CeC Simulations

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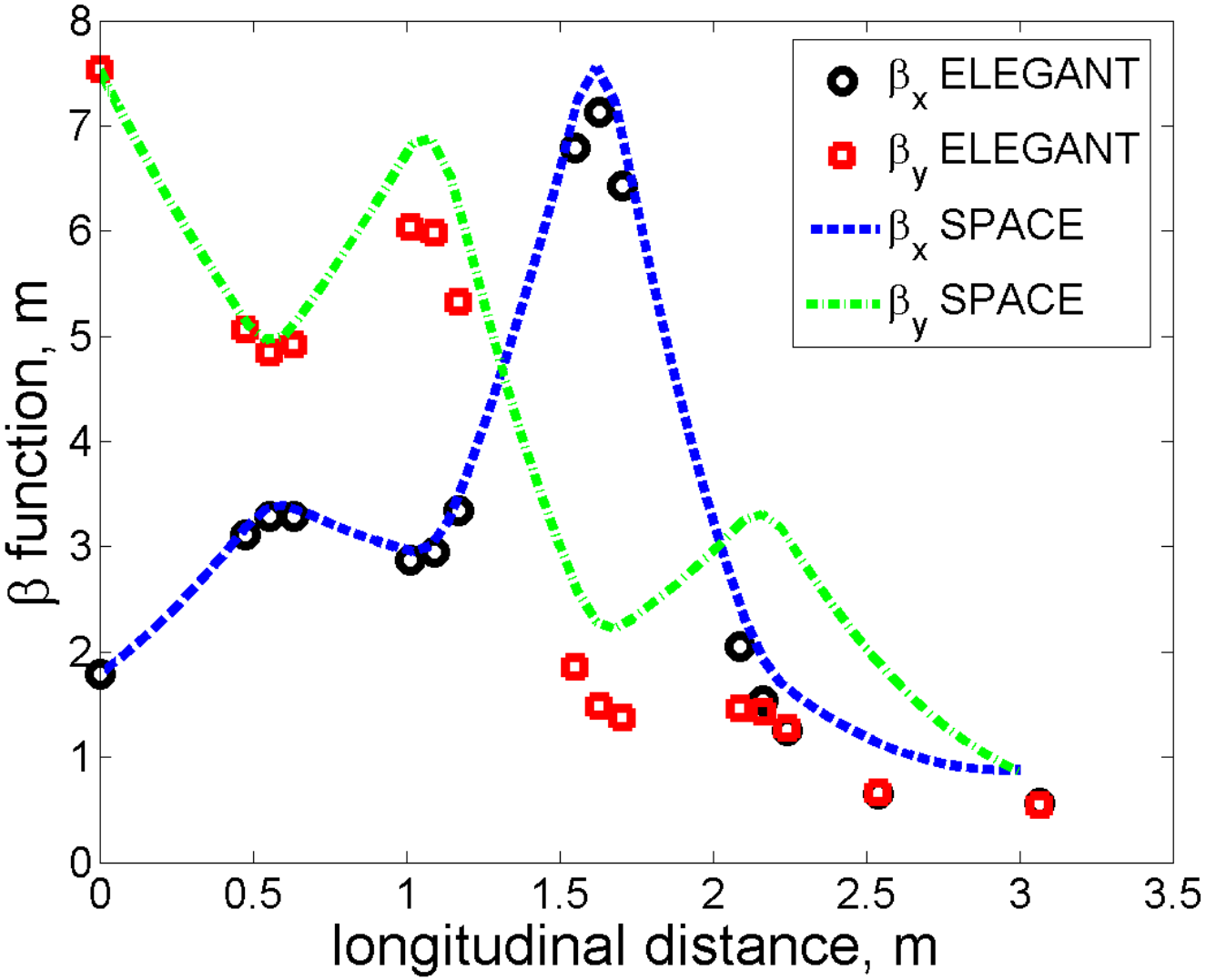
Modulator

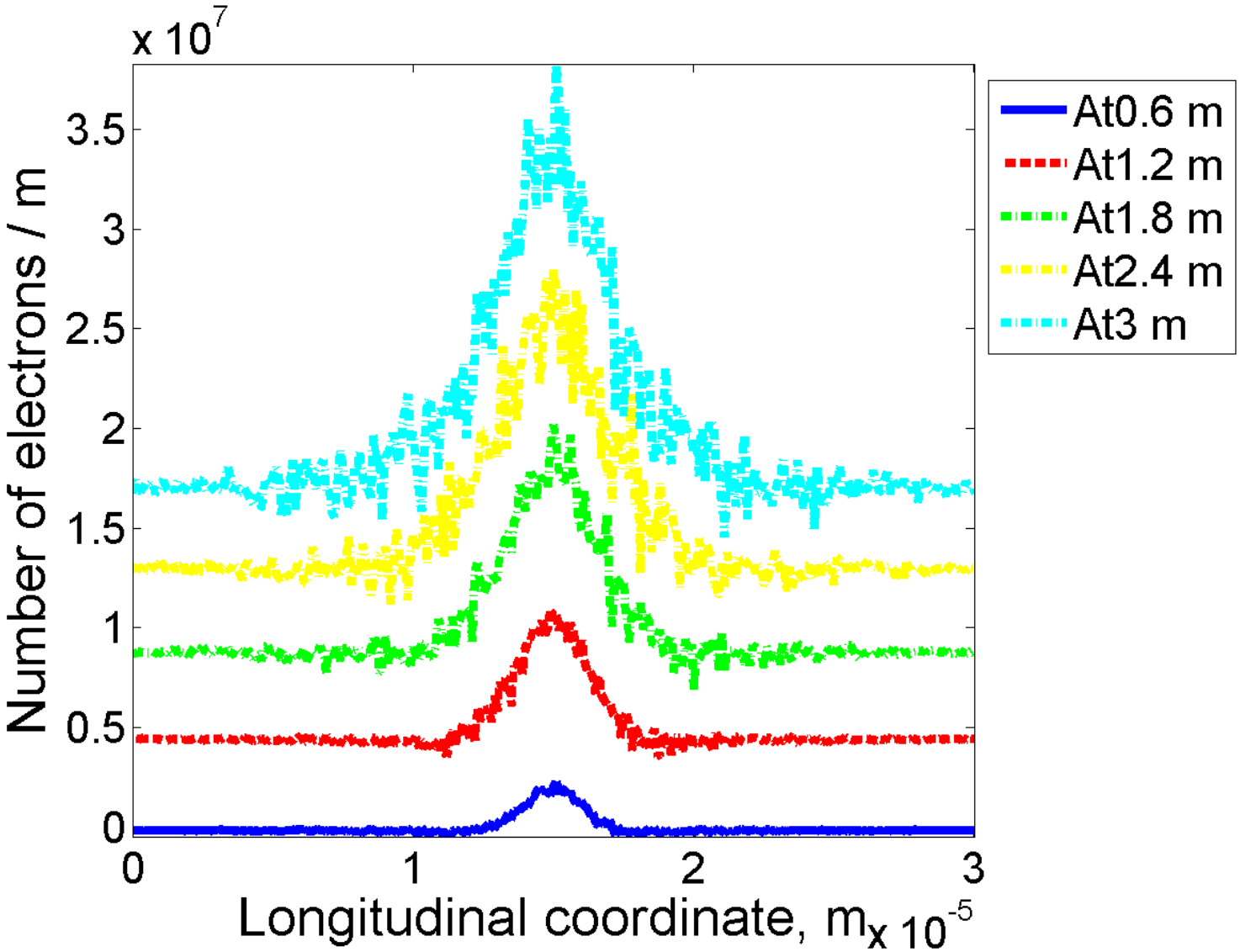
Run one slice in modulator simulations

- slice length = 3e-5 m
- Peak current = 31 A, use 1e+6 macro-particles, each represents 20 real particle
- $\varepsilon^* =$ 3e-6, $\beta_x =$ 1.8 m, $\beta_y =$ 7.5 m, $\alpha_x =$ -1.1, $\alpha_y =$ 2.9

β functions in modulator



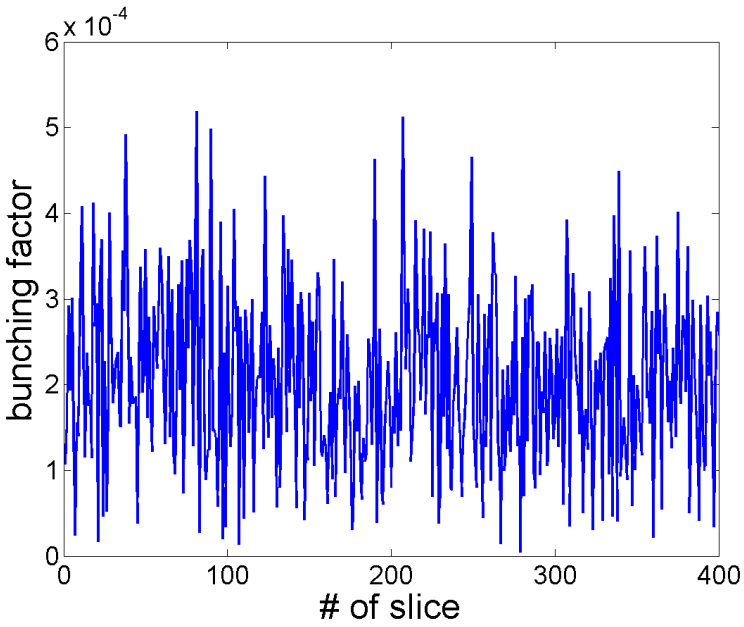
Longitudinal density modulation



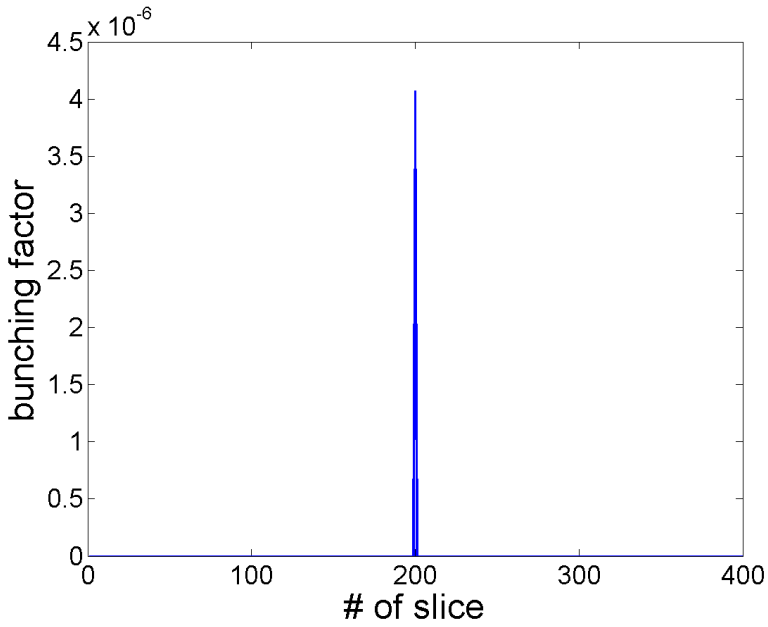
FEL

- Use the beam parameters at the exit of modulator to create 400 slices in GENESIS
- Replace the 200th slice with the results from modulator simulation, run FEL simulation
- $\varepsilon_x^* = 3.07\text{e-}6$, $\varepsilon_y^* = 3.1\text{e-}6$, $\sigma_x = 3.06\text{e-}4$ m, $\sigma_y = 3.05\text{e-}4$ m
- $\lambda = 3\text{e-}5$ m, Wiggler Period $= 4$ cm, $N_{wiggler} = 188$, Wiggler Length $= 7.5$ m

