Bunch Compression and Emittance Growth Minimization at the Advanced Superconducting Test Accelerator

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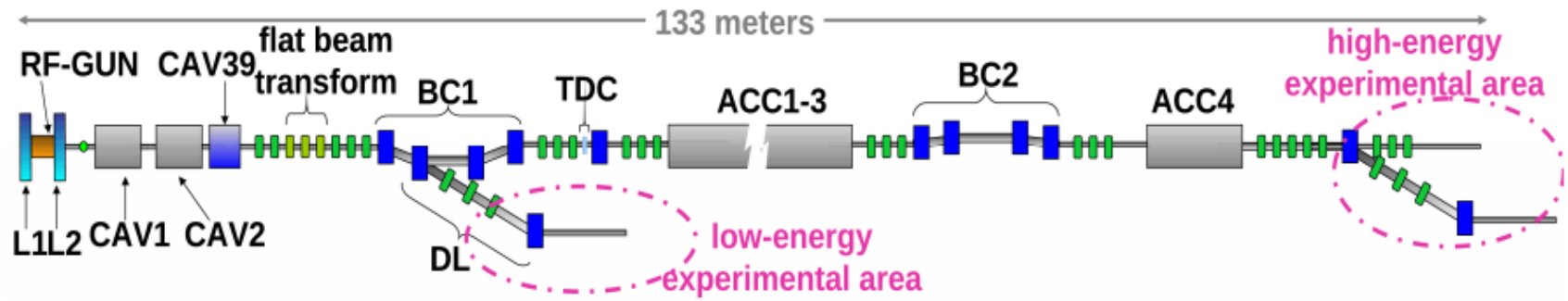
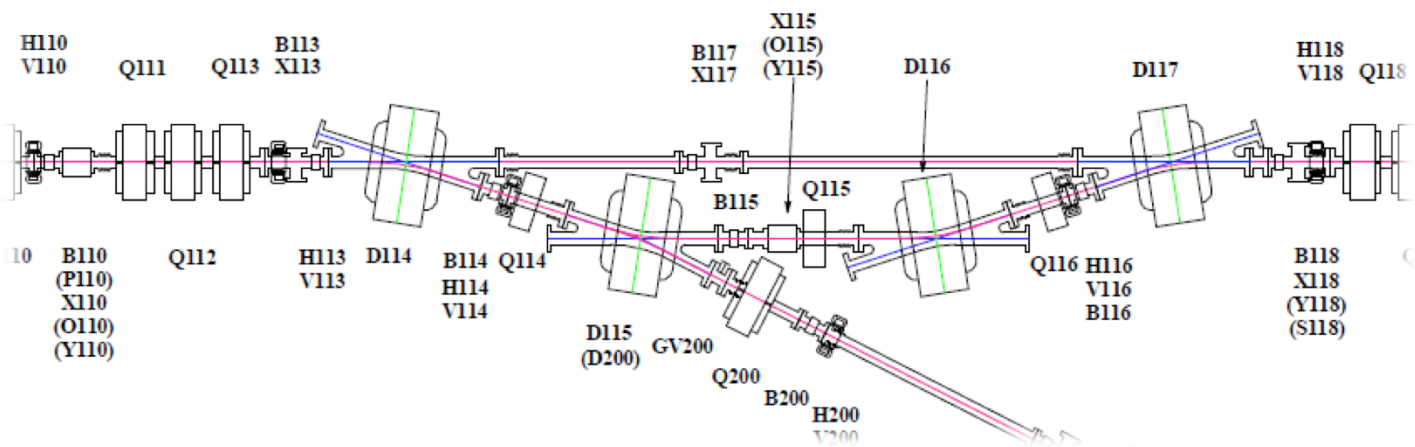
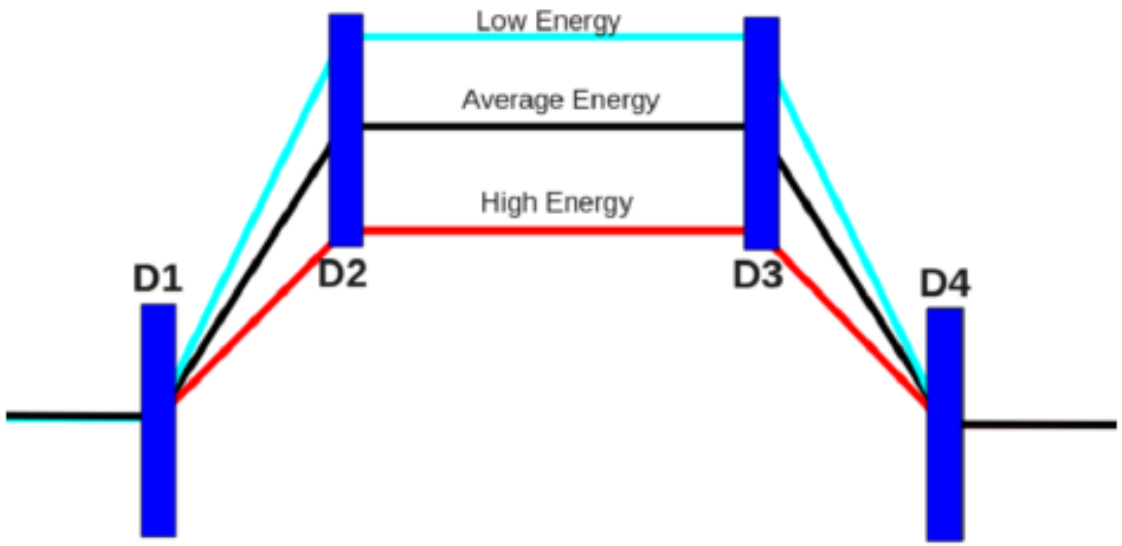
ASTA Beamline and Bunch Compressor

