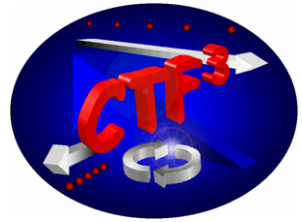
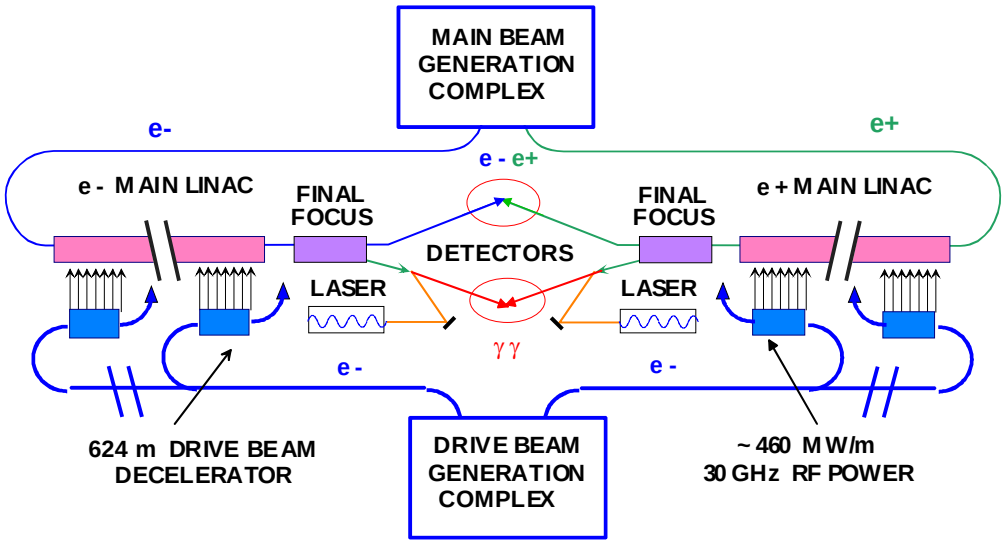


Status of CTF3

G.Geschonke
CERN, AB

CTF3 and CLIC

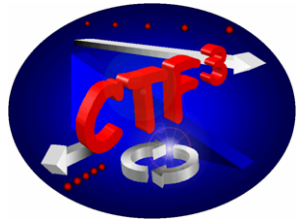


Energy = 3 (5) TeV
Luminosity = $80*10^{33}$ cm^{-2} s^{-1}

- Accelerating structure: 30 GHz, 150 MV/m
- 30 GHz RF power: 460 MW/m
- 2-beam scheme, high efficiency
- electron beam (drive beam):
  - RF frequency multiplication,
  - RF pulse compression
  - energy storage and transport

Aim of CTF3:
Demonstration of main CLIC-technology specific issues

CTF3 objectives



International Linear Collider Technical Review Committee (SLAC-R-606),2003 :

R1.1 CLIC accelerating structure, damped, at design gradient and pulse length

** CTF3 as 30 GHz RF power source as early as possible*

** 30 GHz test stand, well instrumented, extended exploitation*

** aggressive structure development*

R1.2 Drive beam scheme with a fully loaded linac

** CTF3: 150 MeV*	*CLIC: 2 GeV*
3.5 A	*4.9 A*
3 GHz	*937 MHz*

R1.3 Power-Extraction Structure (PETS) with on/off capability, damped

R2.1 Validation of beam stability and losses in the drive beam decelerator, and design of a machine protection system

