ILC BDS Designs with TDR parameters

Edu Marin[1]

[1]SLAC, (USA)

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Outline

OBJECTIVES

Objectives

Design ILC-BDS lattices for 3 different L* ($E_{\mathrm{CM}} = 500$ GeV)

- 3.51 m (foreseen in the TDR)
- 4.0 m (new proposal)
- 4.5 m (foreseen in the TDR)

Assuming TDR parameters:

$$\beta_x^* = 11 \text{ mm} \qquad \sigma_x^* = 474 \text{ nm}$$
$$\beta_y^* = 0.48 \text{ mm} \qquad \sigma_y^* = 5.9 \text{ nm}$$

Considered initial lattice to work with: ILC2012b

- Remove 1.69 m of D2B to match the CFS length
- Split QF7 in 2 magnets (QF7B,QF7A) (0.5 m apart)
- Insert BPM in between the QF7s (*MIP*)

DESIGN STRATEGY

Lattice Design Strategy

Following partially the recipe described at SLAC-PUB-9895

- adjust quadrupoles QF1 and QD0
  - to set $\alpha_{x,y}$ at exit of FD
- adjust quadrupoles from QD2 to QF7
  - to set $\alpha_{x,y}$ at image point (MIP) equal to 0
  - $\Delta\mu_{x,y} = n\frac{\pi}{2}$
  - $R_{ii}^{SF1-SF6}$=1
  - $R_{ii}^{SD0-SD4}$=-1
- adjust matching quadrupoles
  - to match the incoming $\beta_{x,y}$ and $\alpha_{x,y}$
  - to set $\Delta\mu_{x,y}^{Coll-IP} = n\frac{\pi}{2}$

Lattice Design Strategy II

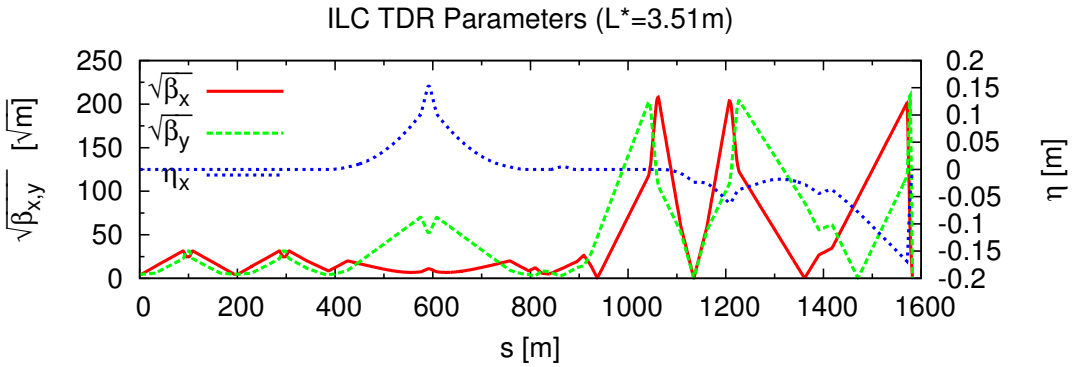
Phase advances between Collimation section and IP:

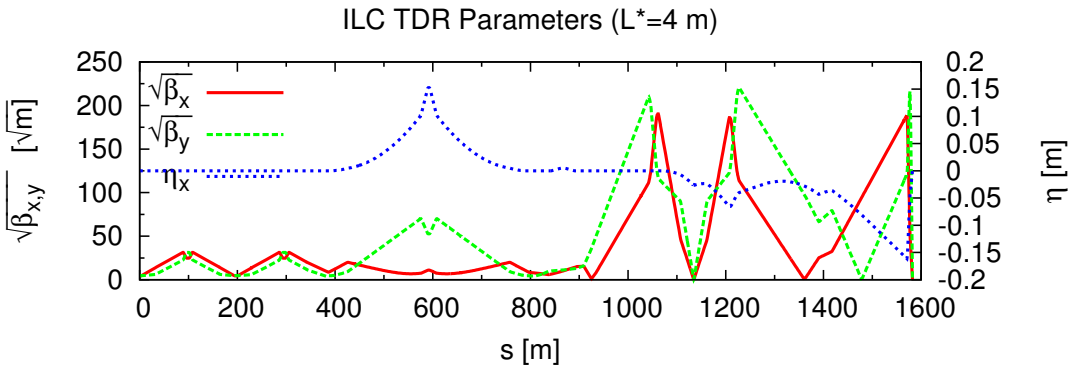
- from SPEX (E-collimation) to IP: $\Delta\mu_{x,y} = n\frac{\pi}{2}$
- from SP4 (β-collimation) to IP: $\Delta\mu_{x,y} = n\frac{\pi}{2}$
- from SP2 (β-collimation) to SP4: $\Delta\mu_{x,y} = n\frac{\pi}{2}$

