Overview
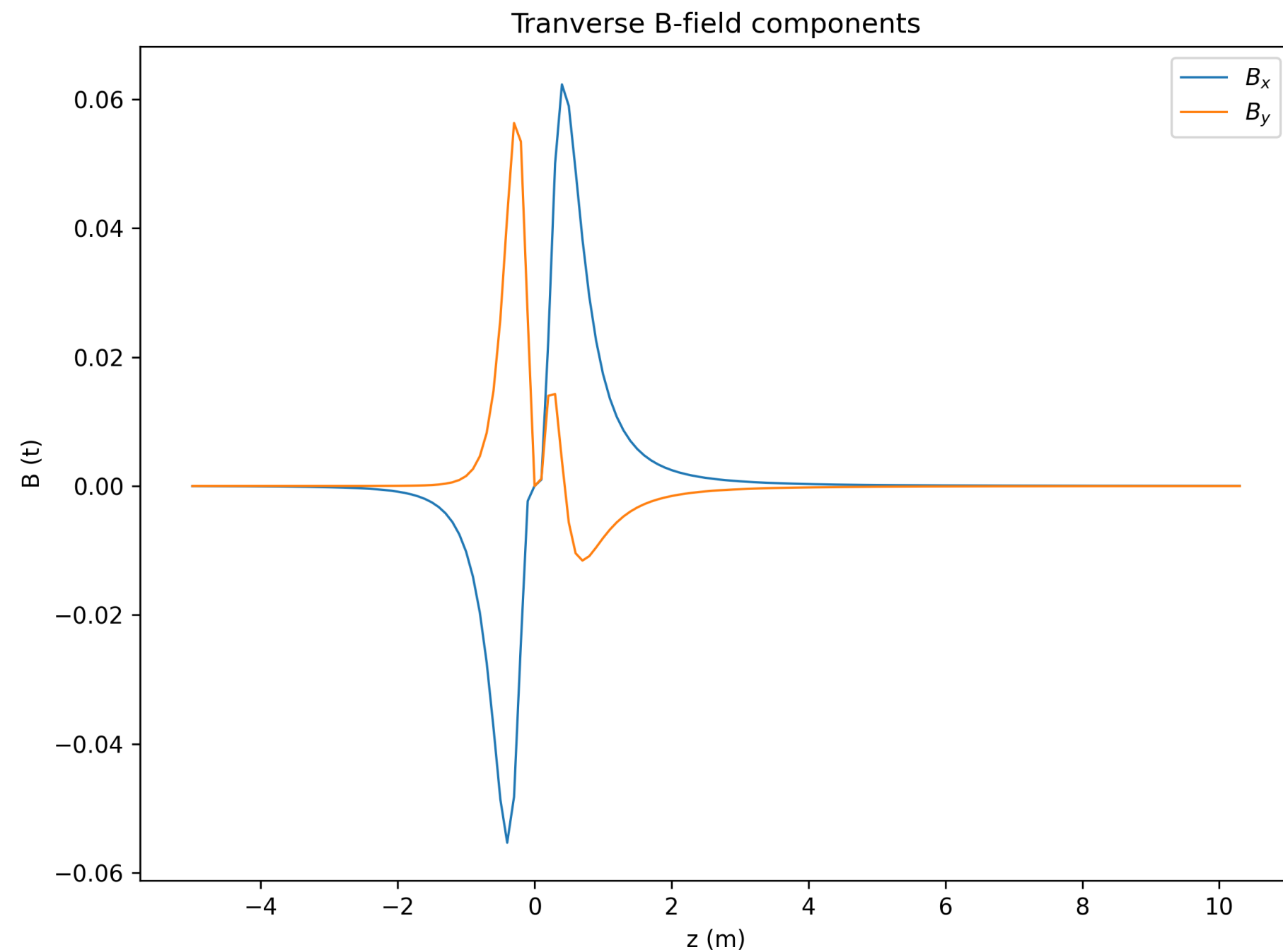
✳ Working on muon cooling at FNAL for the summer!

✳ Goals:

  ✳ Reproduce Yuri's work for the matching section

  ✳ Improve it (?)