** benchmark experiments 35 A @ 150 MeV => 150 A @ 2 GeV*

R2.2 Test of a relevant linac sub-unit with beam

** second beam required (probe beam)*

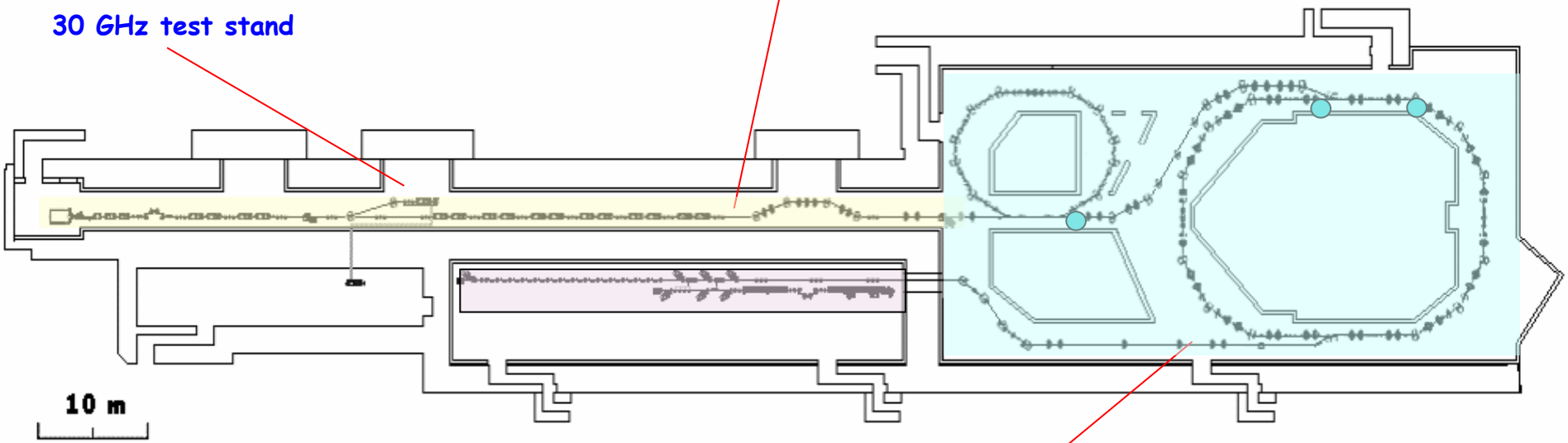
CTF3 building blocks

DRIVE BEAM,
FULLY LOADED
ACCELERATION

3.5 A - 1.4 μs

PULSE COMPRESSION
FREQUENCY MULTIPLICATION

30 GHz test stand



CLEX (CLIC Experimental Area)
TWO BEAM TEST STAND
PROBE BEAM

35 A - 140 ns

RF DEFLECTORS

CTF3 layout

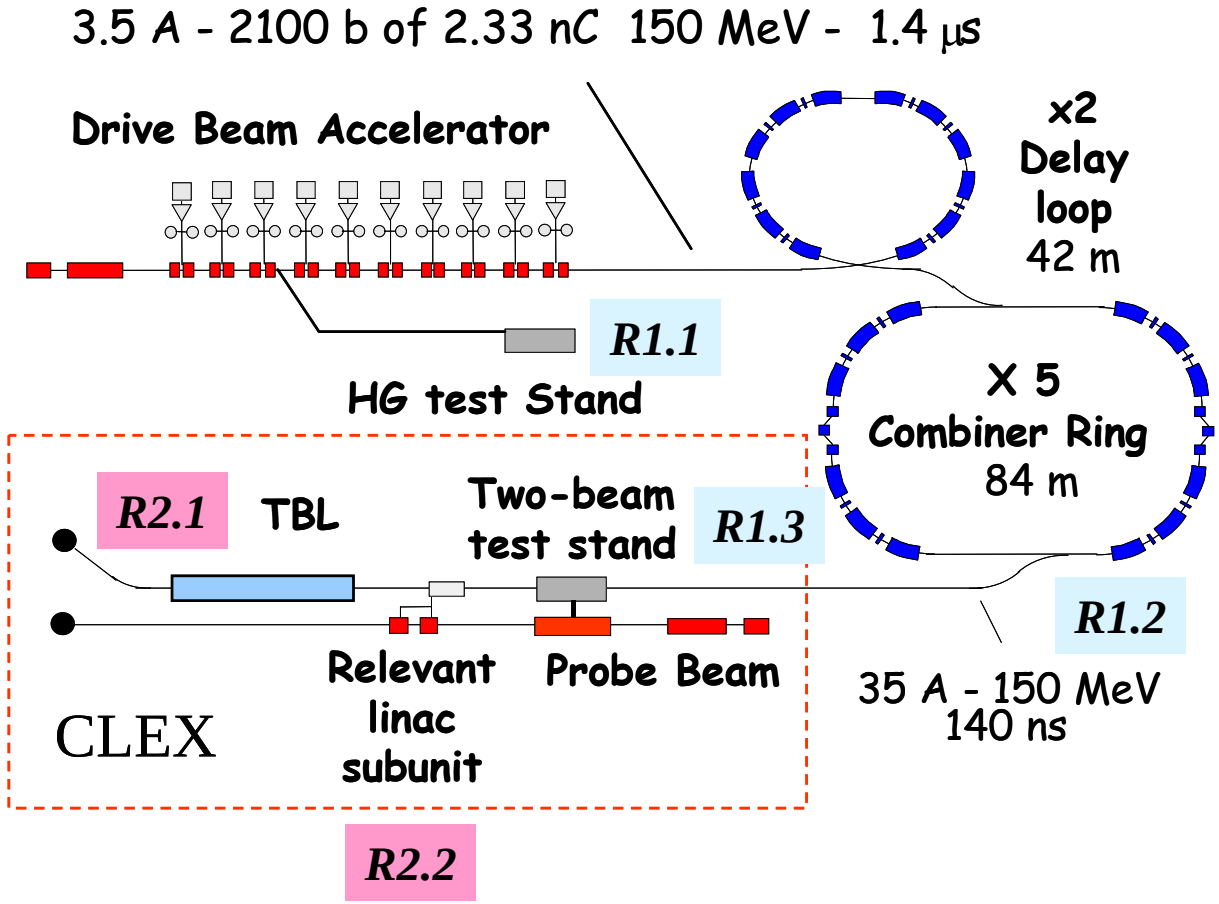
R1.1 CLIC accelerating structure,

R1.2 Drive beam scheme with a fully loaded linac

R1.3 Power-Extraction Structure (PETS)

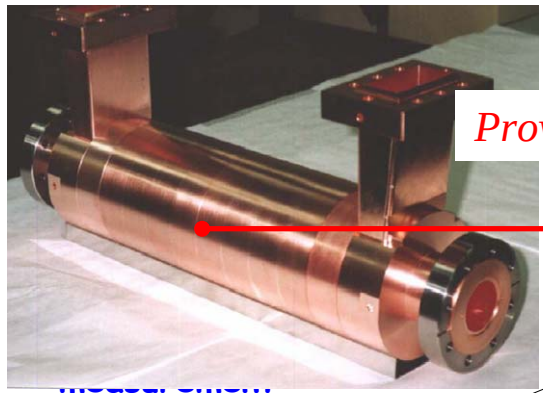
R2.1 stability and losses in the drive beam decelerator,

