The horizontal ε_x, vertical ε_y and longitudinal ε_t emittances evolve with time according to a set of three differential equations:

$$\dot{\varepsilon}_x = -\frac{2}{\tau_x}(\varepsilon_x - \varepsilon_{x0}) + \frac{2\varepsilon_x}{T_x(\varepsilon_x, \varepsilon_y, \varepsilon_t)} \quad (1)$$

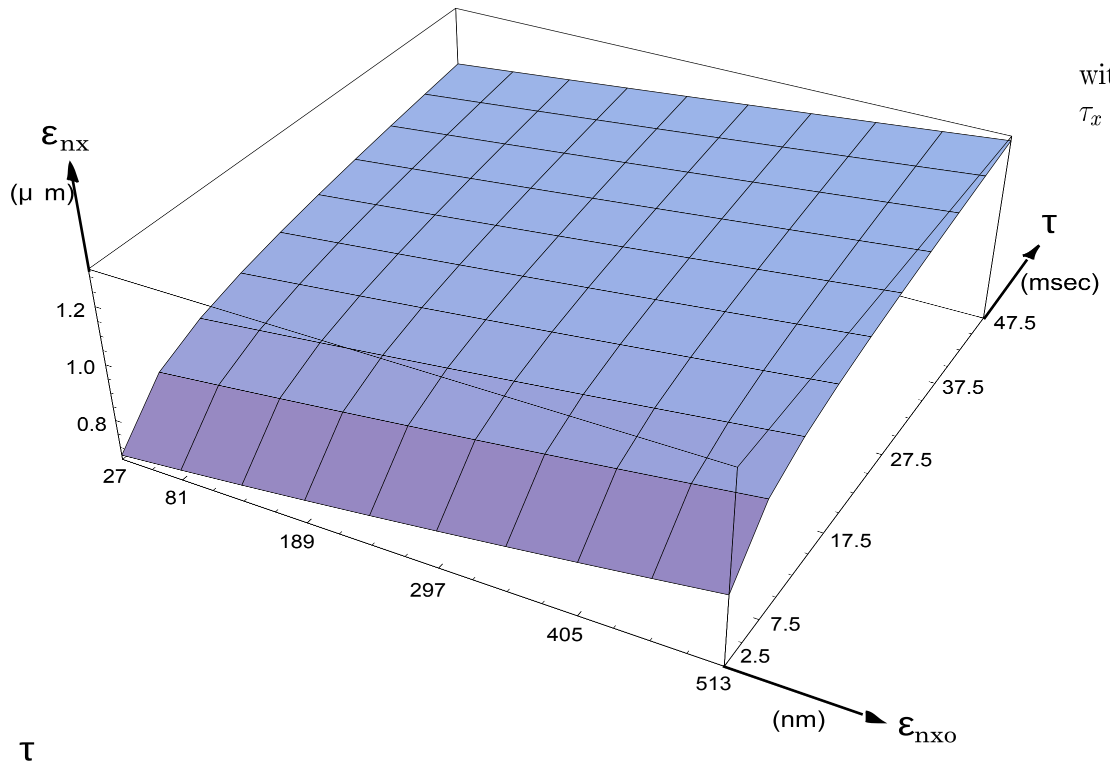
$$\dot{\varepsilon}_y = -\frac{2}{\tau_y}(\varepsilon_y - \varepsilon_{y0}) + \frac{2\varepsilon_y}{T_y(\varepsilon_x, \varepsilon_y, \varepsilon_t)} \quad (2)$$

$$\dot{\varepsilon}_t = -\frac{2}{\tau_t}(\varepsilon_t - \varepsilon_{t0}) + \frac{2\varepsilon_t}{T_t(\varepsilon_x, \varepsilon_y, \varepsilon_t)} \quad (3)$$

where τ_x, τ_y, τ_t are the radiation damping times of the betatron (xy) and synchrotron (t) oscillations respectively. ε_{x0}, ε_{y0}, ε_{t0} are equilibrium emittances determined by radiation damping and quantum excitation in the absence of IBS and $T_\mu(\varepsilon_x, \varepsilon_y, \varepsilon_t)$, $\mu \in \{x, y, t\}$ are intrabeam scattering gtowth times which are non-linear functions of emittances.

