The Study of the drive beam misalignment

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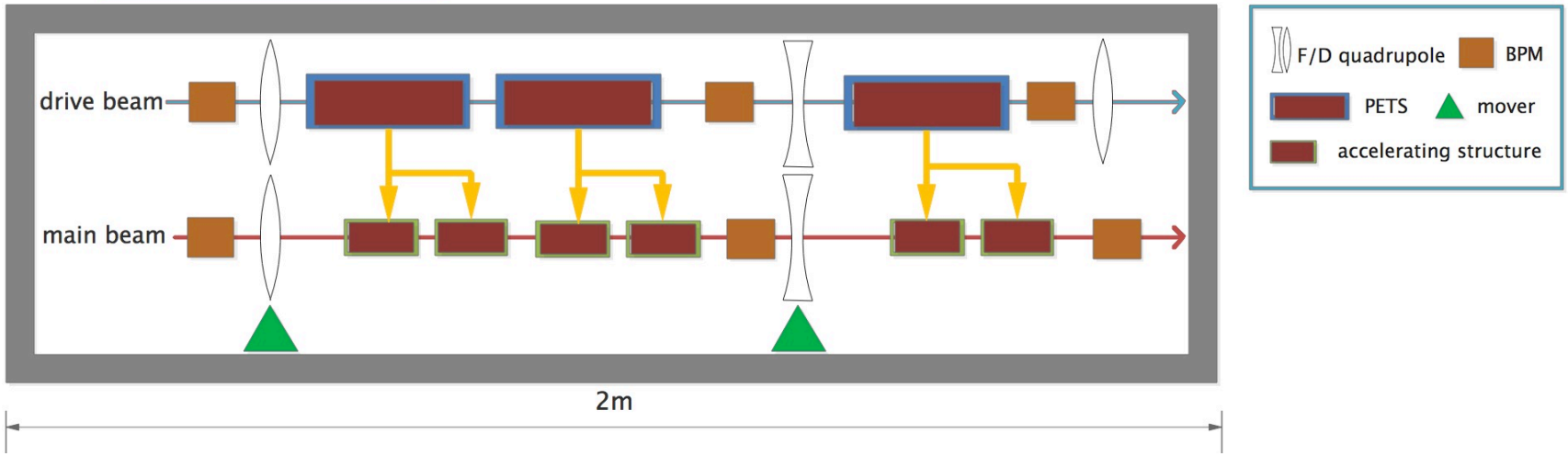
Outline

- Motivation
  - Two ➡ One girder option
    - Why?
    - How?
- Misalignments
  - Sine-like
  - Random
- Conclusions

Why we study it?

- Two girders ⟹ One girder
  - When we align the main beam components, this will impact on the drive beam transport.
  - How much can we misalign the drive beam? While keeping 3σ envelope < 6mm*. Envelope growth should not be more than order of 0.1mm for several 10μm movements of main linac.



* Guido Sterbini. Decelerator BBA using 4 m long girders Is it possible[Z]. CERN,2012.

How to study it?

- Misaligning the drive beam and transport it
  - Survey
    - Sine-like $y = A \cdot sin\left(\frac{2\pi}{\lambda} s\right)$
    - Random
      - Gaussian distribution
      - w/o correction
  - Components
    - Quadrupoles
    - PETS
    - All elements
- Maximum or final envelope is the criteria to determine drive beam sensitivity to misalignments
- The drive beam lattices and scripts* are provided by Guido Sterbini#.
- Lattice considered in this study: scenario 1 (2 m girder without snake. FODO cell with Δμ ≈ 93 deg)

