CLIC progress from IWLC10 and perspectives

J.P.Delahaye/CERN
for the CLIC Study team and CLIC Collaboration

To our Japanese Colleagues

Dear friends and colleagues,

The terrifying news and pictures from the earthquake and tsunami that struck Japan on Friday, have moved us all deeply.

We would like to express our sympathy to our Japanese friends, colleagues and their families, who have been affected by this tragedy. We extend our sincere condolences to those who now suffer as a result of the disaster.

We appreciate very much if you could transmit our thought and concerns to your colleagues.

Yours Sincerely,

Ken Peach, Roberto Corsini, Jean-Pierre Delahaye, Lucie Linssen, Konrad Elsener, Daniel Schulte and Steinar Stapnes

On behalf of the CLIC collaboration and management team

World-wide CLIC&CTF3 Collaboration

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

CLIC multi-lateral collaboration
41 Institutes from 21 countries
Chairman:K.Peach, Spokesperson:RCorsini

New member in 2010

ACAS (Australia)
Aarhus University (Denmark)
Ankara University (Turkey)
Argonne National Laboratory (USA)
Athens University (Greece)
BINP (Russia)
CERN
CIEMAT (Spain)
Cockcroft Institute (UK)
ETHZurich (Switzerland)
FNAL (USA)
Gazi Universities (Turkey)

Helsinki Institute of Physics (Finland)
IAP (Russia)
IAP NASU (Ukraine)
IHEP (China)
INFN / LNF (Italy)
Instituto de Fisica Corpuscular (Spain)
IRFU / Saclay (France)
Jefferson Lab (USA)
John Adams Institute/Oxford (UK)

John Adams Institute/RHUL (UK)
JINR (Russia)
Karlsruhe University (Germany)
KEK (Japan)
LAL / Orsay (France)
LAPP / ESIA (France)
NIKHEF/Amsterdam (Netherland)
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)
Tsinghua University (China)
University of Oslo (Norway)
Uppsala University (Sweden)
UCSC SCIPP (USA)

Joint CLIC –ILC WG on «accelerator general issues»

- Established by Statement of Common Intent between CLIC CB and ILCSC of January 2010
- Membership:
  - CLIC: Ph. Lebrun (co-chair), K. Peach, D. Schulte
  - ILC: E. Elsen, M. Harrison (co-chair), K. Yokoya
- Mandate
  - The ILCSC and the CLIC Collaboration Board have approved formation of a CLIC/ILC General Issues working group with the following mandate:
    - Promoting the Linear Collider
    - Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently
    - Discussing detailed plans for the ILC and CLIC efforts, in order to identify common issues regarding siting, technical items and project planning.
    - Discussing issues that will be part of each project implementation plan
    - Identifying points of comparison between the two approaches to the linear collider
- Reporting line
  - The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board with a goal of producing a joint document
- Working method & milestones
  - Approximately monthly meetings by teleconference
  - Four face-to-face meetings in 2010 held during CLIC/ILC events
  - Interim report early 2011, with oral presentation to CLIC CB and ILCSC
  - Final report early 2012

Activities 2010 & Interim Report

- *"Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently"*
  - Survey of collaborative work done and envisaged by existing CLIC-ILC joint WGs

    Recommendation: the common working groups have demonstrated their efficiency in tackling the technical challenges of a linear collider jointly. All efforts should be made to use this potential for the realization of the Linear Collider
  - Basic study of staging scenariofrom ILC-like @ 500 GeV to CLIC-like @ 3 TeV

    Recommendation: on balance, the WG does not find the potential for cost savings in a phased approach to a linear collider compelling enough at this time to warrant any significant effort to investigate further
  - Comparative sketch of CLIC & ILC tentative roadmaps

- *"Discussing detailed plans for ILC and CLIC efforts, to identify common issues regarding siting, technical items & project planning"*

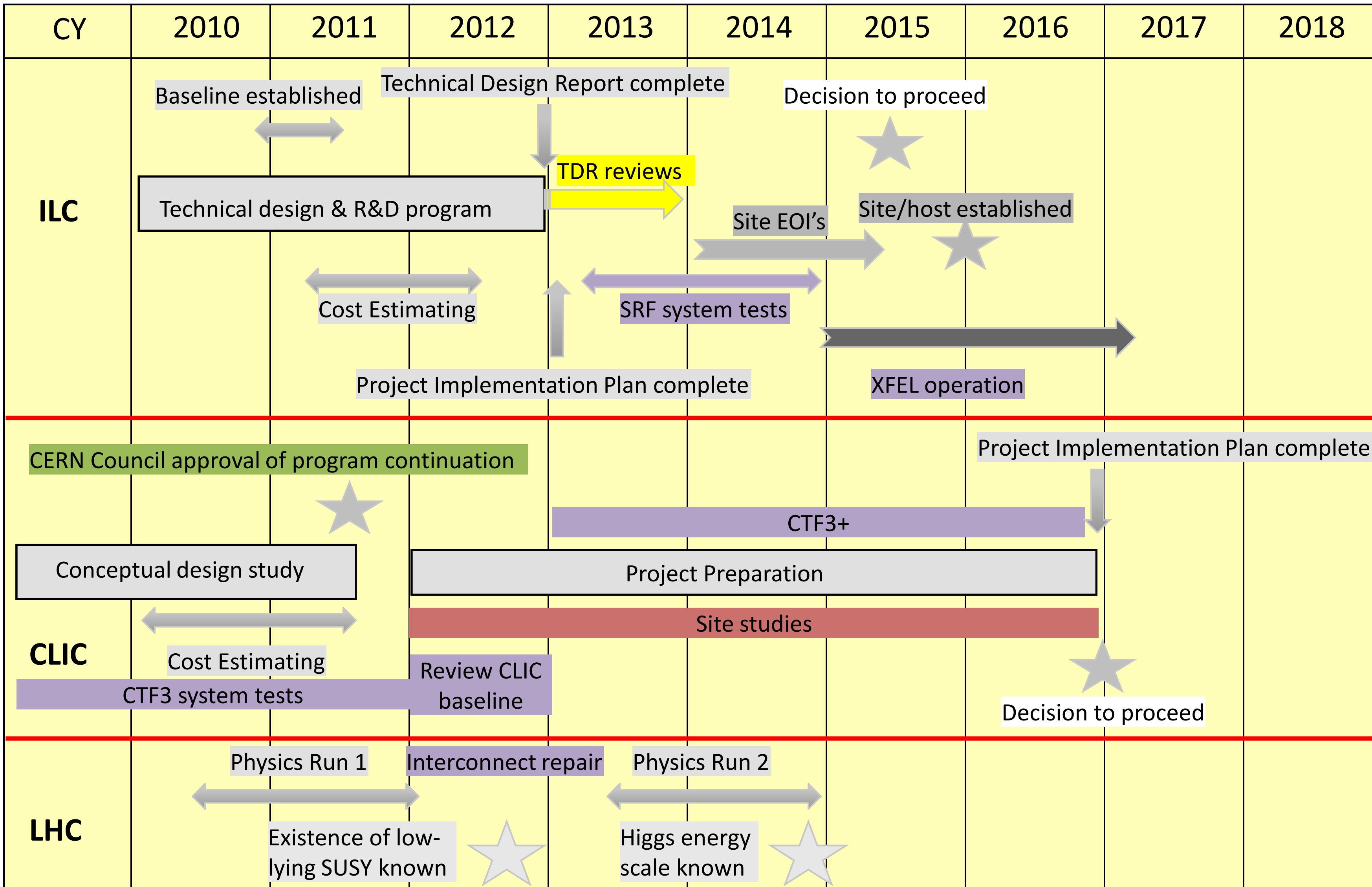
  Recommendation: the CERN management and the ILCSC should agree on the requisite siting procedures

  Recommendation: the CLIC team should determine whether the CLIC design imposes any unique site constraints and on the time scale of the CDR

  Recommendation: the linear collider community should satisfy itself that the proposed system tests for both programs represent acceptable technical milestones to justify a full proposal

  Recommendation: a « cost band » (baseline cost + estimated error vs energy) should be developed by the Joint Cost & Schedule WG for each technology in the energy range up to 1 TeV

“Discussing plans for ILC & CLIC efforts in order to identify common issues regarding siting, technical items, planning”
CLIC & ILC tentative roadmaps

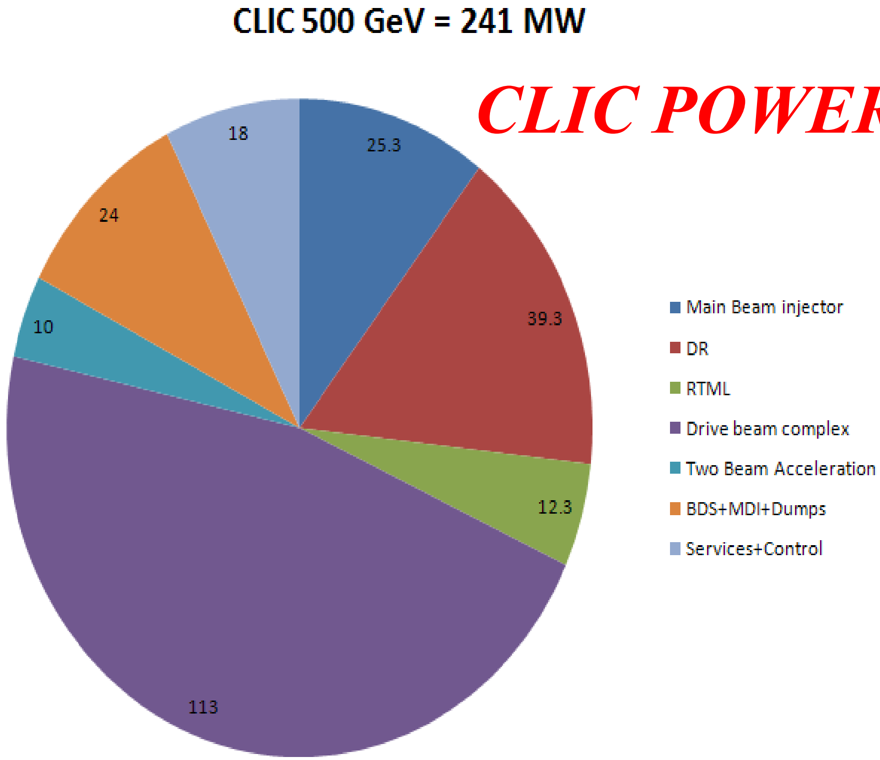


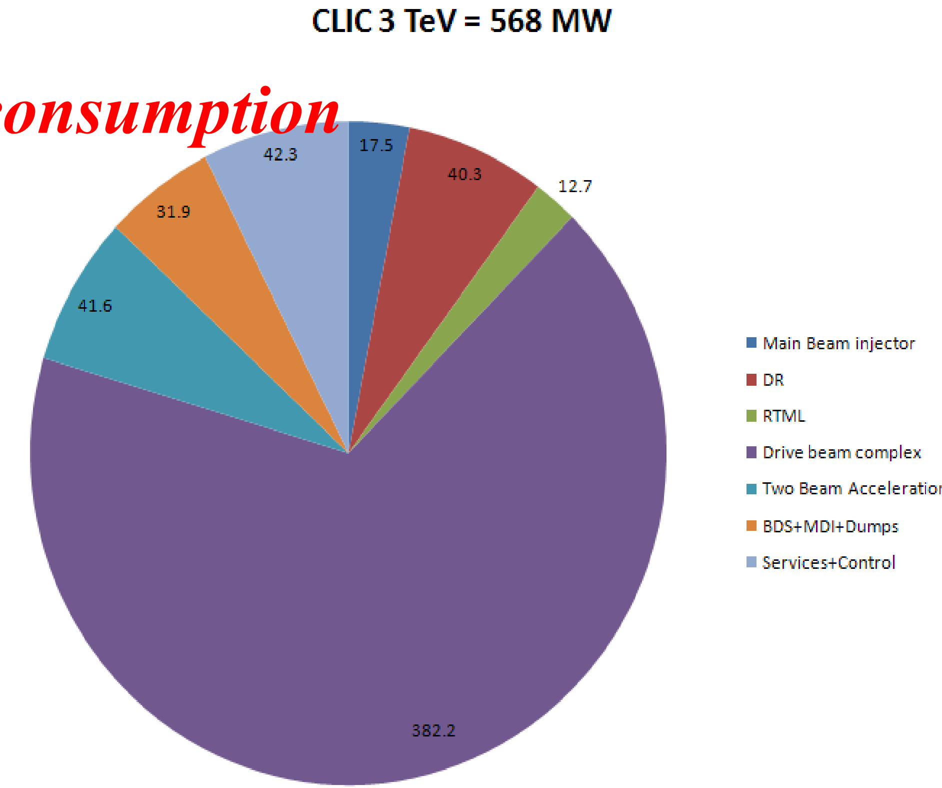
CLIC main parameters

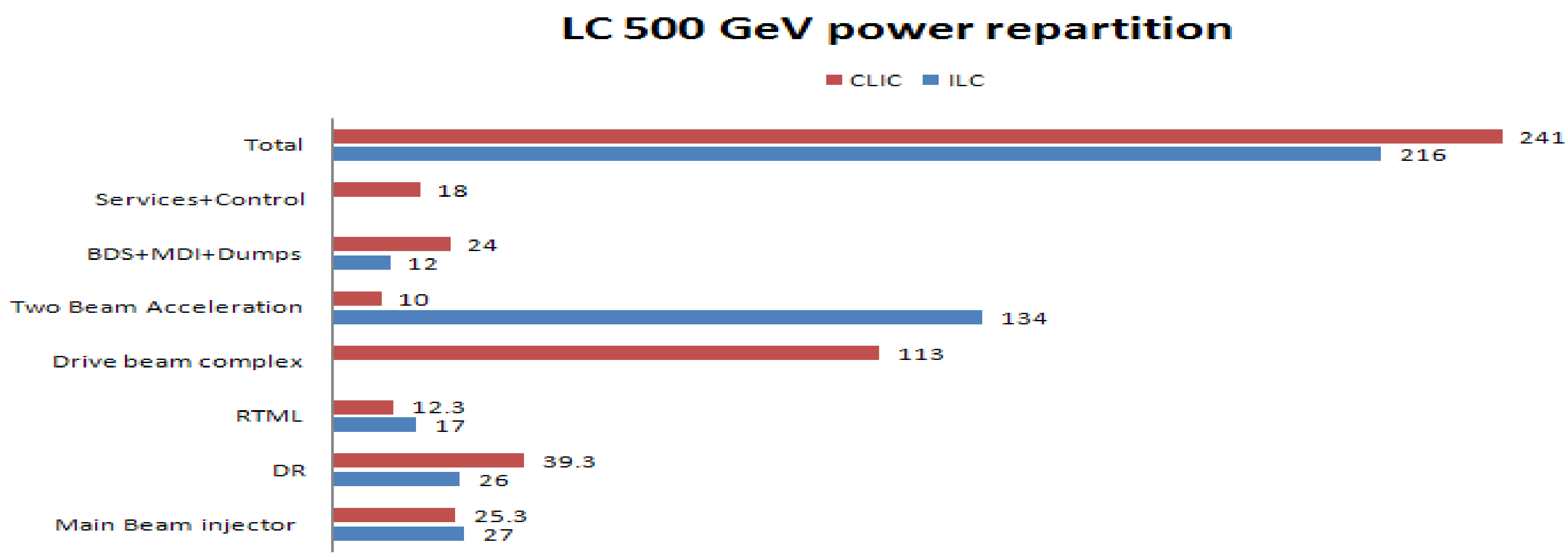
http://cdsweb.cern.ch/record/1132079?ln=fr http://clic-meeting.web.cern.ch/clic-meeting/clictable2007.html

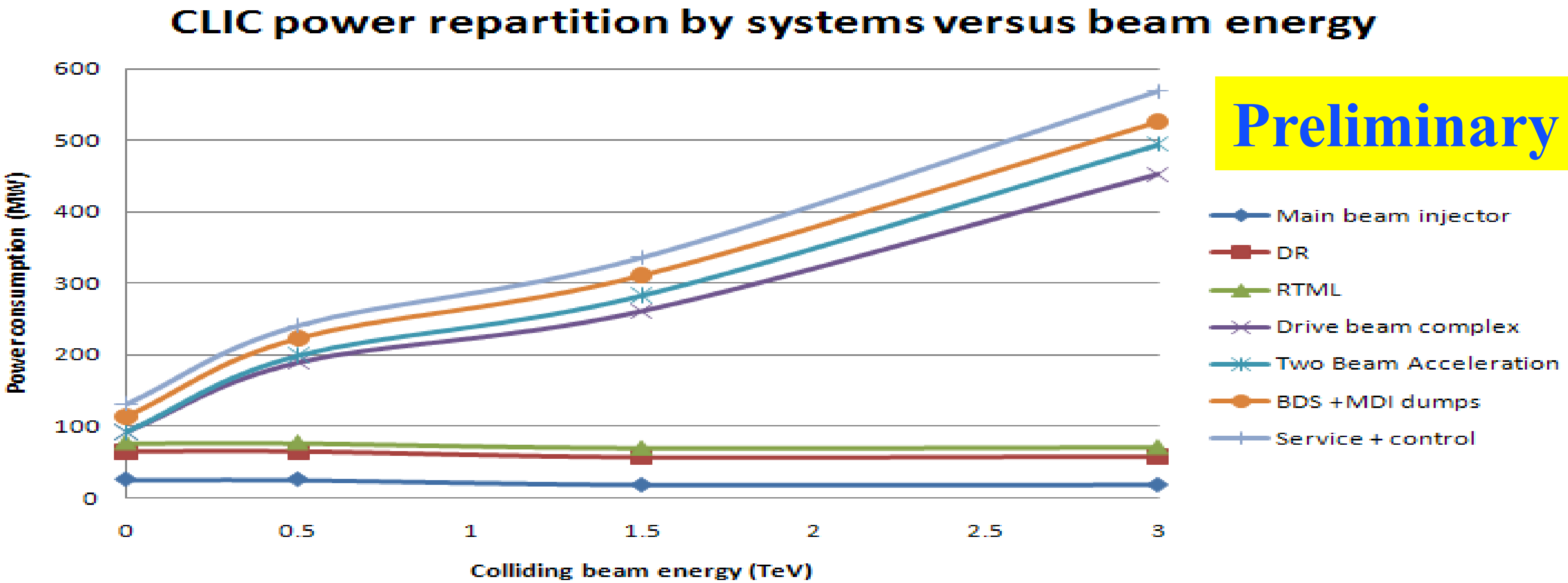
Center-of-mass energy	CLIC 500 GeV		CLIC 3 TeV	
Beam parameters	Relaxed	Nominal	Relaxed	Nominal
Accelerating structure	502		G	
Total (Peak 1%) luminosity	$8.8(5.8)\cdot10^{33}$	$2.3(1.4)\cdot10^{34}$	$7.3(3.5)\cdot10^{33}$	$5.9(2.0)\cdot10^{34}$
Repetition rate (Hz)	50			
Loaded accel. gradient MV/m	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~~ 241		~~415~~ 568	

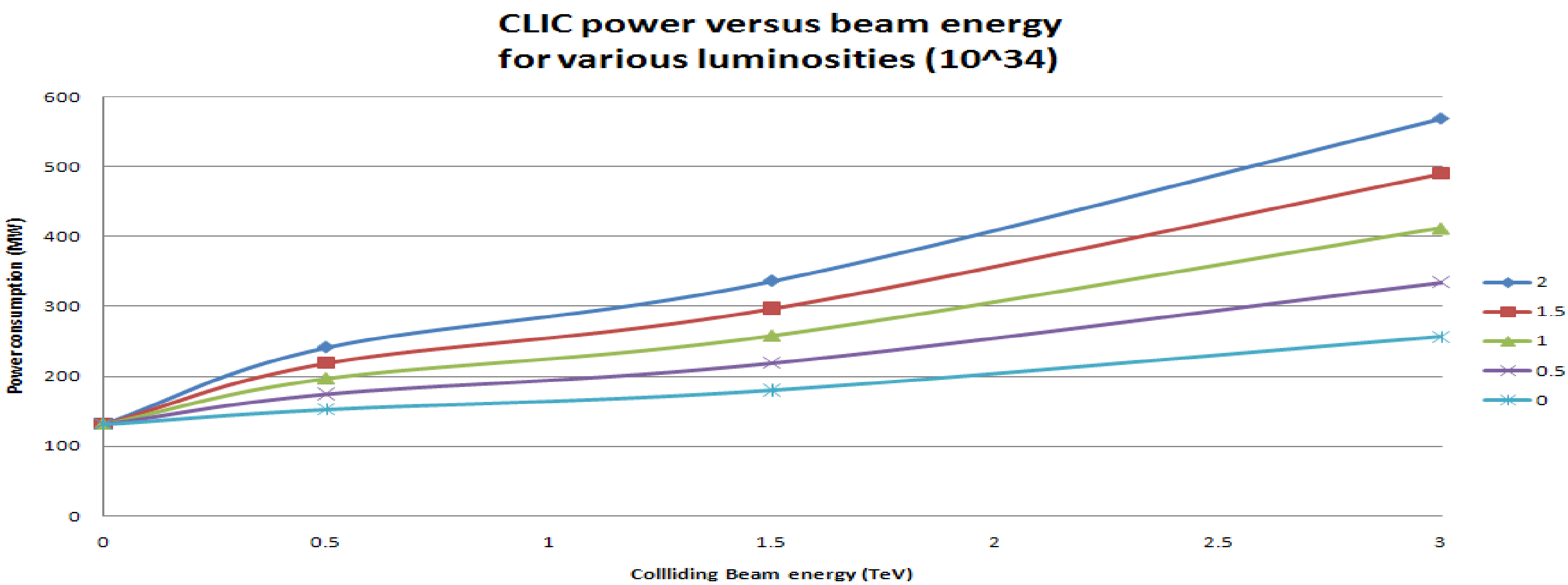
CLIC POWER consumption



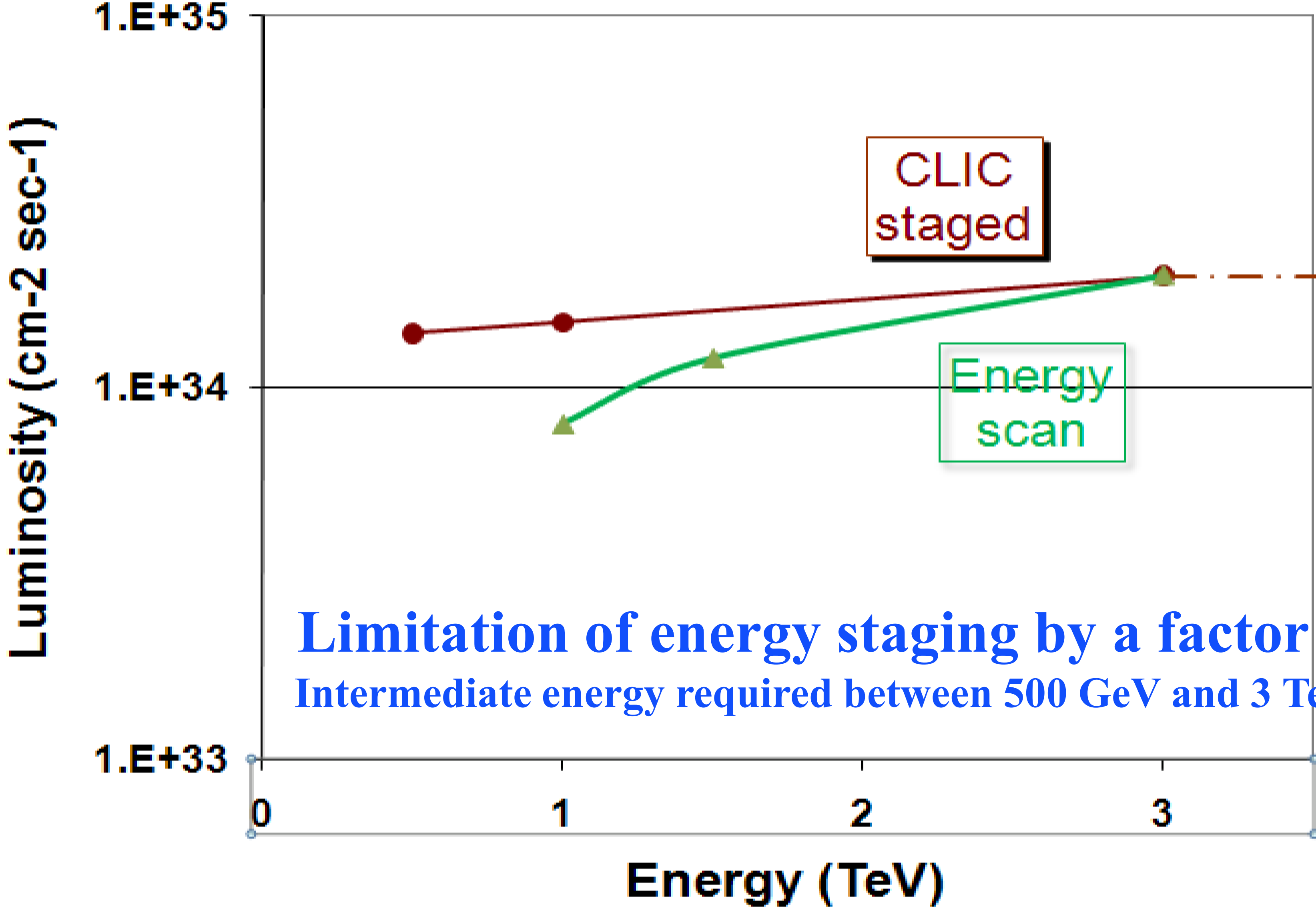





CLIC power repartition by systems versus beam energy
Preliminary
Power consumption (MW)
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
Colliding beam energy (TeV)
Main beam injector
DR
RTML
Drive beam complex
Two Beam Acceleration
BDS +MDI dumps
Service + control


