RFFAG option for νSTORM

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Outline

- First design
- Improvements
- Future plans

Constraints

- Scallop angle < 15 mrad (Near and far detectors).
- 1000 π mm.mrad, horizontally and vertically (2000?)
- ~1.5 m dispersion at injection point

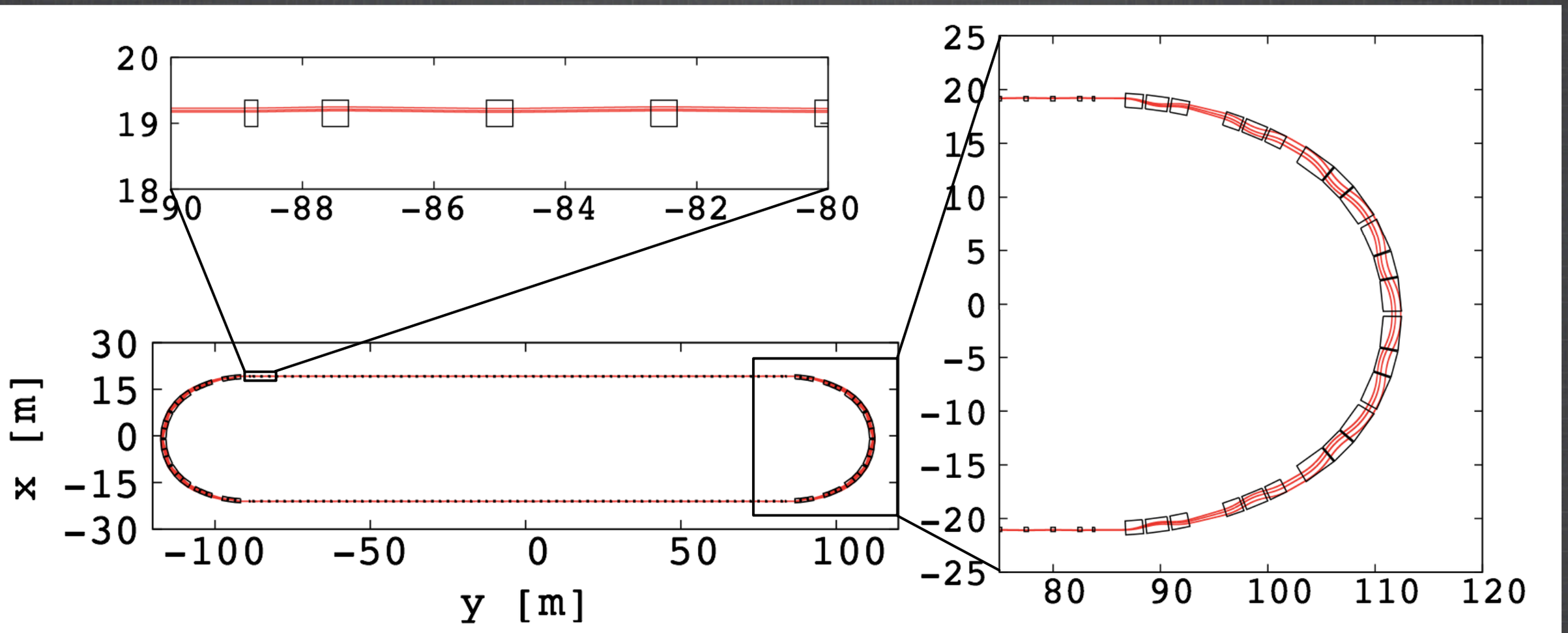
Tracking code

- RK4 stepwise tracking code,
- Enge fringe fields,
- 4^{th} order interpolation off the mid-plane.

→ Realistic DA study

Design 1

Straight: **175 m,** maximum scallop angle: **12 mrad**



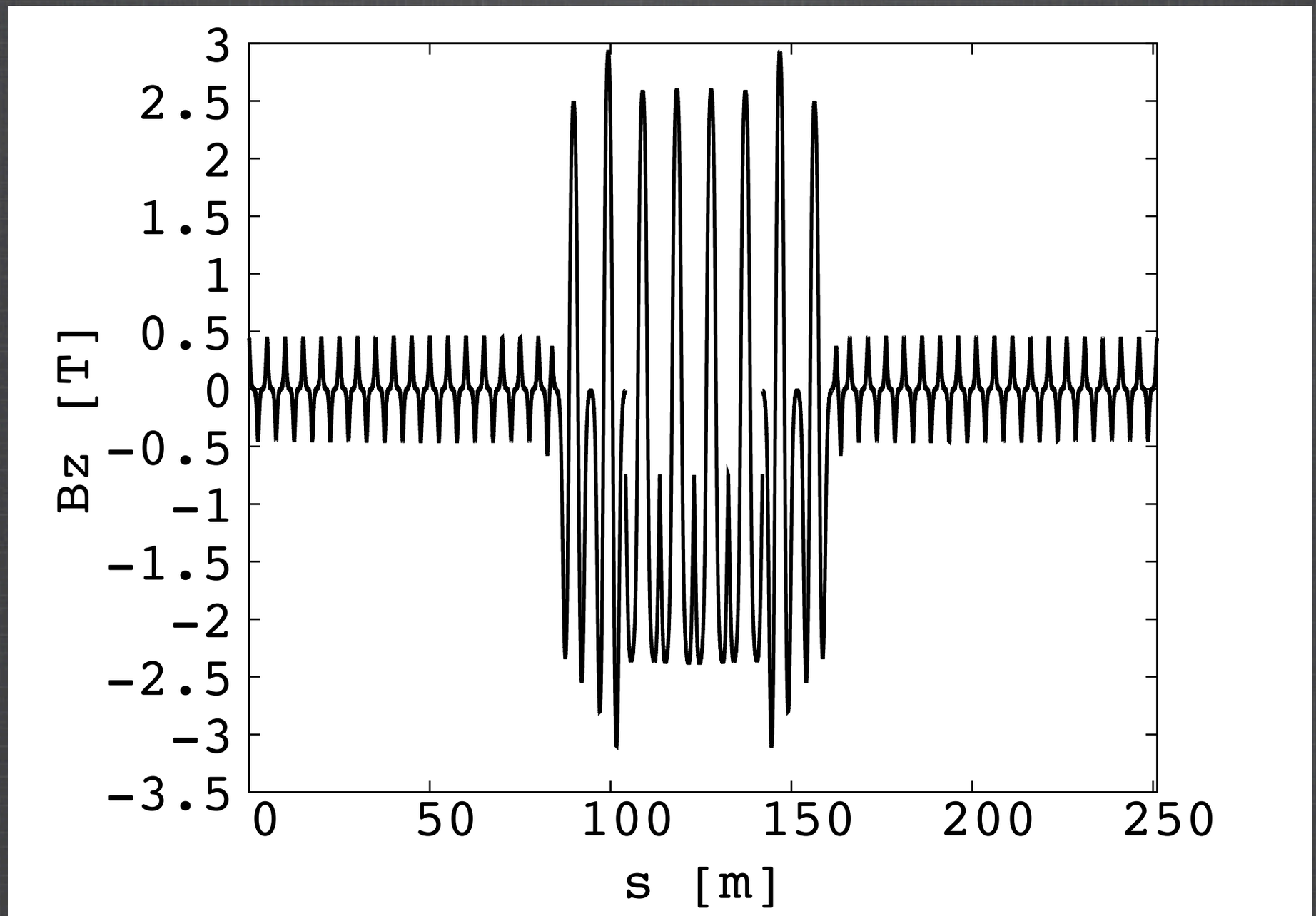
Design 1

Cell parameters

	Circular Section	Matching Section	Straight Section
Type	FDF	FDF	Doublet
Cell radius/length [m]	17.6	36.2	5
Opening angle [deg]	30	15	
k-value/m-value	6.043	25.929	5.5 m^{-1}
Packing factor	0.92	0.58	0.16
Maximum magnetic field [T]	2.5	3.3	1.5
horizontal excursion [m]	1.3	1.1	0.4
Full gap height [m]	0.45	0.45	0.45
Average dispersion /cell [m]	2.5	1.3	0.18
Number of cells /ring	4×2	4×2	35×2

