

Review of the Main Results of the CTF 3 Preliminary Phase



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- **Reminder to the Preliminary Phase**
- **Bunch **Frequency Multiplication****
- **Bunch **Combination Studies****
- **Conclusions**

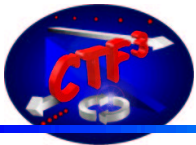


A reminder to the Preliminary Phase

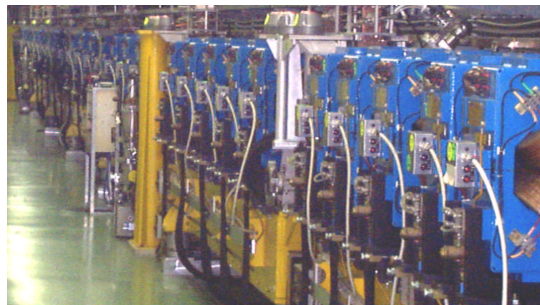
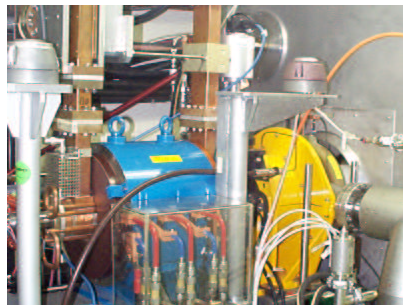


- **CLIC Test Facility 3** addresses **CLIC feasibility** issues:
 - test of **drive beam generation**
 - highly **effective** acceleration (fully-loaded)
 - **combination** of bunch trains by **RF deflectors**
⇒ bunch frequency multiplication
 - **RF power production** at 30 GHz
 - test CLIC components

- **Preliminary Phase**
 - first test of bunch train combination
 - **low charge** (0.1 nC/bunch compared to 2.33 nC)
 - **short pulse** (6 ns instead of 130 ns)
 - maximum use of existing LPI hardware



Preliminary Phase of CTF 3 (2001–2002)



Linac (8 structures)

streak camera measurement

RF deflectors

isochronous injection line

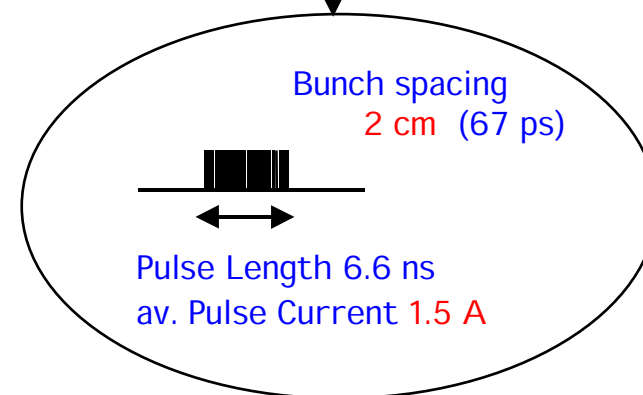
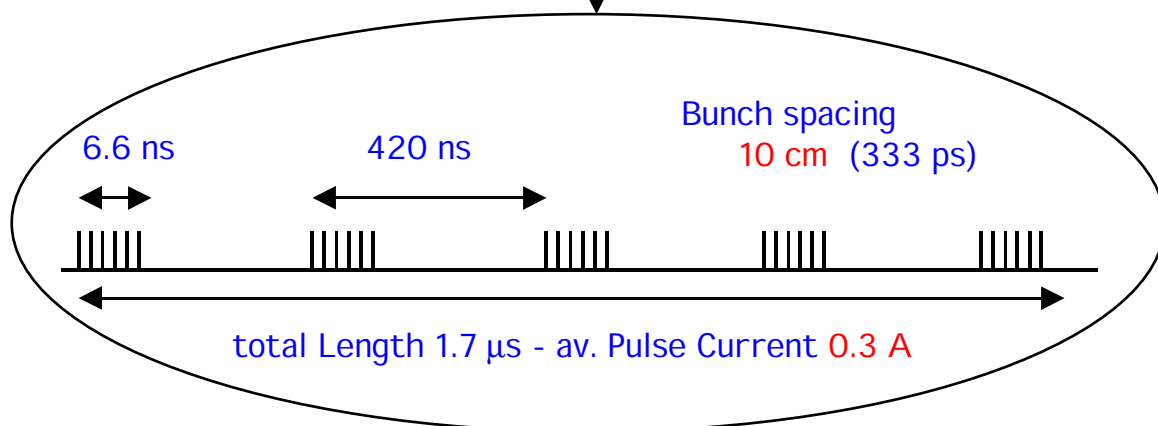
matching section

isochronous ring

gun & bunching system

Beam structure in linac (up to 100 Hz)

Beam structure after combination



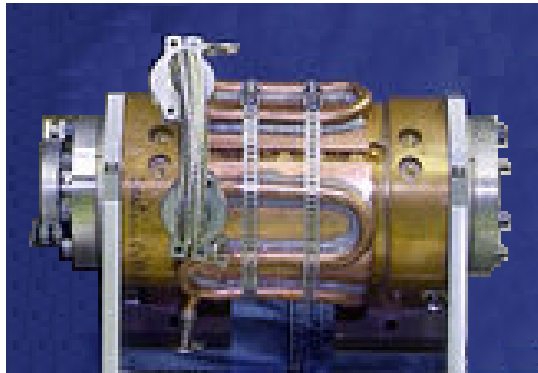


RF deflectors

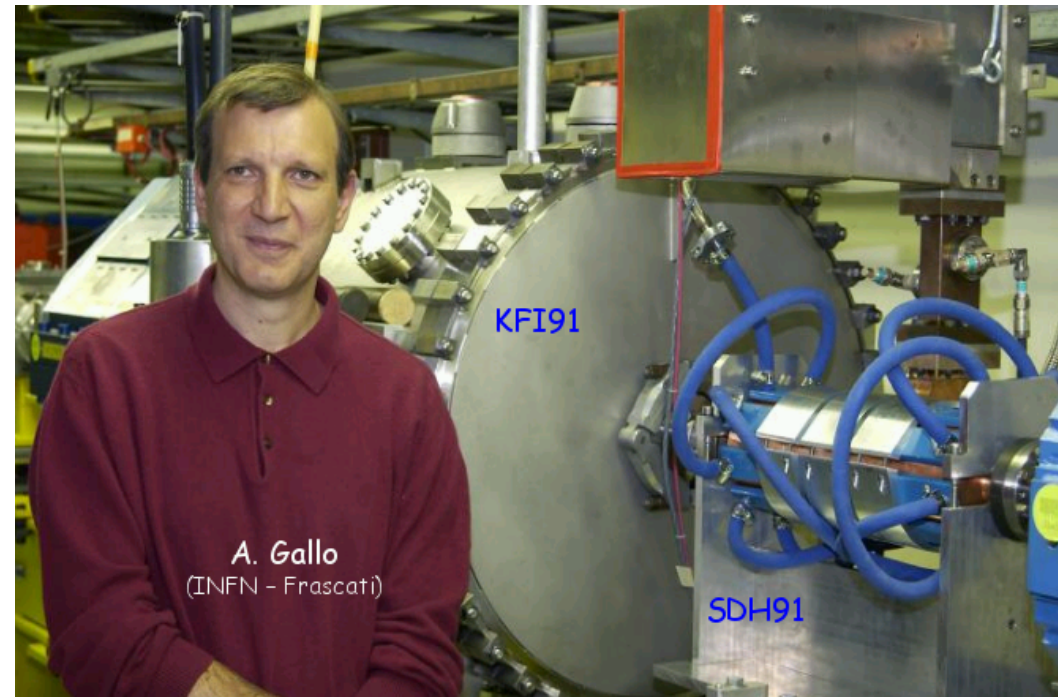
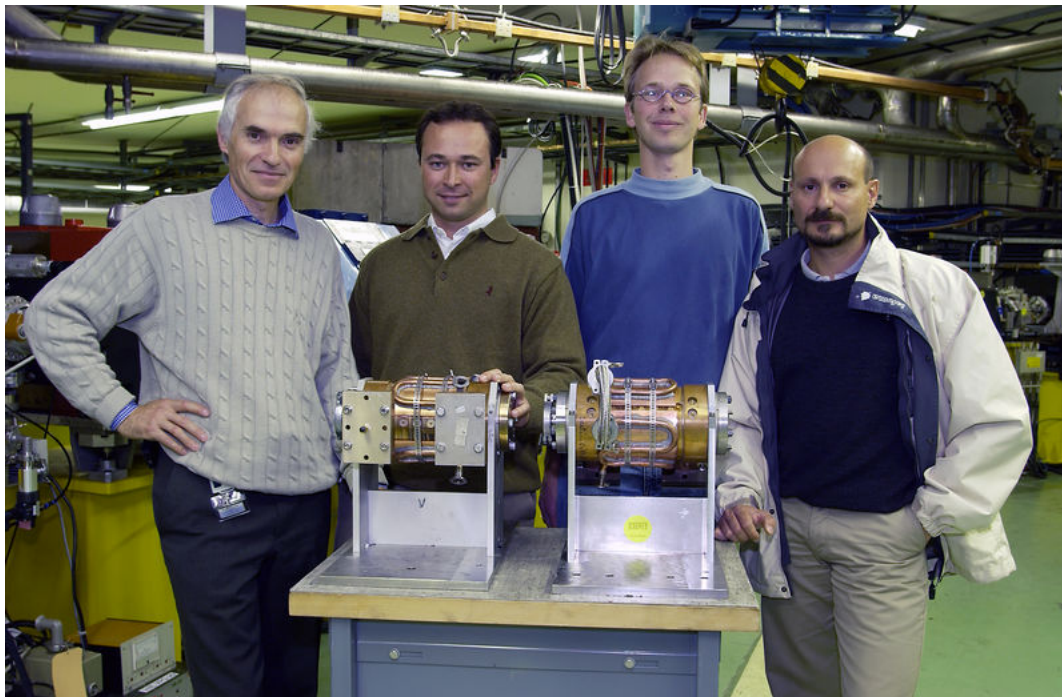
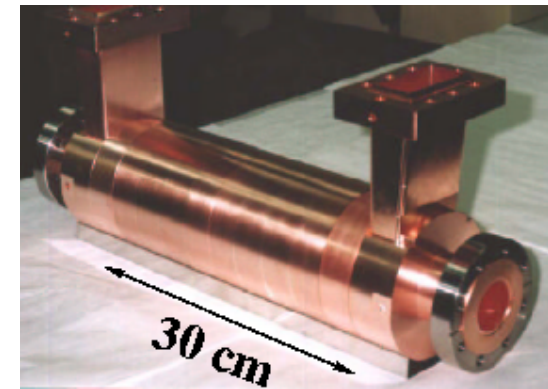


