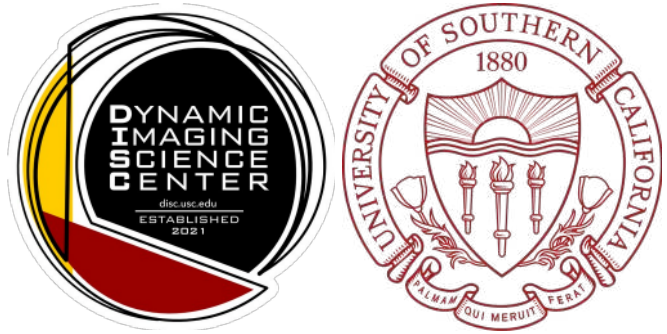
Pulseq for anything under the sun: from dynamic to metal

Bilal Tasdelen

November 17, 2023



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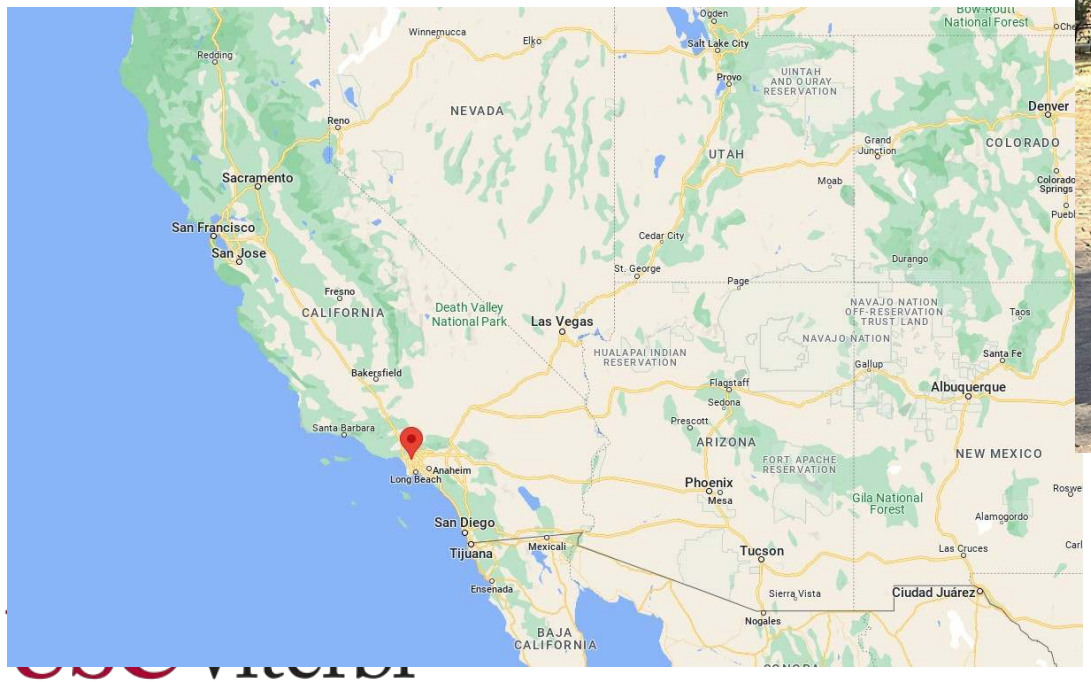
About Us

Magnetic Resonance Engineering Laboratory (MREL)



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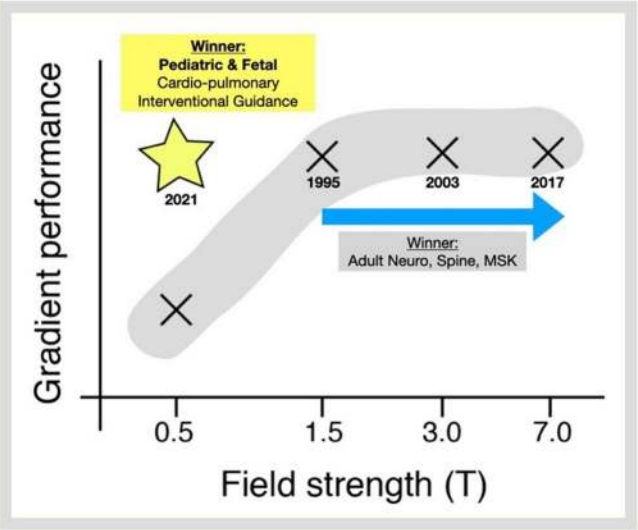
Dynamic Imaging Science Center

DYNAMIC IMAGING SCIENCE CENTER
disc.usc.edu
ESTABLISHED 2021

Developing imaging technology to better understand human health and disease especially during movement.



Opened: January 2021
Human Subjects: May 2021

Suite LL130, Michelson Center for Convergent Biosciences, USC University Park Campus
disc.usc.edu

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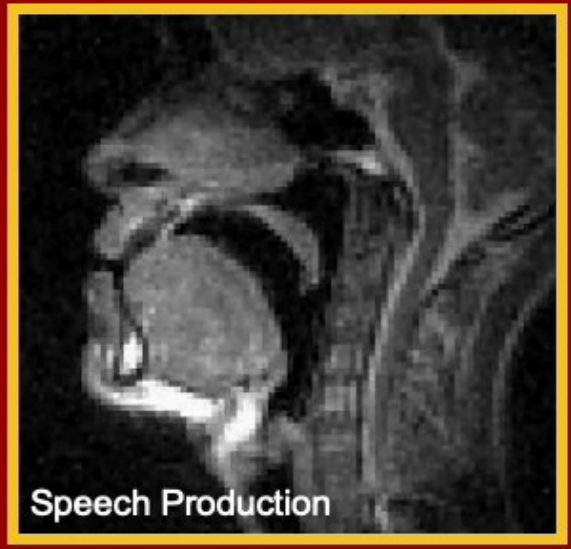