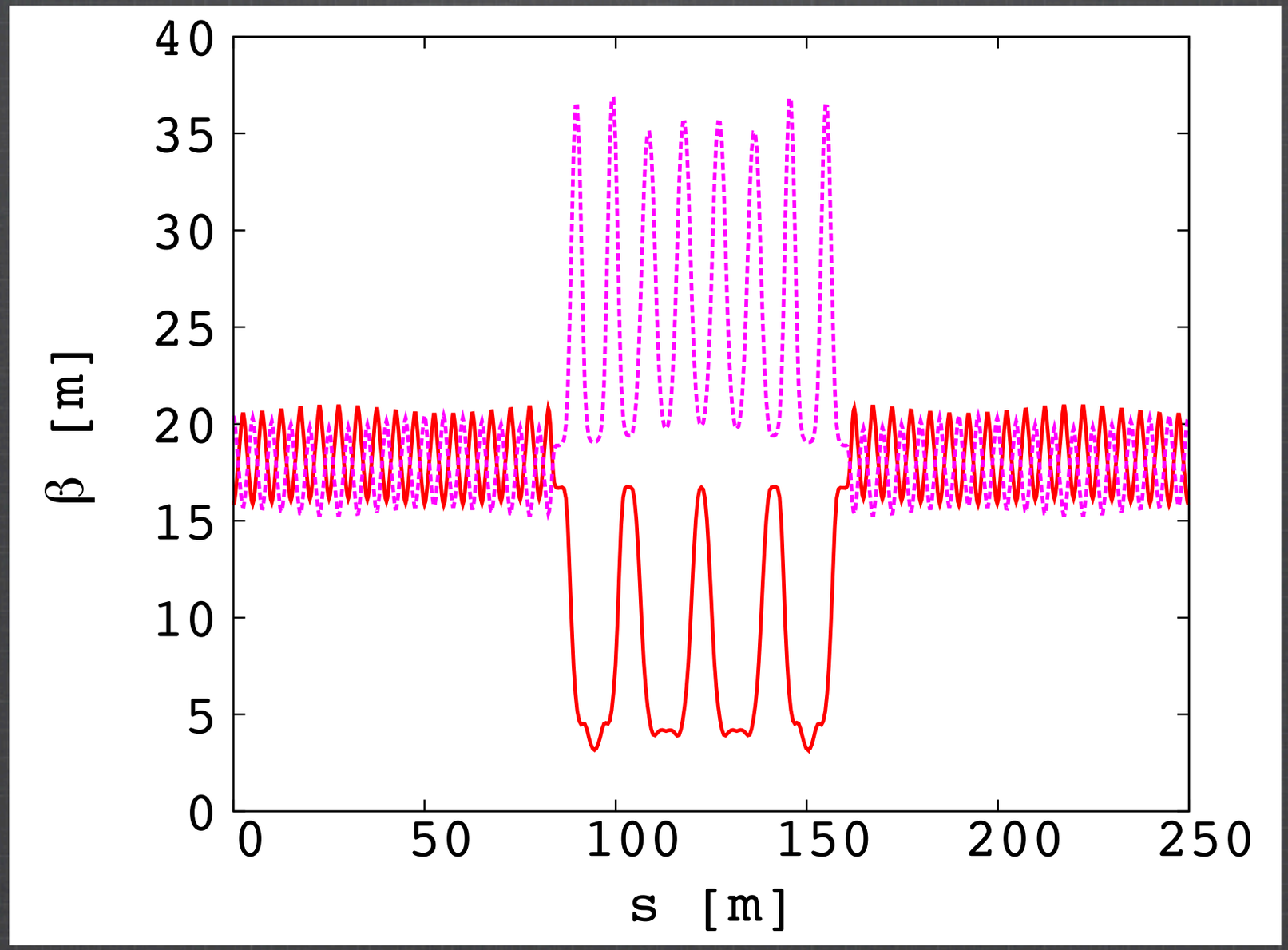
Design 1

Magnetic field for P_{max} (+16%)



Design 1

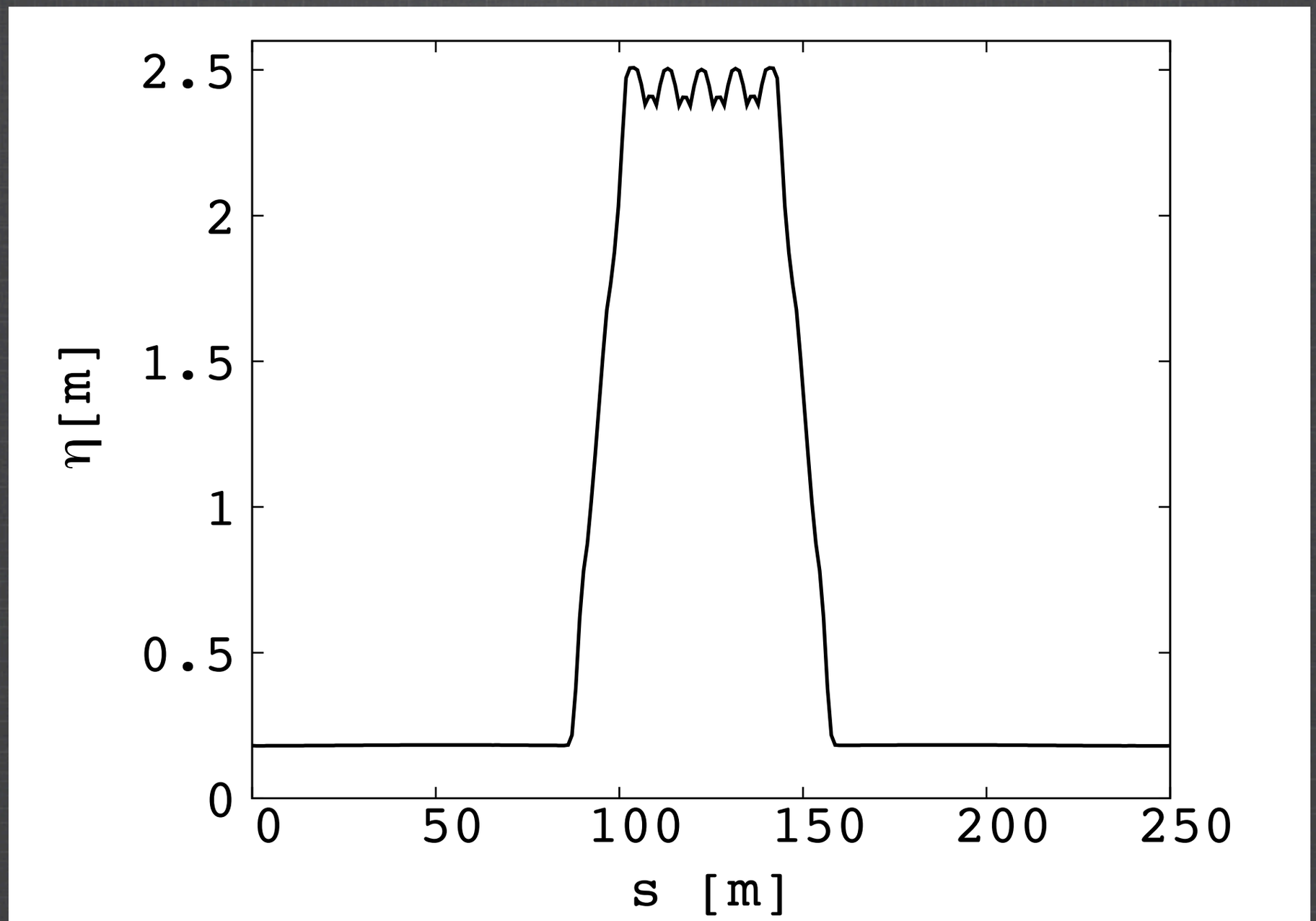
Beta-functions at matching momentum



Horizontal (plain red) and vertical (dotted purple) betafunctions for half of the ring.

