Positron deceleration using RF

- Input e+ beam from Monte Carlo (EGS) simulations
- Field RF cavity – Poisson/Superfish
- Focusing solenoid – Poisson/Superfish
- Beam dynamics – General Particle Tracer

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Results of Monte Carlo simulations:

- e+ production
  from primary e- 10 MeV beam on 1mm W target

- e+ production
  from primary e- 5 MeV beam on 0.5mm W target

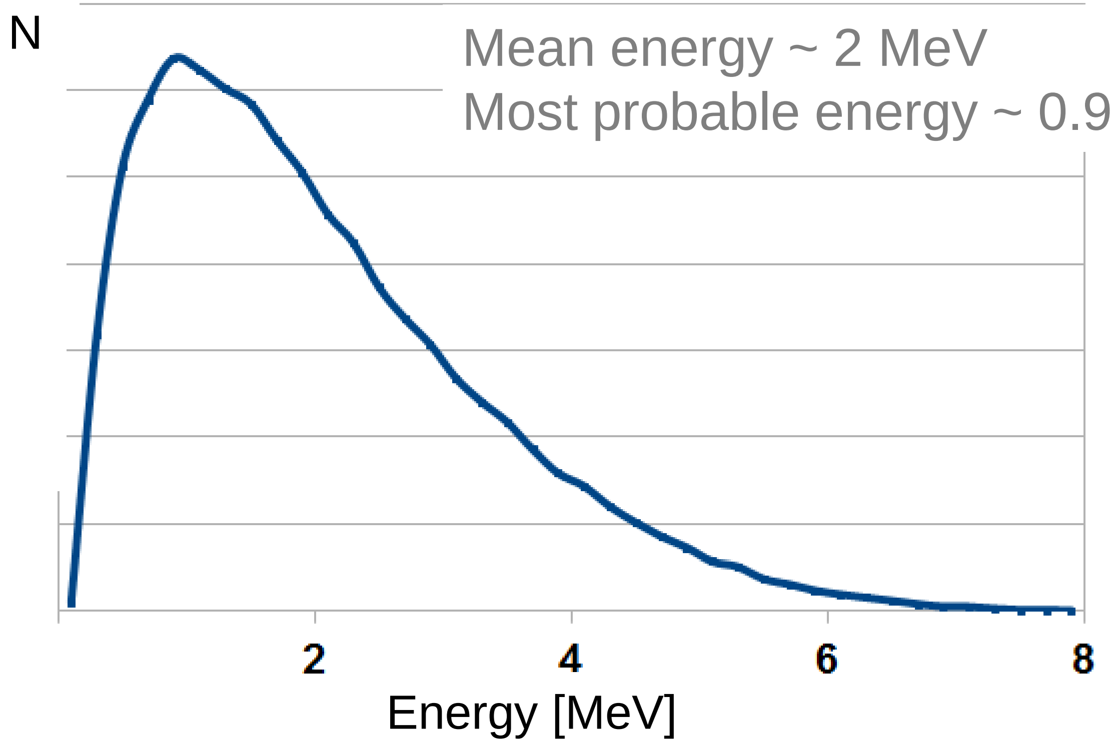
e^+ production (10 MeV)

Primary beam e^- - energy 10 MeV hits 1mm W target.

The total production efficiency ~ 0.16%

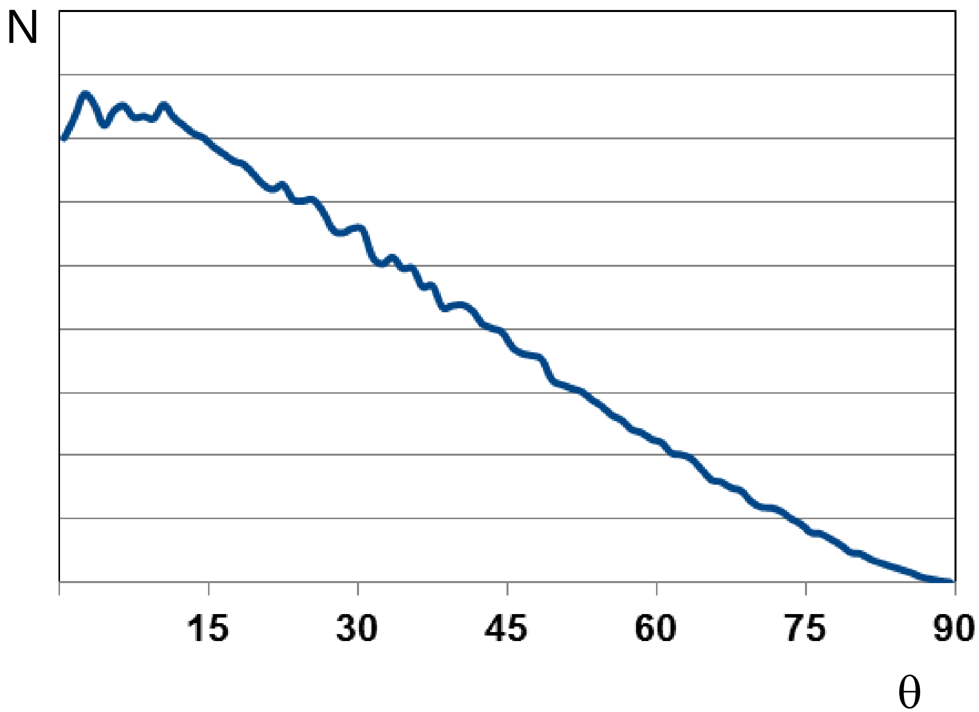
Energy spectrum of produced e+ after living the target:

Mean energy ~ 2 MeV
Most probable energy ~ 0.9 MeV

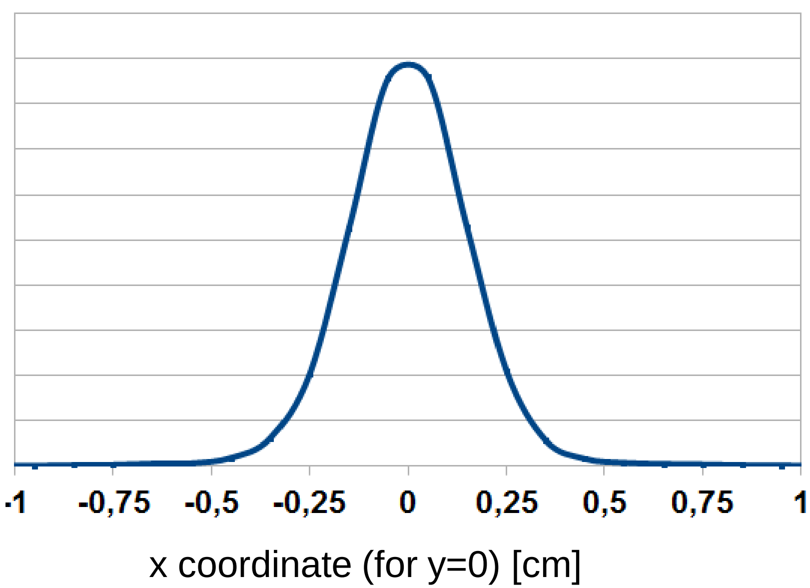


e^+ production (10 MeV)

Angle distribution of e+ behind the target:



Spatial distribution of e+ behind the target. Almost identical as the primary electron beam:

