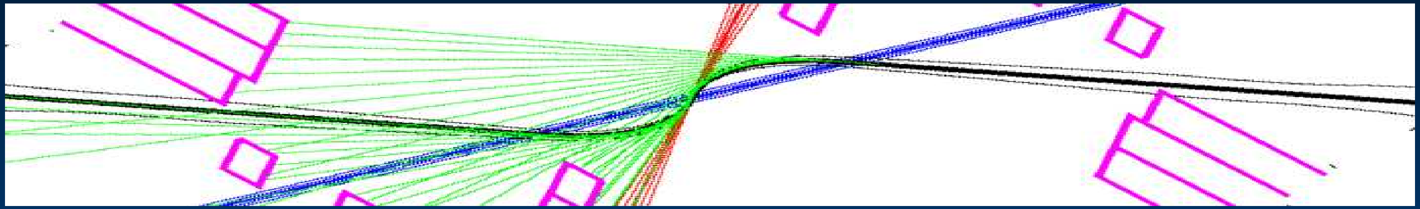
LHeC linac-ring IR



R. Tomás, M. Korostelev and F. Zimmermann

Thanks to N. Bernard, R. De Maria, S. Fartoukh, S. Russenchuck, D. Schulte and B. Holzer

Chavannes-de-Bogis 2010

Aim and contents

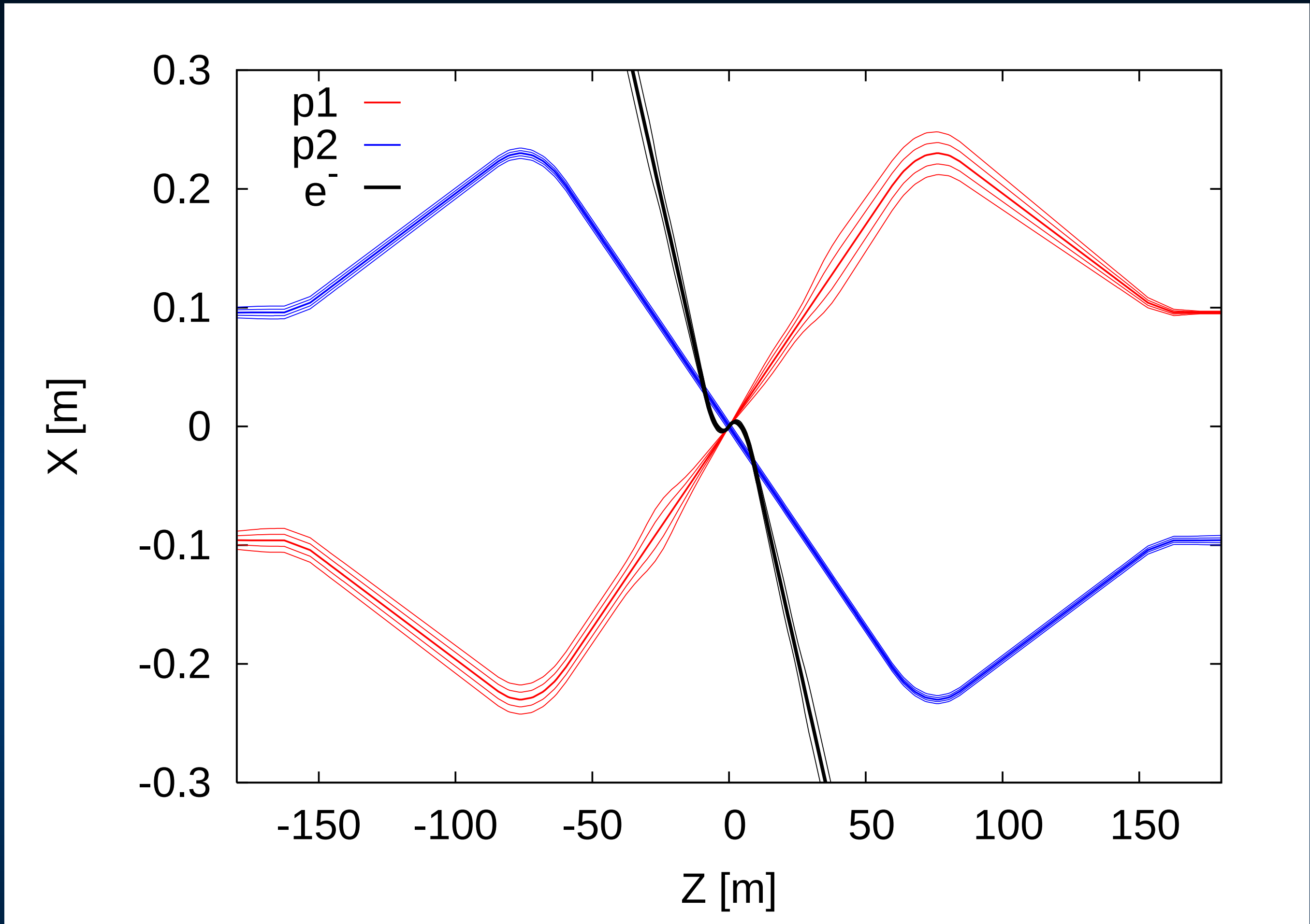
Aim of the study: Present concepts but not technical solutions.

