Recent optics measurements at SLS

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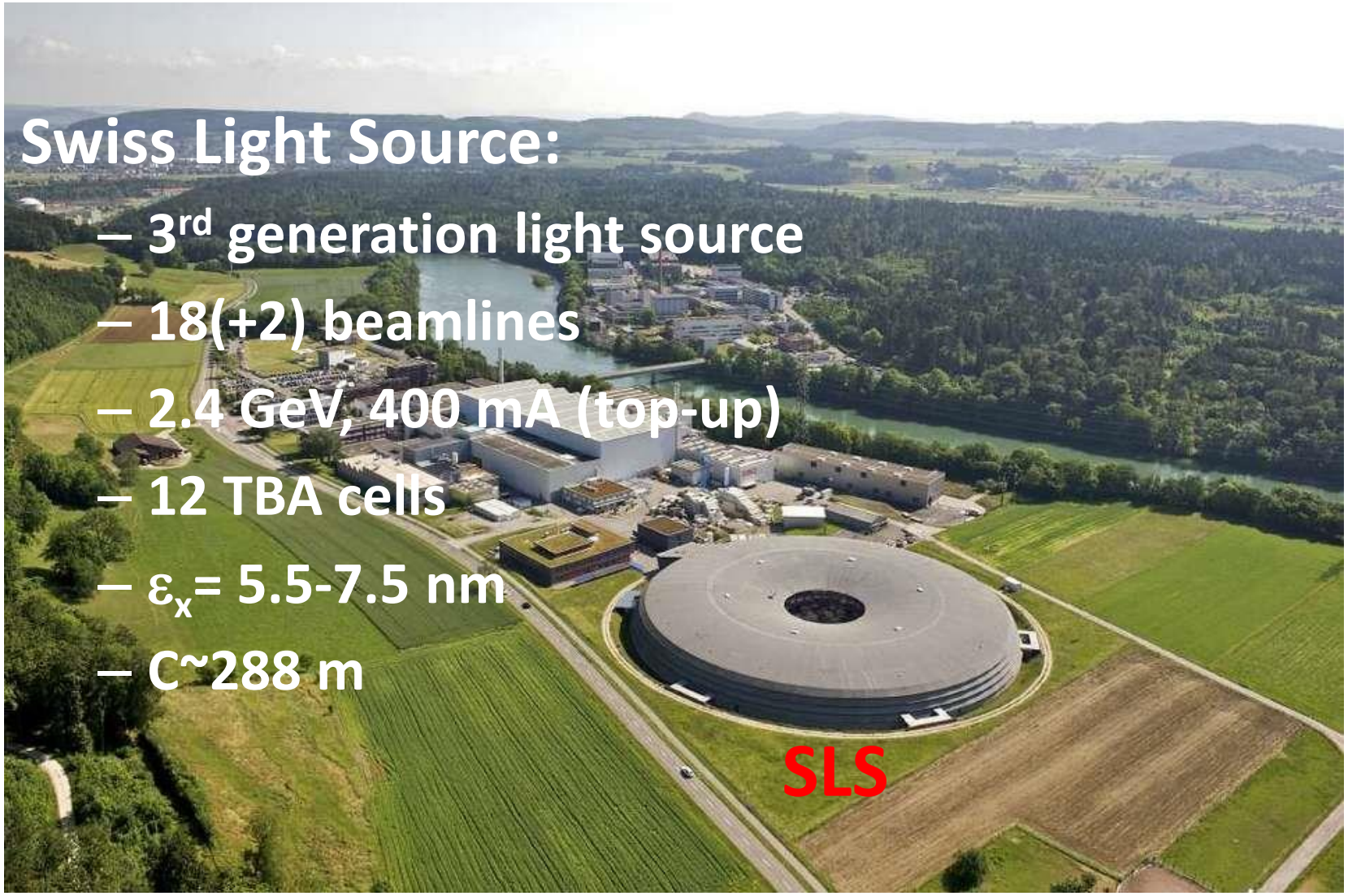
Contents

