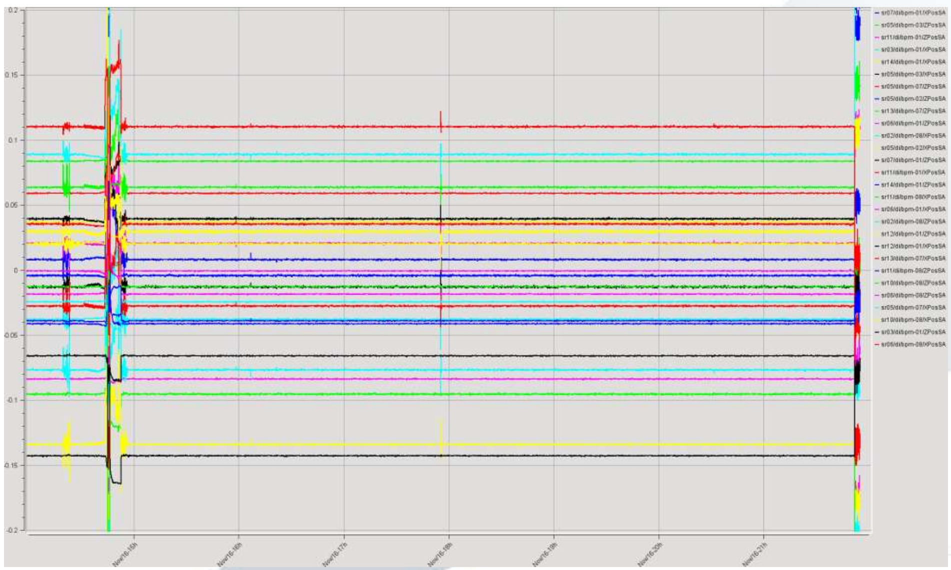
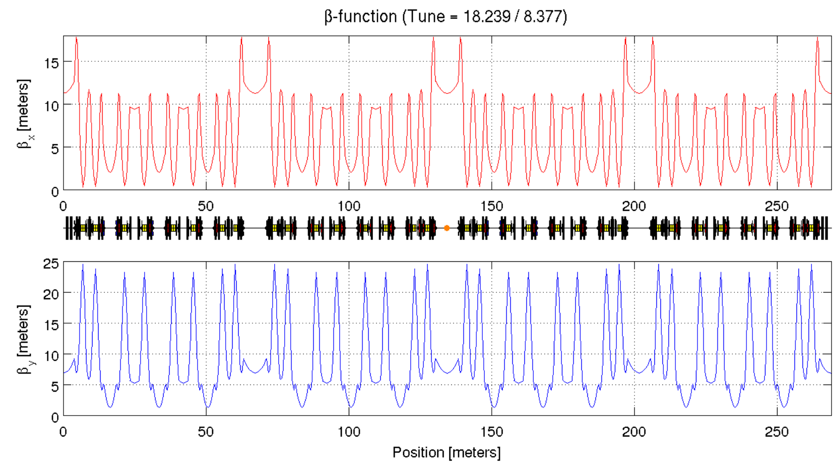
ALBA
Synchrotron Light Facility

Accelerator Division

Beam dynamics measurement during ALBA commissioning





Marc Munoz
on behalf of ALBA Accelerator Division

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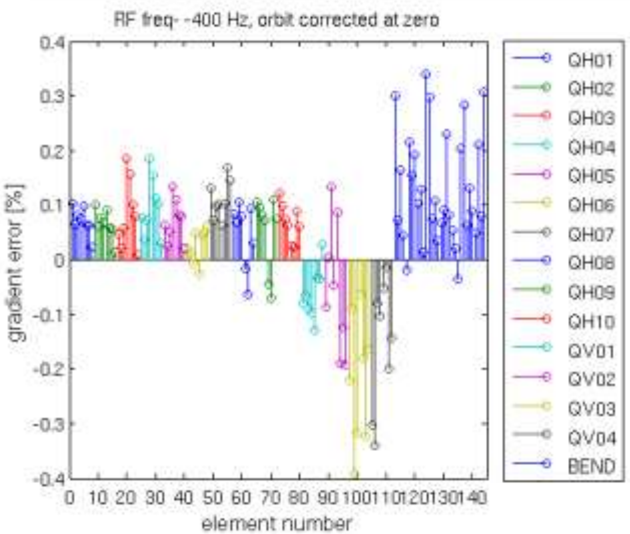
LOCO

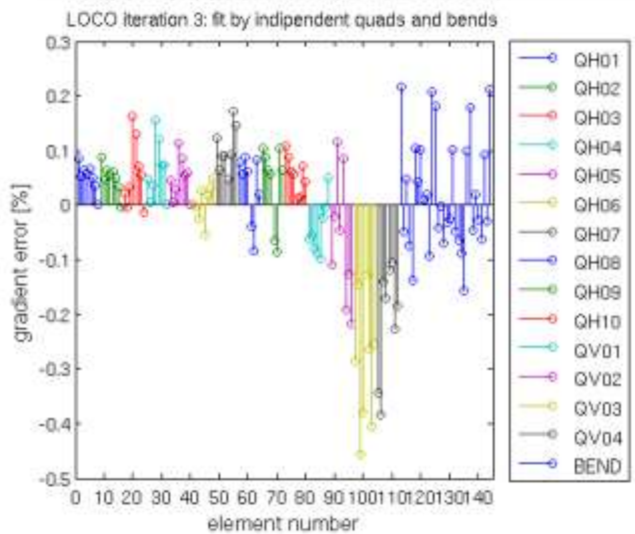
- At ALBA Loco is used for two different purposes:
  1. Calibrate the parameters of the model (in particular the magnet gradients in the 112 quads and 32 combined dipoles)
  2. Calculate the changes in the 112 quads to correct the optics
- Rmagnets to BPMs is higher than one: 112 quads + 32 dipoles for 104 BPMs.
- This problem has been overcame using all the singular values and the scaled Levemberg-Markard minimization method.
- Optics recovered down to beta beatings smaller than 1% after correction, but increasing to 3% after a few days.

Loco to calibrate the model

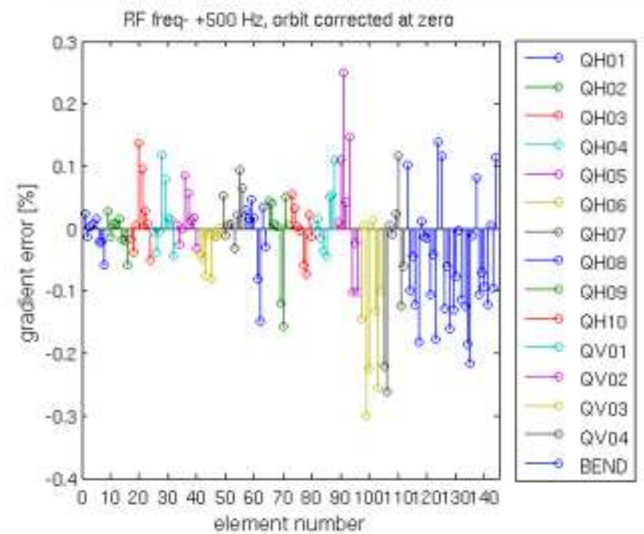
RF frequency change = -400 Hz
Tunes: (0.25, 0.40)
Dipole k-value change = +0.130%



RF frequency change = 0 Hz
Tunes: (0.24, 0.39)
Dipole k-value change = +0.055%

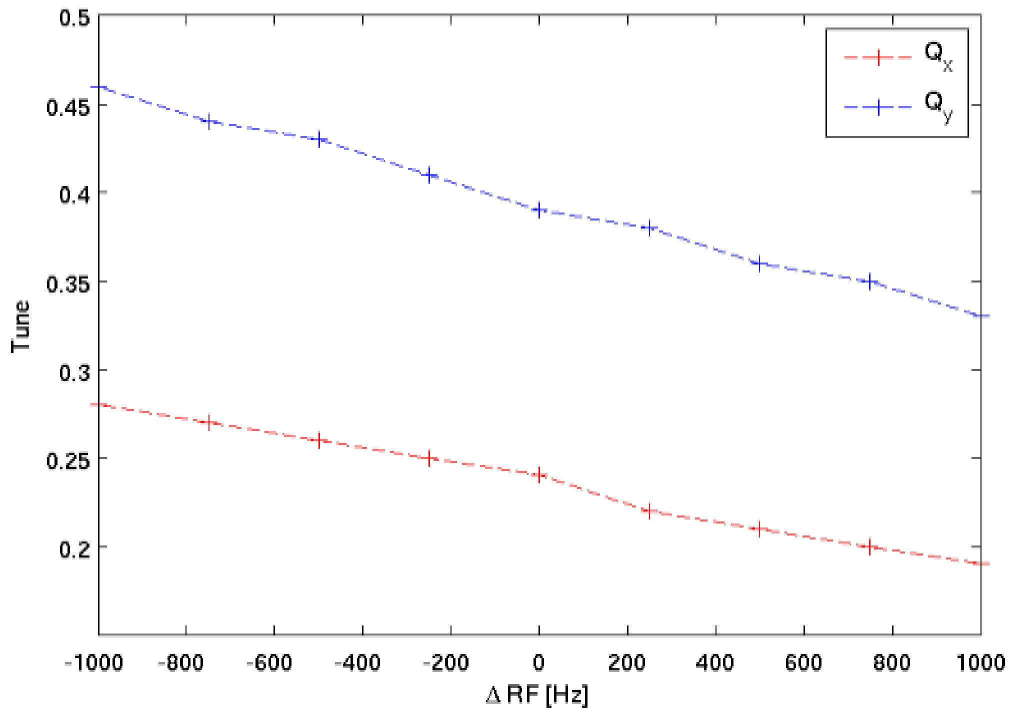


RF frequency change = +500 Hz
Tunes: (0.23, 0.38)
Dipole k-value change = -0.060%



Loco allowed to calibrate the k-values of the magnets.
The magnetic measurements of the quads were confirmed within 0.2%.
Two families (QH08, QH09) were found miscalibrated by +0.7%.
The gradient dipole k-value was miscalibrated by -0.2% and has a strong dependency with the orbit and the adjustment of the central RF frequency.

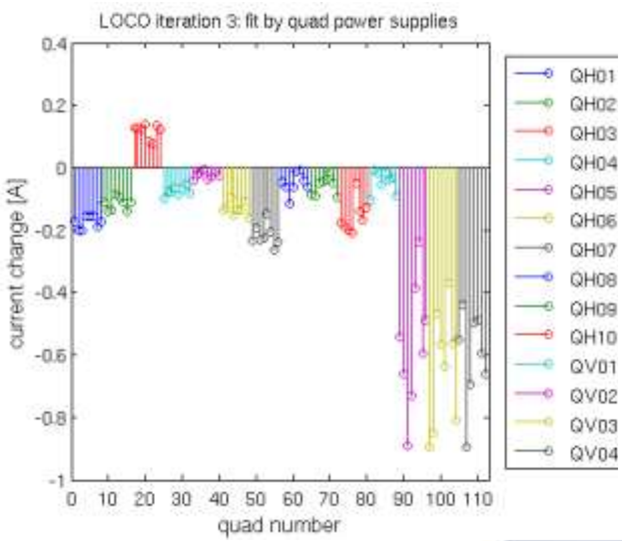
Tune change with RF and SOFB



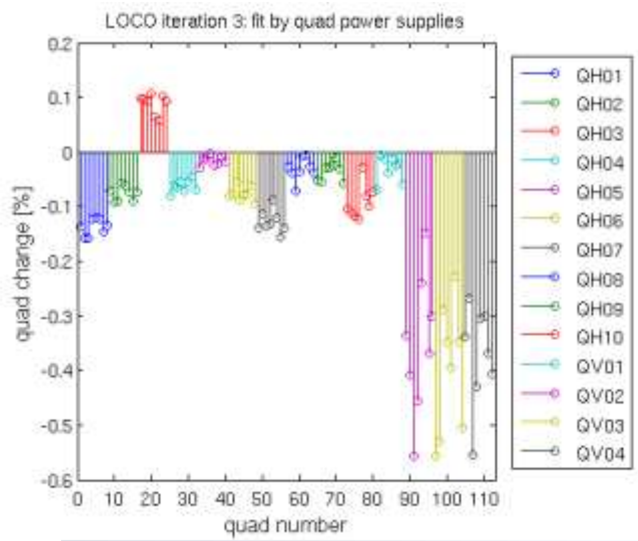
- The change in tune and optics is correlated to changes in circumference due to rain or temperature.

Loco to symmetrize the optics

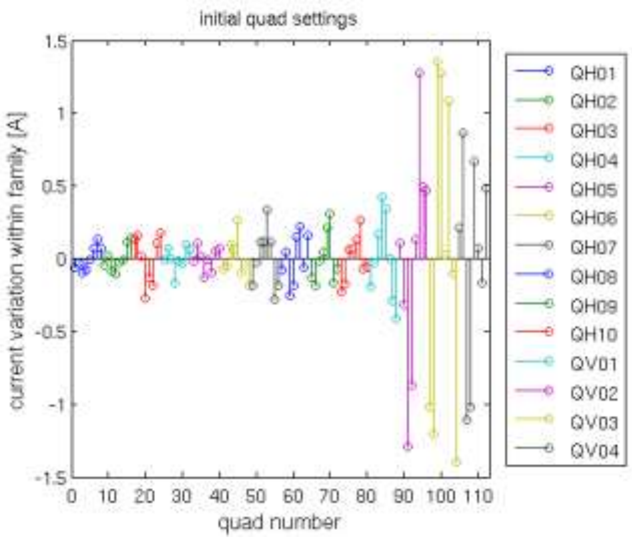
Quad current changes [A]



Quad current changes [%]



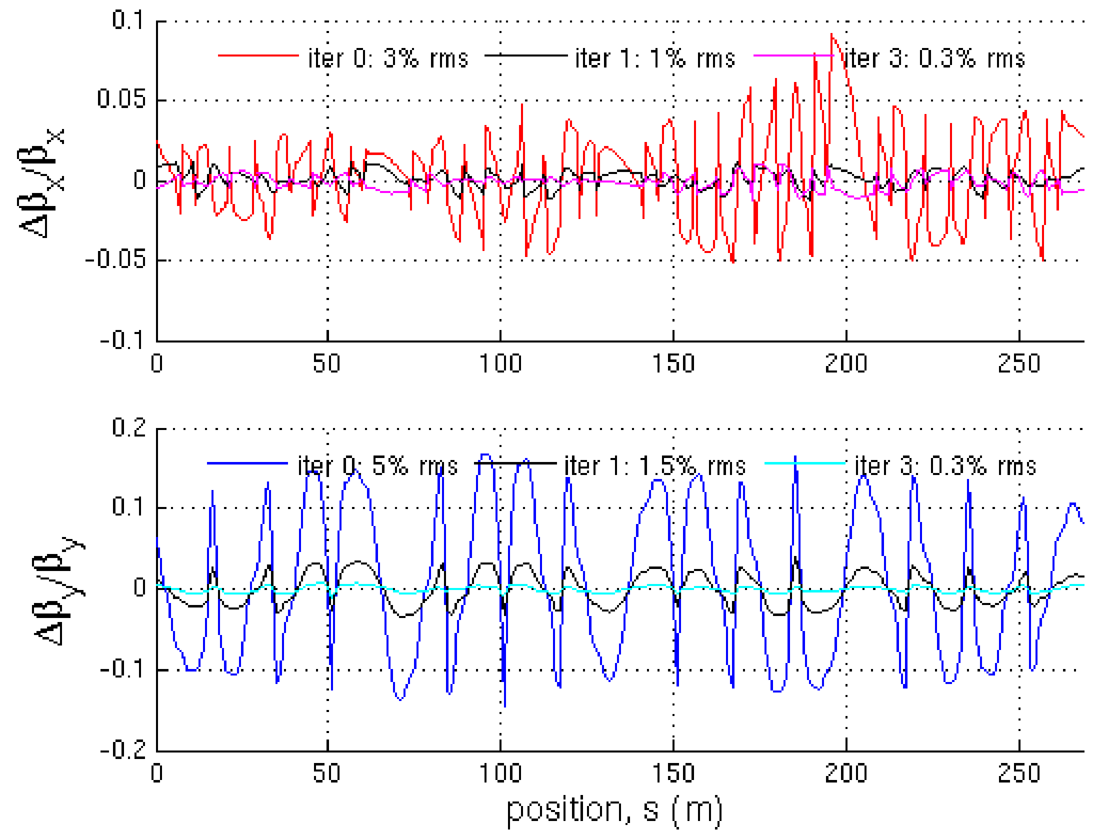
After 2 loco iterations the quadrupole changes to correct the optics are below +/-0.6%



The quadrupole current of the single power supplies within each family has a variation of +/-0.3% in the focusing quads (QH) and +/-1.3% in the defocusing quads (QV).

