Intensity-dependent effects at ATF2

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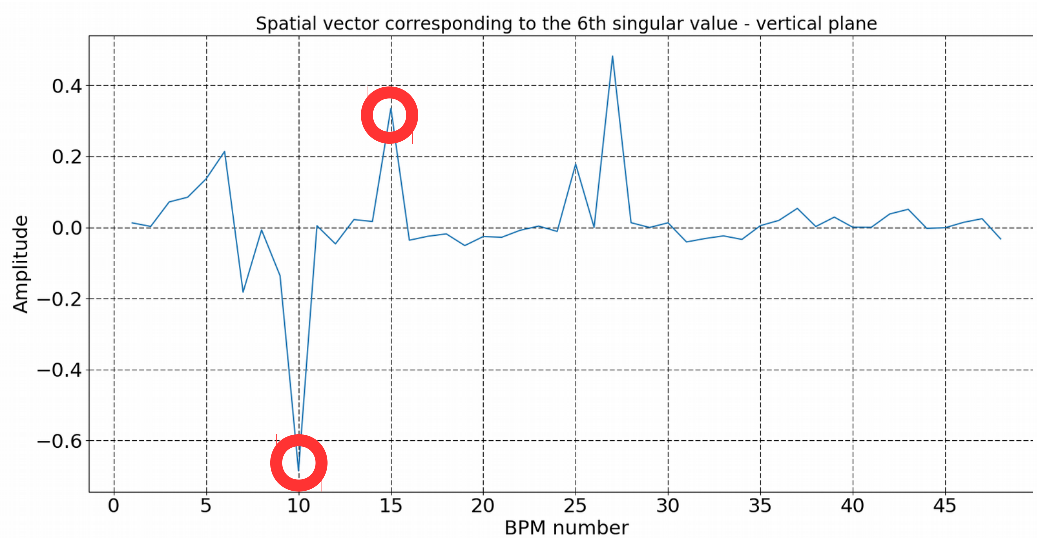
Outline

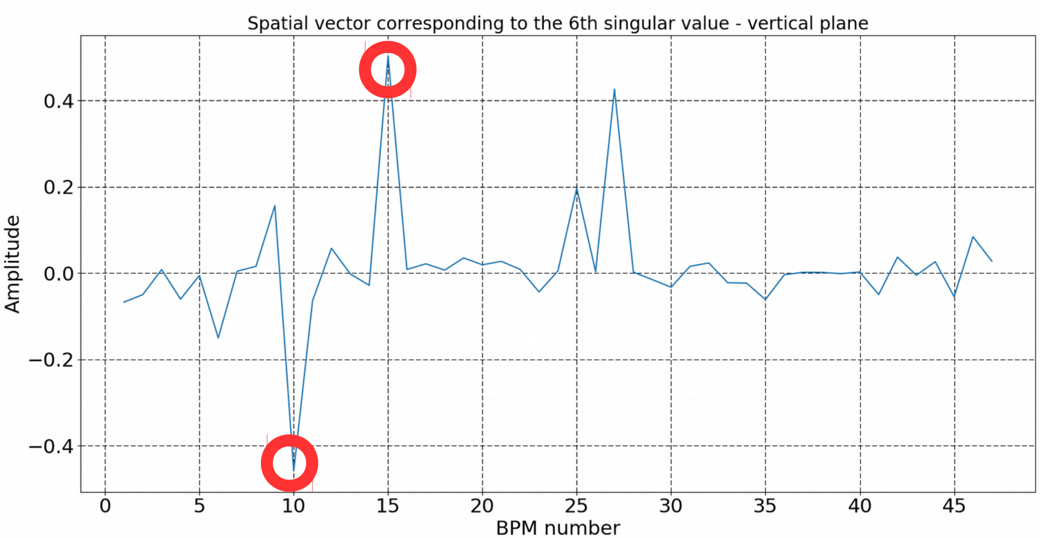
- **Analysis of BPM data taken in February 2018.**
- **Simulations and measurements for wakefield kicks.**
- **First DFS and WFS results.**

Analysis of BPM data of December and February

SVD – Spatial vectors

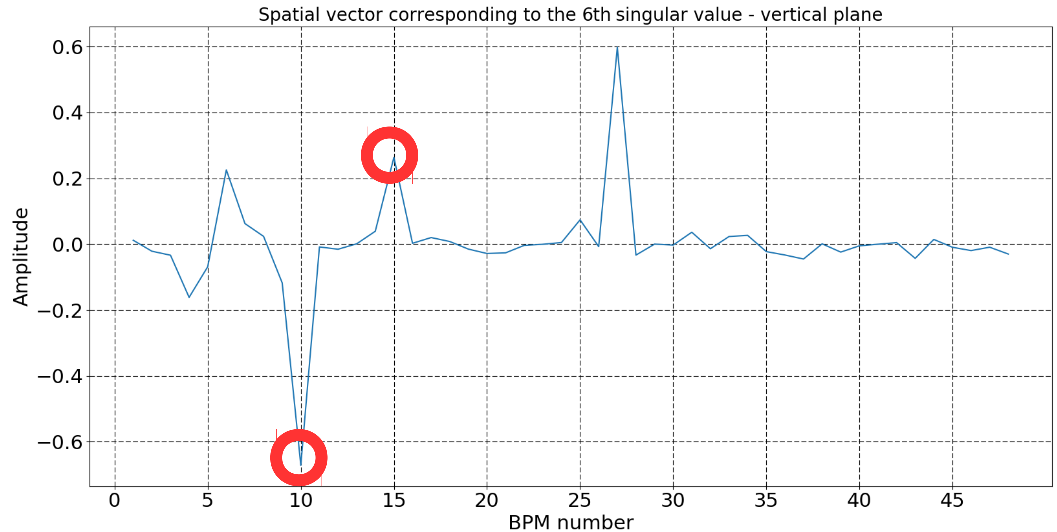


Run1



Run2

PEAKS



Run3

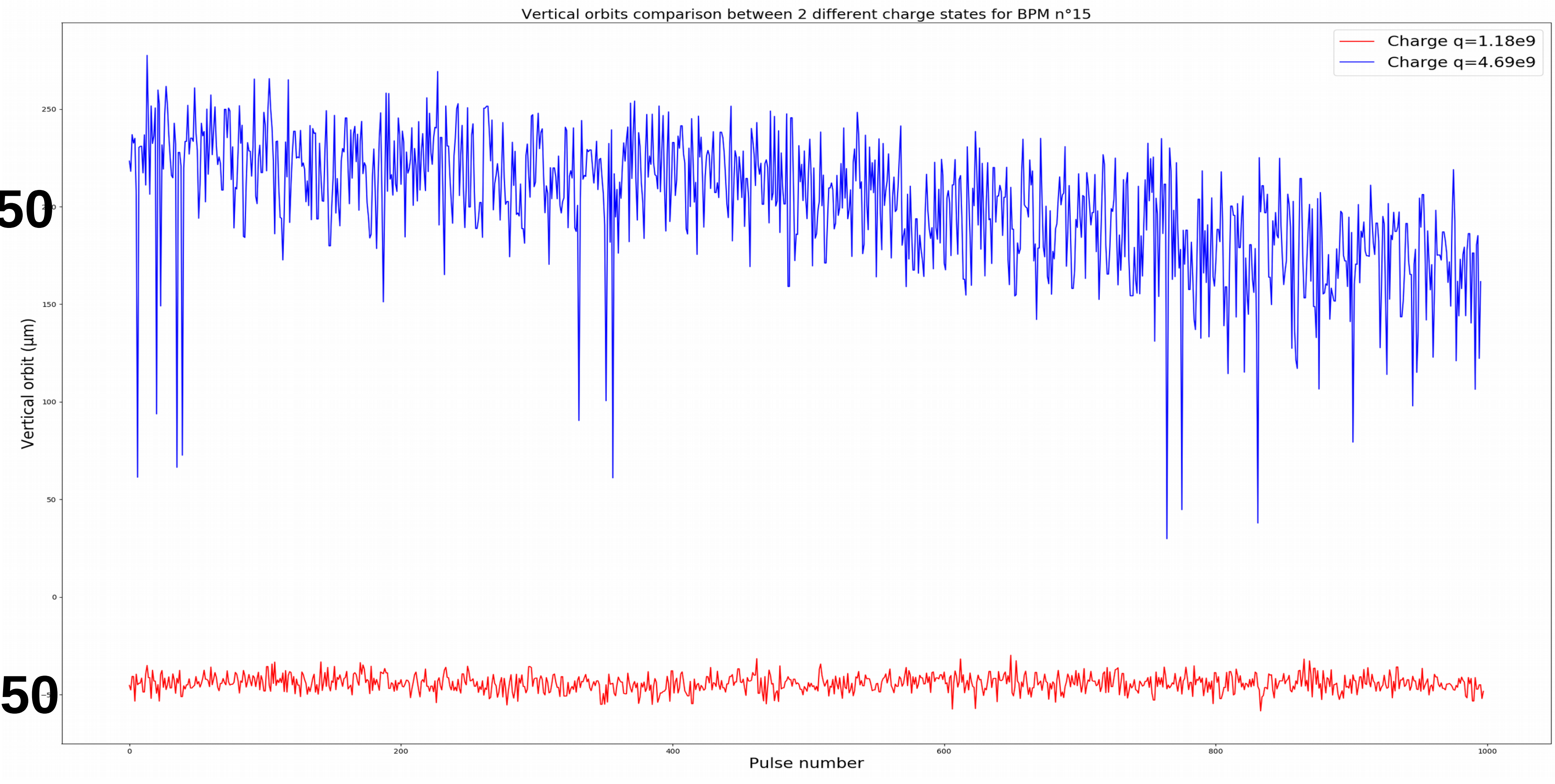
BPM number	BPM name	s(m)	Type
10	MQD8X	22.935	Stripline
15	MQD13X	31.680	Stripline