Bunching factor in FEL at beginning

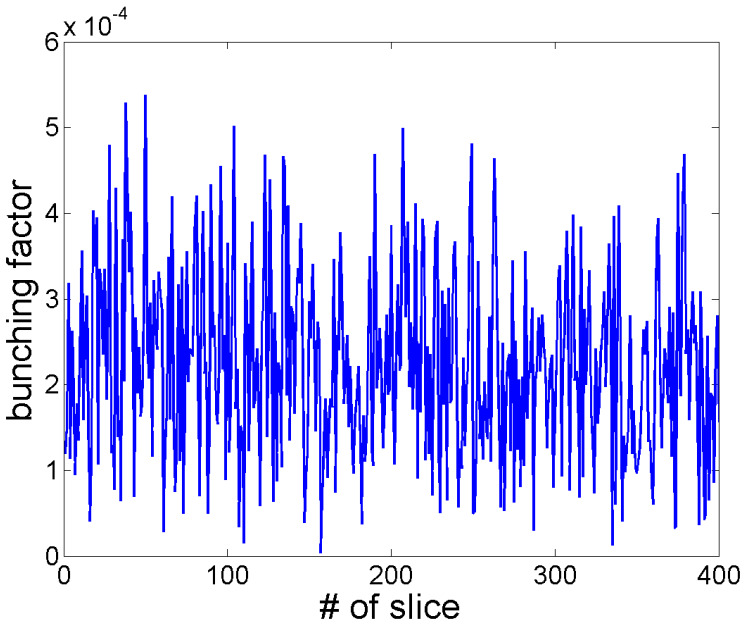


(a) Background

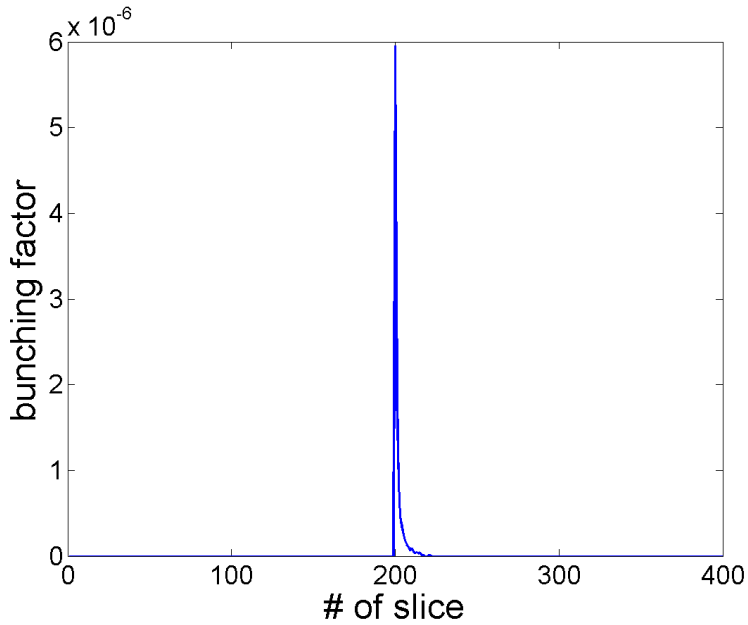


(b) Signal

Bunching factor in FEL at 25 wiggler period

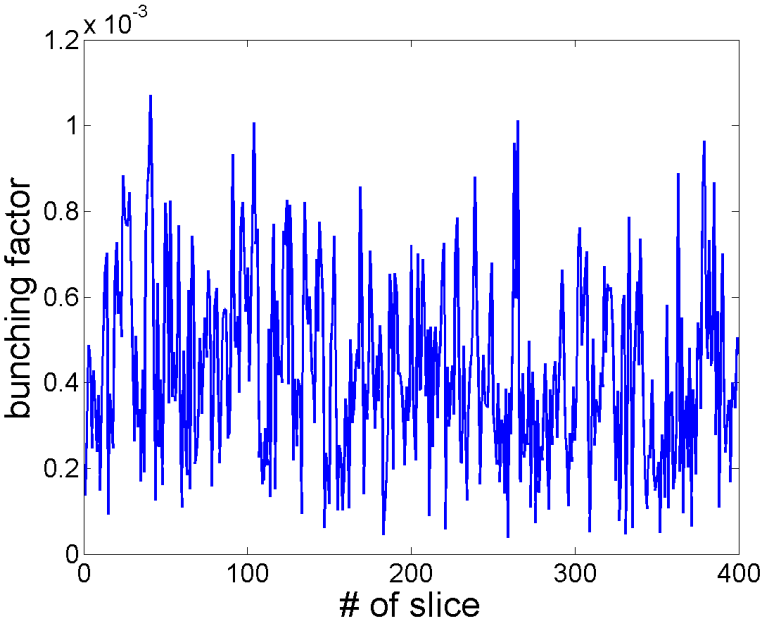


(a) Background

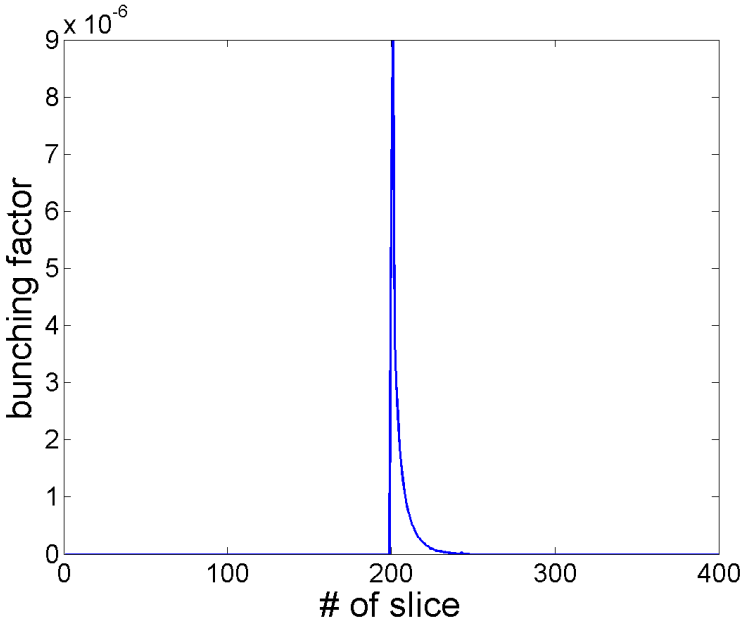


(b) Signal

Bunching factor in FEL at 50 wiggler period

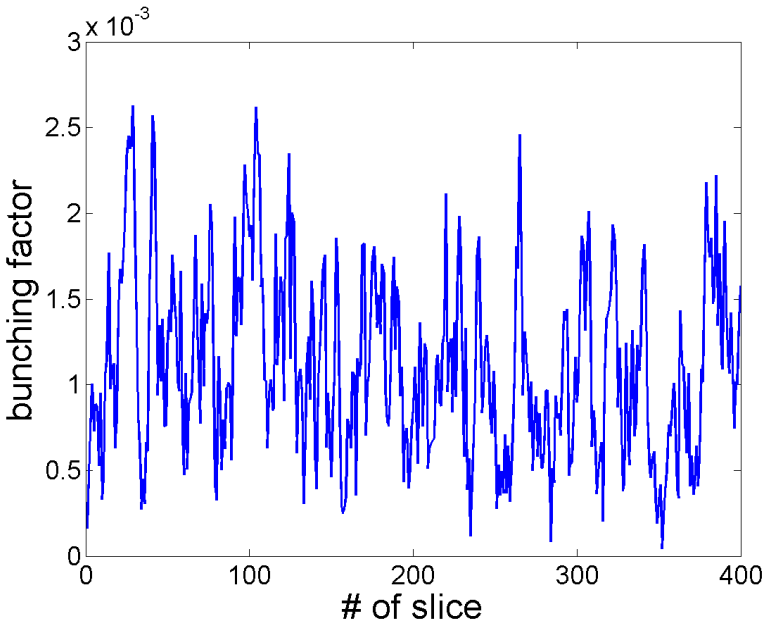


(a) Background

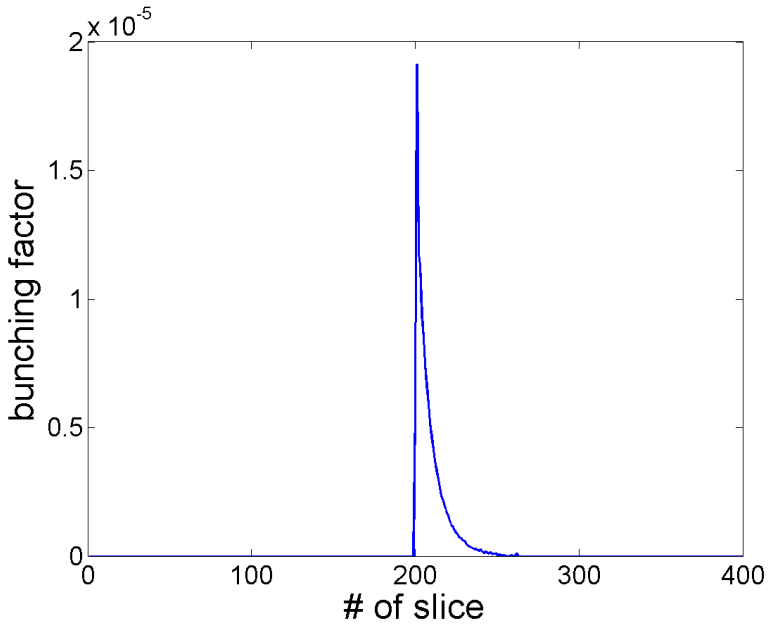


(b) Signal

Bunching factor in FEL at 75 wiggler period

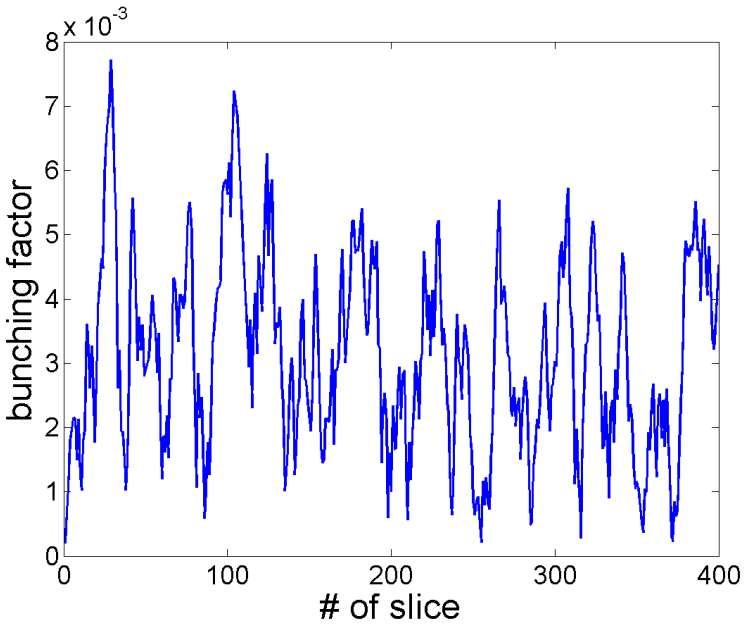