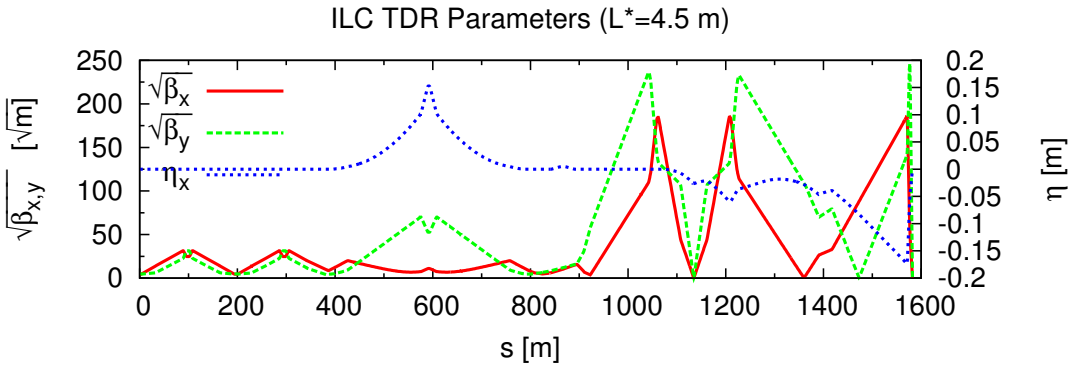
- adjust SD0, SF1, SD4, SF5, SF6, OC10, OC1, OC0, DEC4L and DEC6L
  - σ_x^* = 474 nm
  - σ_y^* = 5.8 nm

DESIGNED LATTICES

ILC-BDS L*=3.51 m, 4m, 4.5m







ILC-BDS Designs

Twiss:

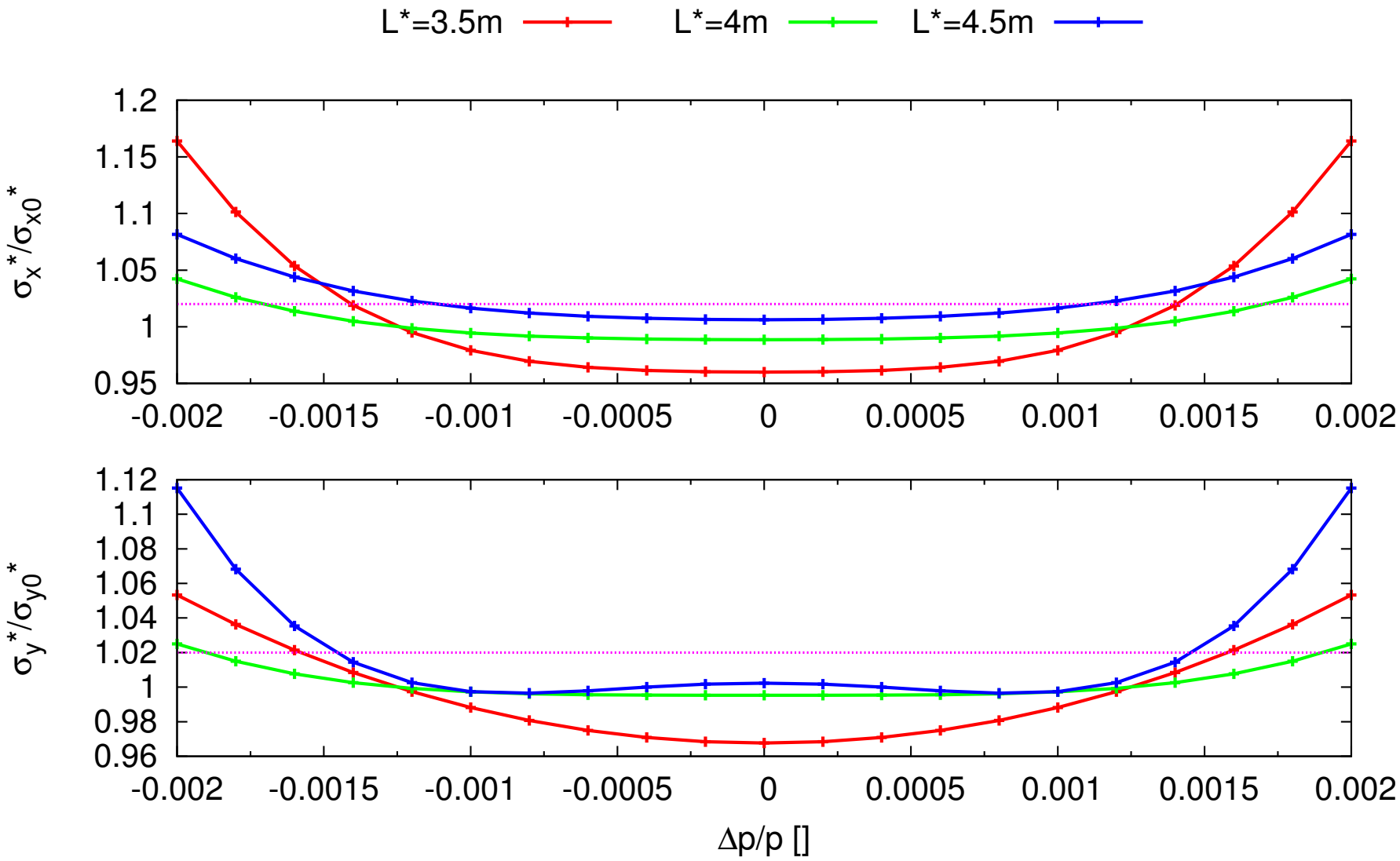
	Unit	L*=3.51m	L*=4m	L*=4.5m
$\beta^*_{x,y}$	[mm]	10.9 , 0.48	11.2 , 0.48	11.2 , 0.48
$\alpha^*_{x,y}$		0.0 , -0.2	0.0 , 0.0	0.1 , 0.2
$\eta^*_{x,y}$	[μm]	10 , 0	-0.3 , 0	15 , 0.0
$\alpha_{x,y}$ (MIP)		0.0 , 0.0	0.0 , 0.4	0.1 , 0.5
$\sigma^*_{x,y}$ (rms)	[nm]	487 , 6.0	484 , 5.9	489 , 6.0
$\sigma^*_{x,y}$ (core)	[nm]	487 , 5.9	480 , 5.8	484 , 6.0

Phases:

		Unit	L*=3.51m	L*=4m	L*=4.5m
$\Delta\mu_{x,y}$	(FB-IP)	[2π]	1.25 , 1.24	1.24 , 1.25	1.25 , 1.24
$\Delta\mu_{x,y}$	(MIP-IP)	[2π]	1.0 , 1.0	1.0 , 1.0	1.0 , 1.0
$\Delta\mu_{x,y}$	(SP4-IP)	[2π]	2.69 , 2.83	2.68 , 2.37	2.35 , 1.71
$\Delta\mu_{x,y}$	(SPEX-IP)	[2π]	2.30 , 2.24	2.30 , 1.78	2.75 , 2.29
$\Delta\mu_{x,y}$	(SP2-SP4)	[2π]	0.25 , 0.75	0.25 , 0.75	0.25 , 0.75

