Multi-turn design for cERL

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Multi-turn ERL, Pros and Cons

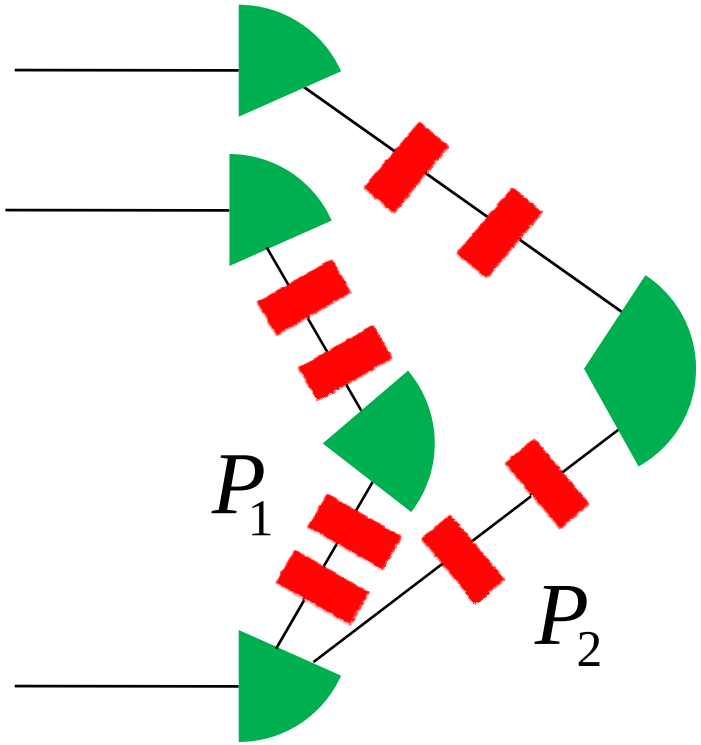
☺ Pros

- Save the cost for both construction and operation.
  - Linac → ½, refrigerator → ½ , RF → ½ …
- Smaller foot print

☹ Cons

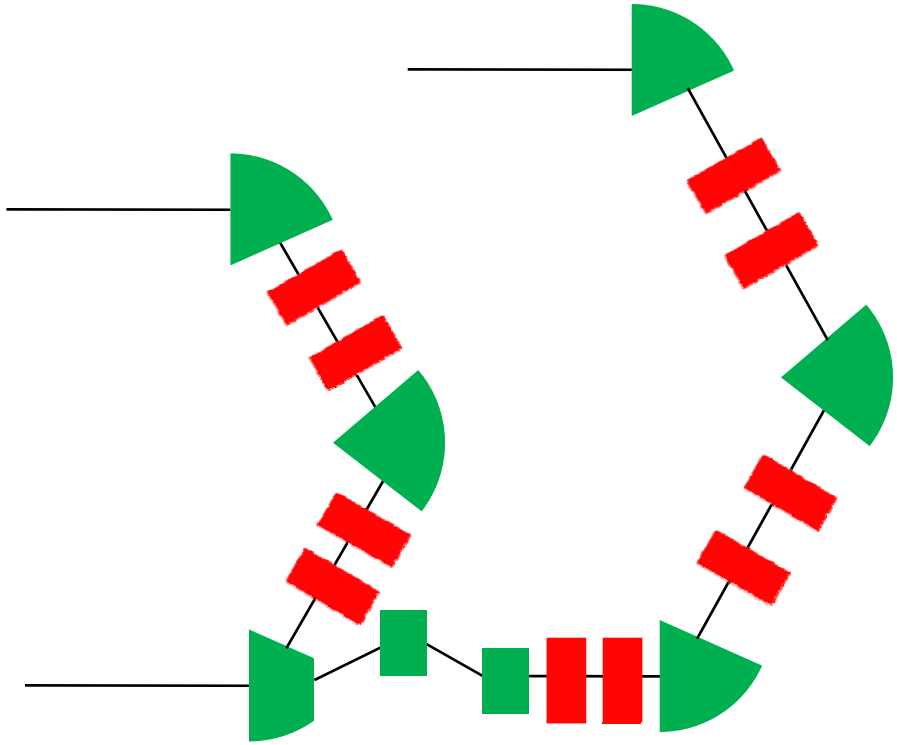
- Complicated beam optics
- Need more attention to BBU and CSR
- Larger HOM-load in the main linac

Beam splitting & merging schemes



Fixed momentum ratio

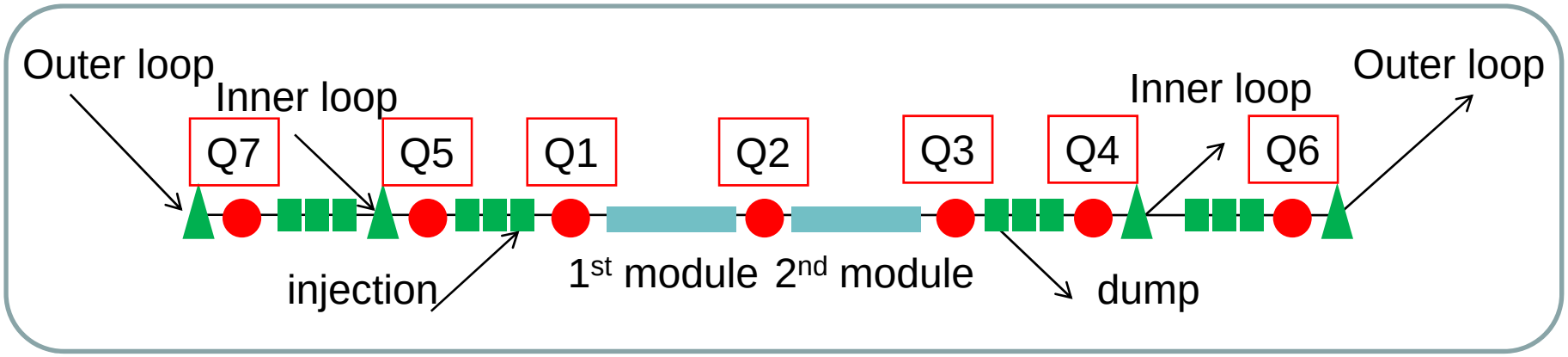
$$P_2 / P_1 = const.$$



Variable momentum ratio

This type is considered here.

Quads layout at the linac section



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

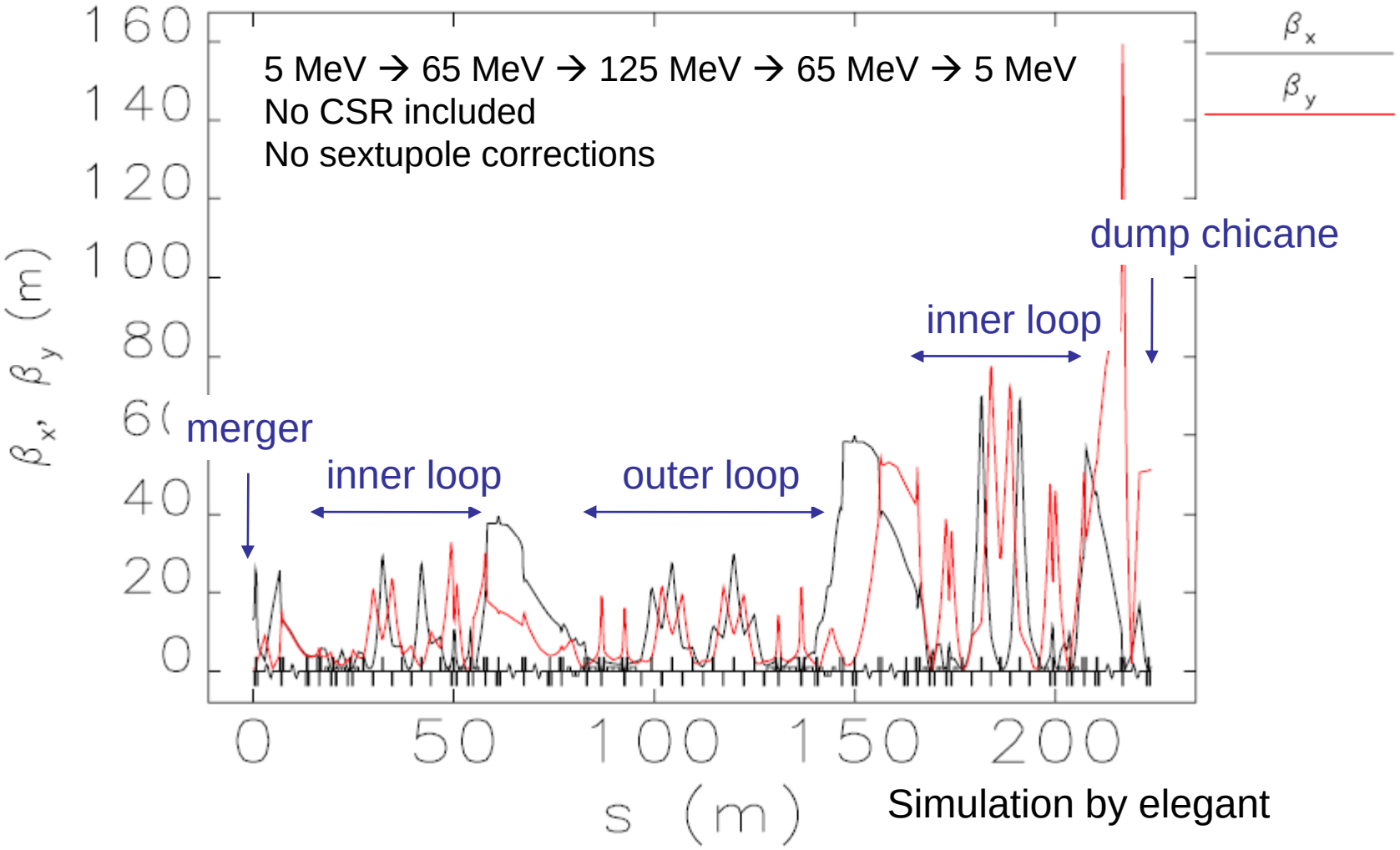
Pass	Q7	Q5	Q1	Q2	Q3	Q4	Q5	loop
1			5	35	65	65		65
2		65	65	95	125	125	125	125
3	125	125	125	95	65	65		65
4		65	65	35	5			

2-loop = 3-turn = 4-pass

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

Design example of 2-loop cERL: 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



Simulation by elegant

Design example of 2-loop cERL: beam parameters