HFOFO Project Updates

Approximating the magnitude of the dipole field

$$B(z) = \boxed{0.055} \sin(2\pi \cdot \boxed{0.0014}z + \boxed{1.6}) + \boxed{0.061}$$

From FFT   From curve fit
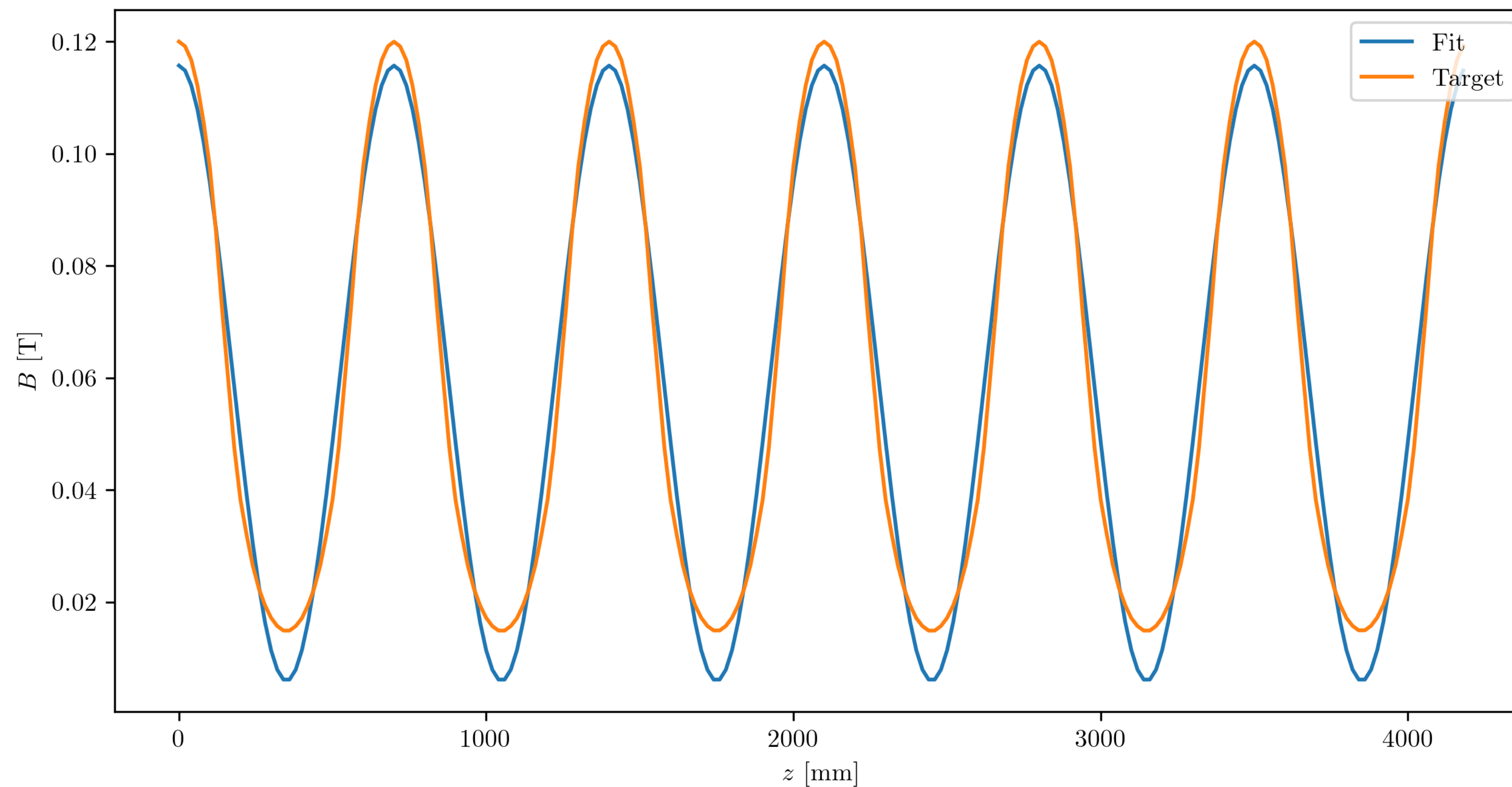
Approximating the magnitude of the dipole field

$$B(z) = \boxed{0.055} \sin(2\pi \cdot \boxed{0.0014}z + \boxed{1.6}) + \boxed{0.061}$$

From curve fit

```python
def model_func(z, a, k, phi, b):
    return a*np.sin(2*np.pi*k*z+phi)+b

# Initial guess based on FFT:
a0 = 0.055
k0 = 0.001
phi0 = 1.55
p0 = [a0, k0, phi0, diff]

popt, pcov = curve_fit(model_func, z, c, p0=p0)
```
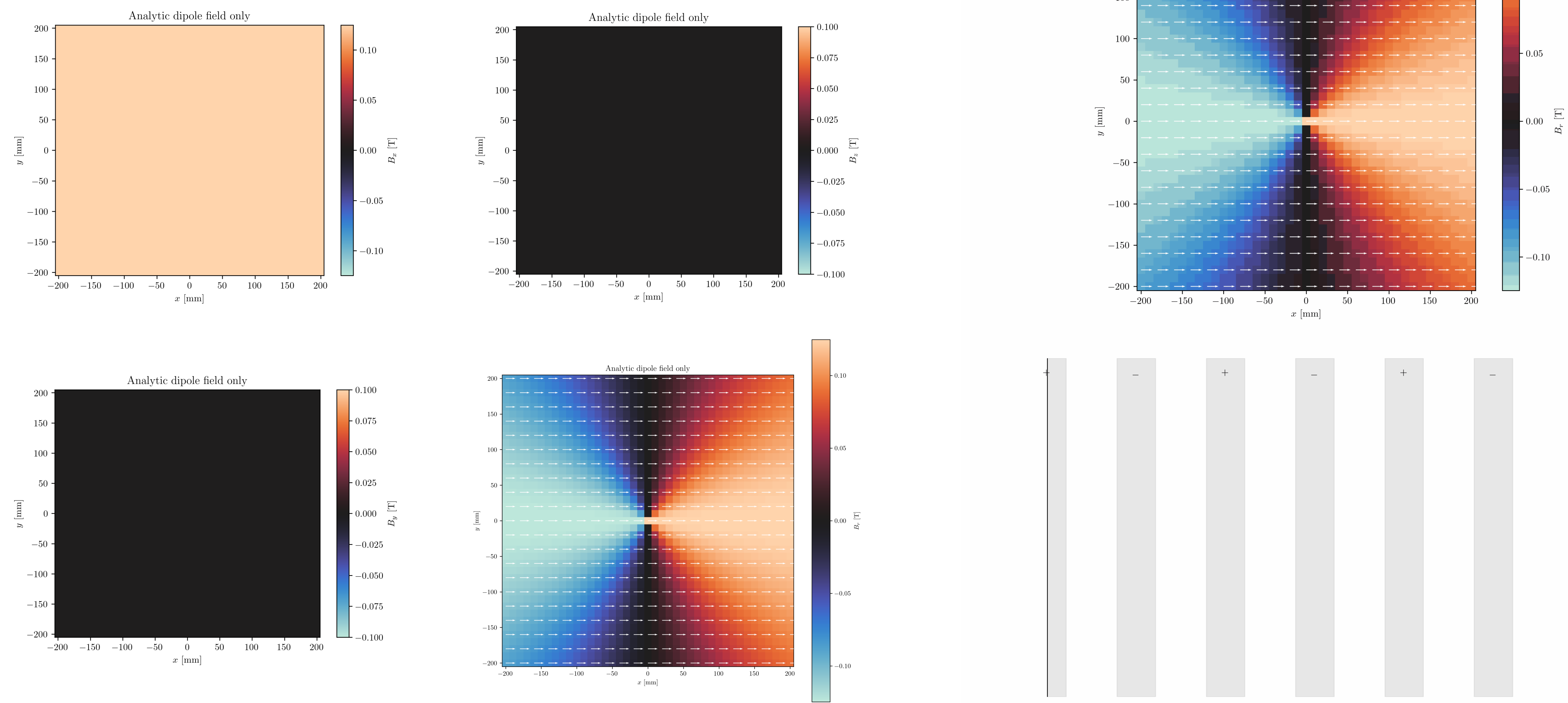
Provide FFT results as initial guess

