GUIs for Orbit Correction, Orbit Response Measurements

& Quadrupole Misalignment Determination

at ***LCLS*** INJECTOR

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Orbit correction GUI

What

It corrects globally the orbit

(at the selected BPMs using the selected correctors)

How

It modifies the trajectory by means of steering, using the orbit response matrices obtained from the model

Orbit response matrix term → $O_{ij} = \Delta x_i / \Delta\theta_j$

Δx_i → change of the trajectory at BPM i

$\Delta\theta_j$ → change of the kick angle at steerer j

It gets the corrector settings using the SVD algorithm:

$||\underline{X}_{meas} + O.\,\underline{\Delta\theta}||^2 = \min$ → $\underline{\Delta\theta}$

Orbit correction GUI

Input (in blue default values)

- BPM's: all
- Correctors: all
- Golden orbit

  Options: all to zero, all to constant, load orbit, edit single BPM
- Plane: horizontal (only one plane at the same time)
- Number of samples: 50
- SVD tolerance: 5%

  it's an indicator of how much we are willing to allow for corrector changes

  ↑ SVDtol → ↓ corrector changes, ↓ orbit goodness

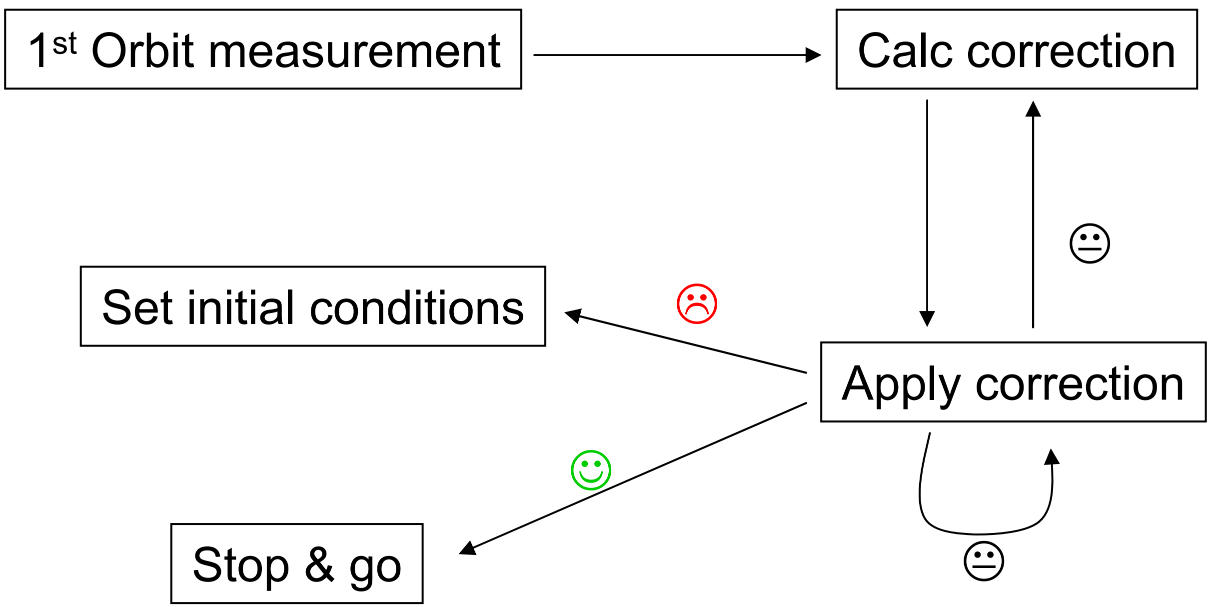
  ↓ SVDtol → ↑ corrector changes, ↑ orbit goodness
- Percentage of applied correction: 75%

  Applying less than 100% is useful to overcome possible machine imperfections

Orbit correction GUI

Action buttons

- Do 1st measurement
- Calculate correction (with given dimension, golden orbit, BPMs, steerers and SVD tolerance)
- Apply correction (with a given percentage)
- Set initial conditions



