OPTICS CORRECTION AT KEKB

K. Oide

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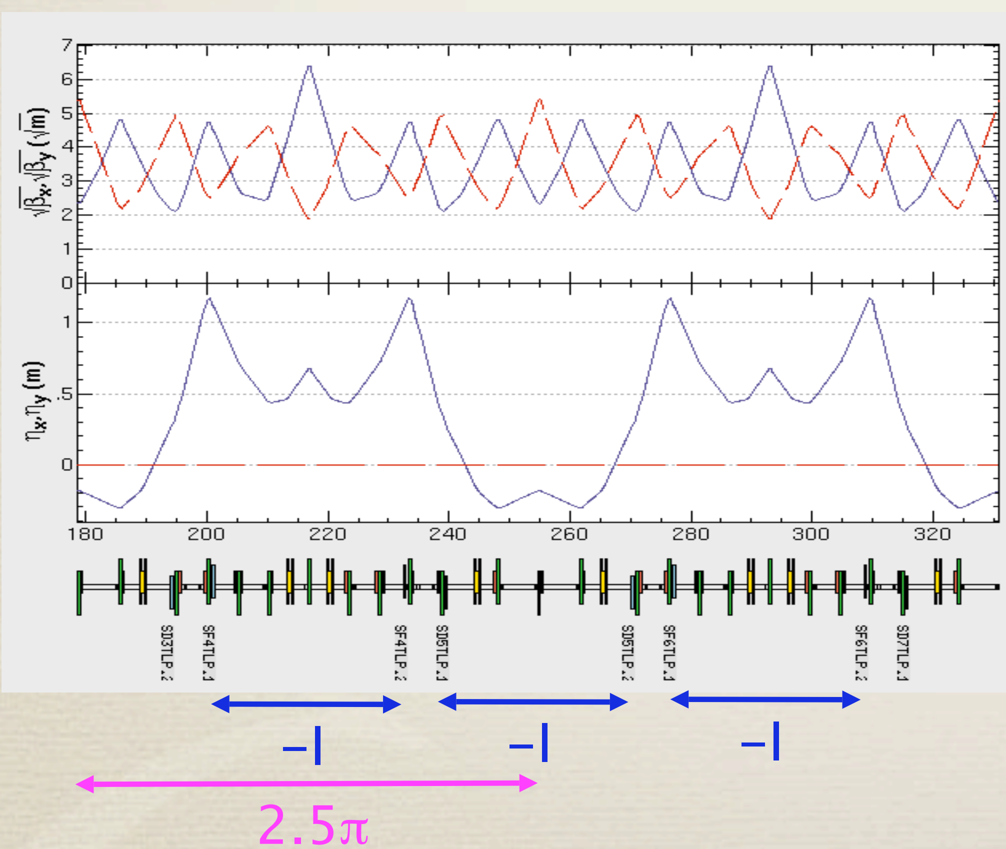
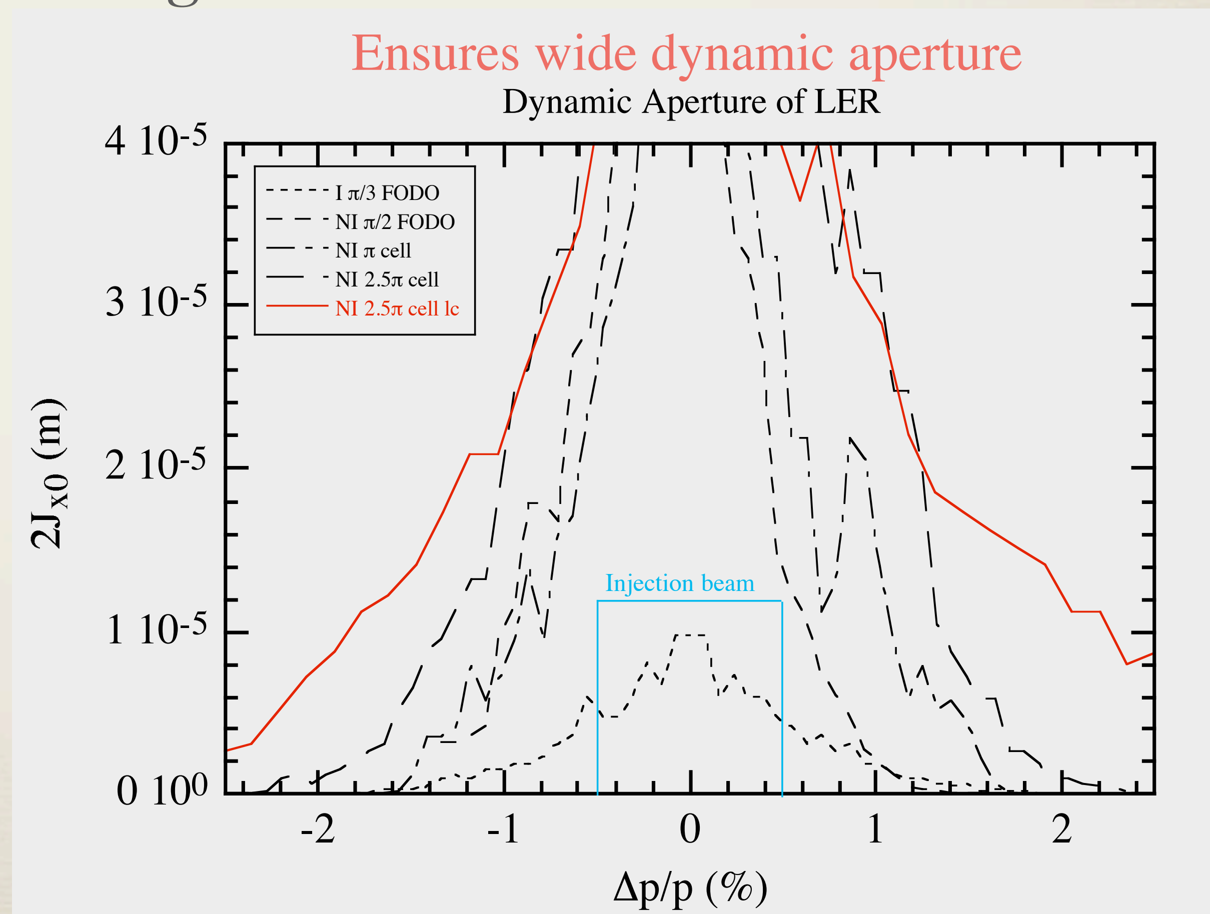
KEKB Optics