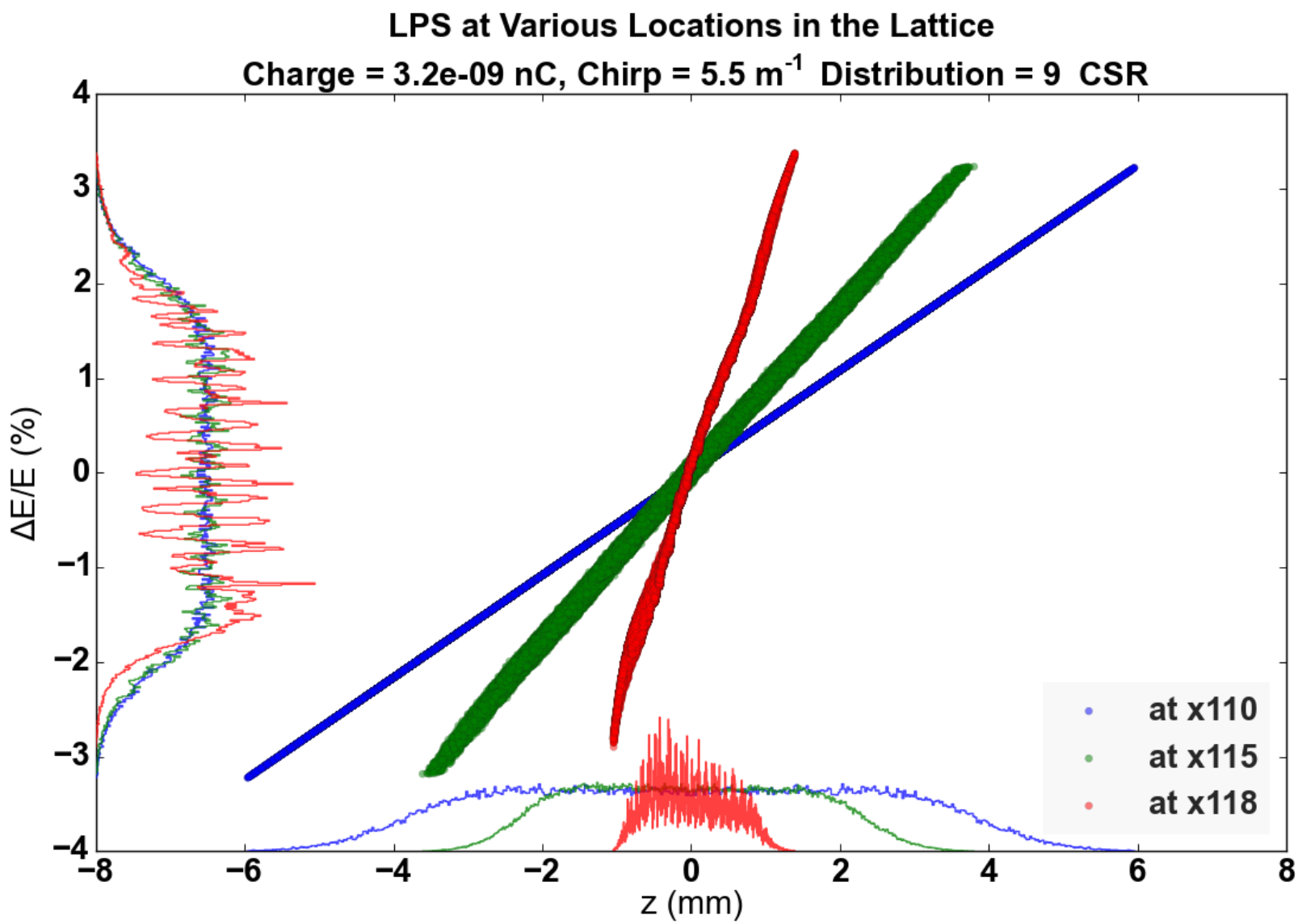




Bunch Compression

- Larmor Radius $\rho = p/eB = E/ceB \propto 1/\theta$




LPS at Various Locations in the Lattice
Charge = 3.2e-09 nC, Chirp = 5.5 m^{-1} Distribution = 9 CSR
ΔE/E (%)
z (mm)
at x110
at x115
at x118
4
3
2
1
0
−1
−2
−3
−4
−8
−6
−4
−2
0
2
4
6
8

What factors into Compression Factor!?

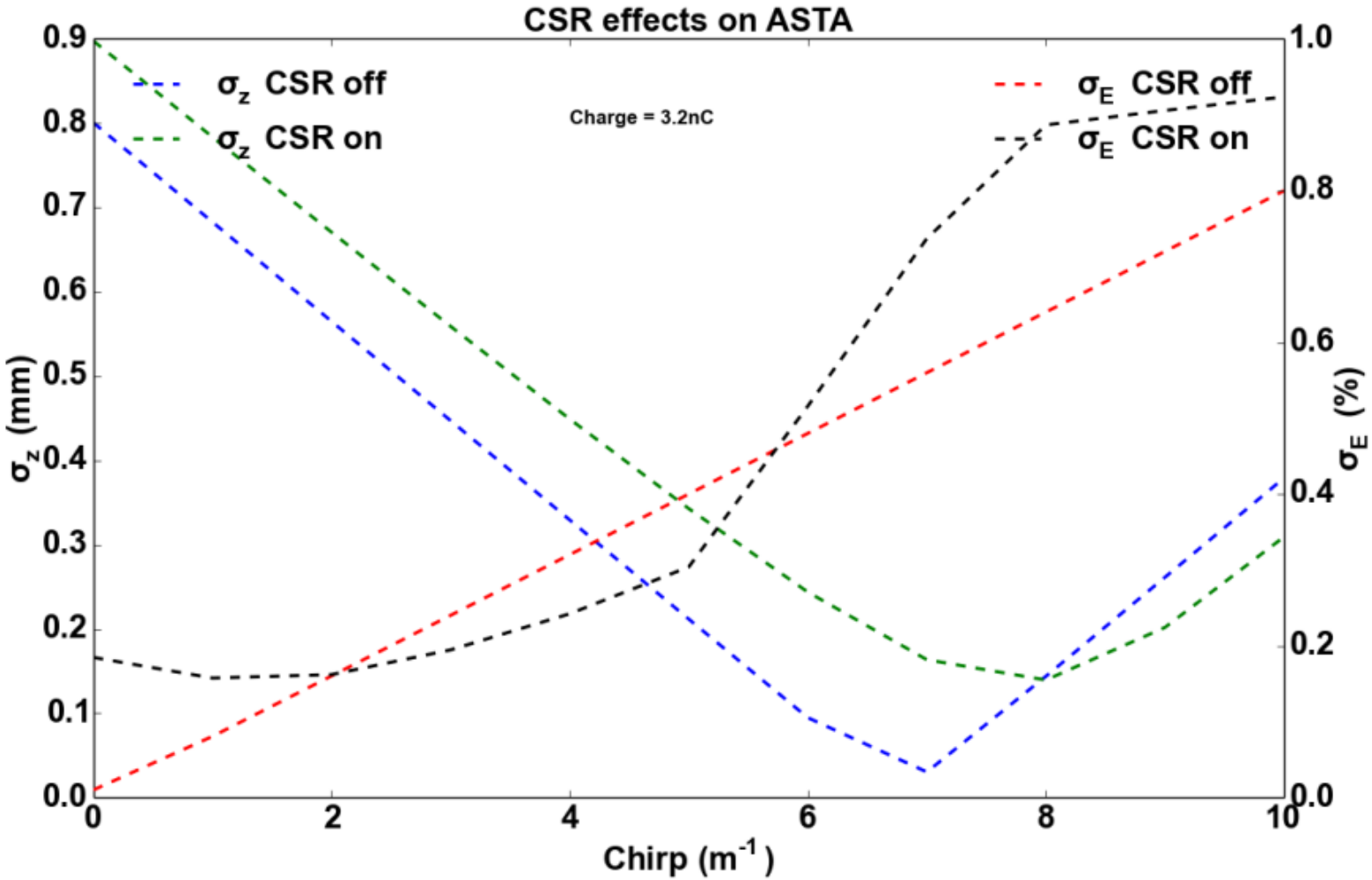
$$C = 1/1 + hR_{56} = \sigma_{z,i} / \sigma_{z,f}$$

