Perspectives for the TDR phase after 2010

R. Corsini for the TDR Phase Task Force

Talk outline

- Introduction
  - Motivation – the CLIC roadmap
  - The TDR task force, boundary conditions
  - Initial ideas - CLIC Zero
- Status of detailed analysis
  - Divided by areas
  - Projected status in 2010
  - Mid term goals (2010-2012)
  - Long term goals (2013-2016)
- Conclusions & Outlook

Disclaimer

- Work in progress – different stages of advancement in different areas
- Contributions from many people, inside & outside the task force
- I present here my personal views (no time to close the loop) (so I take the blame...)
- Need feed-back from ACE (and from the whole CLIC study team)

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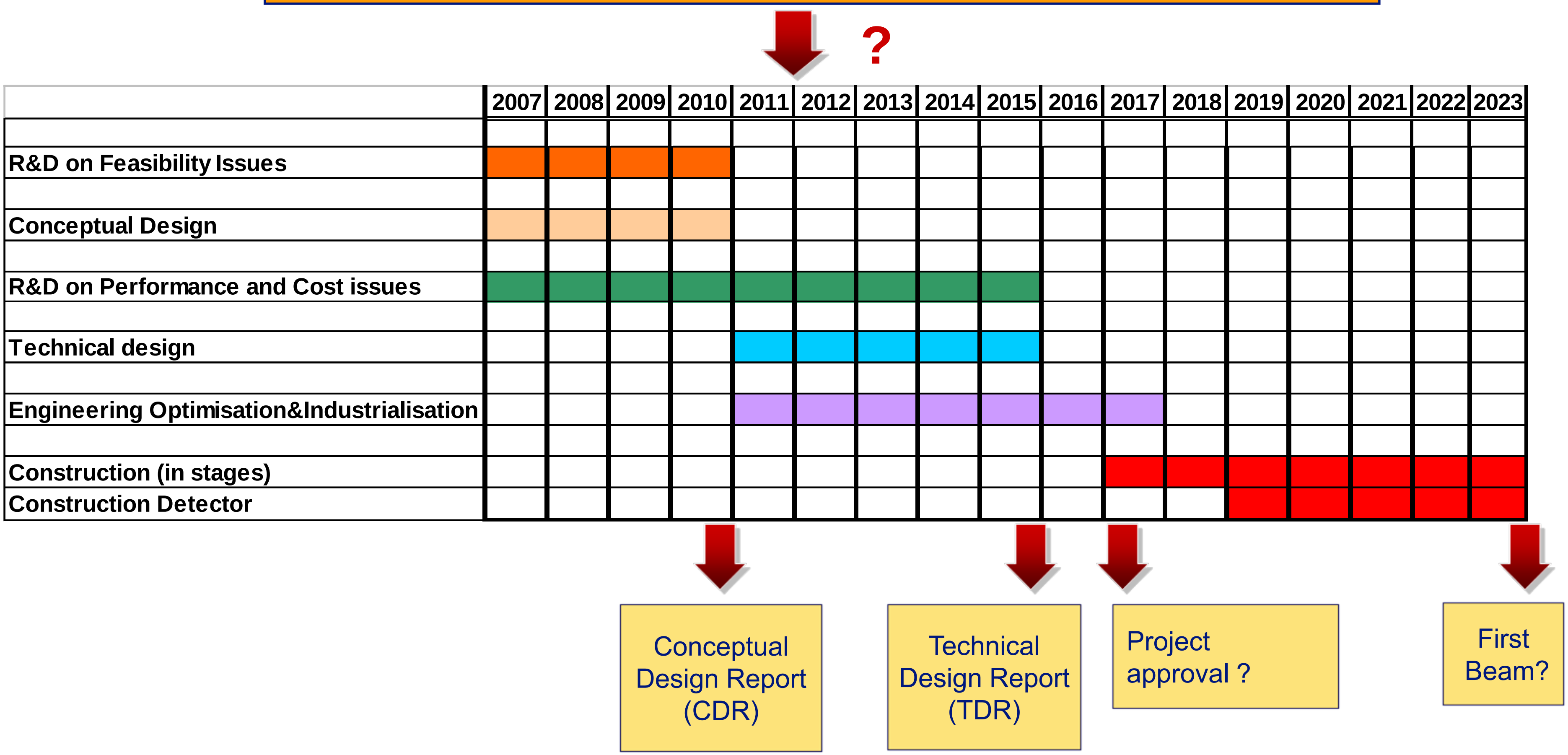
R. Corsini, 8.5.2009

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



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Work Plan until 2010:

- Demonstrate feasibility of CLIC technology (R&D on critical feasibility issues)
- Design of a linear Collider based on CLIC technology
  http://clic-study.web.cern.ch/CLIC-Study/Design.htm
- Estimation of its cost (capital investment & operation)
- CLIC Physics study and detector development
  http://clic-meeting.web.cern.ch/clic-meeting/CLIC_Phy_Study_Website/default.html

Conceptual Design Report to be published in 2010 including:

- Physics, Accelerator and Detectors
- Results of feasibility study
- Preliminary performance and cost estimation

R&D Issues classified in three categories:

- critical for feasibility → fully addressed by specific R&D to be completed before 2010; results in CDR
- critical for performance
- critical for cost → being addressed now by specific R&D to be completed before 2015; first assessments in CDR; results in Technical Design Report (TDR) with consolidated performance & cost

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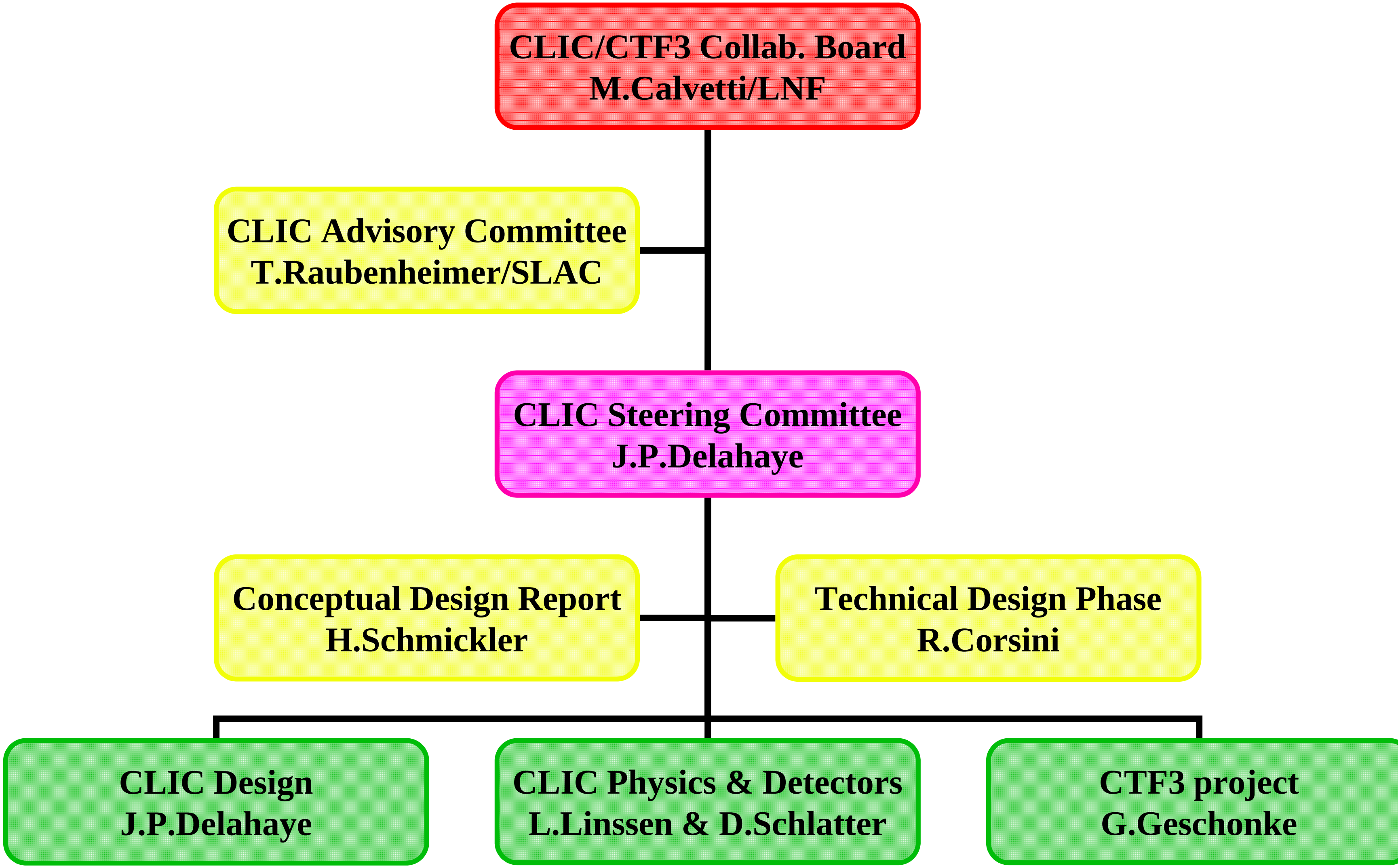

CLIC TDR phase preparation task force - Mandate

- Analysis of the issues still to be addressed:
  - completion of the feasibility related issues if necessary
  - performance and cost related issues
- Elaborate a *proposal of the necessary tasks to be done from mid 2010 up to 2015/16*.

  That should include in particular the motivation, description and expected results of:
  - A possible upgrade of CTF3
  - A possible new facility if necessary
  - R&D on specific subjects
  - Prototyping of critical items
  - Industrialization of major components
  - Finalization of design and cost
  - Technical Design Report including consolidated performance and cost
- *Estimate the (M&P) necessary resources and timescale*
- Describe the proposal (concerning both accelerator and detector) in a document to be available by mid 2009 with a preliminary report of the main strategy by May 2009 for discussion at the ACE
- Members of the Task Force:
  - for the Accelerator part: R.Corsini (chair), J.P.Delahaye, S.Doebert, G.Geschonke, A.Grudiev, H.Schmickler, D.Schulte, I.Syratchev, W.Wuensch
  - for the Detector part: L.Linssen, D.Schlatter

What's required for a TDR?

Should be enough to seek project approval and receive funding to build CLIC

- All major feasibility issues satisfactorily solved

- Technical design of all components which are critical for schedule
- Technical feasibility of all components shown
- Working prototypes for all critical technologies

- Detailed site consideration
- Detailed construction schedule
- Detailed material cost and manpower resource estimates and risk analysis

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What hardware work is desirable for the TDR ?

Full technical design, *prototypes and industrialization* for all schedule critical items:

- Nominal two beam modules with all features this includes accelerating structures & PETS
- Drive beam accelerator units (modulator, klystron, RF network, accelerating structure)
- ...

Full technical design and *prototypes* (when applicable) for all critical components

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Some issues to be considered

- R&D on low emittance generation (ATF, SR sources, …)
- R&D on low emittance transport (SLC heritage, Linac driven FEL's, …)
- R&D on CLIC final focus parameters and stability (ATF2, …)
- R&D of injector parameters (polarised e^-, unpolarised and polarised e^+)
- Integration of R&D program with other relevant facilities around the world
- …

Future facilities should provide

- Engineering test-bed for critical components and industrialization of mass produced components
- Make a convincing case for project readiness
- Provide X-band RF testing capabilities

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CERN DG's talk to Staff
3 October '08

Prospects for Scientific Activities over the Period 2012 - 2016

To be decided in 2010-2011 in light of first physics results from LHC, and designed and R&D results from the previous years. This programme could most probably comprise:

- An LHC luminosity increase requiring a new injector (SPL and PS).

  The total cost of the investment over 6 years (2011-2016: 1000-1200 MCHF + a staff of 200-300 per year. Total budget: ~200-250 MCHF per year.

- Preparation of a Technical Design for the CLIC programme, for a possible construction decision in 2016 after the LHC upgrade (depending on the ILC future).
  Total CERN M + P contribution + ~250 MCHF + 1000-1200 FTE over 6 years.

- Enhanced infrastructure consolidation: 30 MCHF + 40 FTEs from 2011.

NB: Over the period 2012-2016. Effective participation of CERN in another large programme (ILC or a neutrino factory) will not be possible within the expected resources if positive decisions taken on LHC upgrade and CLIC Technical Design. This situation could totally change *if none of the above programmes is approved* or if a new, more ambitious level of activities and support is envisaged in the European framework.