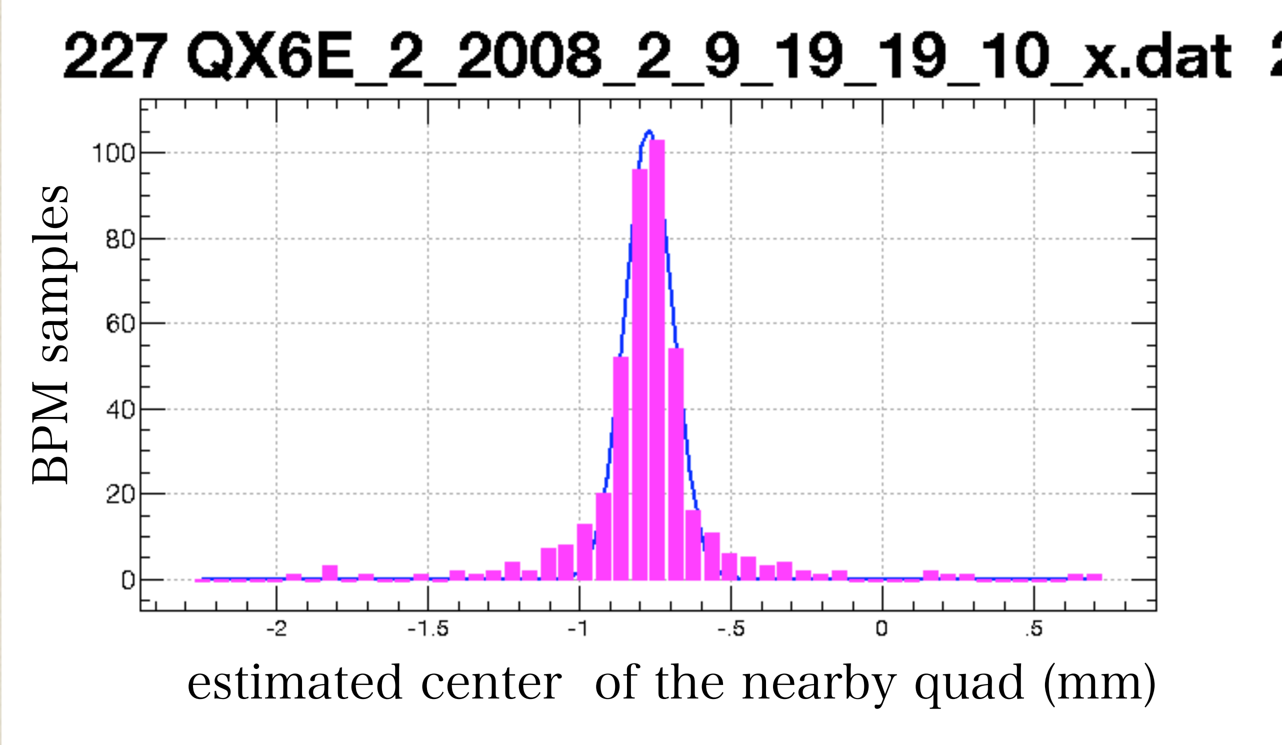
- 3.5 GeV + 8 GeV double ring collider with one collision point, 3016 m circumference.
- About 450 quads, 110 dipoles, 110 sextupoles per ring.
- 2.5 π unit cell, -I transformation between paired sextupoles.
- ν_x close to a half integer: 0.505(LER) & 0.511(HER) at collision.
- 450 BPMs per ring, about 30 per ring are TBT BPMs.