(a) Background

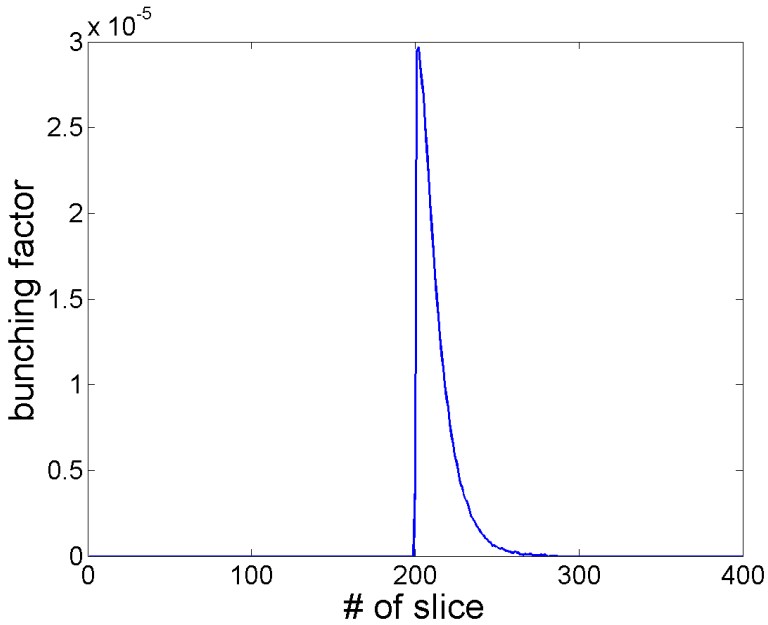


(b) Signal

Bunching factor in FEL at 100 wiggler period

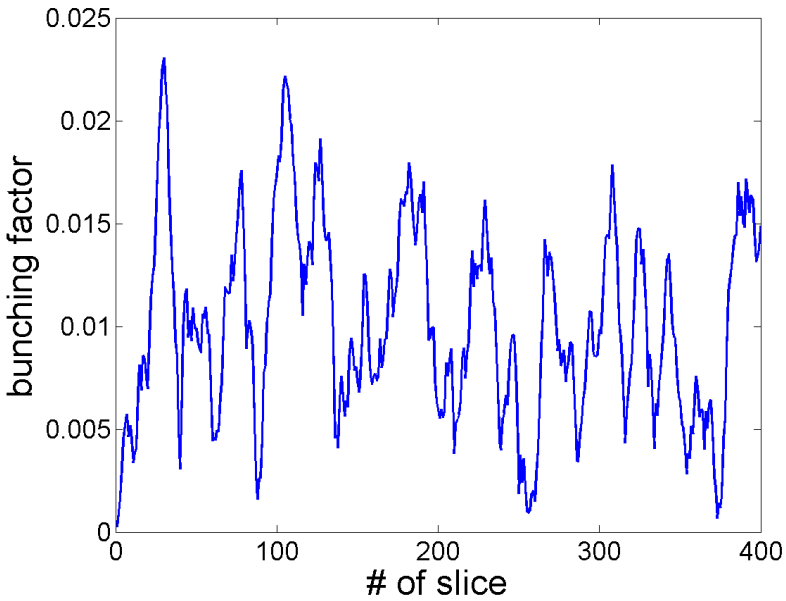


(a) Background

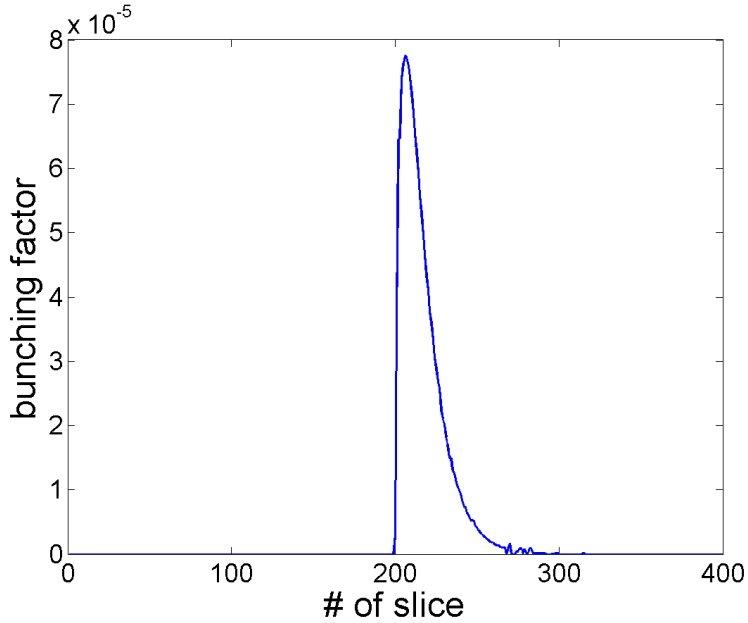


(b) Signal

Bunching factor in FEL at 125 wiggler period

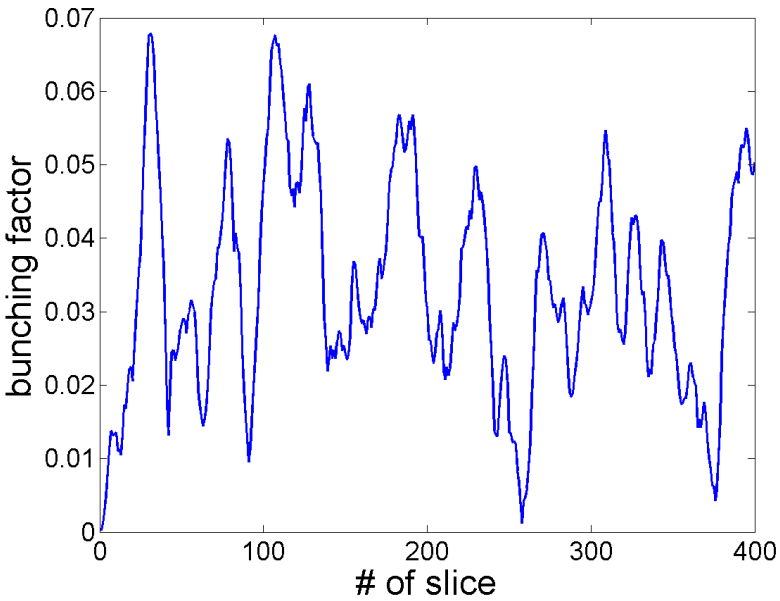


(a) Background

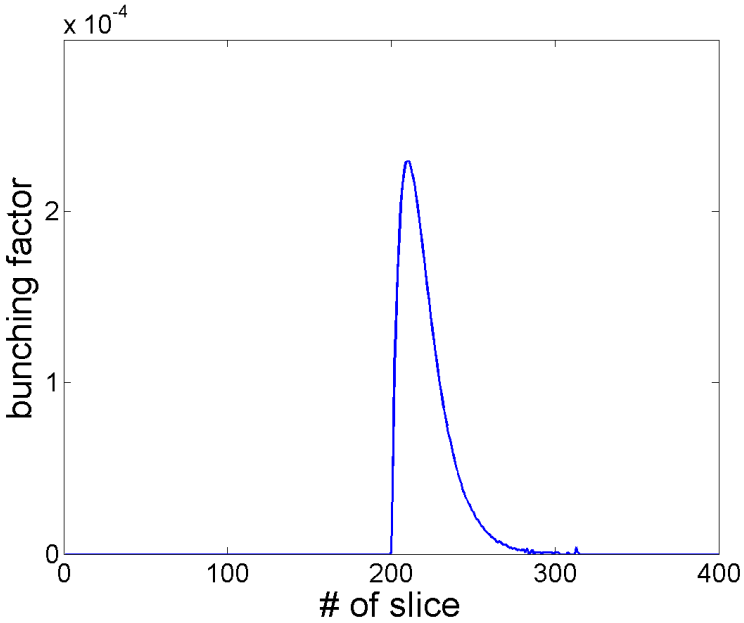


(b) Signal

Bunching factor in FEL at 150 wiggler period

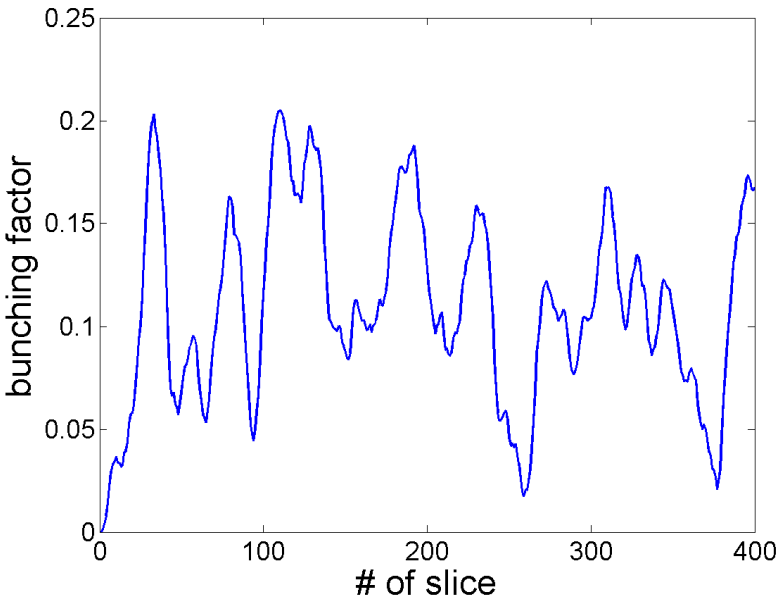


(a) Background

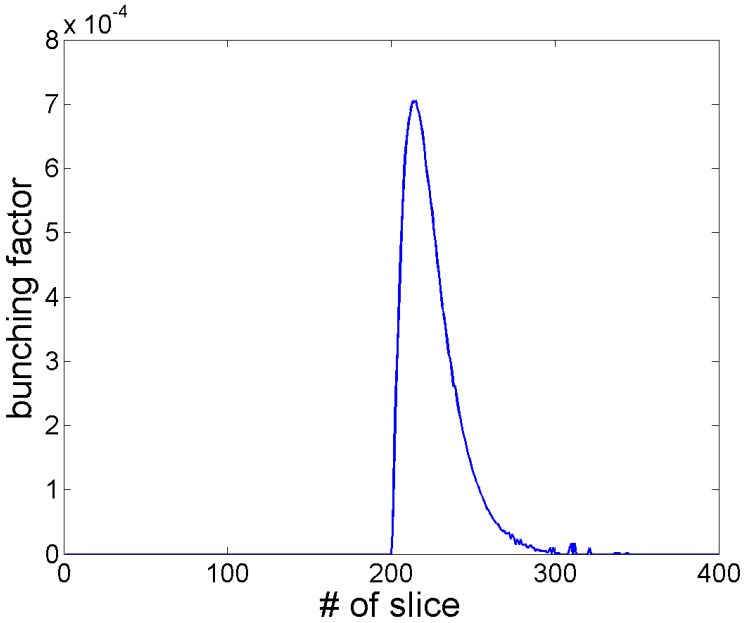