TOLERANCES

Energy Bandwidth



Tolerances Evaluation

- Each tolerance has been evaluated as

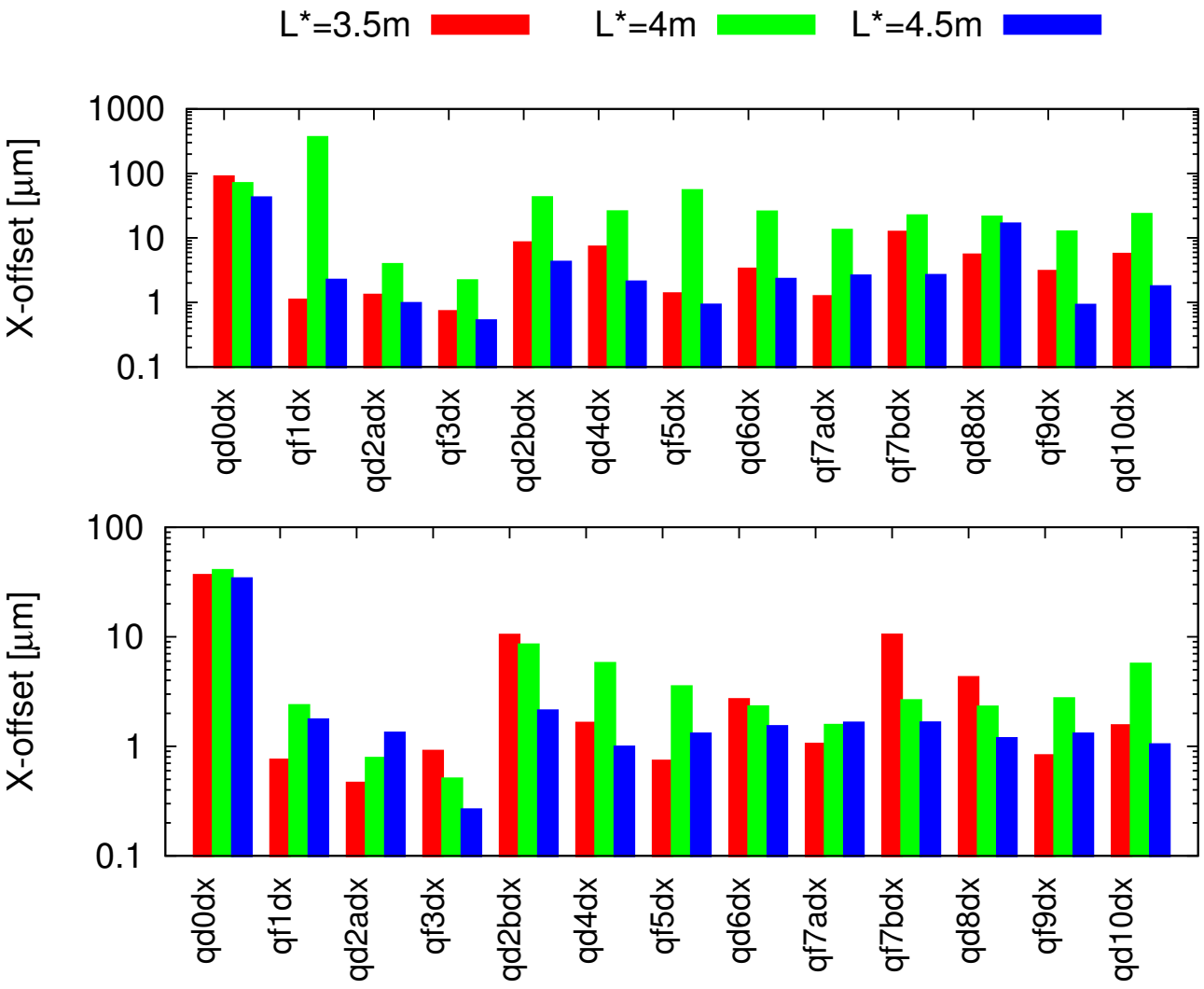
$$\Delta\sigma^* \implies \Delta\mathcal{L} = 2\%$$

