Meeting Agenda Tuesday July 7, 2026 at 3:30 pm

1.	Matt Frost	5'	Paper submission update
2.	Carolyn Haviland	10'	DPF Meeting poster draft on the paper (at Fermilab July 20-24)
3.	Yuri Kamyshkov	20'	Update on the current work with $\mu-$prototype at UT
4.	Mubi Khan	10'	Updates from UKY
5.	Linus Persson	10 '	Updates from LU/ ESS and Japan

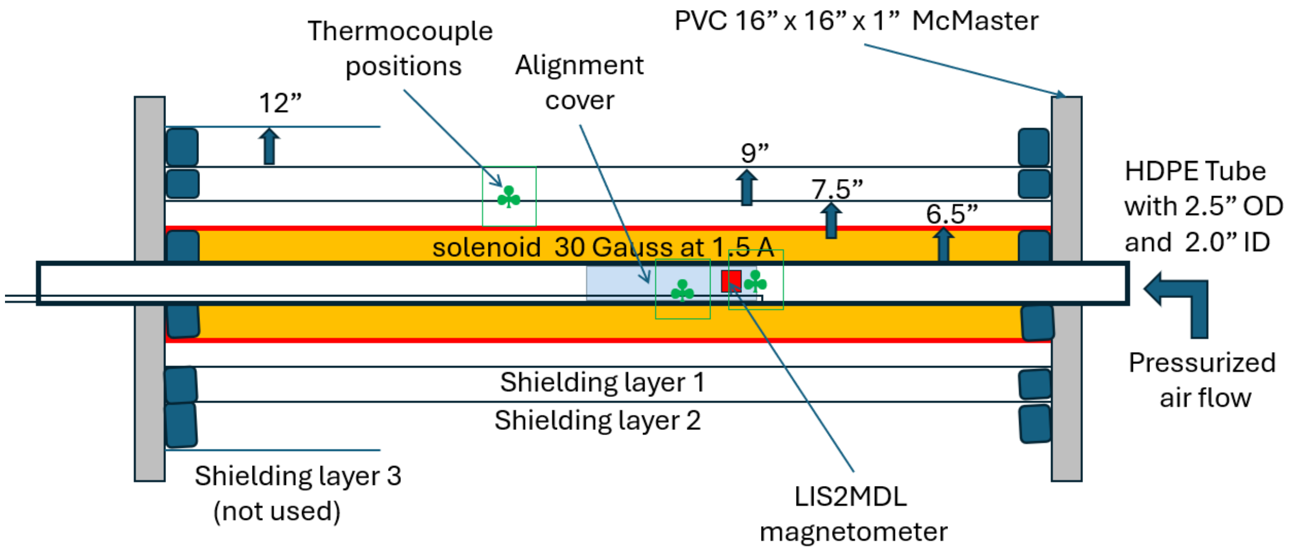
July 7, 2026 – nn’ zoom meeting

Current work with $\mu -$ prototype at UT $- 2$

Update • see part 1 at Indico
https://indico.phy.ornl.gov/event/1061/attachments/2521/5499/YK-current%20work%20on%20mu-prototype-at%20UT.pdf

Y. Kamyshkov & S. Vavra

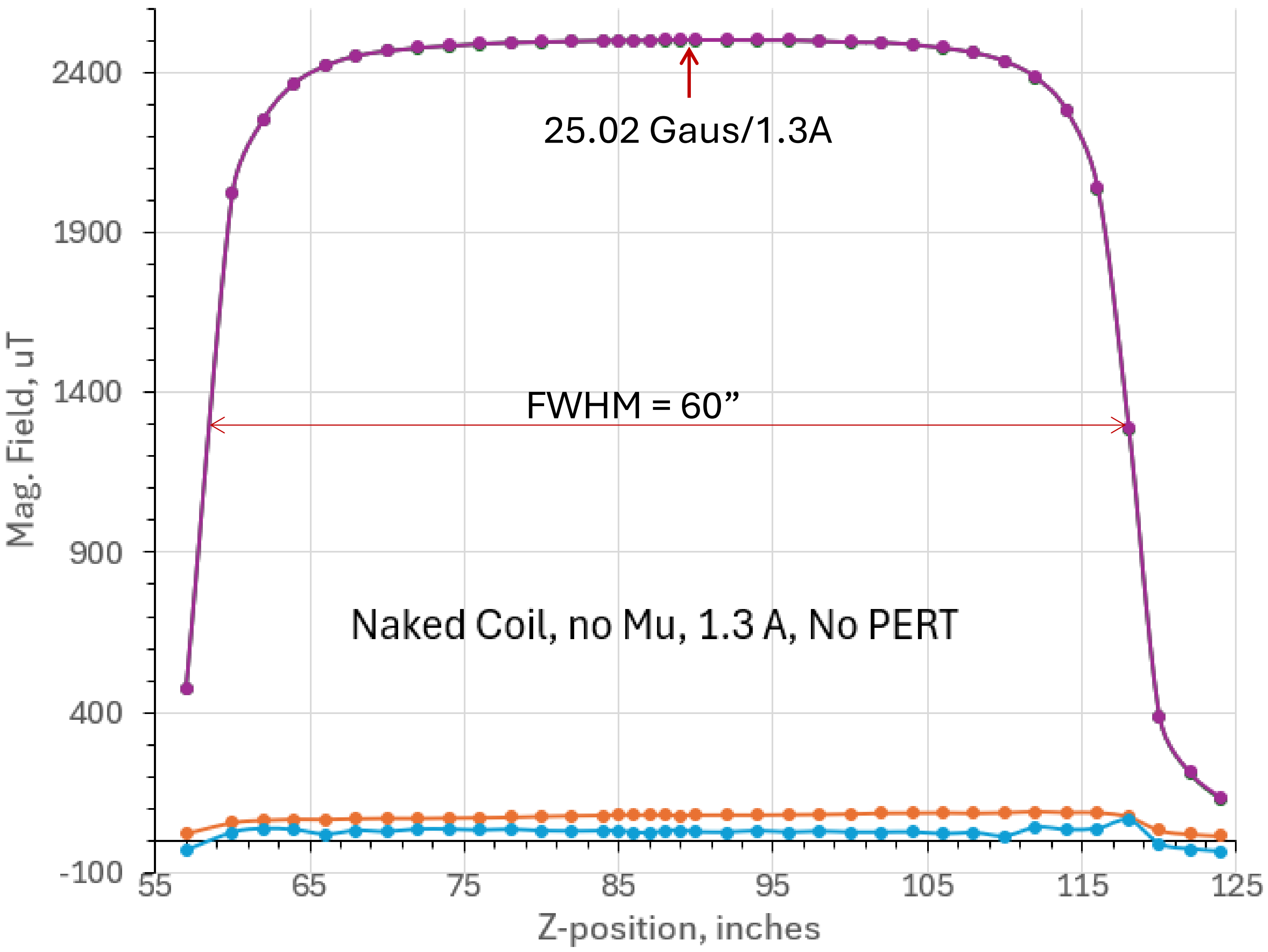
In UT μ-prototype configuration $\rightarrow$



we are trying to measure shielding factors (SF) of μ-metal system in the environment close to this at GP-SANS

