June 30, 2026 – nn' zoom meeting

Current work with $\mu -$ prototype at UT

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Goals of μ Prototype for nTMM experiment

- Confirm that in nTMM experiment the magnetic shielding is sufficient for obtaining adjustable UNIFORM magnetic field in both magnets in the presence of external perturbations

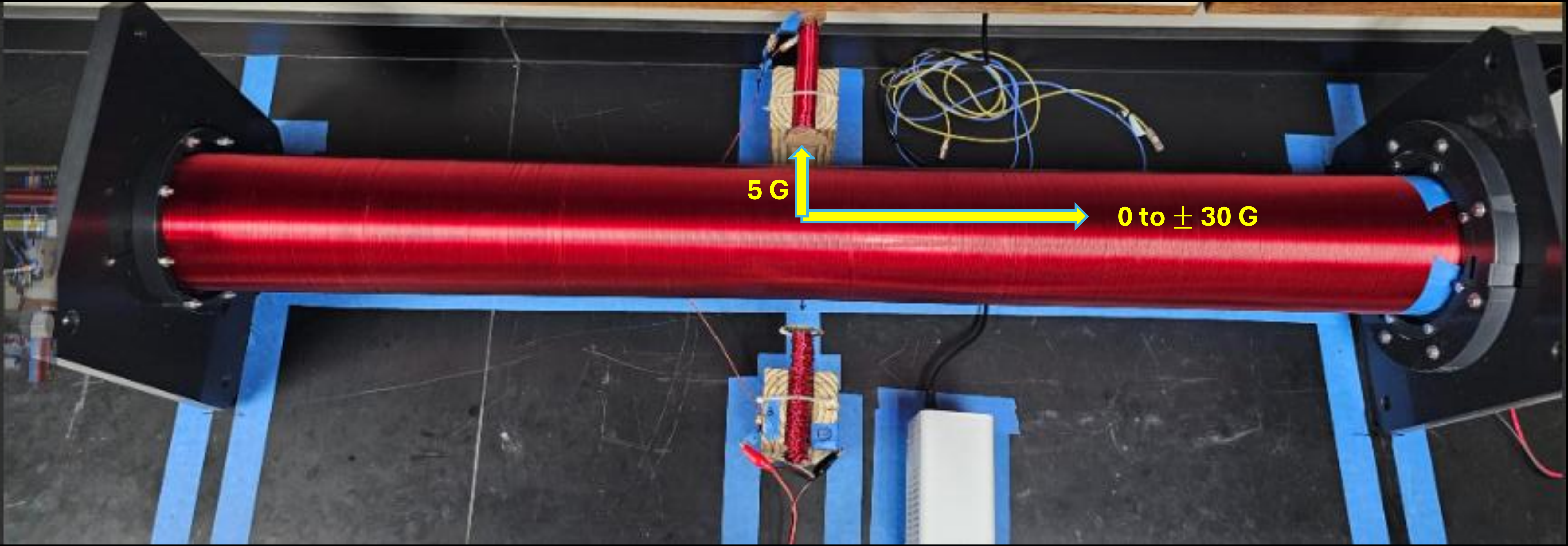
- Width of nTMM resonance peak (@ 1.3 atm $CO_2 \approx$ 26 Gauss) is ~ 0.15 Gauss; field scanning step is 0.04 Gauss.
  Goal of variation of uniformity under perturbation is 0.01 Gauss

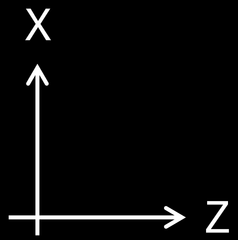
- Thus, max perturbation at GP-SANS 6 Gauss should be shielded with shielding factor S.F. ~ 600

- Lower SF will imply corrections lowering the sensitivity of nTMM

- Effective SF in nTMM can be function of solenoidal field due to saturation of the flux in mu-metal of internal shield. This is focus of prototype tests.

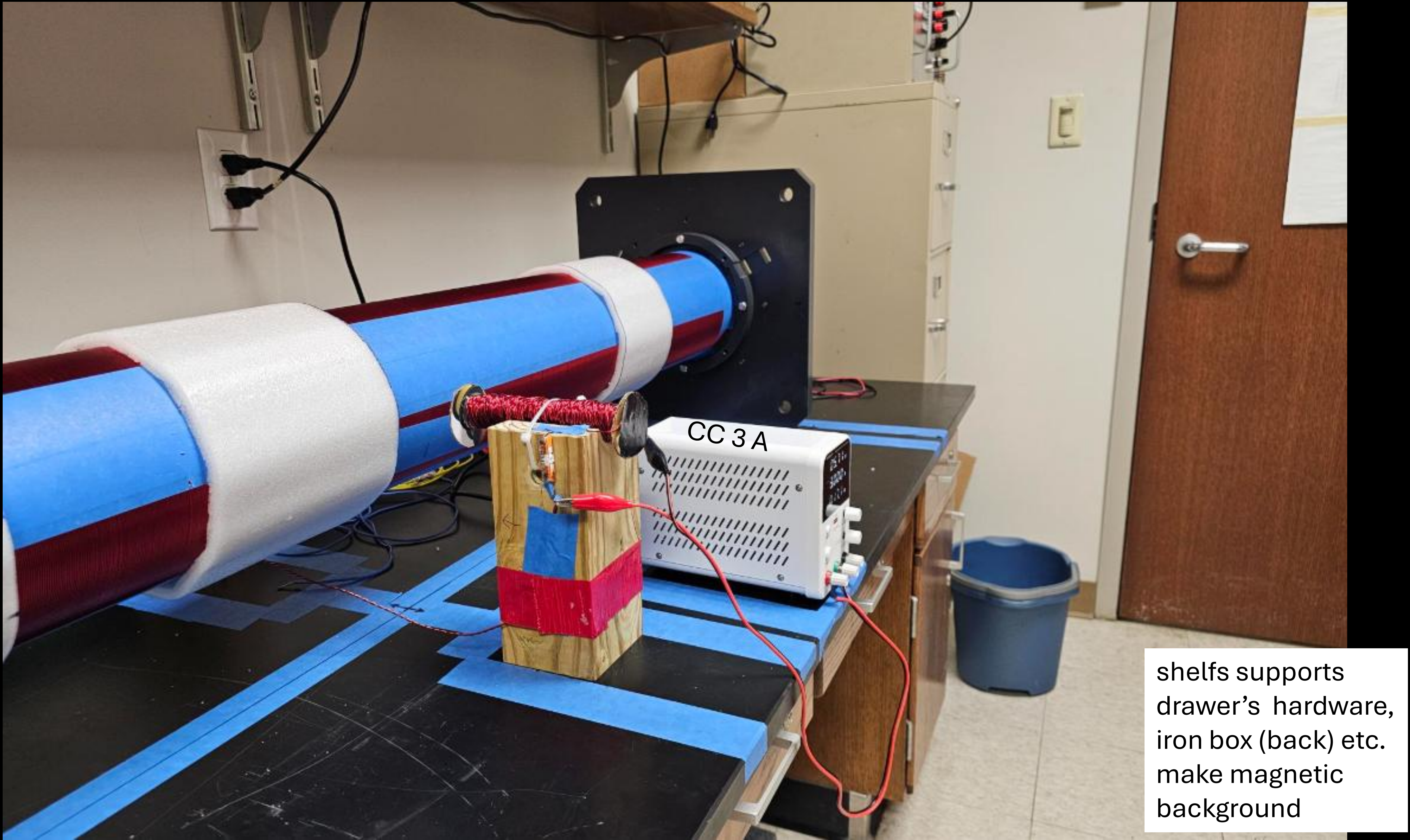
length 60” , 2 layers coil diameter 6.5”, AWG 18 wire with winding step 1.1 mm

