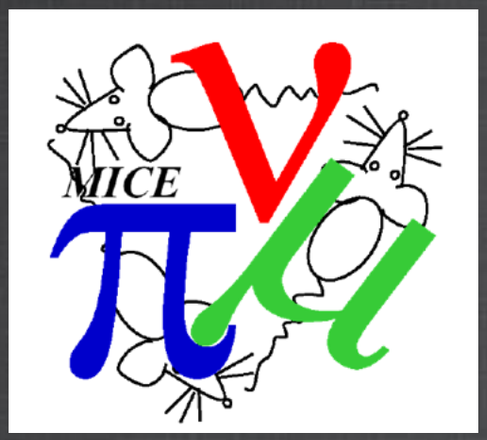

MICE Demonstration of Ionization Cooling

JB. Lagrange[1,2], J. Pasternak[1,3]

(1): Imperial College, UK
(2): FNAL, US
(3): ISIS-RAL-STFC, UK

Outline

- Lattice
- Simulations
  - Lattice length optimization
  - 200 MeV/c settings
  - 140 MeV/c settings
  - 240 MeV/c settings
- Simulations with M1=0
- Summary

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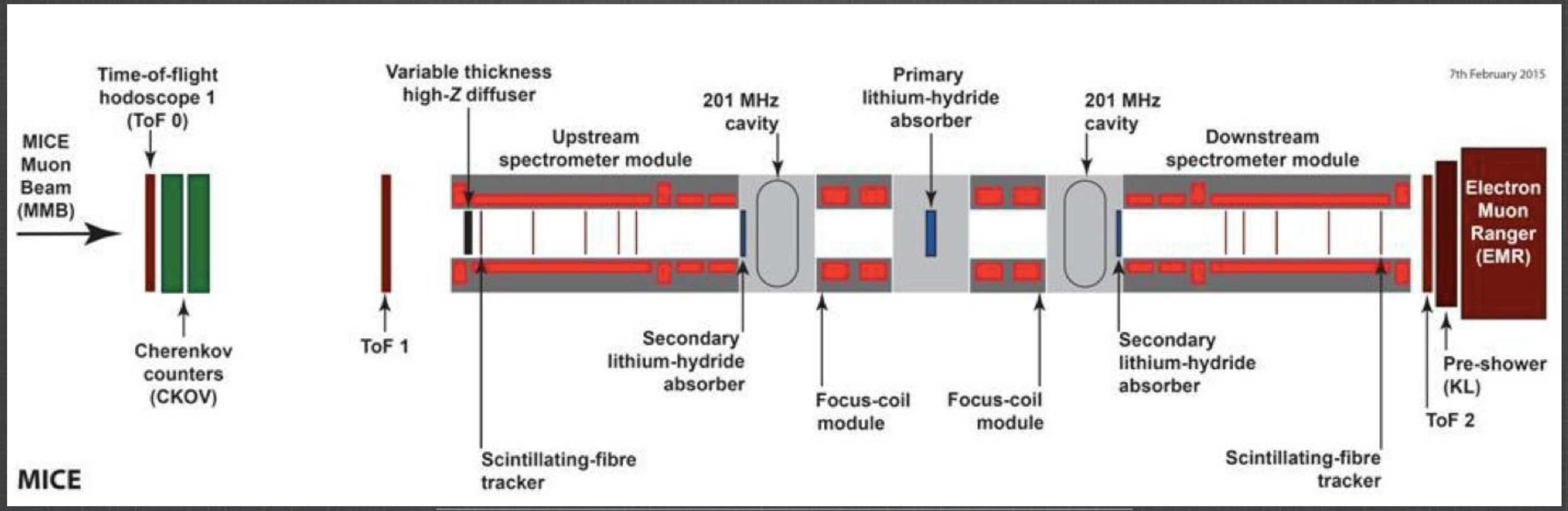
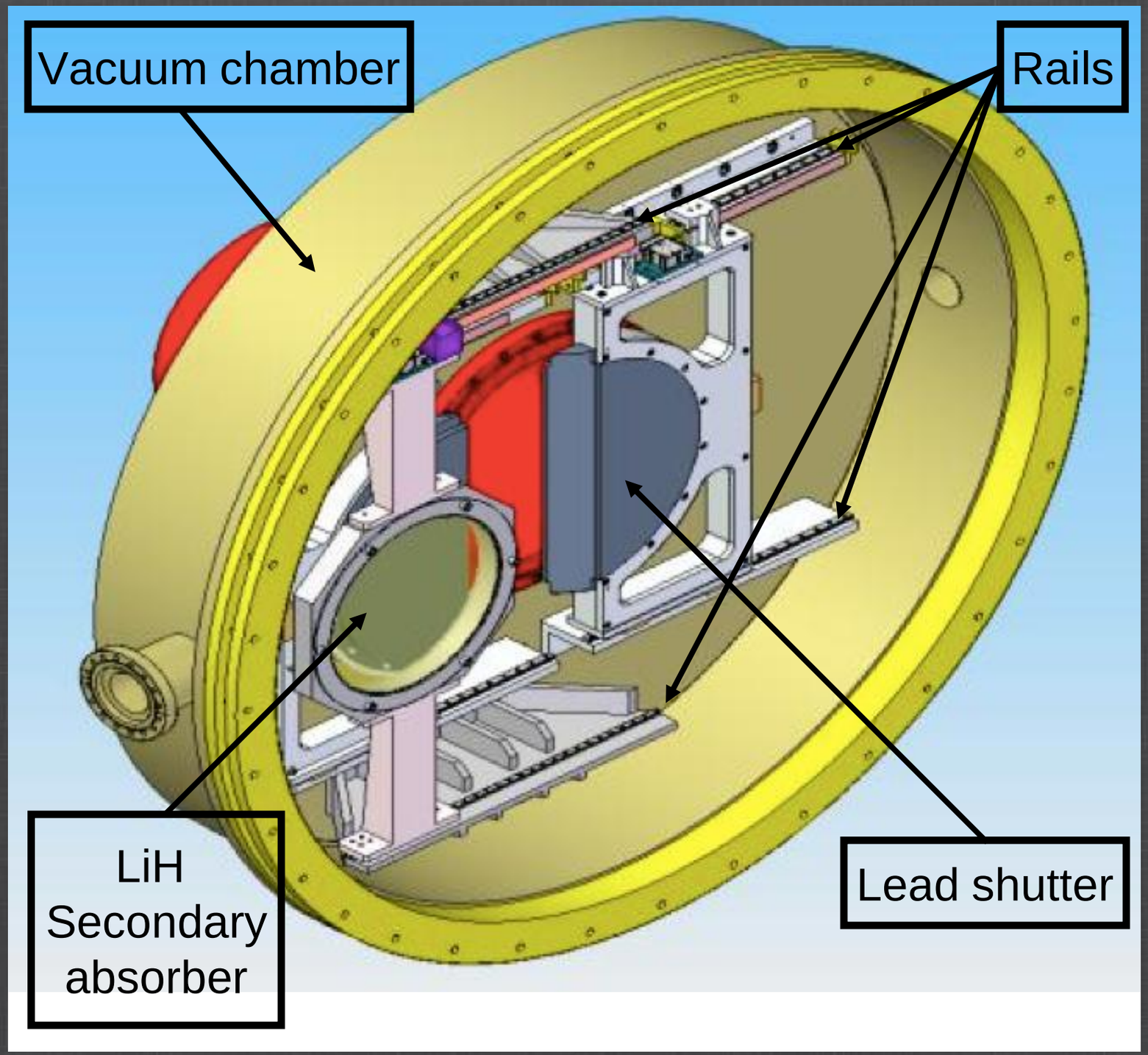
Demo Lattice



Parameter	Value
$L_{SS \to AFC}$ (mm)	2607.5
$L_{AFC \to AFC}$ (mm)	1678.8
$L_{RFmodule \to AFC}$ (mm)	784.0
RF Gradient (MV/m)	10.3
No. RF cavities	2
No. primary absorbers	1
No. secondary absorbers	2

Radiation shutter and movable secondary LiH absorber.



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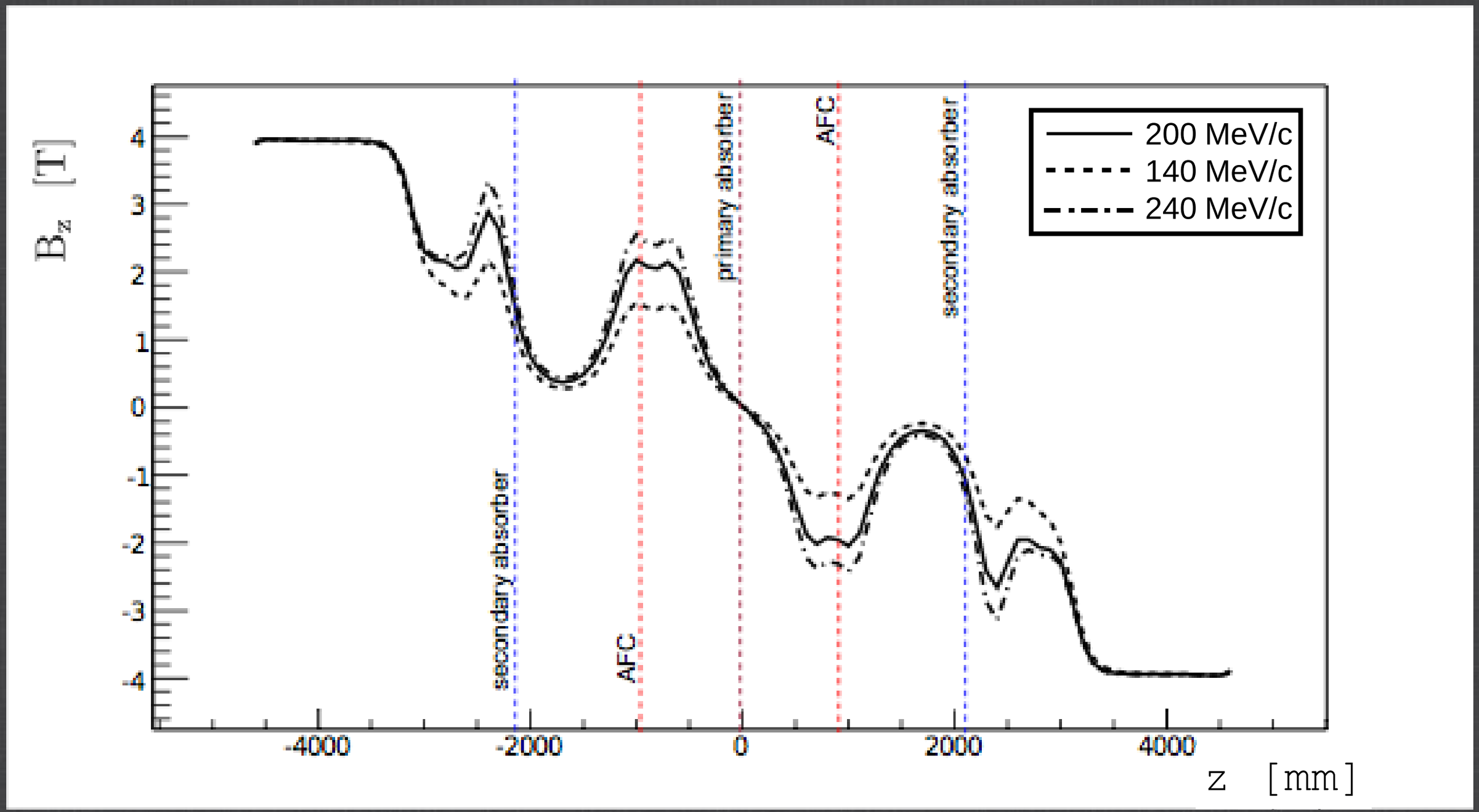
Initial beam

