Orbit Distortion at the transition time in the PS

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Contents

- Review of the work about beam losses in the PS at the transition (2006)
- Orbit distortion observed in the PS machine in 2006
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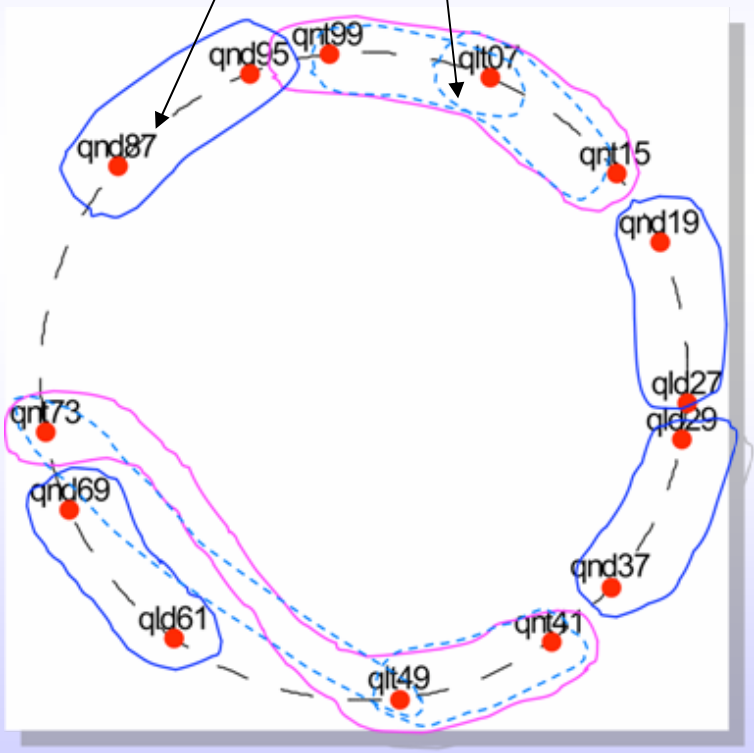
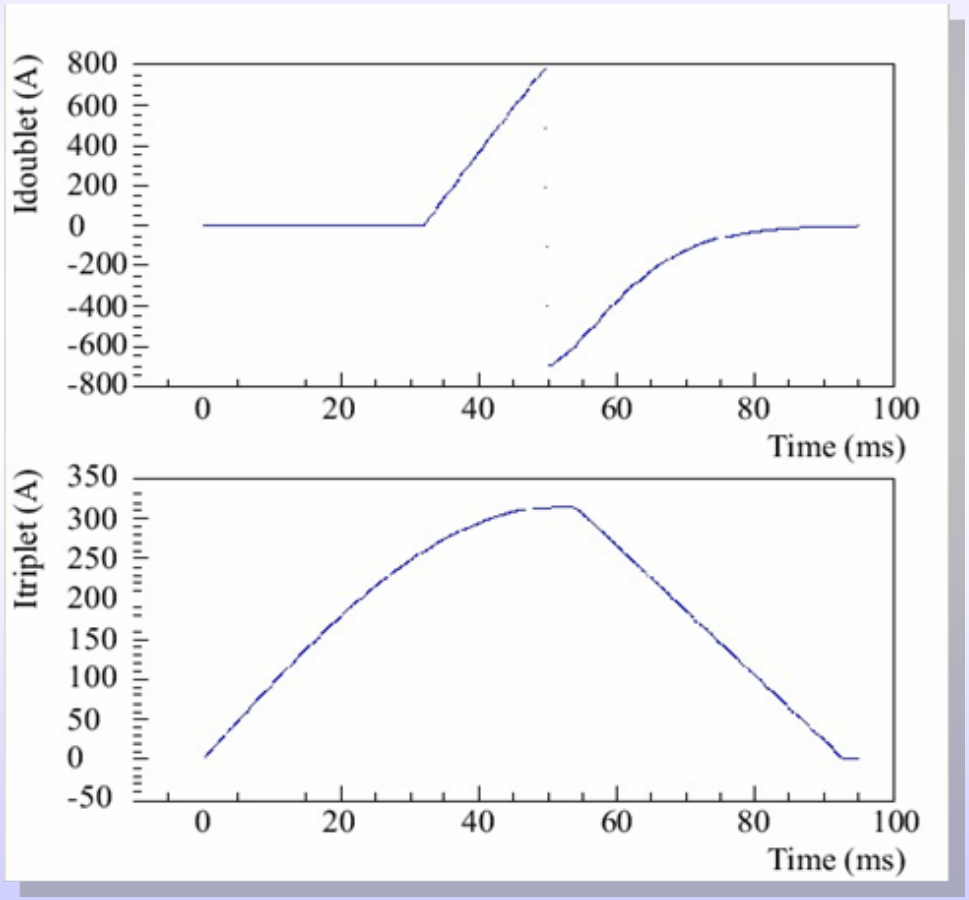
- Results of the PS orbit simulation orbit with GJ quadrupoles misalignments
- First conclusions…
- Orbit and dispersion measurements on MD2 (june 2007)
- Orbits measurements at the transition with steering and non-equilibrated Triplets

GammaJump Quadrupole Currents in the PS

Quadrupoles placed in doublets and triplets magnets



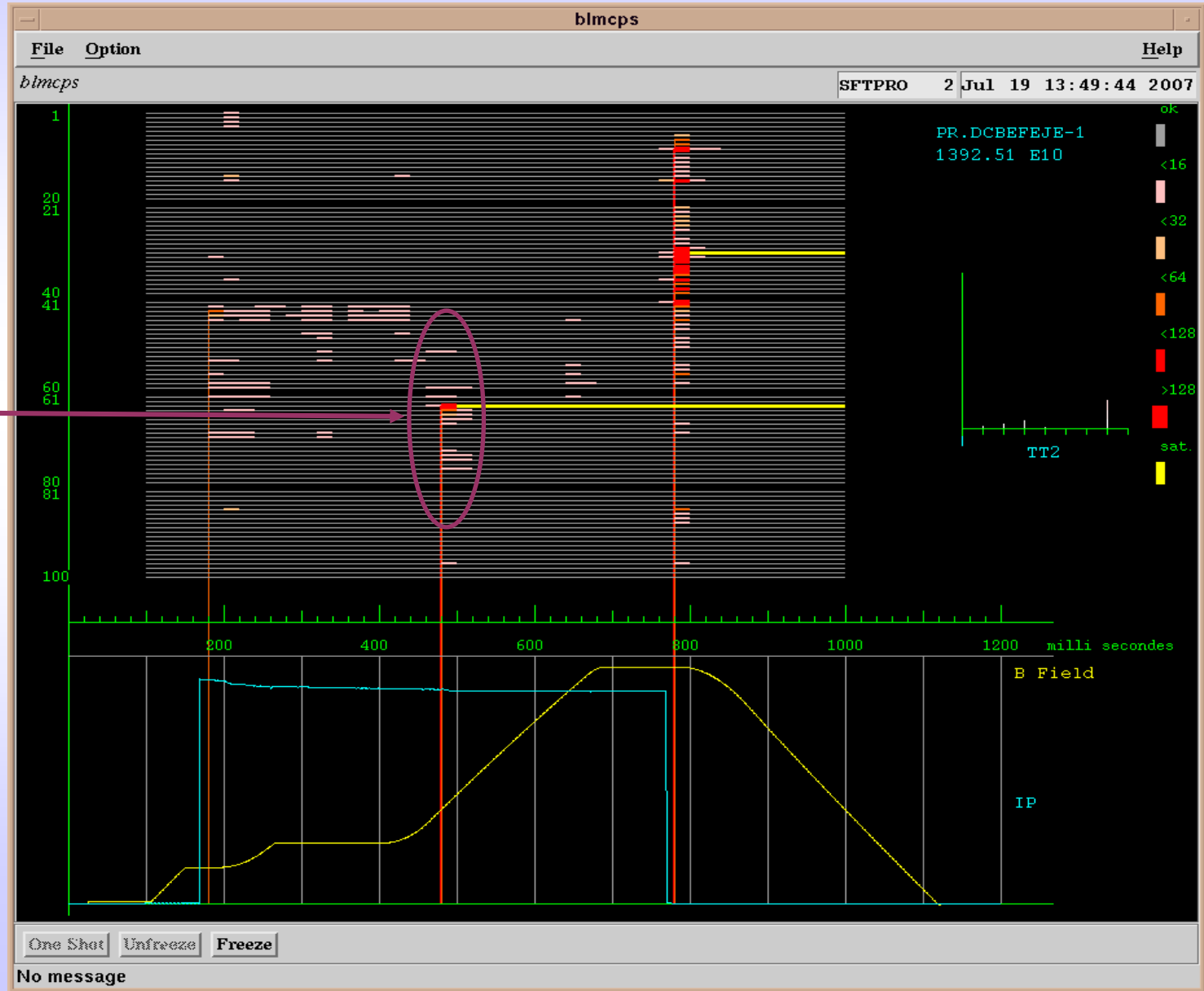


Motivations

2 Juillet 2007

SFTPRO

Transition



About 1-2% of the beam is lost at transition without any correction

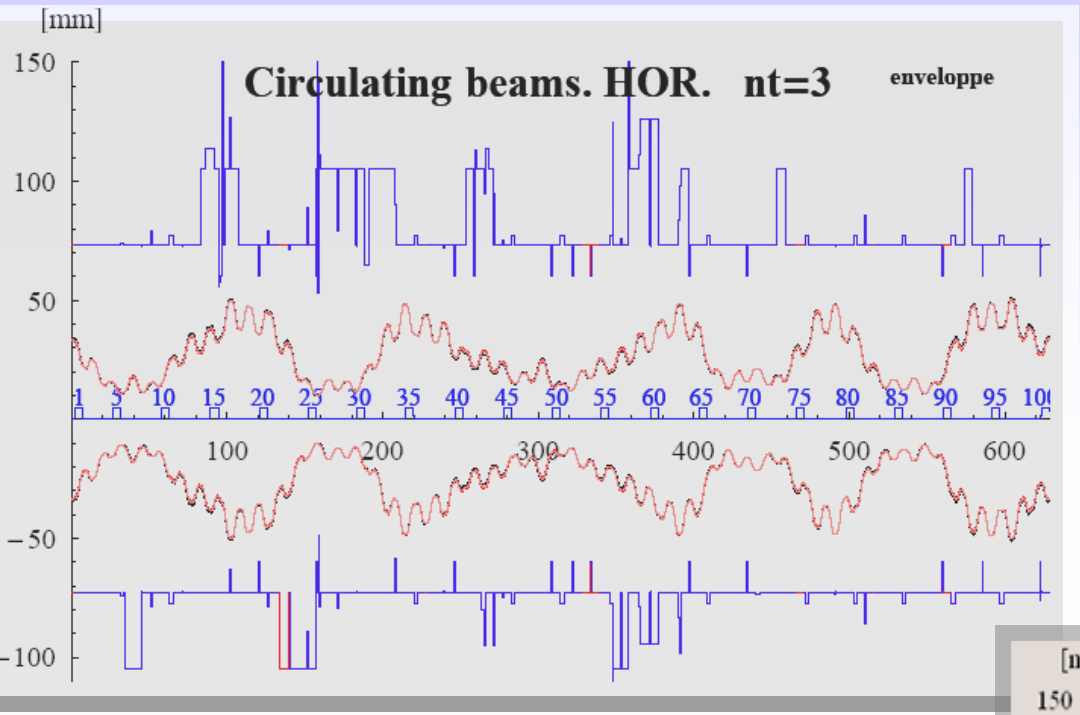
This corresponds to 10-20 e10, roughly a complete EAST cycle

