

Accelerator Aspects for SF Experiments at COSY/AD

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for the PAX collaboration

Central issue

Polarize antiprotons via

Spin-Filtering of antiprotons by multiple passage through an internal polarized gas target

Polarization buildup of protons by spin filtering at COSY

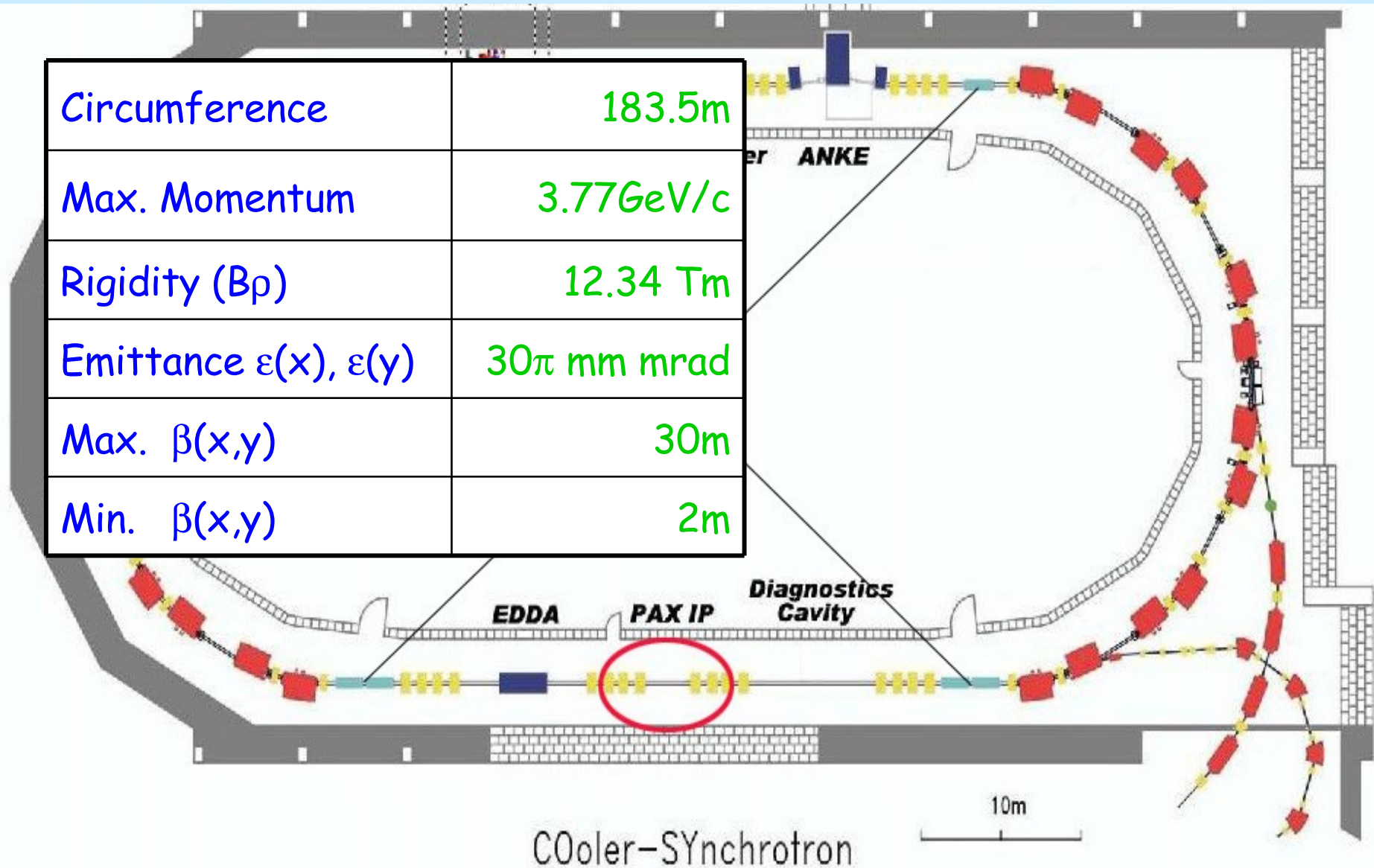
Polarization buildup of antiprotons by spin filtering at AD

Outline

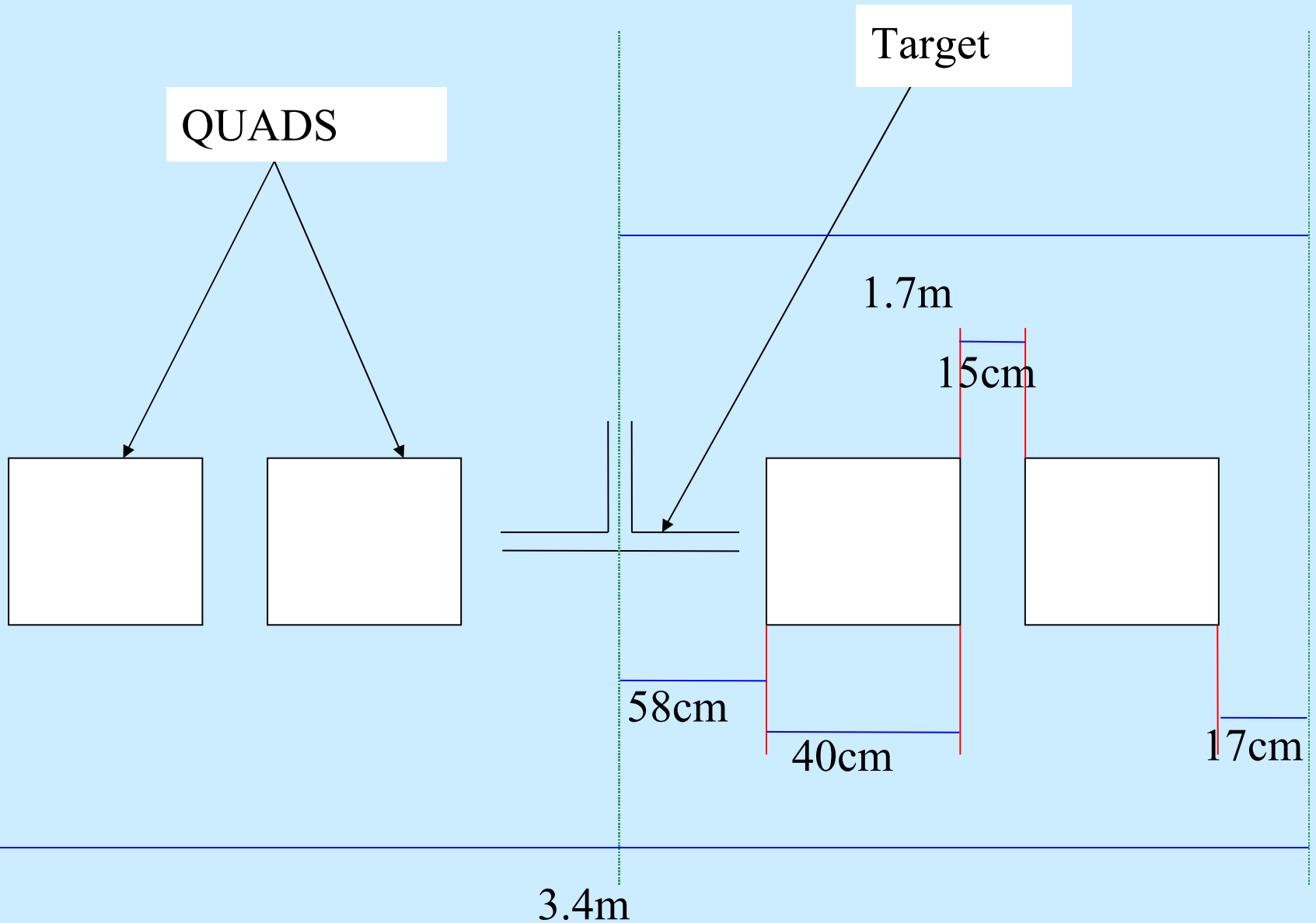
- Low-Beta section at *COSY*
(spin-filtering of protons, commissioning of the setup)
- Low-Beta section at *AD*
(spin-filtering of antiprotons)
- SC Quadrupole for Low-beta section
- Summary
- Low-Beta section at the AD (P. Beloshitskys proposal)
- Snake section at the AD

