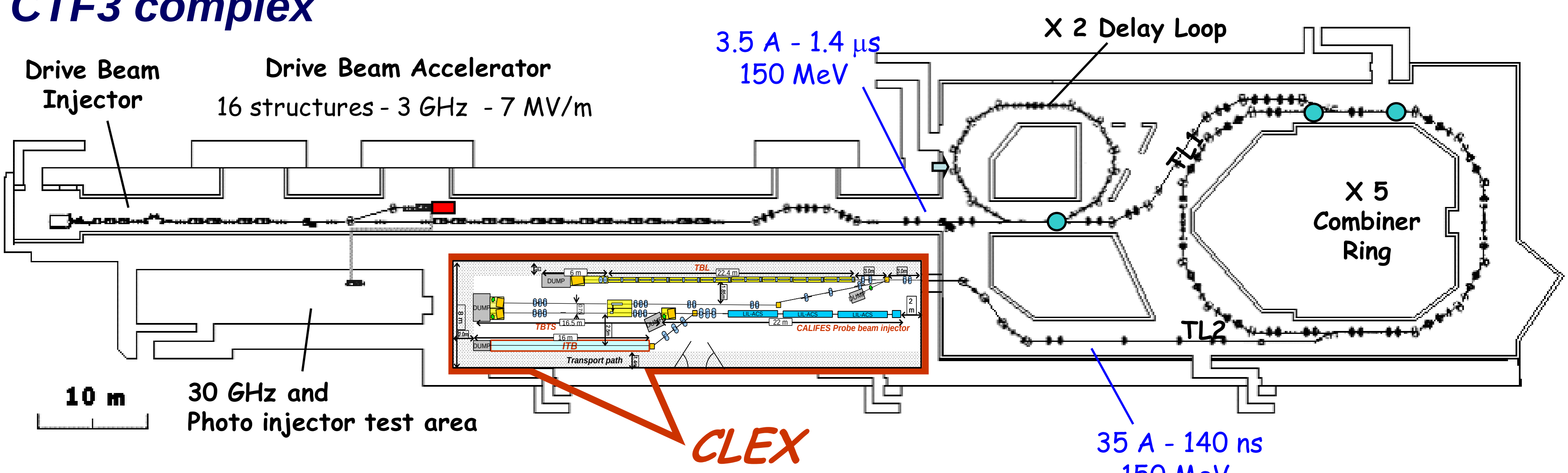
Upgrade Options beyond CTF3 Baseline

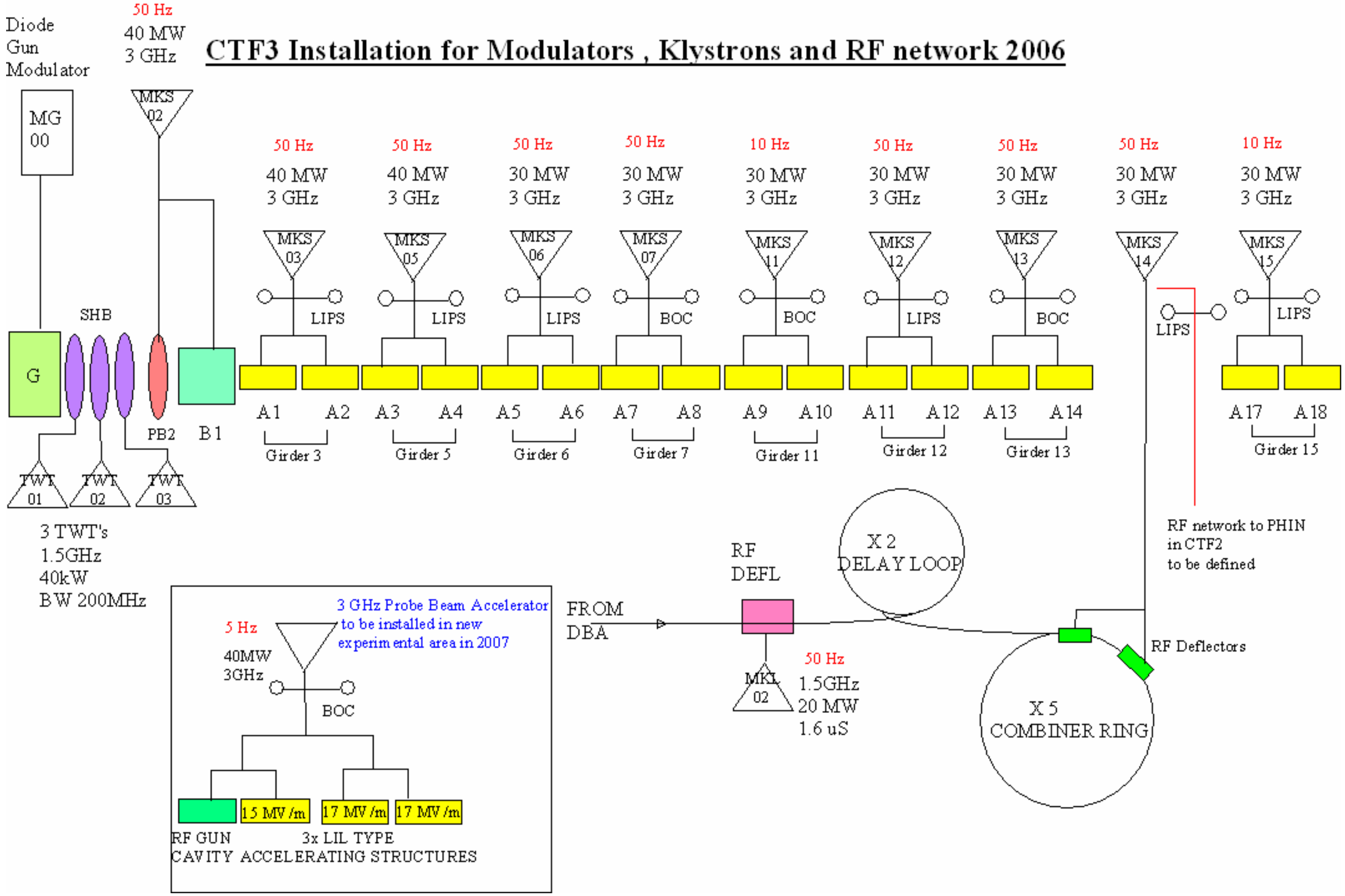
Hans Braun, CTF3 collaboration meeting, 23.1.2008

