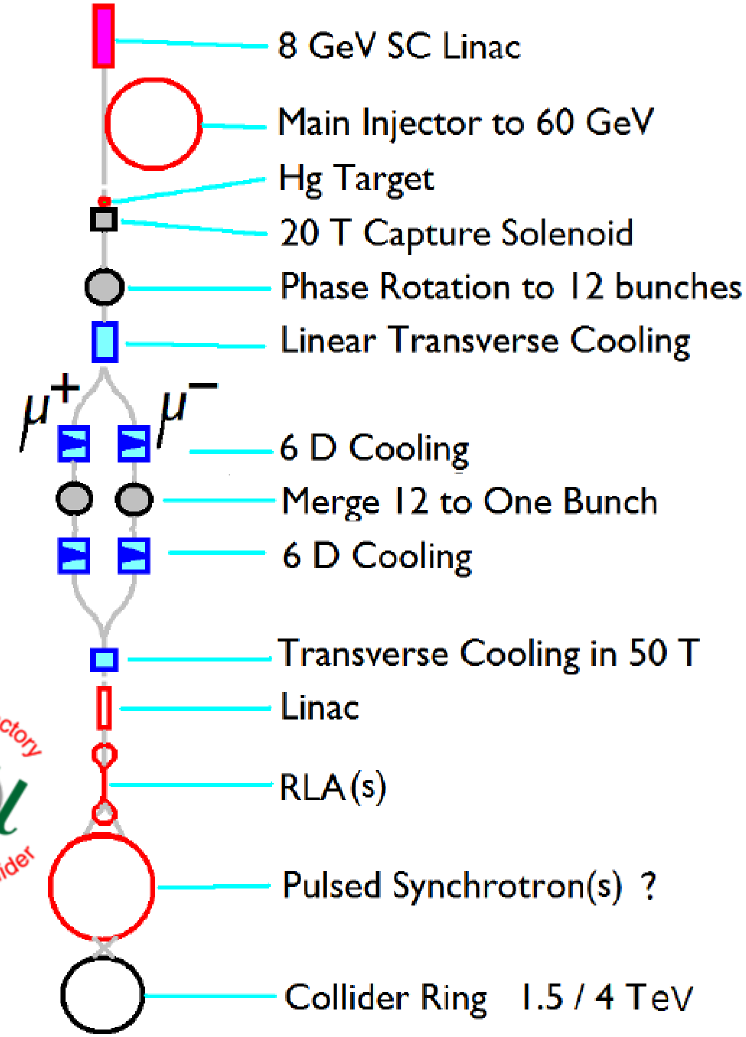
The next energy-frontier accelerator a linear e+e- collider?

G. Geschonke
CERN, Geneva, Switzerland

Muon Collider

Collider Parameters

C of m Energy	1.5	4	TeV
Luminosity	1	4	10^{34} cm^{2}sec^{-1}
Muons/bunch	2	2	10^{12}
Ring circumference	3	8.1	km
Beta at IP $= \sigma_z$	10	3	mm
rms momentum spread	0.1	0.12	%
Required depth for ν rad	13	135	m
Repetition Rate	12	6	Hz
Proton Driver power	$\approx$4	$\approx$ 1.8	MW
Muon Trans Emittance	25	25	pi mm mrad
Muon Long Emittance	72,000	72,000	pi mm mrad



Muon Collider Progress

R. B. Palmer (BNL)

PAC09

5/5/09

Vancouver

Neutrino Factory and Muon Collider Collaboration (NFMCC)

Very active R&D

Time line: ➔ 2028

Linear Collider base-line

LEP: 209 GeV

next Electron-Positron Collider

- Centre-of-mass-energy:
- 0.5 - 3 TeV
- Luminosity: $>2*10^{34}$

⇔

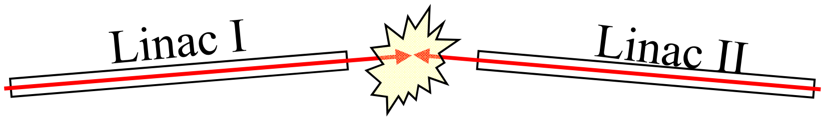
Physics motivation:

"Physics at the CLIC Multi-TeV Linear Collider: report of the CLIC Physics Working Group,“

CERN report 2004-5

Storage Ring not possible, energy loss $\Delta E \sim E^4$

➔ two linacs, experiment at centre



- total energy gain in one pass: **high acceleration gradient**
- beam can only be used once: **small beam dimensions at crossing point**

Boundary conditions: site length

Power consumption

High Energy Physics after LHC

In 1999 ICFA issued a statement on Linear Colliders, ... that there would be compelling and unique scientific opportunities at a linear electron-positron collider in the TeV energy range. Such a facility is a necessary complement to the LHC hadron collider now under construction at CERN.

Two options: ILC - CLIC

Collaboration on common issues

The European strategy *for particle physics*

Unanimously approved by the CERN Council at the special Session held in Lisbon on 14 July 2006

4. In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D programme; *a coordinated programme should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.*

5. It is fundamental to complement the results of the LHC with measurements at a linear collider. In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier; *there should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010.*

CERN/2685

Basic relation

$$L = \frac{n_b * N^2 * f_{rep}}{A} H_D \longrightarrow L = \frac{P_{beam}}{4 * \pi * E_{cm}} * \frac{N}{\sigma_x * \sigma_y} H_D$$

n_b : bunches / train

N: Particles / bunch

A: beam cross section at IP

H_D: beam-beam enhancement factor

➔ optimization process:

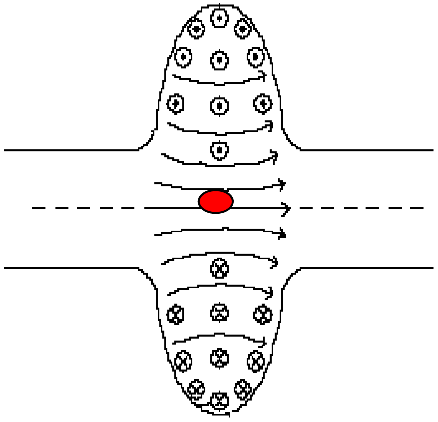
efficiency - Mains power consumption

site length

cost

Particle acceleration

using RF fields in cavity resonators



accelerating voltage $U = \sqrt{R/Q * \omega * W}$

$$W = \frac{Q}{\omega} * P$$

W : stored RF energy

P : RF power

Very high Q ➔ small RF power to obtain accelerating voltage.
only power taken by beam needs to be replaced.

Superconducting cavities: Q about 10^{10}
Cu cavity: about 10^{4}

Superconducting RF

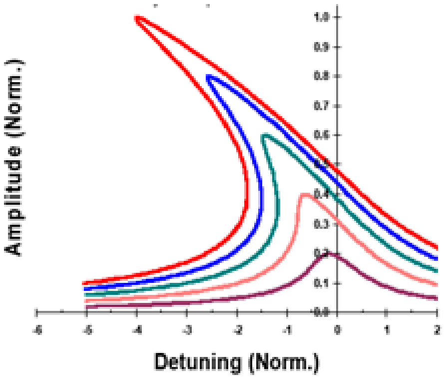
$$R_s = R_{BCS} + R_{Res}$$

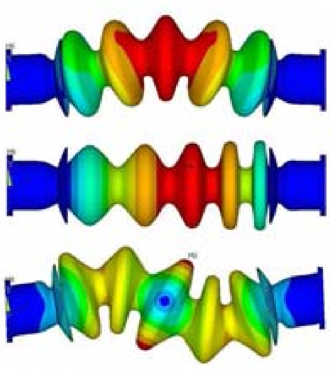
$$R_{BCS} \sim \frac{\omega^2}{T} e^{-\alpha \frac{T_c}{T}}$$

losses not zero !
powerful cryogenics
system needed.

total operating power for cryogenics: 37 MW
(includes also magnets e.t.c.)

Lorentz detuning





I. Ben-Zvi

Ponderomotive oscillations
(coupling of RF energy to mechanical oscillation)

Solutions have been demonstrated
(Flash FEL at DESY)

maximum fields are limited

9-cell NB cavity

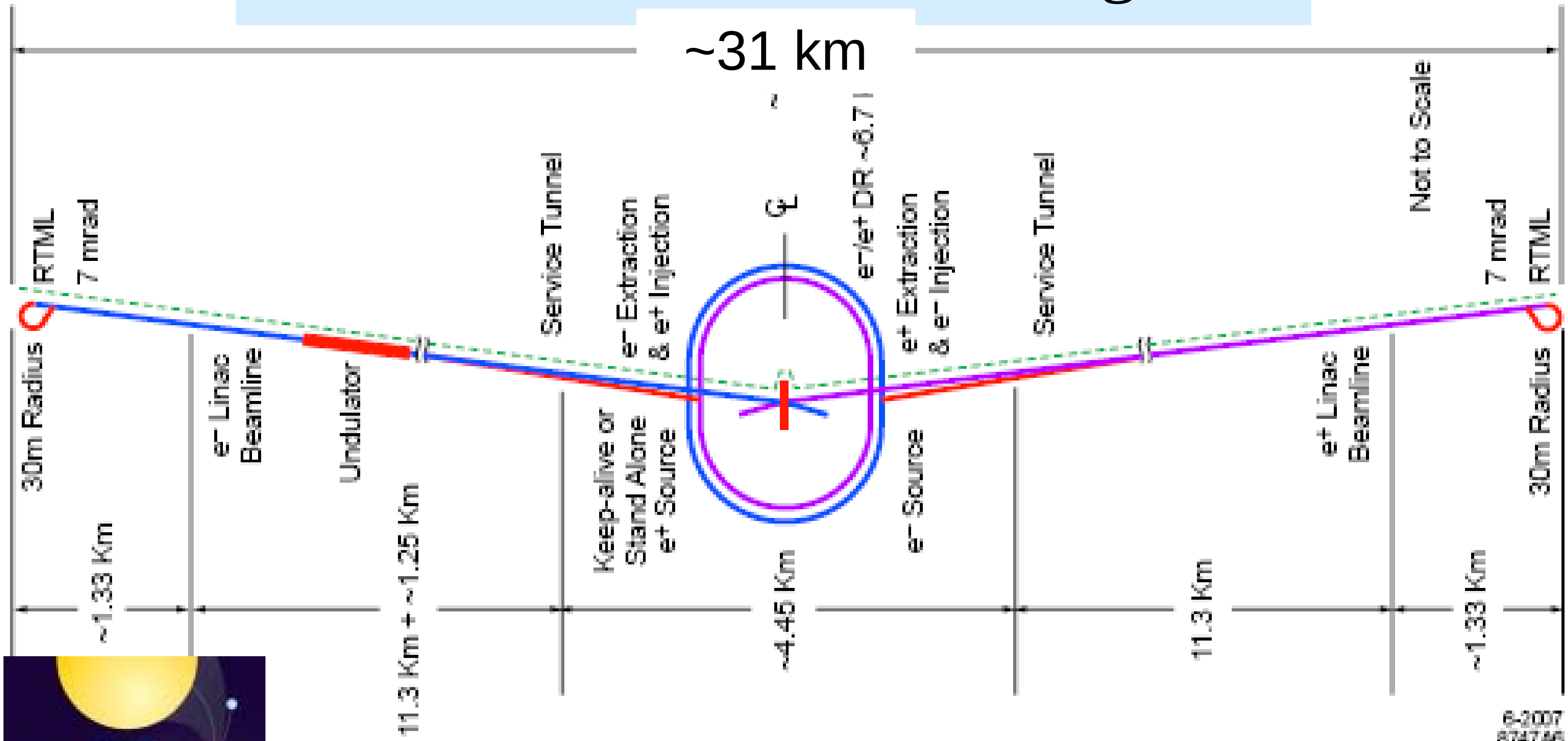
Basic differences ILC-CLIC

	ILC: Superconducting RF	CLIC: normal conducting copper RF
	500 GeV	**3 TeV**
accelerating gradient:	**31.5 MV/m** 35 MV/m target	**100 MV/m**
RF Peak power:	**0.37 MW/m , 1.6 ms, 5 Hz**	**275 MW/m, 240 ns, 50 Hz**
RF average power:	2.9 kW/m	3.7 kW/m
total length:	31 km	48.4 km
site power :	230 MW	392 MW

Beam structure:

particles per bunch:	**$20 * 10^9$**	**$3.7 * 10^9$**
	2625 bunches / pulse of 0.96 ms	312 bunches / pulse of 156 ns
bunch spacing	**369 ns**	**0.5 ns**

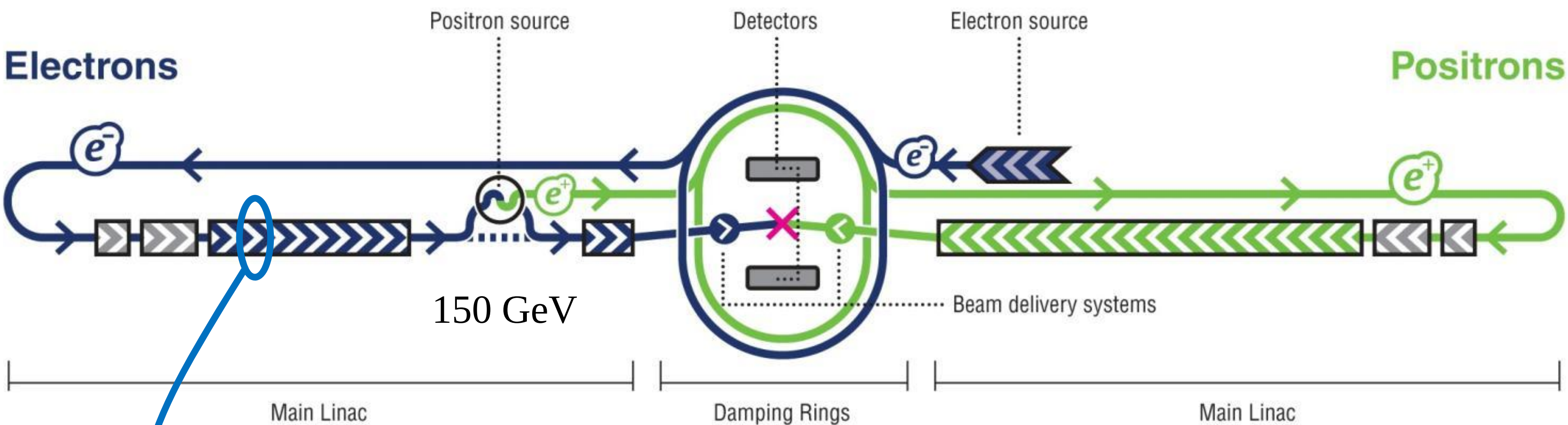
The ILC Reference Design



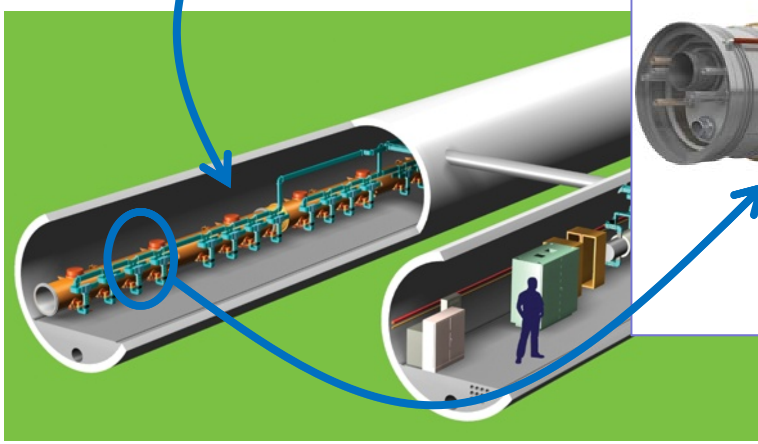
- 200-500 GeV centre-of-mass
- Luminosity: 2×10^{34} cm^{-2}s^{-1}
- Based on accelerating gradient of 31.5 MV/m (1.3GHz SCRF)