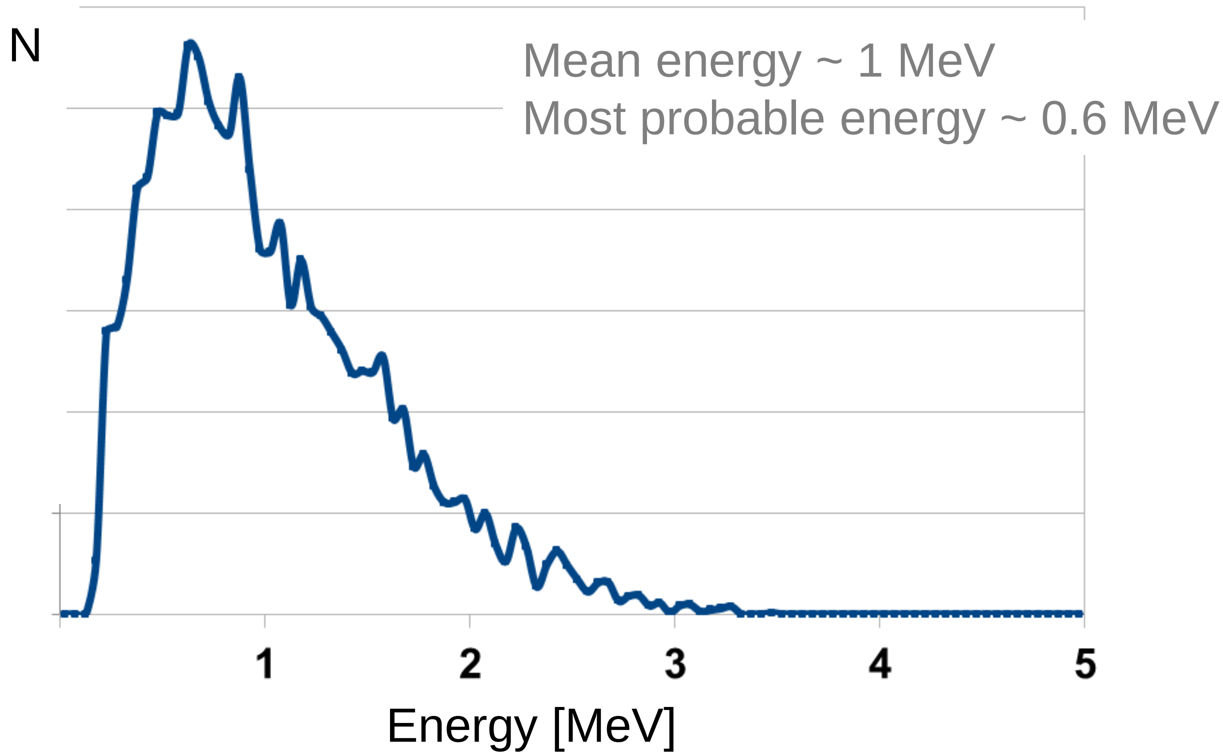


e⁺ production (5 MeV)

Primary beam e⁻ - energy 5 MeV hits 0.5mm W target.

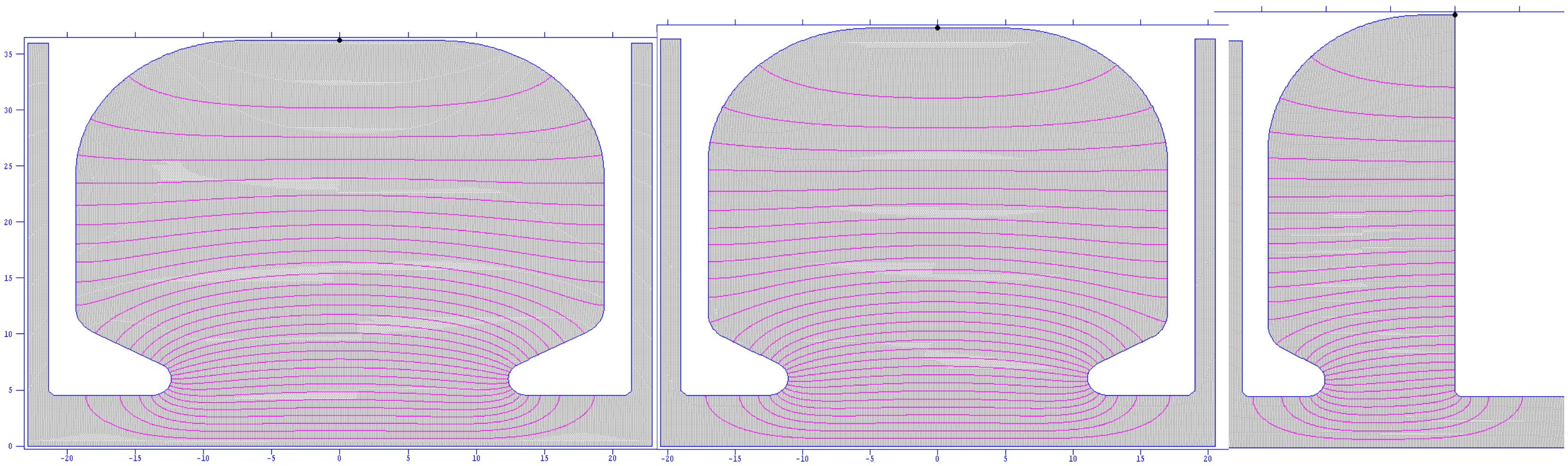
The total production efficiency ~ 0.012%

Energy spectrum of produced e+ after living the target:



RF cavities

2 or 3 cavities (gap/L = 0.54) placed one after another were considered.



L=45.7mm L=41mm L=18mm

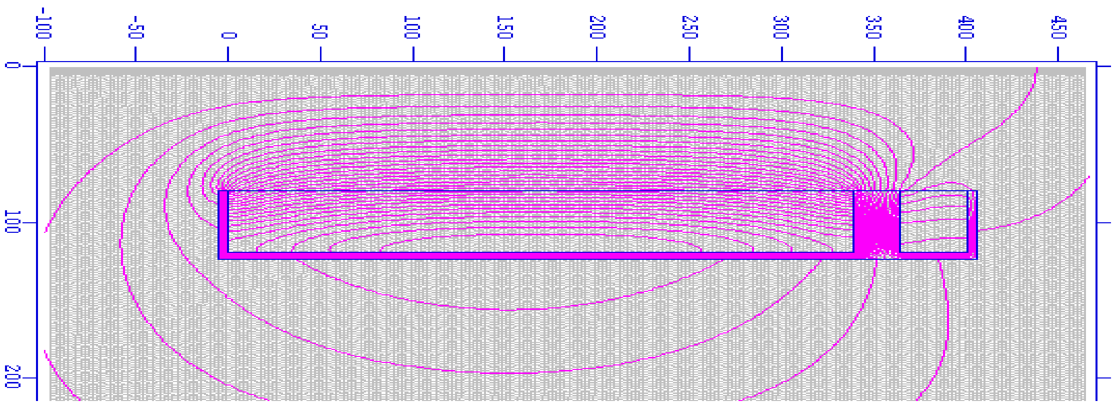
Different positions of cavities and focusing solenoid were tested.

