Welcome to CLIC09

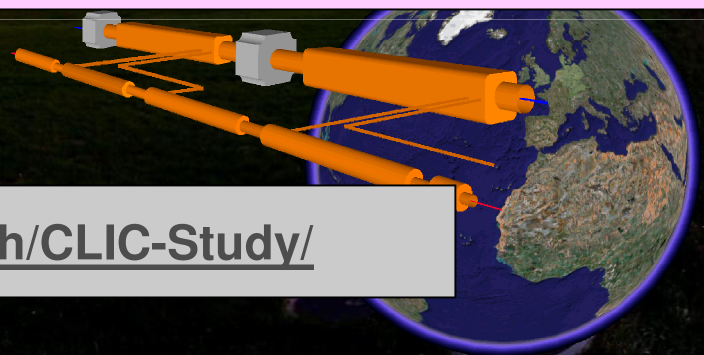
Participants: 247 (registered) from 78 Inst. of 22 countries

- **Bulgaria:** Acad. of Science
- **China:** Tsinghua University
- **Finland:** Helsinki Univ, HIP
- **France:** CEA/IRFU, Ecole Norm Sup, LLR-Ecole Polyt, IN2P3/LAL, IPNL, LAPP, LPHNE, UPMC
- **Germany:** Bonn Univ.,DESY, Karlsruhe Univ, MaxPlanck Inst.
- **Greece:** NTU Athens
- **India:** BARC-RRCAT,
- **Italy:** INFN/LNF, Florence, Genova, Lecce
- **Japan:** KEK, Shinshu Univ, Tokohu Univ
- **Kenya:** Jomom Kenyatta Univ
- **Netherland:** NIKHEF
- **Norway:** Univ of Oslo
- **Pakistan:** NCP
- ***Russia:*** *BINP, IAP, ITEP, JINR*
- ***Romania:*** *IFIN-HH*
- ***Spain:*** *CIEMAT, IFIC, Catalonia Univ.*
- ***Sweden:*** *Uppsala Univ.*
- ***Switzerland:*** *ADAM, EPFL, ETH-Zurich, Lulea Univ Techn, PSI*
- ***Turkey:*** *Abant I B Univ, Ankara Univ, Dumlupinar Univ, TAEA, Uludag Univ*
- ***United-Kingdom:*** *ASTeC, Birmingham Univ., Cambridge Univ, Cockcroft Inst., Daresbury Lab, JAI, Lancaster Univ, Manchester Univ., Oxford Univ, RAL, RHUL, STFC, Univ College London*
- ***United-States:*** *ANL, BNL, Caltech, Cornell Univ., Euclid Techlabs, FNAL, Iowa State Univ, LBNL, LLNL, Minesota Univ, Ohmega-P, Oregon Univ, SLAC, Yale Univ*
- ***Vietnam:*** *Hanoi Univ*

CLIC 09

http://indico.cern.ch/conferenceDisplay.py?confId=45580

Progress from CLIC08
CLIC feasibility issues
R&D program, status and plans
Preparation of Conceptual Design Report
CLIC Collaboration & collaboration with ILC
Conclusion



http://clic-study.web.cern.ch/CLIC-Study/

J.P.Delahaye for the CLIC Collaboration

Towards CLIC Conceptual Design

- **Demonstrate feasibility of CLIC technology**
  - **Address all feasibility issues**
- **Design of a linear Collider based on CLIC technology**

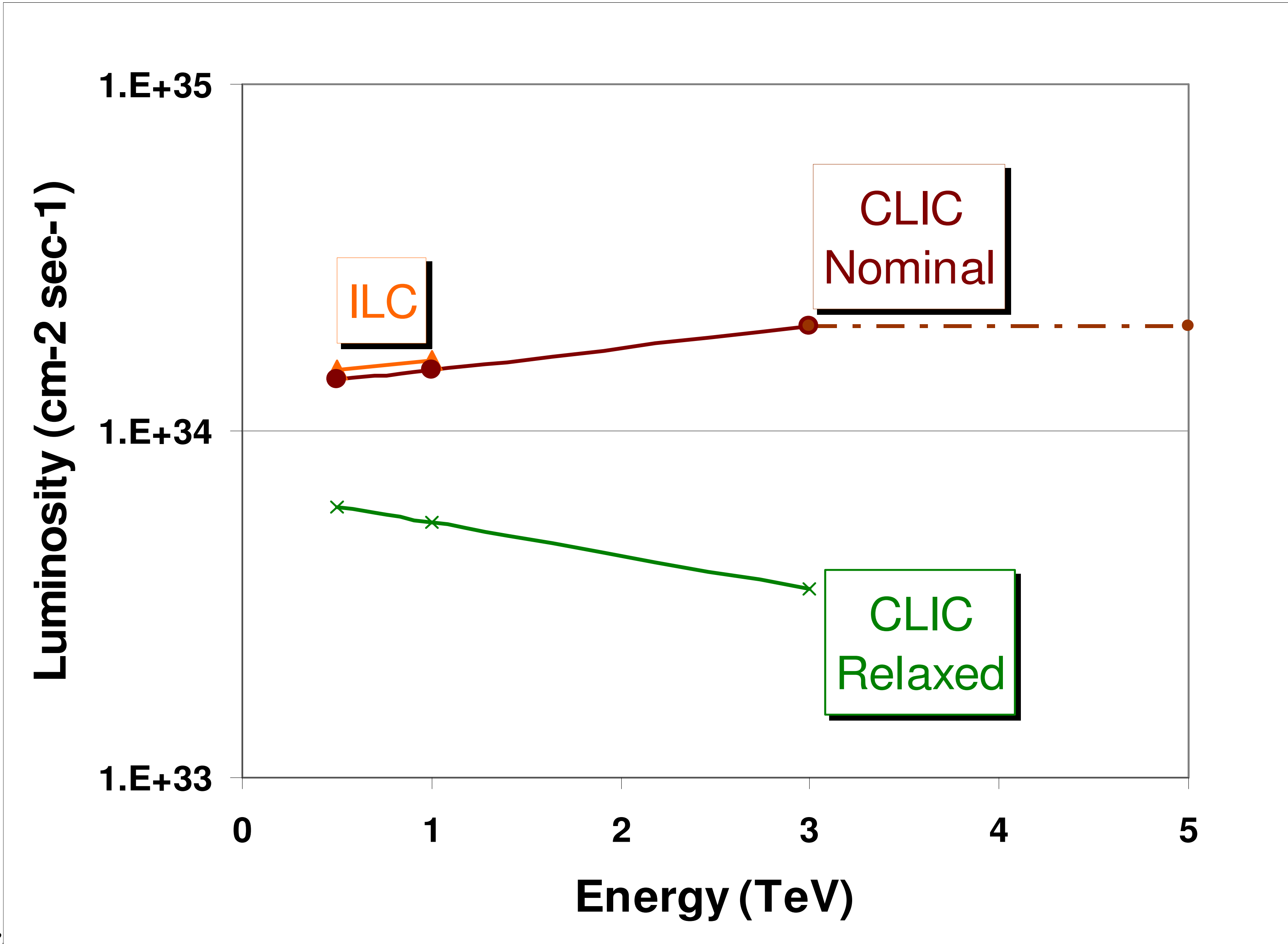
  http://clic-study.web.cern.ch/CLIC-Study/Design.htm
- **CLIC Physics study and detector development**

  http://clic-meeting.web.cern.ch/clic-meeting/CLIC_Phy_Study_Website/default.html

  L.Linssen
  LCD project
- **Estimation of its cost (capital investment & operation)**
- **Conceptual Design Report (CDR) by end 2010 including**
  - **Physics, Accelerator and Detectors**
  - **R&D on critical issues and results of feasibility study,**
  - **Preliminary performance and cost estimation**

CLIC Parameters Range

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



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 GeV		CLIC 3 TeV	
Beam parameters	**Relaxed**	**Nominal**	**Relaxed**	**Nominal**
Accelerating structure	502		G	
Total (Peak 1%) luminosity	$8.8(5.8)\cdot10^{33}$	$2.3(1.4)\cdot10^{34}$	$7.3(3.5)\cdot10^{33}$	$5.9(2.0)\cdot10^{34}$
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 ($10^{-6}/10^{-9}$)	7.5/40	4.8/25	7.5/40	0.66/20
Hor/Vert FF focusing (mm)	4/0.4	4 / 0.1	4/0.4	4 / 0.1
Hor./vert. IP beam size (nm)	248 / 5.7	202 / 2.3	101/3.3	40 / 1
Hadronic events/crossing at IP	0.07	0.19	0.28	2.7
Coherent pairs at IP	10	100	$2.5\ 10^7$	$3.8\ 10^8$
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 critical issues
R&D strategy and schedule

Overall list of critical issues (Risk Register) under:

https://edms.cern.ch/nav/CERN-0000060014/AB-003093

Issues classified in three categories:

- **CLIC design and technology feasibility**

  Fully addressed by 2010 by specific R&D with results in Conceptual Design Report (CDR) with Preliminary Performance & Cost

- **Performance and/or Cost**

  Both being addressed now by specific R&D to be completed before 2016 with results in Technical Design Report (TDR) with Consolidated Performance & Cost

10 CLIC Feasibility Issues

- **Two Beam Acceleration:**
  - Drive beam generation
  - Beam Driven RF power generation
  - Two Beam Module
- **RF Structures:**
  - Accelerating Structures (CAS)
  - Power Production Structures (PETS)
- **Ultra low beam emittance and beam sizes**
  - Emittance preservation during generation, acceleration and focusing
  - Alignment and stabilisation
- **Detector**
  - Adaptation to short interval between bunches
  - Adaptation to large background at high beam collision energy
- **Operation and Machine Protection System (MPS)**

CLIC specific

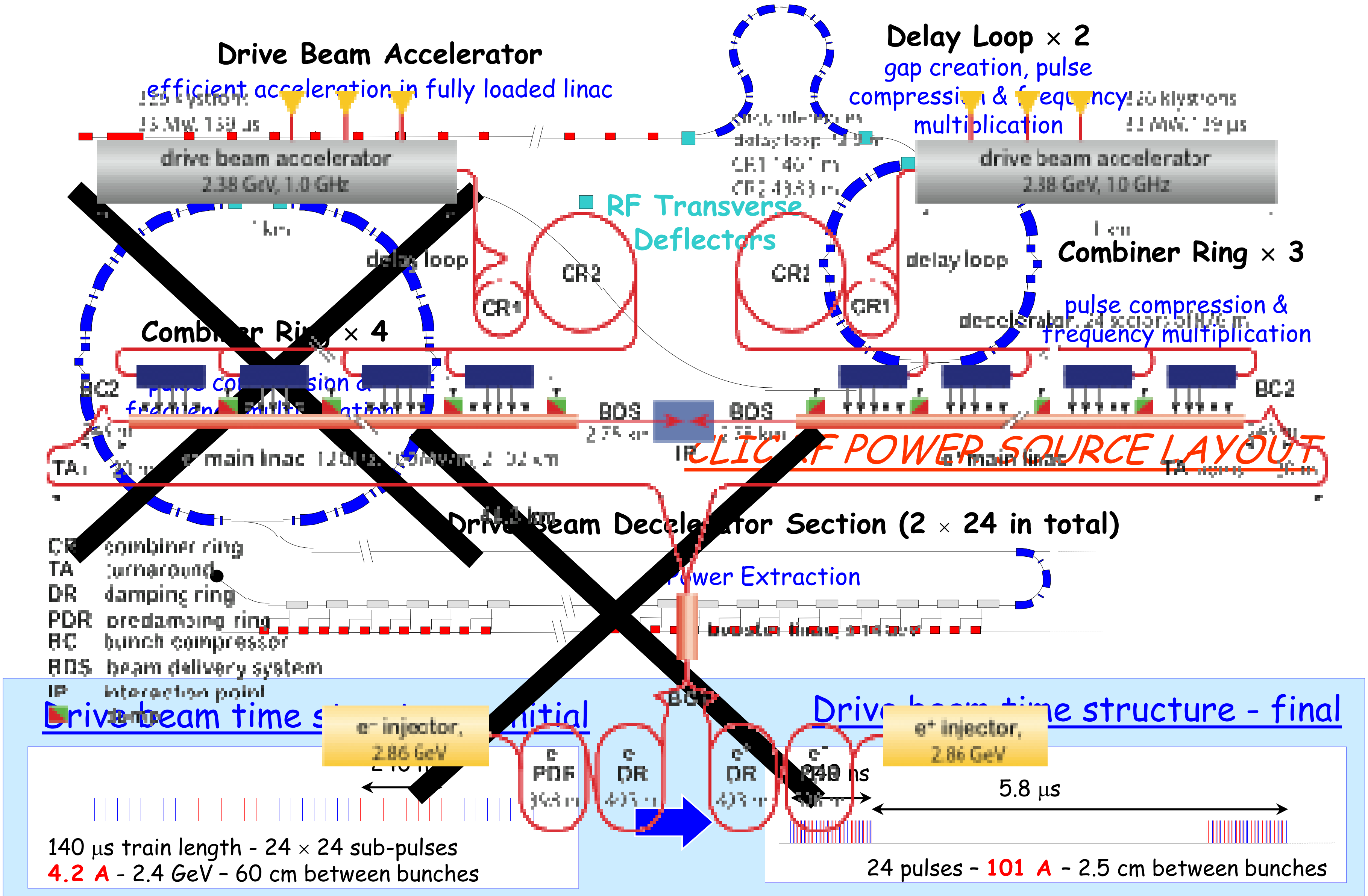
CLIC ILC Common Issues
CLIC more challenging requirements

Feasibility of (at least) relaxed parameters

CLIC feasibility issues

System	Item	Parameter Issue	Test facility Common with ILC
Two Beam Acceleration	Drive beam generation	100 A peak current / 590 µC total charge 12 GHz bunch repetition freq. & 1 mm bunch length 0.2 degrees phase stability at 12 GHz (0.1 psec) $7.5\ 10^{-4}$ intensity stability	CTF3 CTF3/TBL Simulations X-FEL, LCLS
	Beam Driven RF power generation	90% conversion efficiency from drive beam to RF Large drive beam momentum RF pulse shape accuracy < 0.1%	CTF3/TBL Simulations
	Two beam module	Two Beam Acceleration at nominal parameters	CTF2&3/TBTS
RF Structures	Accelerating Structures (CAS)	100 MV/m 240 RF pulse length with flat top 160ns breakdown probability/pulse < 3·10-7 /m	CTF2&3 SLAC/NLCTA&NASTA KEK/NEXTEF
	Power Production Structures (PETS)	132 MW total flat-top pulse length 240/160 ns breakdown probability/pulse < 1·10-7 /m On/Off/adjust capability	CTF3 CTF3/TBTS & TBL SLAC/ASTA
Ultra low beam emittance & sizes	Emittance preservation	during generation, acceleration and focusing: Emittances (nm): H= 600, V=5 Absolute blow-up (nm): H=160, V=15	ATF, SLS, NSLSII Simulations LCLS, SCSS
	Alignment and stabilisation	Main Linac : 1 nm vert. above 1 Hz BDS: 0.15 to 0.5 nm above 4 Hz	CESRTA ATF2
Detector	Short interval between bunches	Time stamping: 0.5 nsec bunch interval	Simulations
	Background at high beam collision energy	Beam-Beam background: $3.8\ 10^{8}$ coherent/1e5 incoherent e+/e- pairs, Hadrons, High muon flux	Simulations
Operation and Machine Protection System (MPS)		drive beam power of 72 MW @ 2.4 GeV main beam power of 13 MW @ 1.5 TeV MTBF, MTTR	CTF3 Simulations

CLIC Drive Beam generation



Addressing all major CLIC technology key issues in CLIC Test Facility (CTF3)

- Demonstrate Drive Beam generation
  (fully loaded acceleration, beam intensity and bunch frequency multiplication x8)
- Demonstrate RF Pow… …test Power Structures
- Demonstrate Two Be… …nd test Accelerating Structures

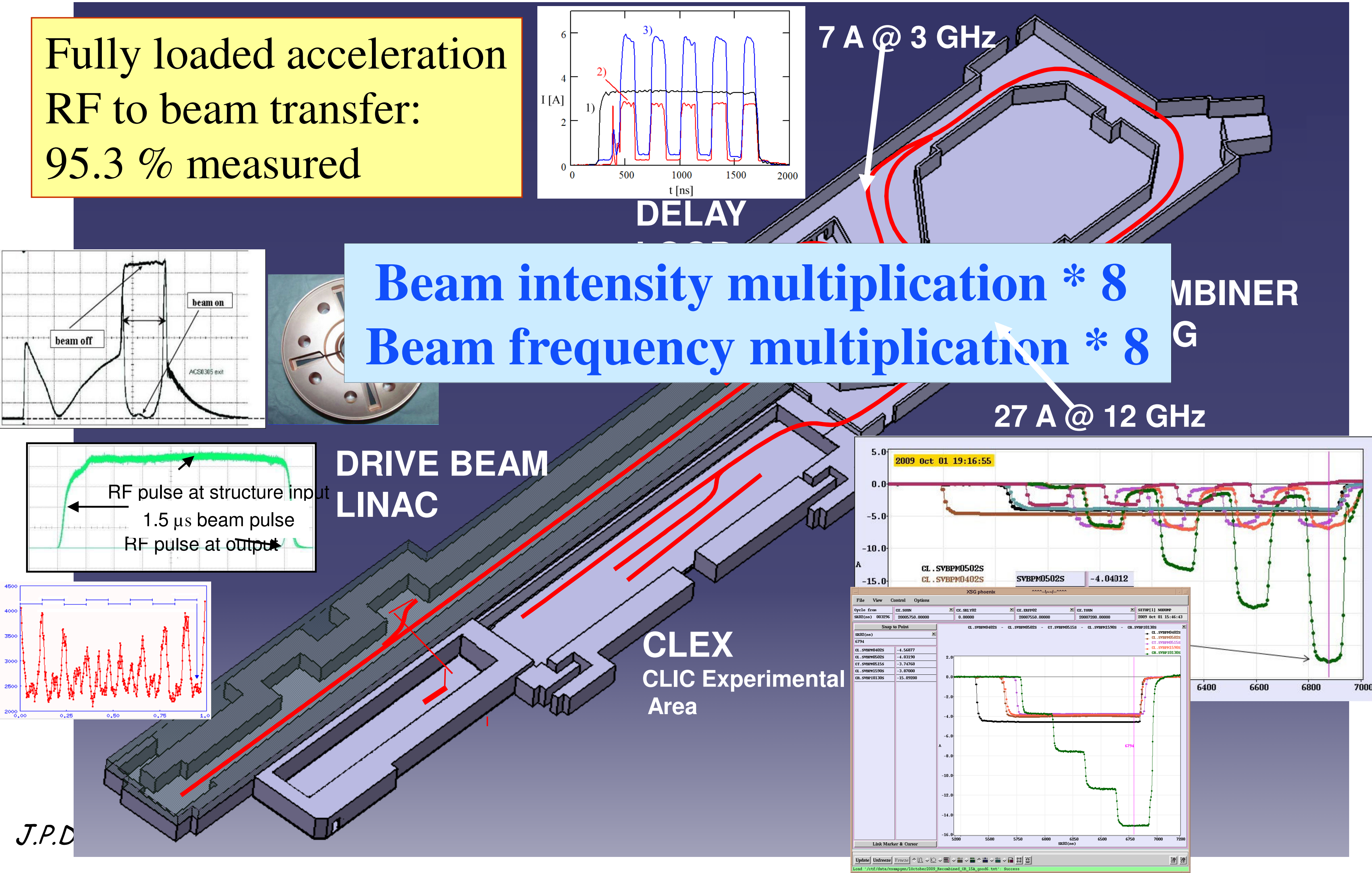
F.Tecker

CTF3 visit on Friday pm
Inscription @ Registration desk (Alexia)

CTF3 completed, operating 10 months/year, under commissioning:Drive Beam Generation demonstrated

