



Stony Brook **University**

eRD2 Progress Report Magnetic Field Cloak

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for the Magnetic Cloak Team and collaborators

EIC Generic Detector R&D Advisory Committee Meeting
Brookhaven National Laboratory, January 26, 2017

The people behind the plots

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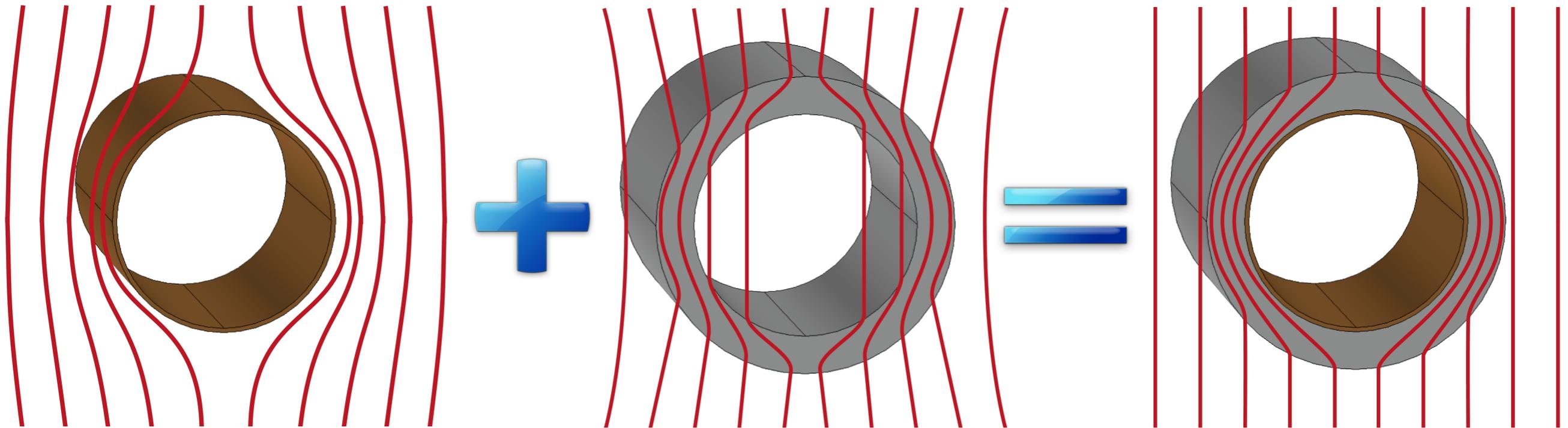
Noor Ward

Graduate Students

Raphael Cervantes

Stacy Karthas

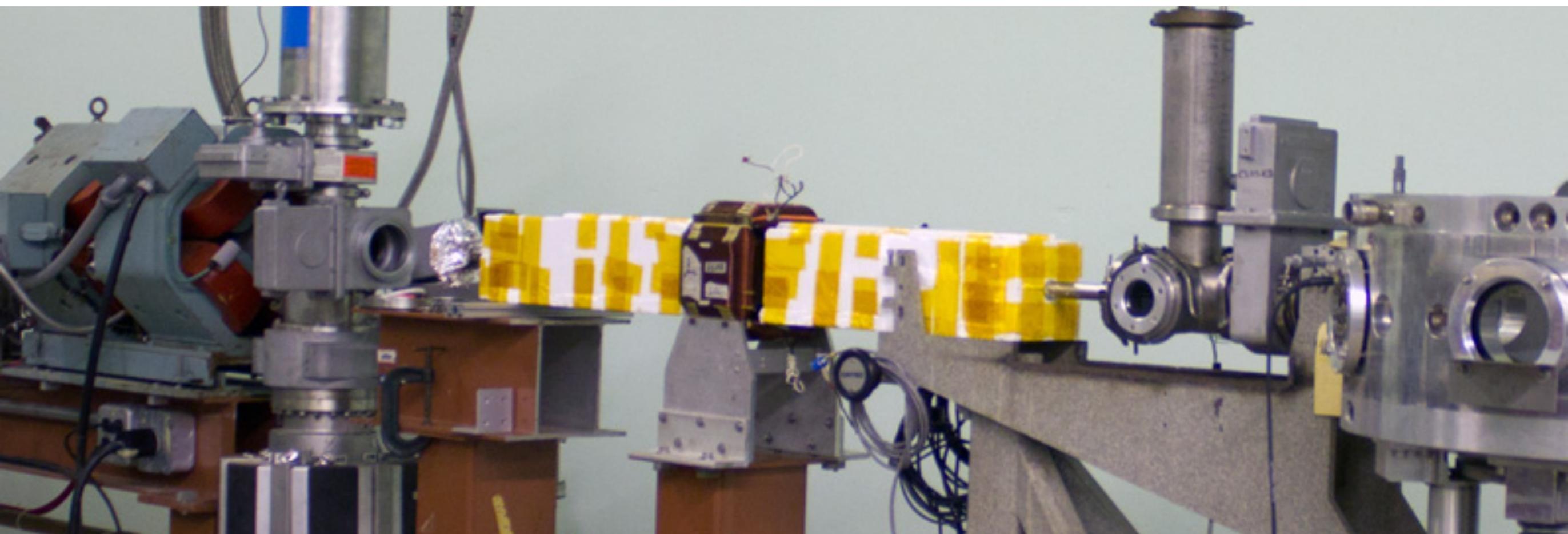
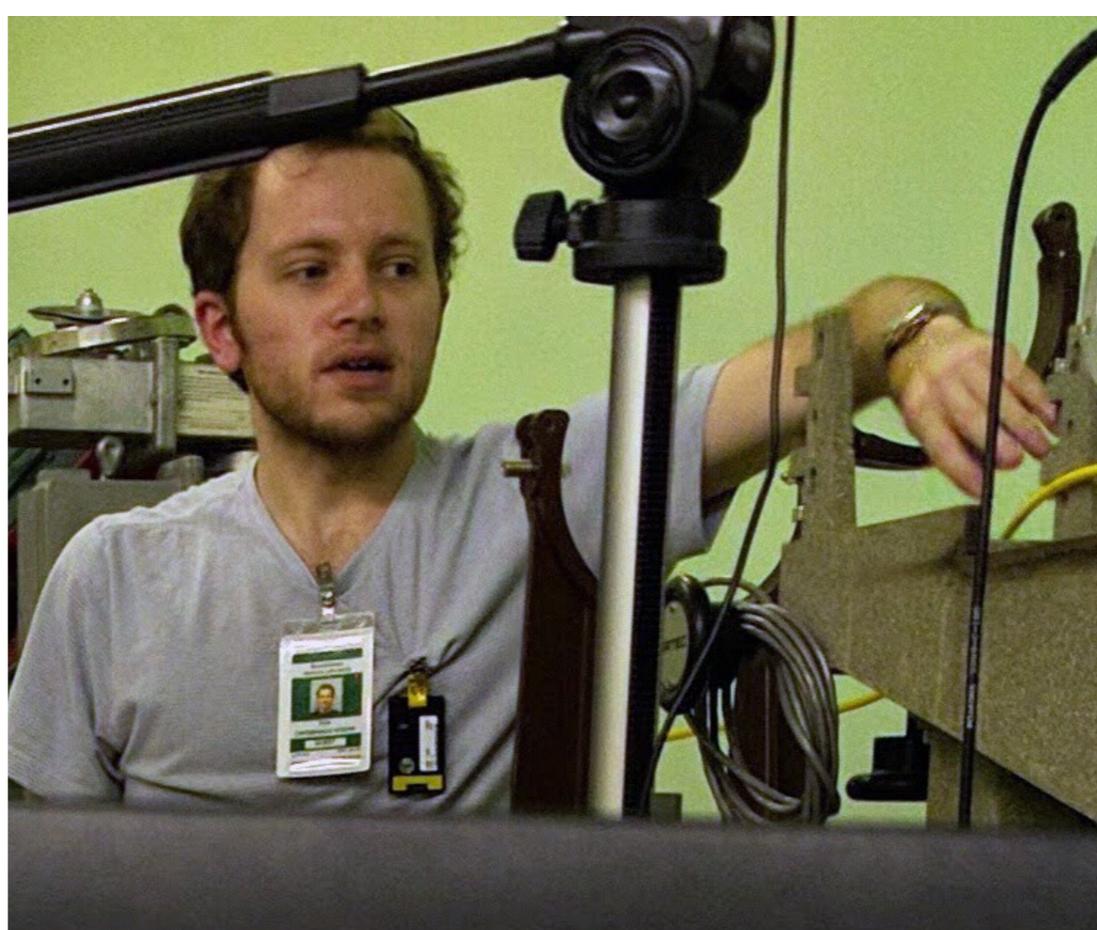
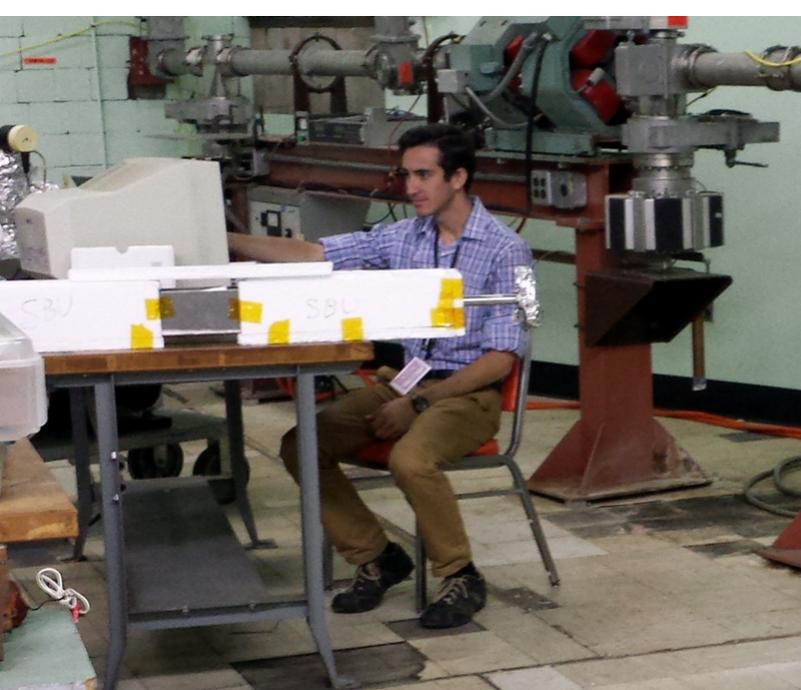
A Magnetic Field Cloak



We have completed...

