Multi-turn design for cERL (2)

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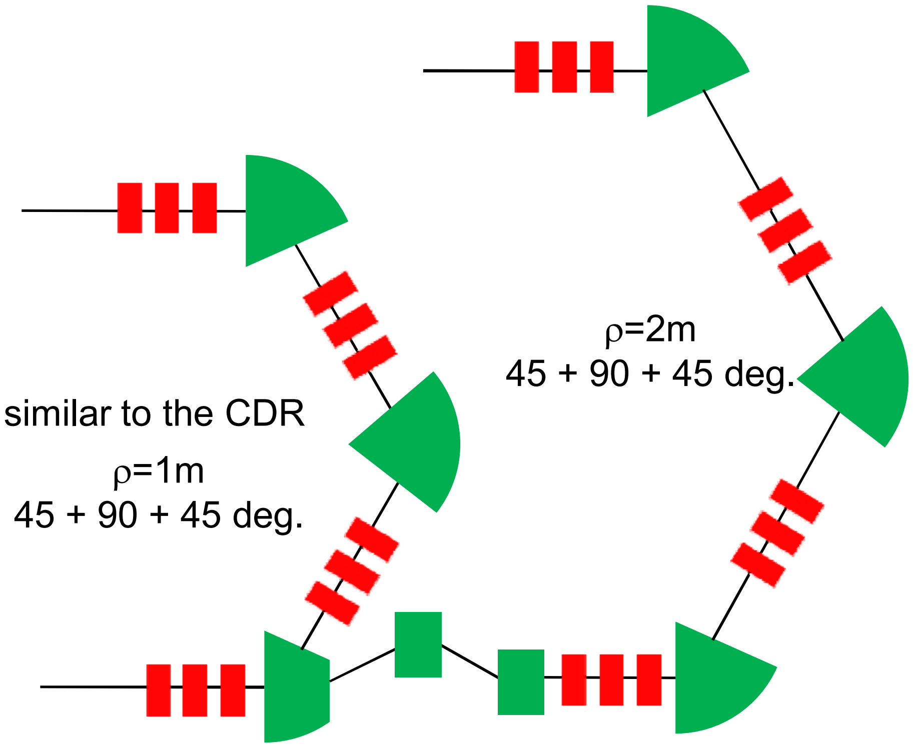
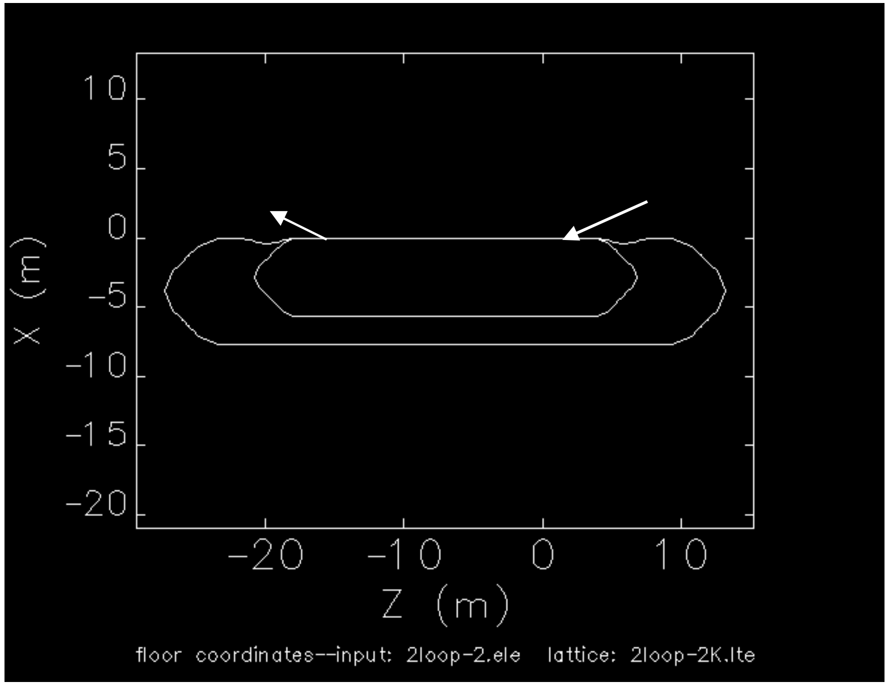
configuration of the return arc