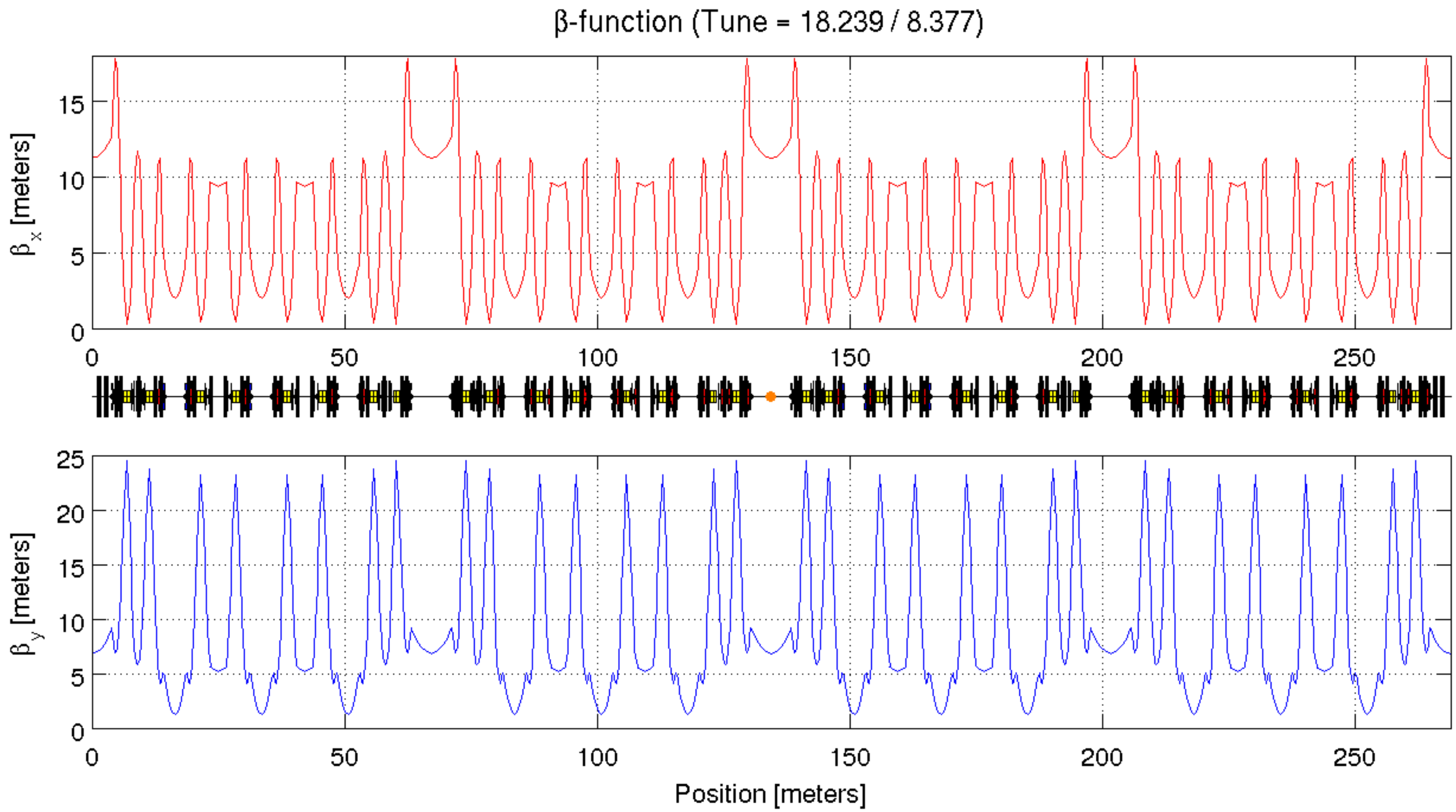
The difference in the QV quads is due to the errors in the vertical focusing combined function dipoles that are corrected with the quads.

Loco: beta beating correction



Beta beating of 0.3% in both planes after 3 LOCO iterations: 112 quadrupoles are used as correctors.
Before the LOCO symmetrization the vertical beta beating is the double than the horizontal one by a due to the errors in the combined dipoles gradients.

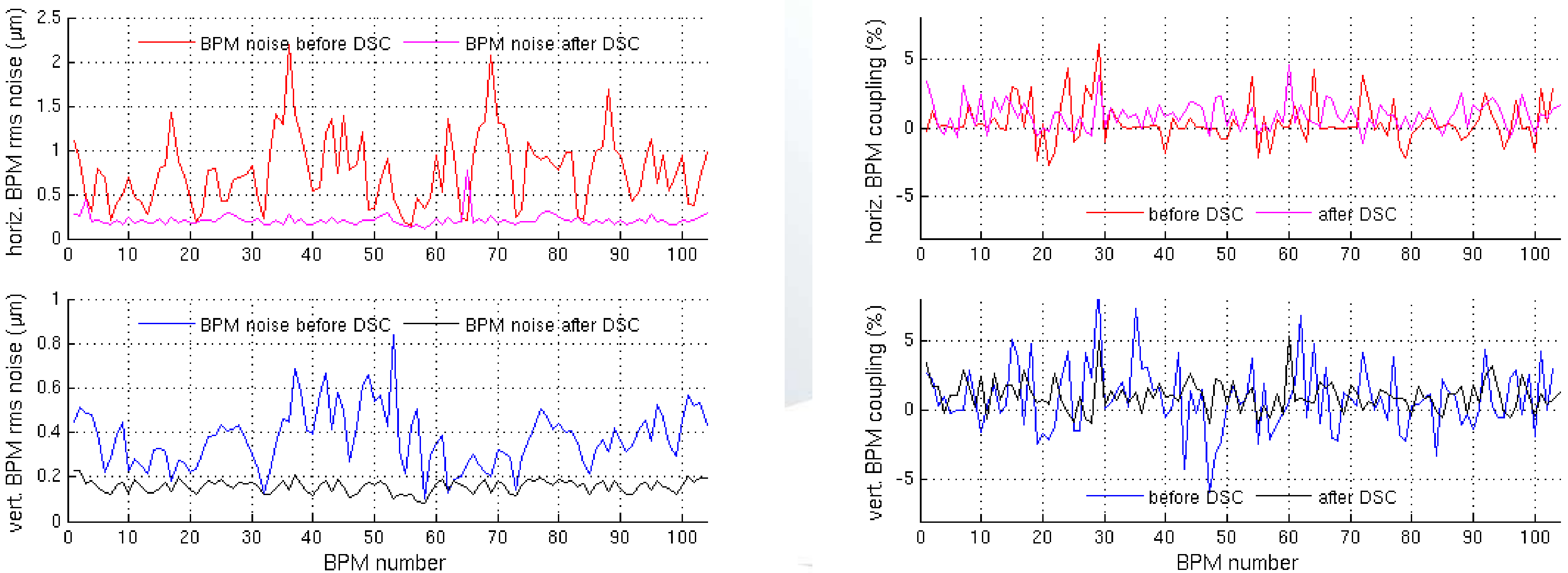
Optics correction



Nominal optics One iteration Three iteration

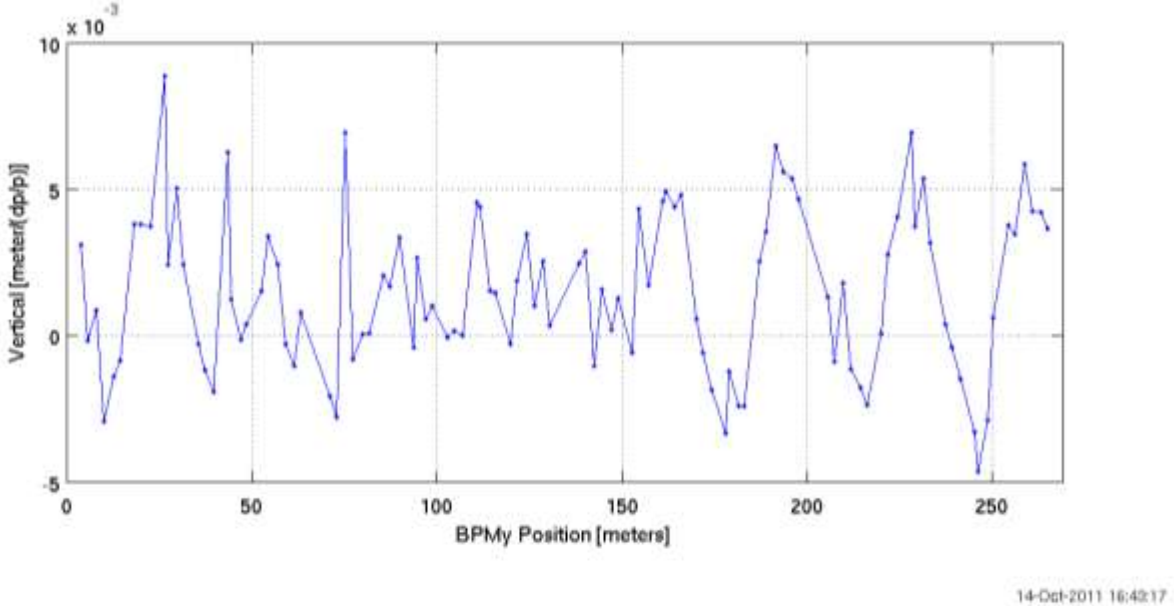
Loco: BPM noise and coupling

LOCO input data set include a measurement of the BPM noise.
LOCO fits the BPM coupling factors.

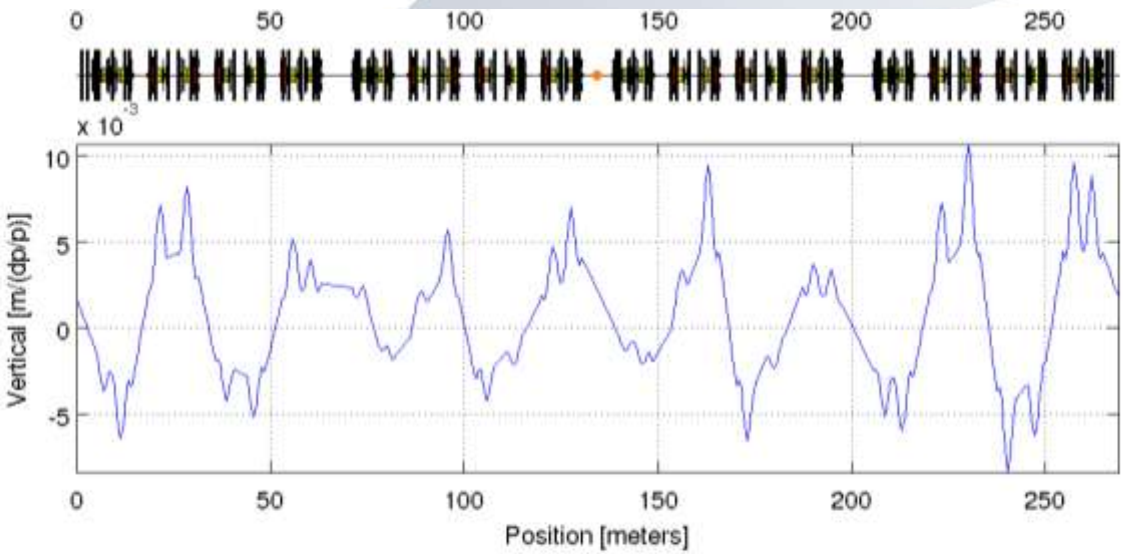


Typical BPM noise for averaged data during 180 s were on the order of 1 μm and the BPM coupling up to 8% before the DSC mode implementation.
Withy the DSC mode the BPM noise was reduced to 0.1 μm and the coupling below 3%.

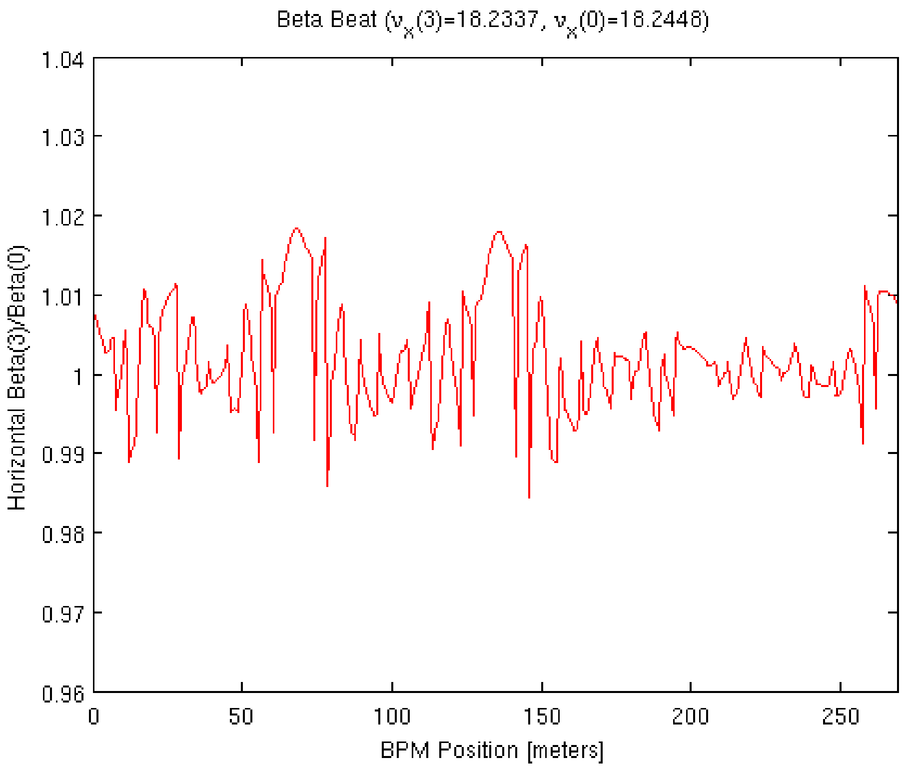
Dispersion

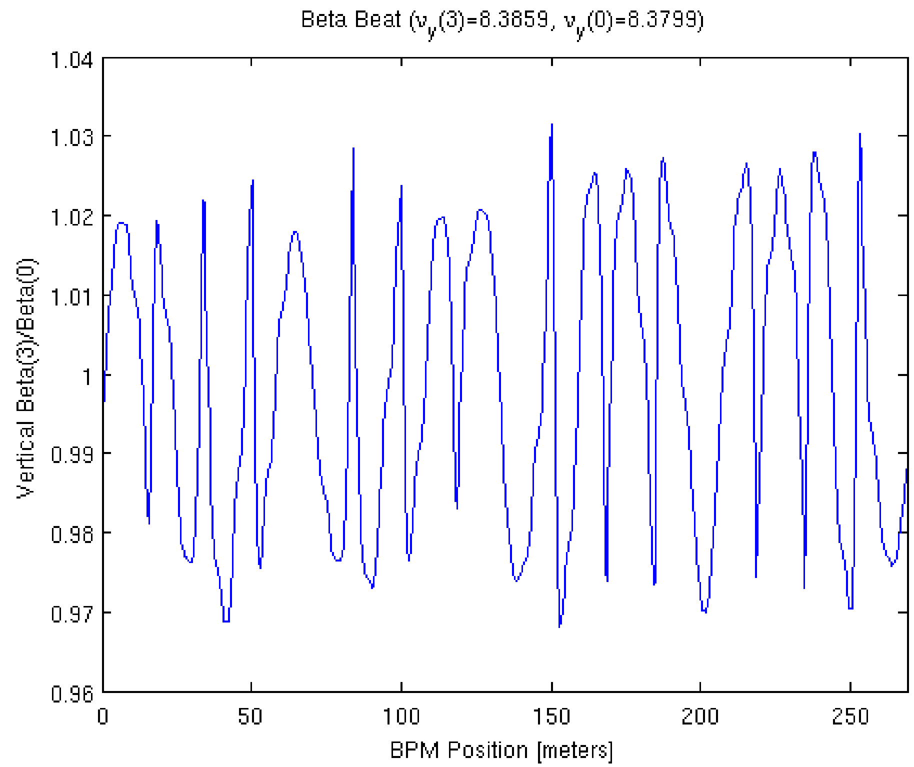


- The coupling has to be taken in account in the vertical dispersion.