(b) Signal

Bunching factor in FEL at 175 wiggler period

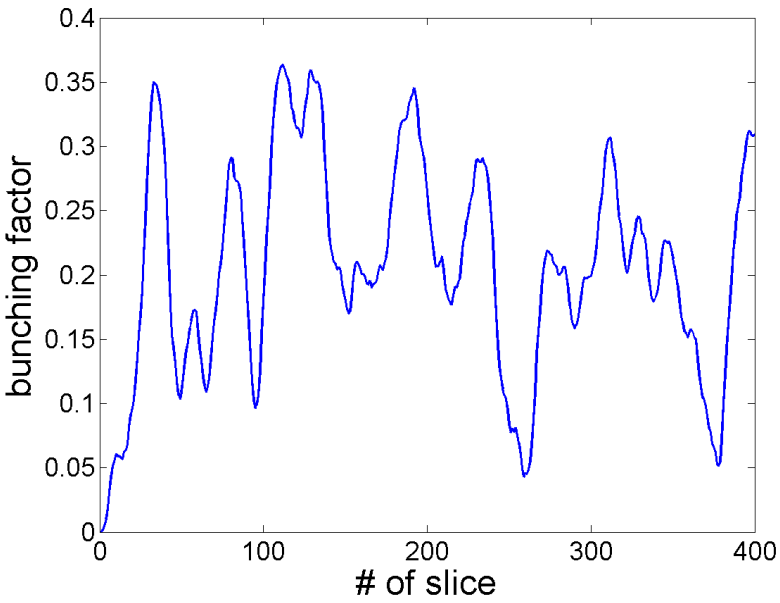


(a) Background

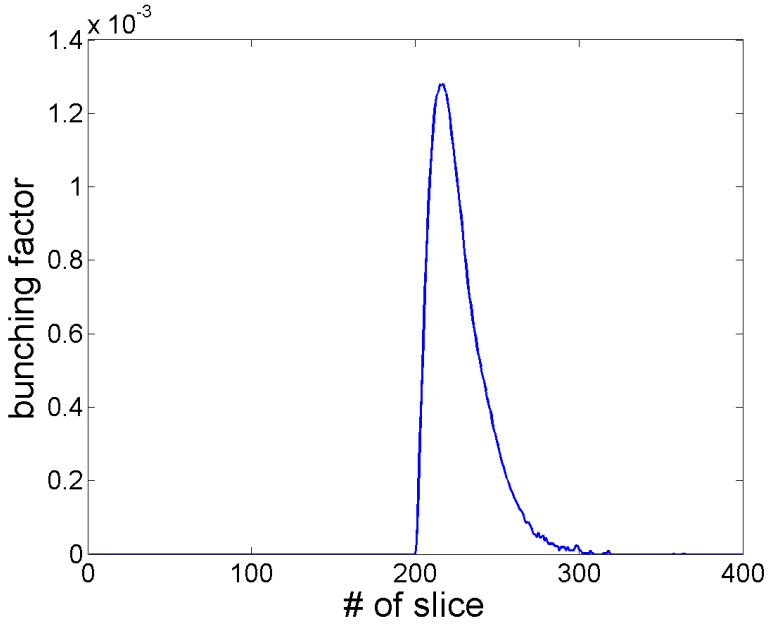


(b) Signal

Bunching factor in FEL at end

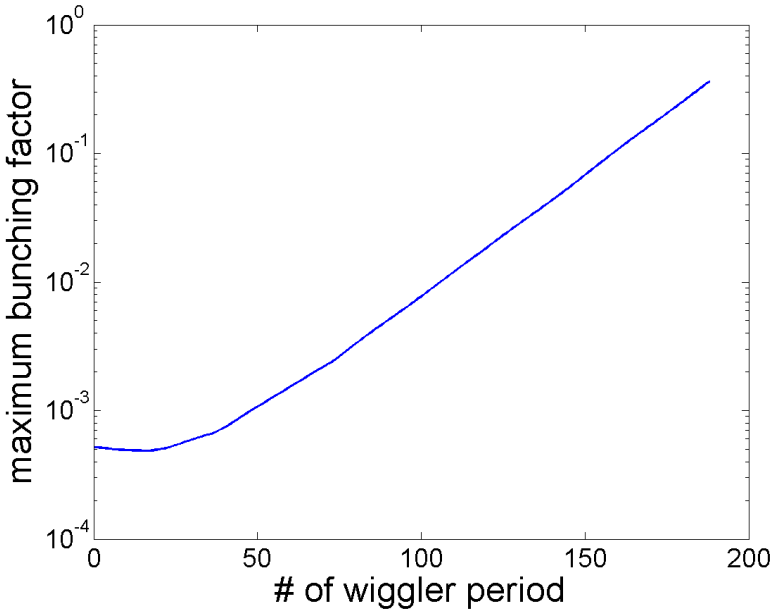


(a) Background

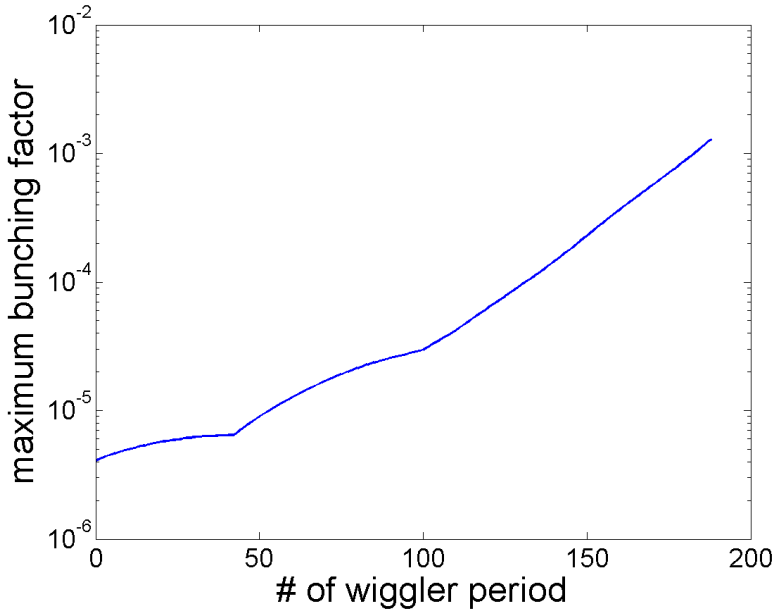


(b) Signal

Bunching factor in FEL

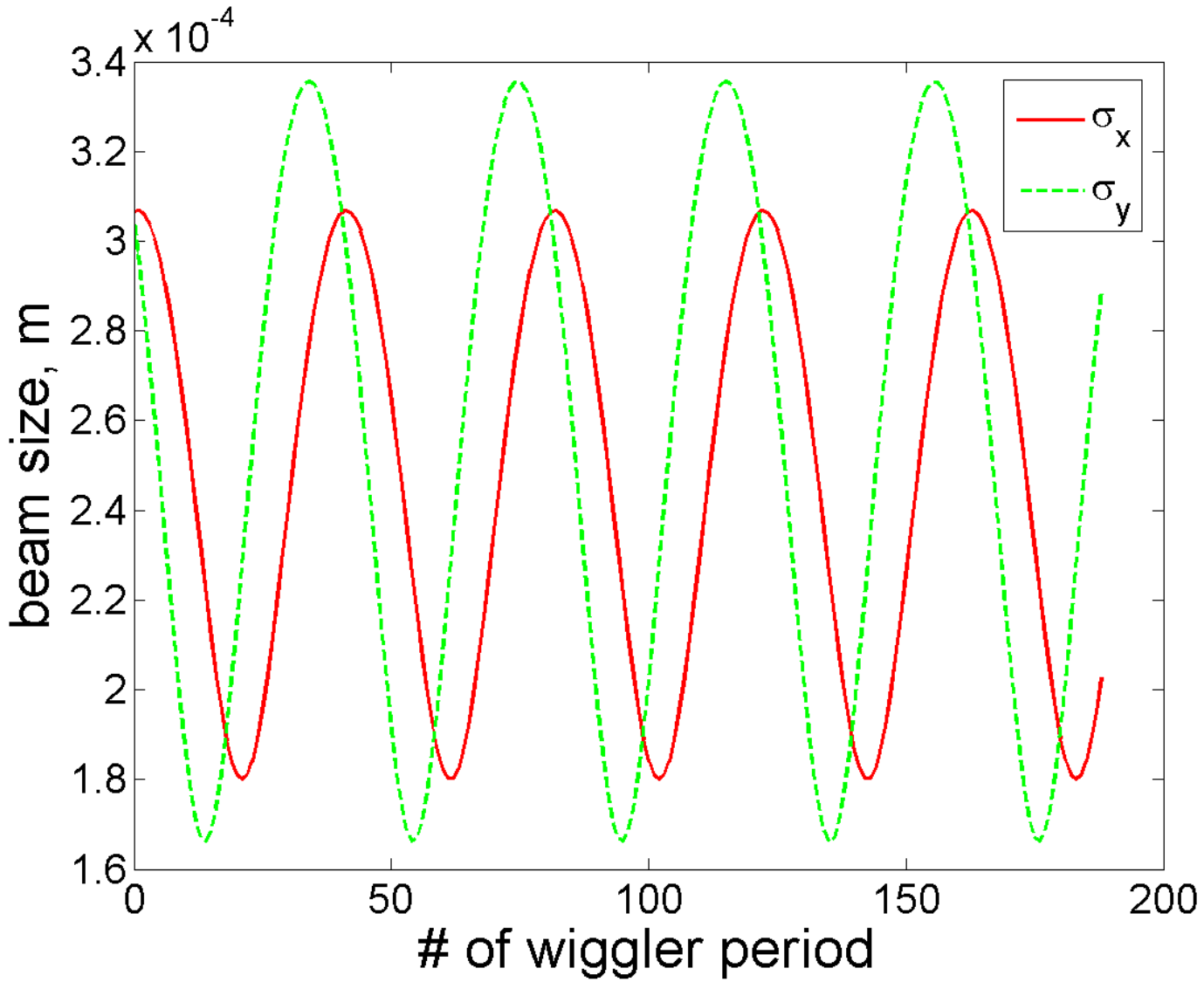


(a) Background



(b) Signal

Transverse beam size in FEL



Vladimir's calculation

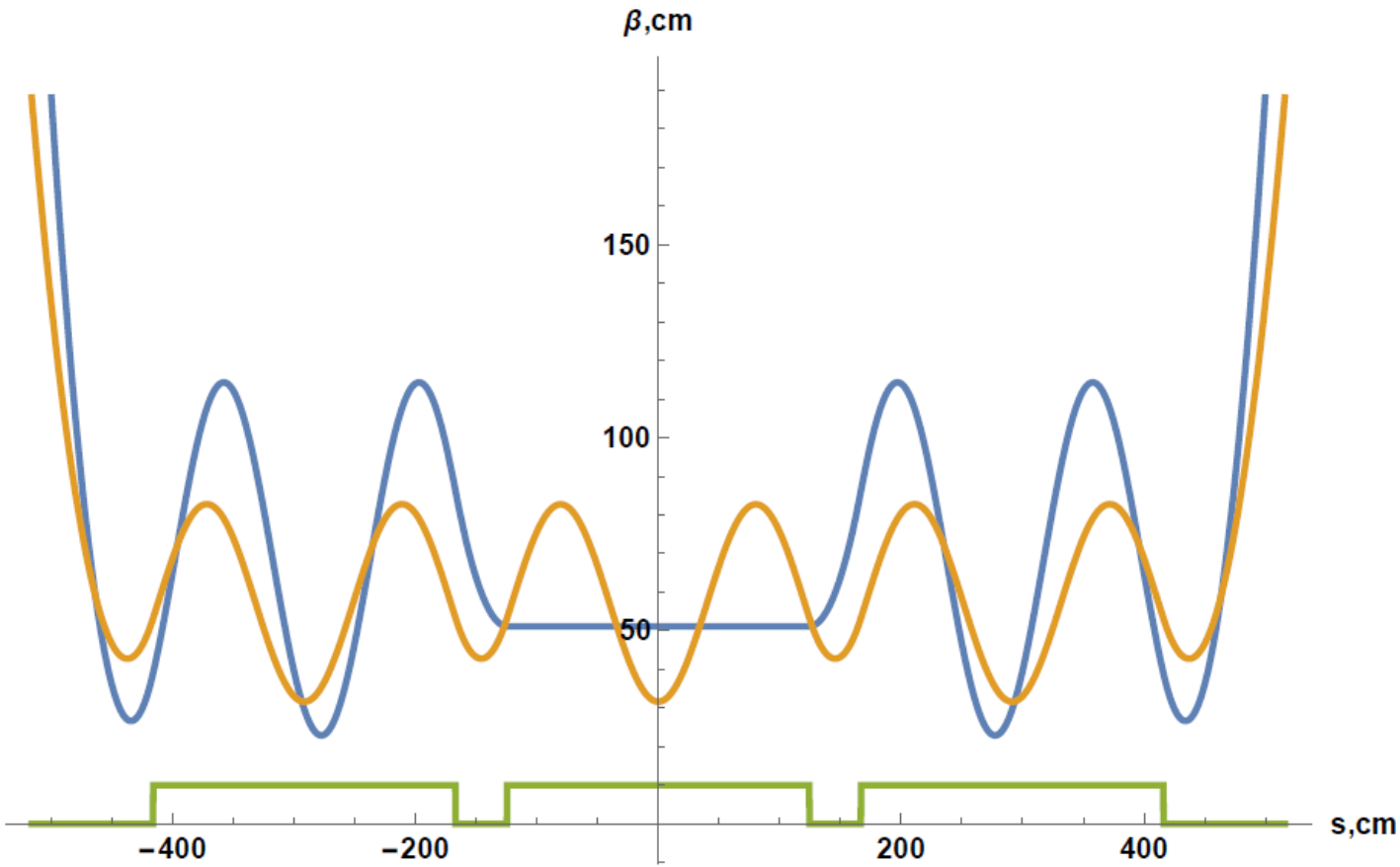
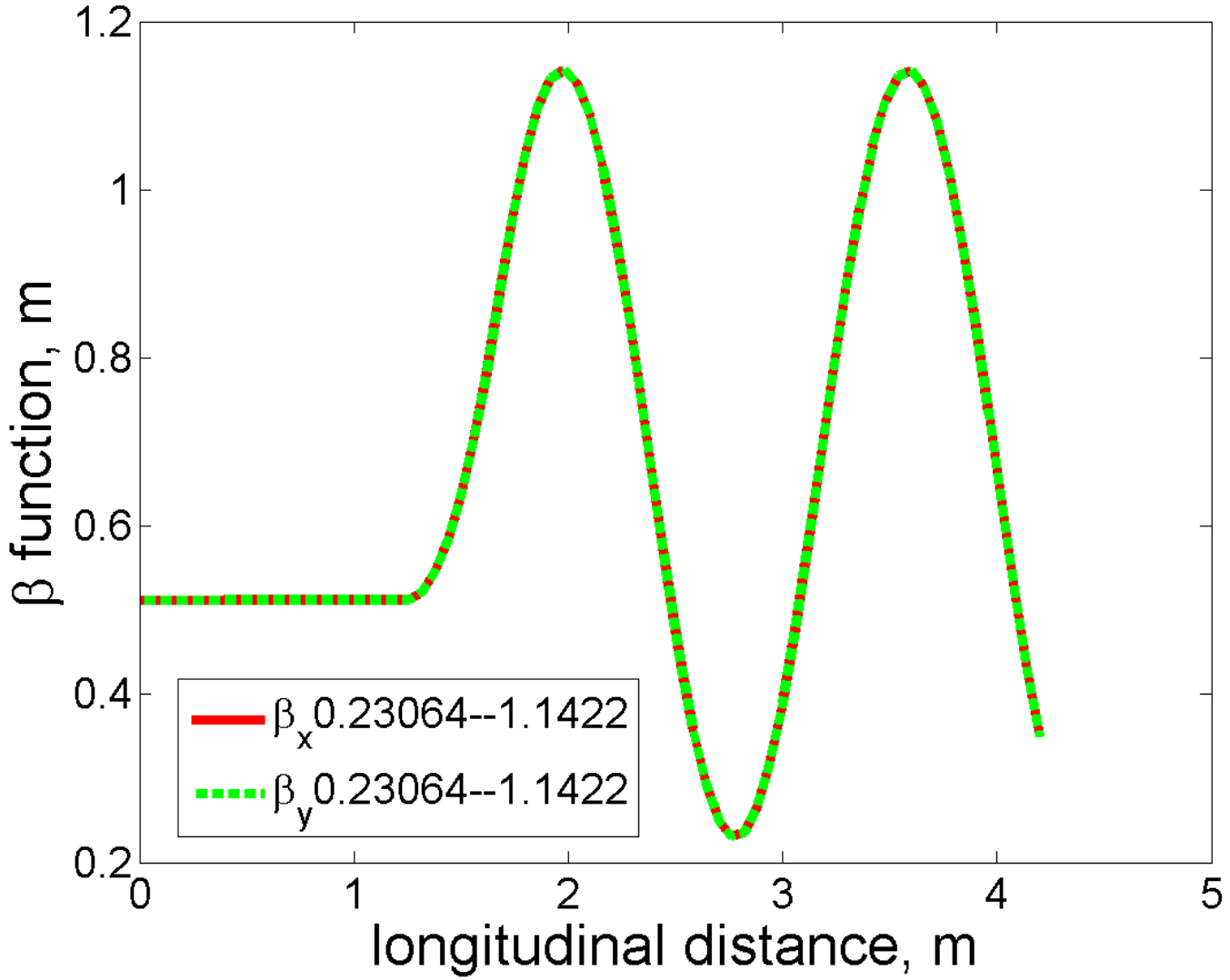


