Simulation of Dispersion Correction at the VUV-FEL

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Dispersion correction algorithm

It corrects both orbit and dispersion, using the orbit and dispersion response matrices

Steerer

- Orbit response term $O_{i,j} = \frac{\Delta x_i}{\Delta \theta_j}$
- Dispersion response term $D_{i,j} = \frac{\Delta D_i}{\Delta \theta_j}$

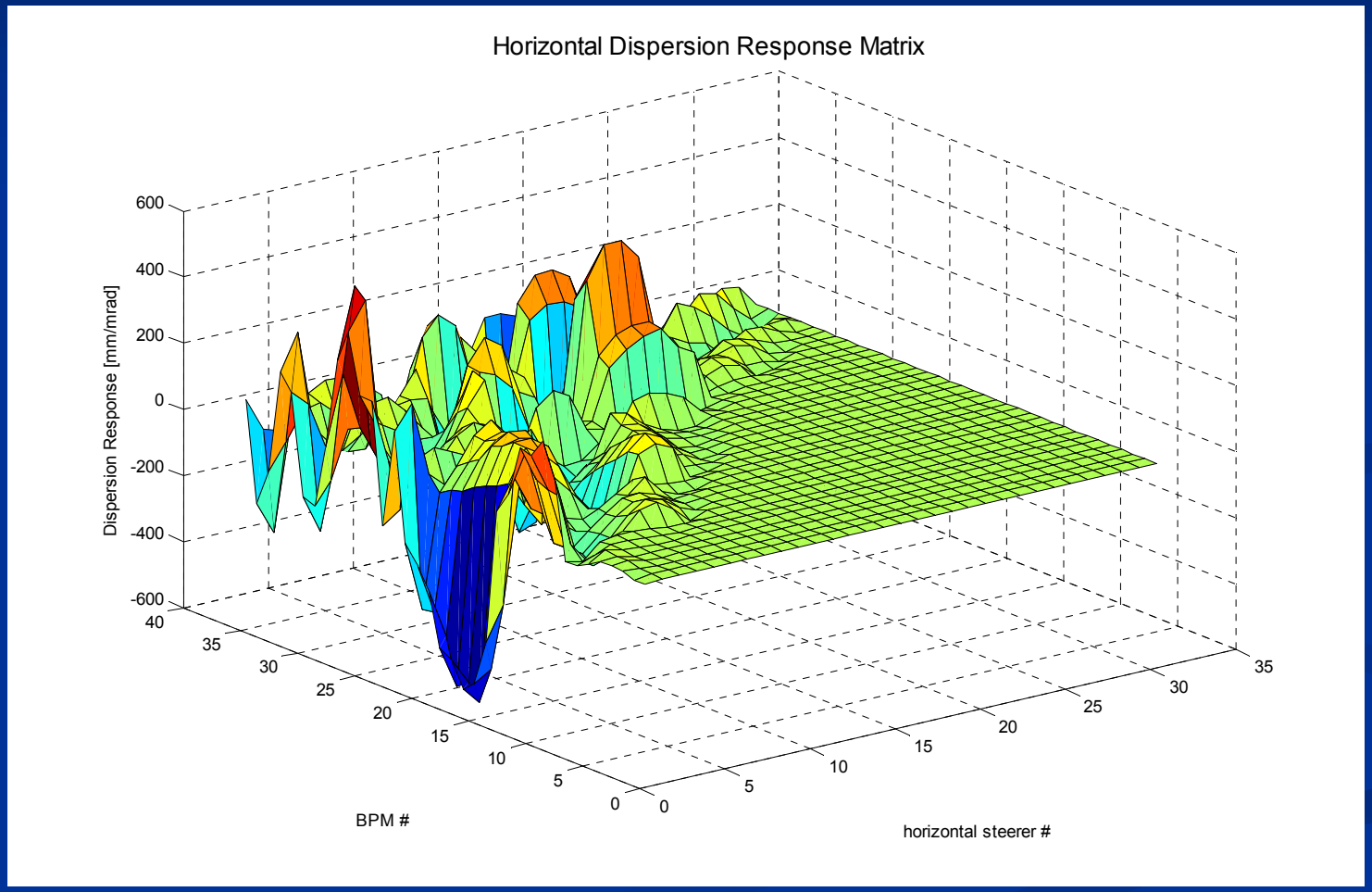
Quad mover

- Orbit response term $O_{i,j} = \frac{\Delta x_i}{\Delta x_j}$
- Dispersion response term $D_{i,j} = \frac{\Delta D_i}{\Delta x_j}$

Δx_i / ΔD_i ----------> change of the orbit / dispersion at the BPM *i*

$\Delta \theta_j$ / Δx_j ---------> change of the kick angle of the steerer *j* / change of transverse position of quad *j*

Response matrix example



Dispersion correction algorithm

$$\begin{pmatrix} \underline{\underline{O}} \cdot (1-w) \\ \underline{\underline{D}} \cdot w \end{pmatrix} \cdot \underline{\Delta\theta} = \begin{pmatrix} \underline{x} \cdot (1-w) \\ \underline{d} \cdot w \end{pmatrix}$$

Response matrices

Corrector strengths
(& quad displacements)

Orbit

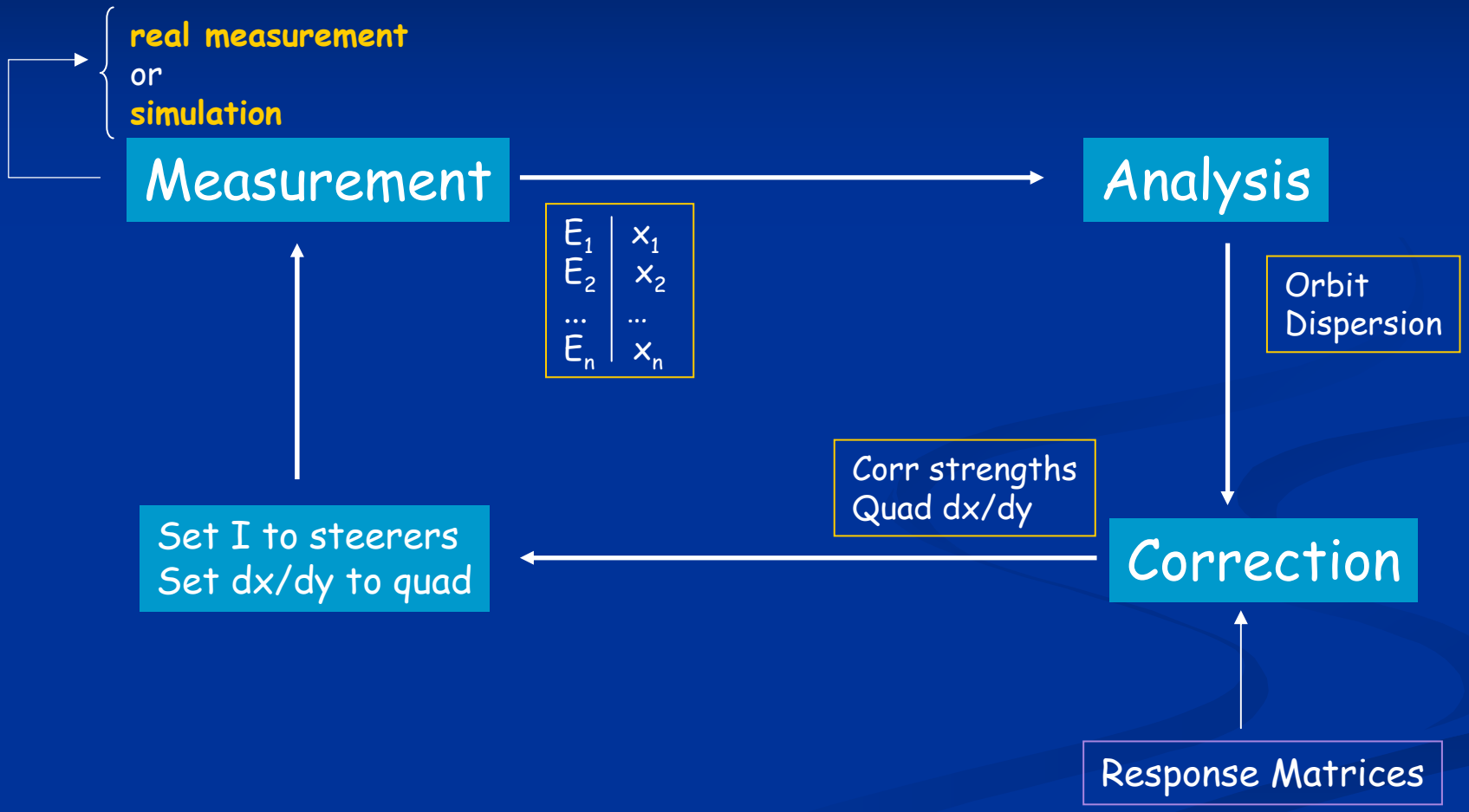
Dispersion

Weighting factor

Measurements

$$\sum \left[\begin{pmatrix} \underline{x}_{meas} \\ \underline{d}_{meas} \end{pmatrix} - \begin{pmatrix} \underline{x} \\ \underline{d} \end{pmatrix} \right]^2 = \min \Rightarrow \Delta\underline{\theta}$$