Effect of the SCW



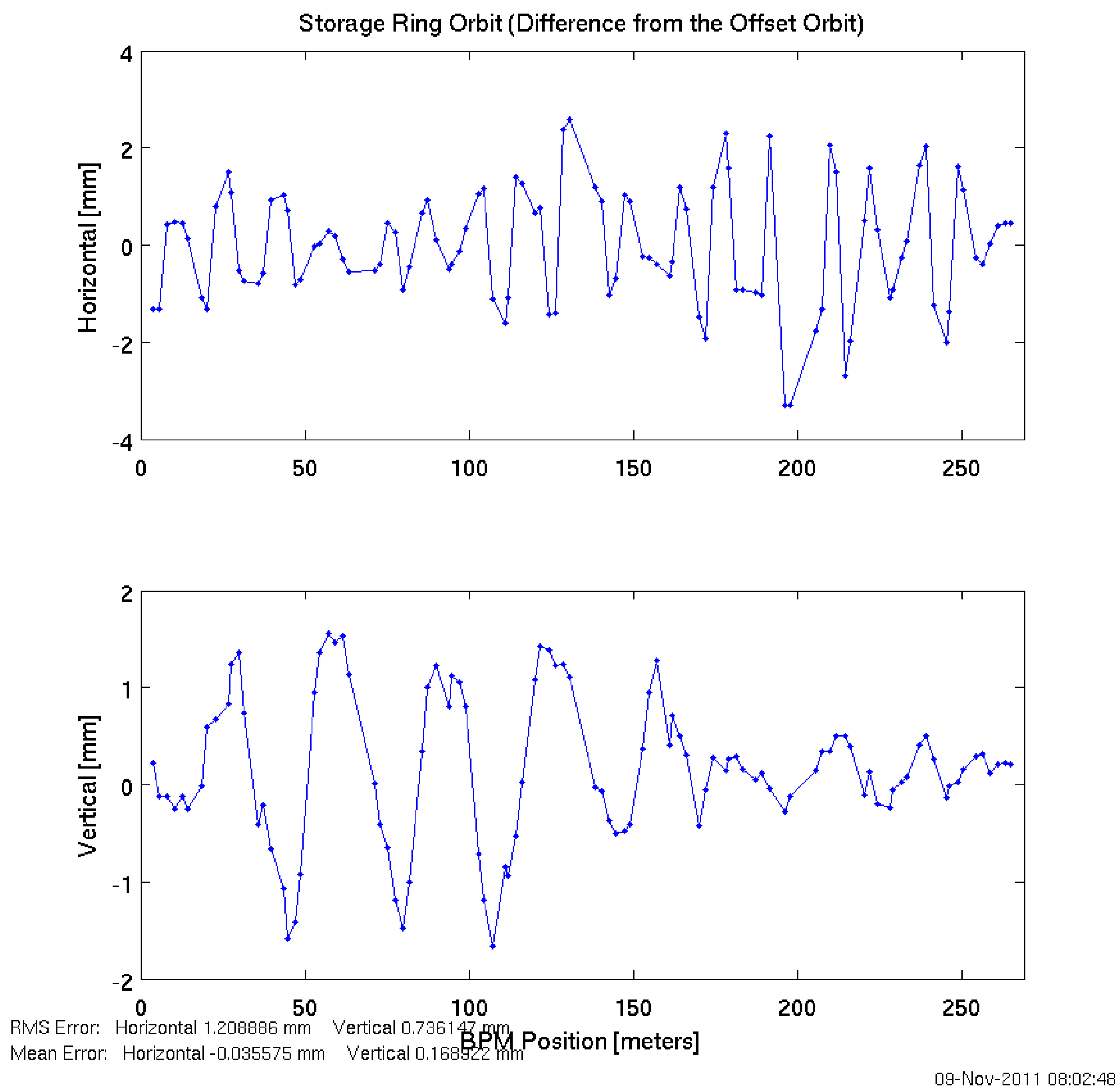


- Data in process of analysis.
- Good agreement with the simulation.

Orbit Stability

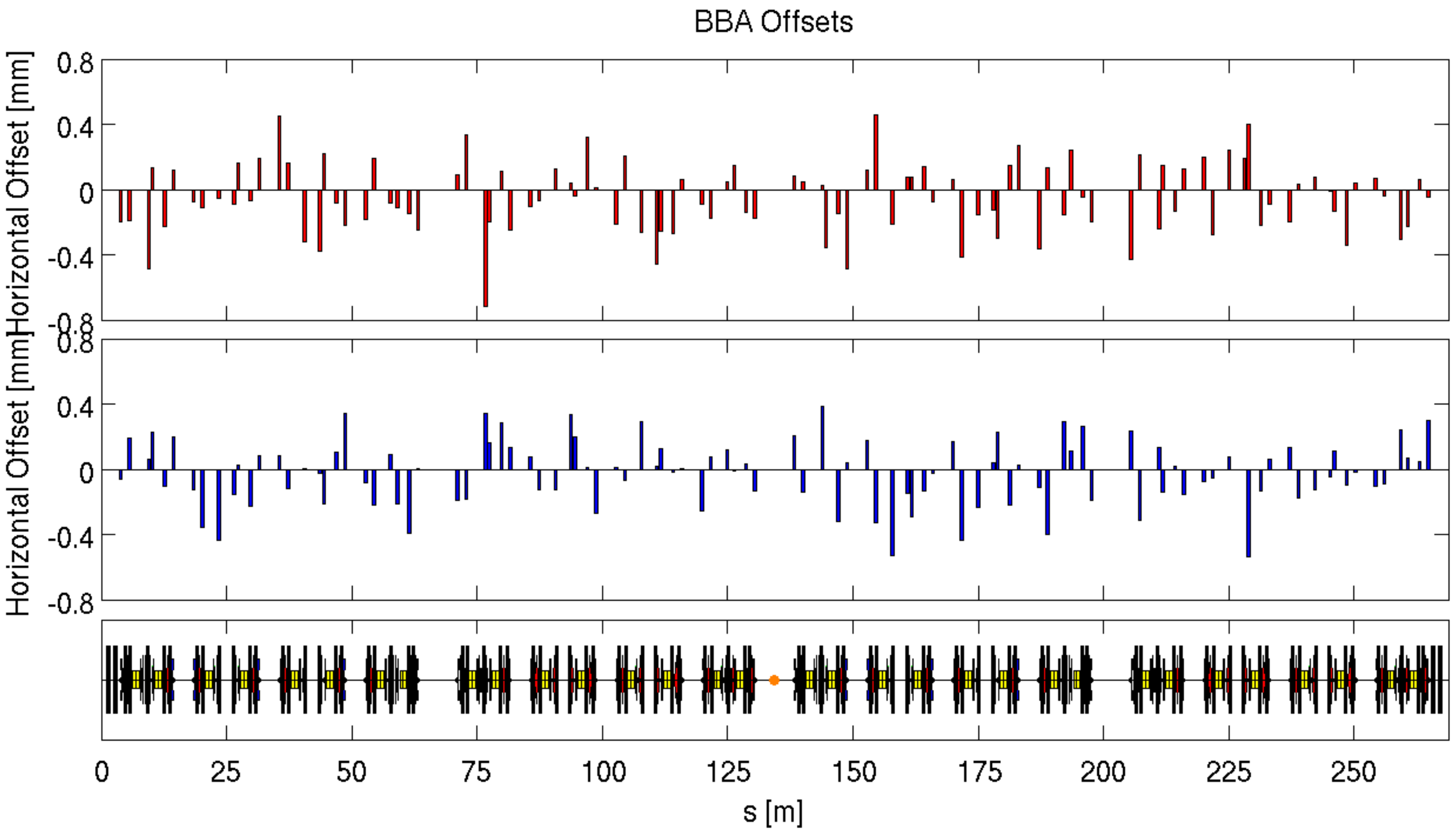
- Orbit feedback running at 0.5 Hz all the time for BL commissioning.
  - Started with a modified `setorbit` from MML,
  - Developed a new one, almost independent from MML but in Matlab
  - Moving it to python as a device server in the near future
- Test for the FOFB running:
  - 2 BPM sectors getting the data at 10 kHz, thanks to an acquisitor board lend by ESRF.
  - Converting some of the spare timing boards of ALBA as acquisiton board/sniffer
  - Cabling between sectors done, other cabling ready in 2 month.
  - Some decisions still open.
- Correcting the orbit using only 88 of the 104 BPMs, as we have only 88 correctors.

Bare orbit


Storage Ring Orbit (Difference from the Offset Orbit)
Horizontal [mm]
4
2
0
-2
-4
0
50
100
150
200
250
Vertical [mm]
2
1
0
-1
-2
BPM Position [meters]
RMS Error: Horizontal 1.208886 mm Vertical 0.736147 mm
Mean Error: Horizontal -0.035575 mm Vertical 0.168922 mm
09-Nov-2011 08:02:48

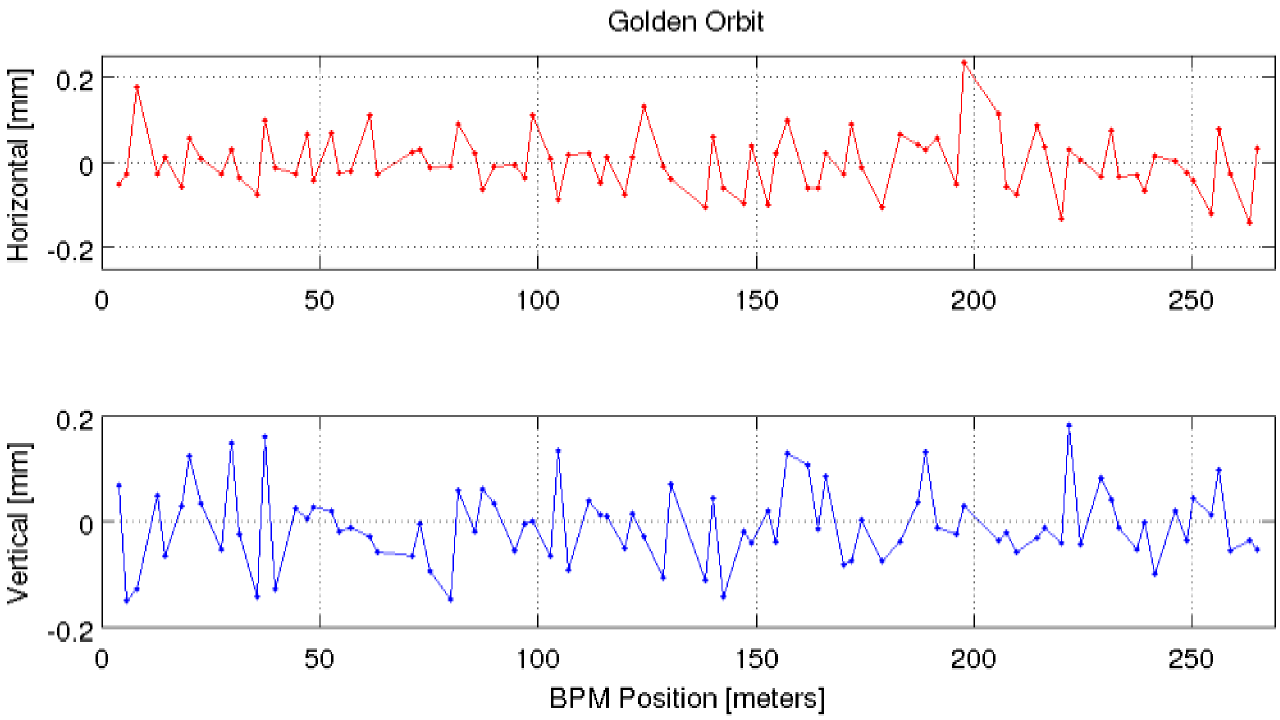
BBA Offsets

- One round done
- Needs to be refined, remaining up to 40 um in some BPMs



Golden Orbit

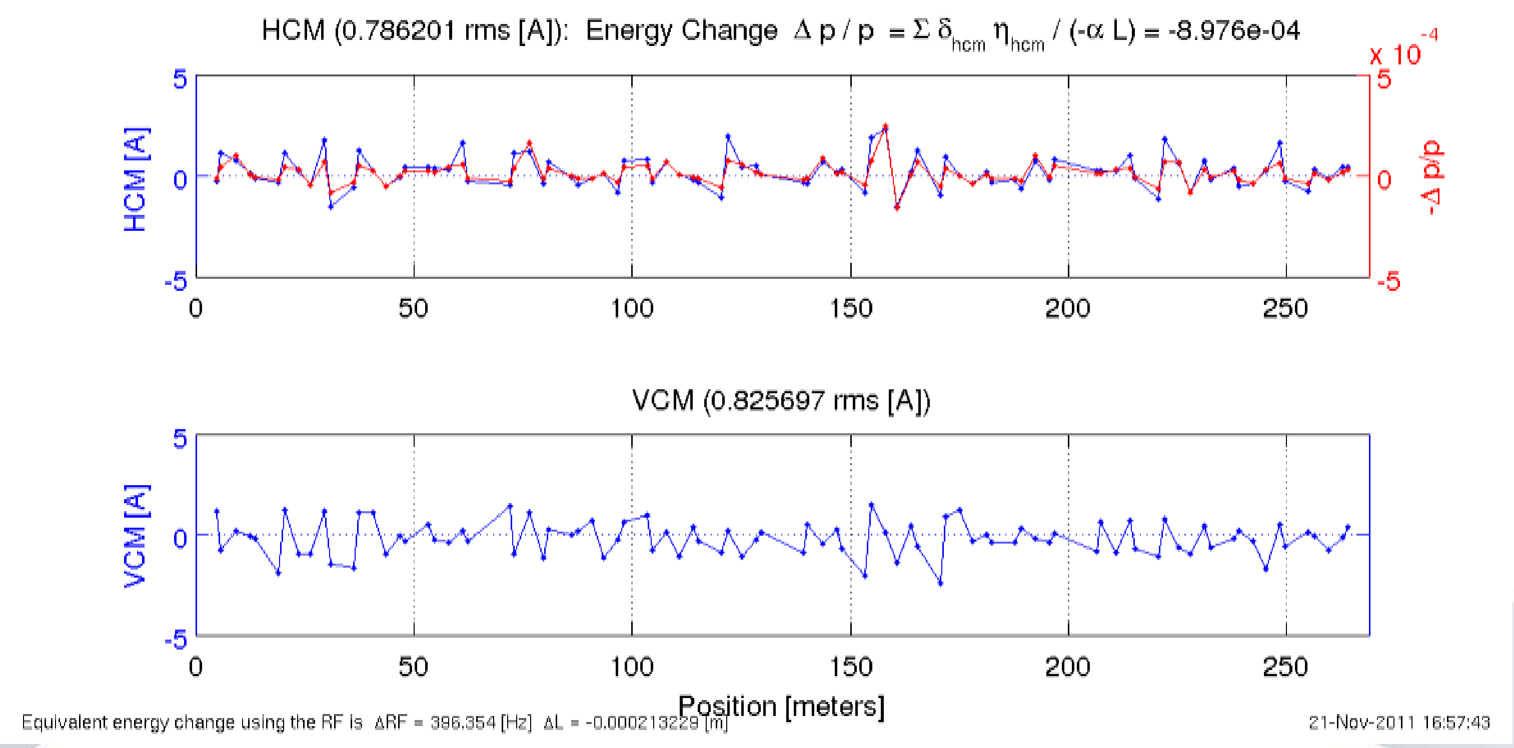
- Needs to be refined:



- The orbit has an angle in some beamlines.

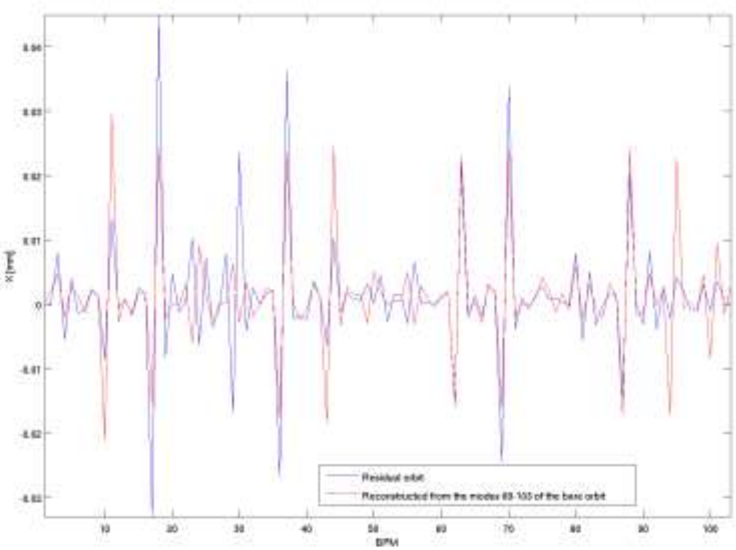
Corrector setting

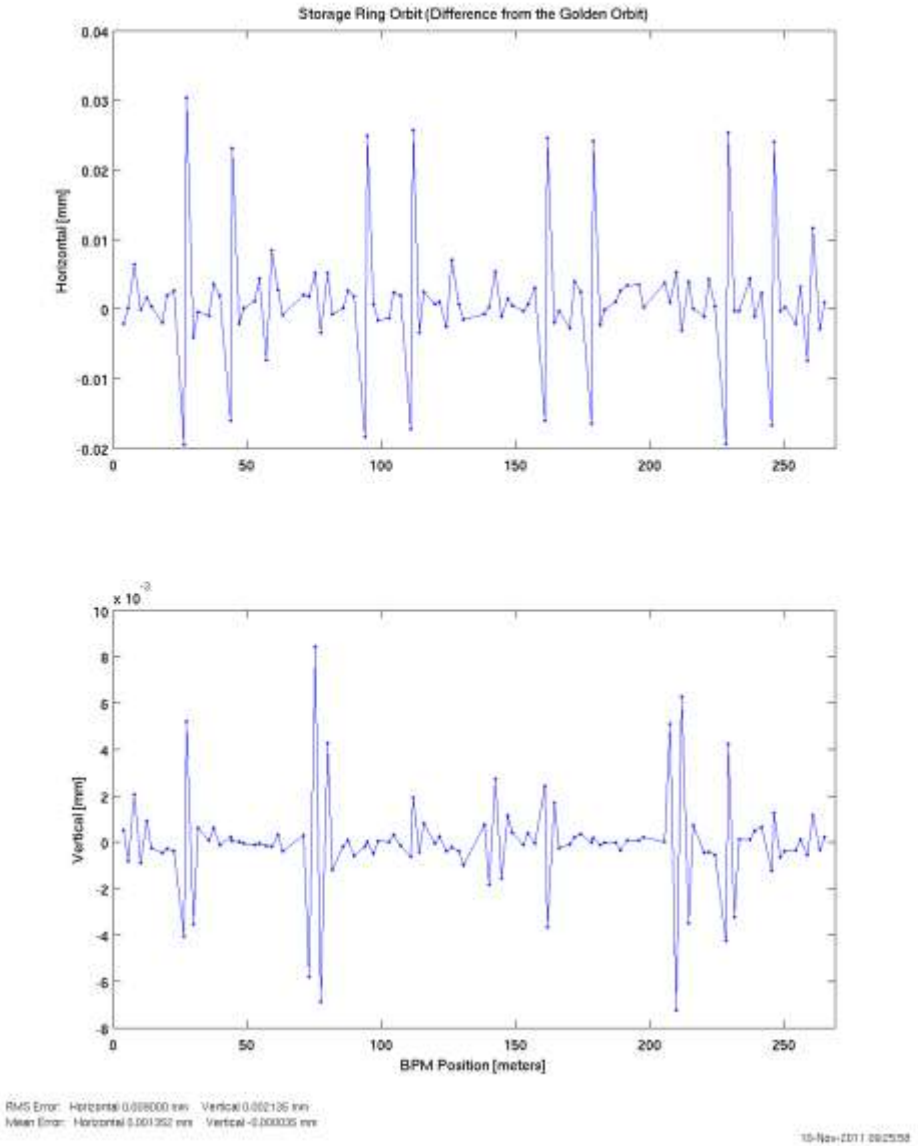
- Small values, up to 30 % of the maximum 10 A.
- Changes up to 0.1 when closing insertion devices.