CLIC WORKSHOP 2018

Raw BPM data

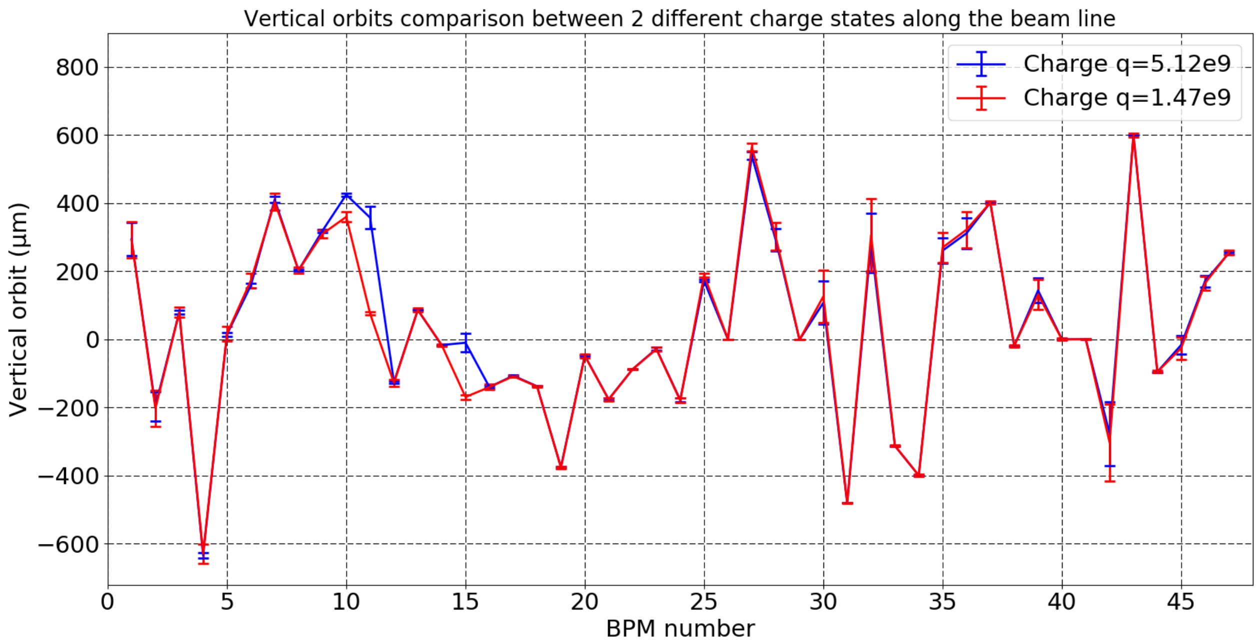
250

-50

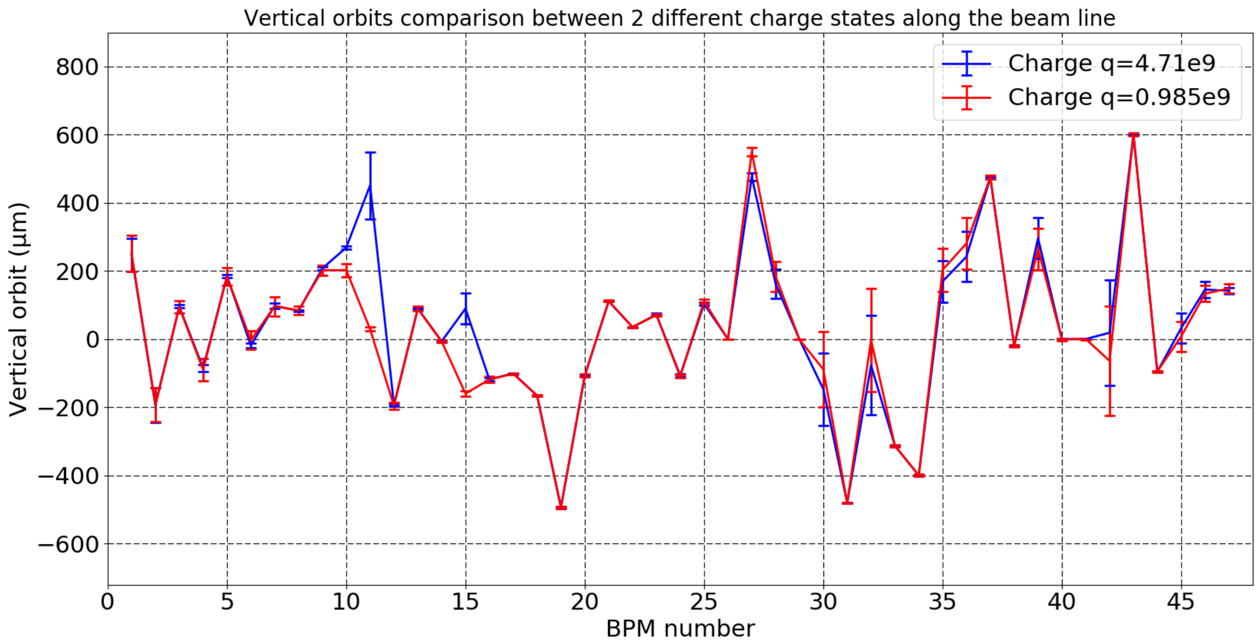


Stripline MQF13X

Results from December 2017



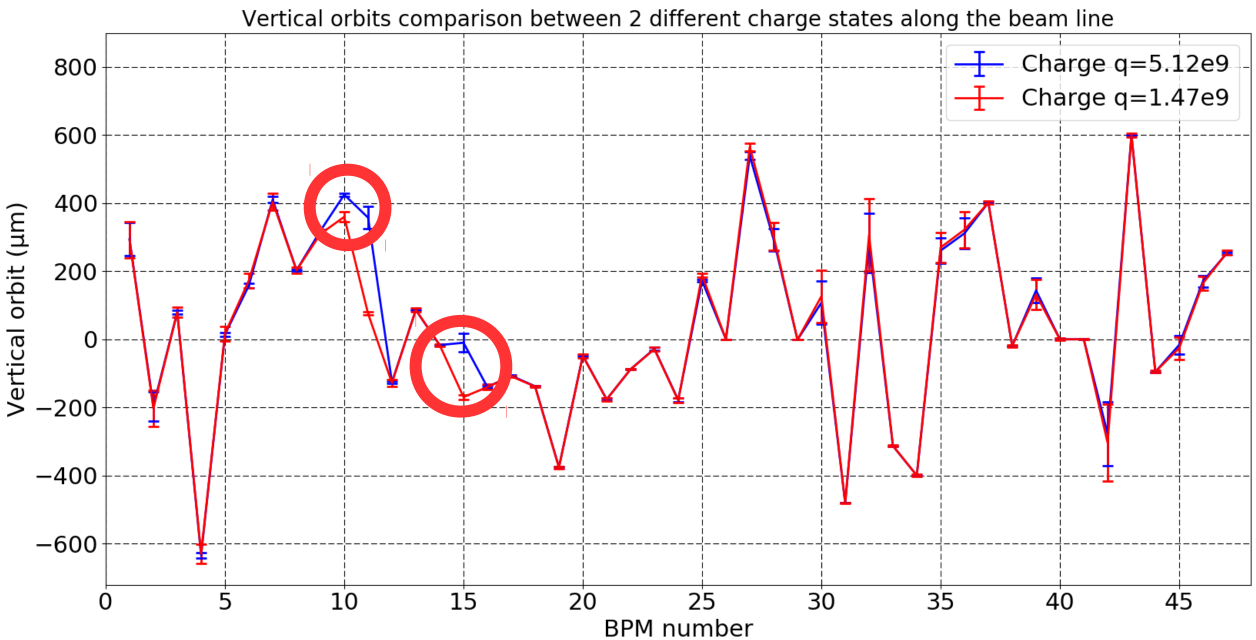
Run 1

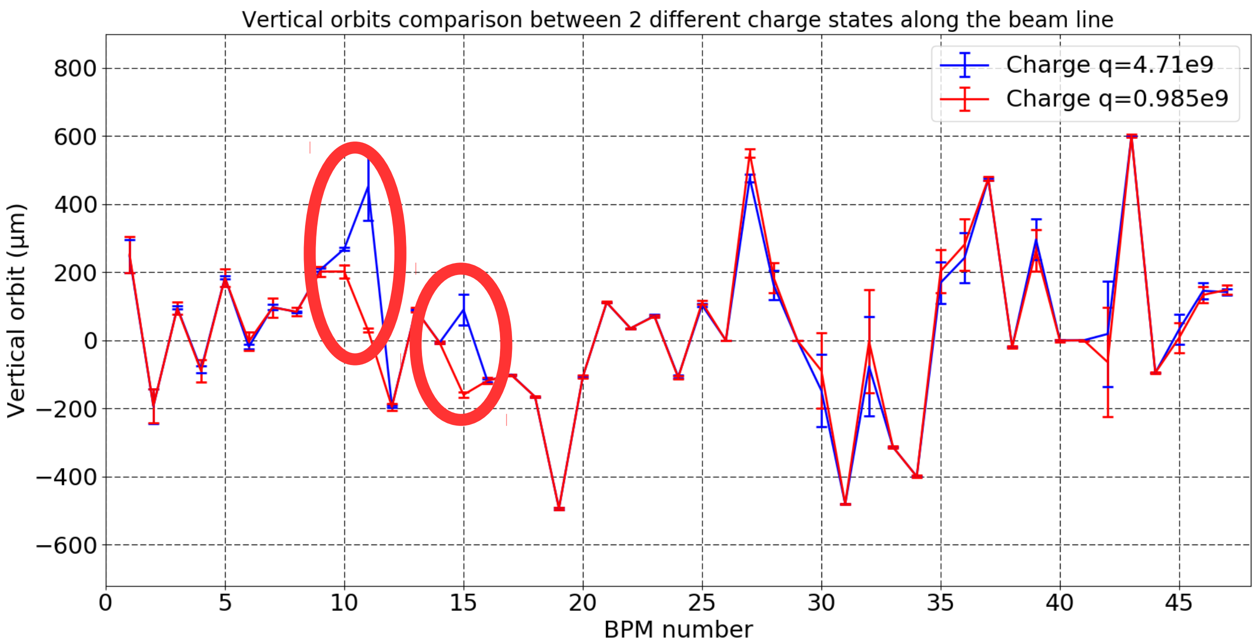


Run 3

Raw data for each BPM available [HERE]