Motivations

Last year, we demonstrated the causes the beam losses at the transition :

- **Beam envelope blow-up, we can control by changing unbalanced triplet currents**
- Orbit distortion at the transition

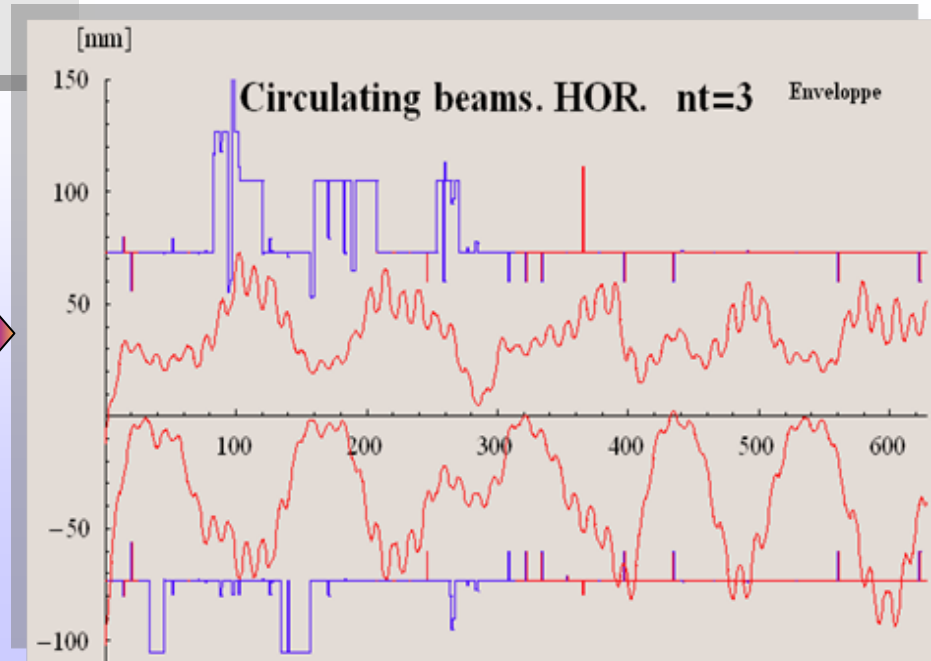
Blow-up of the envelope at the transition



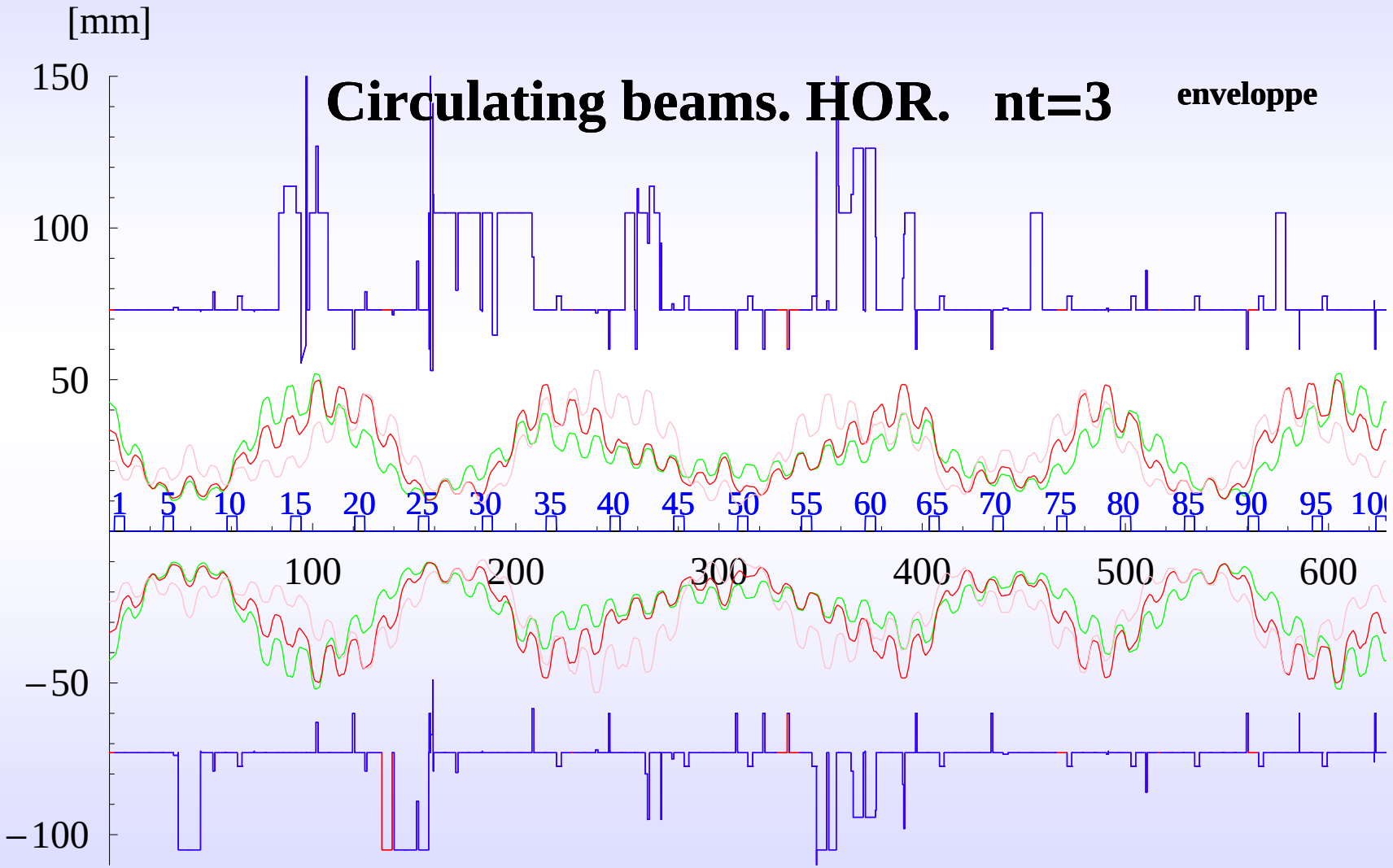
Beam envelope at the transition

losses probably reduced if no orbit distortion

Beam losses in SS63 measured and confirmed by MAD simulation.
Here envelope + measured orbit



Motivation: beam envelope by the use of unbalanced triplets currents



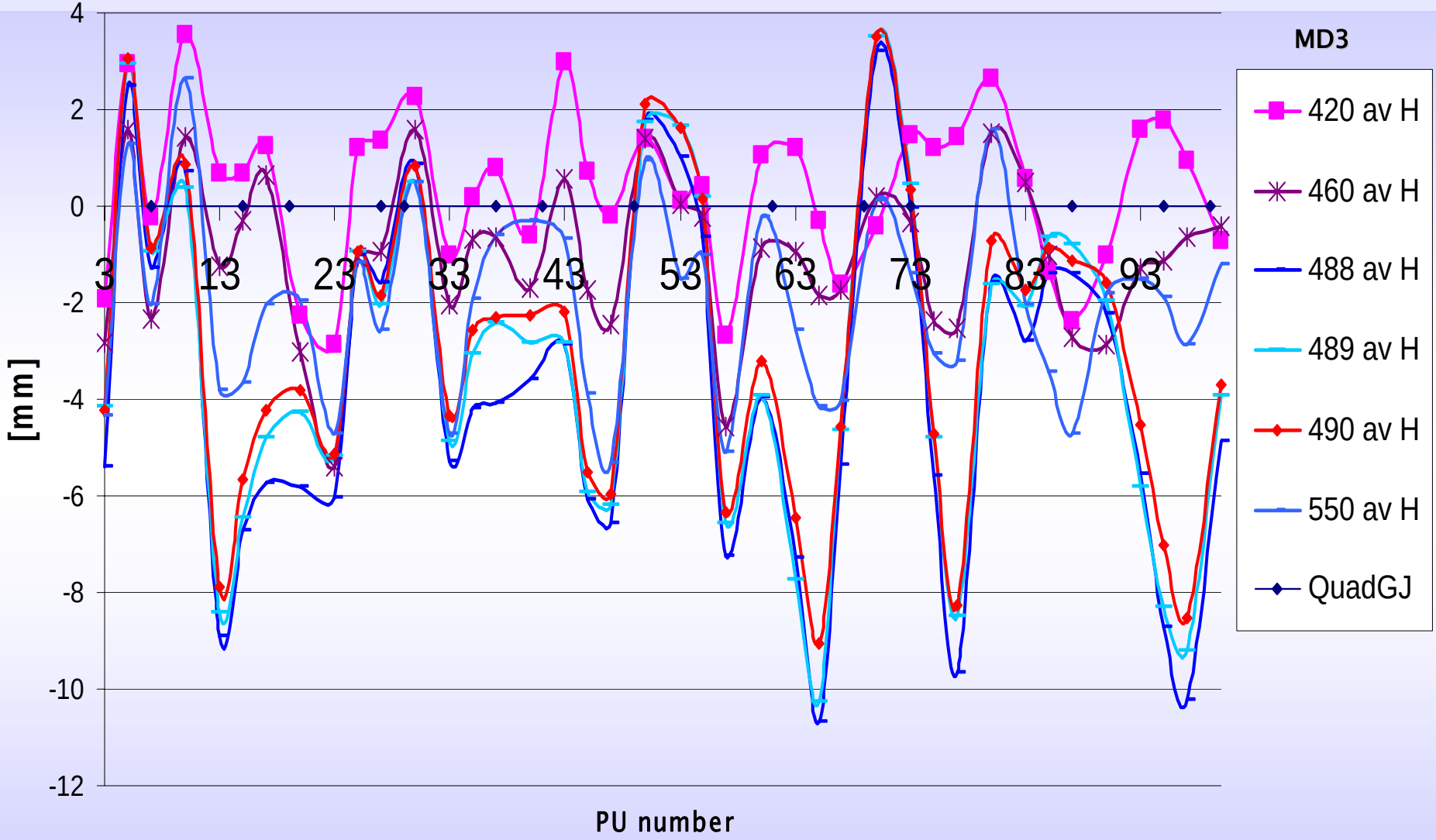
rouge: machine normal – rose: +30% doublets et triplets - vert: +30% triplet

Motivations

Last year, we demonstrated the causes the beam losses at the transition :

- Beam envelope blow-up, we can control by changing unbalanced triplet currents
- Orbit distortion at the transition

