KM steering and Dispersion bump simulation in RTML upstream of BC1

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Introduction

- Emittance preservation in “Old” RTML (no >10 km straight line), up to BC1 entrance
- Try to reproduce (check) results by P.Tenenbaum, presented in Valencia
  - Kick Minimization steering
  - Dispersion bumps
- Macro-particle tracking using computer code SAD

Kick Minimization

Quad magnet, BPM and steering magnets should be attached.

$$\text{Minimize } r\sum_i (x_i^2 + y_i^2) + \sum_i \left[\left(\theta_{x,i} + k_i x_i\right)^2 + \left(\theta_{y,i} - k_i y_i\right)^2\right],$$

$\theta_{x(y)i}$: Additional kick angle (additional to designed kick) of steering at i-th quad

$x(y)_i$: Offset from designed orbit at i-th quad

k_i : K-value (inverse of focal length) of the i-th quad

r : Weight ratio : (Quad-BPM offset)^2/(Quad offset)^2

Dispersion bump

- Knobs

(a) Set opposite strength of a pair of skew quads in turn around, -I between them.

(b) Set opposite strength of another pair of skew quads in turn around, -I between them. 90 degree phase difference from the first pair.

Knob 1: (a) + (b)

Knob 2: (a) - (b)

- Monitors

  Use three laser wire monitors (beam size monitors) at the end of the line (before BC1), 45 degree phase advance between two.

- Minimize

$$\sigma_{y1}^2 + \sigma_{y2}^2 + \sigma_{y3}^2 \quad (\sigma_{yi} \text{ is beam size at } i\text{-th laser wire monitor})$$

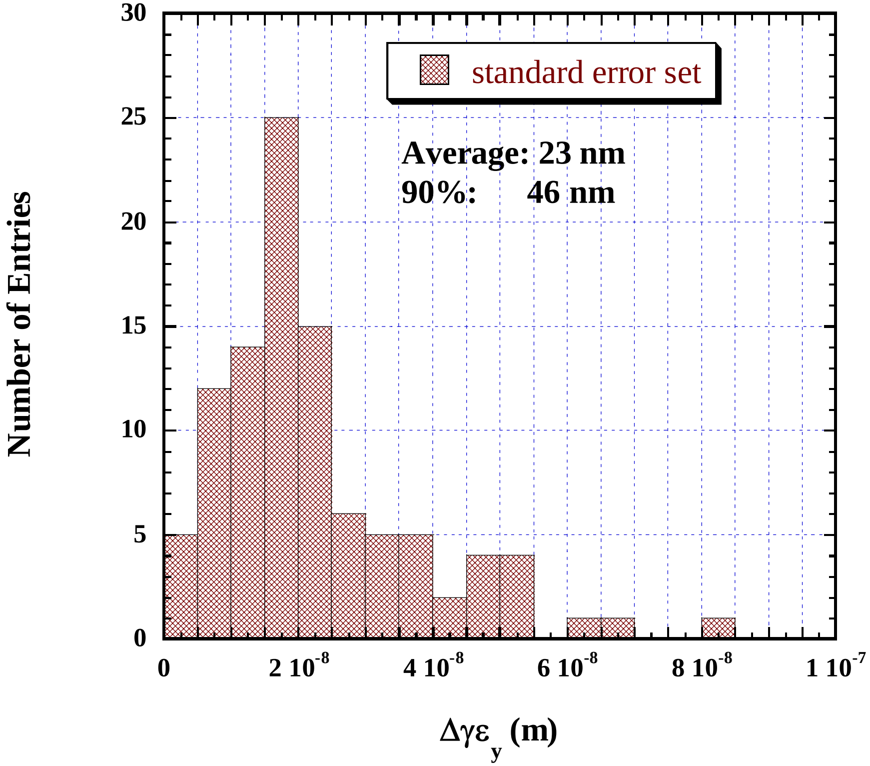
No measurement error is included.