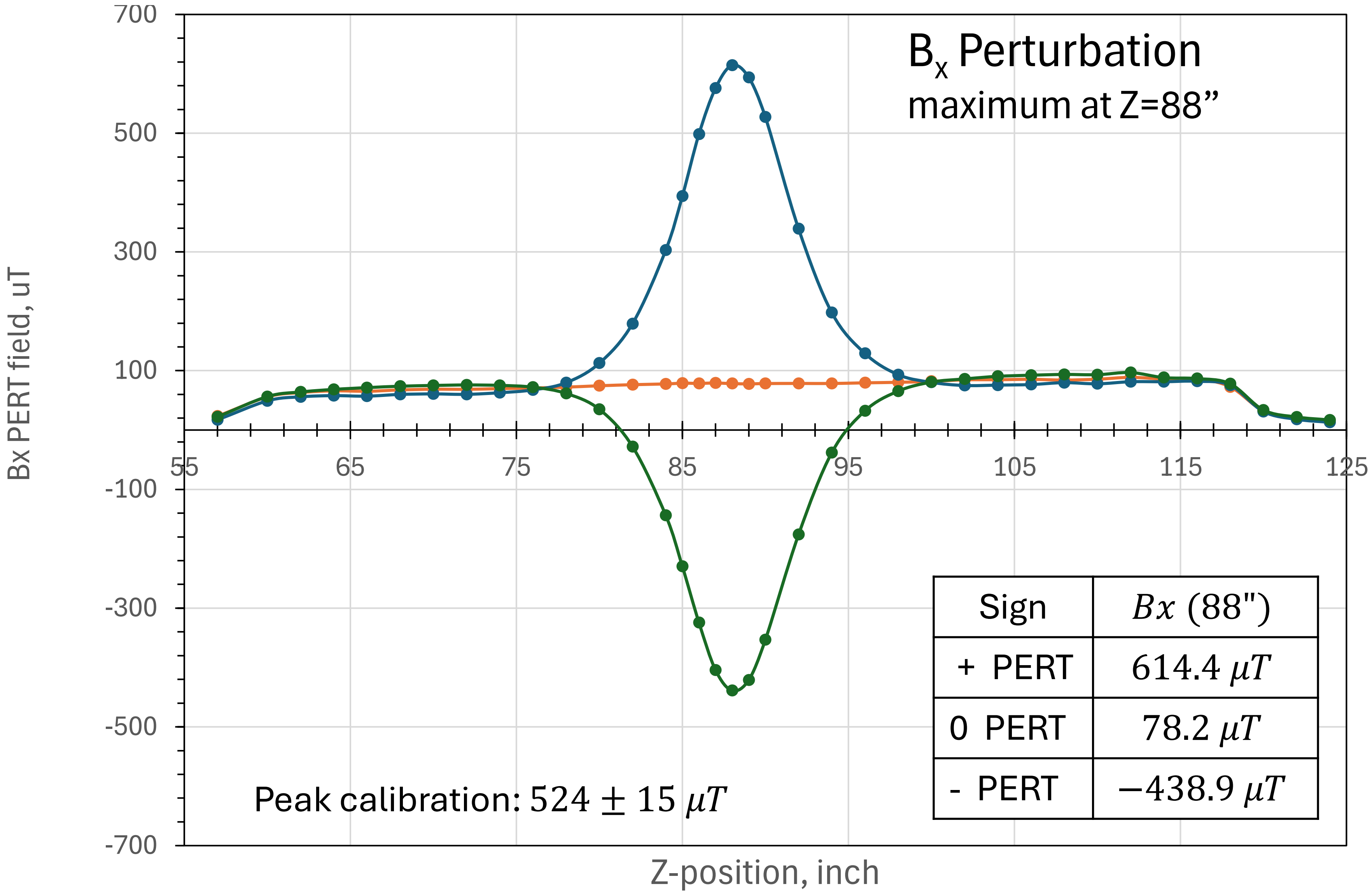
- Solenoid field ~ 26 ± 2 Gauss (coil current ~ 1.3 A)
- Degaussing in presence of perturbation and solenoid field
- Measure SF for Inner shield (dia 7.5") for single 0.3 mm and double layer
- Measure SF for Outer shield (dia 9") for single 0.3 mm and double layer
- Other relevant measurements will be discussed later

Naked Coil: 3 field components, no mu-metal, no PERT



mu-metal endcaps are installed

Naked Coil dia. 6.5”, With $\pm$PERT, Coil cuttent 1.3 A

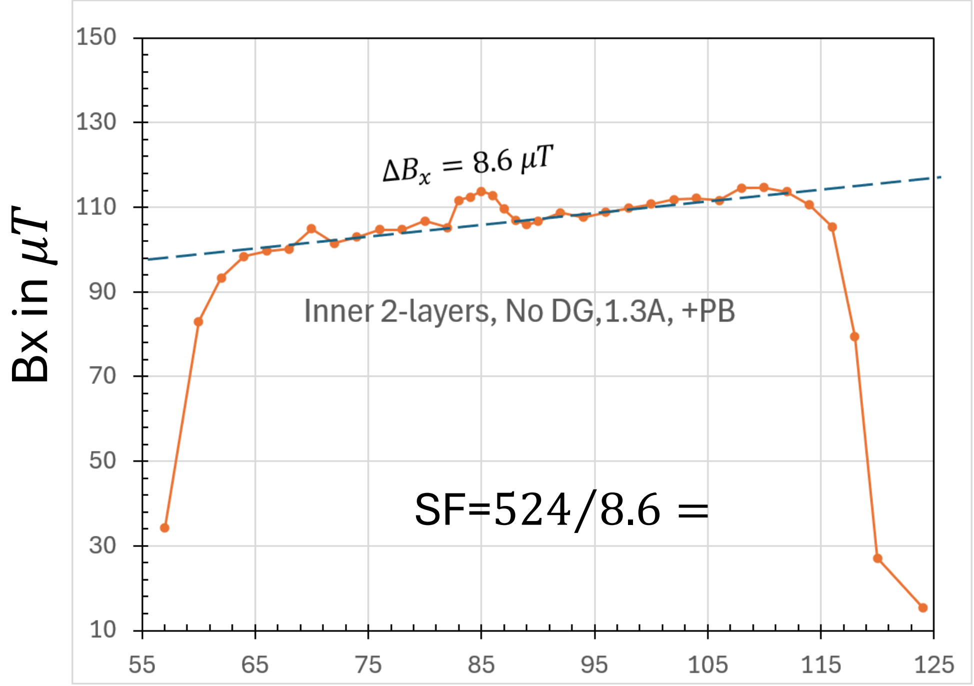


Sign	Bx (88")
+ PERT	$614.4\ \mu T$
0 PERT	$78.2\ \mu T$
- PERT	$-438.9\ \mu T$

Two methods of perturbation measurement in the presence of μ shield:

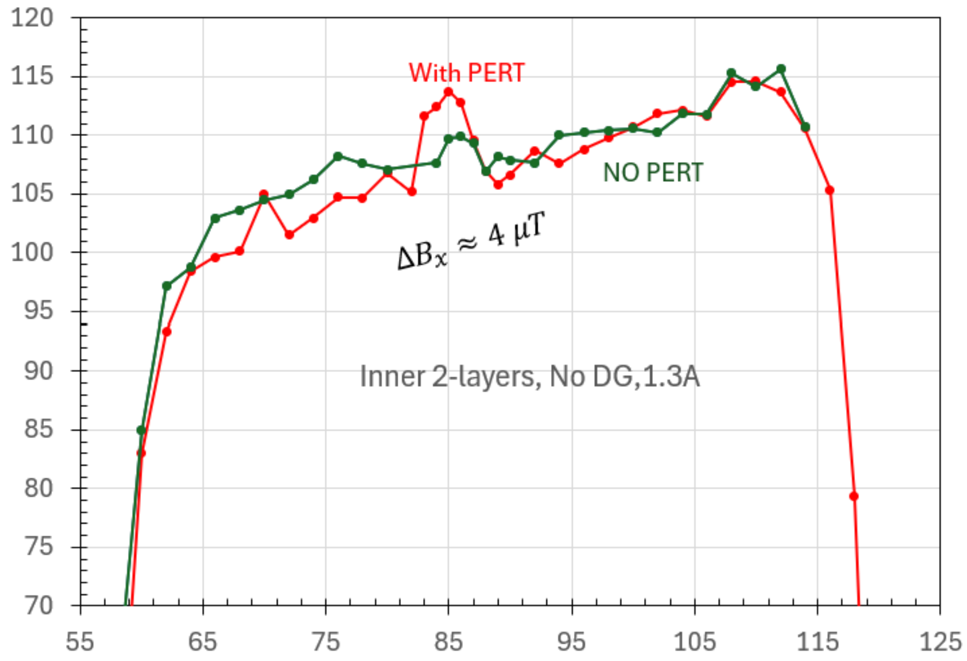
1 Based on z-scan

1a



Magnetometer z-position, inch

1b

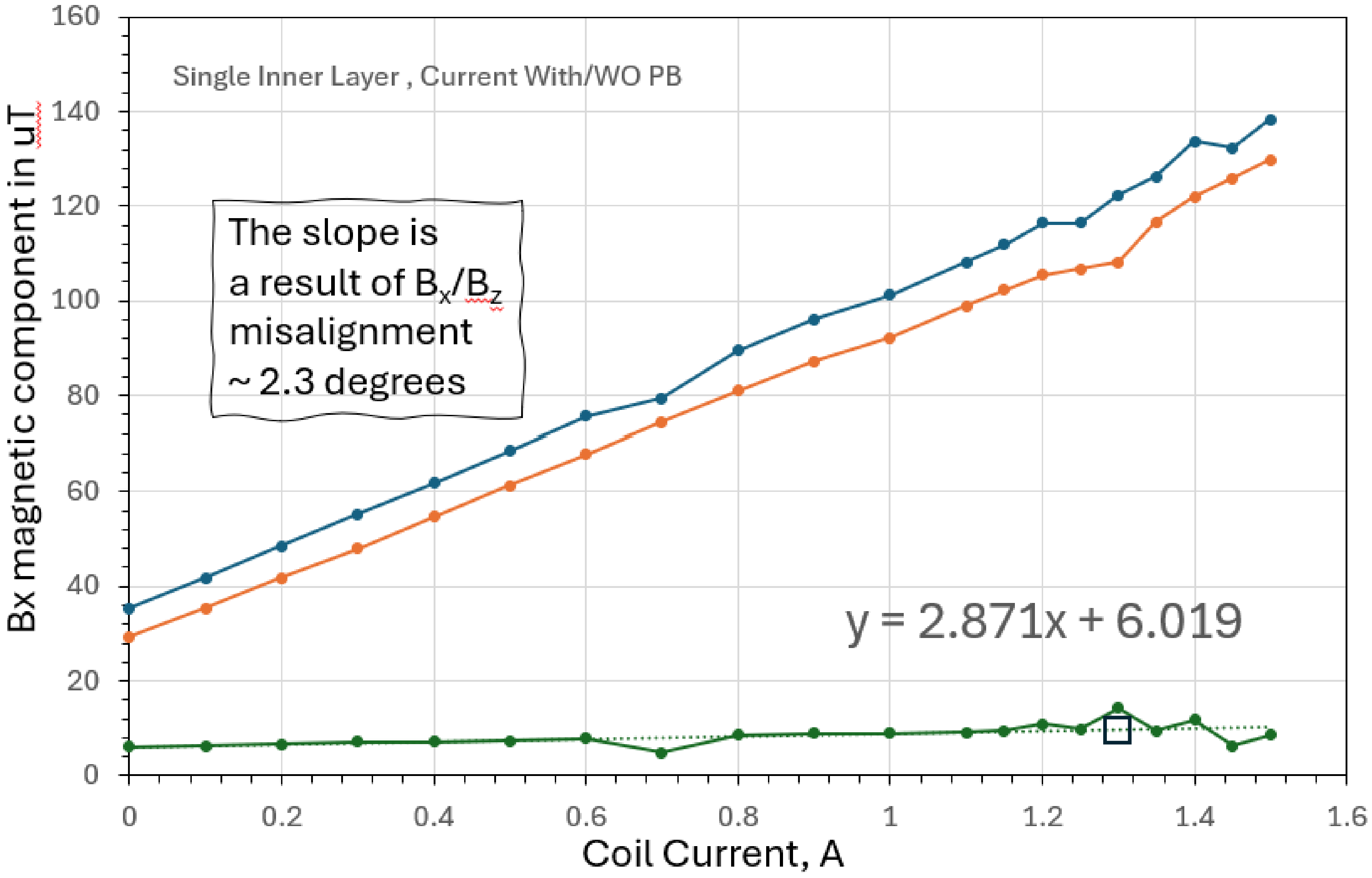


Magnetometer z-position, inch

- Slope due to temperature distribution along the tube
- With Air flow present

2

Magnetometer z-positioned at the peak of perturbation.
Thermal equilibrium reached with Air flow at coil current 1.3 A
Quick variation of coil current from 0 A to 1.5 A with and without PERT.
Perturbation signal is measured at 1.3 A



Shielding factor at I=1.3 A
SF_1=524/9.75=**53.7**

Method 2 seems more reliable

Measurements of Shielding Factor with perturbation 5.24 G with coil current 1.3 A

Inner shield	SF	SF	SF
1 layer 0.3 mm	53.7 (2)	40.3 (2)	
2 layers × 0.3 mm	262 (2)	62 (1a)	131 (1b)
Outer shield	SF	SF	SF
1 layer 0.3 mm	<DG	>DG	>3 days
	29 (2)	28(2)	121 (1)
2 layers × 0.3 mm	Not visible		
	> 50 (2)		

- No reproducibility of measurements
- $\pm$ effect of degaussing not understood
- Effect of temperature variation
- Effect of drift

Combining shielding factor of inner and outer layers

Gubser's formula

Single Layer Equation

$$S_i^T = \frac{\mu_i t_i}{2R_i}$$

Dual Layer Equation

$$S_i^T = S_1 + S_2 + (S_1 * S_2) * \left(1 - \left(\frac{R_1}{R_2}\right)^2\right)$$

Multi-Layer General Formula

$$S = 1 + \sum_{i=1}^{n} S_i^T + \sum_{i=1}^{n-1}\sum_{j>i}^{n} S_i^T S_j^T \left[1 - \left(\frac{R_i}{R_j}\right)^2\right] + \sum_{i=1}^{n-2}\sum_{j>i}^{n-1}\sum_{k>j}^{n} S_i^T S_j^T \left[1 - \left(\frac{R_i}{R_j}\right)^2\right] \ldots\ldots$$

S_i: Shielding Factor for layer i. Where 1 is the innermost layer.

μ: Material permeability

t: Material thickness

R: Inside Radius

Let's take conservatively

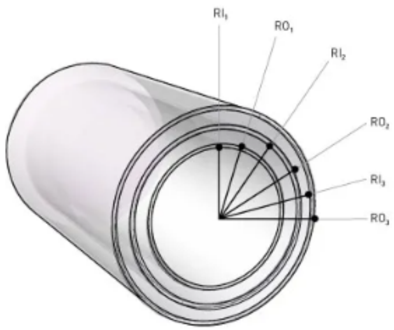
$$S_1 = SF_i = 60$$

$$S_2 = SF_O = 30$$

$$SF_T = 650$$

This shielding factor should be meeting nTMM requirements of field uniformity < 0.01 G

FORMULAS & CALCULATIONS



The attenuation requirements of your specific applications drive the final design of a shield. With a given geometry, we are able to increase the performance of a shield by increasing the thickness of the material. However, if your application requires a more robust shield you can drastically increase your shielding performance by adding additional layers to your shield while maintaining an air gap between each layer.

The following formulas can help you calculate single, dual, and triple-layer shield designs. It is important to note that the value for the permeability of a material used for the purposes of a calculation depends on material composition, shield geometry, and field intensity. Our experienced technical staff is a resource and generous collaborator available to work through these design calculations with you.

Single Layer Equation

$$S_i^T = \frac{\mu_i t_i}{2R_i}$$

Dual Layer Equation

$$S_i^T = S_1 + S_2 + (S_1 * S_2) * \left(1 - \left(\frac{R_1}{R_2}\right)^2\right)$$

Multi-Layer General Formula

$$S = 1 + \sum_{i=1}^{n} S_i^T + \sum_{i=1}^{n-1} \sum_{j>i}^{n} S_i^T S_j^T \left[1 - \left(\frac{R_i}{R_j}\right)^2\right] + \sum_{i=1}^{n-2} \sum_{j>i}^{n-1} \sum_{k>j}^{n} S_i^T S_j^T \left[1 - \left(\frac{R_i}{R_j}\right)^2\right] \ldots \ldots$$

S_i: Shielding Factor for layer i. Where 1 is the innermost layer.

