Progress on RCS Lattices

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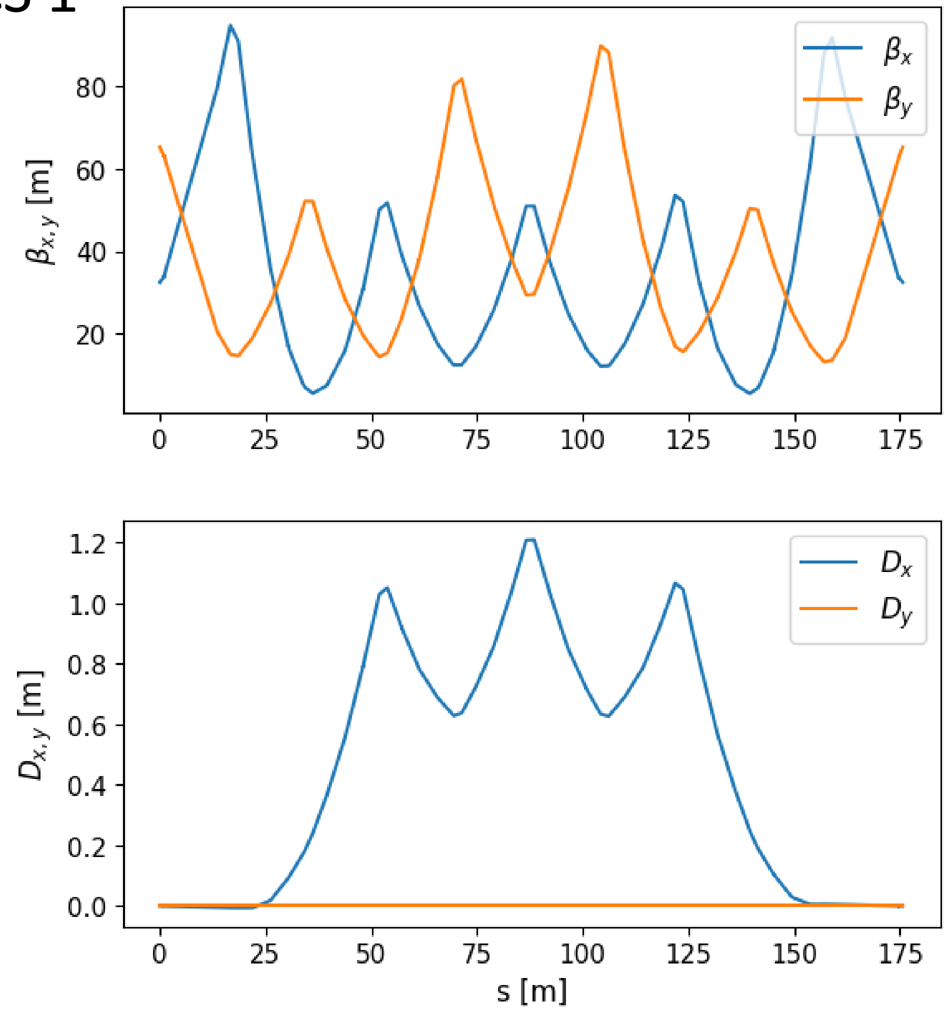
Work on RCS geometry and lattices

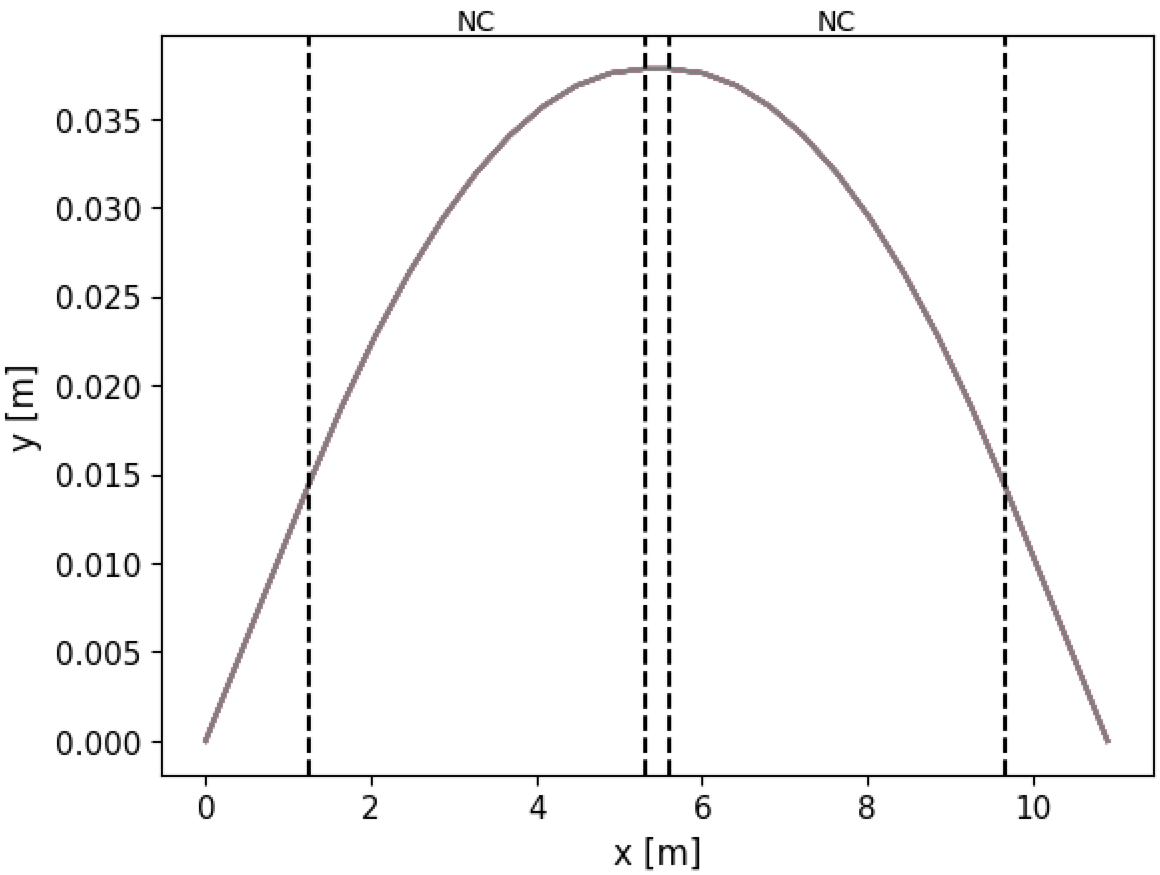
- Work on geometry and lattices for the greenfield proposal

