LET tool for SuperB and SL rings

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Thanks to: M. Biagini, P. Raimondi

Outline

- LET tool
- Measurements at Diamond and SLS
- First error tolerances estimated for V16
- Quad alignments at DAΦNE

L.E.T.

=

DFS

+

Coupling

+

β-beating

−

Time

SVD inversion of RESPONSE MATRIX M determines the Correction

$$\begin{pmatrix} (1-\alpha-2\omega)\,\vec{y} \\ \alpha\,\vec{\eta}_y \\ \omega\,\mathcal{O}\vec{\mathcal{R}}\mathcal{M}_{y,\theta_H} \\ \omega\,\mathcal{O}\vec{\mathcal{R}}\mathcal{M}_{x,\theta_V} \end{pmatrix} = \mathcal{M}_v \begin{pmatrix} \vec{\theta}_V \\ \vec{K} \\ \vec{T} \end{pmatrix}$$

$$\begin{pmatrix} (1-\alpha-2\omega)\,\vec{x} \\ \alpha\,\vec{\eta}_x \\ \omega\,\mathcal{O}\vec{\mathcal{R}}\mathcal{M}_{x,\theta_H} \\ \omega\,\mathcal{O}\vec{\mathcal{R}}\mathcal{M}_{y,\theta_V} \end{pmatrix} = \mathcal{M}_x \begin{pmatrix} \vec{\theta}_H \\ \vec{T} \end{pmatrix}$$

CORRECTORS USED

- V & H steerers
- Skew quad gradients
- Bpm Tilts-Gains (in progress)

P is the orbit H or V

dispersion

$$\eta = \frac{\vec{y}_{+\Delta E} - \vec{y}_{-\Delta E}}{2\Delta E}$$

1 Off-diagonal block ORM column

$$\frac{\vec{x}_{+\Delta V} - \vec{x}_{-\Delta V}}{2\Delta V}$$

1 diagonal block ORM column

$$\frac{\vec{x}_{+\Delta H} - \vec{x}_{-\Delta H}}{2\Delta H}$$

- Matrix M simulated from Model
- SVD inversion for simultaneous minimization of dispersion coupling and β-beating

Only few measurements:
1 to ~10 RM columns , orbit (P) and dispersion (η)
TOTAL TIME: 5 min

Comparison between LET and LOCO

Simulations for Diamond

R.Bartolini

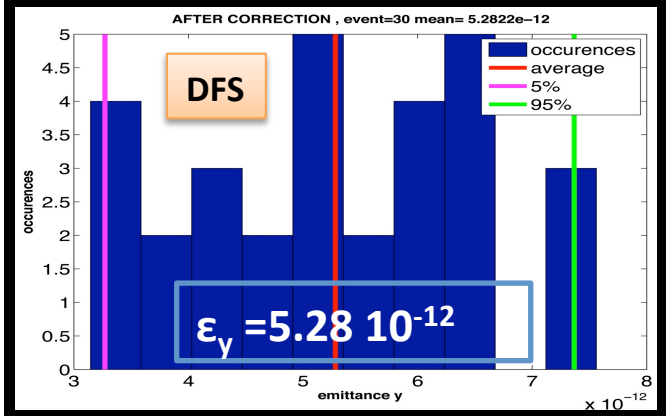
Diamond aerial view

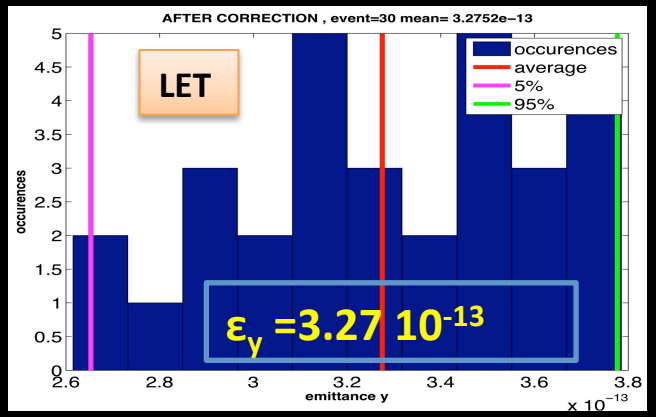
Diamond is a third generation light source open for users since January 2007

100 MeV LINAC; 3 GeV Booster; 3 GeV storage ring

2.7 nm emittance – 300 mA – 18 beamlines in operation (10 in-vacuum small gap IDs)

Simulations: 50 machine with random misalignments and bpm offsets, corrected using DFS and LET