- Wish list for an e^-p IP
- Layout
- The LHC proton IR optics with L*=10m
- The e^- optics with L*=30m (60GeV)
- Is e^-/p chromaticity correction an obstacle?
- Alternative protron optics with L*=23m
- Critical points

Wish list for an e^-p IP

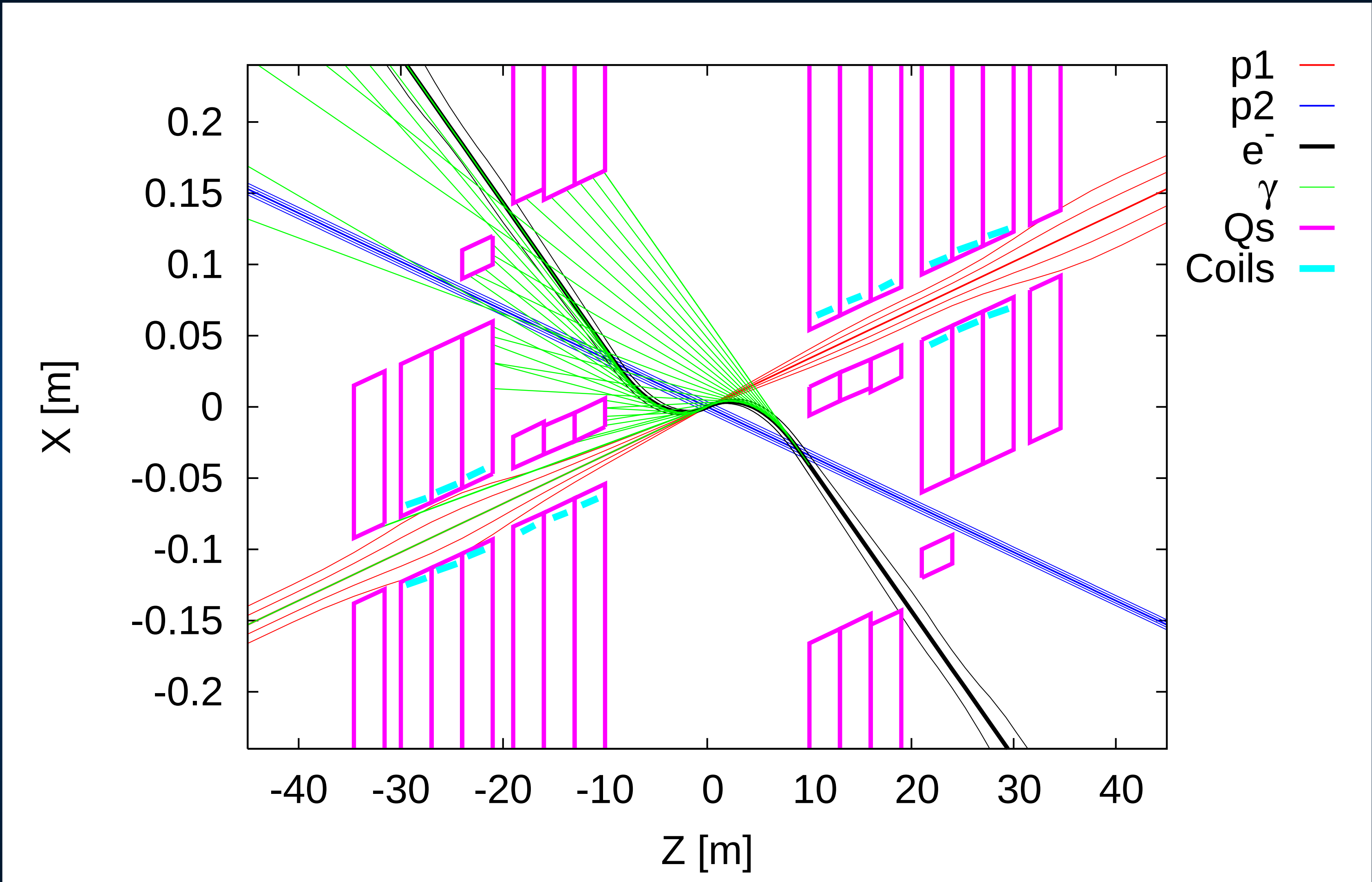
- Head-on collisions (with dipoles)
- Low radiation power ≈ 10 kW
- Critical photon energy < 500 keV
- IP $\beta \approx$ 0.1 m both for e^- and p
- Same geometric e^- and p emittances