Focusing solenoid

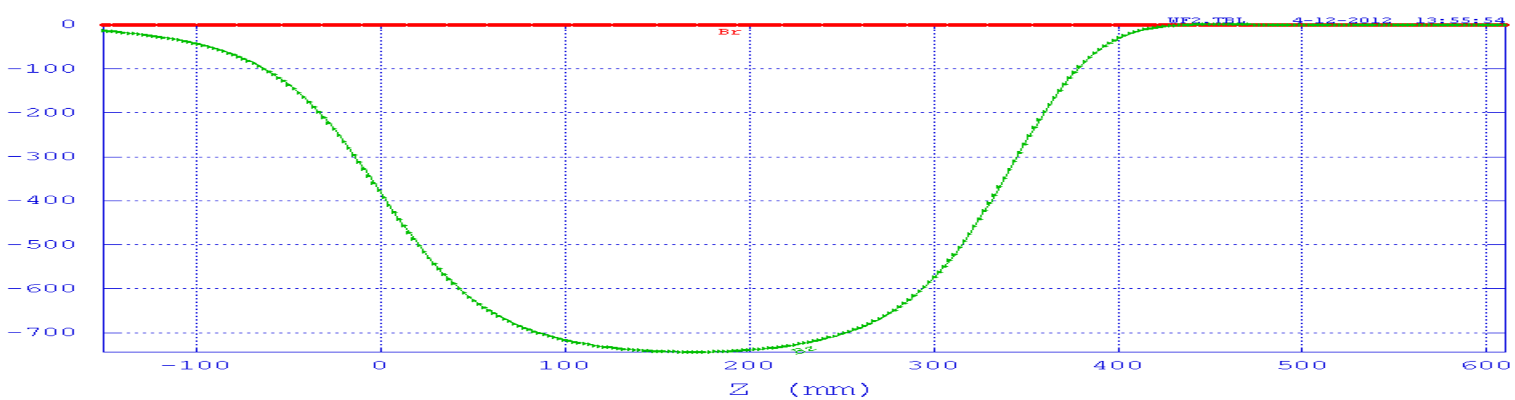
There were analyzed 2 versions - shorter and longer

Max B_z field ~ 0.7 T

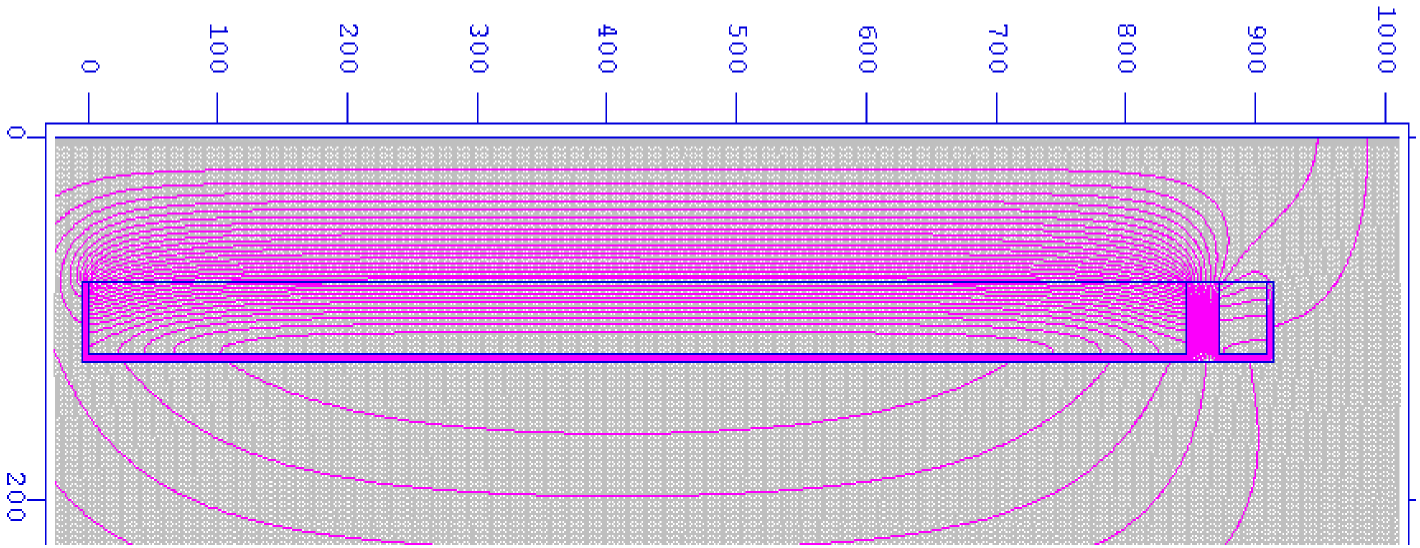
Lower and higher values of magnetic field were also considered.