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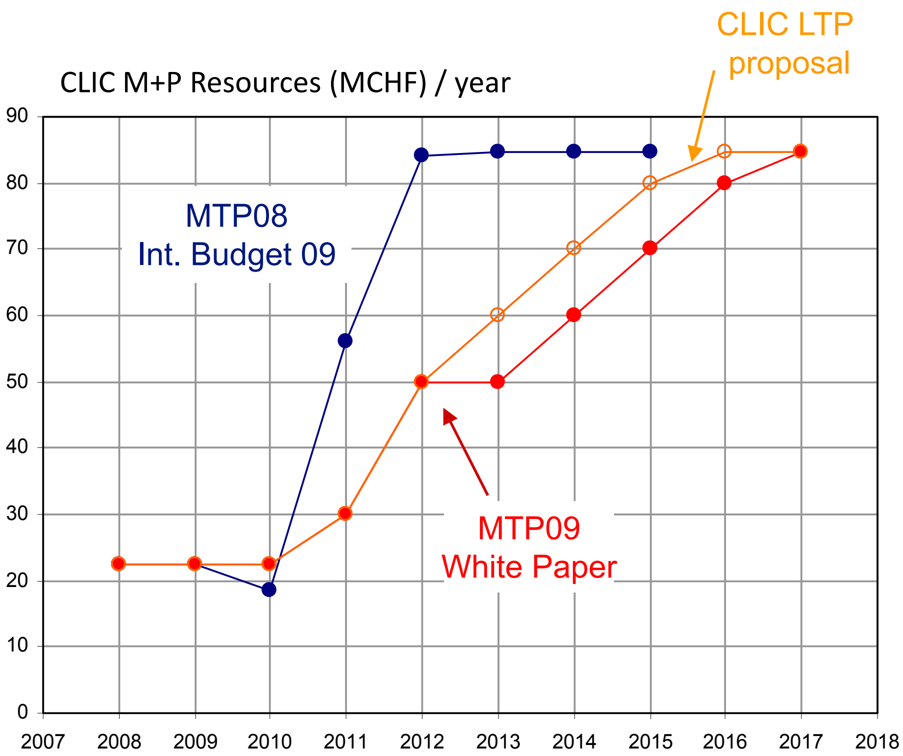
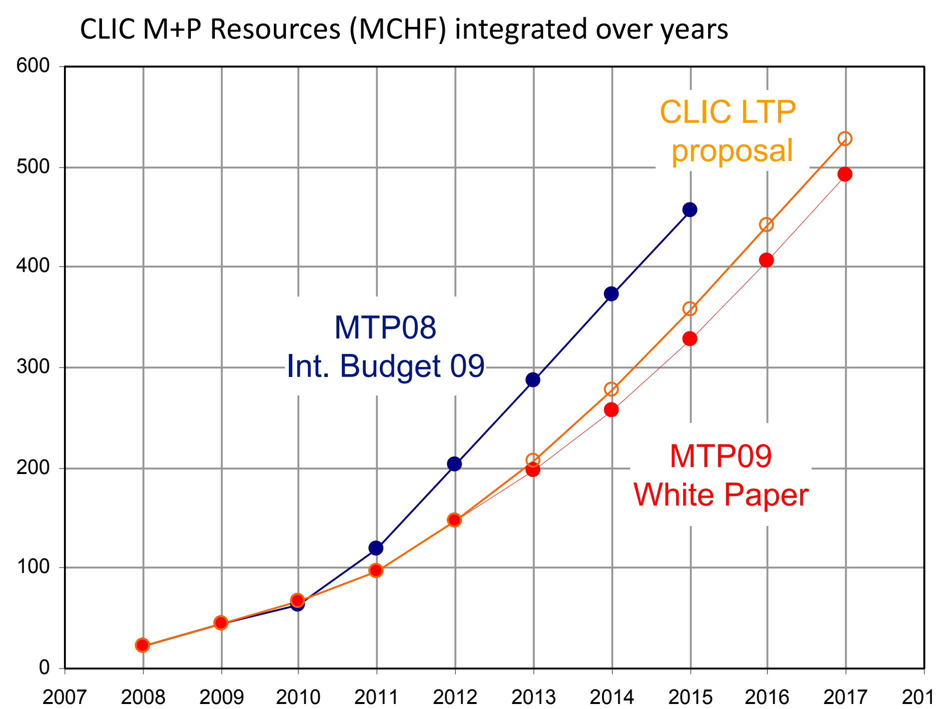
CERN MTP





Expect additional resources from collaborators (from ½ to about the same level)

EuCARD - FP 7

NClinac (2009-2013) - beginning 1st April 2009

Total: 6,562,118 €, EC request: 2,001,478 €

11 Partners

Short name	Full name and hyperlink	Country
CERN	European Organization for Nuclear Research	INO
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	Spain
CNRS/LAPP	Centre National de la Recherche Scientifique	France
INFN/LNF	Istituto Nazionale di Fisica Nucleare	Italy
PSI	Paul Scherrer Institut	Switzerland
RHUL	Royal Holloway University of London	UK
STFC/ASTeC	Science and Technology Facilities Council	UK
UH	Helsingin Yliopisto (University of Helsinki)	Finland
UNIMAN	University of Manchester - Cockcroft Institute	UK
UOXF-DL	The Chancellor, Masters and Scholars of the University of Oxford	UK
UU	Uppsala Universitet	Sweden

Task 9.2: Normal Conducting High Gradient Cavities (G. Riddone/CERN)

Task 9.3: Linac and FF Stabilisation (A. Jeremie/LAPP)

Task 9.4: Beam Delivery System (G. Blair/RHUL)

Task 9.5: Drive Beam Phase Control (F. Marcellini/LNF)

\+ EuCARD Task 10.3:Task “Crab cavities” in WP “SRF” and EuCARD Task 7.6: “Short period helical superconducting undulator” in WP “HFM”

EuCARD - FP 7, some comments

- Not really relevant financially (looking at the final EU contribution)

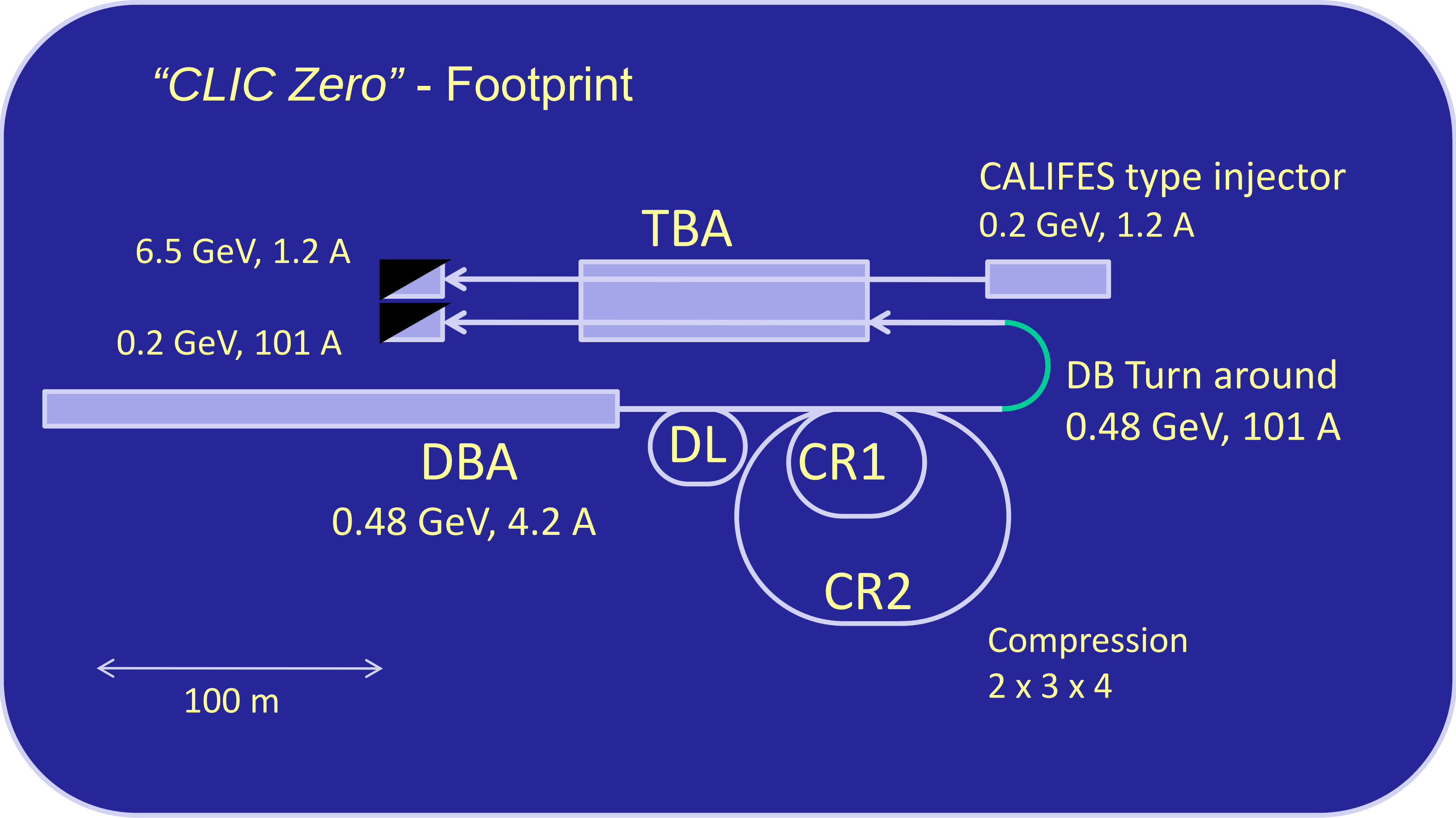
- However, very important for CLIC:
  - Network with collaborating partners
  - Represents an engagement on R&D in the 2009-2013 period

- Note that the scope and size of the present program had been drastically reduced from the initial proposal

- Need to integrate FP7 in the TDR plan & use TDR resources to re-establish initial FP7 plans (when appropriate).

Initial proposal: A next facility towards CLIC

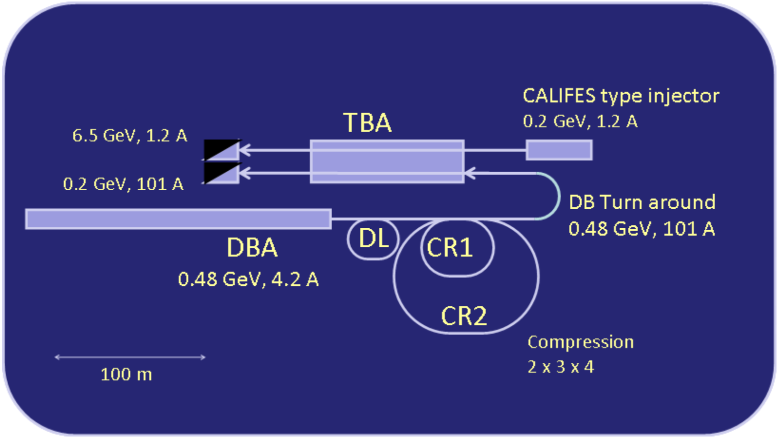
Presented & discussed at the CLIC workshop '08



CLIC Zero – Pros & cons

- Demonstrates nominal DBA injector with all parameters
- Creates nominal drive beam train apart from energy (0.48 GeV instead of 2.4 GeV)
- Demonstrates nominal DBA module with klystron and modulator with all parameters
- Demonstrates two beam acceleration over significant distance with fully nominal modules
- Forces pre-series production of all mass produced components → Industrialization
- Well suited to create confidence in CLIC technology
- All hardware investment is re-usable for real CLIC

- **Expensive** – will absorb almost all planned budget
- **Schedule too long** – results with beam not before 2015
- No obvious use of 6.5 GeV main beam but for testing
- Drive beam dynamics more difficult than in real CLIC (like in CTF3)



Task Force Strategy

- Don’t think in term of a single facility
- Start from needs and not from (potentially) available budget / resources

- Begin with list of activities and feasibility / critical items
- Determine where we will likely stand in 2010.
- Define a logical extension of R&D for each activity in the short term (2010-2012) - when needed - setting clear goals.
- Try to define additional R&D needed to arrive at a TDR in 2015 for each activity & identify schedule critical items.

