Agenda of July 21, 2026 zoom meeting

1. Matt 5' Status of PRD / arXiv paper submission
2. Carolyn Haviland DPF talk at FNAL will be posted at INDICO for comments. Her actual presentation is on Thursday.
3. Yuri 10' Possible physics outcomes of nTTM-2 experiment
4. Yuri 15' Results from mu-shield prototype at UT
5. Mubi 5' Updates from UKY
6. Linus 5' Updates from LU
7. John 15' Discussion of Design Review questions for tomorrow

News: Nathalie Ziehl (PSI) thesis with recent UCN $n \to n'$ search limits can be found at https://doi.org/10.3929/ethz-c-000800962.

Zsigmond Geza (PSI) reconfirmed that they will send us soon digitally their τ vs Δm limits

Possible physics outcomes of nTTM-2 experiment

Yuri Kamyshkov

In the framework of evolution of the mixed $(n\, n')^T$ system

$$i\hbar \begin{pmatrix} \dot{n} \\ \dot{n}' \end{pmatrix} = \mathcal{H} \begin{pmatrix} n \\ n' \end{pmatrix}$$

we can consider different "magnetically compensated" Hamiltonians

$$\mathcal{H} = \begin{pmatrix} U - \mu B & \delta \\ \delta & 0 \end{pmatrix}$$

that can be explored with regeneration nTMM experiment.

In other words, we can analyze nTMM data in different theoretical models.
Or in the absence of resonance peak set limits on different parameters.

Assume two 30-min scans with ~ 80 points each with step 0.04 G

1. nTMM original scheme

$$\mathcal{H} = \begin{pmatrix} V_F - \mu B & \epsilon + \kappa\mu B \\ \epsilon + \kappa\mu B & 0 \end{pmatrix} \qquad \epsilon \ll \kappa\mu B$$

Procedure: scan only around $V_F - \mu B = 0$ is needed

Result : value of nTMM κ

2. nTMM κ and $\pm\Delta m$

$$\mathcal{H} = \begin{pmatrix} V_F \pm \Delta m - \mu B & \epsilon + \kappa\mu B \\ \epsilon + \kappa\mu B & 0 \end{pmatrix} \quad \epsilon \ll \kappa\mu B$$

Procedure: full scan in the range = $2\Delta m$
Result : 2-dimensional limits of
κ value and $\Delta m \in \pm 0.012\ neV$ $(\pm 2\ G)$

3. no nTMM, no Δm - only ϵ

$$\mathcal{H} = \begin{pmatrix} V_F - \mu B & \epsilon \\ \epsilon & 0 \end{pmatrix}$$

Procedure: scan only around $V_F - \mu B = 0$
Result : limit on value of ϵ ($\Delta m = 0, B' = 0$)
Likely not very competitive (except by cold beam)

4. no nTMM, but ϵ and $\pm\Delta m$

$$\mathcal{H} = \begin{pmatrix} V_F \pm \Delta m - \mu B & \epsilon \\ \epsilon & 0 \end{pmatrix}$$

Procedure: full scan range = $2\Delta m$

Result : 2-dimensional limits of

$\epsilon \;\; vs \;\; \Delta m \in \pm 0.012\; neV \; (\pm 2\; G)$

Likely not very competitive (except by cold beam)

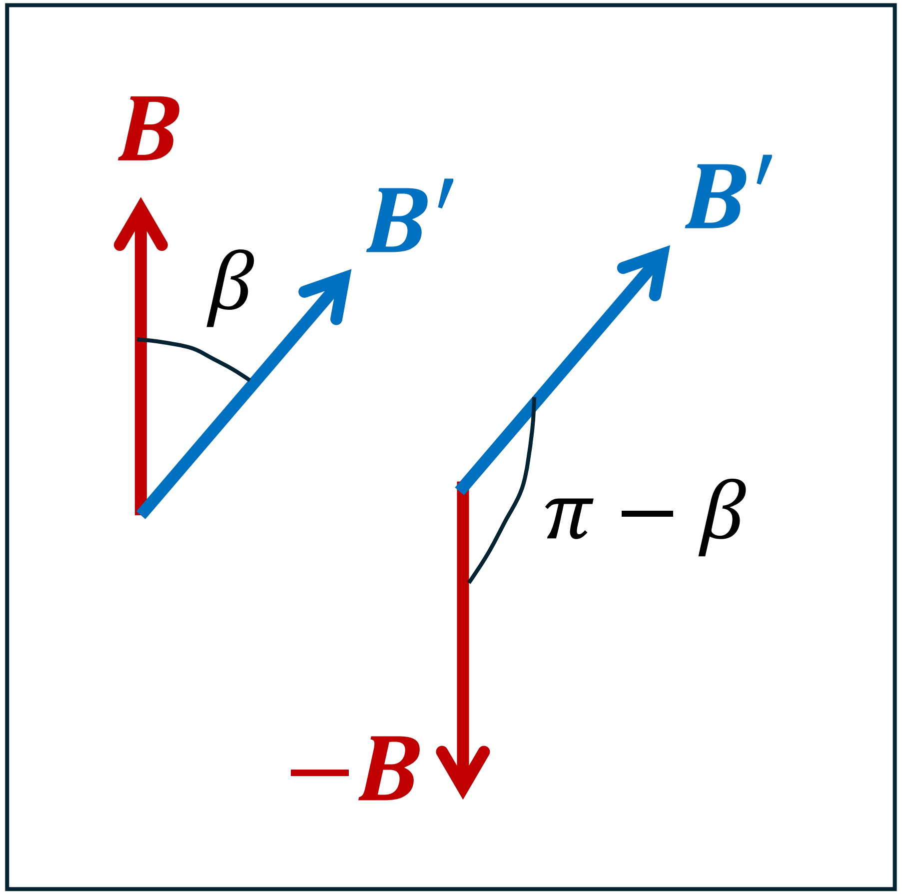
5. Mirror field B' and ϵ ; no nTMM

$$\mathcal{H} = \begin{pmatrix} V_F + \mu\vec{\sigma}\cdot\vec{B} & \epsilon \\ \epsilon & \mu\vec{\sigma}\cdot\vec{B}' \end{pmatrix}$$

Procedure: Full range scan ~ $\pm 2G$ (to compensate B')

Result : 2-dim limits ϵ $(\mathrm{or}\ \tau)$ vs B'

- Width of expected resonance is a QM effect depending on the average TOF provided by n-spectrum (similar for all)
- We might have an advantage of cold beam vs UCN in B' search. In our cold beam scenario B' signal doesn't depend on β. (assuming that depolarization in regeneration is not essential)



$$P_{\boldsymbol{B}}(t) = \mathcal{P}_B(t) + \mathcal{D}_{\boldsymbol{B}}(t) = \mathcal{P}_B(t) + D_B(t)\cos\beta,$$

where β is the angle between the vectors $\boldsymbol{B}$ and $\boldsymbol{B}'$ and

$$\mathcal{P}_B(t) = \frac{\sin^2[(\omega-\omega')t]}{2\tau^2(\omega-\omega')^2} + \frac{\sin^2[(\omega+\omega')t]}{2\tau^2(\omega+\omega')^2},$$

$$D_B(t) = \frac{\sin^2[(\omega-\omega')t]}{2\tau^2(\omega-\omega')^2} - \frac{\sin^2[(\omega+\omega')t]}{2\tau^2(\omega+\omega')^2},$$

with $\omega = \frac{1}{2}|\mu B|$ and $\omega' = \frac{1}{2}|\mu B'|$. $\tau = \hbar/\epsilon$

