



# MICE Demonstration of Ionization Cooling

JB. Lagrange, J. Pasternak





# Outline

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





# Outline

● Demo lattice

● Optimization

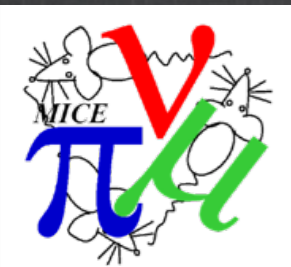
● Lattice Length

● Beta-value (Preliminary)

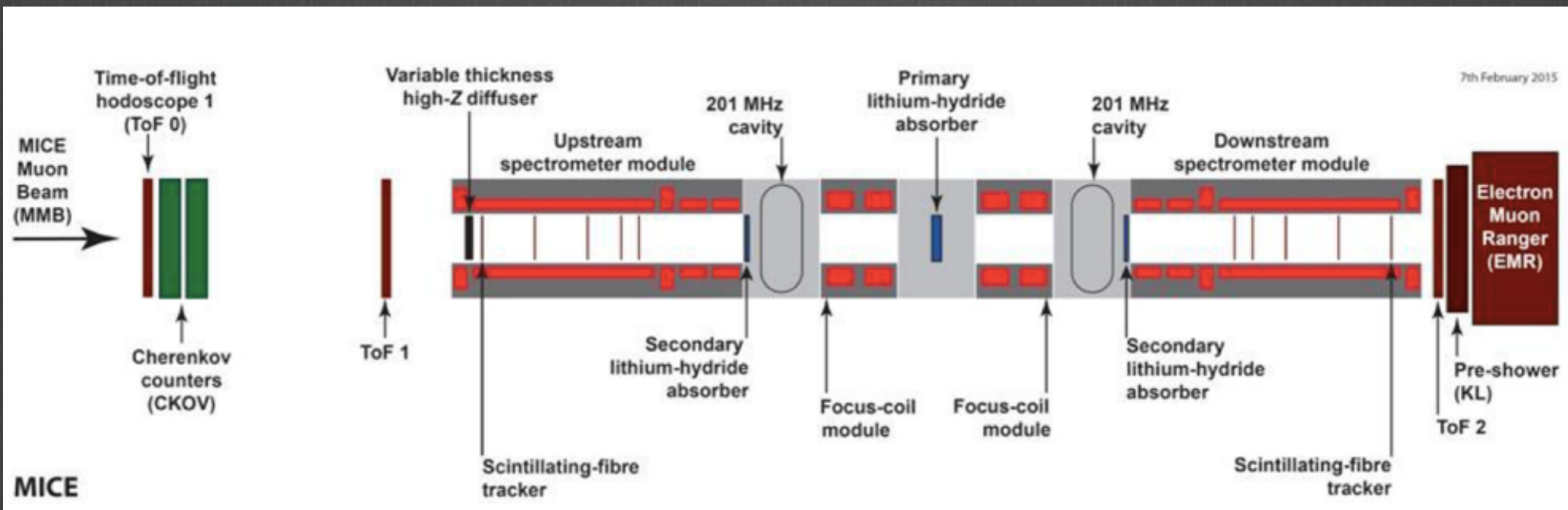
● 140 MeV/c & 240 MeV/c (Preliminary)

● Summary and future plans

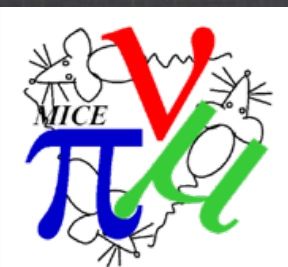




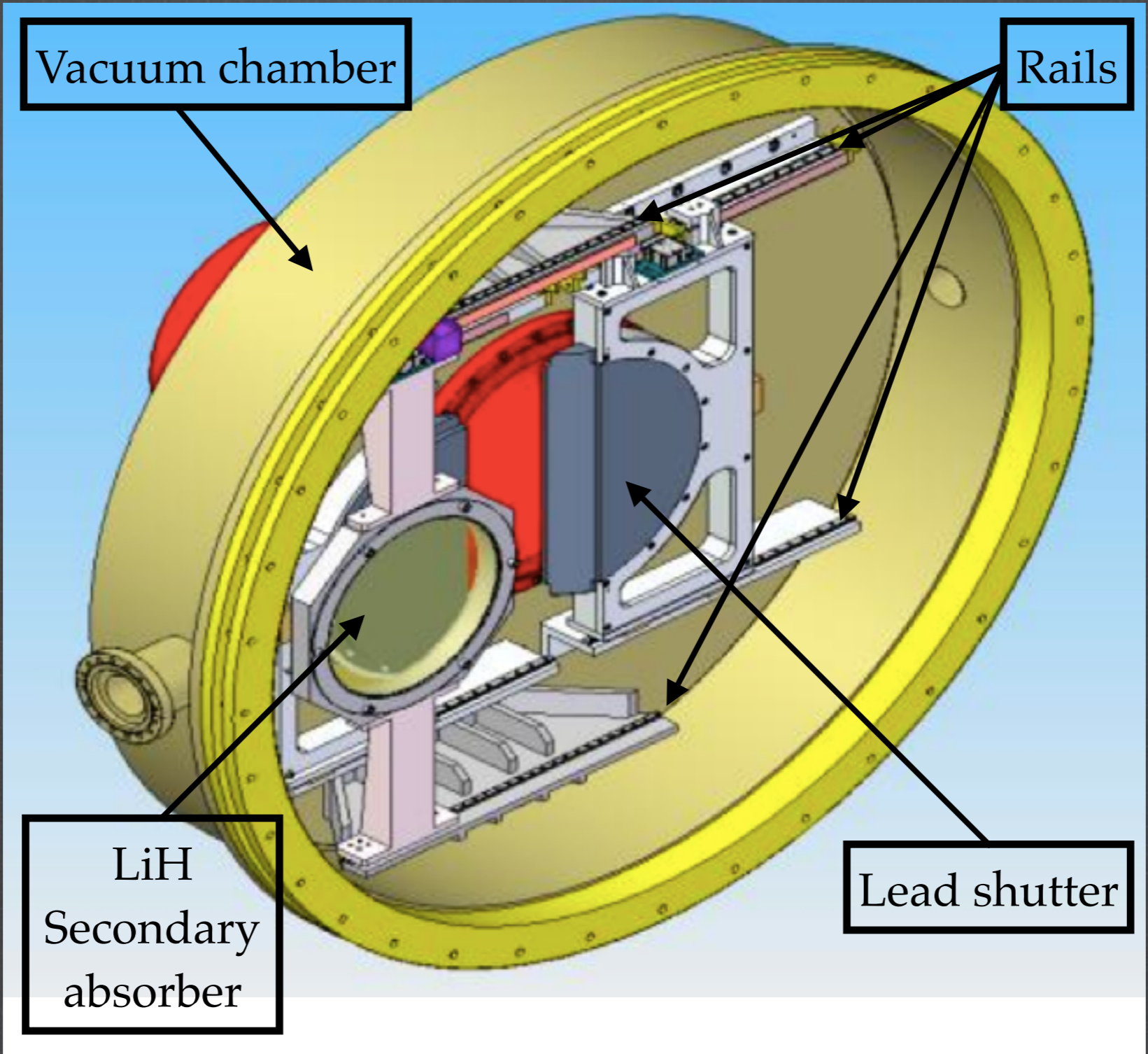
# Demo Lattice



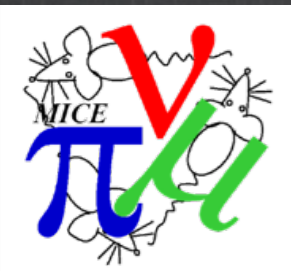




# Radiation shutter and movable secondary LiH absorber.







# Initial beam

- Pure muon beam,  $\sim 10\,000$  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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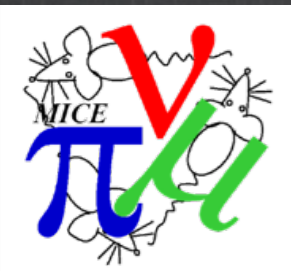
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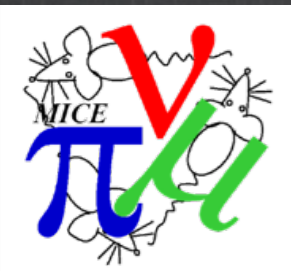




