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Simulation of DFS (Dispersion Free Steering) using SLEPT

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DFS simulation of curved ILC Main Linac

- Code SLEPT.
- Curved linac, following earth's curvature.
- Still use 4 cryomodules per bpm-magnet package: Lattice given by P.Tenenbaum [1]
- "Standard" errors are set. Horizontal misalignments are three times of vertical.
- DFS "mode-1" [2] in both vertical and horizontal.
- Vertical emittance at the end of linac is looked.
- Sensitivity to each error (vertical) is also looked.
- There was a bug in the SLEPT DFS algorithm, which was fixed on August 24. Reports before that may have some errors in "DFS mode-1 and mode-2" [2] .

“Standard” errors (RMS)

	Vertical	Horizontal
Quad Offset (μm)	360	1080
Quad Roll (μrad)	300	
Cavity Offset (μm)	640	1920
Cavity Pitch and Yaw (μrad)	300 (pitch)	900 (yaw)
BPM Offset (μm)	360	1080
BPM Roll (μrad)	0	
BPM resolution (μm)	1	1
BPM scale error	0	0

All errors are random and independent.
This is almost (not exactly) equivalent to the “nominal misalignment” in ref. [3].
The first three quads and BPMs are perfectly aligned.

Simulated Algorithm of DFS, mode 1

One-to-one orbit correction (BPM reading zeroed)

·Divide linac into sections (50 quads-bpm/section, half overlapped)

In each section:

(1) Measure orbit with nominal beam energy. ($x_{0,I}$ and $y_{0,i}$ at i-th BPM)

(2) Reduce initial beam energy and accelerating gradient from the linac entrance to the entrance of the section by a common factor δ (δ= 0.1).

(3) For the second section or downstream, orbit adjusted at the two BPMs just before the section to make the position at the BPM

$$x_\delta = x_0 \text{ and } y_\delta = y_0 - \delta\eta_y$$

(x_0, y_0 are the position with nominal energy, η_y the dispersion at BPM.)

(4) Measure orbit. ($x_{\delta,i}$ and $y_{\delta,i}$ at i-th BPM)

(5) Set dipole correctors in the section to minimize

$$w\Sigma(x_{\delta,i} - x_{0,i})^2 + \Sigma x_{0,i}^{\ 2} \quad \text{and}$$

$$w\Sigma(y_{\delta,i} - y_{0,i} - \Delta y_{cal,i})^2 + \Sigma(y_{0,i} - y_{cal,i})^2$$

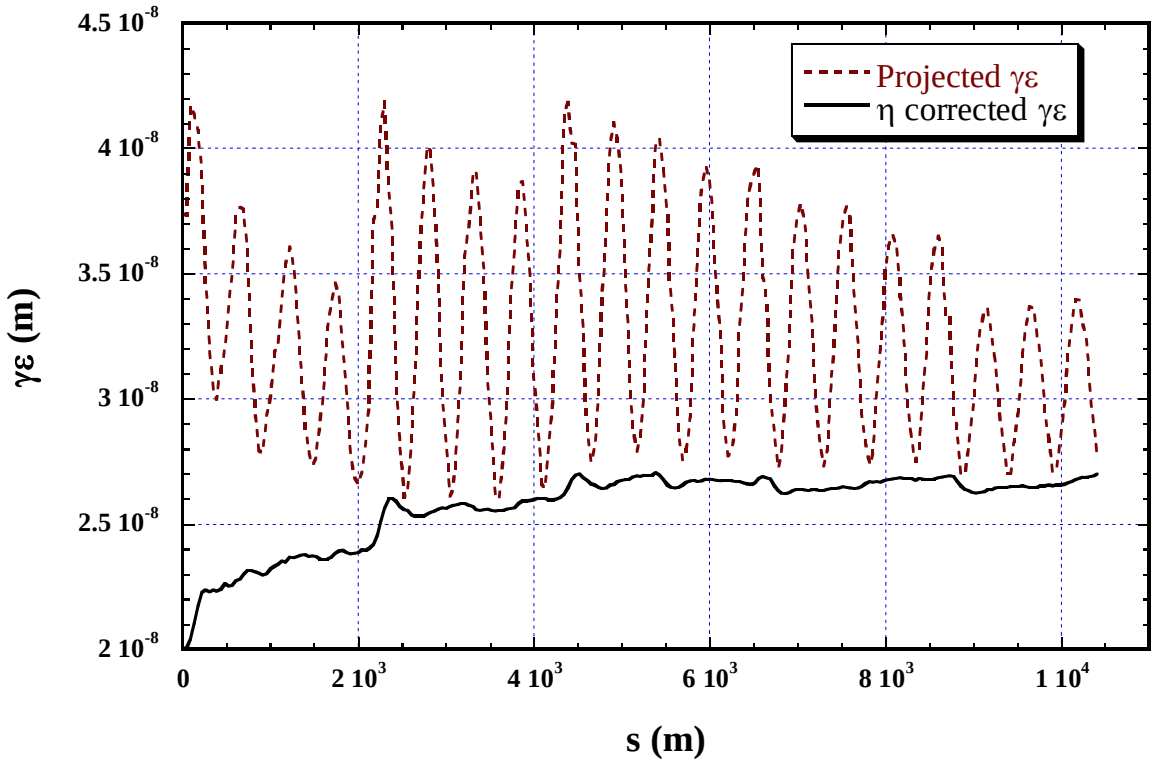
($\Delta y_{cal,i}$ is the calculated orbit difference, $y_{cal,I}$ the calculated orbit, without errors, at i-th BPM. w is the weight factor, w=5000.).