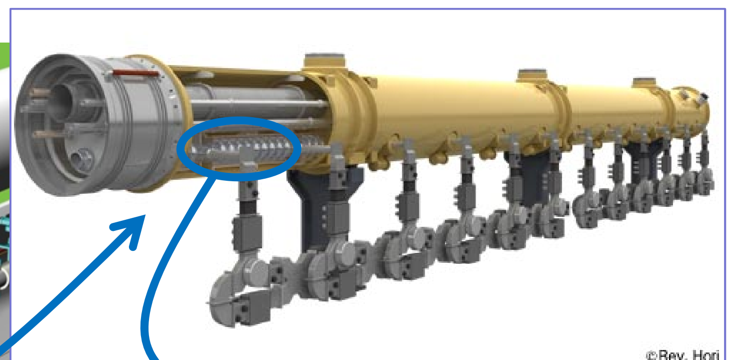
N.Walker

ILC Reference Design



150 GeV





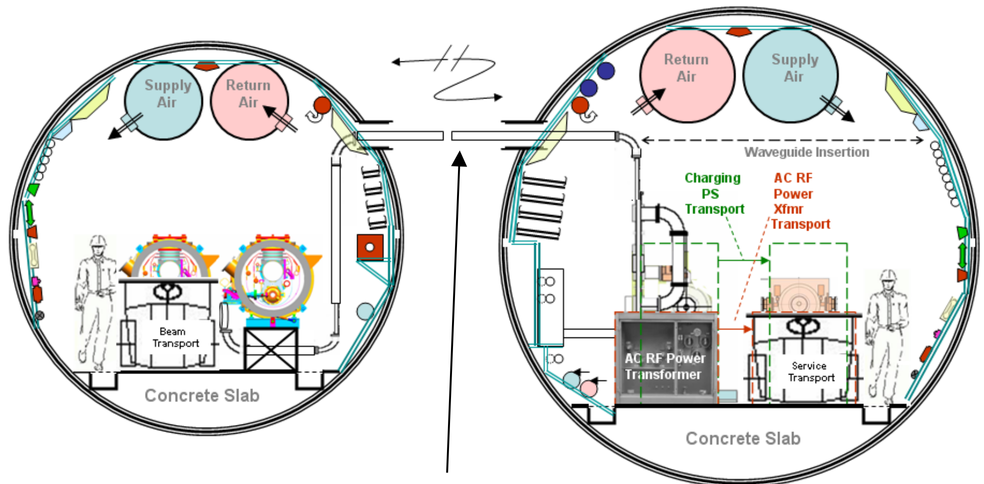
8/9 cavities

SC cavity

N.Walker

RDR Baseline Tunnel Layout

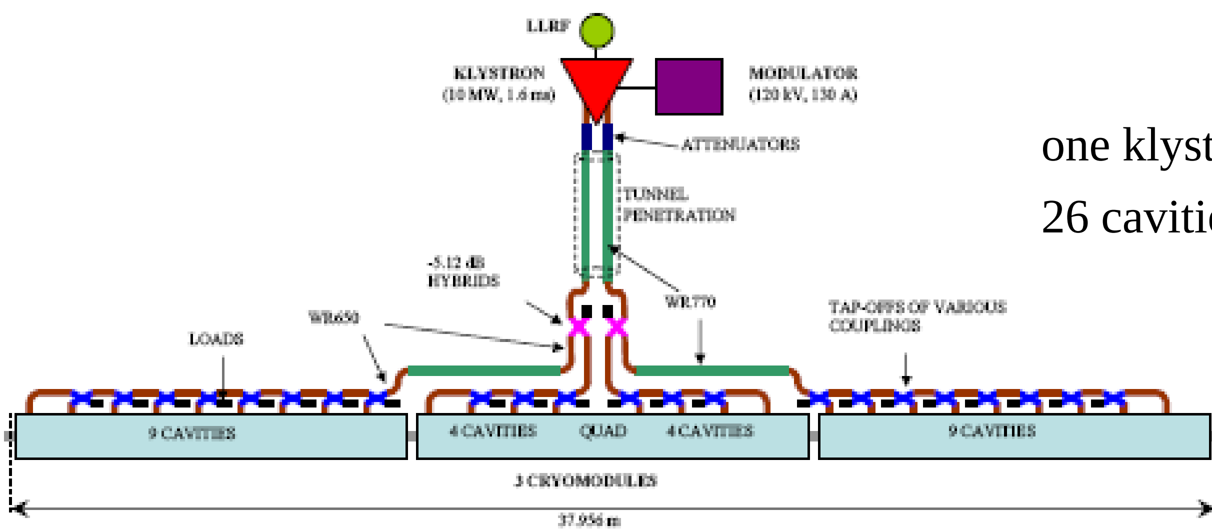
Two 4.5 to 5.5 m diameter tunnels spaced by ~7 m.



Accelerator Tunnel

Penetrations (every ~12 m)

Service Tunnel



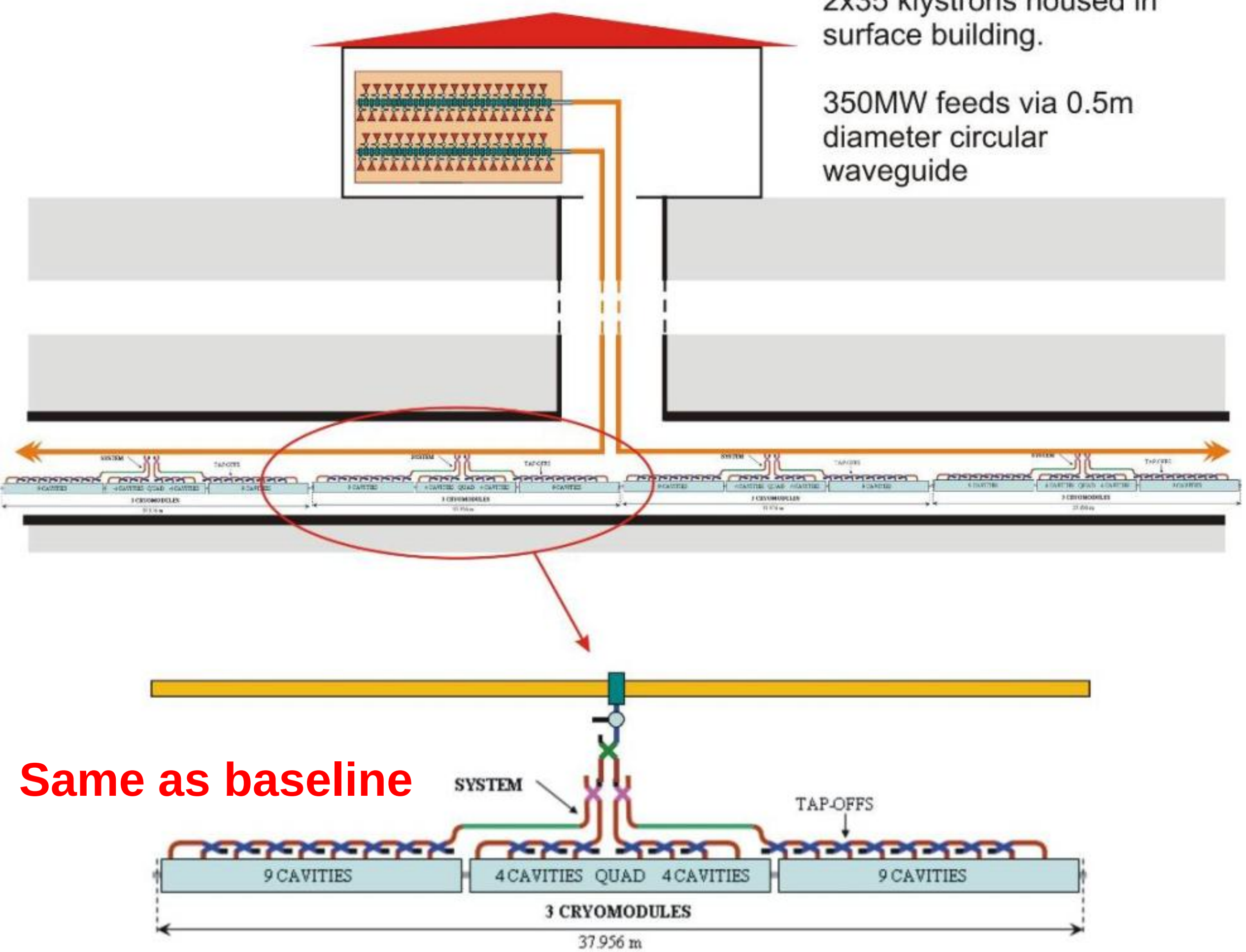
one klystron feeding

26 cavities

KLYSTRON CLUSTER CONCEPT

2x35 klystrons housed in surface building.

350MW feeds via 0.5m diameter circular waveguide



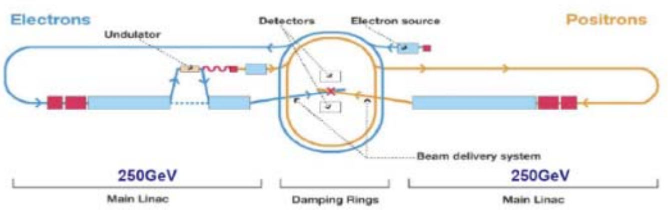
Same as baseline

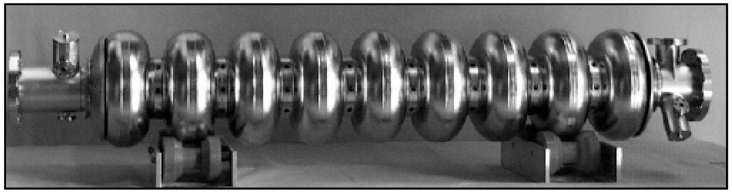
Each tap-off from the main waveguide feeds 10 MW through a high power window and probably a circulator or switch to a local PDS for a 3 cryomodule, 26 cavity RF unit (RDR baseline).

- RF power "piped" into accelerator tunnel every 2.5 km
- Service tunnel eliminated
- Electrical and cooling systems simplified
- Concerns: power handling, LLRF control coarseness

SCRF Technology Required

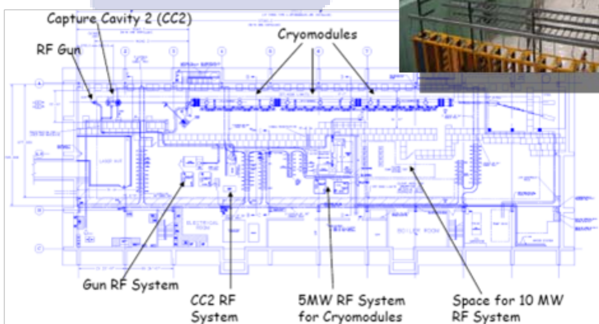
Parameter	Value
C.M. Energy	500 GeV
Peak luminosity	$2x10^{34}$ $cm^{-2}s^{-1}$
Beam Rep. rate	5 Hz
Pulse time duration	1 ms
Average beam current	9 mA (in pulse)
Av. field gradient	**31.5 MV/m**
# 9-cell cavity	**14,560**
# cryomodule	**1,680**
# RF units	**560**





SRF Test Facilities

FNAL



NML facility

Under construction

first beam 2010

ILC RF unit test

DESY

TTF/FLASH

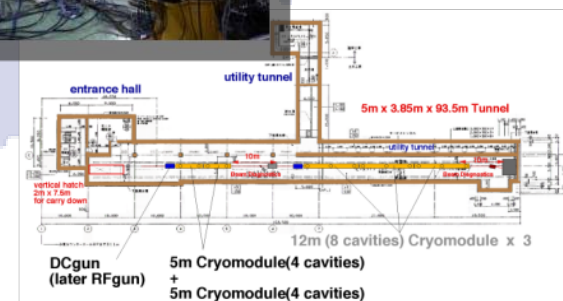
~1 GeV

ILC-like beam

ILC RF unit

(* lower gradient)

KEK, Japan



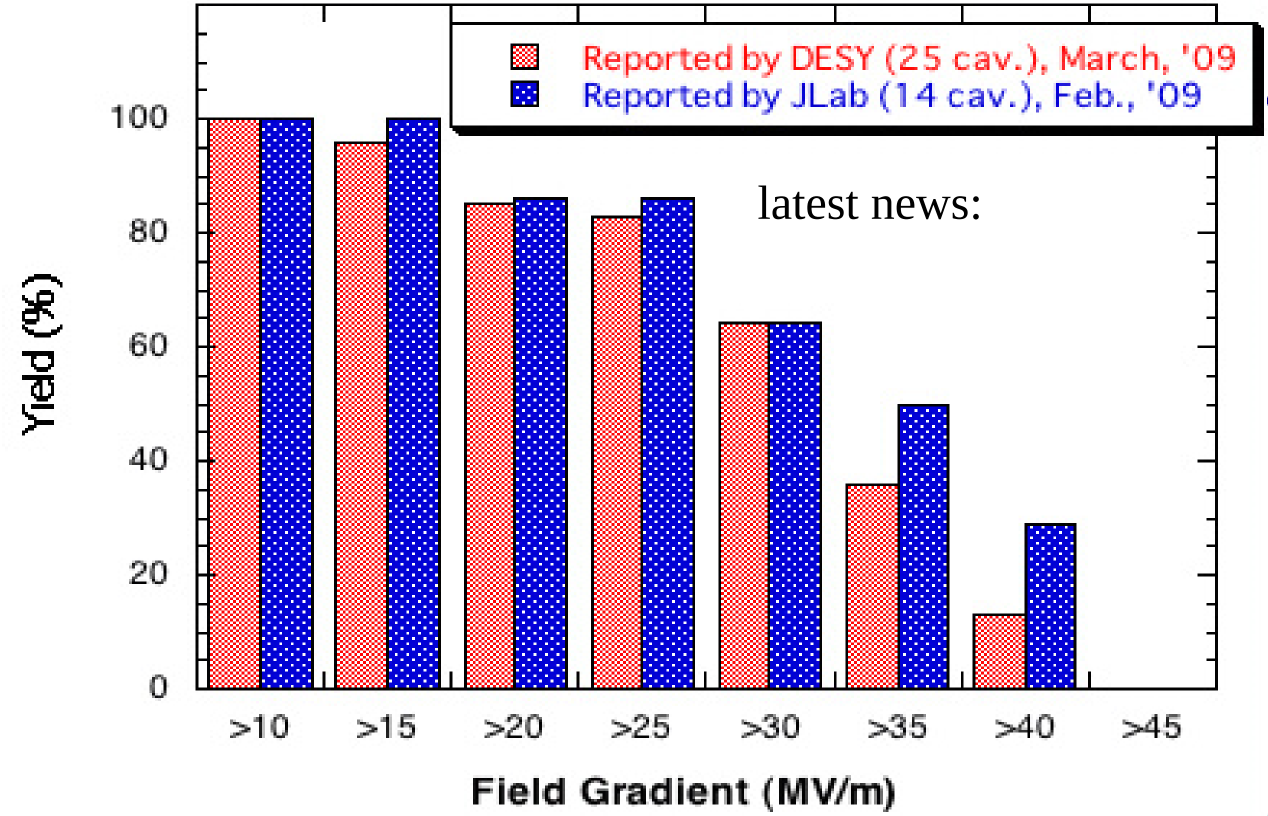
STF (phase I & II)

Under construction

first beam 2011

ILC RF unit test

Cryomodule Gradient Progress



ILC operation :

<31.5> MV/m spec

(27 MV/m achieved at DESY/FLASH)

(29 MV/m achieved DESY test stand)

