DMS steering with BPM scale error
- Trial of a New Optics -

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Problem of DMS (Dispersion Matching Steering) with BPM scale error

ILC Main Linac is curved, following earth's curvature (For L. He supply system.)

- Cryo-modules are aligned along the curvature
- In present (ILC RDR) optics
  - Orbit goes through center of every quadrupole magnet (~ attached BPM)
  - Finite dispersion at all quadrupole magnets (and attached BPM)
  - DMS adjust the dispersion, finite orbit difference due to energy difference
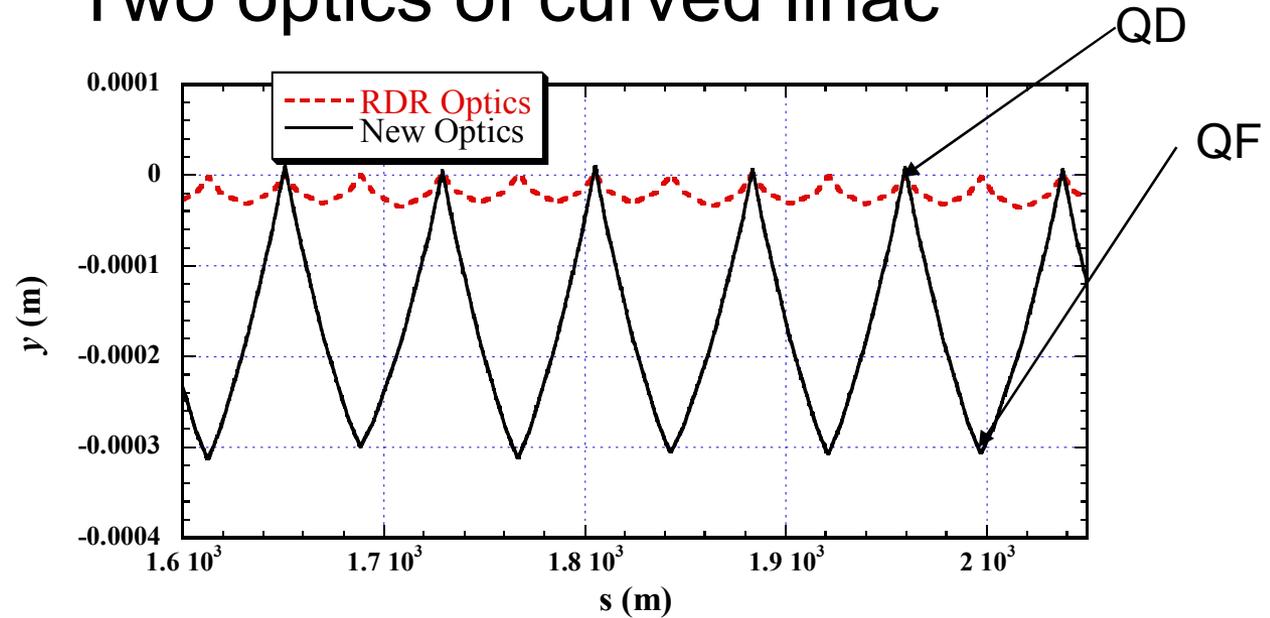 - BPM scale error affects DMS

New Optics for DMS with BPM scale error

- Orbit goes through center of every vertically defocus quadrupole magnet (~ attached BPM)

- Zero dispersion at v-defocus quadrupole magnet (and attached BPM)

- Finite offset and finite dispersion at v-focus quadrupole magnets

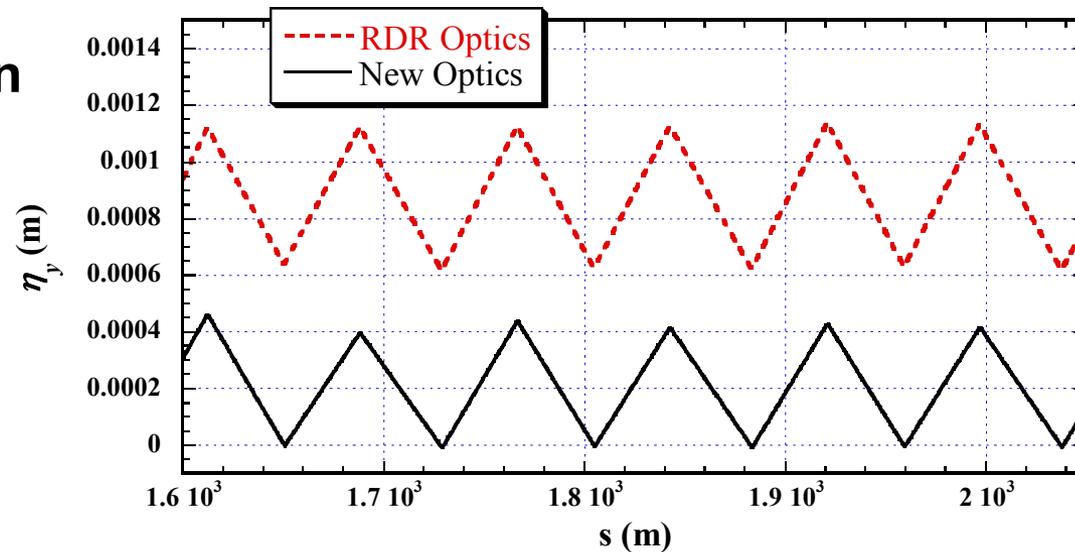- Scale error of BPM attached to v-defocus quads does not affect DMS