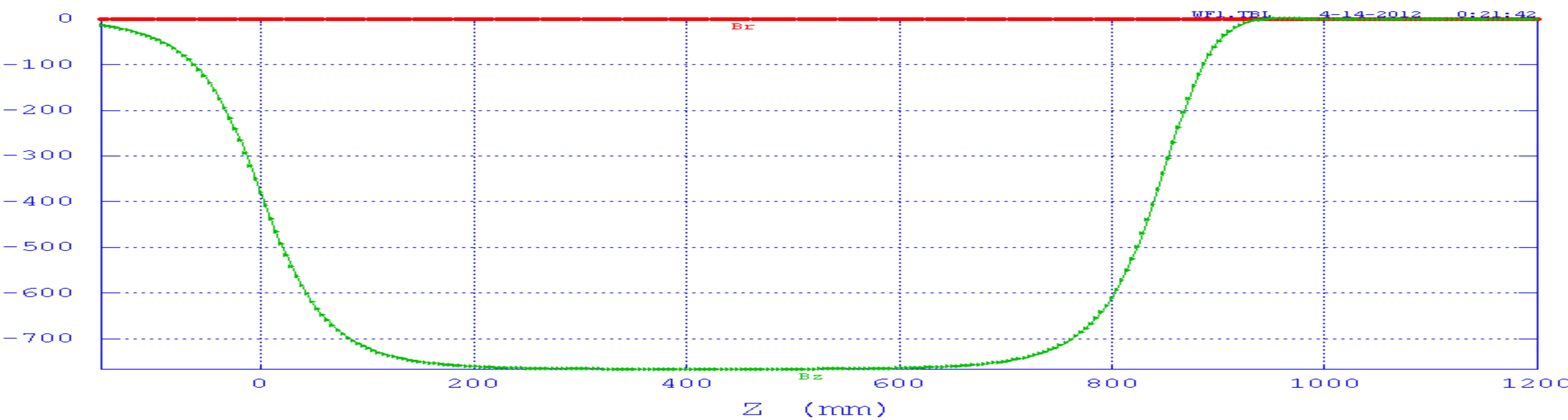


Additional compensating coil was used



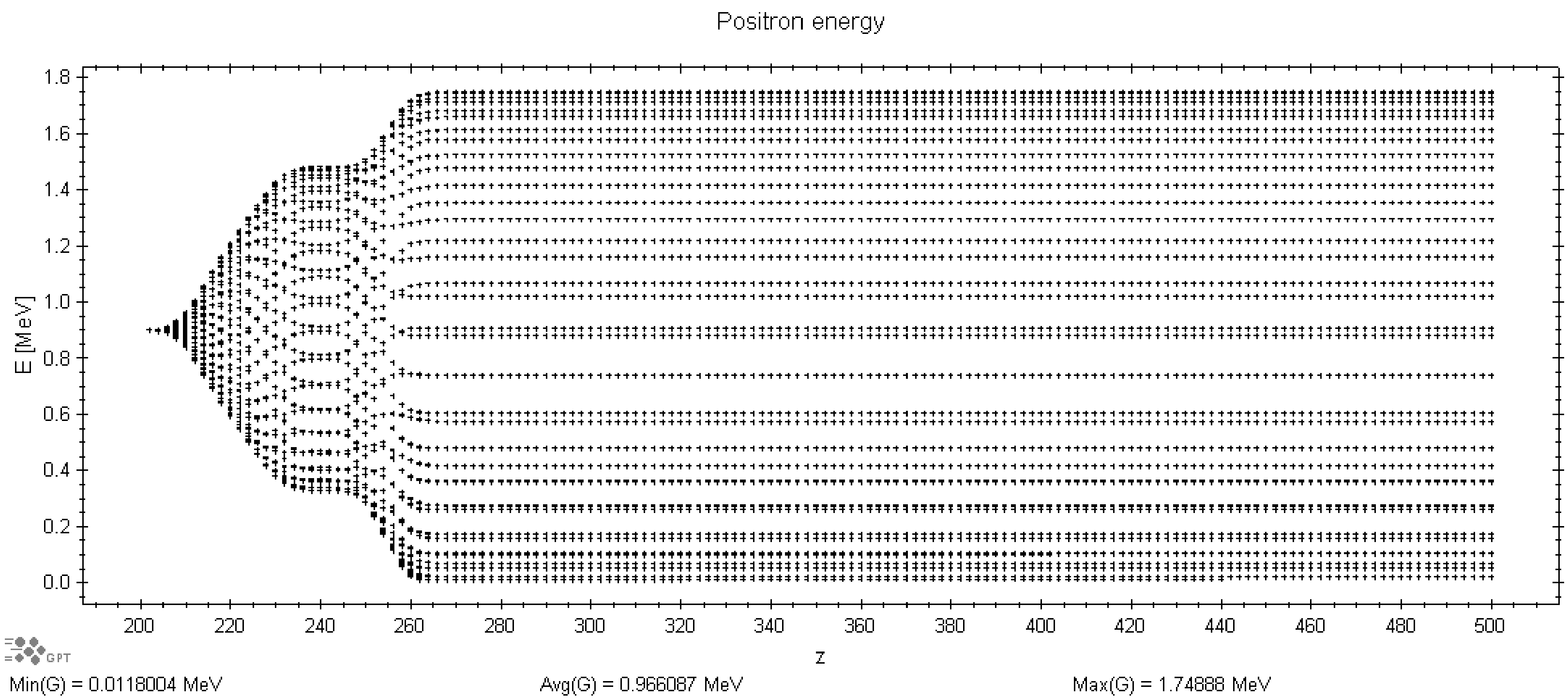
Focusing solenoid





RF positron deceleration

To set the proper values of decelerating E field one can start from mono-energetic e+ beam 0.9MeV

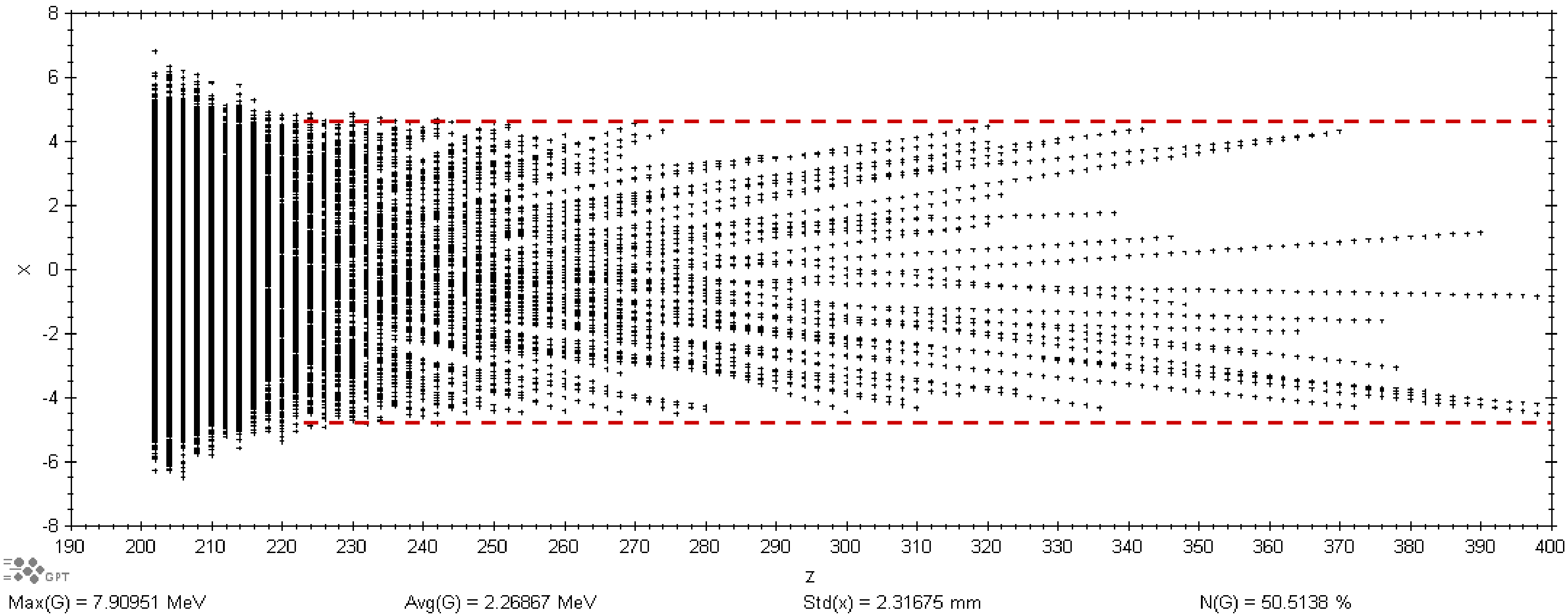


Deceleration and acceleration by 2 RF cavities

RF positron deceleration

The goal is to decelerate as many positrons as possible, close to the peak energy 0.9MeV

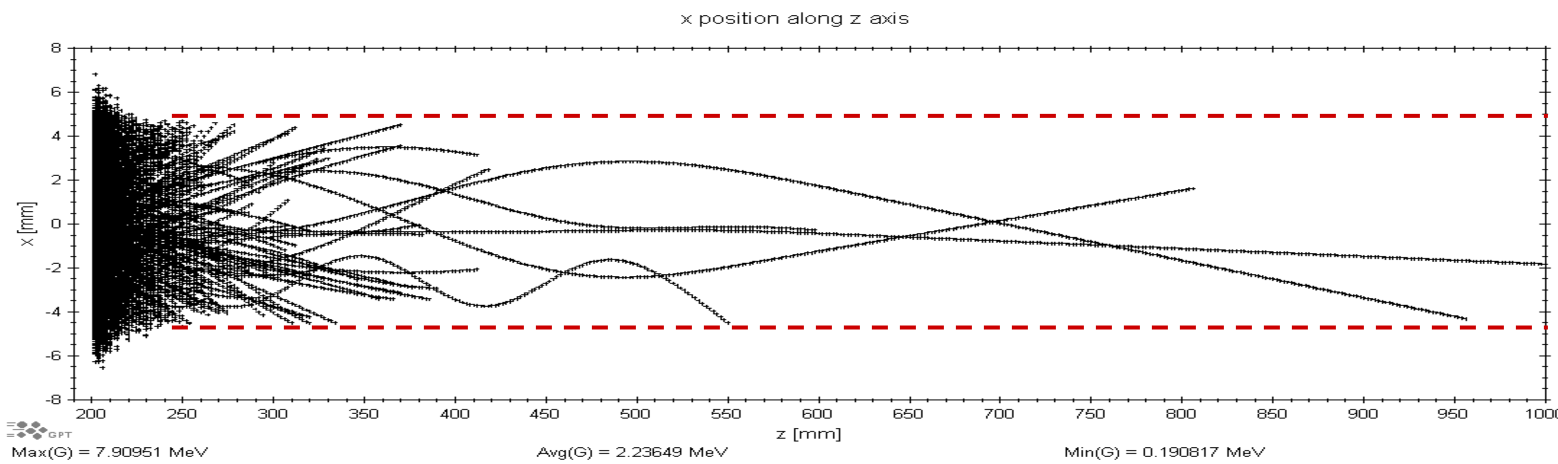
Unfortunately the beam is divergent in all directions.



