

Step I Beam Analysis: Part II

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CM32, RAL, February 2012

Standing on the shoulders...

116 Chapter 7. Simulation of a measured beam in the MICE cooling channel

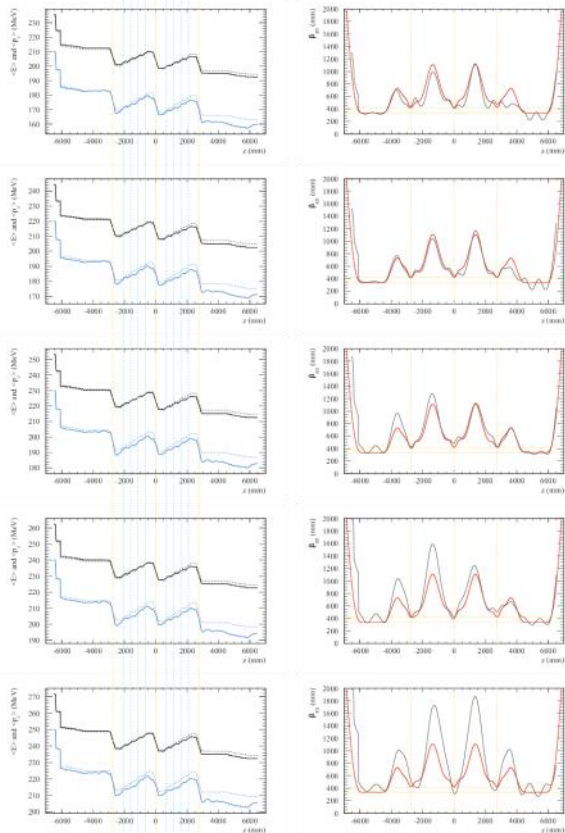
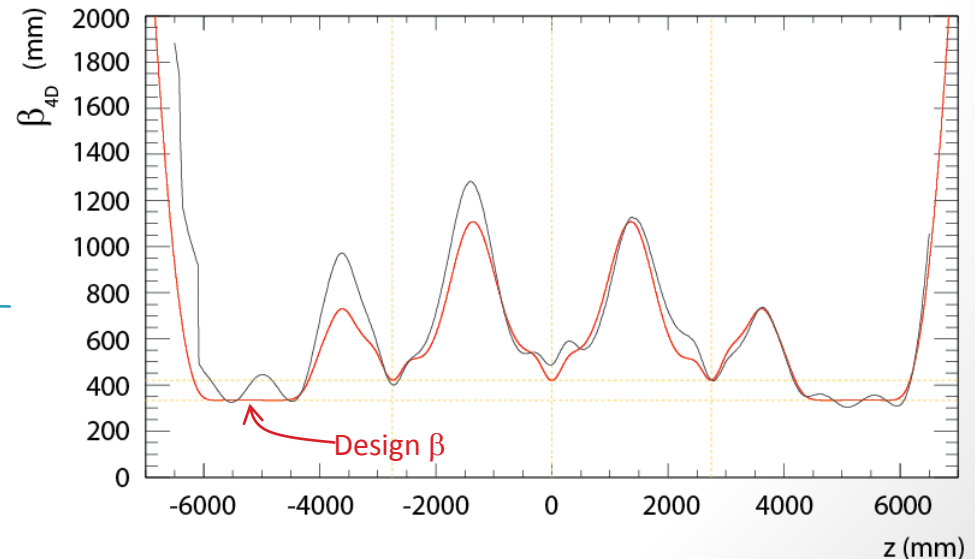
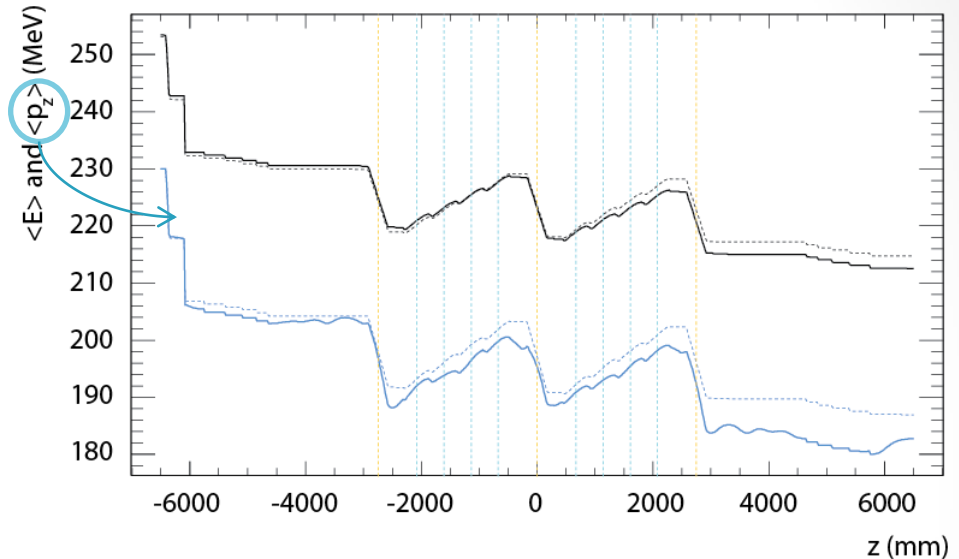