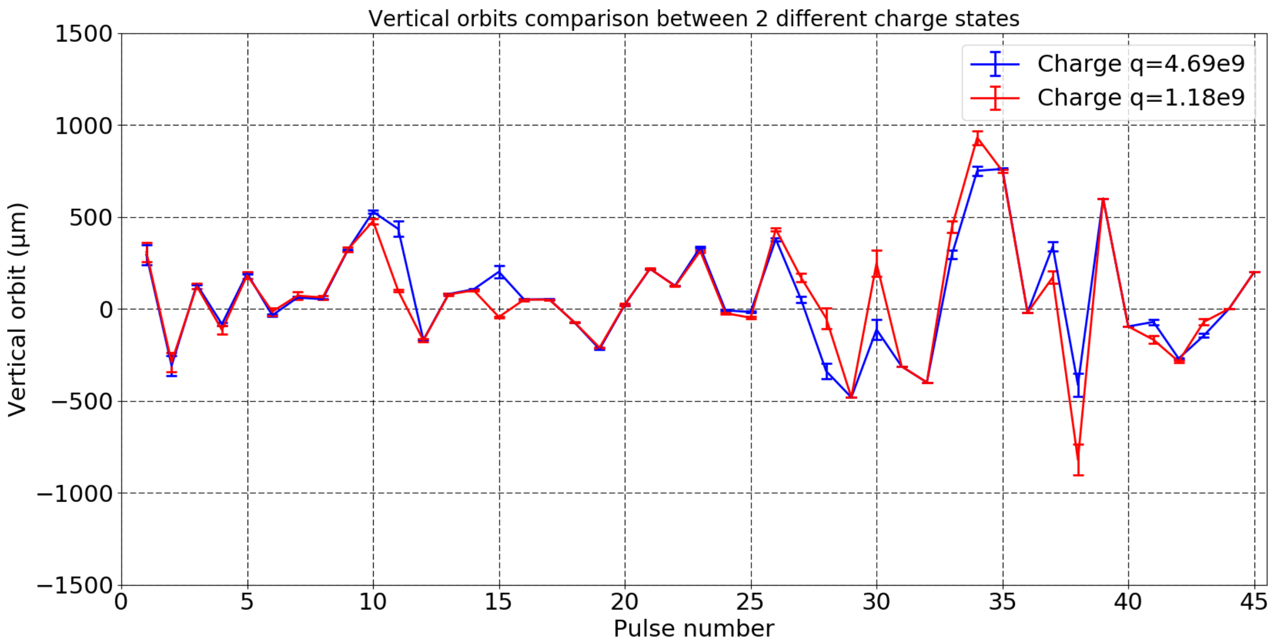
Results from December 2017



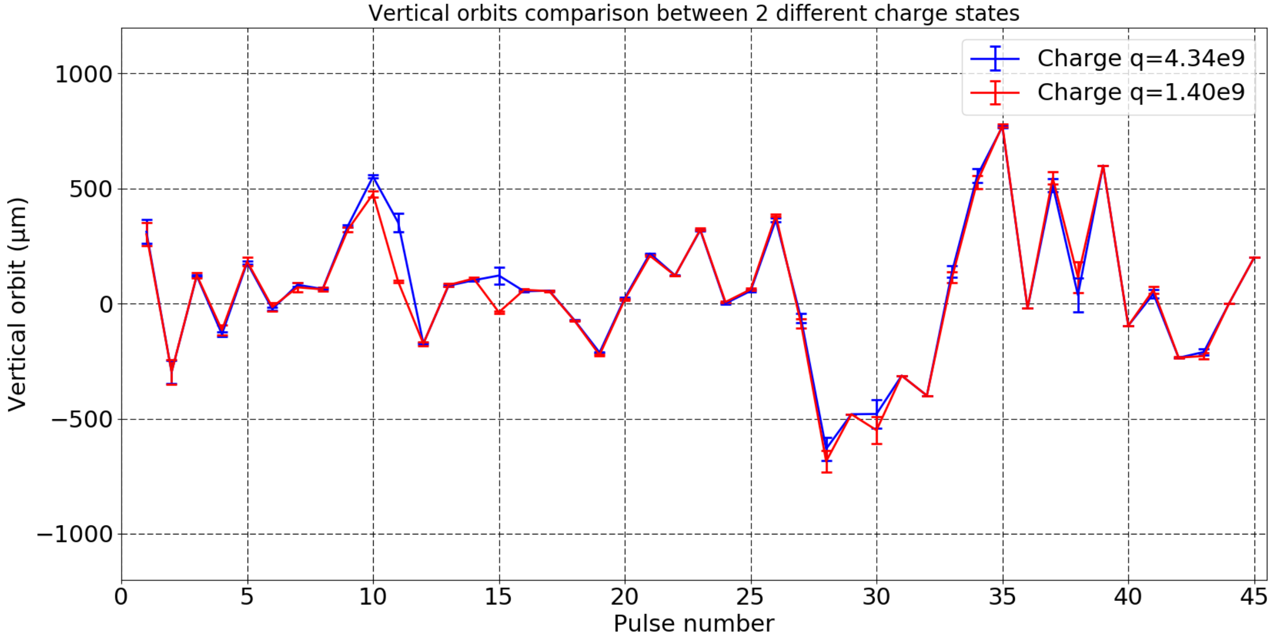


High intensity dependence observed at some BPMs, especially MQD8X (n°10), MQF9X (n°11) and MQF13X (n°15), all striplines.

Results from February 2018



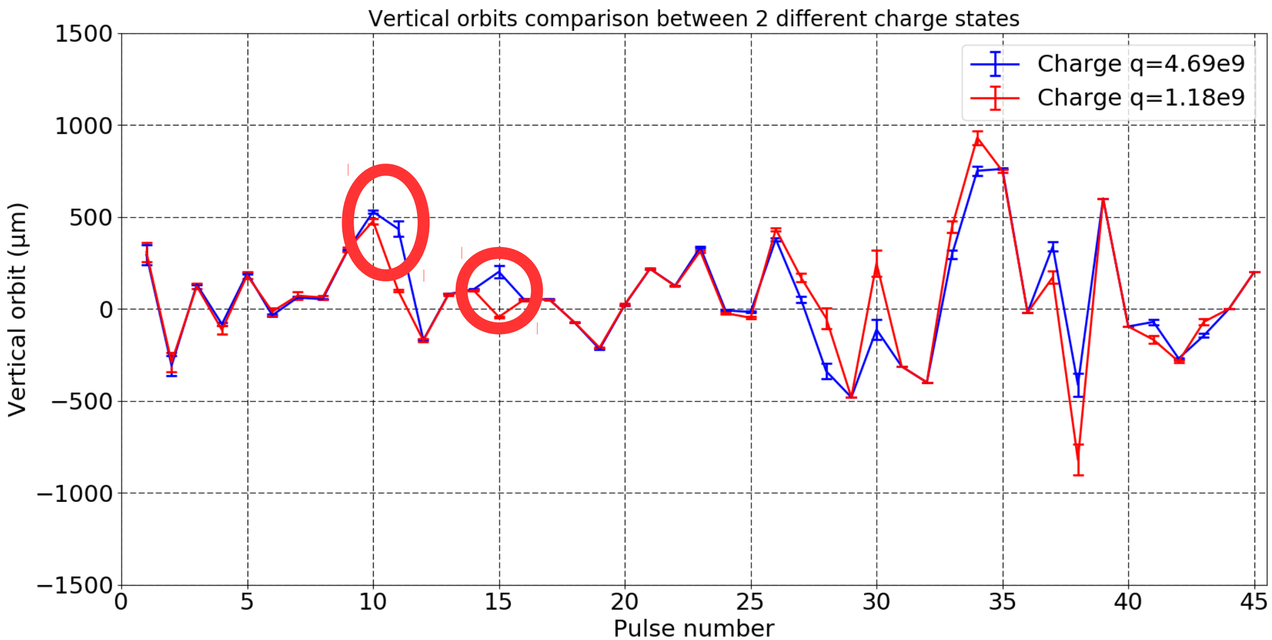
Run 2

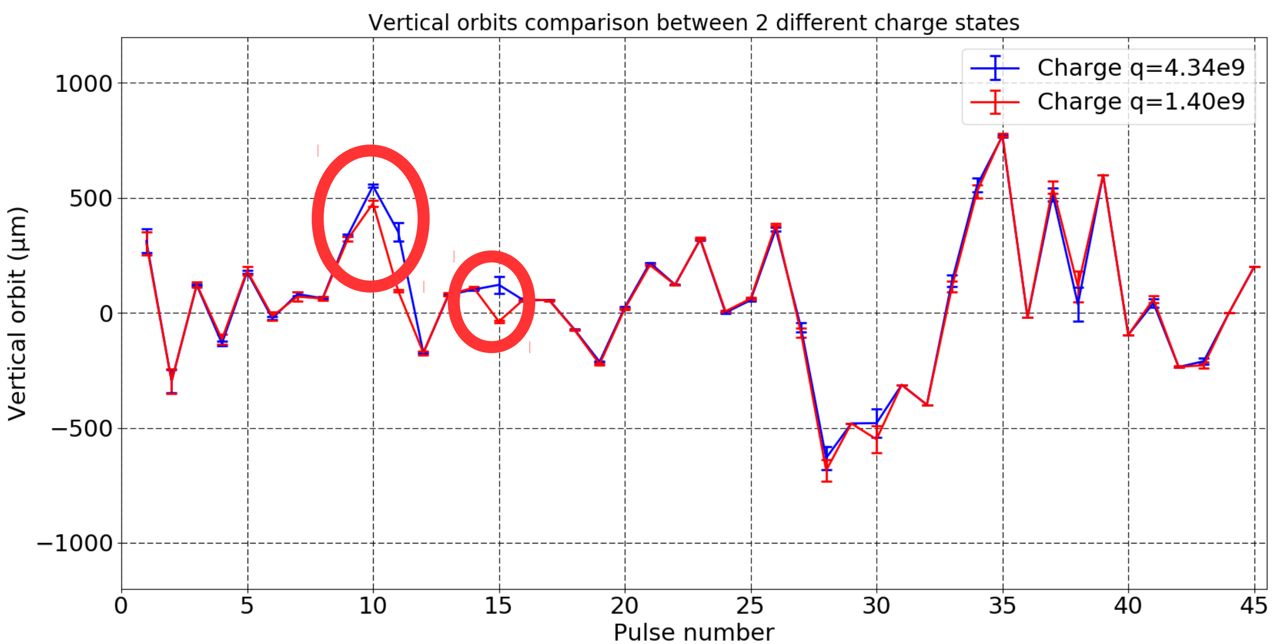


Run 3

Raw data for each BPM available [HERE]

Results from February 2018

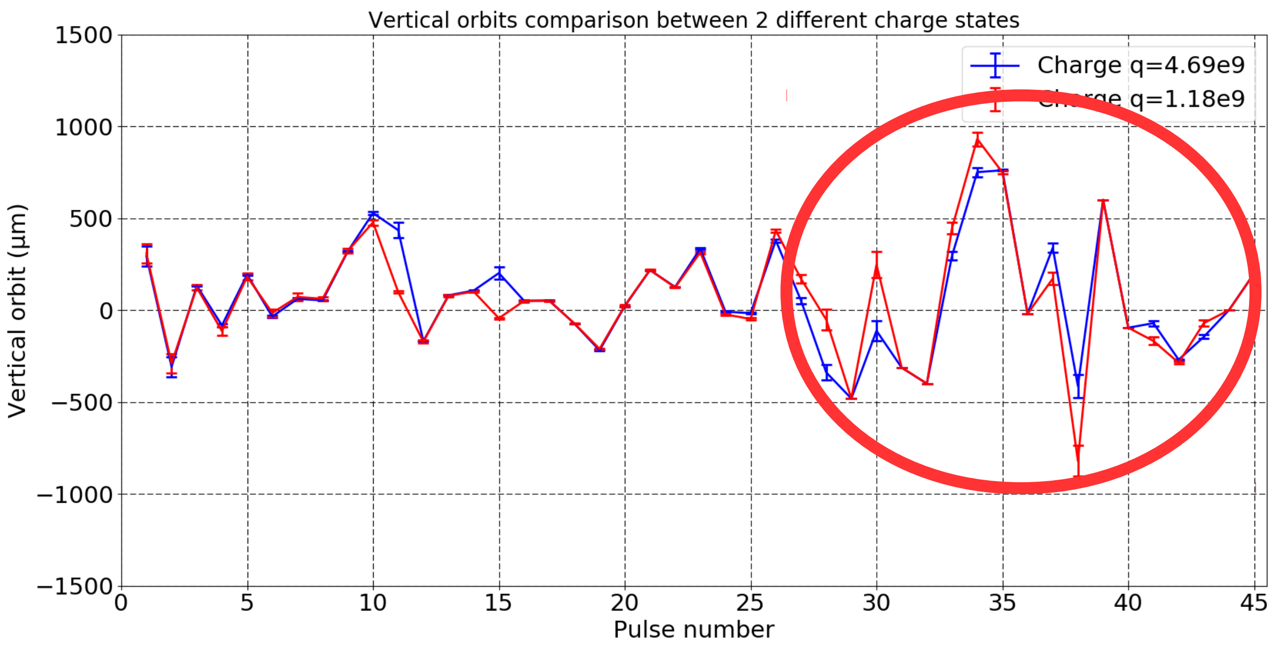




High intensity dependence observed at some BPMs, especially MQD8X (n°10), MQF9X (n°11) and MQF13X (n°15), all striplines.

Okugi-san told me that these striplines can’t be trusted at high charge.

