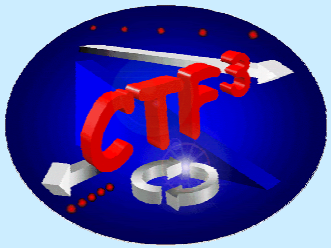


FIRST FULL BEAM LOADING OPERATION WITH THE CTF3 LINAC

R. Corsini, H. Braun, G. Carron, O. Forstner, G. Geschonke, E. Jensen, L. Rinolfi, D. Schulte, F. Tecker, L. Thorndahl - CERN

L. Groening - GSI

M. Bernard, G. Bienvenu, T. Garvey, R. Roux – LAL Orsay

T. Lefevre - North Western University

R. Koontz, R. Miller, D. Yeremian, R. Ruth - SLAC

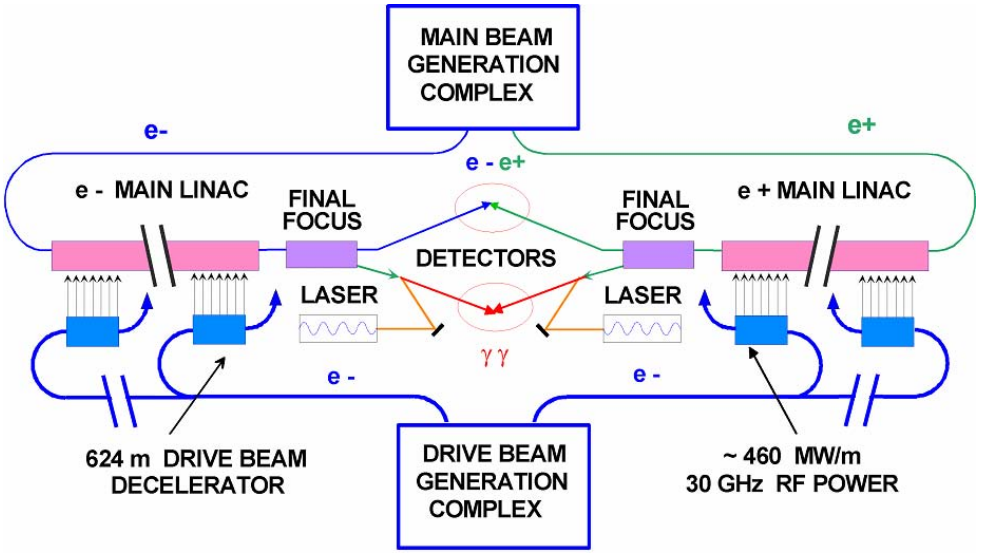
A. Ferrari - Uppsala University

TALK OUTLINE

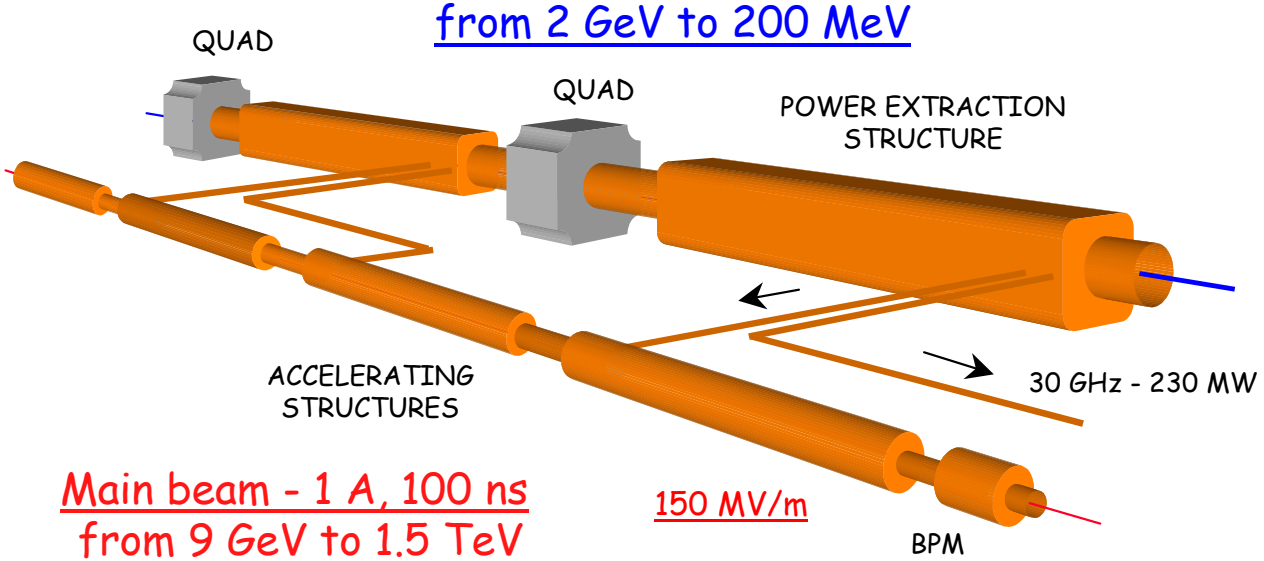
- CTF3 motivations and previous results
- The CTF3 injector and linac commissioning & full beam loading operation
- Conclusions and outlook

CLIC TWO-BEAM SCHEME

OVERALL LAYOUT OF CLIC
FOR A CENTER-OF-MASS ENERGY
OF 3 TeV



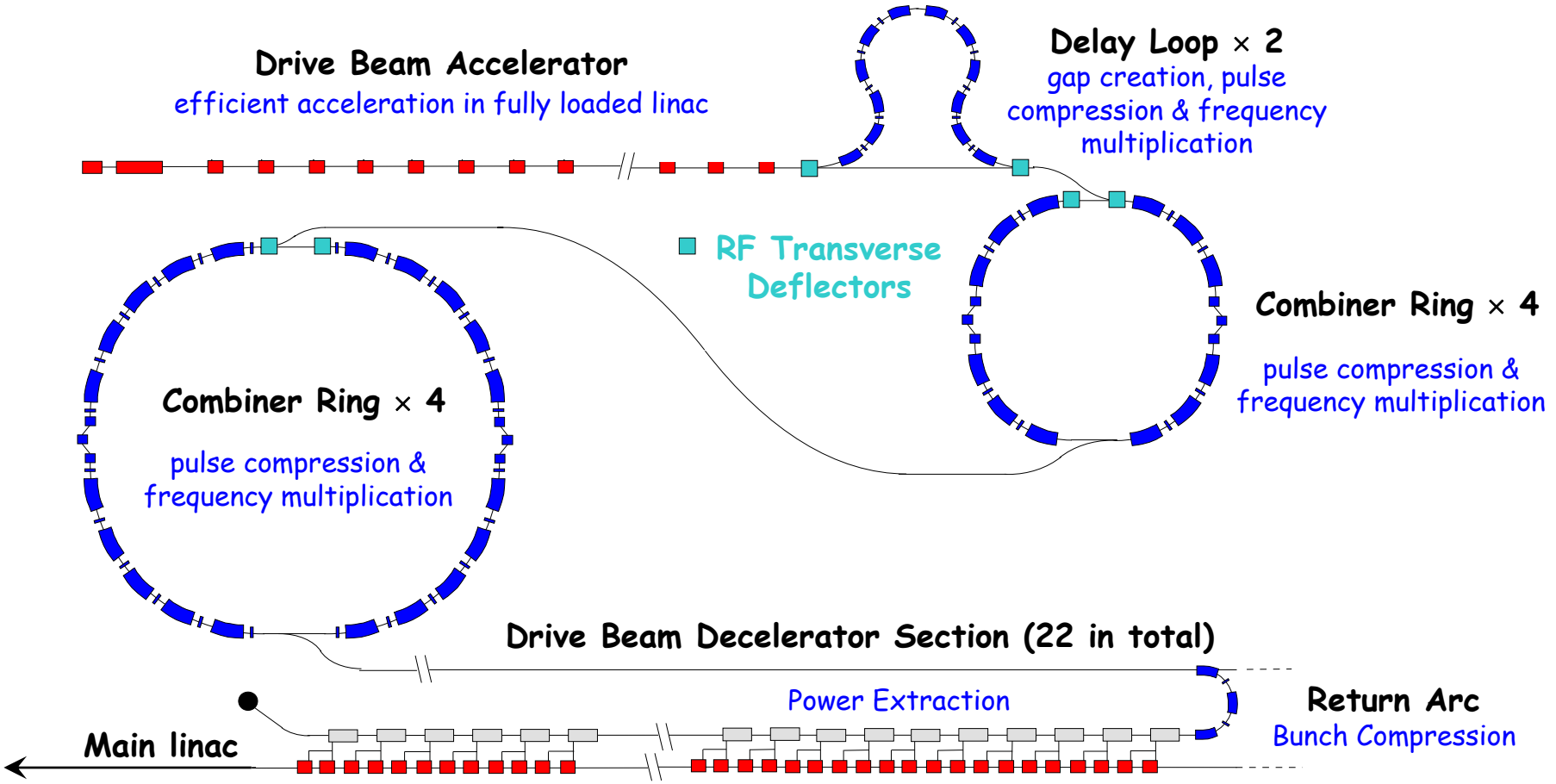
Drive beam - 150 A, 130 ns
from 2 GeV to 200 MeV



