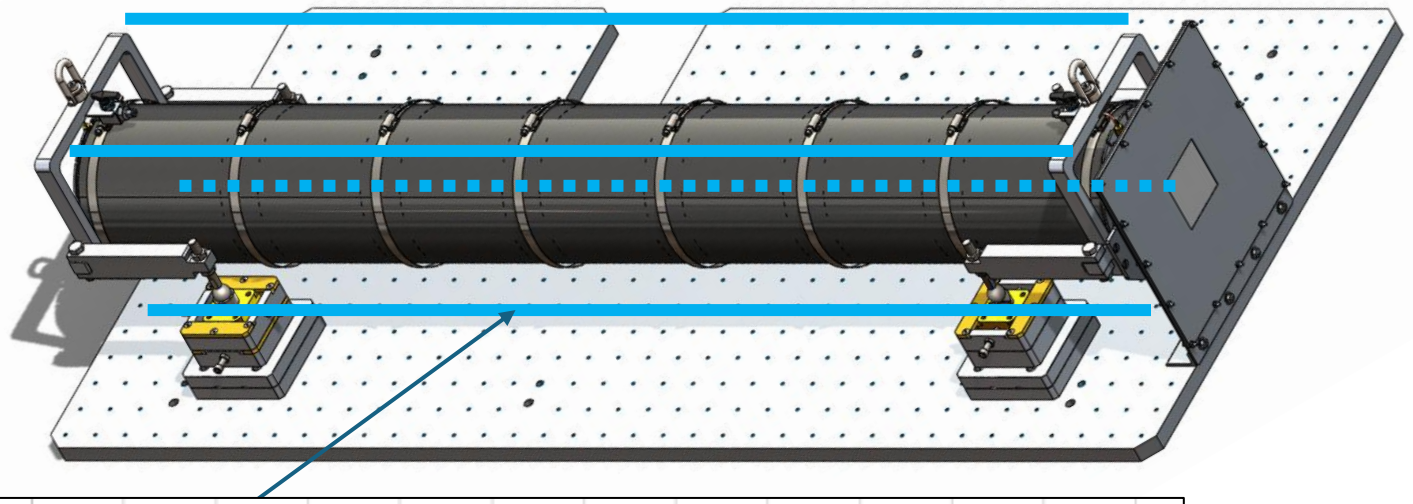
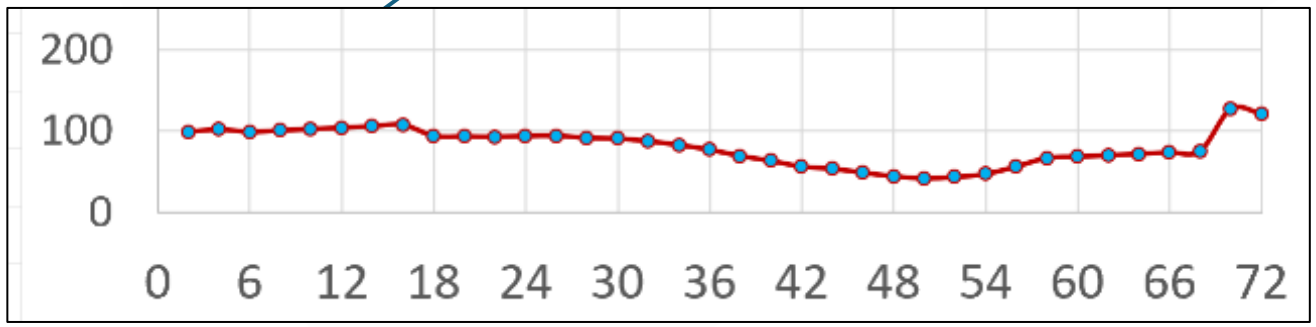
Large Magnetic Field non-uniformity in nTMM environment at GP-SANS and its mitigation effort

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

Magnet 1 Box 7

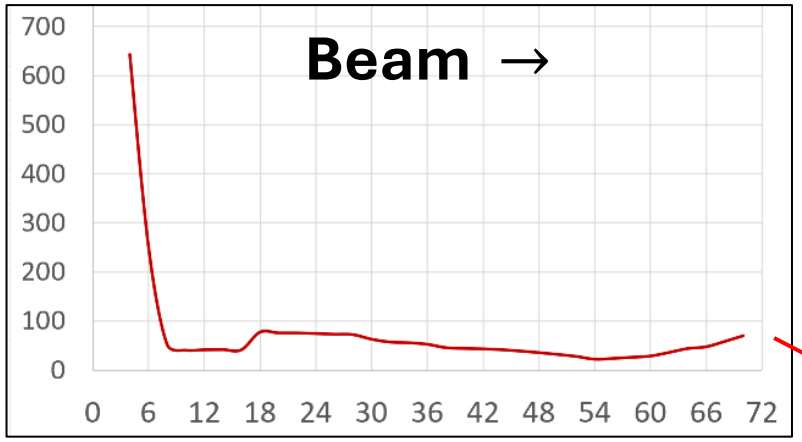


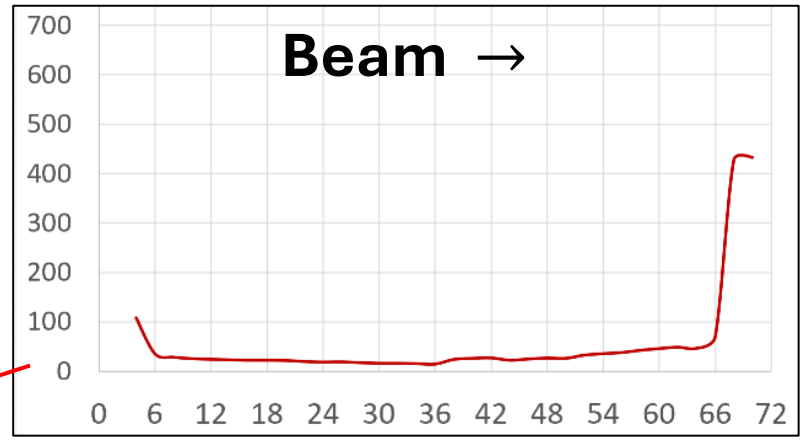


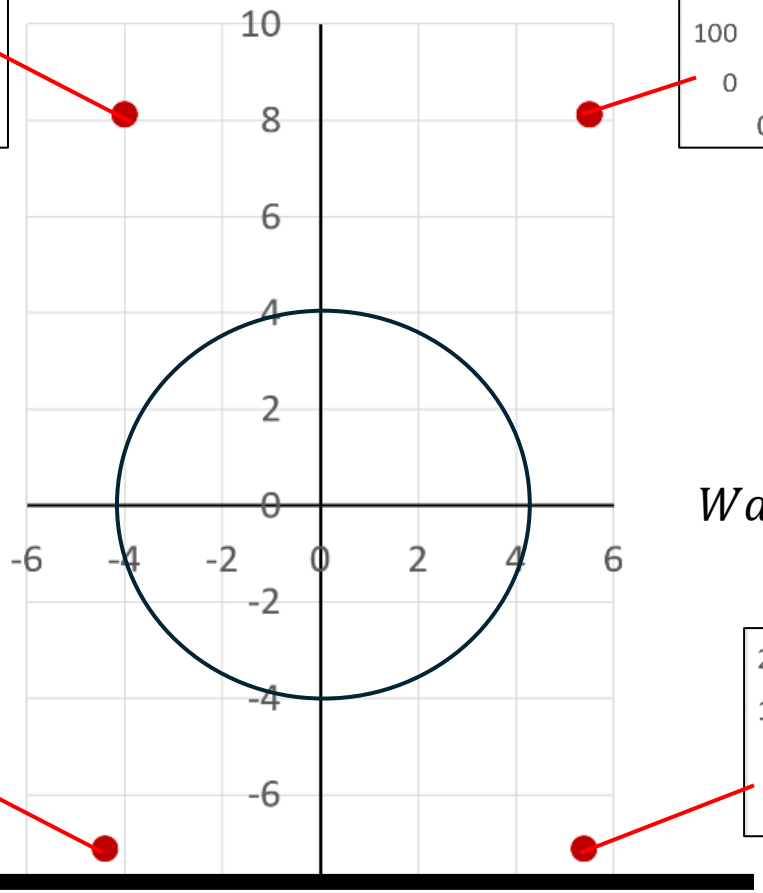
3-D point every
2” along the beam axis

B(total) in μT

Magnet 1(7)

