CLIC 3TeV FFS momentum bandwidth

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Many thanks to Fabien Plassard, Jim Ogren, Neven Blaskovic Kraljevic and Andrii Pastushenko

Outline

- Introduction
- Momentum bandwidth in CLIC 3TeV L*=6 m, CLIC 3TeV L*=3.5 m and in NLC
  - For the beta functions and for the horizontal dispersion
  - For the beam size
  - For the luminosity
- Conclusions

Introduction

- The energy acceptance, or energy bandwidth, is the range of energies that a system like the FFS is able to accept before decreasing its performane drastically.

- Three cases have been studied:
  - CLIC 3TeV with L*=6 m
  - CLIC 3TeV with L*=3.5 m

L^* [m]	3.5	6
FFS length [m]	450	770
Norm. emittance (IP) $\gamma\varepsilon_x/\gamma\varepsilon_y$ [nm]	660 / 20	660 / 20
Beta function (IP) β_x^*/β_y^* [mm]	7 / 0.068	7 / 0.12
IP beam size σ_x^*/σ_y^* [nm]	40 / 0.7	40 / 0.9
Bunch length σ_z [μm]	44	44
rms energy spread δ_p [%]	0.3	0.3
Bunch population N_e [$\times 10^9$]	3.72	3.72
Number of bunches n_b	312	312
Repetition rate f_rep [Hz]	50	50
Luminosity $\mathcal{L}_\mathrm{total}$ [$10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$]	5.9	5.9
Peak luminosity $\mathcal{L}_{1\%}$ [$10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$]	2	2

Introduction

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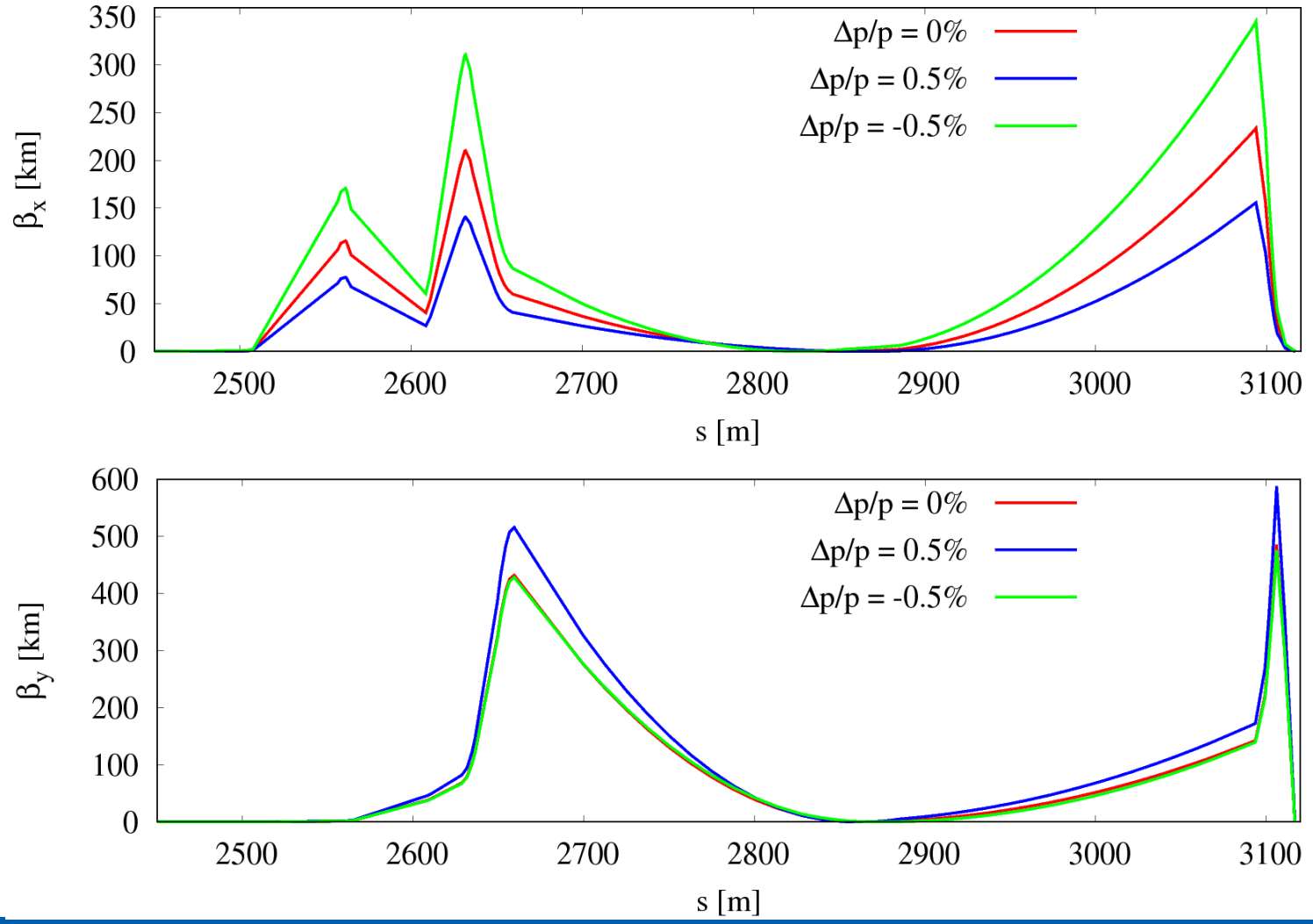
- Three cases has been studied:
  - CLIC 3TeV with L*=6 m
  - CLIC 3TeV with L*=3.5 m
  - NLC

Beam energy		(GeV)	500
Normalized emittances	$\gamma\varepsilon_x$ / $\gamma\varepsilon_y$	(μm)	3.6 / 0.035
IP Beta functions	β_x / β_y	(mm)	10 / 0.12
IP Beam sizes	σ_x / σ_y	(nm)	190.0 / 2.0
IP Beam divergence	θ_x / θ_y	(μrad)	19.0/17.5
Energy spread	σ_E	(10^{-3})	3.0