The equilibrium emittances follow from equation

$$\dot{\varepsilon}_x = \dot{\varepsilon}_y = \dot{\varepsilon}_t = 0$$



The final horizontal equilibrium emittance of TME-cell damping ring with only dipole magnetic field in the bending magnets (the damping time $\tau_x = \tau_y = 2\tau_t$)

$$\varepsilon_{nx0} \geq \frac{C_q \gamma^3 I_5}{J_x I_2} \approx \frac{C_q \gamma^3}{12(J_{x0} + F_w)} \left[\frac{\theta^3}{\sqrt{15}} + \frac{F_w |B^3{}_w| \lambda_w^2 \langle \beta_x \rangle}{16 (B\rho)^3} \right]$$

$$\tau_x \geq \frac{3C}{r_e c \gamma^3 I_2}$$

where

B_a - strength of magnetic field of bending magnet

B_w - strength of magnetic field of wiggler

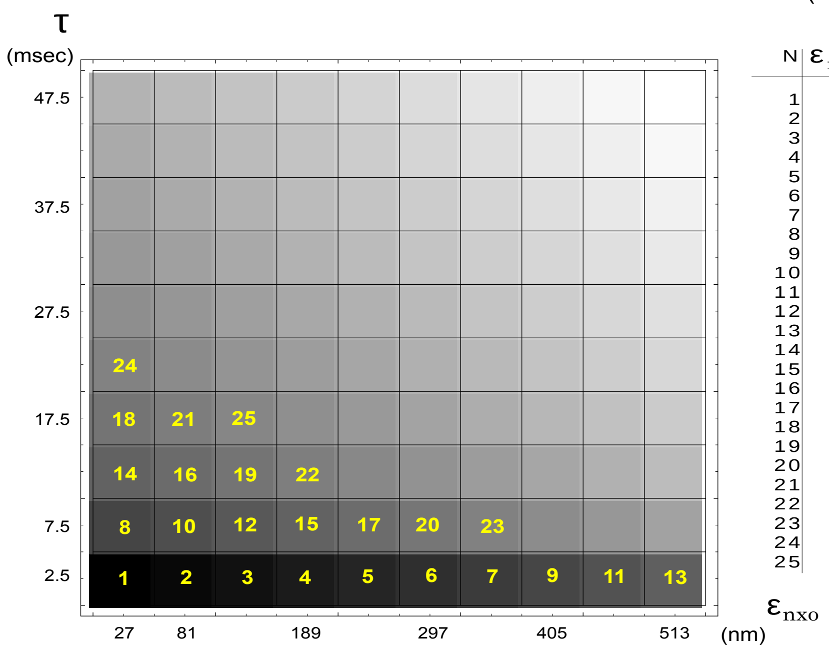
L_w - total length of wigglers sections

C - ring circumference

θ - bending angle of dipole magnet

F_w - relative damping factor in the wiggler compared to the arcs

$$F_w = \frac{I_{2w}}{I_{2a}} = \frac{L_w B_w^2}{4\pi (B\rho) |B_a|}$$



N	ε_{nx} (nm)	ε_{nxo} (nm)	τ (msec)
1	670.58	27	2.5
2	691.61	81	2.5
3	714.14	135	2.5
4	738.10	189	2.5
5	763.42	243	2.5
6	790.03	297	2.5
7	817.86	351	2.5
8	843.77	27	7.5
9	846.86	405	2.5
10	866.88	81	7.5
11	876.95	459	2.5
12	890.72	135	7.5
13	908.07	513	2.5
14	914.92	27	12.5
15	915.29	189	7.5
16	937.85	81	12.5
17	940.57	243	7.5
18	960.72	27	17.5
19	961.33	135	12.5
20	966.53	297	7.5
21	983.18	81	17.5
22	985.34	189	12.5
23	993.16	351	7.5
24	995.73	27	22.5
25	1006.11	135	17.5