Where C is the compression factor, h is the momentum chirp, and R_{56} is a constant parameter of the lattice/ rf-cavities

	Chirp (1/m)	Charge (nC)	Compression Factor
5	3.0	1.0	1.765
8	3.0	1.0	1.768
9	3.0	1.0	1.769
10	3.0	1.0	1.714
5	4.5	1.0	2.855
8	4.5	1.0	2.863
9	4.5	1.0	2.864
10	4.5	1.0	2.742

5	3.0	3.2	1.725
8	3.0	3.2	1.739
9	3.0	3.2	1.749
10	3.0	3.2	1.559
5	4.5	3.2	2.743
8	4.5	3.2	2.784
9	4.5	3.2	2.807
10	4.5	3.2	2.323

What about Chirp?



Goal

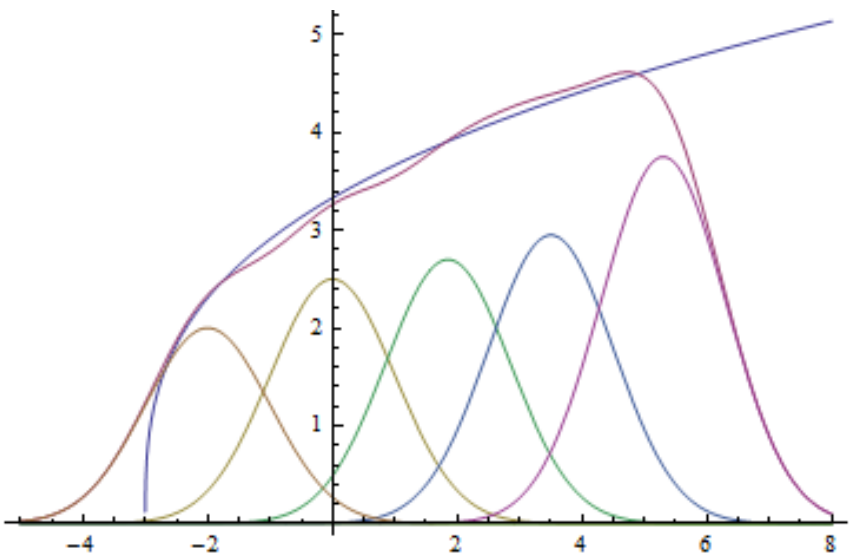
- Low Horizontal Emittance Growth

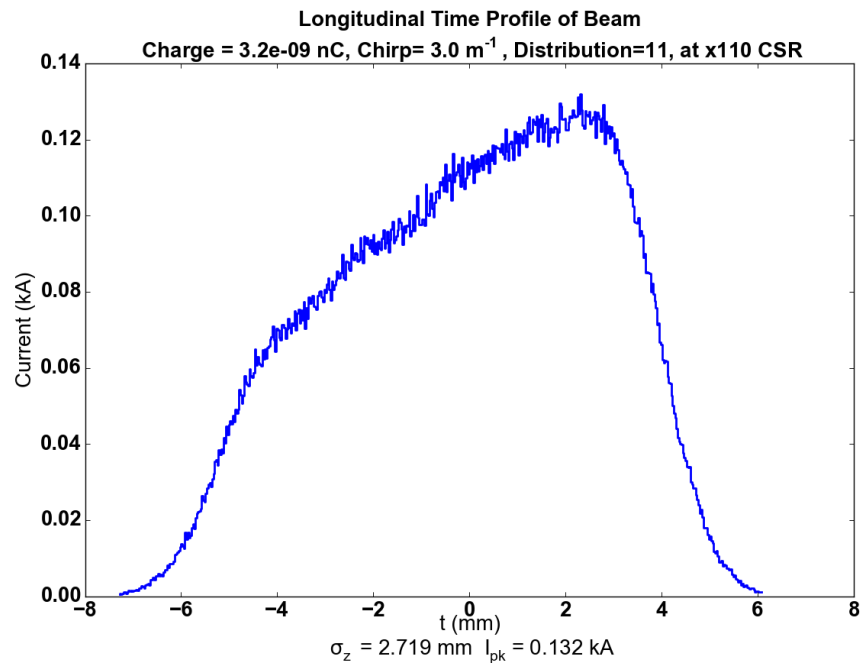
  $\varepsilon = \sqrt{<x^2><x'^2> - <xx'>^2}$

