Accelerated mecho-UTE CT-like Imaging using CG-SENSE and DLR

Hung Do[1], Kacie Sorfleet[2], Mitsuhiro Bekku[3], Dawn Berkeley[1], Takuma Kawai[3],

Brian Tymkiw[1], Wissam AlGhuraibawi[1], Mo Kadbi[1], Dustin Devries[2],

Matthew T. Provencher[2], Scott Tashman[2], Charles P. Ho[2]

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[2]Steadman Philippon Research Institute, Vail, CO

[3]Canon Medical Systems Corporation, Japan

ISMRM 2025, Hawaii, May 12, **Abstract #0156**

ISMRM & ISMRT
ANNUAL MEETING & EXHIBITION
Honolulu, Hawai'i, USA 10-15 MAY 2025

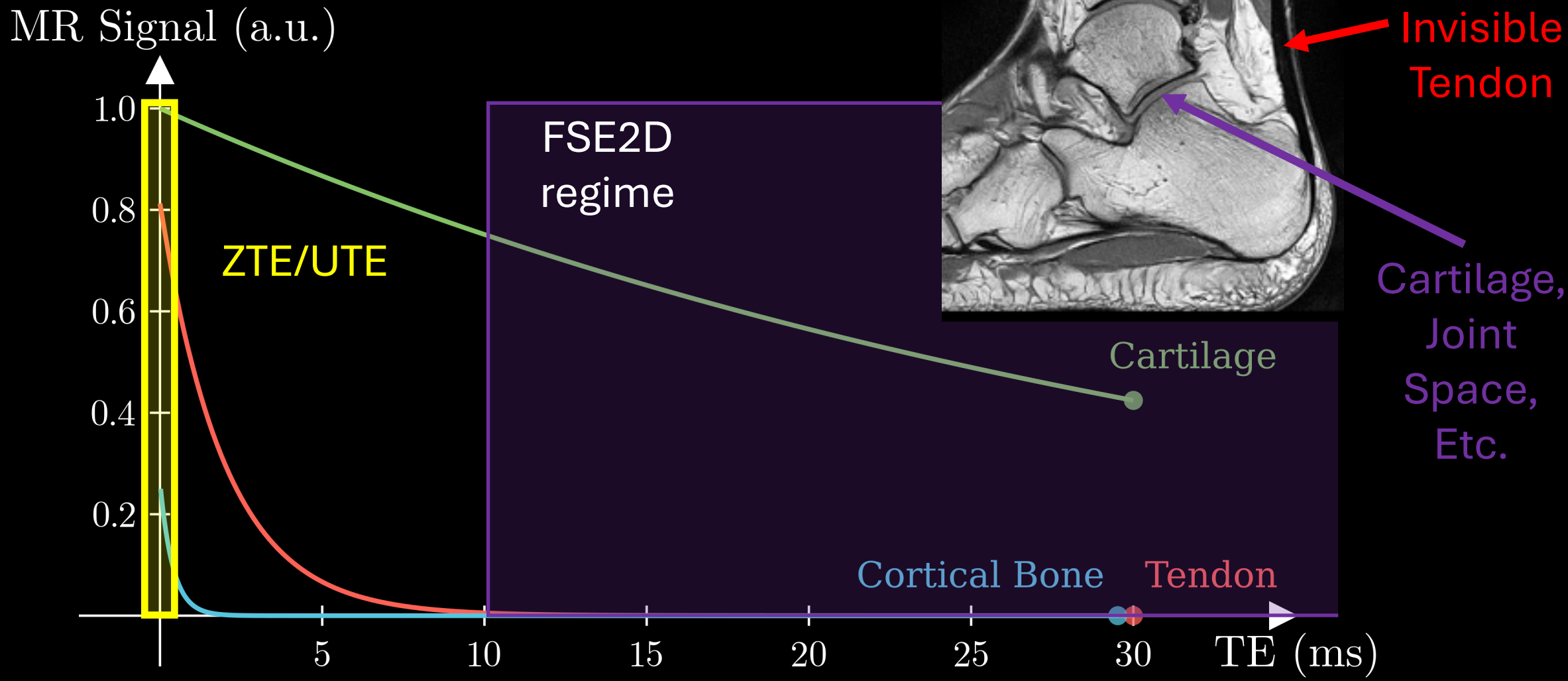
Declaration of Financial Interests or Relationships

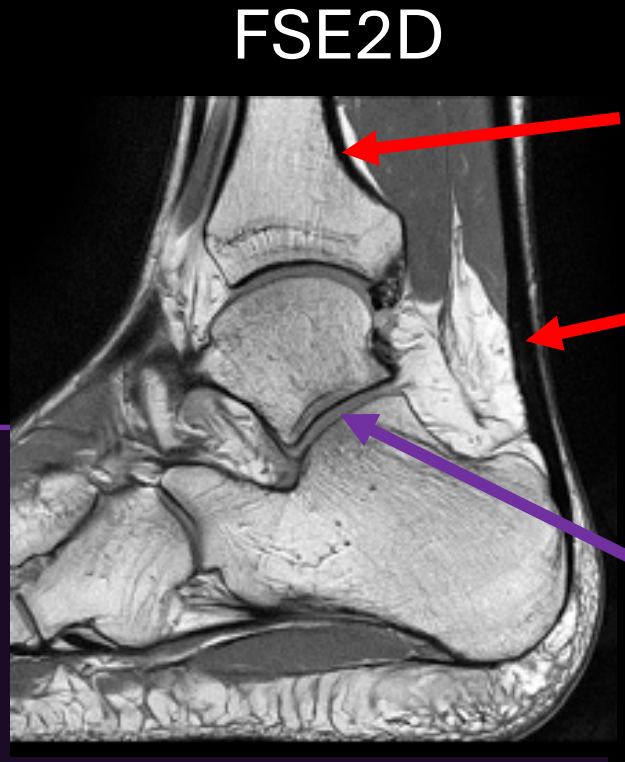
Speaker Name: **Hung Do**

I have the following financial interest or relationship to disclose with regard to the subject matter of this presentation:

Company Name: **Canon Medical Systems USA, Inc.**
Type of Relationship: **Employee**

MSK Imaging





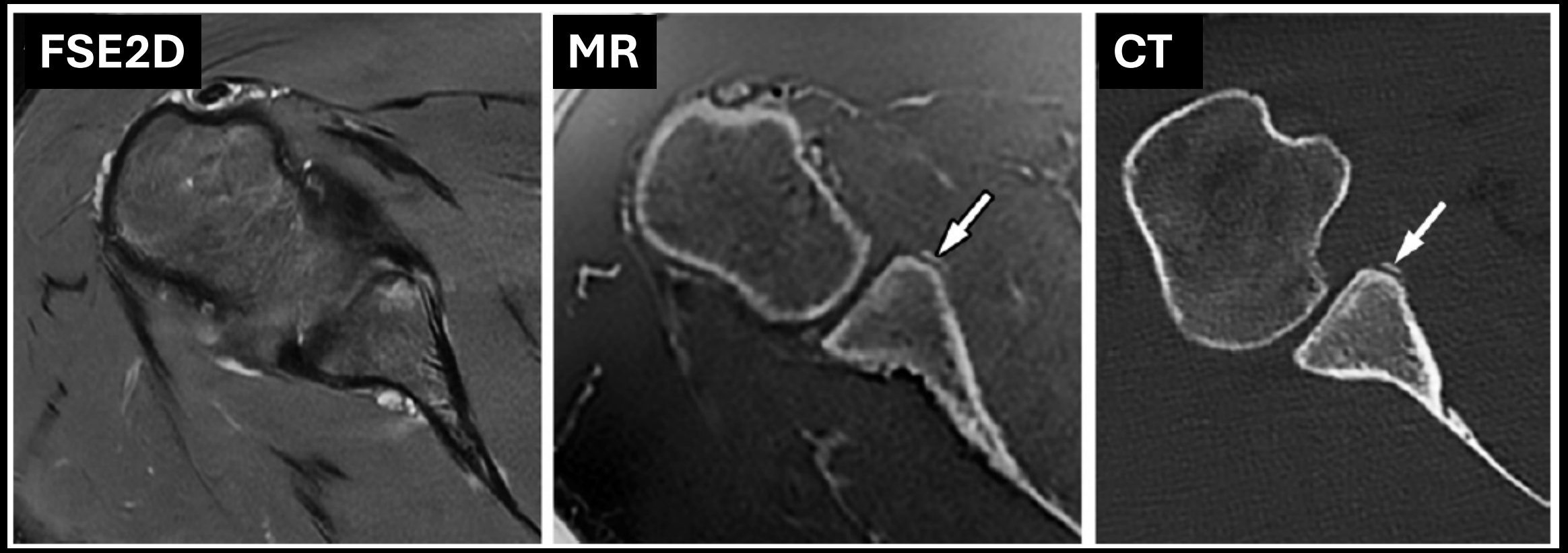
Invisible Bone

Invisible Tendon

Cartilage, Joint Space, Etc.

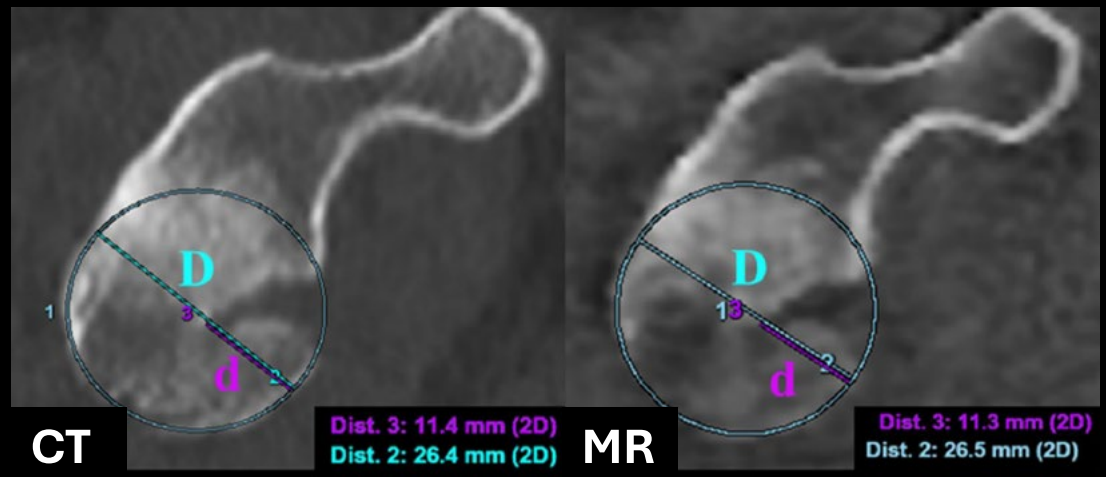
Hennig et al., Magn Reson Med. 1986;3:823-833.