Errors - same as PT’s

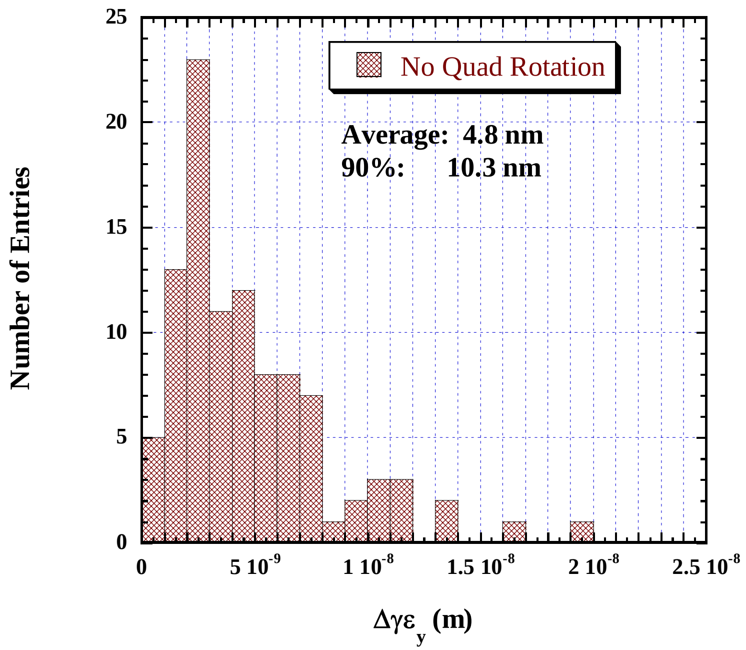
Tolerance Type	RMS Value
Quad Misalignments (x,y)	150 um WRT survey line
BPM Offsets (x,y)	7 um WRT quad center
Quad Strength Errors	0.25%
Bend Strength Errors	0.5%
Quad Rotation	300 urad
Bend Rotation	300 urad

Result of KM steering

Final vertical emittance increase, 100 random seeds

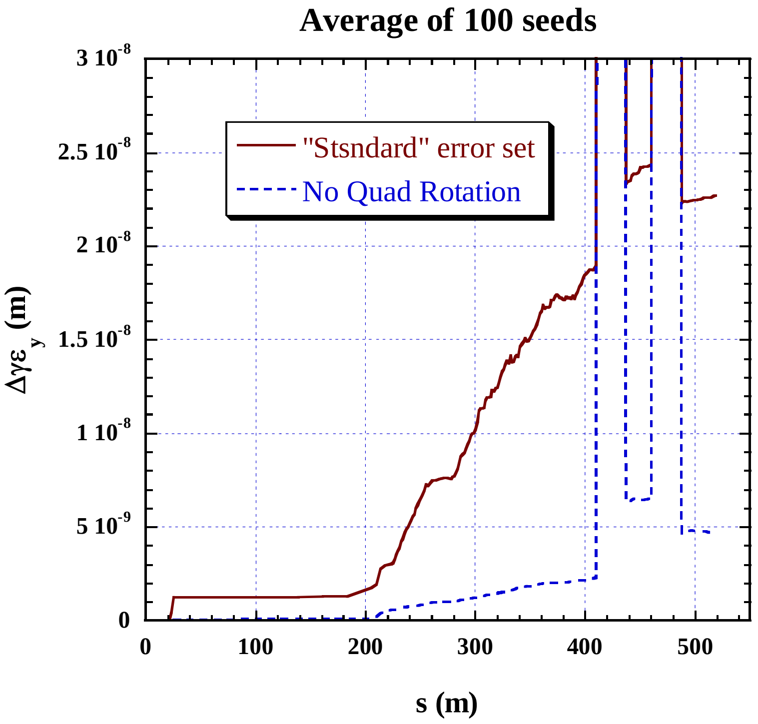


Dominant source of emittance increase is quad rotation. Distribution without quad rotation (with other errors)