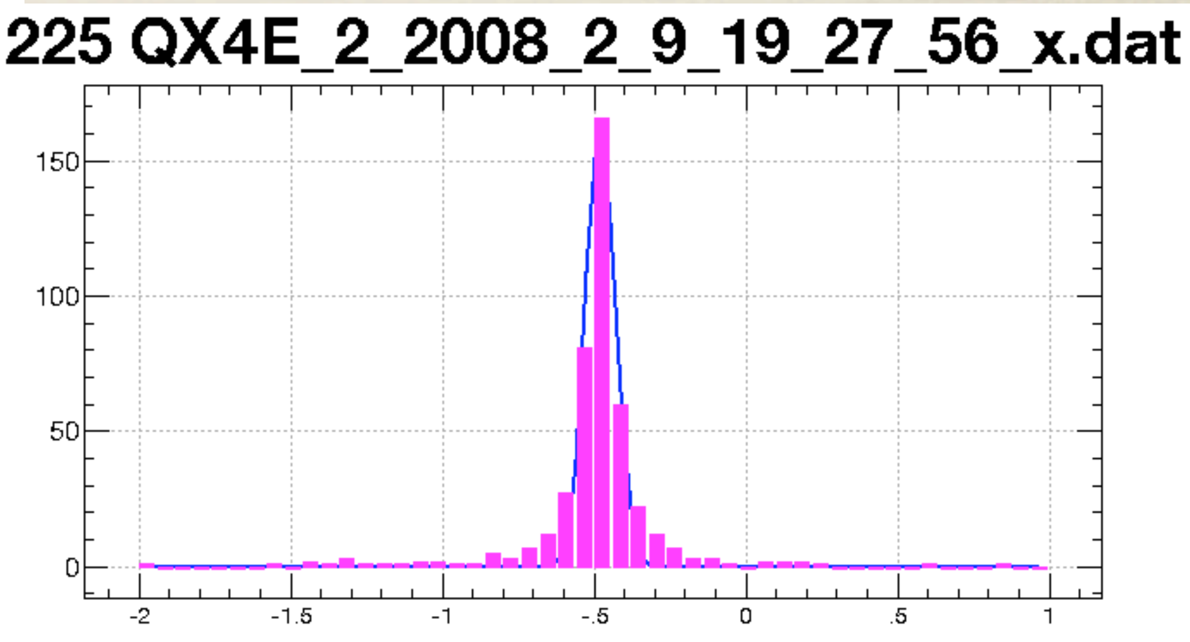




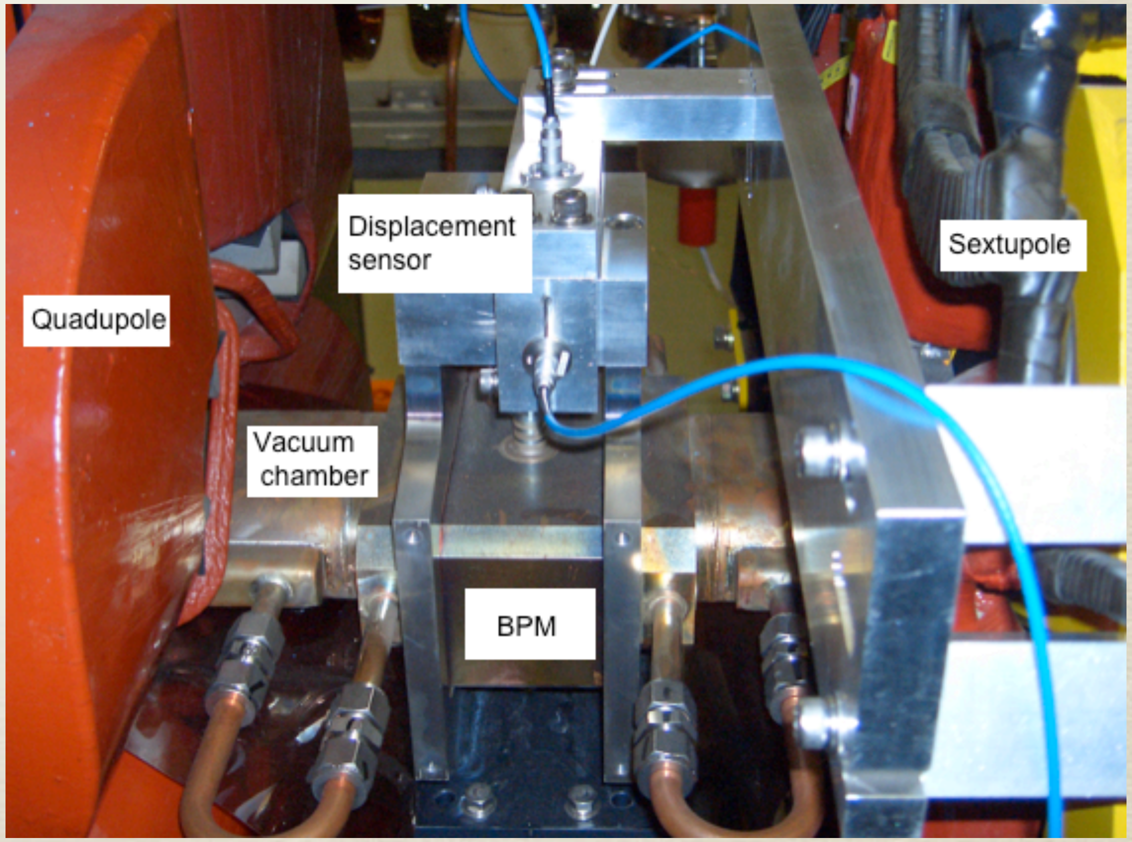
Beam based diagnostics for BPMs (1)

- Beam-based alignment: Quad-BPM





- Once a year, or anything happened to a BPM such as reconnection of cables, realignment, etc.
- BPMs near sextupoles have capacitive sensors to measure relative transverse position of BPMs to sextupoles.



Beam based diagnostics for BPMs (2)

* Gain mapping of BPM **electrodes**

CALIBRATION OF KEKB BEAM POSITION MONITORS

PAC97

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Abstract

This paper first proposes a practical model for output signals of BPM electrodes. The model is based on a definition of the geometric center of a BPM head, and on the assumption that the character of the head can be specified only by a small number of parameters, the relative gains of electrodes. On the basis of the model, calibration was done to find the relative gains of all KEKB LER BPM heads. The paper reports and discusses the calibration results.