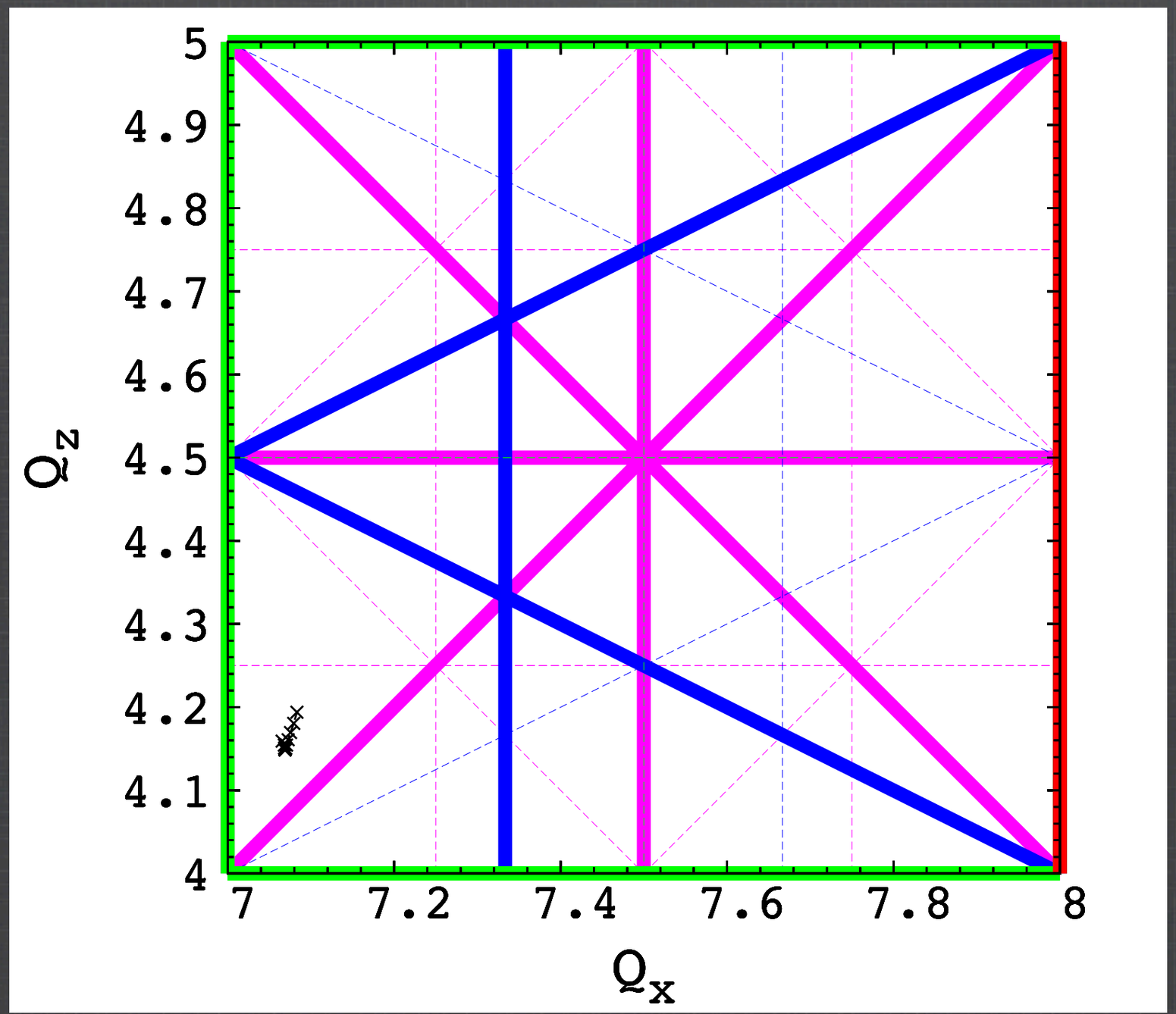
Design 1

Dispersion function at matching momentum



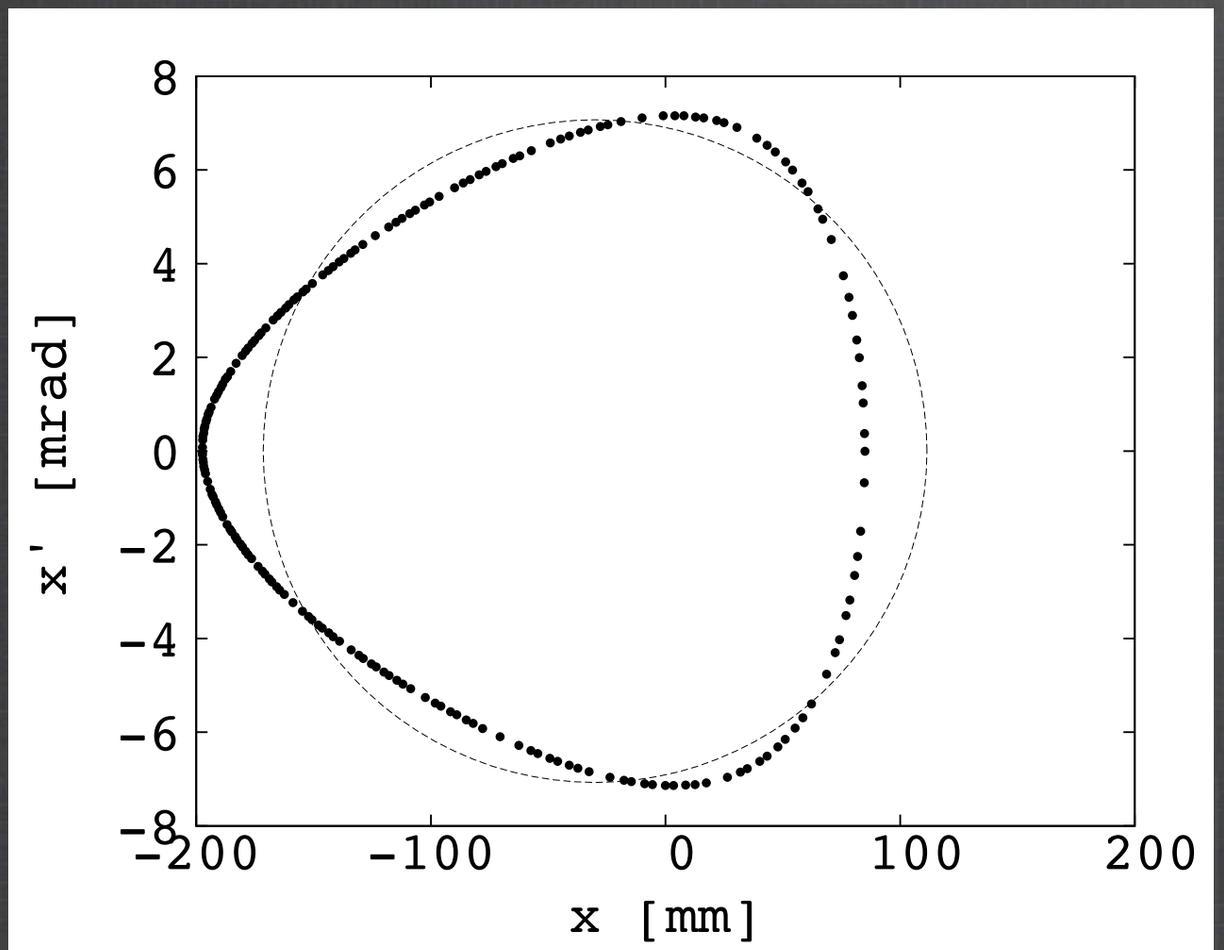
Design 1

Tune diagram $\frac{\Delta P}{P} = \pm 16\%$

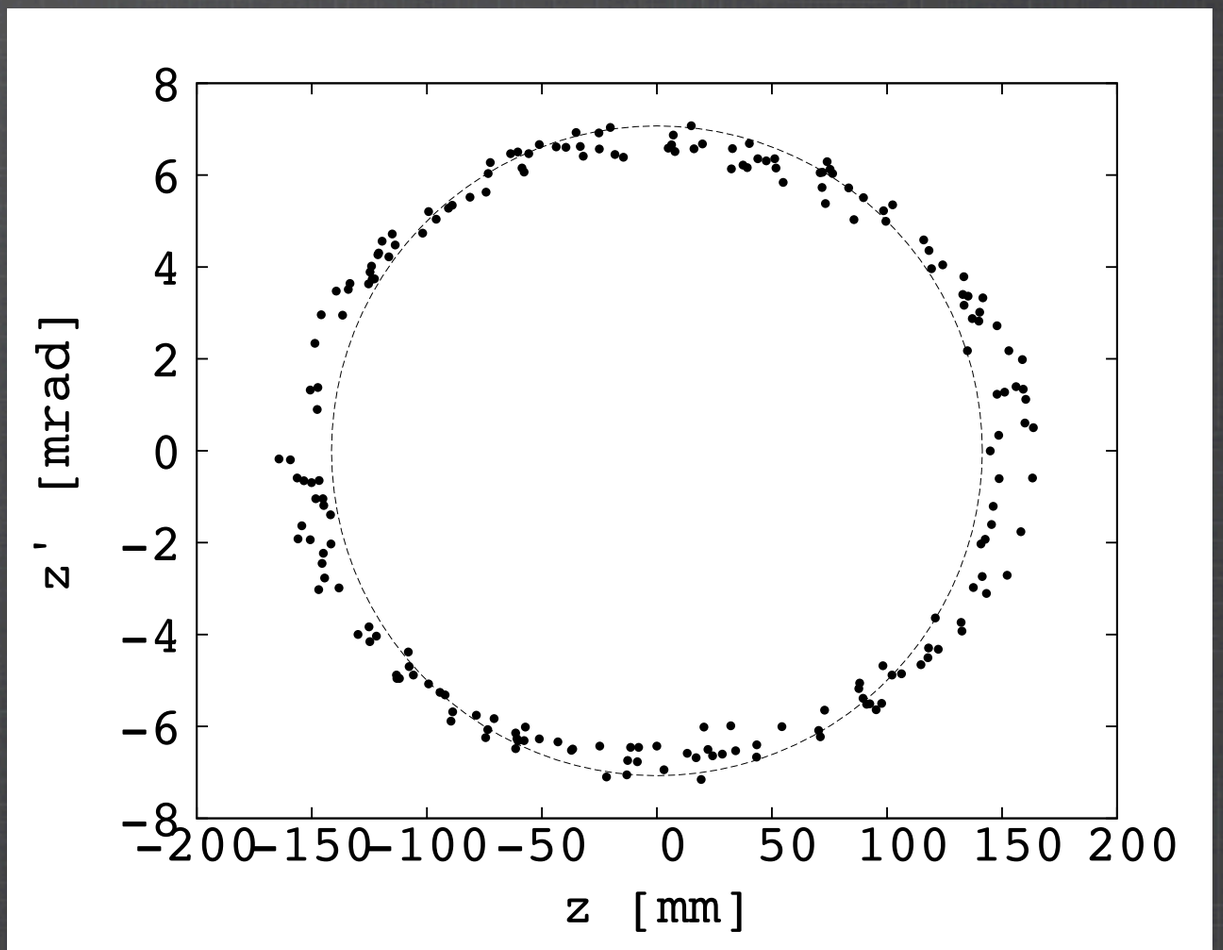


Design 1

Transverse acceptance



Maximum horizontal stable amplitude over 100 turns



Maximum vertical stable amplitude over 100 turns

Outline

- First design
- Improvements
- Future plans

Key parameters

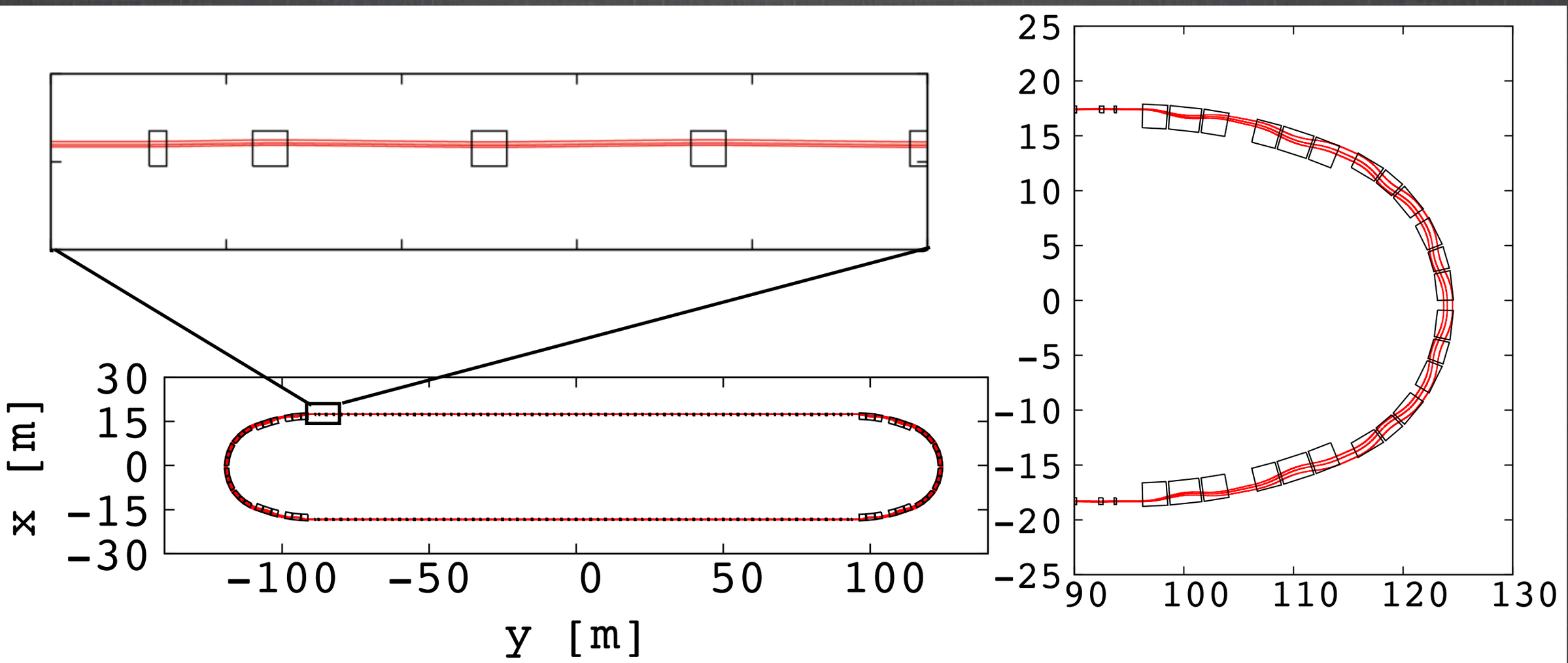
max. scallop angle

m-value

vertical β

