MICE Demonstration of Ionization Cooling

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Outline

- Demo lattice
- Optimization
  - Lattice Length
  - Beta-value (Preliminary)
- 140 MeV/c & 240 MeV/c (Preliminary)
- Summary and future plans

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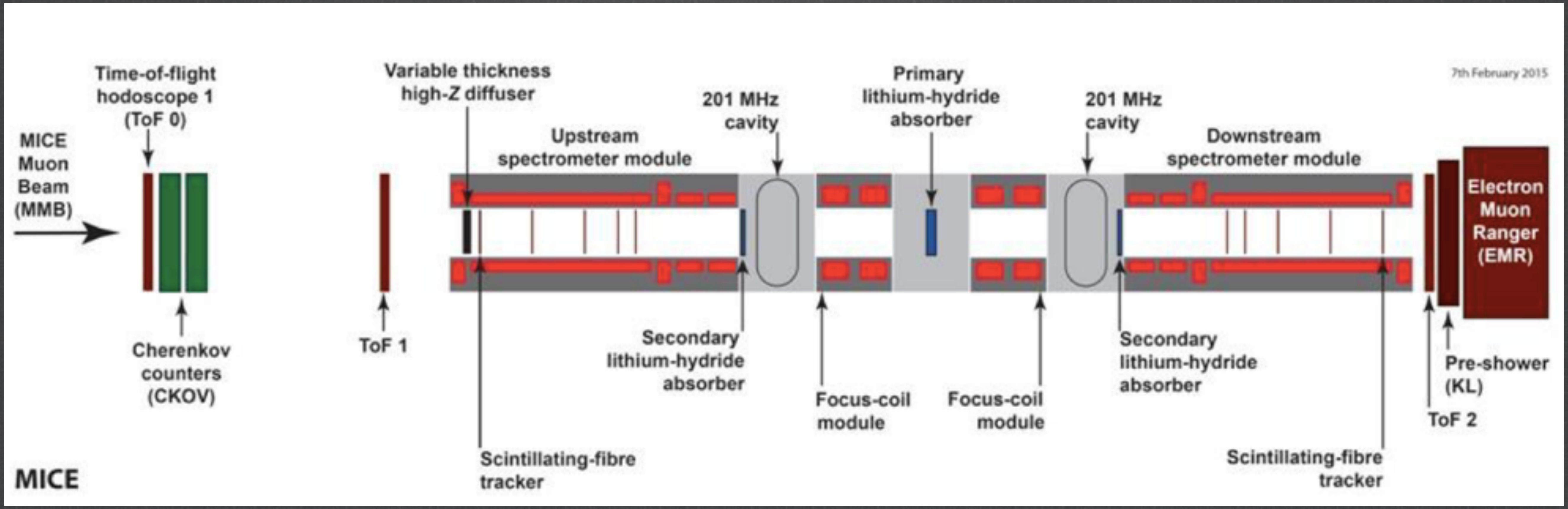
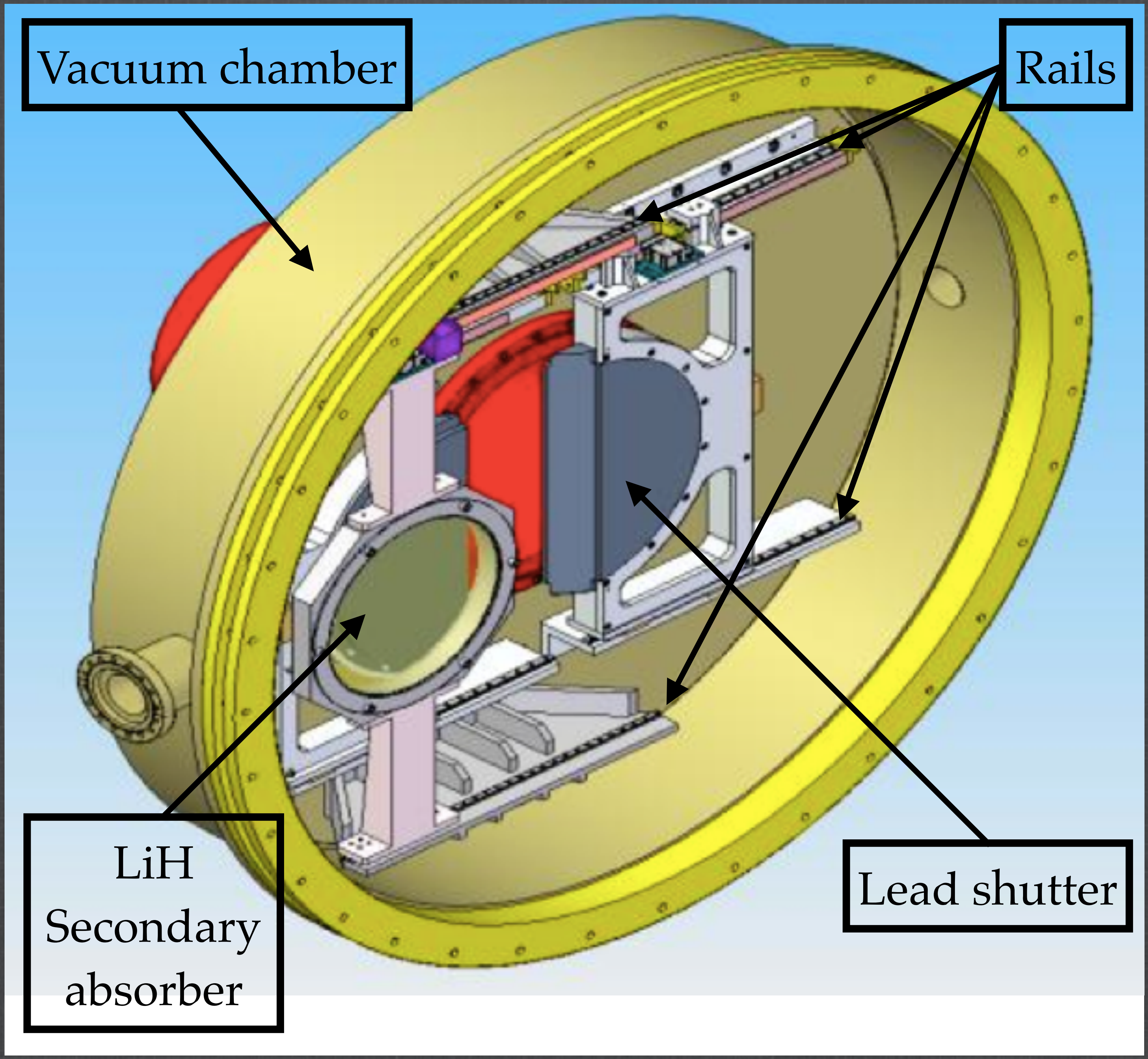
Demo Lattice



Radiation shutter and movable secondary LiH absorber.