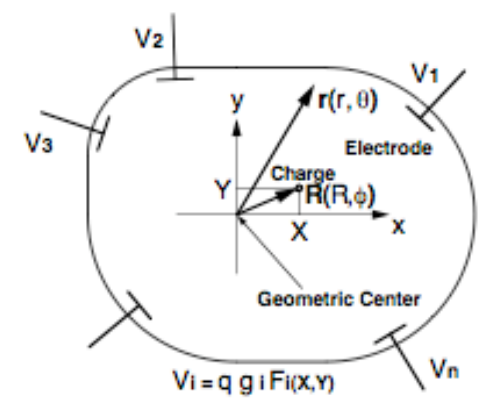
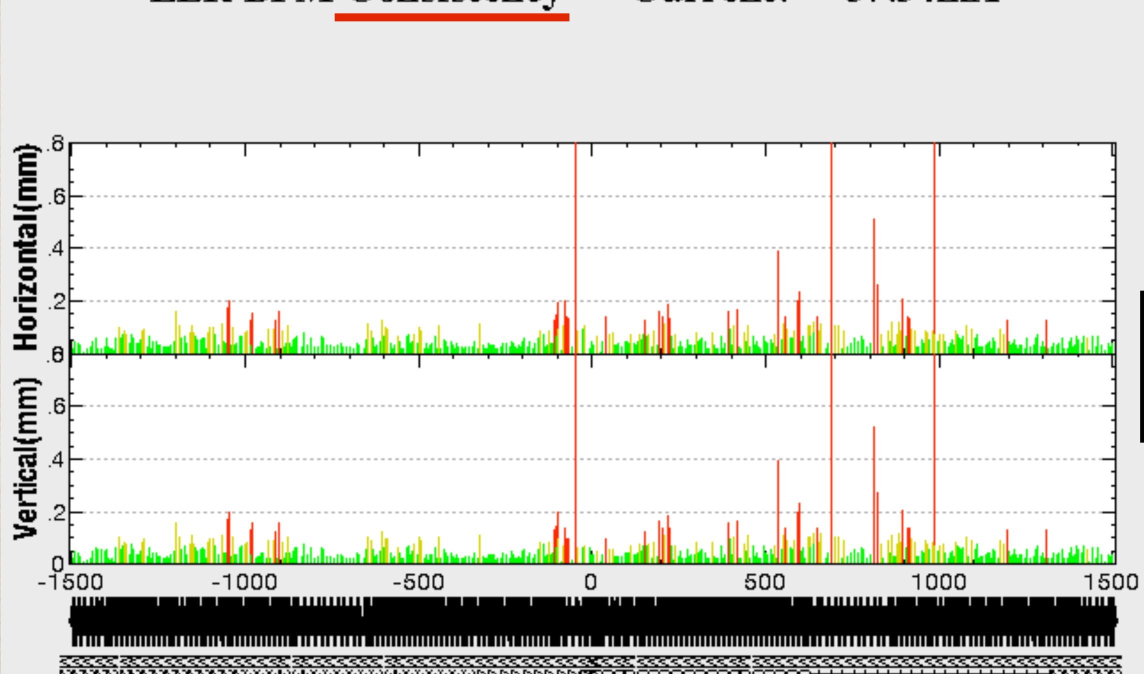
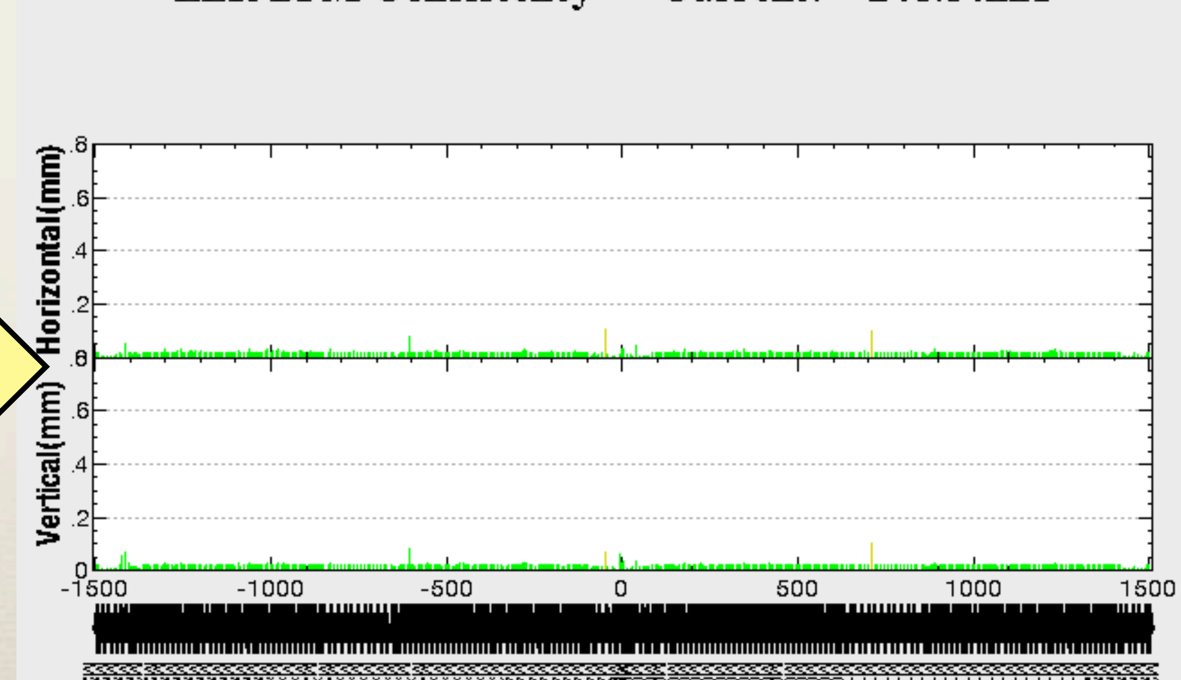


Figure 1: Coordinate system and an image of the model monitor.