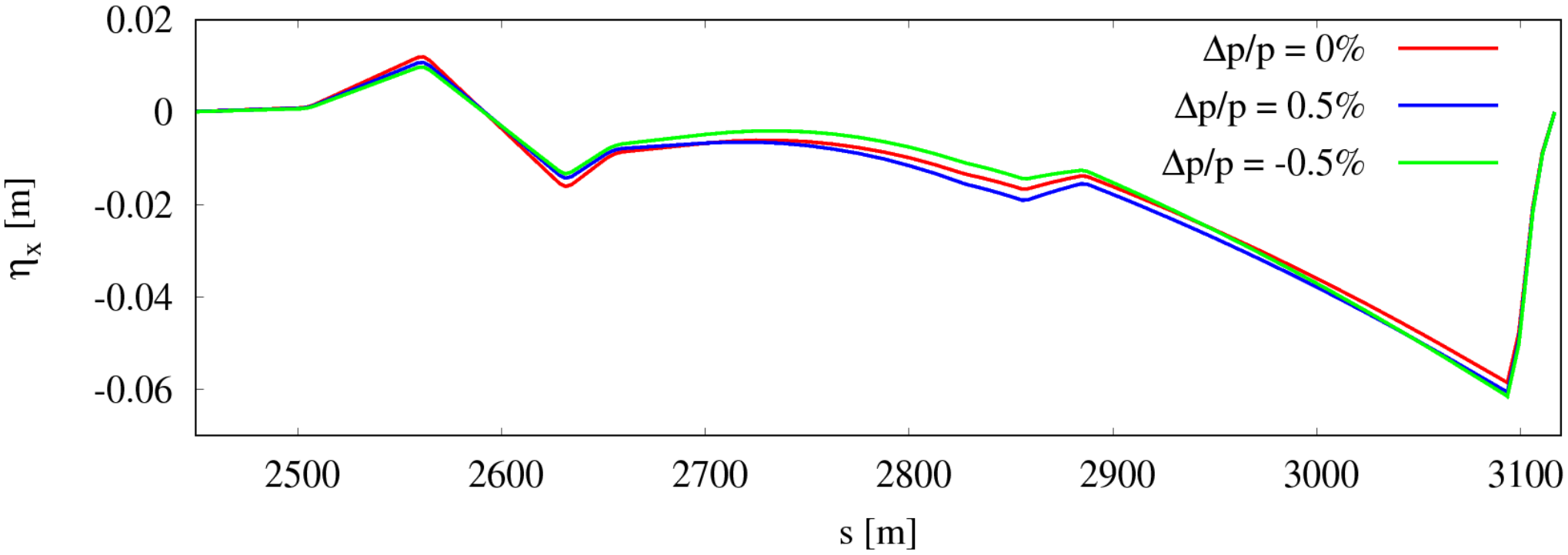
Impact on the twiss functions and the horizontal dispersion for CLIC 3TeV L*=6 m



The final value of the β_x^* and β_y^* are respectively:

- $\Delta p/p$ = 0% → 7 mm and 0.12 mm
- $\Delta p/p$ = -0.5% → 5 mm and 0.28 mm
- $\Delta p/p$ = 0.5% → 12 mm and 0.25 mm

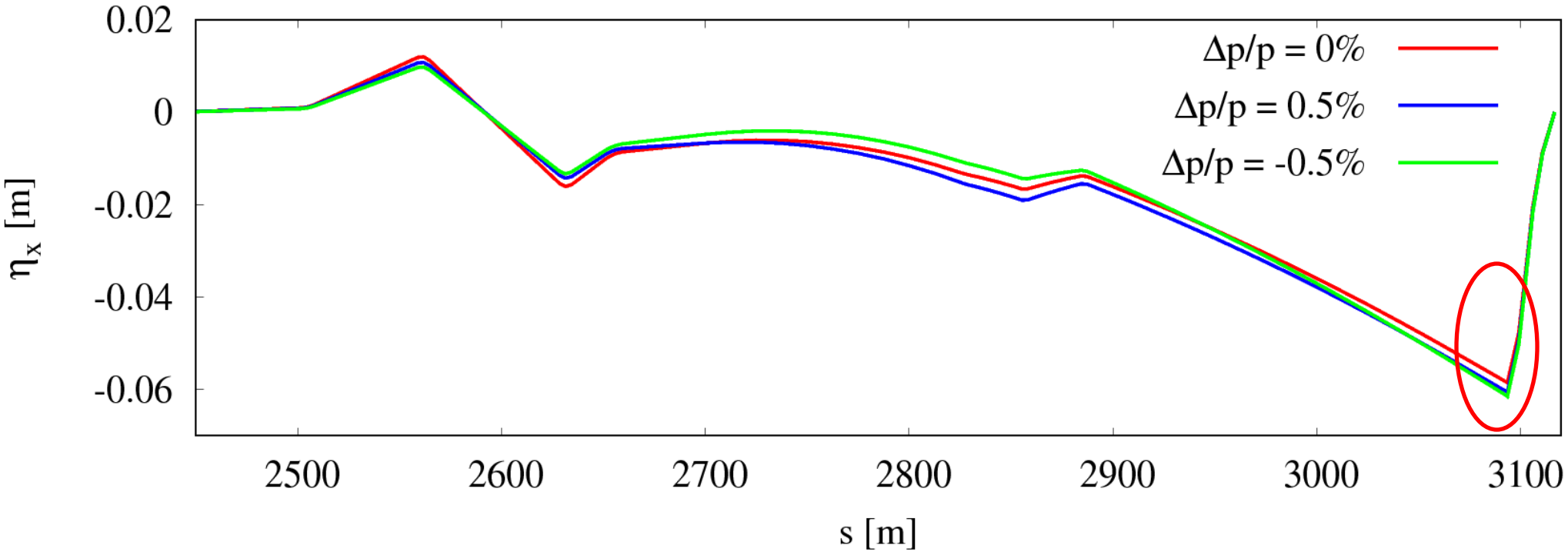
Impact on the twiss functions and the horizontal dispersion for CLIC 3TeV L*=6 m



The final value of the η_x^* is:

- $\Delta p/p$ = 0% → 2.2 x 10^{-8} m
- $\Delta p/p$ = -0.5% → 2.0 x 10^{-8} m
- $\Delta p/p$ = 0.5% → 1.9 x 10^{-6} m

