CTF3 COMMISSIONING STATUS

OPERATION AND PERFORMANCE IN 2005

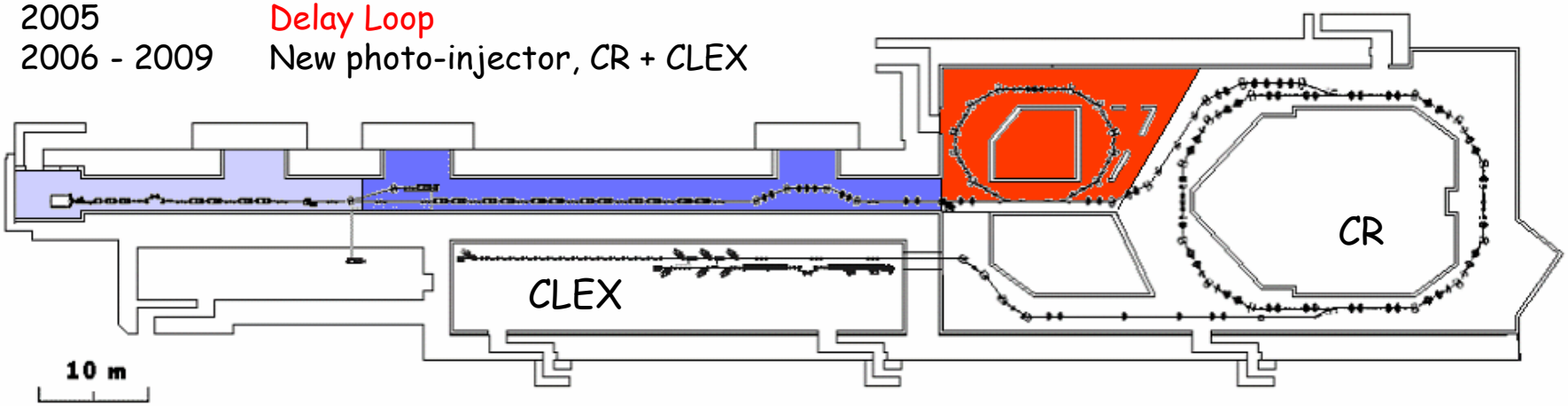
R. Corsini for the CTF3 team

Outline

- CTF3 Status in 2004
- Commissioning & operation program in 2005
- Overview of 2005 runs – main results

CTF3 evolution & past results

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



CTF3 Evolution

CTF3 main results until last year

Preliminary phase (2001-2002)

Low current demonstration of bunch frequency multiplication using RF deflectors

CTF3 injector commissioning (2003)

Nominal parameters achieved in injector and first part of linac

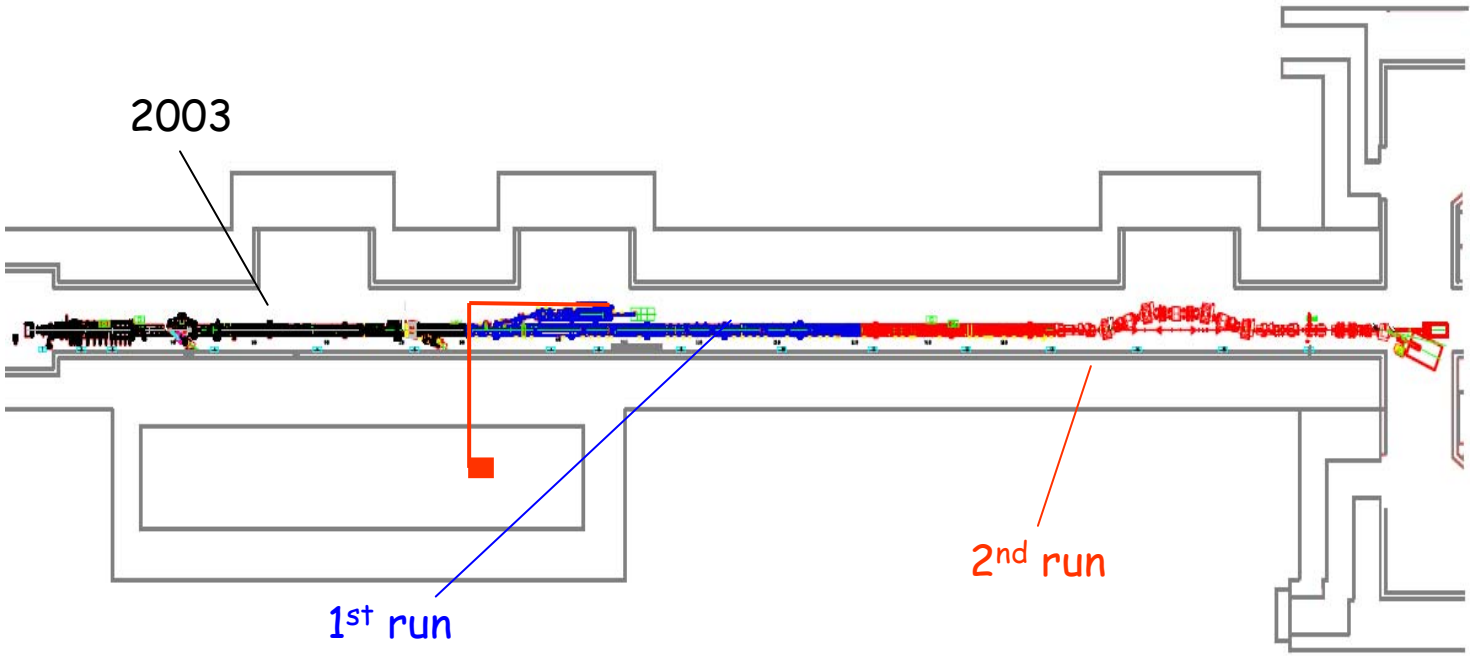
Stable operation in full beam loading condition, high beam current

Linac and chicane commissioning, 30 GHz high-power test stand (2004)

Nominal current at the end of linac, tunable R56 chicane commissioning, bunch length measurement by RF deflector

Production & tranport of 30 GHz RF power (50 MW, 70 ns)

CTF3 status in 2004



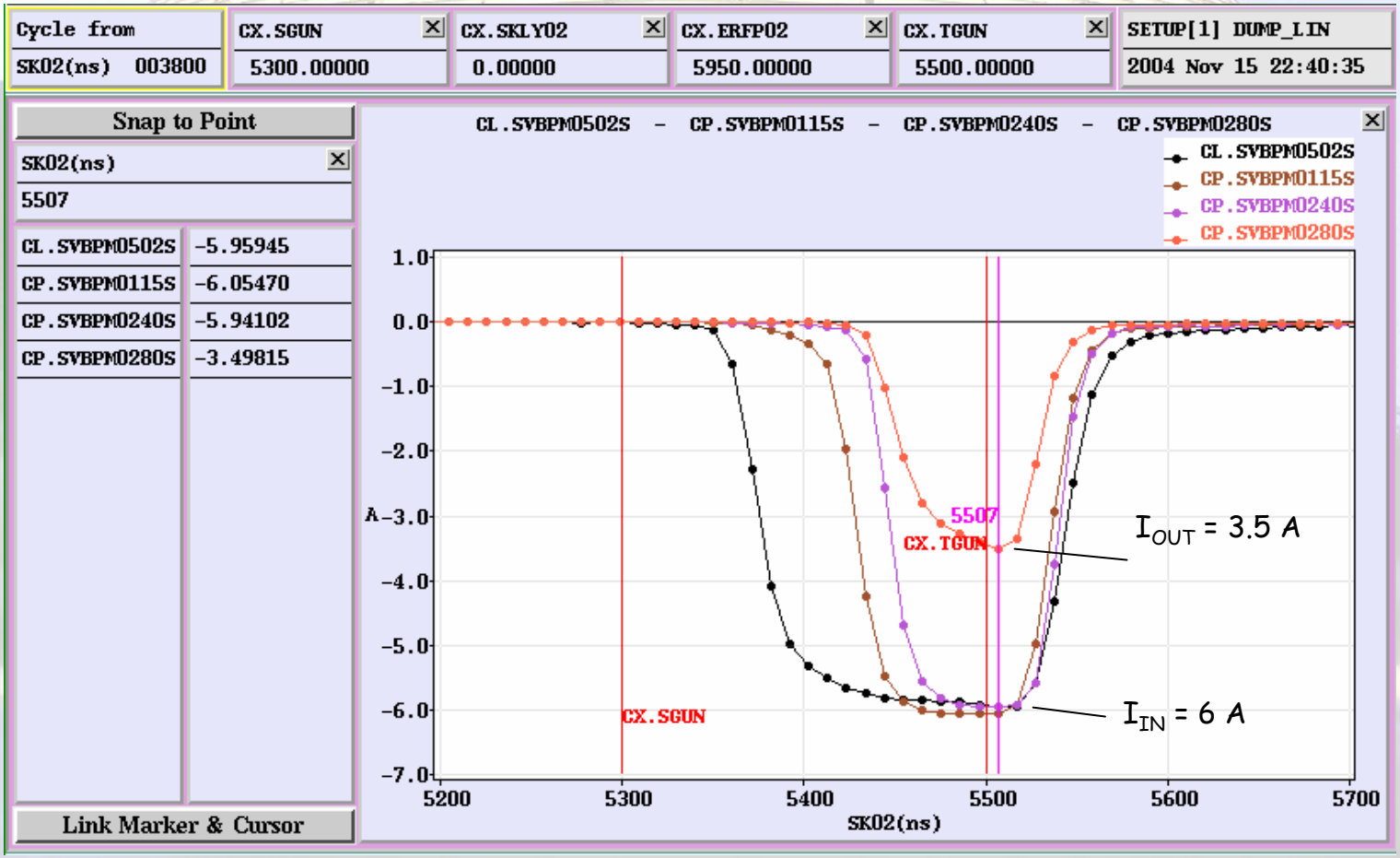
- Commissioning of additional linac modules (four accelerating structures)
- Test of 30 GHz power production ("short" PETS)

- Commissioning of rest of linac, chicane and final instrumentation section
- 30 GHz power production, full PETS and high power RF transfer line