✳ Matching section → lattice of ~6 solenoids

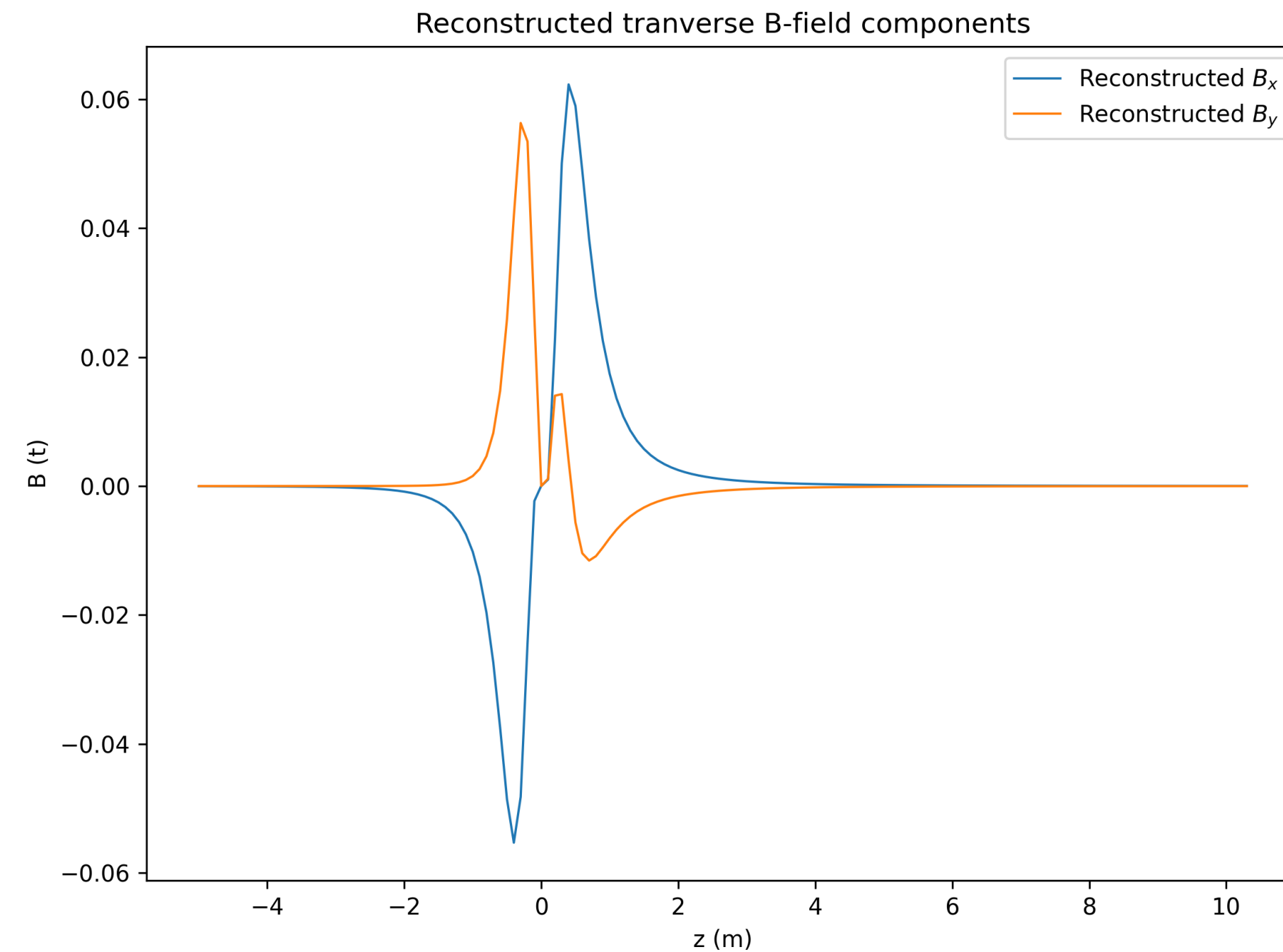✳ Began by studying a single solenoid

Finding Br from Bx and By
Coordinate transformation

Solenoid:
Inner radius 400mm
Thickness 100mm
Length 400mm
Centered at z=0mm

Beam starts at z=-5000mm,
x offset = +20mm