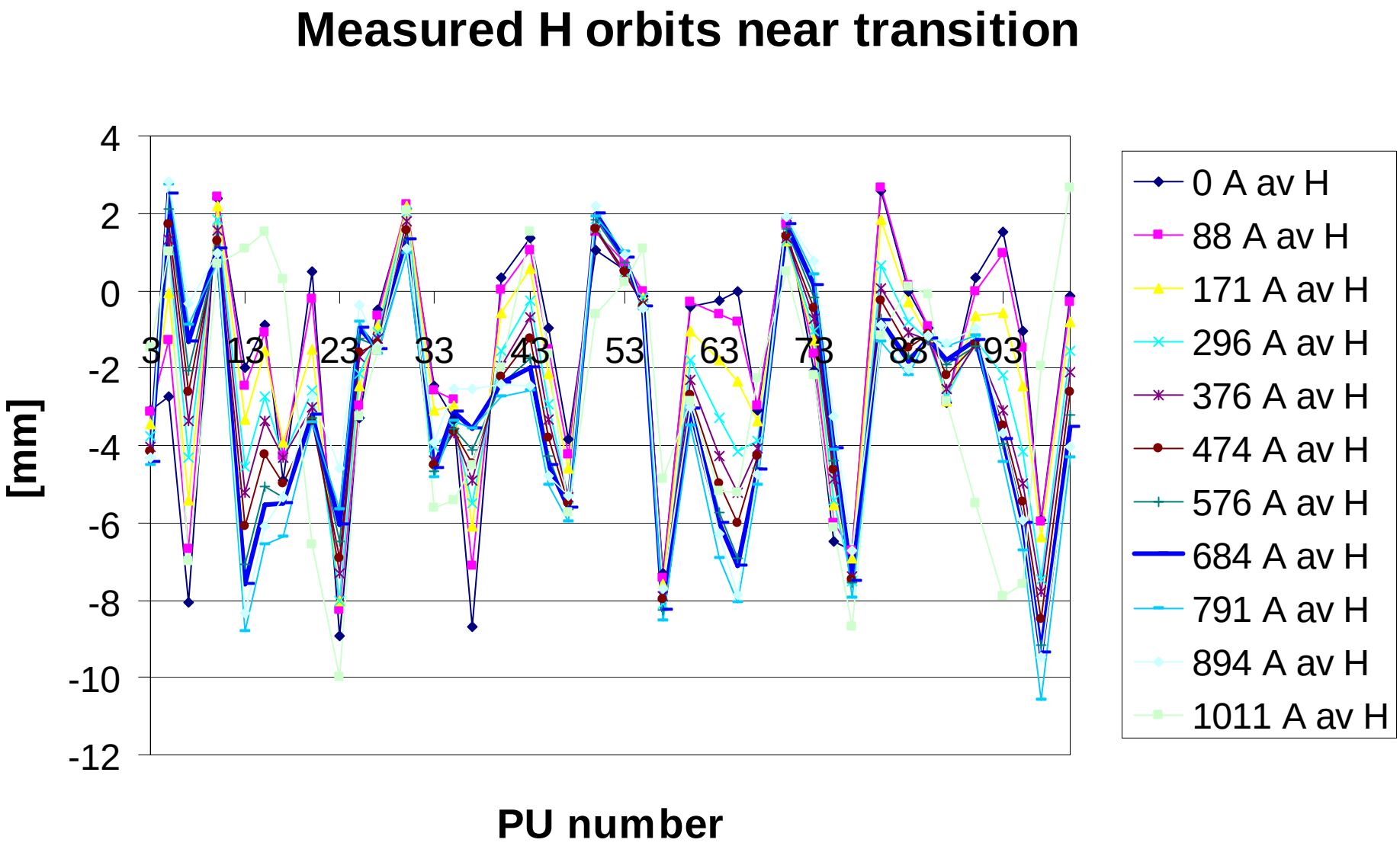
Orbit distortion in the horizontal plane



Orbit distorsion measured in the horizontal plane in june 2006 at the transition
probably due to GammaJump elements

Causes: quadrupoles misalignments ?

Orbit measurements at the transition by varying the doublet magnets



Questions ?

The main cause of Orbit Distortion problem is:

- a **related to the beam control (radial or phase loop)**?
- a physics problem ? Due to **quadrupole misalignments**?
- Both ?

The latest could be checked by simulation with MAD

The quadrupoles have been realigned during this Shutdown

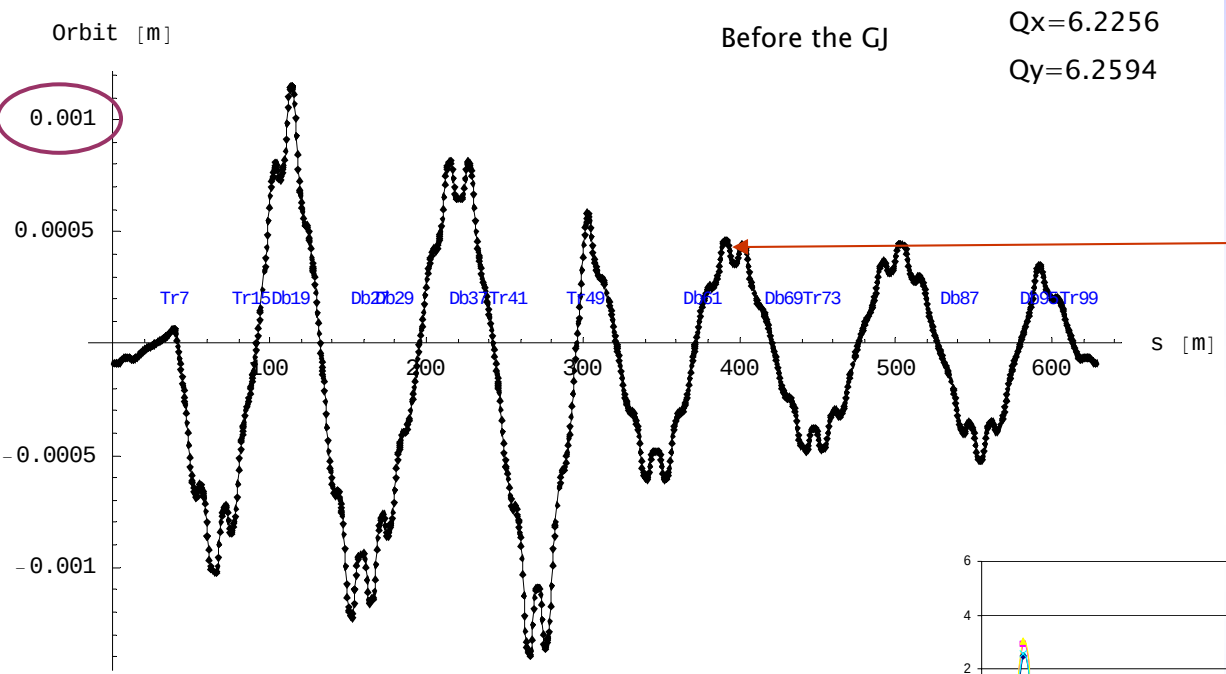
N° SECTION DROITE	QUADRUPOLE	enmm ECART VERTICAL		enmm ECART RADIAL		mrd TILT
		entrée	sortie	entrée	sortie	
7	409.07	+0.3	+0.2	-0.6	-1.2	+1.3
15	407.01	-0.6	-0.3	-0.4	-0.2	+0.1
19	408.06	-0.6	-0.7	-0.4	-0.5	-0.2
27	406.04	+1.2	+1.4	+0.4	-0.6	-0.9
29	406.01	-1.5	-0.7	+0.2	0	-0.7
37	408.04	+1.9	+1.7	+0.3	0	+0.1
41	407.03	-0.7	-0.9	+0.6	-0.1	-0.5
49	409.02	-1.7	-2.2	-0.1	-0.5	+0.1
61	406.02	+0.7	+0.7	+0.1	-0.5	+0.9
69	408.08	+1.2	+1.0	+0.3	-0.7	+0.8
73	407.07	-1.6	-1.7	+0.2	-0.7	+0.4
87	408.05	+1.2	+1.4	-0.3	-0.1	+0.1
95	408.01	+1.4	+1.5	-0.6	-0.7	-0.3
99	407.02	+0.3	+0.5	-0.5	-0.7	+0.1

Orbit meas with Elias and Rende
Quads alignements from T. Dobers

From Simone's slides

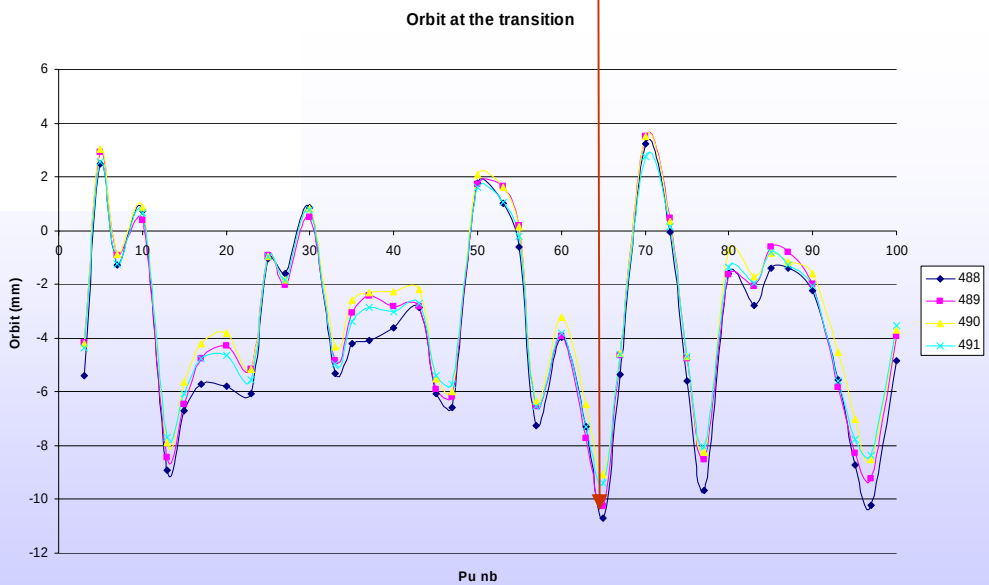
14th August 2006

Results of the PS orbit simulation with GJ quadrupole misalignments



Horizontal plane

PU 63



The orbit due to the quadrupole misalignments is out of phase by a factor π with respect to the measured orbit

The quadrupole misalignments are not a sufficient explanation to find the same order of magnitude (x[Pu63]= -10 mm at the transition instead of 0.5 mm calculated by simulation)

First conclusions…

- The GJ quadrupole misalignments are not the main causes of the orbit distortion, they have a weak influence (maximum around 1 mm).

- It is not possible to reproduce the “real” orbit by simulation

NEED to introduce more errors in MADX PS model IF THE ORBIT DISTORTION IS NOT A CONTROL PROBLEM.

- Next, orbit and dispersion measurements to find out the cause (dispersion growing ? Energy mismatch ? Problem of beam control ?)

