Kicker Simulations

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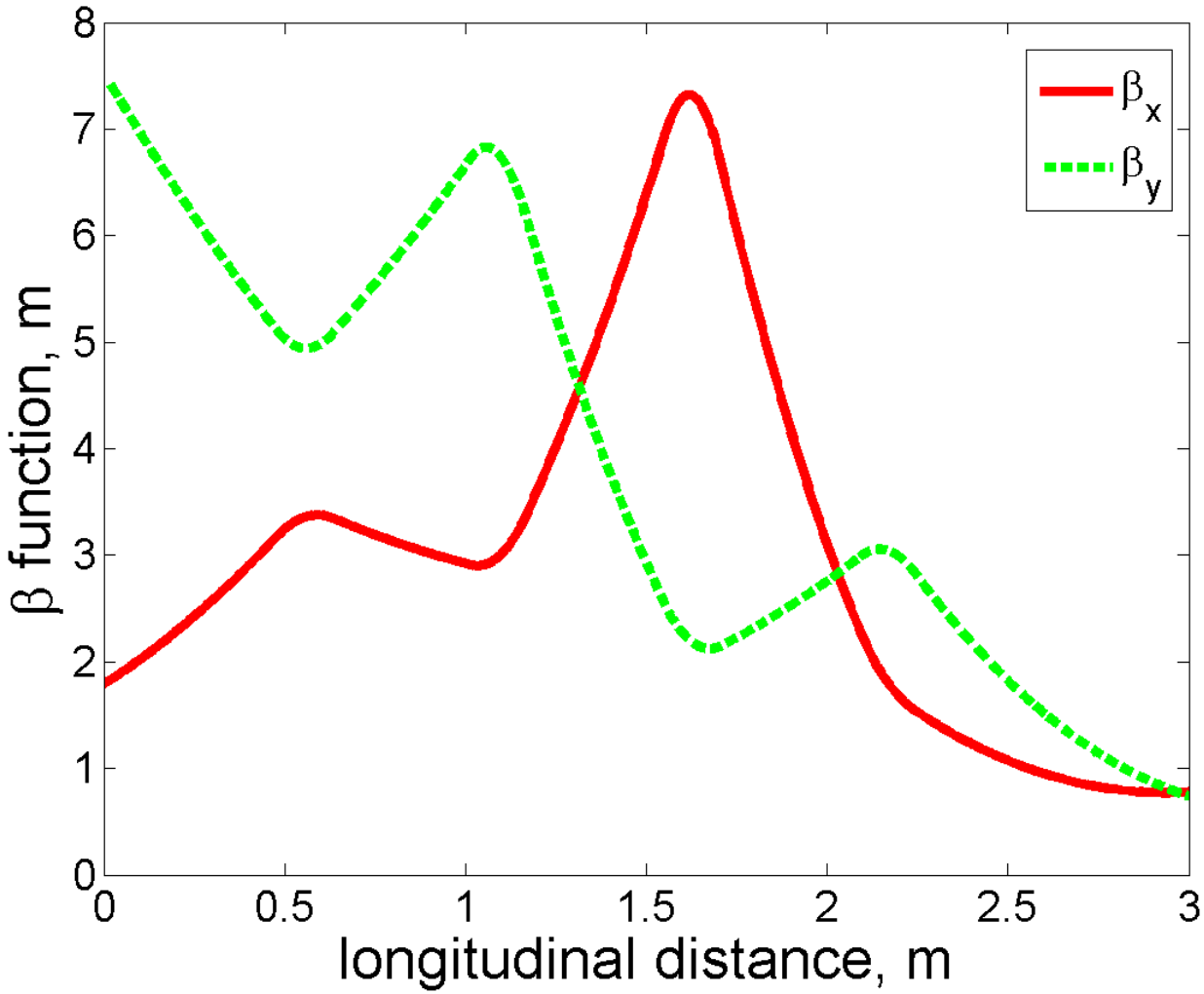
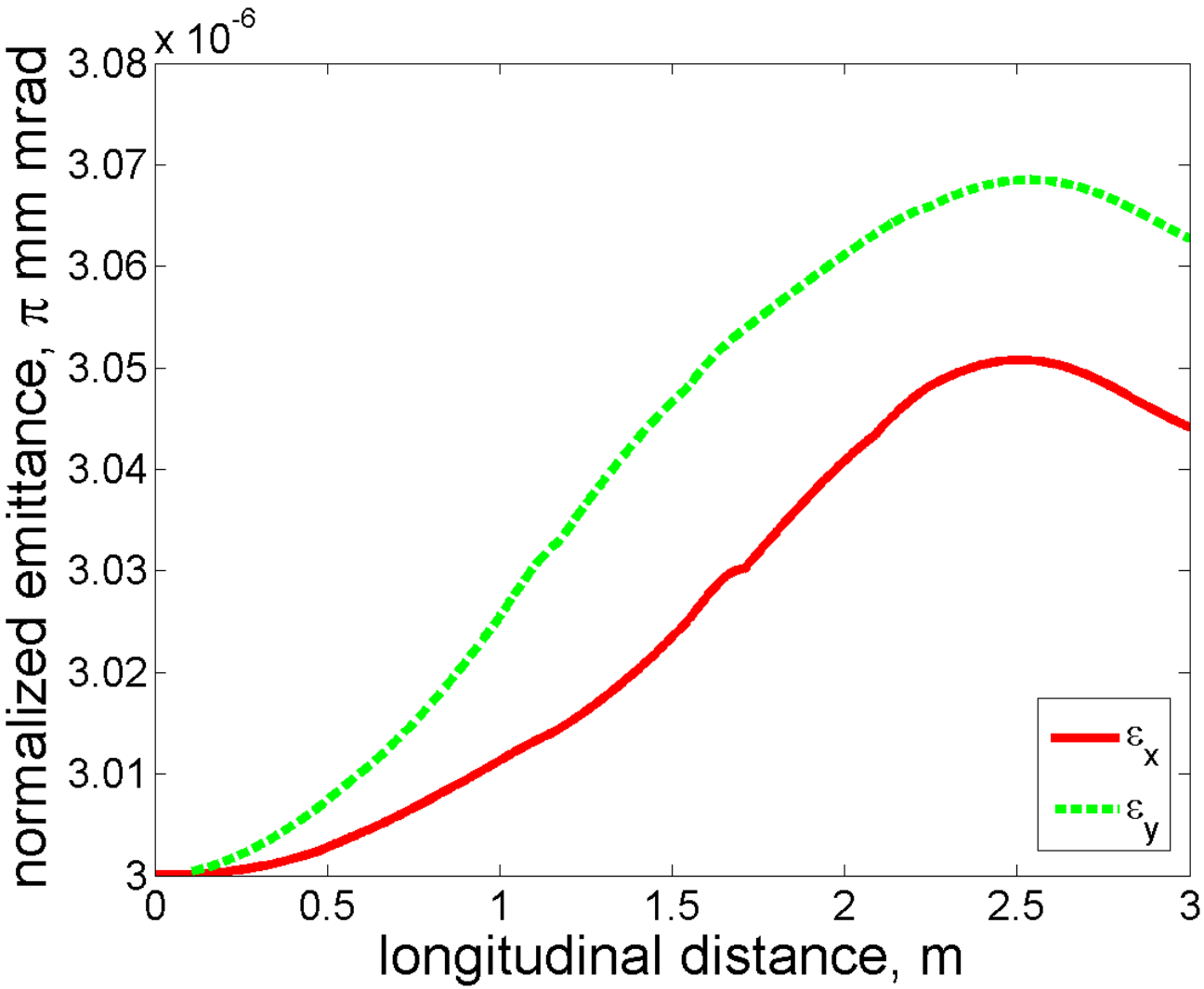
- Peak current 25 A
- FEL max gain is 133, gain at 237th slice is 60
- In kicker, background slips 38.4 degree, signal slips 40.8 degree

