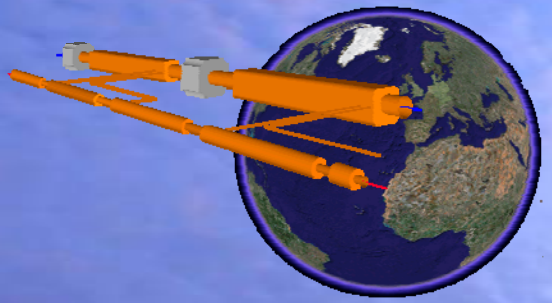
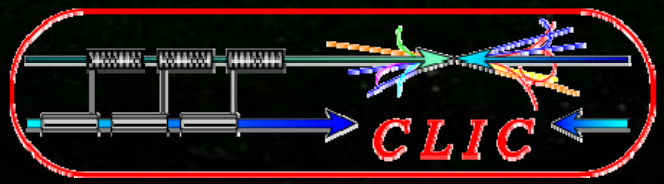
CLIC Perspectives beyond 2010

- Resources & Schedule
- CLIC R&D from CDR to TDR
- CTF3+
- X-band RF testing
- The next CLIC facility



CLIC'08 cocktail
tonight, 7pm



Hans-H. Braun
CLIC'08, 14.10.2008

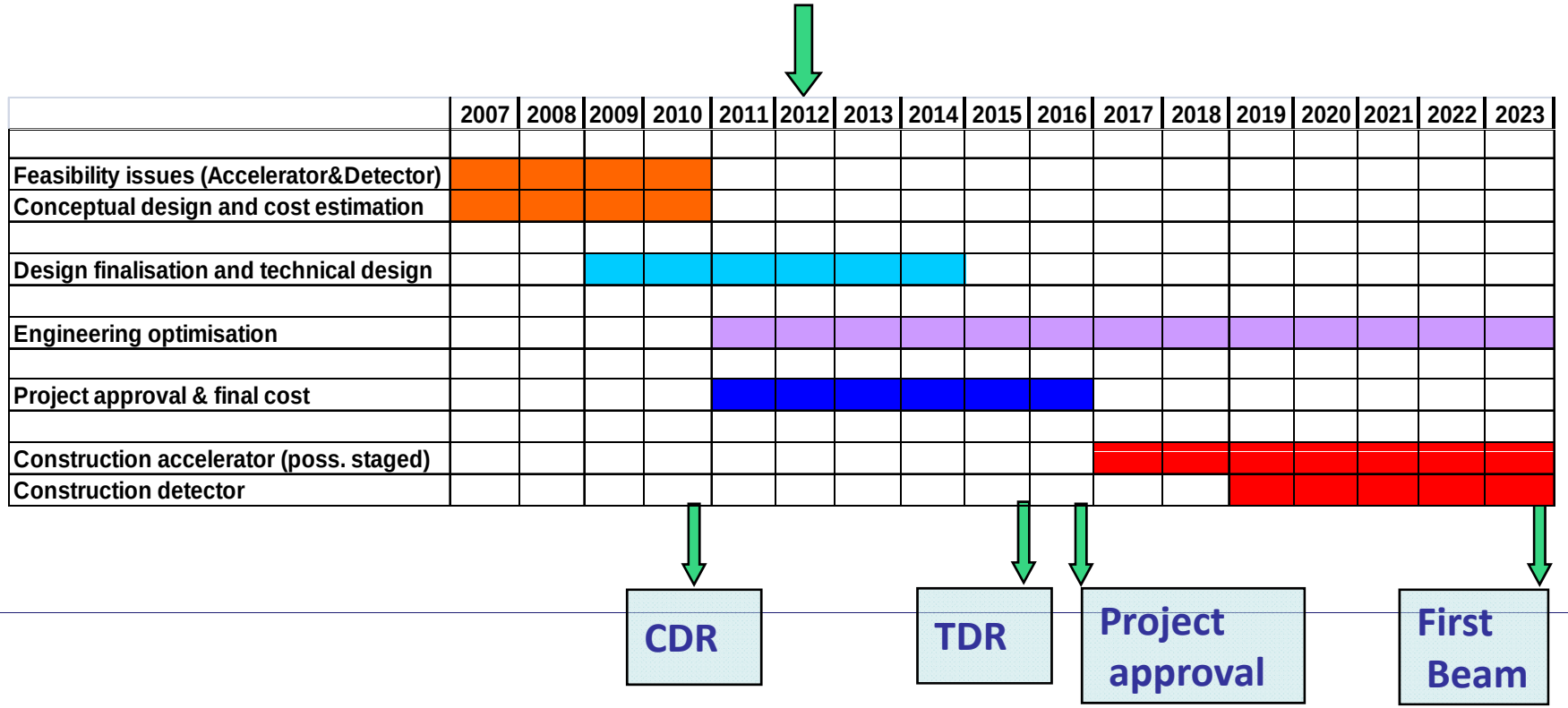
Most material collected from a brainstorming last Tuesday with

Roberto Corsini, Jean-Pierre Delahaye, Günther Geschonke,

Hermann Schmickler, Daniel Schulte, Walter Wuensch and myself

Tentative long-term CLIC scenario
Shortest, success oriented and technically limited schedule

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



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.

DG's speech:

Expected CERN contribution for CLIC TDR phase is
250 MCHF + 1000-1200 FTE over 6 years

What's your contribution ?

What's required for TDR ?