88 or 104 BPMs

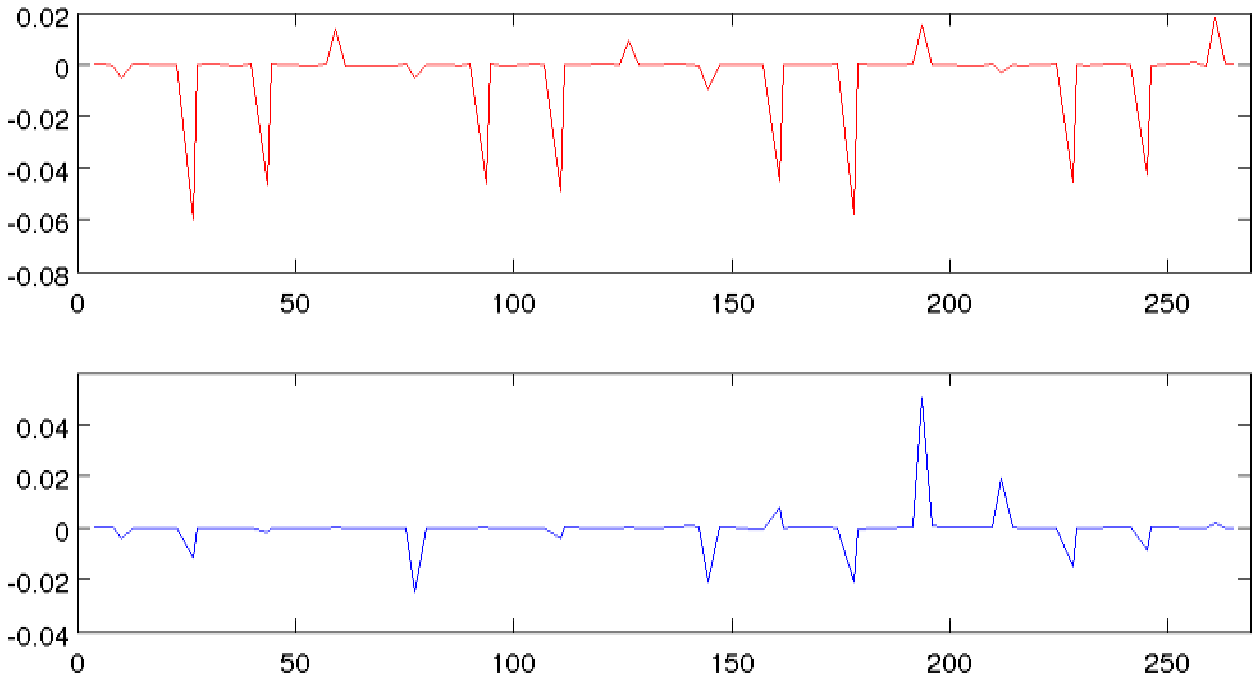
- Typical orbit corrected using the 104 BPMs:
- The spikes can be reconstructed from the bare orbit, using the SVD modes 89 to 104.



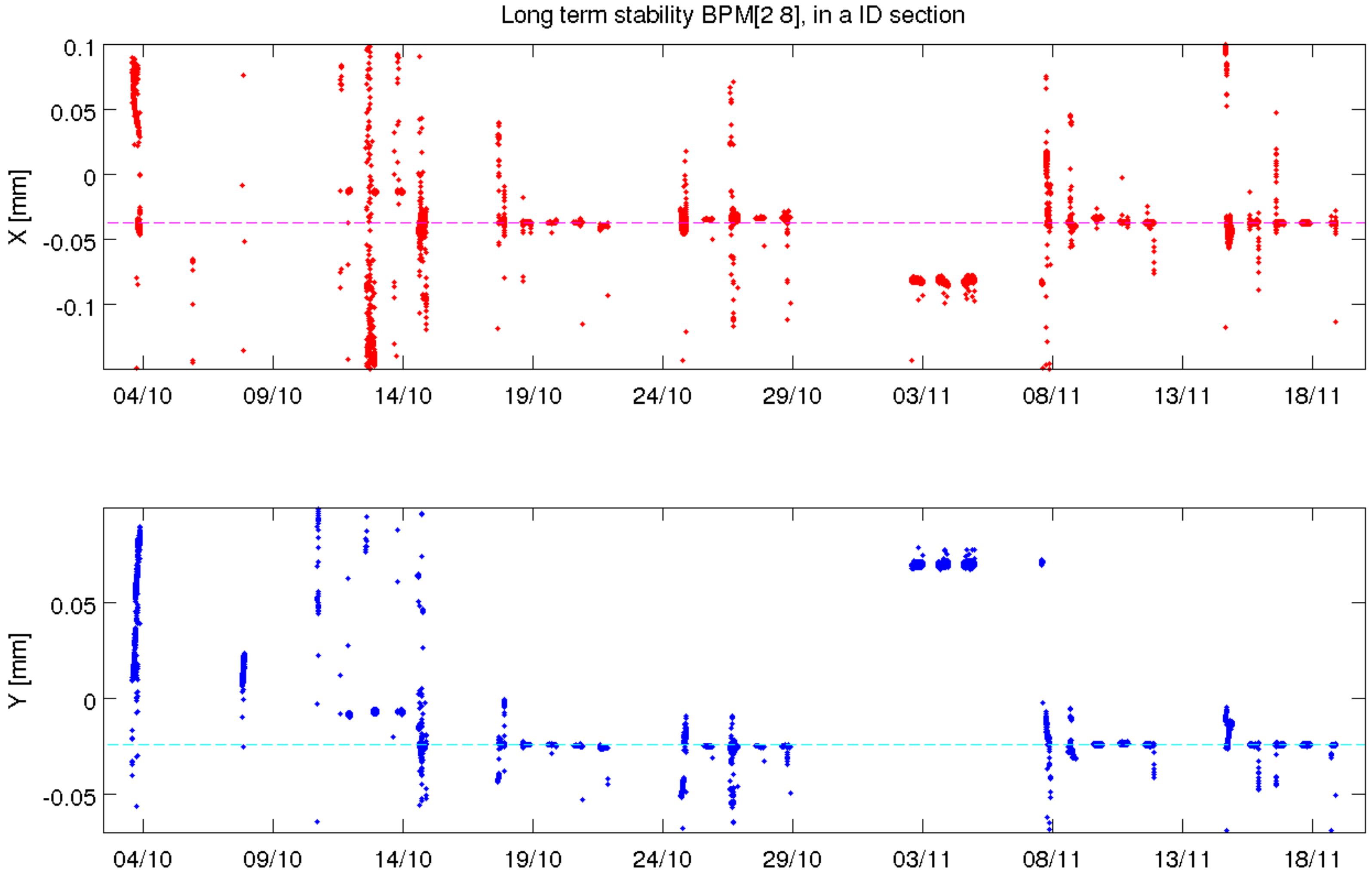


Correction using 88 BPMs

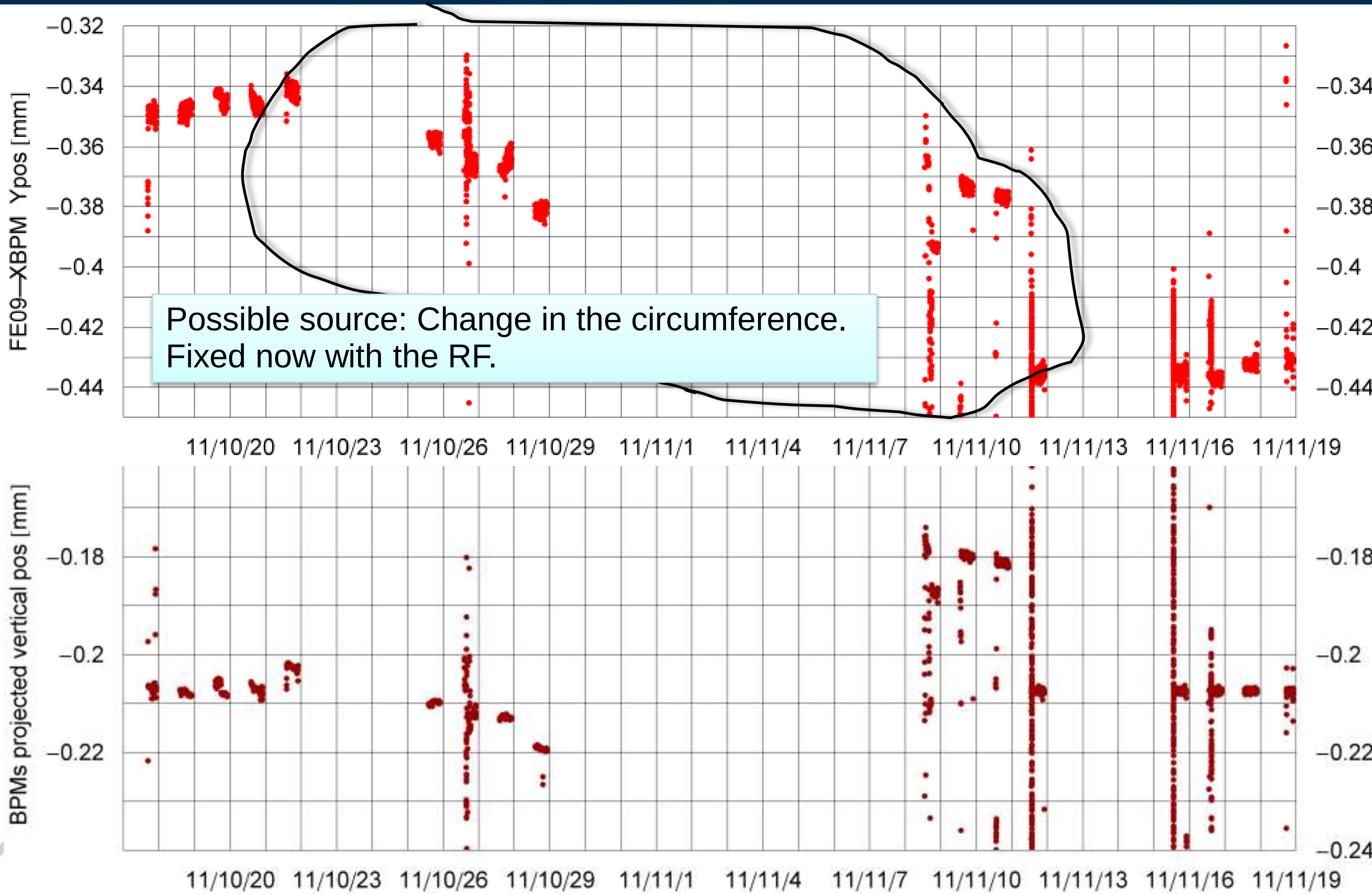
- Orbit in the 104 BPMs
- The peaks (16) are for BPMs not included in the correction, and coincide with the places were the correction using 104 BPMs is not efficient.