Main beam - 1 A, 100 ns
from 9 GeV to 1.5 TeV

CLIC MODULE

DRIVE BEAM GENERATION: THE CLIC RF POWER SOURCE



Drive beam time structure - initial

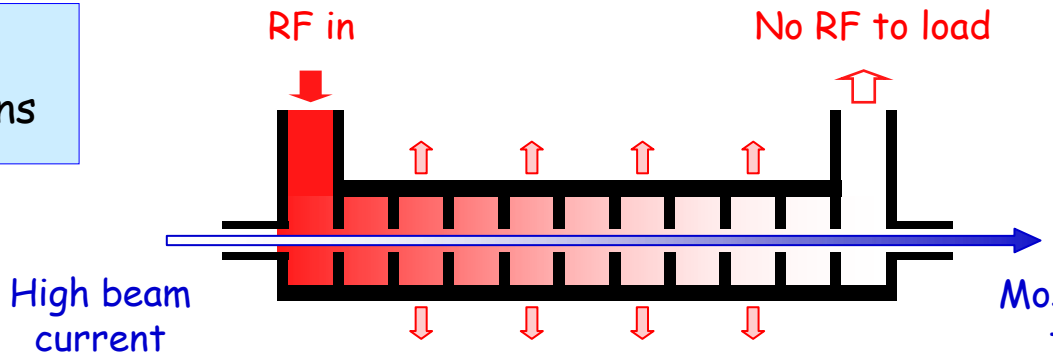
100 μs train length - 32 × 22 sub-pulses – **4.7 A**
2 GeV - 64 cm between bunches

Drive beam time structure - final

22 pulses - **150 A** - 2 cm between bunches

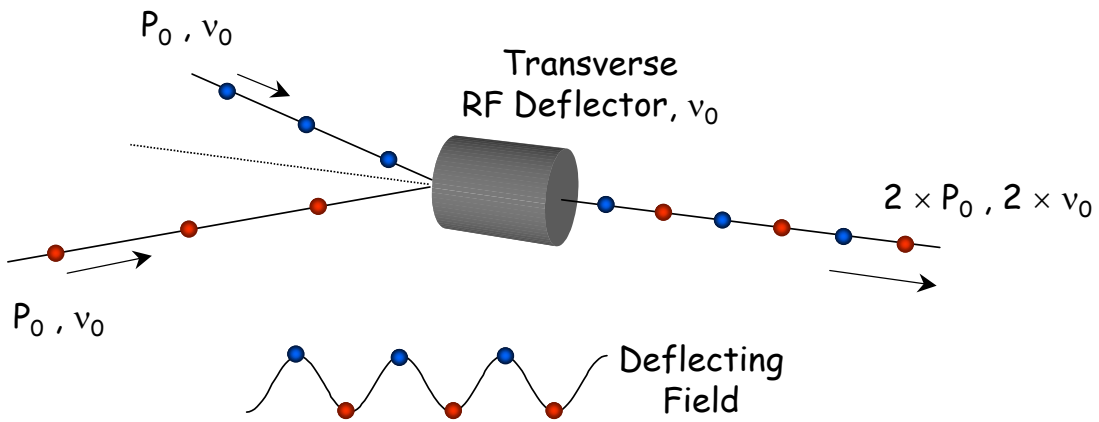
RF POWER SOURCE "BUILDING BLOCKS"

Full beam-loading acceleration in TW sections



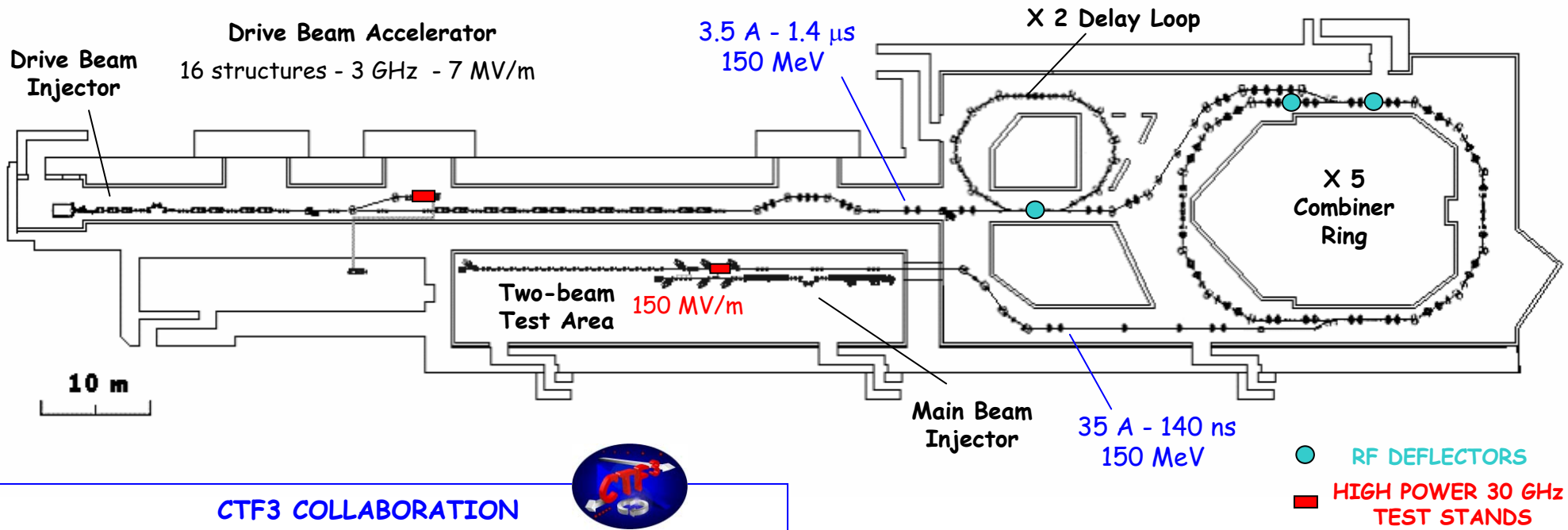
Efficiency > 95 %

Beam combination/separation by transverse RF deflectors



CTF3 NOMINAL PHASE

- Build a small-scale version of the CLIC RF power source, in order to demonstrate:
  - full beam loading accelerator operation
  - electron beam pulse compression and frequency multiplication using RF deflectors
- Provide the 30 GHz RF power to test the CLIC accelerating structures and components at the nominal gradient and pulse length (150 MV/m for 130 ns) .



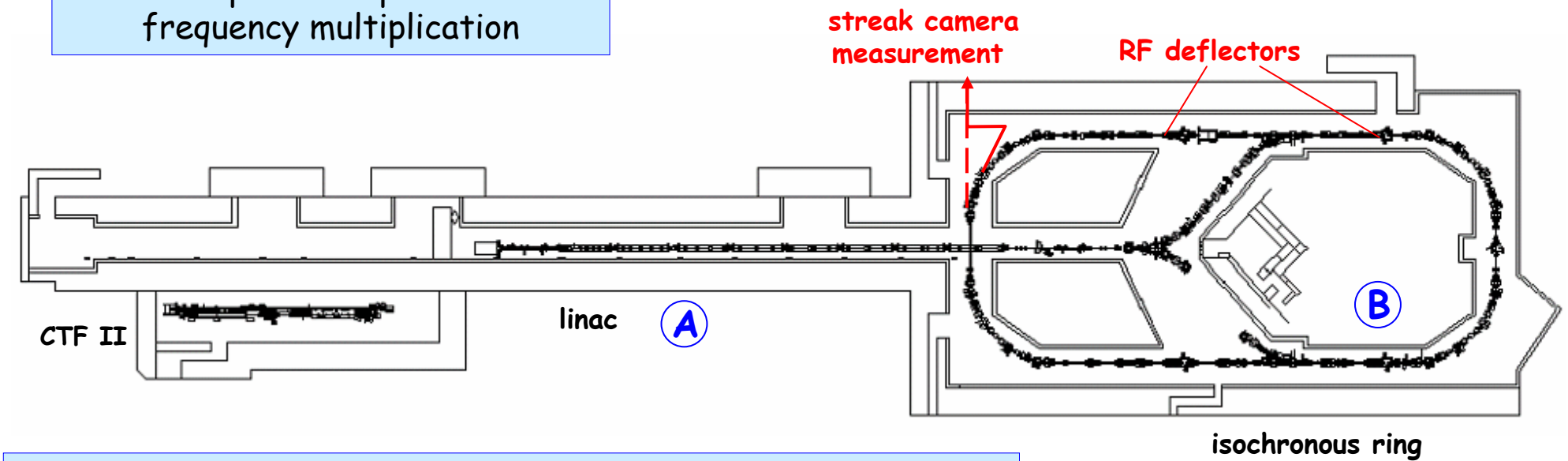
CTF3 COLLABORATION

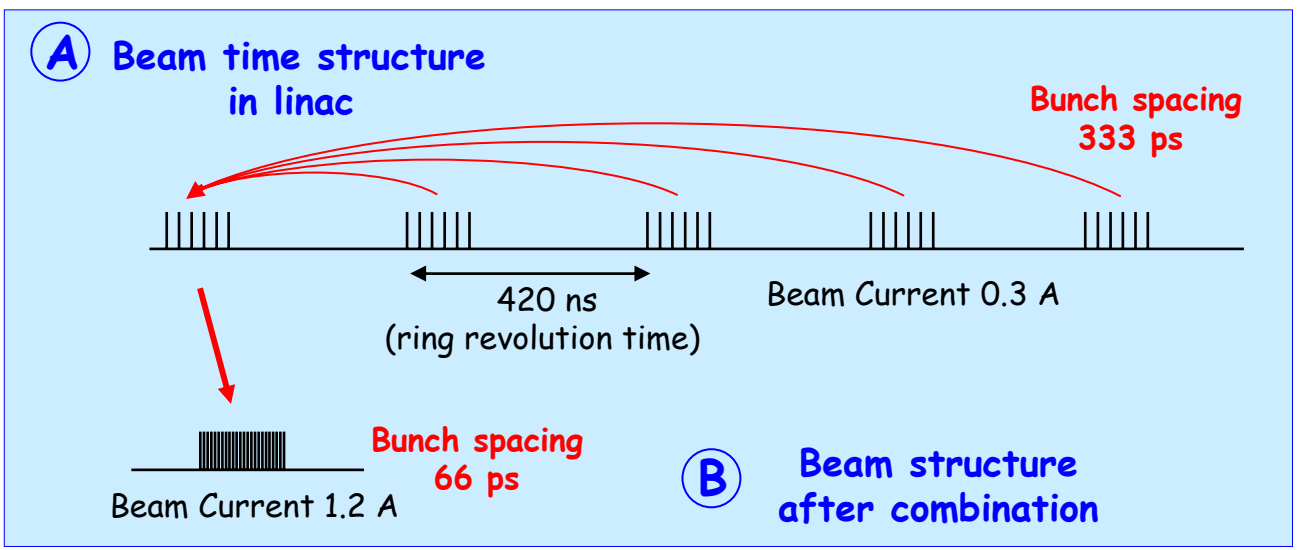
CERN, Geneva (Switzerland)	Northwestern University, (USA)
INFN , Frascati (Italy)	SLAC , San Francisco (USA)
LAL , Orsay (France)	Uppsala University , (Sweden)

THE CTF3 PRELIMINARY PHASE (2001-2002)

low-charge demonstration of the electron pulse compression and frequency multiplication

R. Corsini, A. Ferrari, L. Rinolfi, P. Royer, and F. Tecker, "Experimental results on electron beam combination and bunch frequency multiplication", Phys. Rev. ST Accel. Beams 7, 040101 (2004).