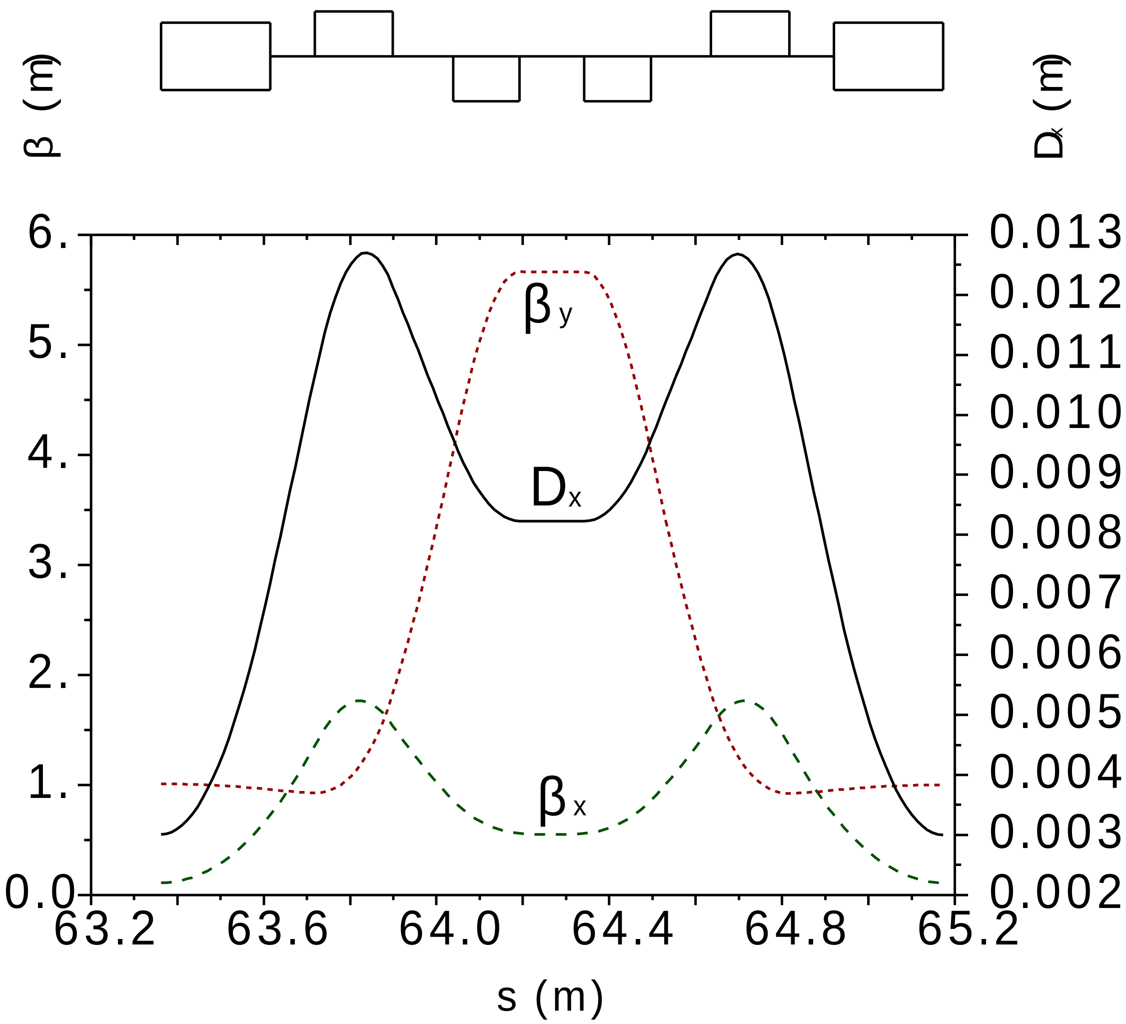


Table 1: Arc cell parameters.