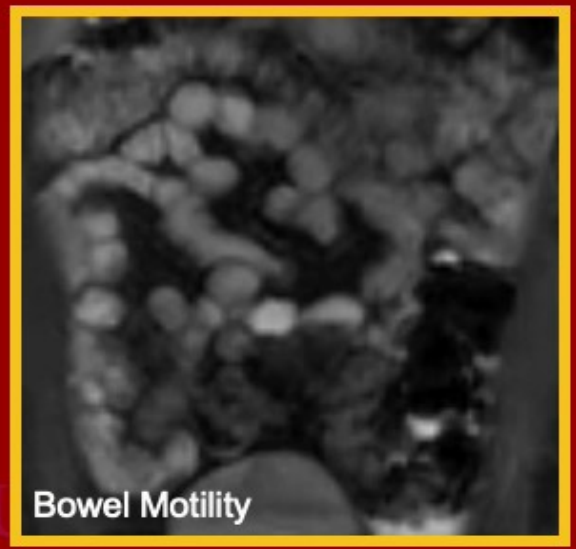

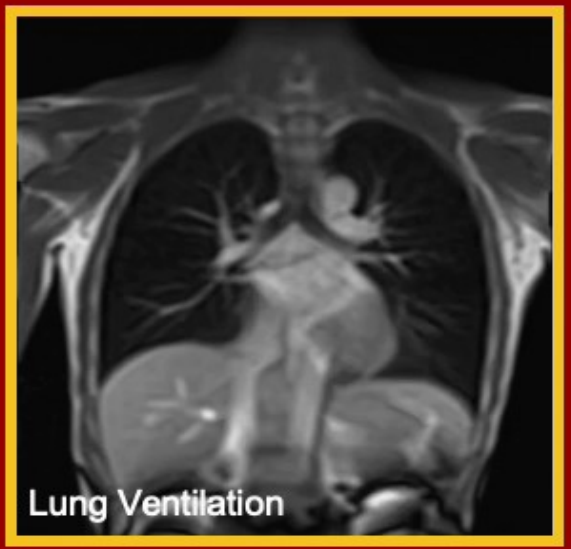

Dynamic Imaging Science Center

Ramped down Aera 0.55T

Free.Max 0.55T

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Our Pulseq Journey

DISC Established
January 2021

I joined.
Fall 2021

Pulseq Interpreter
End 2021

First Pulseq project
Summer 2022

Pulseq

8+ projects with Pulseq:

- Quantitative/Mapping
- Dynamic (cardiac, lung)
- Metal imaging
- MRF
- MP-RAGE/MP-FISP

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Our Pulseq Journey

- Why Pulseq?
  - New scanner, new field, endless possibilities!

    VISTA ai formerly HeartVista
    - Not everyone has it.
    - There is still learning curve.
    - Overkill for static imaging or quick tests.
  - Pulseq checks all the boxes!

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Legend

github.com/usc-mrel

pypulseq

Multisite Quantitative Mapping

Bilal Tasdelen

Protocols → pypulseq

JSON

Pulseq

Raw Data

Acquisition

NIH

Prototype 0.55T

Free.Max

USC

Prototype 0.55T

Michigan

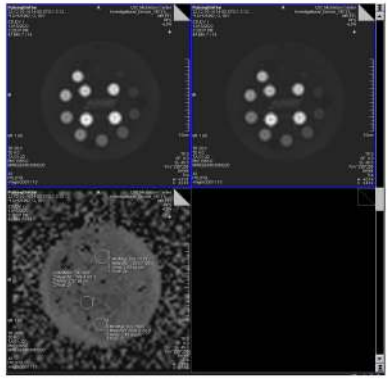
Free.Max

Gadgetron

MRD → qMRLab → Results

StimFit

qMRLab



Reconstruction

Spin Echo Based

- Single-Echo Multi-Contrast Spin-Echo (SESE)
- Multi-echo Spin-Echo (MCSE)
- Inversion Recovery Spin-Echo (IRSE)

Gradient Echo Based

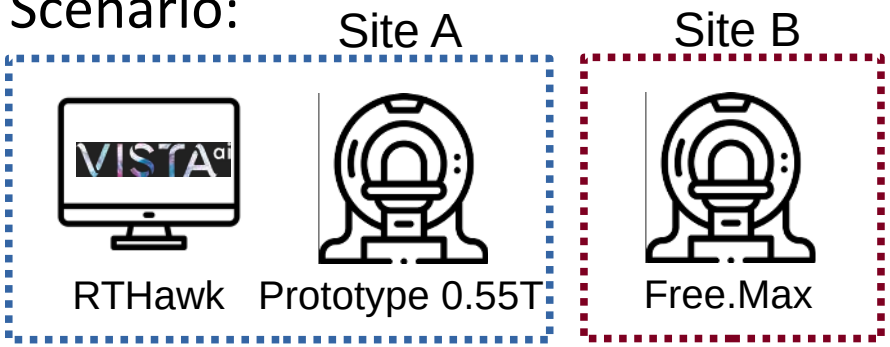
- Variable Flip Angle Gradient Echo (VFA-GRE)
- Double Angle Method (DAM)
- Saturated Double Angle Method (SDAM)
- Actual Flip-angle Imaging (AFI)

Open-source tools for multi-center multi-platform 0.55T relaxometry studies. ISMRM23, #2394

