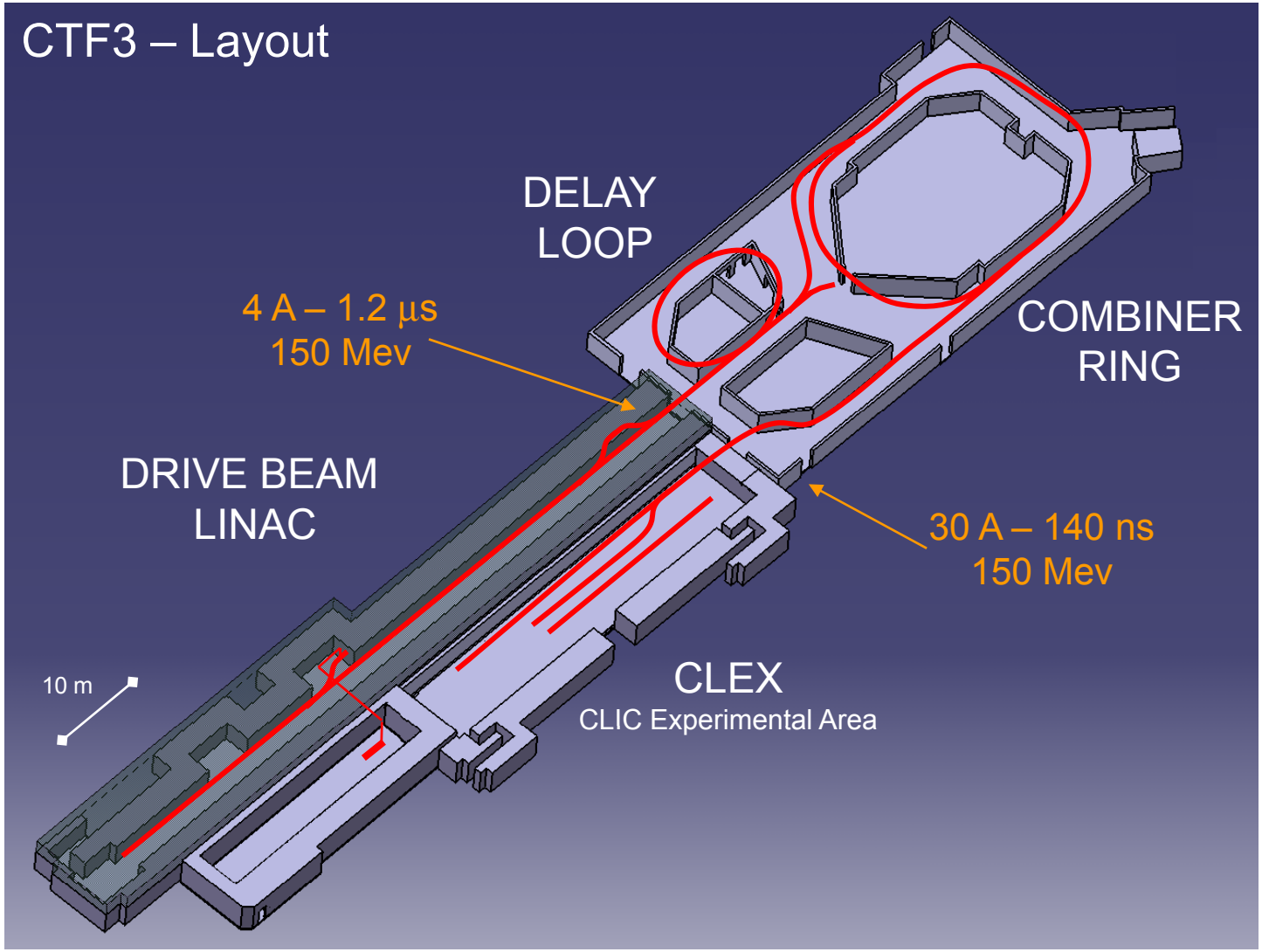
CTF3 consolidation, evolution and future perspectives


CTF3 – Layout
DELAY
LOOP
4 A – 1.2 µs
150 Mev
COMBINER
RING
DRIVE BEAM
LINAC
30 A – 140 ns
150 Mev
10 m
CLEX
CLIC Experimental Area

CTF3 has a well defined program until 2010

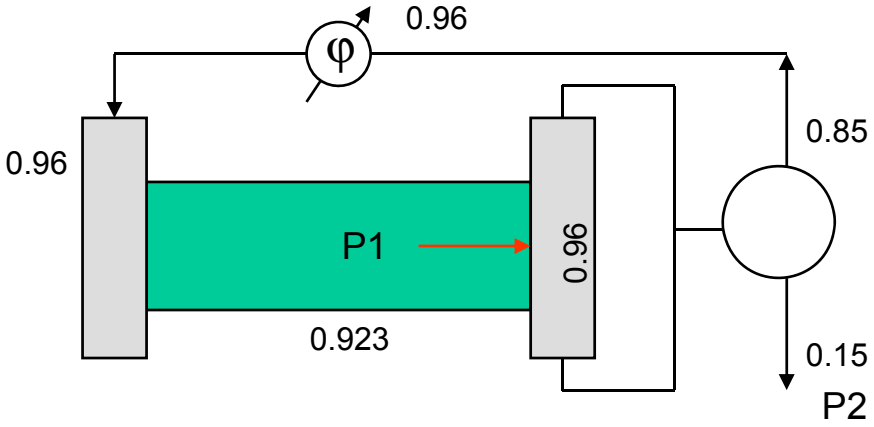
- Prove CLIC RF power source scheme:
  - Drive Beam acceleration (full beam loading – 95% efficiency)
  - Bunch interleaving (reach nominal current ~30 A , combination factor 2 x 4)
  - Two-beam acceleration of test beam in relevant sub-unit (100 MV/m with beam, TBTS in CLEX)
  - Drive beam deceleration (down to 50% of initial energy, TBL in CLEX)
  - Power production in PETS (12 GHz, 135 MW, 240 ns, TBTS & TBL)
- Provide RF power to validate CLIC components (less important after frequency change to 12 GHz) :
  - Accelerating structures, RF distribution, PETS

A warning - CTF3 is scaled down from CLIC:

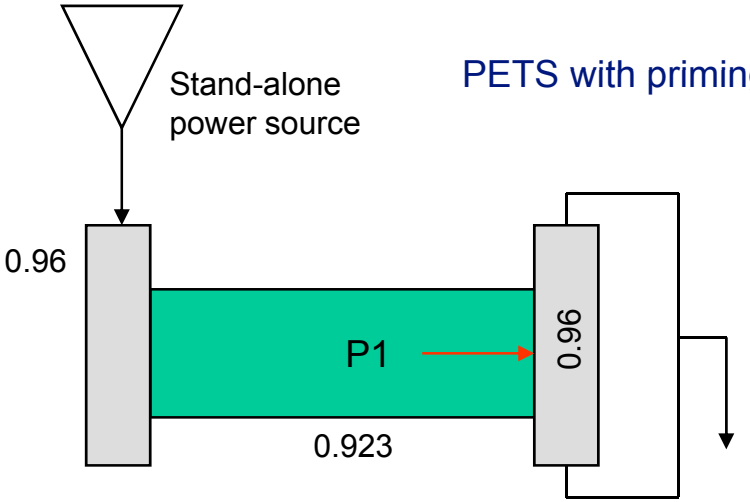
	CLIC	CTF3
Drive Beam energy	2.4 GeV	150 MeV
compression / frequency multiplication	24 (Delay Loop + 2 Combiner Rings)	8 (Delay Loop + 1 Combiner Ring)
Drive Beam current	4.2 A x 24 ➔ 100 A	3.5 A x 8 ➔ 28 A
RF Frequency	1 GHz	3 GHz
train length in linac	140 μs	1.4 μs
energy extraction	90 %	~ 50 %

PETS recirculation & priming – reach nominal power at low drive beam current

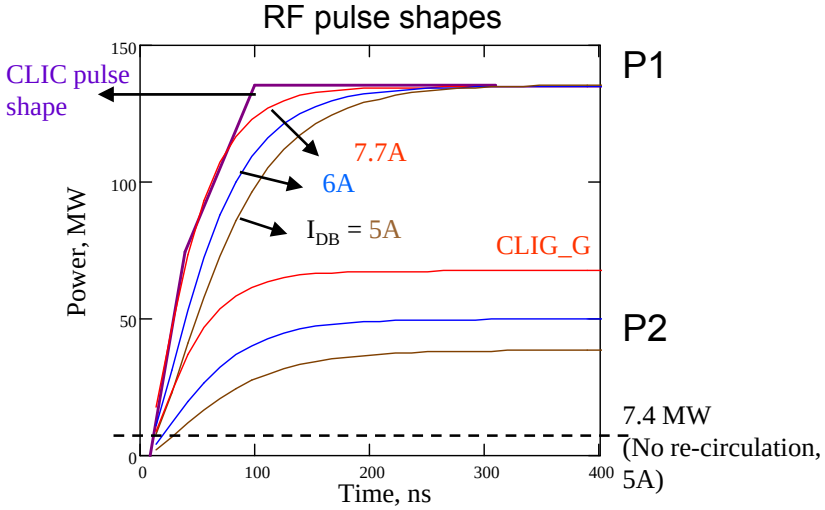
PETS with recirculation schematic:



PETS with priming:



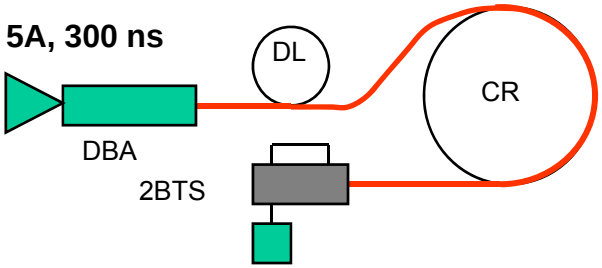
P2 ~ P1

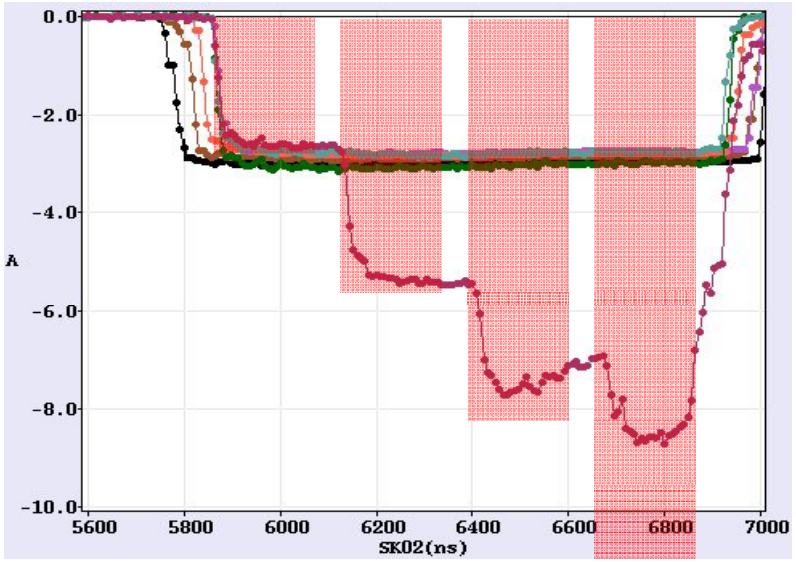


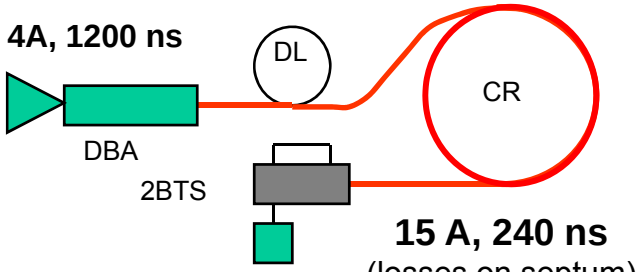
RF input power needed for 135 MW nominal output

DB current	P1
5 A	80 MW
10 A	40 MW
15 A	12 MW

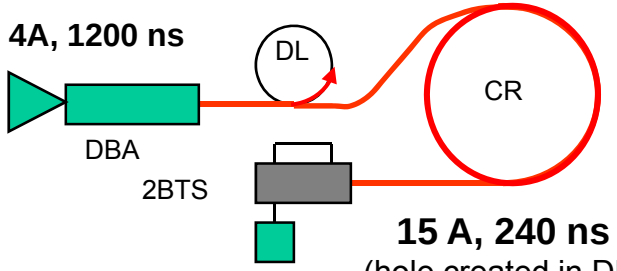
Long DB pulses in CTF3 (reach nominal length)





