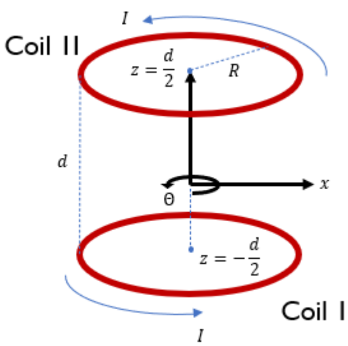
Analytical Result

Sketch



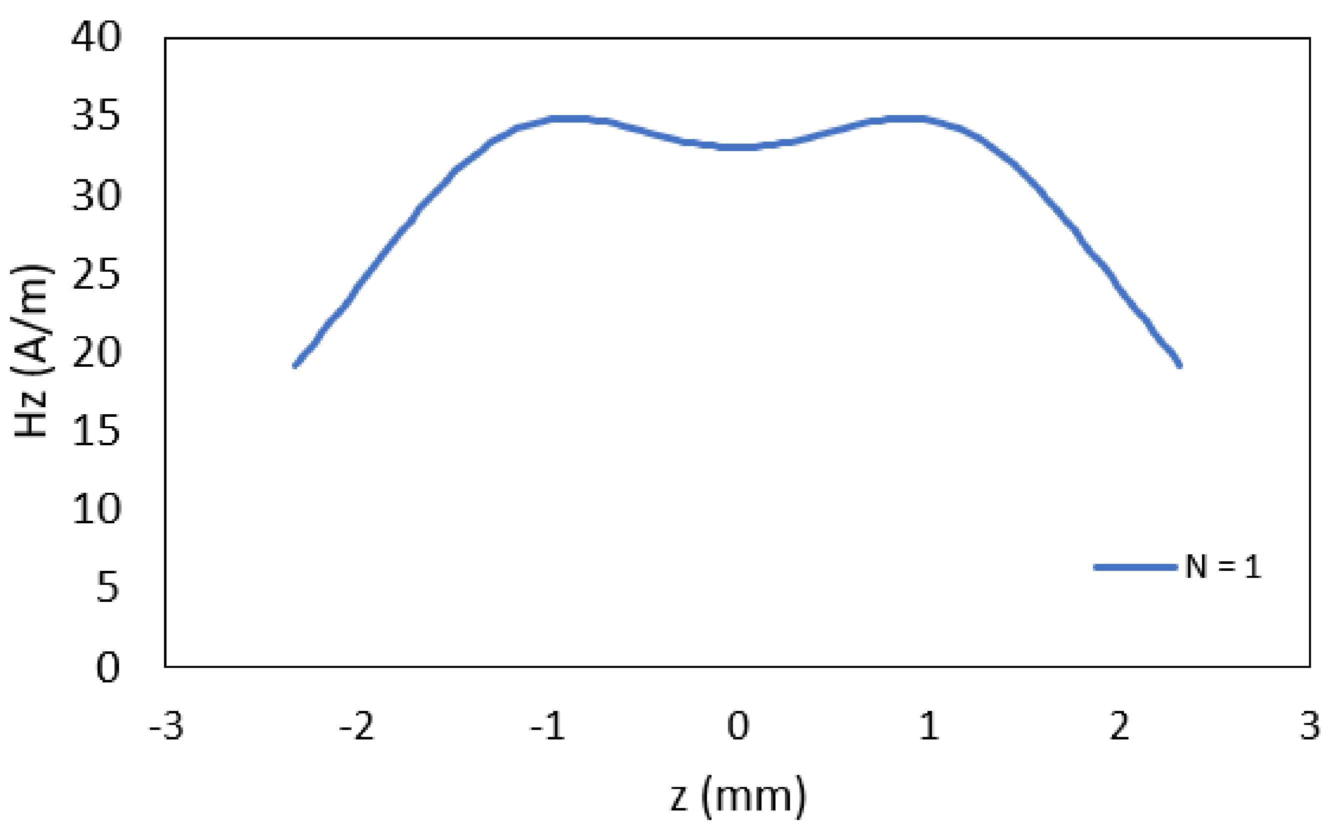
Biot-Savart solution
(x, y = r, θ = 0)

$$H(z) = -\frac{\frac{IR^2N}{2}}{\left(\left(\frac{d}{2}\right)^2 + R^2\right)^{\frac{3}{2}} + \left(\left(\frac{d}{2}\right)^2 + R^2\right)^{\frac{3}{2}}}\hat{\mathbf{z}}$$

