Steering & On line Dispersion Measurement Software

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Transfer Matrix Measurements

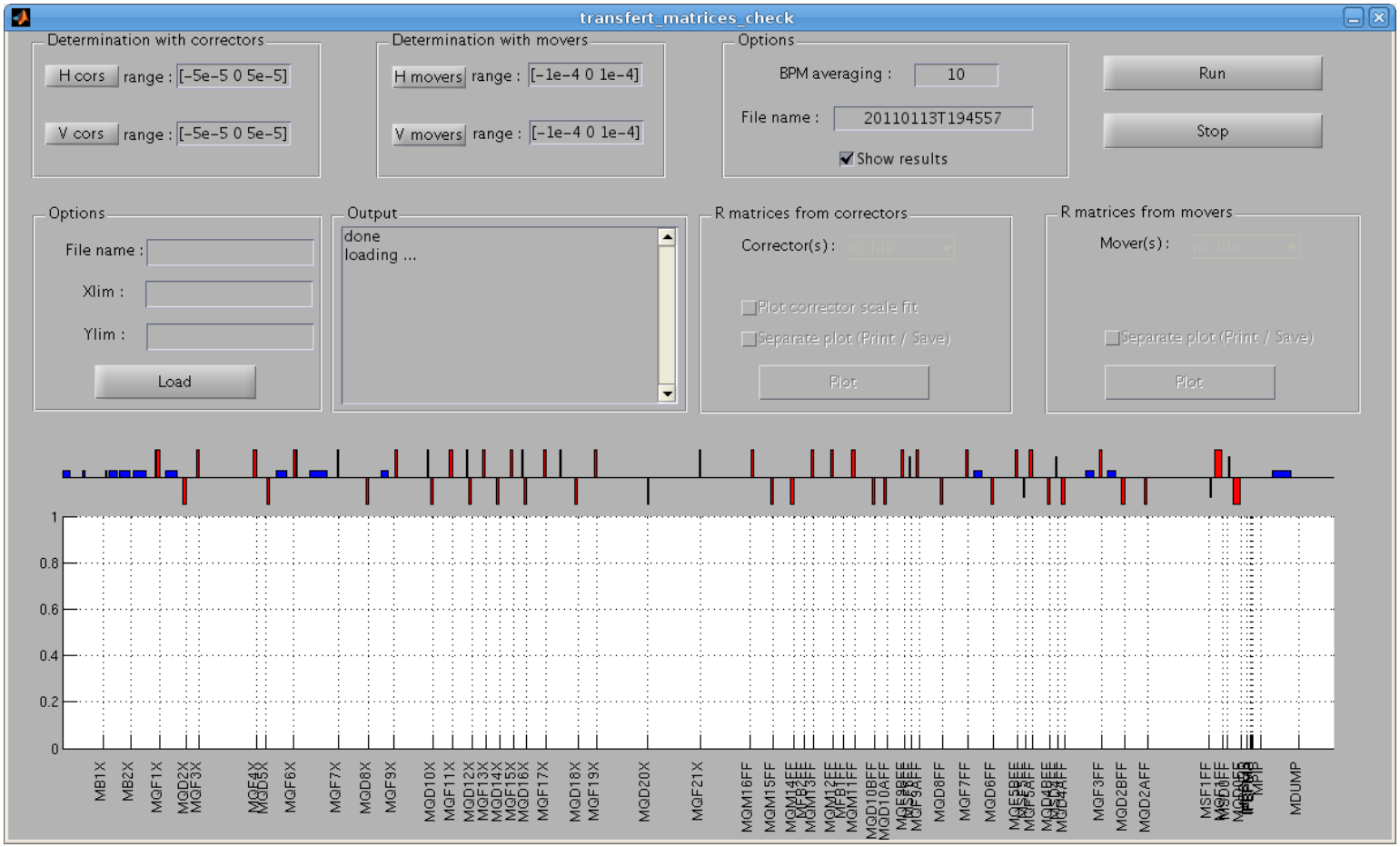
Principle

- Change corrector strength or quadrupole mover position.
- Fit BPM reading variation function of that change.
- Compare with On line mode prediction.