- High Peak Current

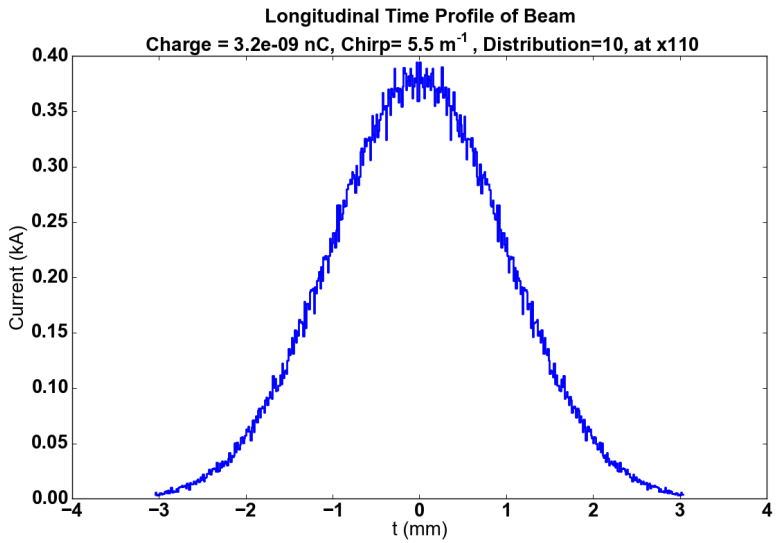
- Why?
  - Both lead to high brightness

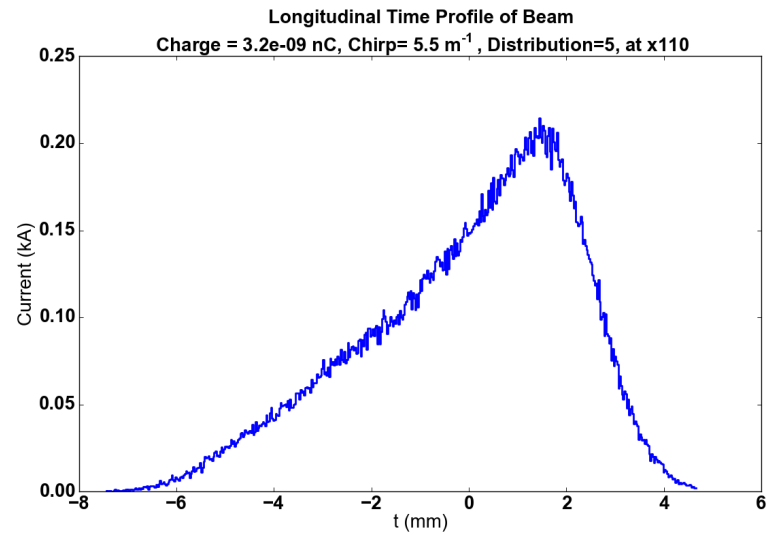
Supposed Ideal

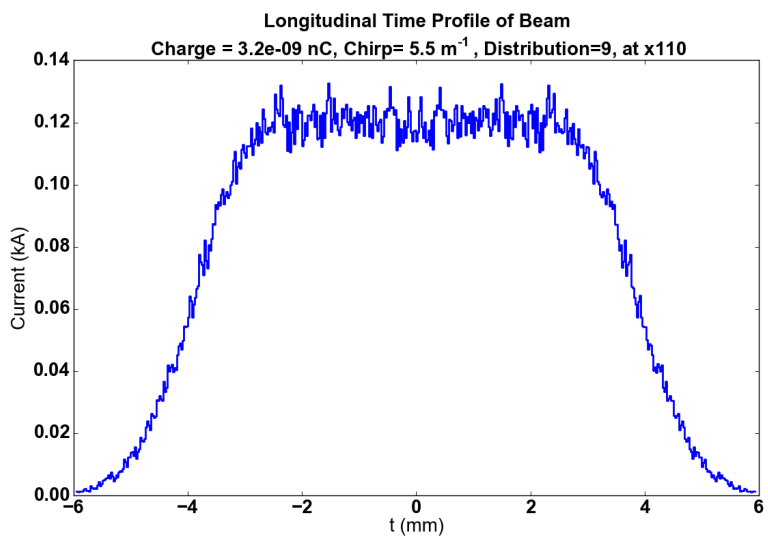


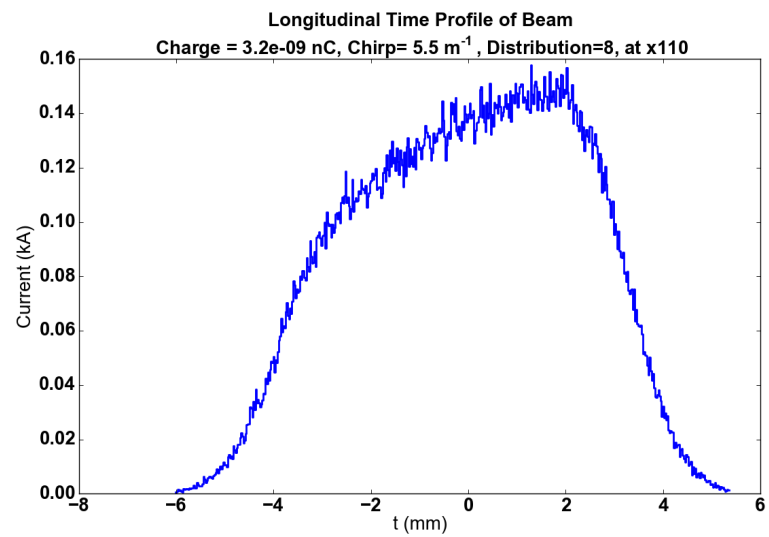