Orbit correction GUI

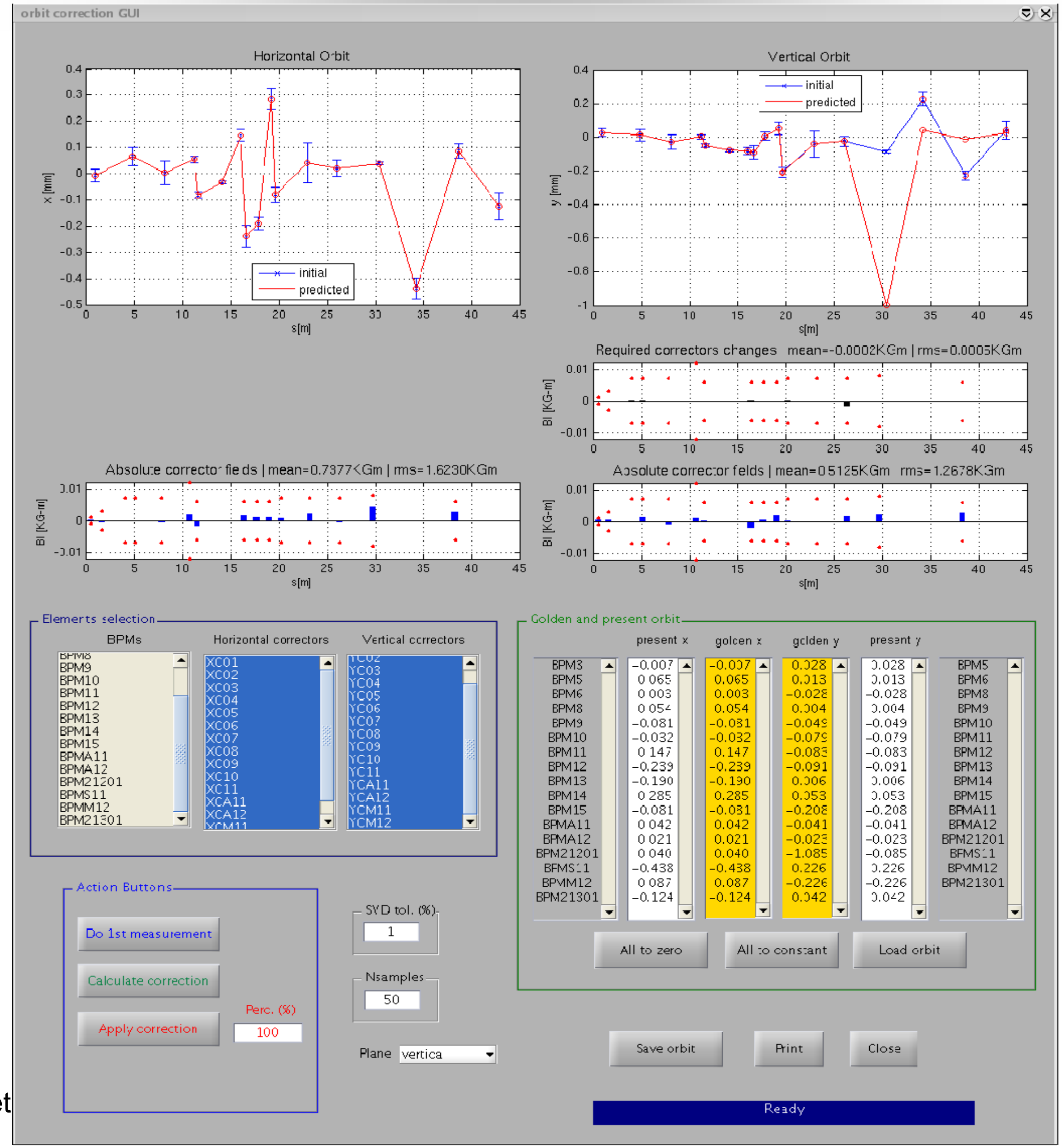
Output

- Plot of the orbit for the different iterations
- Plot of the present absolute corrector fields (with their limits)
- Plot of the required corrector fields for one correction iteration
- Current orbit