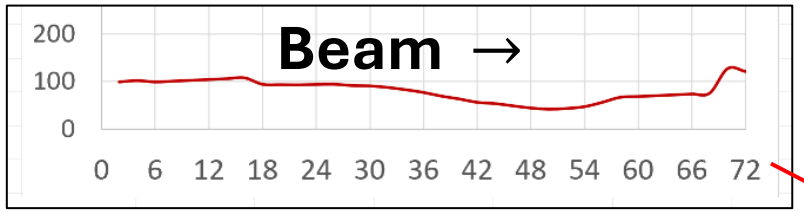


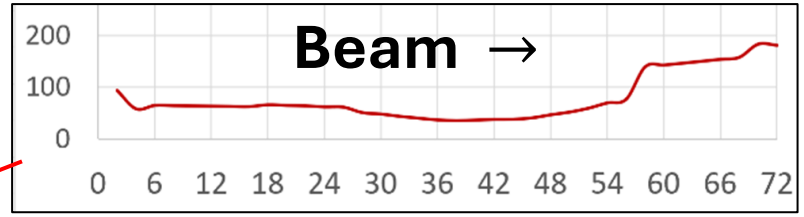




← *Ladder side*

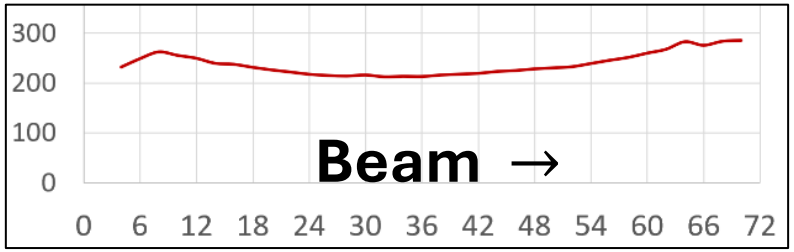
Wall side →

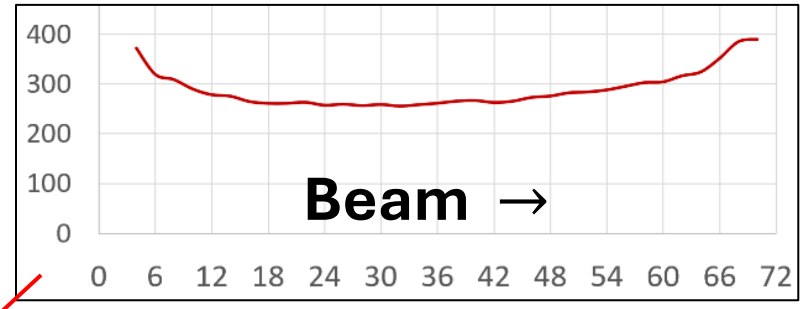




B(total) in μT

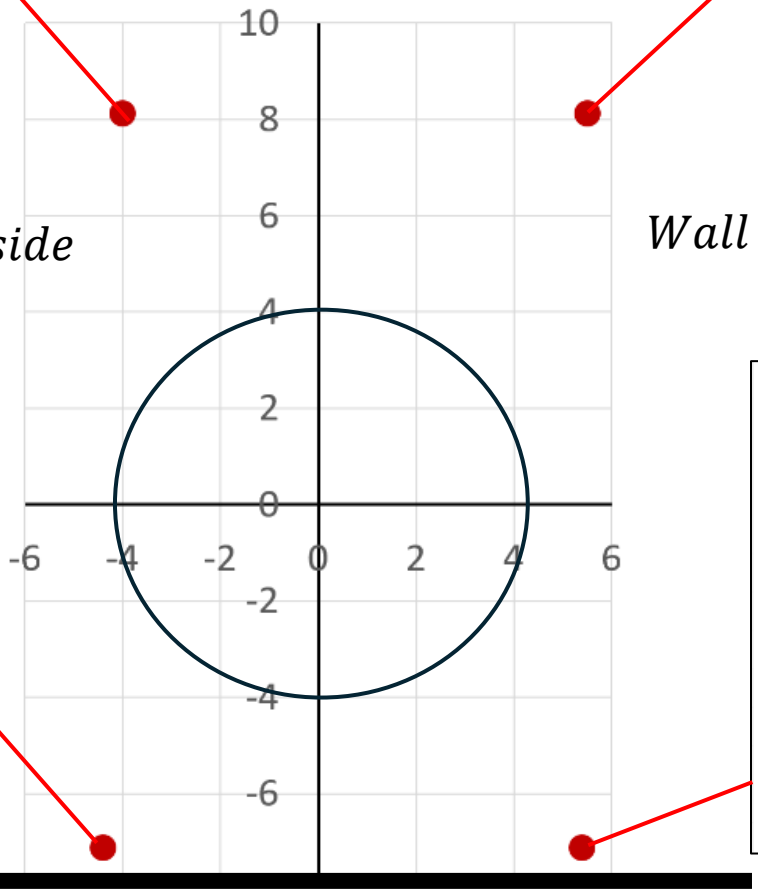
Magnet 2(8)