- 20 % improvement required for ILC

B.Barish

TDP Goals of ILC-SCRF R&D

- **Field Gradient**
  - 35 MV/m for cavity performance in vertical test (S0)
  - 31.5 MV/m for operational gradient in cryomodule
    - to build two x 11 km SCRF main linacs
- **Cavity Integration with Cryomodule**
  - **"Plug-compatible" development to:**
    - Encourage "improvement" and creative work in R&D phase
    - Motivate practical 'Project Implementation' with sharing intellectual work in global effort
- **Accelerator System Engineering and Tests**
  - Cavity-string test in one cryomodule (S1, S1-global)
  - Cryomodule-string test with **Beam** Acceleration (S2)
    - With one RF-unit containing 3 cryomodule

R&D in test facilities

ILC R&D ongoing in several test facilities:

Beam tests at Flash

ATF2 at KEK: Fast kicker performance, final focus design tests

CesrTA: e-cloud mitigation

Damping Rings R&D

ILC R&D Board S3 Task Force (Damping Rings) identified 11 *very high priority* R&D items that needed to be addressed for the technical design:

- Lattice design for baseline positron ring
- Lattice design for baseline electron ring
- Demonstrate < 2 pm vertical emittance
- Characterize single bunch impedance-driven instabilities
- Characterize electron cloud build-up
- Develop electron cloud suppression techniques
- Develop modelling tools for electron cloud instabilities
- Determine electron cloud instability thresholds
- Characterize ion effects
- Specify techniques for suppressing ion effects
- Develop a fast high-power pulser

Targeted for ATF Effort

Targeted for CesrTA Effort with Low Emittance e^+ Beam

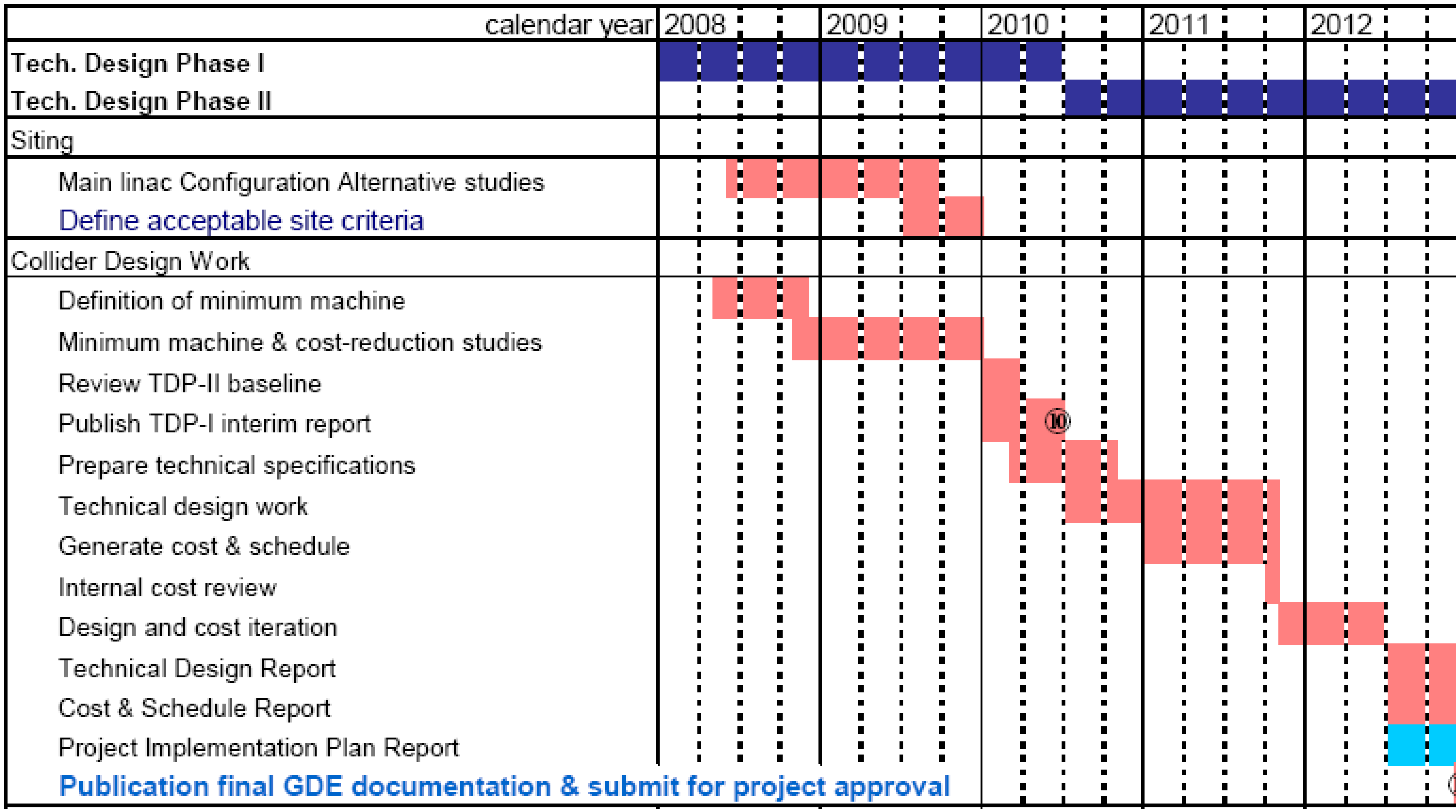
LET Summary for the KEK-ATF

- 2 pm is a TDP R&D plan deliverable for ATF
  - Recent demonstrations at light sources (eg., Diamond) may reduce the critical need for this demonstration
  - BUT, the lowest possible emittance is still needed for the ILC experimental R&D program (FII, ATF2,…)
- 4 pm achieved in 2004
  - LET based on Orbit Response Matrix analysis with iterative correction of orbit dispersion and coupling
  - In 2007 the same tuning procedures yielded 20-30 pm
- Critical Improvements
  - DR magnet re-alignment in 2008
  - BPM upgrade program is in progress
- April 2009: ε_y ~ 10 pm measured by XSR
  ε_y ~ 5 pm measured by Laser Wire

Summary

- Low Emittance Tuning and Vertical Emittance Demonstration
  - **Progress at both ATF and CesrTA towards emittance targets**
  - **Efforts underway for closer collaboration to achieve ultimate goals at both facilities**
  - **Low emittance tuning and measurement tools will be of general benefit to the accelerator community**
- Beam Dynamics Issues – FII and EC
  - **ATF will be in a position for the next series of FII measurements next month**
  - **CesrTA focus shifting from upgrades to experimental measurements**
    - Mitigation studies underway – arrival of chambers with new mitigations from CERN, LBNL, SLAC over the next 2 months
    - Instability and incoherent emittance growth studies will be a principal focus for last half of 2009
- Fast Kickers
  - **Beam demonstration effort continues at KEK**
  - **Development of a *reliable* fast pulser will continue to be a high priority R&D task**
- Integration of R&D Results into the ILC Damping Rings Design
  - **Improved projections (based on new measurements) for DR instabilities and emittance growth issues expected during 2010**
  - **Technical inputs for design (vacuum and feedback systems) available on the same timescale**
  - **Results applicable to both the 6.5 km baseline design as well as the proposed 3 km ring with fewer bunches**

ILC R&D plan


calendar year
2008
2009
2010
2011
2012
Tech. Design Phase I
Tech. Design Phase II
Siting
Main linac Configuration Alternative studies
Define acceptable site criteria
Collider Design Work
Definition of minimum machine
Minimum machine & cost-reduction studies
Review TDP-II baseline
Publish TDP-I interim report
Prepare technical specifications
Technical design work
Generate cost & schedule
Internal cost review
Design and cost iteration
Technical Design Report
Cost & Schedule Report
Project Implementation Plan Report
Publication final GDE documentation & submit for project approval
⑩
⑩

CLIC acceleration system

CLIC = Compact Linear Collider

(length < 50 km)

CLIC parameters:

Accelerating gradient: 100 MV/m

RF frequency: 12 GHz

64 MW RF power / accelerating structure

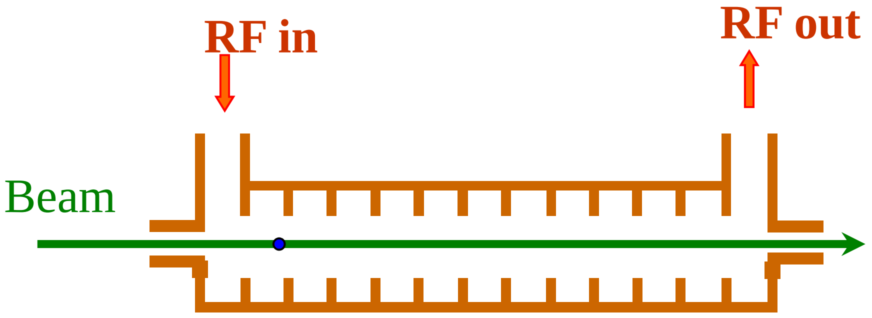
of 0.233m active length

➔ **275 MW/m**

total active length for 1.5 TeV: **15'000 m**

Pulse length 240 ns, 50 Hz

Acceleration in travelling wave structures:



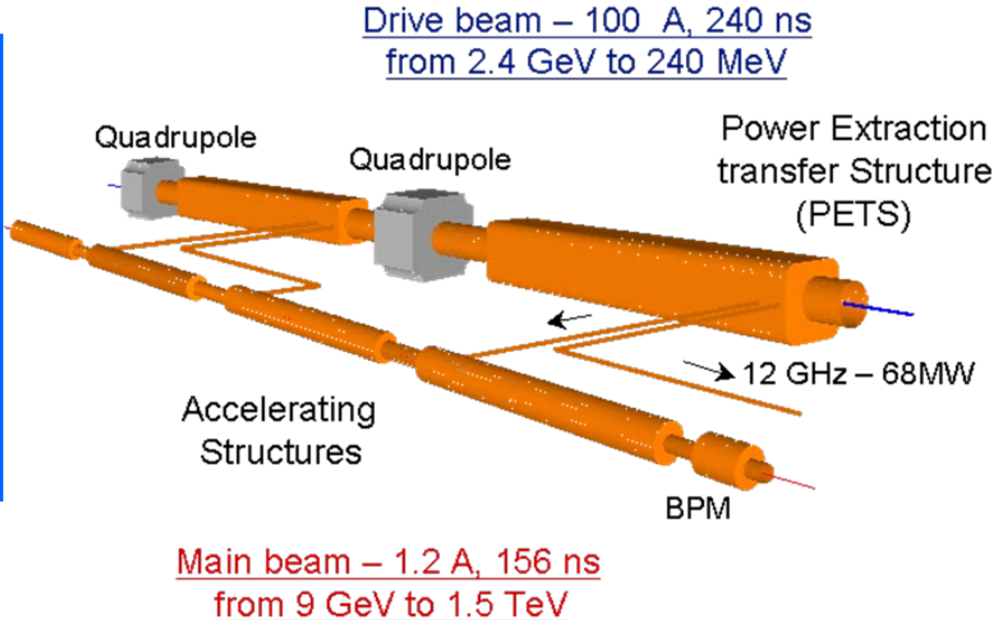
Efficient RF power production !!!!!

The CLIC Two Beam Scheme

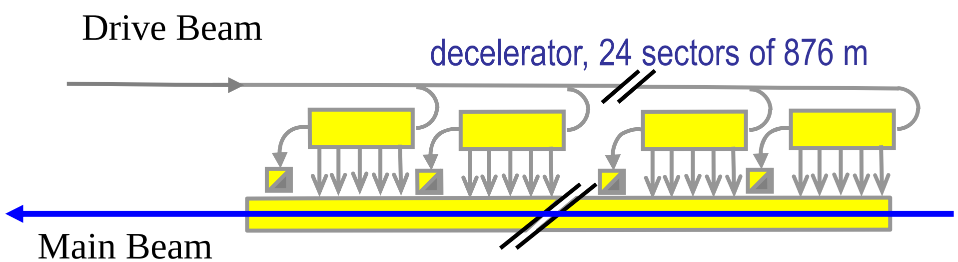
Individual RF power sources ?
➔ Not for the 1.5 TeV linacs

Two Beam Scheme:
Drive Beam supplies RF power

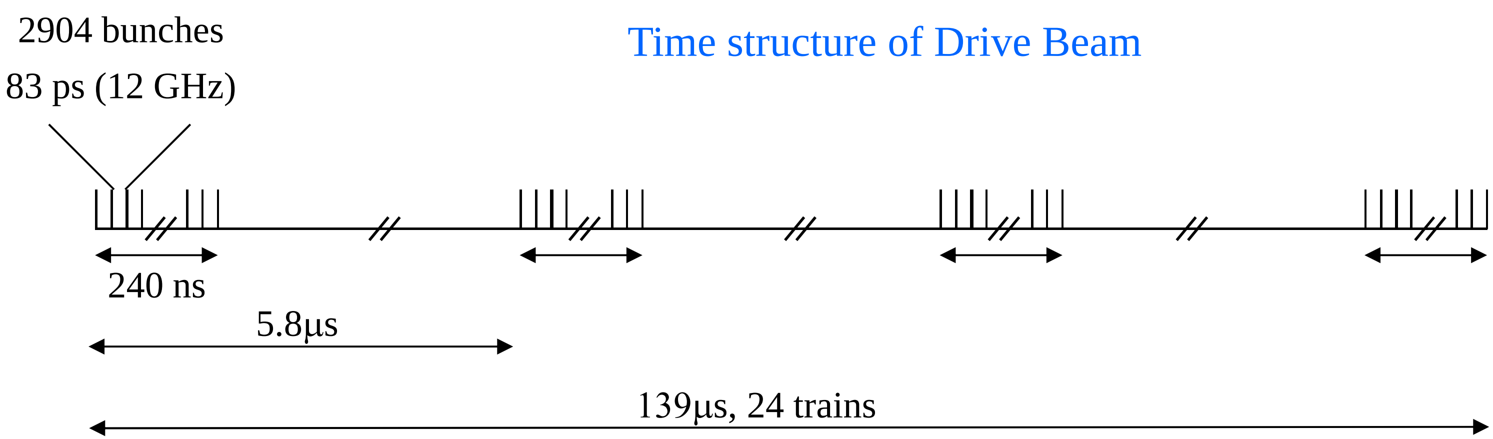
- 12 GHz bunch structure
- low energy (2.4 GeV - 240 MeV)
- high current (100A)