CTF3 complex



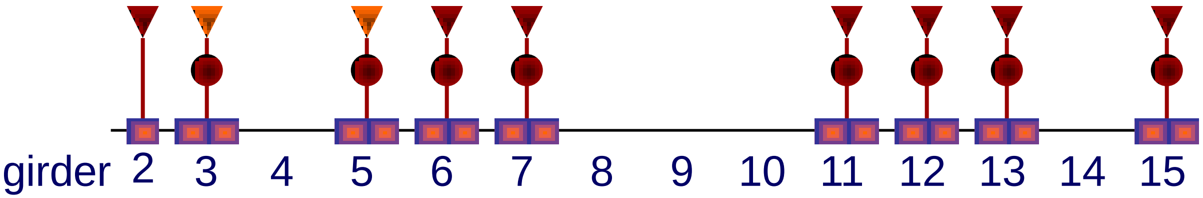
- Evolution of drive beam linac
- Consequences of DB photo-injector
- Instrumentation Test Beam
- TBL, ideas for intermediate program
- TBL long term development
- Cosmological applications

CTF3 Installation for Modulators , Klystrons and RF network 2006

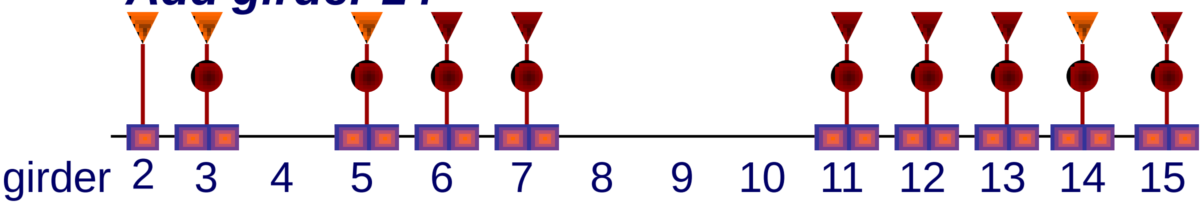


Evolution of CTF3 drive beam linac

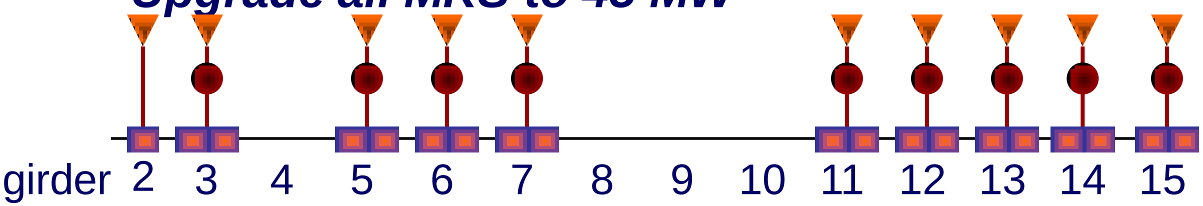
Present



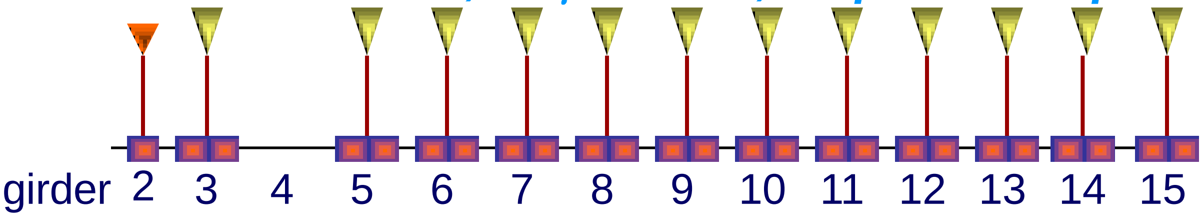
Add girder 14



Upgrade all MKS to 45 MW



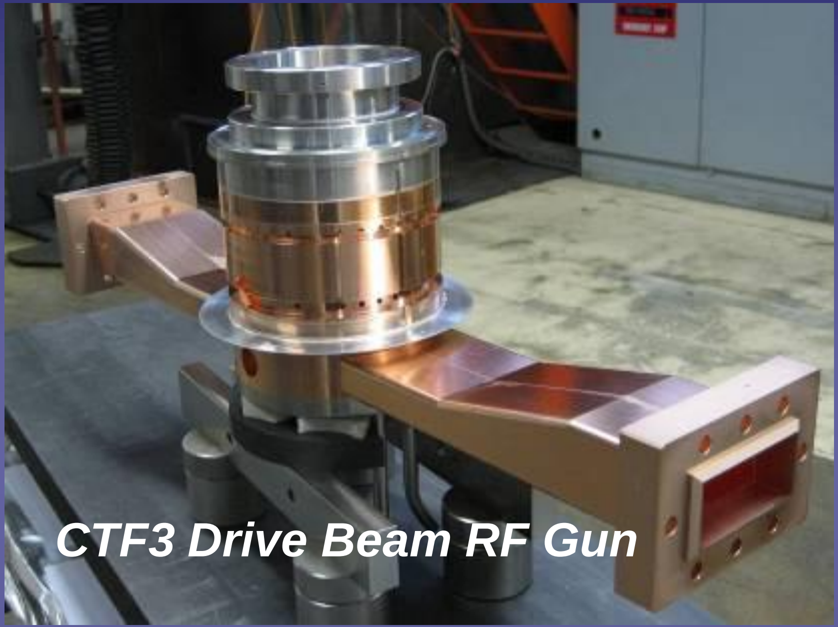
Add RF on girders 8,9,10 and upgrade all MKS to 100 MW, 1.5μs tubes, no pulse compression