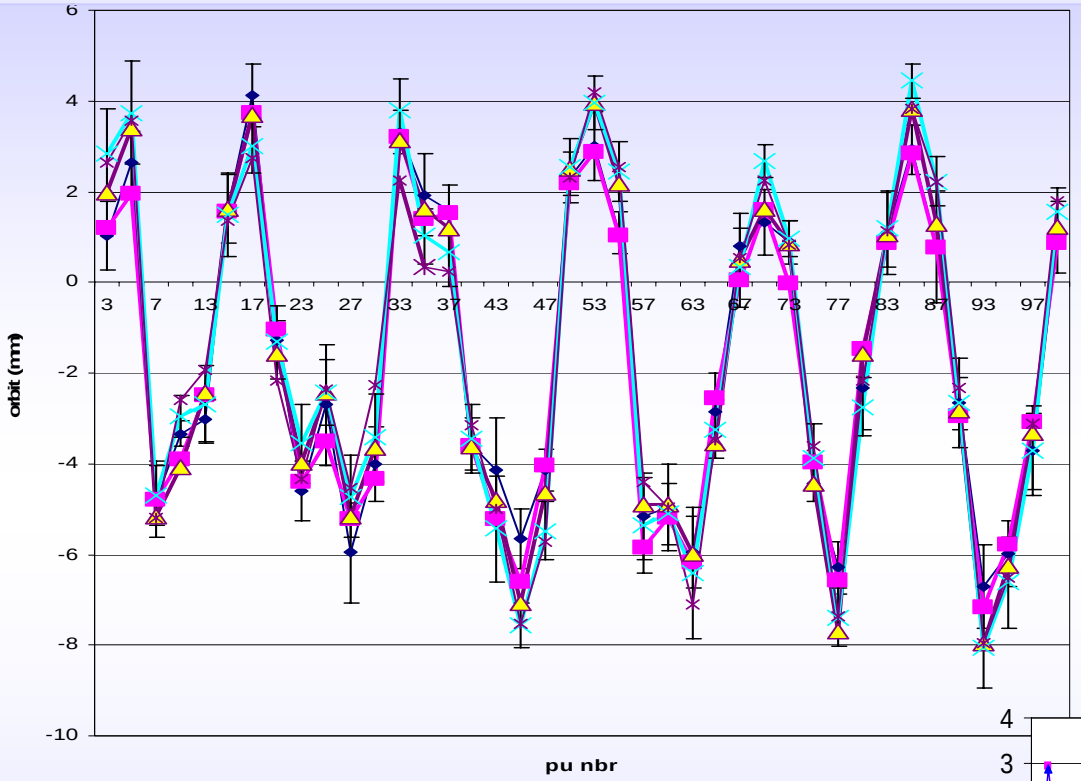
MD 18 of June 2007

Orbits and Dispersion measurements at the transition

Contents of the MD

- Orbit measurements with the nominal values of GJ quadrupoles.
- Dispersion measurements by applying a radial steering to the beam – These measurements have been made to confirm or not the MADX model.
- Tune measurements for the MADX model
- Orbit measurements by switching off some GJ quadrupoles

Beginning of the GJ magnetic cycle: measured orbit in the horizontal plane

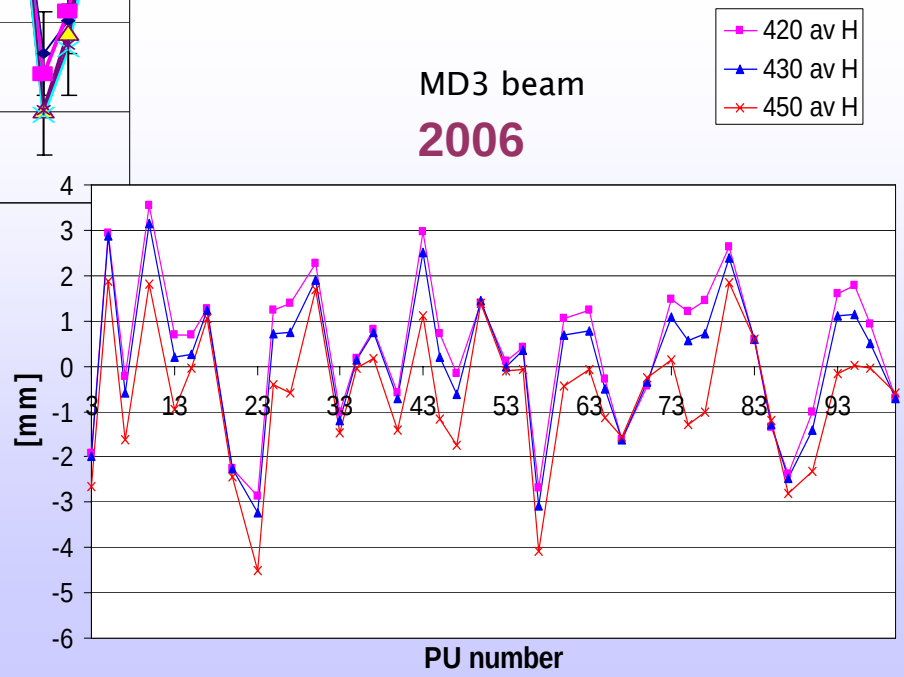


MD2 beam

2007

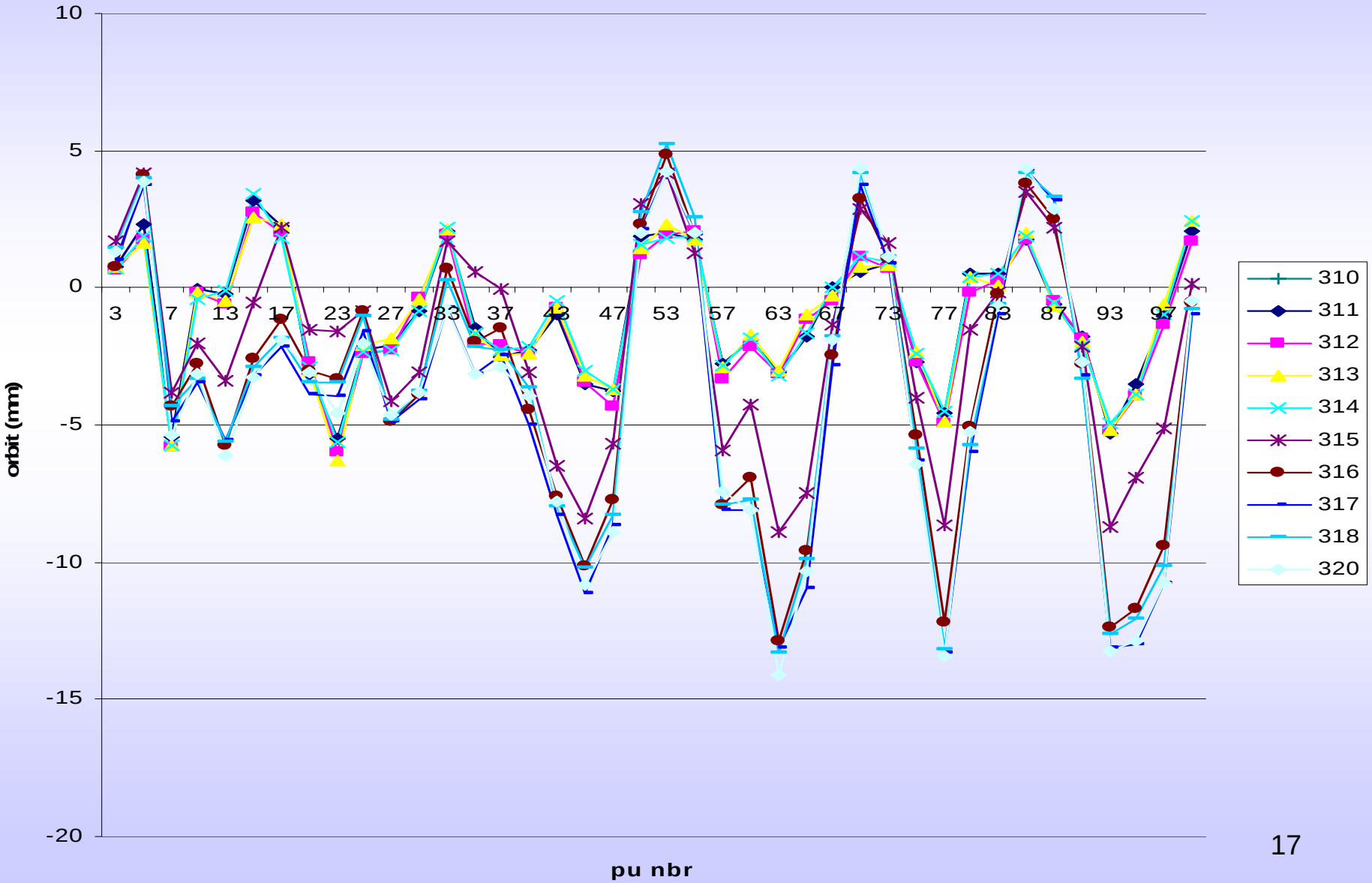
MD3 beam

2006

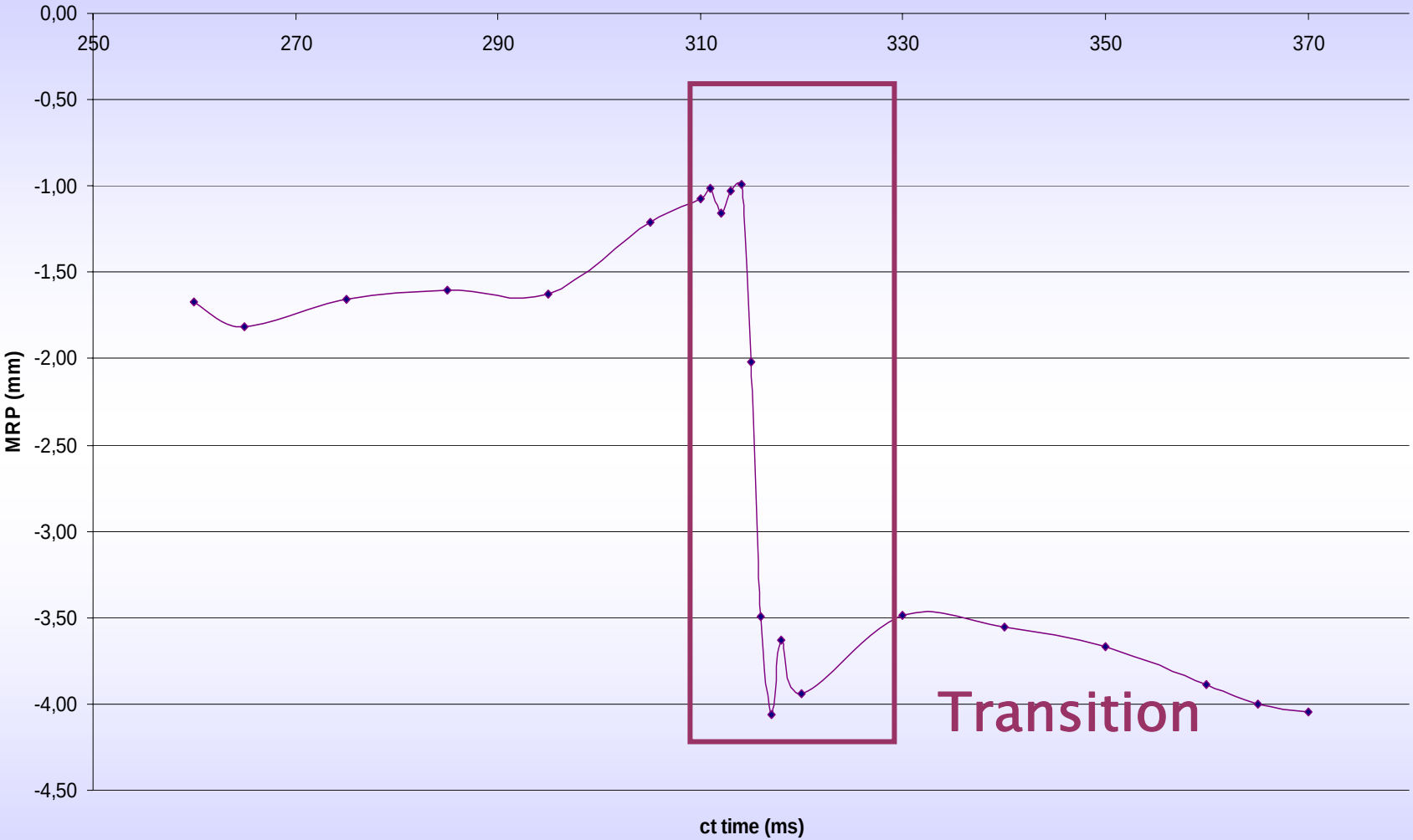


- No triplet magnet effects, seems the magnets are well aligned, compared to the orbit from 2006
- Could be also an effect of the beam