Why is it suggesting this solution? Need to adjust range to explore free parameters?
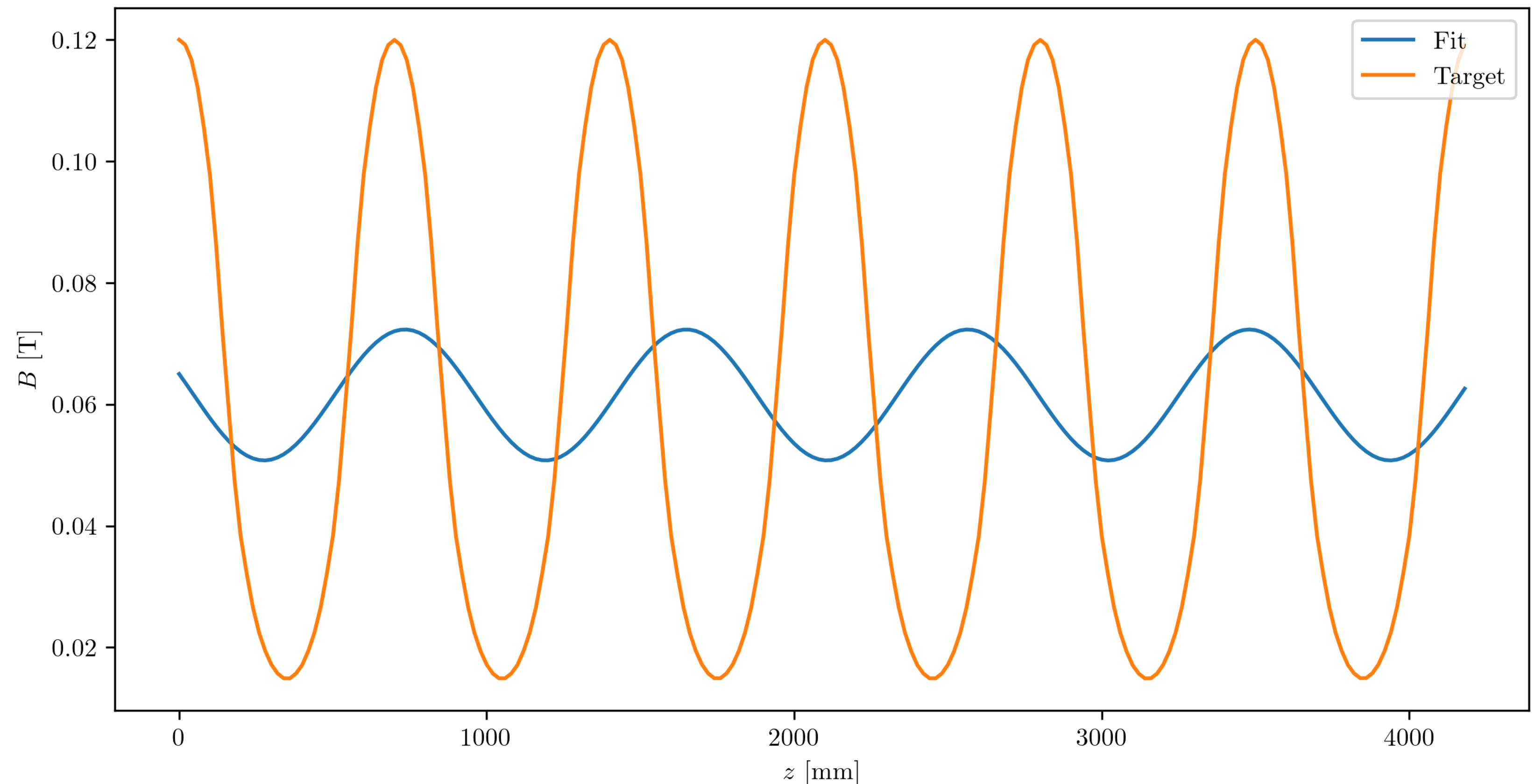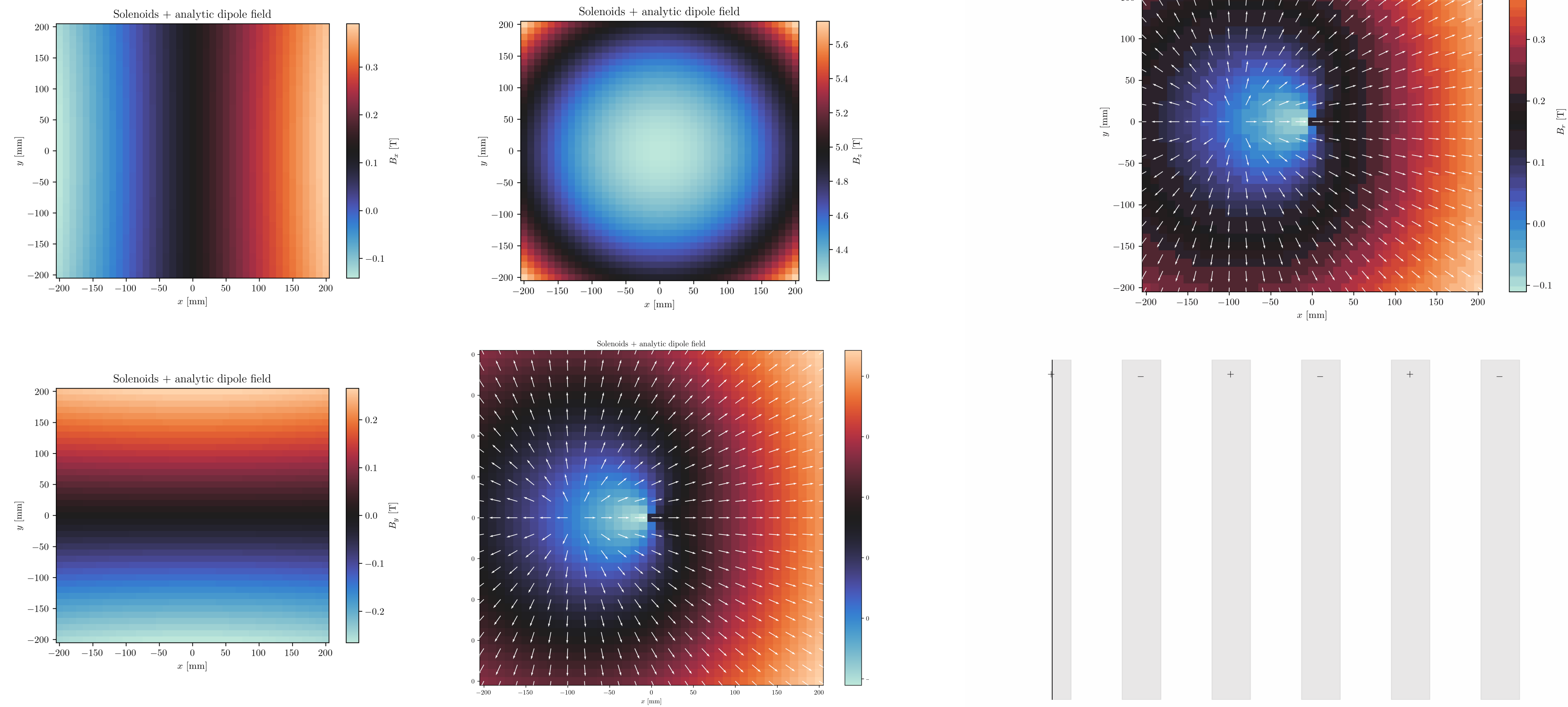
Simulating analytic dipole, no rotations

Transverse slice at $z = 0$

Simulating analytic dipole + solenoids, no rotations
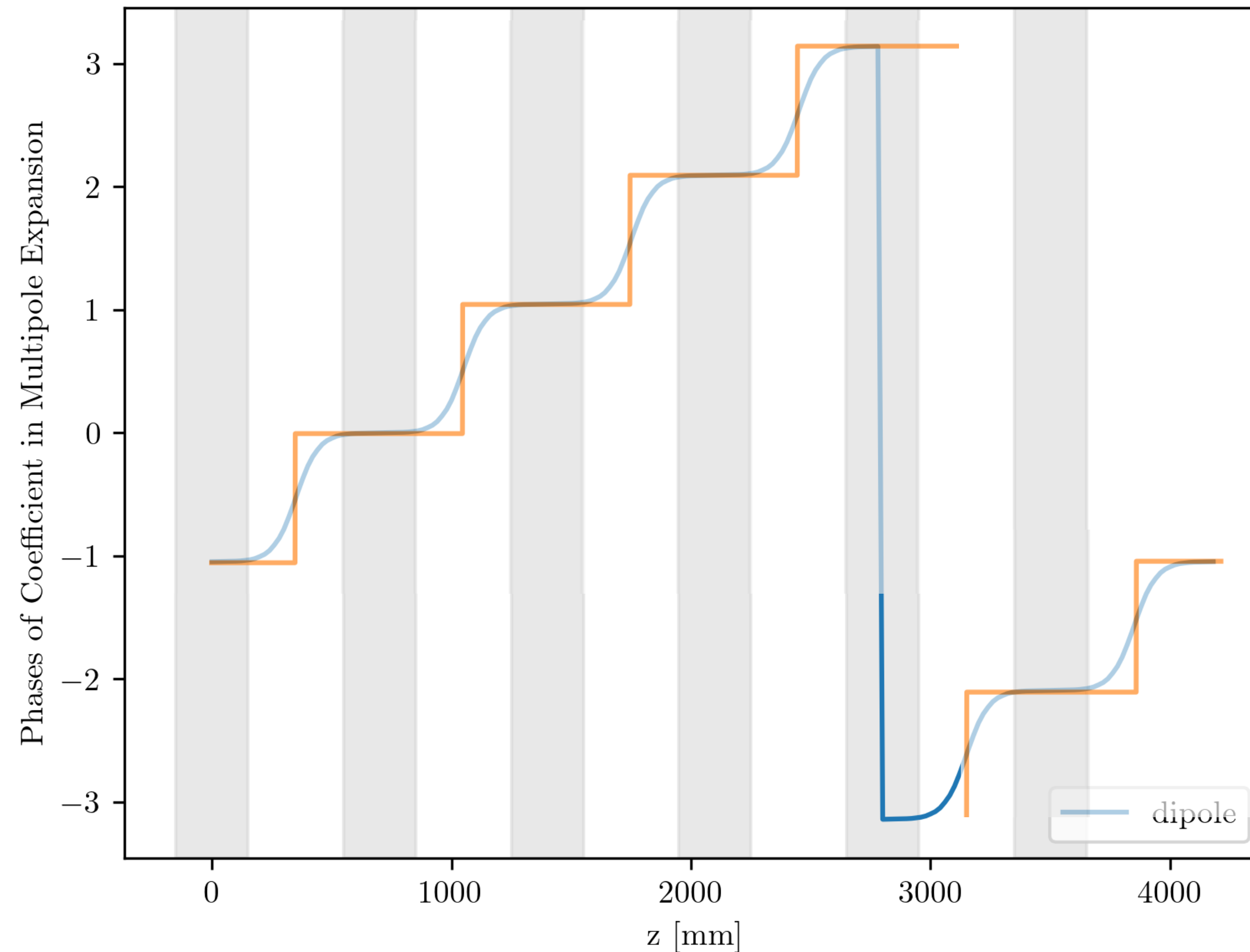
Transverse slice at $z = 0$

