ERDs for the CT extraction in the PS

First results of a new correction scheme

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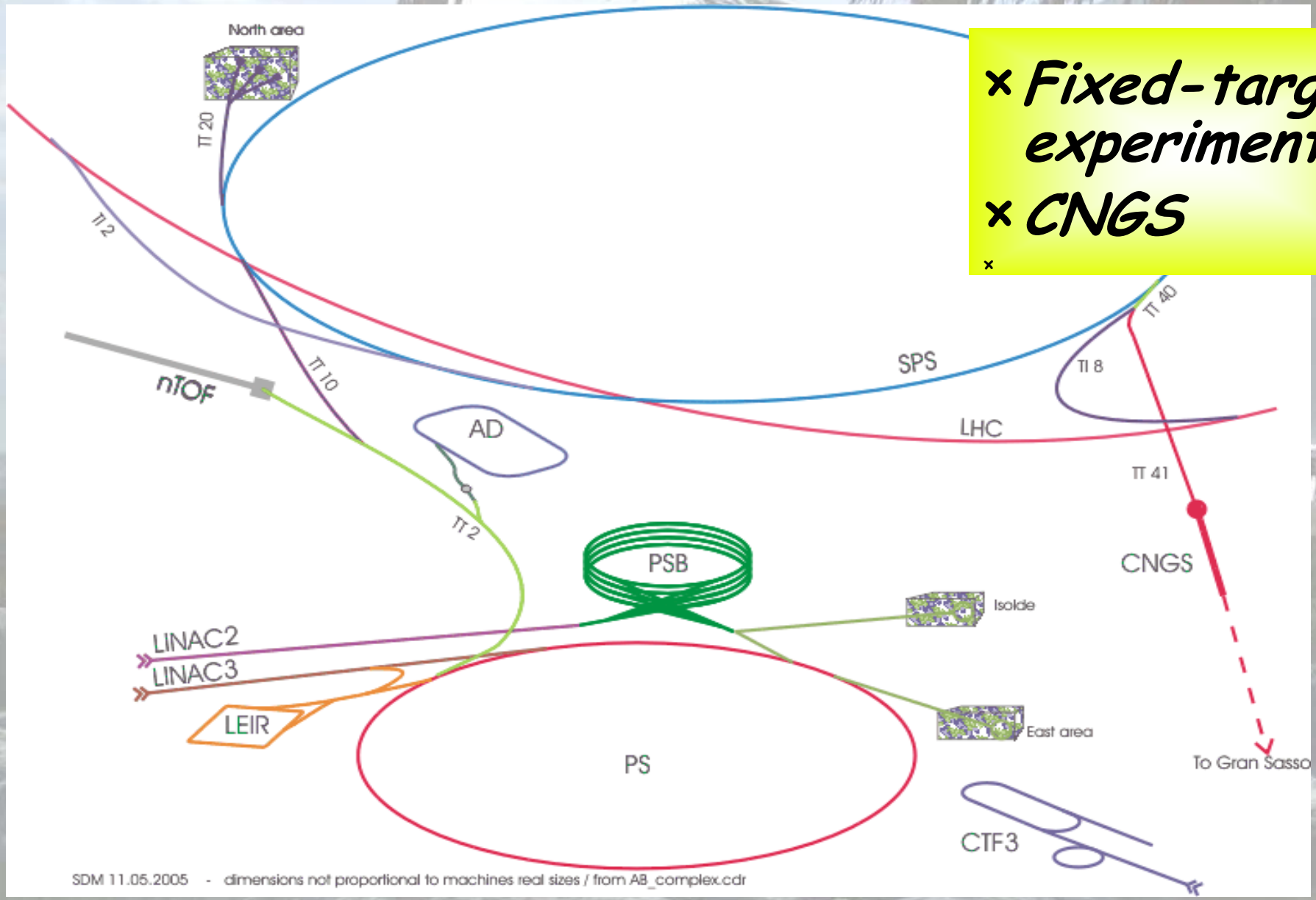
LIS meeting 11 June 2007

Outline

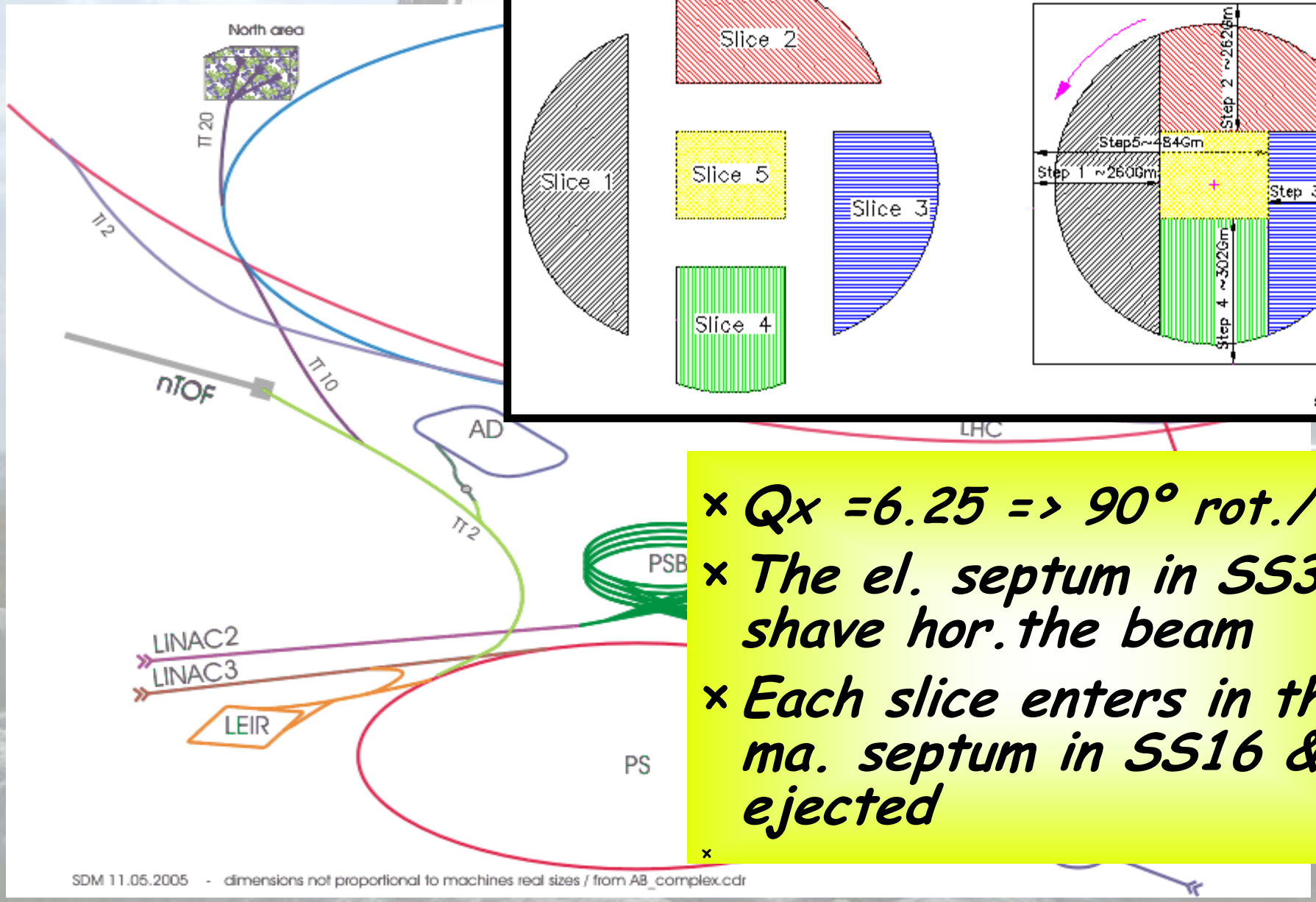
1. Overview and motivations
2. Present correction scheme
3. Principle of the new correction scheme
4. Application manual & first results
5. Summary & conclusion

