

# Beam-beam blowup in the presence of xy coupling sources @ FCCee

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## Acknowledgements:

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K. Ohmi, Dmitri Shatilov, Tobias Tydecks,  
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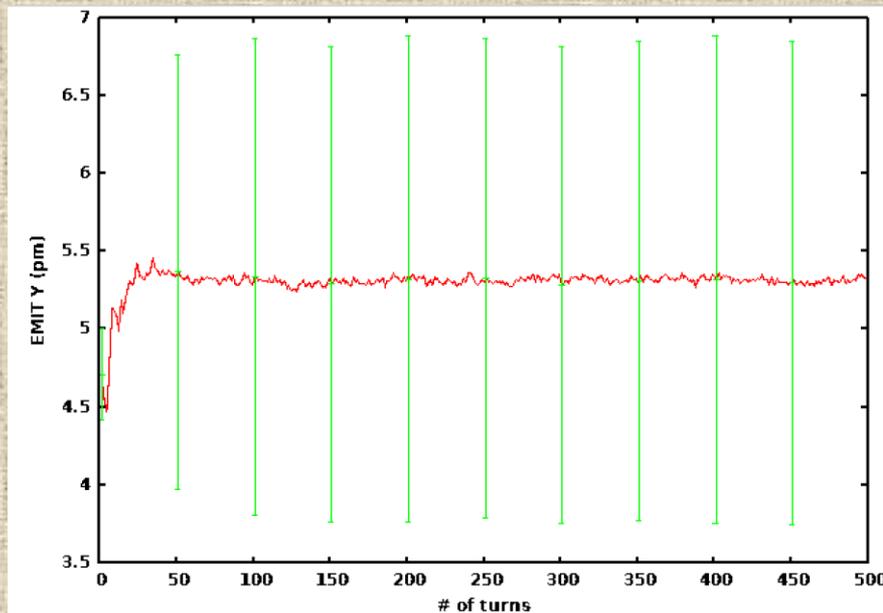


# Outline

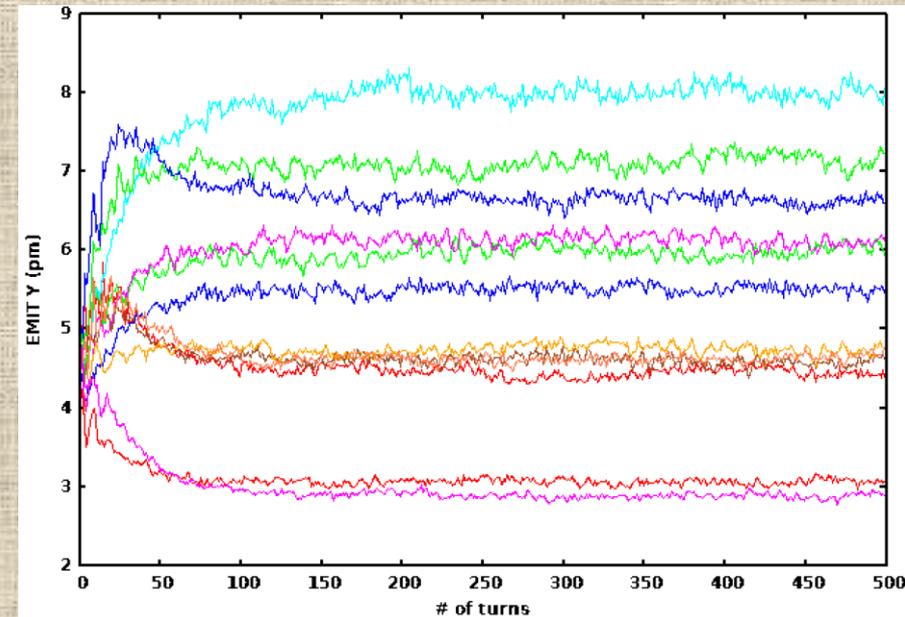
- *Tracking in the presence of xy coupling sources*
- *Tracking in a corrected lattice*
- *Conclusions*

# More Samples, w/o beam beam

- 12 samples were tracked without a beam beam element at the IP
- The results are averaged and plot with error bars



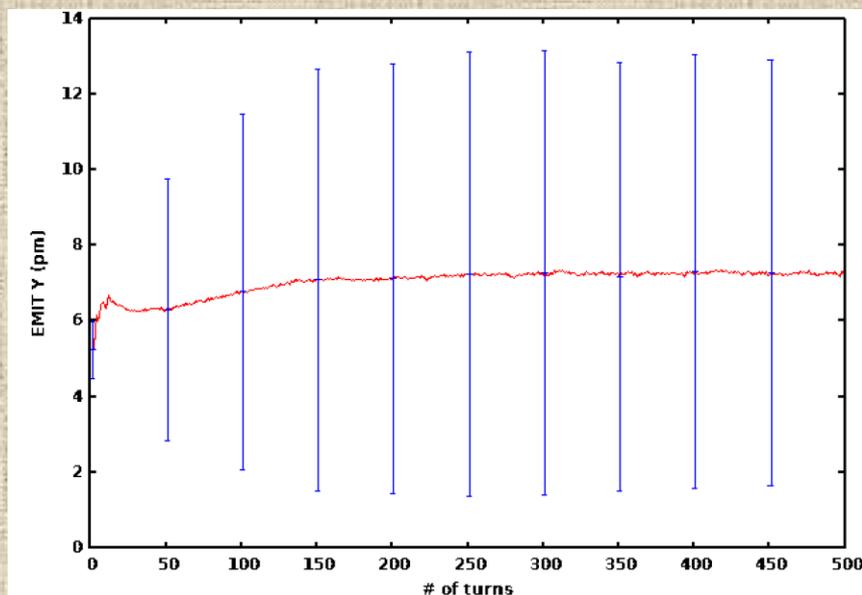
Averaged over 12 samples



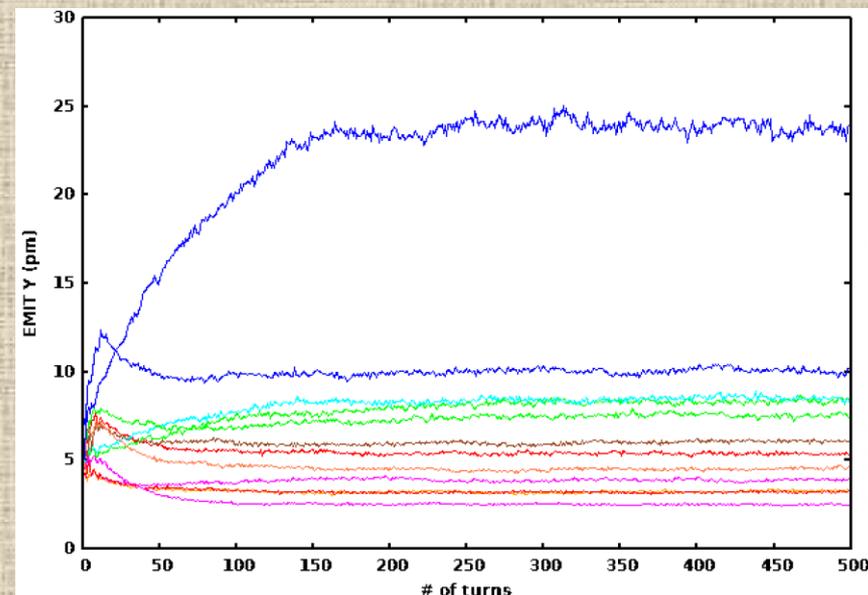
A glance on all samples

# More Samples, w/ beam beam

- 12 samples were tracked with a beam beam element at the IP
- The results are averaged and plot with error bars



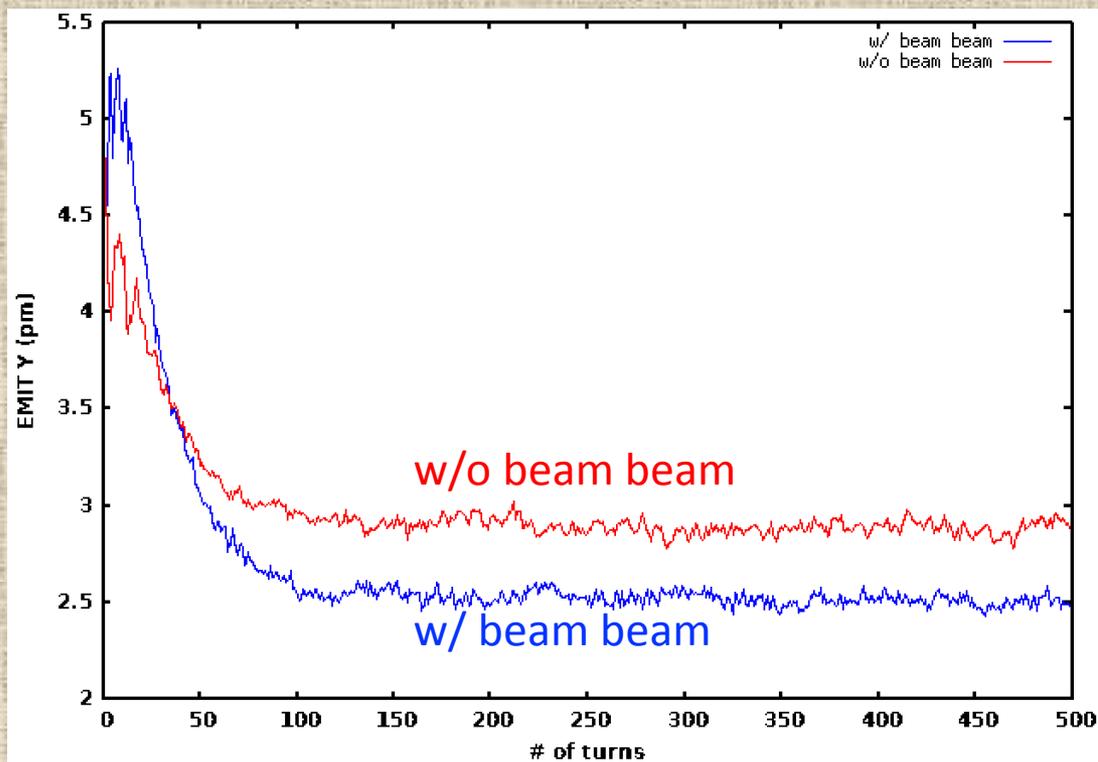
Averaged over 12 samples



A glance on all samples

# A look into seeds- I

→ Seed 13 gives the best results (no blow up w/ and w/o beam beam)