R2.2 Test of a relevant linac sub-unit with beam

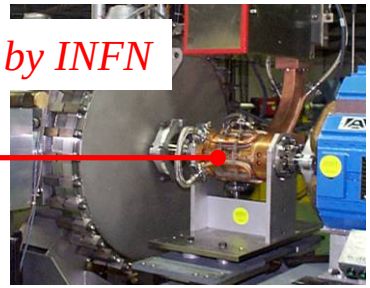


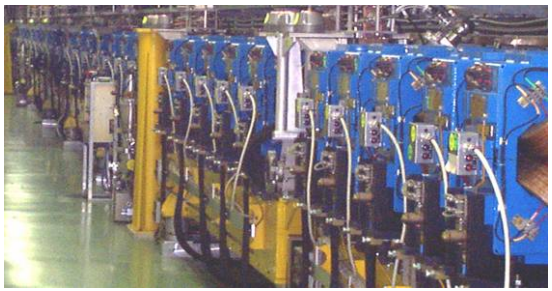
Bunch combination – Preliminary phase

Modifications to the
LEP pre-injector complex



Provided by INFN





RF deflectors

Bunch phase detector

Uppsala

Linac

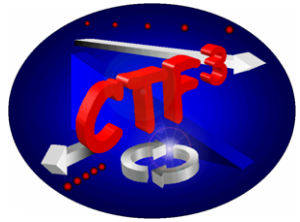
gun & bunching
system

Modified EPA ring

isochronous injection line

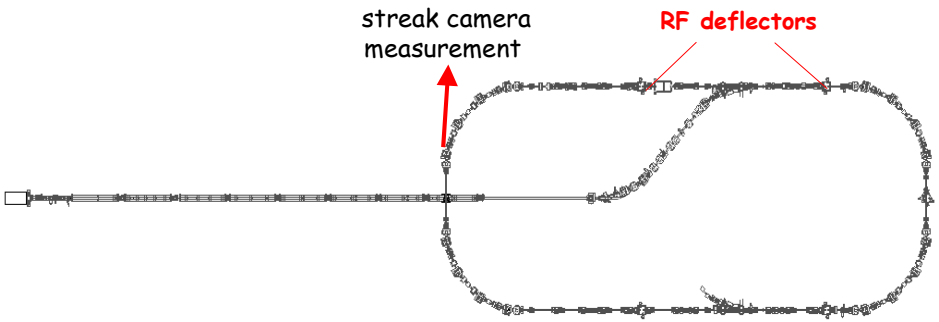
Provided by LAL

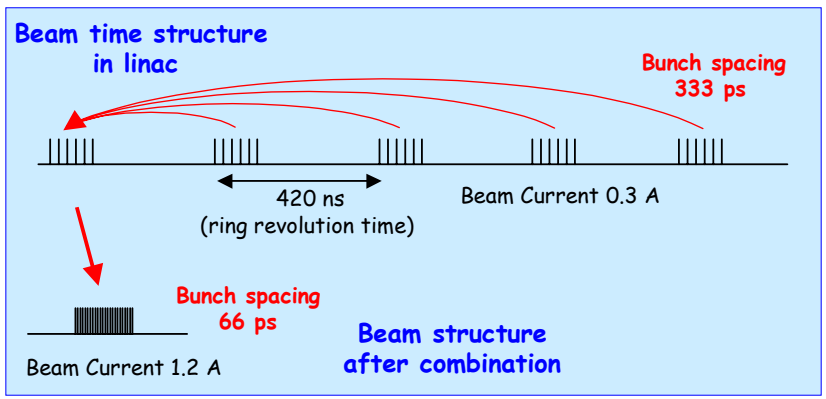
Combination results – Preliminary phase



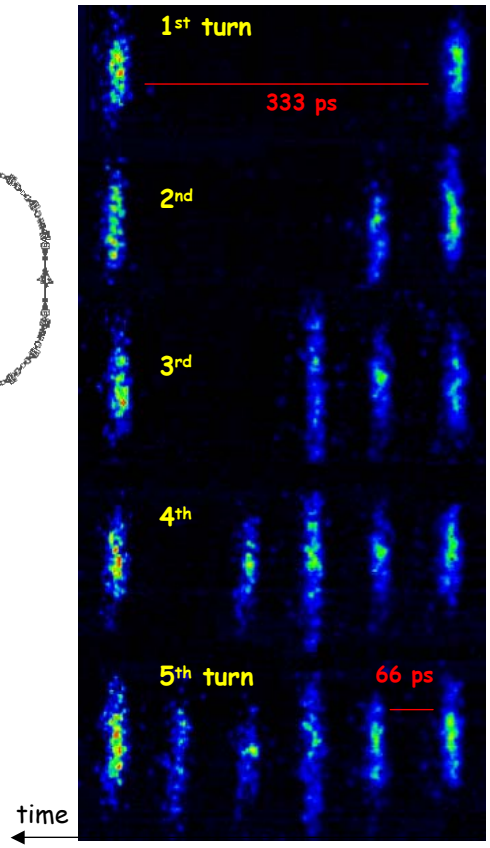
CTF3 - PRELIMINARY PHASE

low-charge demonstration of electron pulse combination and bunch frequency multiplication by up to factor 5



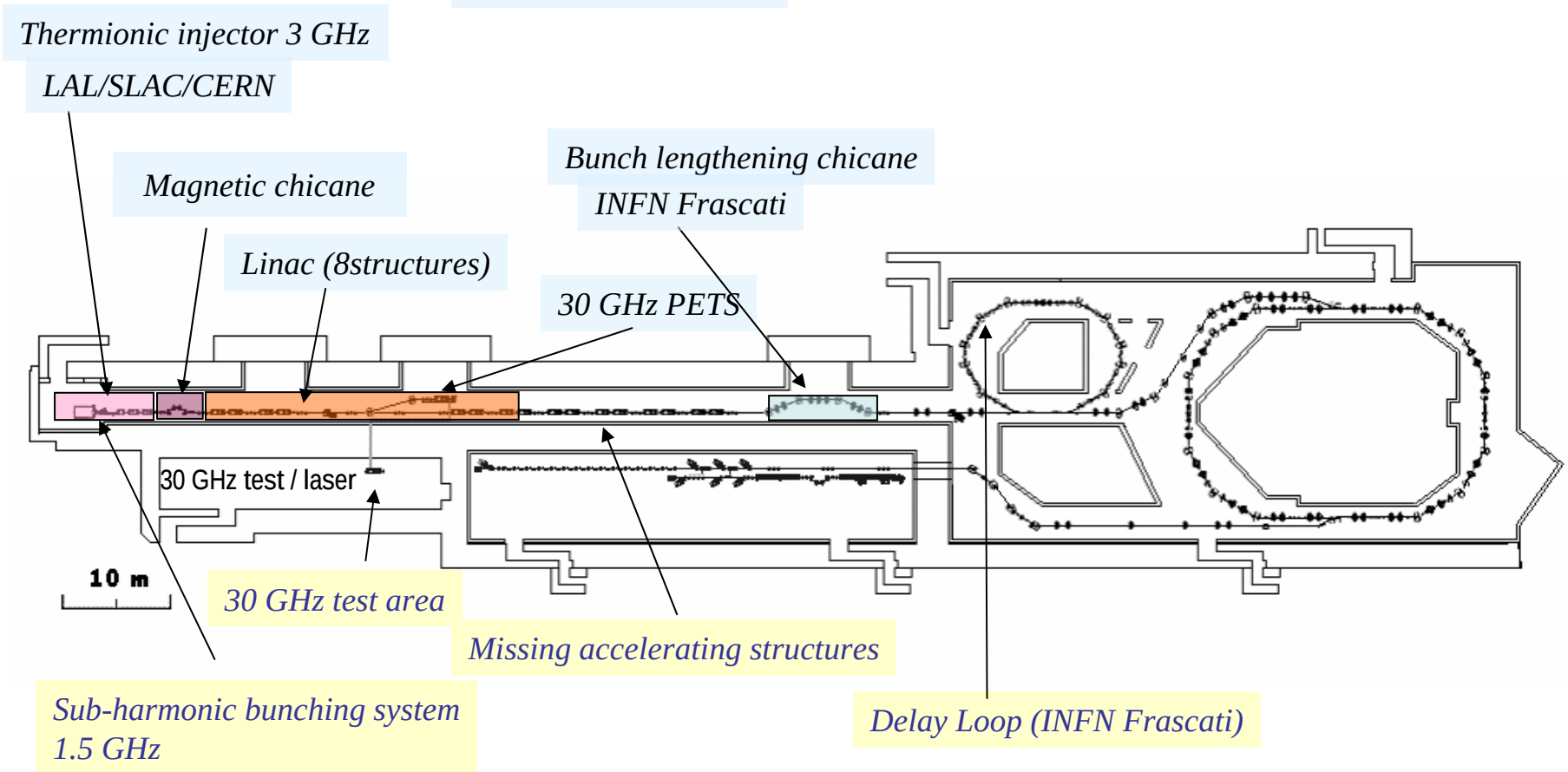


Streak camera image of beam time structure evolution



CTF3 status

Installed so far:



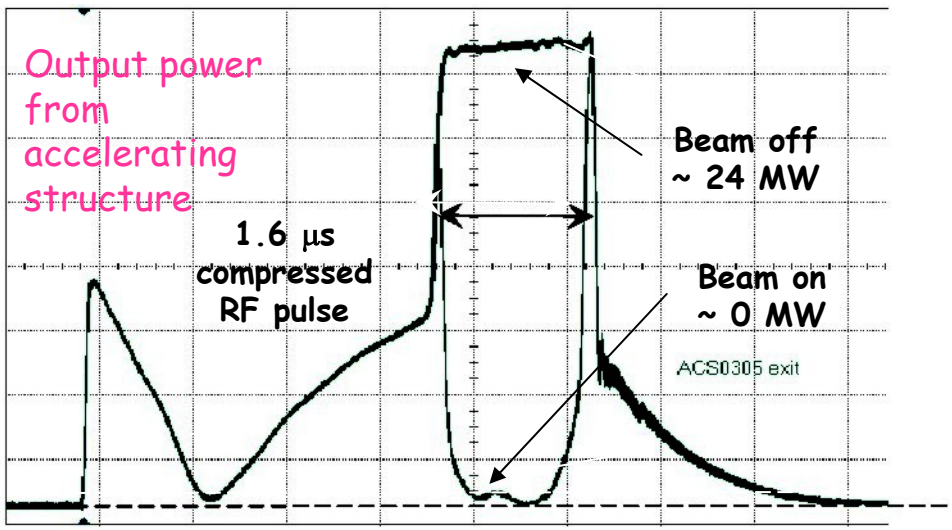
To be installed in 2004 and winter 2004/2005