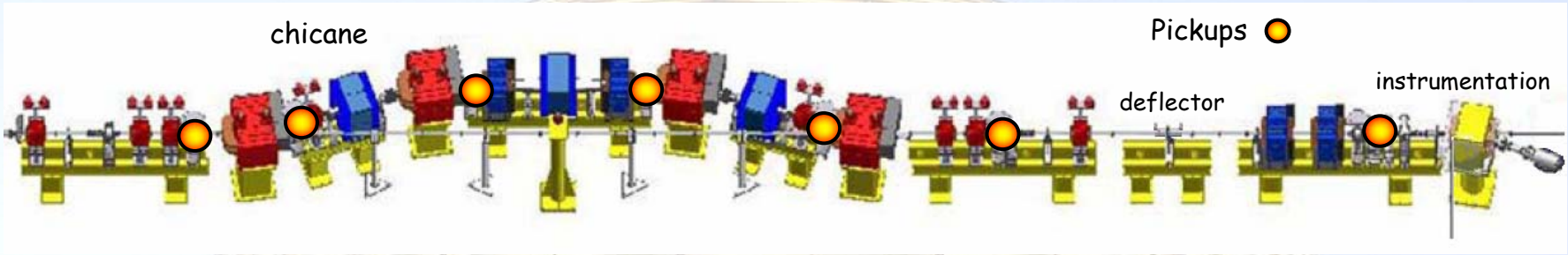
30 GHz power production - 2004

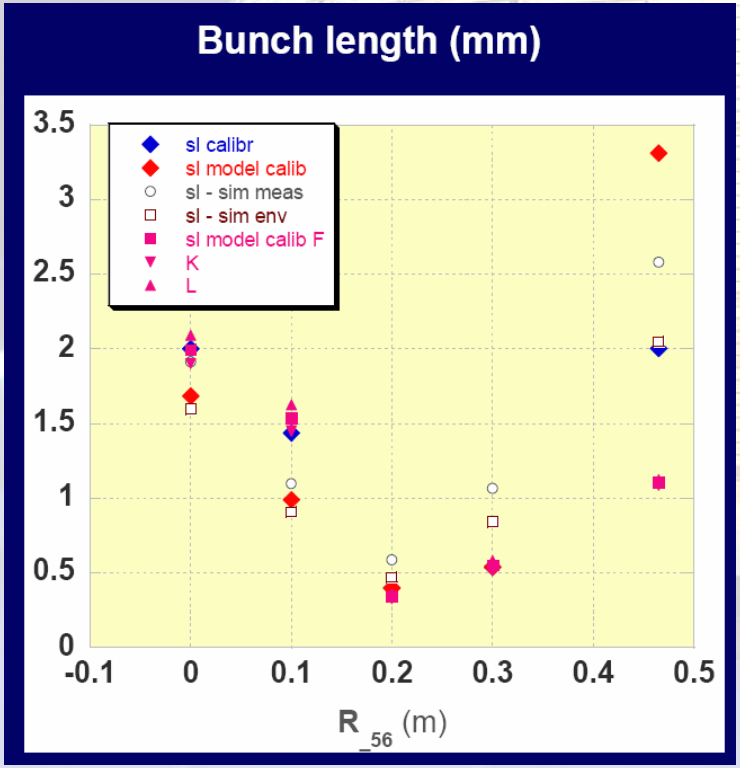
- PETS & high power transfer line installed
- RF Power to load (not yet accelerating structures)

Design values for 5 A beam current ⇒ 95 MW from PETS ⇒ 70 MW @ load

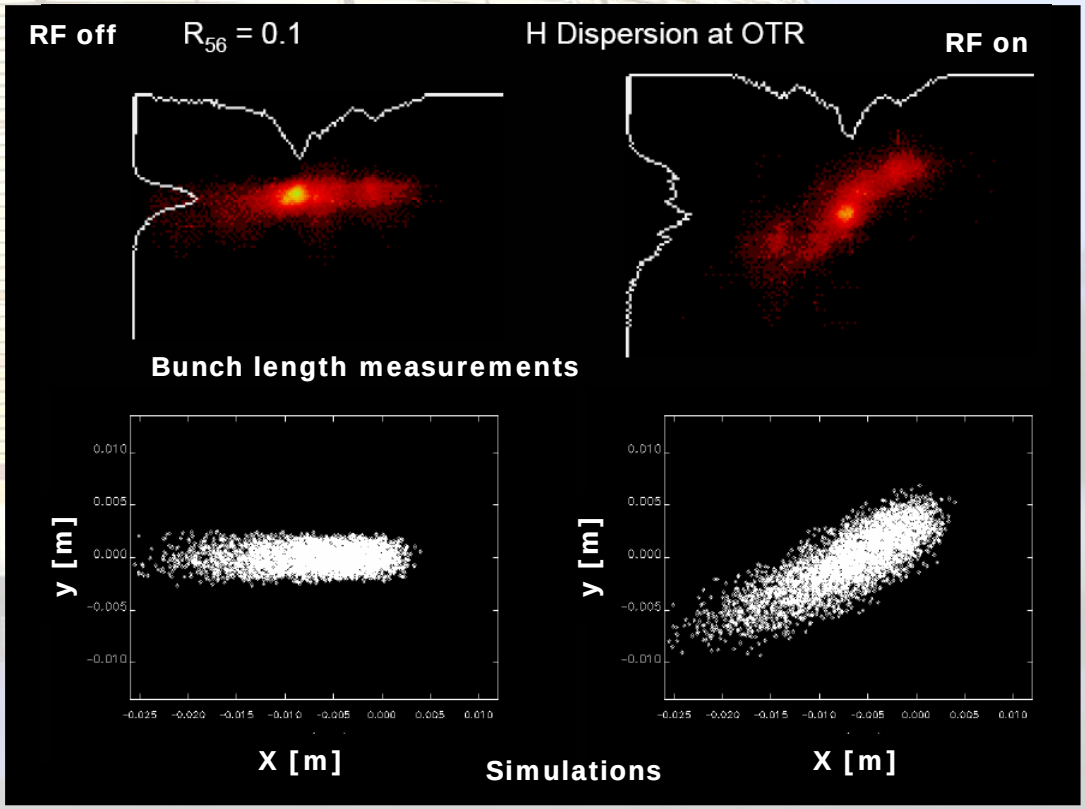


Chicane optics & bunch length measurements - 2004





C. Biscari - INFN



Commissioning & operation program 2005

- 30 GHz power production operation for accelerating structure test

  Aim: produce 75 MW pulses with duration above 70 ns, 50 MW delivered to a Mo-iris test accelerating structure, to reach the nominal CLIC gradient (150 MV/m).

- Commissioning of Delay Loop

- Commissioning of modified injector (SH bunching system and bunch phase coding)

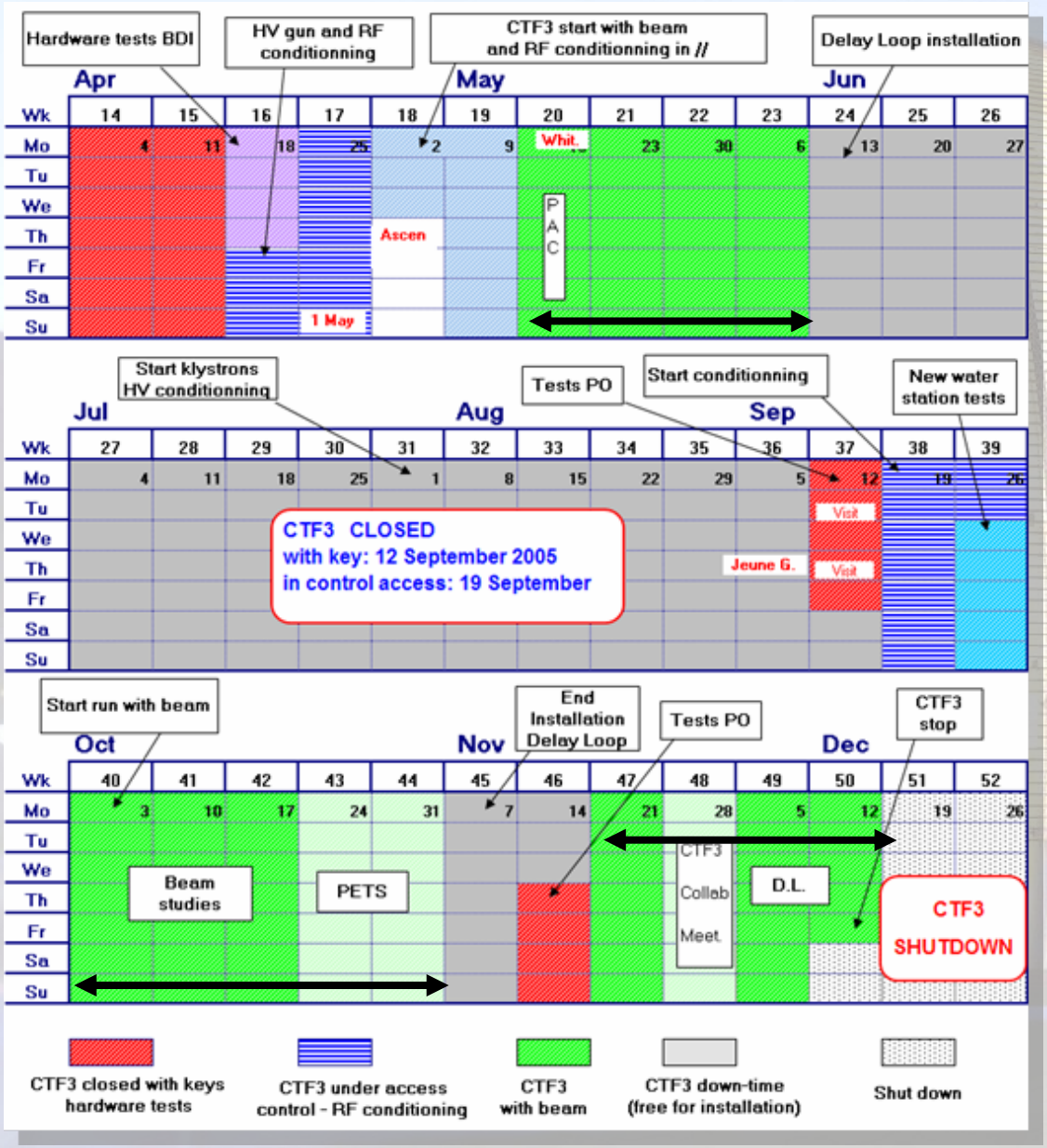
- 30 GHz RF pulse compression studies

  Long pulse from PETS, beam studies on phase jump suitable for RF pulse compression, pulse compressor conditioning.

- Continuation of CTF3 beam studies

  Emittance optimization, linac trajectory, bunch compression/lengthening, direct measurement of longitudinal phase space, RF-to-beam efficiency of high beam loading operation

2005 schedule



- Two runs:
  - 17 May – 10 June
  - 3 Oct – 16 Dec
- (Long) summer shut-down for installation
- Two week interruption during second run, to "complete" DL installation
- A total of ~ 13 weeks of beam operation
- Operation mainly during working days, but
- Several night & week-ends shifts for 30 GHz structure tests – precious help (two operators on shift) from Ankara U.
- Indeed, operation was much less limited by manpower than last year. New operators/machine experts were successfully trained.