Other options

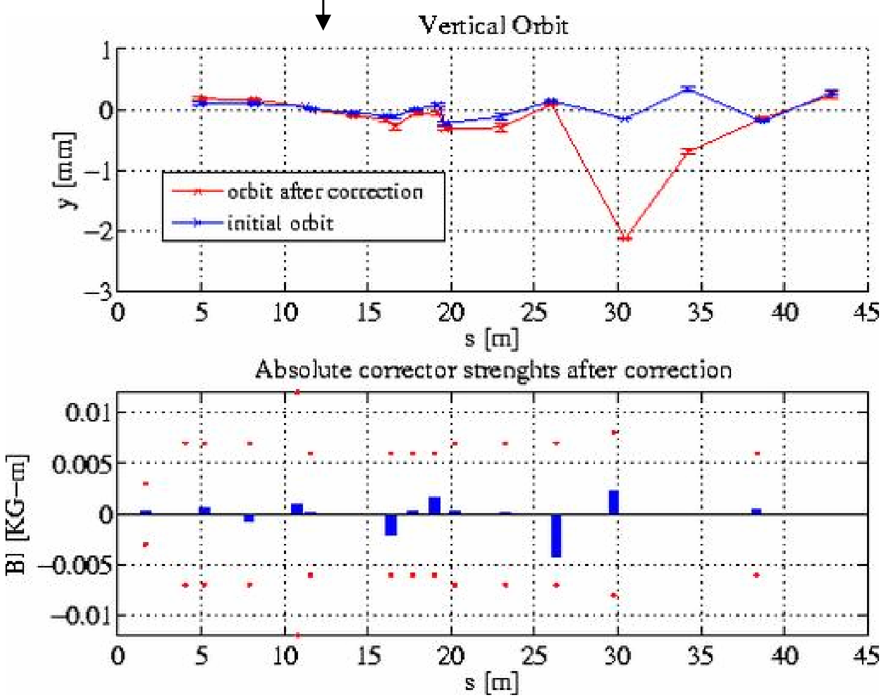
- Save orbit which can be loaded in the future as a golden orbit

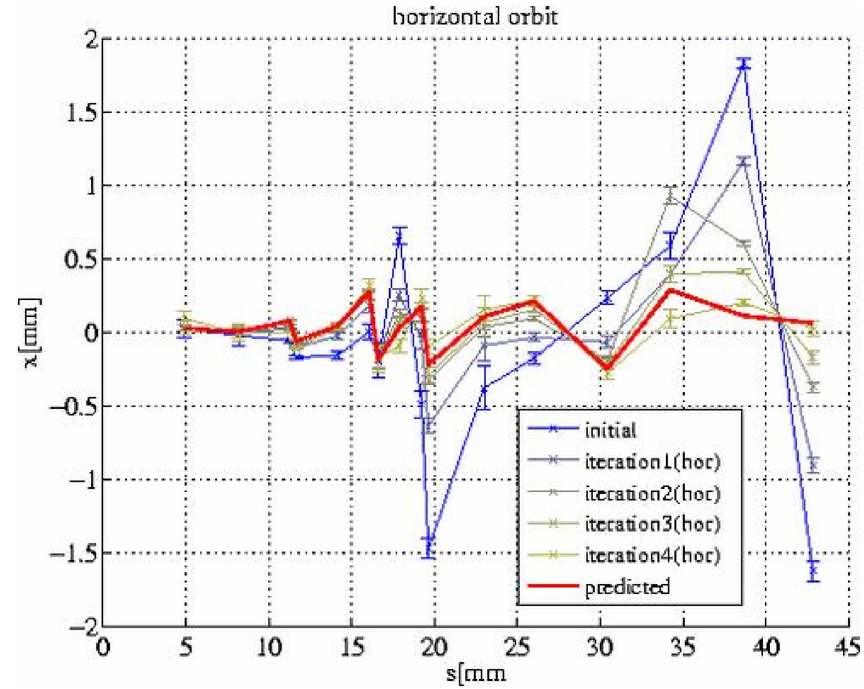
Orbit correction GUI



Orbit correction GUI – examples

2mm vertical bump at BPM21201
Correctors used: YCA12, YCM11 & YCM12





Orbit flattened at the horizontal plane at all BPMs using all correctors

Orbit response measurements GUI

What

It measures the orbit response for selected steerers.

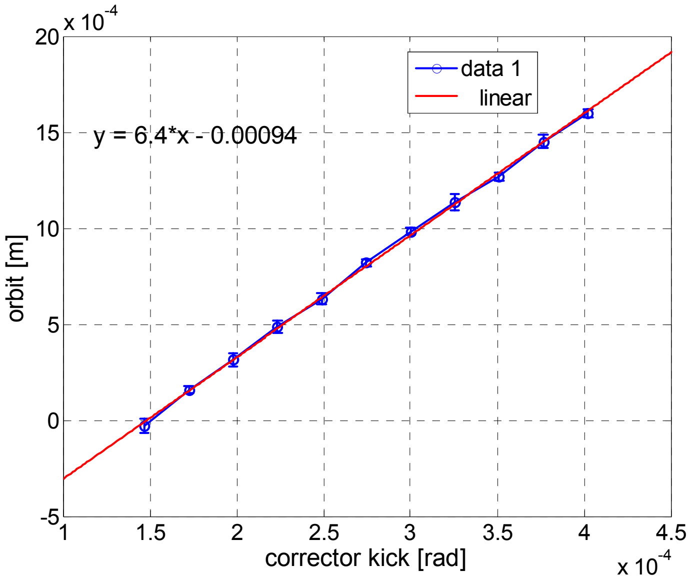
Why

Comparing the measurements with the model can be used to fix possible machine imperfections (BPM's , correctors, optics, energy,…)

The measured orbit response can be used to perform orbit correction or transverse feedbacks.