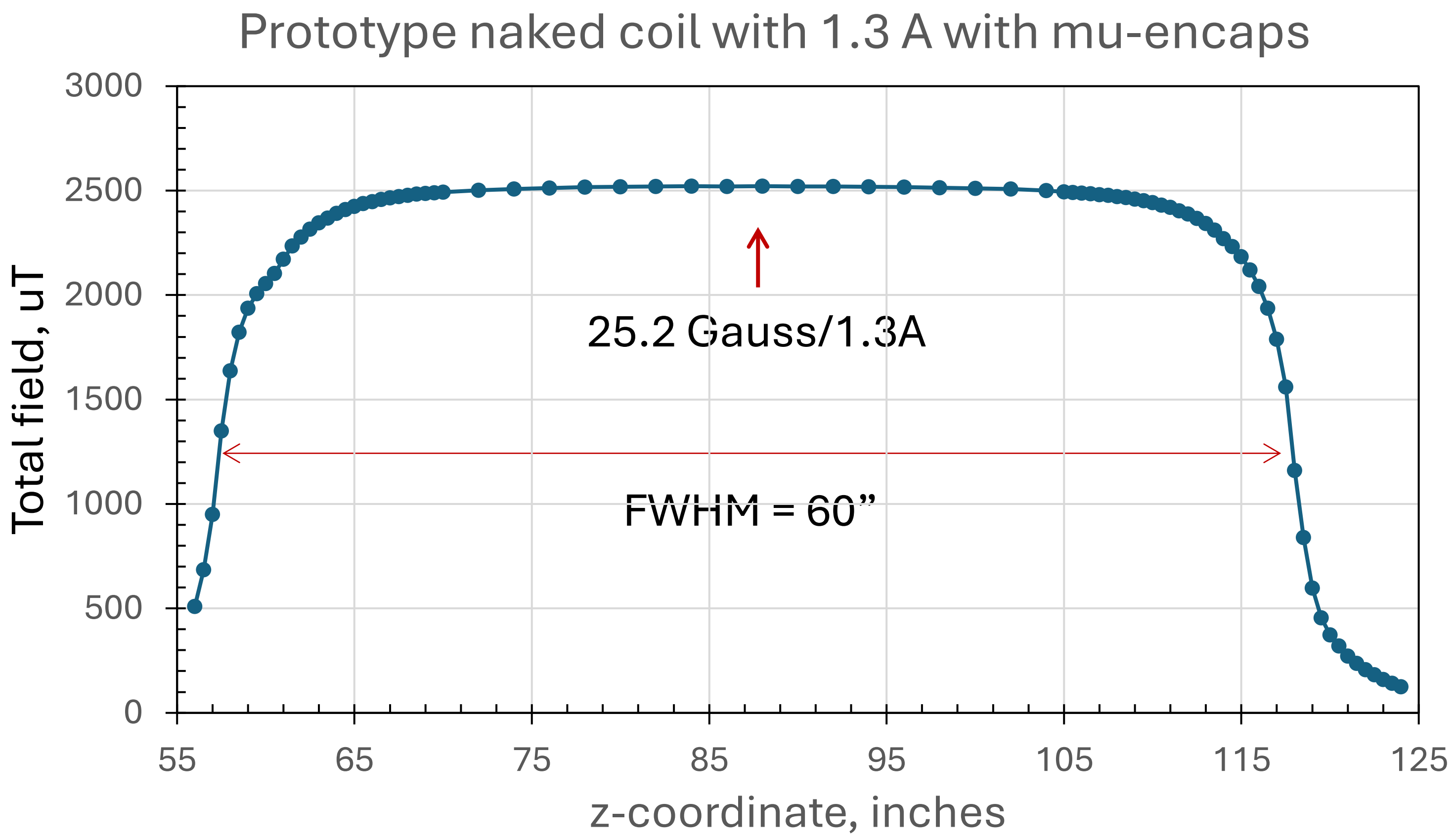
July 21, 2026 – nn’ zoom meeting

Results from $\mu -$ shield prototype at UT

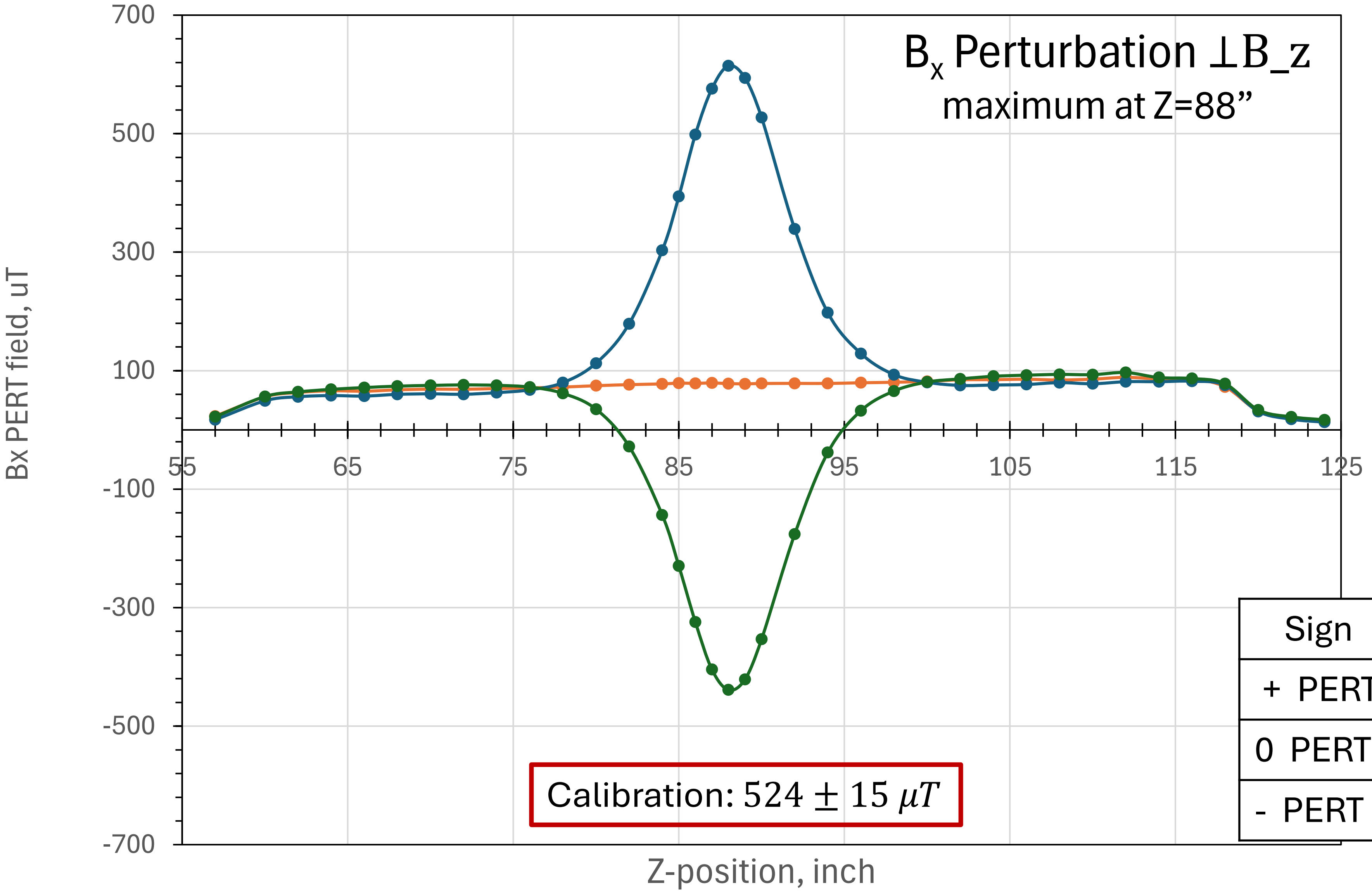
Y. Kamyshkov & S. Vavra

July 16, 2026

Naked Coil, no mu-metal, no PERT