Dispersion correction sketch



Simulations

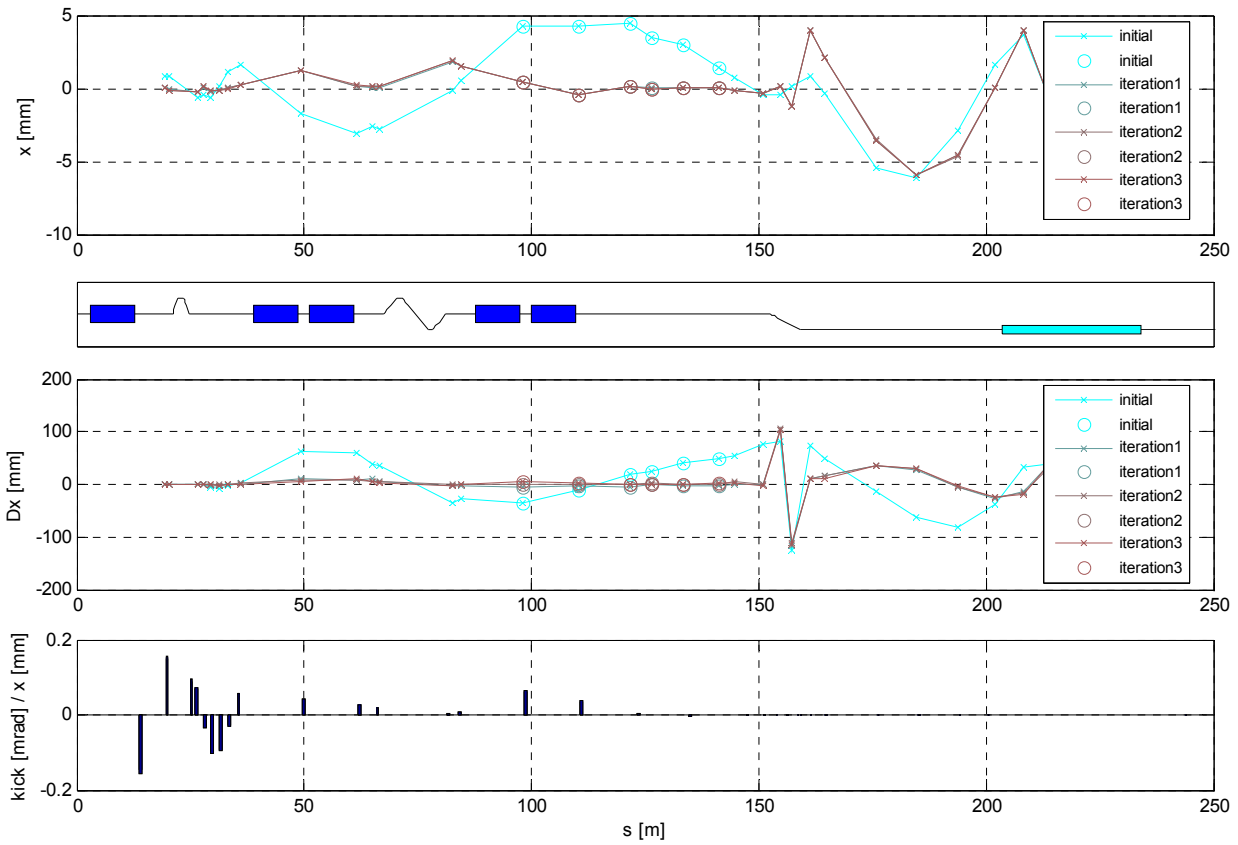
Basic set

Quad misalignments	200um
BPM off-sets	100um
BPM noise	20um
Weighting factor	0.1

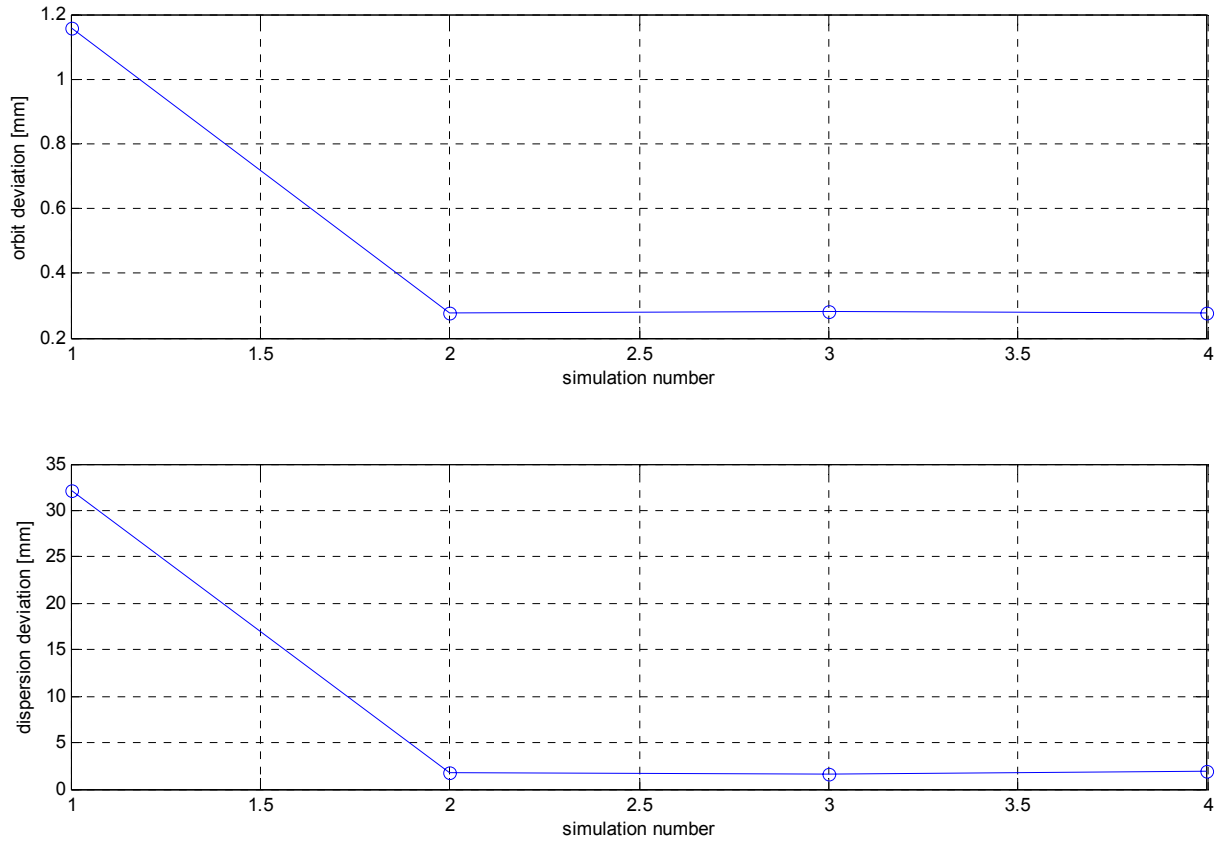
-Not considered effects