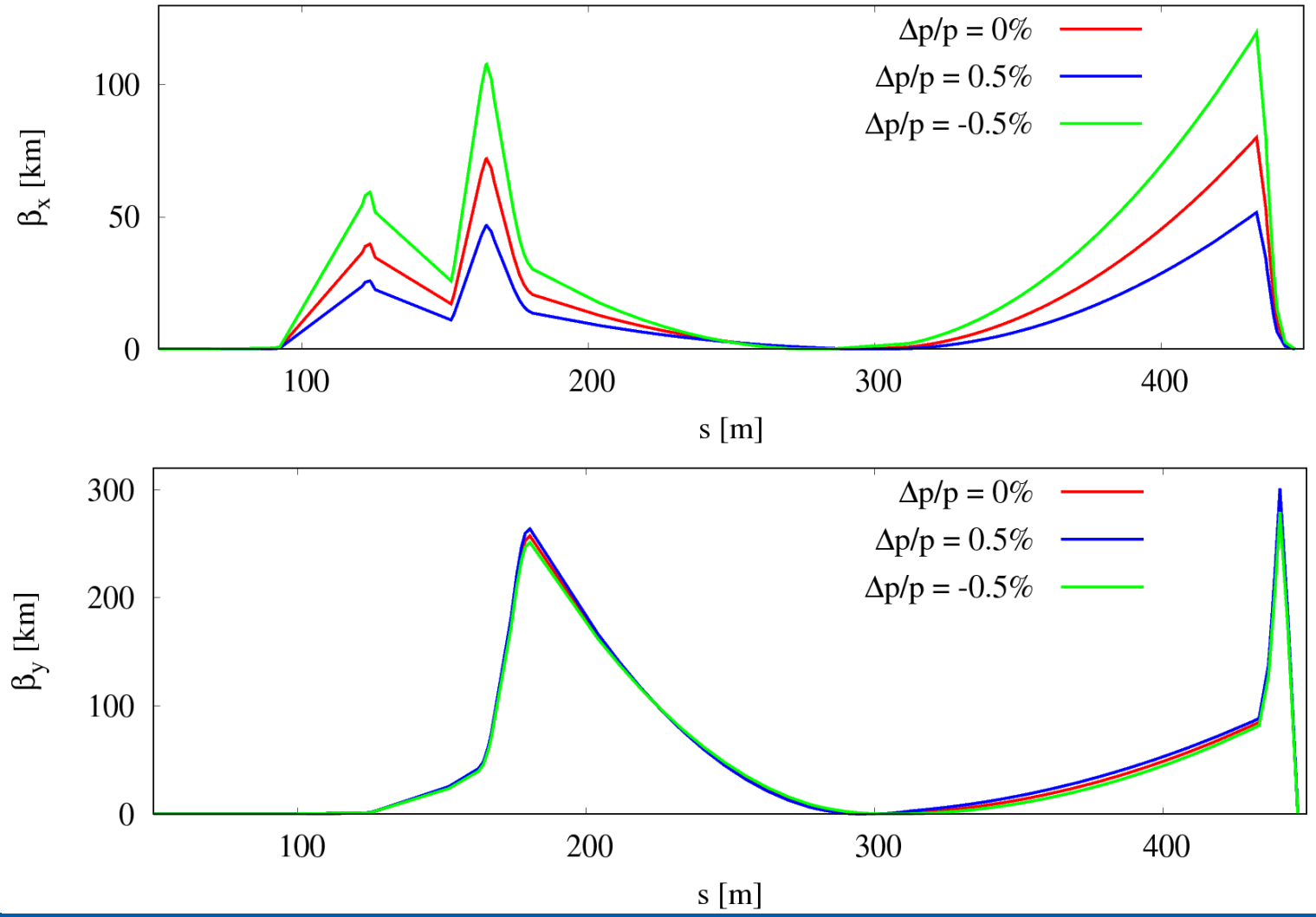
Impact on the twiss functions and the horizontal dispersion for CLIC 3TeV L*=6 m



The value of the η_x at the FD peak is:

- $\Delta p/p$ = 0% → -0.05852 m
- $\Delta p/p$ = -0.5% → -0.06115 m
- $\Delta p/p$ = 0.5% → -0.06054 m

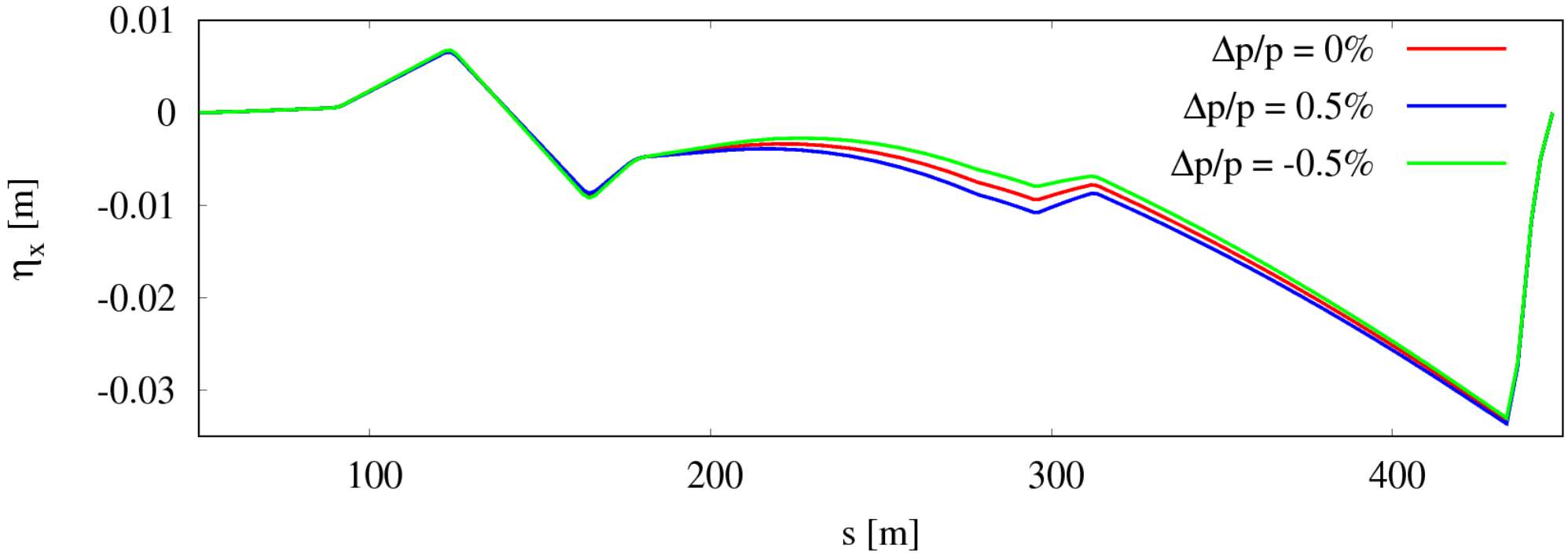
Impact on the twiss functions and the horizontal dispersion for CLIC 3TeV L*=3.5 m



The final value of the β_x^* and β_y^* are respectively:

- $\Delta p/p$ = 0% → 7 mm and 0.068 mm
- $\Delta p/p$ = -0.5% → 5 mm and 0.21 mm
- $\Delta p/p$ = 0.5% → 11 mm and 0.25 mm

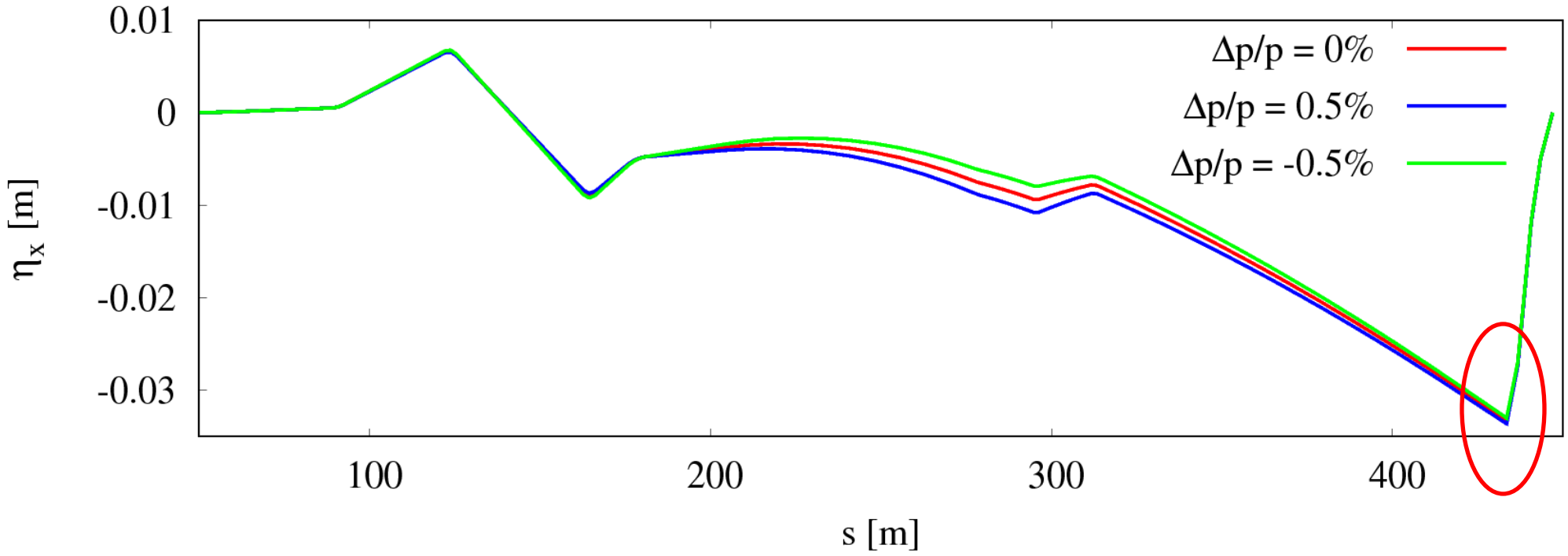
Impact on the twiss functions and the horizontal dispersion for CLIC 3TeV L*=3.5 m