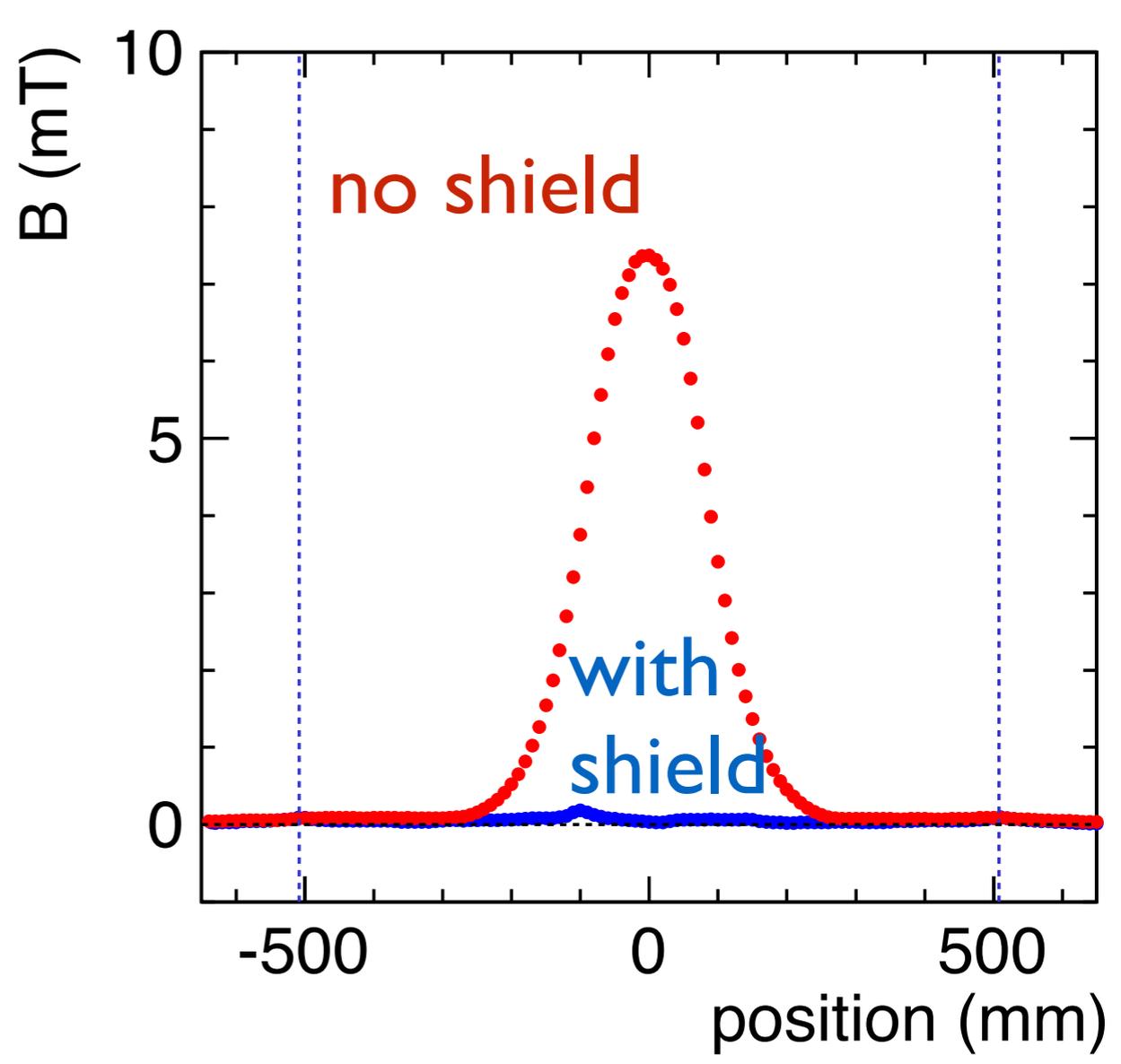
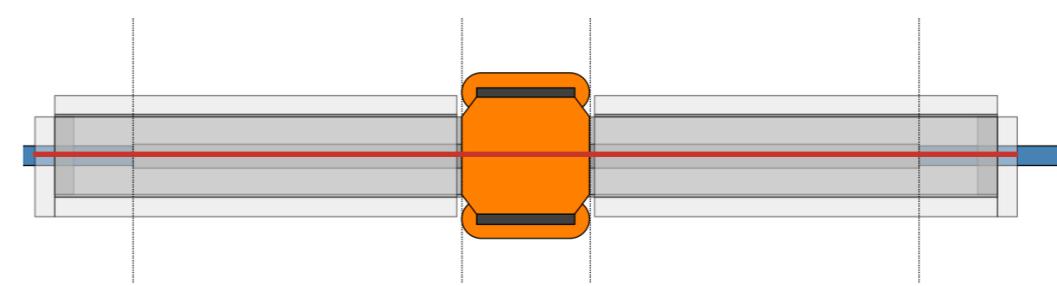
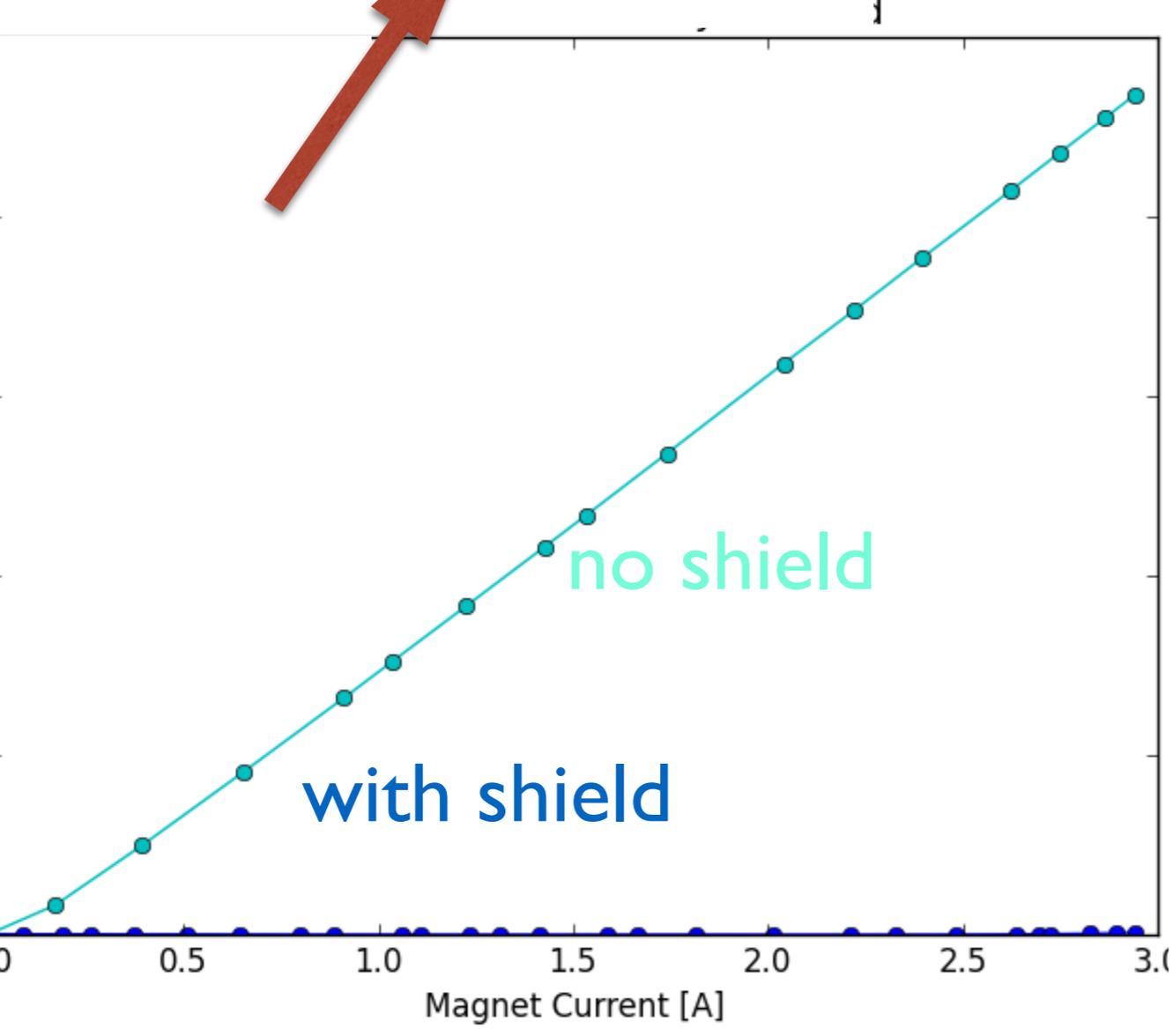
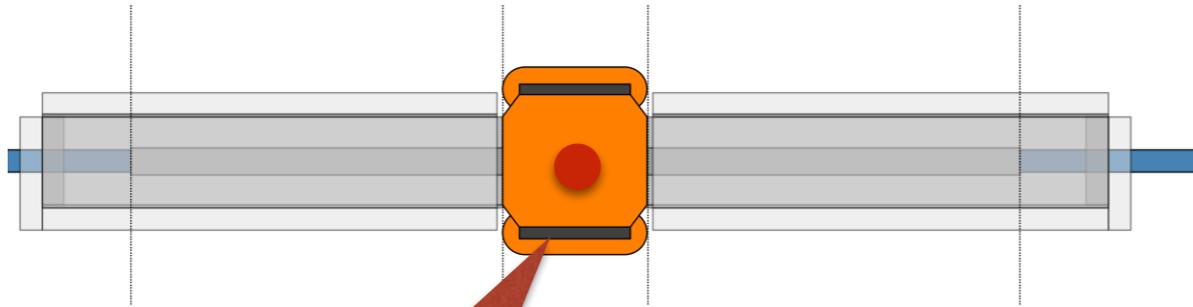
- **beam shielding** tests with the BNL Van de Graaff accelerator,
- **high-field shielding** tests with the MRI magnet at Argonne National Lab,
- **high-field cloaking** tests with the MRI magnet at Argonne National Lab.

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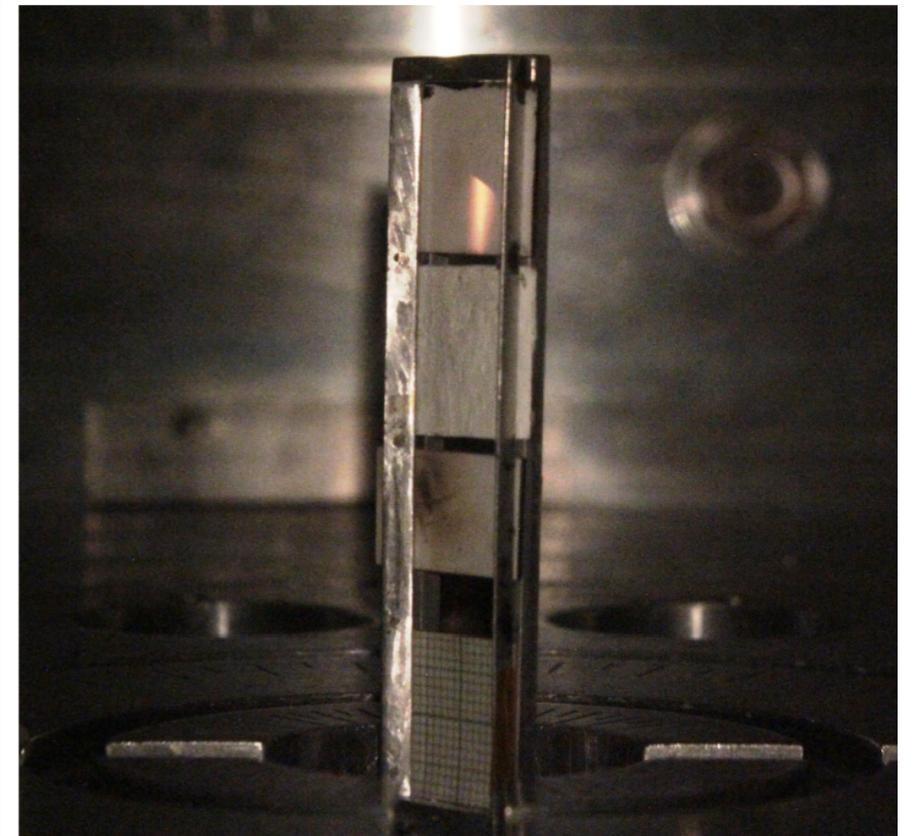
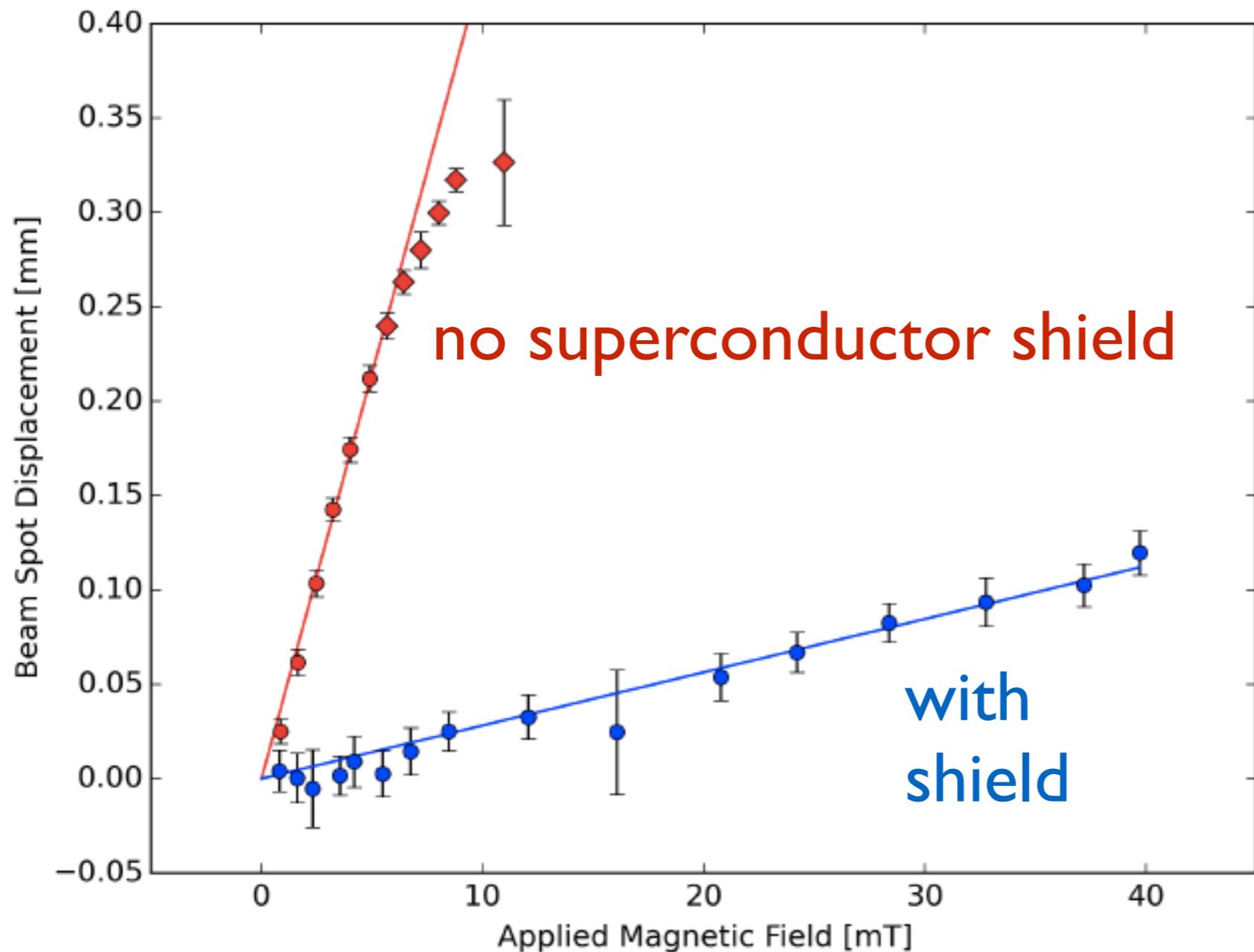