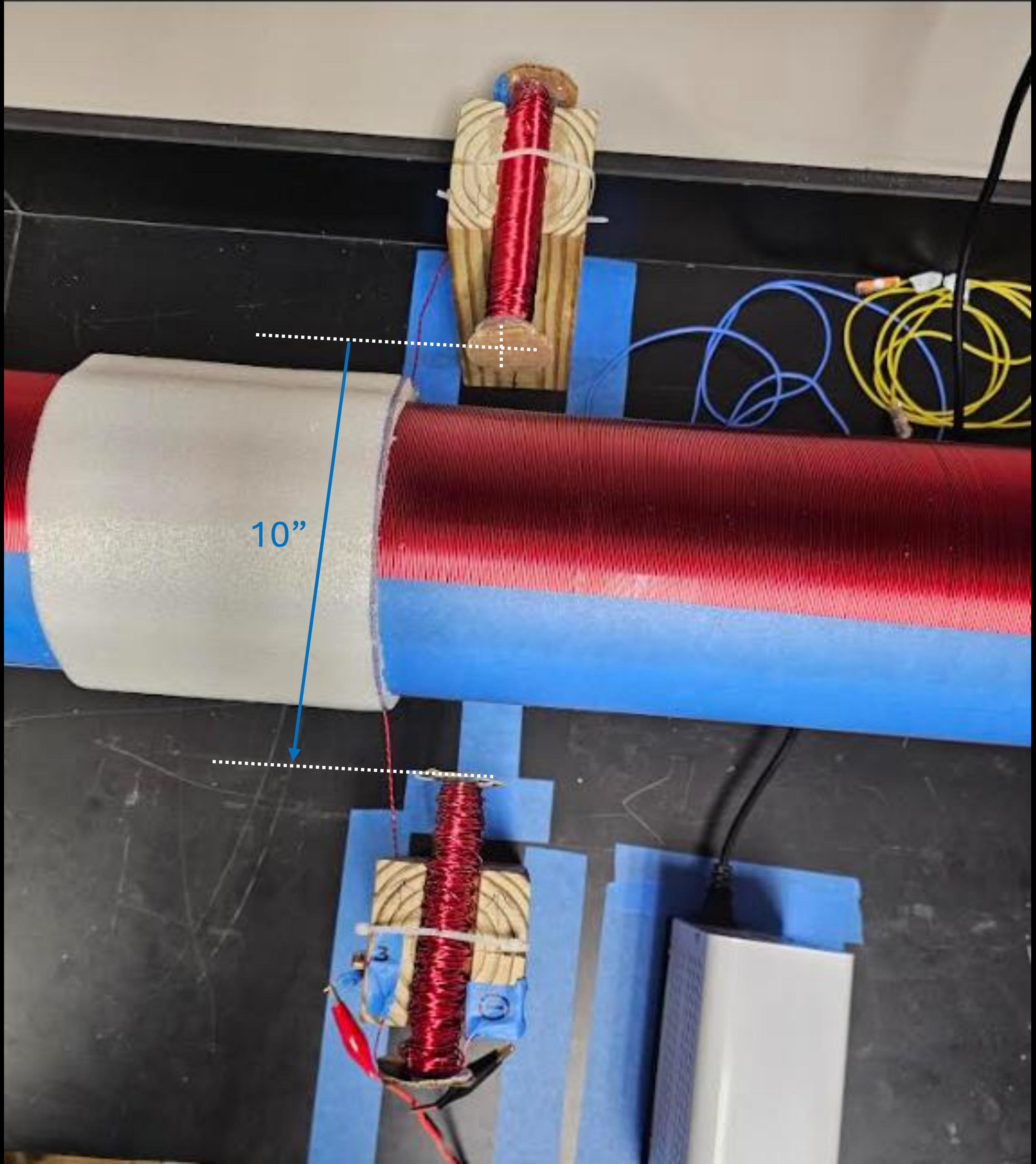




Solenoidal field Bz up to 30 Gauss with coil current 1.5 A

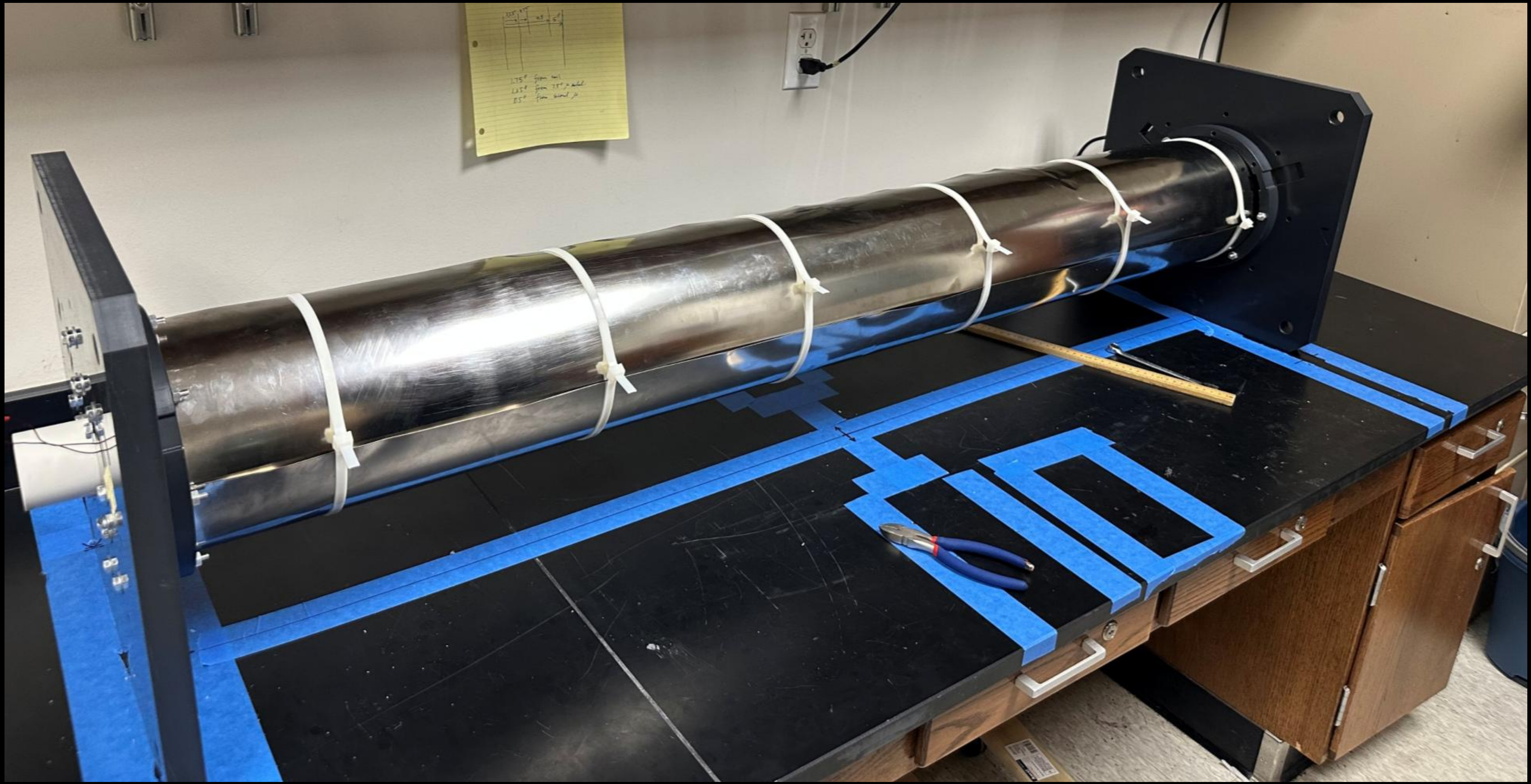
Transversal perturbation field Bx ~ 5 Gauss for current 3A


CC 3 A
shelfs supports drawer’s hardware, iron box (back) etc. make magnetic background

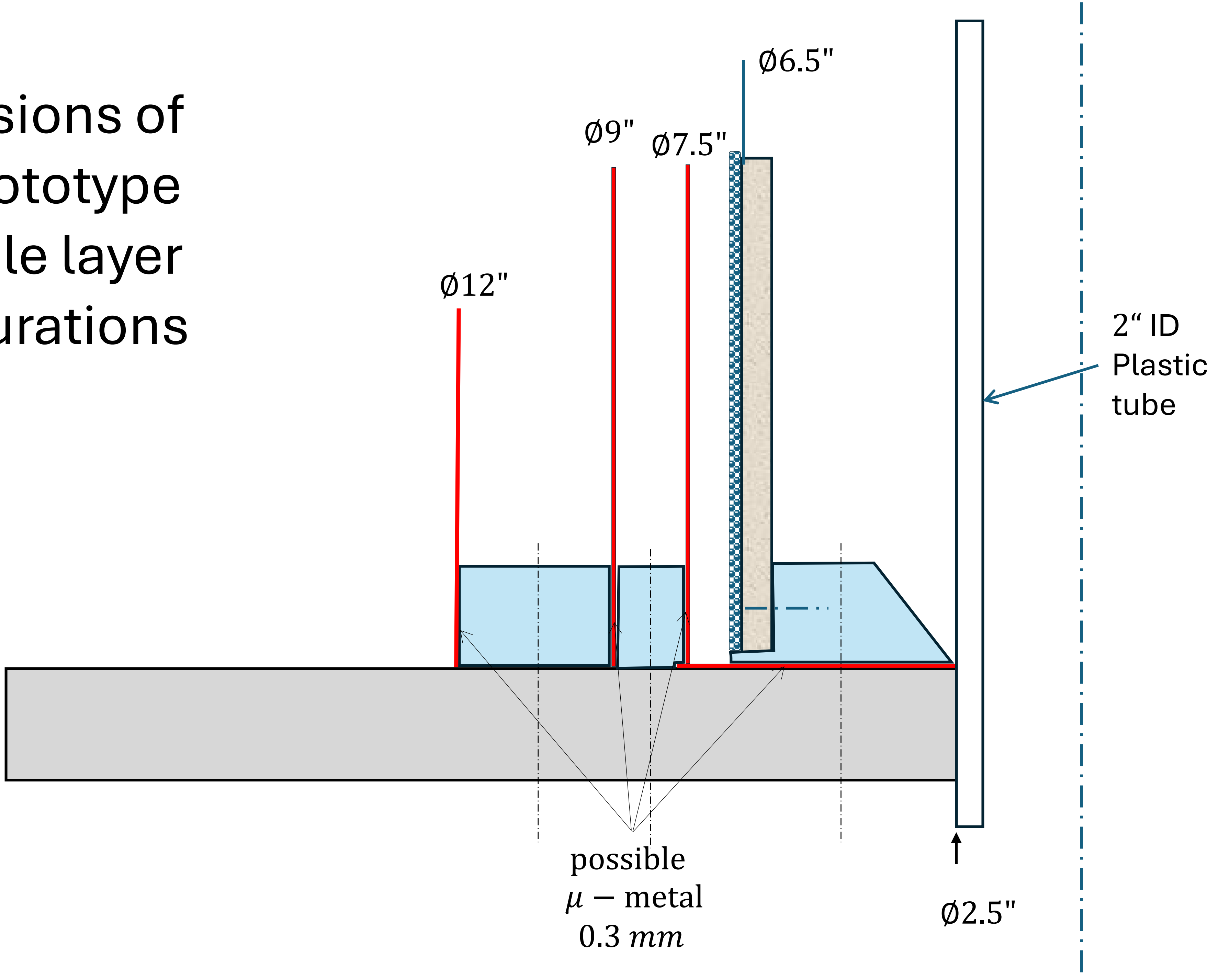


Distance between perturbation magnets is fixed at 10”

First inner mu-shield 0.3 mm foil, diameter 7.5” , made of 3 overlapped bended sheets 12” x 60”
One sheet has a degaussing 10-turns coil.