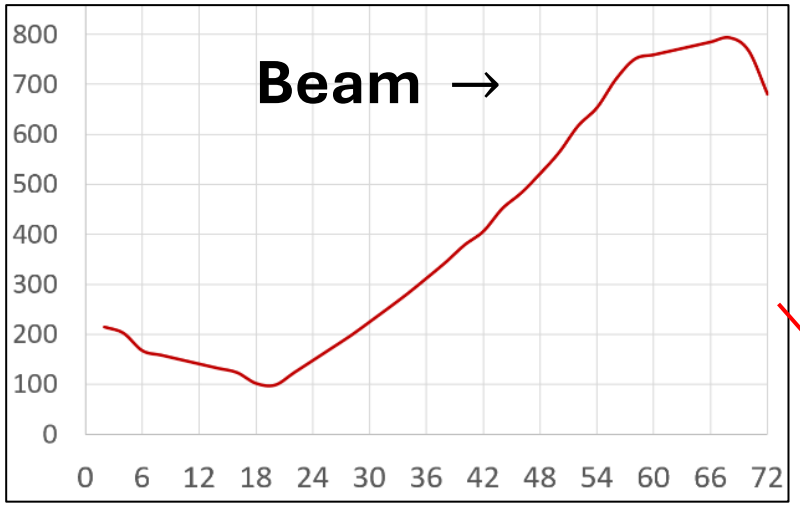


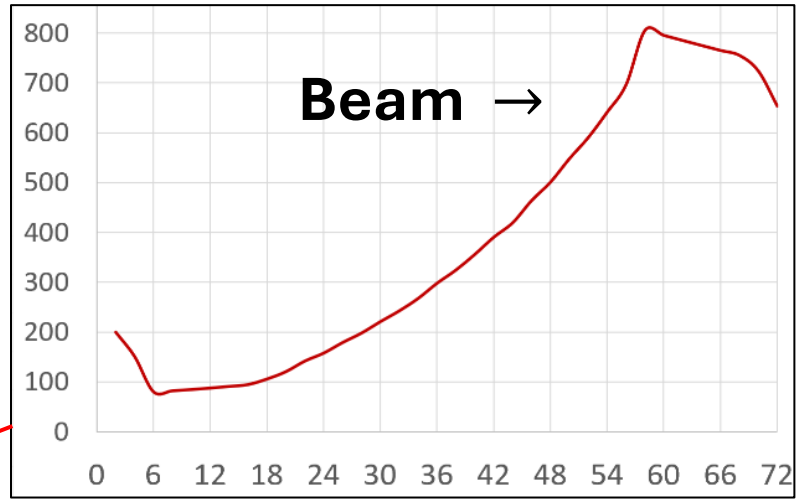


← *Ladder side*

Wall side →





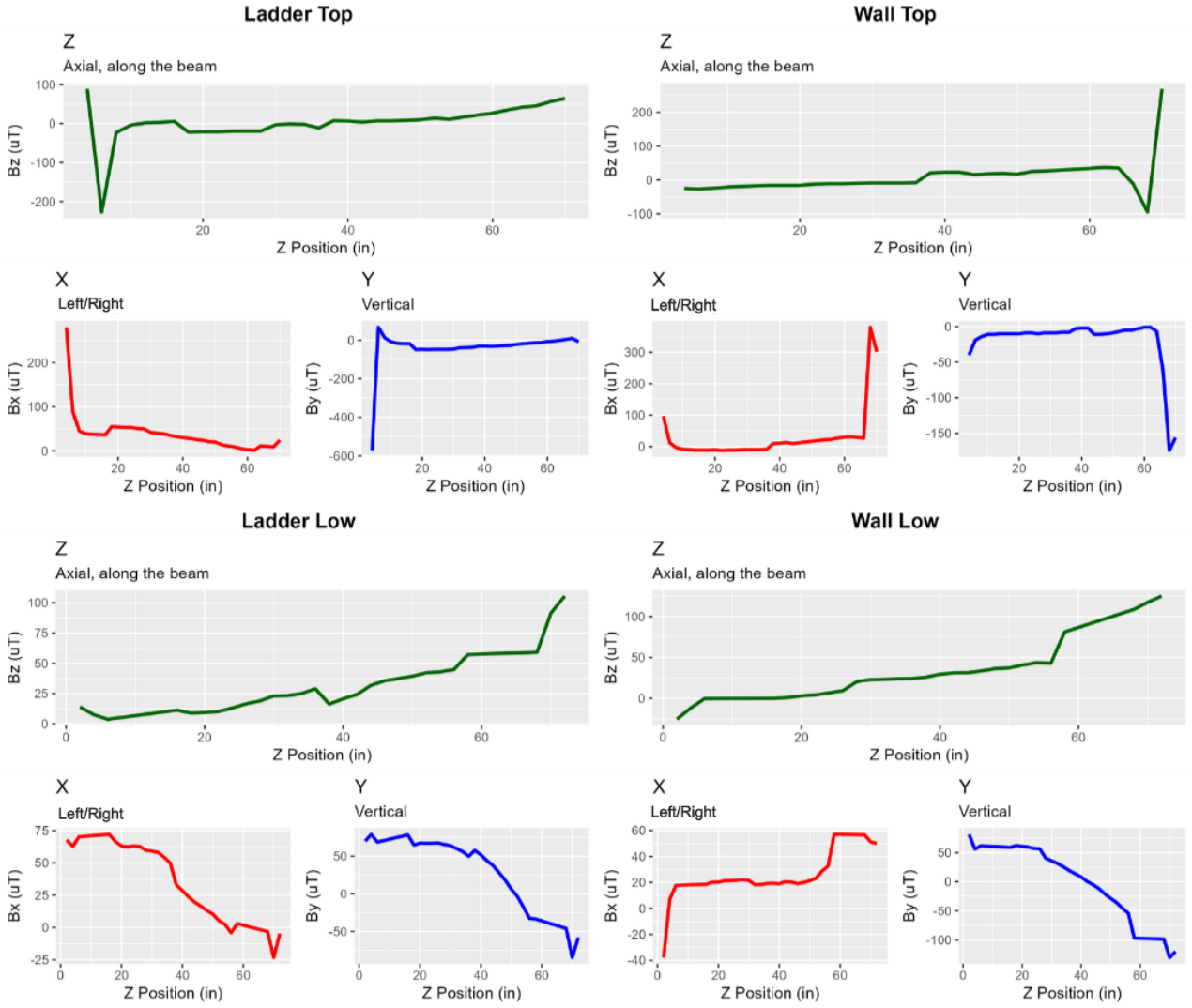


Visualizations for the Environmental Magnetic Field Measurements around the Magnets 1 & 2 at GP-SANS