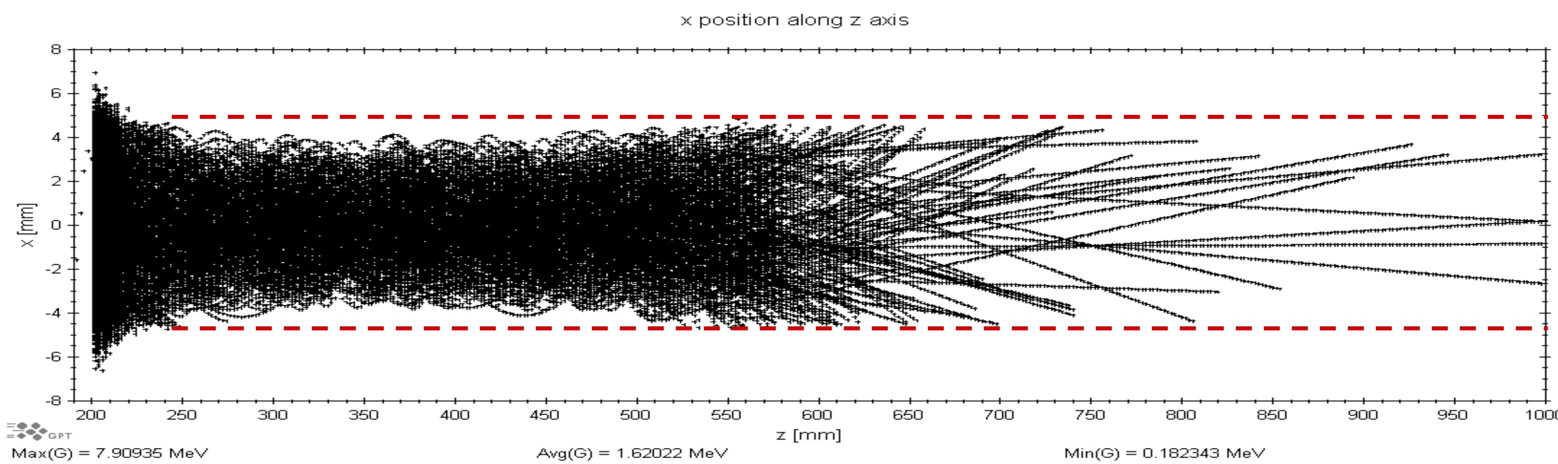
RF positron deceleration

Focusing solenoid (without RF field) – shorter version

$B_z \sim 0.7T$



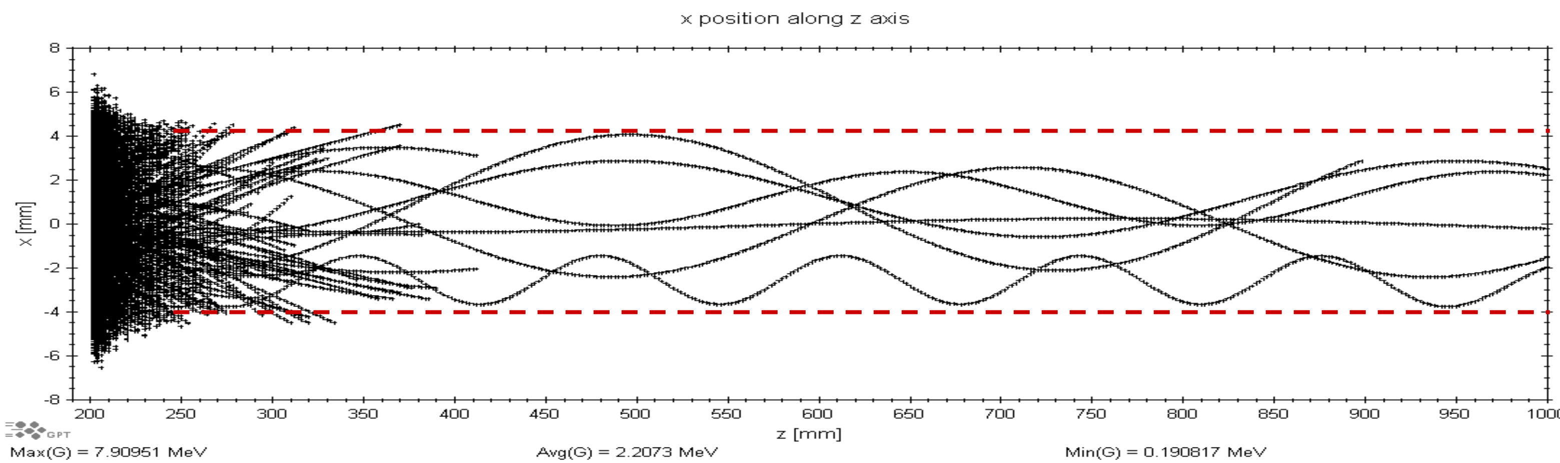
$B_z \sim 7T$



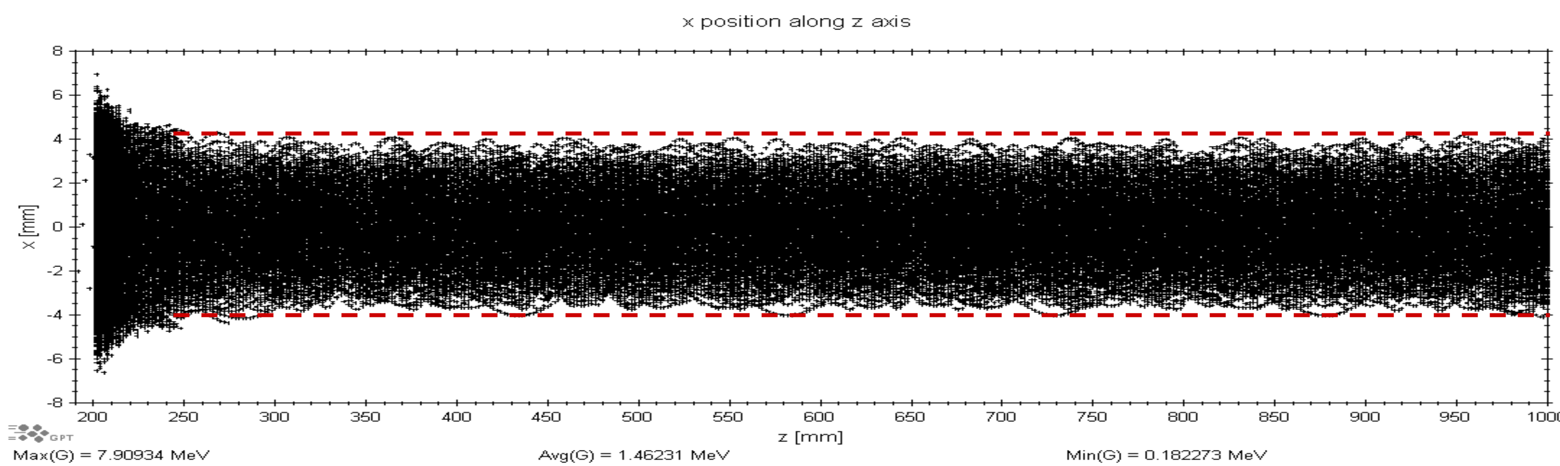
RF positron deceleration

Focusing solenoid (without RF field) – longer version

$B_z \sim 0.7T$



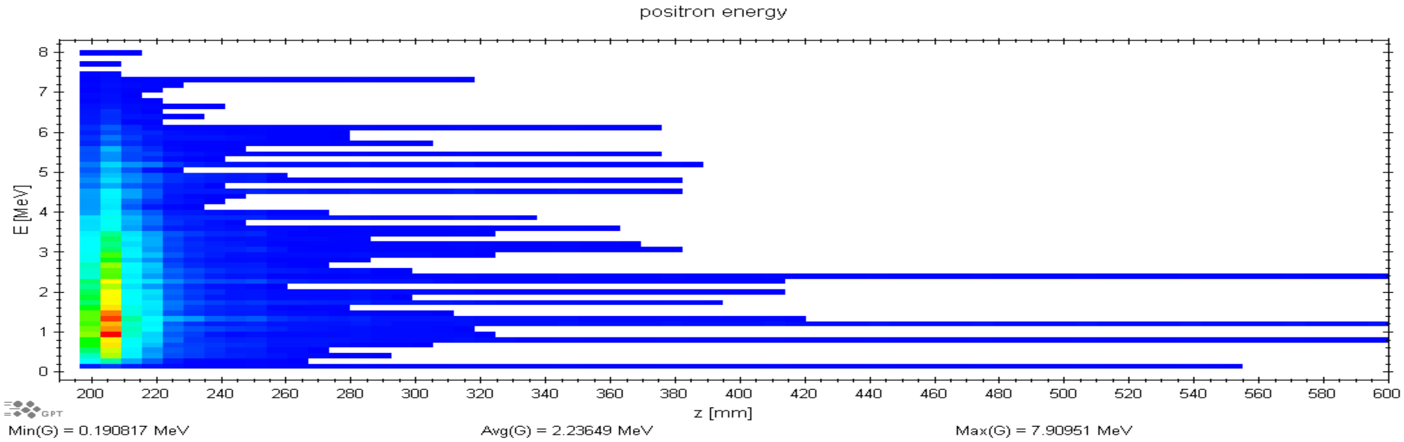
$B_z \sim 7T$



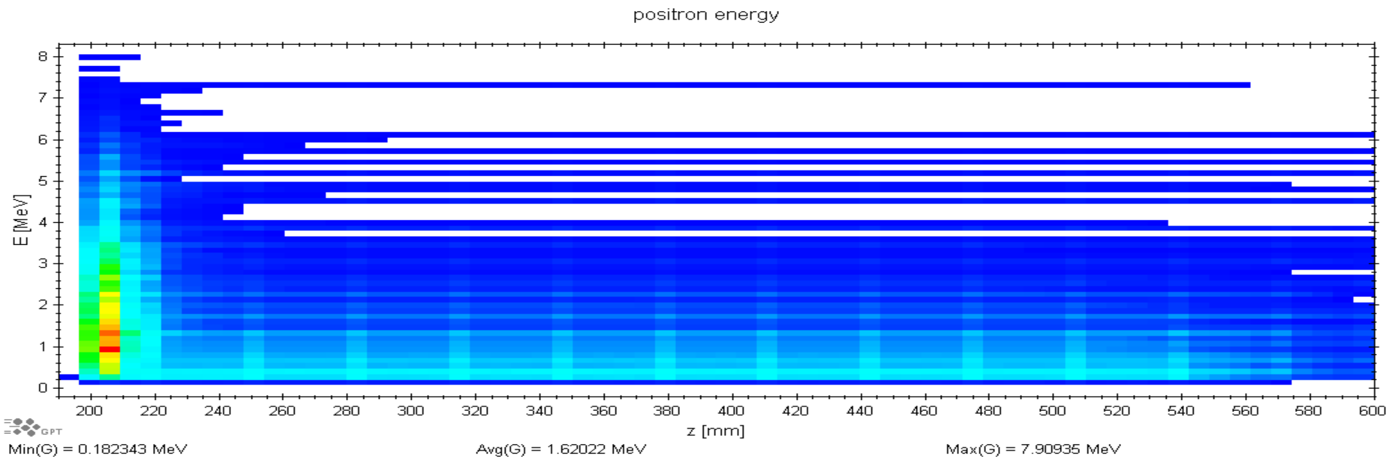
RF positron deceleration

Positron energy along the z axis

$B_z \sim 0.7T$