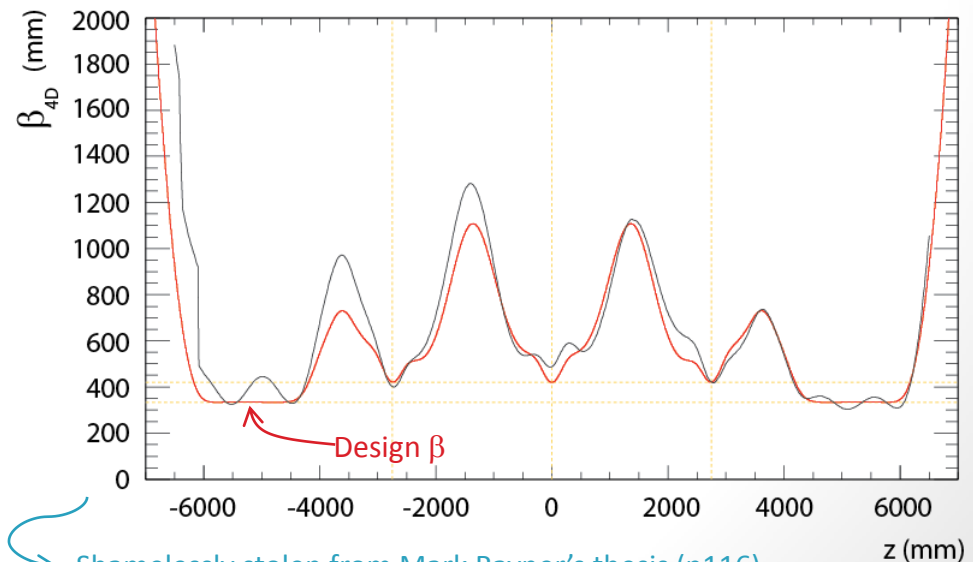
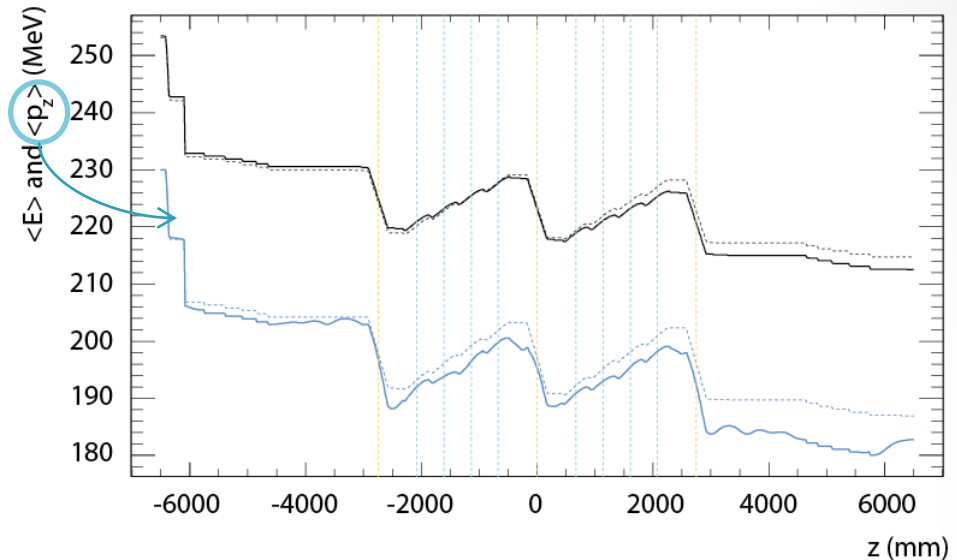
Figure 7.1: From top to bottom: the mean energy and momentum profile and the measured betatron function of monochromatic slices of the base line μ^+ beam with $p_z = 210, 220, 230, 240$ and 250 MeV/c immediately upstream of TOF1. They are defined by their initial $\langle p_z \rangle$ upstream of TOF1 at $z = -6.5$ m in the figure. The diffuser is at $z = -6.2$ m. The yellow dashed lines indicate the positions of the absorber centres and the dashed blue lines indicate the centre of the RF cavities. The red curve is the design beta function.



Shamelessly stolen from Mark Rayner's thesis (p116)

Standing on the shoulders...

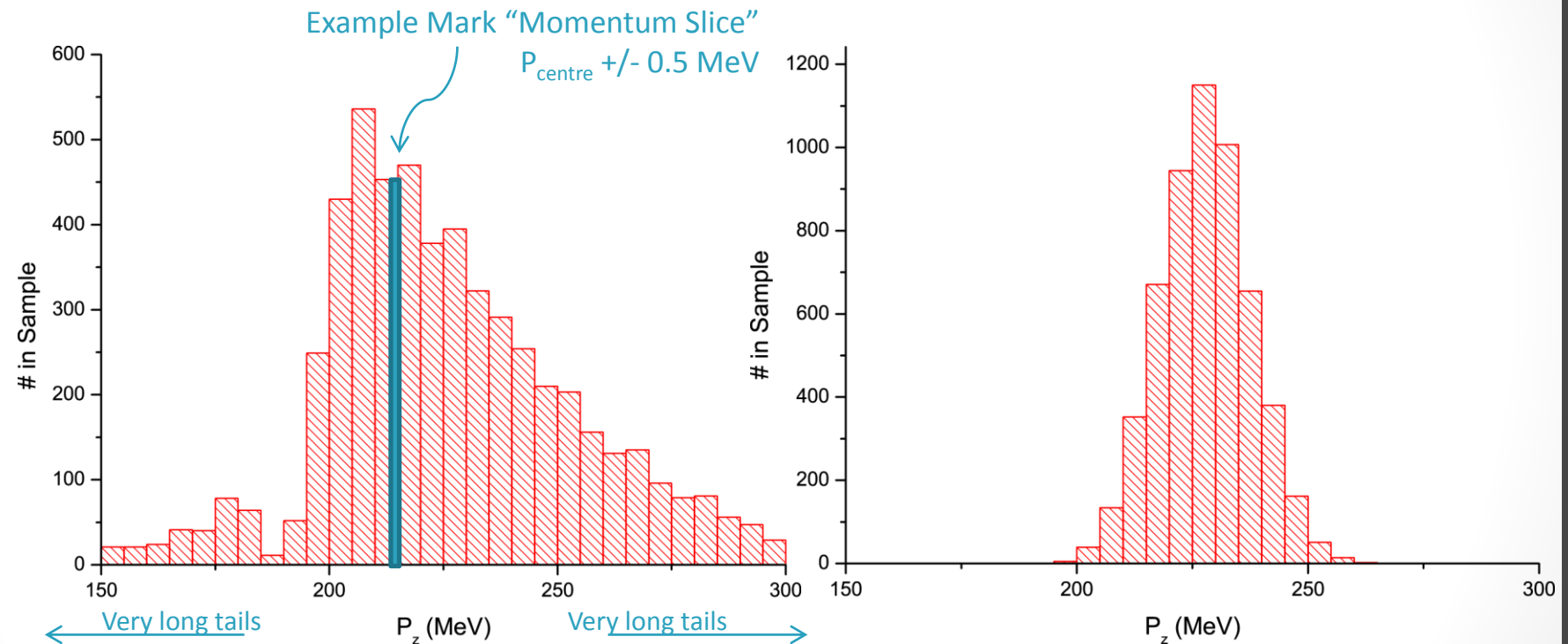
- Mark...
 - ...Reconstructed the beam upstream of TOF1.
 - ...Simulated the passage of *1 MeV slices* of this beam through G4MICE Step VI.
 - Demonstrated emittance reduction!
- What could be improved?
 - Beam selection, RF tuning, matching...