Readiness to receive funding for building CLIC, this implies

- Technical design of all components which are critical for schedule
- Technical feasibility of all components
- Detailed site consideration
- Detailed construction Schedule
- Detailed material cost and manpower resource estimates and risk analysis

What hardware work needs to be done for 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 for all technical components in critical item list***
  (see Jean-Pierre's & Hermann's talks)

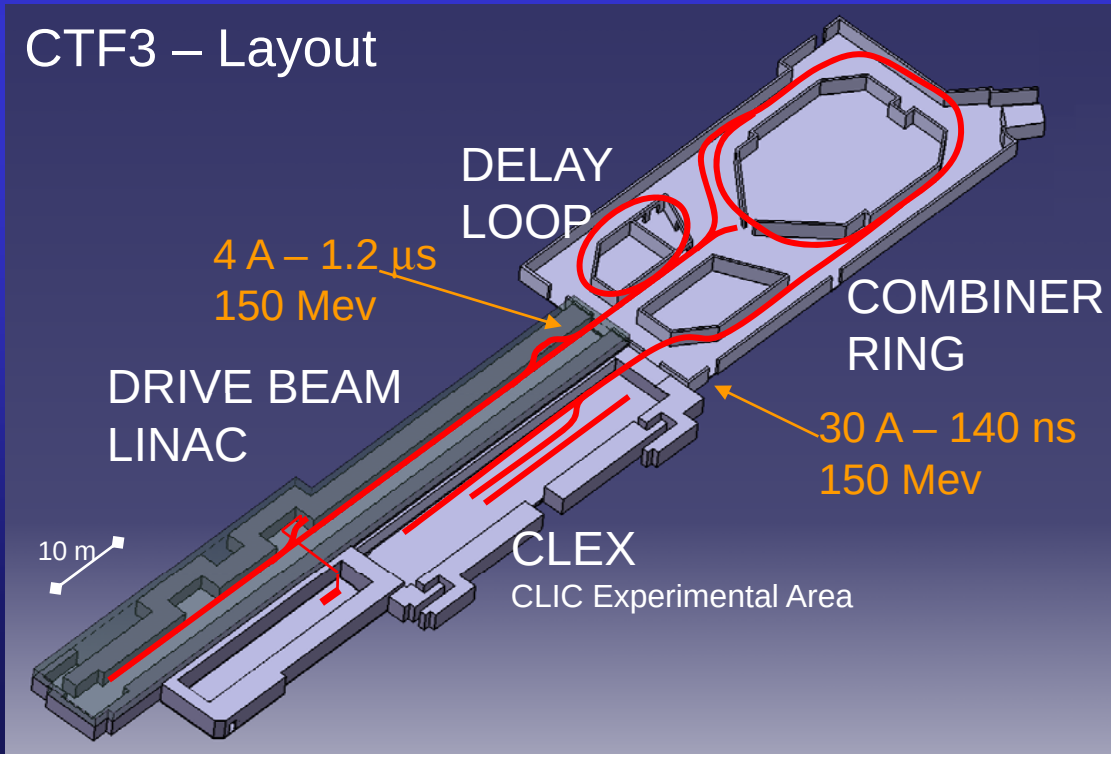
Future facilities should provide

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

Use of CTF3 beyond 2010

- Test of fully equipped CLIC module in TBTS
- Demonstration drive beam phase feed forward with ≈20 fs resolution
- Demonstration beam loading compensation with staggered phase-switch timing
- Demonstration of stable & robust long term operation
- TBL decelerator as multi port X band RF test bed

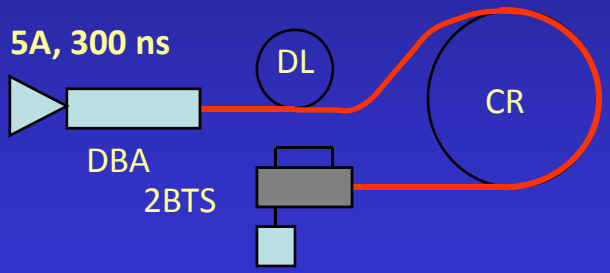
Prerequisite: consolidation !

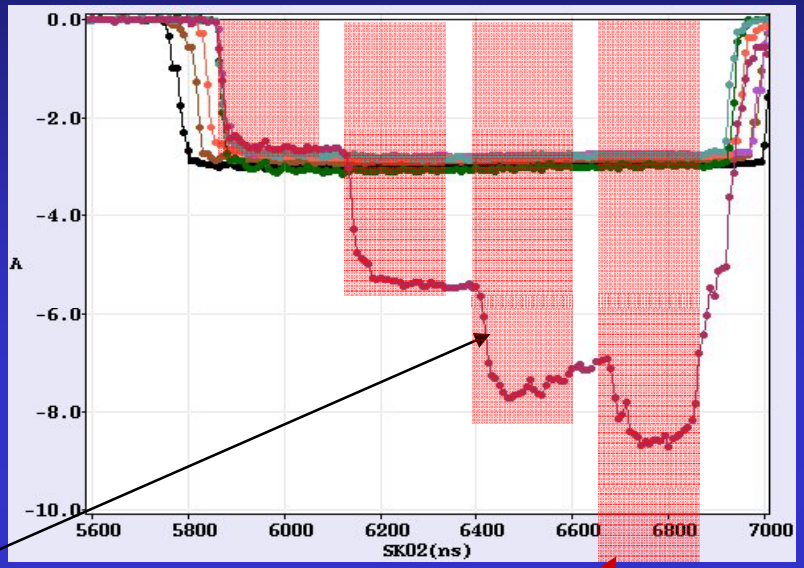


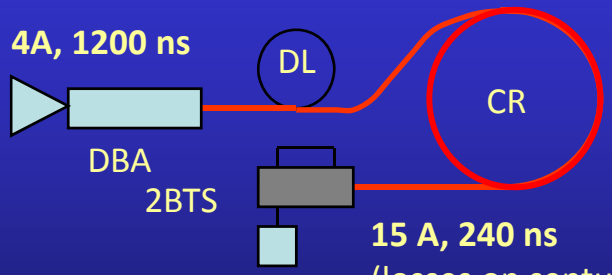
Specific experiments – consolidation – evolution paths

- Phase stability / stabilization / feedback
- Beam loading compensation experiment (control of RF pulse shape with staggered phase switch timing)
- Beam loading compensation full demonstration (need CALIFES upgrade to 1.2 A beam current)
- CTF3 “reasonable upgrade” + 3 klystrons (CALIFES, test + bunchlength deflectors + PHIN tests, girder 14)
- Photo-injector option full implementation (if PHIN results positive)
- More than 1 module in TBTS, with ~ nominal parameters (need PETS priming or recirculation)
- CTF3 TBL upgraded to X-band structure processing testing plant
  (1/2 nominal current, 2 PETS chained, DB dump in DL)
- X-band testing plant requires rep. rate upgrade to 50 Hz (shielding – control of beam losses!)