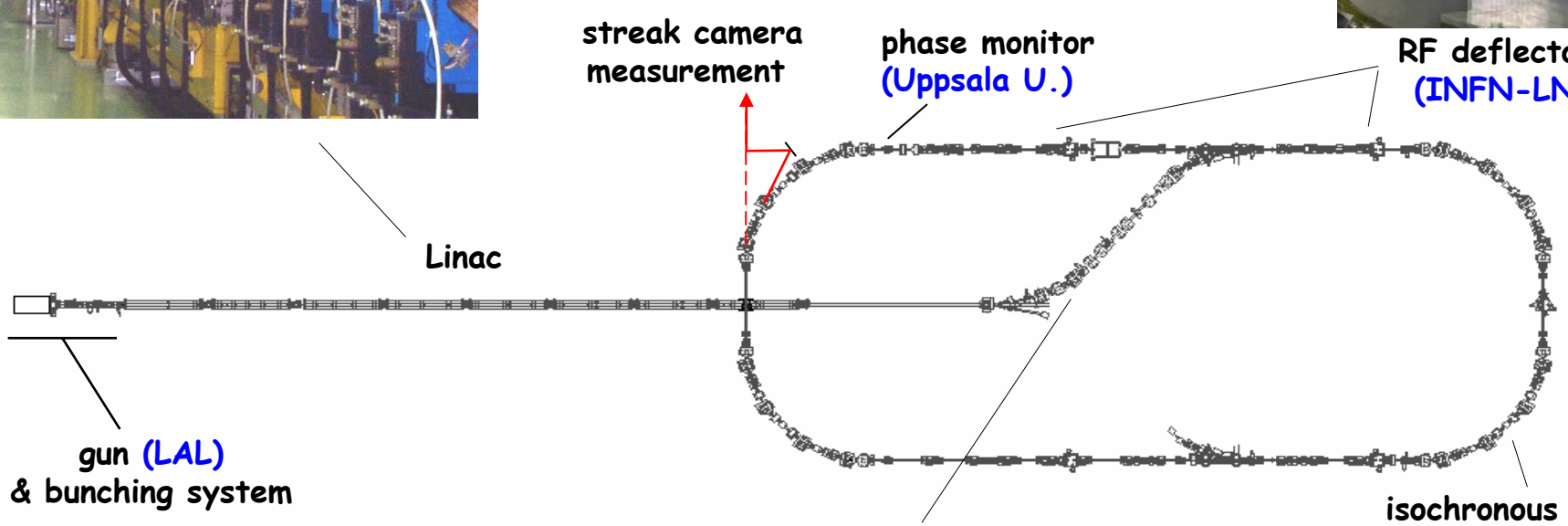


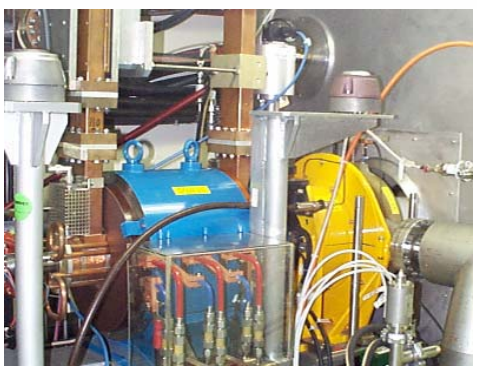
Beam parameters

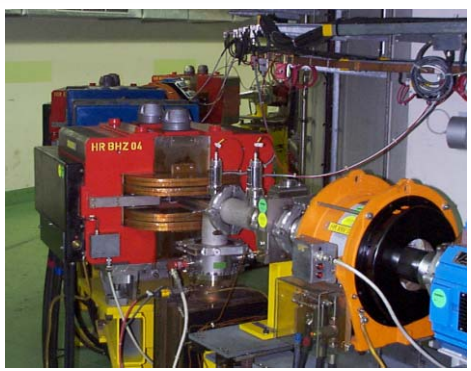
Bunch charge	0.1 nC
Beam energy	350 MeV
$\gamma\varepsilon_{x,y}$	25 π mm mrad
σ_t	< 7 ps
σ_E	~ 0.5 %

THE CTF3 PRELIMINARY PHASE (2001-2002)

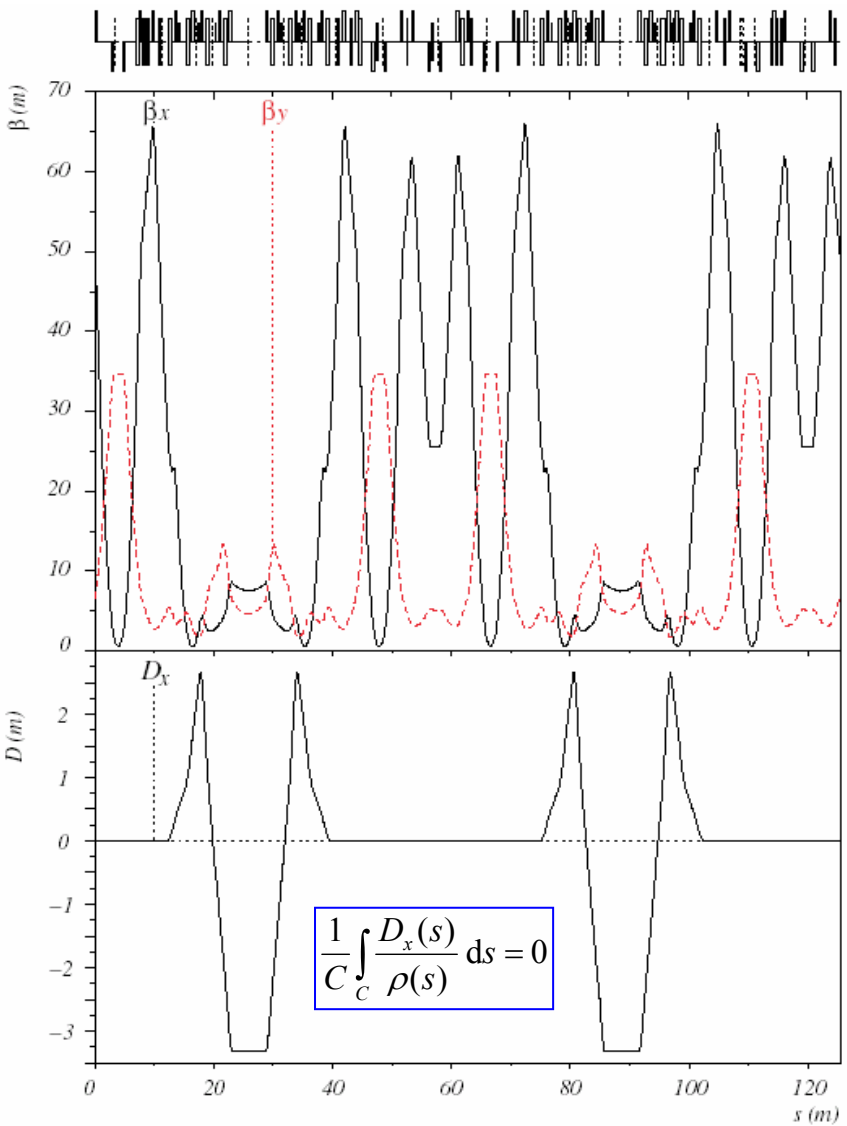
Modifications to the LEP pre-injector complex