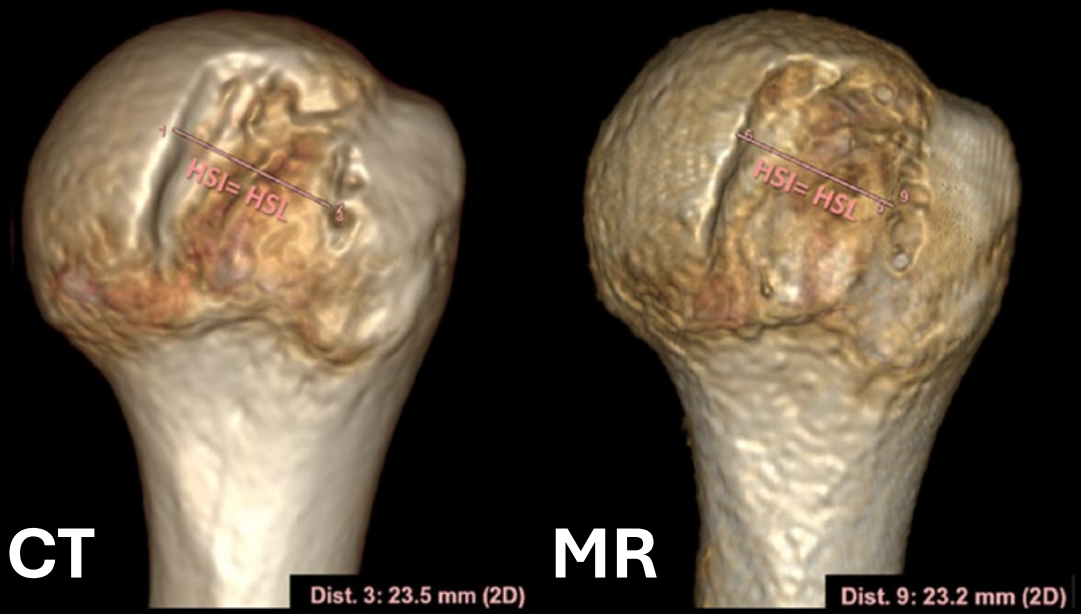
Bone Fracture Detection



Üstün Aydıngöz et al., RadioGraphics 2022; 42:1398–1414

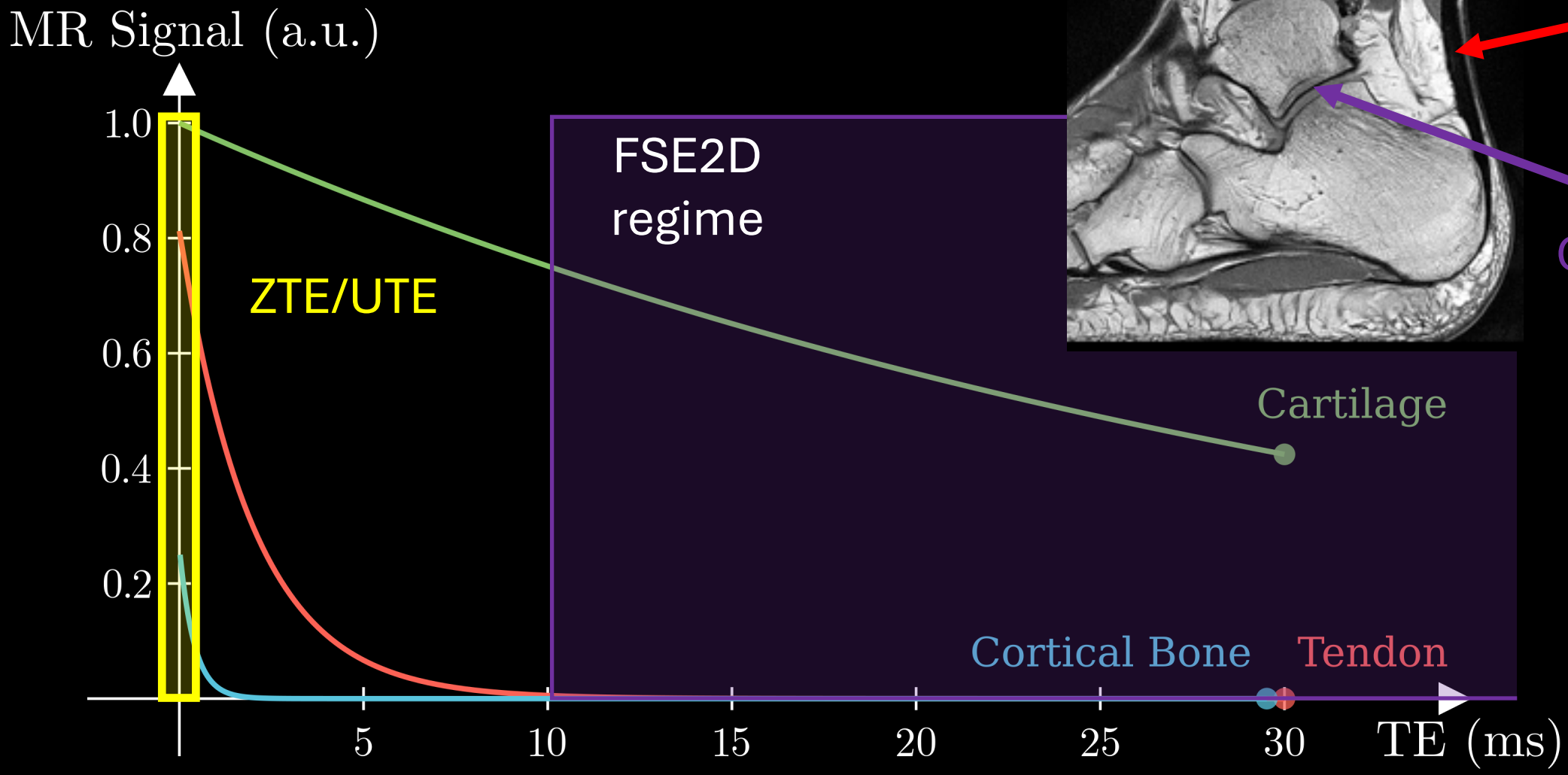
Glenoid Bone Loss Assessment

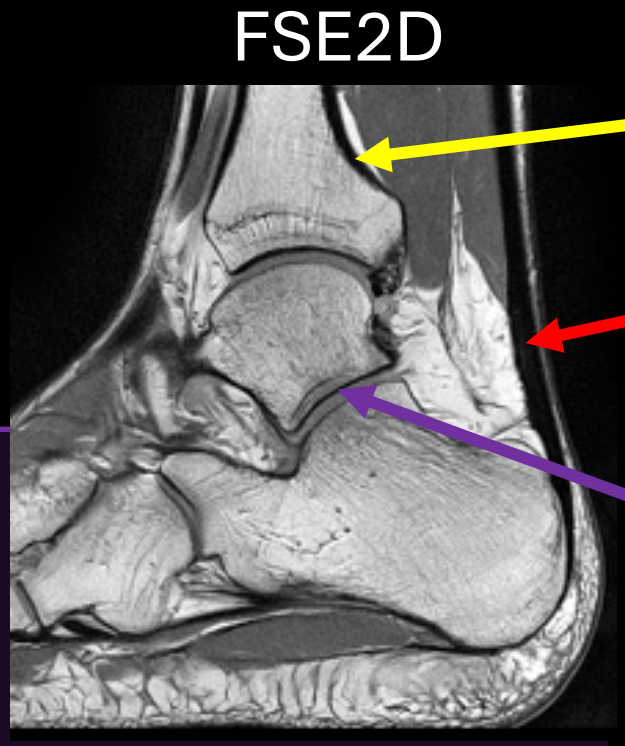




Laura Carretero-Gomez et al., Skeletal Radiol (2024). https://doi.org/10.1007/s00256-024-04830-0

MSK Imaging



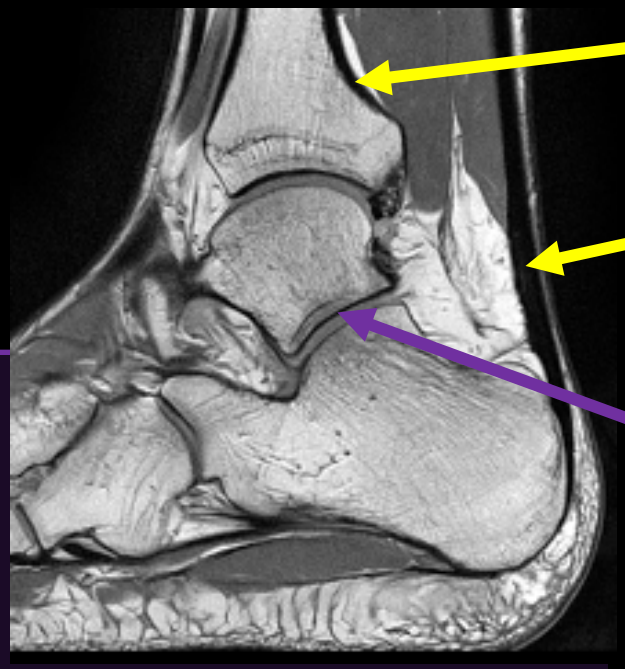


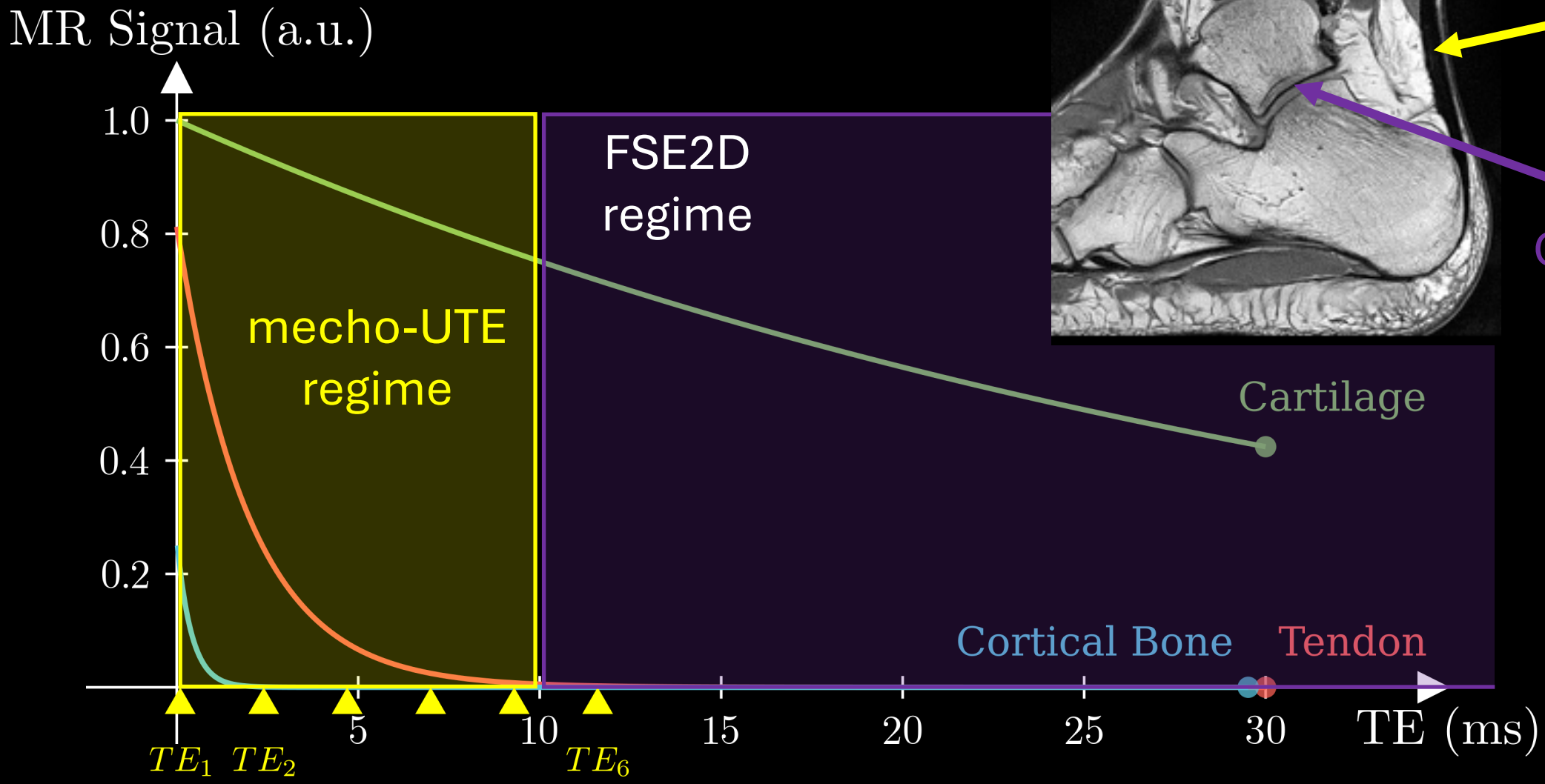
Cortical Bone

Invisible Tendon

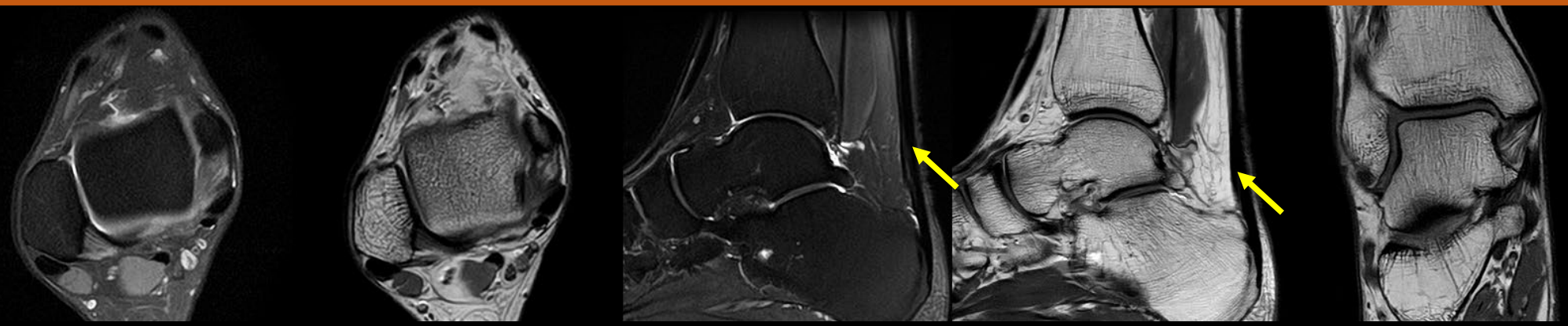
Cartilage, Joint Space, Etc.