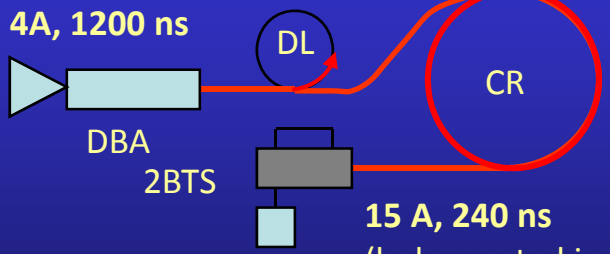
DB pulses with nominal CLIC 240 ns duration in CTF3





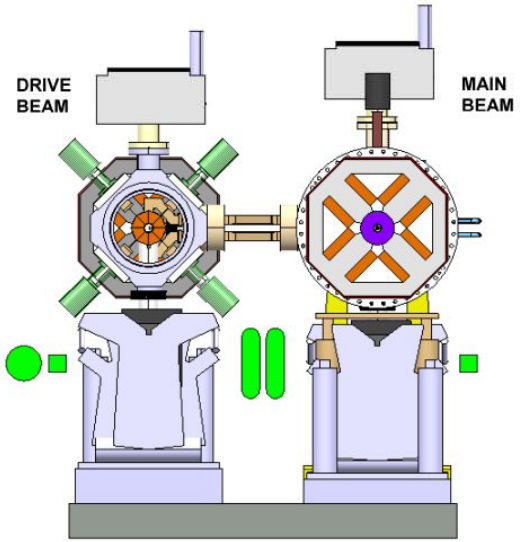


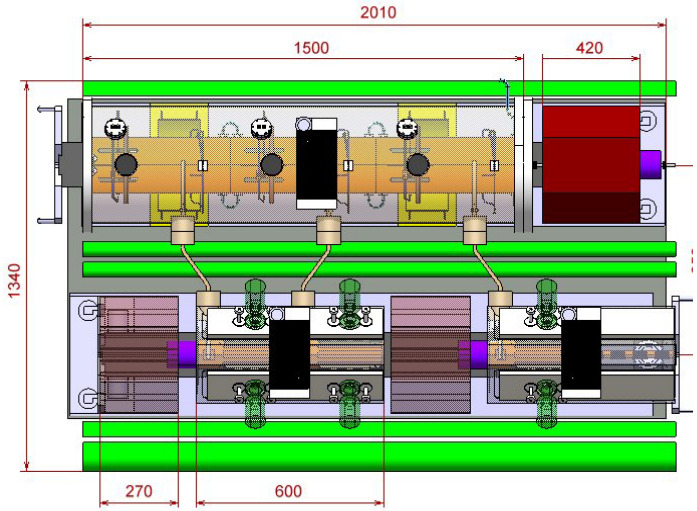
15 A, 240 ns
(losses on septum)



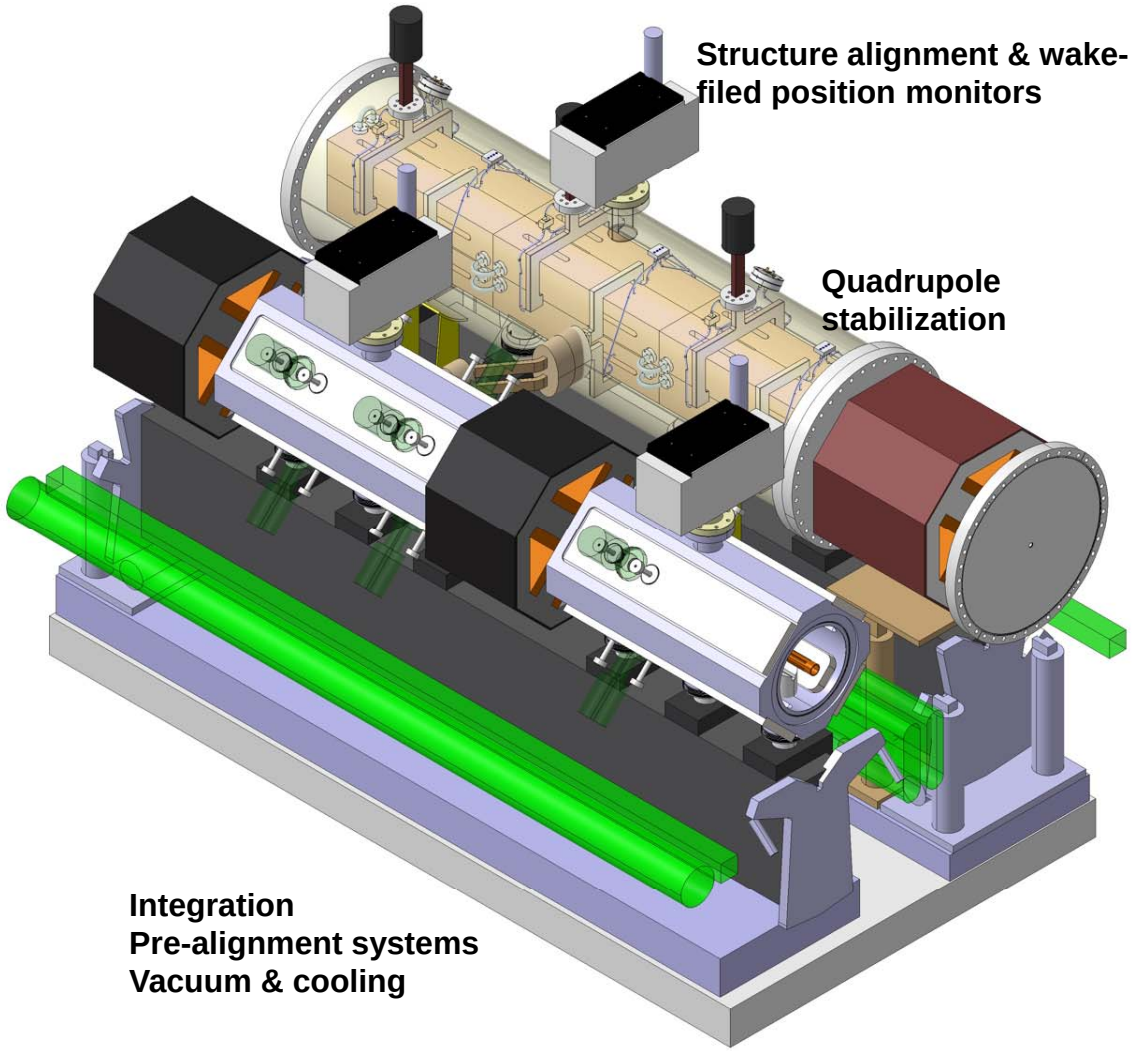
15 A, 240 ns
(hole created in DL)