Vertical Orbit and Dispersion
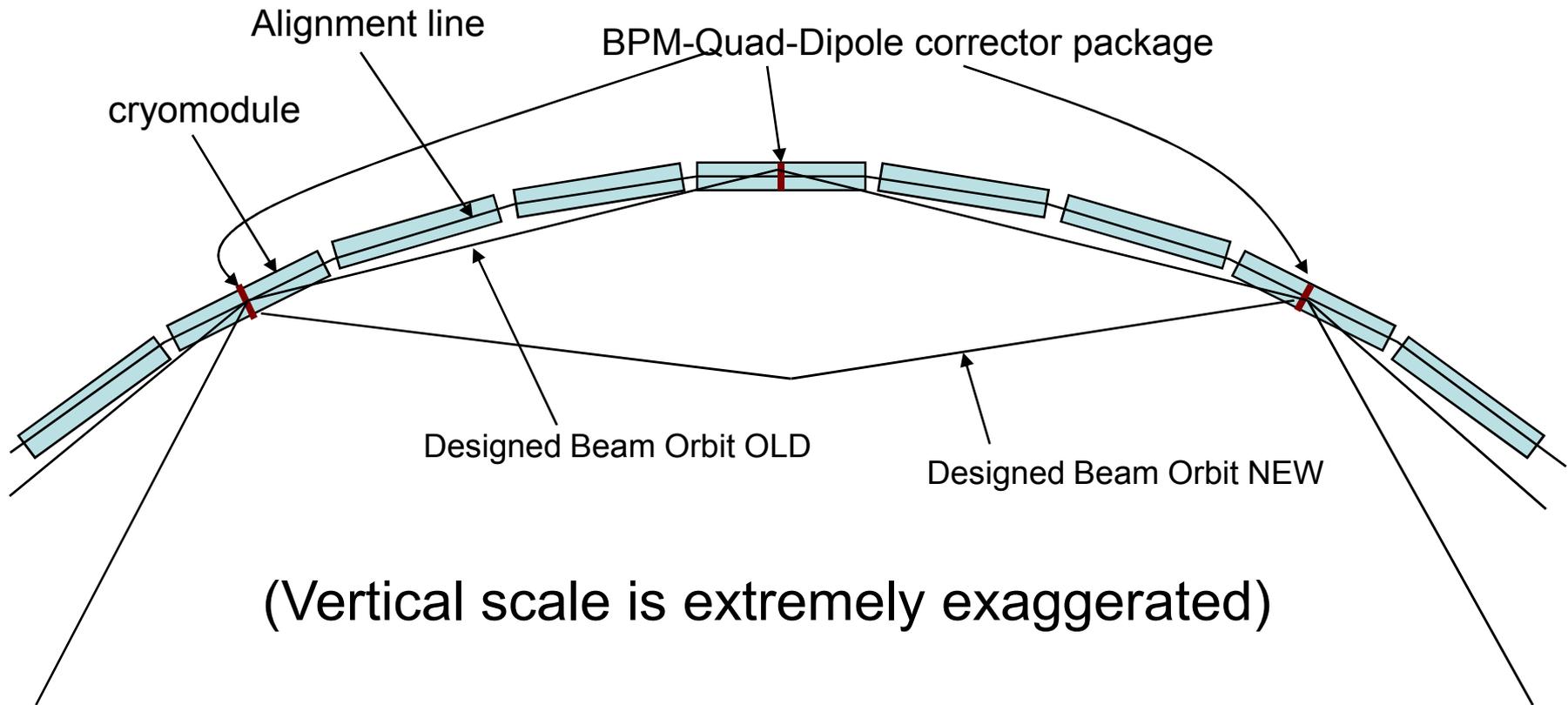## Two optics of curved linac

Alignment and Beam Orbit in Curved Linac, Following earth curvature

Alignment line

BPM-Quad-Dipole corrector package

cryomodule

Designed Beam Orbit OLD

Designed Beam Orbit NEW

(Vertical scale is extremely exaggerated)

Simulation

- "Standard" error set + BPM scale error
- DMS steering.
  - Change energy by 10% for dispersion measurement
  - Minimize