How

The measurement consists on analyzing the orbit change due to a corrector field variation.



Orbit response measurements GUI

Input (in brackets default values)

- Correctors that will be measured
- Maximum BPM difference allowed (1mm)
- Number of correctors settings (5)
- Number of samples per corrector setting (50)

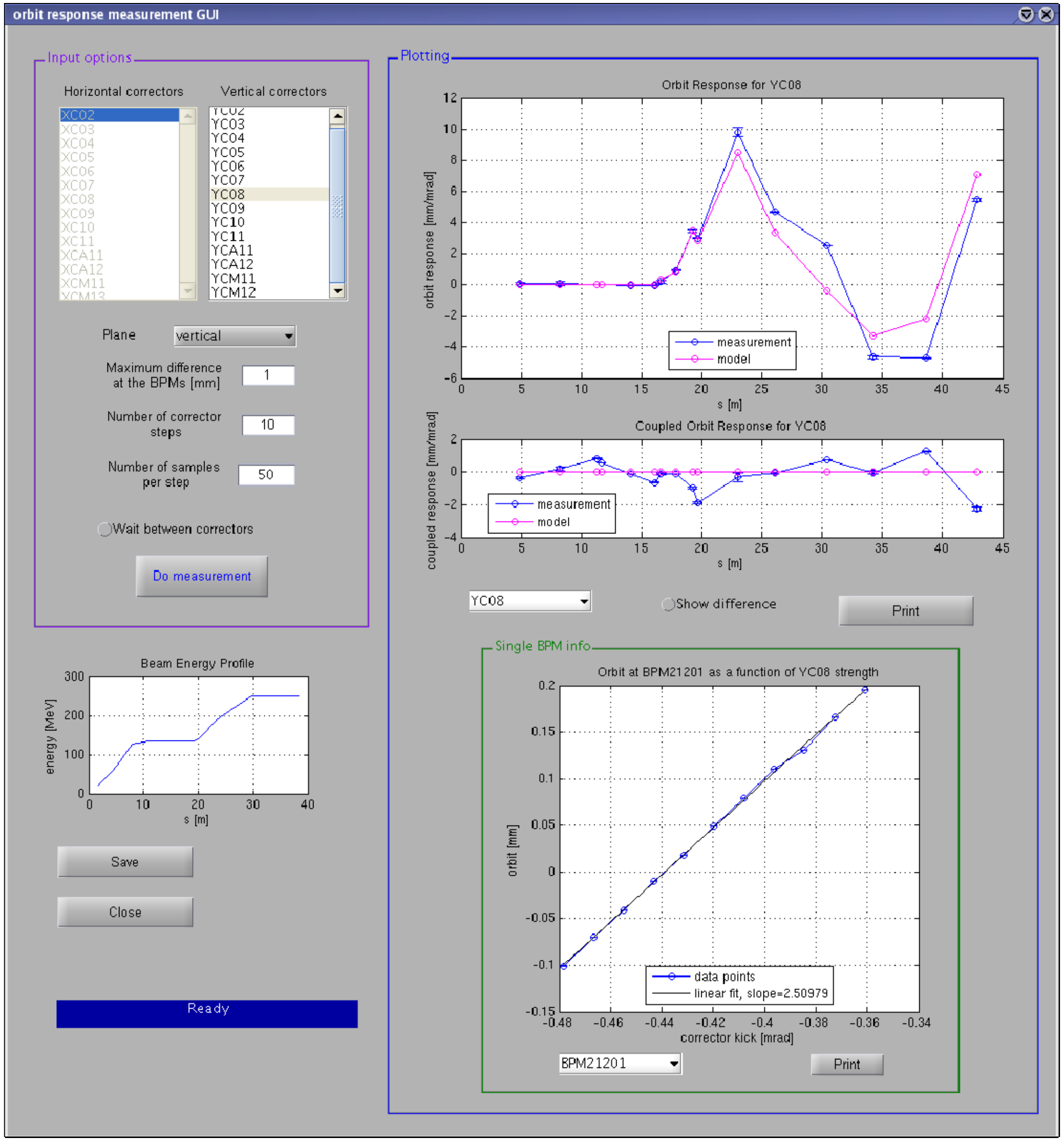
Output

- Plot of the orbit response (measured and from the model)
- Plot of the coupled orbit response
- Single BPM information
- Energy profile