- two types of **RF deflectors** used
- INFN design for Nominal Phase with **larger aperture** (21 → 43 mm)

CTF3
deflector,
CERN



CTF3
deflector,
INFN





Tune measurements



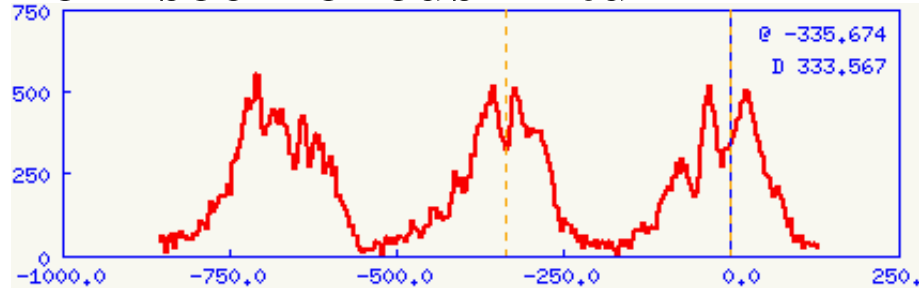
- **Fourier Transform** analysis of injected beam
- cross-checked with standard LPI method
- \Rightarrow stored beam not necessary



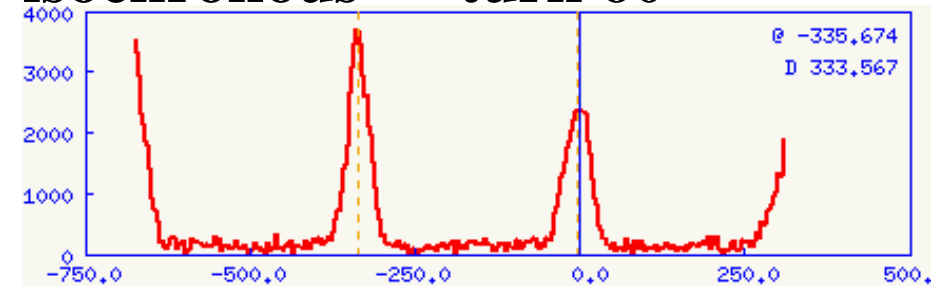
Isochronicity



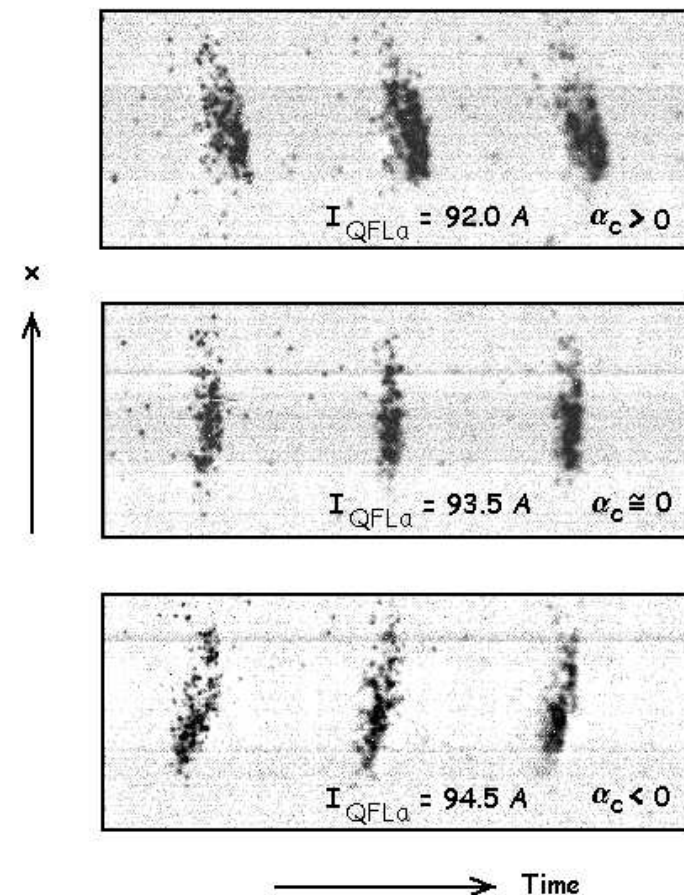
non-isochronous — turn 2



isochronous — turn 60

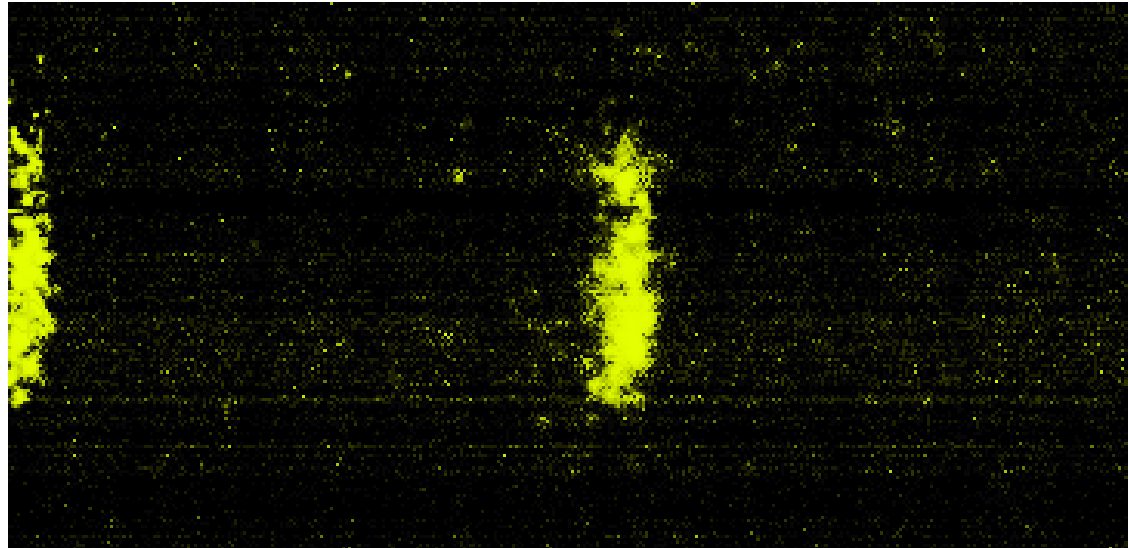


- **crucial** for combination
- adjustable by quadrupole currents
- observed on **streak camera**
- **bunch length** measured
- about 3 ps rms
- no significant lengthening
- momentum compaction $|\alpha_c| < 10^{-4}$