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Beam Selection

Approximately 5'500 μ^+ from the (6,200) μ^+ dataset (before TOF1):



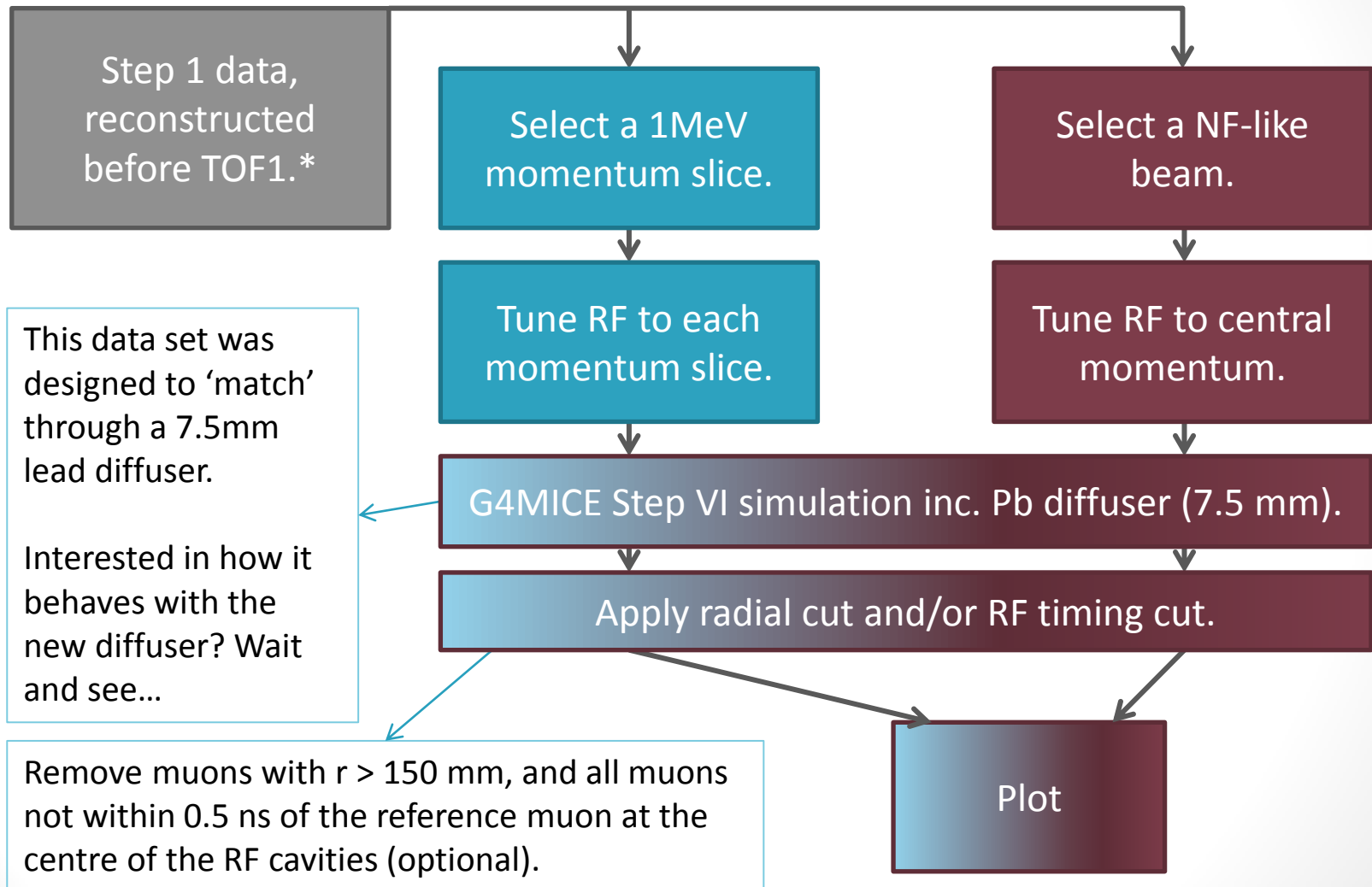
Before muon selection

After muon selection*.

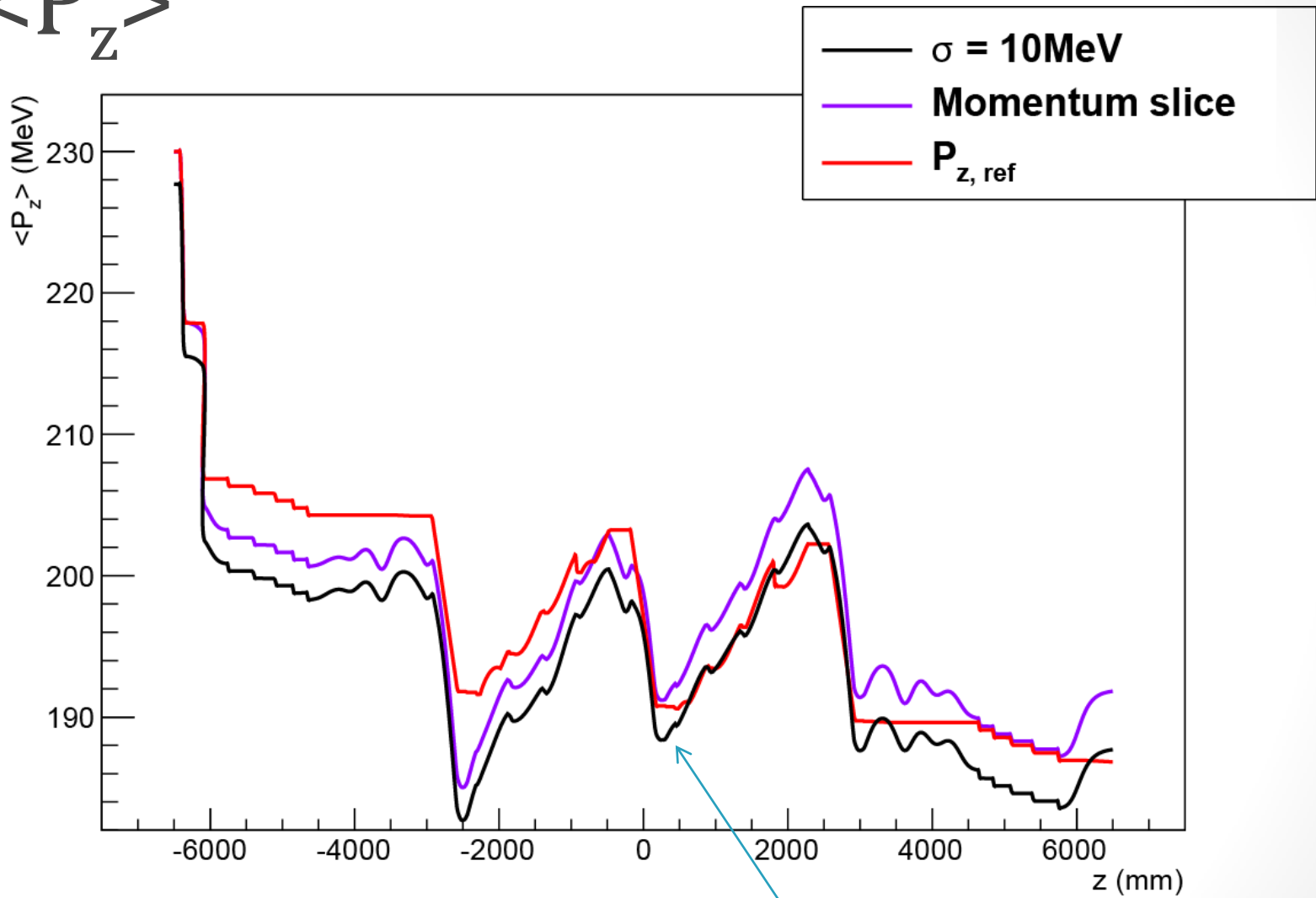
➔ $P_{\text{centre}} = 230 \text{ MeV}$,
 $\sigma = 10 \text{ MeV}$

* Note: The higher frequency of muons in this plot is due to it being approx. 5'500 selected muons!