Various Initial Charge Distributions

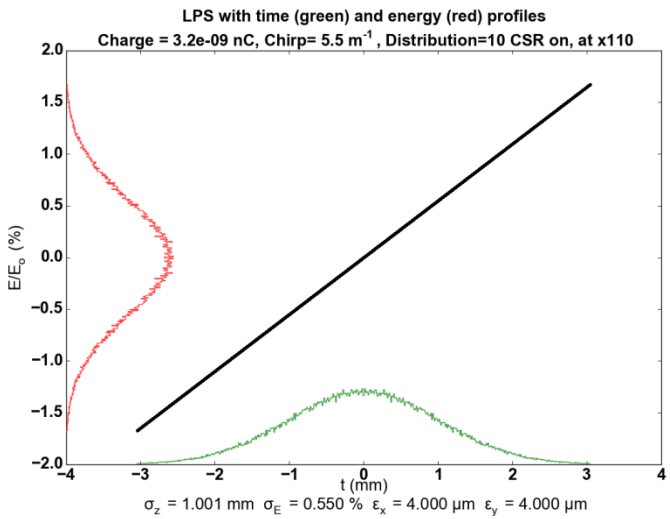


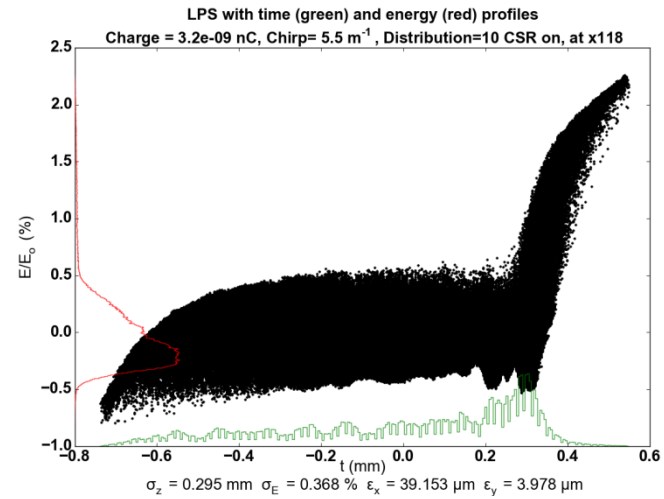


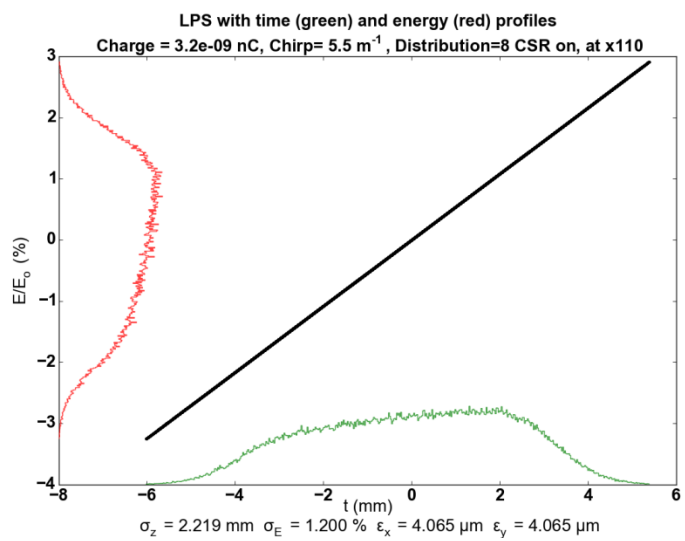


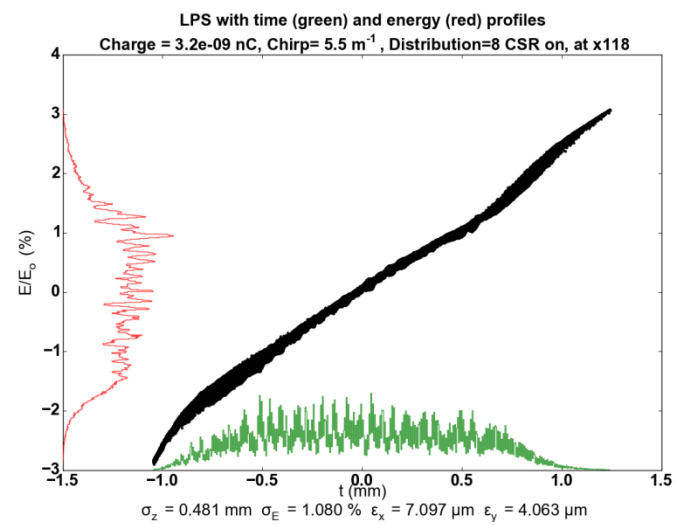


Emittance Control?