Measured orbit in the horizontal plane: at the transition

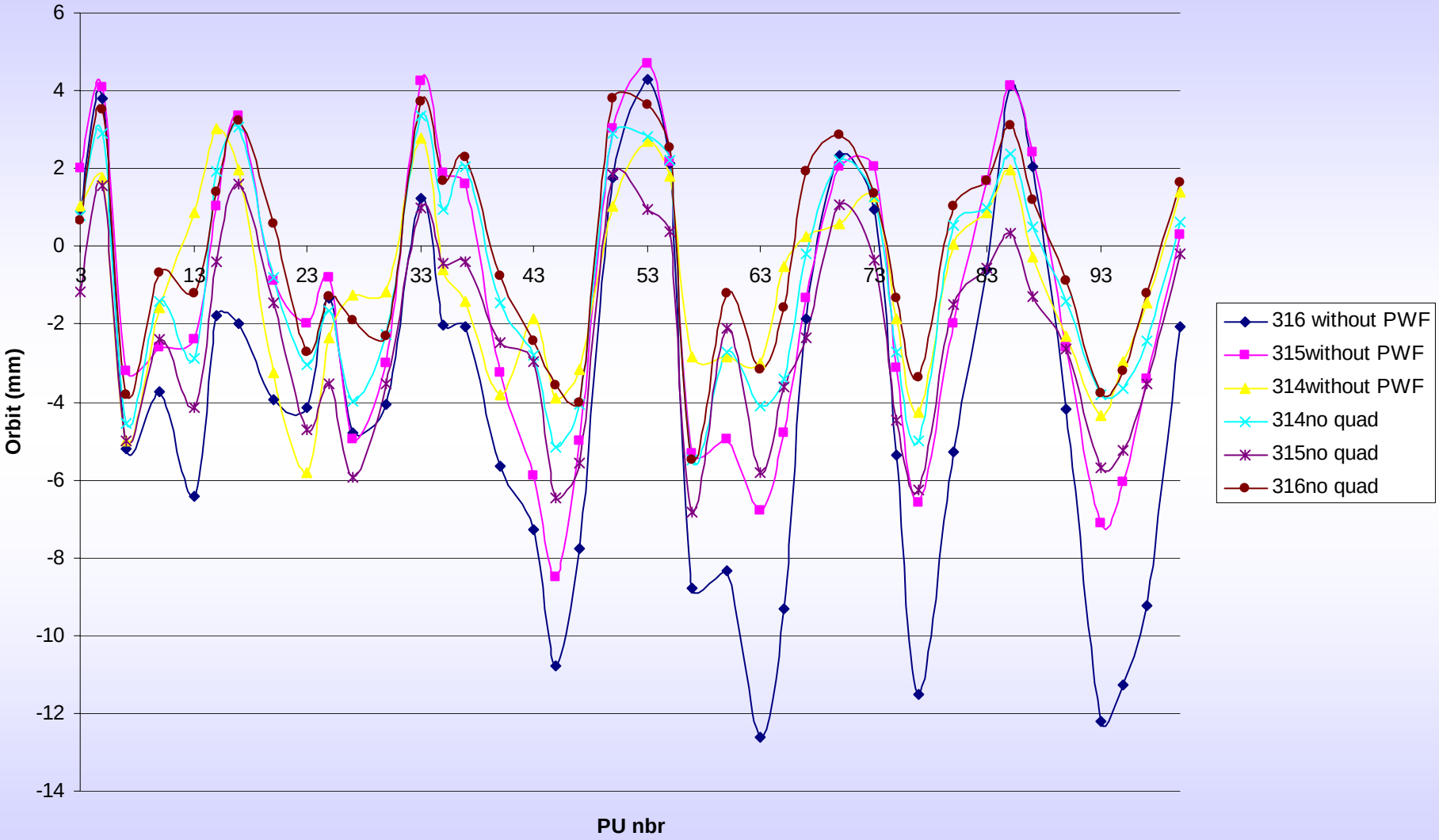


Mean Radial Position of the beam



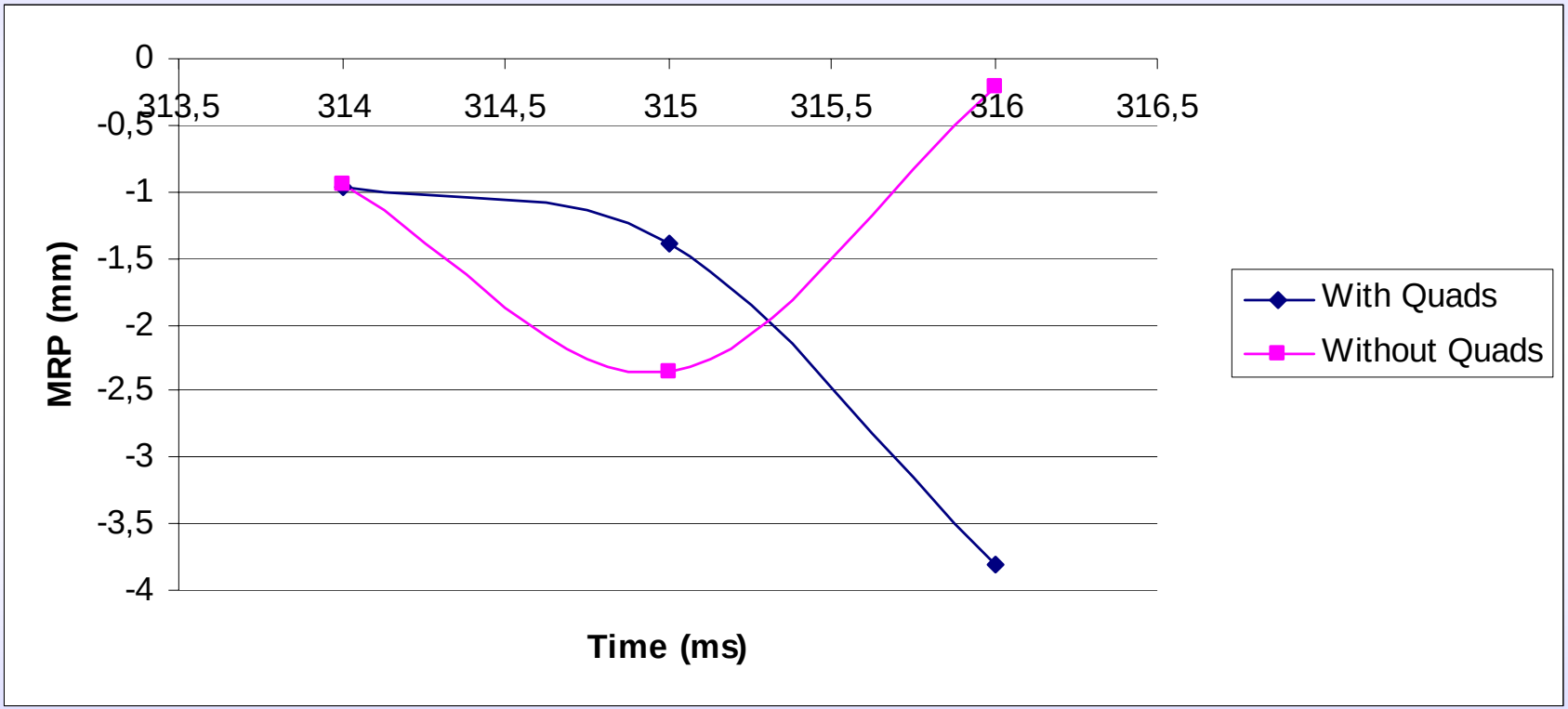
The radial position changed suddenly with phase inversion at the transition