Fig. 1 Periodic solution for CeC FEL system (yellow) and "matched" beta in the middle wiggler. Periodic solution is much better

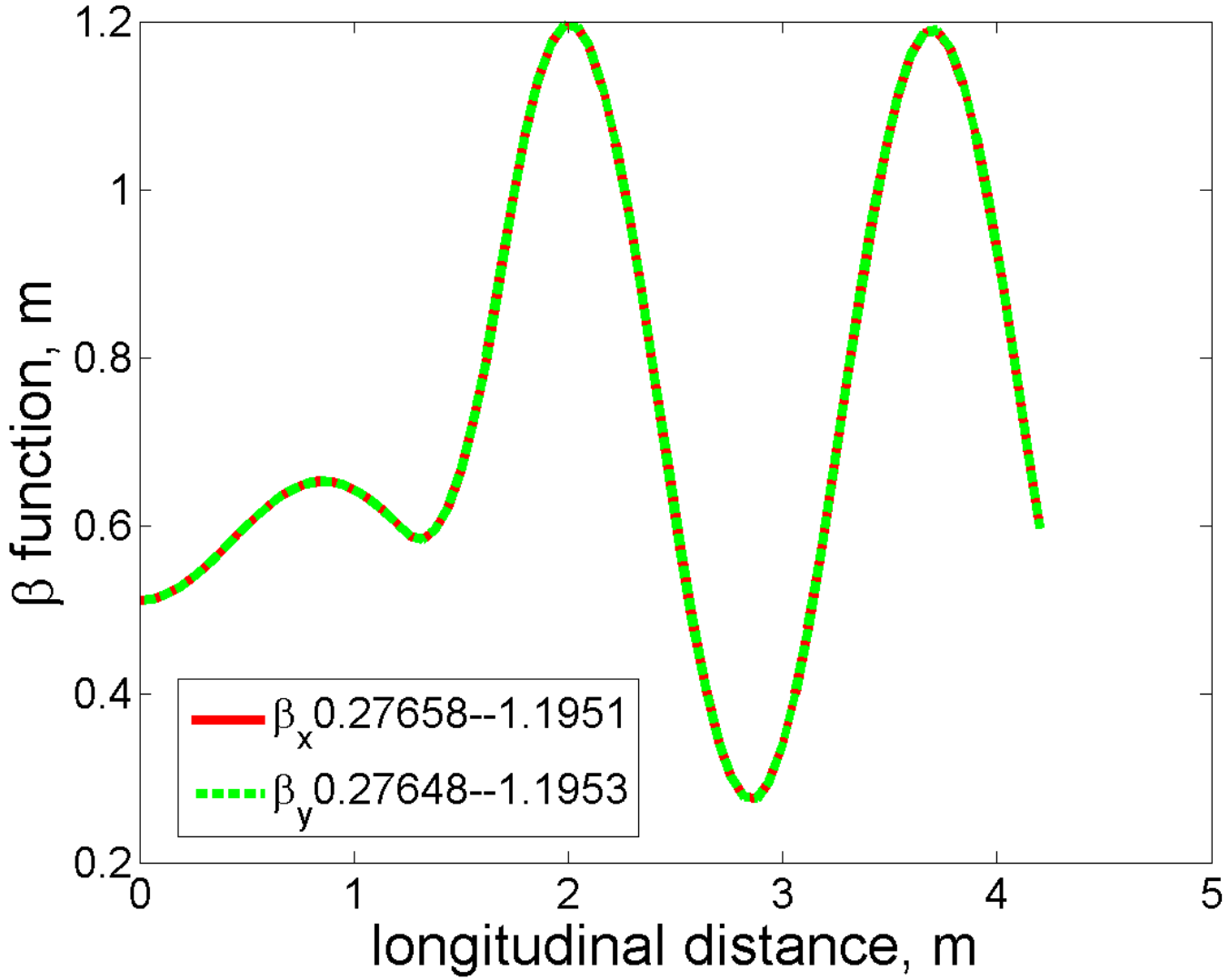
FEL simulation

- Simulate the β function changes using SPACE code, including space charge effect
- Use continuous focusing electric field, which provides the equivalent effect as the magnetic fields used in Vladimir's calculation
- Under the assumption of bilateral symmetry, only simulate the right half of the FEL section

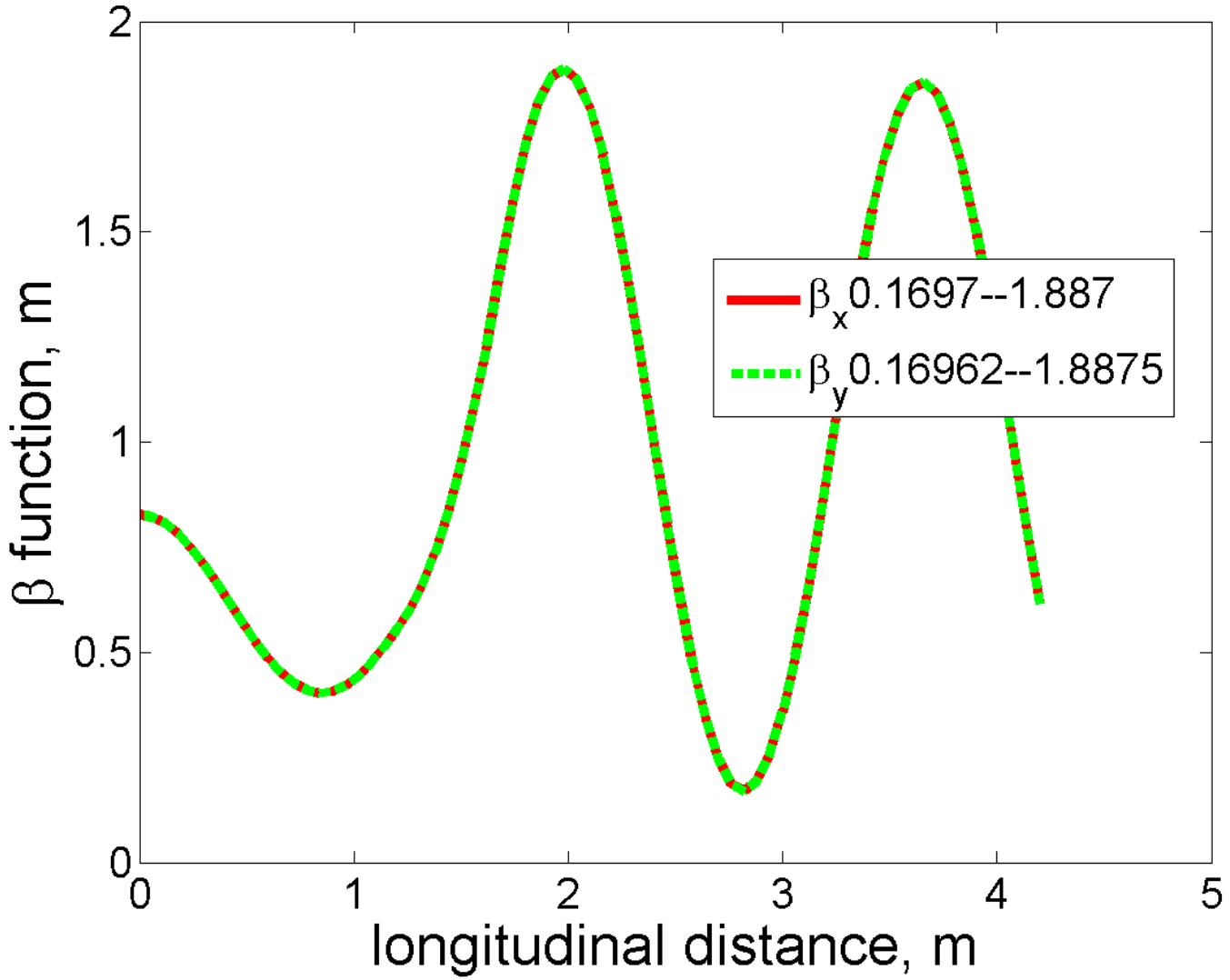
β in FEL, β=0.5117m at center, space charge turned off