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Feasibility Items

SYSTEMS		Critical parameters
Structures	**Main Beam Acceleration Structures:** Demonstrate nominal CLIC structures with damping features at the design gradient, with design pulse length and breakdown rate .	100 MV/m 240 ns < 3·10-7 BR/(pulse*m) RF to Beam efficiency > 30%?
	RF Power production structures: Demonstrate nominal PETS with damping features at the design power, with design pulse length, breakdown rate and on/off capability	136 MW, 240 ns < 10-7 BR/(pulse*m)? Beam to RF efficiency >? On/Off < 20 ms
Two Beam	**Two Beam Acceleration (TBA):** Demonstrate RF power production and Beam acceleration with both beams in at least one Two Beam Module equipped with all equipments	Two Beam Acceleration with simultaneous & nominal parameters as quoted above for individual components
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
	RF power generation by Drive Beam - Rf power extration - Beam stability	90% extraction efficiency Large momentum spread
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
Stabilization	**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
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
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

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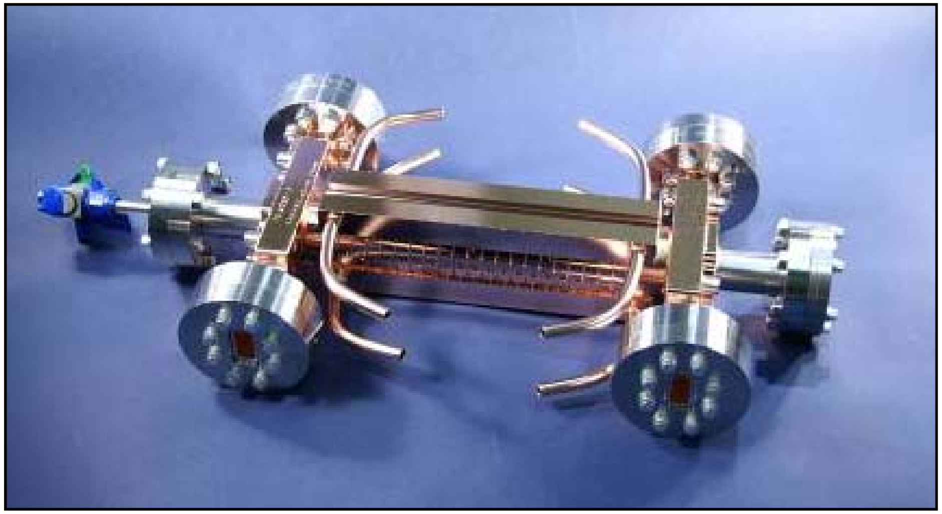
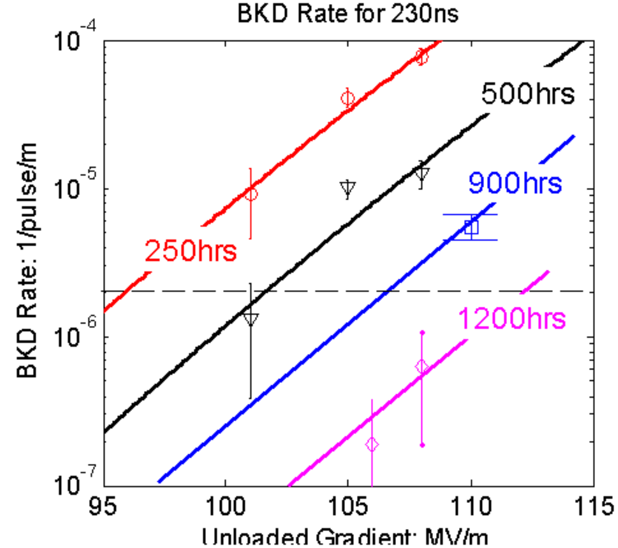
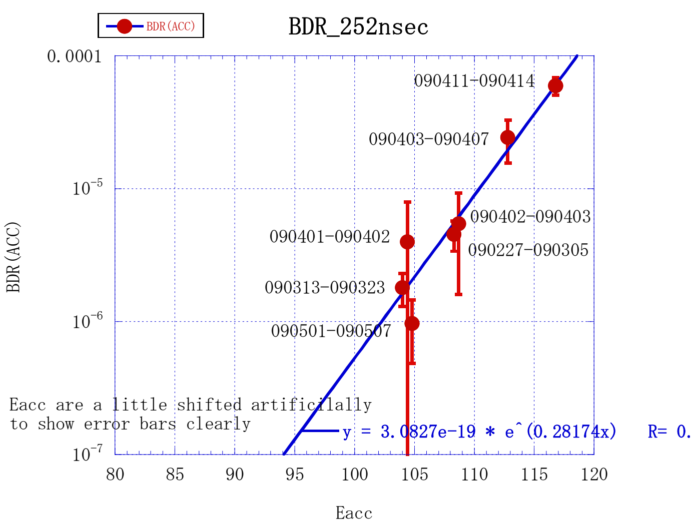
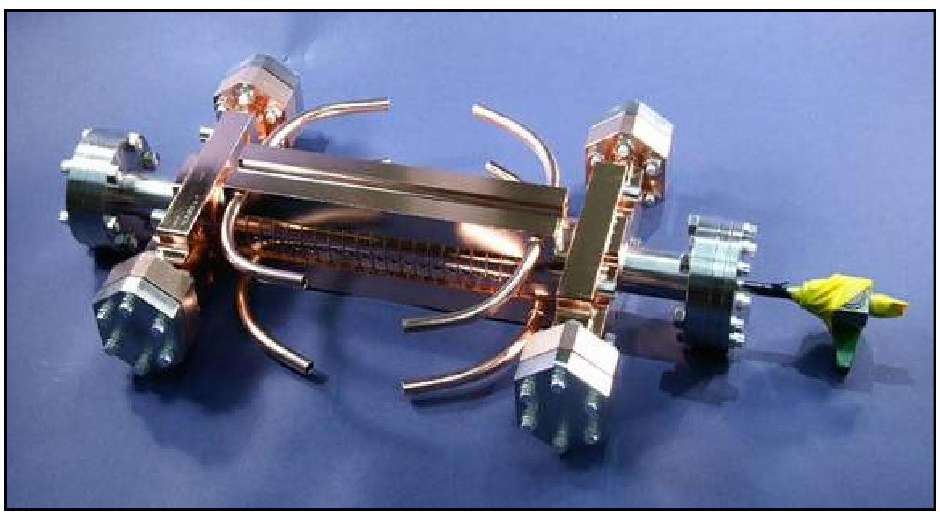
R. Corsini, 8.5.2009

Accelerating Structures









Accelerating Structures

	Projected Status in 2010	Goals for 2012	Goals for 2016
Structure development, high-gradient studies	Successful test of a few structures (TD18, CLIC_G), with nominal parameters (100MV/m 240 ns 3 10^{-7} m^{-1} brkdown rate) operation for a few thousand hours Including HOM damping features (but possibly without damping material)	Test of at least five to ten structures (CLIC_G or current nominal structures) with nominal parameters for statistics. With damping material, compact coupler. Test of potential alternatives for cost & performance (10 - 20 structures) ?	**About 200 structures tested** Medium-series and long-term operation **Need 10-20 testing stations (12 GHz klystrons or TBL+)**
Precision manufacture	Evidence that final mechanical tolerances required by beam dynamics can be reached. Not yet fully implemented on prototypes.	Mechanical tolerances better than 5 μm	Cost optimization of procedures.
Integration, alignment	Design (or alternatives) for final solution including cooling, vacuum, alignment. Not yet implemented on prototypes.	All ancillary subsystems of prototypes (cooling, vacuum) compatible with module integration. Experimental verification in **CTF3 modules** (and elsewhere?) of inner and structure-structure alignment and resolution of the wake-field monitors	Cost optimization.
Facilities, Industrialization	Precision metrology at CERN. Precision assembly (brazing) at CERN. Full qualification capability at CERN and/or within the collaboration. List of qualified outside companies.	Start **precision machining capability** at CERN or elsewhere within the collaboration?	Cost optimization **Pre-series production?** Input needed from costing WG and TE dept.

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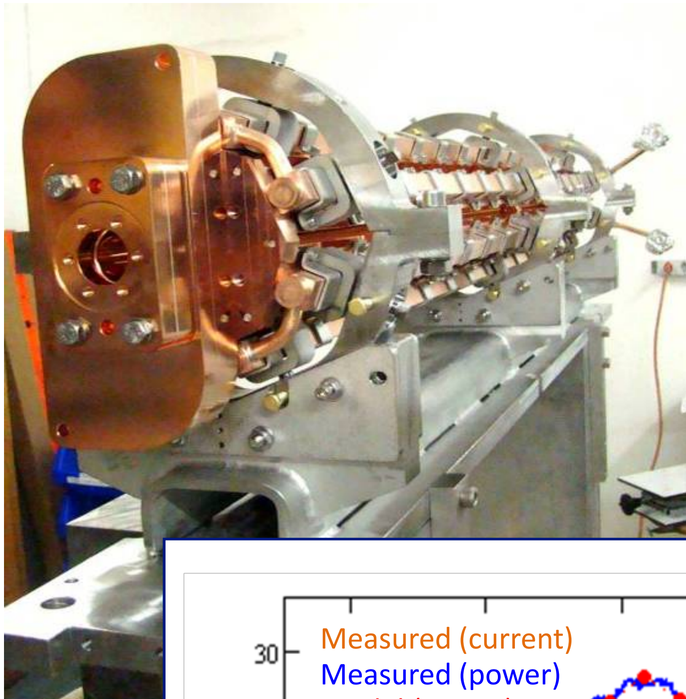
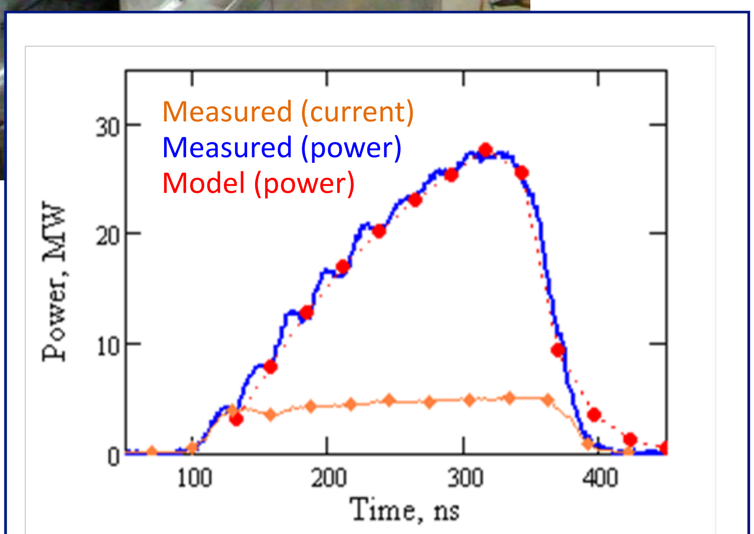
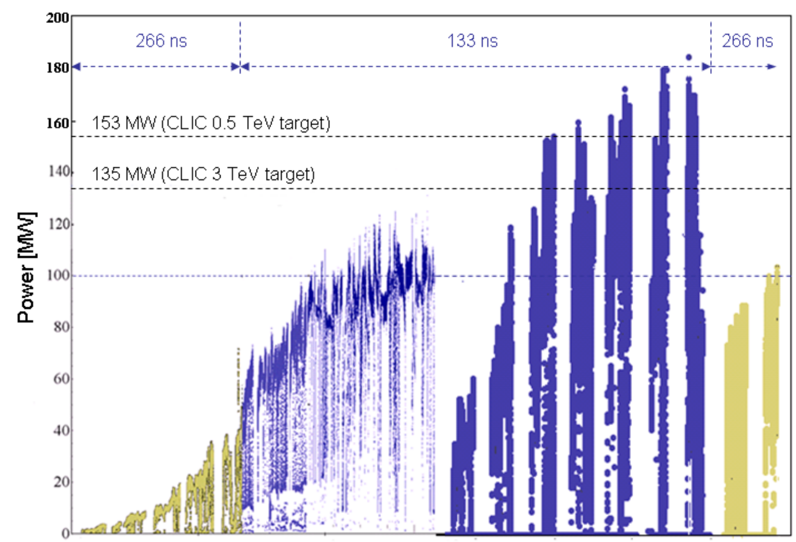
PETS

