Introduction to CTF3

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CERN / PS

Aim of review:

Review the technical solutions
are they realistic ?

Give us technical advice
Comment on alternatives

Guide our funding bodies:
CERN
Collaborations

CTF3 is only possible as International collaboration

INFN Frascati
LAL Orsay
Rutherford Appleton Laboratory
SLAC
Strathclyde University
Uppsala University

CTF3 is not a user facility

Experimental machine :

Demonstration of the RF power generation scheme for CLIC

- Novel drive beam scheme in the two-beam scenario
- This two-beam scheme is not limited to CLIC

long RF pulse at low frequency
==> short RF pulse at high frequency with high power
using an electron beam for energy storage

high efficiency

Demonstration of major CLIC Components

RF power source at 30 GHz with nominal CLIC parameters

Make use of already existing material:

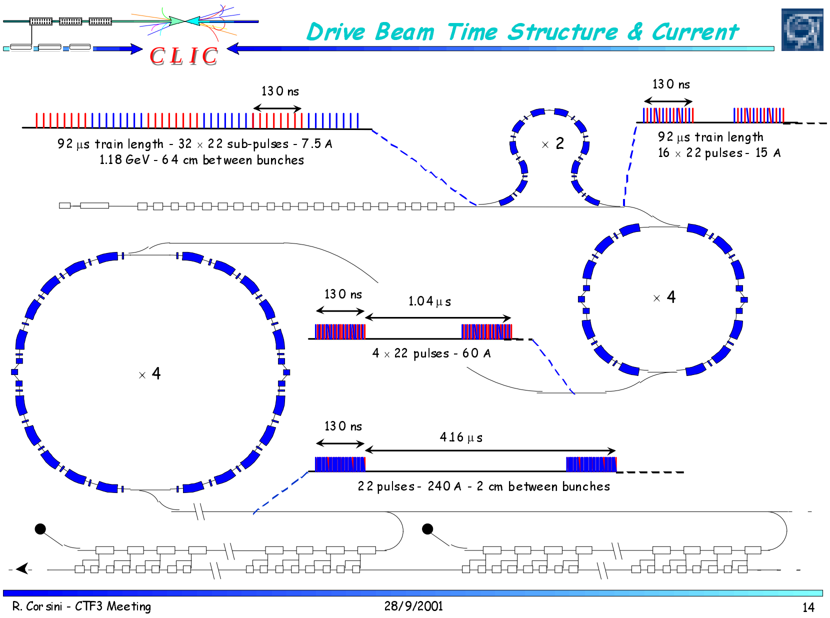
LPI complex available since LEP shut-down:
LEP injector Linac **LIL** and Electron-Positron Accumulator **EPA**

Building : Linac tunnel, space for rings, control room

Hardware:
3 GHz RF system: klystrons, modulators, accelerating sections
magnets, power supplies,
control system

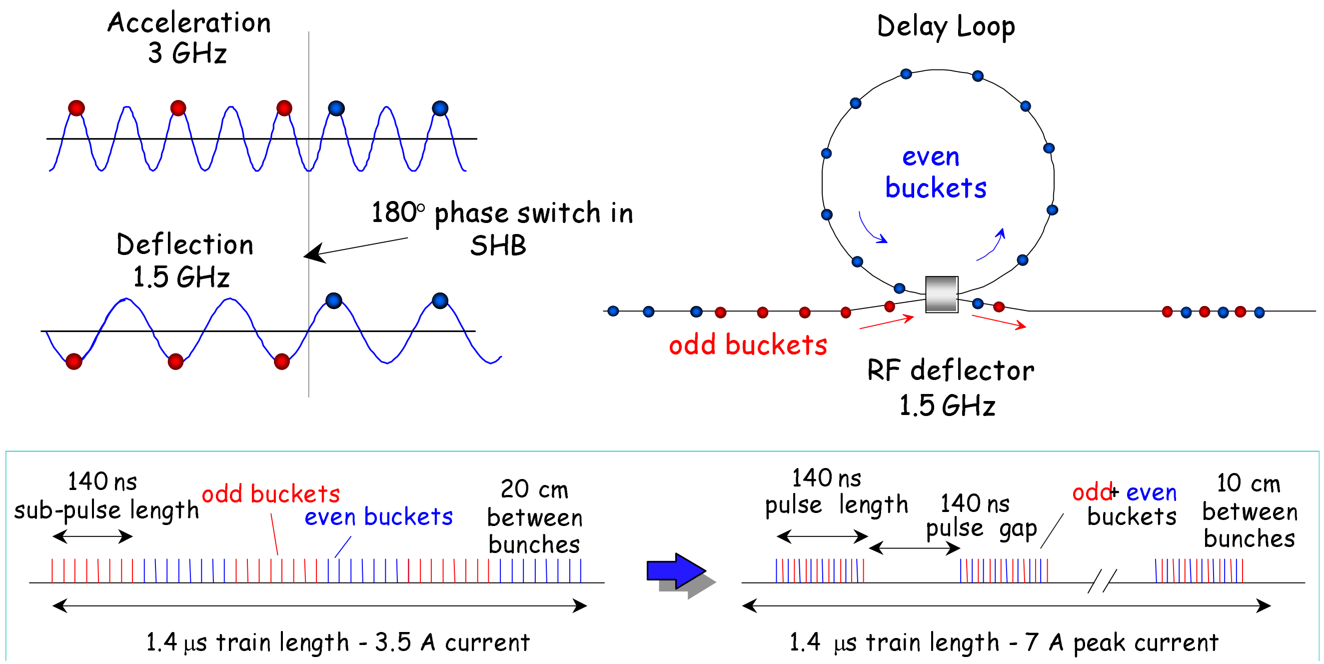
==> some technical choices are a consequence of existing equipment