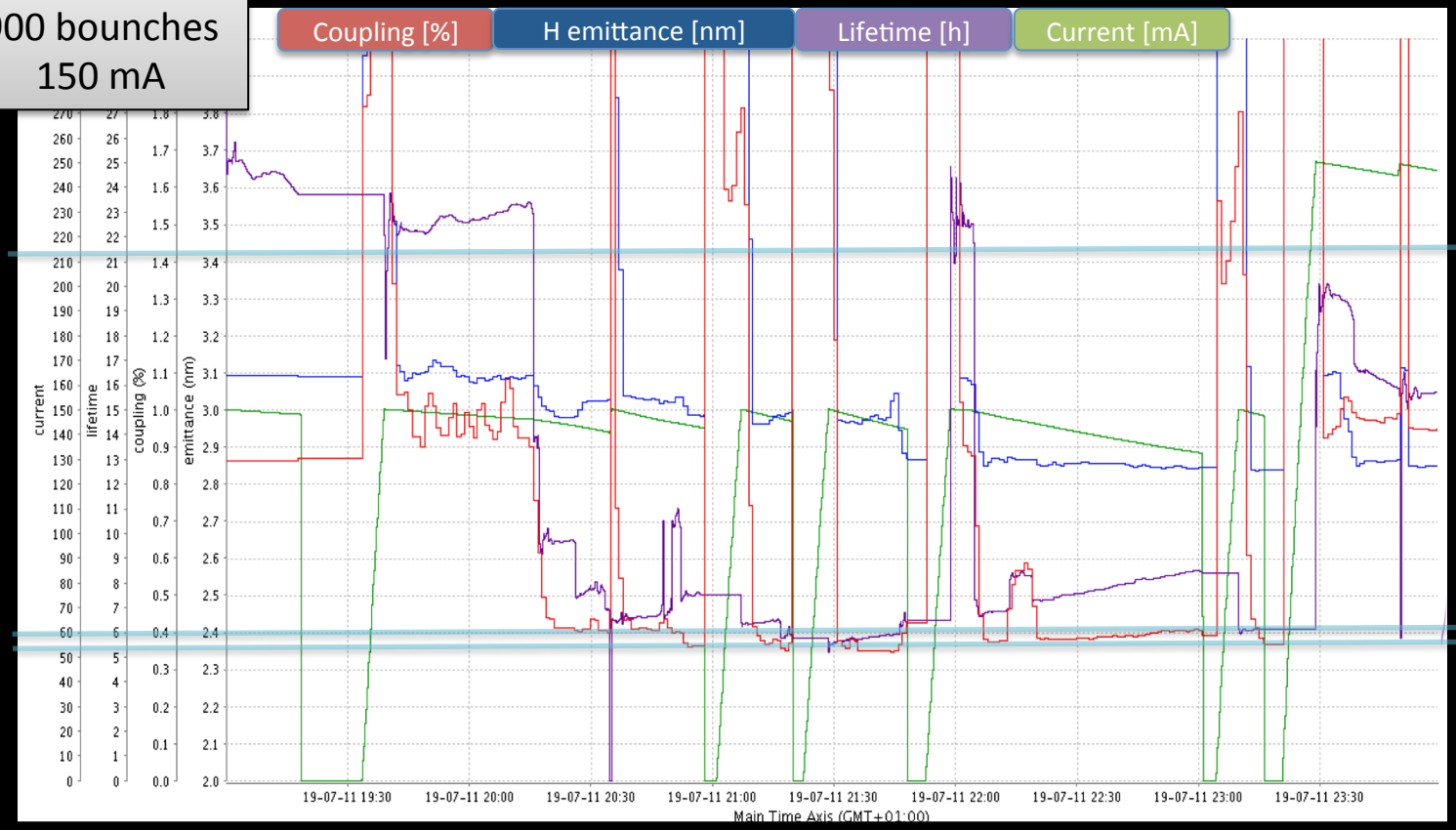


Correction applied in two iterations using H and V steerers only. No BPM Tilts

Comparison between LET and LOCO

Measurements at Diamond

Decay mode
900 bounches
150 mA



Initial conditions
21.1 h

After 2 LOCO iterations with **skew quad and quad**

5.9 h

5.5 h

After 4 LET iterations with **skew quad**

LOCO

LET

LOCO

Final Lifetime measurements preformed after injection

BPM Tilt estimate by LOCO

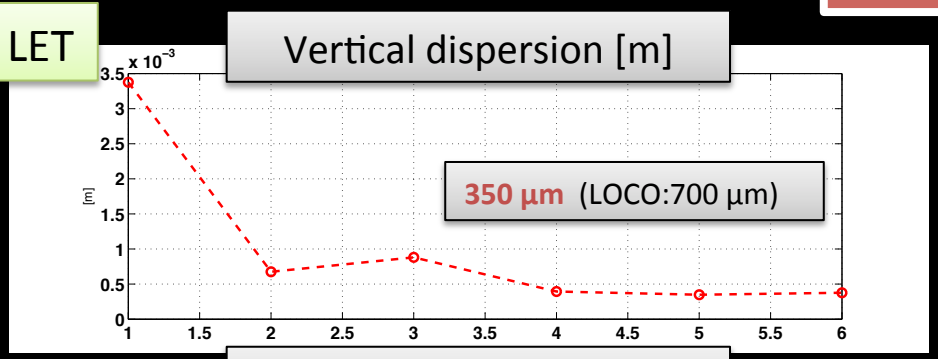
DIAMOND Parameters vs iteration number

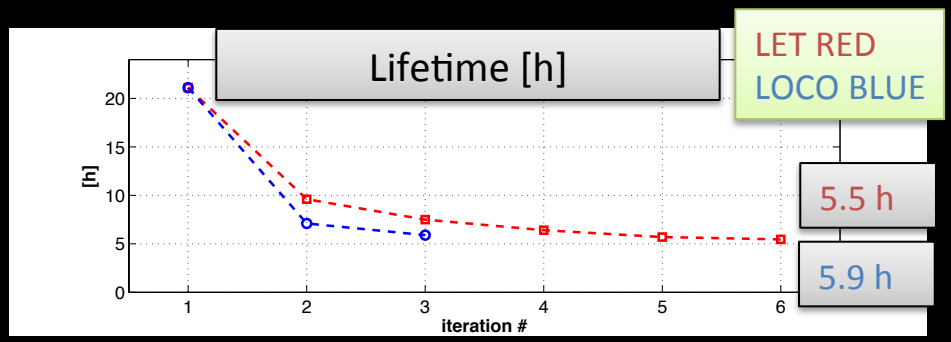
Coupling estimated from lifetime:

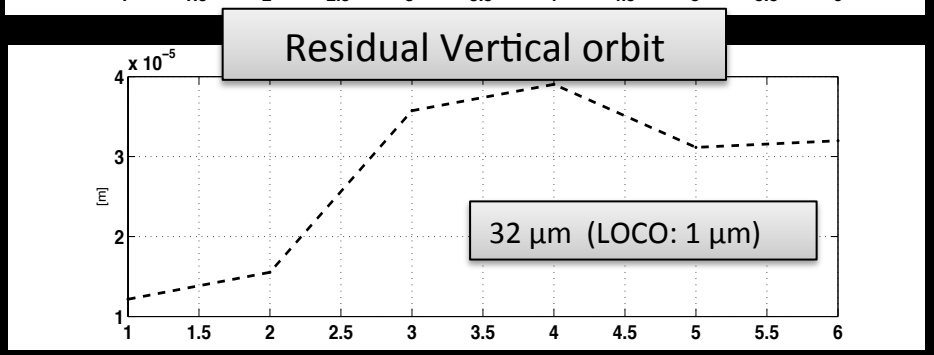
$$K_{end} = \frac{\tau_{end}^2}{\tau_{initial}^2} K_{initial} = 0.06\%$$

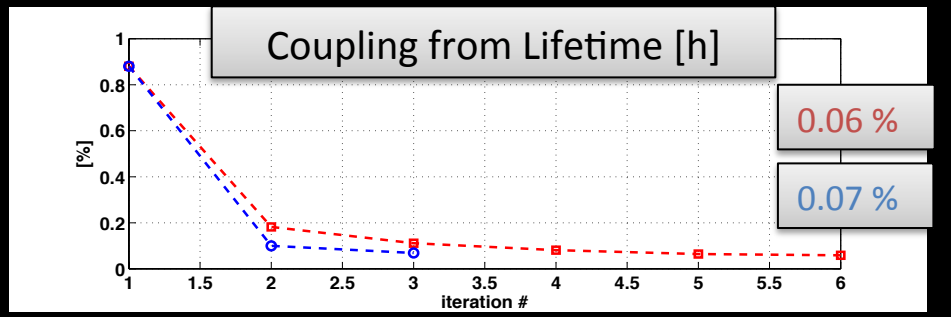
ε_y =1.6 10^{-12} m rad (LET)