The CLIC Module in TBTS





Straightforward continuation of the CTF3 baseline program



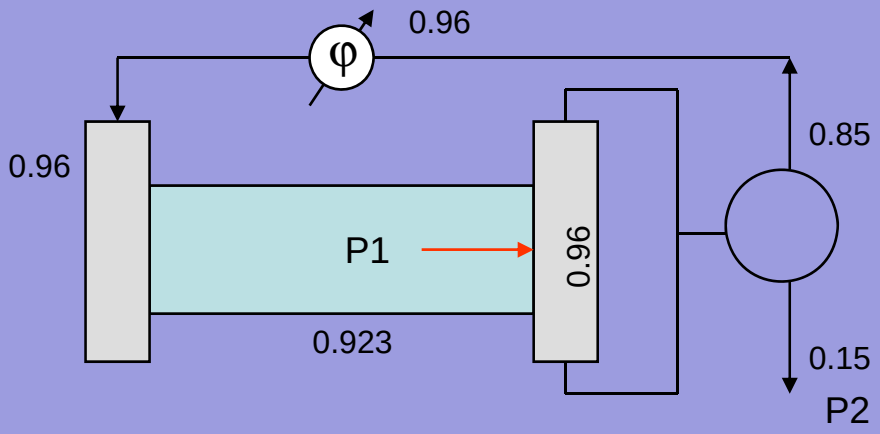
Structure alignment & wake-filed position monitors

Quadrupole stabilization

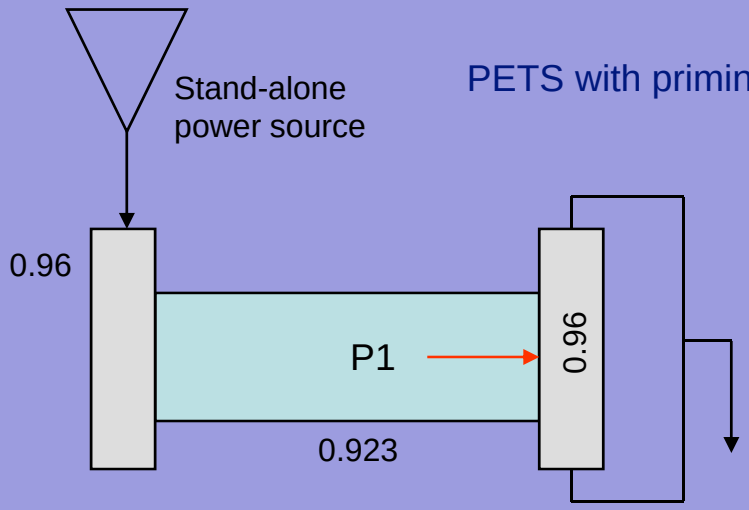
Integration
Pre-alignment systems
Vacuum & cooling

CTF3 cannot provide 100 A drive beam
⇒ PETS recirculation or priming for nominal power

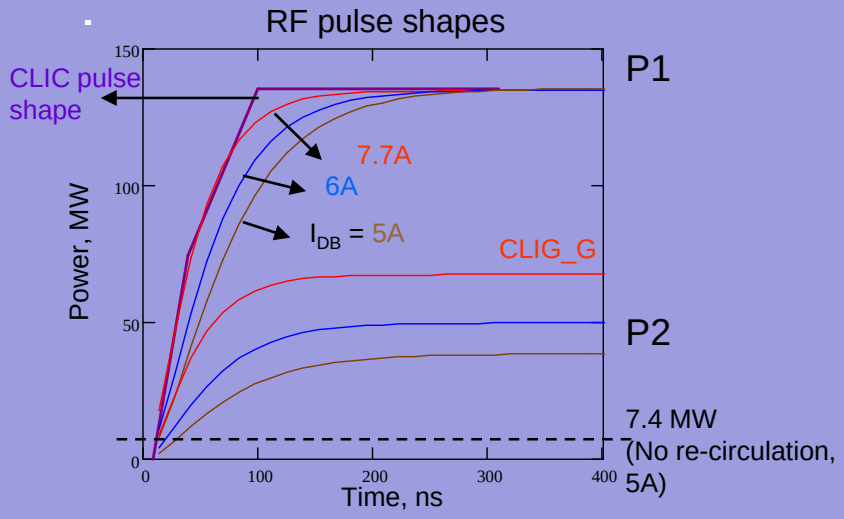
PETS with recirculation schematic:



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

Klystron based X-band test stand facility

In addition to SLAC and KEK facilities at 11.4 GHz
a 12 GHz teststand at CERN with one testing port will be operational from 2010