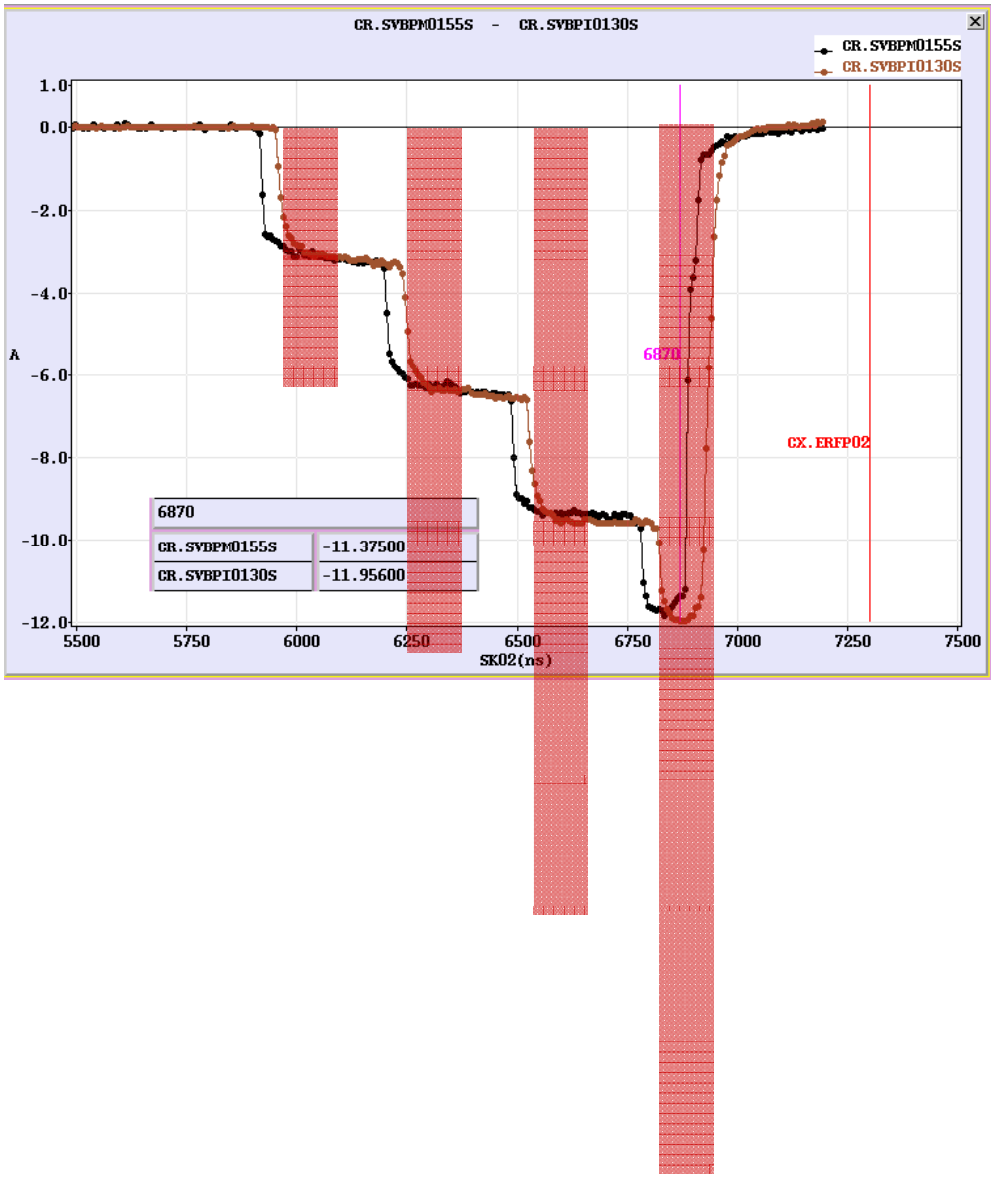


15 A, 240 ns
(losses on septum)



15 A, 240 ns
(hole created in DL)

CTF3 consolidation, evolution and future perspectives



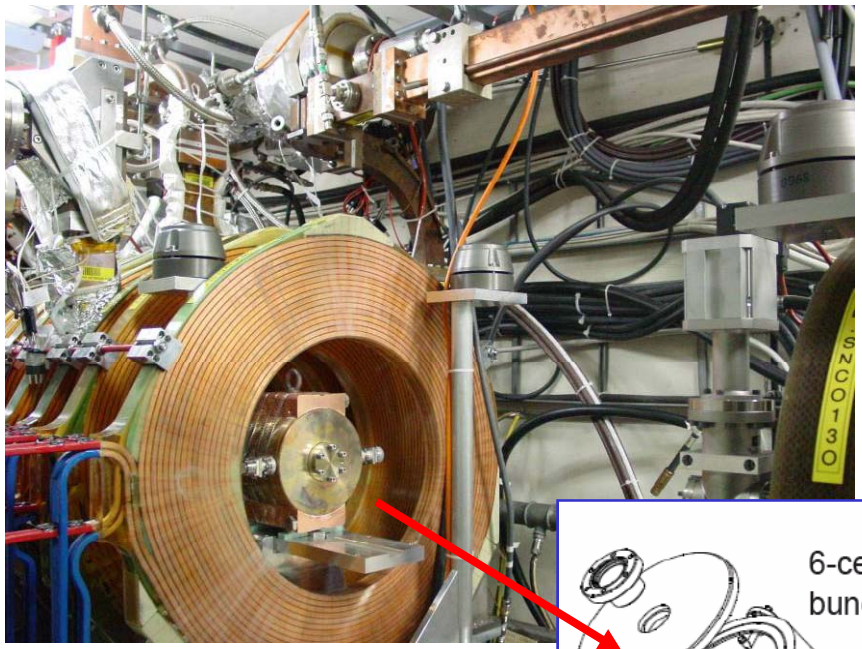
Where are we now for drive beam generation ?

Factor 4 combination in ring, delay loop by-passed

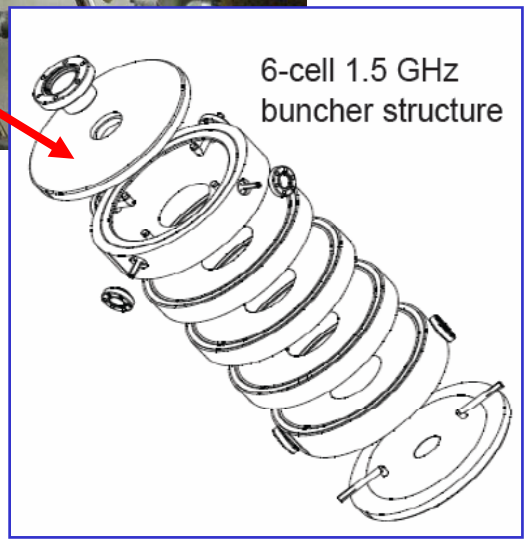
What more do we need for a drive beam concept demonstration in CTF3 ?