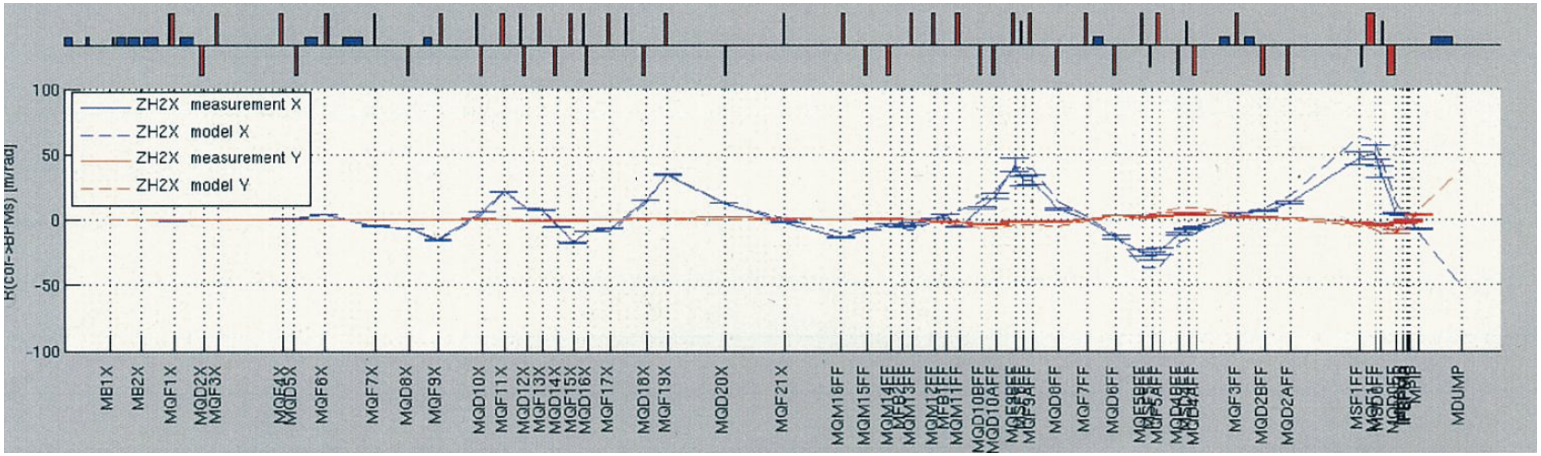
Improvements

- Can measure multiple correctors and movers.
- Faster measurements with movers.
- Estimate correctors strength scale errors.

Interface


transfert_matrices_check
Determination with correctors
H cors
range : [-5e-5 0 5e-5]
V cors
range : [-5e-5 0 5e-5]
Determination with movers
H movers
range : [-1e-4 0 1e-4]
V movers
range : [-1e-4 0 1e-4]
Options
BPM averaging : 10
File name : 20110113T194557
Show results
Run
Stop
Options
File name :
Xlim :
Ylim :
Load
Output
done
loading ...
R matrices from correctors
Corrector(s) :
Plot corrector scale fit
Separate plot (Print / Save)
Plot
R matrices from movers
Mover(s) :
Separate plot (Print / Save)
Plot
1
0.8
0.6
0.4
0.2
0
MB1X
MB2X
MQF1X
MQD2X
MQF3X
MQF4X
MQD5X
MQF6X
MQF7X
MQD8X
MQF9X
MQD10X
MQF11X
MQD12X
MQF13X
MQD14X
MQF15X
MQD16X
MQF17X
MQD18X
MQF19X
MQD20X
MQF21X
MQM16FF
MQM15FF
MQD8FF
MQF7FF
MQD6FF
MQF3FF
MQD2BFF
MQD2AFF
MSF1FF
MDUMP

December Measurements



Usefulness

- Quick check of the on-line optics.
- Allowed to discover a problem with QM16FF and QM13FF mover system.