Overview: the CT extraction



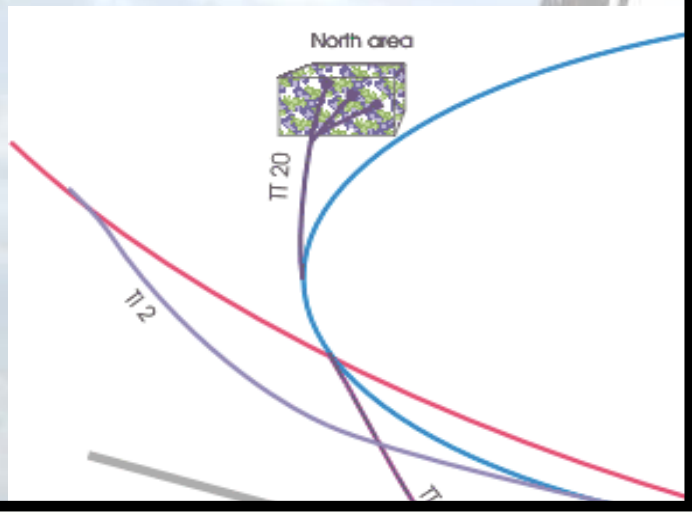
- Fixed-target experiments
- CNGS
-

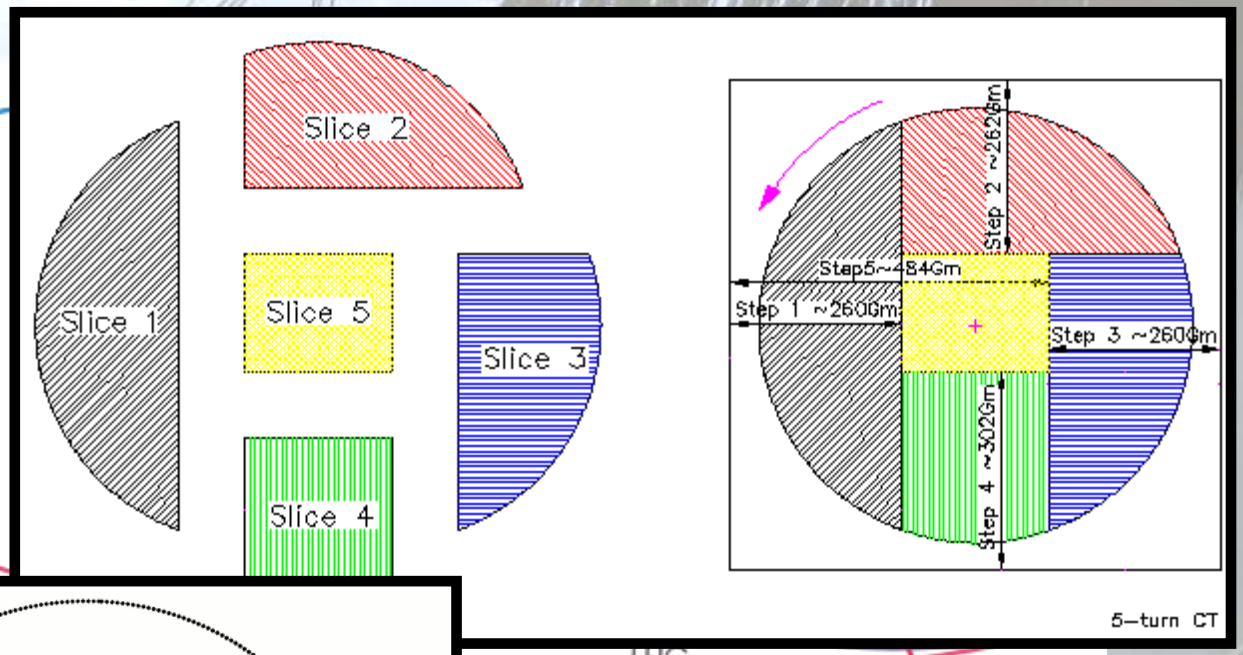
Overview: the CT extraction

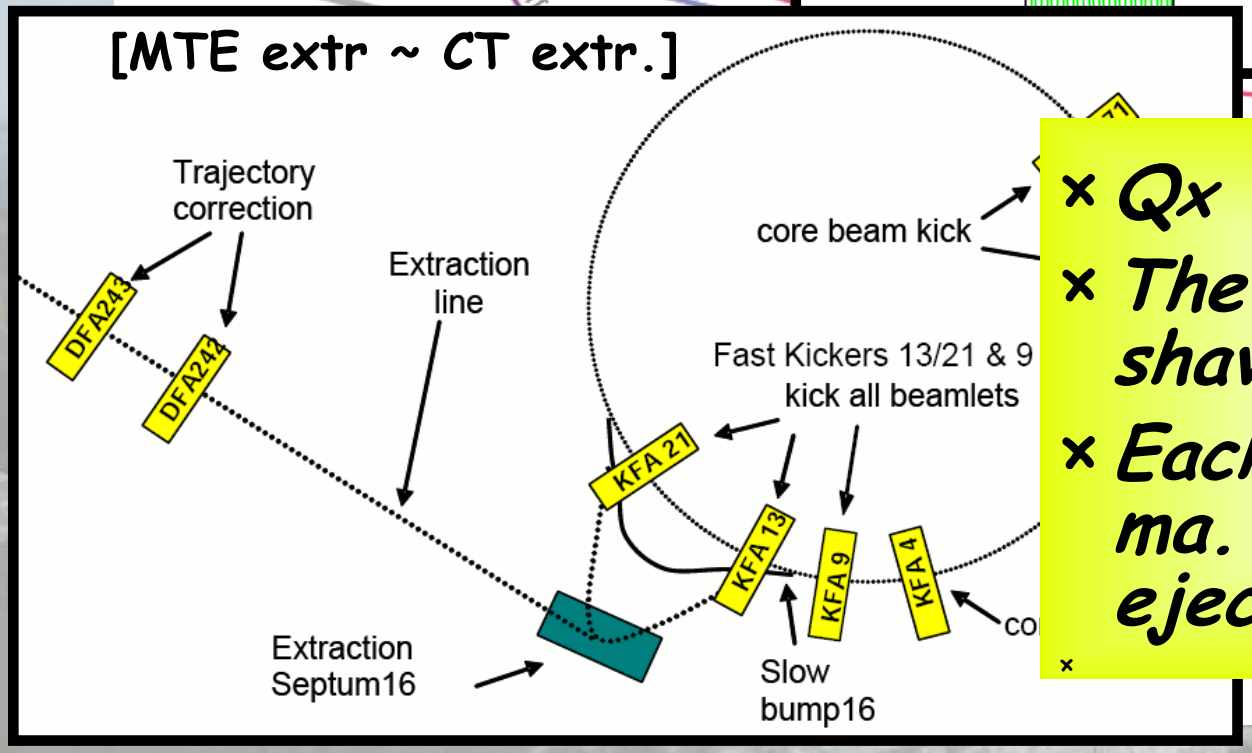


- Qx =6.25 => 90° rot./turn
- The el. septum in SS31 shave hor.the beam
- Each slice enters in the ma. septum in SS16 & is ejected

Overview: the CT extraction







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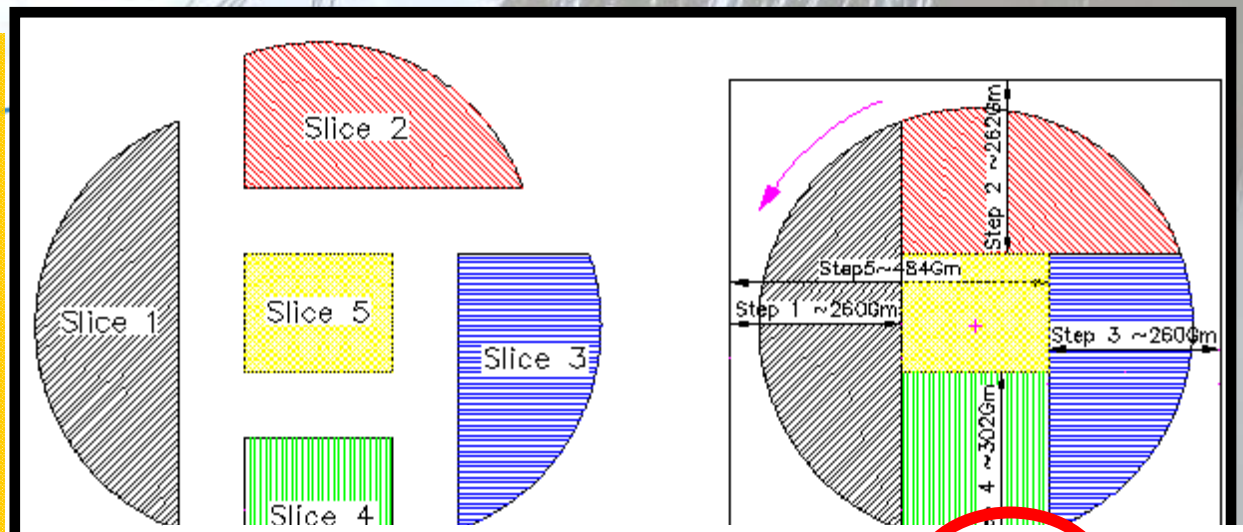
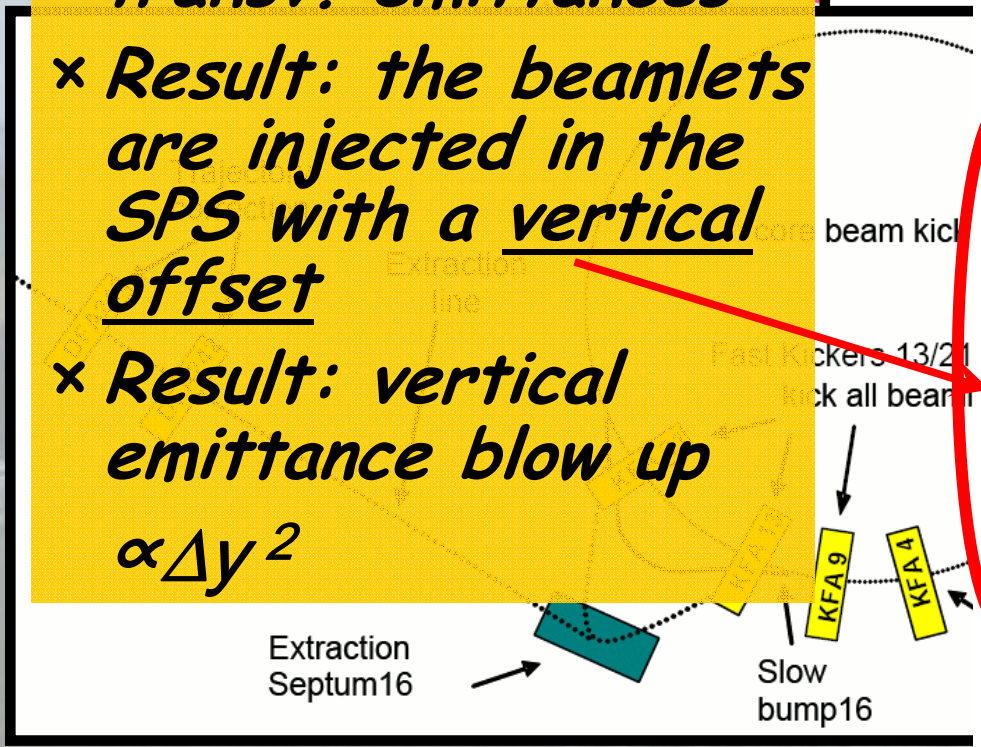
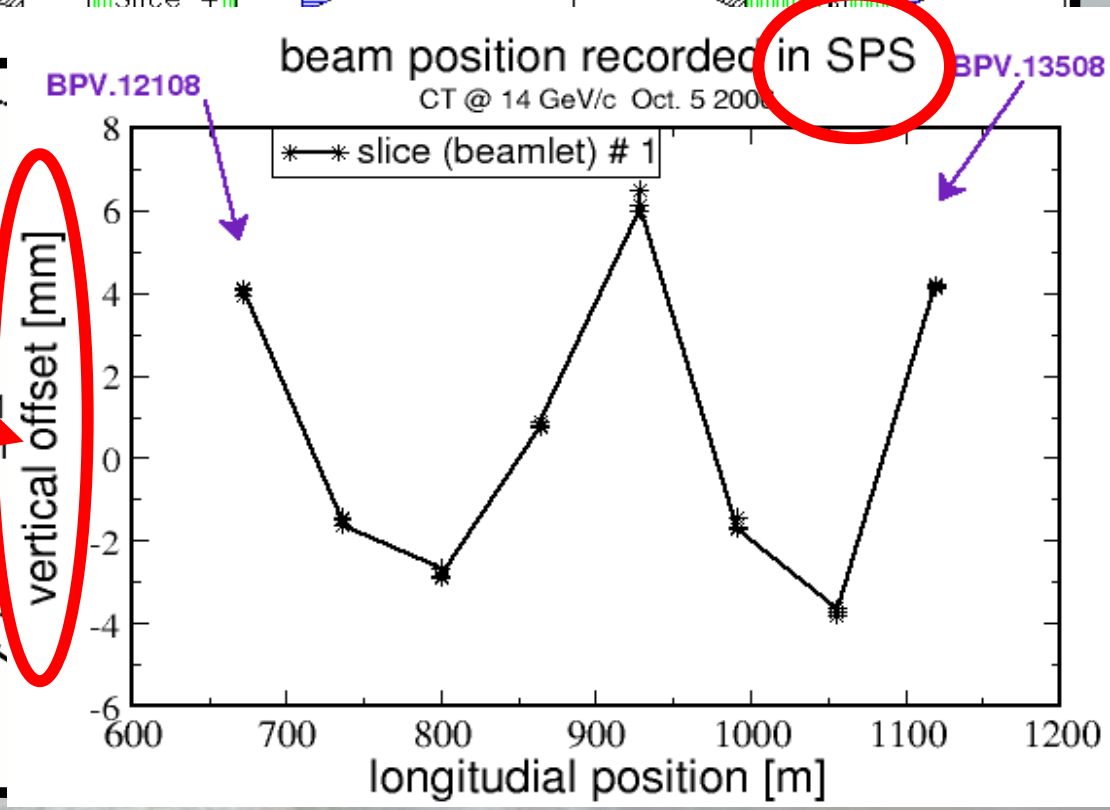
Overview: the CT extraction

- The centroids in (X,PX) of the ejected islands are not the same
- 3 skew quads in TT10 exchange the transv. emittances
- Result: the beamlets are injected in the SPS with a <u>vertical offset</u>
- Result: vertical emittance blow up $\propto \Delta y^2$