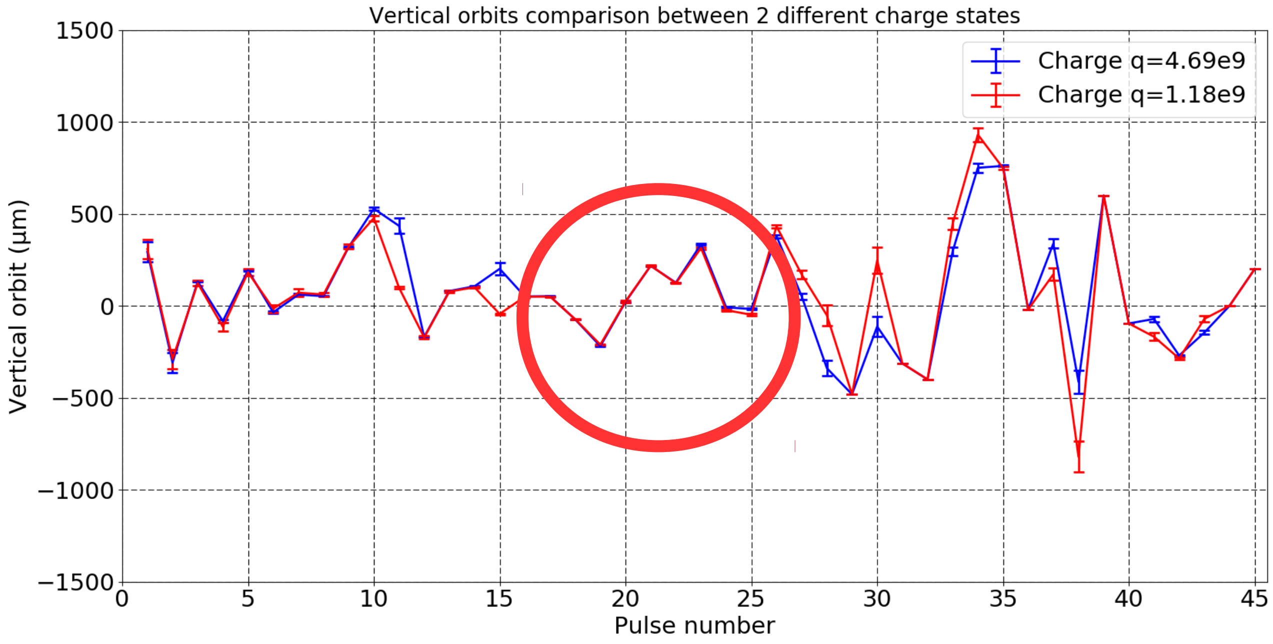
Results from February 2018



High intensity dependence also observed from cavBPM QM12FF (n°27) to the end.

A. Lyapin told me that these cavBPMs can't be trusted at high charge.

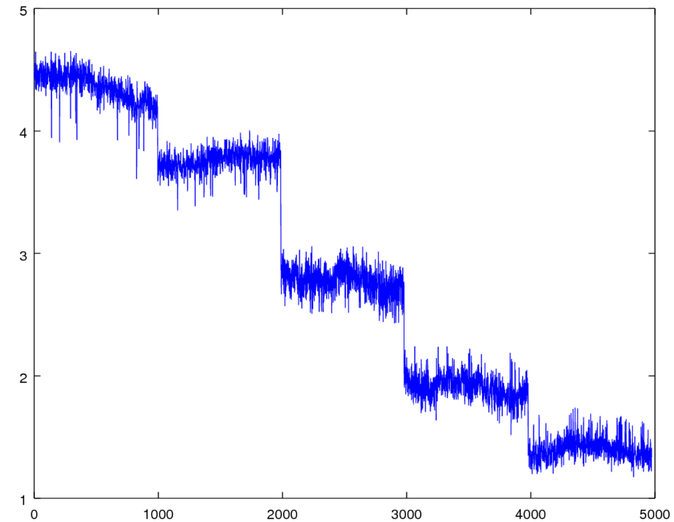
Results from February 2018



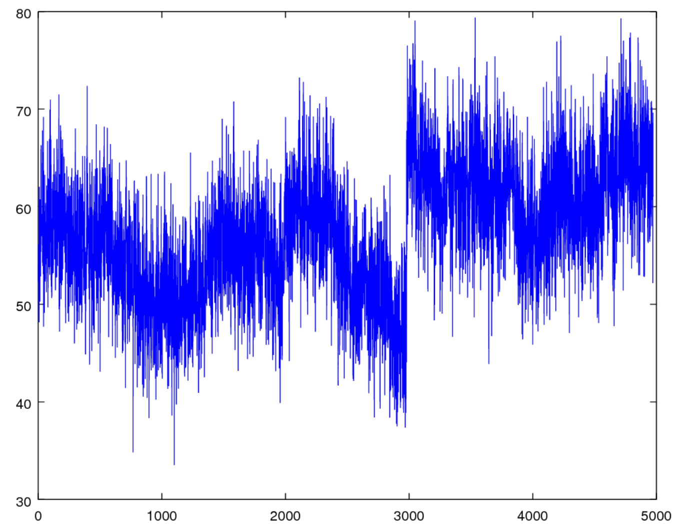
According to A. Lyapin only the first 10 cav BPMs are usabe for intensity dependence studies.
From QD16X to QM13FF

SVD on these 10 cavBPMs cited earlier

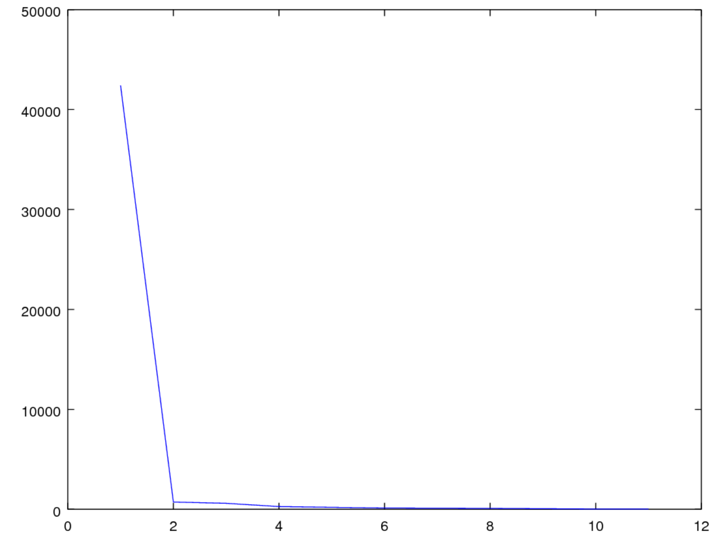
Charge



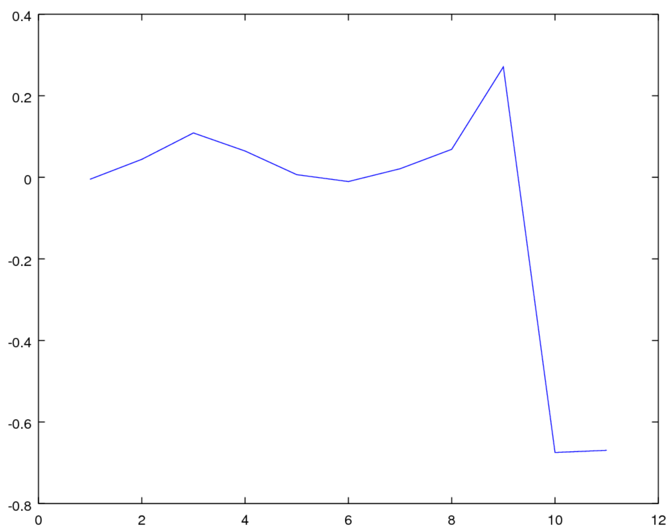
Vertical orbit QM14FF



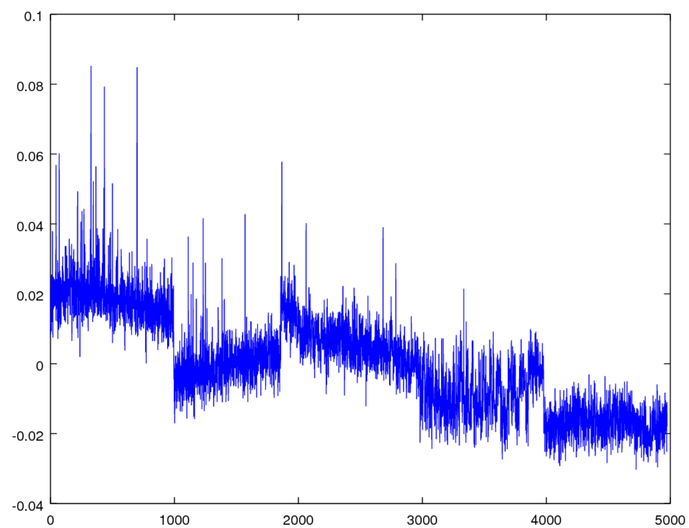
Singular value spectrum



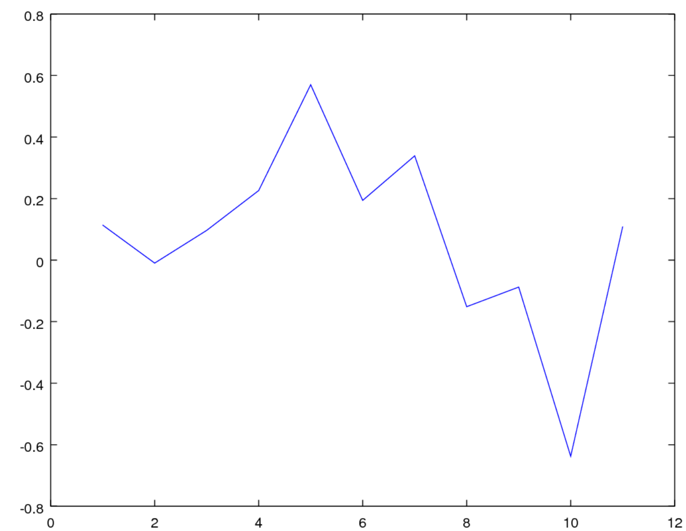
V(end,:)



U(:,3)



V(:,3)



Simulations and measurements for wakefield kicks.

View of the problem

The goal is to evaluate where in the machine and how strong should be the kicks to explain the measured orbit.

To do so, different numbers of Dipoles were artificially added in the Placet lattice in order to calculate the response matrix.

Response matrix

Definition of orbit response matrix

$$R_{ij}^{yy} := \frac{\Delta y_i}{\Delta \theta_{y,j}}$$ **for y-plane**

Δy_i **: change of the beam position at BPM *i***

$\Delta \theta_{y,j}$ **: change of the kick angle of the corrector *j***

Measurement can be written as:

$$\begin{pmatrix} \Delta x \\ \Delta y \end{pmatrix} = \begin{pmatrix} R^{xx} & R^{xy} \\ R^{yx} & R^{yy} \end{pmatrix} \cdot \begin{pmatrix} \Delta \theta_x \\ \Delta \theta_y \end{pmatrix}$$

Calculation response matrices with Placet

The goal is to add correctors in the lattice and calculate the response matrices with Placet.