1st run – 30 GHz production & structure tests

The first 2005 run was fully dedicated to Mo iris structure test, only partly satisfying:

About 25 MW (100 MV/m) with 30 ns long pulses reached

PROBLEMS

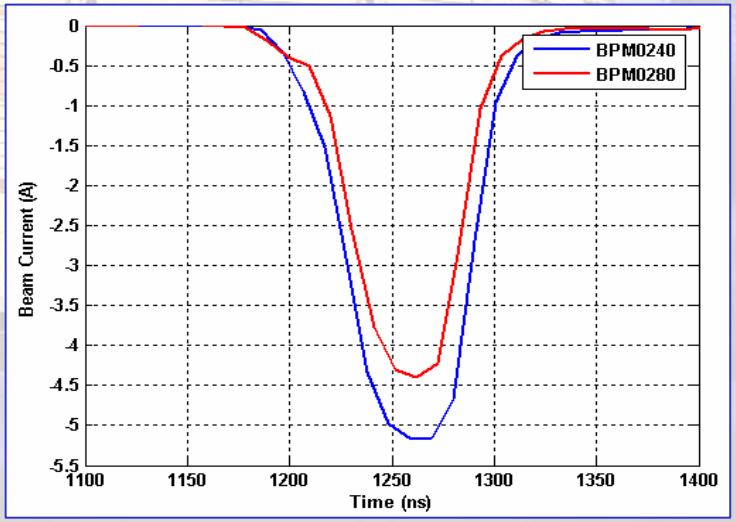
- Short run time – no time for beam measurements and re-matching
- Coupled beam setting-up and conditioning of both PETS and accelerating structure
- Reliability and availability problems
- Stability problems (slow drifts, beam jitter)
- Radiation issues

2nd run – 30 GHz production & structure tests

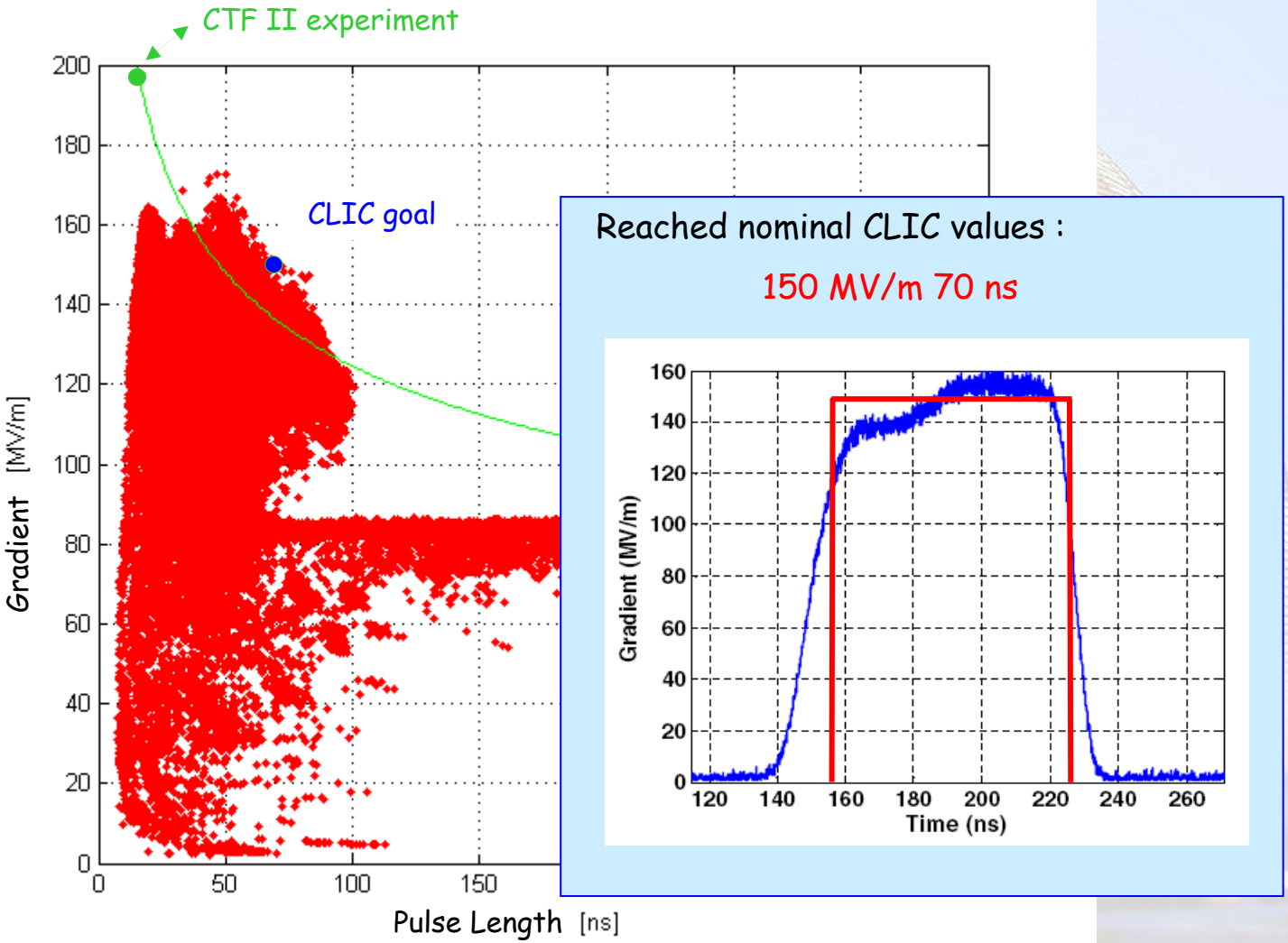
In the second 2005 run, several improvements have been made:

- Variable attenuator in the 30 GHz line allowed to (partially) decouple beam operation and PETS/accelerating structure conditioning
- Improved reliability (mainly klystrons)
- Stability problems:
  - Temperature stabilization of RF pulse compressors – also improves availability !
  - Re-optimized gun working point
  - Ripples from some power supplies stabilized
- Dedicated time for beam studies (better emittance, good beam knowledge)
- Beam loading compensation to minimize beam losses and radiation issues
- Improved diagnostics (screens, spectrometers)

- Produced about 90 MW with a 5 A beam
  (pulse length limited by PETS and structure breakdown)
- About 70 MW delivered to test structure
- Machine stable, routine operation possible
- Improved beam transmission through PETS
  (85 – 90 %)



2nd run – 30 GHz production & structure tests



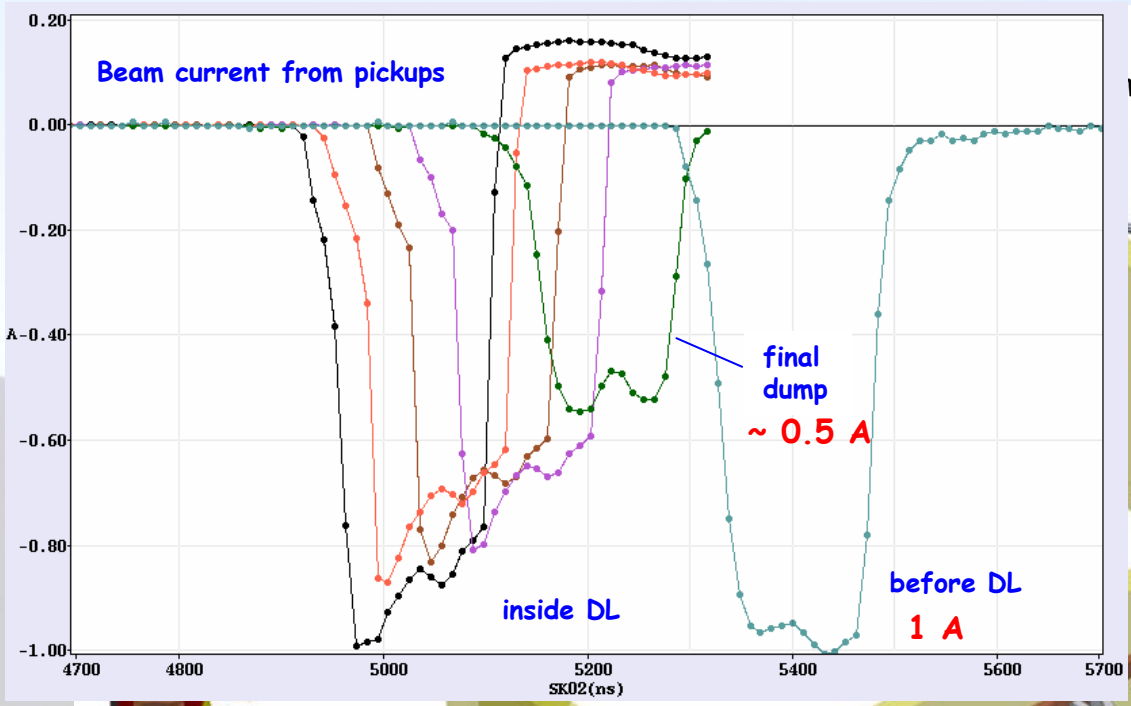
Reached nominal CLIC values :

150 MV/m 70 ns

Commissioning of Delay Loop

- Missing instrumentation: only 7 BPIs installed (one in CT line, 6 in DL)
- One BPI not working properly (5 available inside DL)
- Beam limited to low current (1 A), short pulse (300 ns) for radiation protection
- No Twiss parameter measurements (quad scans) done before sending beam (timing/software problems with cameras – frame grabber)
- Initial matching based on initial condition measured in injector for higher current beam (worked well in the linac)
- Relaxed optics in chicane and Delay Loop (non-isochronous in both). DL optics later modified experimentally to maximize transmission

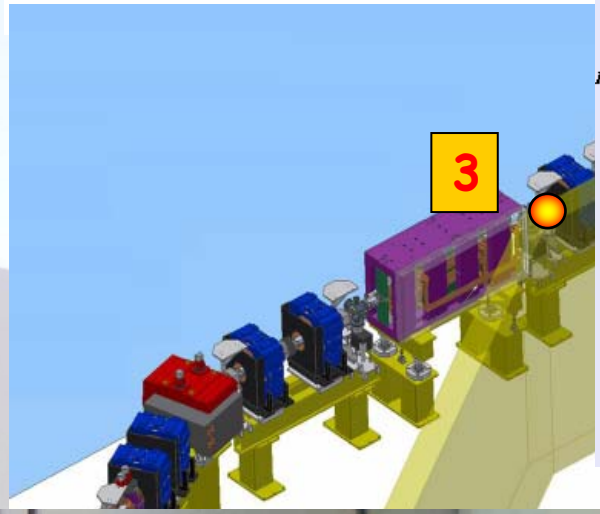
First beam circulating in the Delay Loop