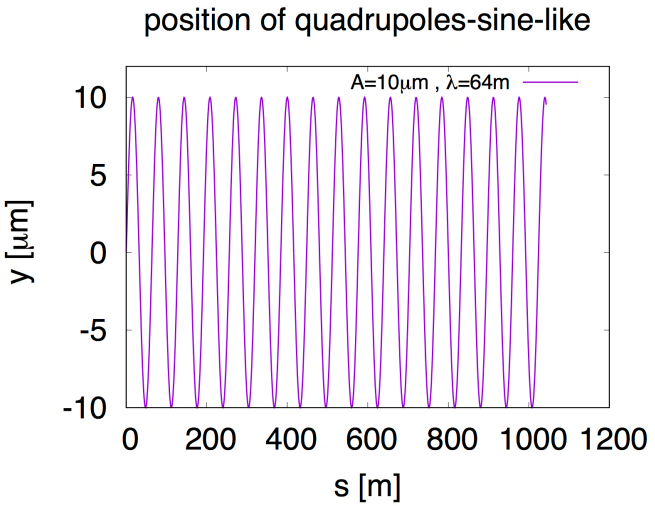
* PLACET is the tool used for tracking. And the beam is sliced beam.

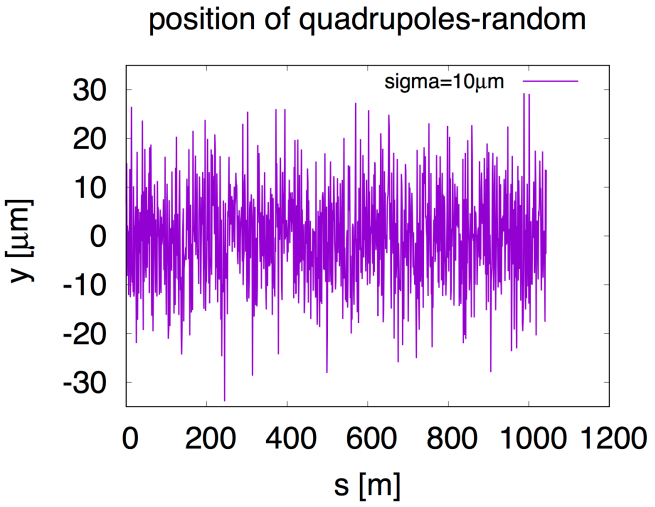
Guido Sterbini. Decelerator BBA using 4 m long girders Is it possible[Z]. CERN,2012.

Guido Sterbini. CLIC Module DB girder alternatives[Z]. CERN,2012.

Drive beam misalignments

- Sine-like
  - No correction
    - All elements
    - PETS
    - Quadrupoles
- Random
  - No correction
    - All elements
    - PETS
    - Quadrupoles
  - With correction