Design 2

Straight: **185 m**, maximum scallop angle: **14 mrad**



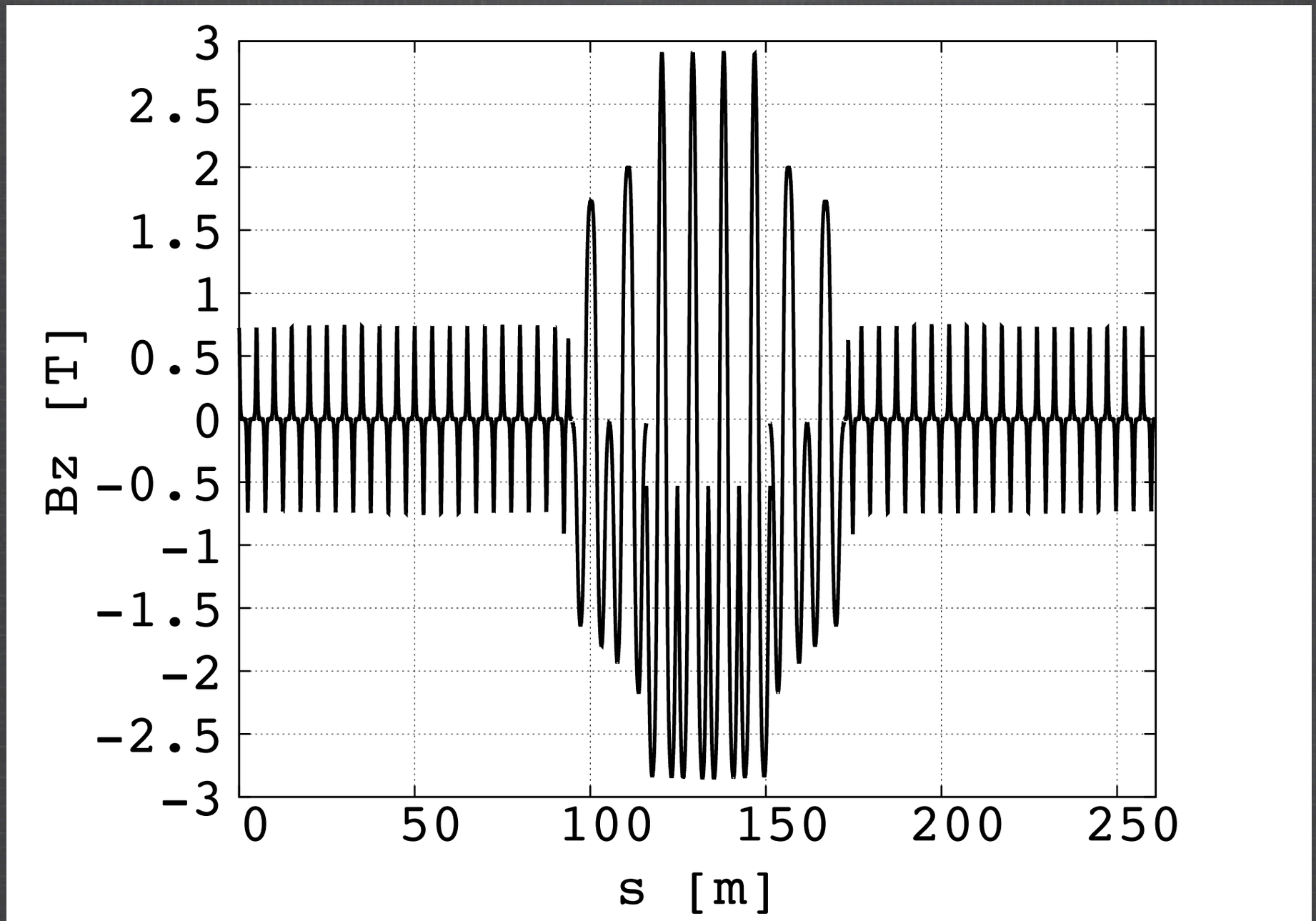
Design 2

Cell parameters

	Circular Section	Matching Section	Straight Section
Type	FDF	FDF	Doublet
Cell radius/length [m]	14.7	49.9	5
Opening angle [deg]	33	12	
k-value/m-value	5.047	36.125	4.2 m^{-1}
Packing factor	0.92	0.58	0.16
Maximum magnetic field [T]	3.1	2.5	1.5
horizontal excursion [m]	1.3	1.1	0.6
Full gap height [m]	0.45	0.45	0.45
Average dispersion /cell [m]	2.5	1.3	0.23
Number of cells /ring	4×2	4×2	37×2