ISSUE	GOAL
• Emittance conservation	final ε_N < 150 π mm mrad
• Longitudinal beam dynamics	final bunch length < 1 mm rms
• Phase & current stability along the pulse	Flat-top in produced RF power < 1 %
• Pulse-to-pulse current fluctuations	below 1 % (actually better!)
• Losses control	Overall losses (from girder 4) < 10 % ?
• Satellites	RF gun option, or scheme to eliminate satellites at low energy in CLIC
• Others…	

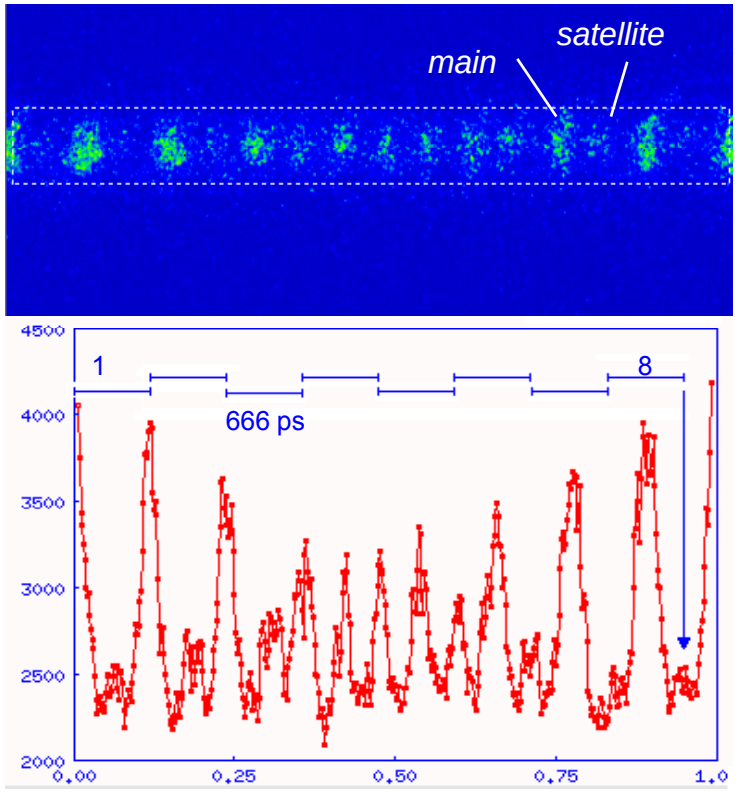
Fast phase switch from SHB system phase coding