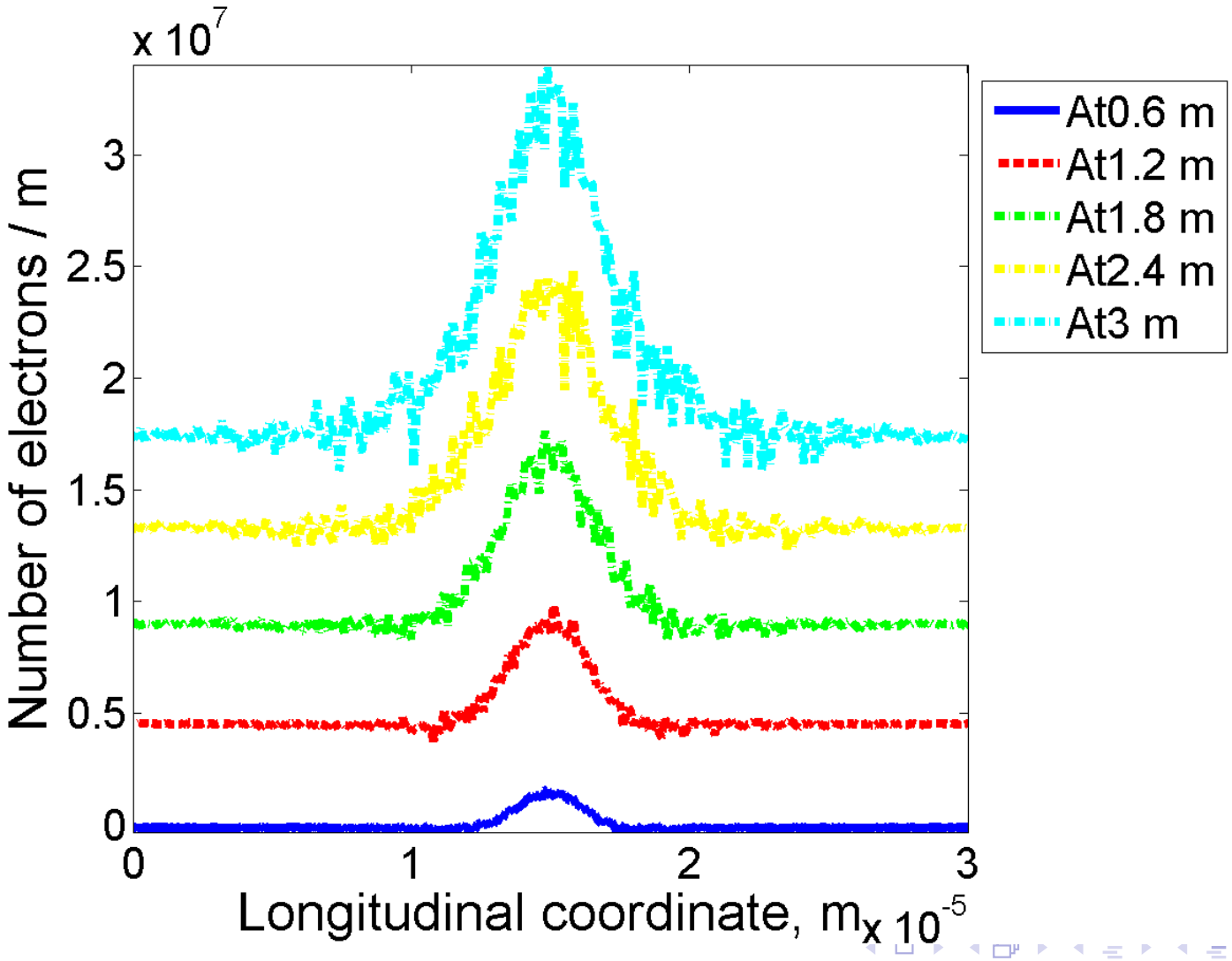
β function



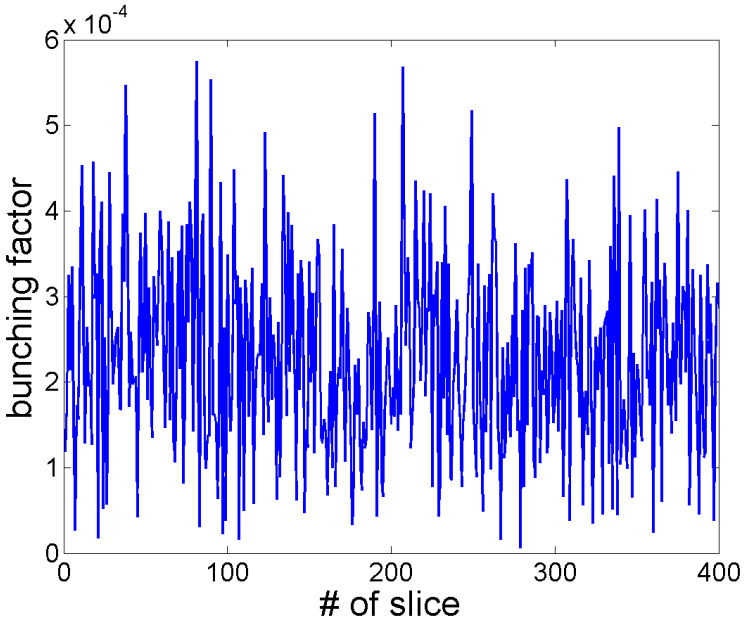
Emittance


x 10^-6
3.08
3.07
3.06
3.05
3.04
3.03
3.02
3.01
3
normalized emittance, π mm mrad
0
0.5
1
1.5
2
2.5
3
longitudinal distance, m
ε_x
ε_y