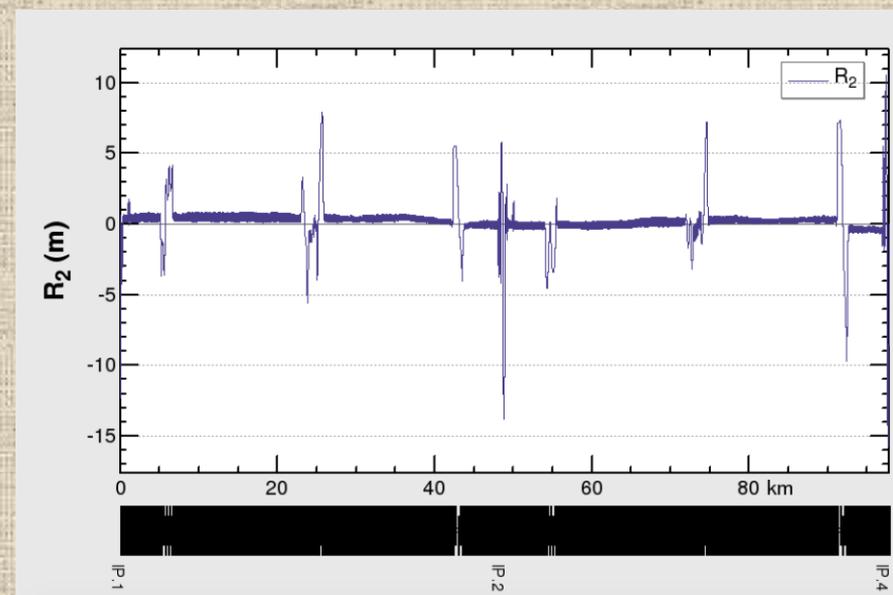
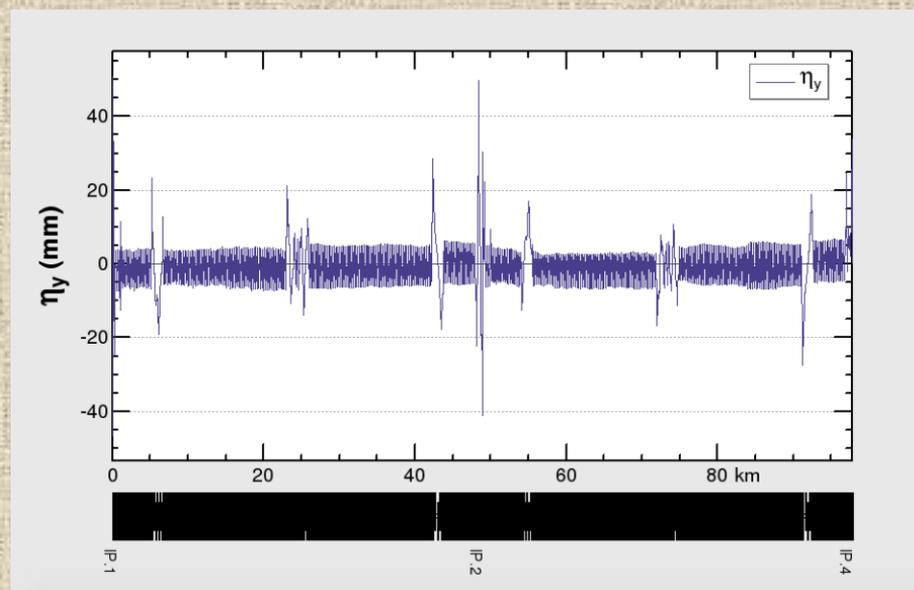


# A look into seeds- I

→ Seed 13 gives the best results : **no blow up w/ and w/o beam beam**)

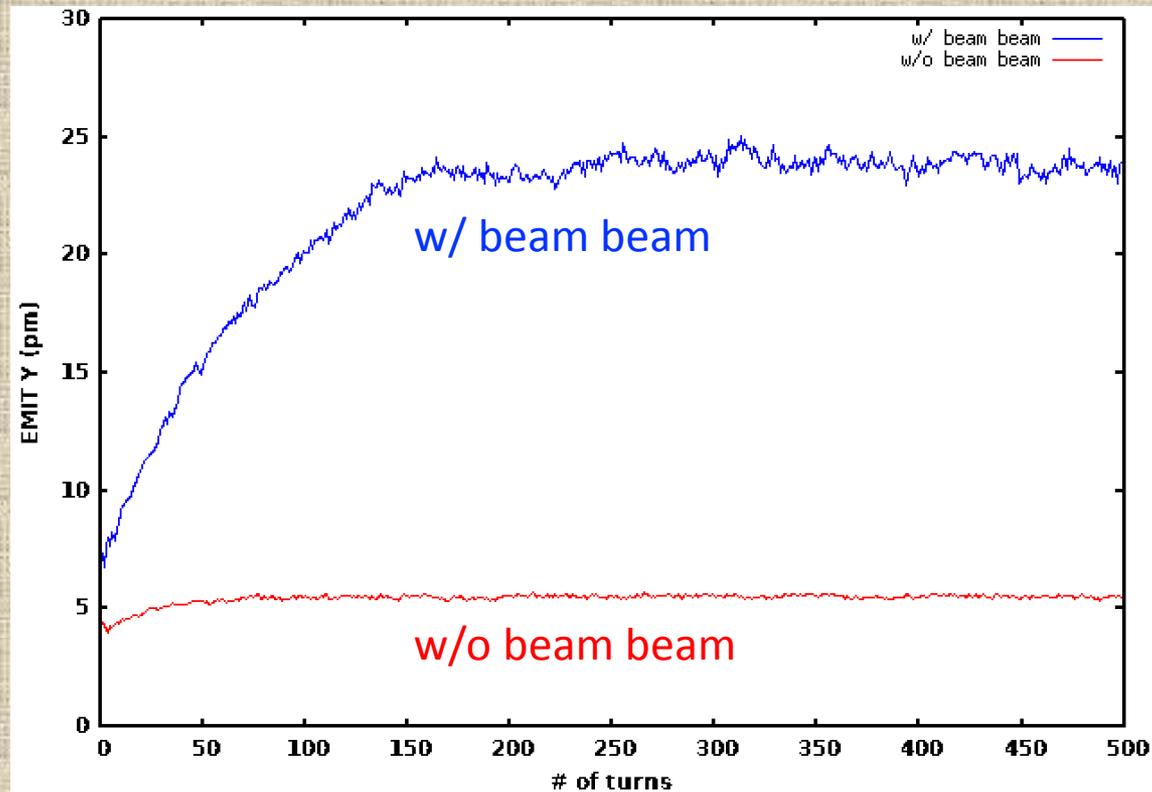
→ Vertical dispersions @ IPs :  $\eta_y = (-15 * 10^{-6} m, 17 * 10^{-6} m)$

→ Coupling parameter R2 @ IPs:  $R2 = (1.5 * 10^{-4} m, -2.9 * 10^{-5} m)$



# A look into seeds- II

→ Seed 25 gives the largest blowup with beam beam

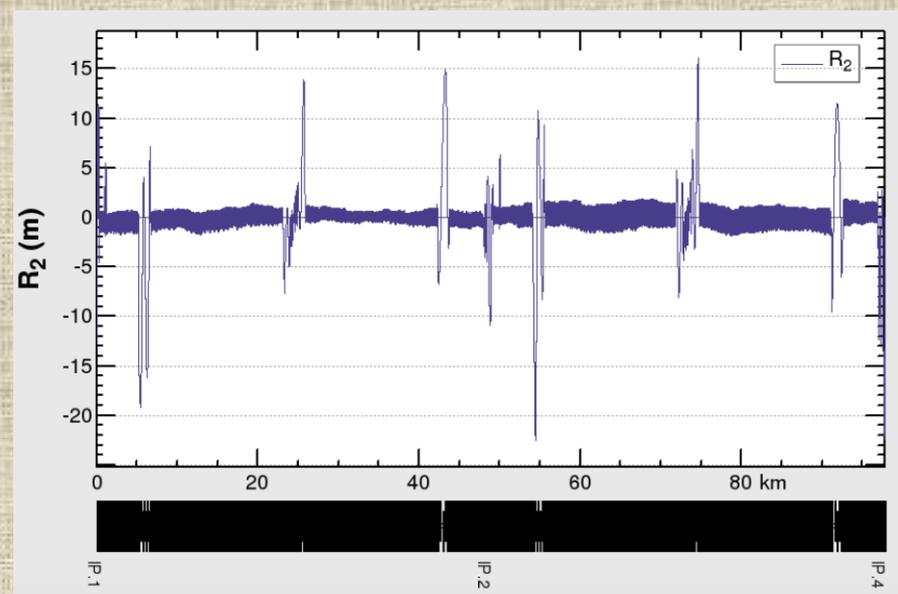
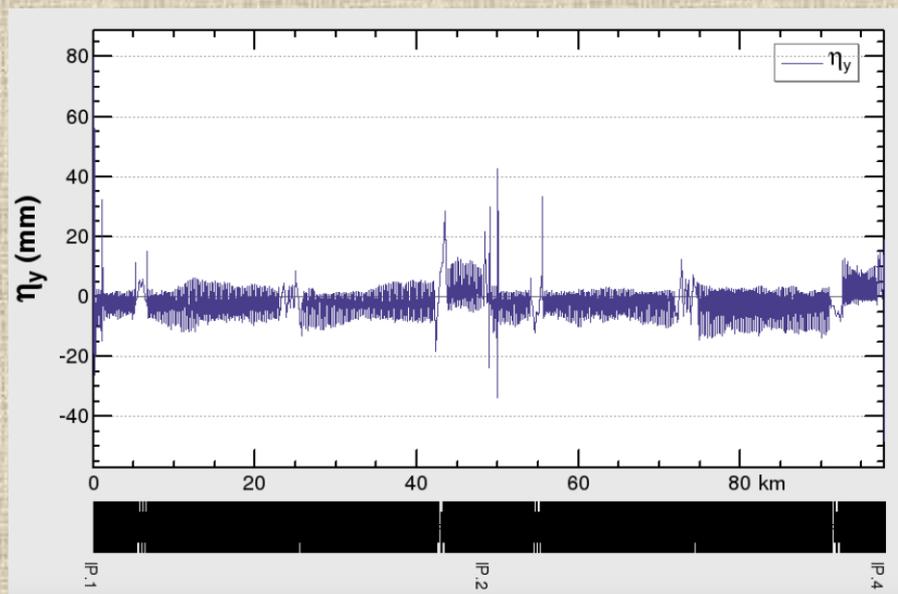