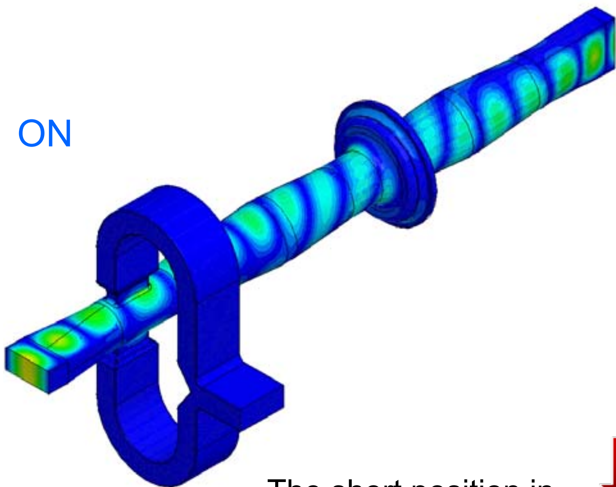






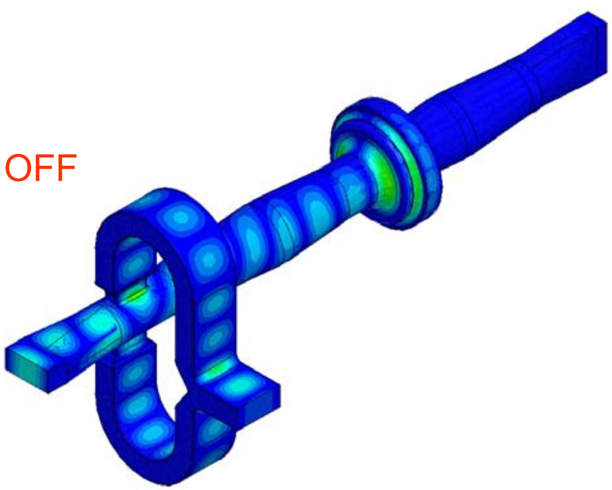
PETS*ONOV*

ON

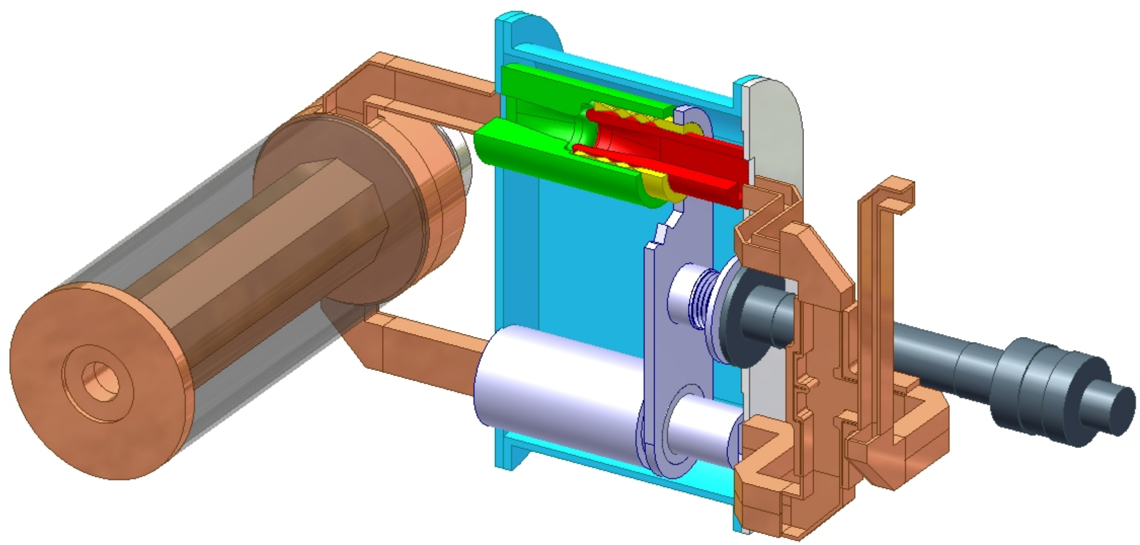


The short position in choke moved by 5.4 mm

OFF



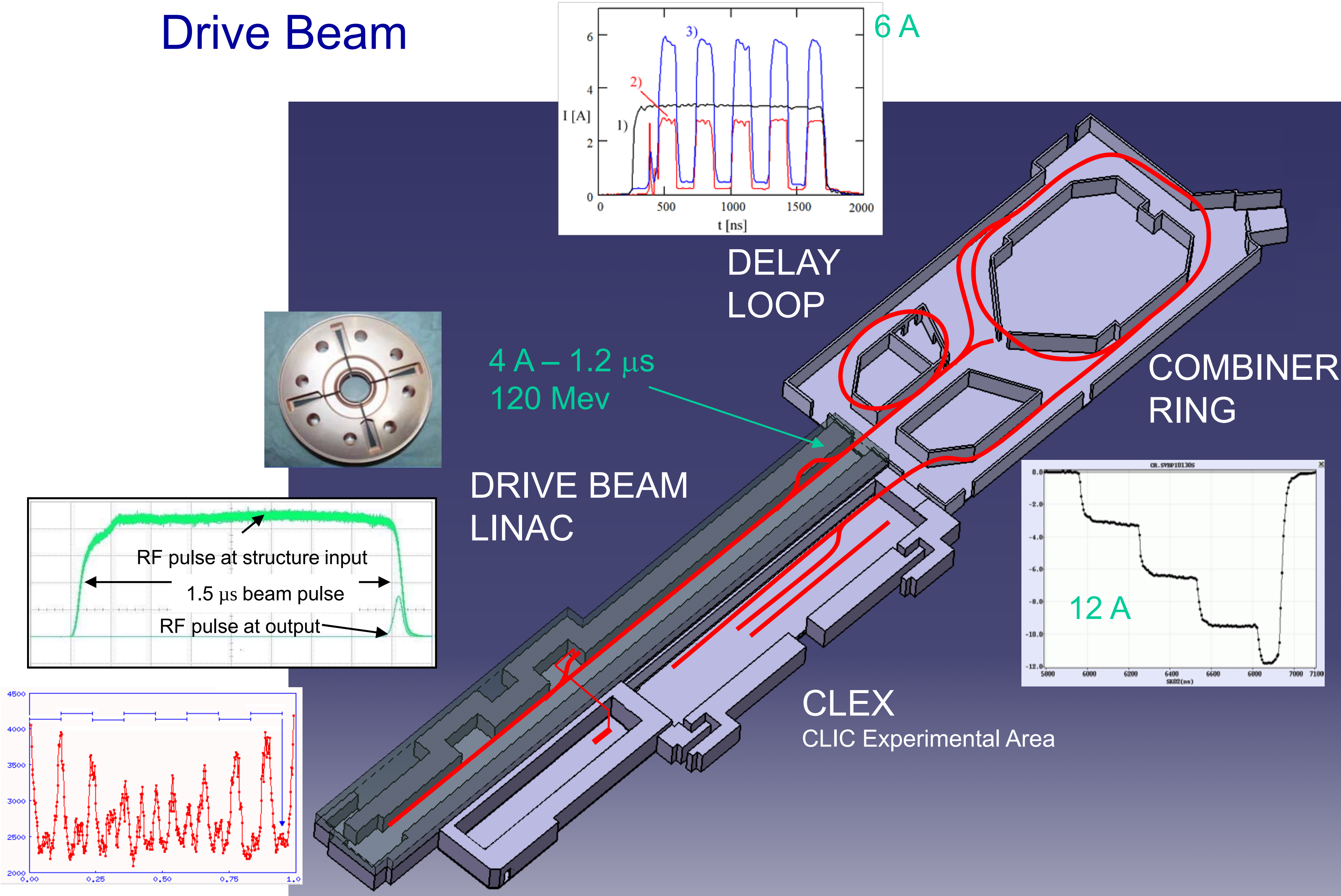
The tunable choke “proof of principle” high power tests at SLAC (autumn 2009) with klystron. The mechanical design is under way. If tests will be successful, one of the TBL PETS will then equipped with such a device



PETS

	Projected Status in 2010	Goals for 2012	Goals for 2016
PETS development, high-power tests	Operation (a few thousand hours) of a few PETS, in klystron-driven mode to nominal parameters (135 MW to 165 MW, 240 ns, breakdown rate a few 10^{-7} /m), eventually with damping. Beam-powered test of a single PETS with external recirculation in TBTS/CTF3, to nominal parameters (135 MW, 240 ns). Beam-powered test of 8 PETS in the TBL/CTF3, to nominal power (135 MW) and 140 ns.	Beam-powered operation of 8-16 PETS in the TBL/CTF3, to nominal power (135 MW) and 140 ns. Beam measurements to verify wake-field model.	**Medium series, long term operation of nominal CLIC PETS (klystron-driven mode?).** **Possible use of TBL+ as power source**
On/Off capability	Design of PETS with internal recirculation. Components: compact damped coupler.	Test of PETS with internal recirculation prototype (TBL). Fast on/off concept.	Full implementation, cost and reliability optimization.
Further optimizations, components	Waveguide components tested to full power (e.g., choke-mode flange). First test of wake monitoring in TBTS.	Full waveguide network prototype in CLIC modules in CTF3. Wake monitoring developments?	Final design of components.
Manufacture, industrialization & integration	Specified tolerances (~10 μm) achieved by several vendors (up to now ~ 6 companies qualified). Design of module integration.	Integration of special PETS in **CLIC modules in CTF3** (no ON/OFF). Choice of damping material.	Cost optimization. **Pre-series production**?