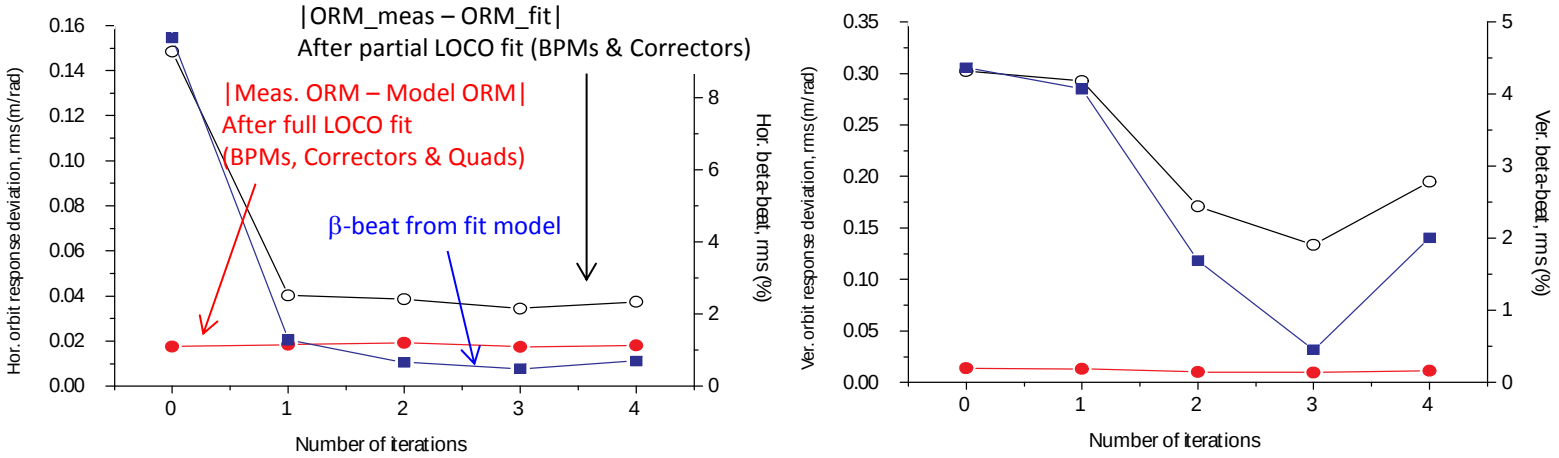
- SLS
- “Local” LOCO
- Emittance monitor status
- Energy spread measurement using TBT data
- Summary

Swiss Light Source



“Local” LOCO (1)

- Motivation
  - LOCO* optics correction did not converge for β_V-beat<~2% at SLS**



ORM difference after BPM&corrector fit/calibration (black plots)

- Should be comparable to the measurement noise level (0.01 m/rad) after iteration
- Should fluctuate within the measurement noise level after a couple of iterations
- Should be close to ORM difference with full LOCO fit (red plot)

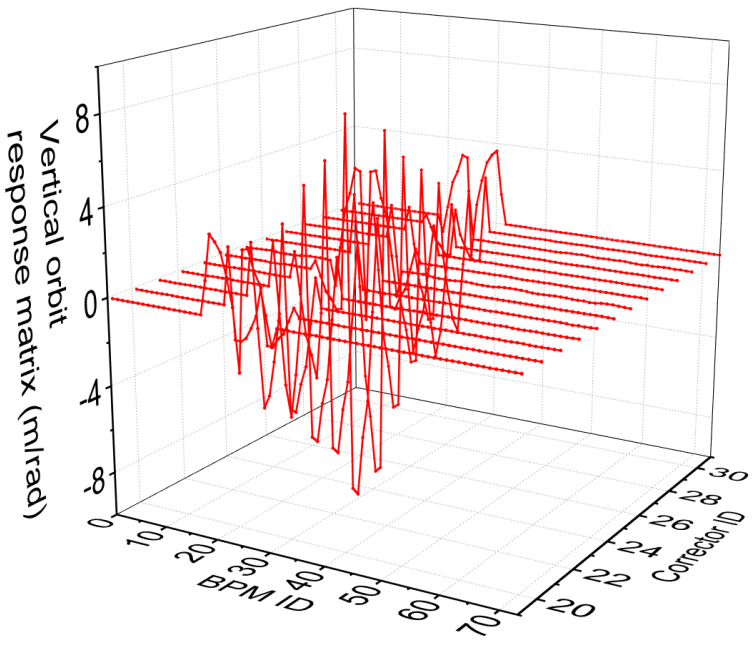
There is something wrong especially in the vertical plane…?
Method to probe the ring optics “locally” may give a better insight.