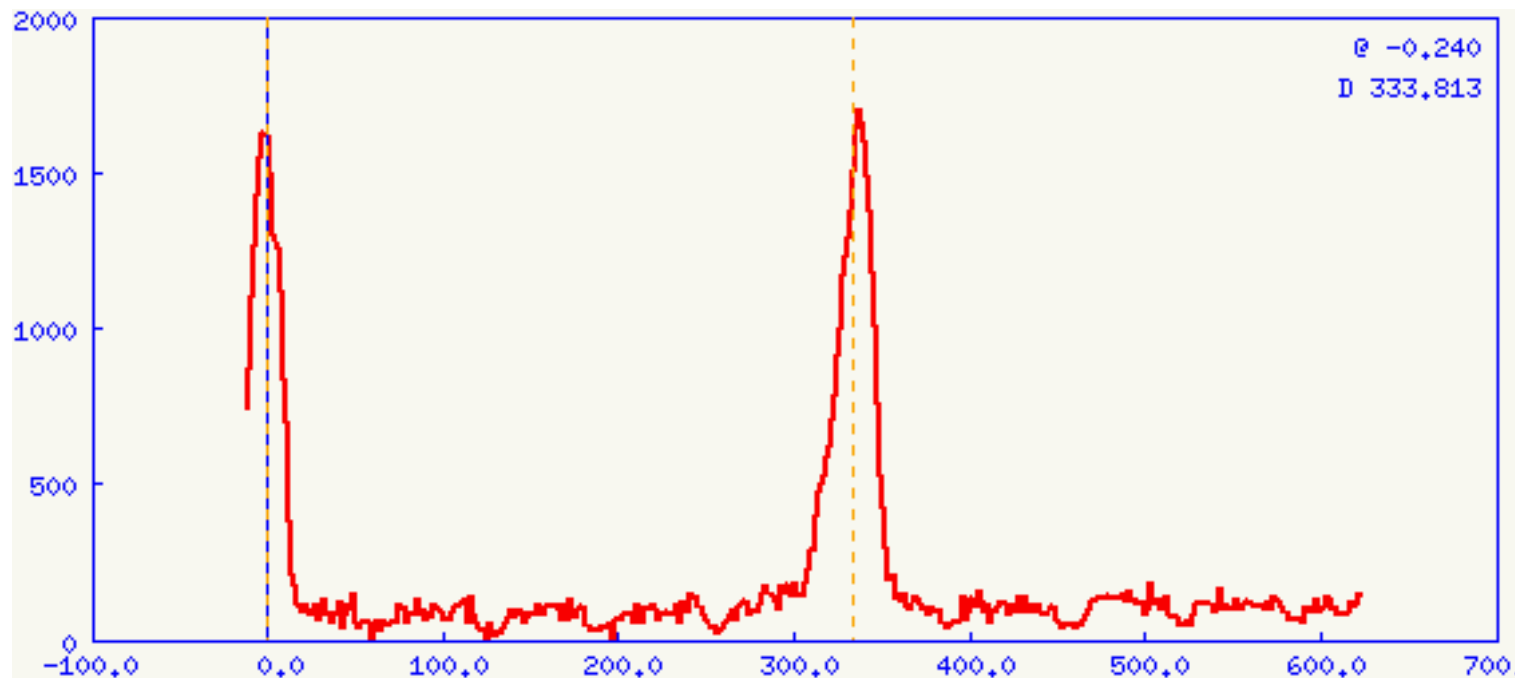




CTF3 recombination factor 4 - 1 pulse

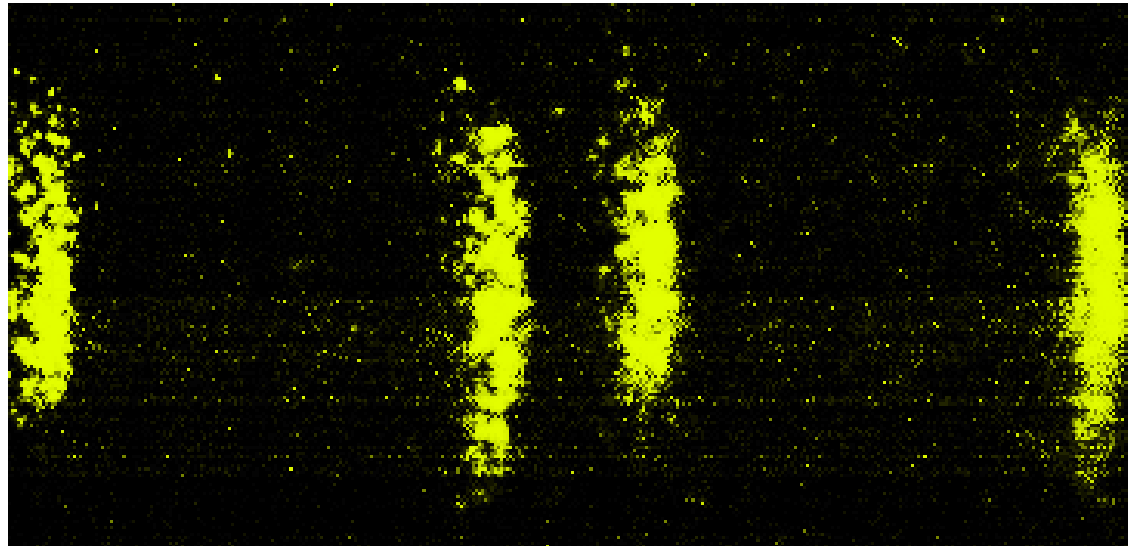


—————→ time

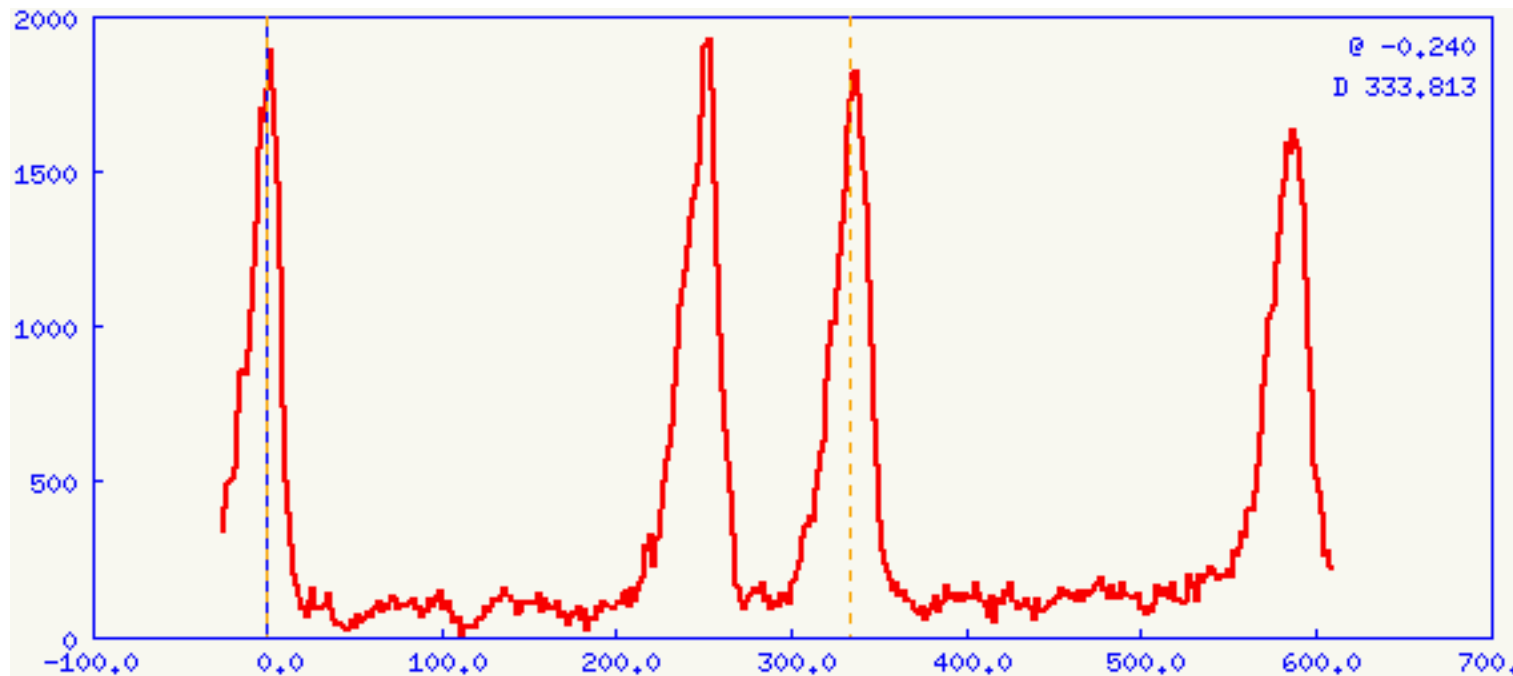




CTF3 recombination factor 4 - 2 pulses

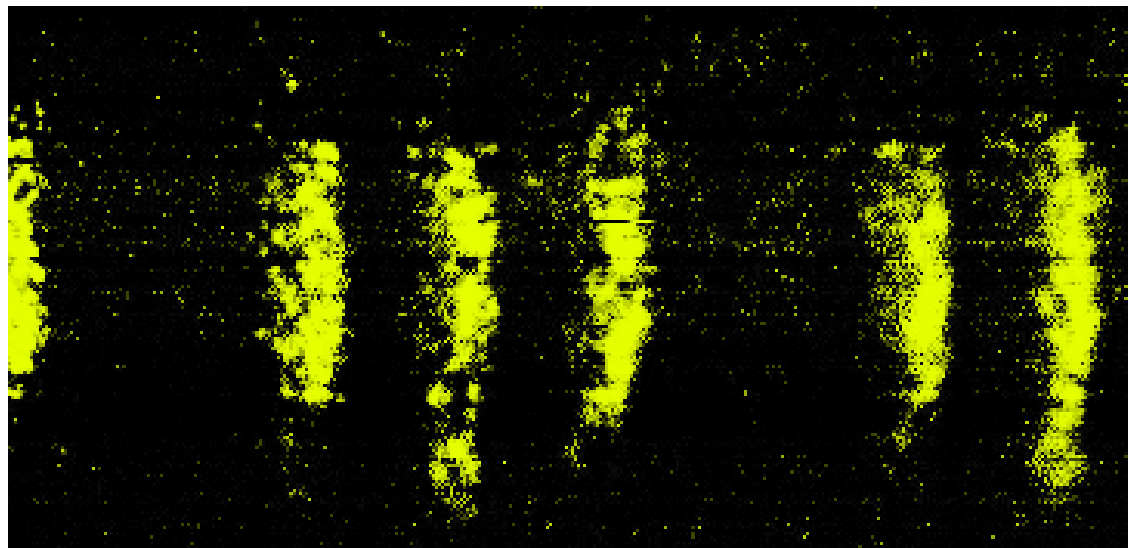


—————→ time

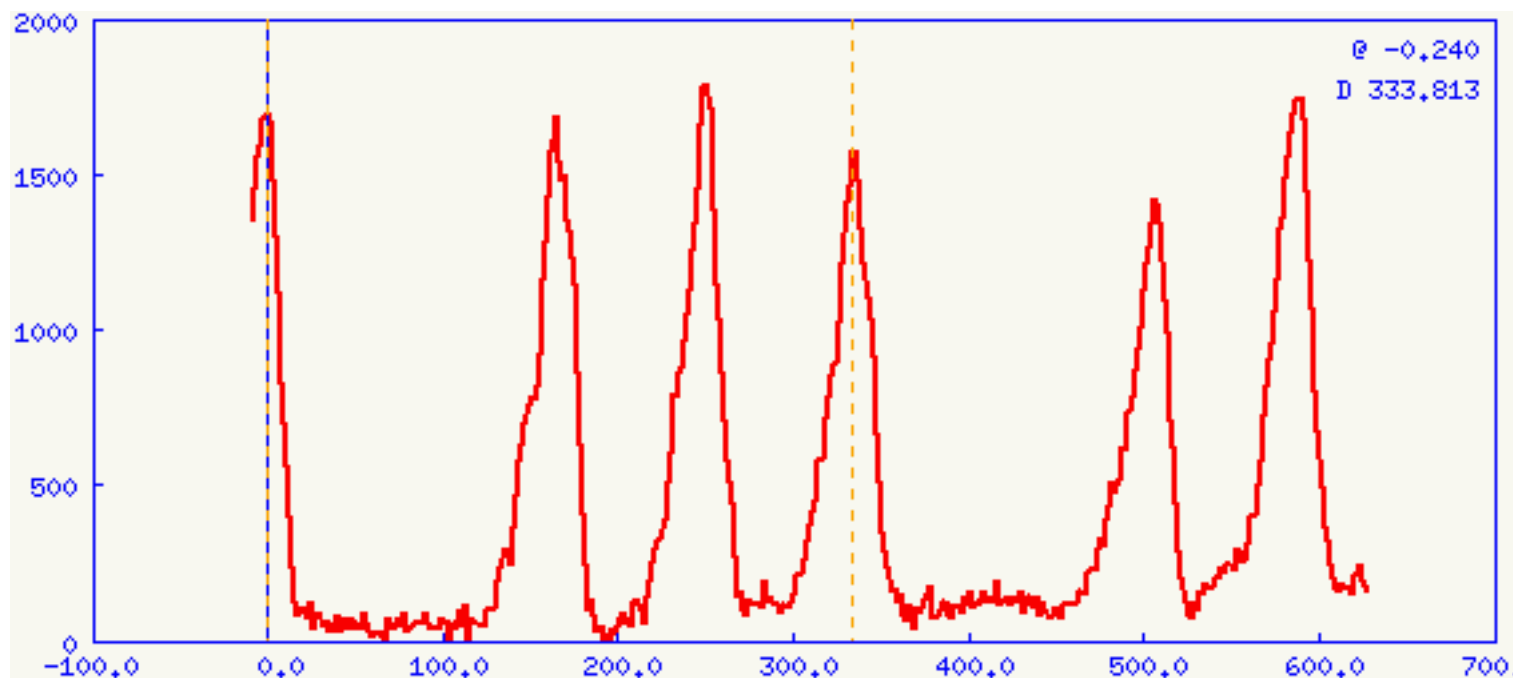