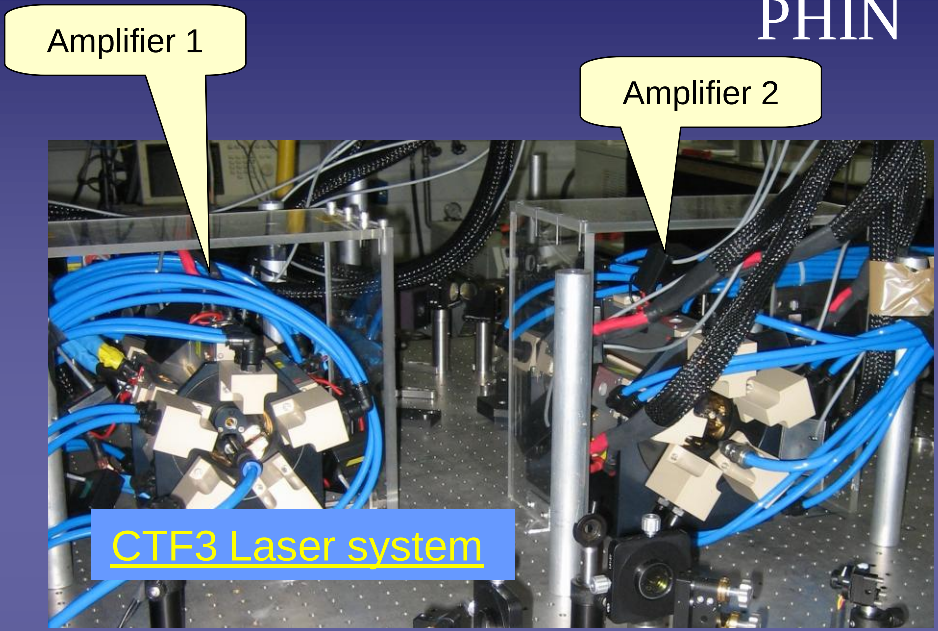


I_{Linac}[A]	I_{CLEX}[A]	T [MeV]
0.1 3.6 4.9	0.72 25.9 34.9	246 156 125
0.1 3.6 4.9	0.72 25.9 34.9	279 179 143
0.1 3.6 5.3	0.72 25.9 38.2	303 203 154
0.1 3.6 5.3	0.72 25.9 38.2	402 270 206

SERA

PHIN





If test in CTF2 set-up successful this will be a great leap forward for DBA beam quality.

- Reduced transverse and longitudinal emittance
- No satellite bunches
- No energy tails from bunching

Single bunch option will allow

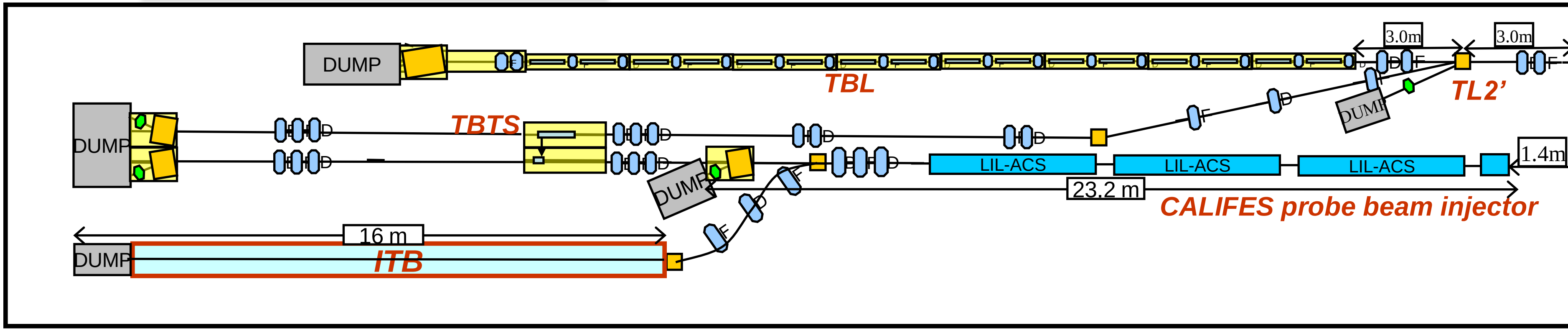
- Check and correction of beam optics with high precision
- CSR measurements with high precision in DL, CR and TL2 bunch compressor.
- δ response of PETS and beam instrumentation
- …

Instrumentation Test Beam Line , ITB

Dedicated beam line for beam diagnostics R&D using CALIFES beam

Features: low ε beam, possibility to achieve very short bunch length, variable time structure, space, accessibility

Layout of CLEX floor space



Didn't fly as joint JAI-CERN-LAPP proposal in FP7 negotiations,

but the disappointing EURO TeV-BPM test last November showed again

how desirable such a beamline would be!

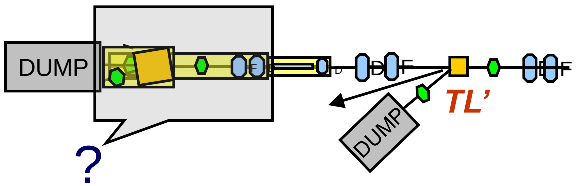
- Dedicated to beam diagnositics R&D
- With beam well known and characterised at location of test device
- Standard BPM's up- and downstream of test location
- Independent of drive beam operation

Test & experiments which could be performed in ITB

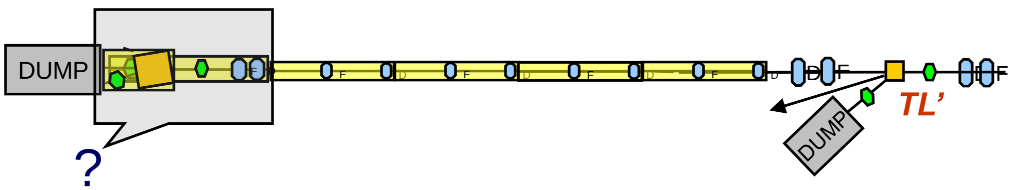
- BPM & WCM developments
- Coherent diffraction radiation monitors
- Longitudinal profile monitors
- Halo monitors
- Beam loss monitors
- Single shot emittance measurements
- Test of CLIC X-band crab cavities
- Wakefield measurements (i.e. collimators)
- …