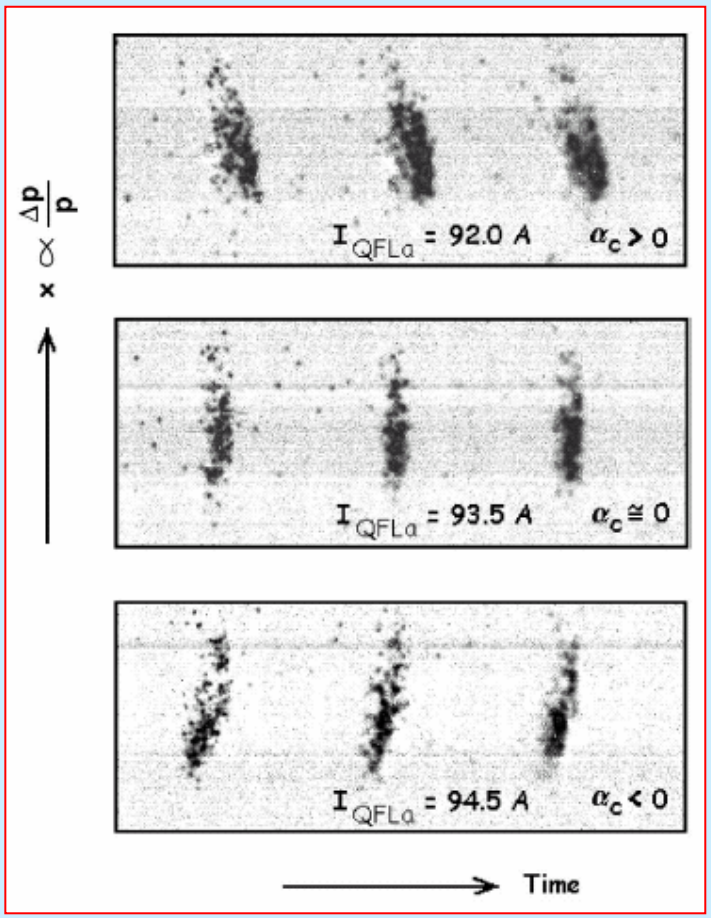


CTF3 PRELIMINARY PHASE - ISOCHRONICITY



Design optics of the isochronous ring

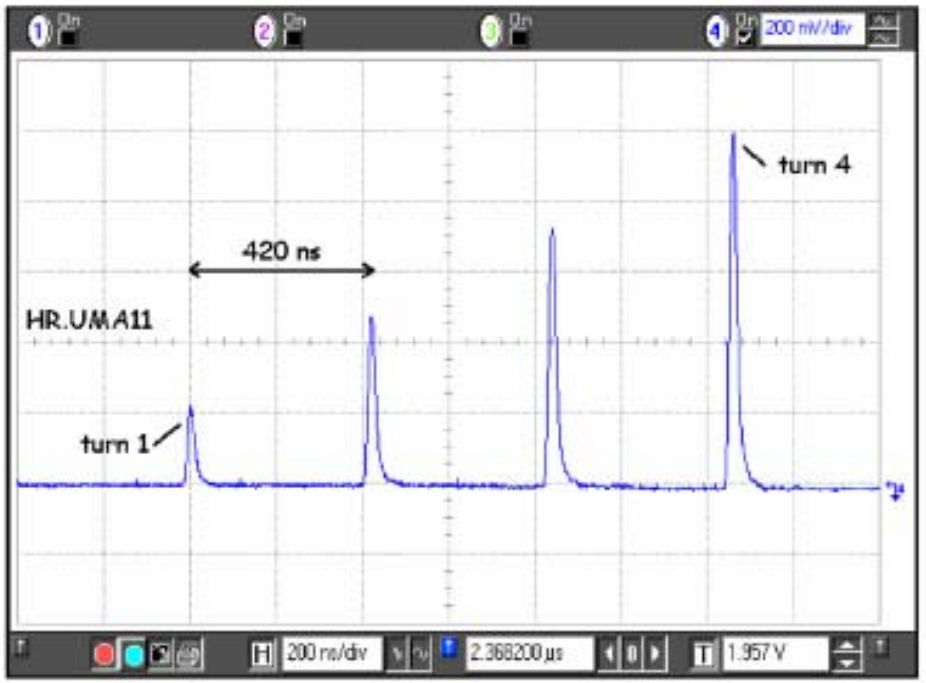
Transition from **positive to negative** momentum compaction α_c seen on streak camera images for different settings of one quad family.



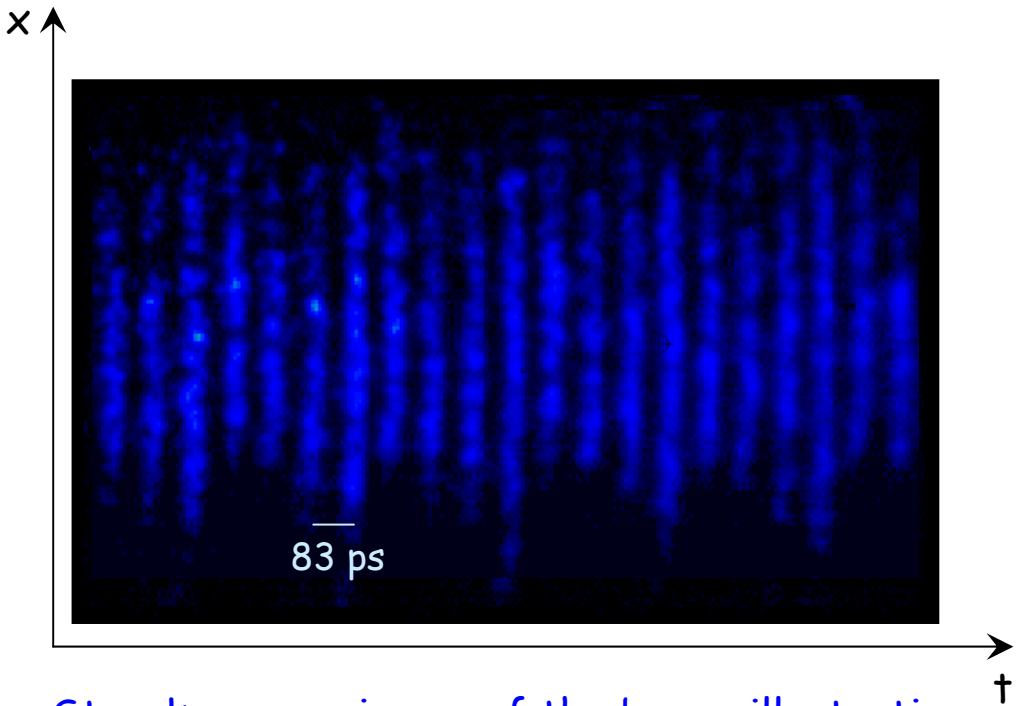
Images taken during the tenth turn at a location with nonzero dispersion. The horizontal position x is dependent on momentum, so the time-momentum correlation becomes apparent.

CTF3 PRELIMINARY PHASE – BUNCH COMBINATION

Combination factor 4

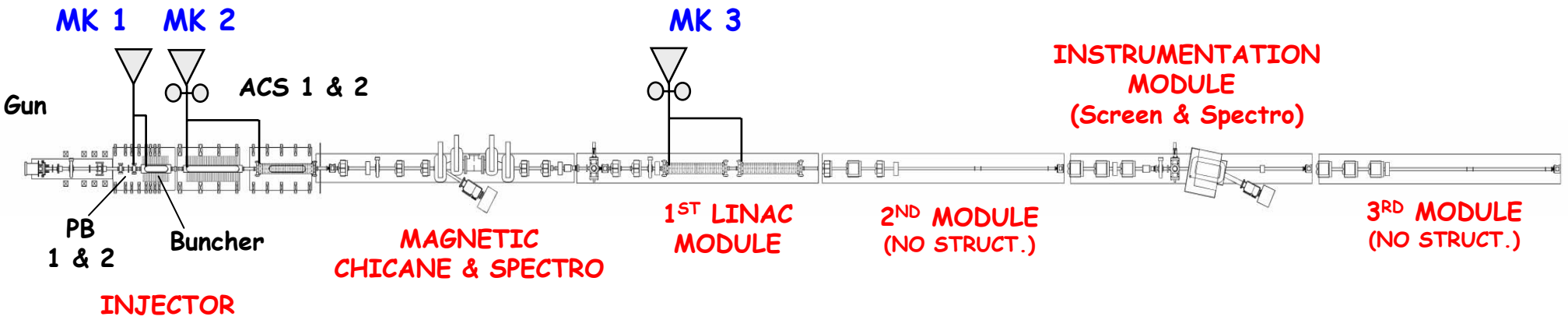


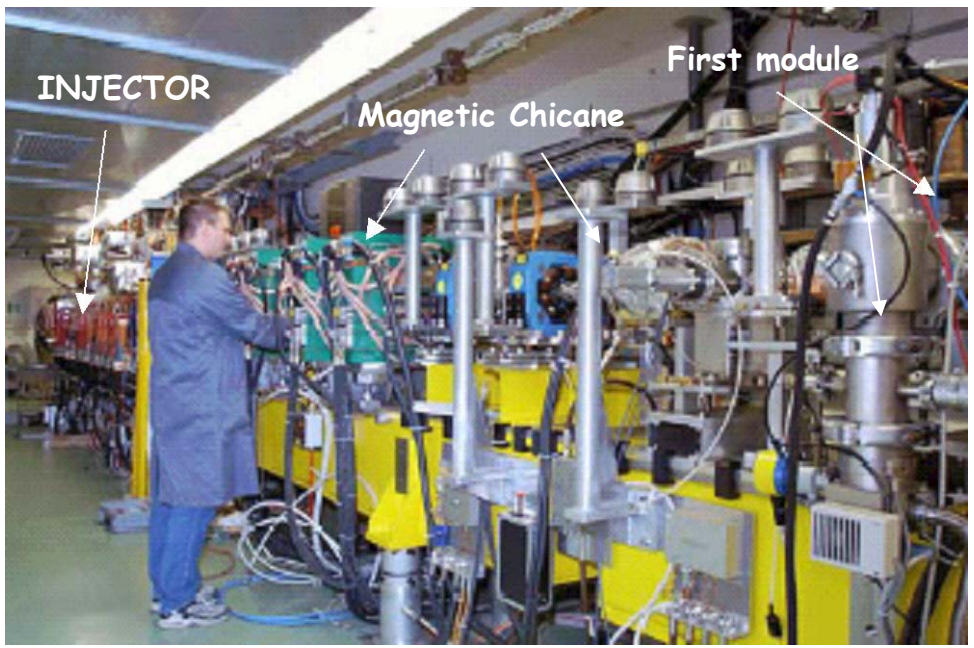
Beam current circulating in the ring measured during combination with a beam current monitor



