IR 10°Optics and Ring Matching

Luke Thompson
Rob Appleby
University of Manchester/CERN/Cockcroft Inst.
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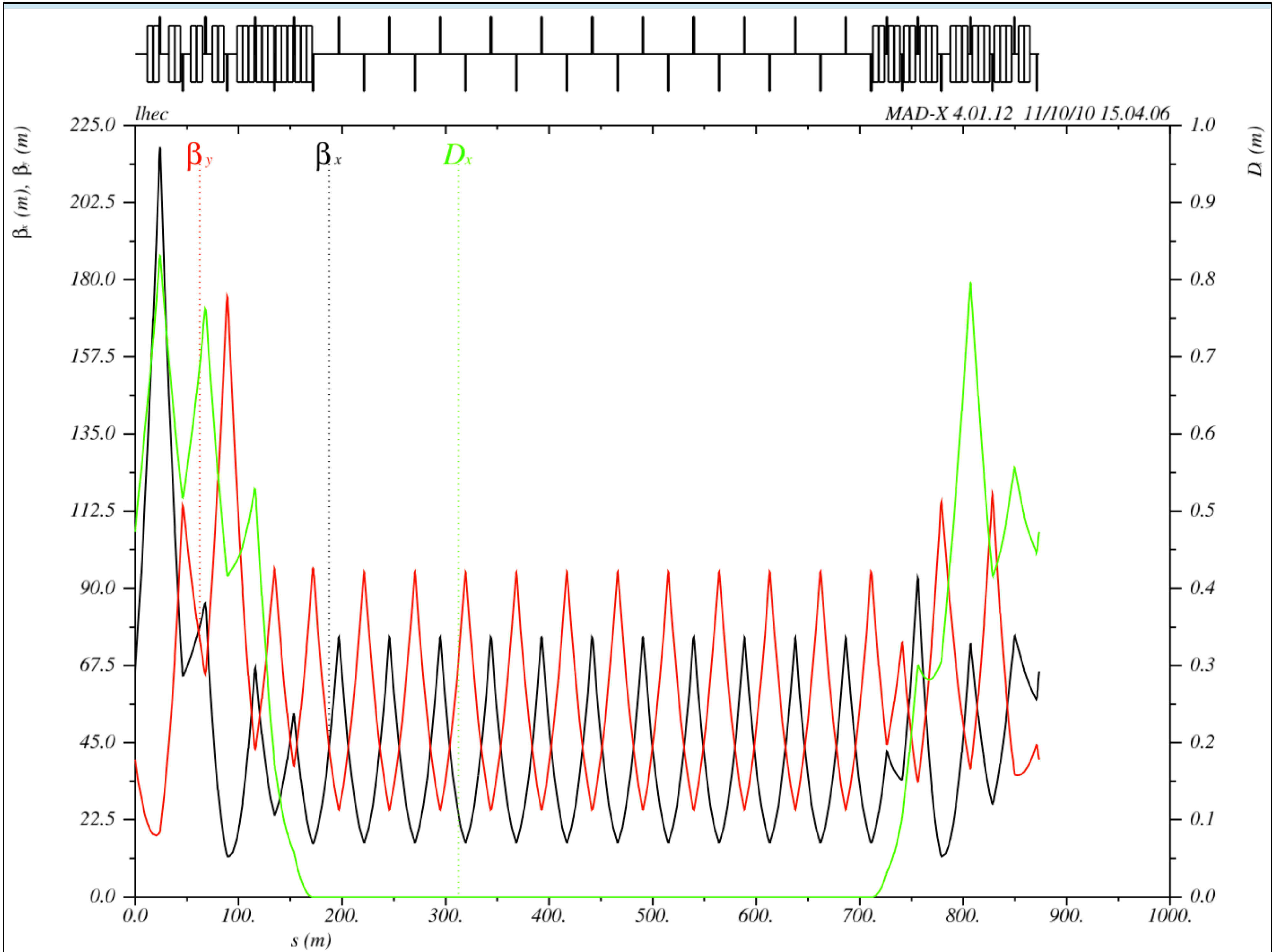
Overview