Parameter	Value
PDG particle ID	-13
Number of particles	10000
Longitudinal position [mm]	-4612.1
Central energy (140/200/240 MeV/c) [MeV]	175.4/228.0/262.2
Gaussian transverse distribution	
$\alpha_\perp$	0
$\beta_\perp$ (140/200/240 MeV/c) [mm]	233.5/339.0/400.3
Gaussian longitudinal distribution	
Longitudinal emittance [mm]	20
Longitudinal β [mm]	11
Longitudinal α	-0.7
rms momentum spread	$\pm 4\%$

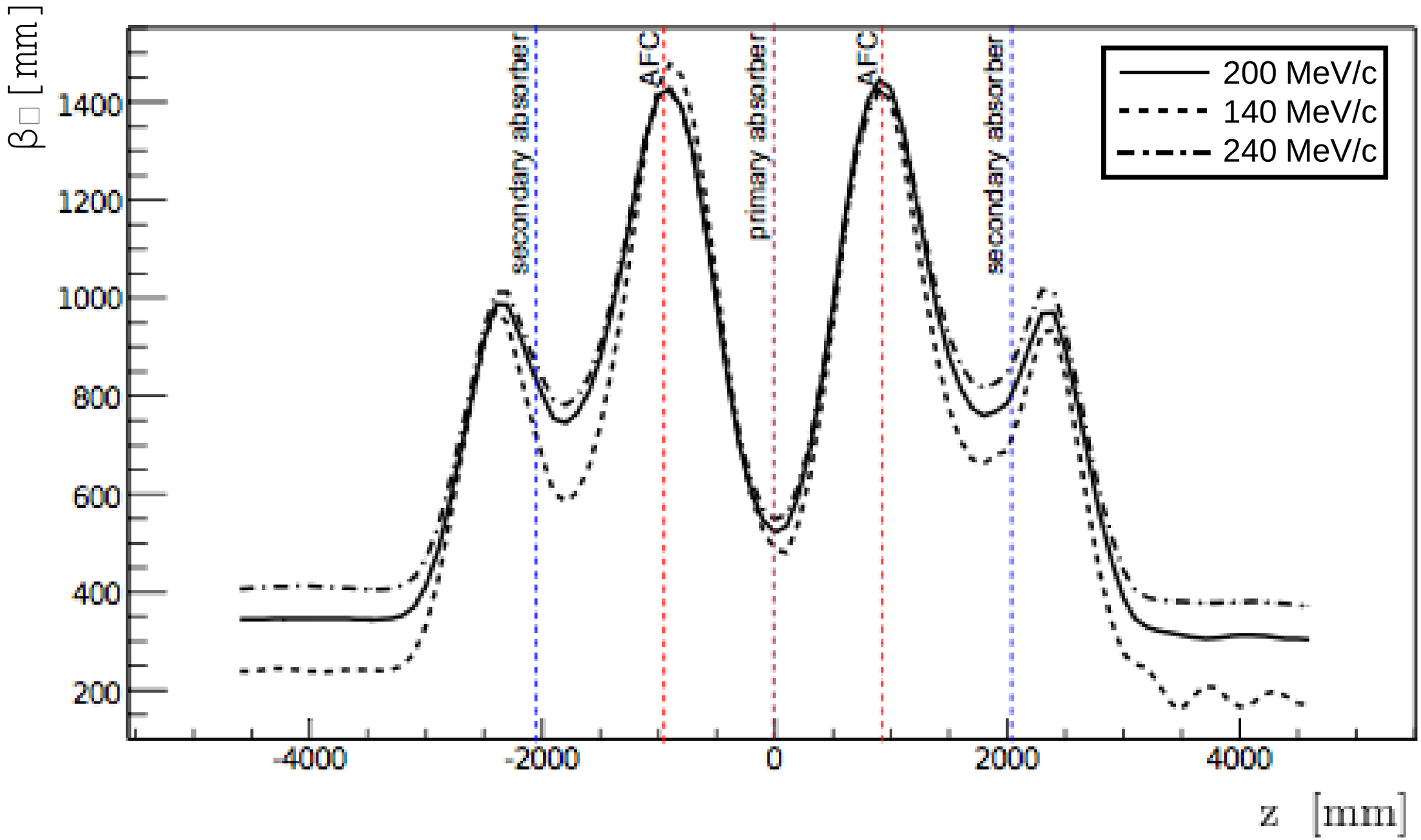
Cuts

Parameter	Muon accepted
Radius at upstream tracker (mm)	≤ 150.0
Radius at downstream tracker (mm)	≤ 150.0
Charge	$+$
PDG particle ID	$\lvert 13 \rvert$

Magnetic field on axis



Transverse Beta



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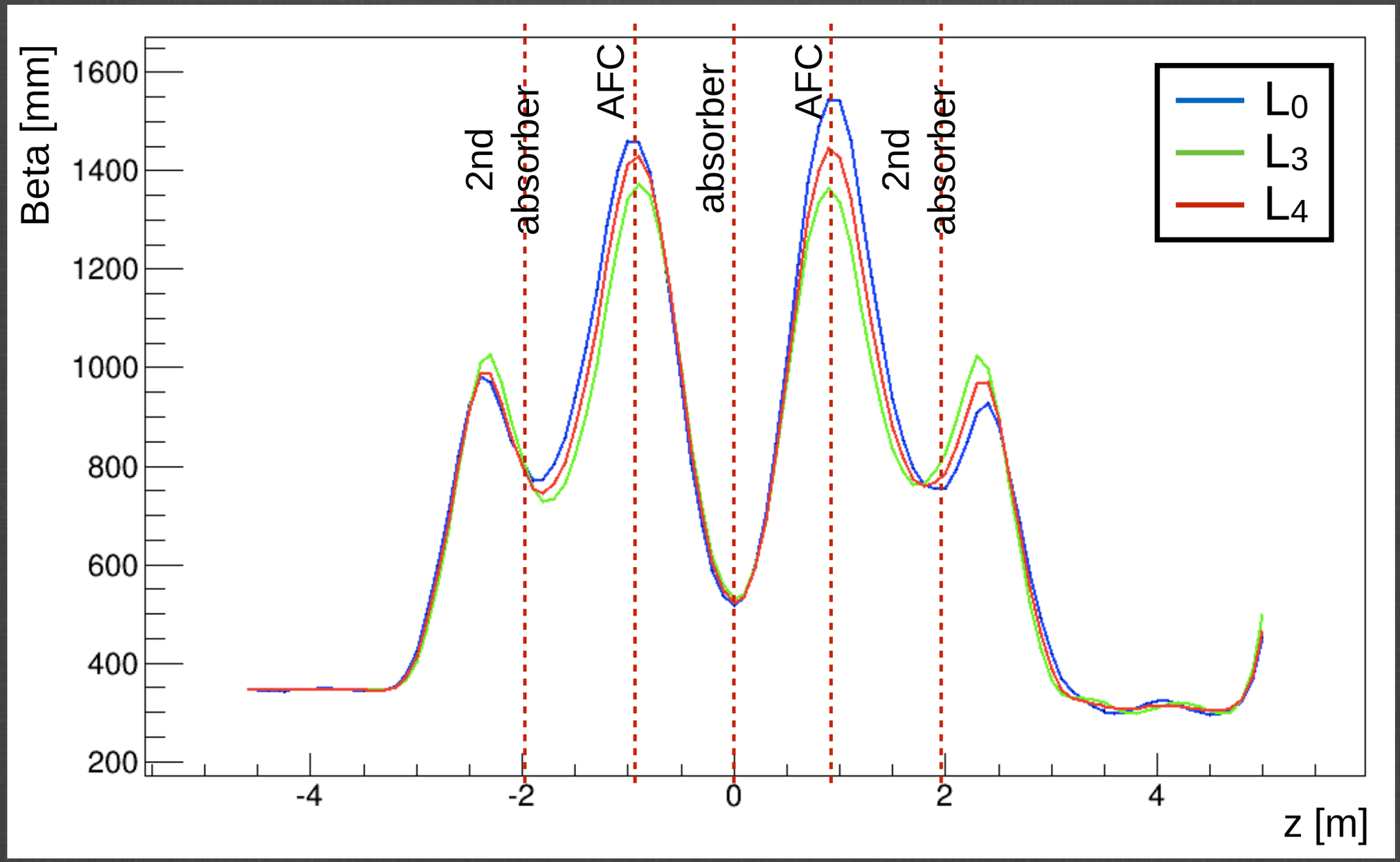
AFC - AFC Length

- Different lengths have been tested
  - L_0=1725.5 mm (updated CM41 lattice)
  - L_1=1349.0 mm (L_0-376.5 mm)
  - L_2=1538.5 mm (L_0-187.0 mm)
  - L_3=1632.0 mm (L_0-93.5 mm)
  - L_4=1678.8 mm (L_0-46.7 mm)

- Best performances for length L_0, L_3 & L_4.
  ⇨ L_4 is the best lattice.