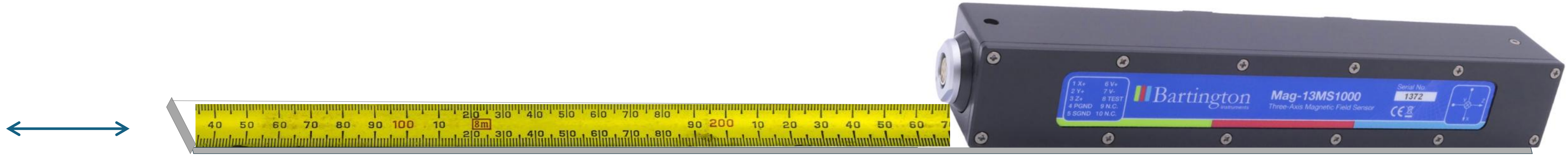


Dimensions of mu-prototype possible layer configurations



Bartington Flux-gate 3D sensor with Spectromag-6 DAQ system

Mag-13MS1000 with range $\pm 1000\mu T$ ($\pm$10 Gauss)



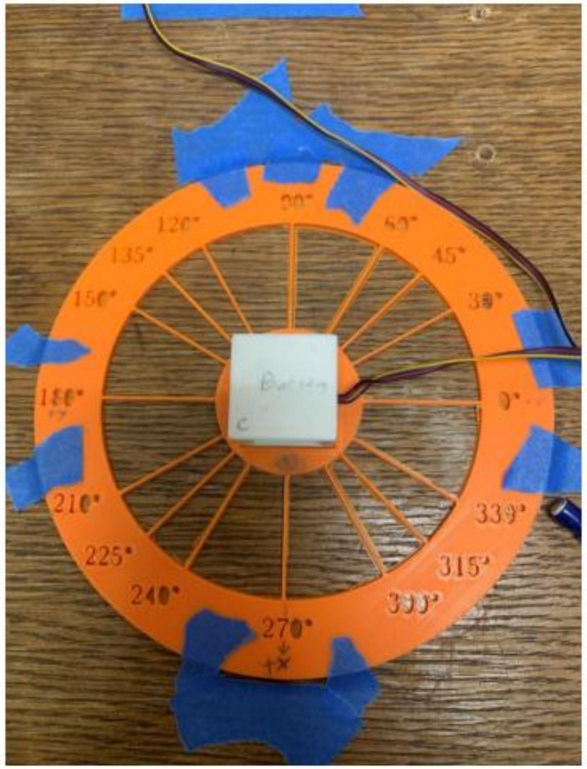
Aluminum bar~ 70” long

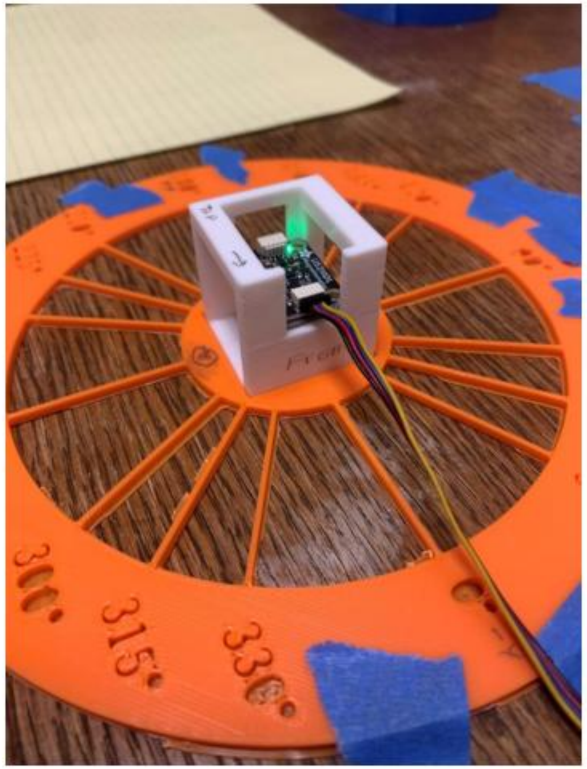
1.25” x 1.25” x 6”

Limitations: Short range of measurement <10 G, distortion of B-readings if one of sensors is saturated

Alternative chip magnetometer LIS2MDL with range ±50 Gauss

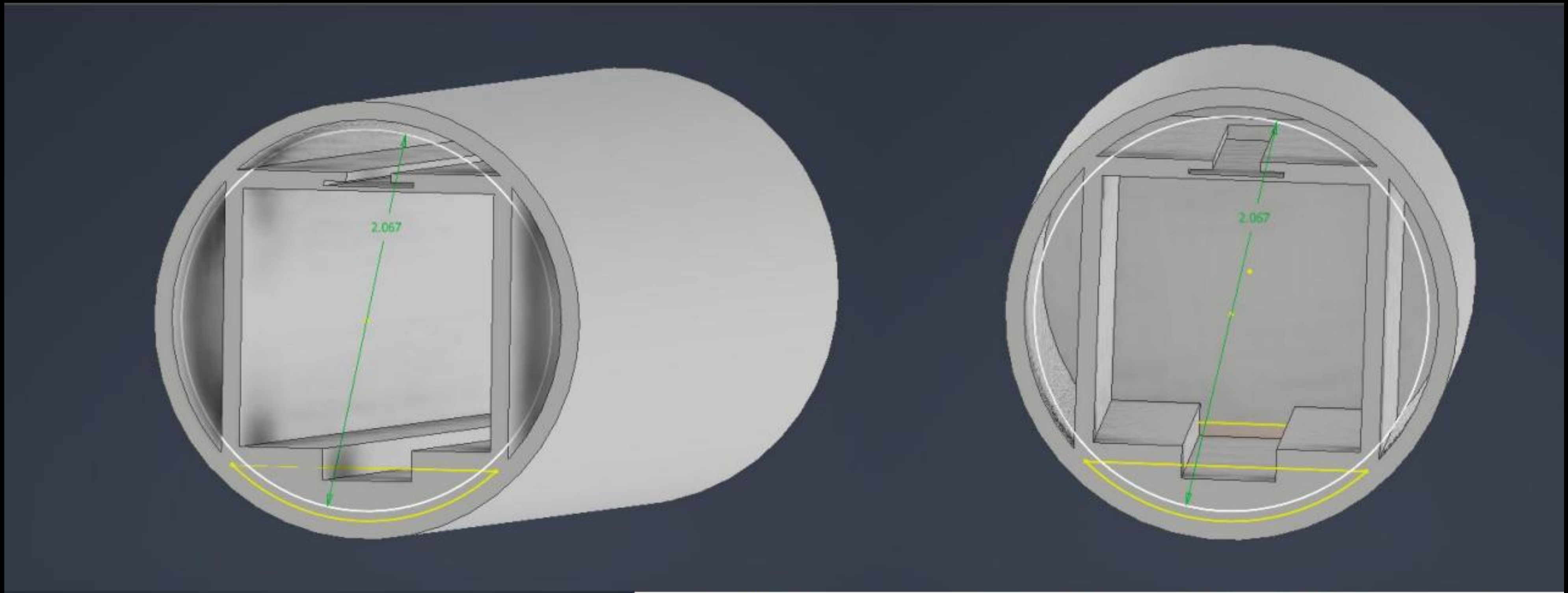
Challenges: in control of alignment (angle B_x/B_z). **Essential temperature dependence.** Introduced thermocouples and compressed air flow in the guide tube to maintain thermal equilibrium in field measurements.