- Ring Lattice
  - Lattice
  - Dispersion suppressors
  - Geometry
- Matching - version 0
  - IR
  - Matching section / LSS
- IR
  - Separation
  - SR
  - Parameters

Ring Lattice

- IR is matched into Miriam's 'zero-order' lattice
  - $\varepsilon_x = 5 \times 10^{-9}$
  - $\varepsilon_y = 2.5 \times 10^{-9}$
  - $I_e = 100$ mA
  - $E_e = 60$ GeV
- IR placed in IP2 LSS
  - Between dispersion suppressors
  - Dispersion suppressors asymmetric



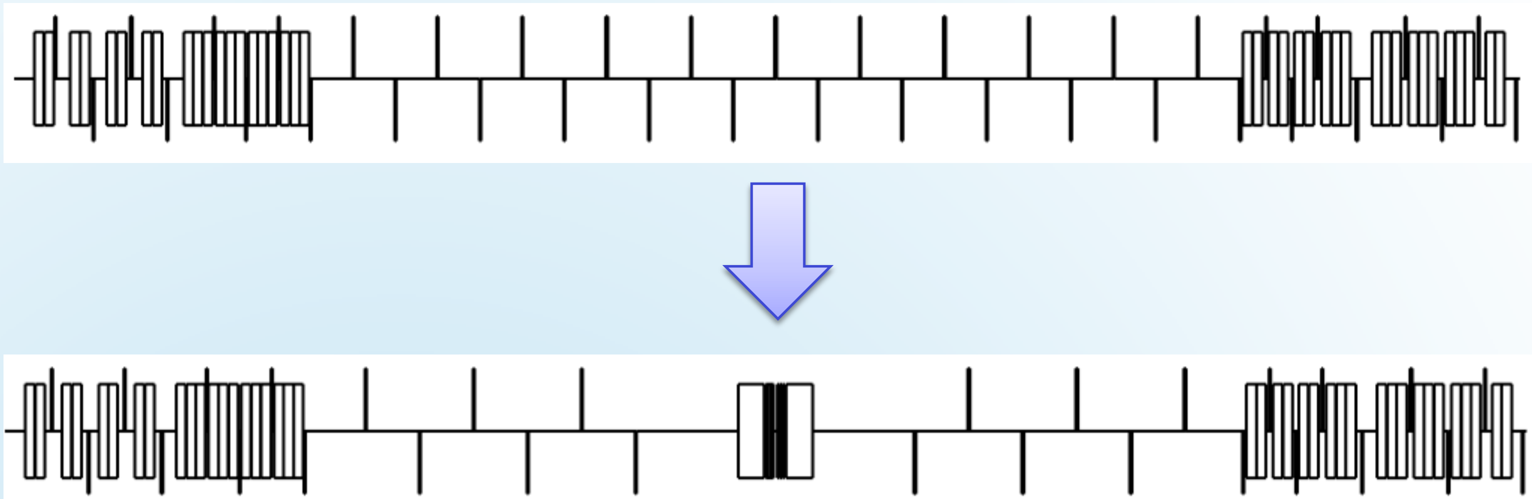
lhec
MAD-X 4.01.12 11/10/10 15.04.06
βx (m), βy (m)
Dx (m)
βy
βx
Dx
225.0
202.5
180.0
157.5
135.0
112.5
90.0
67.5
45.0
22.5
0.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
100.
200.
300.
400.
500.
600.
700.
800.
900.
1000.
s (m)