The CLIC Two Beam scheme



Time structure of Drive Beam



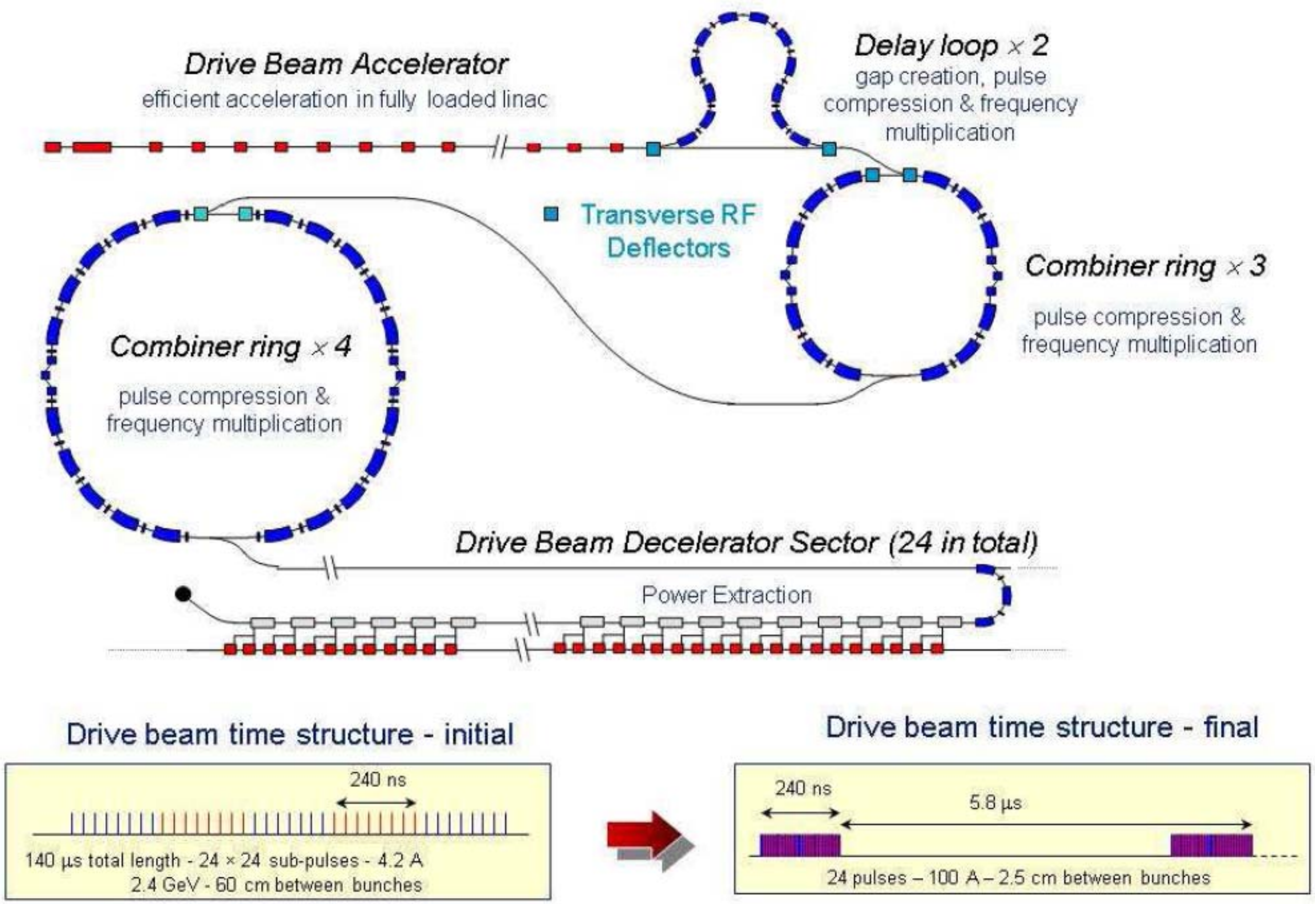
Bunch charge: 8.4 nC, Current in train: 100 A

CLIC Drive Beam generation

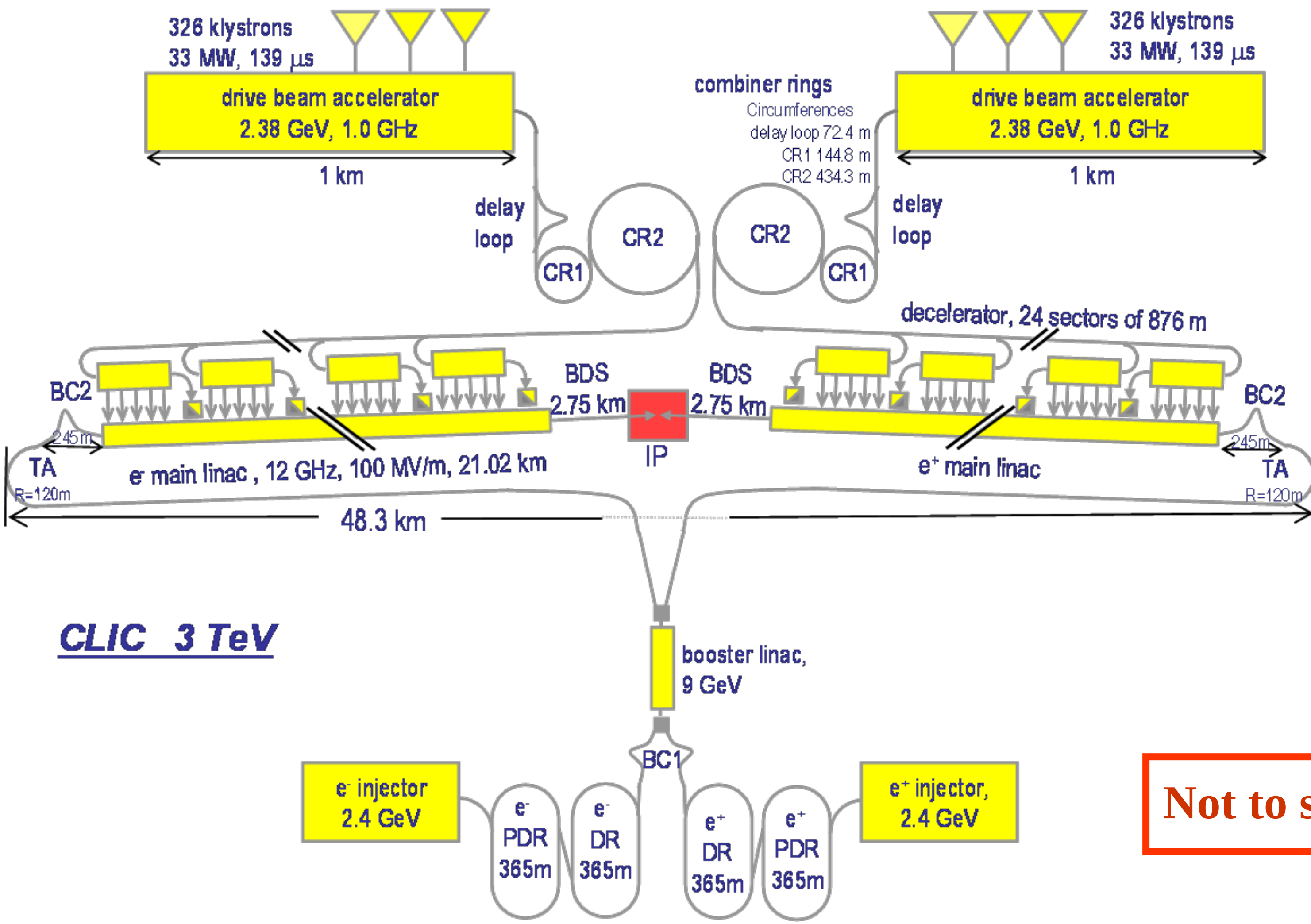
Accelerate long bunch train with low bunch rep rate (500 MHz) with low frequency RF (1 GHz) (klystrons)

⇨

interleave bunches between each other to generate short (280 ns) trains with high bunch rep rate (12 GHz)



The full CLIC scheme



Not to scale!

Why 100 MV/m and 12 GHz ?

Optimisation: (A.Grudiev)

Structure limits:

- RF breakdown – scaling
- RF pulse heating

Beam dynamics:

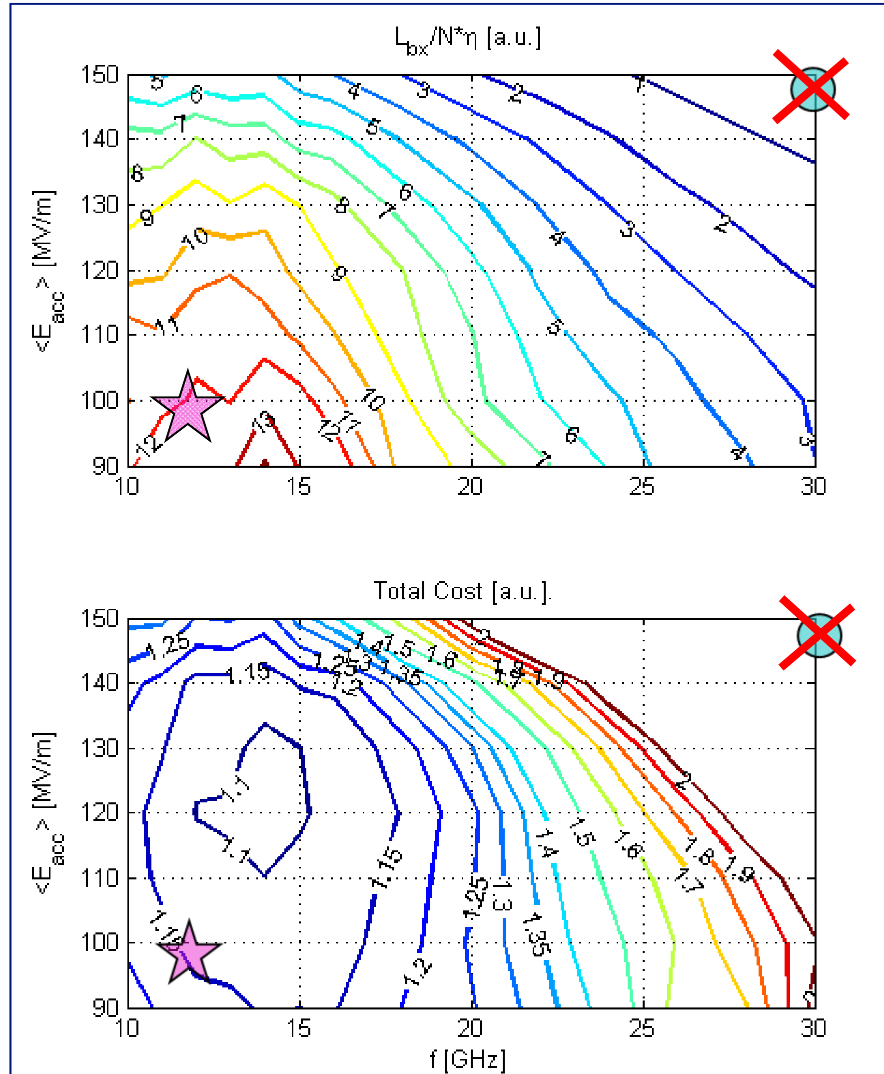
- emittance preservation – wake fields
- Luminosity, bunch population, bunch spacing
- efficiency – total power

Figure of merit:

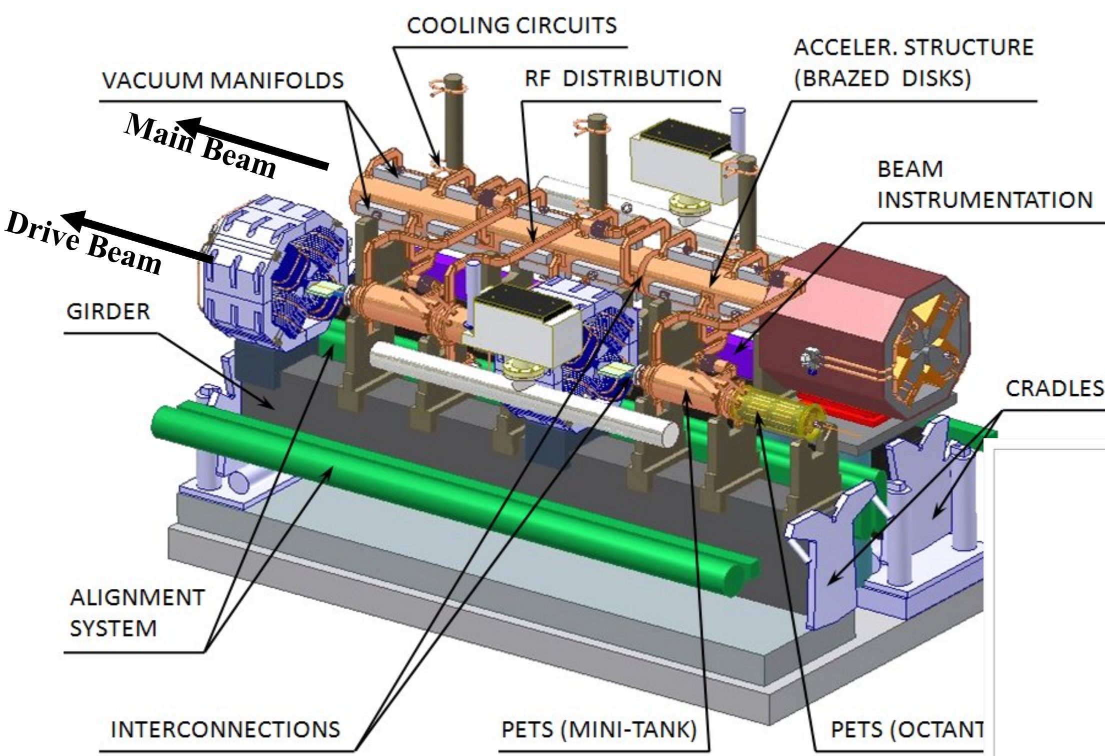
- Luminosity per linac input power

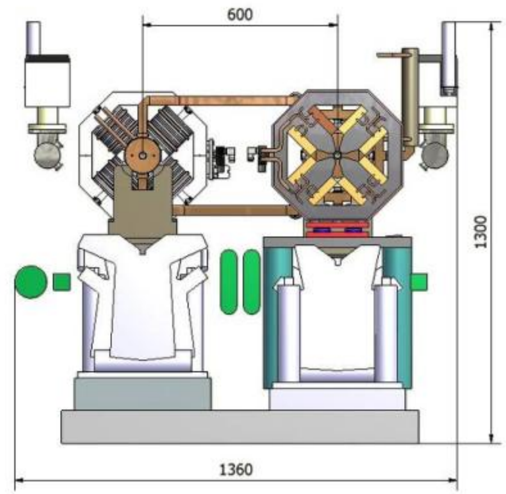
take into account cost model

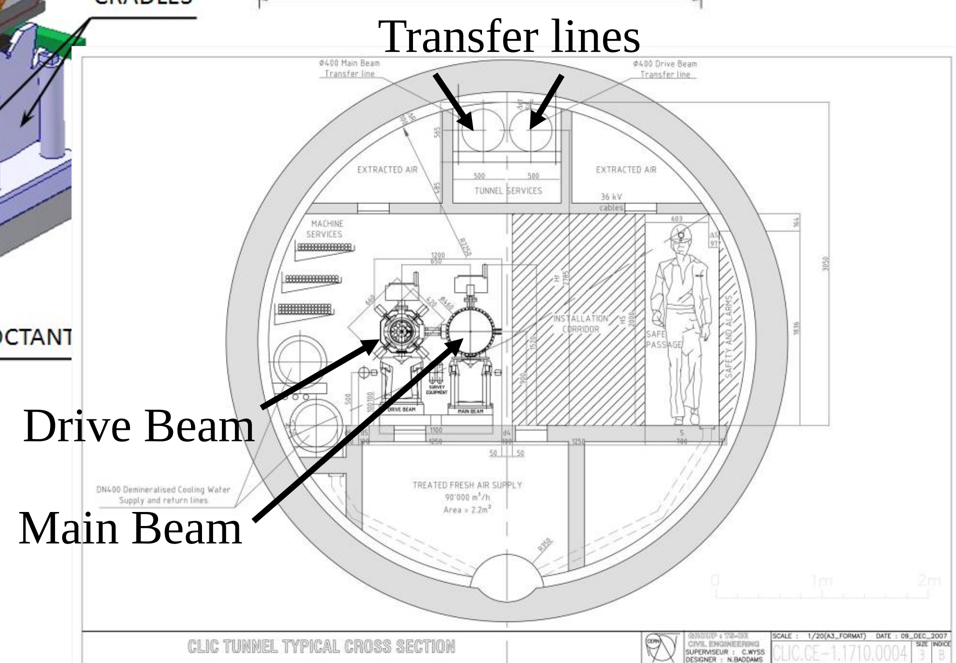
after > 60 * 10^6 structures:
100 MV/m 12 GHz chosen,
previously 150 MV/m, 30 GHz