Adding dipole field rotations

The step function approach

Adding dipole field rotations via a step function
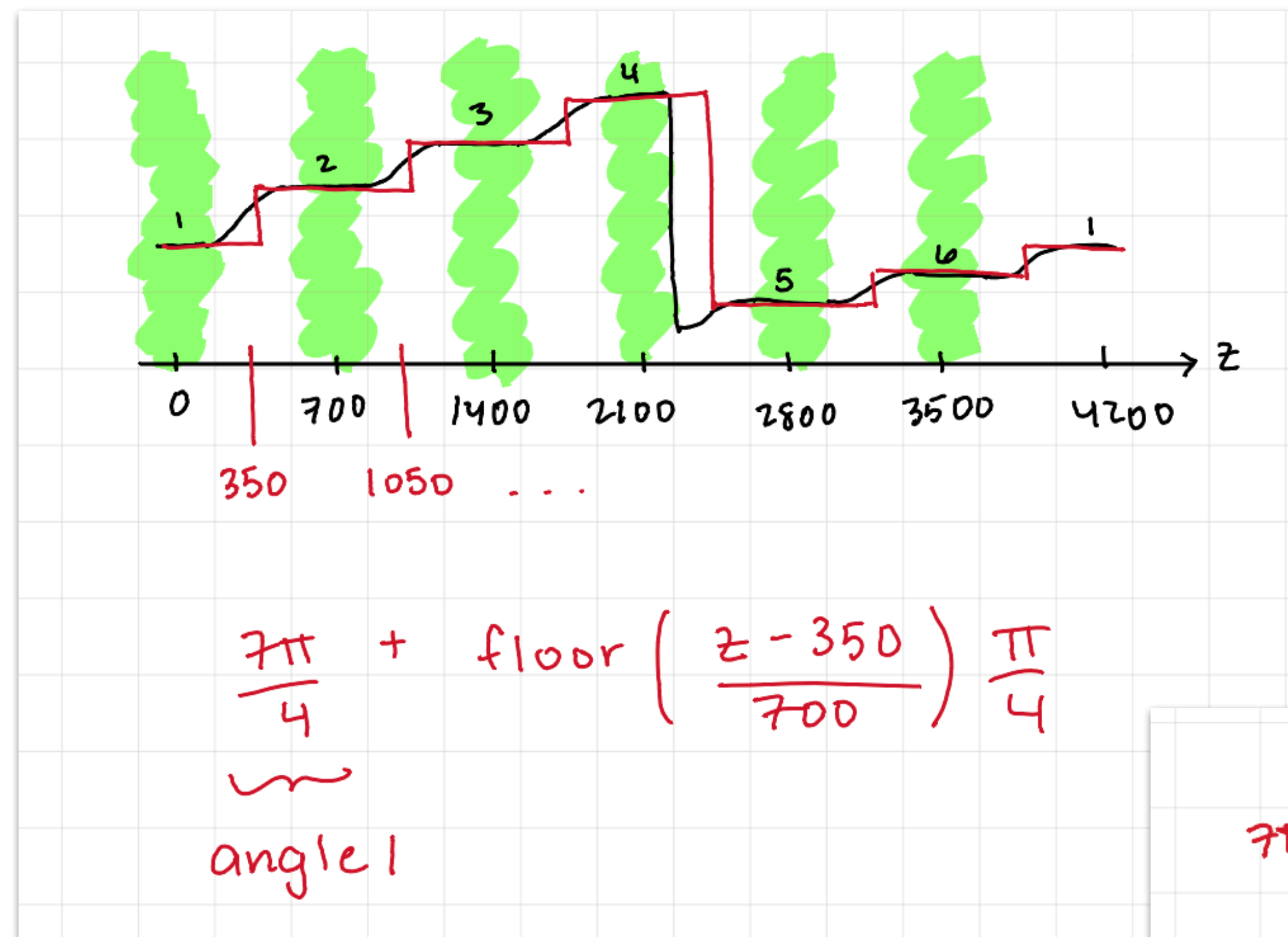

For a simple proof-of concept, let us try fitting to a step function to transition between angles…

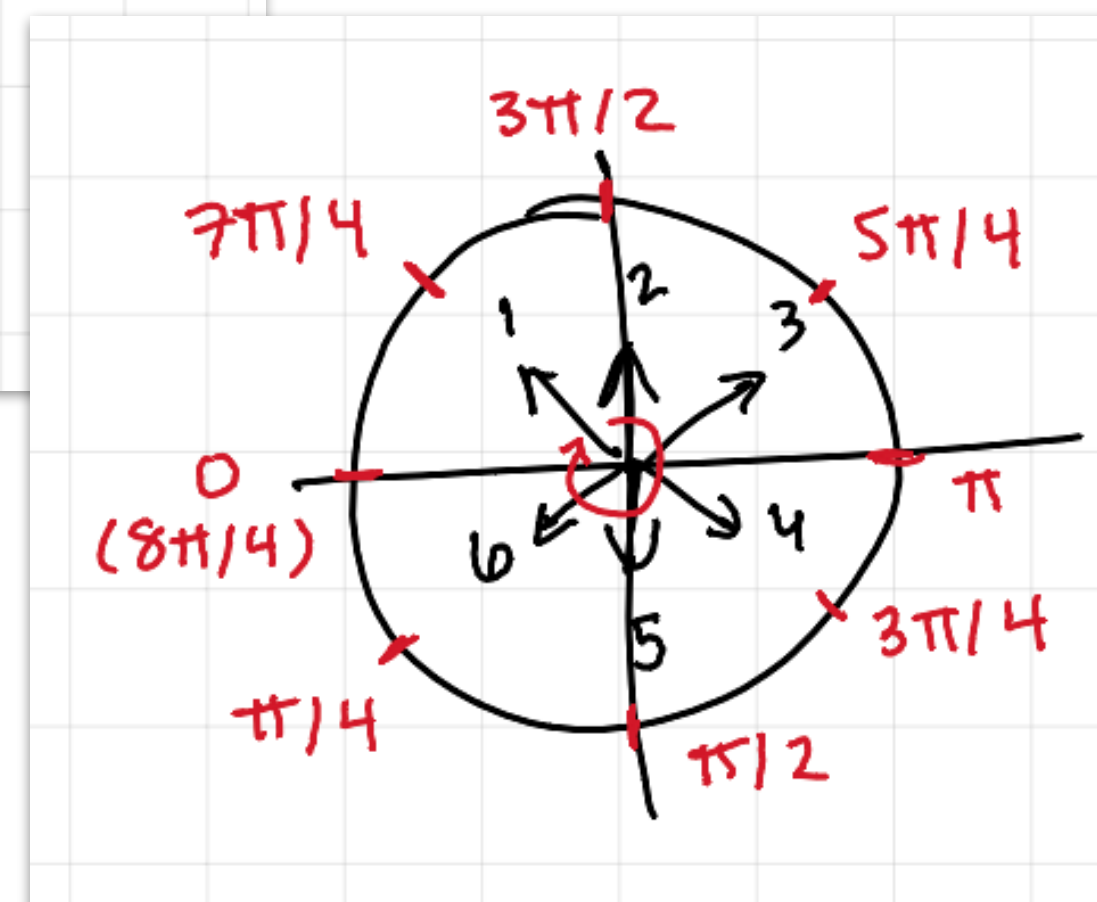# Adding rotations to the dipole field

In G4beamline

```
fieldexpr field Bx=($a*sin($k*z+$phi)+$b)*cos(7*pi/4-floor((z-350)/700)*pi/4) \
    By=($a*sin($k*z+$phi)+$b)*sin(7*pi/4-floor((z-350)/700)*pi/4) \
    Bz=0 \
    length=$period width=600 height=600
```

