Conclusions of e-lens simulations for eRHIC ring-ri

Christoph Montag

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Summary

- Simulation of an e-lens in an electron ring is rather straightforward.

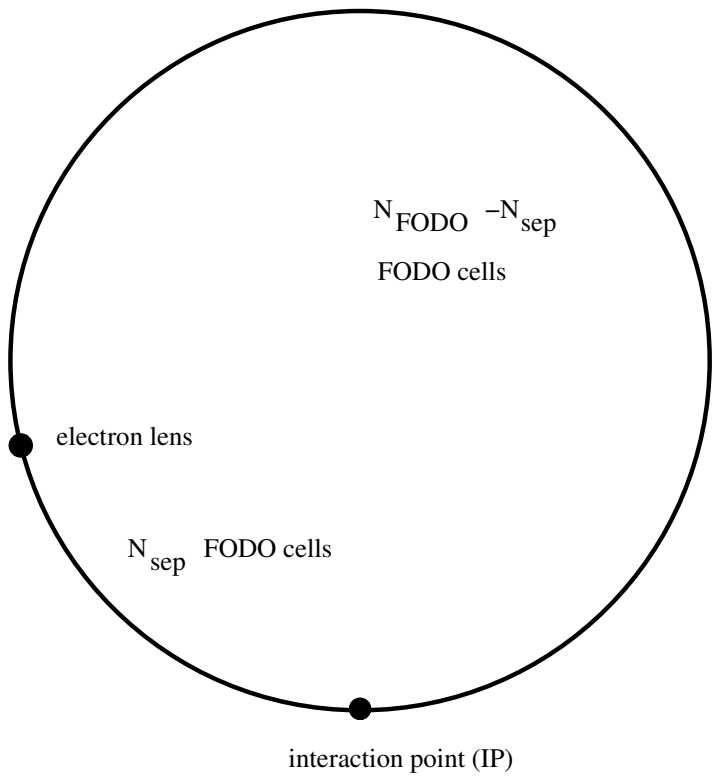
- Observables: equilibrium beam size, transverse tails, useable tune space.

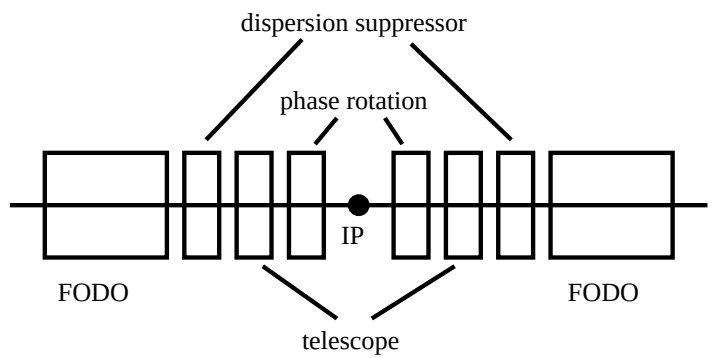
- However, due to large beam-beam parameter, strong dynamic focussing effects occur - unlike in proton rings.

Summary (cont.)

- E-lens opens up huge tune space; nonlinearities between IP and e-lens reduce this space.
- Transverse tails significantly reduced.
- Rather insensitive to size, shape (ellipticity) and intensity errors.
- Phase advance error between IP and e-lens most critical; needs to be better than a few degrees.
- Under-compensation preferred, but that's largely due to dynamic focussing effects.