Naked Coil, with PERT, Coil current 1.3 A



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

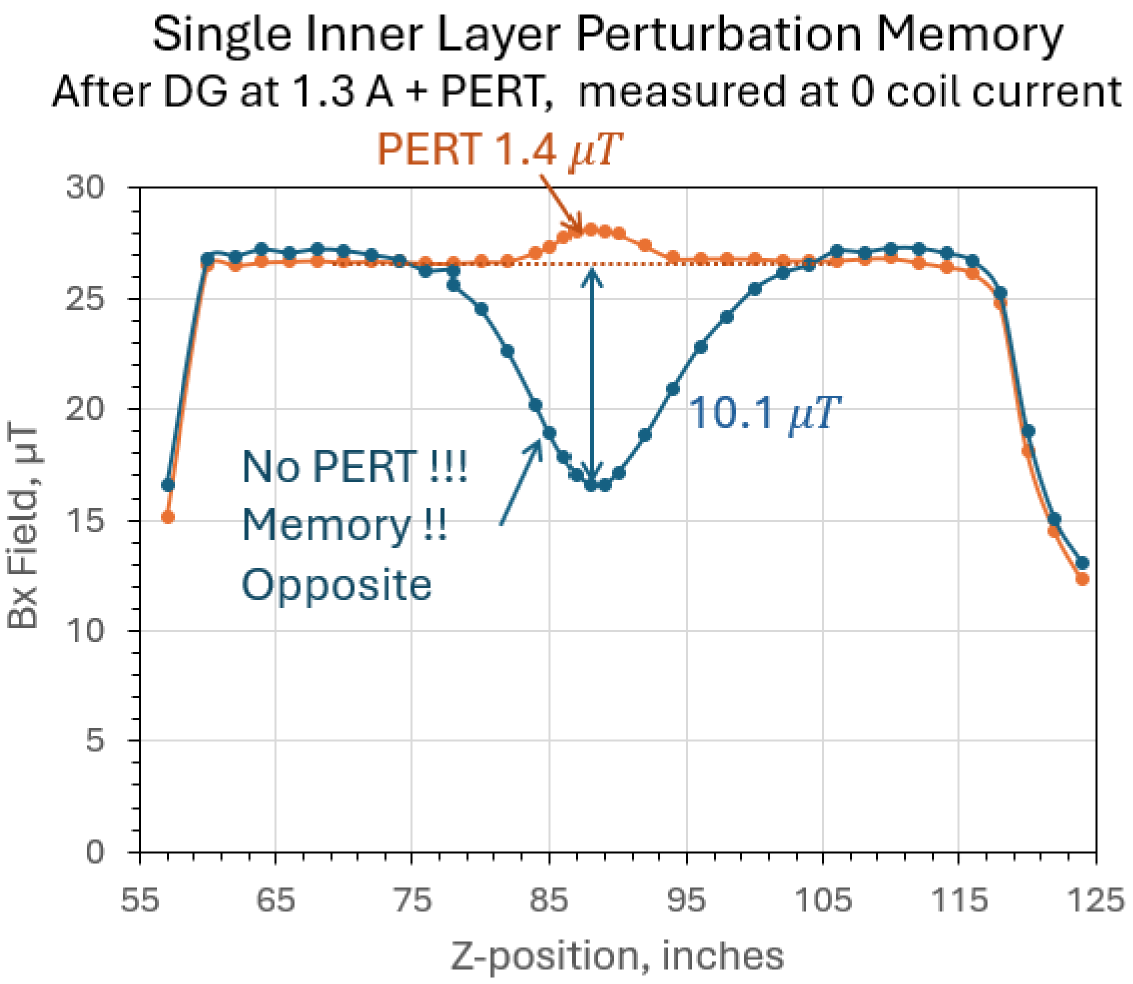
By PERT current inversion

- Degaussing of mu-metal should be performed with the magnet and perturbation state close to operational !