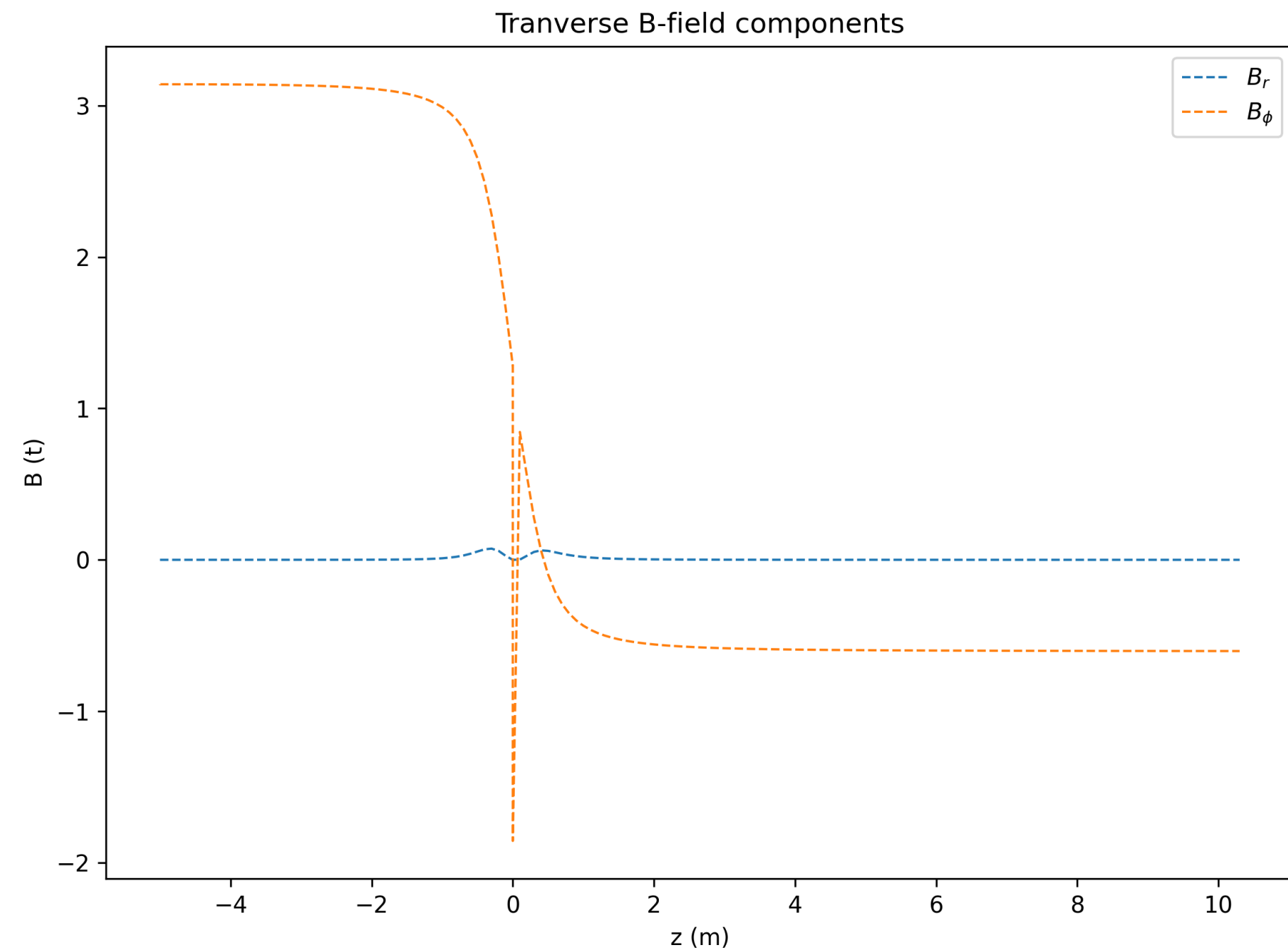Original output from g4bl

B_x, B_y → B_r, B_ϕ → B_x, B_y

- This initially did not work! Replaced `np.arctan(y / x)` with `np.arctan2(y, x)` which fixed the issue.
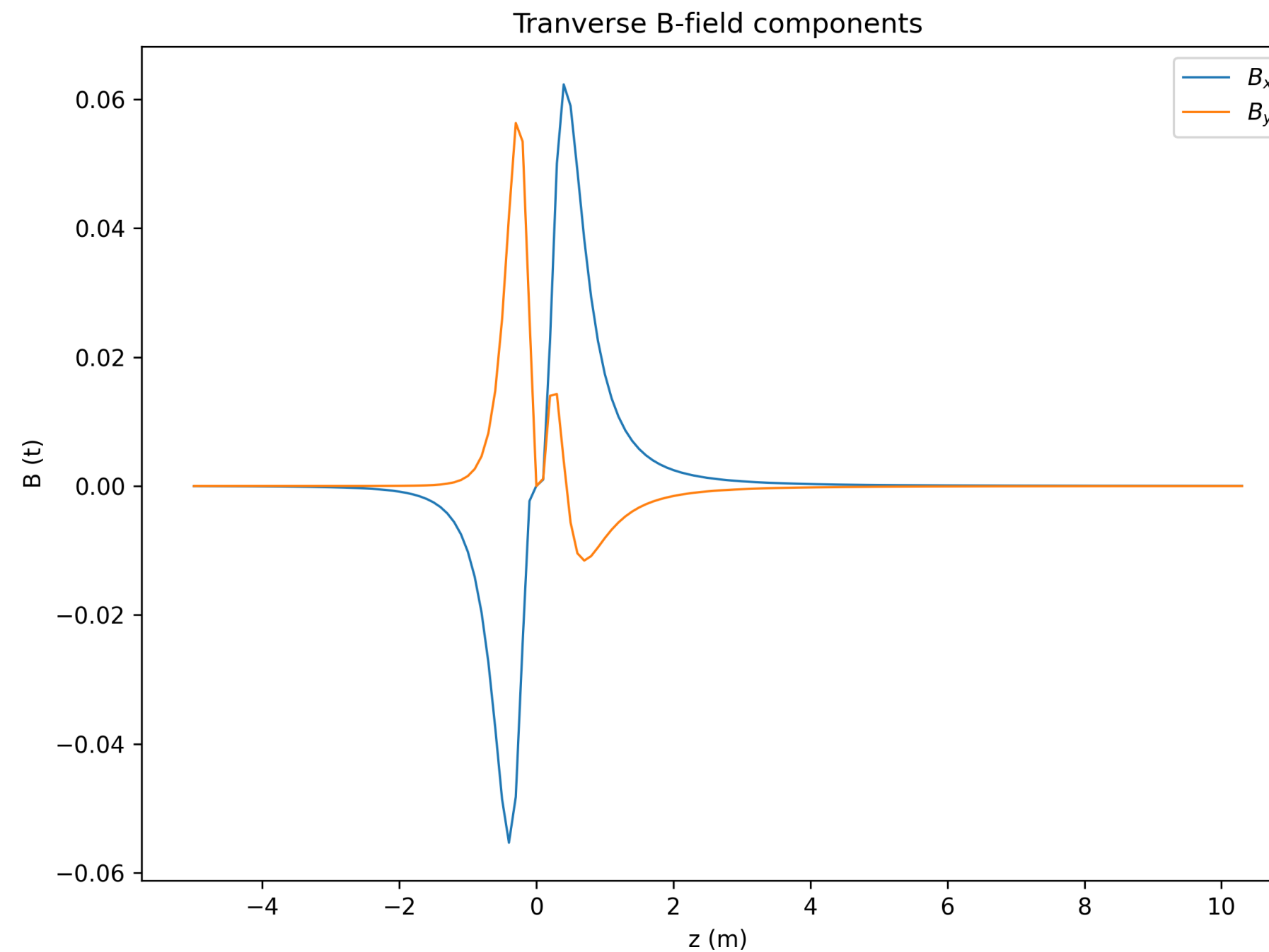
Finding Br from Bx and By
Plotting transverse components:

Solenoid:
Inner radius 400mm
Thickness 100mm
Length 400mm
Centered at z=0mm

Beam starts at z=-5000mm,
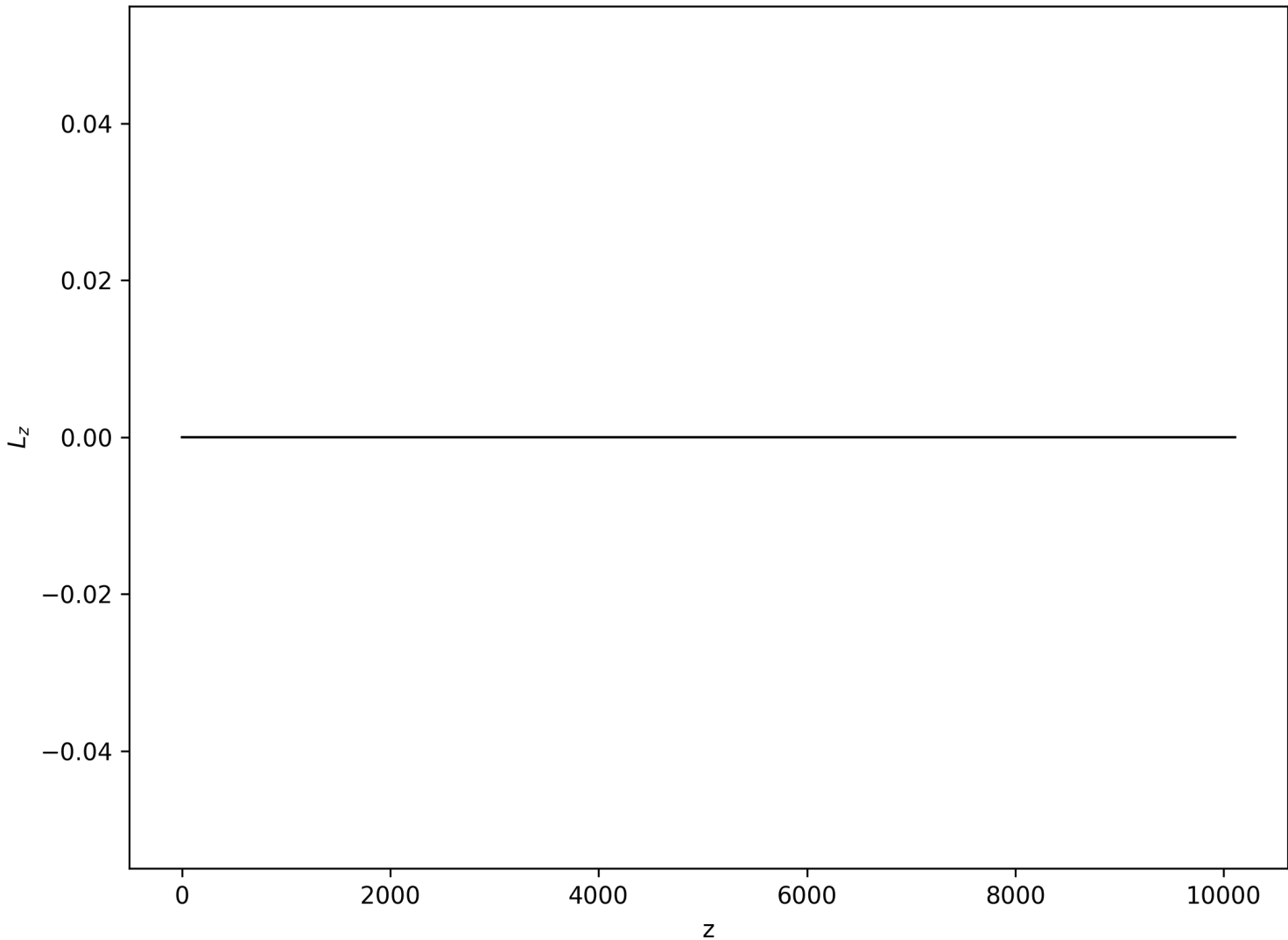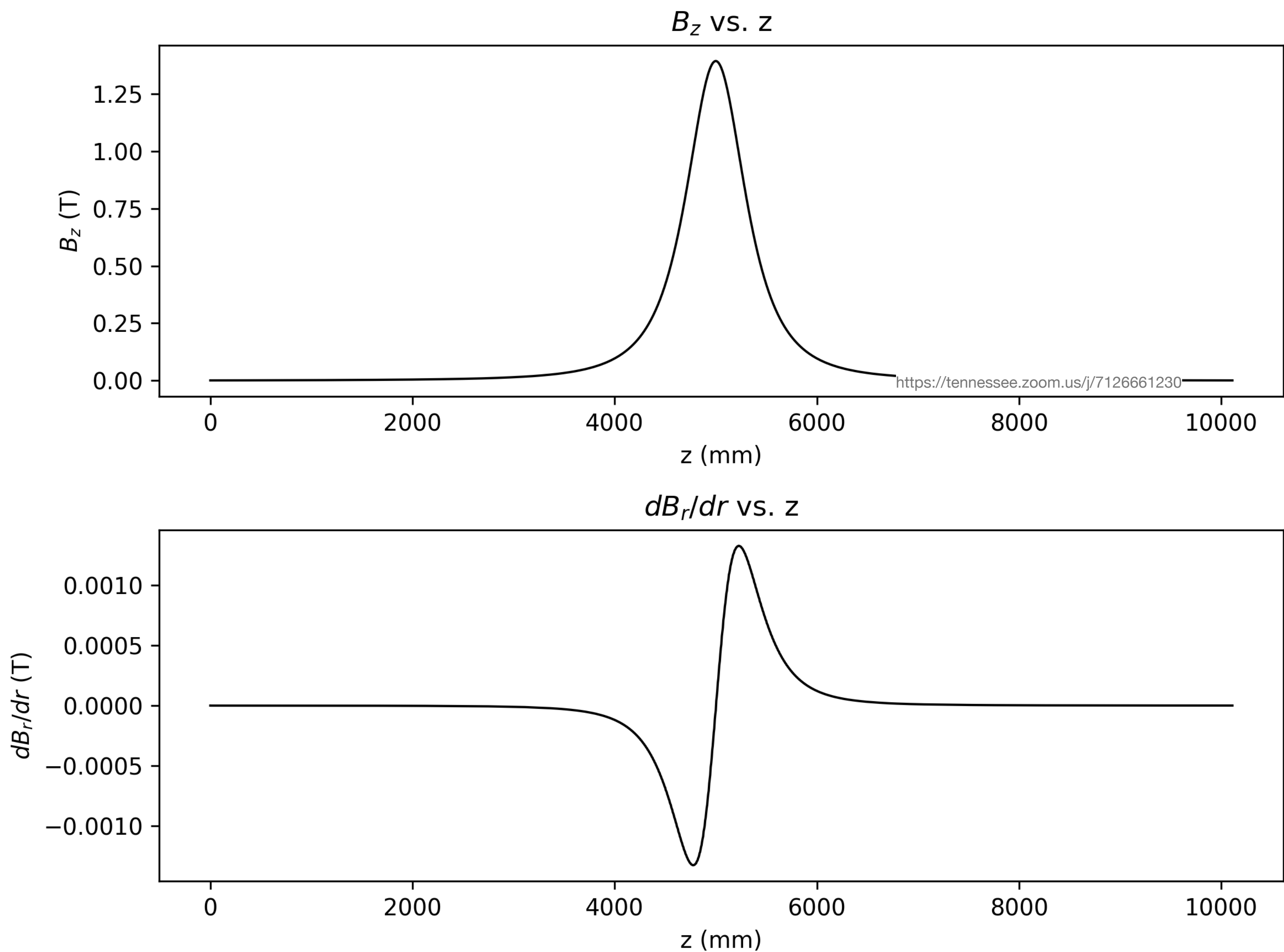x offset = +20mm

Polar components

Cartesian components

- The left plot is kind of difficult to understand. Would looking at it in the transverse plane as an animation be possible?
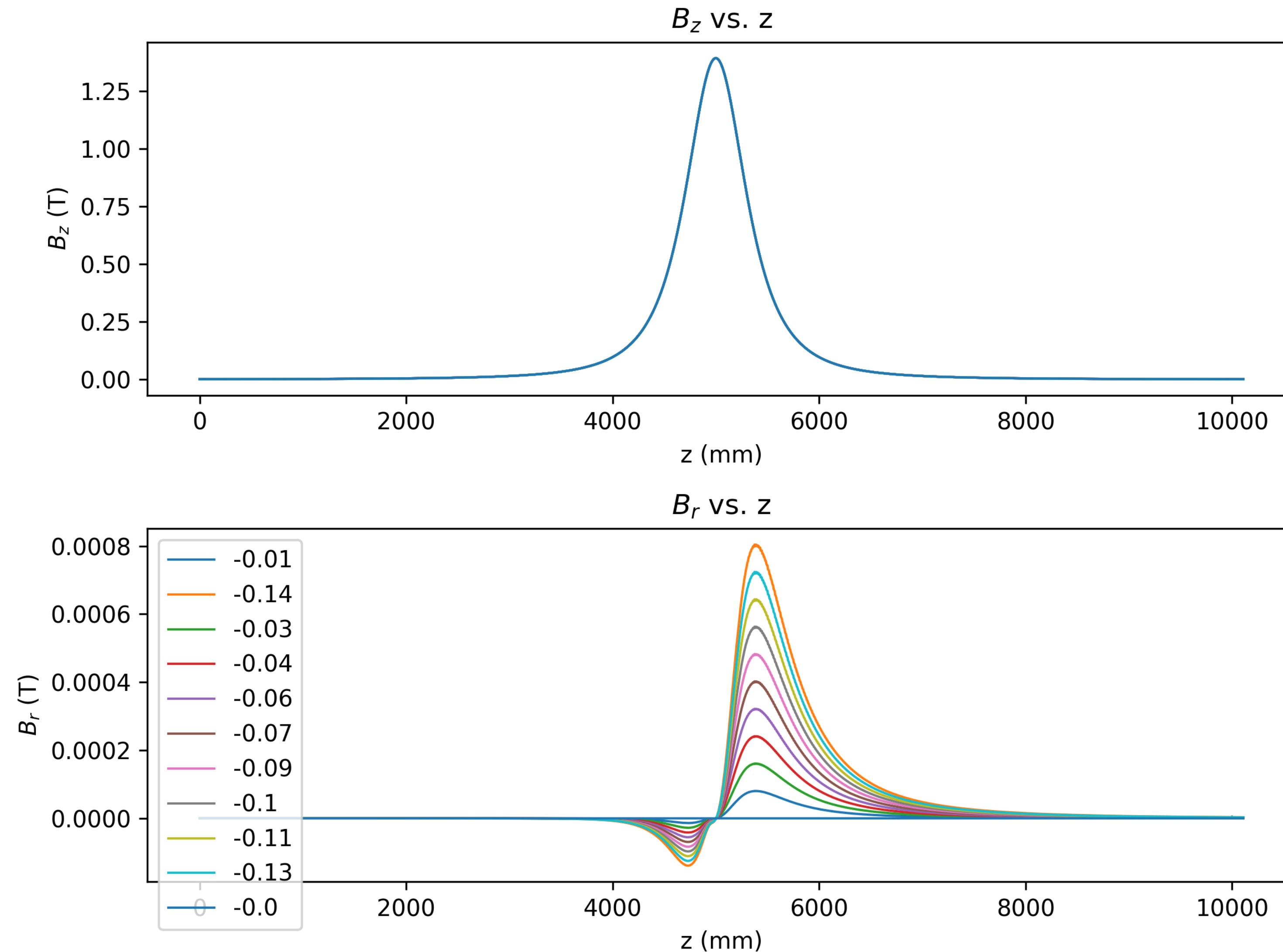
Transverse B-field: Single coil (no pitch)