# Optimization

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

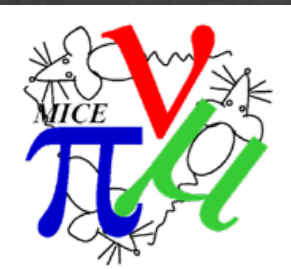




# Phase advance

- 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. ( $1.75 \times 360$  deg.) seems to be the optimum:
  - Best momentum acceptance,
  - smallest non-linear effects (chromatic mismatch downstream minimized).

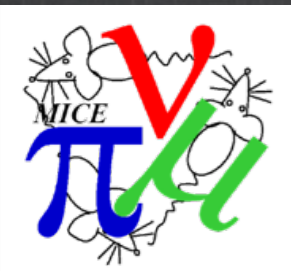




# Focusing strength

- 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.

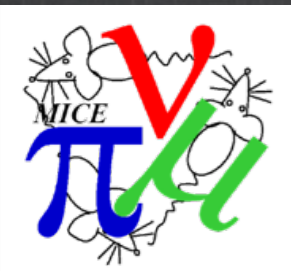




# AFC - AFC Length

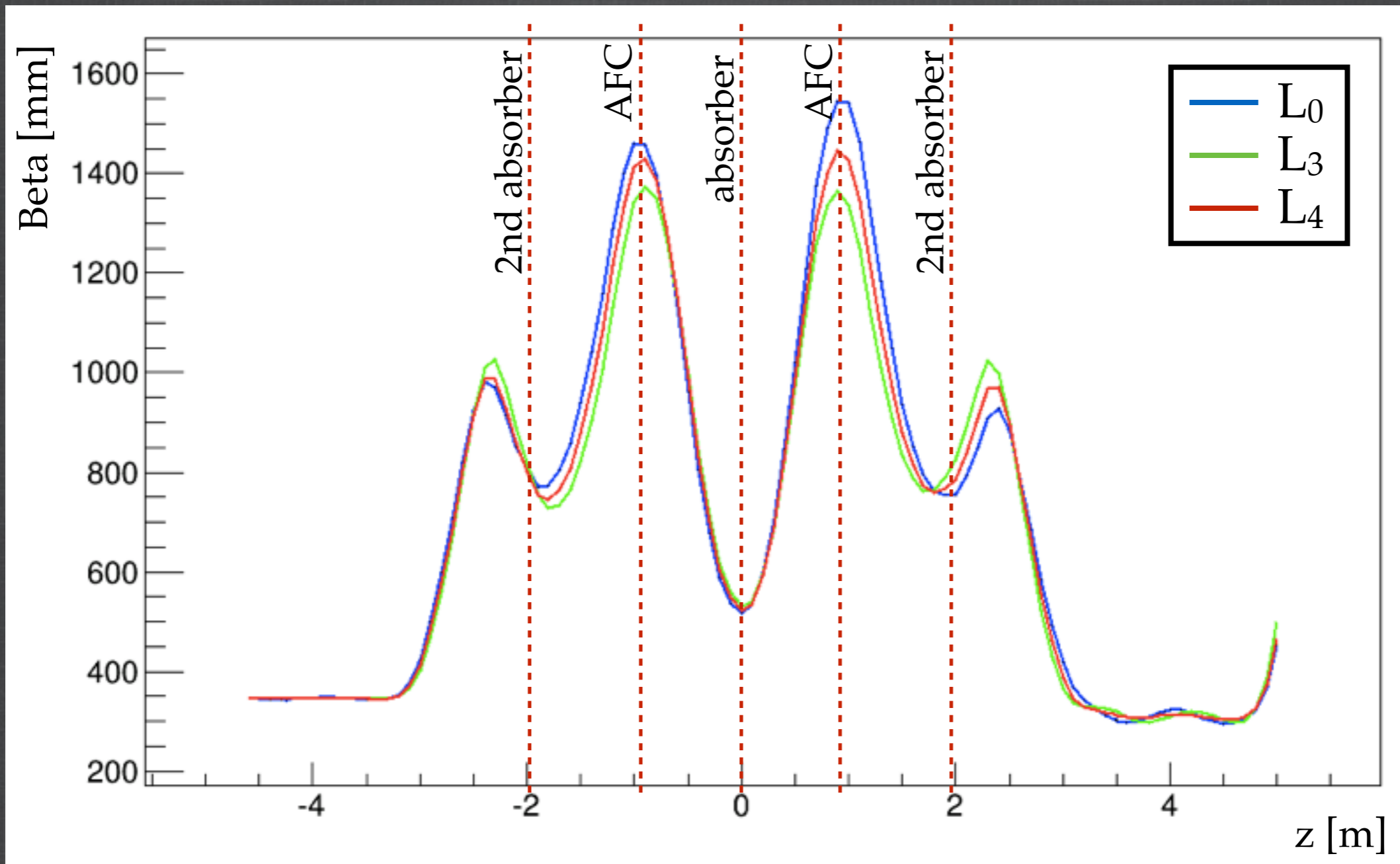
- Different lengths have been tested
  - $L_0=1725.5$  mm (updated CM41 lattice)
  - $L_1=1349.0$  mm ( $L_0-376.5$  mm)
  - $L_2=1538.5$  mm ( $L_0-187.0$  mm)
  - $L_3=1632.0$  mm ( $L_0-93.5$  mm)
  - $L_4=1678.8$  mm ( $L_0-46.7$  mm)
- Best performances for length  $L_0$ ,  $L_3$  &  $L_4$ .
  - ⇒  $L_4$  seems to be the best lattice.