Comprehensive MSK

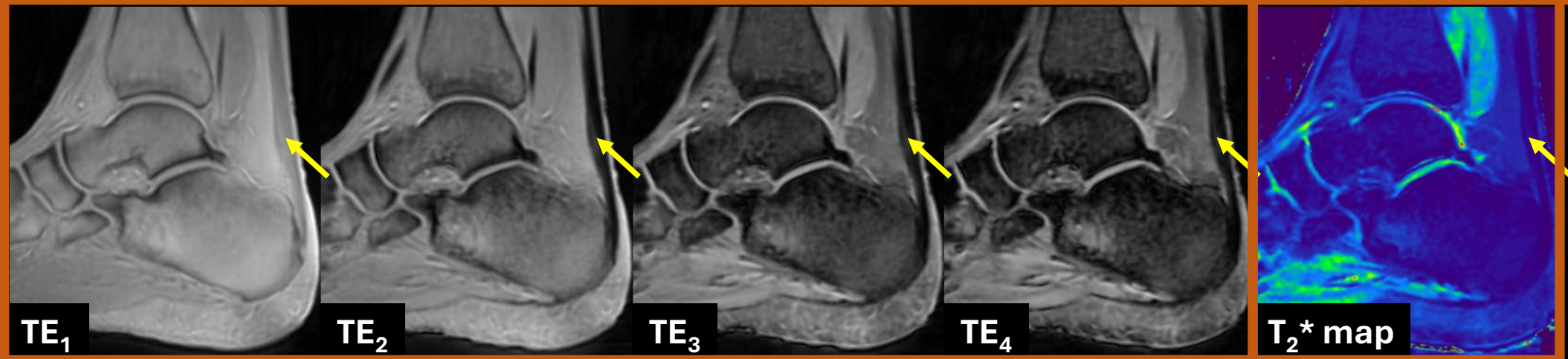


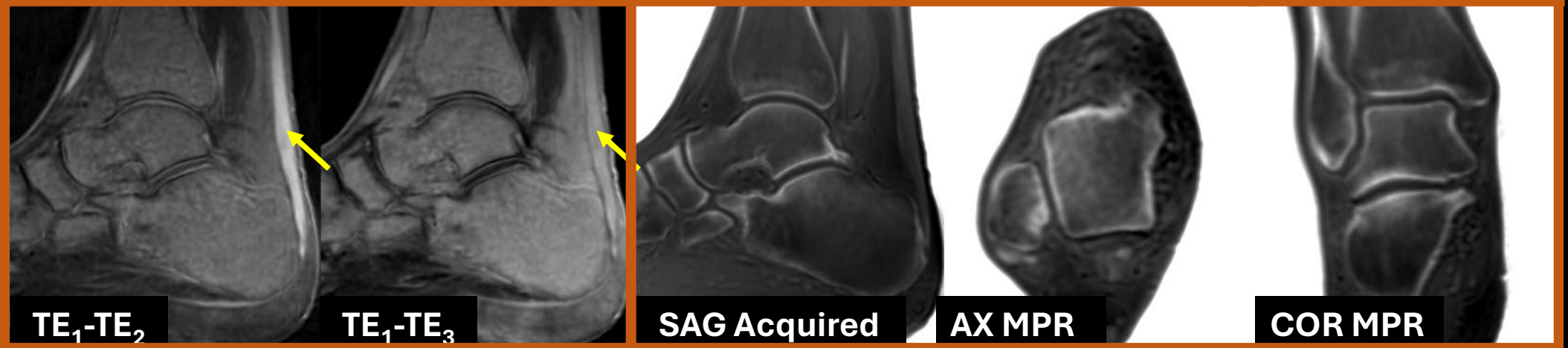


Routine FSE2D

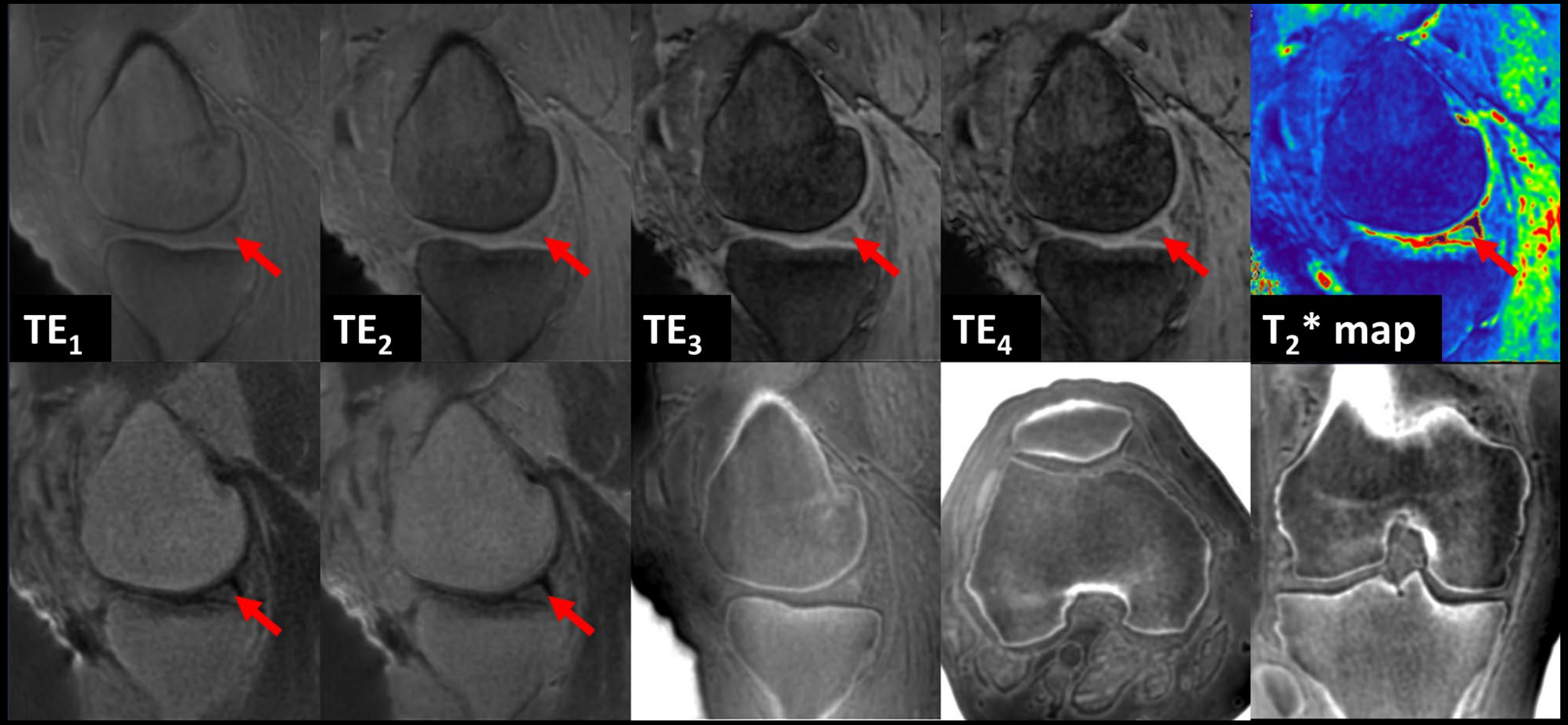


3D isotropic mecho UTE





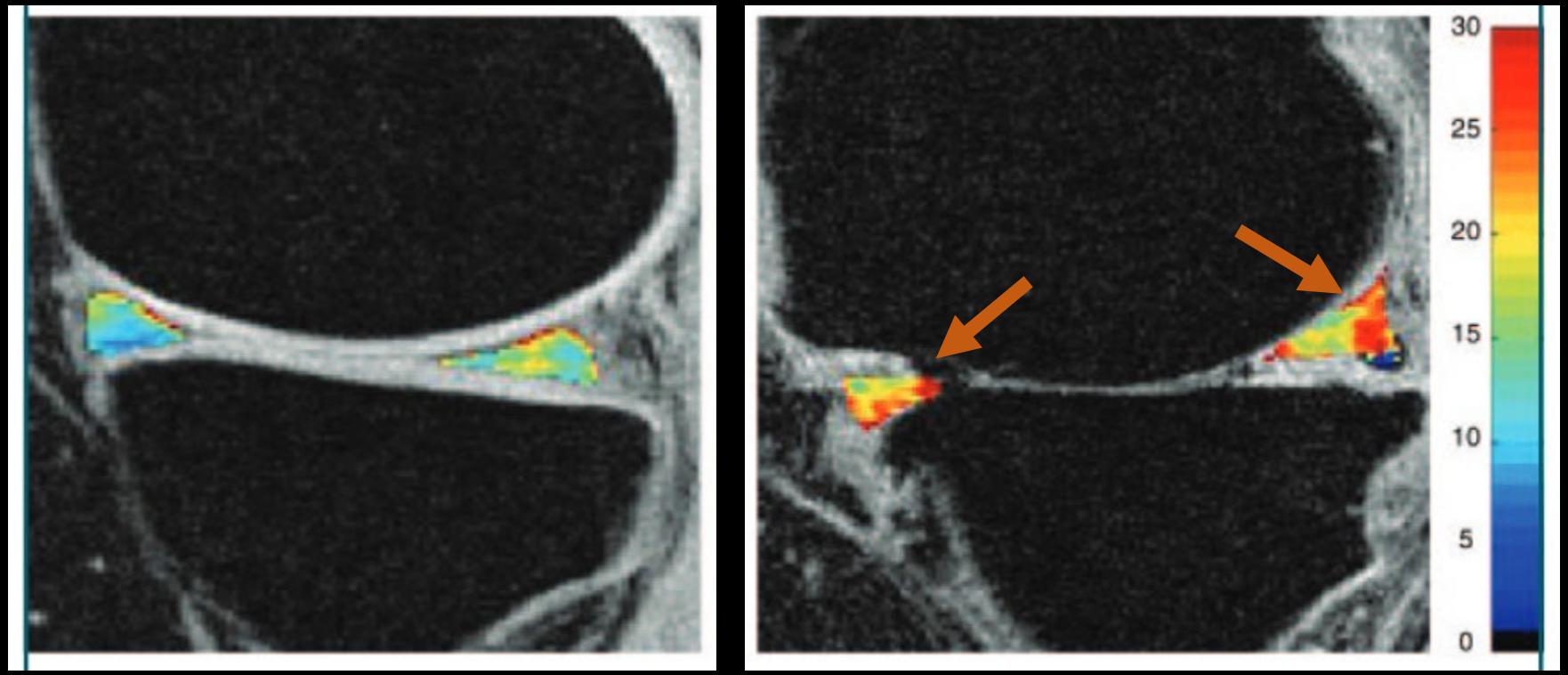
5-min 3D isotropic 0.8mm^3



Increased T2* associated with Disease

Healthy Control

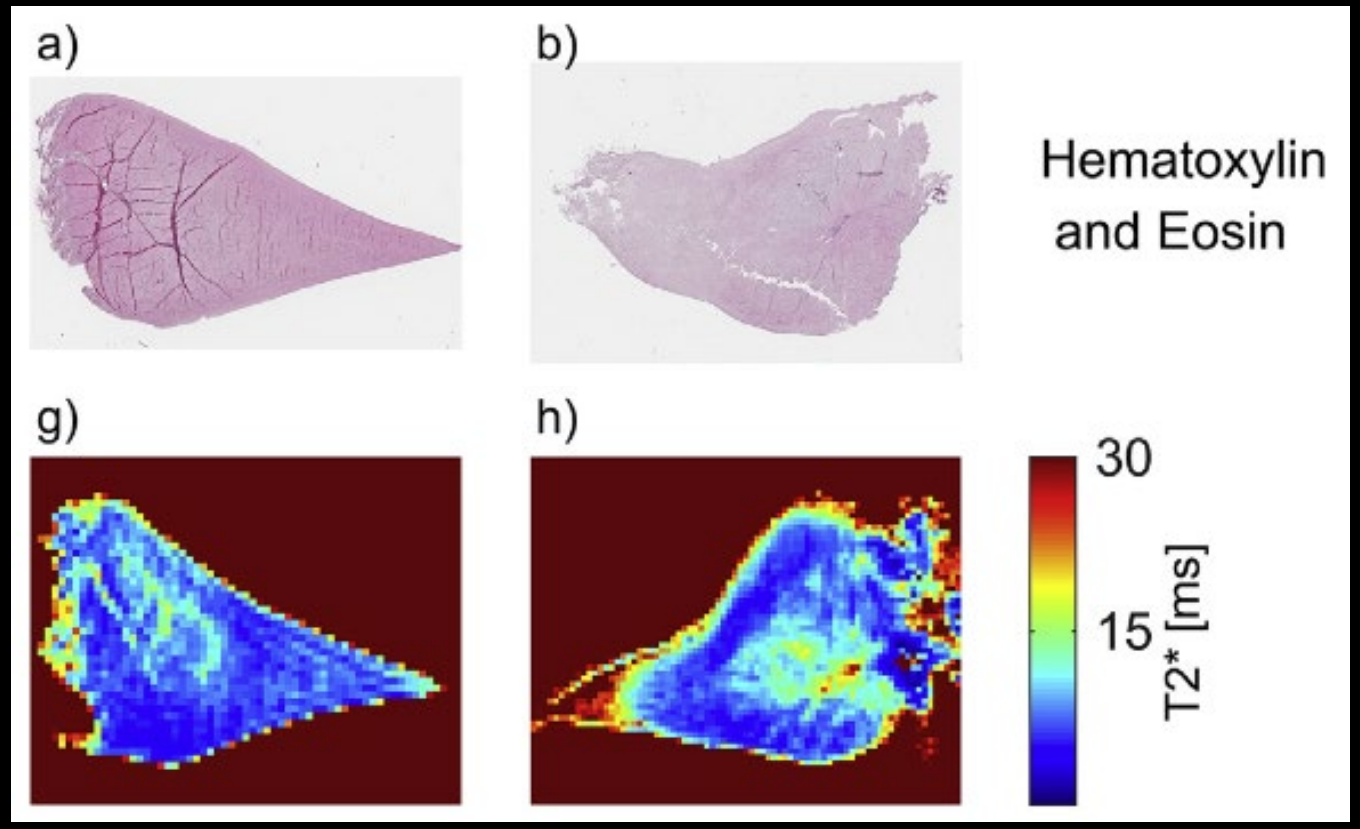
Patient with osteoarthritis (OA)