(6) Iterate from (1) to (5) once.

(7) Go to next section.

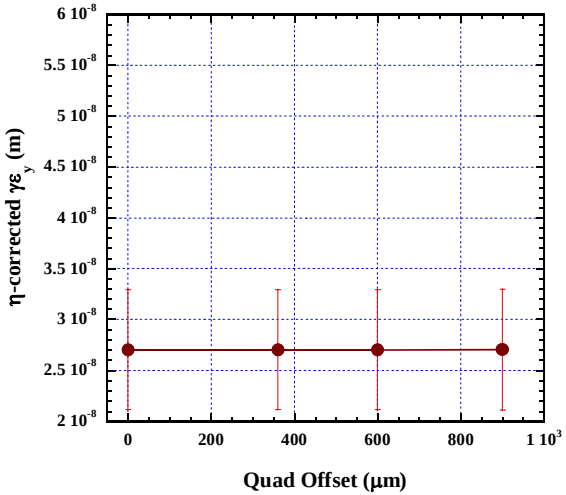
Vertical Emittance along linac

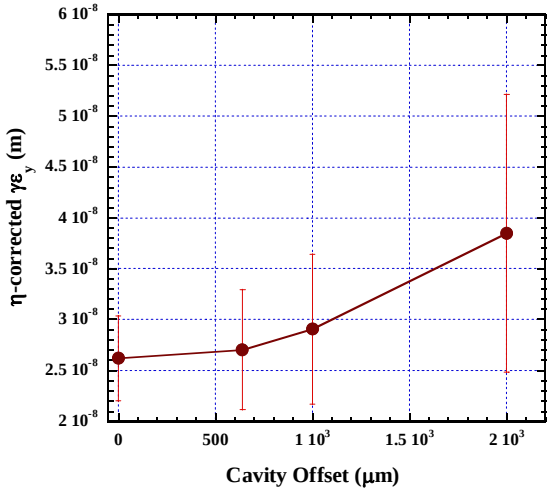
"standard" errors.
Average of 40 random seeds

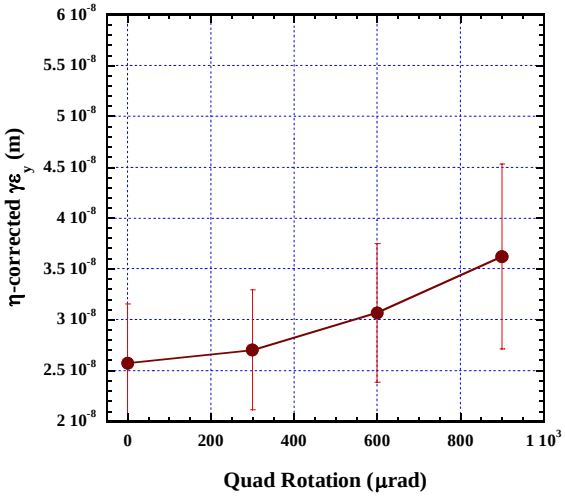


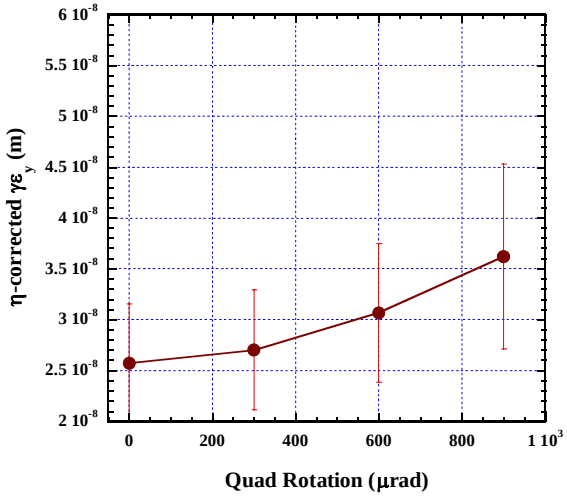
Sensitivity to each error-1

Other errors are kept as “standard”. Initial $\gamma\varepsilon$=2E-8 m.
Average of 40 random seeds. Error bars indicate standard deviations.