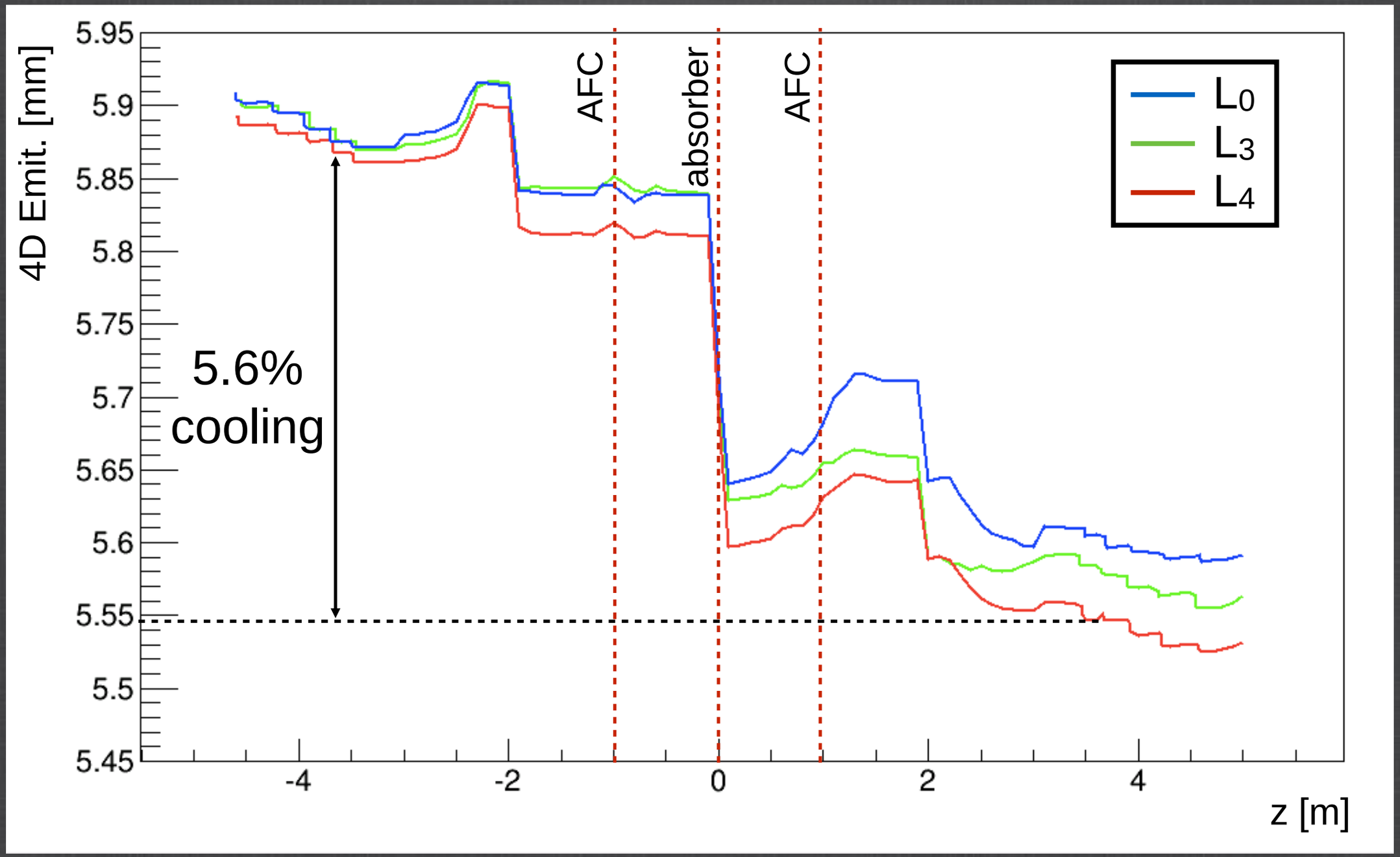
AFC-AFC Optimization

Transverse beta



AFC-AFC Optimization

4D emittance



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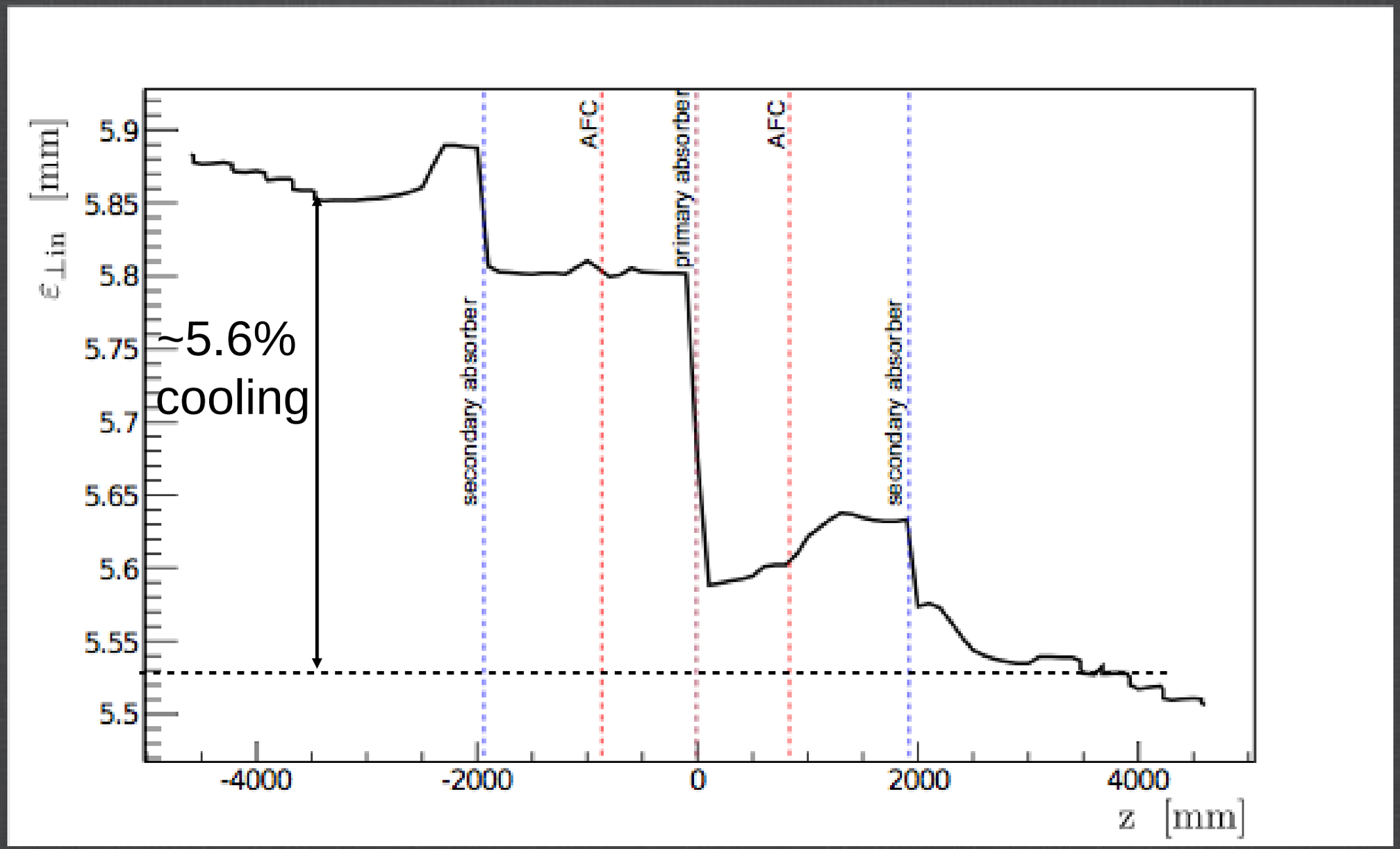
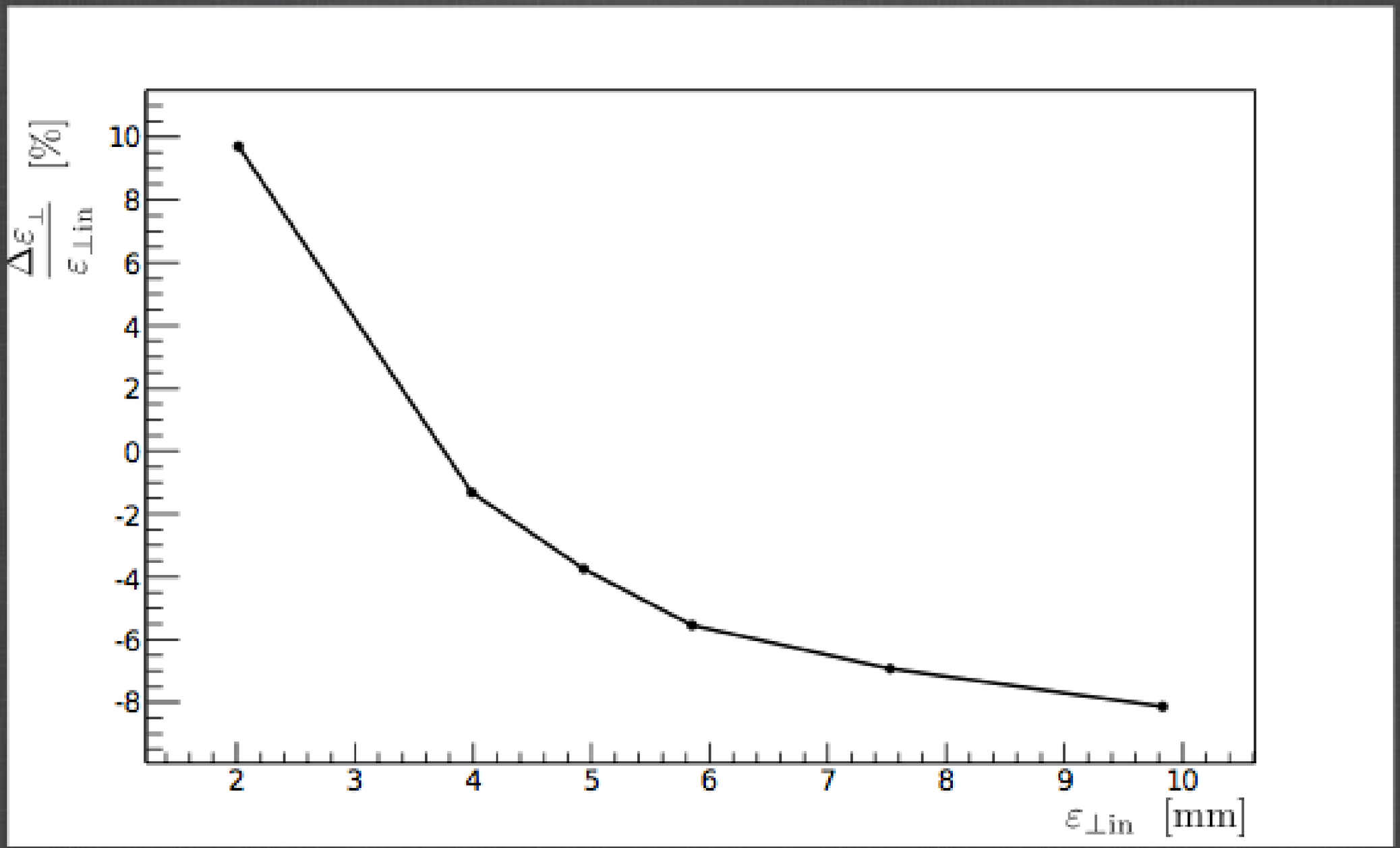
200 MeV/c settings

4D emittance (initial 6.0 mm)



