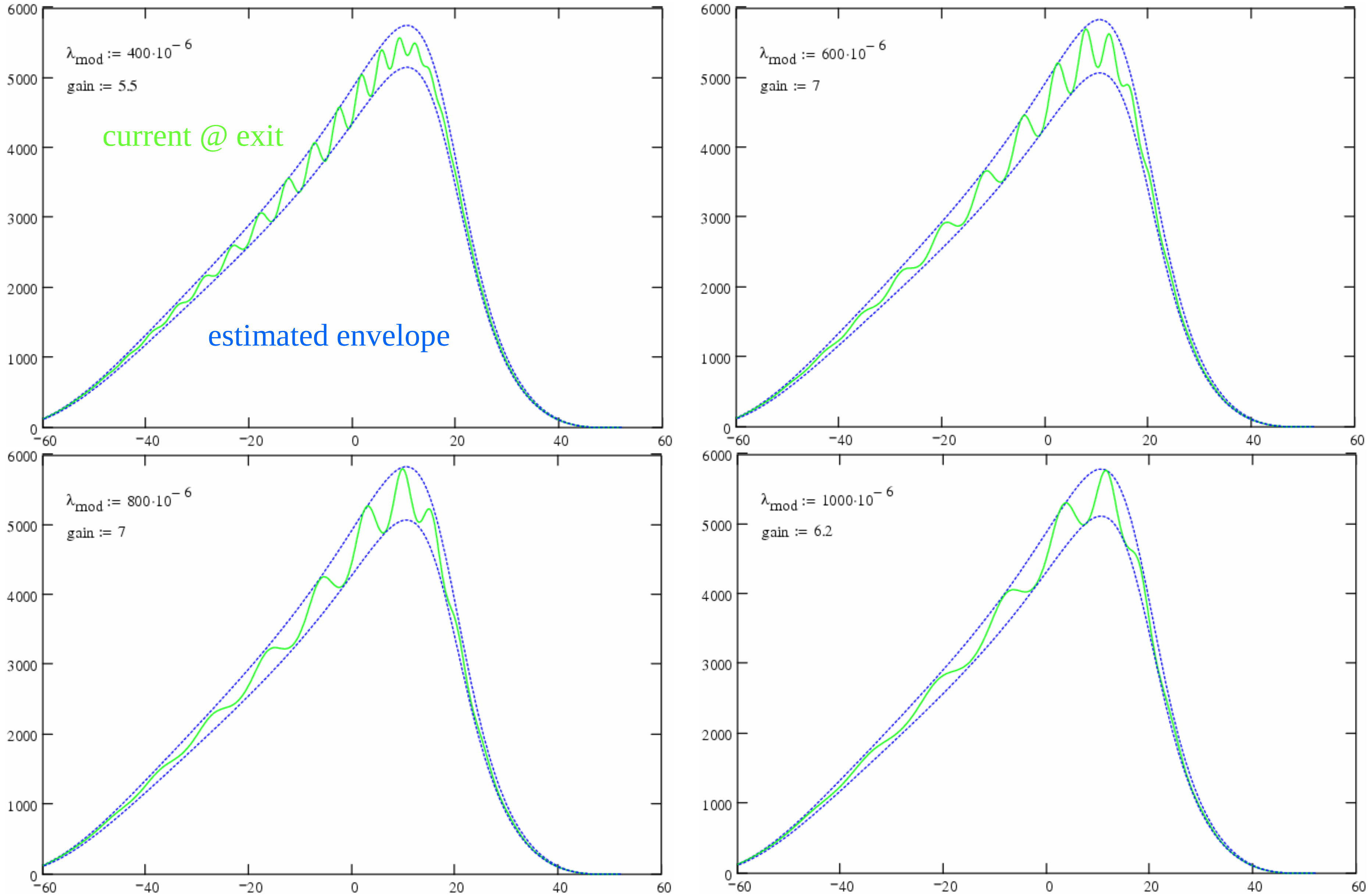
XFEL double BC, μ-bunching

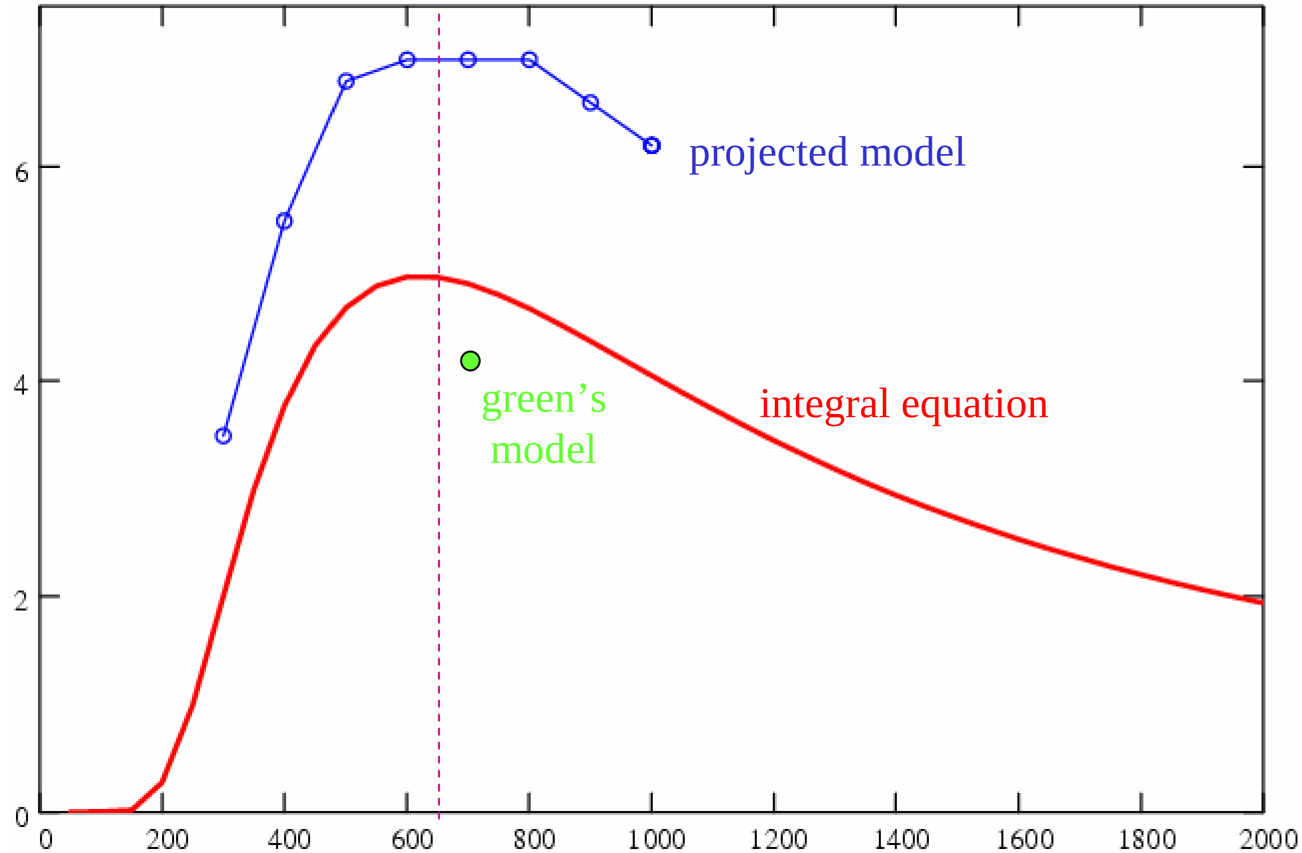
optics between BC1 and BC2

D1	0.761 m	
Q1	0.100 m	k = 4.5340
D2	0.300 m	
Q2	0.100 m	k = –6.8347
D3	0.300 m	
Q3	0.100 m	k = 2.5442
D4	20.100 m	
Q4	0.050 m	k = –3.7623
D5	0.600 m	
Q5	0.100 m	k = 5.2225
D6	0.600 m	
Q6	0.100 m	k = –6.9480
D7	0.200 m	

Gaussian bunch, initial density modulation (1%)