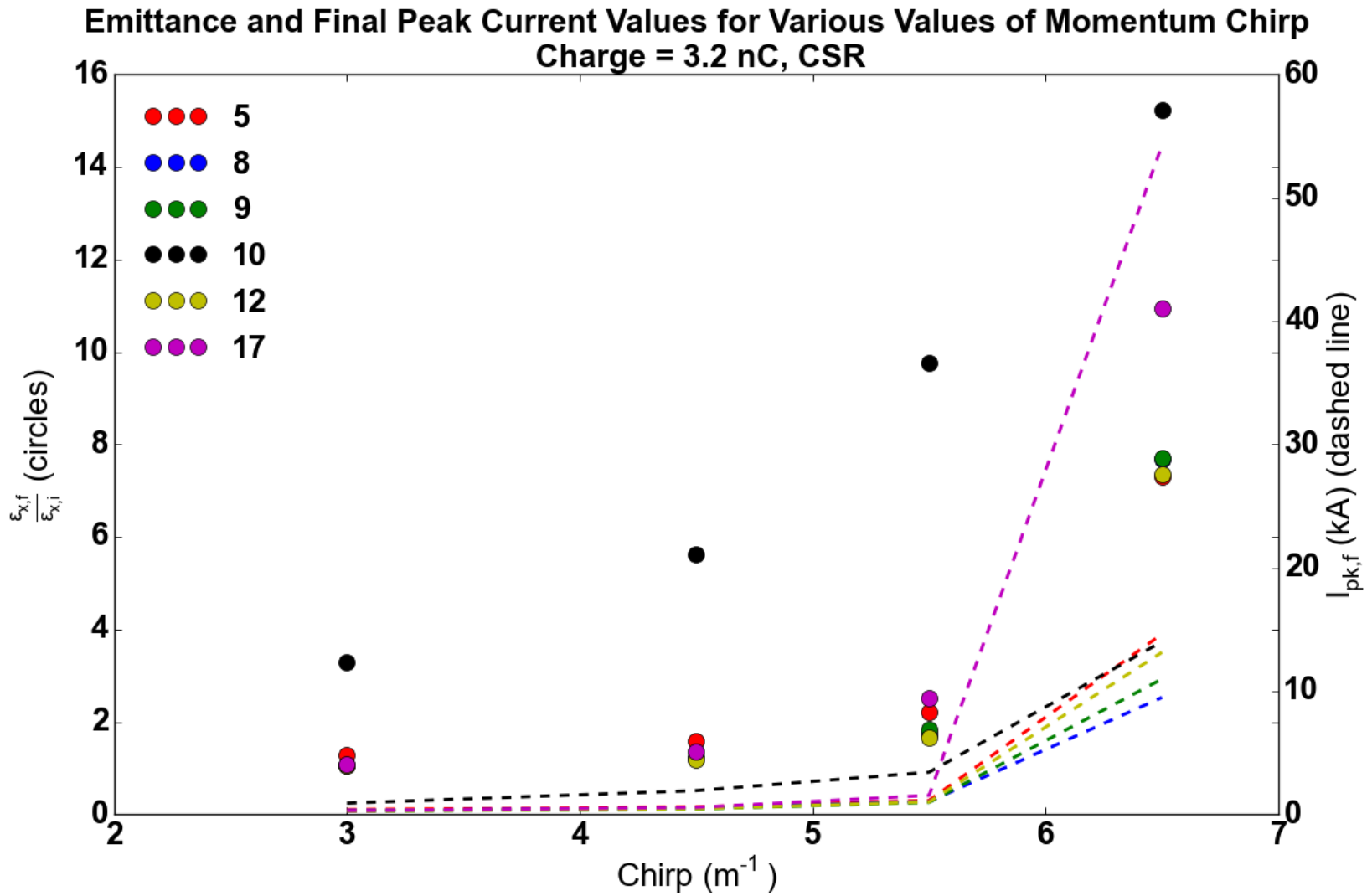




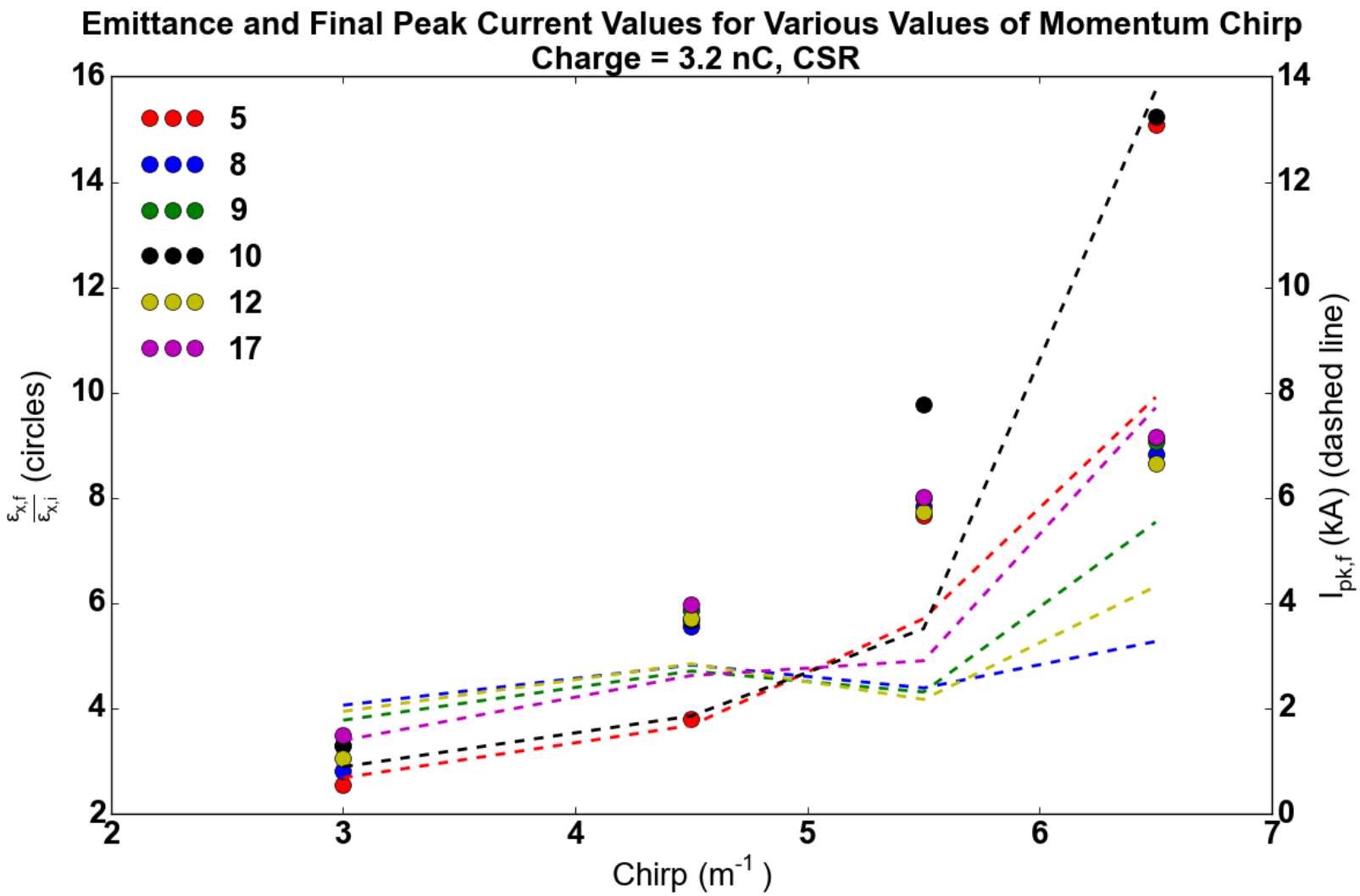