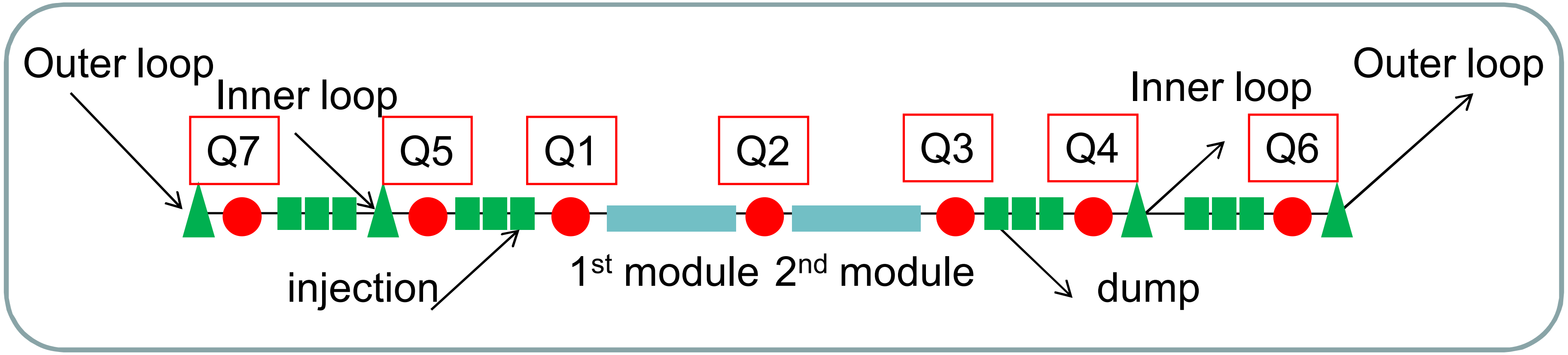




bending magnets are ready for 400 MeV, though it might be unnecessary.

5 MeV → 65 MeV → 125 MeV
9-cell x 2 x 2
This configuration is available with the existing cryogenics.

Quads layout at the linac section



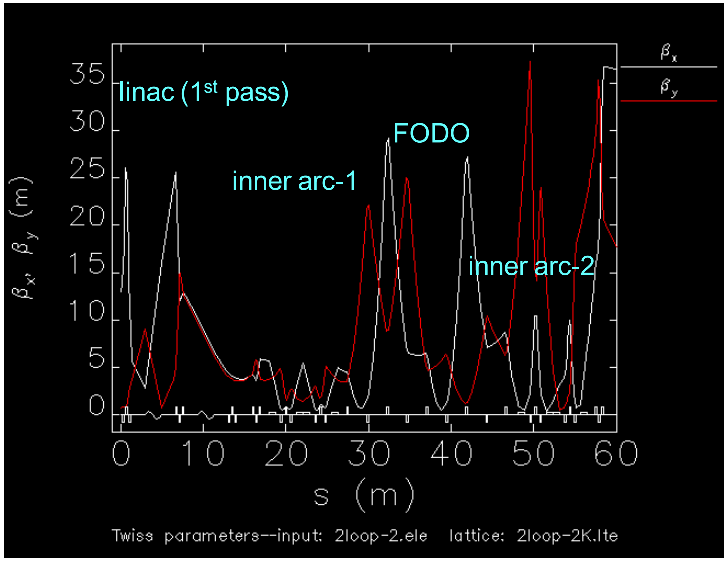
Beam energy at each quad (5 MeV injection, 60 MeV linac)

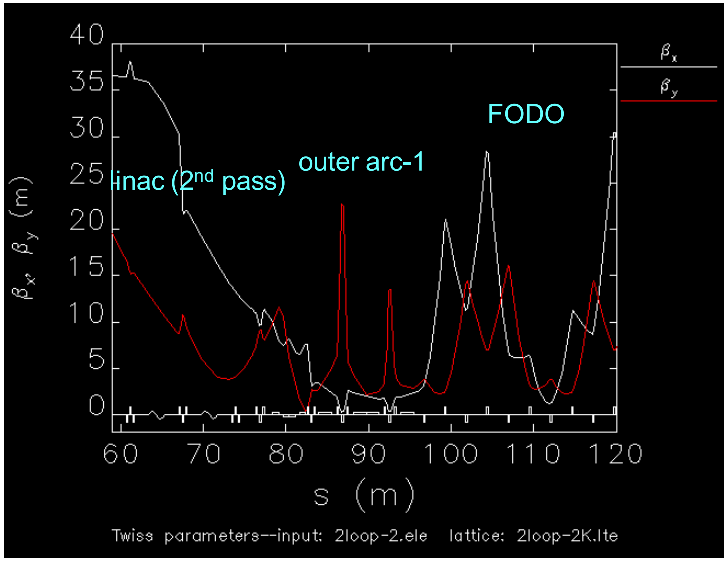
Pass	Q7	Q5	Q1	Q2	Q3	Q4	Q5	loop
1			5	35	65	65		65
2		65	65	95	125	125	125	125
3	125	125	125	95	65	65		65
4		65	65	35	5			