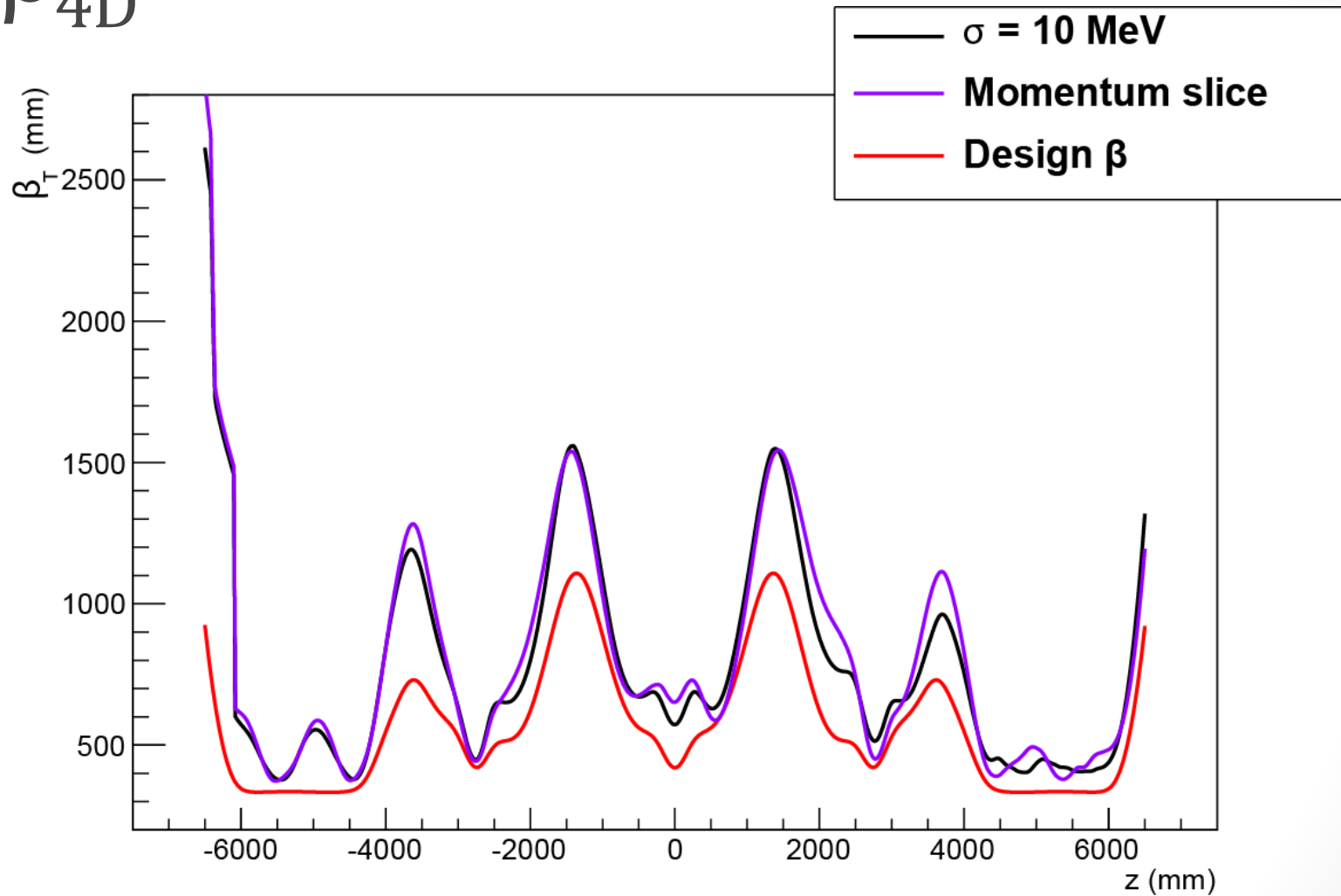
Simulation Procedure



$\langle P_z \rangle$

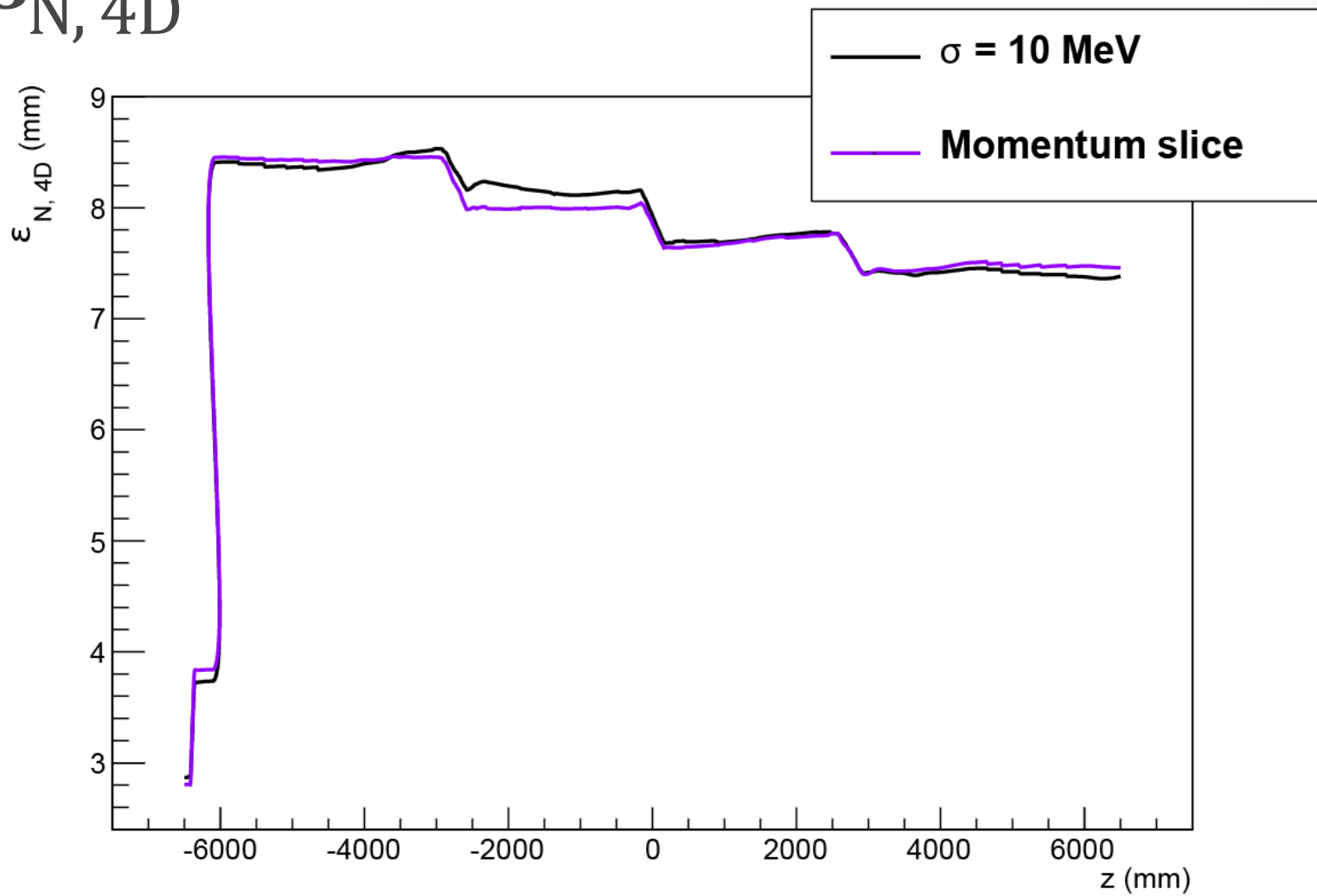