CLIC Accelerating Module

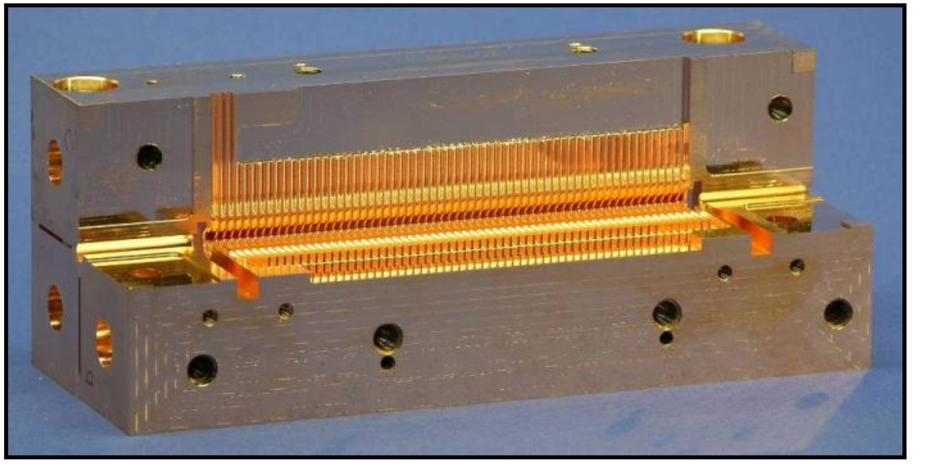






ref: Germana Riddone

Accelerating structures

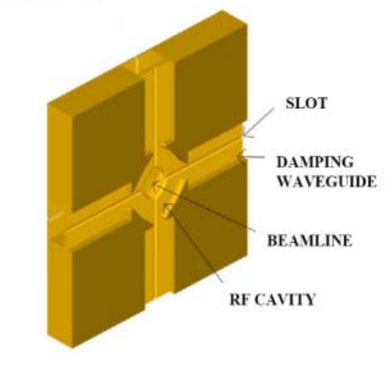


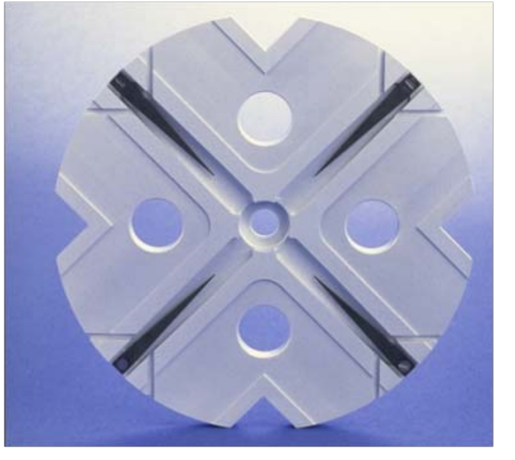
Objective:

- Withstand of 100 MV/m without damage
- breakdown rate < 10^{-7}
- Strong damping of HOMs

Technologies:

Brazed disks - milled quadrants

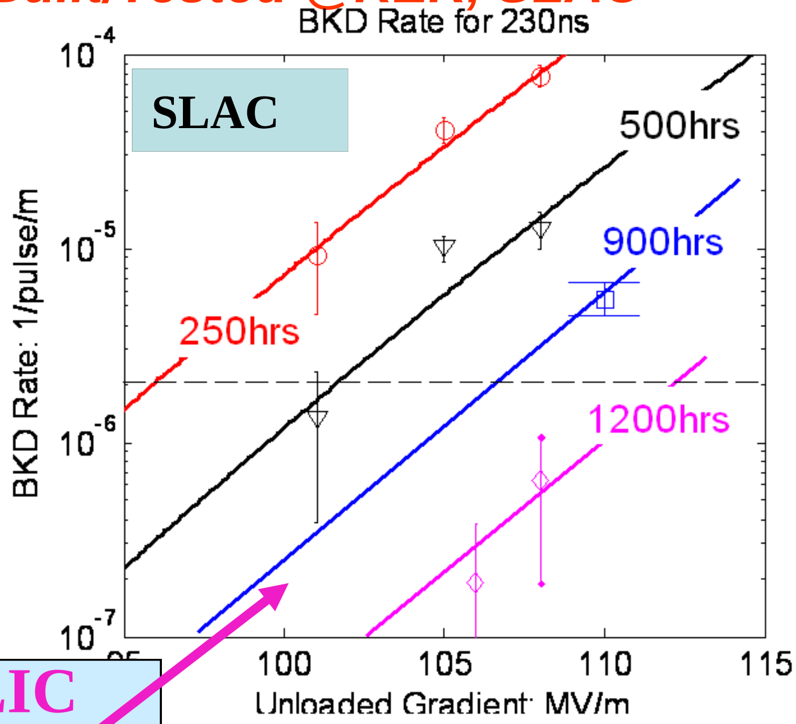


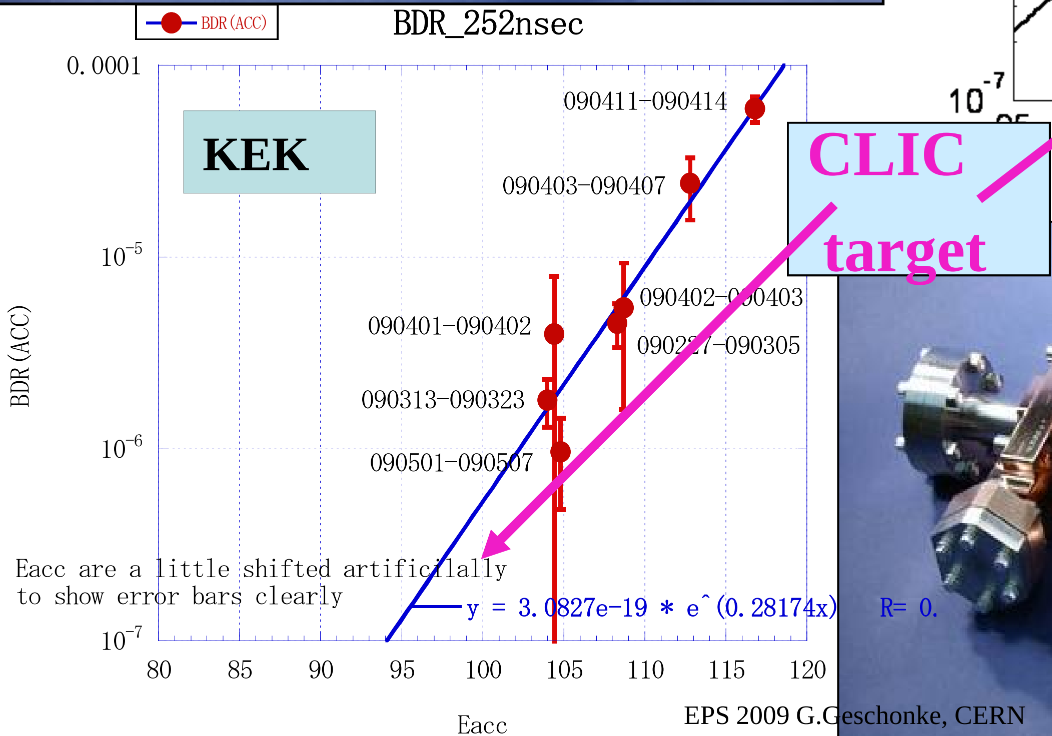


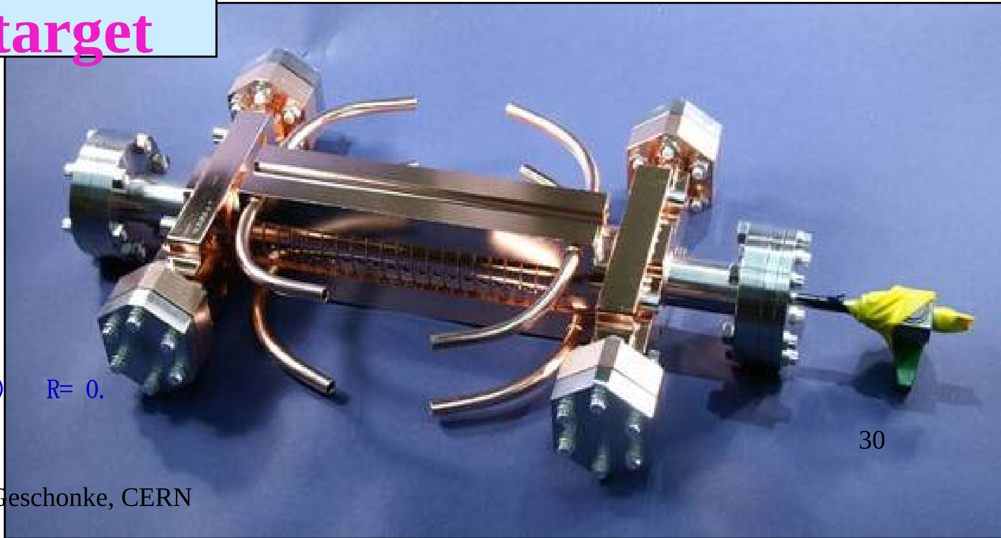
(W. Wünsch this conference)

Collaboration: CERN, KEK, SLAC

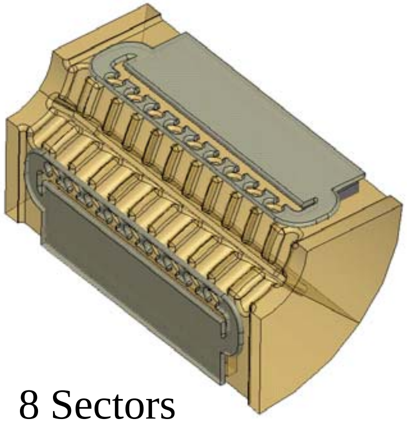
Nominal performance of Accelerating Structures Design@CERN, Built/Tested @KEK, SLAC







Power Extraction : PETS



8 Sectors

damped

on-off possibility

Special development for CLIC

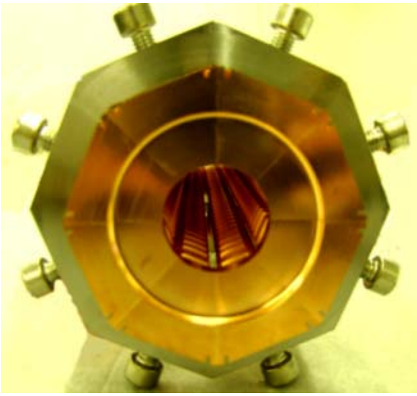
• Travelling wave structures	136 MW RF @ 240 ns per PETS
• Small R/Q : 2.2 kΩ/m	(2 accelerating structures)
(accelerating structure: 15-18 kΩ/m)	0.21 m active length
• 100 A beam current	total number : 35’703 per linac

ref: Igor Syratchev

Status:

CTF3: up to 45 MW peak (3 A beam, recirculation)

SLAC: 125 MW @ 266 ns



Getting the Luminosity (>2*10^{34}cm^{-2}s^{-1})

Beam size at Interaction Point (rms) : σ_x = 40 nm, σ_y = 1 nm

Total site AC power: 392 MW

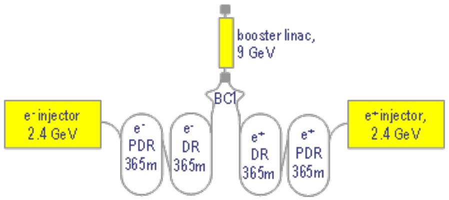
Issues:
- generating small emittance beams
- emittance preservation
- alignment and vibration control
- final focus (Beam Delivery System)

jitter tolerances

	Final Focus quadrupoles	Main beam quadrupoles
Vertical	~0.1 nm > 4 Hz	~1 nm > 1 Hz
Horizontal	2 nm > 4 Hz	5 nm > 1 Hz

work ongoing,
Proof-of-principle:
quadrupole stabilized to < 0.5 nm in vertical plane

Emittance



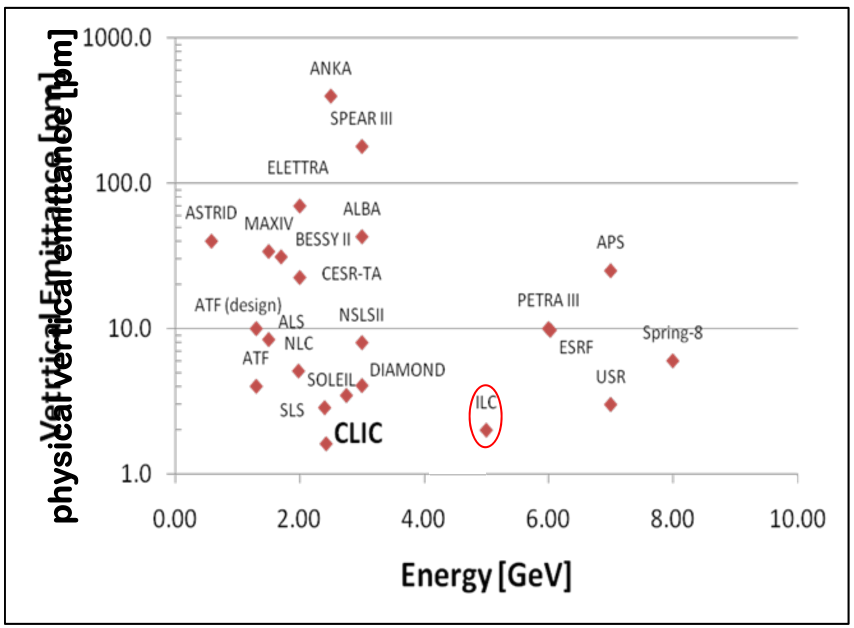
CLIC has two damping rings each for e^+ and e^-