Fully loaded acceleration
RF to beam transfer:
95.3 % measured

Beam intensity multiplication * 8
Beam frequency multiplication * 8



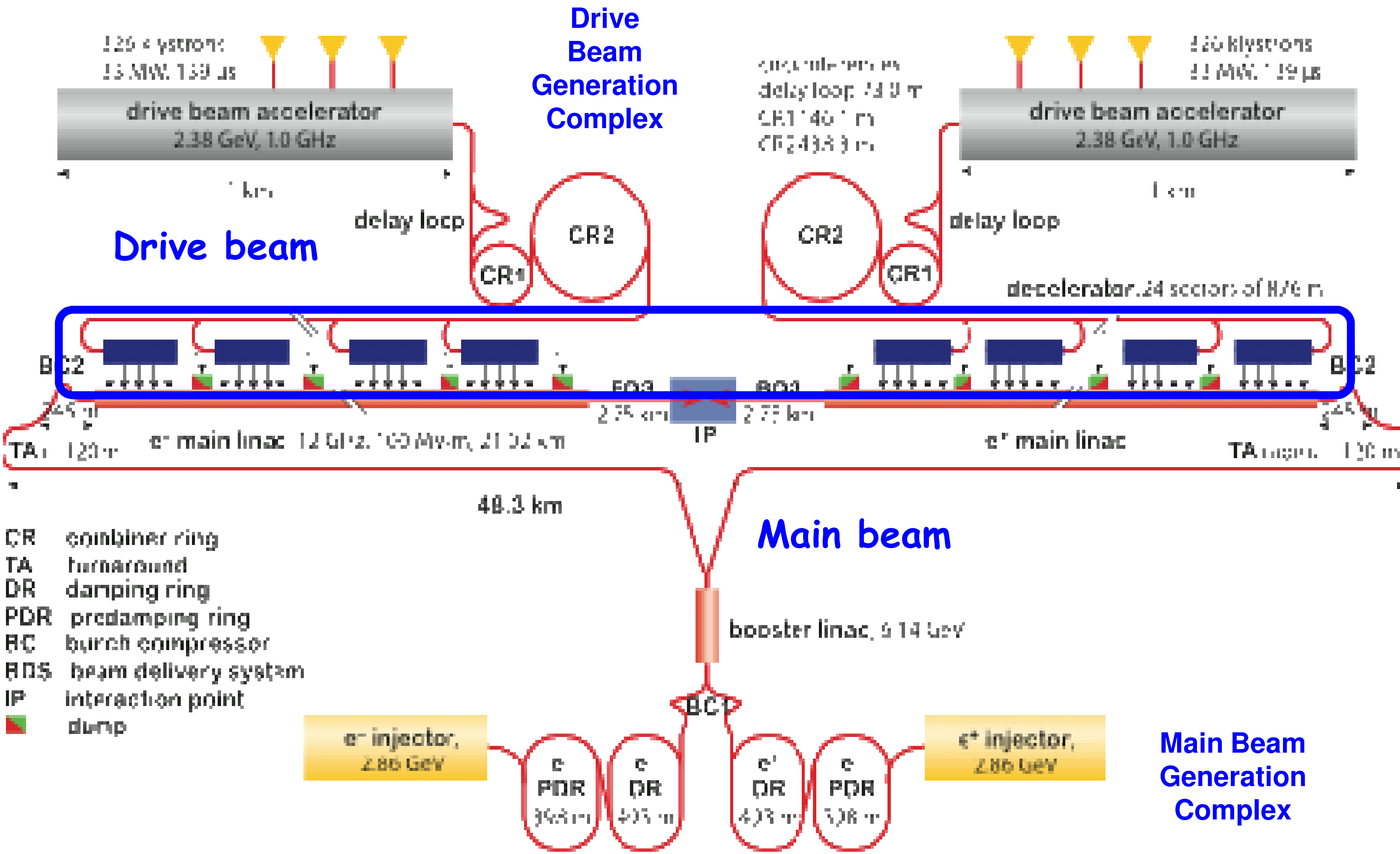
Drive Beam Generation Feasibility

Feasibility Issue	Unit	Nominal @ 2 GeV	Feasibility Target @ 0.2Gev	Achieved @2 GeV	How	Feasibility
Fully loaded accel effic	%	96	95	95	CTF3	✓
Freq&Current multipl		2*3*4	2*4	2*4	CTF3	✓
12 GHz beam current	A	4.5*24=100	3.75*8=30	3.6*8=27	CTF3	✓
12 GHz pulse length	nsec	240	140	140	CTF3	✓
Bunch length	mm	1	1mm	?	CTF3	?
Timing stability	psec	0.1 psec	?	?	XFEL	-
Intensity stability	10^{-4}	7.5	30	30 @ * 4	CTF3	✓ @*4

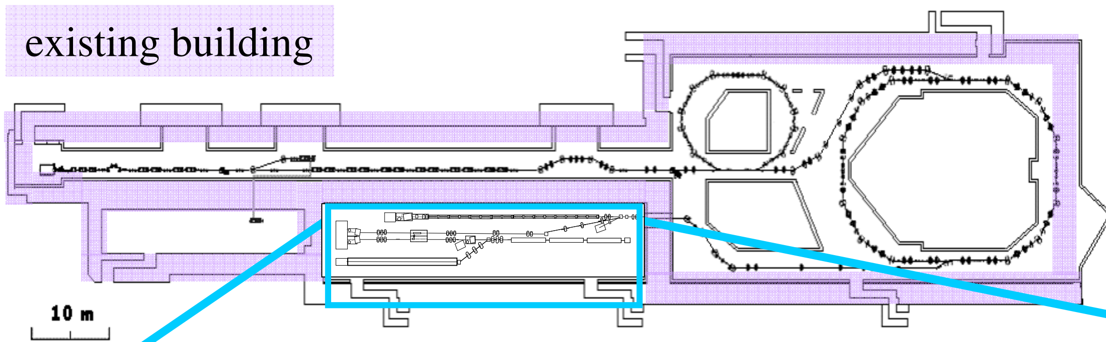
Drive beam generation feasibility demonstrated

- **Intensity stability still to be improved**
- **Timing stability to be addressed (XFEL collab)**

CLIC – Power Generation

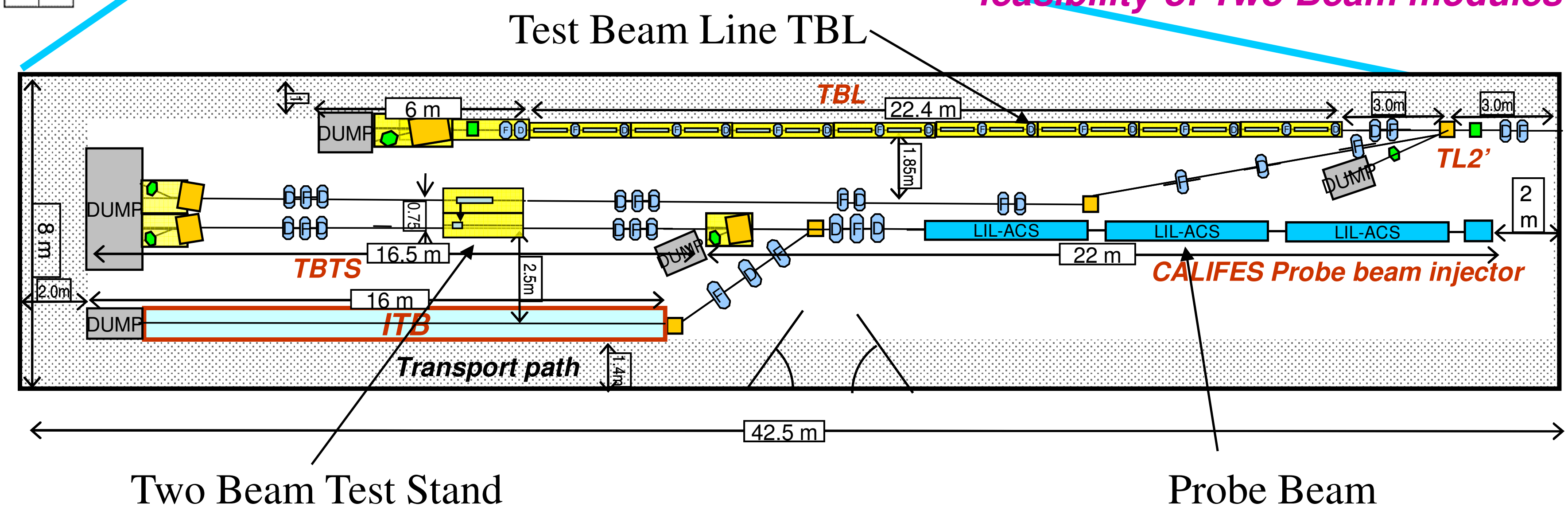


CTF3/CLEX (CLIC Experimental Area)



Test beam line (TBL) to study RF power production (1.5 TW at 12 GHz) and drive beam decelerator dynamics, stability & losses

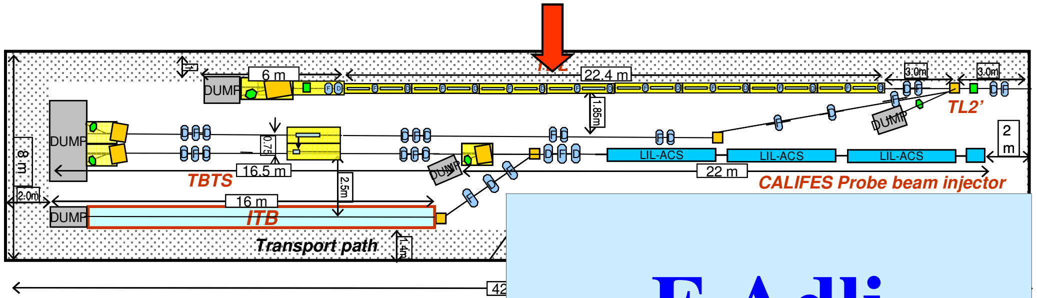
- Two Beam Test Stand to study probe beam acceleration with high fields at high frequency and the feasibility of Two Beam modules



Construction during 2006/beg 2007
installation of equipment from
2007 - 2009

Beam in CLEX from June 2008 onwards

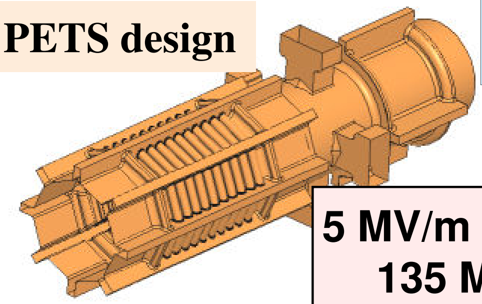
Test Beam Line (TBL)



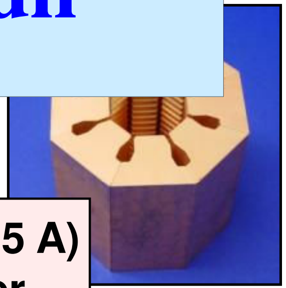
- High energy-spread beam transport decelerate to 50 % beam energy
- Drive Beam stability
- Stability of RF power extraction total power in 16 PETS: 2.5 GW
- Alignment procedures

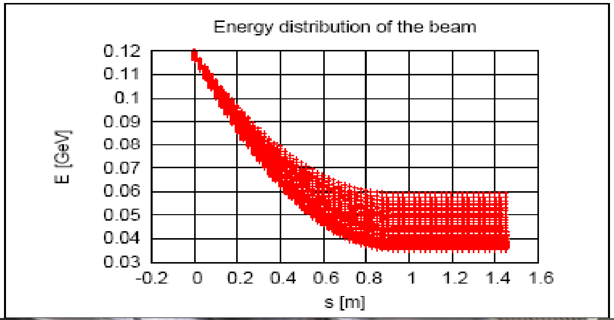
E.Adli

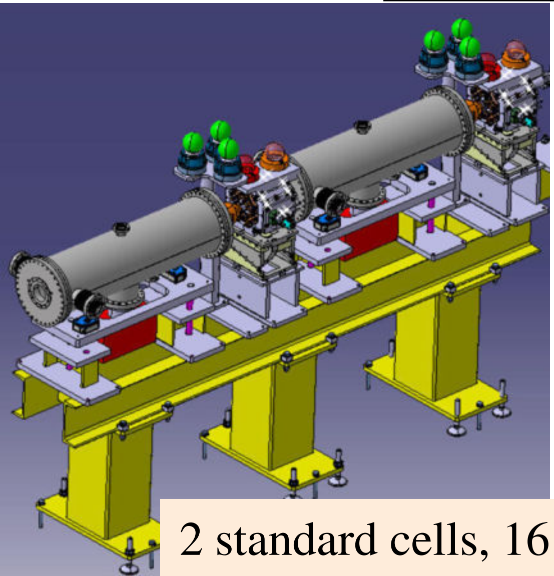
PETS design

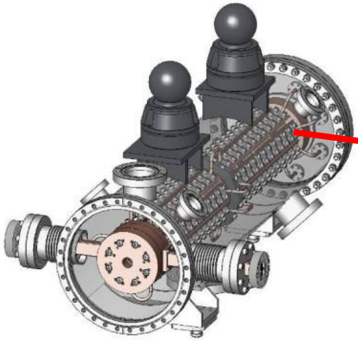


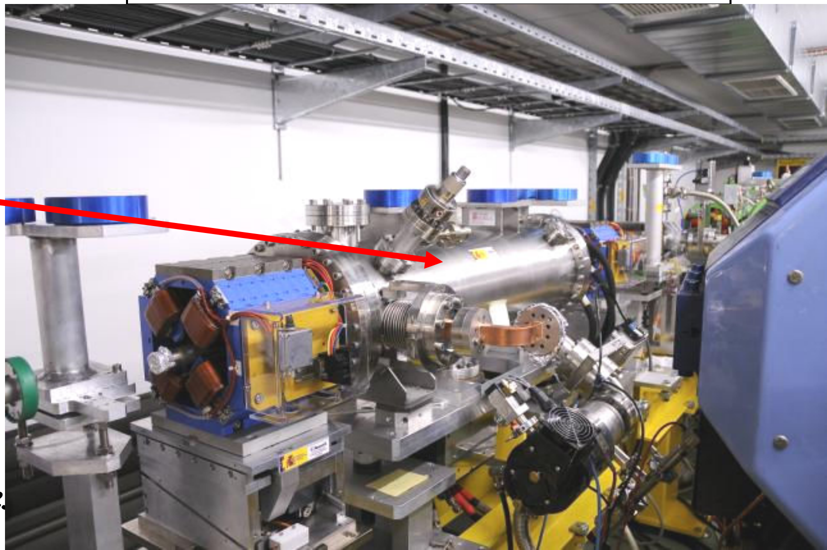
5 MV/m deceleration (35 A)
135 MV output Power







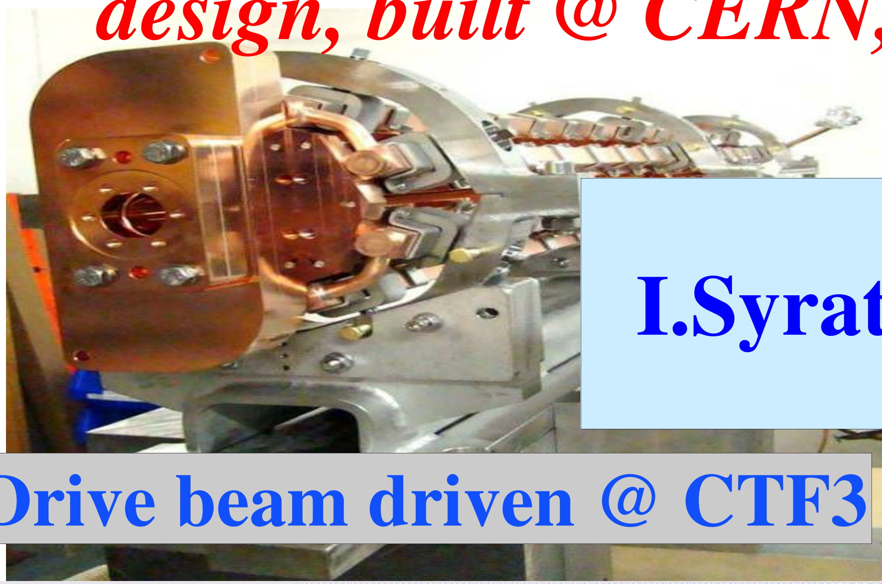




2 standard cells, 16 total

C progress and perspectives

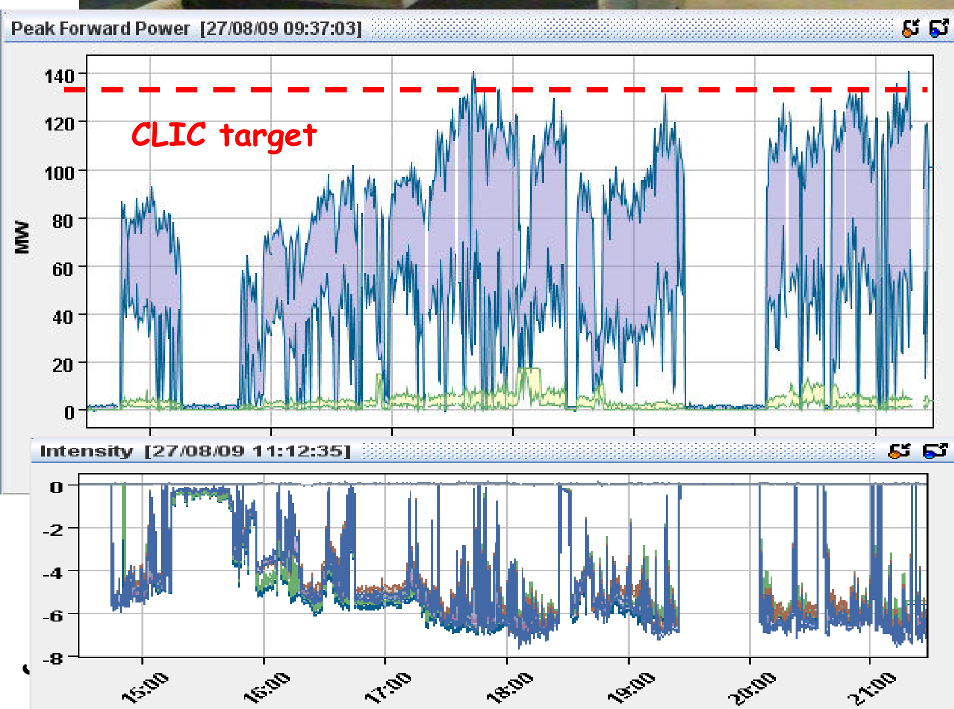
Power Production Structure (PETS) design, built @ CERN, power tests@CTF3,SLAC

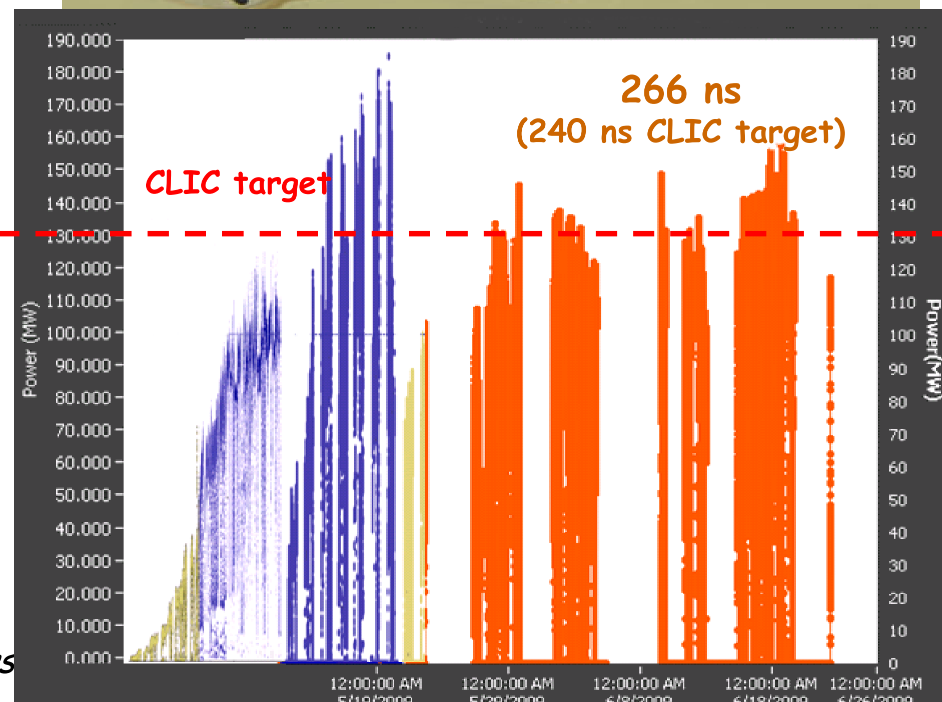


Drive beam driven @ CTF3

I.Syratchev

Klystron driven @ SLAC

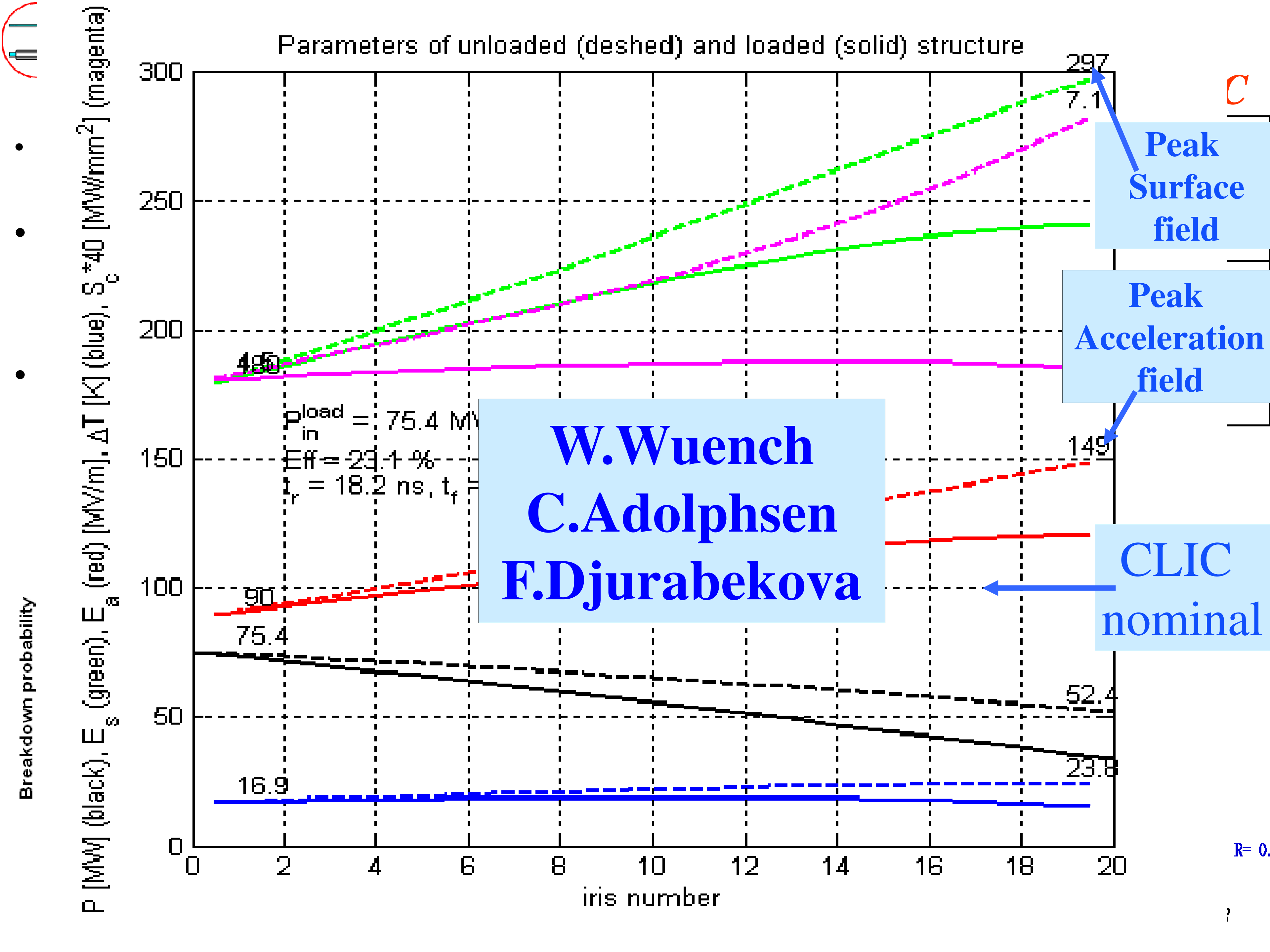




Beam driven RF Power Generation Feasibility

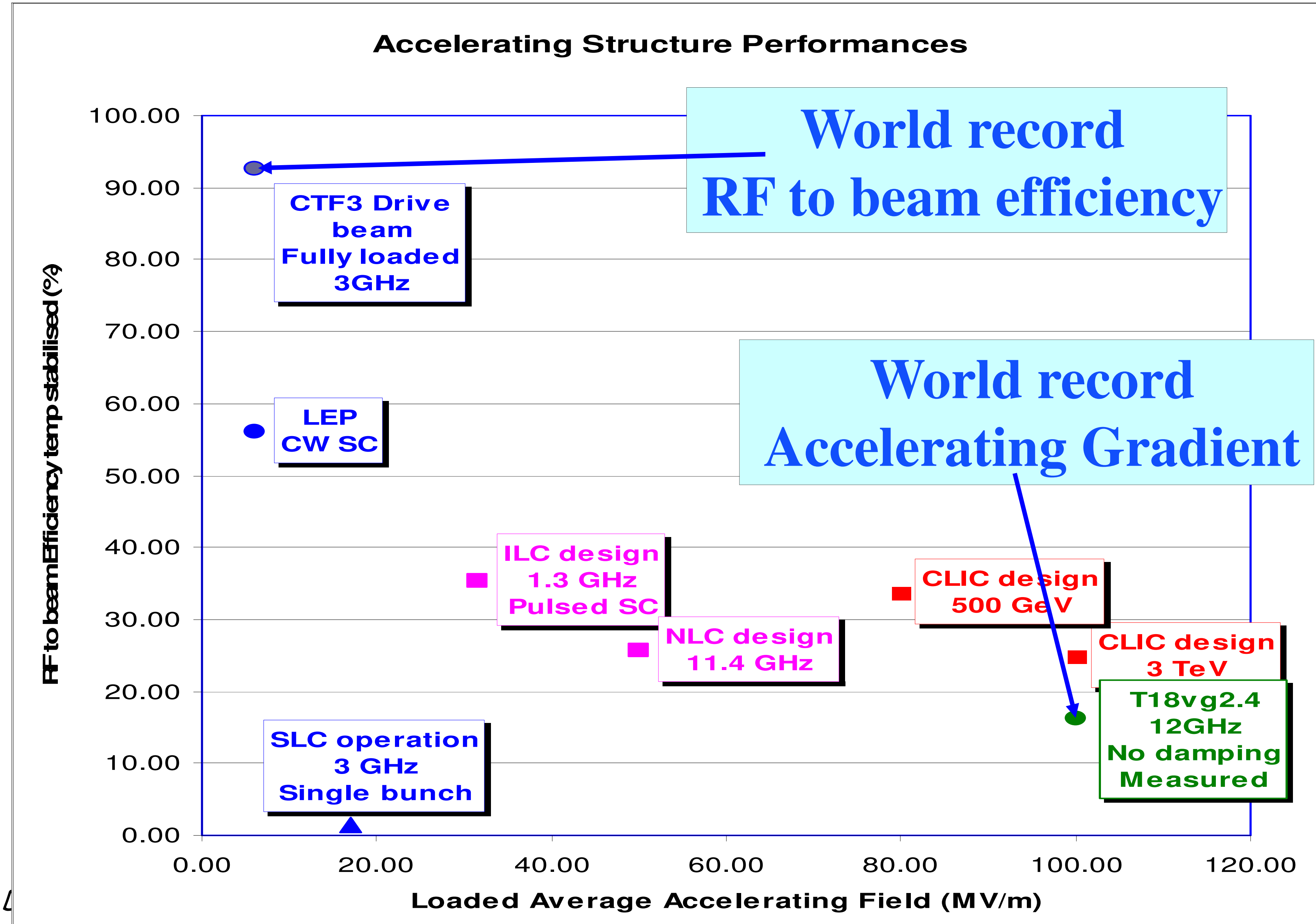
Feasibility Issue	Unit	Nominal	Feasibility Target	Achieved	How	Feasibility
PETS RF Power	MW	132	132	130	TBTS/	✓
PETS Pulse length	ns	240	240	>240	SLAC	✓
PETS Breakdown rate	/m	< 1·10-7	< 1·10-7	?	TBL	under cond.
PETS ON/OFF		@ 50Hz	@ low rep	-	CTF3	Being built
Drive beam to RF effic.	%	90%	50%	-	CTF3	TBL being
Drive mom. spread	%	90%	50%		CTF3	installed
RF pulse accuracy	%	< 0.1%	< 0.1%		CTF3	

- RF power generation by single PETS feasibility demonstrated except for breakdown rate.
- ON/OFF mechanism being built, still to be tested
- Efficient RF power extraction in multiple stages still to be addressed in TBL (being built for tests in 2010)



Parameters of unloaded (deshed) and loaded (solid) structure
P [MW] (black), E_s (green), E_a (red) [MV/m], ΔT [K] (blue), S_c*40 [MW/mm^2] (magenta)
iris number
297
7.1
149
52.4
23.8
90
75.4
16.9
P_{in}^{load} = 75.4 MW
Eff = 23.1 %
t_r = 18.2 ns, t_f =
Peak Surface field
Peak Acceleration field
CLIC nominal
W.Wuench
C.Adolphsen
F.Djurabekova
Breakdown probability

Accelerating Structure Performances

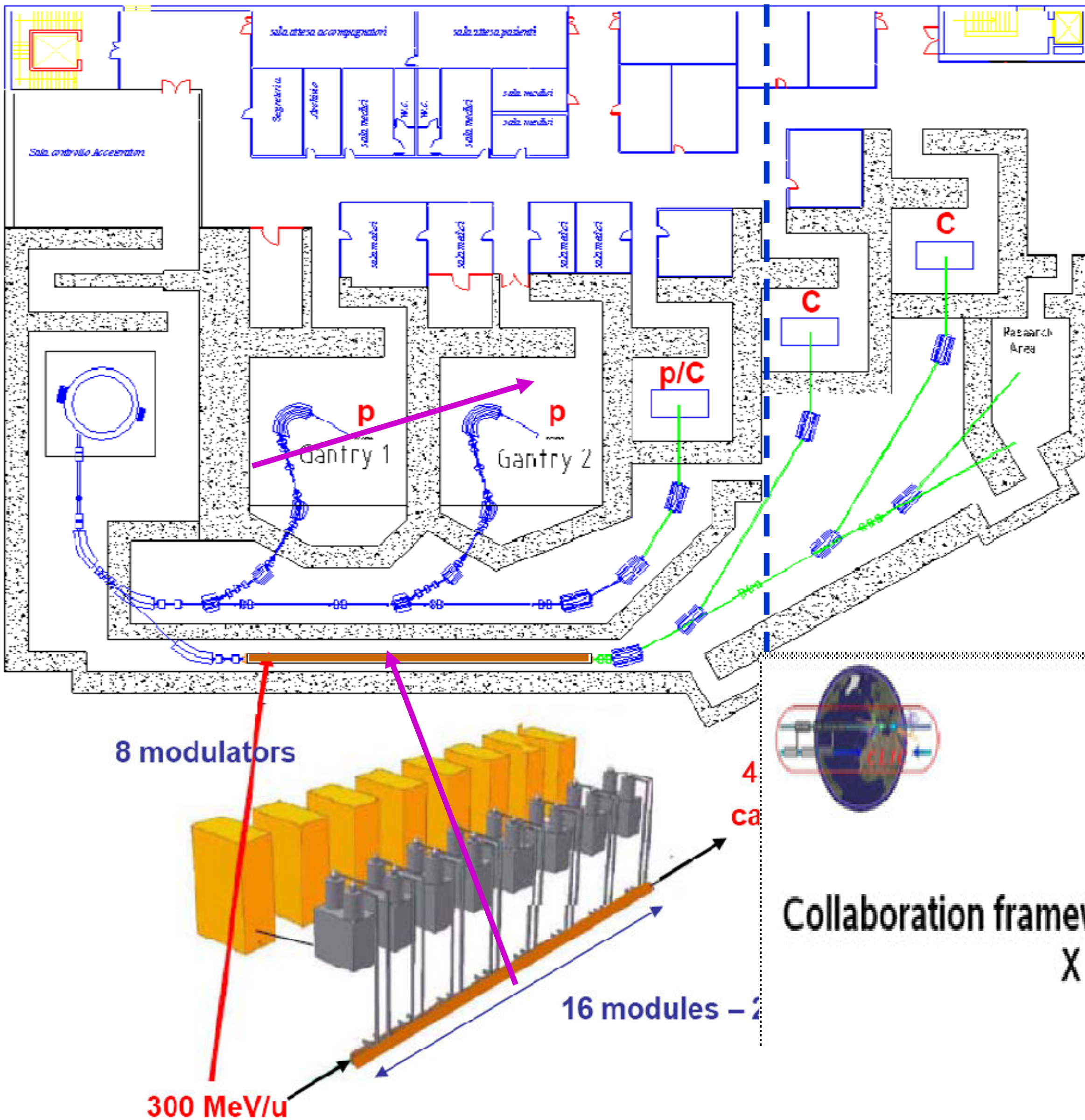


Accelerating Structures

- Nominal parameters demonstrated with high reproducibility:
  - 3 structures tested over 3 structures fabricated with identical procedure derived from NLC/JLC
  - 100MV/m loaded, 140 nsec pulse, ≤3. 10^{-7}/m breakdown rate
- Excellent and fruitful collaboration with SLAC and KEK
  - RF Design by CERN based on rules derived from NLC, JLC and CLIC power tests results at various RF frequencies
  - Tests taking advantage of X band RF power facilities available at SLAC and KEK
- Number of tests limited by available facilities
  - 12 GHz stand alone test stand in fabrication (with SLAC klystron derived from NLC and major contribution of Saclay)
  - Available at CERN mid 2010
- Tests before (?) end of the year:
  - Fully equipped with high order mode damping
  - New design with high(er) efficiency
- Tests next year: Larger statistics

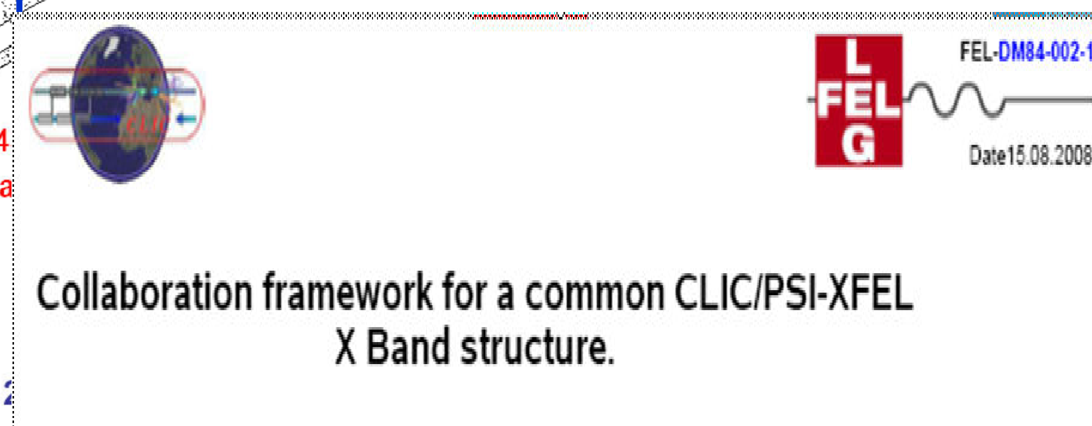
Applications of X band accelerating structures:

CArbon BOoster Therapy in Oncology (TERA)
PSI/X-FEL & ELETTRA Linac based X-FEL



TERA

12 GHz NC Linac (power efficiency)

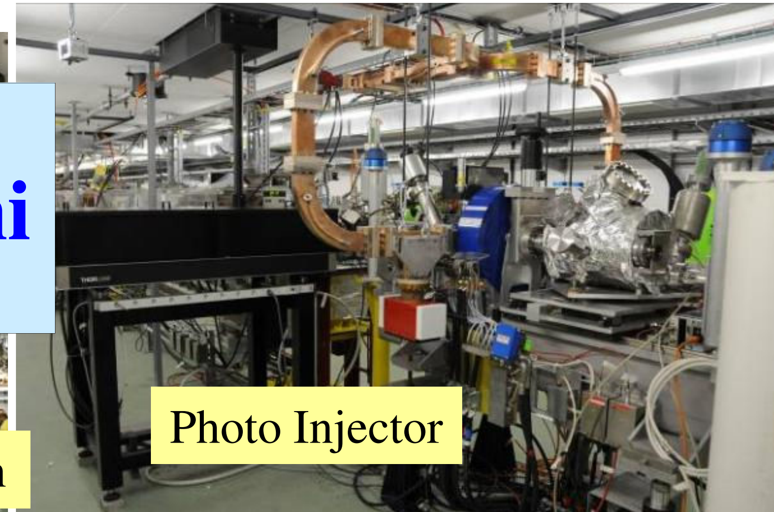

FEL-DM84-002-1

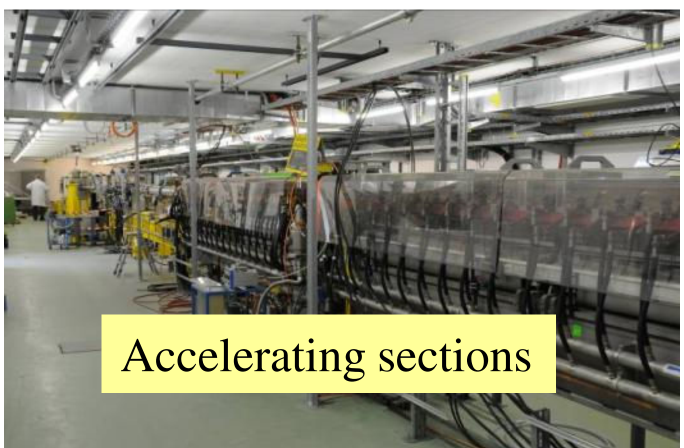
Date15.08.2008

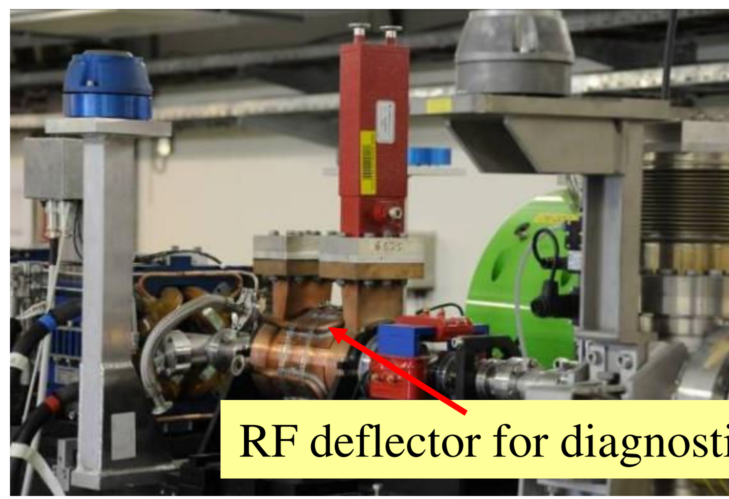
Collaboration framework for a common CLIC/PSI-XFEL X Band structure.

Probe Beam Generation in CTF3/CLEX (Califes)

W.Farabolini





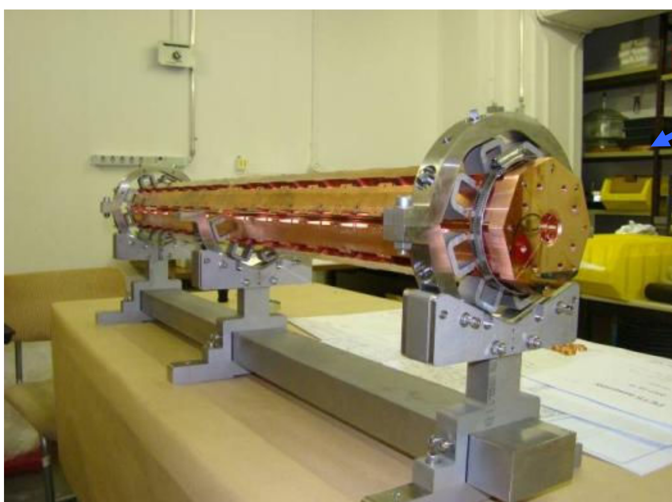


Two Beam Test Stand (TBTS) in CTF3/CLEX

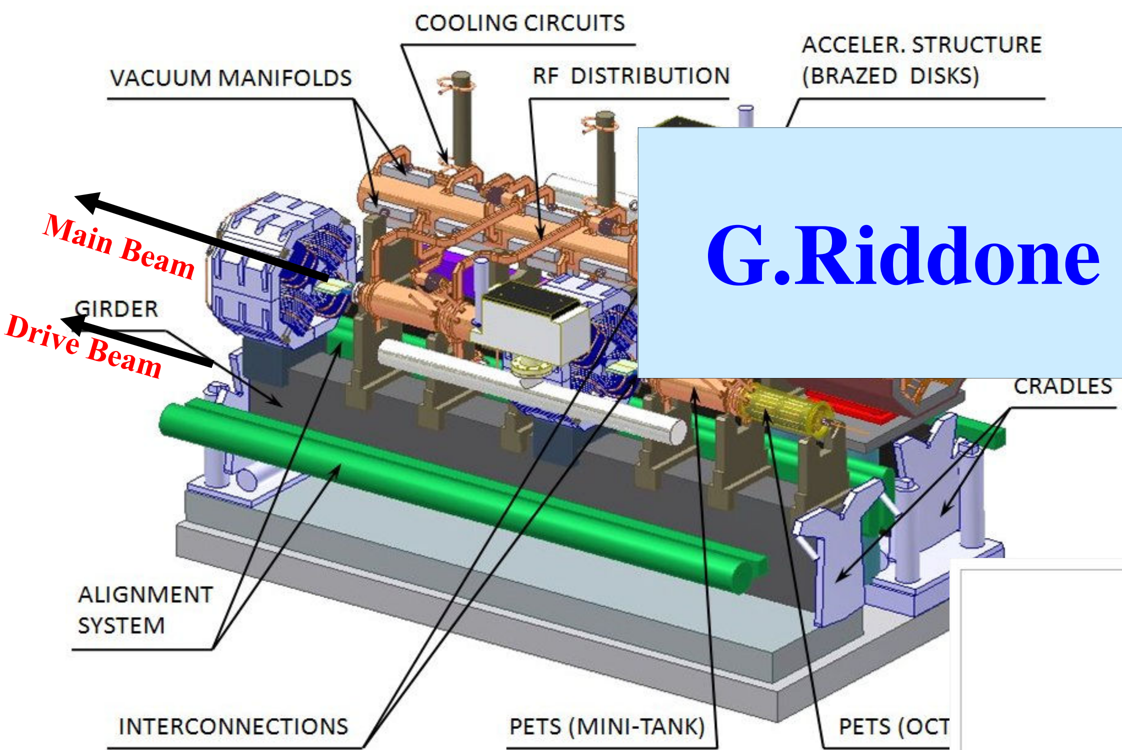
All hardware installed !
…missioning with beam ongoing
… in both lines up to end !

R.Ruber

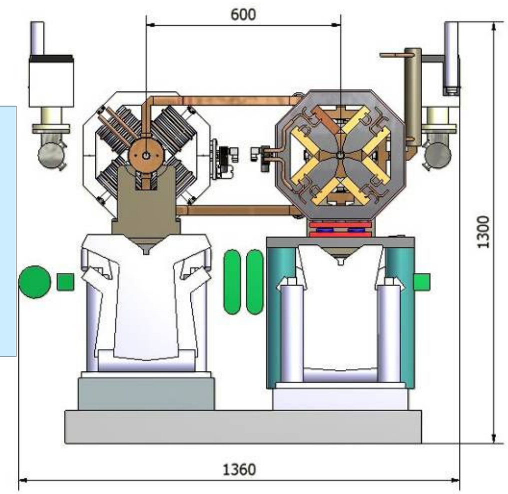
…(CERN) was installed in October, first accelerating structure in 2009

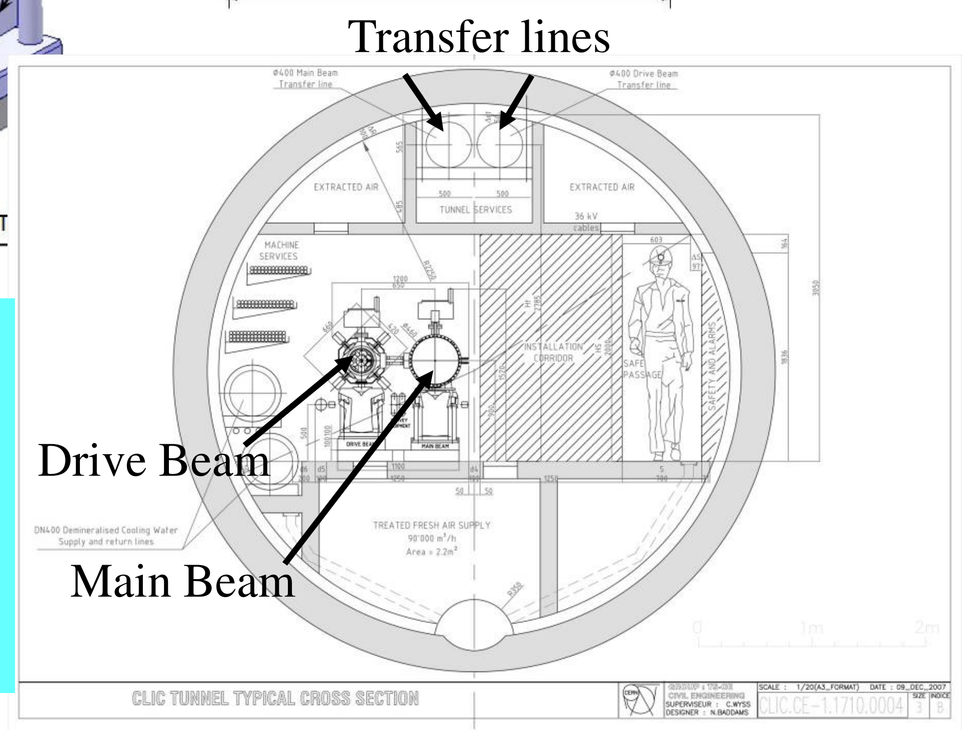


CLIC Two Beam Module



G.Riddone





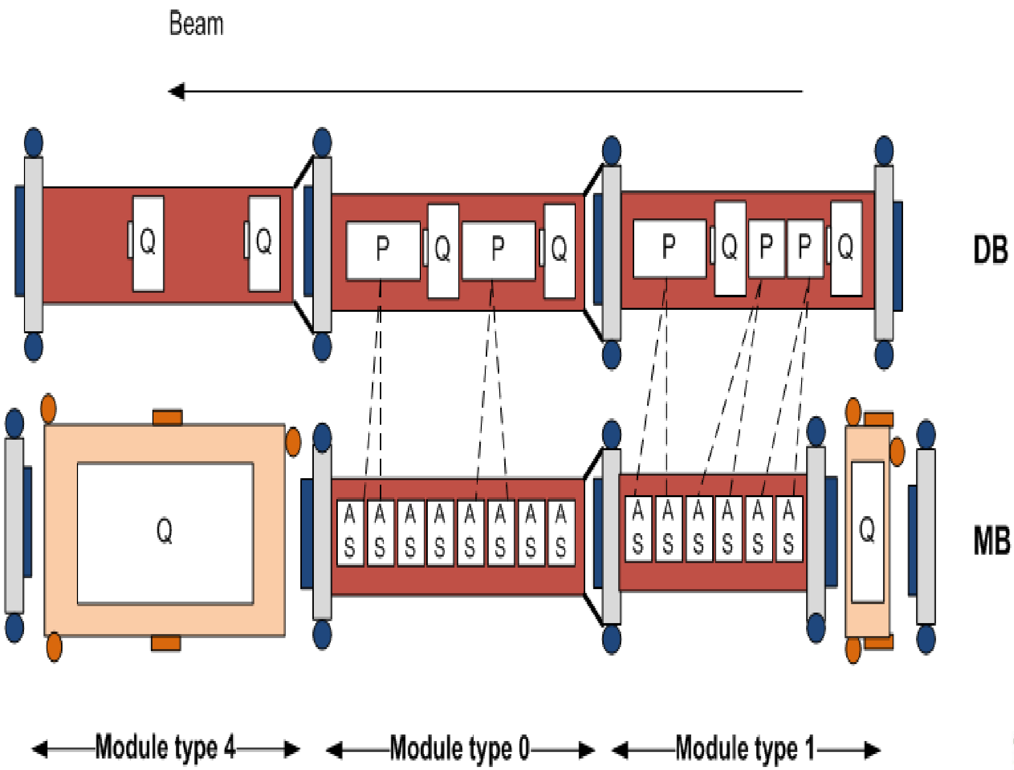
20760 modules (2 meters long)

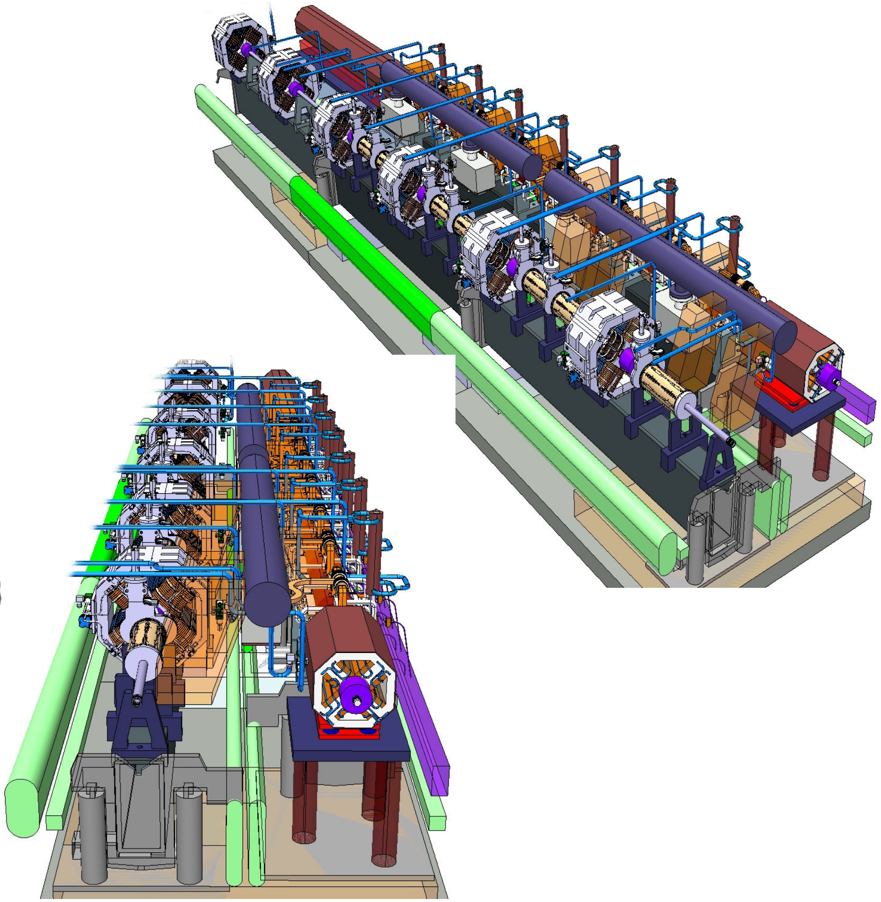
71460 power production structures PETS (drive beam)

143010 accelerating structures

(main beam)

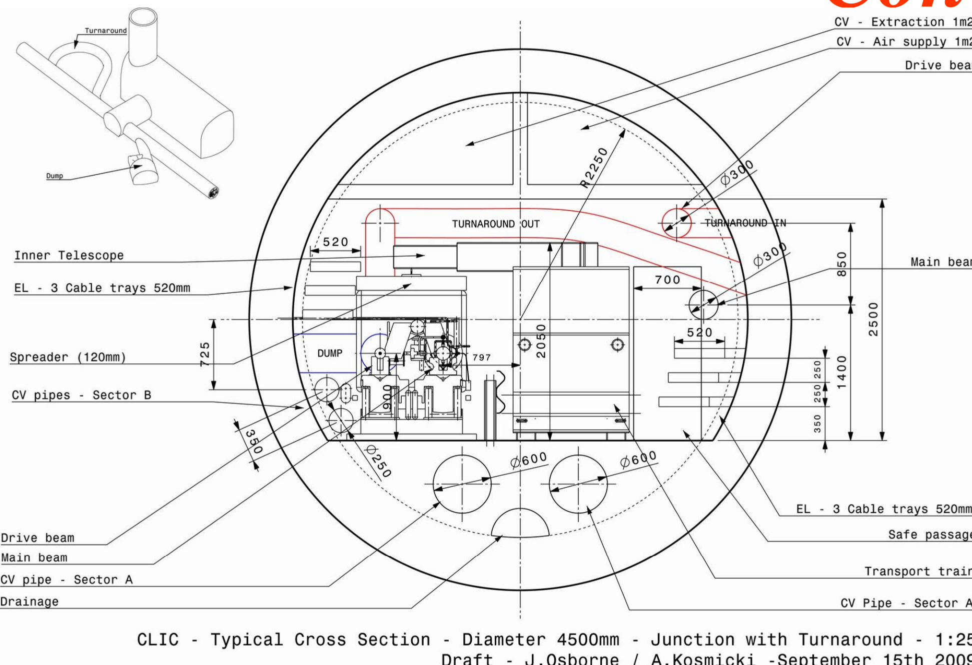
Two Beam Module tests in CTF3/CLEX



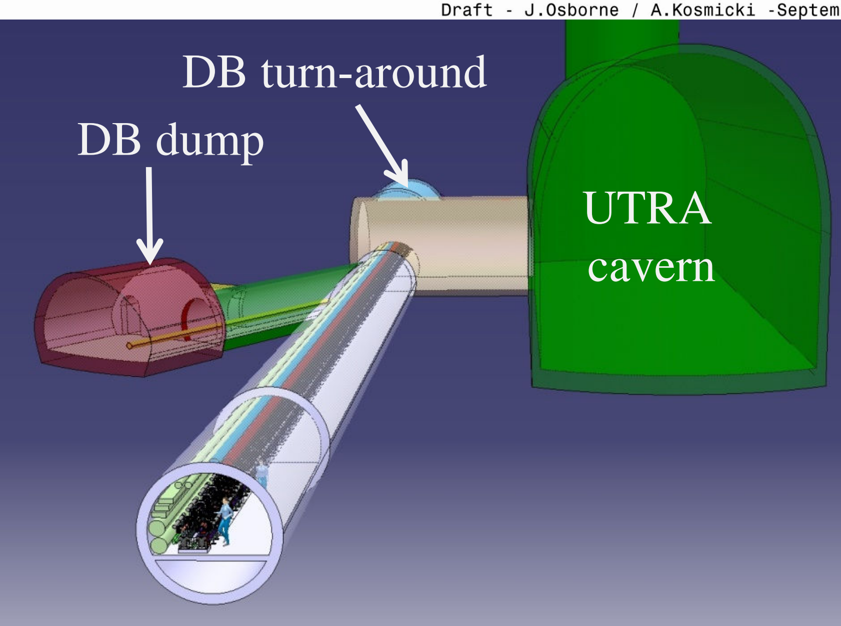


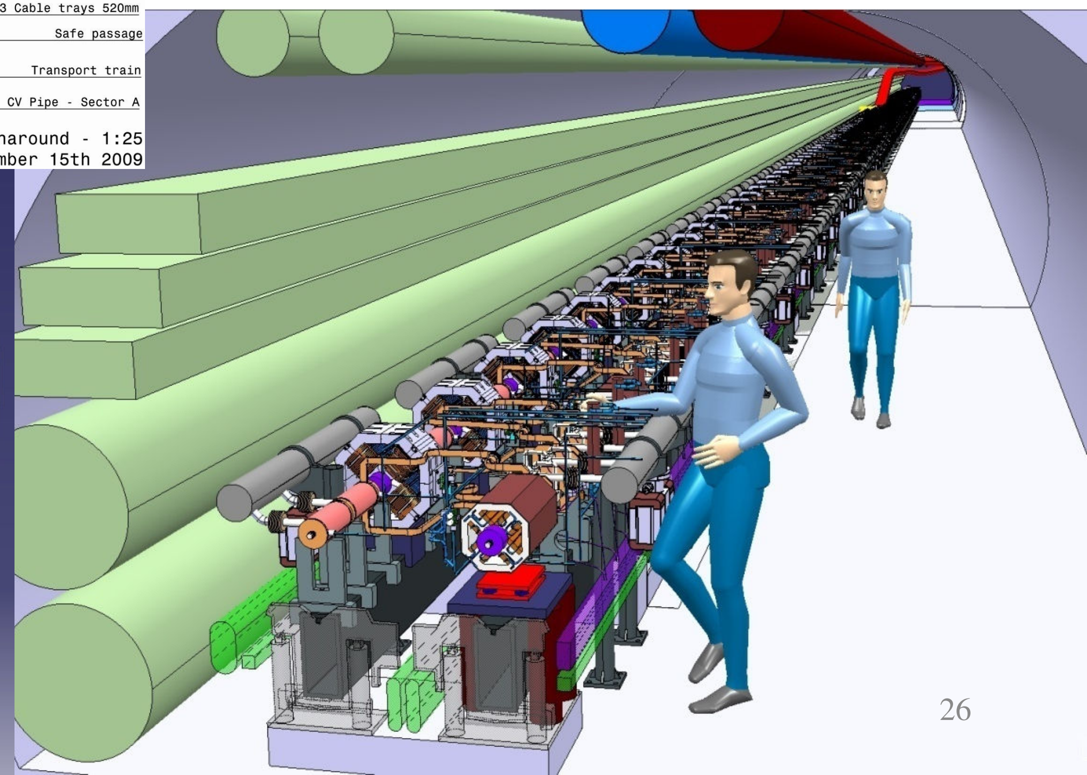
Test module representative of all module types integrating all various components: RF structures, quadrupoles, instrumentation, alignement, stabilisation, vacuum, etc….

Tunnel integration & "Conventional Facilities"

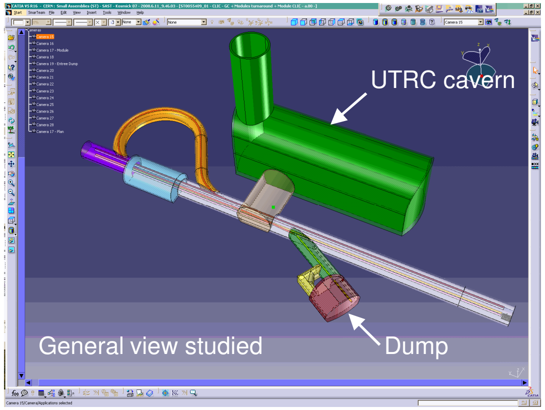


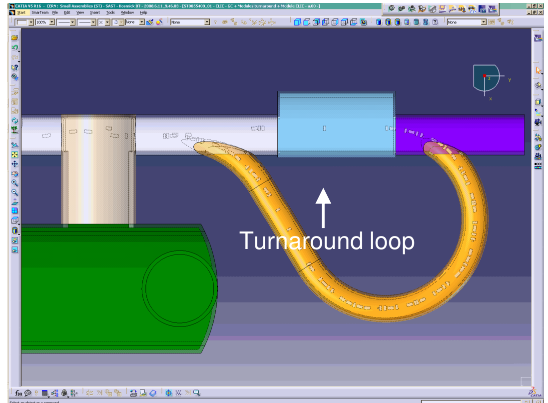
H.Schmickler
Technical Feasibilities

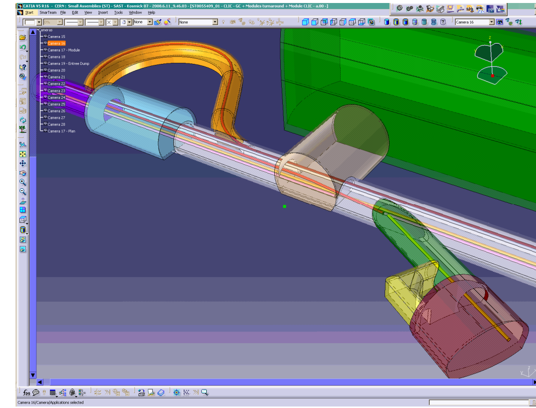


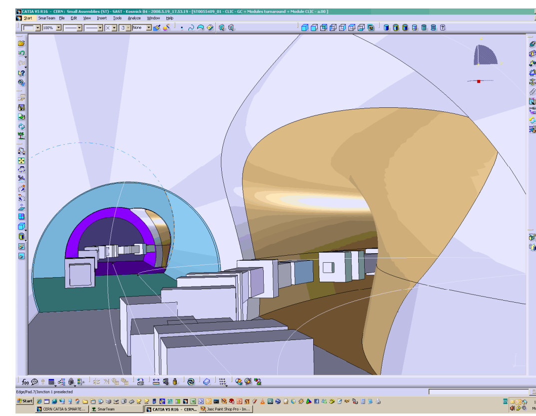


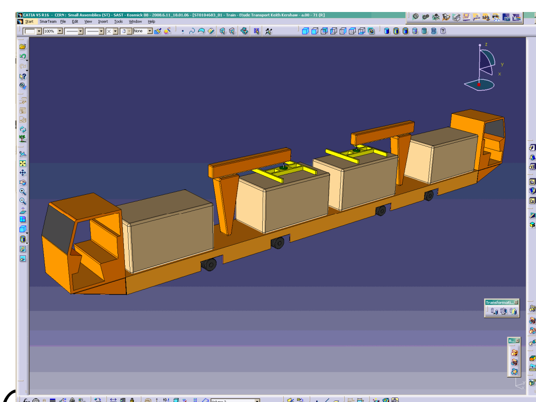
Civil Engineering and Services (CES) :











- Tunn
- Tran
- Cool
- ILC Collaboration for CES issues :
  - Safety issues for underground structures
  - ILC underground layouts

J.Osborne

Common CLIC ILC issue

Use of same methods, tools, consultants

CLIC

Two Beam Acceleration Feasibility

Feasibility Issue	Unit	Nominal	Feasibility Target	Achieved	How	Feasibility
Structure Acc field	MV/m	100	100	100	Test	No Damping
Structure Pulse length	ns	240	240	240	stand/	
Structure Breakd. rate	/m	< 3·10-7	< 3·10-7	< 3·10-7		
Two Beam acceleration	MV/m	100	100	-	TBTS	Under
module	ns	240	240	-		constuction

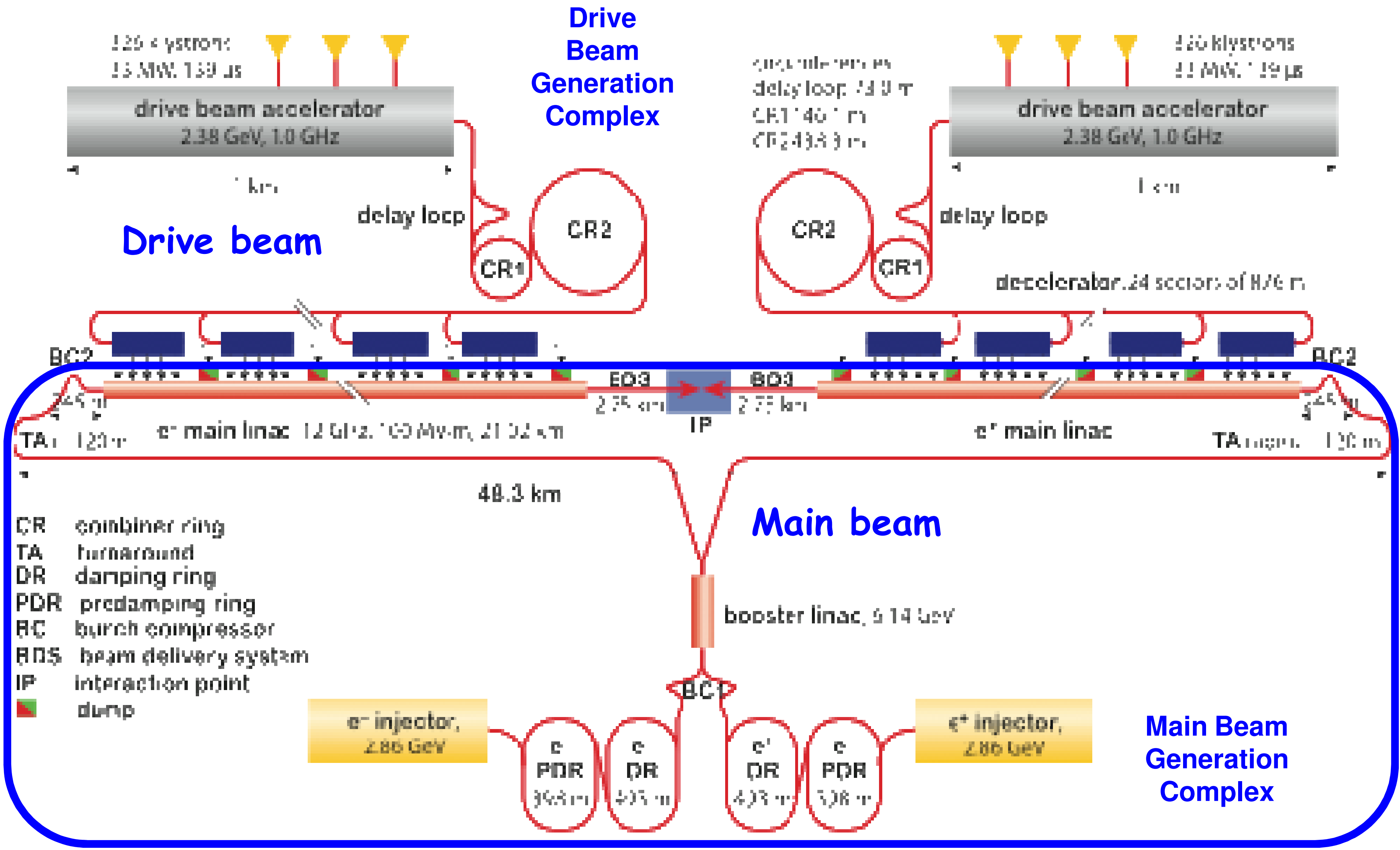
Acceleration Structure with nominal parameters demonstrated without damping:

- **RF to beam efficiency still to be improved.**
- **Structures with Damping being built still to be tested.**

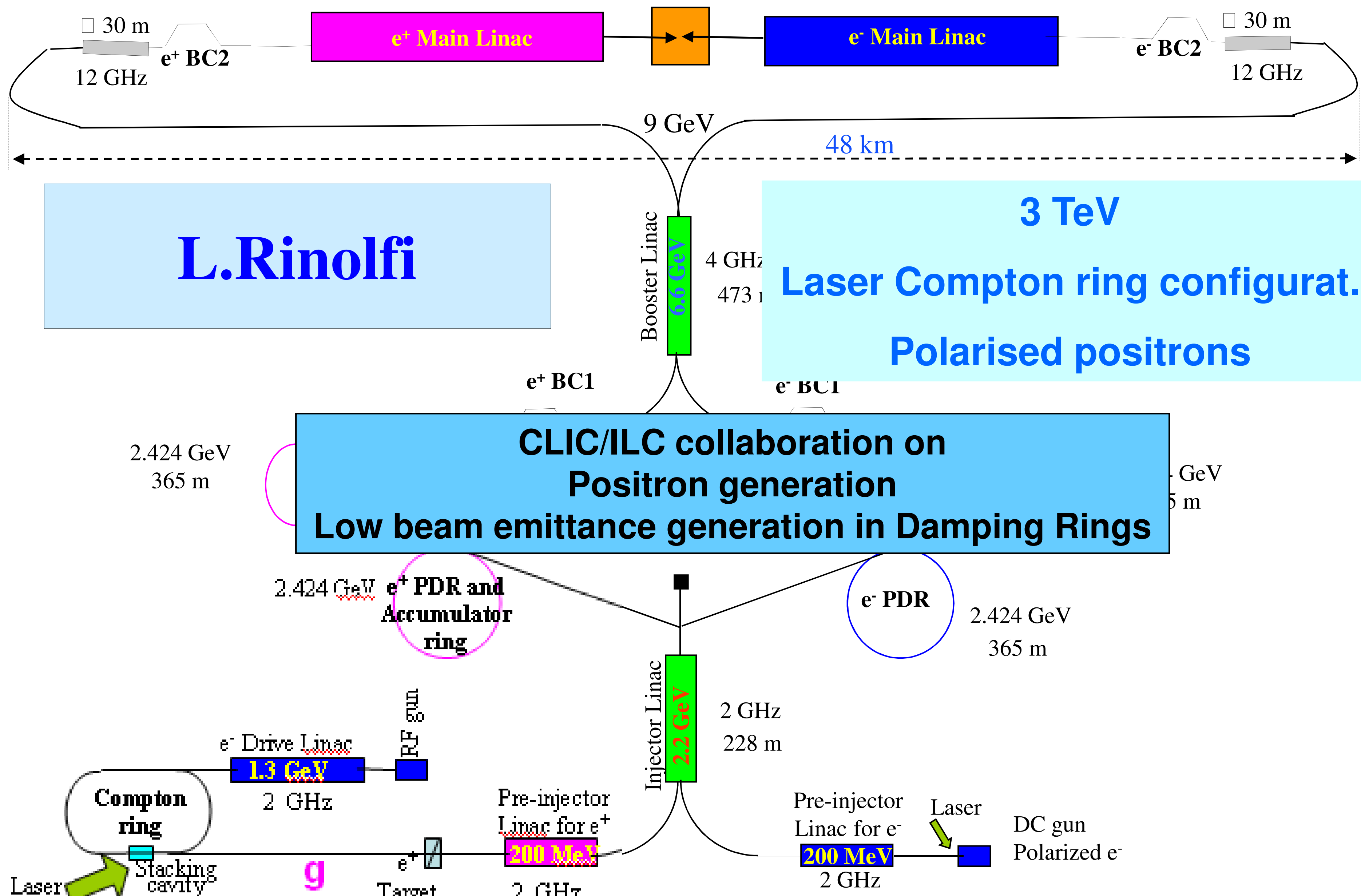
Two beam acceleration principle demonstrated in CTF2

- **Two Beam Test Stand being built integrating (final) prototypes with power and beam tests in CTF3**

CLIC – main beam generation



The CLIC Main Beam Injector complex



L.Rinolfi

3 TeV

Laser Compton ring configurat.

Polarised positrons

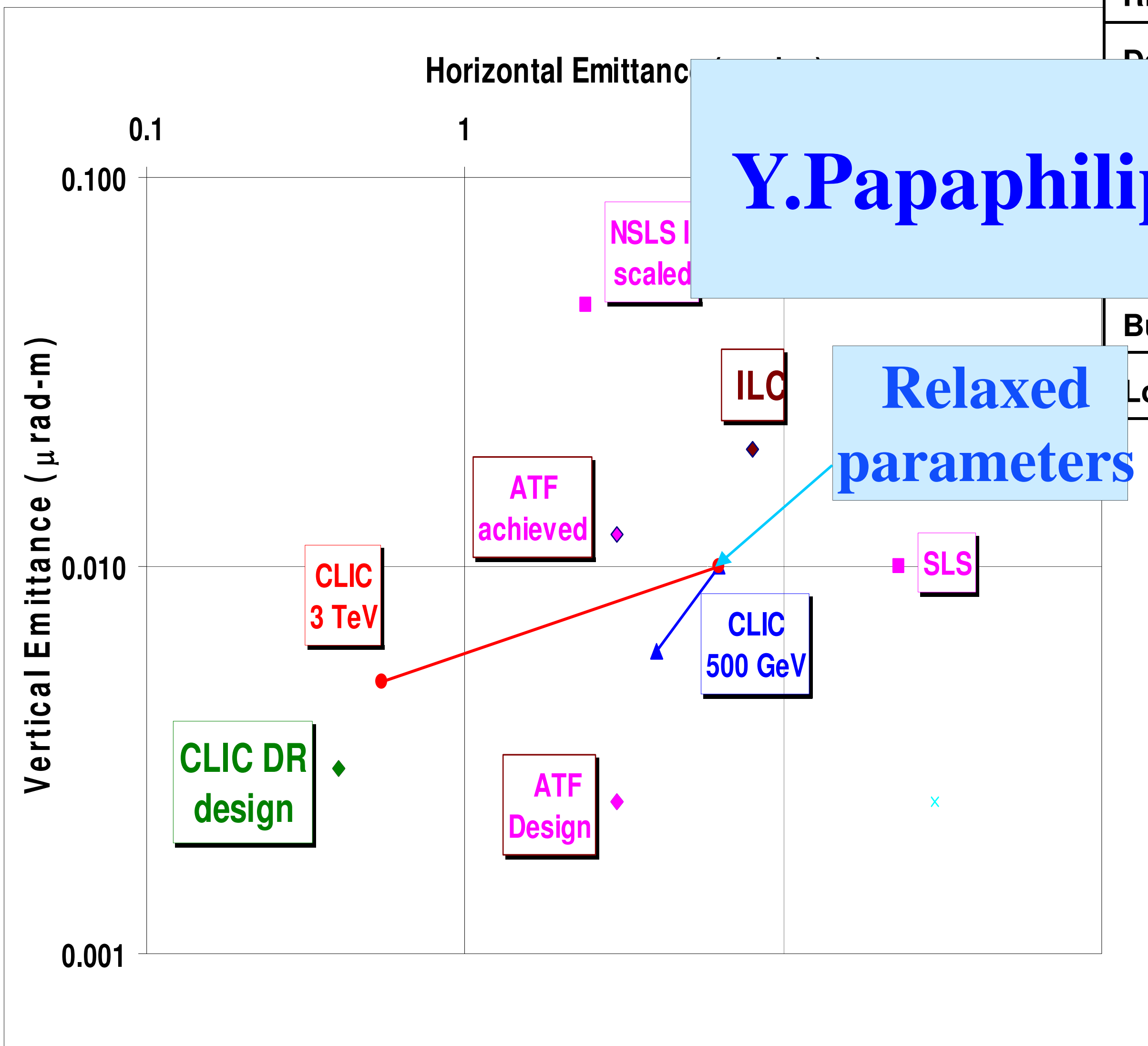
CLIC/ILC collaboration on
Positron generation
Low beam emittance generation in Damping Rings

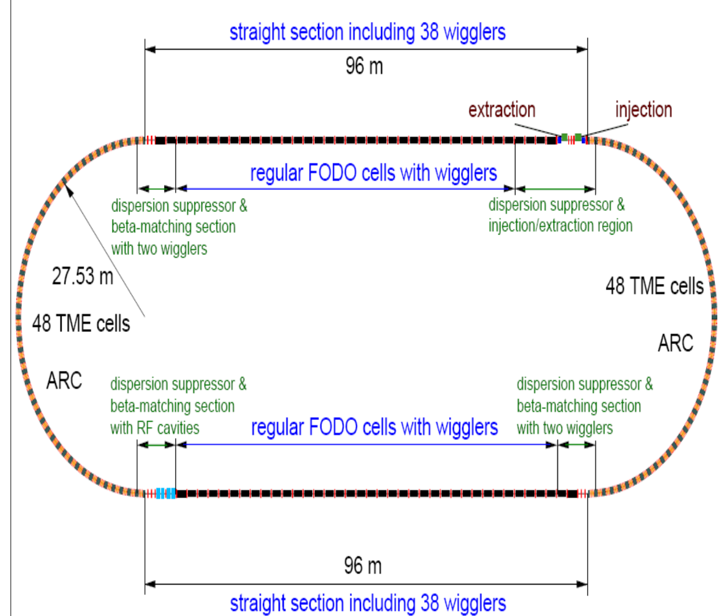
Ultra low emittances generation in Damping Ring

Energy [GeV]	2.86
Circumference [m]	493.05
Number of arc cells	100
Number of wigglers	76
RF voltage [MV]	6.5
... / s [ms]	1.87 / 0.94
...or	2.0
...tance [nm.rad]	480
...ance [nm.rad]	4.7
Bunch length [mm]	1.4
Longitudinal emittance [eVm]	3700

Y.Papaphilippou

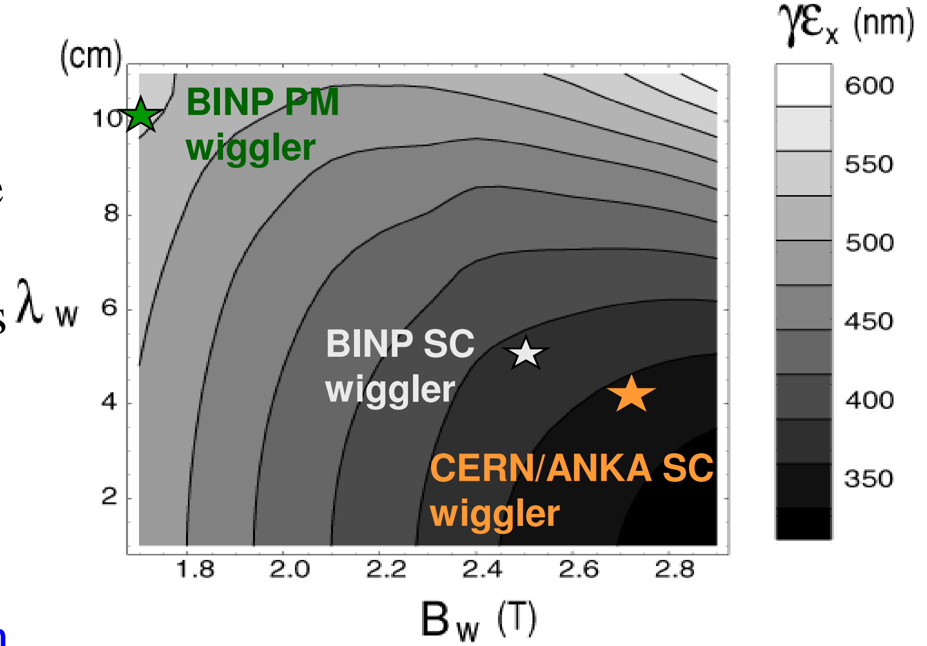
Relaxed parameters



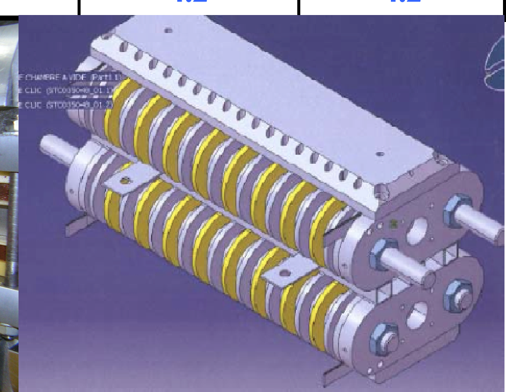


SC Wigglers

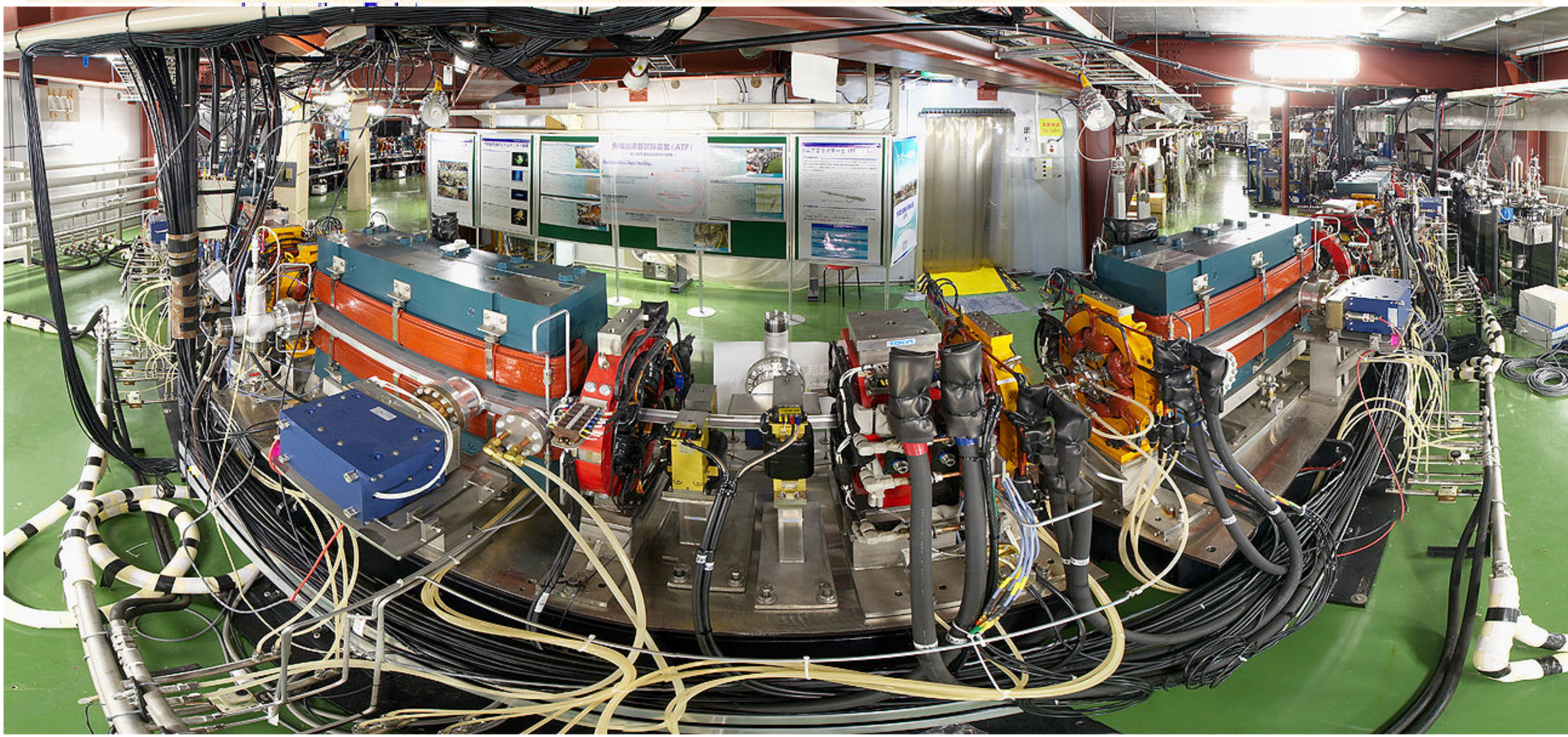
- Two **493m** long rings of racetrack shape @ **2.86GeV**
- Arcs filled with **TME cells** and straights with **2m-long superconducting** damping wigglers (**2.8T**, 4**cm** period)
- IBS dominated beam emittance
- Issues to be addressed:
  - Lattice optimization (magnet design, non-linear dynamics)
  - Superconducting wiggler design ($NbTi/Nb_3Sn$, radiation absorption)
  - Collective effects (e^- cloud, IBS)
  - RF system considerations
  - ILC/CLIC DR common issues
  - Pre-damping ring design (positron stacking)
- **SC wiggler prototype fabrication in collaboration with BINP and future tests with beam in ANKA/Karlsruhe**



Parameters	BINP	CERN/ Karlsruhe
B_{peak} [T]	2.5	2.8
λ_W [mm]	50	40
Beam aperture full gap [mm]	13	13
Conductor type	NbTi	$NbSn_3$
Operating temperature [K]	4.2	4.2



KEK ATF



Addressing feasibility of small beam emittances by international collaboration hosted by KEK

Additional tests on Electron Clouds in CESRTA/Cornell in close collaboration with ILC

Beam emittance preservation
Beam Dynamics, alignment and stability

Emittance blow-up from Damping Ring to BDS limited:
• in Horizontal to 30% from 500 nrad
• in Vertical to 300% from 5 nrad

Alignment procedure based on:

- **Accurate pre-alignme ... ents: 15µm**
- **Beam-based alignme ... with good resolution (100nm)**
- **Alignment of accelera ... eam using wake-monitors**
- **Tuning based on lumi ... urement with 2% resolution**

D.Schulte

Beam stability by quadrupole stabilisation:0.3nm beam-beam stability@IP

- **quadrupole passive and active stabilisation**
- **beam feedback (pulse to pulse)**
- **Intrabeam feedback**

Quadrupole Magnets	Horizontal	Vertical
Linac (2600 quads)	14nm	1.3 nm
Final Focus (2quads)	4 nm	0.2 to 0.5 nm

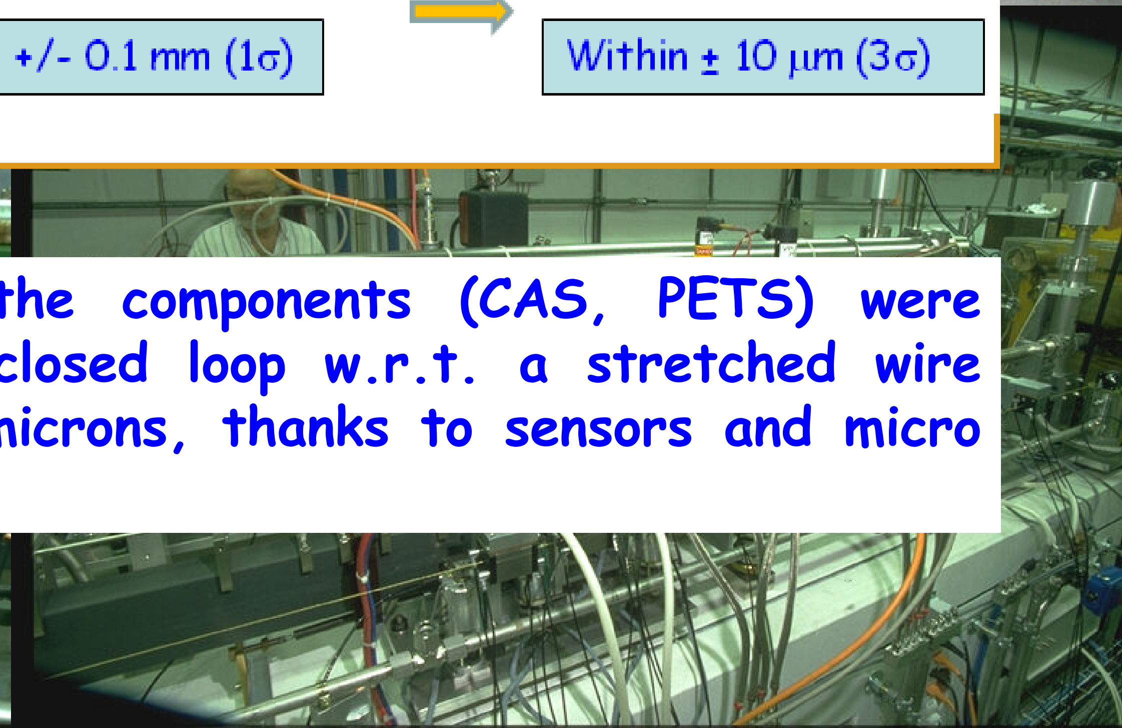
Pre-alignment test benches

H.Mainaud

State of the art: (LHC): ± 0.1 mm (1σ) over 100m

CLIC challenge: Mechanical pre-alignment → Active pre-alignment

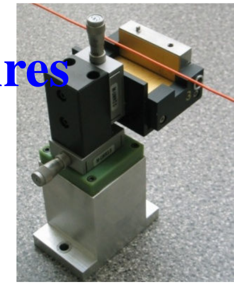
Within +/- 0.1 mm (1σ) → Within ± 10 μm (3σ)

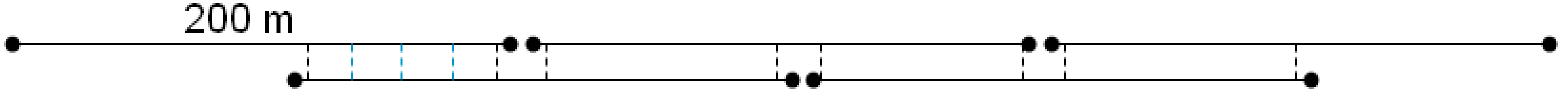


In the CTF2 facility, the components (CAS, PETS) were maintained aligned in a closed loop w.r.t. a stretched wire within a window of ± 5 microns, thanks to sensors and micro movers,

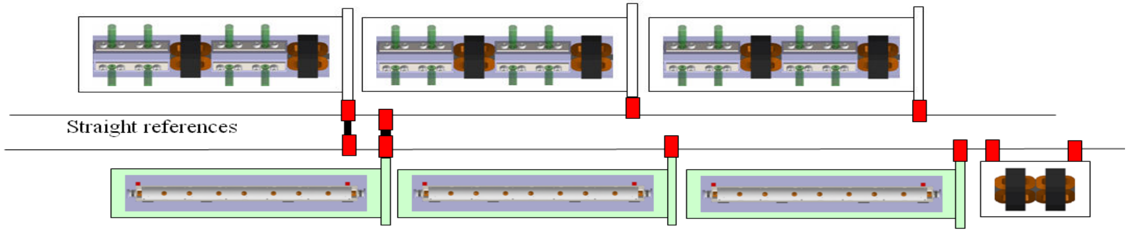
Improved pre-alignment for Two-beam Module Integration

- ✓ Straight alignment reference over 20km by overlapping stretched wires
- ✓ References position measured with Wire Positioning Sensors (WPS)

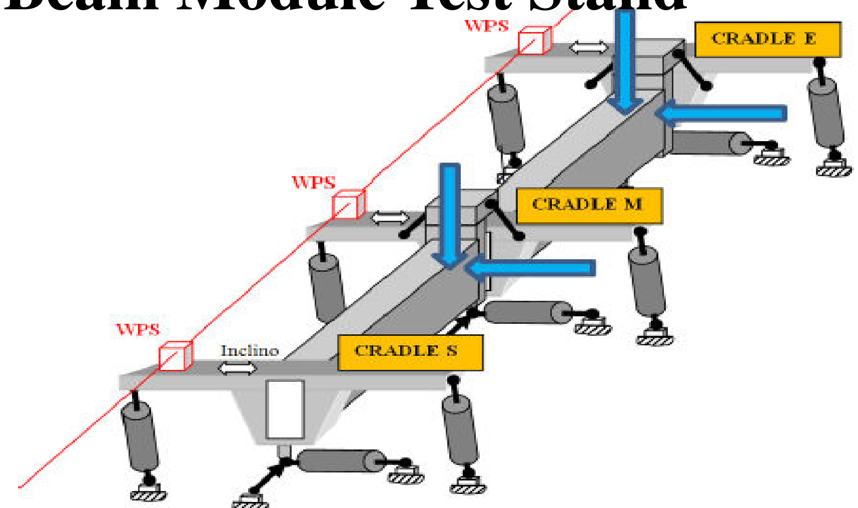




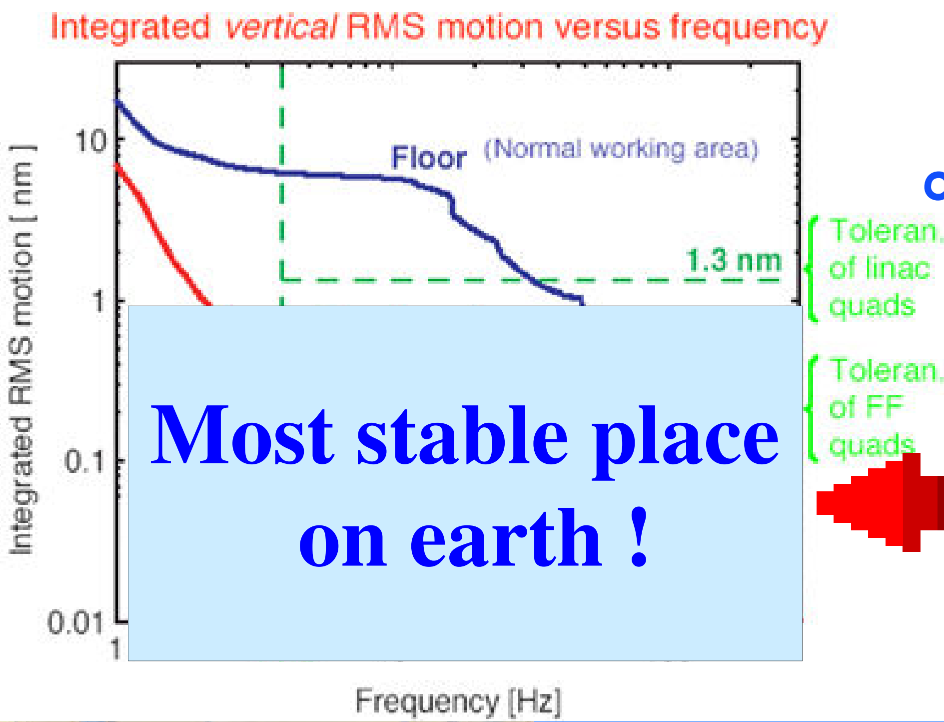
- ✓ Girders pre-aligned ("articulation point") in respect with Wires
- ✓ Quadrupoles pre-aligned independently



Validation & integration in Two Beam Module Test Stand



Nanometer Stabilisation



Most stable place on earth !

CLIC small quadrupole stabilised to nanometer level by active damping of natural floor vibration

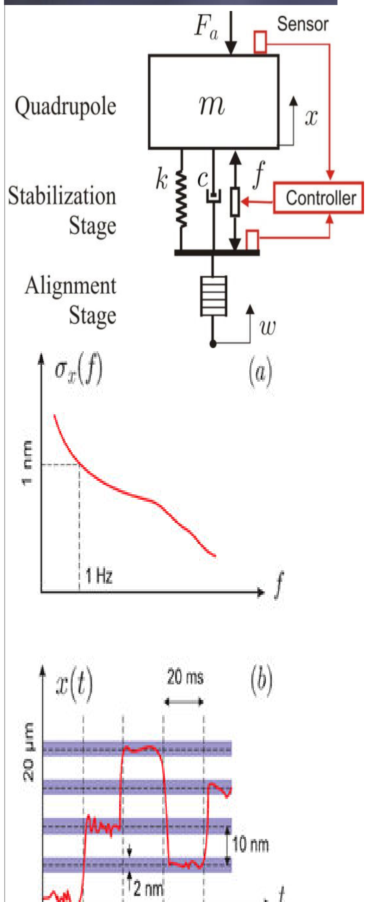
RMS vibrations above 4 Hz

	Quad [nm]	Ground [nm]
Vertical	0.43	6.20
Horizontal	0.79	3.04
Longitud.	4.29	4.32

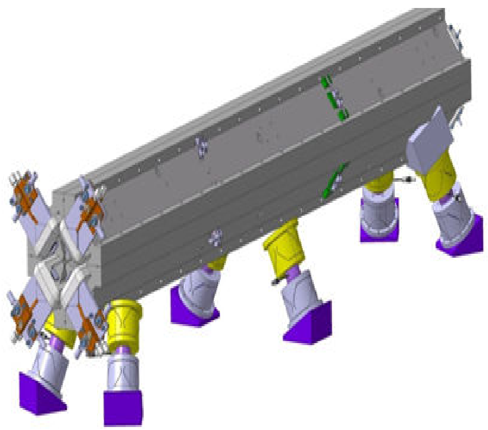
CERN vibration test stand

A.Jeremie

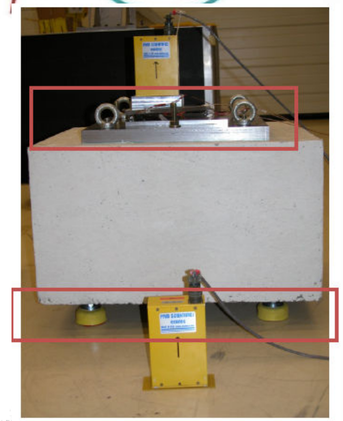
Stabilisation Test Stands (2 methods) with real quadrupole prototype (400 kg)

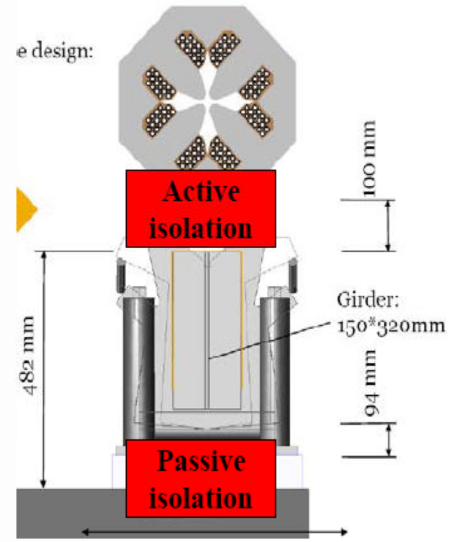


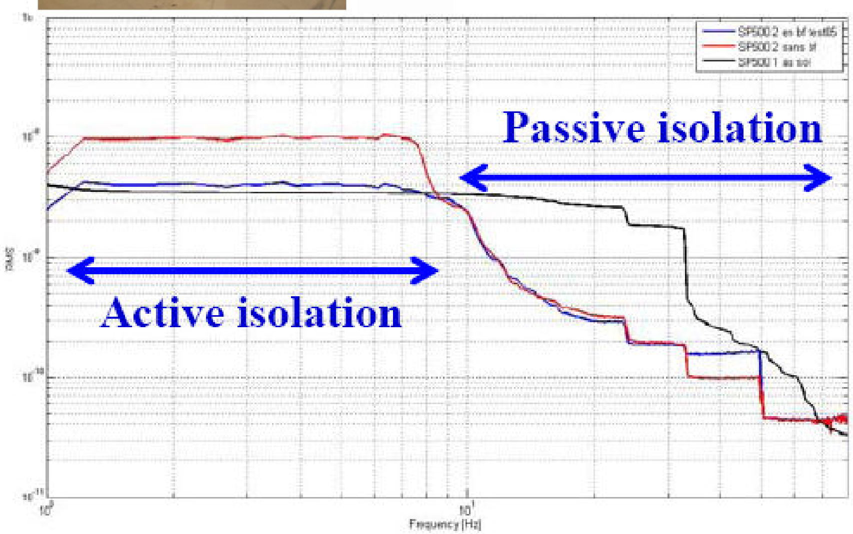
Active stabilisation & nano-alignment by Hexapole:



Passive & Active Stabilisation



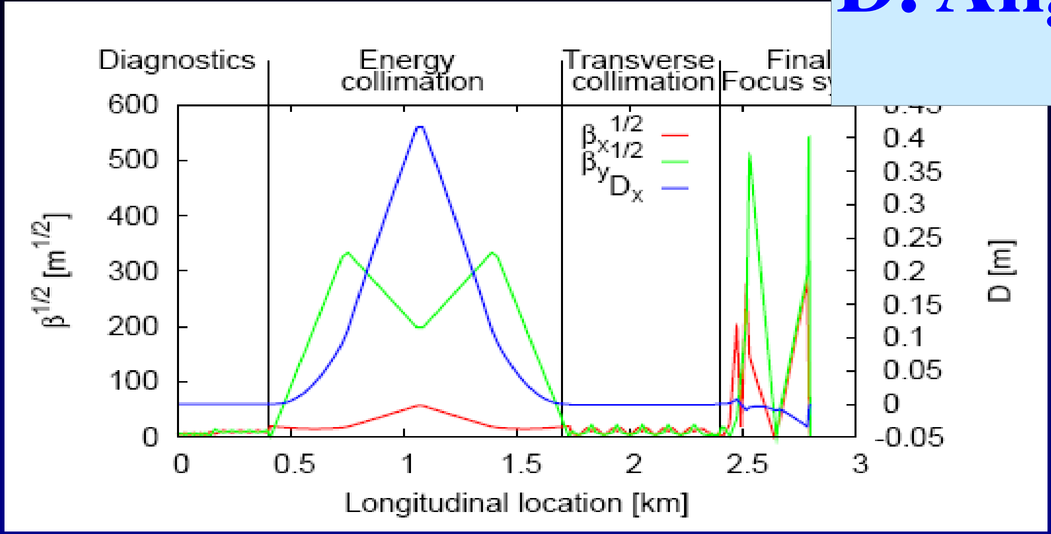




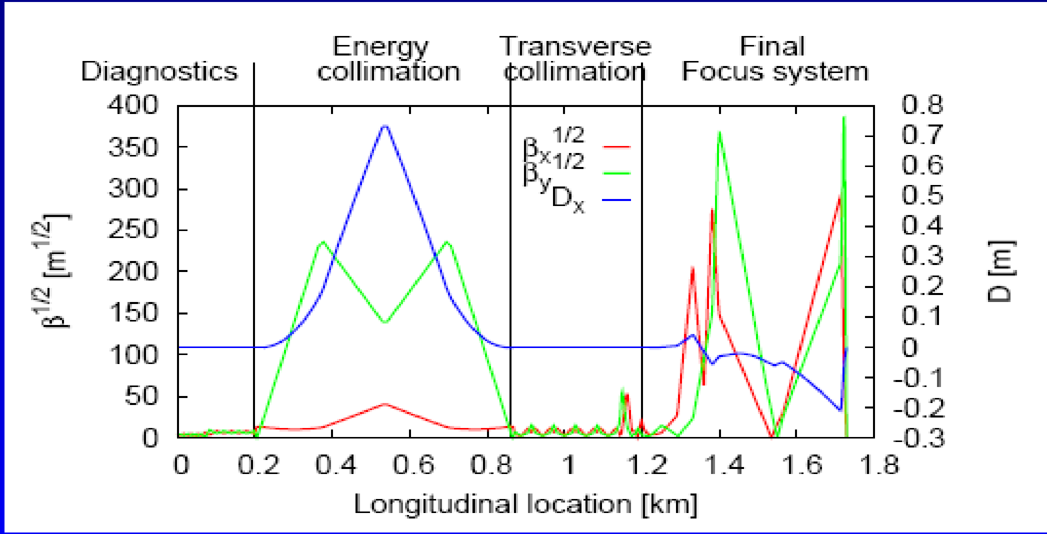
The CLIC BDS

D. Angal-Kalinin

3 TeV

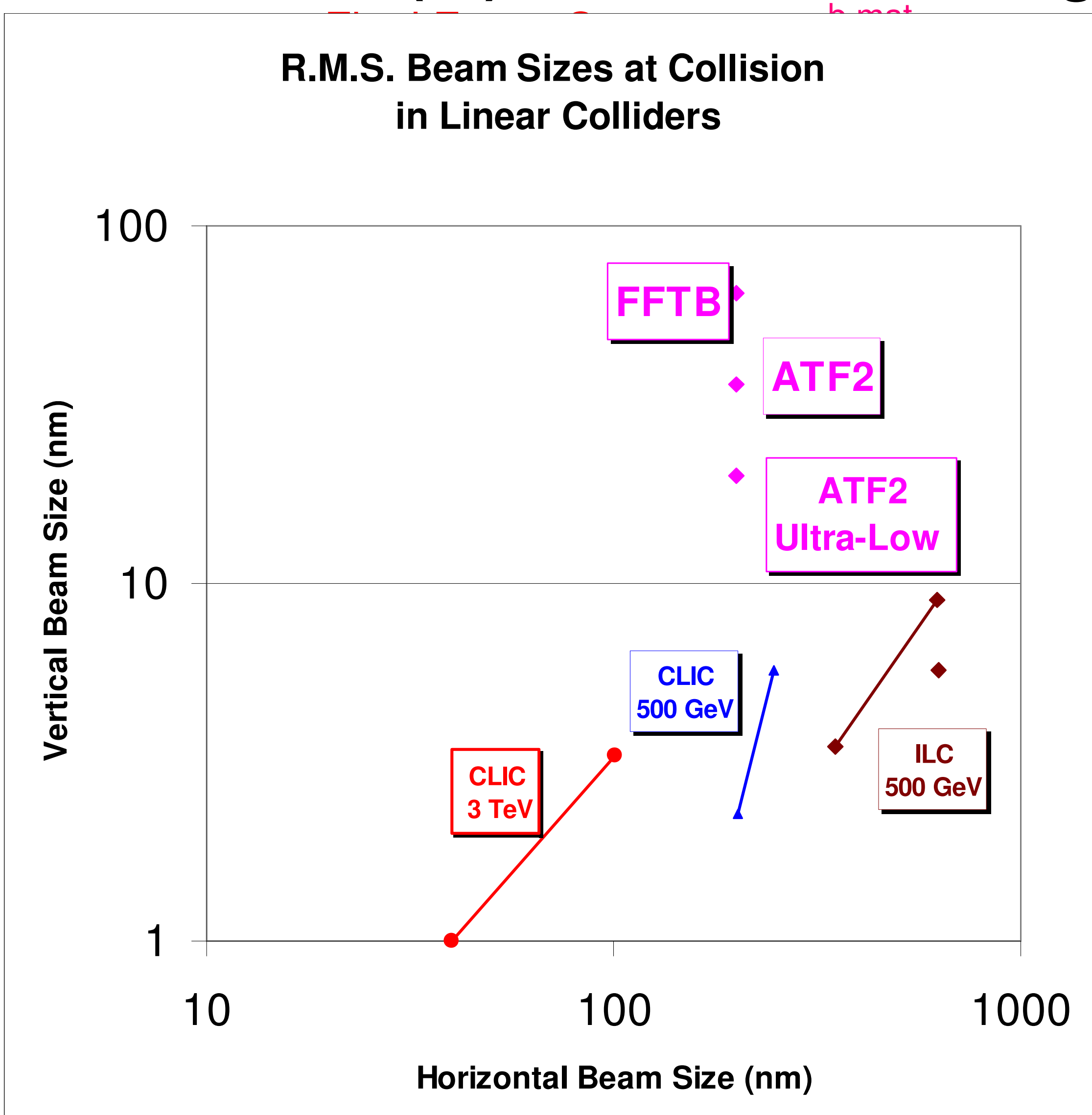


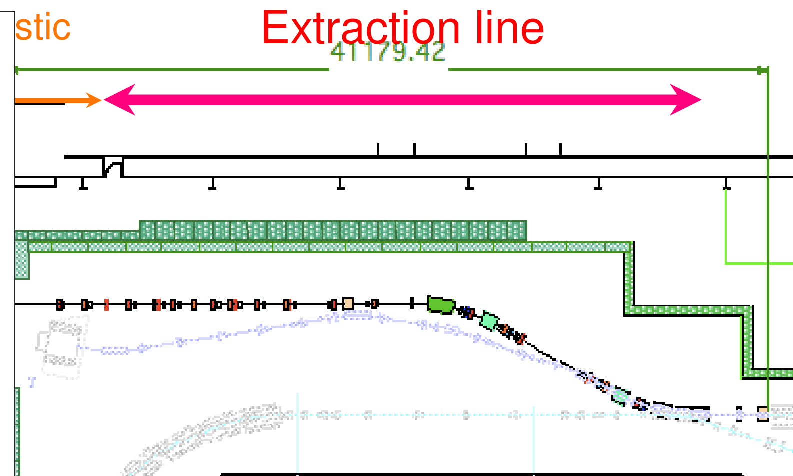
500 GeV



Nanometer beam sizes in KEK ATF2

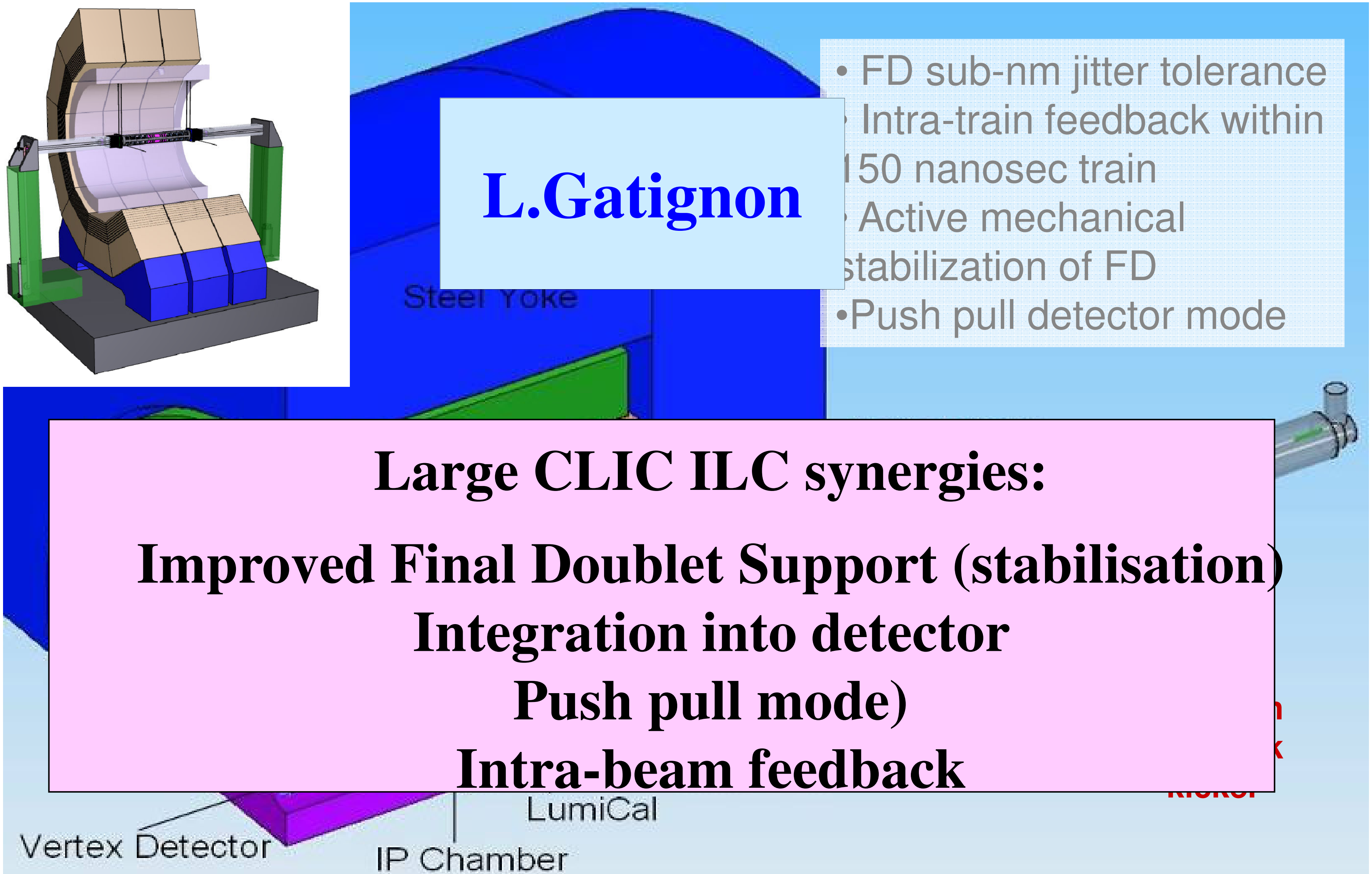
Improved performances to address CLIC issues: small(er) beam sizes and high(er) chromaticities





Project	Status	σ_y^* [nm]
FFTB	Measured	70
ATF2	Commissioning	37
ATF2 ultra-low β	Proposed	20
ILC	Design	6
ILC low power	Proposed	4
CLIC	Design	1

Machine Detector Interface



- FD sub-nm jitter tolerance
- Intra-train feedback within 150 nanosec train
- Active mechanical stabilization of FD
- Push pull detector mode

L.Gatignon

Large CLIC ILC synergies:

Improved Final Doublet Support (stabilisation)
Integration into detector
Push pull mode)
Intra-beam feedback

Beam Emittances Preservation Feasibility

Feasibility Issue	Unit	Nominal	Feasibility Target	Achieved	How	Feasibility
Emit blow-up H Emit blow-up H	Nm nm	H=160, V=15	H=160, V=15	H=160, V=15	Simul ation	-
Pre-Alignment	microns	15	10	10 (principle)	Test bench	Module integration
Stabilisation Vert: Quad Main Linac Final Doublet	 nm>1 Hz nm>4 Hz	 1.3 0.15 to 0.5	 1 1	0.5 (principle)	Test bench	Real quad and real environment

- Ultra low beam emittances addressed in ATF2, SLS & NSLS2
- Emittance preservation by simulation bench-marked CTF3
- Principle of 10 micron Pre-Alignment demonstrated in CTF2

  Feasibility by upgraded method integrated Module Test Bench
- Principle of sub-nanometer active stabilisation demonstrated

  Feasibility of nm stabilisation with main linac quad prototype (400 kGs) addressed with tests in lab and integration in Two Beam Module

  Application to realistic detector environment (adequate support)

R&D on Detectors feasibility

Item	Parameter Issue	Test facility Common with ILC
Short interval between bunches	Time stamping: 0.5 nsec bunch interval	Simulations
Large background at high beam collision energy	Beam-Beam background: 3.8 10^8 coherent/1e5 incoherent e+/e- pairs, Hadrons, High muon flux	Simulations

Addressed by new project on Linear Collider Detector R&D (L.Linssen)
G.Giudice (Physics), M.Thomson (Detectors)

Adaptation from ILC detector concepts
ILC Energy Upgrade Path

R&D on CLIC feasibility issue: Operation & Machine Protection System

System	Item	Parameter Issue	Test facility Common with ILC
Operation and Machine Protection System (MPS)		drive beam power of 72 MW @ 2.4 GeV 1.5 TeV	CTF3 Simulations

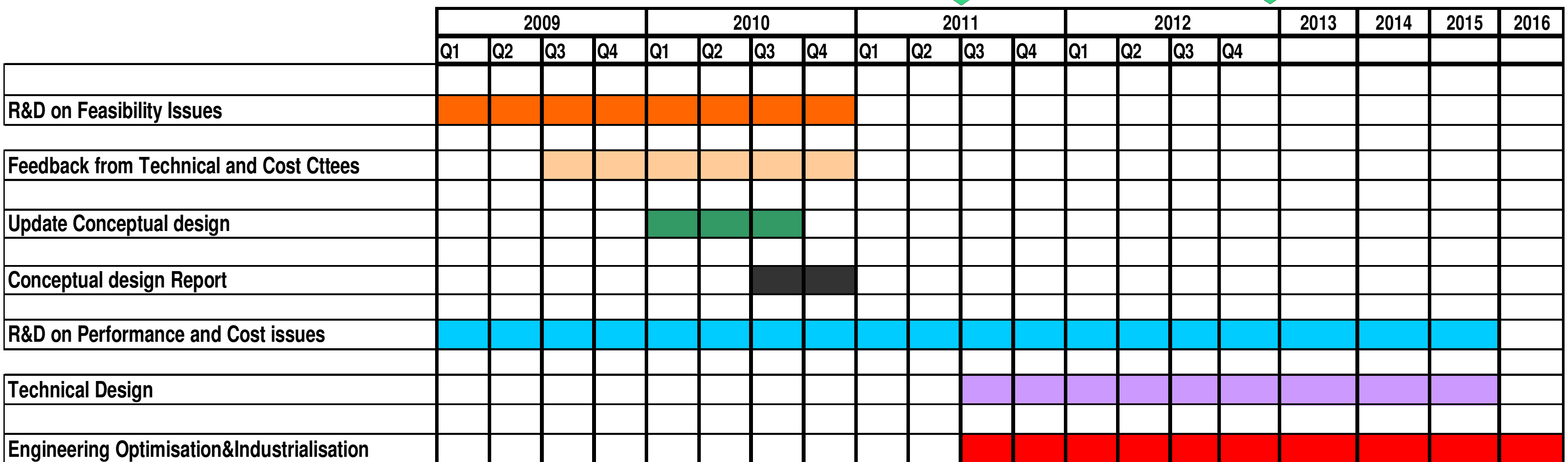
M.Jonker

Working Group just starting
Taking advantage of LHC experience !
Great synergy with ILC main beam (11MW @ 500GeV)
Common reflection on reliability & availability

CLIC Tentative Schedule

CERN Council decision of CLIC TDP based on CLIC CDR results

ILC Technical Design Report



Conceptual Design Report (CDR)

Start Technical Design Phase (TDP)

Technical Design Report (TDR)

TDR phase R.Corsini

Conceptual Design Report
Coordinator/editor: H.Schmickler
Contribution/Authors by CLIC collaborators

3 volumes: similar to ILC CDR:

- **Vol1: Executive Summary**
- **Vol2: Physics at CLIC and Detectors**
- **Vol3: The CLIC accelerator and site facilities**
- **Detailed value Estimate**

specific contribution in vol. 2-4; summary in vol. 1.

Outline with Authors/abstract & key words by end 09

Taking advantage of CLIC09 to discuss and define contributions

Progressive redaction from early 2009

Preliminary draft at LC 2010?

World-wide CLIC&CTF3 Collaboration

http://clic-meeting.web.cern.ch/clic-meeting/CTF3_Coordination_Mtg/Table_MoU.htm

33 Institutes involving 22 funding agencies from 18 countries

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)
Karlsruhre University (Germany)
KEK (Japan)
LAL / Orsay (France)
LAPP / ESIA (France)
NCP (Pakistan)
North-West. Univ. Illinois (USA)
Patras University (Greece)

Polytech. University of Catalonia (Spain)
PSI (Switzerland)
RAL (UK)
RRCAT / Indore (India)
SLAC (USA)
Thrace University (Greece)
University of Oslo (Norway)
Uppsala University (Sweden)

CLIC/CTF3 Multi-Lateral Collaboration of Volunteer Institutes

33 Institutes involving 22 funding agencies from 18 countries

Organized as a Physics Detector Collaboration

Collab. Board: Chair: K.Peach/JAI; Spokesperson: G.Geschonke/CERN

MoU with addenda describing specific contribution (& resources)

http://clic-meeting.web.cern.ch/clic-meeting/CTF3_Coordination_Mtg/Table_MoU.htm

Members (full responsibility of work packages and providing corresponding resources):

- **11 CERN members with additional voluntary contributions:**
  CERN, Finland (HIP), Denmark (Aarhus), France (IRFU, LAL, LAPP), Germany (Karlsruhe), Greece (Athens, Patras, Thrace), Italy (LNF), Norway (Oslo U.), Spain (CIEMAT, UPC, IFIC), Sweden (Uppsala), Switzerland (PSI), UK (Cockcroft, JAI, RAL)
- **7 CERN non members with voluntary contributions:**
  India (RRCAT), Japan (KEK), Pakistan (NCP), Russia (BINP, IAP, JINR), Turkey (Ankara U., Gazi U.), Ukraine (IAP), USA (ANL, JLAB, NWU, SLAC)

MoU under discussion: China (IHEP, Tsinghua Univ.), Iran (IPM), European Space Agency (ESA), TERA

Extremely fruitful CLIC /ILC Collaboration

http://clic-study.web.cern.ch/CLIC-Study/CLIC_ILC_Collab_Mtg/Index.htm

- **Common working groups on technical subjects with strong synergy between CLIC & ILC:**

  Physics & Detectors

  Beam Delivery System (BDS) & Machine Detector Interface (MDI)

  Civil Engineering & Conventional Facilities

  Positron Generation

  Damping Rings

  Beam Dynamics

  Cost & Schedule

ILC GDE Director: B.Barish

- **Recently extended with joint W.G. on Linear Collider General Issues (Accelerator & Detectors)**

LC2010 ECFA workshop (20-24/09/2010 @ CERN)
Joint CLIC & ILC
(Accelerator and Detectors)

Conclusion

- **CLIC work program well established and (still) on schedule to address CLIC feasibility issues with preliminary performance and cost, but still a lot of work:**
  - **CTF3 completion (TBL..) and commissioning (consolidation)**
  - **RF structure: fabrication&test of fully equipped structures (Accel&PETS)**
  - **Technical feasibility issues: alignment, stabilisation, inst., etc.**
- **Conceptual Design Report by end 2010**
- **Challenging program and tight schedule!**

all welcome to contribute

Only possible due to outstanding contributions of CLIC Collaboration in the past, present and …. future

Close CLIC / ILC collaboration extremely beneficial for Linear Colliders in preparation for best possible facility adapted to Physics following LHC results