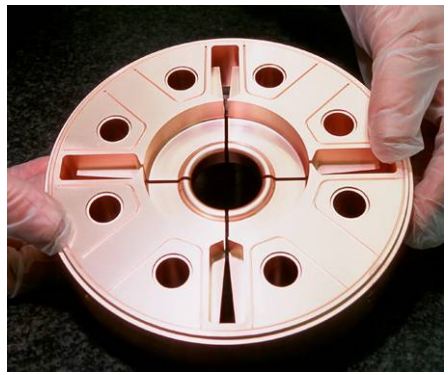
Commissioning results 2003

	Nominal	Achieved
I	3.5 A	4.5 A
τ_p	1.5 μs	1.5 μs
E	20 MeV	20 MeV
$\varepsilon_{n,rms}$	100 π mm mrad	60-90 π mm mrad
$\tau_{bunch,rms}$	5 ps	< 6.5 ps

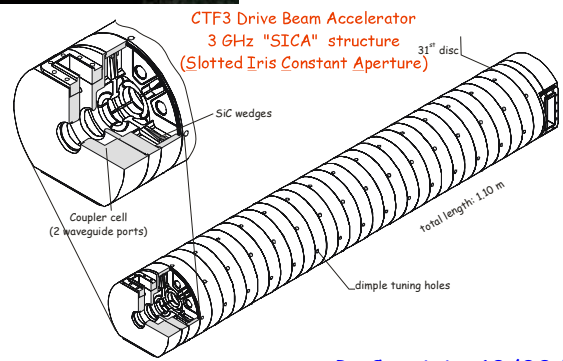
Full Beam Loading demonstrated:
>95 % efficiency ! More than Superconducting systems !
Beam stable !