- Our standard mode of degaussing was with + PERT and coil 1.3 A

- By degaussing the shielding remembers the perturbation with opposite sign →

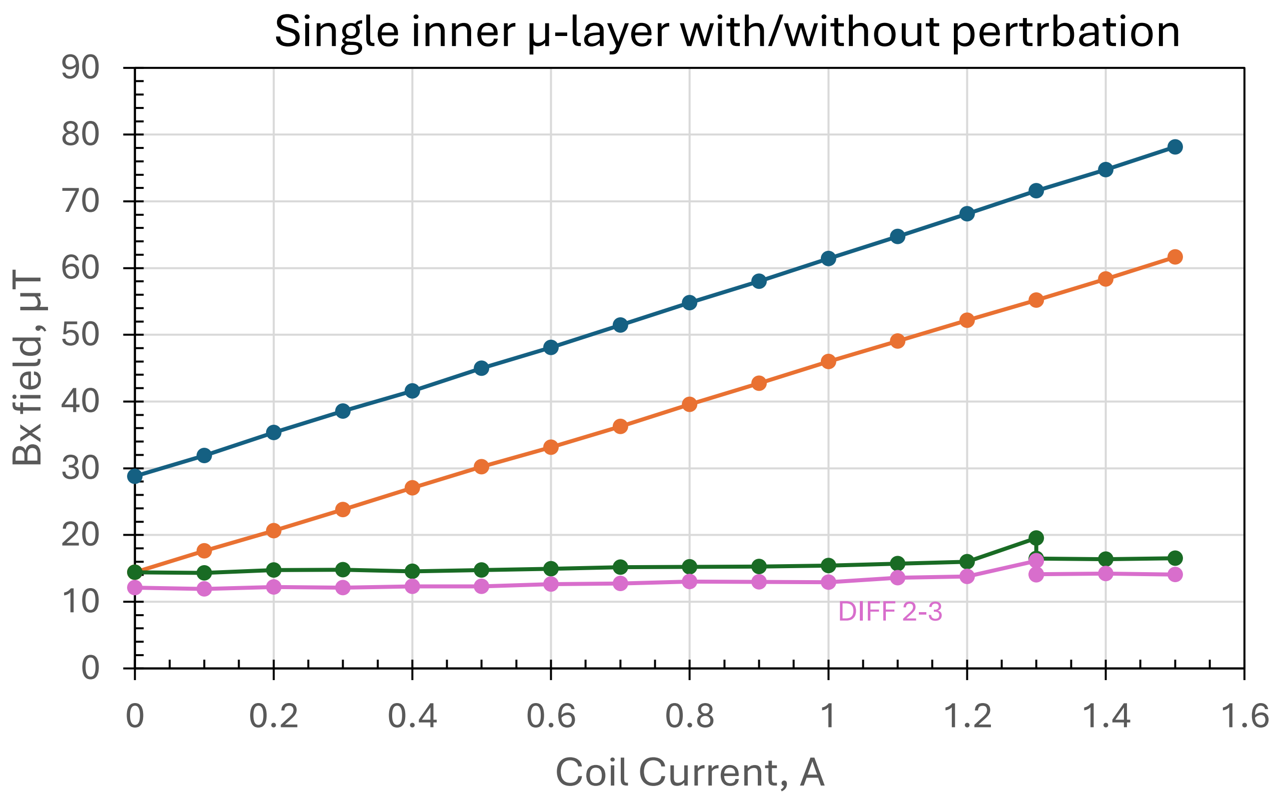
- For Shielding Factor measurement it was important to set magnetometer position on the peak of PERT



1 μ - inner layers

- Major question was how shielding factor will change with the saturation of mu-metal serving as flux return yoke of the solenoid.

Standard degaussing, B_x field with/without perturbation at z peak position 88”



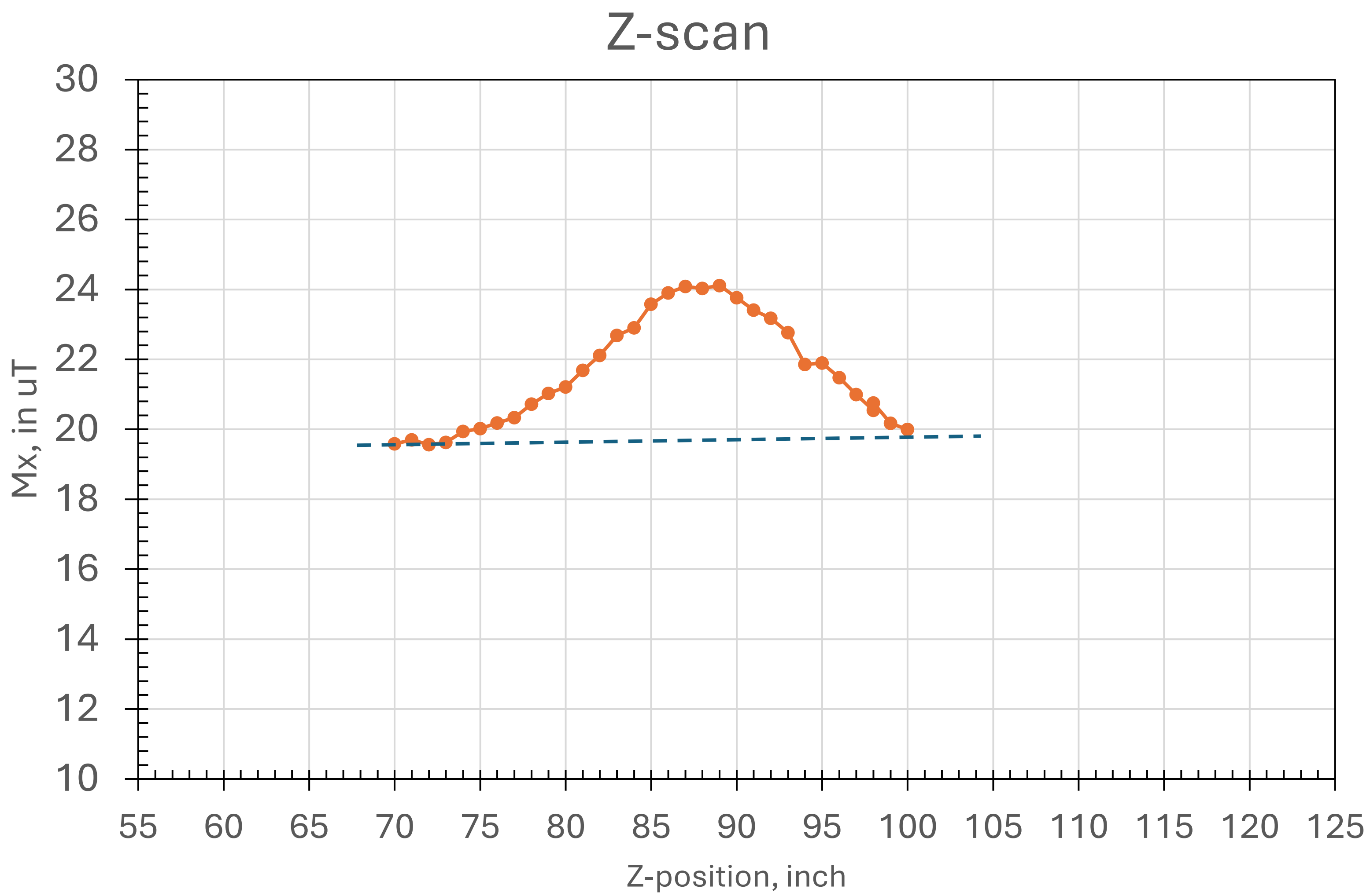
Single inner mu-layer
Seen PERT at 1.3 A
$\overline{\text{PERT}}$= 16.1 $\pm$ 1.8 μT

DIFF dependence on current
~ 14.18 + 1.47$\cdot$ $i(A)$ μT

2 µ - inner layers

Double shielding is good. Difficult to see the perturbation peak after 2-μ shield