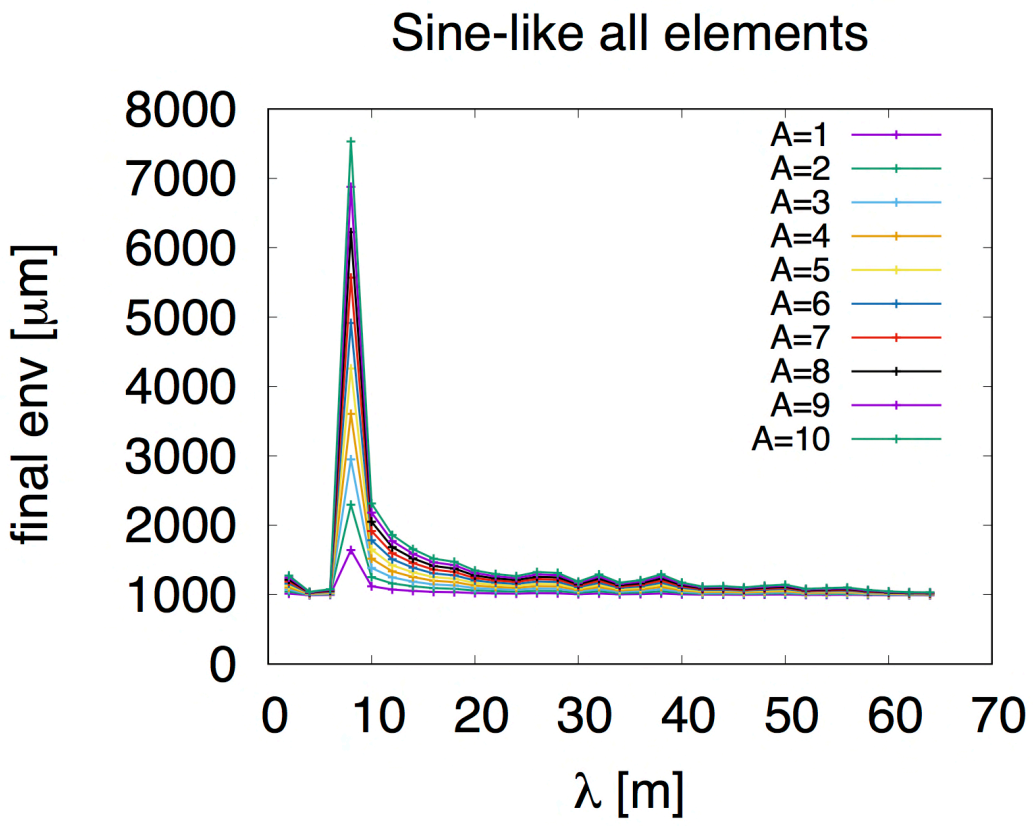




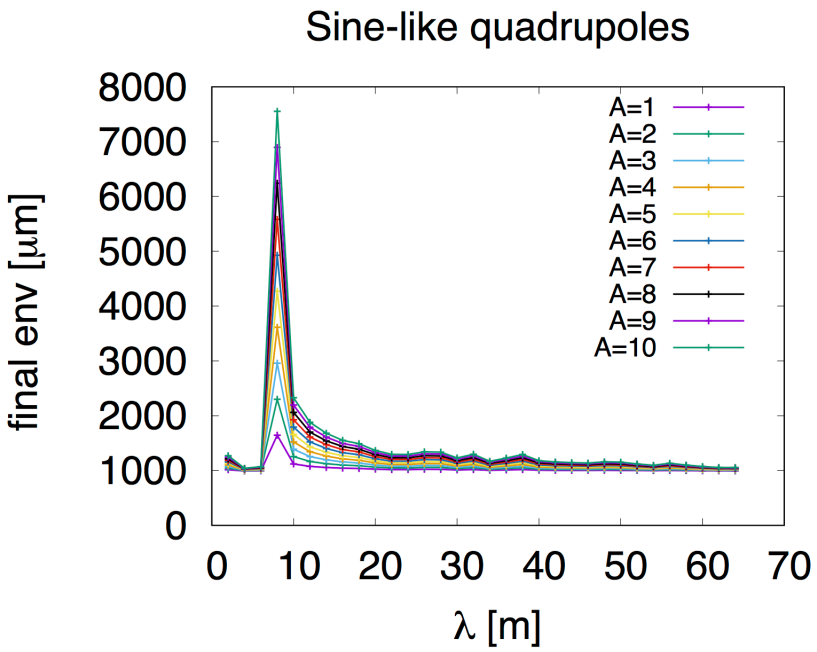
Sine-like without correction all elements

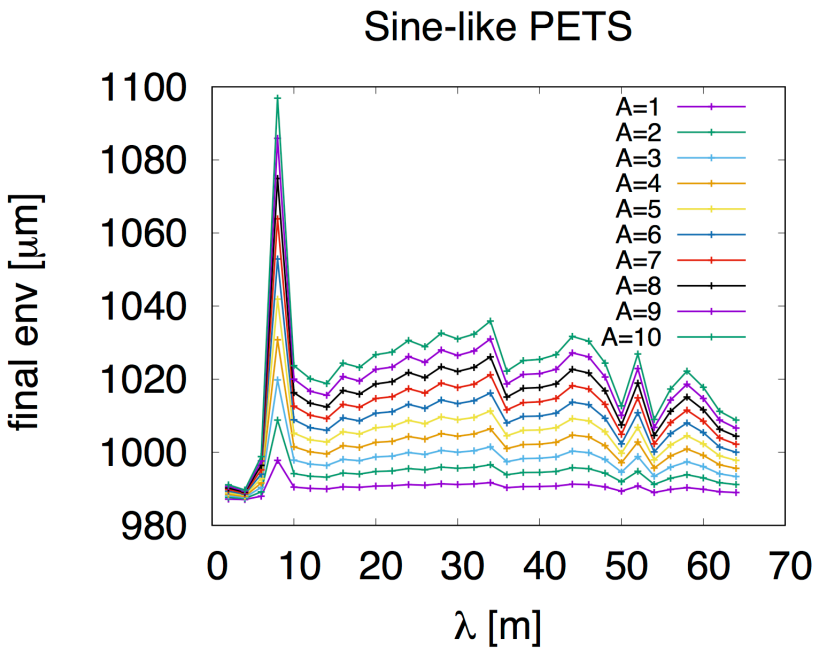
$$y = A \cdot sin\left(\frac{2\pi}{\lambda}s\right)$$