CLIC - CTF3

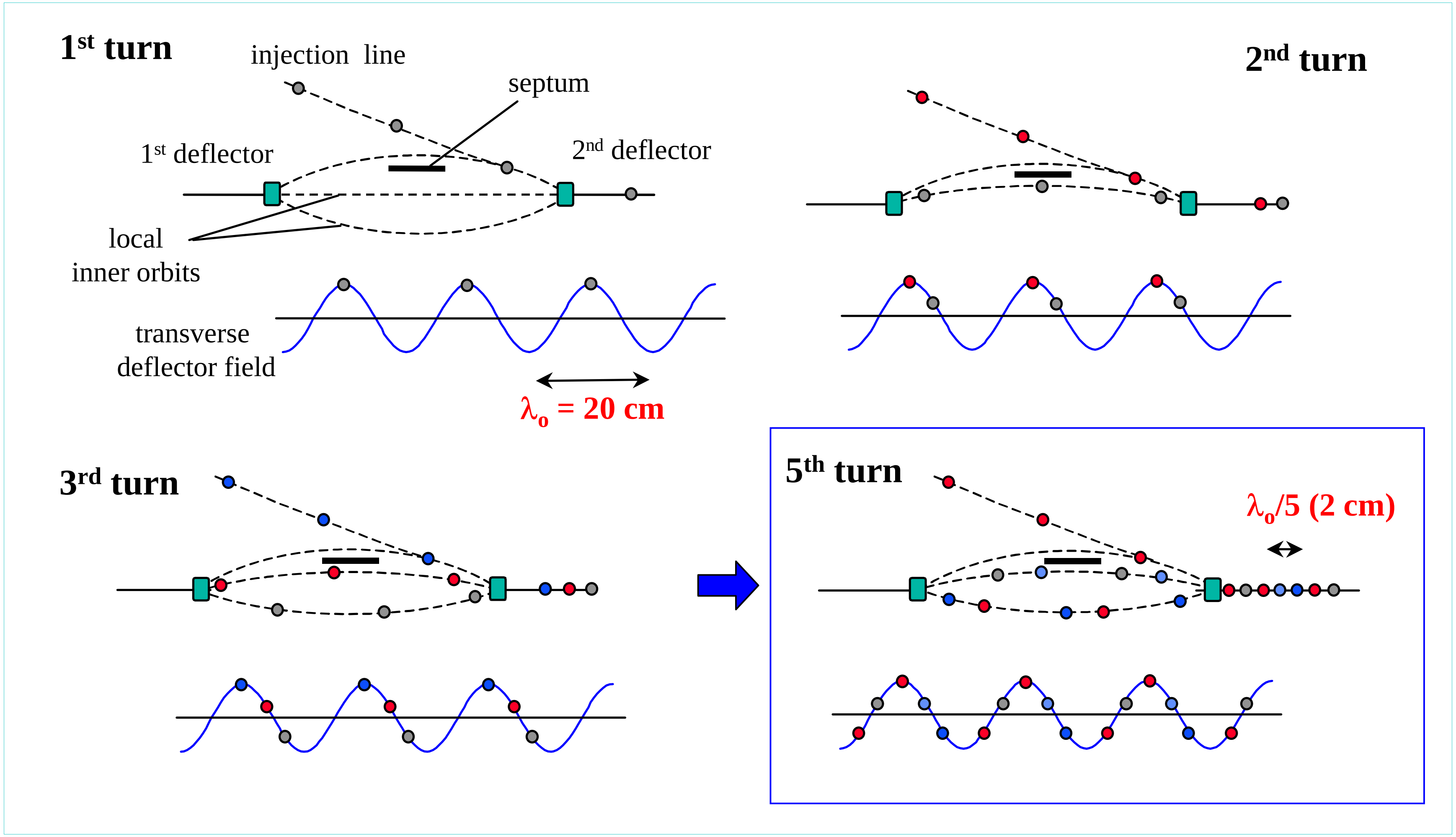


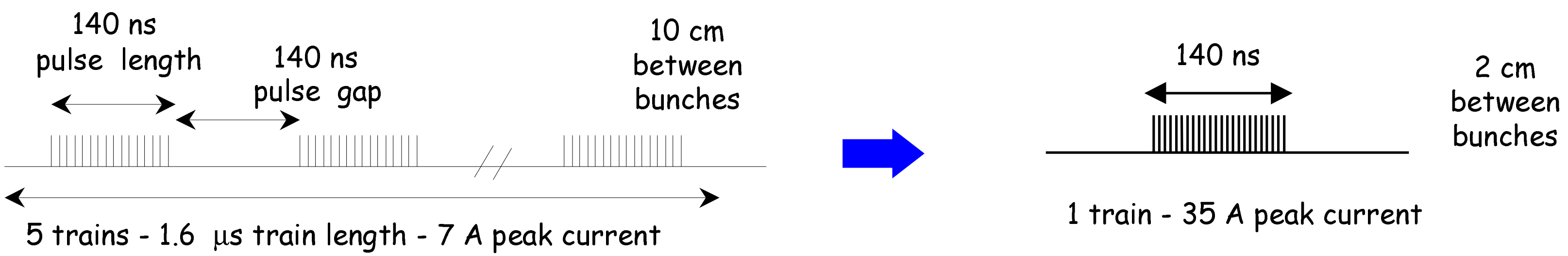
		CTF3	CLIC (3 TeV)
Drive beam			
Acceleration frequency	MHz	2 998.55	937
repetition rate	Hz	5	100
energy	MeV	150	1180
Number of accelerating structures		16 + 2	182
average current after linac	A	3.5	7.5
Number of klystrons		10	182 x 2
Number of RF pulse compressors		9	0
Beam pulse length	µs	1.4	92
Bunch spacing before compression	cm	20	64
Delay Loop length	m	42	39
Combiner Ring length	m	84	78
Average beam current after compression	A	35	240
Bunch spacing after compression	cm	2	2
Drive beam energy per pulse	kJ	0.8	814
average beam power	kW	4.1	81 000
Main beam			
Number of accelerating structures		max 8	22 x 976
RF Pulse length	ns	140	130
Acceleration Frequency	GHz	30	30
Acceleration Gradient	MV/m	150	150