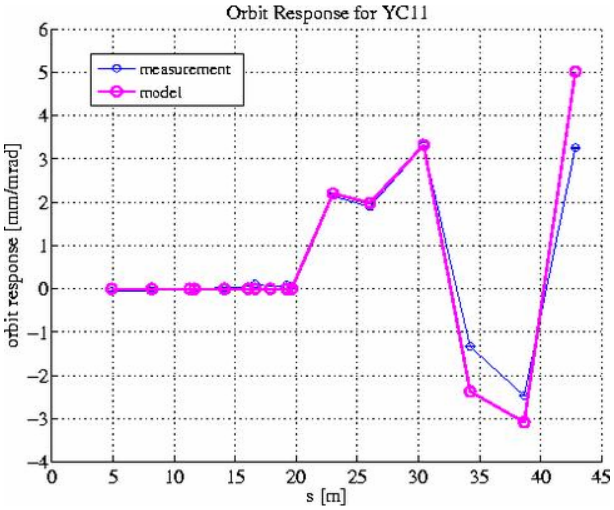
Other options

- Save
- Analysis to look for the "most likely errors" is missing

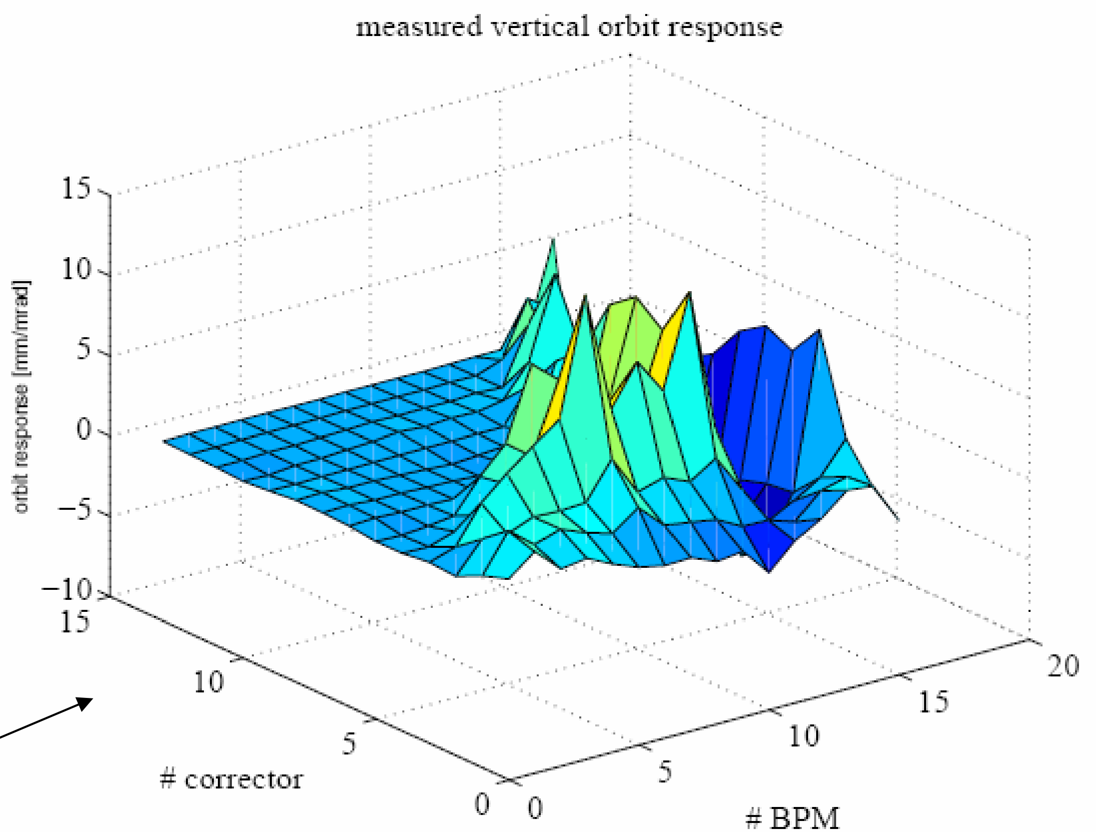
Orbit response measurements GUI



Orbit response measurements GUI – examples



Measurement for a single steerer (YC11)



Measurement for all vertical correctors

Quad misalignment GUI

What

It determines the misalignment of a quad respect to the beam.