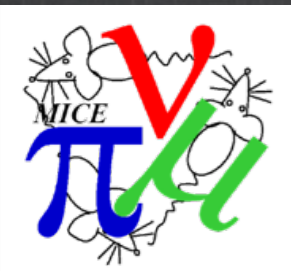


# AFC-AFC Optimization

## Transverse beta

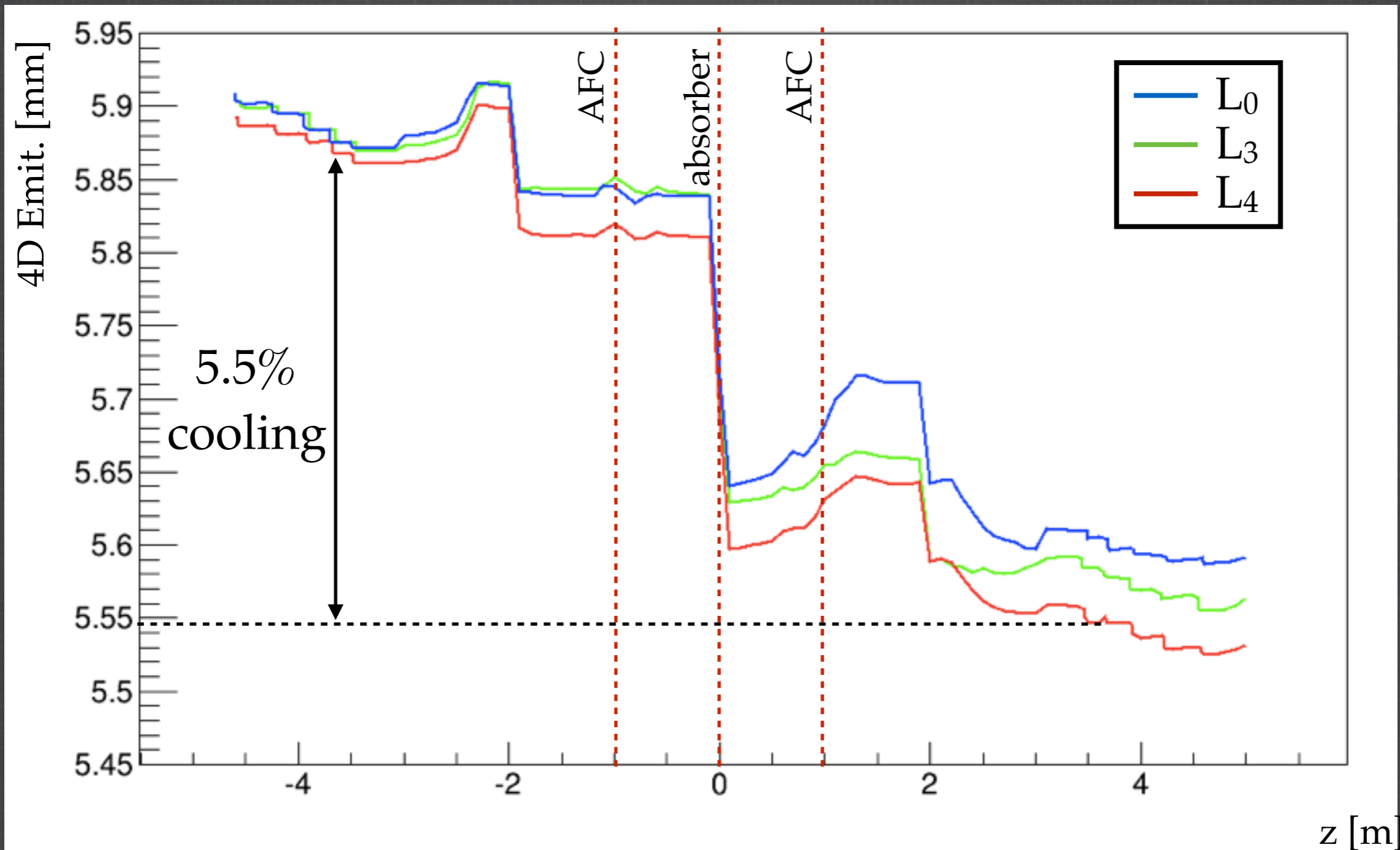




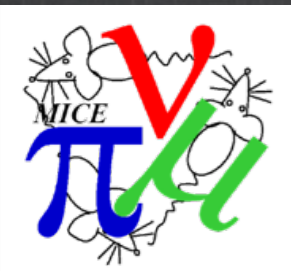


# AFC-AFC Optimization

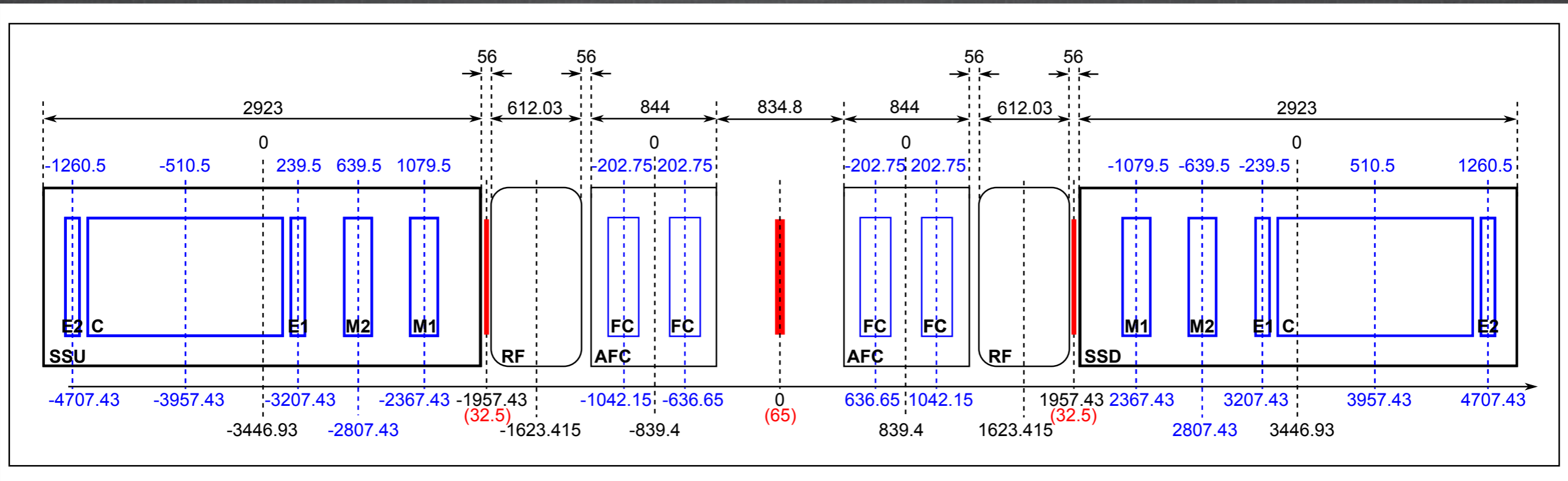
## 4D emittance







# Optimized Lattice



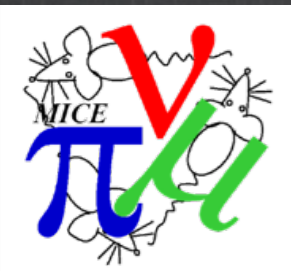




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# Beta-value optimization (Preliminary)