“Phase-coding” of bunches

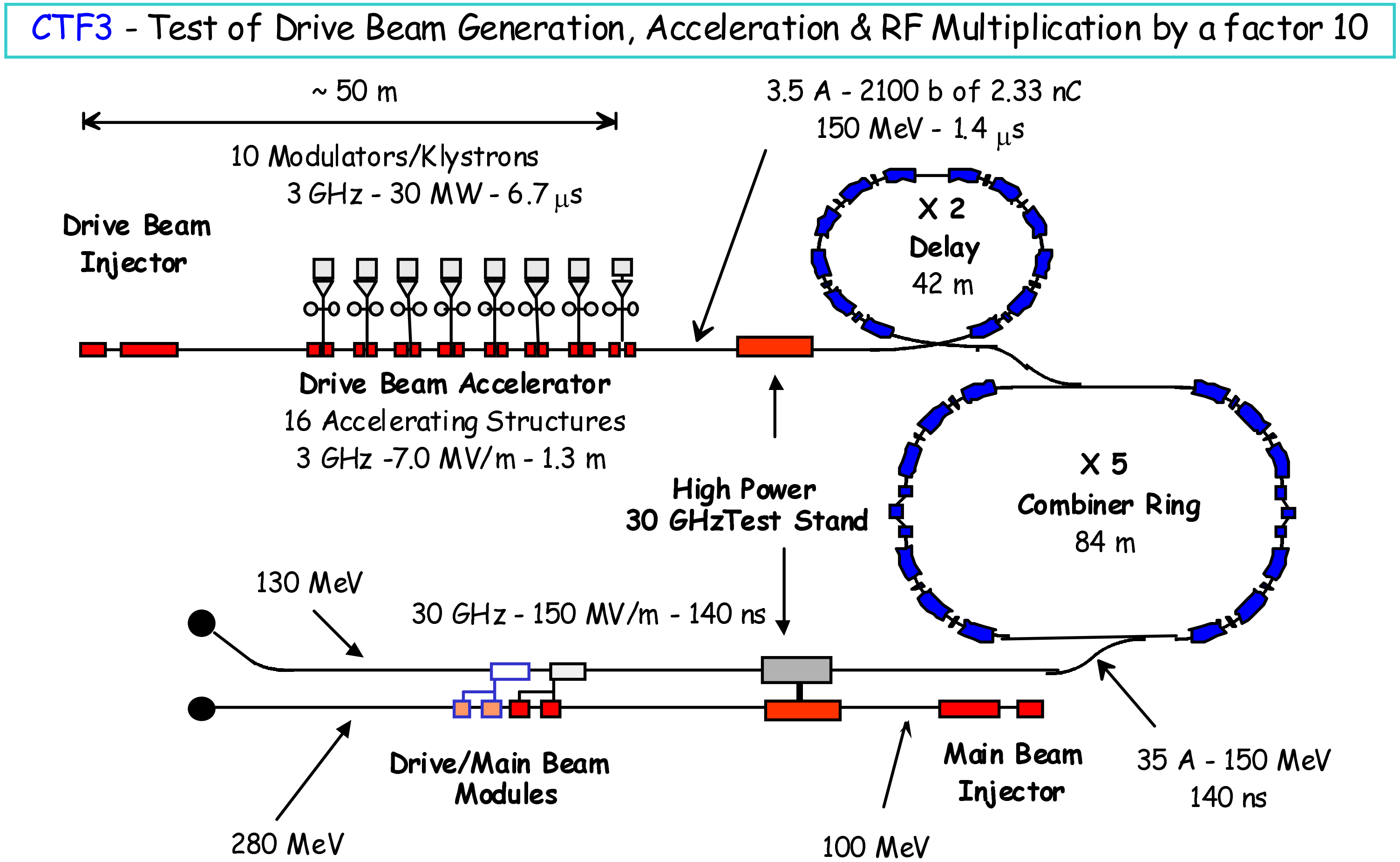


Bunch frequency multiplication - Combiner Ring injection

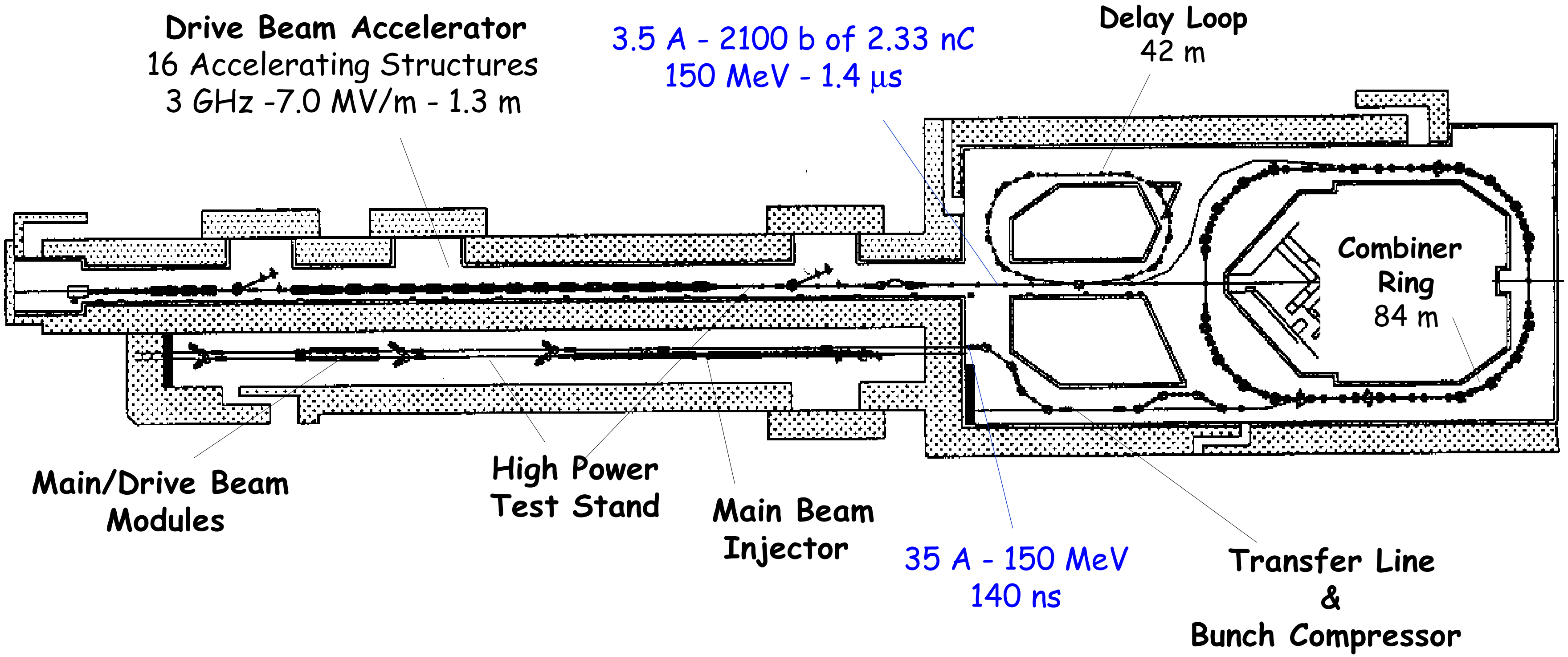




Generic layout of CTF3



CTF3 layout - Nominal phase



A possible housing of the CLIC Test Facility (CTF3) in the LEP Pre-injector building

Main objectives and challenges

Drive beam production:
3.5 A,
Estimation: Stability of Voltage
and beam current of 10^{-3} !
