

Equivalent-Charge-Based Optimization of Spokes-and-Hub Magnets for Hand-Held and Classroom MR Imaging

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Declaration of Financial Interests or Relationships

Speaker Name: Irene Kuang

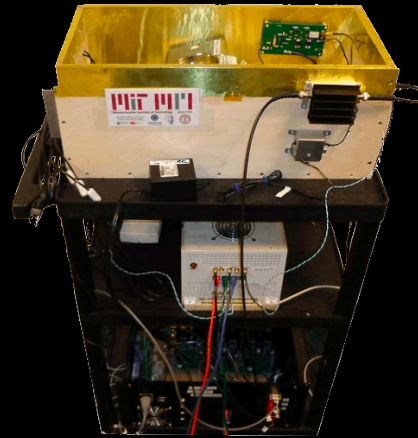
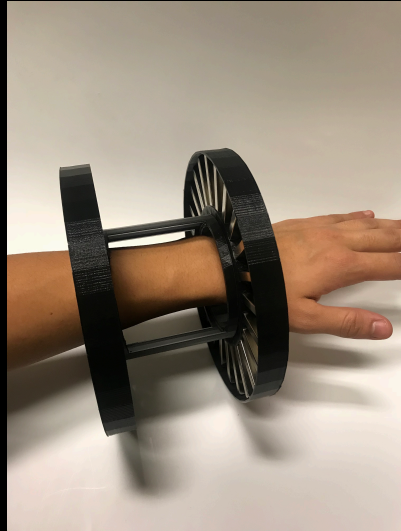
I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Motivation

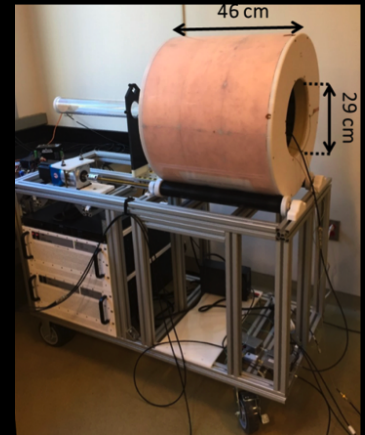
✓ Cost

✓ Size

✓ Safety



Cooley et al., Implementation of low-cost, instructional tabletop MRI scanners. *Int. Soc. Magn. Res. Med.* 2014, p. 4819.



Cooley et al., 2D Imaging in a Lightweight Portable MRI Scanner without Gradient Coils. *Magn. Res. Med.* 2015, p. 1.

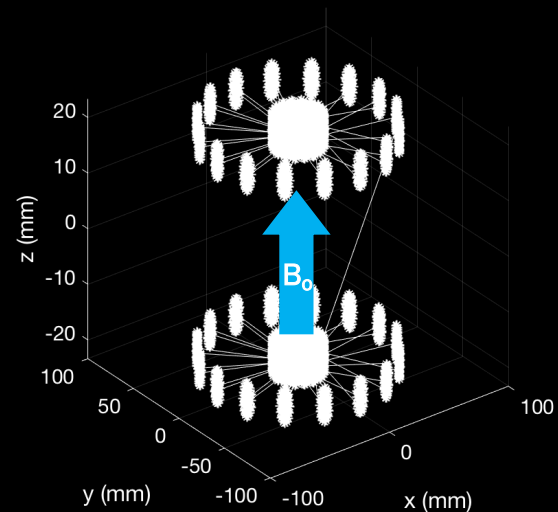
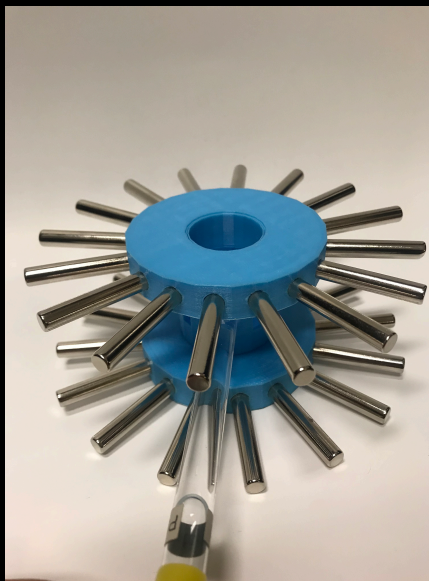
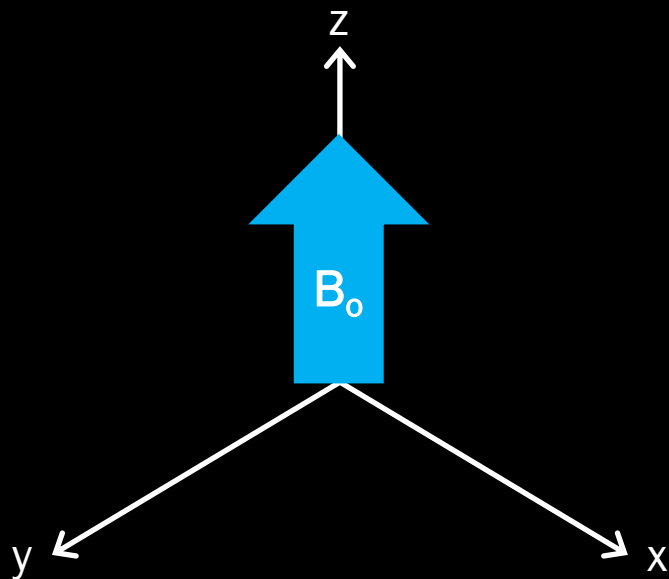


<https://www.aspectimaging.com/news/aspect-imaging-announces-fda-clearance-of-wristview-mri-system/>