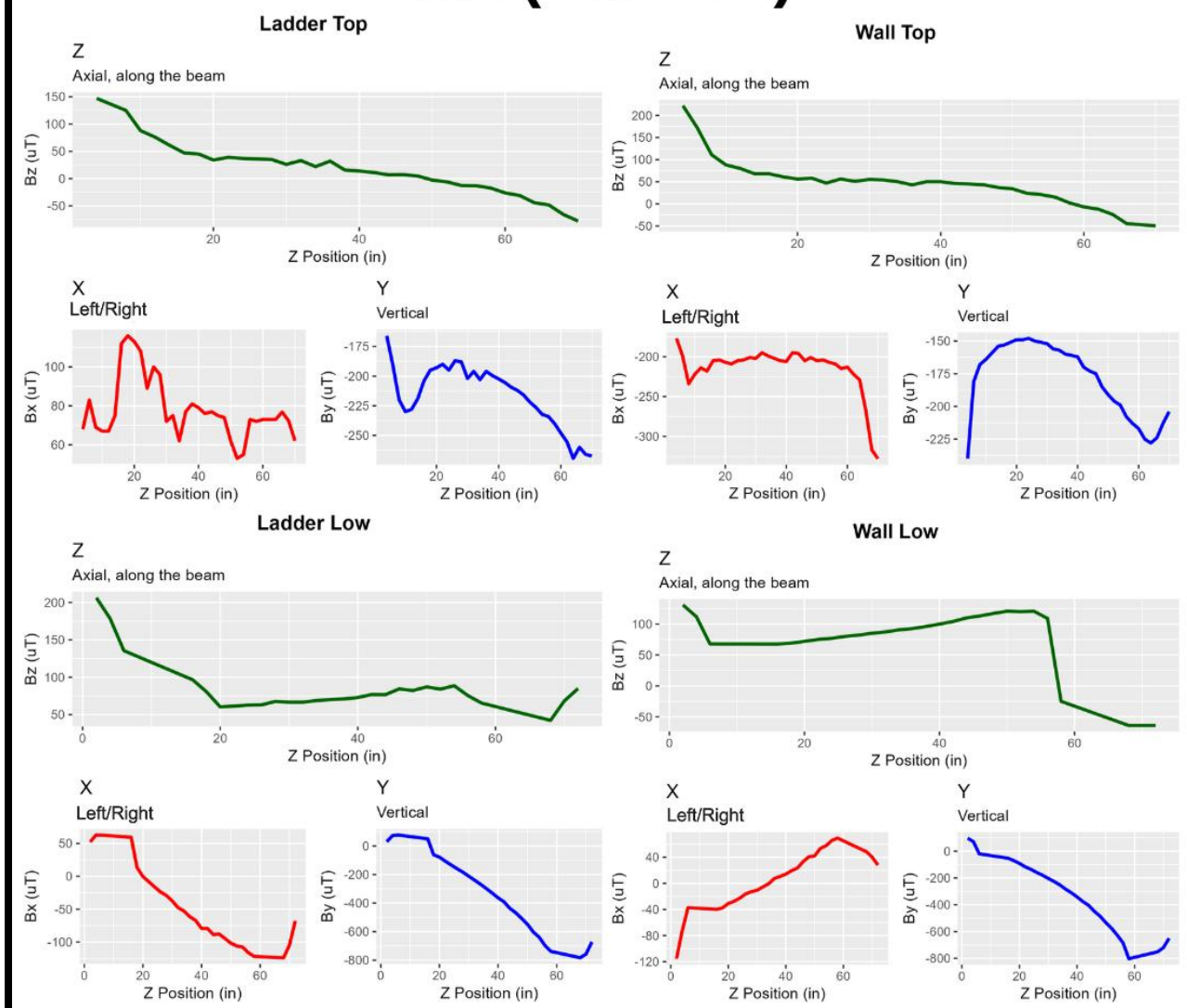
Alina Moore 6.6.2025 – UTK n-n’ Group

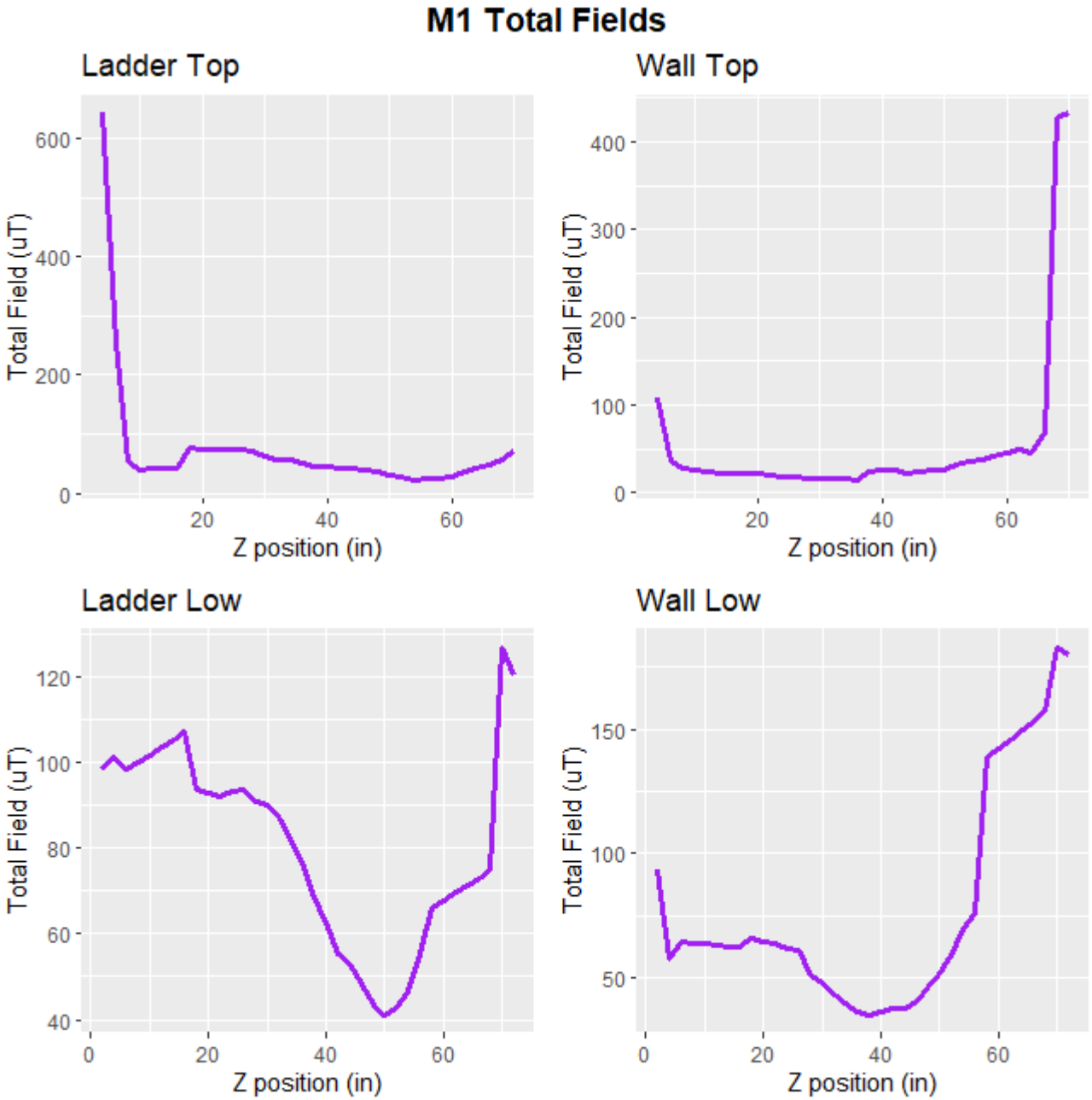
Field Component Plots from measurement tables

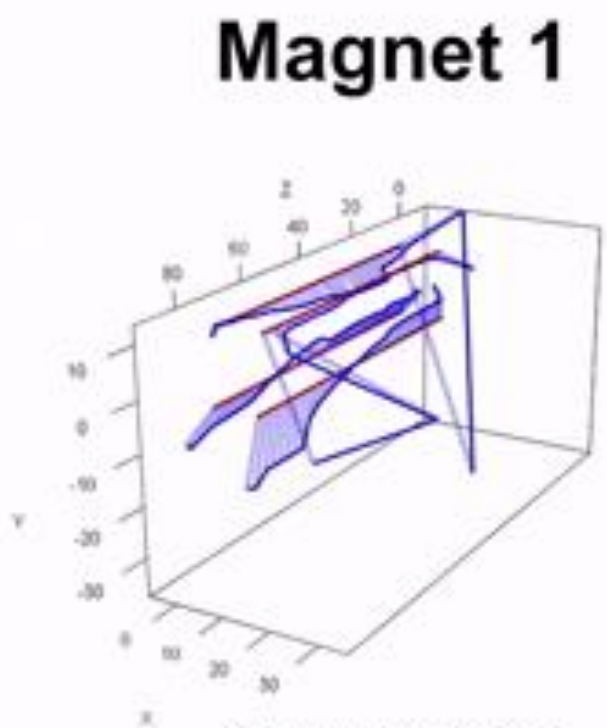
M1 (Guide 7)



M2 (Guide 8)