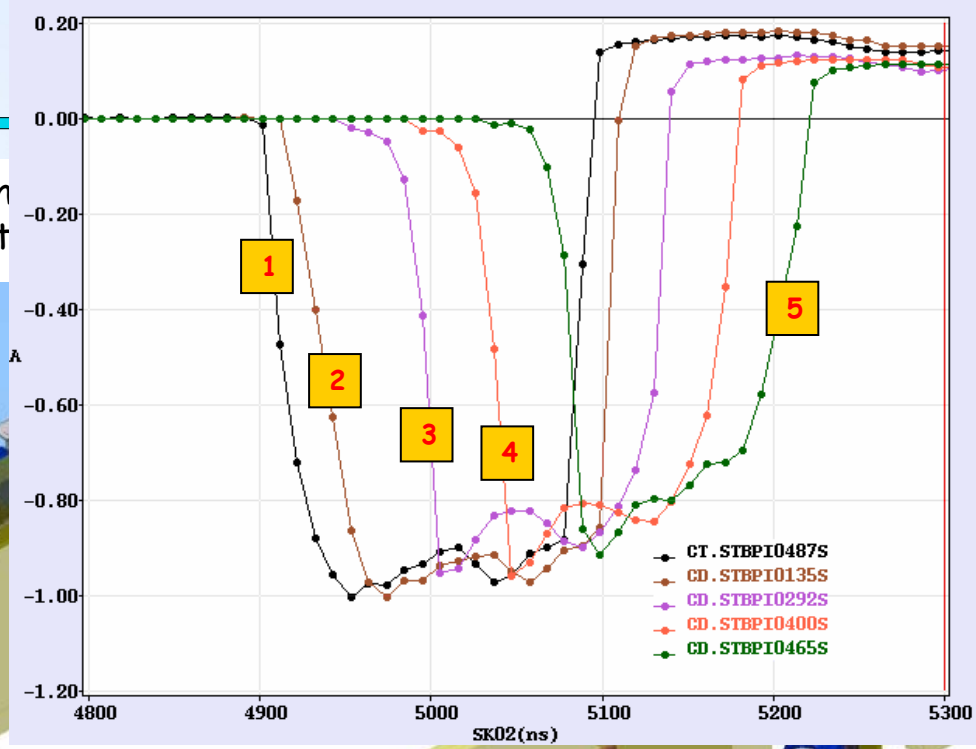


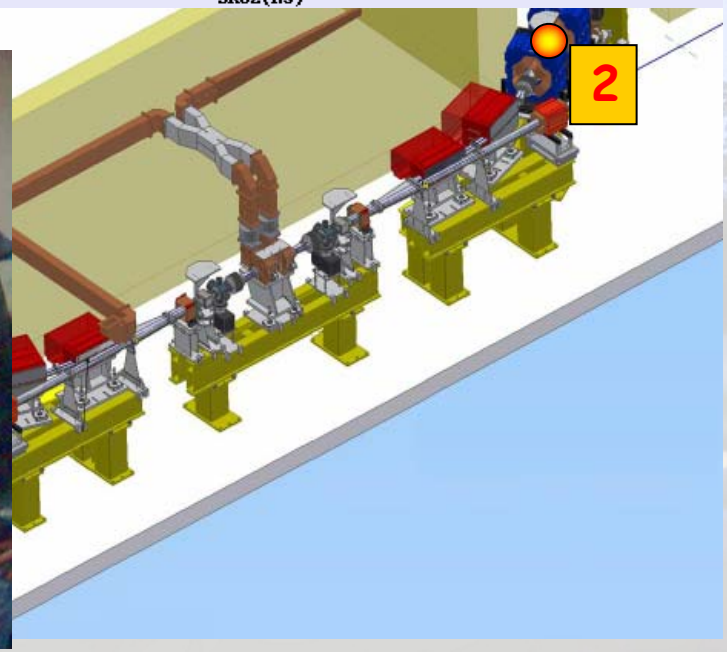
nagnetic injection, with dipoles)

Losses

Next day, obtained a better tran
optics (but more problems at ext

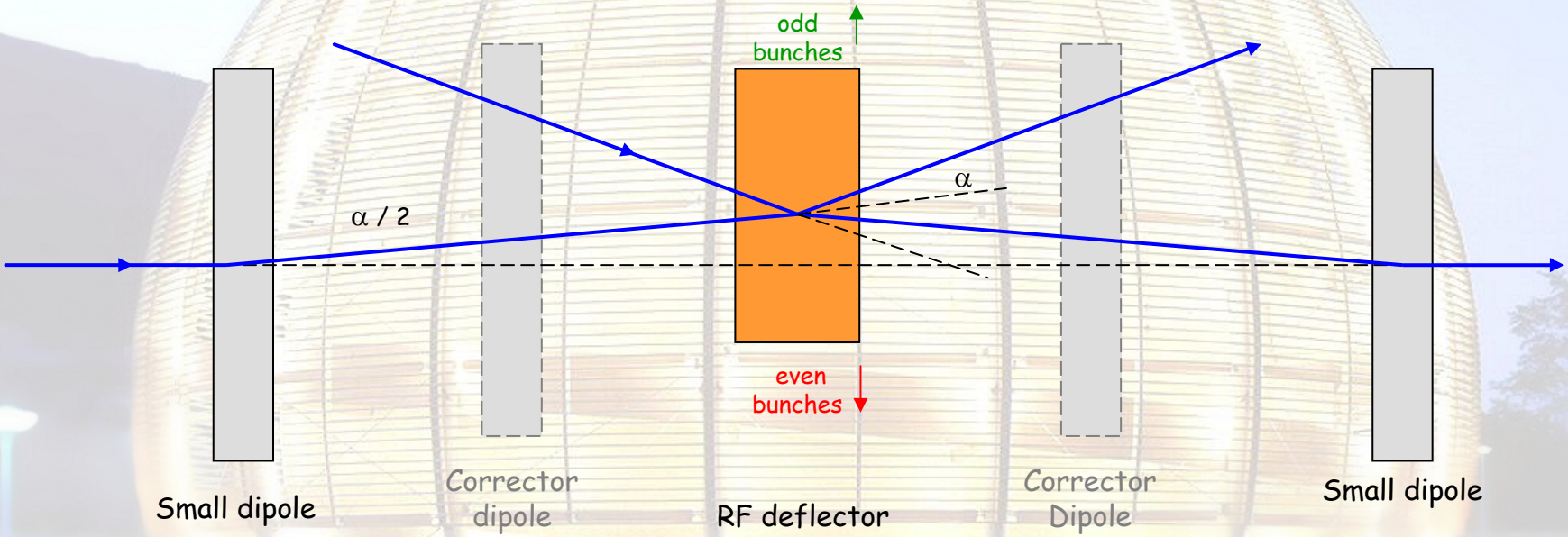






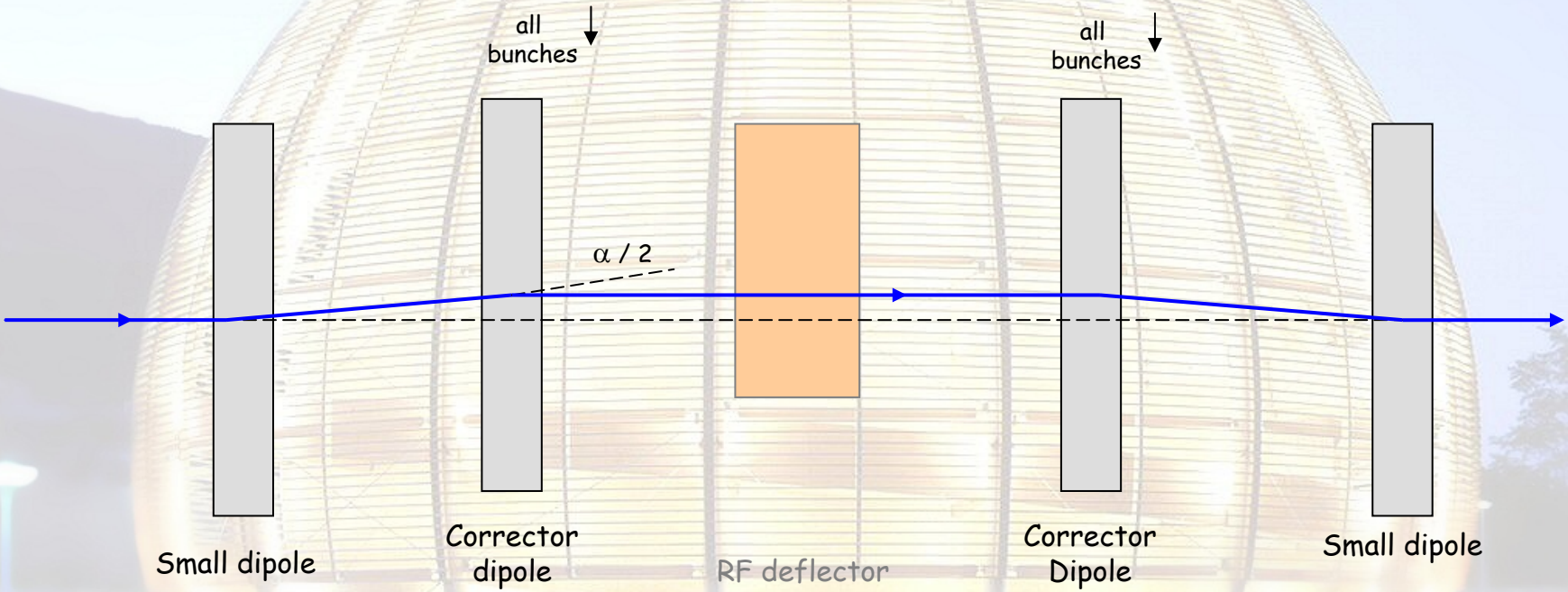
Delay Loop injection region (I)