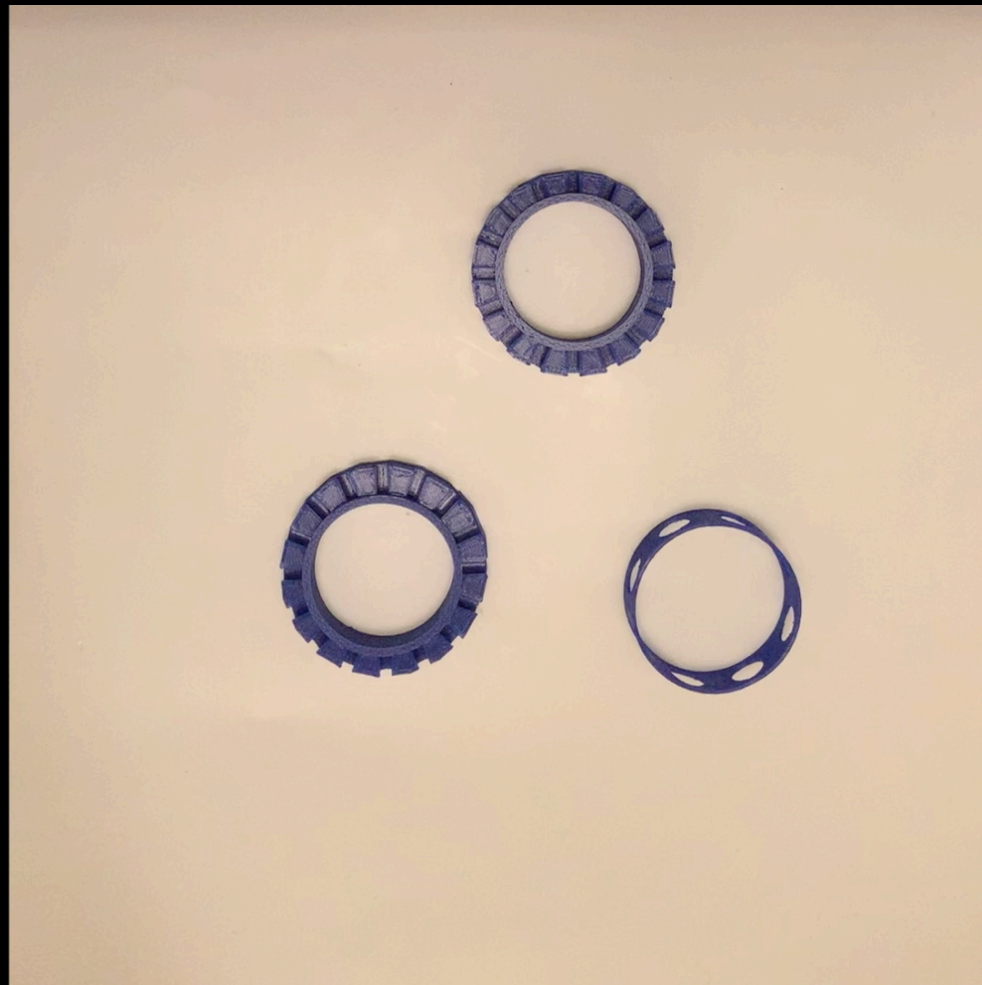


<https://www.siemens-healthineers.com/en-us/magnetic-resonance-imaging/3t-mri-scanner/magnetom-skyra>