Alternatives for TBL evolution until 2010

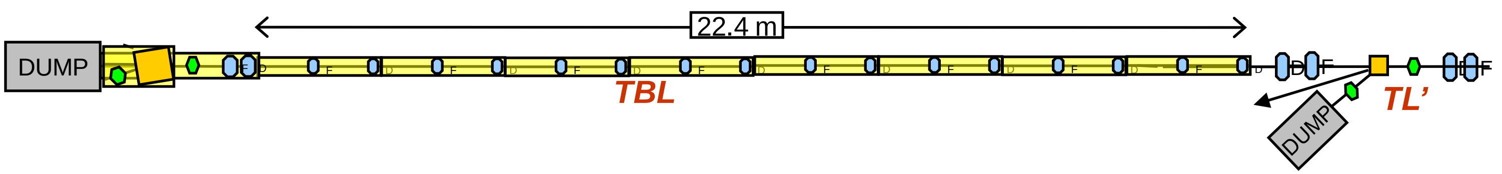
TBL 2008, beam test of first TBL PETS



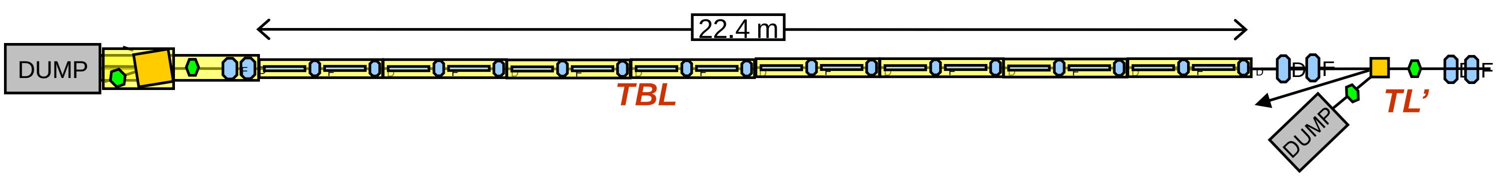
TBL 2009, 8 PETS structures



Alternative TBL 2009, test line for single pass collective instabilities



TBL 2010



Option for TBL programme 2009

Prepare and install all quadrupoles and at least a fraction of BPM’s in 2008

Install in shutdown 2008/09 a ~20mm diameter stainless beampipe on 22.4 m length with control of residual gas species and pressure, and complete end of line beam diagnostics.

This allows

+ Understanding and debugging of TBL line decoupled from PETS experiments

+ Quantitative experiments to benchmark predictions for single pass fast ion instability

+ Quantitative experiments to benchmark predictions for single pass multibunch transverse resistive wake effect

For the latter two items an effect with amplification factor of ~ 1.5-2 of initial beam offset expected (B. Jeanneret)

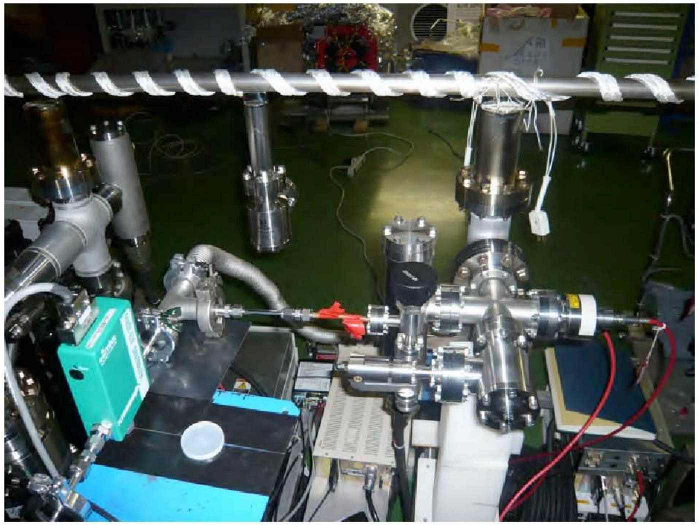
Disadvantages

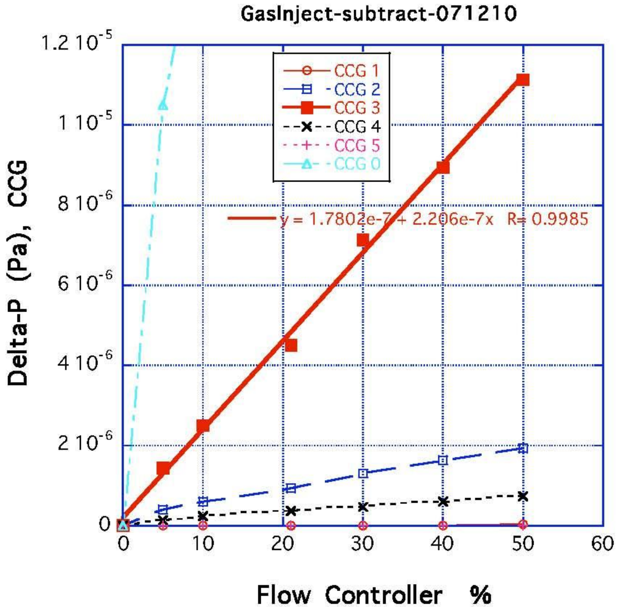
- Testing of incoming TBL PETS will be delayed

- No “half TBL” experiments

N. Terunuma

Gas Injection system





- Continuous gas leak into the beam chamber.
- We can control the leak rate of N_2 gas.
- Pressure range: 10^{-7} Pa ~10^{-3} Pa.

From Frank Zimmermann's ATF presentation, CLIC meeting 11.1.2008

Options for long term use of TBL

1) Power plant for structure testing

Advantages

+ 32 RF ports with nominal power for CLIC structure (or 16 with twice the power)
+ Cheaper than several stand alone X-band sources
+ Gives incentive to consolidate drive beam operation towards large facility standards

Problems

- No individual pulselength control of test slots
  (unless Igor has a smart idea)
- Pulse length shorter than CLIC nominal
  (unless Igor has a smart idea)
- Increase of rep. rate 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