The final value of the η_x^* is:

- $\Delta p/p$ = 0% → -4.4 x 10^{-8} m
- $\Delta p/p$ = -0.5% → -1.4 x 10^{-6} m
- $\Delta p/p$ = 0.5% → 3.3 x 10^{-6} m

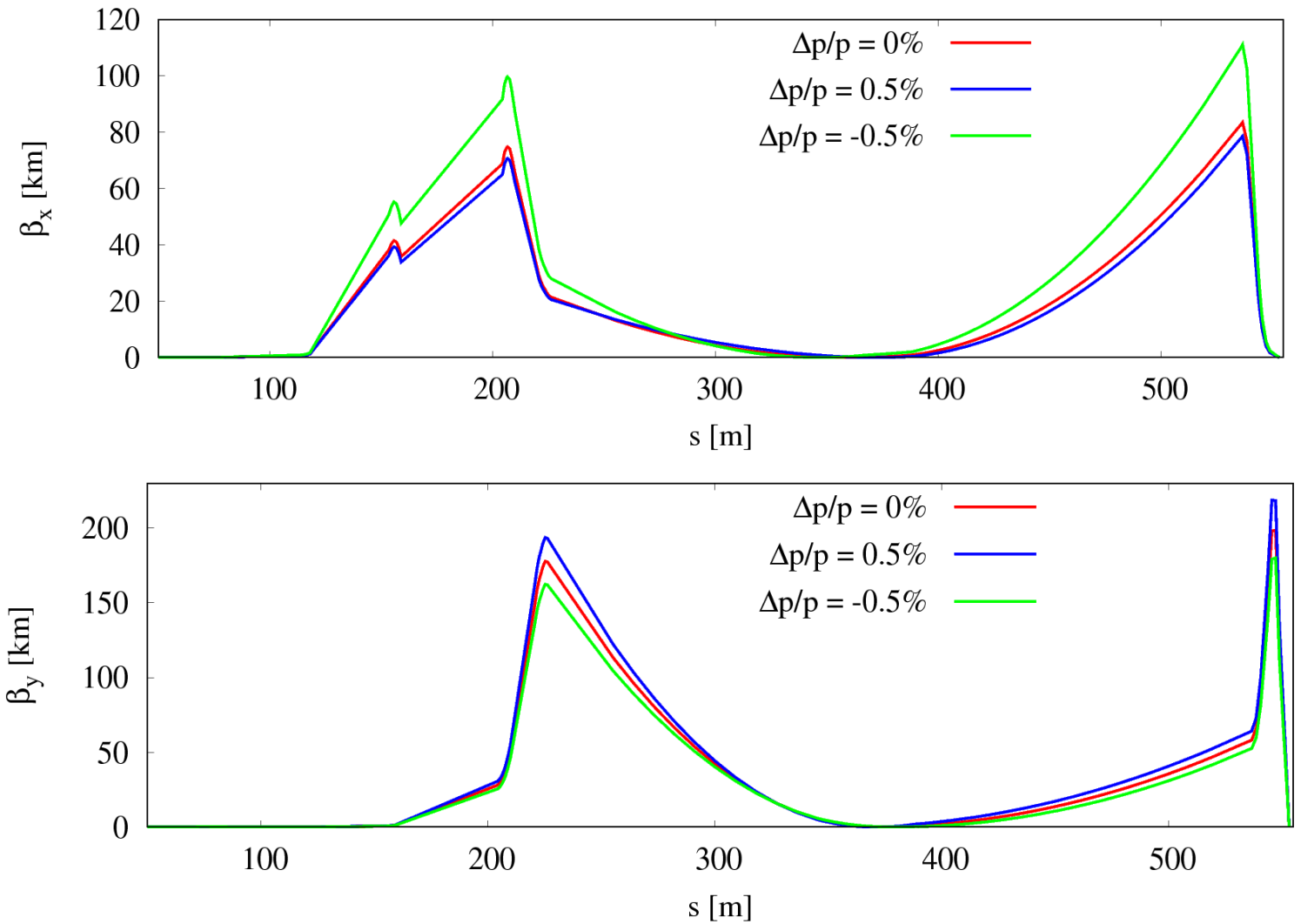
Impact on the twiss functions and the horizontal dispersion for CLIC 3TeV L*=3.5 m



The value of the η_x at the FD peak is:

- $\Delta p/p$ = 0% → -0.03326 m
- $\Delta p/p$ = -0.5% → -0.03301 m
- $\Delta p/p$ = 0.5% → -0.03360 m

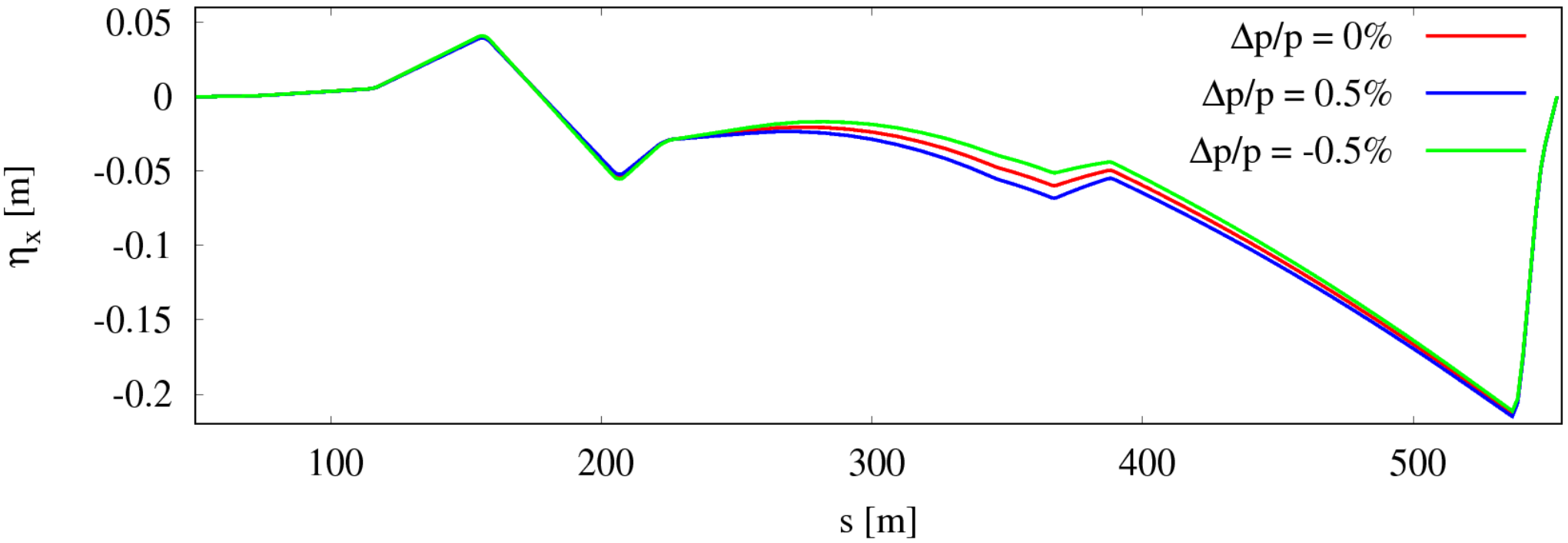
Impact on the twiss functions and the horizontal dispersion for NLC