* J. Safranek, NIM-A, 388, p.27 (1997)
** M. Aiba et al., PRST-AB, 16, 012806 (2013)

“Local” LOCO (2)

- Local orbit response matrix measurement
  - Keep orbit feedback running except for the section under measurement
  - Measure orbit response as in LOCO for the correctors in the measurement section
  - Statistical measurement error ~0.02 m/rad in the vertical plane (cf. full ORM ~0.01 m/rad)
  - Larger error in the horizontal (dispersive) plane, not fully understood

Local orbit response matrix example
(V correctors #19-#31 out of #1-#73)



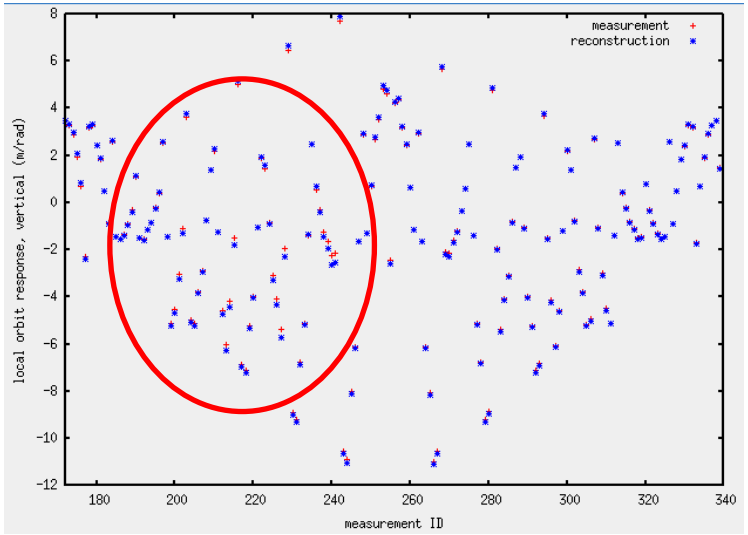
- Local response matrix measurement is established
- Quadrupole errors outside the measurement section are transparent

“Local” LOCO (3)

- First results (using only vertical data):

	Sect.2-3	Sect.3-4	Sect.4-5	Sect.6-7
RMS residual before/after LOCO fit |ORM_meas - ORM_fit| (m/rad)	0.0207/0.0099	0.0312/0.0267	0.0494/0.0439	0.0264/0.0145
Average quad change, <|dK|> (m^-2)	0.0020	0.0066	0.0071	0.0044