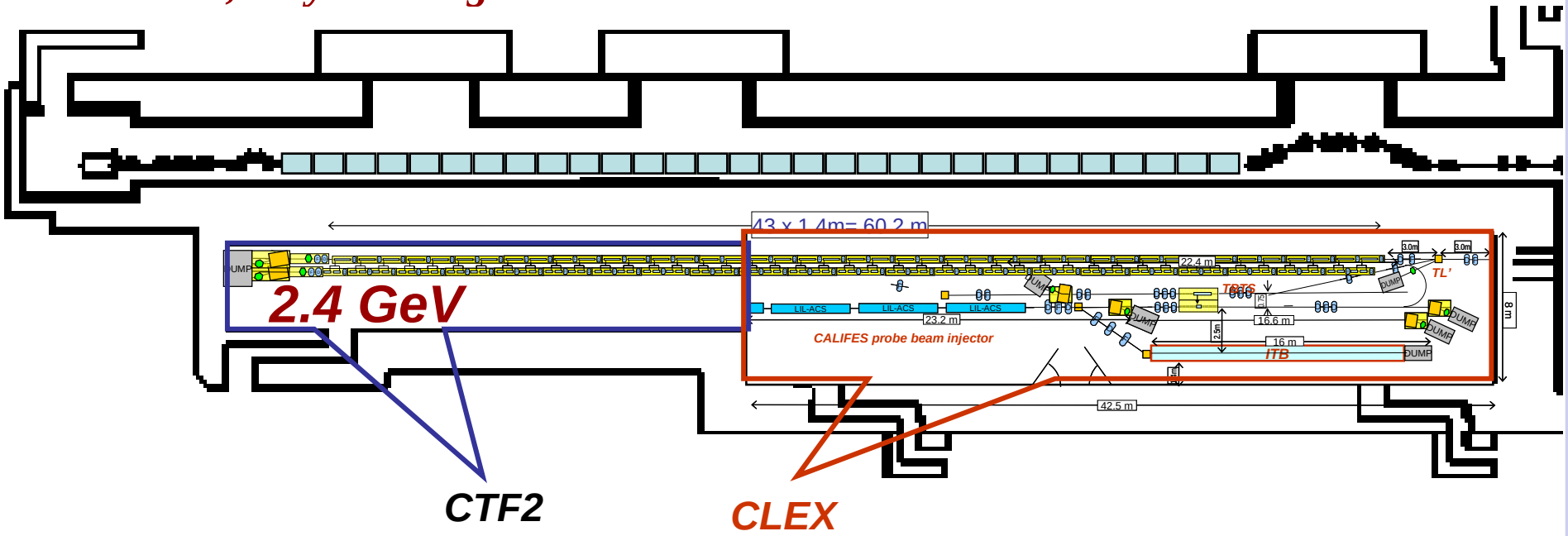
For full fledged structure development program several klystrons
with fully equipped test stands required.

Motivation:

- High-throughput, long-period running capability for structure development program
- Verification of nominal design structures, reproducibility
- Test bed for higher-performance lower cost variants on nominal design
- Experimental area for high-gradient studies: breakdown, pulsed surface heating and dark current
- Test bed for other structures like crab cavities

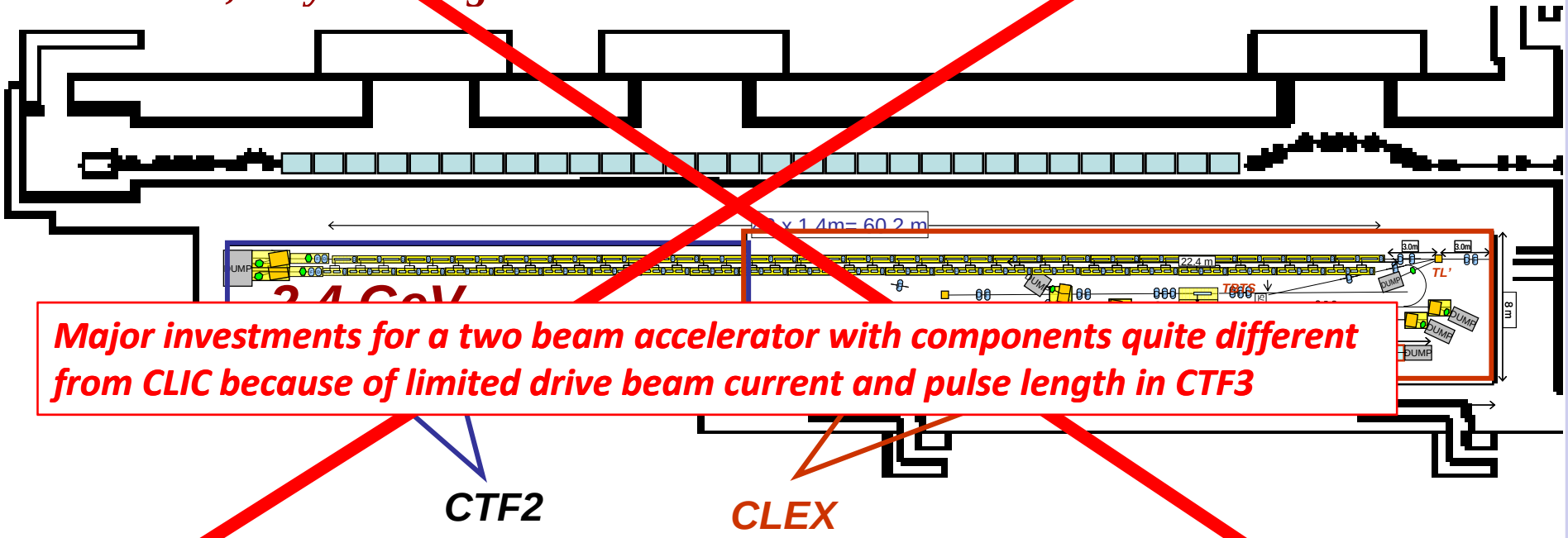
Options for long term use of CTF3: *Two beam X-band linac*

The ultimate, only building limited two beam accelerator in CTF3 !