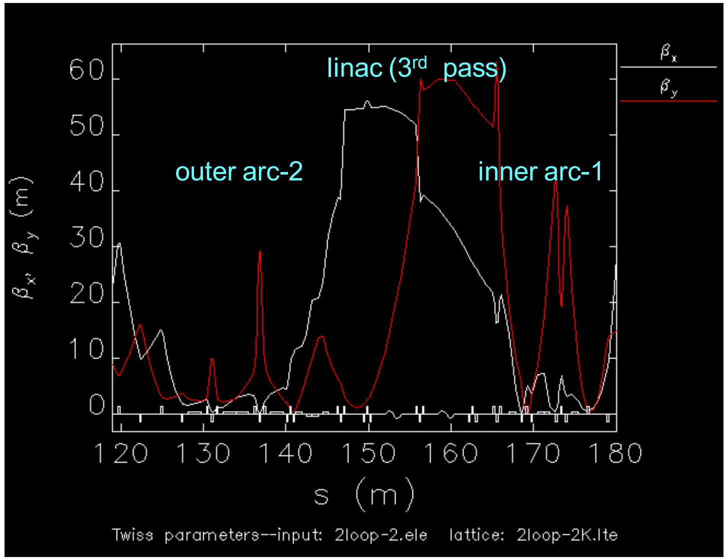
2-loop = 3-turn = 4-pass

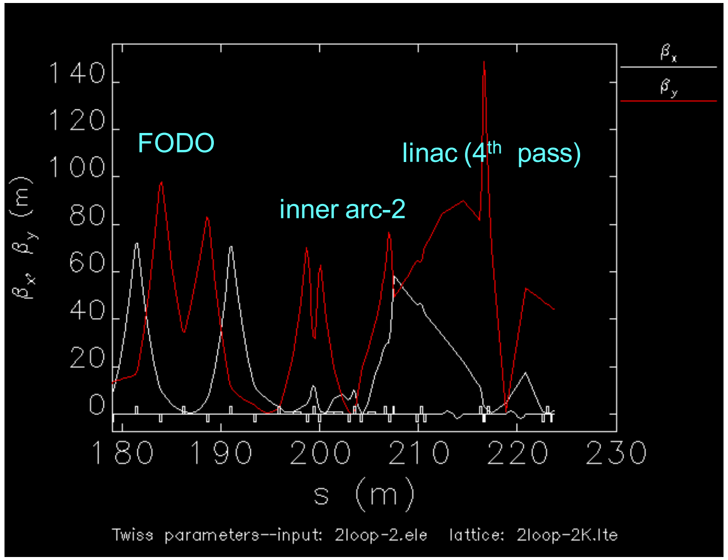
Q7 is the last knob to control the beam envelope for the 3rd and the 4th passes.