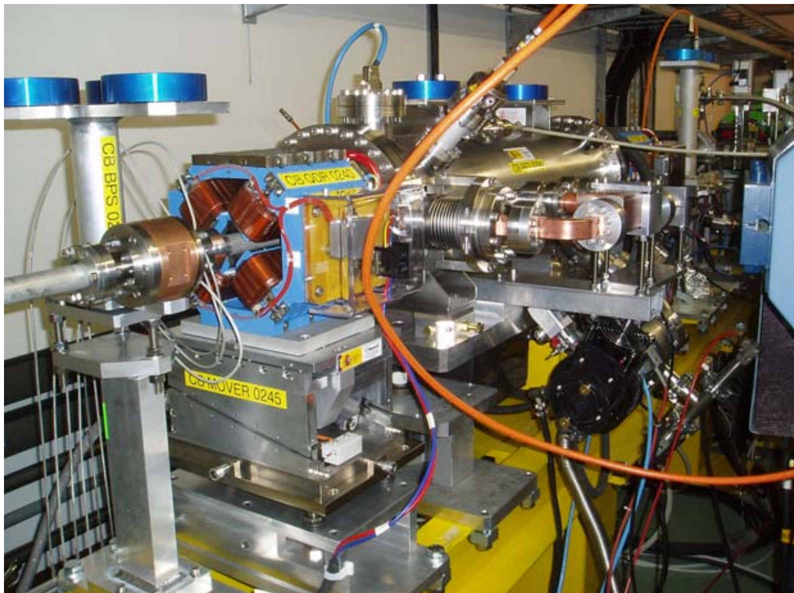
Drive Beam

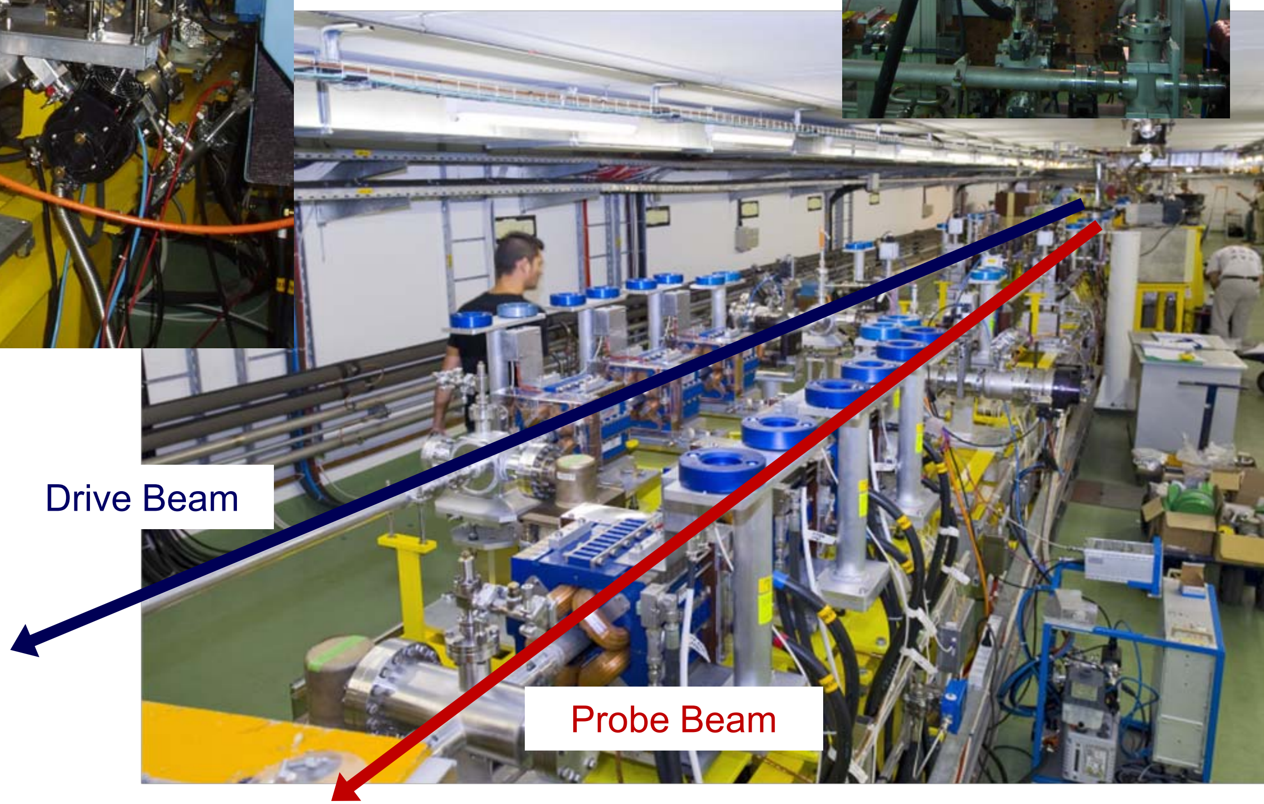

6 A
I [A]
t [ns]
1)
2)
3)
DELAY LOOP
4 A – 1.2 μs
120 Mev
COMBINER RING
DRIVE BEAM LINAC
RF pulse at structure input
1.5 μs beam pulse
RF pulse at output
12 A
CLEX
CLIC Experimental Area

Drive Beam

	Projected Status in 2010	Goals for 2012	Goals for 2016
Drive beam injector	Thermionic option: scheme for satellites control, stability assessment in CTF3 Photoinjector option: meas. beam quality, stability and long test running of photo-injector in CTF2	Comparison and choice between photo-injector and thermionic possible Photo-injector in CTF3 ?	**Injector prototype at the right frequency and energy**, possibly for both solution if choice is not made
DBA, Full Loading, efficiency	95% efficiency RF-to-beam, SICA 3 GHz, 5 A Current stability ~ 10^{-3} Energy stability ~ 10^{-3}	Current stability < 10^{-3} Energy stability < 10^{-3}	**First part of linac at right frequency**, 200 MeV ? final stability Efficiency > 90% includ. WGs
Rings, combination scheme	~ 30 A combined and transported, bunch length < 1 mm, emittance ~ 100 π mm mrad, current &energy stability a few 10^{-3} Phase stability ? CLIC DL & CR design	C & E stability below 10^{-3} Phase stability monitor (FP7), measurements	Eventually add final DL & ring(s) to injector/DBA ??
Sources (modulators & klystrons)	Parametric study of DBA power scheme, reference structure design, M&K specs	Design of M&K, start prototyping – possibly a few prototypes ready in 2012	**M&Ks with full specs, as needed for injector and DBA section.**
Drive beam phase and amplitude feedback system	timing reference system conceptual feedback system	low impedance phase monitor, test in CTF3	**DB fast phase feed-back in CTF3 – experimental studies** (Kickers, amplifiers, improved phase monitors) alternative timing reference (e.g. X-FEL)

Power production and Two-beam issues





Power production and Two-beam issues

	Projected Status in 2010	Goals for 2012	Goals for 2016
Power production from drive beam, Two-Beams	Beam-powered test of a single PETS with external recirculation in TBTS/CTF3, to nominal parameters (135 MW, 240 ns). Power, energy loss & gain measurements. First break-down kick measurement.	Complete break-down kick measurement. Break-down studies.	**Possible use of TBL+ as power source**
Deceleration, stability	Beam deceleration experiment in TBL 8 PETS, ~ 30 A & 30% energy extraction Lattice design including cost optimization options - study of decelerator stability, beam loss estimates, including beam based alignment	Beam deceleration experiment in TBL up to 16 PETS, ~ 30 A & 50% energy extraction	Eventually add test decelerator to final DL & ring(s) to injector/DBA ??
Beam loading compensation	Concept First experiment on beam loading control in CTF3/TBTS	Improved beam loading experiment in CTF3/TBTS – full charge	Drive beam bunch charge control Main beam current feed-forward? e.g. temperature effects
Manufacture, industrialization & integration	Design of CLIC module	Integration of accelerating structures, PETS & ancillary equipment in CLIC modules in CTF3.	**Production of N modules (N>20) with combined alignment/stabilization system ?**

Next Steps in CTF3

- TBL drive beam deceleration studies (string ofup to 16 PETS)
- Study of two-beam issues
    - RF breakdown kicks experiment
    - Beam loading compensation of probe beam

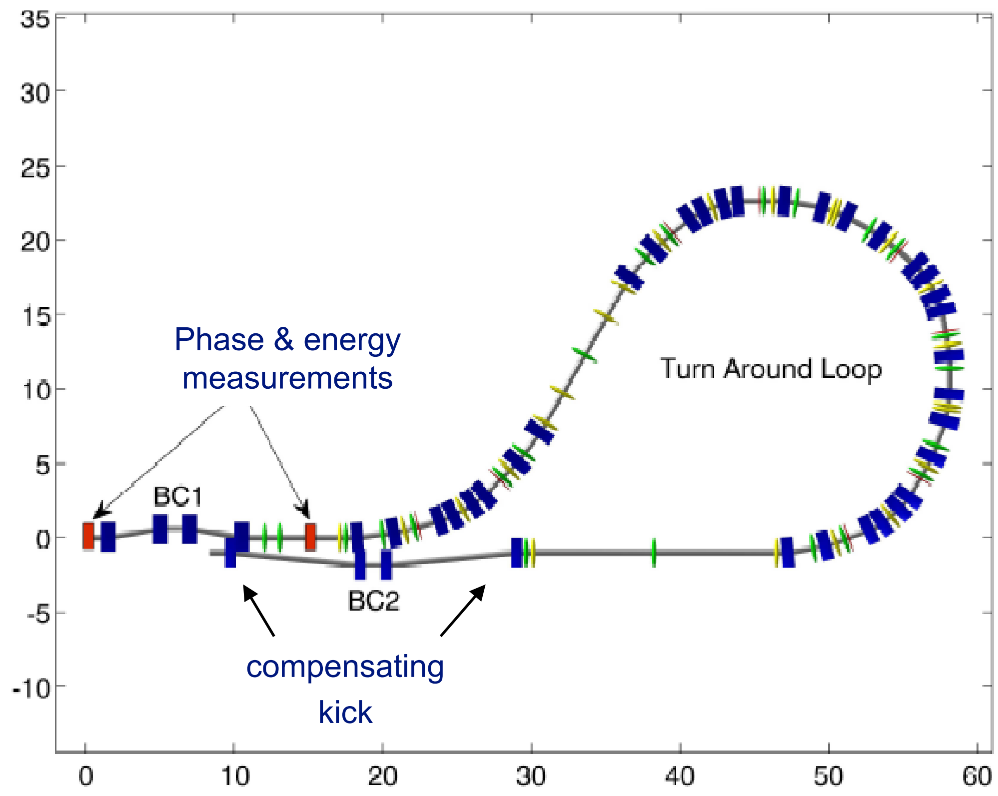
2010

- Photo-injector option full implementation
- Phase stability measurements & feed-forward tests
- Full-fledged CLIC modules beam tests in CLEX
- CTF3 upgraded to X-band power production & testing facility
- Instrumentation development for LC – Instrumentation Test Beamline

2012 +

Phase stability measurements & feed-forward

0.2 degrees phase stability @ 12 GHz required for CLIC drive beam for 2% luminosity loss



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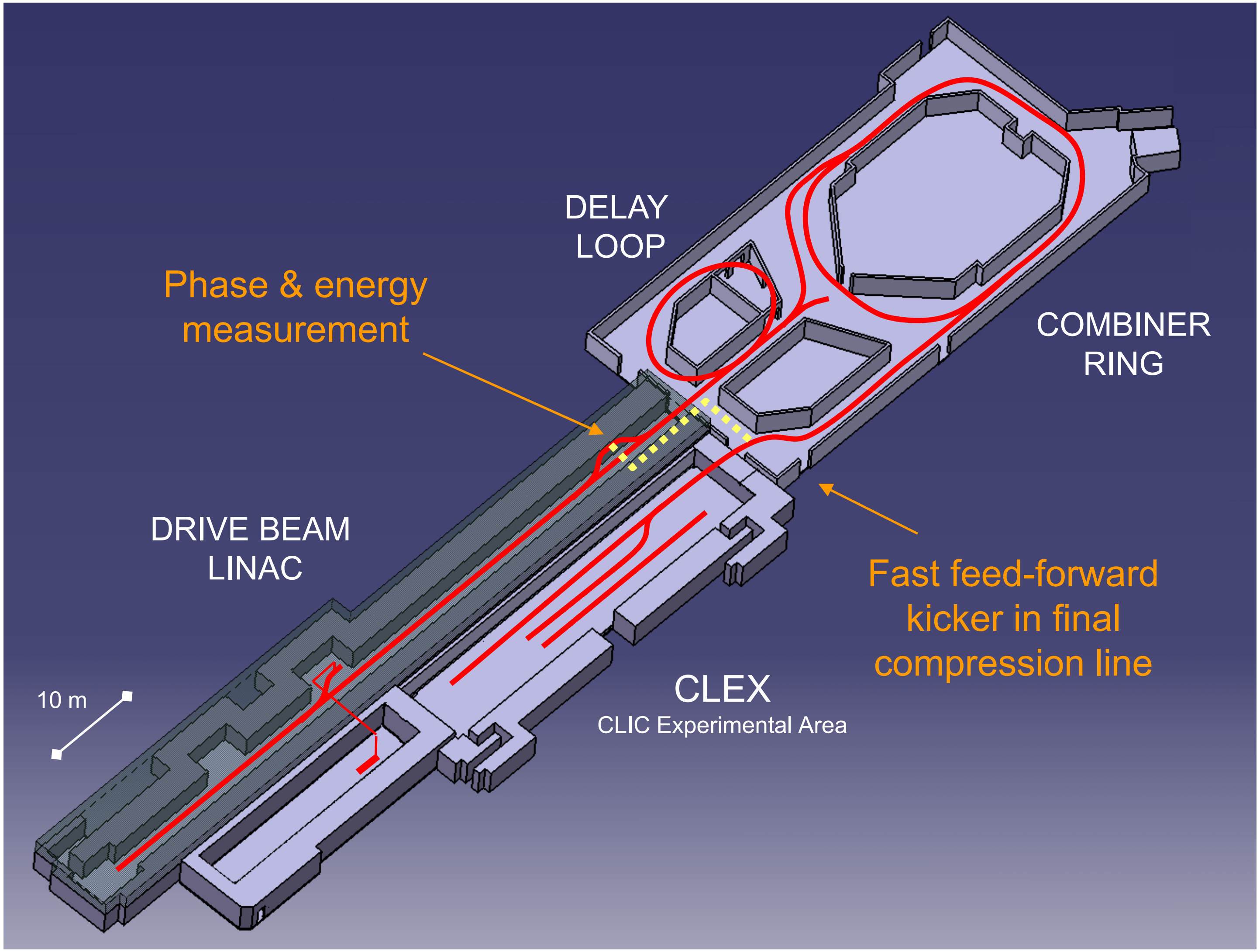
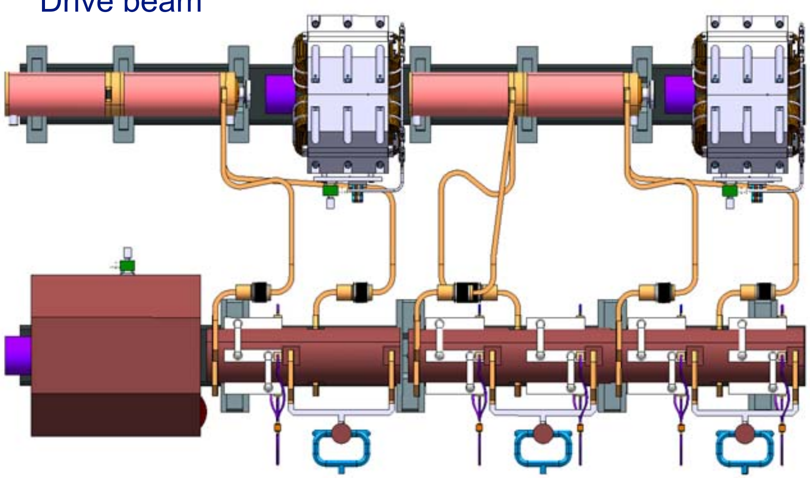
Phase stability measurements & feed-forward