Trajectory Steering

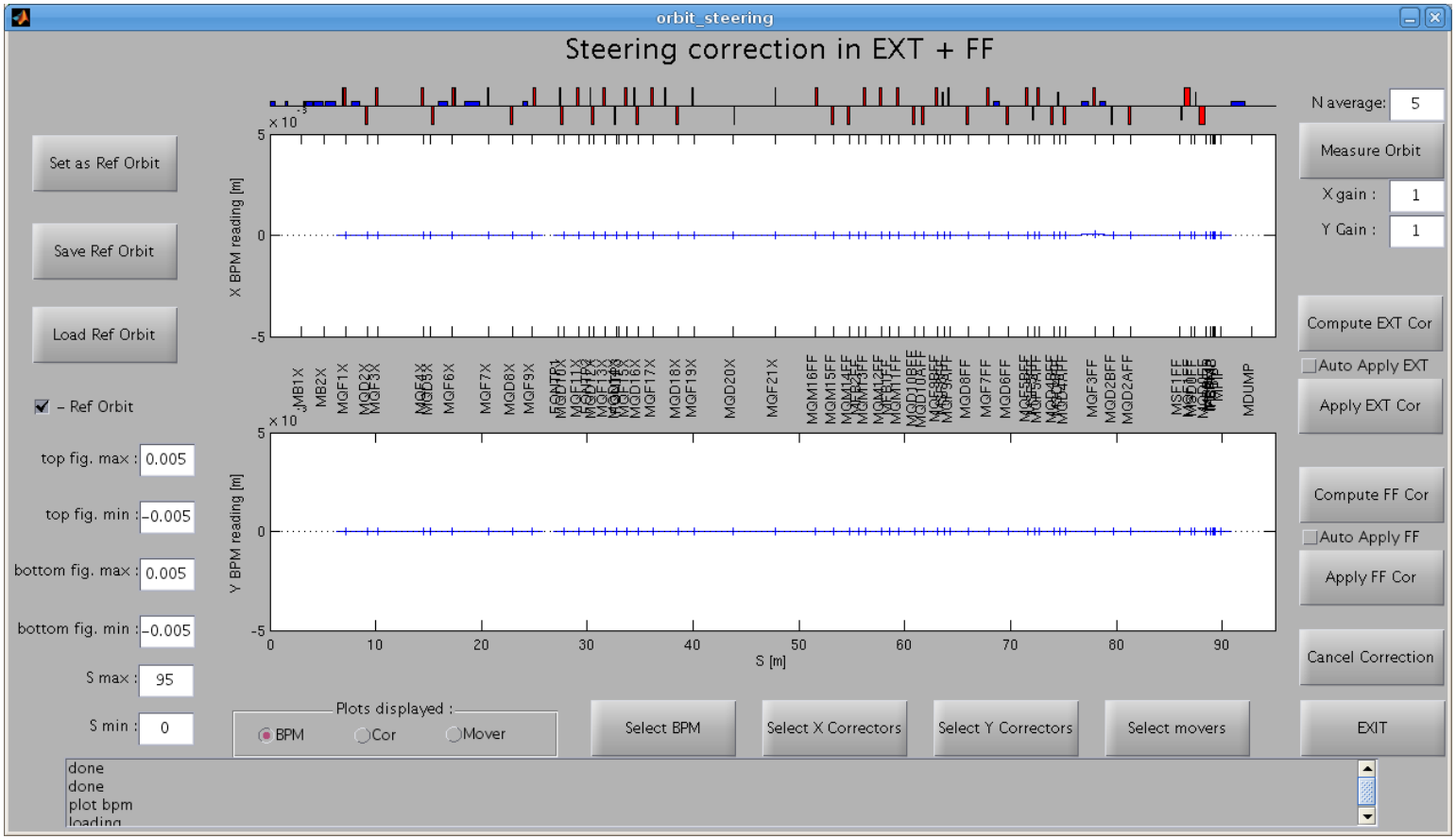
Principle

- Measure beam position at each BPM (corrected by BBA).
- Use corrector or quadrupoles on movers to correct to a reference orbit.

Improvements

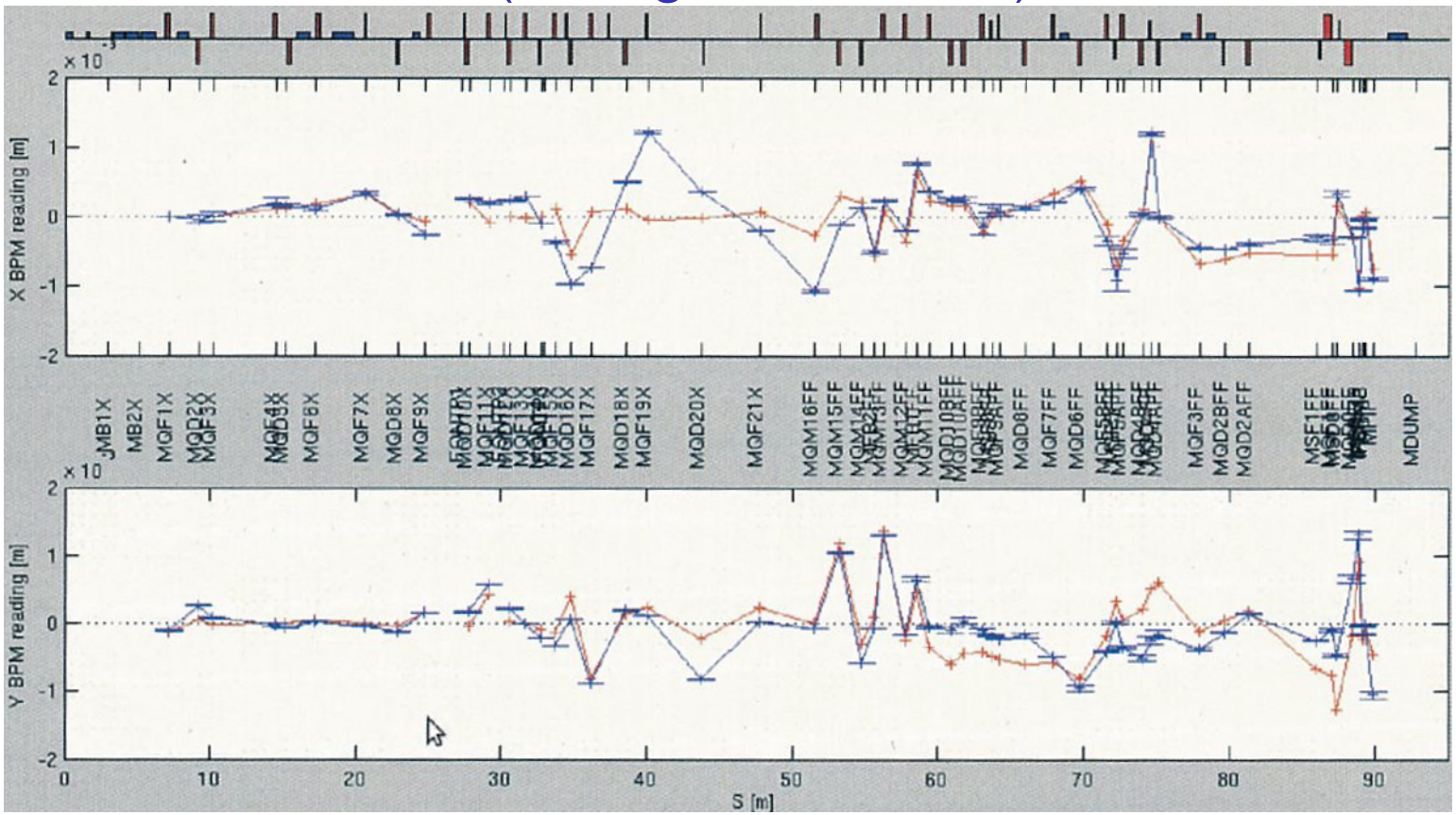
- Minimize corrector strength and mover displacements (no more saturation problems).
- Gain implemented.
- Cancellation works properly.
- Much less badly set correctors observed.