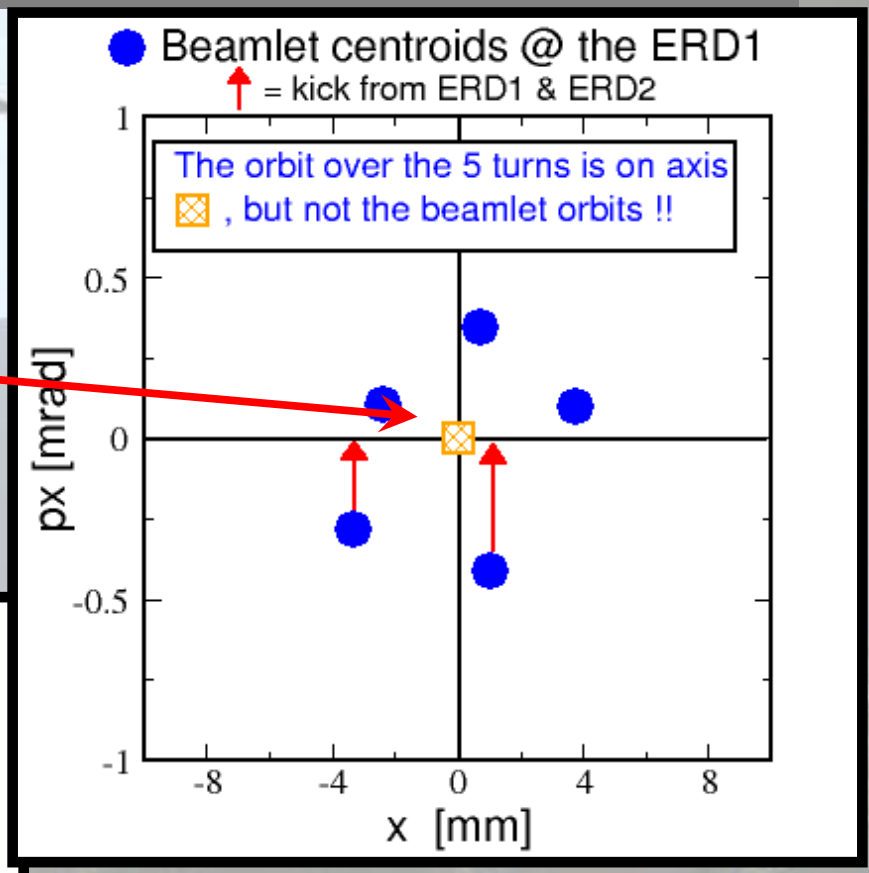


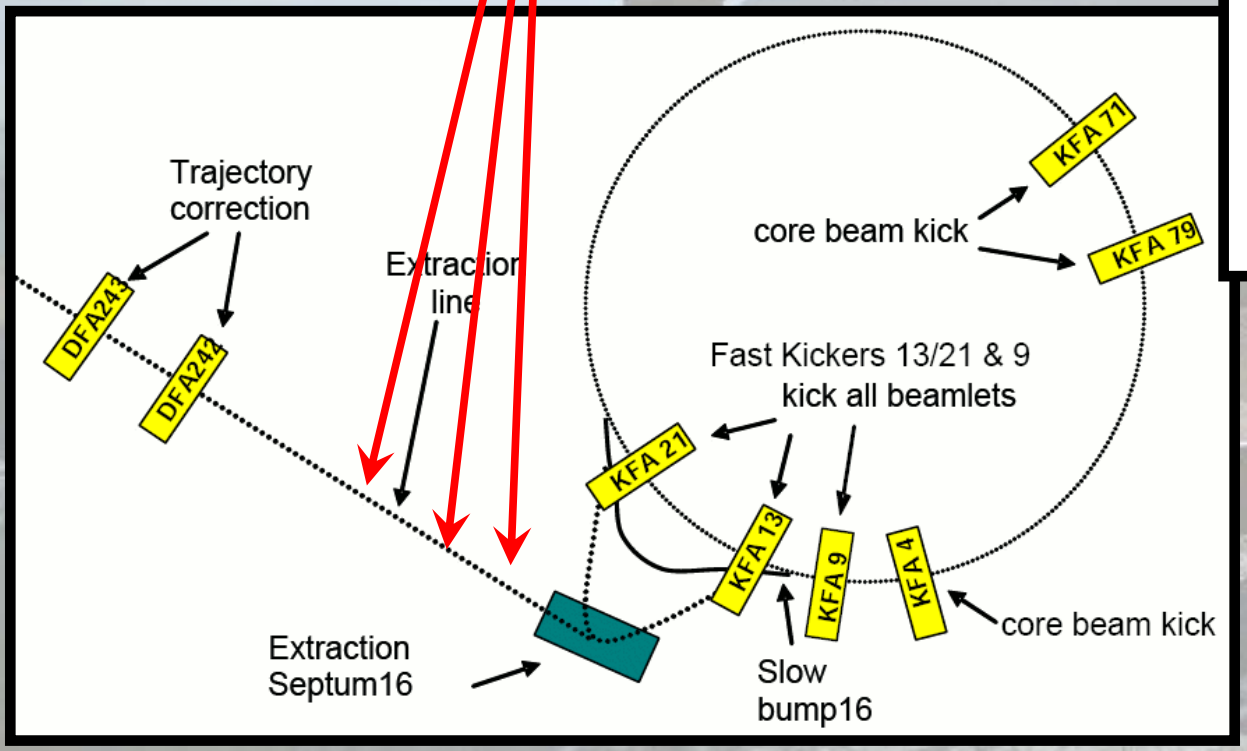




Present correction scheme

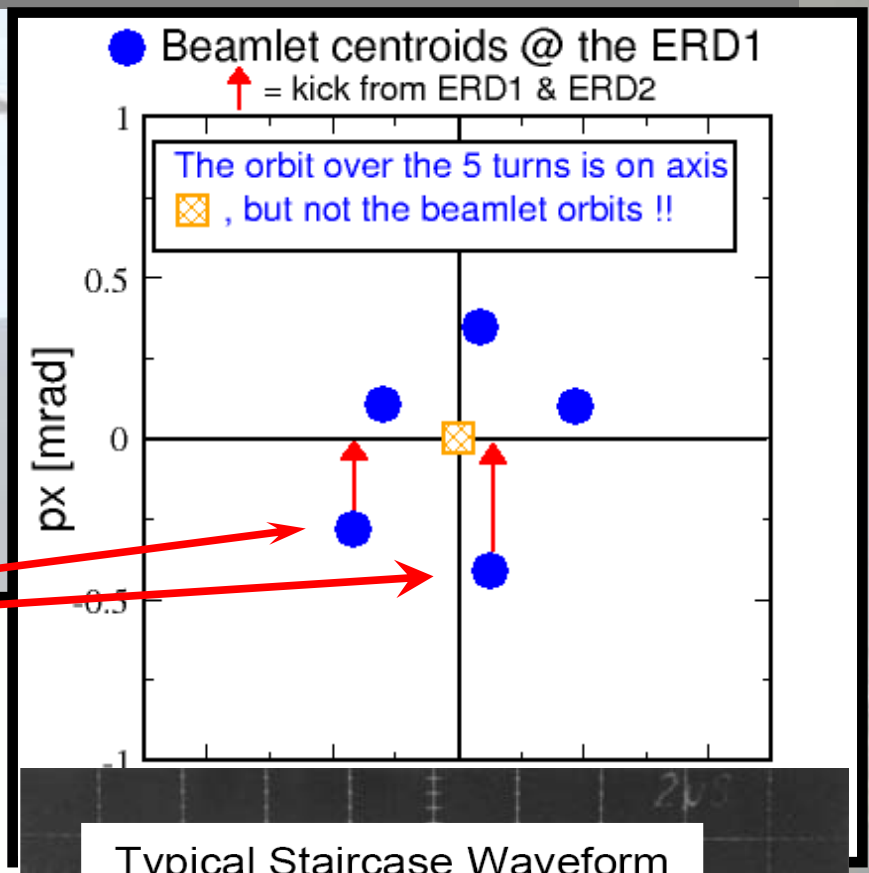
1. The trajectory averaged over the 5 turns is corrected with 3 BHZs (Automatic Beam Steering)

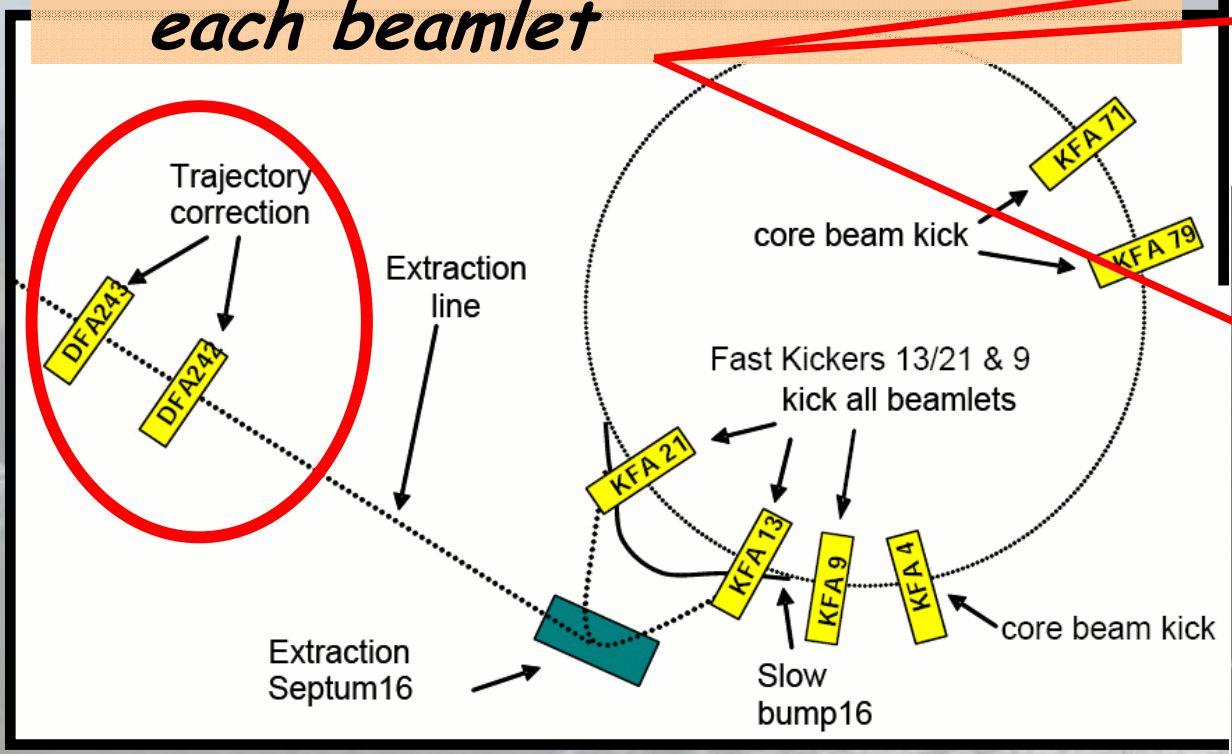


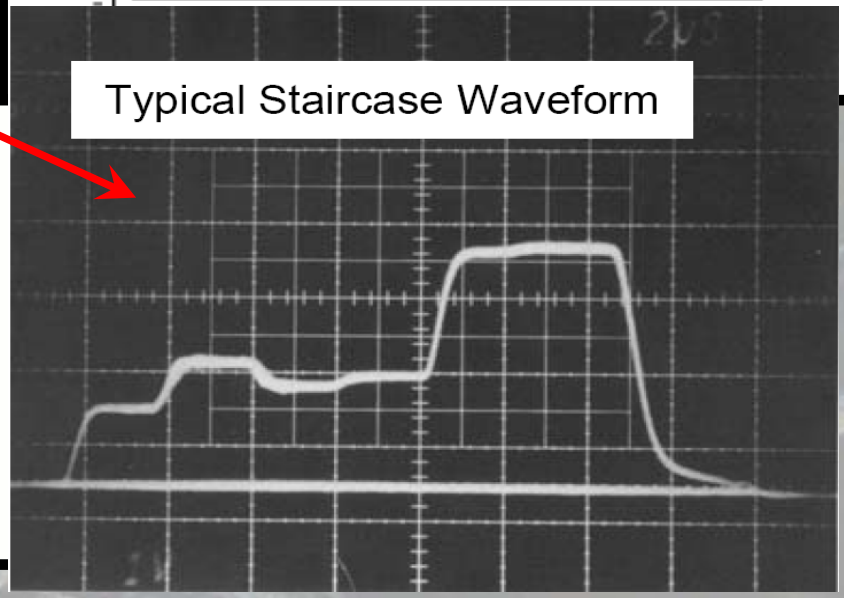


Present correction scheme

1. The trajectory averaged over the 5 turns is corrected with 3 BHZs (Automatic Beam Steering)
2. The 2 ERDs (1 pedestal + 1 staircase=turn by turn) can correct the trajectory of each beamlet