Two-beam modules in TBTS

- Module design and integration have to be studied for different configurations.
- Integration of the systems in terms of space reservation has been done. Detailed design started for the main systems, such vacuum, cooling, alignment, stabilisation …
- Important aspects for cost and basic parameters provided for other areas of the study.
- Goal: → test with beam of a few modules in CTF3/CLEX [includes FP7]: first module ready in 2011

Drive beam

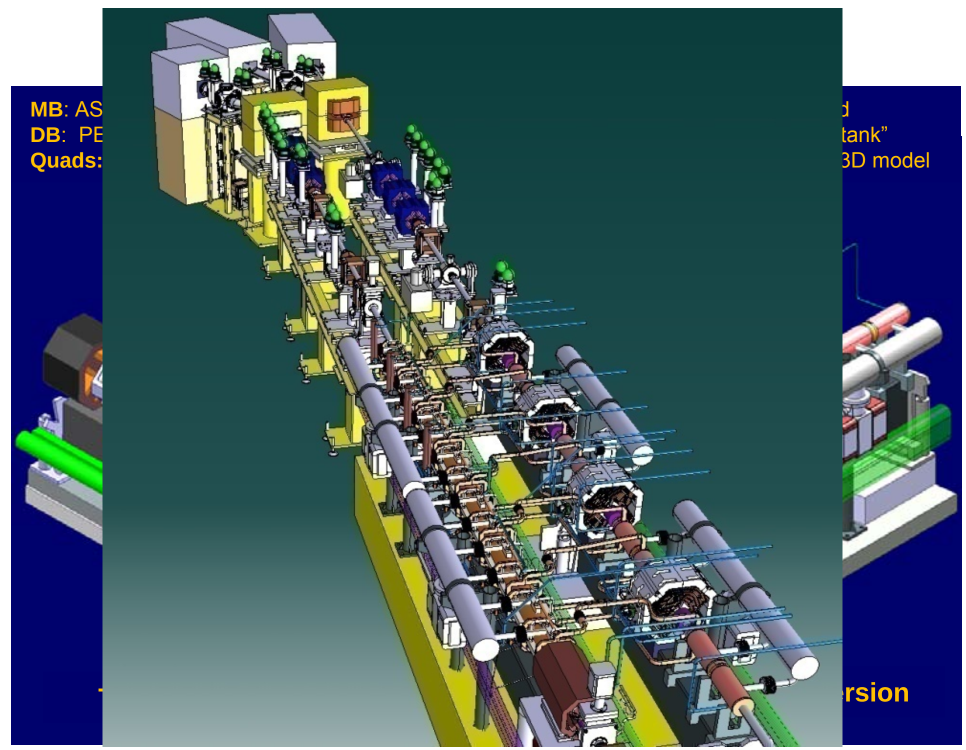


Main beam

20760 modules (2 m long)

71460 power prod. structures PETS (drive beam)

143010 accelerating structures (main beam)



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Special CLIC modules in CLEX after 2010 (no ON/OFF)
Low beam current regimes

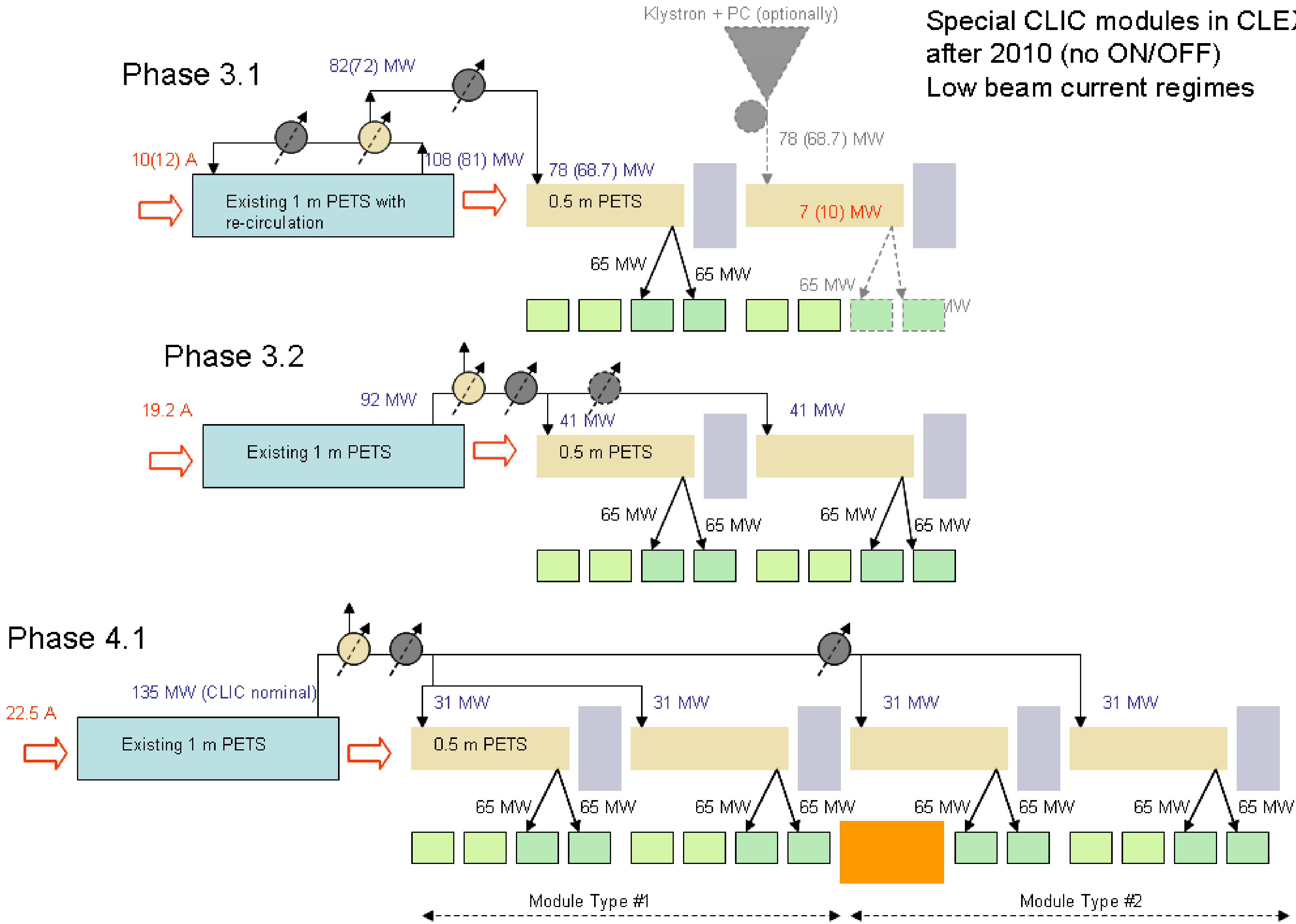
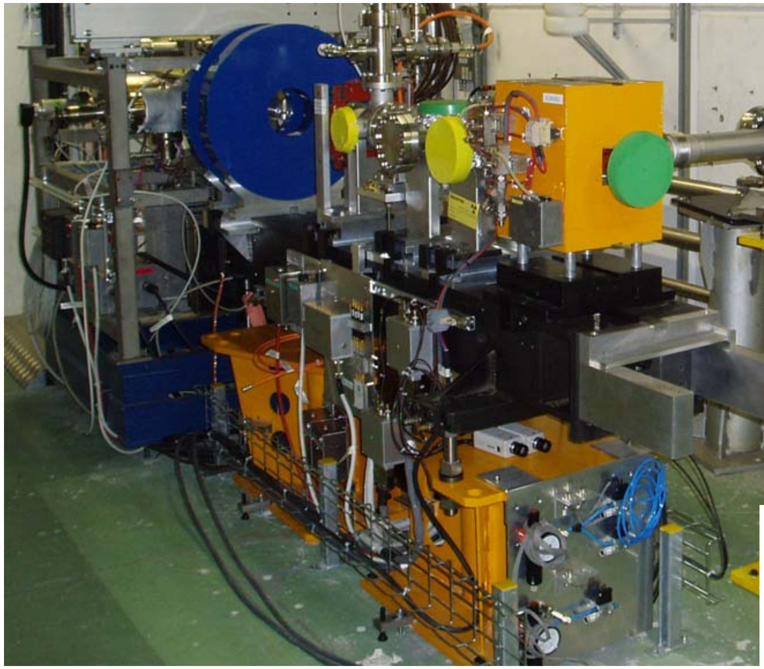
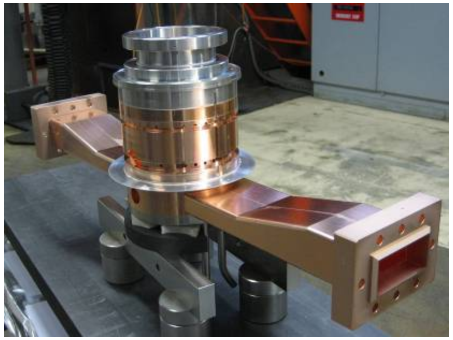
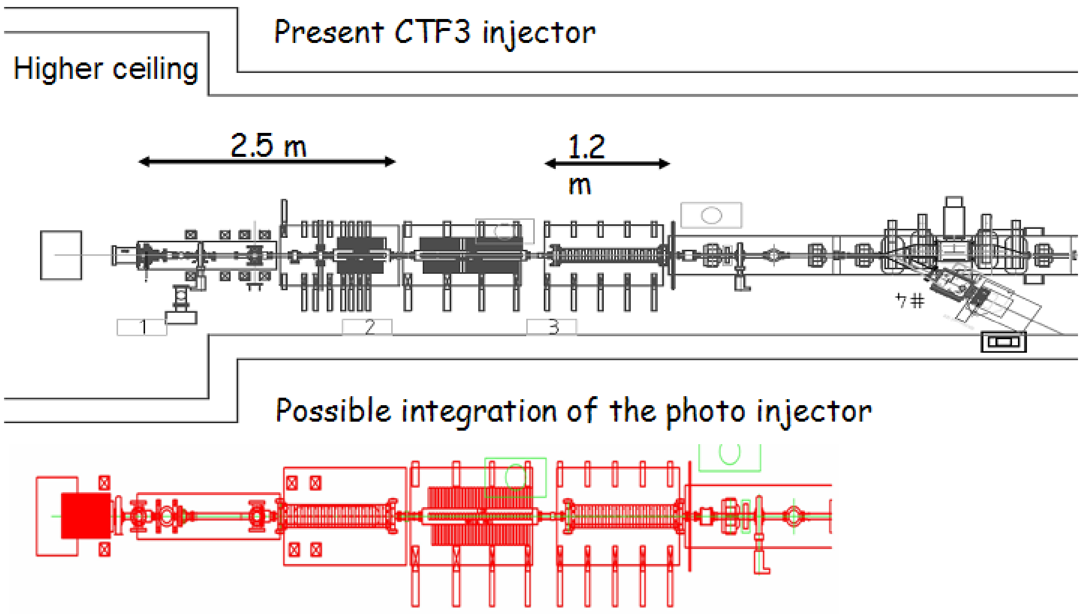