Thanks to the staff at the BNL Van de Graaff for their support

Initial tests with Hall sensors



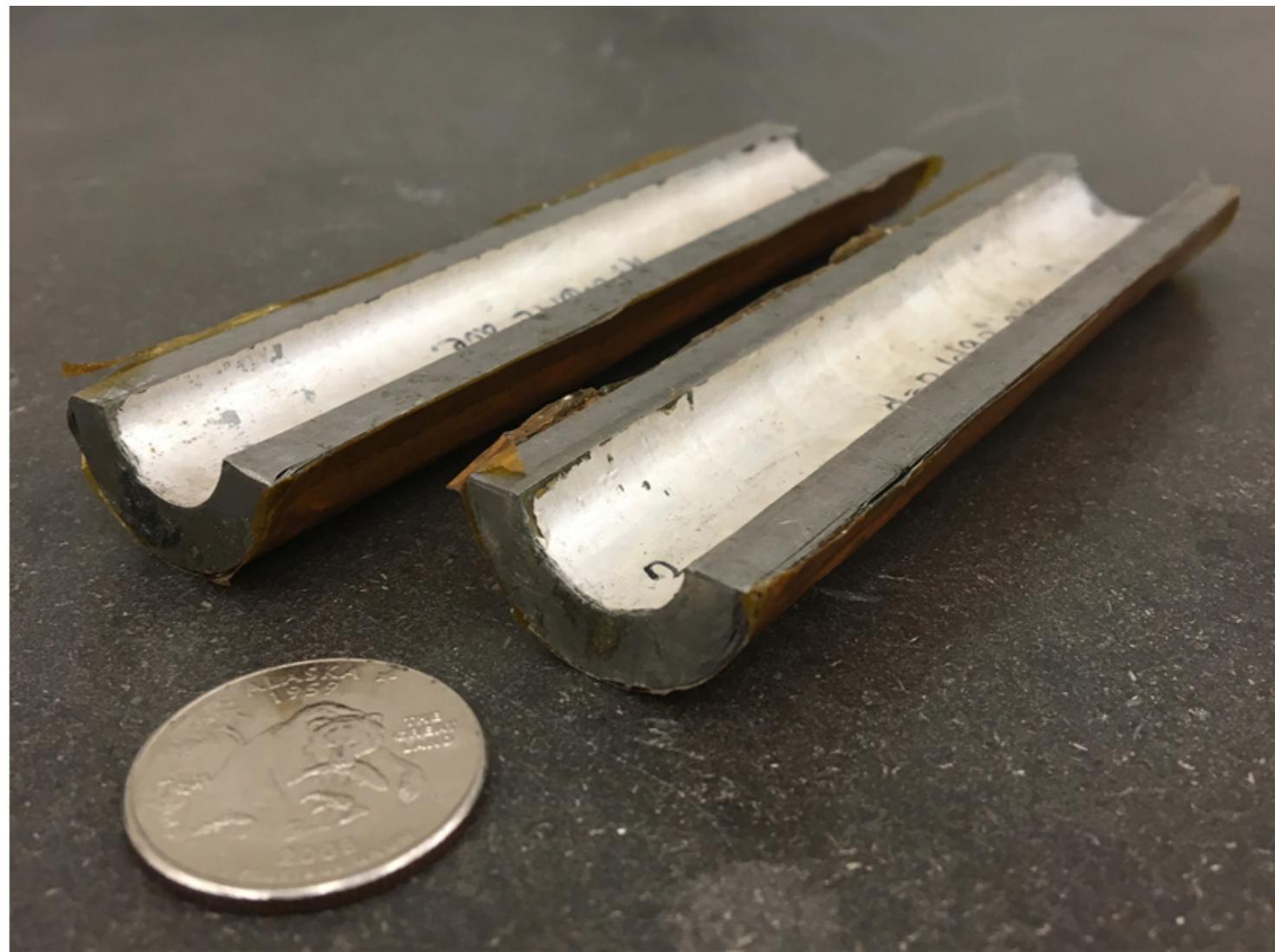
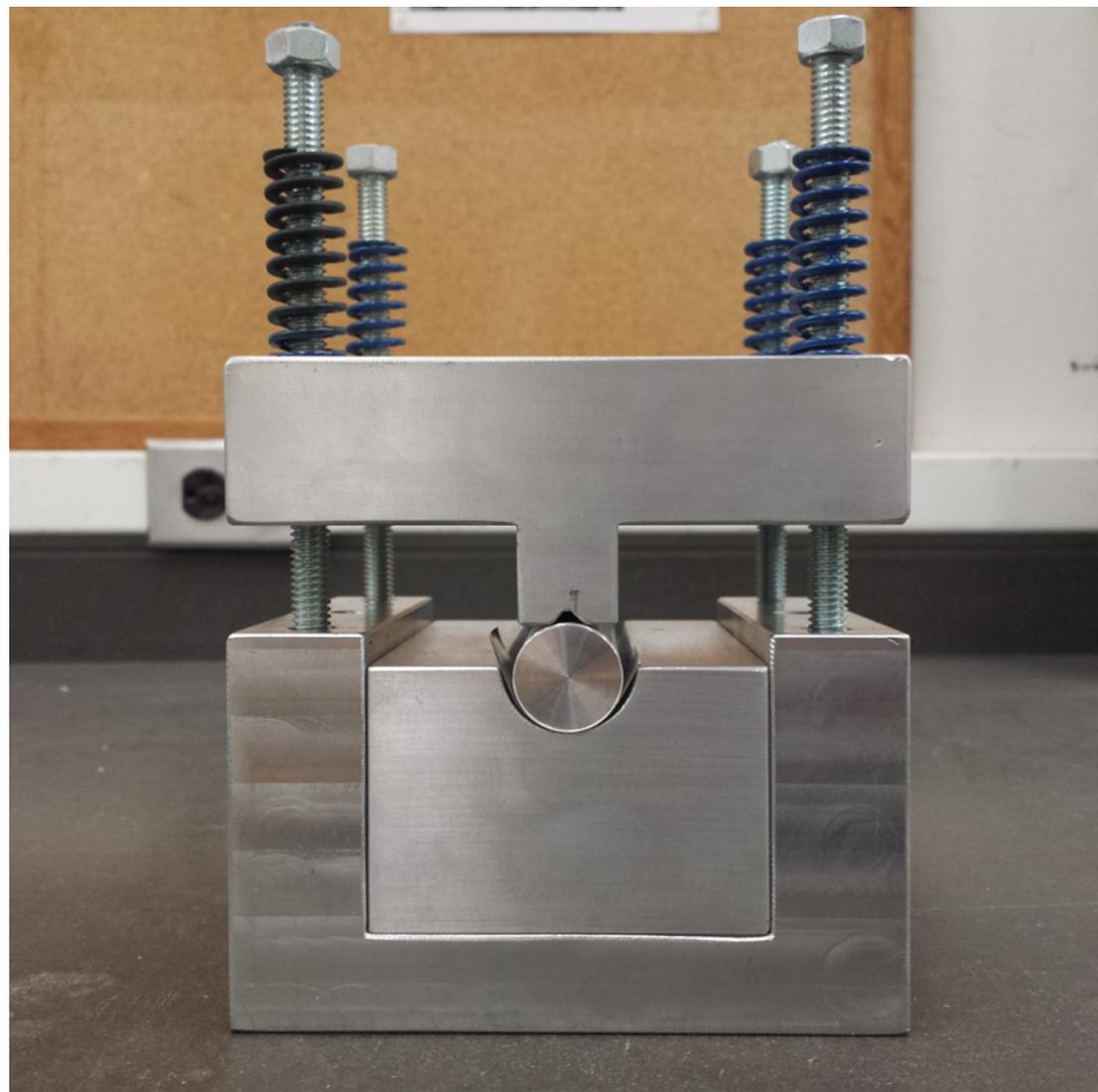
Beam Test with lithium-7 at BNL Van de Graaff

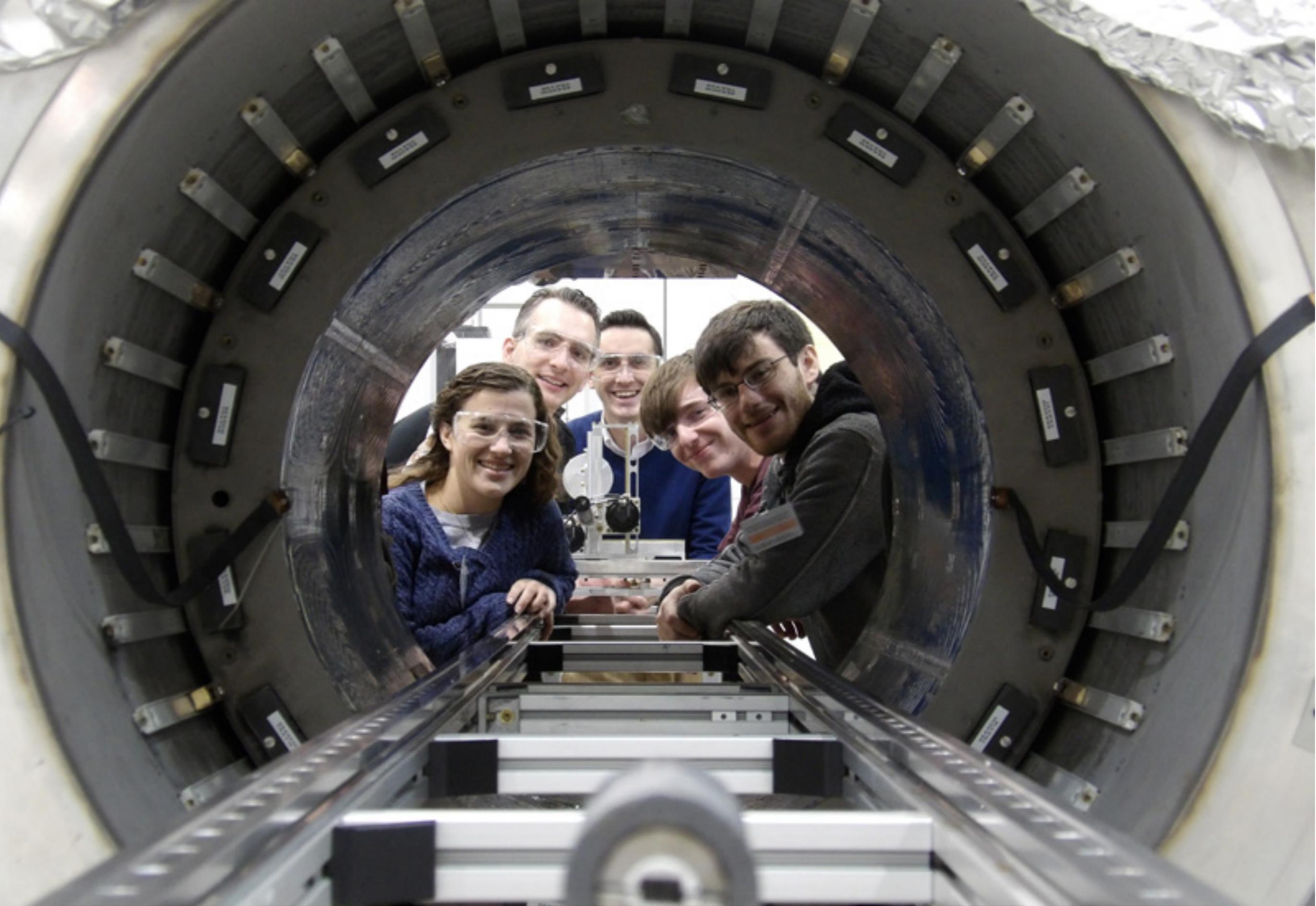


lines are linear fits to data (excluding \blacklozenge)

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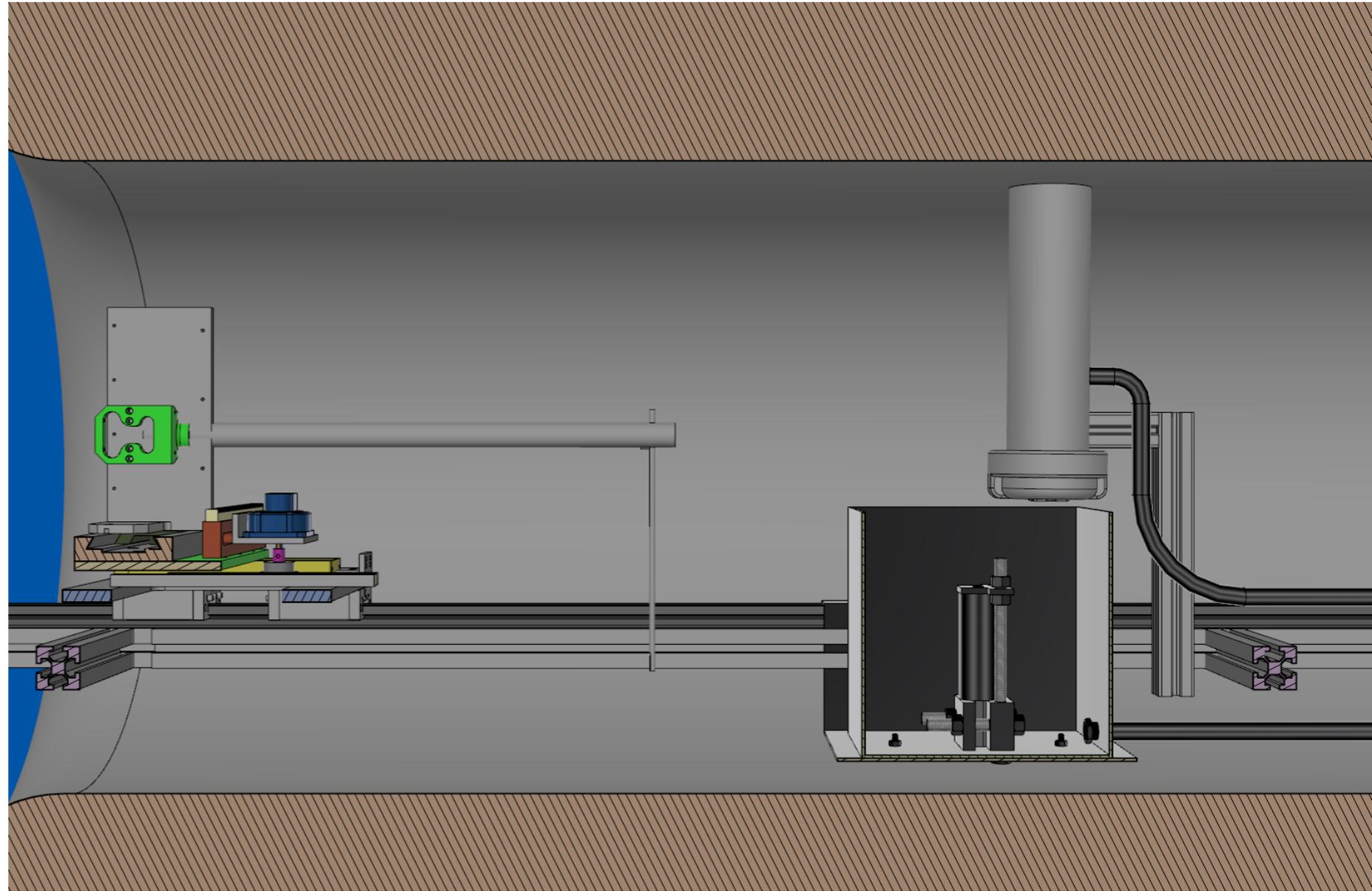
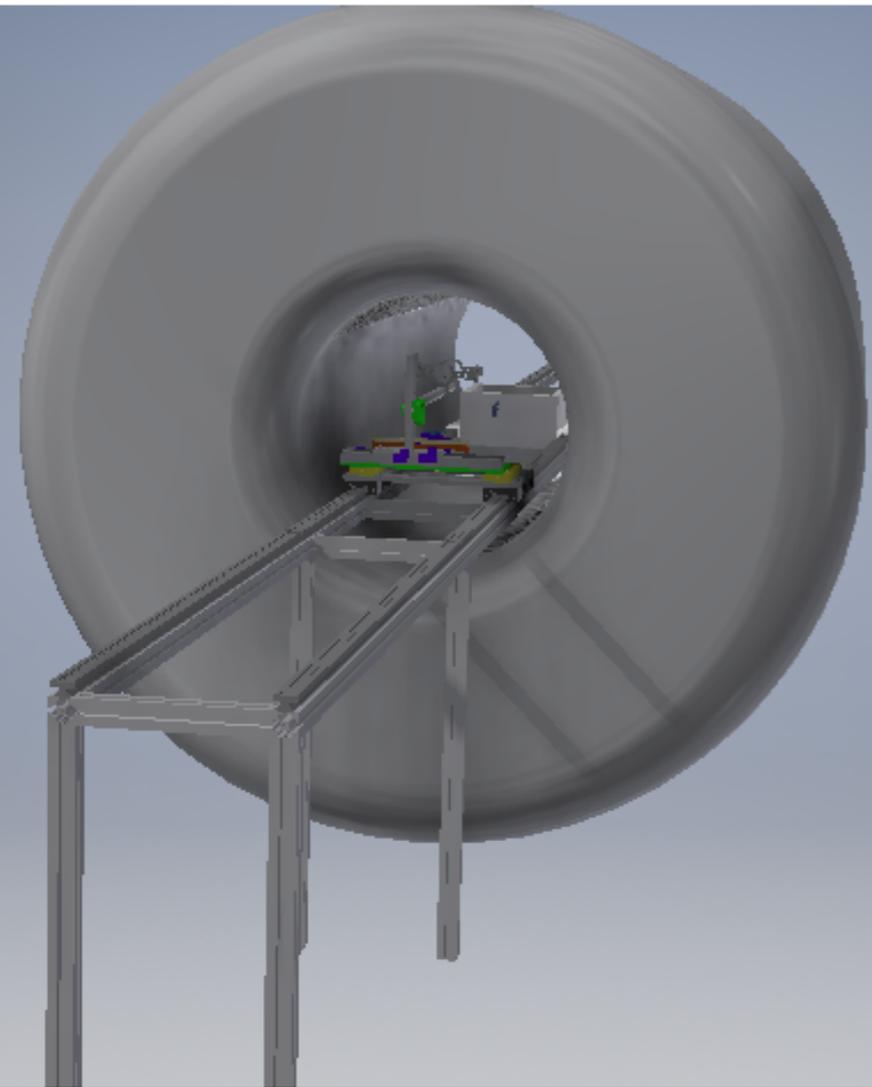
The 45 Superconductor Layer Cloak Prototype