Layout for 60 GeV e^-



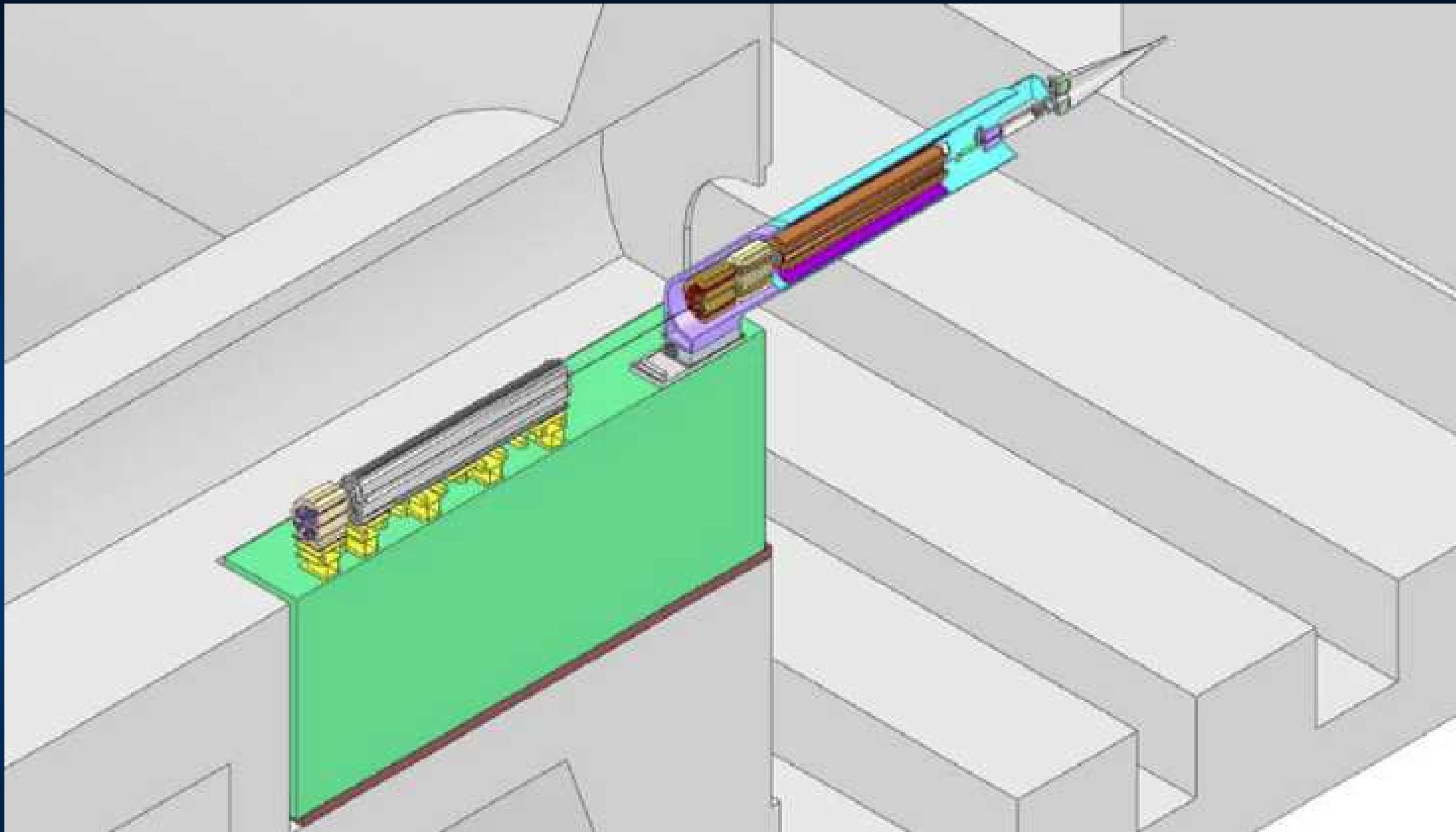
proton D1: 6 T, 4.5× stronger than current D1
proton D2: 6 T, 1.5× stronger than current D2
e- dipole: 0.3 T, ±9 m

The IR



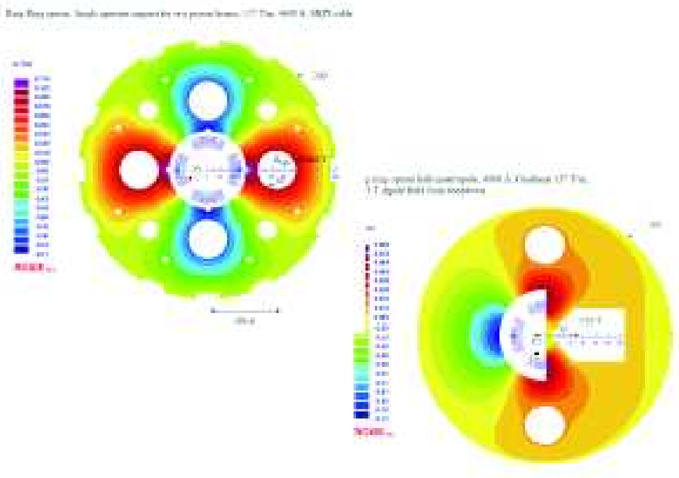
Radiated power = 48 kW, Ec= 720 keV

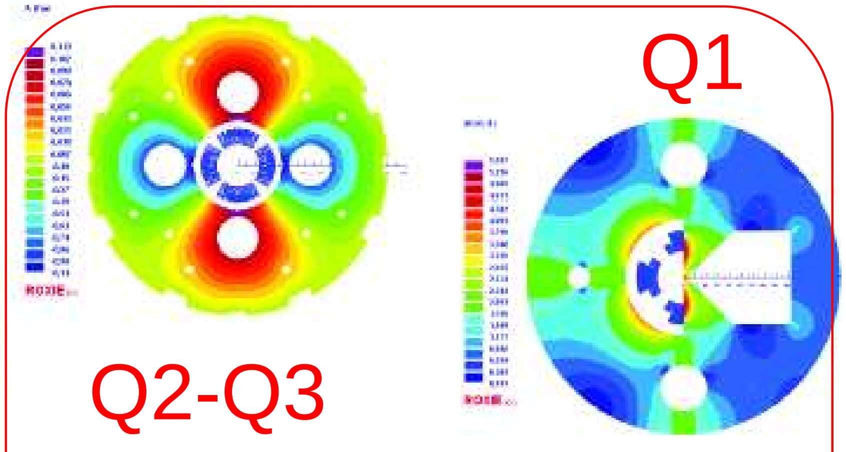
How to get to L*=10 m?



CLIC QD0 ground preisolation and canteliver.

Stephan Russenschuck's quad designs





4600 A MQY cable	4900 A MQY	NbTi: 6700 A, 248 T/m at 88% LL Nb3Sn (HFM46): 8600 A, 311 T/m, at 83% LL	NbTi: 4500 A, 145 T/m, 3.6 T at 87% Nb3Sn (HFM46): 5700 A, 175 T/m, 4.7 T at 82% on LL (4 layers)
35 mm aperture 107 mm beam sep.	35 mm (half) app. 65 mm beam sep.	23 mm app. 87 mm beam sep.	46 mm (half) app. 63 mm beam sep.
0.016 T fringe field in electr. pipe	0.03 T	0.03 T, 3.5 T/m 0.09 T, 9 T/m	0.37 T, 18 T/m 0.5 T, 25 T/m

NbTi at 1.8 K, Nb3Sn at 4.2 K

Stephan Russenschuck, CERN AT/MEL, 1211 Geneva 23

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0.5 T in e$^-$ Q1 hole too large, can it be reduced?