Initial beam

- Pure muon beam, ~10 000 particles
- Position: before first plane upstream tracker (after diffuser)
- Gaussian distribution
- Normalised rms longitudinal emittance = 20 mm
- Normalised rms transverse emittance = 6 mm

Cuts

- PID cut
- Transmission cut
- Radial cut r < 200 mm, at first and last plane.

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Optimization

- Optimization through 2 parameters
  - phase advance of the channel
  - Strength of the focusing elements

Phase advance

- Phase advance is computed from the last plane of the upstream tracker to the first plane of the downstream tracker.
- Different phase advances for different lattices show the same effect: phase advance should stay between half-integer resonances. 630 deg. (1.75×360 deg.) seems to be the optimum:
  - Best momentum acceptance,
  - smallest non-linear effects (chromatic mismatch downstream minimized).

Focusing strength

- Once the phase advance and values of beta at the absorbers is decided, only free parameters are
  - the length between SS and Cavity module,
  - the length between the AFCs.

- Different cases show that M1 should be minimized to limit non-linearities. so the length SS-Cavity should be kept minimum (case of the CM41 lattice)

- Different cases show that large values of beta in the FC trigger strong non-linearities.

  ⇨ Optimum of the length AFC-AFC.

AFC - AFC Length

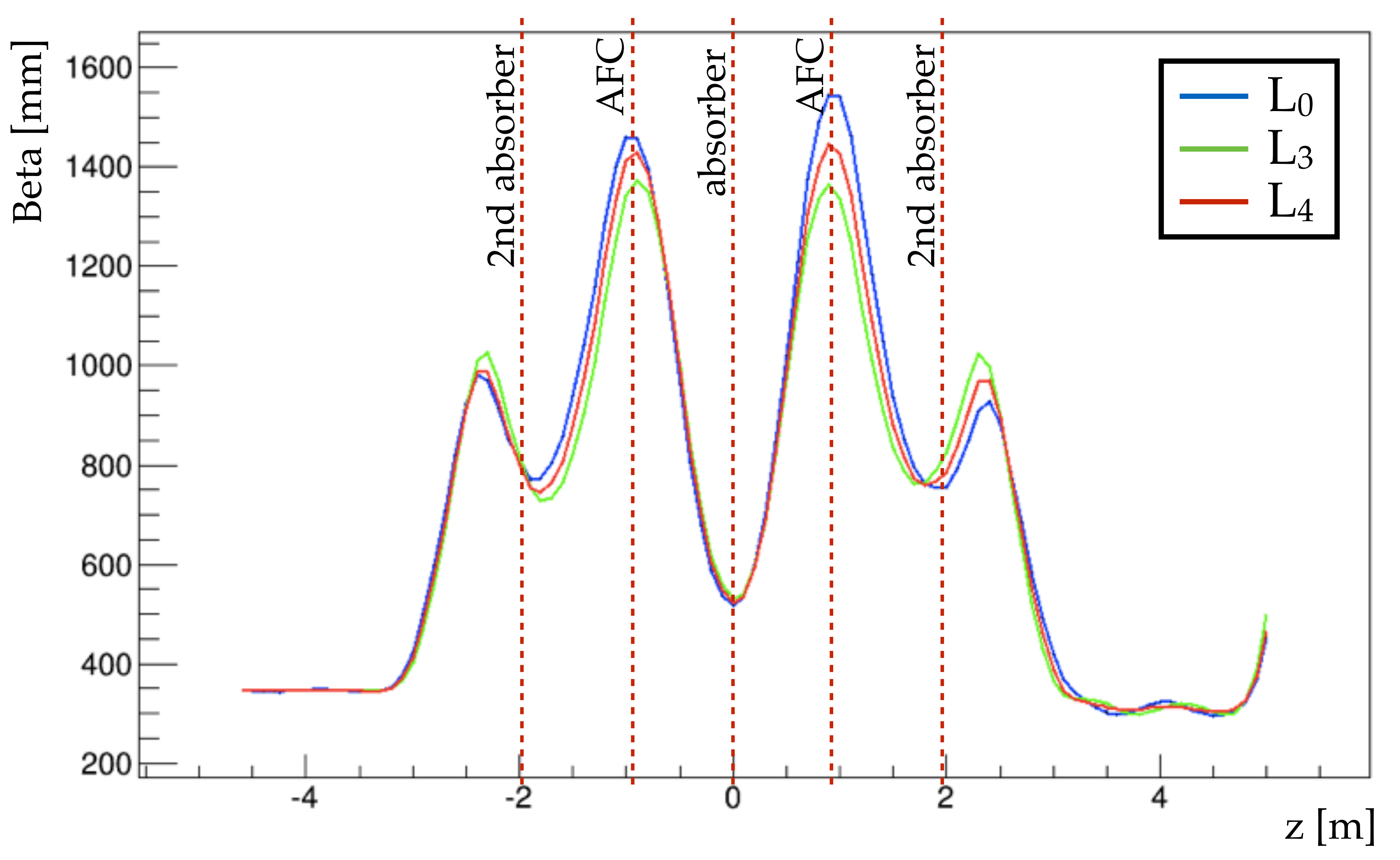
- Different lengths have been tested
  - L_0 (updated CM41 lattice)
  - L_1 (L_0 - 376.5 mm)
  - L_2 (L_0 - 187.0 mm)
  - L_3 (L_0 - 93.5 mm)
  - L_4 (L_0 - 46.7 mm)

- Best performances for length L_0, L_3 & L_4.

  ⇨ L_4 seems to be the best lattice.