Interface


orbit_steering
Steering correction in EXT + FF
Set as Ref Orbit
Save Ref Orbit
Load Ref Orbit
– Ref Orbit
top fig. max : 0.005
top fig. min : -0.005
bottom fig. max : 0.005
bottom fig. min : -0.005
S max : 95
S min : 0
X BPM reading [m]
Y BPM reading [m]
S [m]
Plots displayed :
BPM
Cor
Mover
N average: 5
Measure Orbit
X gain : 1
Y Gain : 1
Compute EXT Cor
Auto Apply EXT
Apply EXT Cor
Compute FF Cor
Auto Apply FF
Apply FF Cor
Cancel Correction
Select BPM
Select X Correctors
Select Y Correctors
Select movers
EXIT
done
done
plot bpm
loading

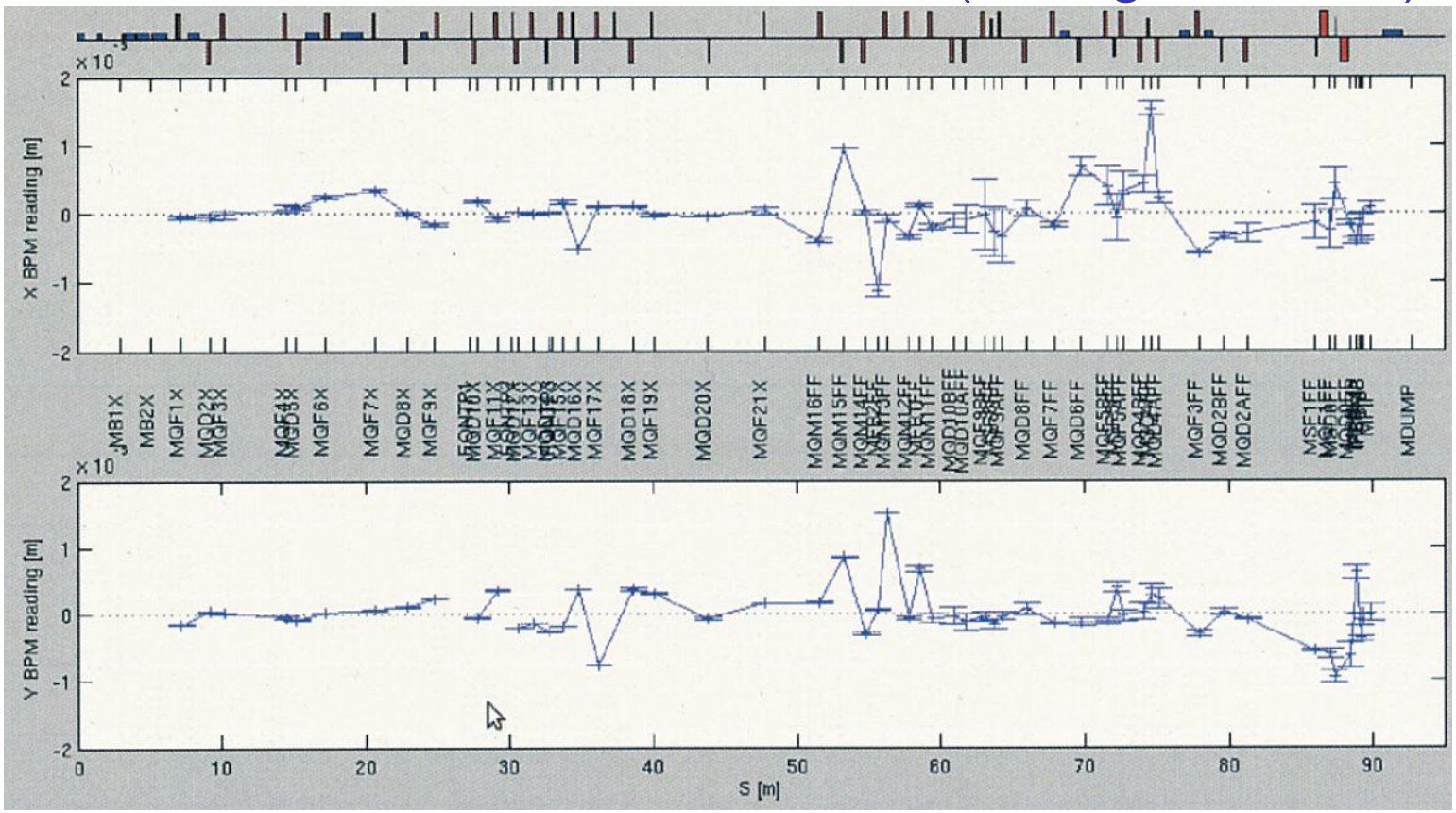
December Measurements

Before correction (Background$>$ 100)



December Measurements

After 4 corrections in EXT, 1 in FF (Background< 1)



Remarks

- Trajectory correction in 3 clicks !
- First time used by "not me" : 1 new happy user ;-)