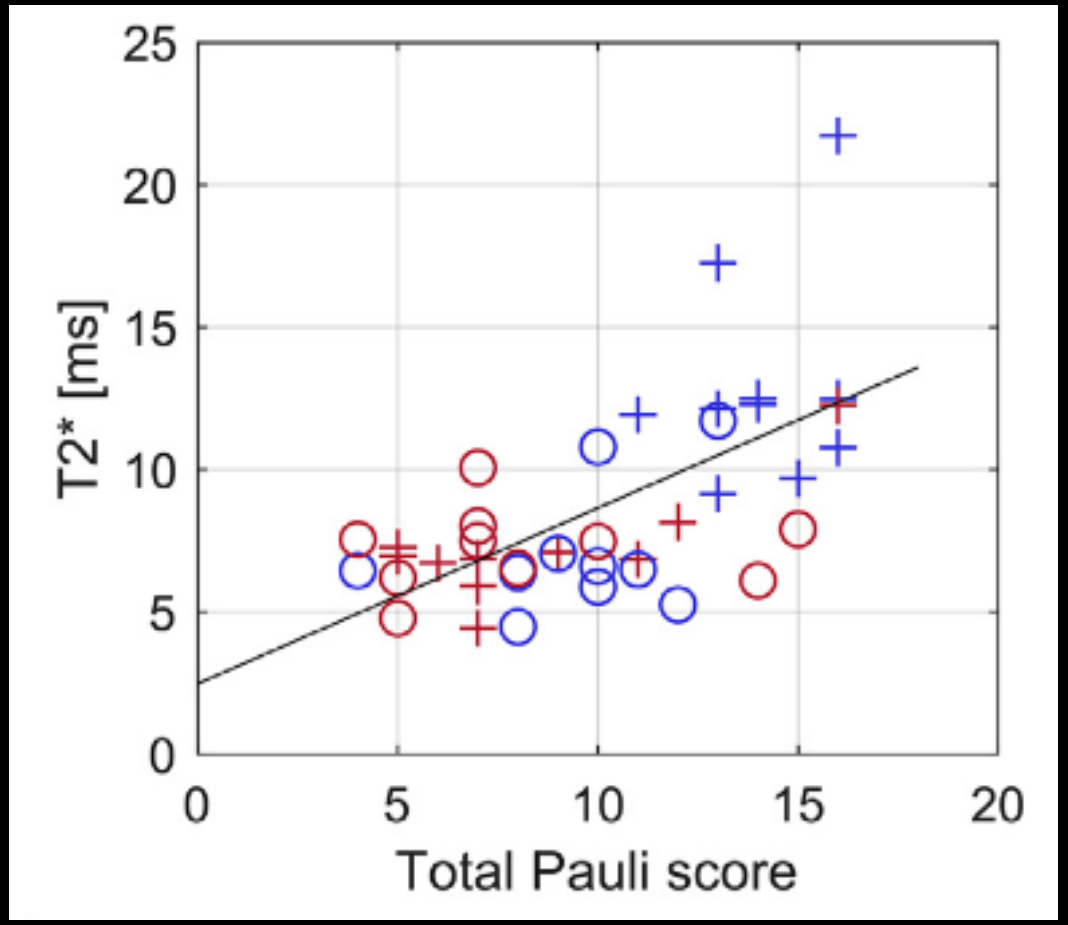


Rauscher et al., Radiology: Volume 249: Number 2—November 2008

Increased T2* is Correlated with Disease Severity

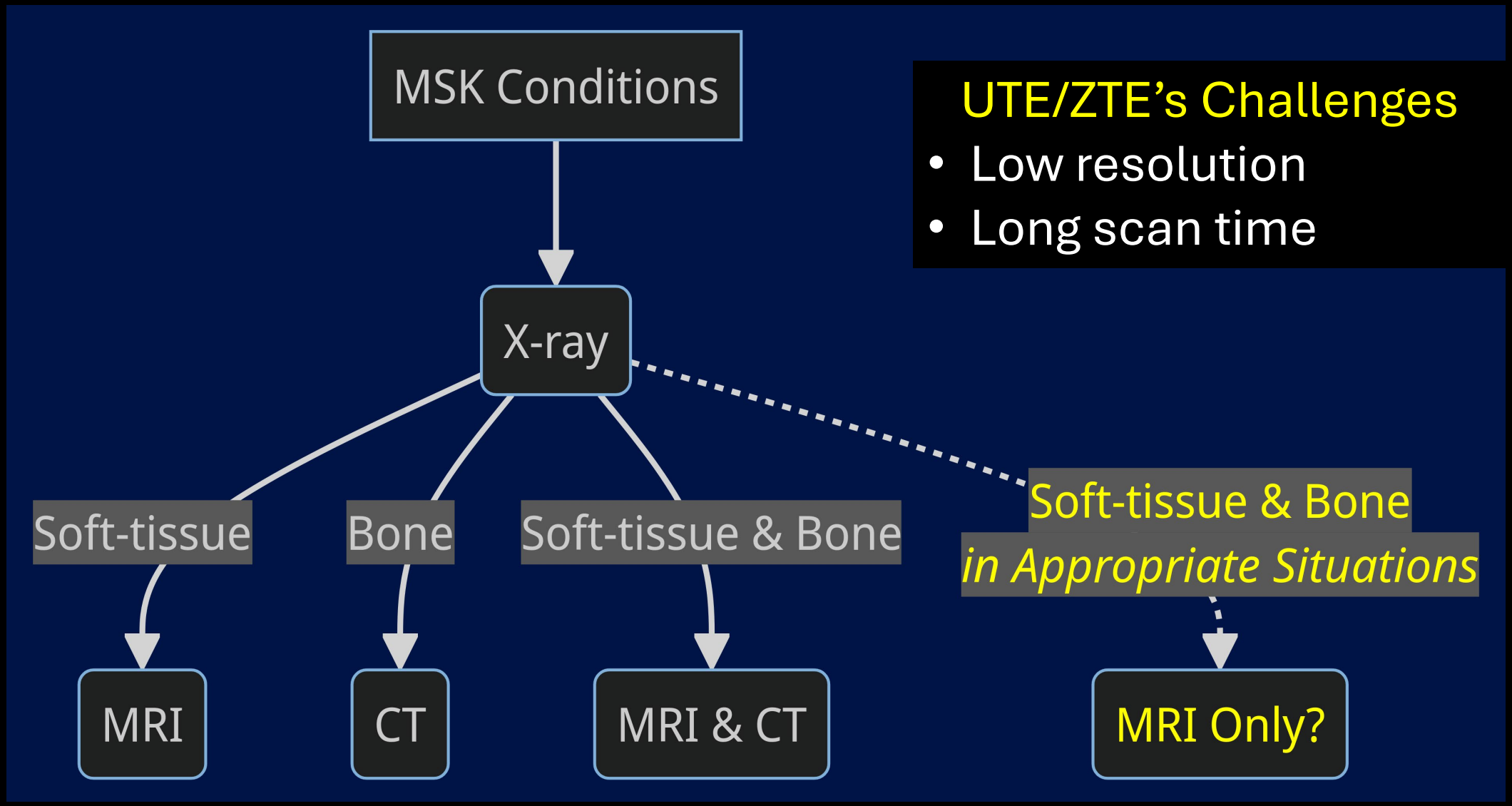
Normal Degenerated





Einarsson et al., Osteoarthritis and Cartilage Open 2 (2020) 100061

Goal: Accelerate Mecho-UTE using CG-SENSE & DLR



UTE/ZTE's Challenges

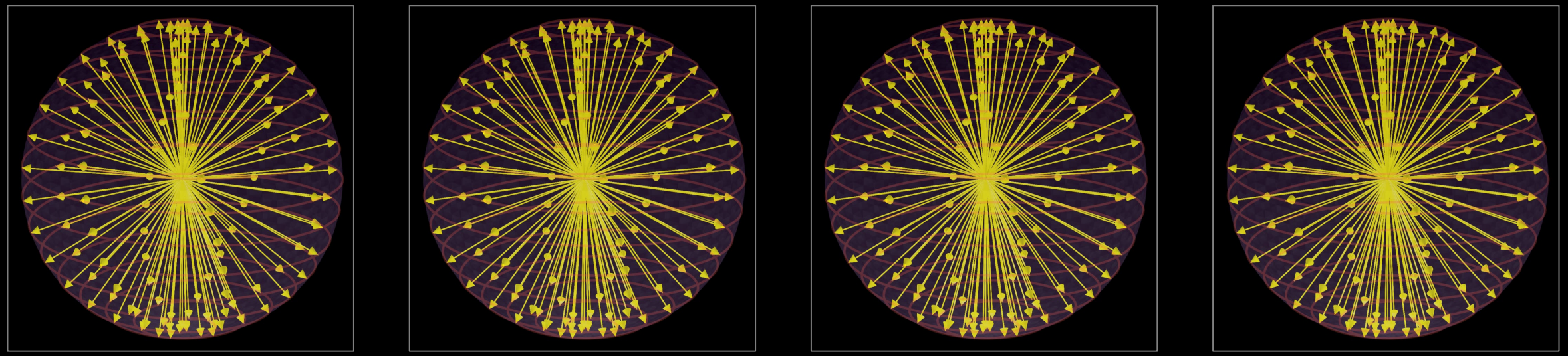
- Low resolution
- Long scan time

Beaman et al., J Am Coll Radiol 2022;19:S473-S487.