Parameter	Symbol	Value
Nominal e^+ ring energy	γmc^2	2.424 [GeV]
Number of cells	N_{cell}	100
Field of bending magnet	B_a	10.04 [kG]
Gradient field of bending magnet	G_a	-150 [kG/m]
Length of bending magnet	L	0.506 [m]
Bending curvature	ρ	8.05 [m]
Length of arc cell	L	1.81 [m]

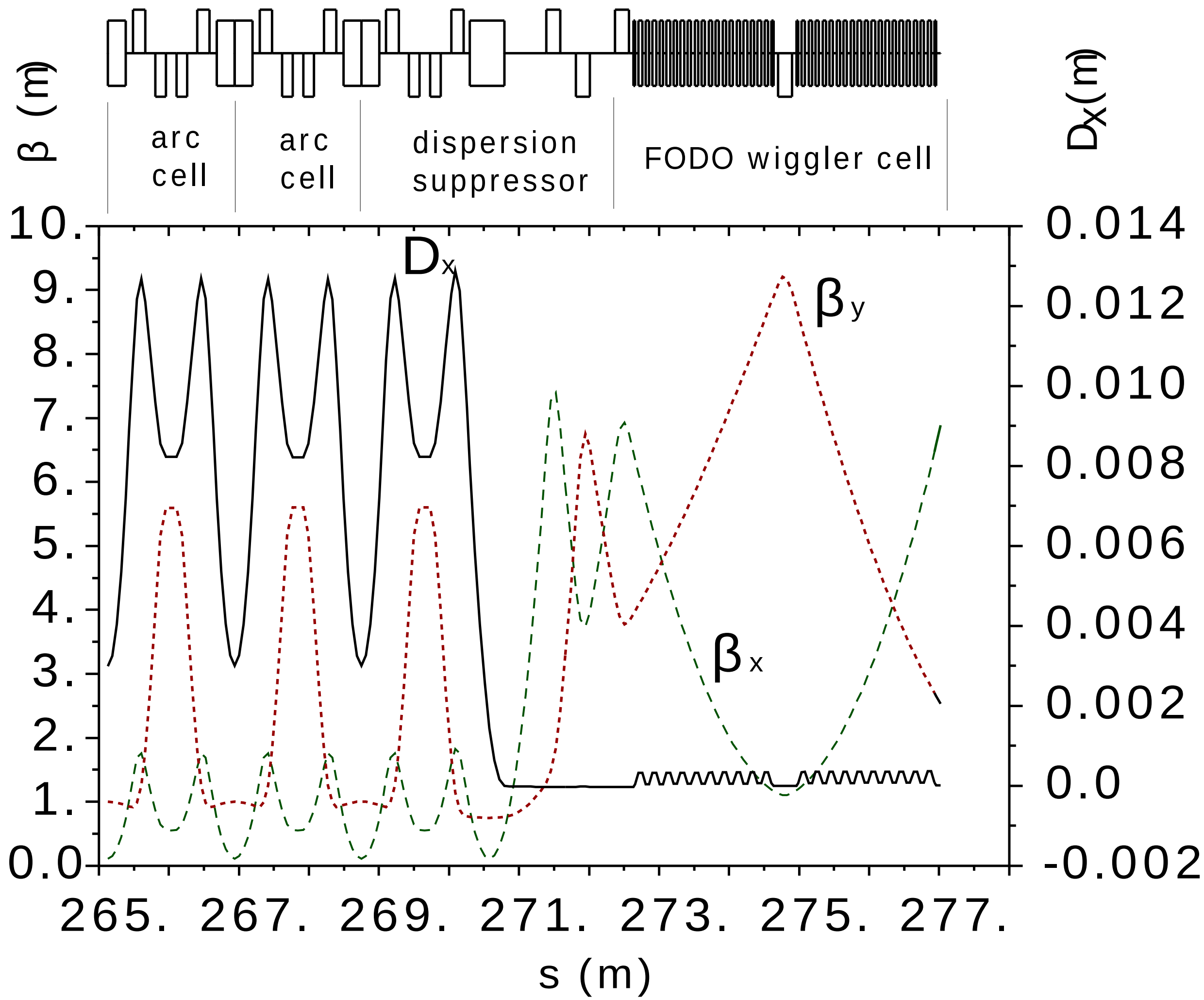
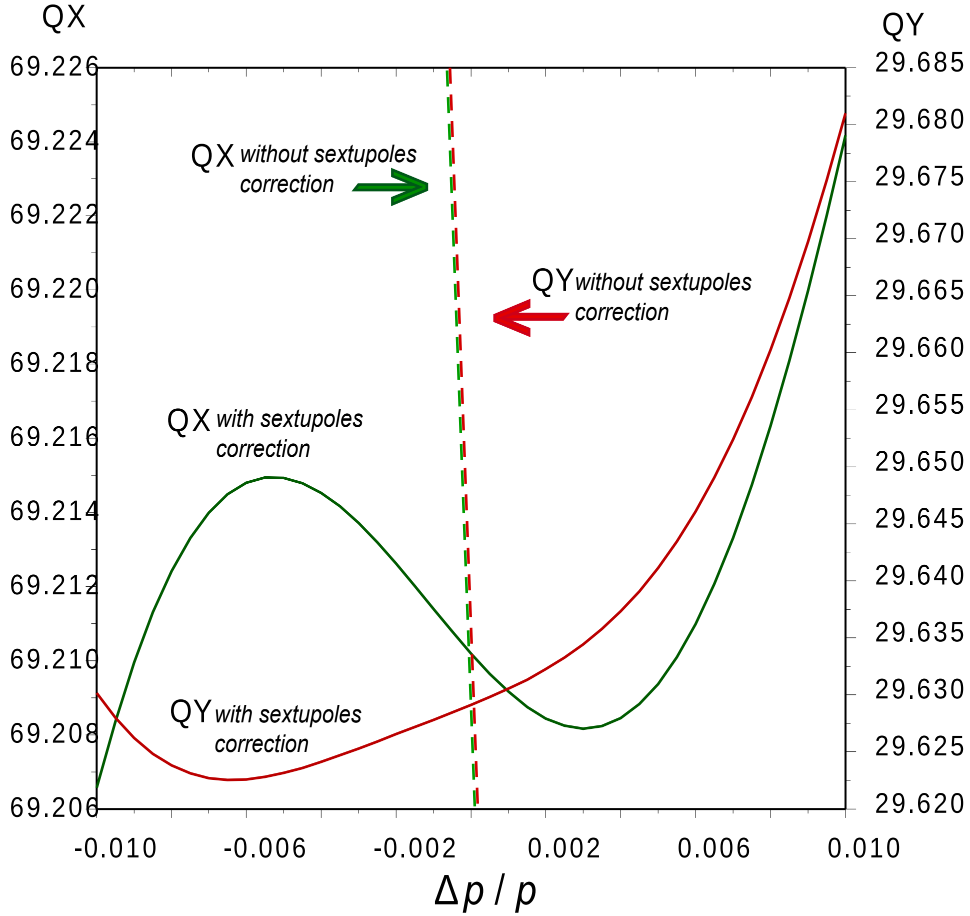
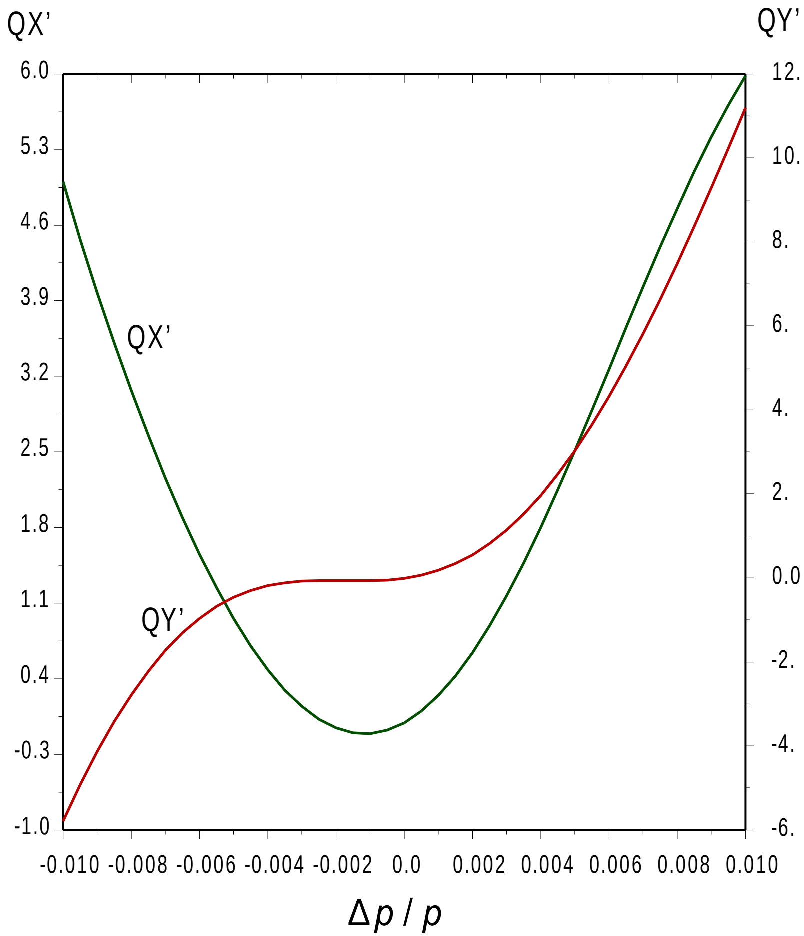
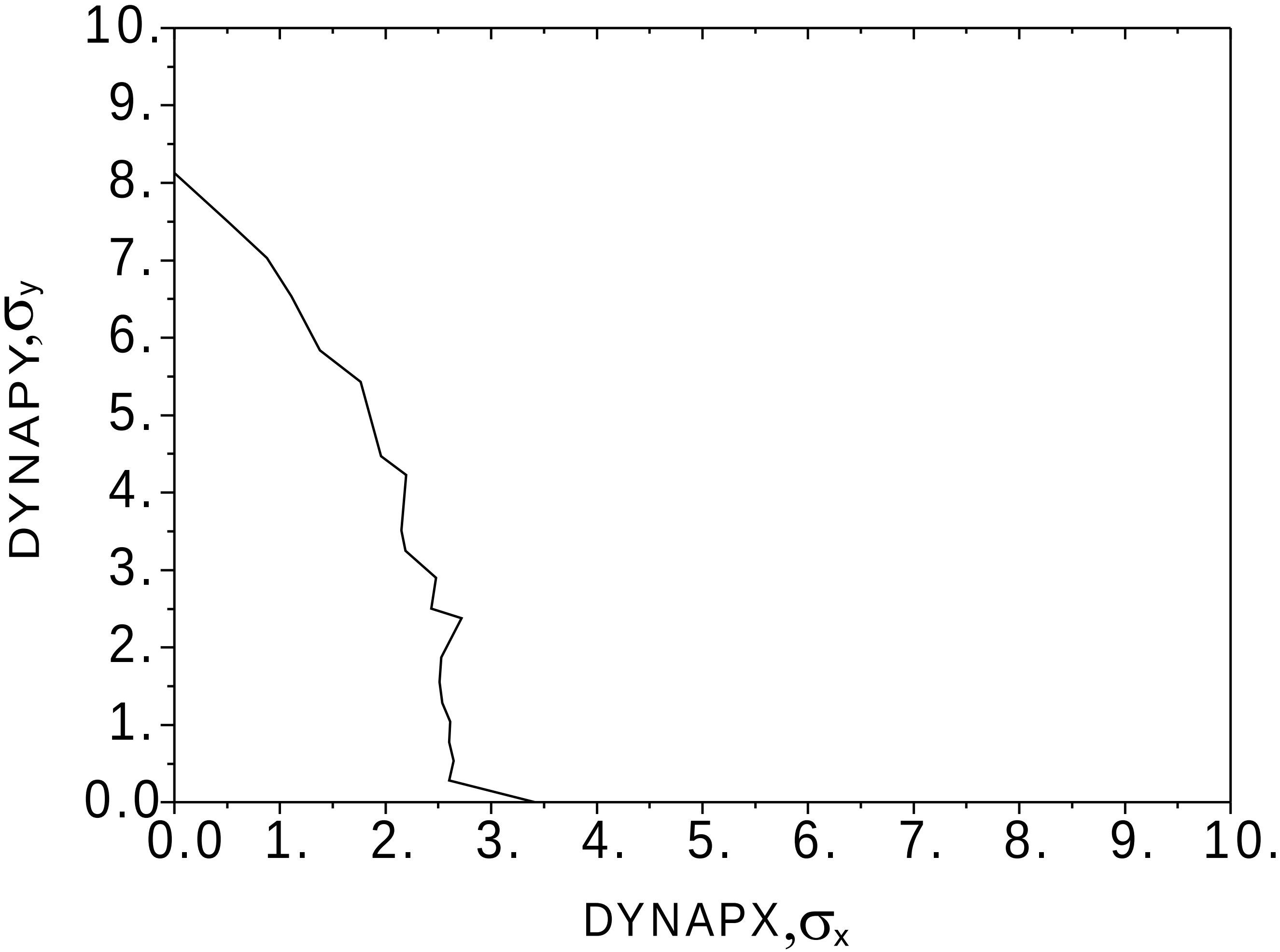