$$\frac{7\pi}{4} + floor\left(\frac{z-350}{700}\right)\frac{\pi}{4}$$
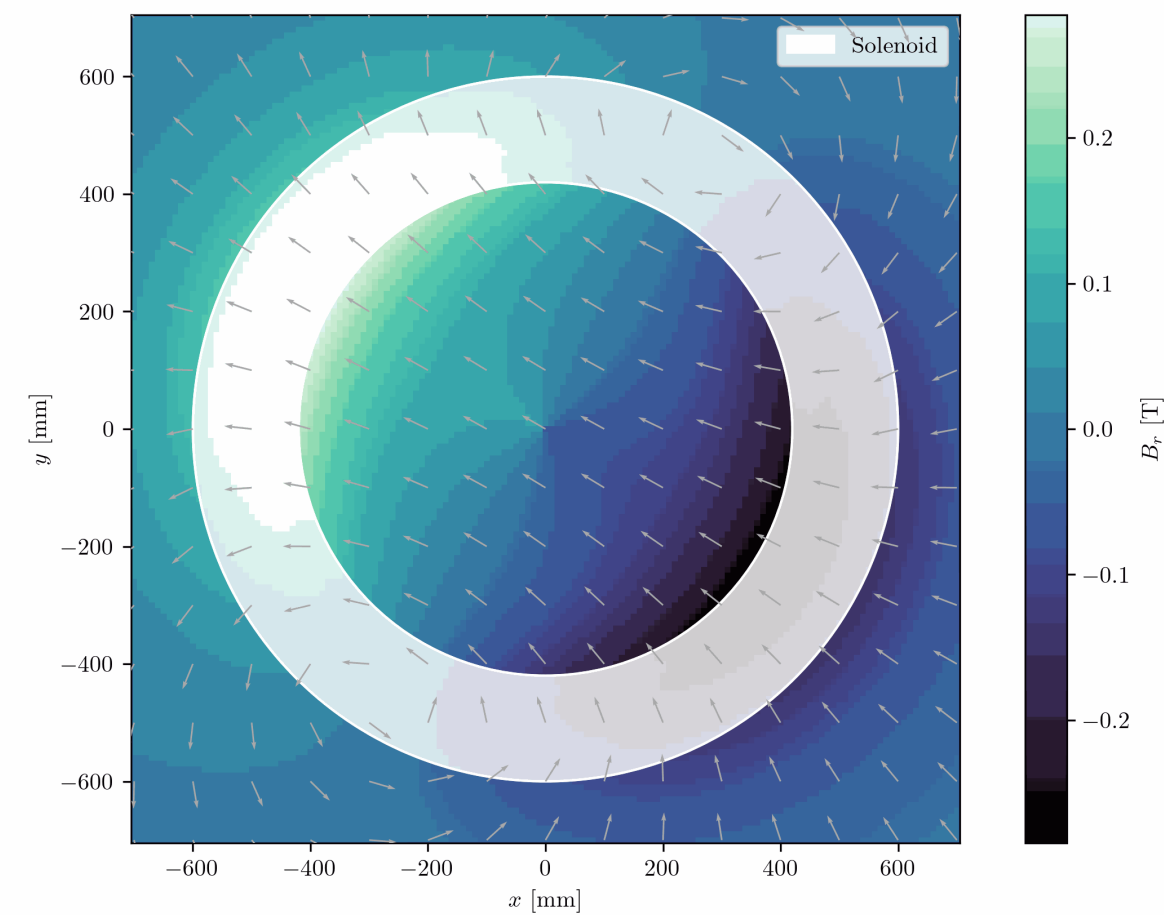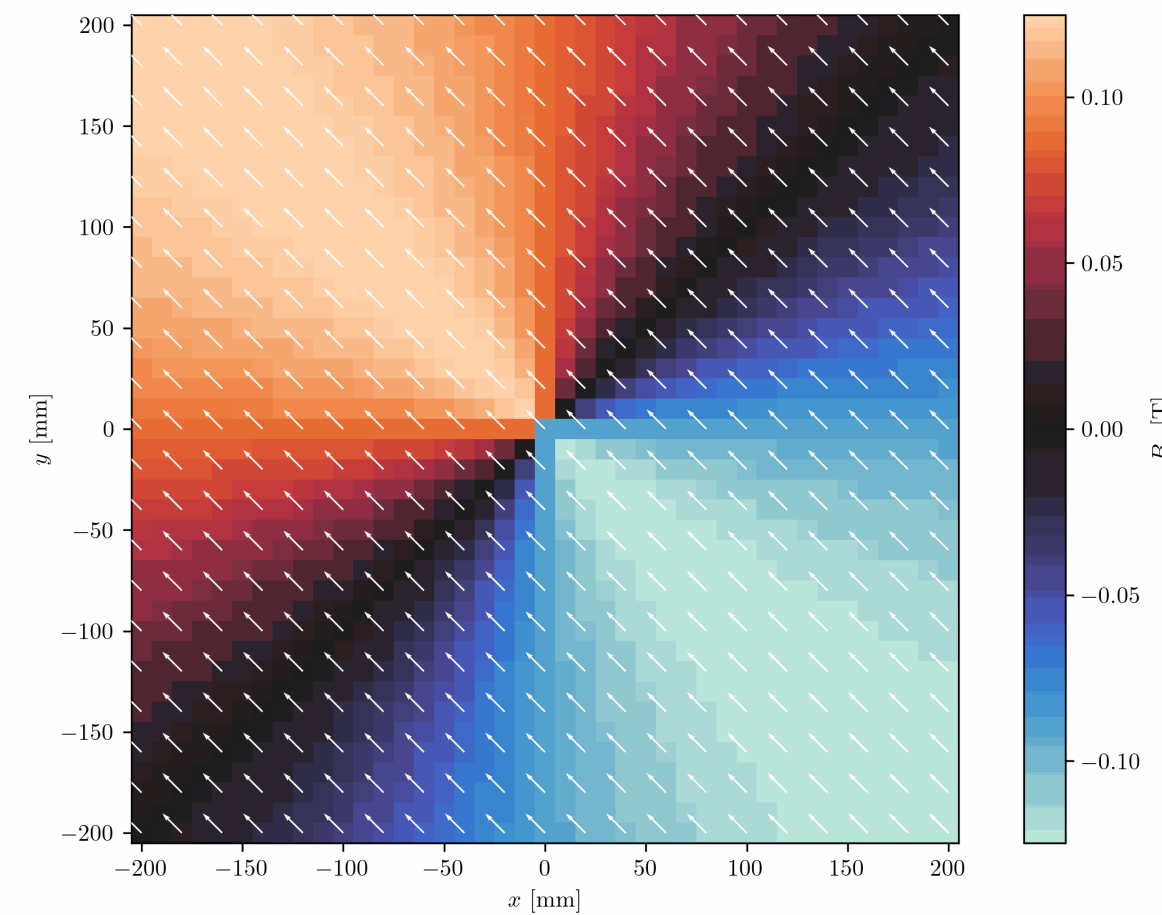
angle 1