CTF3 recombination factor 4 - 3 pulses

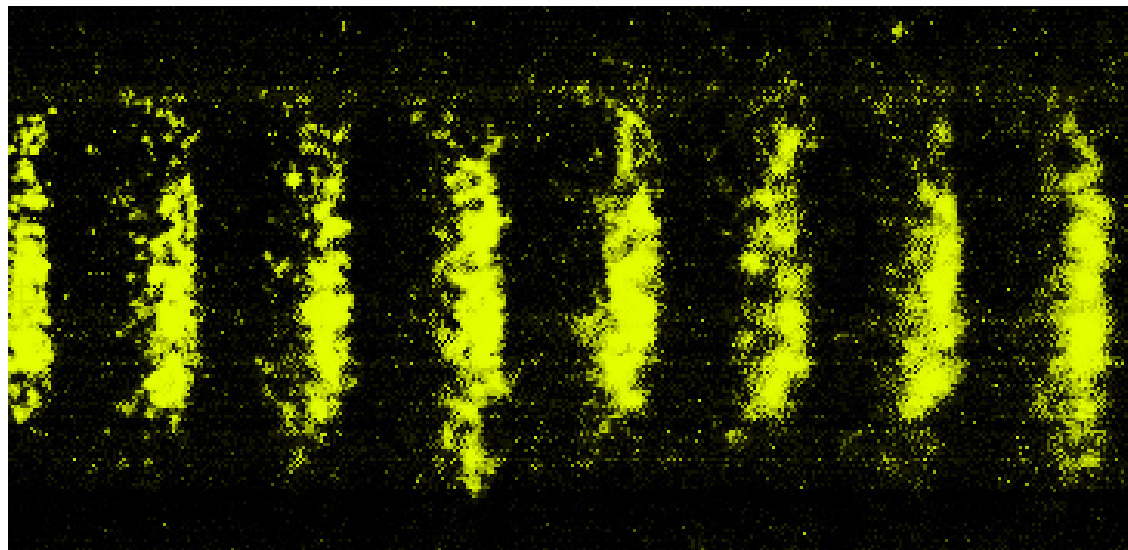


time

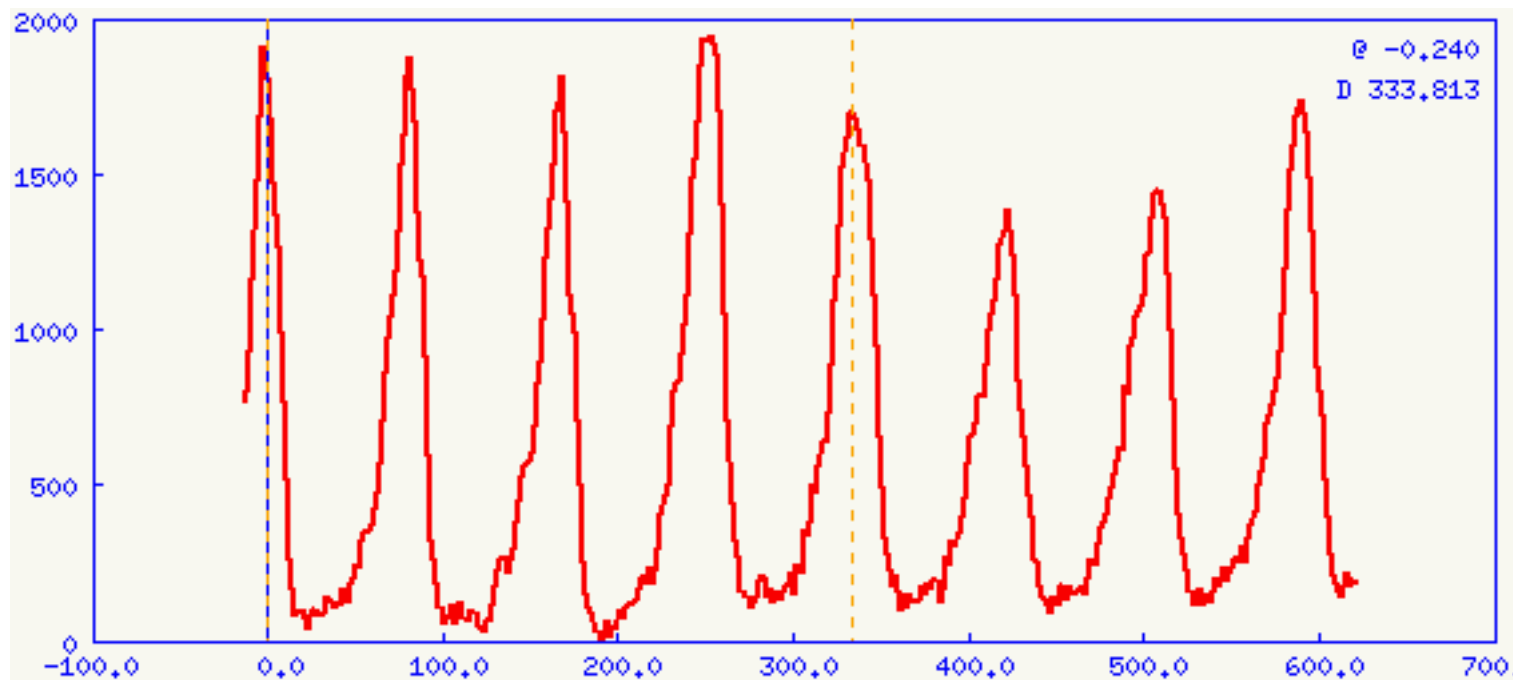




CTF3 recombination factor 4 - 4 pulses

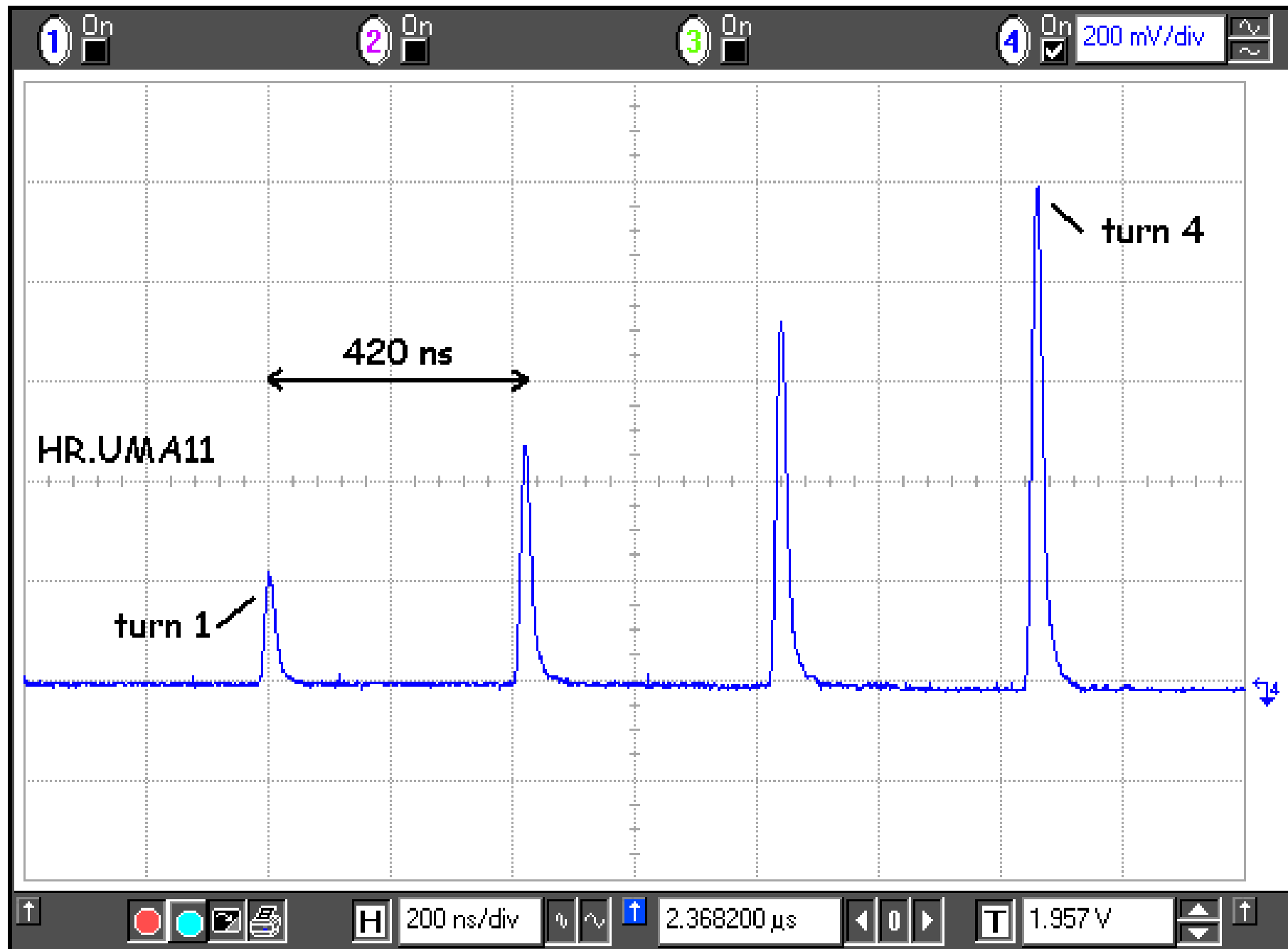


—————→ time



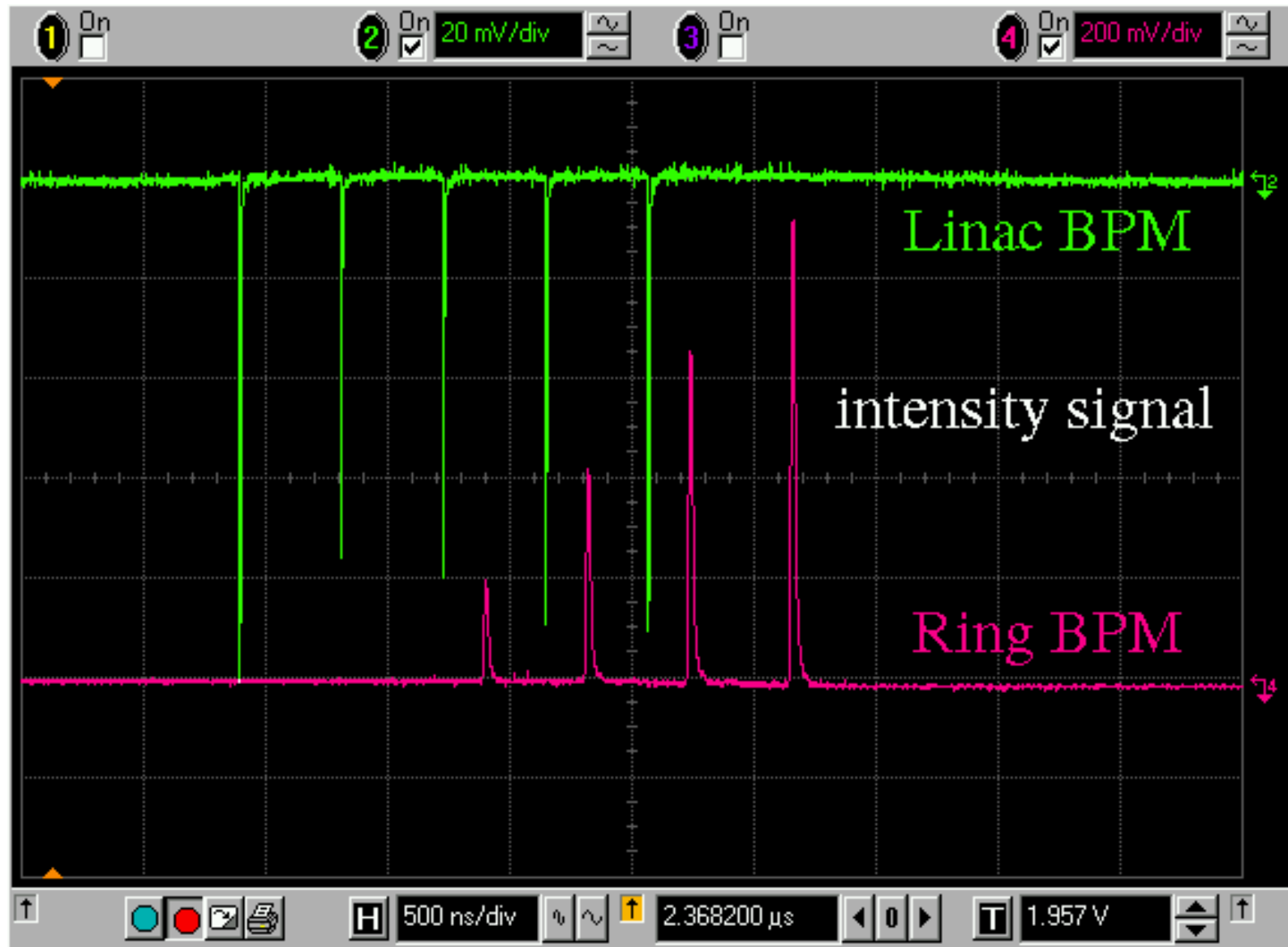


Recombination factor 4 - beam current