COoler SYnchrotron

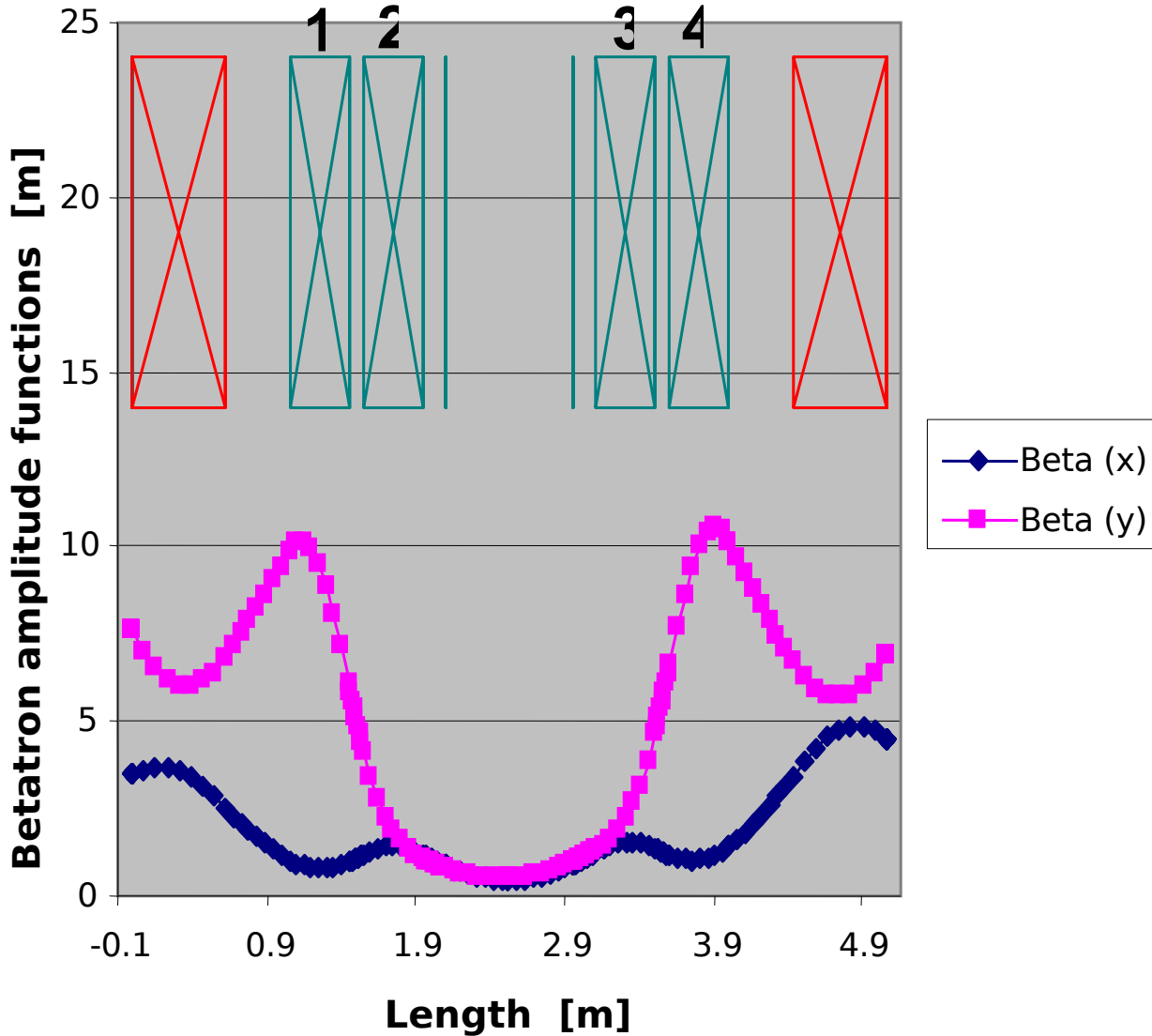
Circumference	183.5m
Max. Momentum	3.77GeV/c
Rigidity (Bρ)	12.34 Tm
Emittance $\varepsilon(x), \varepsilon(y)$	30π mm mrad
Max. $\beta(x,y)$	30m
Min. $\beta(x,y)$	2m