assuming,

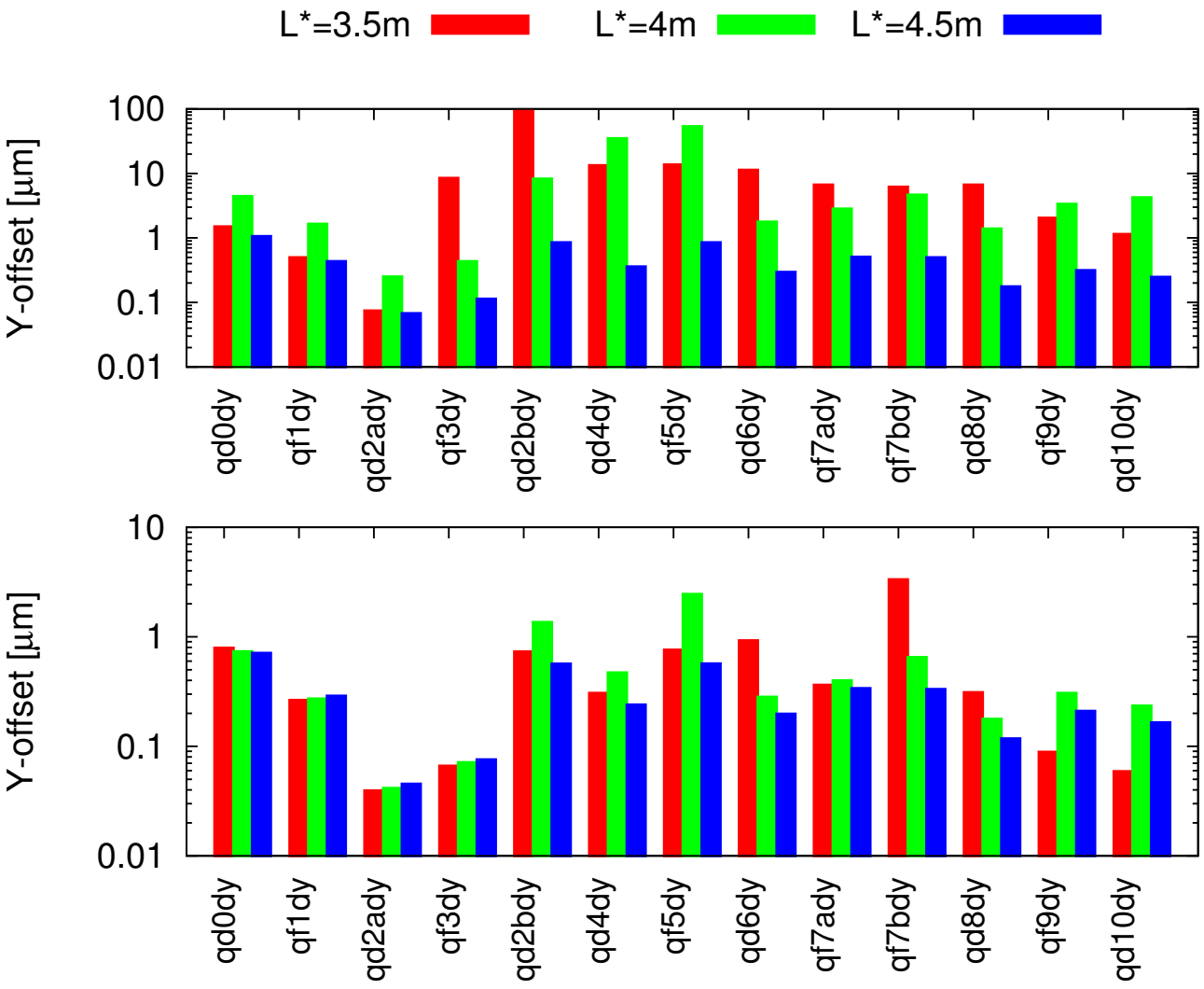
$$\mathcal{L} \sim \frac{1}{\sigma_x^* \sigma_y^*}$$

- Tolerance before and after linear aberrations subtraction are calculated
  - Dispersion
  - Waist shift
  - Coupling