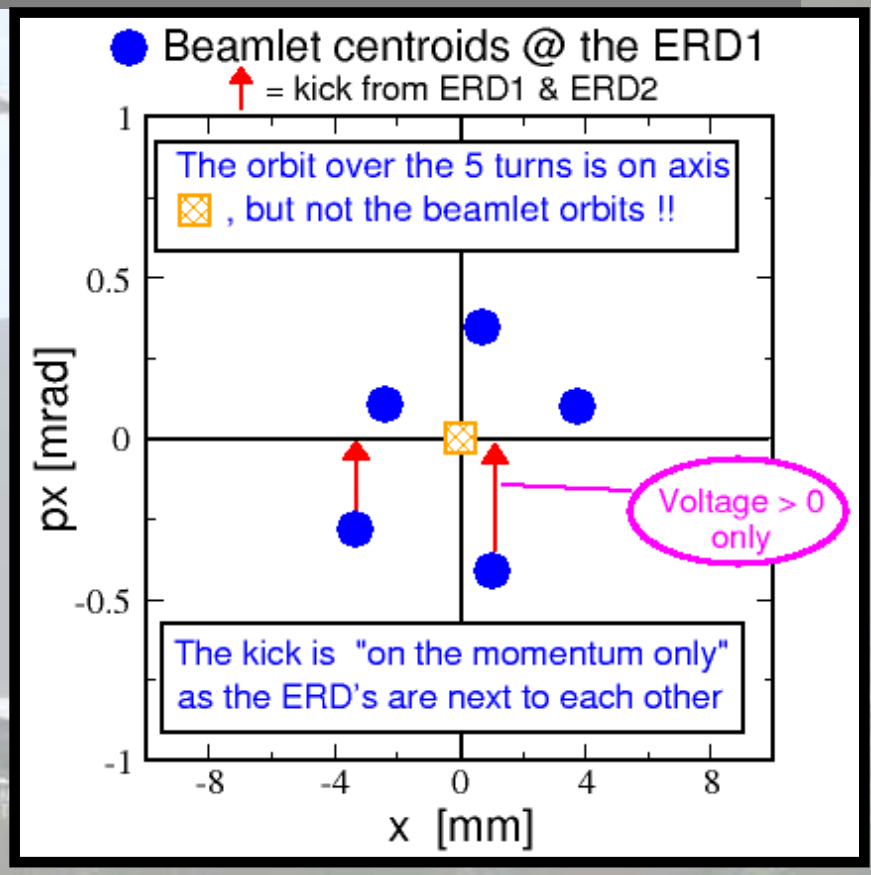




Present correction scheme

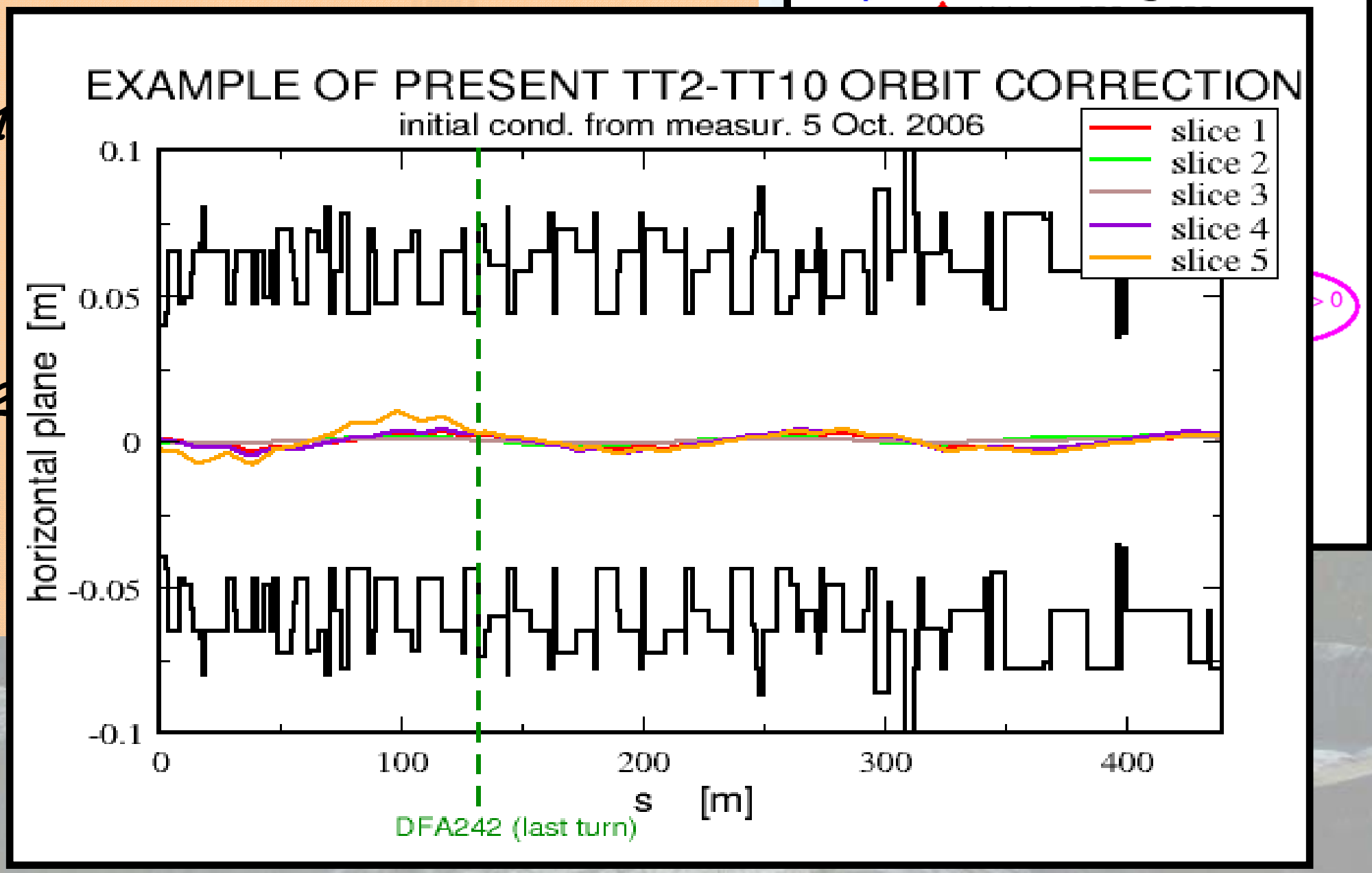
Constraints

1. The 2 kickers are next to each other => only the angle PX can be corrected (vertical arrows in the picture) [up to 2006]
2. The kicker voltage can be only positive => beamlets with positive angle PX @ the entrance of the ERDs cannot be corrected



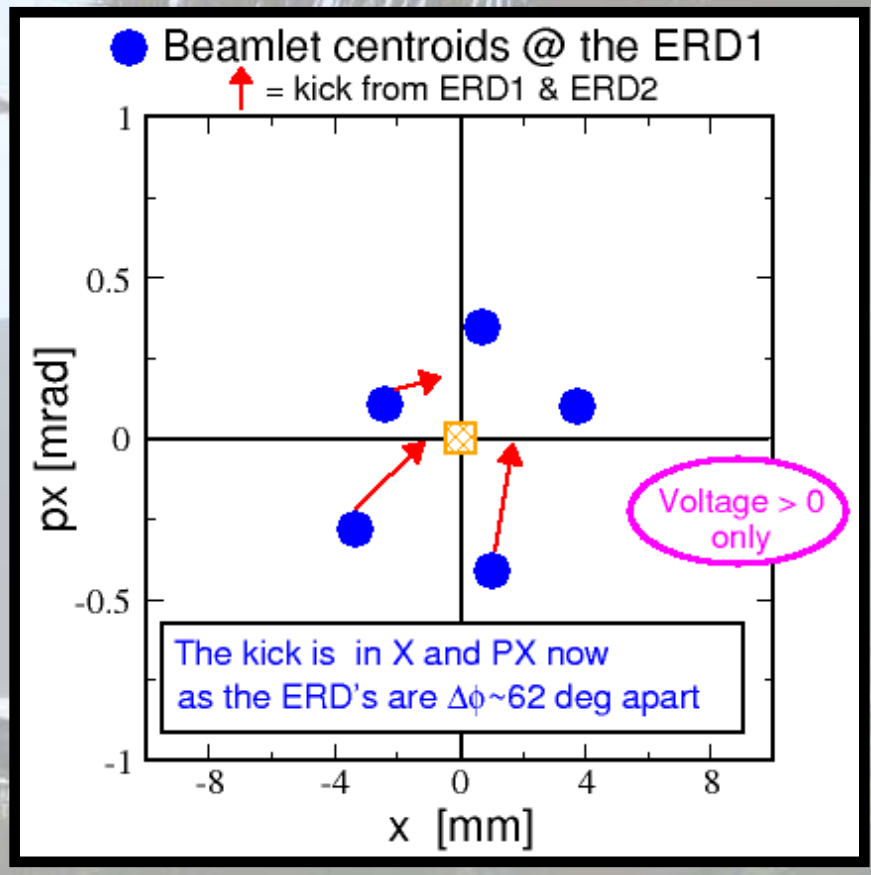
Present correction scheme

Beamlet centroids @ the ERD1



New correction scheme (principle)

1. The 2nd kicker (ERD2) has been moved ~ 20 m downstream the ERD1 (~62° phase advance) => correction in angle & position



62° phase advance is a trade off between the best "angle & position" correction (90°) and other constraints (installation, aperture)

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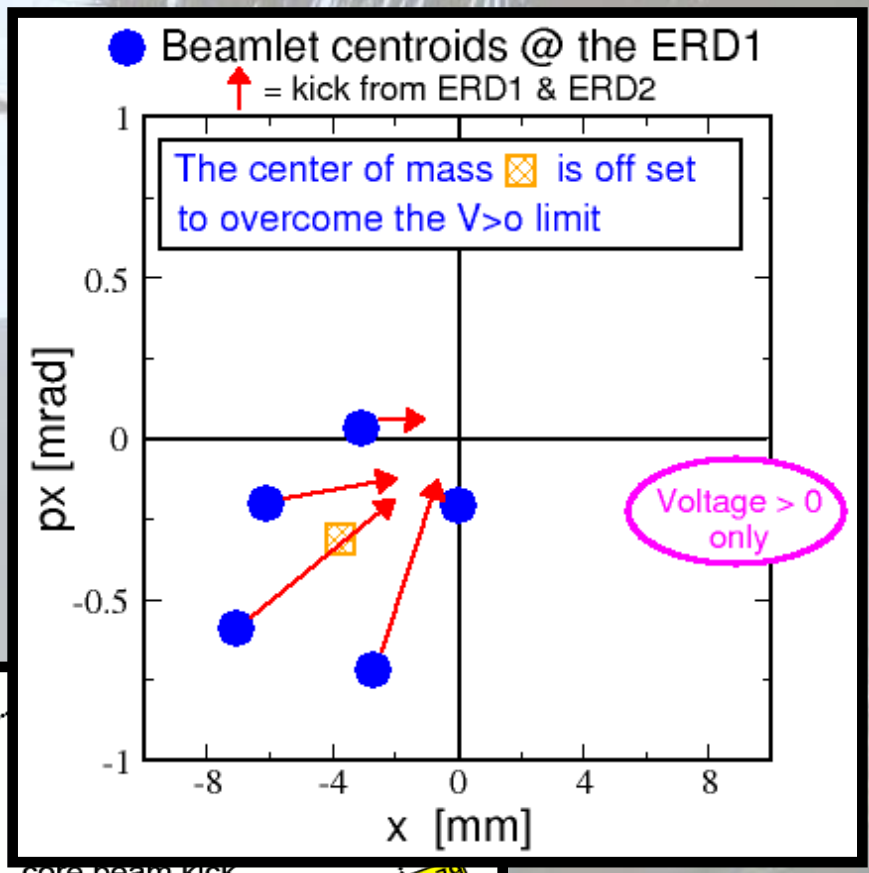
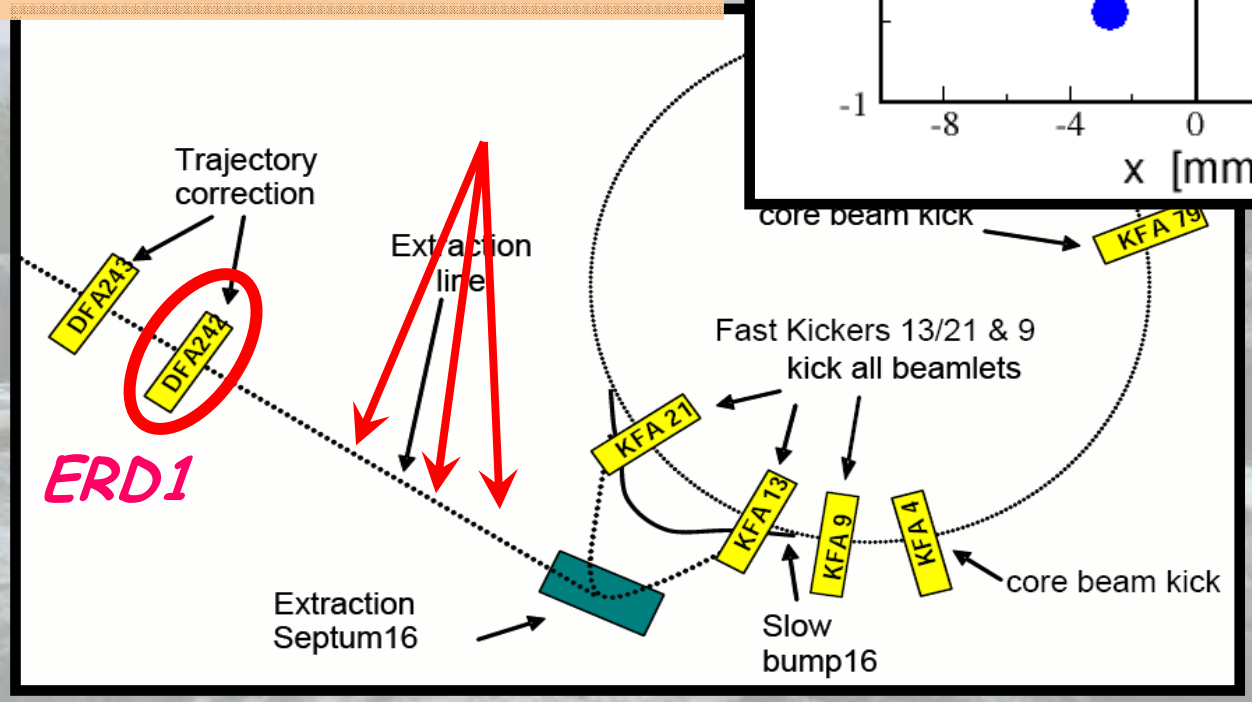
2. To overcome the V>0 limit, the beam is displaced with 3 BHZs => the largest angle @ ERD1 is ~ zero





