# Update on Mathematica code

VL

April 19, 2024

Solenoids = { 58.7697, -117.5394, 123.1715, -122.9266, 122.9266, -117.5394,  58.7697 }

# Attempt to compare with SPACE

- Original goal was to improve beam envelopes for various slices of the electron beam
- It did not worked out because beam envelopes were very different from SPACE simulations
- It turned out that there is significant difference in beam envelopes resulting from different (so-called analytical) fit for solenoid's field when compared with more accurate fit used in my code
- Using fit used in SPACE simulations resulted in very good agreement
- But is also indicated that we must use accurate representation for magnetic field of our solenoids

# Two fits at 145 A

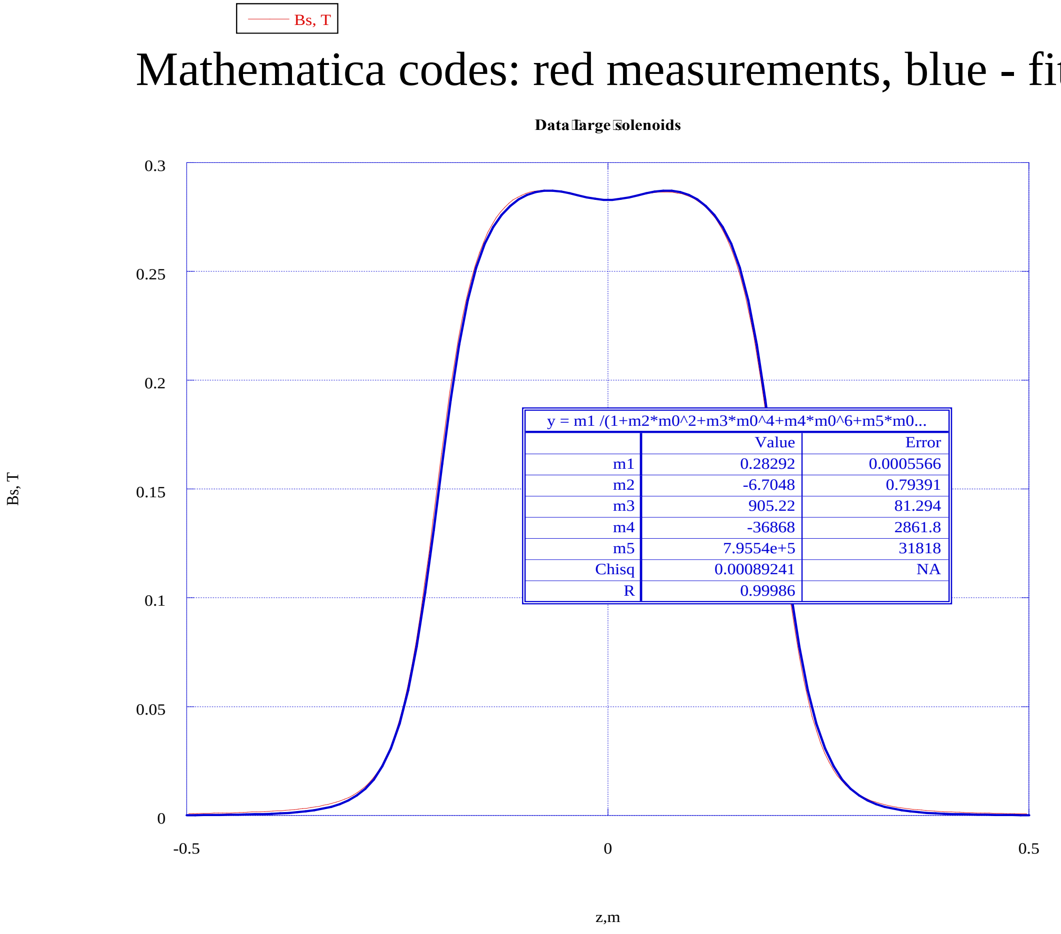
Mathematica

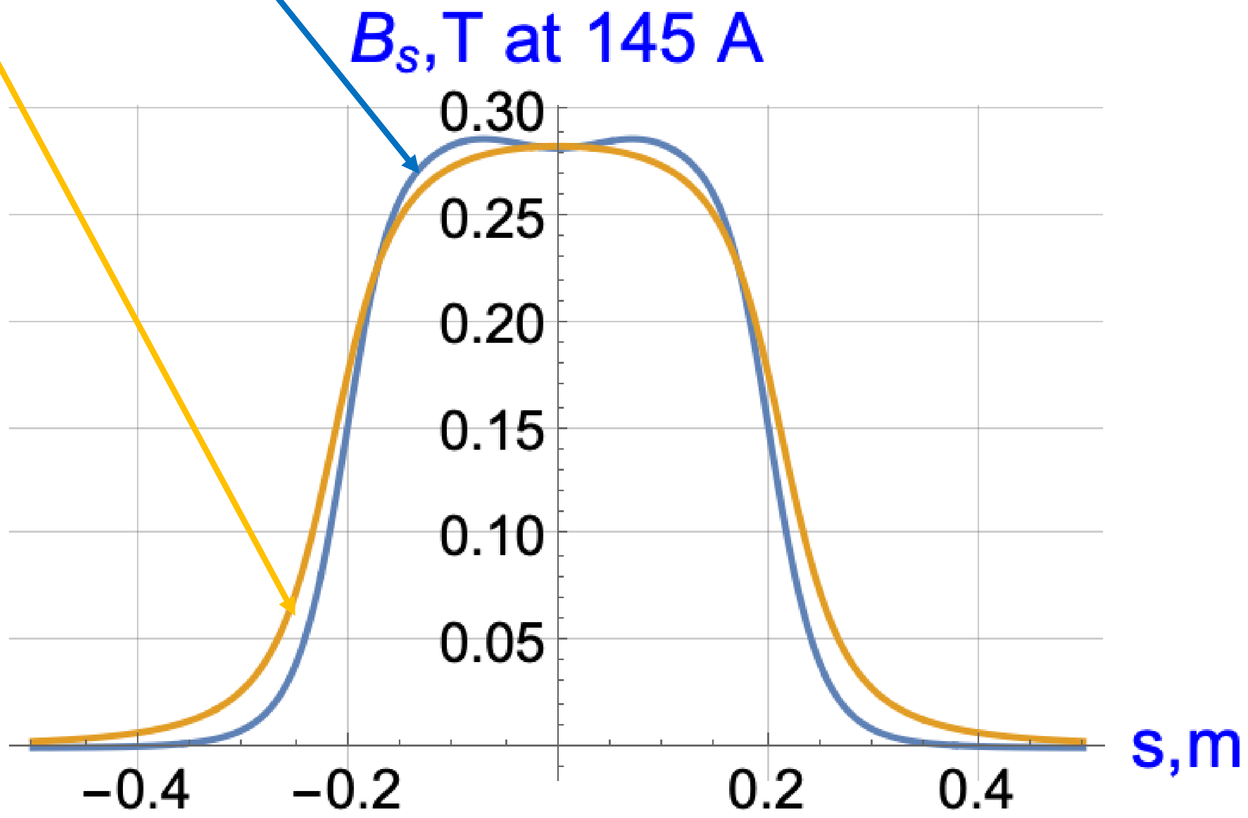
$$B_o(z) = \frac{m1}{1 + m2\cdot z^2 + m3\cdot z^4 + m4\cdot z^6 + m2\cdot z^8}$$

SPACE

$$B_{z,0} = \frac{B_0}{2}\left(\frac{L/2 - z}{\sqrt{(z - L/2)^2 + R^2}} + \frac{L/2 + z}{\sqrt{(z + L/2)^2 + R^2}}\right)$$