- λ goes from 1 to 64m
- A goes from 1 to 10μm
- 1-σ envelope
- Env_initial = 986.77μm
- Bpm resolution: 1μm
- Peak at λ = 8m due to betatron oscillation



Sine-like without correction Quads & PETS



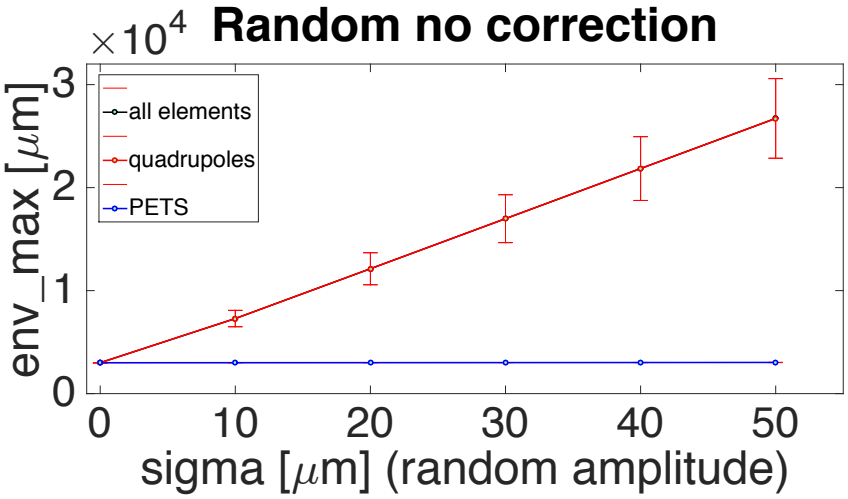


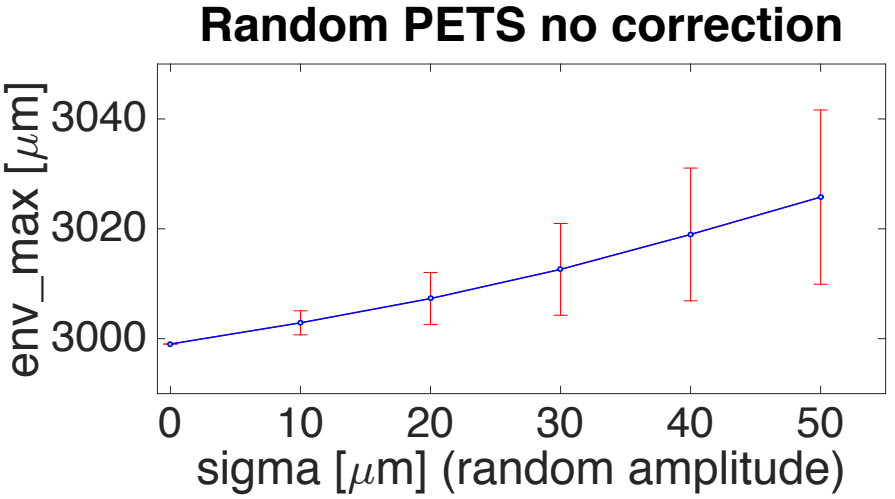
- Quadrupoles are way more important than PETS.