- Optimization of cell length L_c (= optimization of n_c) to get more feasible QP strengths
- Number of arcs remains unmodified (RCS 1: 32 arcs, RCS 2,3,4 : 26 arcs)
- Generate the arc layout with a FODO structure :
  - Allocate place for QP and SXT in the arcs and RF insertions (thick elements)
  - Distribute remaining straight sections between the cells and RF insertions
- Dispersion suppressor for RF insertions
- Correct chromaticity to dqx = dqy = 5

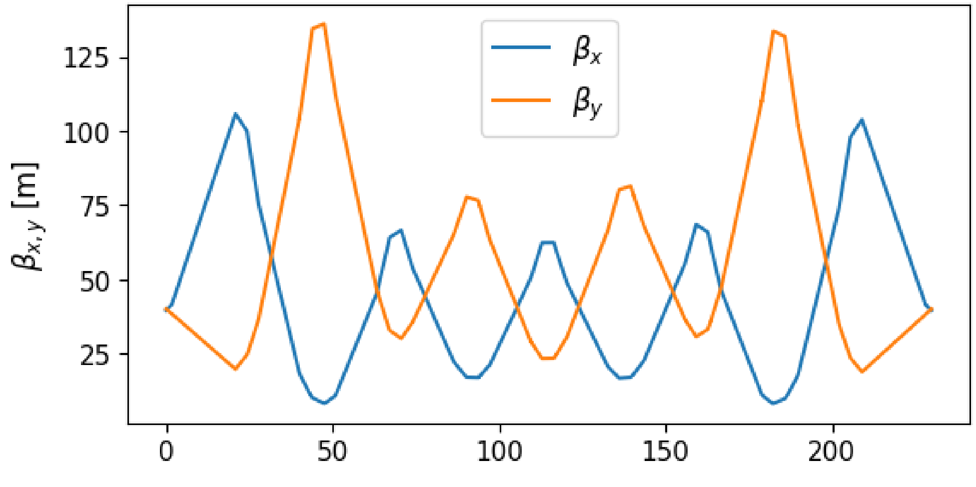
Normal RCS 1

RCS 1

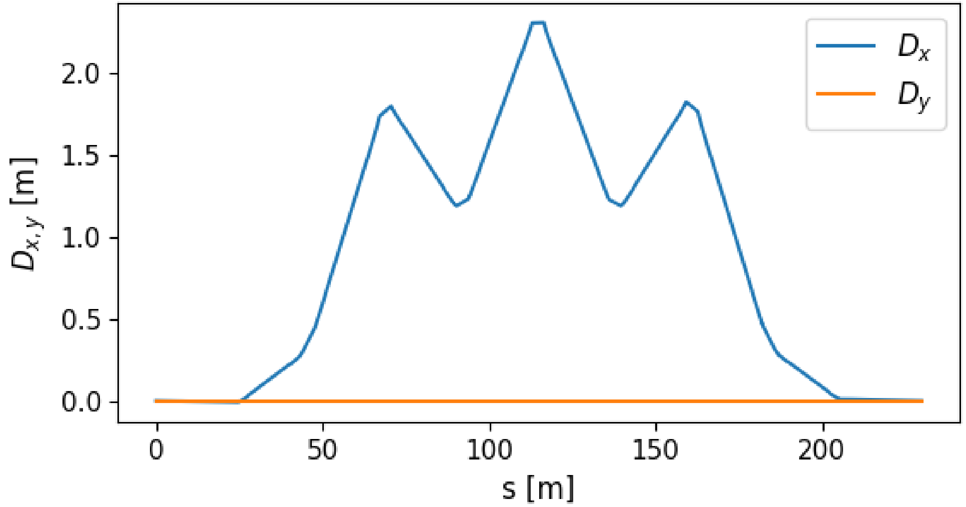




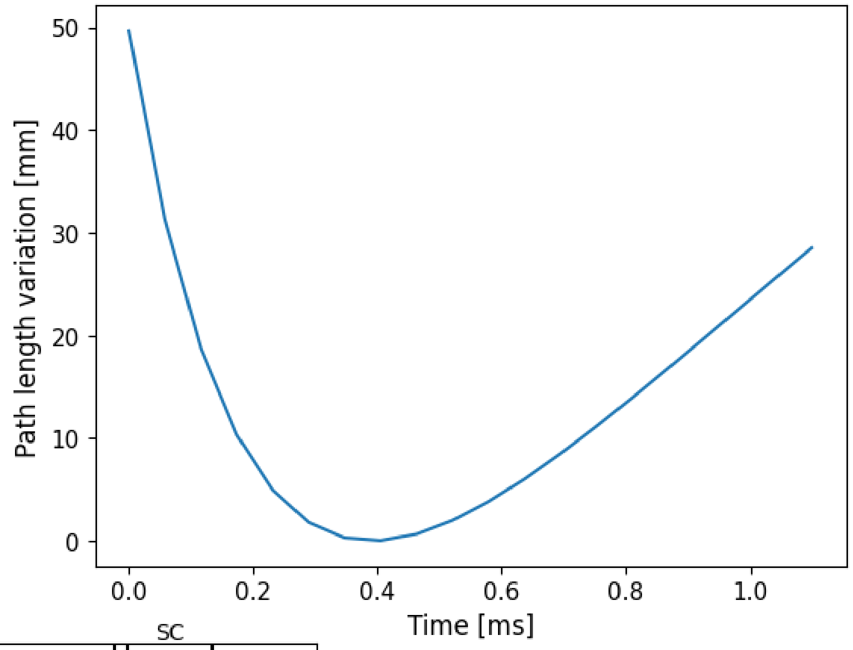
Hybrid RCS 2



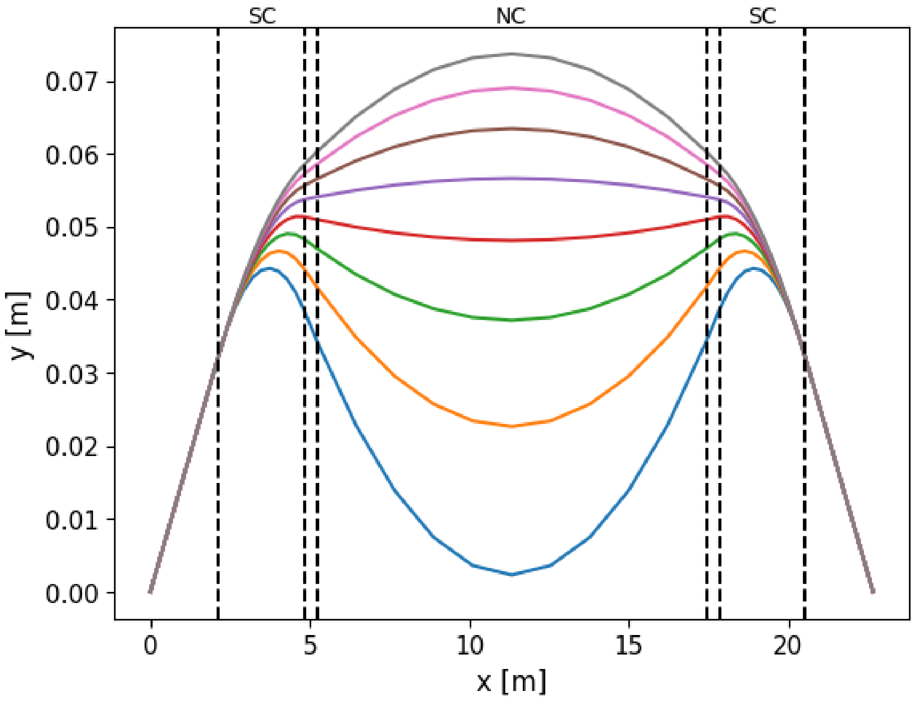
$\beta_{x,y}$ [m]
β_x
β_y
125
100
75
50
25
0
50
100
150
200



$D_{x,y}$ [m]
D_x
D_y
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
s [m]