~0

$$w_1 \sum_{\text{BPM at QD}} \left(y_0 - y_{\Delta E} - (\Delta E / E)\eta_{y,\text{design}} \right)^2$$

$$+ w_2 \sum_{\text{BPM at QF}} \left(y_0 - y_{\Delta E} - (\Delta E / E)\eta_{y,\text{design}} \right)^2$$

$$+ \sum_{\text{all BPM}} \left(y_0 - y_{\text{design}} \right)^2$$

(QD: defocus in vertical plane)

$y_{\Delta E}$: BPM read with energy change ΔE

y_{design} : Design beam position at BPM

$\eta_{y,\text{design}}$: Design dispersion at BPM

w_1 and w_2 : Weight factors

"standard" set of errors (RMS)

	"standard"	Used in this study (approximation)
Quad Offset (μm)	300	360
Cavity Offset (μm)	300	640
Cavity Pitch (μrad)	300	300
BPM Offset (μm)	300	360
Cryomodule ofset (μm)	200	0
Cryomodule pitch (μm)	20	0
Quad and BPM roll (μrad)	300	0
Horizontal	Vertical x 3	0
BPM resolution (μm)	1	1

All errors are random and independent.
No roll errors, no horizontal errors.

Vertical emittance (average of 40 random seeds) vs. BPM scale error
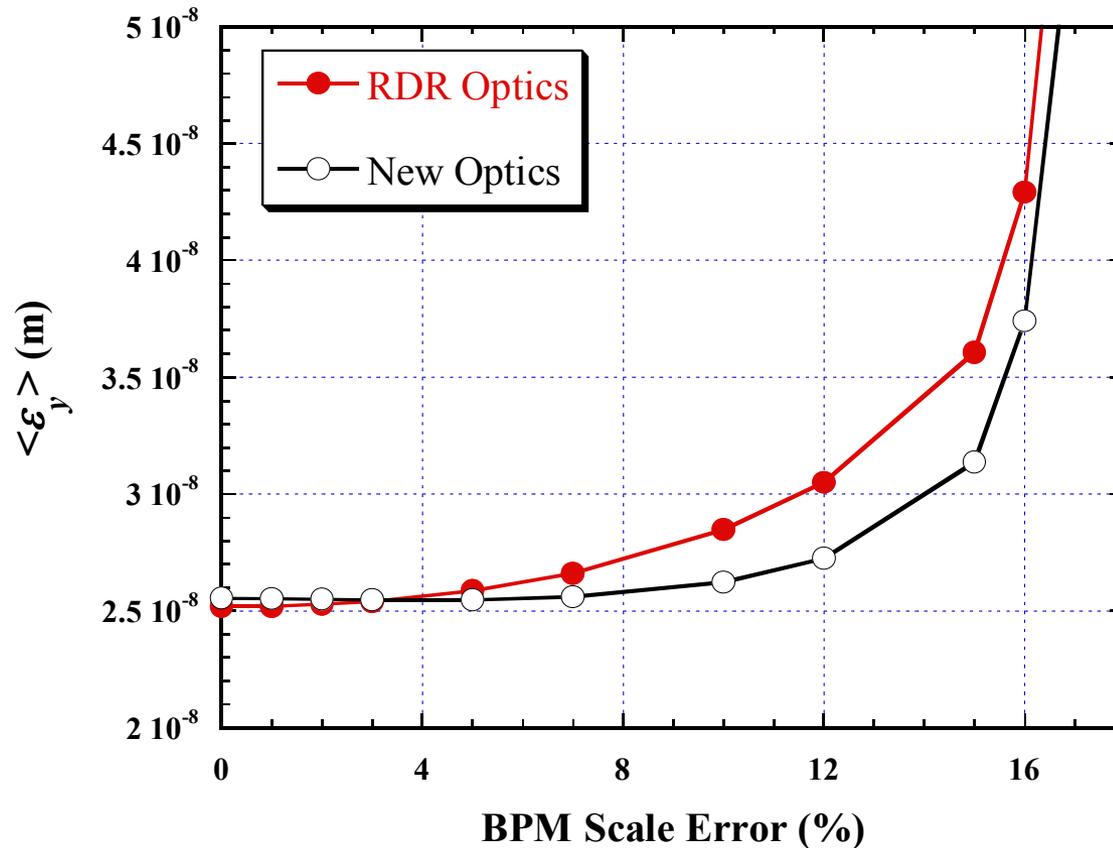
New optics is less sensitive to BPM scale error.
But scale error > 10% will still cause a problem.

SUMMARY

- DMS was simulated in curved ILC linac with BPM scale error for a new optics, compared with old (RDR) optics.
  - New: Zero dispersion at V-defocus quad magnets
  - Old: Finite dispersion at all quad magnets
- New optics is less sensitive to BPM scale error.
  - Tolerance may be increase from "a few%" to "about 10%". But not 20 % (which was suggested by some BPM experts.).
- Dependence on fitting weights should be studied.