Orbit Measurements without PFW and/or Quadrupoles



No orbit distortion if No GJ quadrupoles

MRP without PFW and/or Quadrupoles



MRP calculated with the 40 PU

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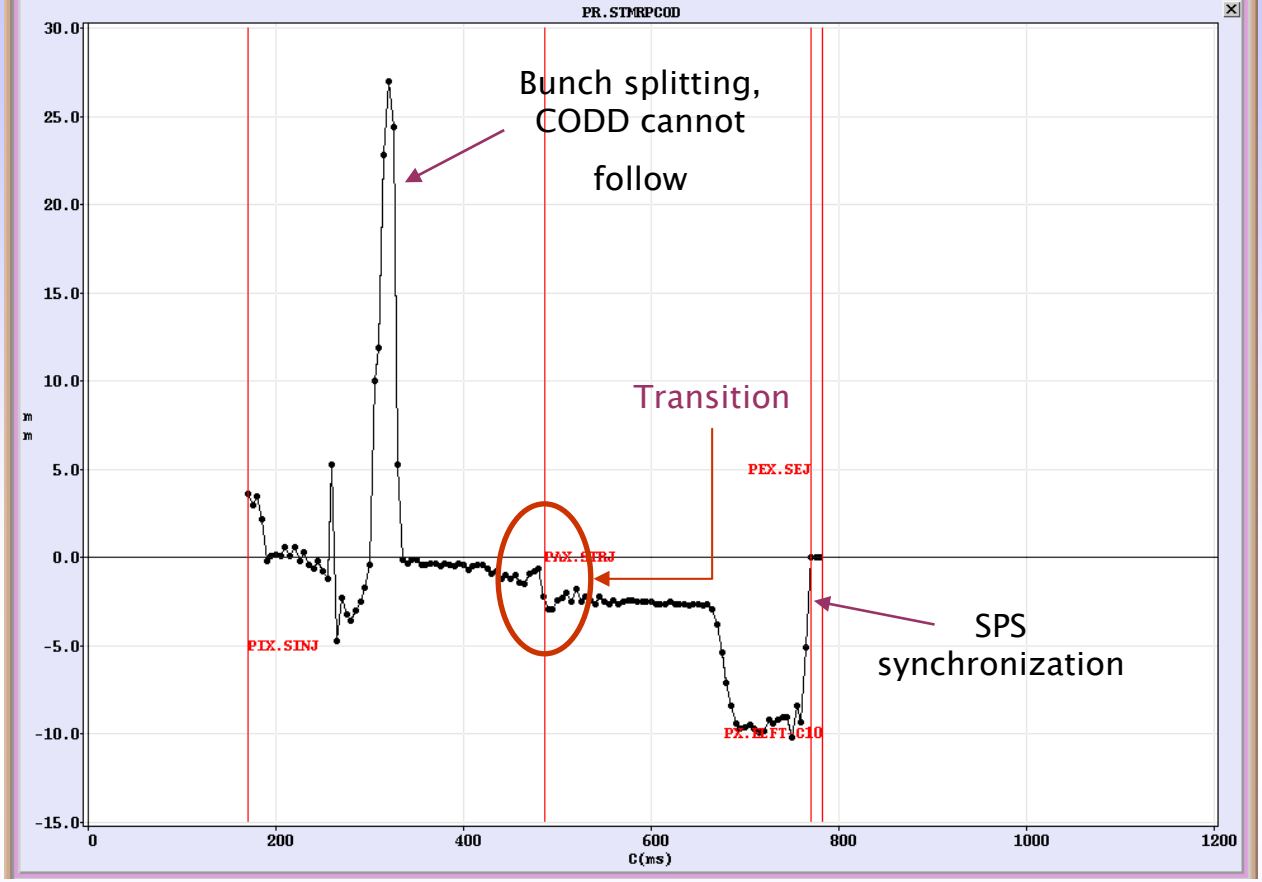
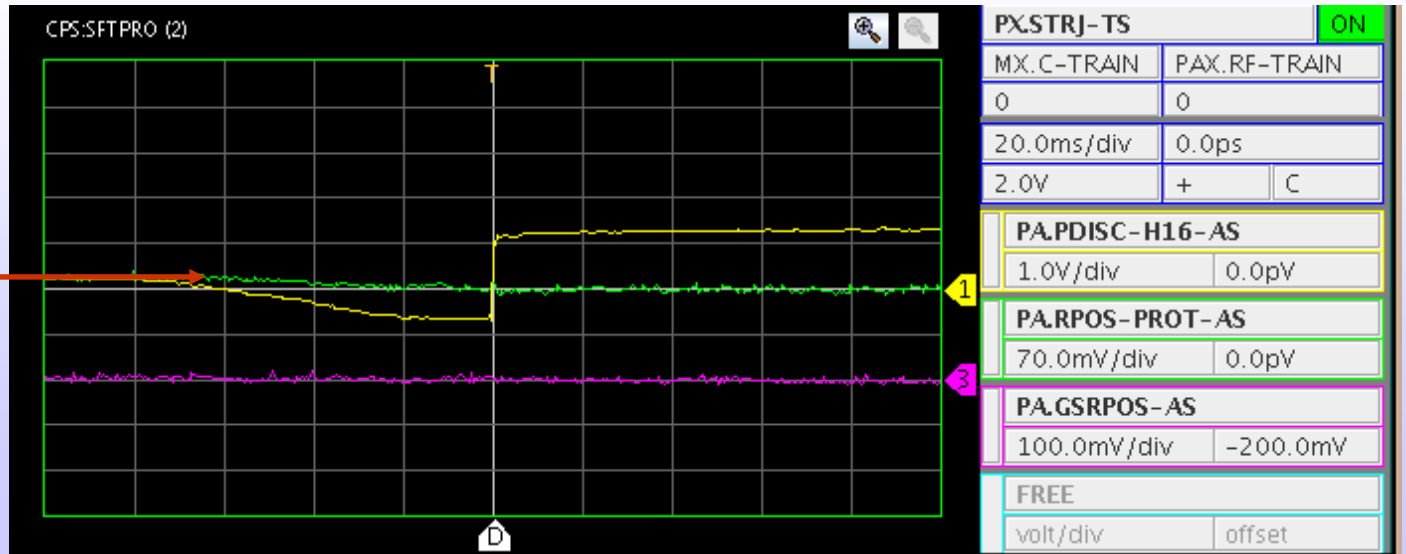
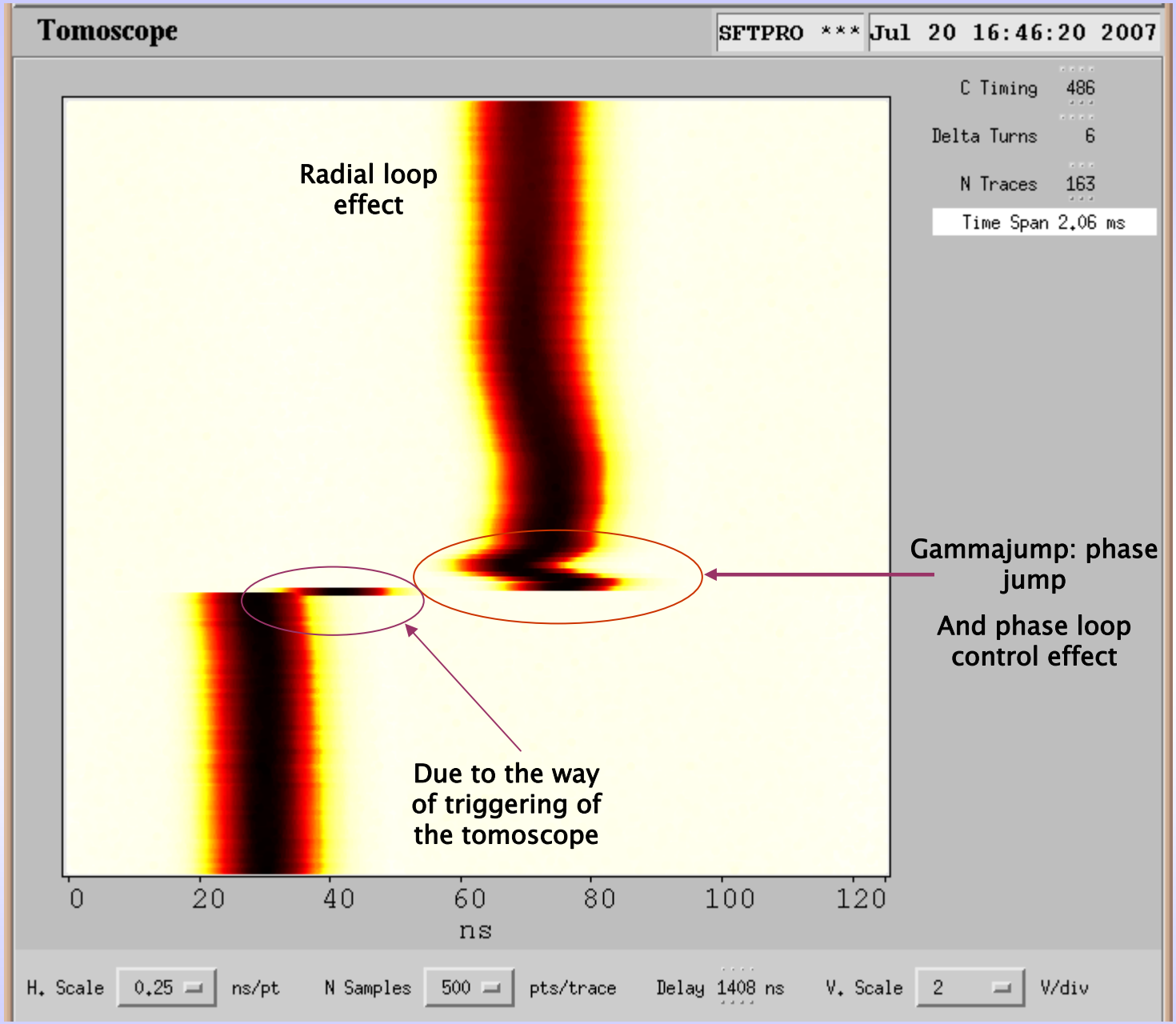
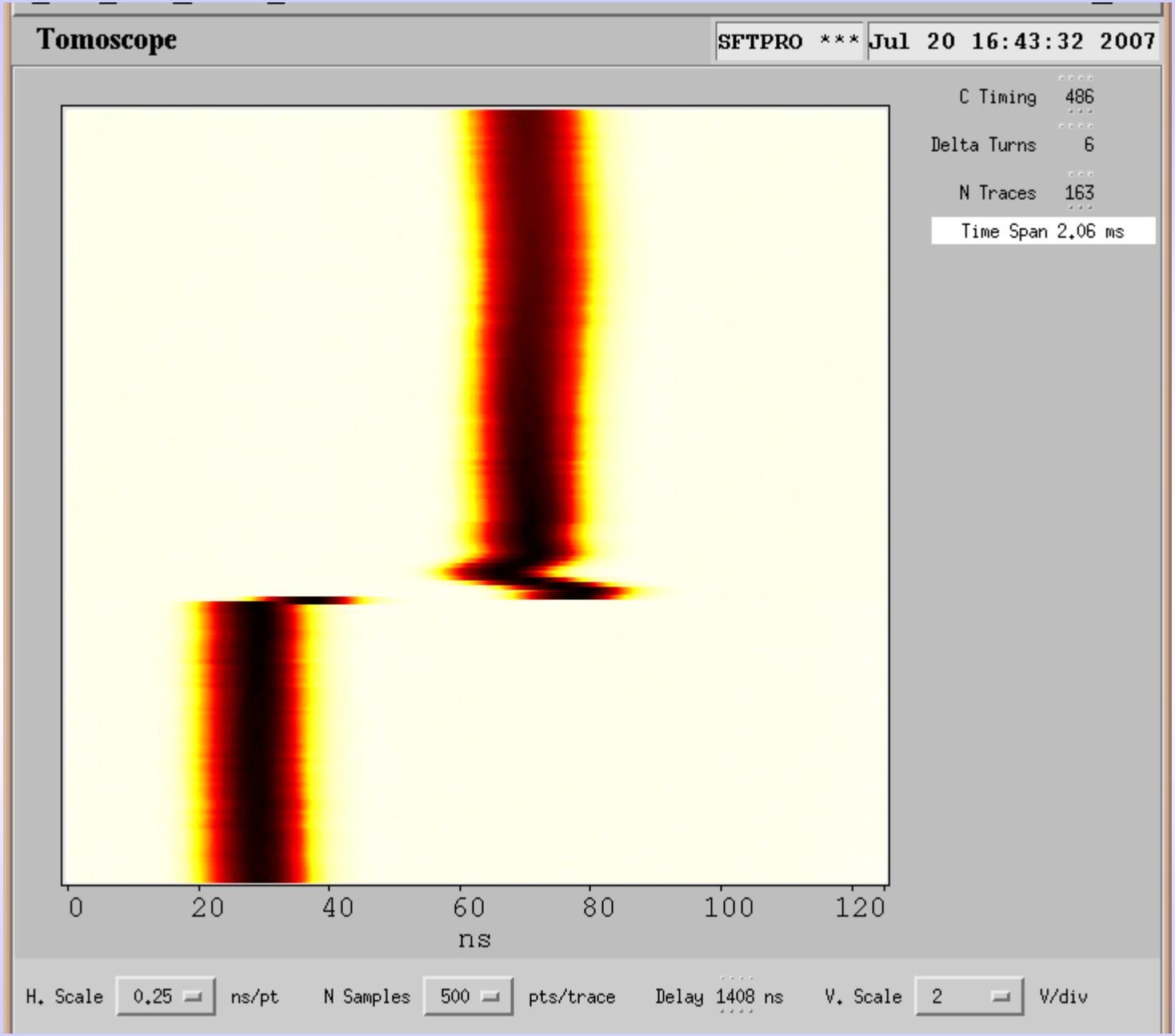