1 INTRODUCTION

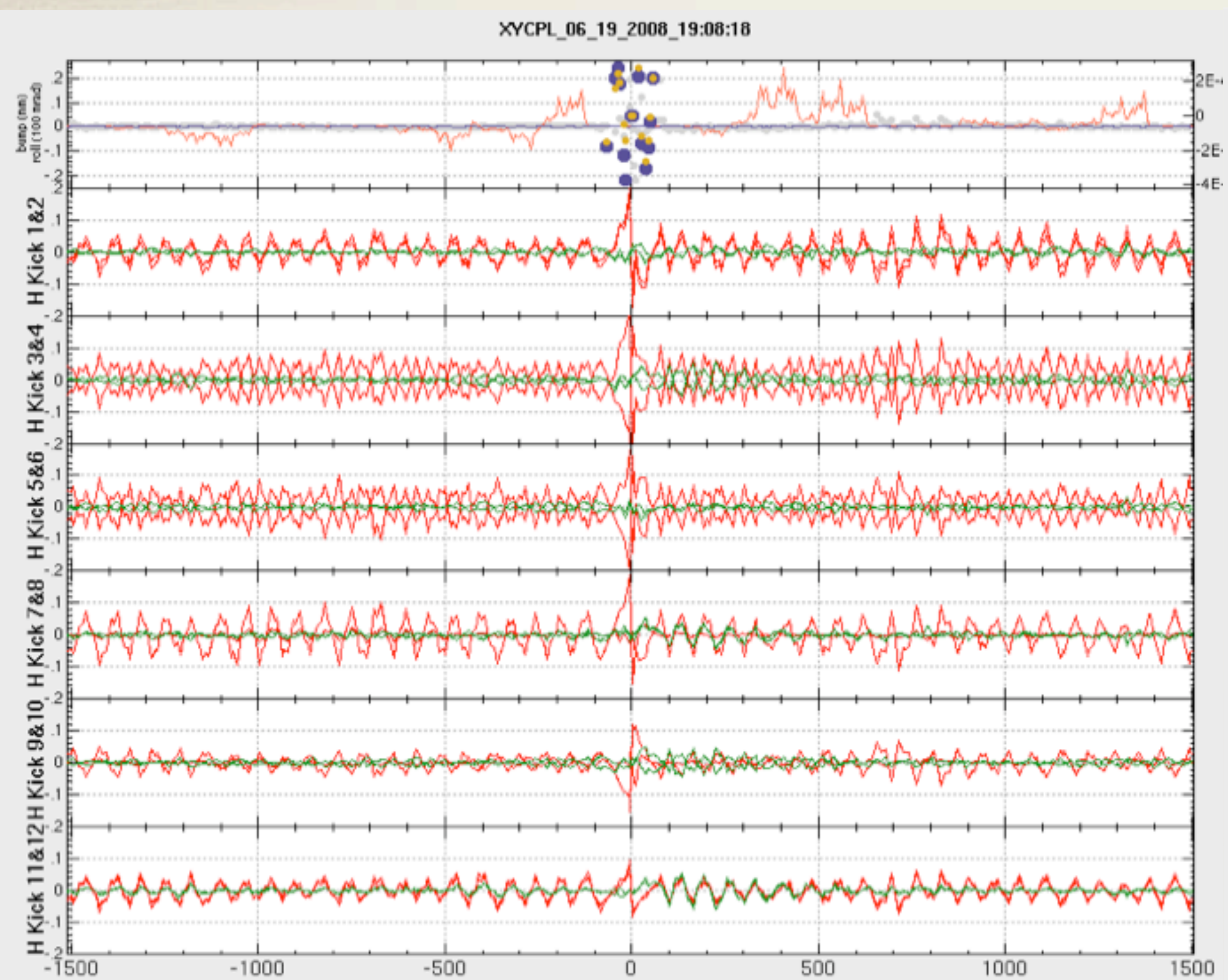


Gain Mapping

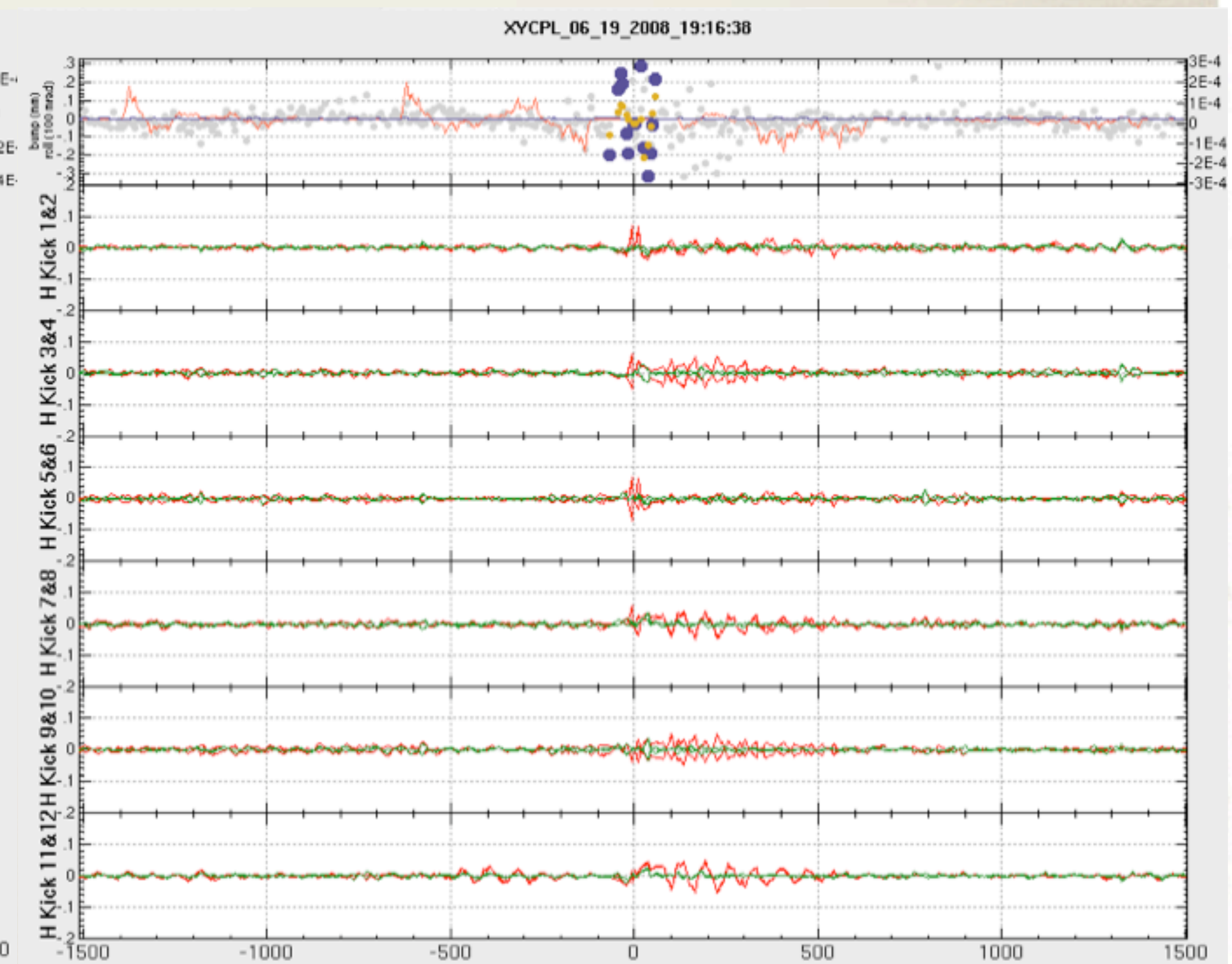


X-y coupling correction

- Kick the beam by horizontal dc correctors at non-coupled, non-dispersive places.
- Measure leaked closed orbit in the vertical plane.
- Correct the leak by **vertical symmetric bumps at sextupole pairs** and skew quads around the IP.
- Only 12 correctors, with equally separated phases, are used.