Special degaussing with 0A and NO PERT. Then, Z-scan with PERT, current 0 A



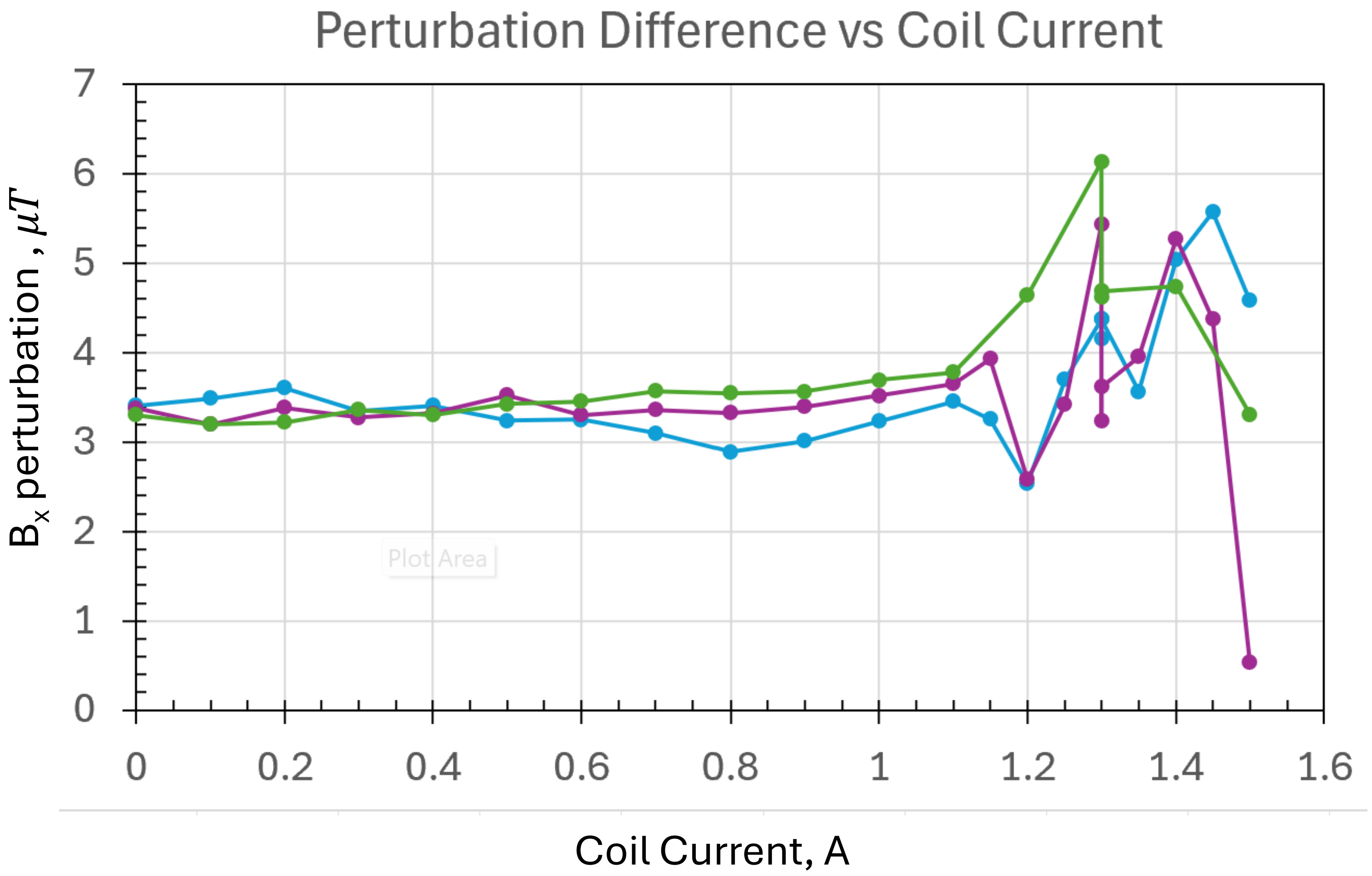
Peak position 88”

Perturbation ~ 4.5 μT

2 μ - inner layers

After Standard Degaussing, Z=88”. DIFF=PERT-NOPERT, with Air

At smallest PERT signals (double layer) with large coil current temp. regime is not stable



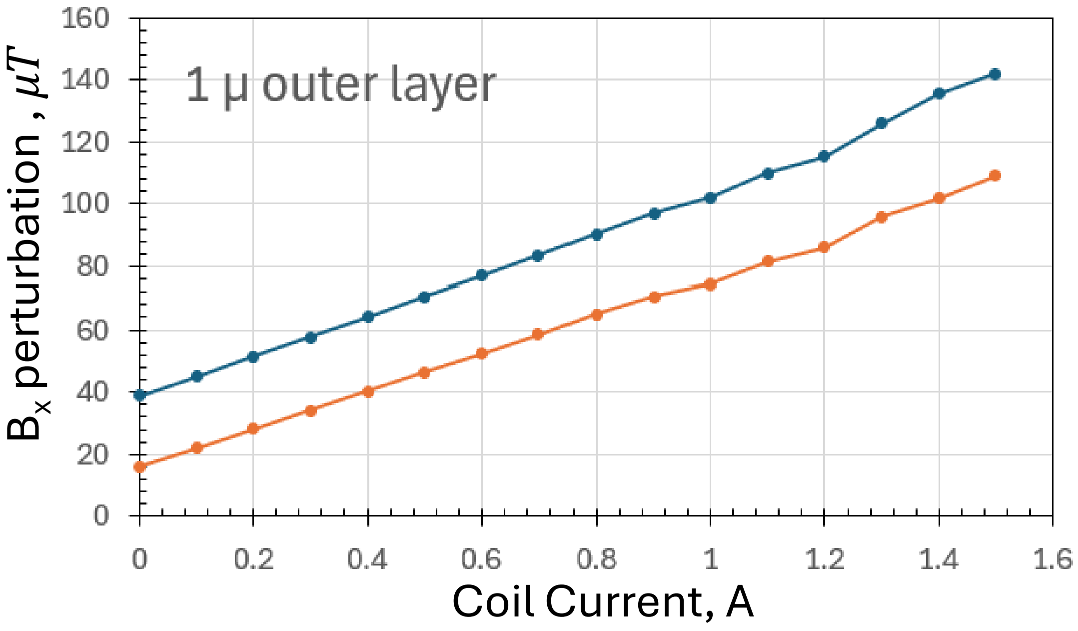
Double inner mu-layer
Seen PERT at 1.3 A
$\overline{\text{PERT}} = 4.51 \pm 0.61\ \mu T$

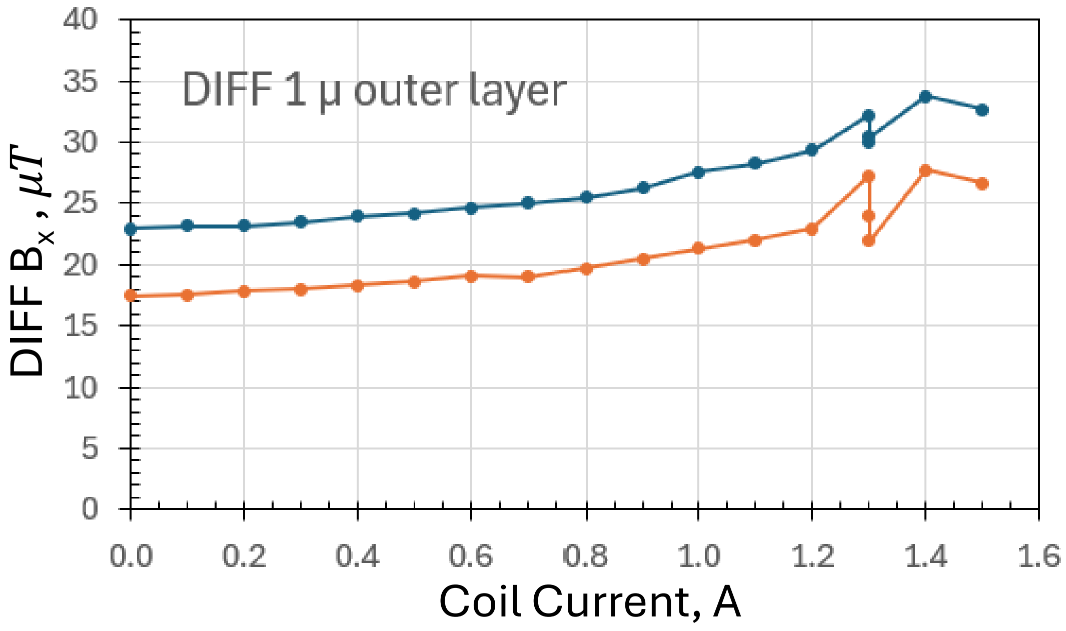
DIFF dependence on current
~ $1.2965i^2 - 1.2367i + 3.5084\ \mu T$