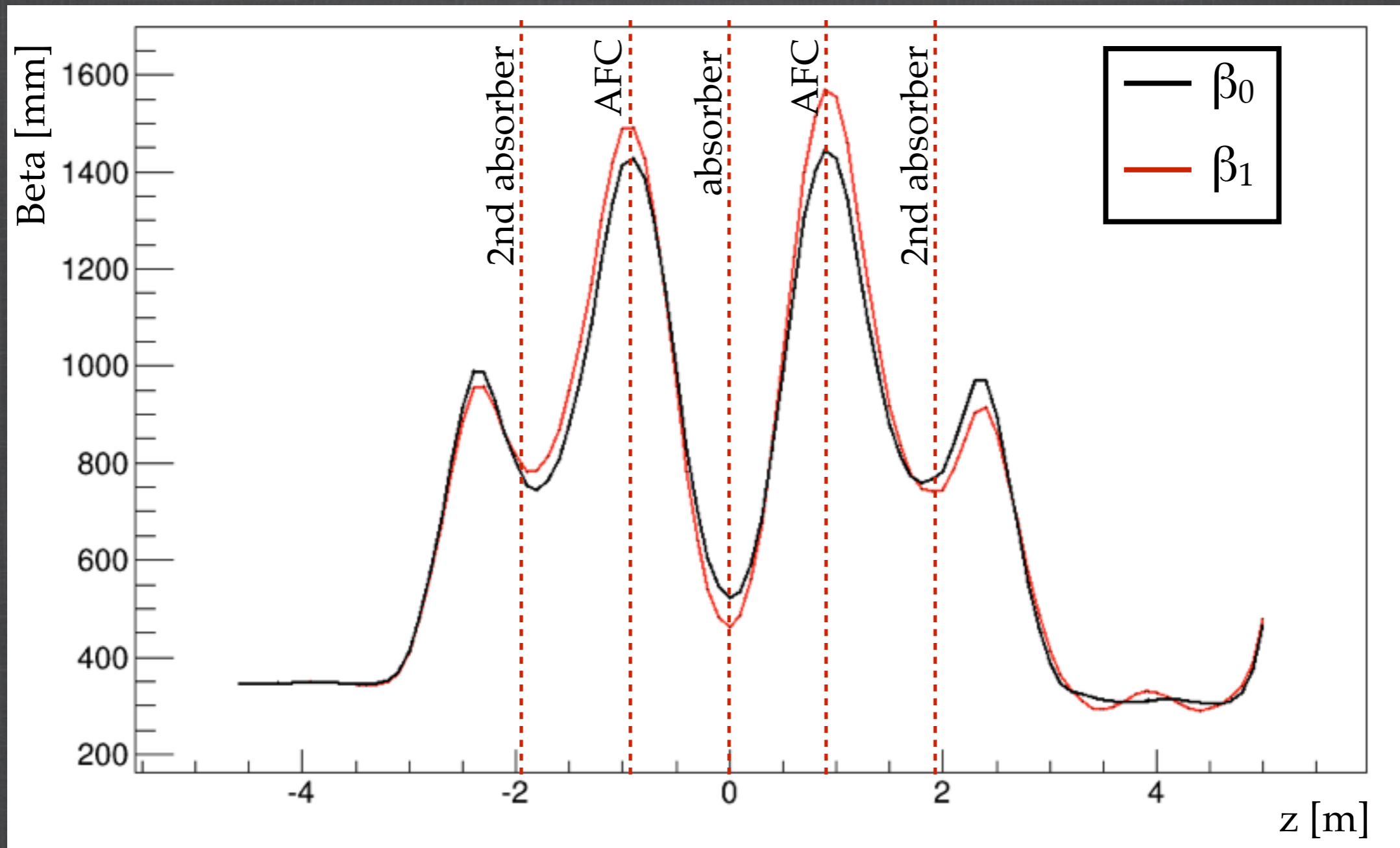
- Different values of  $\beta$  at the central absorber are being tested:
  - $\beta_0$  (53 cm)
  - $\beta_1$  (46 cm)
- Same performance for  $\beta_0$  and  $\beta_1$ .
  - ⇒ Robust lattice.



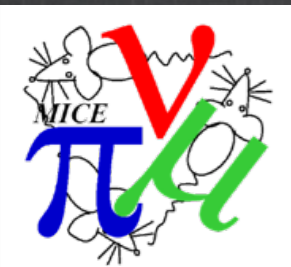


# Beta-value optimization

## Transverse beta

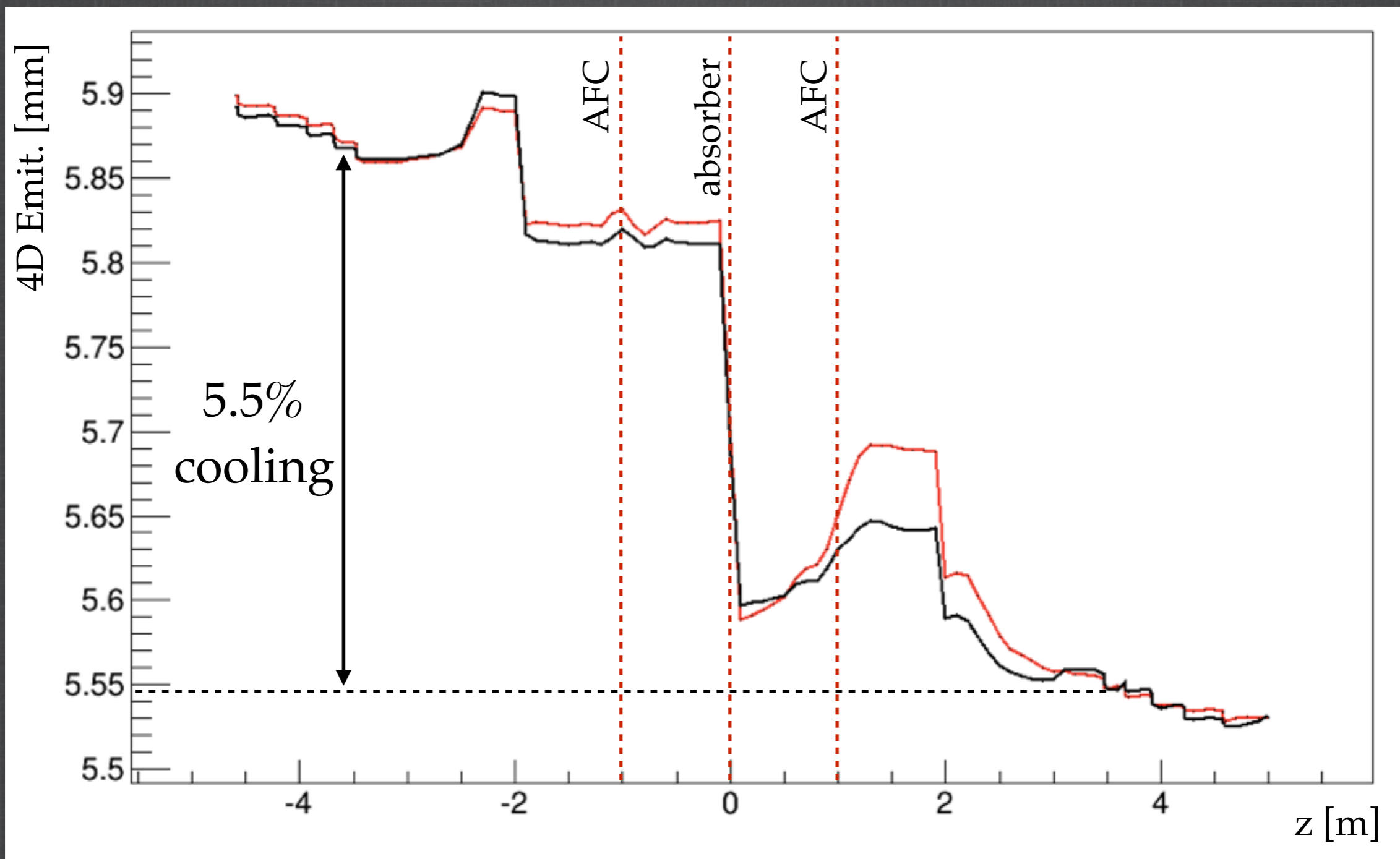






# Beta-value optimization

## 4D emittance



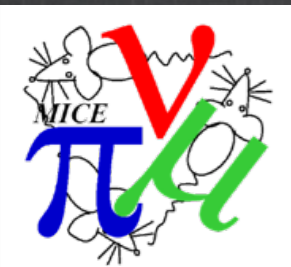




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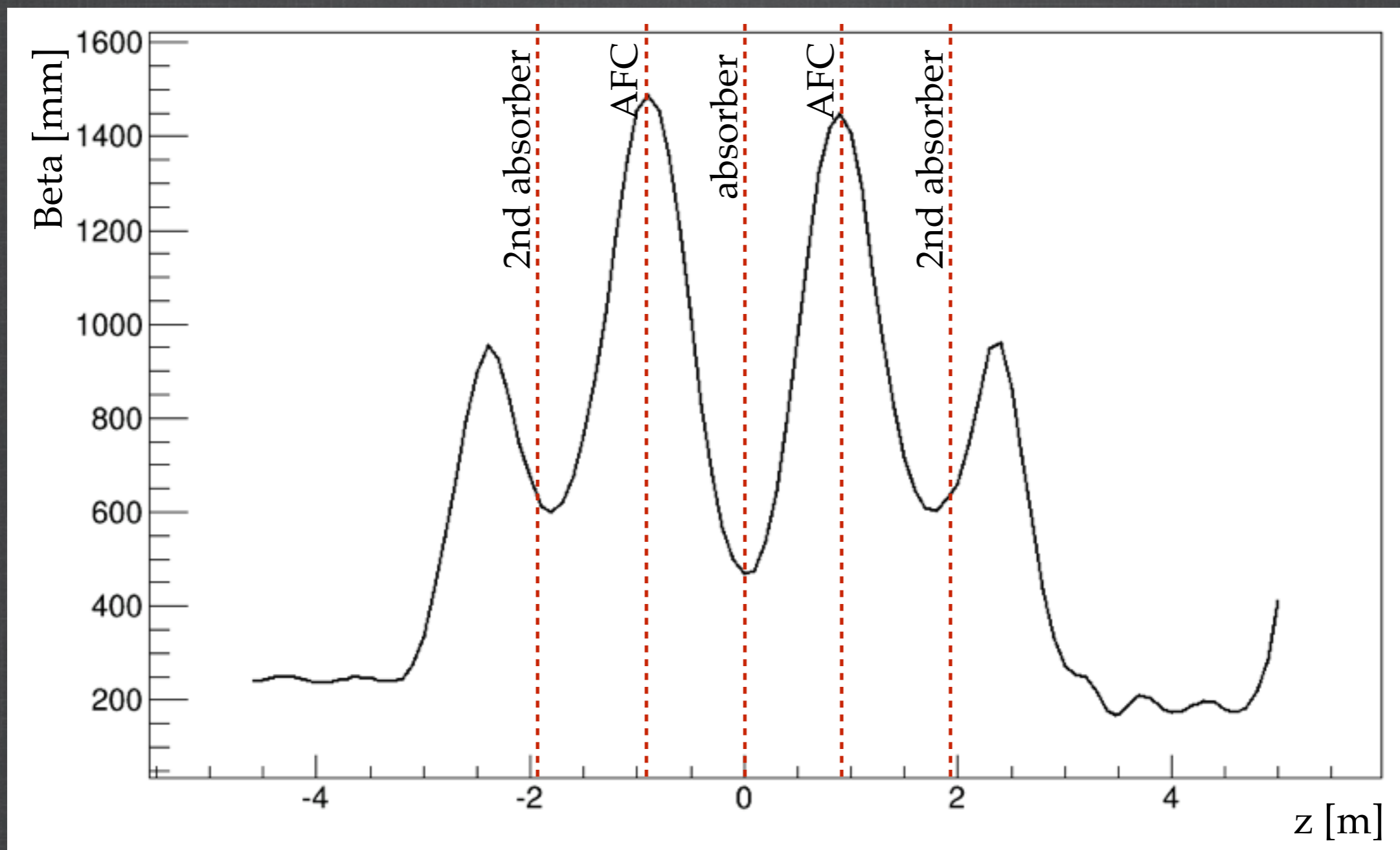
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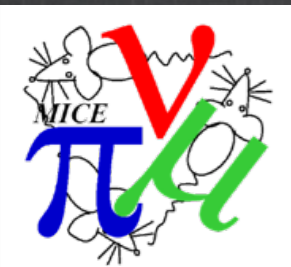


# Preliminary: 140 MeV/c

## Transverse beta

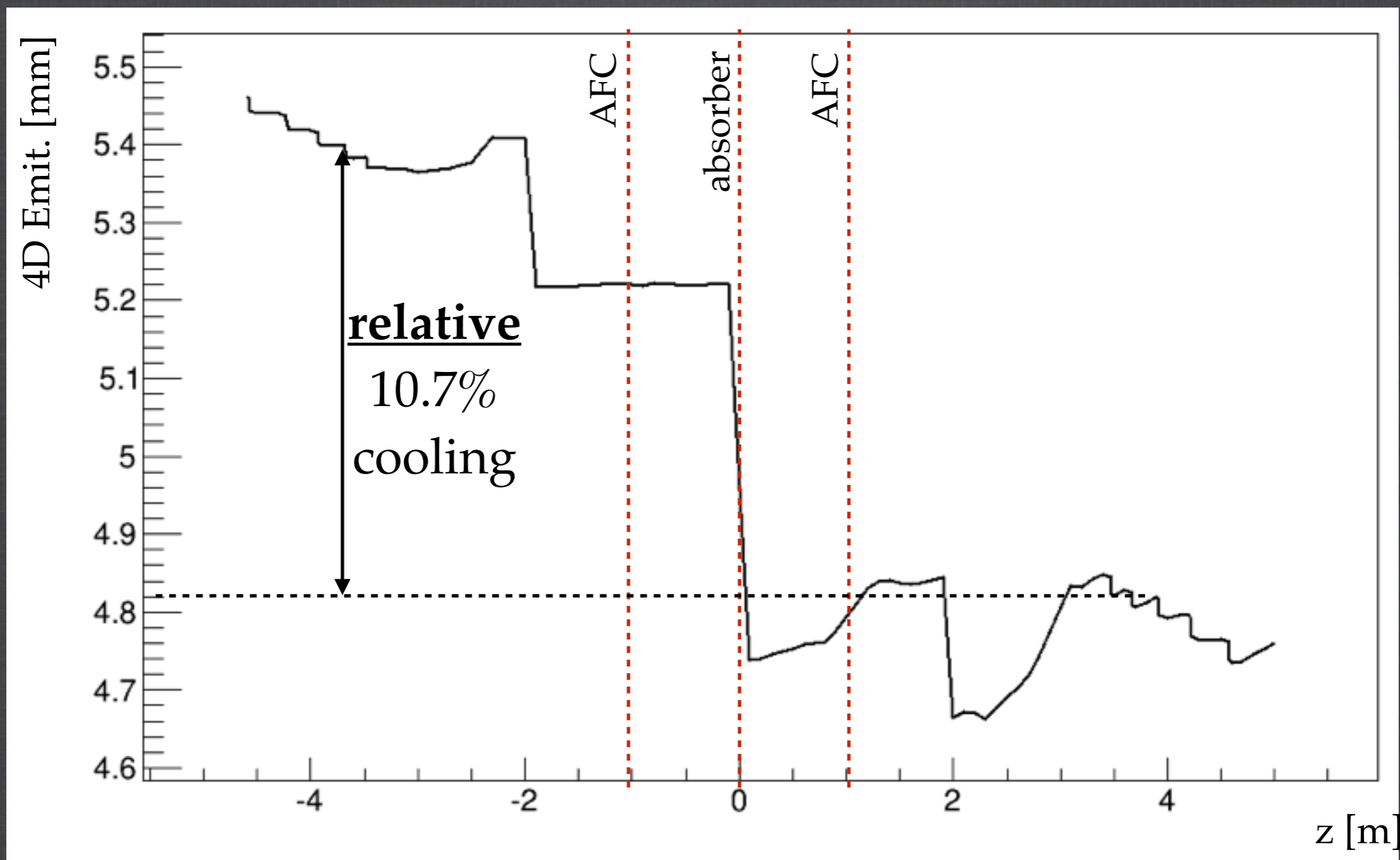




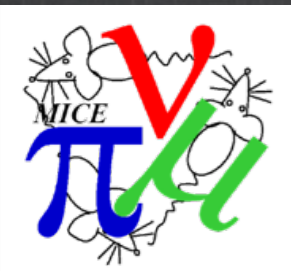


# Preliminary: 140 MeV/c

## 4D emittance

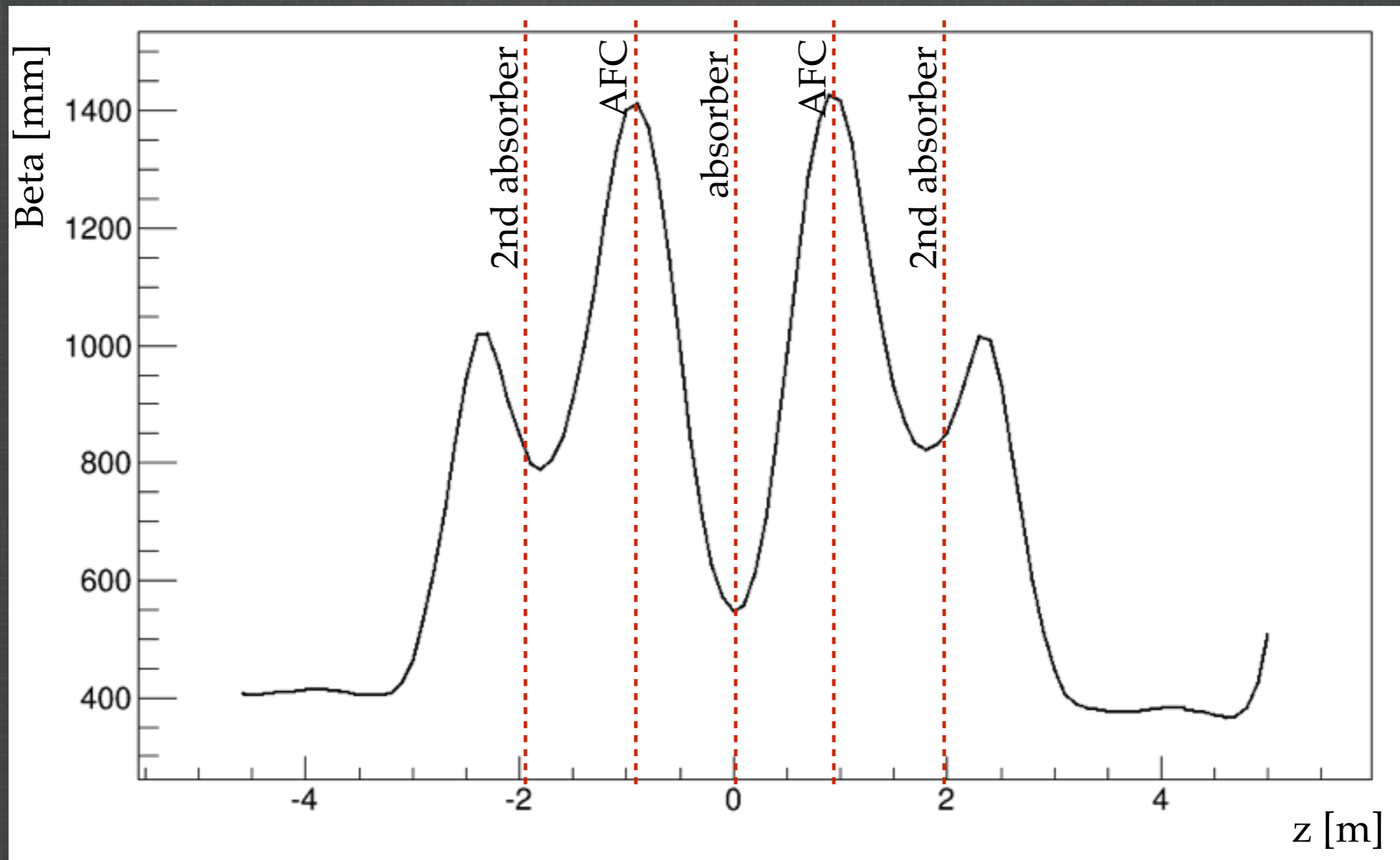




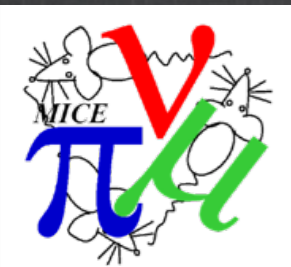


# Preliminary: 240 MeV/c

## Transverse beta

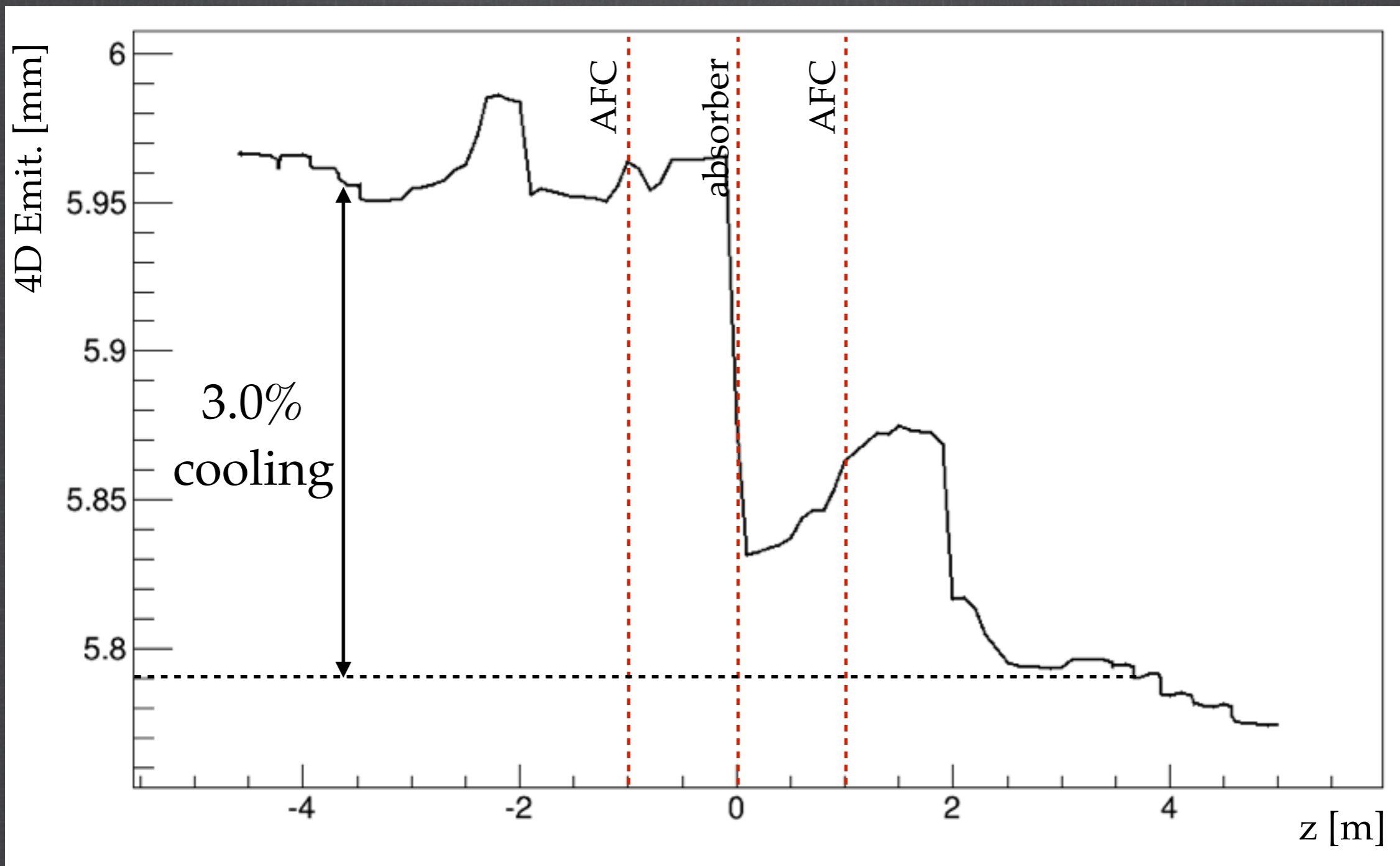






# Preliminary: 240 MeV/c

## 4D emittance



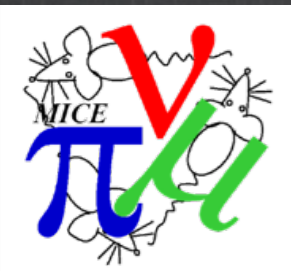




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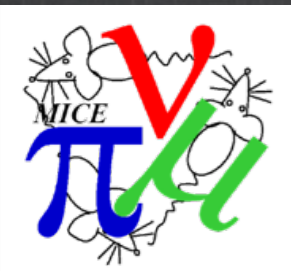




# Summary

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

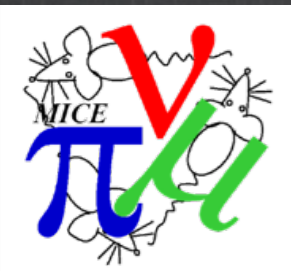




# Future plans

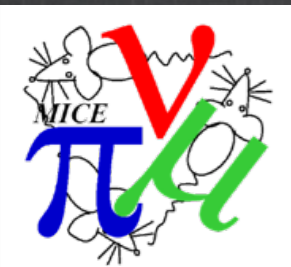
- Finalize the current settings (hours away from completion)
- Scan of emittances for
  - 140 MeV / c settings,
  - 200 MeV / c settings,
  - 240 MeV / c settings.
- Paper including all settings to be finalized soon (Draft v0.0 ready).





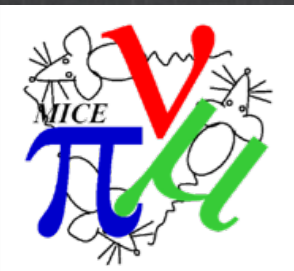
Thank you for your attention





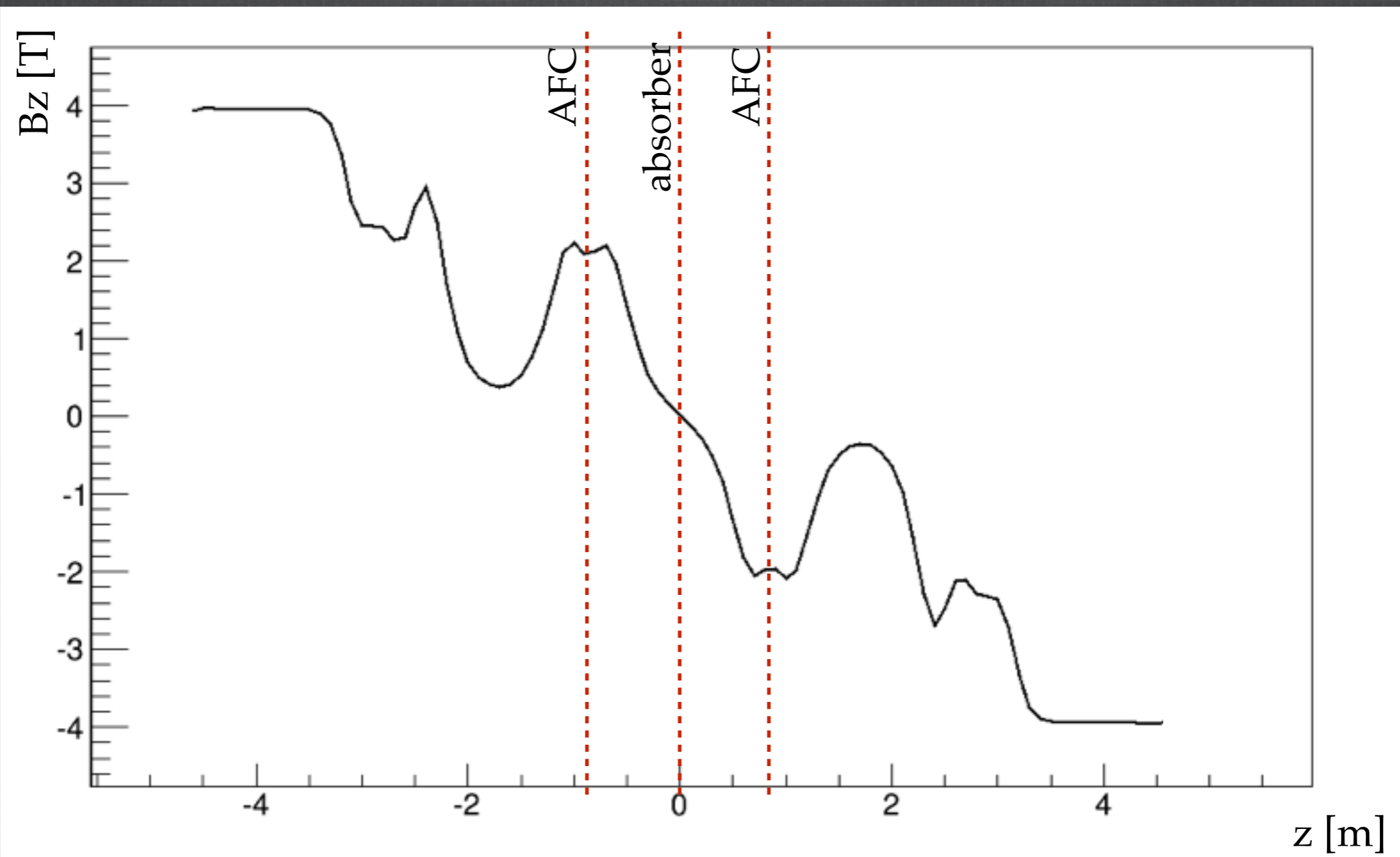
# Back-up slides



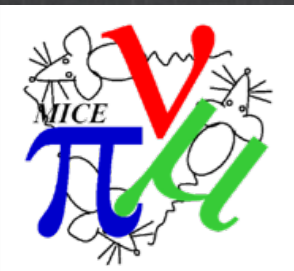


# CM41 Demo Lattice

## Magnetic field

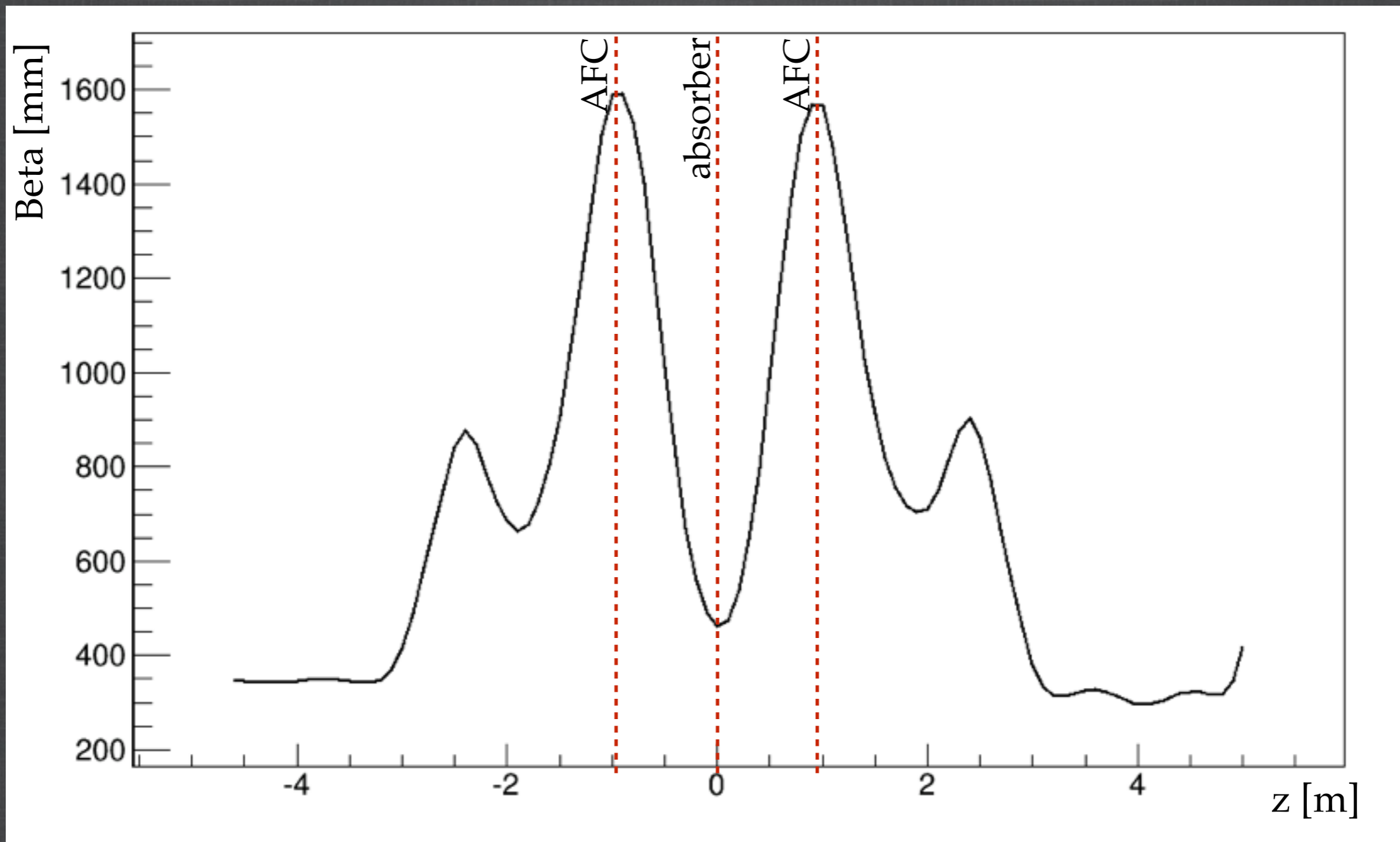




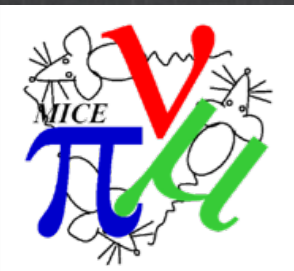


# CM41 lattice

## Transverse beta

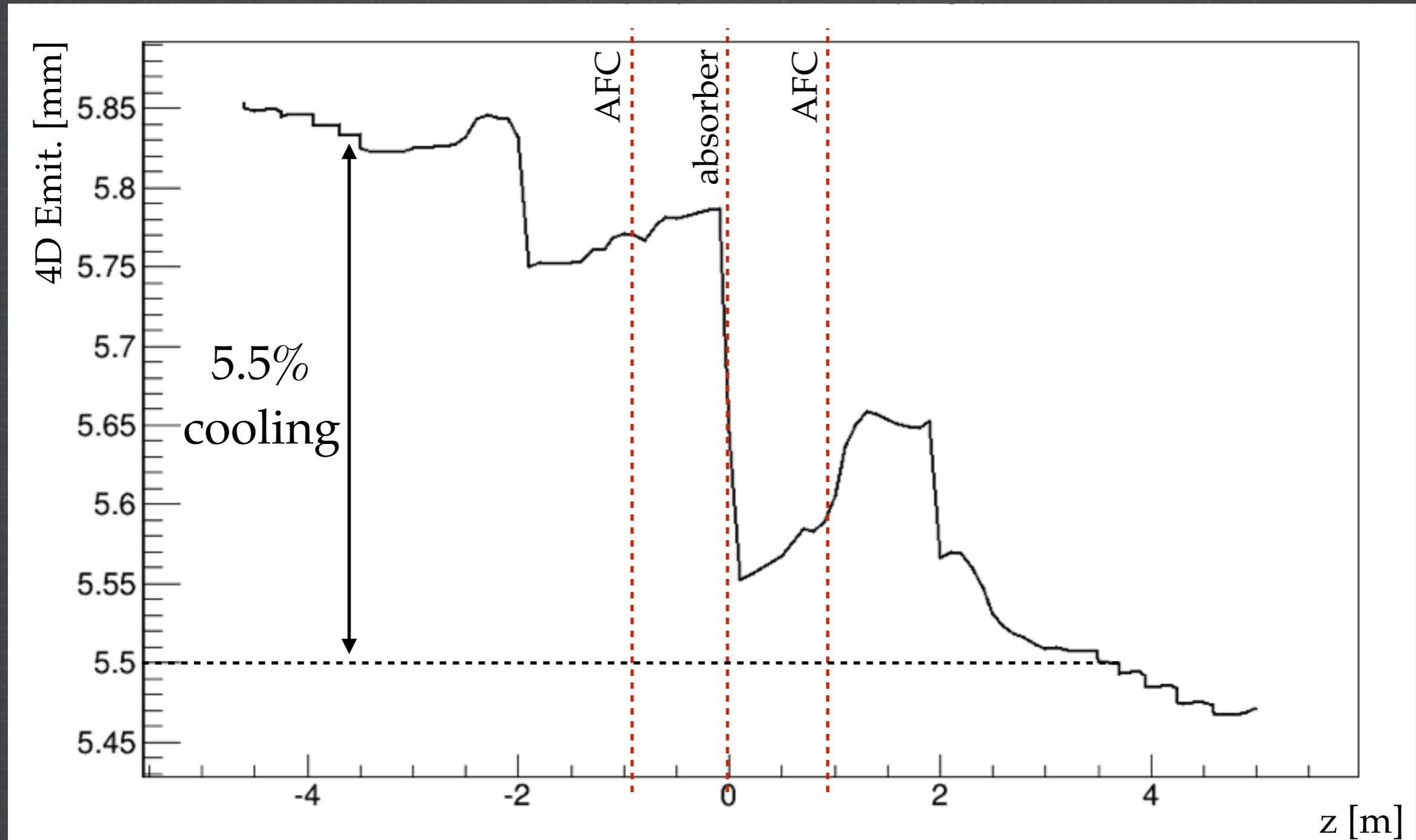




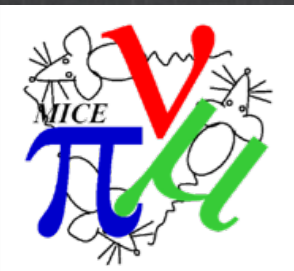


# CM41 lattice

## 4D emittance







# CM41 lattice

## 6D emittance