Table 2: Wiggler parameters

Parameter	Symbol	Value
Magnetic field of wiggler	B_w	17.64 [kG]
Wiggler period	λ_w	20 [cm]
Length of wiggler	L	2.1 [m]
Number of magnetic poles	N_p	21 pairs
Number of wigglers	N_w	76
Total length of wigglers	L_w	160 [m]


QX
QY
69.226
69.224
69.222
69.220
69.218
69.216
69.214
69.212
69.210
69.208
69.206
29.685
29.680
29.675
29.670
29.665
29.660
29.655
29.650
29.645
29.640
29.635
29.630
29.625
29.620
QX without sextupoles correction
QY without sextupoles correction
QX with sextupoles correction
QY with sextupoles correction
-0.010
-0.006
-0.002
0.002
0.006
0.010
Δp / p


QX'
QY'
6.0
5.3
4.6
3.9
3.2
2.5
1.8
1.1
0.4
-0.3
-1.0
12.
10.
8.
6.
4.
2.
0.0
-2.
-4.
-6.
QX'
QY'
-0.010
-0.008
-0.006
-0.004
-0.002
0.0
0.002
0.004
0.006
0.008
0.010
Δp / p


DYNAPY,σy
DYNAPX,σx
0.0
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

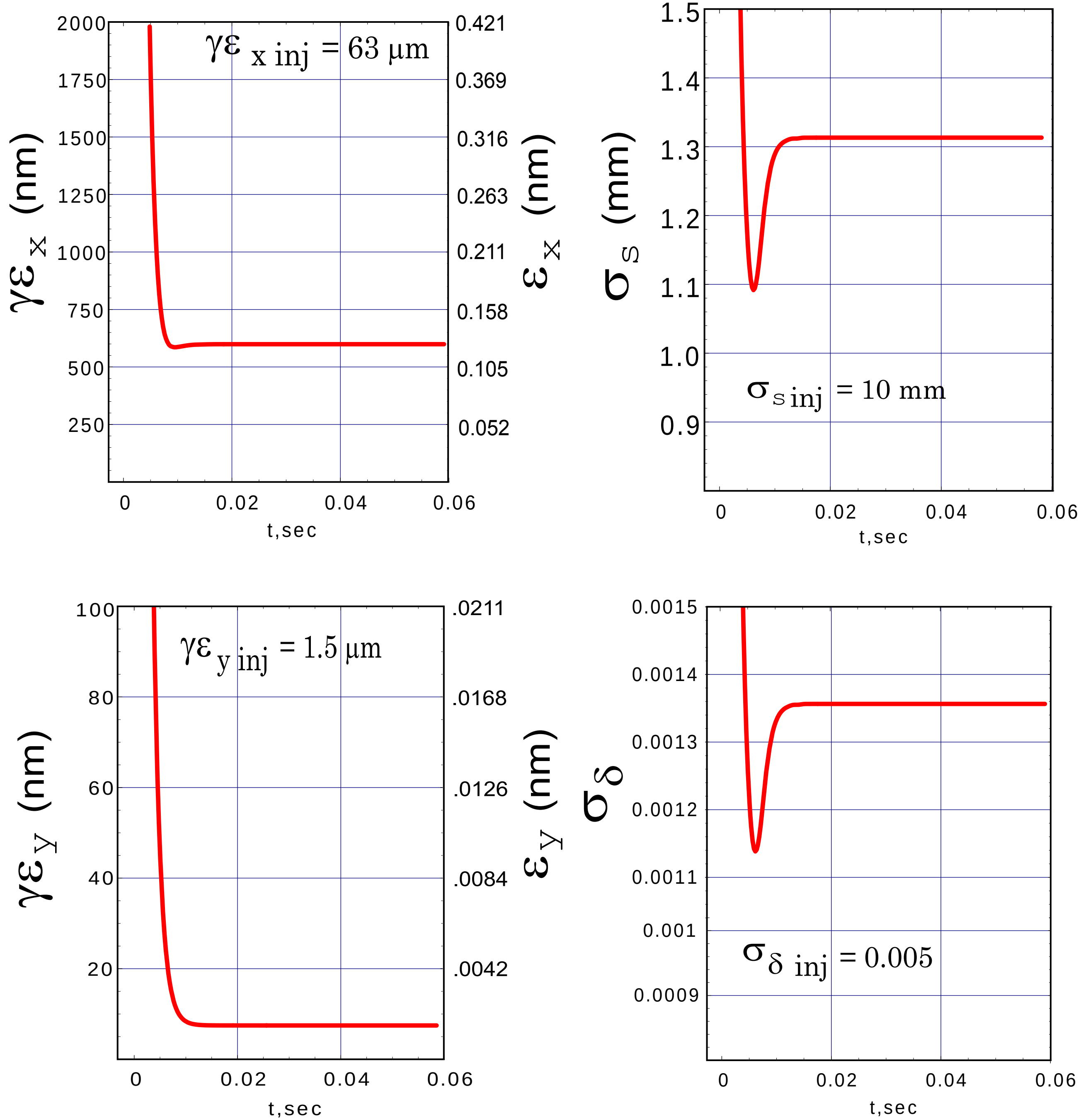


Table 3: Beam parameters required for CLIC.

Parameter	Symbol	Value
Bunch population	N_b	4.2×10^9
No. of bunches per train	k_{bt}	154