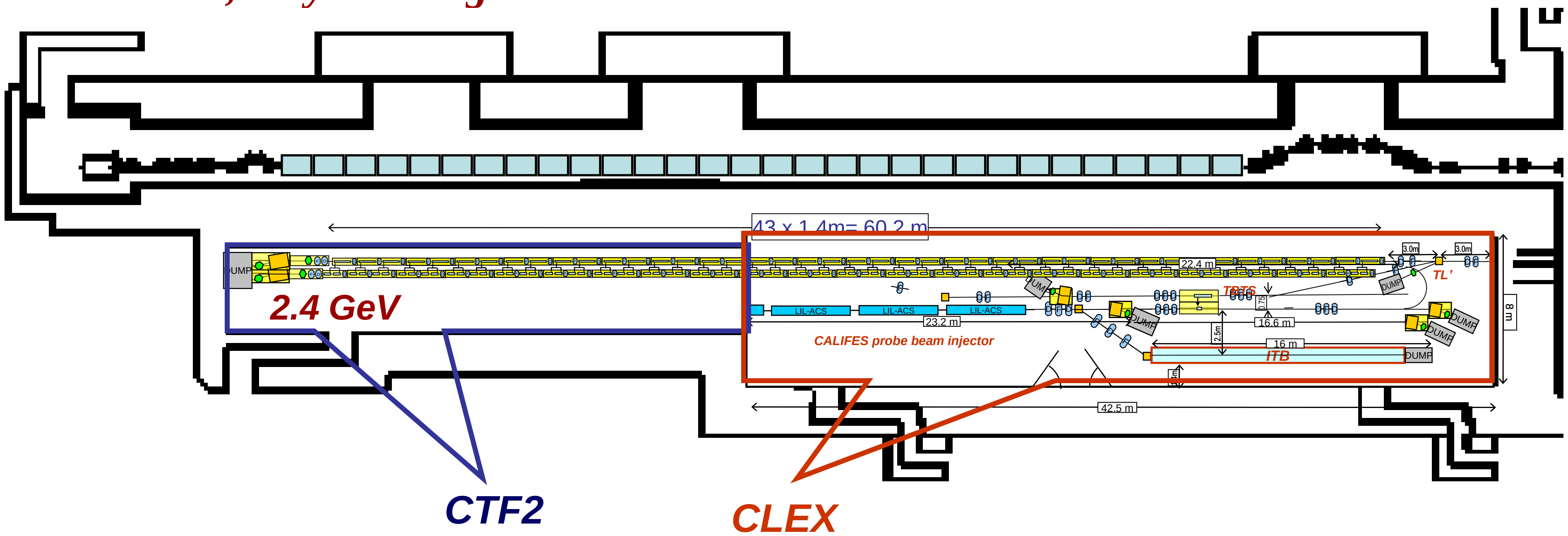
$$\frac{144000 \times 2}{7 \times 365} = 113 \text{ RF slots}$$

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

Options for long term use of TBL

2) Two beam X-band linac

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



What needs to be done for this ?

- Upgrade DBA to maximum performance as outline before

  (Replace all DBA 35 MW klystrons with 45 MW tubes, add MKS 14 and 2 SICA structures on girder 14,

  Build new modulators MKS08,09 & 10 (space not yet obvious), take DBA PETS line out and add 6 SICA structures on girders 8, 9 &10

➢ This gives 270 MeV drive beam energy for 3.6 A linac beam current.

- Break wall between CLEX and CTF2
- Turn CALIFES by 180^0 and build a 180^0 turn around line
- Extend TBL to 43 PETS structures of same design as other PETS TBL
- Connect two nominal CLIC accelerating structures to each TBL PETS

➢ This gives a drive beam deceleration by **79%** to **58 MeV** (final energy similar to present TBL design)

➢ This gives a total **instantenous 12 GHz power of 5.5 GW** and

nominal RF power to 86 CLIC structures with **110 MV/m** average gradient.

110 MV/m because CALIFES current is limited to ~ ½ CLIC beam current.

➢ This give an energy gain of **2.17 GeV** and final probe beam energy of **2.35 GeV**

What can be shown ?
If the thing operates over long period (> 1month) stable and with up-time > 90%
credibility of CLIC scheme would get a huge boost.

Decelerator beam dynamics more realistic, 10.8 betatron oscillations, deceleration to 20% of initial energy.

A first step to mass production of CLIC structures

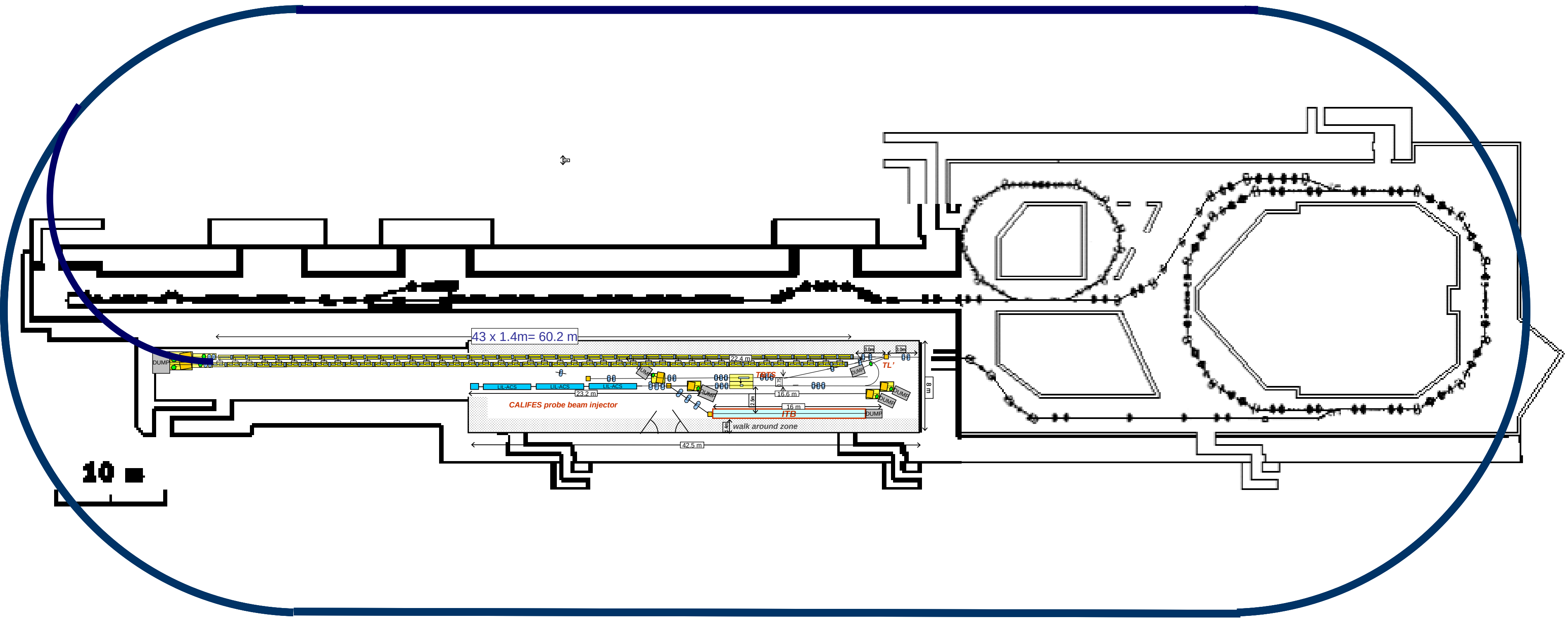
Active alignment and stabilisation could be tested over distance of 60 m in presence of beams