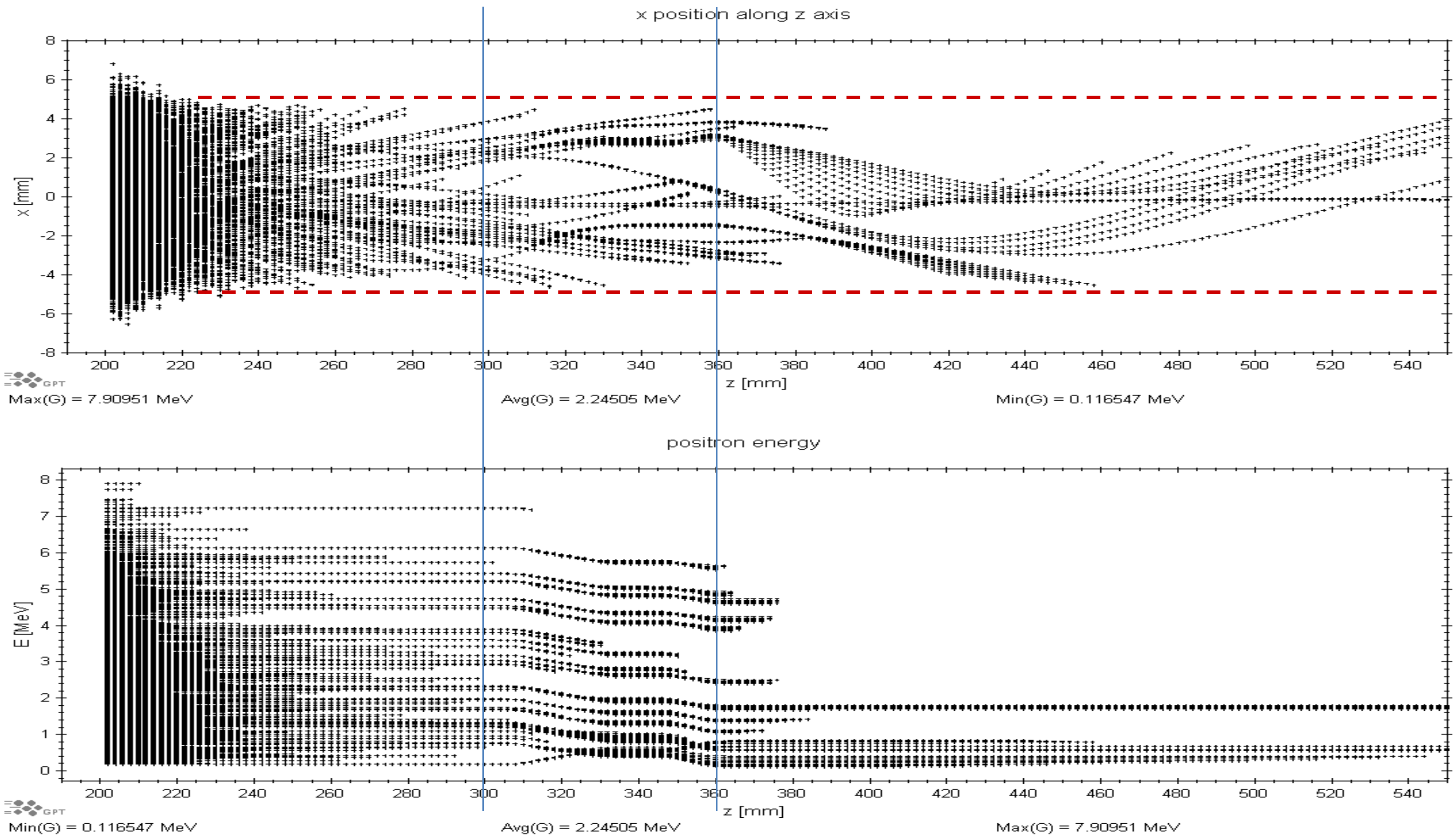


$B_z \sim 7T$



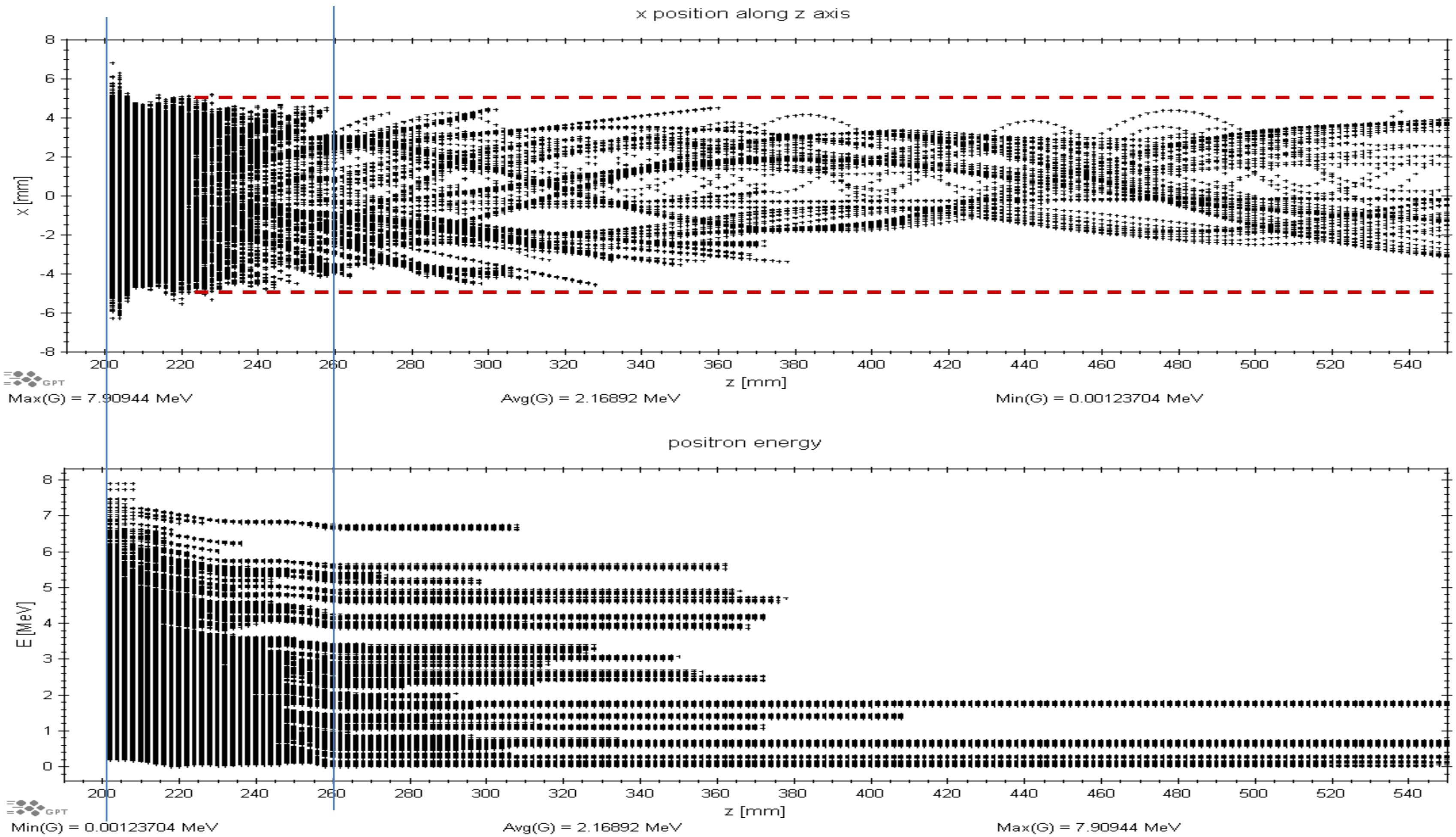
RF positron deceleration

B_z ~ 0.7T, cavities start 100mm after the target



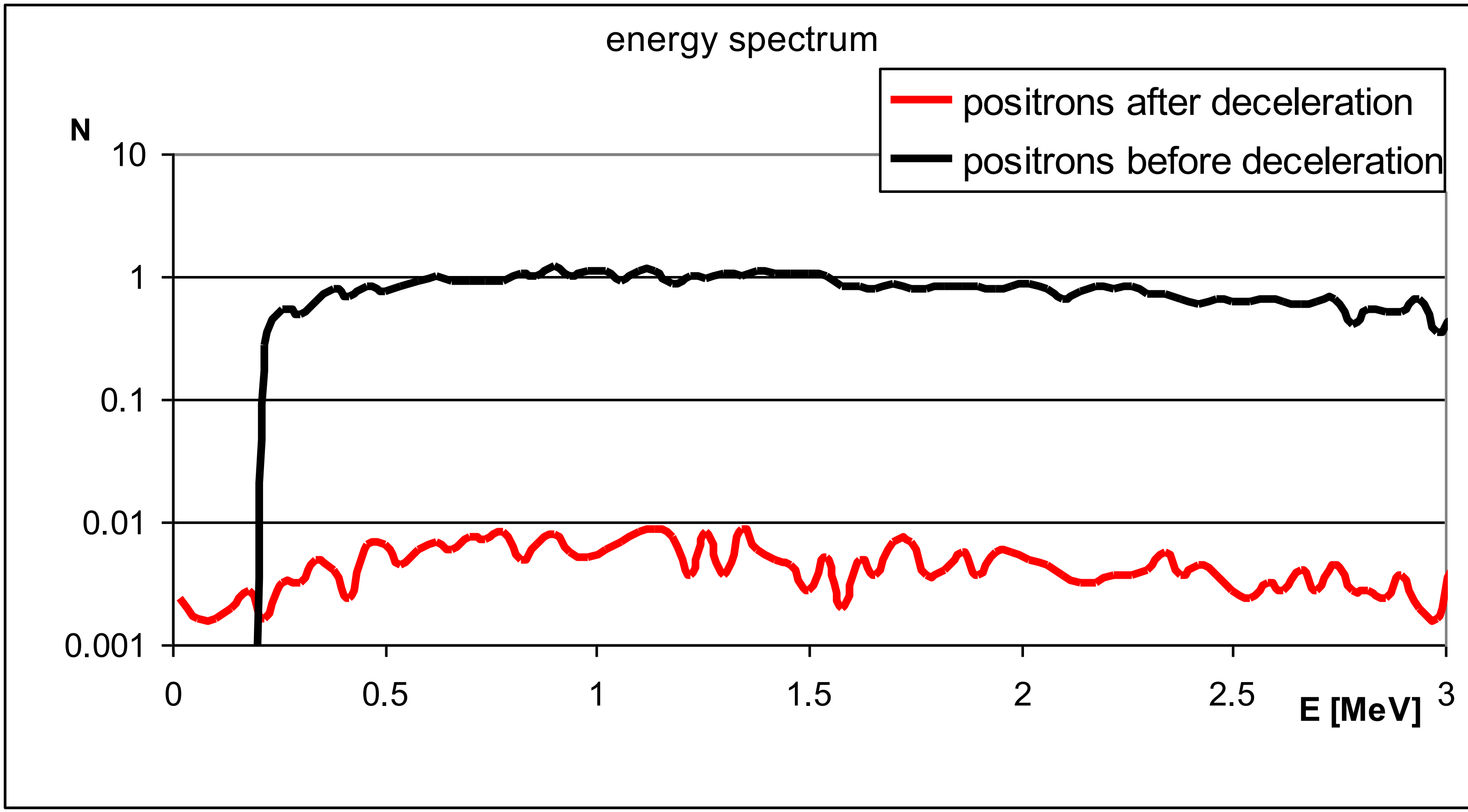
RF positron deceleration

B_z ~ 0.7T, cavities start 1mm after the target



RF positron deceleration

Energy spectrum, bin width ΔE = 40 keV



RF positron deceleration

E_{av}	N before deceleration	N after deceleration
20 keV	0	6
60 keV	0	4
100 keV	0	4
140 keV	0	5
180 keV	270	7
220 keV	702	4