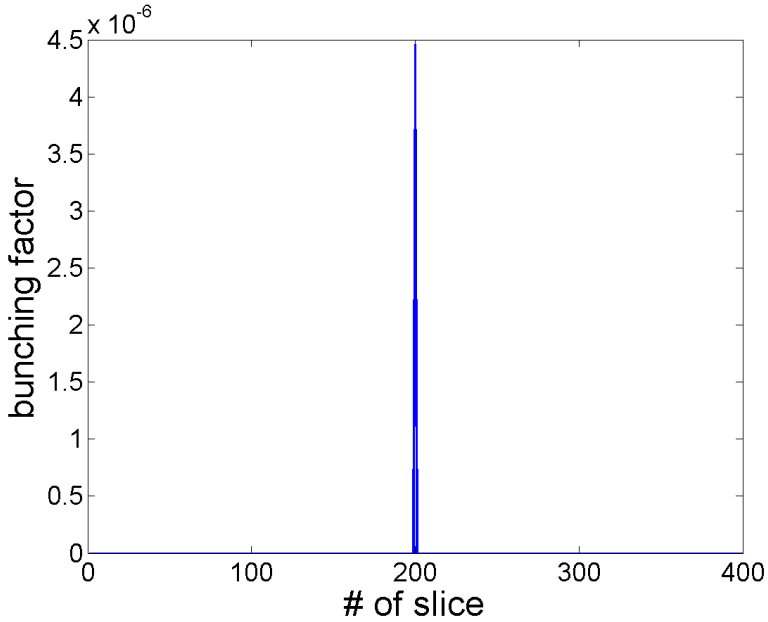
Longitudinal density modulation



Bunching factor at beginning

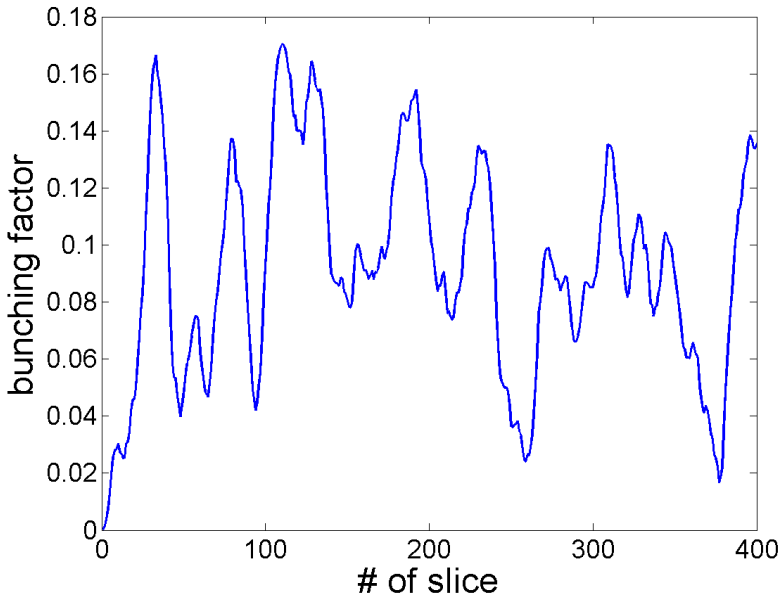


(a) Background

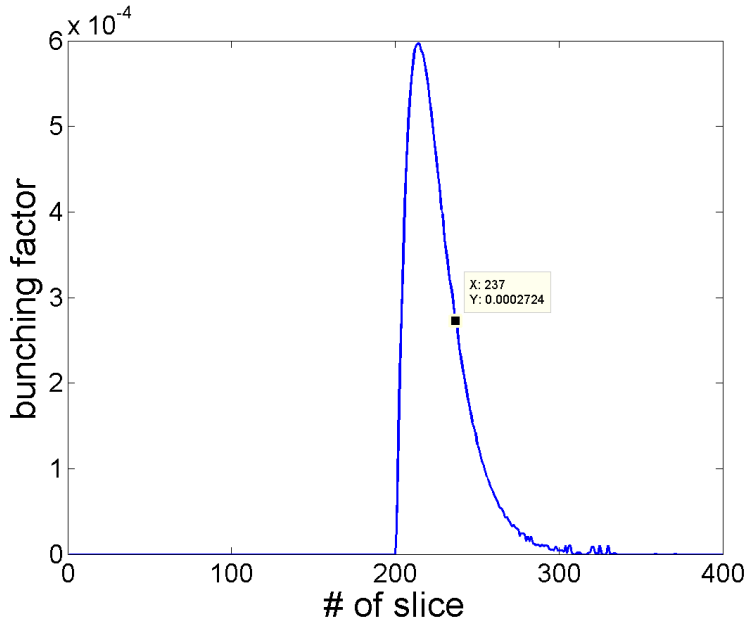


(b) Signal

Bunching factor at end

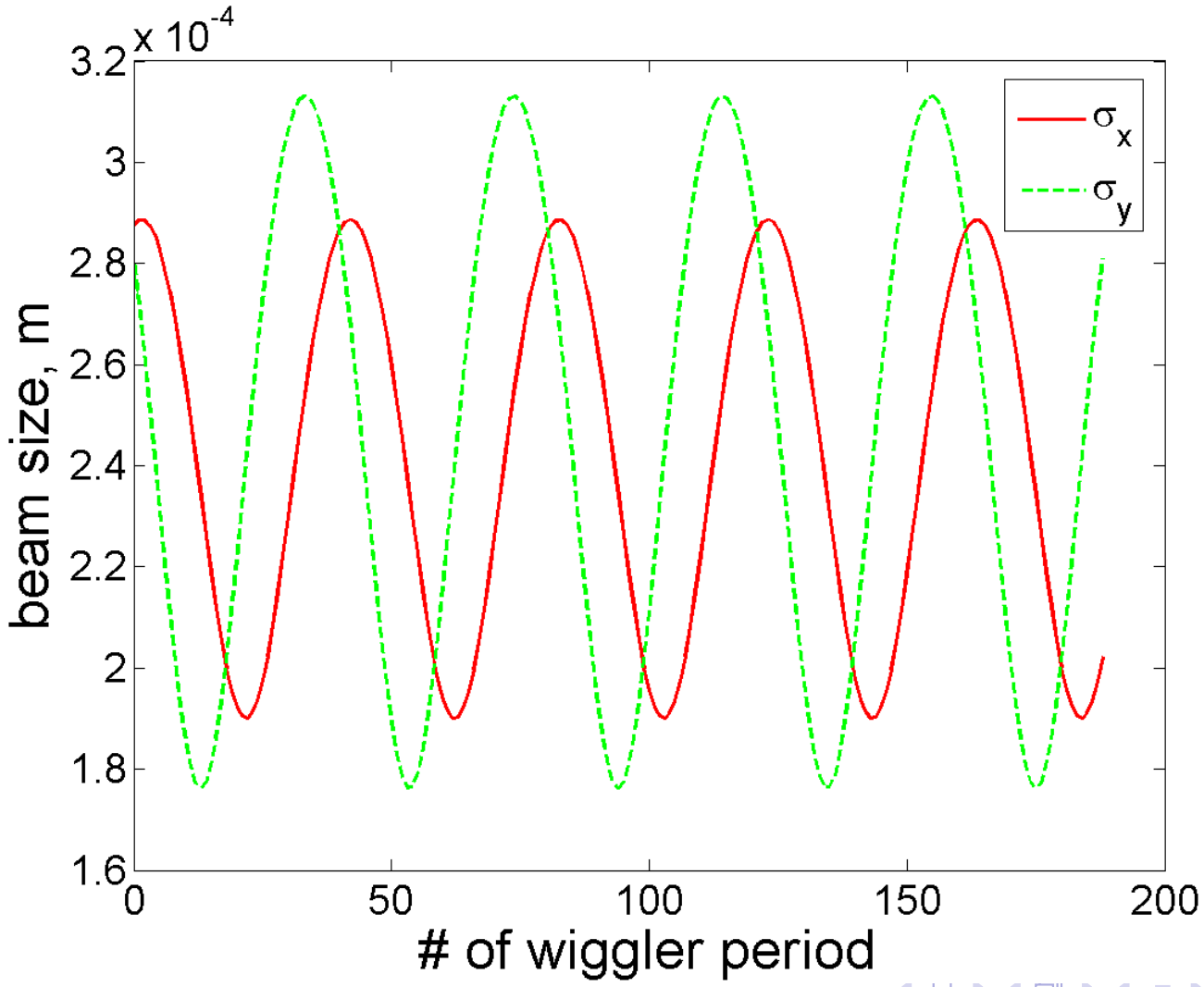