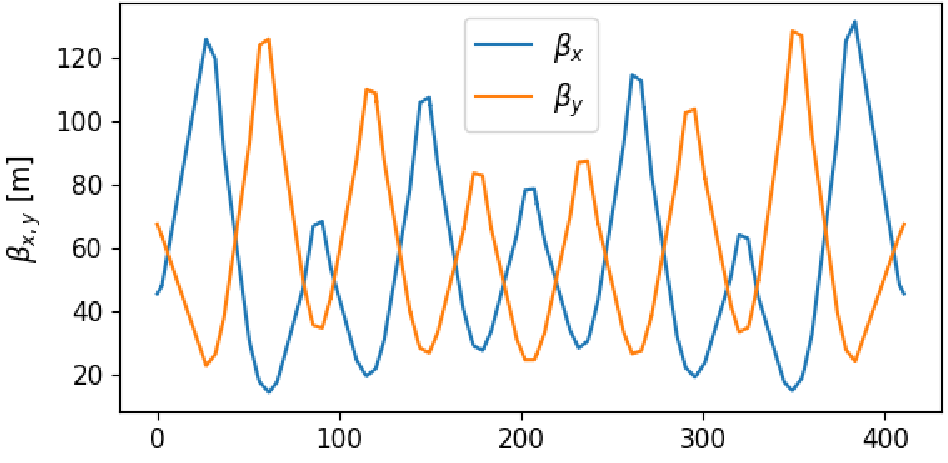


Path length variation [mm]
50
40
30
20
10
0
0.0
0.2
0.4
0.6
0.8
1.0
Time [ms]

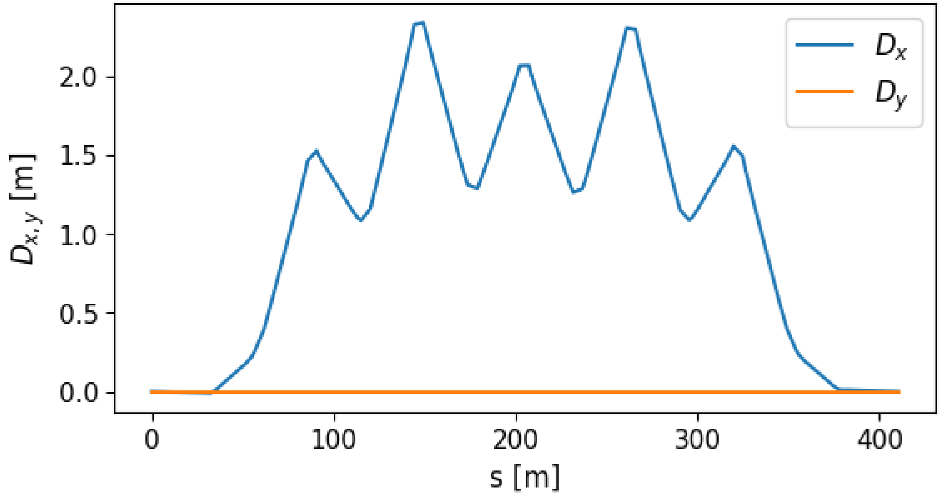


SC
NC
SC
y [m]
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
5
10
15
20
x [m]