satellite bunches
bunch phase coding

Thermionic injector
wide bw 1.5 GHz klystron

Alternative: Laser gun

Drive beam accelerator:
Near 100% beam loading
high beam current in short bunches
beam stability

strong damping of HOM ,
new RF structures

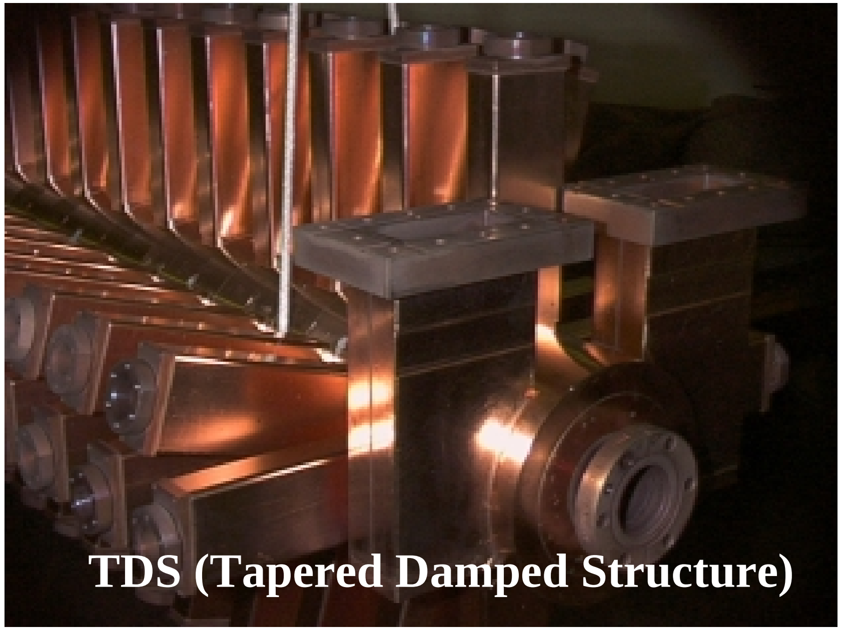
Delay loop, Combiner ring, bunch compressor
injection with RF deflector
isochronous lattice
Impedance
coherent synchrotron radiation
handling of 35 A beam current