betatron functions





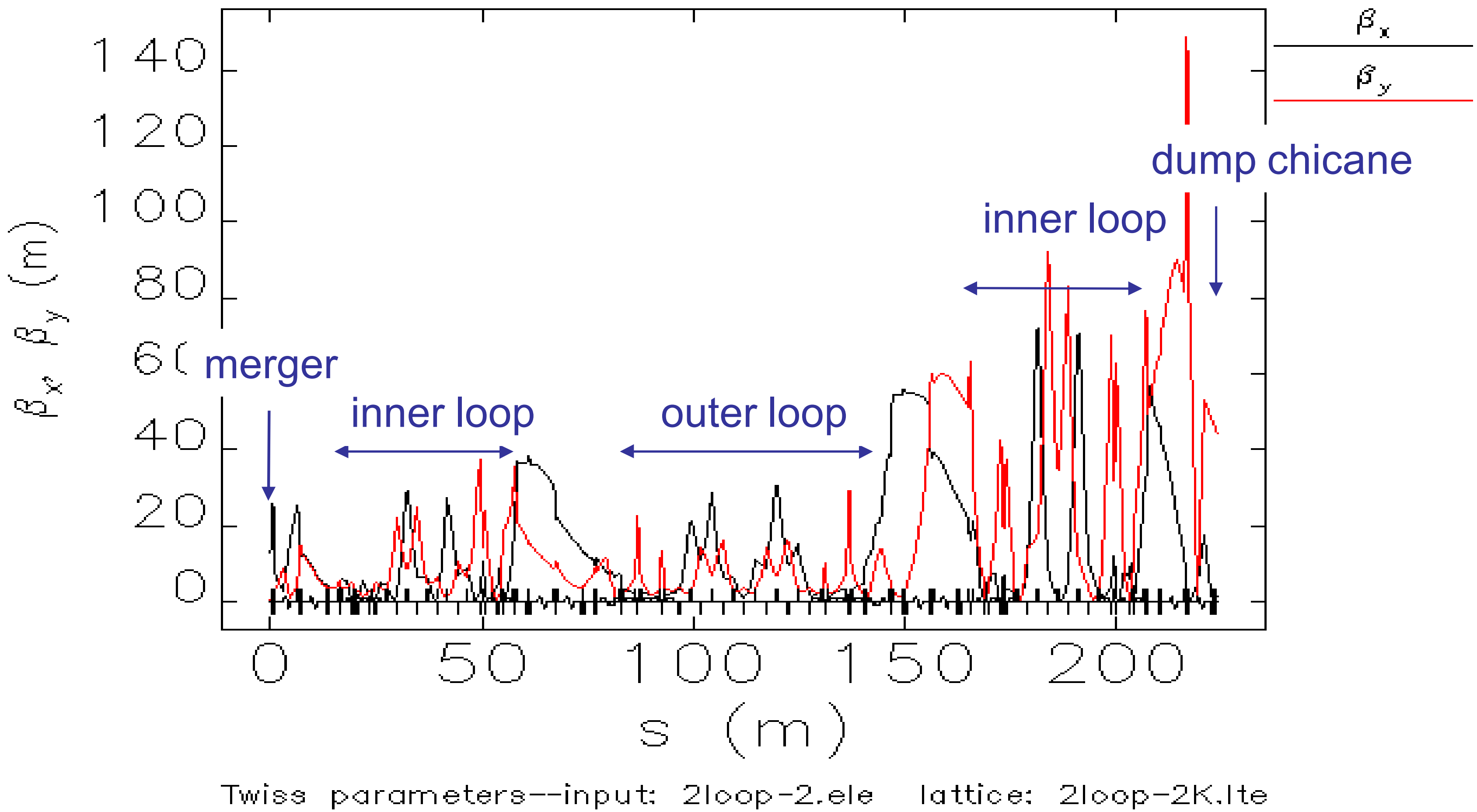




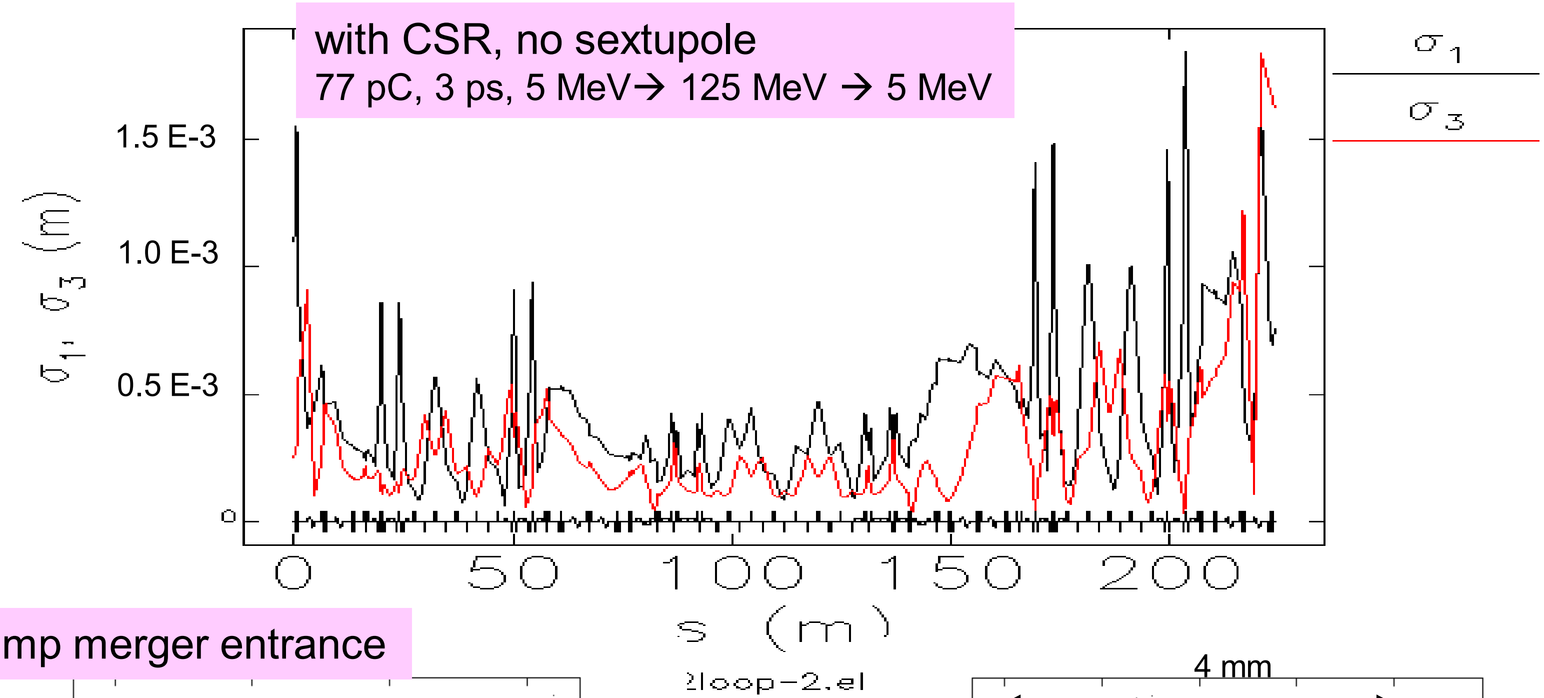
betatron functions

Inner loop → similar to the CDR design, R_{56}=0, FODO for the back straight
Outer loop → TBA arc, ρ=2m (ready for 400 MeV), R_{56}=0, FODO for the back straight
Linac → 9-cell (15 MeV) x 2 cavities x 2 modules

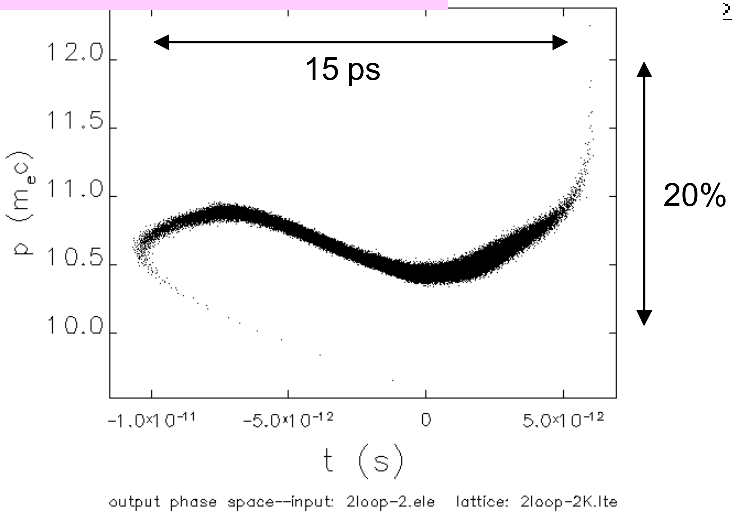
5 MeV → 65 MeV → 125 MeV → 65 MeV → 5 MeV

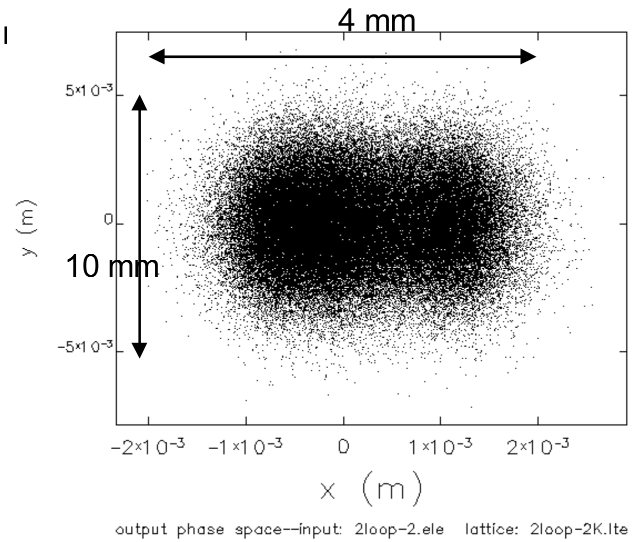


beam size and longitudinal phase space



at the dump merger entrance

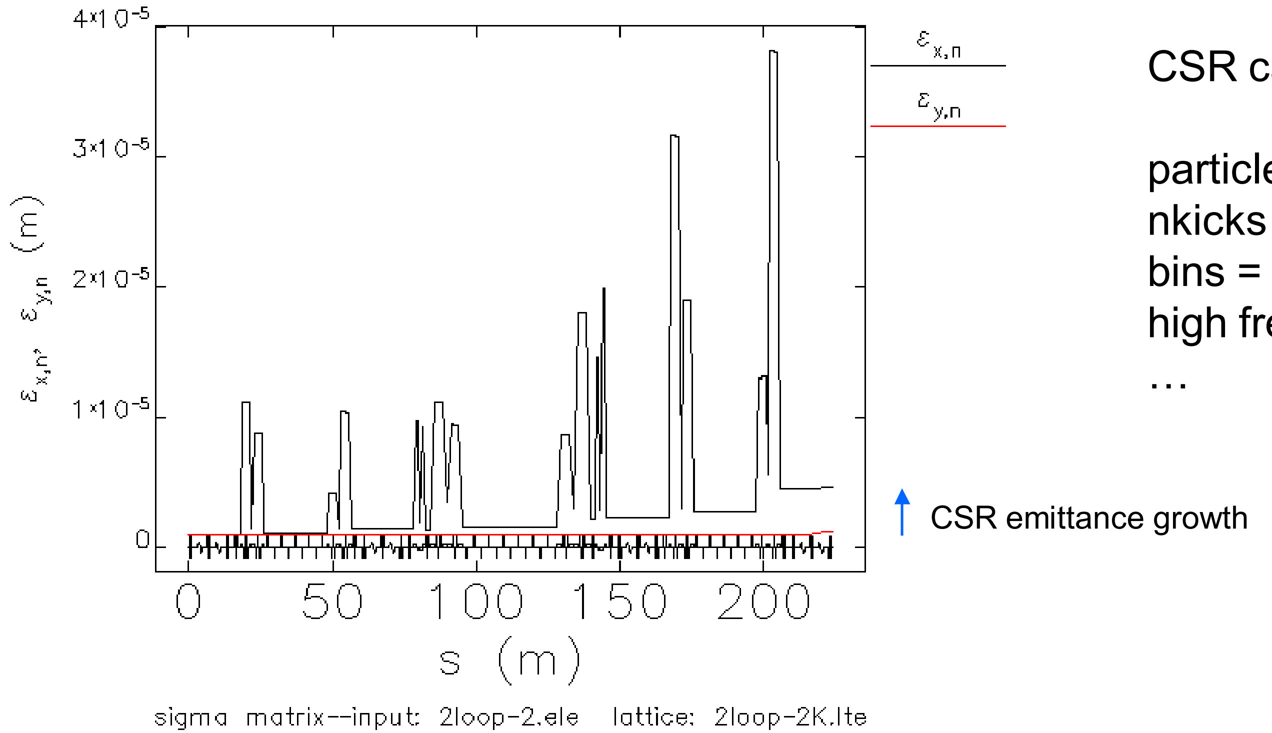




CSR emittance growth

with CSR, no sextupole

77 pC, 3 ps



CSR calculation

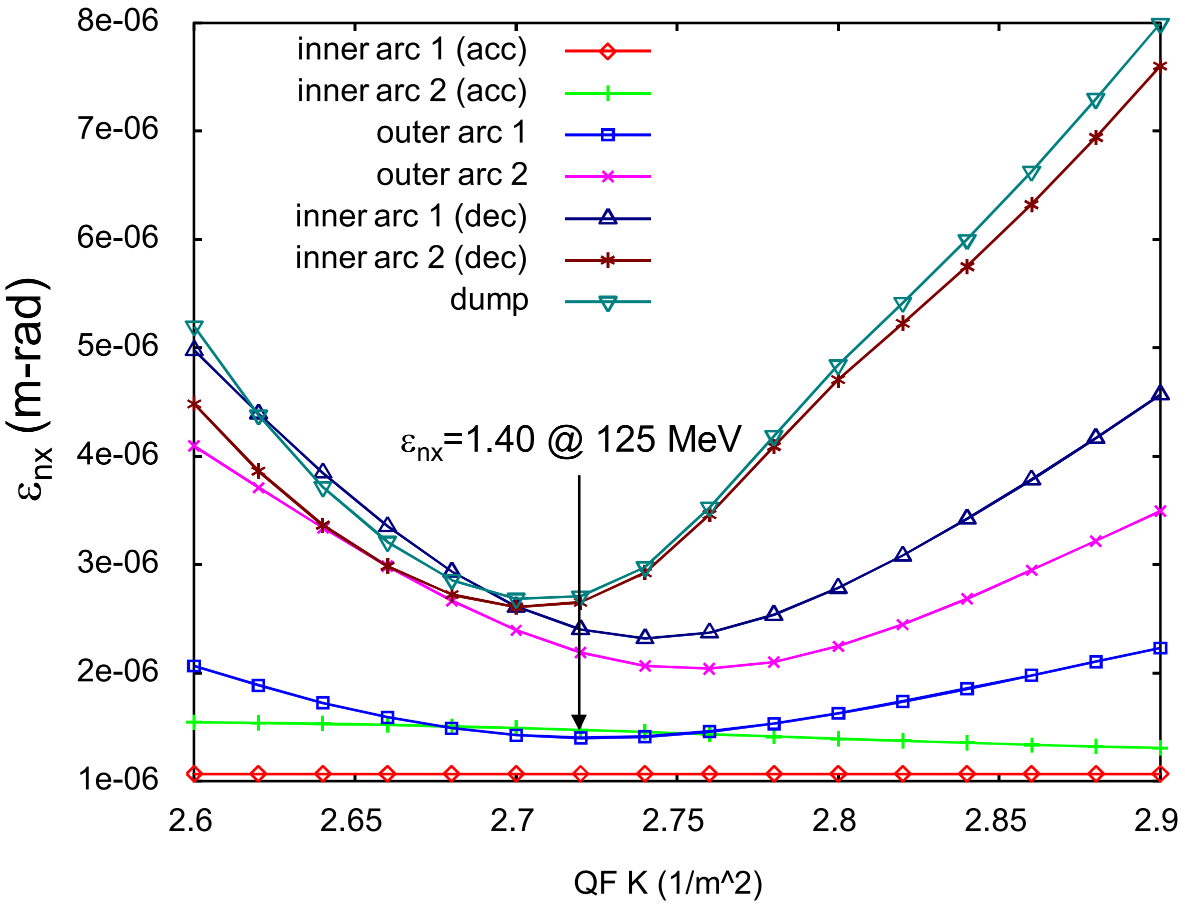
particle = 100k
nkicks = 100 (for 45 deg. bend)
bins = 100
high frequency cut-off = 0.3
…

- CSR emittance growth is accumulated turn by turn.
- Small emittance is necessary at the outer-loop straight (125 MeV).
- Optimization is available by tuning beam envelope.