The final value of the β_x^* and β_y^* are respectively:

- $\Delta p/p$ = 0% → 10 mm and 0.15 mm
- $\Delta p/p$ = -0.5% → 9.3 mm and 0.19 mm
- $\Delta p/p$ = 0.5% → 12 mm and 0.16 mm

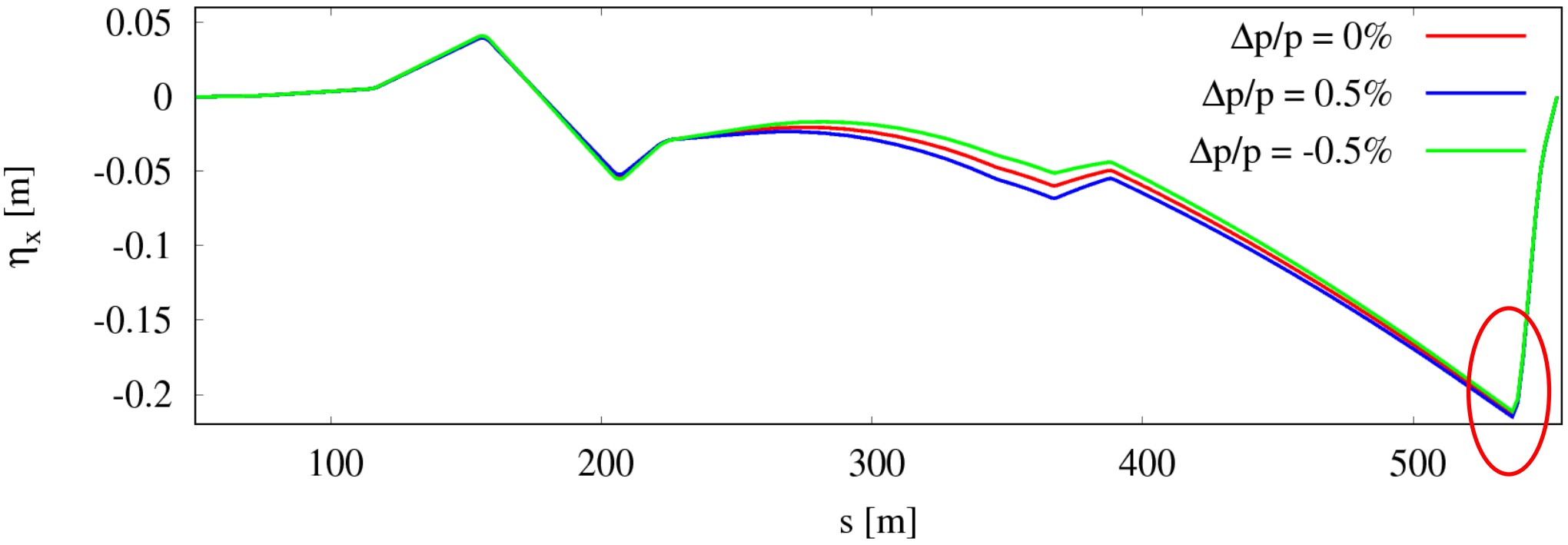
Impact on the twiss functions and the horizontal dispersion for NLC



The final value of the η_x^* is:

- $\Delta p/p$ = 0% → -3.6 x 10^{-6} m
- $\Delta p/p$ = -0.5% → 6.1 x 10^{-5} m
- $\Delta p/p$ = 0.5% → -5.6 x 10^{-5} m

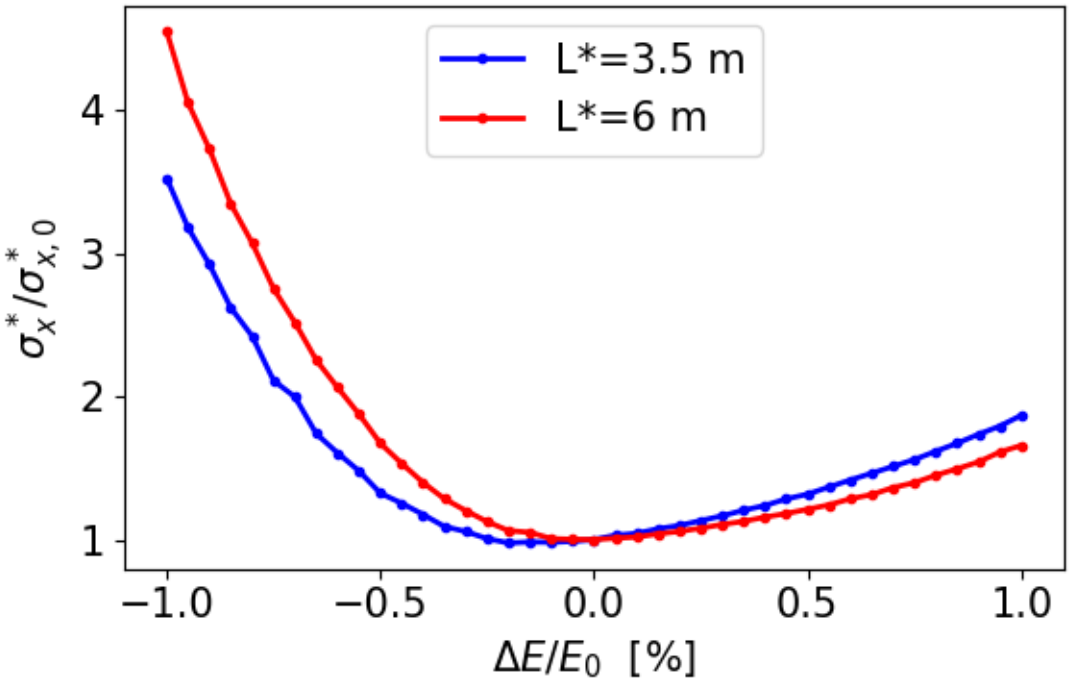
Impact on the twiss functions and the horizontal dispersion for NLC