μ: Material permeability

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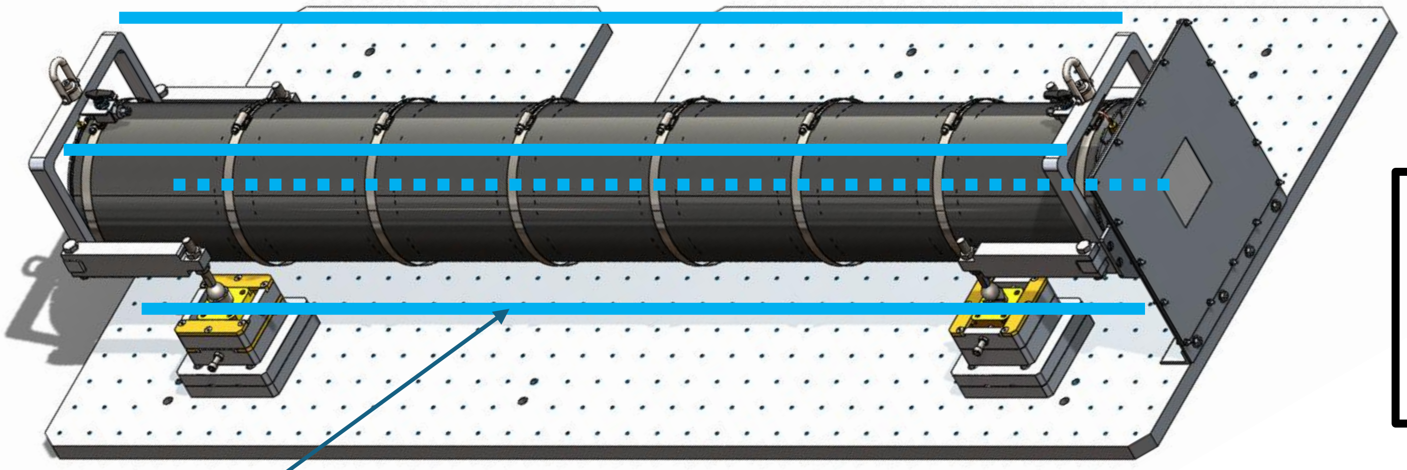
R: Inside Radius

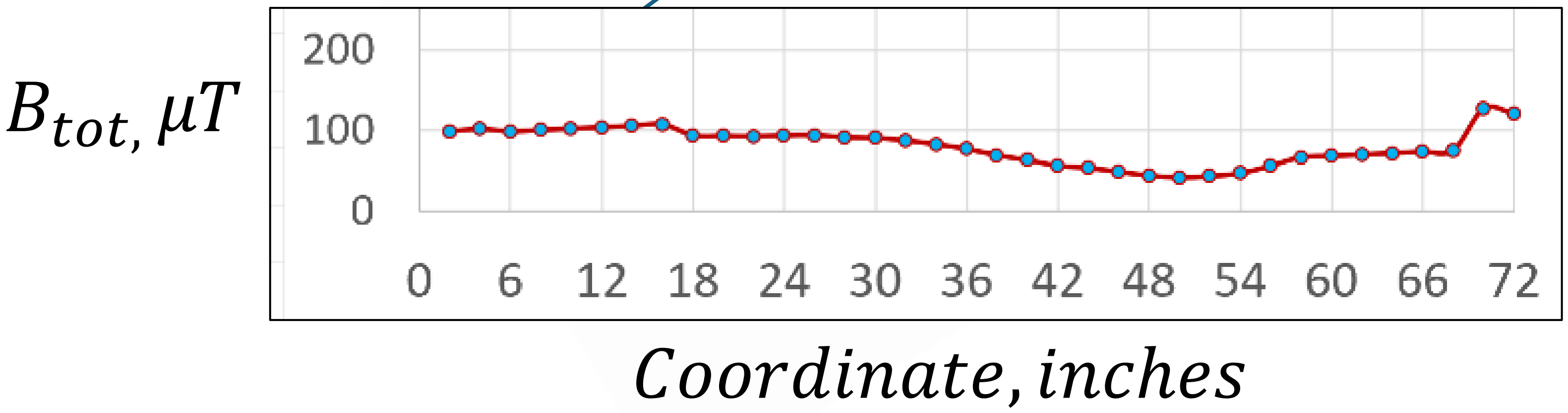
June 9, 2025

Magnetic Field measurement performed around the magnet with Android S23 U Phone

Magnet 1 Box 7



These measurements were performed without current in the coil and without outer mu-shield



3-D point every
2” along the beam axis

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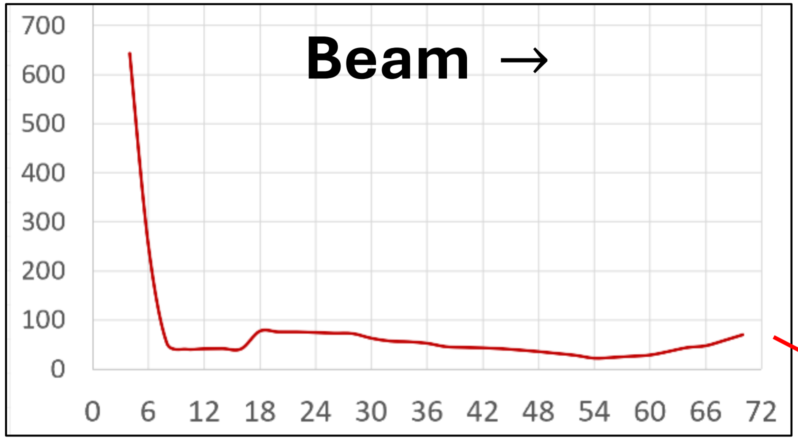
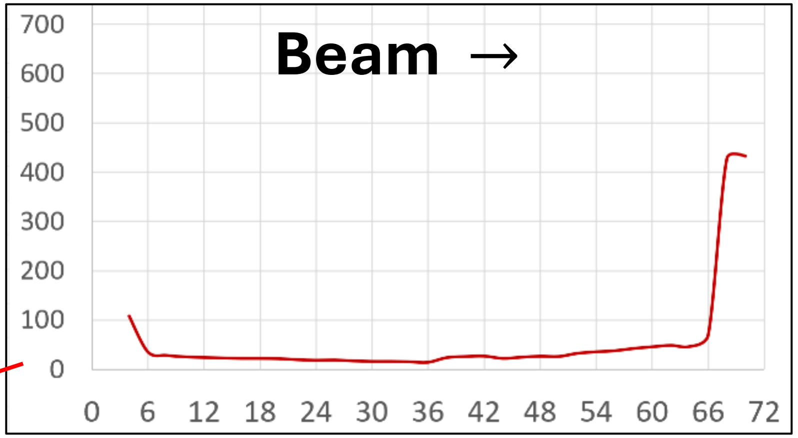
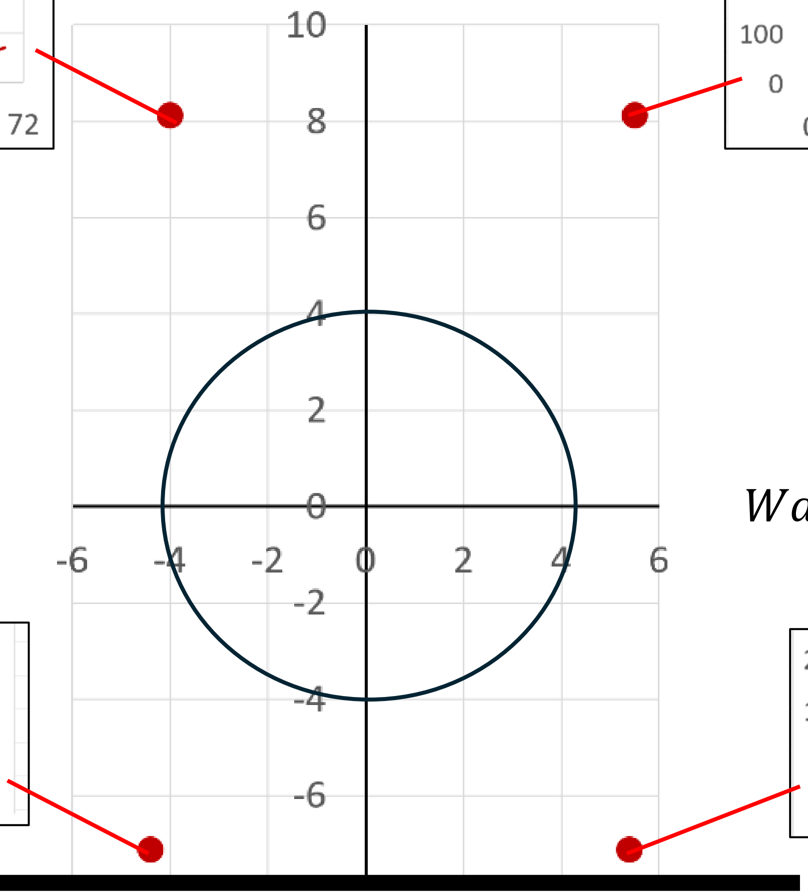
B(total) in μT

Magnet 1(7)