-Coupler kicks
-Dipole and quadrupole field errors
-Response matrix errors
-…

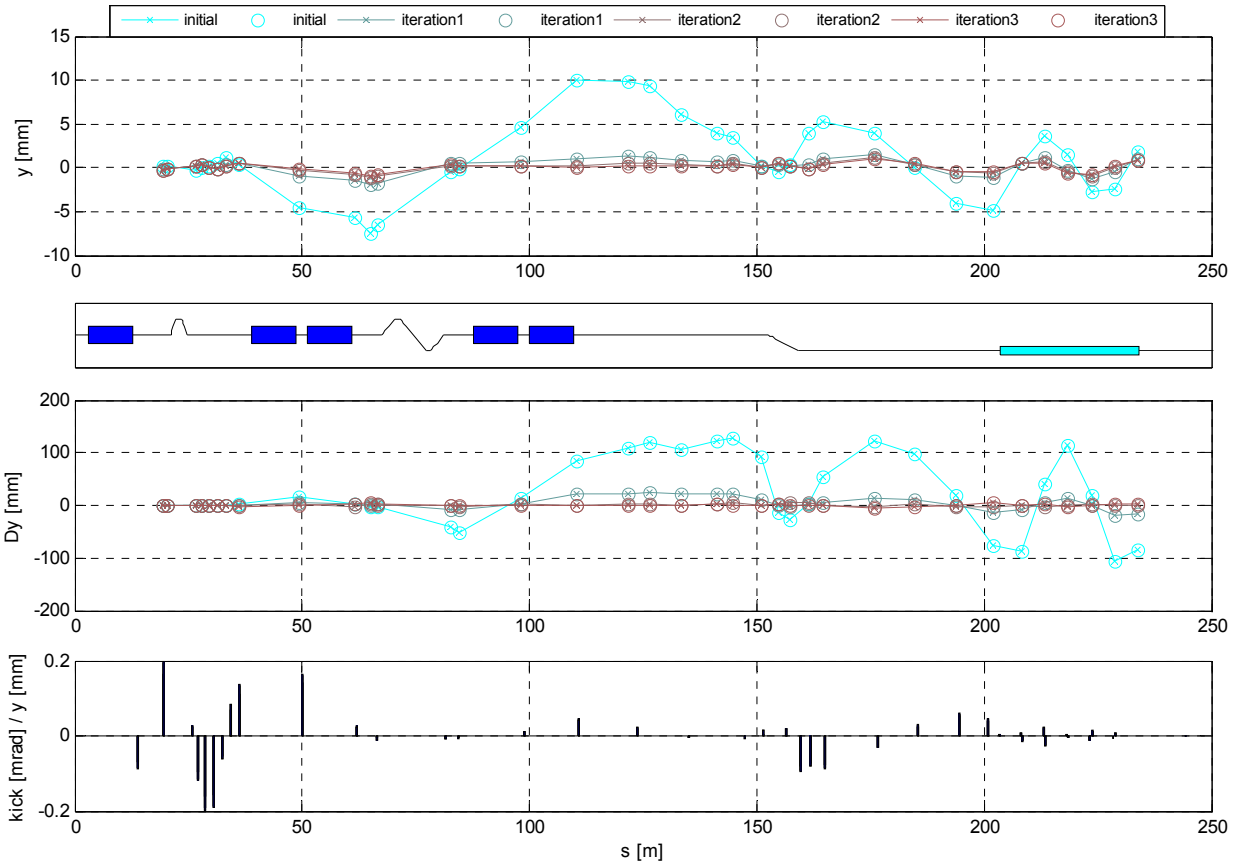
Basic set / BPM=15:20



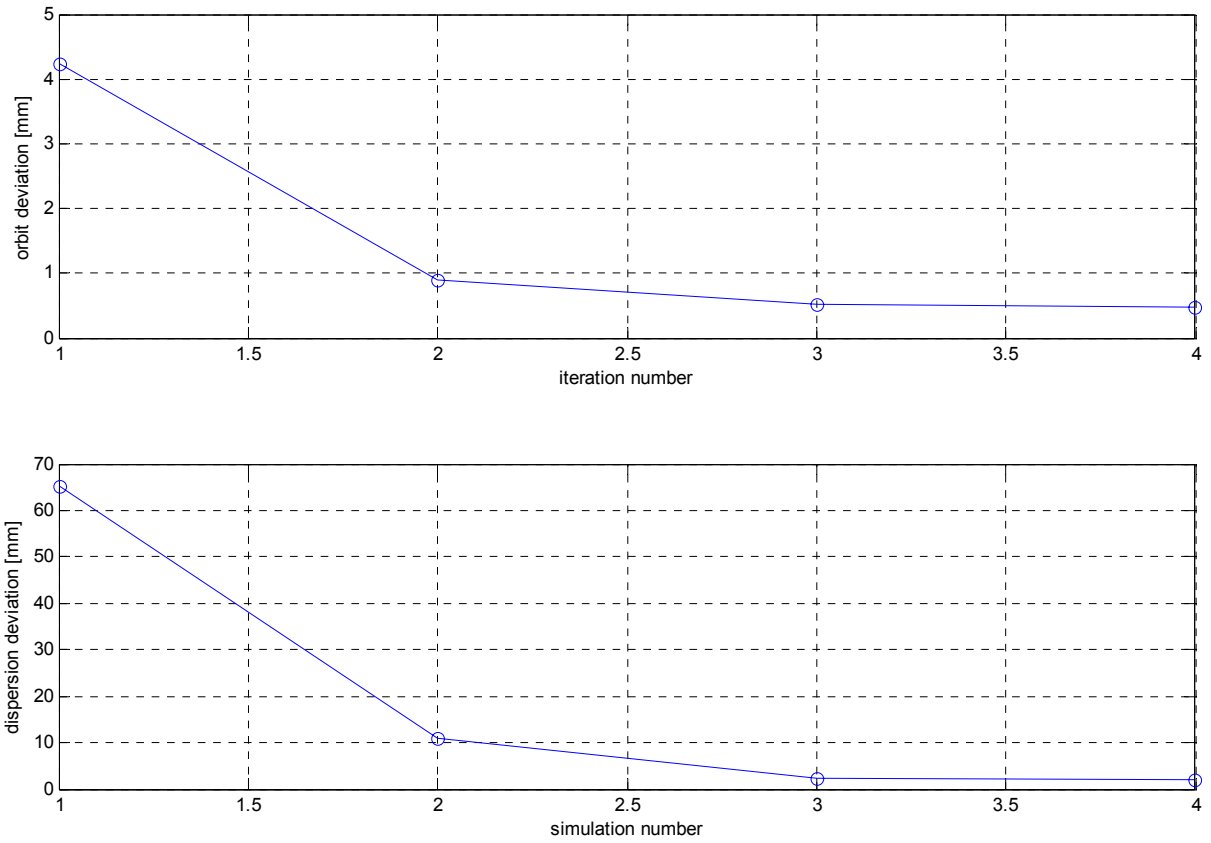
Basic set / BPM=15:20