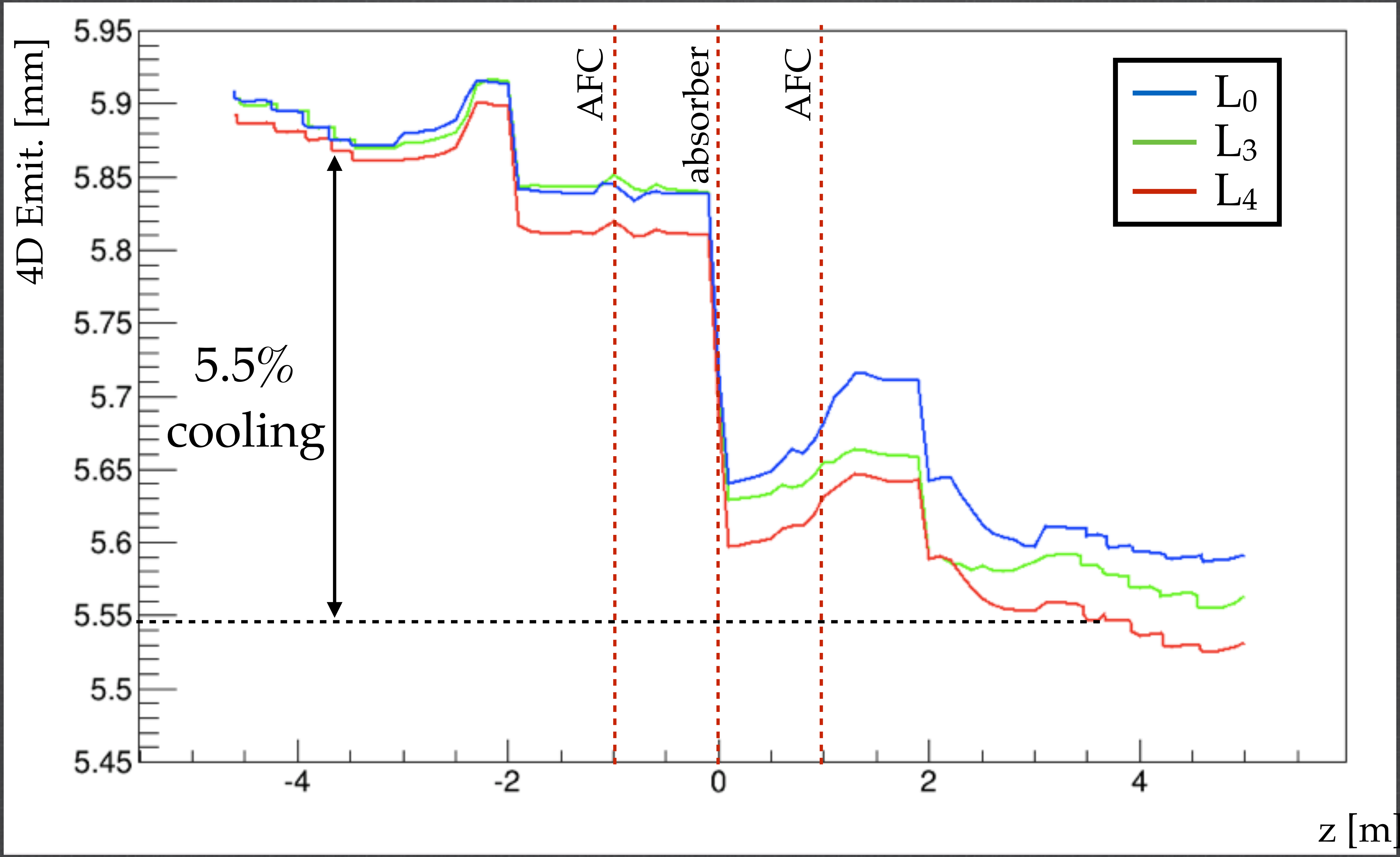
AFC-AFC Optimization

Transverse beta

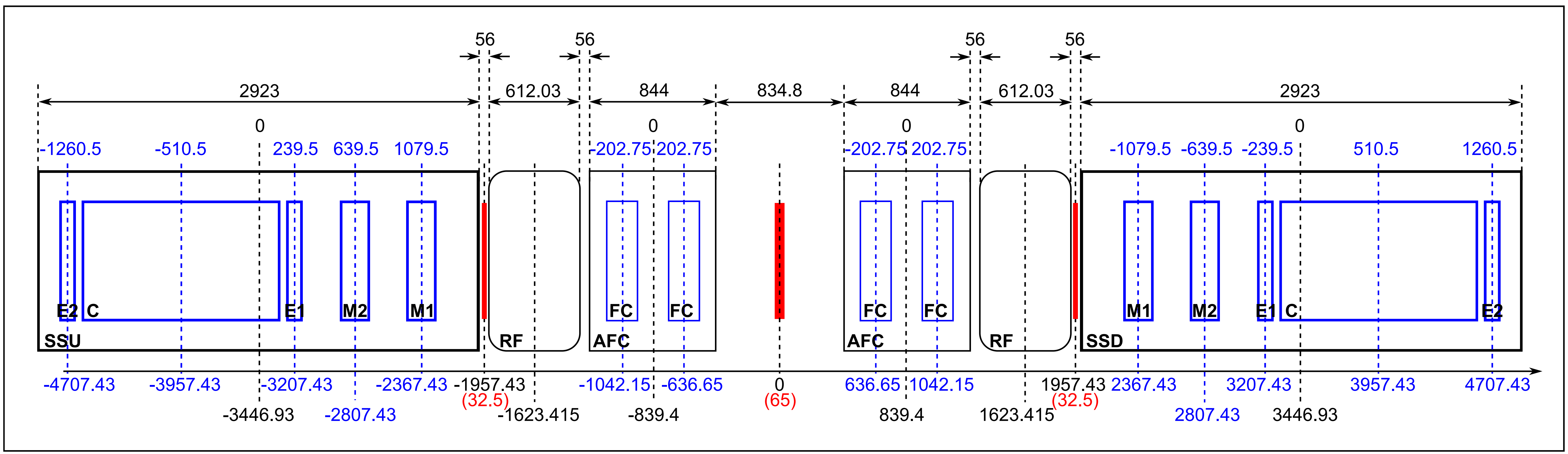


AFC-AFC Optimization

4D emittance



Optimized Lattice



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Beta-value optimization (Preliminary)