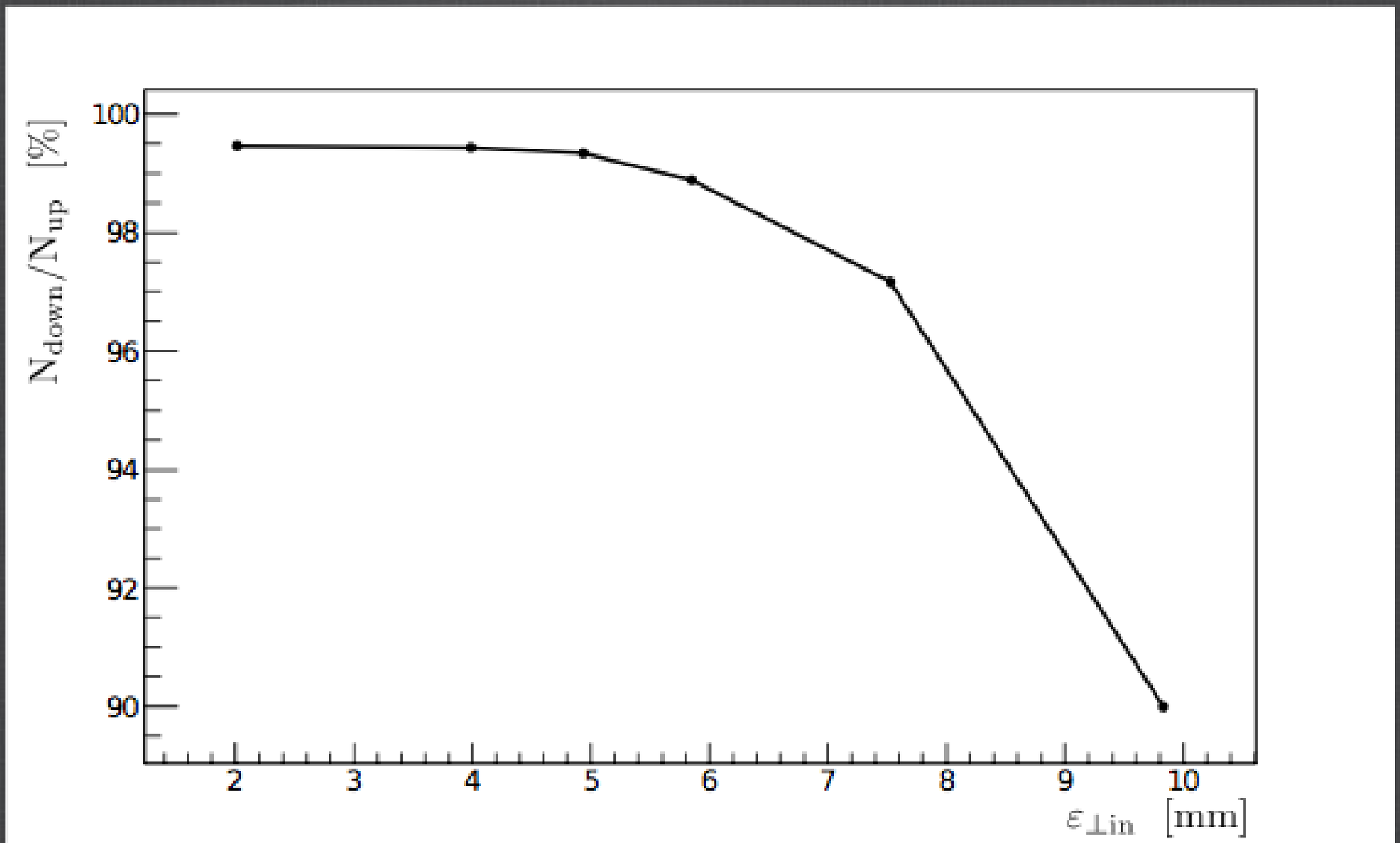
200 MeV/c settings

Performance vs initial emittance



200 MeV/c settings

Transmission



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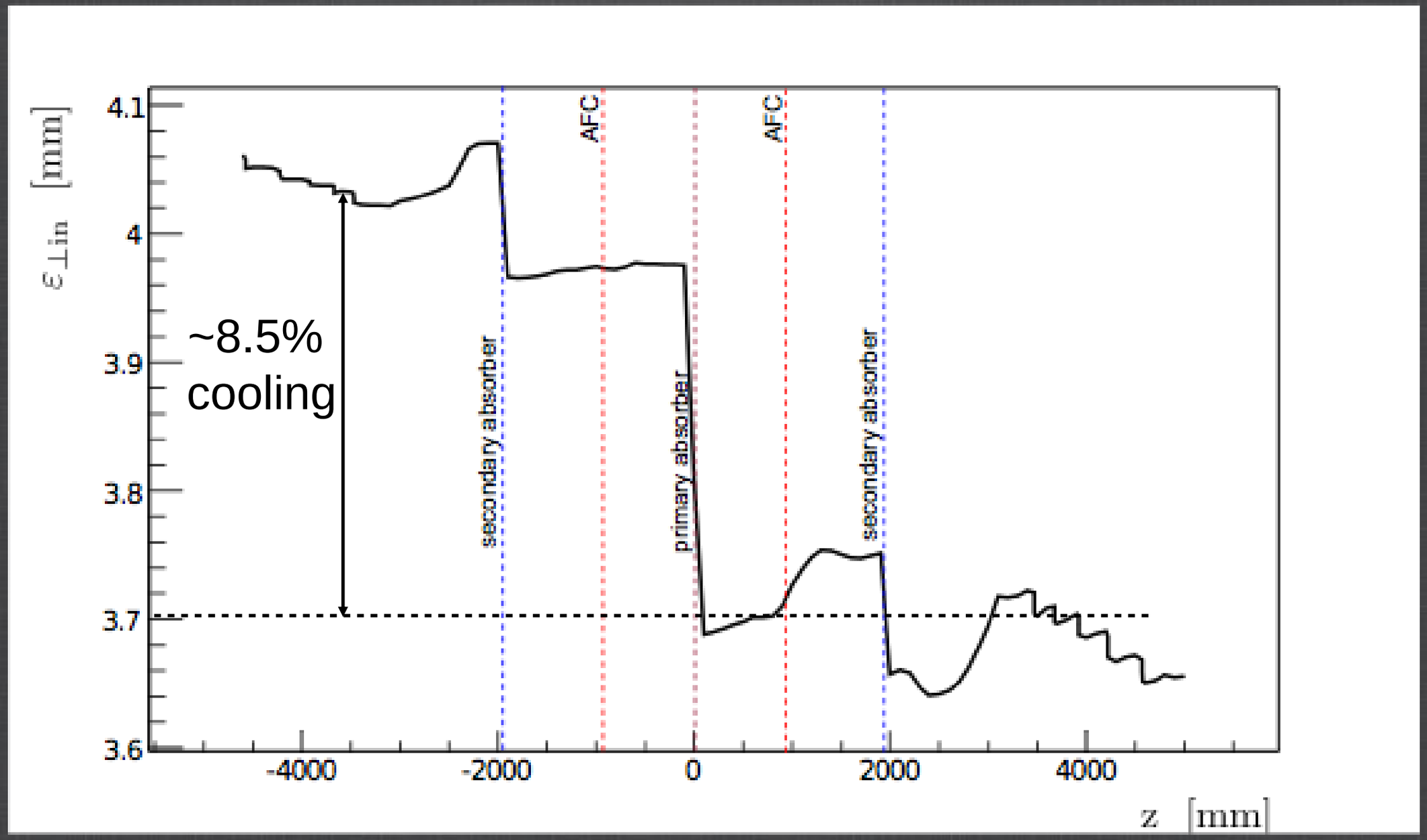
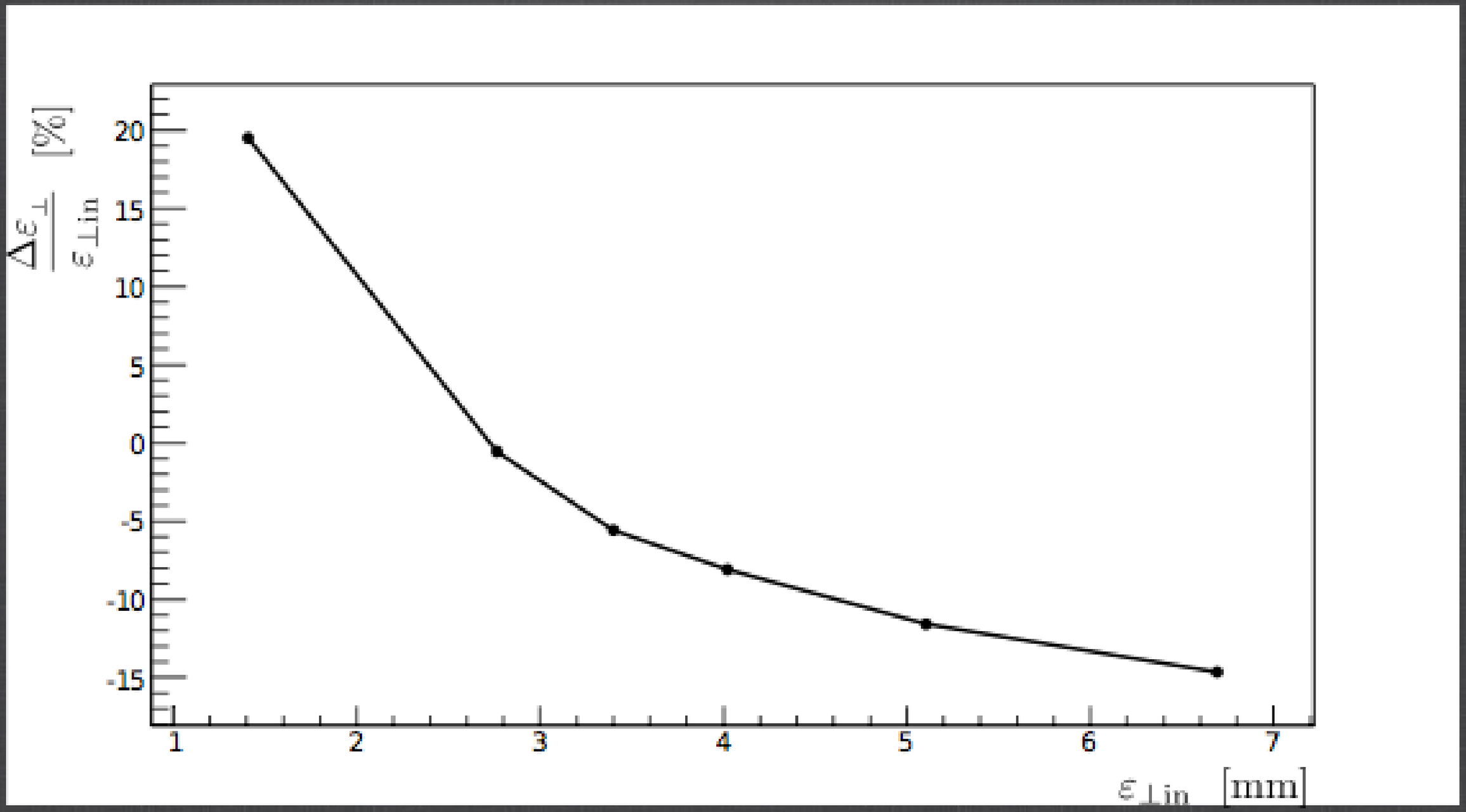
140 MeV/c settings

4D emittance (initial 4.2 mm)