# A look into seeds- II

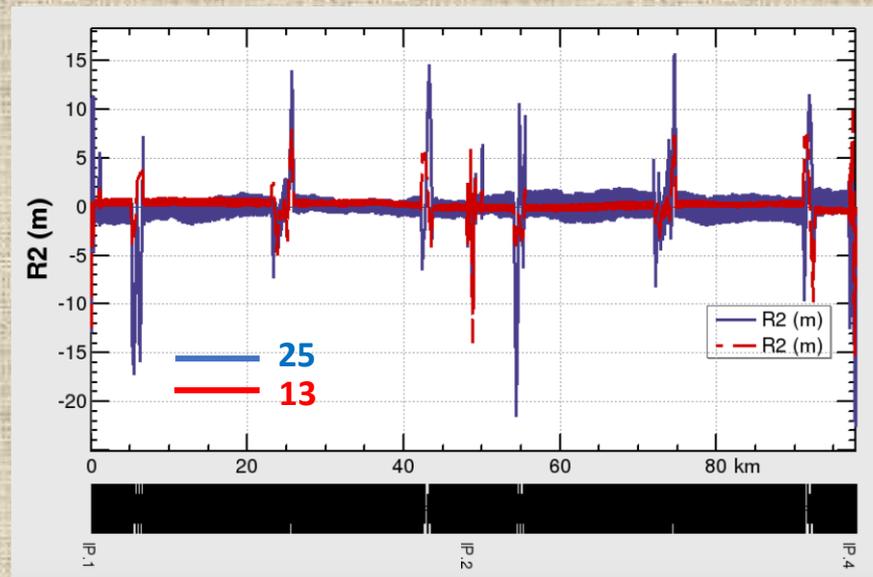
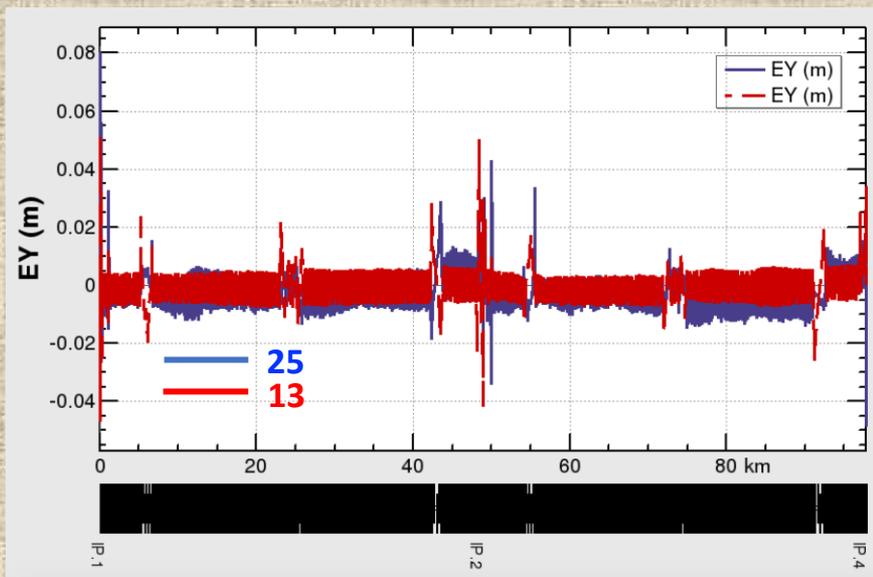
→ Seed 25 gives the largest blowup with beam beam

→ Vertical dispersions @ IPs :  $\eta_y = (5.3 * 10^{-6} m, -22.1 * 10^{-6} m)$

→ Coupling parameter R2 @ IPs:  $R2 = (5 * 10^{-4} m, 10^{-3} m)$



# Sum Up

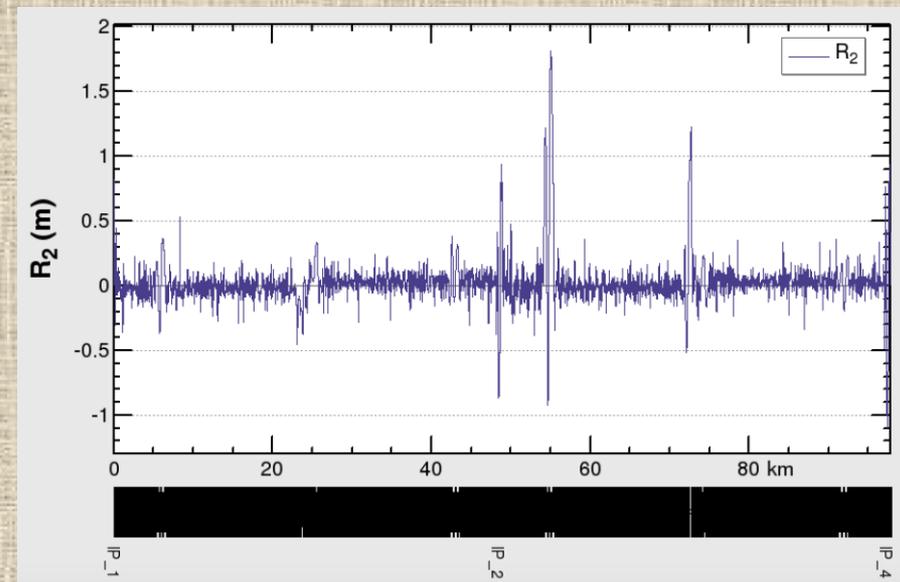
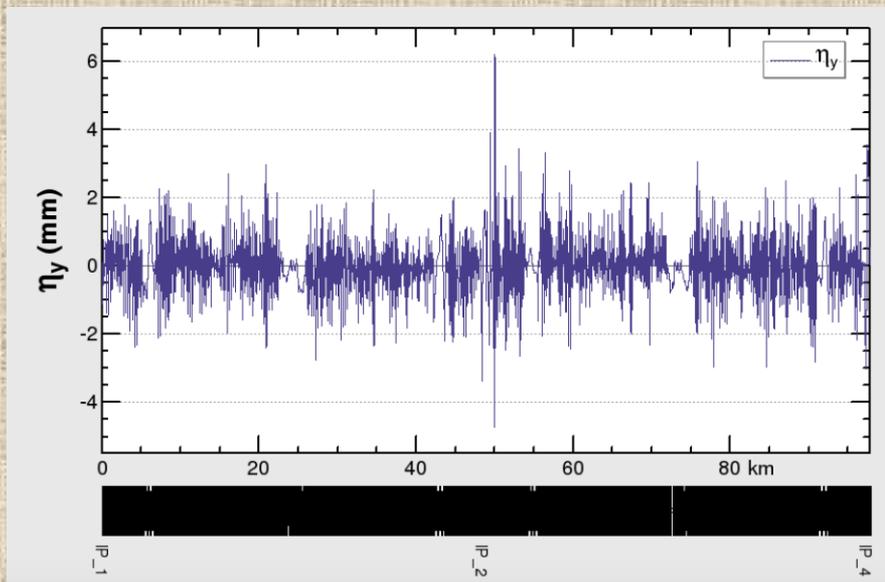


Seed	$\eta_y @IP$ ( $\mu m$ )	R2@IP (mm)
13 (Good)	(-15,17)	(0.15, -0.03)
25 (Bad)	(5.3,-22.1)	(0.5, 1)

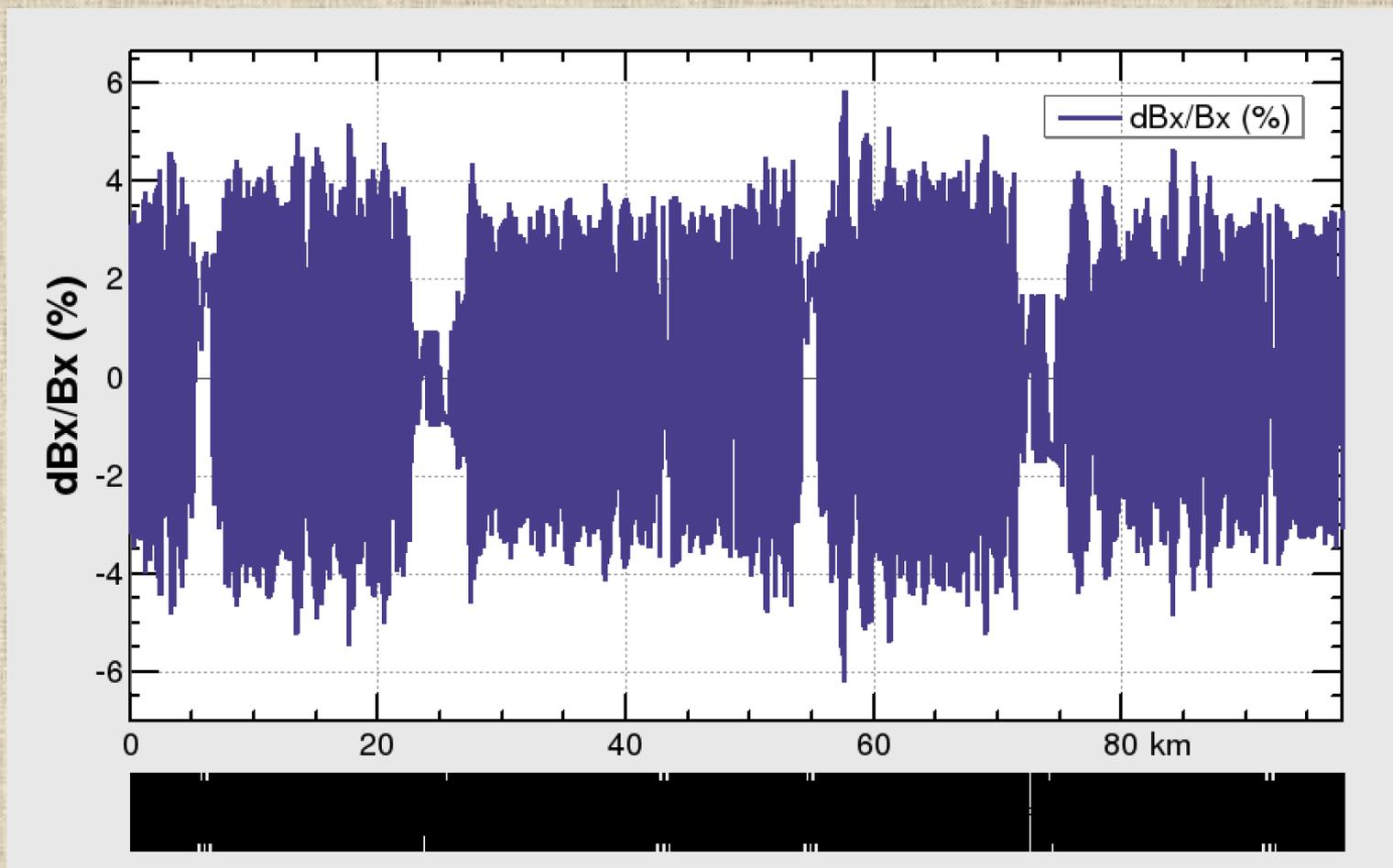
- Vertical dispersions are comparable between the good and the bad seeds
- Coupling could be the main cause of such a blowup