Photo-injector option full implementation





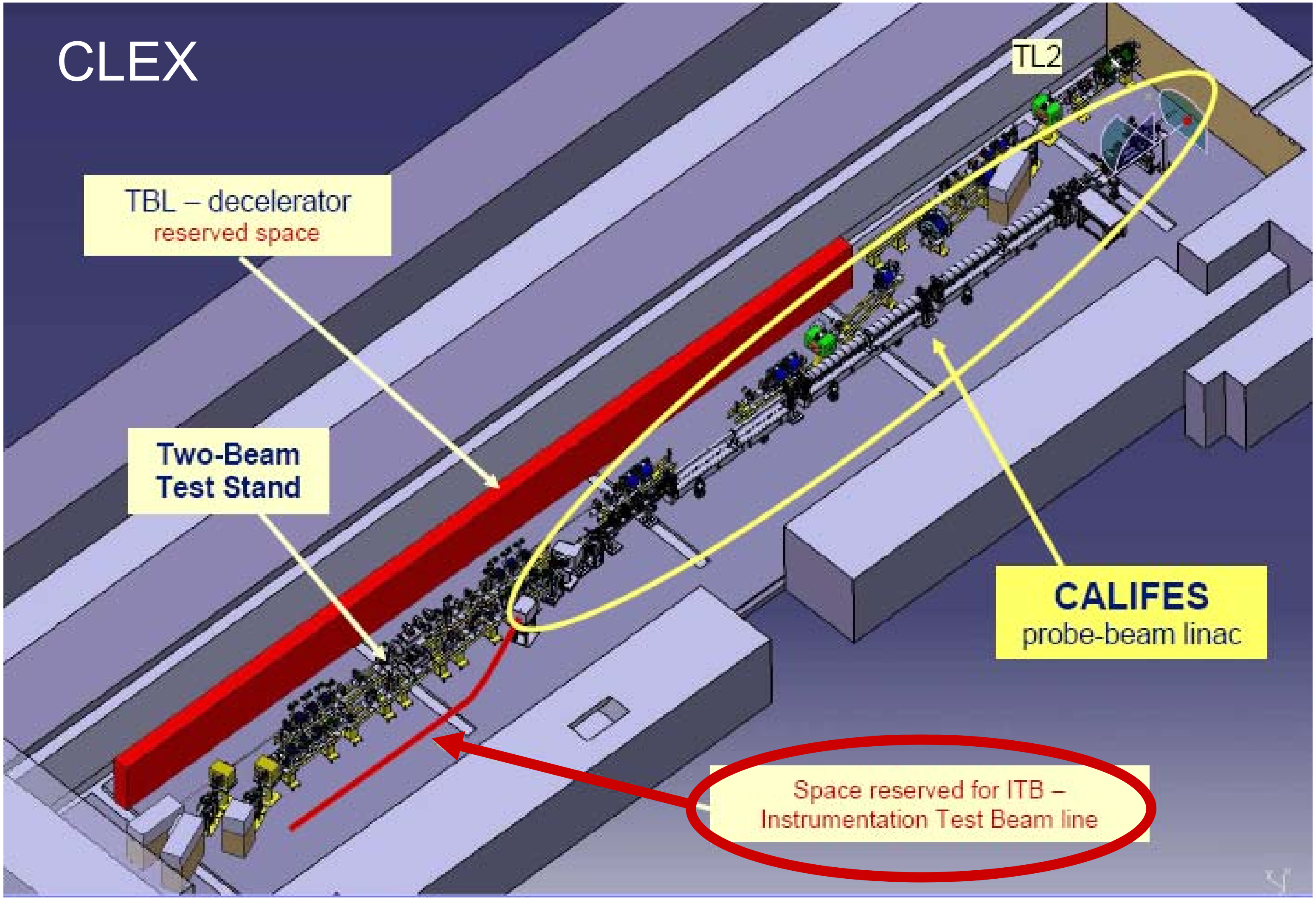


- Smaller transverse emittance
- Shorter bunches, no energy tails
- No satellites
- Lower current

Single bunch option will allow

- Check and correction of beam optics with high precision
- CSR measurements with high precision in DL, CR and TL2 bunch compressor.
- δ response of PETS and beam instrumentation
- …

Instrumentation Test Beamline



CTF3 klystron upgraded to X-band testing plant

Advantages

+ Up to 16 RF ports with nominal power & pulse length
+ Cheaper than several stand-alone X-band sources
+ Gives incentive to consolidate drive beam operation towards large facility standards

Problems

- No individual pulse-length control of test slots
  (unless Igor has a smart idea)
- Pulse length obtained only sacrificing power – or need priming
- Increase of rep. rate up to 50 Hz desirable,
  but requires substantial increase of radiation shielding

But don't say that you don't believe in testing structures with a drive beam RF source.

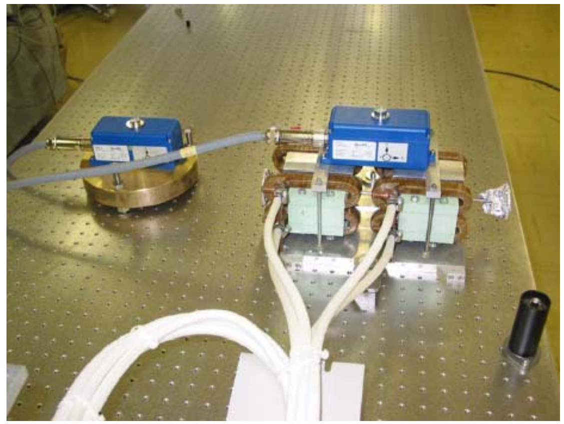
If you don't believe this, there is no point to continue to work on CLIC !

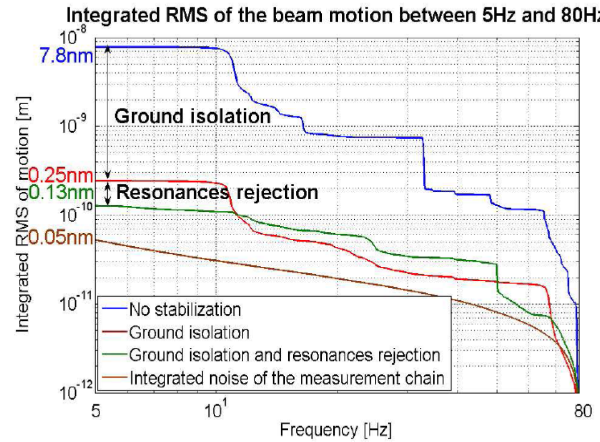
CLIC 3 TeV needs 144000 accelerating structures. If every structure needs four days of RF processing before installation in the tunnel and we want to build CLIC over 7 years we need

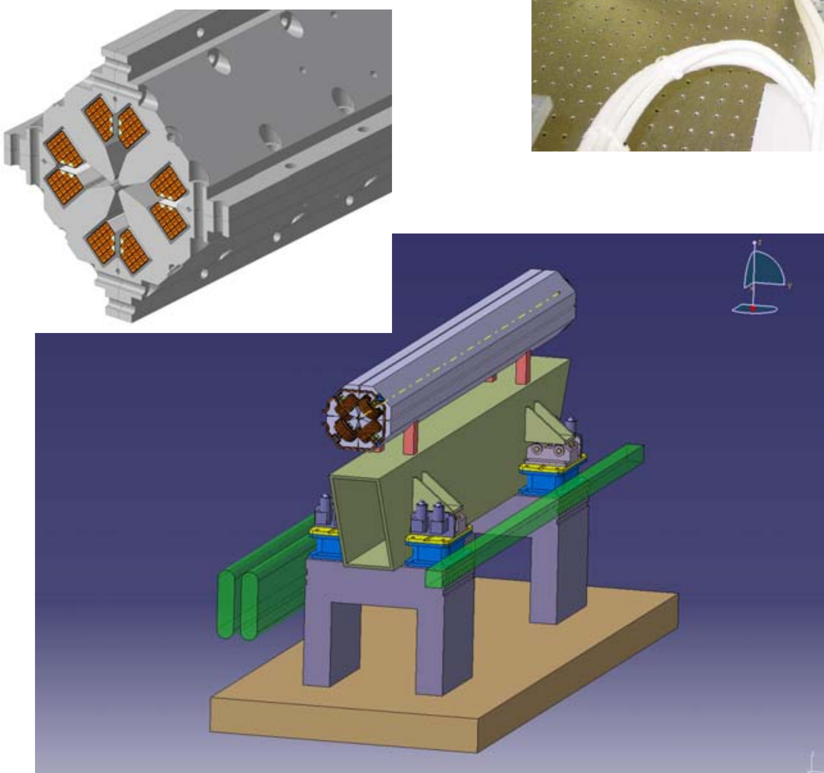
$$\frac{144000 \times 2}{7 \times 365} = 113 \text{ RF slots}$$

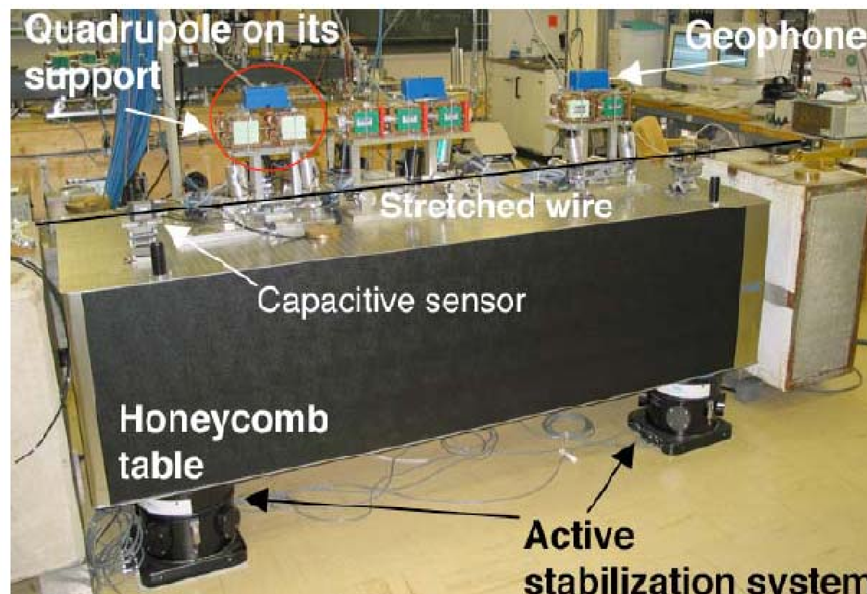
CTF3 with a drive beam linac upgraded as outlined before and a TBL extended to 43 PETS could provide **86 RF slots** !

Stabilization









Stabilization

	Projected Status in 2010	Goals for 2012	Goals for 2016
Main linac quads	Mechanical stability assessment of Main beam Quad in CTF3. Mechanics optimized for passive damping. Design of Alignment / stabilization system, within specs for: i) automatic mechanical pre-alignment ii) beam based correction +stabilization Test mockup in laboratory with first feedback loops. Gain of external feedback below 100. Meeting specification for MB Quad of 1nm rms above 1 Hz probable.	Integration into CLIC module (in CTF3/TBTS) Validation of magnet axis stability through a beam experiment at CESRTA or elsewhere Full implementation of feedback loops	**Production of N modules (N>20) with combined alignment/stabilization system ?** Assessment of performance Chose technical implementation of controller; global feedback versus distributed systems.
FF quads	Measurements of ground motion and environmental vibrations. Stabilization experiments at LAPP for a simple cantilever mockup of a FF magnet. Studies on options for FF magnet technology and options for FF magnet support structures. Simulations.	Mechanical stability of a superconducting FF magnet at ATF2. Mechanics optimized for passive damping. Gain of external feedback below 100. Meeting specification of 0.18 nm is challenging, if not unlikely.	**CLIC prototype on chosen technology including alignment system and stabilization system.** Assessment of performance
General	R&D on diagnostics; laser systems, interaction of lasers or other radiation with gas filled chambers (beyond geophones, i.e. laser interferometers, other)	Apply advanced diagnostics for assessment of performance	Apply advanced diagnostics for assessment of performance

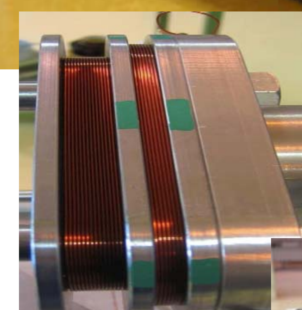
Generation & preservation of low emittances