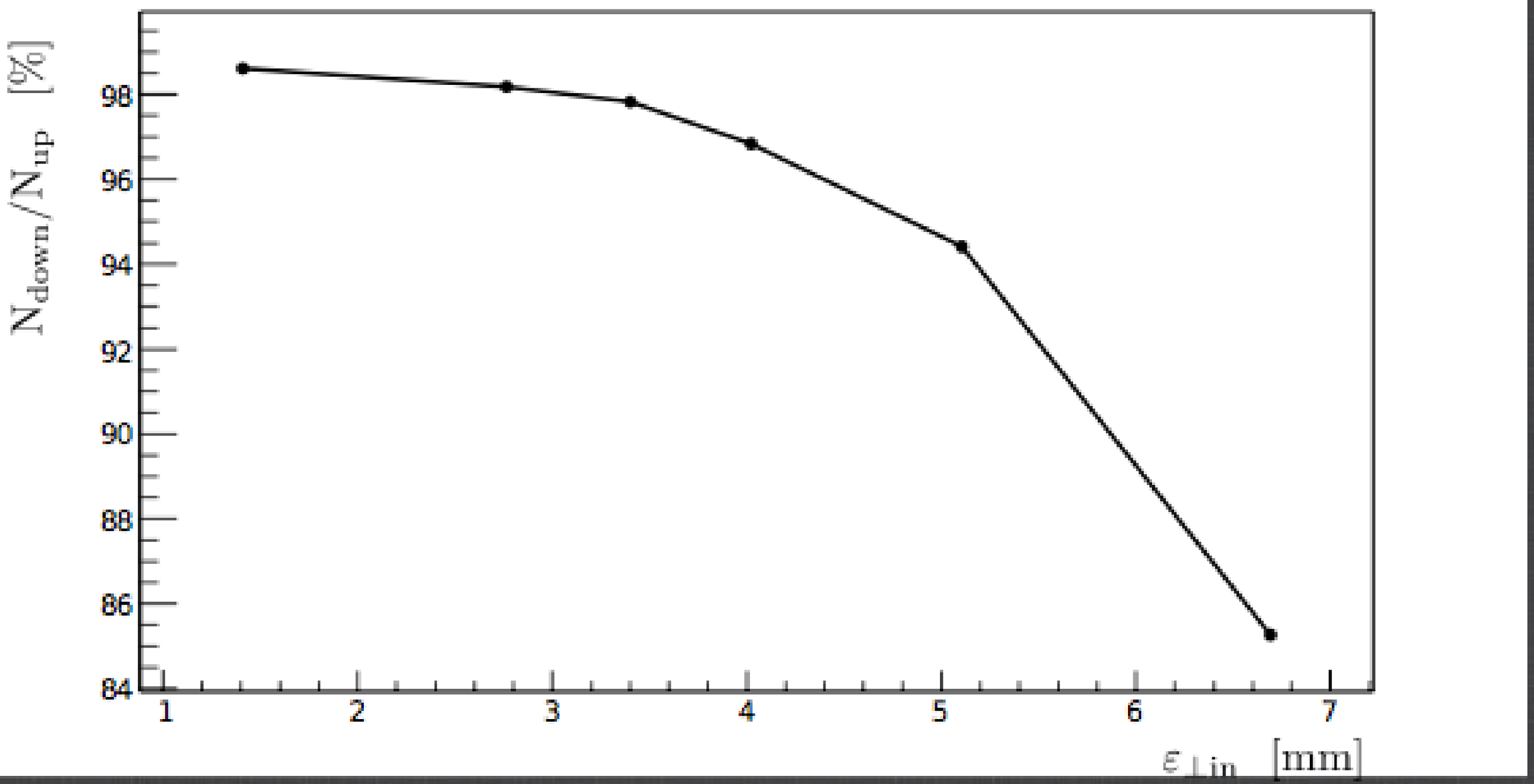
140 MeV/c settings

Performance vs initial emittance



140 MeV/c settings

Transmission



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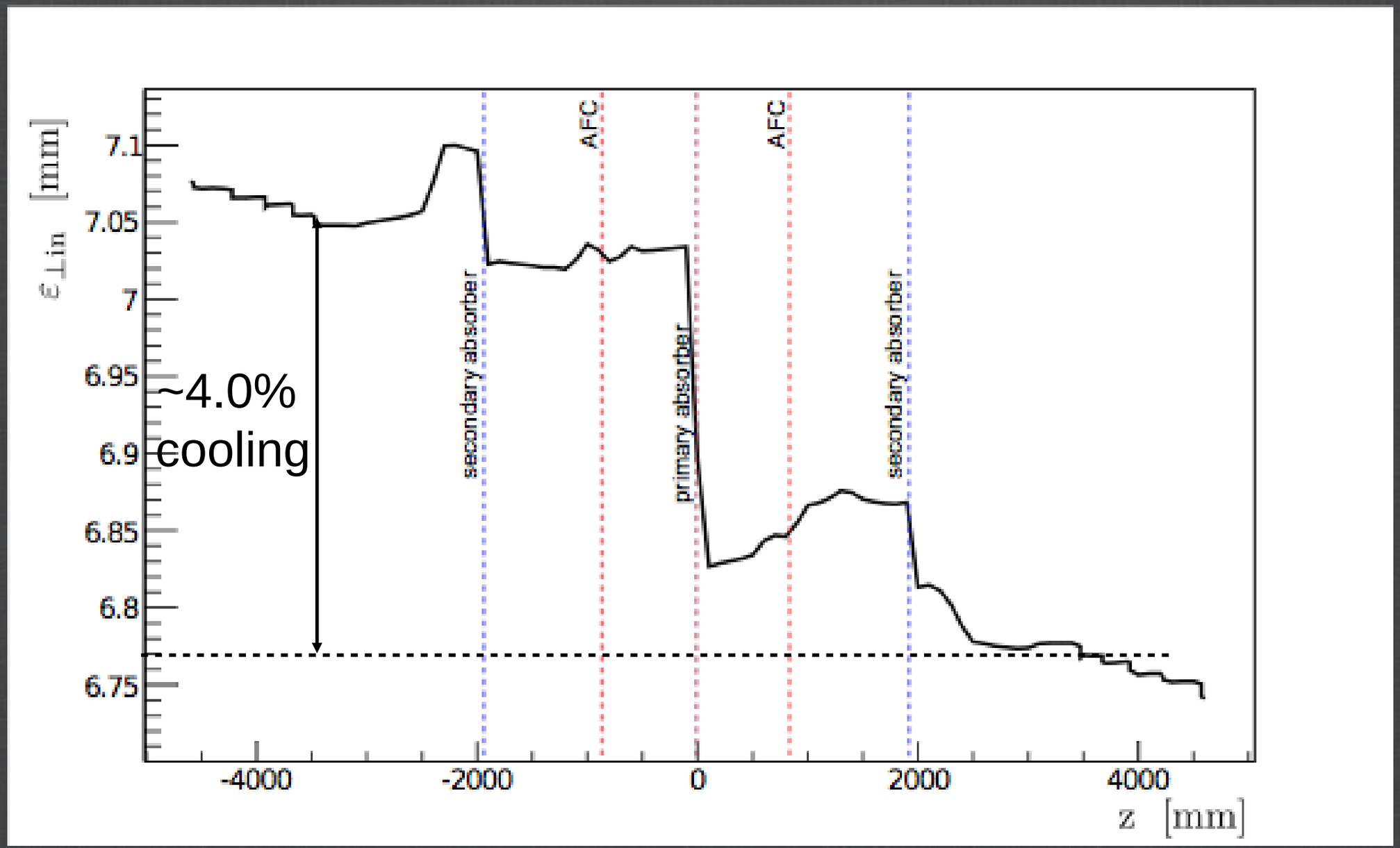
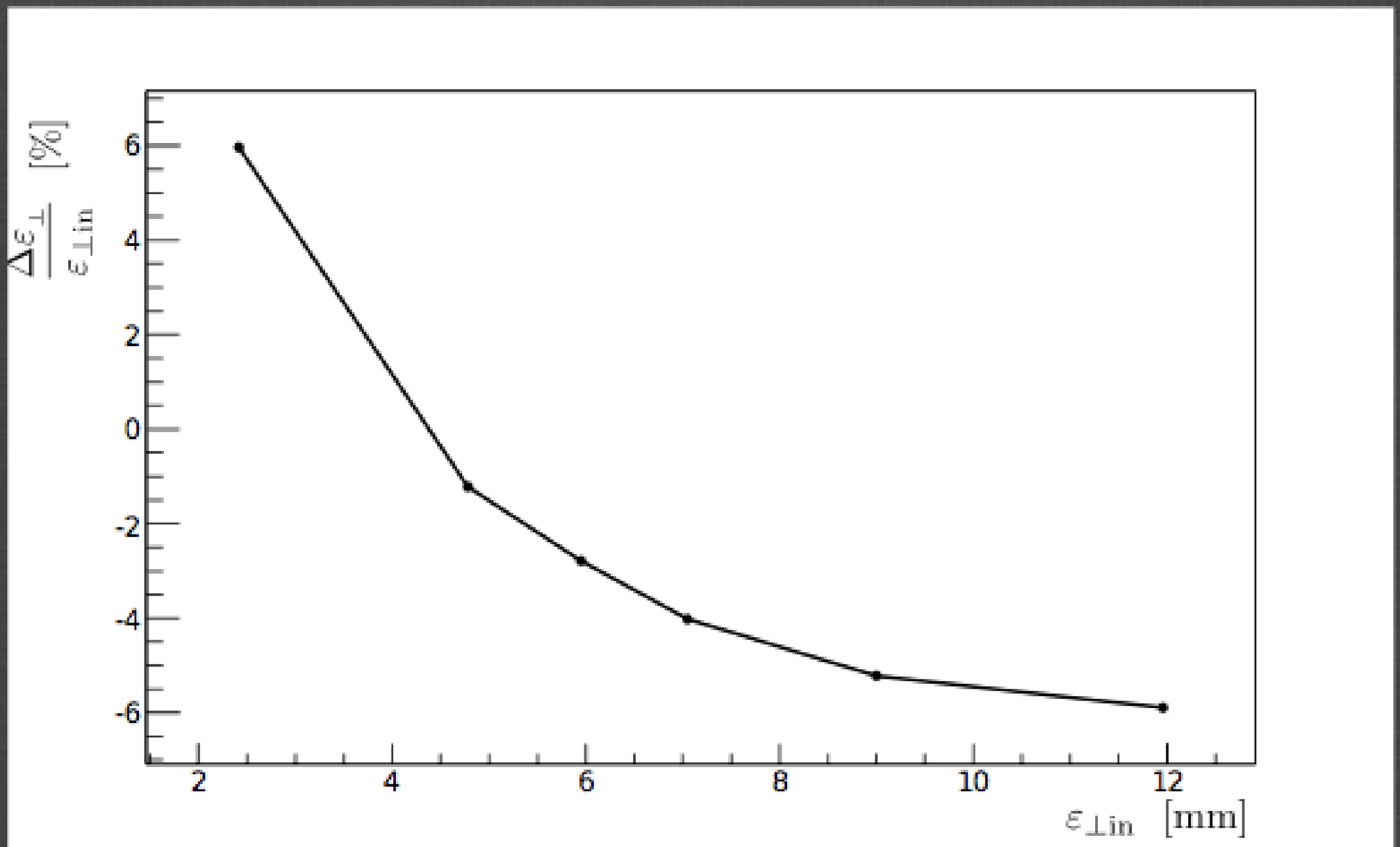
240 MeV/c settings

4D emittance (initial 7.2 mm)