bunch length manipulation

3 GHz RF:
pulse compression, long flat-top

longer RF pulse, phase ramping
New BOC development

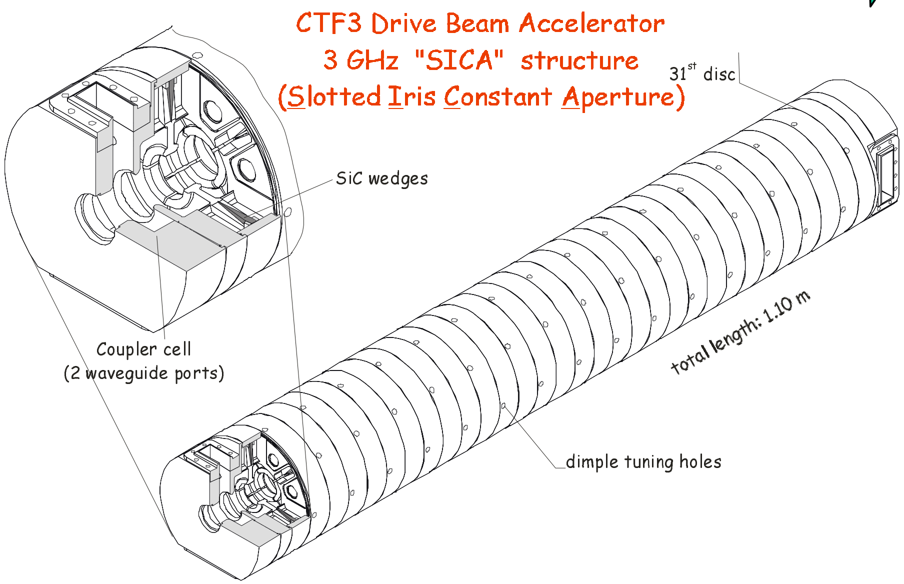
Drive beam accelerating structure

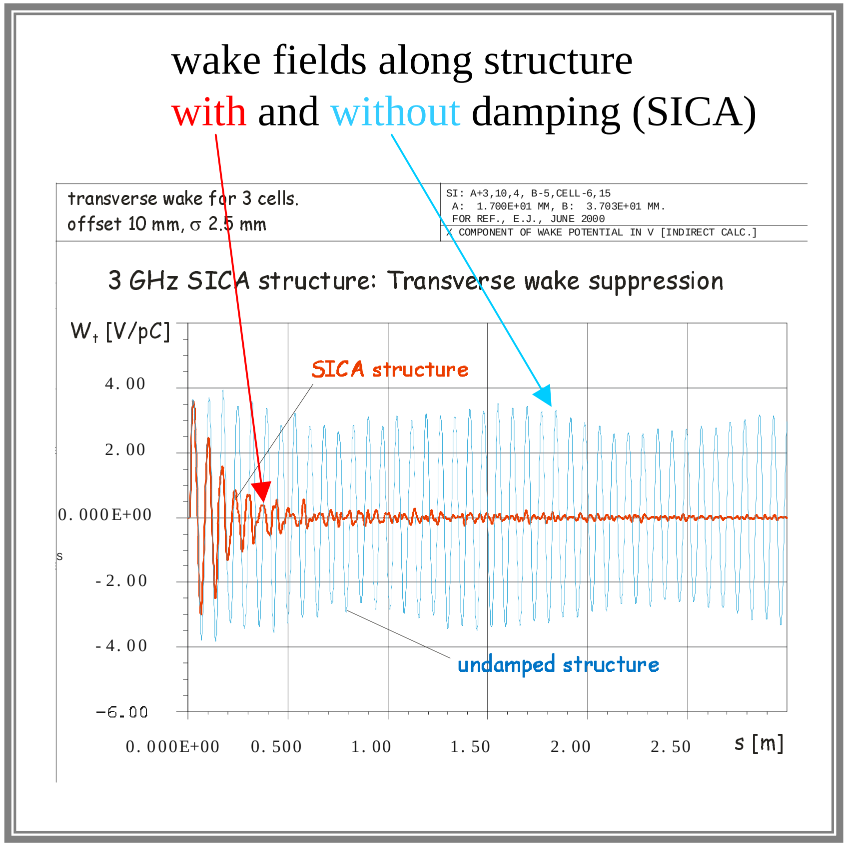


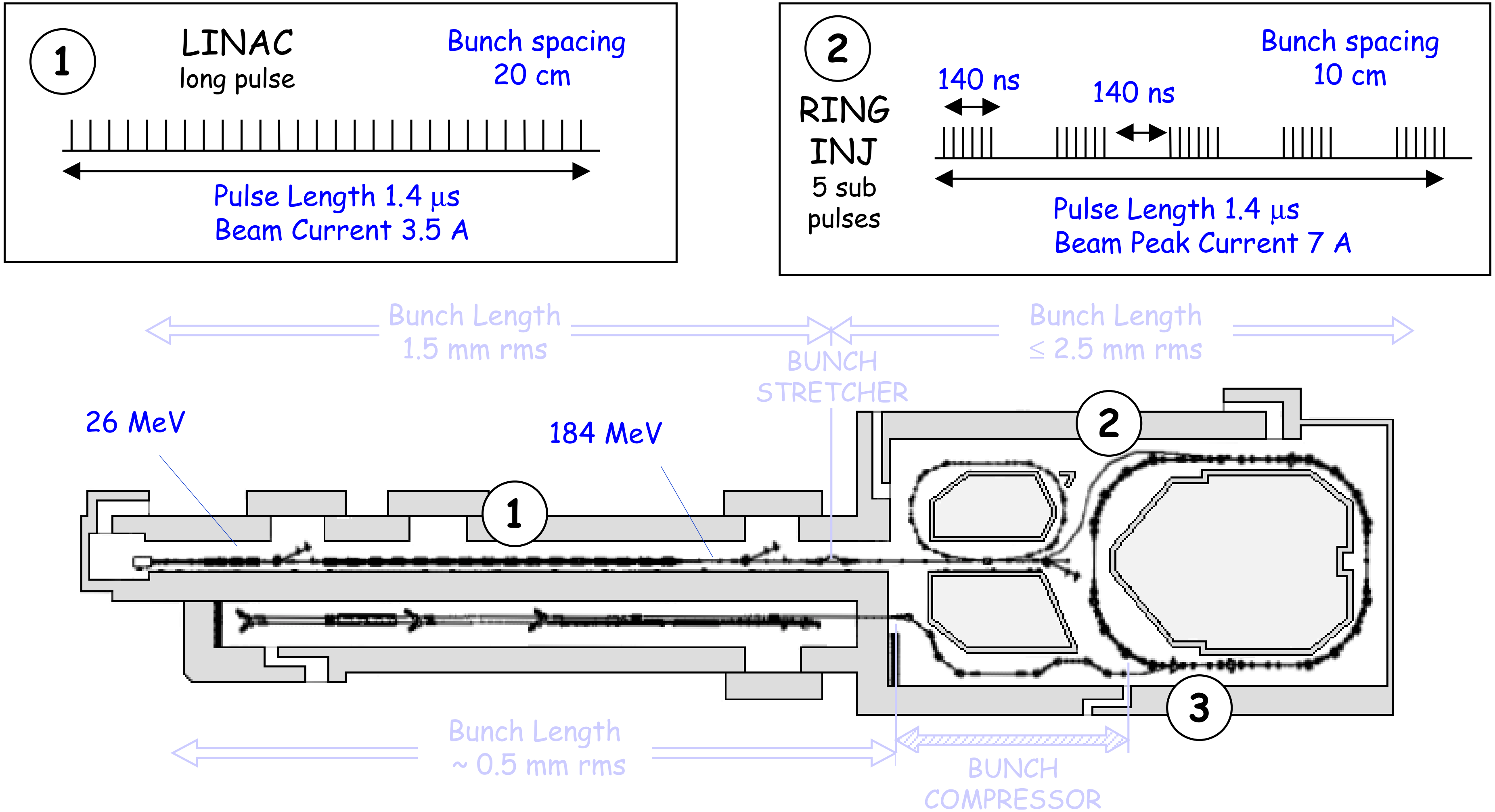
High beam current =>
Beam induced modes have to be damped