On Line Dispersion Measurement

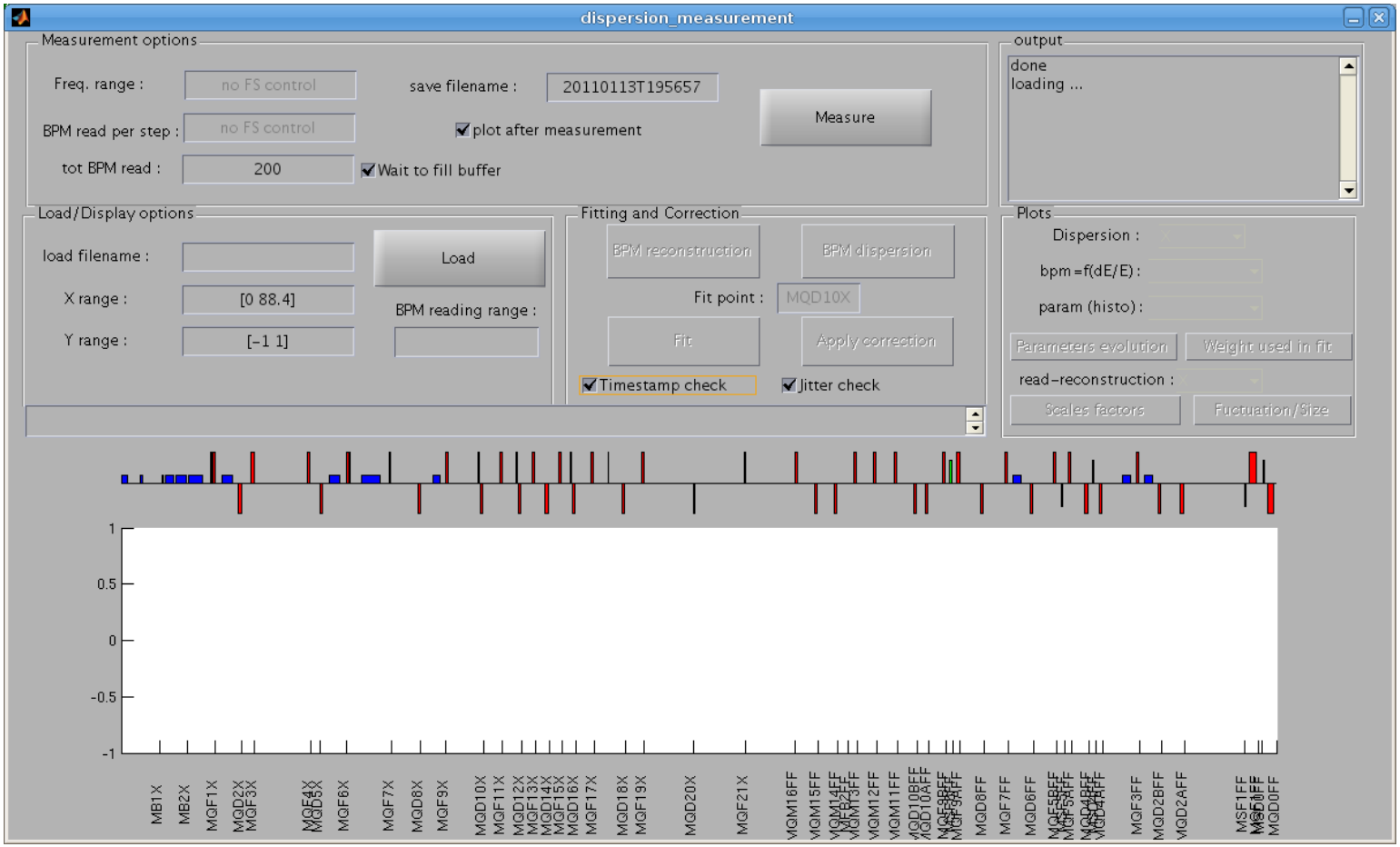
Principle

- Measure pulse to pulse beam position variation at each BPM.
- Reconstruct the parameter at injection : $x, x', y, y', \frac{\Delta E}{E}$ (weights $\propto \frac{1}{\text{BPM resolution}^2}$).
- Get the correlation the position measurements and $\frac{\Delta E}{E}$ to get dispersion at each BPM.
- Fit the dispersion.

Improvements

- Check the synchronization of the different BPMs systems.
- Detect bad pulses.

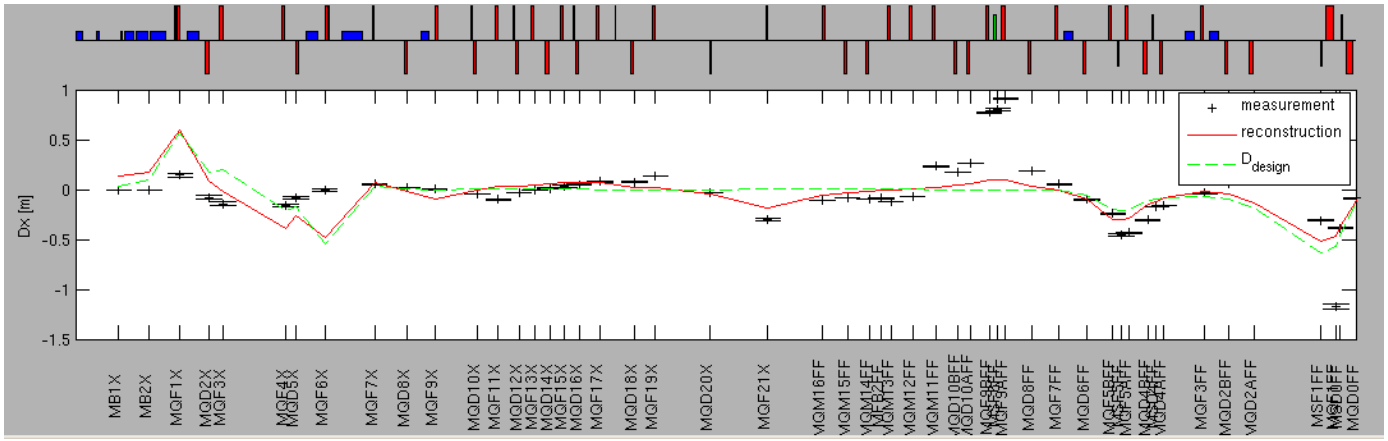
Interface


dispersion_measurement
Measurement options
Freq. range :
no FS control
save filename :
20110113T195657
BPM read per step :
no FS control
plot after measurement
Measure
tot BPM read :
200
Wait to fill buffer
output
done
loading ...
Load/Display options
load filename :
Load
X range :
[0 88.4]
BPM reading range :
Y range :
[-1 1]
Fitting and Correction
BPM reconstruction
BPM dispersion
Fit point :
MQD10X
Fit
Apply correction
Timestamp check
Jitter check
Plots
Dispersion :
bpm=f(dE/E) :
param (histo) :
Parameters evolution
Weight used in fit
read-reconstruction :
Scales factors
Fluctuation/Size
1
0.5
0
-0.5
-1
MB1X
MB2X
MQF1X
MQD2X
MQF3X
MQF6X
MQF7X
MQD8X
MQF9X
MQD10X
MQF11X
MQD12X
MQF13X
MQD14X
MQF15X
MQD16X
MQF17X
MQD18X
MQF19X
MQD20X
MQF21X
MQD8FF
MQF7FF
MQD6FF
MQF3FF
MQD2BFF
MQD24FF
MQD0FF