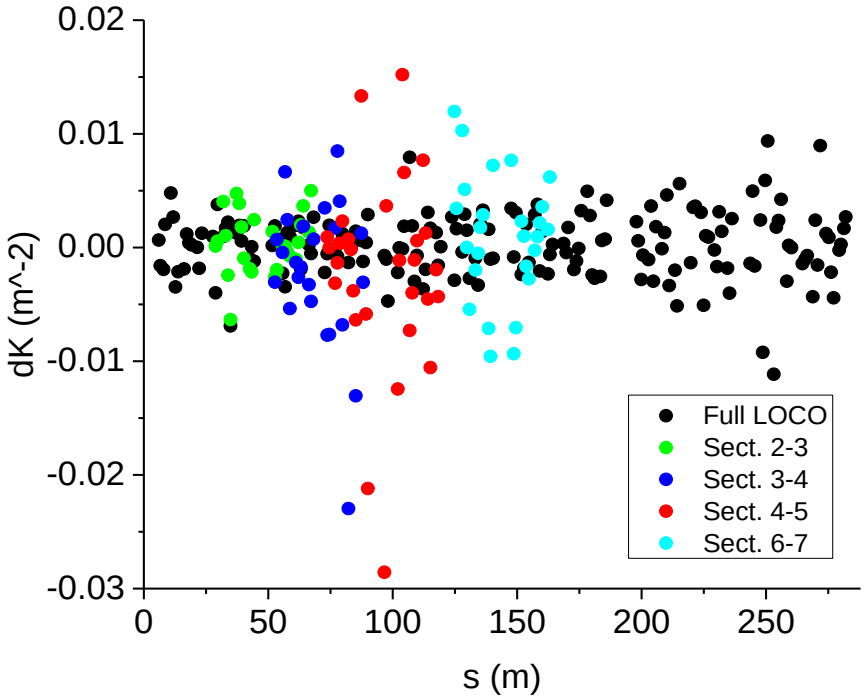
Sect. 4-5, ORM meas. vs ORM fit model (unsuccessful case)



“Local” LOCO (4)

- Comparison – LOCO and Local LOCO

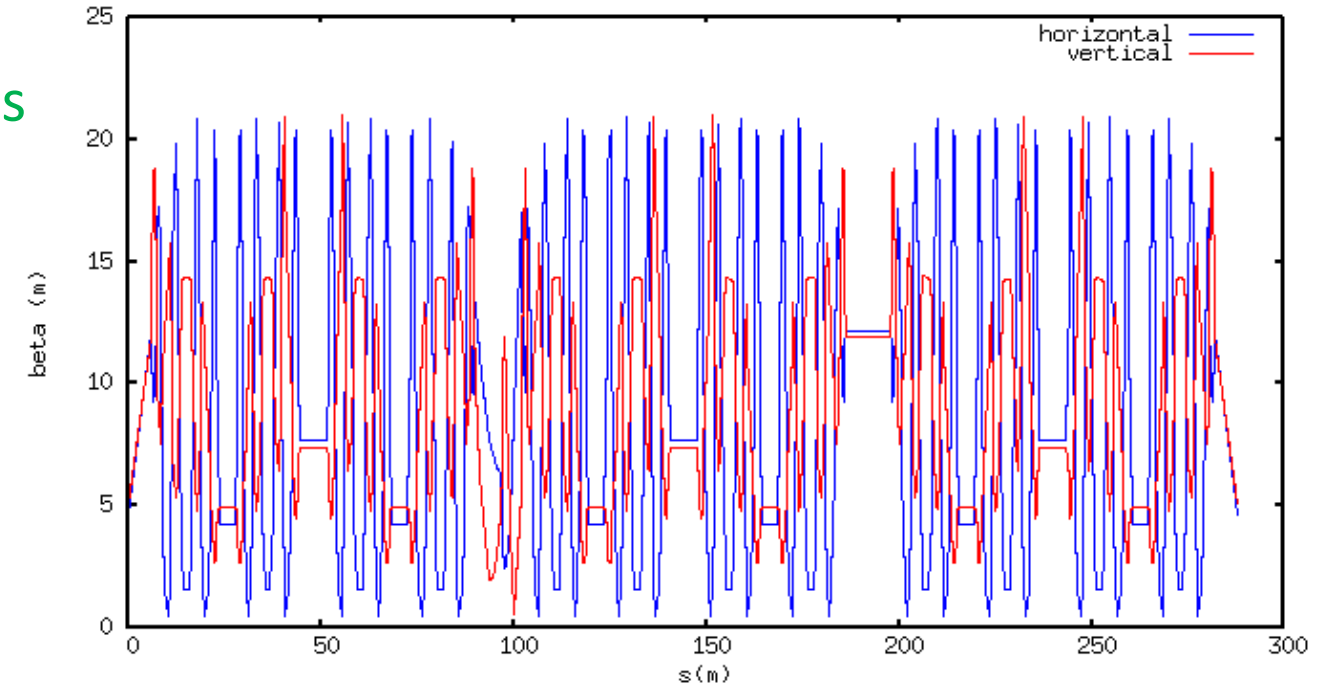
Quad corrections from fit



It seems that there is something wrong around Sector 4-5!