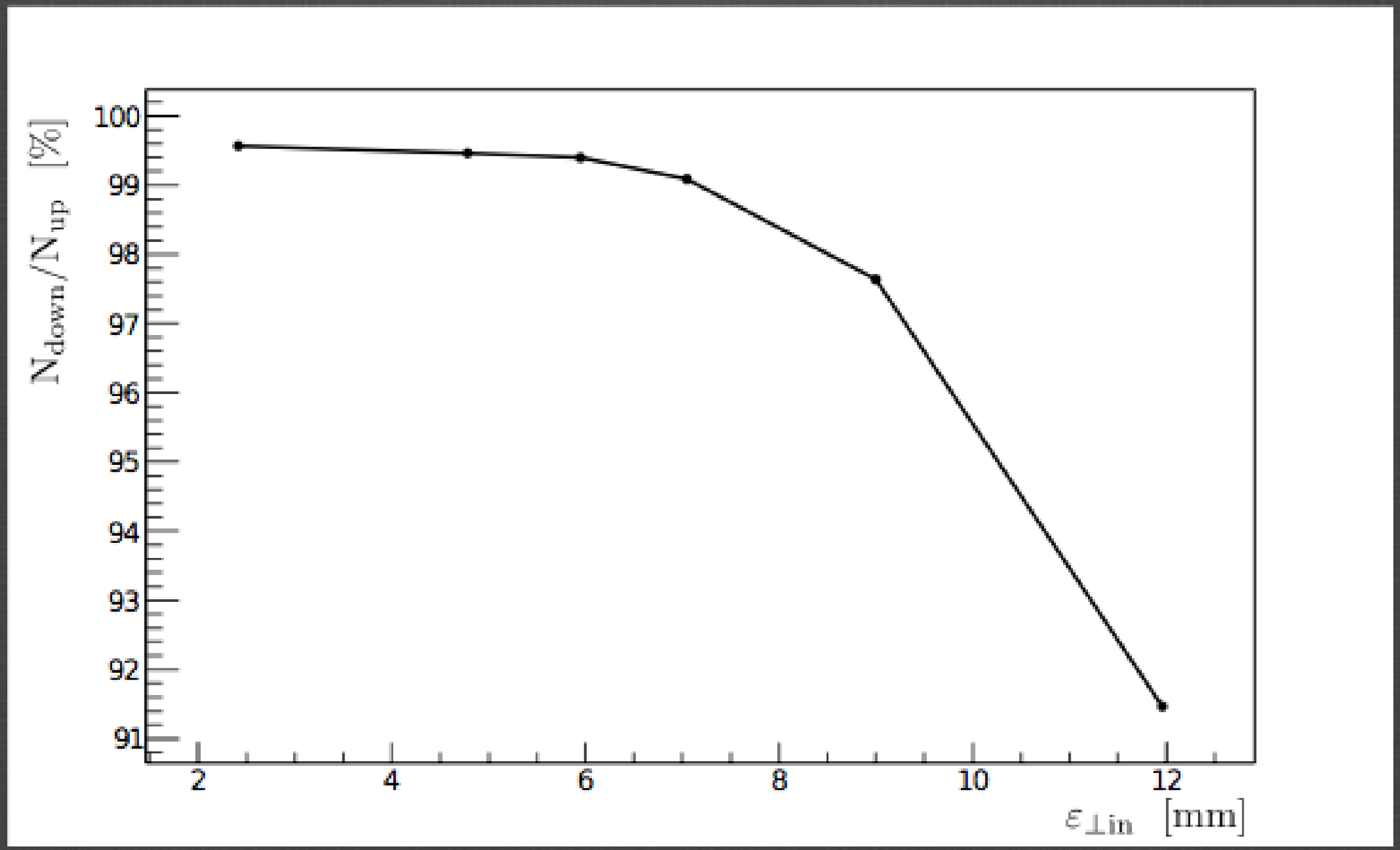
240 MeV/c settings

Performance vs initial emittance



240 MeV/c settings

Transmission



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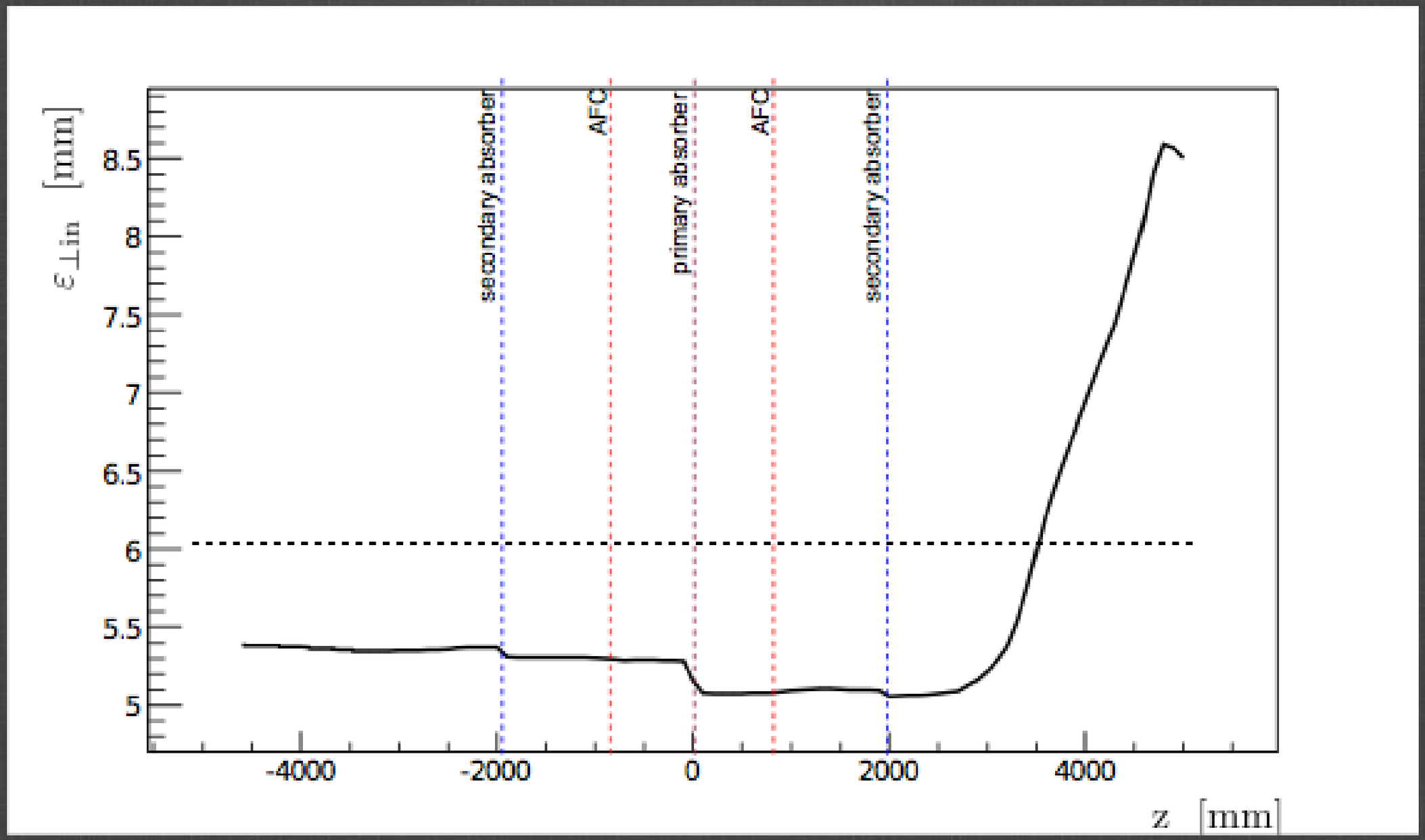
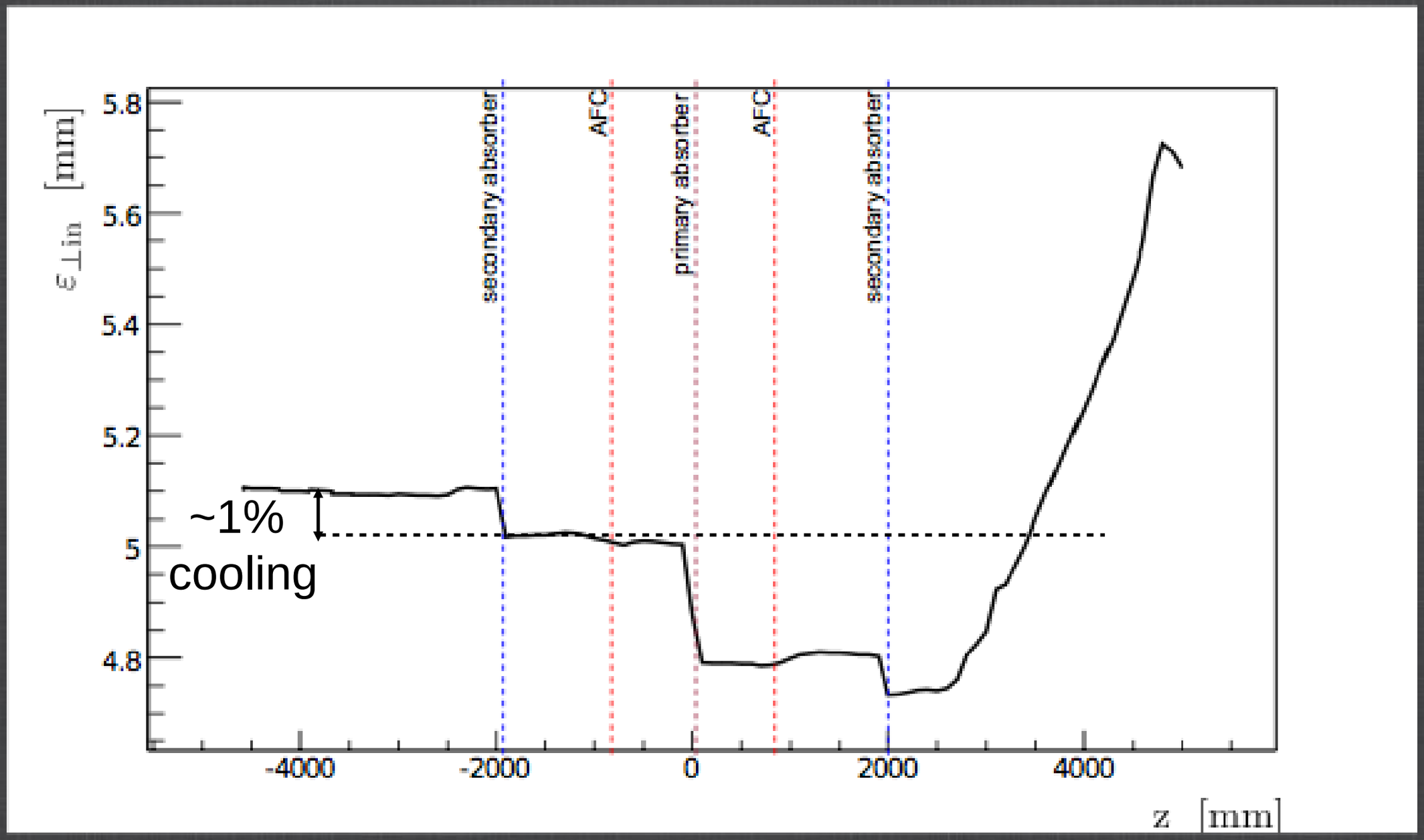
200 MeV/c settings w/o M1, 4T in SS

4D emittance (initial 6 mm)



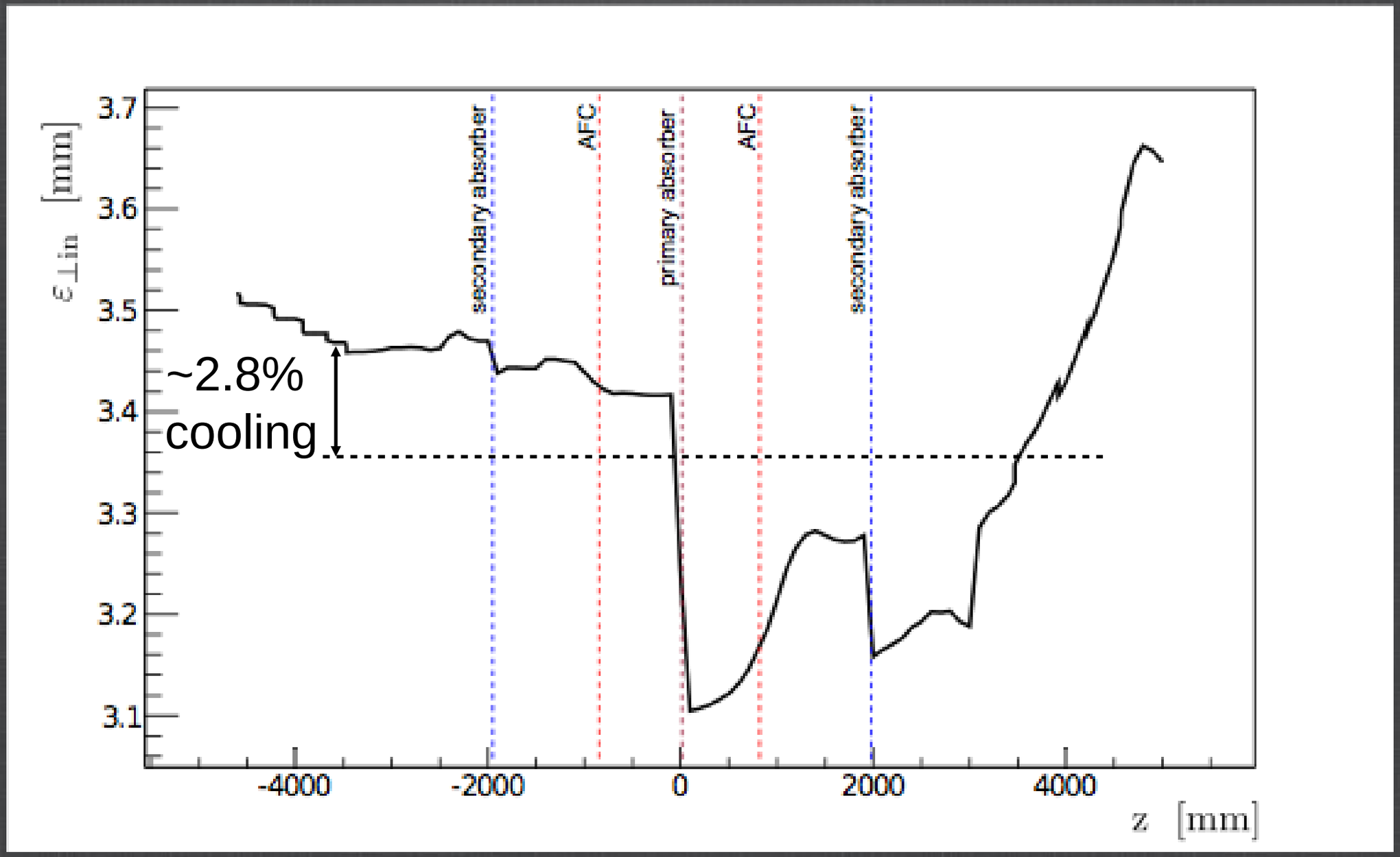
200 MeV/c settings w/o M1, 2T in SS

4D emittance (initial 6 mm)



140 MeV/c settings w/o M1, 4T in SSU, 1.21T in SSD

4D emittance (initial 4.2 mm)



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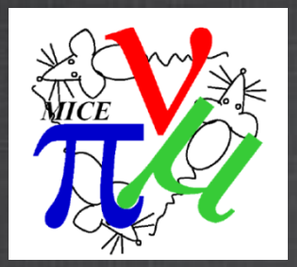
Summary

- Lattice design length has been optimised and is frozen.
- Good results for different settings:
  - 5.6% for 200 MeV/c settings (6 mm initial emittance),
  - 8.5% for 140 MeV/c settings (4.2 mm initial emittance),
  - 4.0% for 240 MeV/c settings (7.2 mm initial emittance).
- Bad results for the case M1 = 0 downstream (no matching found)
    - Heating in 4T case and 1% cooling in 2T case for 200 MeV/c,
    - 2.8% cooling for 140 MeV/c.