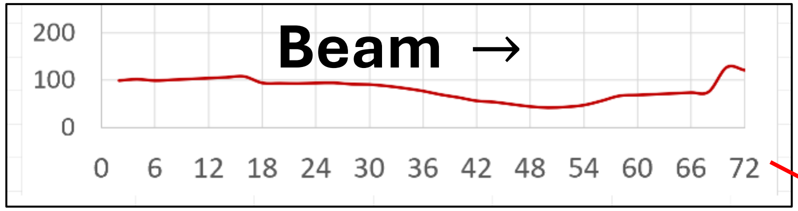


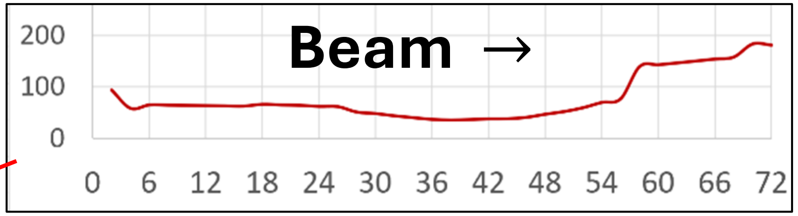


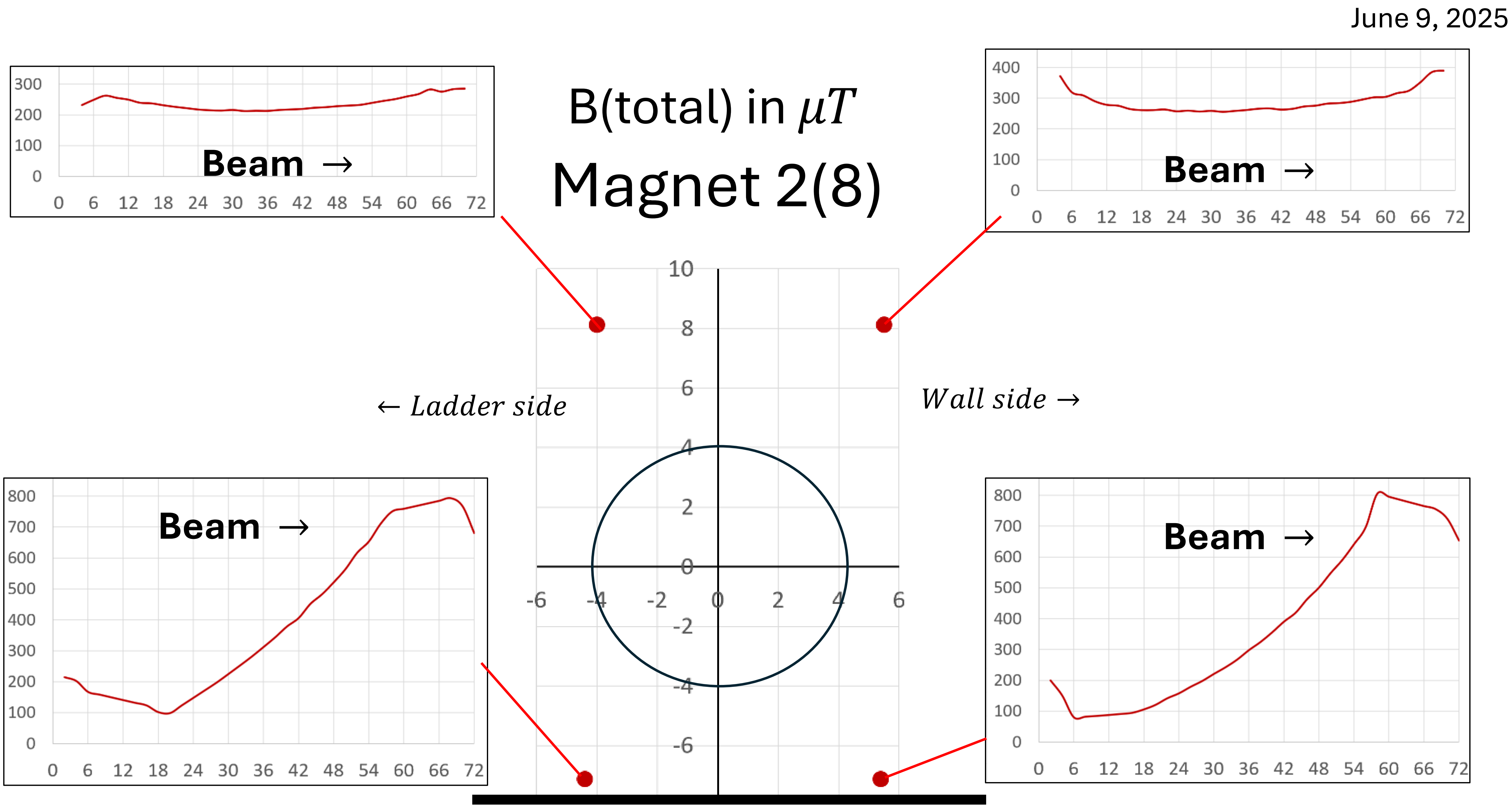
← Ladder side



Wall side →





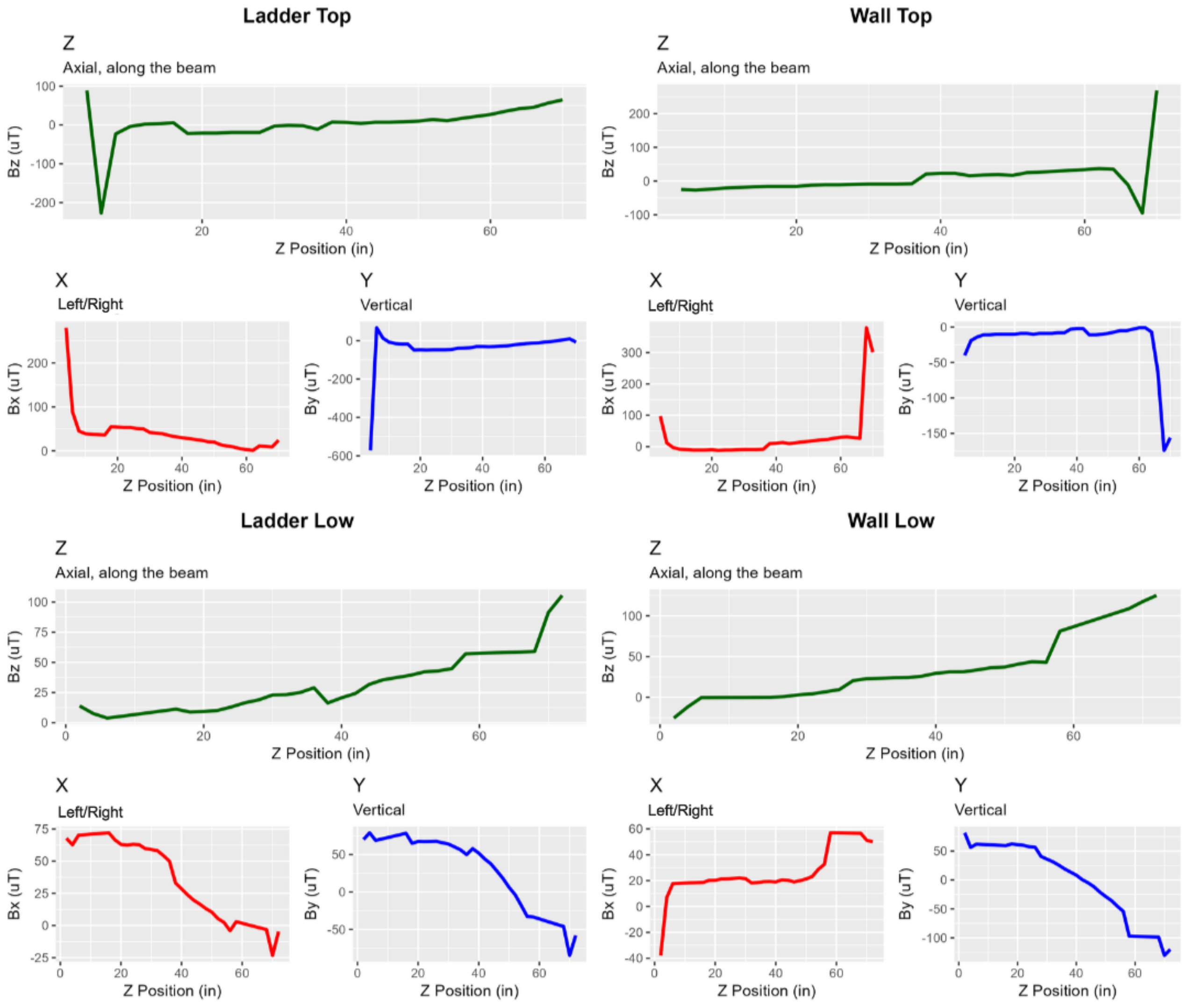


June 9, 2025
B(total) in μT
Magnet 2(8)
← Ladder side
Wall side →
Beam →
Beam →
Beam →
Beam →
0 6 12 18 24 30 36 42 48 54 60 66 72
0 100 200 300
0 100 200 300 400
0 100 200 300 400 500 600 700 800
10 8 6 4 2 0 -2 -4 -6
-6 -4 -2 0 2 4 6