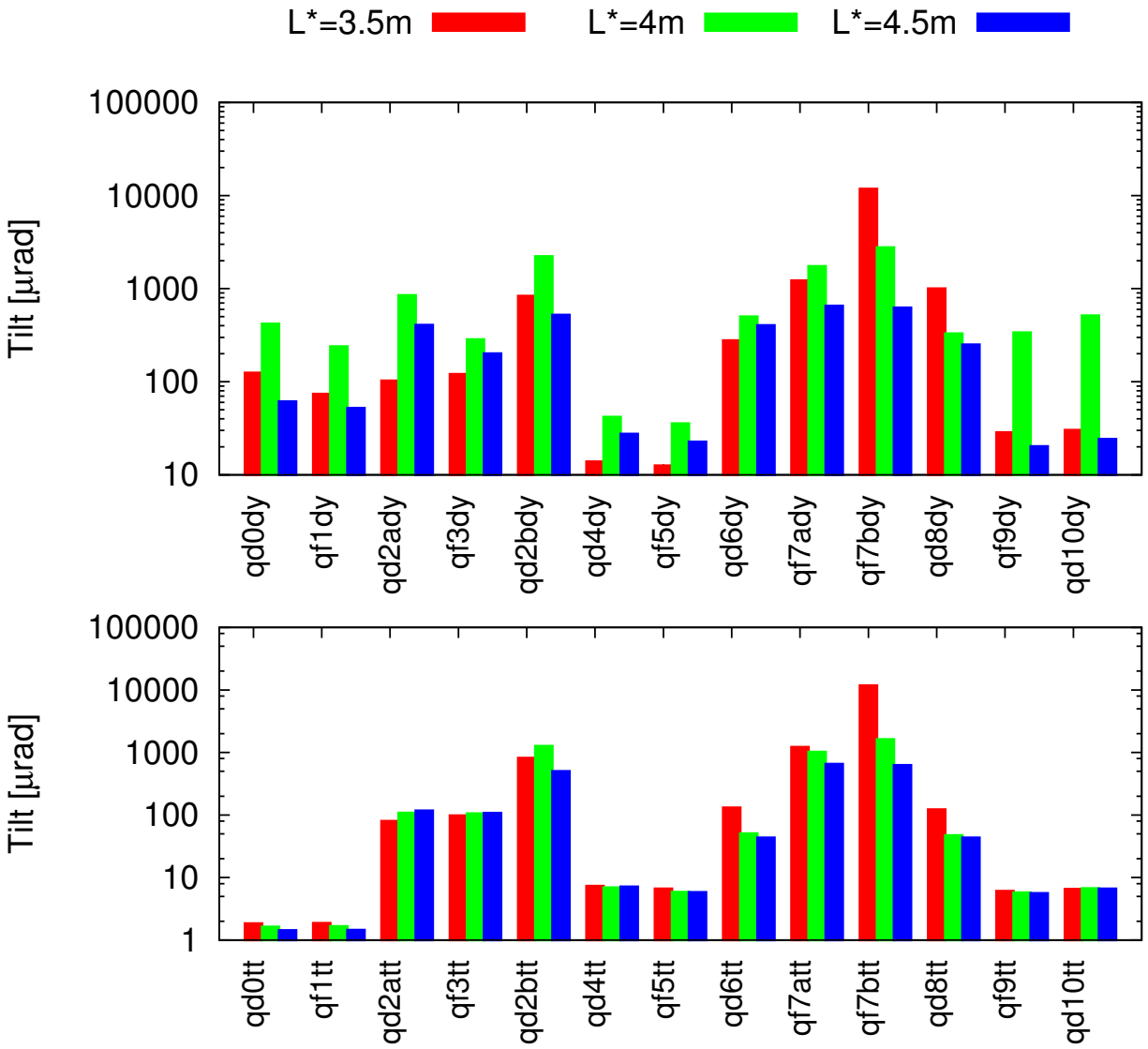
Horizontal


L*=3.5m
L*=4m
L*=4.5m
X-offset [µm]
1000
100
10
1
0.1
qd0dx
qf1dx
qd2adx
qf3dx
qd2bdx
qd4dx
qf5dx
qd6dx
qf7adx
qf7bdx
qd8dx
qf9dx
qd10dx
X-offset [µm]
100
10
1
0.1
qd0dx
qf1dx
qd2adx
qf3dx
qd2bdx
qd4dx
qf5dx
qd6dx
qf7adx
qf7bdx
qd8dx
qf9dx
qd10dx