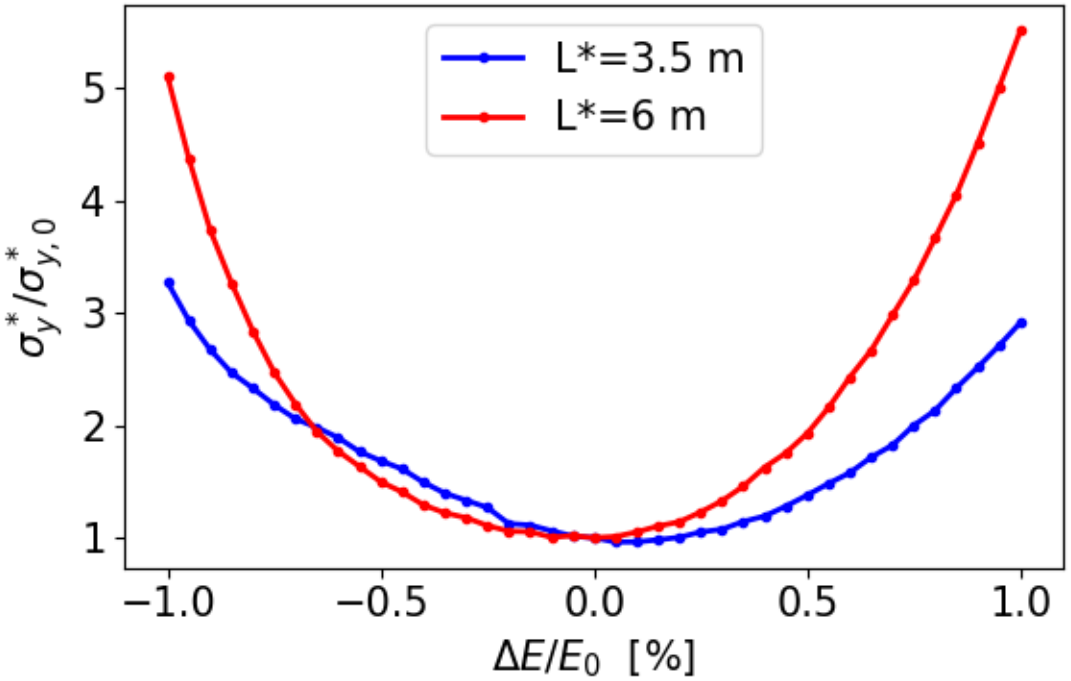


The value of the η_x at the FD peak is:

- $\Delta p/p$ = 0% → -0.2128 m
- $\Delta p/p$ = -0.5% → -0.2112 m
- $\Delta p/p$ = 0.5% → -0.2148 m

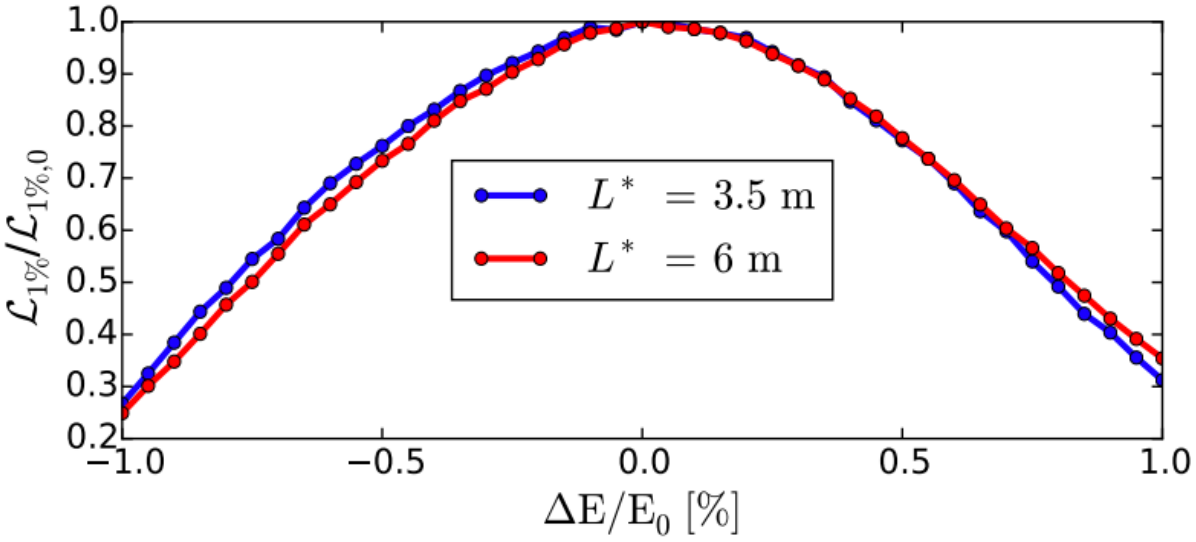
Impact on the beam size for CLIC 3TeV L*=6 m vs CLIC 3TeV L*=3.5 m