3 TW Sub-harmonic bunchers, each fed by a wide-band TWT

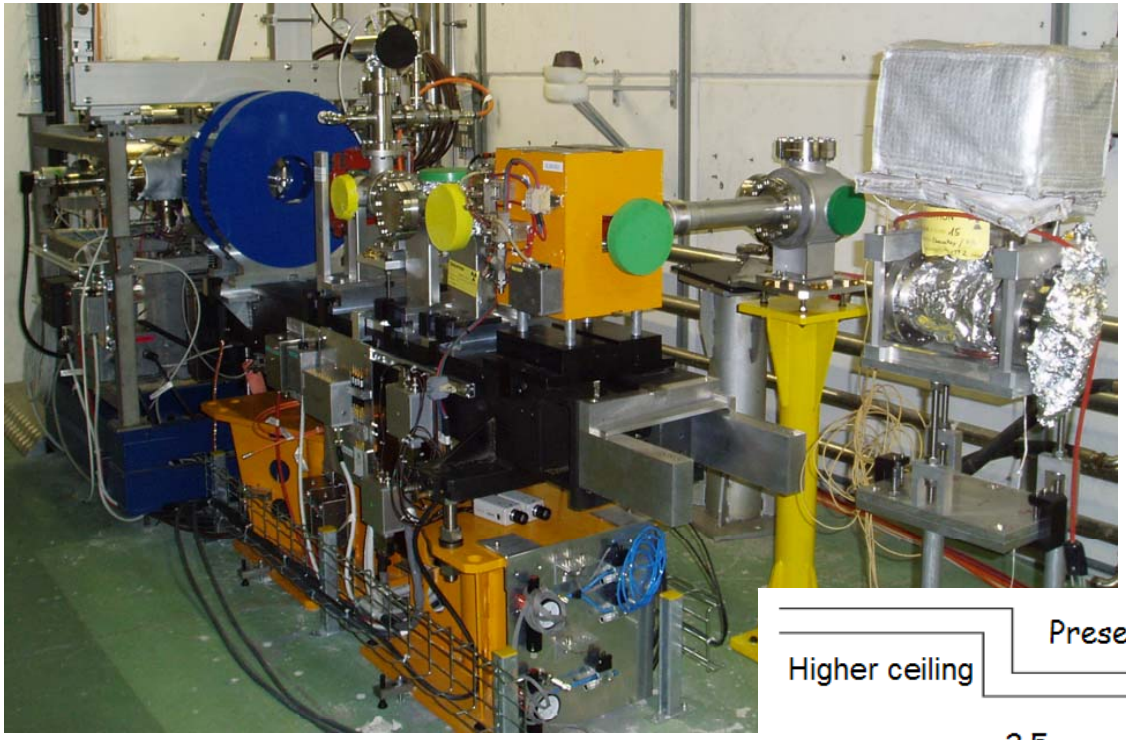


Streak camera image

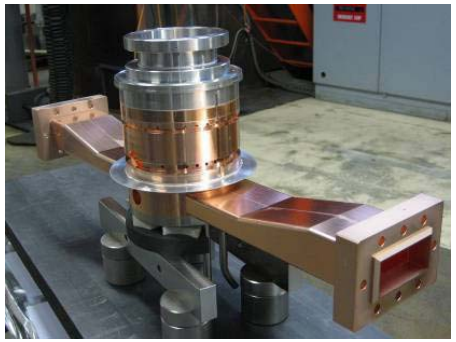


8.5 · 666 ps = 5.7 ns

CTF3 consolidation, evolution and future perspectives



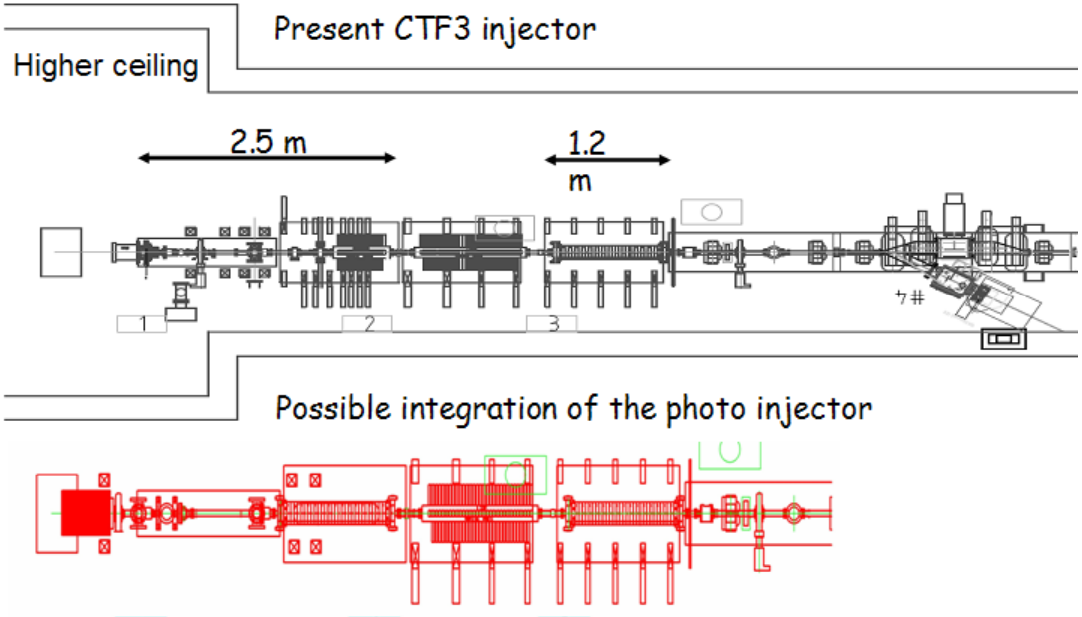
Satellite control, RF gun option



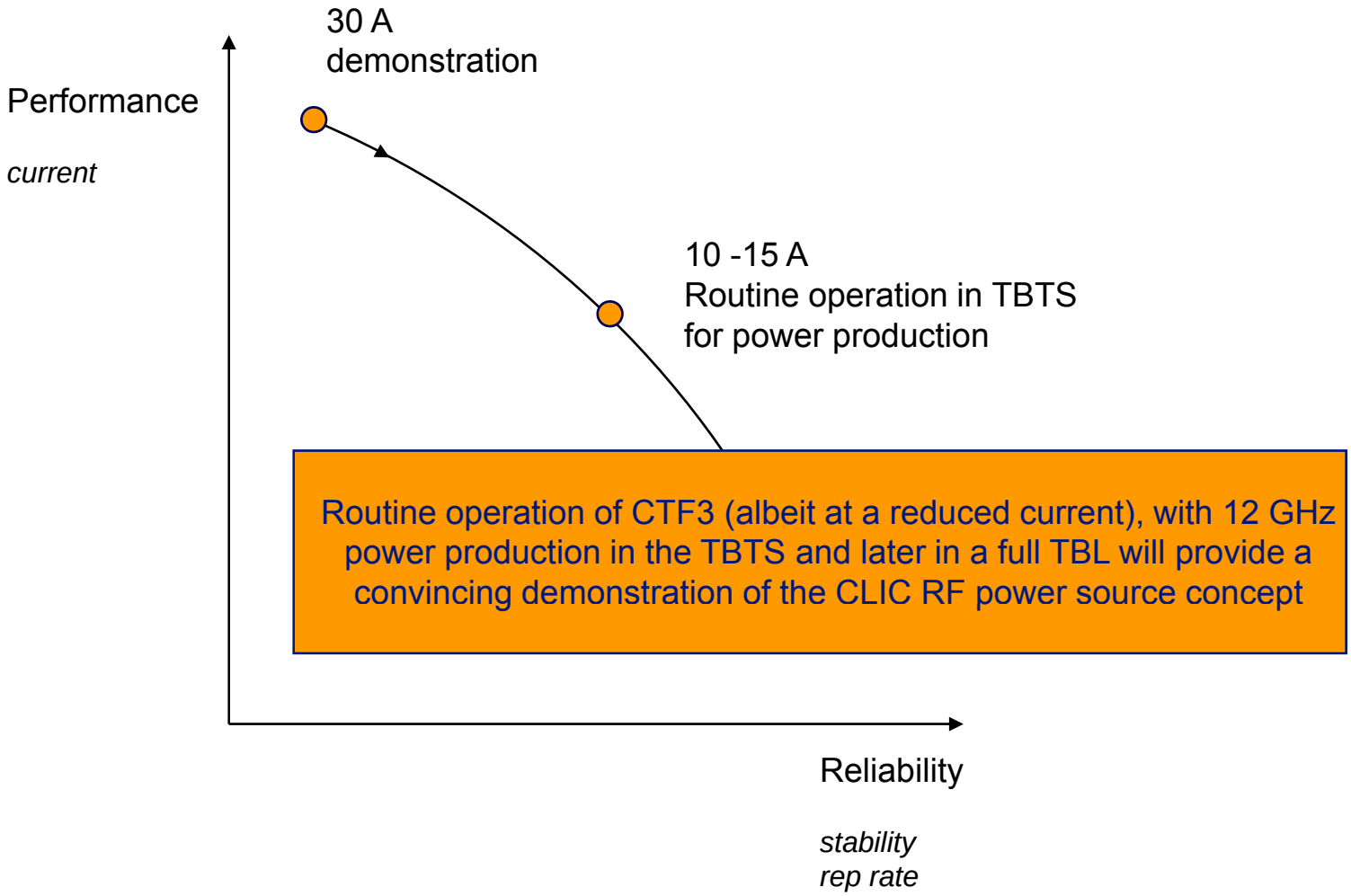
- Smaller transverse emittance
- Shorter bunches, no energy tails
- No satellites
- Lower current

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
- …



Performance vs reliability



CERN DG's talk to Staff
3 October '08

Objectives 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 progra… …cted resou… …l Design. This s… …*proved* or if a new, more ambitious level of activities and support is envisaged in the European framework.