β_{4D}

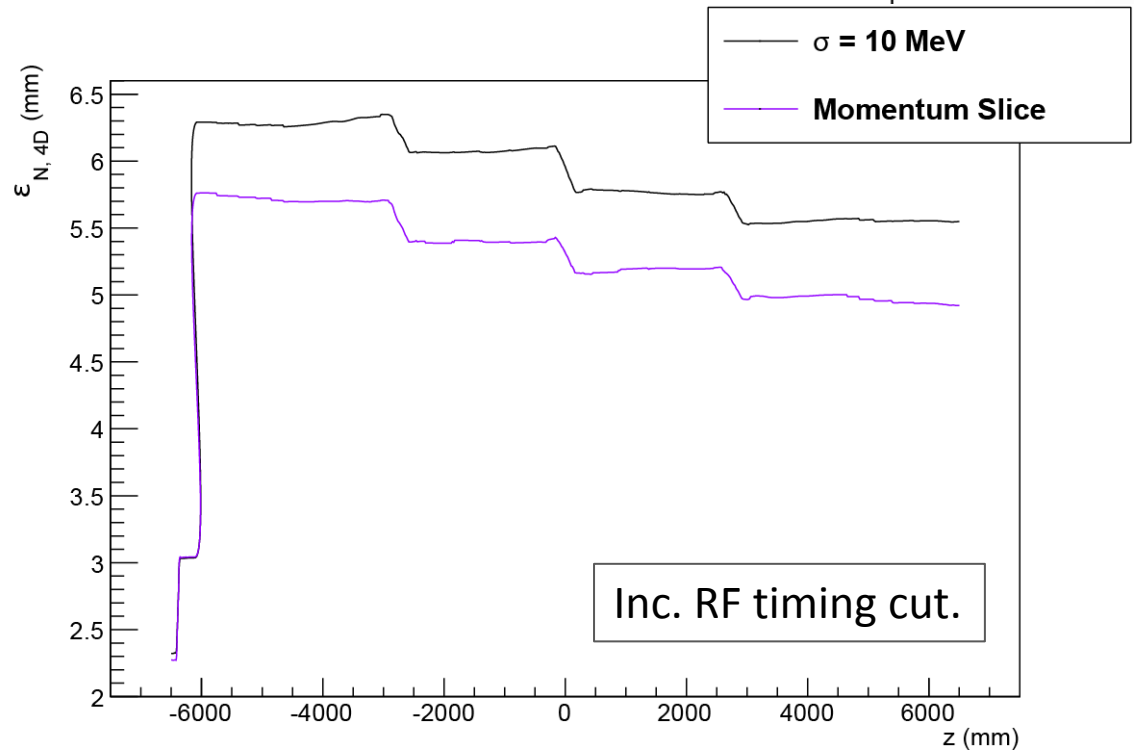
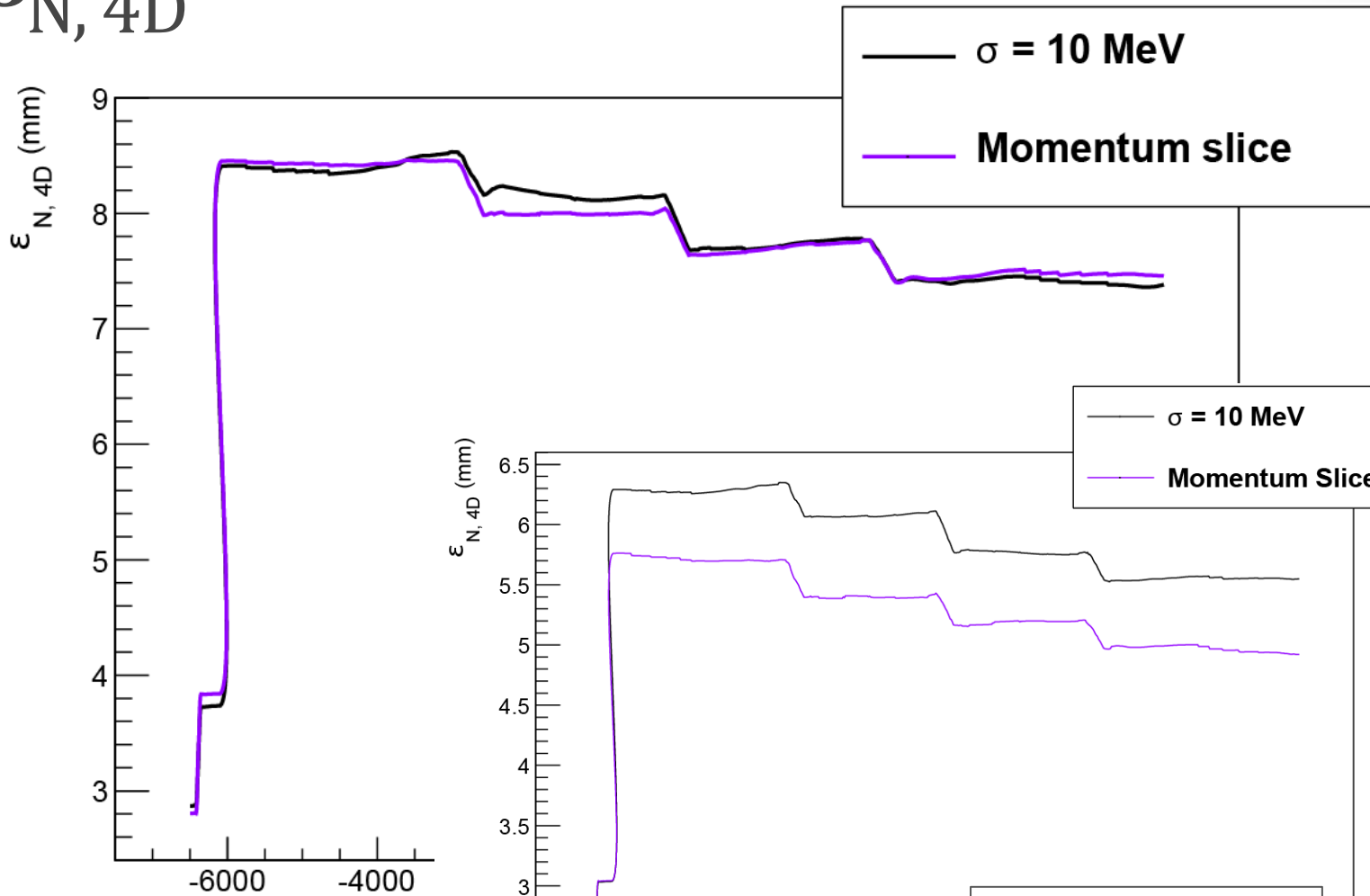