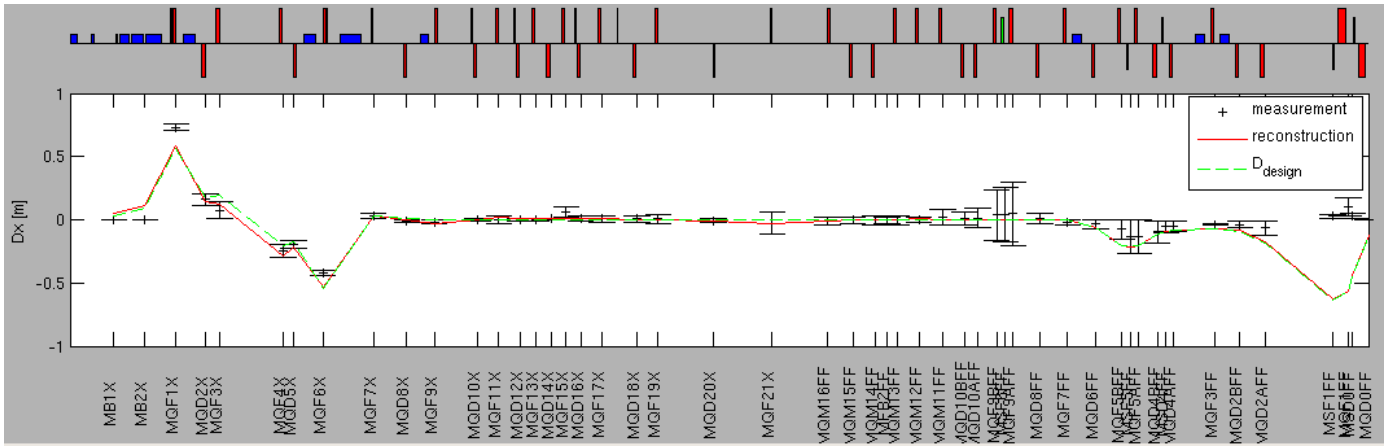
Problems

Experimental Problems

- Good measurement when the ramp is used.
- Bad measurement otherwise using cavity BPMs.



- Works well using just stripline BPMs (bad precision).



Problems (2)

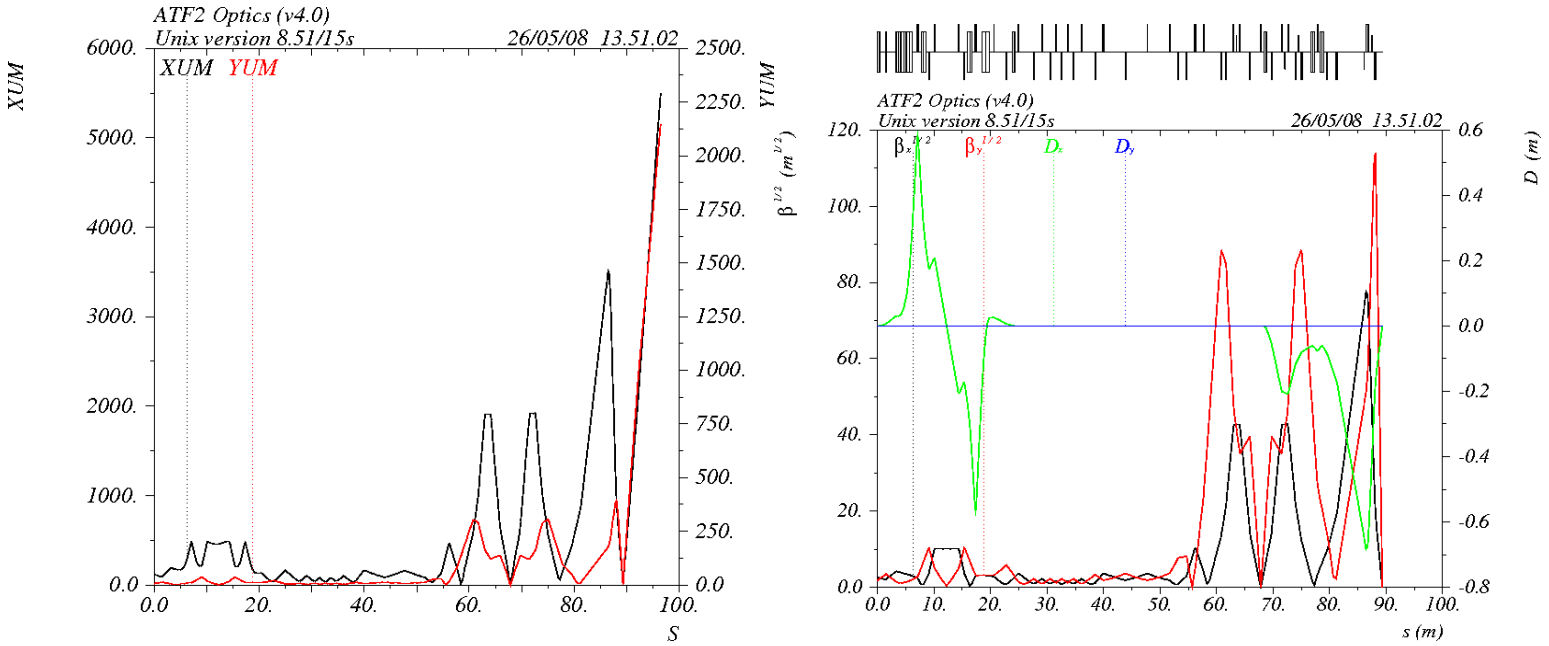
Characterization

- Nominal optics produce very large beam size & fluctuations in FF.
- Energy reconstruction is much more sensitive to BPM scales errors and modeling errors.