# Lattice w/ errors and corrections

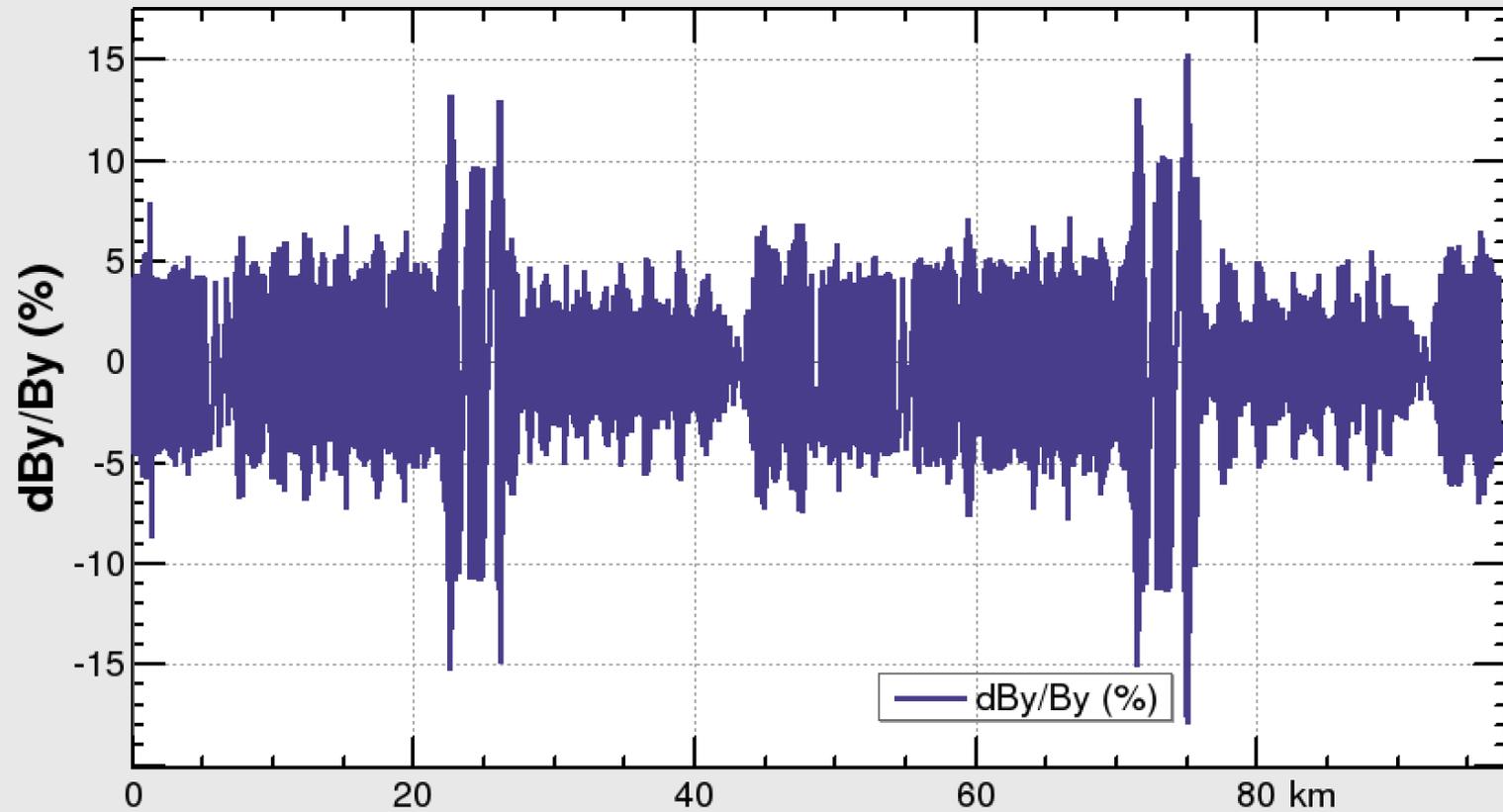
- Lattice with correctors is converted from MADX to SAD :
- <http://svnweb.cern.ch/world/wsvn/madx/branches/madx-SAD/tools/translators/>
- [https://indico.cern.ch/event/617116/contributions/2490914/attachments/1421449/2178736/MADX\\_dmzhou\\_20170303.pdf](https://indico.cern.ch/event/617116/contributions/2490914/attachments/1421449/2178736/MADX_dmzhou_20170303.pdf)
- Seed 999 is a converging seed, closed orbit is found
- Vertical emittance after correction  $\epsilon_y = 0.12 \text{ pm}$



# Beta beat - Horizontal

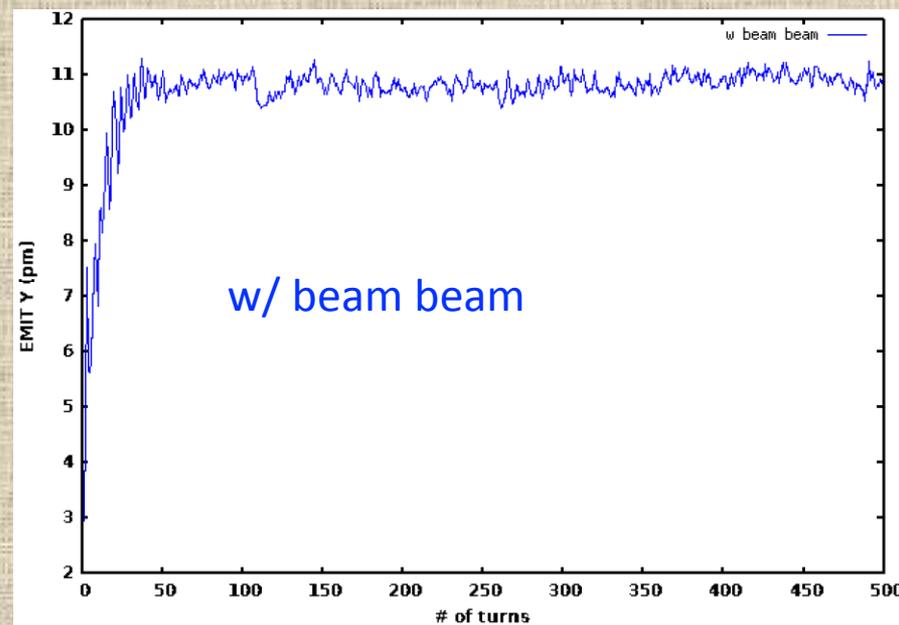
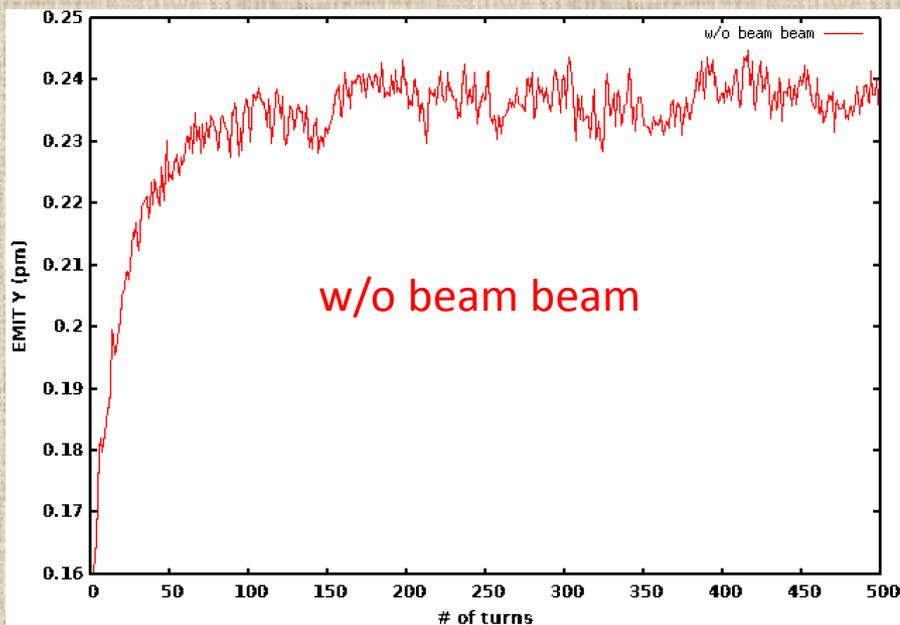


# Beta beat- Vertical



# Tracking with errors/corrections

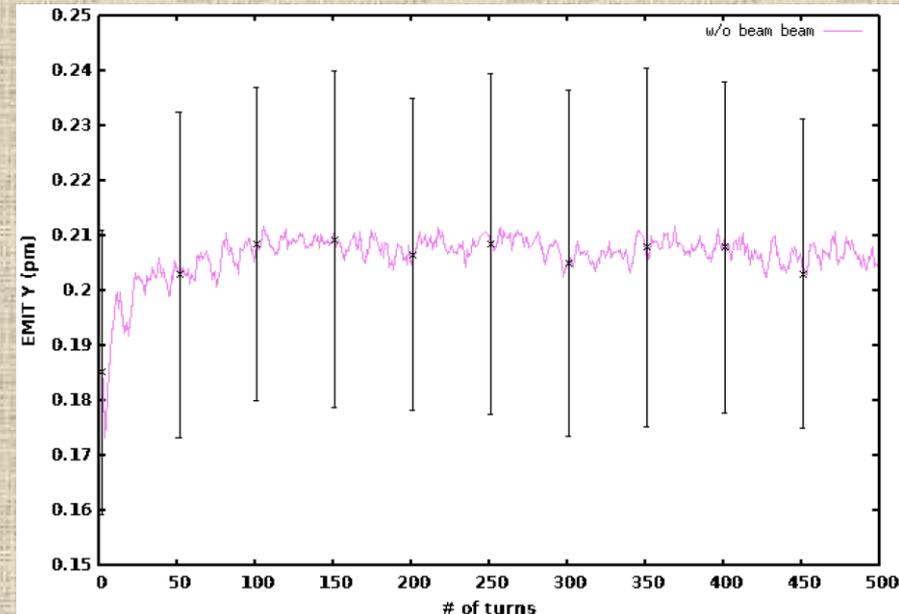
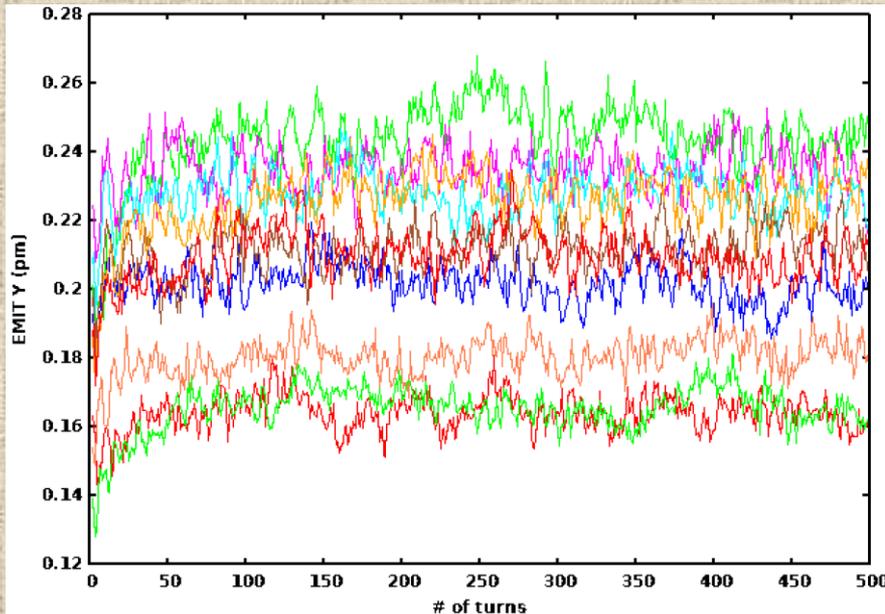
- Tracking without beam-beam was OK !
- A blowup was observed while tracking with beam beam