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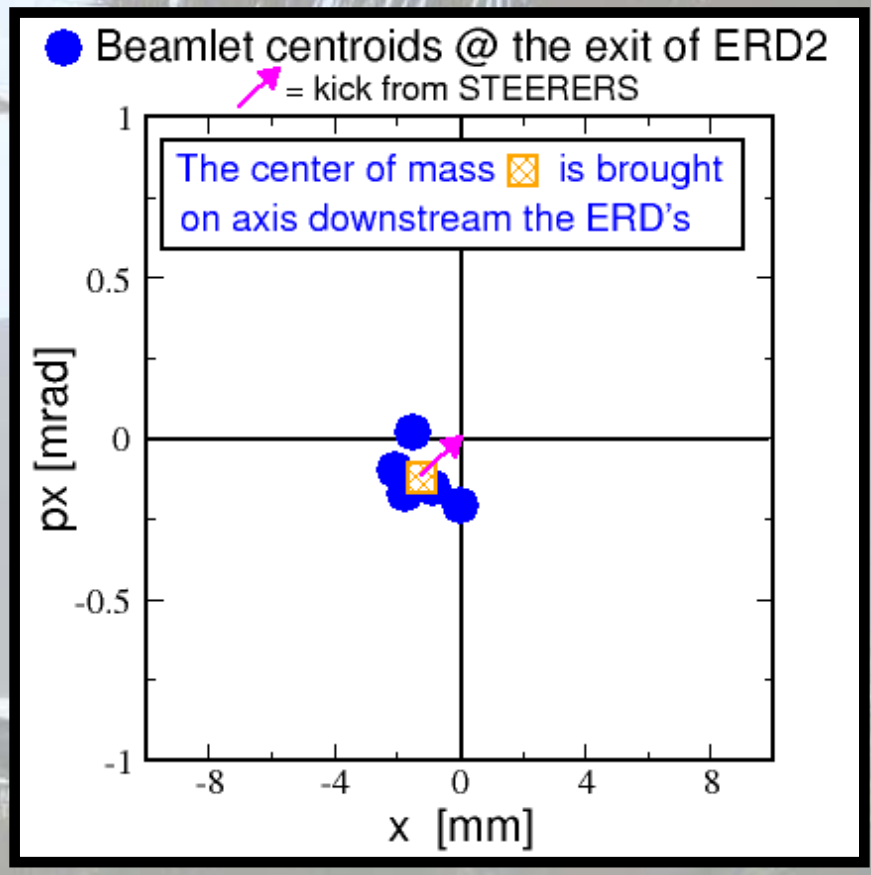

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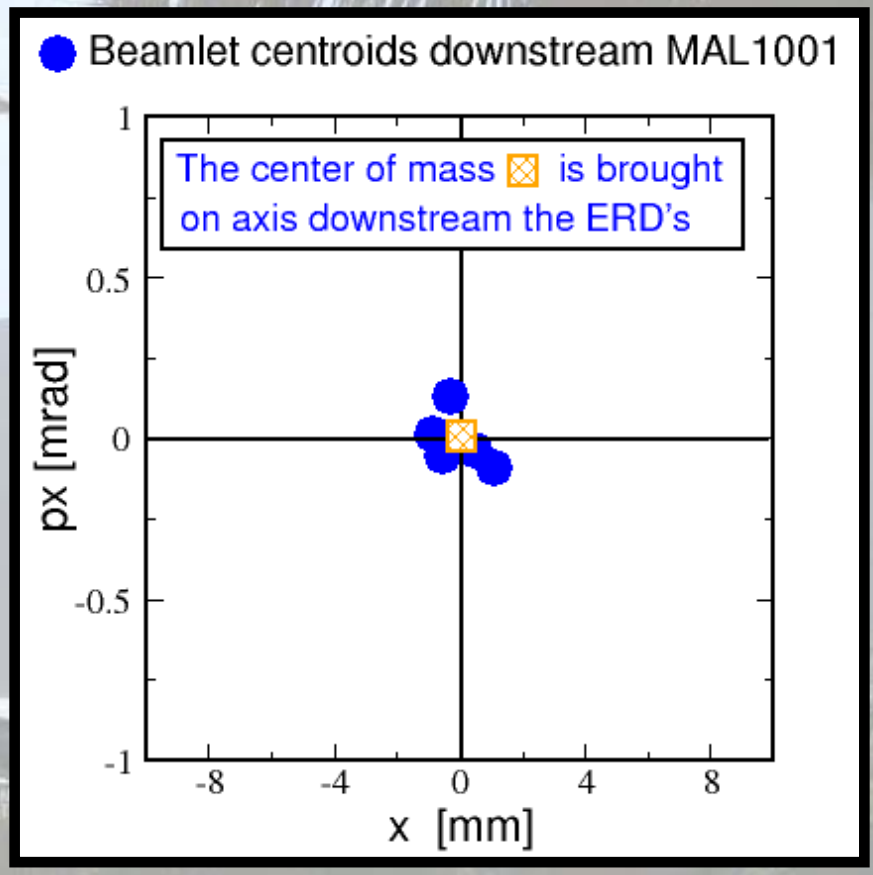
3. The ERD2 impart a turn-by-turn variable kick and reduce the "spread"
4. 4 Bending magnets (BHZ377/8 & MAL1001s) downstream the ERDs are used to correct the "average" trajectory



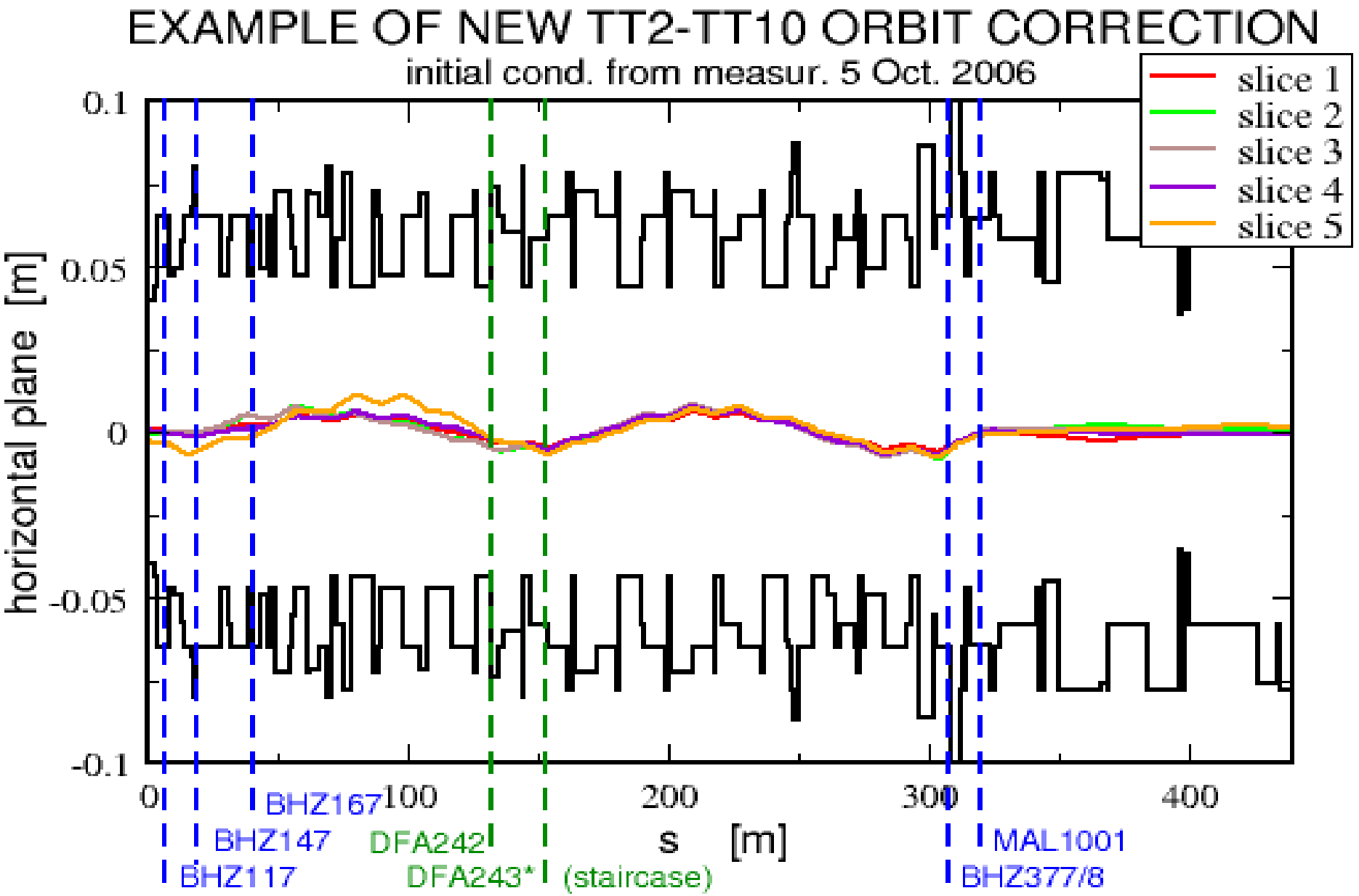
New correction scheme (principle)