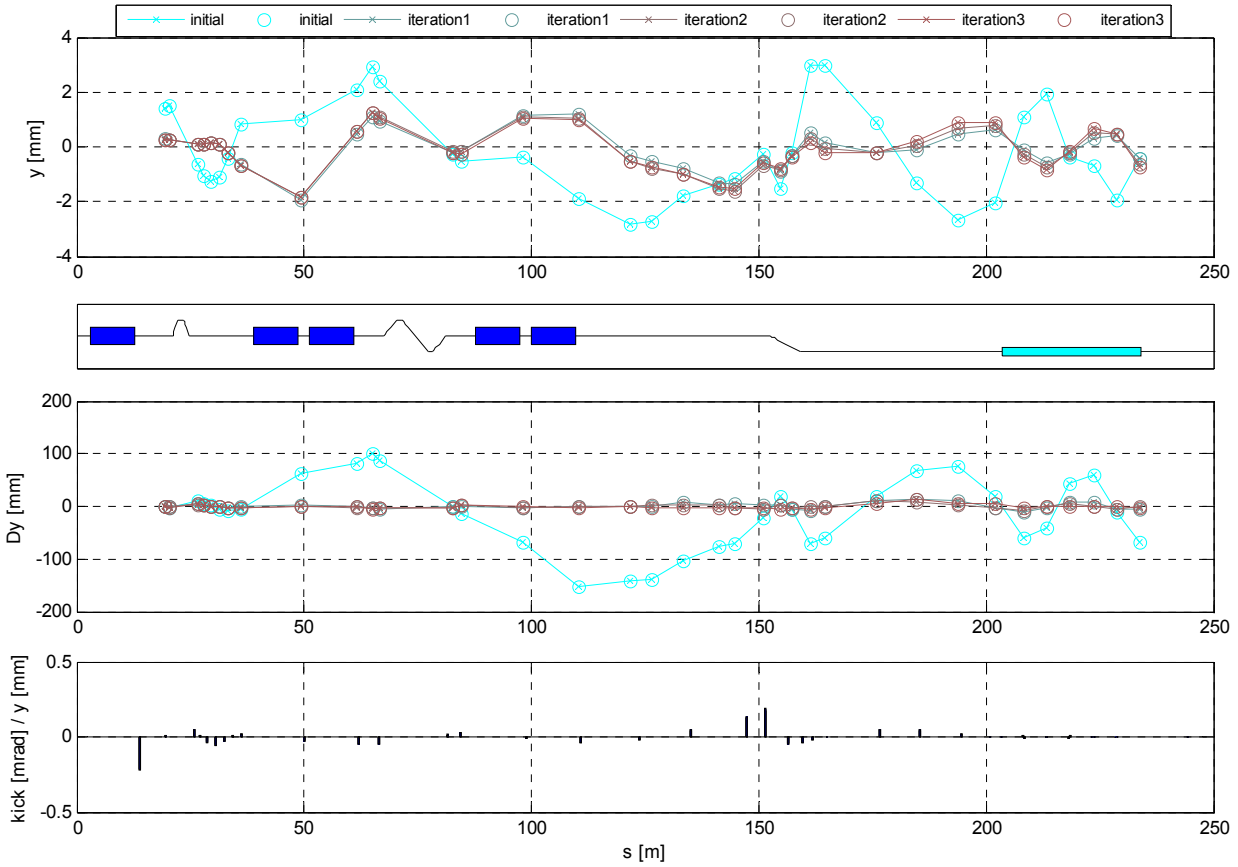
Basic set / All BPM's



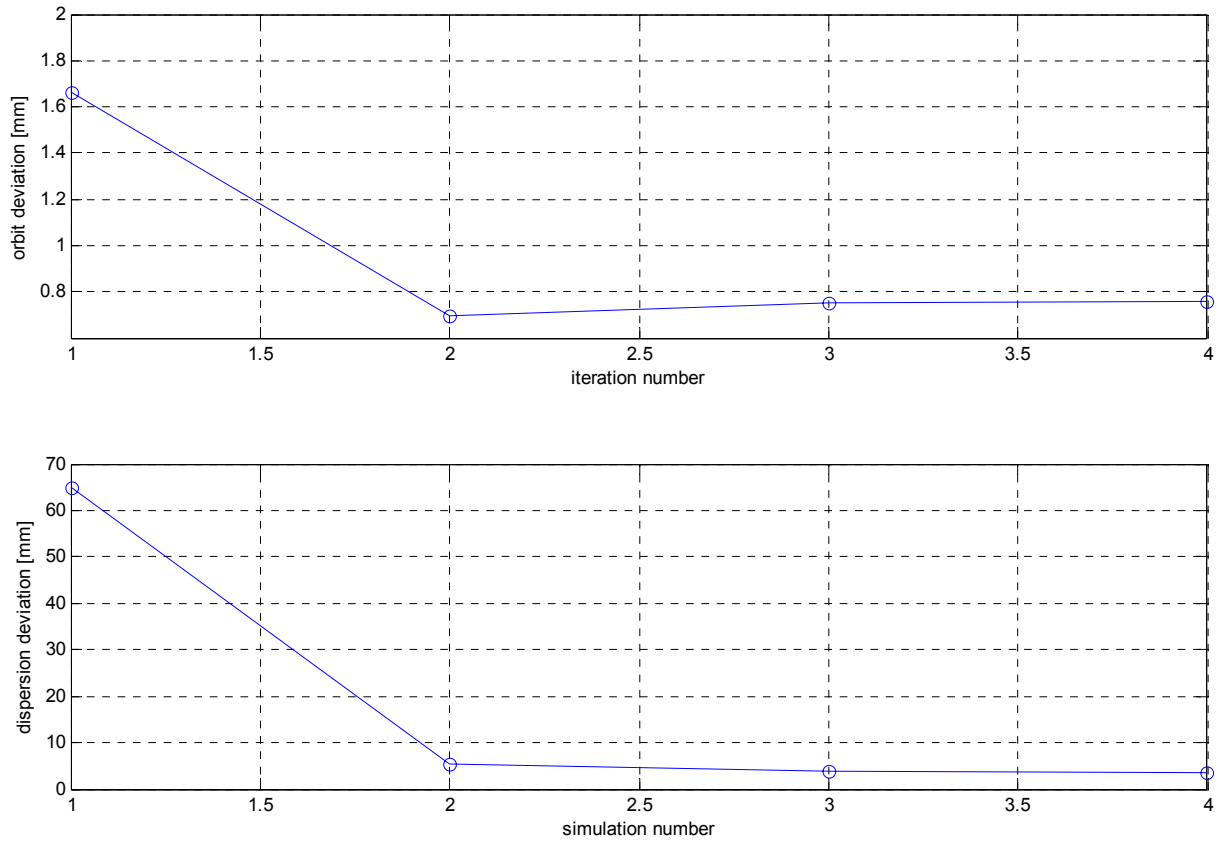
Basic set / All BPM's



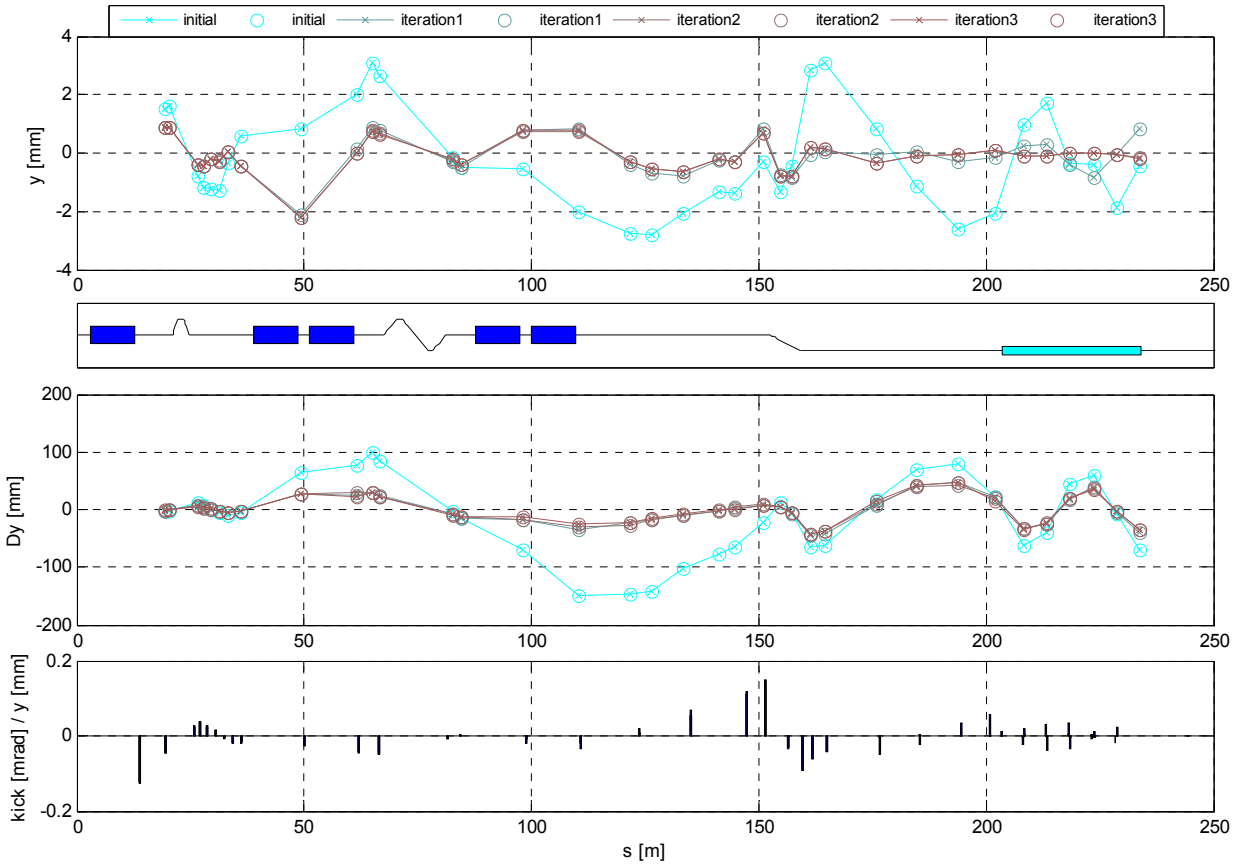
Basic set / All BPM's



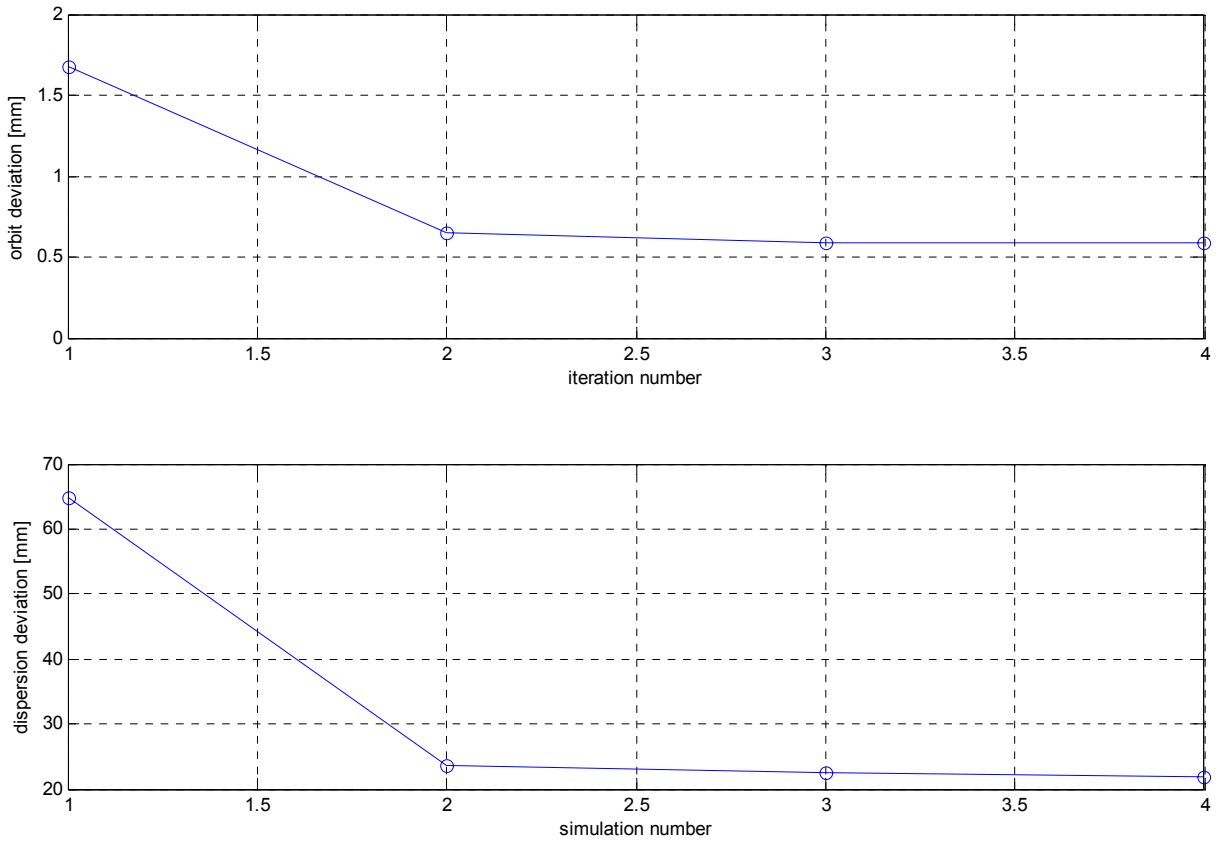