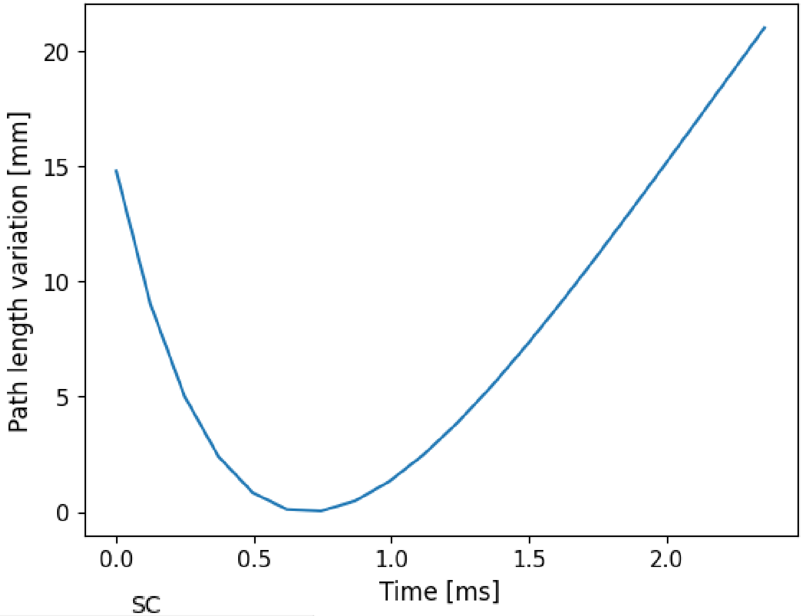
Hybrid RCS 3



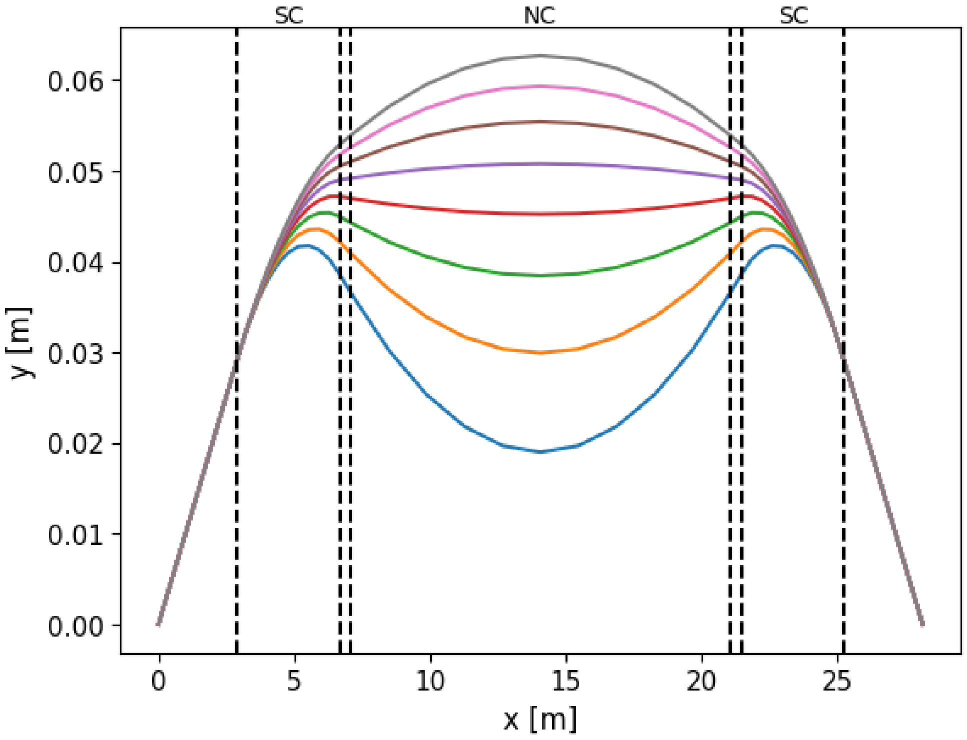
βx
βy
βx,y [m]



Dx
Dy
Dx,y [m]
s [m]

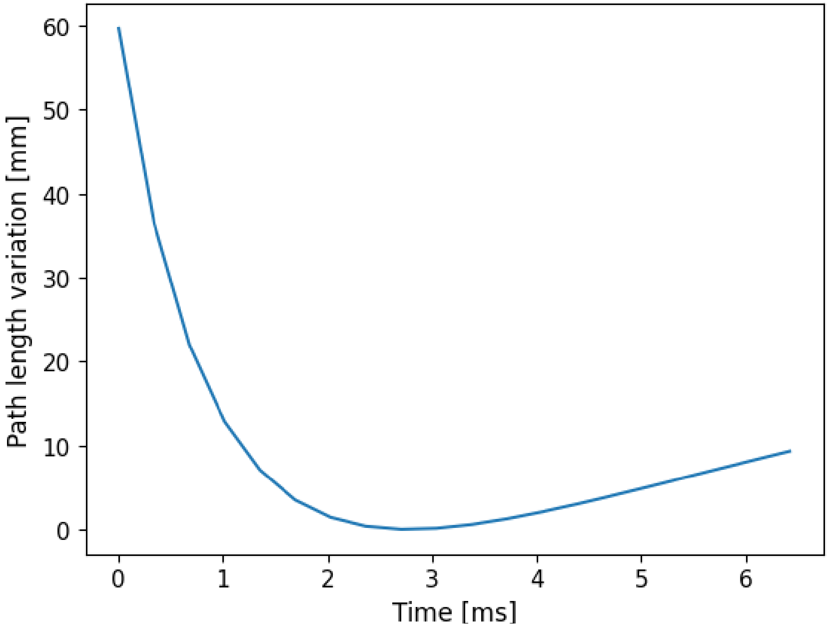


Path length variation [mm]
Time [ms]

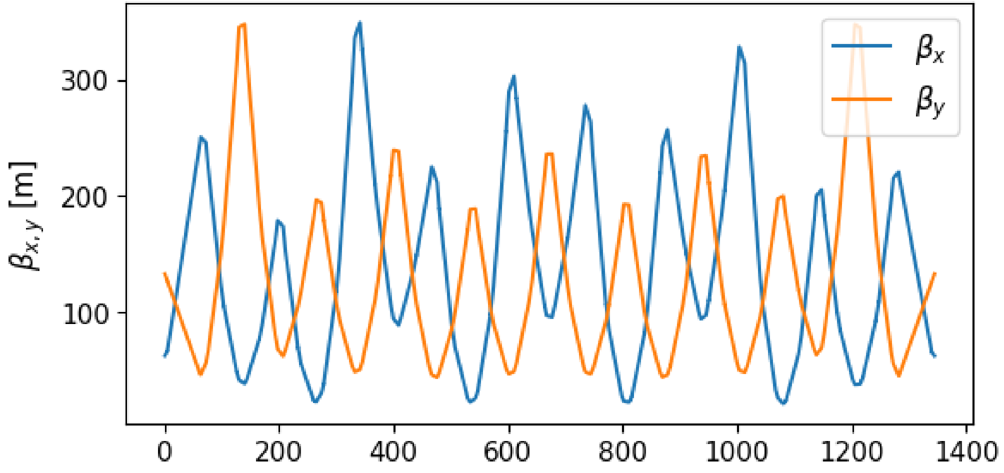


SC
NC
SC
y [m]
x [m]