260 keV	1368	8

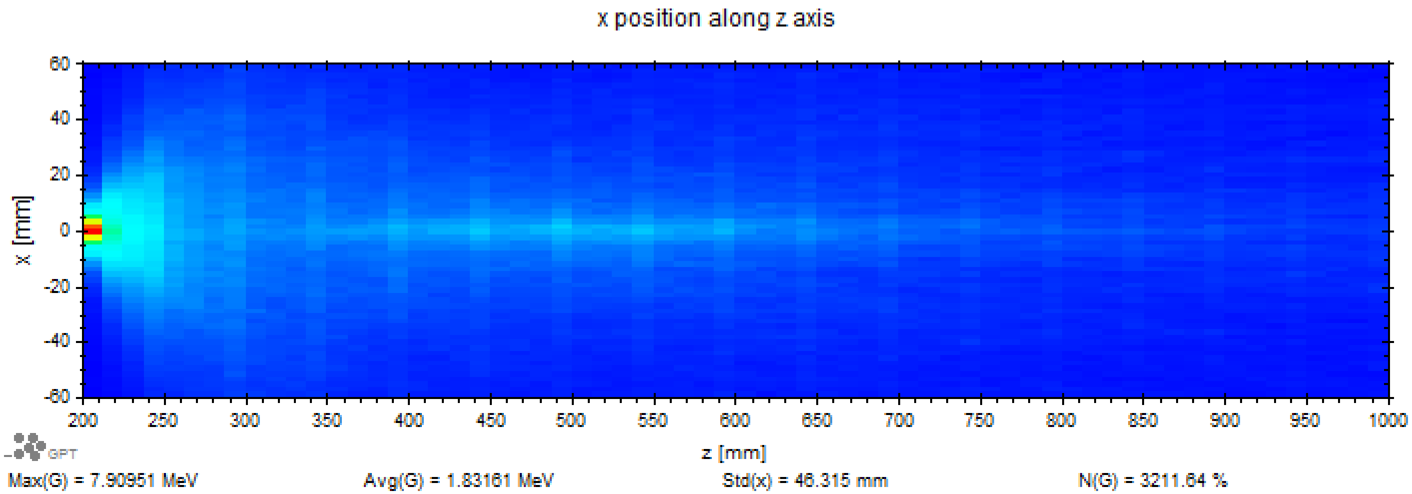
Only about 10^{-4} of all positrons are decelerated below 100keV.

To get more accurate data of deceleration efficiency further optimizations of decelerating and focusing fields with higher number of initial particles have to be performed.

RF positron deceleration

The beam aperture was small about 10mm

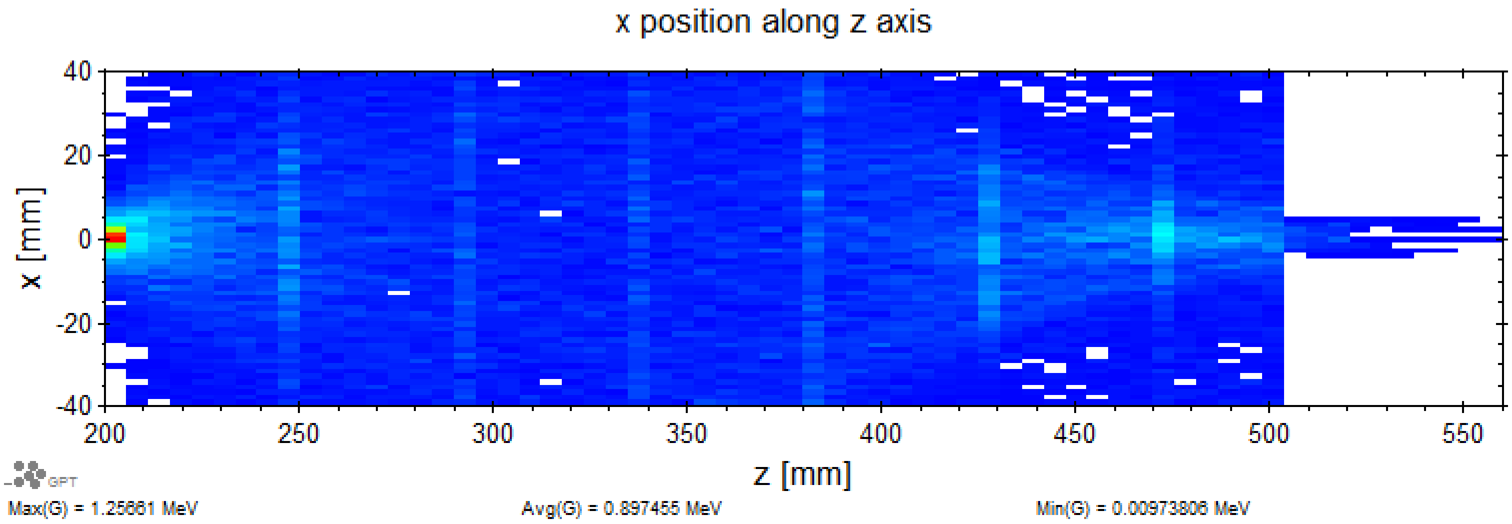
After increasing the radius acceptance more positrons are focused and decelerating cavities can be placed farther.



This is the next step that will be considered

RF positron deceleration

First results with wider aperture at the beginning and RF cavities at the end:



RF positron deceleration

CONCLUSIONS

1. Preliminary studies have been performed.
2. Deceleration has been observed. Pulsed positron beam in effect.
3. Efficiency is still low.
4. Main problem is geometry and positron divergence living the target.
5. More optimizations and further simulations must be performed.
6. Higher initial electron energies should be considered.