Drive beam misalignments

- Random Study
  - PETS
  - Quadrupoles
  - All elements
- Comparison
  - No correction
  - Oscillation Free Steering
  - Dispersion Free Steering
- 3-σ envelope
- Bpm resolution: 1μm
- env_max is the mean value of the maximum envelope over 30 machines

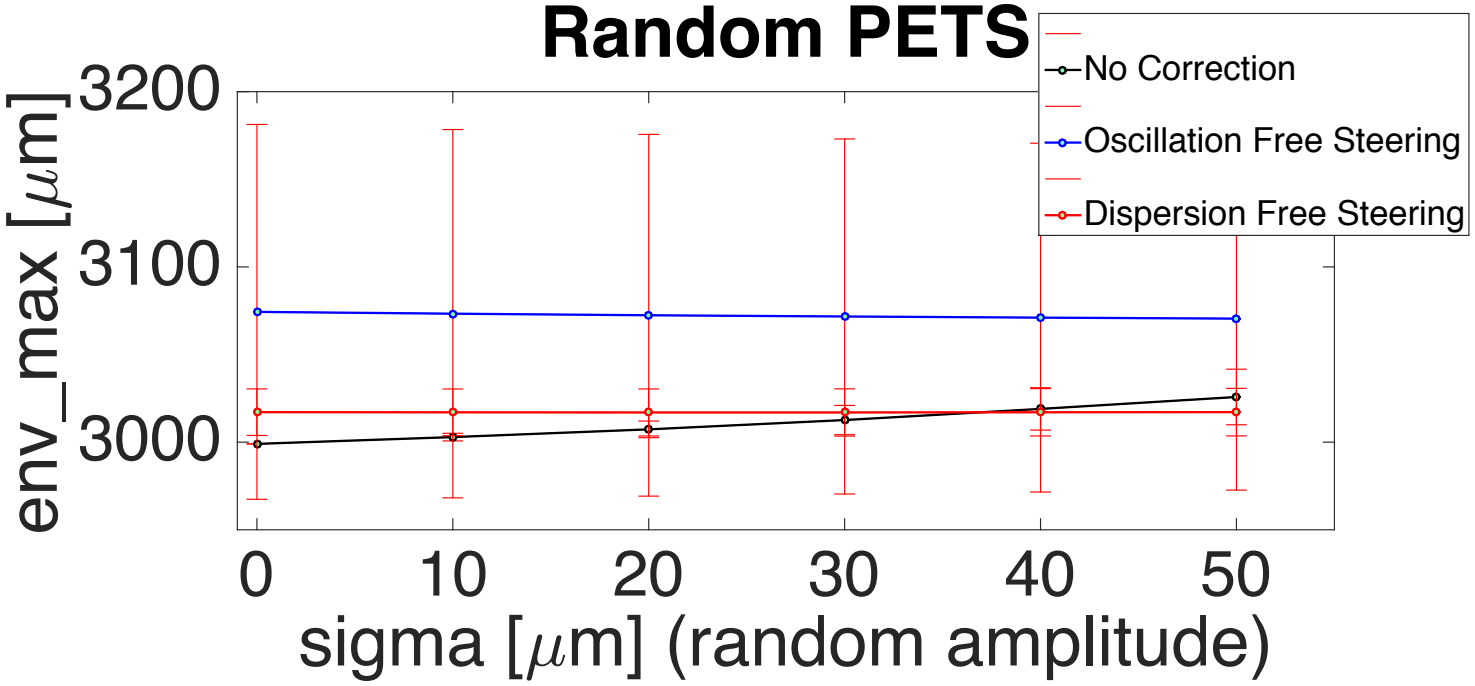
Comparison with no correction