The electron accelerator model

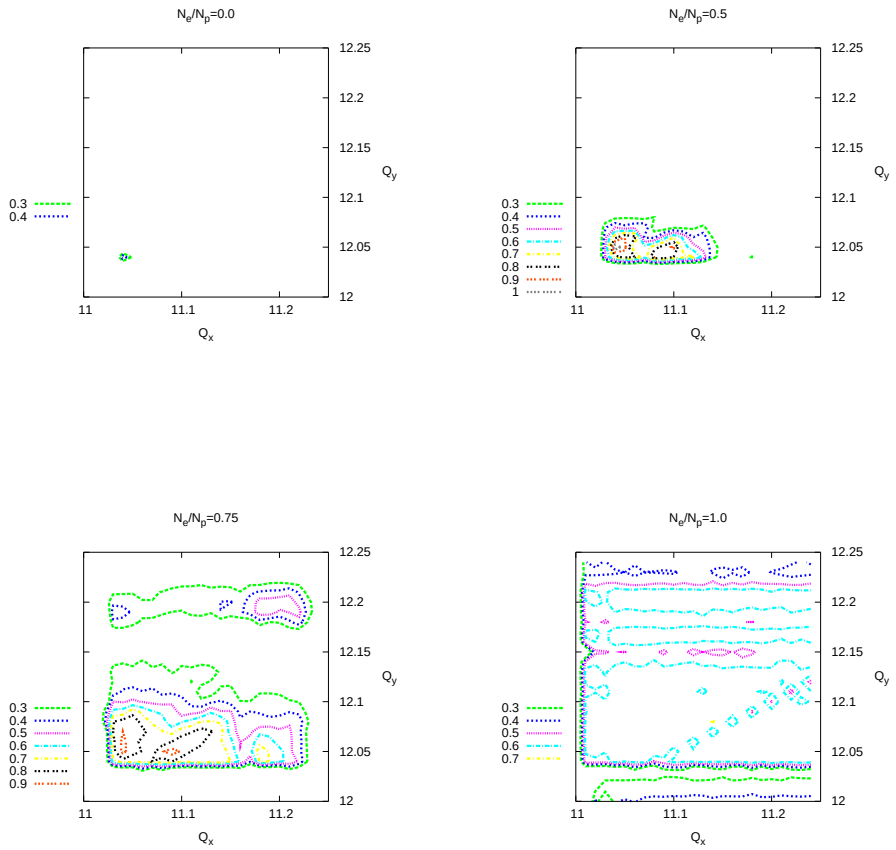




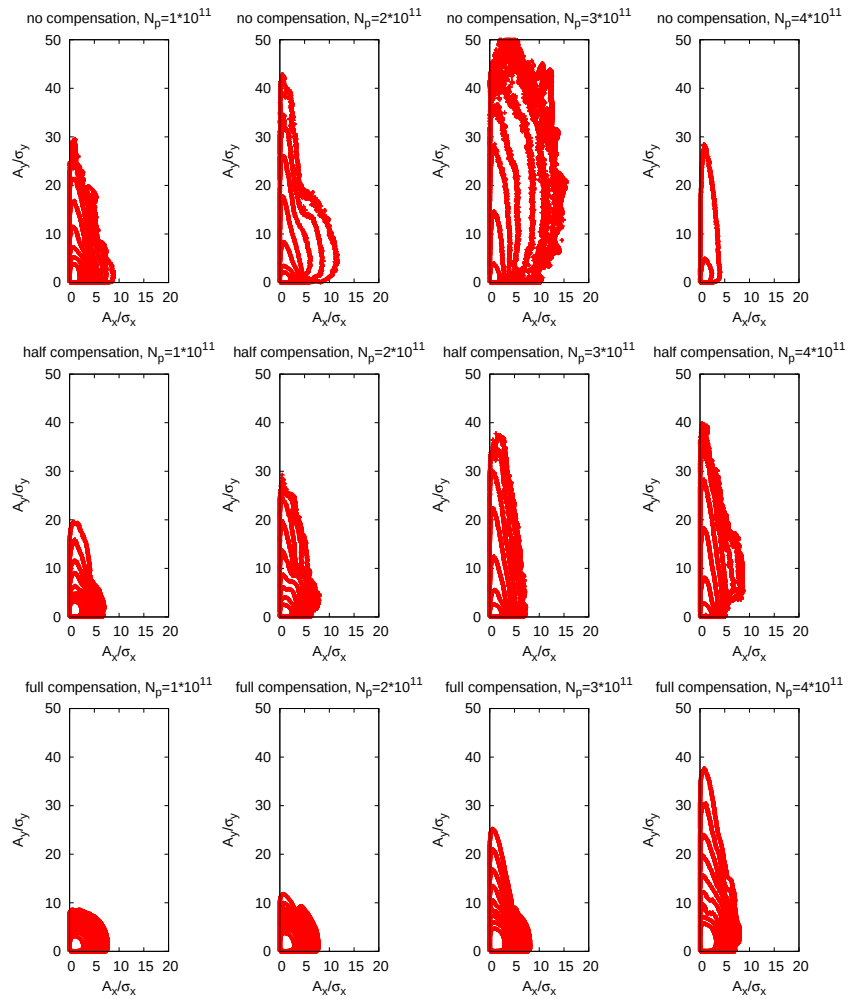
Parameter table

no. of FODO cells	N_{FODO}	50
no. of cells between IP and electron lens	N_{sep}	10
phase advance/cell (hor./vert.)	$\Delta\Phi_x/\Delta\Phi_y$	$79.7^\circ/89.0^\circ$
chromaticity (hor./vert.)	$Q'_{x,y} = \Delta Q_{x,y}/\frac{\Delta p}{p}$	+2/+2
synchrotron tune	Q_s	0.015
rms bunch length	σ_s	0.0117 mm
rms momentum spread	σ_p	$9.4 \cdot 10^{-4}$