Train current variations



- variations in the gun current

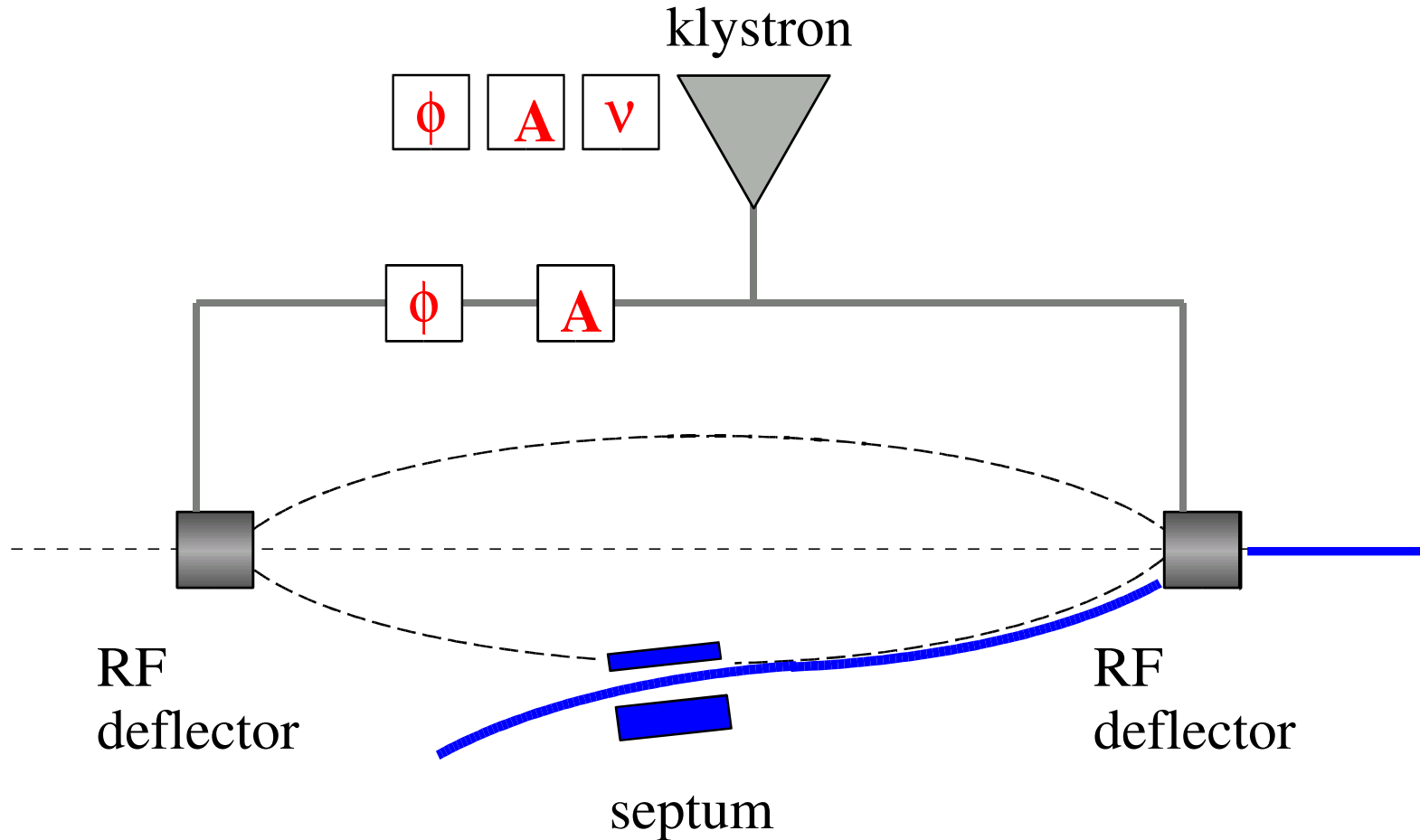


Recombination factor 4 - Circulation





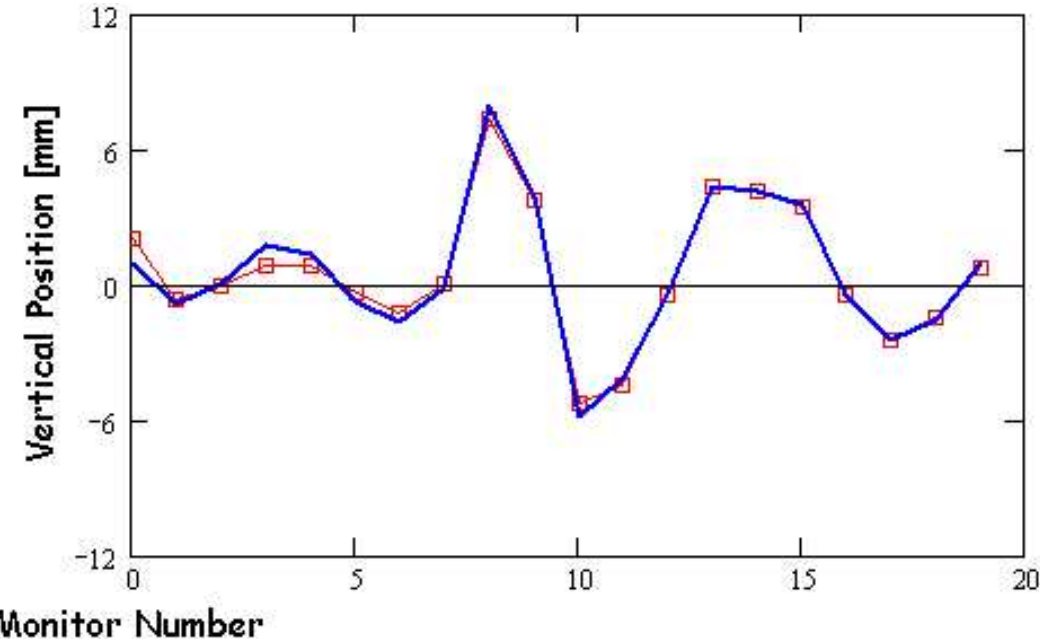
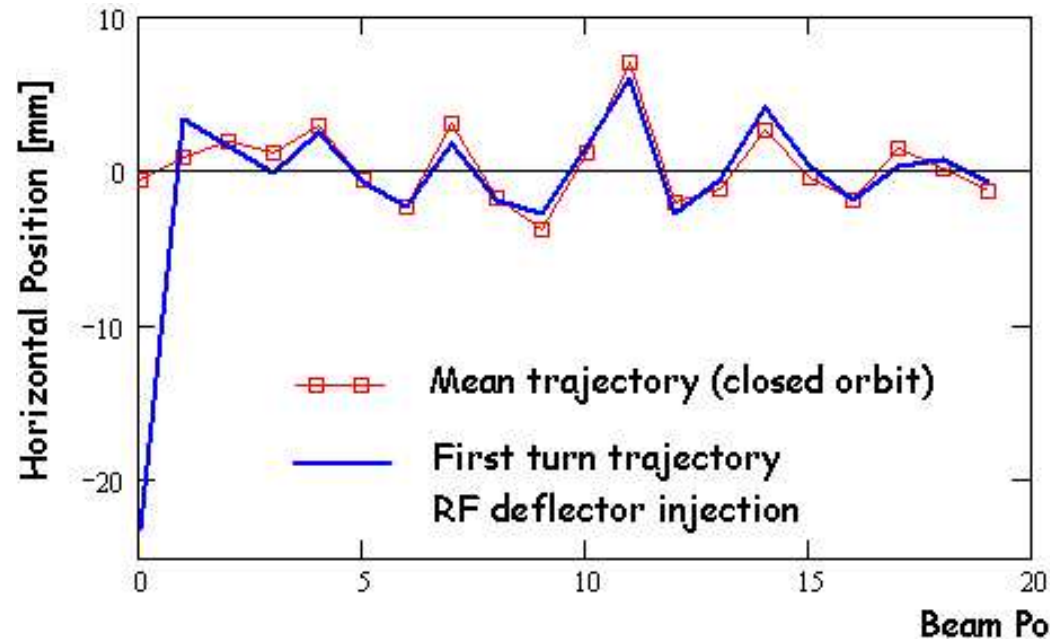
Optimization procedure – Factor 4



- **5** parameters