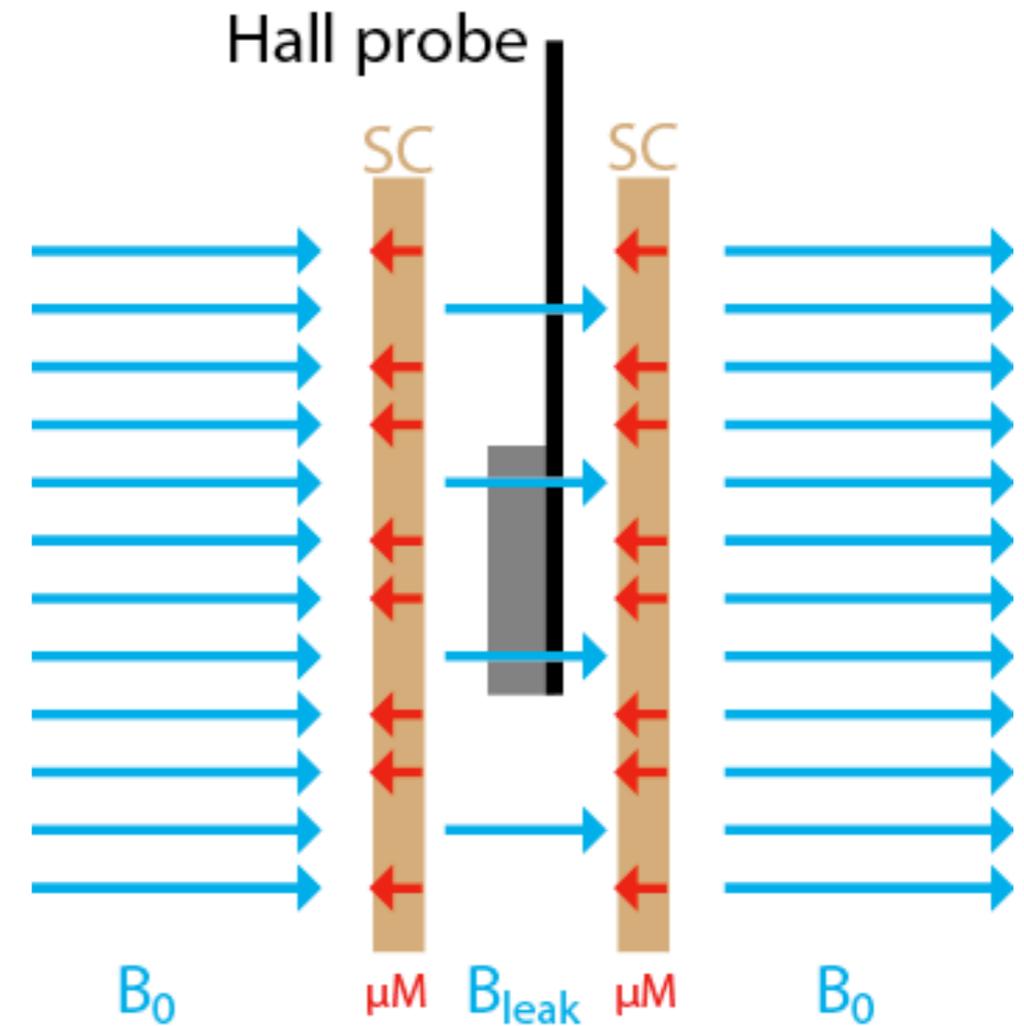
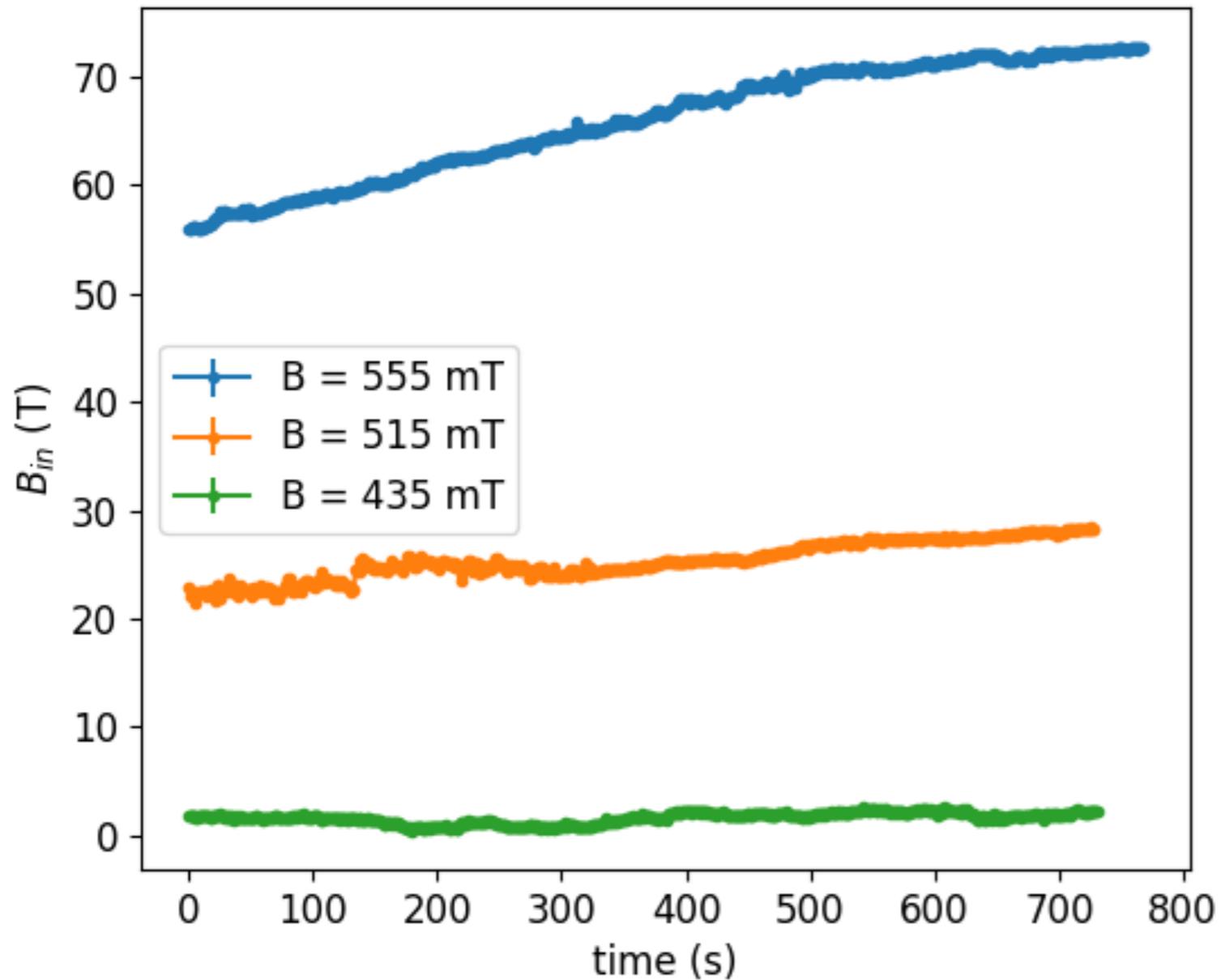
Thanks to the staff at Argonne National Lab for their support

Test setup with MRI magnet at Argonne National Lab

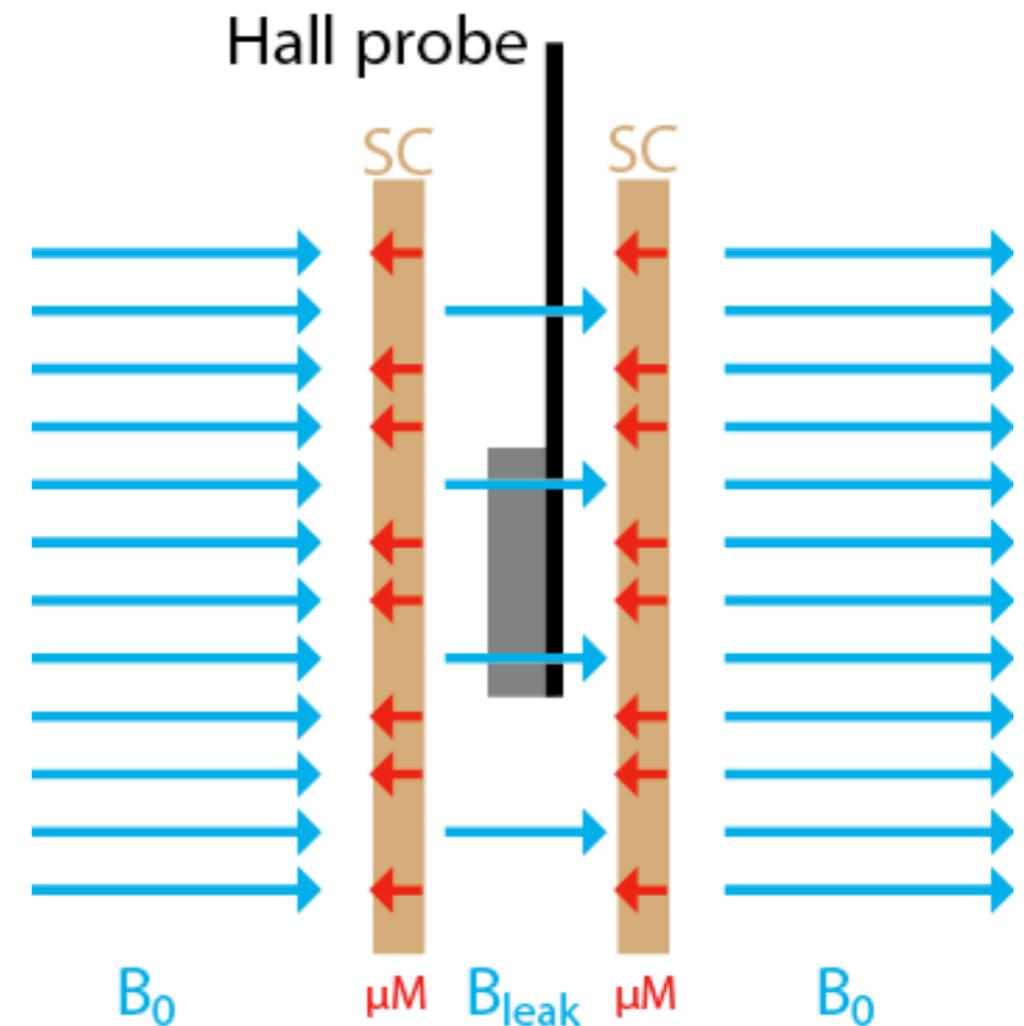
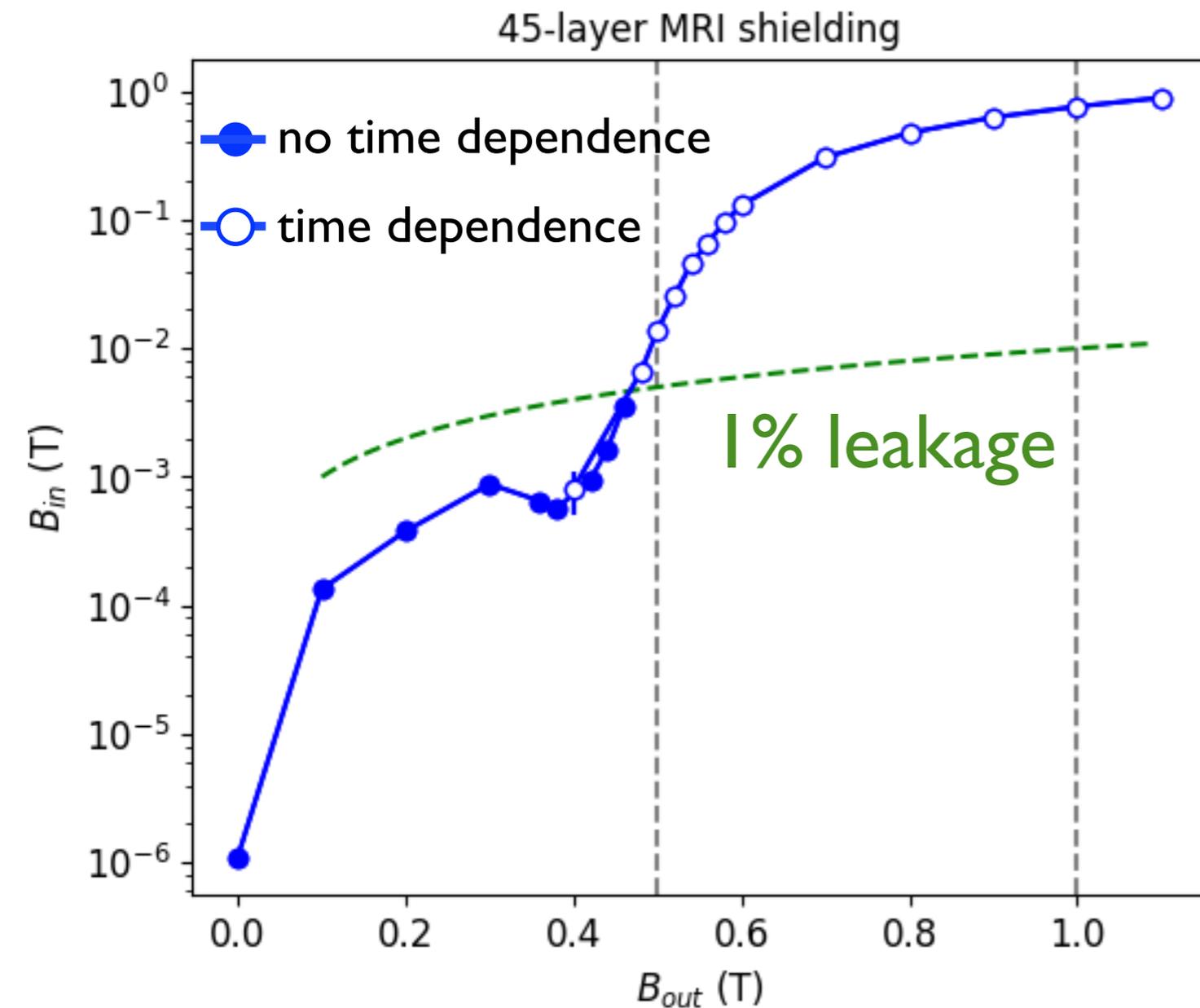