Then supposing there is no coupling, one can conclude that:

$$\begin{pmatrix} \Delta x \\ \Delta y \end{pmatrix} = \begin{pmatrix} R^{xx} & 0 \\ 0 & R^{yy} \end{pmatrix} \cdot \begin{pmatrix} \Delta\theta_x \\ \Delta\theta_y \end{pmatrix}$$

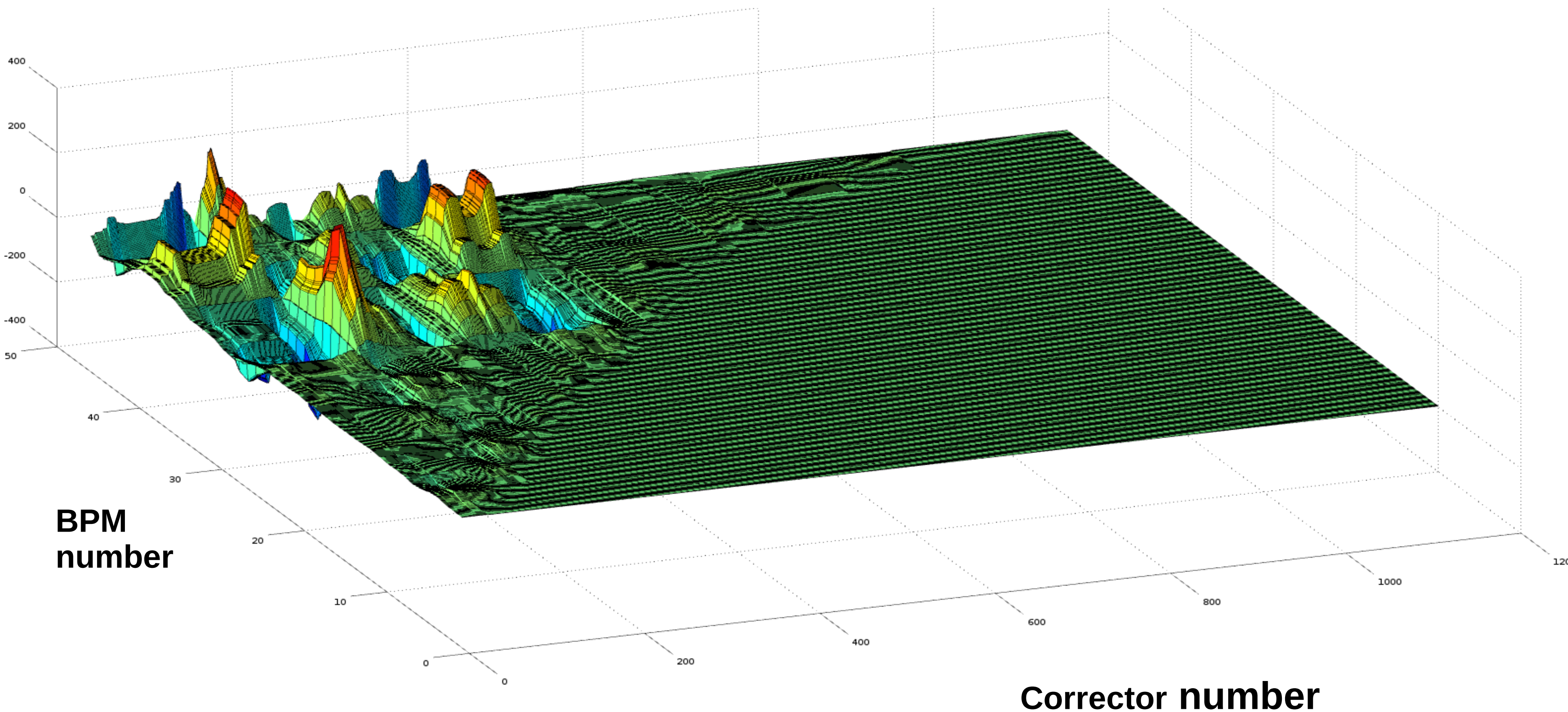
Using the measured *Δx* and *Δy* in the actual machine, one can calculate the kick angle necessary to explain the orbit difference between high and low charge:

$$\begin{pmatrix} \Delta\theta_x \\ \Delta\theta_y \end{pmatrix} = \begin{pmatrix} R^{xx} & 0 \\ 0 & R^{yy} \end{pmatrix}^{-1} \cdot \begin{pmatrix} \Delta x \\ \Delta y \end{pmatrix}$$

Calculated **Measured**

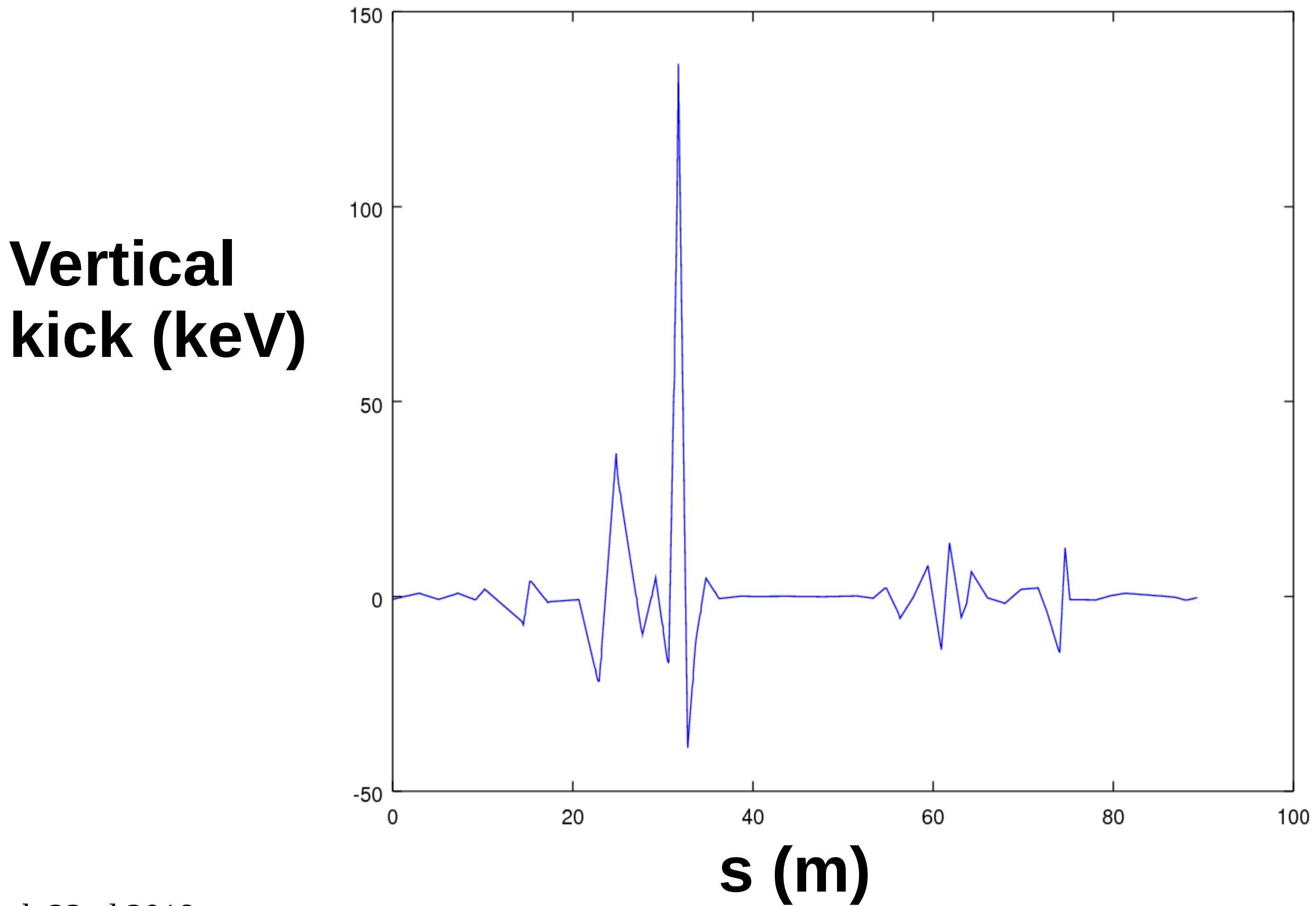
Simulation:
Response matrix Placet

First case: corrector at each element of the lattice (1115 in total).



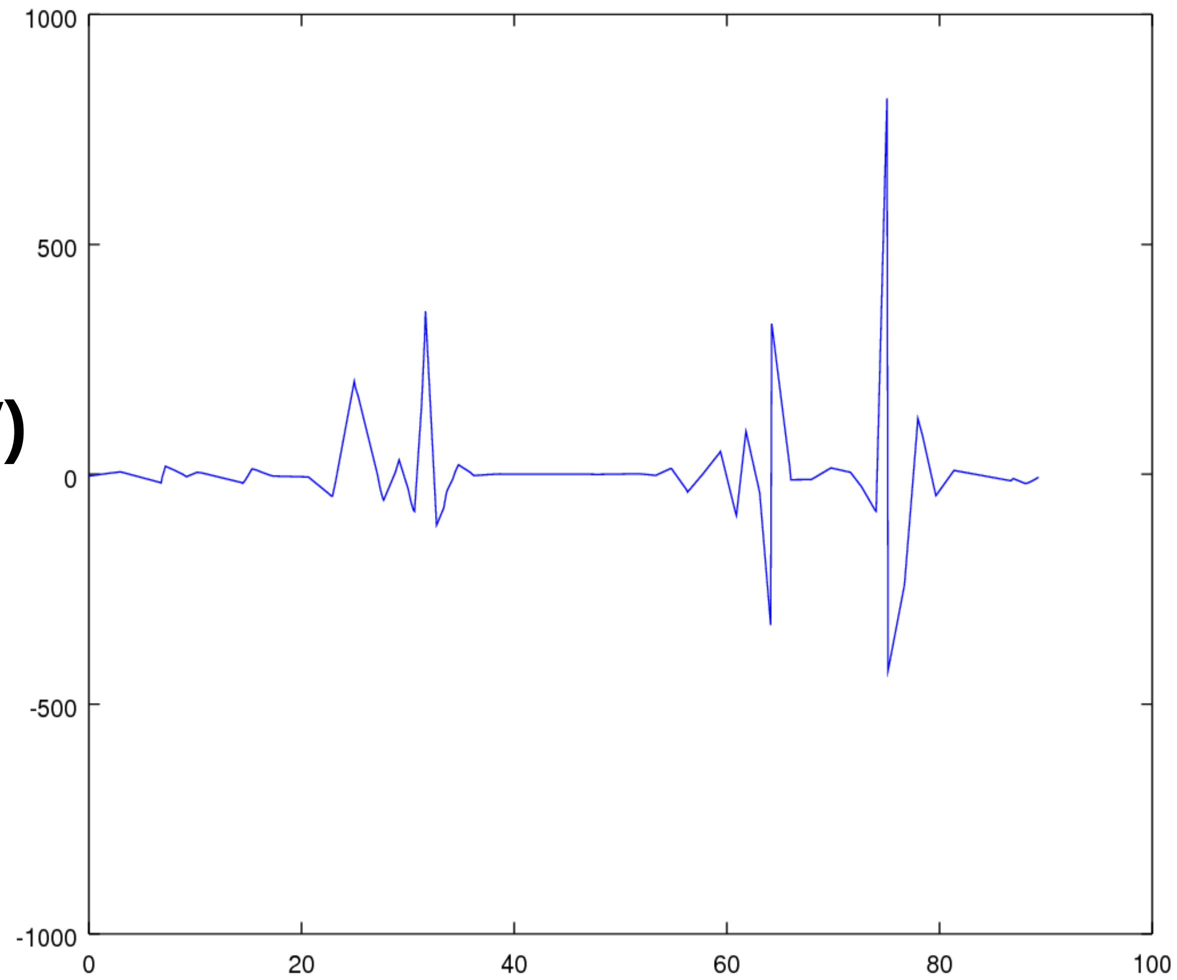
Simulation:
Vertical kicks needed to obtain measured vertical orbit

First case: corrector at each element of the lattice (1115 in total).