Ring Lattice

- Must consider geometry
  - Electron IR optics within ±22.96m of IP2
  - LHC proton final triplet
  - Need enough space to bend beam into ring
    - ‘Around’ LHC – optics, DFBMs, tunnel restrictions
  - Details of separation scheme not yet set
    - Horizontal or vertical crossing angle
    - Dispersion-free bends
    - Polarisation optimisation – siberian snakes?
- Conclusions
  - Must leave space for LHC optics and other electron elements
  - Therefore, sizeable gap between IR and matching quads

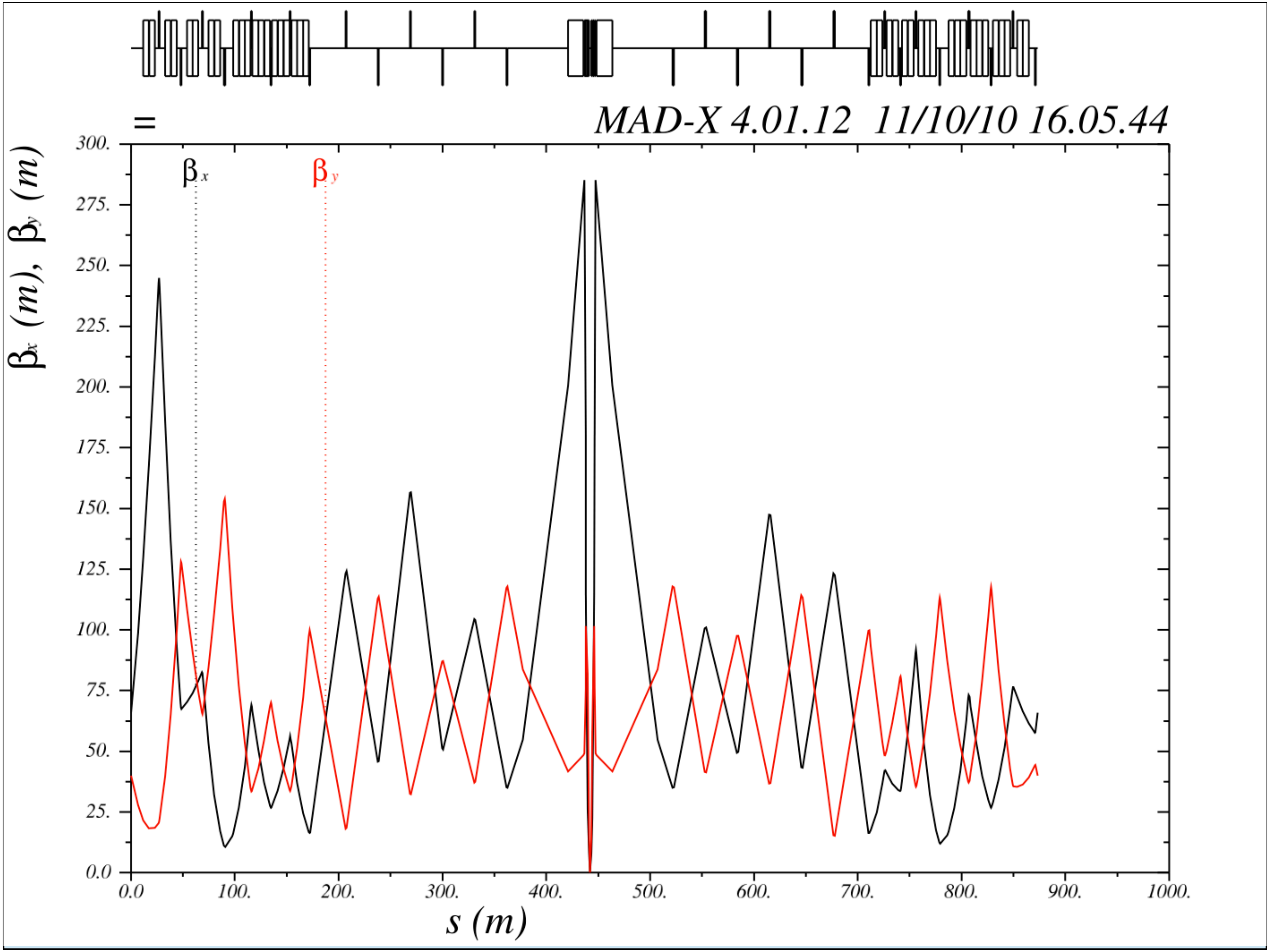
Matching

- Quads removed from LSS
- IR elements inserted
- Matching quads inserted
  - ~ 80m from IP2