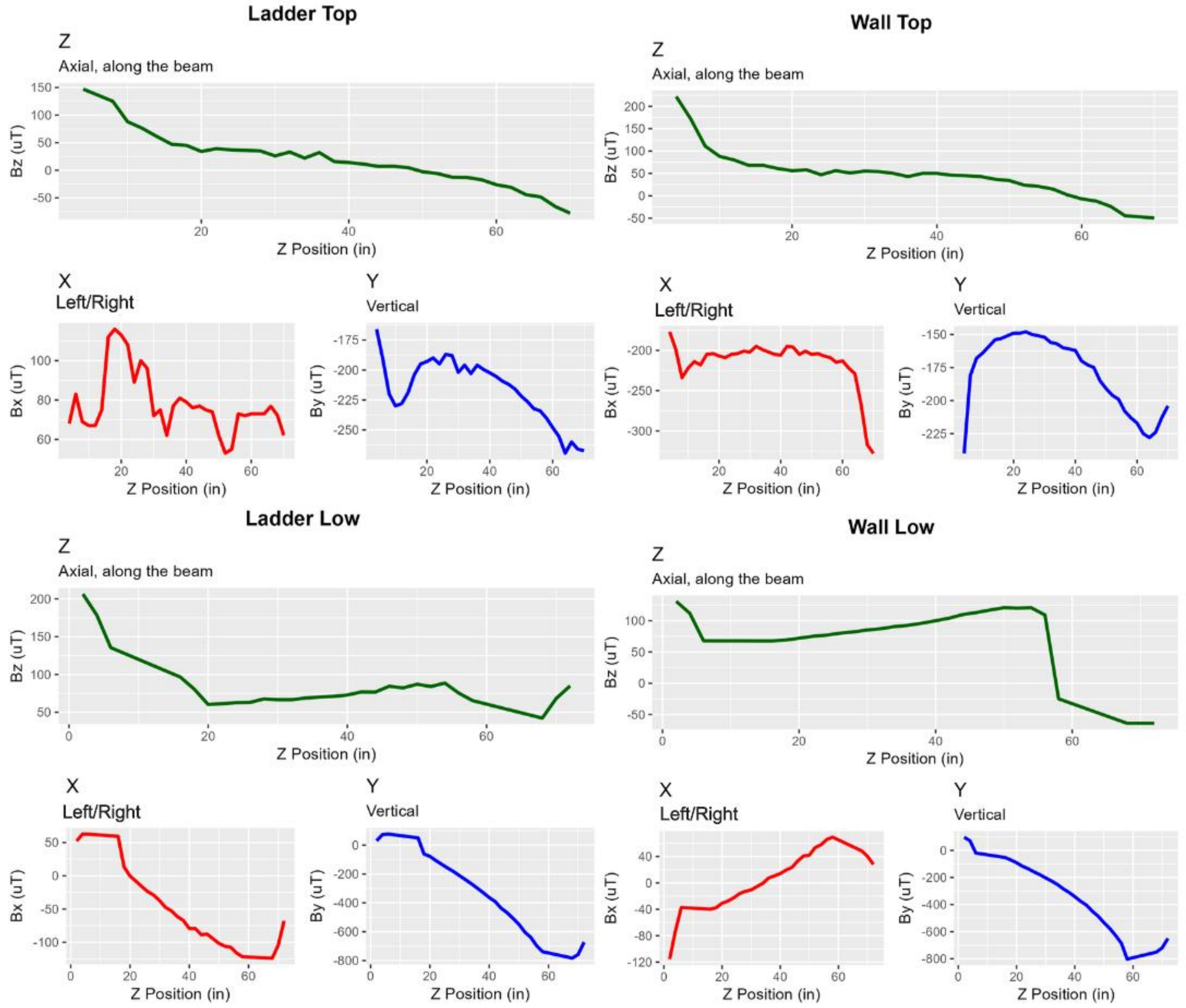
June 9, 2025

Field Component Plots from measurement tables

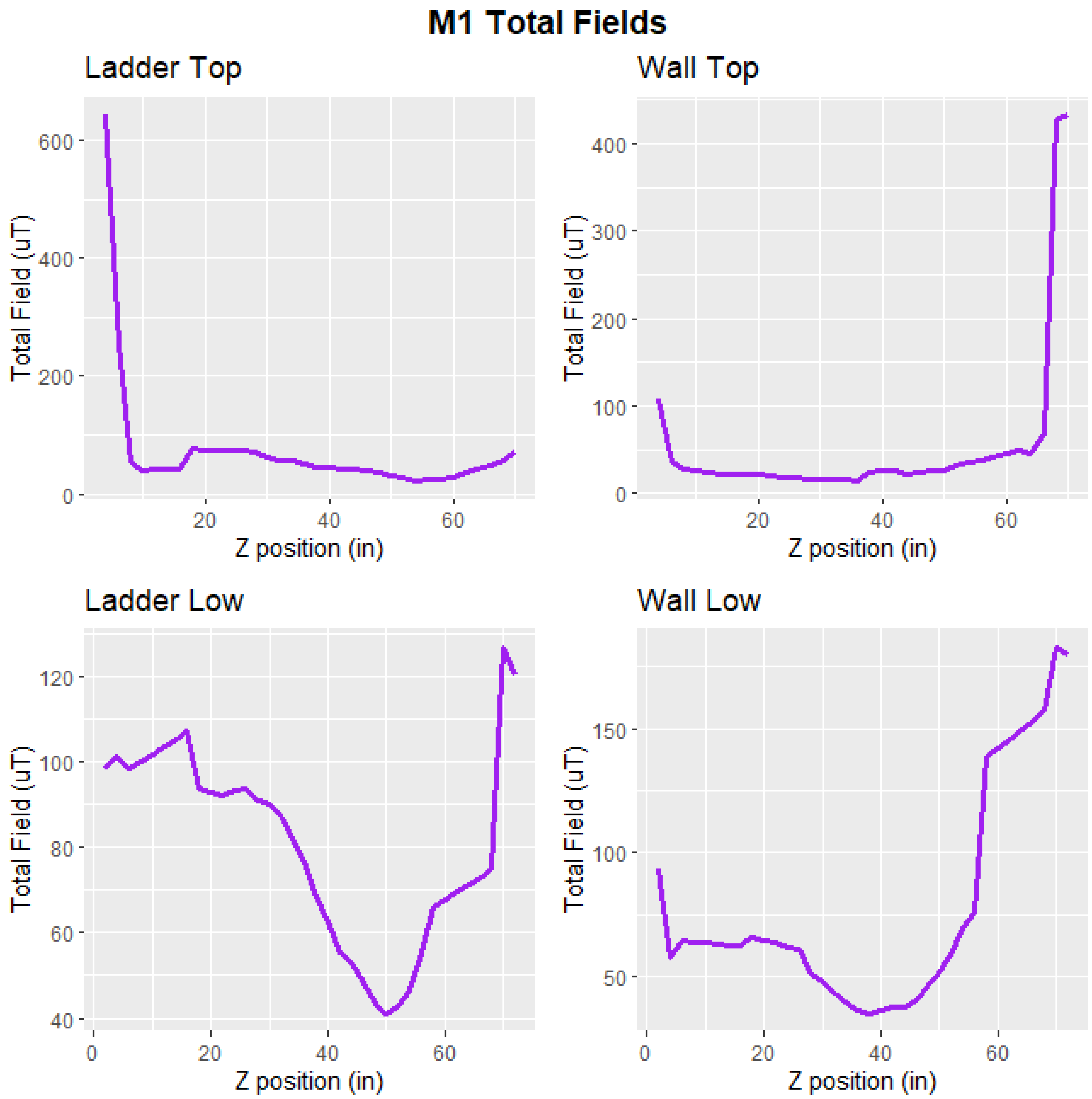
M1 (Guide 7)