First demonstration of full beam loading

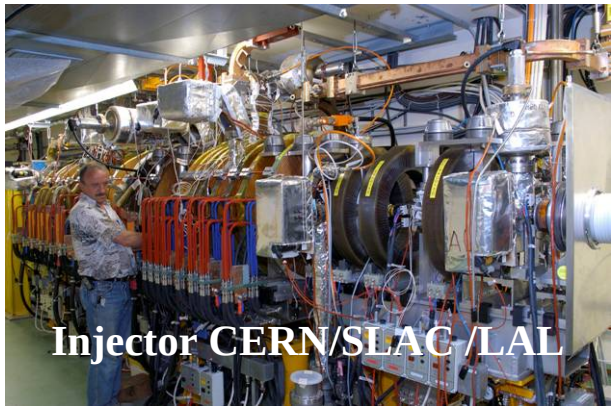


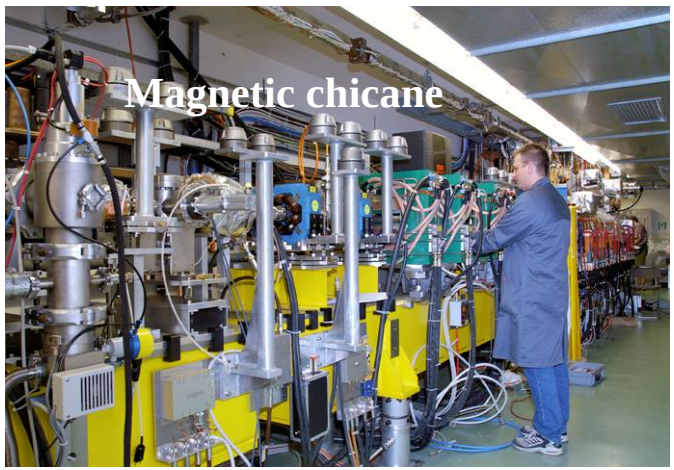


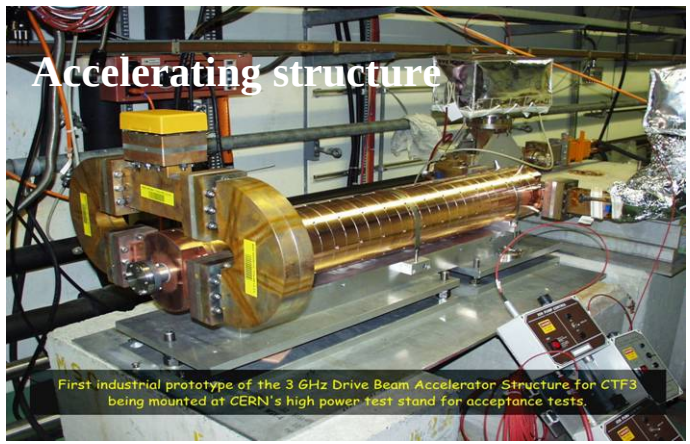
Damped DBA structure



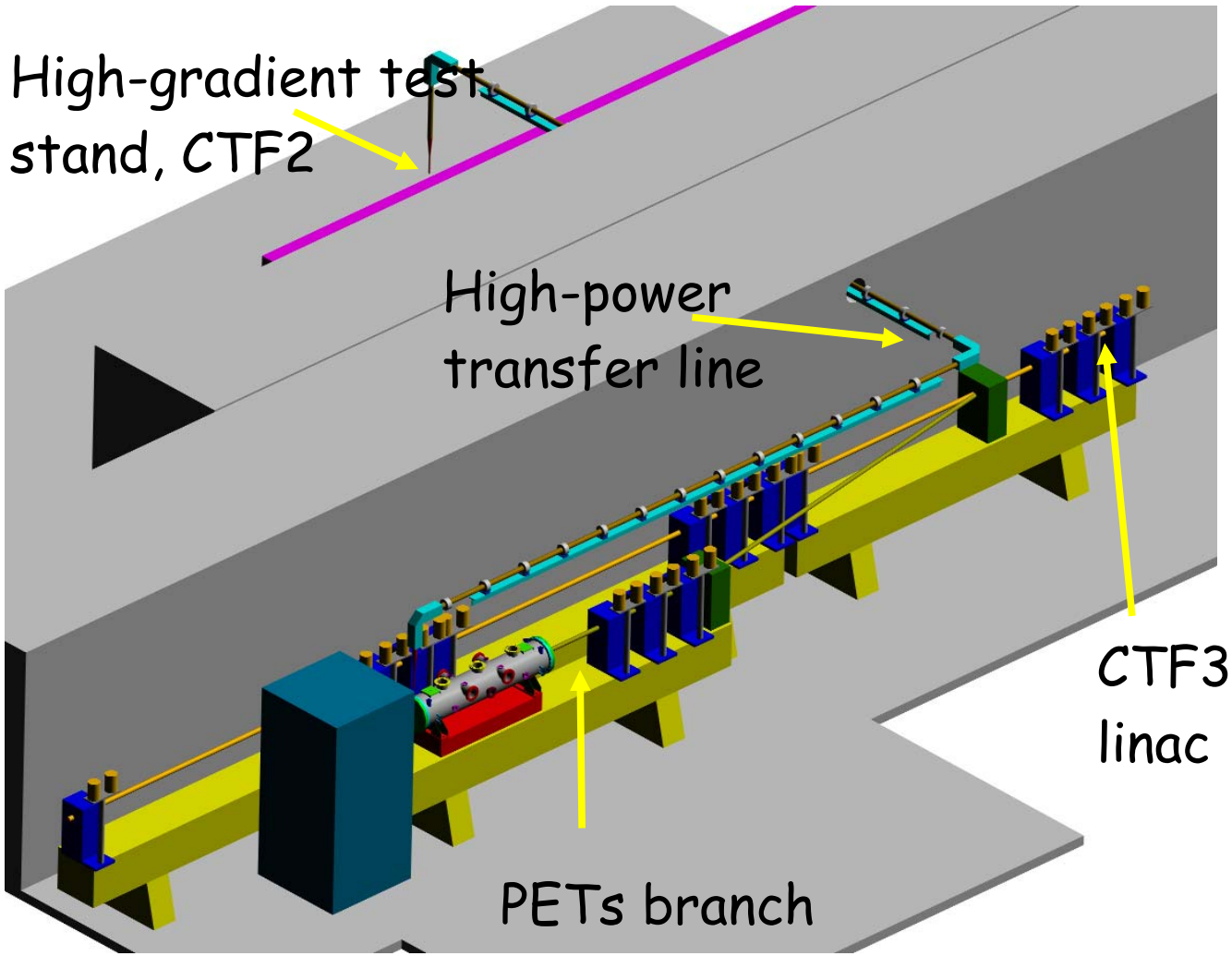
Installation status



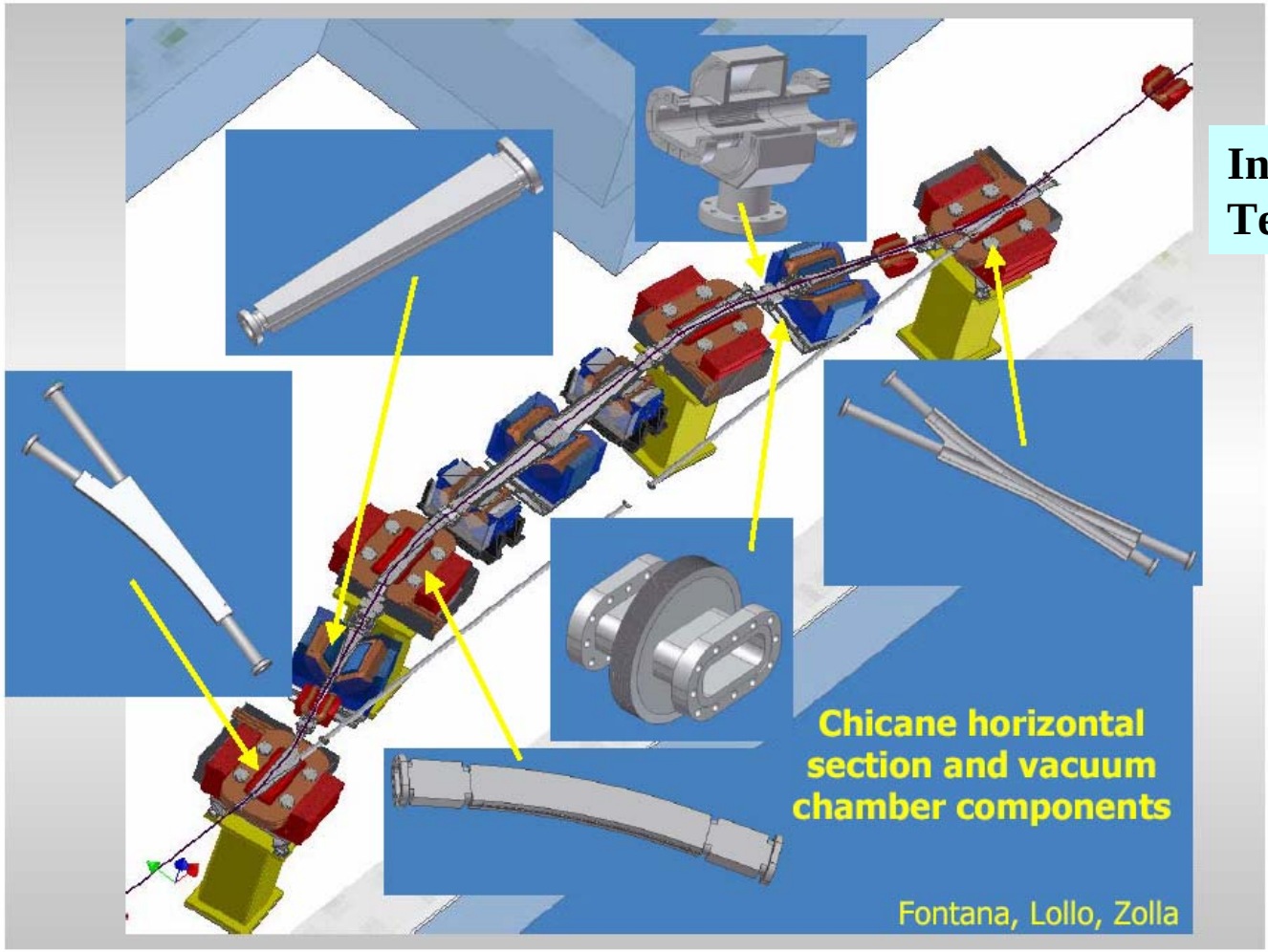




Two-Beam 30 GHz power production in CTF3



Installation status INFN

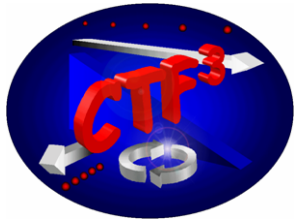


Installation finished
Test with beam in 2004

Tunable R_{56} from bunch stretcher to compressor

Slide from A.Ghigo

CTF3 RF power plant



To be used at start-up in 2004

Installed, being modified

40 MW
3 GHz
MKS 02

40 MW 3 GHz — MKS 03 — LIPS
40 MW 3 GHz — MKS 05 — LIPS
40 MW 3 GHz — MKS 06 — BOC
30 MW 3 GHz — MKS 10 — EX 98 — BOC
30 MW 3 GHz — MKS 11 — EX 25
30 MW 3 GHz — MKS 12 — EX 27
30 MW 3 GHz — MKS 13 — EX 29
30 MW 3 GHz — MKS 14 — EX 31
30 MW 3 GHz — MKS 15 — EX 33

SHB
G
PB1 PB2 B1

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15 A16 A17 A18

(to be installed 2004/5)
1.5GHz bw 200 MHz
3 tw tubes/40 kW each

ordered

Delay Loop

RF Deflector

FROM DBA

Delivered to CERN

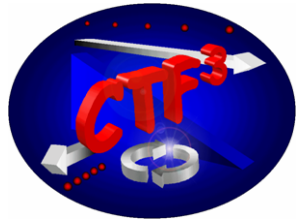
MKL 02
EX 35

1.5GHz
20 MW
1.6 uS

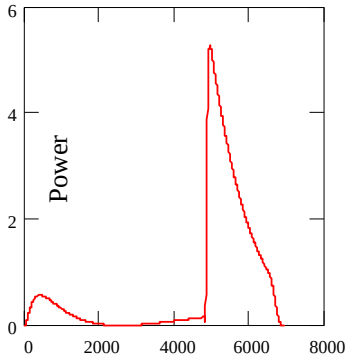
(to be installed 2004/5)

N.B. This Installation scenario assumes that we do not build a reserve modulator for testing purposes and that all tests on faulty equipment will be done in shutdown or to the detriment of available machine time