CLIC power versus beam energy
for various luminosities (10^34)
Power consumption (MW)
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
Collliding Beam energy (TeV)
2
1.5
1
0.5
0

CLIC performances and energy scan



Limitation of energy staging by a factor 3

Intermediate energy required between 500 GeV and 3 TeV

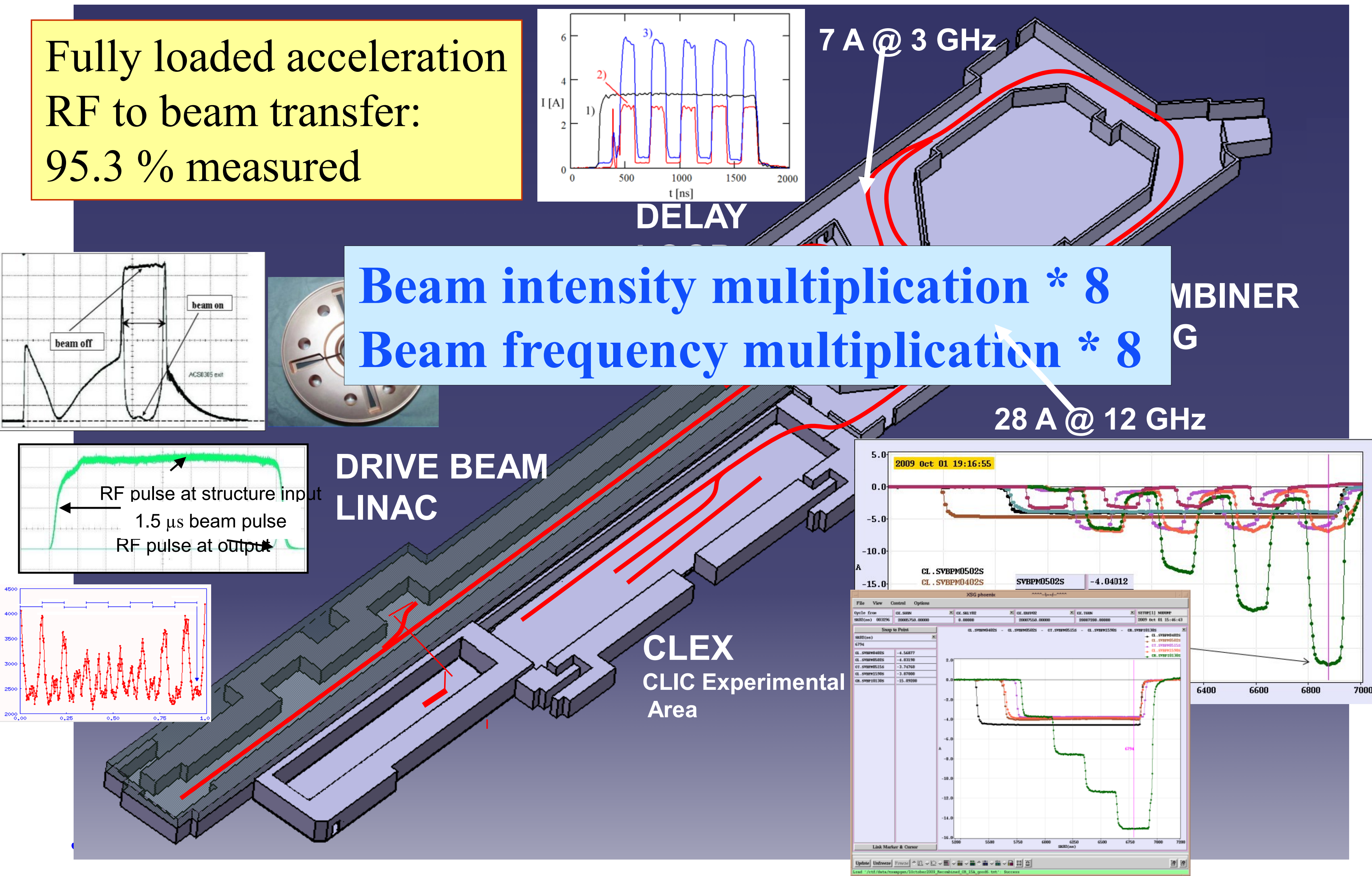
Towards CLIC feasibility demonstration

System	Item	Feasibility Issue	Unit	Nominal	Achieved	How	Feasibilit
Two Beam Acceleration	Drive beam generation	Fully loaded accel effic	%	97	95	CTF3	✓
		Freq&Current multipl	-	2*3*4	2*4	CTF3	✓
		Combined beam current (12 GHz)	A	4.5*24=100	3.5*8=28	CTF3	✓
		Combined pulse length (12 GHz)	ns	240	140	CTF3	✓
		Intensity stability	1.E-03	0.75	< 0.6	CTF3	2011
		Drive beam linac RF phase	Deg (1GHZ)	0.05	0.035	CTF3, XFEL	✓
	Beam Driven RF power generation	PETS RF Power	MW	130	>130	TBTS/SLAC	✓
		PETS Pulse length	ns	170	>170	TBTS/SLAC	✓
		PETS Breakdown rate	/m	< 1·10-7	≤ 2.4 10-7	TBTS/SLAC	✓
		PETS ON/OFF	-	@ 50Hz	-	CTF3/TBTS	2011
		Drive beam to RF efficiency	%	90%	-	CTF3/TBL	2012
		RF pulse shape control	%	< 0.1%	-	CTF3/TBTS	2011-2012
	Accelerating Structures (CAS)	Structure Acc field	MV/m	100	100	CTF3 Test Stand, SLAC, KEK	✓
		Structure Flat Top Pulse length	ns	170	170		✓
		Structure Breakdown rate	/m	< 3·10-7	5·10-5(D)		2011
		Rf to beam transfer efficiency	%	27	15		2011
	Two Beam Acceleration	Power producton and probe beam acceleration in Two beam	MV/m - ns	100 - 170	106 - <130	TBTS	2011
		Drive to main beam timing	psec	0.05	-	CTF3	2012
		Main to main beam timing	psec	0.07	-	XFEL	2012
Ultra low beam emittance & sizes	Ultra low Emittances & Beam Sizes	Norm. Emitttance generation	H/V (nm)	500/5	3000/12	ATF, NSLS/SLS	✓
		Emittance preservation: Blow-up	H/V (nm)	160/15	160/15	+ simulation	2011-12
		Strong focusing: β*eff /L* from IP	mm/m	0.1/3.5	2.0/1.0	ATF2	2011-12
		Nanometer beam sizes at IP	H/V (nm)	40/1	70 300	FFTB ATF2+simul.	2011-12
	Alignment	Main Linac components	µm	10	10 (princ.)	Align. & Mod. Test Bench	2011
		Final-Doublet tolerance	µm	10			
	Vertical stabilisation	Quad Main Linac	nm>1 Hz	1.5	0.13 (principle)	Stabilisation Test Bench	2011-12
		Final Doublet (with feedbacks)	nm>4 Hz	0.2			
Operation and Machine Protection System (MPS)		72MW@2.4GeV 13MW@1.5TeV				CTF3 simulations	2011-12

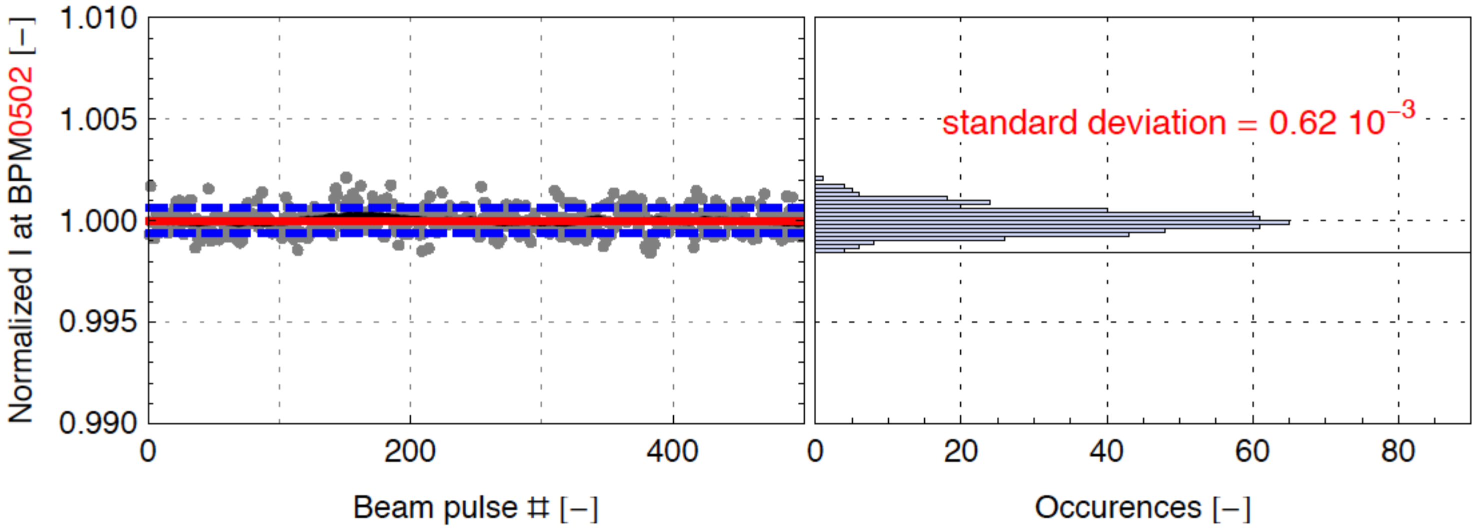
CTF3 completed, operating 10 months/year, under commissioning:Drive Beam Generation demonstrated

Fully loaded acceleration RF to beam transfer: 95.3 % measured

Beam intensity multiplication * 8
Beam frequency multiplication * 8



CTF3: Achieved current stability
(at DB linac end, still to be demonstrated after combiner ring)
Specification: 7.5 10^{-4}



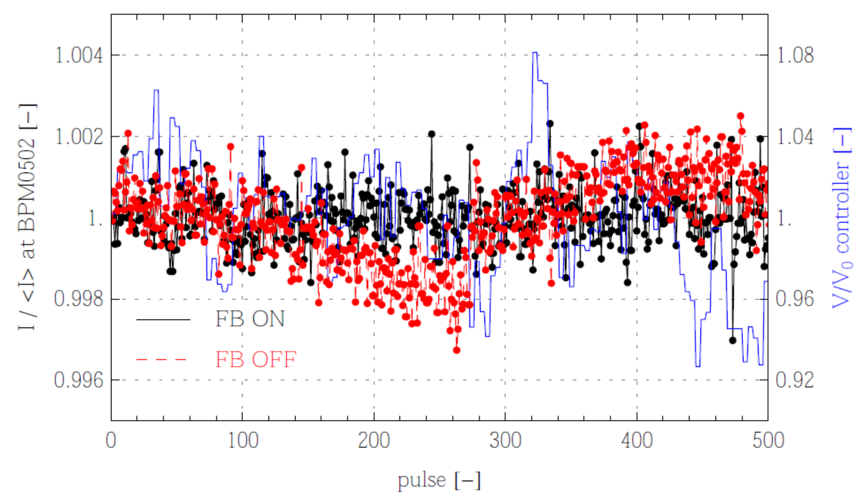
- New heater power supply, better set-point, improved measurement procedures

  ⇨ $\Delta I/I \sim 0.75 - 1 \;\; 10^{-3}$

- Gun feed-back

  ⇨ (or lower…)

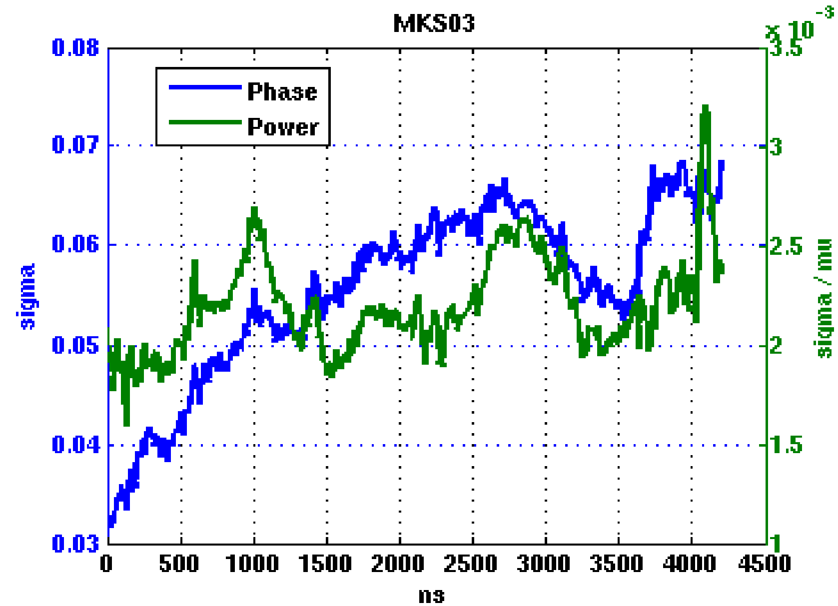
Below CLIC DB specs!

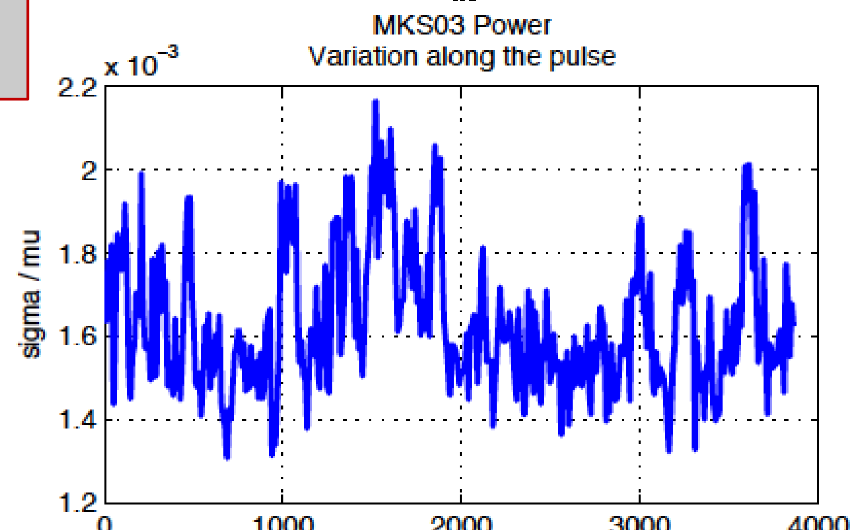


CTF3: Achieved Klystron RF phase stability
Drive beam RF phase specification: 0.05 RF degrees

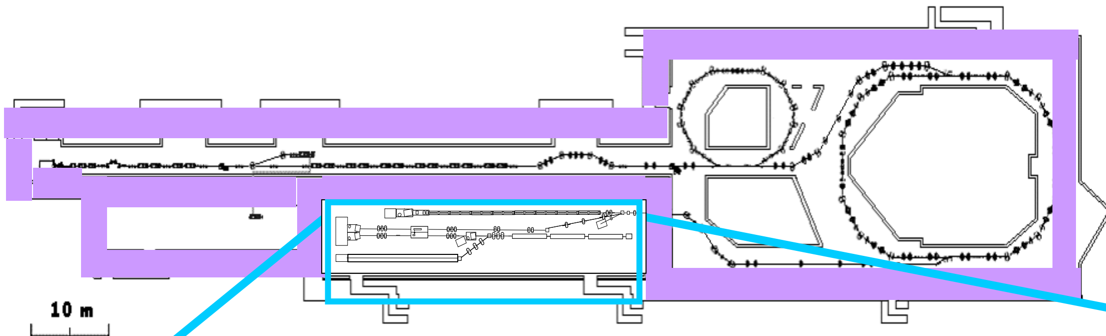
- Measurements of klystron phase and power indicate
  - pulse-to-pulse average phase stability with respect to local reference phase 0.035°
  - for each 10 ns times slice the pulse to pulse jitter is 0.07°

⇨ Corresponds to CLIC drive beam accelerator specs





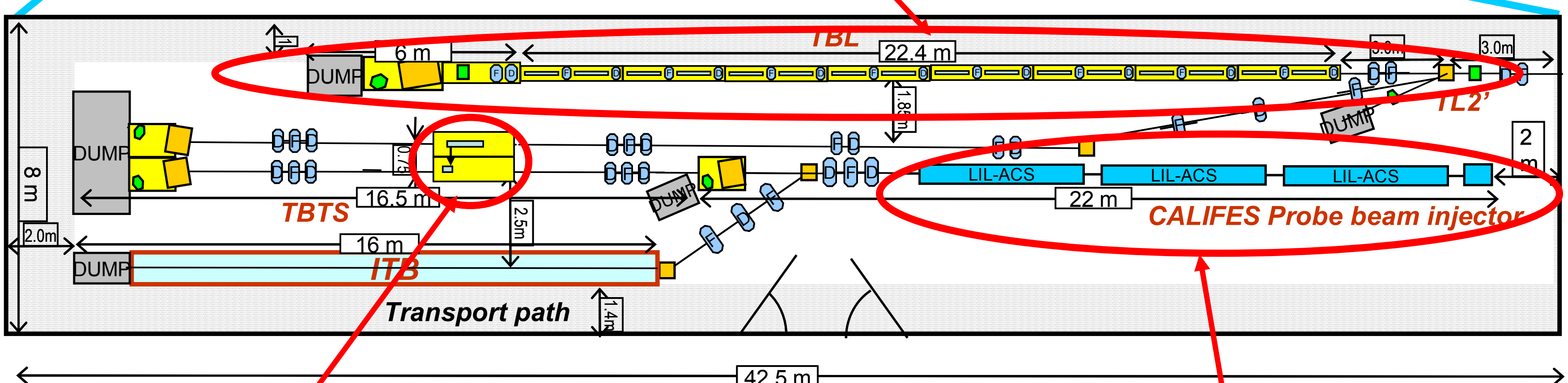
CTF3/CLEX (CLIC Experimental Area)



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

Test Beam Line TBL



Two Beam Test Stand

Probe Beam

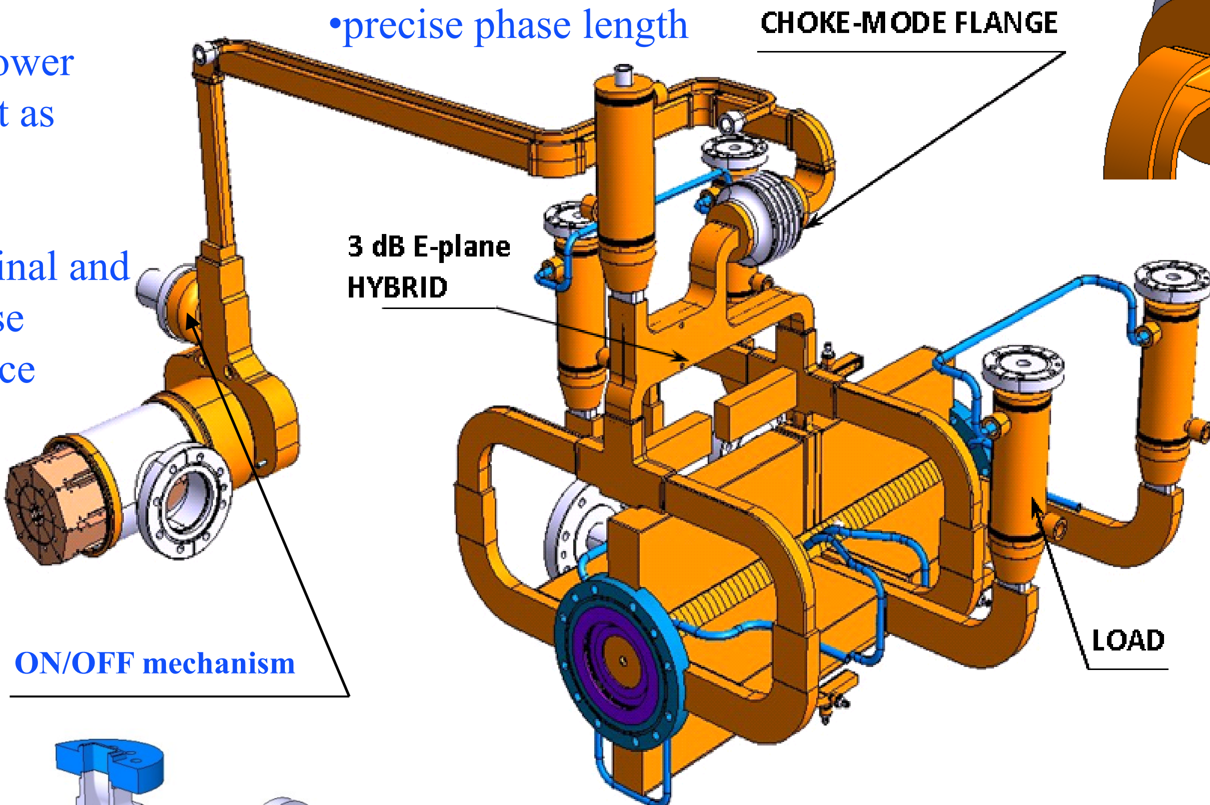
Installation completed except for PETS in TBL

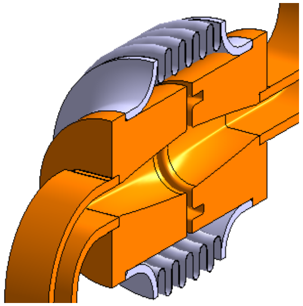
Drive and probe beams in CLEX from June 2008