MRP calculated with the PU 22-51-96

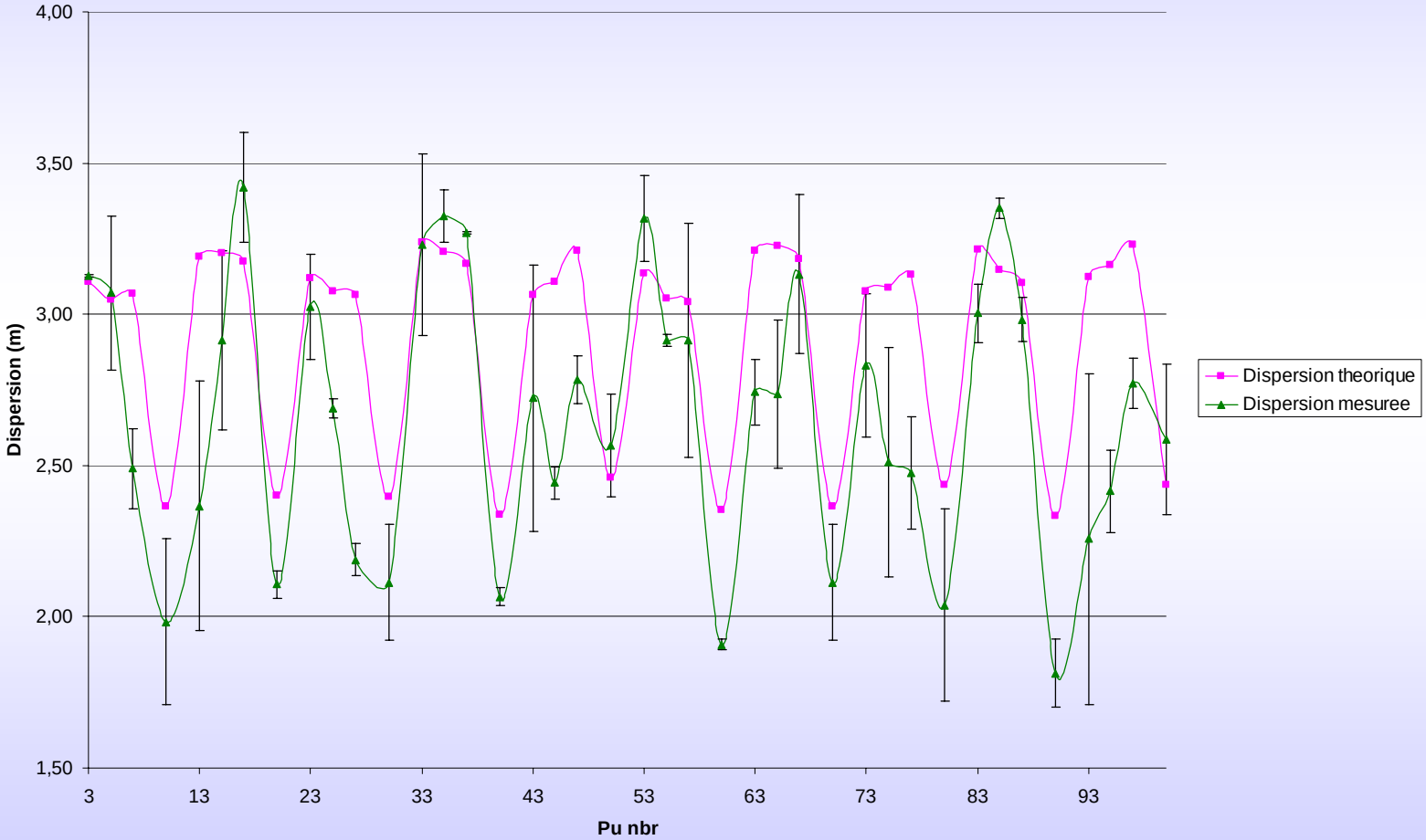



Tomoscope
SFTPRO *** Jul 20 16:46:20 2007
C Timing 486
Delta Turns 6
N Traces 163
Time Span 2.06 ms
Radial loop effect
Gammajump: phase jump
And phase loop control effect
Due to the way of triggering of the tomoscope
0
20
40
60
80
100
120
ns
H. Scale 0.25 ns/pt
N Samples 500 pts/trace
Delay 1408 ns
V. Scale 2 V/div



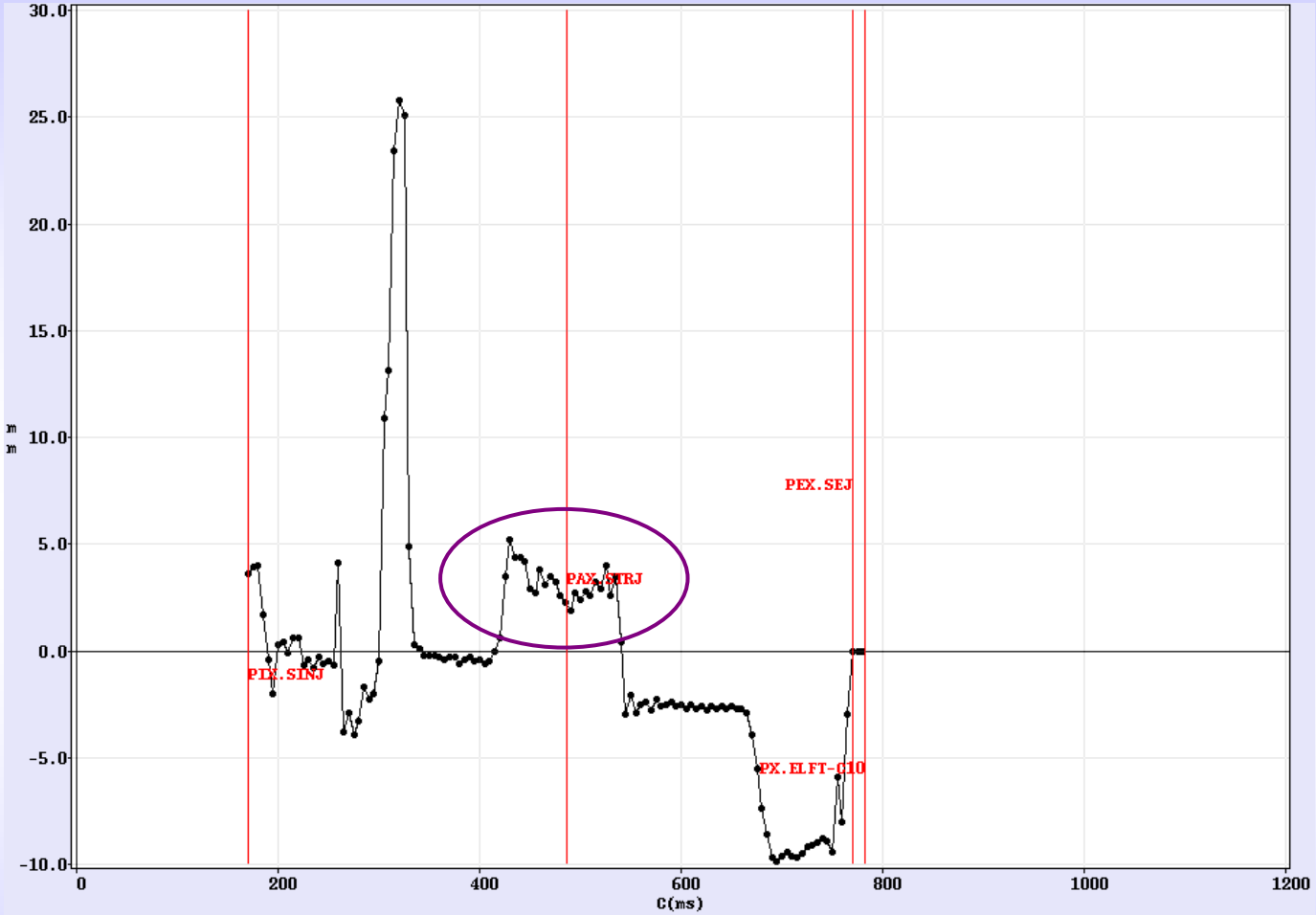
Radial Loop
Gain OFF

Measured Dispersion vs simulated dispersion



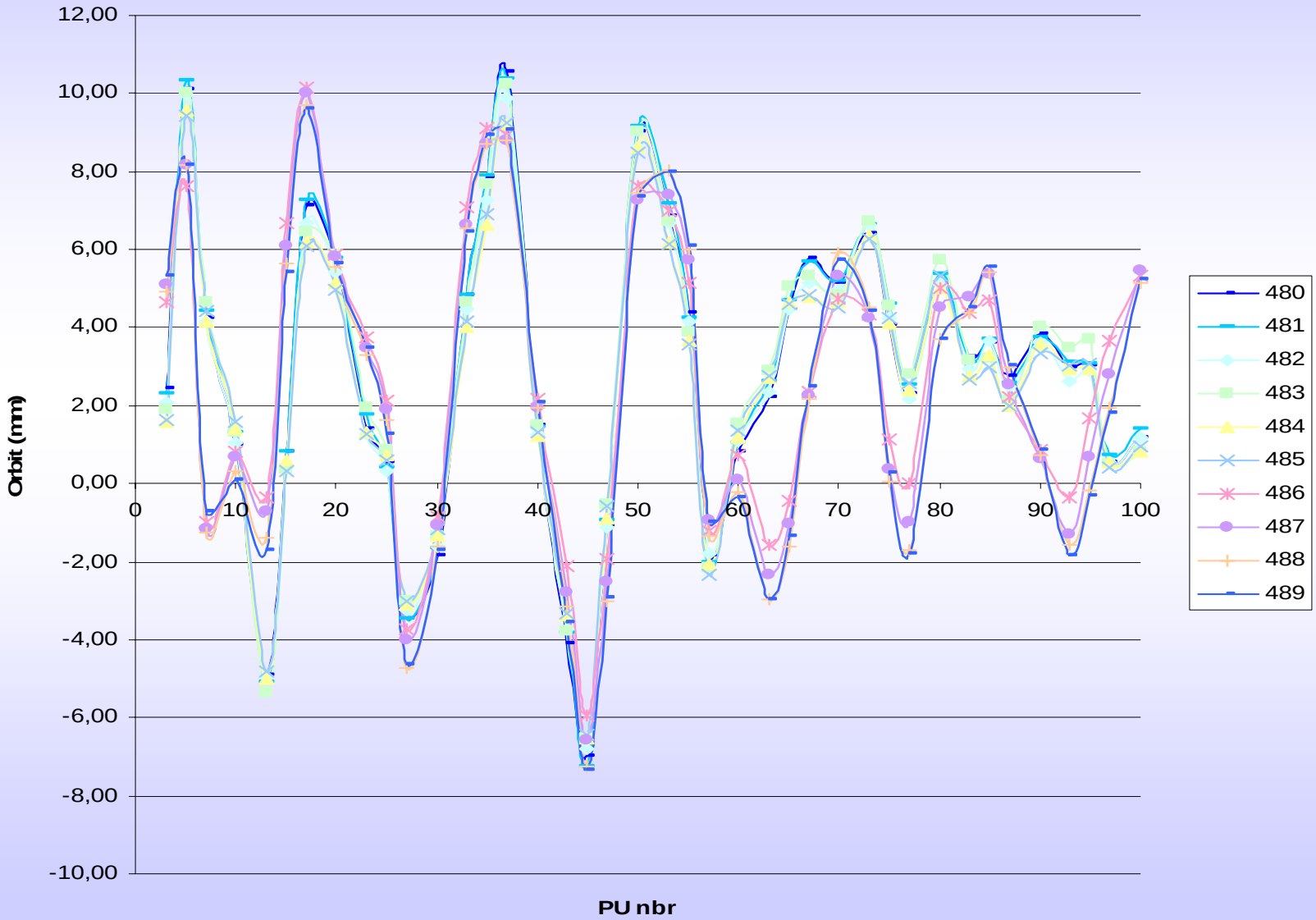
Orbit measurements at the transition with steering and non-equilibrated Triplets

How to correct the beam at the transition ?