Shielding MRI Magnet Field

45-layer MRI shielding

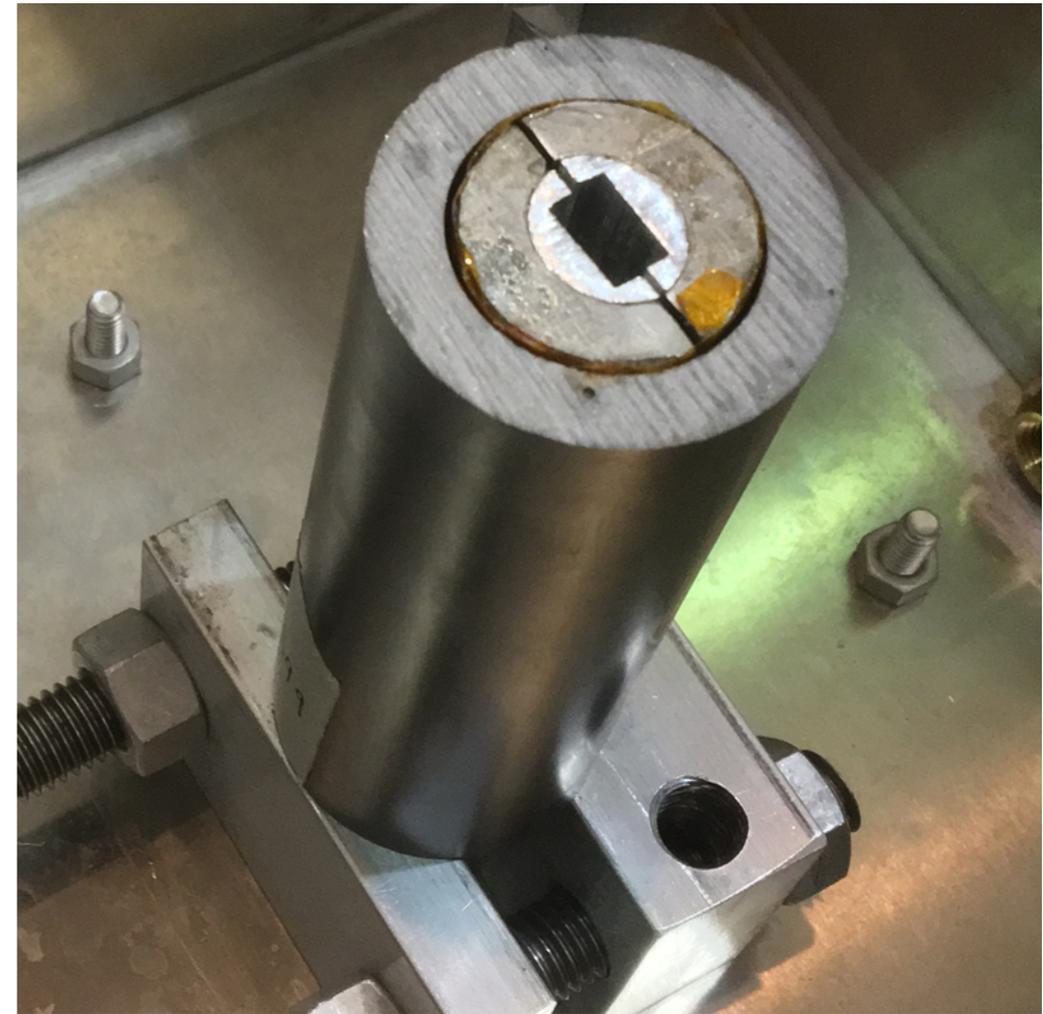
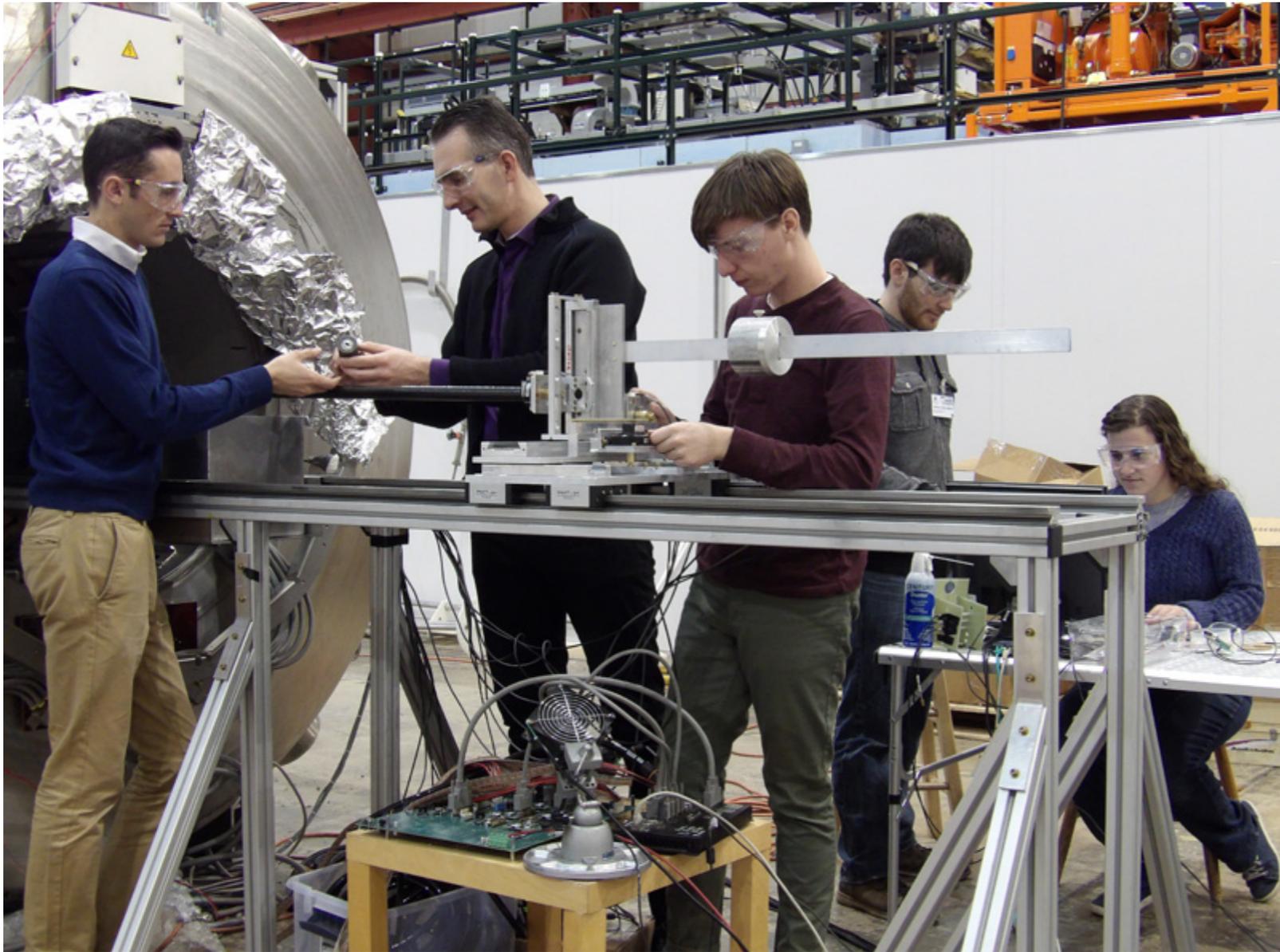


We shield 99% of 0.45 tesla!