CLIC main linac rf network

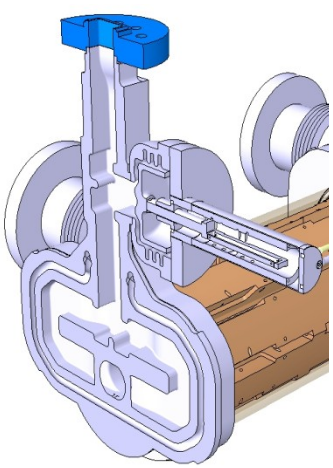
Waveguide network
- high power
- precise phase length

PETS
- high-power
- as short as possible
- low longitudinal and transverse impedance



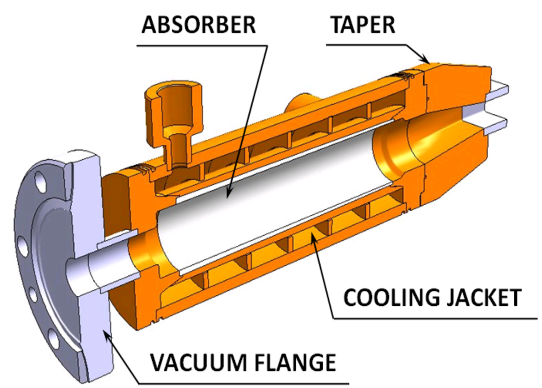


Choke mode flange
- independent alignment of main and drive beam

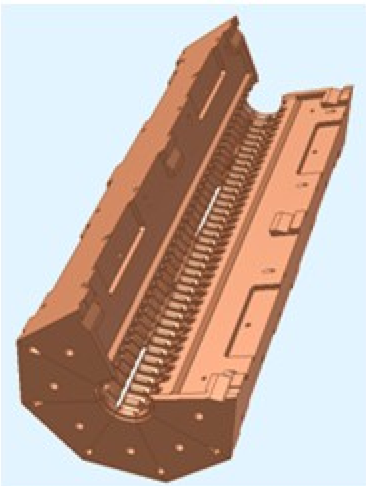


On/ramp/off
- necessary (?) to react to breakdown and/or failure

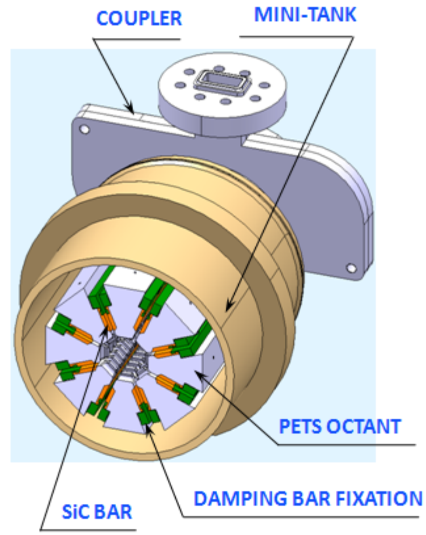
Accelerating structure
- high-gradient
- as long as possible
- micron precision
- transverse wakefield suppression



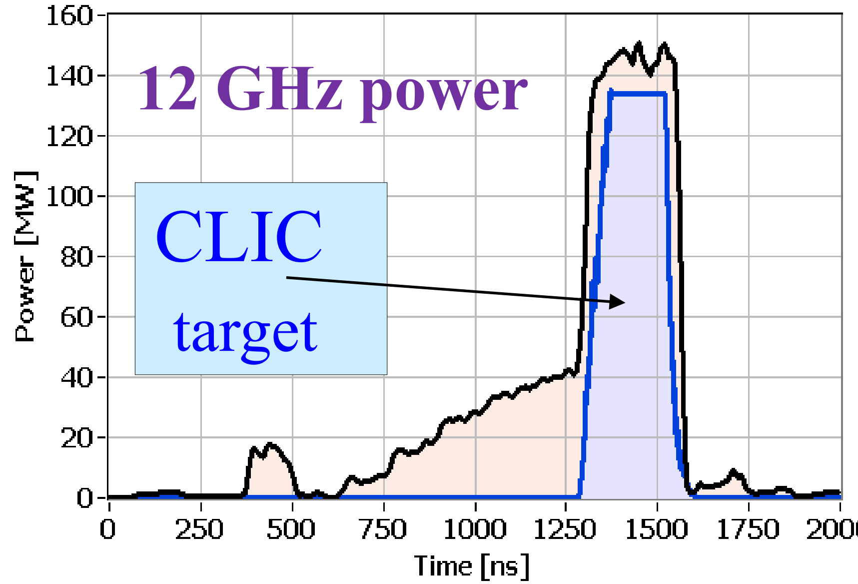
Power Production Structure (PETS)
> Nominal Performance demonstrated

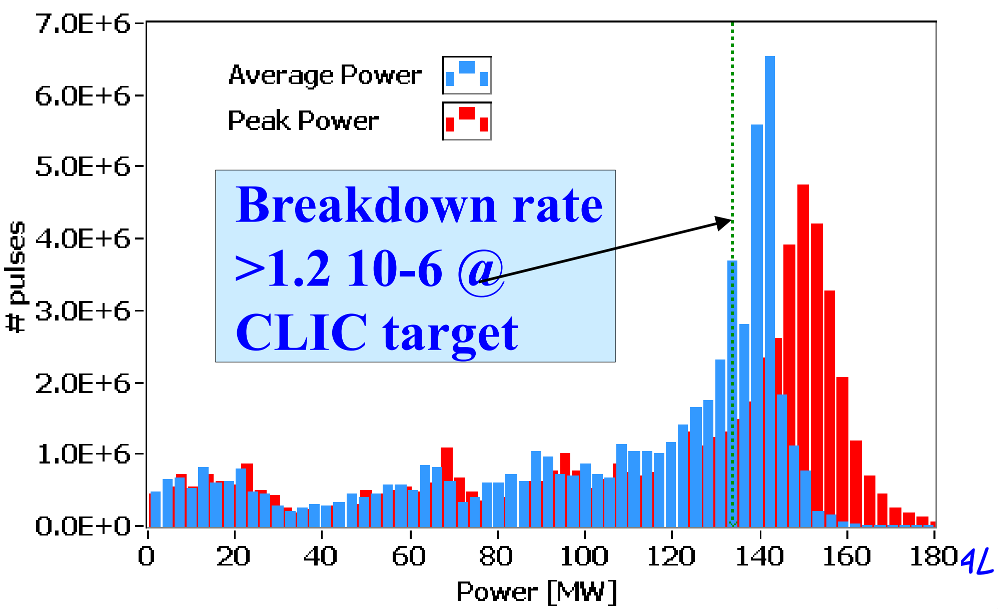


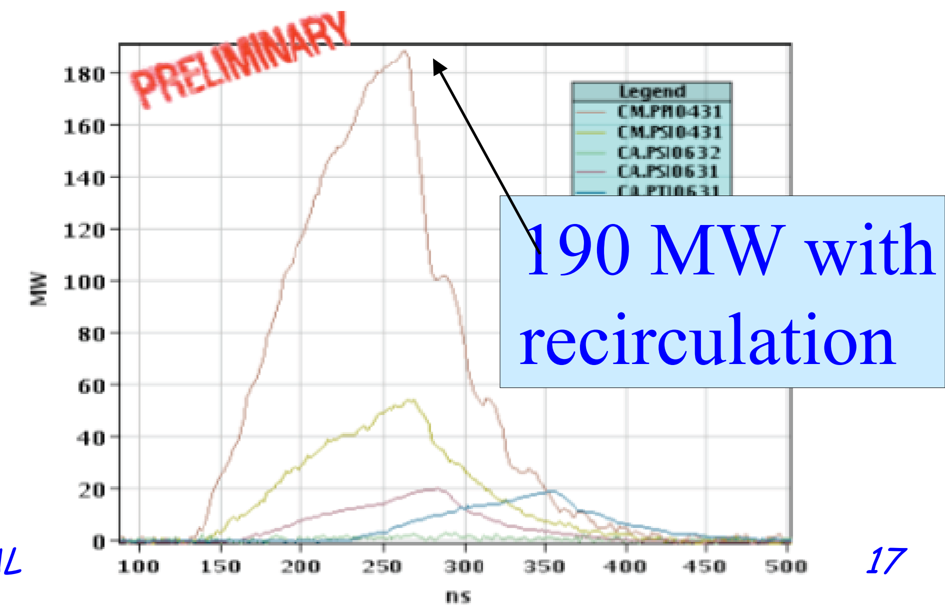
PETS octants assembly



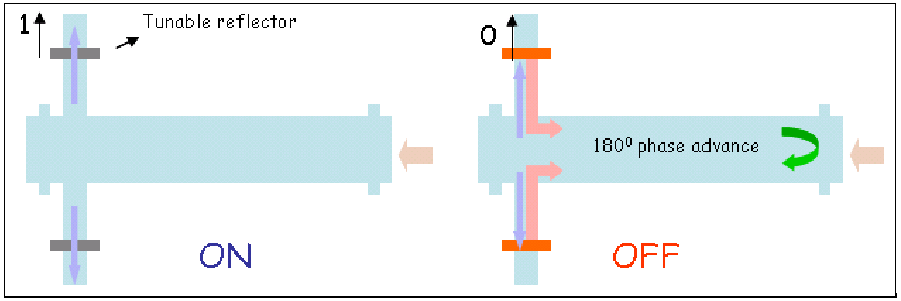
PETS with damping material

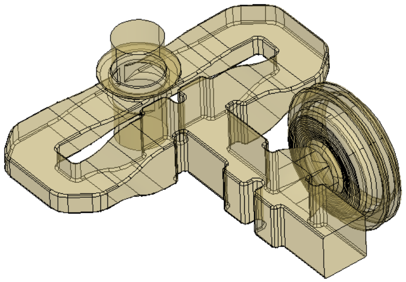




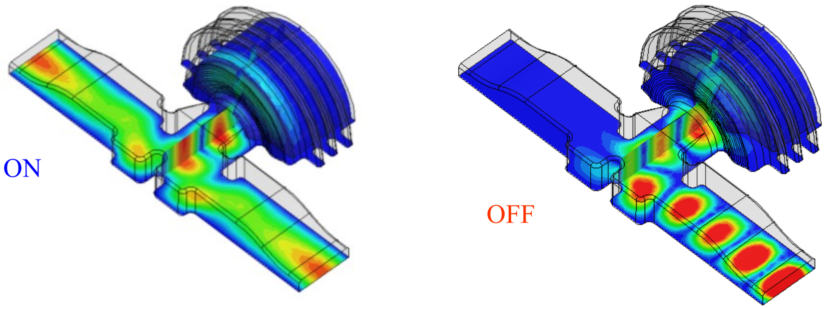


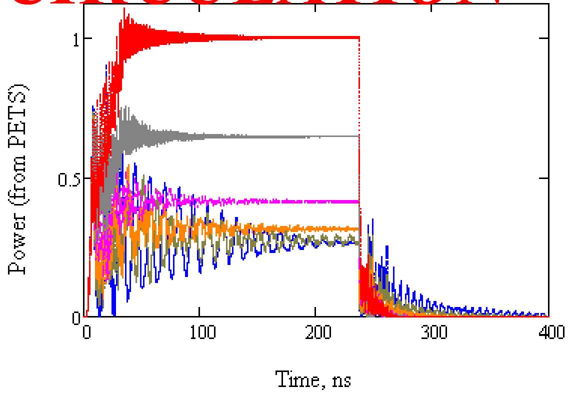
PETS ON/OFF CONCEPT WITH EXTERNAL COMMUTATION & INTERNAL RECIRCULATION



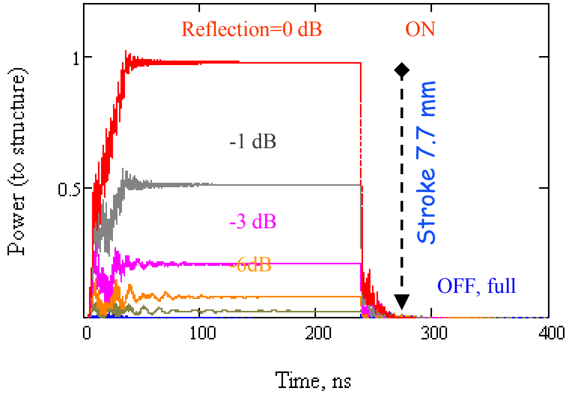


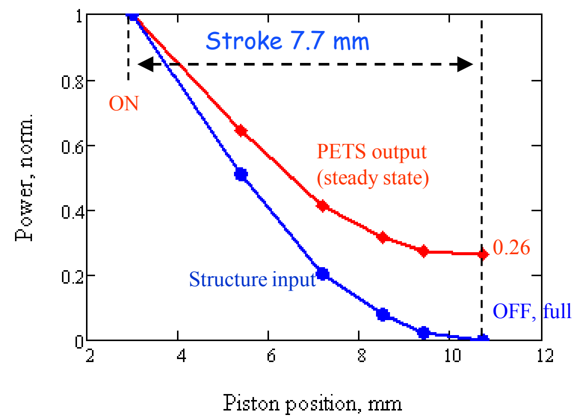
PETS coupler design with integrated RF reflector





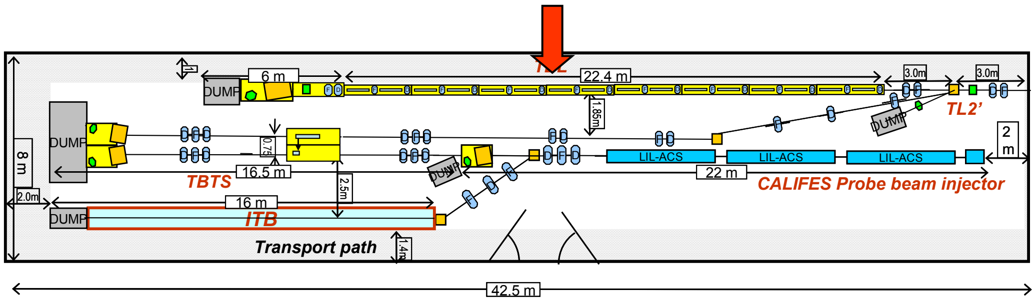
Power attenuation vs. piston position (full reflection in OFF position)





- Components under construction
- High power tests of components & concept validation (slow movement, external reflector at input coupler) can be done from summer 2011 in the TBTS PETS
- replaces recirculation loop (lower losses, faster recirculation)

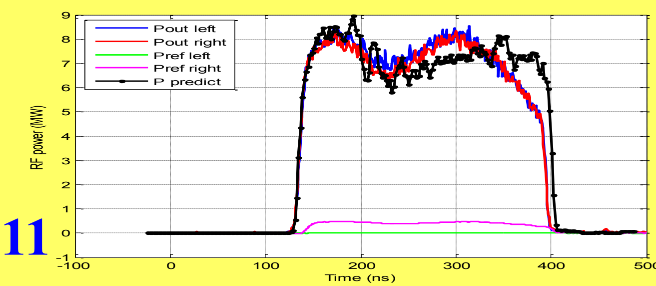
Test Beam Line (TBL)



- High energy-spread beam transport
  decelerate to 50 % beam energy
- Drive Beam stability
- Stability of RF power extraction
  total power in 16 PETS: 1.5 GW
- Alignment procedures

- **TBL line fully completed up to dump including PETS prototype**

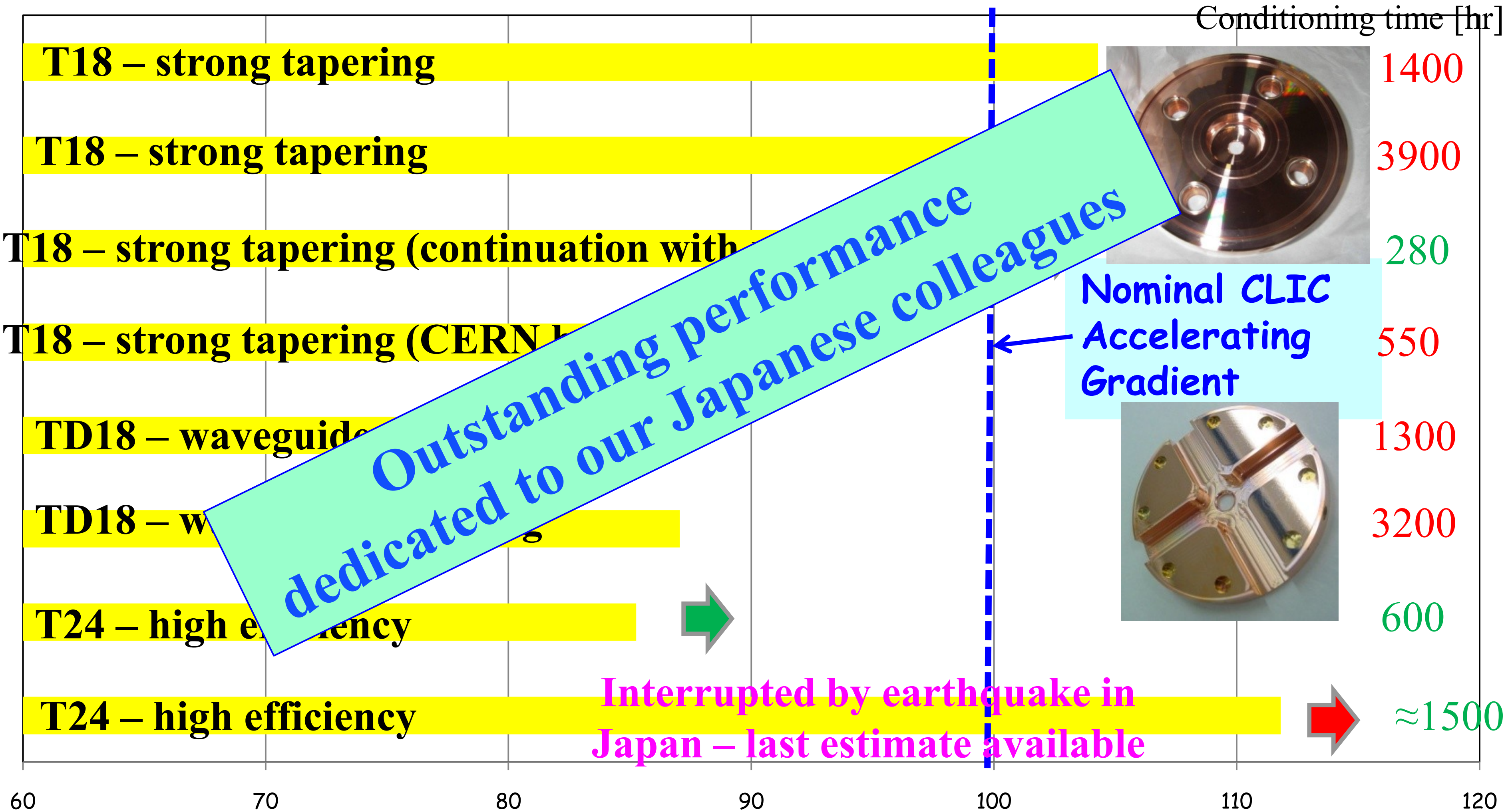
  all Quads on movers, BPM's with new read out electronics, diagnostic section with emittance meter and time resolved spectrometer



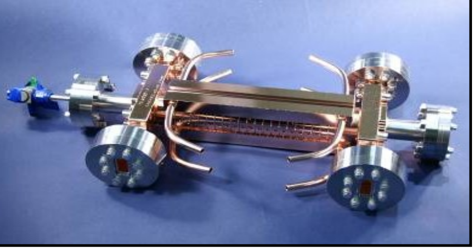
- **PETS prototype fully qualified up to 20 MW**
- **3 additional PETS implemented in February 2011**
- **4 additional PETS in Summer for tests with 8 PETS (>30% deceleration) by end 2011 (CDR)**
- **Complete TBL with 12 then 16 PETS in 2012 (>50% deceleration)**

4 standard cells, 16 total

Accelerating structures: Achieved > 100 MV/m Accelerating Gradient (Fruitful collaboration CERN-KEK-SLAC)

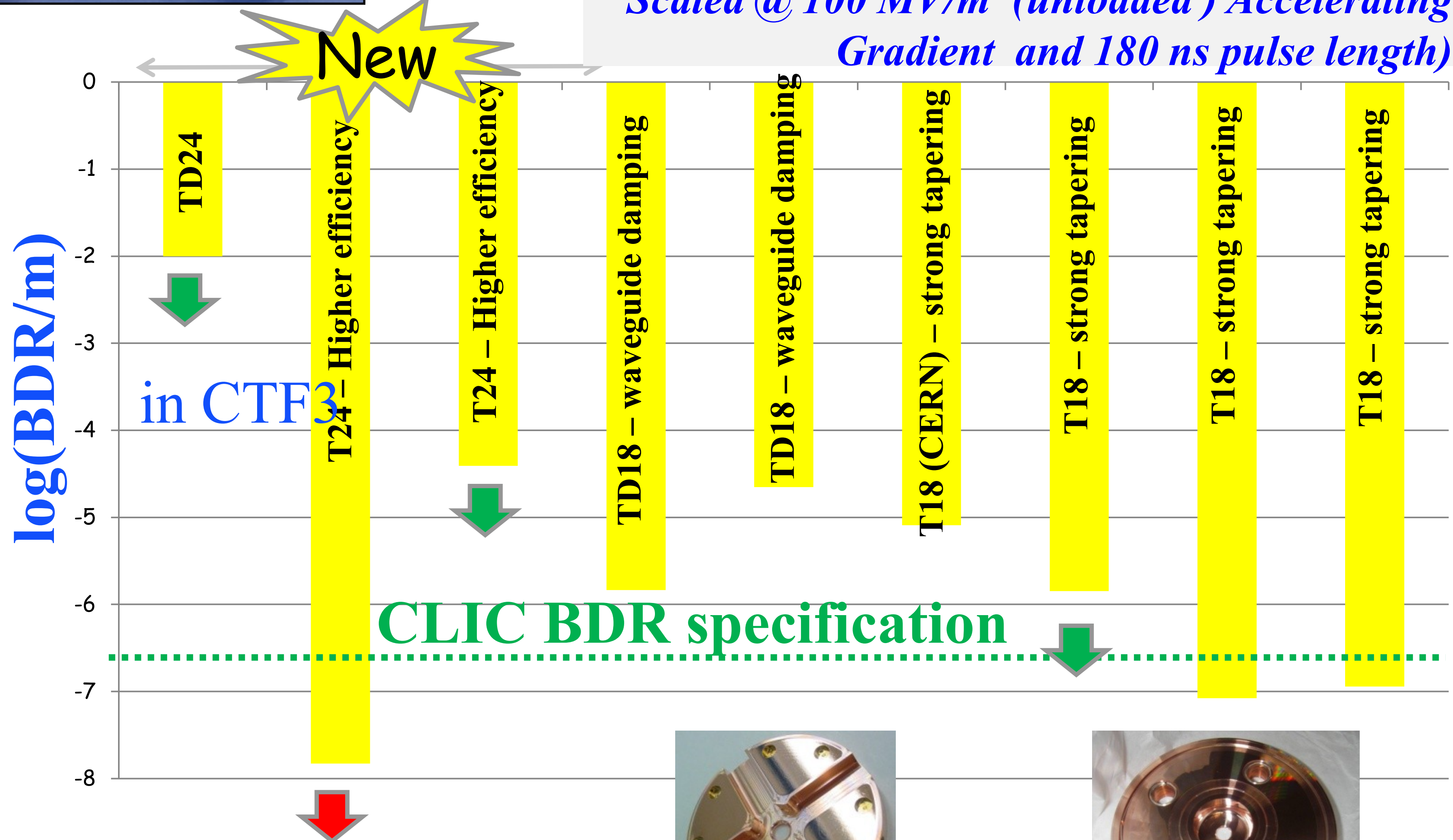


Unloaded gradient (MV/m) at $4*10^{-7}$ BDR and 180 ns pulse length

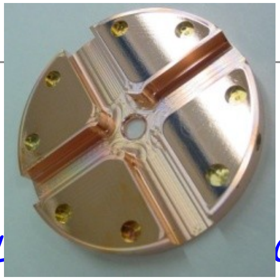


Accelerating structures: Achieved < nominal Break down

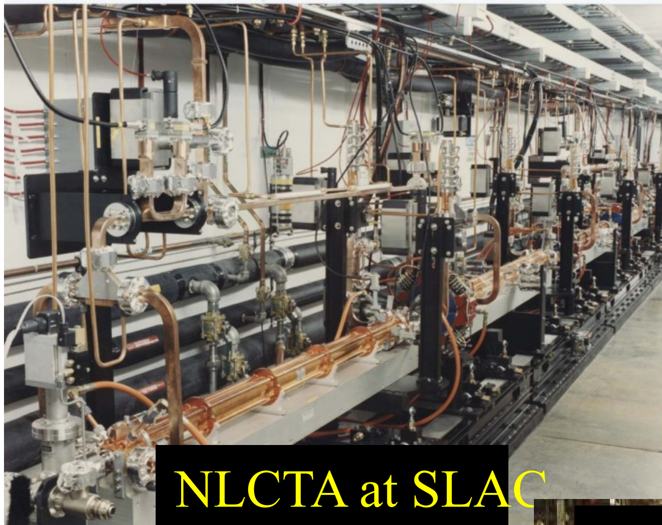
Scaled @ 100 MV/m (unloaded) Accelerating Gradient and 180 ns pulse length)