(a) Background

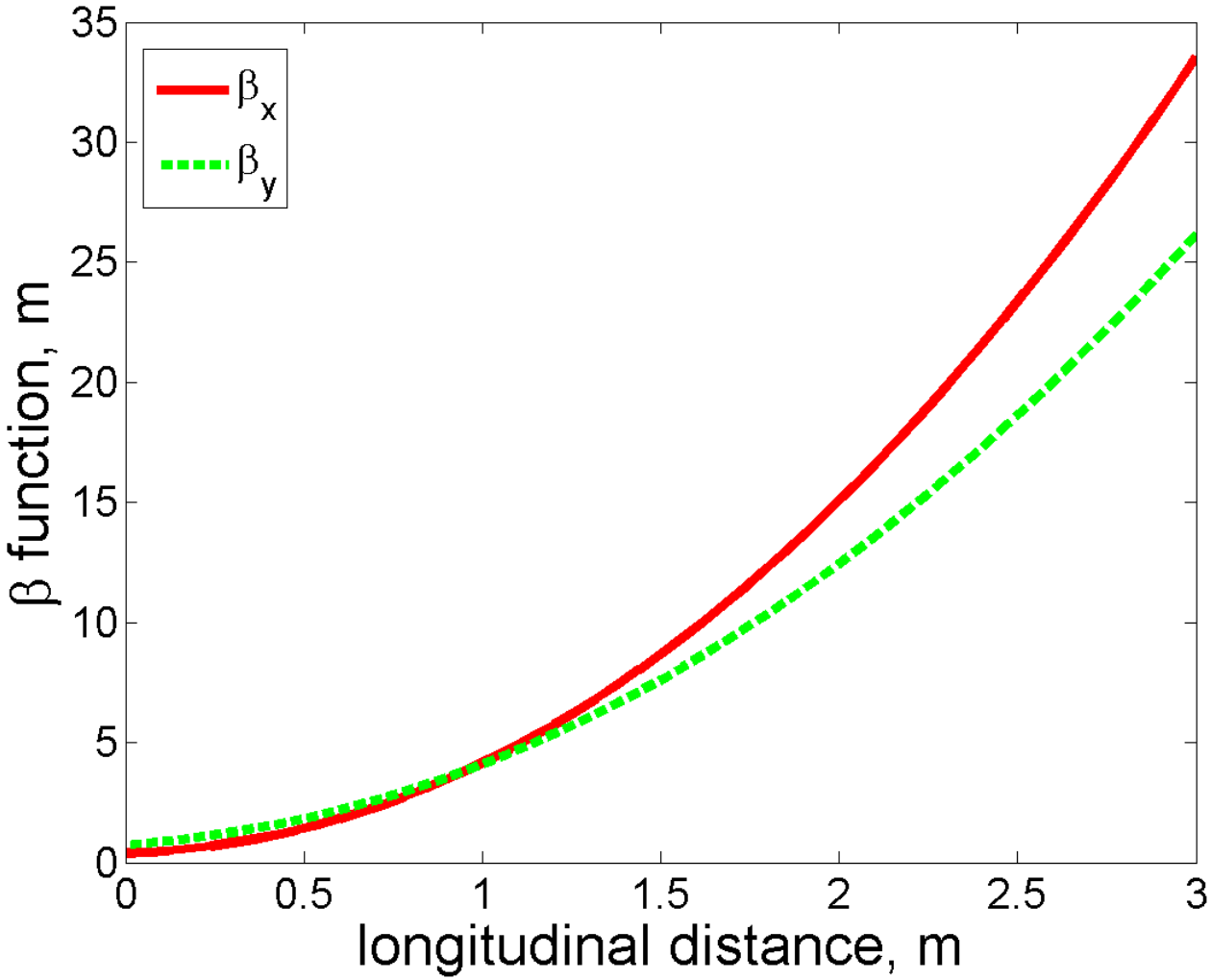


(b) Signal

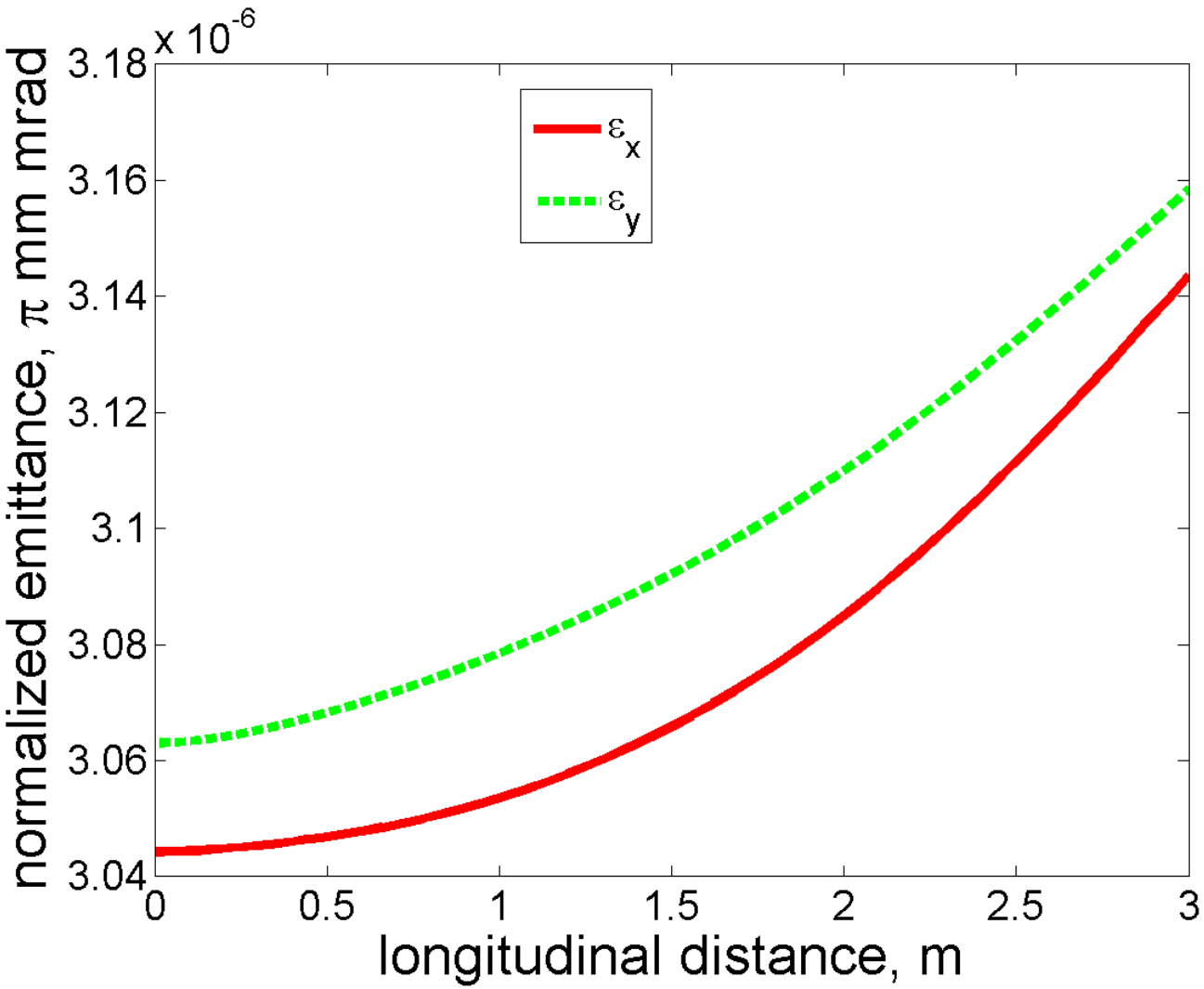
Transverse size



β function



Emittance


x 10^-6
3.18
3.16
3.14
3.12
3.1
3.08
3.06
3.04
normalized emittance, π mm mrad
ε_x
ε_y
0
0.5
1
1.5
2
2.5
3
longitudinal distance, m