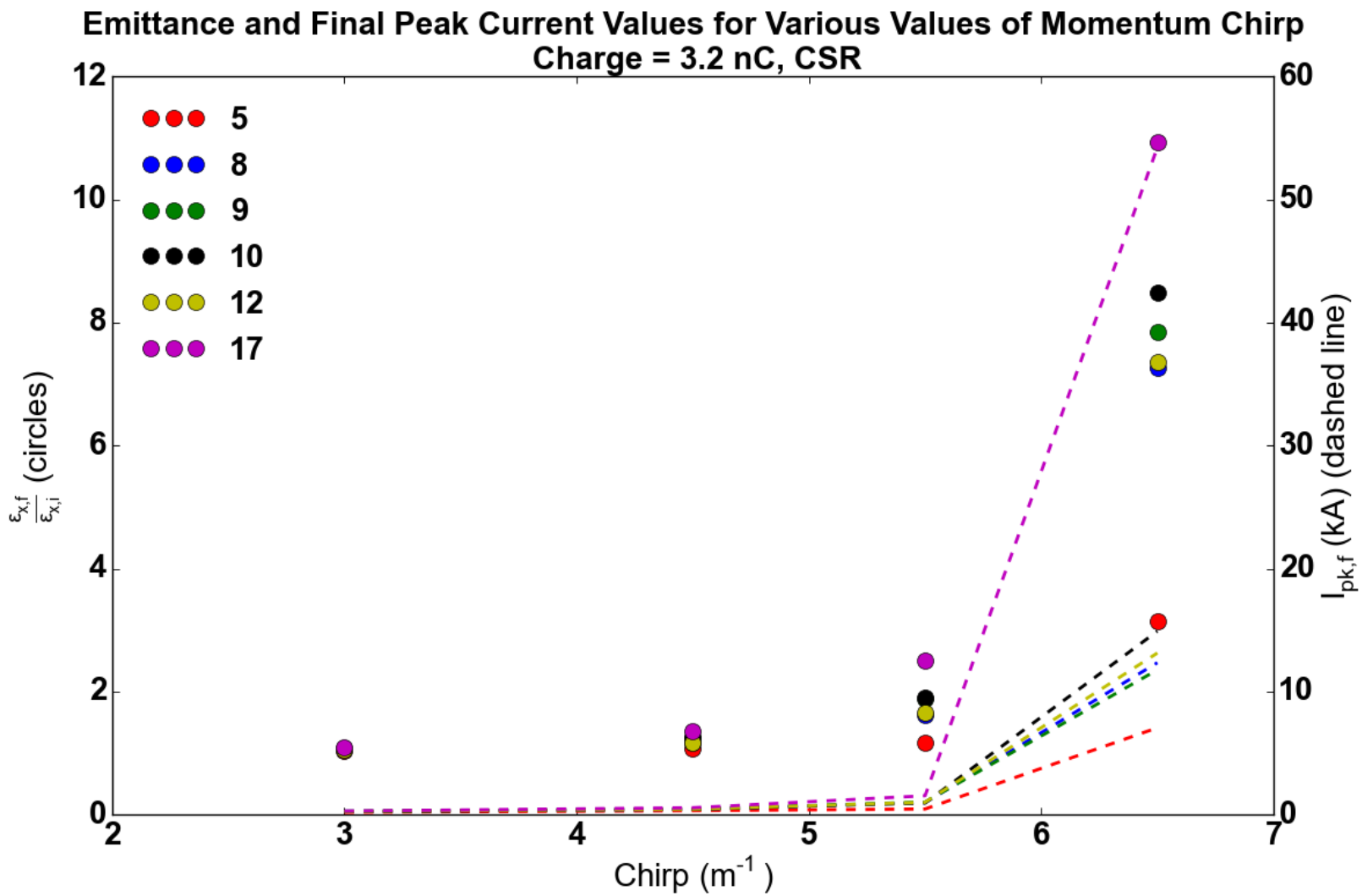
Emittance and Peak Current for Initial FWHM = “default”