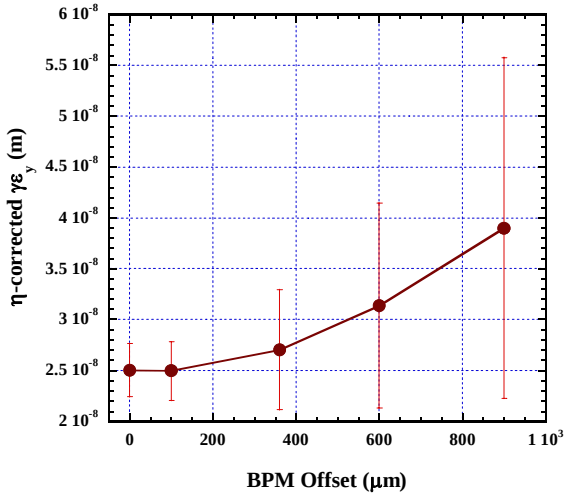


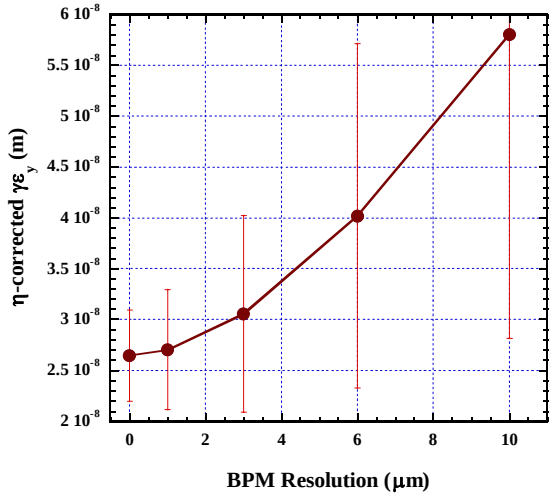


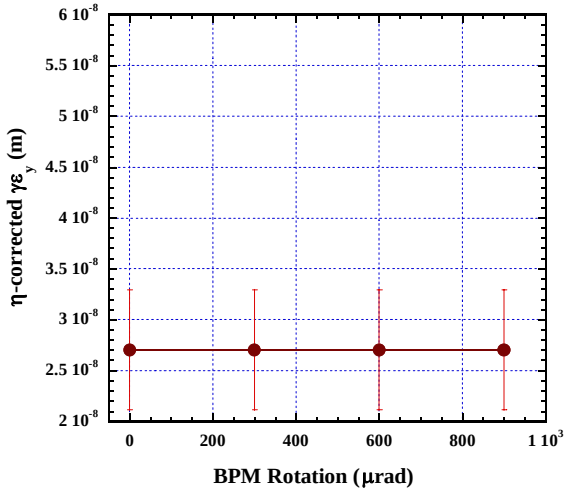


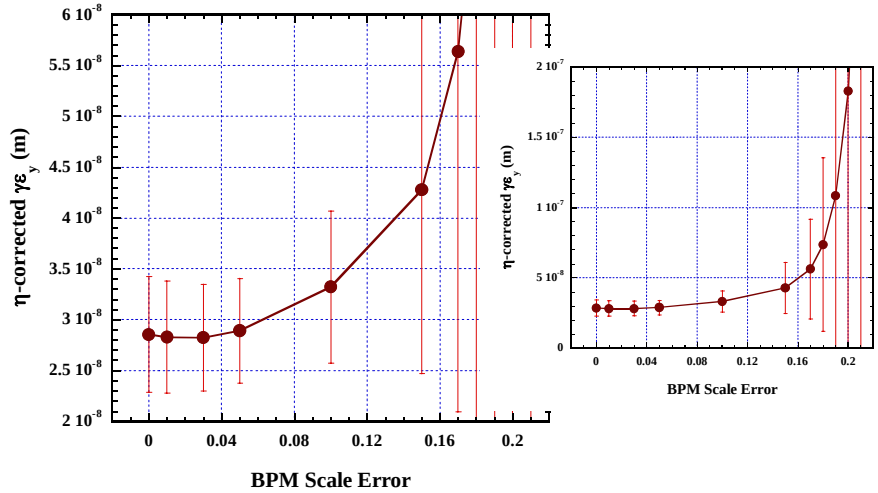
Sensitivity to each error-2

Other errors are kept as “standard”. Initial $\gamma\varepsilon$=2E-8 m.
Average of 40 random seeds. Error bars indicate standard deviations.









SUMMARY

- DFS with “Standard” errors give 35% emittance dilution (dispersion-corrected emittance), which will be (barely) tolerable.
- Within the surveyed range:
  - Strong dependence on BPM offset, resolution and scale error
  - Some dependence on Quad rotation and Cavity offset
  - Almost no dependence on Quad offset , Cavity tilt and BPM rotation
- Dependence on BPM offset looks inconsistent with K.Ranjan’s result, [3].
  - The reason is unknown.

References

[1]: http://www-project.slac.stanford.edu/ilc/acceldev/LET/ilc_linac.xsif

[2]: K.Kubo, in ILC Beam Dynamics Meeting,
http://ilcagenda.cern.ch/getFile.py/access?resId=3&materialId=slides&confId=694

[3]: K.Ranjan, Vancouver GDE meeting paralell session,
http://ilcagenda.cern.ch/conferenceDisplay.py?confId=753