Some Numbers (at QF5FF):

- horizontal jitter due to energy jitter :
  $D_x = 0.2m \left.\frac{\Delta E}{E}\right|_{jitter} = 5.10^{-5}$
  $\Delta x_{E\ jitter} = D_x \times \left.\frac{\Delta E}{E}\right|_{jitter} = 10\mu m$
- horizontal jitter due to position and angle jitter :
  $\sigma_x = 2mm \frac{\Delta x_{jitter}}{\sigma_x} = 20\%$
  $\Delta x_{jitter} = \frac{\Delta x_{jitter}}{\sigma_x} \times \sigma_x = 400\mu m$

Problems (3)



Explanation

- Final Doublet BPMs not used
  $\Rightarrow \frac{\Delta E}{E} \propto X(MQF9FF) - X(MQF5FF)$.
- reason : same $\beta_x and \phi_x$ but different D_x values.
- Subtraction of 2 large numbers to get a small one ...

Planned Solutions

Better model & scales factor determination

- $\simeq 1\%$ scales factor uniformity required.
- Same for uncertainty on transfer matrices.
- Not realistic.

Using Ring's BPMs

- Lots of dispersive regions, small fluctuations.
- Last turn readings needed.
- Not available yet.

Using Extraction line Chicane

- Large dispersion, small beam sizes.
- Not very precise BPMs.
- Scales factors are not very goods.

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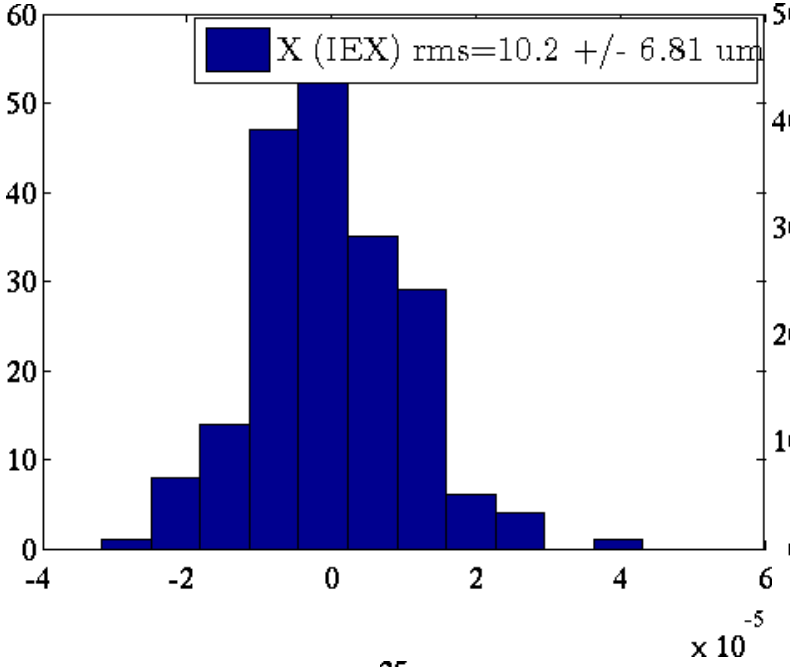
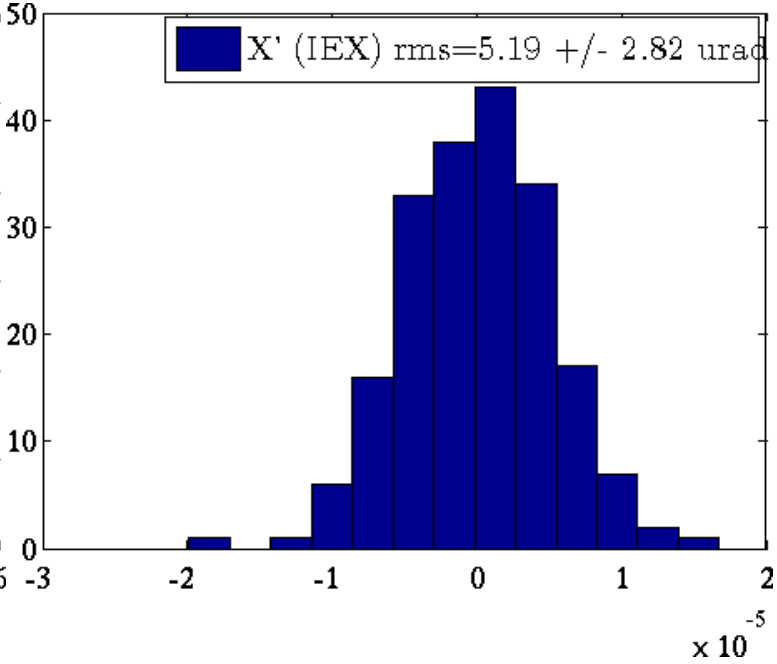
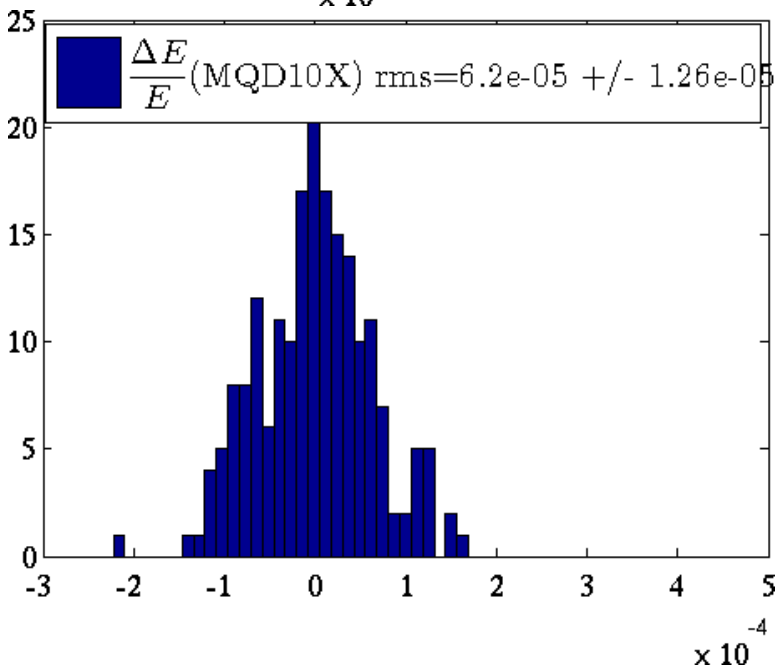
Preliminary results (using EXT BPMs)