Colliding proton triplet

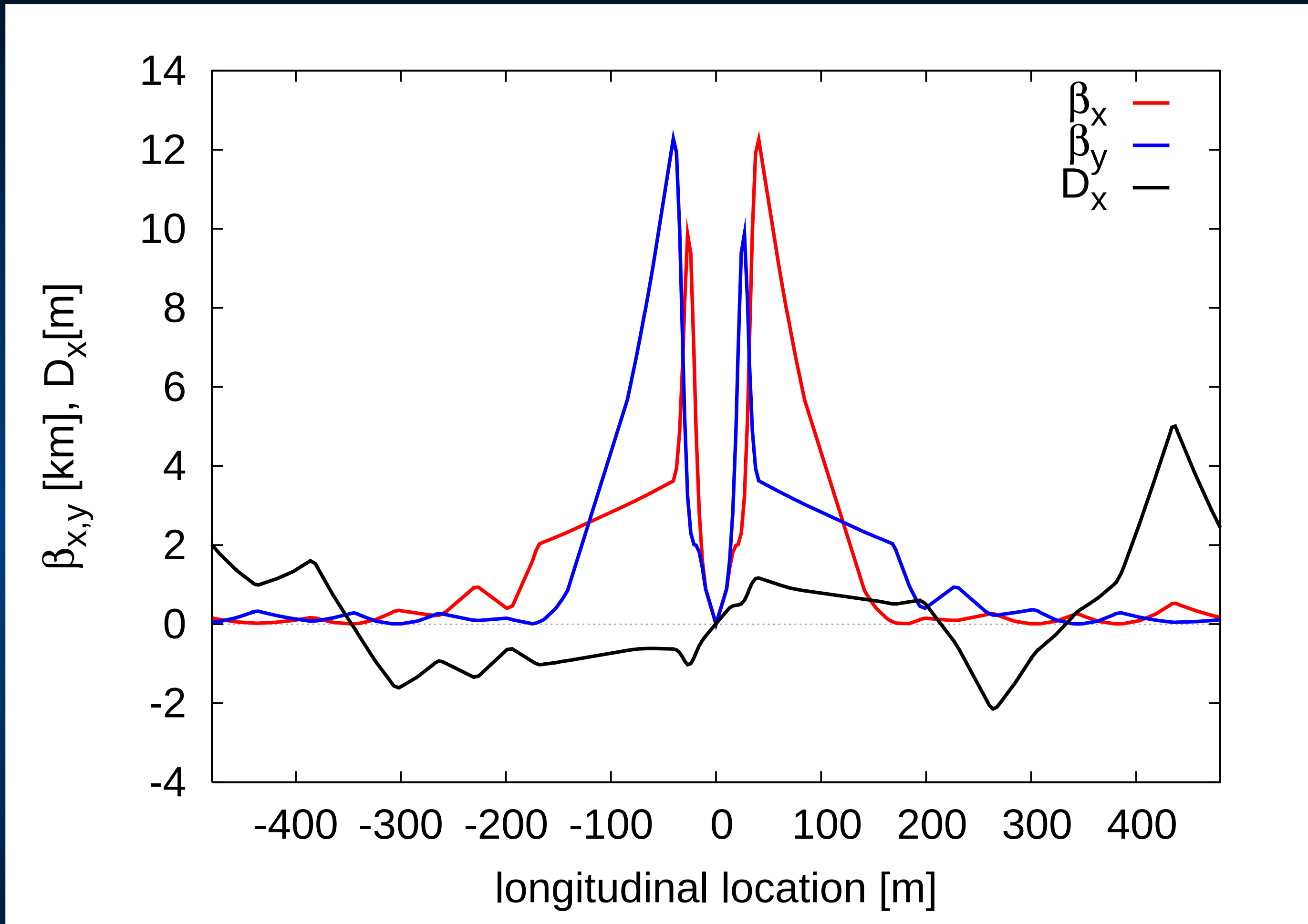
Name	Gradient [T/m]	Length [m]	Radius [mm]
Q1	187	9	22
Q2	308	9	30
Q3	185	9	32

Apertures are computed as

$$11 \max(\sigma_x, \sigma_y) + 5 \text{ mm}$$

All parameters need iterations to be fully consistent.