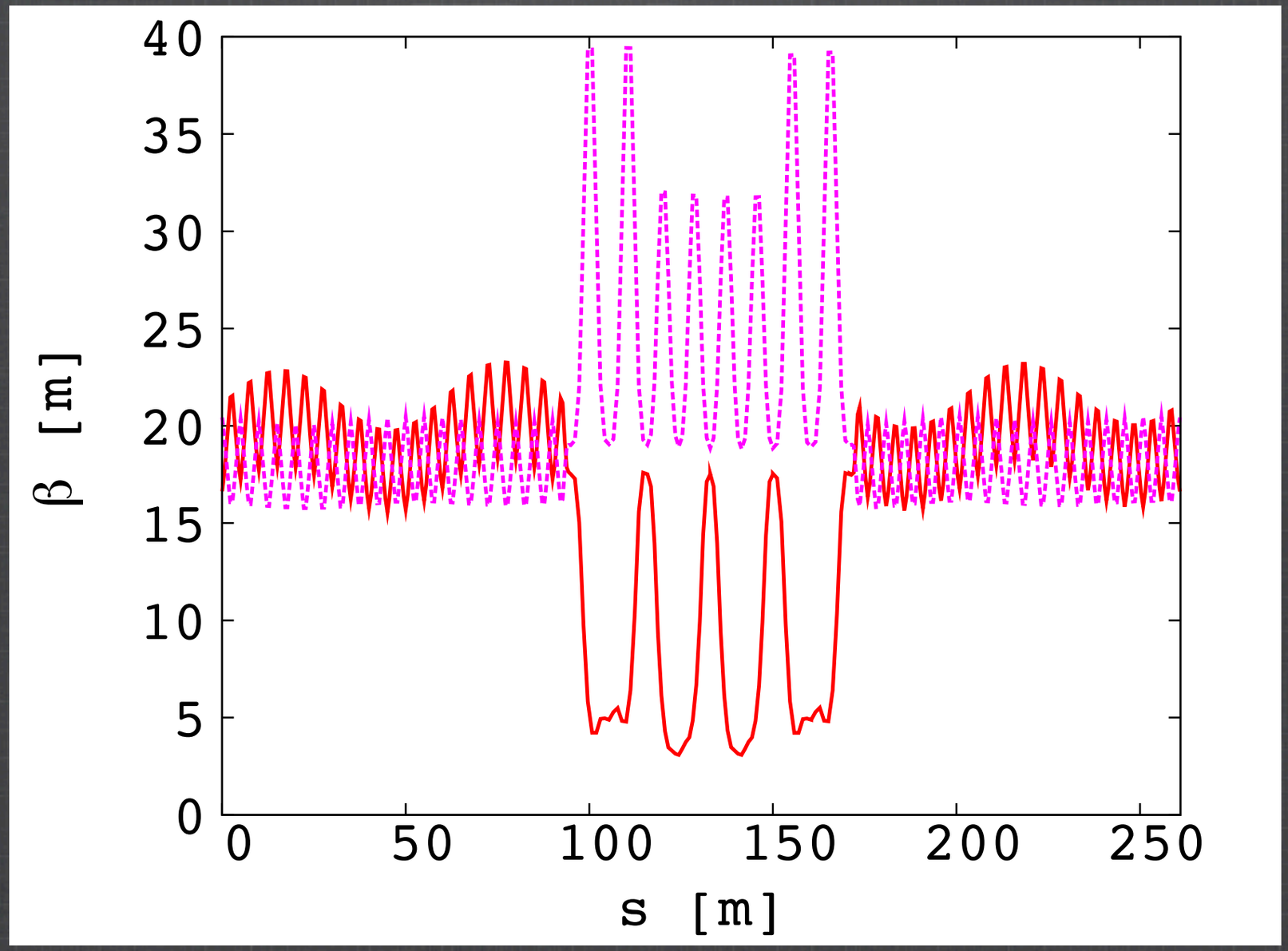
Design 2

Magnetic field for P_{max} (+16%)



"FODO-LIKE" RFFAG

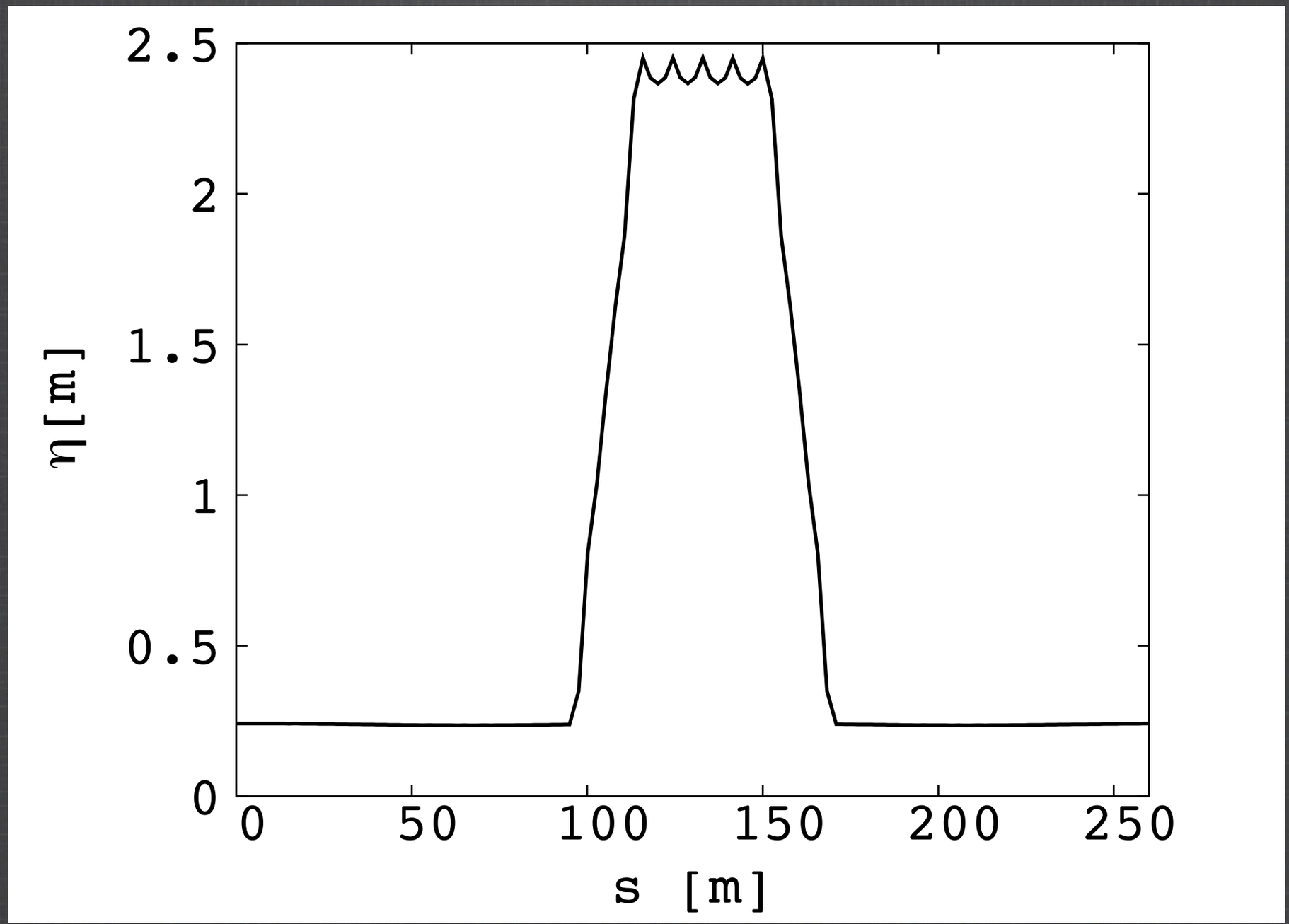
Beta-functions at matching momentum



Horizontal (plain red) and vertical (dotted purple) betafunctions for half of the ring.