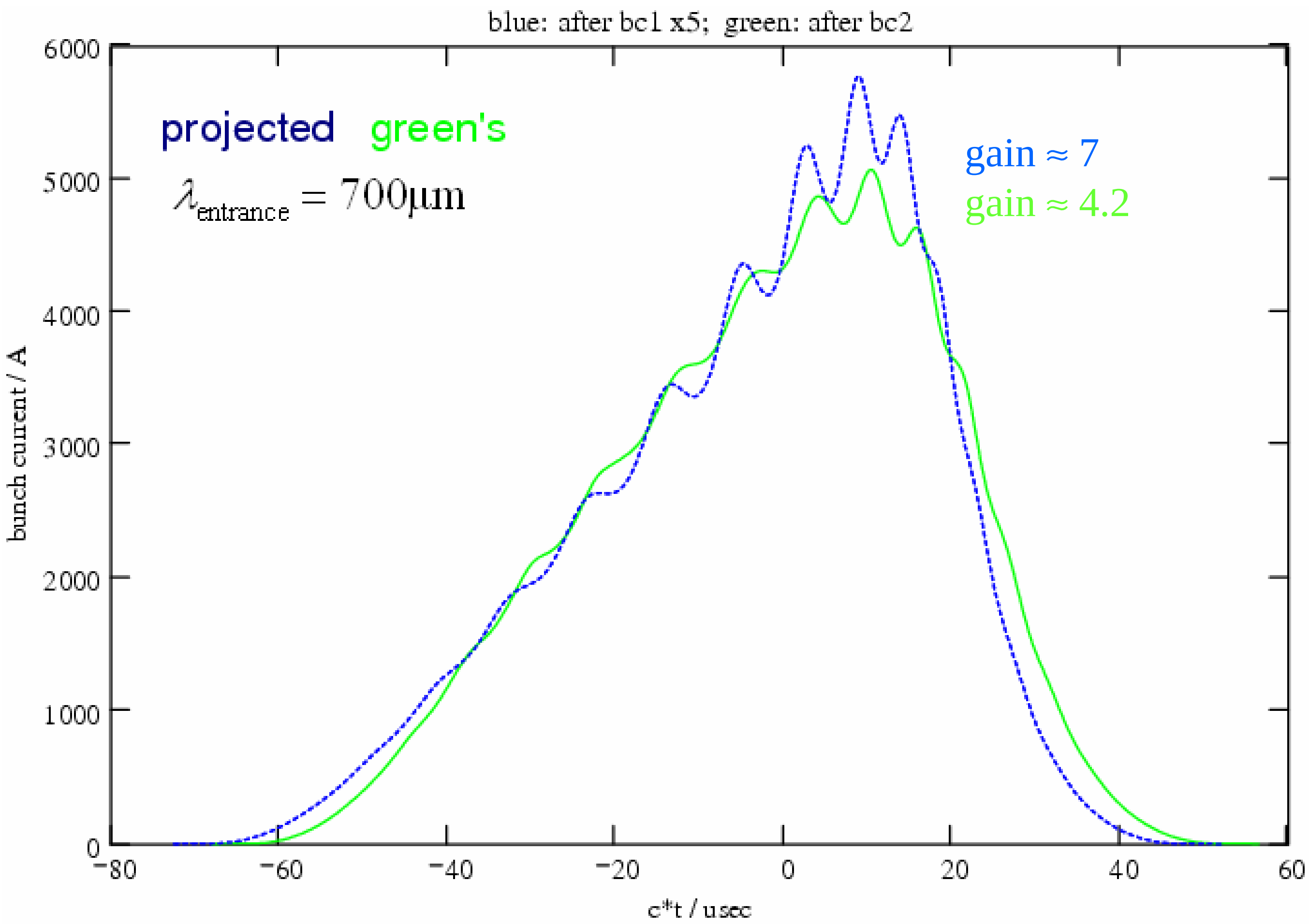
gain in double bc, (initial density modulation)



$$\frac{\delta E}{E_0} \cdot R_{56} \cdot C \cdot 2\pi = 650\ \mu\text{m}$$

integral equation not justified: overtaking length in BC1 long compared to magnets !

Gaussian bunch, initial density modulation (1%)



initial energy modulation

entrance:

$$\lambda(s)$$

$$E(s)/E_0 = a \cdot s + b \cdot \cos(2\pi\, s/\lambda)$$

exit (no CSR):