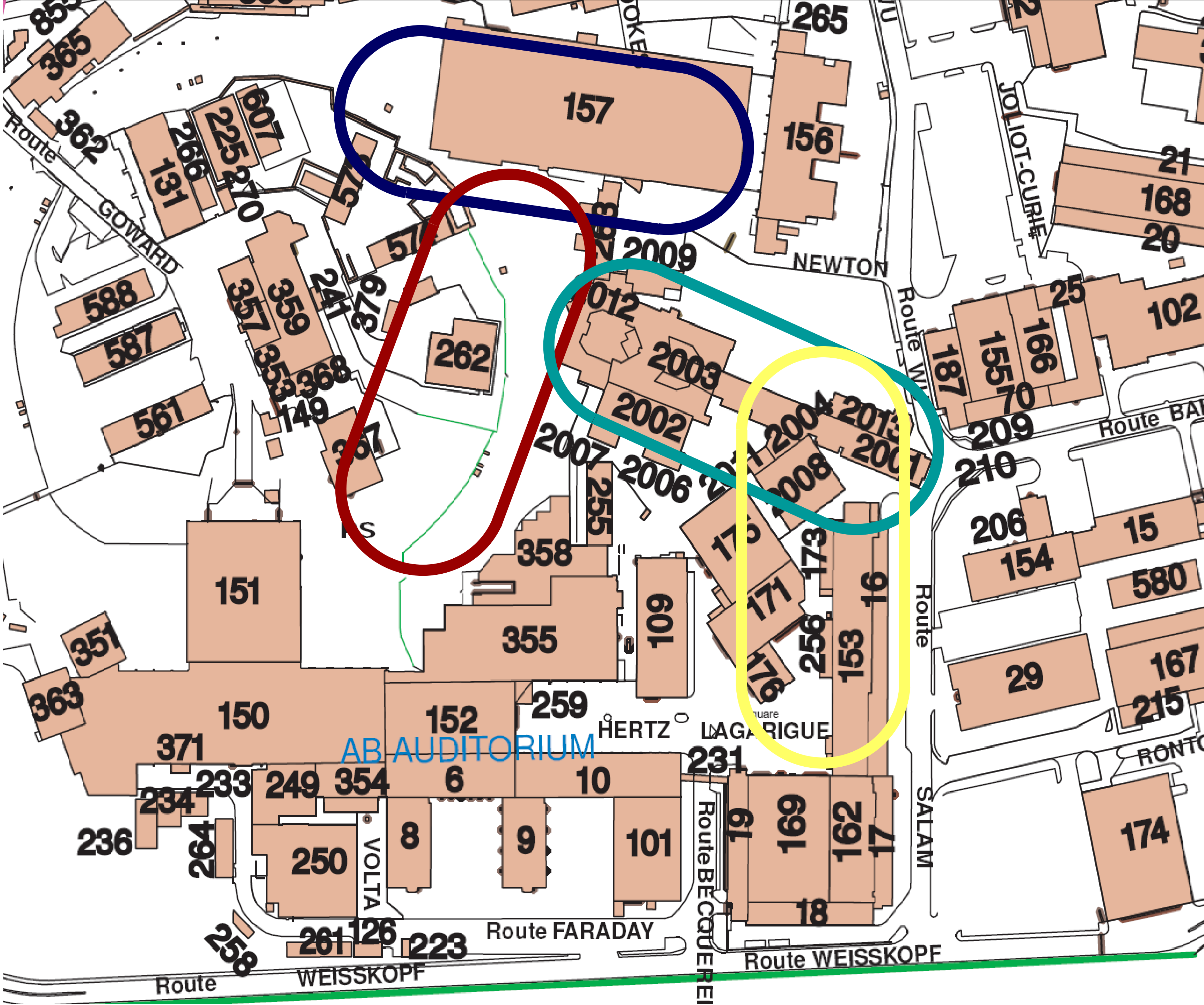
Problems

- Modules would not be representative for CLIC ,
  only 2 accelerating structures instead of 4 per PETS
  Module length different from nominal
- Poor Probe beam filling factor of 33%
- Radiation shielding insufficient for rep. rate >5 Hz
- RF Pulse length shorter than nominal
- CALIFES cannot give nominal CLIC beam current

This gives just the most extreme case all kind of intermediate solutions can be envisaged !

And the probe beam reaches almost nominal energy for Damping Ring Injection !
(2.35 GeV instead of 2.45 GeV)