# Sextupoles misalignments/ $\epsilon_y=0.12 \text{ pm}^{-1}$

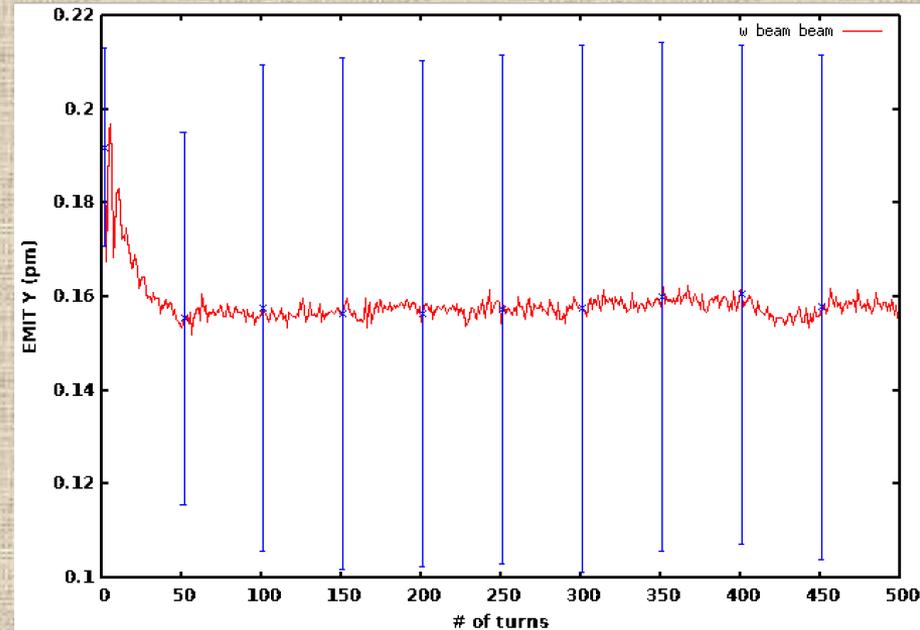
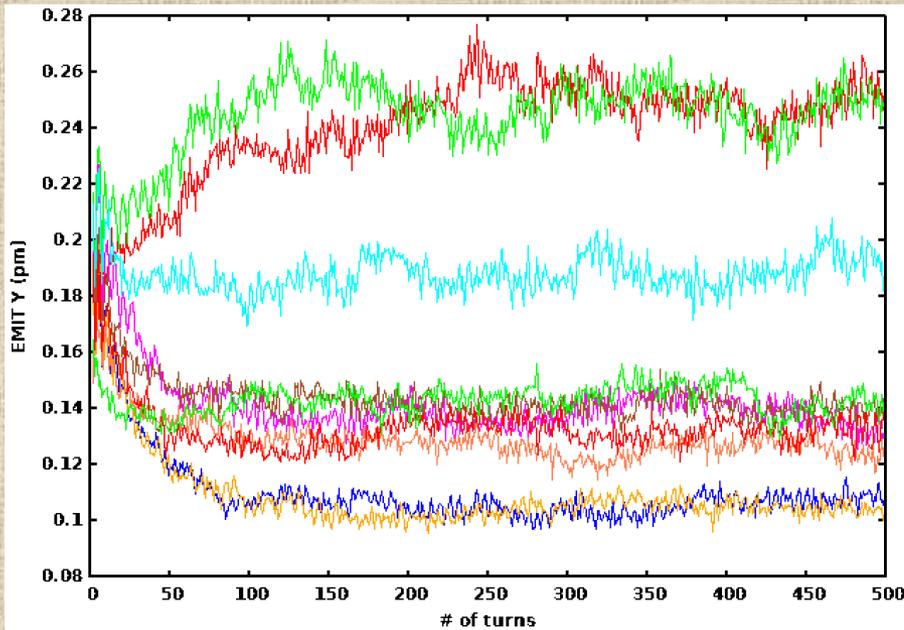
→ Achieve a vertical emittance of 0.2 pm only by vertical misalignments of sextupoles keeping the design tune

**→ Without beam-beam, no blowup was observed**



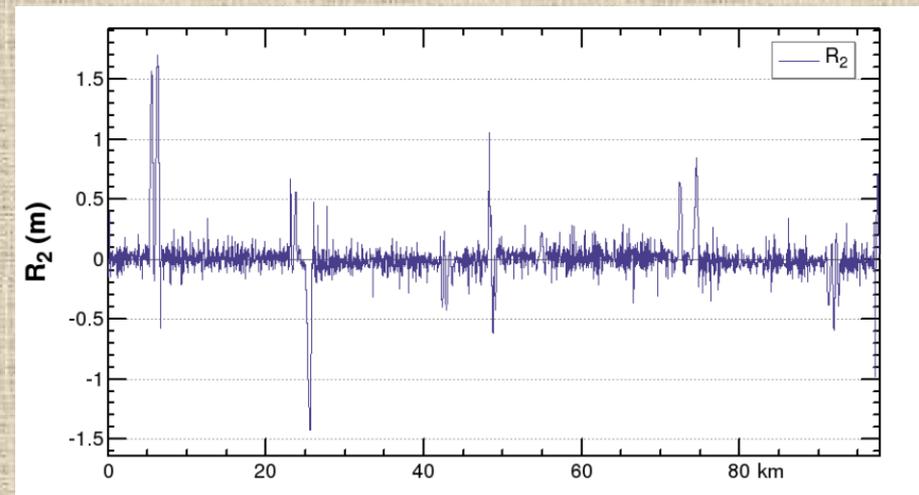
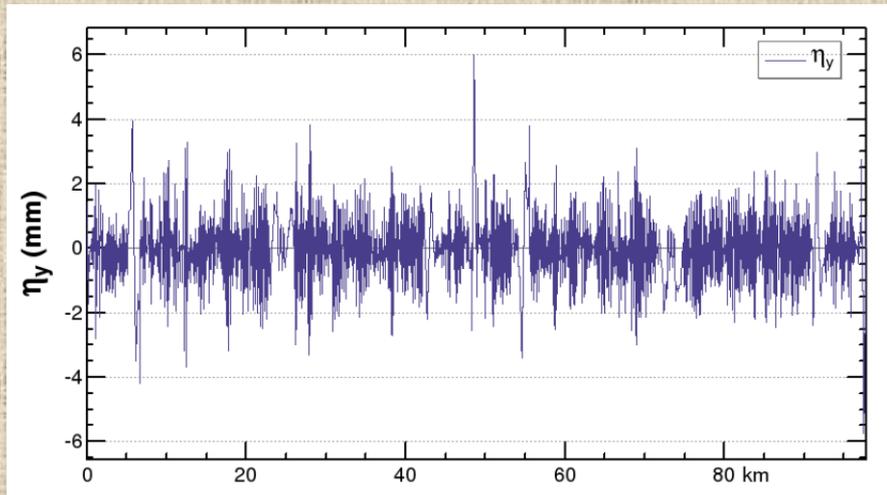
# Sextupoles misalignments/ $\epsilon_y=0.2$ pm - II

- Achieve a vertical emittance of 0.2 pm only by vertical misalignments of sextupoles keeping the design tune
- Without beam-beam, no blowup was observed
- Neither with beam beam a blowup was observed**