N.B.: Expect additional significant contribution from outside CERN, up to the same level

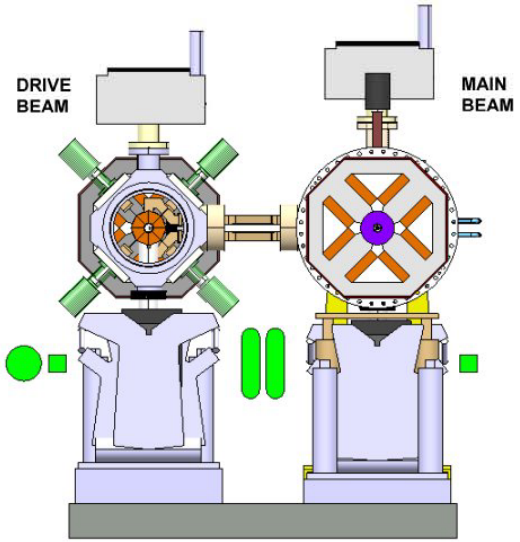
Talk to Staff - 3 October 2008 54

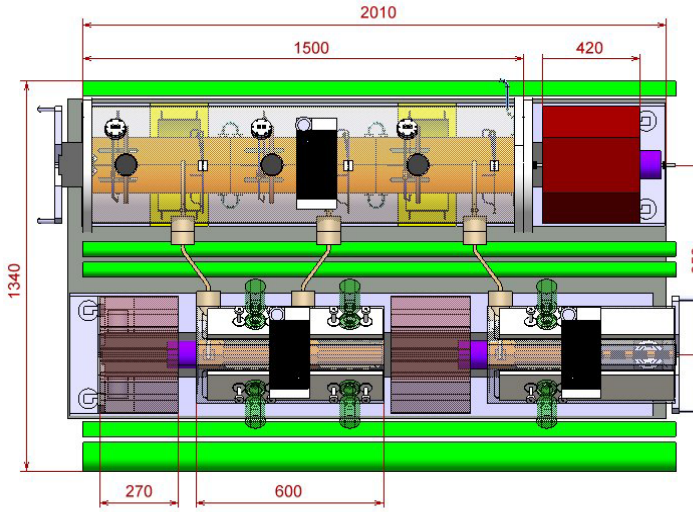
Specific experiments – consolidation – evolution paths

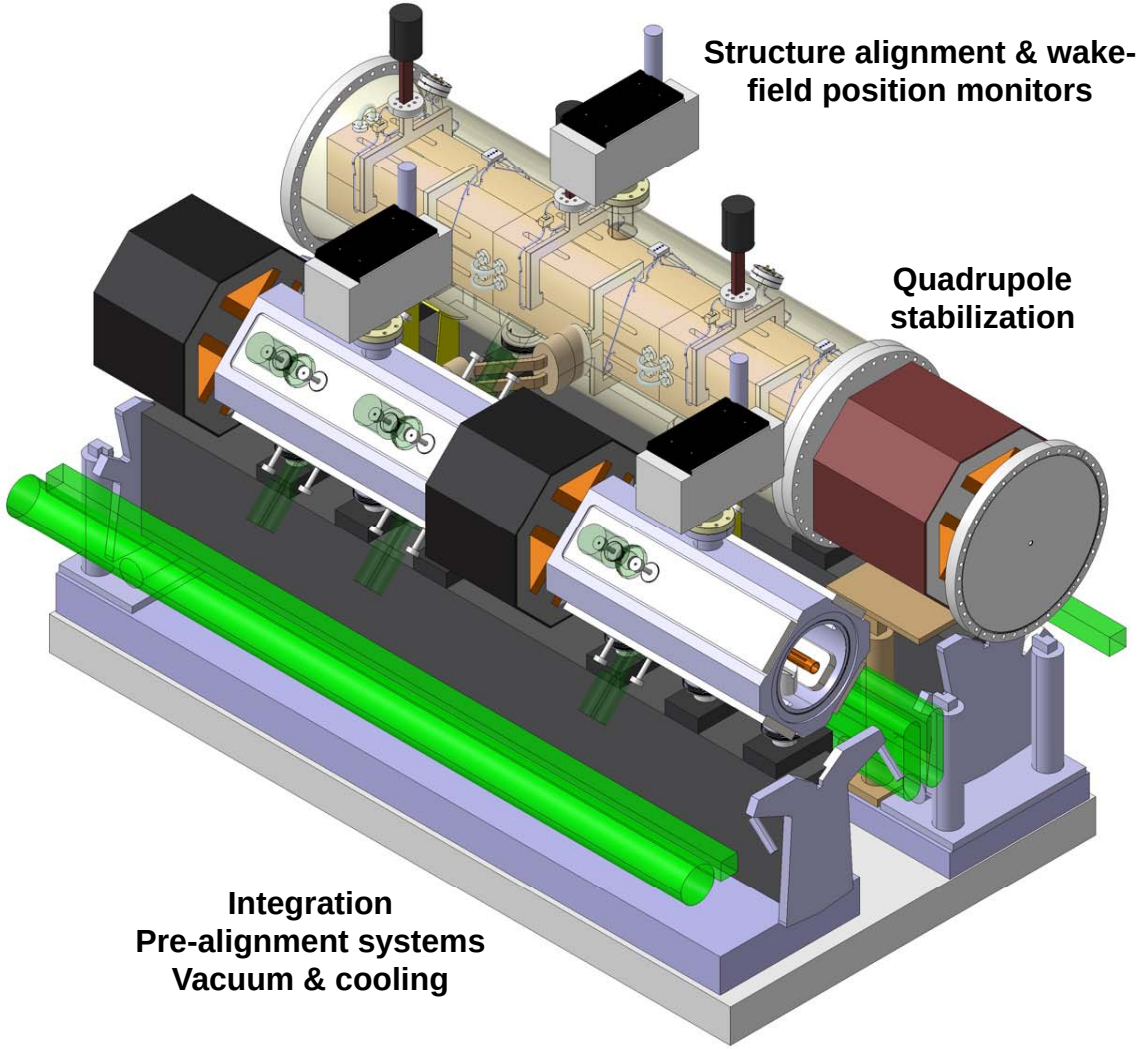
- Phase stability / stabilization / feedback
- Beam loading compensation experiment (control of RF pulse shape)
- Beam loading compensation full demonstration (need CALIFES upgrade – 1 klystron)
- CTF3 “reasonable upgrade” + 3 klystrons (CALIFES, test + diag defl + phin, girder 14)
- Photo-injector option full implementation
- One, then several modules in TBTS, with ~ nominal parameters (need PETS priming or recirculation)
- CTF3 upgraded to X-band testing plant (1/2 nominal current, 2 PETS chained, DB dump in DL)
- Rep rate upgrade, up to 50 Hz (shielding – control of beam losses!)
- Instrumentation development for LC – Instrumentation Test Beamline ?