Mathematica codes: red measurements, blue - fit

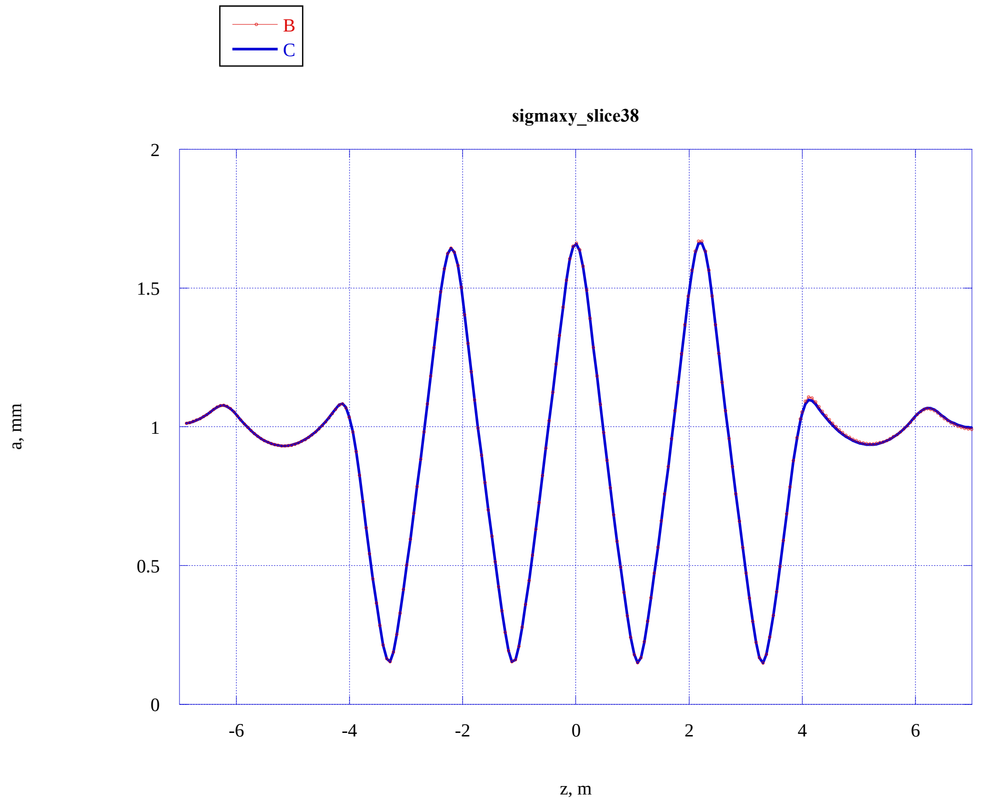


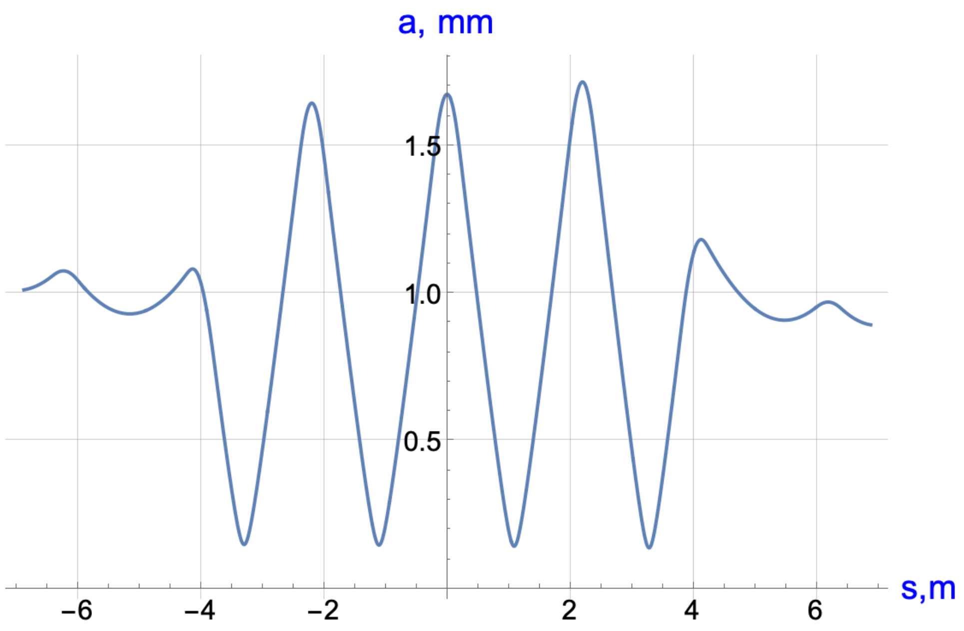
# Envelopes for slice #38

$$B_{z,0} = \frac{B_0}{2}\left(\frac{L/2 - z}{\sqrt{(z - L/2)^2 + R^2}} + \frac{L/2 + z}{\sqrt{(z + L/2)^2 + R^2}}\right)$$