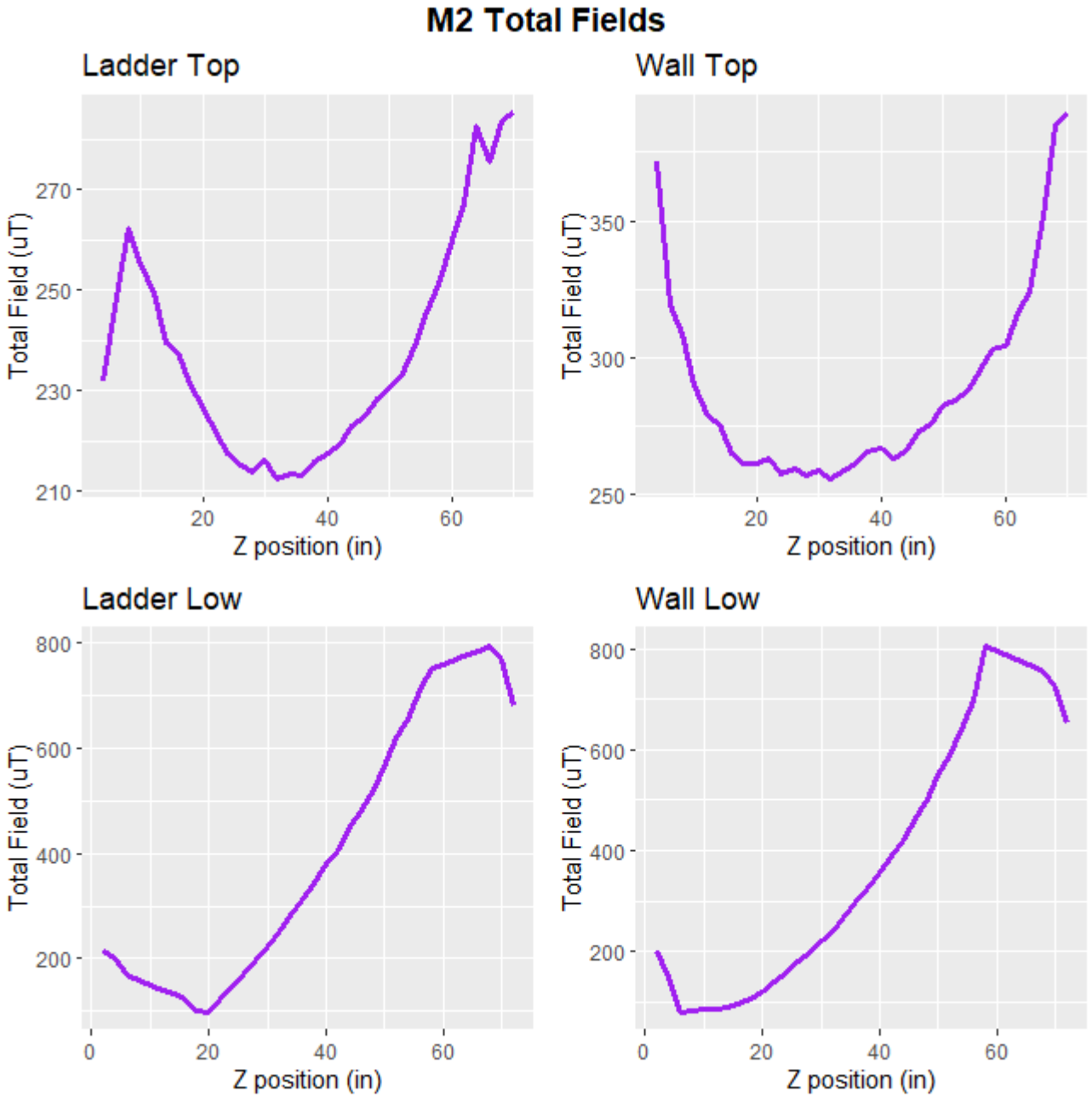


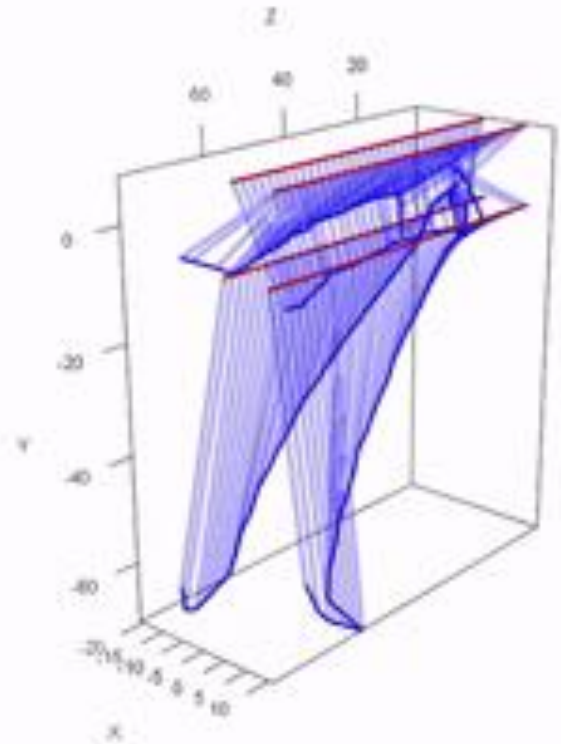




Gif causes lower quality, see download links for mp4 and interactive versions

Scaling factor for visibility = 0.08





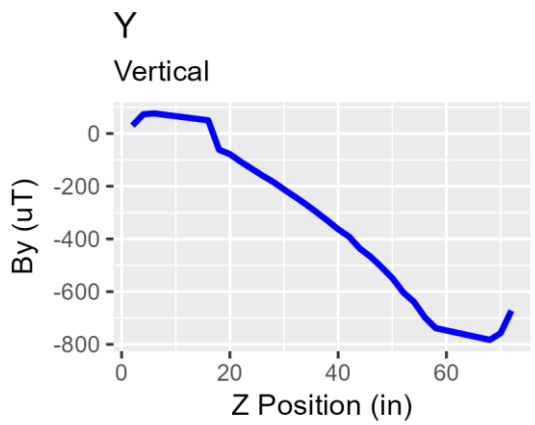
Magnet 2

Max field = 805 uT

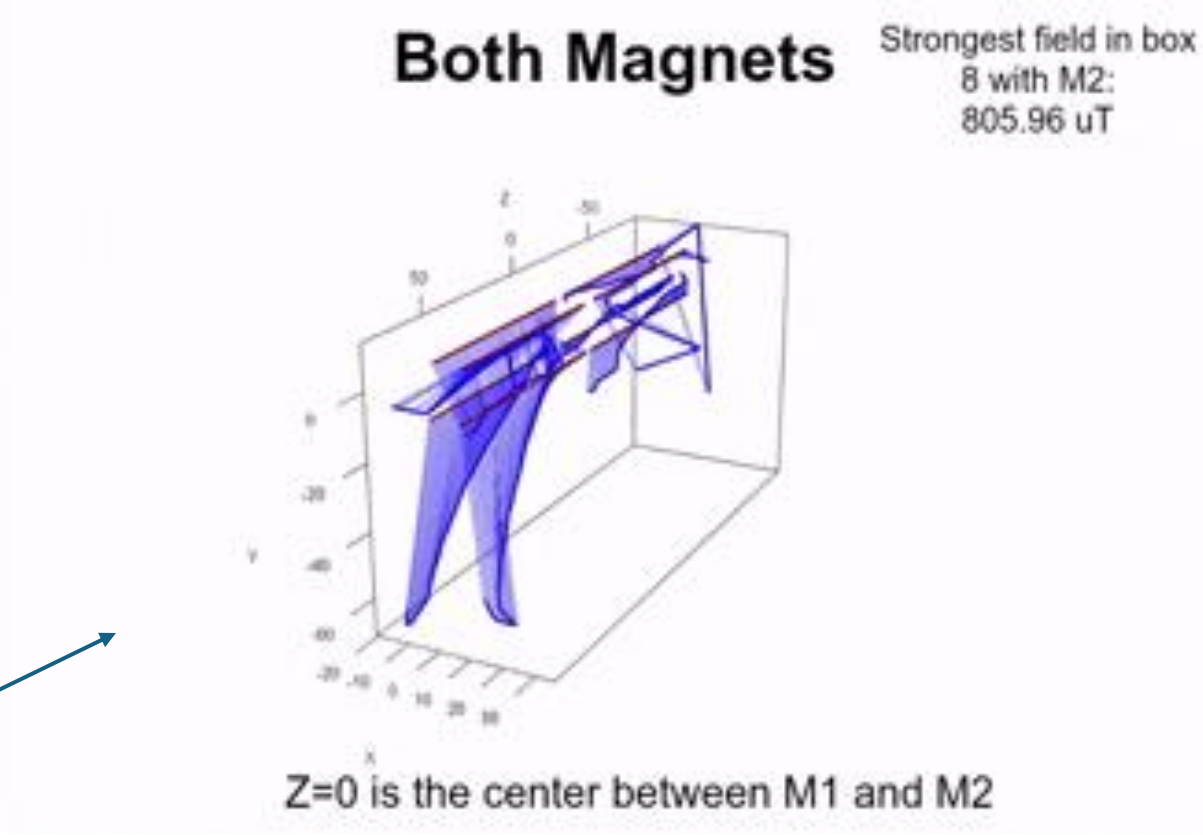
X - left/right
Y - Vertical
Z - Axial

Scaling factor for visibility = 0.08

Main problem:
Y component of M2's lower measurement paths
- Pointing to a beam below the magnets
- Seen in the Components for Magnet 2 low