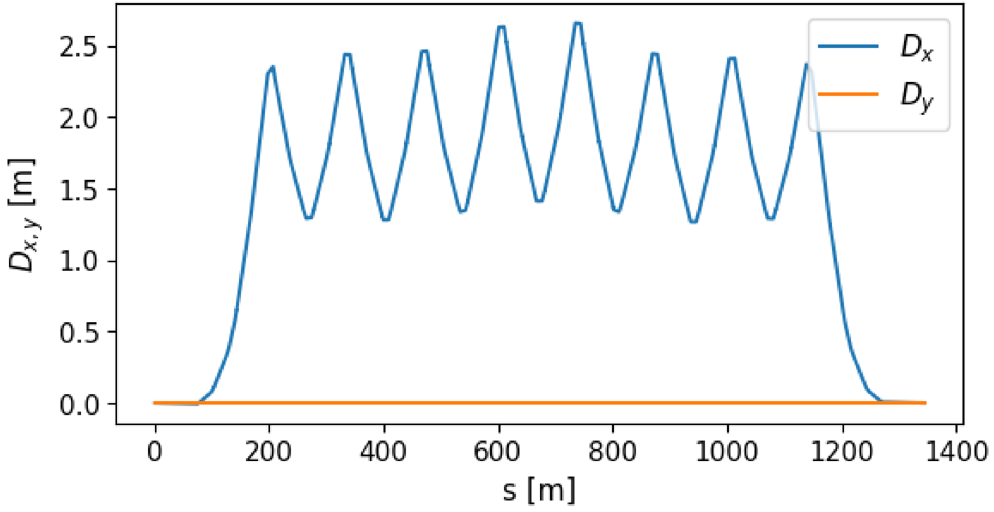
Hybrid RCS 4



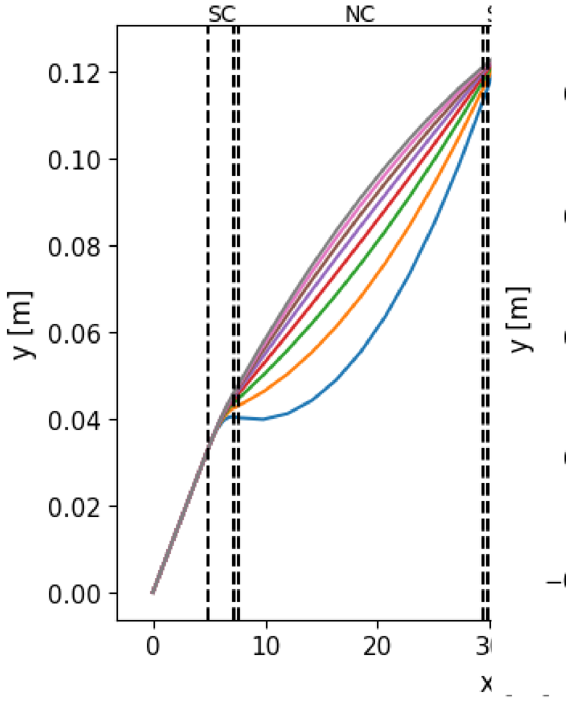
60
50
40
30
20
10
0
0 1 2 3 4 5 6
Path length variation [mm]
Time [ms]



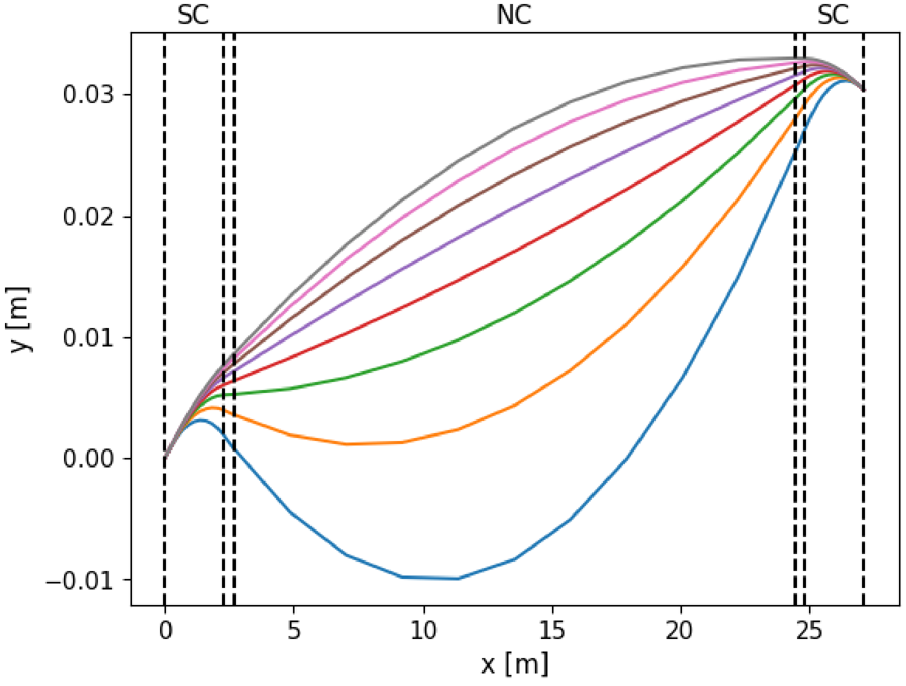
β_x
β_y
300
200
100
0 200 400 600 800 1000 1200 1400
$\beta_{x,y}$ [m]