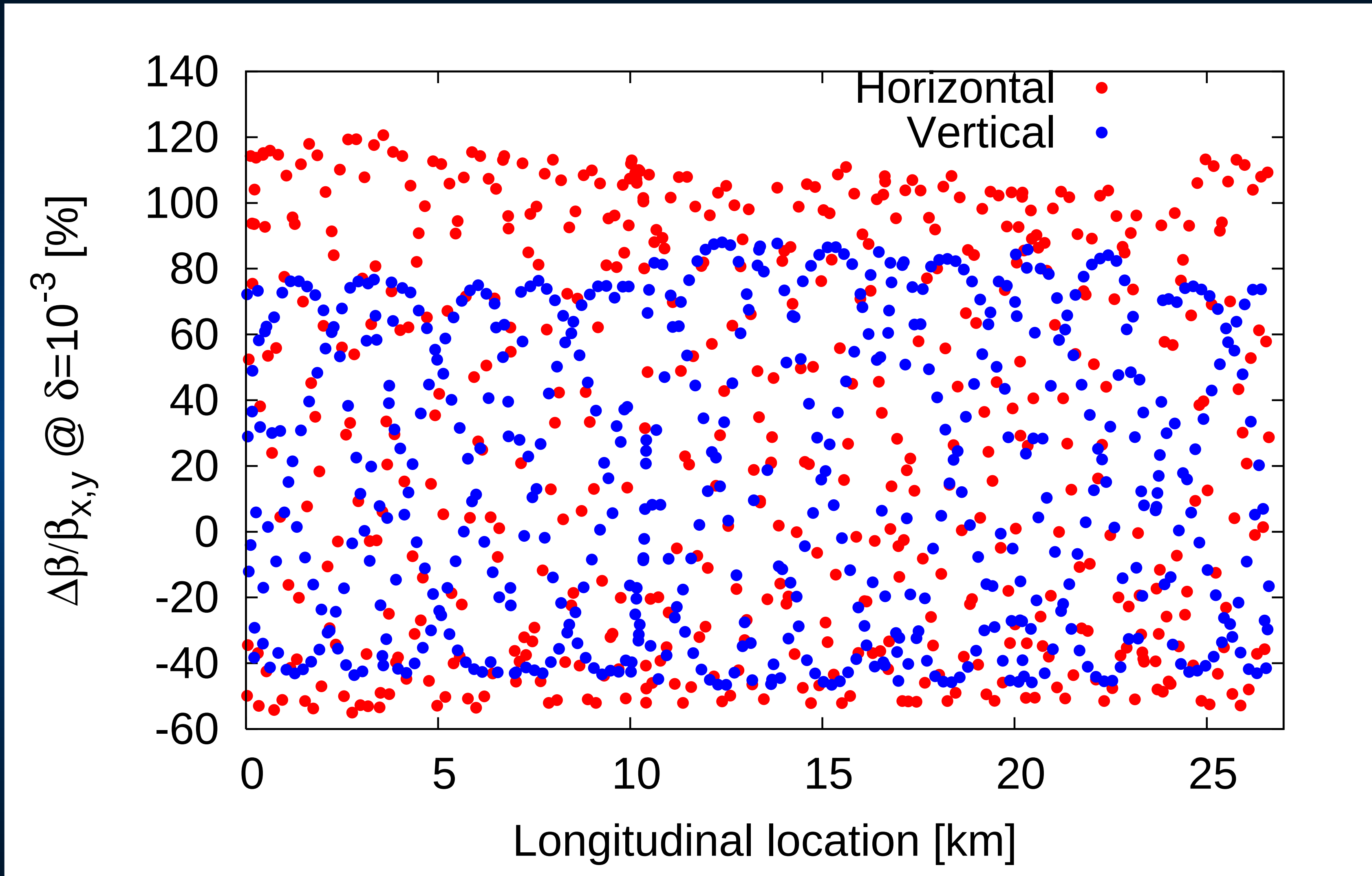
Colliding proton beam optics



Matched to the ring without respecting current aperture/gradients.

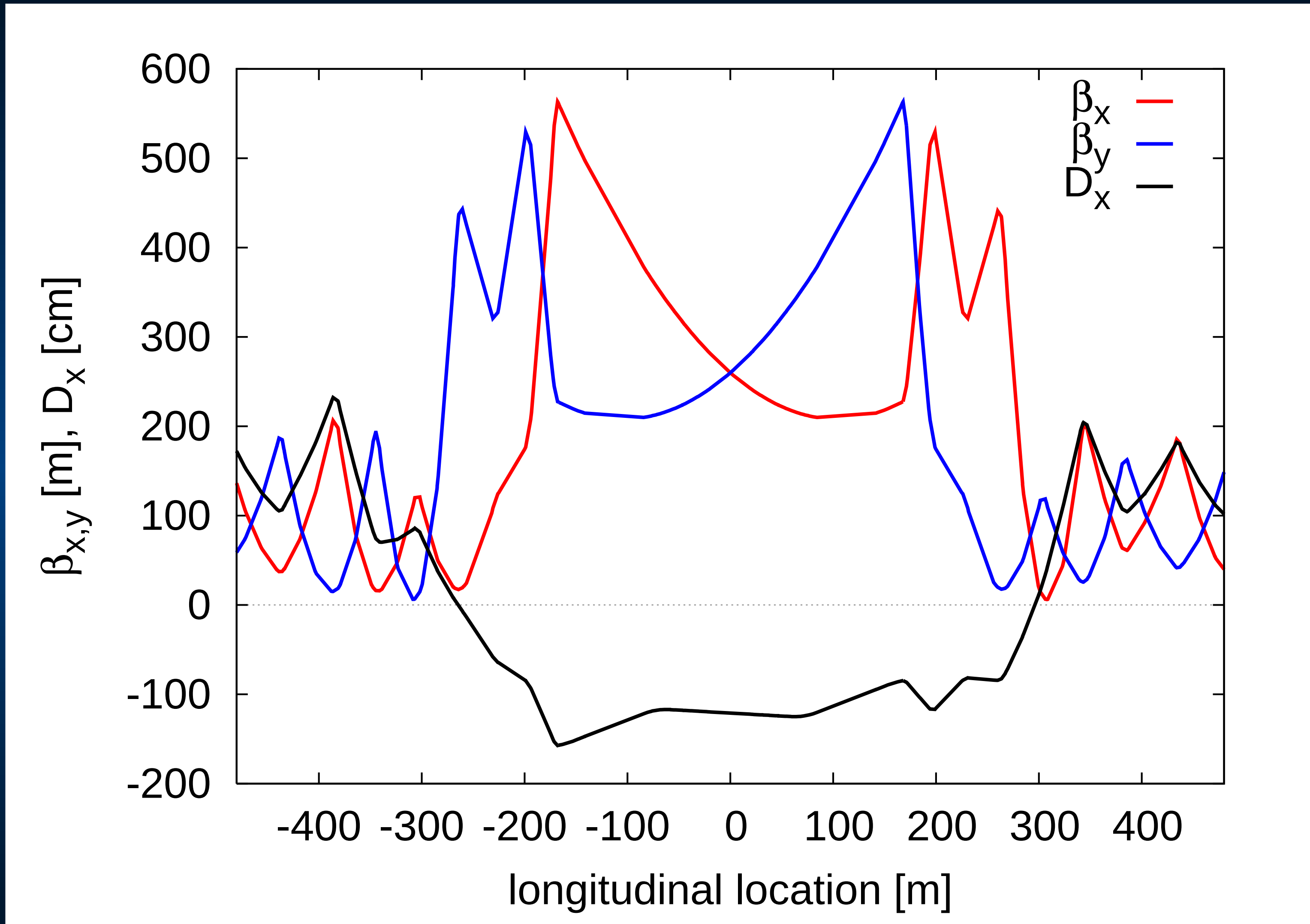
Do we need a chromaticity correction scheme?