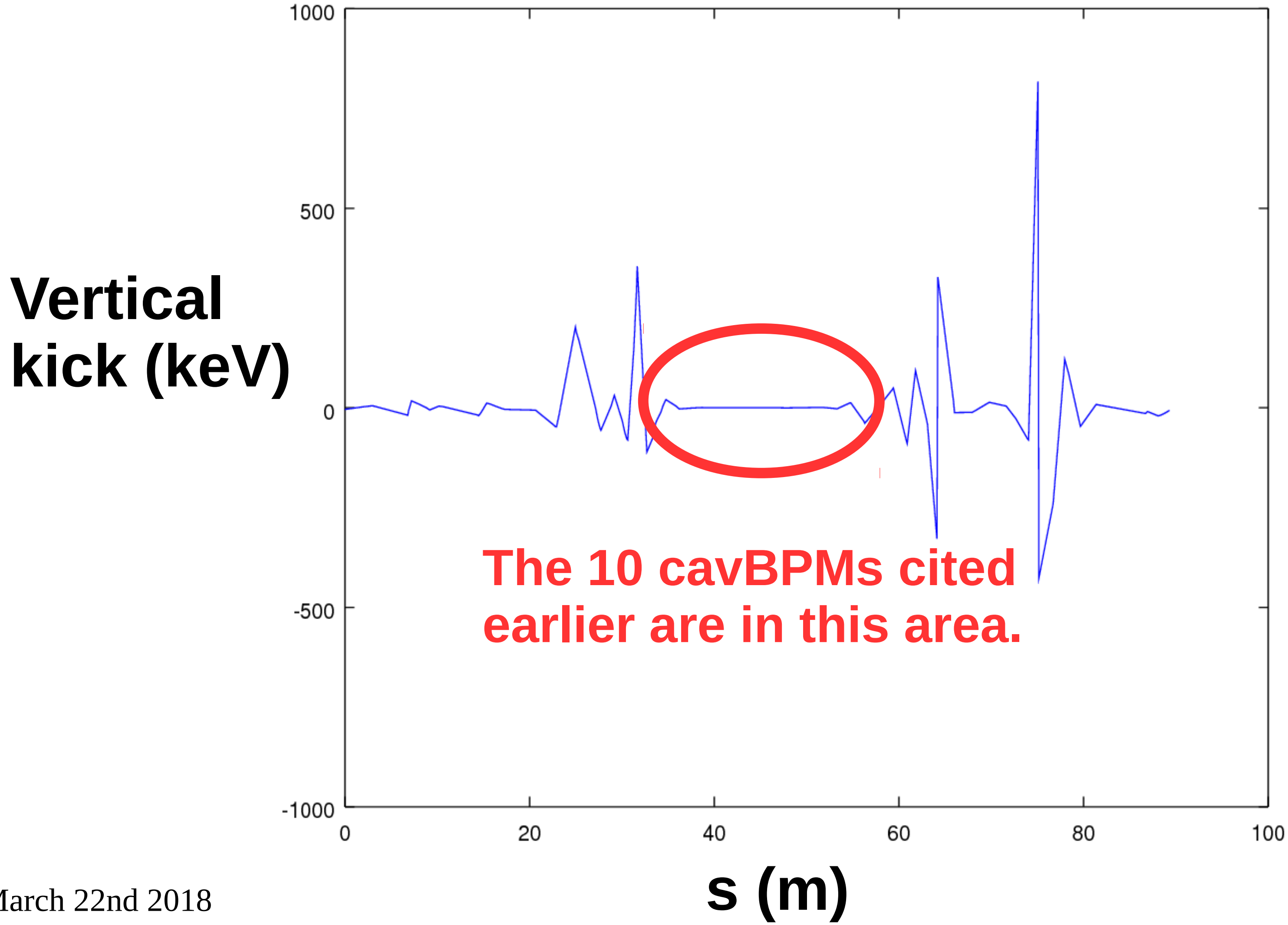
Simulation:
Vertical kicks needed to obtain measured vertical orbit

Second case: corrector at each quadrupole (144 in total).

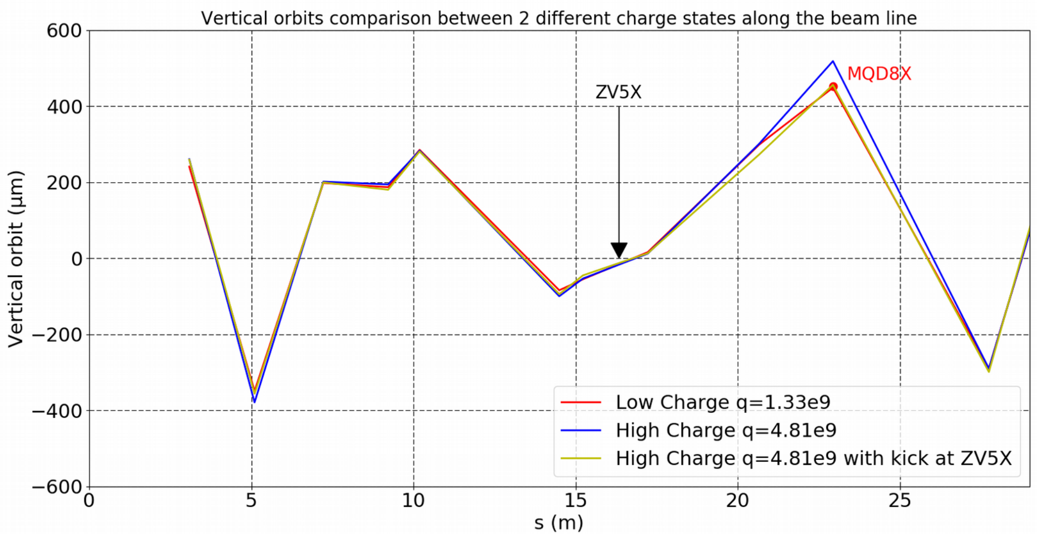


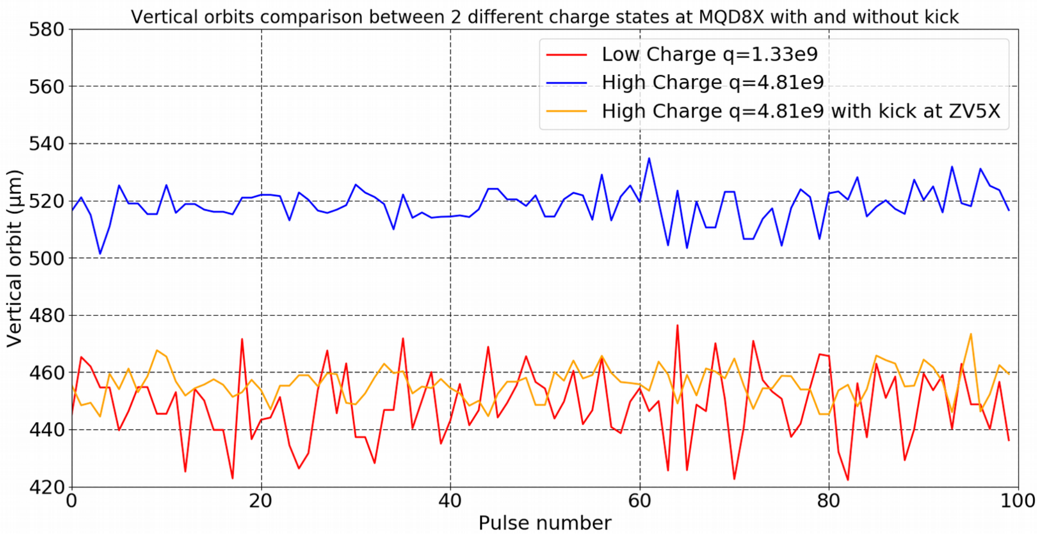
Simulation:
Vertical kicks needed to obtain measured vertical orbit

Second case: corrector at each quadrupole (144 in total).

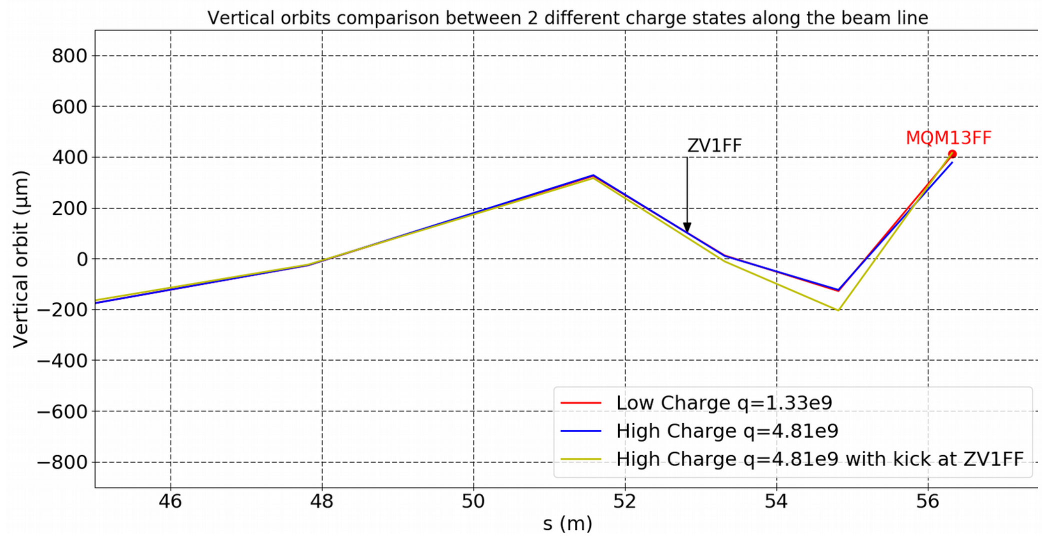


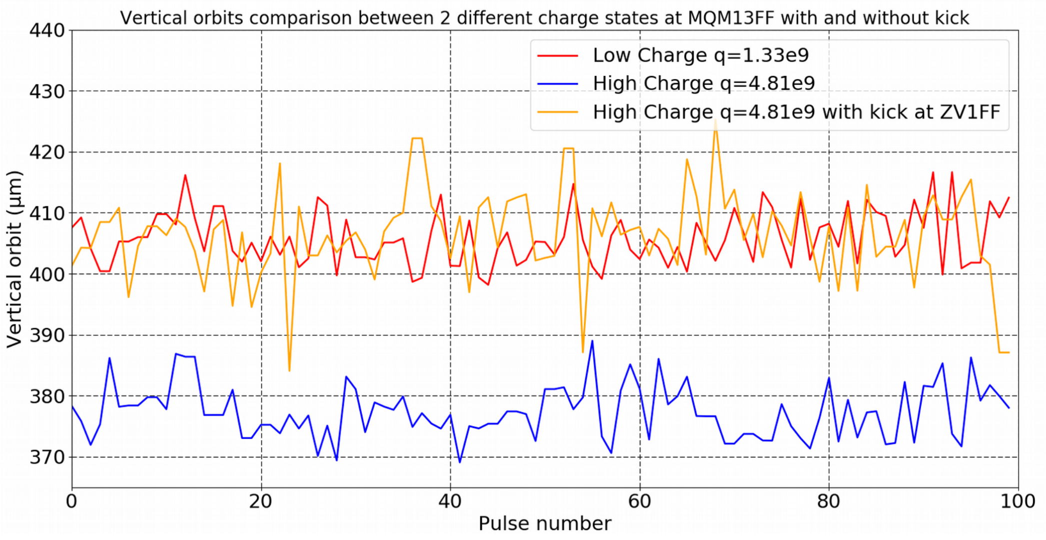
Measurement: correctors kicks needed to compensate the vertical orbit difference at high charge





In order to compensate the orbit difference at MQD8X, one needs to have an extra "kick" at ZV5X of I=+0.020A.