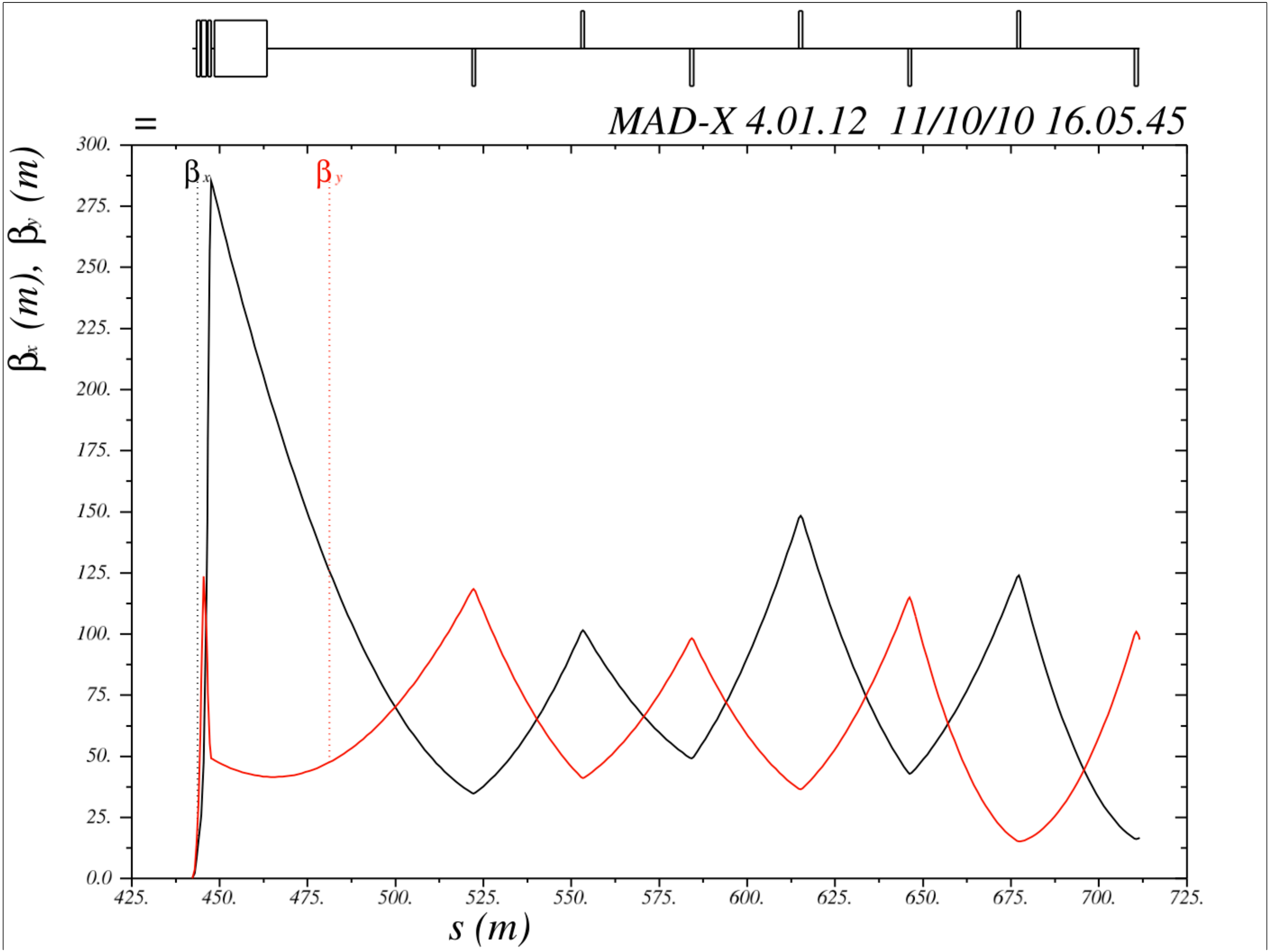


Matching

- New matching-friendly 10° IR draft designed
  - Previous IR matched to old lattice
- Starting point for matching
- IR and LSS matched to dispersion suppressor
  - Matched in iterations
- ‘Smooth’ FODO-like solution achieved
  - Slightly asymmetric



MAD-X 4.01.12 11/10/10 16.05.44