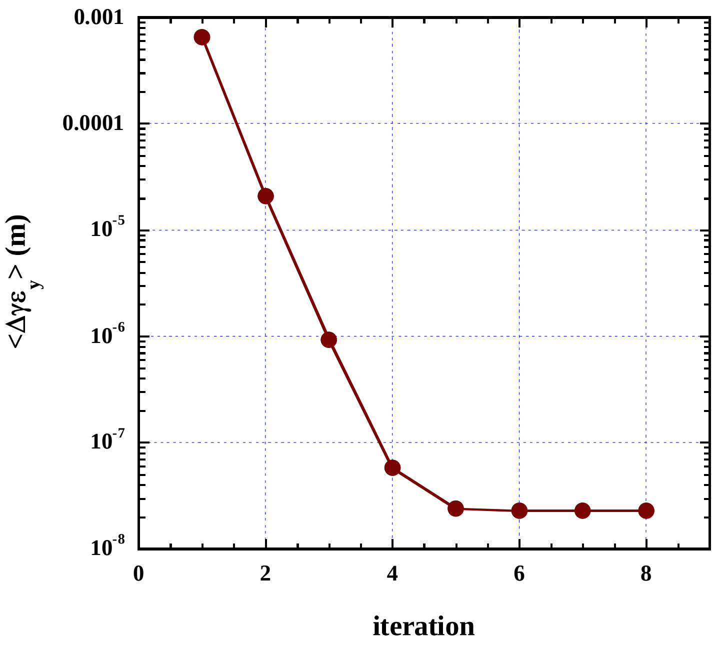


Result of KM steering - 2

Emittance vs. distance
Emittance increase in turnaround

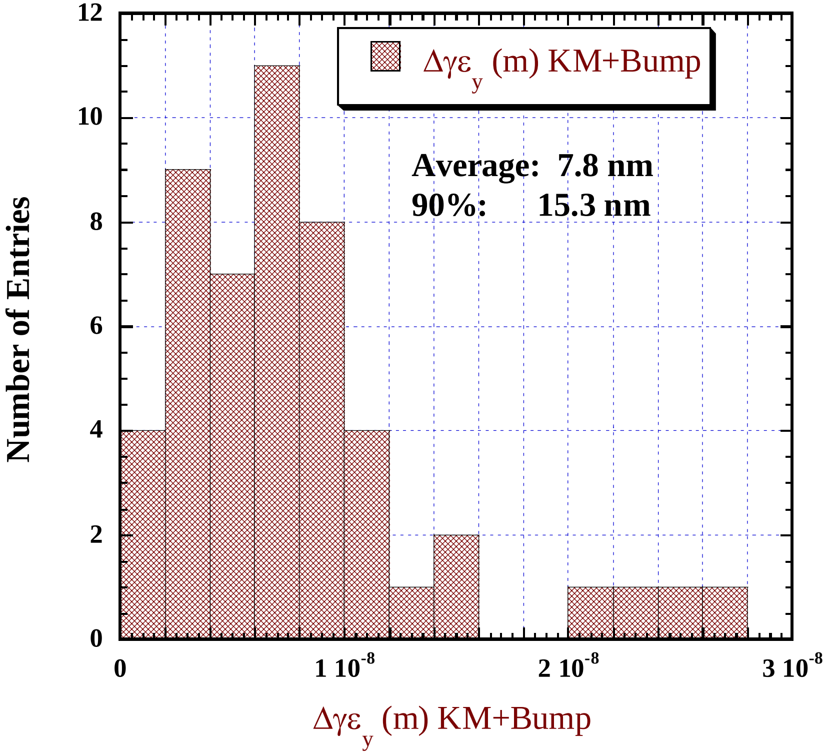


Need several iteration of KM steering



Result of KM steering + Bump

Final vertical emittance increase,
50 random seeds



SUMMARY - Comparison with PT's results

	This simulation	PT
KM steering		
Mean	23 nm	23 nm
90%CL	46 nm	44 nm
KM + Bump		
Mean	7.8 nm	7.6 nm
90%CL	15.3 nm	13.2 nm

Agree well.

Next step:

Include beam size monitor errors

Add coupling correction