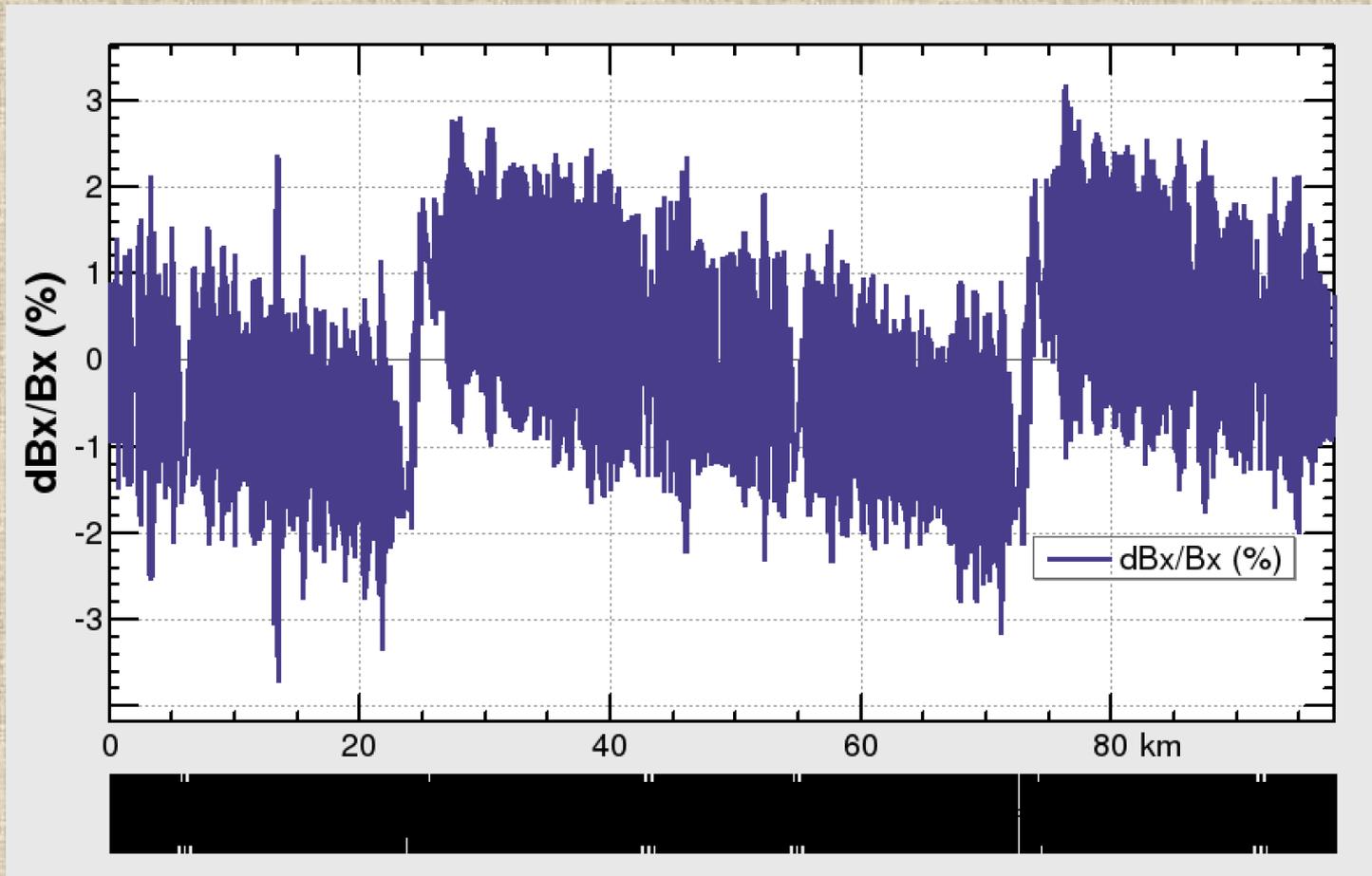


# Another seed 57

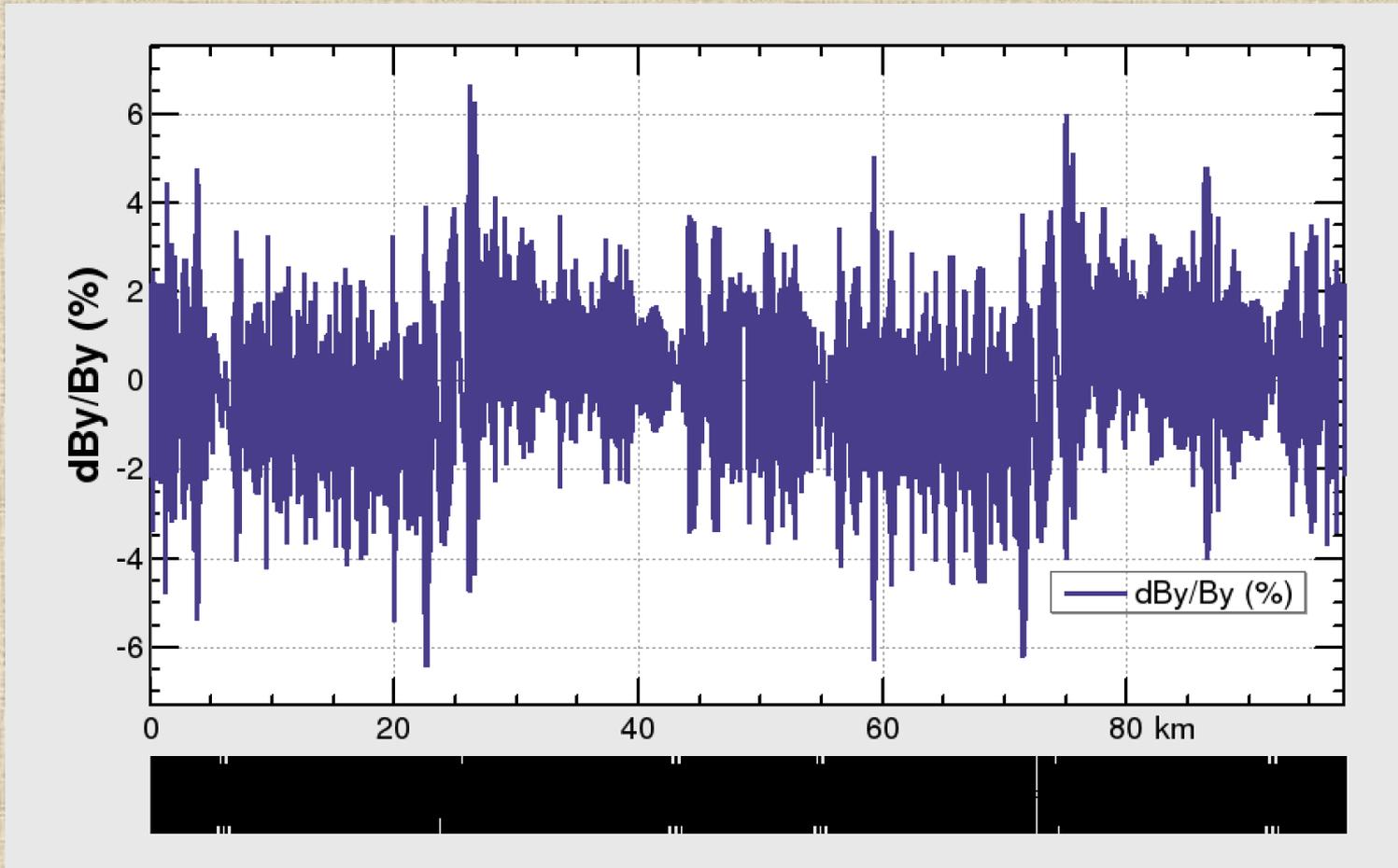
- Study another converging seed: 57
- The vertical emittance given by this lattice is  $0.14 \text{ pm}$
- Vertical dispersion at IP :  $\eta_y = (-1.8 \text{ } \mu\text{m}, 0.8 \text{ } \mu\text{m})$
- Coupling R2 parameter at IP:  $R_2 = (-98 \text{ } \mu\text{m}, -25 \text{ } \mu\text{m})$



# Beta beat - Horizontal

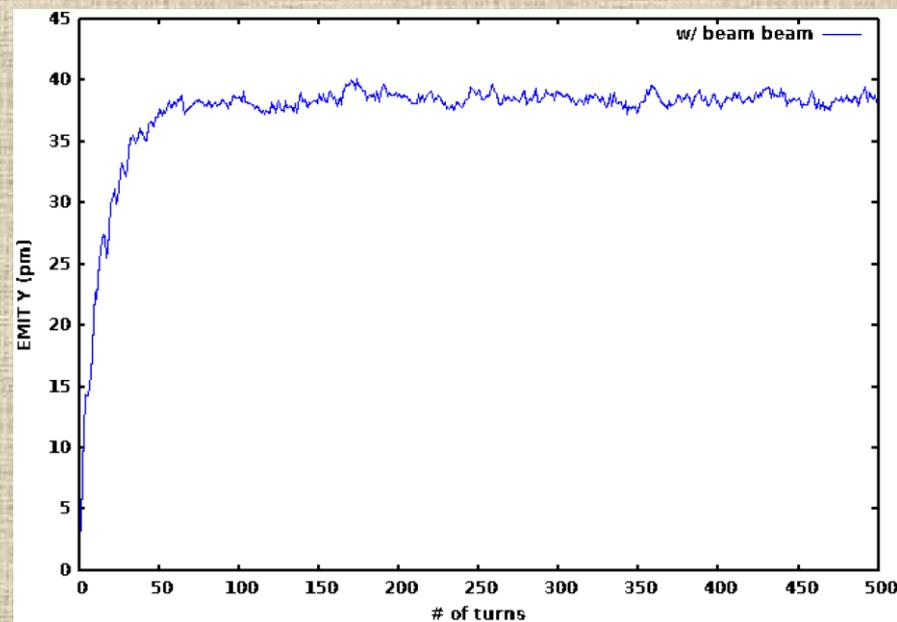
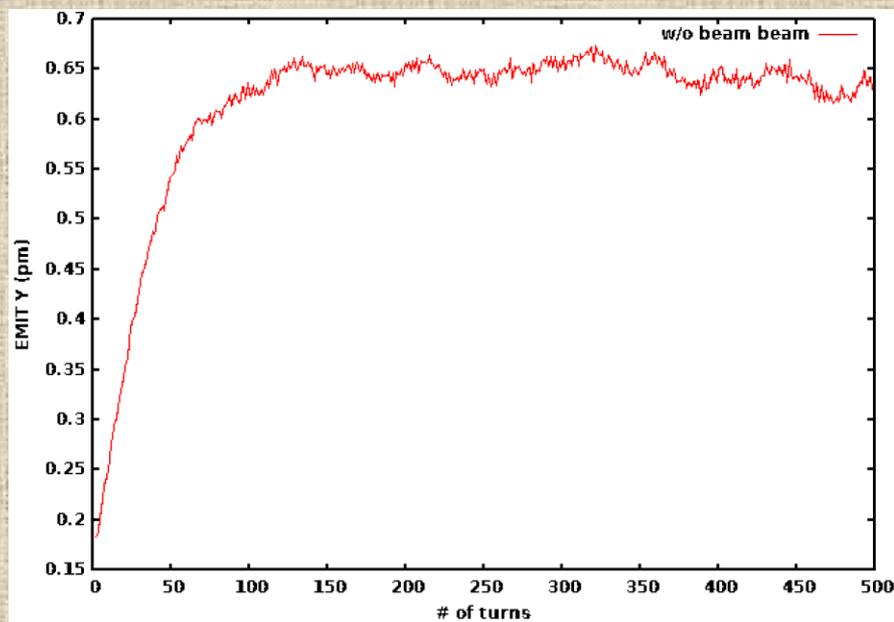