Assumptions

- Use 3e-4 as the energy spread of ions
- Use 10 m as the distance from exit of modulator to entrance of kicker, to calculate the slippage of off-reference energy ions

Trace kick force

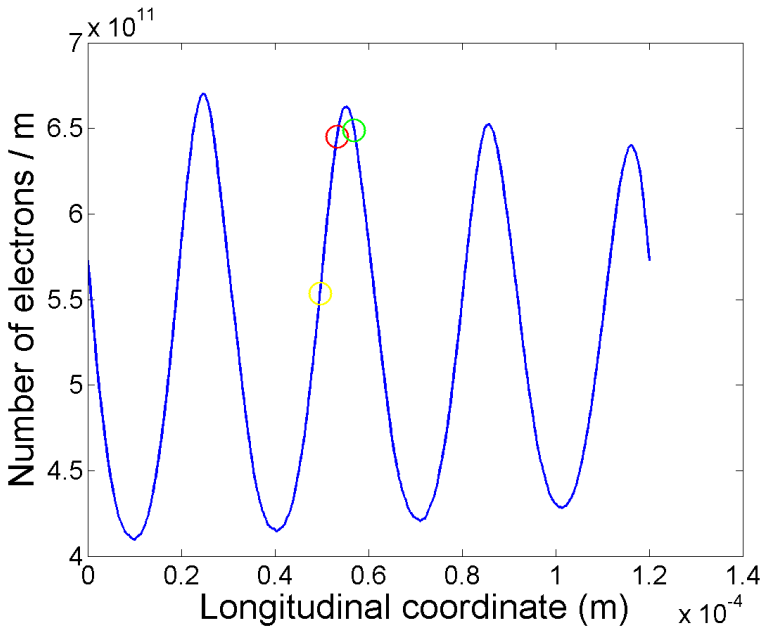
Trace three typical ions

- Reference energy ion sitting at the center
- Larger energy ion (vz=9e+4 m/s in moving frame) 3.65e-6 m ahead
- Smaller energy ion (vz=-9e+4 m/s in moving frame) 3.65e-6 m behind

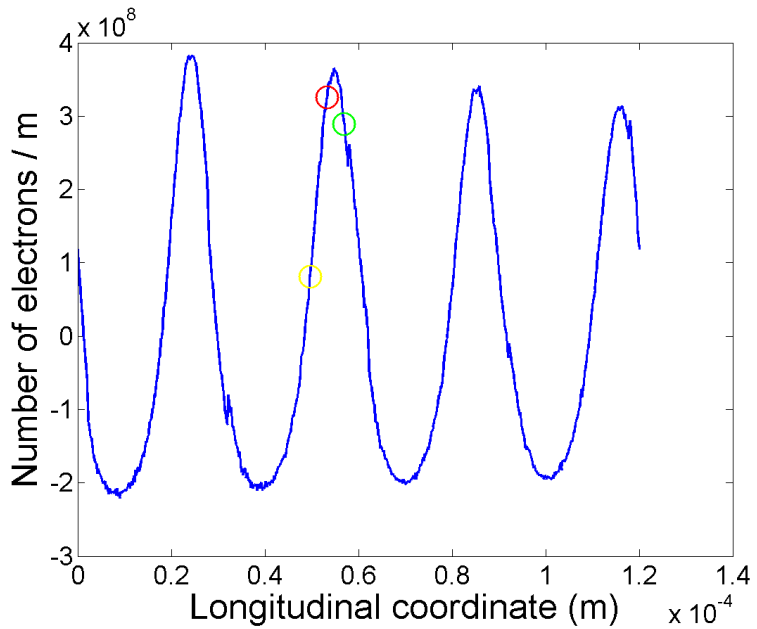
Trace methods

- Real ion
- Ghost ion with zero charge and constant velocity, read the forces on ghost ion's positions and make time integral