 - **Amplitude** and **phase** in each deflector
 - **RF frequency**
- **monitor trajectory** differences over various turns



Orbit optimization



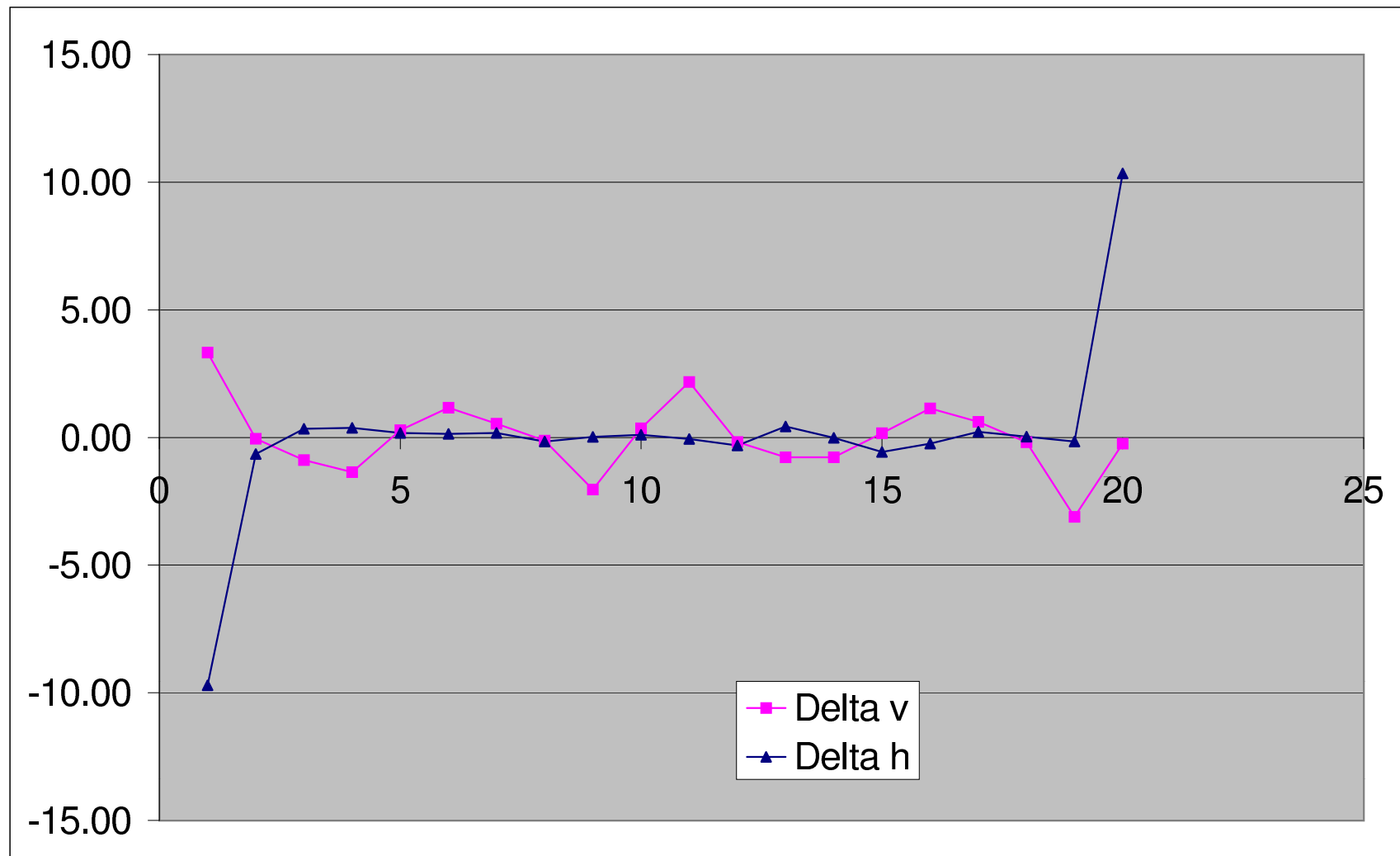
- Closed orbit by **averaging** (10 turns)
- CO not well corrected due to limited number of correctors
- injection well corrected