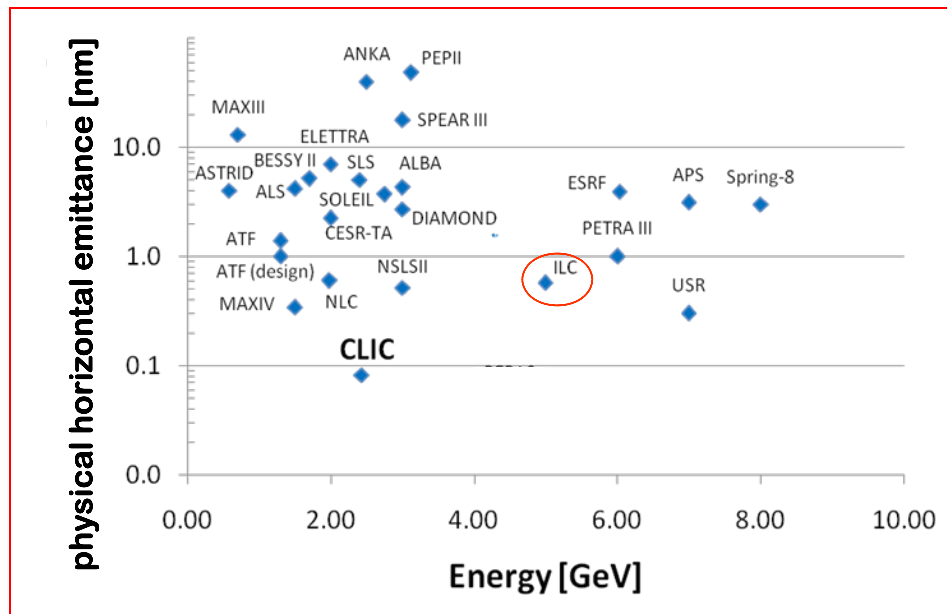
output DR: $\gamma\varepsilon_x$=381 / $\gamma\varepsilon_y$= 4.1 nm rad

for $4.1*10^9$ particles at 2.4 GeV

DR design exists

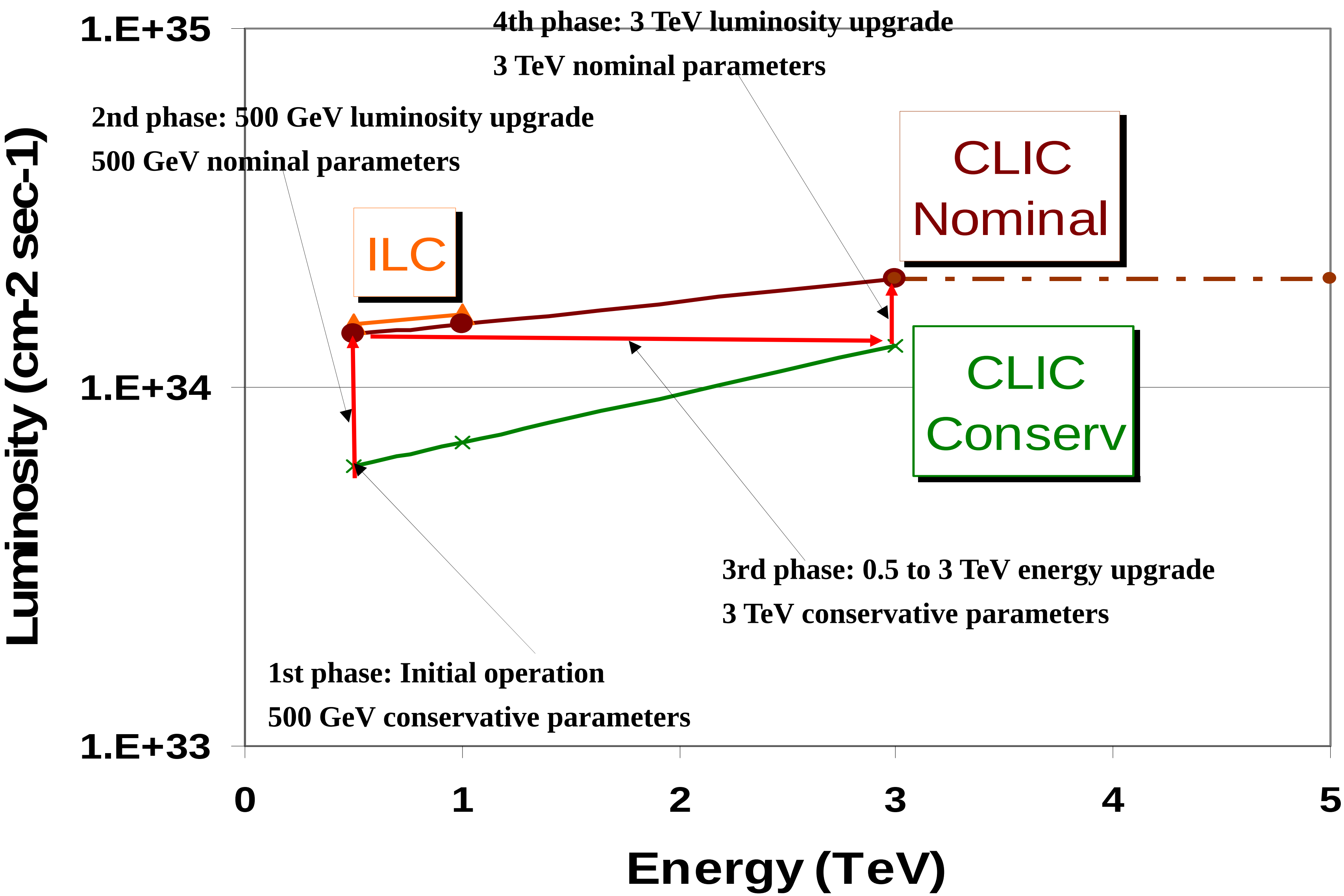
Wigglers being developed, superconducting and normal conducting versions considered



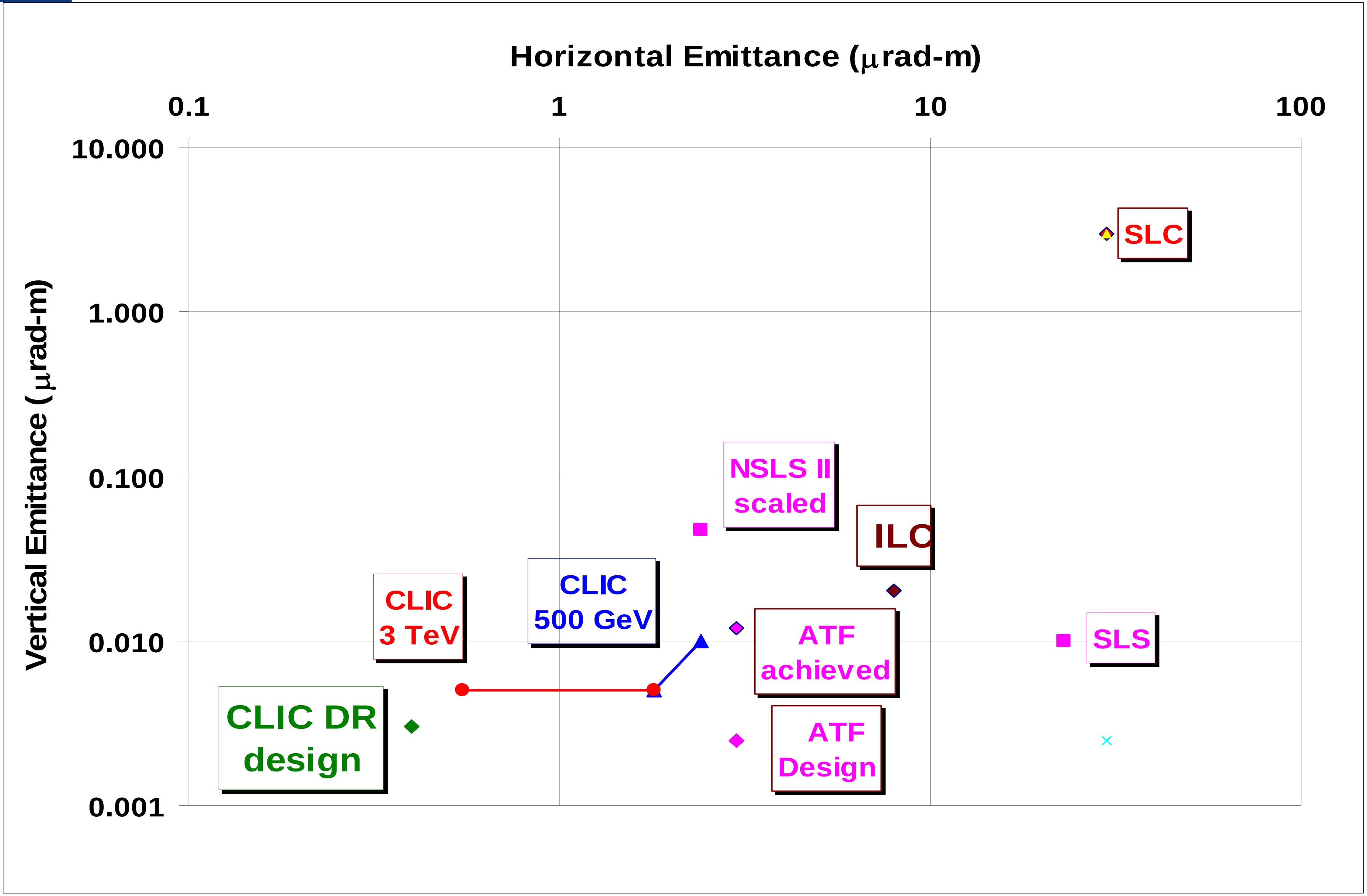


CLIC Parameters and upgrade scenario

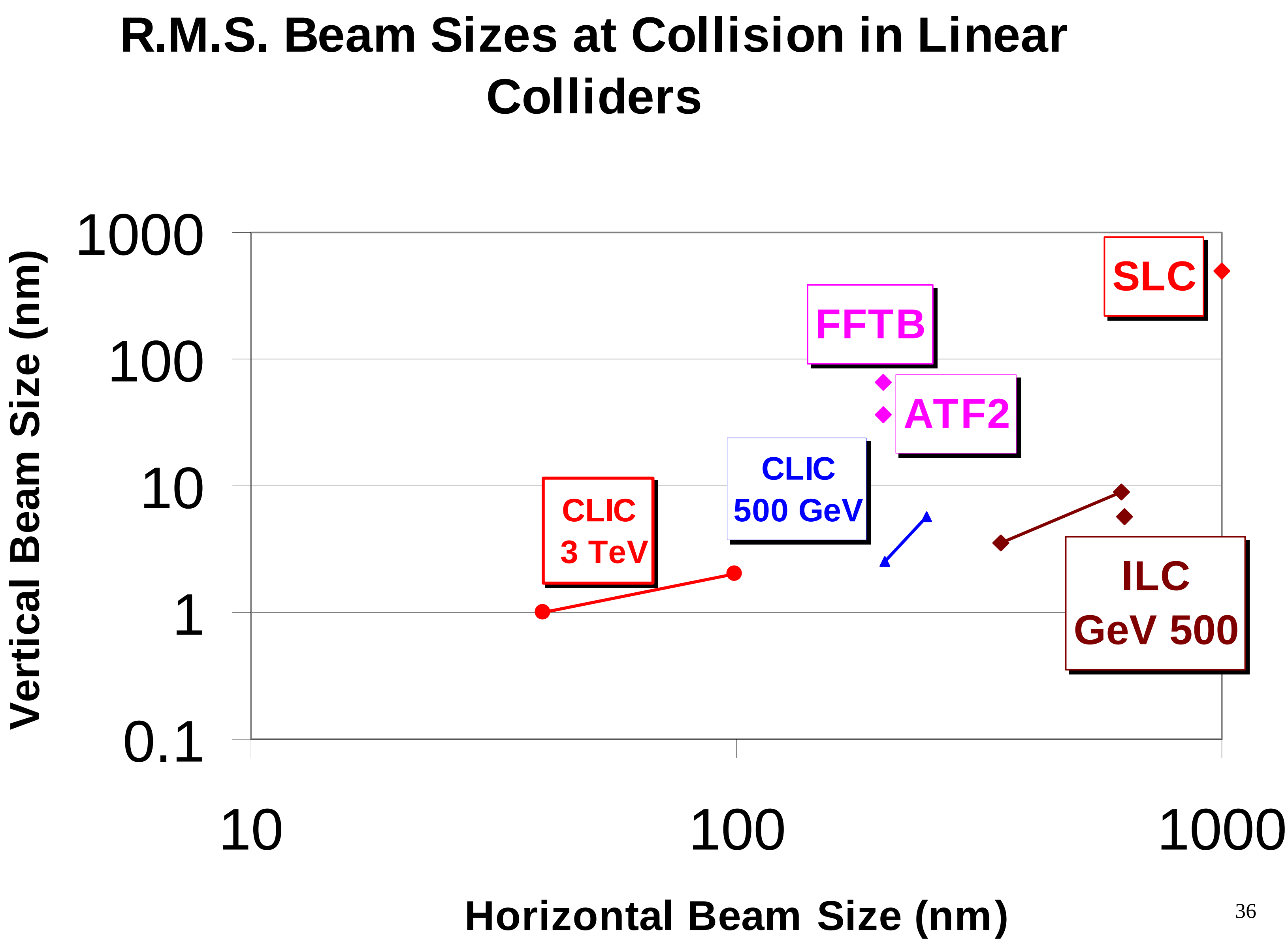
http://cdsweb.cern.ch/record/1132079/files/CERN-OPEN-2008-021.pdf



Beam emittances at Damping Rings



Beam sizes at Collisions



CLIC main parameters

http://cdsweb.cern.ch/record/1132079?ln=fr   http://clic-meeting.web.cern.ch/clic-meeting/clictable2007.html

Center-of-mass energy	CLIC 500 G		CLIC 3 TeV	
Beam parameters	Conservative	Nominal	Conservative	Nominal
Accelerating structure	502		G	
Total (Peak 1%) luminosity	$0.9(0.6)\cdot10^{34}$	$2.3(1.4)\cdot10^{34}$	$1.5(0.73)\cdot10^{34}$	$5.9(2.0)\cdot10^{34}$
Repetition rate (Hz)	50			
Loaded accel. gradient MV/m	80		100	
Main linac RF frequency GHz	12			
Bunch charge10^9	6.8		3.72	
Bunch separation (ns)	0.5			
Beam pulse duration (ns)	177		156	
Beam power/beam (MWatts)	4.9		14	
Hor./vert. norm. emitt ($10^{-6}/10^{-9}$)	3/40	2.4/25	2.4/20	0.66/20
Hor/Vert FF focusing (mm)	10/0.4	8 / 0.1	8 / 0.3	4 / 0.07
Hor./vert. IP beam size (nm)	248 / 5.7	202 / 2.3	83 / 2.0	40 / 1.0
Hadronic events/crossing at IP	0.07	0.19	0.57	2.7
Coherent pairs at IP	10	100	$5\ 10^7$	$3.8\ 10^8$
BDS length (km)	1.87		2.75	
Total site length km	13.0		48.3	
Wall plug to beam transfert eff	7.5%		6.8%	
Total power consumption MW	129.4		415	

CLIC Test Facility CTF3

Provide answers for CLIC specific issues

➔ Write CDR in 2010

Two main missions:

Prove CLIC RF power source scheme:
- bunch manipulations, beam stability,
- Drive Beam generation
- 12 GHz extraction

Demonstration of "relevant" linac sub-unit:
- acceleration of test beam

Provide RF power for validation of CLIC components:

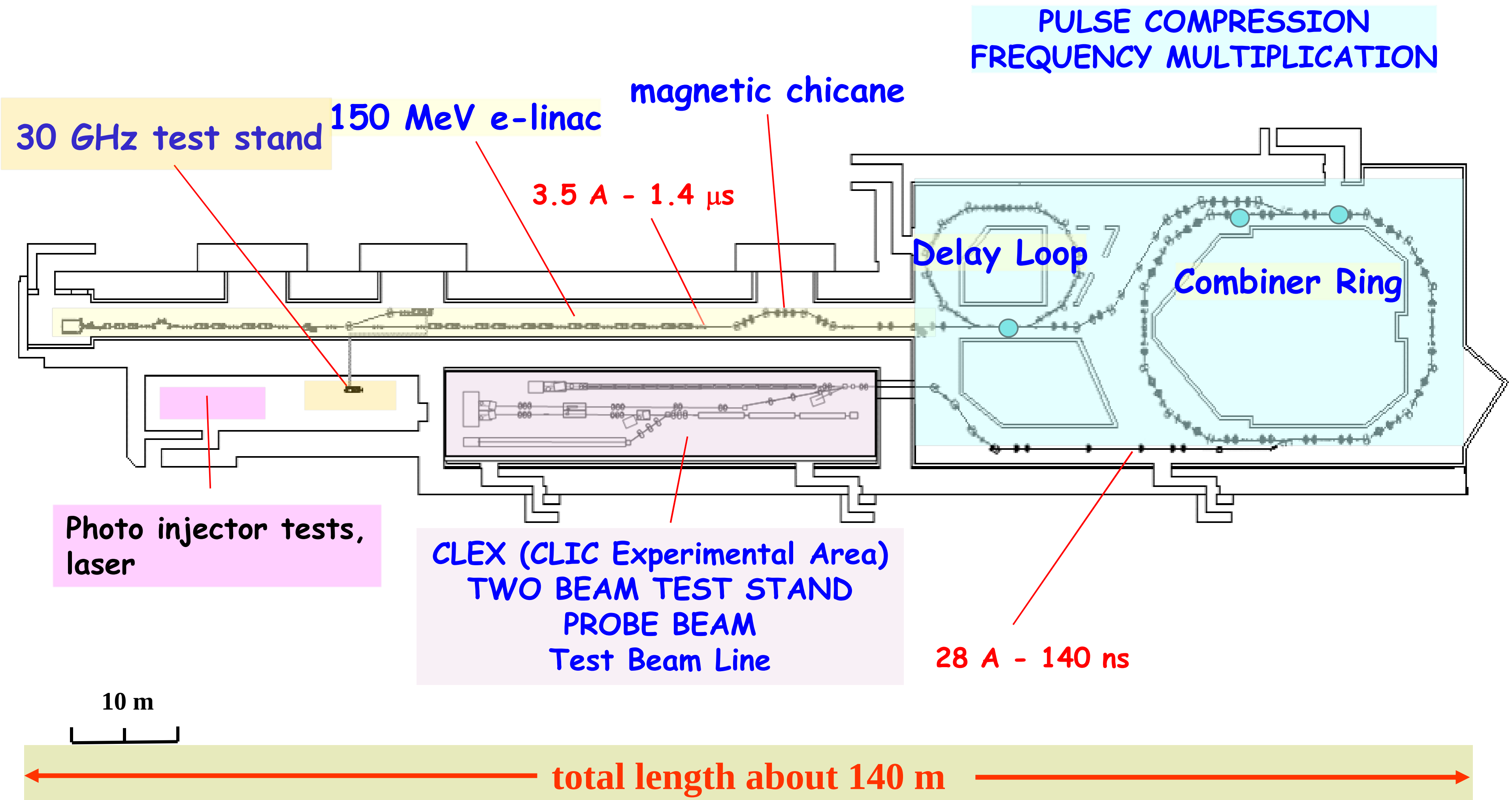
accelerating structures,

RF distribution,

PETS (Power extraction and Transfer Structure)