The CLIC Module

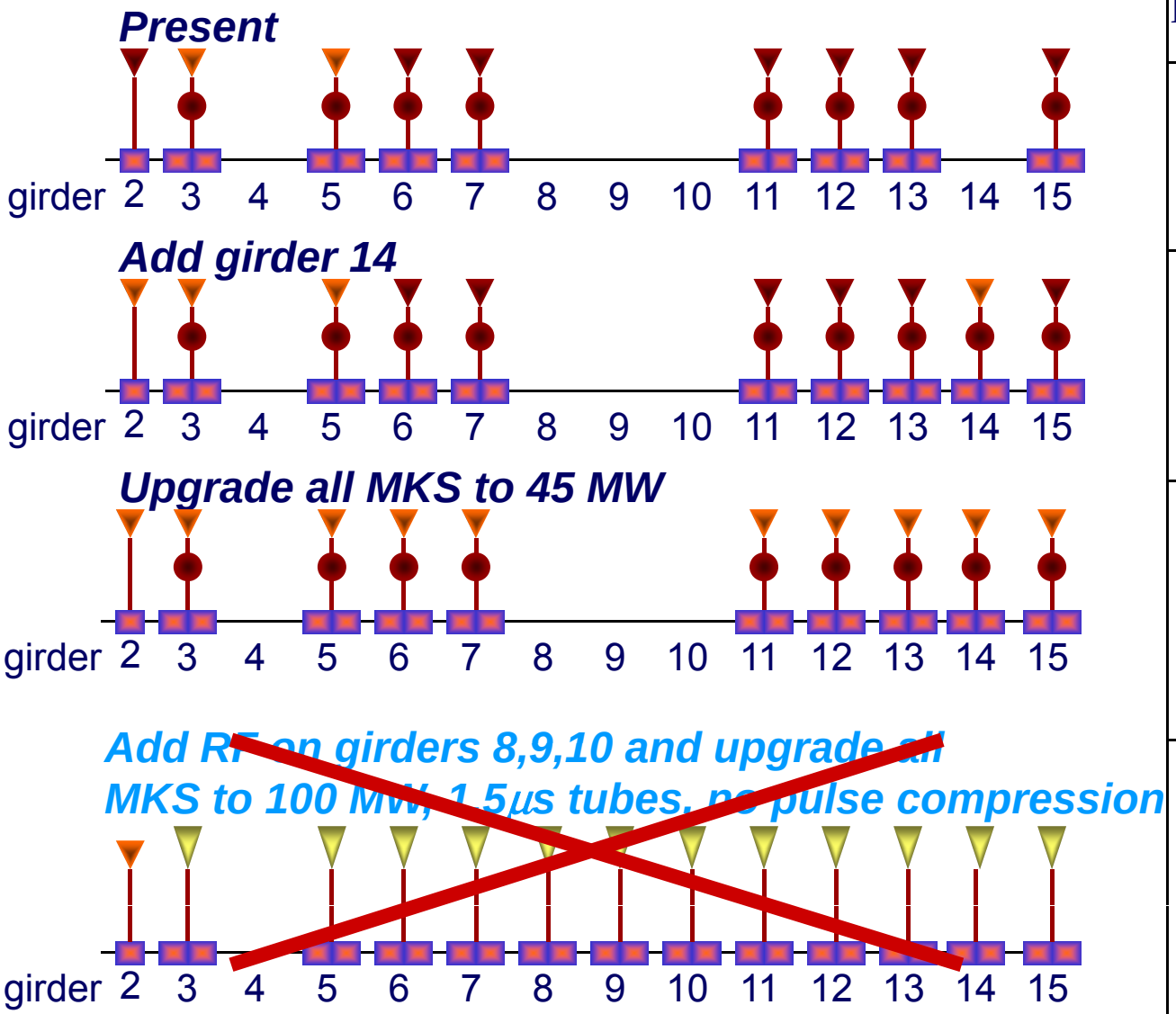
Straightforward continuation of the CTF3 baseline program







Evolution of CTF3 drive beam linac



I_{Linac}[A]	I_{CLEX}[A]	T [MeV]
0.1	0.72	246
3.6	25.9	156
4.9	34.9	125
0.1	0.72	279
3.6	25.9	179
4.9	34.9	143
0.1	0.72	303
3.6	25.9	203
5.3	38.2	154
0.1	0.72	402
3.6	25.9	270
5.3	38.2	206

Options for long term use of TBL

1) Power plant for structure testing

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.