Low-Beta section @ COSY

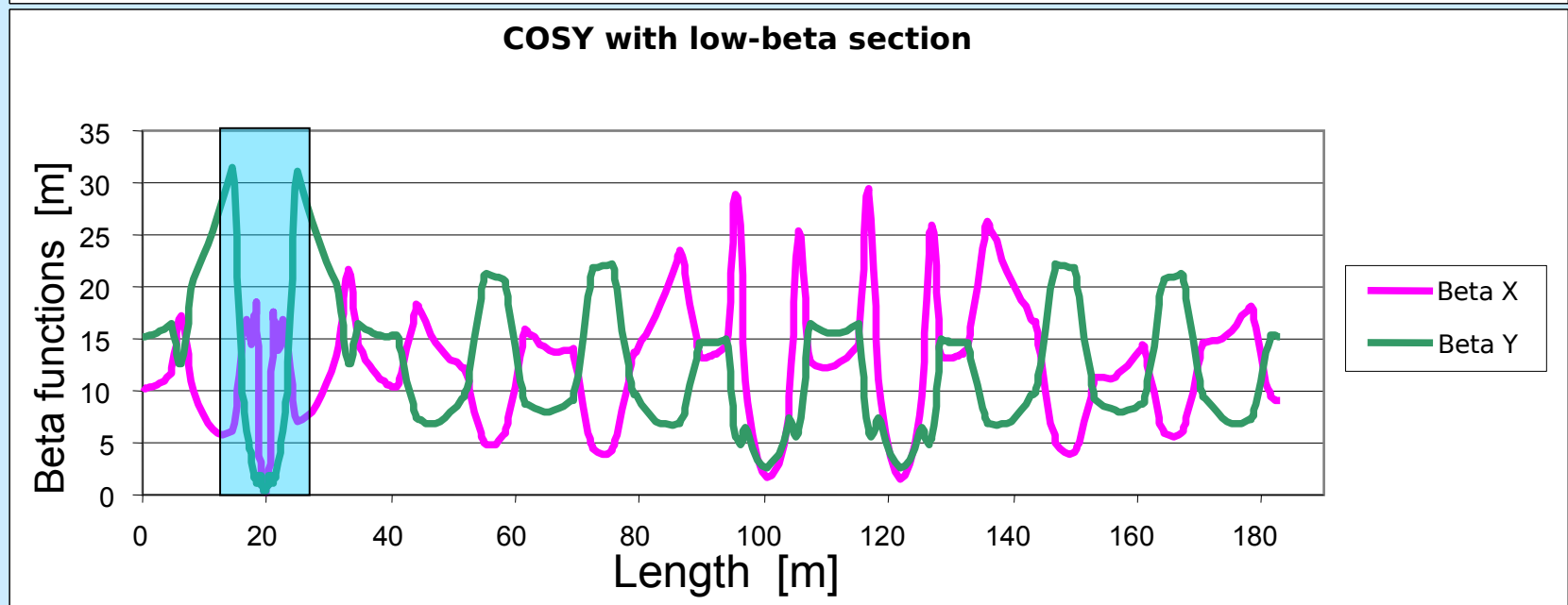
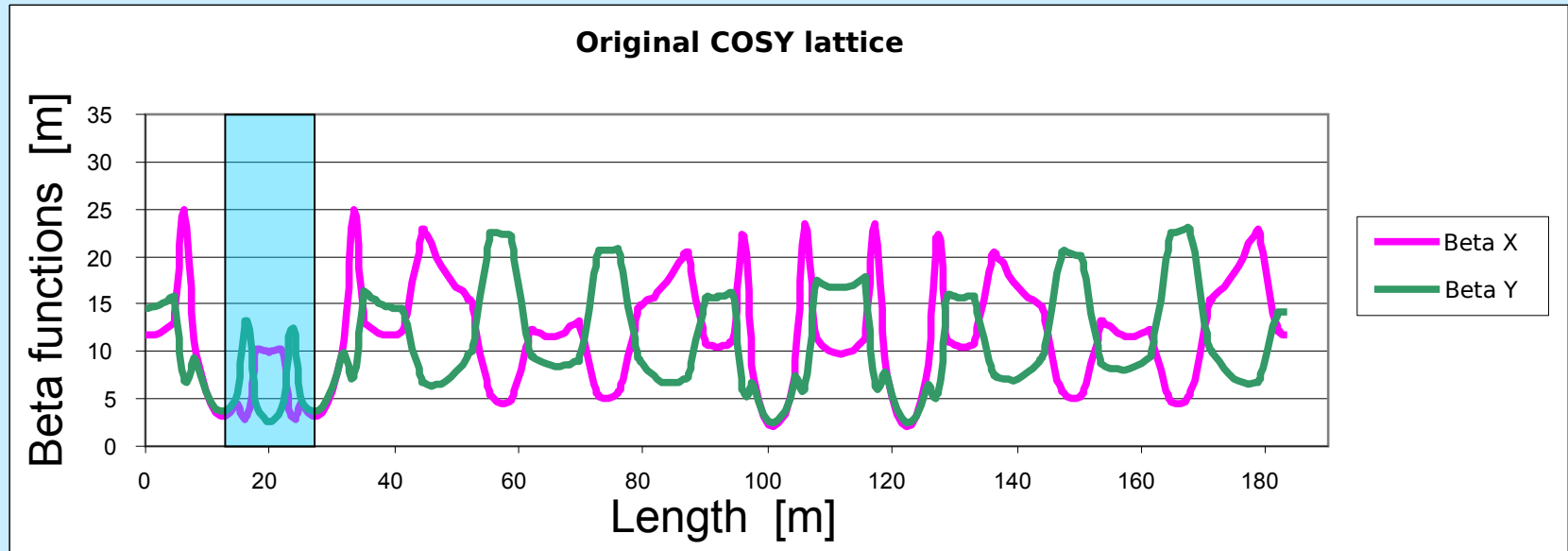


Low-Beta section @ COSY

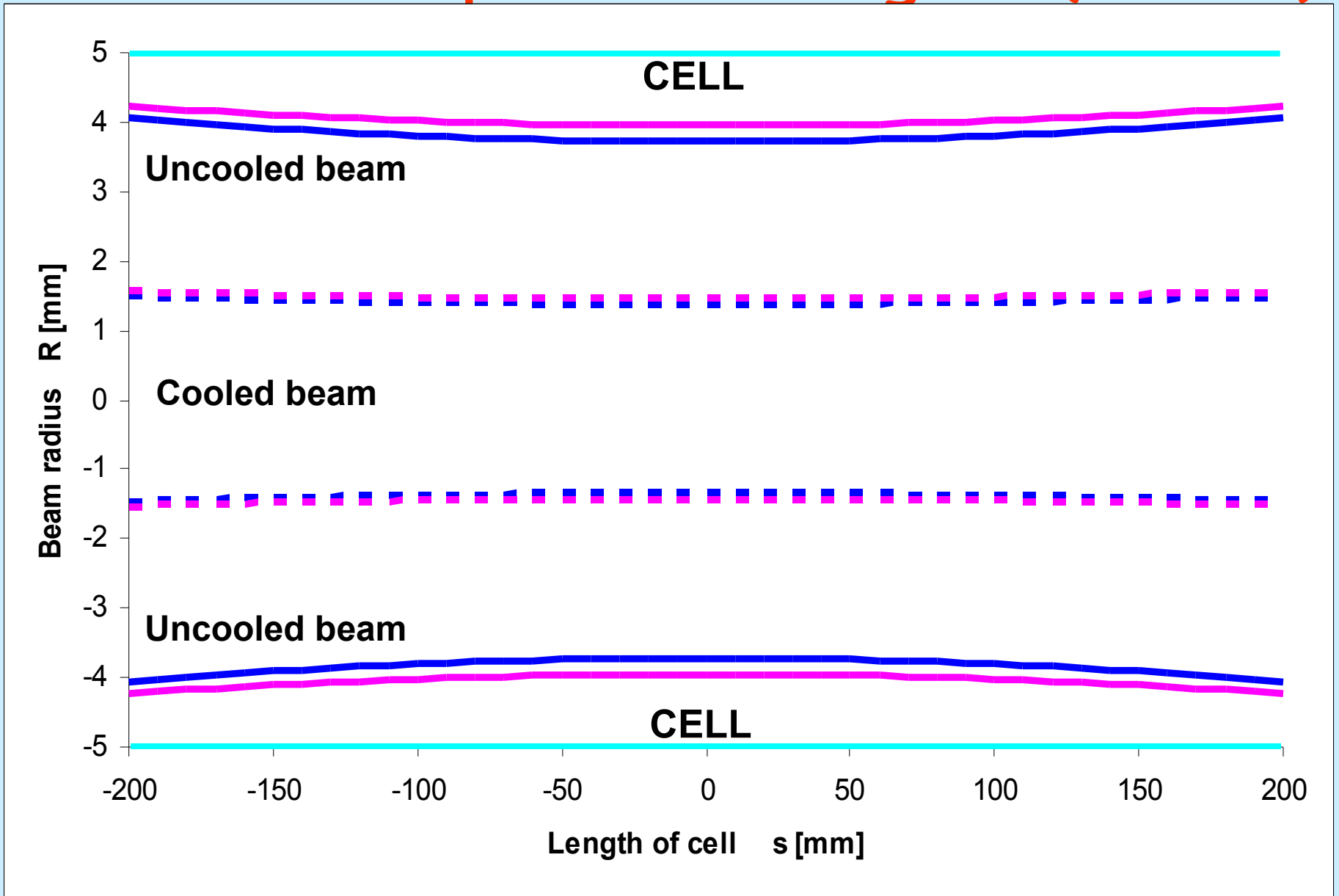


K- Quad 1	-4.43 m ⁻²
K- Quad 2	5.16 m ⁻²
K- Quad 3	4.54 m ⁻²
K- Quad 4	-4.43 m ⁻²
β_x (center)	0.46 m
β_y (center)	0.52 m