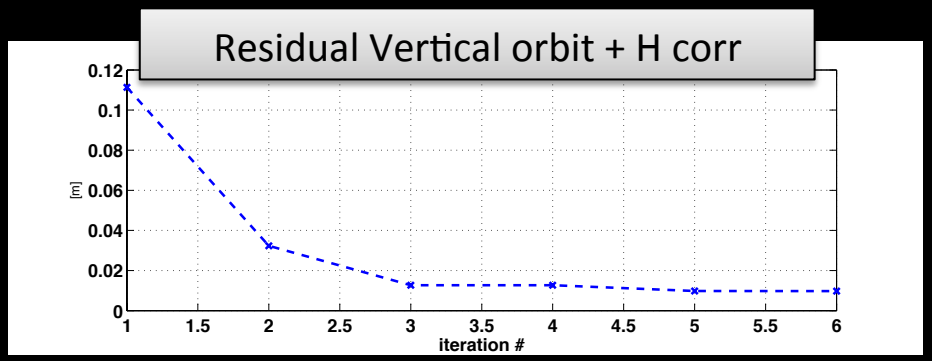
LET

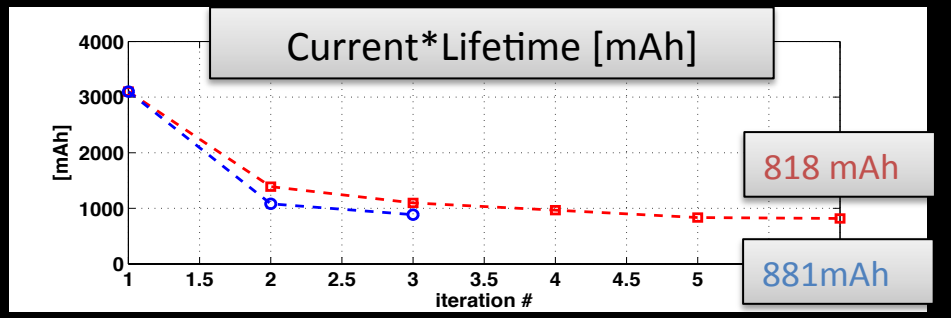








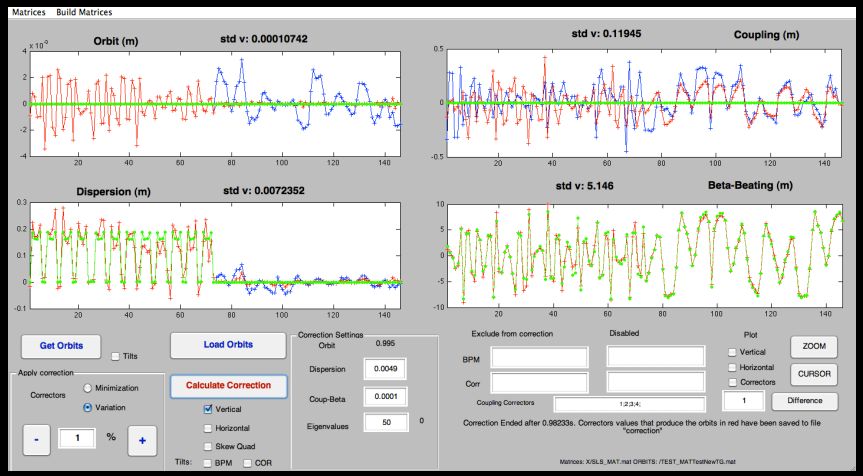




Measurements at SLS

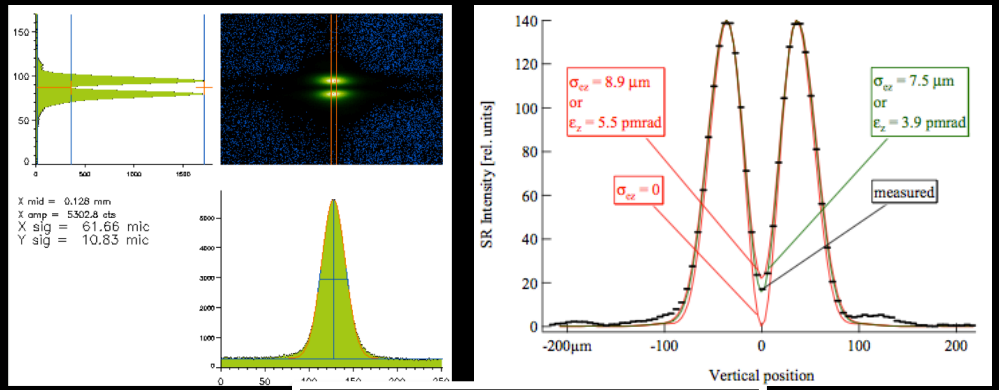
Measurements aimed to achieve low vertical emittance

SWISS LIGHT SOURCE
2.4 GeV, 288m, 12 beamlines, 400 mA, 5.4 nm Hor. Emit.



Same Tool used for Diamond, modified for direct access to Control System

Vertical beam size measurements performed using vertically polarized Syhnchrotron Light Monitor

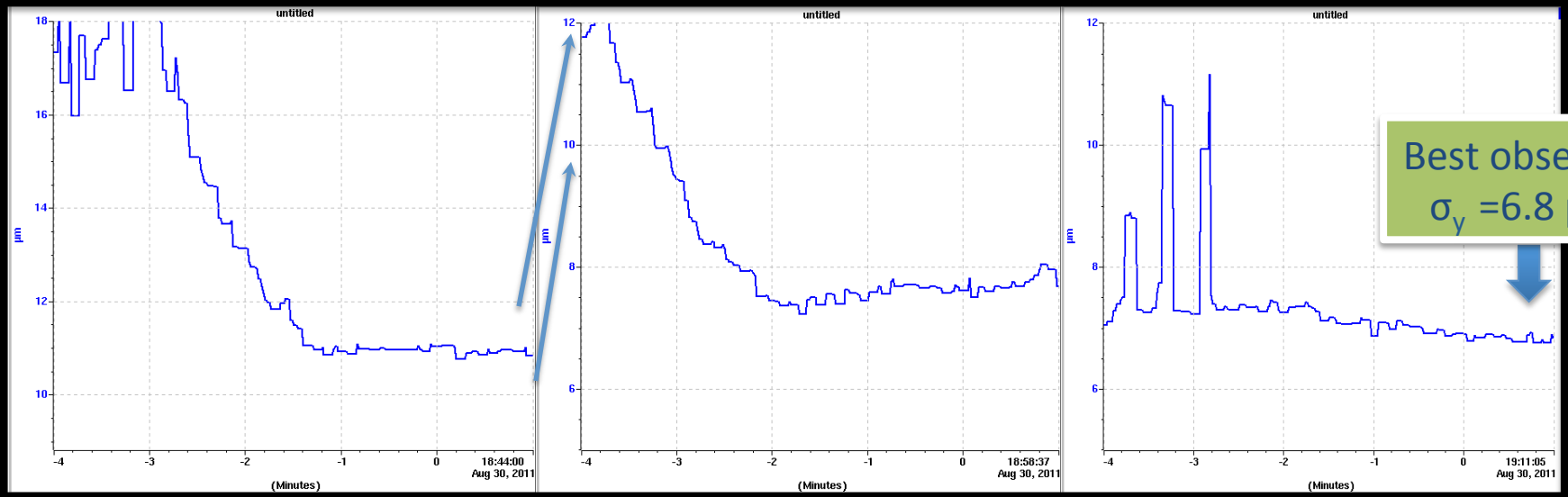


TUPB27 Proceedings of DIPAC 2007, Venice, Italy

Measurements at SLS

Top-up mode
400 mA
Normal user operations

Beam size measurement for 3 subsequent correction performed using only
VERTICAL STEERERS



Best observed
σ_y =6.8 µm

400 µm residual vertical orbit.