β_x (m), β_y (m)
β_x
β_y
s (m)



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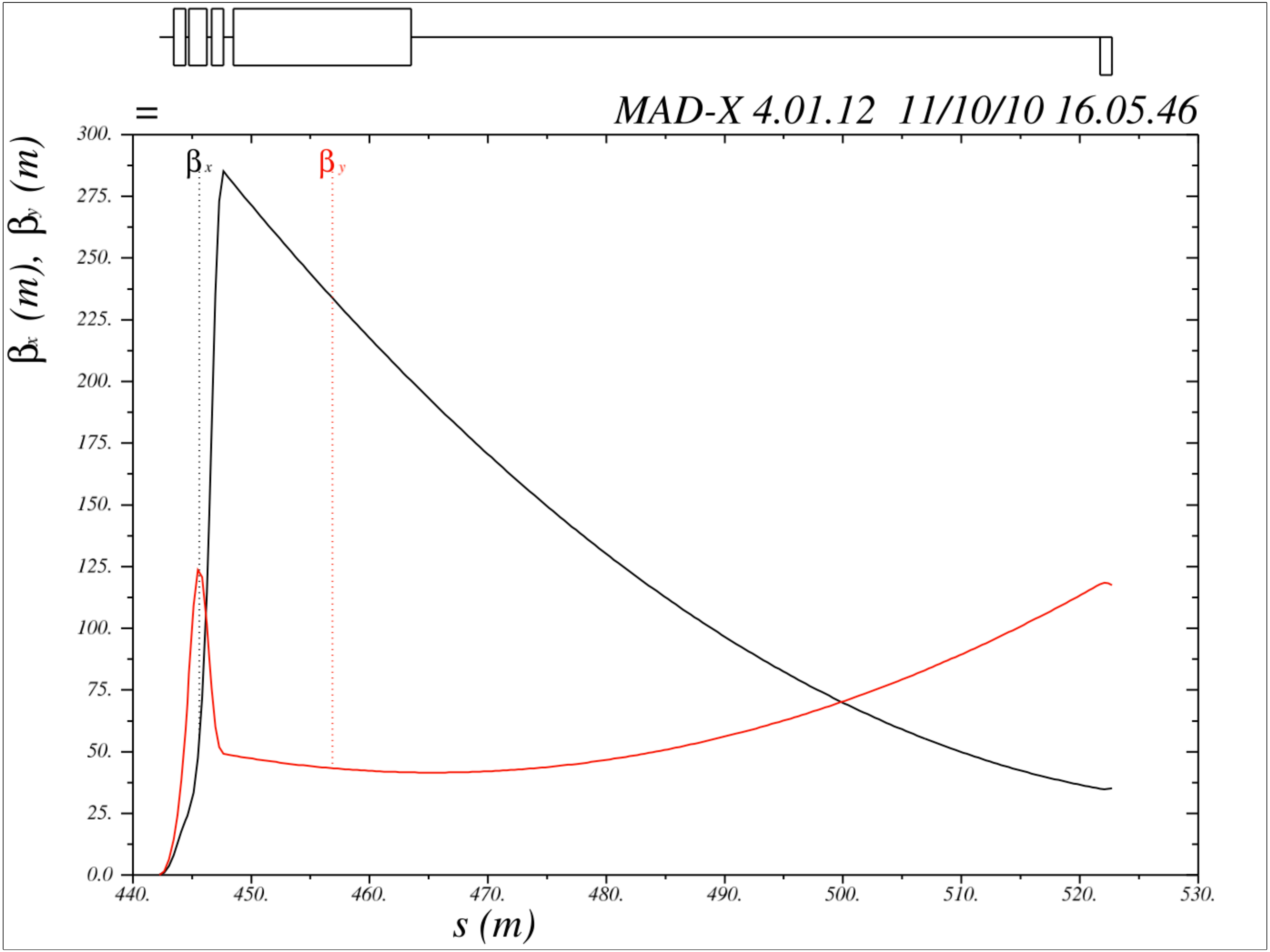
MAD-X 4.01.12 11/10/10 16.05.45
β_x (m), β_y (m)
β_x
β_y
300.
275.
250.
225.
200.
175.
150.
125.
100.
75.
50.
25.
0.0
425.
450.
475.
500.
525.
550.
575.
600.
625.
650.
675.
700.
725.
s (m)