Streak camera image of the beam, illustrating the bunch combination process

CTF3 COMMISSIONING 2003





CTF 3 during 2003 installation period

Main beam parameters

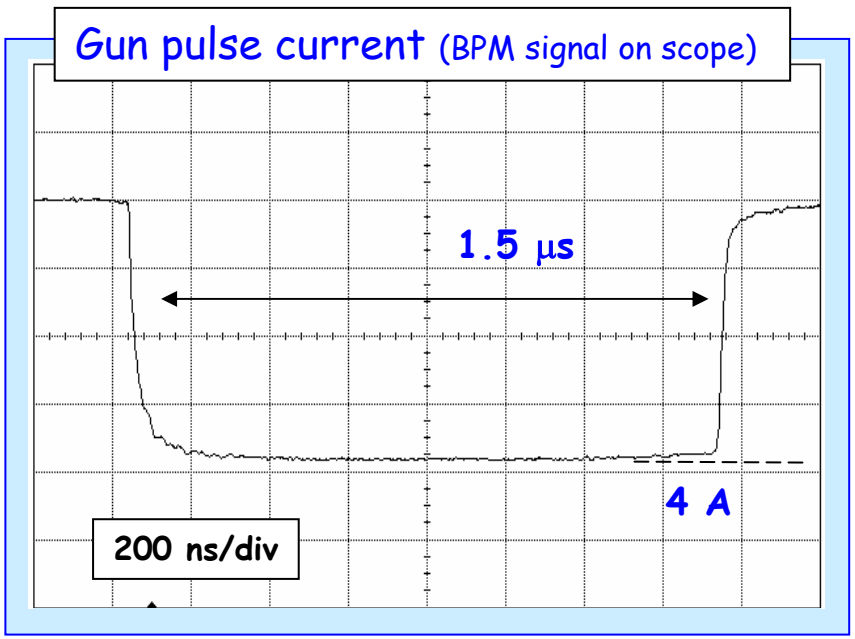
	Nominal	Achieved
I	3.5 A	5 A
τ_p	1.5 μs	1.5 μs
E	35 MeV	35 MeV
$\varepsilon_{n,rms}$	100 π mm mrad	~ 110 π mm mrad *
$\tau_{b,rms}$	5 ps	~ 4 ps *

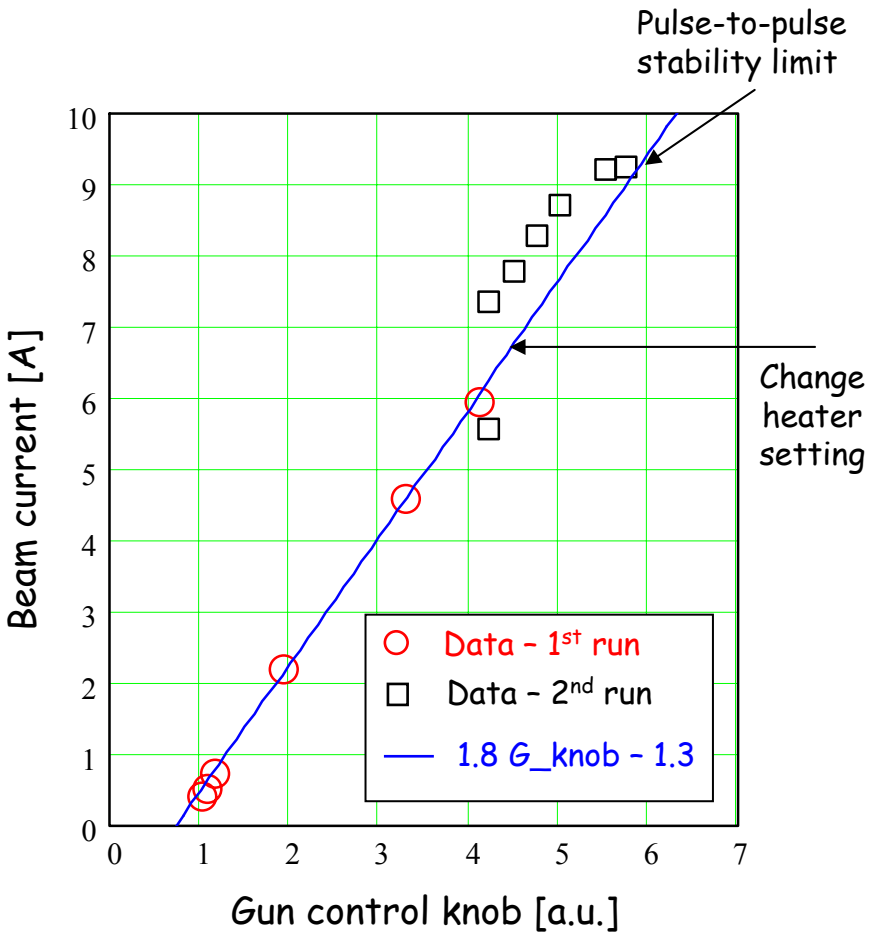
* Preliminary - for 3.5 A, 1.5 μs beam

CTF3 COMMISSIONING 2003 - GUN & TESTS

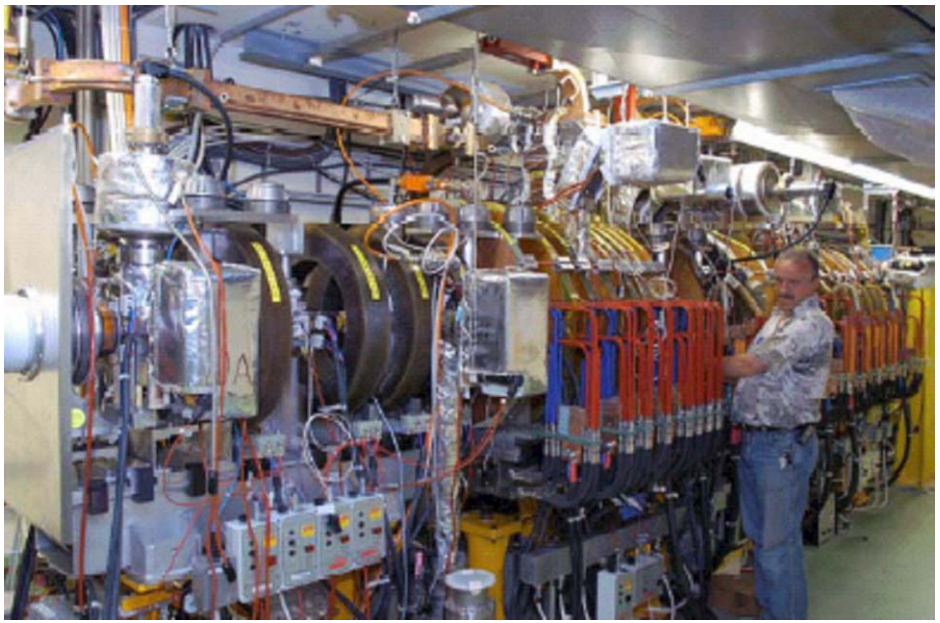
Max gun current	9 A
Max pulse length	1.5 μs