CTF3 building blocks

Infrastructure from LEP



CTF3 - CLIC

CTF3 is scaled down from CLIC:

	CLIC	CTF3
Drive Beam energy	2.4 GeV	150 MeV
compression / frequency multiplication	24 (Delay Loop + 2 Combiner Rings)	8 (Delay Loop + 1 Combiner Ring)
Drive Beam current	4.2 A*24 → 101 A	3.5 A*8 → 28 A
RF Frequency	1 GHz	3 GHz
train length in linac	139 μs	1.5 μs
energy extraction	90 %	~ 50 %

CTF3 uses existing infrastructure from LEP injector:

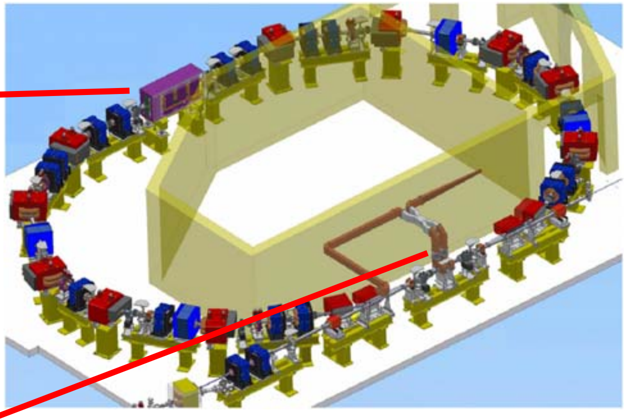
Building, infrastructure,

3 GHz RF power plant,

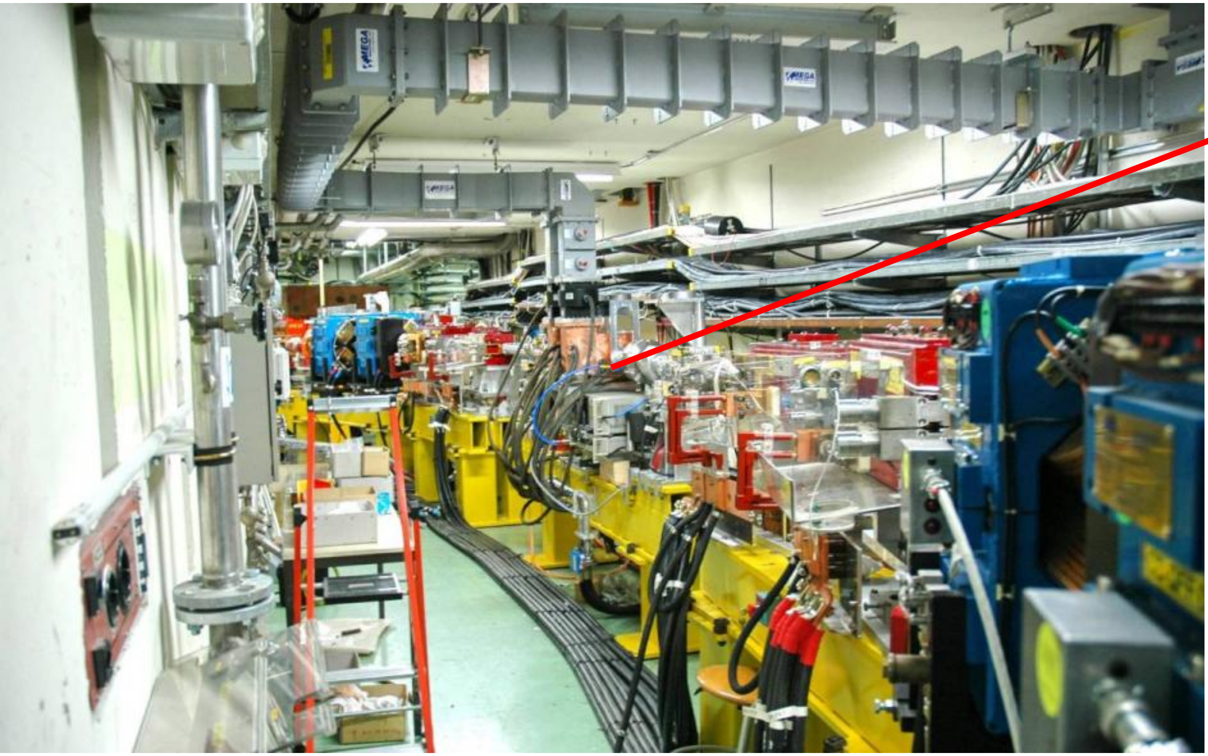
Delay Loop

Designed and built by INFN Frascati

circumference 42 m (140 ns)
isochronous optics
wiggler to tune path length
(9 mm range)



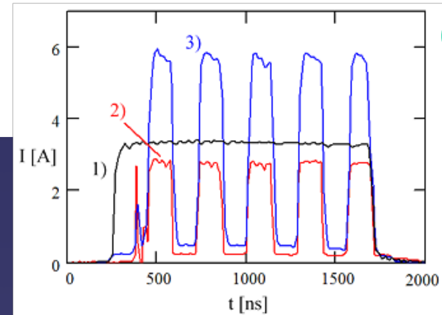
1.5 GHz RF deflector



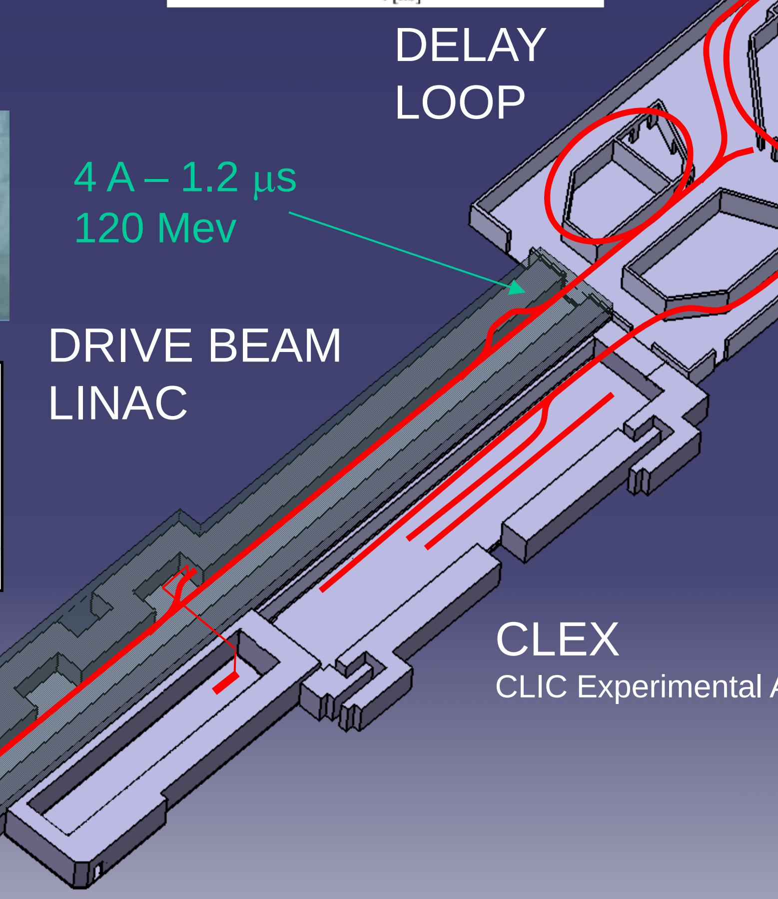
CLIC feasibility in CTF3 & perspectives after 2010

R. Corsini, 29.5.2009

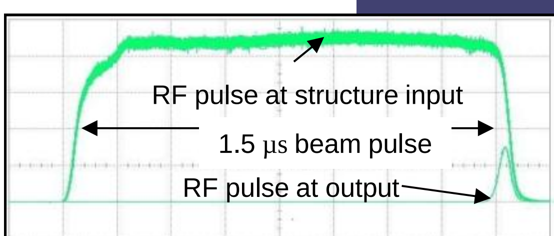
CTF3 Achievements

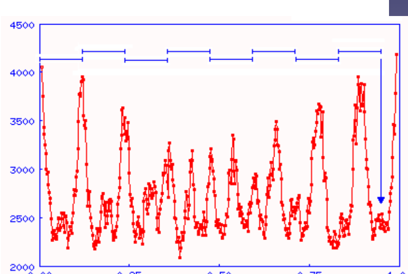


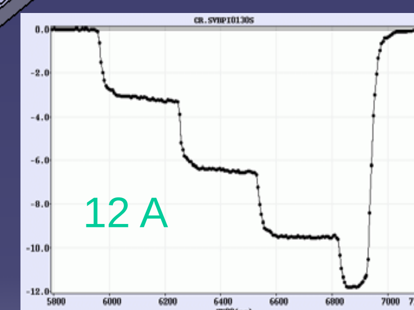
6 A



4 A – 1.2 μs
120 Mev







12 A

CLIC feasibility issues

	SYSTEMS	Critical parameters	Relevant Facilities Common with ILC in red
Structures	Main Beam Acceleration Structures: Demonstrate high-power operation of nominal CLIC structures with damping features at the design gradient, with design pulse length and breakdown rate .	Average loaded gradient 100 MV/m total/flat-top pulse length 240/160 ns < 3-10-7 BR/(pulse*m) minimum average a/λ 0.11 Long range wake <6V/pC/m/mm	CTF2&3 (2005-2010) Test Stand (2009-10) SLAC/NLCTA SLAC/ASTA KEK/NEXTEF
	RF Power production structures: Demonstratehigh-power operation of nominal PETS with damping features at the design power, with design pulse length, breakdown rate and on/off capability	132 MW total/flat-top pulse length 240/160 ns < 10-7 BR/(pulse*structure) Wakefield below 9 V/pC/m/mm On/Off/adjust capability	CTF3 (2005-2010) CTF3/TBTS (2008-10) CTF3/TBL (2009-10) SLAC/ASTA
Two Beam	Two Beam Acceleration and module integeration: Demonstrate two-beam acceleration and operation in a prototype module equipped with all critical subsystems	Two Beam Acceleration at nominal parameters as given above for individual components Pulse shape accuracy 0.1%	CTF2&3/TBTS (2004-10)
Drive Beam	Drive Beam Production - Beam generation and combination - phase and energy matching - Potential feedbacks	100 Amp peak current 12GHz bunch repetition frequency 0.2 degrees phase stability at 12 GHz $7.5\ 10^{-4}$ intensity stability	CTF3 (2005-2010) CTF3/TBL (2009-10) X-FEL LCLS
	RF power generation by Drive Beam - Rf power extraction - Beam stability	90% extraction efficiency Large momentum spread	CTF3/TBL
Beam Physics	Generation and Preservation of Low Emittances Damping Rings, RTML and Main Linacs	Emittances(nm): H= 600, V=5 Absolute blow-up(nm): H=160, V=15	ATF, SLS, NSLSII Simulations LCLS, SCSS
Stabili zation	Main Linac and BDS Stabilization	Main Linac : 1 nm vert. above 1 Hz; BDS: 0.15 to 1 nm above 4 Hz depending on final doublet girder implementation	CESRTA ATF2
Operation and reliability	Operation and Machine Protection Staging of commissioning and construction MTBF, MTTR Machine protection With high beam power	drive beam power of 72 MW @ 2.4 GeV main beam power of 13 MW @ 1.5 TeV	CTF3
Detector	Beam-Beam Background Detector design and shielding compatible with breakdown generated by beam beam effects during collisions at high energy	$3.8\ 10^{8}$ coherent pairs	

World-wide CLIC&CTF3 Collaboration

<u>33 Institutes involving 21 funding agencies and 18 countries</u>

- Aarhus University (Denmark)
- Ankara University (Turkey)
- Argonne National Laboratory (USA)
- Athens University (Greece)
- BINP (Russia)
- CERN
- CIEMAT (Spain)
- Cockcroft Institute (UK)
- Gazi Universities (Turkey)
- Helsinki Institute of Physics (Finland)
- IAP (Russia)
- IAP NASU (Ukraine)
- INFN / LNF (Italy)
- Instituto de Fisica Corpuscular (Spain)
- IRFU / Saclay (France)
- Jefferson Lab (USA)
- John Adams Institute (UK)
- JINR (Russia)
- Karlsruhe University (Germany)
- KEK (Japan)
- LAL / Orsay (France)
- LAPP / ESIA (France)
- NCP (Pakistan)
- North-West. Univ. Illinois (USA)
- Oslo University (Norway)
- Patras University (Greece)
- Polytech. University of Catalonia (Spain)
- PSI (Switzerland)
- RAL (UK)
- RRCAT / Indore (India)
- SLAC (USA)
- Thrace University (Greece)
- Uppsala University (Sweden)

Physics issues

Beam structure:

	ILC	CLIC
particles per bunch:	**$20 * 10^9$**	**$3.7 * 10^9$**
	2625 bunches / pulse of 0.96 ms	312 bunches / pulse of 156 ns
bunch spacing	**369 ns**	**0.5 ns**

Luminosity spectrum

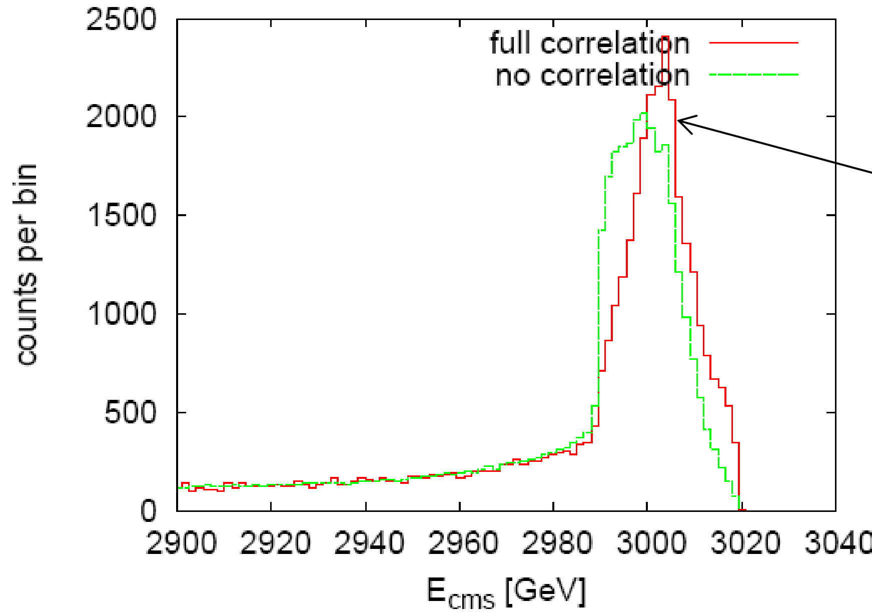
Luminosity Spectrum Reconstruction

- Luminosity Spectrum reconstruction is a challenging task
- One proposed method is to measure Bhabha angles

$$p_{\perp,1} = -p_{\perp,2} \quad \Rightarrow \quad \frac{p_1}{p_2} = \frac{\sin\theta_2}{\sin\theta_1}$$