$$\beta_T = \frac{\langle p_z \rangle (\sigma_x + \sigma_y)}{m \epsilon_N 2}$$

$\mathcal{E}_{N, 4D}$



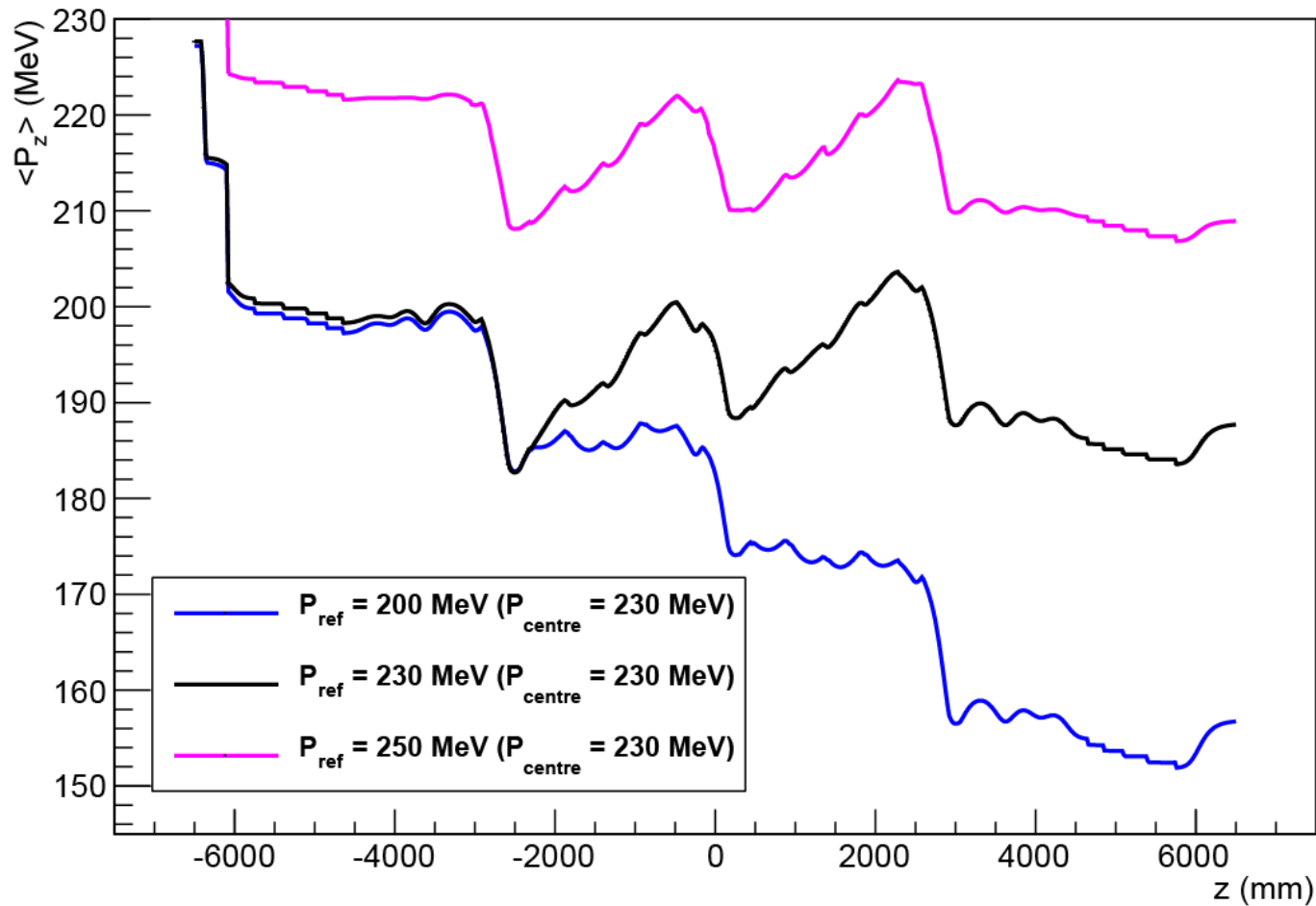
$\epsilon_{N, 4D}$



Inc. RF timing cut.