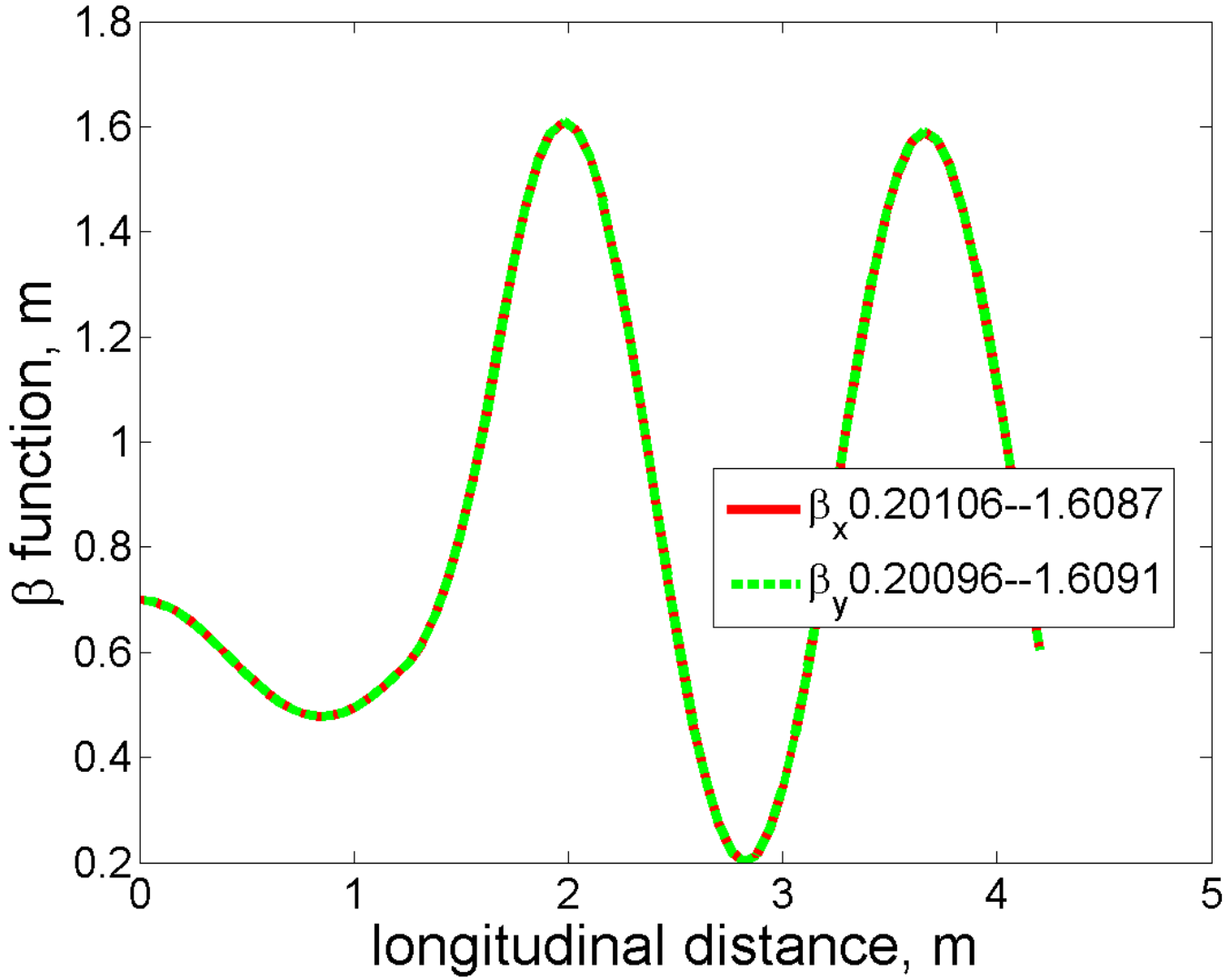
β in FEL, β=0.5117m at center, with space charge



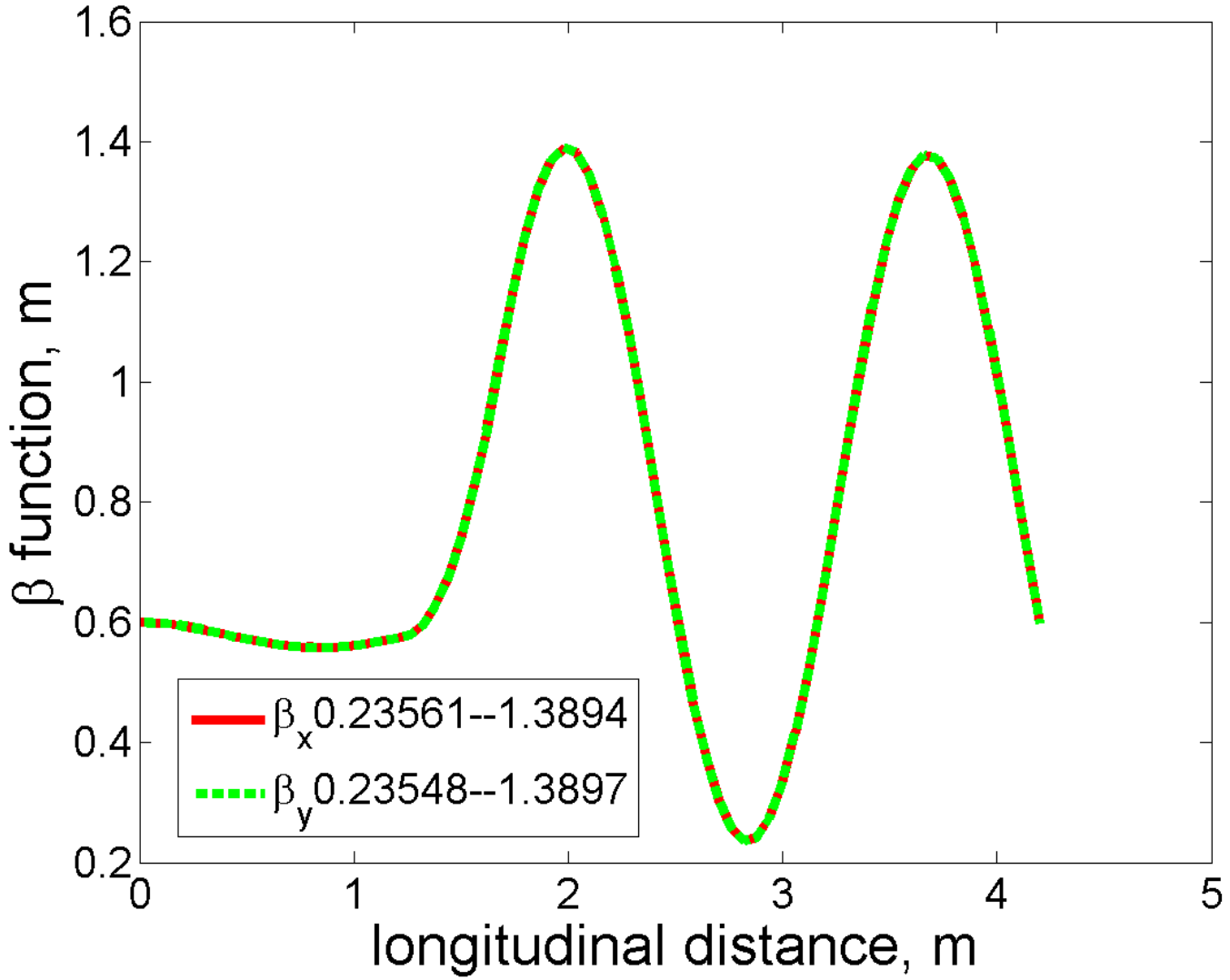
β in FEL, β=0.8m at center, with space charge



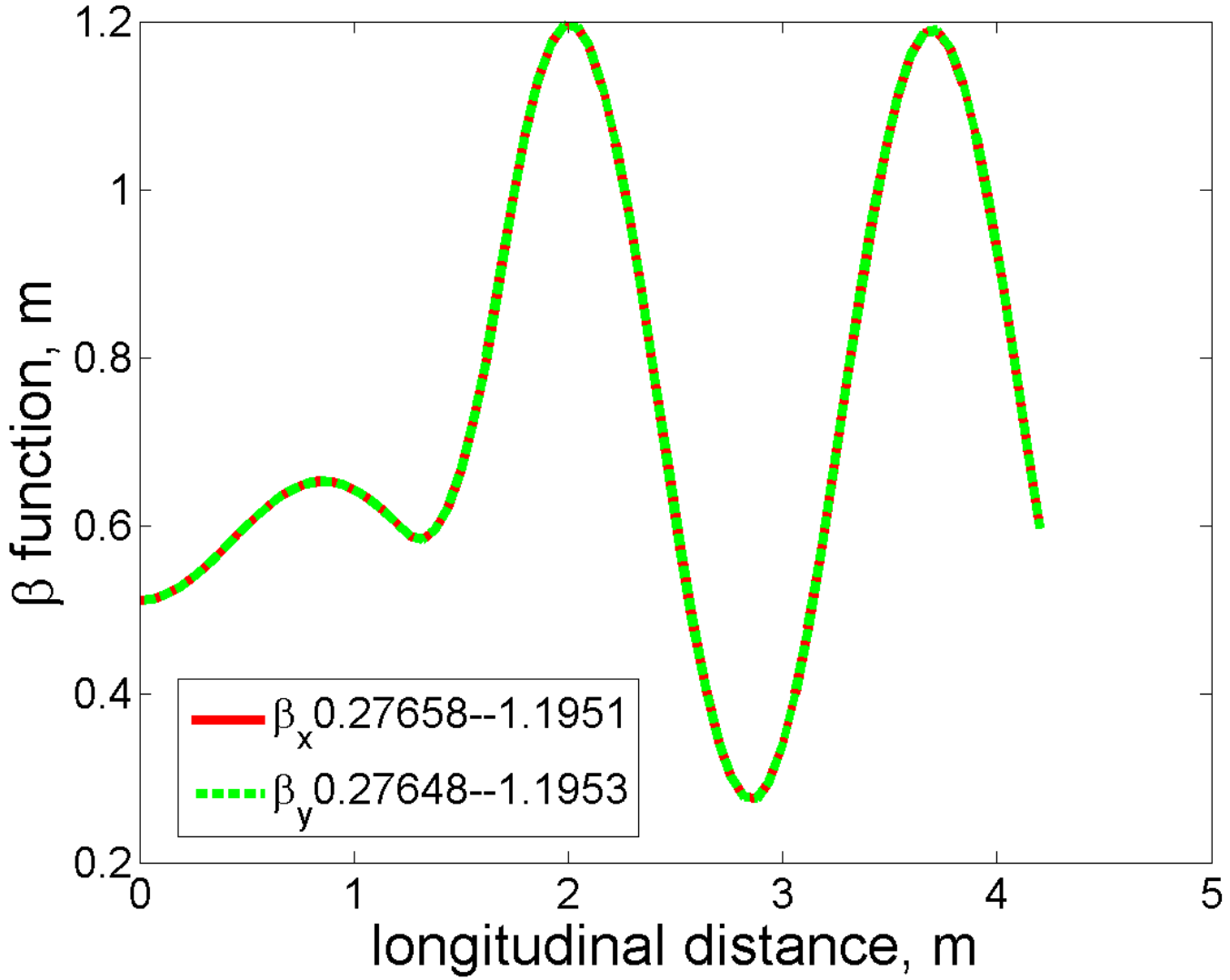
β in FEL, β=0.7m at center, with space charge