Prototype of TDS structure built, RF power tested

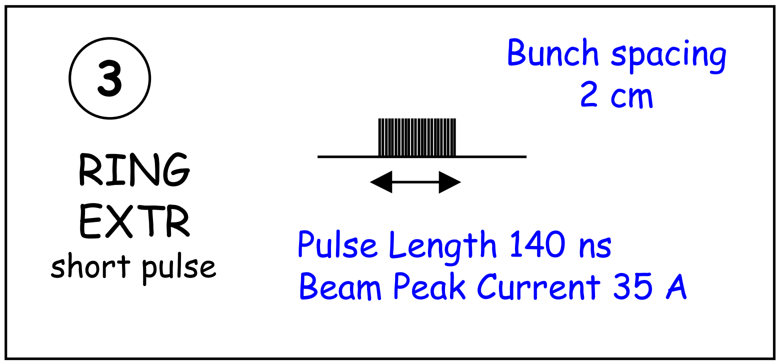
New structure type has been developed :
(SICA = Slotted Iris Constant Aperture)





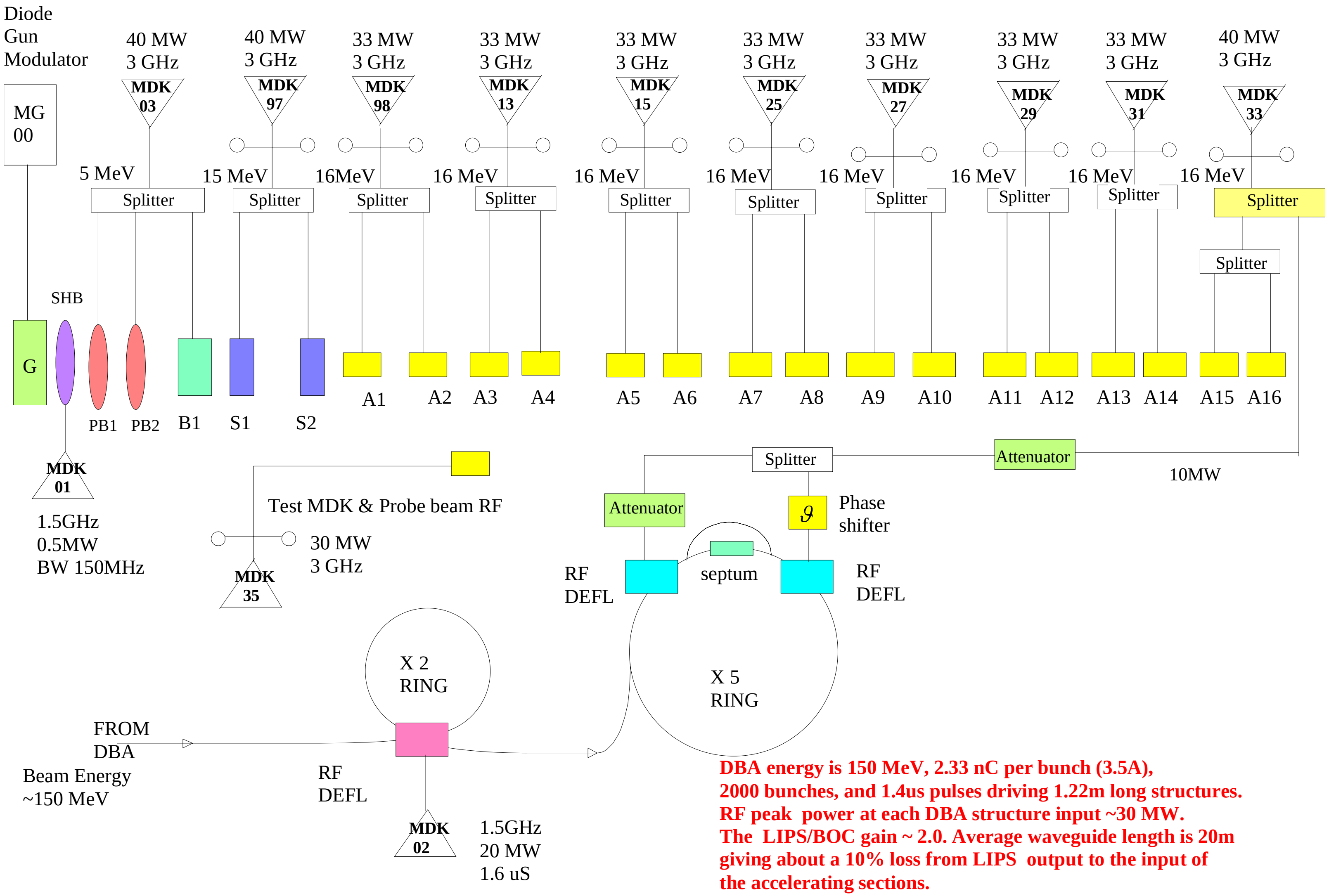


Bunch Length (rms)	0.5-2.5	mm
Bunch Charge	0.1-2.4	nC
Norm Emittance (rms)	100	π mm mrad
β-functions	0.5-15	m
Beam size	0.25-1.5	mm