Basic set / All BPM's



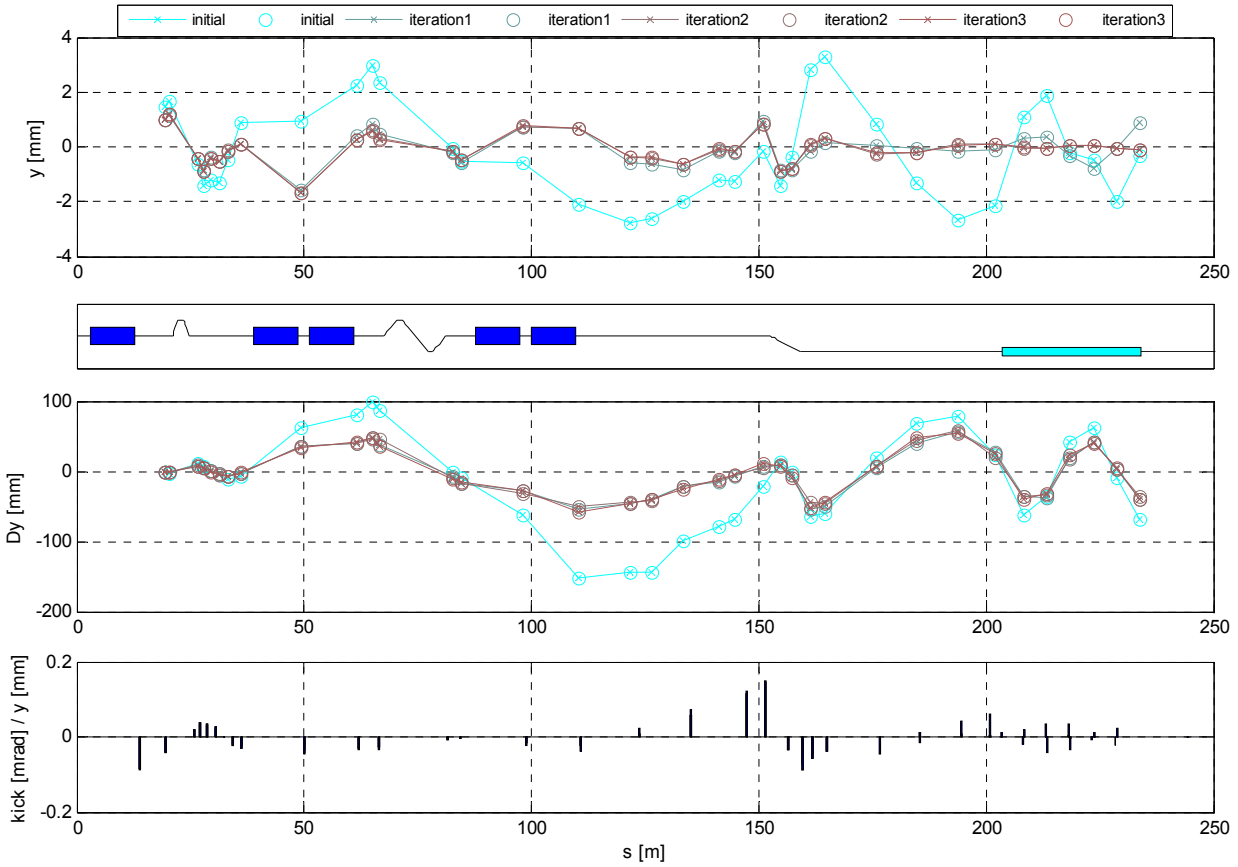
w=0.01 / All BPM's



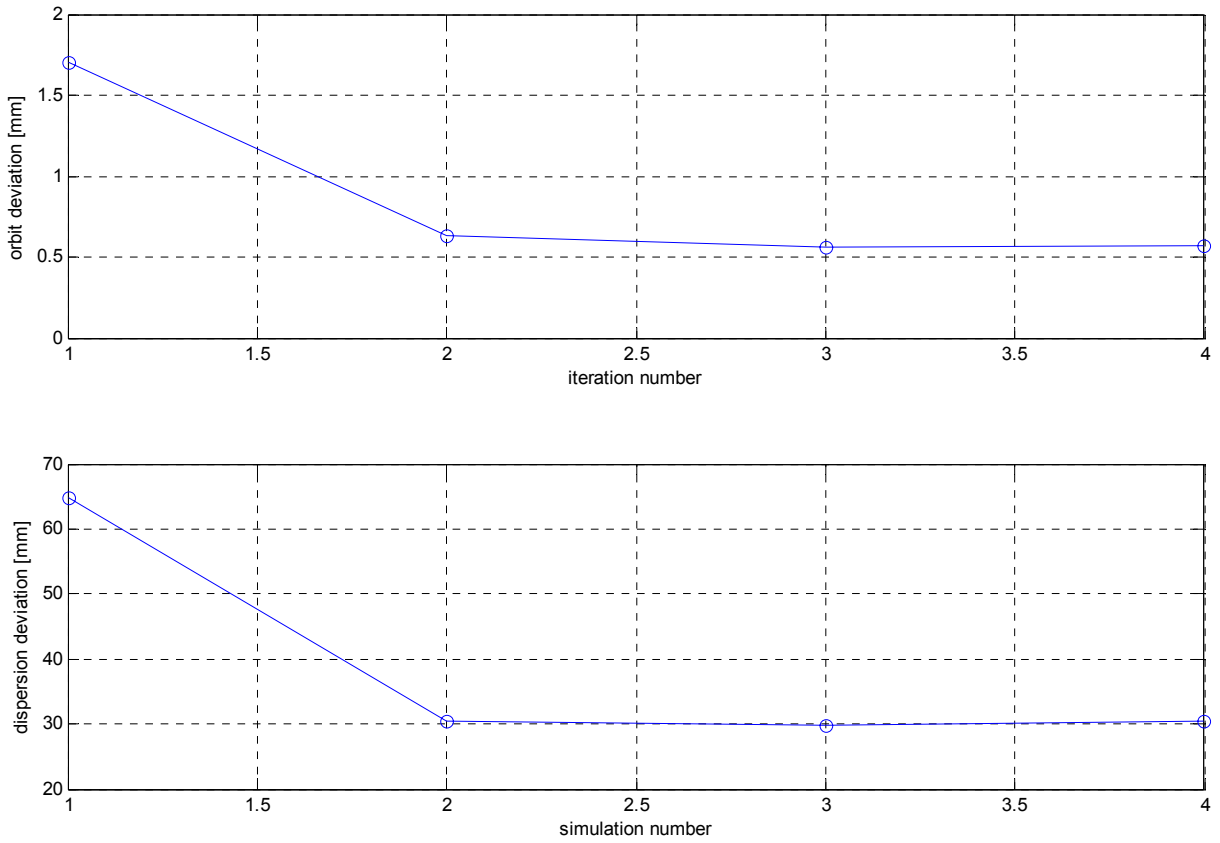
w=0.01 / All BPM's



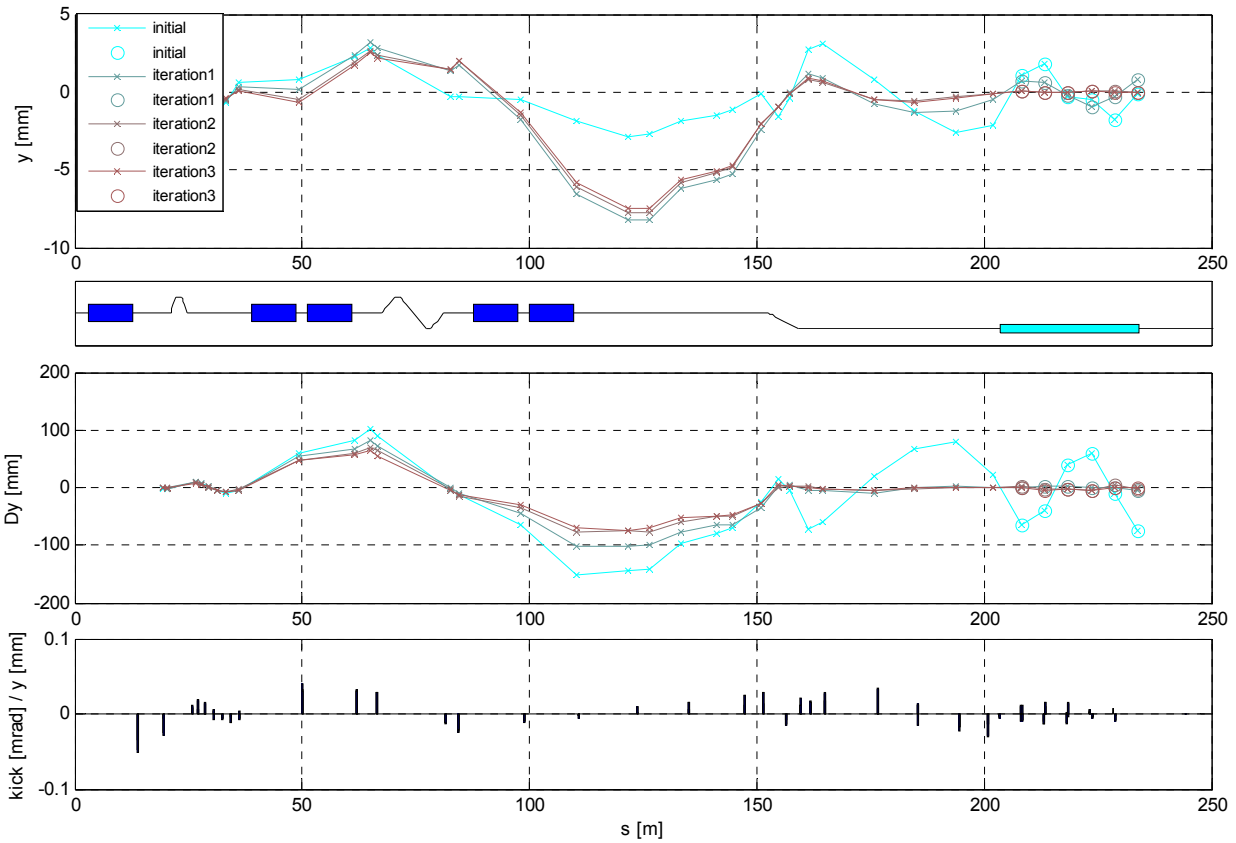
w=0.0 / All BPM's


initial
initial
iteration1
iteration1