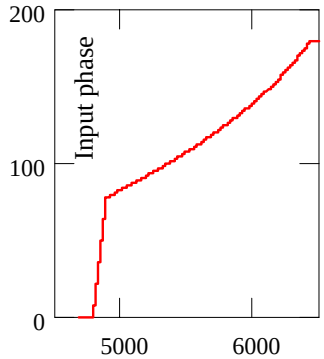
RF power pulse compression system



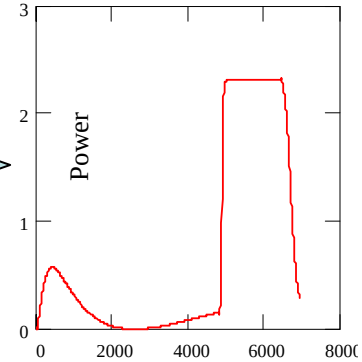
Standard "SLED"Pulse



Phase programme



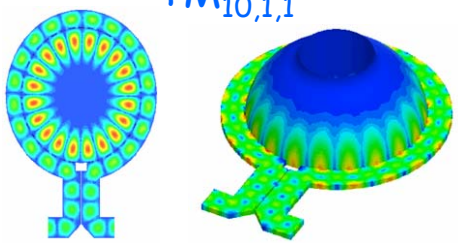
CTF3 Pulse



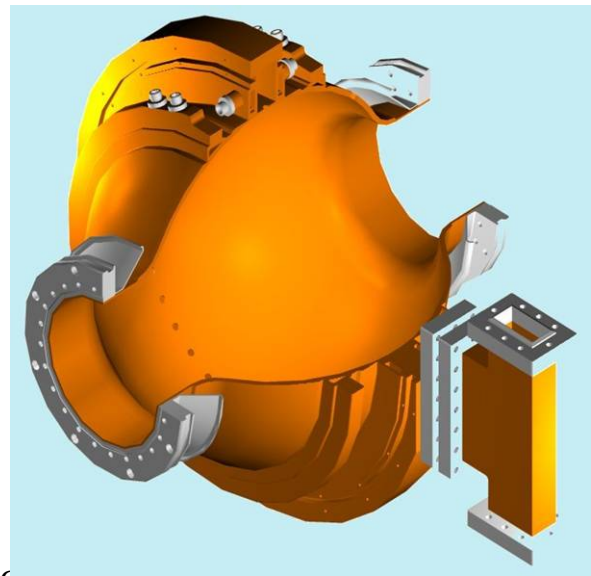
time

Barrel-Open-Cavity

$TM_{10,1,1}$



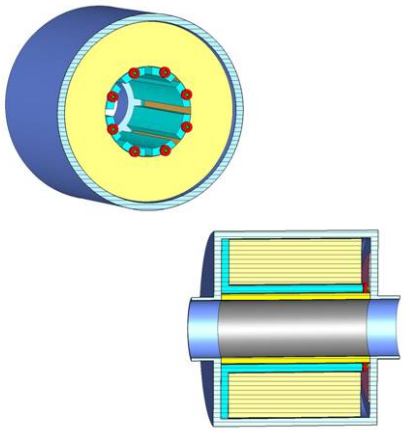
Electric Magnetic Field
Field

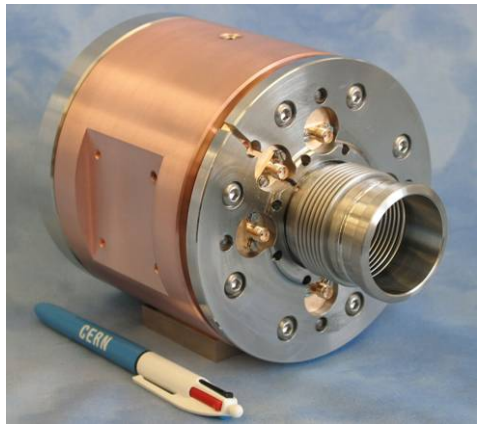


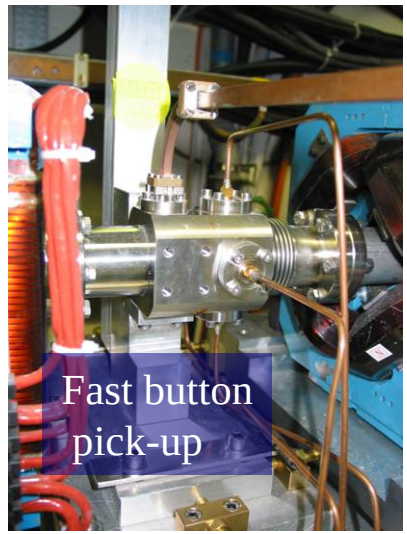
Prototype power tested, installed
5 more being manufactured

Beam Diagnostic system

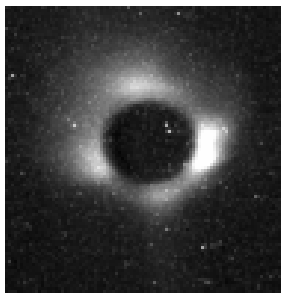
Inductive Beam Position monitor



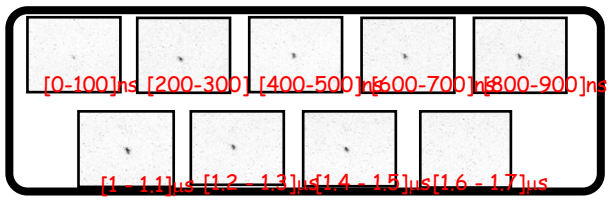


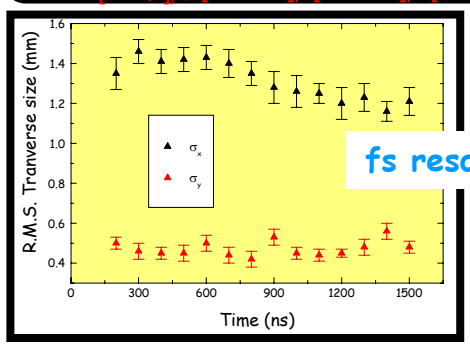


Beam halo imaging with OTR and masking technique
Screen : 10μm Al



Total dynamic range : 10^4-10^5



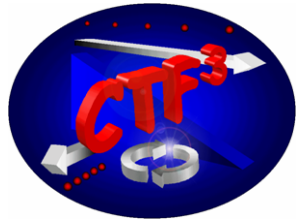


·100ns Camera (>5ns) gate width
5μm thick Graphite OTR

Beam loss monitoring:
- Fast system based on current loss
- Dedicated detectors (NW University)

Fast beam phase monitor
(Uppsala)

Objective for 2004



Two operation periods in 2004

1.: • Commission new linac installation (8 structures)
• Test of 30 GHz RF power production with 1/3 PETS installed

2.: • Commission the remaining linac as far as possible
• Commission Bunch lengthening chicane with beam
• Commission full PETS incl. 30 GHz RF line