In theory

Simulating analytic dipole only, with rotations
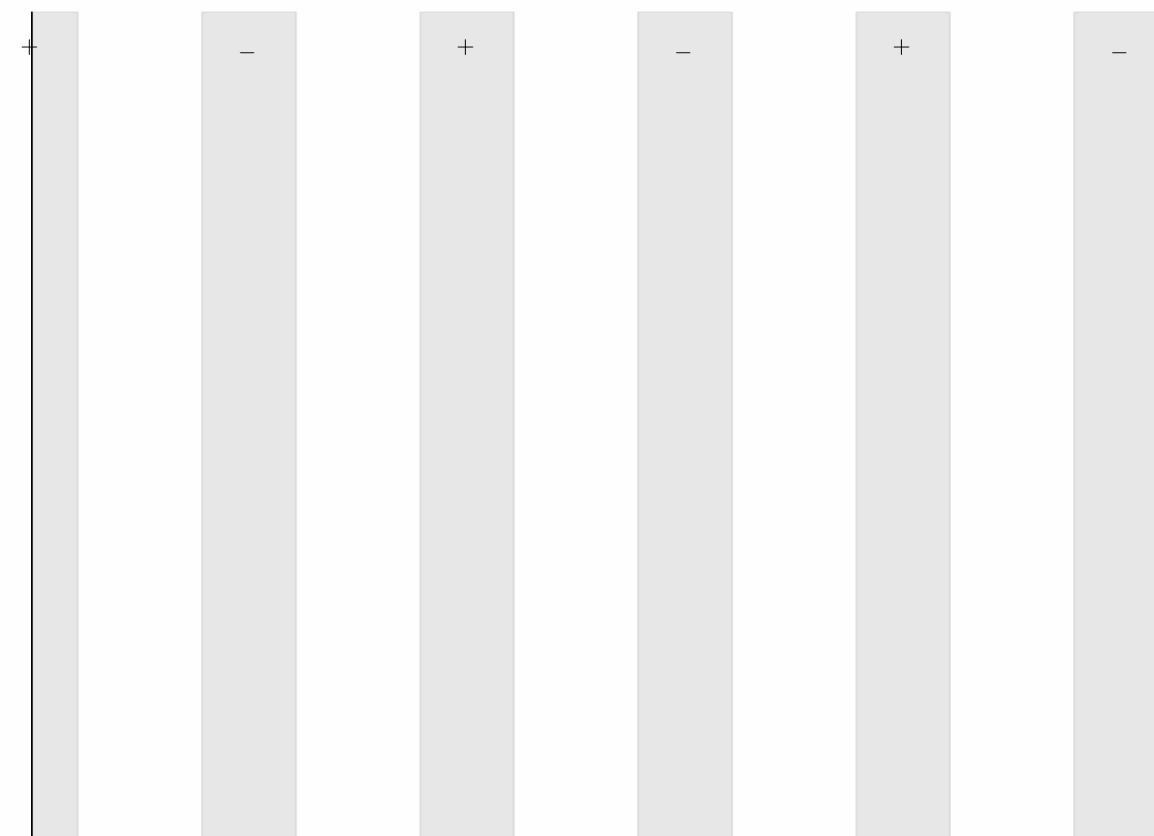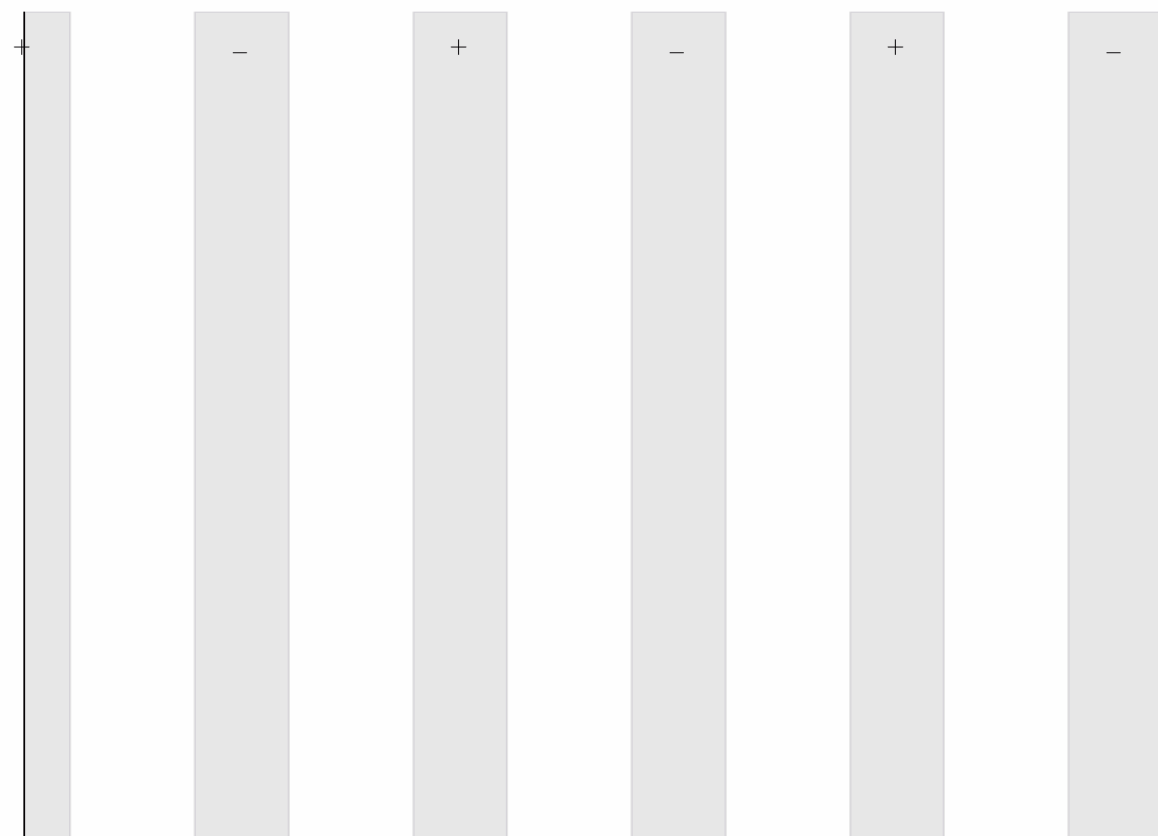
HFOFO actual

Analytic approximation

✓ Field rotations and changes in magnitude are correctly timed with position in lattice
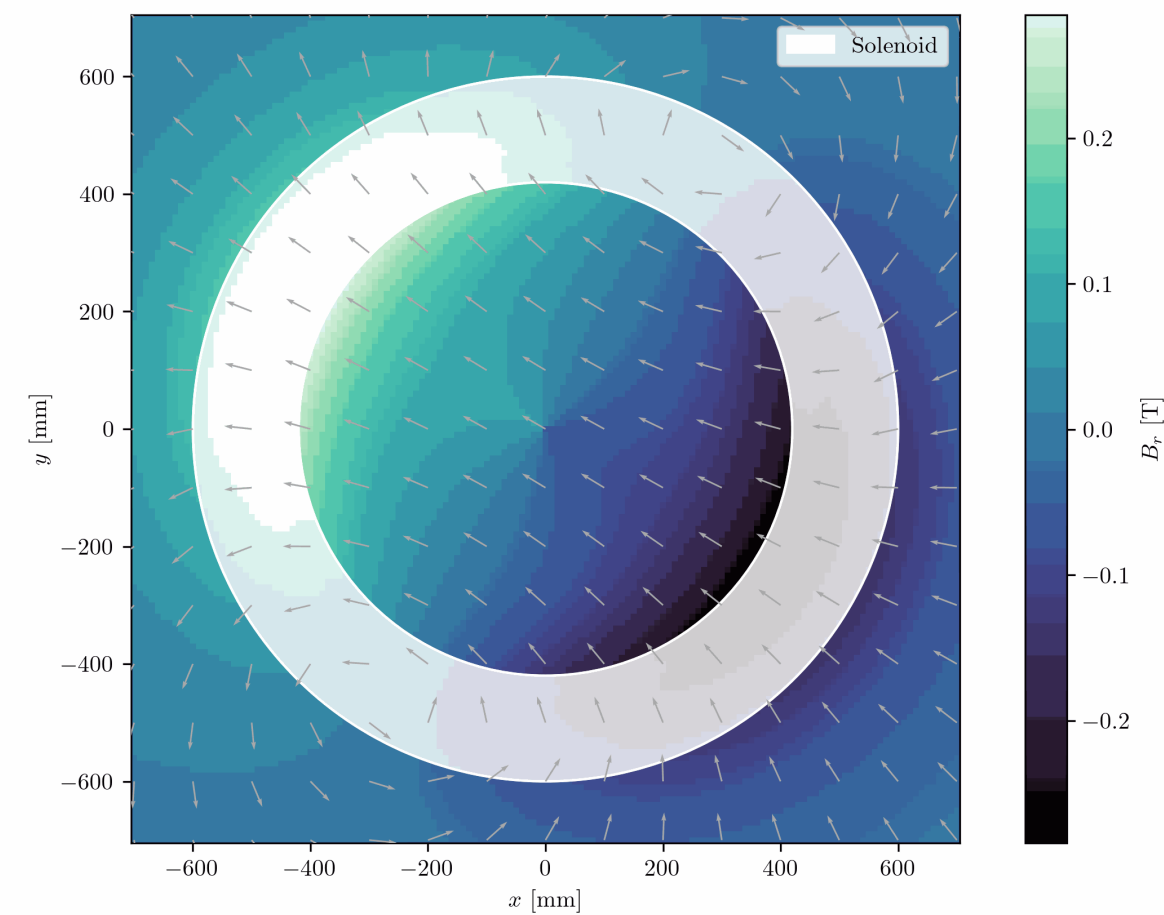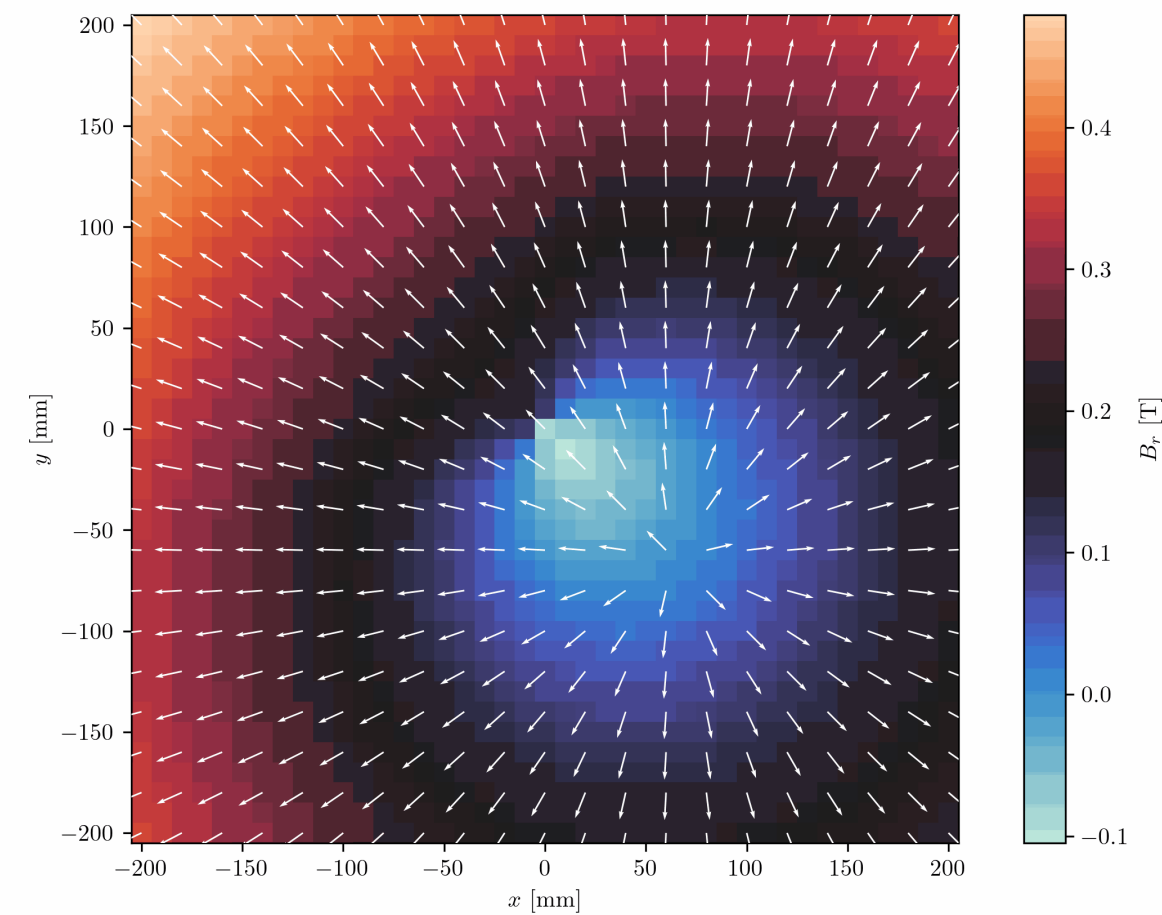
✓ Magnitude behaves as expected for dipole only