Nominal RF injection



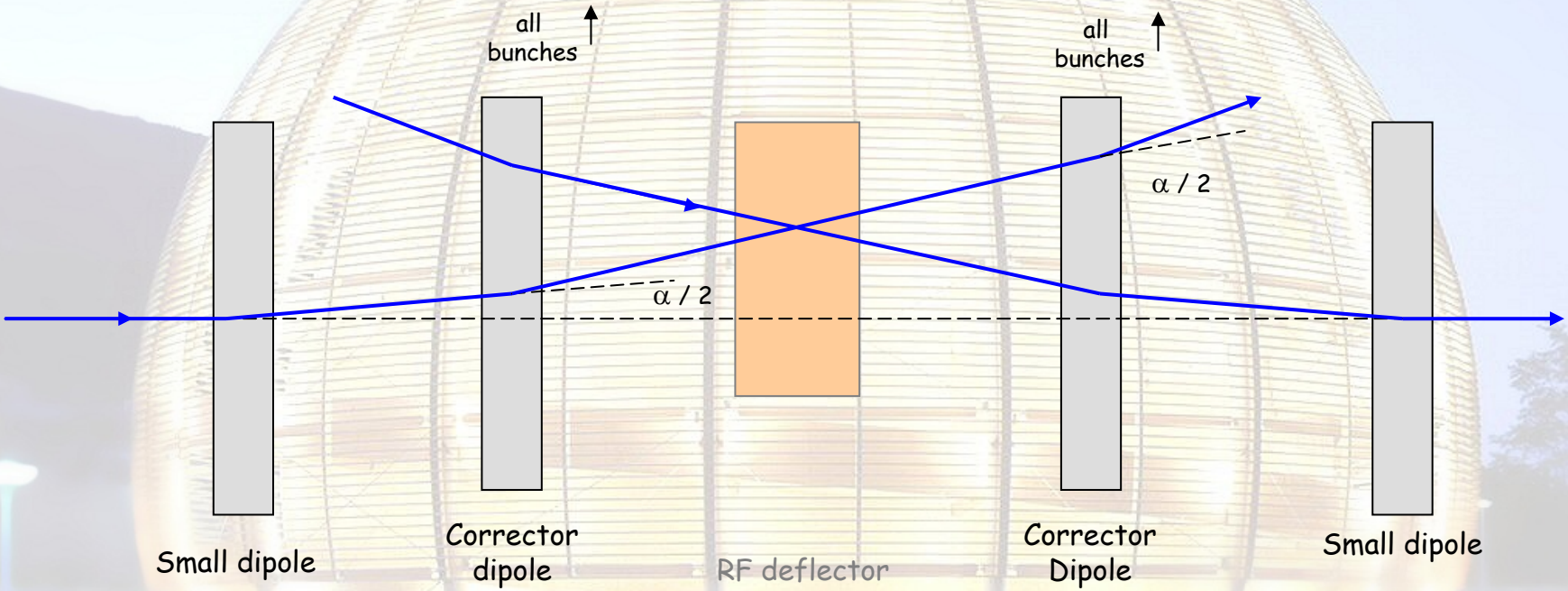
Delay Loop injection region (II)

Magnetic bump

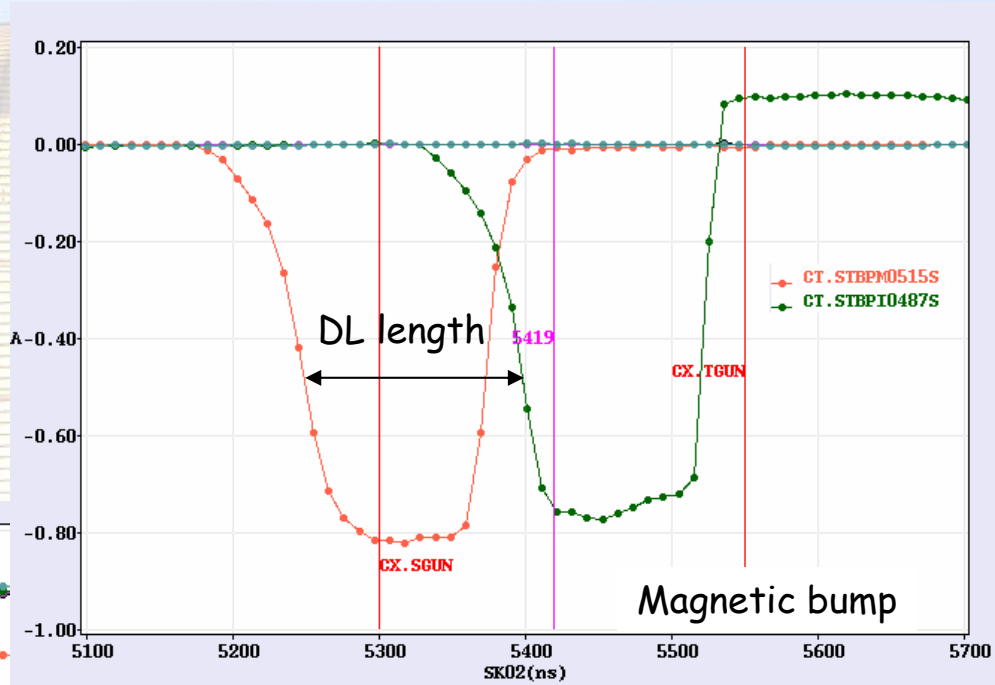


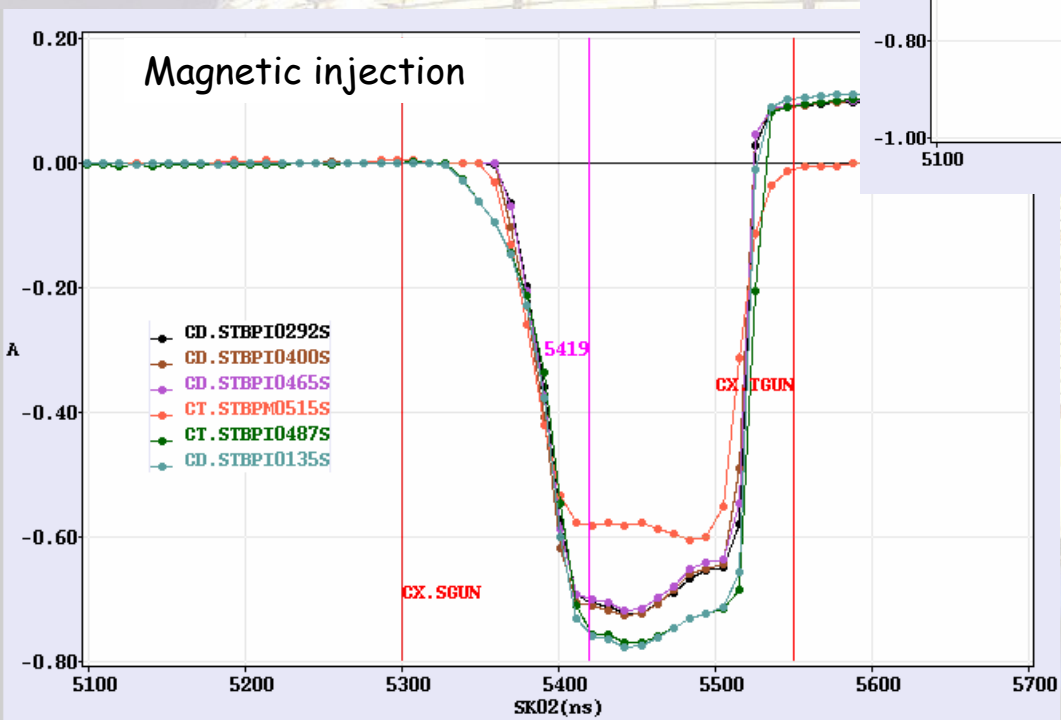
Delay Loop injection region (III)