1

2

3

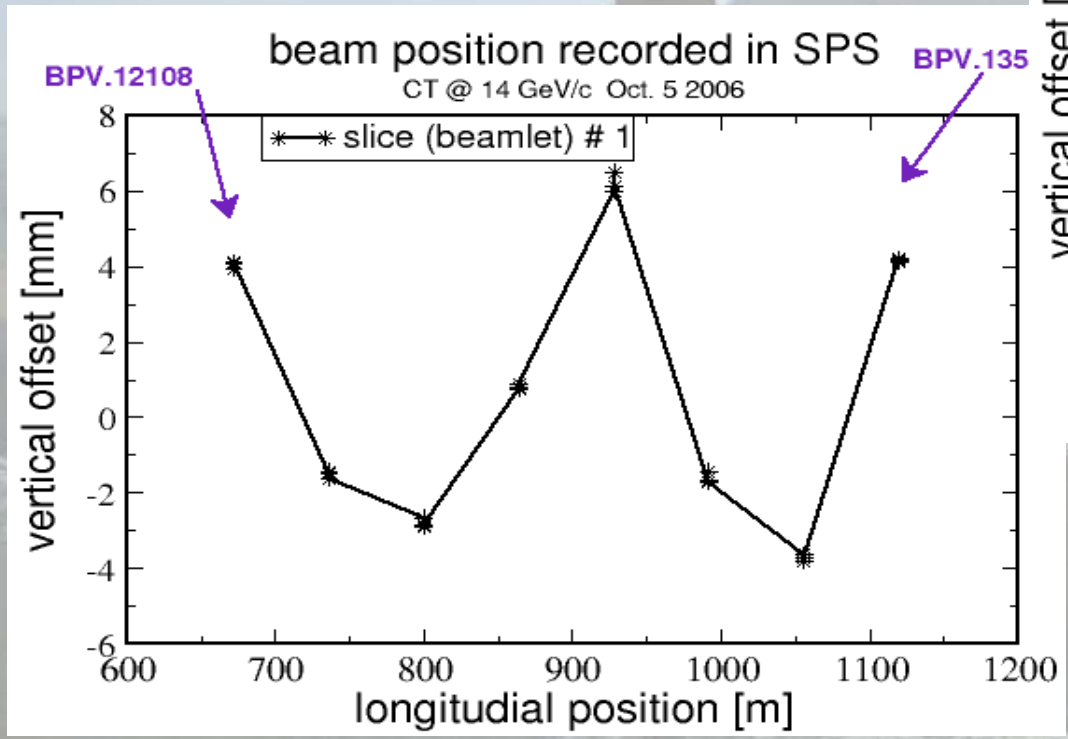
4

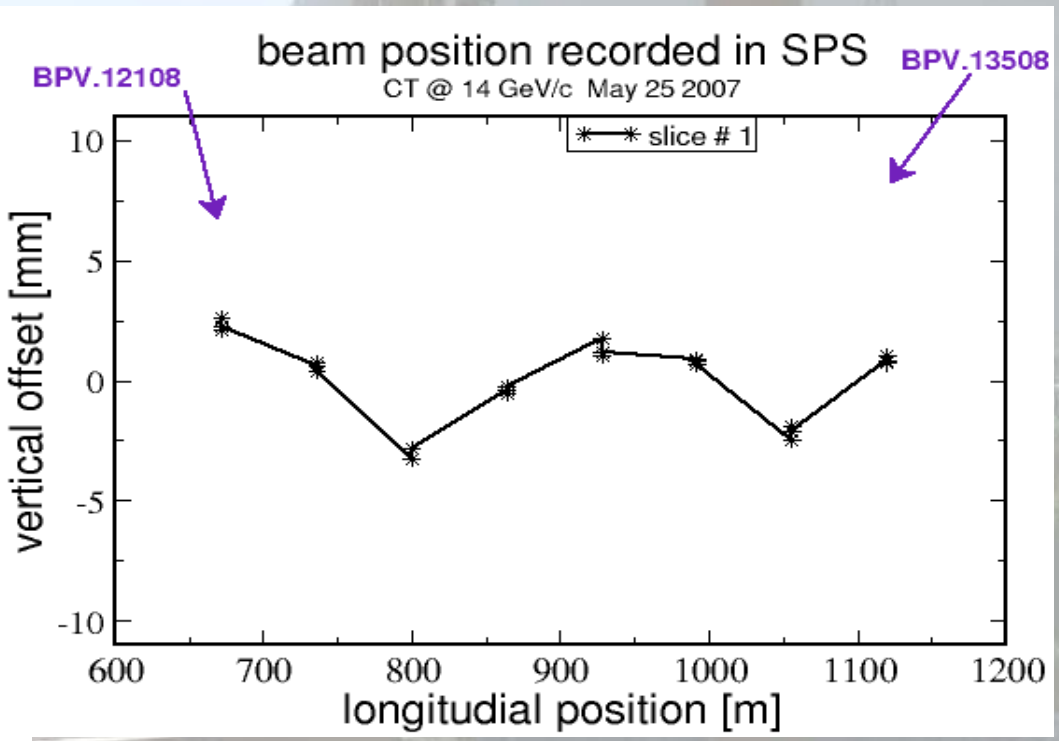


Application manual

1. Measure the vertical beamlet positions in the SPS right after the injection (First-Turn option)

2006



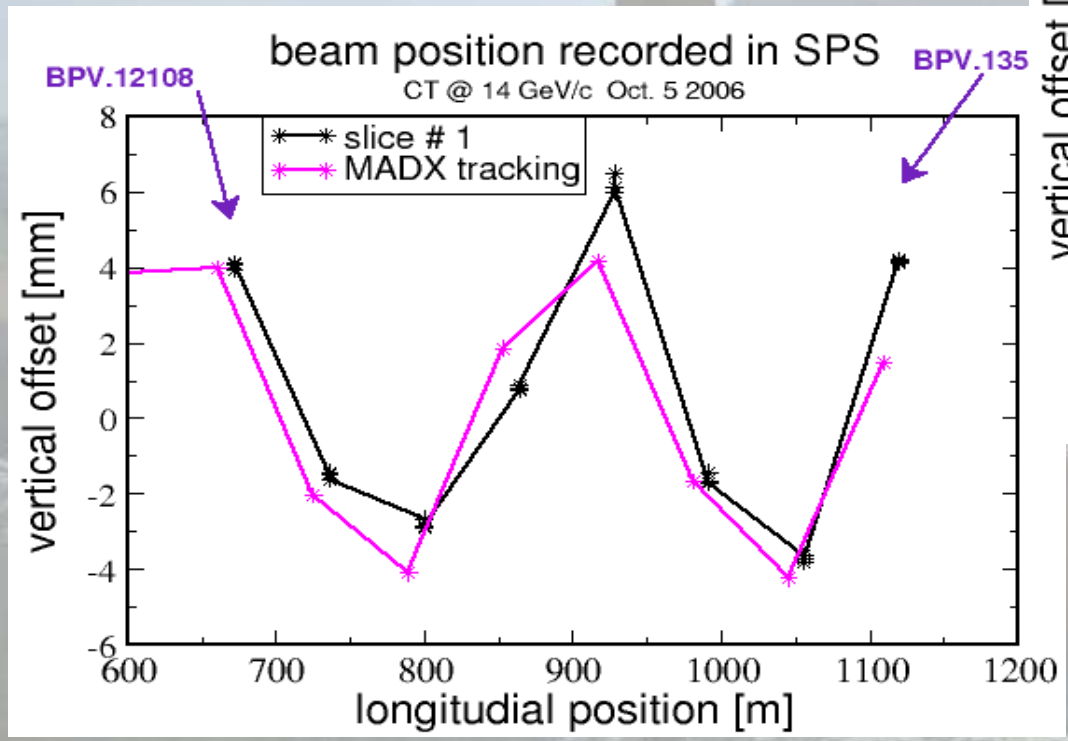


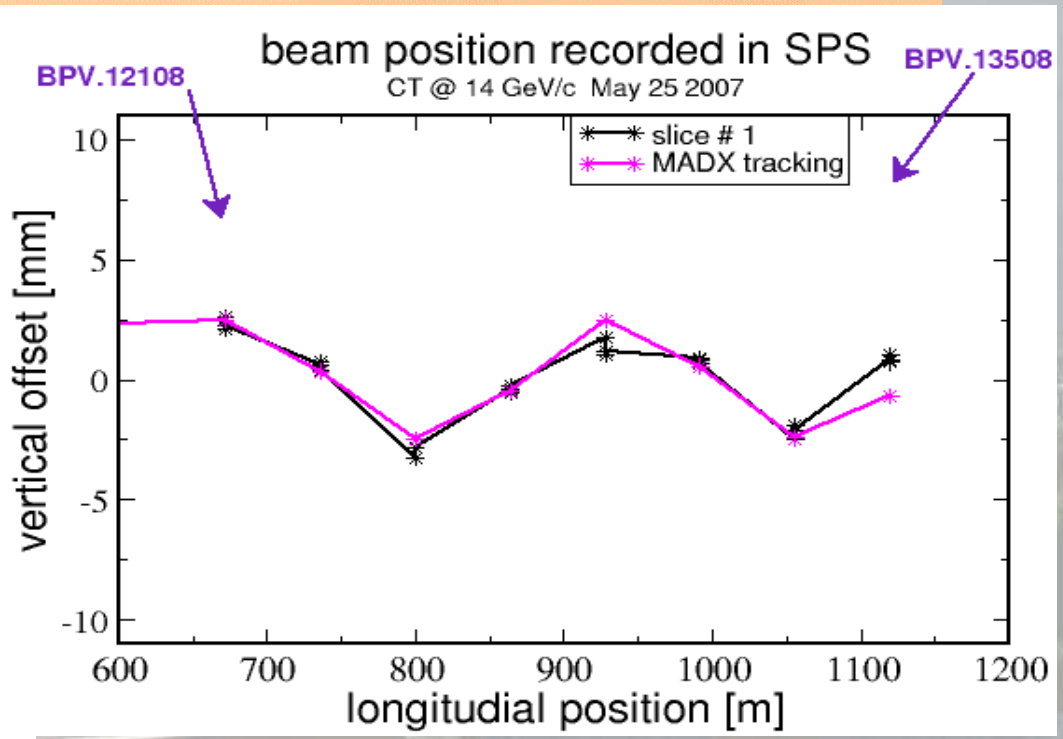
2007

Application manual

2. Infer the initial conditions (X,X') at the beginning of TT2 that best reproduce the measured SPS values

2006





2007

Application manual

3. Launch a routine that, given the TT2-TT10 setting and the initial conditions of the 5 beamlets/slice, find the best corrector setting (BHZs,ERDs,MAL1001)

```
****************** STEERERS ***************************
BEST BHZ117    correction [A,mrad] :  0.7567593      0.1000E-03
BEST BHZ147    correction [A,mrad] :  0.7567593      0.1000E-03
BEST BHZ167    correction [A,mrad] :  0.9586615      0.1000E-03
BEST BHZ377    correction [A,mrad] : -0.8695056     -0.5000E-04
BEST MAL100103 correction [mrad]   :                -0.1600E-03
 ********************  ERD  ***************************
BEST  DFA242 setting  [kV,mrad] :   12.56443      0.1400E-03
      DFA242 START FROM SLICE  #  5
BEST DFA243-1 setting [kV,mrad] :   9.444498      0.1200E-03
BEST DFA243-2 setting [kV,mrad] :   9.444498      0.1200E-03