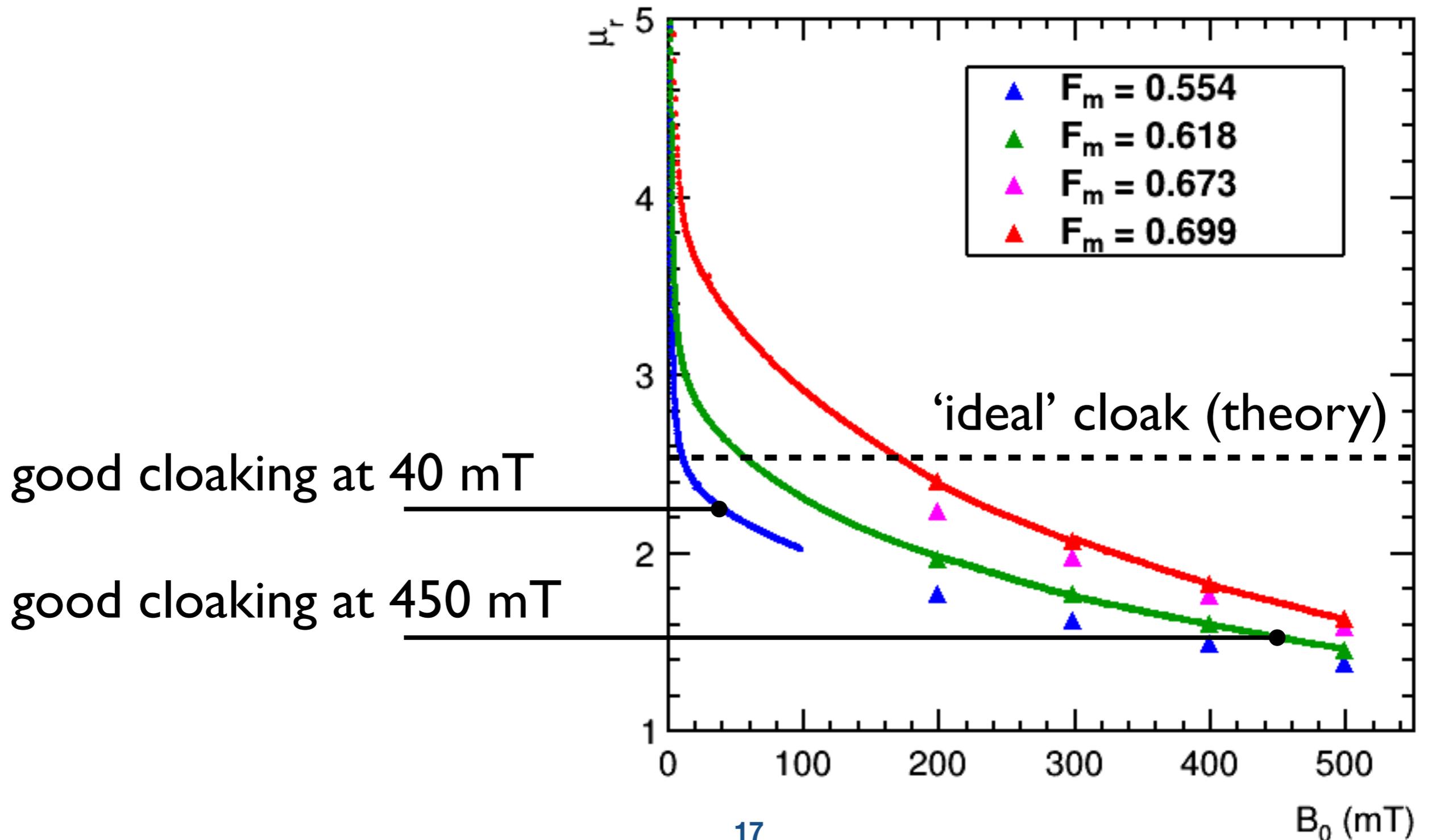


~95% shielding at 0.50 T

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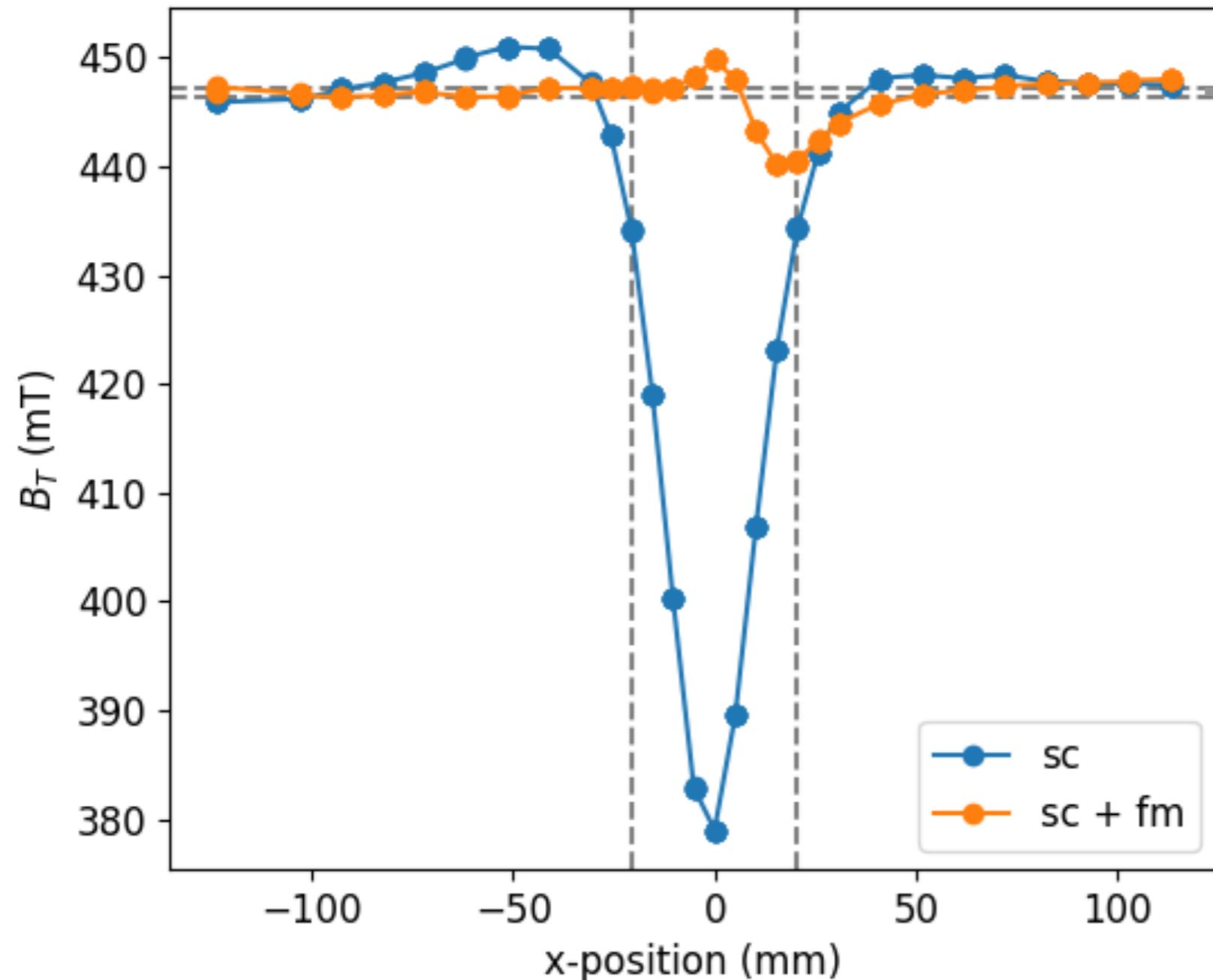


Permeabilities of different ferromagnets up to 0.5 T



Cloak reduces front field distortions by 90% at 0.45 T

Cloaking at 0.45 T (field measured in front of prototype)

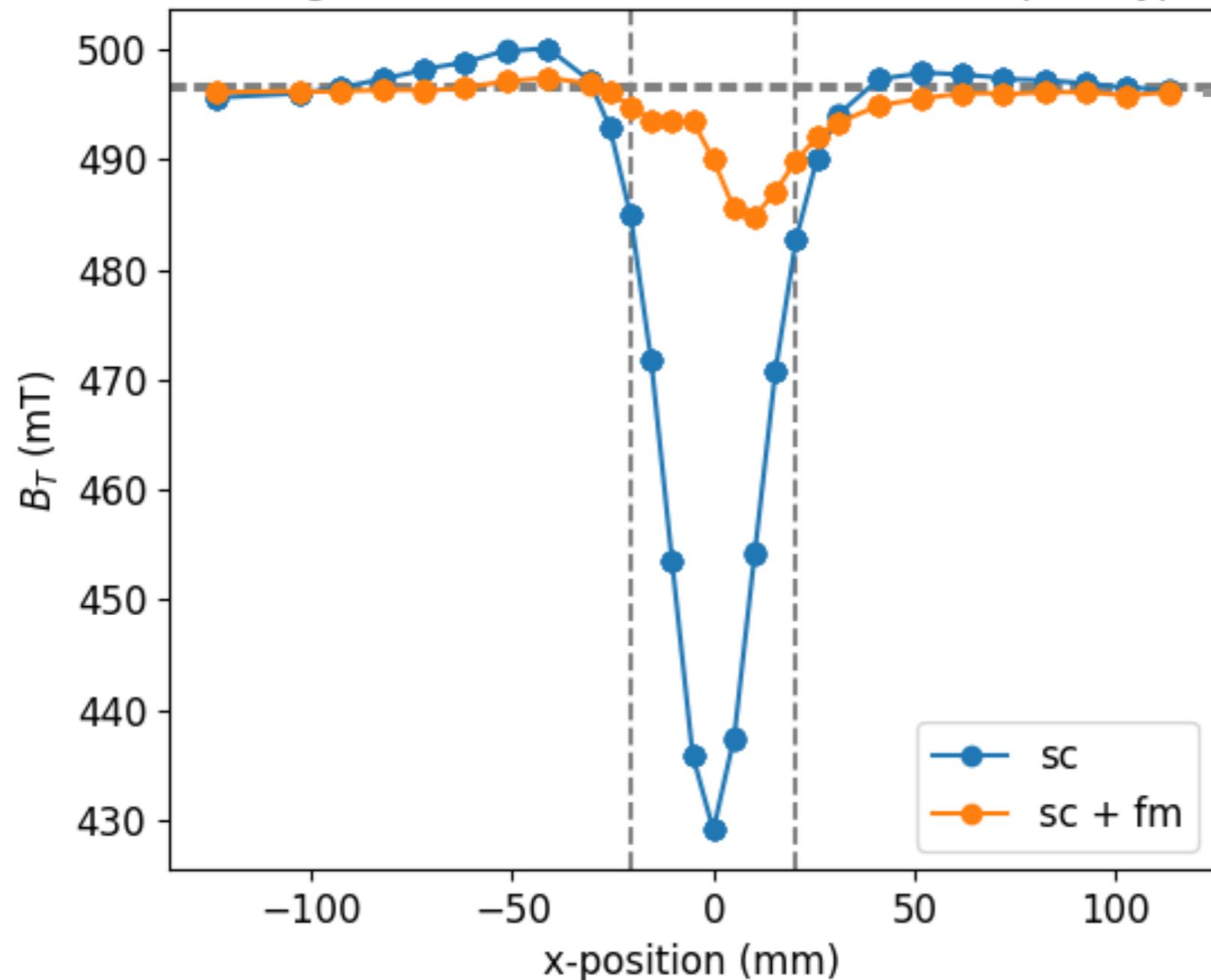


The schematic shows a vertical red line representing a magnetic field source with an upward-pointing arrow labeled 'x'. To its right is a gray ring-shaped object representing the cloak. Below the diagram is the following equation:

$$\sum \frac{|B_{sc+fm} - B_{nom}|}{|B_{sc} - B_{nom}|} \sim 10\%$$

Cloak reduces front field distortions by 79% at 0.50 T

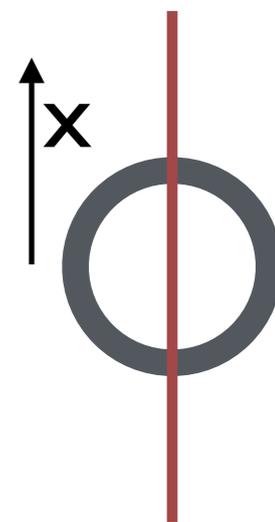
Cloaking at 0.50 T (field measured in front of prototype)



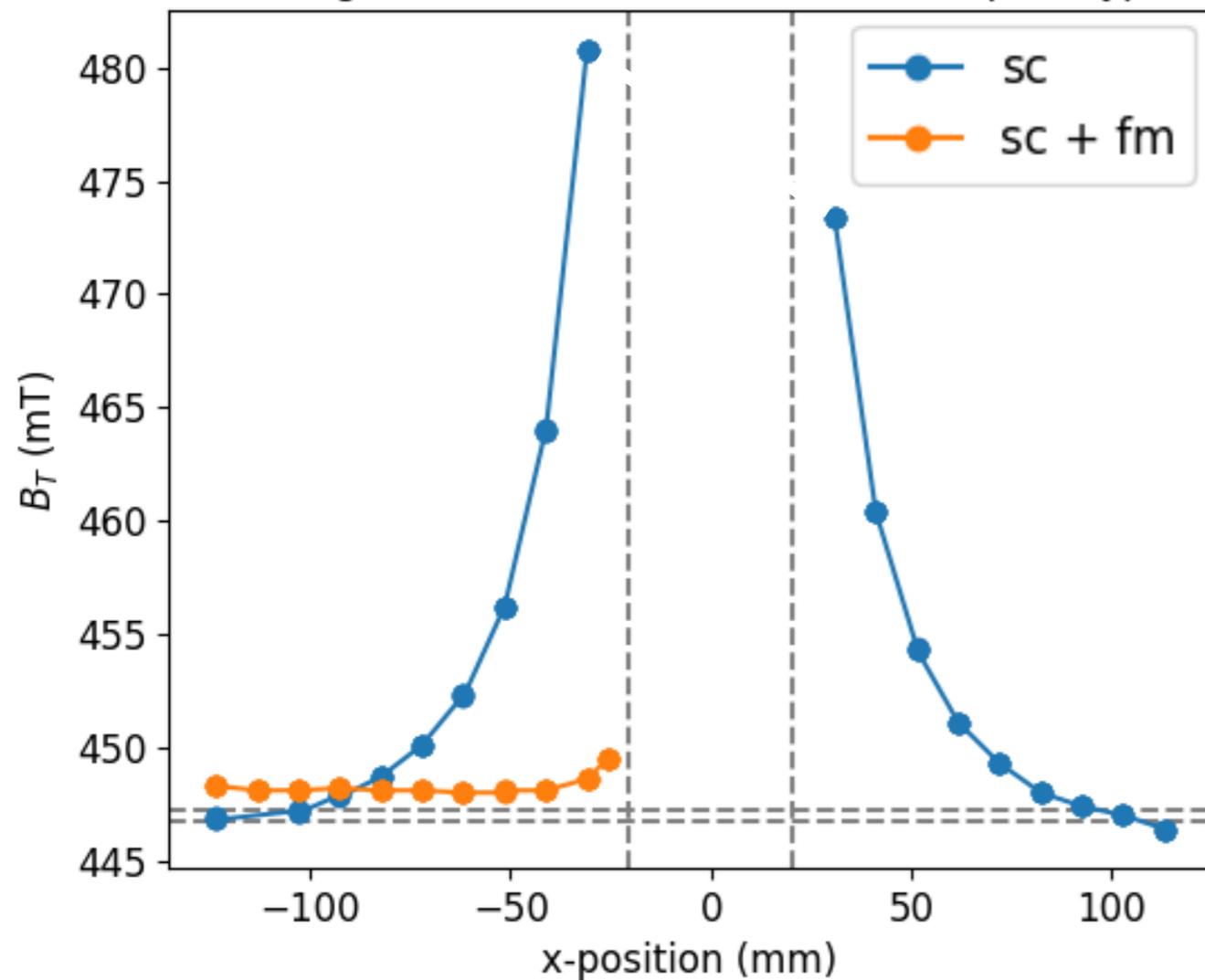
The schematic shows a vertical red line representing a magnetic field source with an upward-pointing arrow labeled 'x'. To its right is a gray ring-shaped object representing the cloak. Below the diagram is the following equation:

$$\sum \frac{|B_{sc+fm} - B_{nom}|}{|B_{sc} - B_{nom}|} \sim 21\%$$

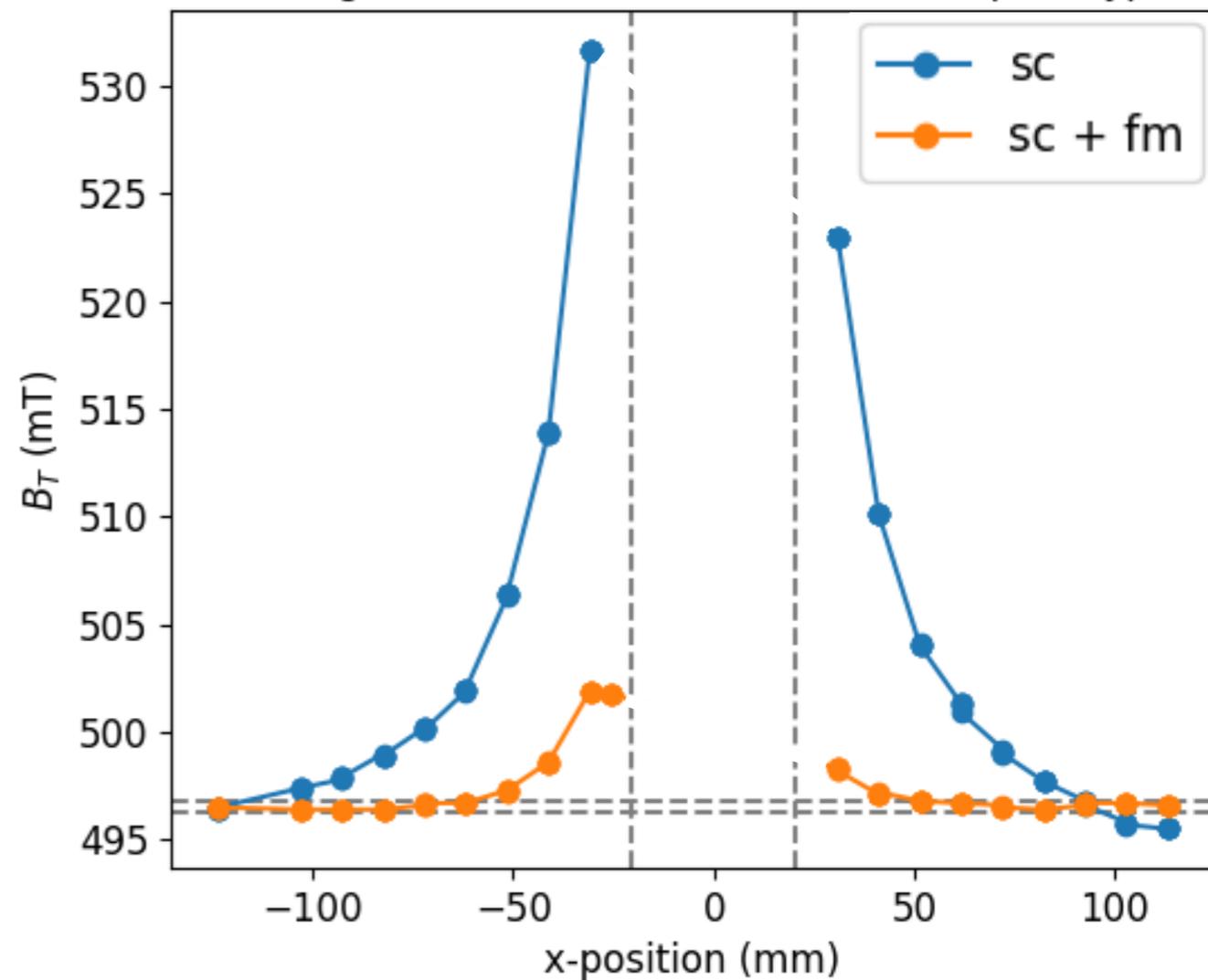
Magnetic field cloaking 'across cloak'