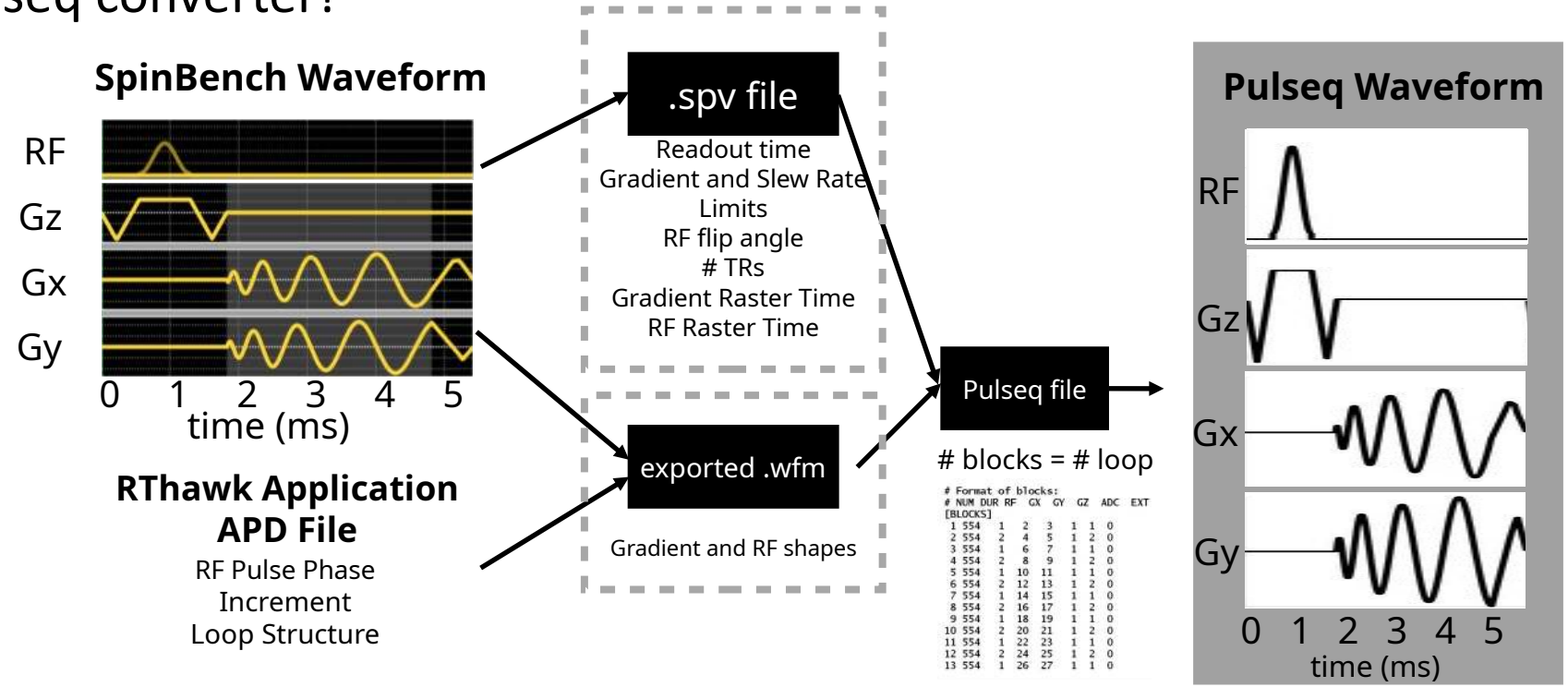
Real-time cardiac

Prakash Kumar

- Scenario:



- RTHawk to Pulseq converter!



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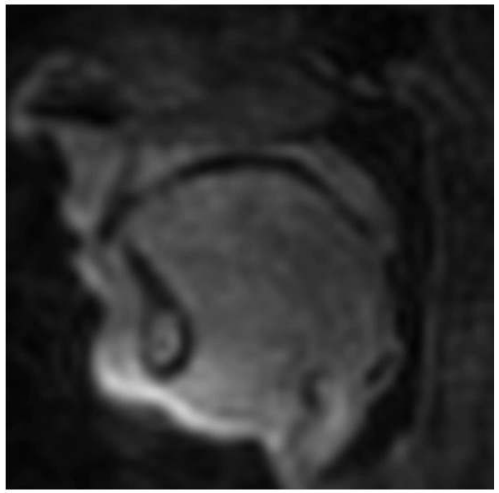
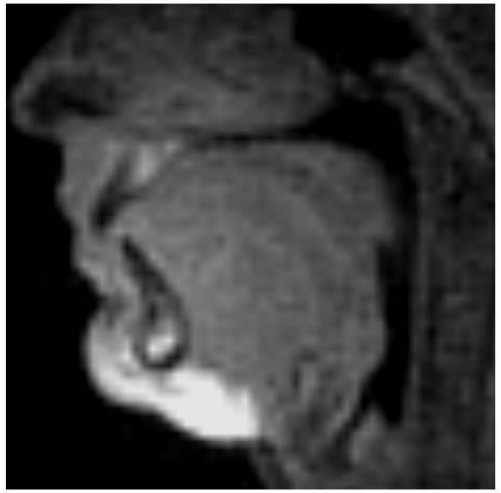
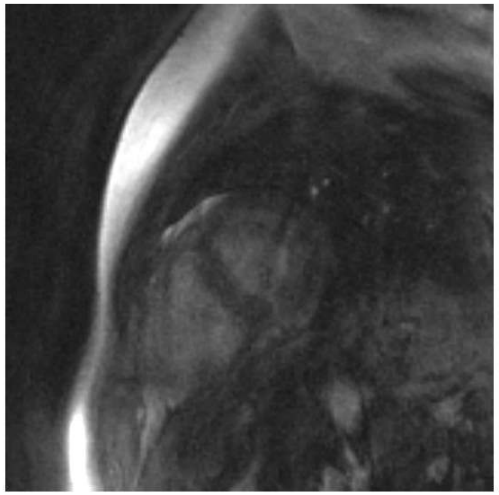
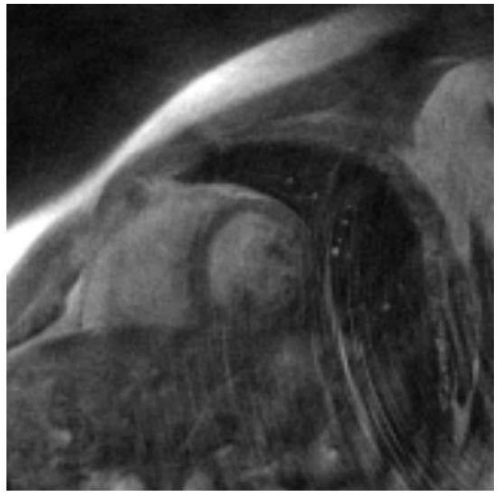
Prakash Kumar