Interrupted by earthquake in Japan – last estimate available



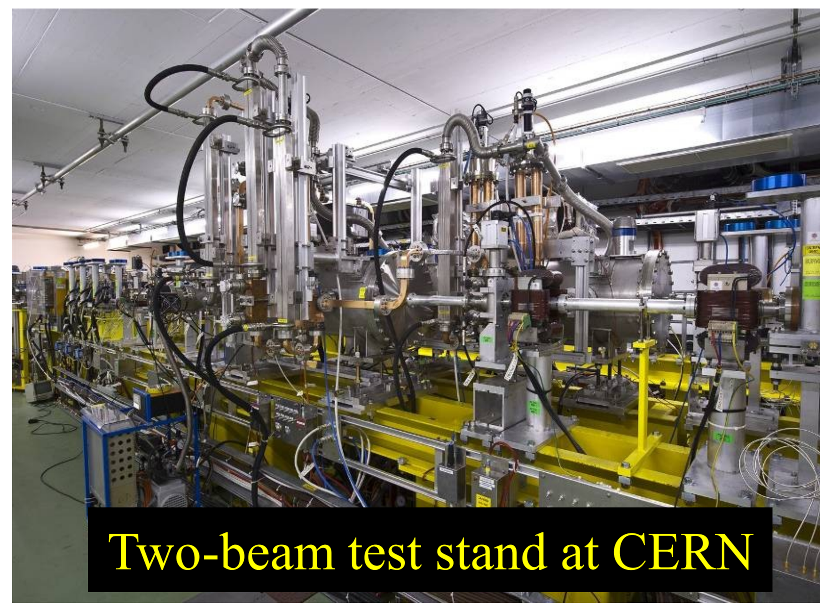
Prototype accelerating structure test areas


NLCTA at SLAC


Nextef at KEK

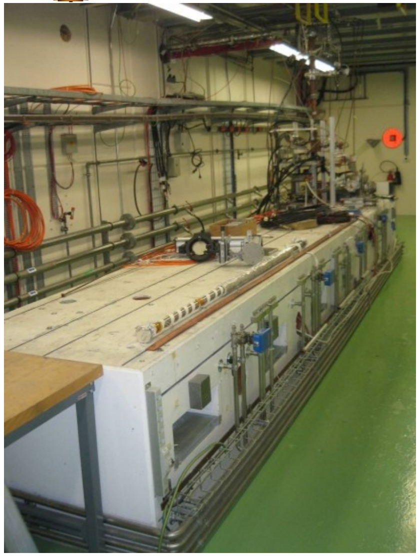

New klystron at CERN


ASTA at SLAC


Two-beam test stand at CERN

X band Test stand: Installation Progress

CERN - CEA – PSI – SLAC



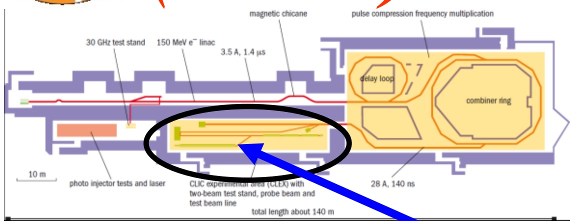
CTF2 test bunker

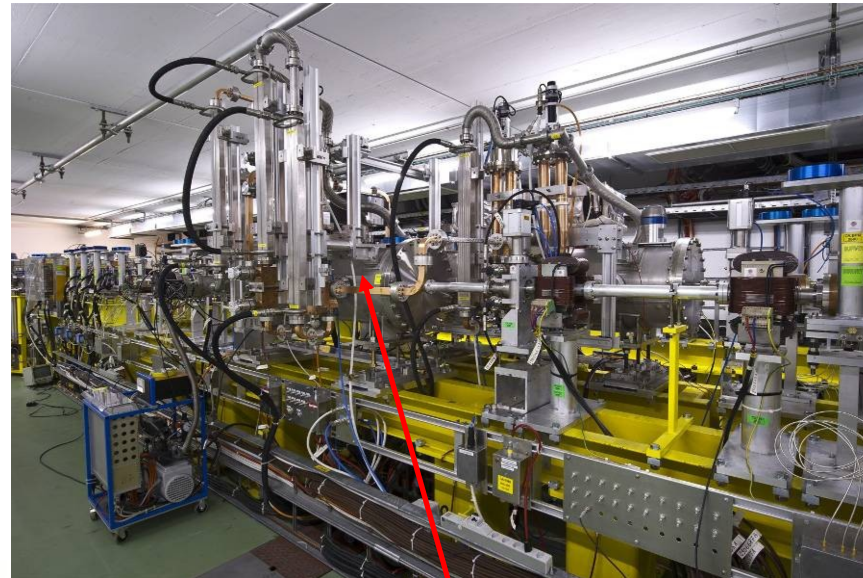
Modulator by Scandinova

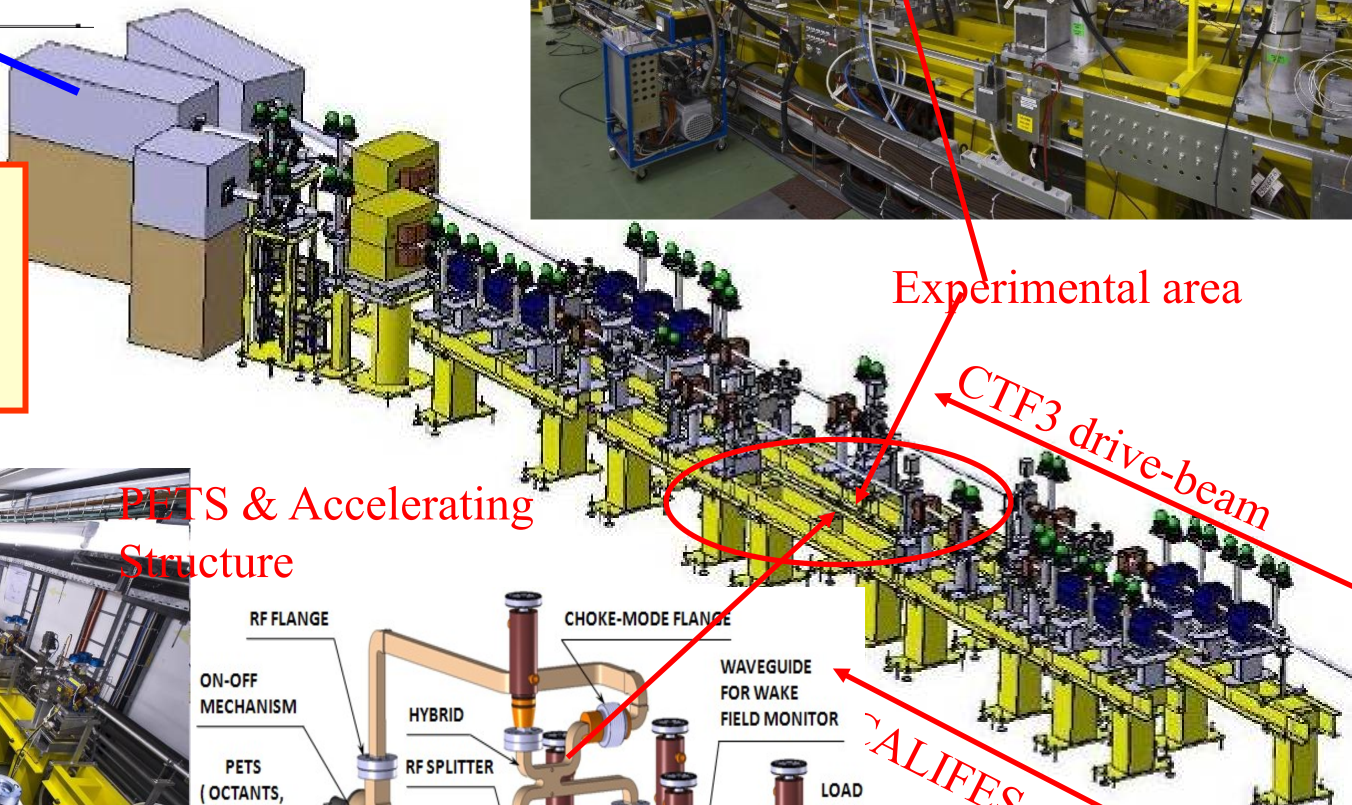
RF pulse compressor
by Gycom

XL5 Klystron developed and
fabricated by SLAC

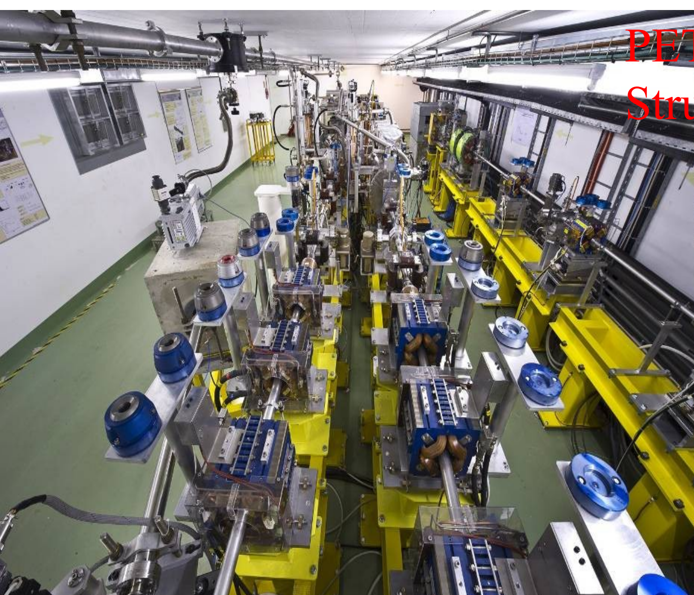
Two Beam Test Stand (TBTS) in CTF3/CLEX

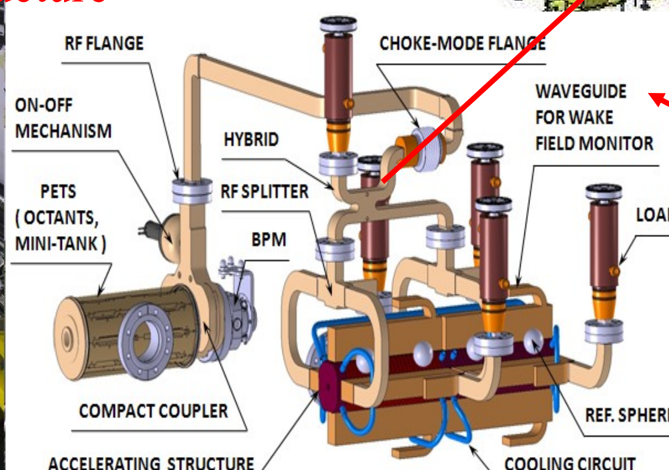




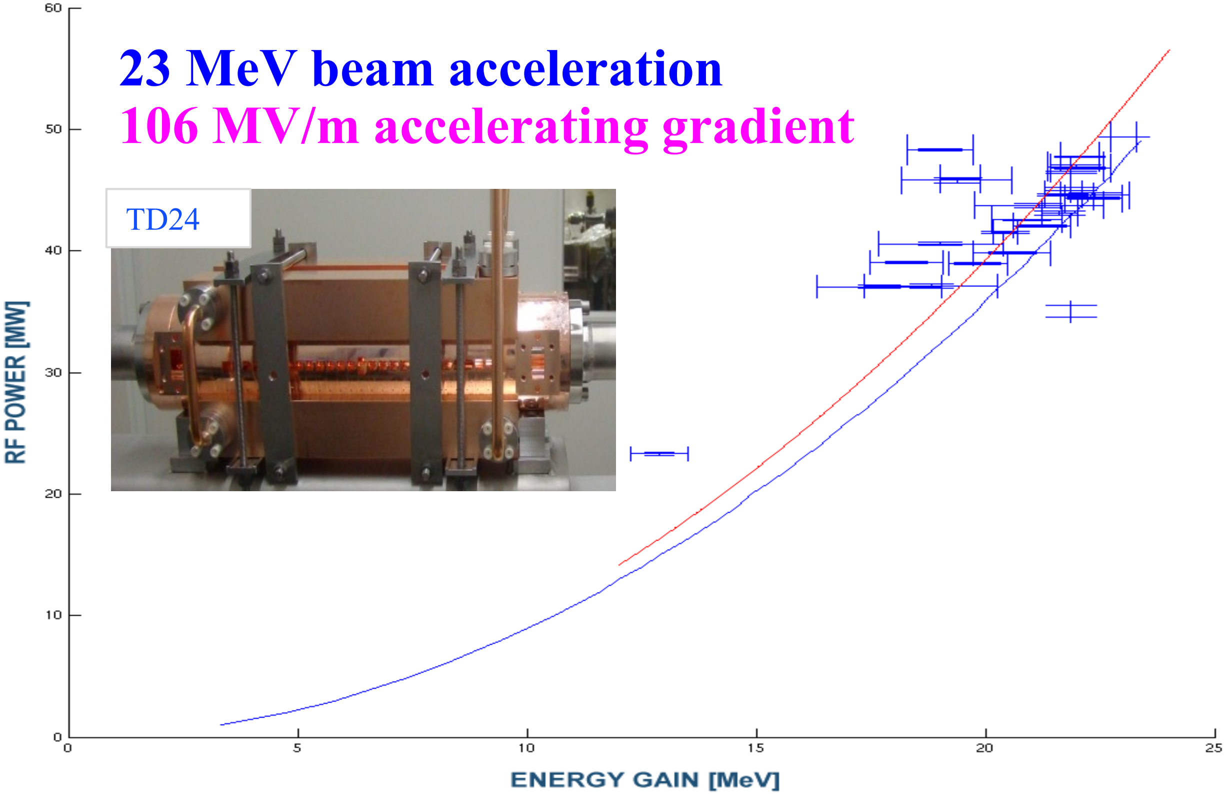


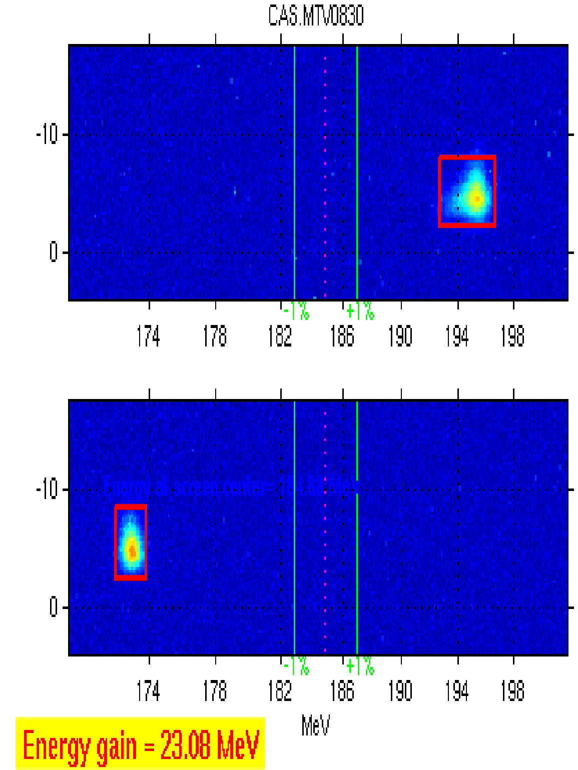
All hardware installed
Beam in both lines up to end
Commissioning with beam:
PETS 2009,
Two Beam Acceleration 2010

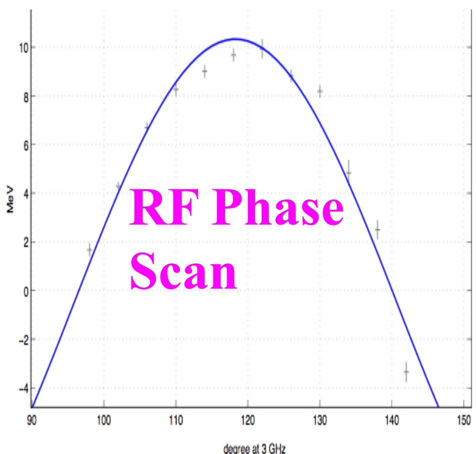


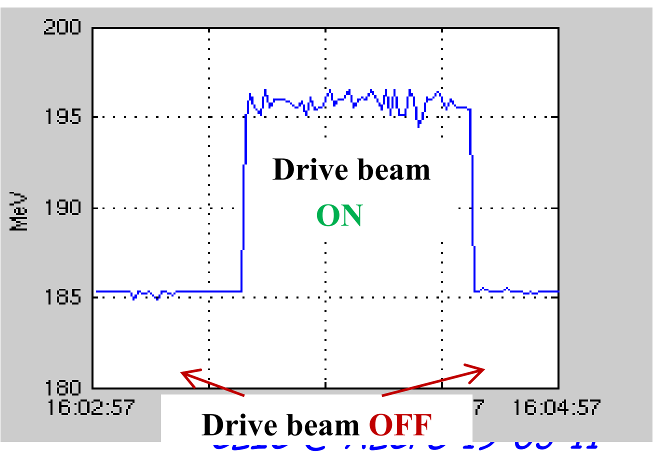


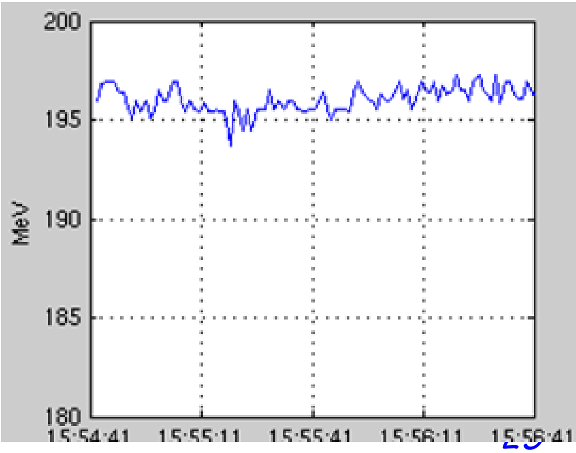
Nominal Two Beam Acceleration demonstrated





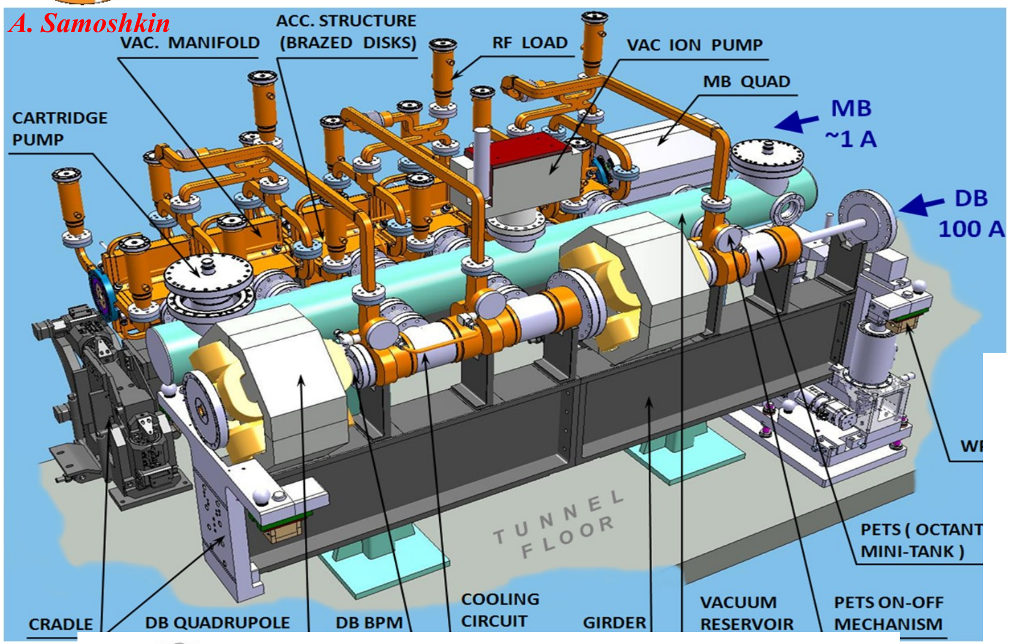


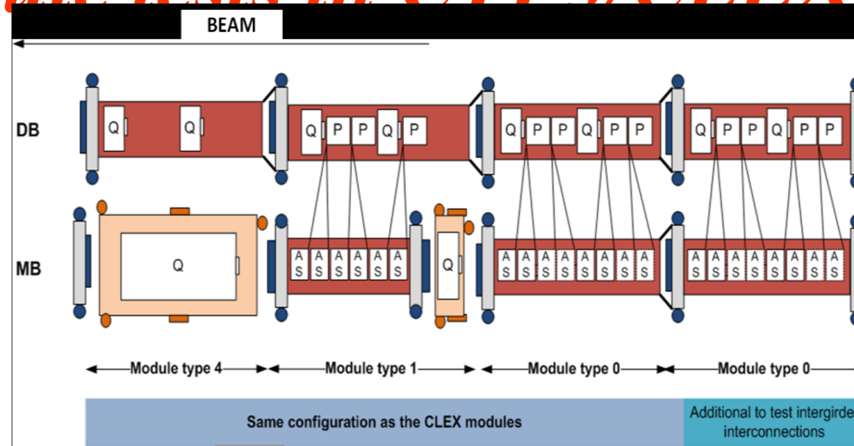


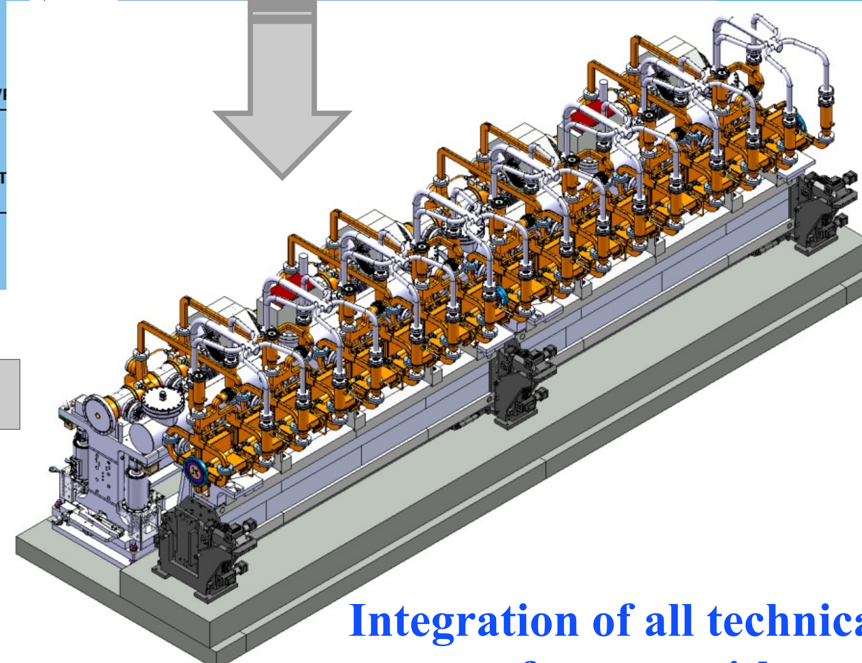


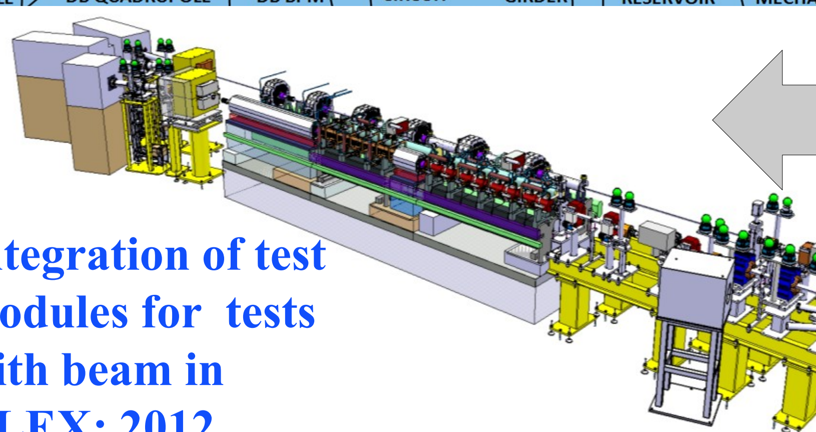
Two Beam Module tests in CTF3/CLEX

A. Samoshkin









Integration of test modules for tests with beam in CLEX: 2012

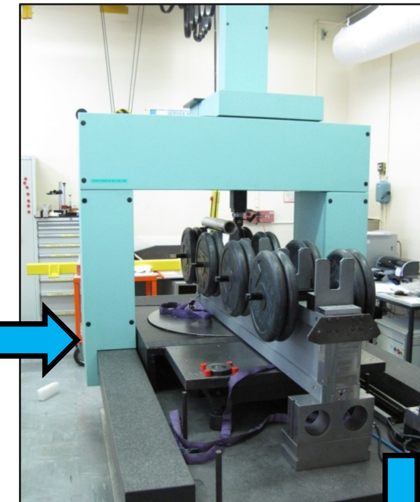
Integration of all technical systems for tests without beam in laboratory: 2011