SLS best σ_y = 4.9 µm is obtianed using skew quadrupoles

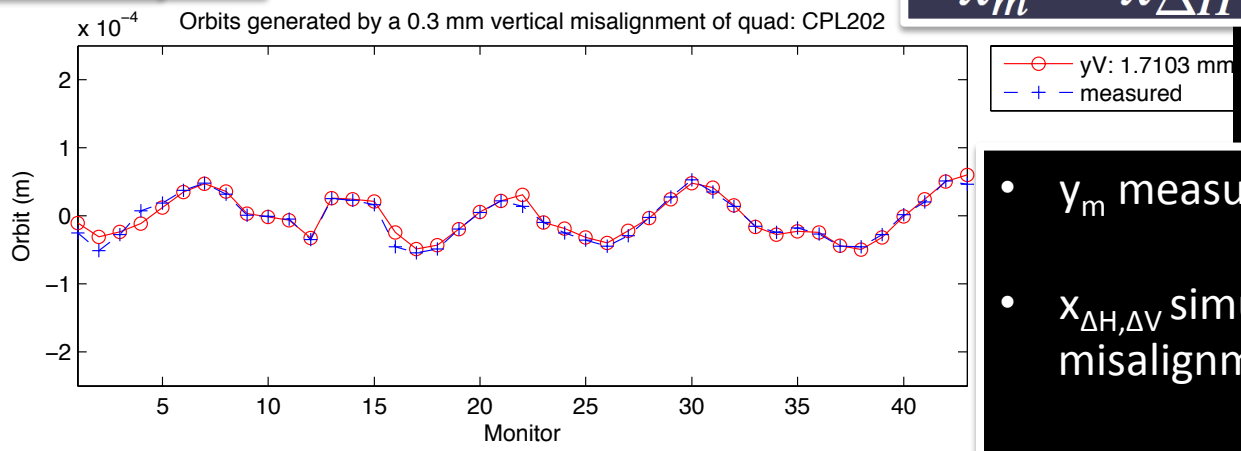
Tested also
Horizontal correction and Skew quadrupoles correction, but still work is in progress.

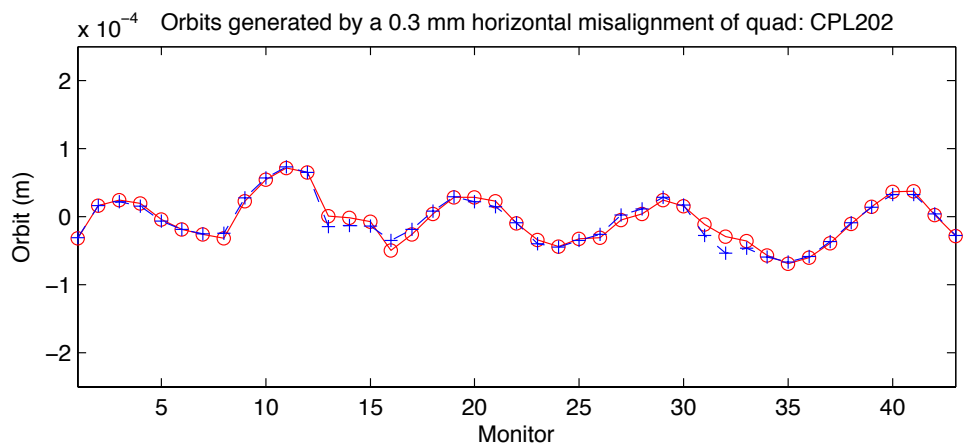
DAΦNE Quadrupole Alignments

MEASURED FIT

for every Quadrupole

$$y_m = y_{\Delta H}\, k\Delta H + y_{\Delta V}\, t\Delta V$$
$$x_m = x_{\Delta H}\, k\Delta H + x_{\Delta V}\, t\Delta V$$