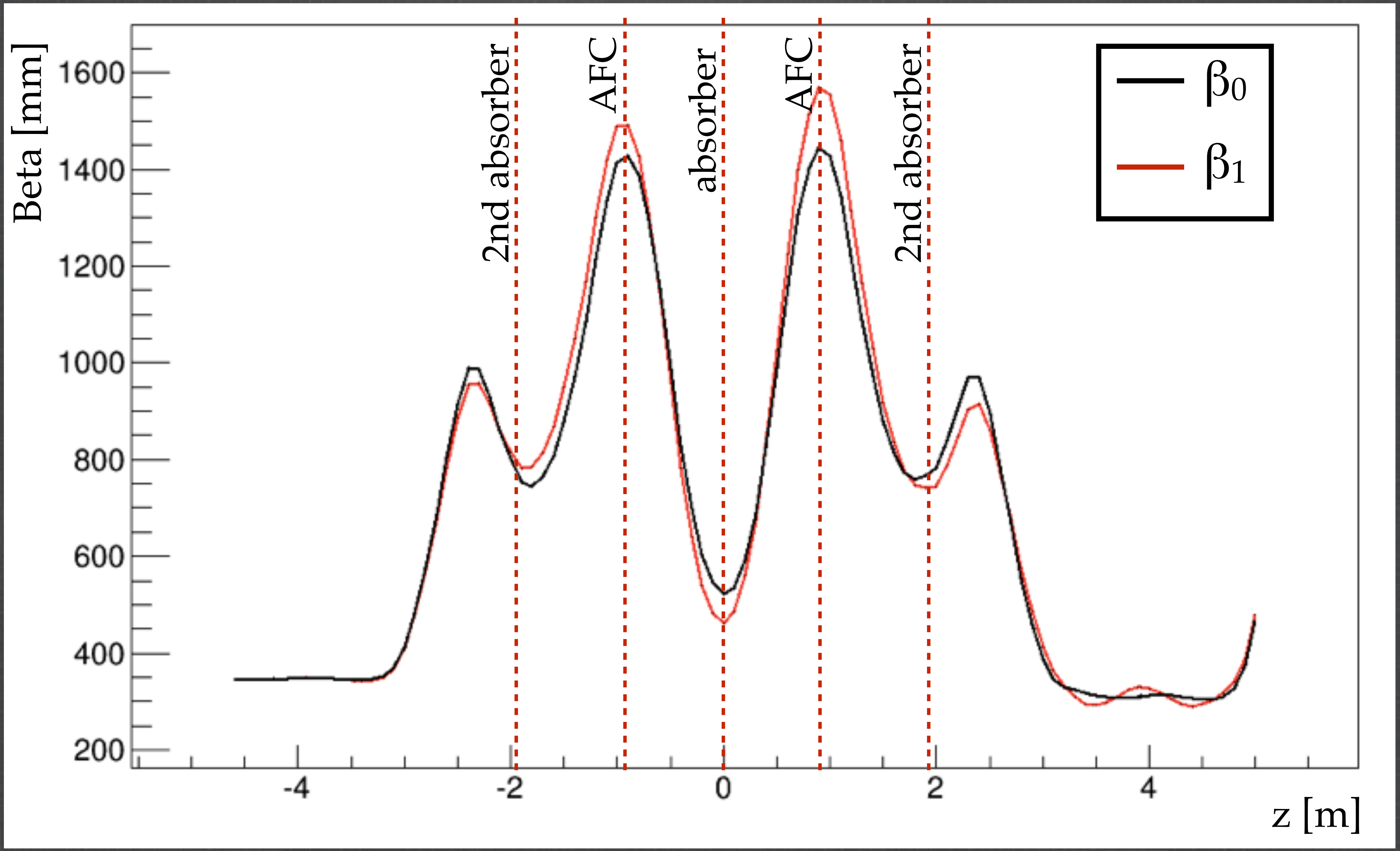
- Different values of β at the central absorber are being tested:
    - β_0 (53 cm)
    - β_1 (46 cm)

- Same performance

  ⇨ Optimum between?