Magnetic injection

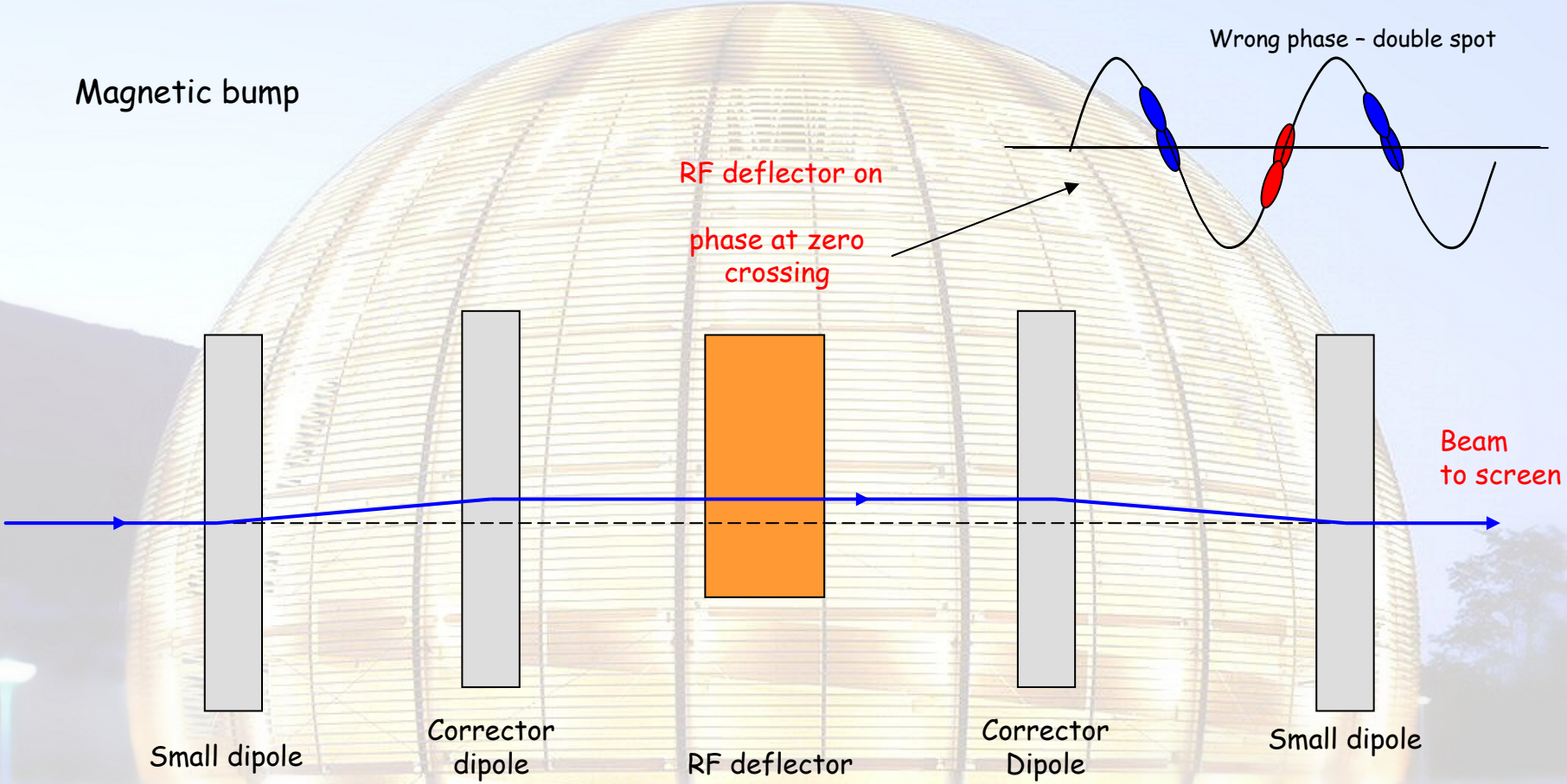


Delay Loop – bump or magnetic injection



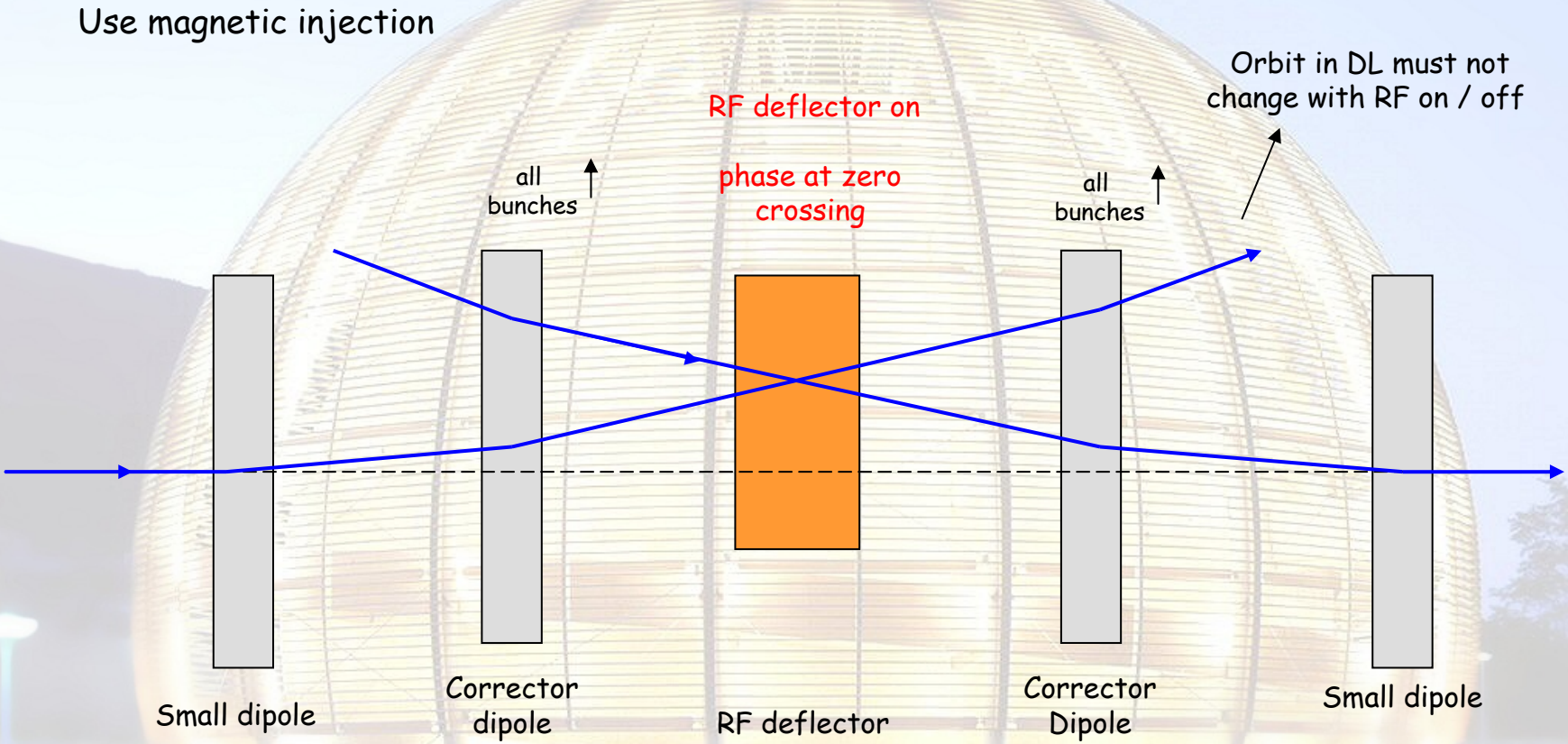


Bunch length measurement

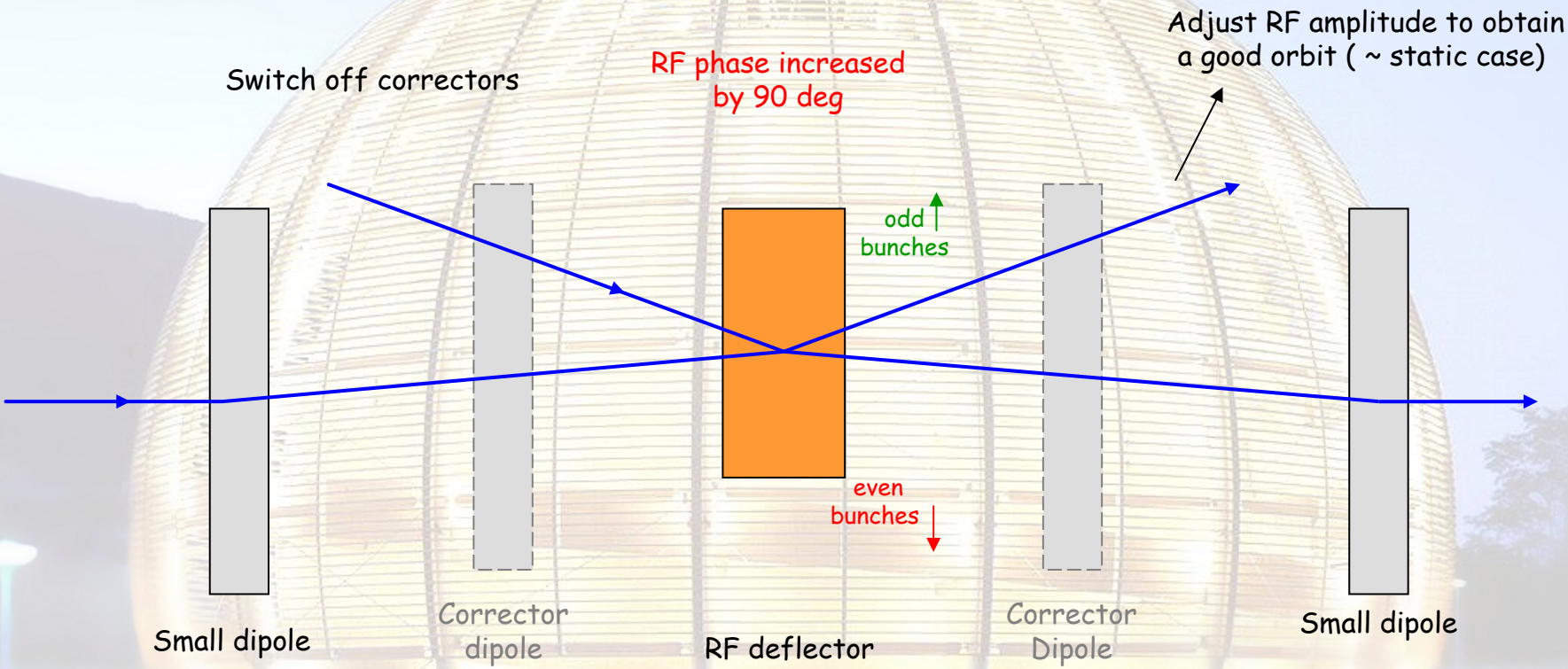


Procedure for RF injection

Use magnetic injection



Procedure for RF injection



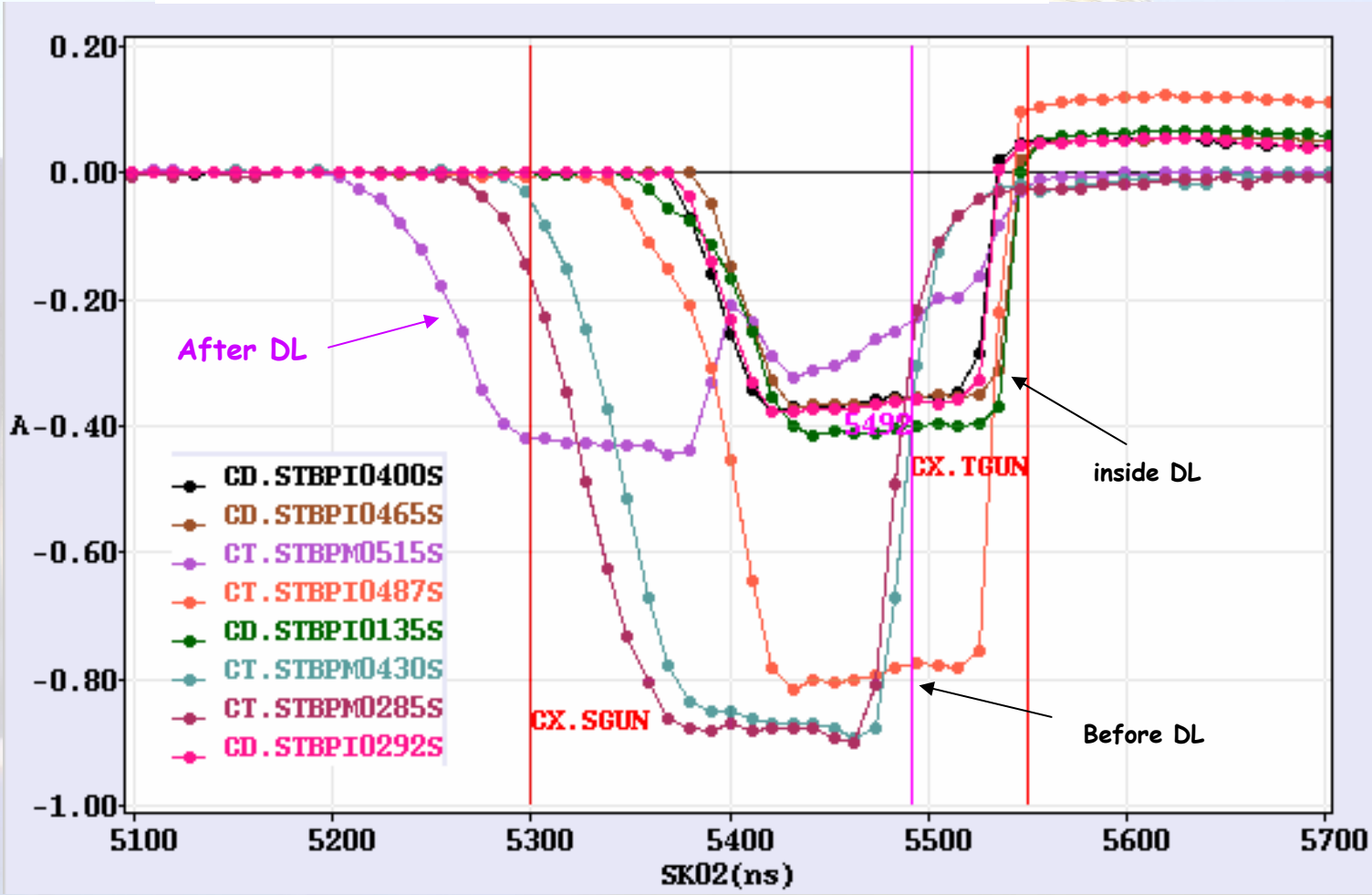
Need a few iteration
(phase / amplitude coupling)