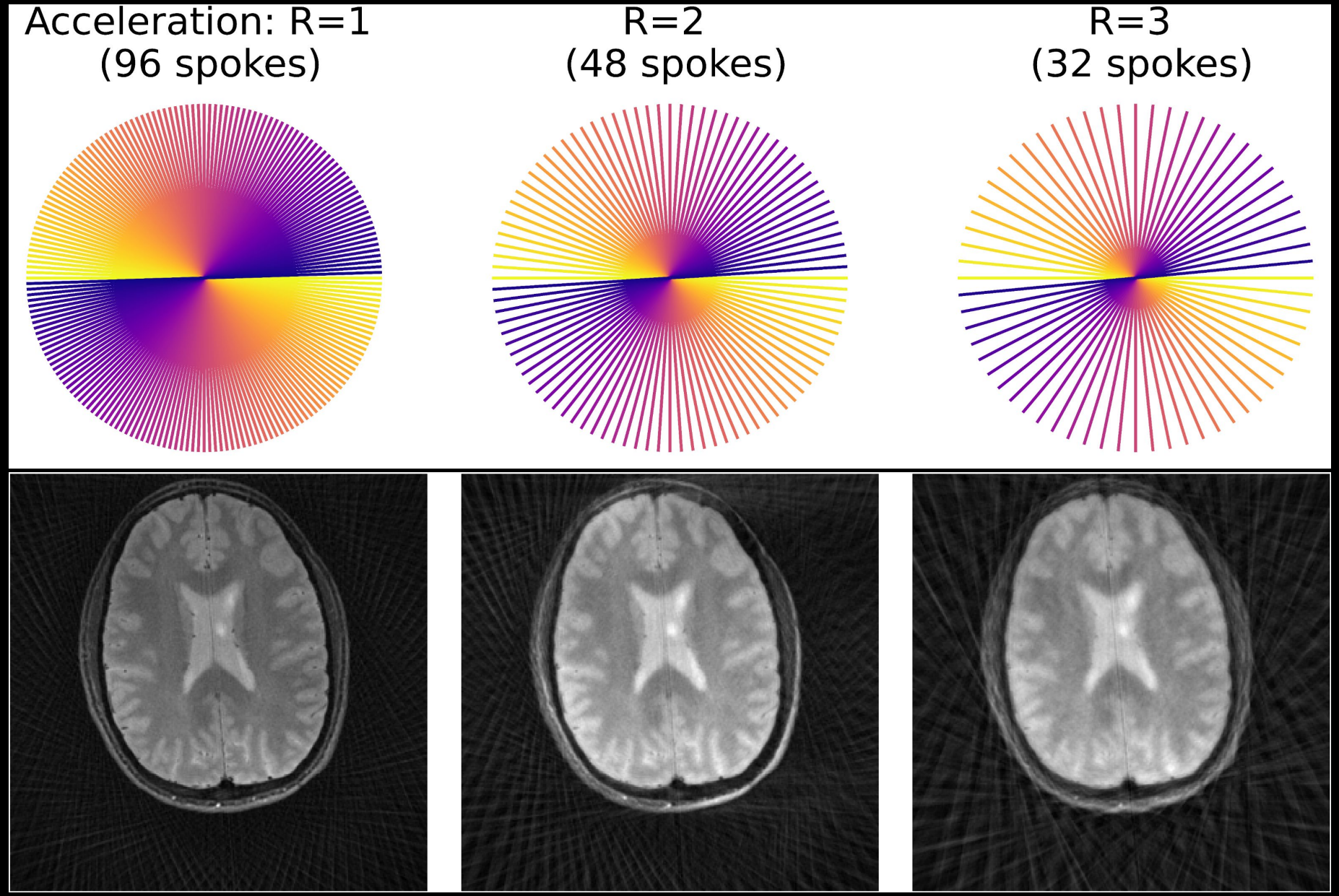
Florkow et al., J Magn Reson Imaging 2022;56(1):11-34.

Methods: 5.8-min 3D-isotropic 0.8mm^3 UTE

TE_1 = 0.096 (ms) TE_2 = 2.396 TE_3 = 4.696 TE_4 = 6.996



- One volunteer & 4 patients prior to surgery (Canon's 3T MRI) and CT
- Retrospectively under-sampled factors: 2, 3, 4, and 5 (i.e., 1.2-min)
- Reconstructed with (1) Gridding (GRID) and (2) CG-SENSE+DLR (DLR)
- Full-Width at Half-Maximum (FWHM) & Relative Edge Sharpness (RESH)

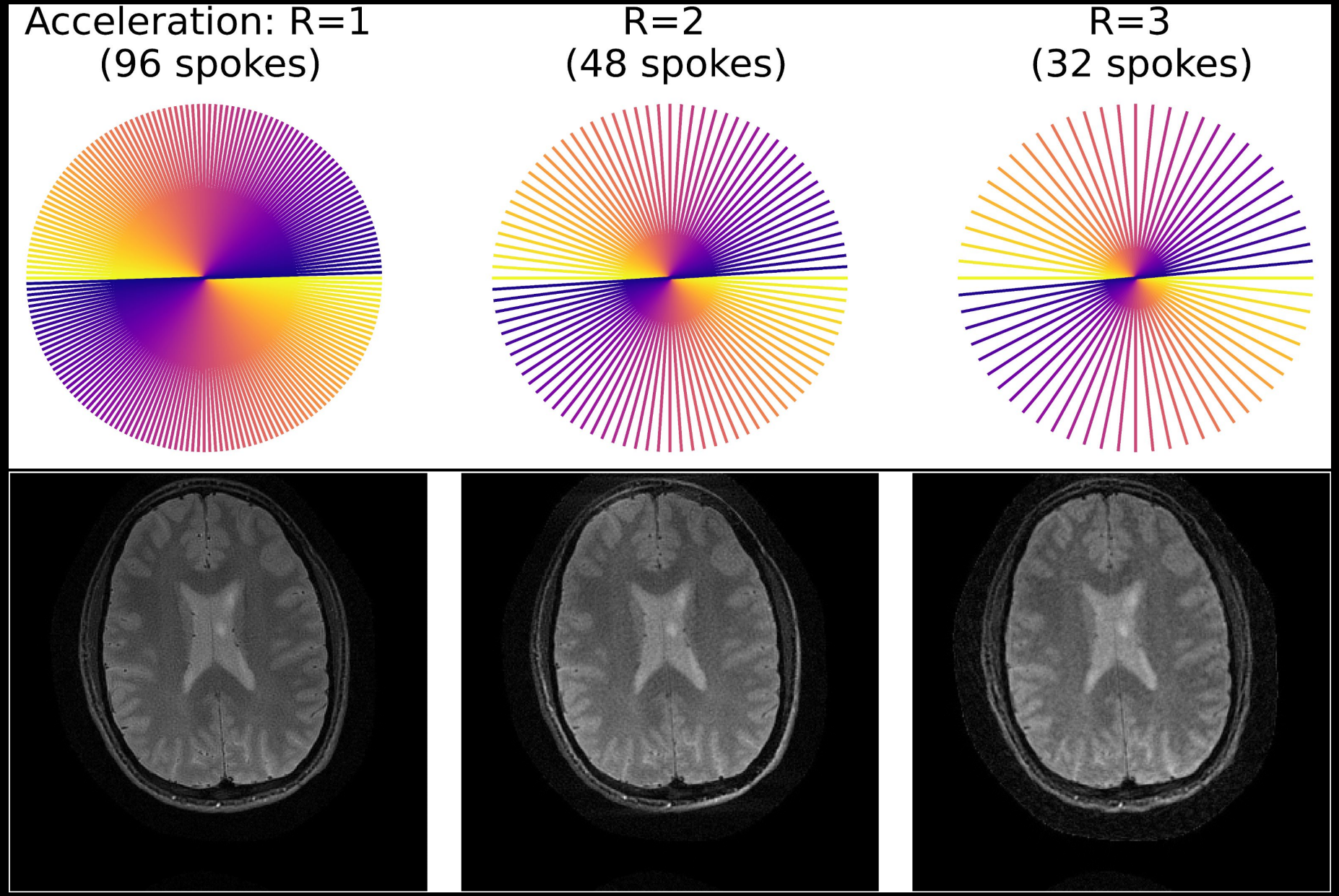


K-space trajectory

Gridding reconstruction

Pruessmann et al., Magn Reson Med. 2001;46:638-651.

Maier et al., Magn Reson Med. 2021;85:1821-1839.



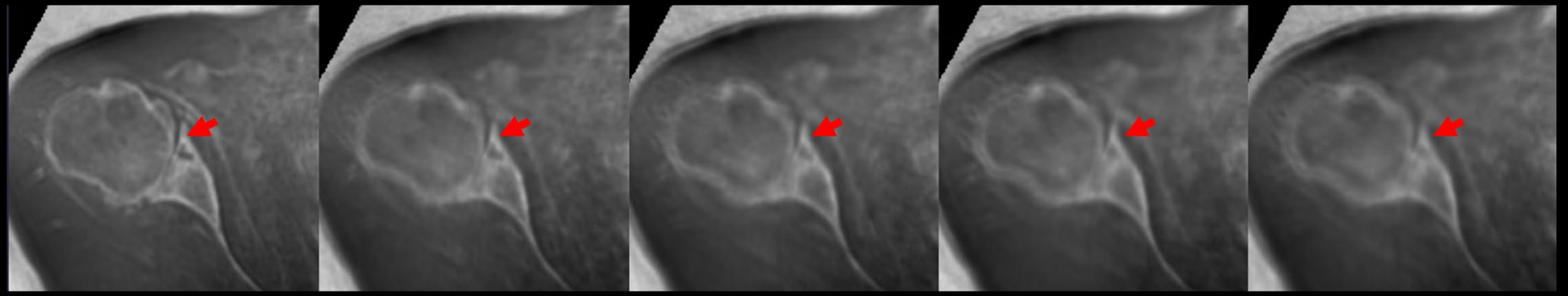
K-space trajectory

CG-SENSE reconstruction

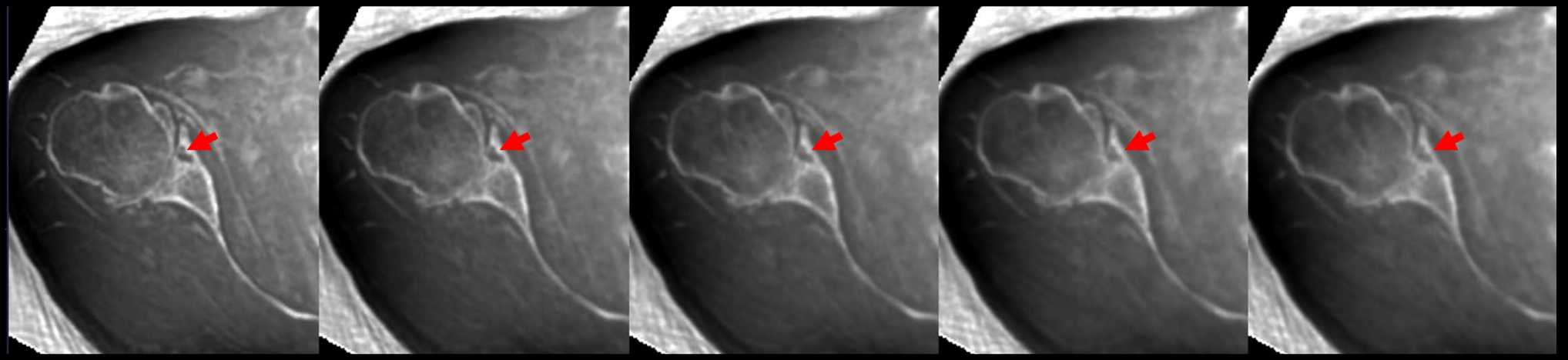
Pruessmann et al., Magn Reson Med. 2001;46:638-651.

Maier et al., Magn Reson Med. 2021;85:1821-1839.

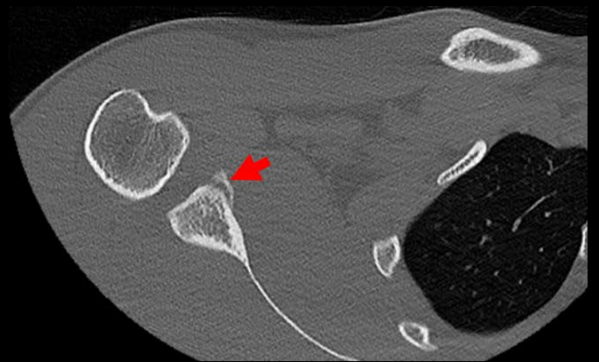
GRID: 5.8min 2.9min 1.9min 1.4min 1.2min