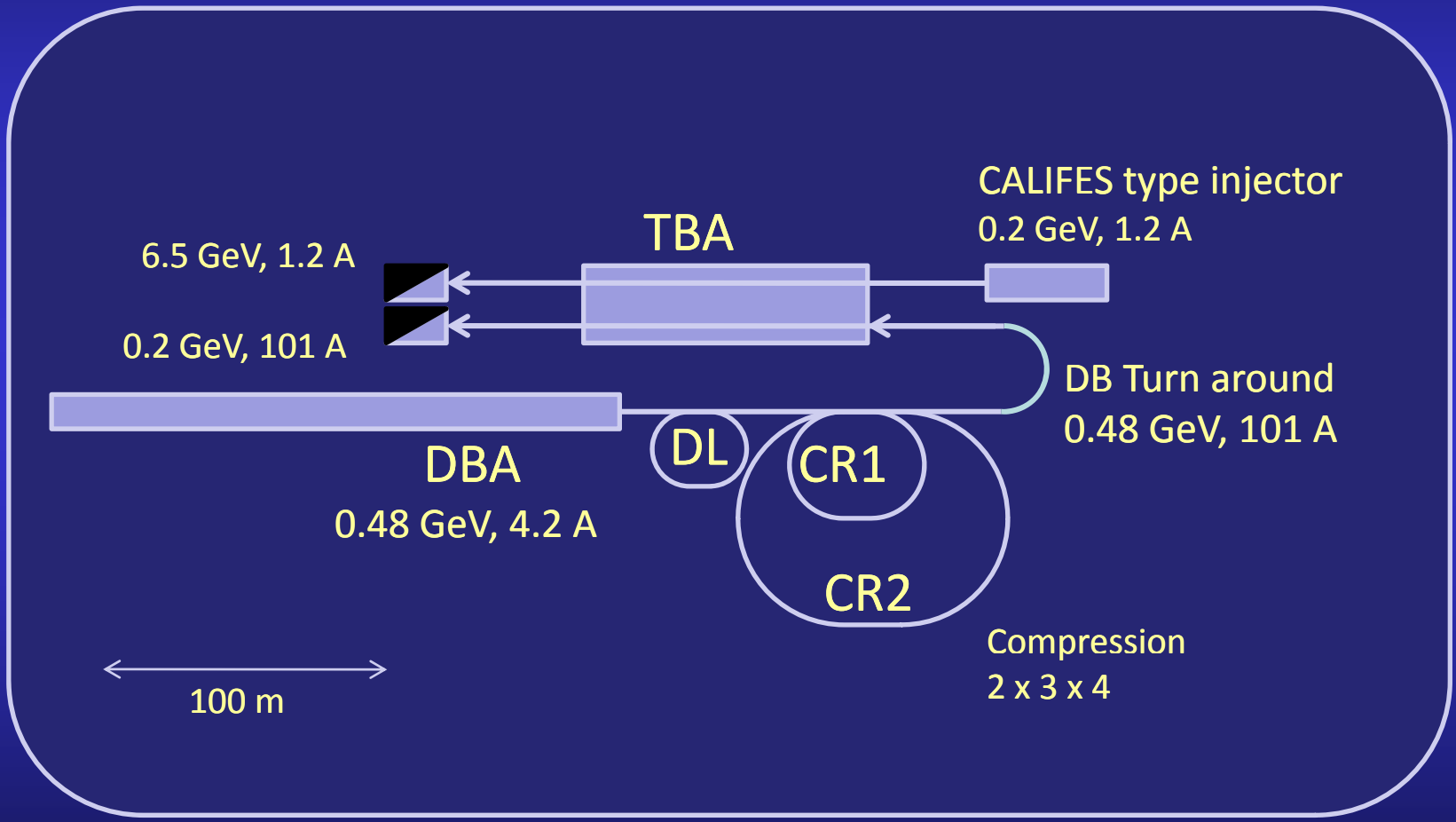
Options for long term use of CTF3: *Two beam X-band linac*

The ultimate, only building limited two beam accelerator in CTF3 !

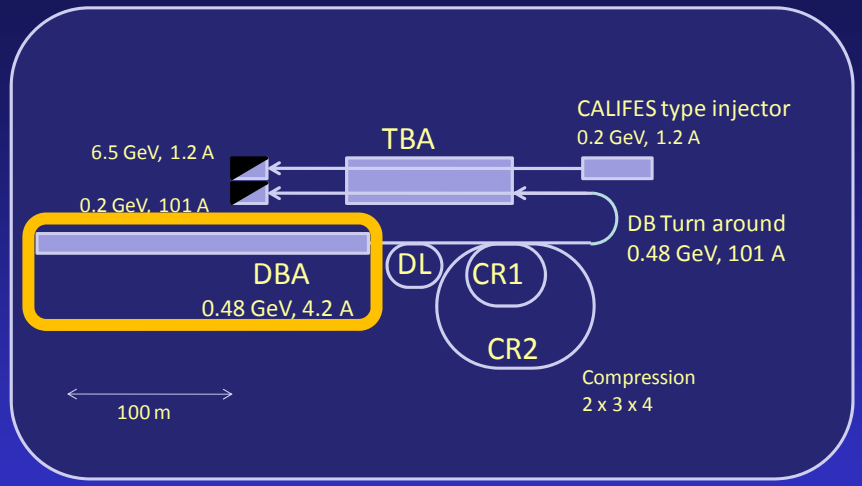


Major investments for a two beam accelerator with components quite different from CLIC because of limited drive beam current and pulse length in CTF3