Delay Loop – RF injection

Using a 3 GHz bunched beam, the pulse is split in two

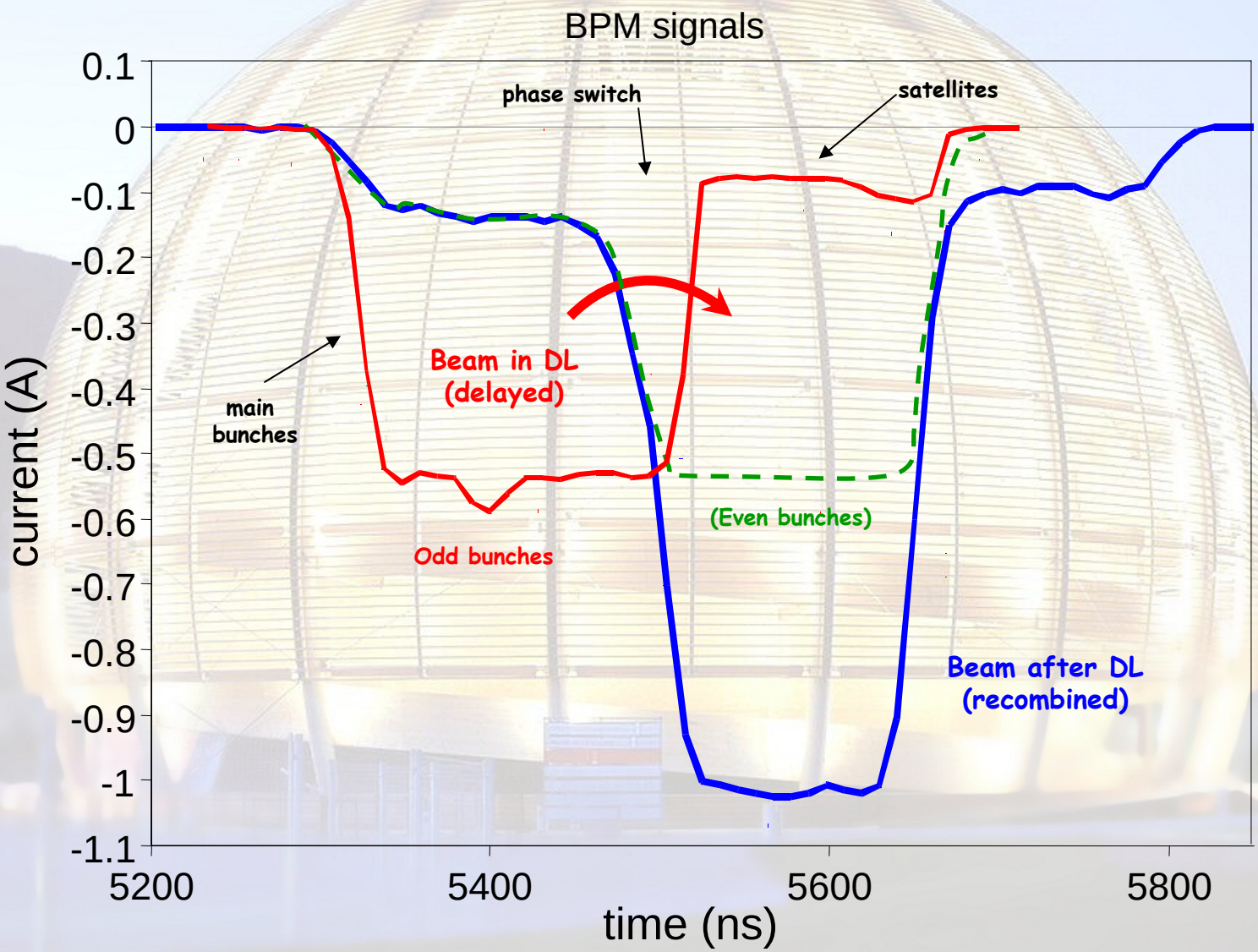
Even bunches go straight, odd ones in the DL