$$\tilde{s} = s + r_{56}\frac{E(s)}{E_0} = s\underbrace{(1 + r_{56}a)}_{1/C} + r_{56}b \cdot \cos(2\pi\, s/\lambda)$$

compression factor

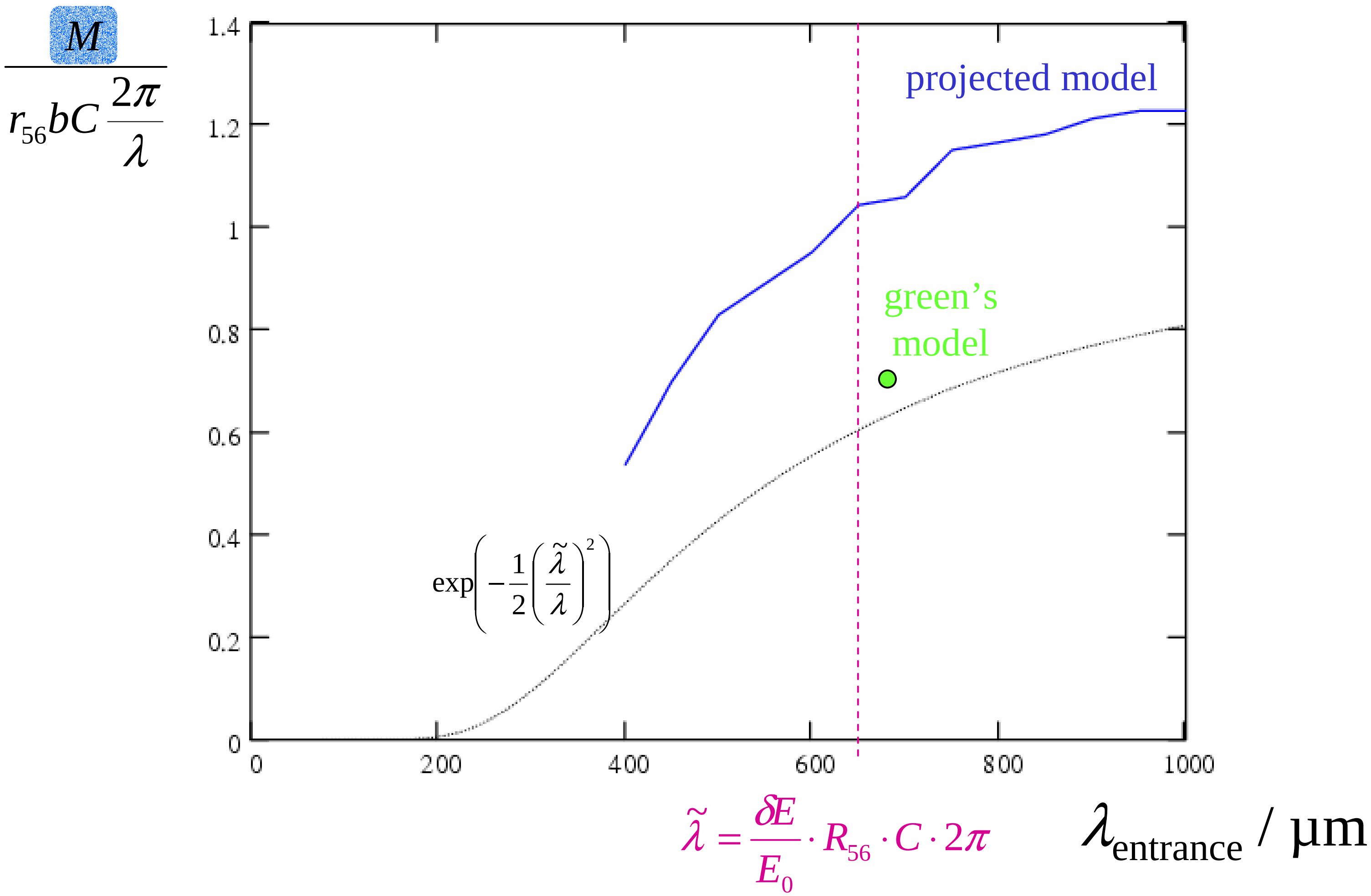
$$\tilde{\lambda}(\tilde{s}) = \frac{\lambda(s)}{\partial\tilde{s}/\partial s} \approx \frac{\lambda(C\tilde{s})}{1/C - r_{56}b\dfrac{2\pi}{\lambda}\cdot\sin(2\pi\, s/\lambda)} \approx C\lambda(C\tilde{s})\cdot\left(1 + \underbrace{r_{56}bC\frac{2\pi}{\lambda}}_{\text{M}}\cdot\sin(2\pi\, s/\lambda)\right)$$