“Local” LOCO (5)

SLS optics

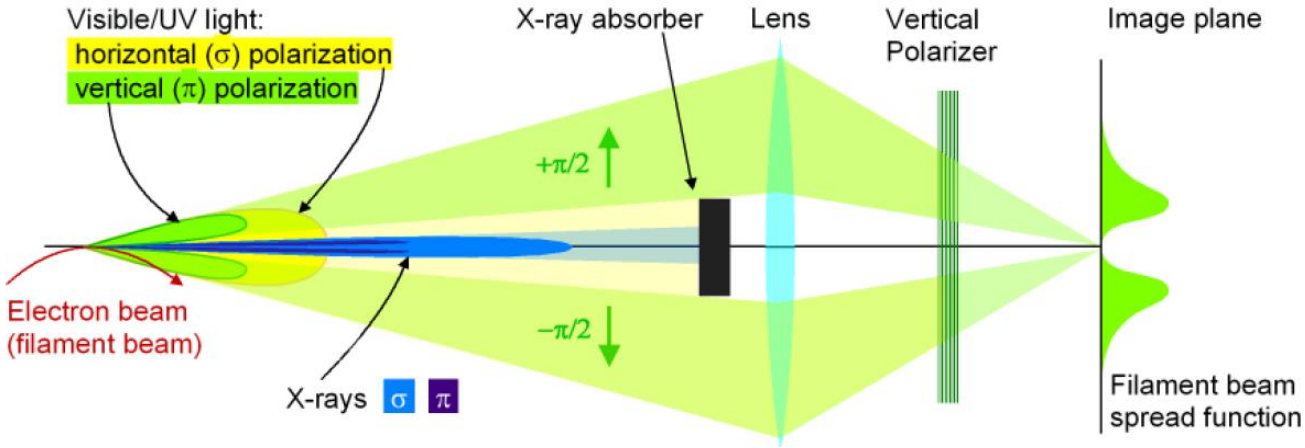


Straight section 5 accommodates Femto beamline…

- With wiggler, chicane, additional quads…
- With additional π phase advance and irregular optics

Emittance monitor status (1)

- Vertical emittance monitors at SLS
  - Synchrotron radiation -> Vertical beam size -> ε_y
  - Monitor #1* used for achieving ε_y =0.9 pm** (σ_y ~3.6 μm) reaching the resolution limit