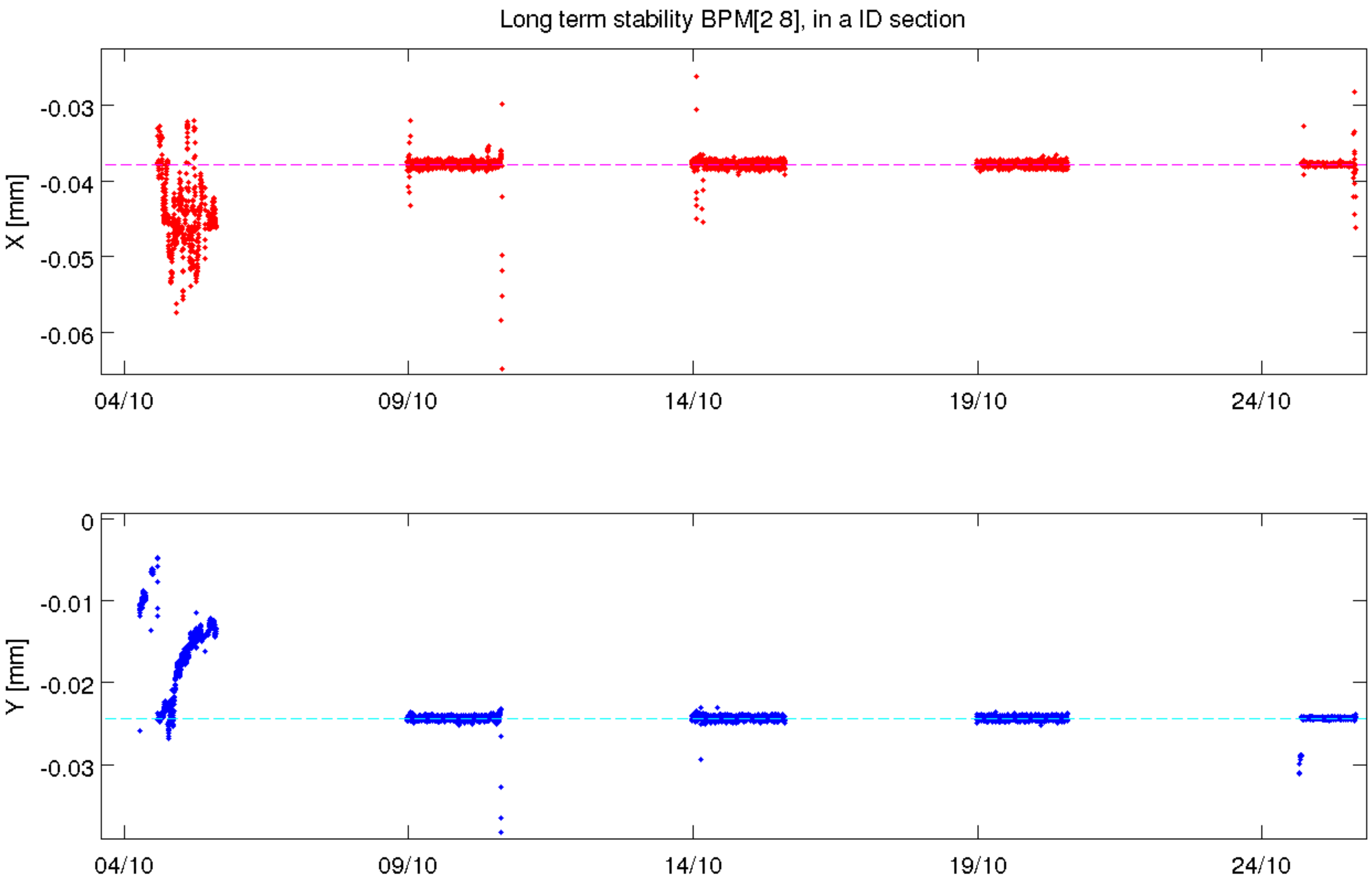
Orbit Stability – BL Operation



Stability in the XBPM

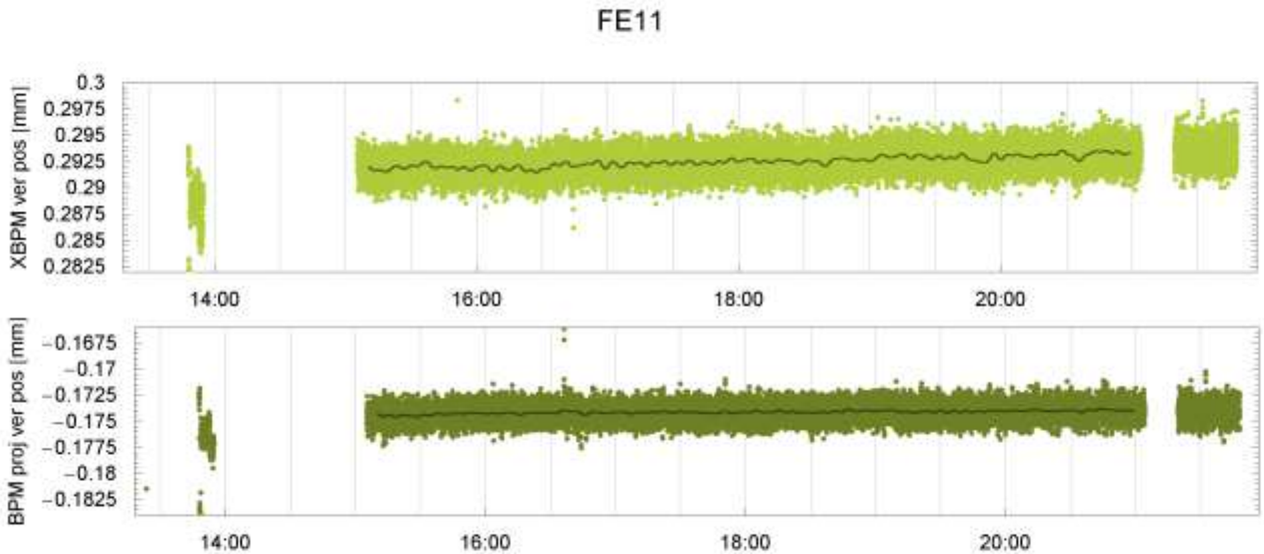


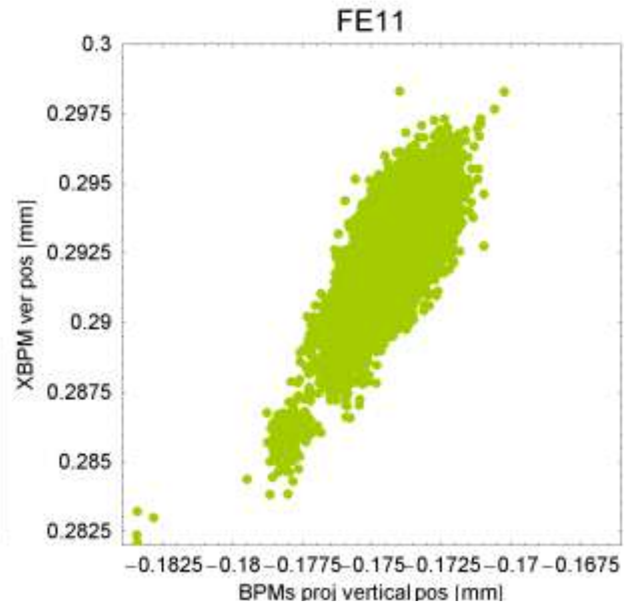
One Week data BPM

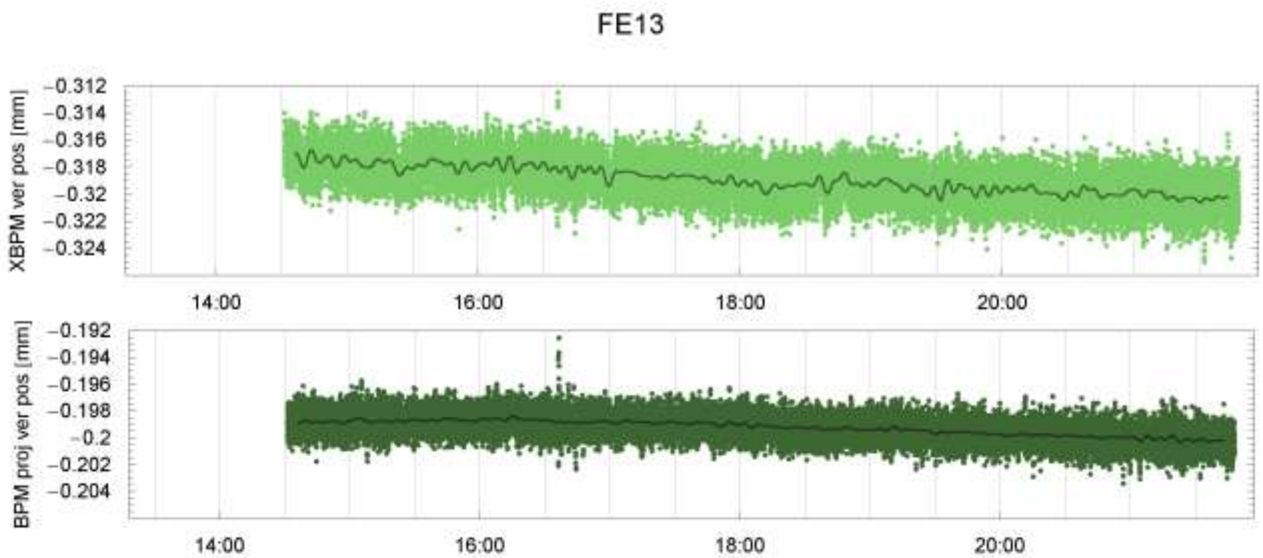


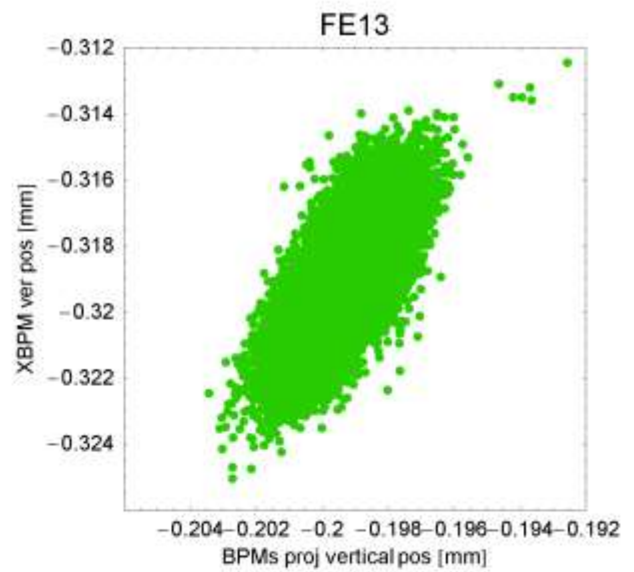
Short term stability

XBPM data

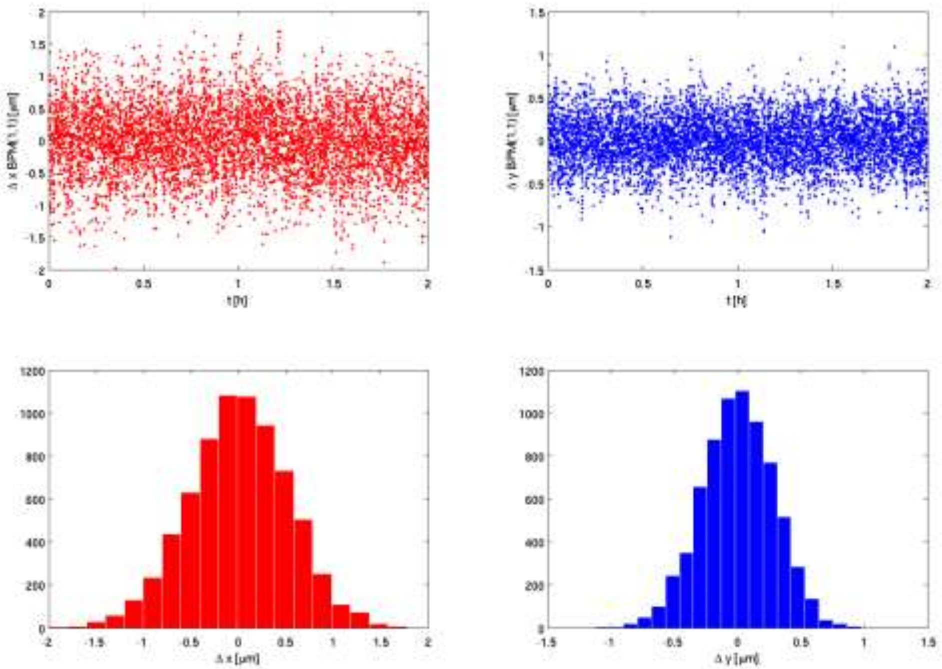

FE11
XBPM ver pos [mm]
0.3
0.2975
0.295
0.2925
0.29
0.2875
0.285
0.2825
14:00
16:00
18:00
20:00
BPM proj ver pos [mm]
−0.1675
−0.17
−0.1725
−0.175
−0.1775
−0.18
−0.1825
14:00
16:00
18:00
20:00

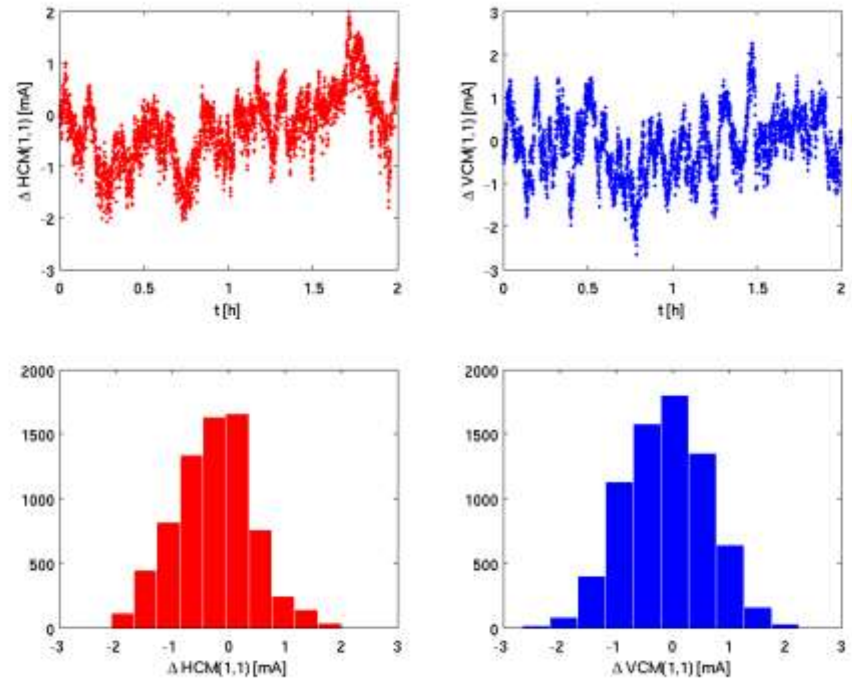

FE11
XBPM ver pos [mm]
0.3
0.2975
0.295
0.2925
0.29
0.2875
0.285
0.2825
−0.1825 −0.18 −0.1775 −0.175 −0.1725 −0.17 −0.1675
BPMs proj vertical pos [mm]


FE13
XBPM ver pos [mm]
−0.312
−0.314
−0.316
−0.318
−0.32
−0.322
−0.324
14:00
16:00
18:00
20:00
BPM proj ver pos [mm]
−0.192
−0.194
−0.196
−0.198
−0.2
−0.202
−0.204
14:00
16:00
18:00
20:00


FE13
XBPM ver pos [mm]
−0.312
−0.314
−0.316
−0.318
−0.32
−0.322
−0.324
−0.204 −0.202 −0.2 −0.198 −0.196 −0.194 −0.192
BPMs proj vertical pos [mm]

SOFB data

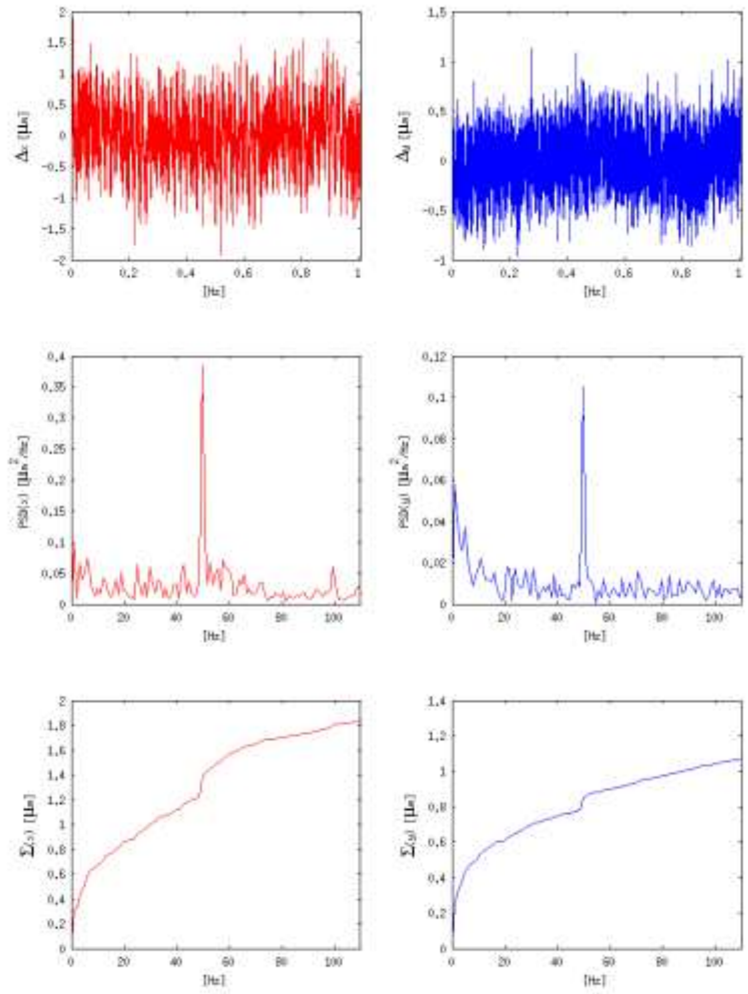




2 hours of data, with the SOFB running.
β_x ~ 14 m
β_y ~ 8 m
Micron stability
Small changes in the correctors

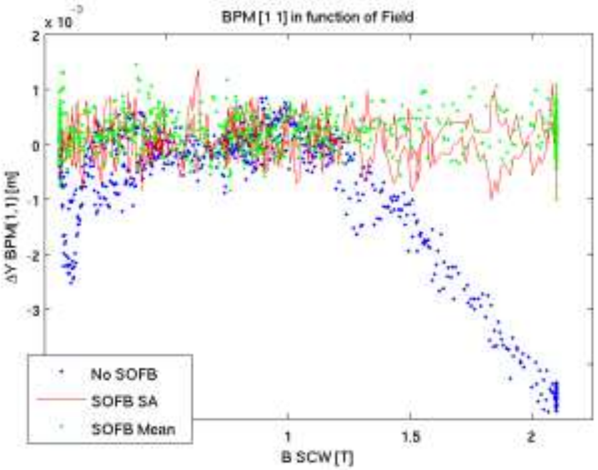
10 kHz data

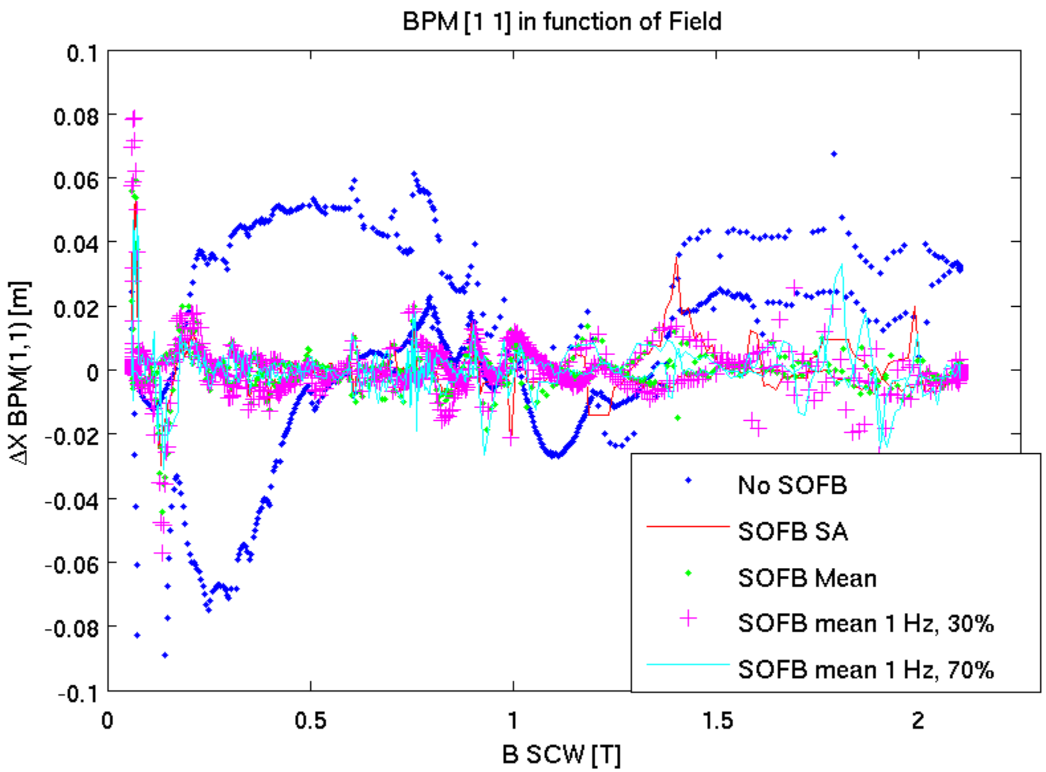
- Projected beam position and angle in the middle of one MSS, using the two BPMs of the extreme of the section.
- Motion of the order of the micro meter and micro rad in both planes.
- More measurement, including ID effects coming.