Colliding proton chromaticity



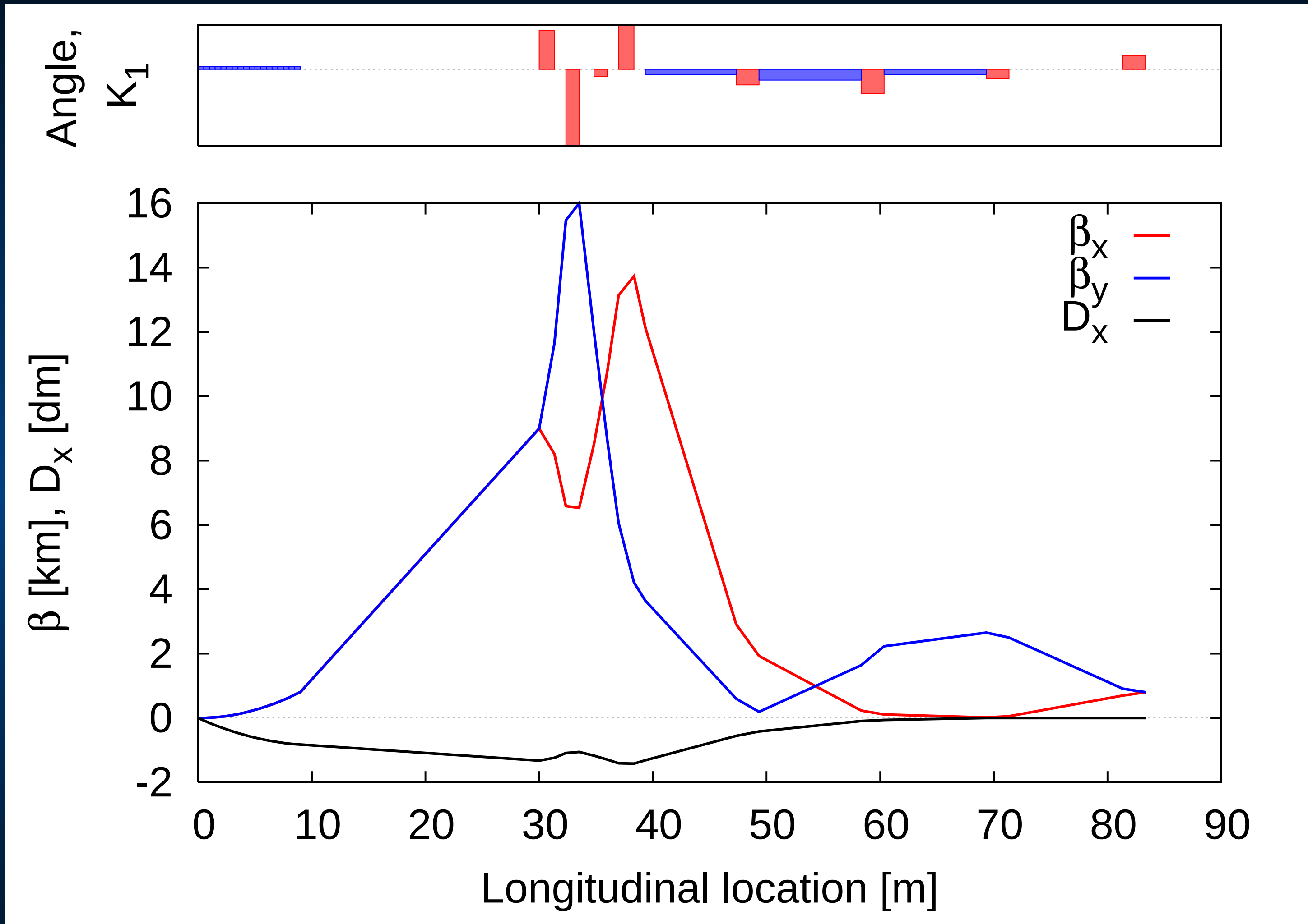
Yes, we need a chromaticity correction scheme.