2005 - 2006

RF power plant 3 GHz and 1.5 GHz



DBA energy is 150 MeV, 2.33 nC per bunch (3.5A), 2000 bunches, and 1.4us pulses driving 1.22m long structures. RF peak power at each DBA structure input ~30 MW. The LIPS/BOC gain ~ 2.0. Average waveguide length is 20m giving about a 10% loss from LIPS output to the input of the accelerating sections.

Major building modifications

Radiation shielding

Beam power 5 kW !

shielding assumes :
permanent beam loss of only 5% (250 W)
beam loss monitors in interlock chain   shut-off beam

additional shielding required:

some outside walls

between accelerator tunnel and klystron gallery above
up to 20 cm of iron

above EPA:
additional 90 cm concrete

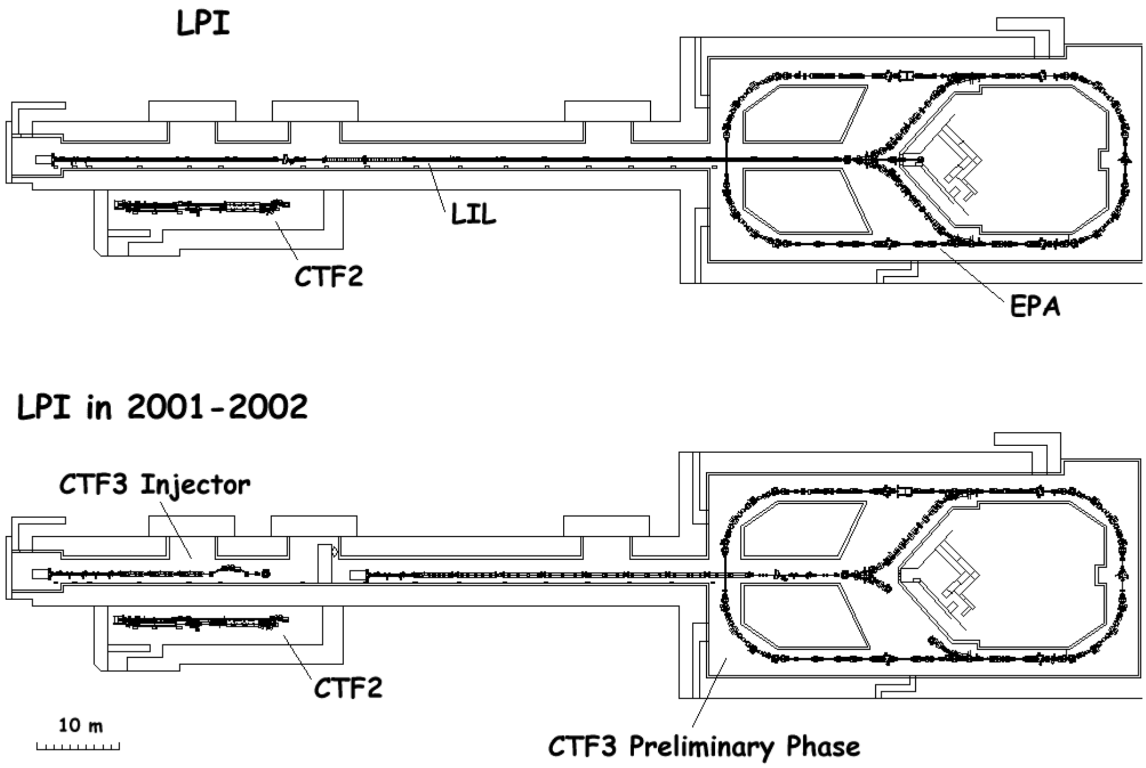
Other building modifications:

make room for DL
new CLEX building

Construction in phases

Preliminary phase 2001 / 2002

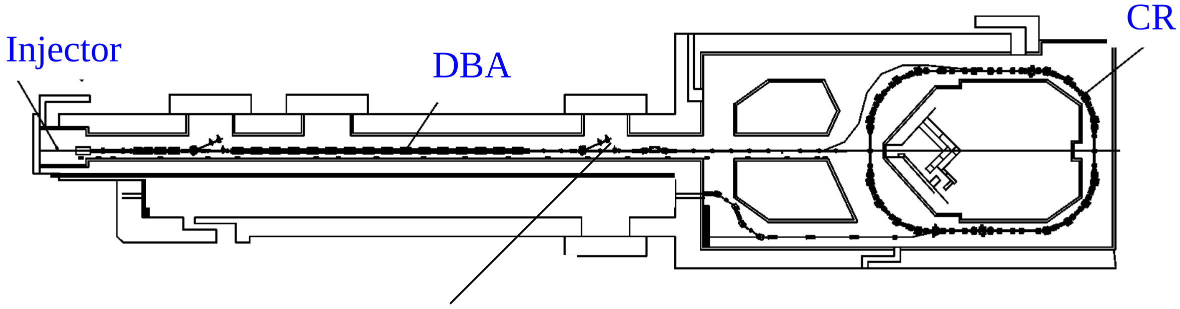
LPI + modified EPA
new e-gun
only 8 accelerating sections
EPA ring 17 mm shorter
transfer lines and EPA isochronous