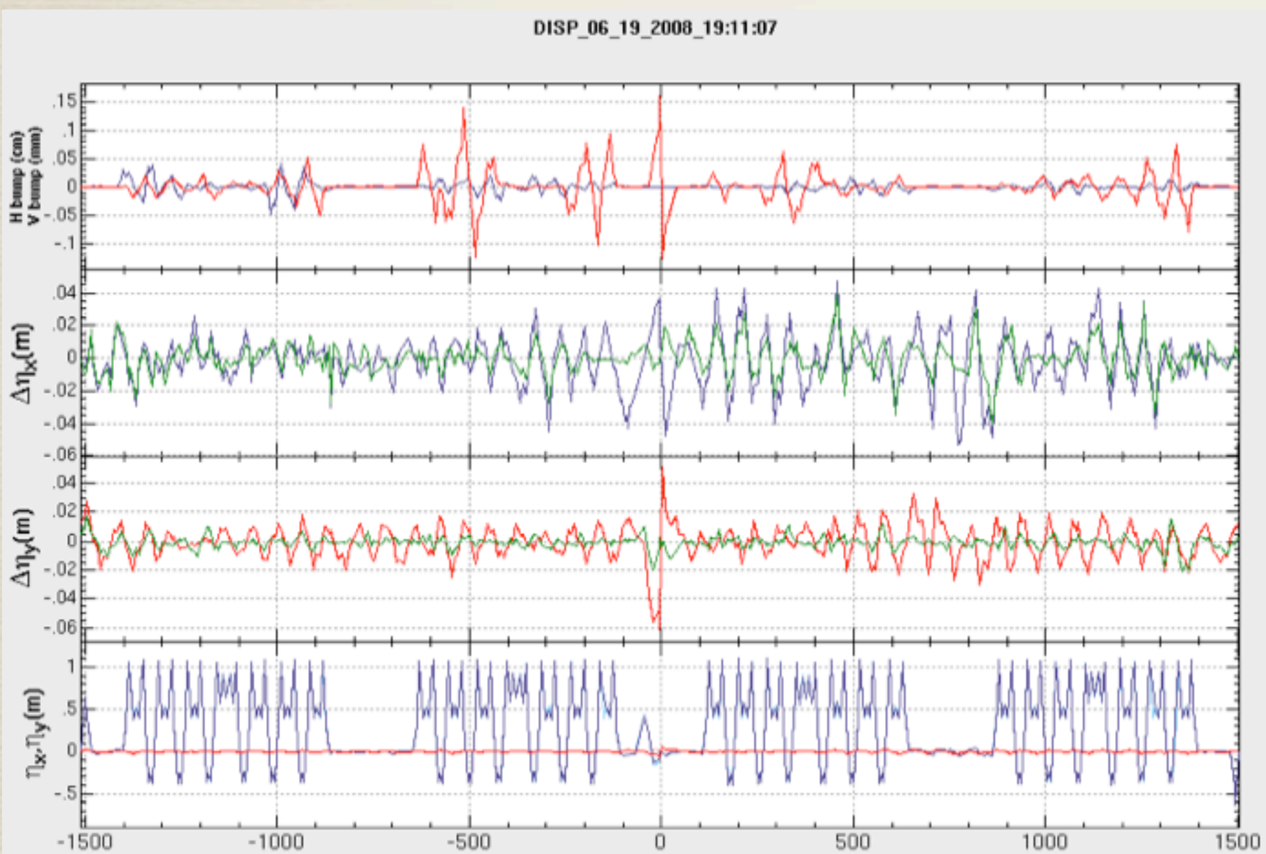
before



after 1 correction

Dispersion correction

* Change rf frequency by ±100 Hz, measure the orbit change in x and y.
* Correct the difference from the model by horizontal & **vertical antisymmetric bumps at sextupole pairs.**
* Residuals: $\Delta\eta_{x,\text{rms.}} \approx 10\ \text{mm}, \quad \Delta\eta_{y,\text{rms.}} \approx 8\ \text{mm}$