D_x
D_y
2.5
2.0
1.5
1.0
0.5
0.0
0 200 400 600 800 1000 1200 1400
$D_{x,y}$ [m]
s [m]



SC
NC
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0 10 20
y [m]



SC
NC
SC
0.03
0.02
0.01
0.00
−0.01
0 5 10 15 20 25
y [m]
x [m]

Larger apertures

- Larger excursion than what we had in the previous estimations
  - Fewer n_c per cells
  - Analytical model: trajectory excursion in middle dipole $\Delta y \propto 1/n_c^2$
- Reduce excursion is to divide a half-cell in 2 blocs and place each bloc on a different mechanical axis
  - Limited by minimum dipole length: $L_{SC} > 2$ m

Parameter table

	RCS 1	RCS 2	RCS 3	RCS 4
Type	Hybrid	Normal	Normal	Normal
Circumference	5990	5990	10700	35000
Number of arc	34	26	26	26
Number of cells per arc	4	4	6	9
Filling ratio arc	0.85	0.92	0.94	0.89
Filling ratio dipole	0.37	0.61	0.63	0.70
Pattern	NC, NC	SC, NC, SC	SC, NC, SC	2 bloc: SC, NC, SC
Length NC [m]	4.06	12.21	13.99	21.77
NC traj excursion [mm]	-	71.0	44.0	35.0
NC aperture [mm]	-	126.0	95.0	91.0
Length SC [m]	-	2.68	3.78	2.27
SC traj excursion [mm]	-	26.0	24.0	6.0
SC aperture [mm]	-	80	75.0	62.0
Length QP [m]	1.89	3.49	4.98	9.16
Length SXT [m]	0.5	0.5	1.0	1.0
Beam size [mm]	36.0	34.3	31.5	36
QP B_{pole} (ϕ 50 mm)	1.31	1.25	1.35	1.18
SXT B_{pole} (ϕ 50 mm)	0.17	0.2	0.12	0.13
Max path length diff. [mm]	-	49.6	21.0	59.7
MCF	0.0006	0.0011	0.0007	0.0002
Qs	0.754	0.345	0.285	0.297
Qx	44.358	33.291	41.780	65.624
Qy	31.563	23.069	35.694	58.604
dQx	5.0	5.0	5.0	5.0
dQy	5.0	5.0	5.0	5.0

Beam size:

$$= 2\left(n_\sigma\sqrt{\beta_{max}\epsilon} + D_{max}\sigma_\delta\right)$$

with n_σ=6 and σ_δ=5.10^{-3}

→ to be refined for each RCS

NC too long, to be separated later

For apertures: 20 mm of margin (vacuum pipes..)

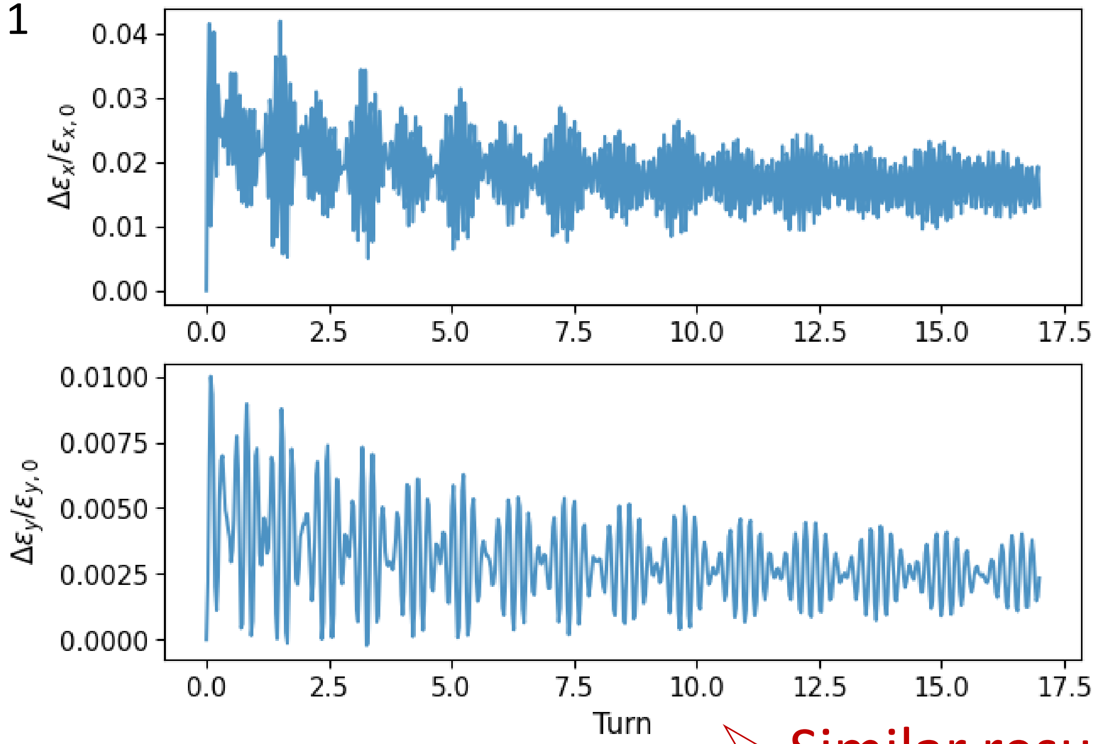
> 1 T recommended: Lengthen QP from extra straight section