Simulating analytic dipole + solenoids, with rotations
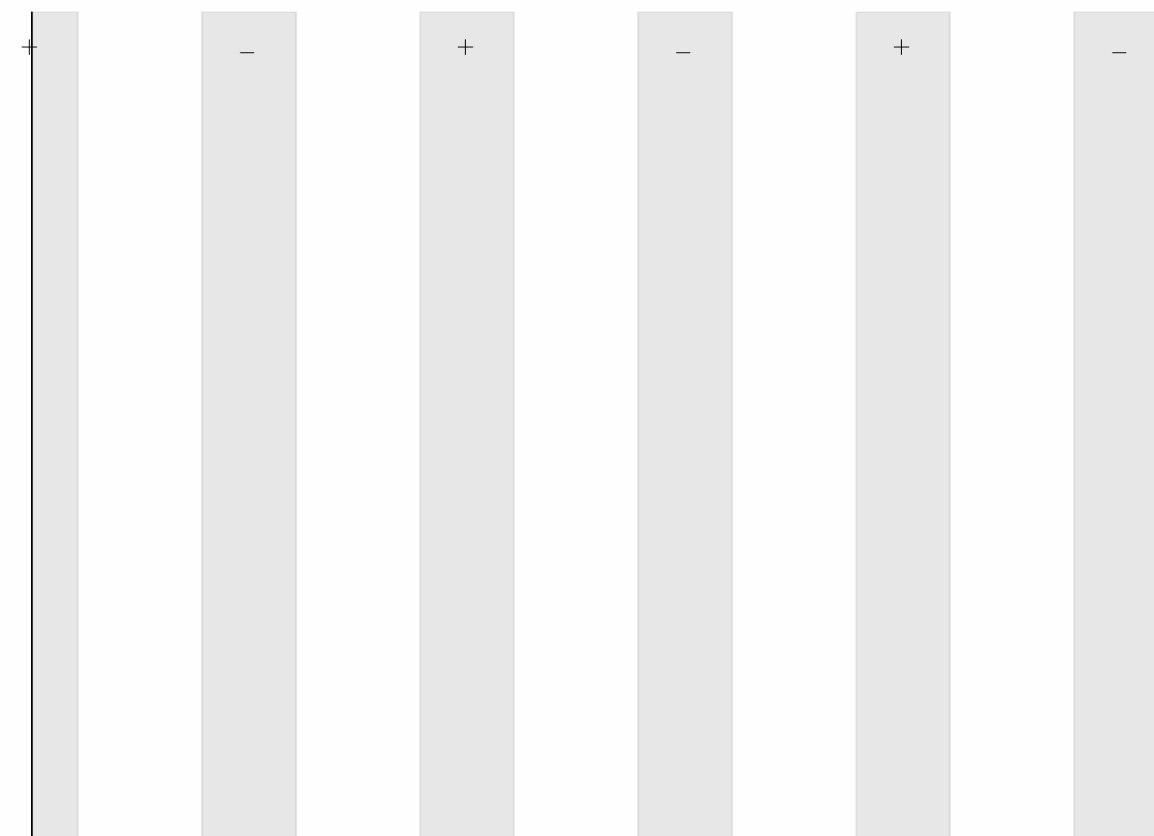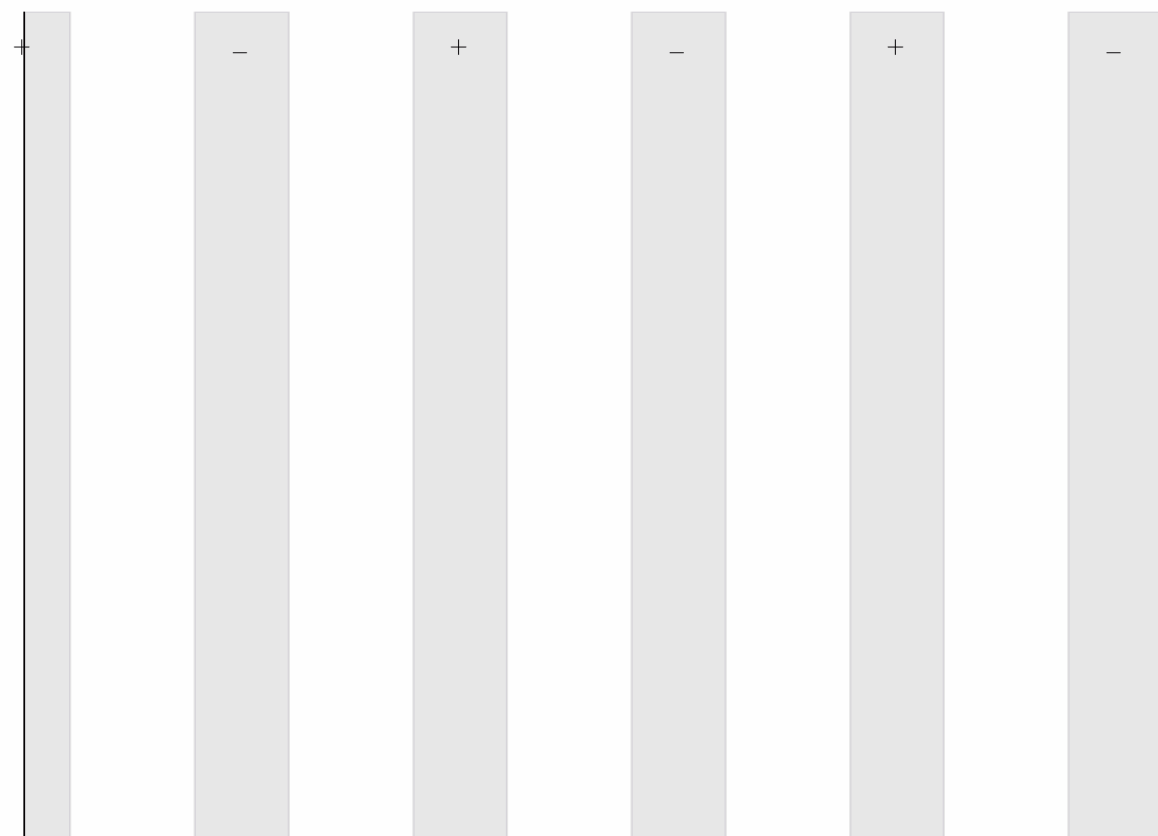
HFOFO actual