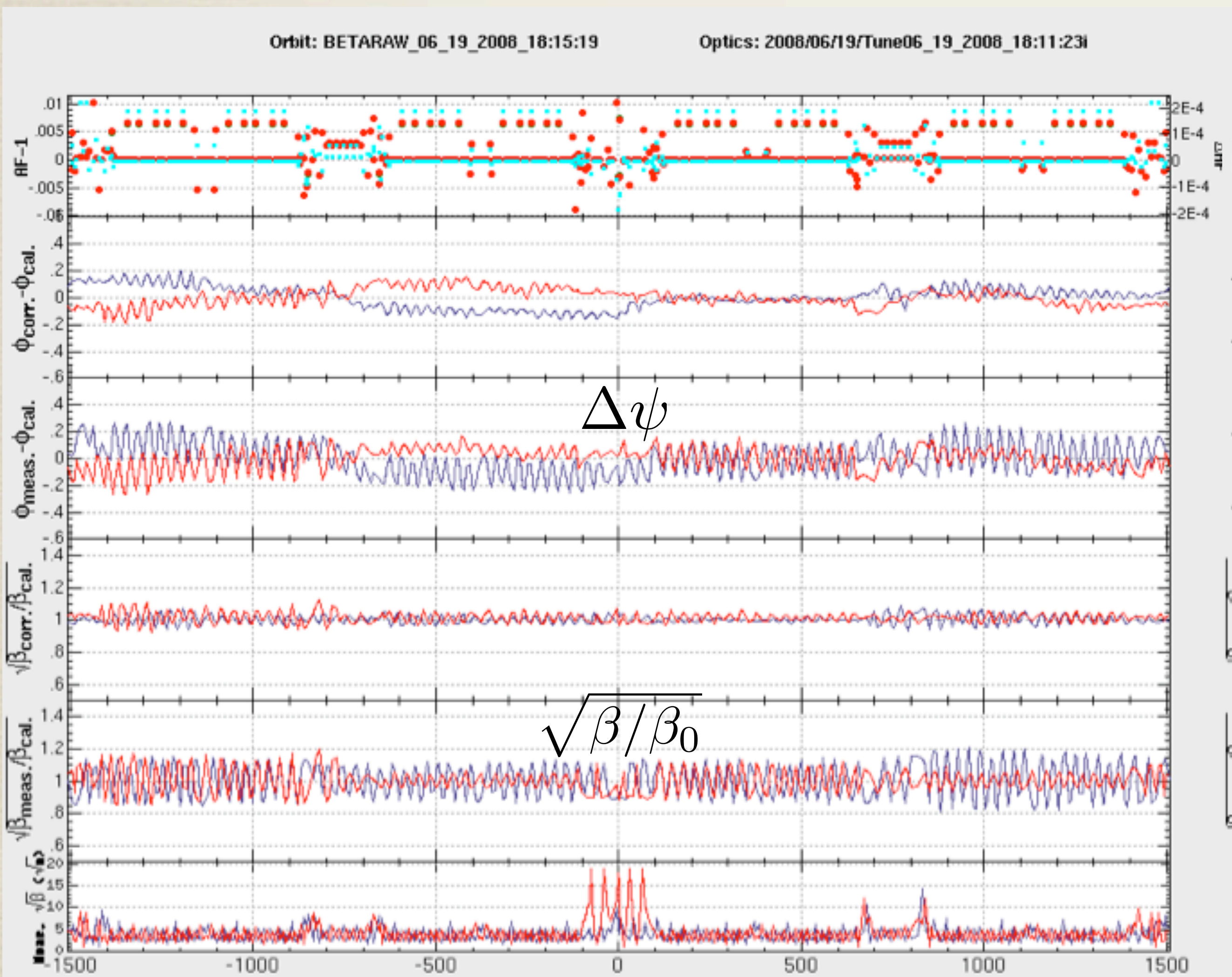


Before correction

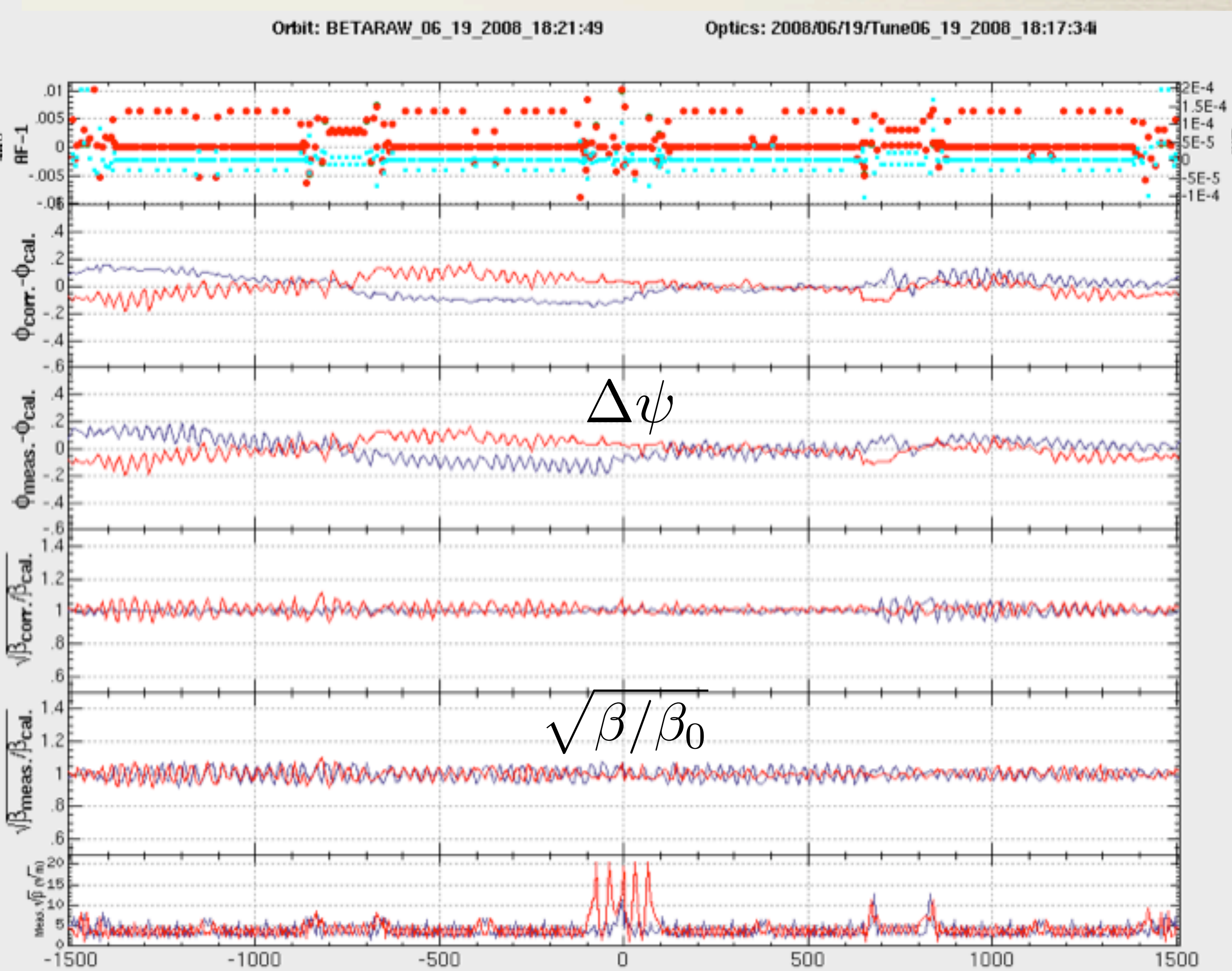
After 1 dispersion and 1 coupling correction applied alternatively.
Note that the vertical scale becomes less than half.