DLR: 5.8min 2.9min 1.9min 1.4min 1.2min

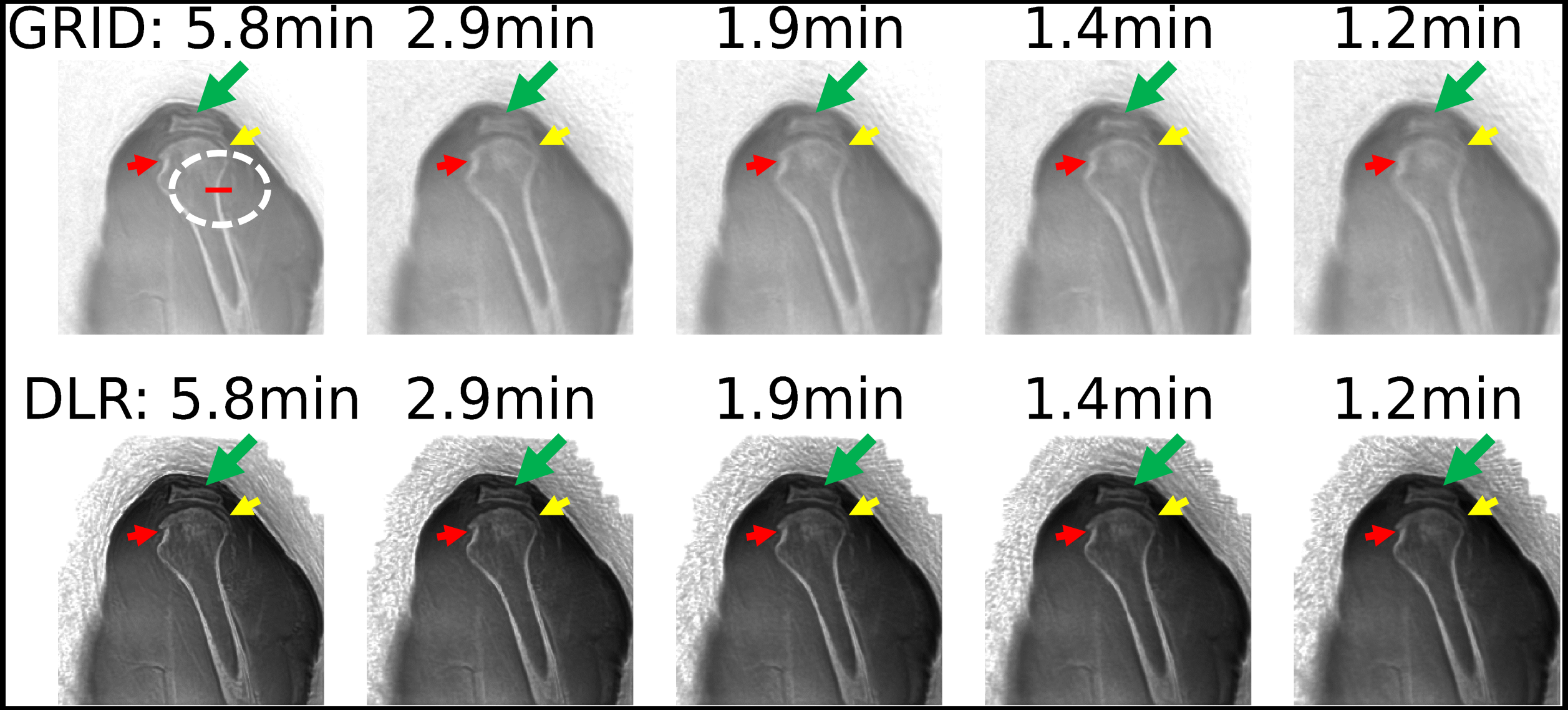


CT



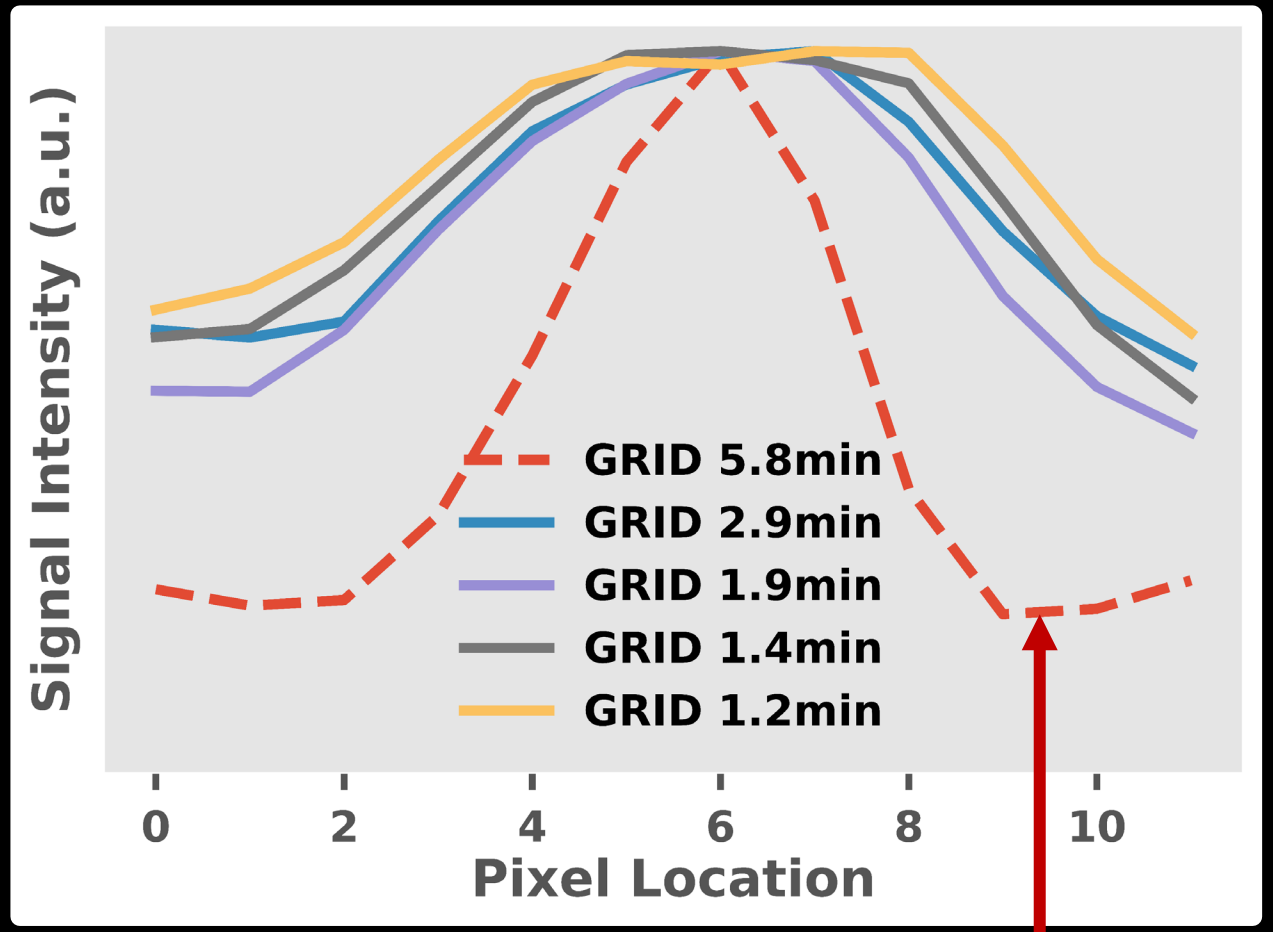
Bony Bankart Lesion

Representative Reconstructions



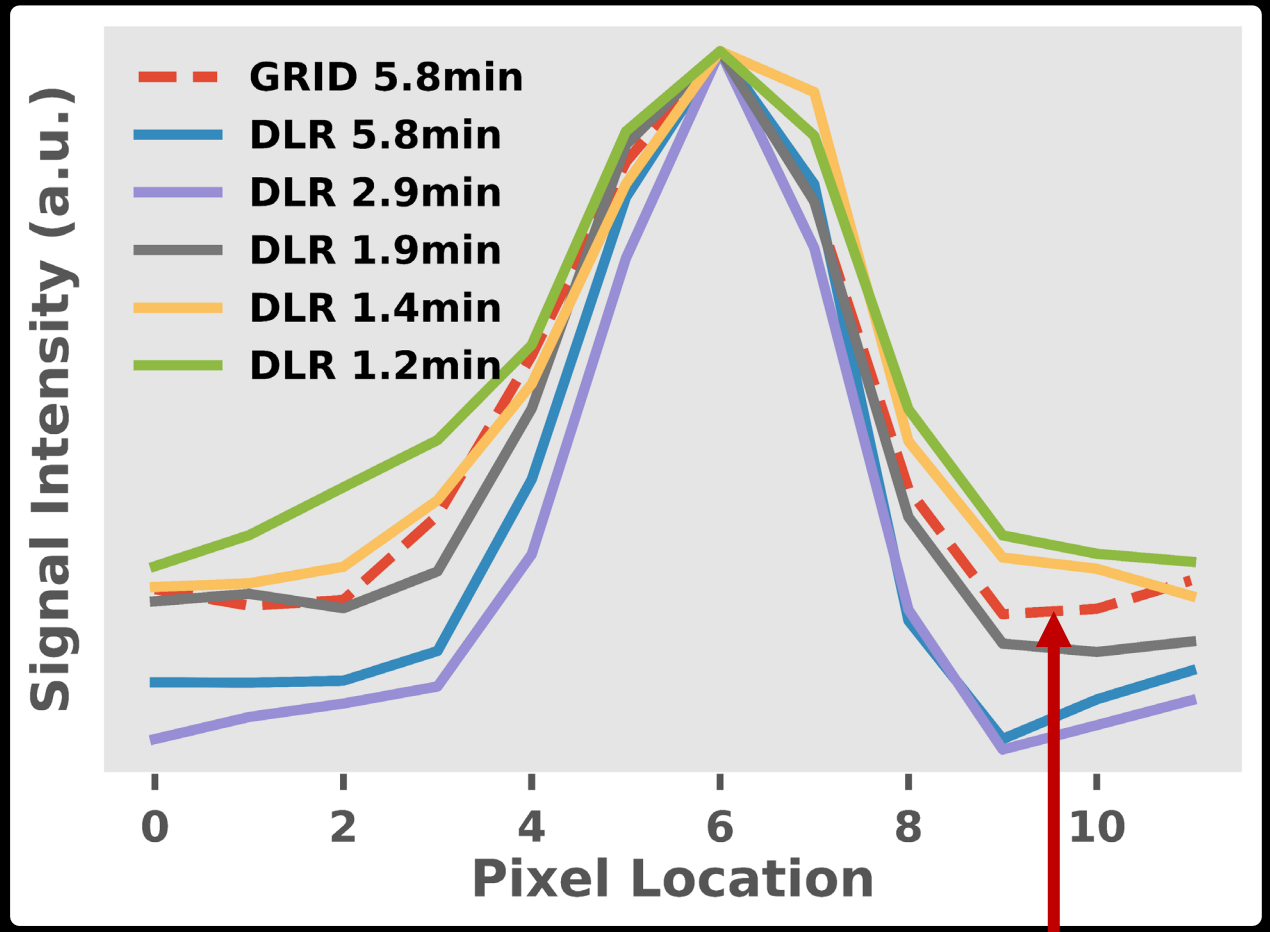
Representative FWHMs

GRIDDING

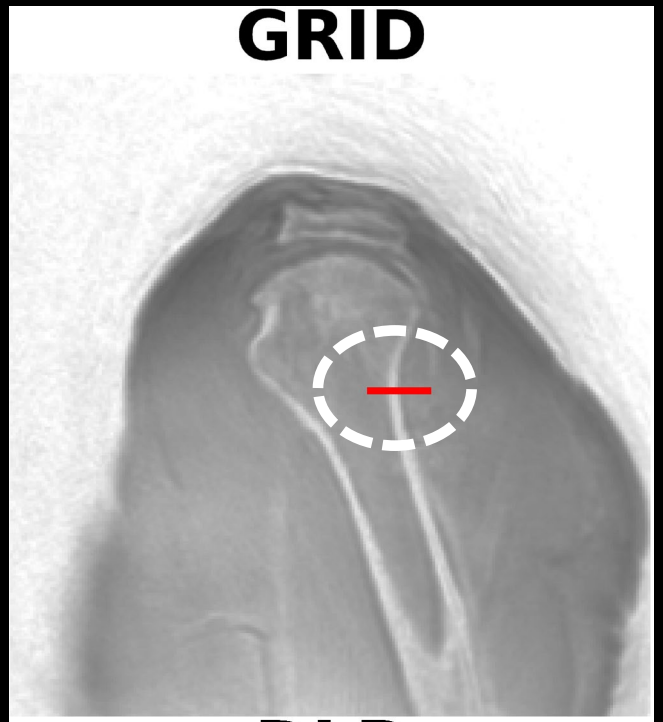