Longitudinal density distribution at 0 m

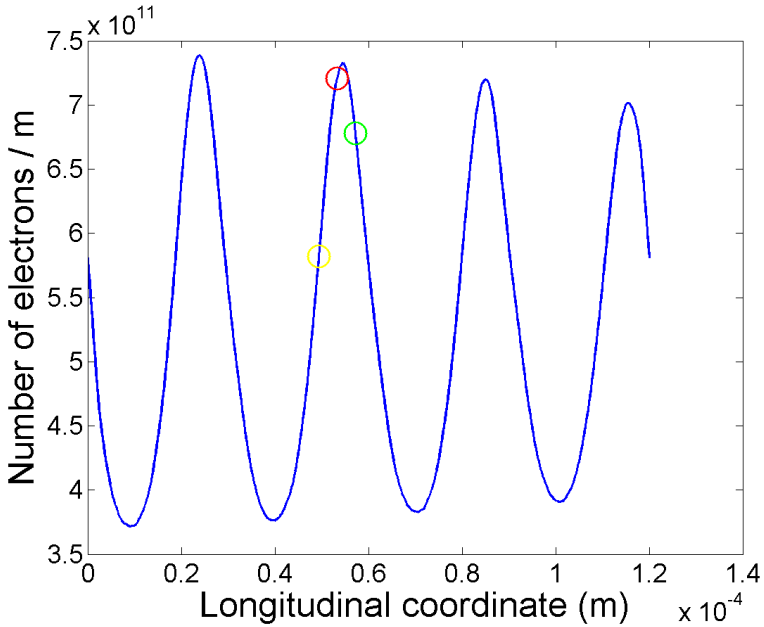


(a) Background

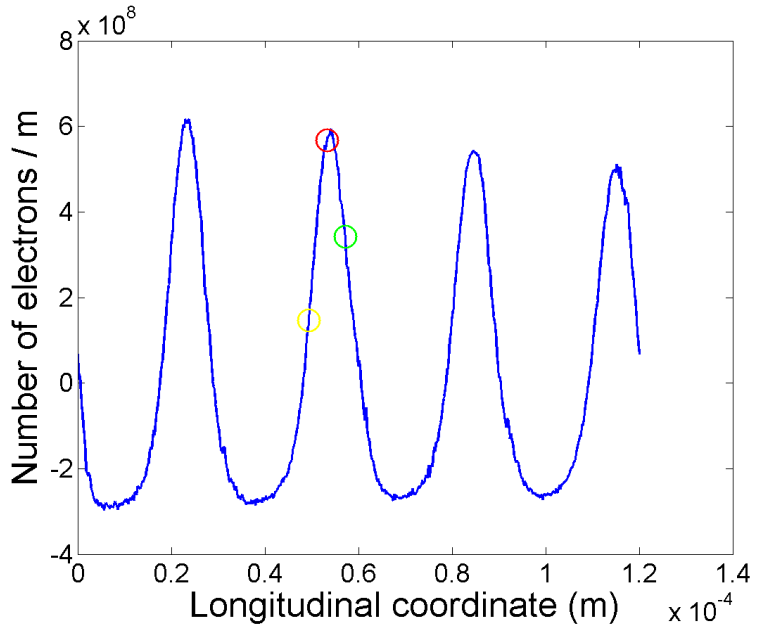


(b) Signal

Longitudinal density distribution at 0.6 m

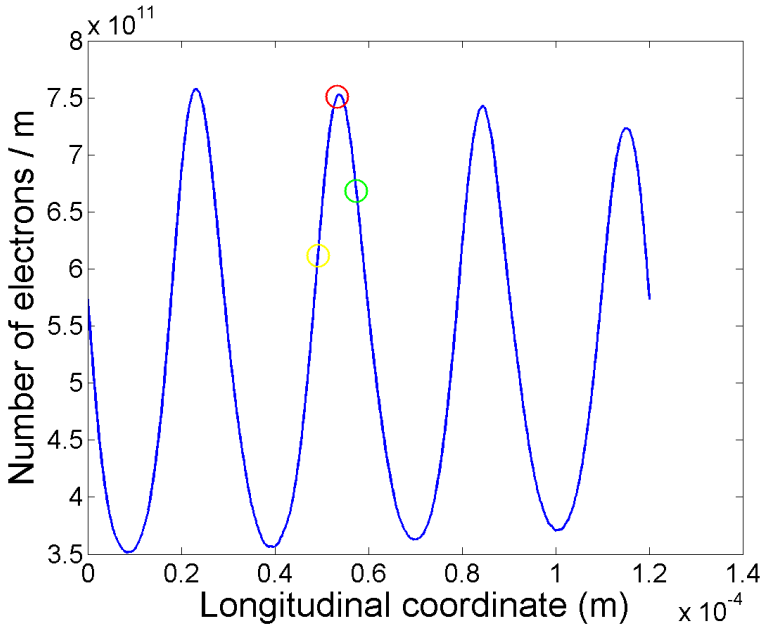


(a) Background

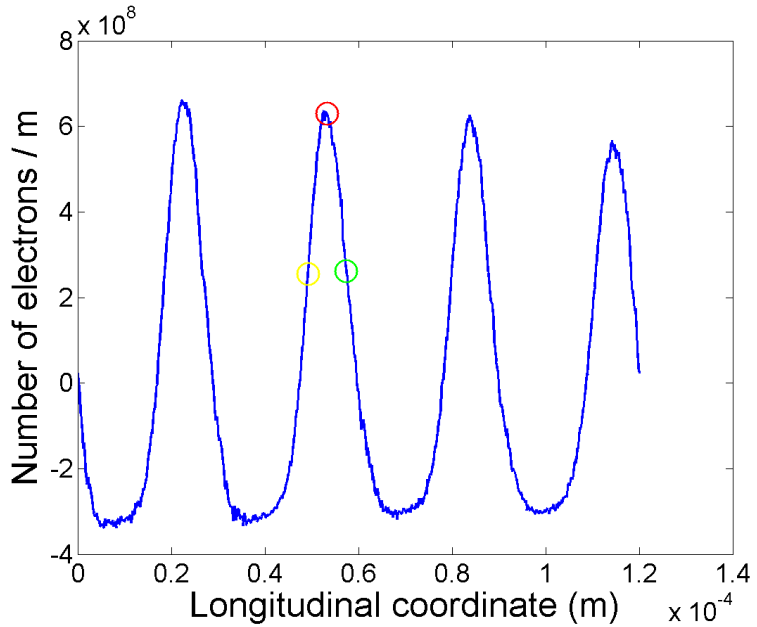


(b) Signal

Longitudinal density distribution at 1.2 m

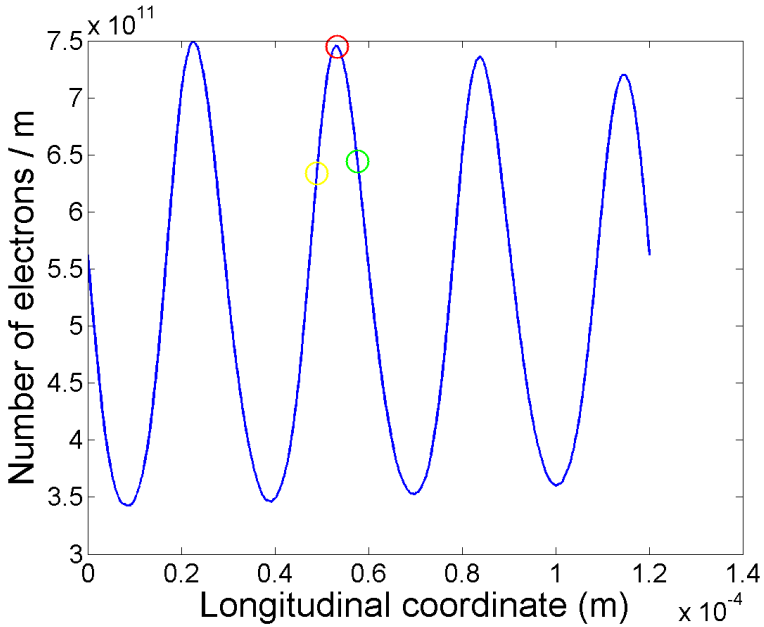


(a) Background

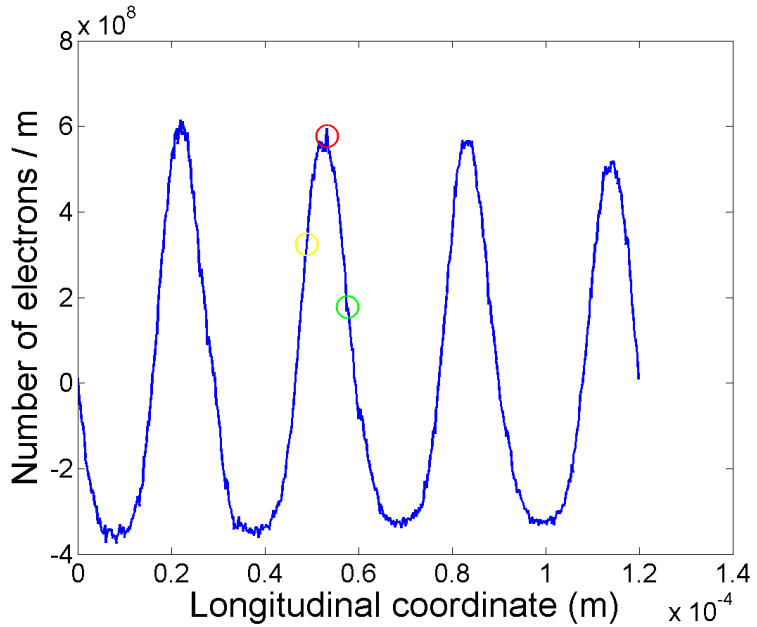


(b) Signal

Longitudinal density distribution at 1.8 m

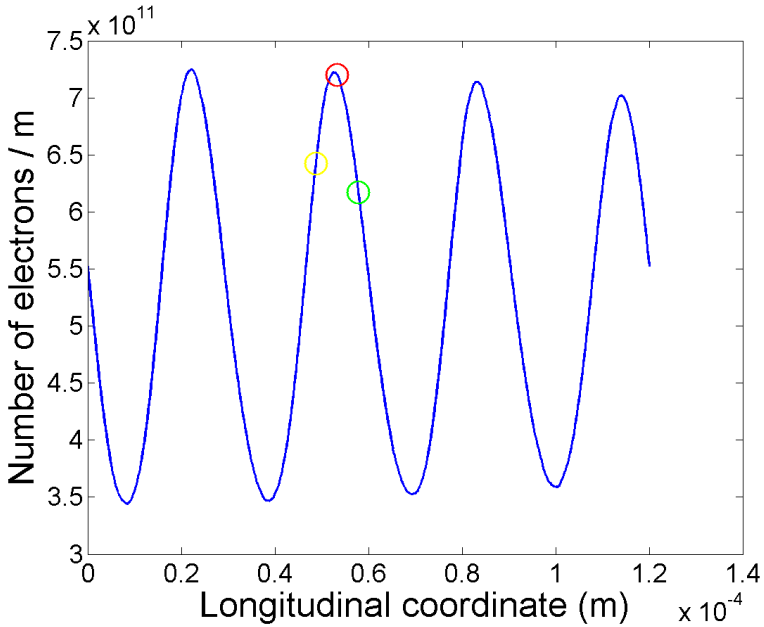