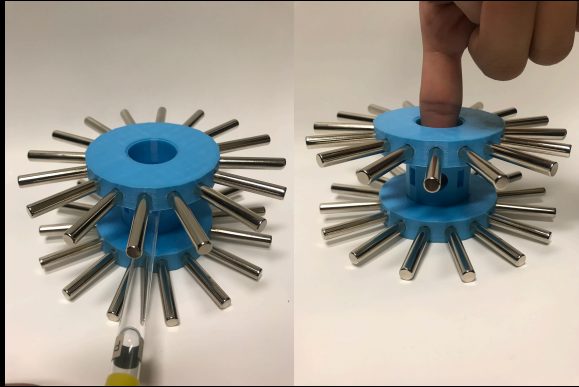
Spokes-and-Hub Magnets



***Spokes-and-Hub
Magnet Assembly
(<5 min)***



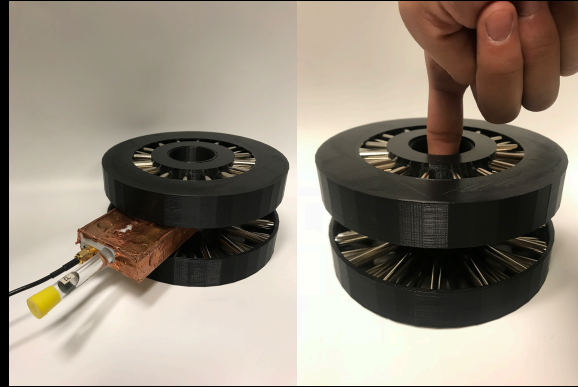
Spokes-and-Hub Magnets



“Spokes”
32 cylindrical magnets
→ 6.35 mm diameter, 50.8 mm thick

“Hub”
34.29 mm diameter

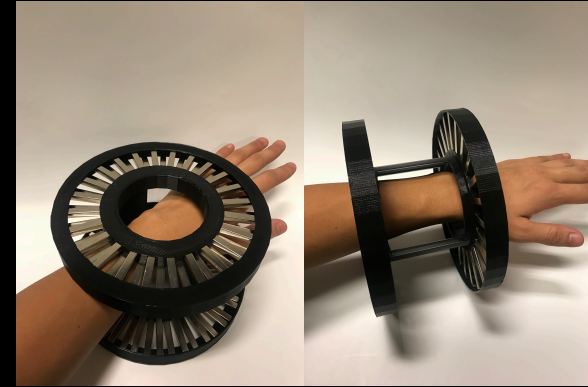
~100 mT
90 USD



“Spokes”
96 cylindrical magnets
→ 6.35 mm diameter, 50.8 mm thick

“Hub”
42.672 mm diameter

~195 mT
350 USD

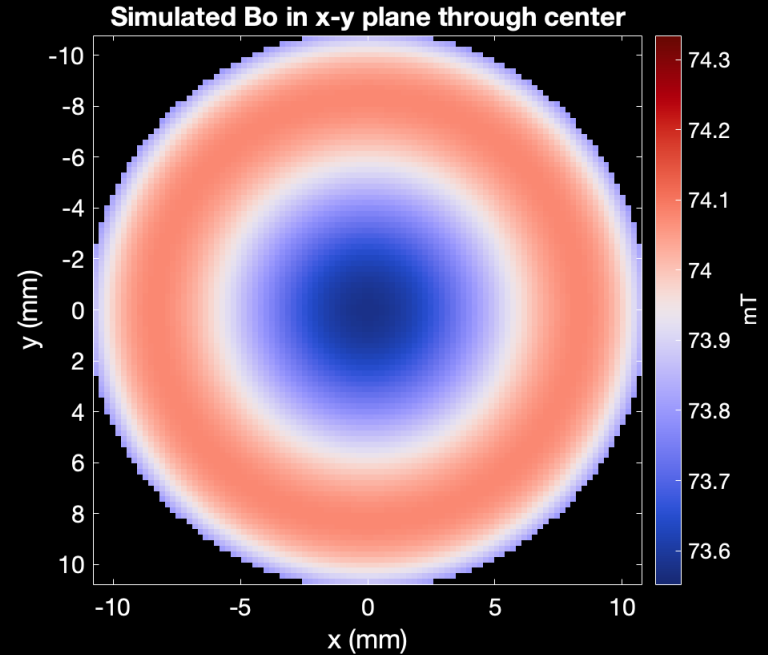
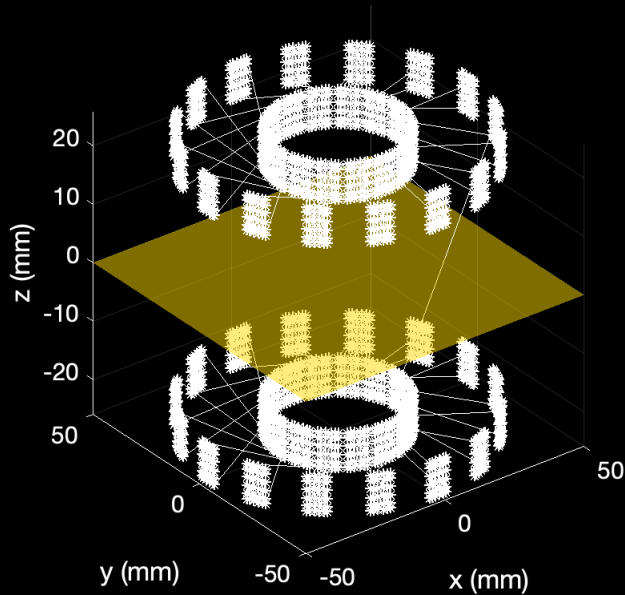


“Spokes”
96 rectangular magnets
→ 6.35 x 6.35 x 50.8 mm

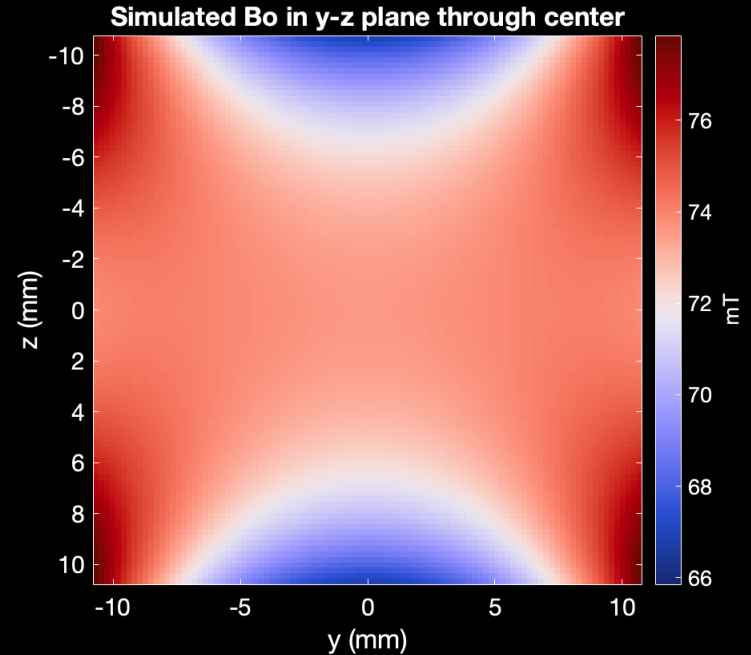
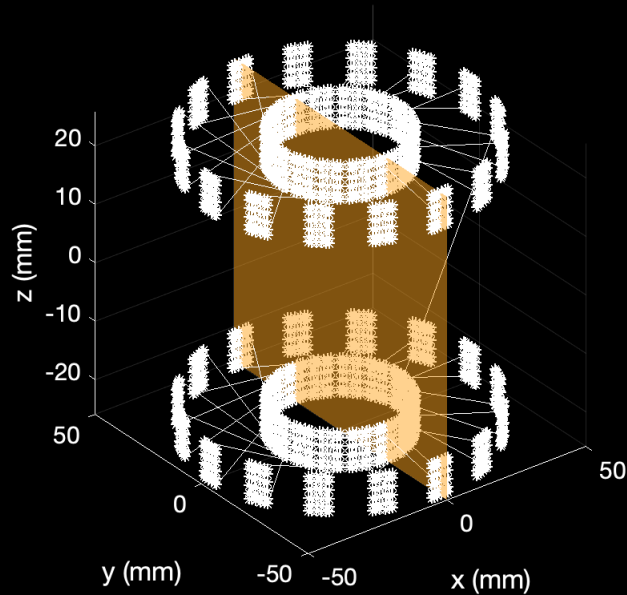
“Hub”
134.62 mm diameter