A next facility towards CLIC



Drive Beam Accelerator DBA



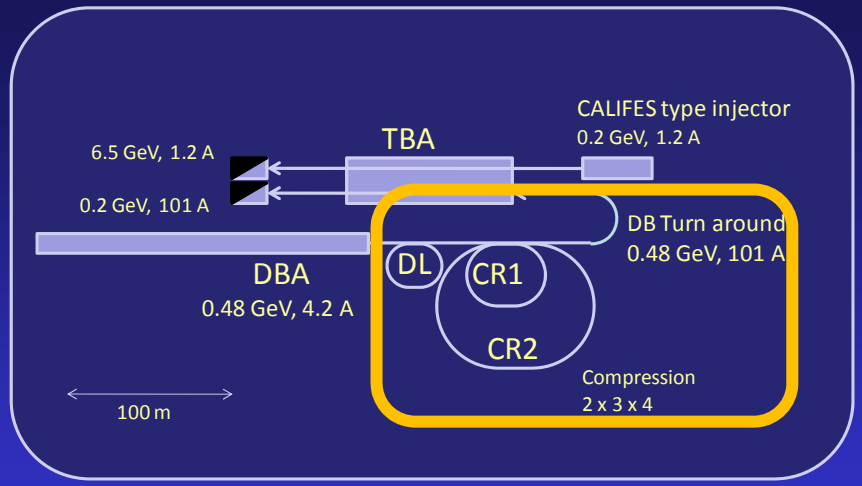
- Nominal CLIC DBA injector
  (thermionic or Photo injector, depending on results of PHIN tests)
- 2 nominal accelerator modules
  equipped with nominal 33 MW, 1 GHz, 50 Hz, 140μs pulse length klystrons
  development of nominal drive beam klystrons & modulators required
- 58 nominal accelerator modules with reduced pulse length klystrons (6 μs)

Total length ≈ 200 m, nominal 4.2 A beam

final energy 0.48 GeV instead of 2.4 GeV for CLIC
6μs pulse length instead of 140μs, *for economy, sufficient to produce one nominal bunch train*

all hardware nominal and re-usable for CLIC !

Delay Loop + Combiner Rings + Turnaround



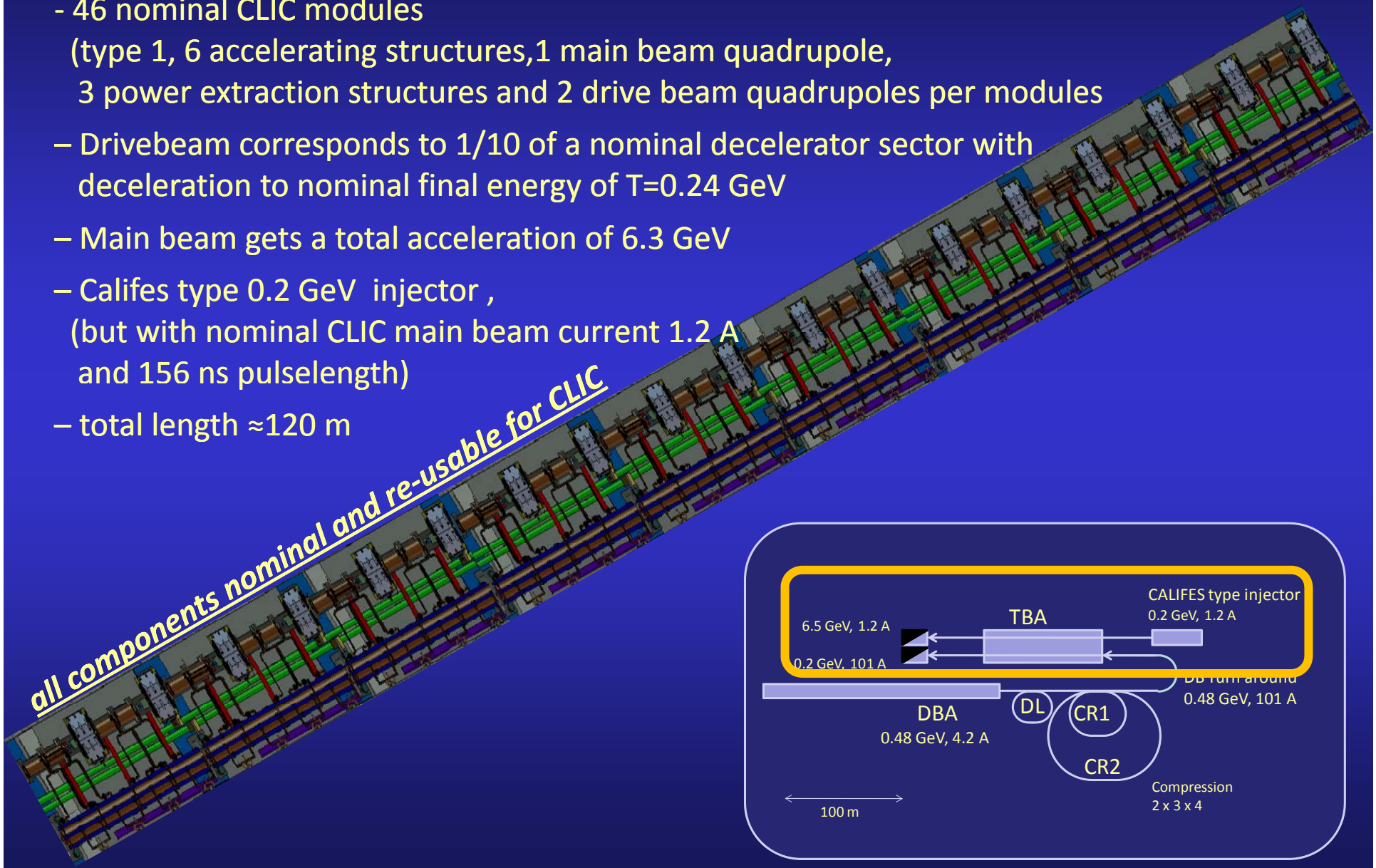
– Nominal CLIC Delay Loop, 2 x current multiplication
– Nominal CLIC combiner ring 1 , 3 x current multiplication
– Nominal CLIC combiner ring 2 , 4 x current multiplication
– Nominal DB turnaround with bunch compressor