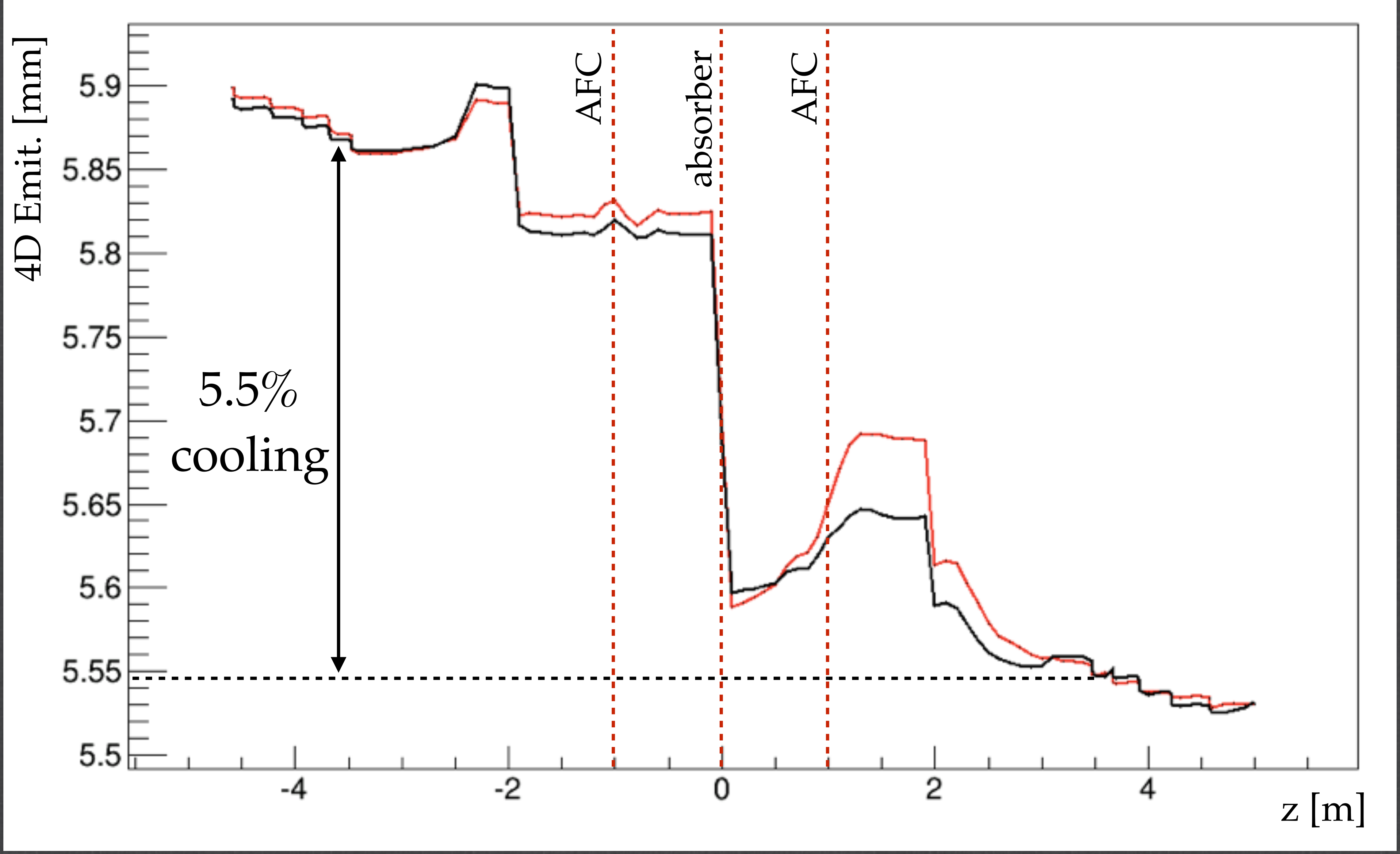
Beta-value optimization

Transverse beta



Beta-value optimization

4D emittance



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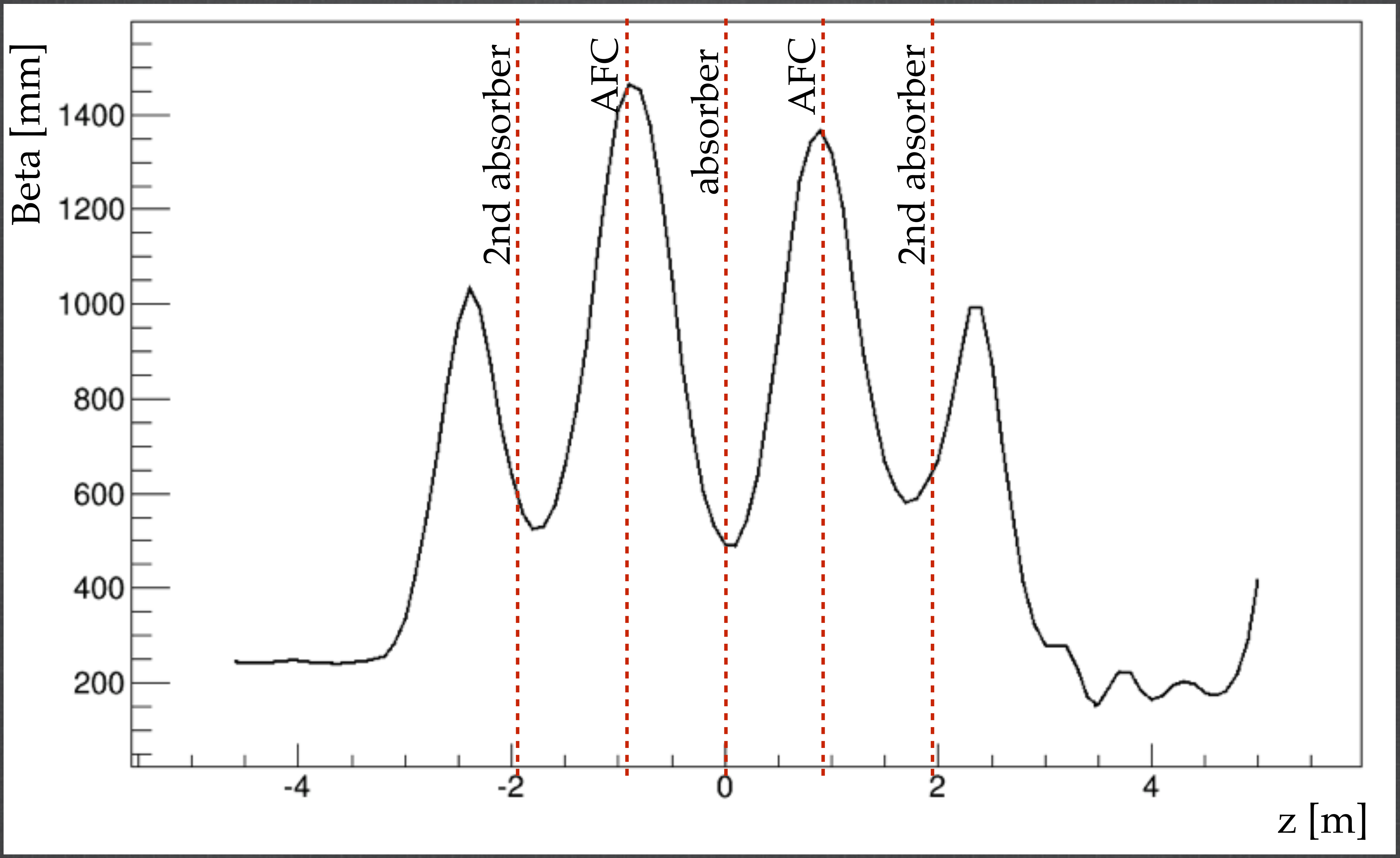
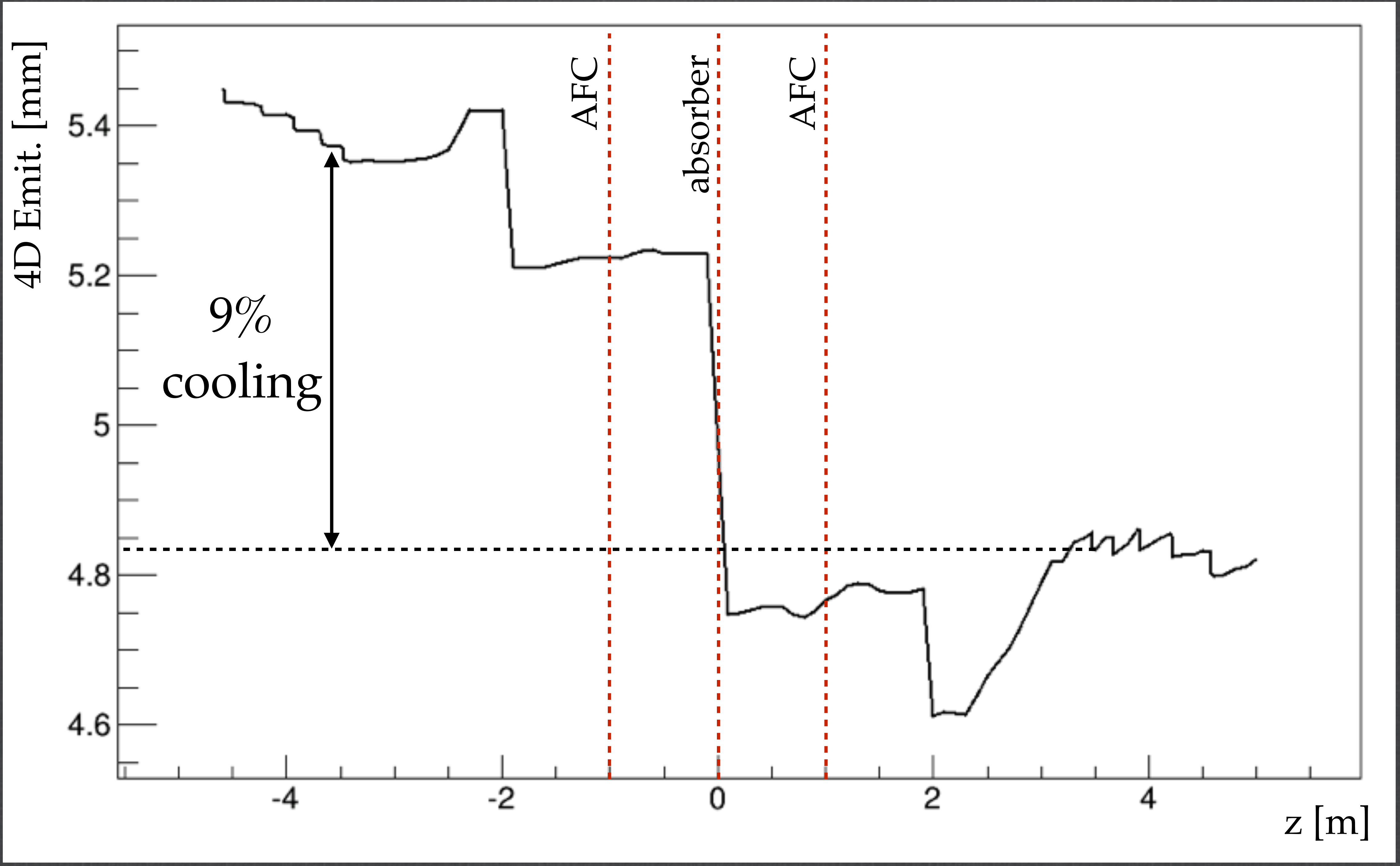
Preliminary: 140 MeV/c