~60 mT
425 USD

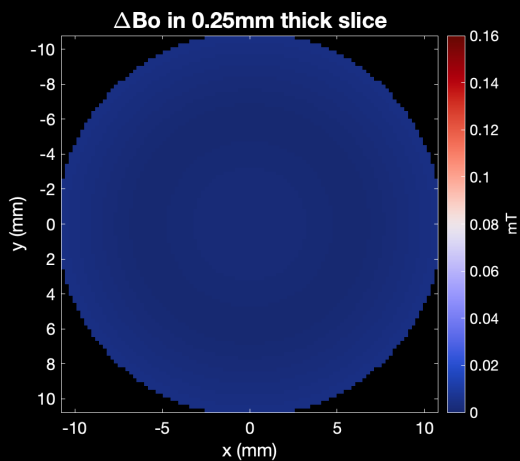
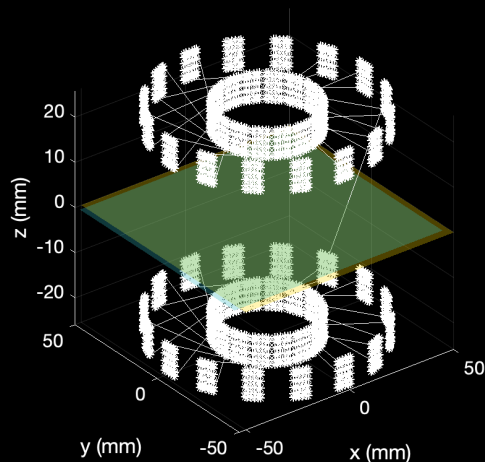
Efficient computation of fields from end-cap equivalent charges



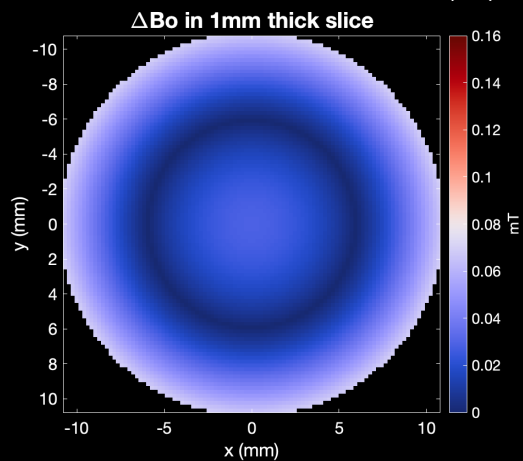
Efficient computation of fields from end-cap equivalent charges