Emittance and Peak Current for Initial FWHM = 2.34 mm

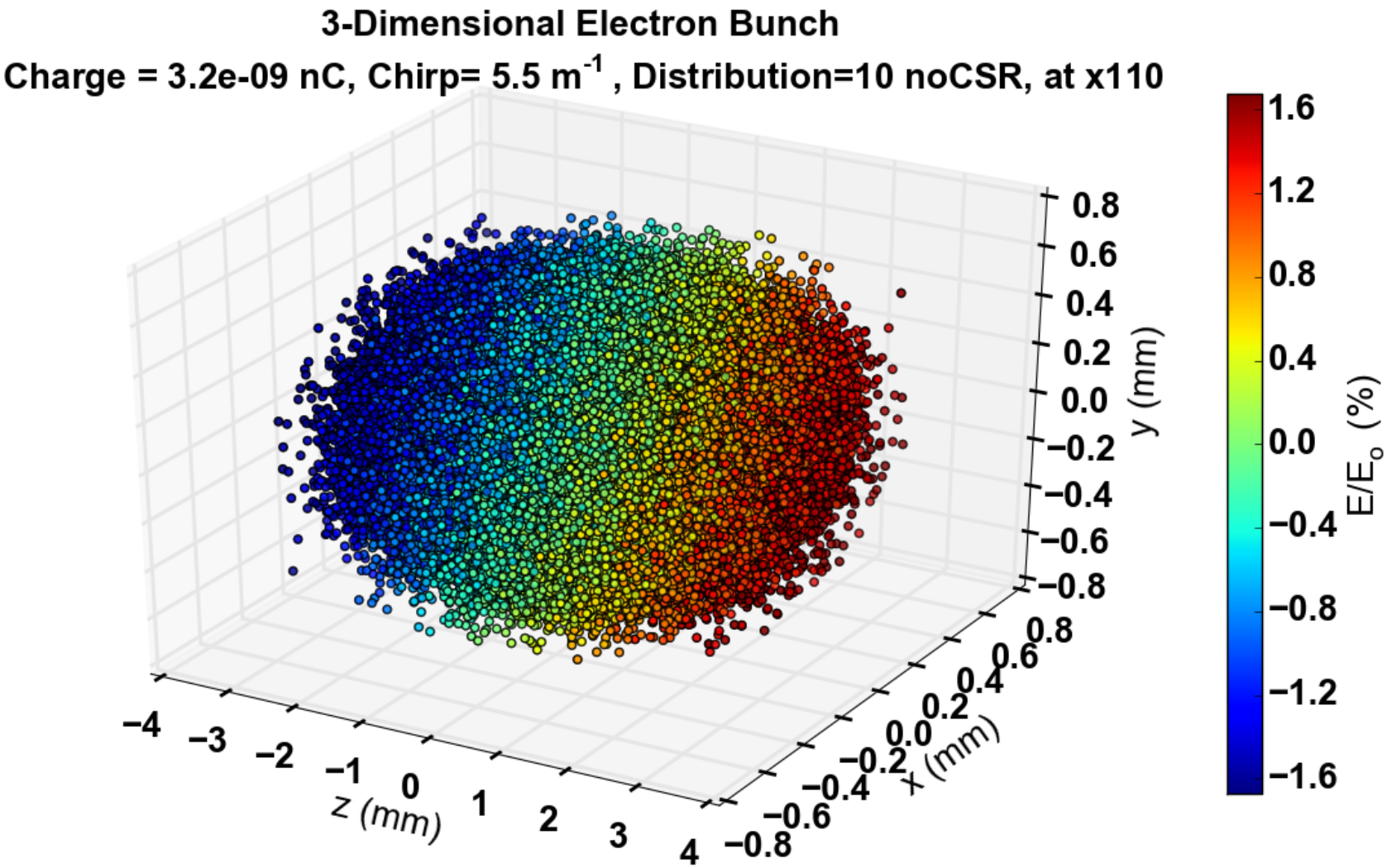


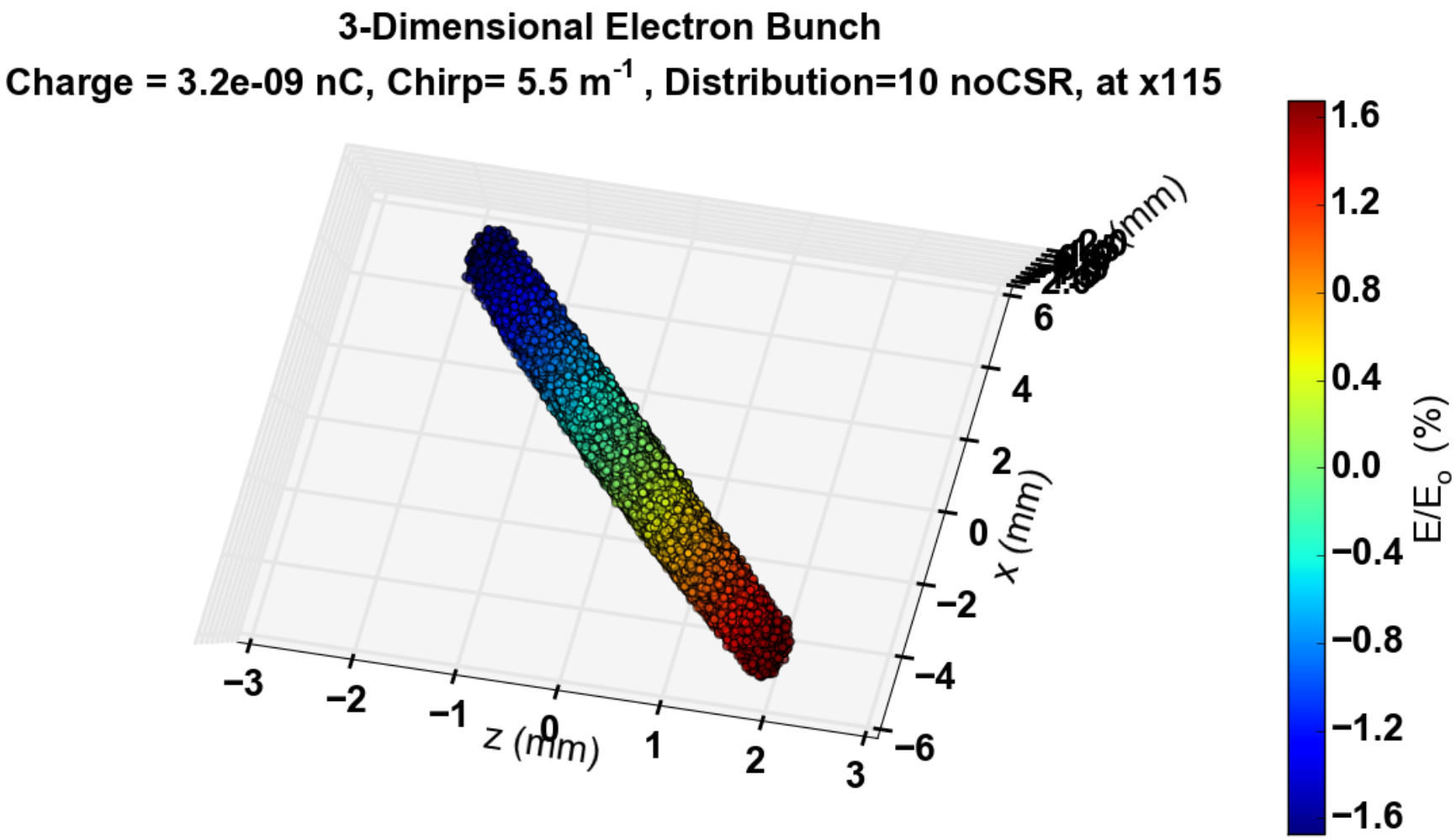
Emittance and Peak Current for Initial FWHM = 7.7 mm



More Work

- Take data with the CSR drifts enabled
- Check core emittance
- Look into the gigantic peak current displayed by distribution 17 at high values of chirp
  - Is this real?
- Get good data for paper from the scraper usage


3-Dimensional Electron Bunch
Charge = 3.2e-09 nC, Chirp= 5.5 m^{-1} , Distribution=10 noCSR, at x110
z (mm)
x (mm)
y (mm)
E/E$_o$ (%)


3-Dimensional Electron Bunch
Charge = 3.2e-09 nC, Chirp= 5.5 m^{-1} , Distribution=10 noCSR, at x115
z (mm)
x (mm)
E/E$_o$ (%)
−3
−2
−1
0
1
2
3
−6
−4
−2
0
2
4
6
1.6
1.2
0.8
0.4
0.0
−0.4
−0.8
−1.2
−1.6