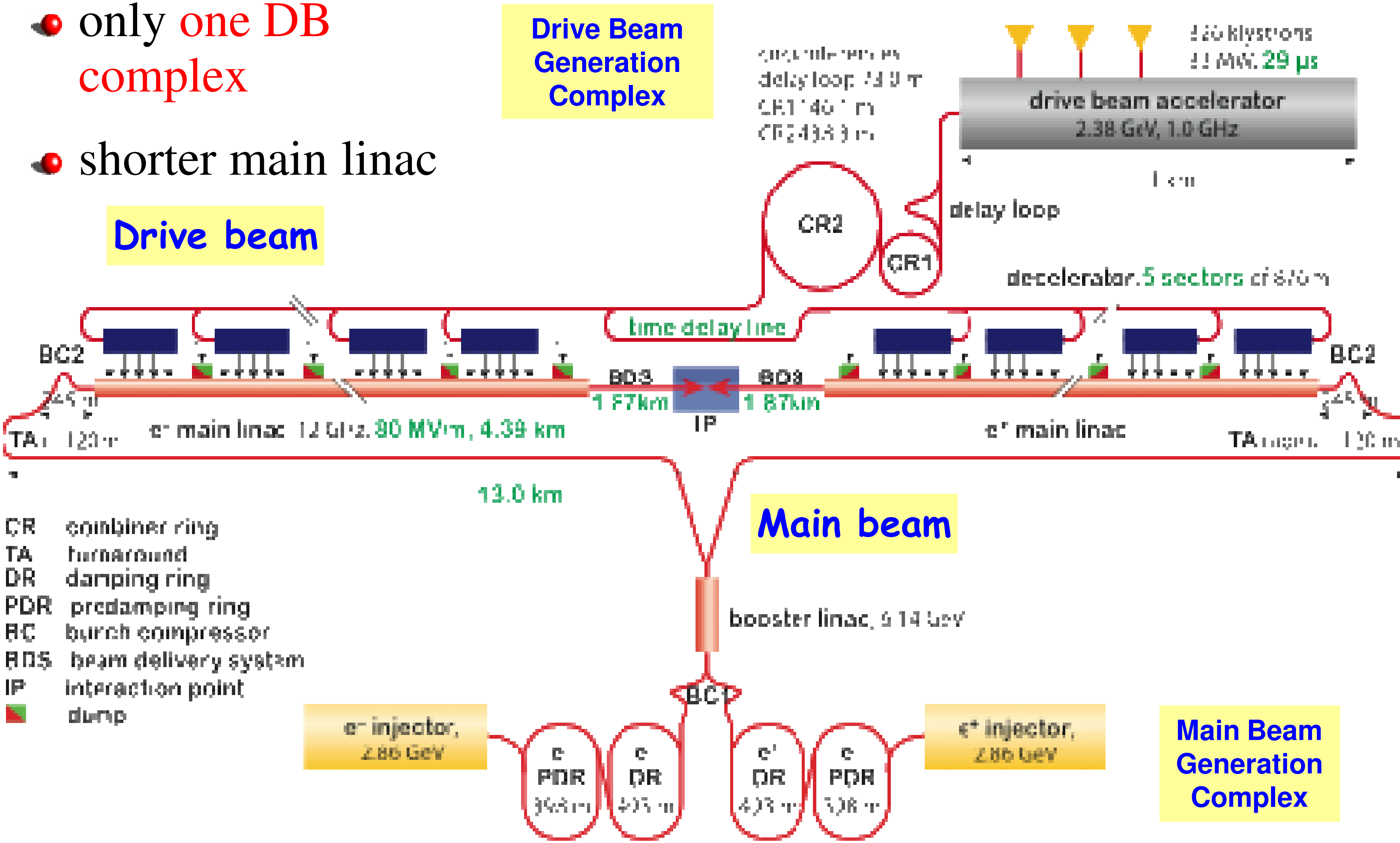
Spares

LC 500 GeV Main parameters

Center-of-mass energy	NLC 500 GeV	ILC 500 GeV	CLIC 500 G Relaxed	CLIC 500 G Nominal
Total (Peak 1%) luminosity	$2.0(1.3)\cdot10^{34}$	$2.0(1.5)\cdot10^{34}$	$0.9(0.6)\cdot10^{34}$	$2.3(1.4)\cdot10^{34}$
Repetition rate (Hz)	120	5	50	
Loaded accel. gradient MV/m	50	33.5	80	
Main linac RF frequency GHz	11.4	1.3 (SC)	12	
Bunch charge 10^9	7.5	20	6.8	
Bunch separation ns	1.4	176	0.5	
Beam pulse duration (ns)	400	1000	177	
Beam power/linac (MWatts)	6.9	10.2	4.9	
Hor./vert. norm. emitt $(10^{-6}/10^{-9})$	3.6/40	10/40	7.5 / 40	4.8 / 25
Hor/Vert FF focusing (mm)	8/0.11	20/0.4	4/0.4	4/0.1
Bunch length (microns)	100	300	100	72
Hor./vert. IP beam size (nm)	243/3	640/5.7	248 / 5.7	202/ 2.3
Soft Hadronic event at IP	0.10	0.12	0.07	0.19
Coherent pairs/crossing at IP	10?	10?	10	100
BDS length (km)	3.5 (1 TeV)	2.23 (1 TeV)	1.87	
Total site length (km)	18	31	13.0	
Wall plug to beam transfer eff.	7.1%	9.4%	7.5%	
Total power consumption MW	195	216	129.4	

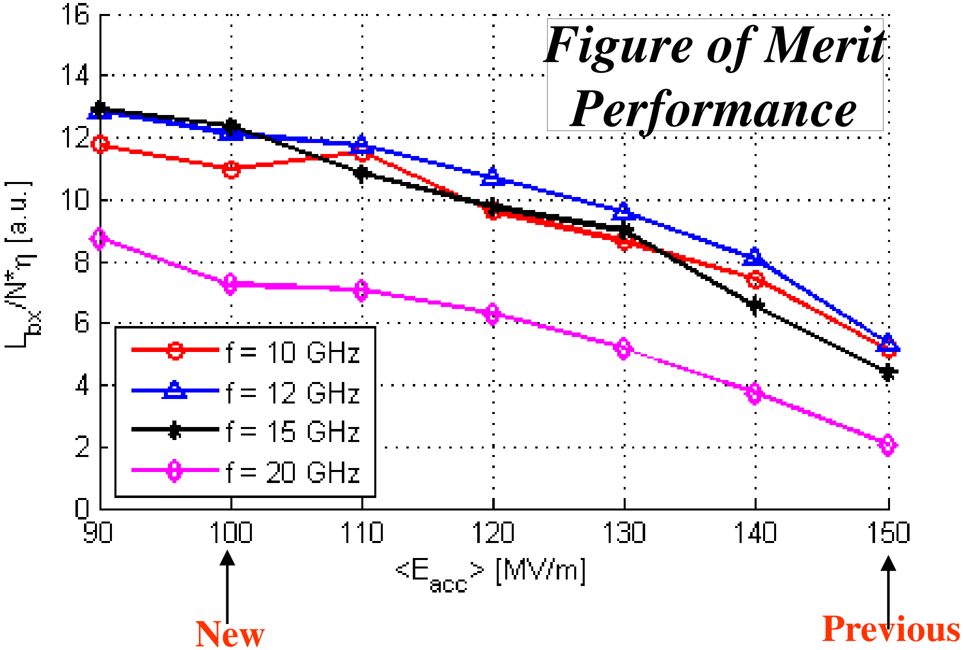
CLIC – layout @ 500 GeV

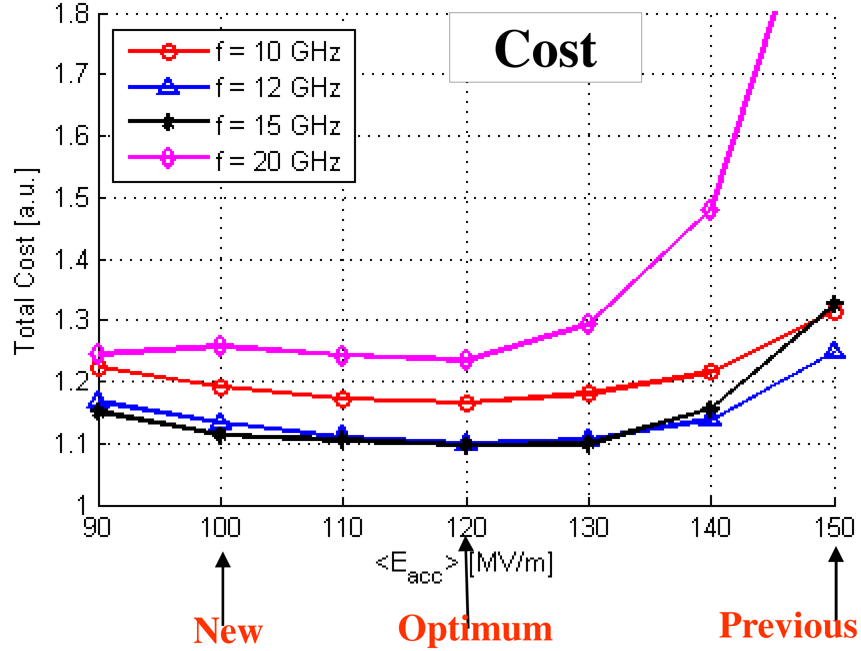
- only one DB complex
- shorter main linac



CLIC performances (FoM) and cost (relative) as a function of the accelerating gradient

E_{cms} = 3 TeV $L_{(1\%)}$ = 2.0 10^{34} $cm^{-2}s^{-1}$

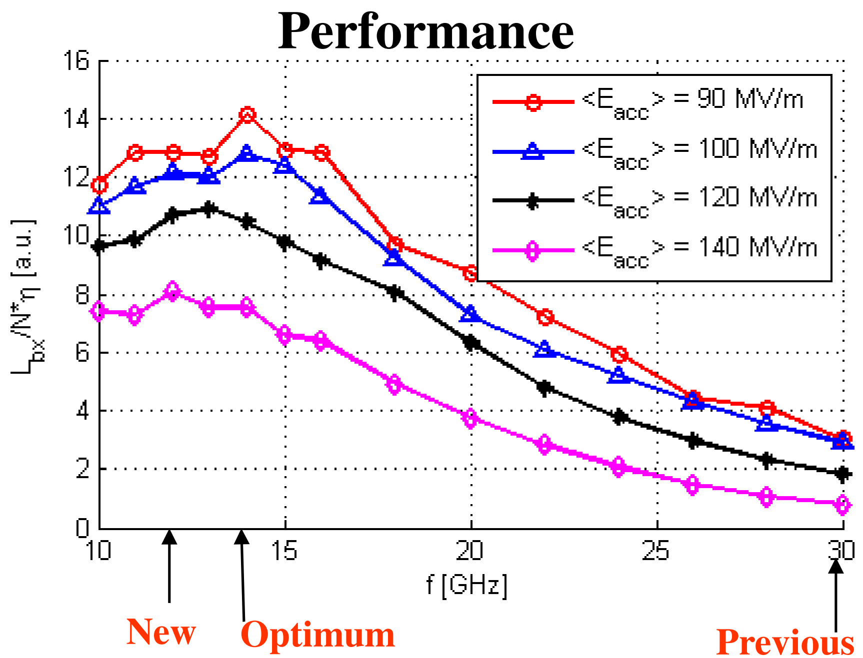


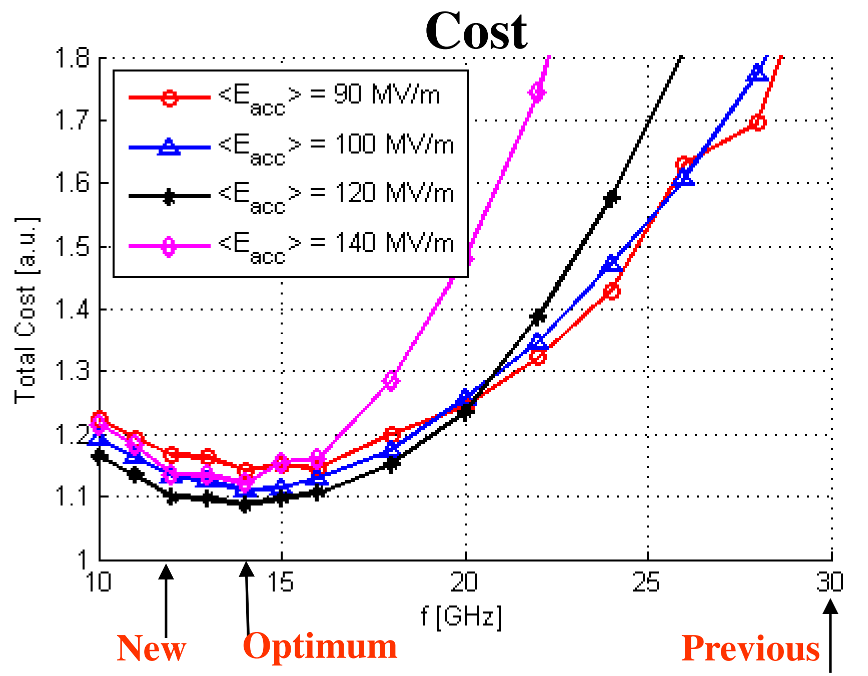


- **Performances increasing with lower accelerating gradient (mainly due to higher efficiency)**
- **Flat cost variation in 100 to 130 MV/m with a minimum around 120 MV/m**

CLIC performances (FoM) and cost optimisation as function of RF frequency

E_{cms} = 3 TeV $L_{(1\%)} = 2.0\ 10^{34}\ cm^{-2}s^{-1}$



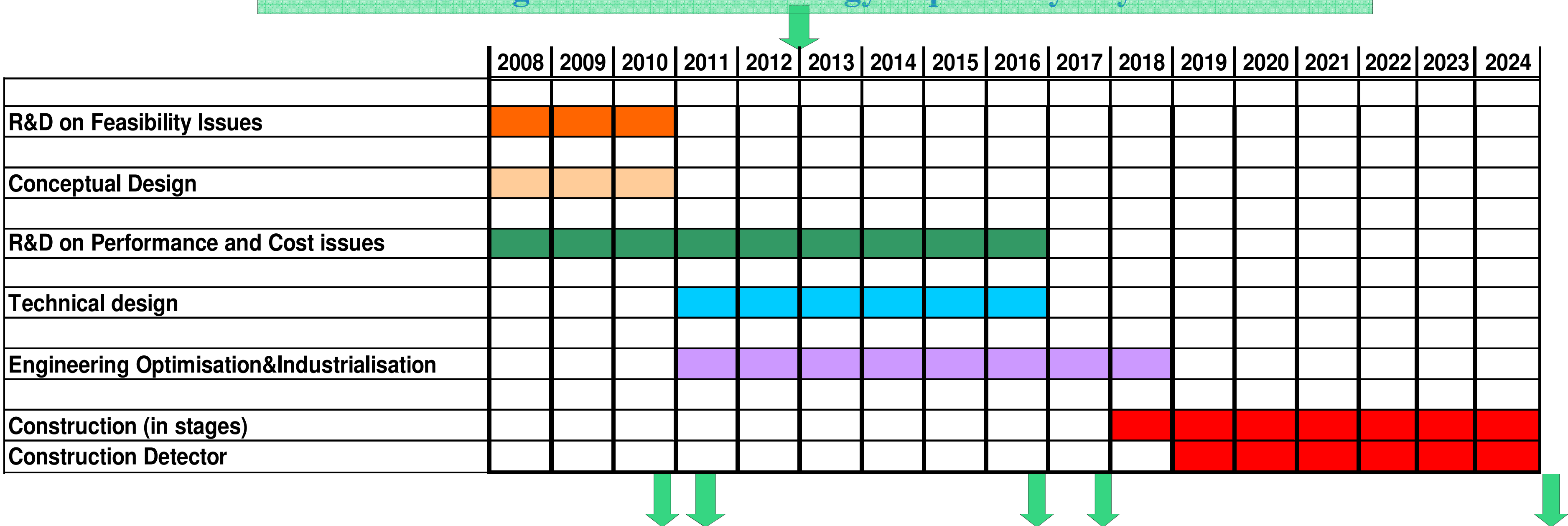


- **Maximum Performance around 14 GHz**
- **Flat cost variation in 12 to 16 GHz frequency range with a minimum around 14 GHz**

Tentative long-term CLIC scenario

Shortest, Success Oriented, Technically Limited Schedule

Technology evaluation and Physics assessment based on LHC results for a possible decision on Linear Collider with staged construction starting with the lowest energy required by Physics



Conceptual Design Report (CDR)

Council approval Technical Design?

Technical Design Report (TDR) ?

Project approval ?

First Beam?

EC supported programmes

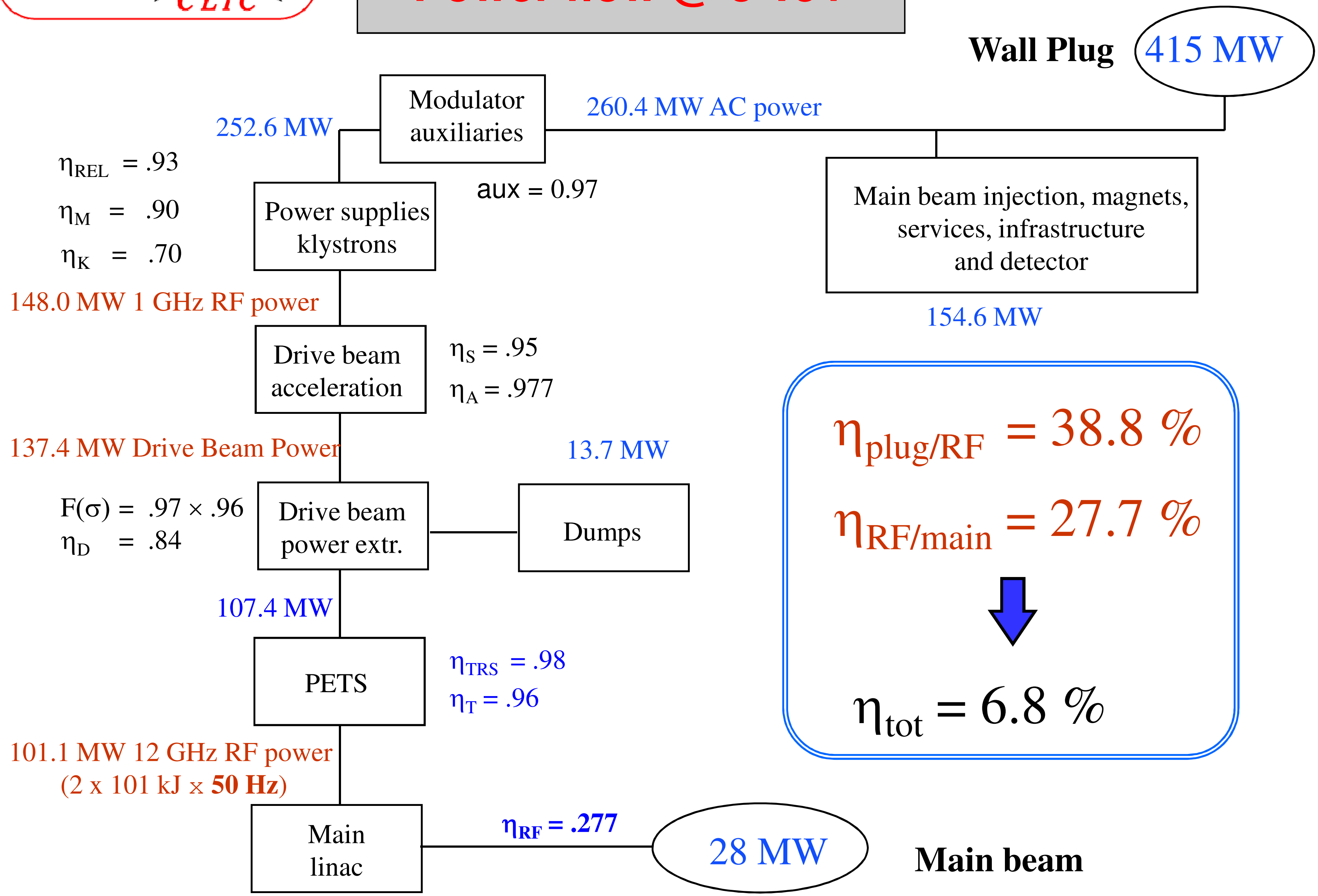
FP6 IA:CARE

FP7 IA:EUCARD

FP7 CNI:TIARA

FP7 CNI:CLIC?

Power flow @ 3 TeV



Power flow @ 500 GeV