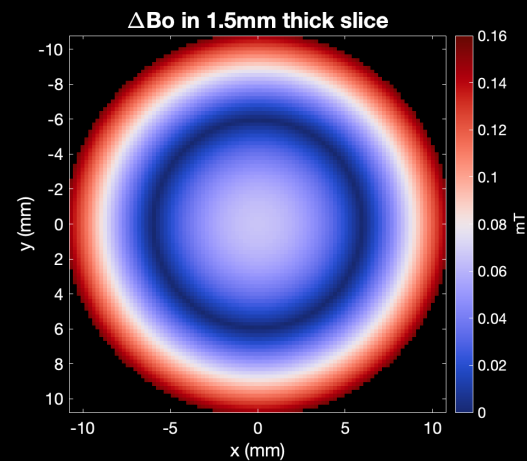
Slice Thickness



~50 ppm

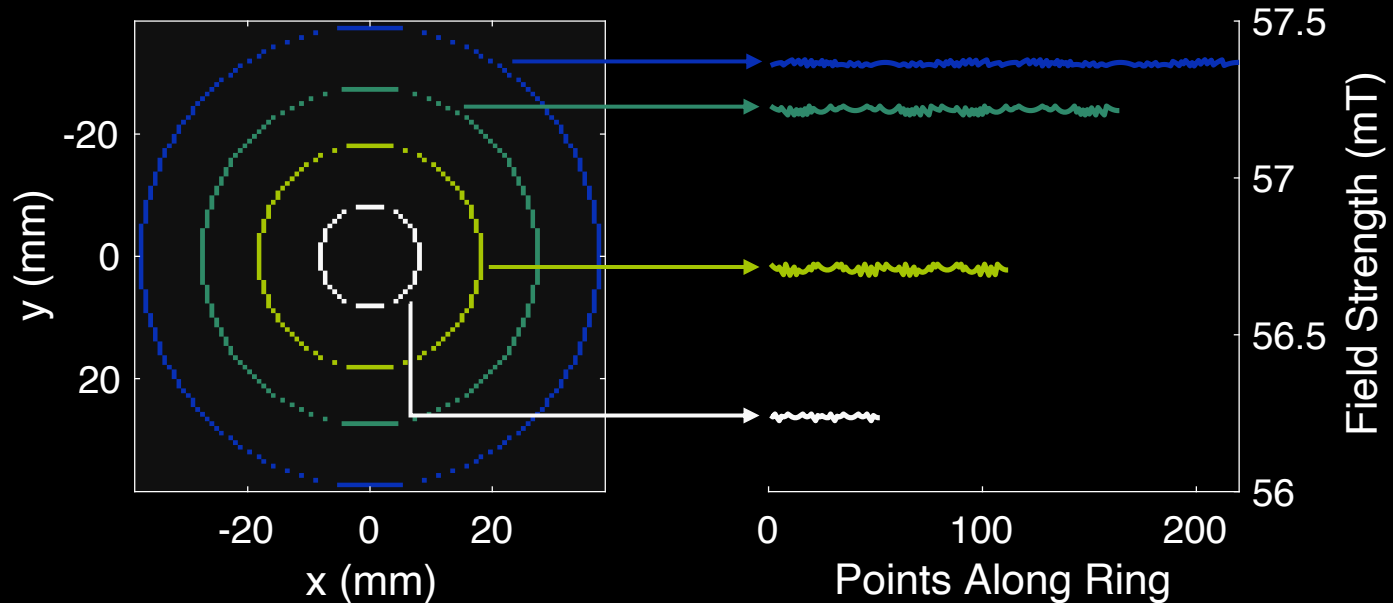


~1000 ppm



~2100 ppm

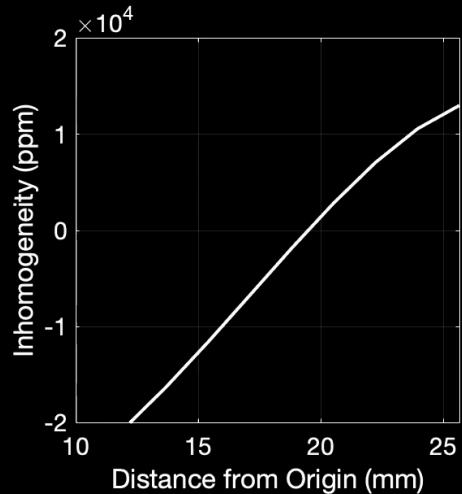
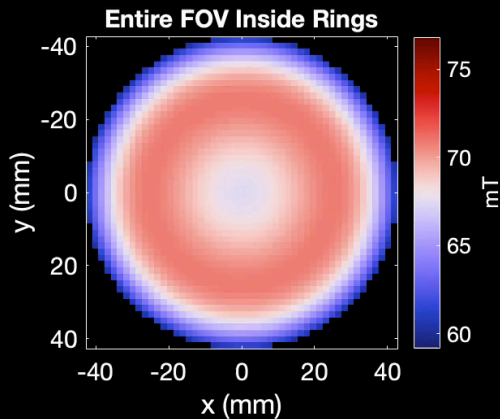
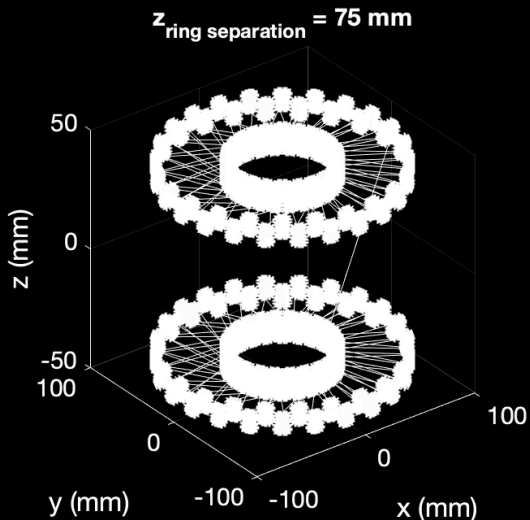
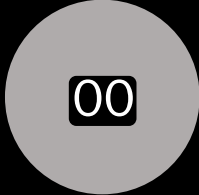
Radially Symmetric Fields



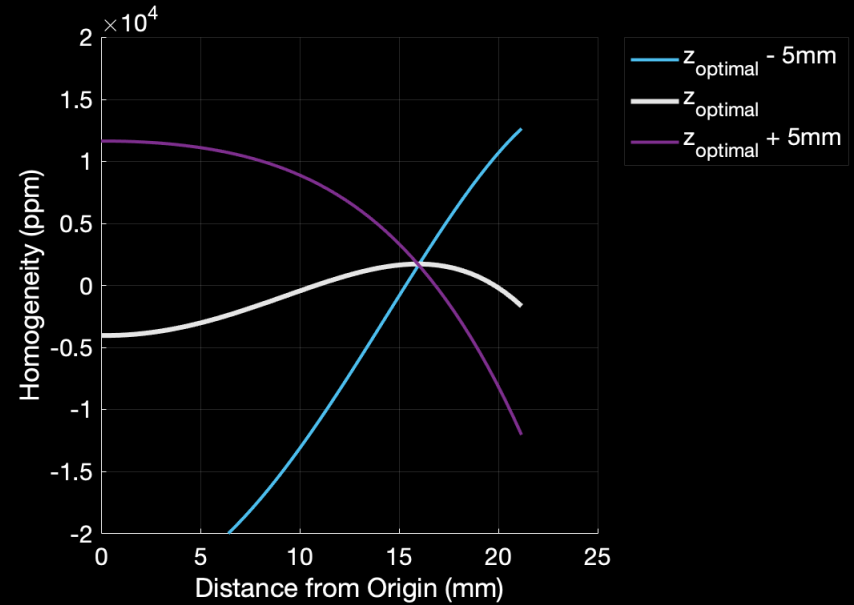
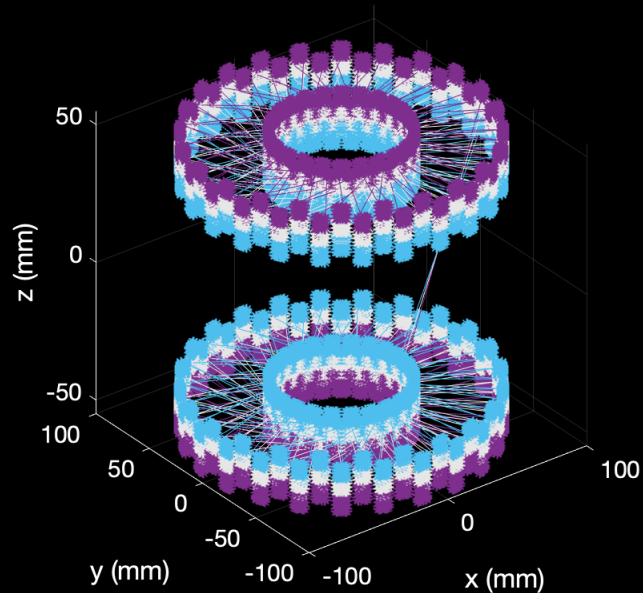
Field within ring has an varies by ~ 0.02 mT
Homogeneity on the order of hundreds of ppm