iteration2
iteration2
iteration3
iteration3
y [mm]
Dy [mm]
kick [mrad] / y [mm]
s [m]

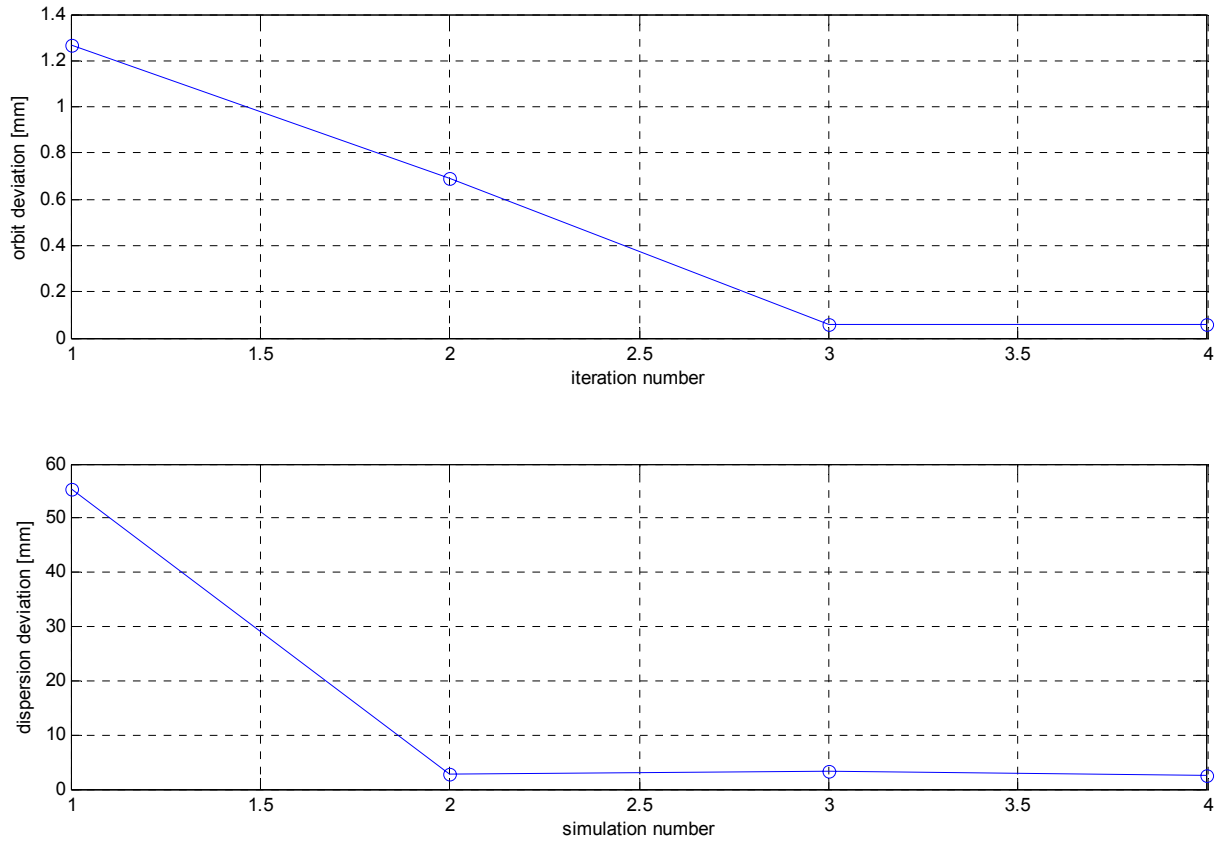
w=0.0 / All BPM's


orbit deviation [mm]
iteration number
dispersion deviation [mm]
simulation number