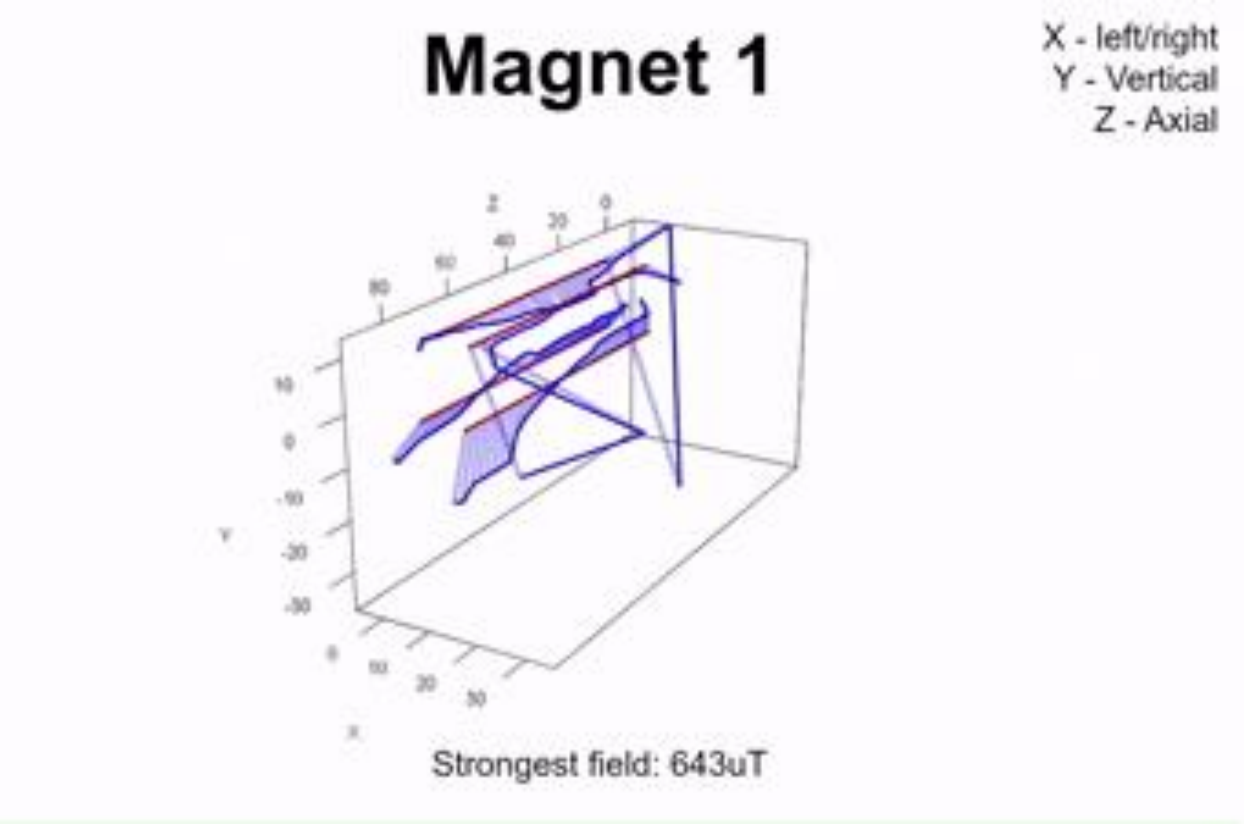


M2 (Guide 8)