(a) Background

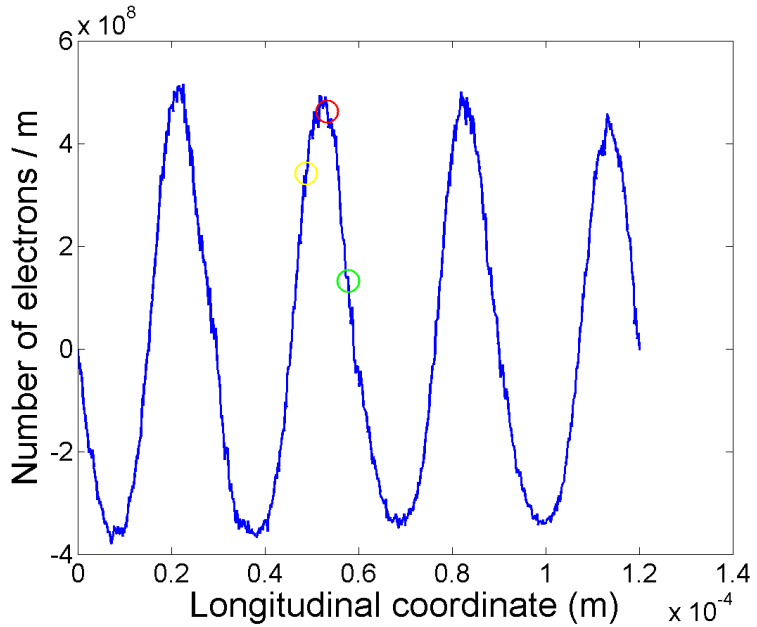


(b) Signal

Longitudinal density distribution at 2.4 m

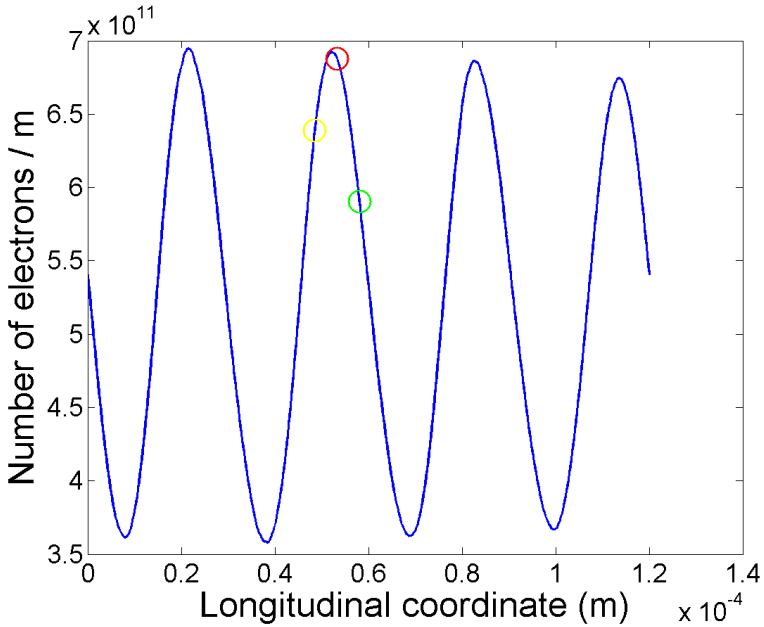


(a) Background

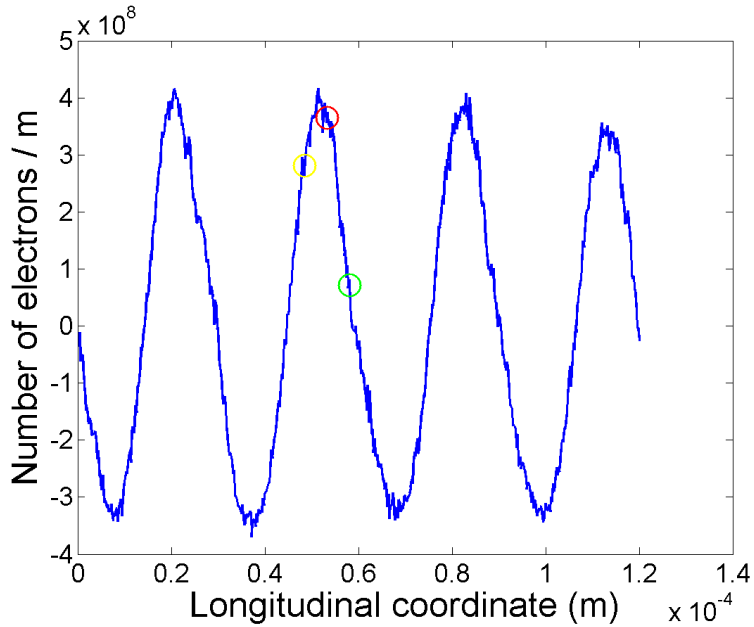


(b) Signal

Longitudinal density distribution at 3 m

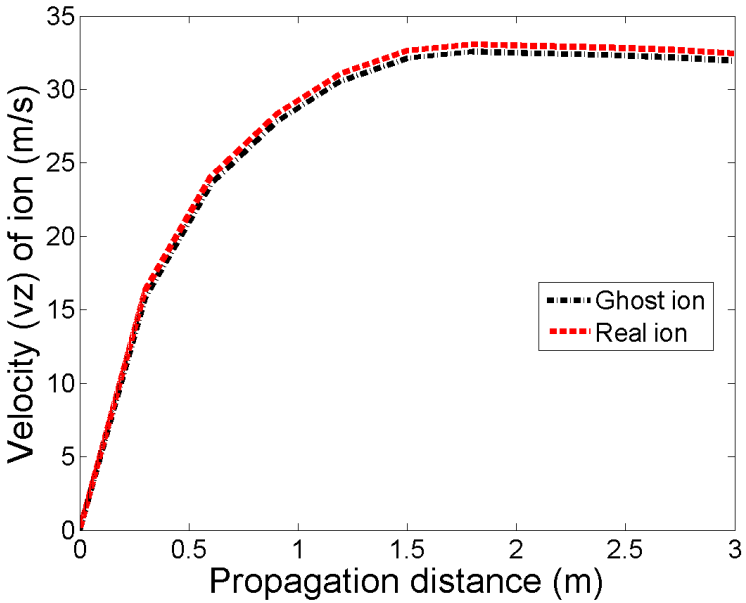


(a) Background

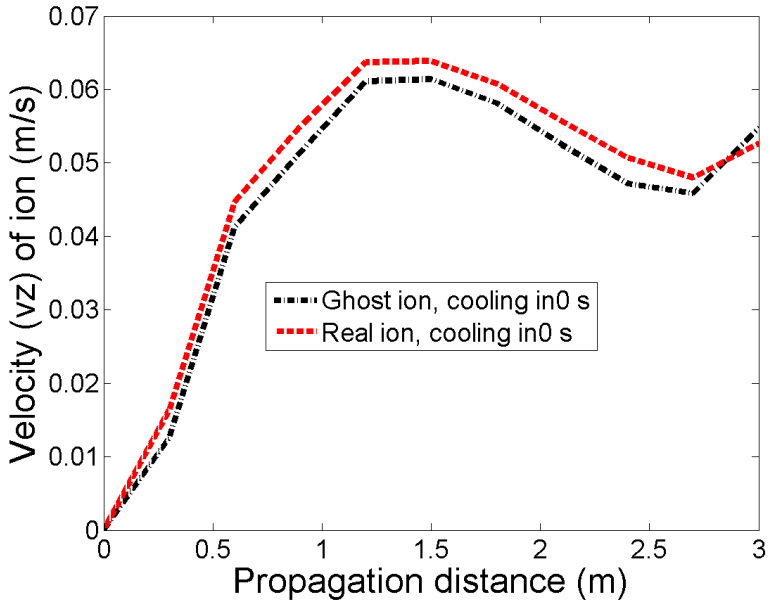


(b) Signal

Reference energy

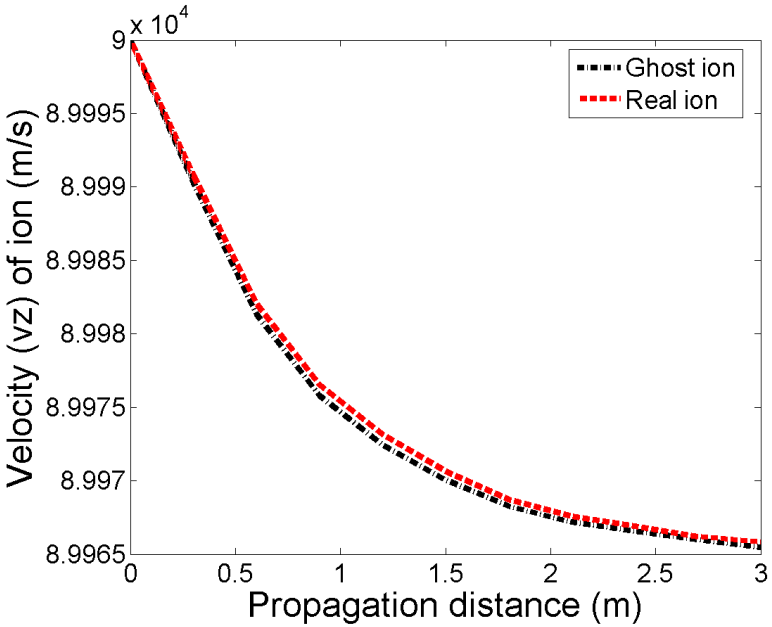


(a) Background

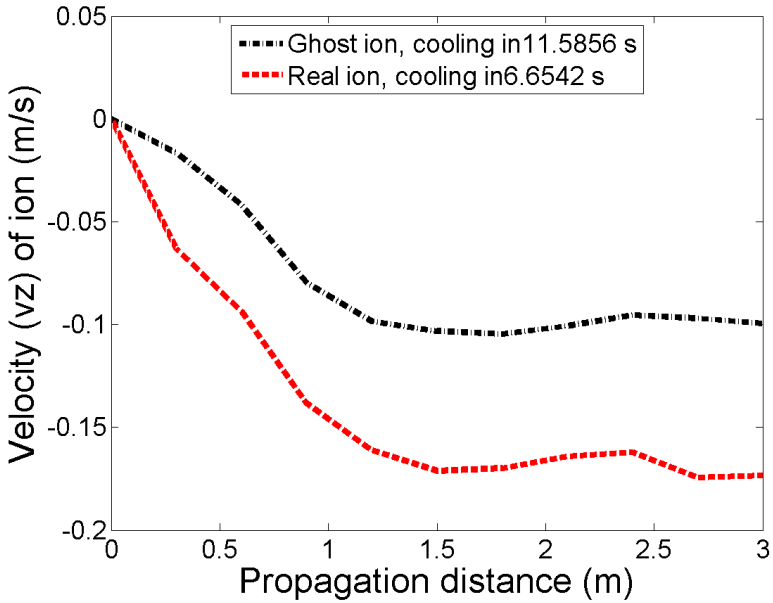


(b) Signal

Larger energy