pypulseq

	Pulseq	RTHawk
Speech Spiral SSFP		
Cardiac Spiral SSFP		

Open-source dynamic MRI workflow for reproducible research, ISMRM23, #2402

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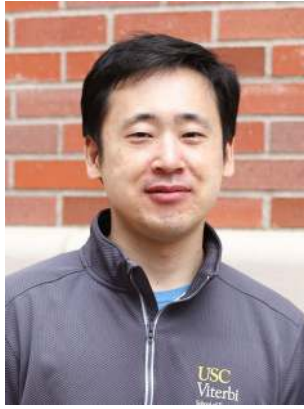
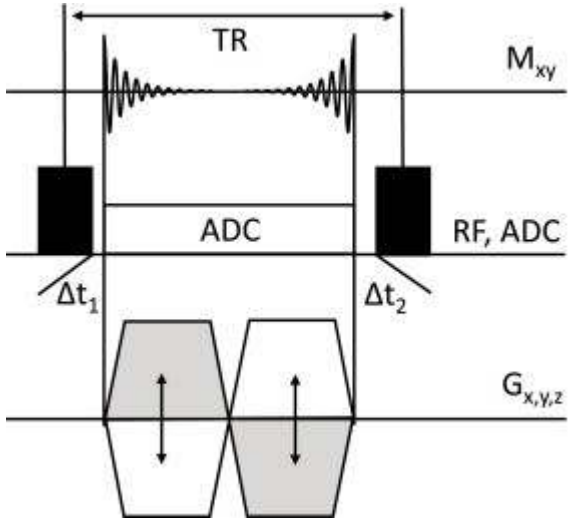
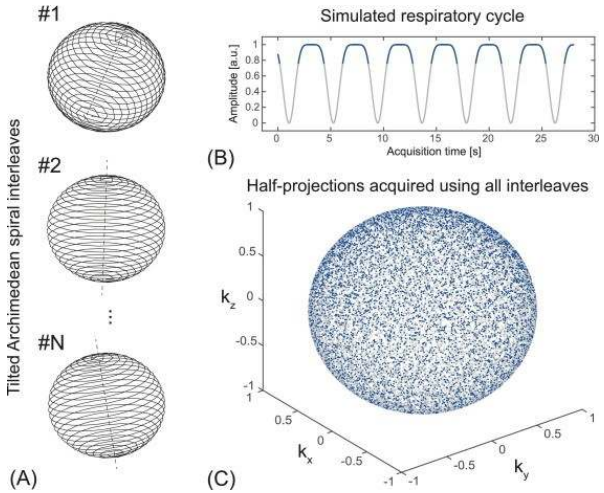
Lung bSTAR



Nam G. Lee

- Bieri et al. Free-breathing half-radial dual-echo balanced steady-state free precession thoracic imaging with wobbling Archimedean spiral pole trajectories. Zeitschrift für Medizinische Physik. 2023.
- Radial, dual echo bSSFP.
- Designed for lung.





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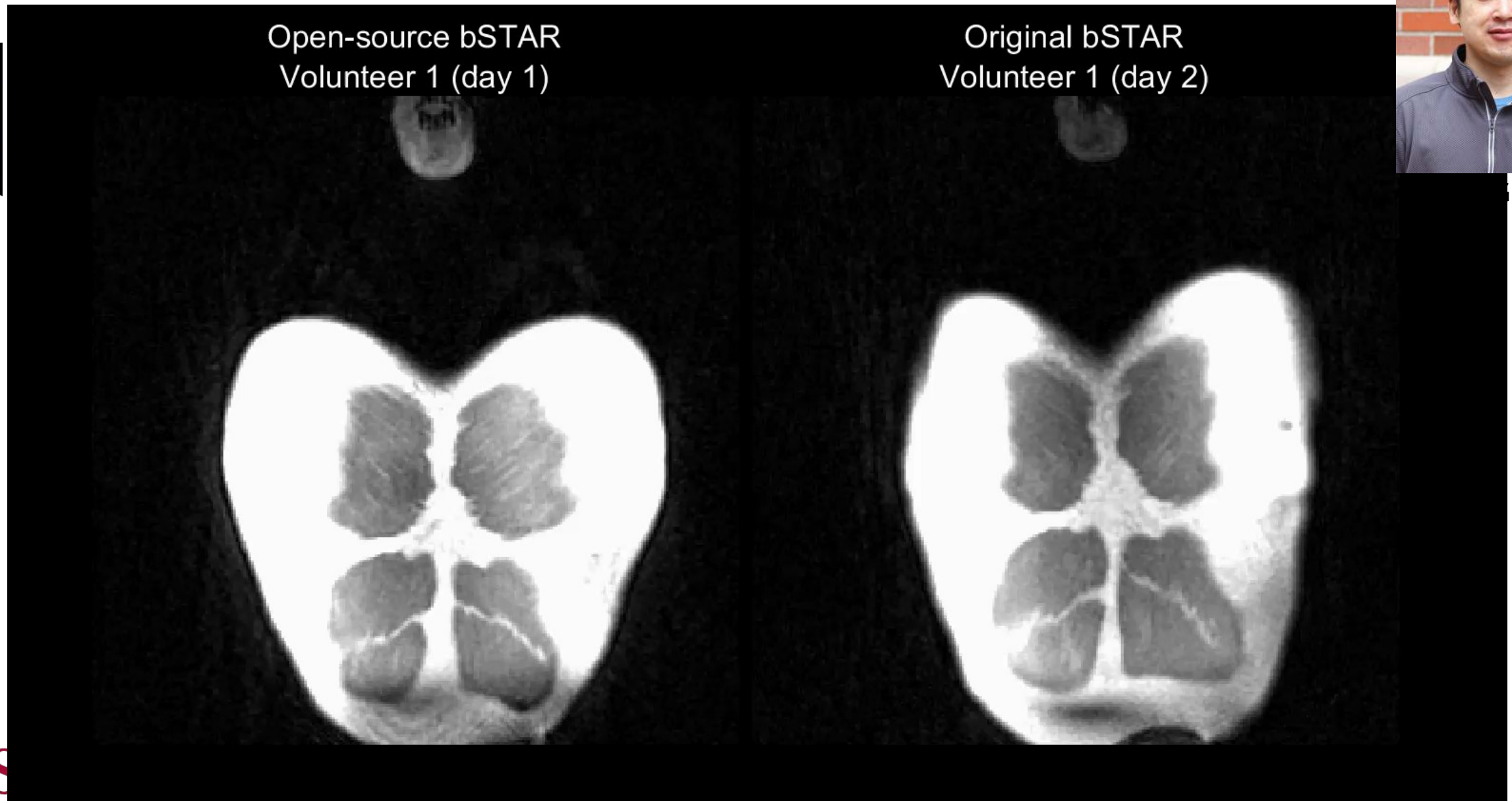
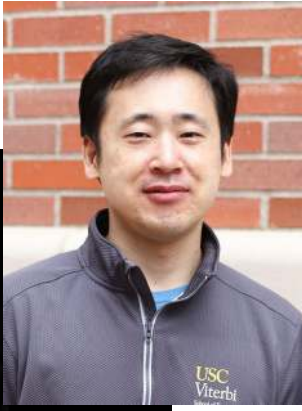
bSTAR





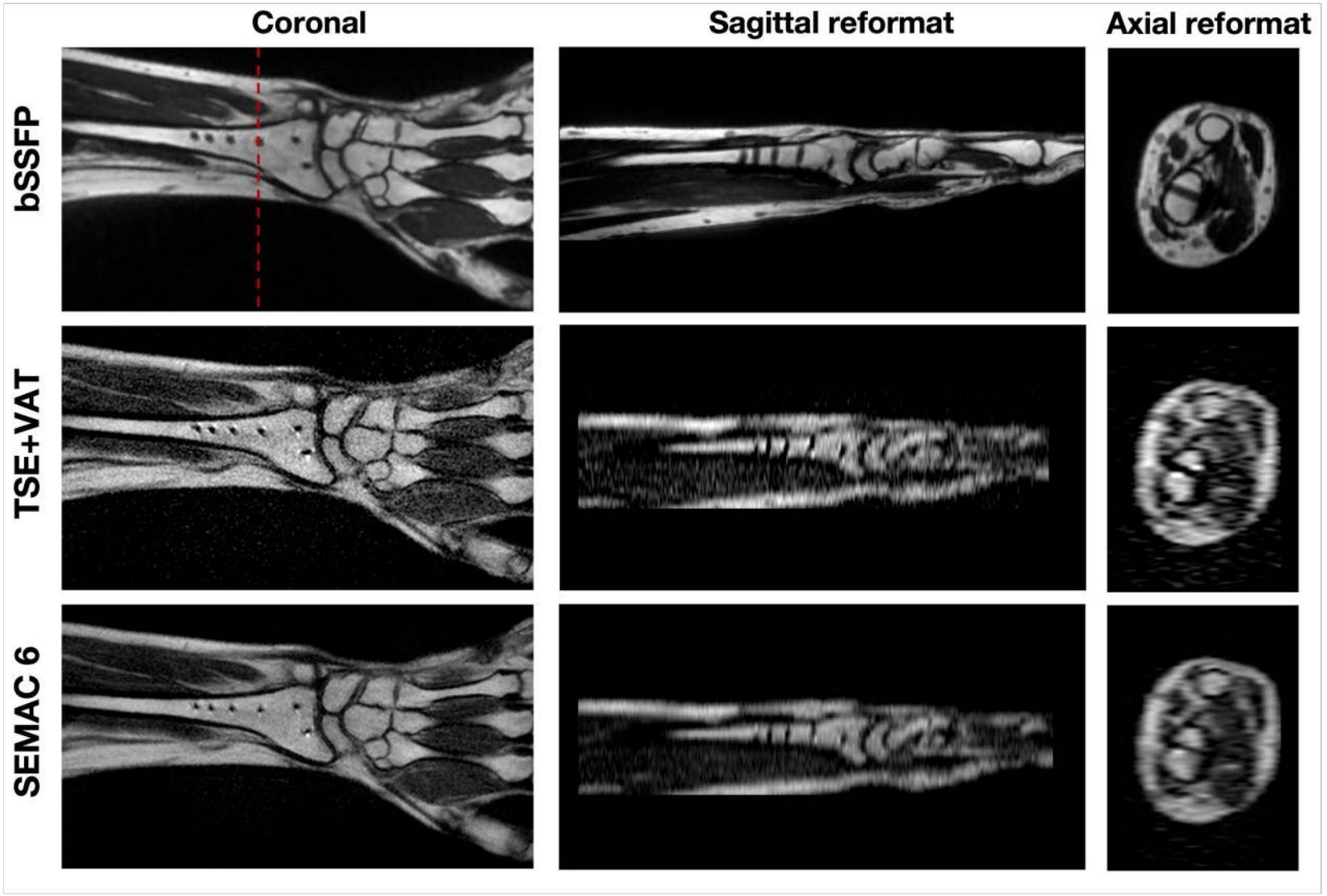
. Lee

MERIT AWARD
SUMMA CUM LAUDE

School of Engineering

"Replication of the bSTAR sequence and open-source implementation." MRM. Accepted.

Metal

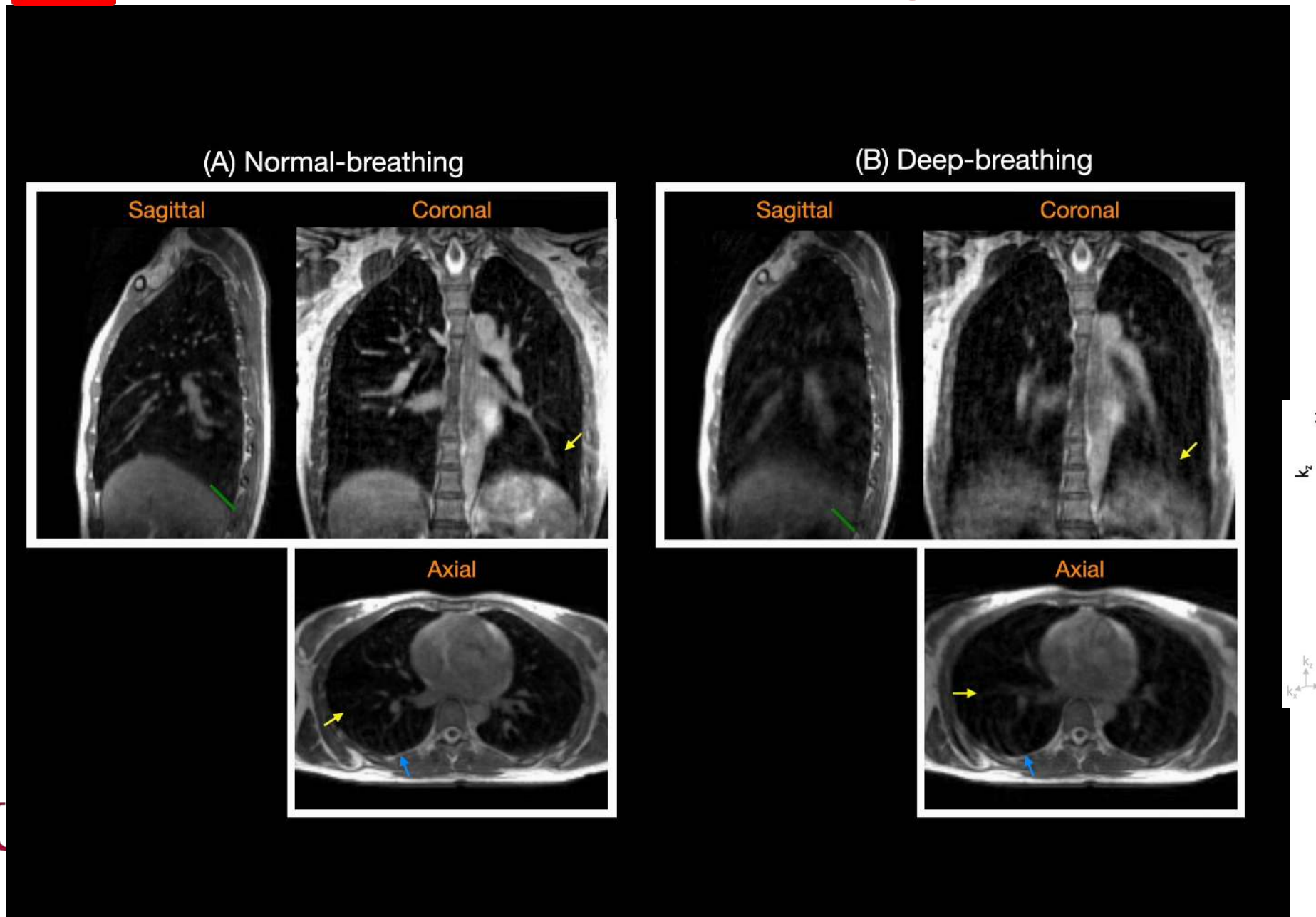


Kübra Keskin

USC Viterbi School of Engineering

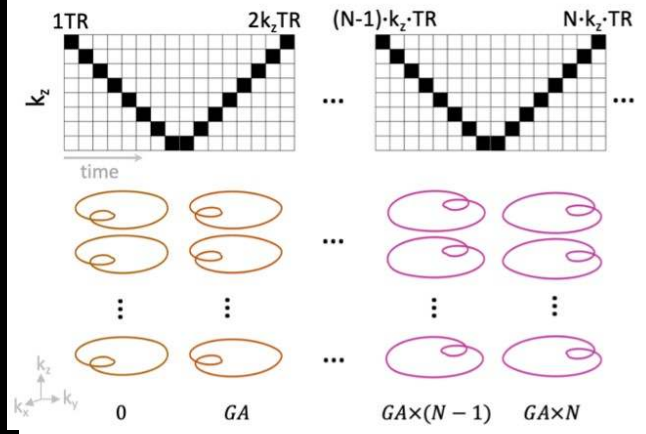
Isotropic sub-mm bSSFP imaging near metal at 0.55T. ISMRM23. #7832

Lung

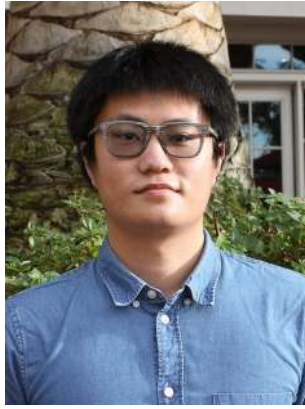


Ziwei Zhao

High resolution free-breathing respiratory-resolved volumetric lung imaging at 0.55T using stack-of-spiral out-in bSSFP, ISMRM24, Submitted

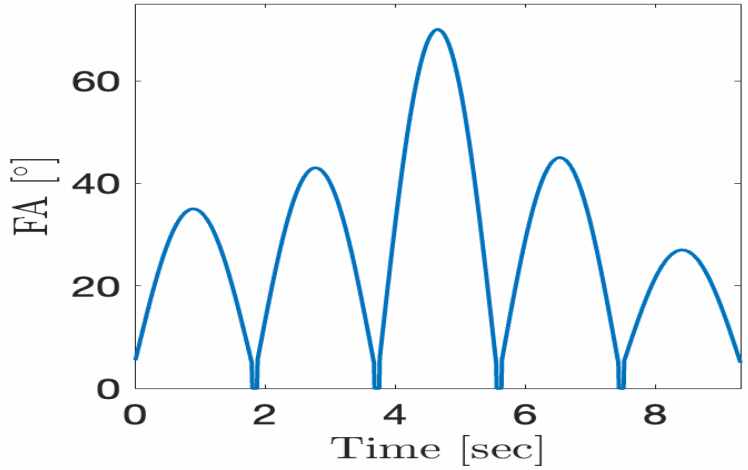


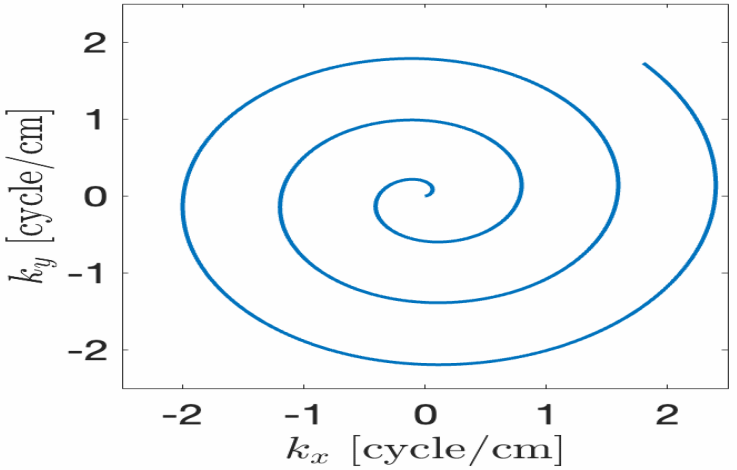
MRF



Zhibo Zhu

- Spiral, FISP
- Pseudo random parameter schedules (TE, TR, FA)
- Readout sweep.





RO=2.74ms, TR=6.38ms, T_{total}=9.25s

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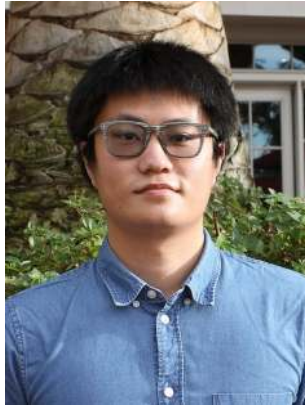
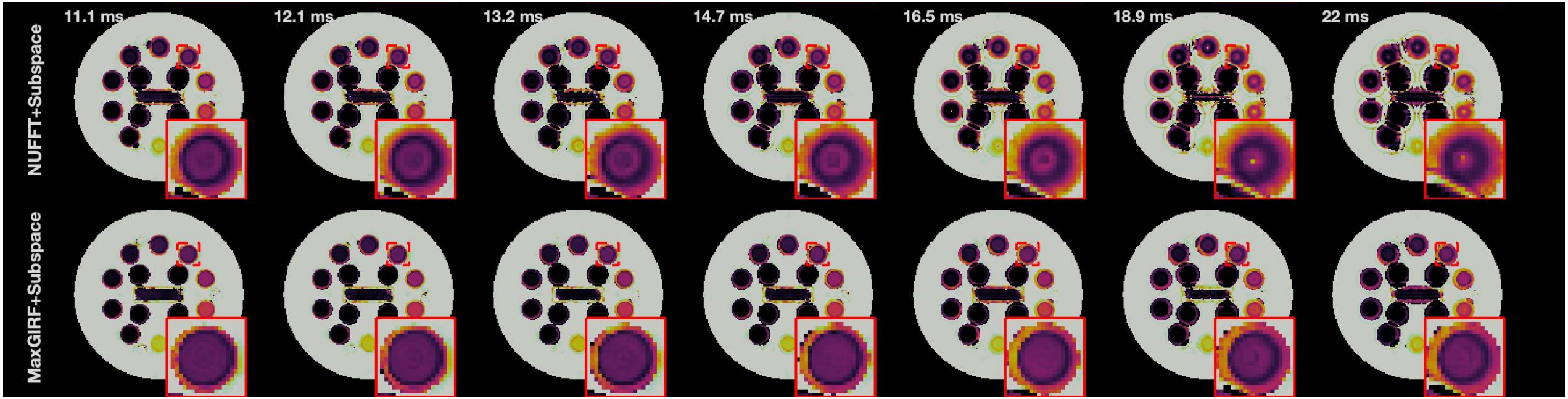
MRF



Zhibo Zhu

Increased readout, increased artifact



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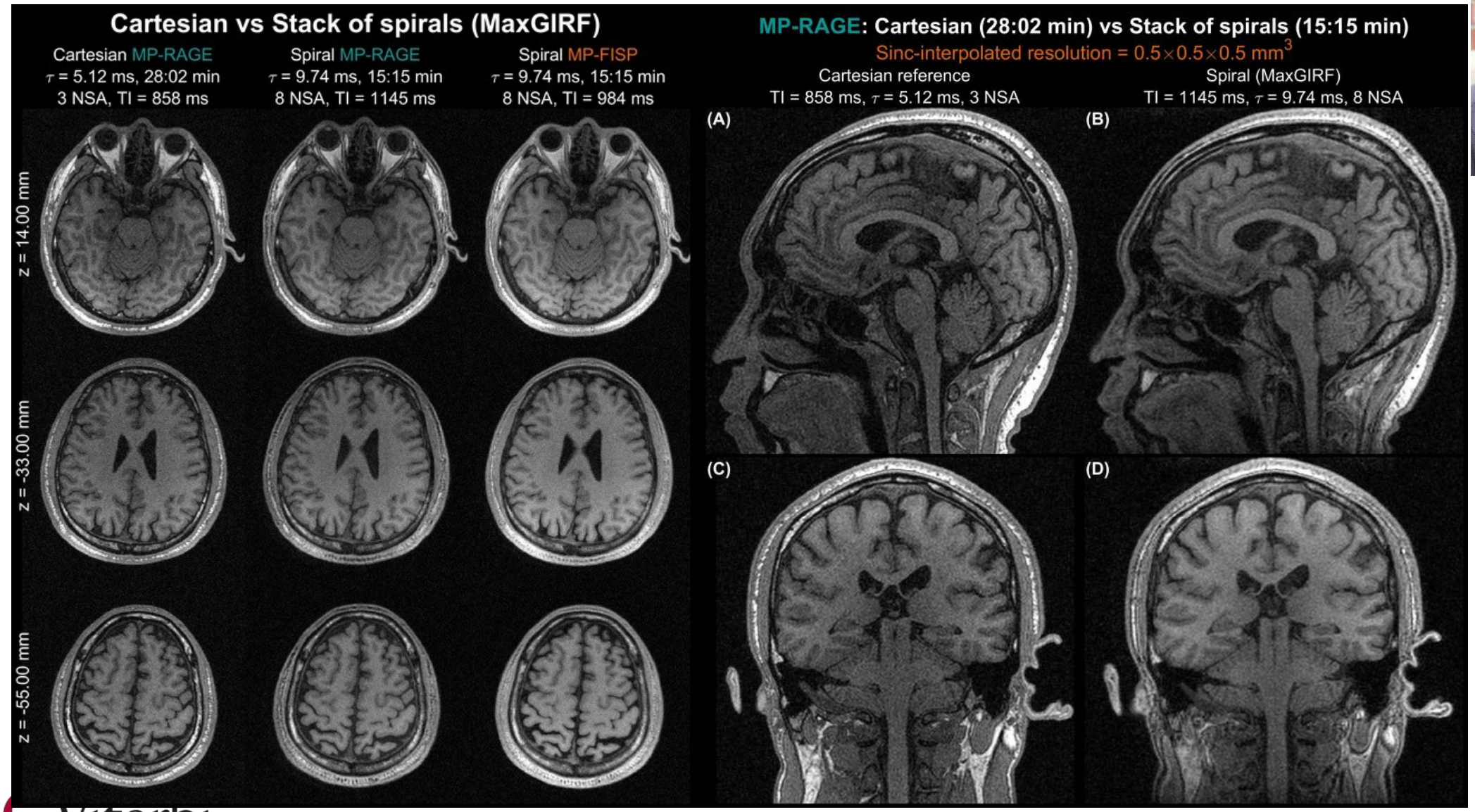
Zhu et al. Trade-off between Readout Duration and Concomitant Field Effect in 3D MRF at 0.55T. ISMRM24. Submitted.

Brain



Nam G. Lee

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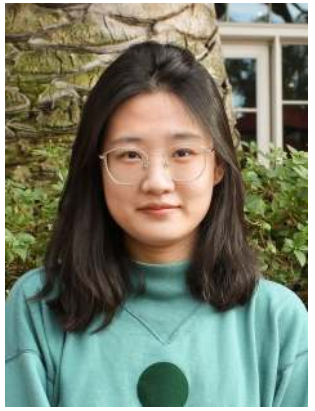
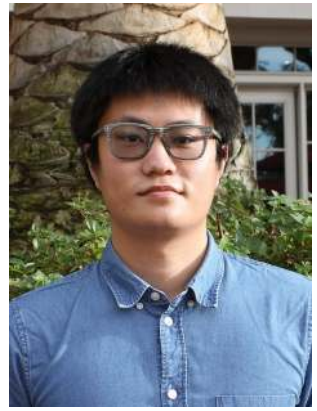
High SNR rapid T1-weighted MP-RAGE and MP-FISP using a 3D stack-of-spirals trajectory at 0.55T ISMRM24, Submitted.

Pulseq Wishlist

- Sequence generation for >10k TRs
- Better sequence visualization.
- More utility functions, UI helpers for sequence development.
- Easy simulation (Pulseq → JEMRIS?)
  - https://github.com/imr-framework/py2jemris (does not support v1.4)

Thanks!





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