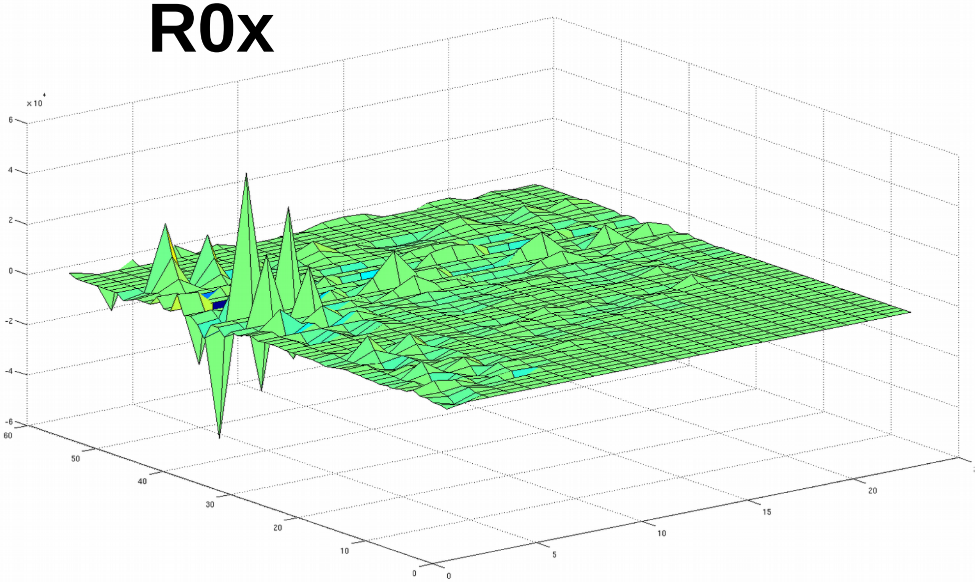


In order to compensate the orbit difference at MQM13FF, one needs to have an extra "kick" at ZV1FF of I=+0.100A.