Optimization of Hub Separation

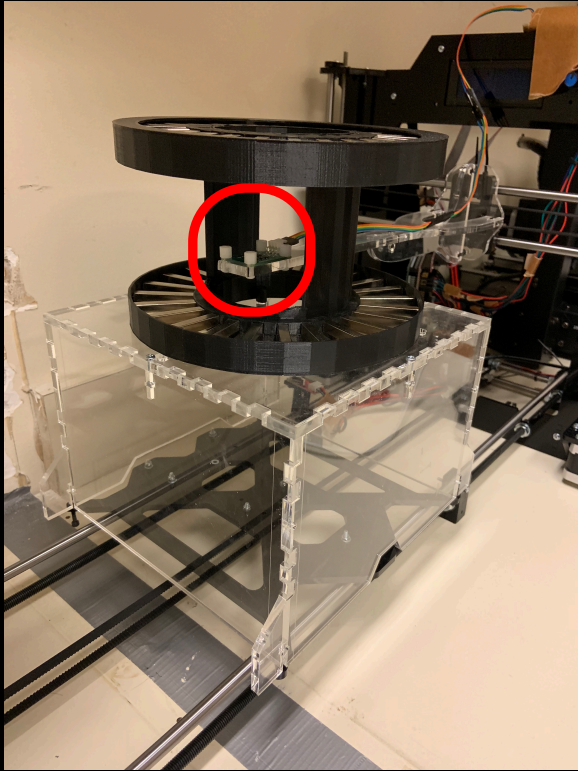
▶ MATLAB Simulation on CPU



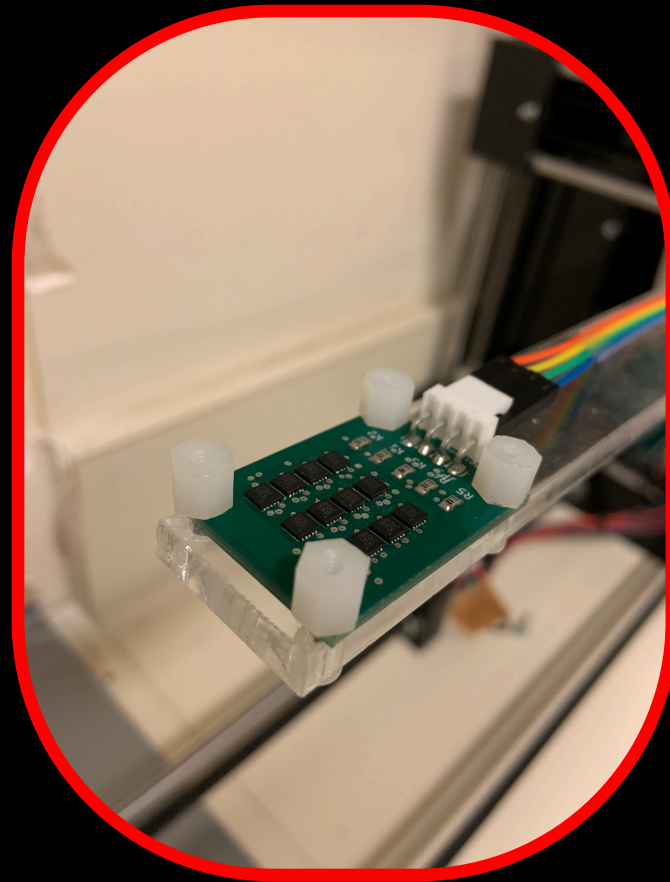
Optimal Hub Separation



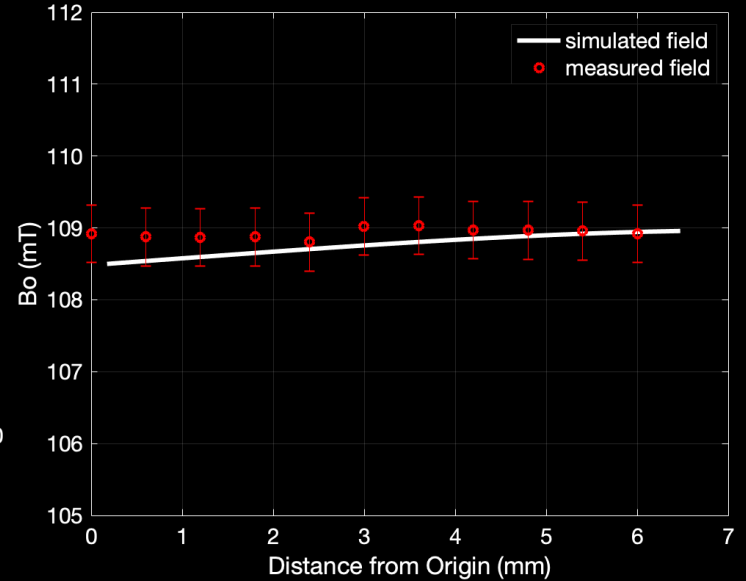
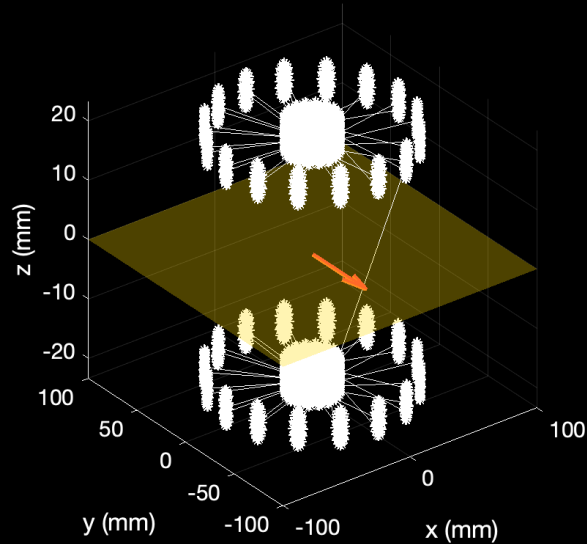
Field Mapping