Non-colliding proton beam optics



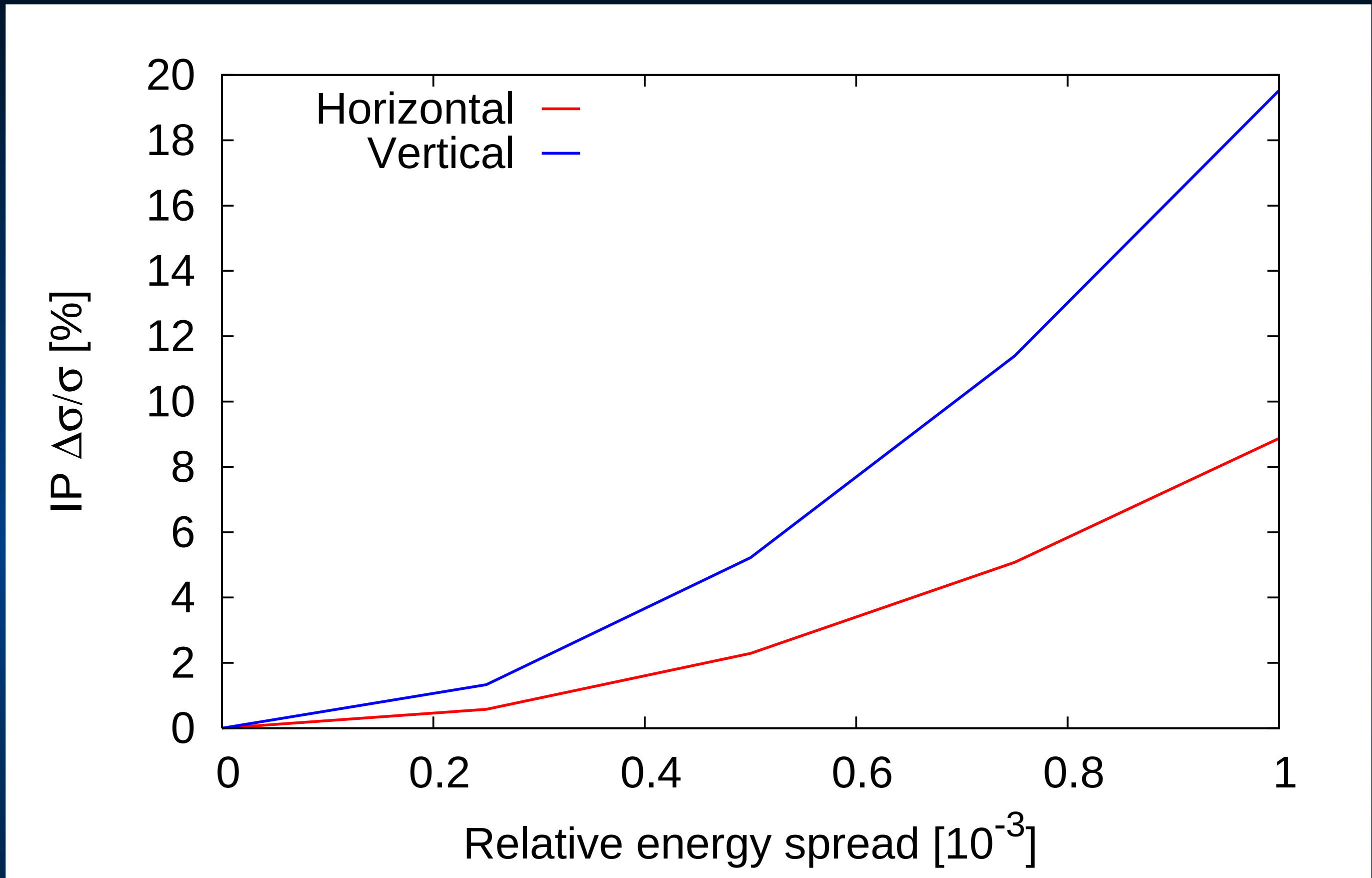
Based on A. Verdier's alignment optics

Electron toy IR optics (L^*=30m)



Matched to the exit of the linac.
Do we need chromaticity correction?

Chromaticity of the electron triplet

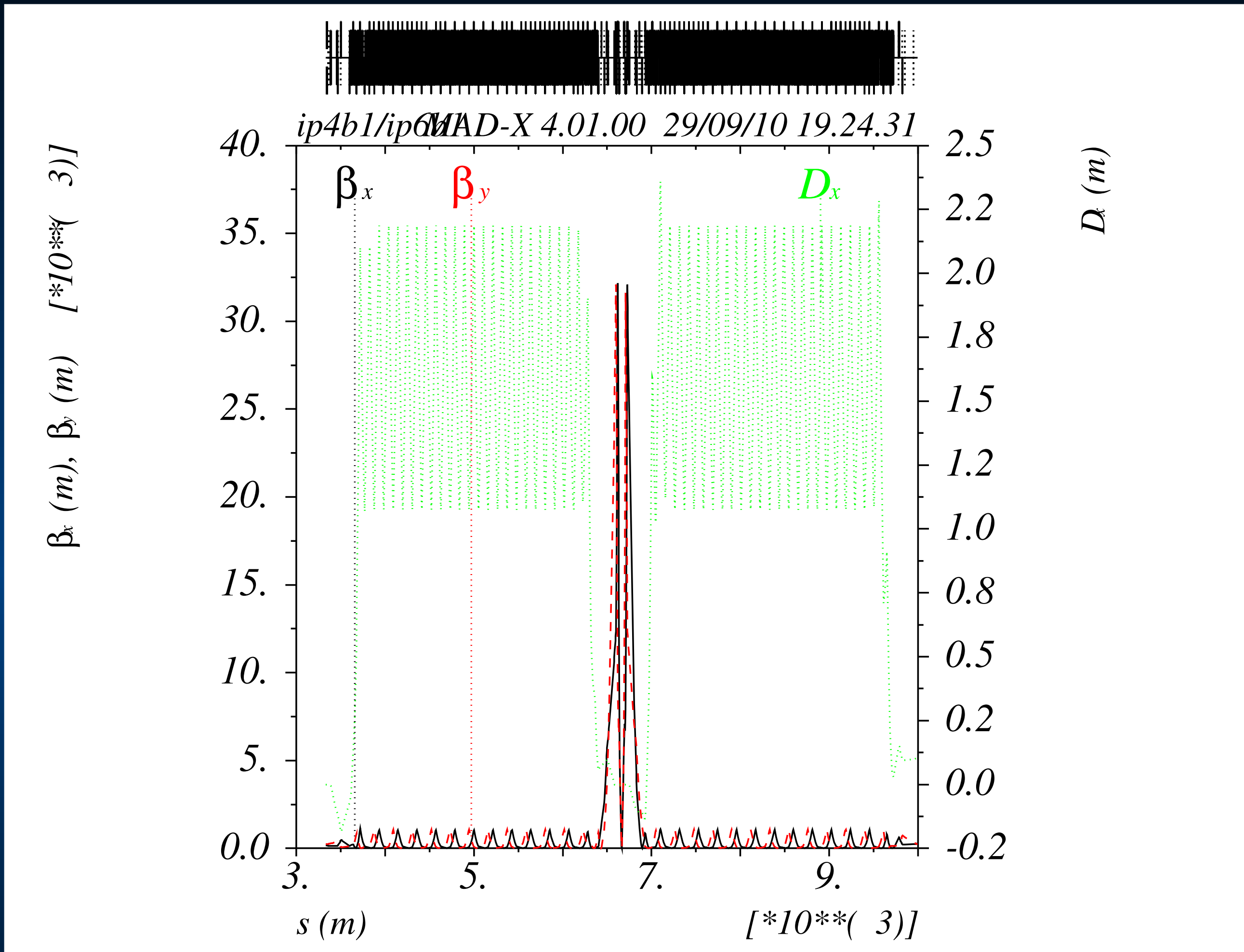


We need chromaticity correction if dp/p$> 4 \times 10^{-4}$ (spread and jitter combined).