Inner radius 400mm
Thickness 100mm
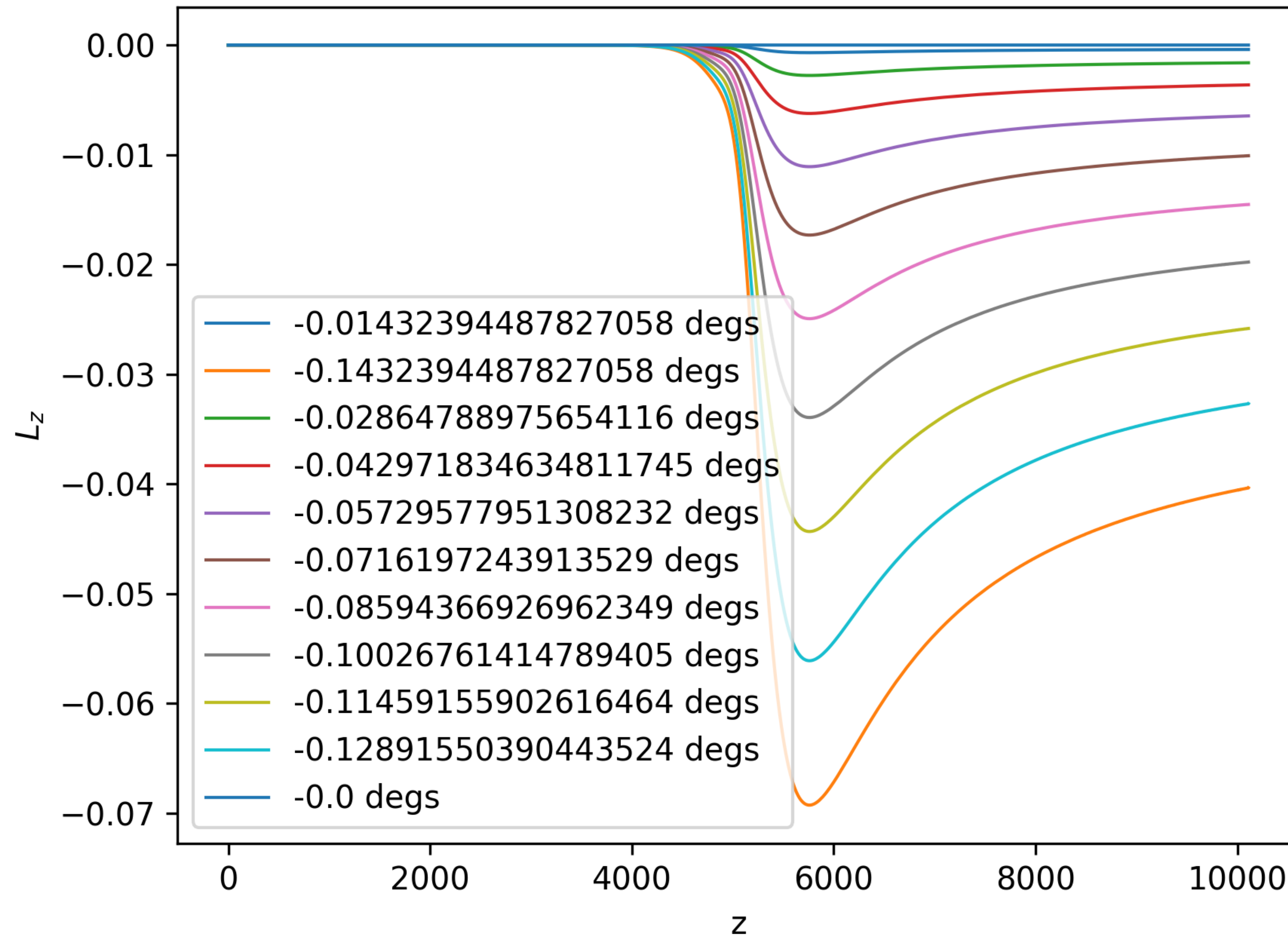Length 400mm
Centered at z=5000mm