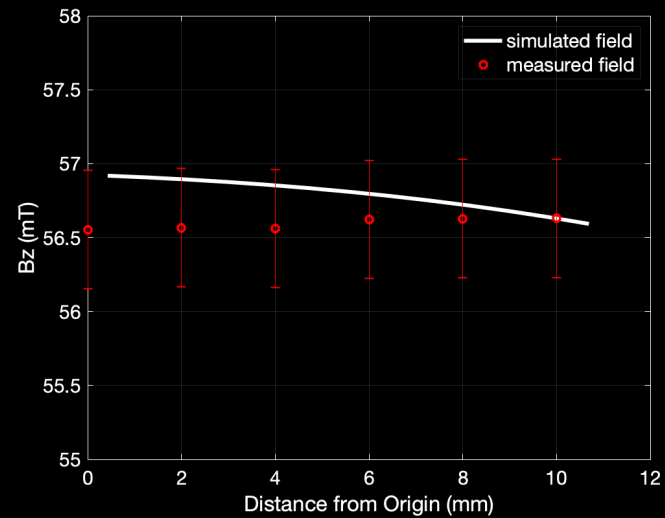
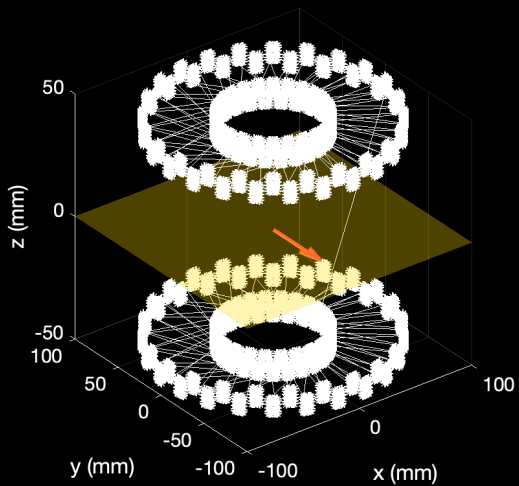
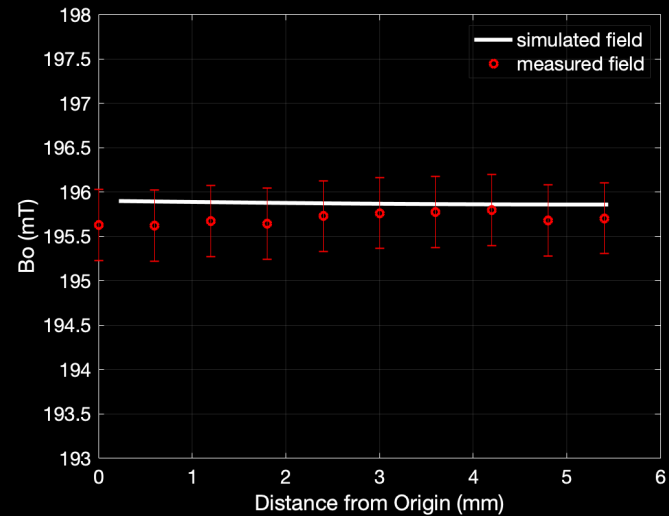
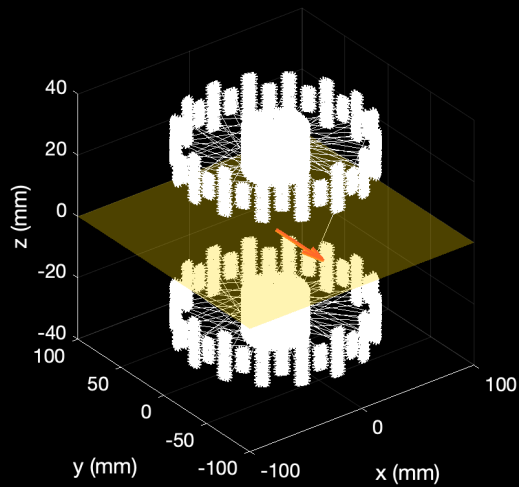
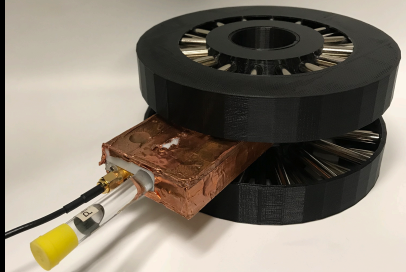