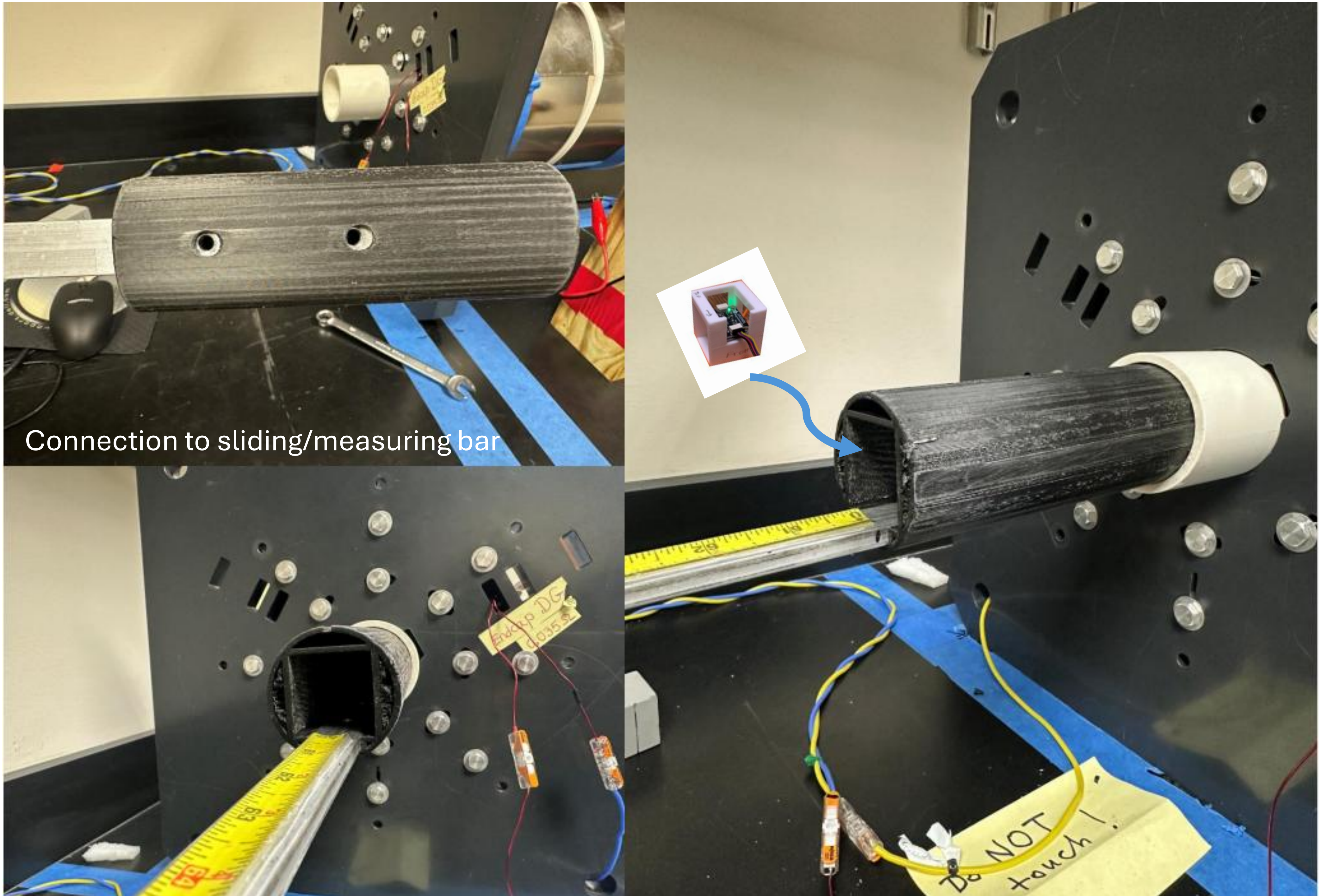


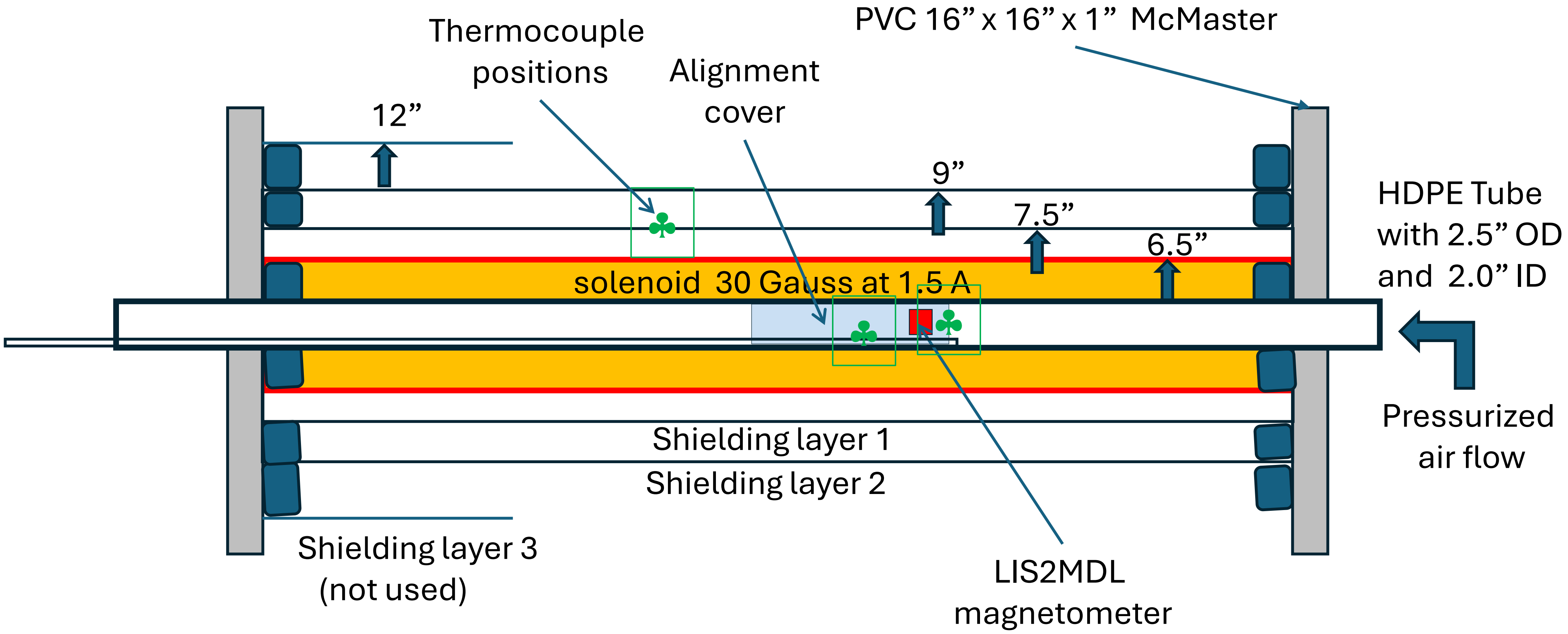
LIS2MDL inside the box with the side 1.25”

3D printed magnetometer holder improves reproducibility of magnetometer reading inside the guide tube. The gadget can be used both for Bartington and for LIS2MDL chip positioning.



- Cylindrical with minimal tolerance to prevent freedom of movement, slots into current PVC tube
- Slot for Bartington MAG, cut-out for metal guidance rod (need to add slot for screws on bottom of rod)
- Groove on top of outer radius, will catch screws connected to current PVC tube and prevent rotation (to be implemented)
- Suggestions?
- Connor Cambria developing similar brace for his custom magnetometer to be used in future measurements

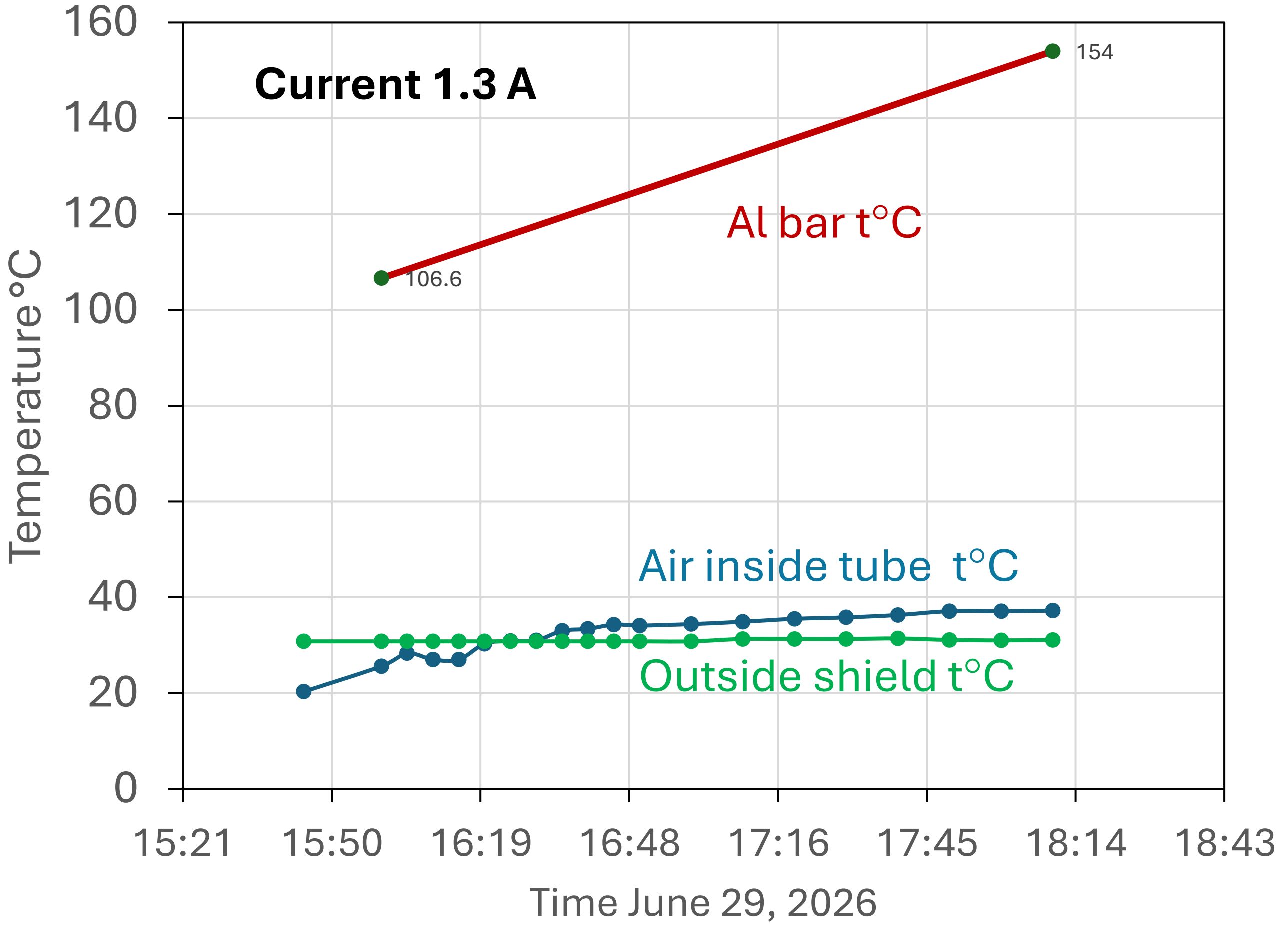

Connection to sliding/measuring bar
Do NOT touch!



Thermocouple
positions
Alignment
cover
PVC 16” x 16” x 1” McMaster
12”
9”
7.5”
6.5”
HDPE Tube
with 2.5” OD
and 2.0” ID
solenoid 30 Gauss at 1.5 A
Pressurized
air flow
Shielding layer 1
Shielding layer 2
Shielding layer 3
(not used)
LIS2MDL
magnetometer

Recent finding. At high coil currents, 1.3A (~ 26 G field) dissipated power is ~ 47 W. Inside the plastic measurement tube temperature can substantially increased

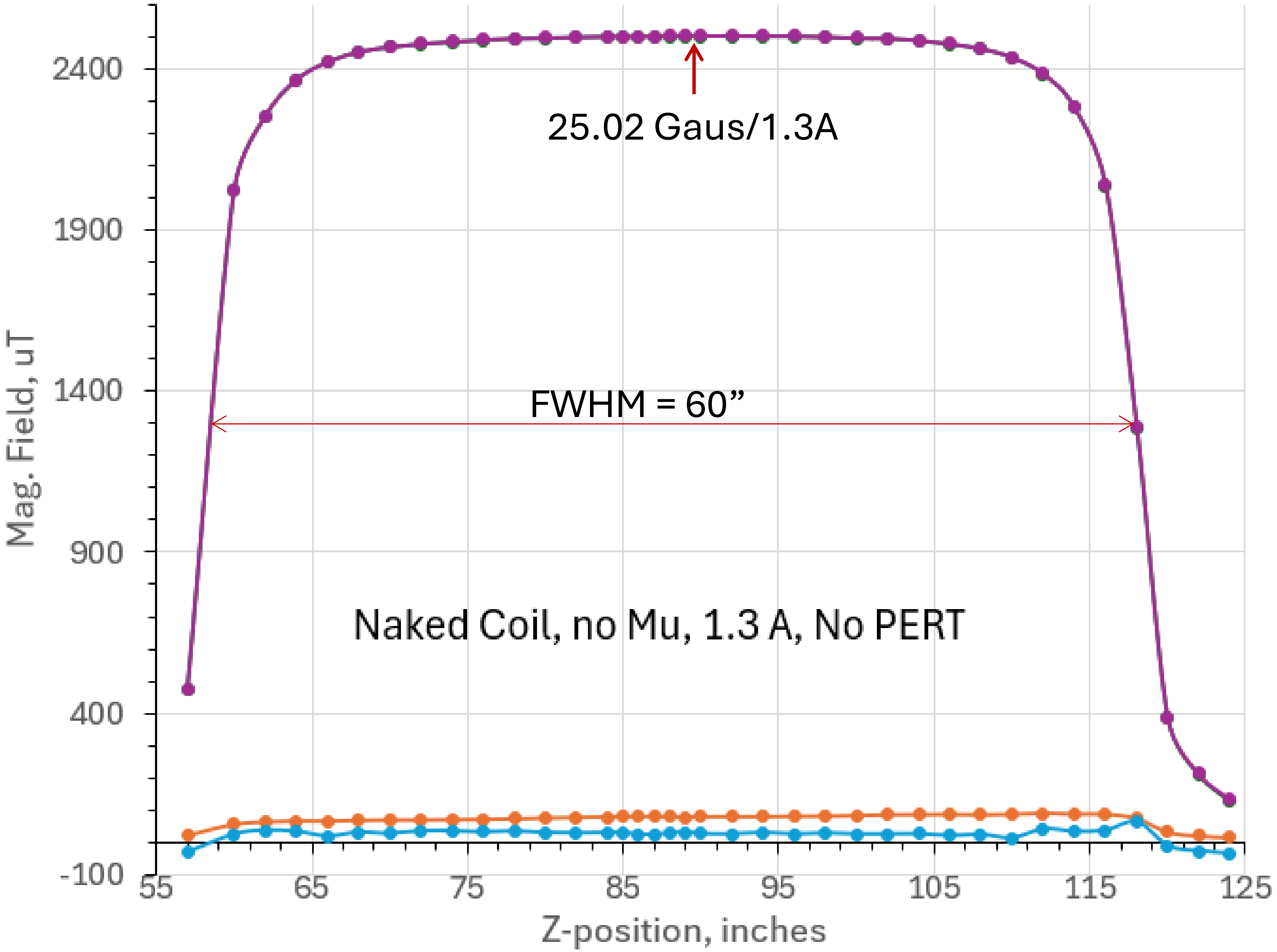
Configuration : inner mu-shielding is 0.6 mm, chip magnetometer in the center of coil z=88”