$$B_r \approx \frac{-r}{2}\frac{\partial B_z}{\partial z}$$

$$\frac{dB_r}{dr}\Big|_{r=0} \approx \frac{-1}{2}\frac{\partial B_z}{\partial z} + \frac{-r}{2}\frac{d}{dr}\frac{\partial B_z}{\partial z} = \frac{-1}{2}\frac{\partial B_z}{\partial z}$$
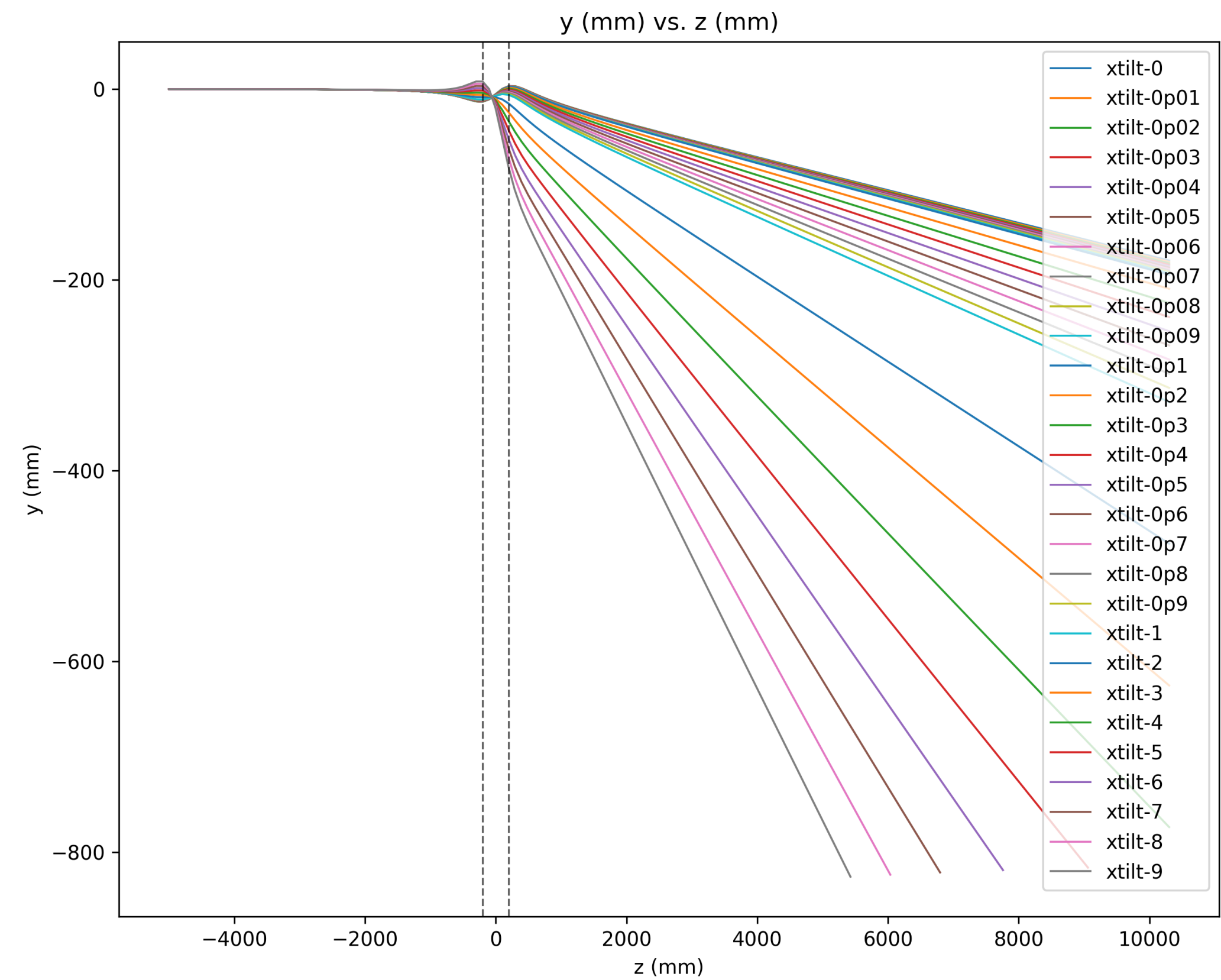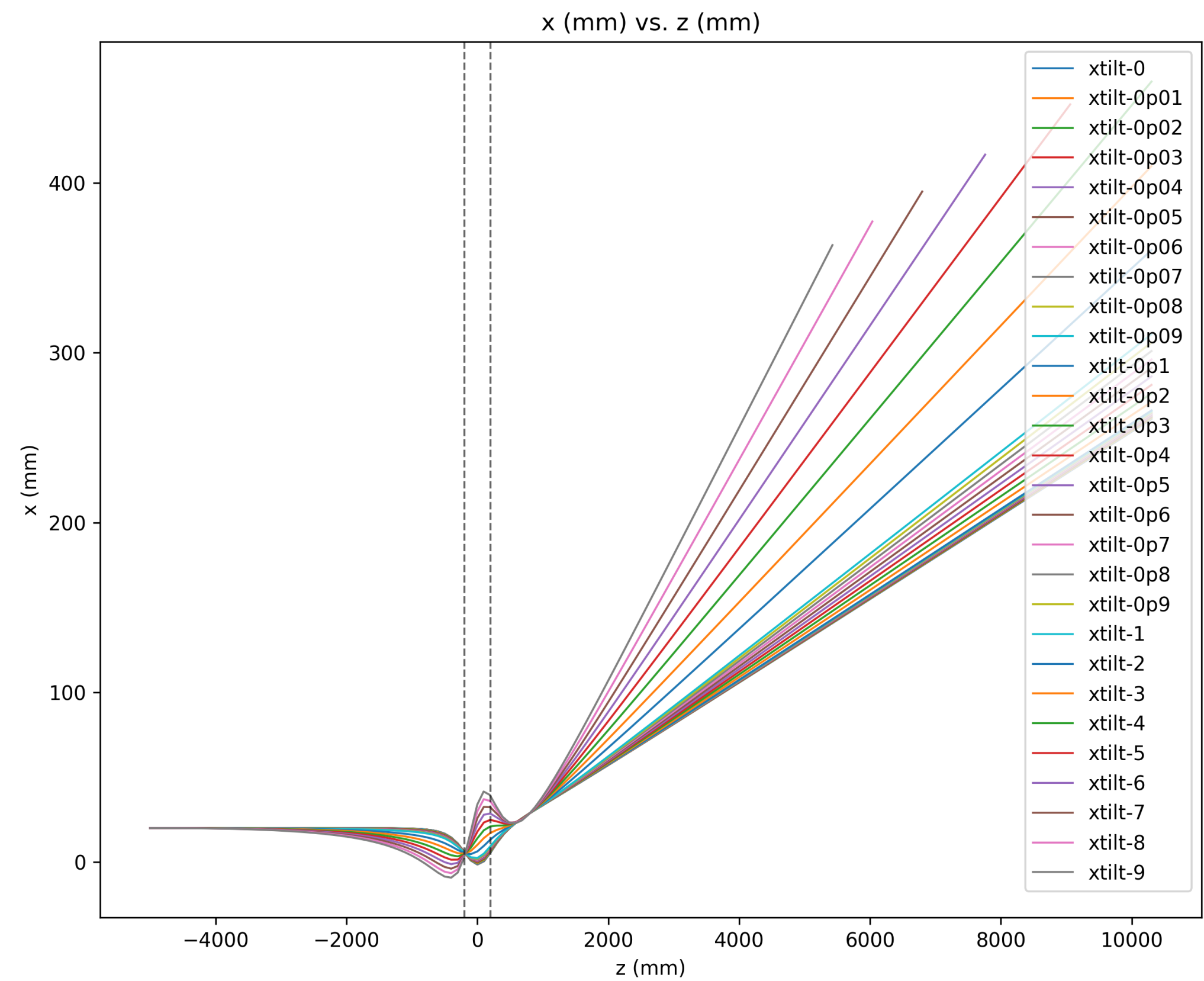
Transverse B-field: Single coil (with pitch)