density modulation at exit

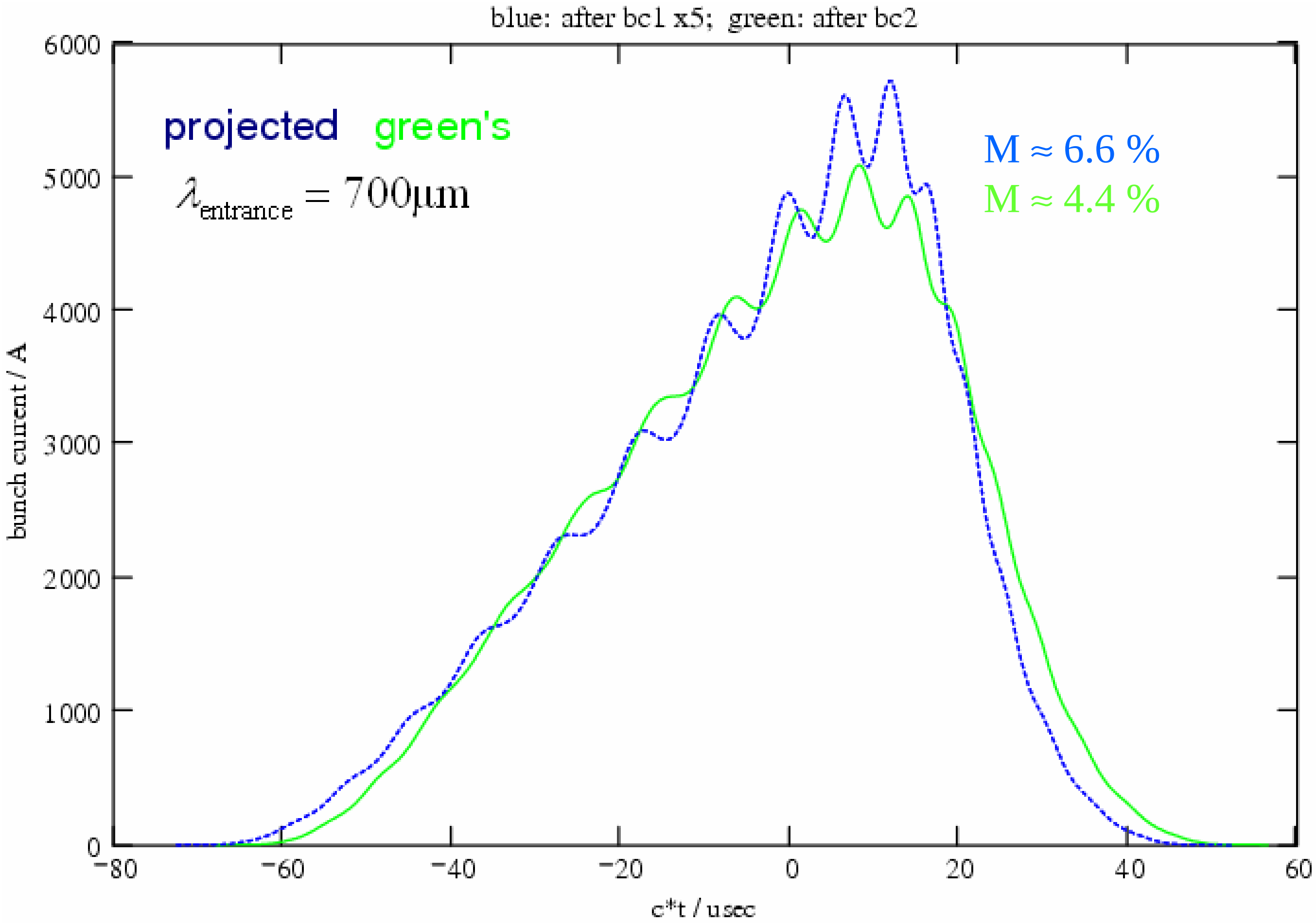
double BC: $C = 100, \quad r_{56} \approx -105\text{mm}, \quad E_0 = 511\text{MeV}$