Difference trajectory

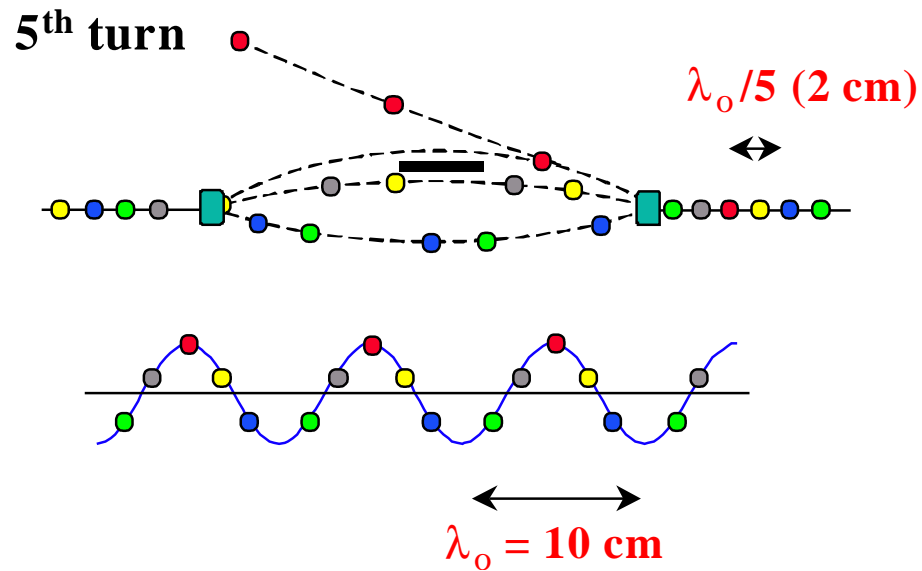


- difference trajectory 2nd and 3rd turn, **0.3 mm horiz. rms**

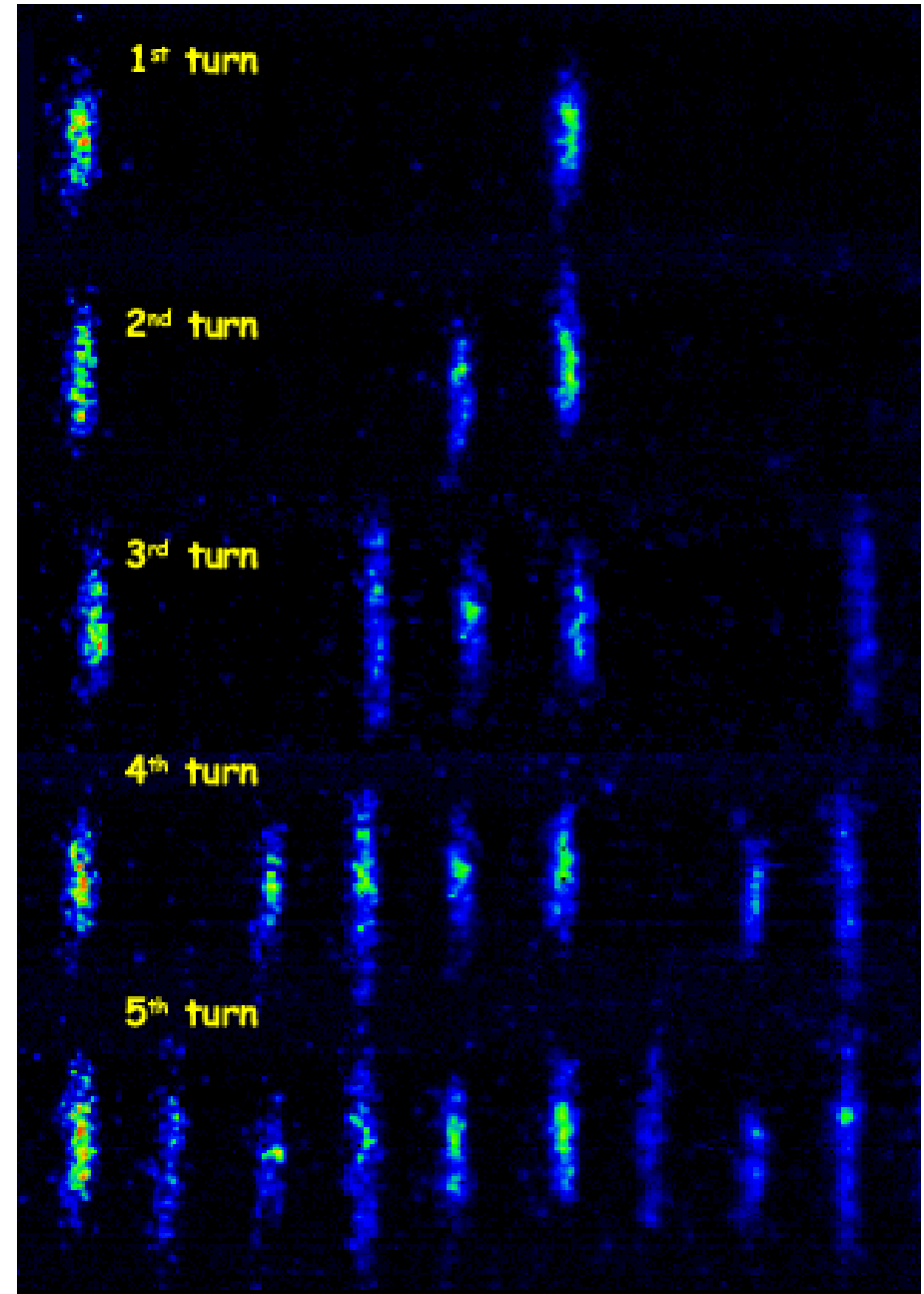
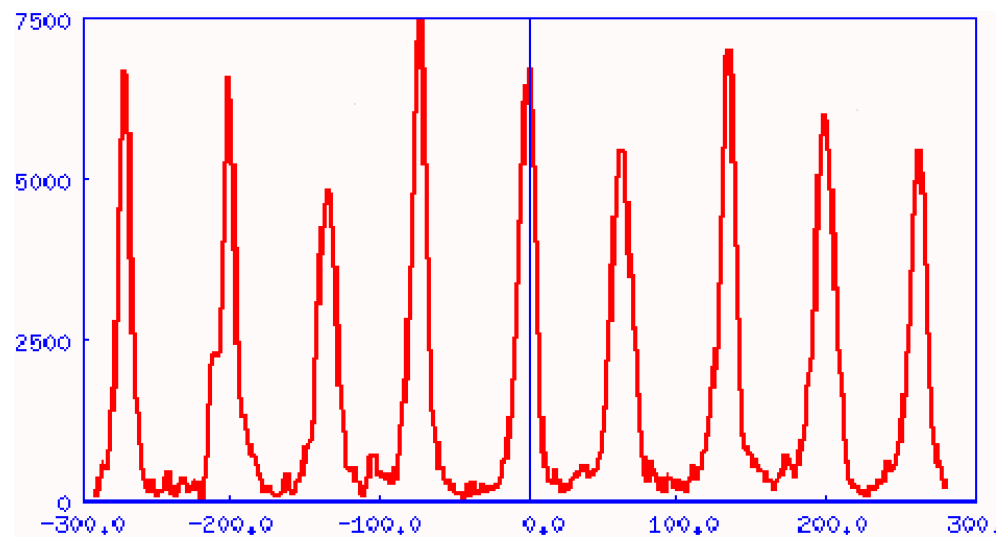