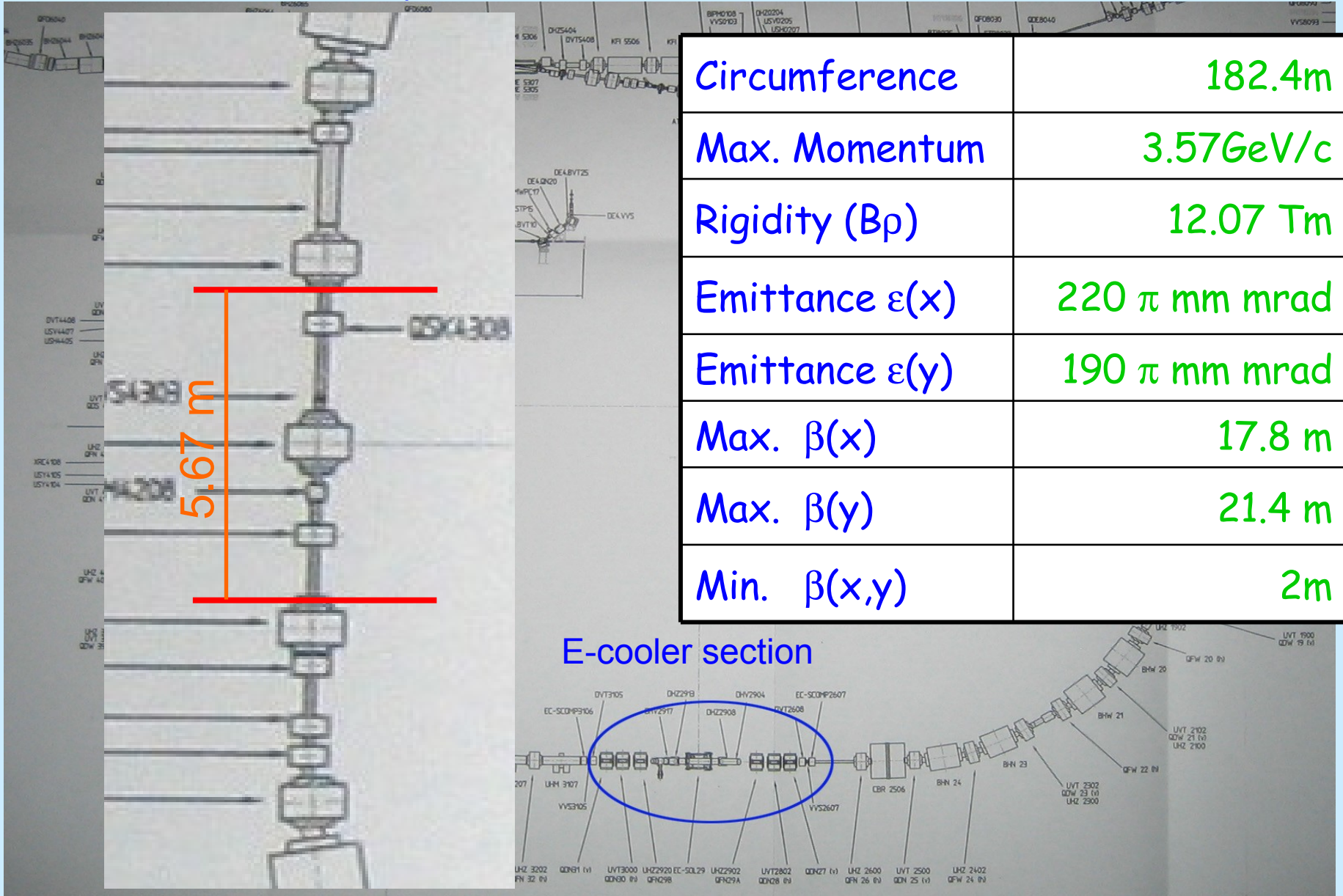
COSY lattice



Beam envelope in cell region (COSY)