e.g.: $\lambda = 500\mu\text{m}, \quad b = \dfrac{500\text{eV}}{E_0} \longrightarrow \text{M} \approx 13\%$

Gaussian bunch + initial energy modulation with CSR

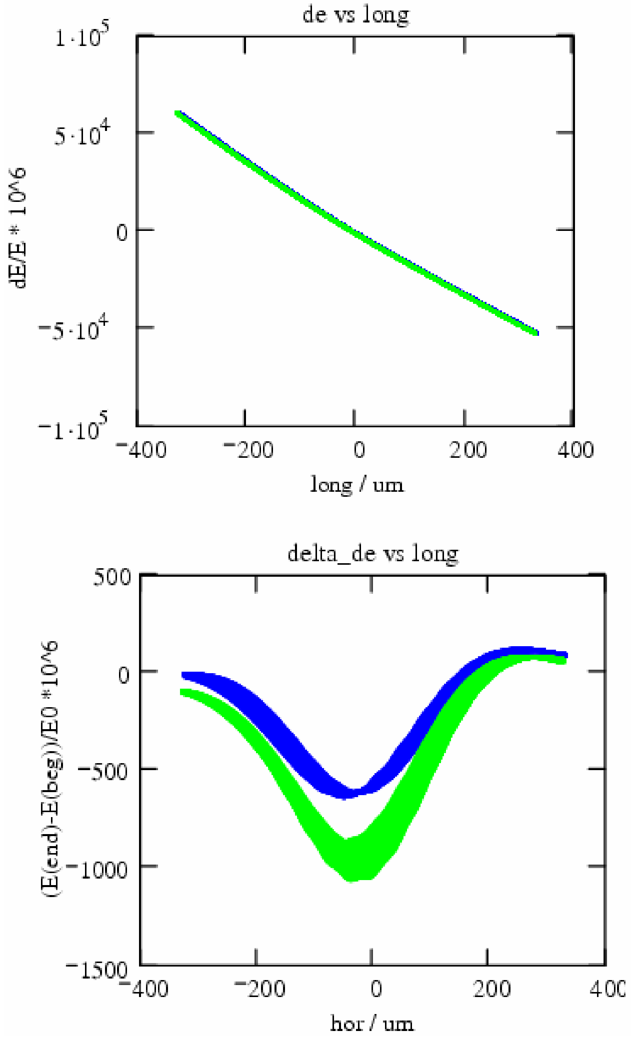


Gaussian bunch, initial energy modulation (~350 eV)