July 15, 2026

1 μ - OUTER layers

Standard degaussing, B_x field with/without perturbation at z peak position 88”



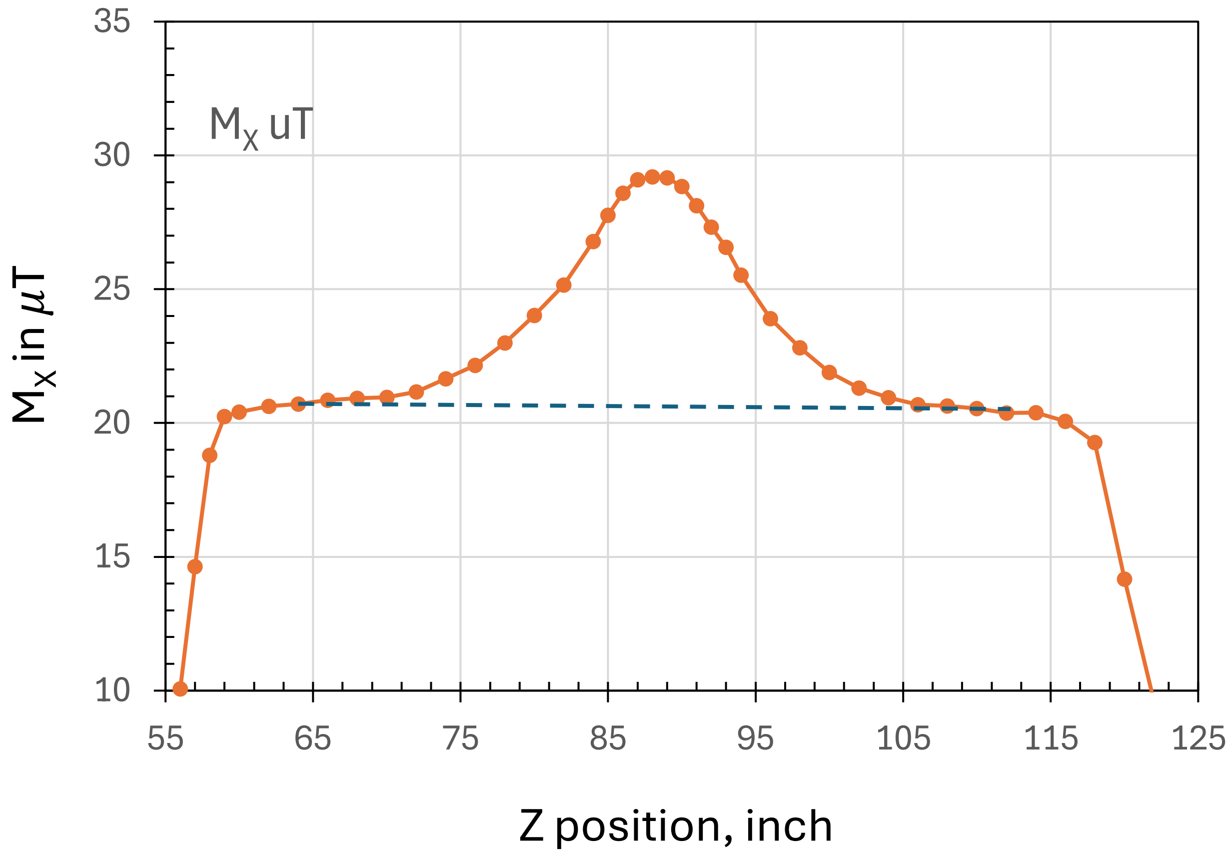


Single outer mu-layer seen PERT at 1.3 A
$\overline{\text{PERT}} = 27.6 \pm 3.7\ \mu T$