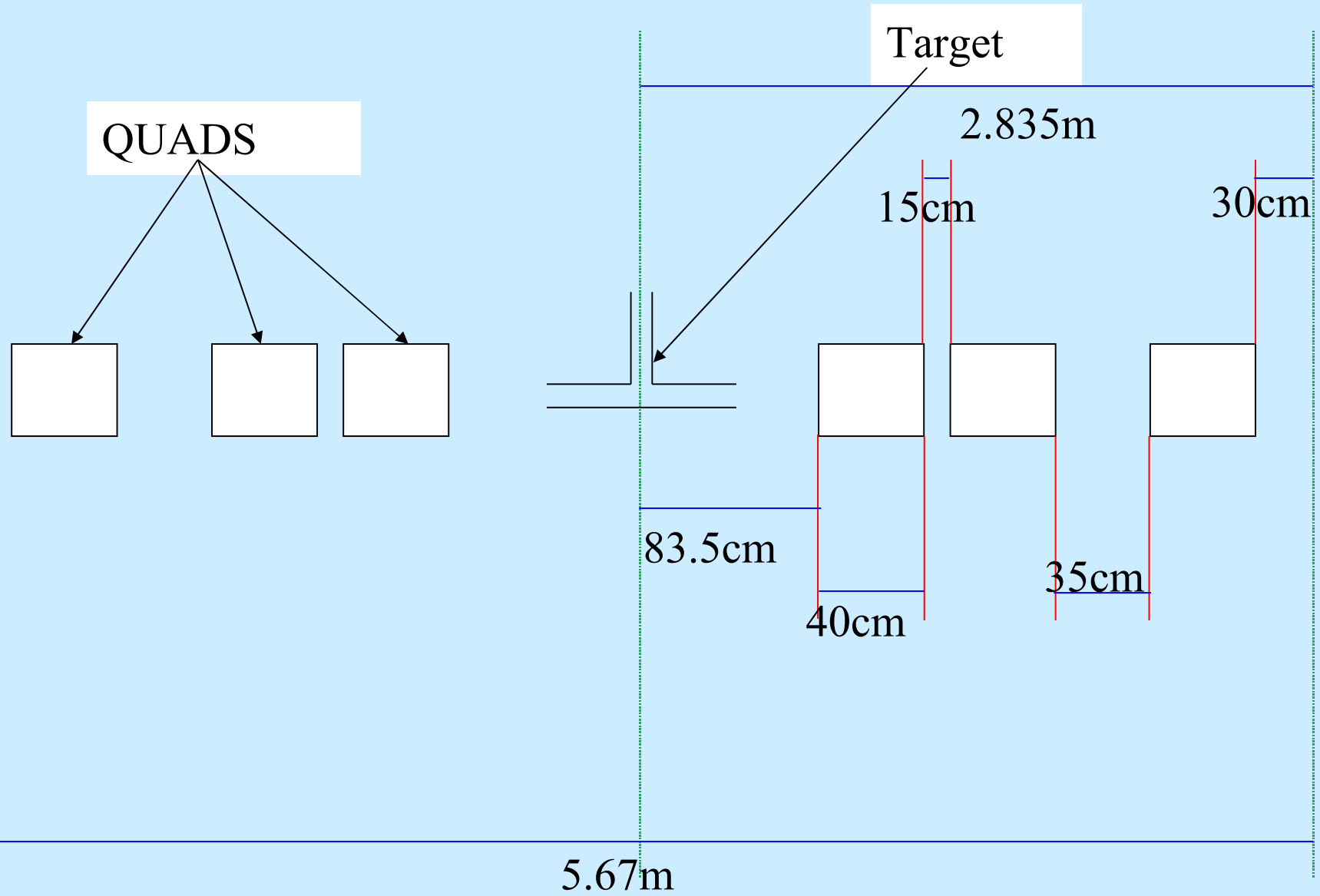


Antiproton Decelerator

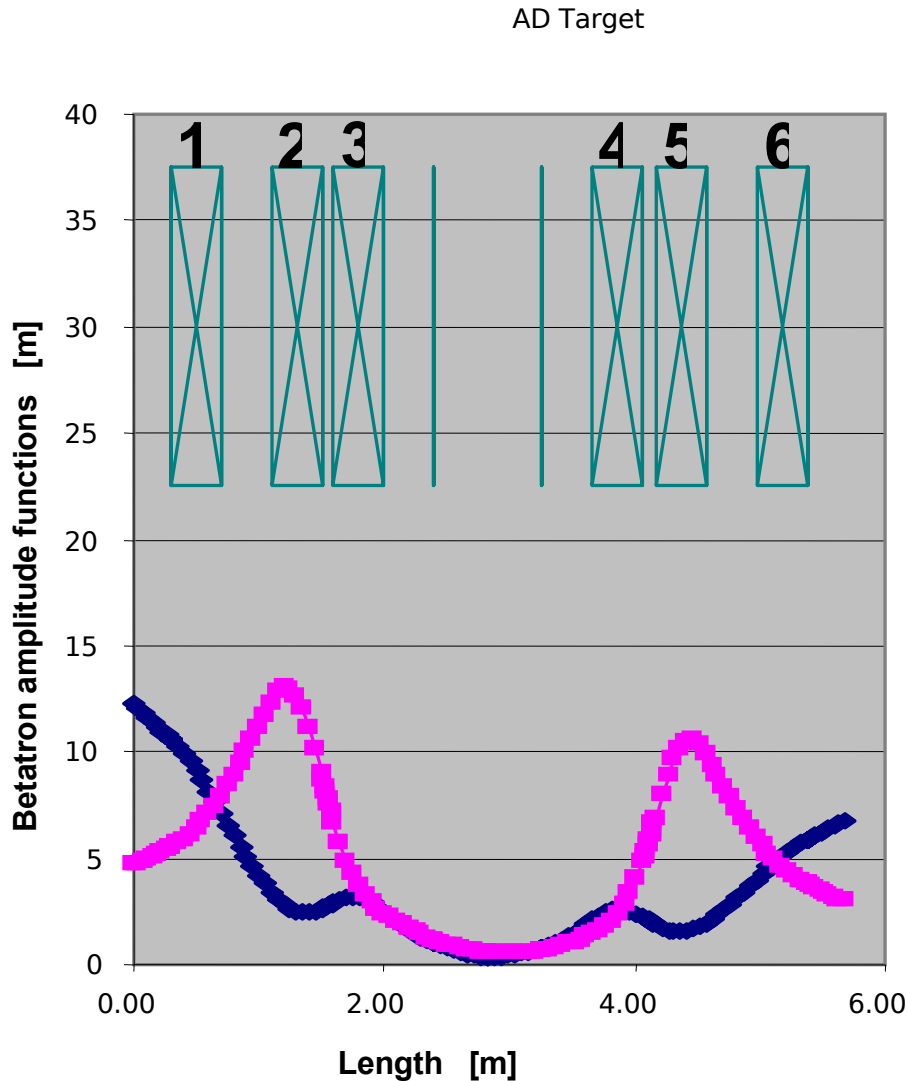


Circumference	182.4m
Max. Momentum	3.57GeV/c
Rigidity ($B\rho$)	12.07 Tm
Emittance $\varepsilon(x)$	220π mm mrad
Emittance $\varepsilon(y)$	190π mm mrad
Max. $\beta(x)$	17.8 m
Max. $\beta(y)$	21.4 m
Min. $\beta(x,y)$	2m