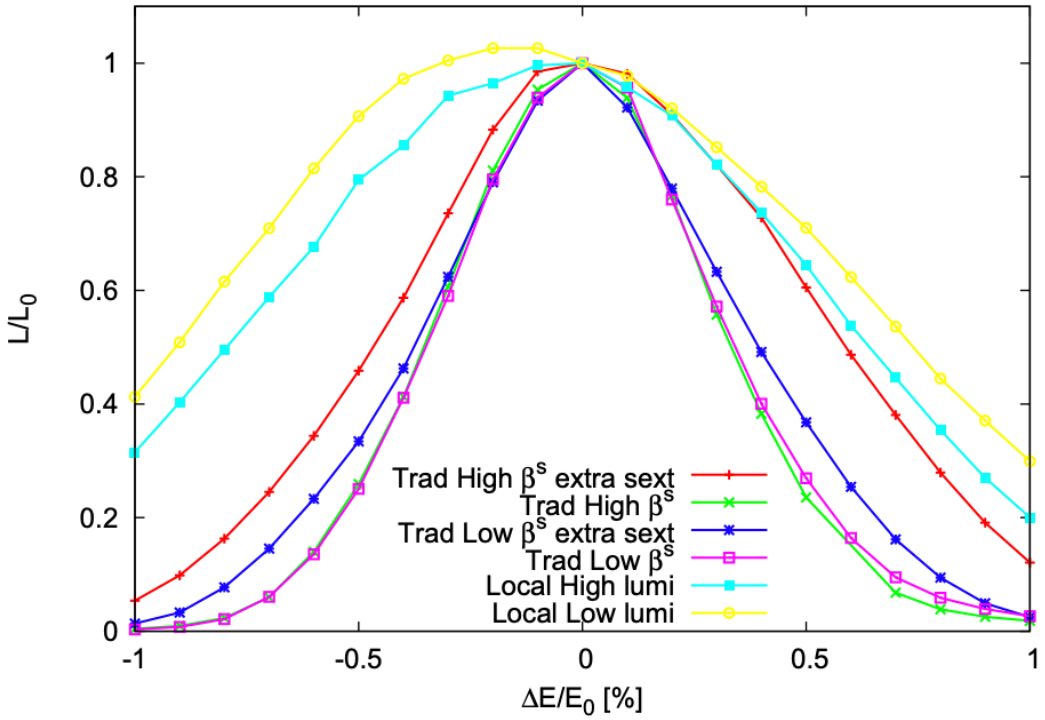


Impact on the luminosity for CLIC 3TeV

- CLIC 3TeV L*=6 m vs L*= 3.5 m

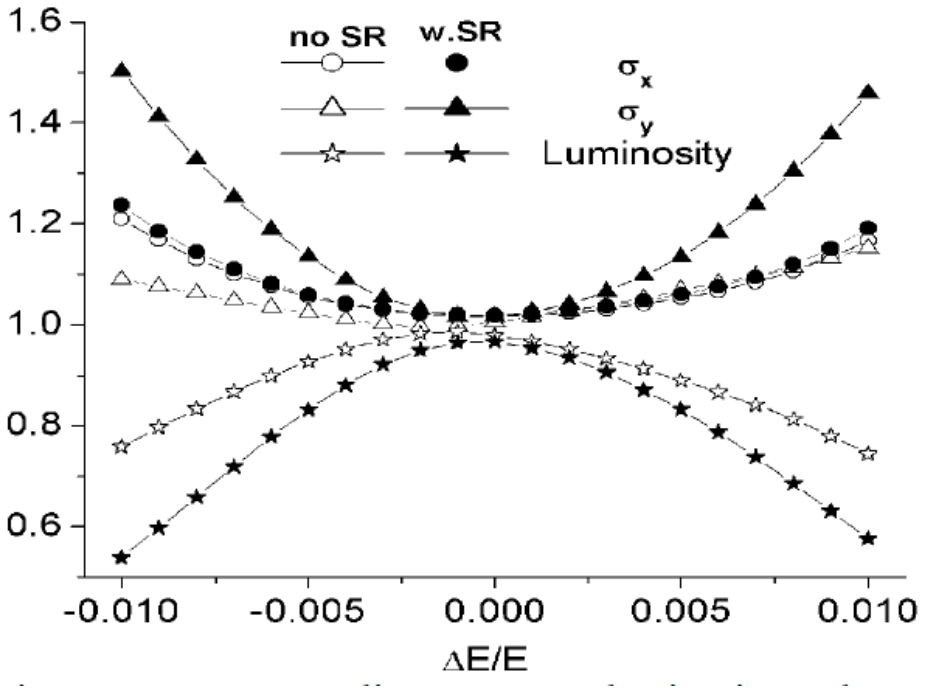


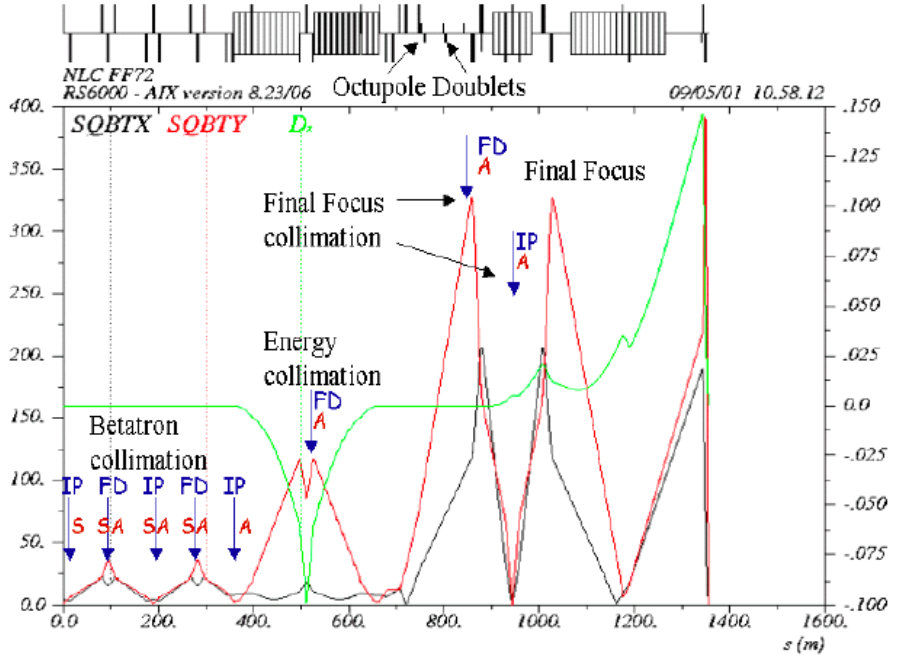
- CLIC 3TeV with L*= 3.5 m Traditional vs Local*



* From Hector Garcia Morales "*Comparative study of Final Focus Systems for CLIC and other luminosity enhancement studies for future linear colliders*". 2015. PhD Thesis. Universitat Politècnica de Catalunya.

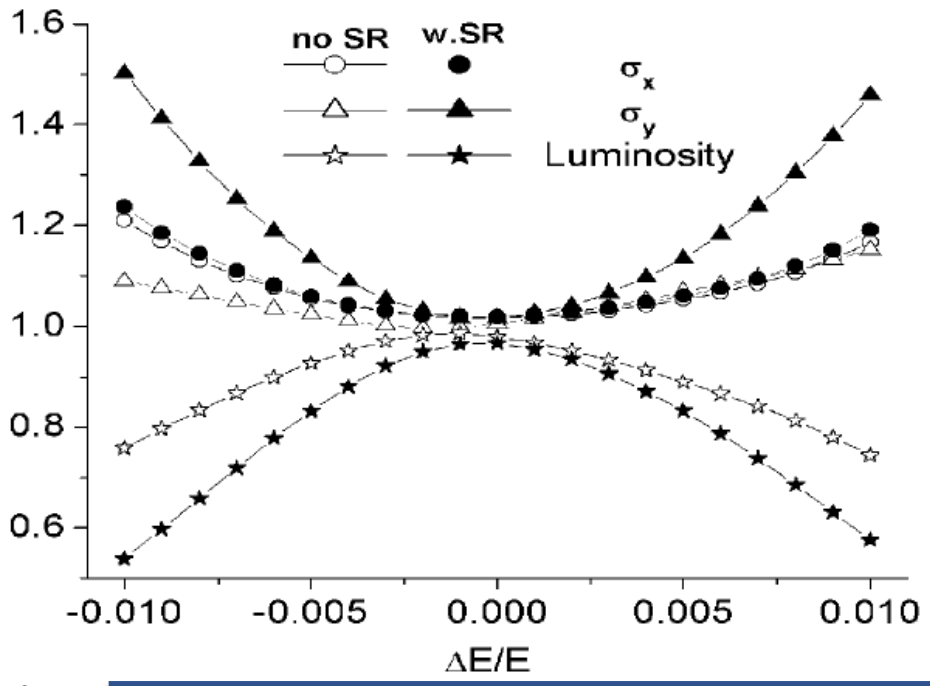
Impact on the beam size and the Luminosity for NLC*