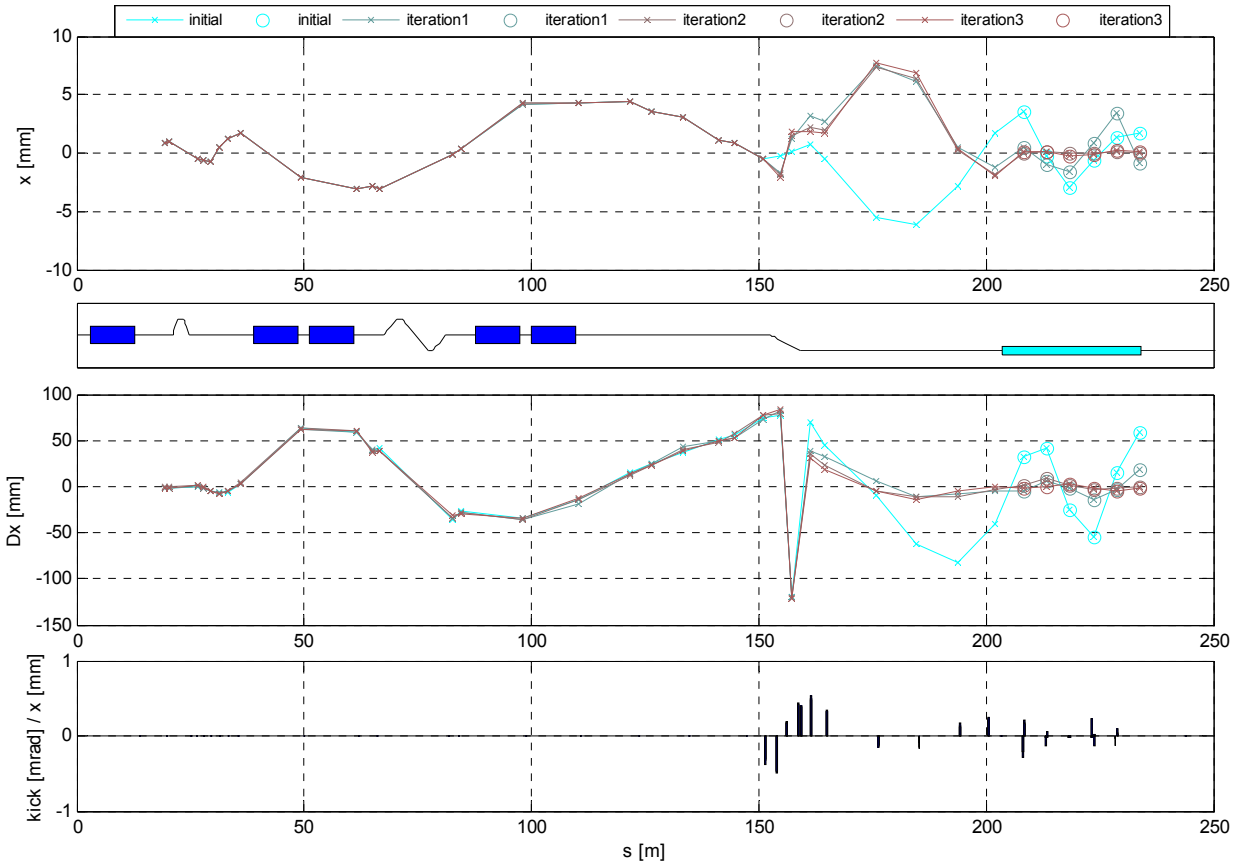
Basic set / undulator BPM's - all steerers



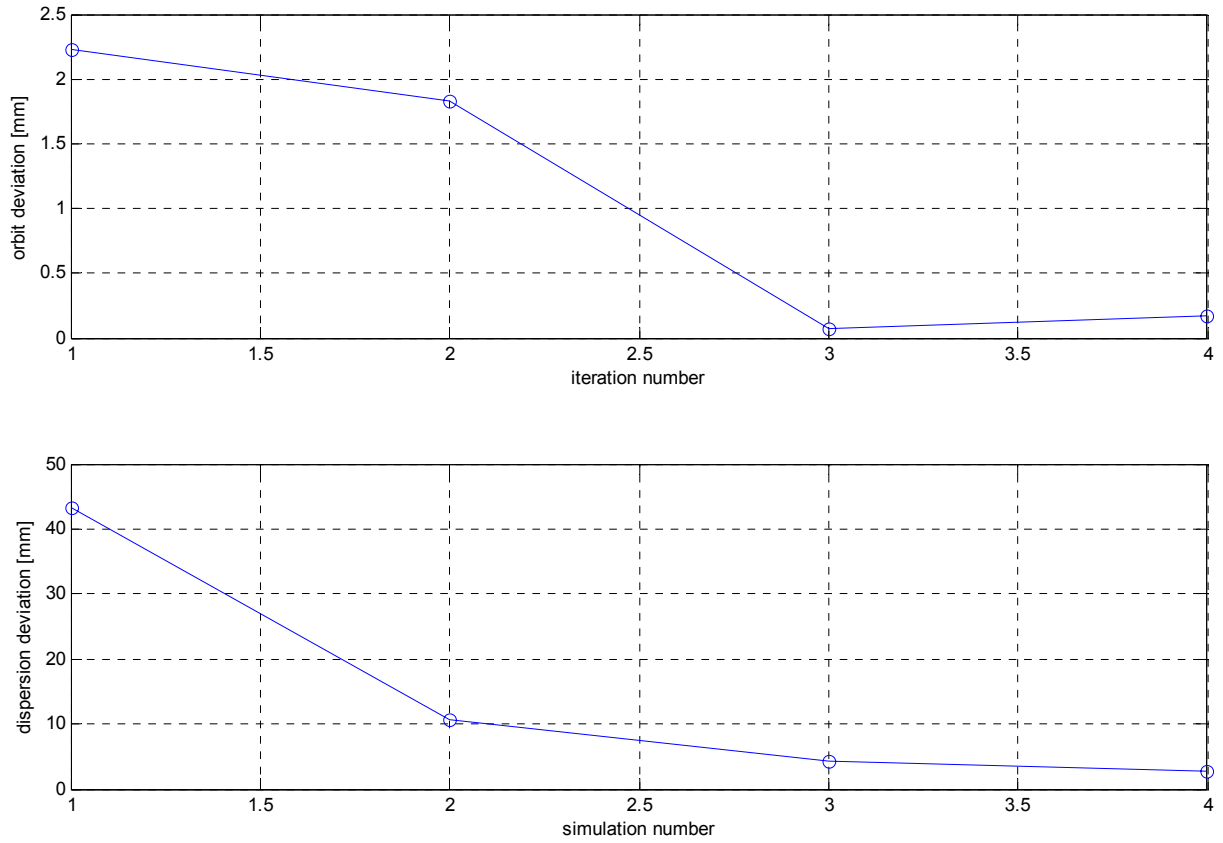
Basic set / undulator BPM's – all steerers