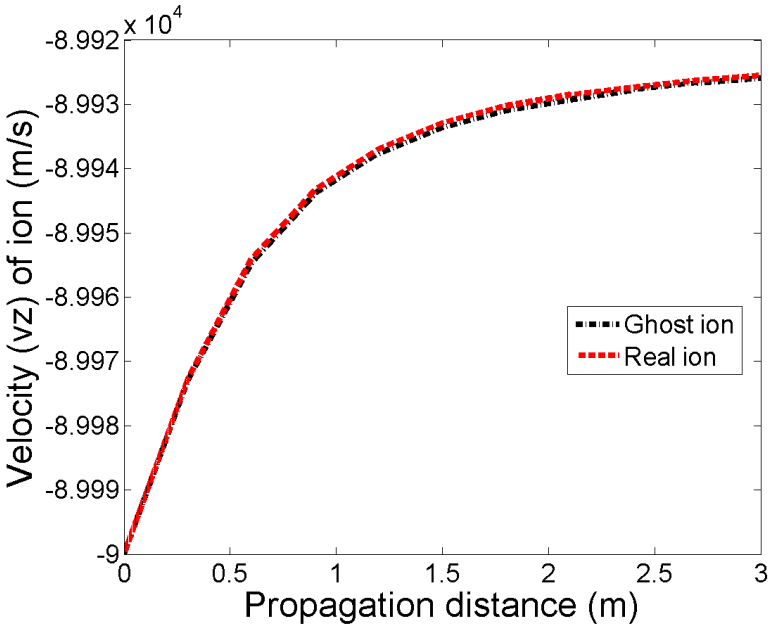


(a) Background

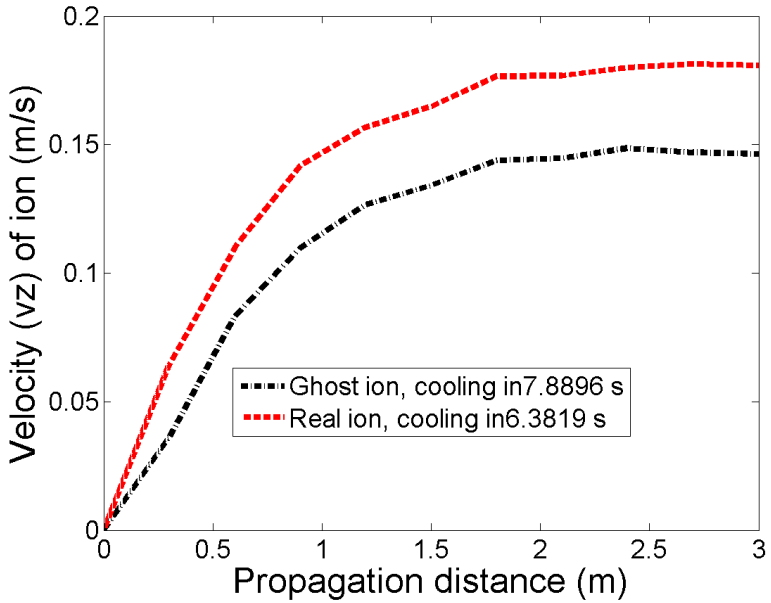


(b) Signal

Smaller energy, comparison



(a) Background



(b) Signal

Discussion

- Macro particle simulations are used in kicker (1 macro particle = 14.8929 real particles)
- The numerical noise does not affect the background kick, but may be comparable with the signal kick, which could be the reason for the difference between ghost ion and real ion
- Repeat the kick simulations using different random seeds
- Use more macro particles to reduce the numerical noise