Forced air colling flow inside the tube is mandatory

- When previously we used 10-Gauss Bartington magnetometer (0.5 A) power dissipation was ~ 10 times lower. Now we perform all measurements with chip magnetometer,
- With high current operation longitudingal position scan are not reliable even with air flow cooling due to temperature variation along z

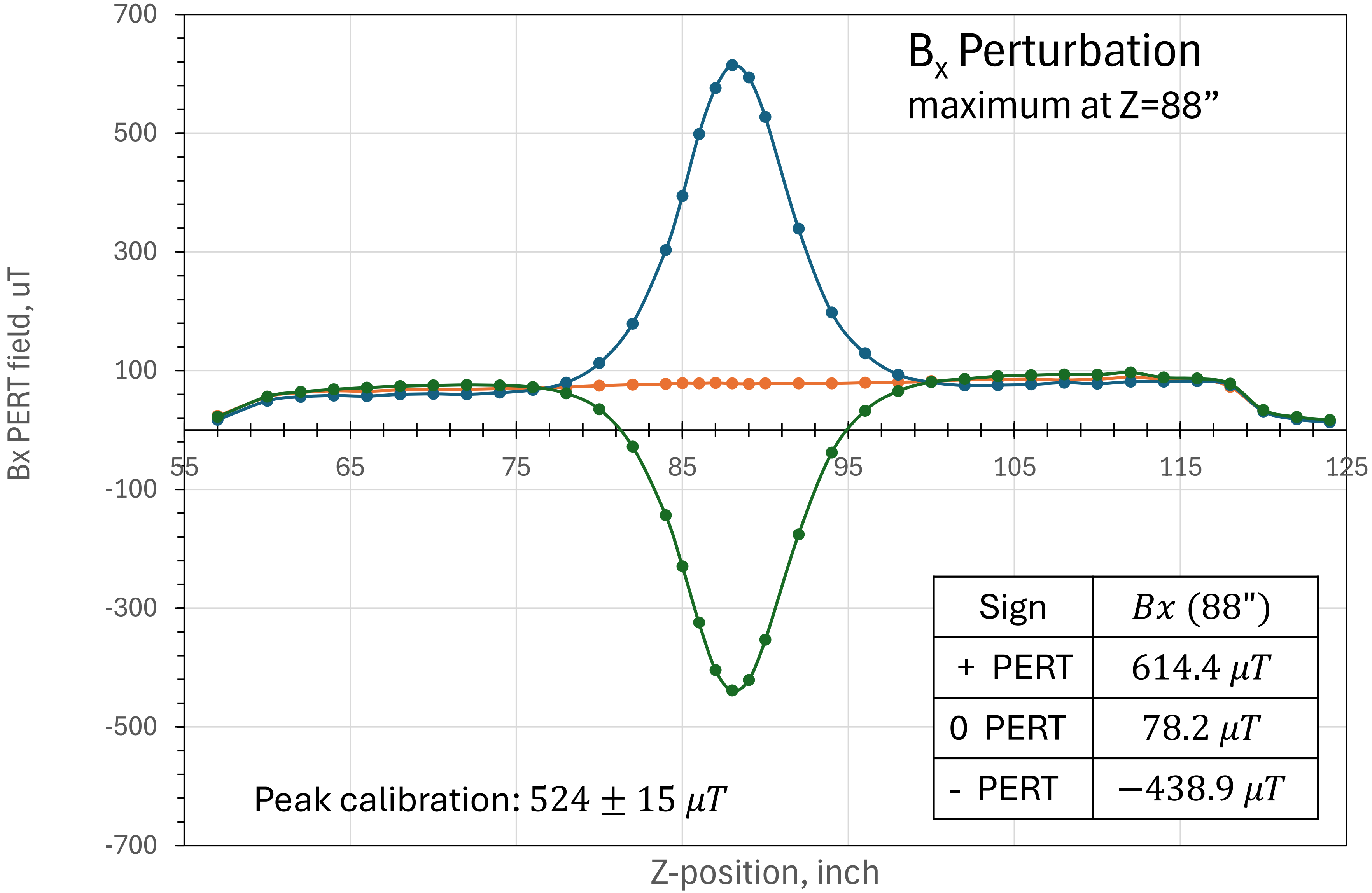
Naked Coil 3 field components, no mu-metal, no PERT



mu-metal endcaps are installed

June 12,2026

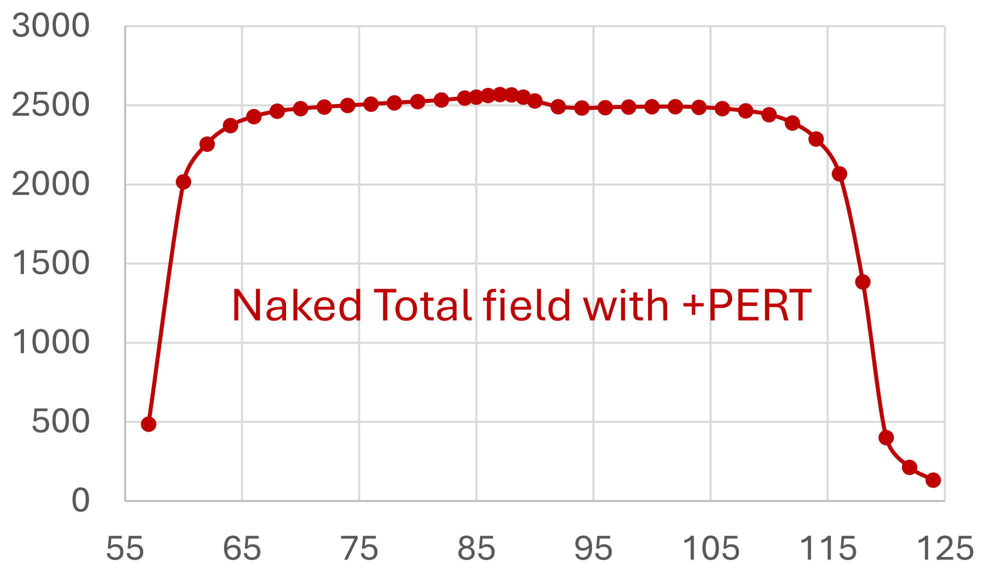
Naked Coil, with PERT, Current 1.3 A

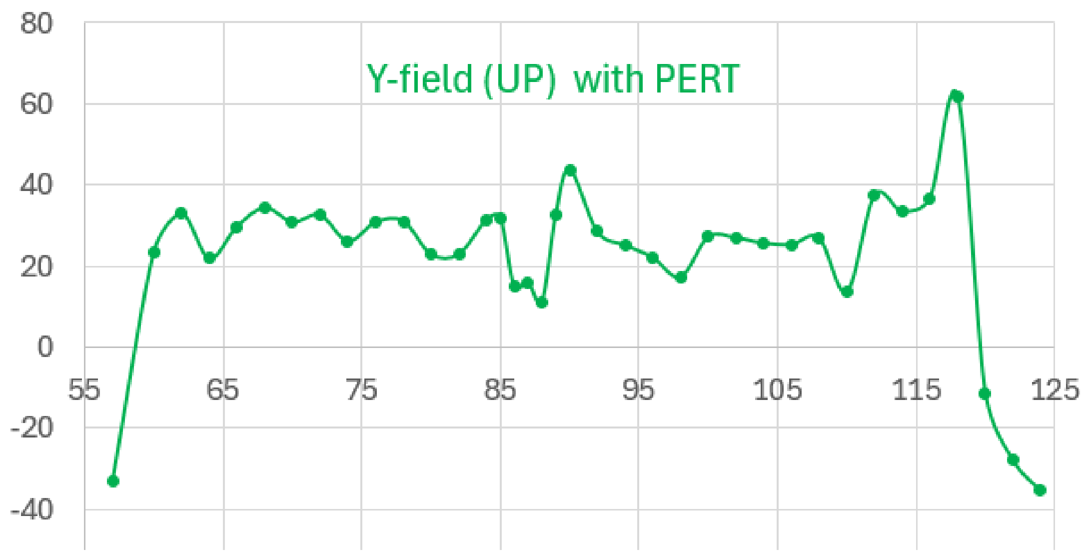


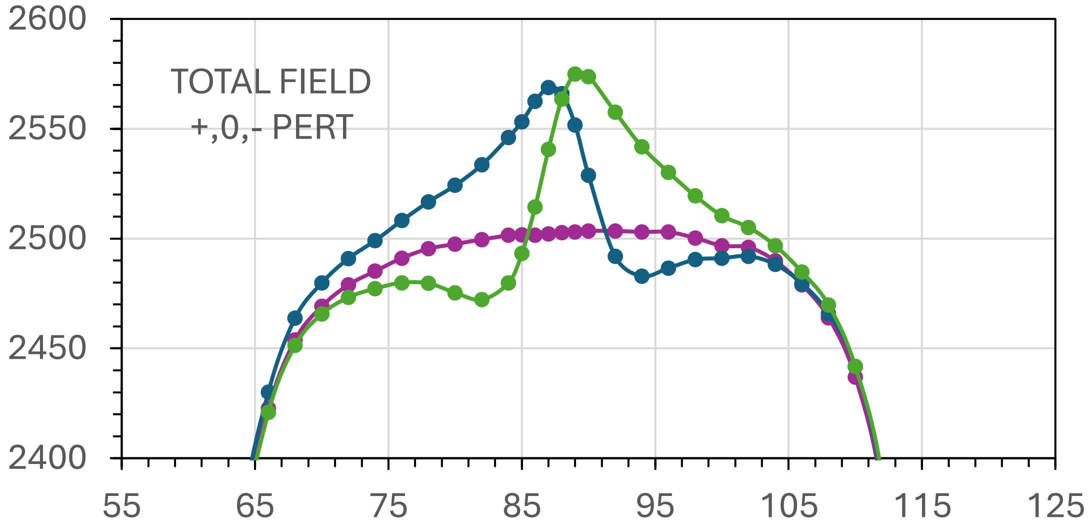
Sign	Bx (88")
+ PERT	$614.4\ \mu T$
0 PERT	$78.2\ \mu T$
- PERT	$-438.9\ \mu T$