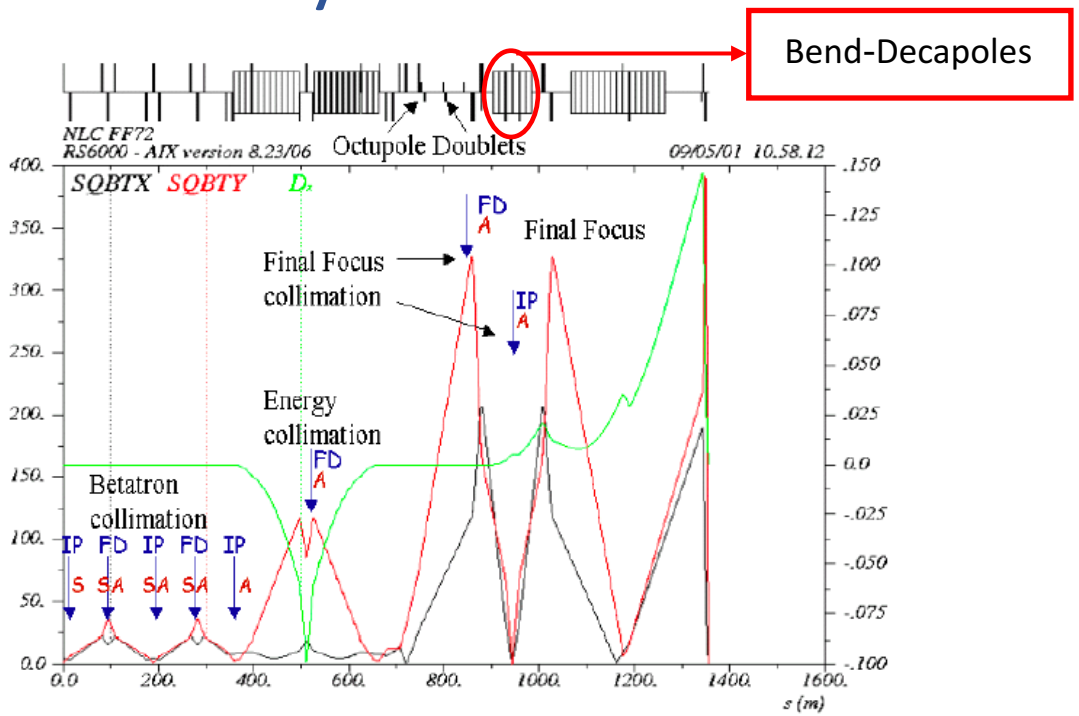




* From Pantaleo Raimondi, Andrei Seryi and Peter Tenenbaum. "Tunability of the NLC final focus system." *Particle Accelerator Conference, 2001. PAC 2001. Proceedings of the 2001*. Vol. 5. IEEE, 2001.

Impact on the beam size and the Luminosity for NLC*



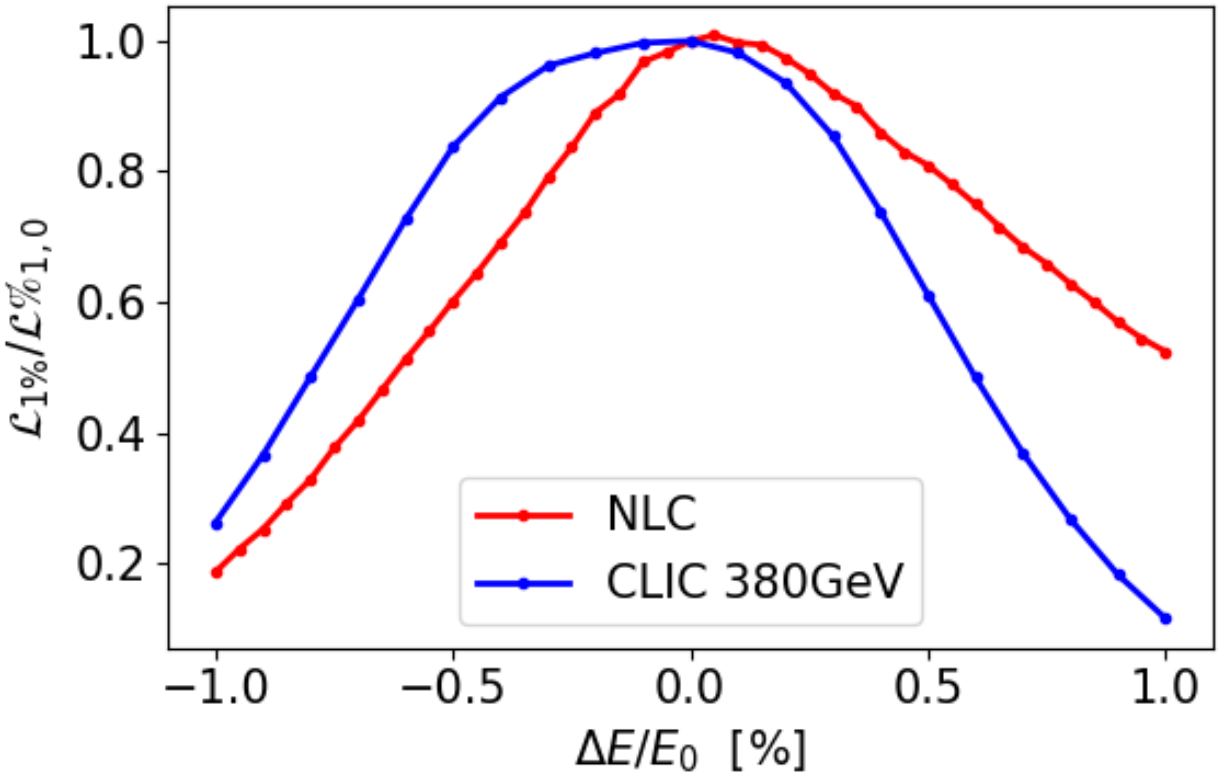


The energy bandwidth was improved in NLC thanks to:

- A bend between the X and Y geometric sextupoles to provide a more local chromatic correction and a better cancellation of the second order dispersion.
- Two decapoles, separated by an "Identity Transformation" in between the X and Y geometric sextupoles to cancel 4th order chromo-geometric aberrations.

* From Pantaleo Raimondi, Andrei Seryi and Peter Tenenbaum. "Tunability of the NLC final focus system." *Particle Accelerator Conference, 2001. PAC 2001. Proceedings of the 2001*. Vol. 5. IEEE, 2001.

Impact on the beam size and the Luminosity for NLC



From the energy bandwidth evaluated and from the lattice design of our NLC lattice file is clear that we don't have the latest version (shown before) → we should look for the latest NLC lattice

Conclusions

- Comparing the Traditional vs the Local Chromaticity scheme in terms of momentum bandwidth the Local one ensures a larger energy acceptance.

- Comparing CLIC 3TeV L*=3.5 m vs L*=6 m the lattice with L*=3.5 m shows a better behaviour for different momentum offsets
  - In terms of second order horizontal dispersion
  - In terms of beam size
  - In terms of luminosity

- Going to L*=6 m we lost some energy bandwidth plus NLC demonstrated a significantly larger one (although we do not have that design).

- Next we will try to improve FFS energy bandwidth with the 'geometric bend' and inserting dodecapoles as reported for NLC.

Thank you for the attention!