Low-beta section @ AD

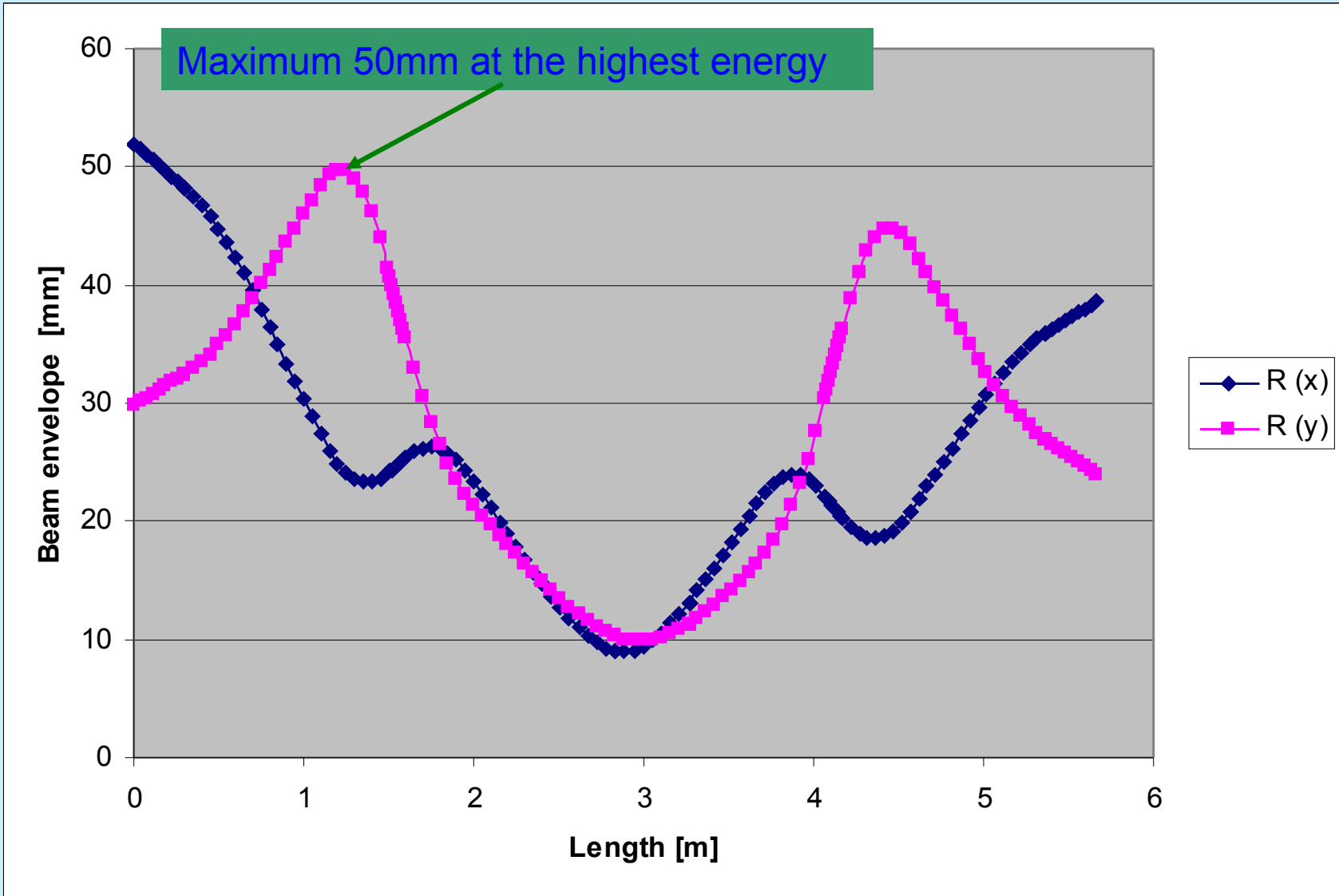


Low-beta section @ AD

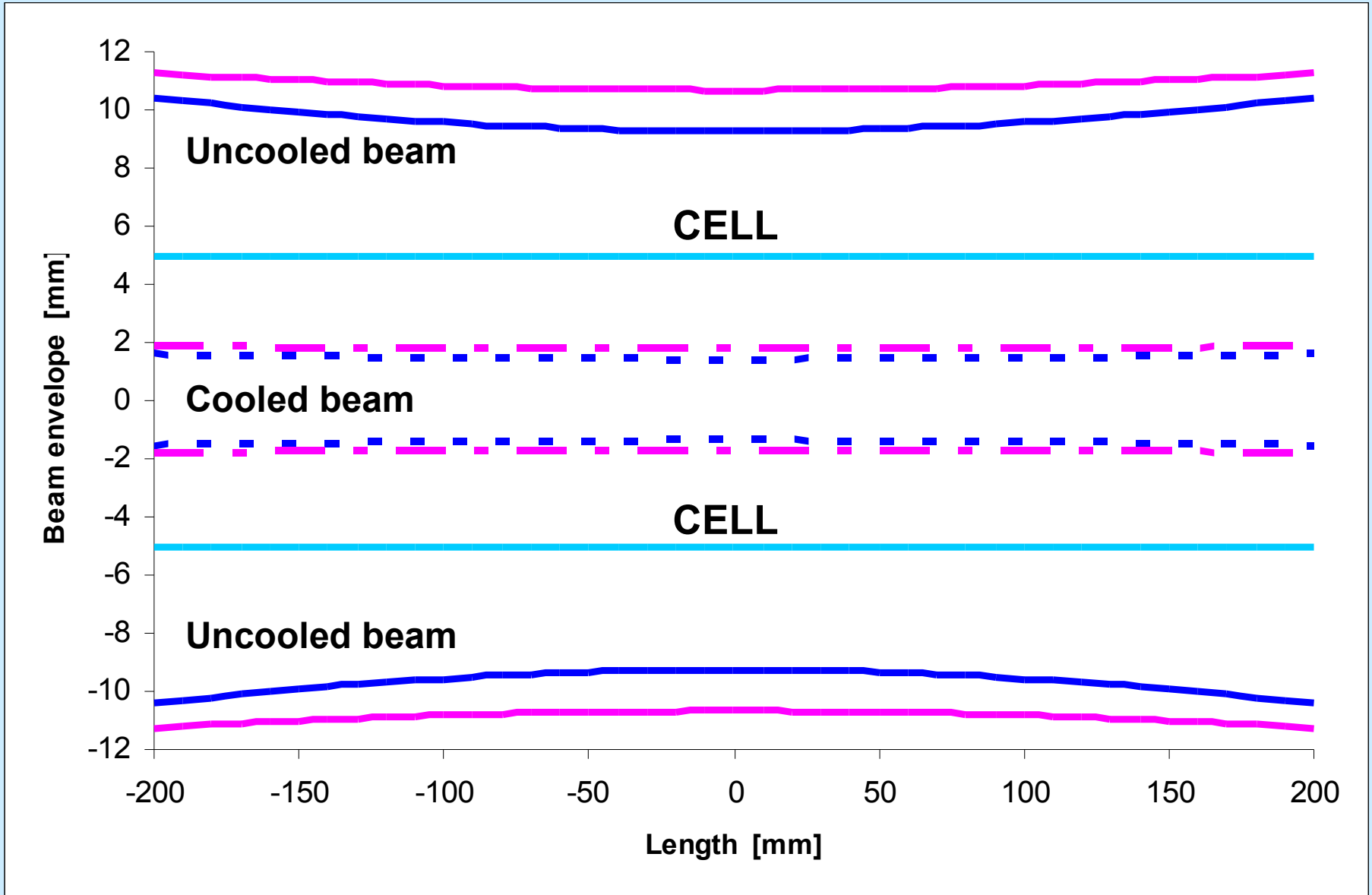


K- Quad 1	1.09 m ⁻²
K- Quad 2	-4.06 m ⁻²
K- Quad 3	3.32 m ⁻²
K- Quad 4	4.40 m ⁻²
K- Quad 5	-4.66 m ⁻²
K- Quad 6	1.21 m ⁻²
β_x (center)	0.39 m
β_y (center)	0.60 m
Max (β_x, β_y)	12.4 m