Naked Coil with current 1.3 A and PERT

June 12,2026







Two perturbation magnets are slightly misaligned

In General:

- Longitudinal scans along z with magnet ON are subject of temperature variation of readings

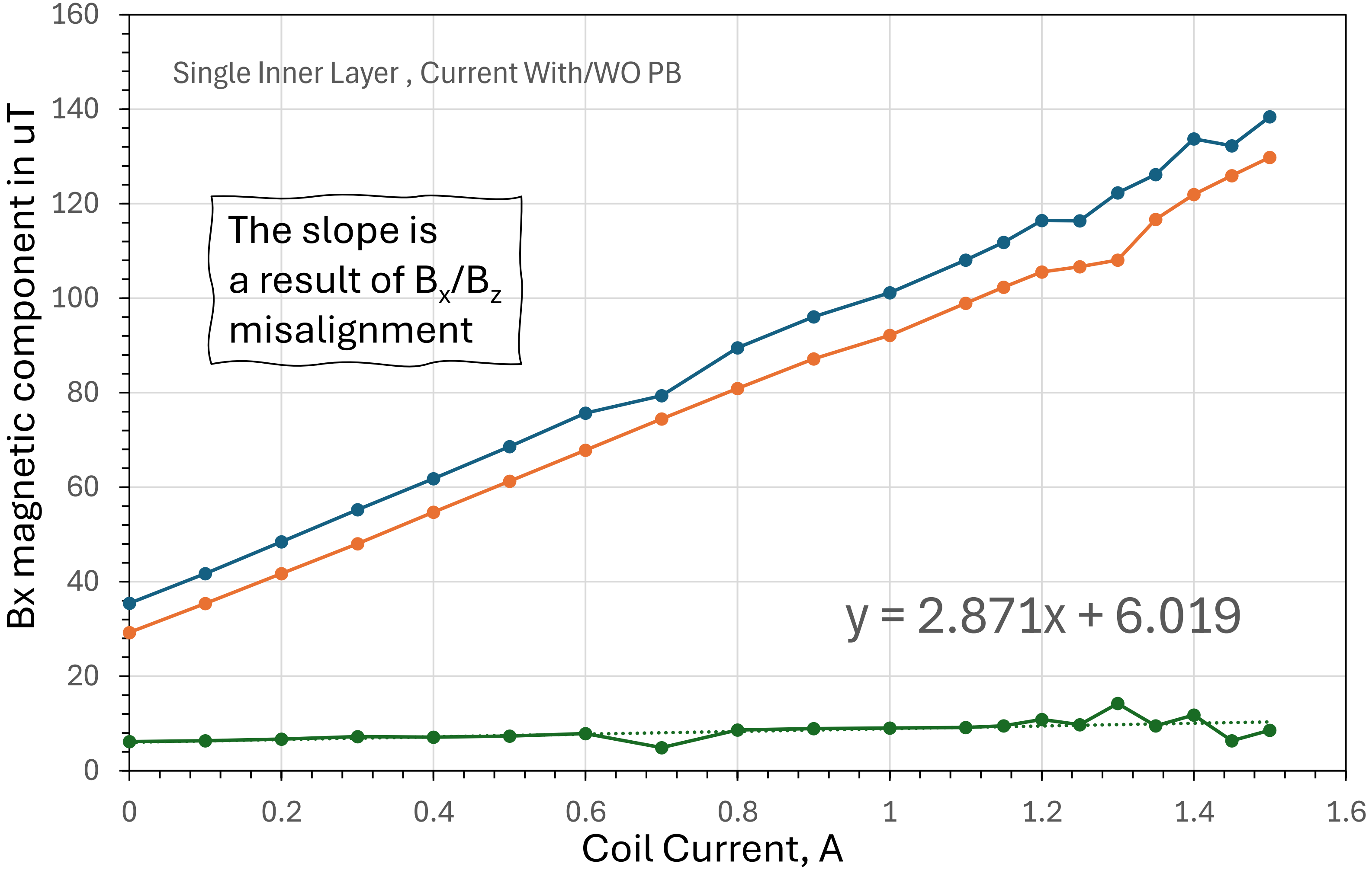
- Air blowing through the guide tube improves the t-variation, however, needs time for thermalization

- Best compensation of t-dependence can be reached when magnetometer is at fixed z-position (88" – peak position) and air-cooled for long time for equilibrium setting.

- In this case, if coil current variation/measurements are quick, effect of temperature variation is small.

Single 0.3 mm Inner Mu-shield Layer

Magnetometer position at peak z=88”. Previous DG at 1.3 A + PERT.
Air flow and Thermal Eq. Study current dependence with/without PERT



Single Inner Layer Shielding Factor SF_1=524/8.5=**61.5**

in coil field range from 0 to 30 G for external PERT ~ 5 Gauss

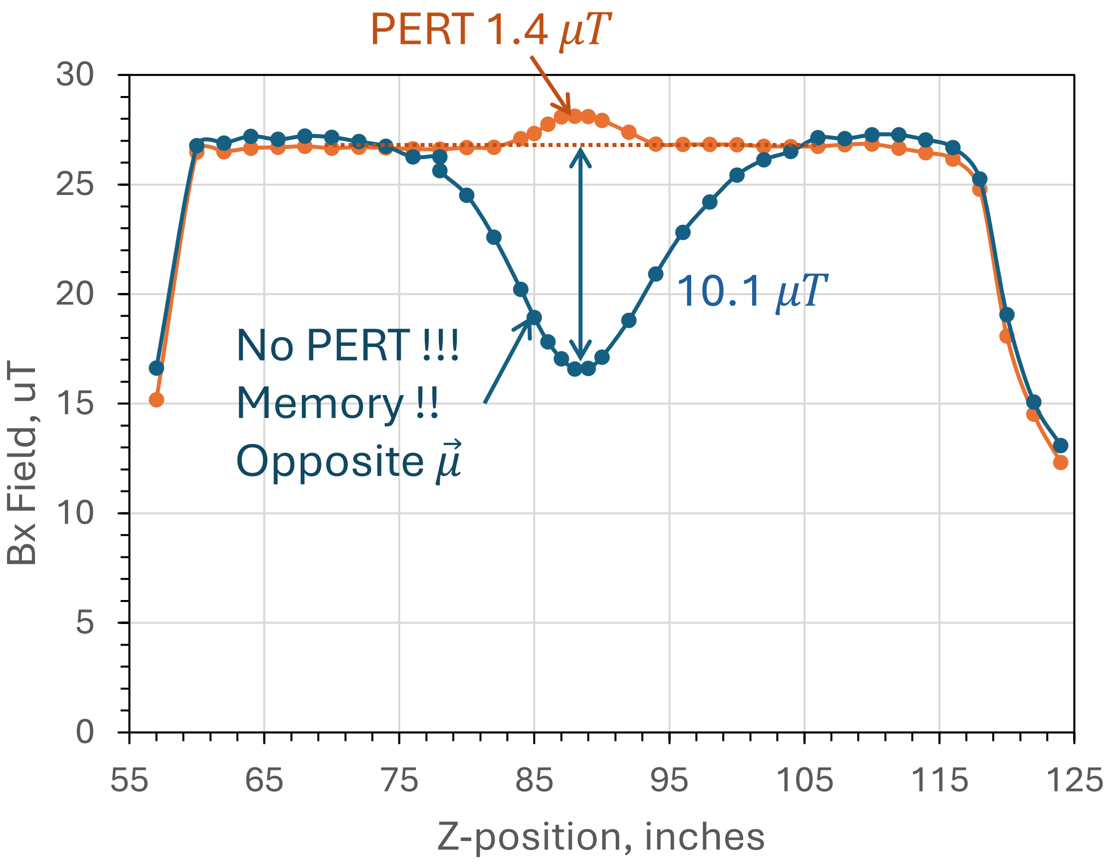
←Average effect of PERT is 8.5 μT small trend for increase

- With the chip magnetometer and thermal effect under control we perform set of planned measurements with different shield configurations and with/without degaussing.