Repetition frequency	f_r	100 Hz
Bunch spacing	τ_b	0.2 m
Min. kicker rise time	τ_k	25 ns
Final transv. emittances	$\gamma\epsilon_{x,y}$	450, 3 nm

Table 4: CLIC damping ring parameters.

Parameter	Symbol	Value
Nominal e^+ ring energy	γmc^2	2.424 [GeV]
No. of bunche trains stored	N_{train}	9
Ring circumference	C	363.7 [m]
Betatron coupling	$\varepsilon_{y0}/\varepsilon_{x0}$	2.1%
X-betatron tune	Q_x	71.62
Y-betatron tune	Q_y	26.65
Damping time	τ_x	2.58 [msec]
Damping time	τ_y	2.65 [msec]
Damping time	τ_t	1.34 [msec]
Extracted hor. emittance	$\gamma\varepsilon_x$	617 [nm]
Extracted vert. emittance	$\gamma\varepsilon_y$	7.3 [nm]
Extracted energy spread	σ_δ	1.34×10^{-3}
Extracted bunch length	σ_s	1.32 [mm]
x-IBS growth time	T_x	3.03 [msec]
y-IBS growth time	T_y	34.1 [msec]
t-IBS growth time	T_t	5.0 [msec]
Horiz. emittance w/o IBS	$\gamma\varepsilon_{nx0}$	315 [nm]
Energy loss per turn	U_0	2.214 [MeV]
Momentum compaction	α_p	0.67×10^{-4}
RF voltage	V_m	3.0 [MV]
RF frequency	f_{rf}	1500 [MHz]
Revolution time	T_r	1.213 [μs]
Harmonic number	h	1819