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VOLTA
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SALAM
Route BECQUEREL
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Route FARADAY
Route WEISSKOPF
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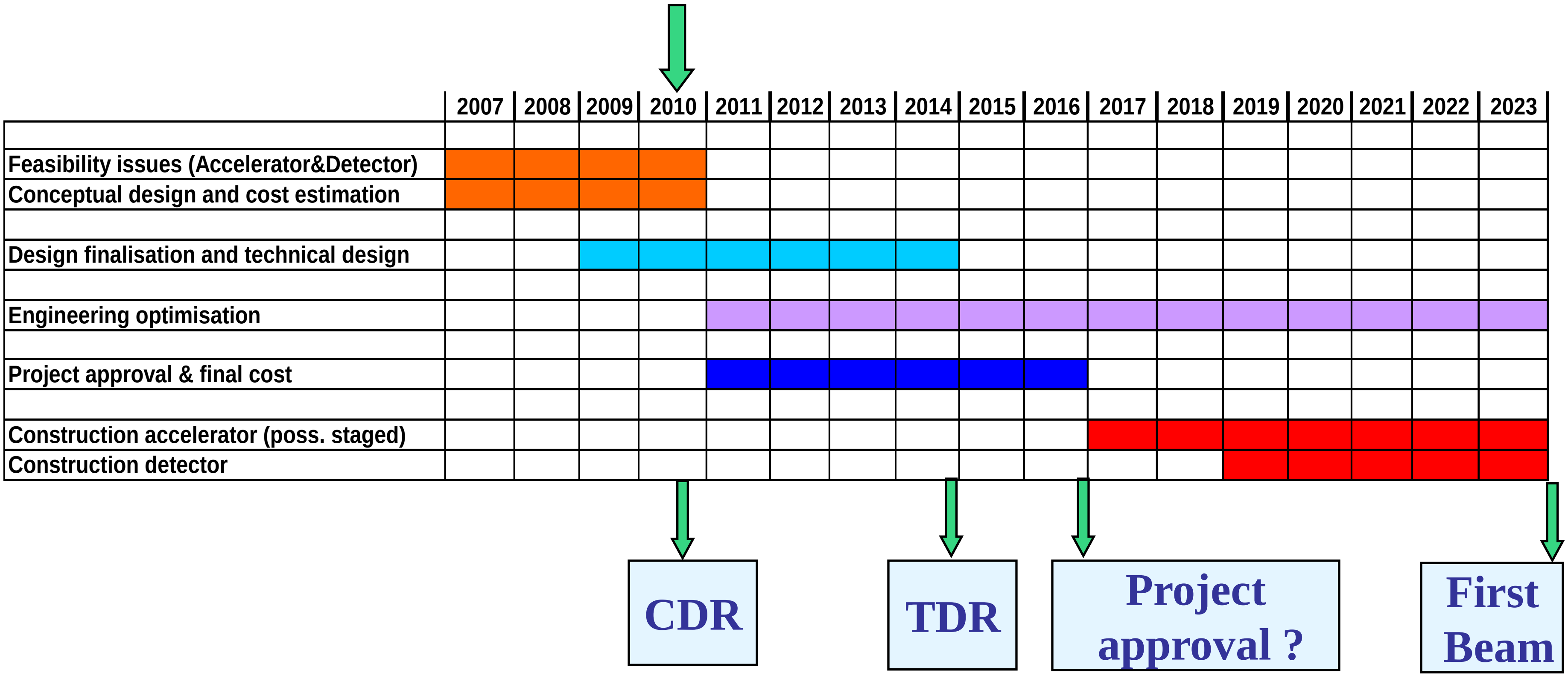
Tentative long-term CLIC scenario
Shortest, Success Oriented, Technically Limited Schedule

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



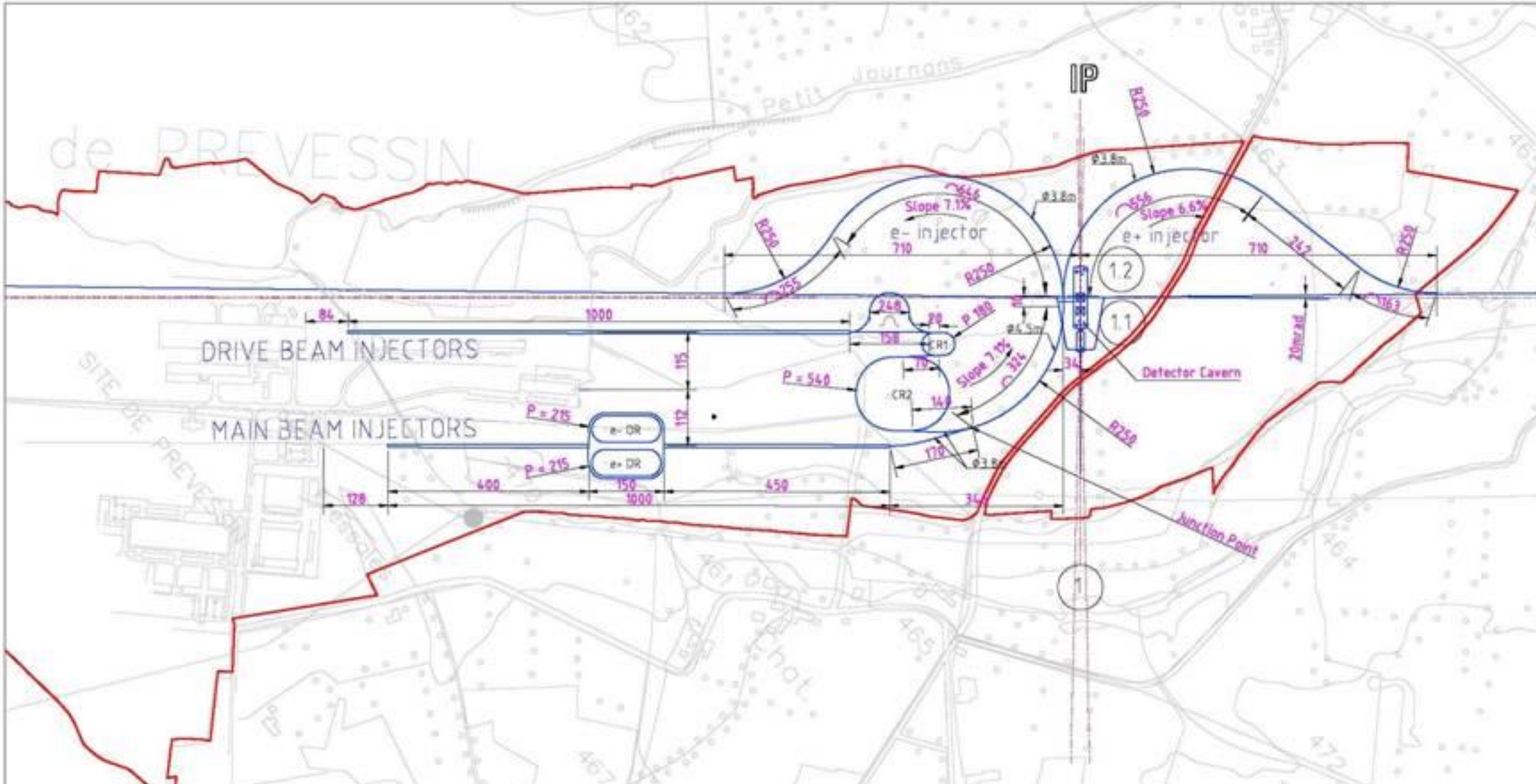
If you believe in this schedule, the next CTF should demonstrate and test fully engineered nominal CLIC prototypes consistent with the TDR.
This is in particular true for all components which have to be produced in large numbers, because their production contracts have to be launched in 2017 !