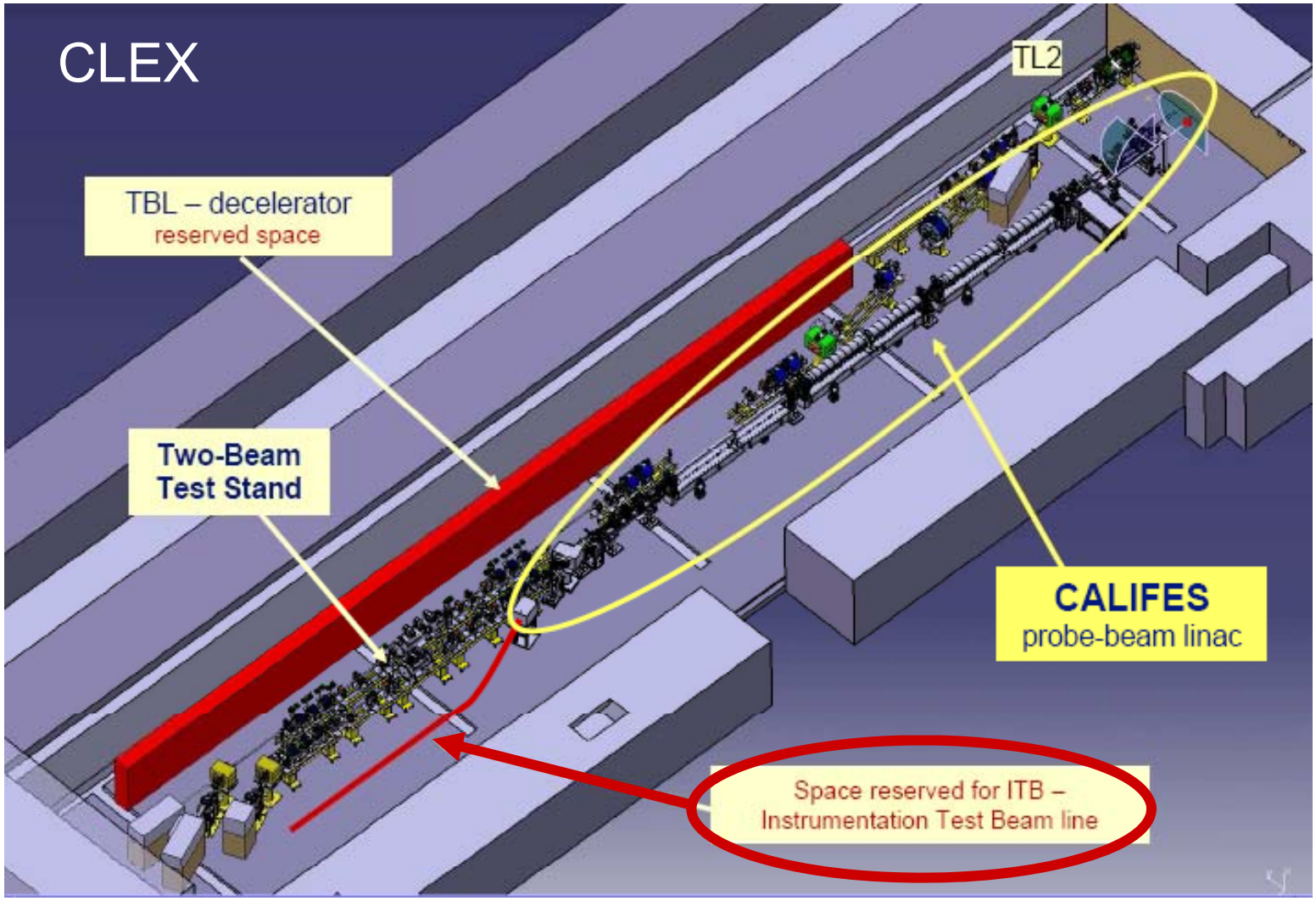
If you don't believe this, there is no point to continue to work on CLIC !

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

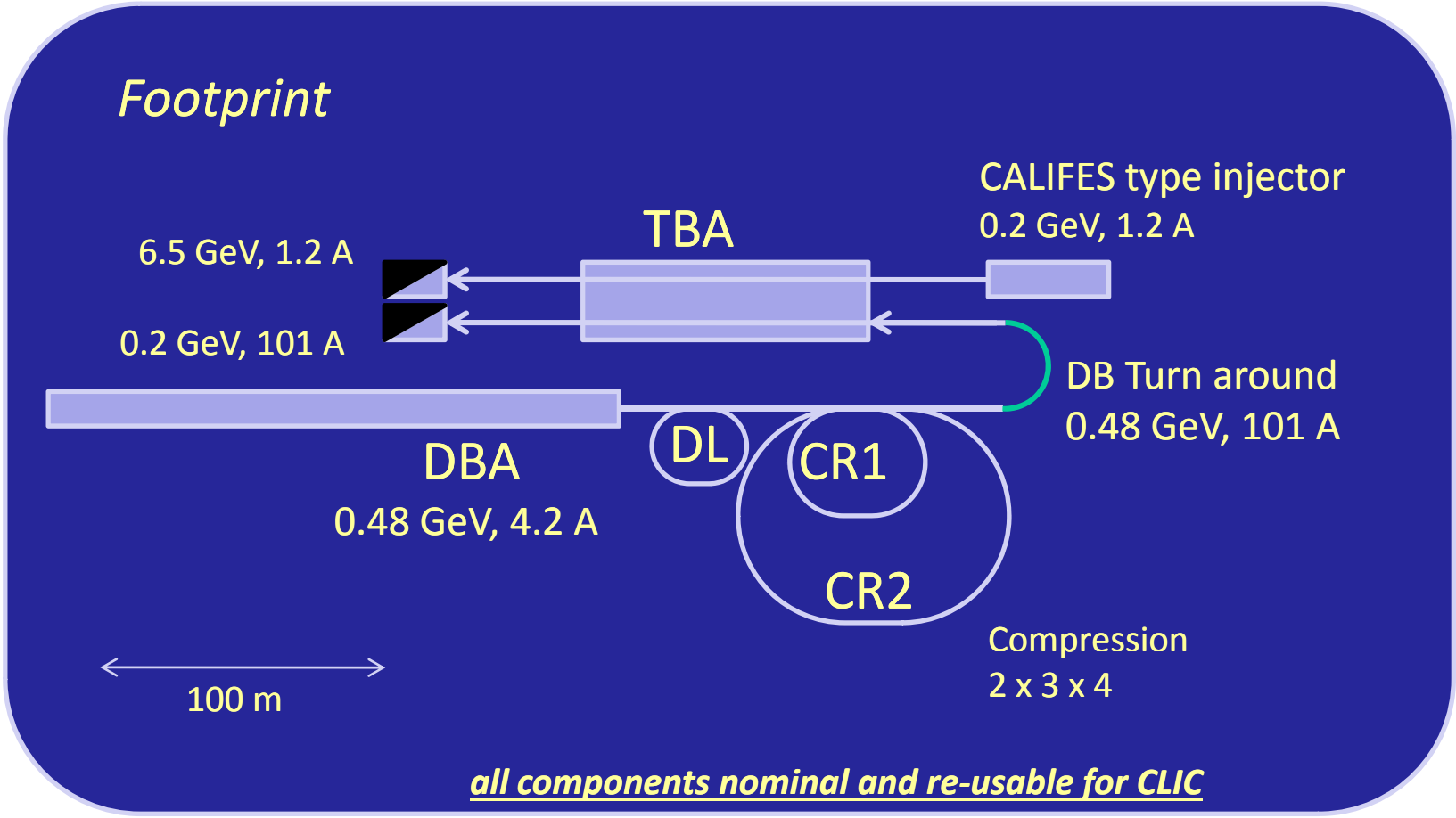
$$\frac{144000 \times 2}{7 \times 365} = 113 \text{ RF slots}$$

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

CTF3 consolidation, evolution and future perspectives



A next facility towards CLIC



H. Braun - CLIC Perspectives beyond 2010

Tentative schedule for CLIC R&D 2010-2016

Year		2010	2011	2012	2013	2014	2015	2016
CTF3+	module test	design	build	commision				
	TBL+	finish TBL program	modify	X RF test	X RF test	X RF test	X RF test	X RF test
	phase feedforward	design	build	commision & 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						

+ possibly other R&D programs to be defined…

We need YOU!