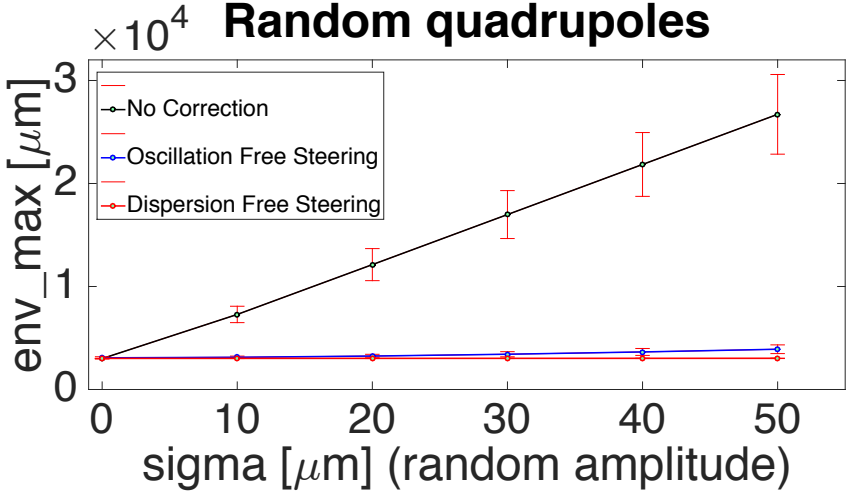
- Envelope increases linearly with the amplitude.
- PETS misalignments impact a little on envelope compare to quads.

Random PETS with correction

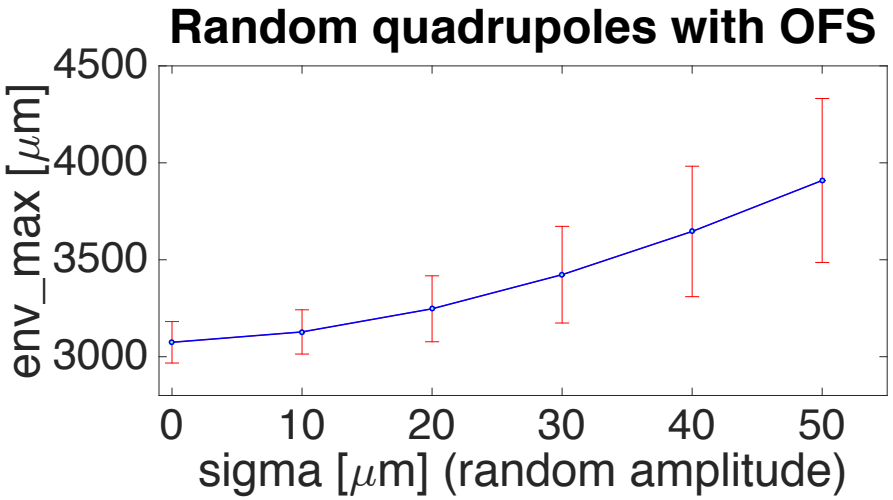


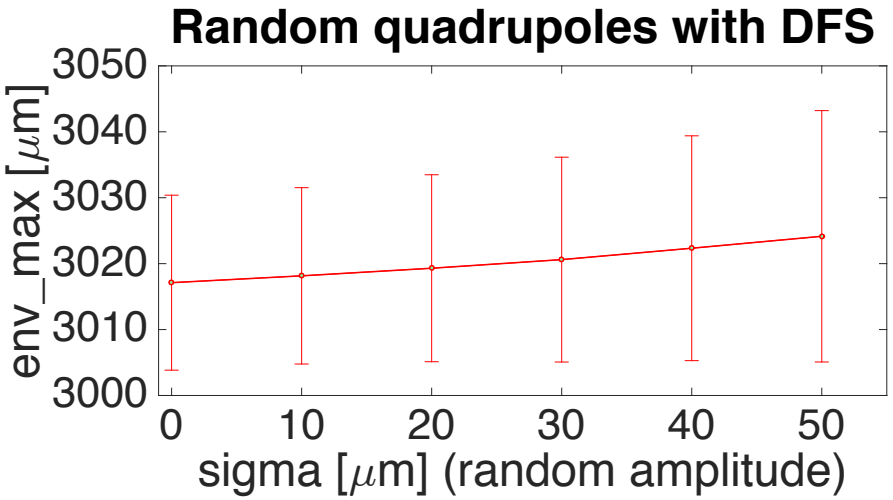
➢Corrections impact little for PETS misalignments. It is more like statistical fluctuation.