SPACE




Mathematica with fit used in SPACE

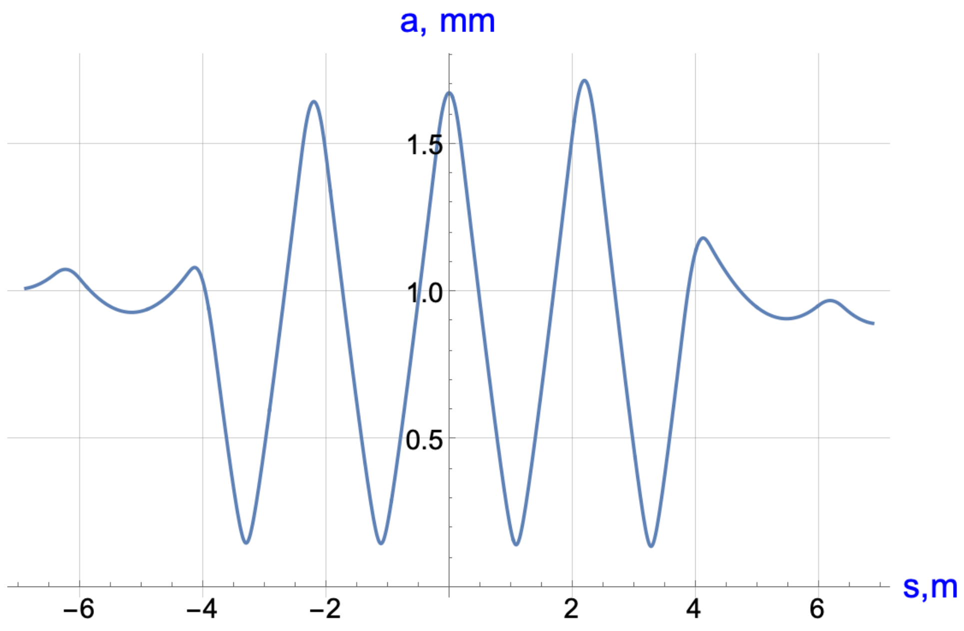


# Envelopes for slice #38

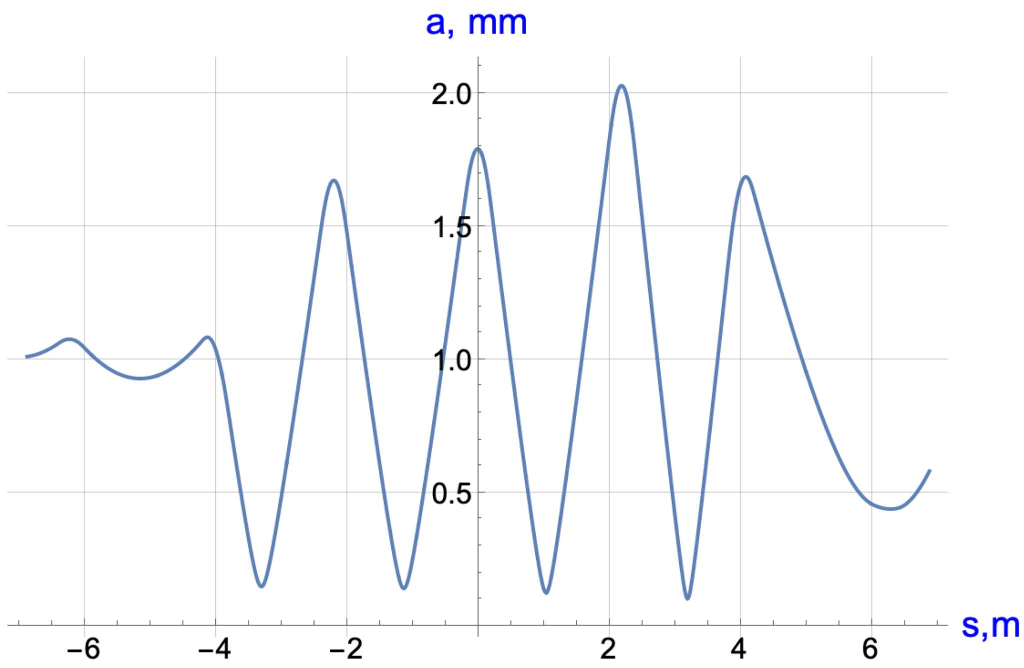
$$B_{z,0} = \frac{B_0}{2}\left(\frac{L/2 - z}{\sqrt{(z - L/2)^2 + R^2}} + \frac{L/2 + z}{\sqrt{(z + L/2)^2 + R^2}}\right)$$