Sources & Injectors

	Projected Status in 2010	Goals for 2012	Goals for 2016
Polarized electron source	Scheme & alternatives solutions for 500 GeV. Test at SLAC ?	Test at SLAC, JLAB or elsewhere.	Full design, **CLIC micro + macro pulse demonstration.** Prototype ?
Positron source	Full simulation for yield to DR R&D on polarized positrons.	R&D on polarized positrons.	Full design, **Positron target demonstration (KEK/SLAC)?**
Main beam injectors	Simulation from DR to main linac, phase stability study, structure design		Full design, structure prototypes, 2,4 and 12 GHz **Klystrons: 2, 4 and 12 GHz** Laser specs

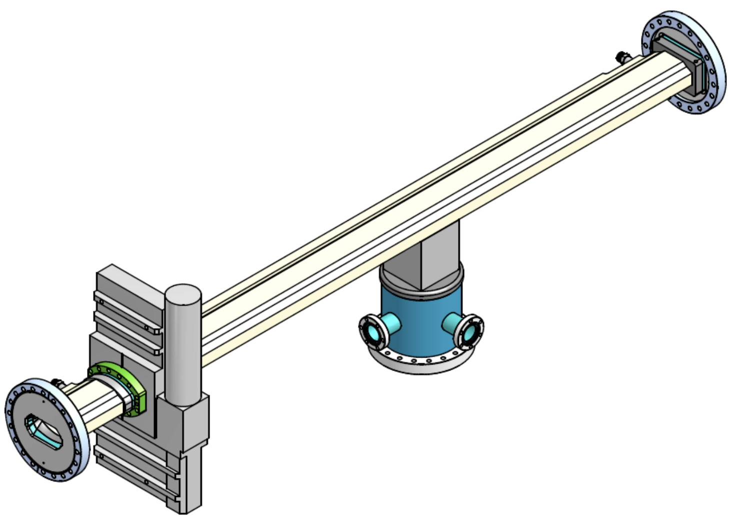
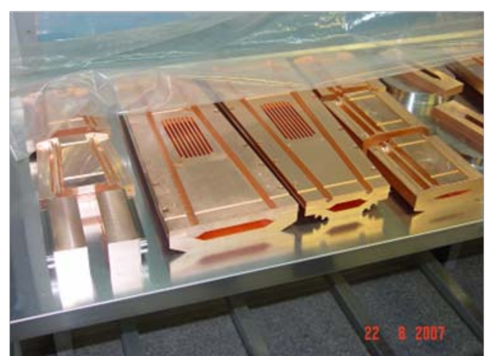
Generation & preservation of low emittances

Damping Rings


Status in 2010

- Updated reference lattice designs for the damping ring and pre-damping rings at 3TeV and 500GeV.
- Simulations confirming the damping ring performance with IBS.
- Simulations defining the requirement beam pipe surface properties to suppress electron cloud. The results of the world-wide collaboration on electron cloud suppression.
- Updated vacuum specifications to suppress fast beam-ion instability.
- Prototype wigglers will be available.
- Simulations showing that the heat load in the wigglers is acceptable.
- A solution for the RF system including beam loading compensation.

Generation & preservation of low emittances

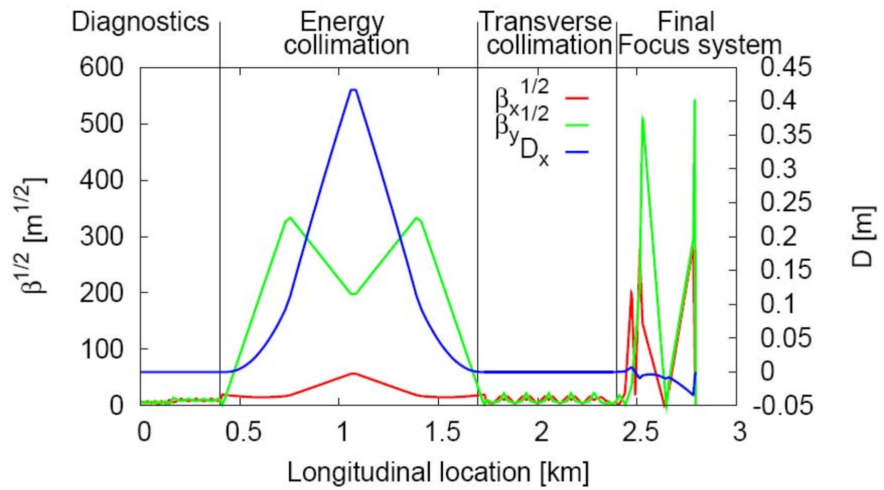
Final Focus

Status in 2010

- Updated reference lattice exists for CLIC at 3TeV.
- A lattice at 500GeV needs to be optimised for performance and machine protection.
- Studies establishing the performance of the collimation system.
- Studies establishing that the detector solenoid and shielding are acceptable.
- A tuning technique that removes the effect of static imperfections.
- A conceptual orbit feedback.
- A study of a tuning strategy that uses fast signals from the beam-beam collision.

Status in 2012

- Test of the CLIC beam-based alignment scheme at ATF2. While the beam size that can be reached in ATF2 is 20 nm, much larger than the 1 nm for CLIC, ATF2 will serve as a test bed for the chromaticity suppression and the system tuning algorithms.



Project	Status	β_y^* [mm]	L* [m]	L*/β_y^*	ξ_y
FFTB	Measured	0.167	0.4	2400	10000
ATF2	Design	0.1	1.0	10000	19000
ATF2 ultra-low β	Proposed	0.025	1.0	40000	76000
CLIC	Design	0.08	3.5	39000	63000
Andrei's prop.	Proposed	0.1	8.0	80000	120000

Perspectives for the TDR phase after 2010

R. Corsini, 8.5.2009

Main Linac RF Stability

Item	By 2010	FP7/2012	Requ. for TDR
Beam loading compensation	concept some experiment in TBTS	better experiment	improved design drive beam bunch charge control main beam current feed-forward? e.g. temperature effects
Drive beam phase and amplitude feedback system	timing reference system conceptual feedback system	low impedance phase monitor	kickers, amplifiers, improved phase monitors, alternative timing reference (e.g. X-FEL)
Stable Klystrons main and drive beam (12GHz, 1GHz)	measurements of existing klystrons		development of stabilised klystron
Stable drive beam injector	measurements in CTF3 model of injector stability	satellite suppression	stable injector stable components e.g. laser
Crab cavitiy phasing		some system	stable system (impact on experiment)

Static Imperfections

Item	By 2010	FP7/2012	Requ. for TDR
Wake Monitors	design	prototypes with limited tests	improved design improved tests (FP7 can fail) cost reduction alternatives
Drive Beam BPMs	specification and number concept	prototypes	cost reduction alternatives (e.g. in PETS)
Controls	concept of low-cost read-out (wireless?)		prototypes machine protection radiation hardness number scalability improvements
Alignment system	some prototypes	motors/module	cost reduction robustness long distance
Train flattener			design
Temperature variations			evaluation for critical components component design

Main Beam Stability

Item	By 2010	FP7/2012	Requ. for TDR
Stable components and module active stabilisation see also Hermann's talk	measurement of component stability (e.g. accelerating structures)		design of critical components for low vibrations, e.g. accelerating structures, detector components vacuum pumps etc.
Orbit feedback	concept of feedback, concept of BPMs BPM prototypes concept of correctors corrector prototypes		BPM cost reduction corrector cost reduction
Breakdown detection	concept of detection		prototype system cost reduction
Main linac vacuum	concept		measurement capabilities, prototypes, improvements, dynamic vacuum w. drive beam
Stray fields	model and mitigation concept		improved model mitigation concept e.g. vacuum pumps with low field, shielding
IP feedback	concept		prototypes detector integration

RF Components

Item	By 2010	FP7/2012	Requ. for TDR
Module interconnects (impedance, mechanics)	concept	module tests	improved design alternatives robustness
Long-range wakefields PETS and accelerating structures	calculations		experiments improvements
Dark current	some indications		dedicated experiments, multiple modules
Beam halo (losses and impact on instrumentation)	some code		experiments

Operation and machine protection

What performances will realistically be achieved (Target Performances):
by end 2010

Full inventory of failure modes, simulation of their impacts on the accelerator structures
Detailed requirements for passive machine protection.
Evaluation of the requirements for beam observation systems to detect the onset of instabilities in drive and the main beam (i.e. beam loss, beam intensity loss, position and emittance).
Proof of feasibility for magnet power circuits with guaranteed tolerance for 2 ms after the onset of failure.
Required tolerance for all magnet circuits for safe operation with nominal beams.
Establish the procedure to reach nominal CLIC operation starting from a “cold” machine, based on successive beams of increasing intensity and brilliance.
Evaluate the unavailability of the machine for nominal operation due to various interlock conditions and equipment failures.

by end 2012 (including FP7)

Complete and validated design of passive protection system.
Detailed scenario for machine protection checks
Detailed design of “next beam permit” machine protection system for slow failures.

Perspectives for the TDR phase after 2010

List of issues/options to be explored to get to the TDR

- Completion of feasibility demonstration (basic information on feasibility should be already available, but...)
- R&D on critical issues (performance + cost, e.g. stabilization & alignment)
- Prototyping of critical components for performance (small number items, e.g. final doublet quads, sc wigglers)
- Prototyping (and possibly pre-series) of critical components for cost (e.g. drive beam modulators/klystrons)
- Start industrialization of mass produced components (e.g. RF structures, RF components...) ?
- Integration of components in large number modular sub-systems (two-beam modules)
- Test of full (small?) sub-systems, critical for performance (e.g. D.B. Injector, positron source...)
- Tests at existing test facilities on specific issues (e.g. phase stability, electron cloud, IBS…)
- R & D on diagnostics, machine protection ?
- Need (larger) facilities for RF conditioning/testing ?

Conclusions ?

- A single large facility, as initially envisaged, is probably not the best option to prepare the CLIC TDR.
- The TDR phase preparation Task Force is identifying milestones in the short (2012 / 2013) and longer (2015 / 2016) time scales, in all areas of the study.
- The operation of CTF3 should be extended to at least 2012, to allow full exploitation of the present installation and extend it to include the construction and use of a series of full-fledged CLIC TBA modules and the implementation of a fast phase feed-back system to test the very tight phase stability requirements of the CLIC drive beam (0.2° at 12 GHz).
- The extension of CTF3 to a power production facility for structure & RF component testing is highly desirable. The construction of an Instrumentation Beam Line using the CALIFES beam is also desirable.
- There is a large potential for experimental tests, that cannot be made in CTF3, in other facilities around the world – many are presently pursued (ATF2, CeSRTA, ANKA, …).
- Need to prepare as soon as possible extensive prototyping of schedule critical items:
  - Nominal two beam modules with all features this includes accelerating structures & PETS
  - Drive beam accelerator units (**modulator, klystron**, RF network, accelerating structure)

Tentative schedule for CLIC R&D 2010-2016

Year		2010	2011	2012	2013	2014	2015	2016
CTF3+	module test	design	build	commission				
	TBL+	finish TBL program	modify	X RF test	X RF test	X RF test	X RF test	X RF test
	phase feedforward	design	build	commission & run				
	general	consolidation						
Next facility towards CLIC	DBA Injector		Design		build	commission		
	Nominal DBA modules		Design		build		commission	
	Economy DBA modules				build			commission
	combiner rings		Design		build			commission
	TBA		Design		build			commission
	civil engineering	Design	build					
Stand alone X-band sources		build & commission additional test ports						
		RF test program						
X-band structure development		continuation						
Design & beam dynamics studies		continuation						
LC Detector R&D		continuation						

The ILC TDR

The Technical Design (TD) Phase of the ILC Global Design Effort will produce a technical design of the ILC in sufficient detail that project approval from all involved governments can be sought.

The TD phase will culminate with the publication of a Technical Design Report (TDR) at the end of 2012. The key elements of the TDR will be:

- A complete and updated technical description of the ILC in sufficient detail to justify the associated VALUE estimate.
- Results from critical R&D programmes and test facilities which either demonstrate or support the choice of key parameters in the machine design.
- One or more models for a Project Implementation Plan, including scenarios for globally distributed mass-production of high-technology components as “in-kind” contributions.
- An updated and robust VALUE estimate and construction schedule consistent with the scope of the machine and the proposed Project Implementation Plan.

The report will also indicate the scope and associated risk of the remaining engineering work that must be done before project construction can begin.