β correction

- Kick the beam by dc correctors in x and y, measure the orbit response in each plane.
- Fit the response with βs and phases at each BPM and the kicked correctors, assuming x-y coupling to have been already corrected. 6 correctors per plane.
- Correct the difference from the model by fudge factors of quads.
- Residuals: $(\Delta\beta/\beta_0)_{x,y\ \mathrm{rms}} \approx 6\%$



Before correction

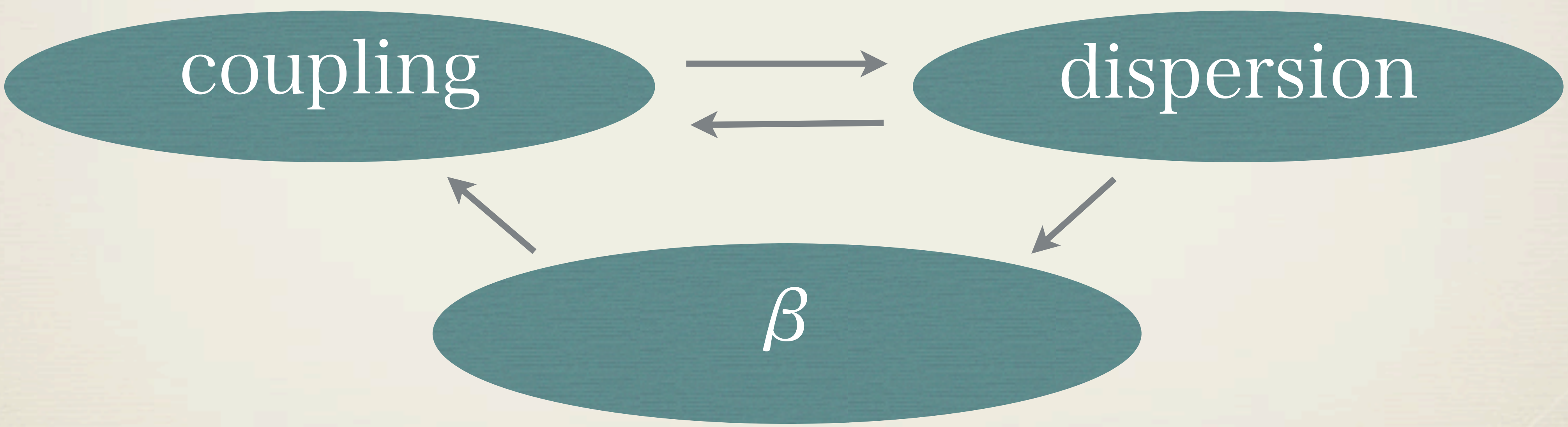


After 1 corrrection.

Iteration

2008_06_19_19_06_29fop	Fill-Length Optimization
2008_06_19_19_06_32luh	Beam Collision Panel
2008_06_19_19_09_12XY_Coupling	MeasOptHER
2008_06_19_19_12_59Dispersion	MeasOptHER
2008_06_19_19_18_27XY_Coupling	MeasOptHER
2008_06_19_19_21_34Dispersion	MeasOptHER
2008_06_19_19_22_29Dispersion	MeasOptHER
2008_06_19_19_23_29Dispersion	MeasOptHER
2008_06_19_19_31_36Global_Beta	MeasOptHER
2008_06_19_19_38_29Global_Beta	MeasOptHER
2008_06_19_20_16_46_amsad8	amsad8 screen capture
2008_06_19_20_34_16_amsad8	amsad8 screen capture

* A loop of coupling, dispersion, β corrections takes **30-60 minutes** per ring to converge. (1 correction takes 3.5 to 7 minutes)



* We do not have to solve the entire problem at once by a single big matrix.
* Although these corrections are not independent, their cross-talks are smaller than the diagonal parts, so the iteration converges quickly.

Issues

* Although $\varepsilon_y/\varepsilon_x \approx 0.5\%$ is achieved by the correction....
* High current optics can be deformed due to focusing by the image current, electron cloud, thermal expansion, etc. Even hard to measure them.
* Off-momentum optics.
* Arc-to-arc energy deviation due to radiation and rf.
* No direct measurement at the IP. No information relative to the other beam.
* Slow drifts in 2 weeks.