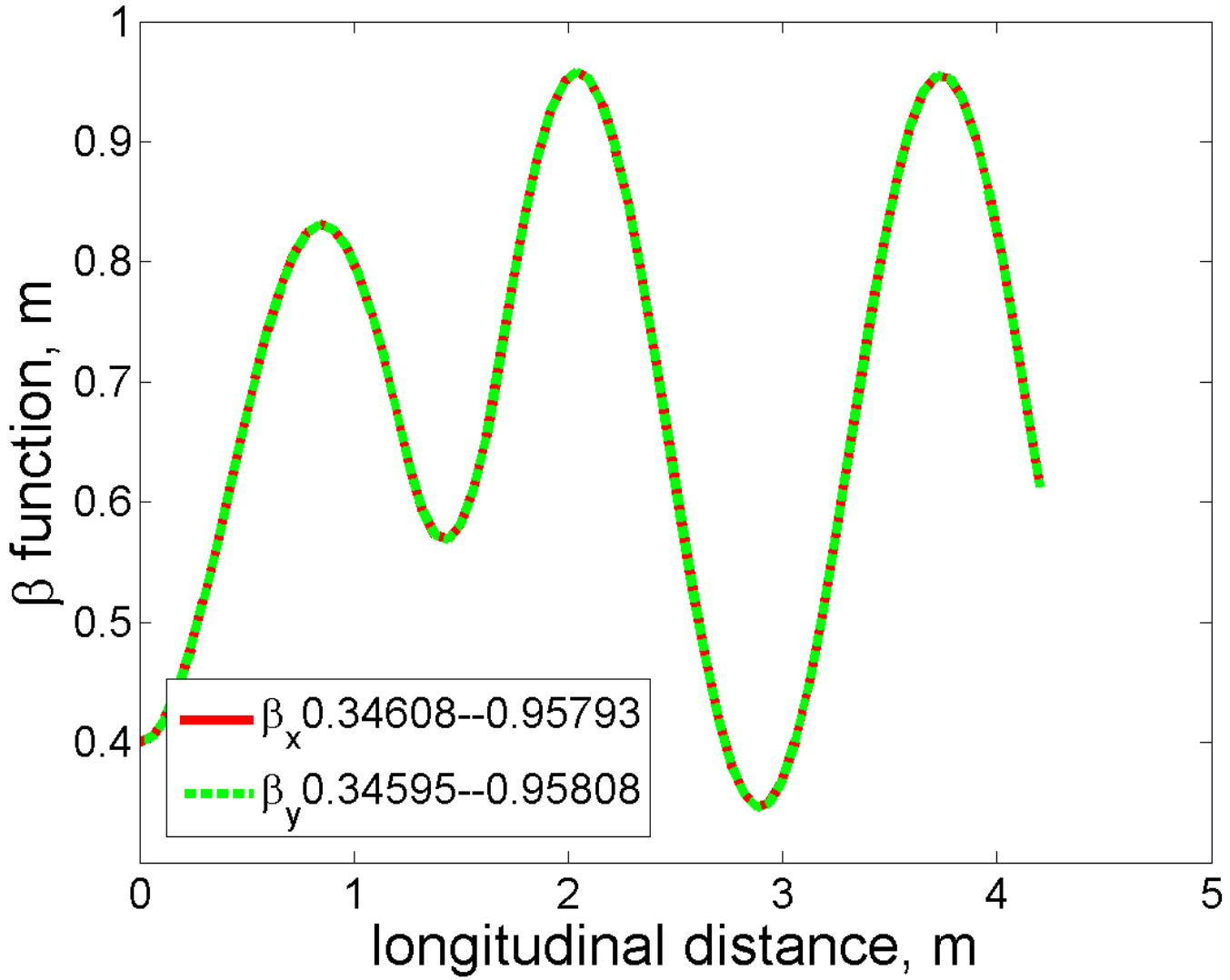
β in FEL, β=0.6m at center, with space charge



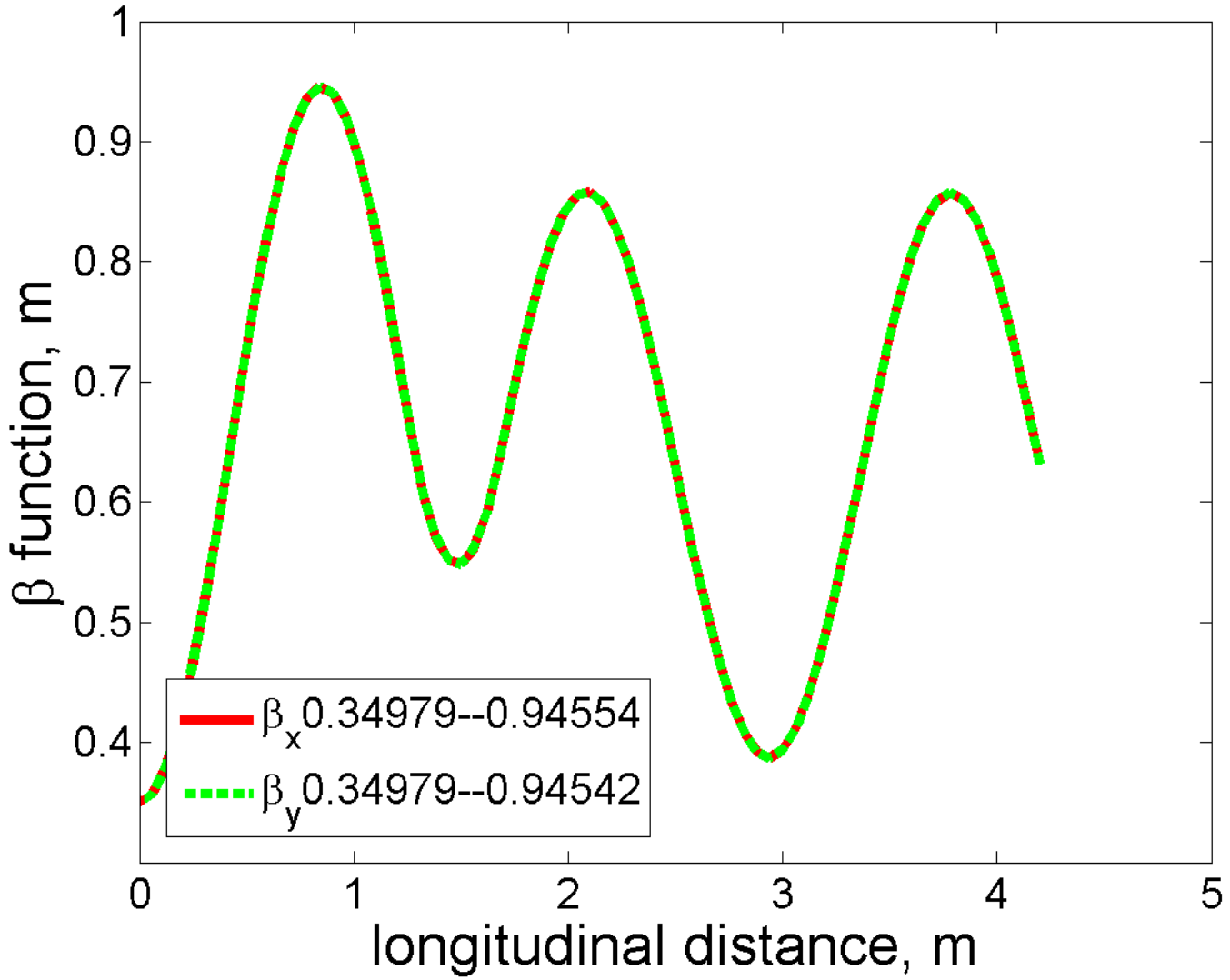
β in FEL, β=0.5m at center, with space charge



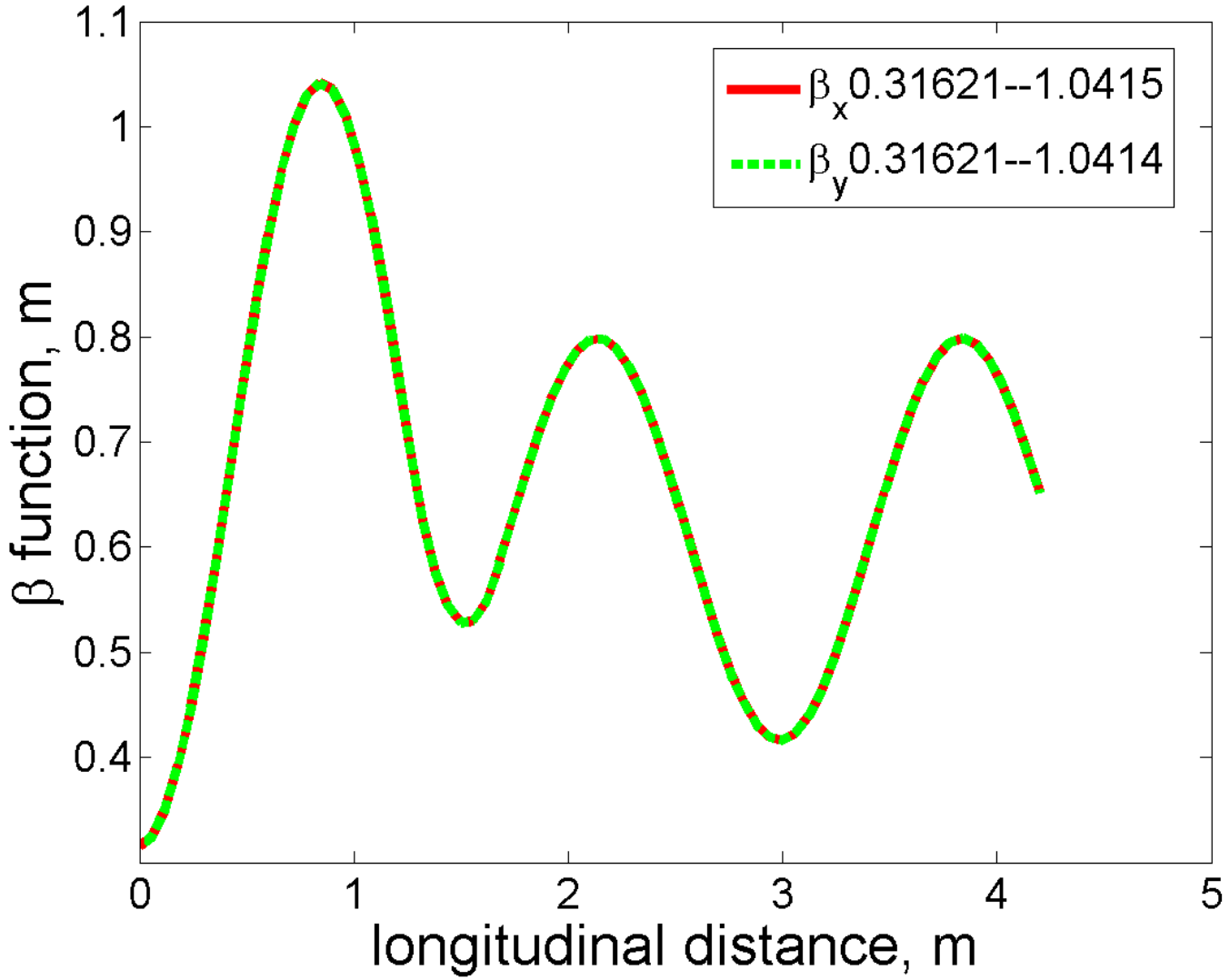
β in FEL, β=0.4m at center, with space charge