BEST DFA243-3 setting [kV,mrad] :   9.444498      0.1200E-03
BEST DFA243-4 setting [kV,mrad] :   15.74083      0.2000E-03
BEST DFA243-5 setting [kV,mrad] :   15.74083      0.2000E-03
 ************************************************
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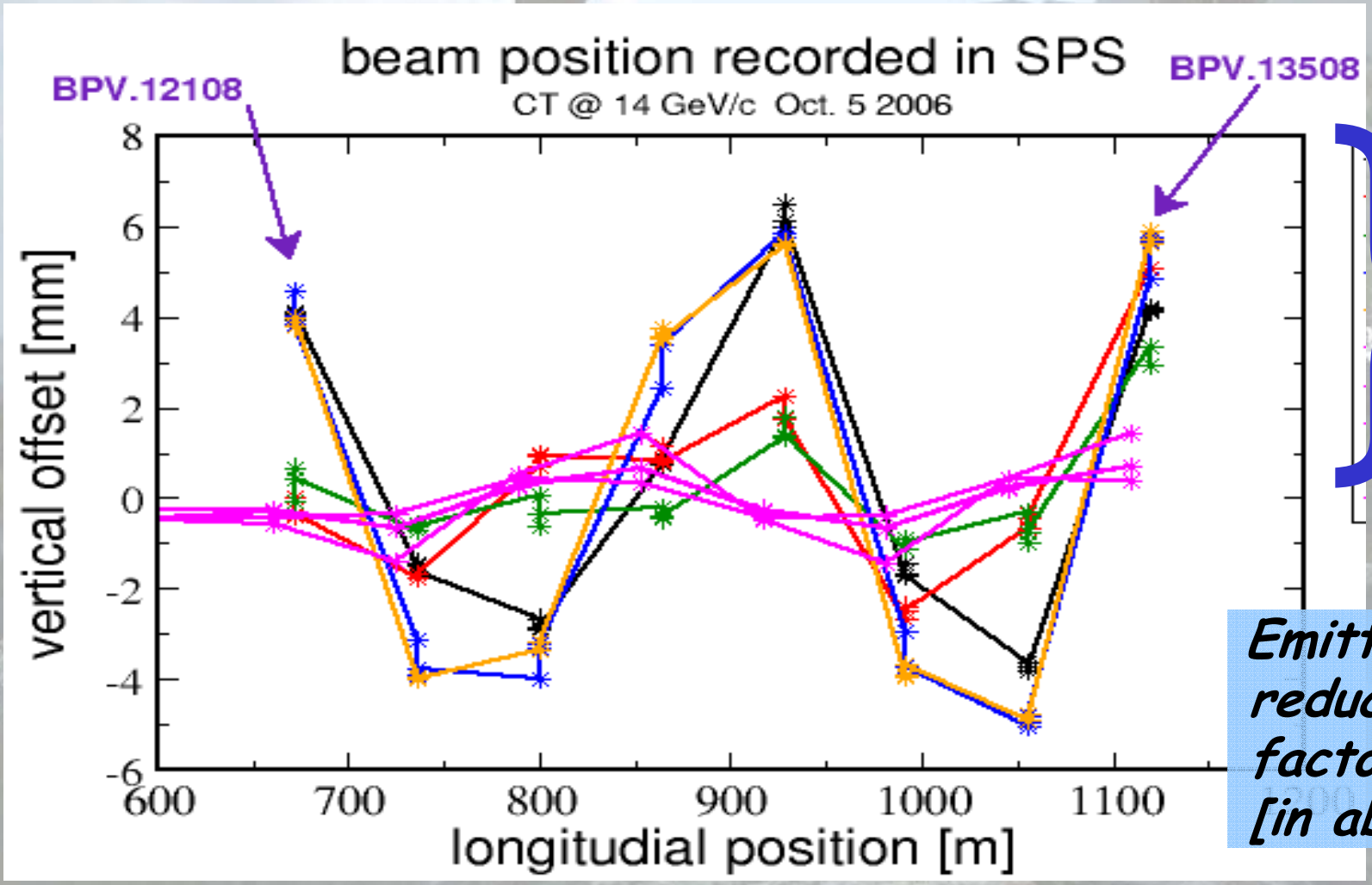
Application manual

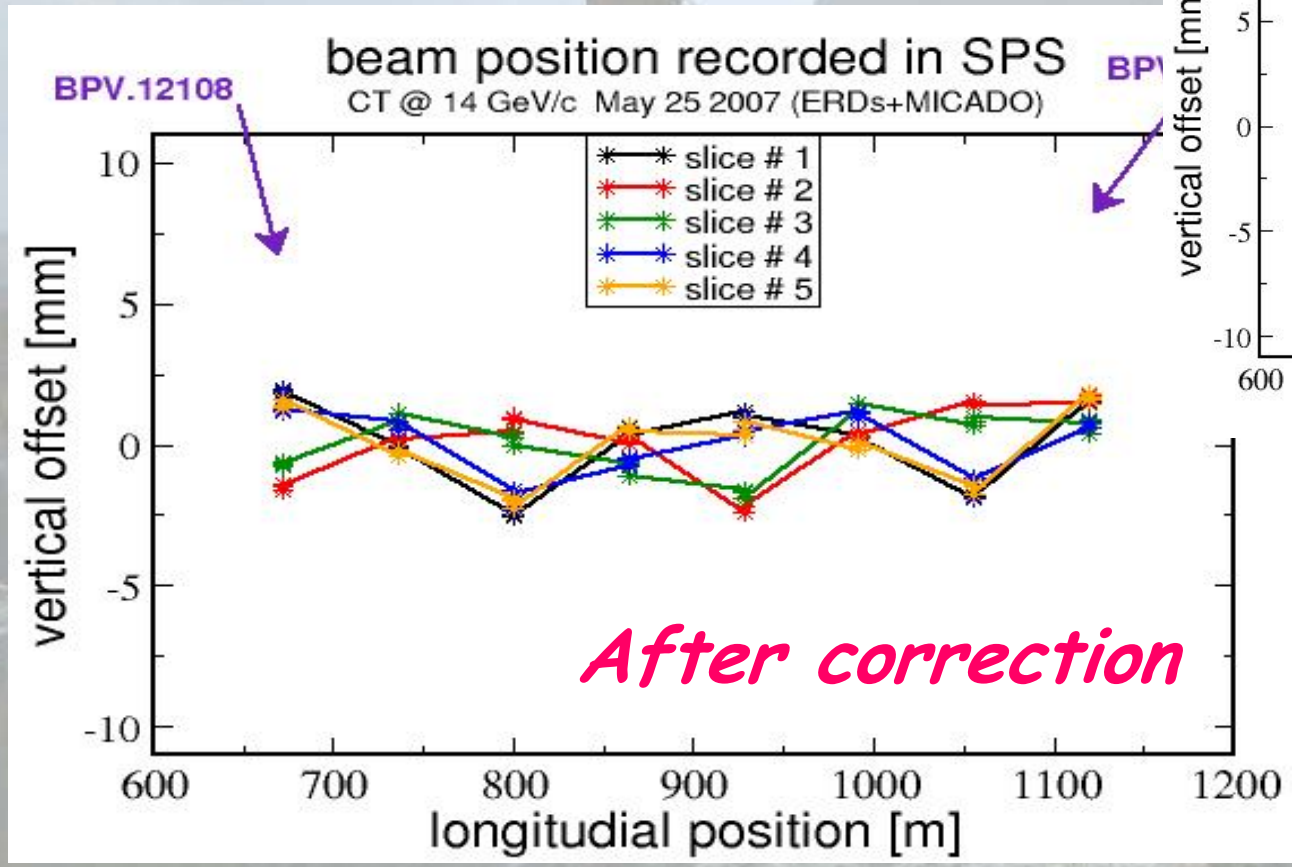
4. 2006: Run MADX with the new setting, and check the vertical offset in the SPS

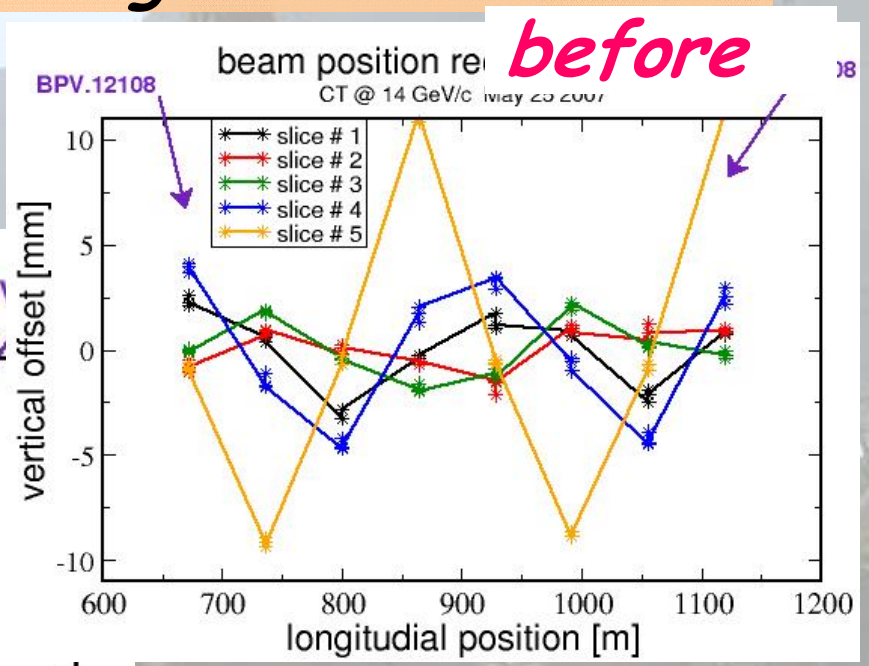


Emittance blow up reduced by a factor ~(2/6)²=1/9 [in absence of TFB]

2007 First Results

May 25, 2007: First measurement of the vertical offset in the SPS with the new setting.

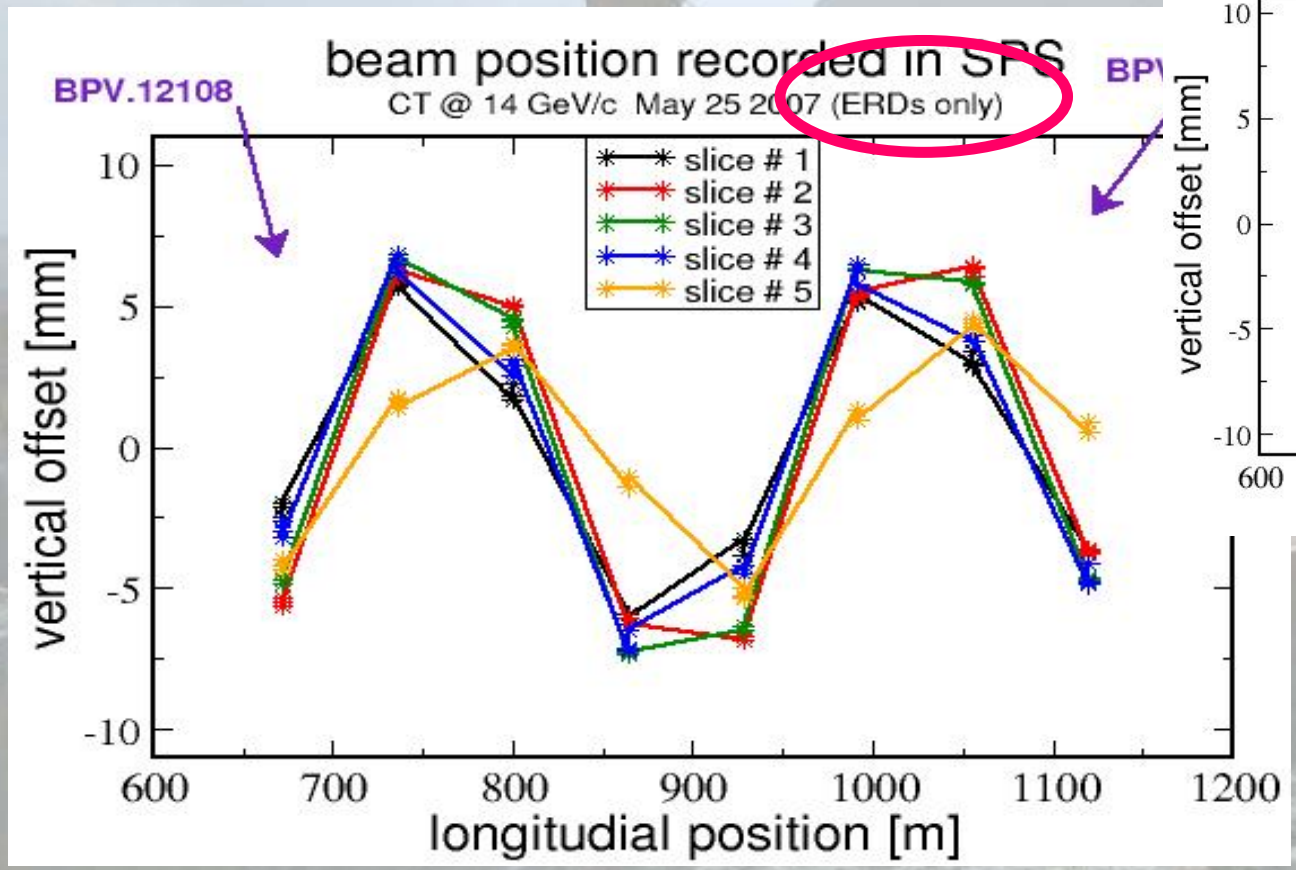


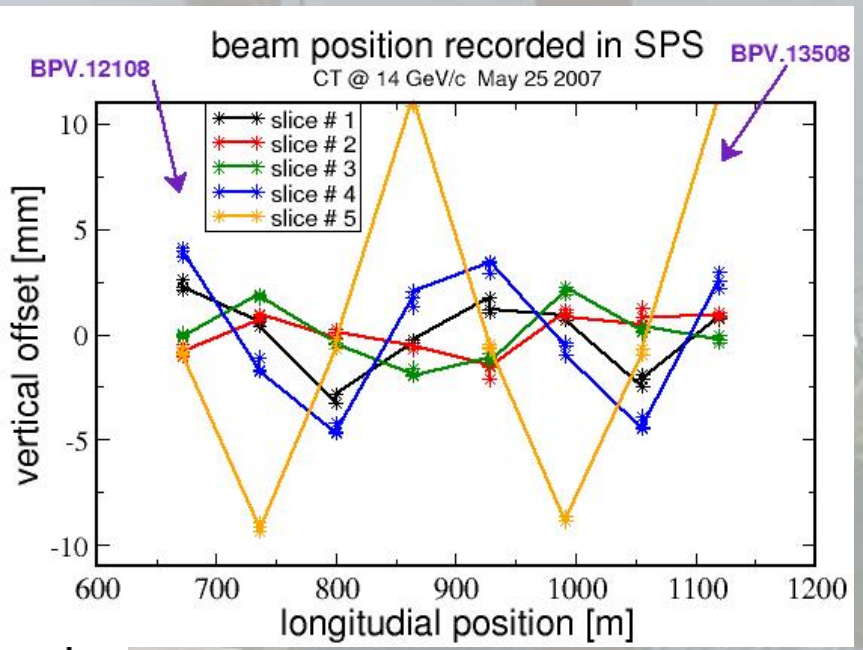


But …

2007 First Results, but …

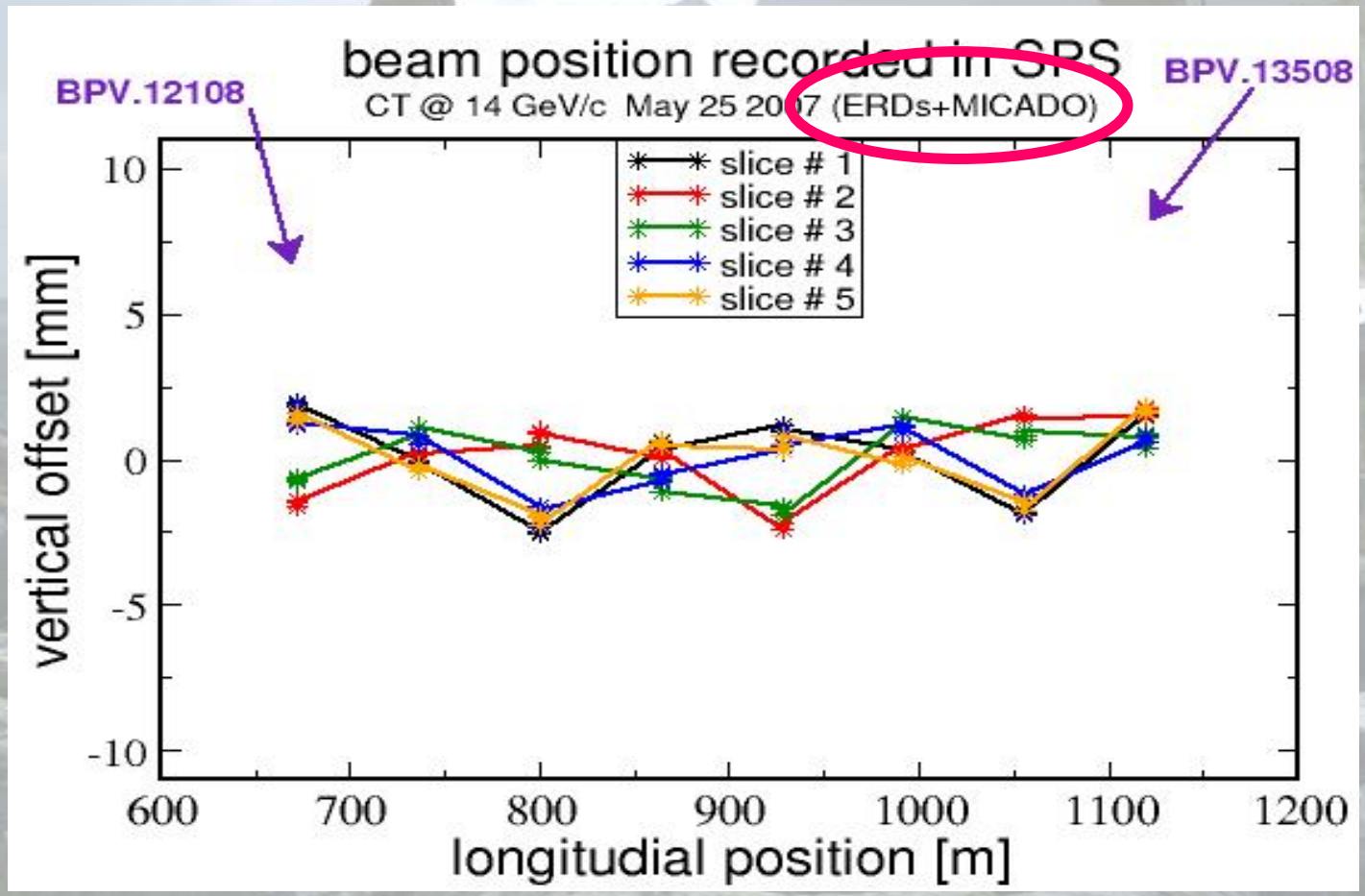
The steering setting in TT2 (upstream the ERDs) and in TT10 (downstream the ERDs) did not work => First: ERDs setting implement only





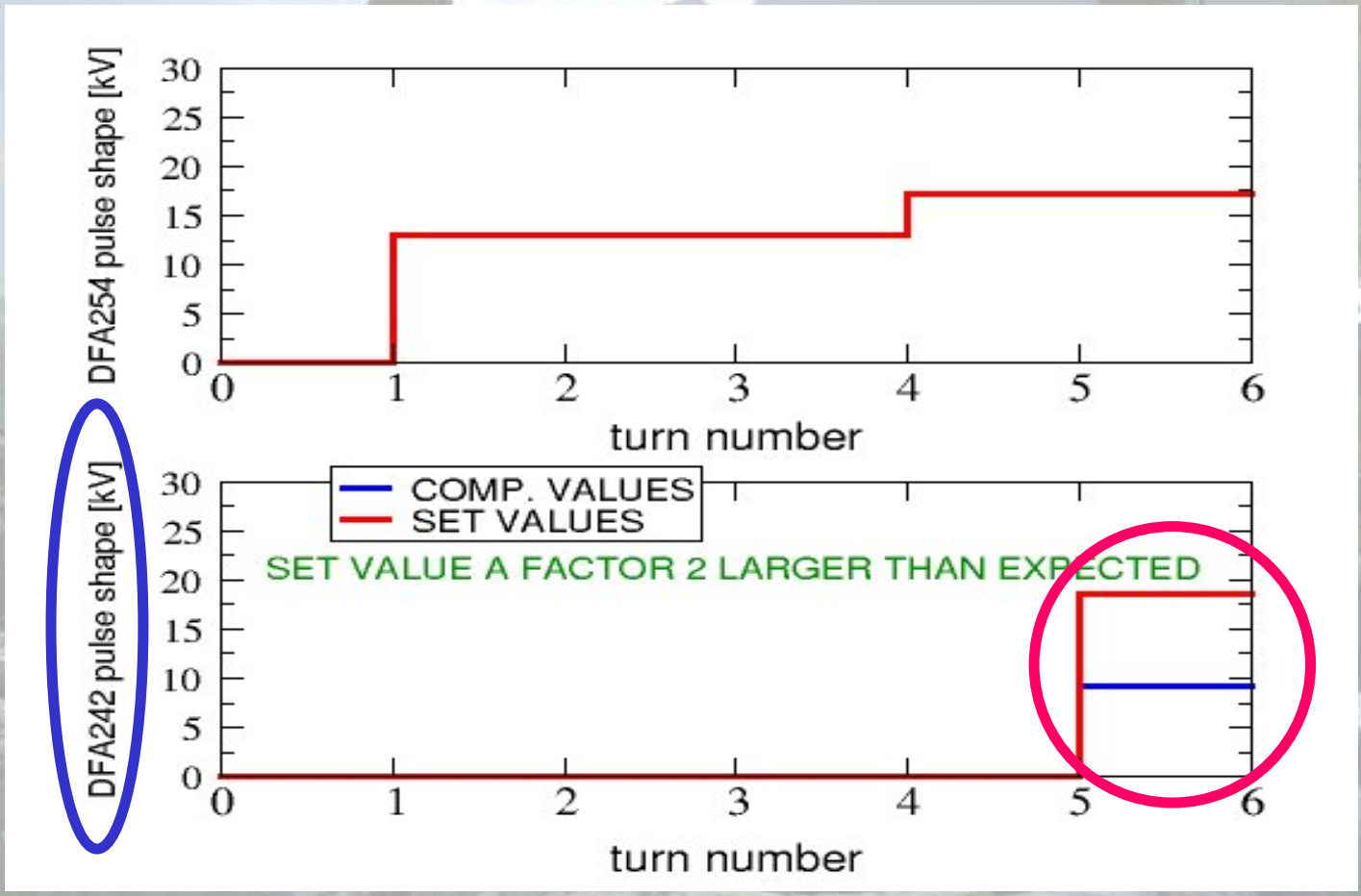
2007 First Results, but …

The steering setting in TT2 (upstream the ERDs) and in TT10 (downstream the ERDs) did not work => Second: ERDs setting implement + MICADO



2007 First Results, but …

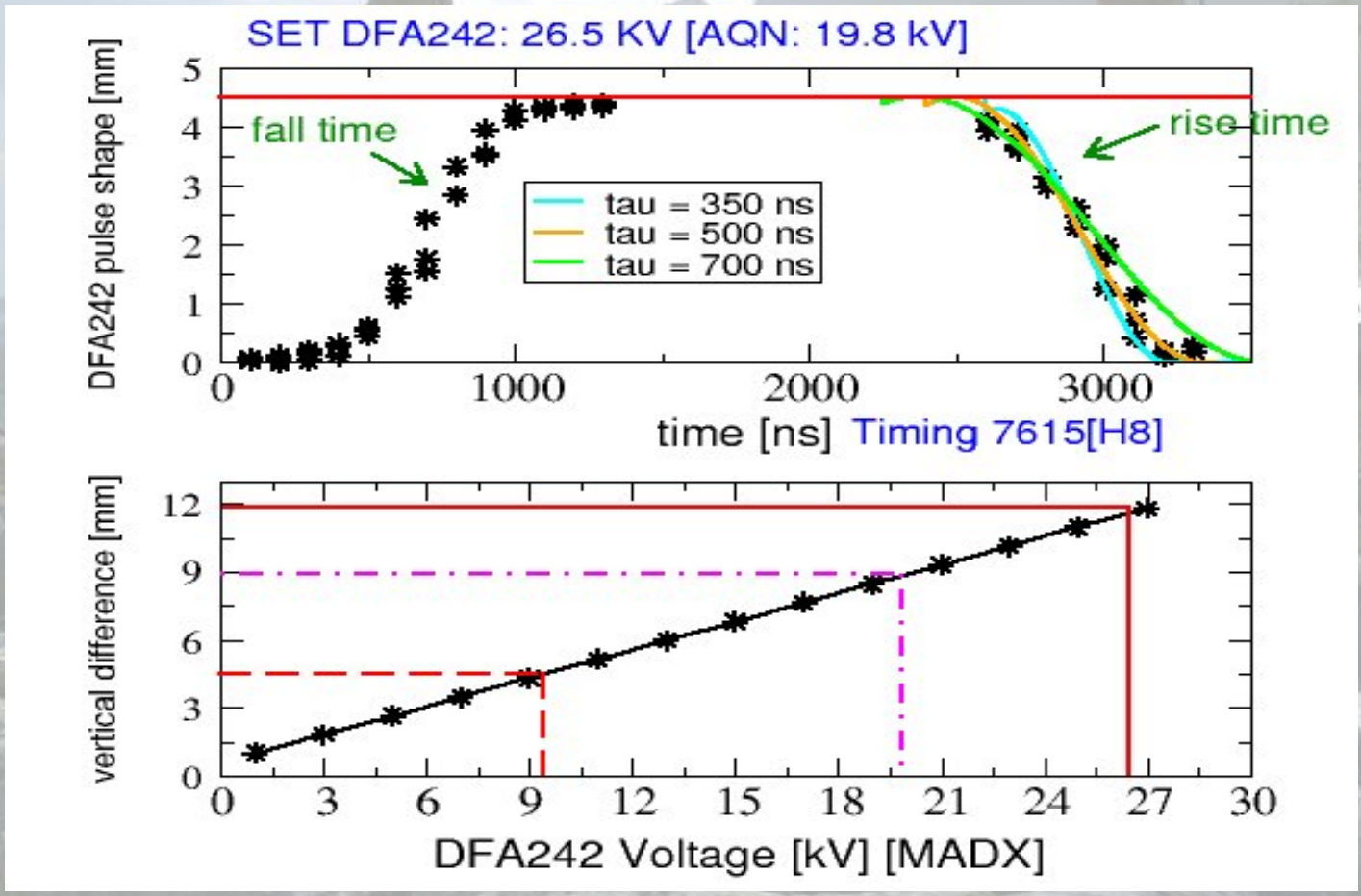