Random quadrupoles with correction

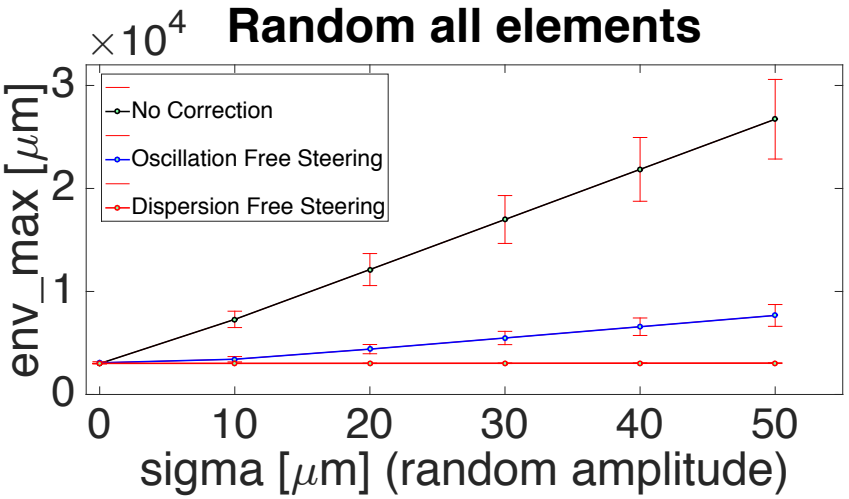


- Corrections work well, especially the DFS.
- The envelope increases likely quadratically with amplitude with OFS.