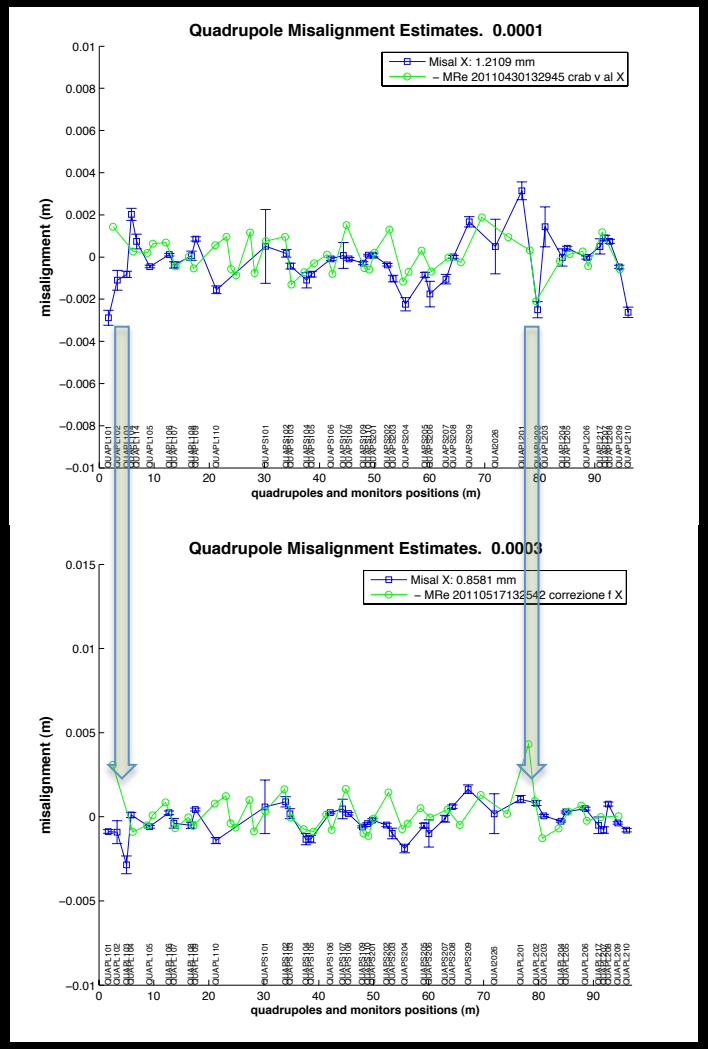
- y_m measured orbit $\Delta I_q = \pm 1A$
- $x_{\Delta H,\Delta V}$ simulated orbit generated by misalignment
- $\Delta H, \Delta V$ simulated misalignments value
- t, k fit parameters (coupled estimations)