Matching

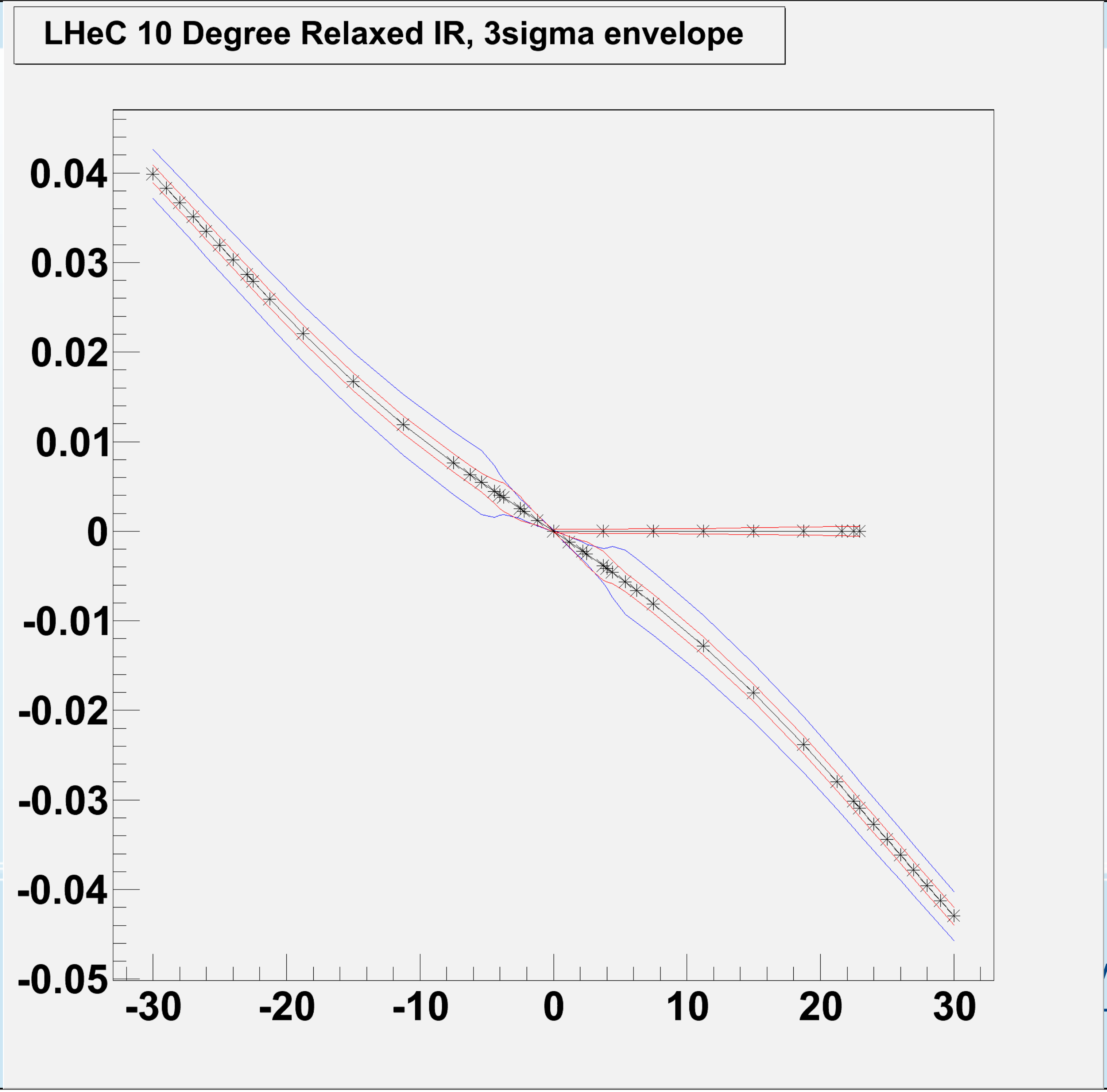
- First ‘zero-order’ solution - doesn’t account for:
  - Separation
  - Dispersion
  - Correctors
  - Phase advance
- 6 or 7 matching quads on each side, depending on your view…
  - Final quad before DS on right is required, but is not part of DS
  - Corresponding quad on left is part of DS
- Aim to reduce number of quads in later versions
- Gap between IR and matching quads should allow other elements
- Files available at /afs/cern.ch/eng/lhc/optics/LHeC/IR10_Lattice0/