CTF3 recombination factor 5



- bunch distance 333 ps \rightarrow 67 ps
- frequency 3 GHz \rightarrow 15 GHz

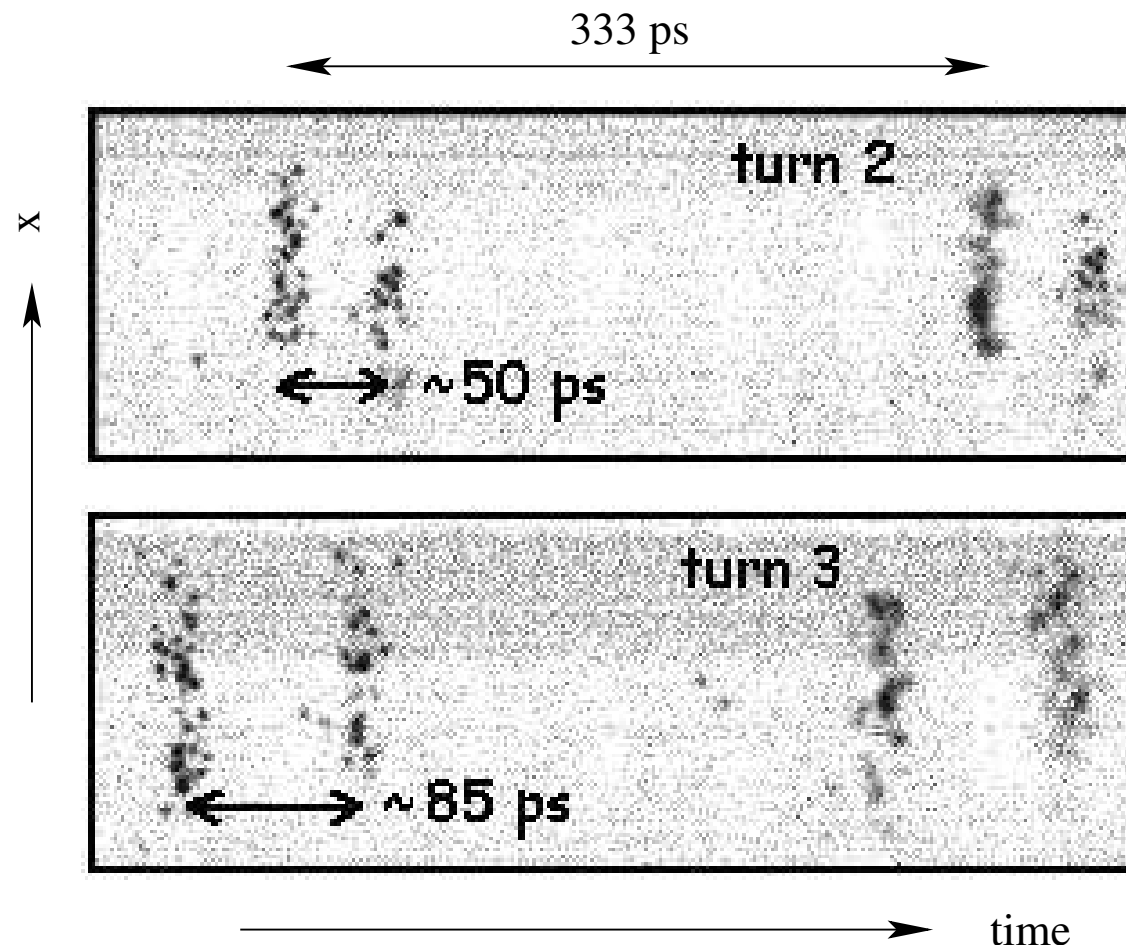


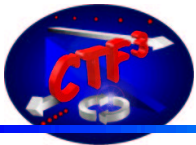


Bunch spacing variations

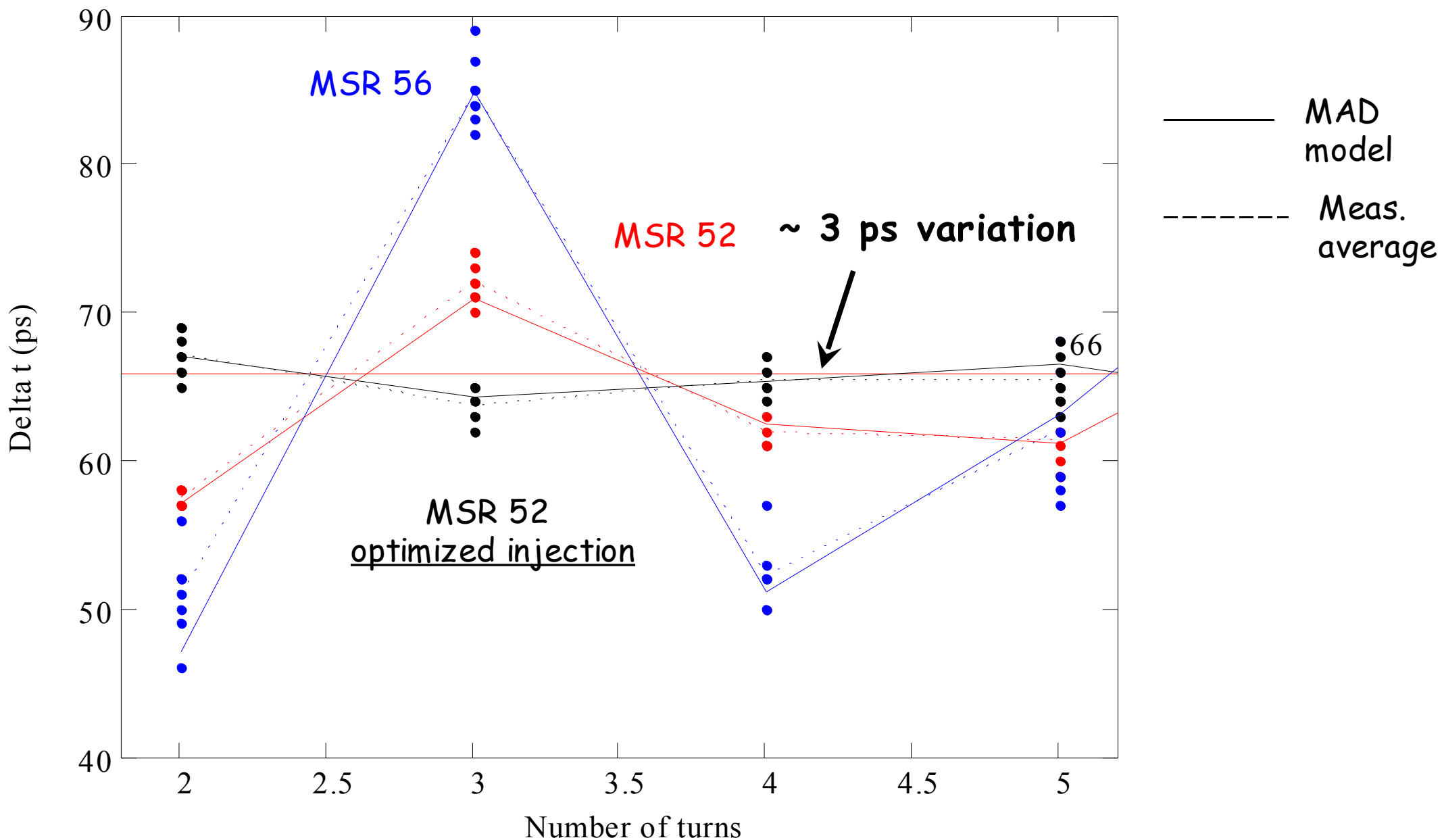


- bunch **distance variations** were observed
- dedicated **experiment** with 2 bunch trains
- observation at each turn





Bunch spacing experiment results



R.Corsini



Bunch spacing variations - Explanation



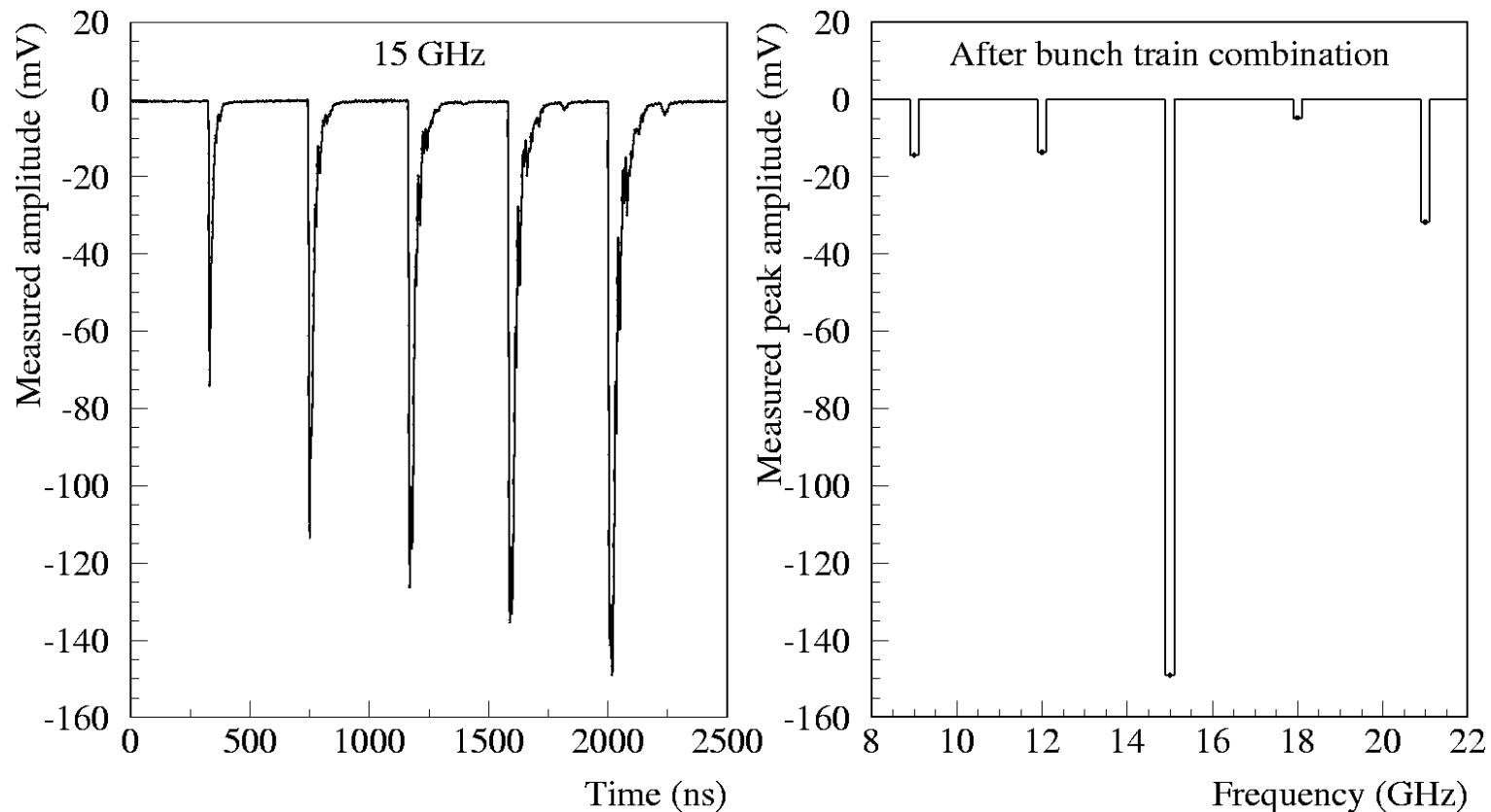
- **dispersion $D \neq 0$** at observation point
- **1-turn transfer matrix elements R_{51} and R_{52} non-zero**
- **position/angle dependant revolution time**
- **position different each turn**
- **minimized by set-up procedure (< 3 ps)**
- **irrelevant** at extraction ($D = 0$)
⇒ **no loss of RF generation efficiency**
- **measurement should be at non-dispersive location**



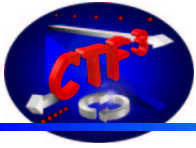
Bunch frequency monitor



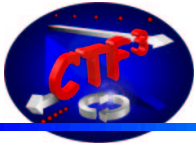
- signal of 5 harmonics of 3 GHz beam frequency
- increase of one harmonic during combination
- other harmonics decrease



- short train length problematic
- parasitic waveguide modes



- **CTF 3 Preliminary Phase**
 - bunch **frequency multiplication** by RF deflectors successfully **demonstrated** for factors 4 and 5
 - **low charge** (0.1 nC/bunch)
 - **short bunch trains** (6 ns)
 - **procedure** developed to optimize combination
 - no measurable losses
 - distance and position variations understood
 - crucial step for the CLIC study
- next step **CTF 3 Initial Phase**
 - \Rightarrow Roberto after coffee



CTF3 is dead – long live CTF3

- **Acknowledgements:**

- **R. Corsini, A. Ferrari, L. Rinolfi, P. Royer**
- **various CERN divisions and groups**
- **Collaborations:**

INFN, Frascati, Italy

SLAC, USA

RAL, UK

IN2P3-LAL, France

Uppsala University, Sweden

References: (links to the papers)

CTF3 Design Report - Preliminary Phase

Operation of the CTF3 Preliminary Phase in 2002: [CTF3 Note 054](#), [052](#), and [CTF3 Note 049](#)

CTF3 Preliminary Phase Commissioning 2001: [CTF3 Note 044](#), [043](#), [040](#), [037](#), and [CTF3 Note 034](#)