β-function at IP and electron lens	β_x/β_y	0.19 m, 0.26 m
no. of positive charges/bunch	N_p	$4 \cdot 10^{11}$
electron lens intensity/bunch	N_e	$4 \cdot 10^{11}$
rms proton beam size at IP	$\sigma_{x,p}/\sigma_{y,p}$	101 μm/50.5 μm
rms electron lens beam size	$\sigma_{x,e}/\sigma_{y,e}$	101 μm/50.5 μm
Lorentz factor	γ	19560
electron beam-beam parameter	ξ_x/ξ_y	0.11/0.32
damping times	$\tau_x/\tau_y/\tau_z$	1740/1740/870 turns

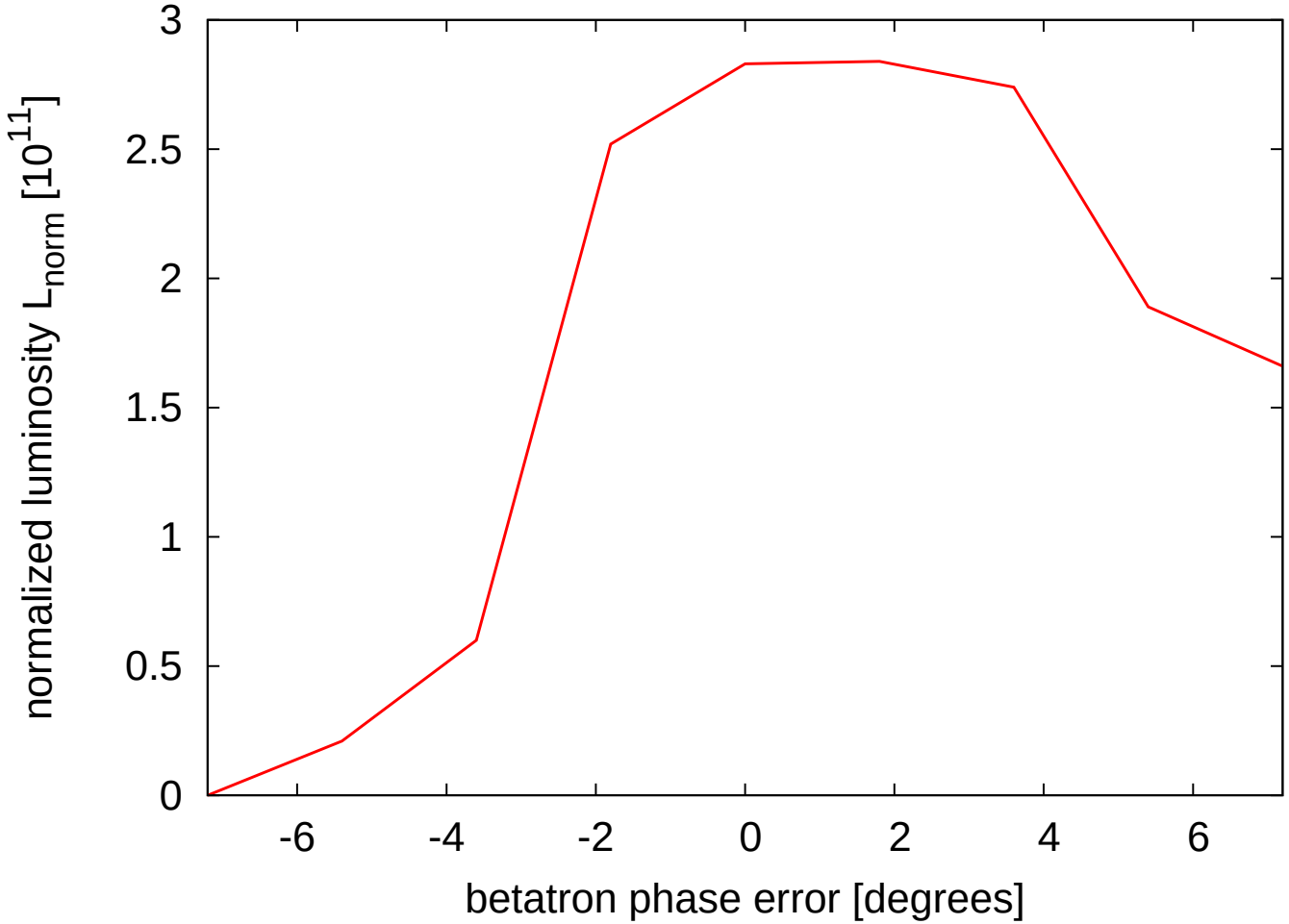
Luminosity contours for various degrees of compensation