Test module representing all module types & integrating all various components: RF structures, quadrupoles, instrumentation, alignment, stabilization, vacuum, etc

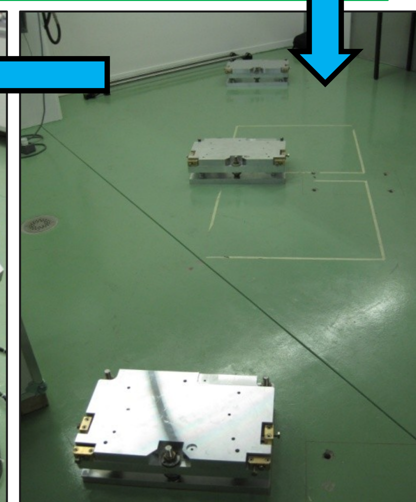
Launched Two Beam Module in lab
Micro-Controle Girders (Type 0)

Visit for on site inspection and preliminary dimensional control (Lazer Tracker)

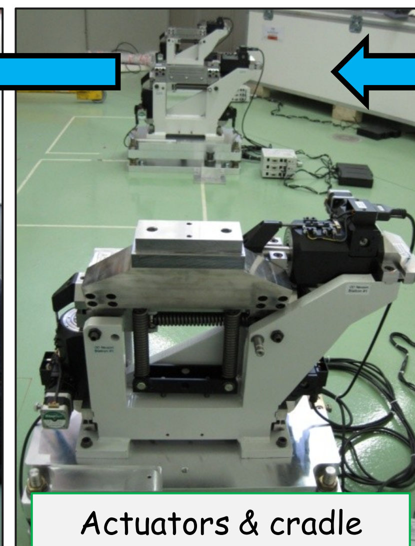
Delivery at CERN



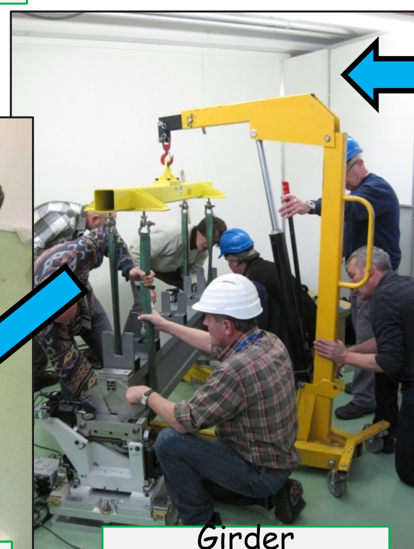
CMM control at CERN



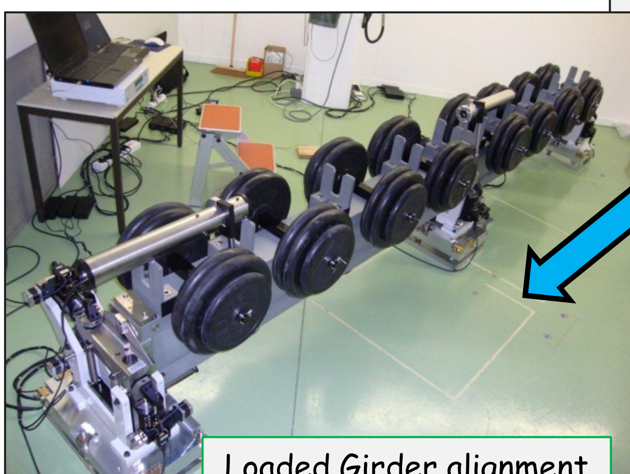
Base plates installation



Actuators & cradle installation

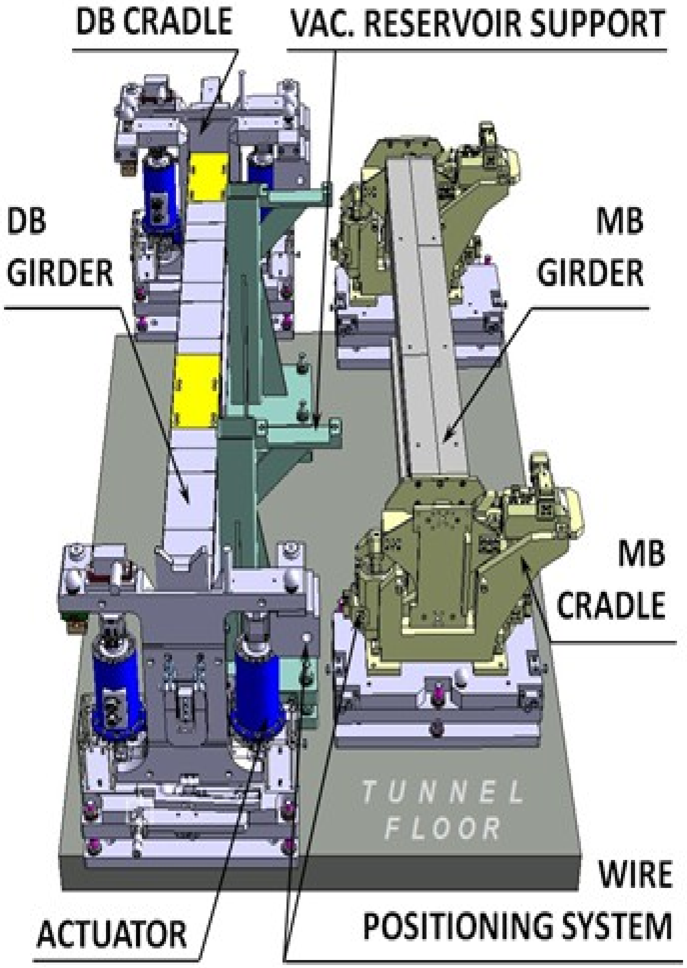


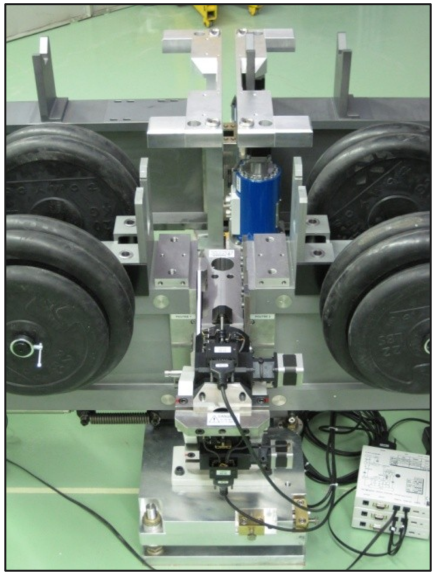
Girder installation

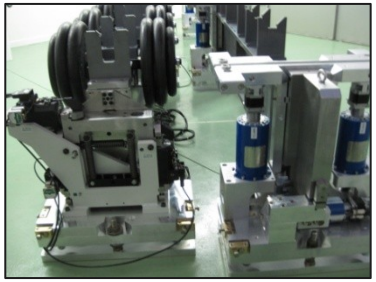


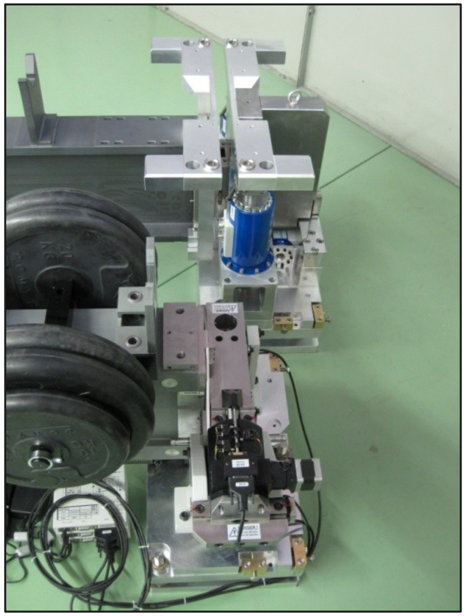
Loaded Girder alignment measurements

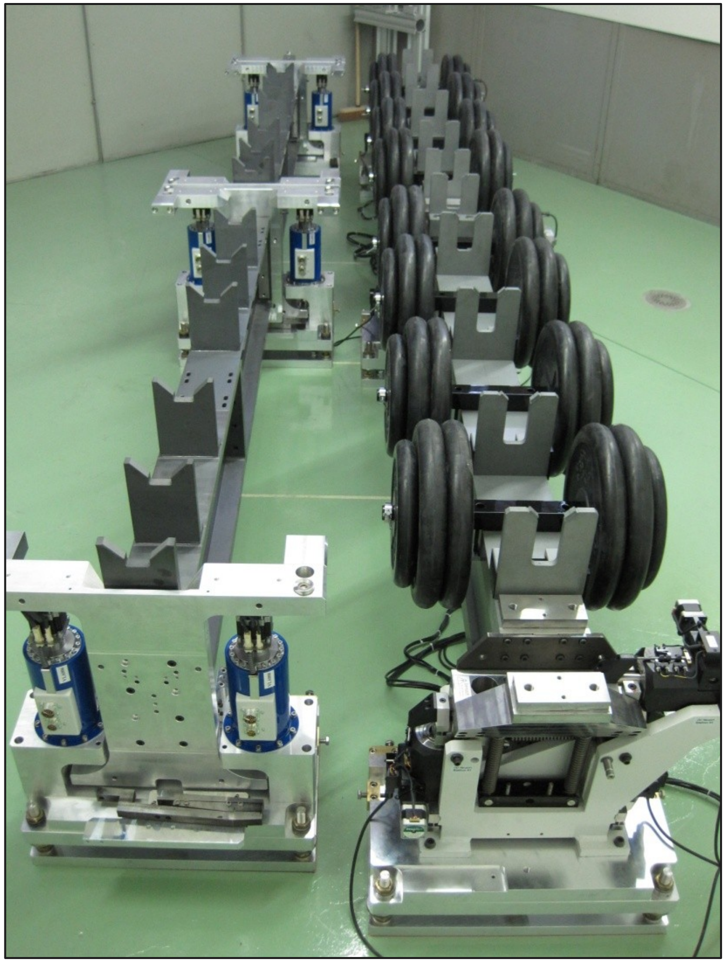
Girders: Final Assembly



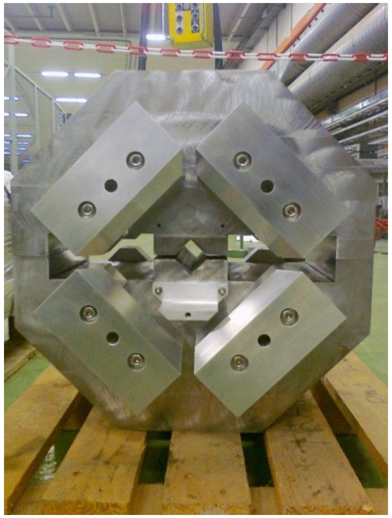


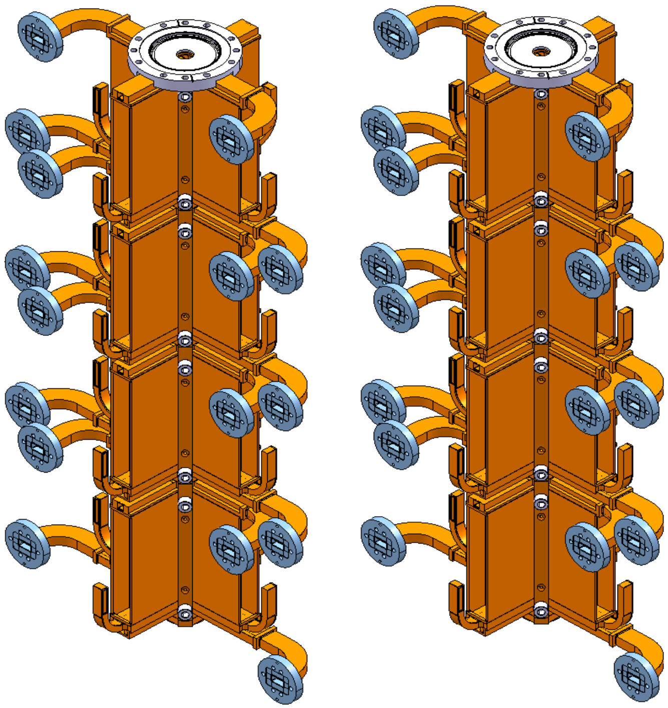






Components for prototype modules in the lab

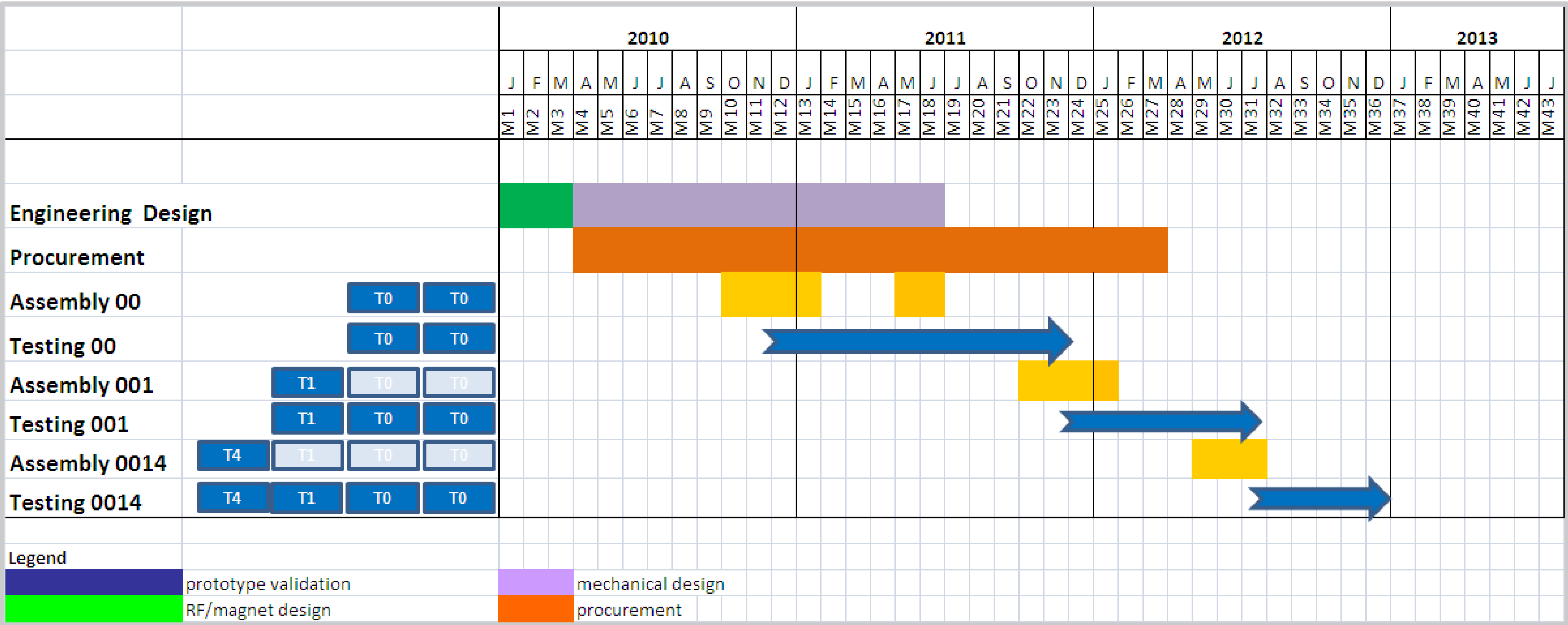




Quadrupole mock-ups at CERN

Accelerating structure mock-ups under fabrication

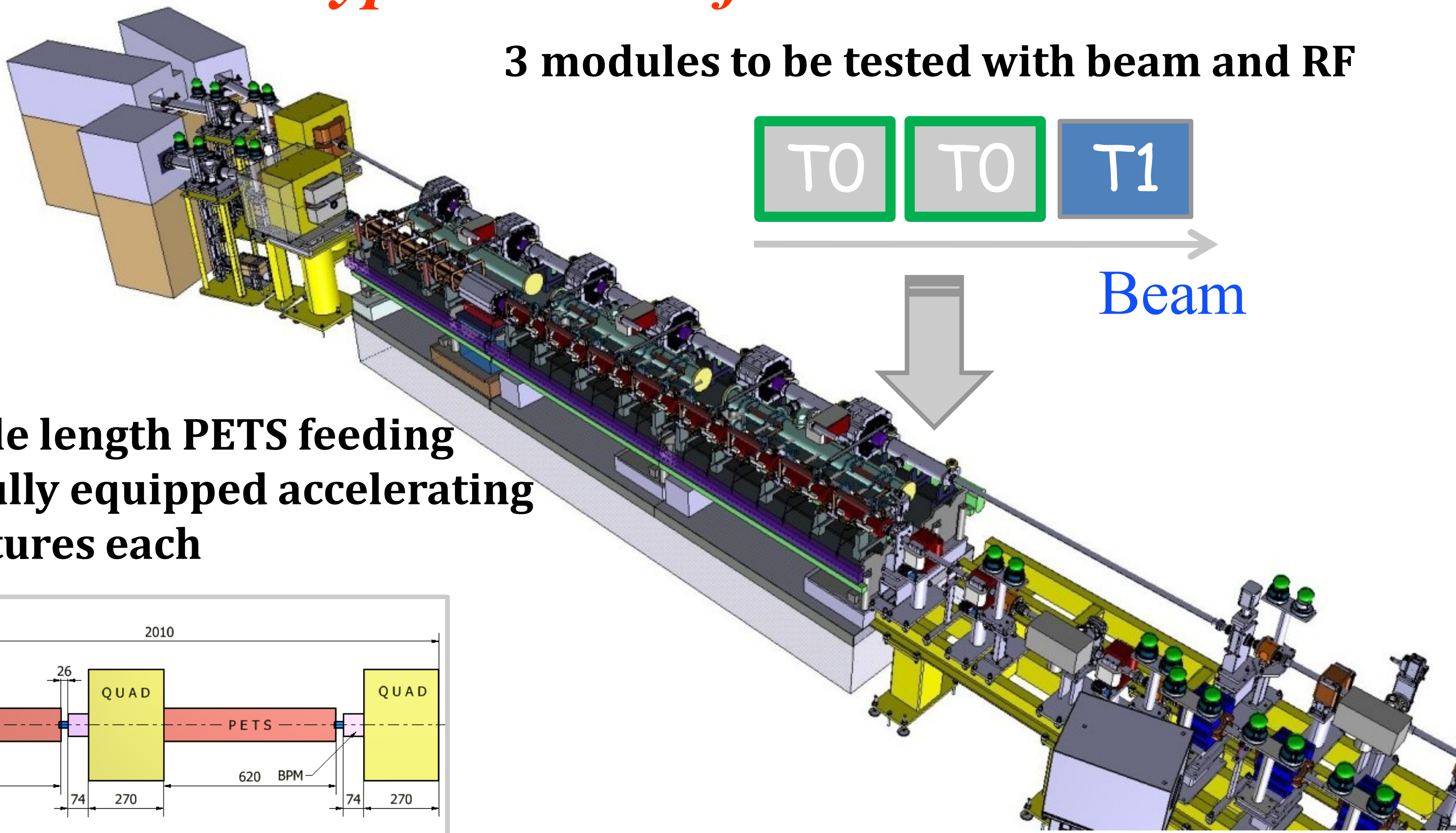
Prototype modules in the lab - Schedule



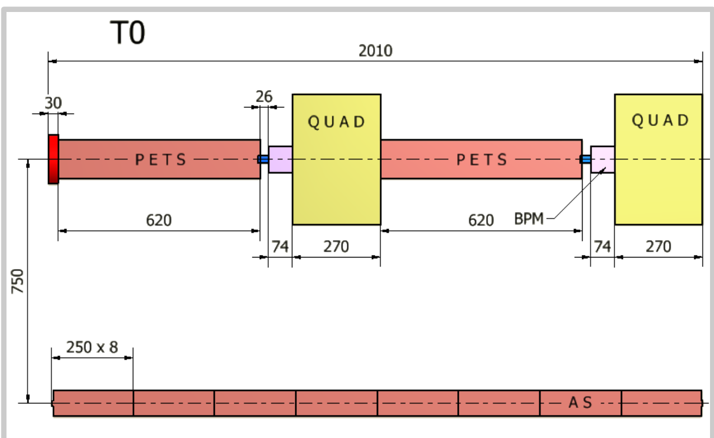
- Under tendering: vacuum system, beam instrumentation and RF system for the first two T0 modules and supporting system for T1 module
- Most probably tests will continue in 2013