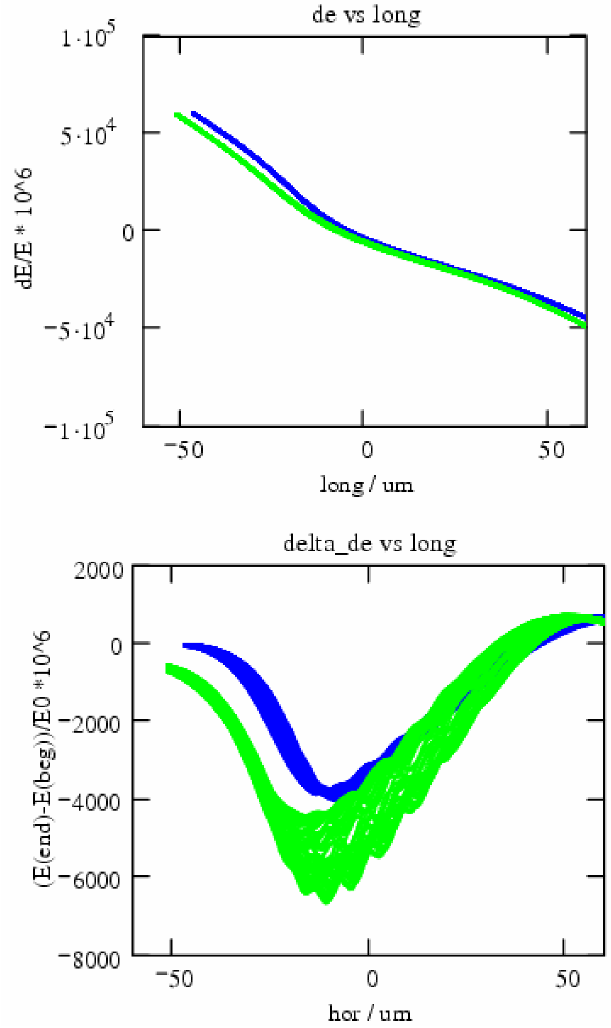


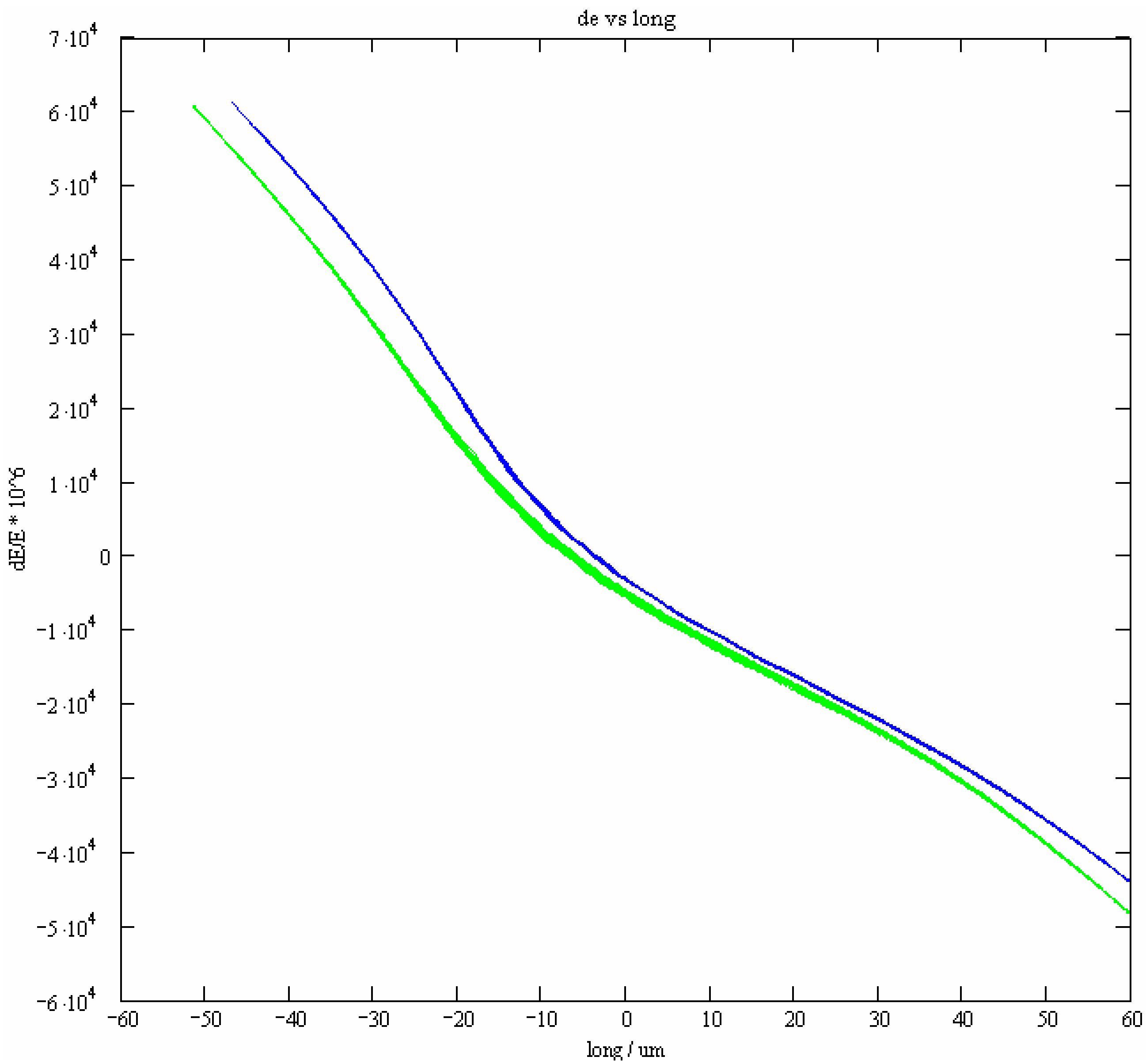
projected ↔ green's

XFEL double BC (compression factor = 100)
exit of BC1, initial density modulation