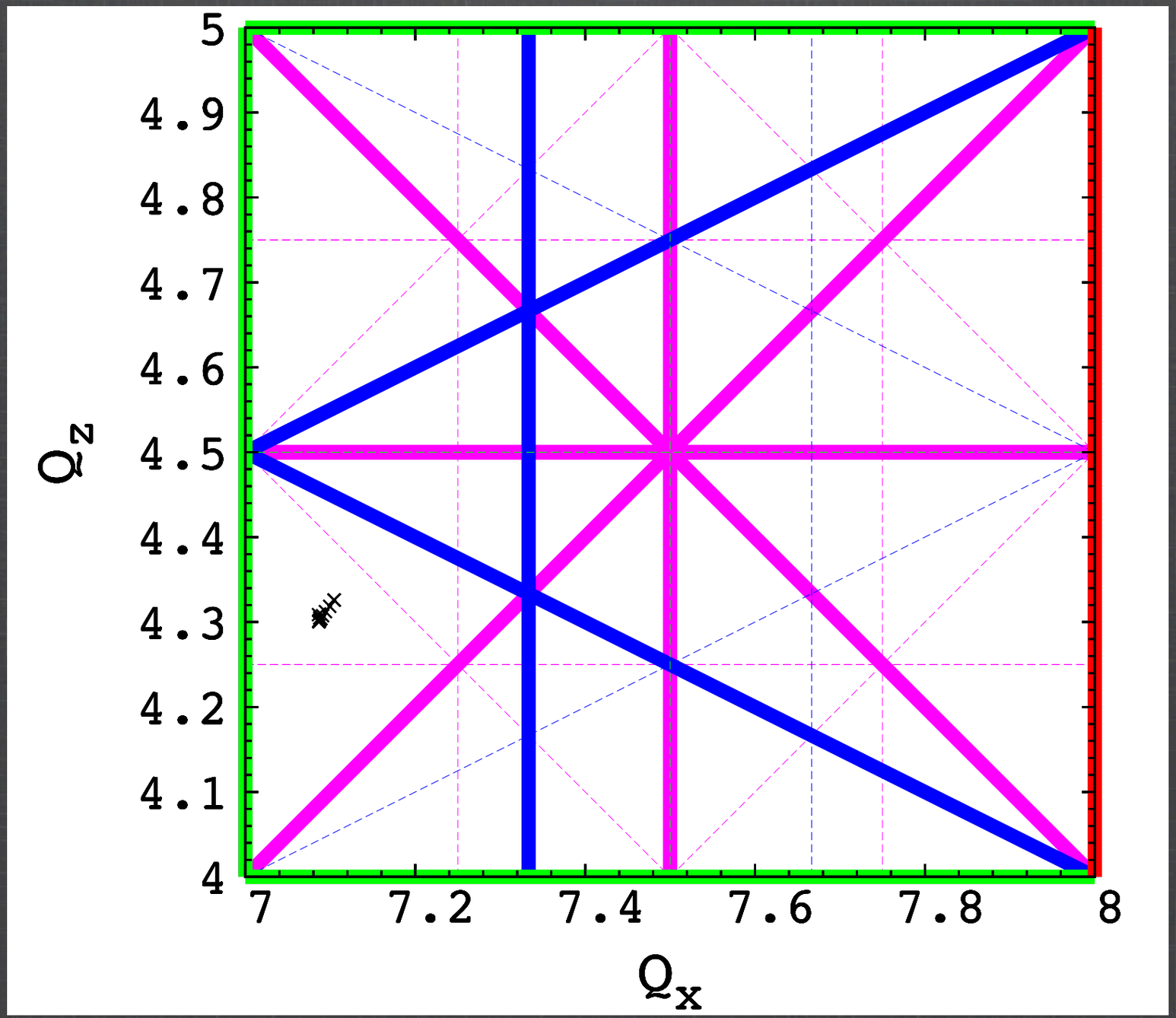
"FODO-LIKE" RFFAG

Dispersion function at matching momentum



Design 2

Tune diagram $\frac{\Delta P}{P} = \pm 16\%$



Triplet Solution

1300 km decay scenario incompatible with scallop of the closed orbit.

Doublet in the straight section cannot be used.

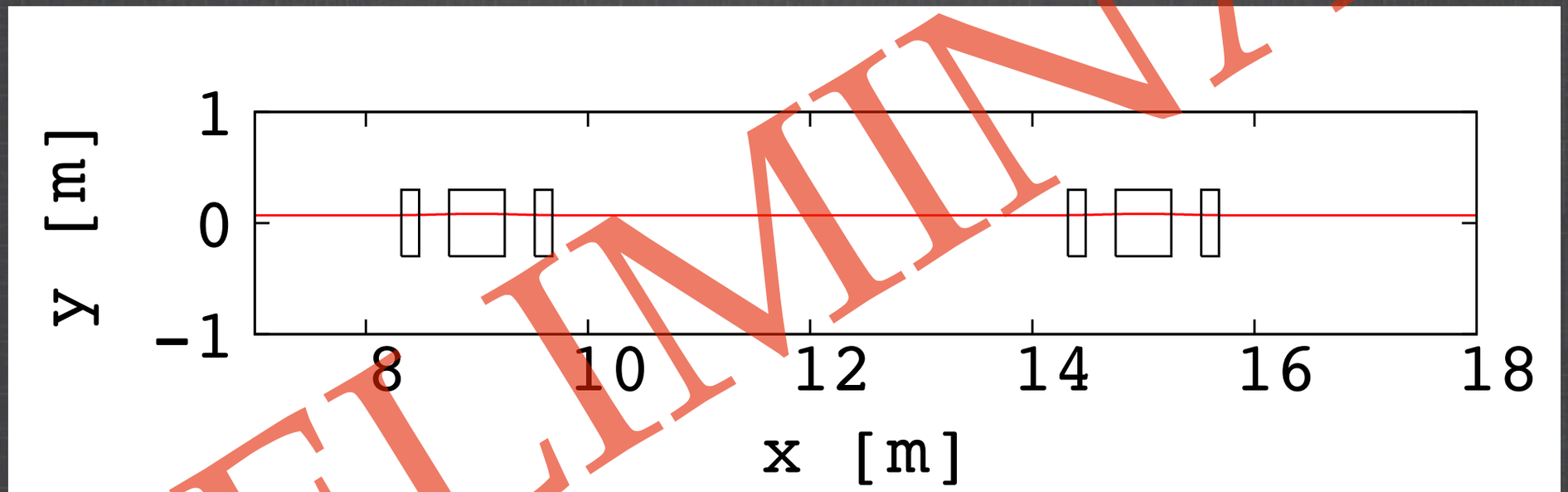
→ Triplet in the straight section.

Triplet Solution

Crude first try:

max. scallop angle: 26 mrad

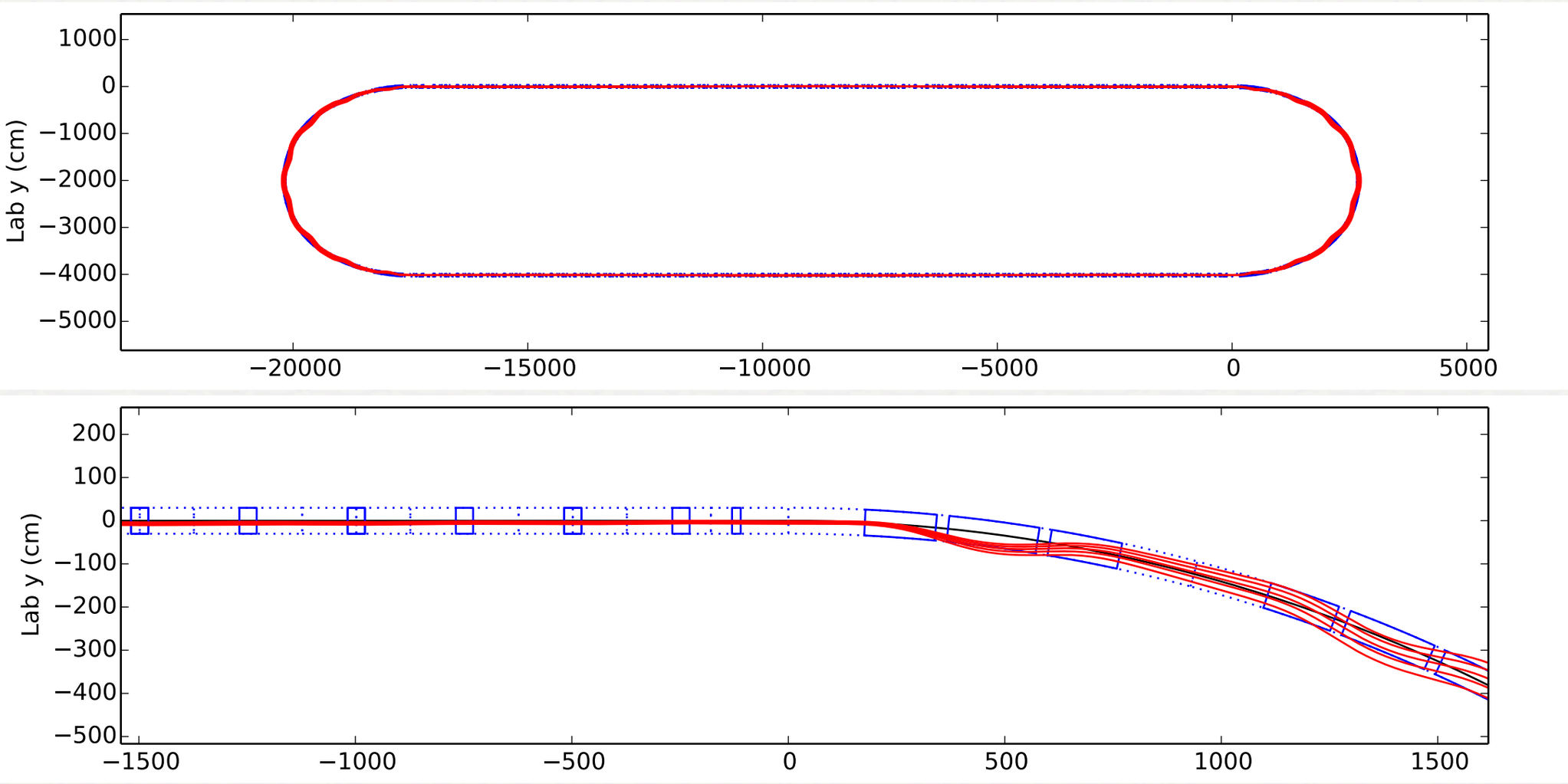
Useful decay length: ~75% straight section