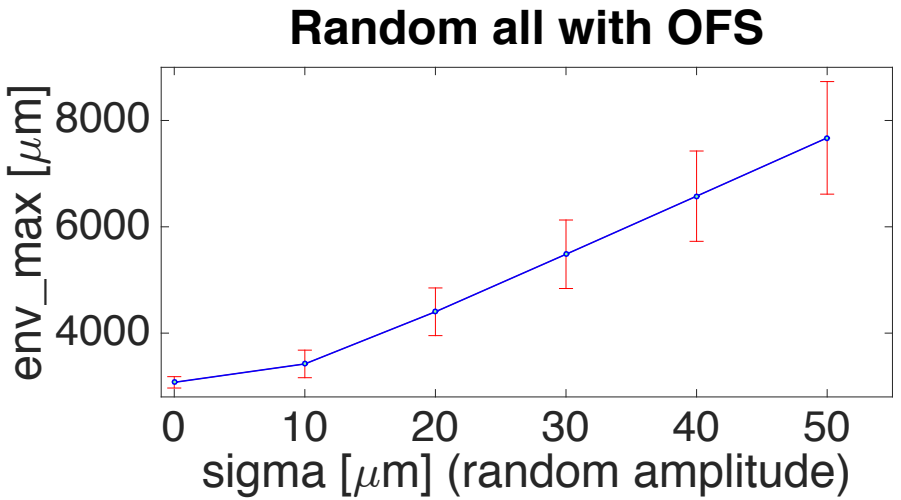


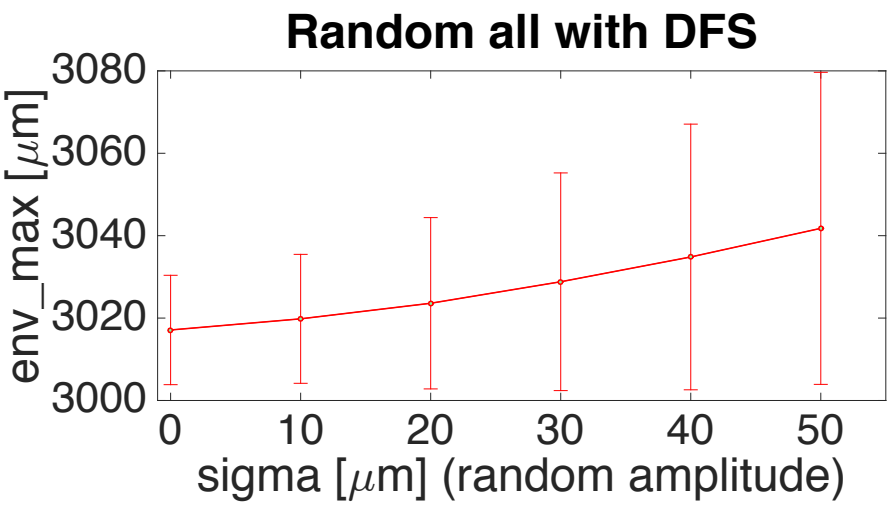


Random all elements with correction

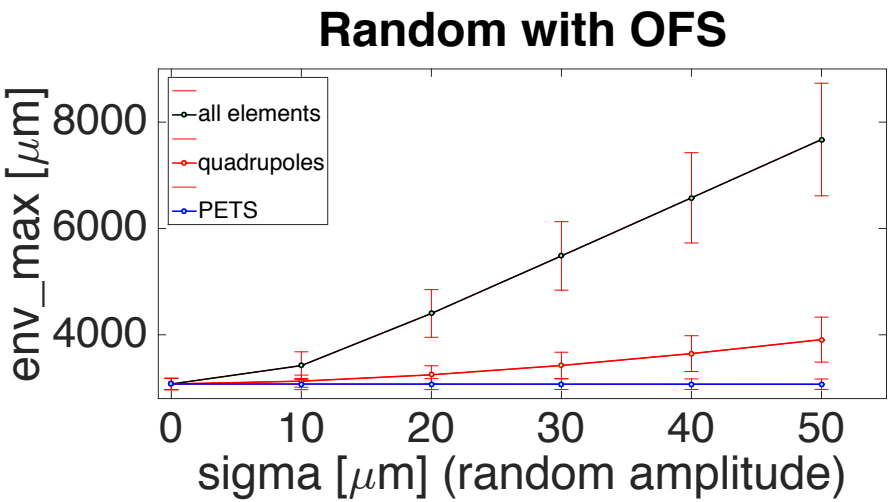


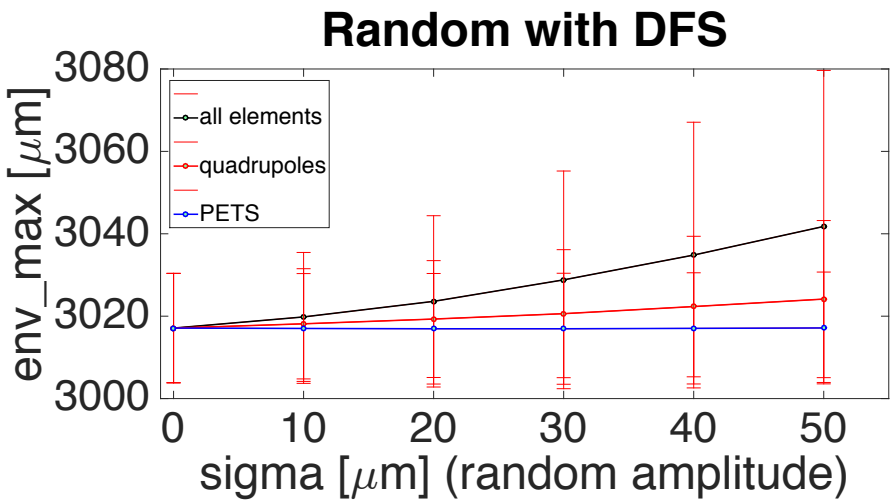
- It is nearly the same as only with quads without correction.
- Worst performance after correction, as expected.





Correction summary





- OFS does not perform well.
- DFS works well, and the differences between quadrupoles and PETS become smaller.

Conclusions

- When misaligning elements following either sine-like or random distributions, envelope increases linearly with amplitude. A peak is observed at the betatron oscillation (wavelength=8m).

- Quadrupoles misalignments have a much bigger impact on beam envelope than PETS.

- DFS is the most effective correction method.

Conclusions

- When randomly misaligning all elements at 50µm
  - Envelope increases to 26mm without correction.
  - OFS corrects envelope down to 8mm. (167% growth)
  - DFS corrects envelope down to 3.04mm. (4% growth)
- When randomly misaligning PETS at 50µm
  - The envelope is 3.03mm without correction.
  - After OFS correction it is 3.07mm.
  - After DFS correction it is 3.02mm.
- Moving quadrupoles does not look good and requires complex correction for each small step.

Thank you!