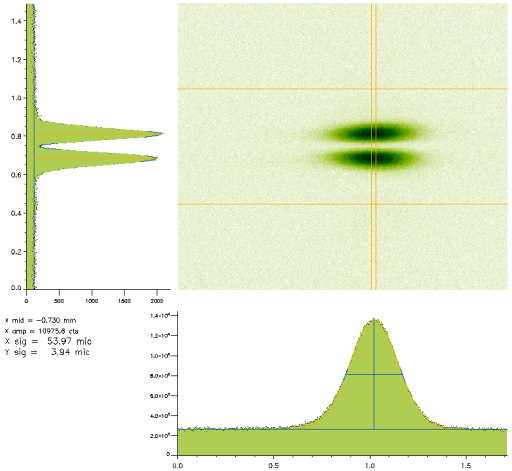


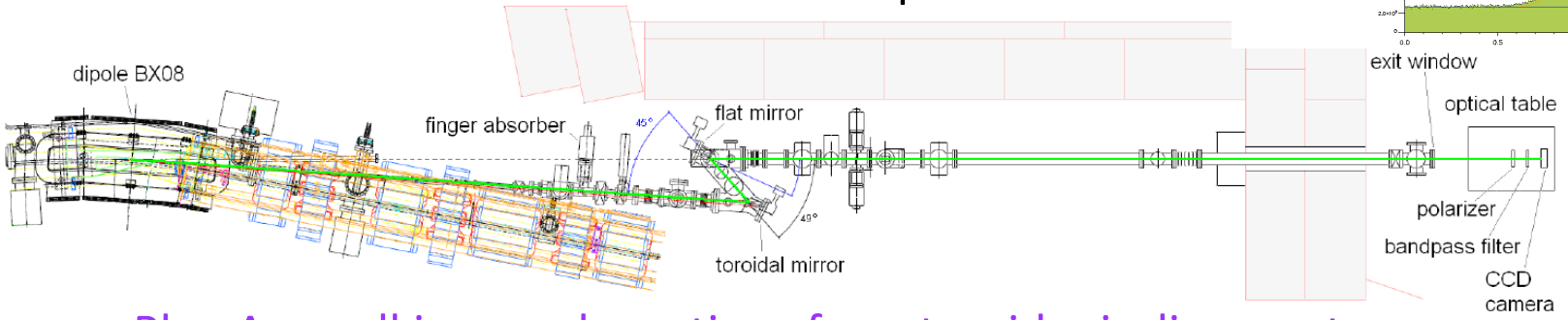
Hill-Valley ratio
→ Beam size

* A. Andersson et al., NIM-A 591, p.437 (2008)
** M. Aiba et al., NIM-A 694, p.133 (2012)

Emittance monitor status (2)

- Monitor #2 development*
  - Longer arm to improve the resolution
    (+ optical table accessible even during operation)
  - Plan A: Toroidal mirror optics → λ independent
    Plan B: Lens optics (as in Monitor #1)
  - Interferometric method is also implemented





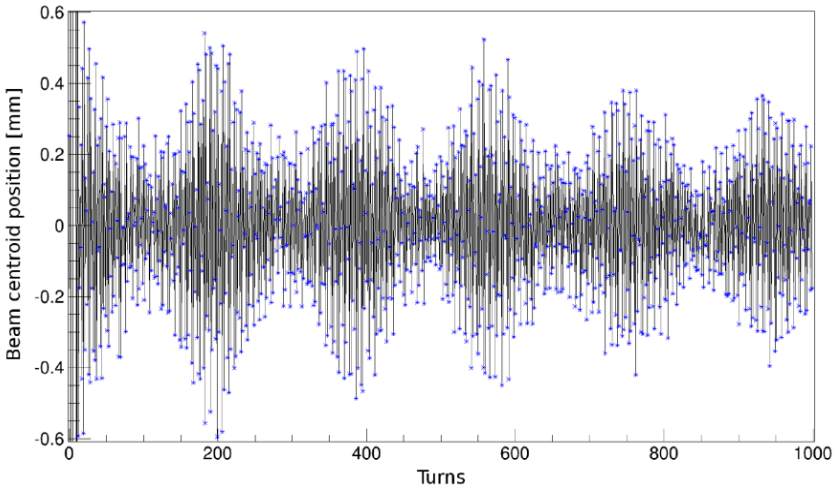
- Plan A: small image aberrations from toroid misalignment
- Plan B: clean images, so far ε_y =1.3 pm** (σ_y ~4.3 μm) measured
- Another vertical emittance tuning campaign is foreseen with Plan B

* Work supported by TIARA WP6 TIARA-REP-WP6-2012-015

** Á. Saá Hernández et al., ICFA Newsletter 62 (2013)

Energy spread measurement (1)

- Energy spread measurement using TBT data*



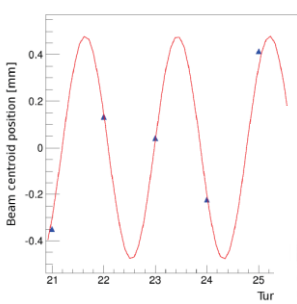
  - Procedure
    - Merge TBT data from all BPMs
    - Fit (locally) sine function to data to find the envelope of the betatron oscillation
    - Fit theoretical formula** to the envelope