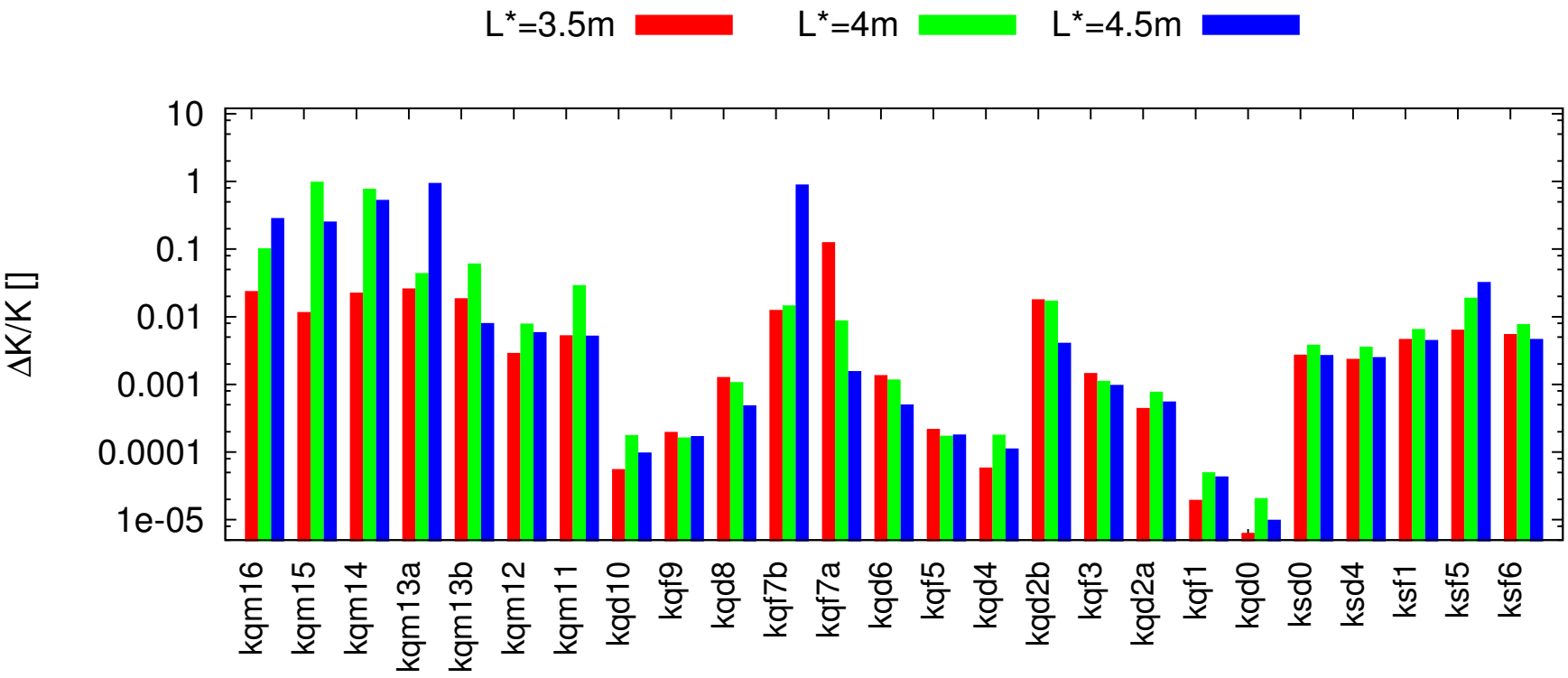
Vertical


L*=3.5m
L*=4m
L*=4.5m
Y-offset [µm]
100
10
1
0.1
0.01
qd0dy
qf1dy
qd2ady
qf3dy
qd2bdy
qd4dy
qf5dy
qd6dy
qf7ady
qf7bdy
qd8dy
qf9dy
qd10dy
Y-offset [µm]
10
1
0.1
0.01
qd0dy
qf1dy
qd2ady
qf3dy
qd2bdy
qd4dy
qf5dy
qd6dy
qf7ady
qf7bdy
qd8dy
qf9dy
qd10dy

Tilt


L*=3.5m
L*=4m
L*=4.5m
Tilt [µrad]
100000
10000
1000
100
10
qd0dy
qf1dy
qd2ady
qf3dy
qd2bdy
qd4dy
qf5dy
qd6dy
qf7ady
qf7bdy
qd8dy
qf9dy
qd10dy
Tilt [µrad]
100000
10000
1000
100
10
1
qd0tt
qf1tt
qd2att
qf3tt
qd2btt
qd4tt
qf5tt
qd6tt
qf7att
qf7btt
qd8tt
qf9tt
qd10tt

Magnet Strength



CONCLUSIONS

Conclusions and Future Work

- The ILC-BDS lattice for 3 different L* have been obtained
- All lattice satisfy the beam size requirements
- BDS with L^*=4.5m shows tightest energy bandwidth and alignment tolerances
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- The required B field precision of FD is below 10^{-4} in all designs

Next steps:

- Final adjustments of phases between collimation and IP
- Optimization without OCTs and DECs