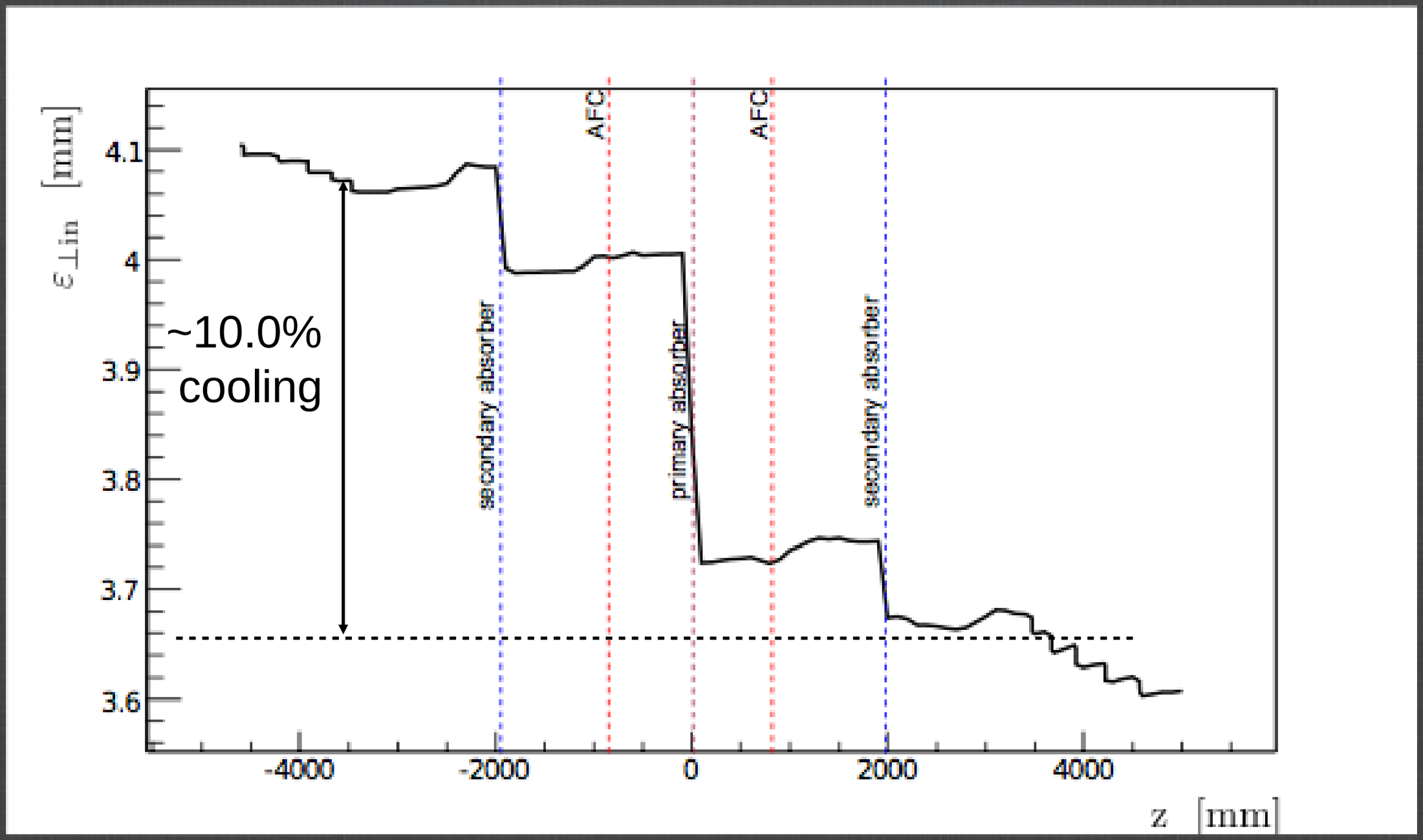


Thank you for your attention

Back-up slides

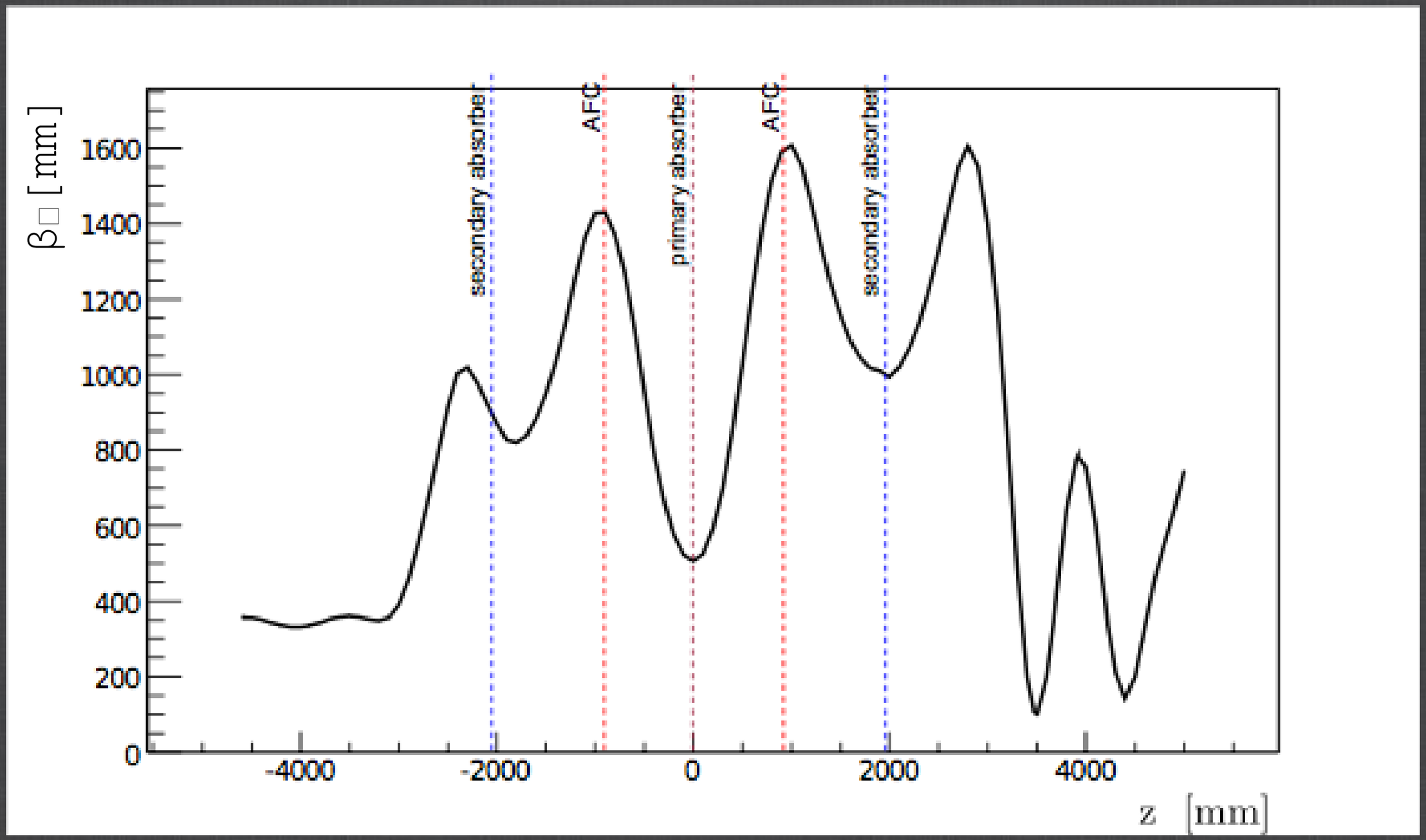
140 MeV/c settings

4D emittance (ε_{4D}=4.2 mm, $\varepsilon_{\parallel}$=8.9 mm)