- Same for wall side



Scaling factor for visibility = 0.08

Notice difference in magnitudes of exterior fields between both magnets

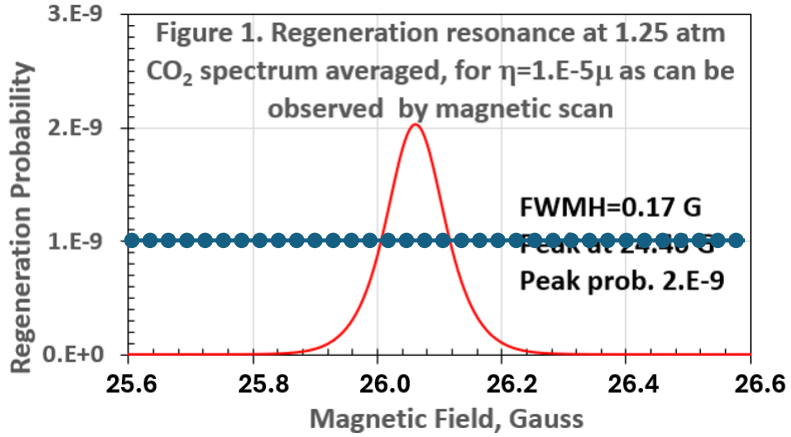
Downloads

- HTML interactive widgets
  - M1 https://drive.google.com/file/d/1gqCQmOwdoRJJ1-hSOob3vhPefNtpAO0w/view?usp=drive_link
  - M2 https://drive.google.com/file/d/1c5BuUtKv_T9Wuv6uZd_u8rjFt4o45bZt/view?usp=drive_link
  - Both https://drive.google.com/file/d/1pMvjZGdH9qwPyYvZUmR5k_Uh3BgyCKf3/view?usp=drive_link

- MP4 videos
  - M1 https://drive.google.com/file/d/1sE7O9vAeV9LSdpdP9beAHCaAId68vSbi/view?usp=drive_link
  - M2 https://drive.google.com/file/d/1libJzGokTBG9nXLUi1YicFSGmAJ3GaNo/view?usp=drive_link
  - Both https://drive.google.com/file/d/1dD_zm5KOksW5xh1Un04nV-_RMfDf3VH5/view?usp=drive_link

Major disturbance is coming from magnetized steel guide support piece (blue on picture) with surface field up to 30 G

FWHM of expected resonance $(V_F - \mu B = 0)$ $is \sim$ 0.17 Gauss
Step in field scan FWHM/6 ~ 0.03 Gauss
Scan region 25 – 27 Gauss, resonance peak expectation at ~26 Gauss
In terms of current: from 0.32 A to 0.35 A with step 0.0004 A

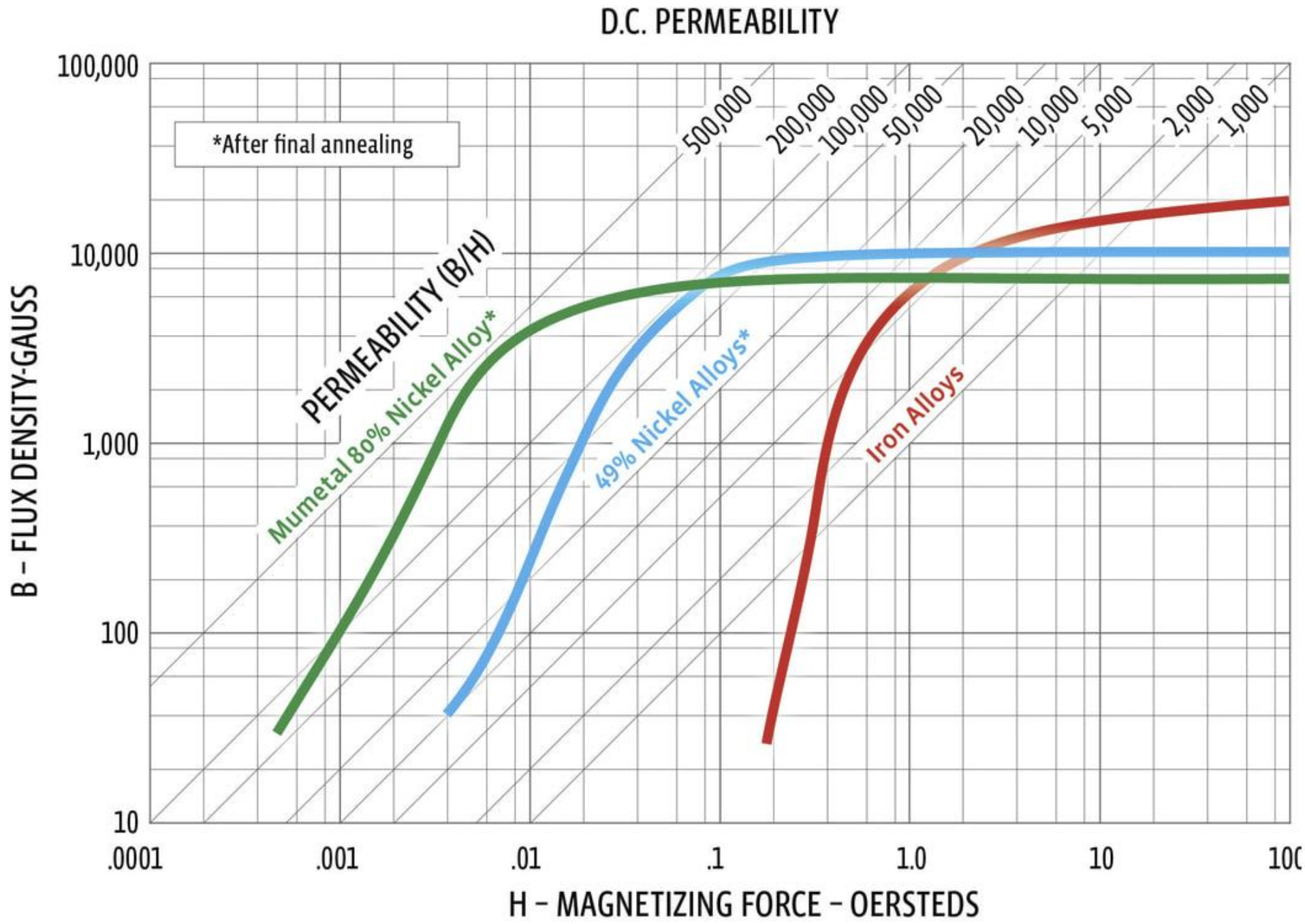


Mag. field non-uniformity requirement < 0.03 Gauss
Required suppression factor for 8 Gauss / 0.03 Gauss > 270
Field non-uniformity expected in design < 0.1 Gauss
and expected required suppression > 36