It determines the BPM offsets (if the quad has a BPM).

How

Basic idea: a beam going off-axes through a quadrupole receives a dipole field proportional to the offset and to the gradient.

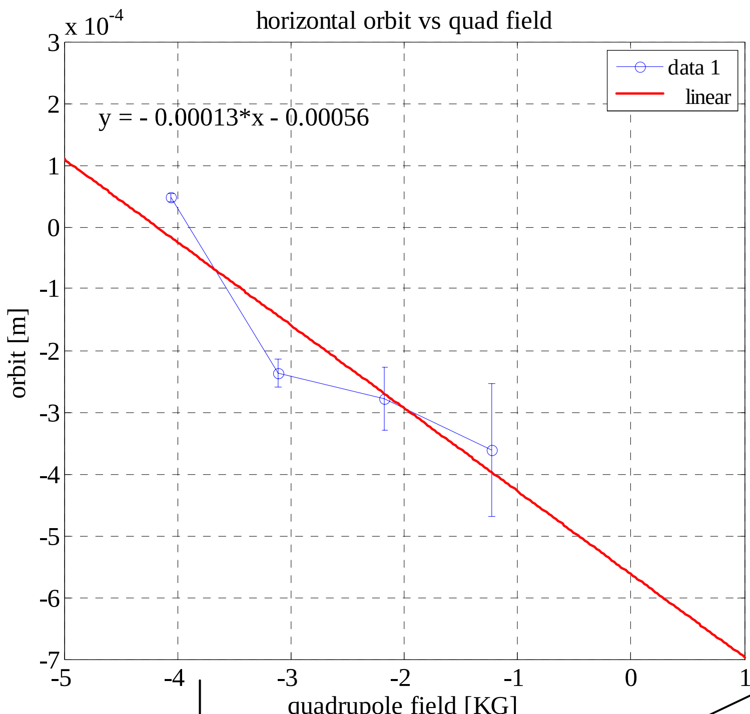
$Bx = g \cdot y_0$, $By = g \cdot x_0$;

The measurement consists on scanning the quadrupole field and analyze the orbit deflections downstream.

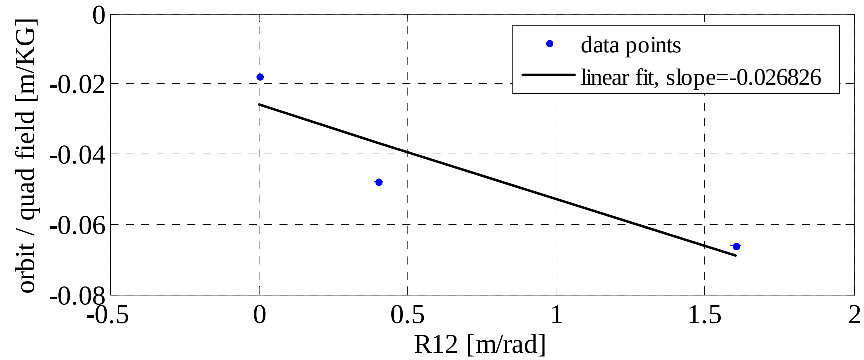
The measurement relies in having the right transport matrix from the quad up to where the orbit is read, right quadrupole strengths and right BPM scaling factors.

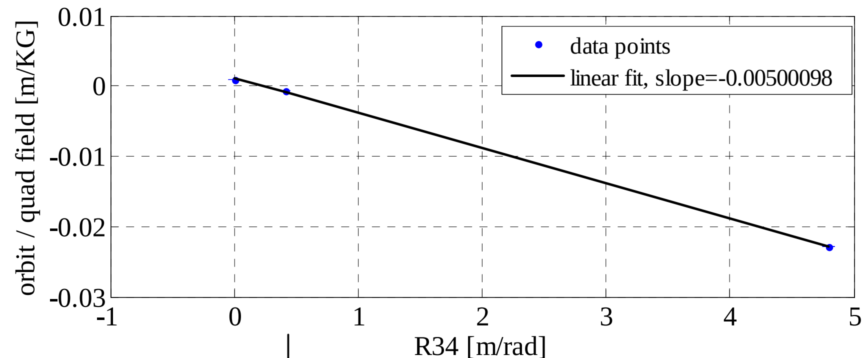
Quad misalignment GUI
Misalignment determination