For the values

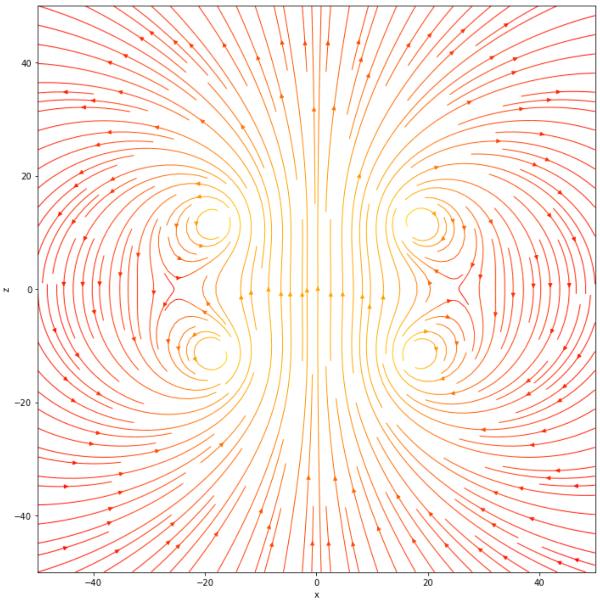
d = 0.0232 m, R = 0.018 m, I = 1 A, N = 1

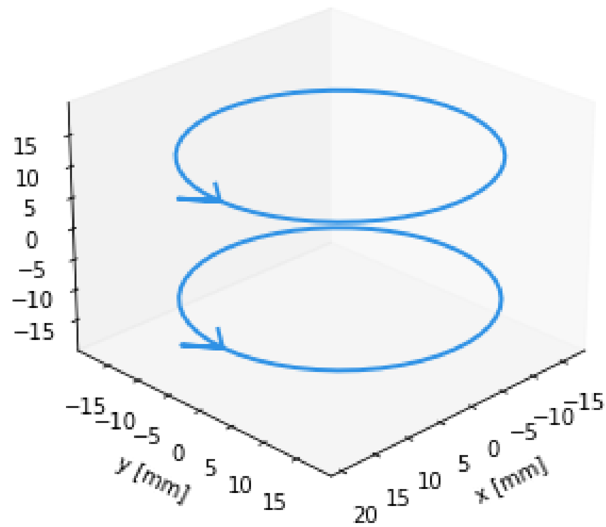
We have:

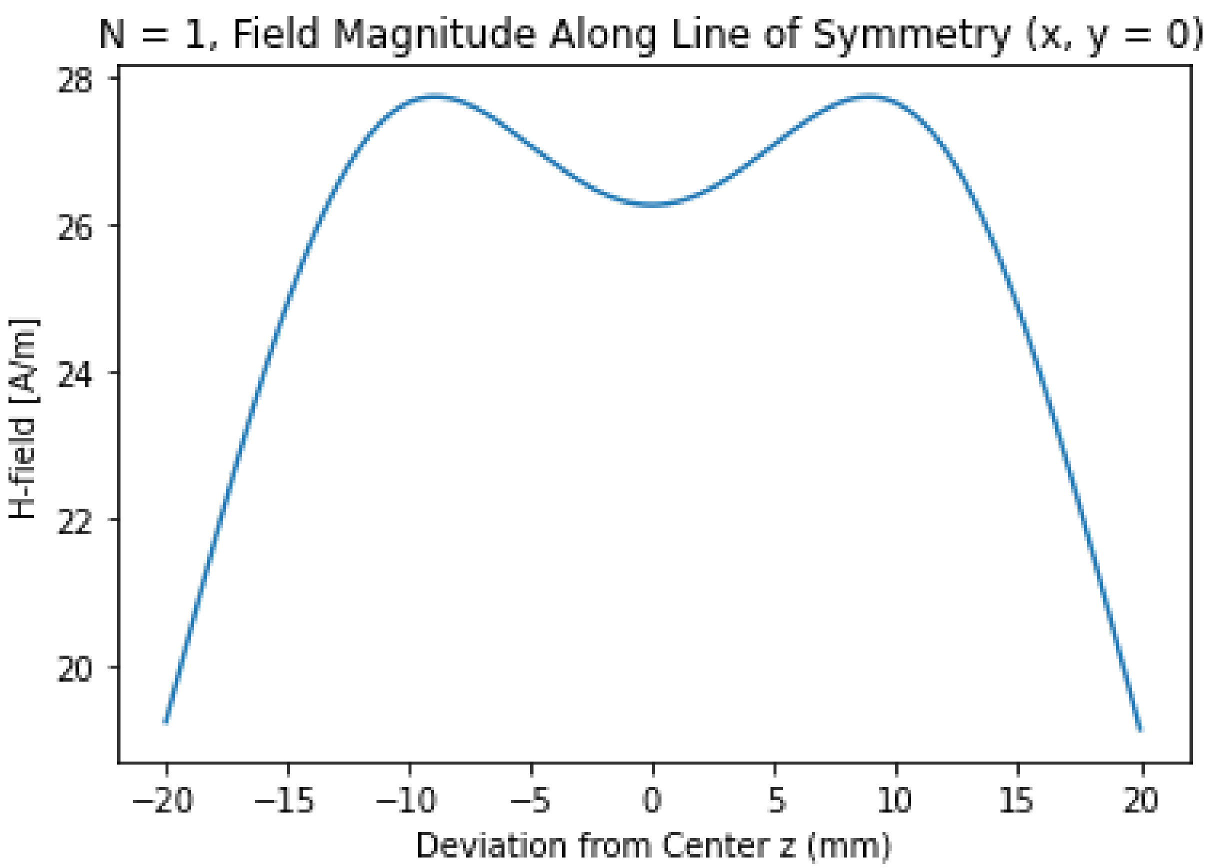


Magpylib Result

For a coil separation of 23.2 mm, coil radius of 18 mm, and current of 1 A, we get the following result:







The values deviate from Biot-Savart by about 20%. For a single-winding, shouldn't the simulation give an identical or near-identical result?

Magpylib Code

```
import numpy as np

import magpylib as magpy

from magpylib.current import Loop

import matplotlib.pyplot as plt


#Define coils


#Spool depth = 8 mm

#Spool diameter (A105) = 20 mm

#A104 + A103/2 = 1.6*2 + 12


n = 1 #Number of winds

I = 1 #Current (A)

R  = 18 #Radius of winding (mm)

d = 23.2 #Coil separation (mm)


coil_1 =  magpy.Collection(style_label='coil_1')

coil_2 =  magpy.Collection(style_label='coil_2')


coil_1.add(Loop(current=I, diameter=2*R, position=(0,0,d/2)))

coil_2.add(Loop(current=I, diameter=2*R, position=(0,0,-d/2)))

helmholtz = coil_1 + coil_2


# 5

# Coils: 20 AWG, M22759/11-20

# Coils: wire appears 5x width


#Plotting field along line of symmetry

fig2 = plt.figure(figsize=(10, 10))


ax2 = fig2.add_subplot(projection="3d")  # 3D-axis

ax2.view_init(25, 45)

ax2.grid(False)
```

```
ax2.set_zlabel('z [mm]')
magpy.show(helmholtz, canvas=ax2)
fig2.tight_layout()

numObs = 500

Hz = np.zeros(numObs)
zMin = -20
z = np.arange(-zMin,zMin,(2*zMin)/numObs)
for ind in range(len(Hz)):
    Hz[ind] = helmholtz.getH((0,0,z[ind]))[2]

Hz = n*Hz*795.77471545947673925 #mT to A/m

fig3,ax3 = plt.subplots()
ax3.plot(z,Hz, label='Hz')
ax3.set_ylabel('H-field [A/m]')
ax3.set_xlabel('Deviation from Center z (mm)')
ax3.set_title('N = 1, Field Magnitude Along Line of Symmetry (x, y = 0)')
#Plot H and B fields of slices

def plotH(axis_one,axis_two,):
    print('hey')

import numpy as np
import matplotlib.pyplot as plt
import magpylib as magpy

fig, ax = plt.subplots(figsize=(10,10))

# create an observer grid in the xz-symmetry plane
ts = np.linspace(-50, 50, 50)
grid = np.array([[(0,x,z) for x in ts] for z in ts])
```

```
# compute B- and H-fields of a cuboid magnet on the grid
H = helmholtz.getH(grid)

# display field with Pyplot
ax.streamplot(grid[:,:,1], grid[:,:,2], H[:,:,1], H[:,:,2], density=2,
   color=np.log(np.linalg.norm(H, axis=2)), linewidth=1, cmap='autumn')

ax.set_xlabel('x')
ax.set_ylabel('z')

plt.tight_layout()
plt.show()
```