SLAC triode assembly
LAL HV deck, pulser, controls

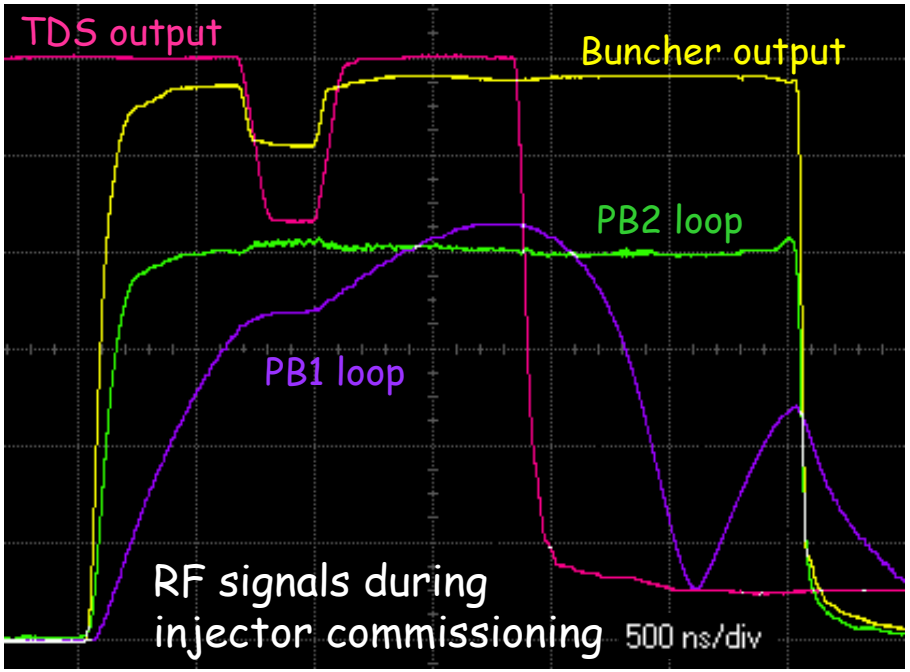


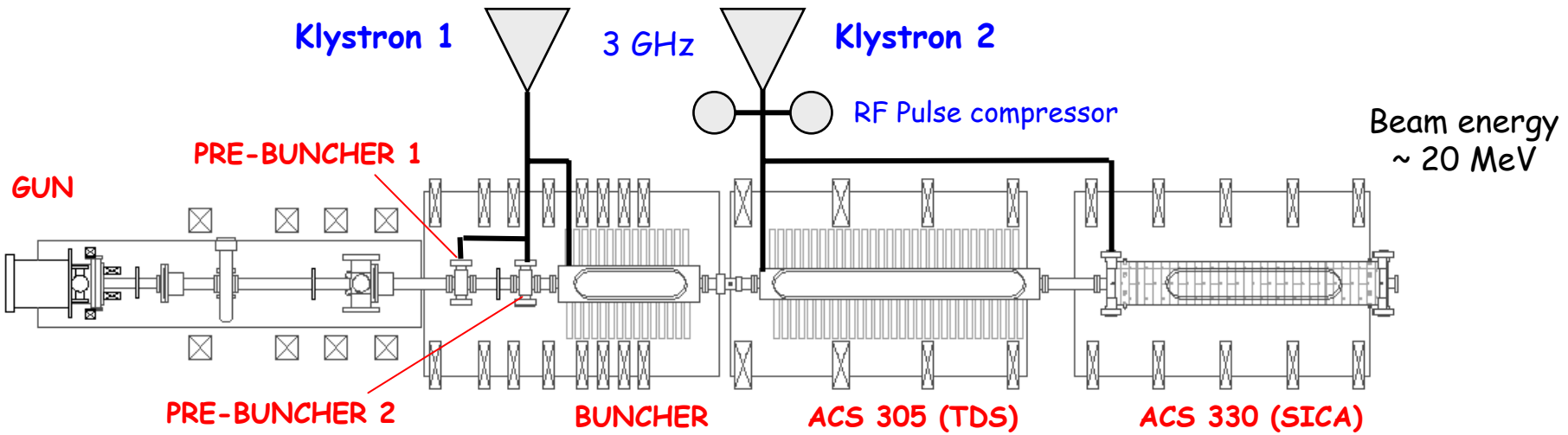


COMMISSIONING 2003 - THE CTF3 INJECTOR

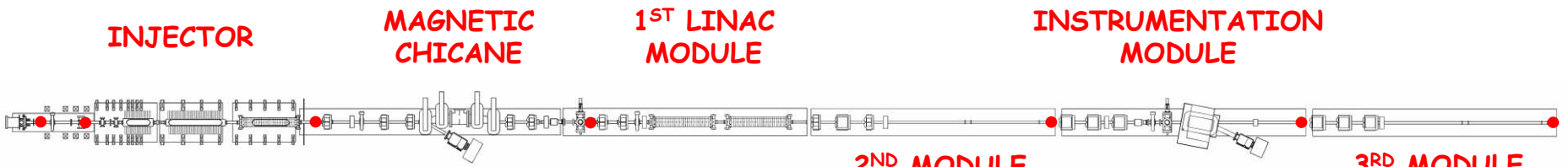


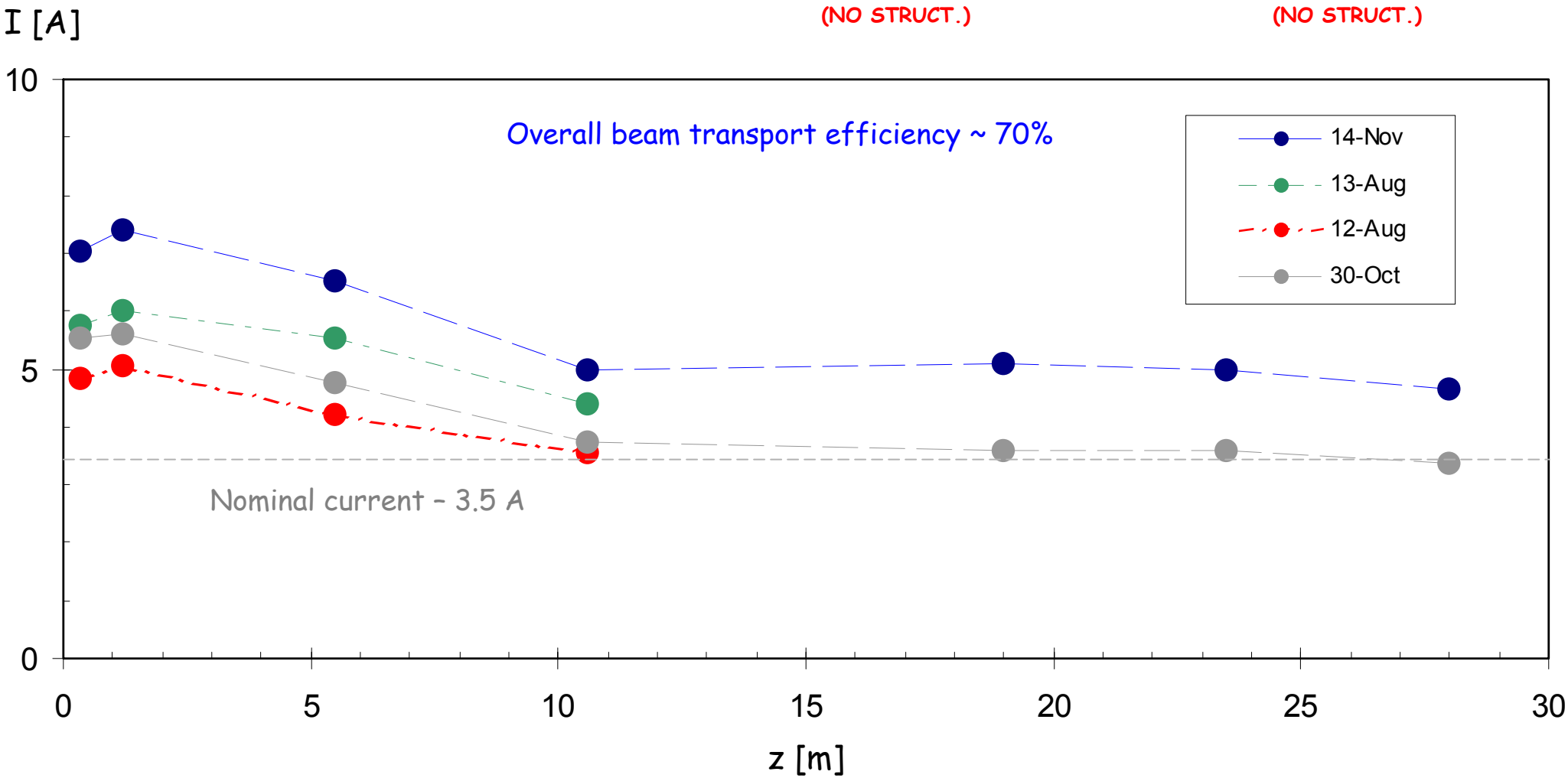
SLAC	design, simulations, commiss. support
LAL	PB1 & PB2, commiss. support
INFN/LNF	commiss. support