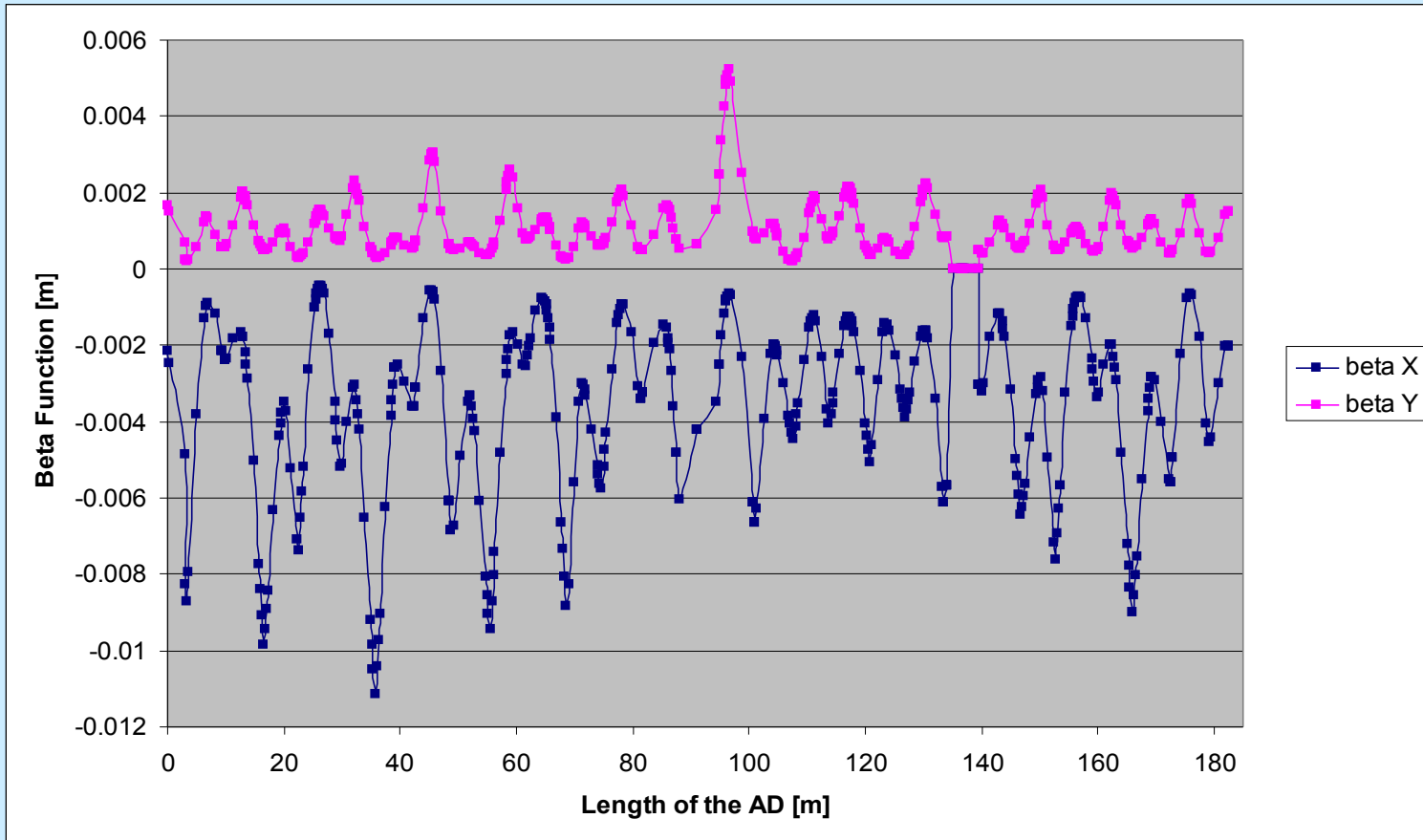
Beam envelope in low-beta section (AD)



Beam envelope in cell region (AD)



AD(original) Vs AD(low-beta)



Original AD tunes: $Q_x=5.45, Q_y=5.42$

AD tunes with low-beta: $Q_x=5.77, Q_y=5.75$

SC Quadrupole

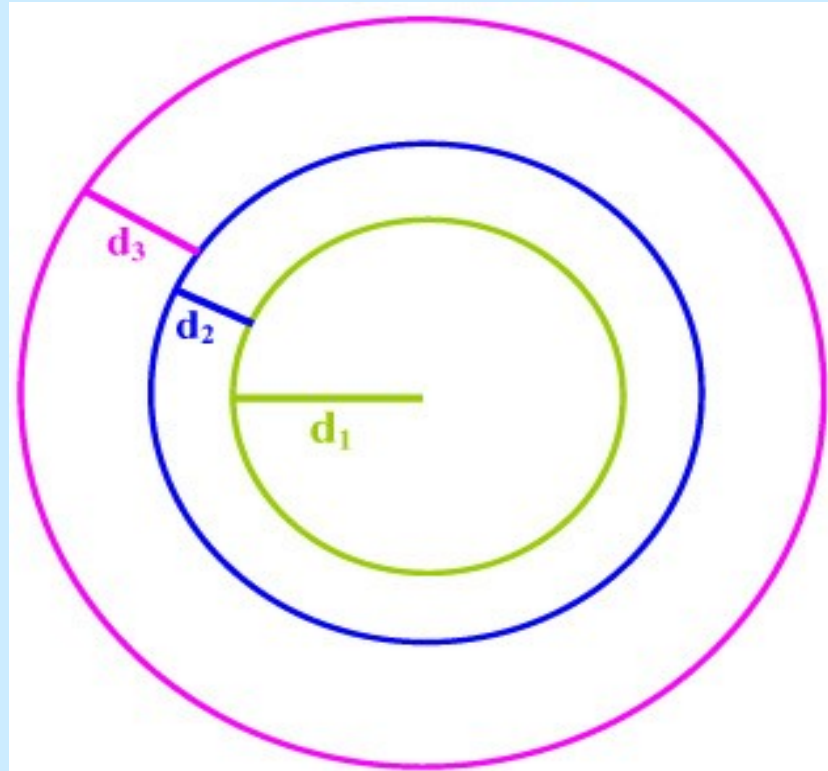
$$R_1 = d_1 + d_2 + d_3 = 67\text{mm}$$

Possible gradient

$$g = \frac{B_P}{R_1} \approx 83 \text{ T/m}$$

Requested gradient

$$g = K \cdot B \rho \approx 60 \text{ T/m}$$



d_1 – Max. beam envelope (50mm) + 10mm safety margin for closed orbit distortion

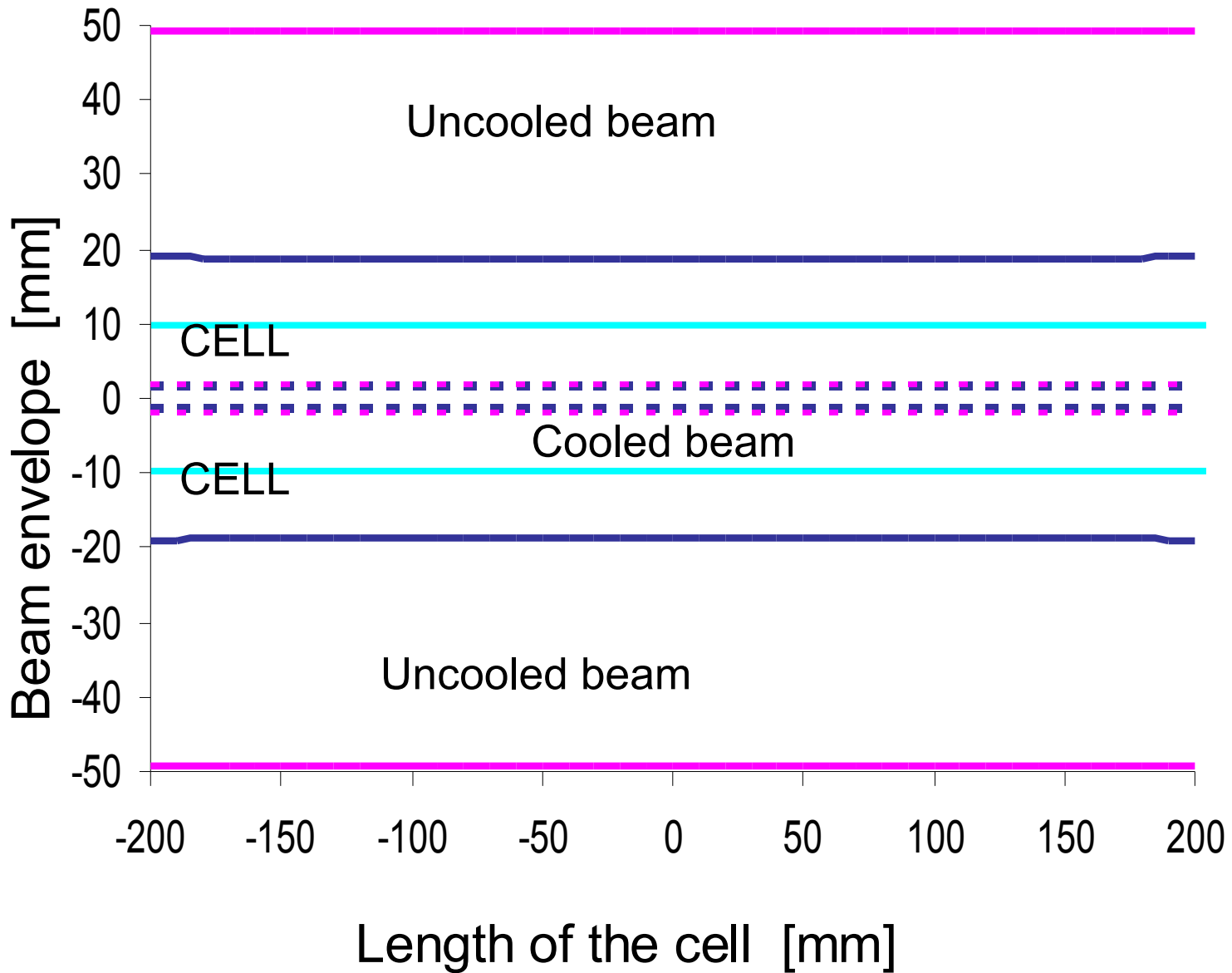
d_2 – space for vacuum chamber (2mm)