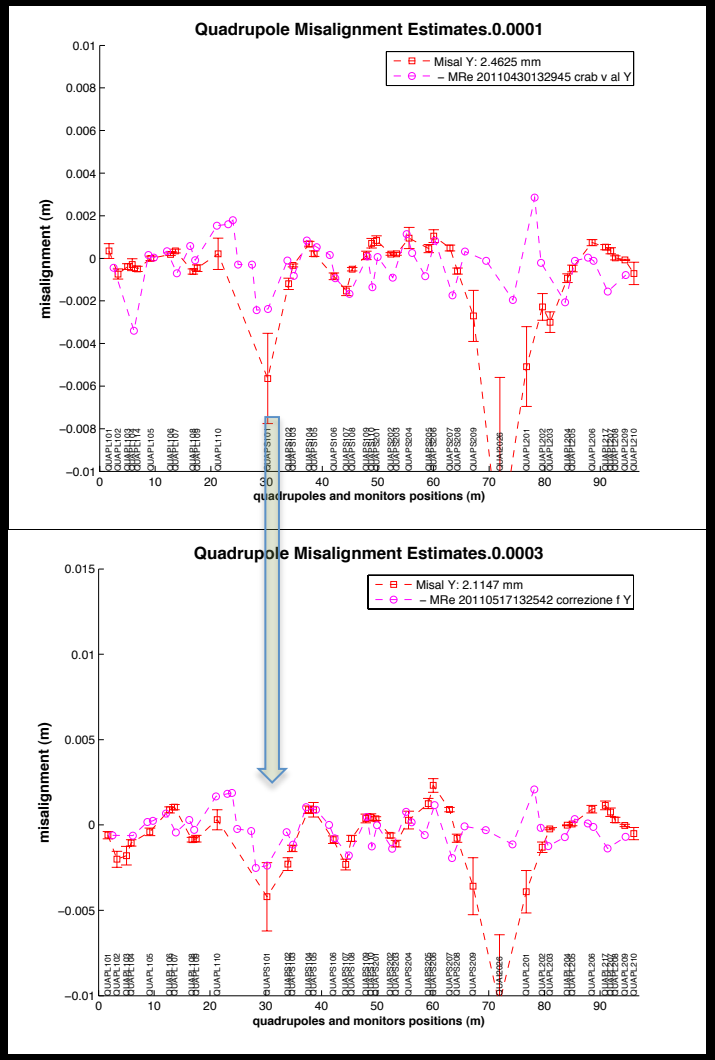
Electron Ring re-Alignment

Horizontal | Vertical

BEFORE

AFTER

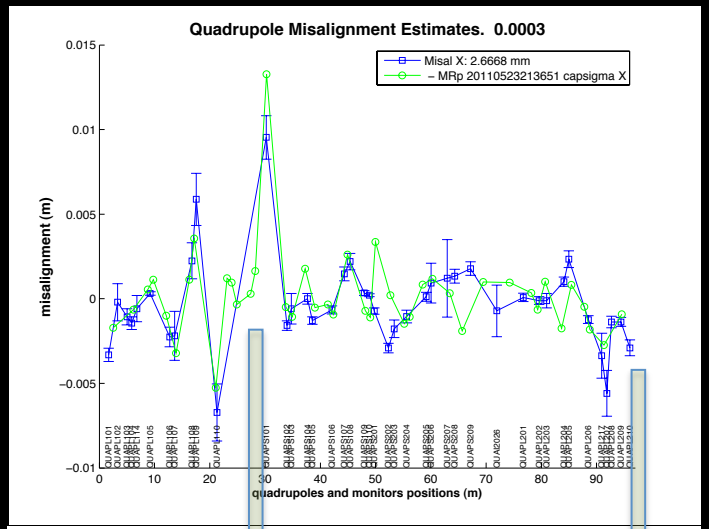


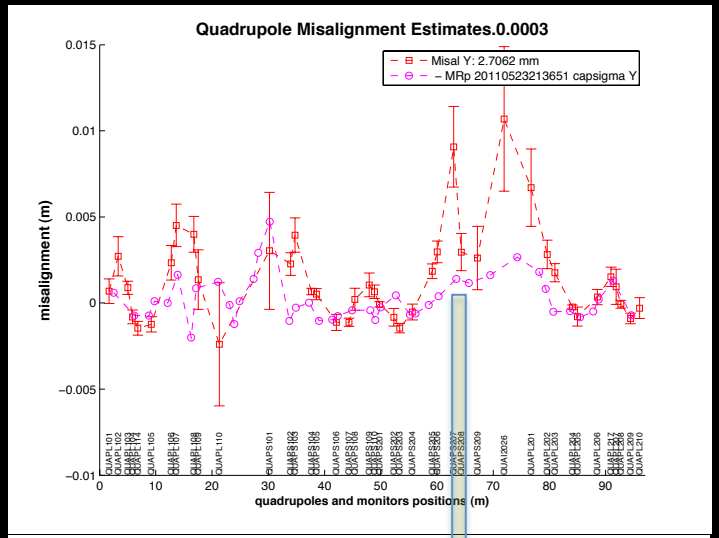


Positron Ring re-Alignment

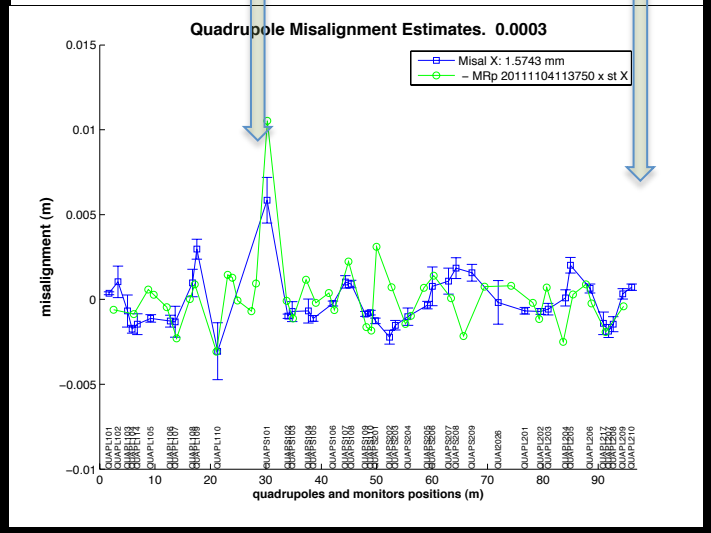
Horizontal | Vertical

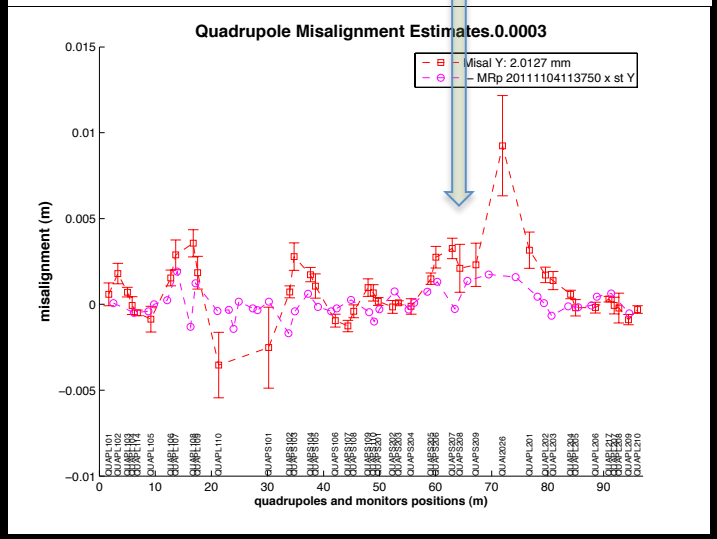
BEFORE





AFTER





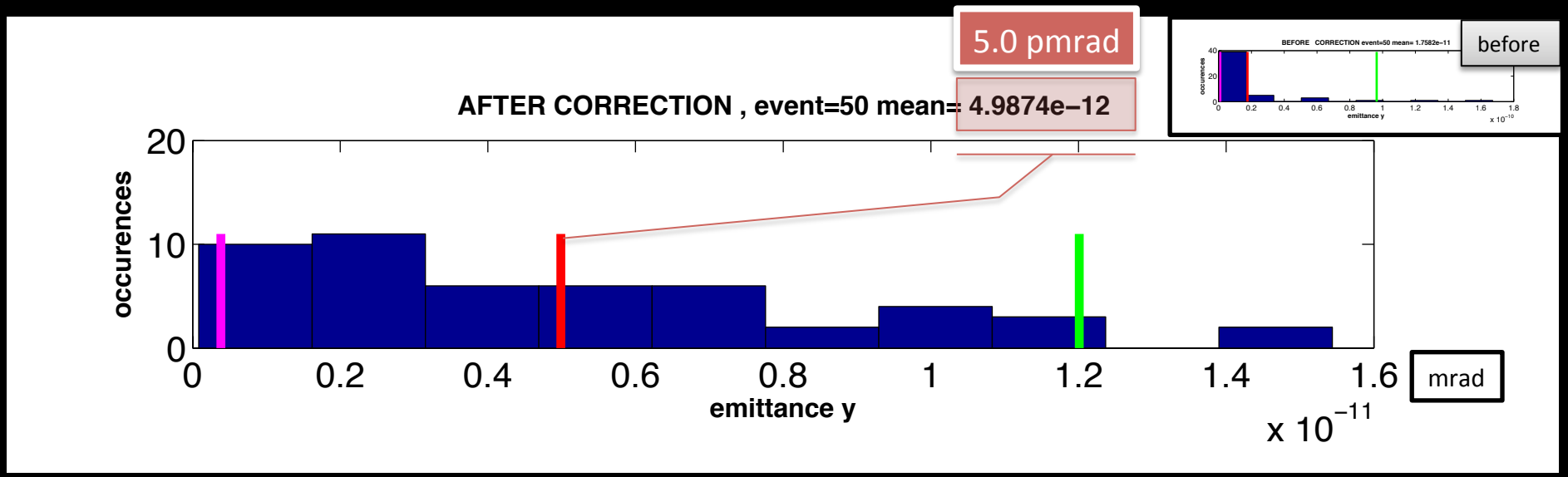
HER modified for Tolerances and LET

- Correctors, and monitors at every quadrupole and sextupole including FF → 352 correctors & monitors
- Splitted MAD elements have same misalignment
- Final doublet (from qf1l to qf1r) misaligned as one single element
- Re-iterations : 3 SEXT OFF & 2 SEXT ON

First tolerance tests for HER V16