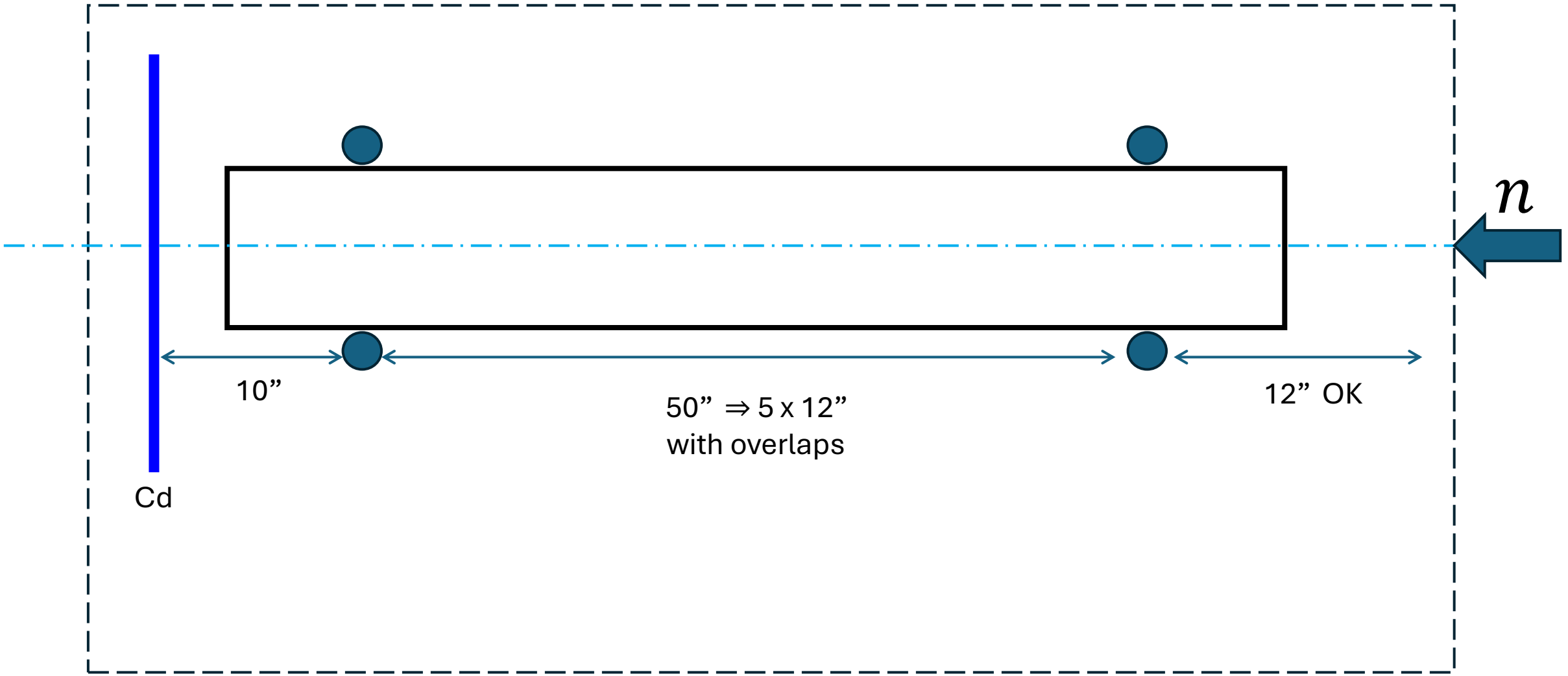
For the cylinder of mu-metal with diameter D, thickness T and rel. permeability $\mu\,(H)$
theoretical transversal field suppression factor $S \approx \mu\,(H) \cdot T/D$
longitudinal field suppression factor ~ 10 times worse

In the original design $T = 0.6\,mm$, $D = 8.5 \times 25.4\,mm$, μ depends on the external field / history
For non-uniformity 0.1 Gauss $\mu > 50{,}000$ $S \sim 140$
For non-uniformity 8 Gauss $\mu > 5{,}000$ $S \sim 14$

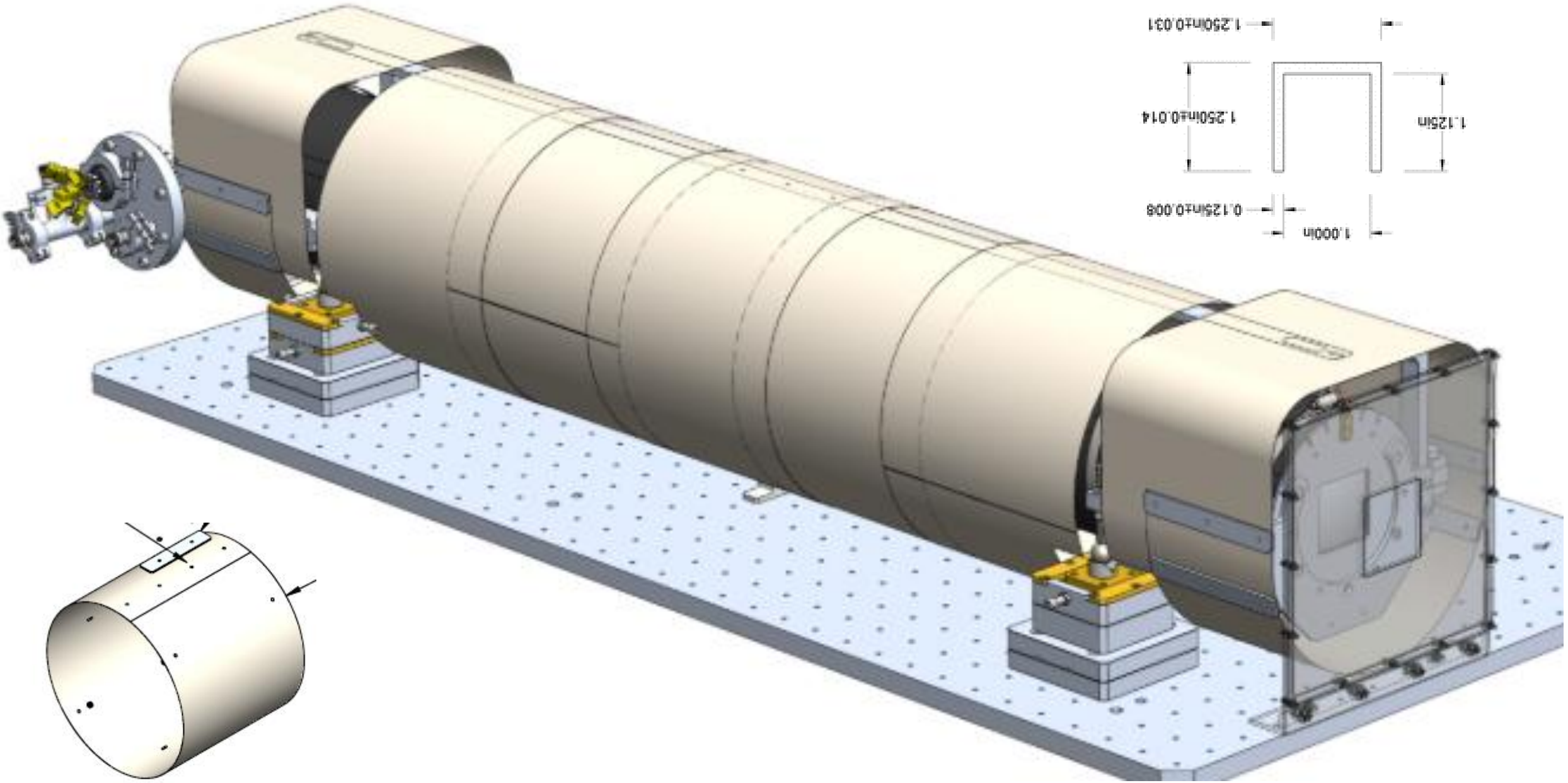
We need additional layer of magnetic shielding !