demonstrate bunch recombination by factor 3-5
using 2 RF deflectors

limited beam current

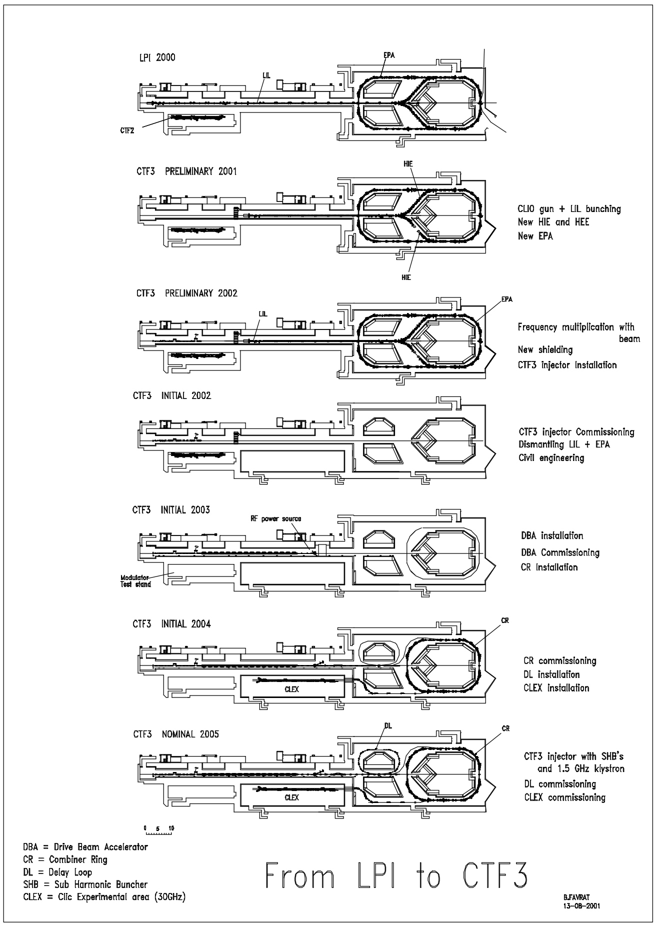
Initial phase
2003 / 2004



new injector (no Sub-harmonic bunchers ...)
new accelerating structures for DBA
30 GHz test station after linac

transfer lines
combiner ring

combination tests can be done at reduced bunch charge

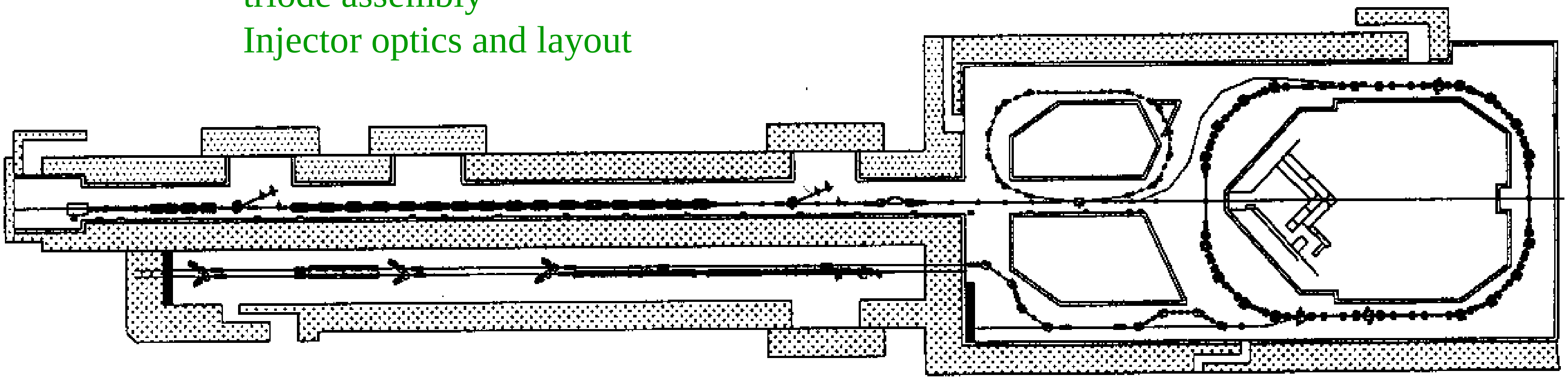

LPI 2000
EPA
LIL
CTF2
CTF3 PRELIMINARY 2001
HIE
CLIO gun + LIL bunching
New HIE and HEE
New EPA
HIE
CTF3 PRELIMINARY 2002
LIL
EPA
Frequency multiplication with beam
New shielding
CTF3 injector installation
CTF3 INITIAL 2002
CTF3 injector Commissioning
Dismantling LIL + EPA
Civil engineering
CTF3 INITIAL 2003
RF power source
DBA installation
DBA Commissioning
CR installation
Modulator Test stand
CTF3 INITIAL 2004
CR
CR commissioning
DL installation
CLEX installation
CLEX
CTF3 NOMINAL 2005
DL
CR
CTF3 injector with SHB's
and 1.5 GHz klystron
DL commissioning
CLEX commissioning
CLEX
0 5 10
DBA = Drive Beam Accelerator
CR = Combiner Ring
DL = Delay Loop
SHB = Sub Harmonic Buncher
CLEX = Clic Experimental area (30GHz)
From LPI to CTF3
B.FAVRAT
13-08-2001

Collaborations

LAL:
gun, HV deck
pre-bunchers
CLIO-type gun for prel. phases already delivered

INFN Frascati:
transfer lines, bunch lengthening chicane
Delay Loop layout and hardware
Combiner Ring layout and hardware
RF deflectors
Fast kickers
Participate in commissioning and exploitation

SLAC:
triode assembly
Injector optics and layout



RAL and **Strathclyde University**:
Laser for Photo-Injector option

Uppsala University:
mm wave detector for beam diagnostics
participation in commissioning