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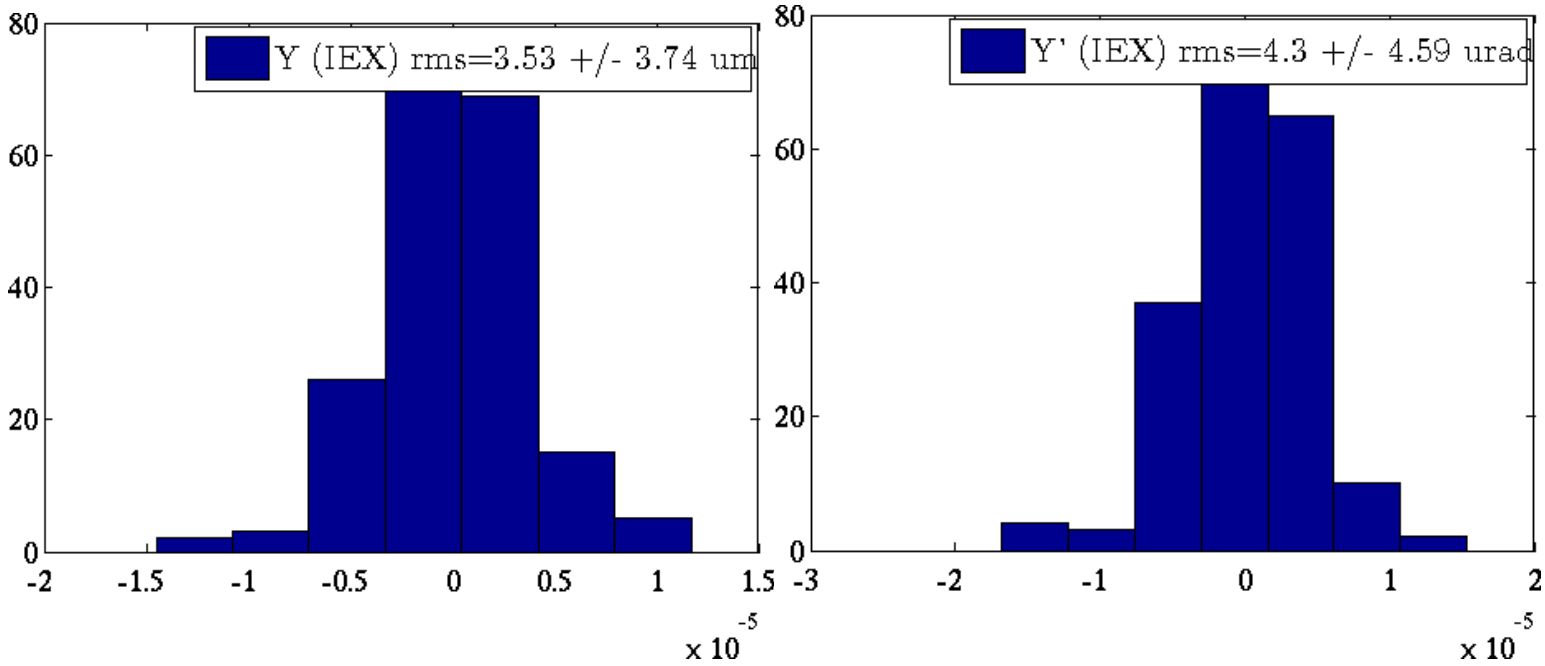

Conclusion

- Transfer matrices check application available for all.
  - Extensively checked.
  - Has already been used successfully by various people.
- Trajectory steering application available for all.
  - Still sometimes need to repeat corrections.
  - Has already been used successfully by Glen.
- On line dispersion measurement still under development.

Prospects on the On-line dispersion Measurement

- Separate energy reconstruction from positions and angles.
- Will use extraction line BPMs for energy reconstruction.
- Would benefit from availability of turn by turn DR BPMs ?
- Any suggestions / remarks ?