The computed DFA242 strength (last turn only) is half of the value set in CCC [calibration curves angle Vs Voltage checked with kicker specialists]



2007 First Results, but …

- MADX simulations confirm the presence of factor 2.
- DFA242Timing had to be shift to "center" the beam.

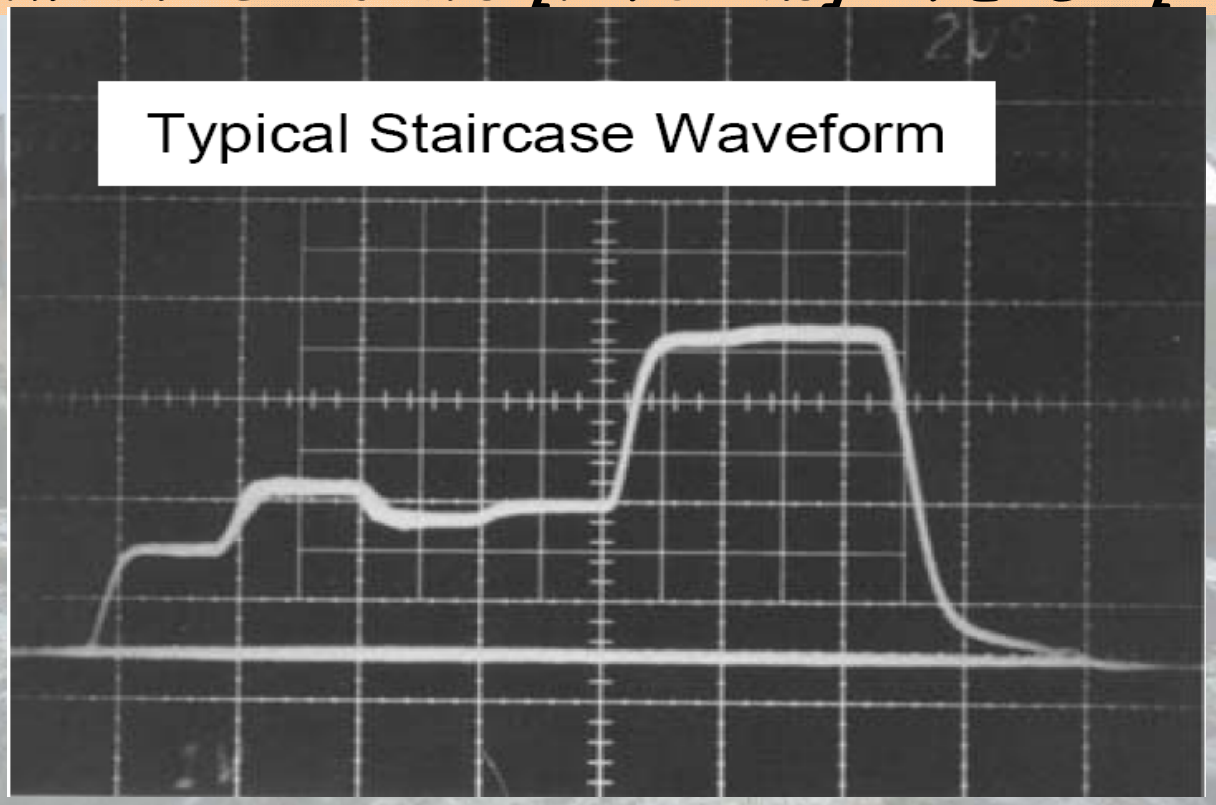
=> SPS BPM timing/gating to be checked



New correction scheme

The correction, even on the paper, cannot be perfect!

1. *ERD1 will remain pedestal (constant Vs time) until 2009*
2. *ERDs staircase: turn by turn the voltage can be either increased or left at the same value (± 10%). 4th & 5th turns must have the same voltage (to avoid mismatch of the rise time between PS kickers [70/80 ns] & ERD2 [~500 ns])*



Summary & conclusion

1. The slice/beamlets extracted with the CT (& MTE) enter in TT2 with a slice-dependent horizontal offset, that leads to a vertical emittance blow up in the SPS if not corrected.
2. The BHZs are used to correct the global trajectory, while two ERD kickers (1 pedestal & 1 staircase) are used to steer the beamlets individually => vertical offset in the SPS ~ 2.5(10^{max}) mm (measur. 2006)
3. A new correction scheme has been tested => vertical offset in the SPS ~ 1(2^{max}) mm.
4. SPS BPM timing to be checked [last slice only]
4. To be checked: steering (should be included or left to MICADO?) + DFA242 timing & strength