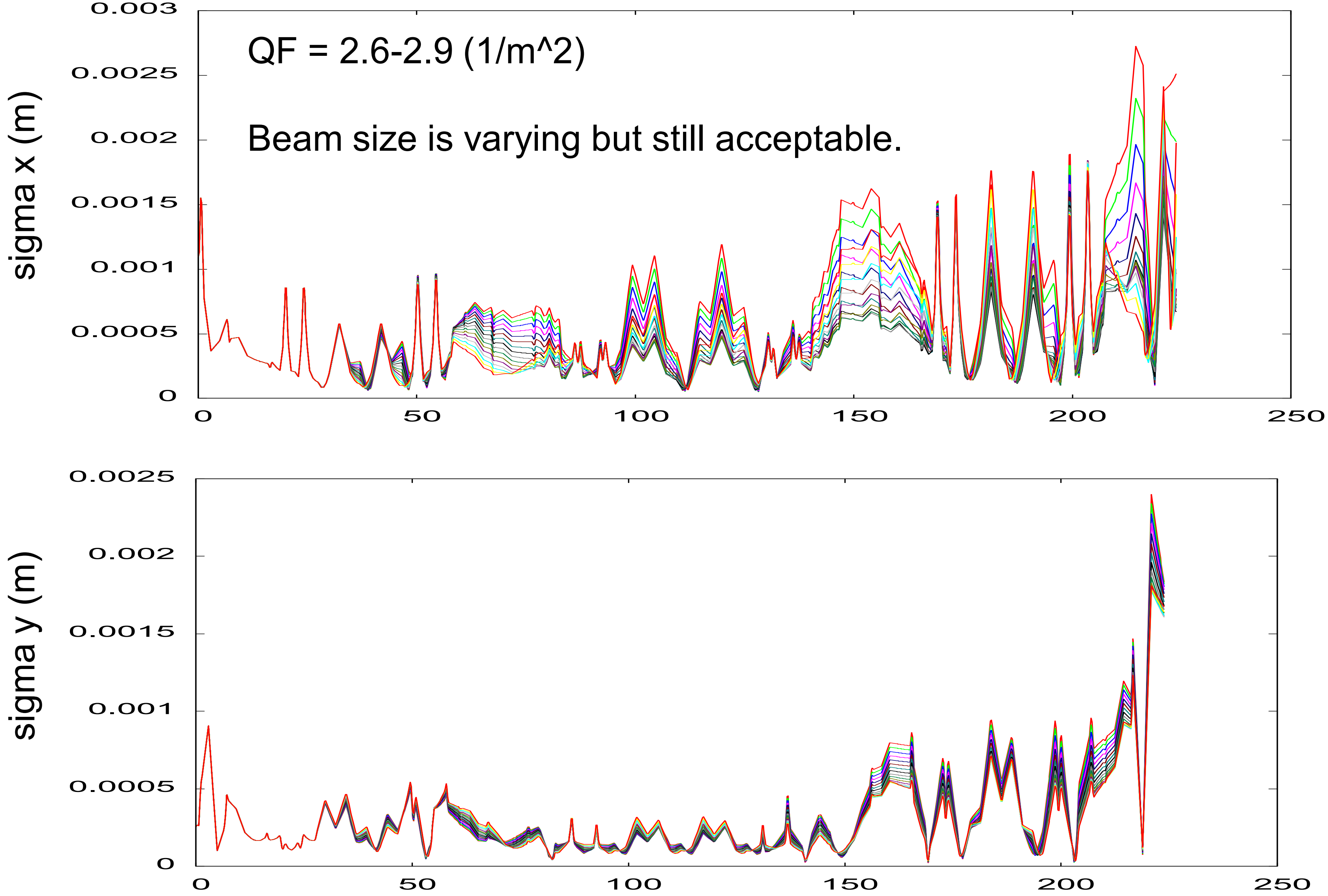
compensation of the emittance growth

optimization of QF at the inner FODO section.