For each BPM



orbit / gl





(orbit / gl) / R12 = (orbit / gl) / (orbit / kick) =

= kick / gl α misalignment / E

Quad misalignment GUI

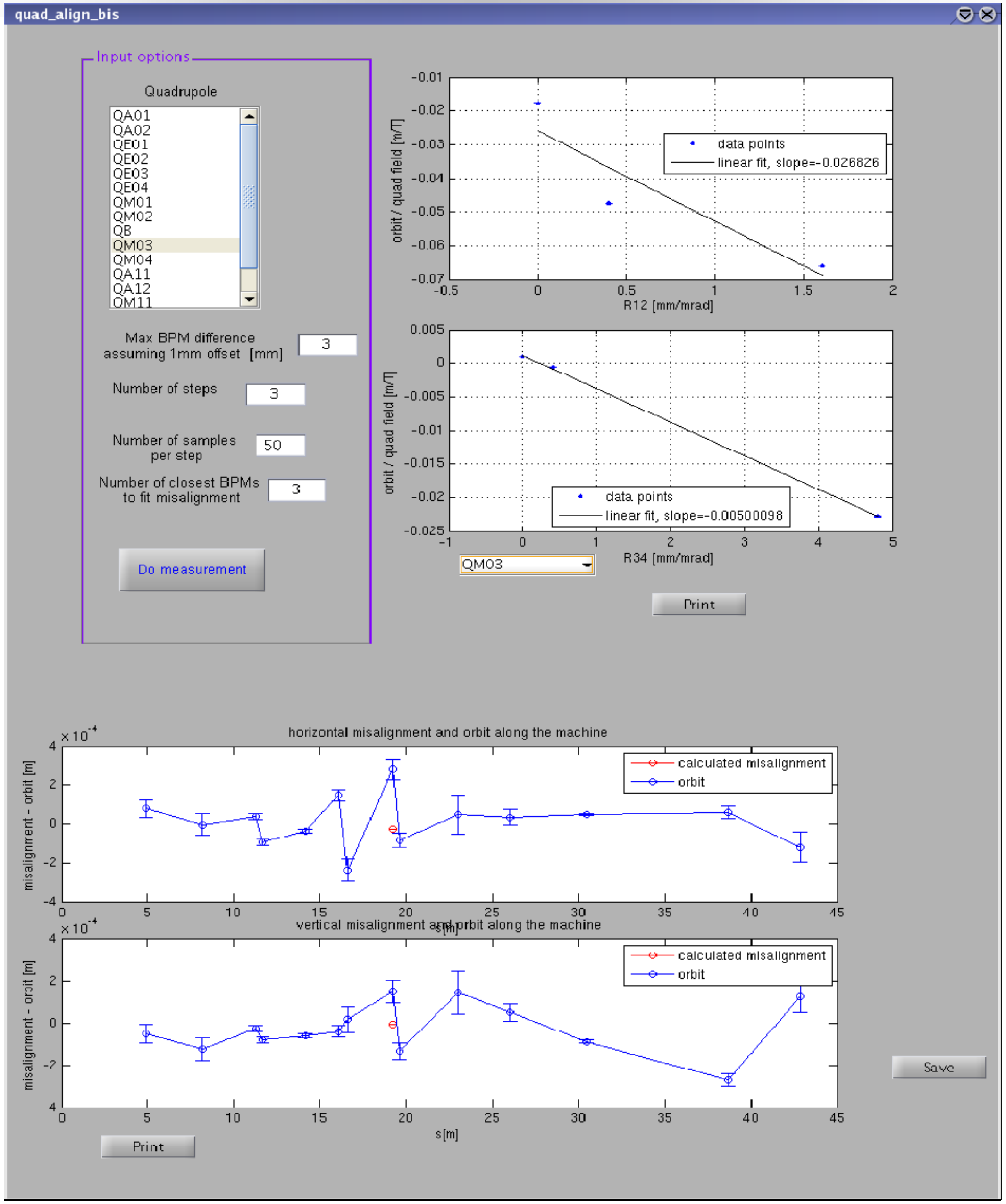
Input (default in brackets)

- Quadrupoles
- Maximum BPM difference assuming 1mm offset (3mm)
- Number of BPMs to use for fitting (3)
- Number of quadrupole settings (4)
- Number of BPM readings per quad setting (100)