Is e-/p chromaticity correction an obstacle?

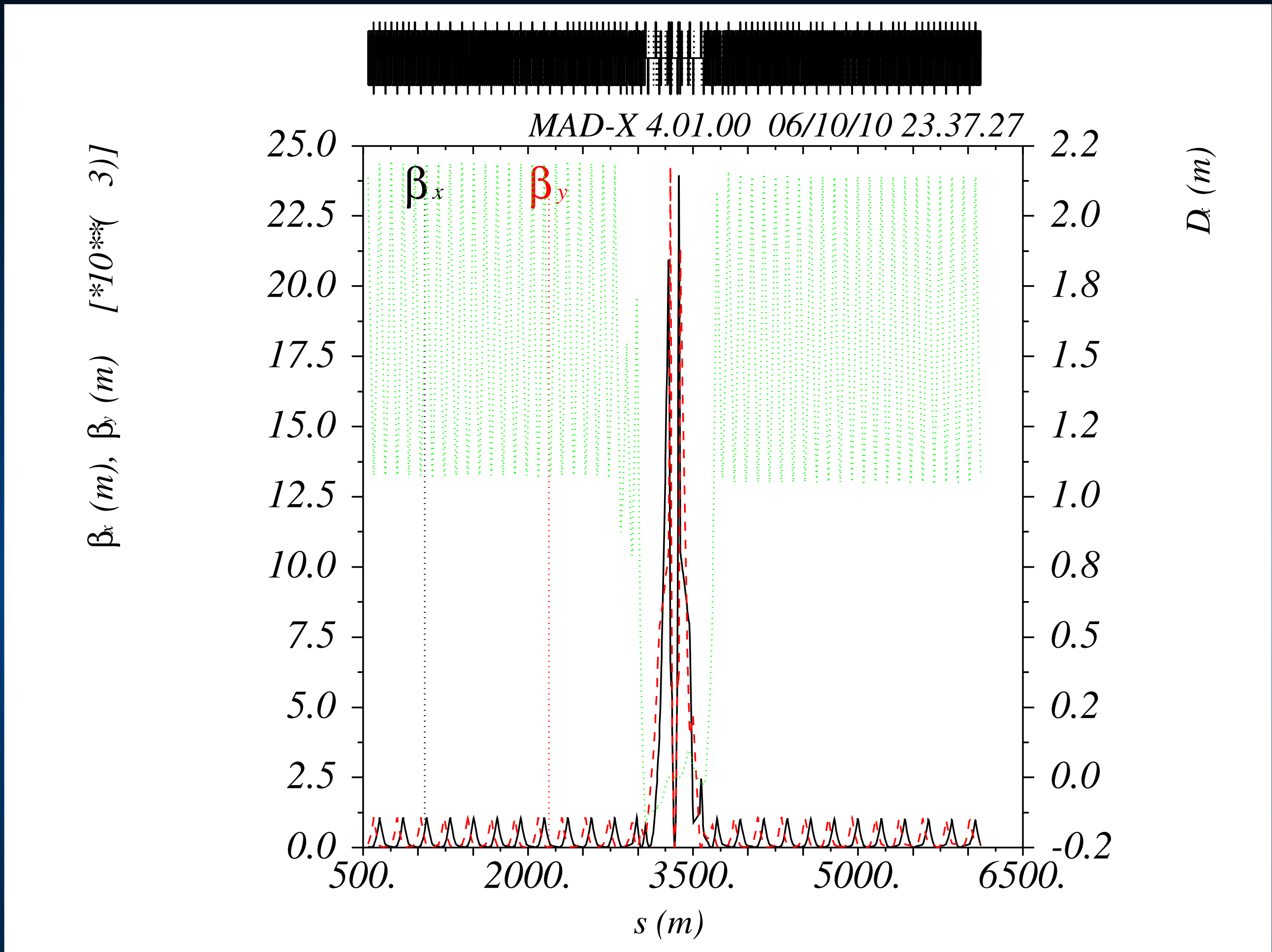
- Most likely not. There are various approaches for chromaticity correction in the LHC:
  - ⋆ In the matching section, C.J. Johnstone.
  - ⋆ IR-to-IR phase and arc cell phase optimization, S. Fartoukh.
  - ⋆ Beta wave in the arcs, S. Fartoukh.
- Similarly for the e^-:
  - ⋆ FFTB approach
  - ⋆ Local chromaticity correction, P. Raimondi and A. Seryi

Alternative optics with L*=23m in IR5



Made by Maxim based on Stephan's SLHC 3.0 ($\beta_{x,y} = 0.1$m). Chromaticity corrected! Requires new triplets,D1,D2,Q4 and Q5.

Alternative optics with L*=23m in IR2



Made by Maxim based on Stephan's SLHC 3.0 ($\beta_{x,y} = 0.1$m). Chromaticity corrected! Requires new triplets,D1... and new magnets left to IP3.

Critical points

- SR absorver location and performance need assessment
- Beam pipe
- Quadrupole design, layout and optics need many many iterations but seem feasible.
- Chromaticity correction is mandatory for protons and feasible
- Chromaticity correction for e- only if dp/p$> 4 \times 10^{-4}$ and there is space (200 m)
- Effect of solenoid field needs to be studied
- Critical e^{-} instrumentation to be identified