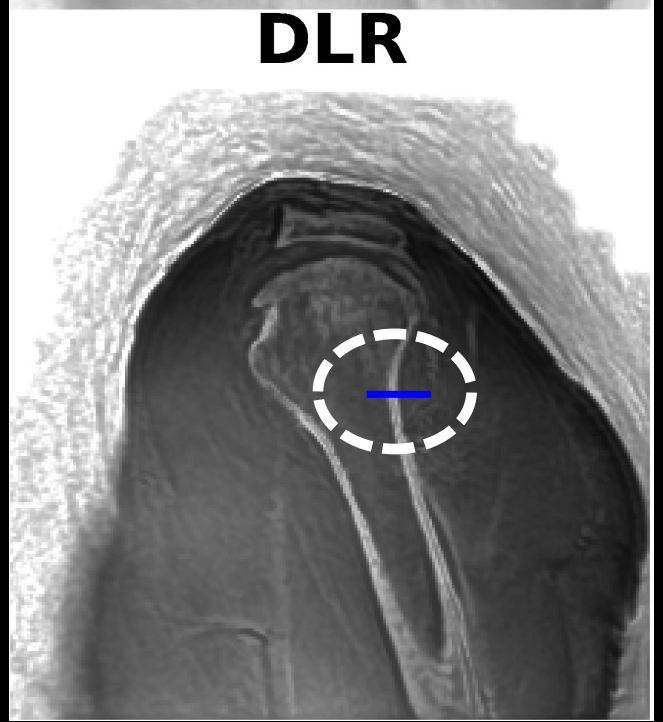
Line profile of a 5.8-min GRID

CG-SENSE + DLR

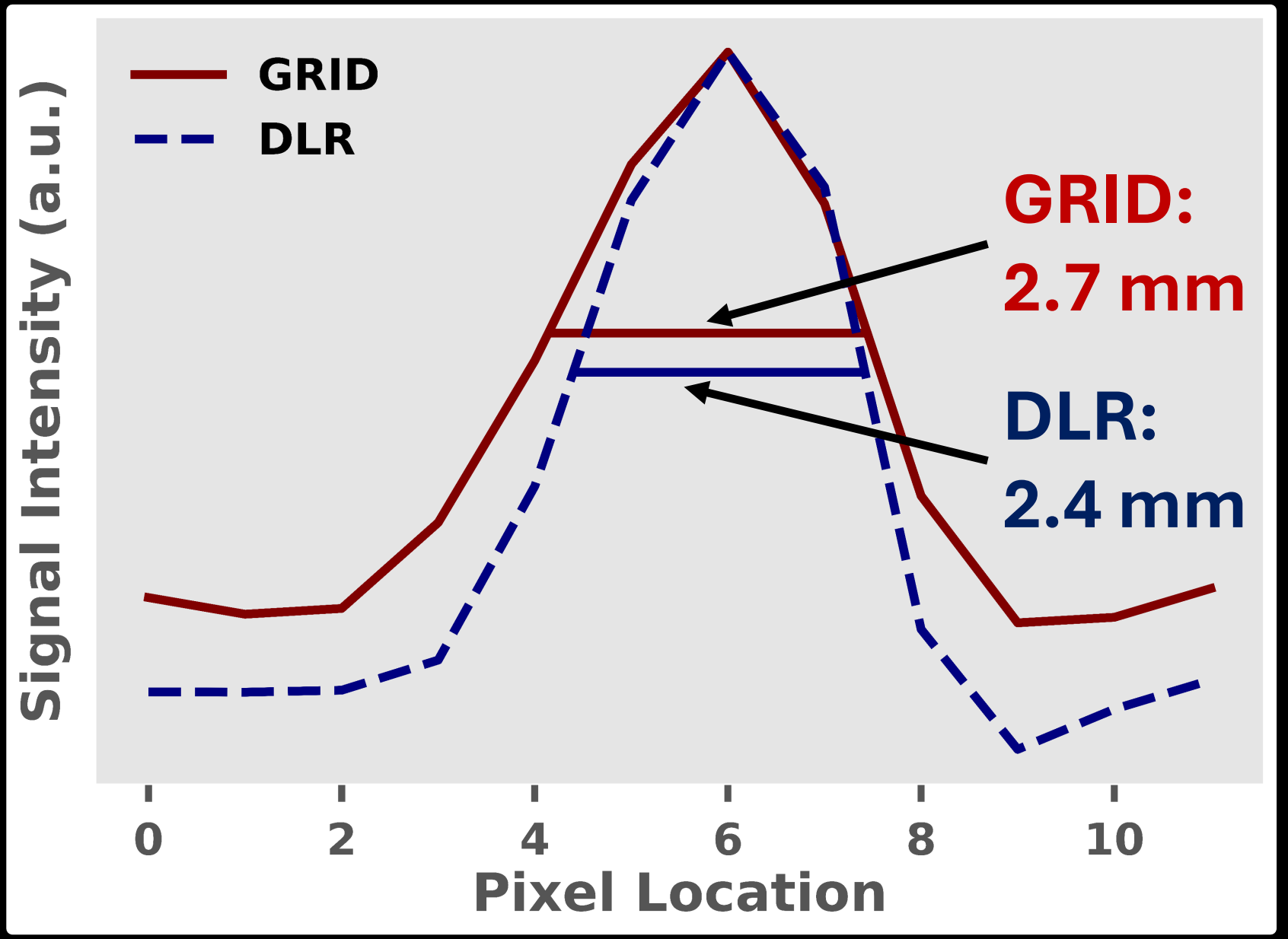


Line profile of a 5.8-min GRID

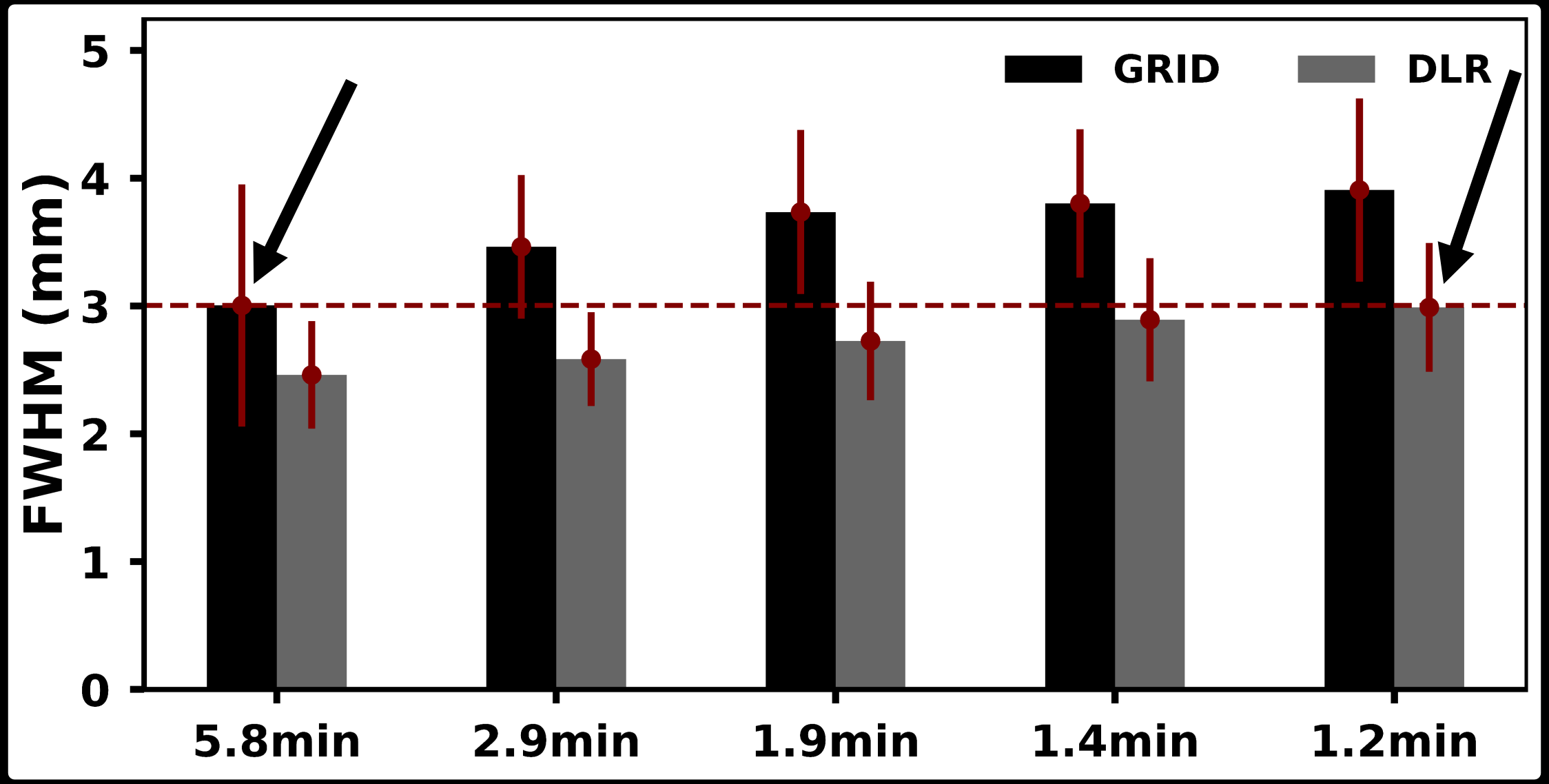




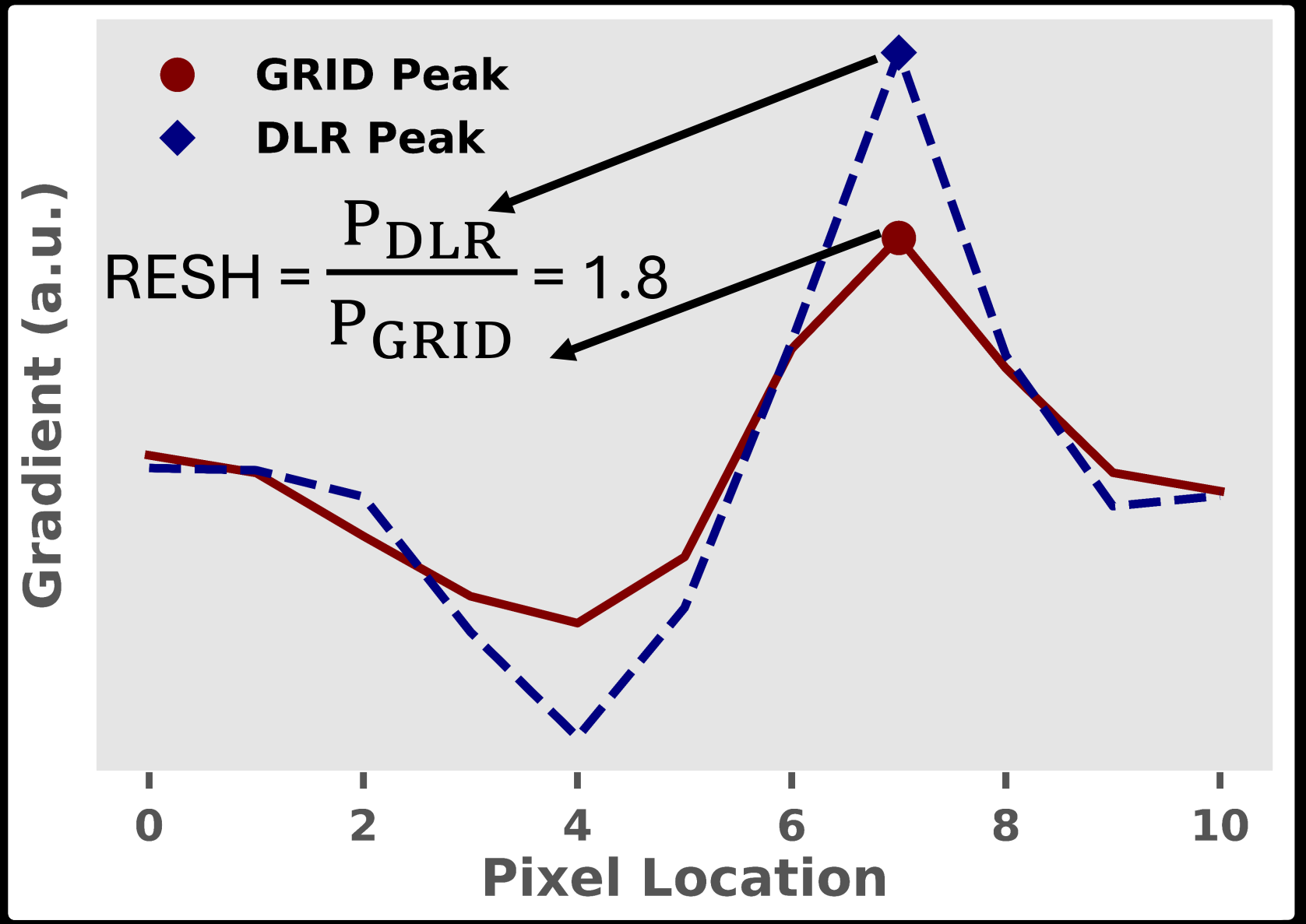
Full-Width at Half-Max (FWHM)