Prototype modules for test in CLEX

3 modules to be tested with beam and RF

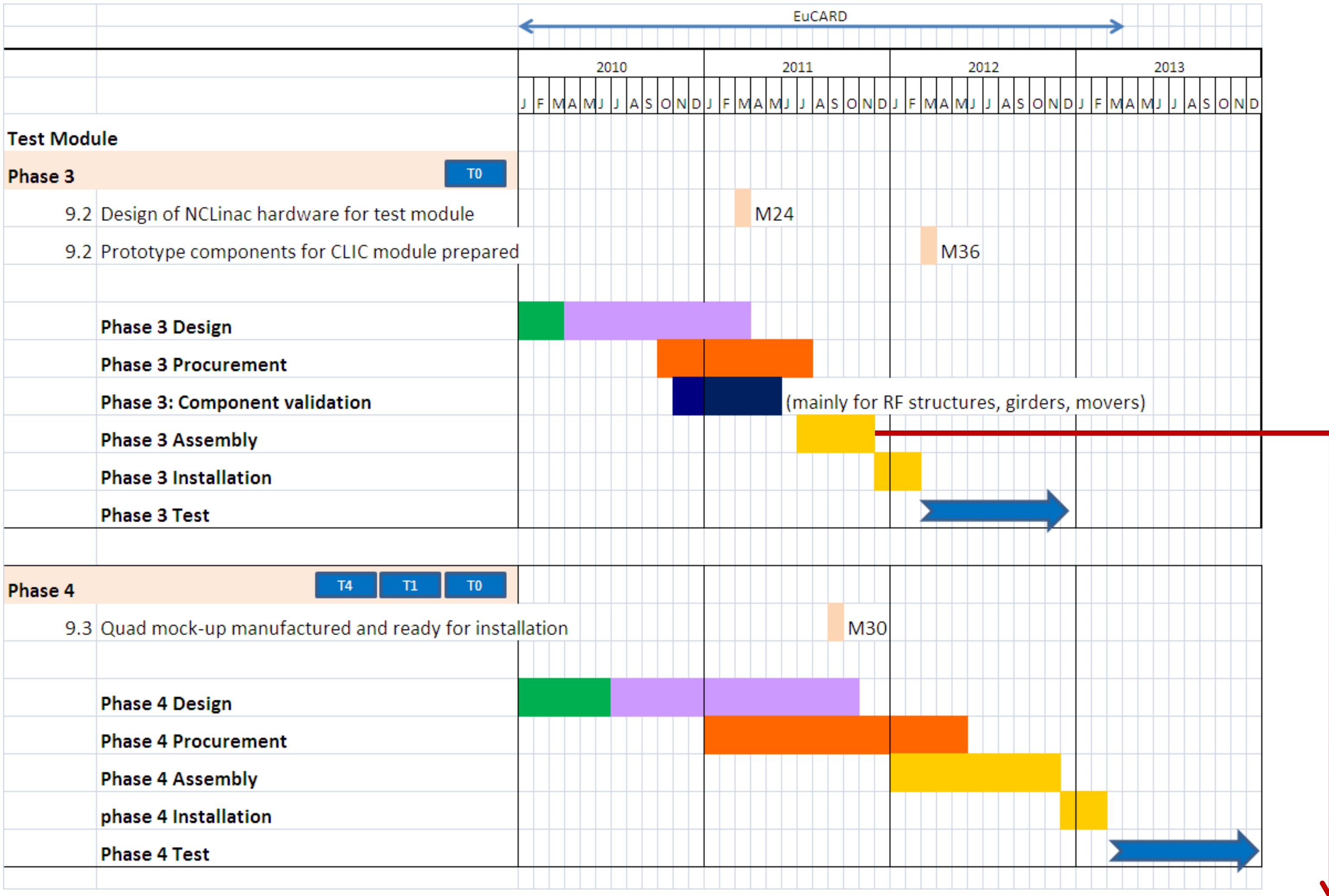


Double length PETS feeding two fully equipped accelerating structures each



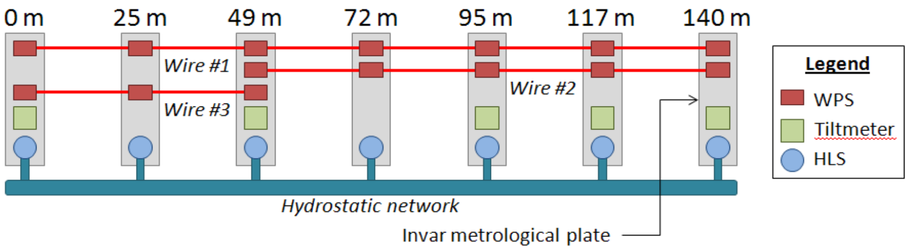
First module to be ready by 2012

Prototype module in CLEX- Schedule

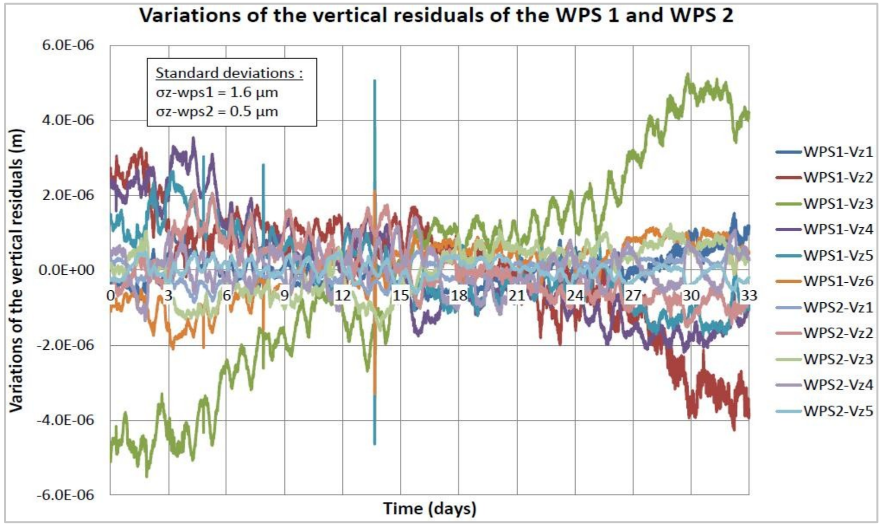


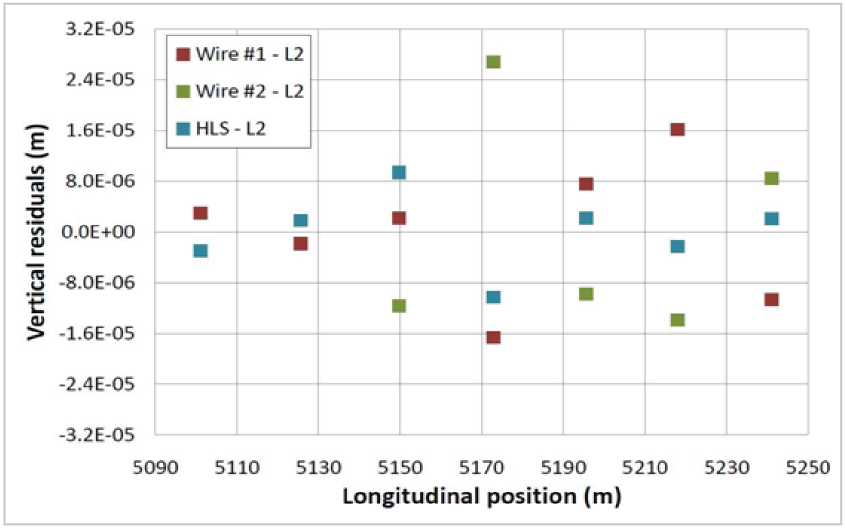
Availability of components depends on the feedback from the modules in the lab. and high power test of RF structures

Alignment



Results in TT1
- ✓ **Precision on a 140 m wire: better than 2 microns over 33 days**
- ✓ **Accuracy: 11 microns in vertical, 17 microns in radial. Can be improved!**





Vertical residuals of the 2 longest wires:

σ (wire 1) = 1.6 μm

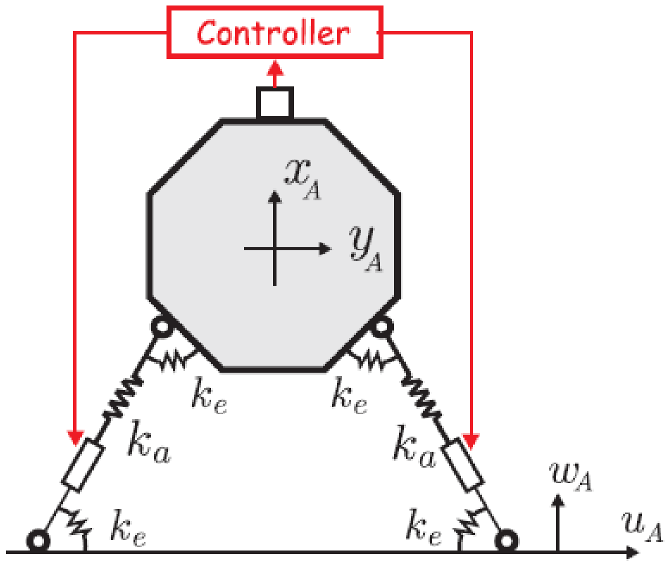
σ (wire 2) = 0.5 μm

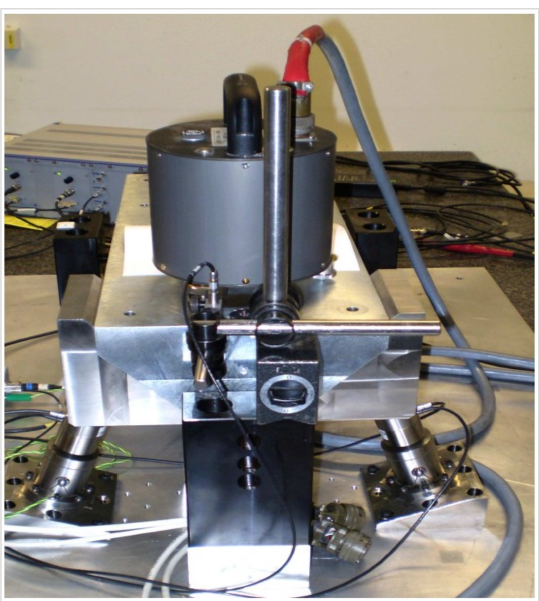
Accuracy of the TT1 network adjusted by the least squares method in vertical:

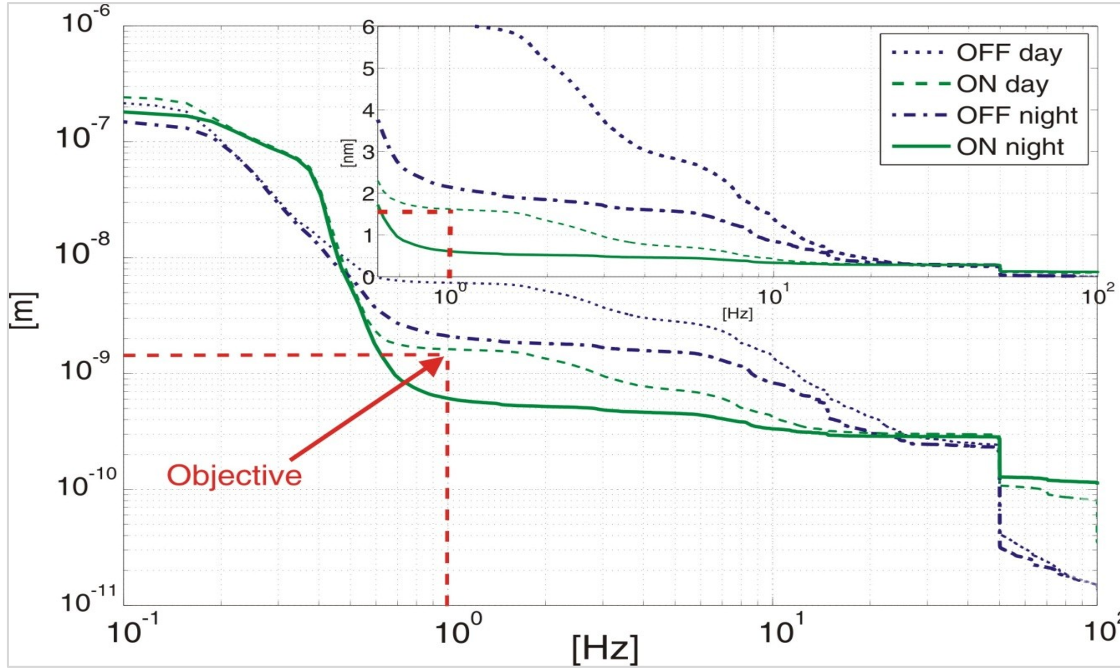
σ = 11 μm r.m.s (27 μm max. value)

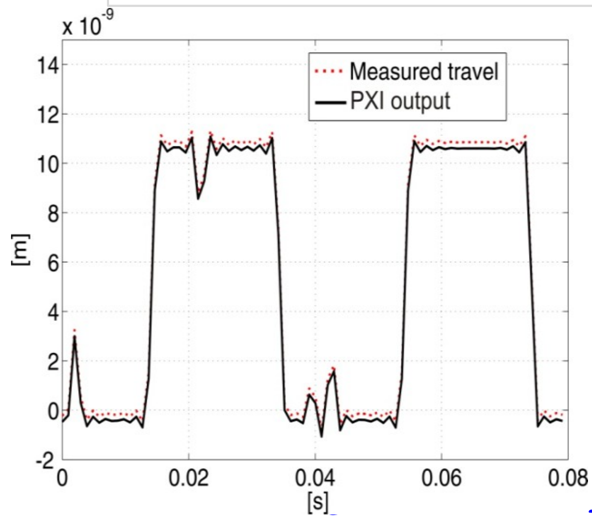
Subject of a PhD thesis: « Proposal of an alignment method for the CLIC linear accelerator: from the geodetic networks to the active pre-alignment » (T. Touzé)

Stabilization in sub-nanometer range (2 degrees of freedom)





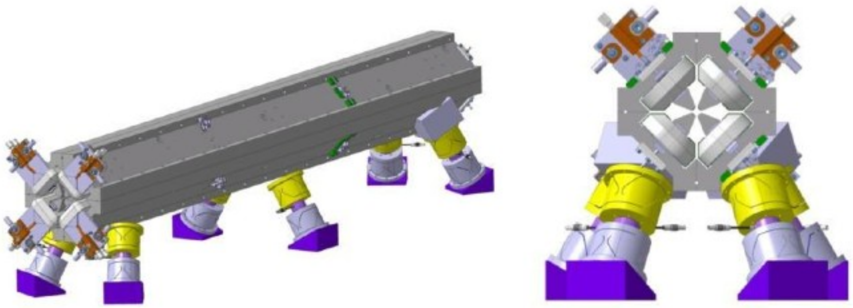


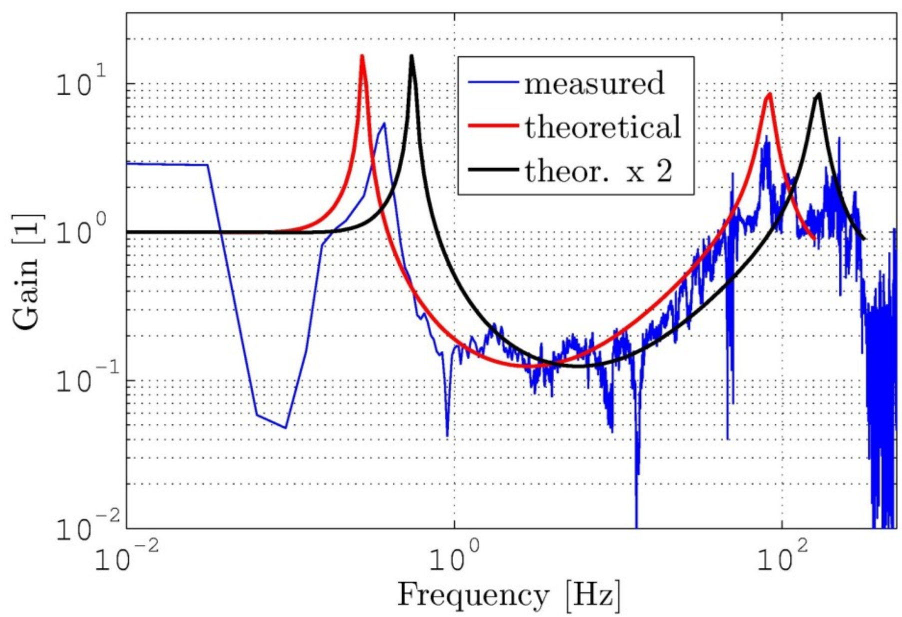


Objectives reached

Result:
0.6 nm at 1 Hz from 2.2 nm
day: 1.6 nm from 6.4 nm
0.44 nm at 4 Hz

Main Linac Quadrupole Stabilisation





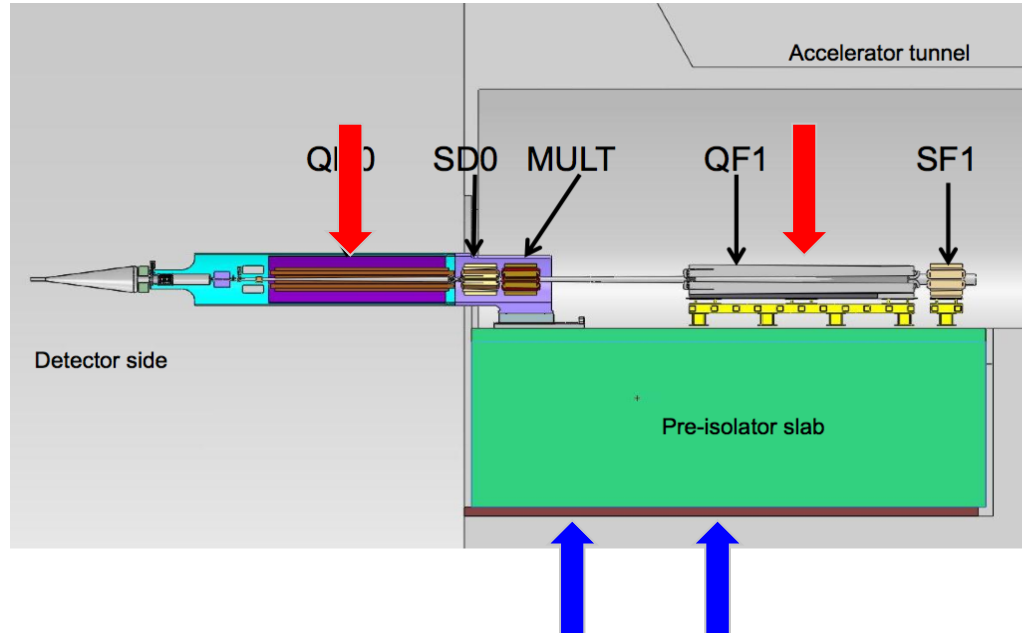
- System reduces quad movements above 1 Hz (int. RMS 1 nm)
- Reduces emittance growth and beam jitter for high frequencies

- Implemented transfer function into beam dynamics code
  - For the moment all elements are moved with transfer function
  - But magnets completely dominate the luminosity loss

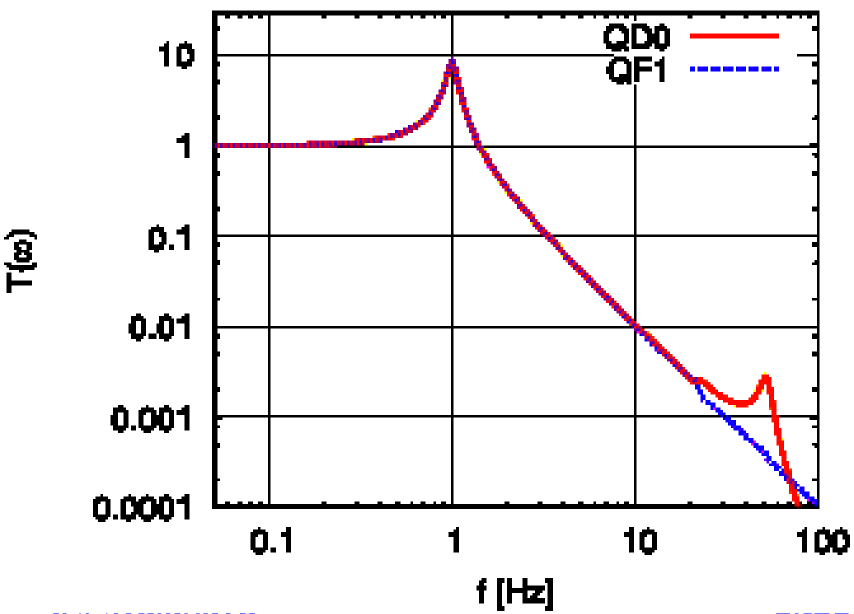
Taken from CERN stabilisation group

Pre-Isolator Transfer Function

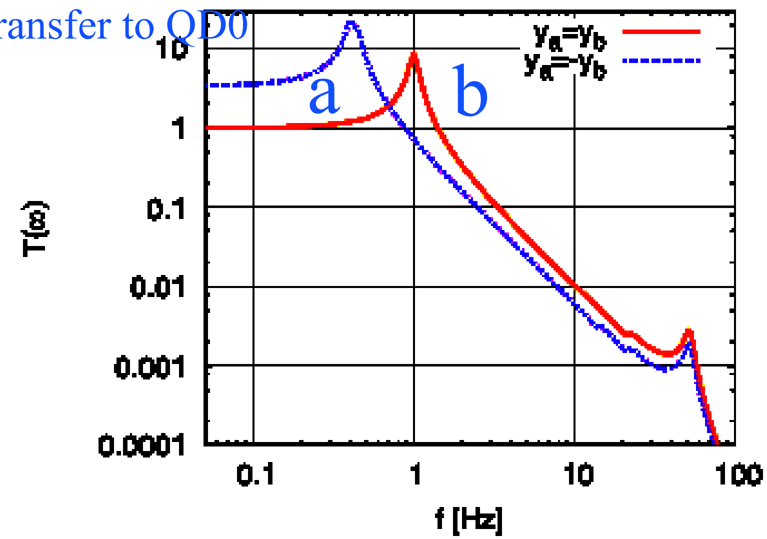
- QD0 supported by cantilever from Pre-isolator slab in the tunnel)
- Transfer function is complex
- Modified ground motion generator to correctly model this
- Further improved by an active stabilisation