Analytic approximation

✓ Unique rotation of central vector

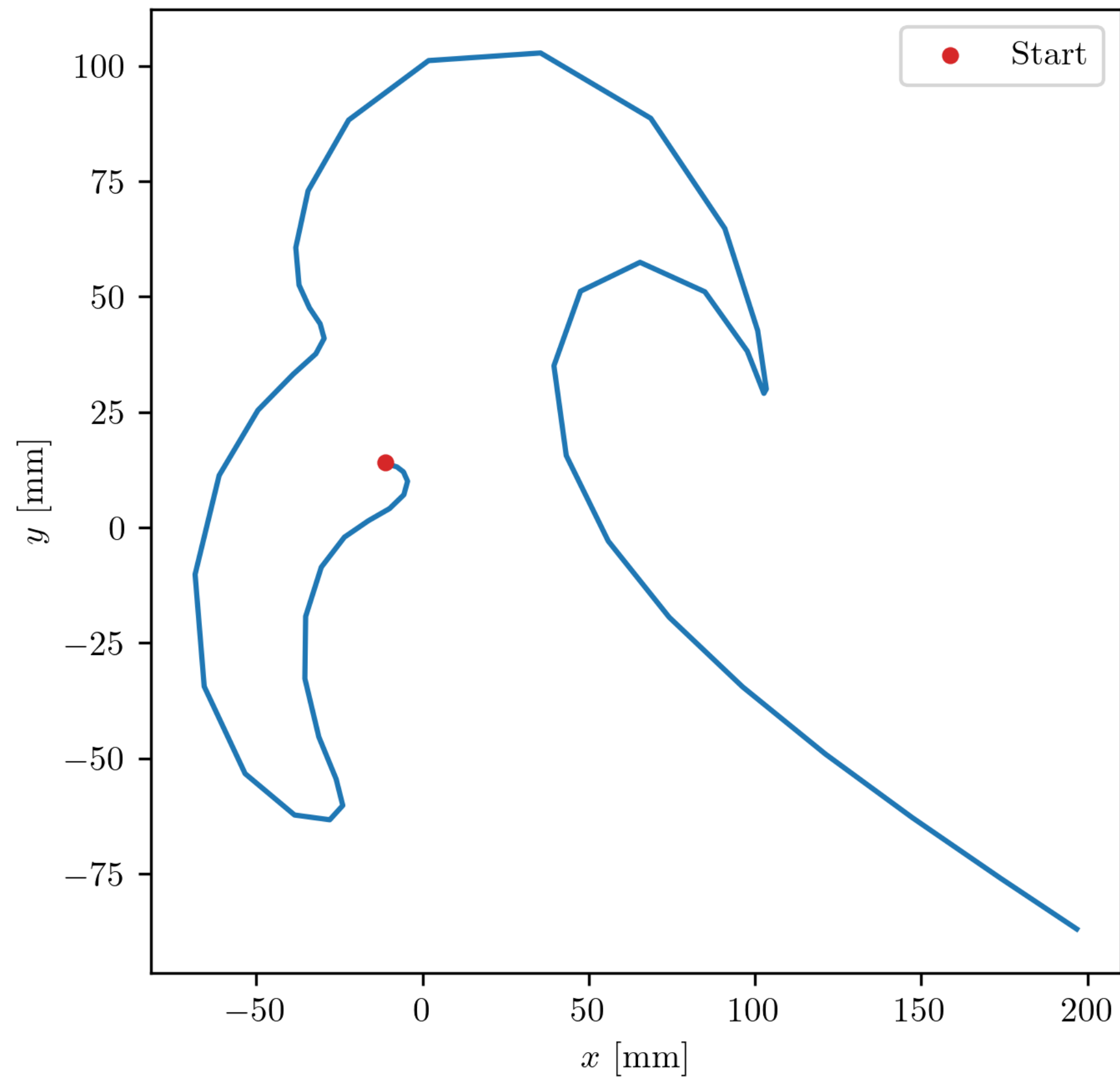✓ Field flips occur at correct positions in the lattice

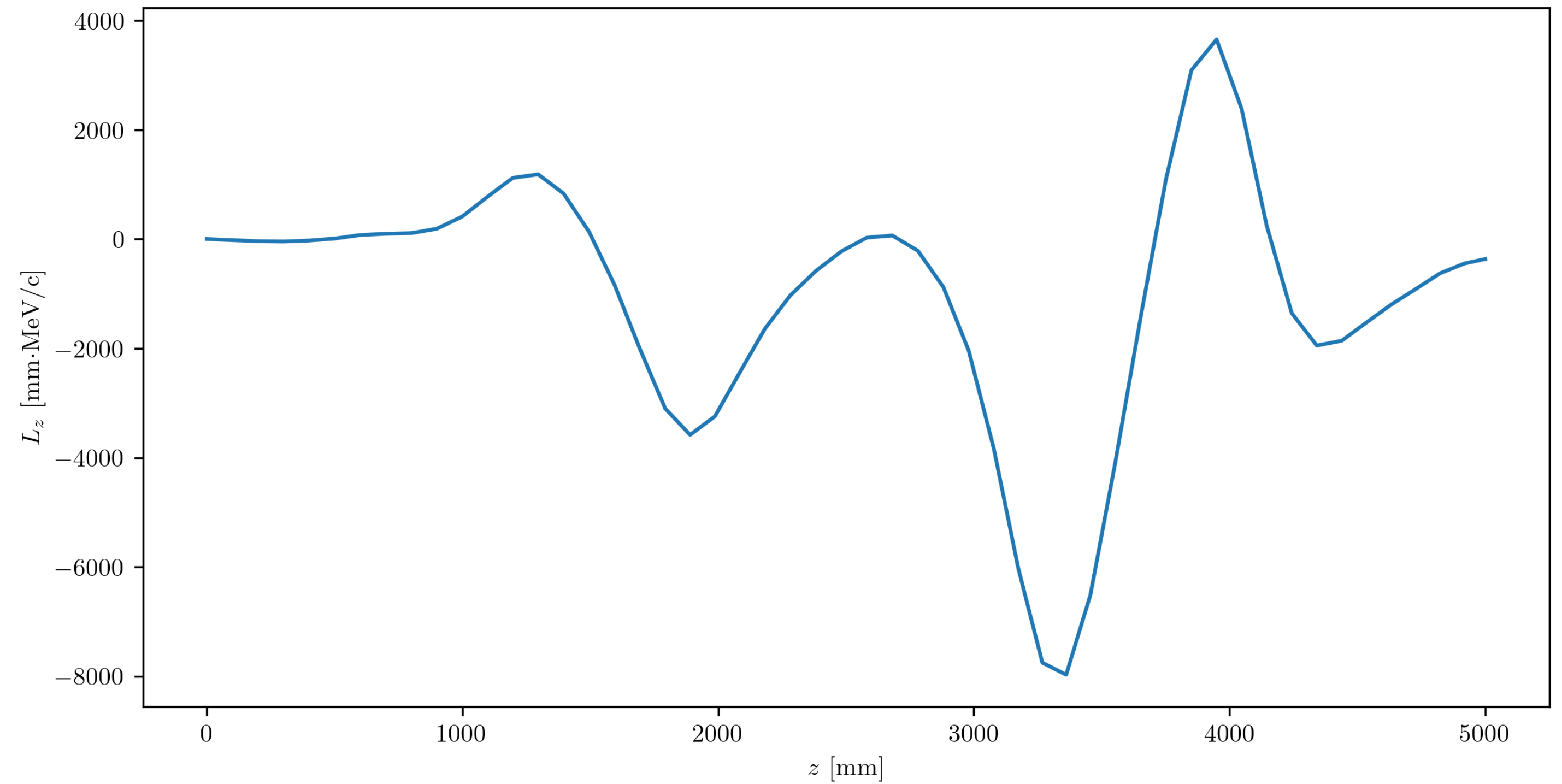✓ Field flips occur at correct positions in the lattice