DIFF dependence on current
~ $5.27i^2 - 1.26i + 20.46\ \mu T$

2 μ - OUTER layers

Special degaussing with 0A and NO PERT. Then, Z-scan with PERT, current 0 A

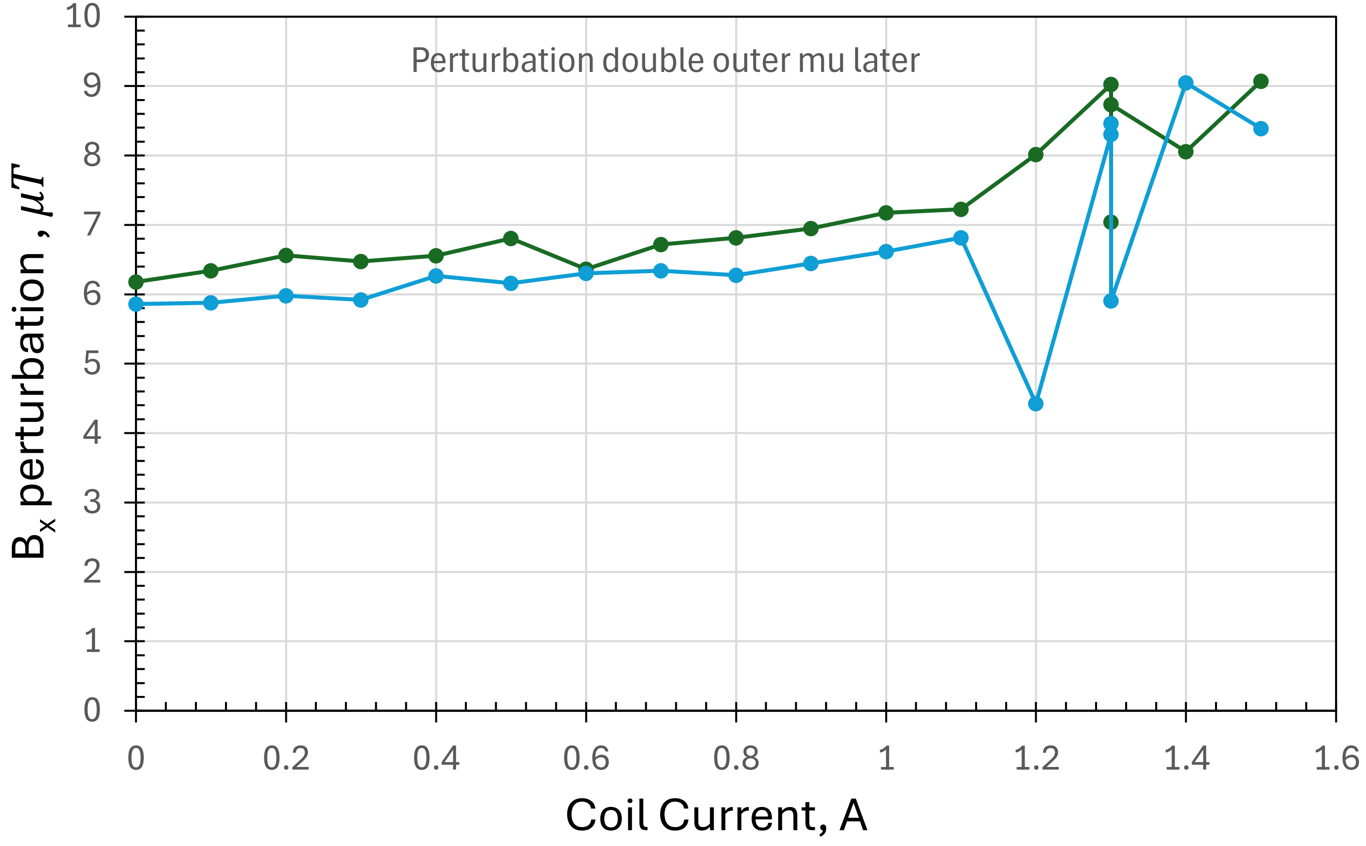


Peak position 88”
Perturbation ~ 8.6 μT

2 μ - OUTER layers

July 14-15, 2026

After Standard Degaussing, Z=88”. DIFF=PERT-NOPERT, with Air



Double outer mu-layer
Seen PERT at 1.3 A
$\overline{\text{PERT}} = 7.9 \pm 1.1\ \mu T$

DIFF dependence on current
~ $1.713i^2 - 1.088i + 6.311\ \ \mu T$

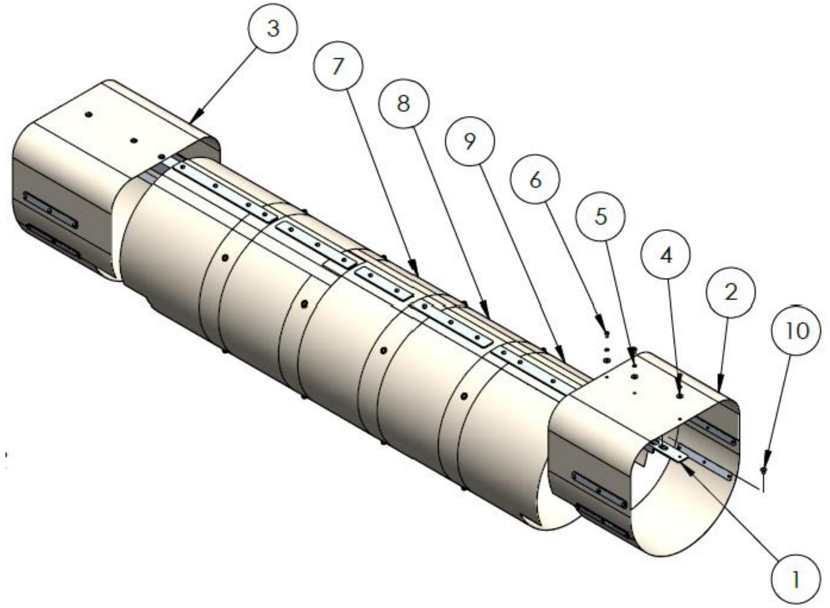
Summary of shielding factors

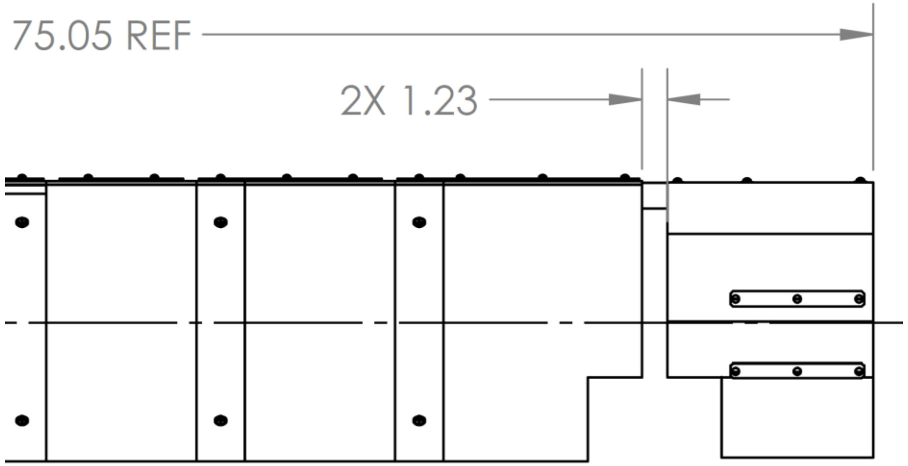
All measurements are after standard degaussing with coil current 1.3 A (~ 25 Gauss)

Configuration	Diameter, inch	Seen PERT μT	SF	μ_{eff}
1μ inner layer	7.5	16.1$\pm$1.8	32.6$\pm$ 3.8	13,317
2μ inner layer	7.6	4.51 ± 0.61	116.2$\pm$16.1	24,050
1μ outer layer	9.0	27.6 ± 3.7	19.0$\pm$2.6	11,220
2μ outer layer	9.1	7.9 ± 1.1	66.3$\pm$9.4	19,794

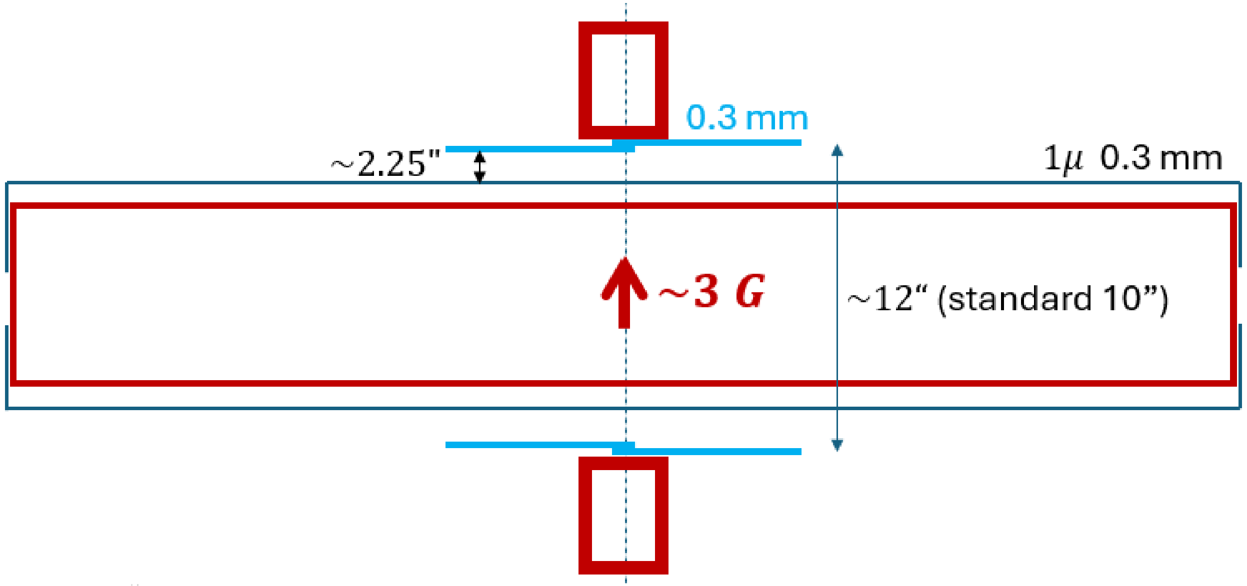
- We do not have degaussing of the outer layer – maybe we should
- Double layer seems have higher μ probably due to effective space between two layers
- Layer thickness calculated effectively accounting for sheets overlay