Transfer for coherent motion

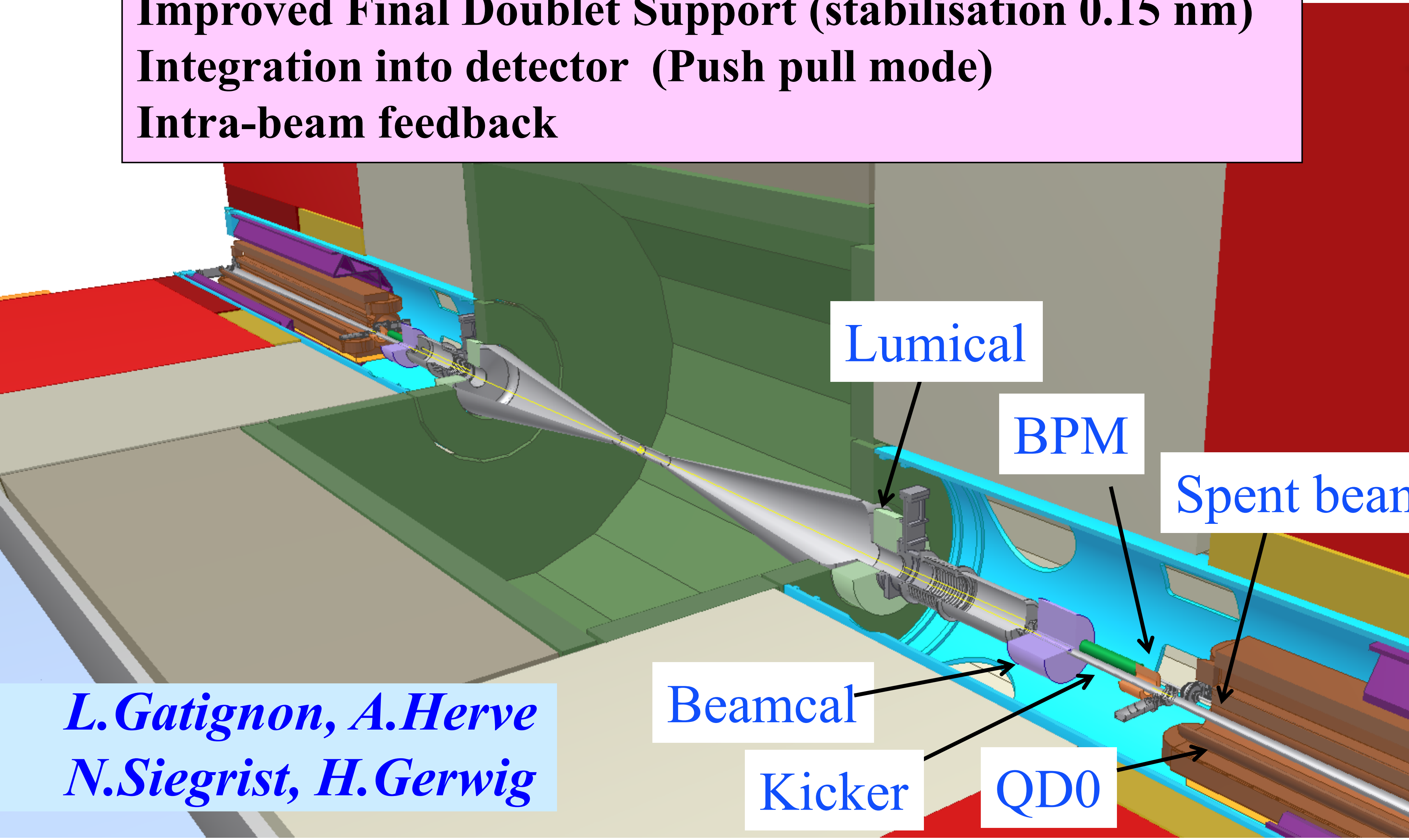


Transfer to QD0



Machine Detector Interface

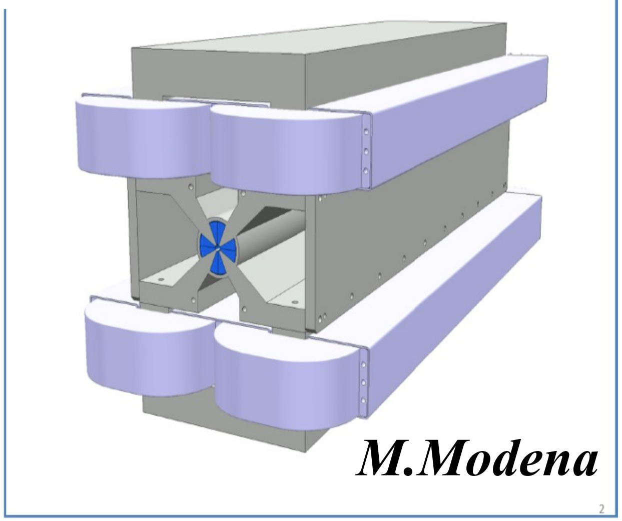
Improved Final Doublet Support (stabilisation 0.15 nm)
Integration into detector (Push pull mode)
Intra-beam feedback



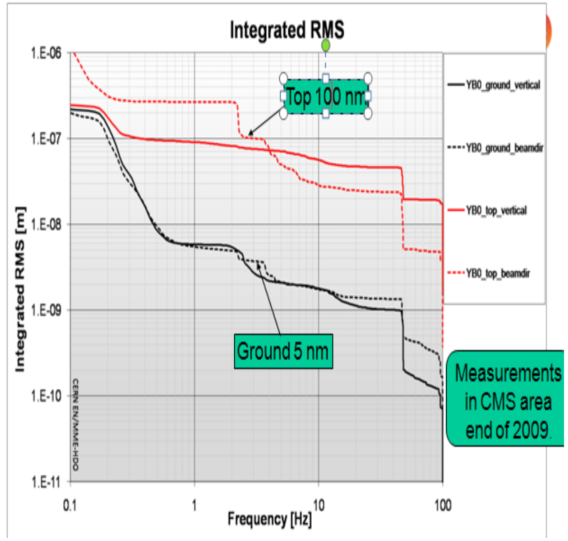
L.Gatignon, A.Herve
N.Siegrist, H.Gerwig

Final doublet integration & stabilisation

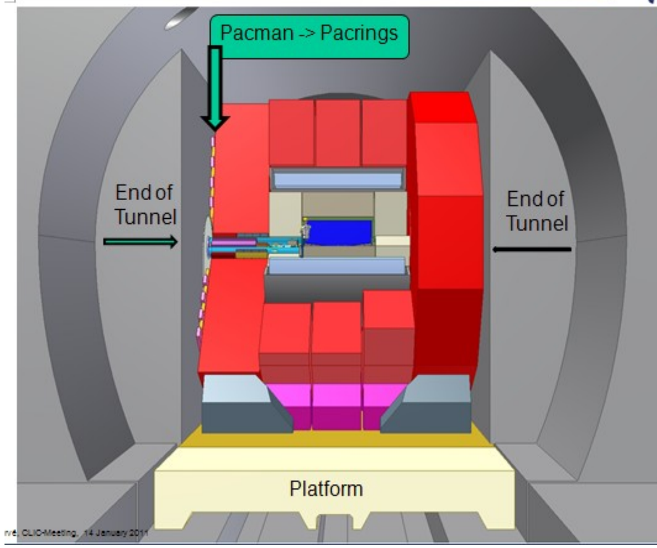
Hybrid QD0 permanent magnet stabilised with coils mounted independent of yoke



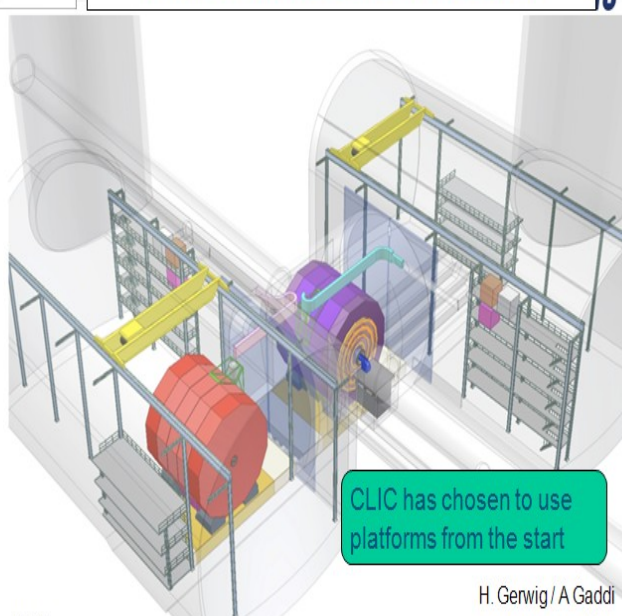
2-Decouple the QD0 support from the experiment



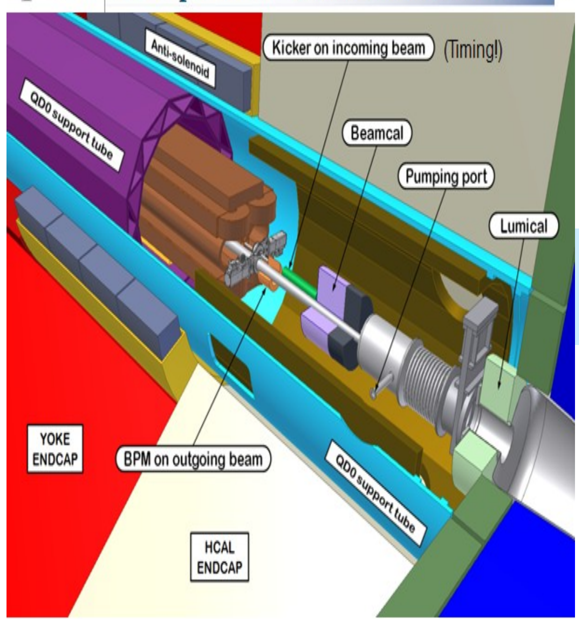
Minimize the length of the support tube



Push-Pull for CLIC detectors



5-Adopt the solution of a double tube

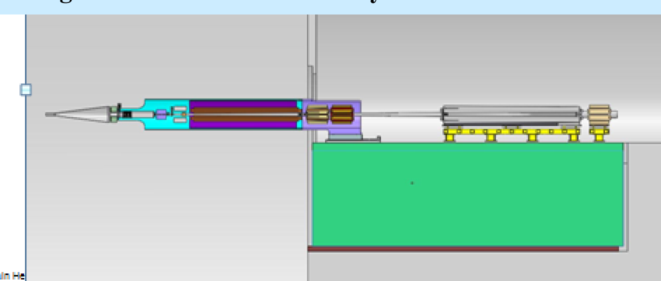


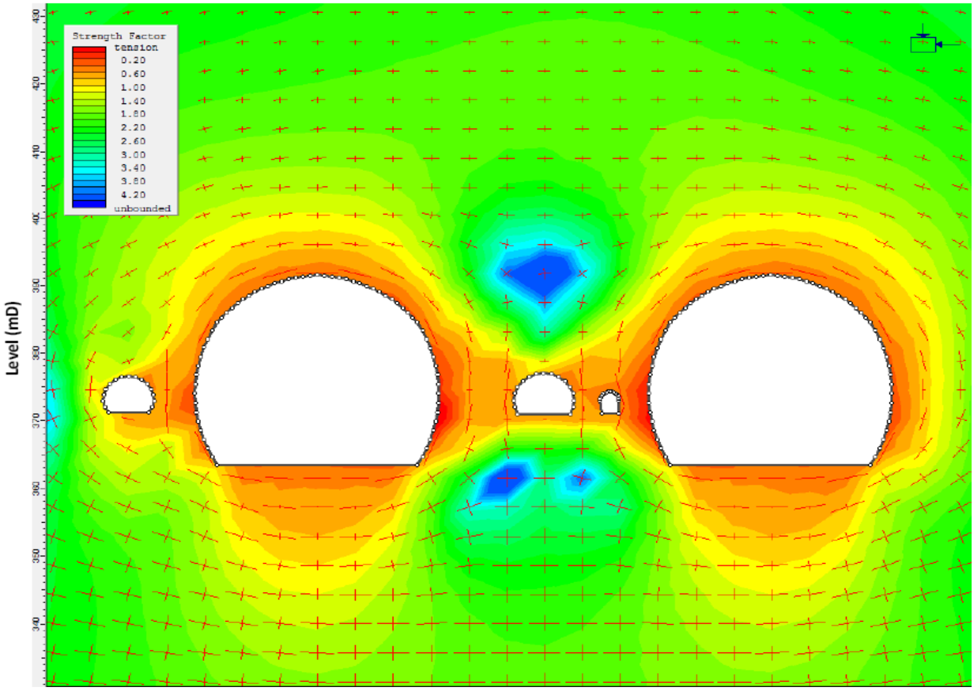
4-Support the QD0 and QF1 from a Pre-Isolator

(Andrea Gaddi et al. / CERN)

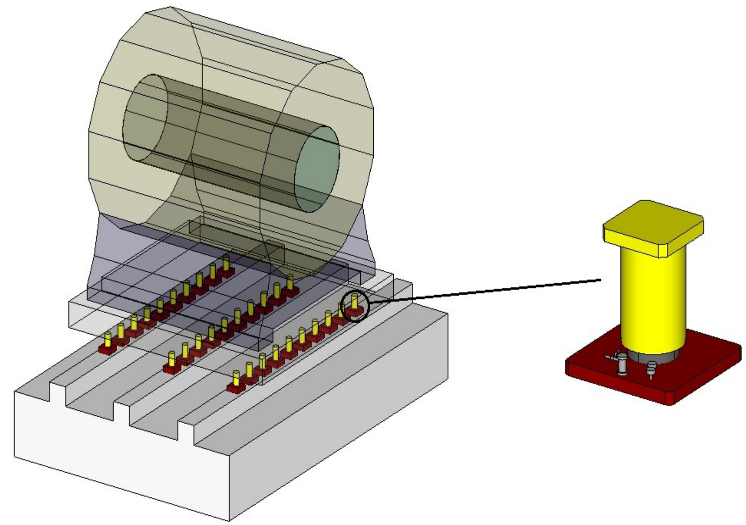
- The idea is to decouple and stabilize the support of QD0 and QF1.
- It must be connected to the active pre-alignment system to correct or low freq. (< 1 Hz) movements.

Concrete mass of ~ 80 tons mounted on calibrated springs.
Eigenfrequency ~ 1 Hz.
Designed to reduce vibrations by a factor of ~ 30.



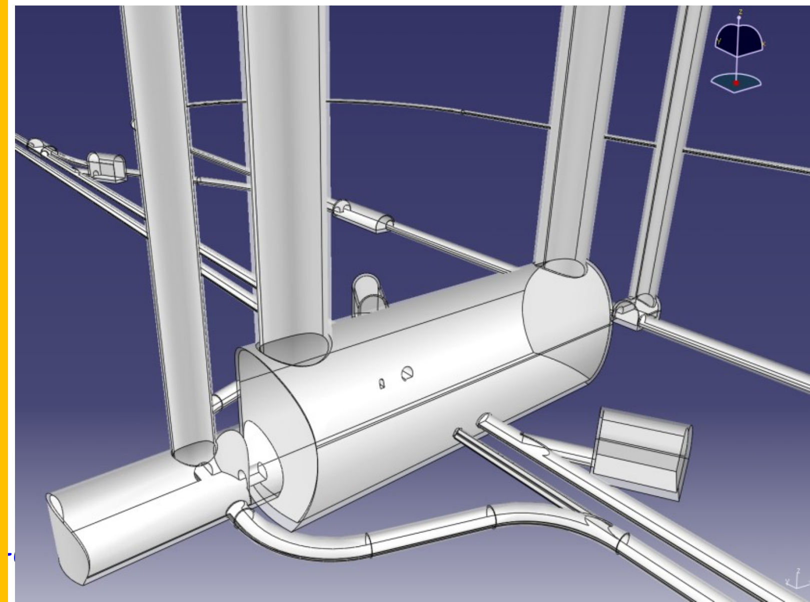


Close collaboration with ILC



The civil engineering design of the CLIC Interaction Region has been launched to specifically look at :

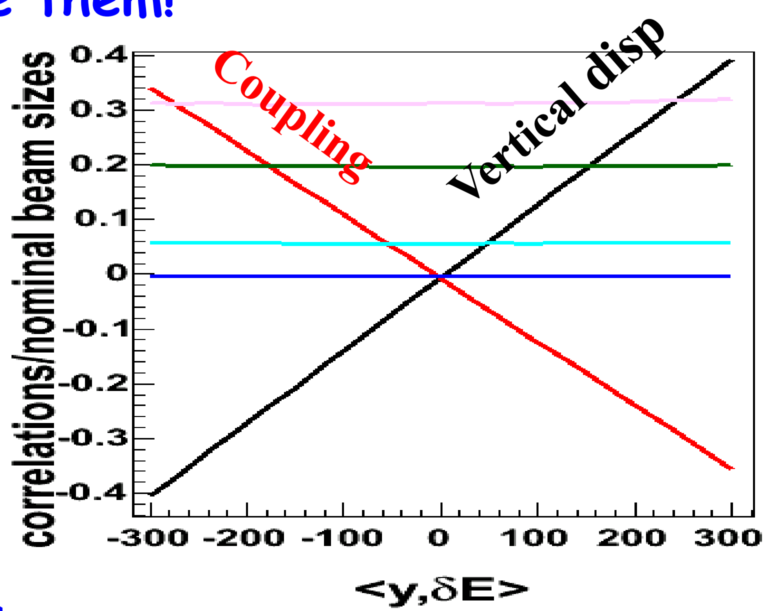
- The design of the concrete platform for detector movement
- The overall rock movements induced



Progress on BDS and tuning FFS with l=3.5m*

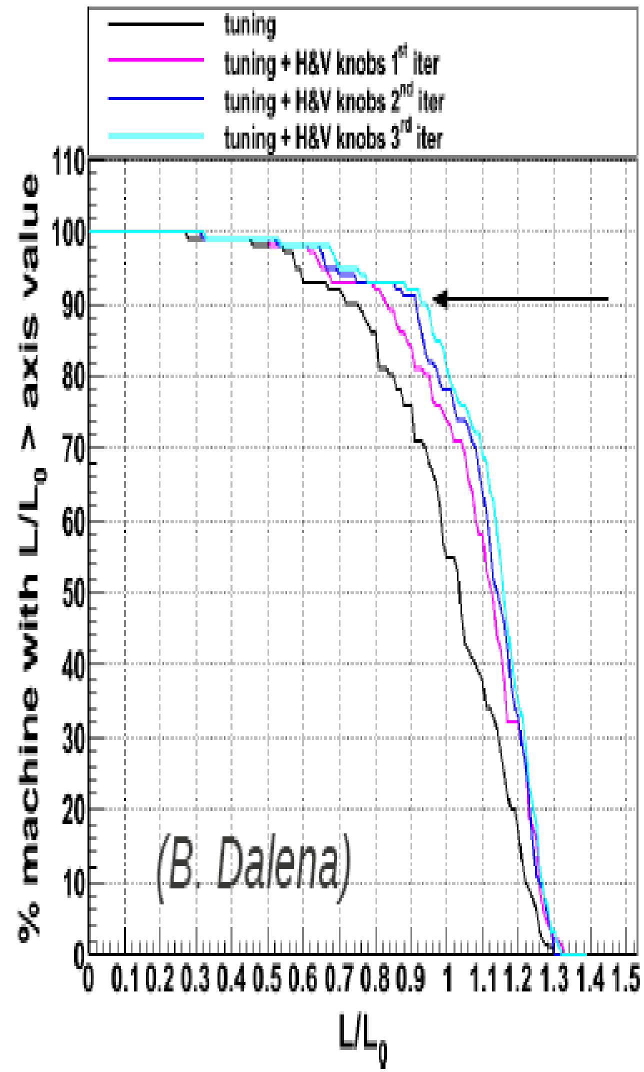
Designing knobs

- Knobs are combinations of the FFS sextupole H&V transverse displacements
- They are built to target relevant aberrations in an orthogonal way
- We have not managed to build orthogonal knobs yet but still we use them!



Vertical dispersion knob

Systematic use of (not ideal) knobs



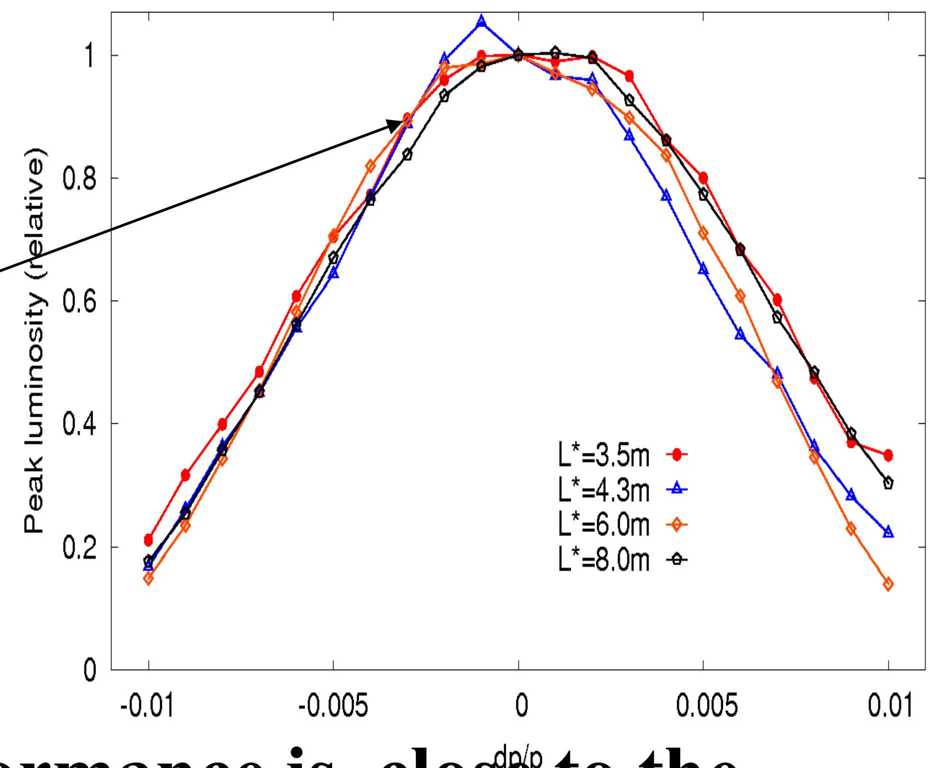
Two iterations of H&V knobs enough to reach 90% probability of 90% lumi !!! (goal is reached!)

Still to improve: # of iterations by improving the initial "brute force" tuning

The L*=6m FFS

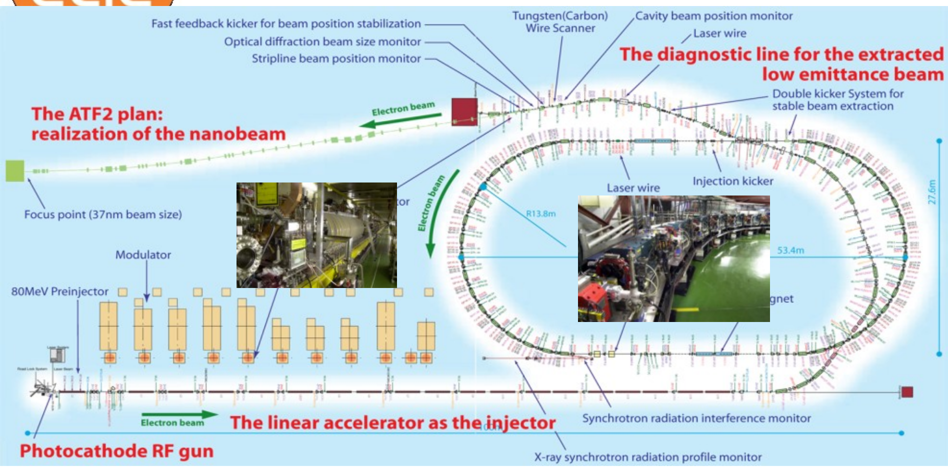
- Lumi=1.1L0 (larger than design but lower than for L*=3.5m)
- Bandwidth is similar
- Tuning 8µm prealign.: 80% prob. to reach 90% of L0 (without knobs!)

E bandwidths of all CLIC FFS



The L*=6m FFS performance is close to the current L*=3.5m. With a bit more effort we might be able to move QD0 out of the detector!