After the DL one gets twice the pulse length, half the current

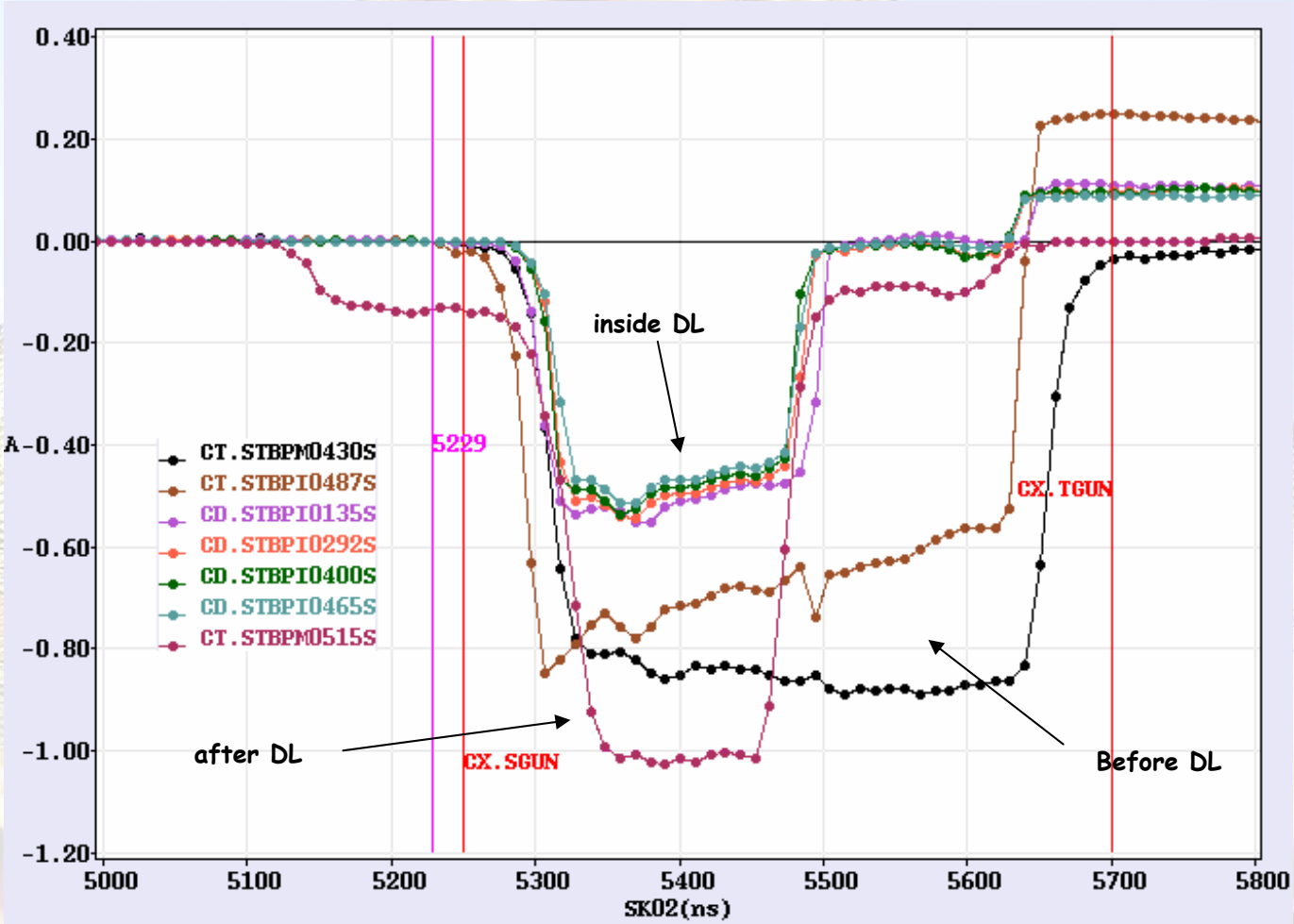


Delay Loop – recombination

Nominal conditions, 1.5 GHz from SHB system (one cavity only), and phase switch

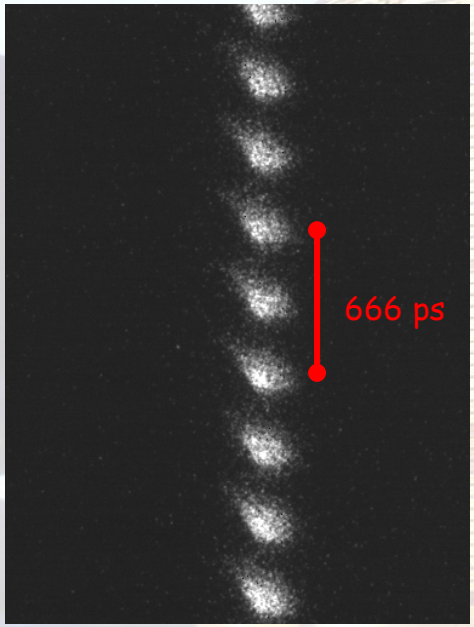


Delay Loop – recombination

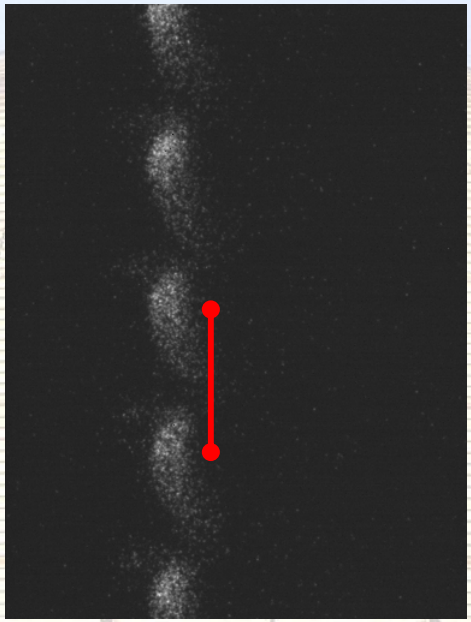


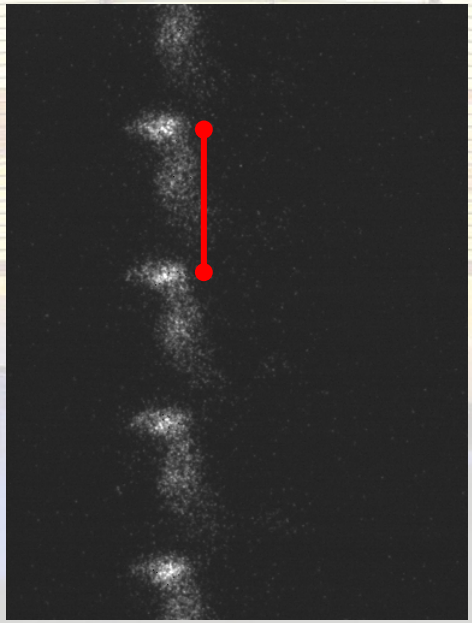
Delay Loop – streak camera images

3 GHz beam in DL

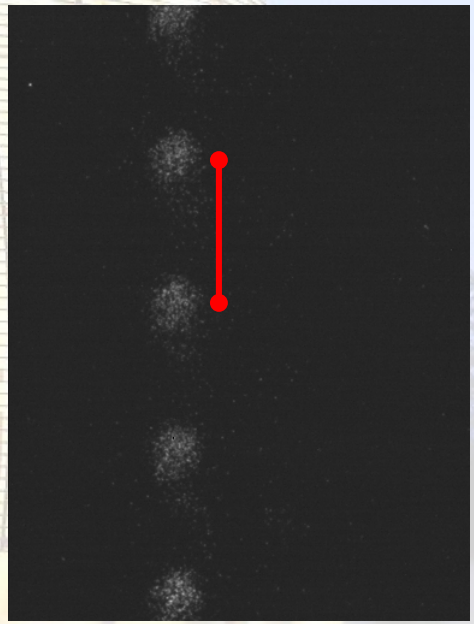


1.5 GHz beam
Main bunches

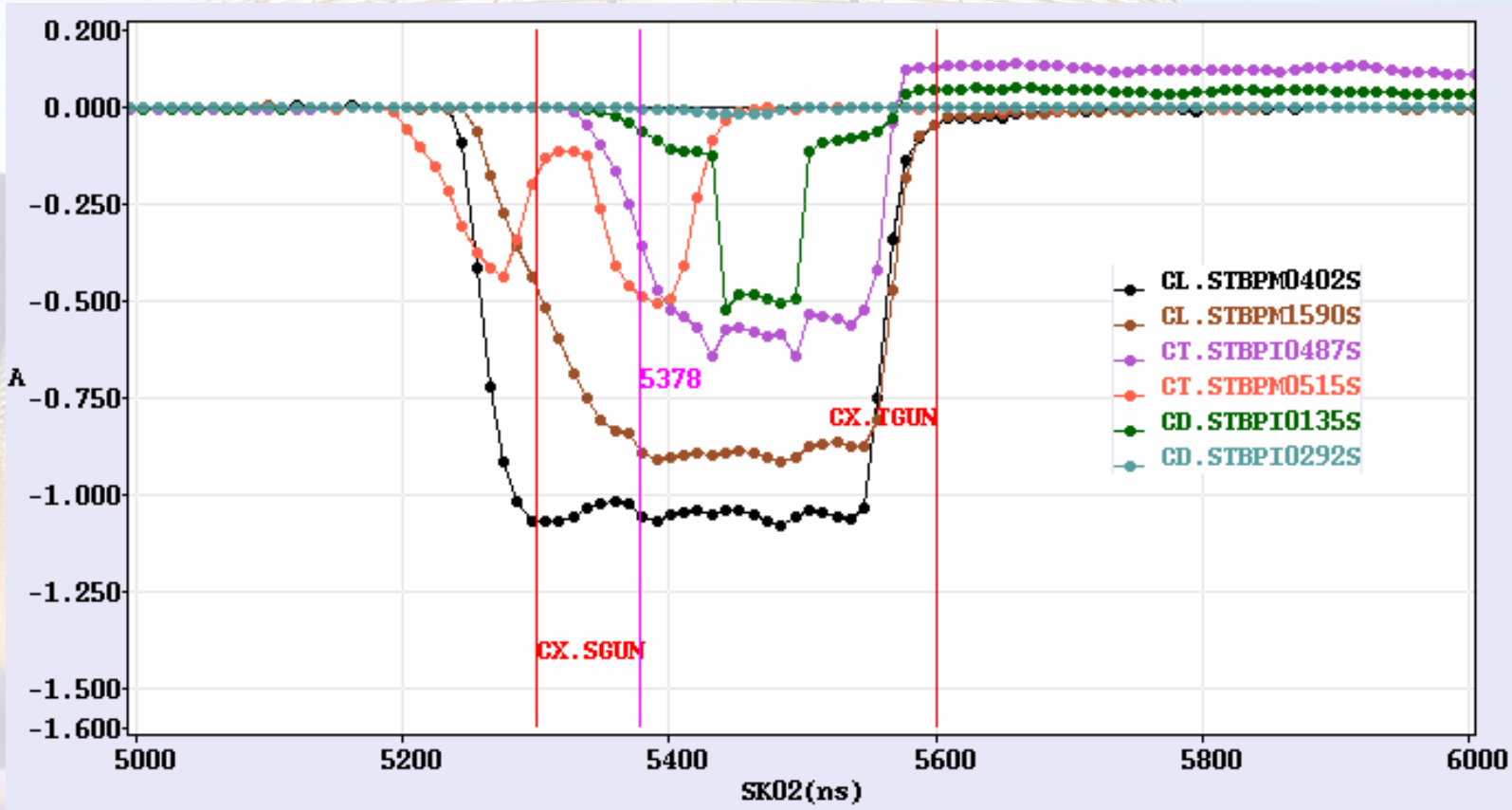




1.5 GHz beam
satellites



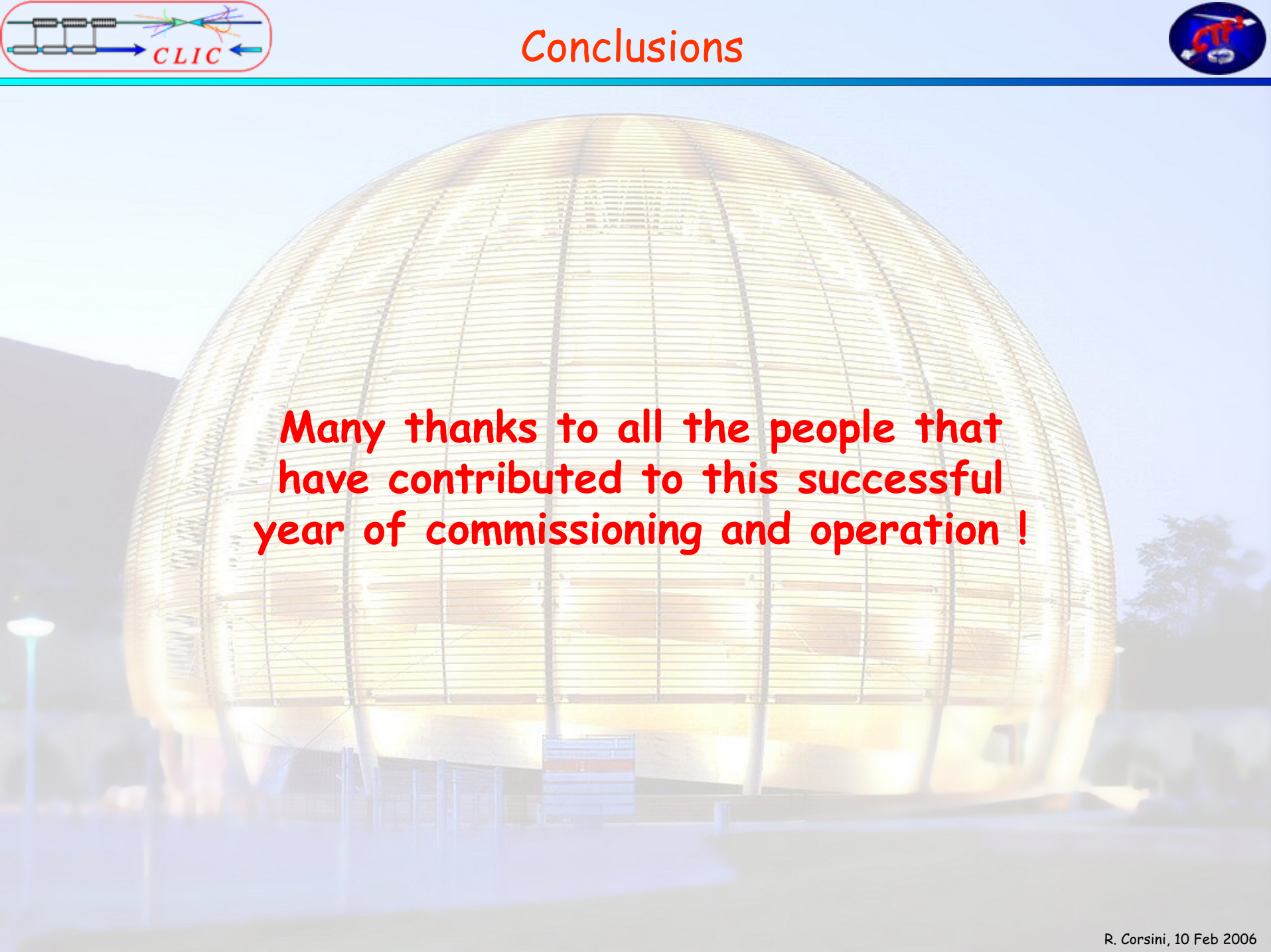
The way to short pulses ?



Conclusions (from Collab. Meeting)

- After some initial problems, extremely good results for 30 GHz power production and accelerating structure conditioning
- Routine operation for 30 GHz power production established – but not enough manpower for longer running periods
- In a very short time, obtained the first beam circulating through the Delay Loop
- Still 2-3 weeks of operation left, will try to:
  - Inject in DL using the RF deflector
  - Progress with 30 GHz conditioning
  - Progress with beam studies (phase jump for 30 GHz pulse compression) and diagnostics development
- However, cannot fulfill all the goals of the very ambitious program (missing hardware, not enough beam time…) – DL commissioning to be concluded next year – decoupled linac operation/CR installation could help

Conclusions



Many thanks to all the people that have contributed to this successful year of commissioning and operation !