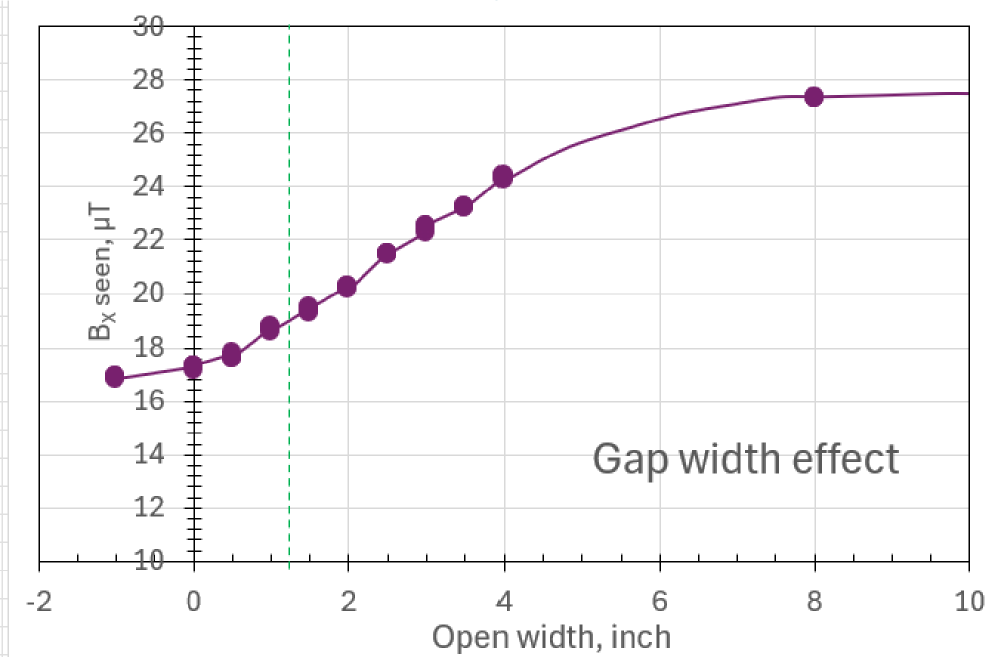
Gap in nTMM outer shield

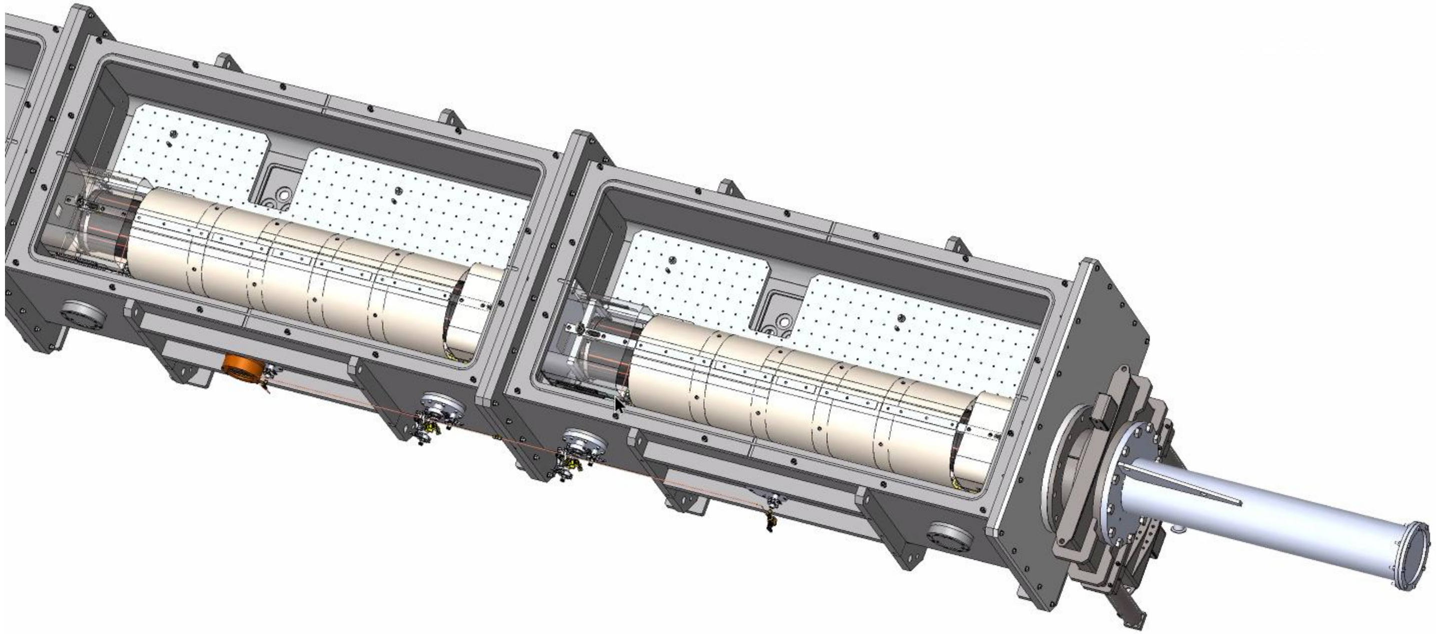




Gap simulated in prototype







Changes From Previous Run

- CO_2 cans to be connected to each other (via 1/8" copper tubing) to ensure consistent CO_2 pressure
- CO_2 charge pressure to be increased 10% to mitigate any leakage during transportation or installation
- Preparation for the possibility of CO_2 gas recharge
- An additional borated poly beam stop is added between the CO_2 cans upstream of the cadmium beam stop
- The cadmium beam stop previously located in the downstream end of chamber 7 is moved to the upstream end of chamber 8
- The outer magnetic shield has been augmented with a second layer of mu-metal for improved shielding + gap patch?
- Degaussing capability added to for outer shield