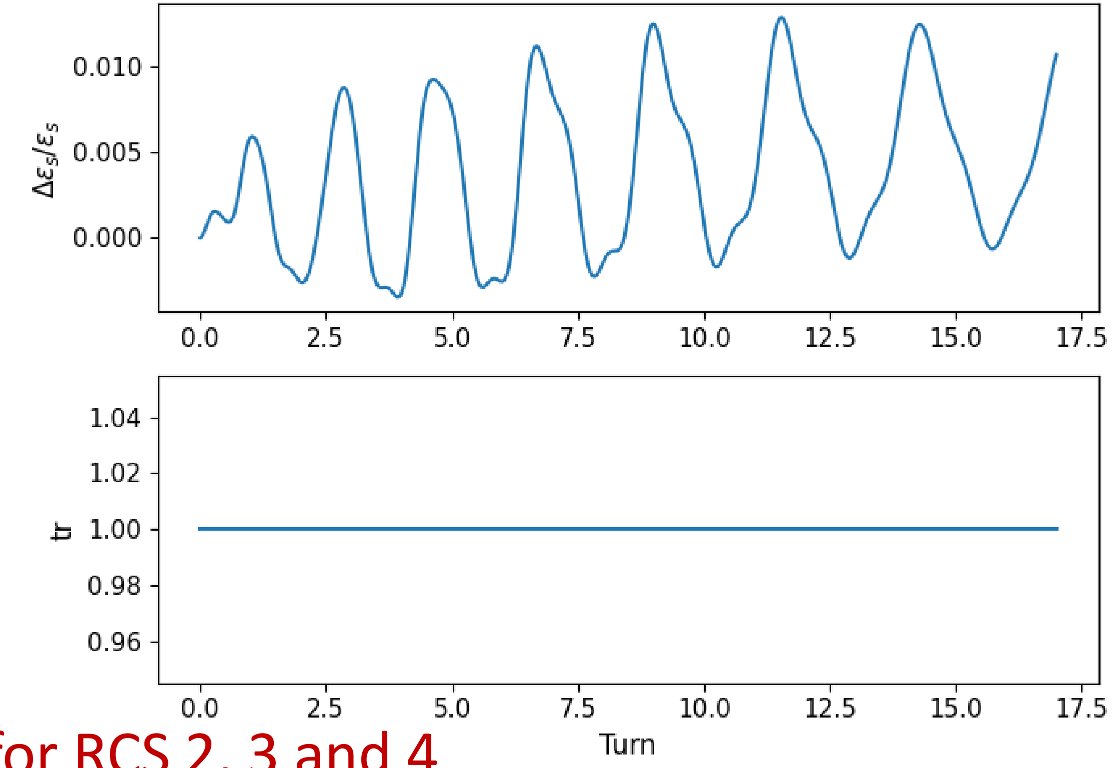
Tracking studies

- Very preliminary
- Check for instabilities and emittance growth
- Initial beam distribution linearly matched :
  - ➢ Effect of Montague functions

Initial distribution: 5000 particles
$\epsilon_n^h = \epsilon_n^v = 25\ \mu m$
$\sigma_z \sigma_E = 0.025\ eVs$

RCS 1





➢ Similar results for RCS 2, 3 and 4

Conclusion

- First optics with thick elements for the RCS
- QP with 1T on the pole requires large total length of QP to focus the beam: number of cells per arc reduced
- Larger aperture and bigger variation of path length than in previous estimation
- High dispersion function that greatly contributes to the beam size

Next steps:

- ➢ Use tracking to compute apertures and beam sizes
- ➢ Could consider alternative lattice (combined functions, bend achromat to reduce dispersion)