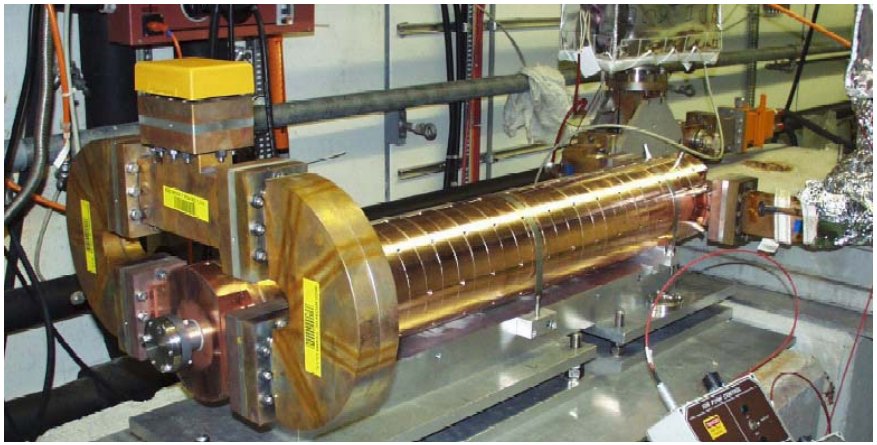


HIGH BEAM CURRENT OPERATION





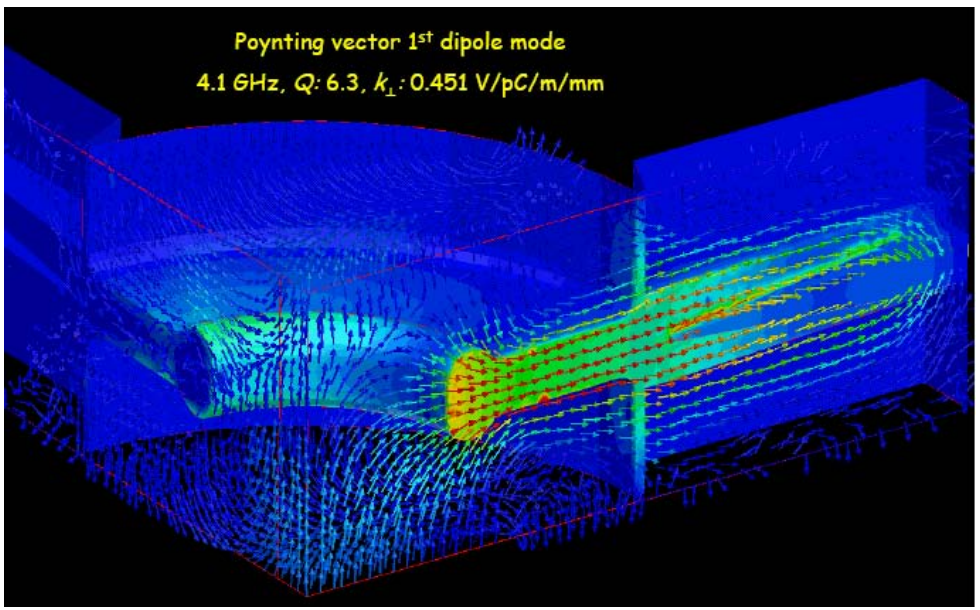
SLOTTED IRIS CONSTANT APERTURE (SICA) STRUCTURES

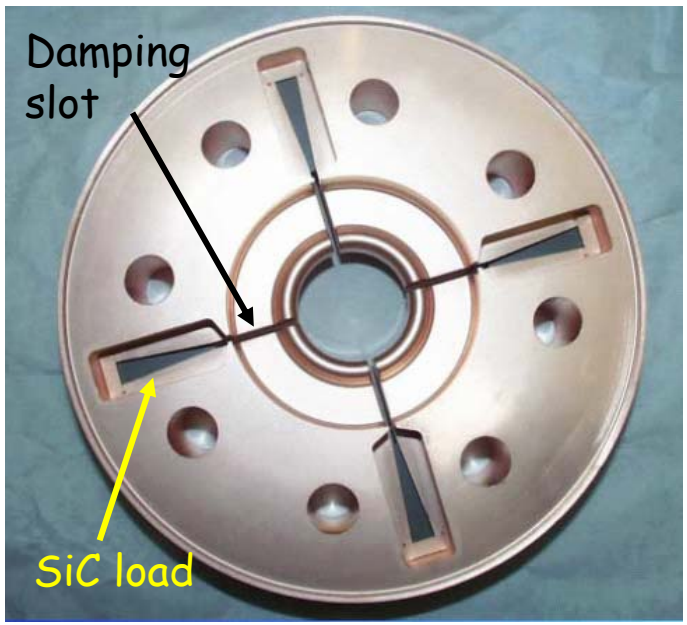


SICA Cavity during high power tests

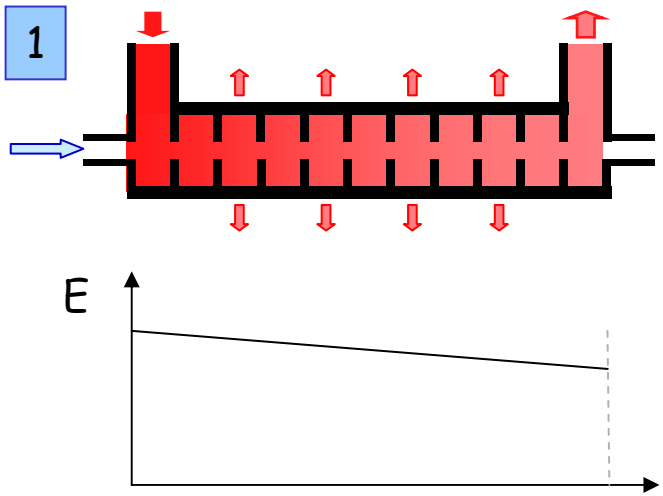
frequency	3 GHz
2π/3 mode	
total length	1.22 m
loaded gradient	6.5 MV/m (nominal current)

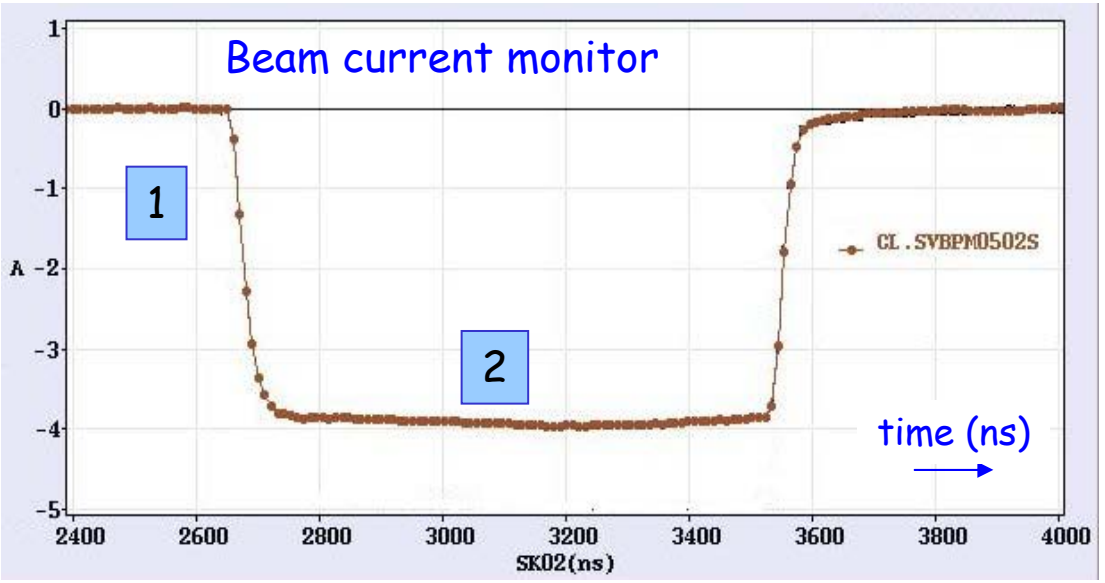
Dipole modes suppressed by slotted iris damping (first dipole's Q factor < 20) and HOM frequency detuning