    → Energy spread corresponds to one of fitting parameters

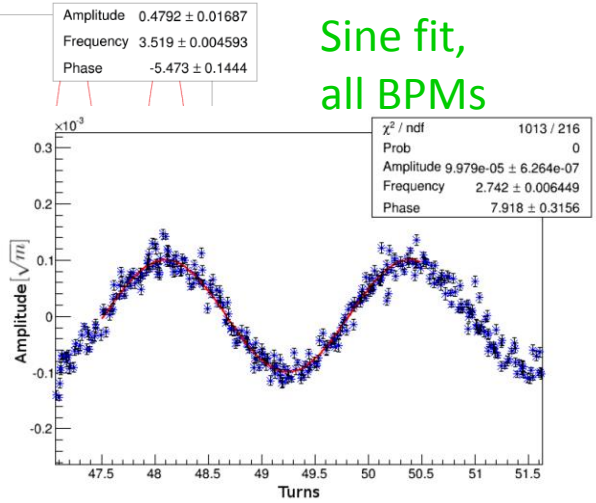
* D. Mayilyan, Master thesis, ETH Zurich (2014)

** A. Sargsyan, NIM-A, 638, p.15 (2011)

Energy spread measurement (2)

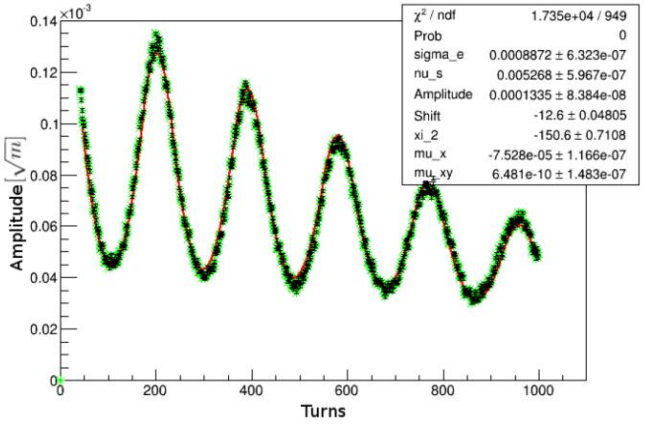


Sine fit,
single BPM

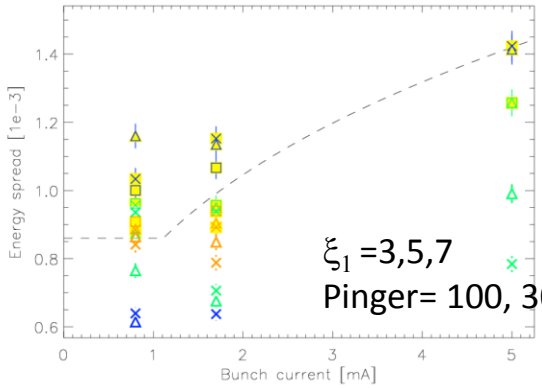


Sine fit,
all BPMs

Envelop fit (a good example)



Energy spread…?



ξ_1 =3,5,7
Pinger= 100, 300, 700 A

Fixed parameters
(measured separately):
- 1st order chromaticity, ξ_1

Fitting parameters:
- Energy spread
- Amp. dependent tune shift(s)
- 2nd order chromaticity
- Synchrotron tune
- Kick amplitude

Summary

- "Local" LOCO
  - Method to probe the ring optics locally under development
  - First results indicate that Sector 4-5 could be a source that prevents LOCO from converging
- Vertical emittance monitor #2 R&D is on-going
  - Difficulties with Toroidal mirror…
  - Another ε_y tuning campaign is foreseen with Monitor #2 (Plan B)
- Energy spread measurement attempted
  - Using TBT data
  - Measured values depend on chromaticity and kick amplitude…