Alina Moore



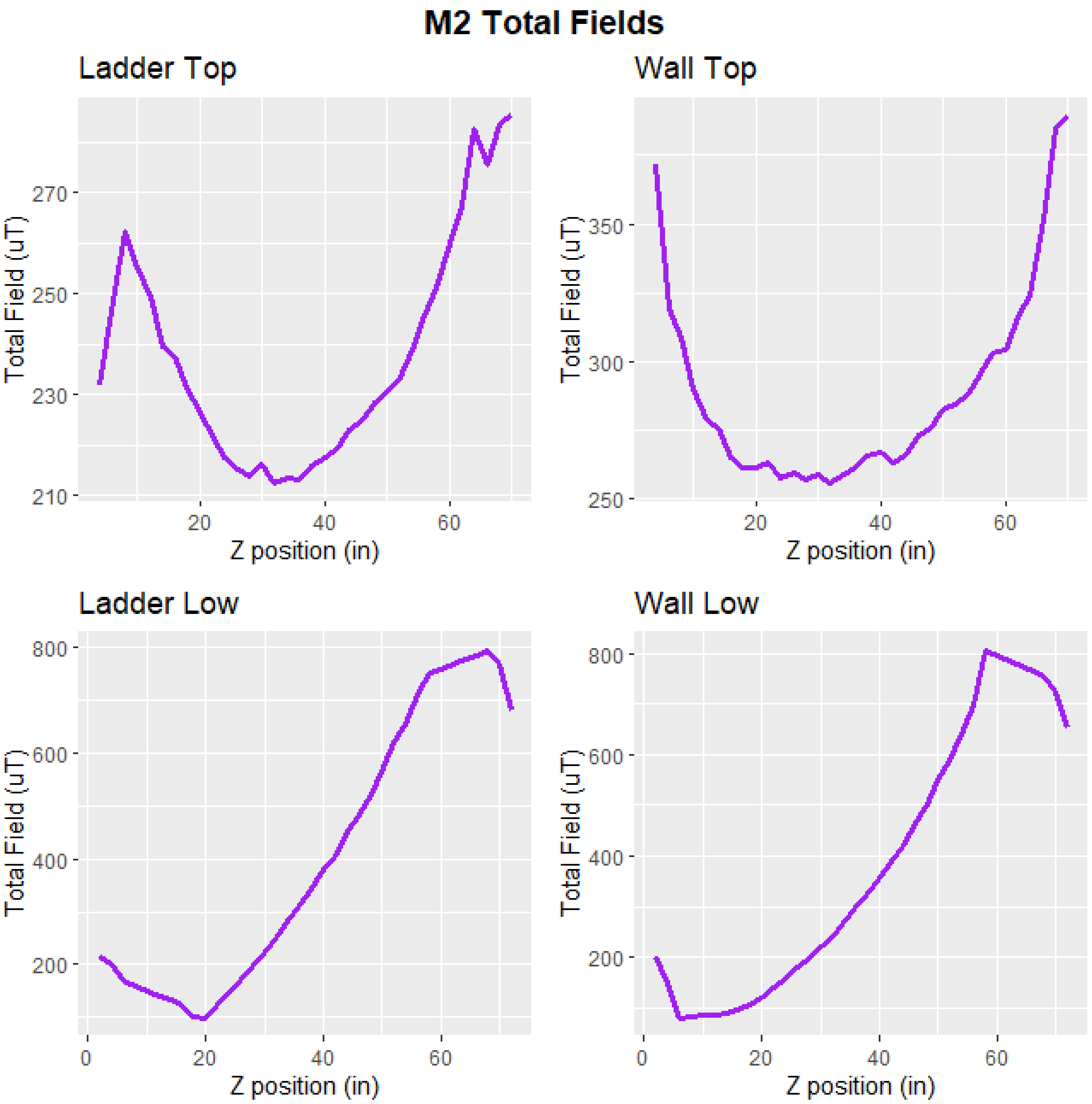


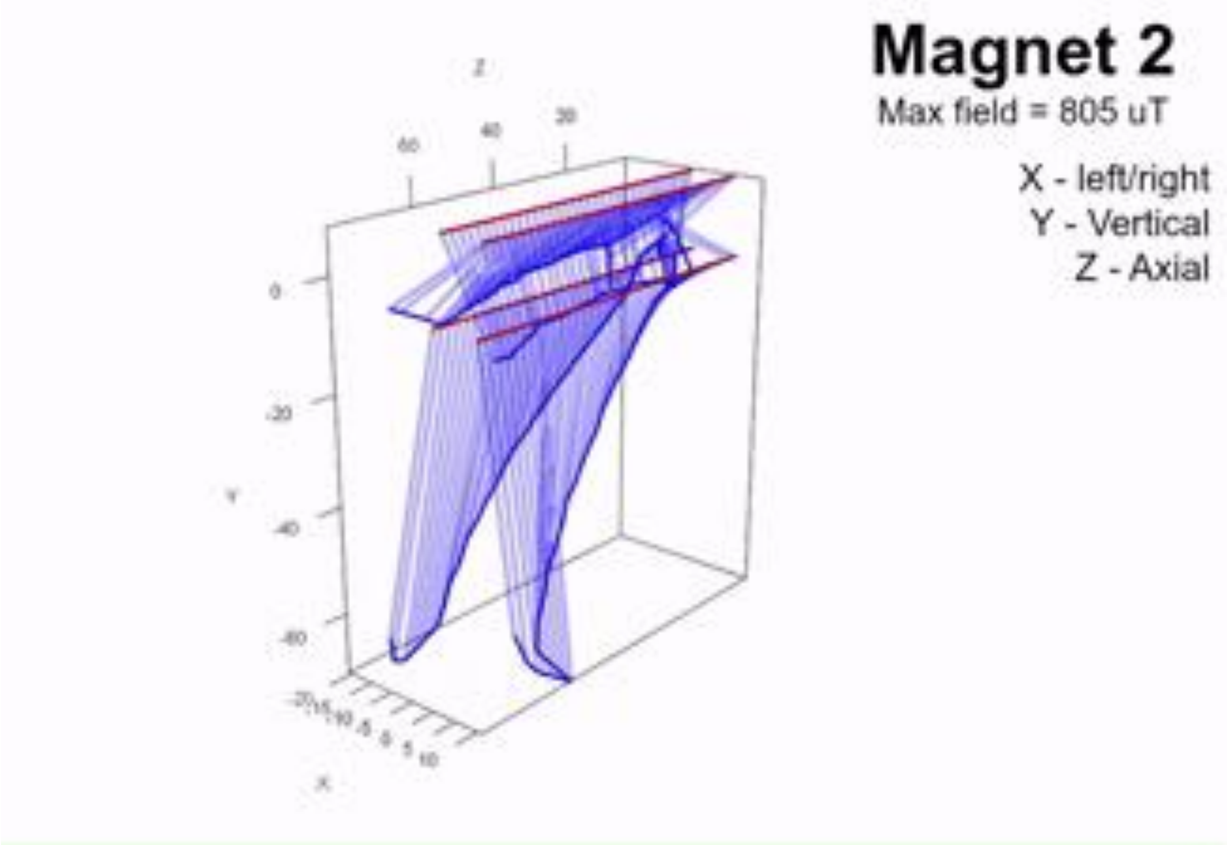
Gif causes lower quality, see download links for mp4 and interactive versions

Scaling factor for visibility = 0.08

Alina Moore

June 9, 2025





Scaling factor for visibility = 0.08

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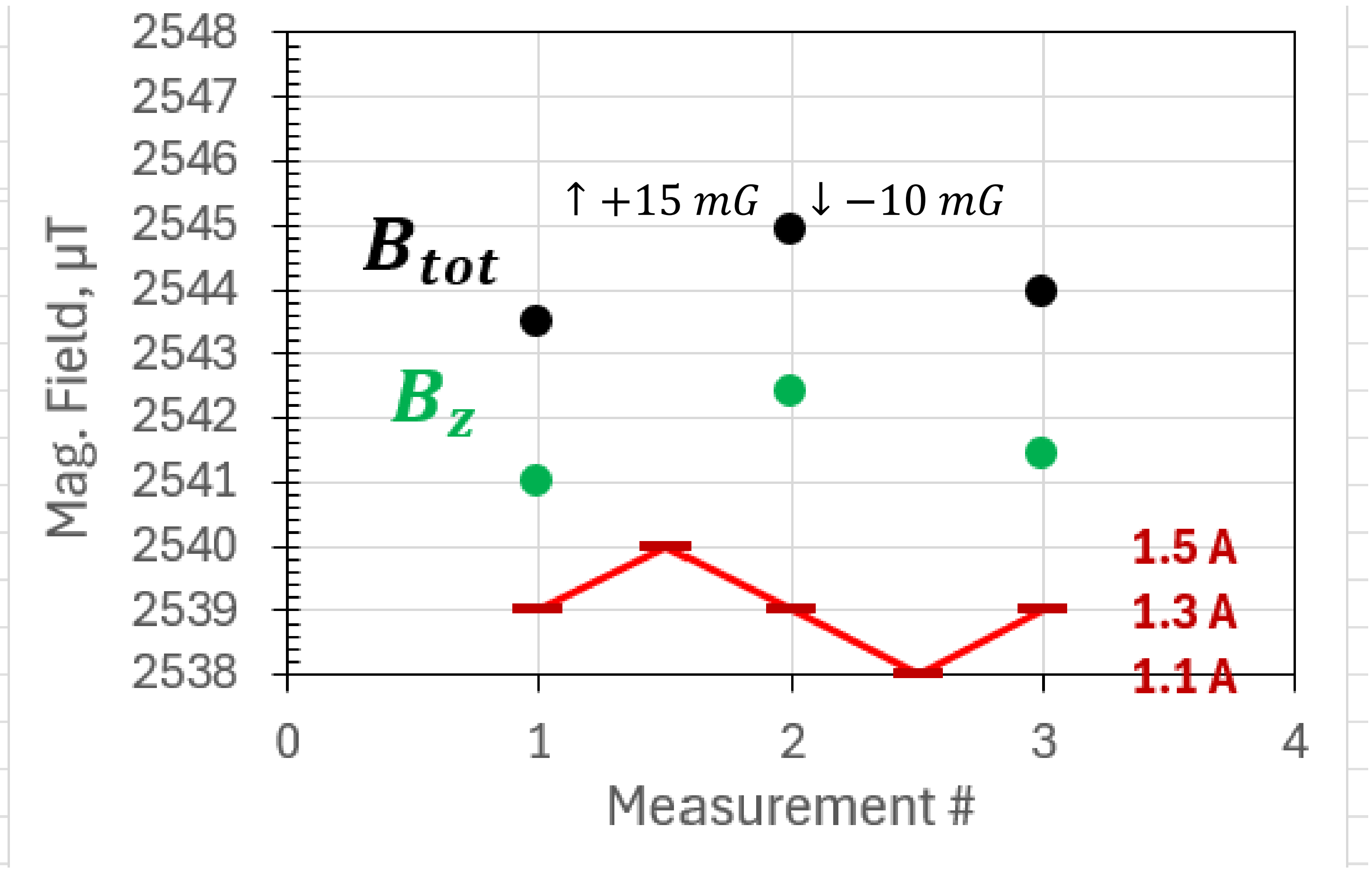
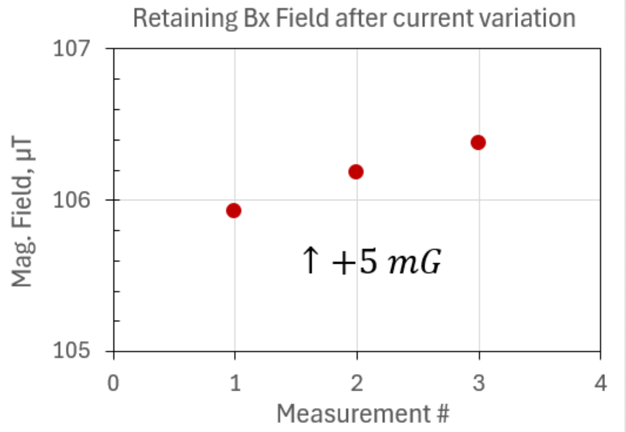
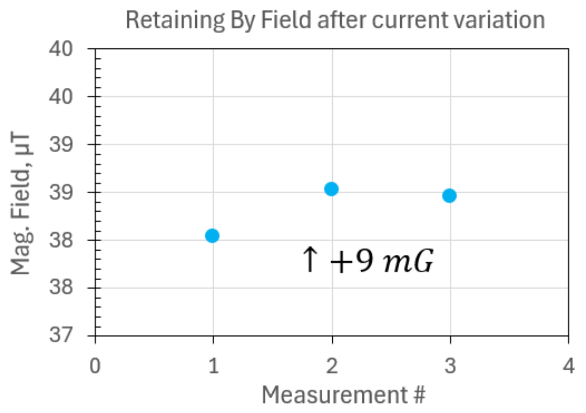
Retaining Field after current variation
Two inner mu shields, I=1.3 A

June 24, 2026

(measured with Chinese power supply. Should be repeated with TDK)







Planning following work

- Find final consistent shielding factors for inner and outer shielding layers in mu-prototype (should be done with coil current 1.3 A and with degaussing in the presence of perturbation)

- Tune μ values in inner and outer layers with COMSOL to match prototype SF values (Mubi)

- With tuned μ for nTMM layout calculate total shielded magnetic field without/with perturbation (Mubi)

- Study stability of magnetic field in the μ- prototype during 4 days of continuous running.

- Study with μ- prototype the effect of outer shielding discontinuity at the ends of magnets

- …