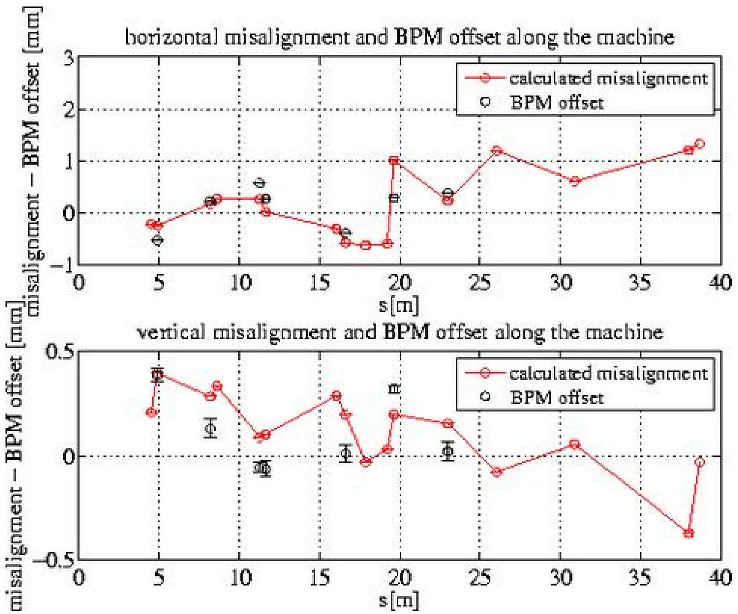
Output

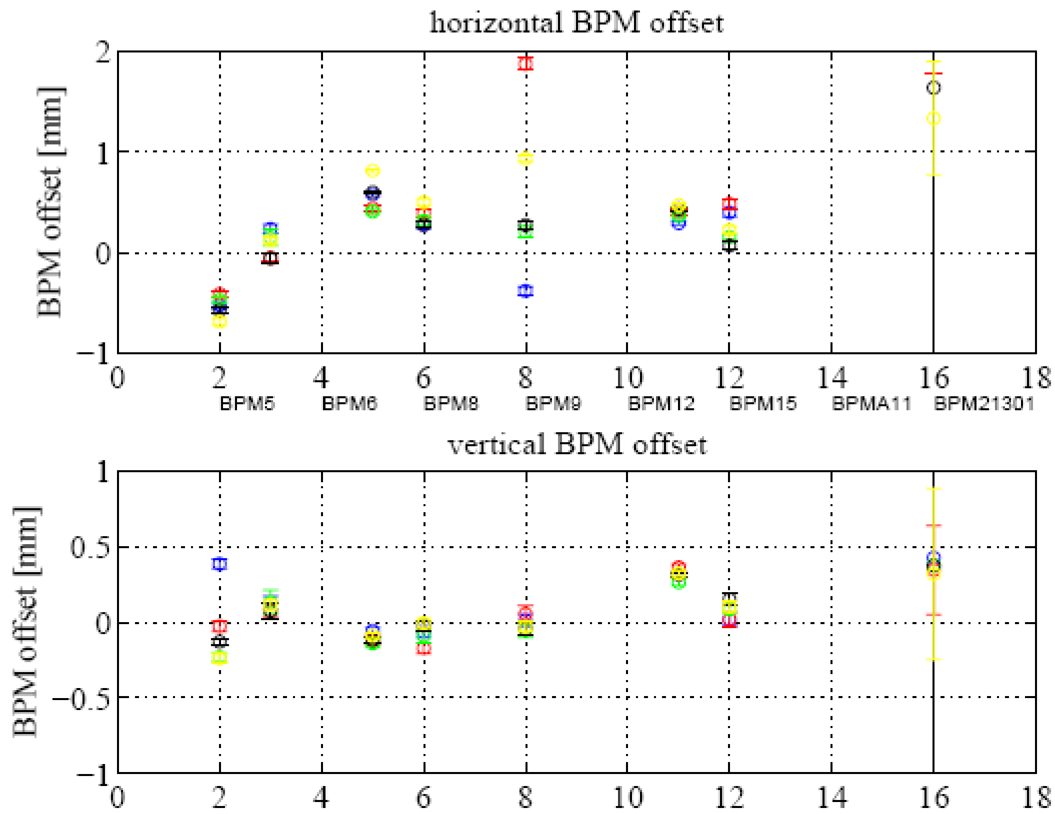
- Quadrupole misalignment and orbit along the machine
- Single quad information

Quad misalignment GUI



Quad misalignments and BPM offsets along the machine (1 measurement)





BPM offsets along the machine (5 different measurements)

Summary

3 tools have been developed and (more or less) tested:

- orbit correction
- orbit response measurements

  error analysis is missing
- quadrupole misalignment determination

Thanks a lot to all the LCLS team!