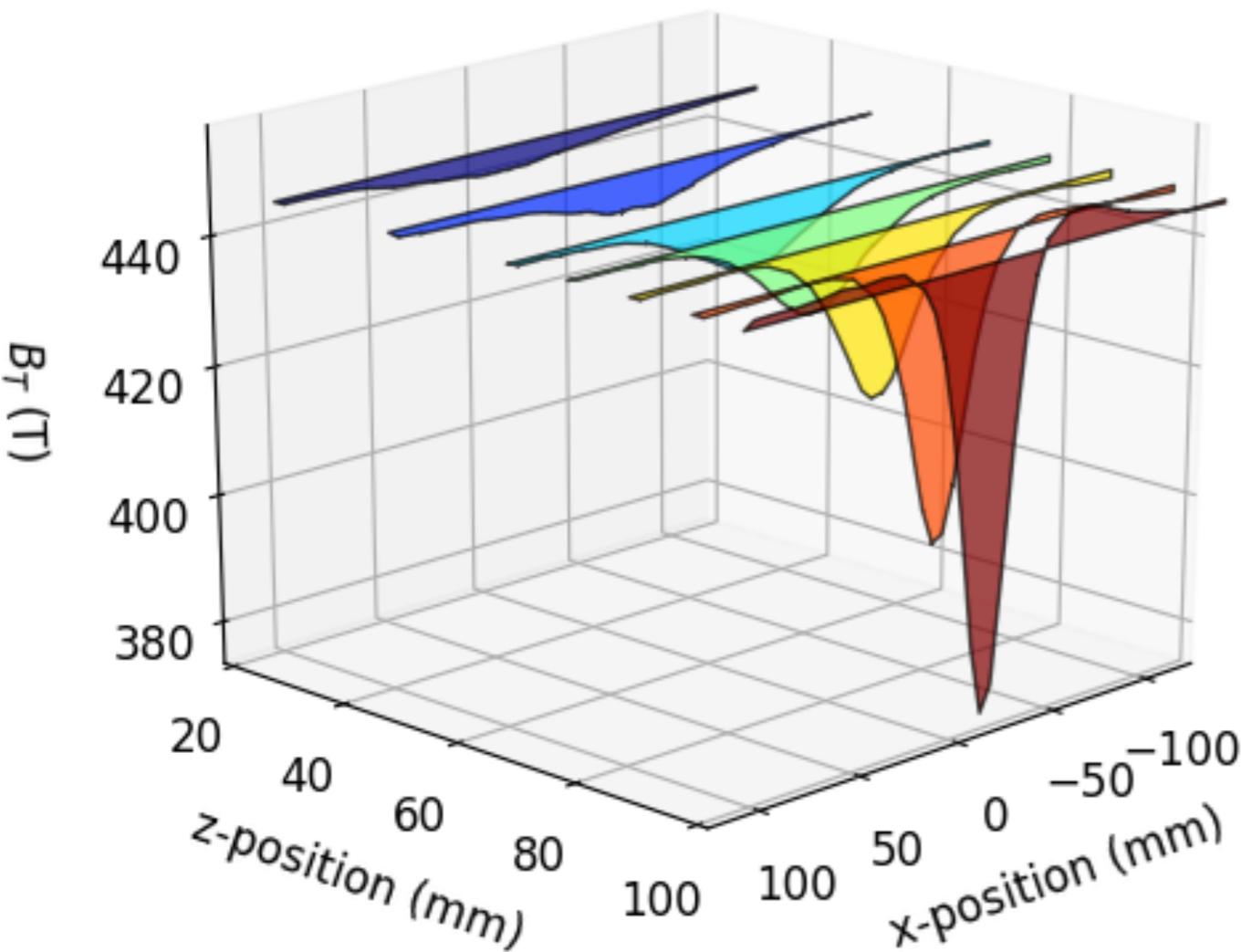
Cloaking at 0.45 T (field measured across prototype)



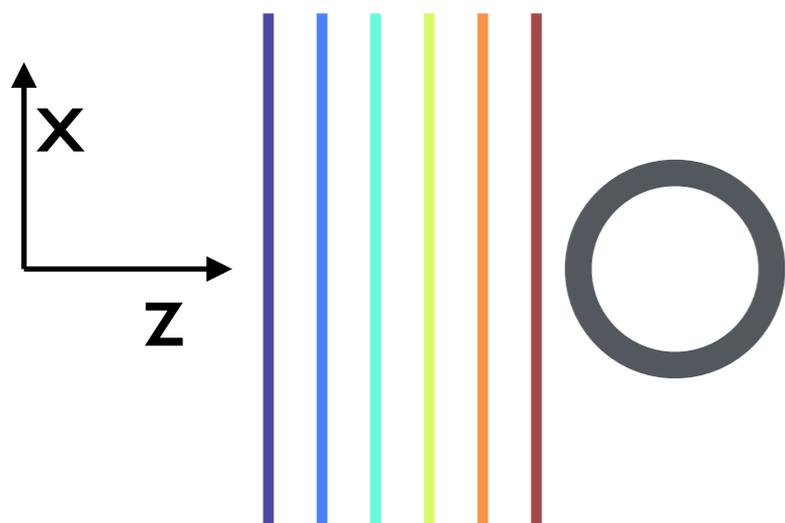
Cloaking at 0.50 T (field measured across prototype)



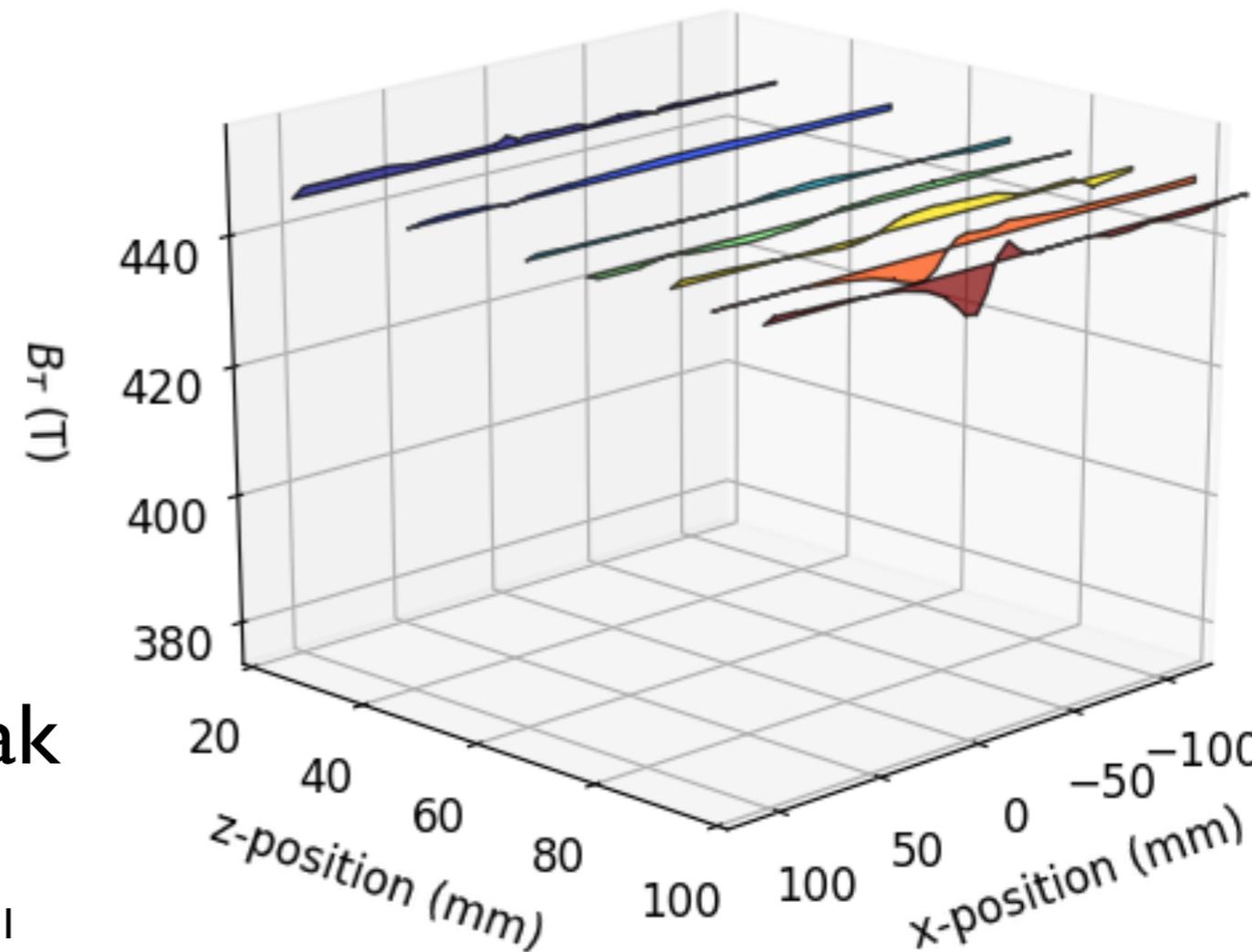
Long-range Cloaking Effect



superconductor only



cloak



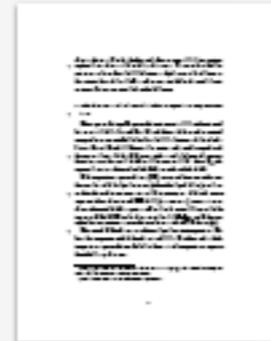
Getting ready for publication



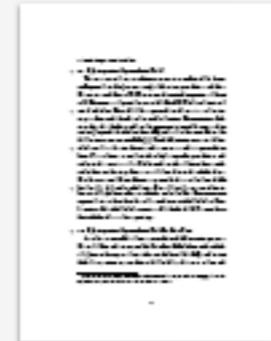
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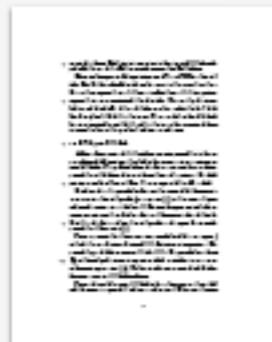
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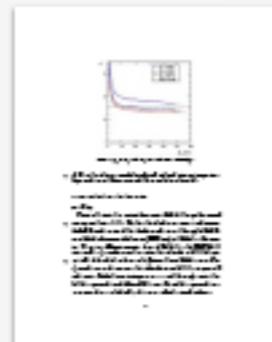
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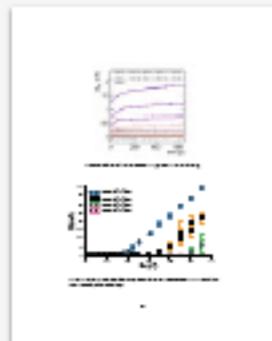
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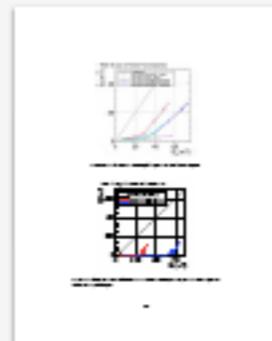
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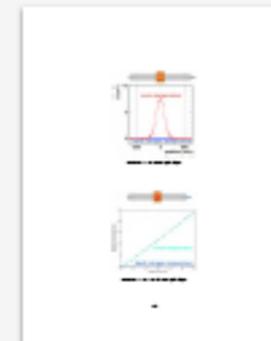
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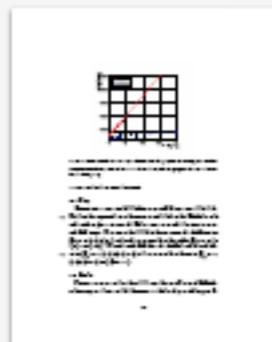
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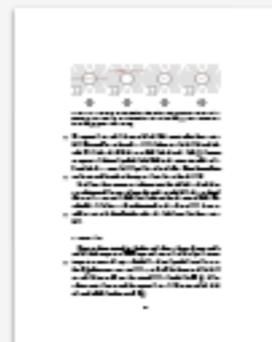
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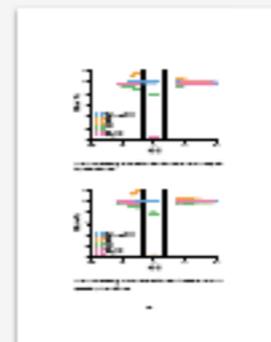
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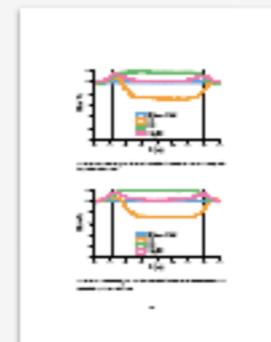
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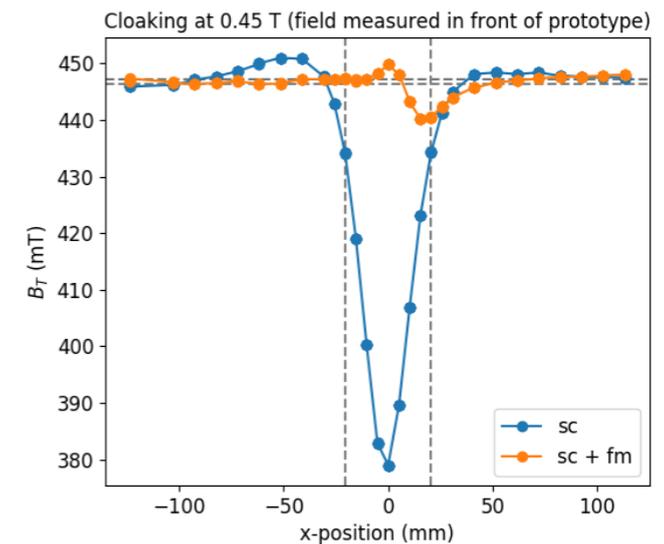
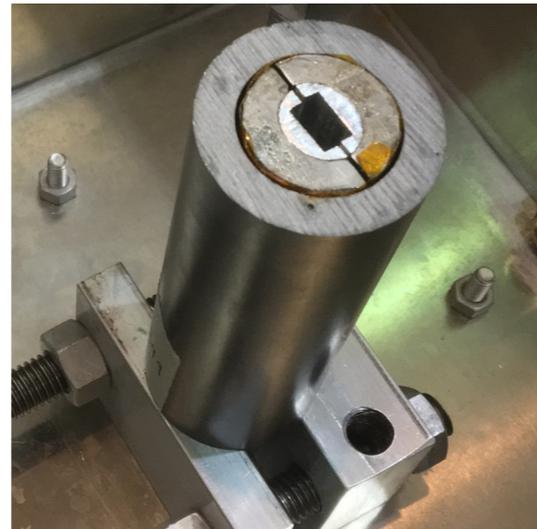
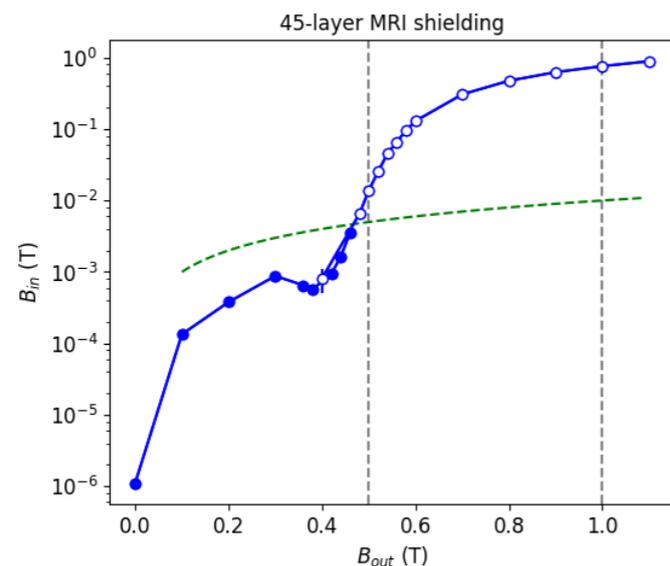
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✓ COMPLETED