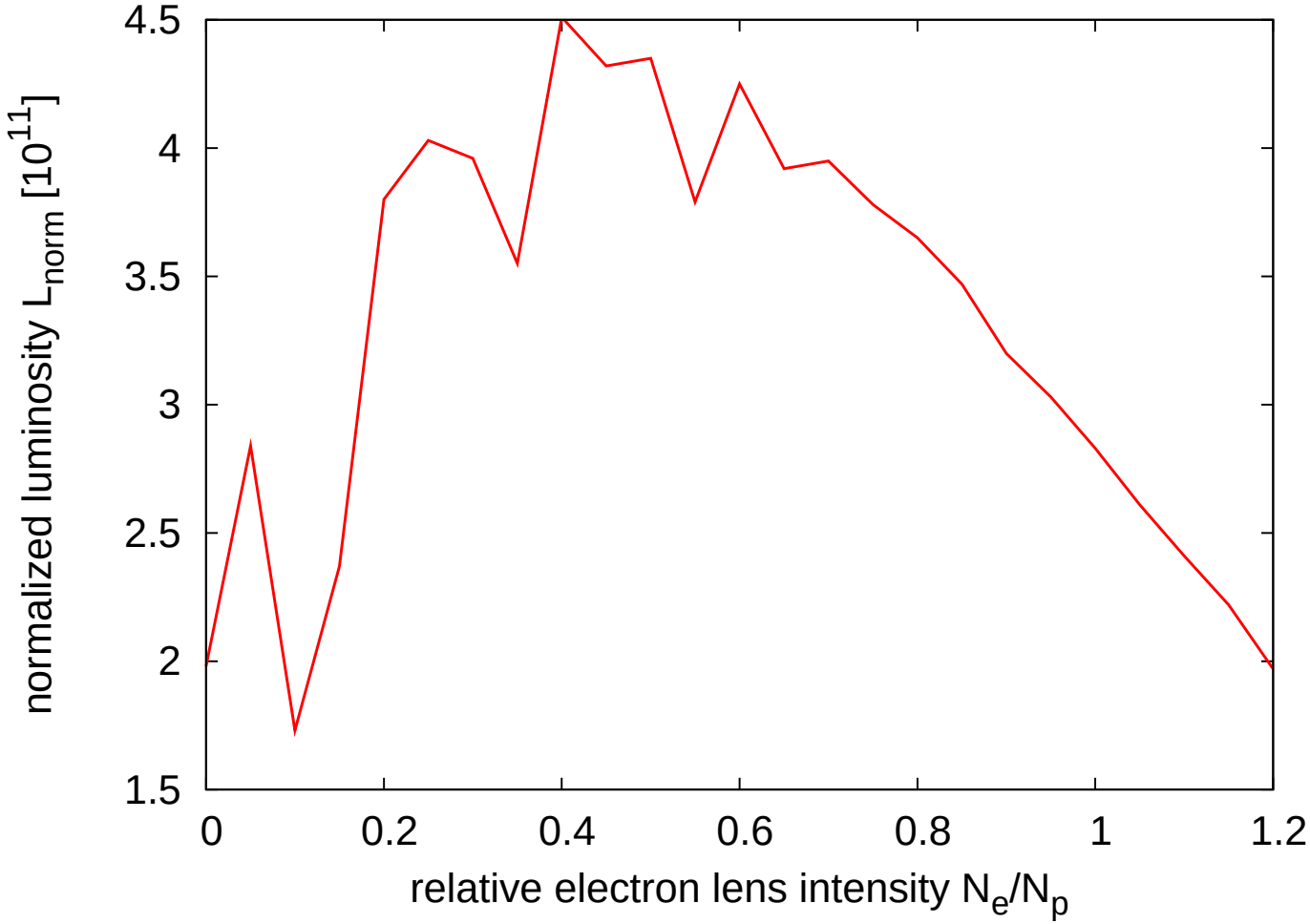
Transverse tails



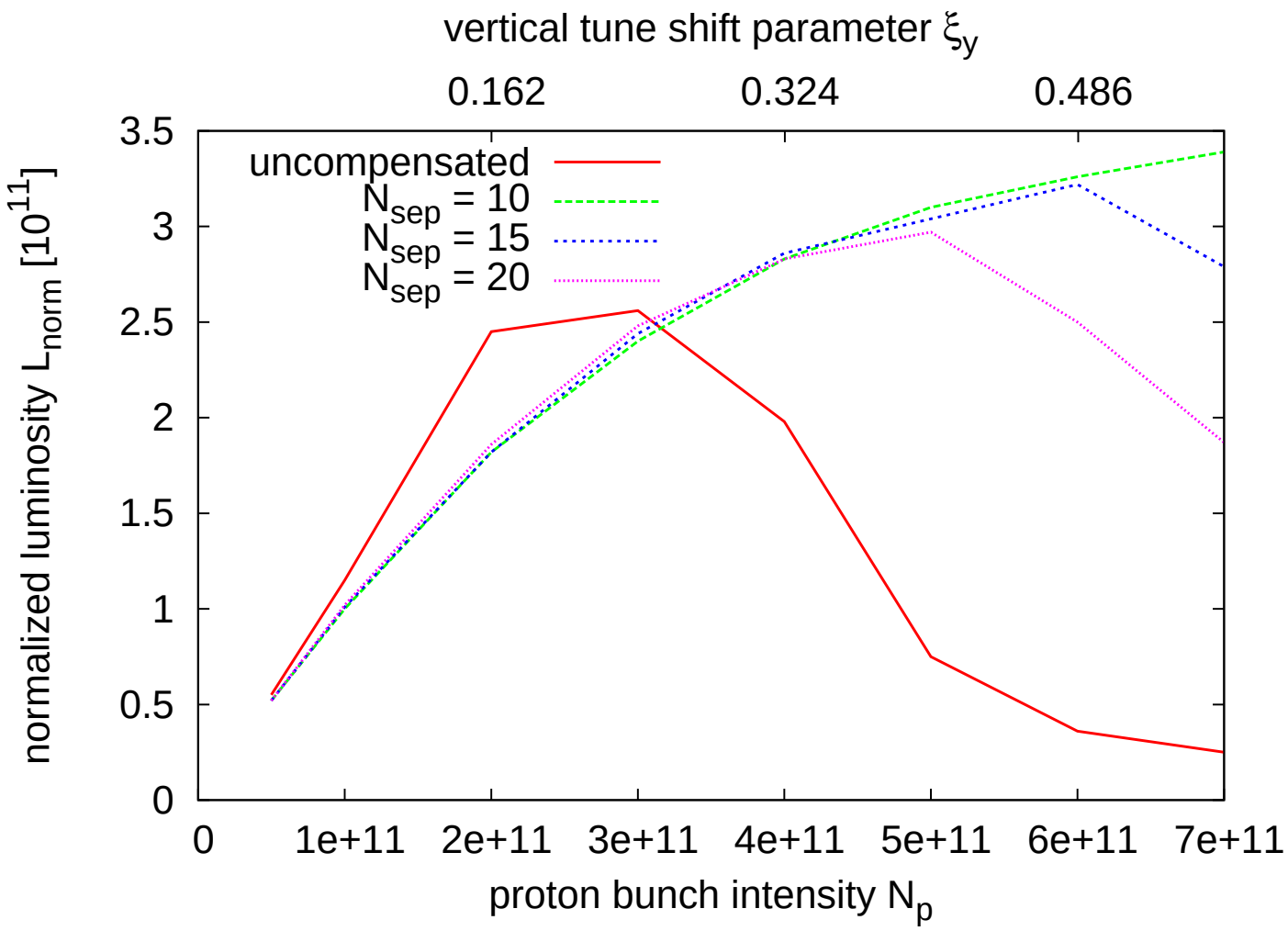
“Luminosity” vs. phase error



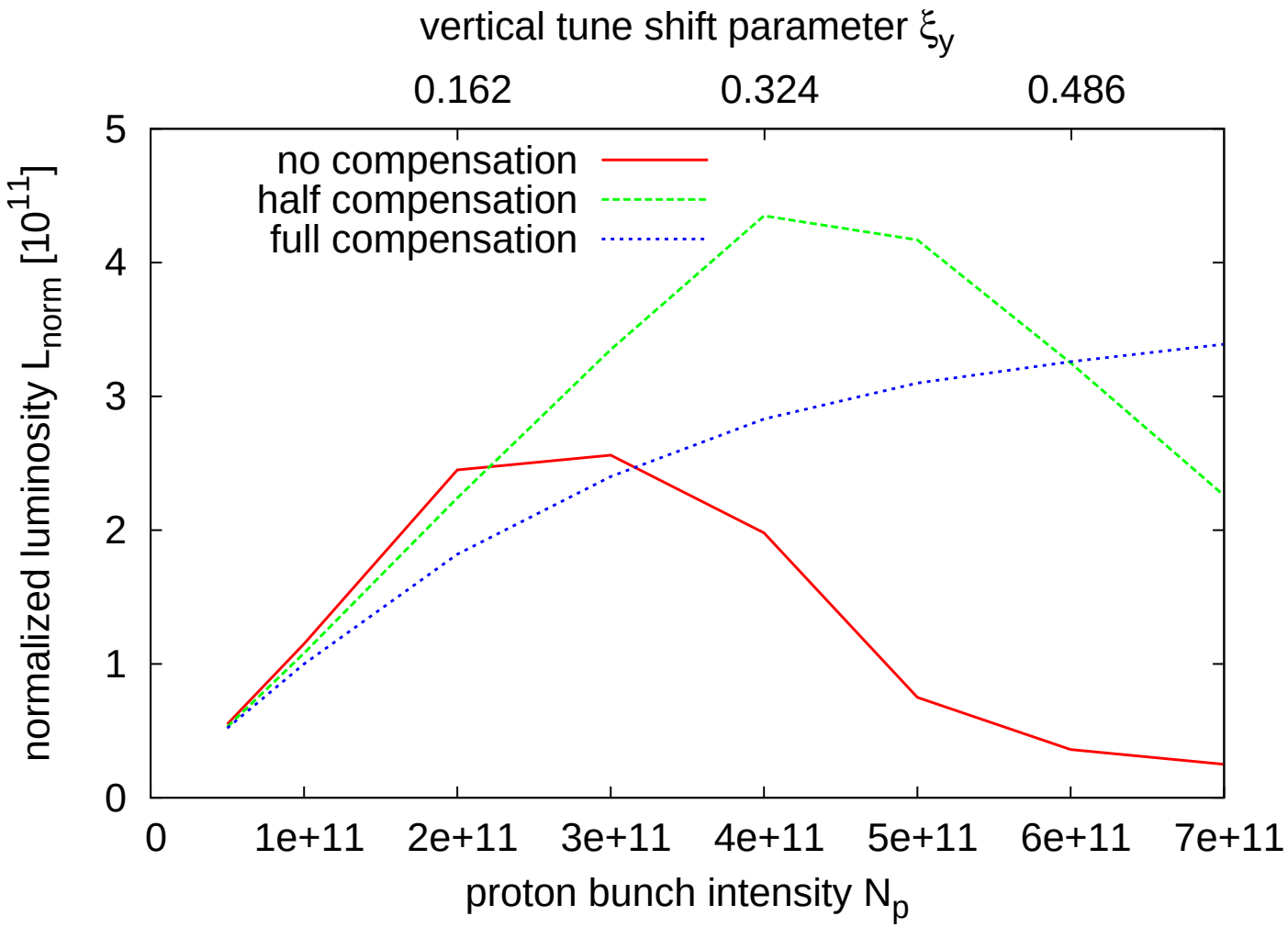
“Luminosity” vs. compensation degree



“Luminosity” vs. number of FODO cells (=nonlinearity)



"Luminosity" vs. compensation degree



"Luminosity" vs. shape mismatch

		r_x					
		1.00	1.05	1.10	1.15	1.20	1.25
	1.00	2.83	2.91	2.99	3.08	3.08	3.25
	1.05	2.91	3.00	3.03	3.06	3.14	3.20
r_y	1.10	3.01	3.08	3.08	3.17	3.03	3.13
	1.15	3.08	3.11	3.15	3.09	3.18	3.16
	1.20	3.13	3.13	3.15	**3.44**	3.25	3.07
	1.25	3.04	3.17	3.17	3.19	3.24	3.00

"Luminosity" vs. size and intensity mismatch

		N_e/N_p				
		0.80	0.85	0.90	0.95	1.00
	1.00	3.65	3.47	3.20	3.03	2.83
	1.05	3.67	3.49	3.48	3.22	3.00
r	1.10	3.75	3.42	3.54	3.36	3.08
	1.15	**3.76**	3.43	3.47	3.51	3.09
	1.20	3.50	3.41	3.27	3.58	3.25
	1.25	3.51	3.31	3.24	3.10	3.00