IR - Separation

- New FDF electron triplet
  - Previous triplet was DFD
  - Higher peak β_x BUT peak is later
  - Separation appears improved
- Separation provided by crossing angle, dipole and offset quads
  - Possibly also detector dipole
  - Currently aiming at 50mm separation
  - Minimum crossing angle decreased with increased bending (for 10° optics)
- Separation not yet studied in detail
  - In short, separation is comparable or better than previous IR design
- Side note: nice solution for vertical crossing angle!



MAD-X 4.01.12 11/10/10 16.05.46
β_x (m), β_y (m)
β_x
β_y
300.
275.
250.
225.
200.
175.
150.
125.
100.
75.
50.
25.
0.0
440.
450.
460.
470.
480.
490.
500.
510.
520.
530.
s (m)



latching

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IR – Synchrotron Radiation

- Not yet studied, but roughly compare to previous IRs
  - SR power dominated by quads
- 10° triplet strengths:
  - KQ1: 0.27
  - KQ2: -0.51
  - KQ3: 0.45
- Previous 10° triplet strengths:
  - KQ1: -0.59
  - KQ2: 0.40
  - KQ3: -0.34
- SR power should be comparable

IR – Parameters

$E_{electron}$	60GeV
L(0)	**1.8e33**
S(1 mrad)	0.744
L(1 mrad)	**1.34e33**
B*x	0.18
B*y	0.1
ex	5e-9
ey	2.5e-9
I	100 mA
l*	1.2 m
ρ	26.3 km

Minimum crossing angle for 5σ+5σ separation at all parasitic crossings is just below 1 mrad for constant bending radius ρ = 26.3 km.

This does not result in 50 mm separation at S = 23 m. Bend radius used to compare to previous IR layouts' separation.

What's next

- Similar solution required for 1° layout
  - Aim for ~1e33 lumi
  - Aim for viability as single-IR solution
- Separation scheme
- Consider vertical crossing angle
- Study SR for new IR
- Optimise solution for less quads?