Transverse beta



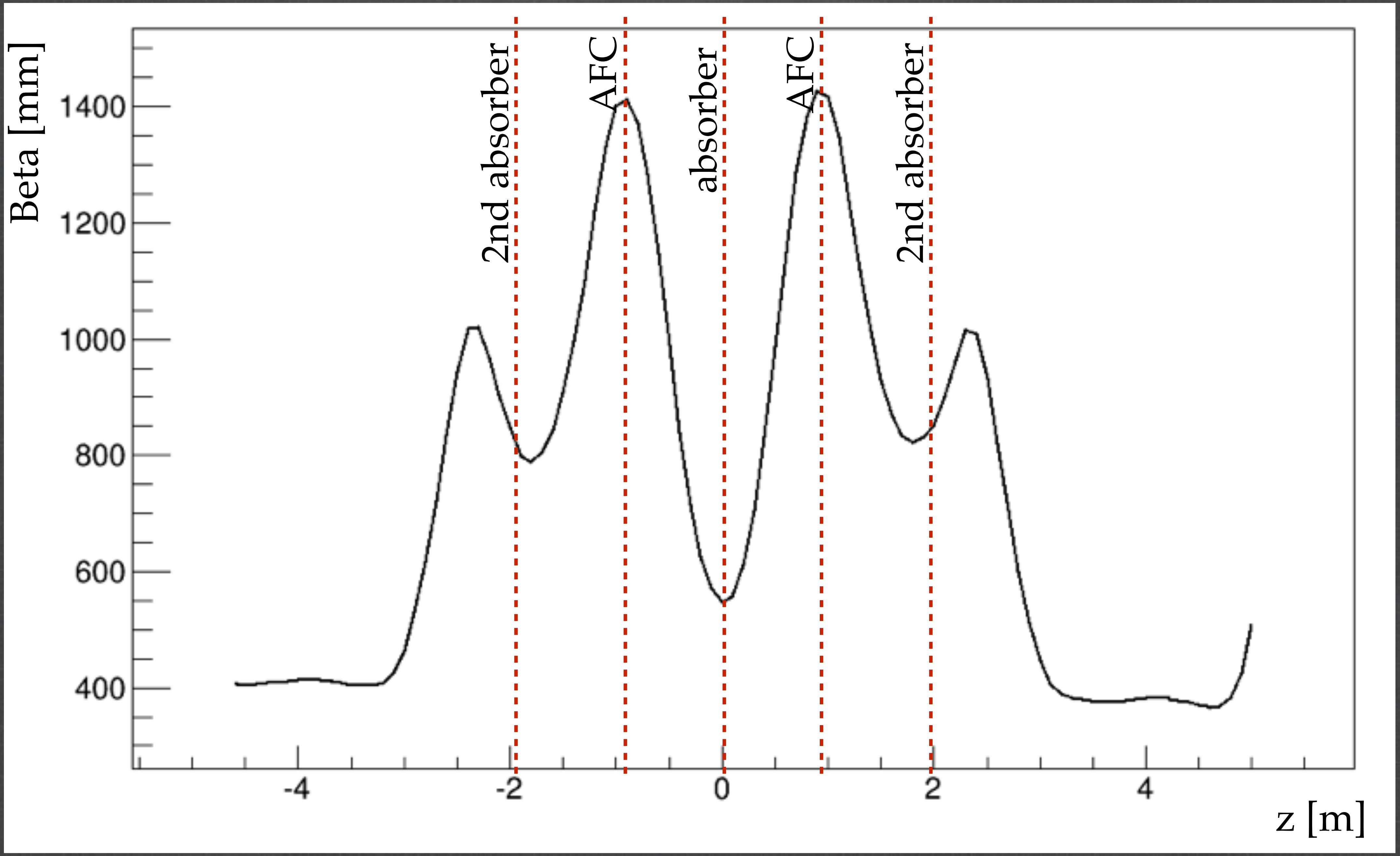
Preliminary: 140 MeV/c

4D emittance



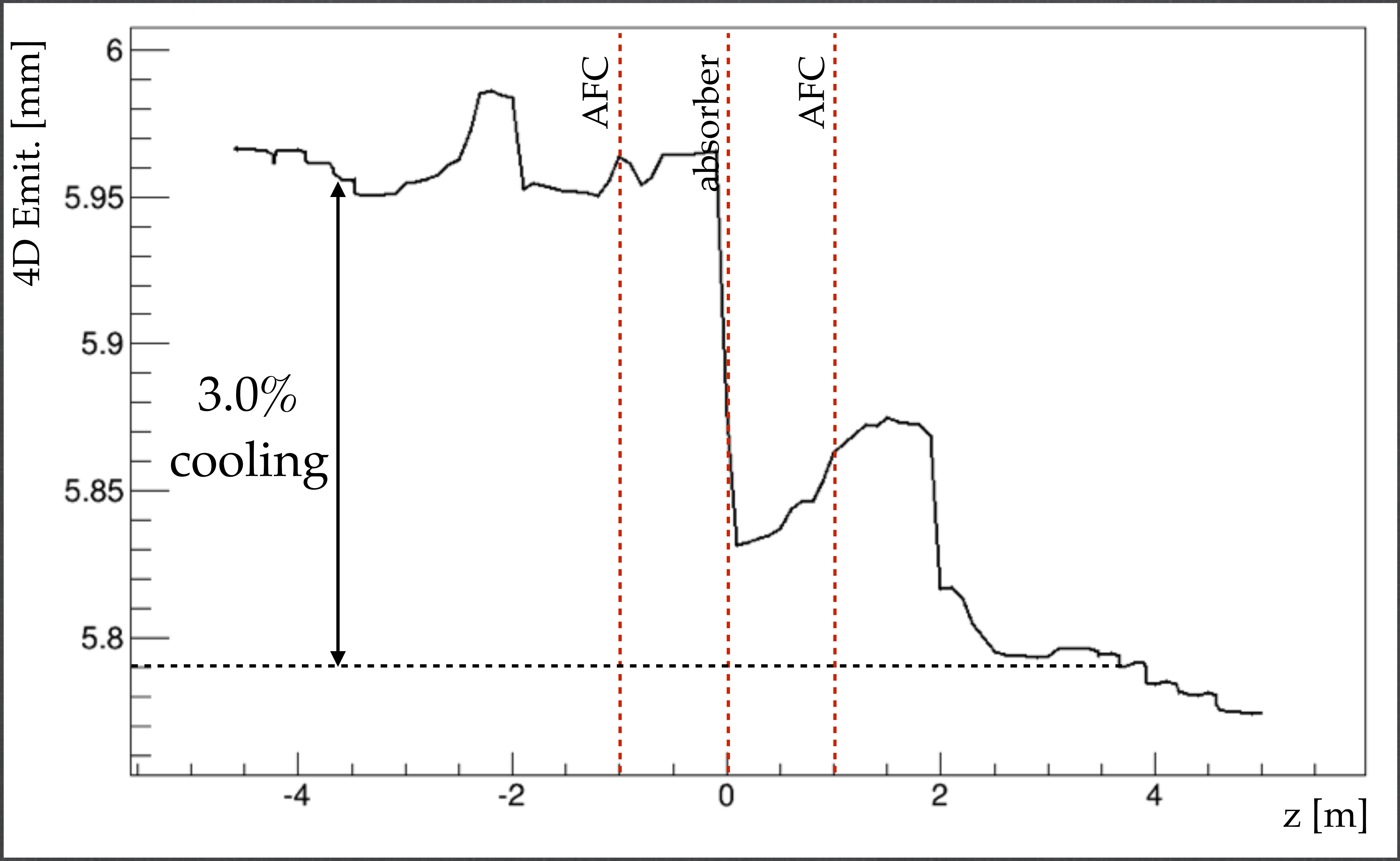
Preliminary: 240 MeV/c

Transverse beta



Preliminary: 240 MeV/c

4D emittance



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Summary

- Optical parameters have been studied and optimization of the length have been done.