Angular momentum: single coil (with pitch)

Legend:
- -0.01432394487827058 degs
- -0.1432394487827058 degs
- -0.02864788975654116 degs
- -0.042971834634811745 degs
- -0.05729577951308232 degs
- -0.0716197243913529 degs
- -0.08594366926962349 degs
- -0.10026761414789405 degs
- -0.11459155902616464 degs
- -0.12891550390443524 degs
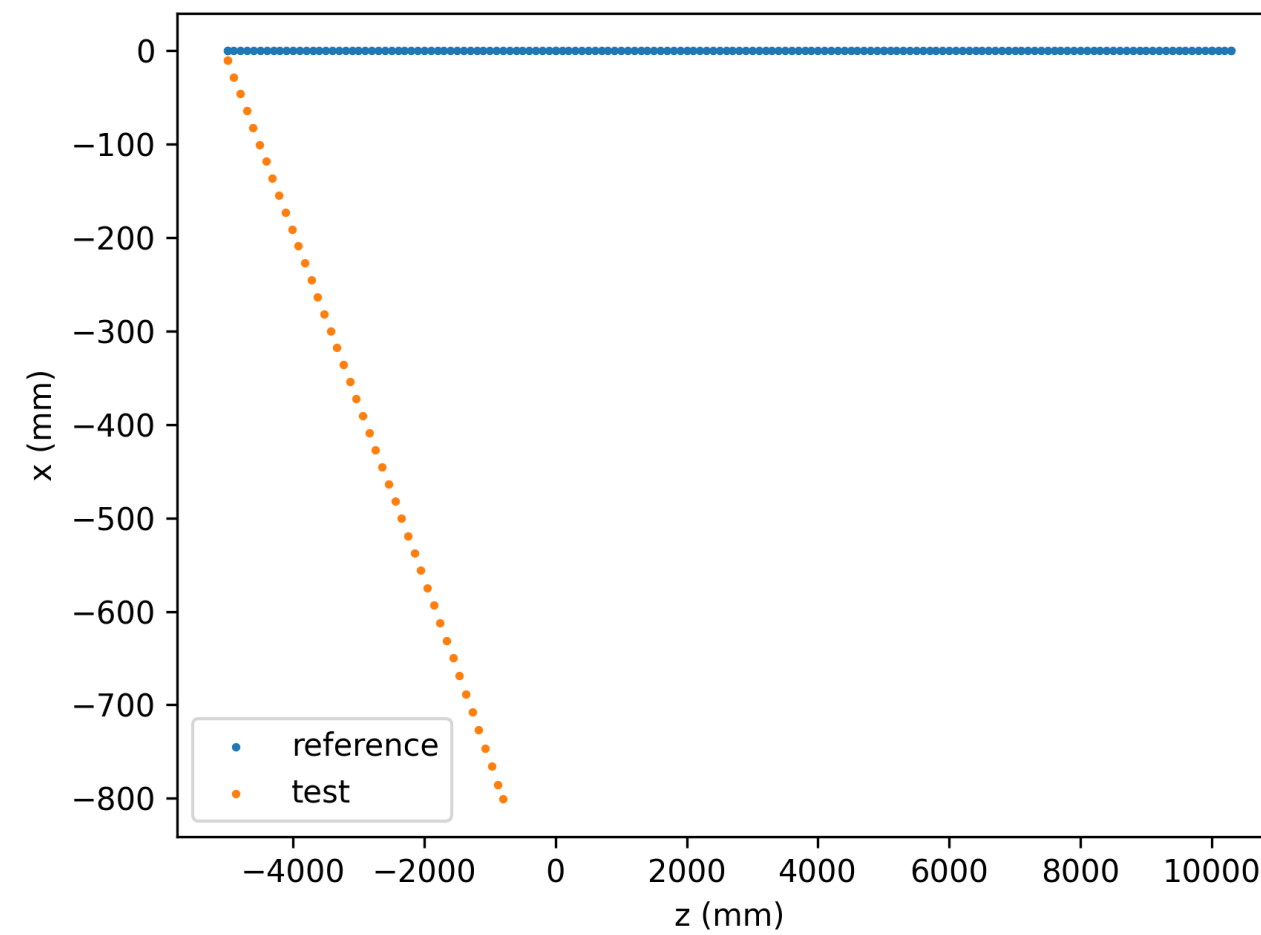- -0.0 degs
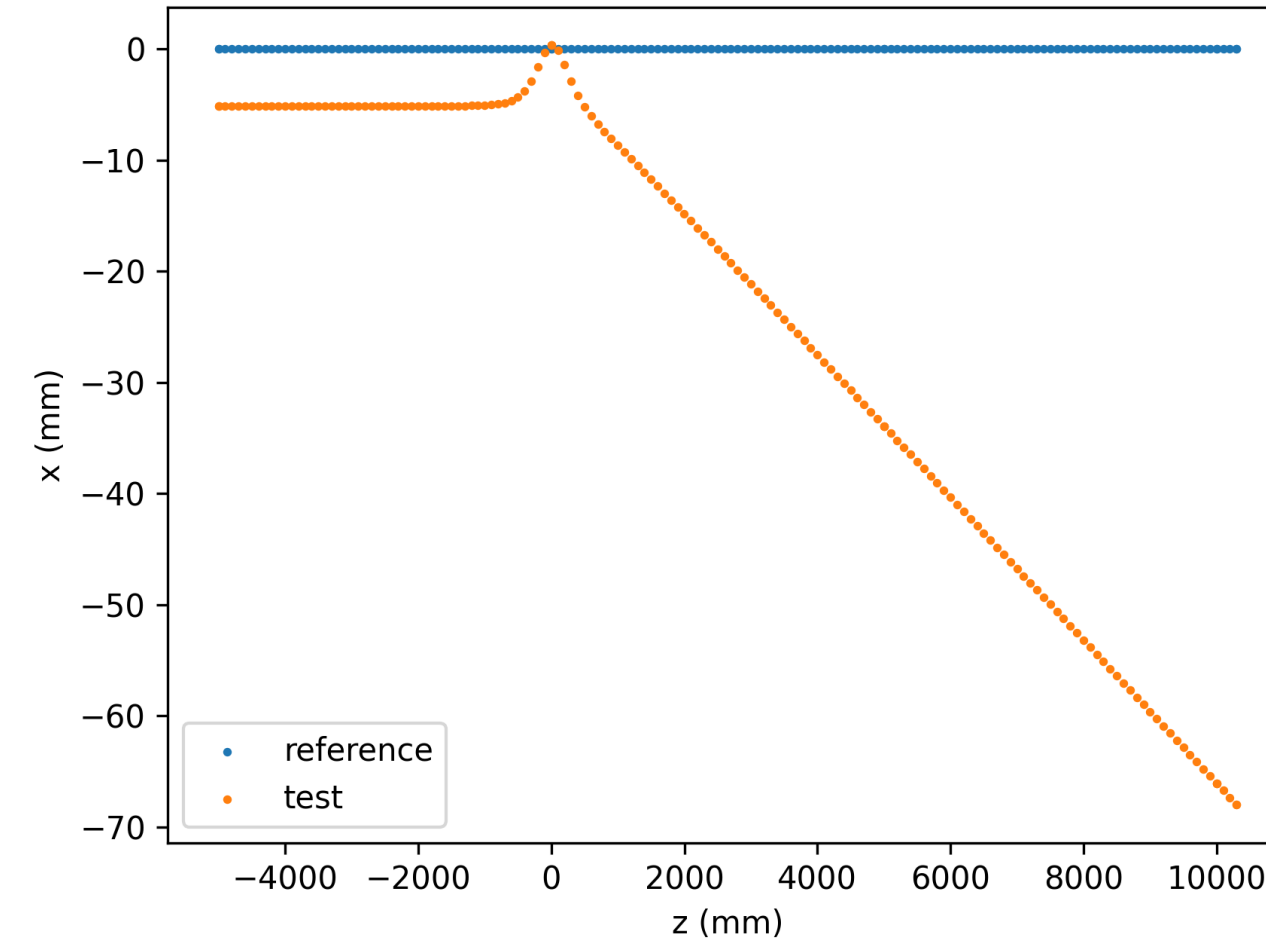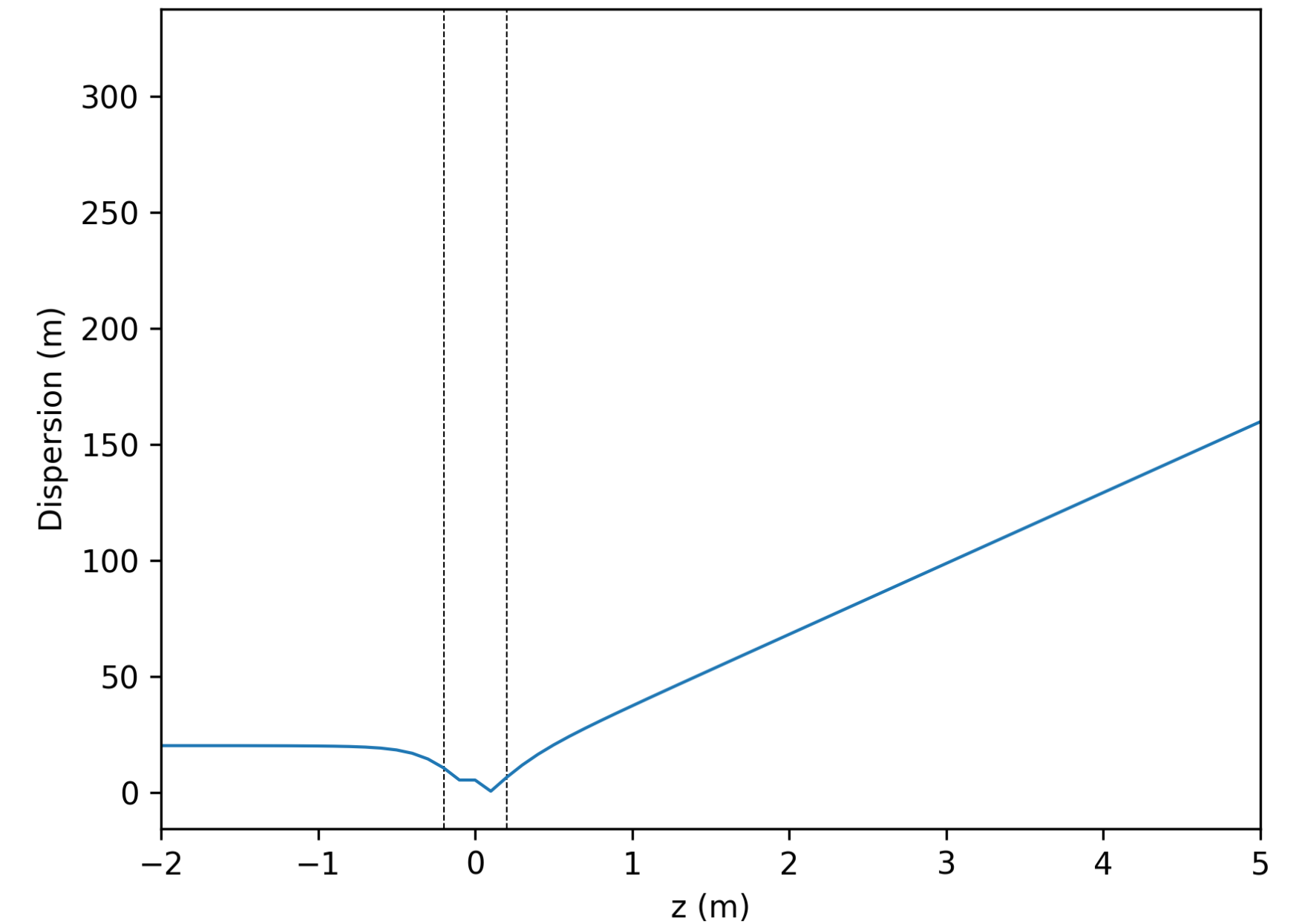
Scans over pitch: single solenoid

Dispersion

- Initially the test particle didn't pass through the solenoid

Any value of dp
Any value of offset in X
(plotted for 0)
Any value < 10.0 for
SigmaX, SigmaY
SigmaXp, SigmaYp non-
zero

Any value of dp
Any value of offset in X
(plotted for 5)
Any value < 10.0 for
SigmaX, SigmaY
SigmaXp, SigmaYp = 0

- For dp=0.1 MeV/c → units seem off?

- Likely conversion error and y-axis is in mm