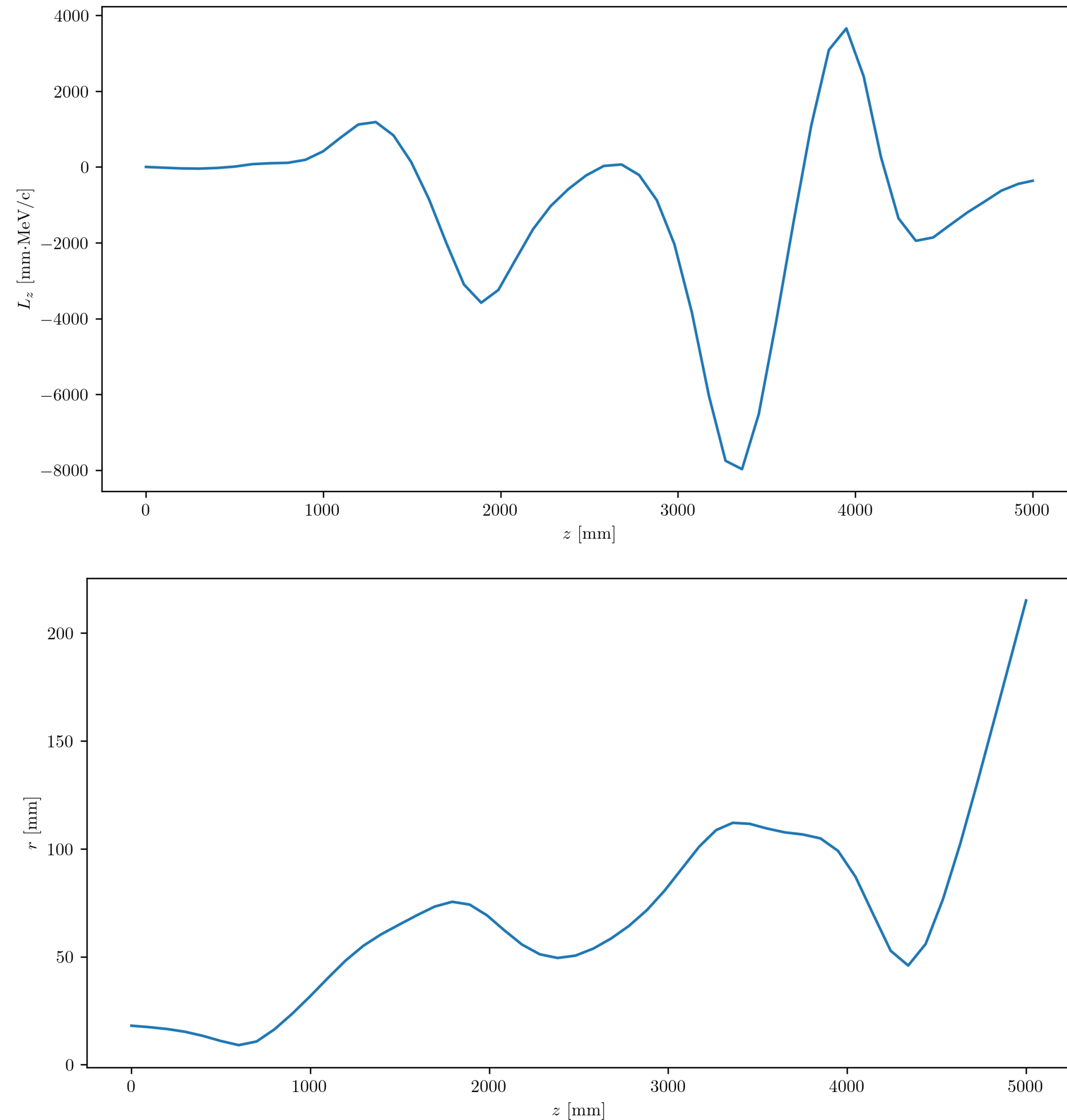*Start a 200 MeV/c μ^+ at z = 0, with the same initial conditions as in the "simplified" HFOFO channel*
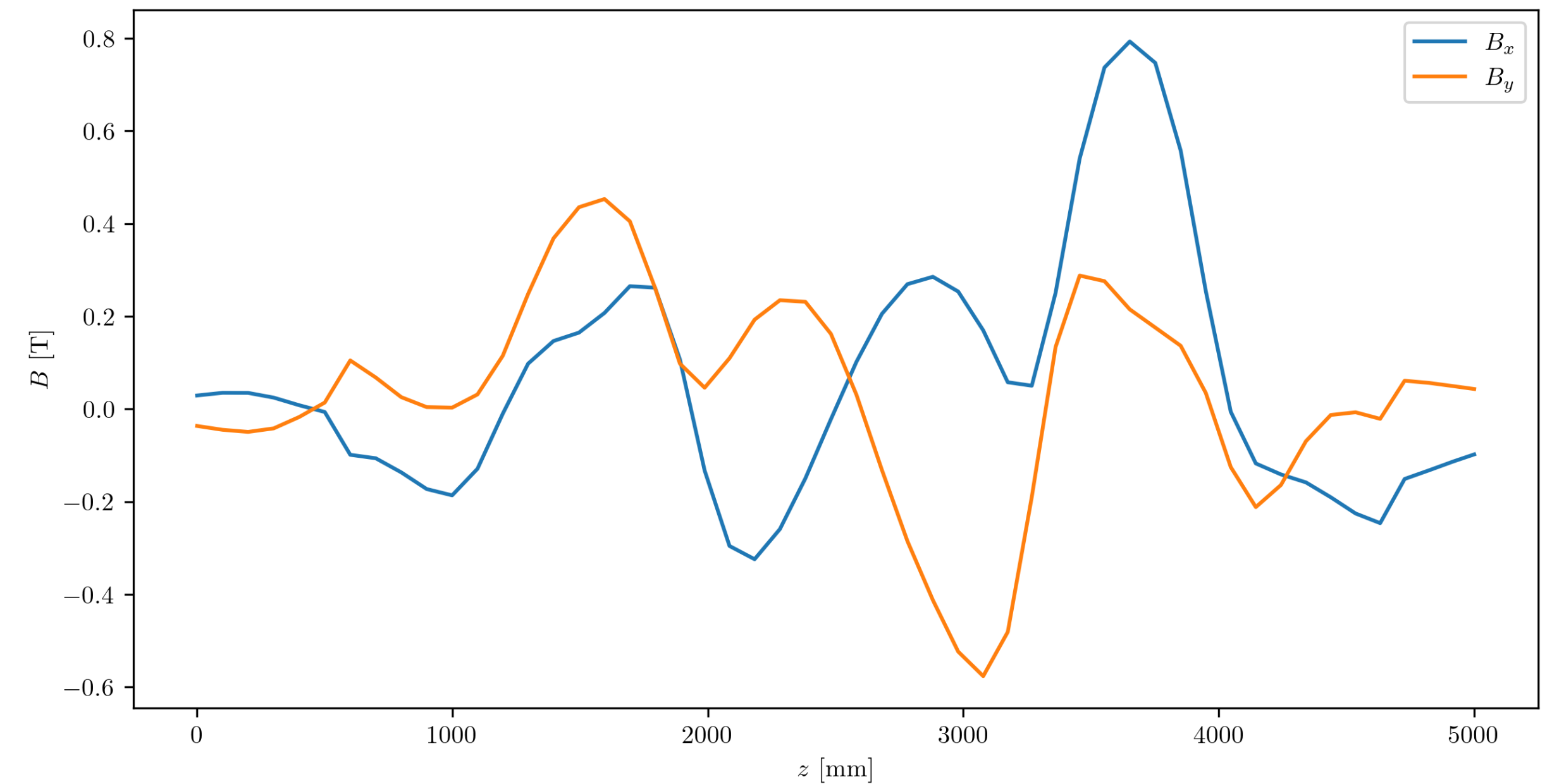
Start a 200 MeV/c μ^+ at $z = 0$, with the same initial conditions as in the "simplified" HFOFO channel
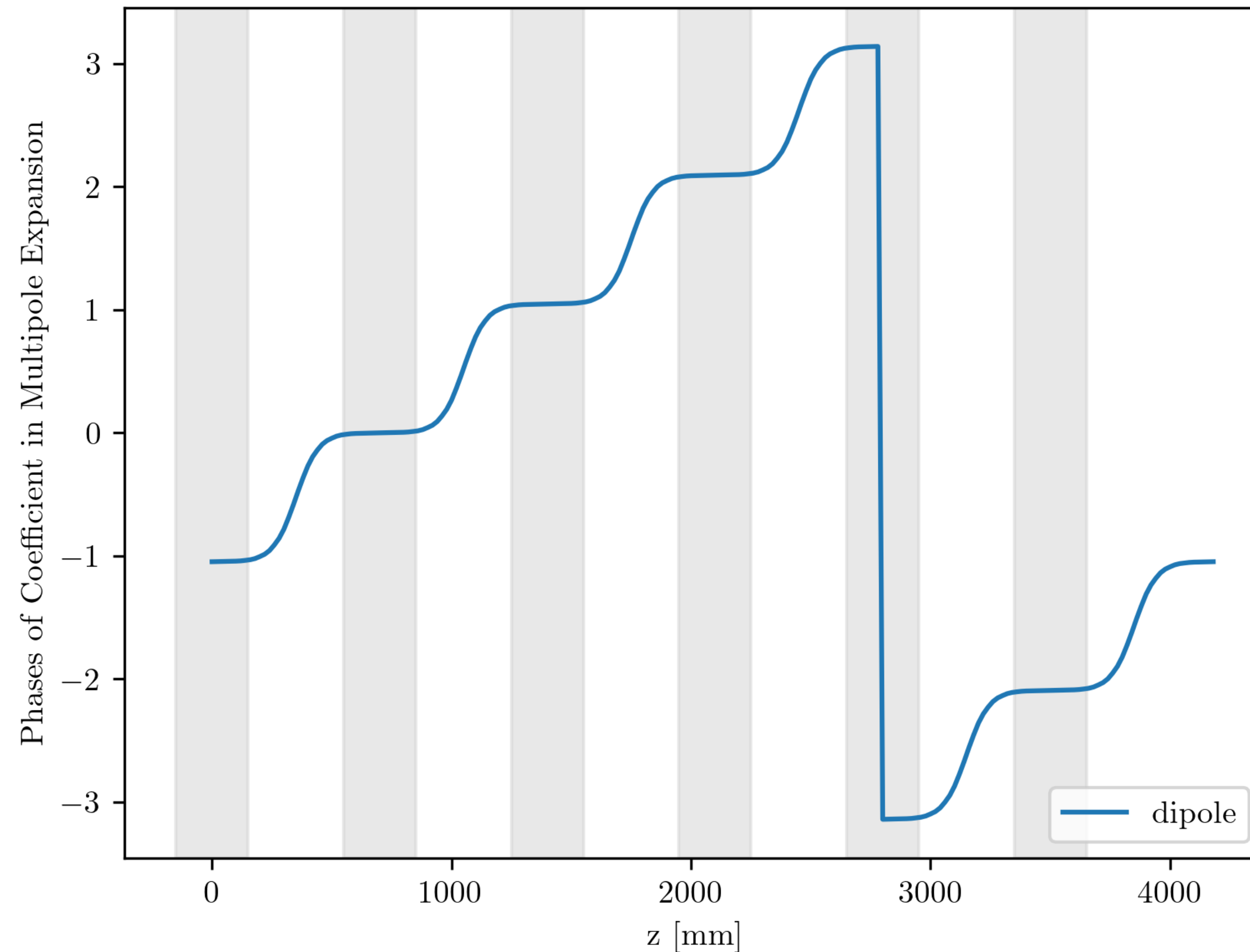

Am I sure I have matched the initial conditions properly?

Adding dipole field rotations

The sigmoid fit approach

Adding dipole field rotations via a sigmoid curve

<u>Next steps</u>: fit to sigmoid curve for behavior during field flip, then use floor function to scale with z