misalignments	ARCS	FF
QUAD SEXT DX,DY	50 µm	30 µm
QUAD SEXT DPHI	100 µrad	50 µrad
Monitor resolution	1 µm	1 µm
Monitors OFFSETs	50 µm	50 µm

50 random sets, correcting with LET for 2 iterations after 3 orbit pre-correction iterations



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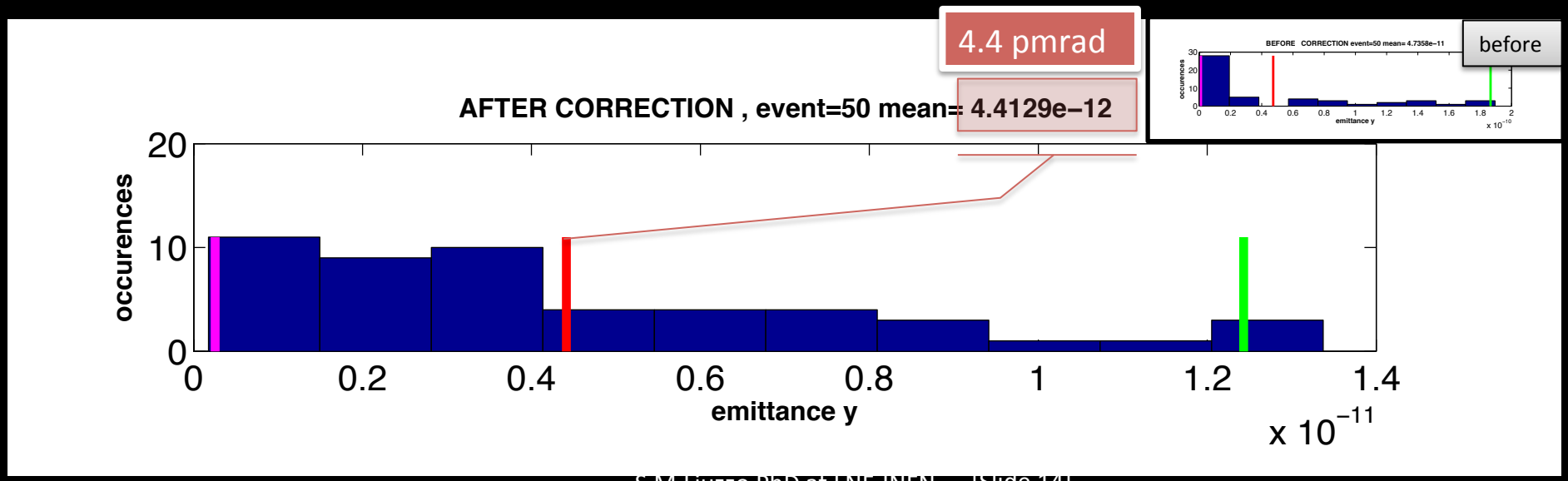
QUAD SEXT DX,DY	50 µm	30 µm
QUAD SEXT DPHI	100 µrad	50 µrad
Monitor resolution	1 µm	1 µm
Monitors OFFSETs	50 µm	50 µm
DIPOLE DPHI and DTHETA	50 µrad	50 µrad

50 random sets, correcting with LET for 2 iterations after 3 orbit pre-correction iterations



Conclusions

- LET tool under test at DIAMOND and SLS
- Started work also on DAΦNE
- First tolerances for the HER V16 slightly better than those of V12