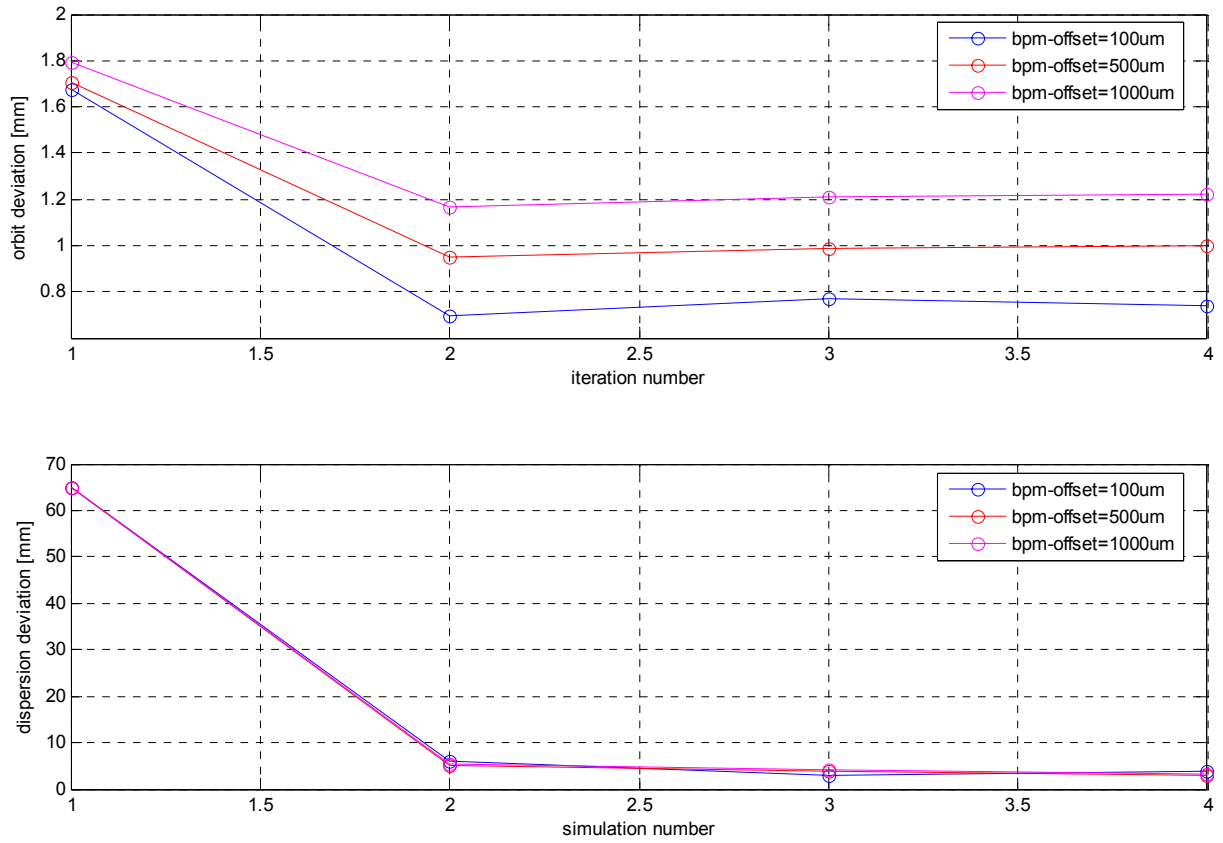
Basic set / undulator BPM's –steerers 20:end



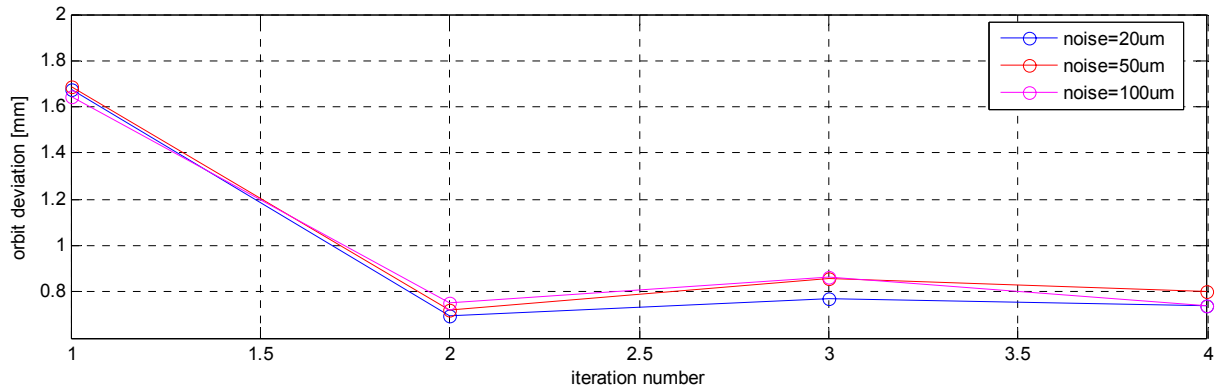
Basic set / undulator BPM's – steerers 20:end

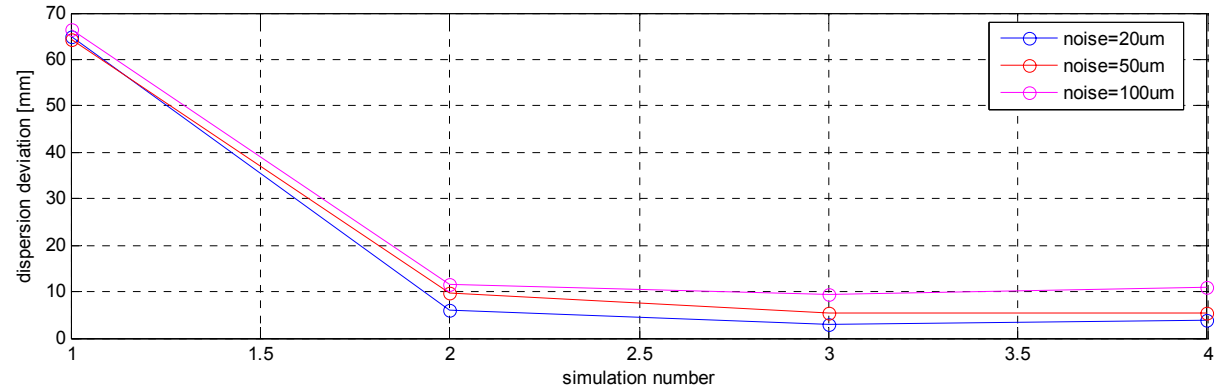


Sensitivity to BPM off-sets

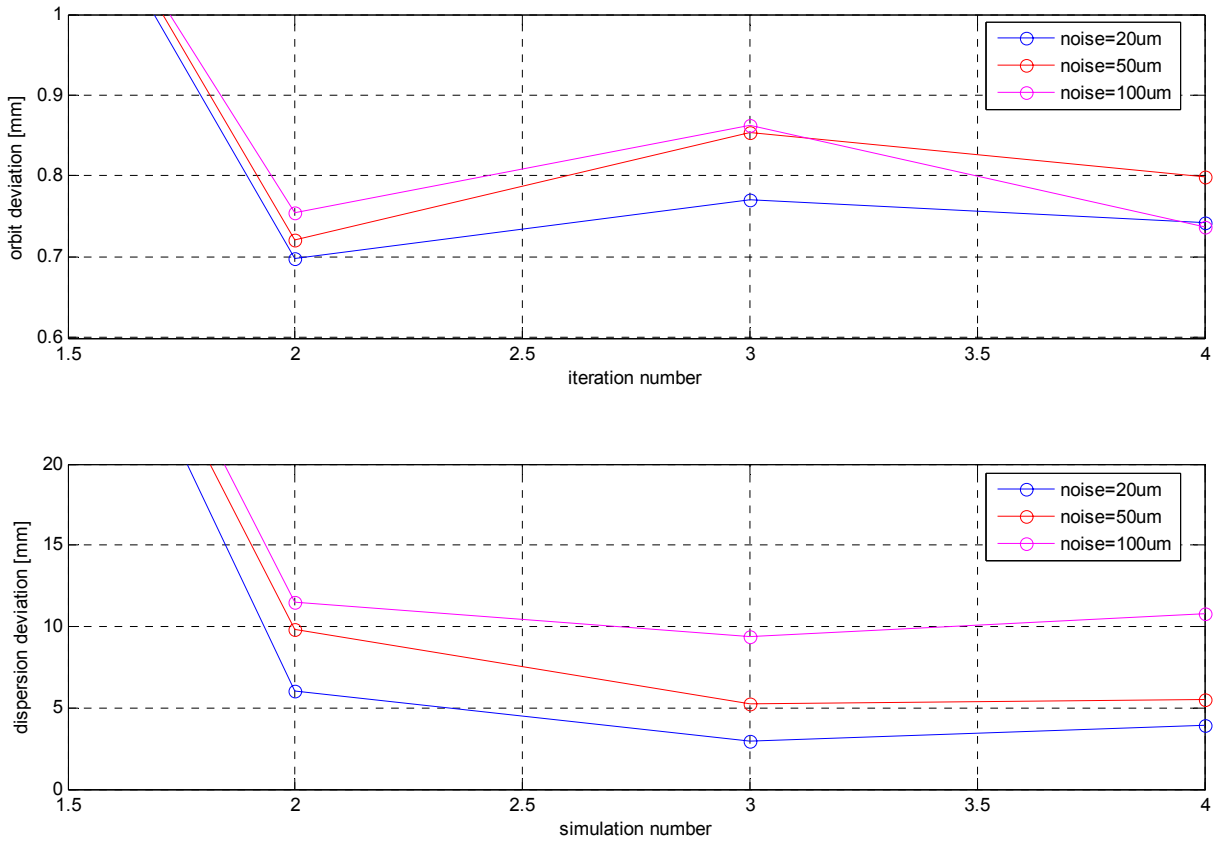


Sensitivity to BPM noise





Sensitivity to BPM noise
All BPM's



Summary/conclusions

- Dispersion correction simulation works properly
- Good results can be achieved in the undulator
- Next steps: include more effects, analyses sensitivity to more errors, adapt tool to real machine.

Thank you!