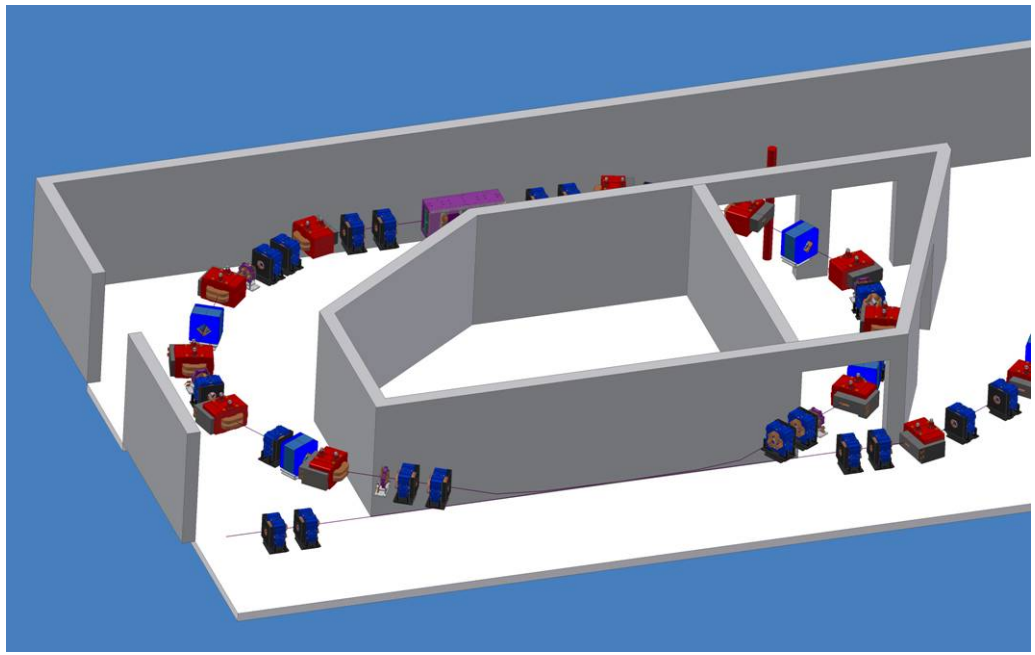
For start-up 2005:

Linac complete incl. sub-harmonic buncher
Bunch Lengthening Chicane, Transfer Line and Delay Loop installed

Delay Loop (INFN)

- Delay Loop magnetic layout has been completed
- DL Vacuum Chambers components ordered:
  - Pumping sections
  - Shielded Bellows: first batch ordered
- DL Vacuum Chambers components mechanical drawing ready:
  - Beam position monitor
- DL 1.5 GHz RF deflector electromagnetic design finished
- Missing magnets:
  - Sextupoles and correctors ordered
  - Wiggler call for tender started
- Injection-extraction region vacuum chamber: drawing started

Civil engineering modifications to building finished

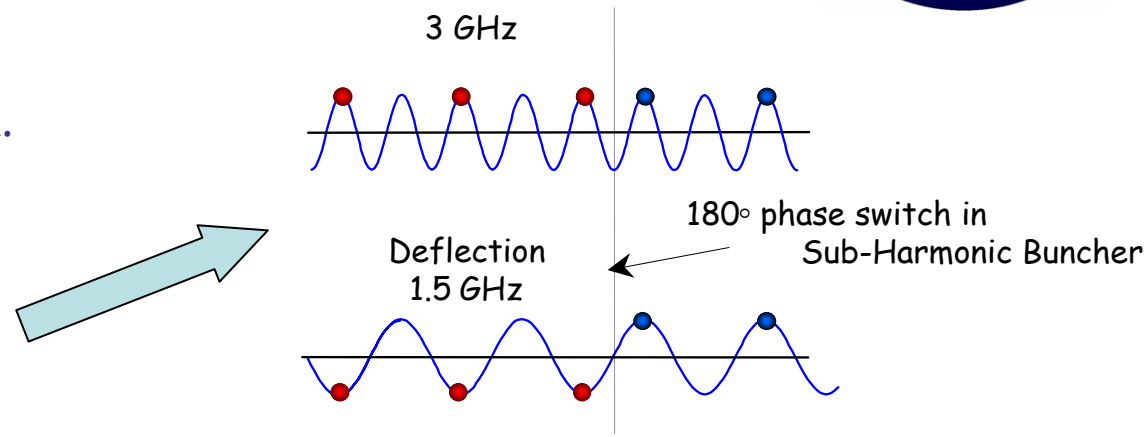


Slide from A.Ghigo INFN

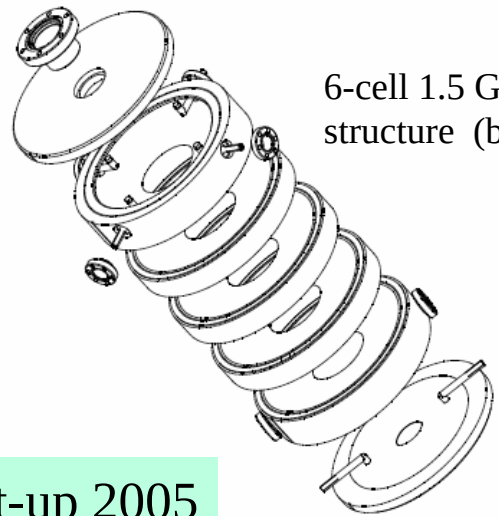
Injector issues

Present status:
only 3 GHz bunching system.

For bunch interleaving in
Delay Loop the bunches
have to be “phase-coded”



Base line design: Thermionic injector
with Sub-Harmonic Bunchers.
design finished
recent technical change:
3 Travelling wave buncher structures driven by three 40 kW Travelling Wave Tubes (already ordered)



6-cell 1.5 GHz buncher
structure (being built)

To be installed for start-up 2005

Injector issues

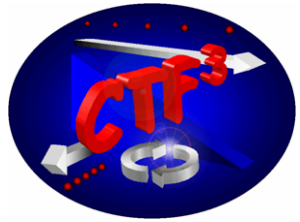


Photo Injector:
bunch phase coding done by laser timing

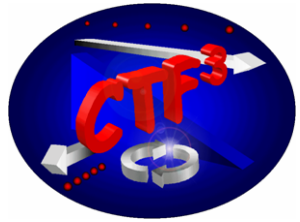
Unprecedented stability and beam current specifications

Collaboration : **Laser: RAL**
promising test done with fully diode pumped laser
RF gun: LAL
design in progress
Photo Cathodes: CERN
feasibility demonstrated

Bid to EU in FP 6 programme for Photo injector (PHIN): funded up to 90 % !

Available end 2006

Collaboration



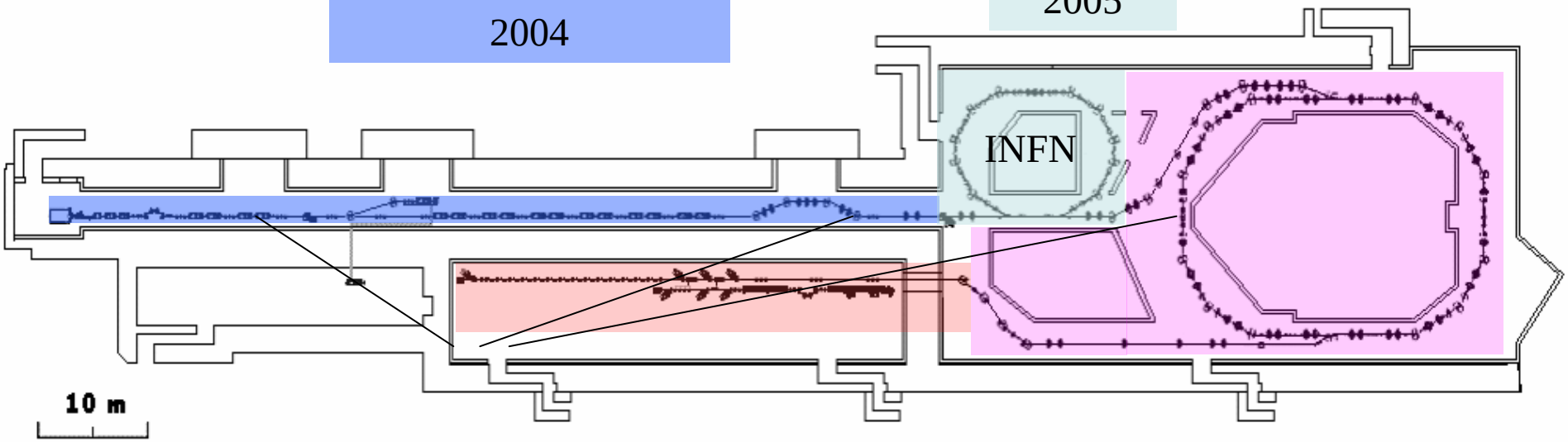
- **INFN:**
  Full responsibility of Delay Loop, Design of Combiner Ring,
  RF Deflectors
  participation in operation
- **RAL**
  Laser Development for Photo Injector and manufacture
- **LAL**
  Gun for Preliminary Phase,
  Gun High Voltage and electronics,
  Pre-bunchers,
  RF gun for Photo injector
- **Uppsala University**
  Bunch phase monitor
  Operations support
- **SLAC**
  Thermionic gun assembly, injector layout,
  participation in commissioning
- **NW University USA**
  Beam loss monitoring system
  Participation in DBA linac
- **Finnish Industry**
  One post for CLIC / CTF3
- **University Lausanne**
  PhD Student
- **Many CERN groups:**
  Beam diagnostics
  RF and acceleration system
  Infrastructure, cabling,
  Power converters
  Vacuum
  Operation
  Controls