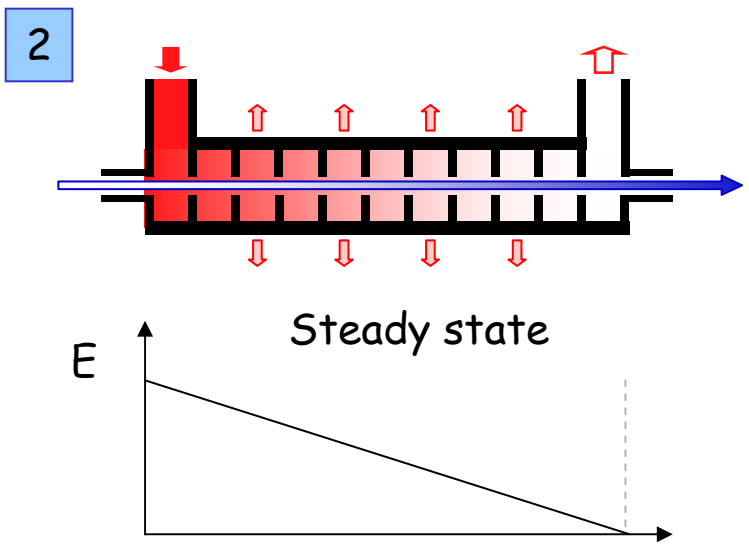


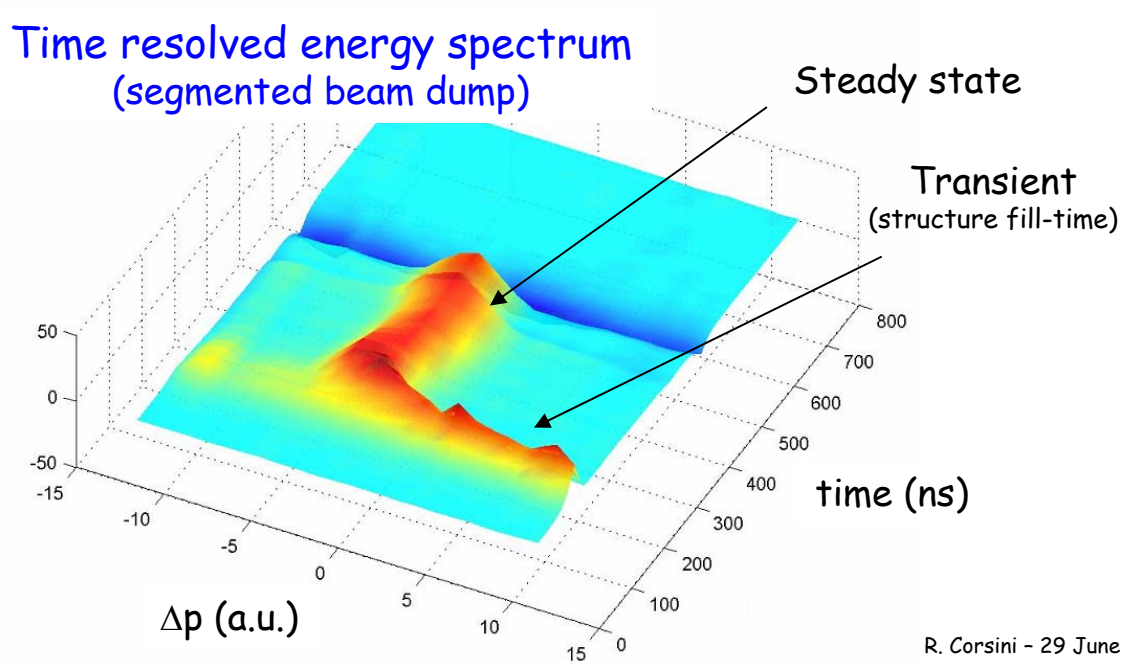


FULL BEAM LOADING – BEAM TRANSIENT

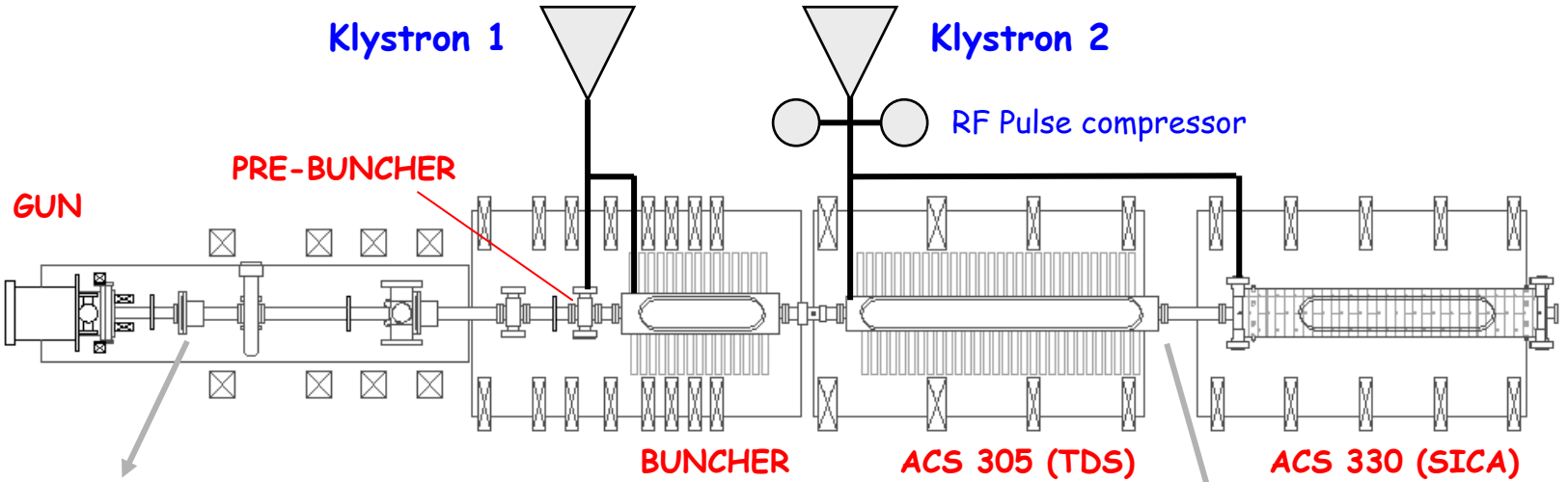


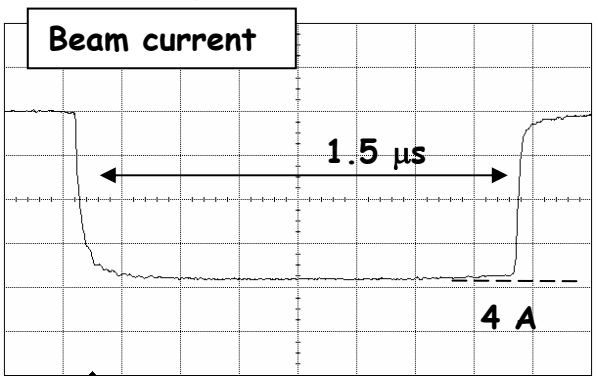




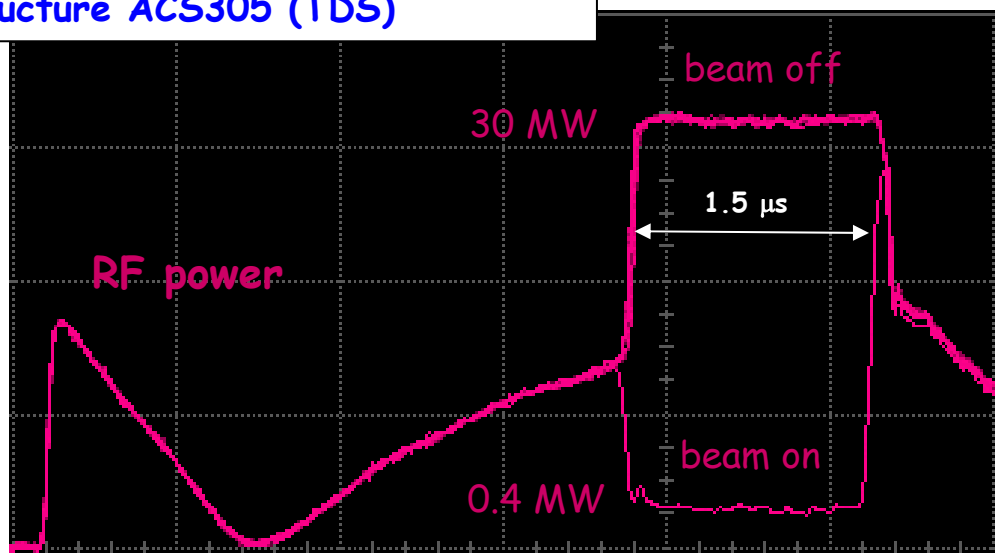


FIRST "FULL" BEAM LOADING OPERATION IN CTF3



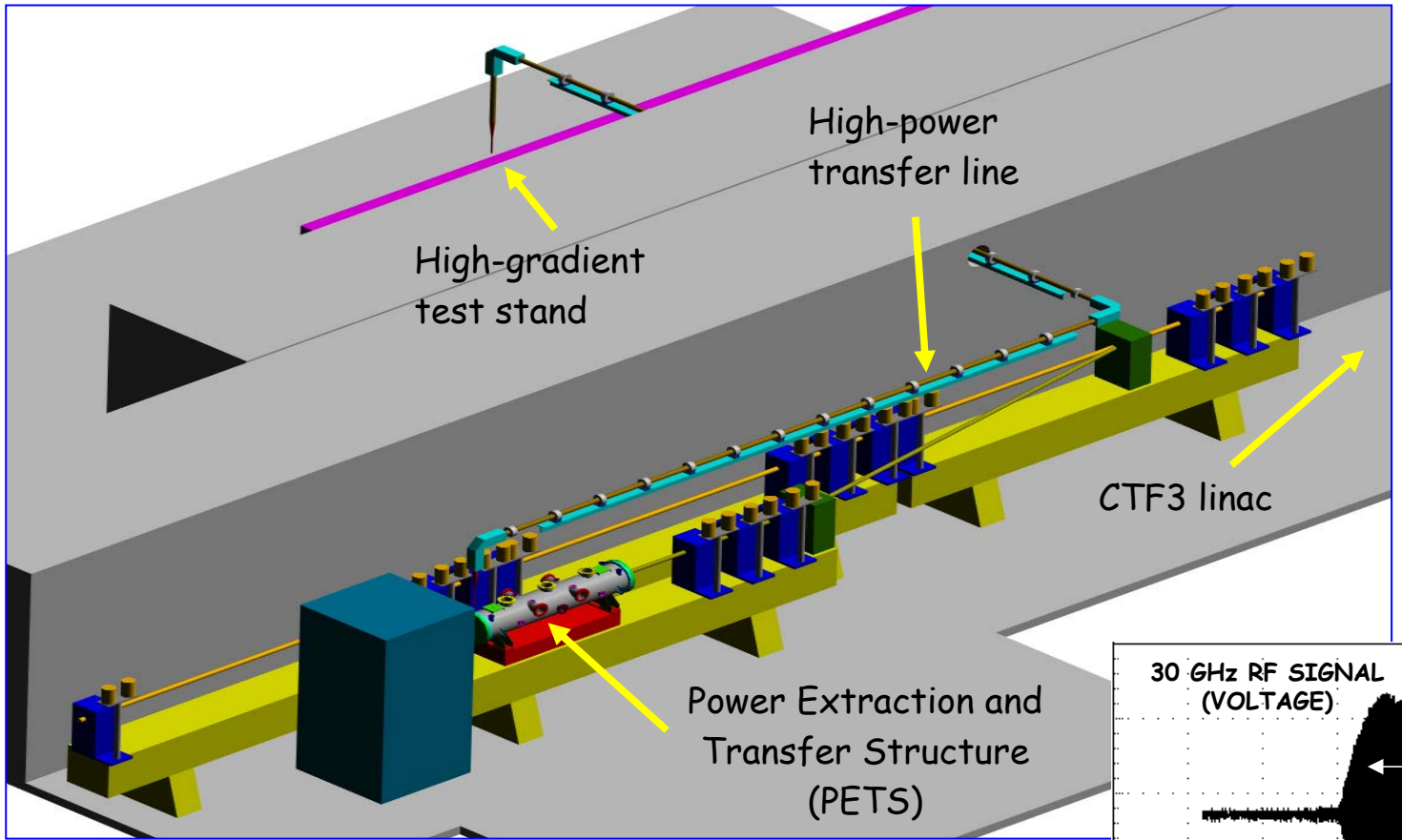


RF signals / output coupler of structure ACS305 (TDS)



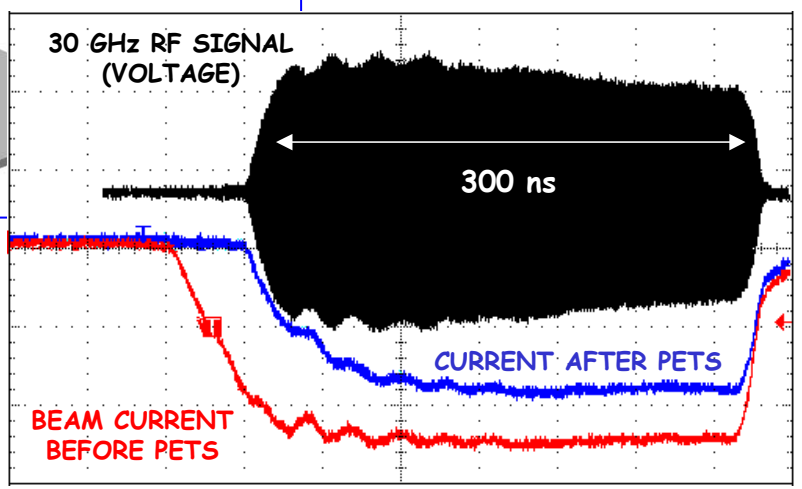
Beam current	4 A
Beam pulse lenght	1.5 μs
Power input/structure	35 MW
Ohmic losses (beam on)	1.6 MW
RF power to load (beam on)	0.4 MW
RF-to-beam efficiency	~ 94%

LAST CTF3 RESULTS – 30 GHZ POWER PRODUCTION



Two-beam 30 GHz power production in CTF3
June 2004

"short" PETS
$I \leq 1$ A
$P > 100$ kW



I. Syratchev, W. Wuensch

CONCLUSIONS AND OUTLOOK

CTF3 main results

Preliminary phase (2001-2002)

Low current demonstration of bunch frequency multiplication using RF deflectors

CTF3 injector and linac commissioning (2003-2004)

Nominal parameters achieved in injector and first part of linac

Stable operation in full beam loading condition

First production of 30 GHz RF power beyond CLIC nominal pulse length

CTF3 Evolution over the next years

- 2003 Injector + part of linac
- 2004 Linac + 30 GHz test stand
- 2005 Delay Loop
- 2006 - 2009 New photo-injector, CR + CLEX