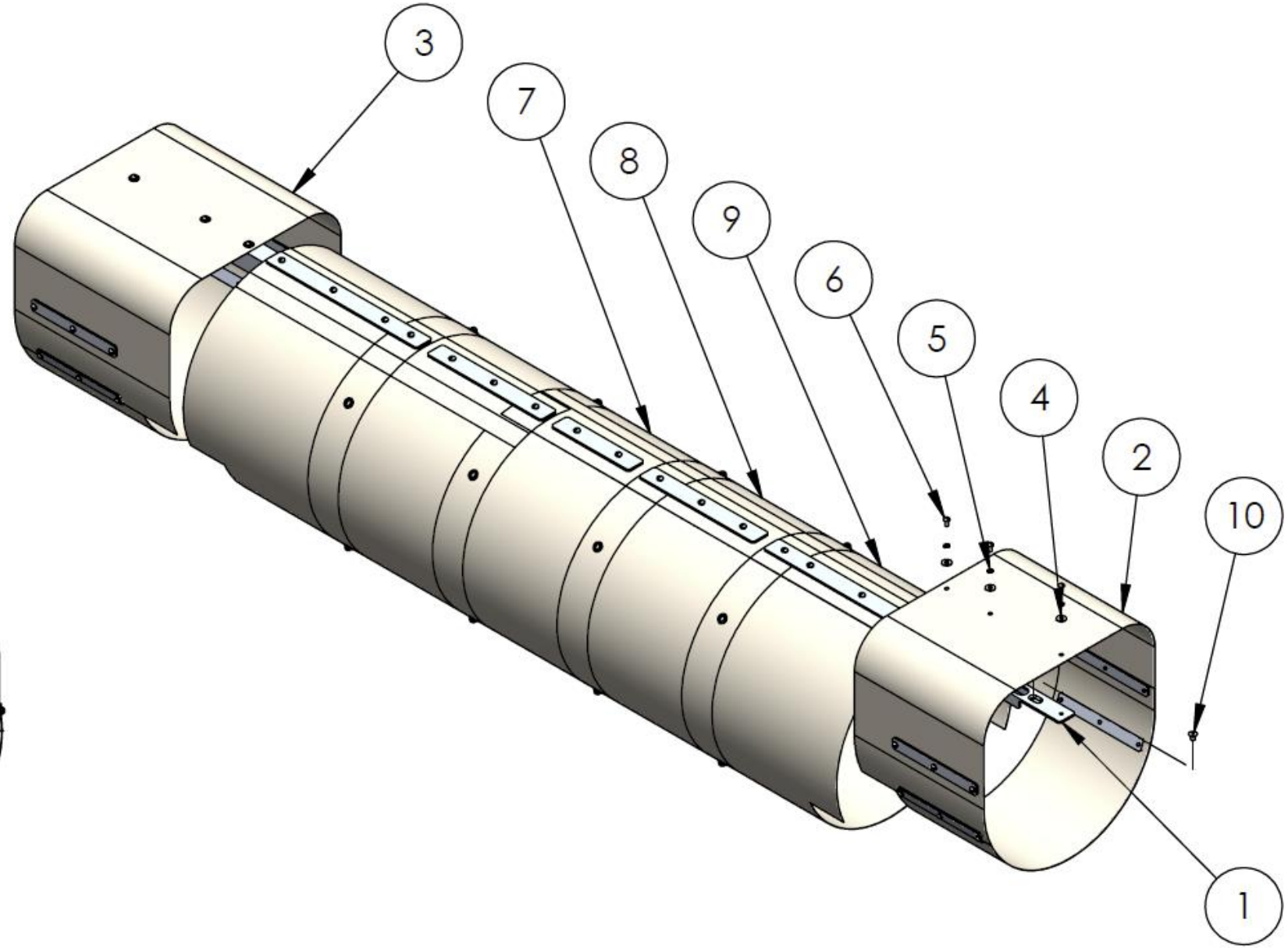

D.C. PERMEABILITY
*After final annealing
PERMEABILITY (B/H)
500,000
200,000
100,000
50,000
20,000
10,000
5,000
2,000
1,000
Mumetal 80% Nickel Alloy*
49% Nickel Alloys*
Iron Alloys
B – FLUX DENSITY-GAUSS
100,000
10,000
1,000
100
10
.0001
.001
.01
.1
1.0
10
H – MAGNETIZING FORCE – OERSTEDS

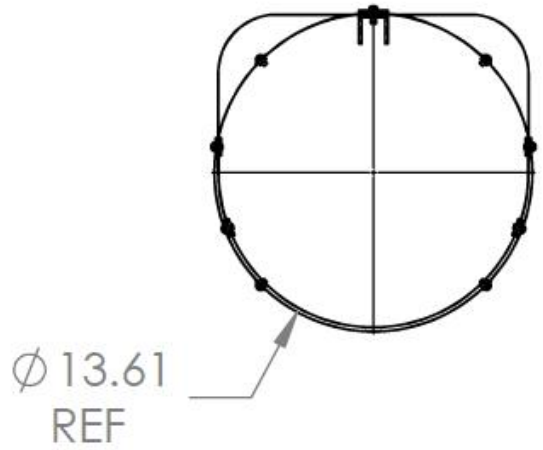
Space available for additional mu-metal shield on both magnets



Al spine bar

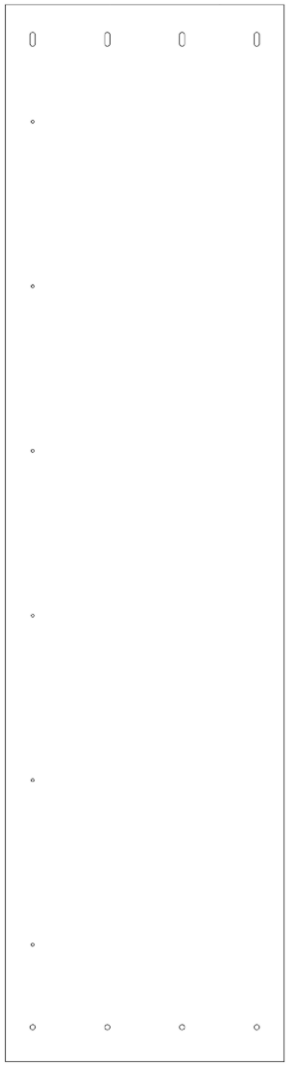






PHYSICS DIVISION	DIMENSIONS ARE IN INCHES TOLERANCES UNLESS SPECIFIED: ANGULAR: ±0° 30' TWO PLACE DECIMAL ± 0.01 THREE PLACE DECIMAL ± 0.003		NAME / DATE
		DRAWN	John C. Ramsey — Digitally signed by John C. Ramsey Date: 2025.06.09 06:17:15 -06'00'
		CHECKED	Taylor Dodson — Digitally signed by Taylor Dodson Date: 2025.06.09 10:30:49 -04'00'
		APPROVED	Yuri Kamyshkov — Digitally signed by Yuri Kamyshkov Date: 2025.06.09 16:58:00 -04'00'
			nTMM@HFIR

Prototype Friday June 6 at UT




YURI KAMY

Expected schedule

- All construction materials are in hands and final drawings are ready
- Plan to finish construction at UT by Thursday June 12 evening
- Deliver parts to GP-SANS on Friday June 13 morning
  and perform installation during Friday
- Guides closing and pumping started next week (June 19 latest)
- Dry system run without neutrons with data for ~ 1 day after July 4