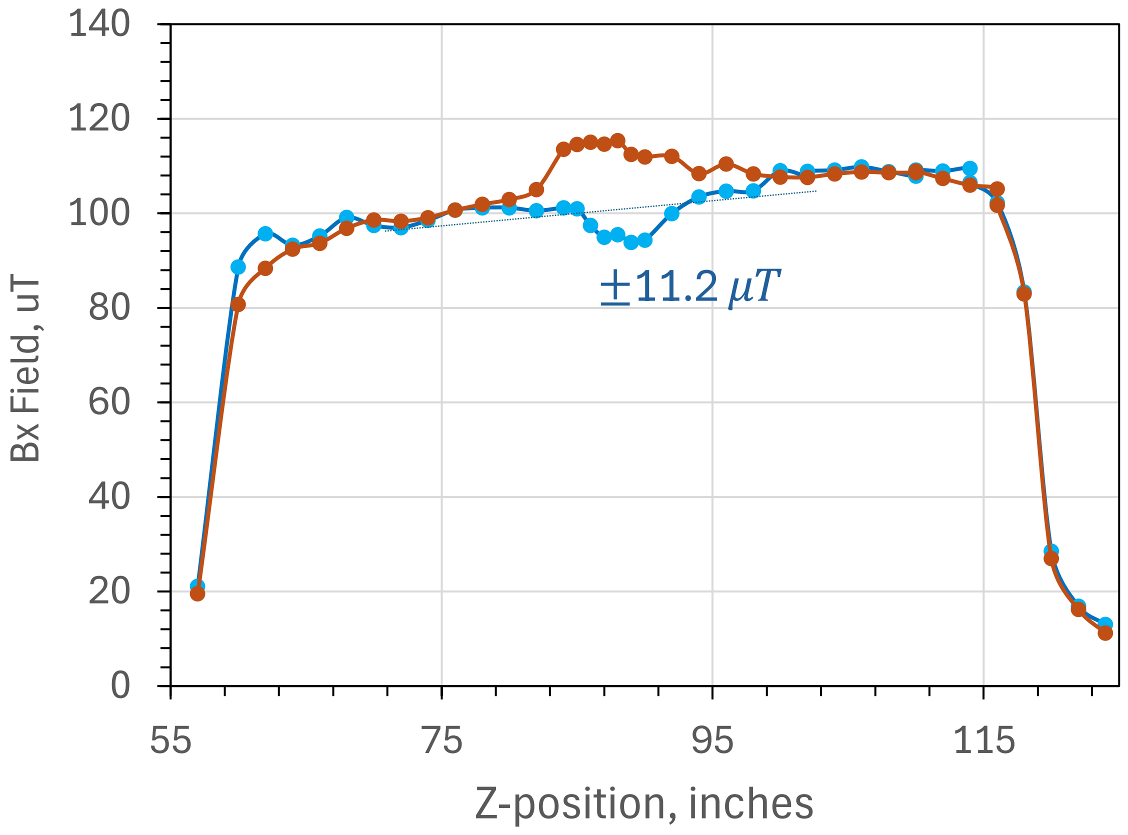
- These results are being analyzed and will bepresented at the next zoom collaboration meetings in July.

Single Inner Layer Perturbation Memory

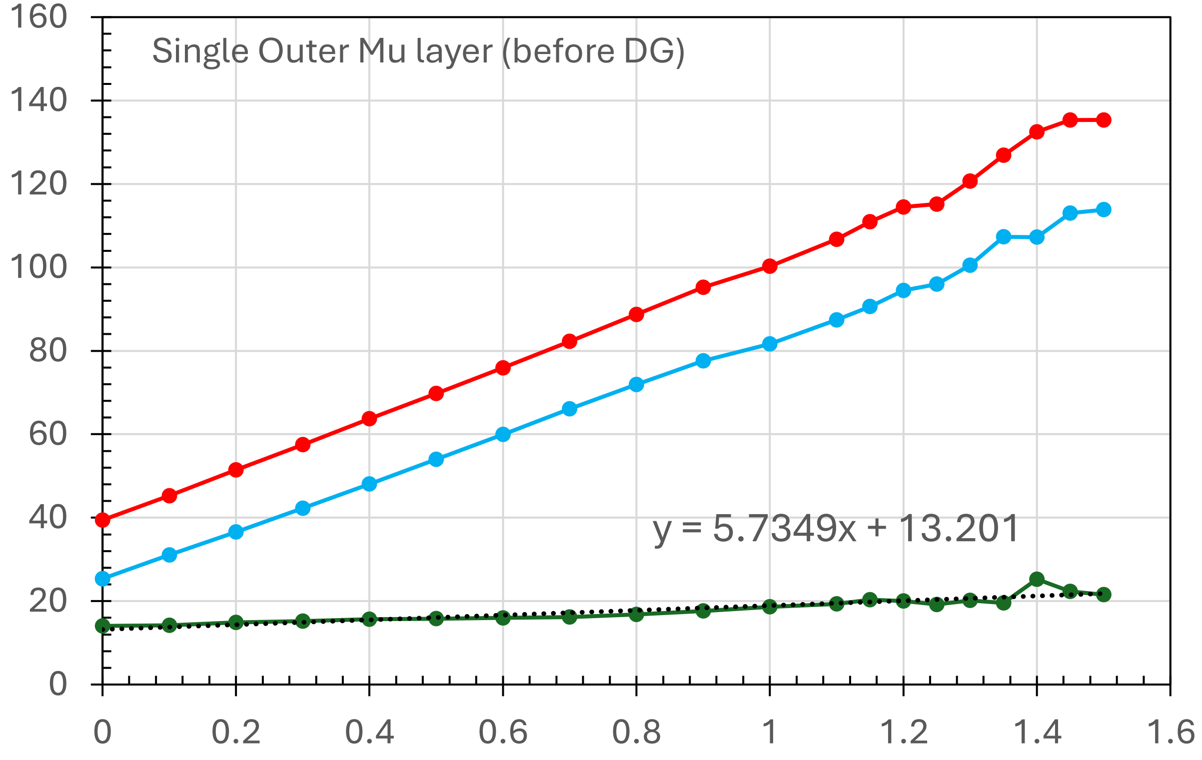
After DG at 1.3 A + PERT, measured at 0 field →

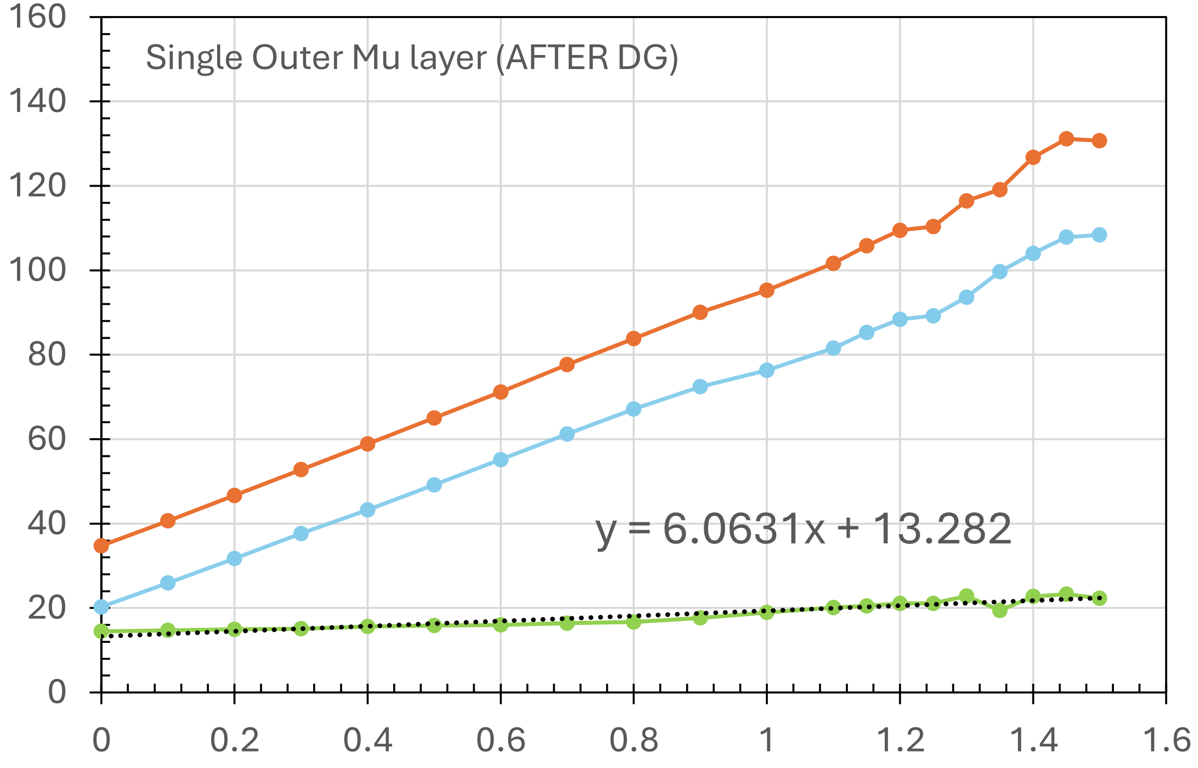


After another DG at 1.3 A with Current 1.3 A



Single 0.3 mm Outer Mu-shield Layer Before and After Degaussing (peak z=88”)