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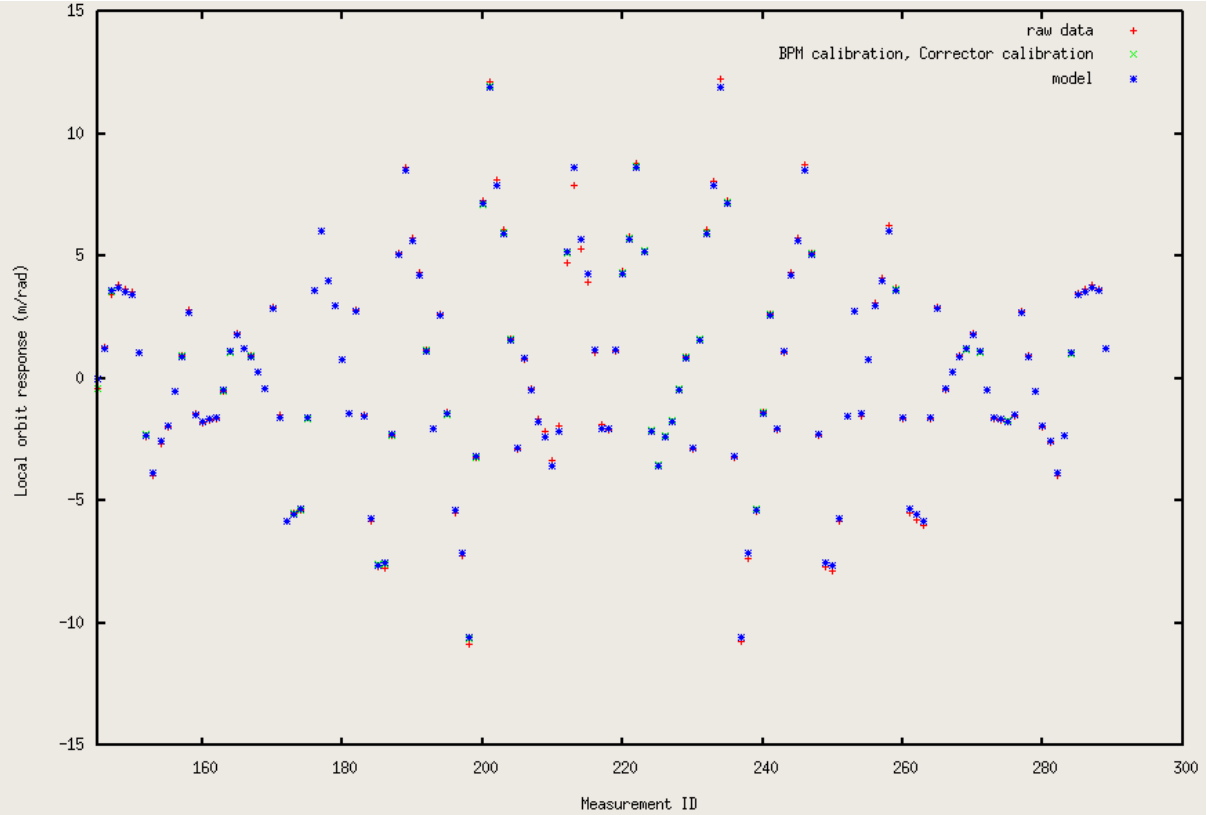
Back up slides

Local orbit response matrix analysis (1)

- Procedure
  - BPM calibrations from normal LOCO
  - Momentum deviation found from non-measurement section BPMs (not important for vertical plane)
  - Corrector calibrations found from Local response matrix
  - Find best quadrupole setting (corrections) by fitting (SVD)

Local orbit response matrix analysis (2)

- BPM and corrector calibration for Sector 2-3



Local orbit response matrix analysis (3)

- Momentum deviation
  - Momentum is slightly varied when the measurement corrector is in a dispersive section
  - Momentum correction (1 Hz) is independent, and there can be residual momentum deviation at the time of measurement
  - Local orbit response data is corrected by finding momentum deviation using the non-measurement BPMs

Momentum deviation fir for Sector 2-3 (BPM 7-18)