We have demonstrated magnetic field cloaking with **99% field shielding** and **90% reduced field distortions** next to the shield at **0.45 T**.



A magnetic field cloak seems to be a viable option for EIC. We think we understand its design parameters, fabrication, and limitations.

The people behind the plots

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Kartik Sharma

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Shawn Thompson

Abraham Tishelman-Charny

Helena Van Nieuwenhuizen

Noor Ward

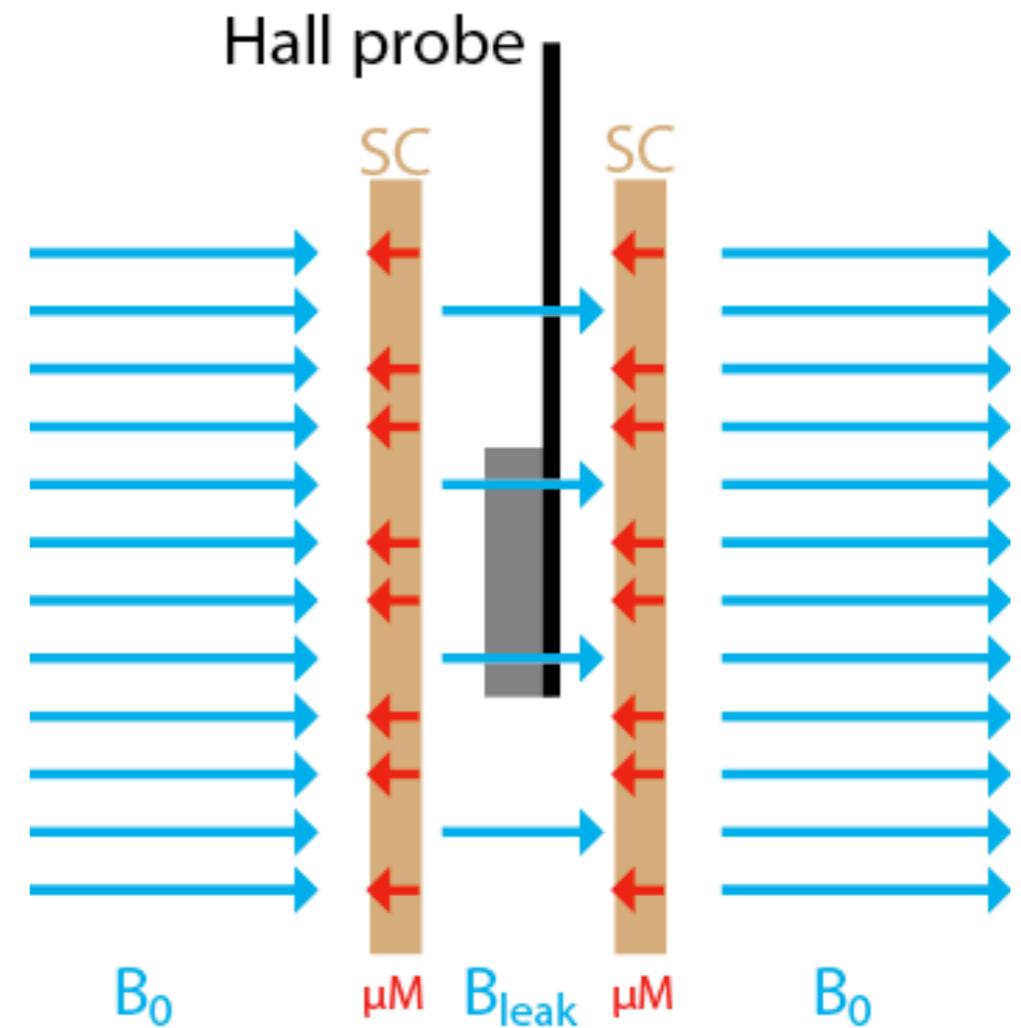
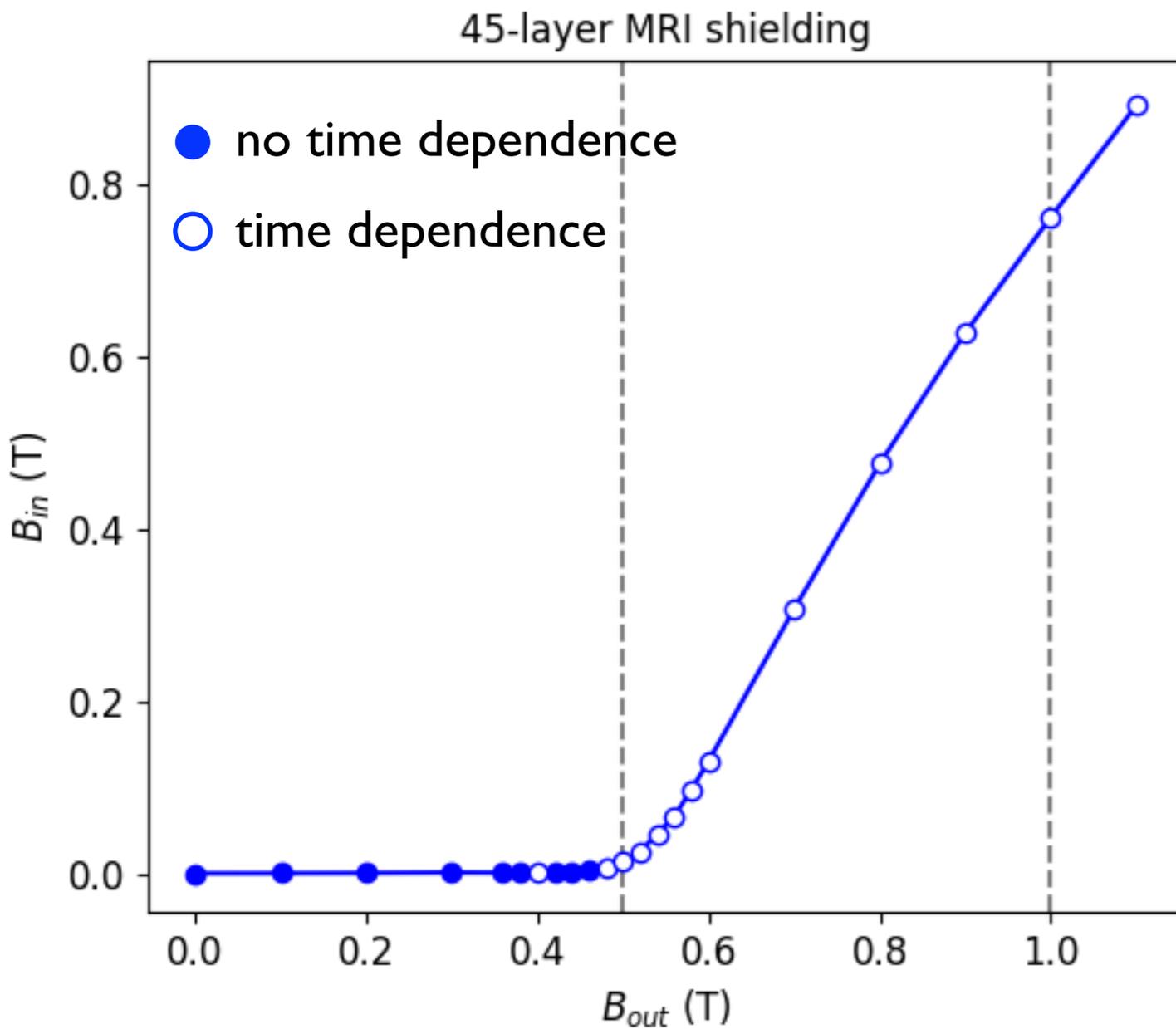
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Raphael Cervantes

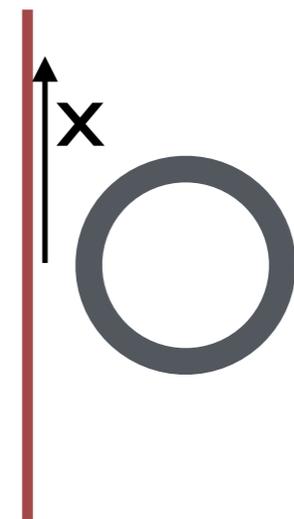
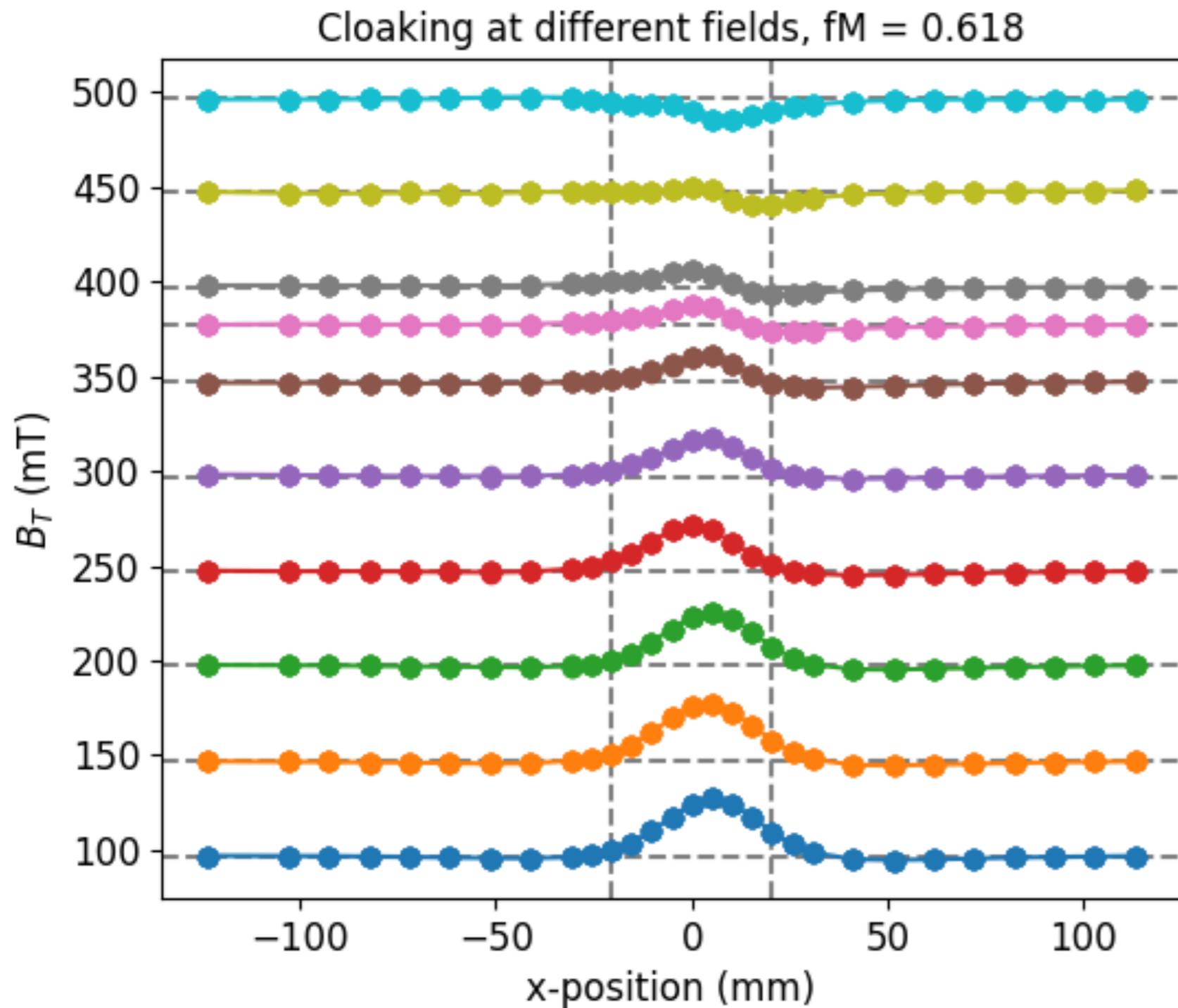
Stacy Karthas

ADDITIONAL SLIDES

Shielding MRI Magnet Field



Cloaking at different fields



Beam Test with oxygen-16 at BNL Van de Graaff