Room for large improvement!

Goal: Useful decay length: ~85-90%

Zgoubi Implementation

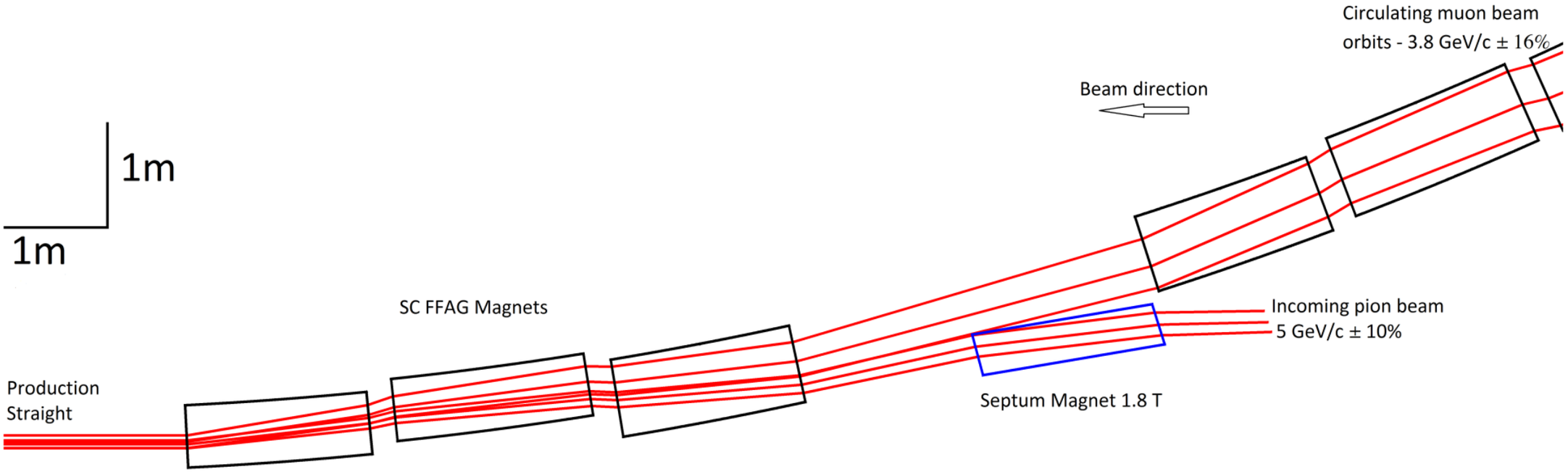


(Courtesy: S. Tygier)

DA studies in pyzgoubi

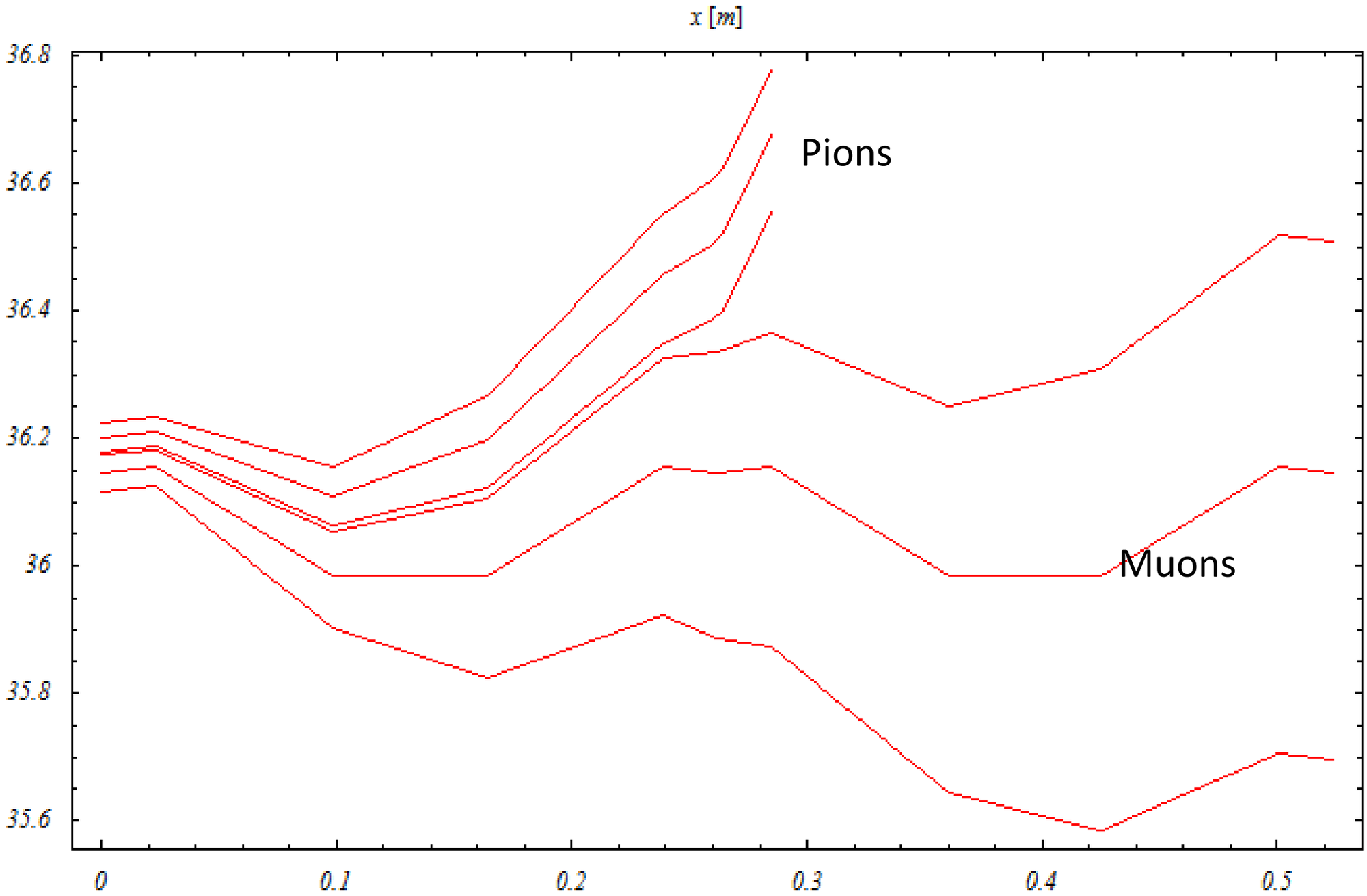
- New tools developped in pyzgoubi
- Avoid over estimation of the DA (plane coupling, error studies)

Preliminary SI geometry for FFAG



(J. Pasternak)

Lattice “Enge-1”