CTF3 programme

Damped accelerating structure (R1)

2004

2005



CLEX

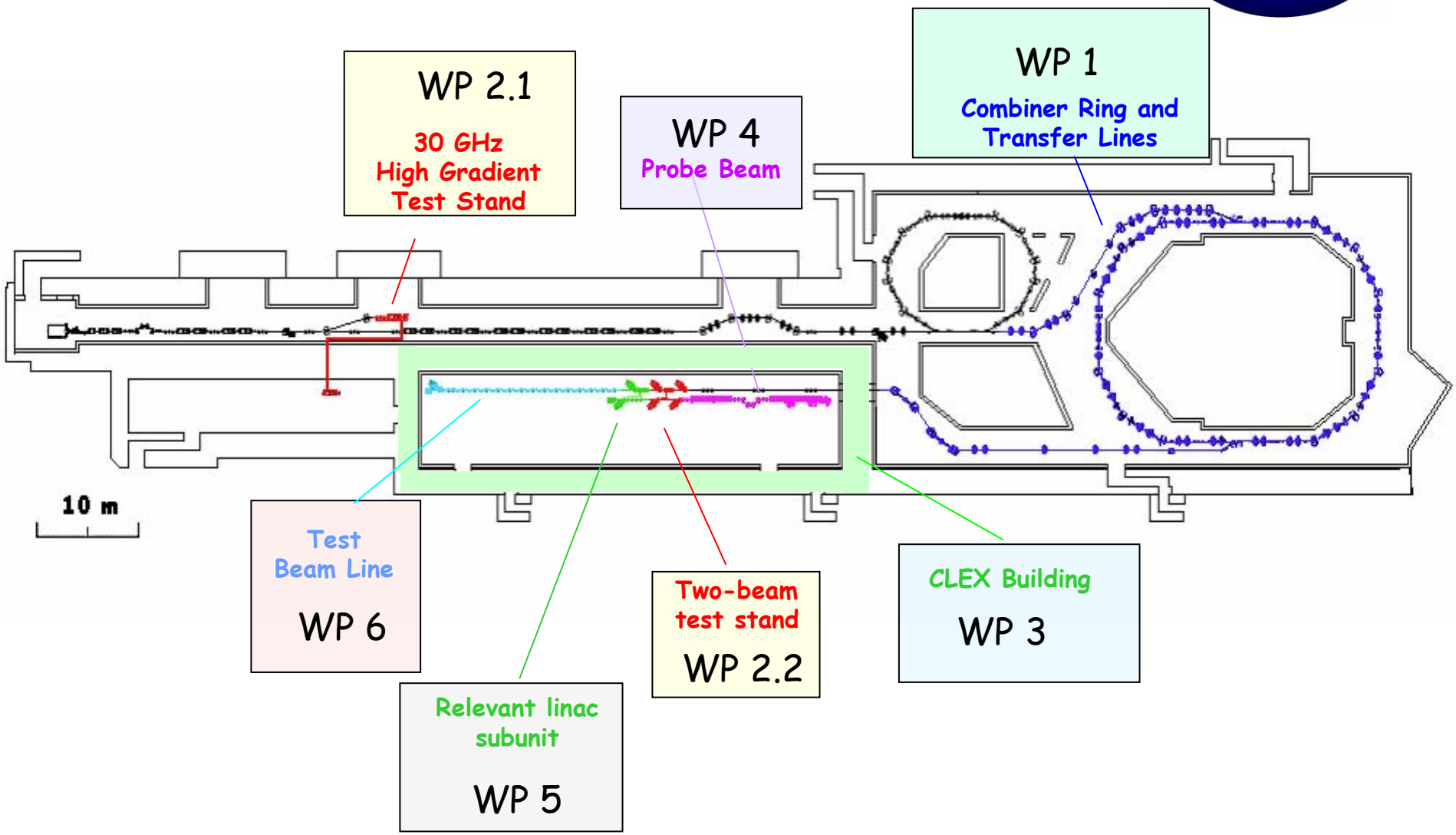
2006 **unfunded**

2007-2009 **unfunded**

Drive beam generation scheme (R1)
ON/OFF PETS (R1)

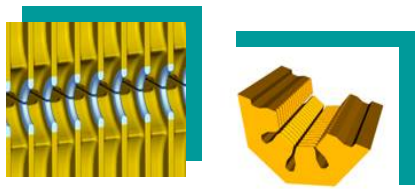
Stability bench marking (R2)
CLIC sub-unit (R2)

Work packages



Work packages

Structures

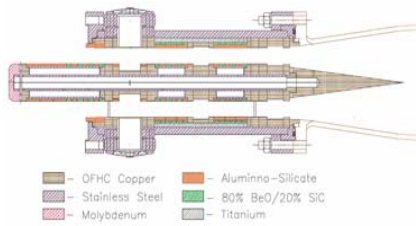


WP 7

CTF3 Operation

WP 8

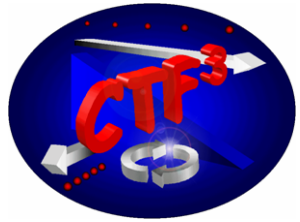
30 GHz power source



WP 9

Cost and manpower of work packages:
Indicative estimate only

Conclusion



- Programme assured up to including Delay Loop
- Very ambitious programme
- Many open questions, in particular concerning benchmarking experiments
- Completion within time scale possible with more resources and more collaborations

Highly motivated team,
excellent collaboration between all partners

Planning

	2004	2005	2006	2007	2008	2009
Drive Beam Accelerator						
30 GHz high-gradient test stand						
30 GHz high-gradient testing (4 months per year)						
R1.1 feasibility test of CLIC accelerating structure						
Delay Loop						
Combiner Ring						
R1.2 feasibility test of drive beam generation						
CLEX						
R1.3 feasibility test of PETS* structure						
Probe Beam						
R2.2 feasibility test of relevant CLIC linac sub unit						
Test beam line						
R2.1 Beam stability bench mark tests						