- Best performance for length L_4 (5.5% 4D cooling).
- Same performance for β_0 and β_1.
- Preliminary results for 140 MeV/c and 240 MeV/c.

Future plans

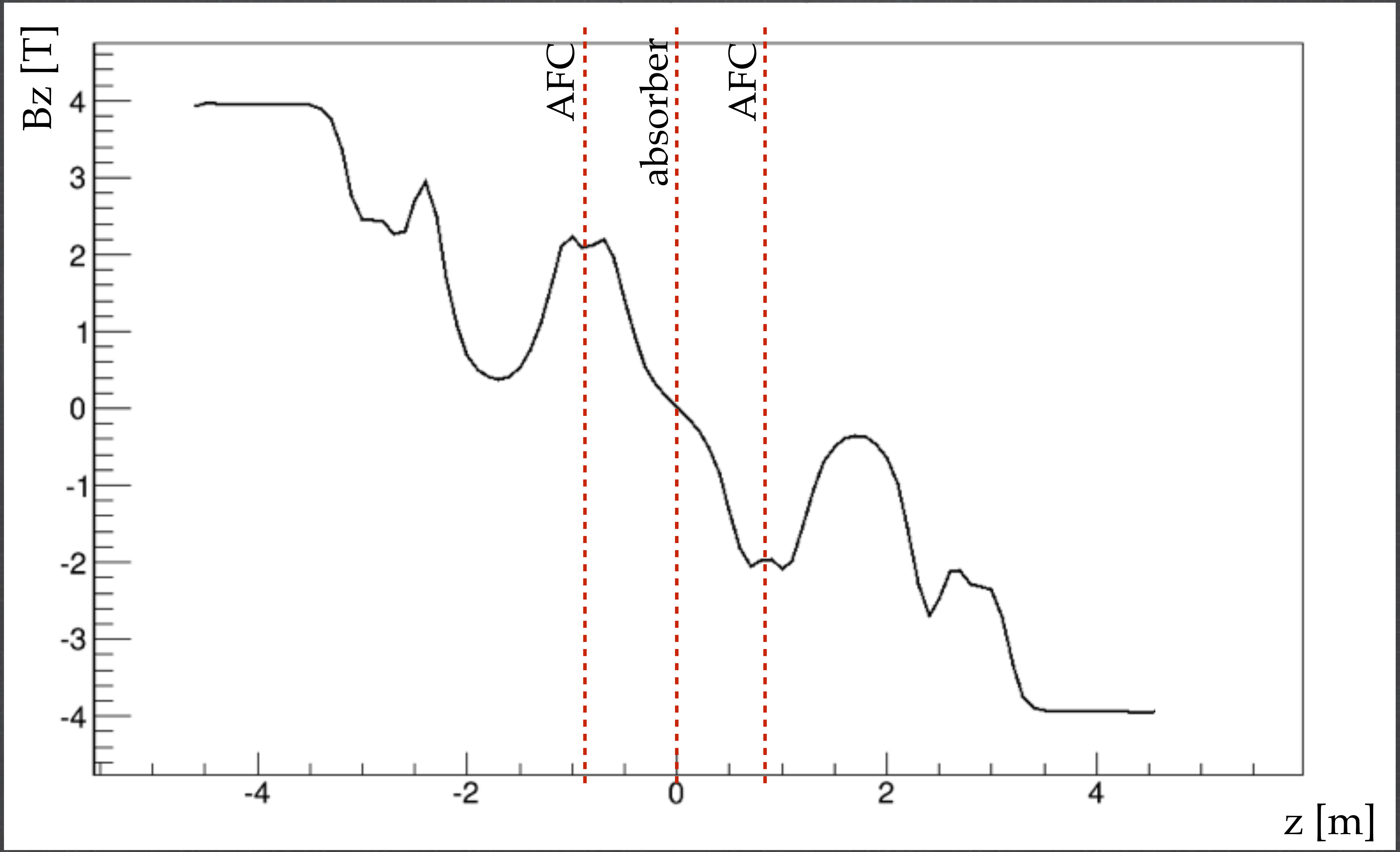
- Study of different emittances for
  - 140 MeV/c,
  - 200 MeV/c,
  - 240 MeV/c.
- Paper including all settings to be finalized soon.