d_3 – (5mm) gap between vacuum chamber and the inner radius of current

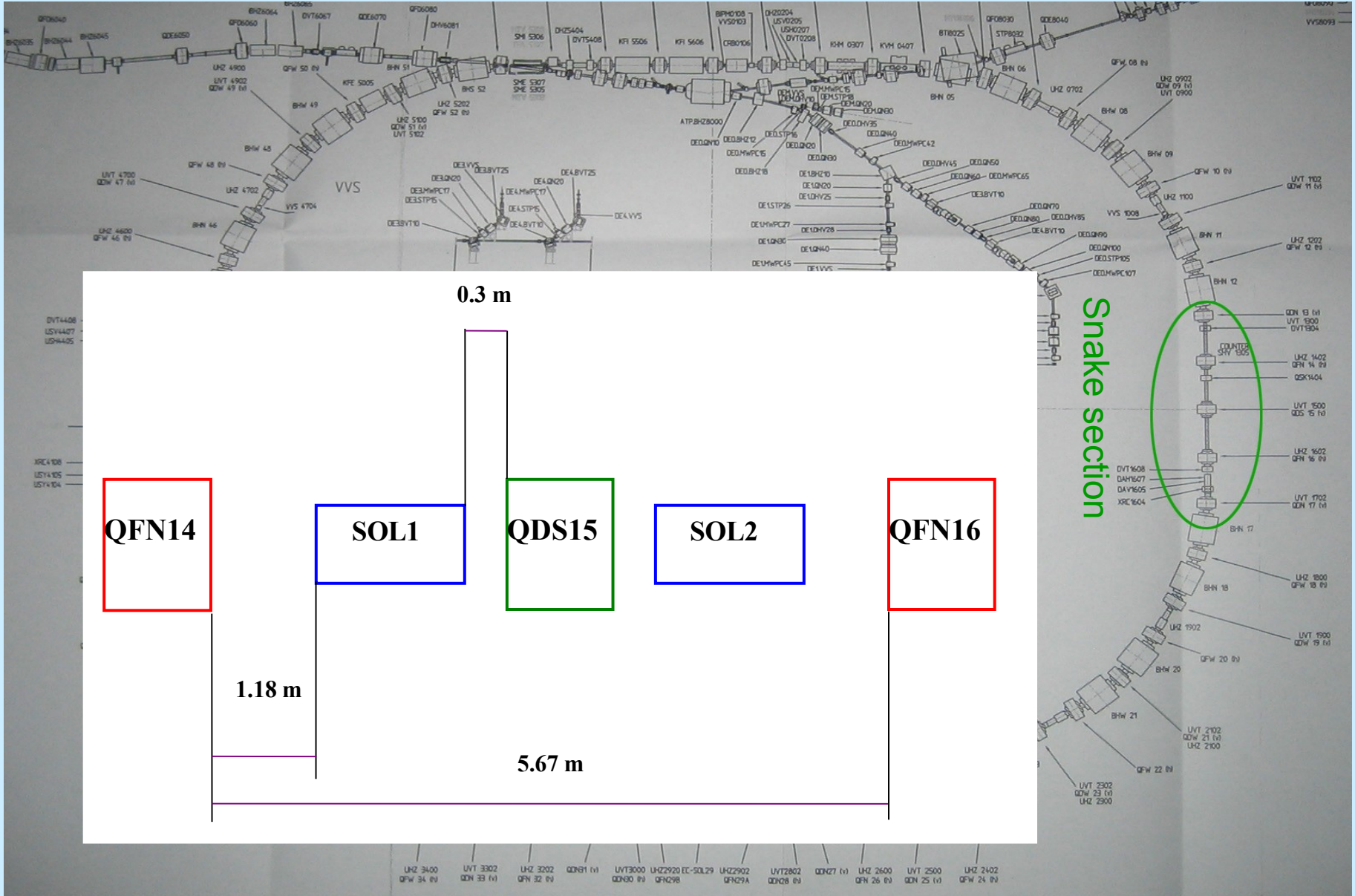
P. Beloshitskys proposal

Momentum GeV/c	3.57 - 0.6	0.6	0.6
Tunes: Q _x / Q _y	5.56 / 5.54	5.56 / 5.54	5.64 / 5.62
β_x and β_y at cell [m]	1.6 / 12.7	0.44 / 0.65	0.37 / 0.43
R _x and R _y at cell [mm]	18.9/49.1	1.48 / 1.80	1.36 / 1.47

	3.57	0.6 (arrival)	0.6 (squeezed)
Quad 1 T/m	6.1	1.0	3.5
Quad 2 T/m	5.8	0.96	8.7
Quad 3 T/m	4.6	0.78	5.1
Quad 4 T/m	17.3	2.9	8.0
Quad 5 T/m	12.9	2.2	9.6
Quad 6 T/m	1.1	0.2	2.6



Snake section at the AD



Field of the solenoid

$$\chi = (1 + G) / B\rho \cdot \int B dL$$

Field of solenoid roughly 2 T
at 500 MeV

Strength of solenoid

$$KS = \frac{B}{B\rho} \approx -0.56 \text{ m}^{-2}$$

Summary

- Low-beta section can be realized at COSY as well as at the AD
- SC magnets do not affect the telescopic setup of the COSY straight section
- At the AD cell has to be opened by about 10 cm in vertical plane

Outlook

- For measuring longitudinal spin-dependent cross-section at the AD has to be installed Siberian snake
- Design of Siberian snake
- Optimization of the AD working point with inserted low-beta and snake sections