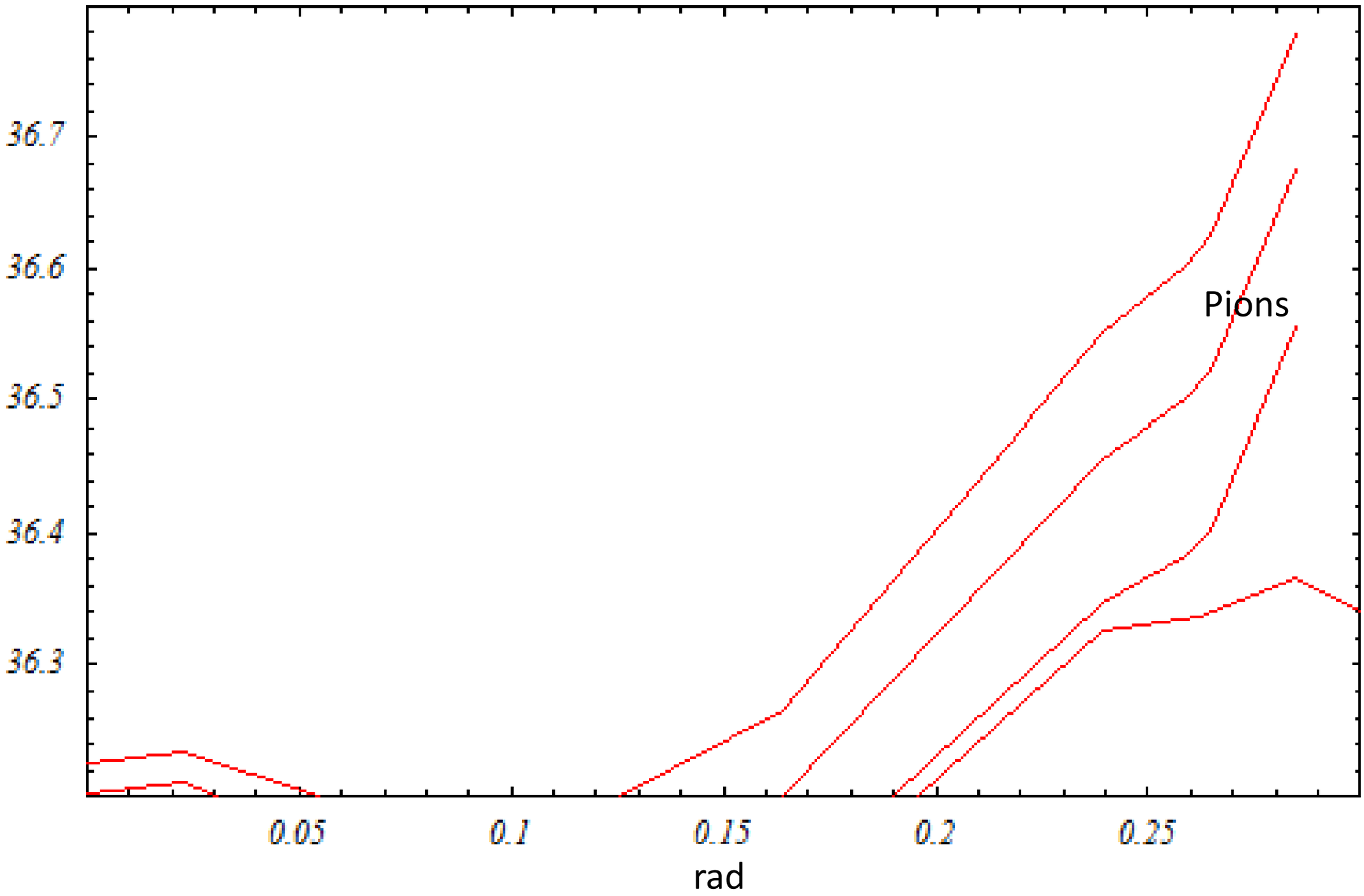
(J. Pasternak)

Parameters

- Septum field 1.4 T (room temperature)
- Septum thickness/length ~2cm/~72cm
- It requires SC dipole/septum of 4 T and 6 cm thickness to be placed upstream (72 cm in length)
- It gives 20 cm beam clearance at the upstream FFAG magnet.
- Alternatively we could use ~2cm/164 cm SC septum with 1.8T (results are pretty the same)

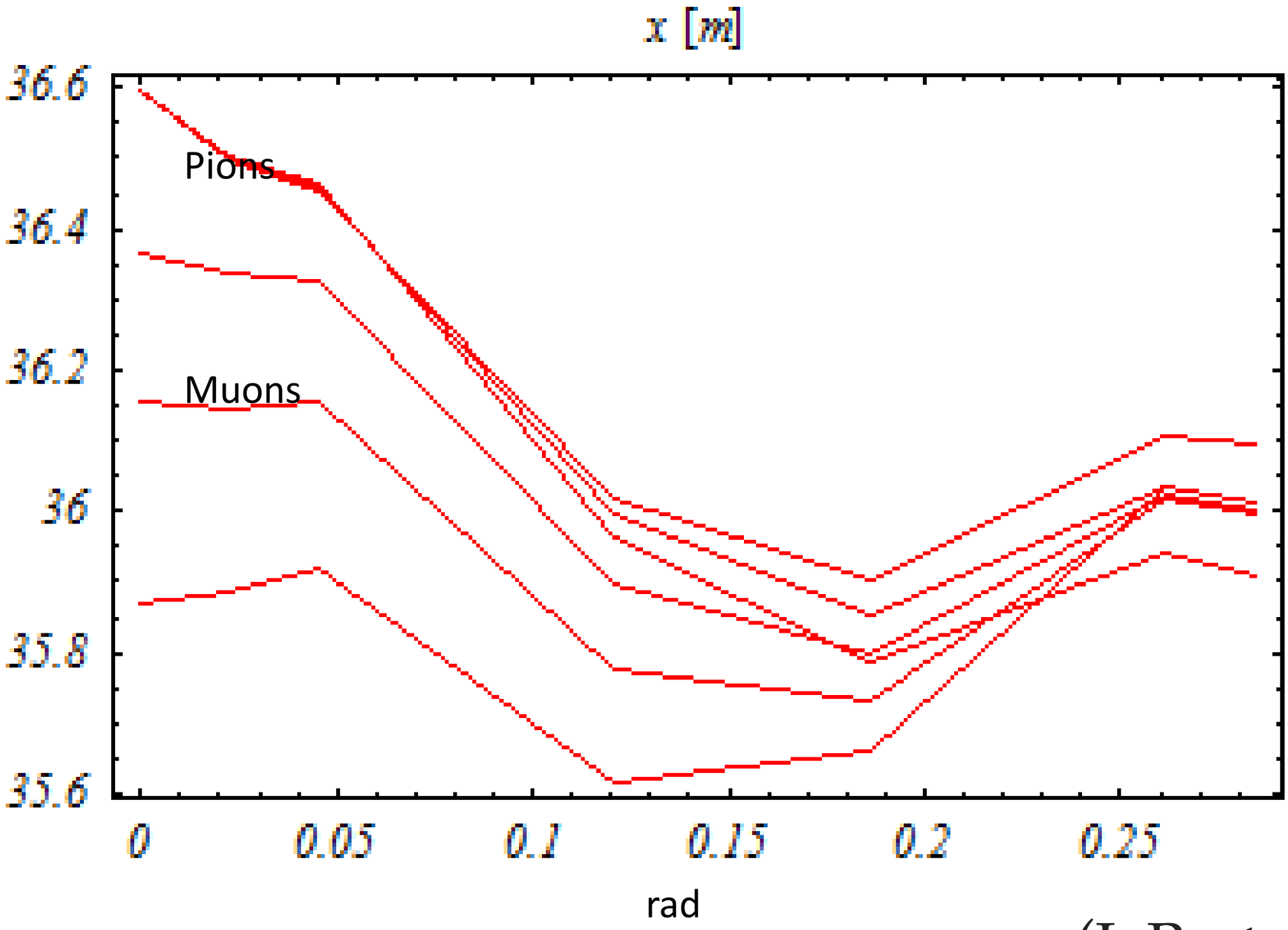
(J. Pasternak)

Zoom in



(J. Pasternak)

Injecting with 0m pion dispersion (note the inverse direction)



(J. Pasternak)

Parameters for injection with 0m pion dispersion

- Septum field 0.8 T (room temperature)
- Septum thickness/length ~2cm/~164cm
- It gives 20 cm beam clearance at the upstream FFAG magnet.
- The pion orbits will oscillate in the decay section. We need to evaluate, how this affects the muon collection efficiency.

(J. Pasternak)

Outline

- First design
- Improvements
- Future plans

Future plans

- New design needs to be adjusted (different tune point).
- Matching arc magnet with reduced max. B field, but increased in the arc magnets.

→ Compromise between matching cells and arc cells

- Implement the lattice in pyzgoubi (tune, DA).
- Injection promising, with room for improvement.
- Triplet solution seems promising, needs investigation.
- Neutrino flux estimation from pion & muon decay.

Thank you for your attention