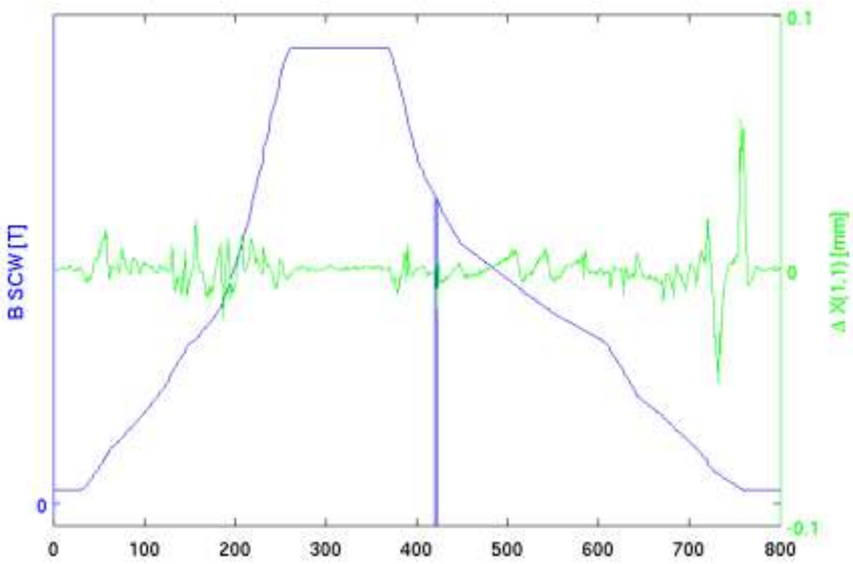


Effect of the SCW

- Effect in the horizontal plane, mostly.
- In the vertical is compensate by the SOFB
- Dynamic effect

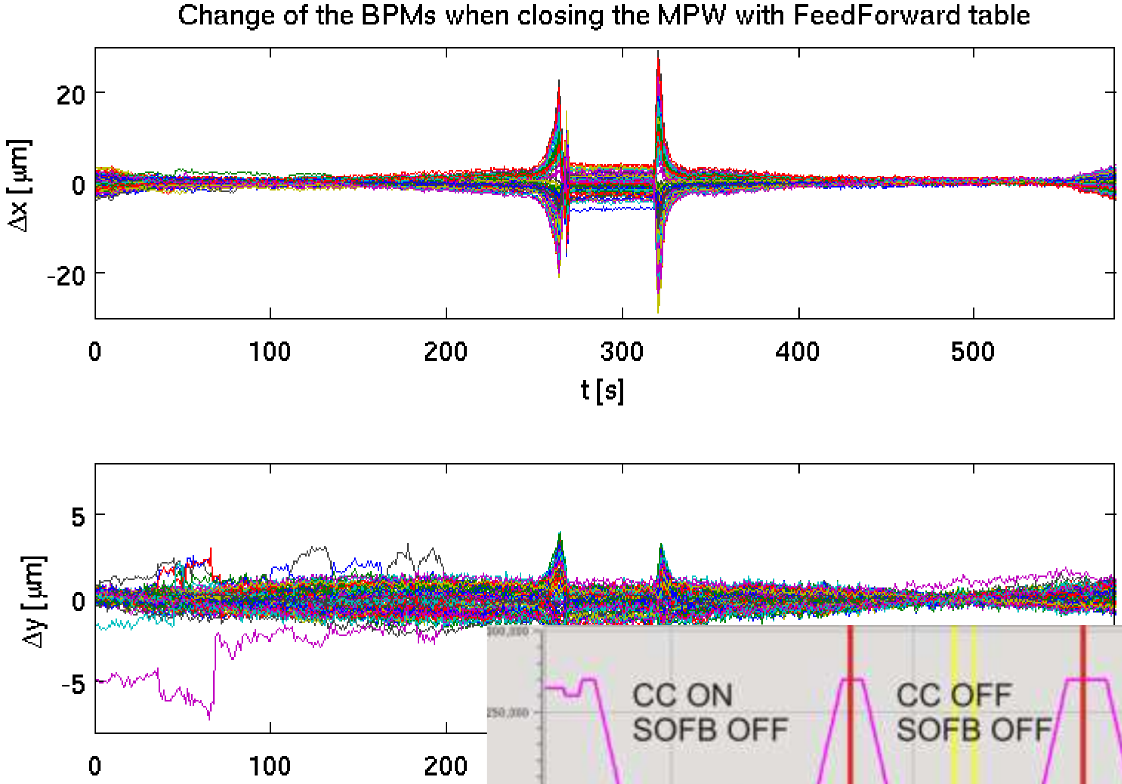


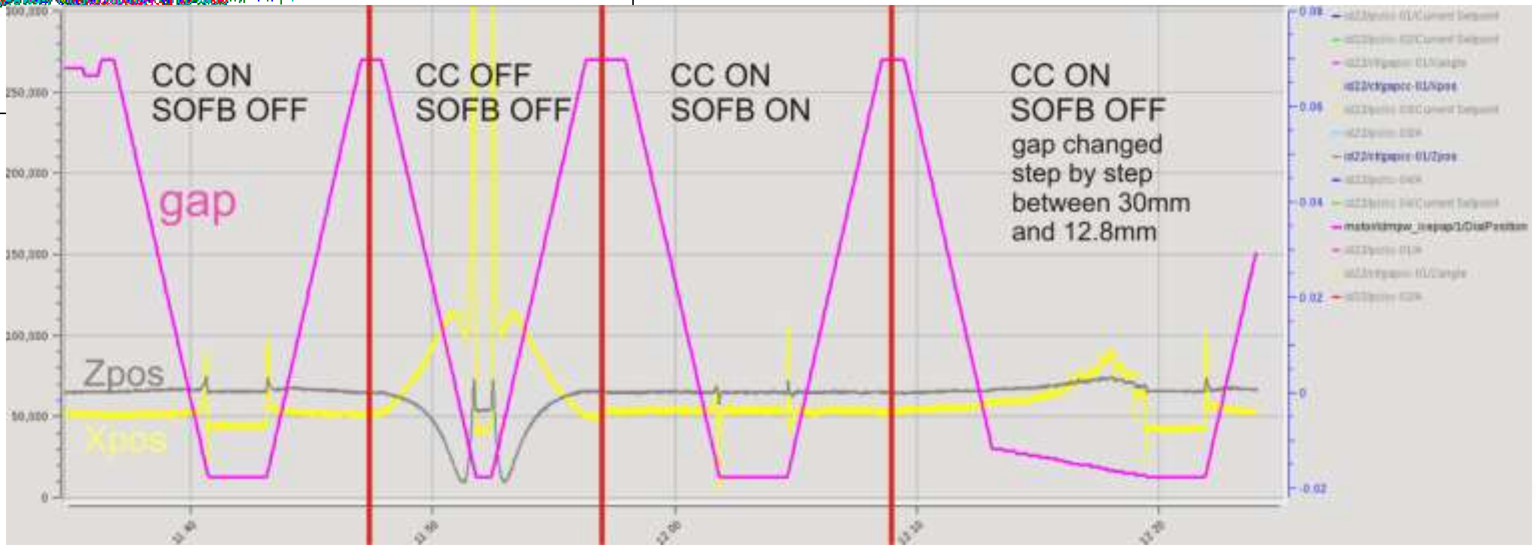




Effect of the MPW

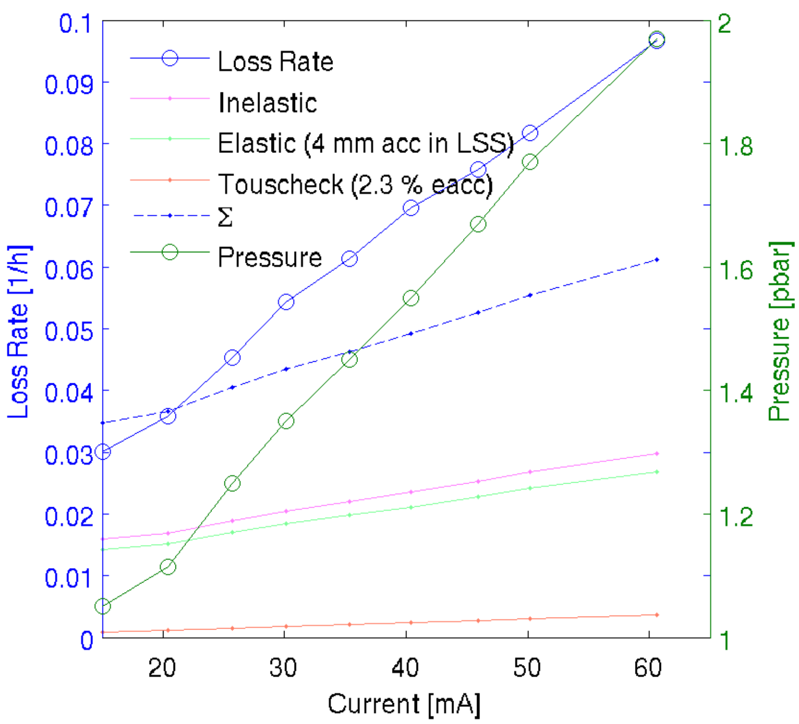
- In process of improving the lookup tables:

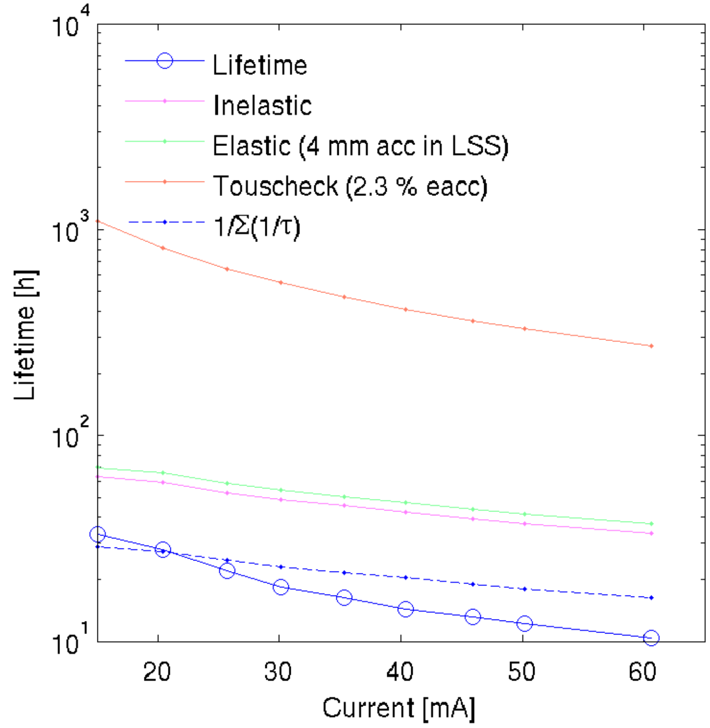




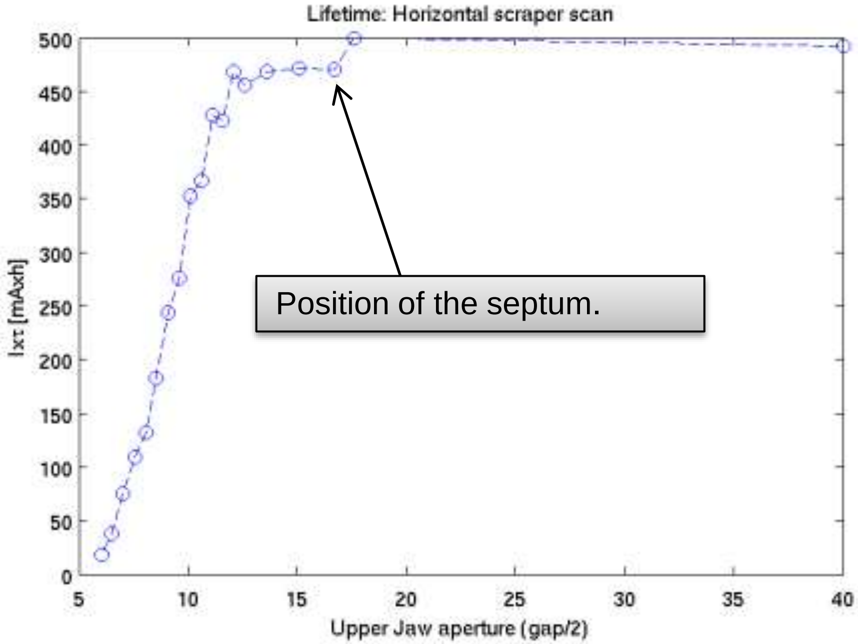
Lifetime

- For the evaluation of the Elastic lifetime, 4 mm vertical acceptance in the LSS has been assumed (measured on Oct 23).
- For the evaluation of the Touscheck lifetime, 2.3% energy acceptance has been assumed (measured on Oct 26).
- For the evaluation of the Touscheck lifetime, 1.7·10^-3 energy spread and 9 mm bunch length have been used (measured on Oct 26).
- Notice that :
  - The loss rate is pressure dominated.
  - There is an unidentified loss rate increase as we increase the beam current.