- Initial transverse momenta could be different
  - is noticeable in ILC

  $\Rightarrow$ needs to be studied for CLIC



red curve
is relevant

- Need model to seperate the beams
- Simple test remix colliding beam particle energies

  $\Rightarrow$ different spectrum

  $\Rightarrow$ correlations are important

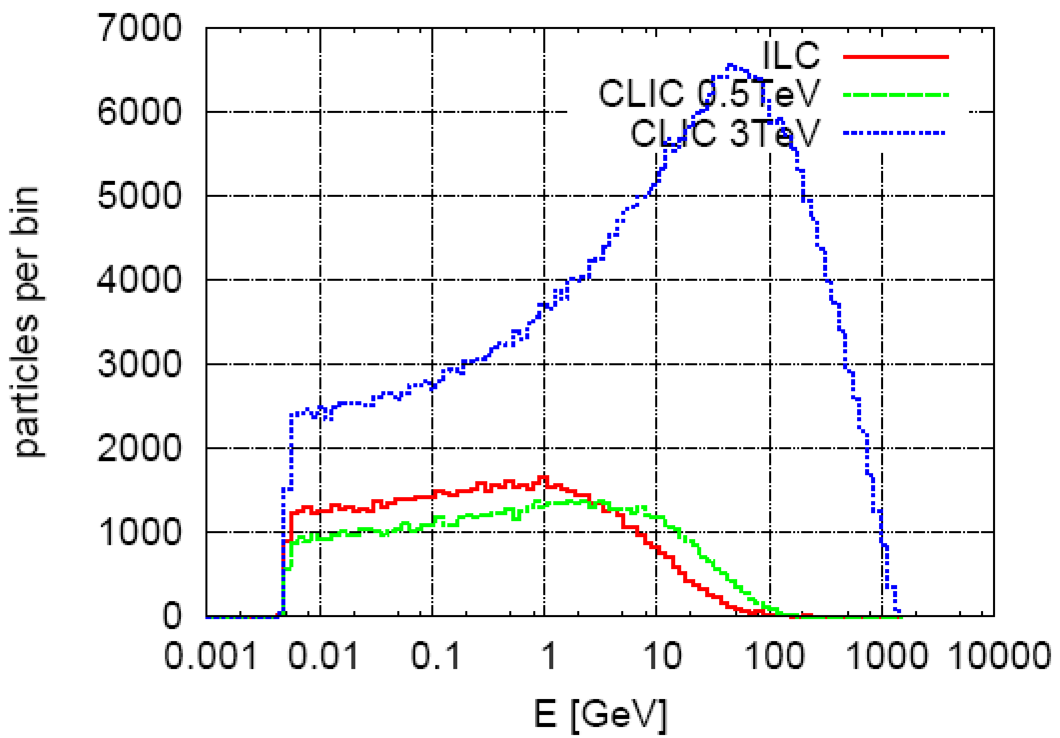
Daniel Schulte

$\Rightarrow$ Further study needed

Electron positron pairs

Pair Spectrum

- ILC, CLIC at 3 TeV and CLIC at 0.5 TeV nominal parameters used
- Spectrum per bunch crossing shown



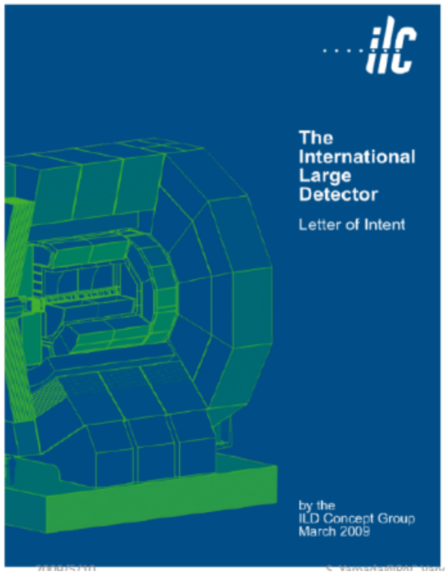
Daniel Schulte

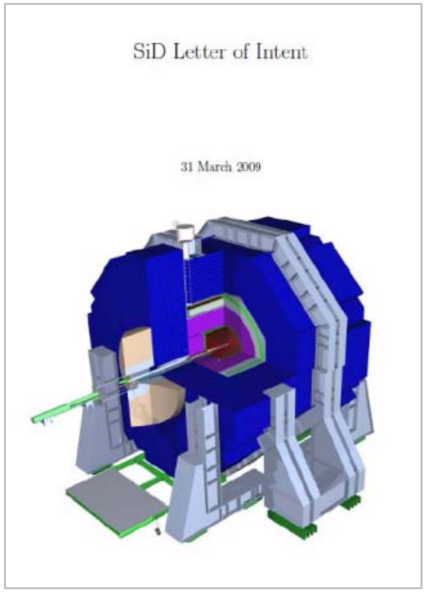
Detectors and physics

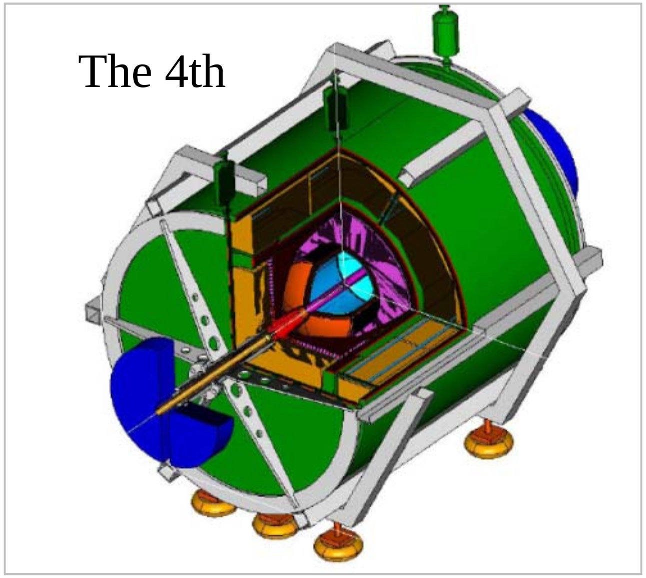
ILC: IDAG (International Detector Advisory Group

Physics and Experiments Board

LOI's





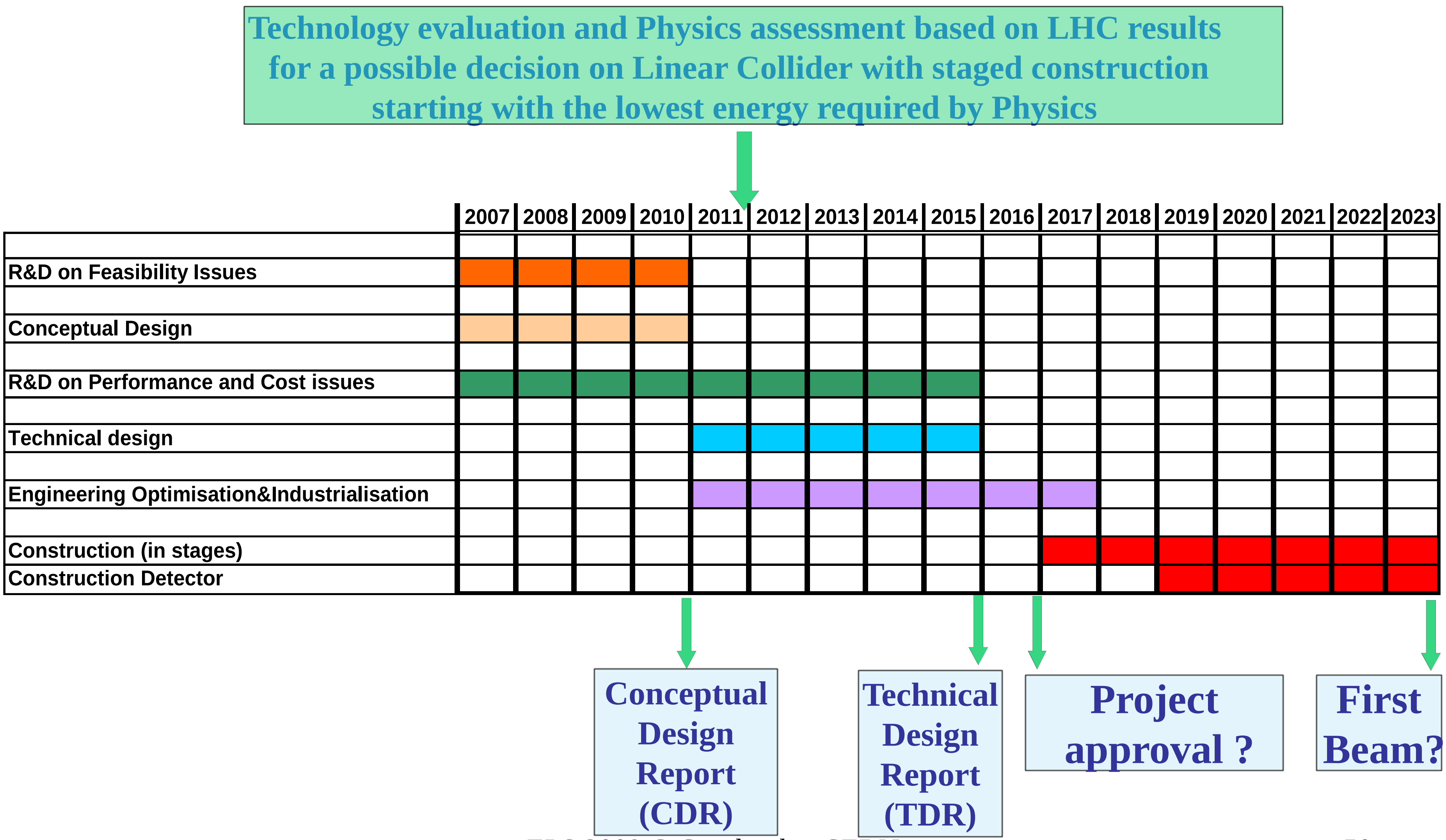


CLIC: Physics and detectors working group established

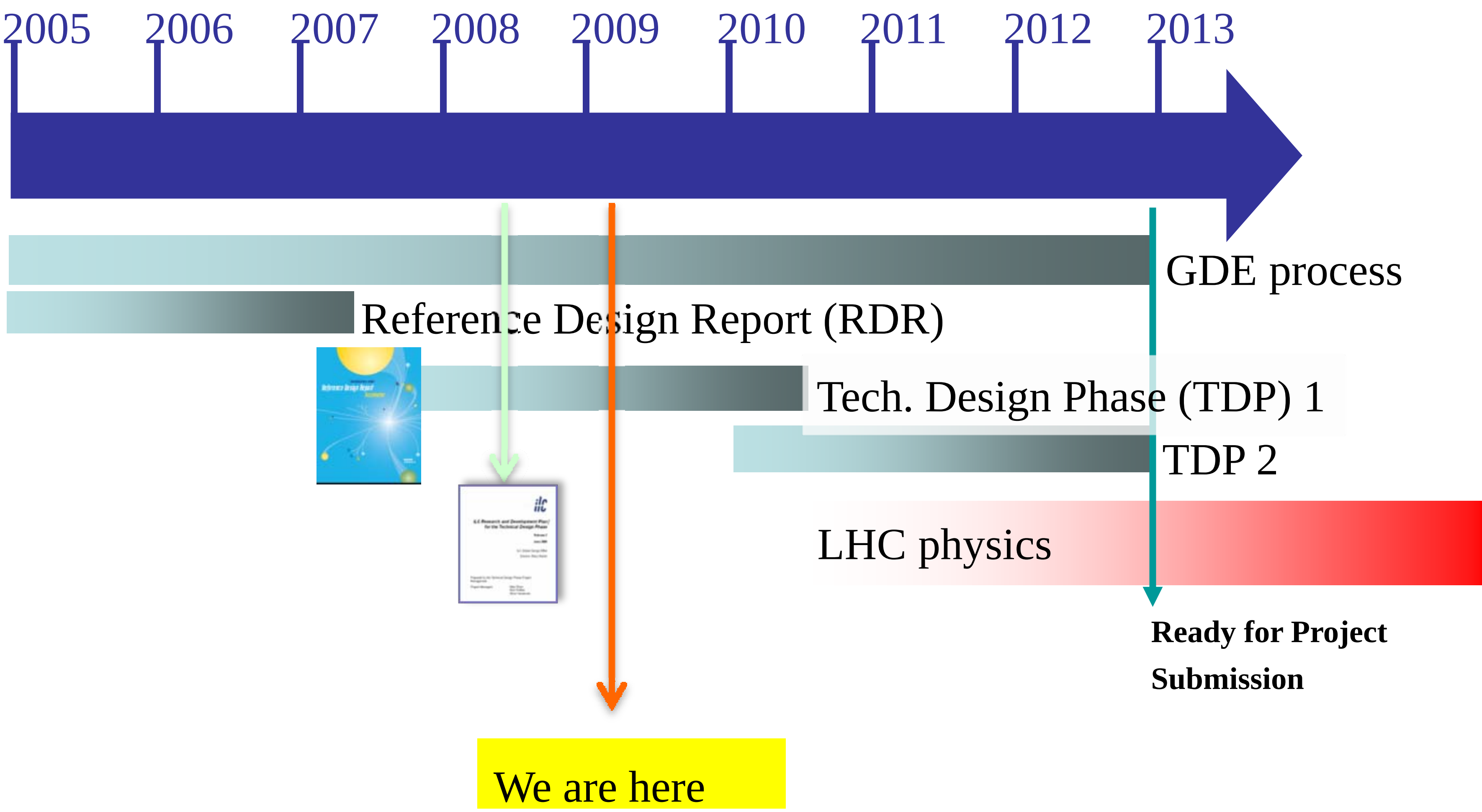
ILC – CLIC collaboration

	CLIC	ILC
Physics & Detectors	L.Linssen, D.Schlatter	F.Richard, S.Yamada
Beam Delivery System (BDS) & Machine Detector Interface (MDI)	D.Schulte, R.Tomas Garcia E.Tsesmelis	B.Parker, A.Seriy
Civil Engineering & Conventional Facilities	C.Hauviller, J.Osborne.	J.Osborne, V.Kuchler
Positron Generation (new)	L.Rinolfi	J.Clarke
Damping Rings (new)	Y.Papaphilipou	M.Palmer
Beam Dynamics	D.Schulte	A.Latina, K.Kubo, N.Walker
Cost & Schedule	P.Lebrun, K.Foraz, G.Riddone	J.Carwardine, P.Garbincius, T.Shidara

Tentative long-term CLIC scenario
Shortest, Success Oriented, Technically Limited Schedule



GDE: ILC Timeline



Conclusion

ILC: 500 GeV, upgradable to 1 TeV

Technology quite advanced. Project could be proposed in 2012

CLIC: reach up to 3 TeV

still in R&D phase ,TDR expected end 2015.

Some parameters are more challenging than ILC.

500 GeV parameters however, more relaxed, close to state of the art