3x4 Array of Linear Hall Effect Sensors

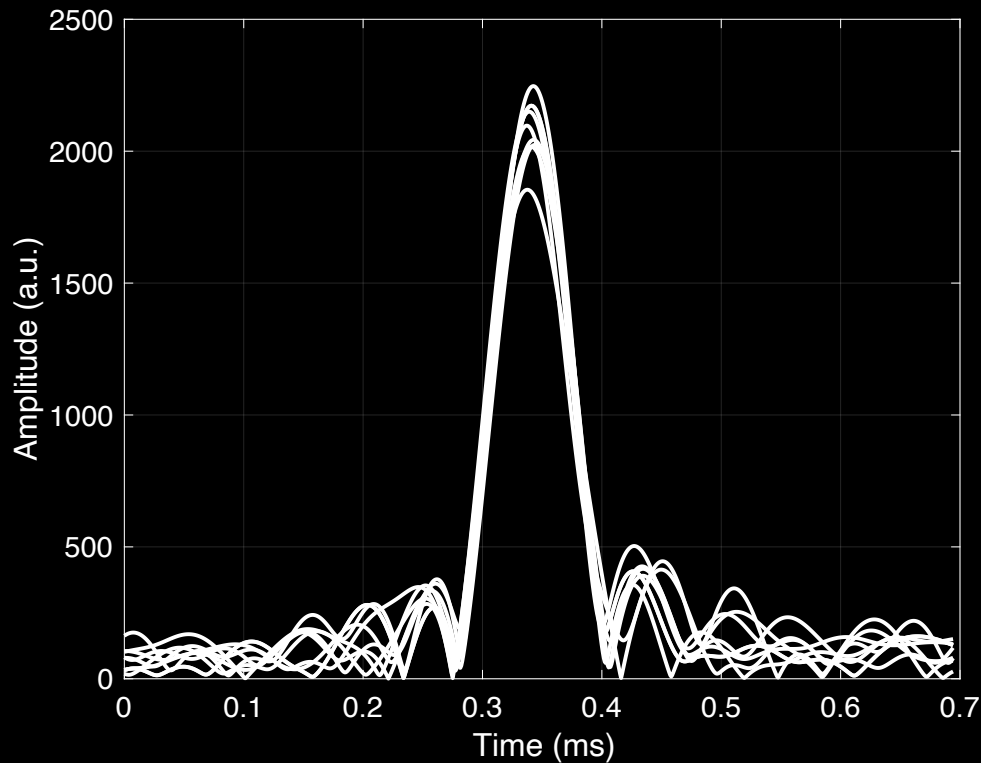
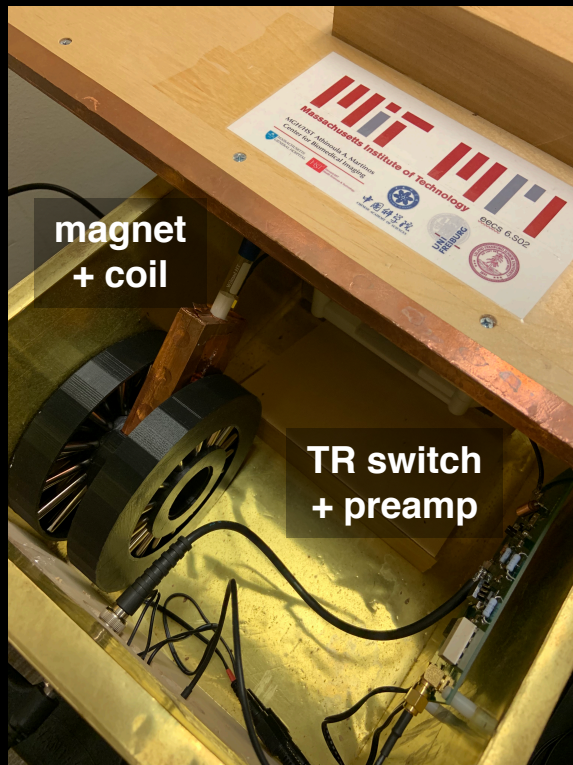


Measured vs. Simulated Radial Fields





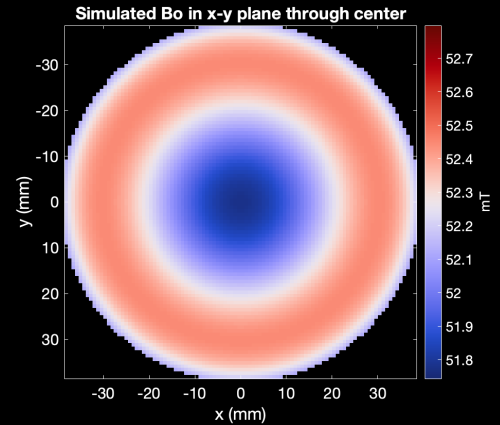
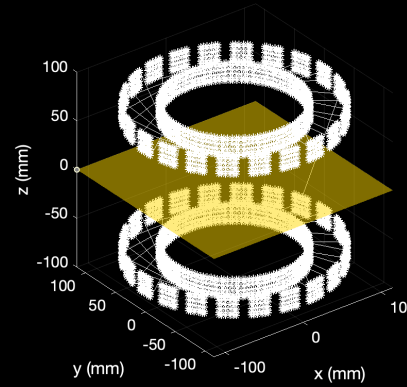
Spin Echo



Looking Ahead

Scale up magnet ring size

- simulation shows feasibility up to 150 mm diameter ring opening (for 50 mT)



Physically open design

- novel coil geometries and applications

Educational tool

- projection encoding by rotation



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MIT



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Martinos/HMS



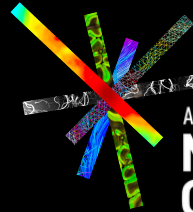
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HARVARD
MEDICAL SCHOOL

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Thank You!

Questions?