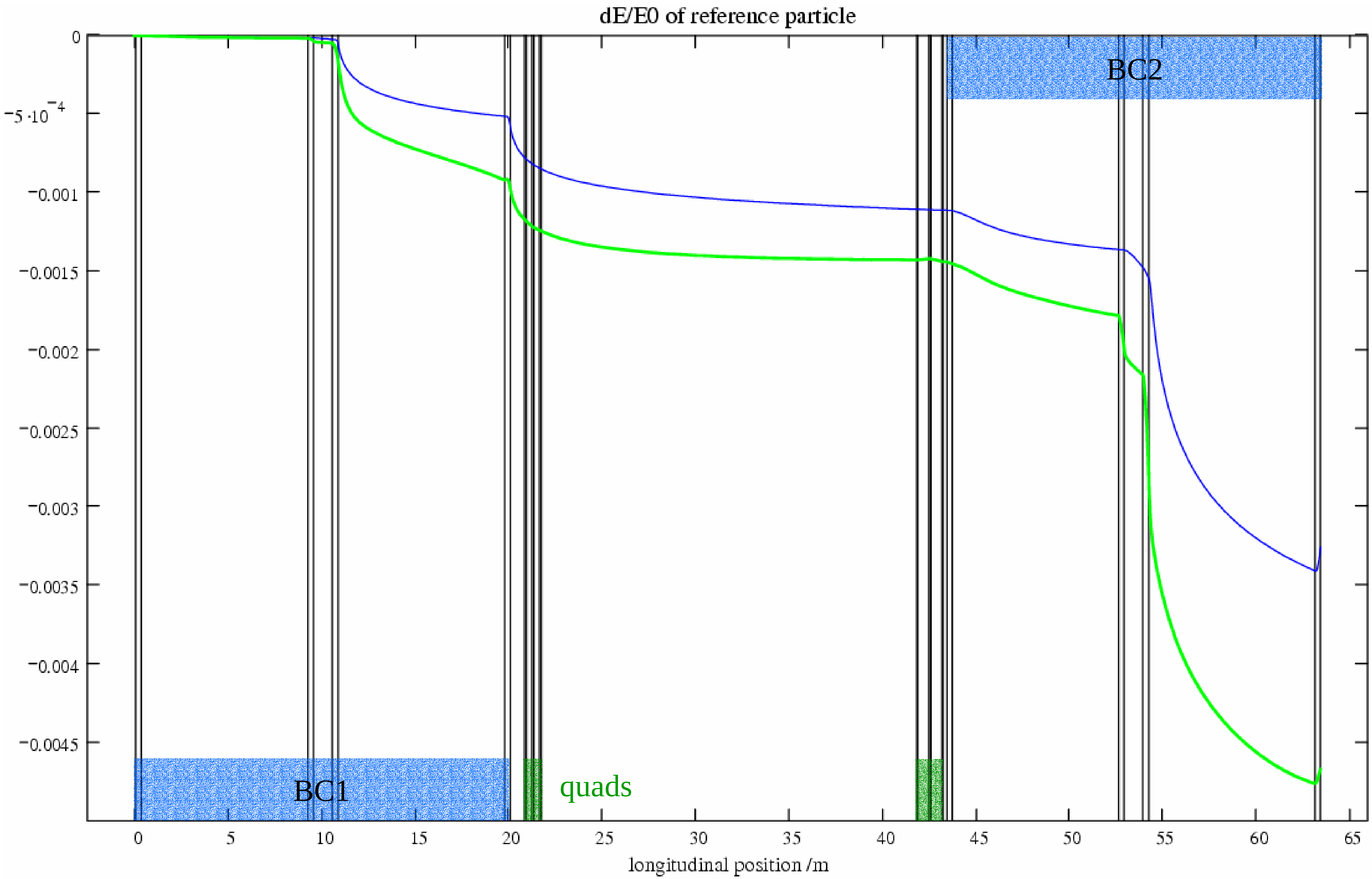


exit of BC2

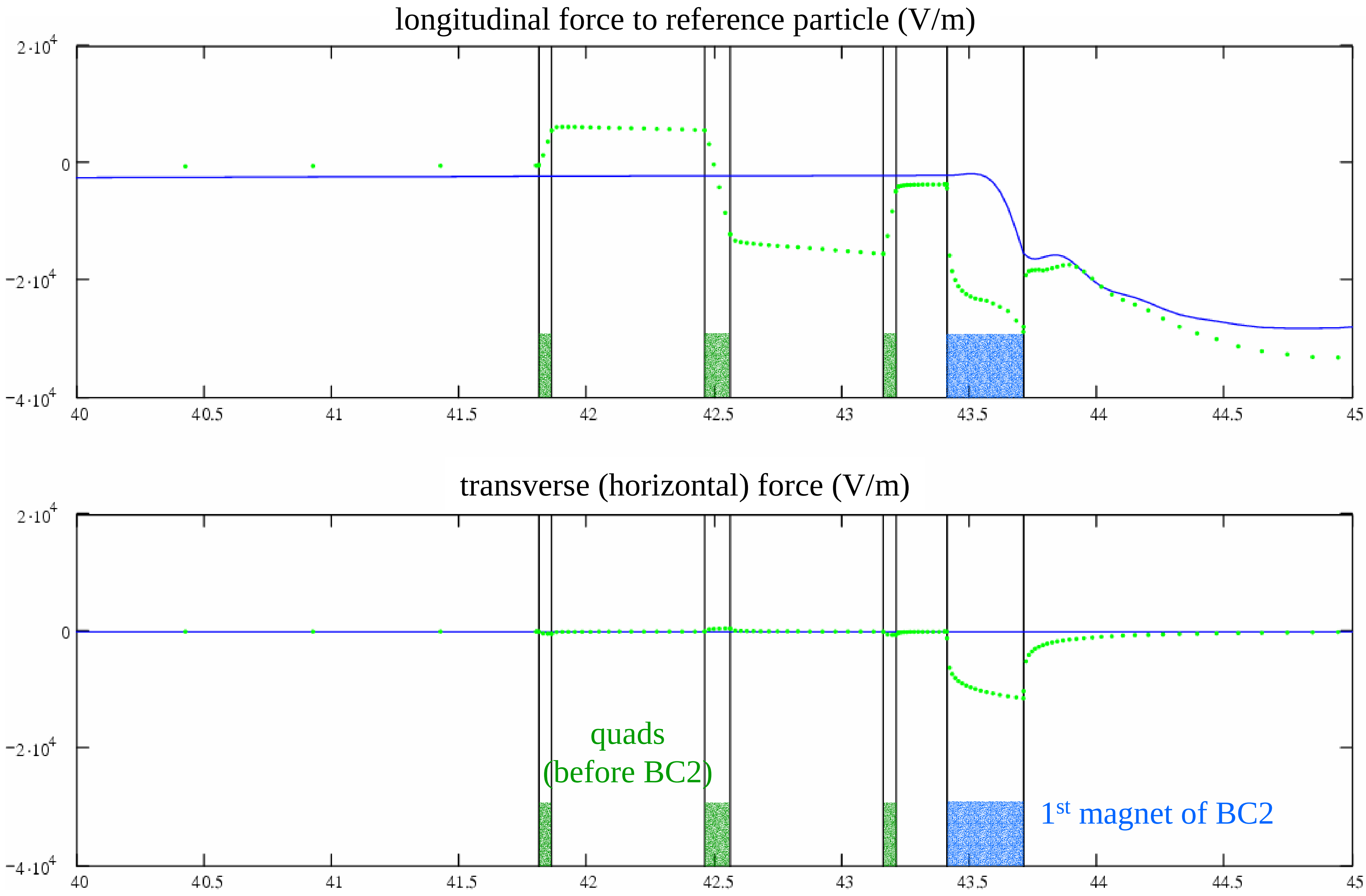




de vs long
7·10^4
6·10^4
5·10^4
4·10^4
3·10^4
2·10^4
1·10^4
0
-1·10^4
-2·10^4
-3·10^4
-4·10^4
-5·10^4
-6·10^4
dE/E * 10^6
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
long / um

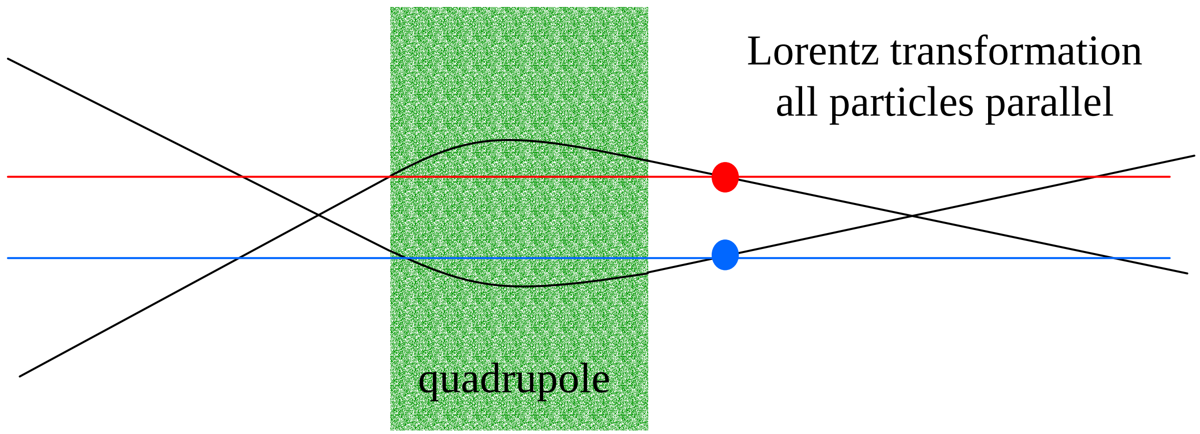


dE/E0 of reference particle
0
−5·10^−4
−0.001
−0.0015
−0.002
−0.0025
−0.003
−0.0035
−0.004
−0.0045
BC2
BC1
quads
0
5
10
15
20
25
30
35
40
45
50
55
60
65
longitudinal position /m



longitudinal force to reference particle (V/m)
2·10^4
0
−2·10^4
−4·10^4
40
40.5
41
41.5
42
42.5
43
43.5
44
44.5
45
transverse (horizontal) force (V/m)
2·10^4
0
−2·10^4
−4·10^4
quads
(before BC2)
1st magnet of BC2
40
40.5
41
41.5
42
42.5
43
43.5
44
44.5
45

usual (linear motion) SC model:



Green's function model: