Mechanical Tilt-Induced Gradient Fields for Low-Field Spokes-and-Hub Permanent Magnet MR Imagers

Irene Kuang, Jason Stockmann, Elfar Adalsteinsson, Jacob White



Irene Kuang *MIT*



Jason Stockmann Martinos/HMS



Elfar Adalsteinsson MIT



MGH/HST Athinoula A. Martinos Center for Biomedical Imaging



Harvard-MIT Health Sciences & Technology



Jacob White *MIT*





ISMRM & SMRT Annual Meeting & Exhibition

An Online Experience

15-20 May 2021

Declaration of Financial Interests or Relationships

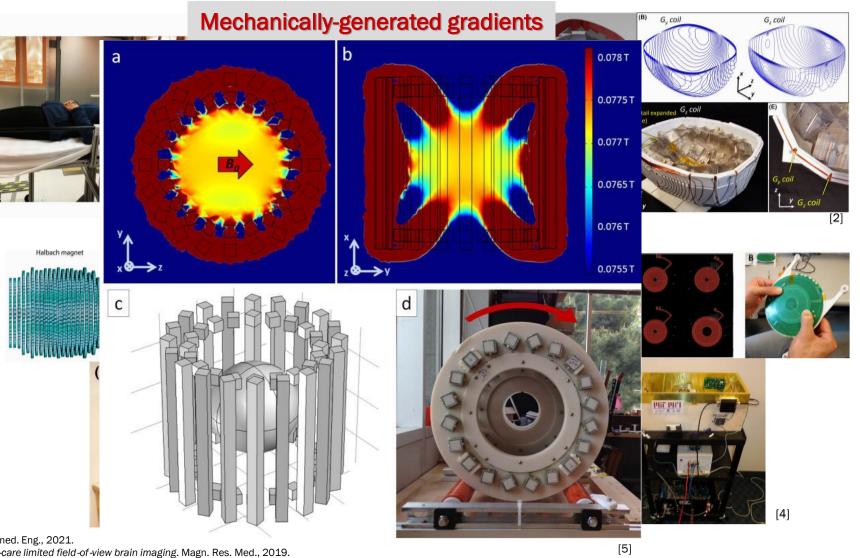
Speaker Name: Irene Kuang

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

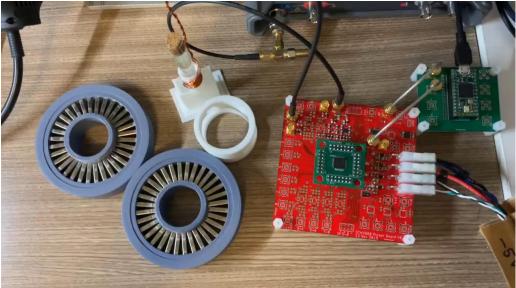
Permanent magnet MR imagers

- ✓ Low cost
- ✓ Portable
- ✓ Safe for point-ofcare and classroom use
- Inhomogeneous
 compared to
 clinical scanners
- —Gradient nonlinearity across FOV

[1] Cooley et al., A portable scanner for magnetic resonance imaging of the brain. Nat. Biomed. Eng., 2021.
 [2] McDaniel et al., The MR Cap: A single-sided MRI system designed for potential point-of-care limited field-of-view brain imaging. Magn. Res. Med., 2019.
 [3] O'Reilly et al., In vivo 3D brain and extremity MRI at 50 mT using a permanent magnet Halbach array. Magn. Res. Med., 2020.
 [4] Cooley et al., Design and implementation of a low-cost, tabletop MRI scanner for education and research prototyping. J. Magn. Res. Imaging, 2019.
 [5] Cooley et al., Two-Dimensional Imaging in a Lightweight Portable MRI Scanner without Gradient Coils. Magn. Res. Med., 2015.
 ISMRM, 19 May 2021

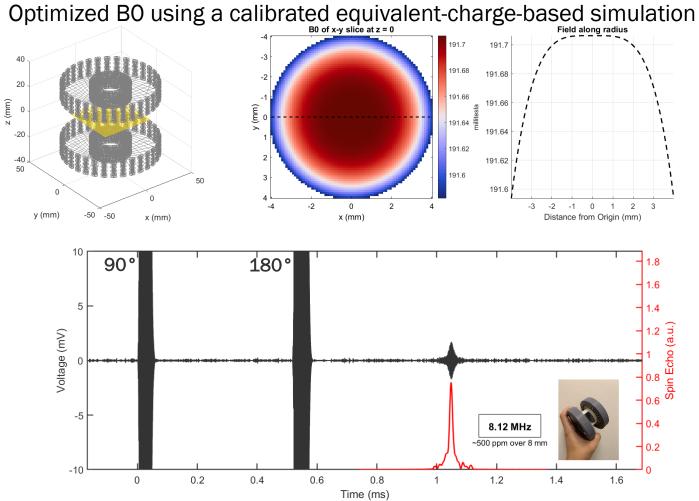






[6] Kuang et al., Equivalent-Charge-Based Optimization of Spokes-and-Hub Magnets for Hand-Held and Classroom MR Imaging. Int. Soc. Magn. Res. Med., 2019. [7] Kuang et al., Bloch-Optimized Dithered-Ultrasound-Pulse RF for Low-Field Inhomogeneous Permanent Magnet MR Imagers. Int. Soc. Magn. Res. Med., 2020.

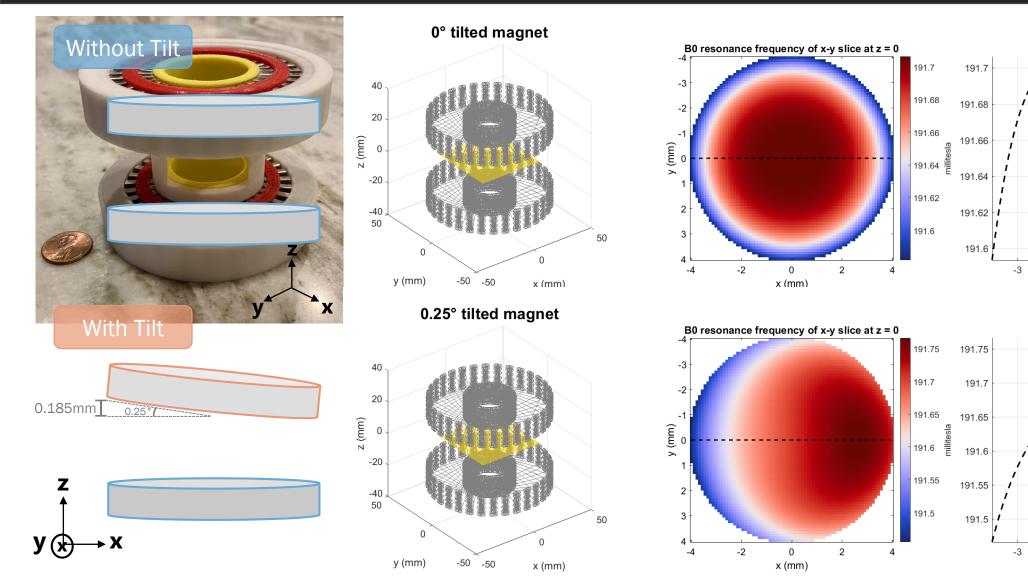
"Spokes-and-Hub" magnet arrays



ISMRM, 19 May 2021

Irene Kuang (#3100)

Simulated magnetic fields patterns



[6] Kuang et al., Equivalent-Charge-Based Optimization of Spokes-and-Hub Magnets for Hand-Held and Classroom MR Imaging. Int. Soc. Magn. Res. Med., 2019.

Irene Kuang (#3100)

3

2

Field along radius

-2 -1 0

1

Distance from Origin (mm)

Field along radius

29.4 mT/m

0

Distance from Origin (mm)

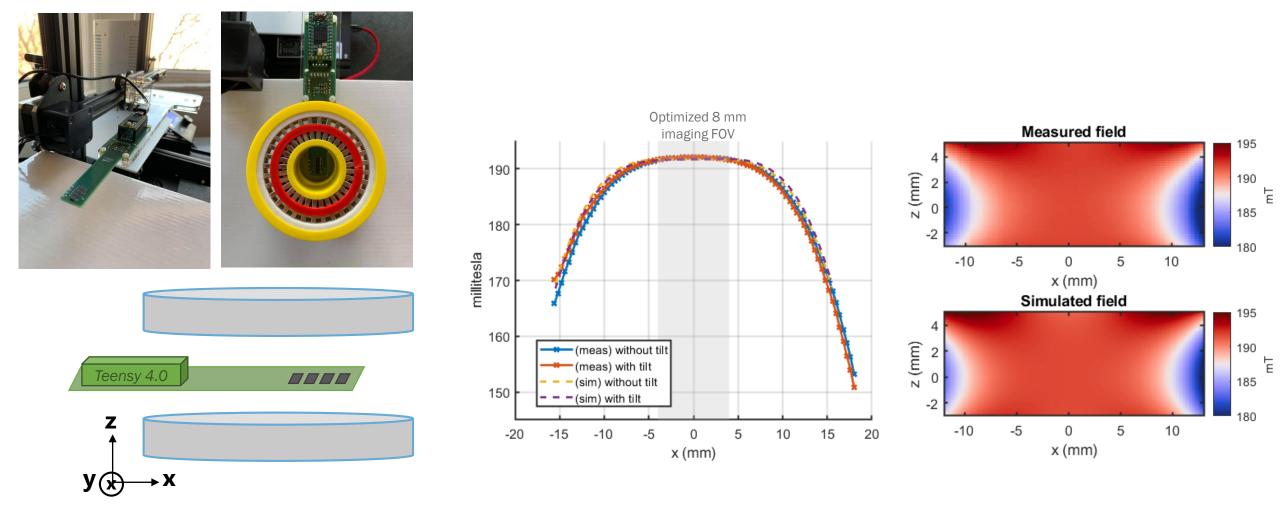
1

-1

-2

2 3

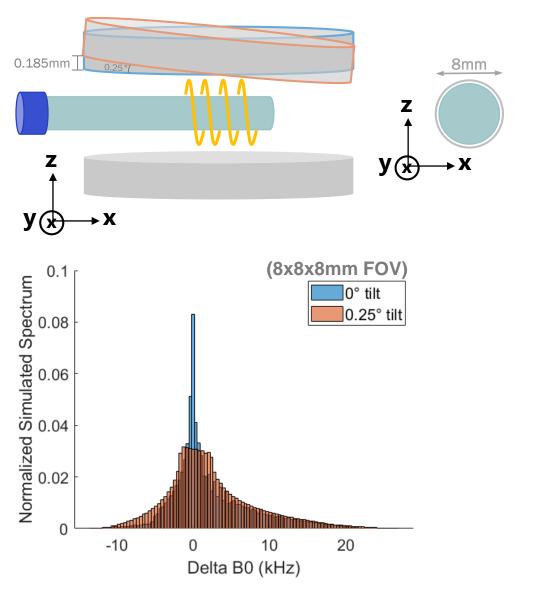
Field map measurements

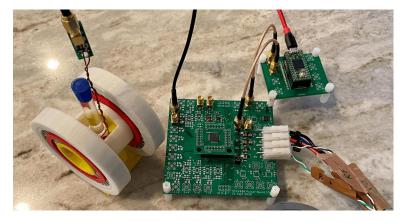


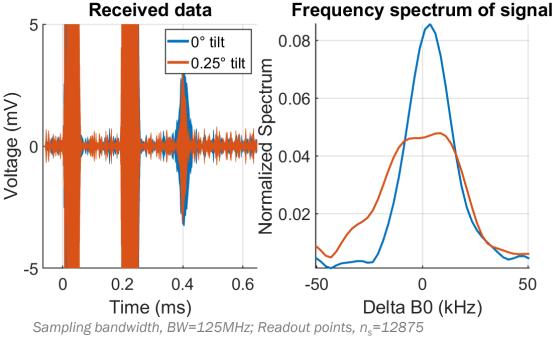
ALS31300 3D Linear Hall Effect Sensor (12-bit ADC) Sensor range: ±2000 Gauss, Sensitivity: 1 LSB/Gauss Sensitivity error: ±0.6%, Offset error: ±12 LSB RMS noise: 1 LSB

ISMRM, 19 May 2021

Tilted-gradient experiment setup



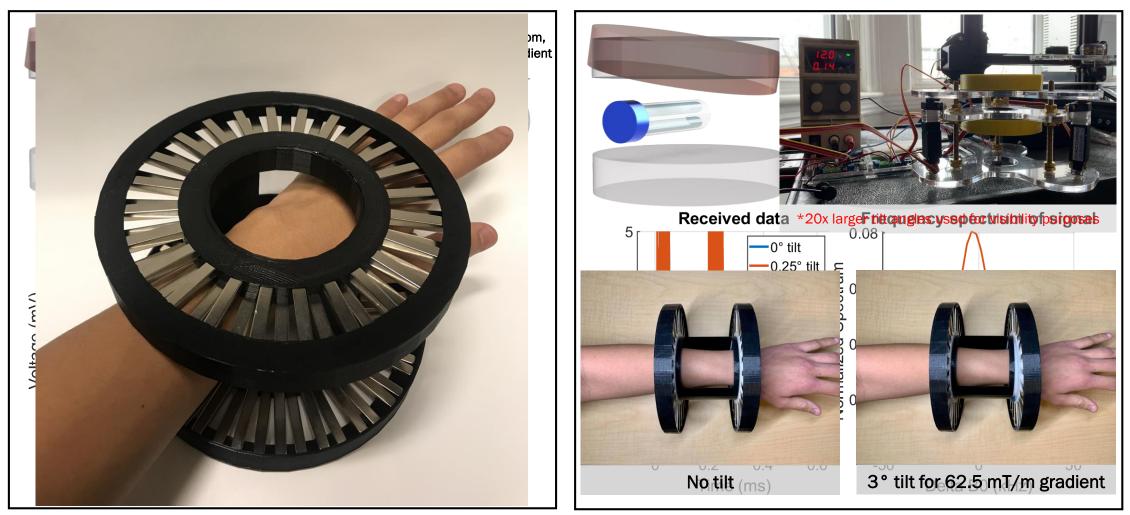




TE=0.4ms (to reduce impact of T2*)

Irene Kuang (#3100)

Tilted-gradient experiment results



Sampling bandwidth, BW=125MHz Readout points, n_s =12875

Acknowledgements

- DoD NDSEG Fellowship
- NIH NIBIB R01EB018976
- MIT-MGH seed grant
- Skolkovo Institute of Science and Technology Next Generation Program
- MIT EECS department





Jason Stockmann Martinos/HMS



Elfar Adalsteinsson *MIT*



Jacob White MIT



MGH/HST Athinoula A. Martinos Center for Biomedical Imaging





HARVARD MEDICAL SCHOOL

Irene Kuang (#3100)