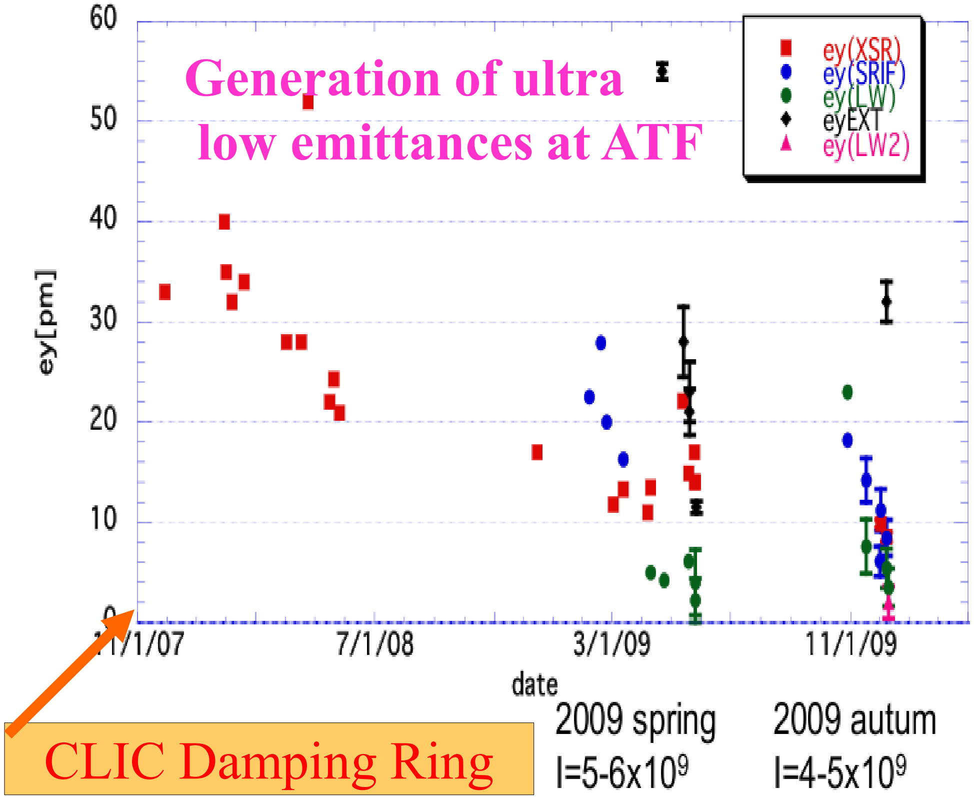
Fruitful collaboration with ATF/KEK

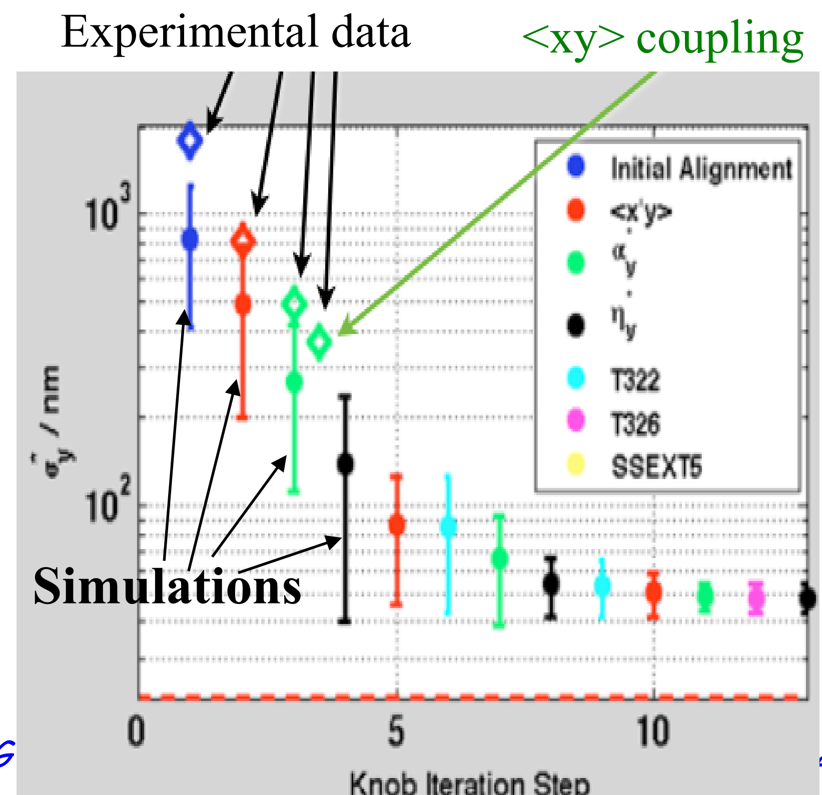


ATF2 commissioning - Dec 2010

- ATF2 & ATF2 ultra-low β* successes are critical for CLIC
- CERN contributes 2 “commissioners”:
  E. Marin & Y. Renier
- Dec. run: 300nm were reached with a MAPCLASS-optimized lattice

Simulations set good expectations for next run





Low Emittance Rings collaboration

- Initiated by the ILC-CLIC working group on damping rings
- Workshop in January 2010 at CERN identifying items of common interest among the low emittance … community (synchrotron light sources, LC de… …factories)
- Low emittance rings wo…
- A EU netwo… …pproval (FP7/ESGARD)
  - Intere… …worldwide

Next LER workshop being organized:
Oct 3-5, 2011 in Heraklion /Creta

	Low Emittance Network Tasks
1	Optics design of low emittance rings
2	Minimization of vertical emittance
3	Beam instabilities, impedances and vacuum
4	Instrumentation for low emittance
5	Design of fast kicker systems
6	Insertion device, magnet design and alignment
7	RF design

Conceptual Design Report: New strategy towards European Strategy for HEP

3 volumes: http://project-clic-cdr.web.cern.ch/project-CLIC-CDR/

- **Vol 1: The CLIC accelerator and site facilities (H.Schmickler)**
  - CLIC concept with exploration over multi-TeV energy range up to 3 TeV
  - Feasibility study of CLIC parameters optimized at 3 TeV (most demanding)
  - Application to 500 GeV as first stage and intermediate energy range
  - No cost figures (peer review postponed)
- **Vol 2: The CLIC physics and detectors (L.Linssen)**
- **Vol 3: CLIC study summary (S.Stapnes)**
  - Comprehensive summary for European Strategy
  - Staging scenario compatible with LHC Physics
  - Including cost issues and cost drivers for R&D mitigation in next phase
  - Proposing objectives and work plan of post CDR phase

Schedule:

Mid April 2011: Vol1, Contributions by individual Authors
mid July 2011: Vol1, Reviewed for consistency by Editorial Board
mid Sept 2011: Vol1, Completed and Processed
Dec 2011: Vol 1 presented @ SPC for comments
Spring 2012: Final Vol 1 and 2 + Vol3 to European Strategy for PP

CLIC Tentative Schedule

CTF3 Modulator (before-after fire)

Delay of CDR (fire in CTF3 Klystron gallery)
Towards European Strategy for Particle Physics (mid 2012)
Post CDR phase reviewed following Medium Term Plan

Final CLIC CDR & prop. Project Preparation Phase (PPP) @ European Strategy

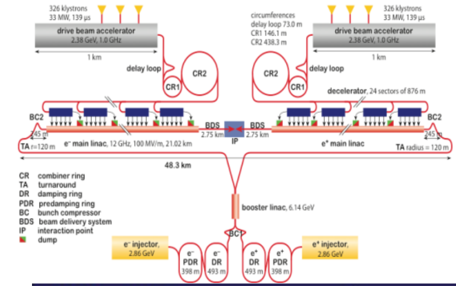
European Strategy for Particle Physics @ CERN Council

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Feasibility issues (Accelerator&Detector)									
Conceptual design & preliminary cost estimation									
Engineering, industrialisation & cost optimisation									?
Project Preparation									
Project Implementation									?

Draft Conceptual Design Report(CDR) (Acc.&Det.) to SPC

Project Implementation Plan (PIP) & proposal for next phase

Work-plan for the coming years

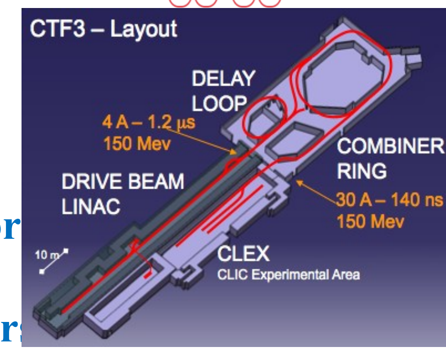


Before 2011 - CDR (2011), CLIC feasibility established

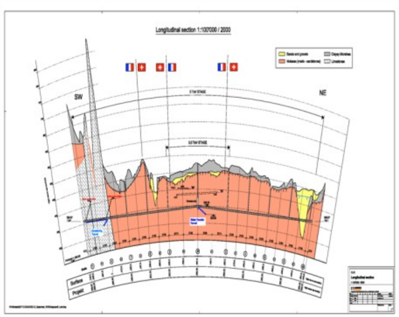
2011-2016 – Project Preparation Phase (PPP)

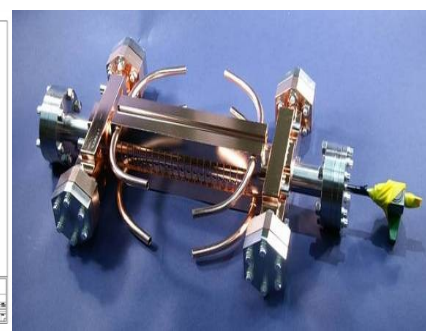
Goal : Develop a project implementation plan (PIP) for a Linear Collider :

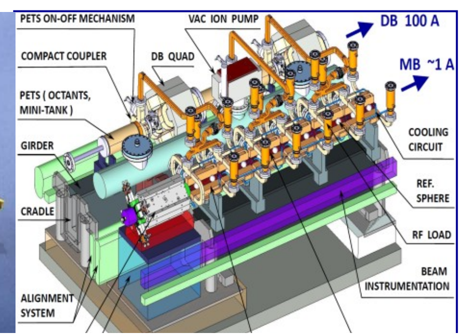
- ✓ **addressing the key physics goals as emerging from the LHC data**
- ✓ **with a well-defined scope (i.e. technical implementation and operation model, energy and luminosity), cost and schedule**
- ✓ **With solid technical basis for the key elements of the machine & detector**
- ✓ **including the necessary preparation for siting the machine at CERN**
- ✓ **within a project governance structure defined with international partners**



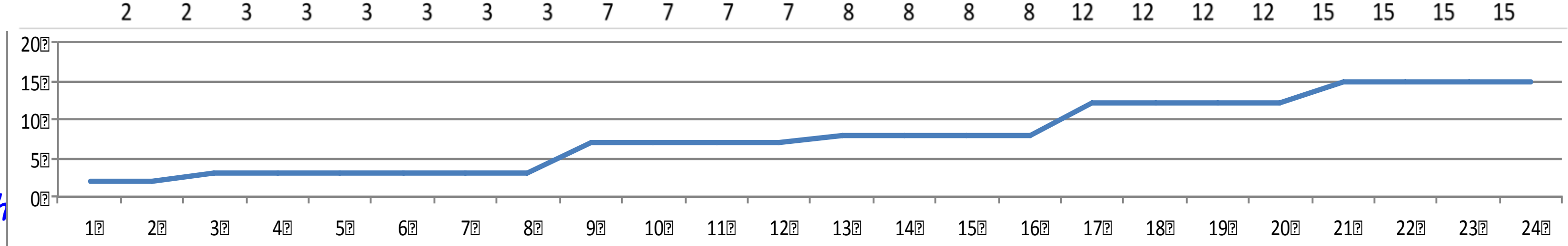
After 2016 – Project Implementation Phase, including initial period to lay the grounds for full approval







	2011				2012				2013				2014				2015				2016			
number of rf ports	2	2	3	3	3	3	3	3	7	7	7	7	8	8	8	8	12	12	12	12	15	15	15	15



The next steps – focusing points

In order to achieve the overall goal for 2016 the following four primary objectives for 2011—16 can be defined:

- to be addressed by activities (studies, working groups, task forces) or work-packages (technical developments, prototyping and tests of single components or larger systems at various places)

Define the scope, strategy and cost of the project implementation. Main input:

- The evolution of the physics findings at LHC and other relevant data
- Findings from the CDR and further studies, in particular concerning minimization of the technical risks, cost, power as well as the site implementation.
- A Governance Model as developed with partners.

Define and keep an up-to-date optimized overall baseline design that can achieve the scope within a reasonable schedule, budget and risk.

- Beyond beamline design, the energy and luminosity of the machine, key studies will address stability and alignment, timing and phasing, stray fields and dynamic vacuum including collective effects.
- Other studies will address failure modes and operation issues.

Indentify and carry out system tests and programmes to address the key performance and operation goals and mitigate risks associated to the project implementation.

- The priorities are the measurements in: CTF3+, ATF and related to the CLIC Zero Injector
- System-tests related to verification of some of the issues mentioned under 2) needed .... still to be specified (technical work-packages and studies addressing system performance parameters)

Develop the technical design basis. i.e. move toward a technical design for crucial items of the machine and detectors, the MD interface, and the site.

- Priorities are modulators/klystrons, module/structure development including testing facilities, & site studies (technical work-packages providing input and interacting with all points above)

"Resource – drivers"

preliminary

Cost studies, Civil engineering, Proj,Implementati	Update and improve CLIC cost model & civil engineering studies	• Technical Design (TD) and Project Implementation Plan (PIP) of CLIC Zero • Improved cost model, feedback to CLIC baseline review	4 MCHF
Beam physics studies	Beam physics and overall design	• Review of the CLIC baseline design • Stability and alignment, timing and phasing, stray fields and dynamic vacuum • Studies towards CLIC Zero	3 MCHF
CTF3 +	CTF3 consolidation and upgrade	• Consolidation and upgrade (higher energy, stability, reliability) • Drive beam phase feed-forward experiments • Upgrade and operate TBL as 12 GHz power production facility • Operation with beam of a long string of CLIC two-beam modules	25 MCHF
CLIC Zero	Injector for the CLIC drive beam generation complex	• Build and commission 30 MeV Drive Beam injector with nominal CLIC parameters • Build and commission a few Drive Beam accelerator nominal modules • Participation to Technical Design of full CLIC Zero facility	30 MCHF
RF Structures	design and fabrication of 12 GHz accelerating structures & PETS and associated R&D	• Build and test about 120 accelerating structures • Build and test about 10 PETS prototype • Establish quality control, brazing and assembly procedures for structure fabrication at CERN • Precision machining center at CERN	29 MCHF
RF test infrastructure	Building, commissioning and operation of high-power RF test stands	• Four 12 GHz klystron-based RF high-power test stations, for about 8 slots, running before 2016 • Continue high-power testing at 11.4 GHz (KEK and SLAC) • Contribution to high-power testing in CTF3+ (TBL)	13 MCHF
Prototypes of critical components	Technical R&D – design, build and test prototypes of CLIC critical components	• R&D and prototypes of two-beam modules alignment and stabilization systems • Prototype of final focus quadrupole and stabilization system • Several nominal CLIC two-beam modules, mechanically tested, possibly beam tested • R&D and prototyping of critical beam instrumentation • Design and studies of machine protection system • DR superconducting wiggler prototypes, test with beam, extraction kickers prototypes • Dynamic vacuum assessment • Contribution to the CLIC Zero • DB RF system and powering	40 MCHF++

Total: 150 MCHF

Project preparation Phase (PPP) - Preliminary schedule

<table>
<tr><th></th><th colspan="4">2010</th><th colspan="4">2011</th><th colspan="4">2012</th><th colspan="4">2013</th><th colspan="4">2014</th><th colspan="4">2015</th><th colspan="4">2016</th></tr>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>1</th><th>2</th><th>3</th><th>4</th><th>1</th><th>2</th><th>3</th><th>4</th><th>1</th><th>2</th><th>3</th><th>4</th><th>1</th><th>2</th><th>3</th><th>4</th><th>1</th><th>2</th><th>3</th><th>4</th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>CTF3 TBTS operation</td><td>inst.</td><td colspan="7">1-2 structures, beam loading, breakdown kick</td><td colspan="20"></td></tr>
<tr><td>CTF3 TBL operation</td><td colspan="2">inst.</td><td colspan="2">Decelerati on 8 PETS</td><td colspan="4">final decelerator test (16 PETS, 50%)</td><td colspan="20"></td></tr>
<tr><td>Modules lab</td><td colspan="4">initial tests, installation 2 modules</td><td colspan="4">further tests, installation 4 modules</td><td colspan="8">testing</td><td colspan="12">pre-series production, industrialization</td></tr>
<tr><td>Modules CTF3</td><td colspan="7"></td><td colspan="2">1 module inst.</td><td colspan="2">testing 1 module</td><td colspan="2">3 modules inst.</td><td colspan="7">testing 3 modules</td><td colspan="8">> upgrades?</td></tr>
<tr><td>CTF3 phase feedback</td><td colspan="7">design, hardware tests</td><td colspan="2">installatio n</td><td colspan="7">testing</td><td colspan="12"></td></tr>
<tr><td>CTF3 TBL+</td><td colspan="7"></td><td colspan="2">installatio n</td><td colspan="2">commissi o-ning</td><td colspan="17">RF testing, potential upgrades</td></tr>
<tr><td>CLIC DB injector & linac / CLIC 0-</td><td colspan="6">design</td><td colspan="5">component construction (injector)</td><td colspan="2">installatio n (inj)</td><td colspan="3">commissioning (inj)</td><td colspan="12">staged upgrade & testing</td></tr>
<tr><td>RF structures construction</td><td colspan="4">precision metrology, fabr. procedures</td><td colspan="12">up to 40 structures built, establish precision machining at CERN or elsewhere, 5 μm tolerances achieved</td><td colspan="12">more than 200 structures built, final cost optimization, pre-series with industry</td></tr>
<tr><td>RF test infrastructure</td><td colspan="2">CERN test stand inst.</td><td colspan="6">CERN test stand testing and upgrades (at least two slots)</td><td colspan="8">continue testing with increased capabilities, CERN or elsewhere, up to 10 slots</td><td colspan="12">testing, up to 200 accelerating structures plus PETS and RF components</td></tr>
<tr><td>Prototypes of critical components</td><td colspan="8">technical choices, design</td><td colspan="8">construction, hardware tests</td><td colspan="12">finalization, performance & cost optimization, industrialization for large scale components</td></tr>
<tr><td>Other systems, Civil Engineering…</td><td colspan="4">detailed program definition</td><td colspan="12">first phase (CDR baseline)</td><td colspan="12">second phase (new baseline ?, project implementation plan)</td></tr>
<tr><td>Beam physics studies</td><td colspan="6">CDR activities, feasibility studies</td><td colspan="10">Performance and cost optimization</td><td colspan="12">new baseline? Preparation for commissioning, operational scenarios…</td></tr>
</table>

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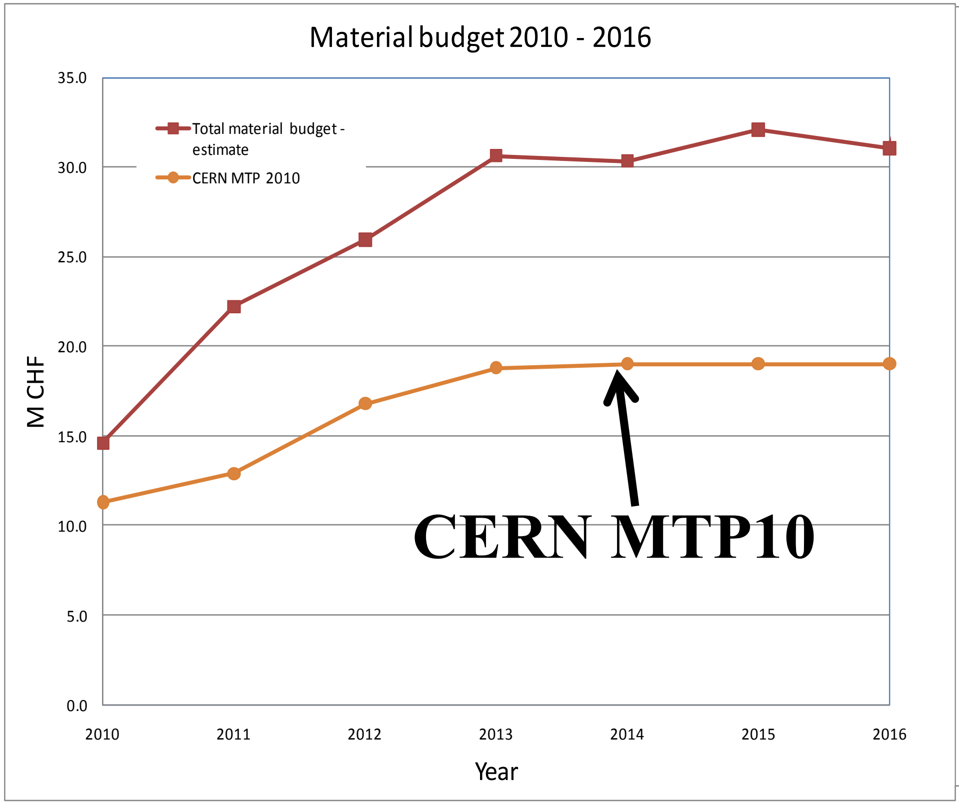
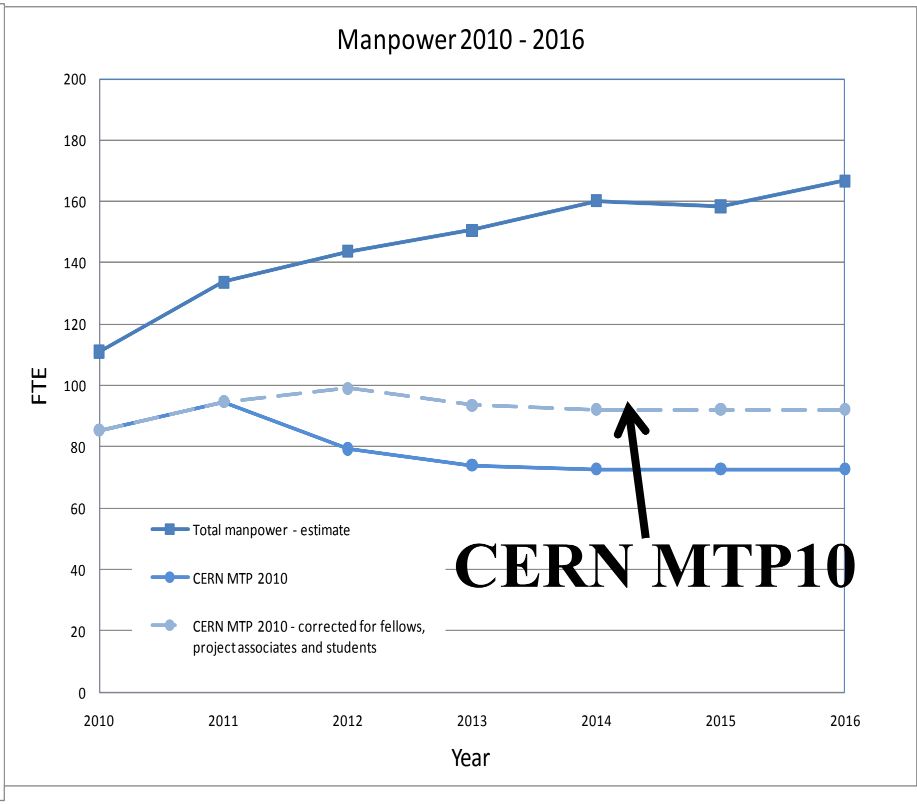
Resources

Required: 150 MCHF and 600 FTE (2012-16)





Available @ CERN (MTP10): 100 MCHF and 400FTE
Expected from Collaborators: 50 MCHF and 200 FTE

Conclusion

- 2011 critical and transition year (not only for me)!
- CLIC concept and Feasibility studies described in CDR (end 2011) towards European HEP Strategy (Spring 2012)
  - Exploration of multi-TeV energy range up to 3 TeV
  - Design optimized at 3 TeV (most demanding) and R&D focused on corresponding feasibility issues
  - Findings on performances & limitations by technology risks,power& cost
  - Staging scenario with parameters range compatible with LHC Physics
- Strong R&D on risk, performance, power and cost issues during Project Preparation Phase (PPP) from 2012 towards a Project Implementation Plan (PIP) in 2016
  - addressing the key physics goals as emerging from the LHC data
  - with a well-defined scope (i.e. technical implementation and operation model, energy and luminosity), cost and schedule

CLIC progress (present and future) deeply relying on CLIC collaboration and with ILC

Towards joint LC community