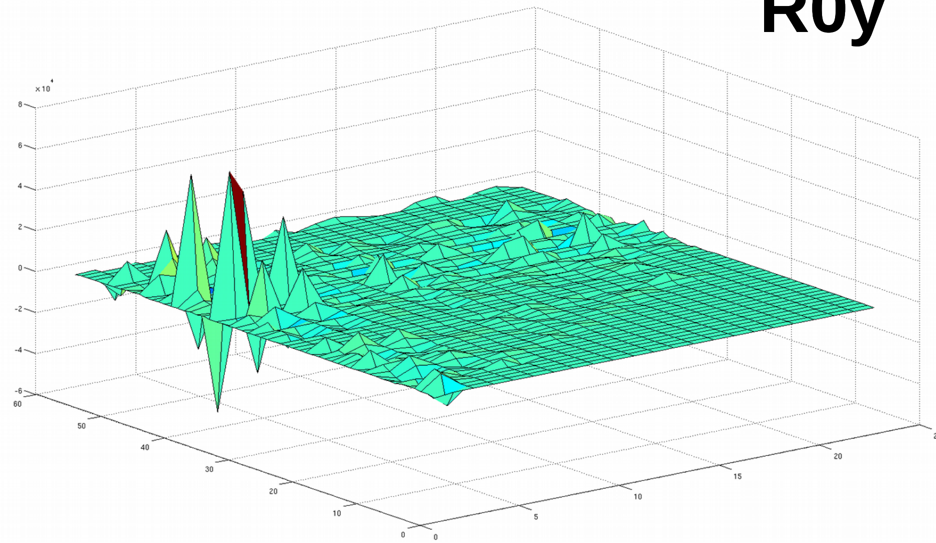
First DFS and WFS results

First results Dispersion Free Steering
Response matrices

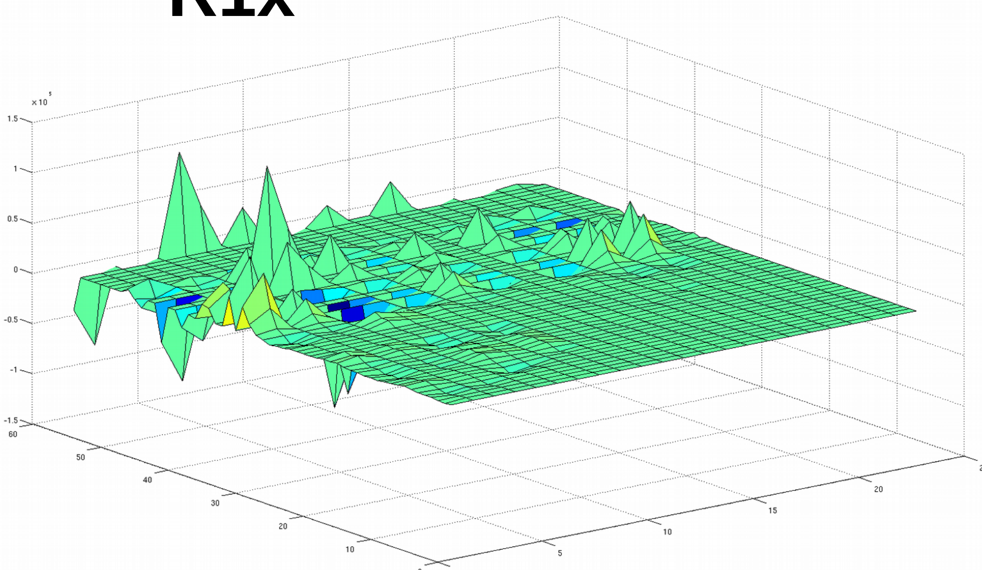
R0x



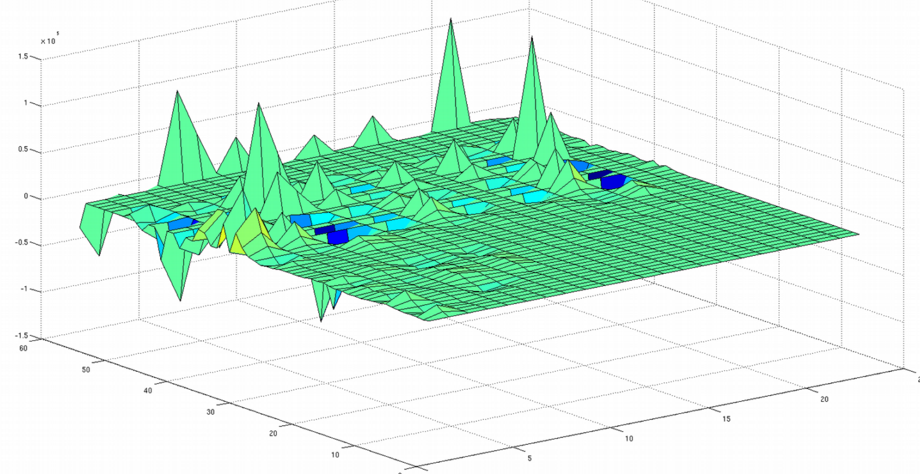
R0y



R1x

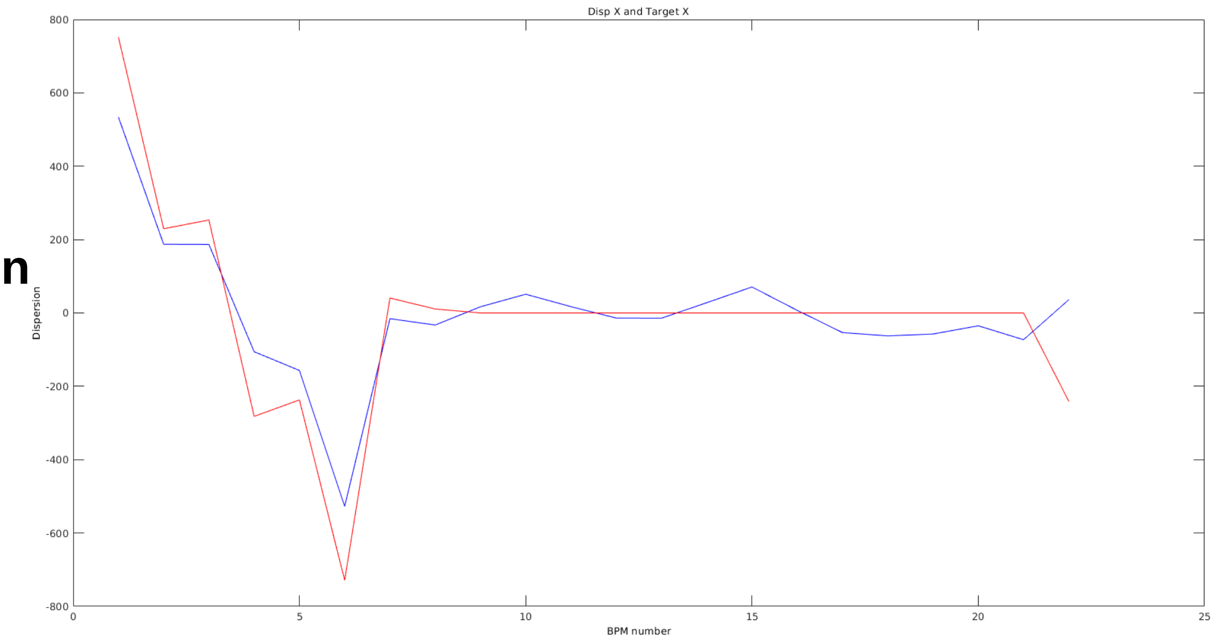


R1y

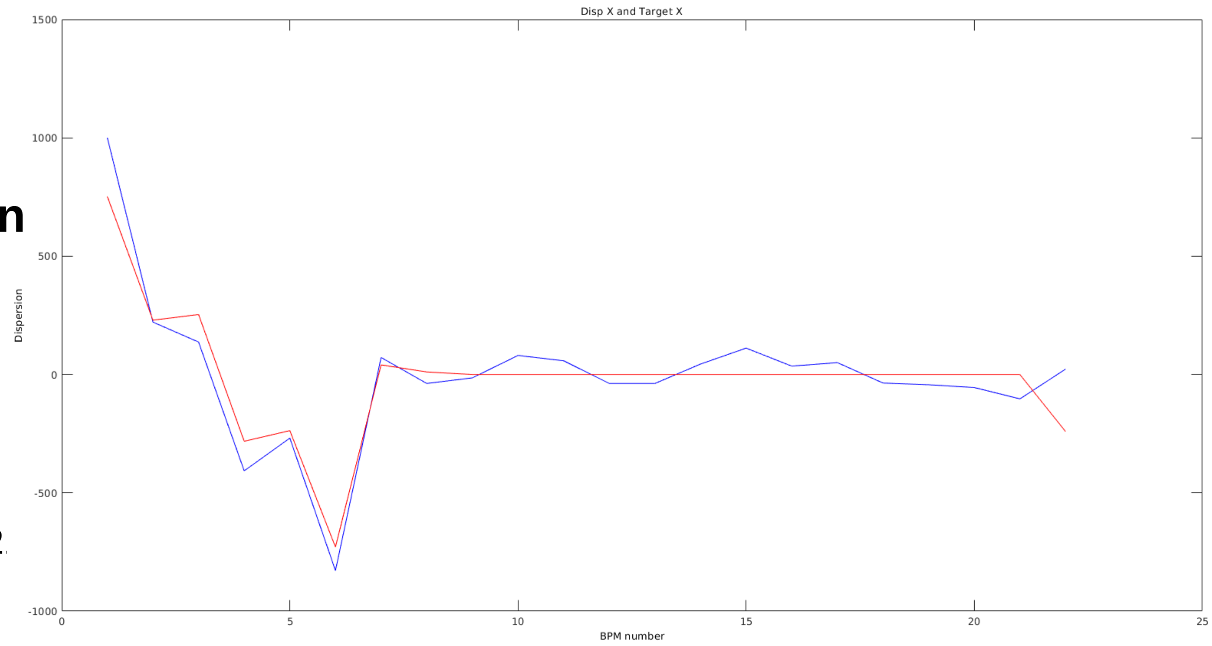


First results Dispersion Free Steering Horizontal dispersion

Before correction



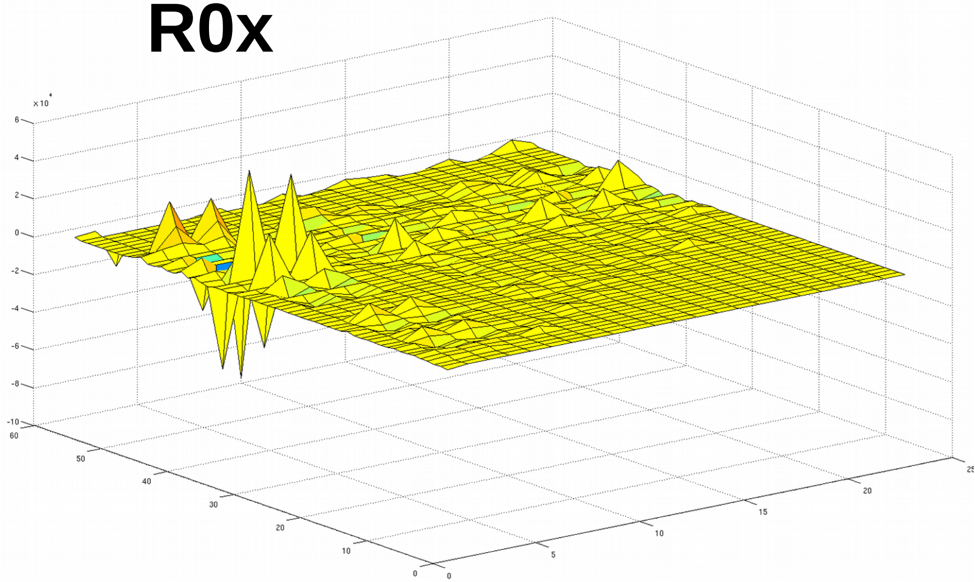
After correction



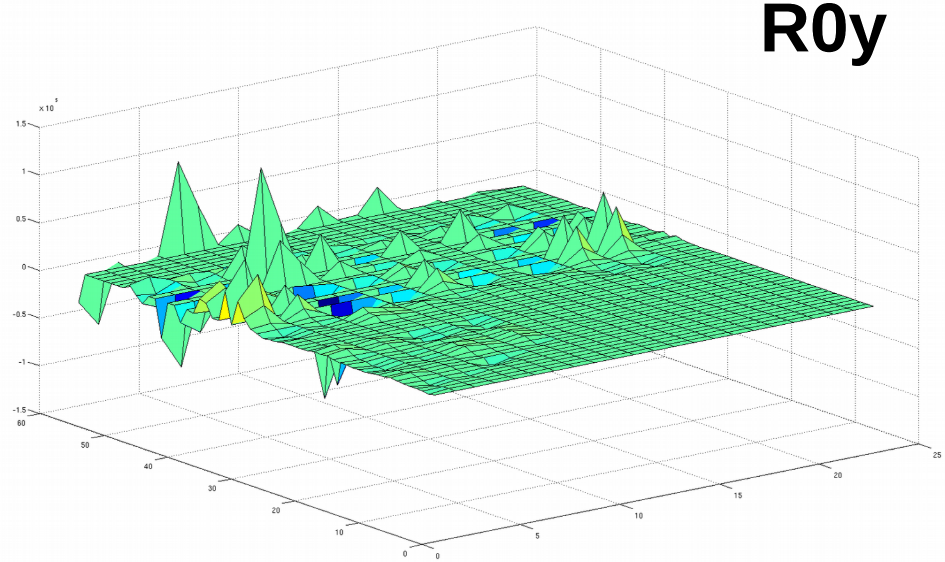
Script running and working. It needs a little more tuning to have better results. For example use more or less BPMs, remove the ones with wrong orbit, change the DFS parameters (gain, weights, number of singular values, …).

First results Wakefield Free Sterring
Response matrices

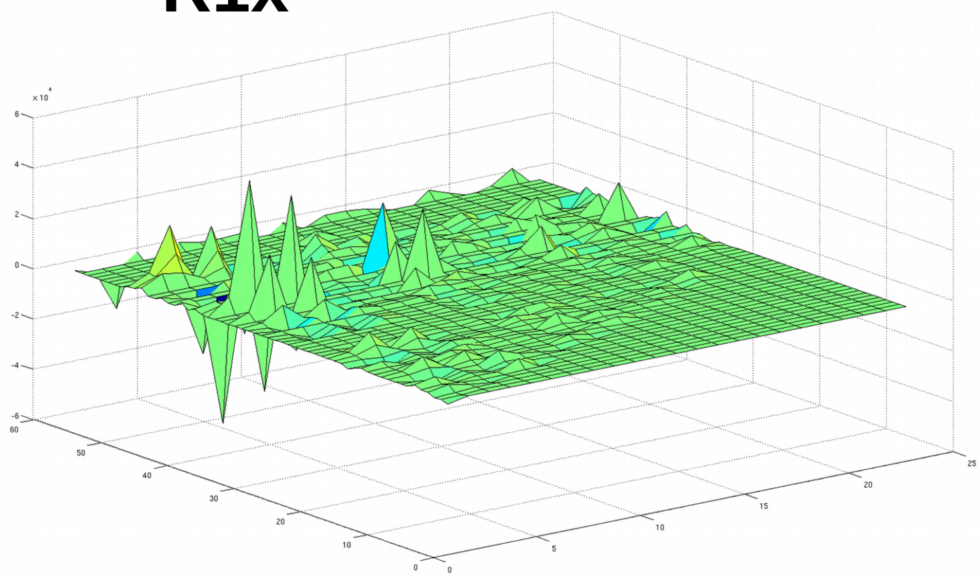
R0x



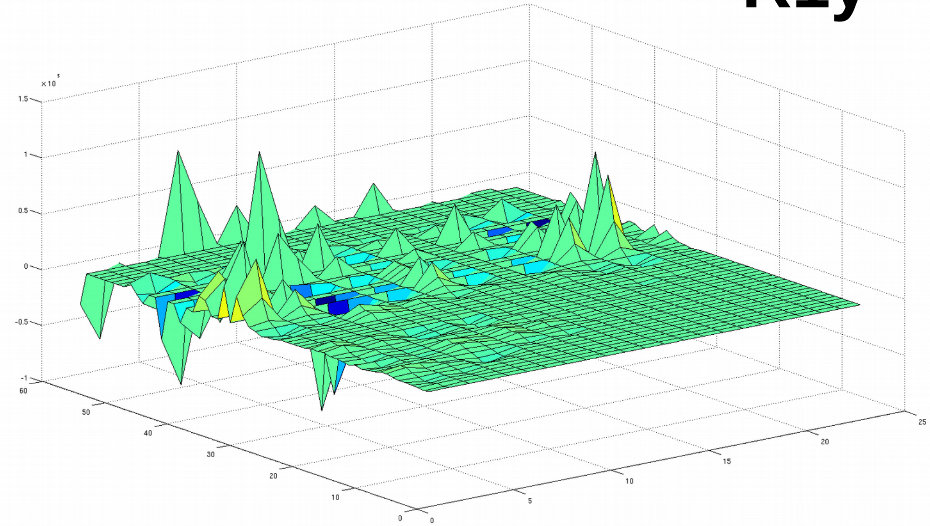
R0y



R1x

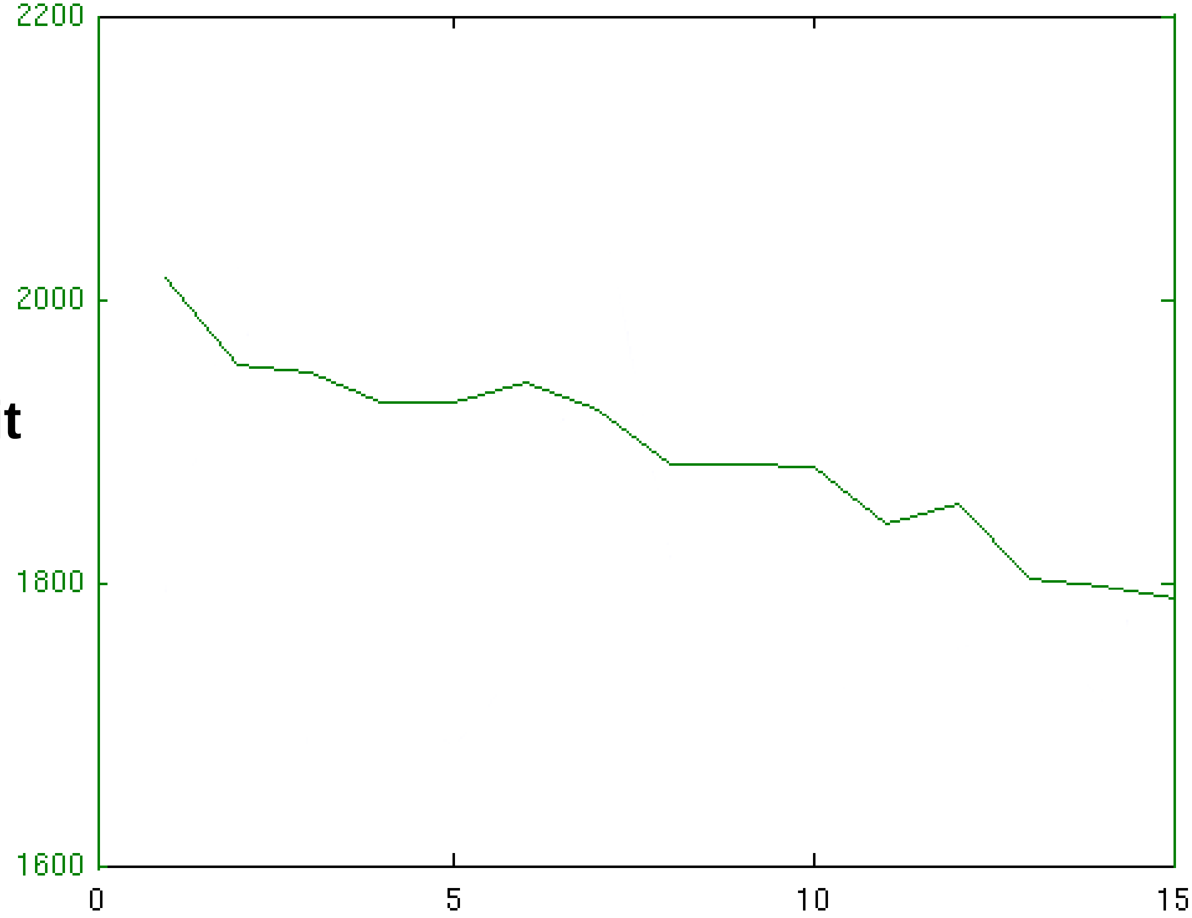


R1y



First results Wakefield Free Steering

Arb unit



Number of iterations

Script running and working. It needs a little more tuning to have better results. For example use more or less BPMs, remove the ones with wrong orbits...

Conclusions

- **Most of the BPMs are not able to give a stable measurement at high charge. Only 10 cavBPMs in the middle of the extraction line can be used.**

- **DFS and WFS are giving promising results.**

Outlook

- **Continue the studies focusing on the 10 interesting cavBPMs.**
- **Use the beam size measurement (screens and IPBSM) for the intensity studies.**
- **Pursue the DFS and WFS correction studies.**

Thank you