Thank you for your attention

Back-up slides

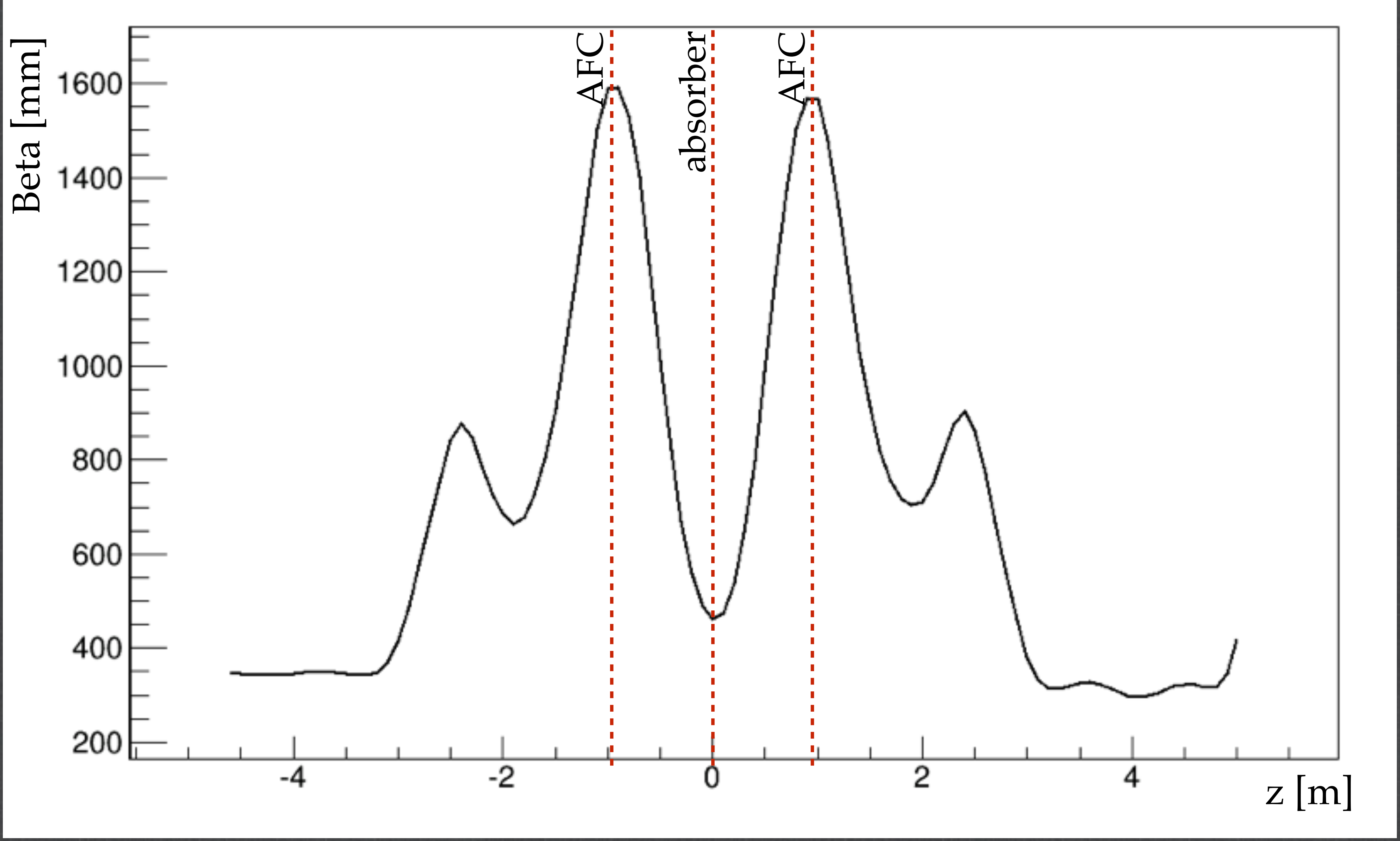
CM41 Demo Lattice

Magnetic field



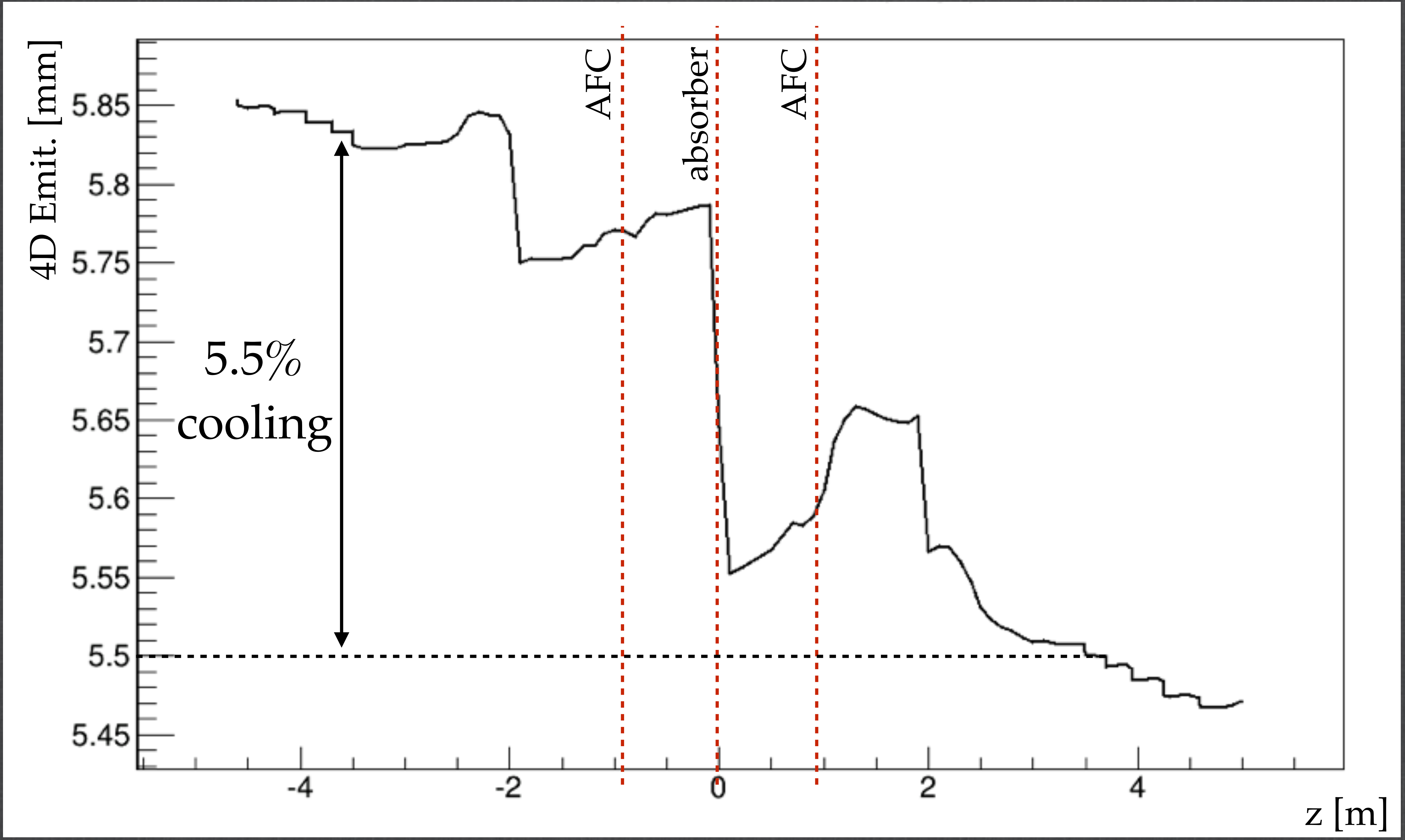
CM41 lattice

Transverse beta



CM41 lattice

4D emittance



CM41 lattice

6D emittance