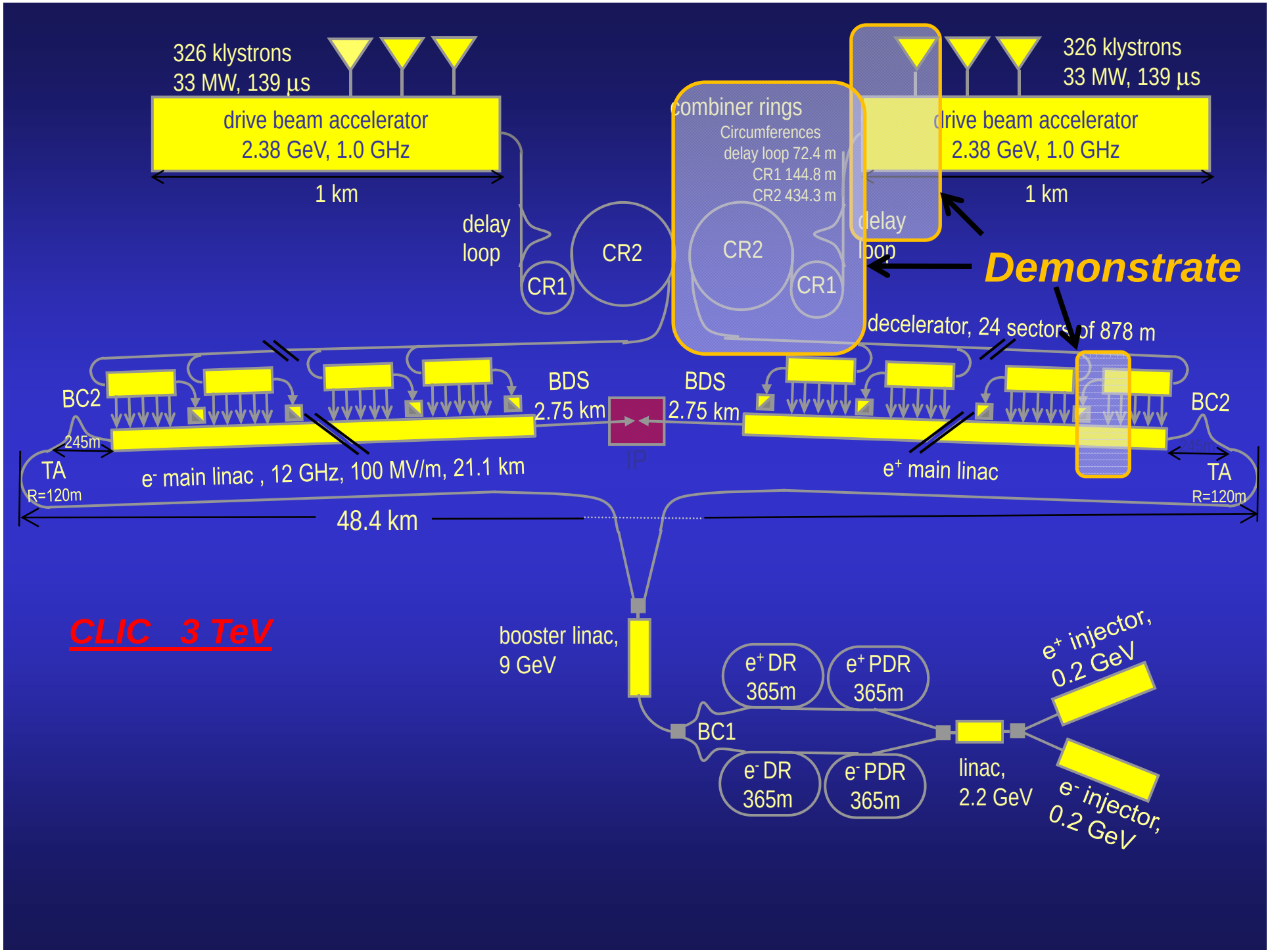
Total beamline length ≈800 m, ***all components nominal and re-usable for CLIC***

Magnets operate at 1/5 of nominal strength.

Two Beam Demonstrator

- 46 nominal CLIC modules
  (type 1, 6 accelerating structures,1 main beam quadrupole,
  3 power extraction structures and 2 drive beam quadrupoles per modules
- Drivebeam corresponds to 1/10 of a nominal decelerator sector with deceleration to nominal final energy of T=0.24 GeV
- Main beam gets a total acceleration of 6.3 GeV
- Califes type 0.2 GeV injector ,
  (but with nominal CLIC main beam current 1.2 A
  and 156 ns pulselength)
- total length ≈120 m




326 klystrons
33 MW, 139 µs
drive beam accelerator
2.38 GeV, 1.0 GHz
1 km
delay
loop
CR1
CR2
combiner rings
Circumferences
delay loop 72.4 m
CR1 144.8 m
CR2 434.3 m
CR2
CR1
326 klystrons
33 MW, 139 µs
drive beam accelerator
2.38 GeV, 1.0 GHz
1 km
delay
loop
Demonstrate
decelerator, 24 sectors of 878 m
BC2
245m
TA
R=120m
BDS
2.75 km
e- main linac , 12 GHz, 100 MV/m, 21.1 km
IP
BDS
2.75 km
e+ main linac
BC2
245m
TA
R=120m
48.4 km
CLIC 3 TeV
booster linac,
9 GeV
e+ DR
365m
e+ PDR
365m
BC1
e- DR
365m
e- PDR
365m
linac,
2.2 GeV
e+ injector,
0.2 GeV
e- injector,
0.2 GeV

Next facility towards CLIC

Rational

- Creates drive beam train nominal for everything but energy (0.48GeV instead of 2.4 GeV)
- Demonstrates nominal DBA injector with all parameters
- 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

Problems

- Combiner ring beam dynamics more difficult than in real CLIC (like in CTF3)
- Expensive (but re-usable)
- No obvious use of 6.5 GeV main beam but for testing (injector for proto damping ring, FEL ?)

Where can we put it ?

Could fit in one of the big experiment halls at CERN
Problem: They are all in use

Can be put in final location
Problem: immediate cost and time delays

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						

More issues

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

You are welcome to discuss your ideas in the working groups !