$$B_o(z) = \frac{m1}{1 + m2 \cdot z^2 + m3 \cdot z^4 + m4 \cdot z^6 + m2 \cdot z^8}$$

Mathematica with fit used in SPACE



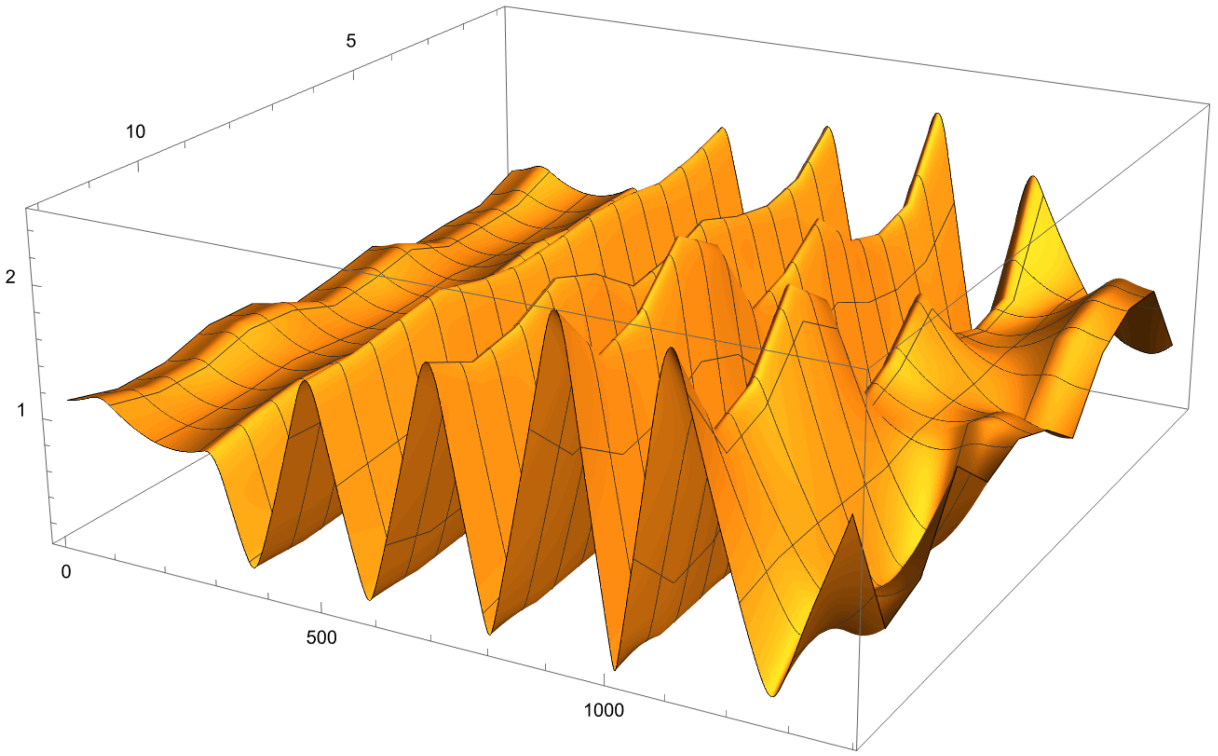

Mathematica with accurate fit

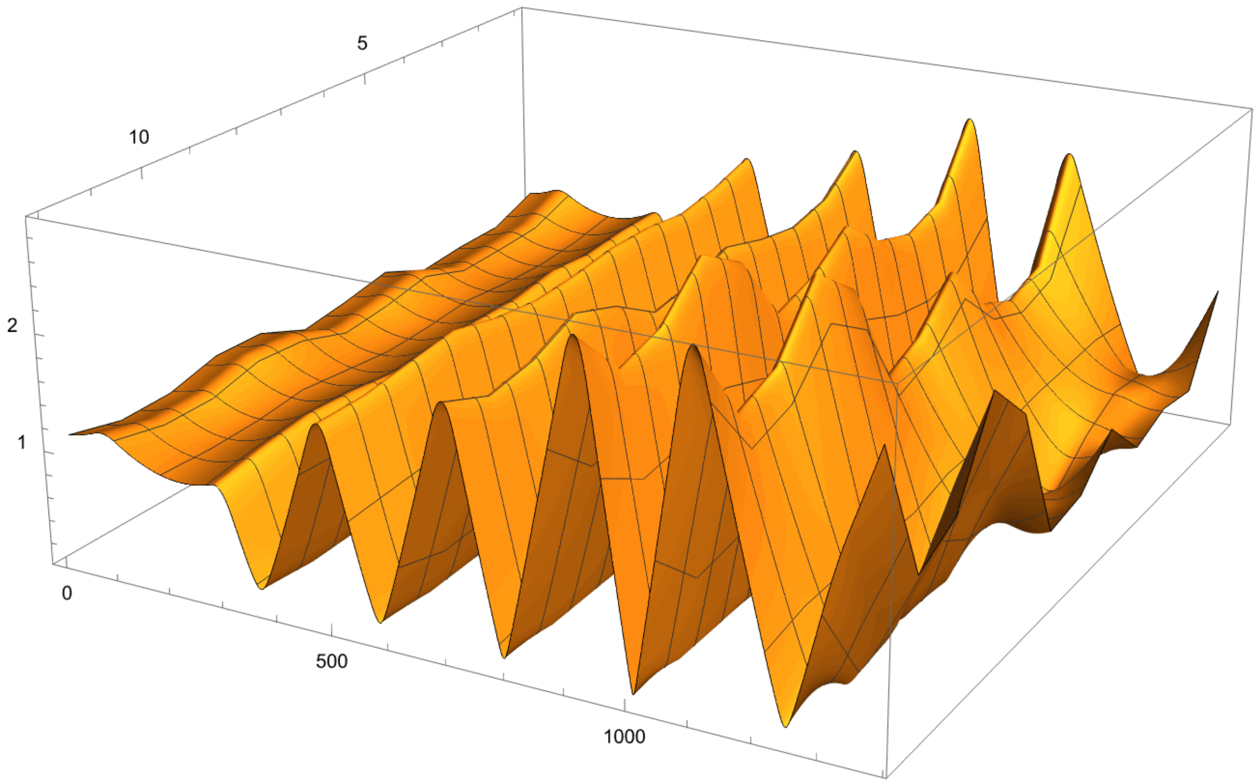


# 12 slices

$$B_{z,0} \;=\; \frac{B_0}{2}\left(\frac{L/2-z}{\sqrt{(z-L/2)^2+R^2}}+\frac{L/2+z}{\sqrt{(z+L/2)^2+R^2}}\right)$$

$$B(z) = B_o \frac{1+m1\cdot z^2}{1+m2\cdot z^2+m3\cdot z^4+m4\cdot z^6+m5\cdot z^8}$$



# Discussion

- Integrals of $Bs^2$ are the same but envelopes are very different
- We can see that small differences in shape of the field make huge difference in the beam envelope
- It means that we need to use best fits and, may be, individual fits for each solenoid to account for some asymmetries