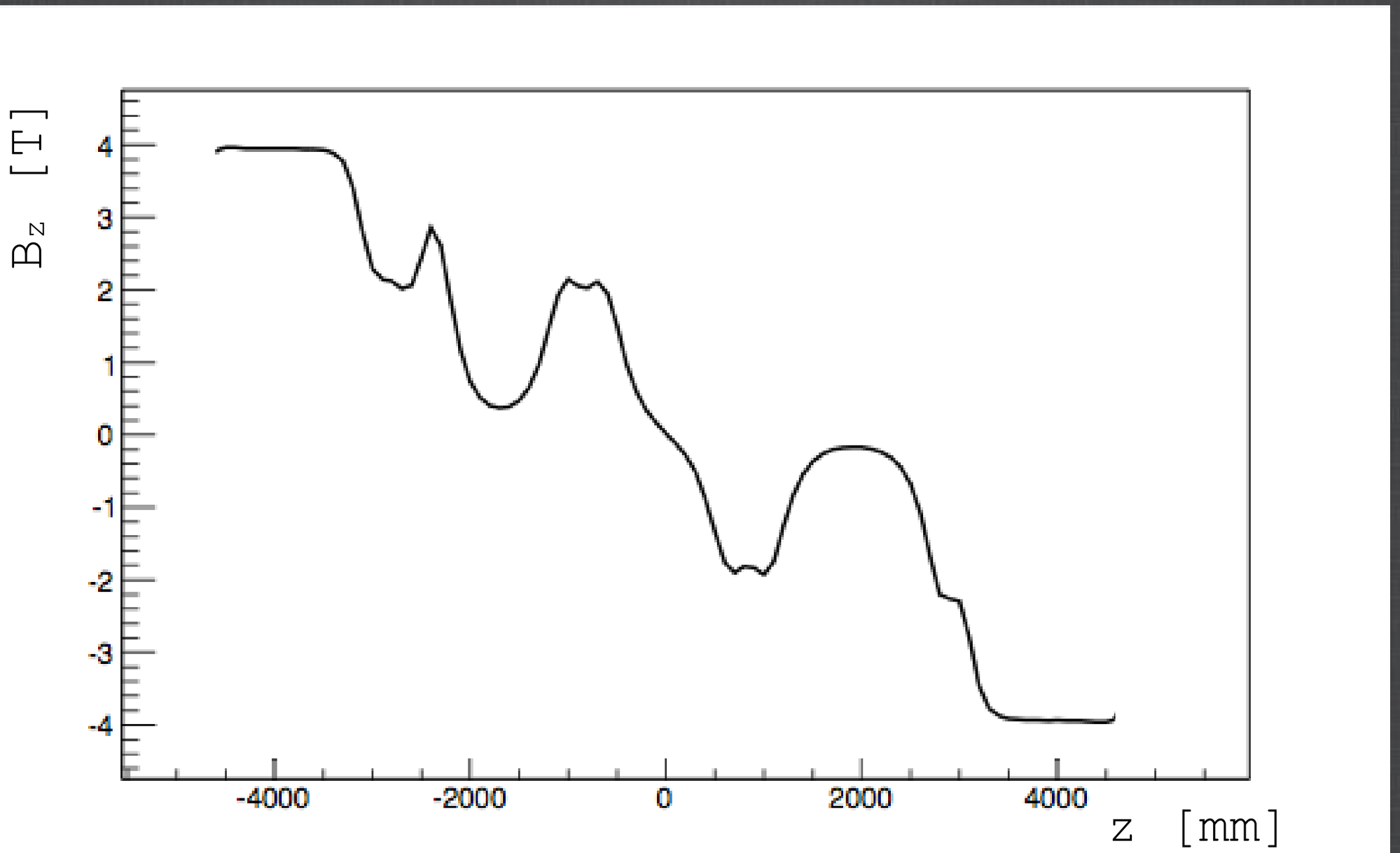
200 MeV/c settings w/o M1, 4T in SS

Transverse beta



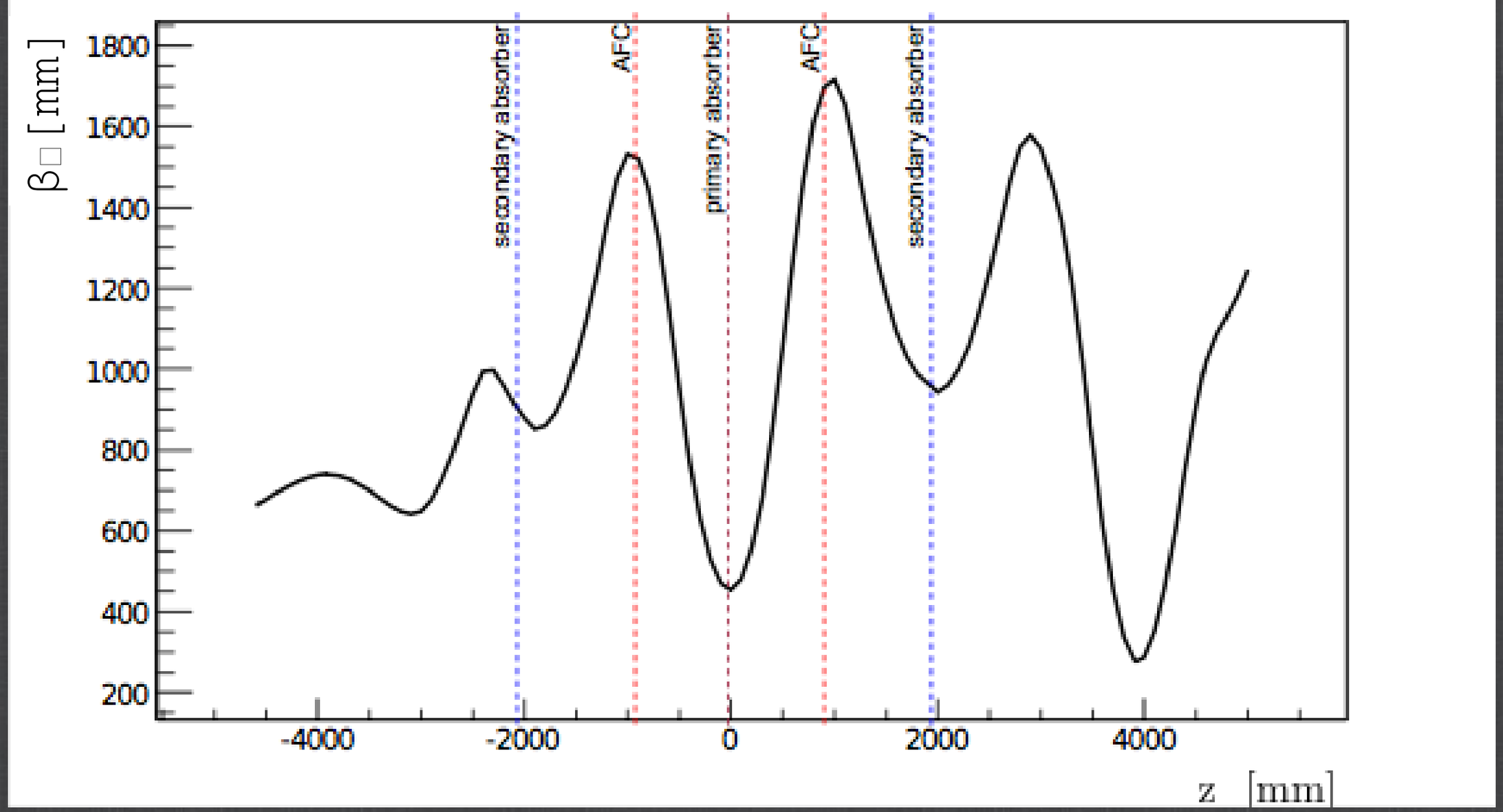
200 MeV/c settings w/o M1, 4T in SS

Magnetic field on axis



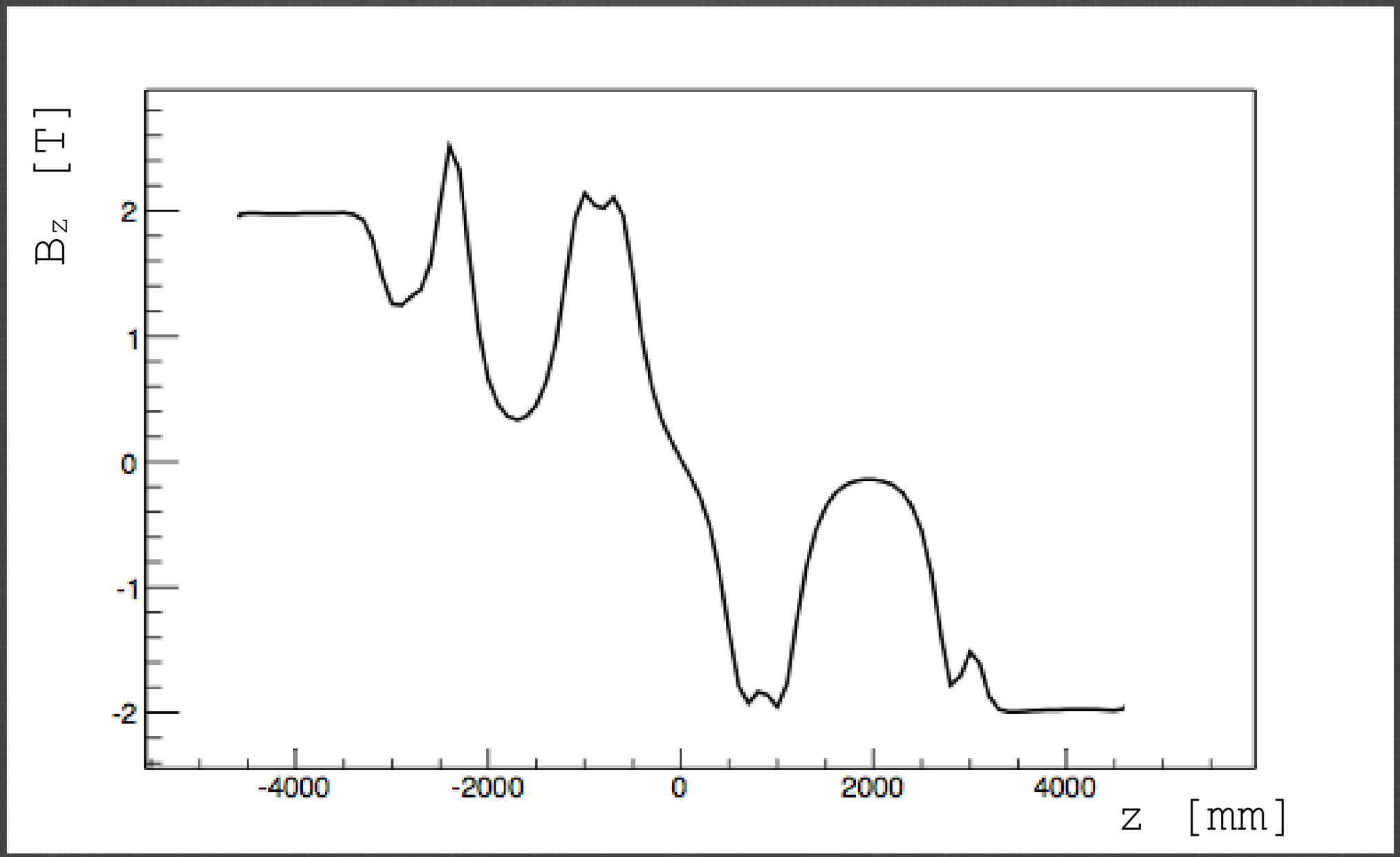
200 MeV/c settings w/o M1, 2T in SS

Transverse beta



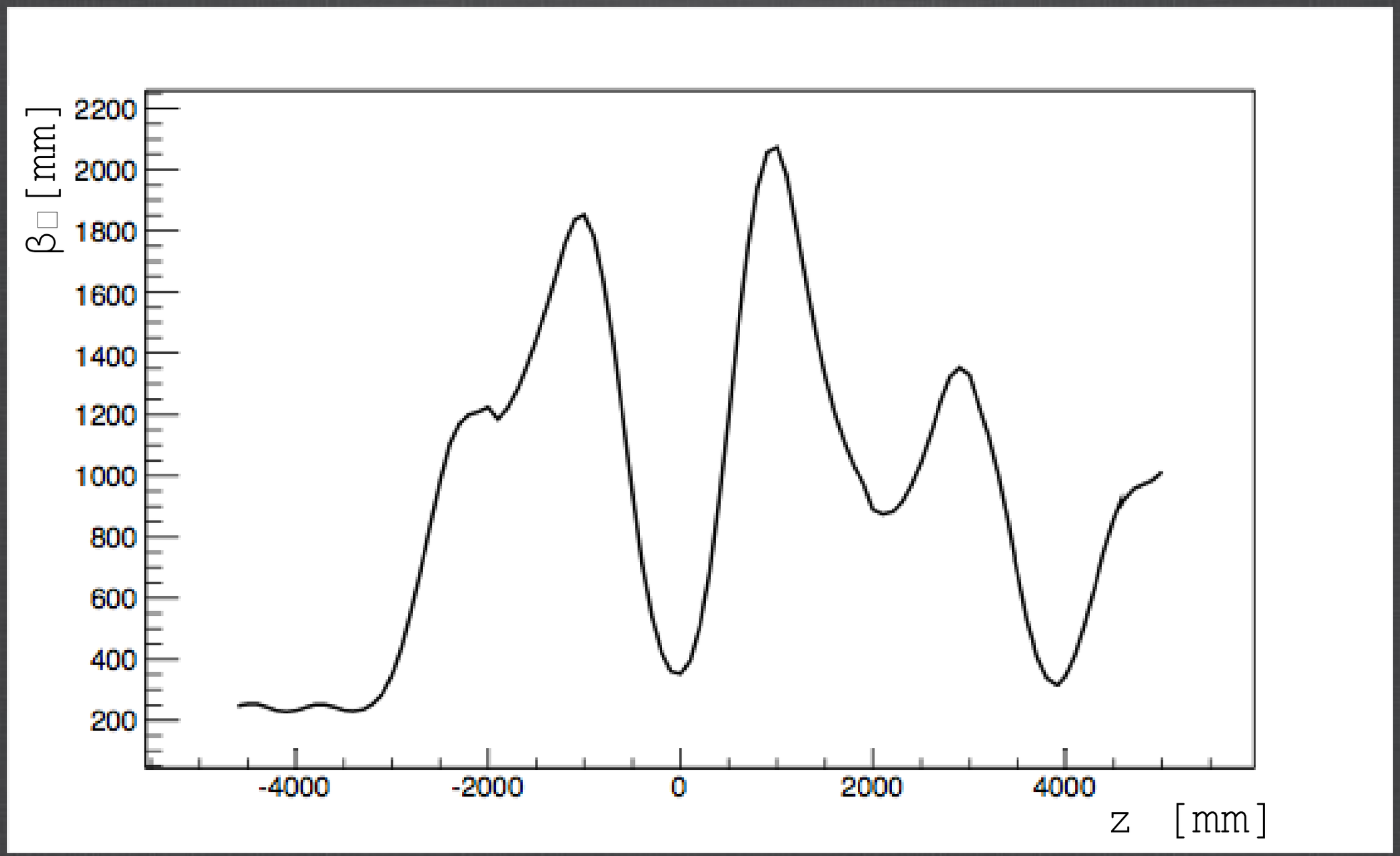
200 MeV/c settings w/o M1, 2T in SS

Magnetic field on axis



140 MeV/c settings w/o M1, 4T in SSU, 1.21T in SSD

Transverse beta



140 MeV/c settings w/o M1, 4T in SSU, 1.21T in SSD

Magnetic field on axis