# Beta beat -Vertical



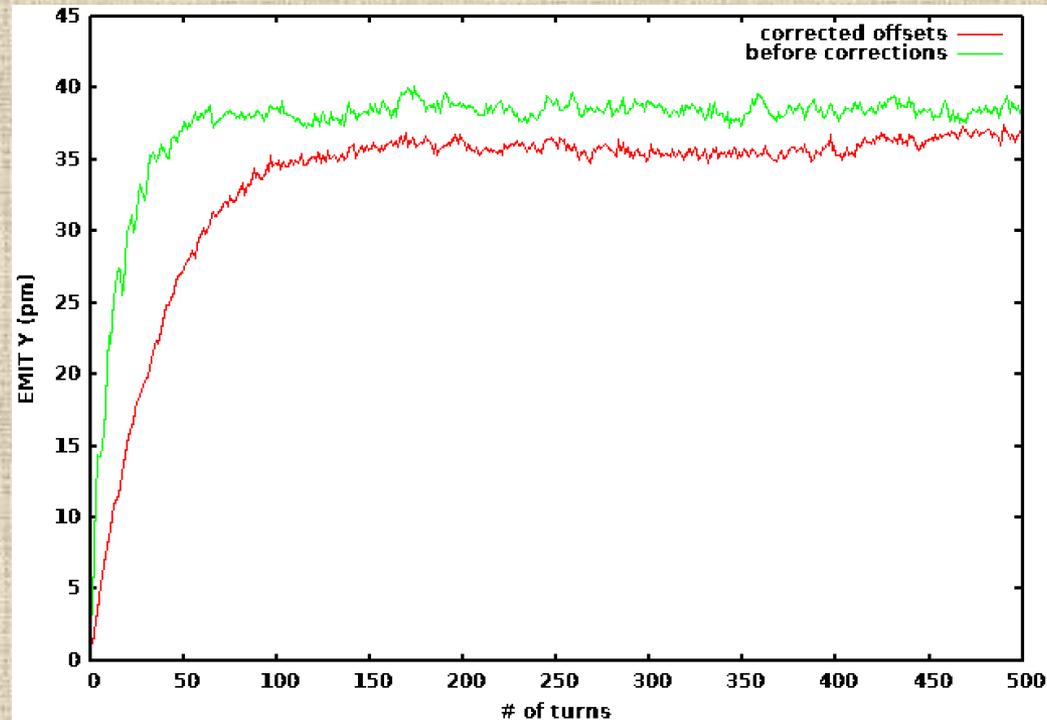
# Tracking

→ The blowup is large with beam beam



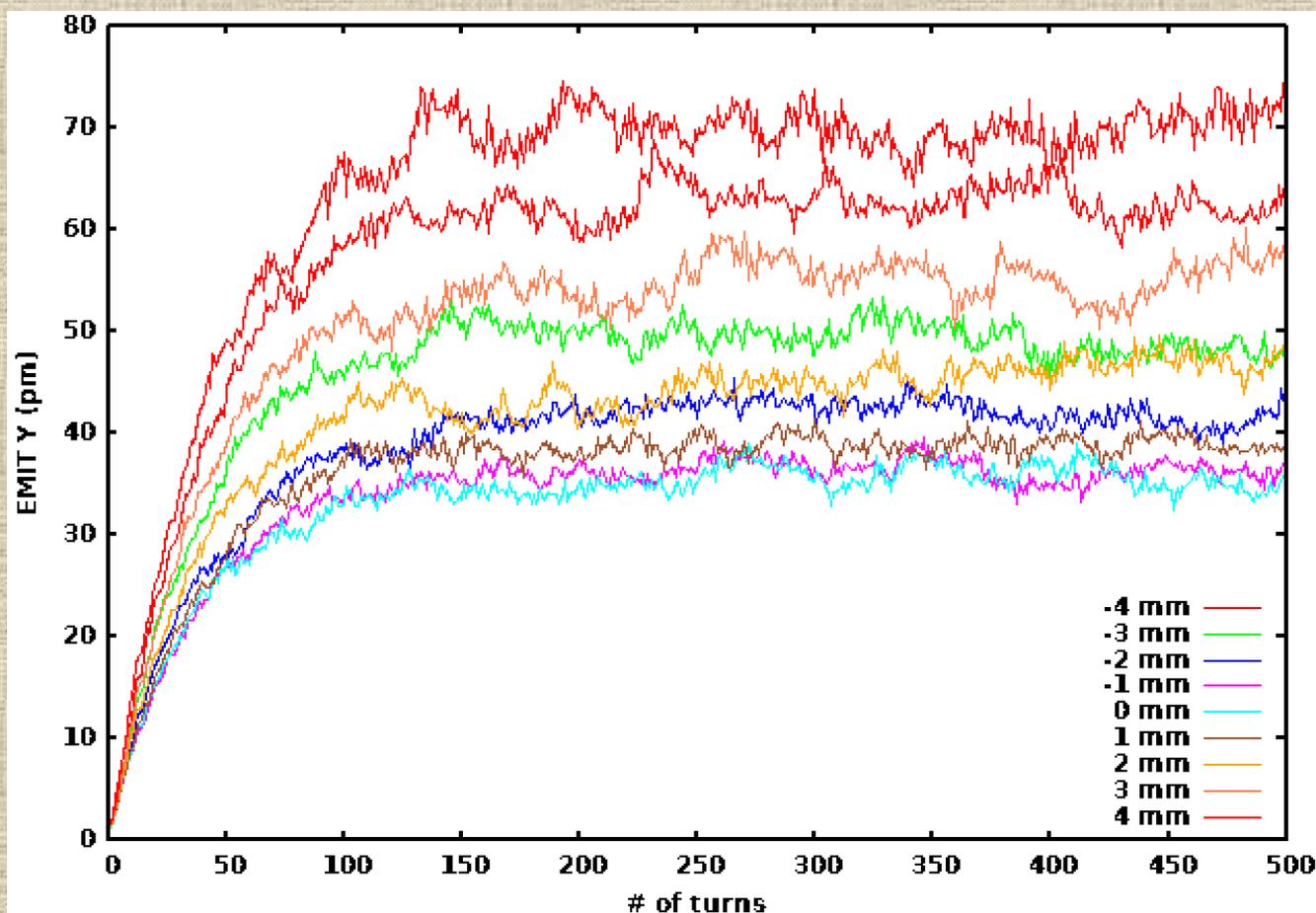
# Orbit Offsets at the IP

- After performing the misalignments + corrections, an orbit offset is introduced at the IP
- $\Delta x @ IP: (-0.6 \mu m, 15.1 \mu m)$
- $\Delta y @ IP: (-1.34 \mu m, 1 \mu m)$



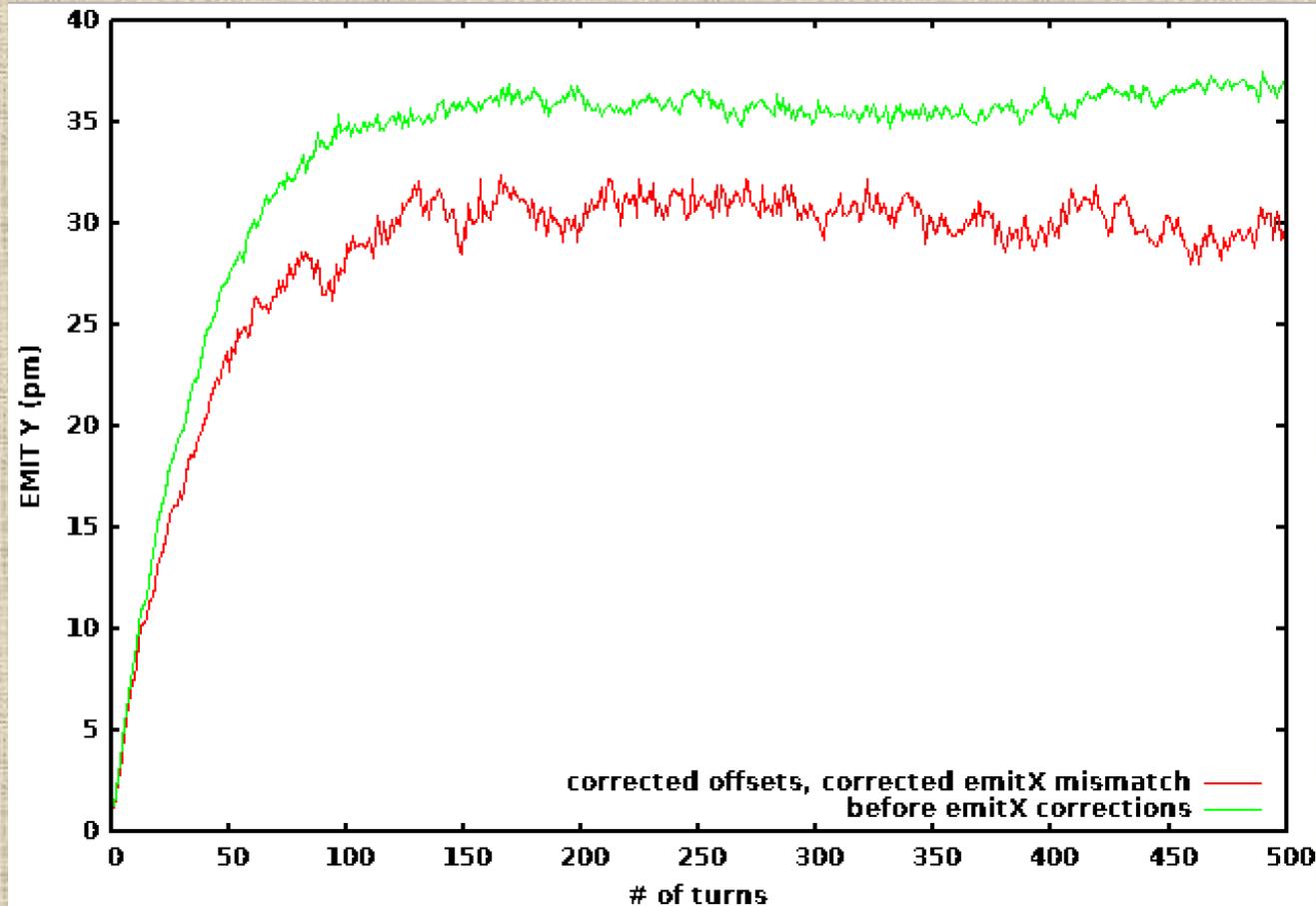
# Waist scan

- After offset corrections, let us perform a waist scan.
- Is the waist point shifted from the IP??
- From the values of the Twiss parameter  $\alpha_x = (-0.0054, -0.0057)$  and  $\alpha_y = (-0.0036, -0.0032)$ , we believe that the waist is not moved