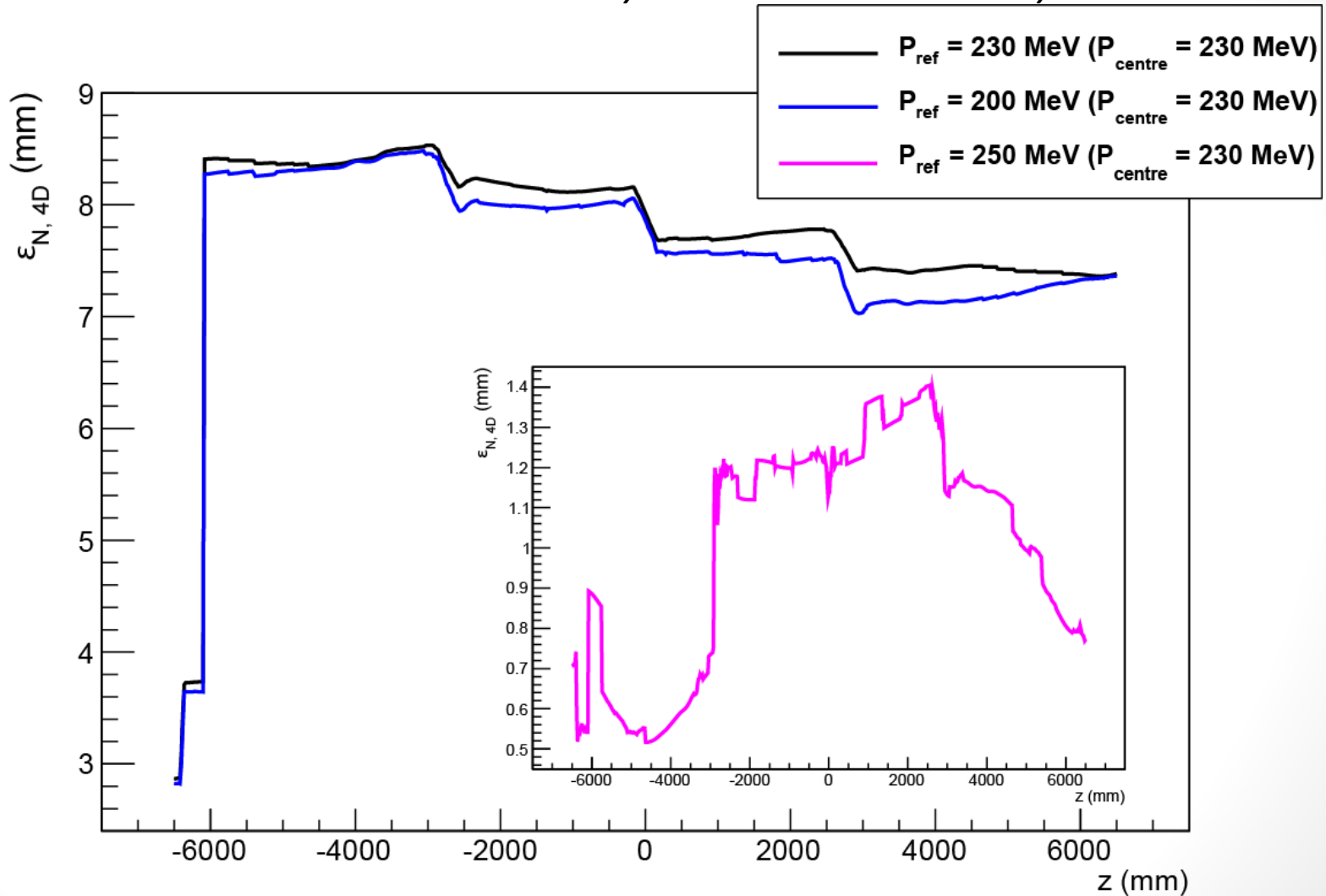
Tuning the Reference Muon

AKA an easy lesson in how to 'destroy' a beam...



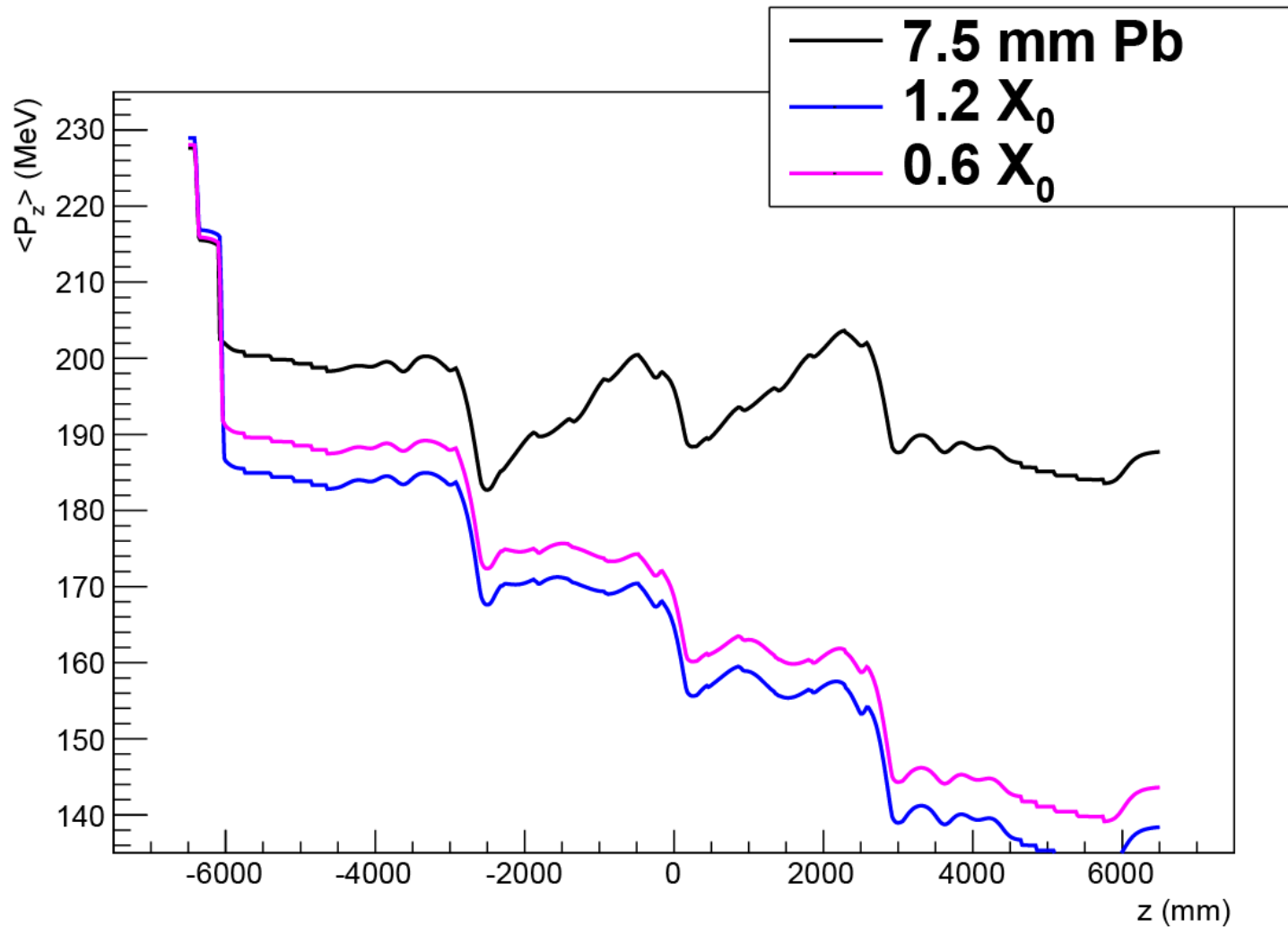
Tuning the Reference Muon

AKA an easy lesson in how to 'destroy' a beam...