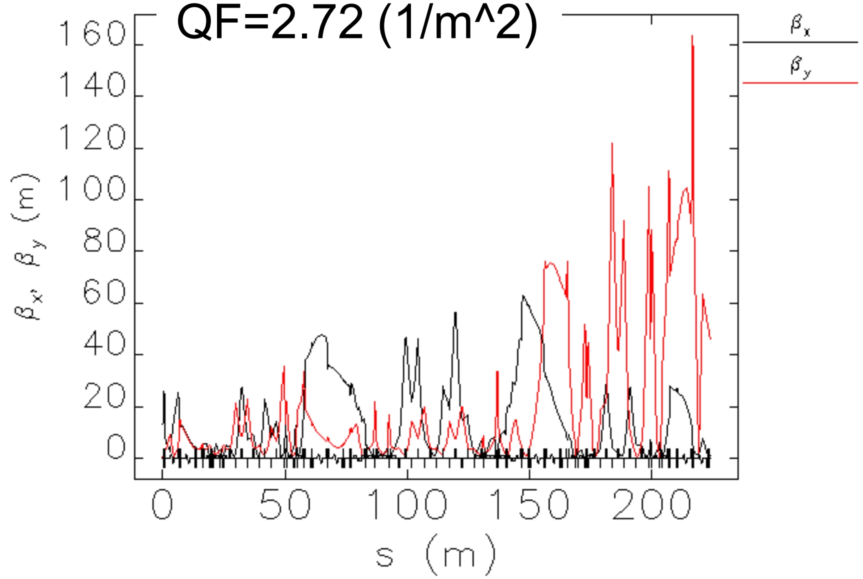
→ change pass-to-pass phase advance

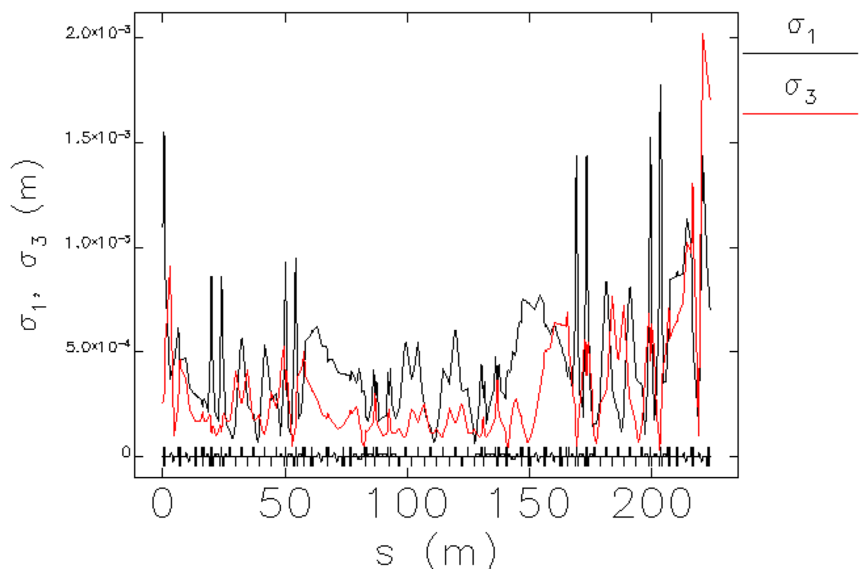


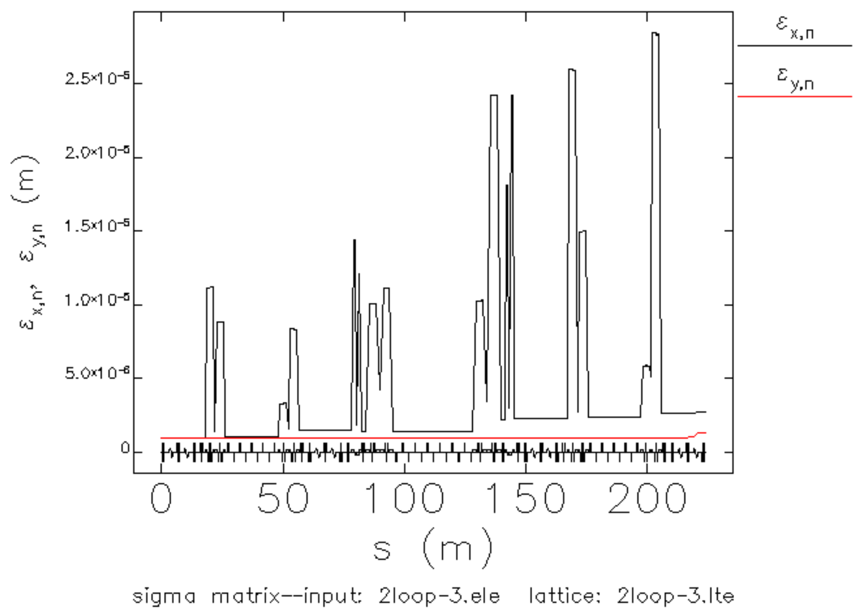
Beam size variation with QF at the inner FODO

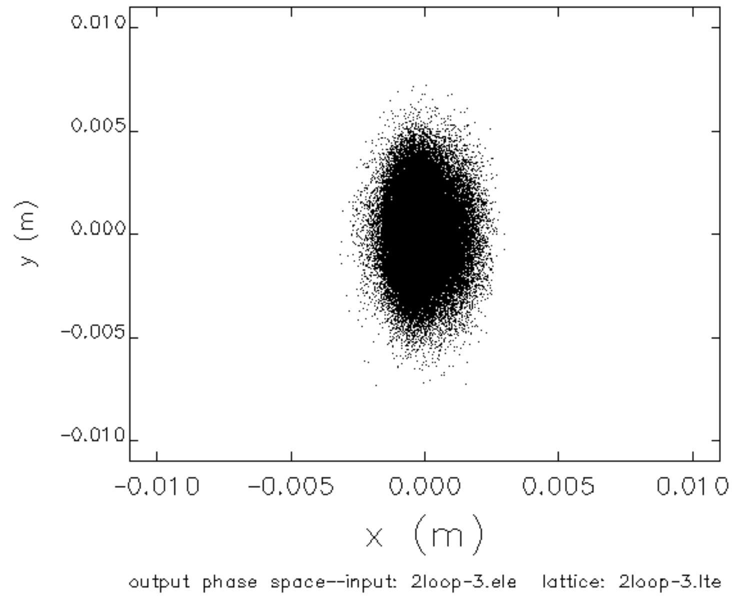


betatron functions & beam size after the “QF optimization”









Summary

- 2-loop configuration of cERL is presented.
- Tracking simulation with the CSR effects is carried out.
- Emittance growth can be ‘partially’ compensated by envelope tuning.
  - 1.0 mm-mrad (5 MeV) → 1.4 mm-mrad (125MeV) for 77 pC, 3 ps bunch
- Works remain
  - More realistic design (smaller bending magnets)
  - Bettrer emittance compensation
  - Optics with bunch compression
  - Optics for specific applications (Compton, THz …)