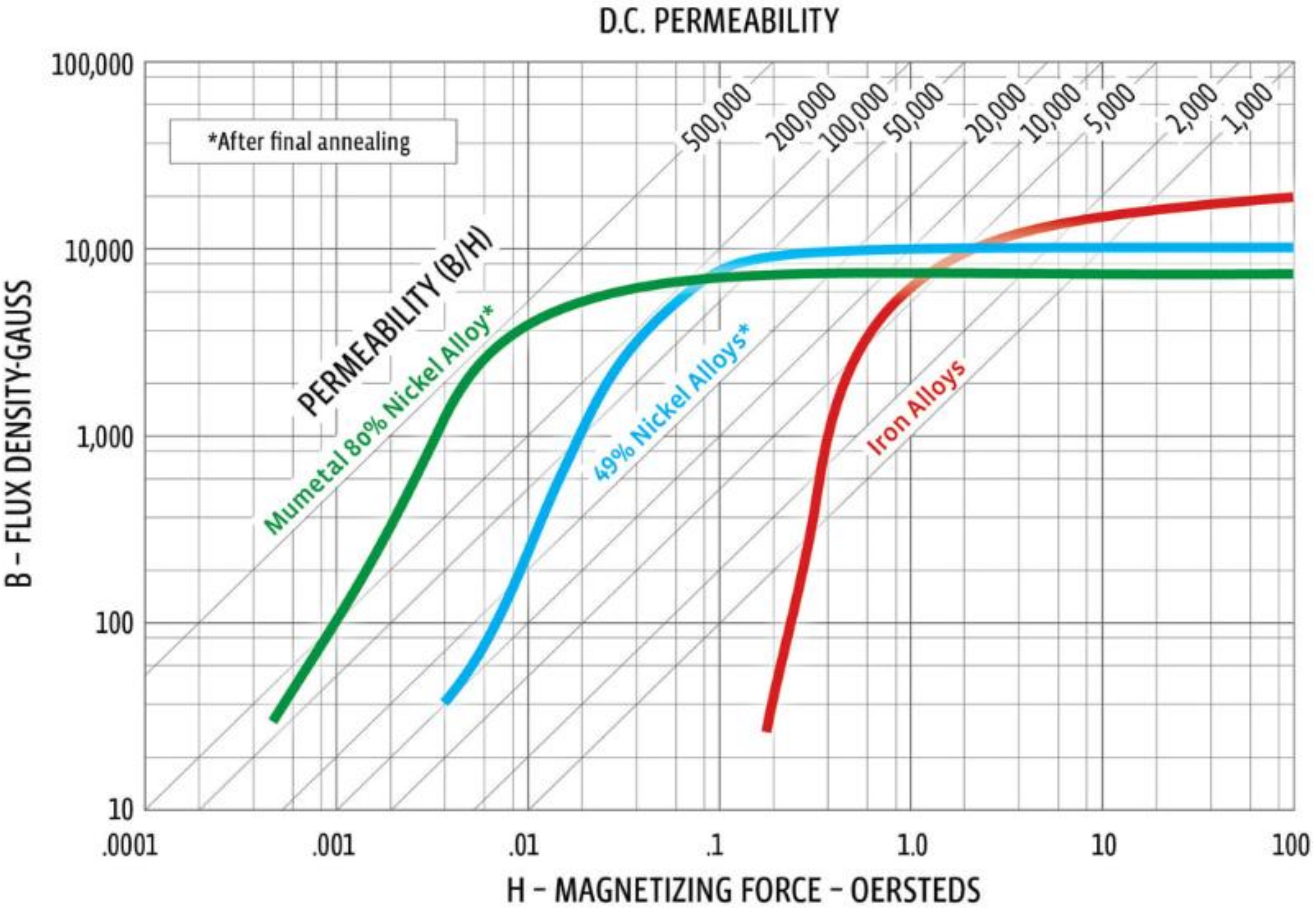




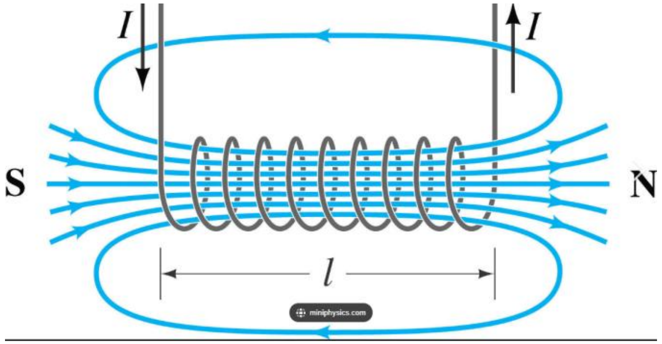
Average DIFF=18.13 μT ; SF1=29

Average DIFF=18.7 μT ; SF1=28

μ metal shielding material foil 0.3 mm thick 12” wide

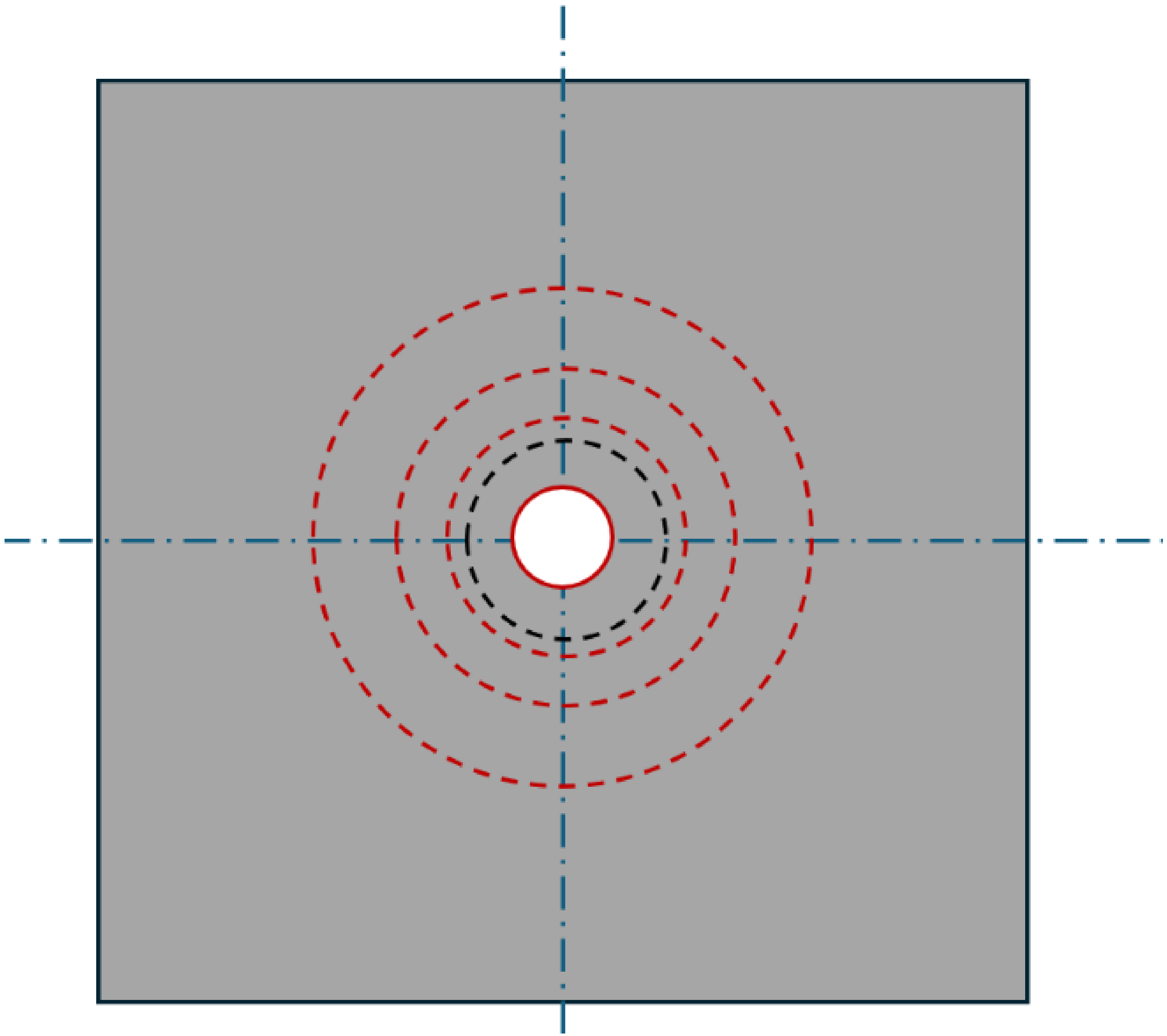


Scheme of our two nTMM magnets

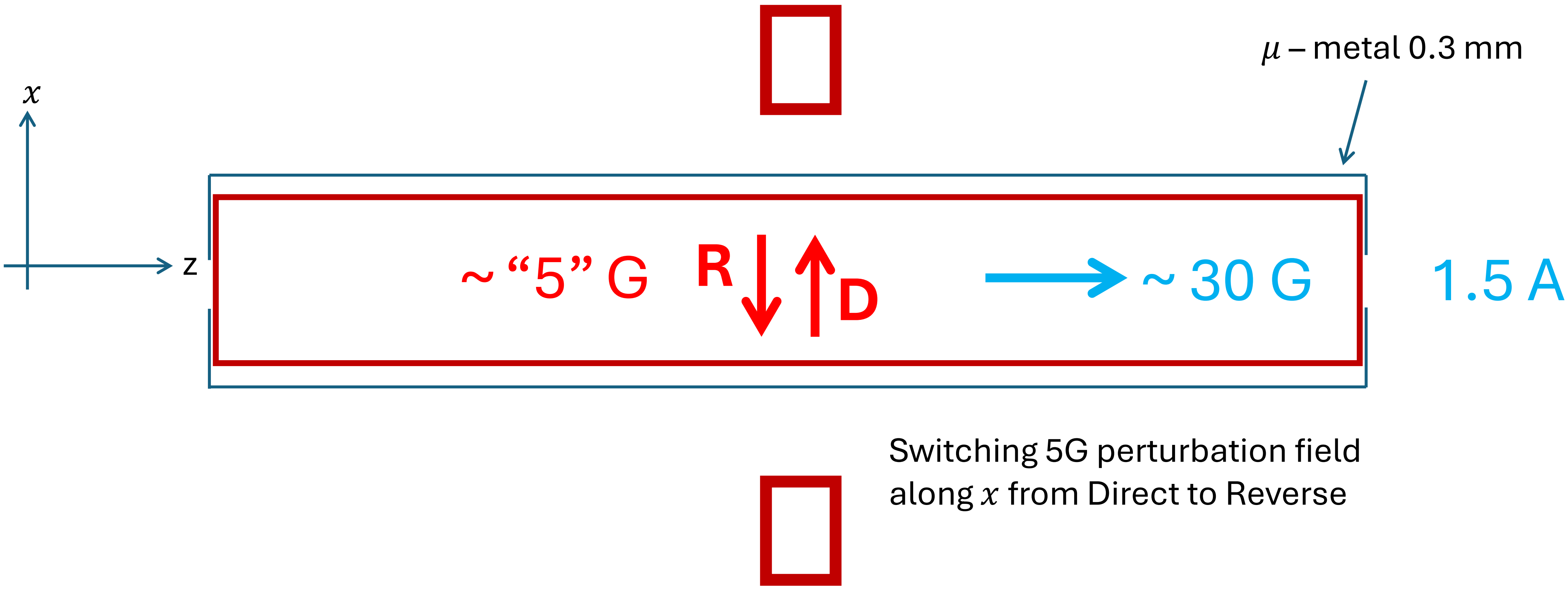


- Shielding factor can be measured (μ prototype)
- Not understood factor is how return flux in inner mu-metal created by solenoidal field will change permeability of μ- metal and shielding factor

24” x 24” x 1” McMaster ~ 10 kg



3 degaussing circuits (cylinder and endcaps) serially connected with total resistance ~ 1 Ω



Degaussing in the presence of coil current (1.3A ≡ 26 G) and Perturbation (3 A → 5 G)
Will use LIS2MDL chip magnetometer for all measurements.