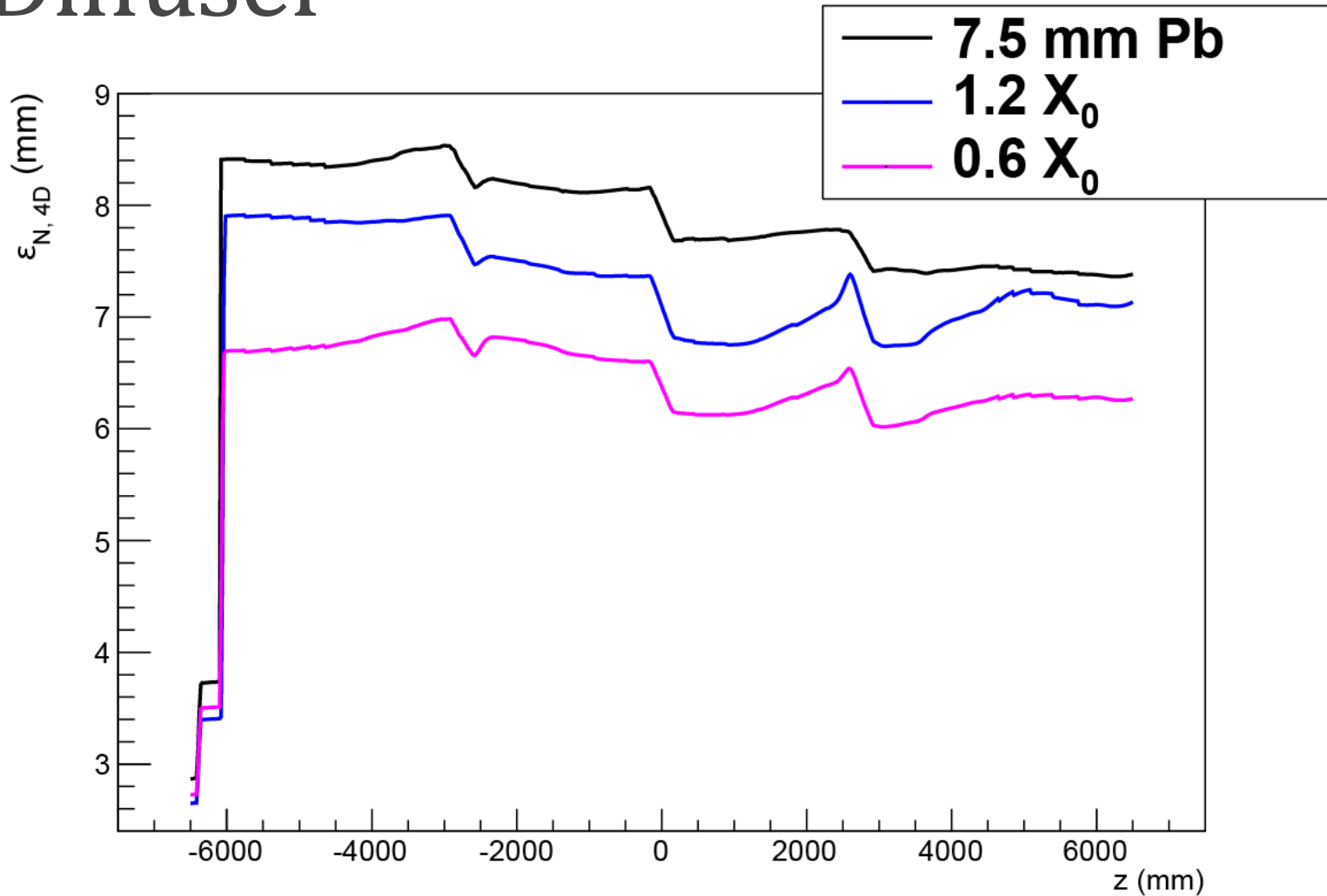
NB: Using the RF-timing cut made these plots much more 'boring' (i.e. normal).

A Quick Glimpse with the New Diffuser



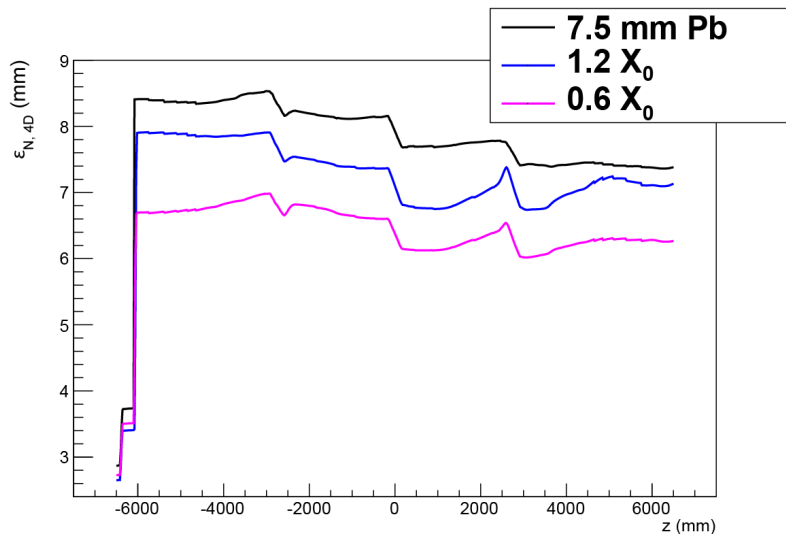
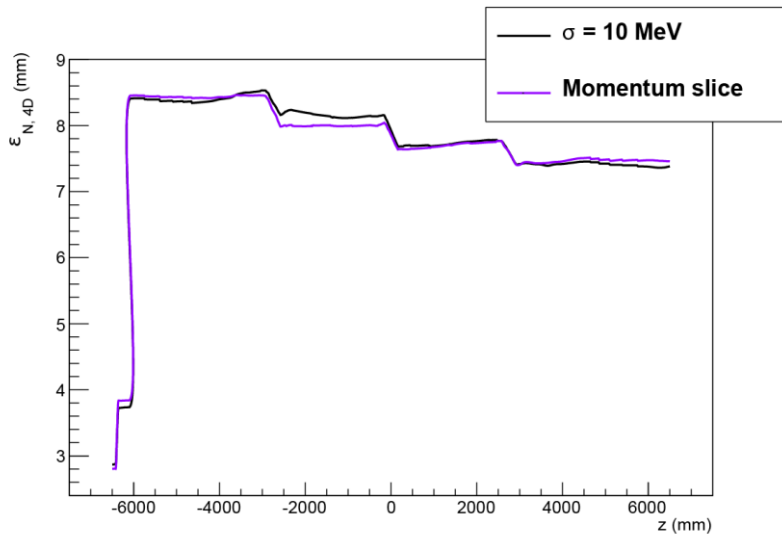
Using the $P_{\text{centre}} = P_{\text{ref}} = 230$ MeV Gaussian beam, with $\sigma = 10$ MeV.

A Quick Glimpse with the New Diffuser



Using the $P_{\text{centre}} = P_{\text{ref}} = 230$ MeV Gaussian beam, with $\sigma = 10$ MeV.

Summary



- Have expanded upon the Step I simulations through Step VI by including a Gaussian spread to the input beam.
 - Does have an effect on beam matching.
 - Similar emittance reduction.
- The reference muon can have a large effect on the resulting emittance (cut dependent).
- Step I beams were devised for the lead diffuser, which no longer exists. Their suitability for the new diffuser requires further investigation!
- Still a *lot* to do...