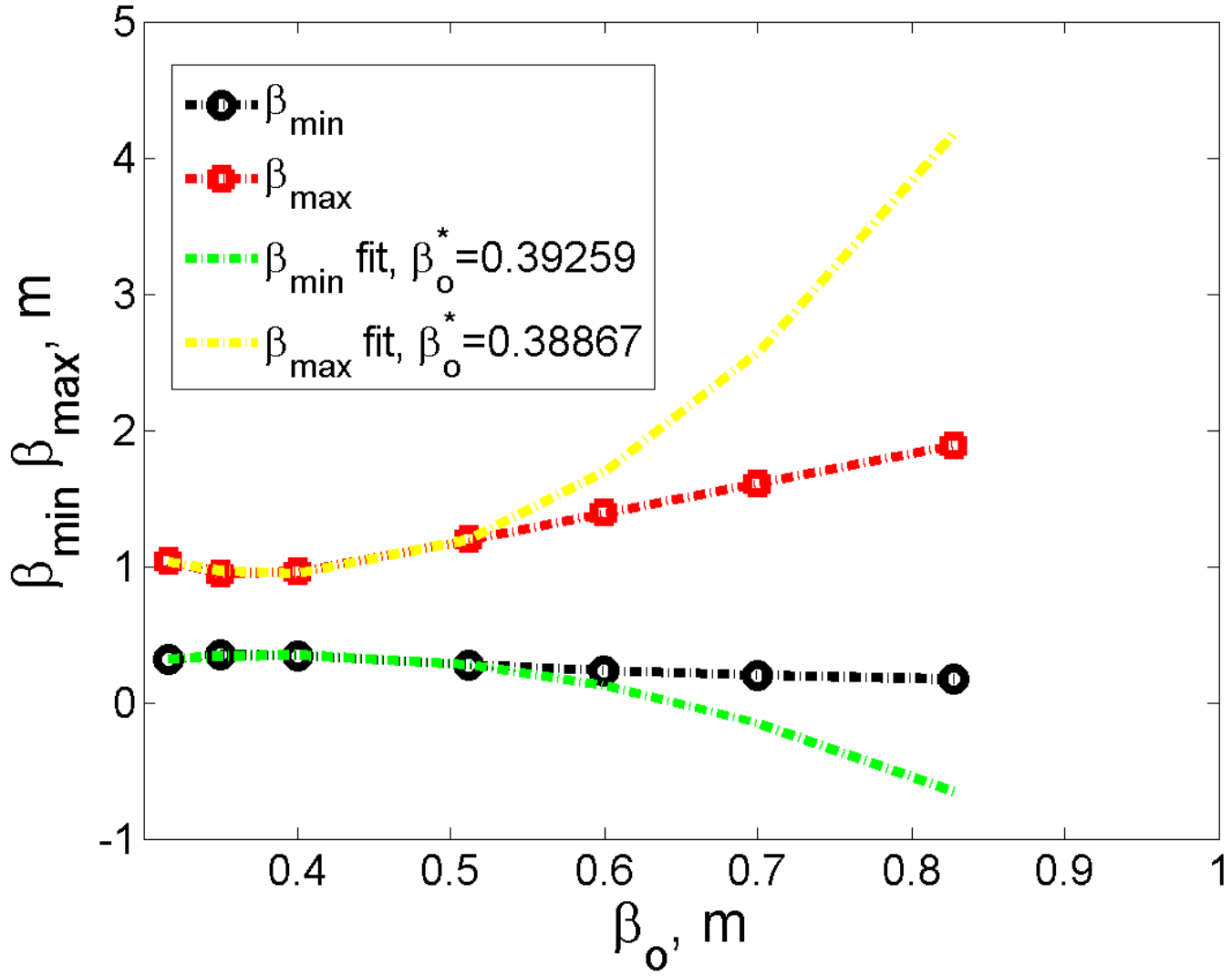
β in FEL, β=0.35m at center, with space charge



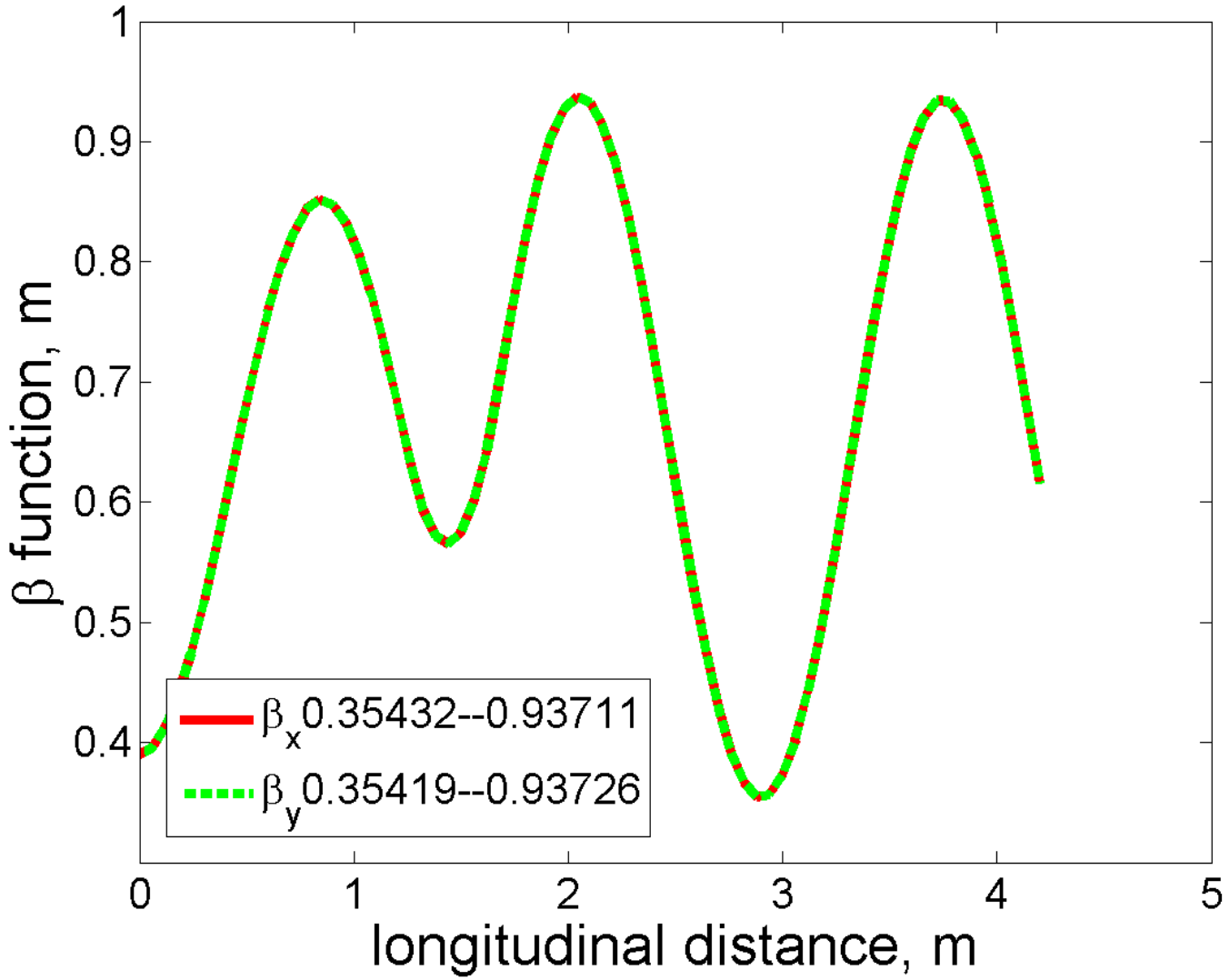
β in FEL, β=0.3m at center, with space charge



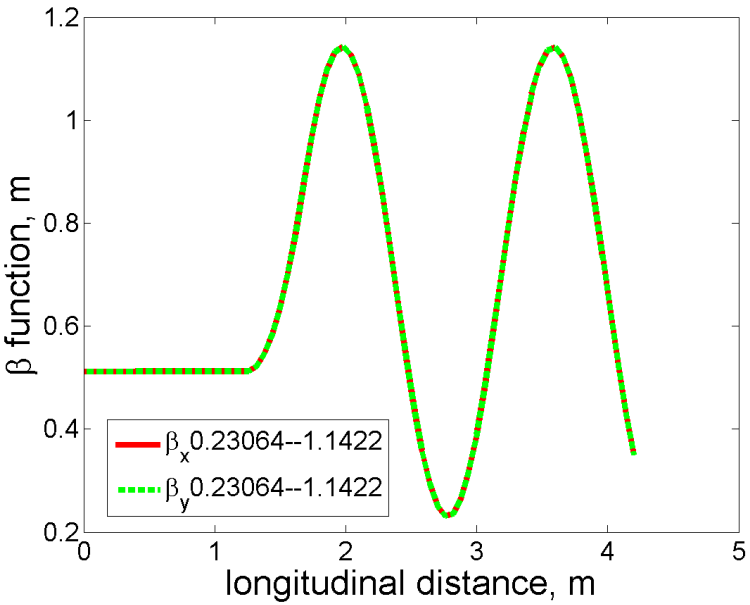
β in FEL, finding best β at center, with space charge



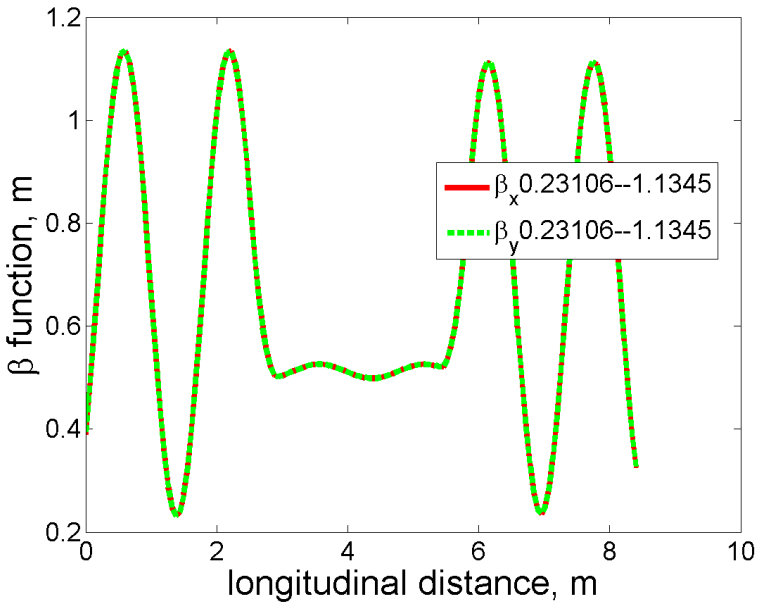
β in FEL, β=0.39m at center, with space charge



β in FEL, β=0.5m at center, space charge turned off

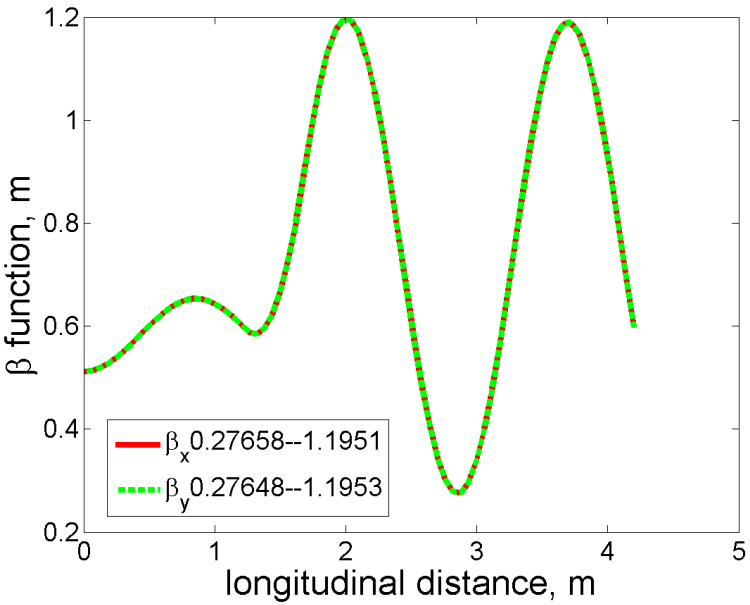


(a) Right half

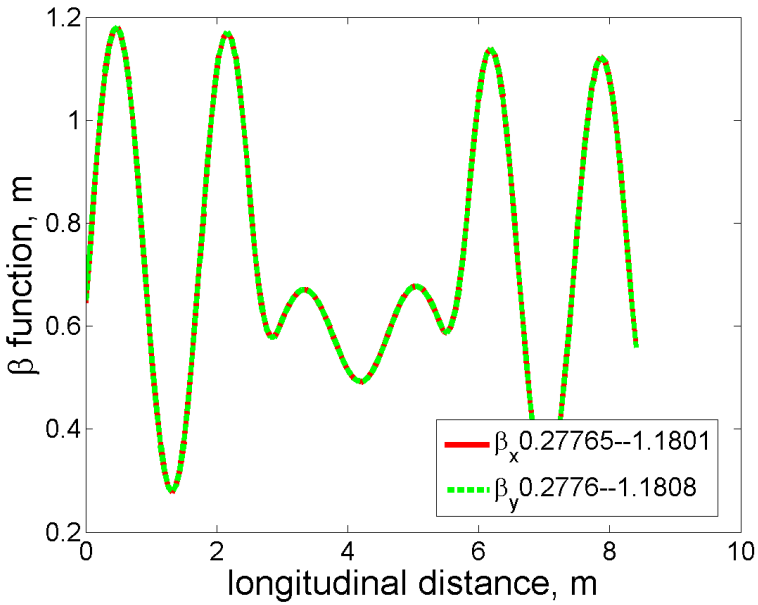


(b) Whole

β in FEL, β=0.5m at center, with space charge



(a) Right half



(b) Whole