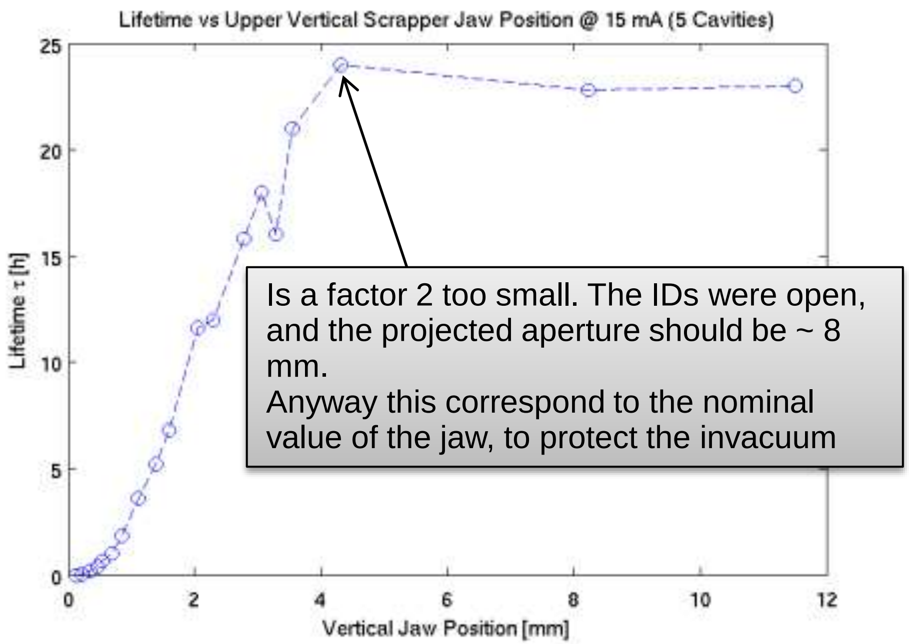


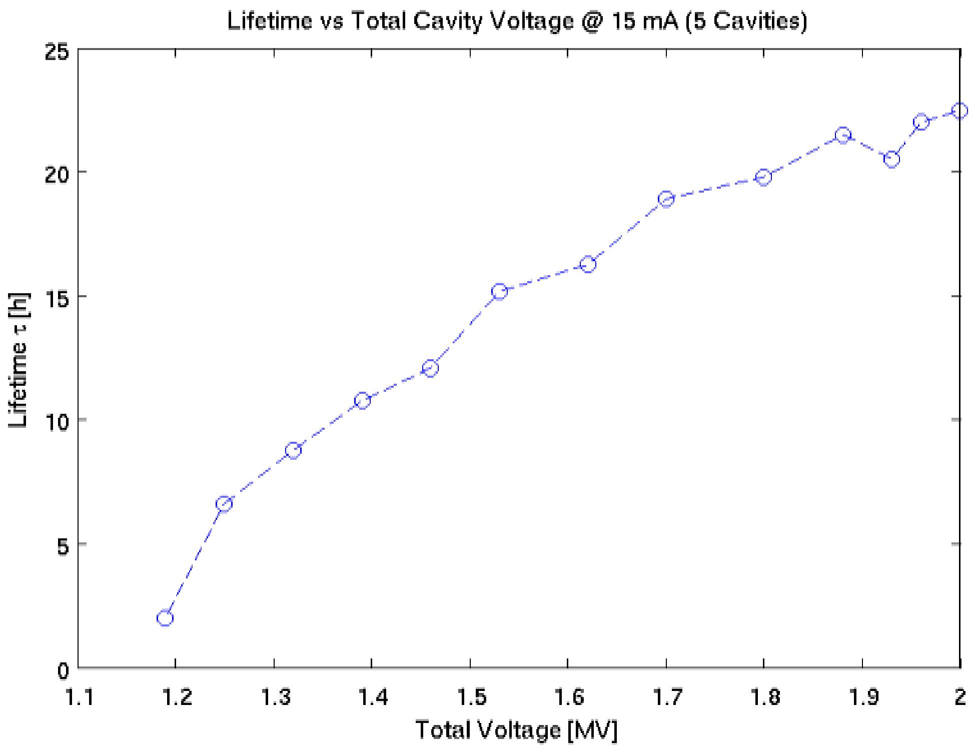


Measures

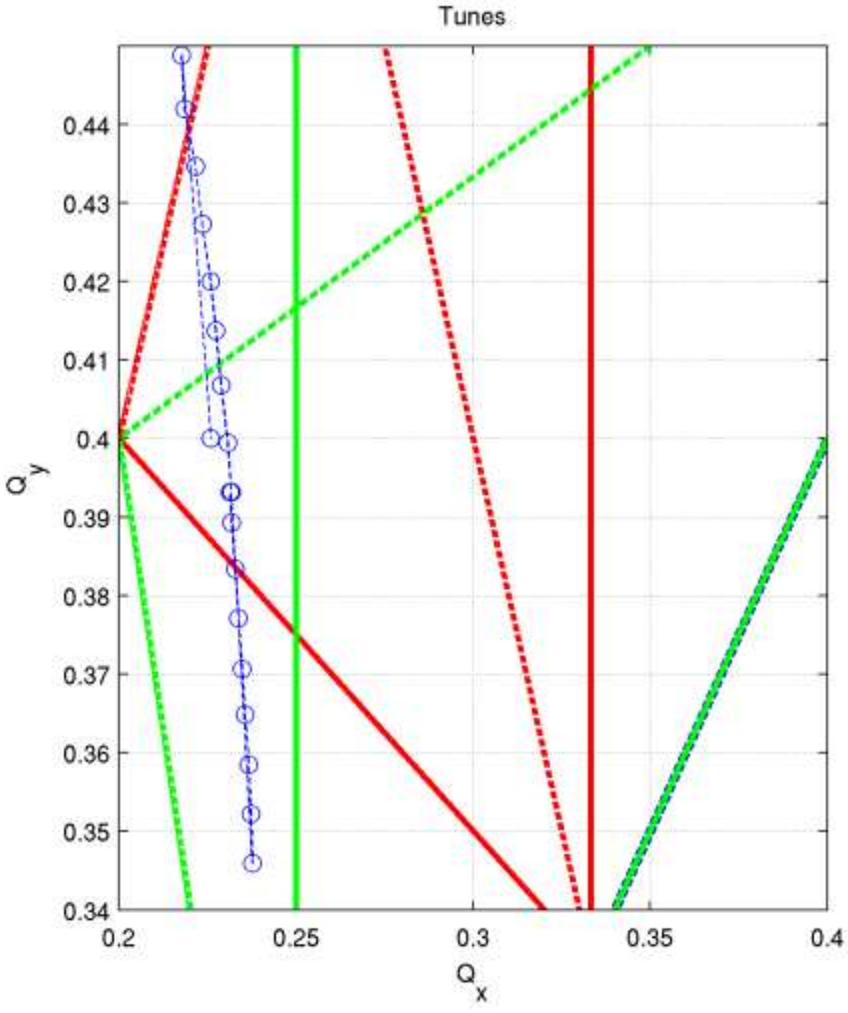


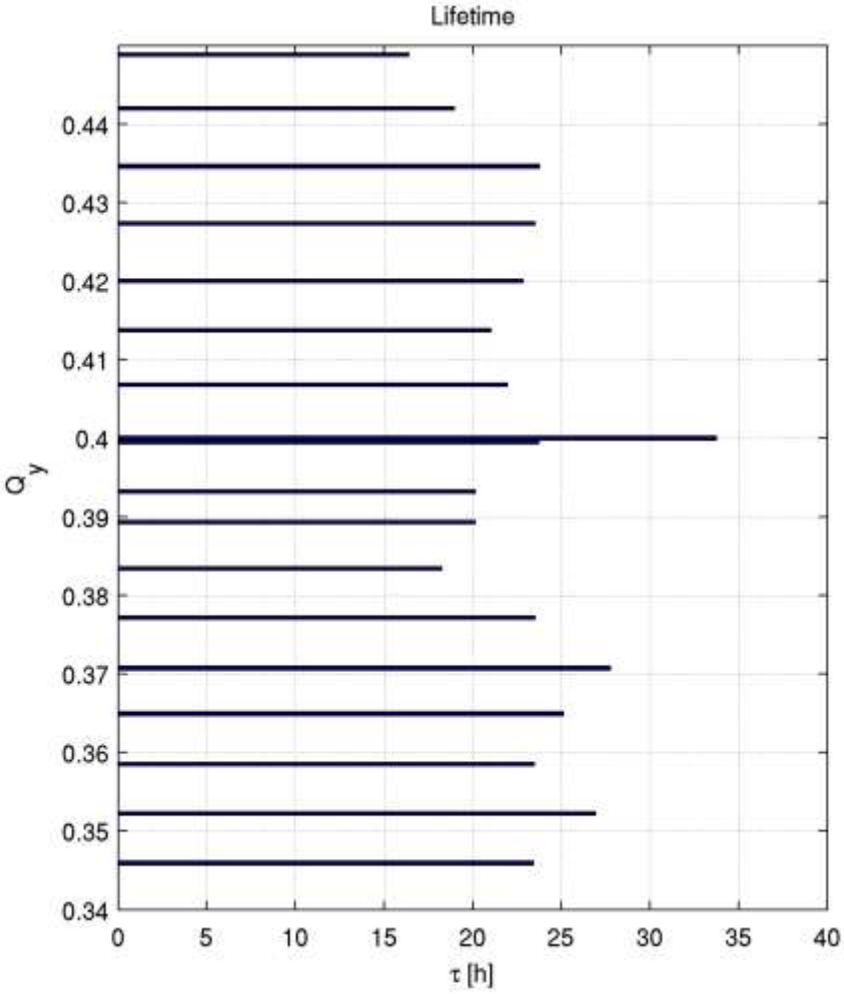
- Scrapers in the injection region, large betas.
- Some vertical limit?
- We already had a problem with an RF finger.



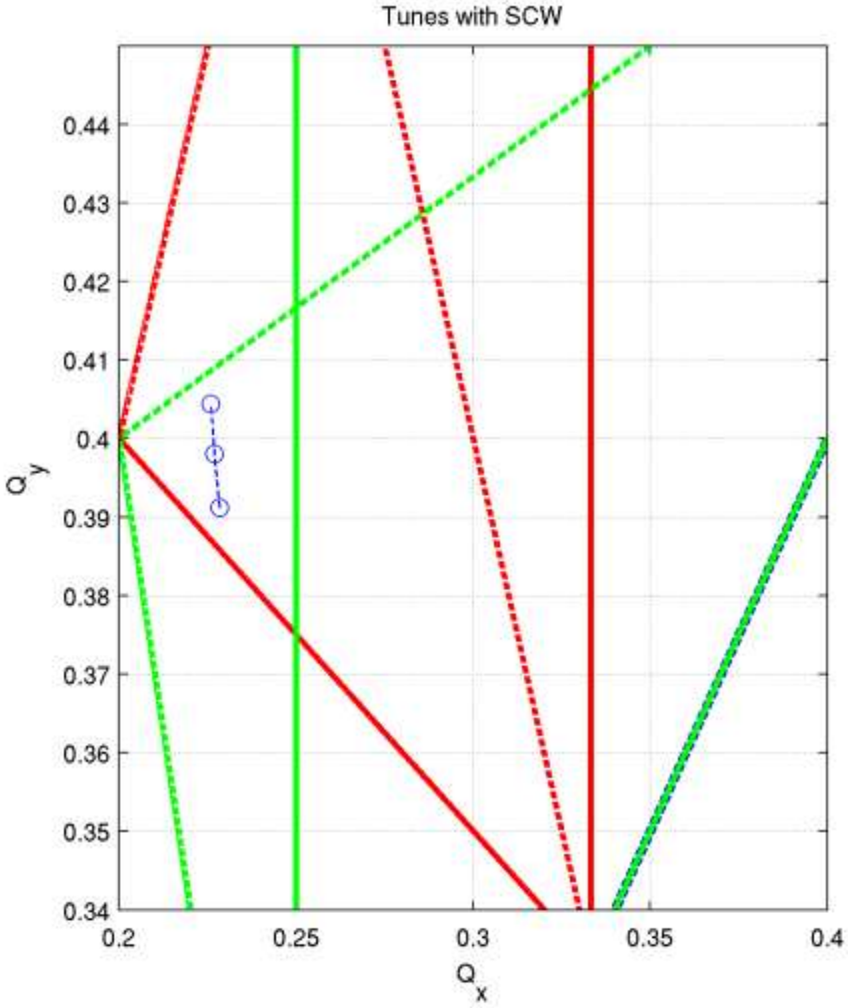


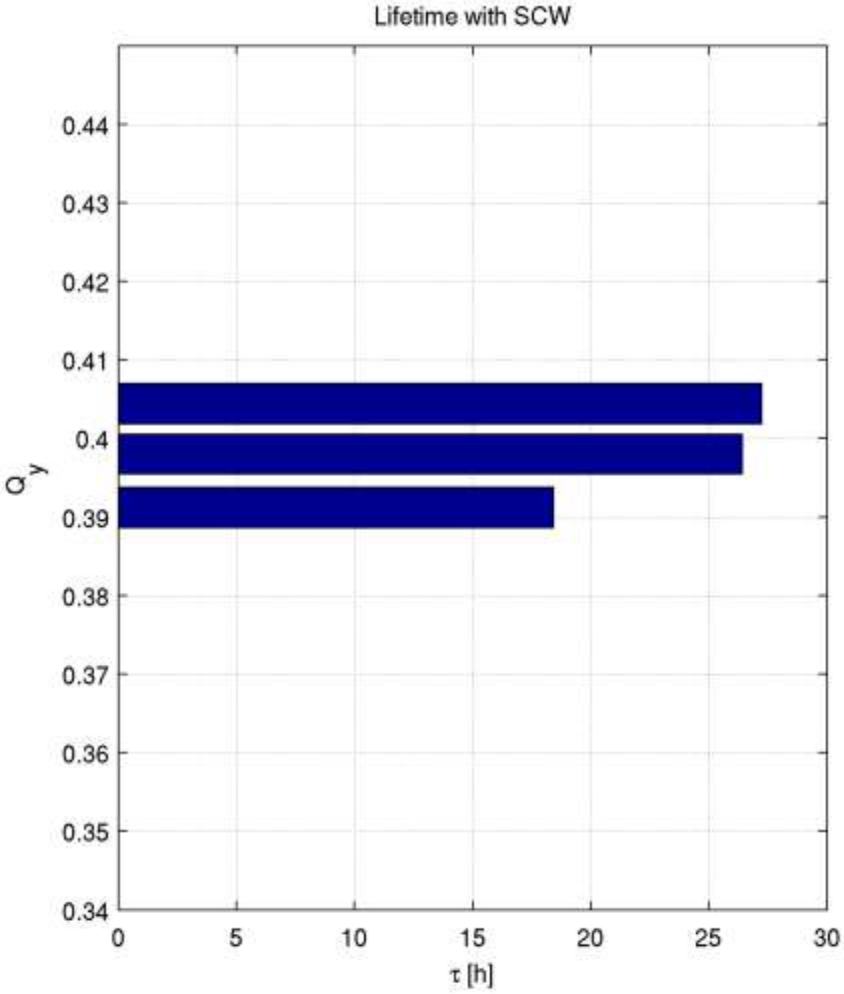
Lifetime and Working point





But when SCW on



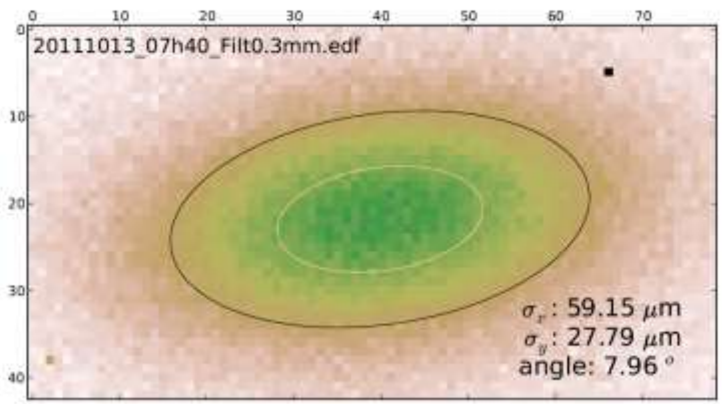


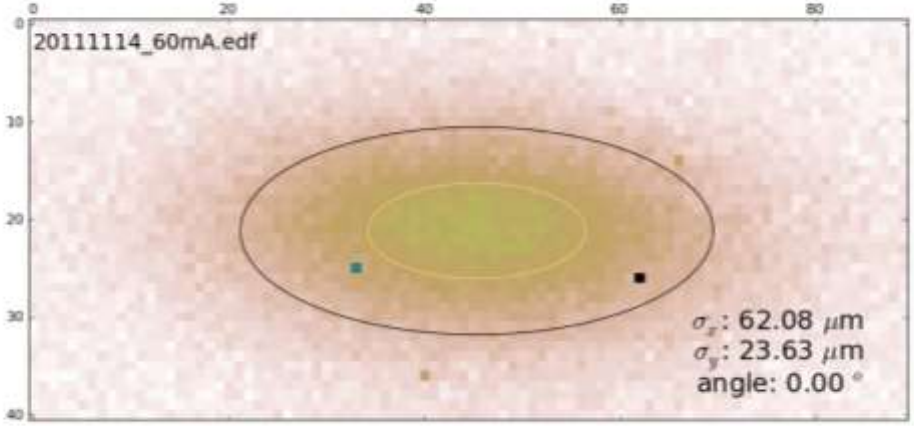
Beam size and Coupling

- Continuous beam size (emittance) monitoring
  - Use xrays from a bending magnet
    - Magnification factor: **2.295**
      - Available since day-1

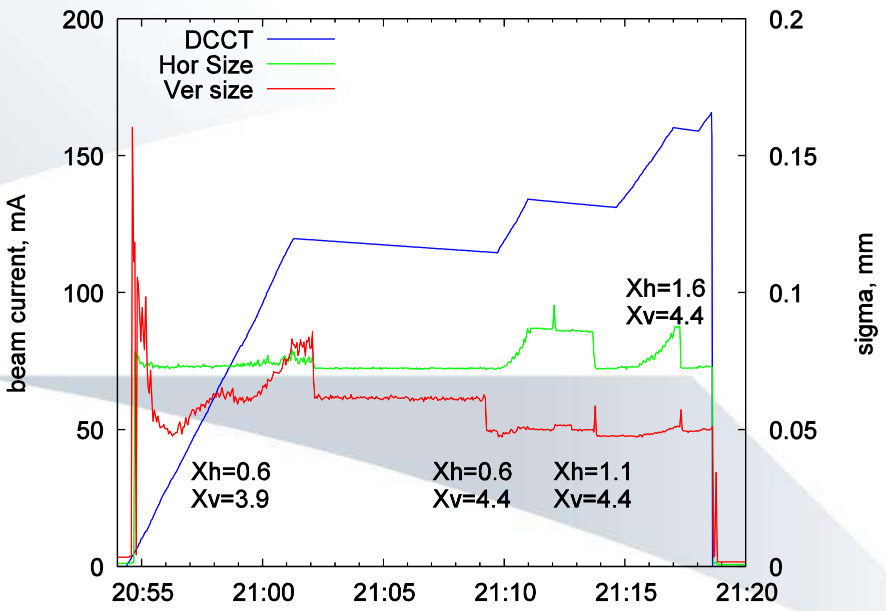
Coupling around 0.8 %

Beam size and angle:



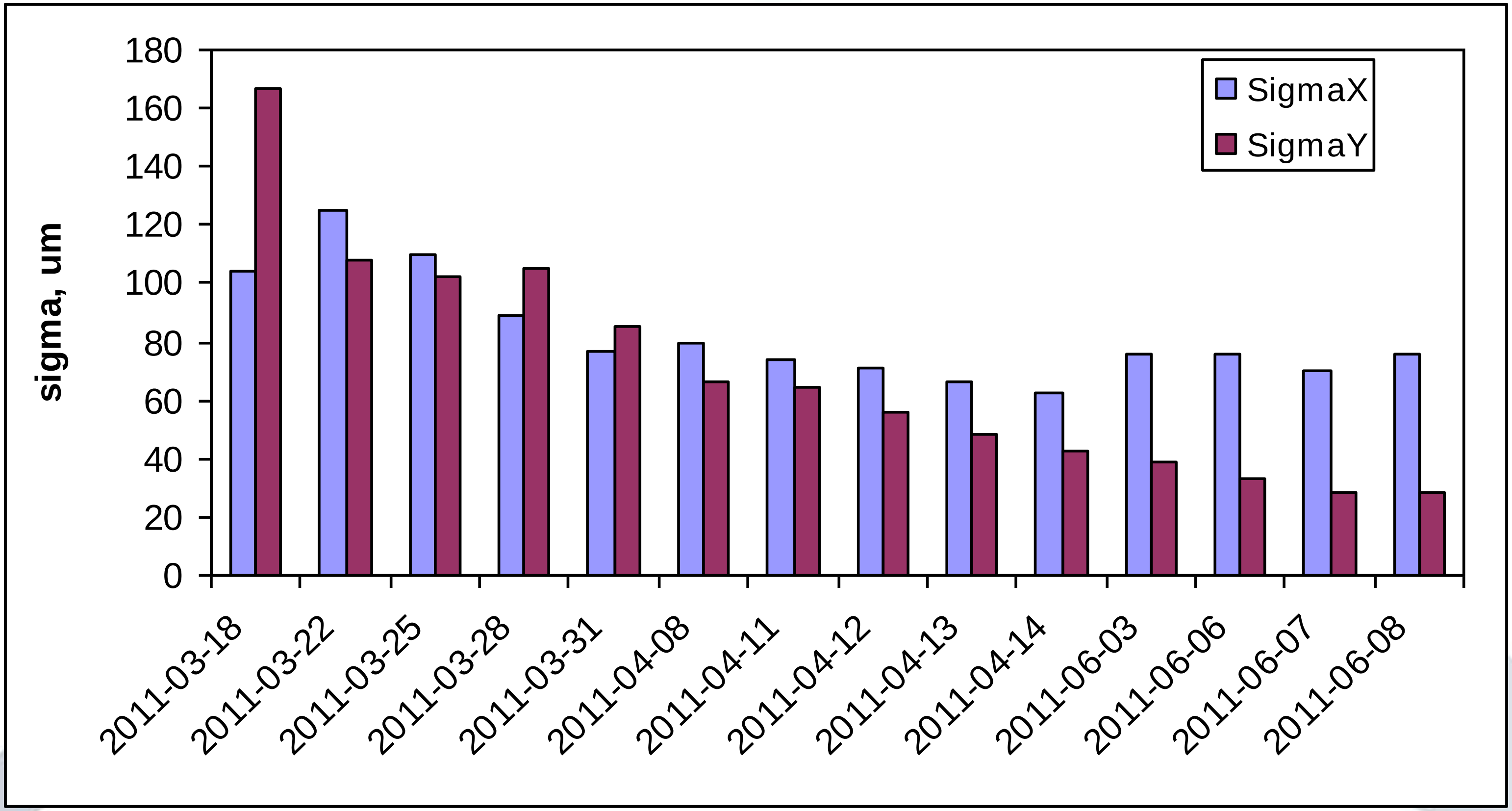


Beam size during high intensity fill:

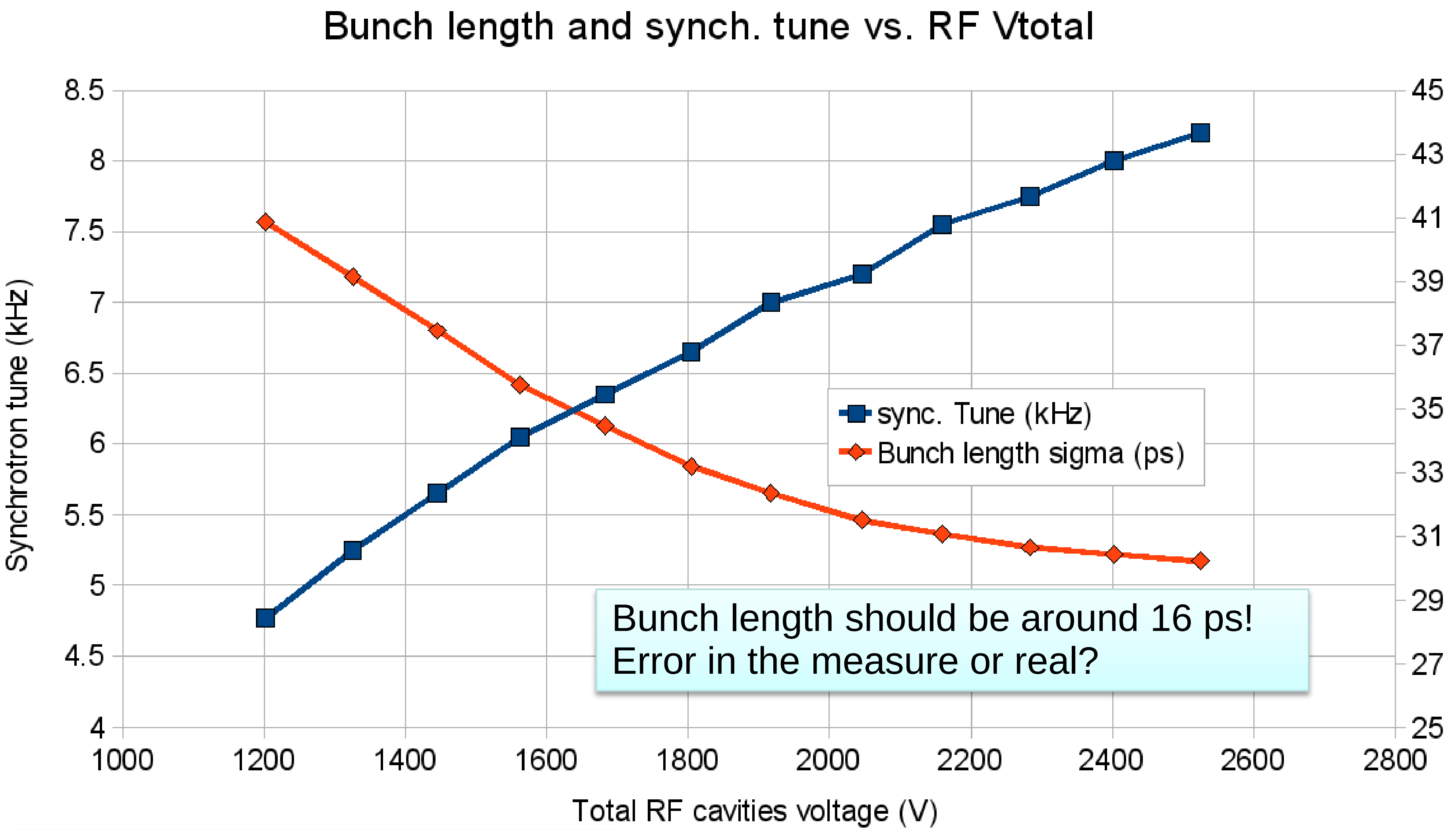


Evolution of the size

Beam size evolution during first part of Commissioning, March – June:



Energy Spread, Bunch Length



Bunch length should be around 16 ps!
Error in the measure or real?

Energy spread is around 1.5E-3, in place of the natural 1.0E-3

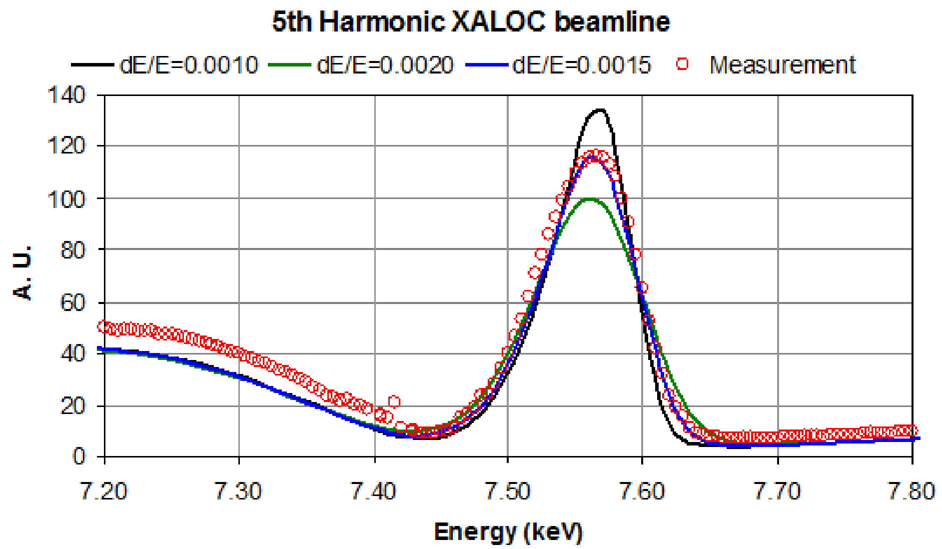
Energy spread from IDs

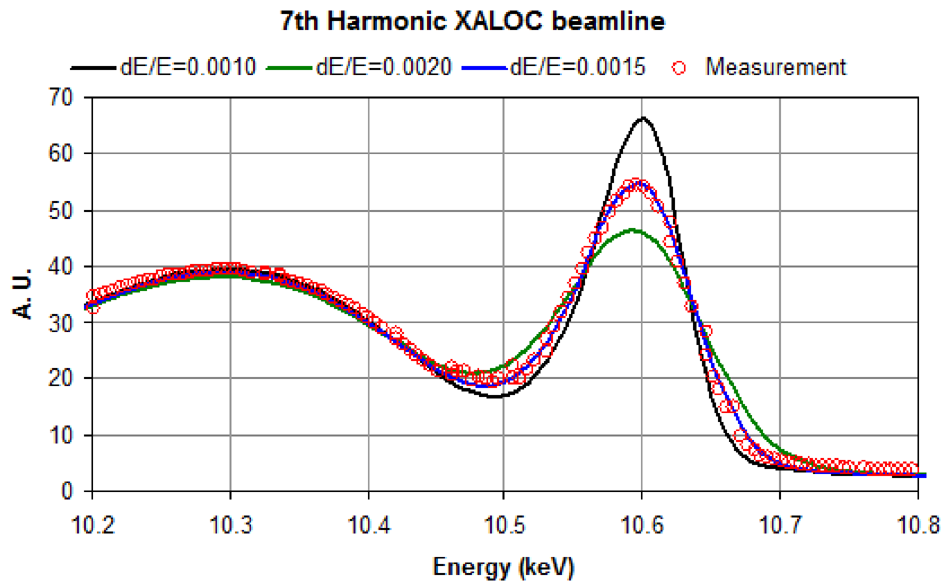
- An energy spread of 1.5E-3 agrees with the data from ID

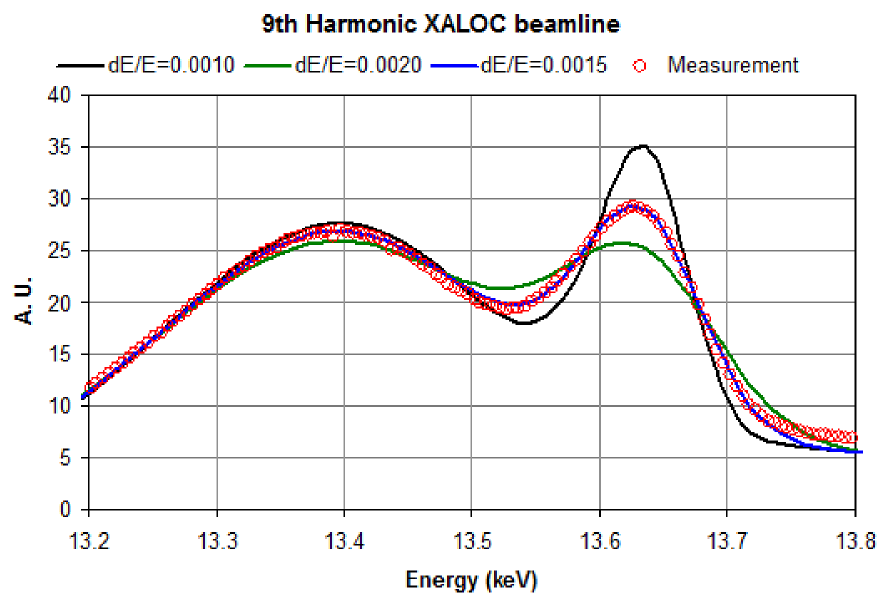
XALOC, IV21 with nominal gap (5.7 mm)

Assumptions:

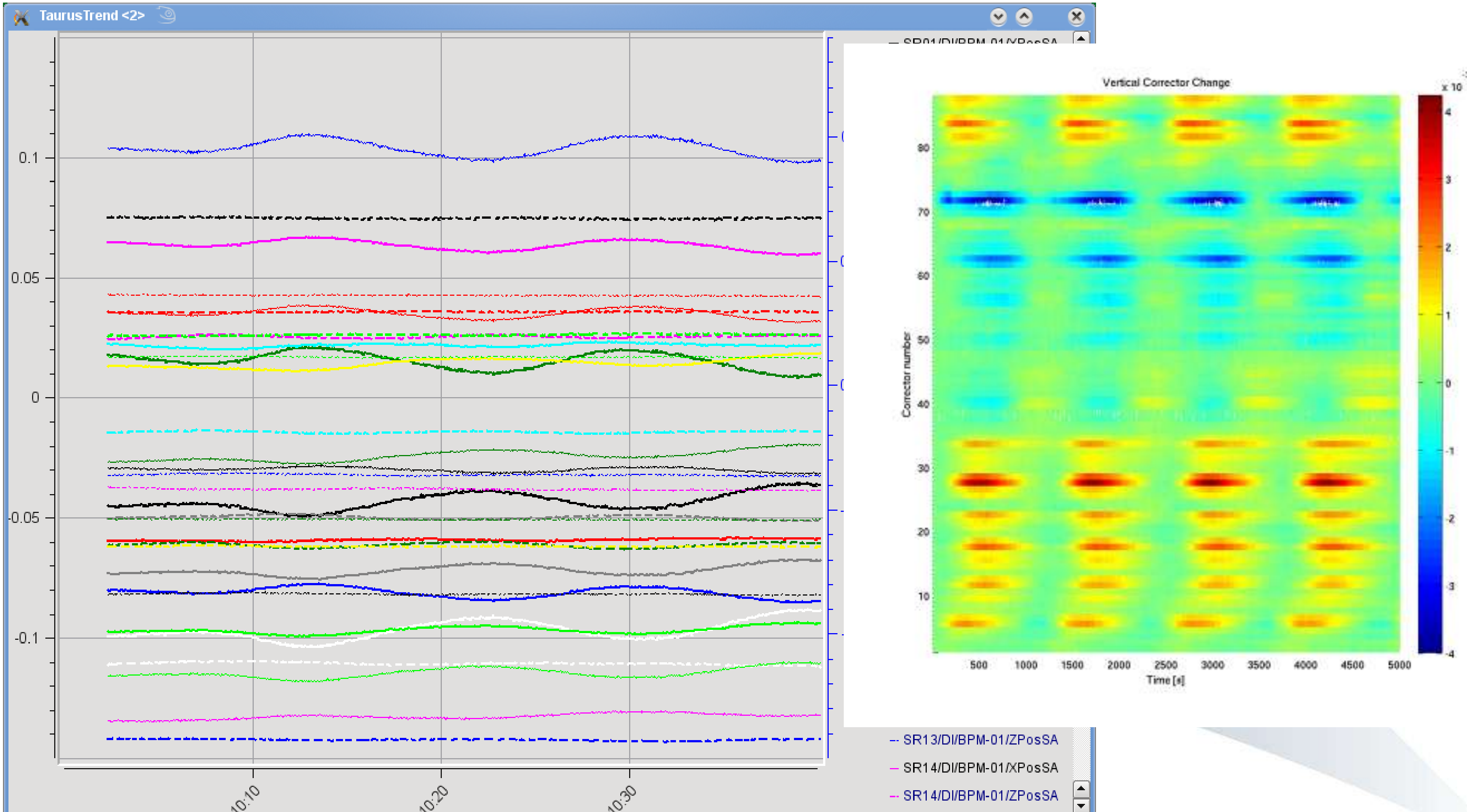
Energy SR= 2.987
Theoretical SR optics
Movable masks: H = 1.5 mm ; V = 0.5 mm
Ondulator: K (g=5.7 mm) = 1.7805



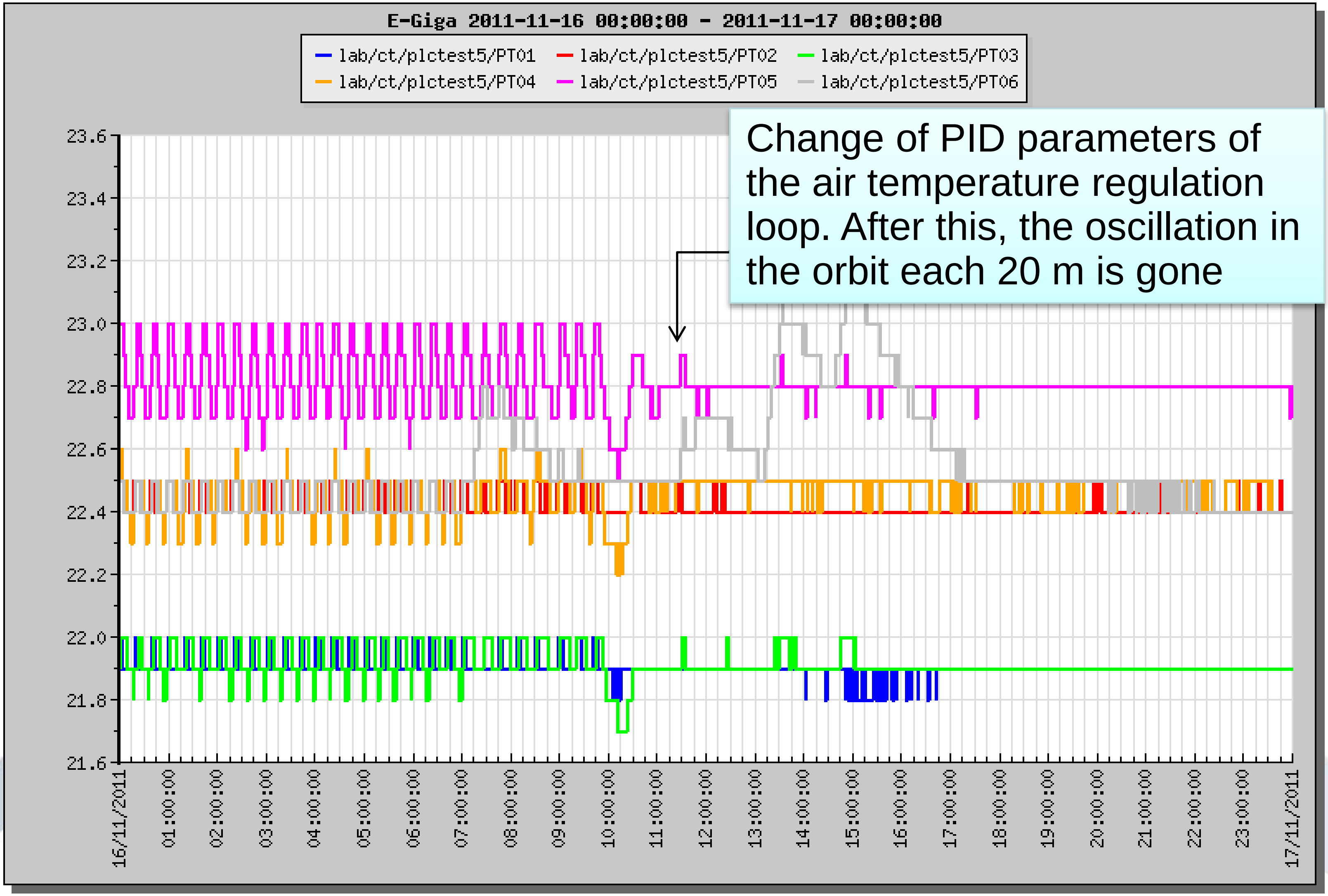




Temperature Oscillation 20 m



Air temperature tunnel



Change of PID parameters of the air temperature regulation loop. After this, the oscillation in the orbit each 20 m is gone