For example one could consider to start building

- First part of 1 GHz drive beam accelerator injector with nominal klystrons
- 2 GHz probe beam injector for 2.45 GeV
- One of the damping rings

and put them already in their final location for later use with CLIC !

The testing of 12 GHz components could be continued in an upgraded CTF3 and/or in stand alone 12 GHz sources



INJECTORS TUNNELS	DRIVE BEAM INJECTORS COMPLEX					MAIN BEAM INJECTORS COMPLEX						COMMON & FINAL TRANSFER TUNNELS (after Junction Point)		
	LINAC	DELAY LOOP	CR 1	CR 2	TT to Junction Point	LINAC 1	e- DR	e+ DR	DR Link	LINAC 2 + BC 1	TT to Junction Point	COMMON	e- TT	e+ TT
Length (l) m	1000	406	180	540	140	400	215	215	150	450	170	334	901	971
Section (l x h) m	6 x 3	4 x 3	4 x3	4 x 3	ø 3.8	3 x 3	6 x 3	6 x 3	14 x 3	3 x 3	ø 3.8	ø 4.5	ø 3.8	ø 3.8

CLIC- MAIN / DRIVE BEAM INJECTORS AND EXPERIMENTAL AREA LAYOUT

CERN
CIVIL ENGINEERING
SUPERVISOR : J.L.BALDY
DESIGNER : N.BADDAMS
SCALE : 1:5000(A3_FORMAT) DATE : 12_JUNE_2007
CLIC.CE-1.1799.0002
SIZE 3
INDICE D

Experimental Cosmology in CTF3

NUHEP-EX/07-01

An Experiment to Search for Light Dark Matter in Low-Energy *ep* Scattering

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December 12, 2007

Abstract

Anomalous production of low-energy photons from the galactic center have fueled speculations on the nature and properties of dark matter particles. In particular, it has been proposed that light scalars may be responsible for the bulk of the matter density of the universe, and that they couple to ordinary matter through a light spin-1 boson. If this is the case, then such particles may be produced in the quasi-elastic low-energy scattering of electrons off protons. We present a proposal for an experiment to search for this process and assess its viability.

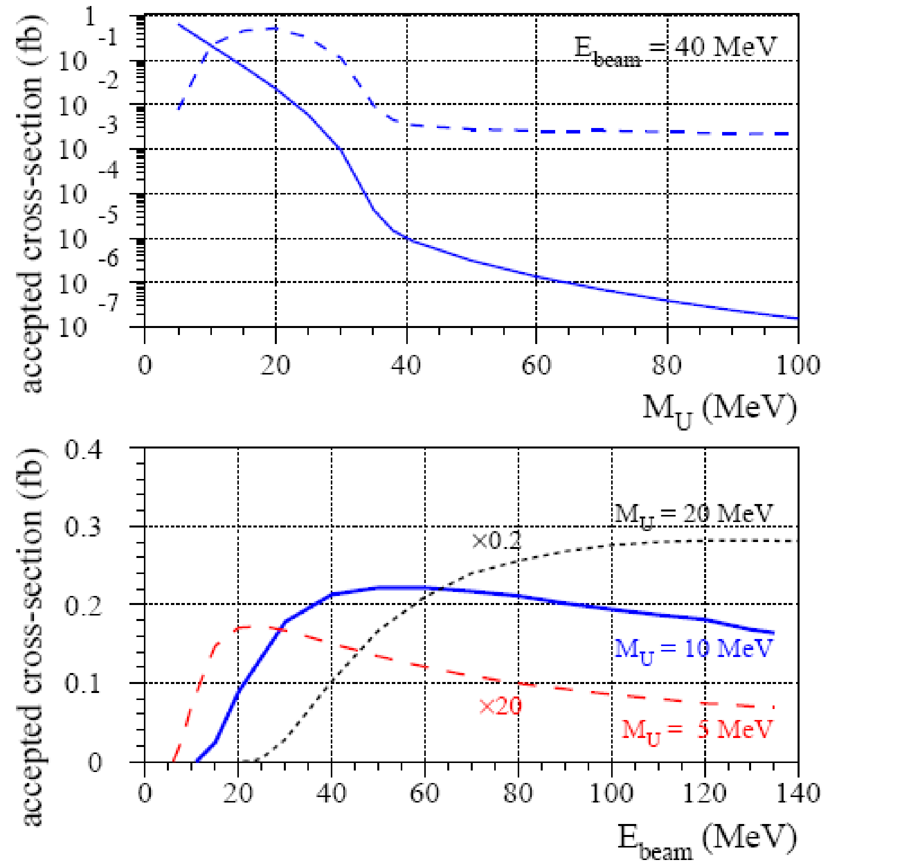

Figure 5: *signal cross-sections. TOP: accepted cross-section as a function of M_U. The solid line shows the result with a fixed coupling constant, and the dashed line shows the result when the constant varies with mass according to Eq. (1). Here, "accepted" refers to a limited angular range for the scattered electron: $89.4° < \theta < 90.6°$. BOTTOM: cross-section as a function of the beam energy, for three values of M_U, as indicated. The curves for $M_U = 5$ MeV and 20 MeV have been multiplied by factors of 20 and 0.2, respectively.*

Could this be after 2010 an experiment in CTF3 combiner ring in a storage ring mode with hydrogen gas target ?

Fig. 5 indicates that even just three modest measurements at $E_{beam} = 40$ MeV, 20 MeV and 80 MeV would allow one to distinguish clearly between the three mass values $M_U = 10$ MeV, 20 MeV and 5 MeV.

Basic requirements I_B>10mA and 20-80 MeV
Very good vacuum and
very small beam halo essential required ?

- All this can only be considered if a stable beam can be delivered to CLEX with reasonable up time.

- Therefore any work on future options is futile without improving the operating conditions of CTF3!

- An increase of technical manpower for maintenance, repair, consolidation and upgrade of CTF3 technical equipment is essential!

- Spares for critical equipment are urgently needed!