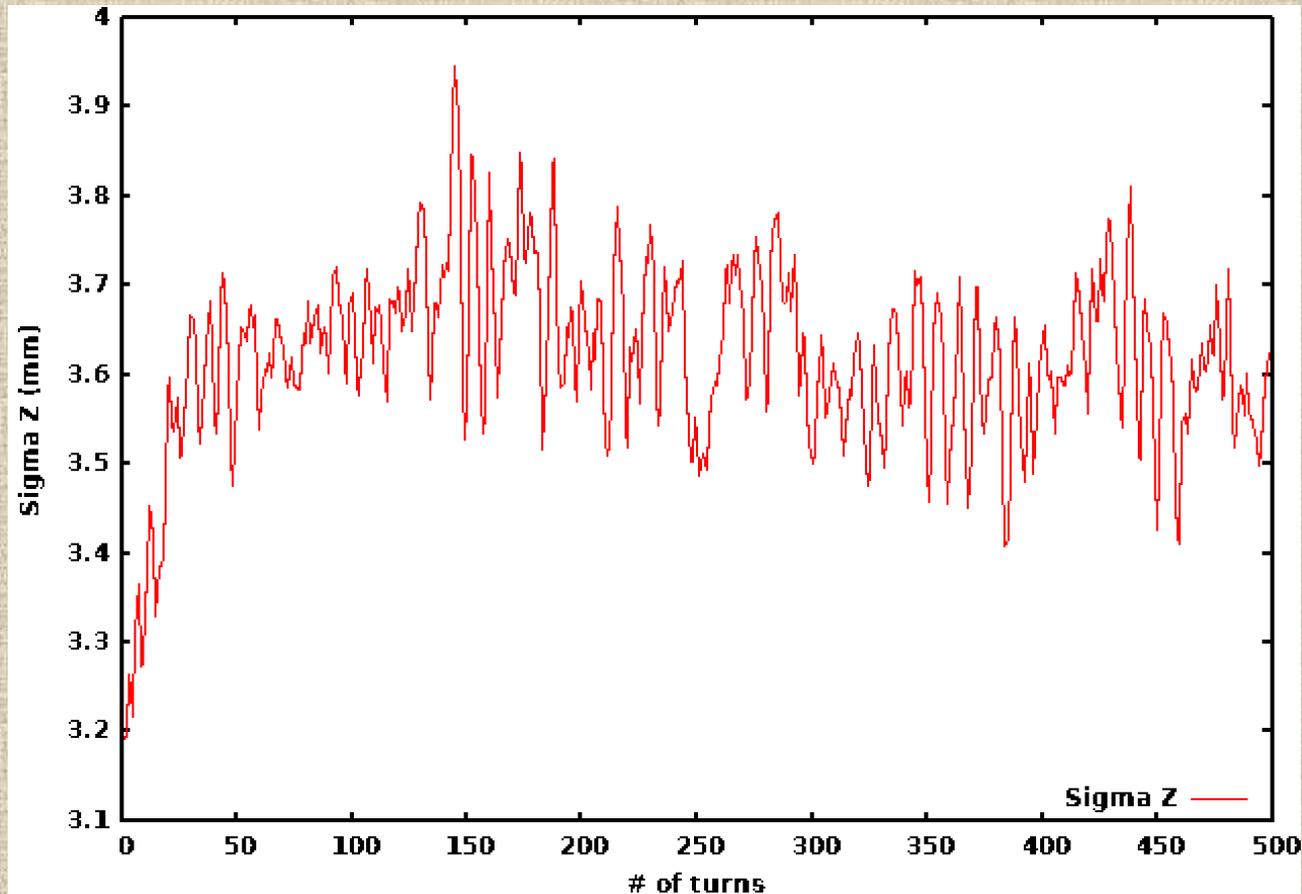
# Horizontal emittance

- A mismatch in horizontal emittance?
- The design value is 1.34 nm, the value resulting after corrections is 1.52 nm

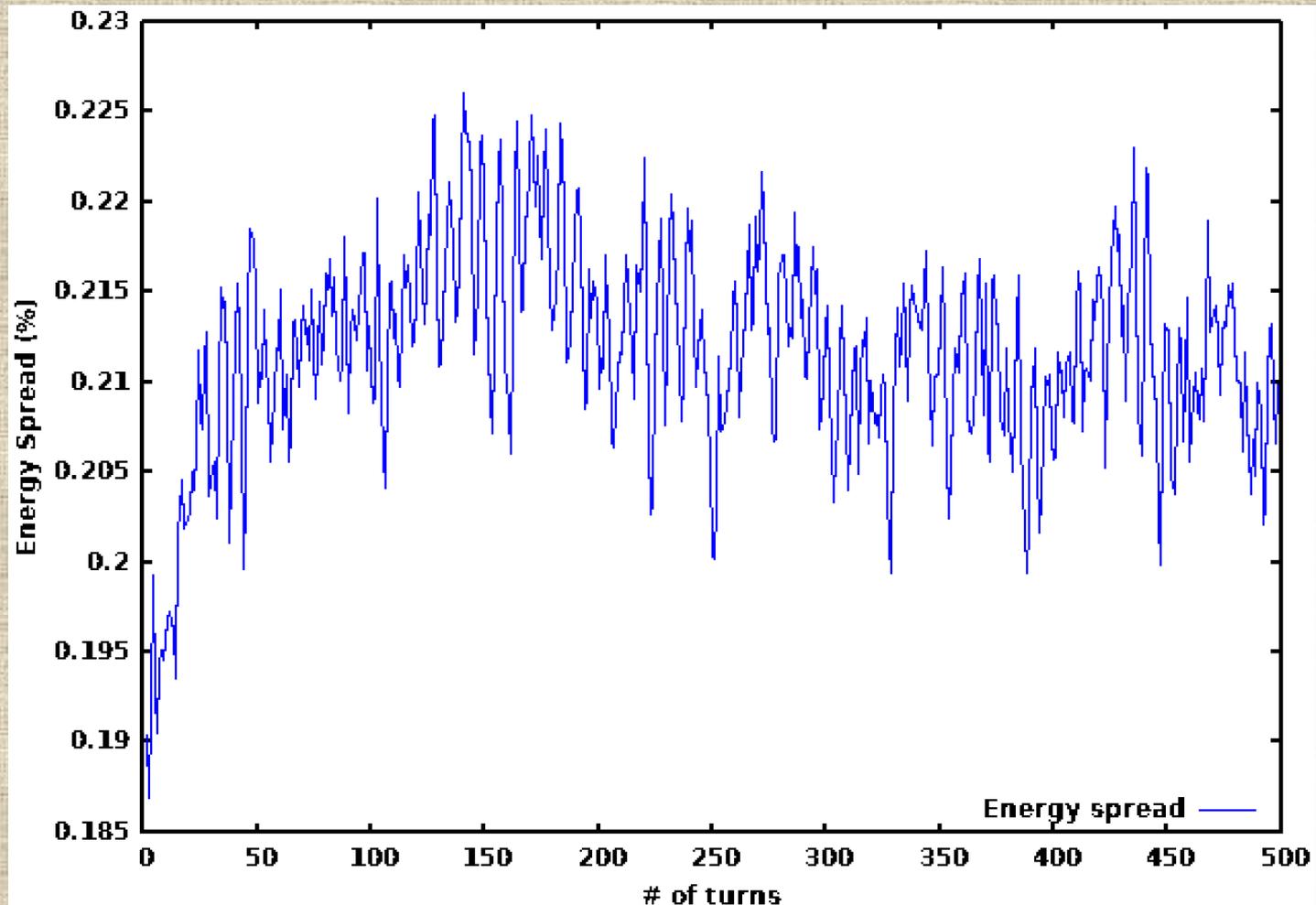


# Longitudinal emittance

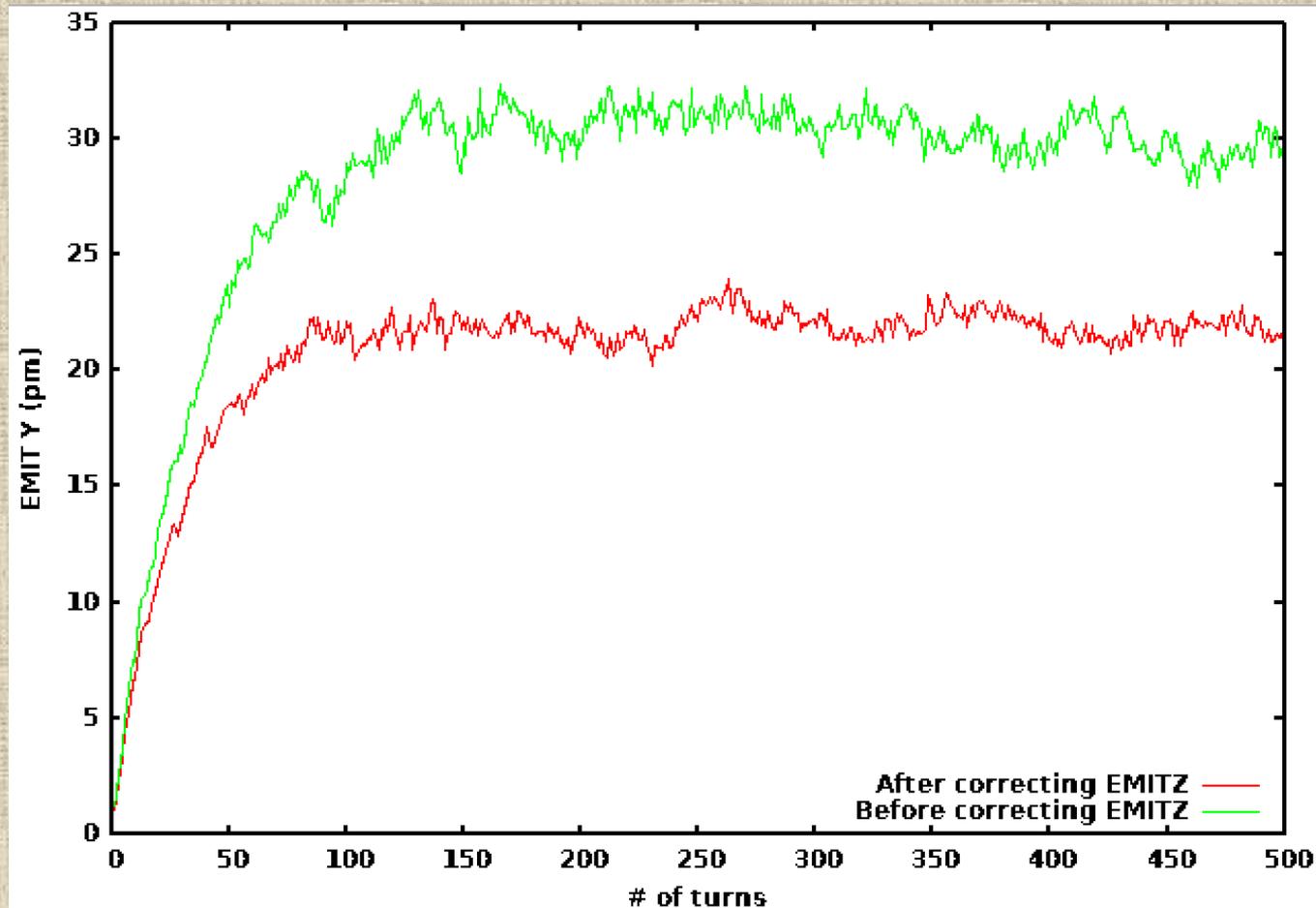
- A mismatch in longitudinal emittance?
- From parameter table, after beamstrahlung:  $\sigma_z = 3.25 \text{ mm}$  and  $\delta_E = 0.192\%$



# Longitudinal emittance



# Longitudinal emittance



## Conclusions

- Beam-beam effects are being simulated at FCCee in the presence of xy coupling sources
- A blowup of the vertical emittance has been observed, even in the absence of beam beam
- The blowup is observed to be depending on the random seed generator/ coupling overall the ring
- Different mismatch parameters were studied and corrections resulted in improvement of the blowup
- And still more studies are going on

# Perspectives

- Perform further simulations with corrected lattices (different seeds)
- Simulations with new corrected lattices with conserved tunes
- Proceed further to reconstruct loss maps due to beamstrahlung losses
- Establish a collimation system to protect the IR from backgrounds from beamstrahlung and radiative Bhabha

THANK YOU FOR YOUR ATTENTION

## Sextupoles misalignments/ $\epsilon_y=0.12$ pm + shifted tunes

- Note: The tunes are shifted from the design values after corrections
- Is the blowup due to the shifted tunes?
- $(\nu_{x_0}, \nu_{y_0}) = (0.553, 0.59)$ .
- $(\nu_{x_f}, \nu_{y_f}) = (0.544, 0.611)$ .
- Now, the tunes have been shifted from the design tune to represent “a similar” case as the corrected lattice
- A blowup **with a beam beam** has been observed compared to the design tunes