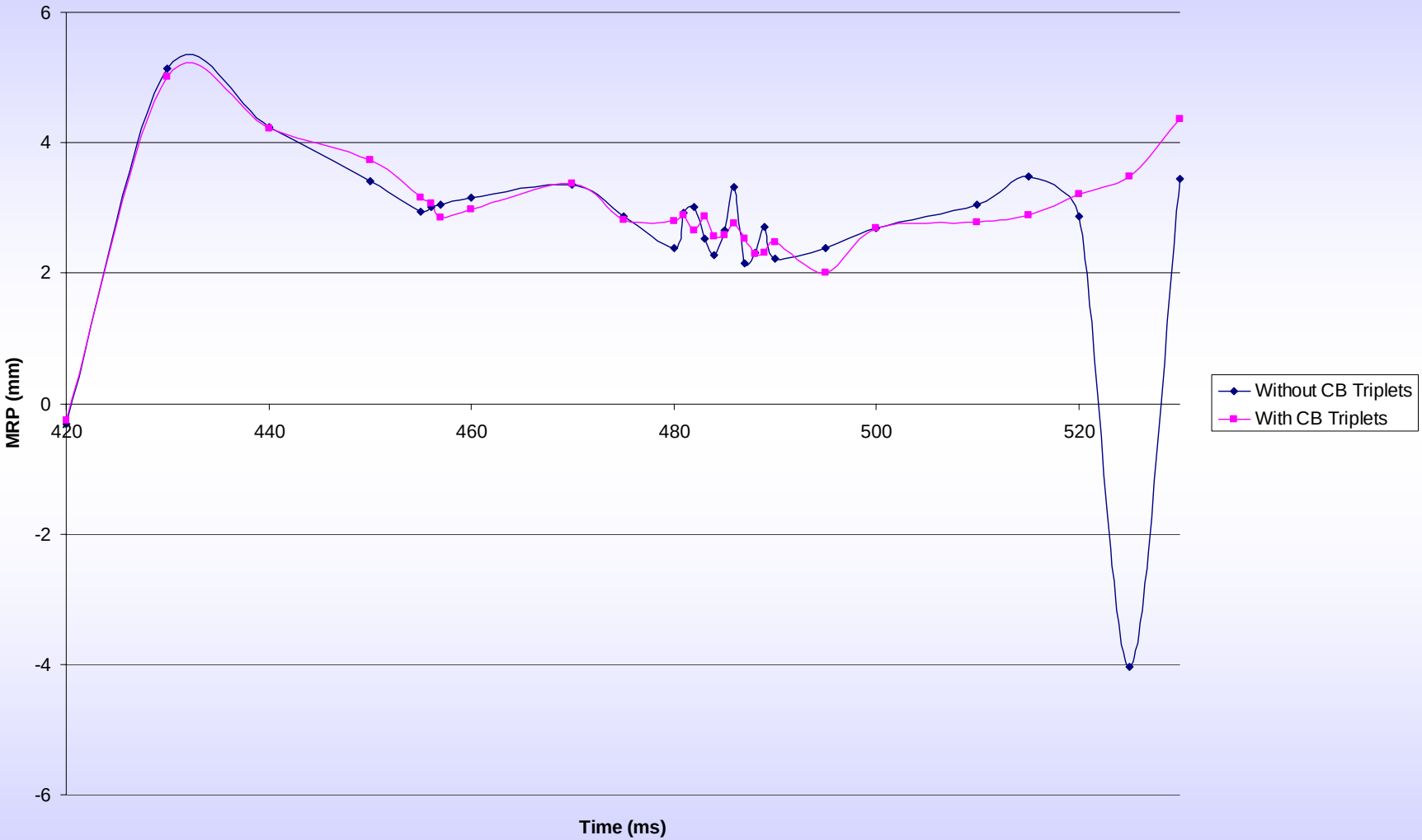


- Radial steering of 3.50 mm at the injection to compensate the MRP jump
- Unbalanced triplets : 0.8 of the nominal value in part A and 0.9 in part B

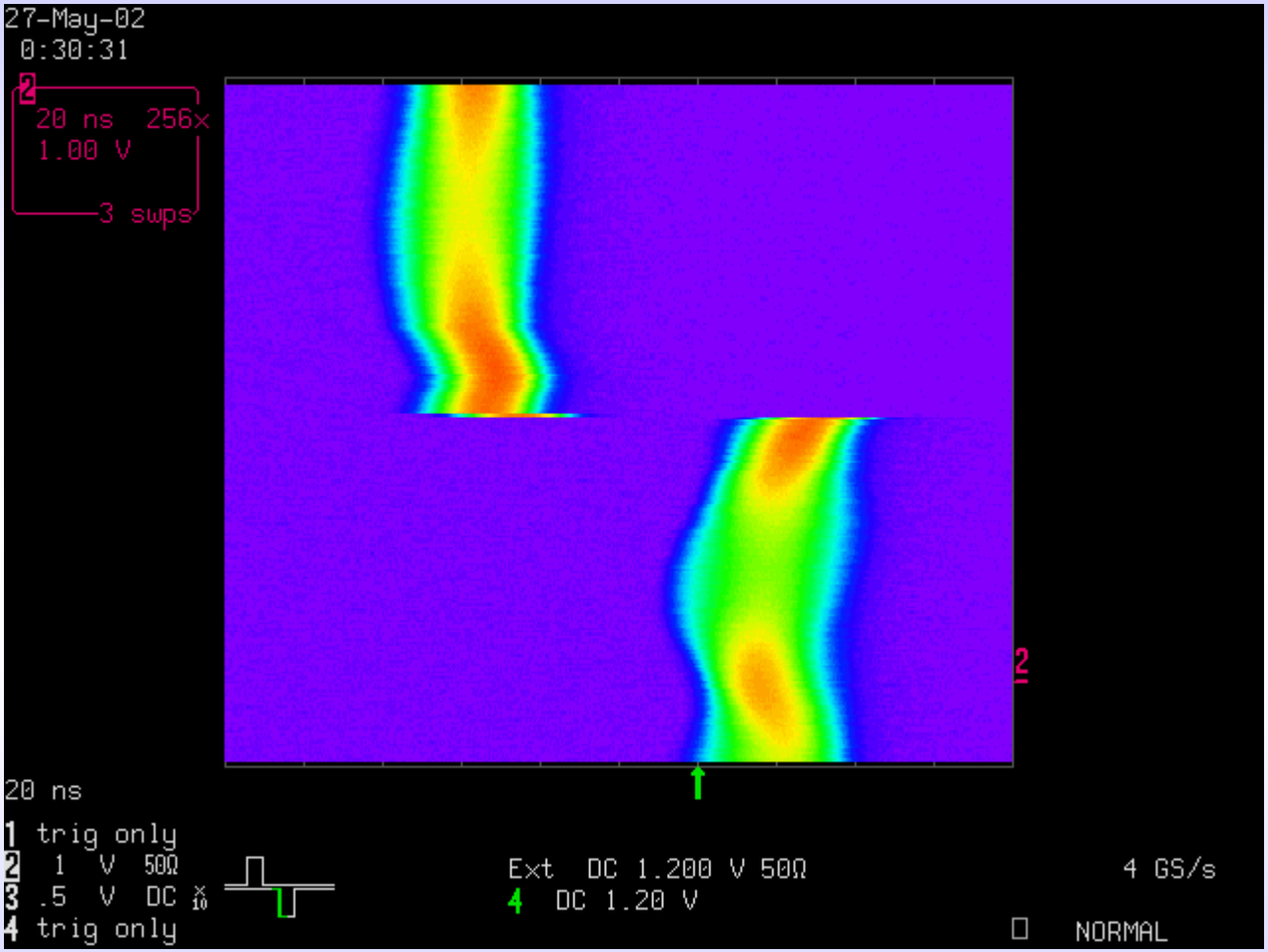
Orbit with the radial steering and nominal triplet value



MRP with the steering



Phase jump with the oscilloscope



TOF from *G Metral*

Beam more intense

There used to be no large phase oscillation for half of the TOF beam loading on the cavities

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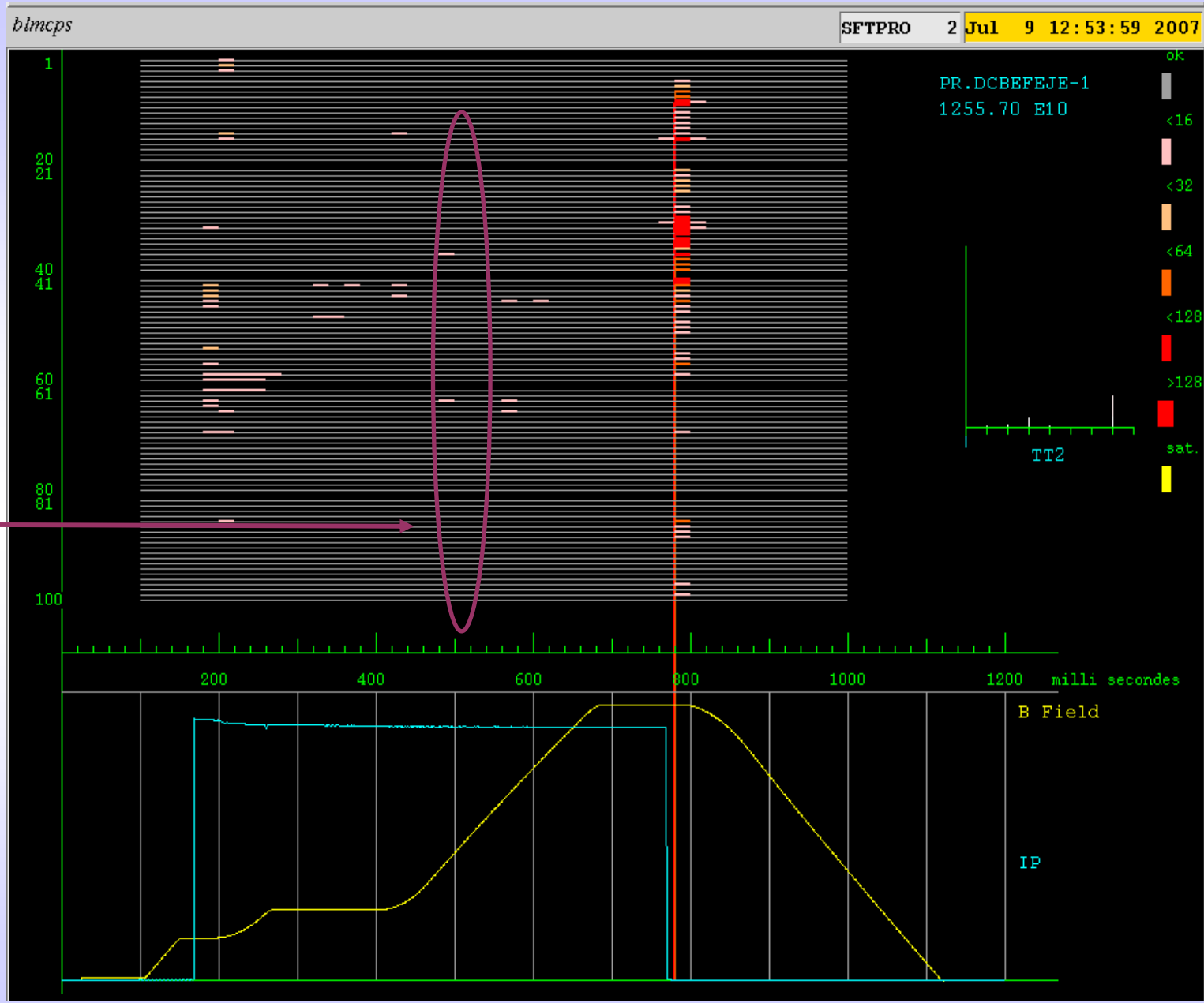

Transition

0.2% Losses !!

Conclusions

Orbit distortion problem : phase and radial loop control problem

- With the radial steering and/or the unbalanced triplet magnets, reduction of the beam looses at the transition
- Some losses appear in SS35 for exemple, but it is explained by the MADX model

What to do next

- Orbit measurements in detail with the radial loop gain OFF
- Orbit correction at the transition with MICADO