24% Narrower FWHM with DLR

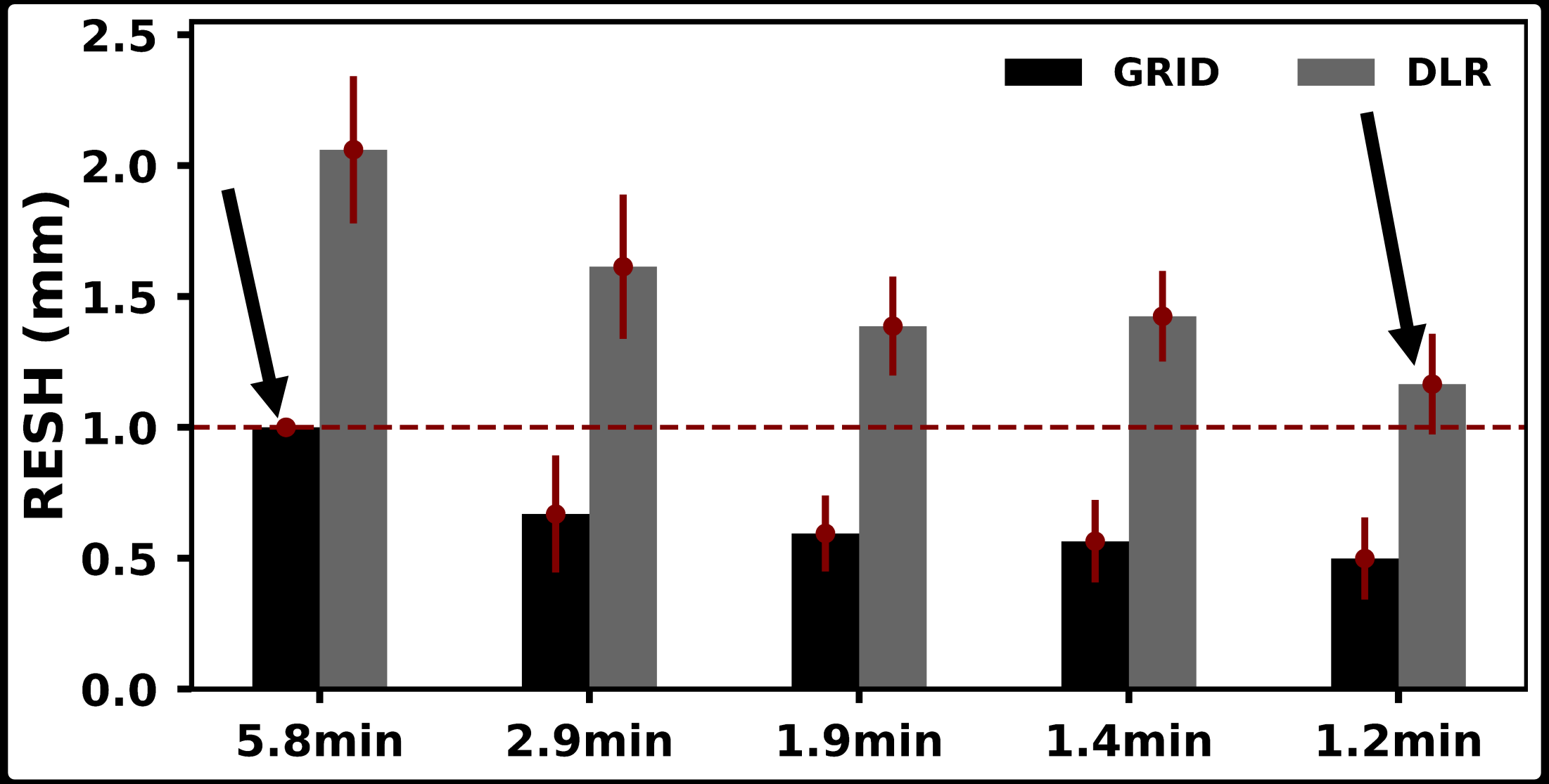


Relative Edge Sharpness (RESH)



Lebel et al., ArXiv200806559

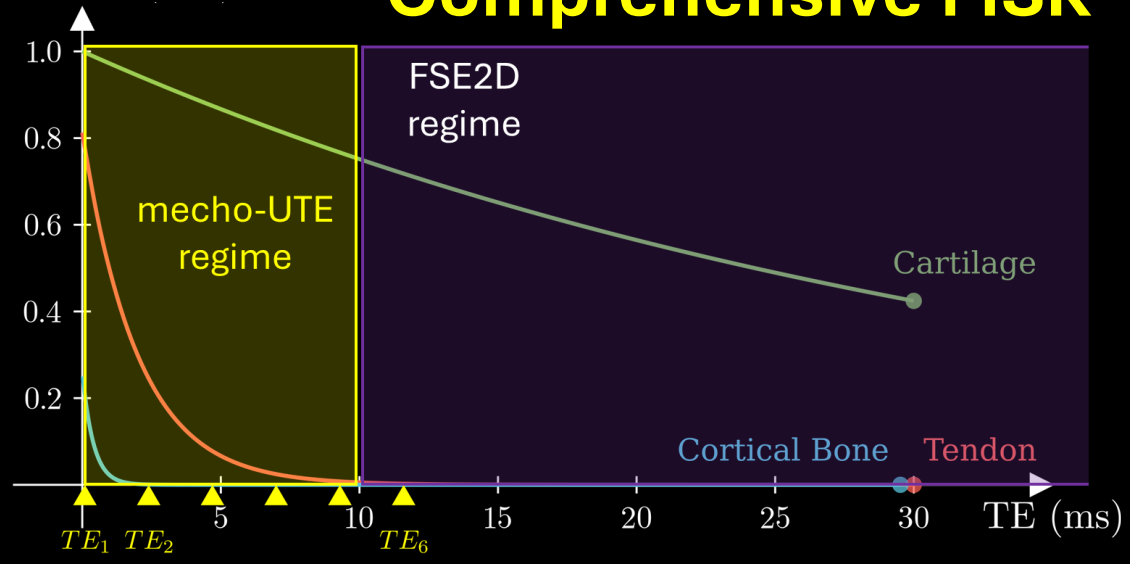
2.3X Higher RESH with DLR



Conclusions

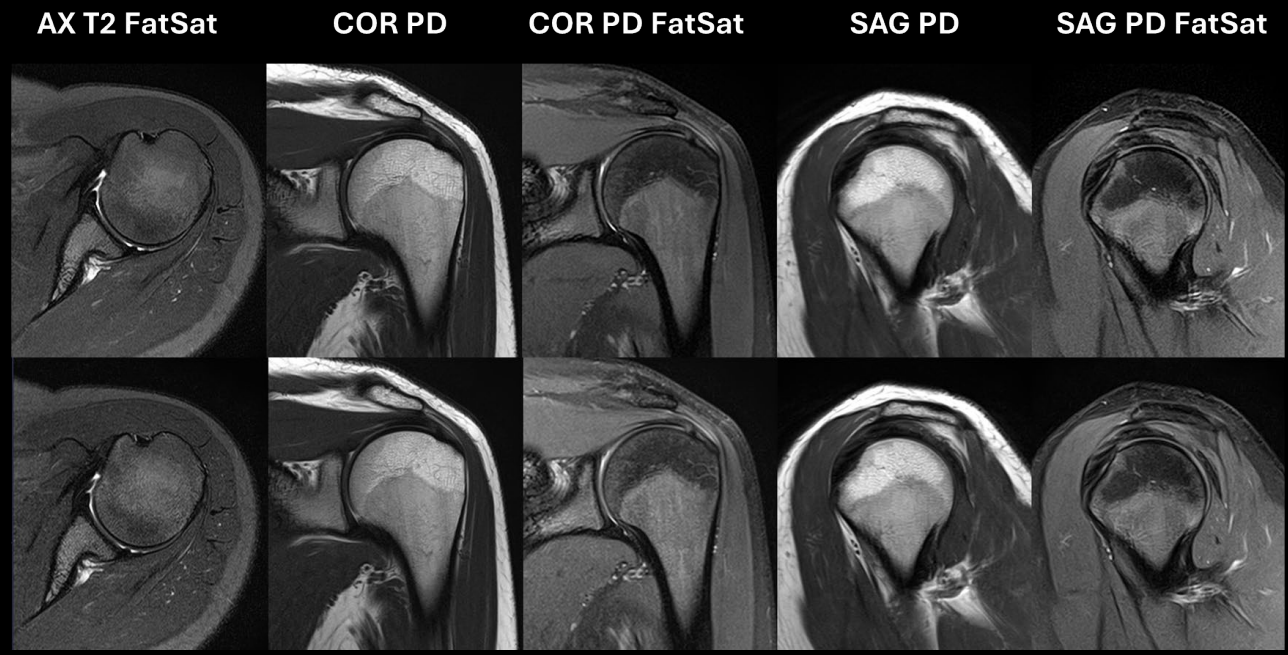
- Feasibility of <2-min 3D-iso mecho UTE
- 10-12-min one-stop-shop comprehensive MSK. Reduce logistics & costs, and eliminate radiation exposure (pediatric)

Comprehensive MSK



7.5-min 1-Average with DLR

14.5-min 2-Average w/o DLR



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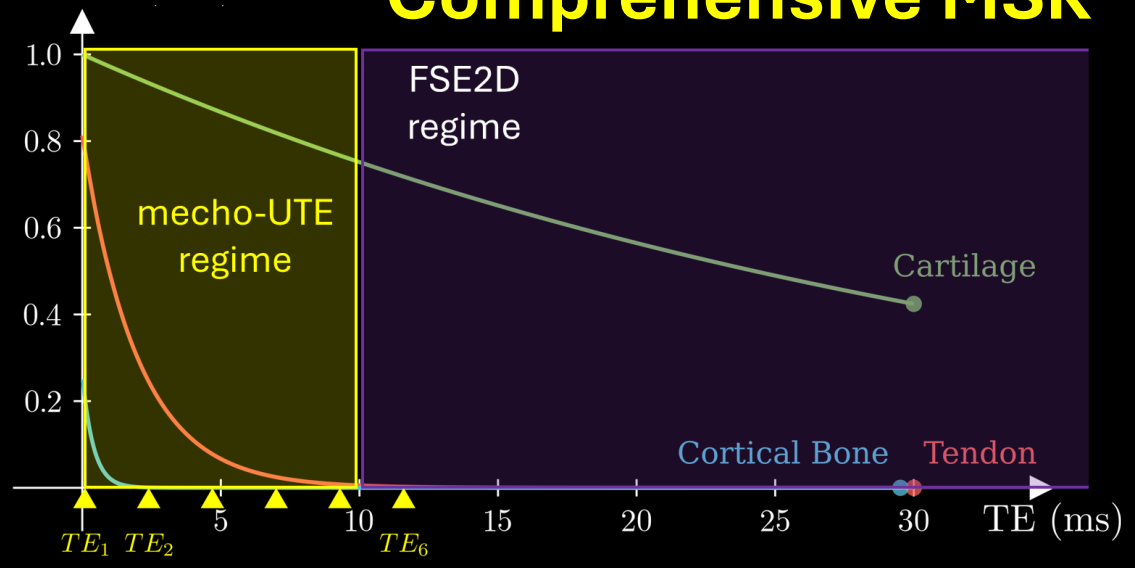
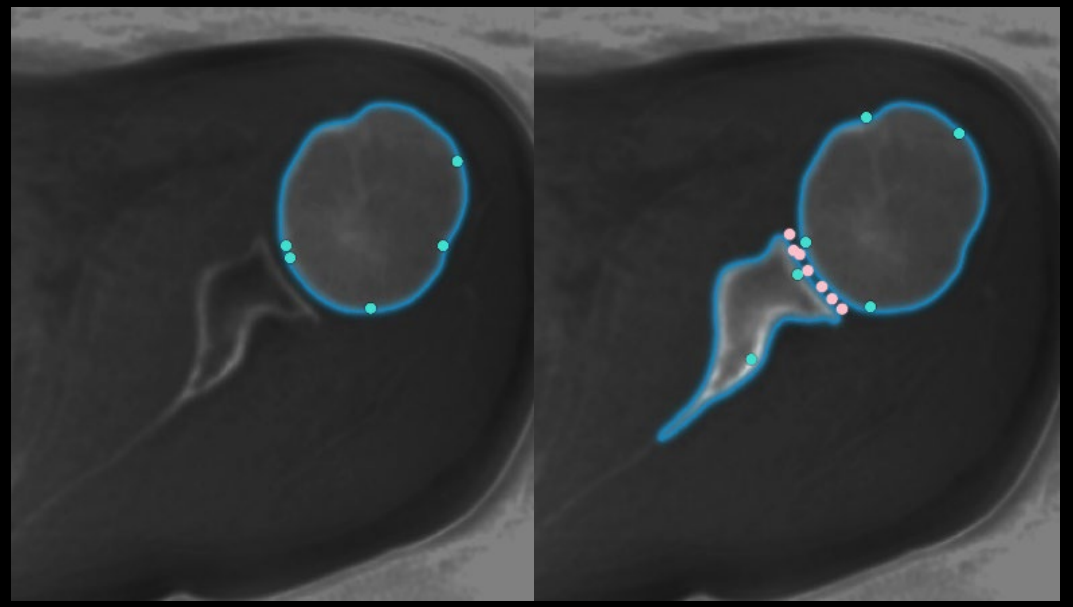
Comprehensive MSK



- <u>Future work:</u>
  - Larger patient cohort
  - Automatic segmentation
  - Improve resolution & sharpness using DL-based super-resolution



[1] https://news.harvard.edu/gazette/story/2019/04/harvard-scientists-lead-team-revealing-black-hole/

Accelerated mecho-UTE CT-like Imaging using CG-SENSE and DLR

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Thank you for your attention!

"Seeing the Unseeable"
... first-ever image of a black hole[1]

Canon

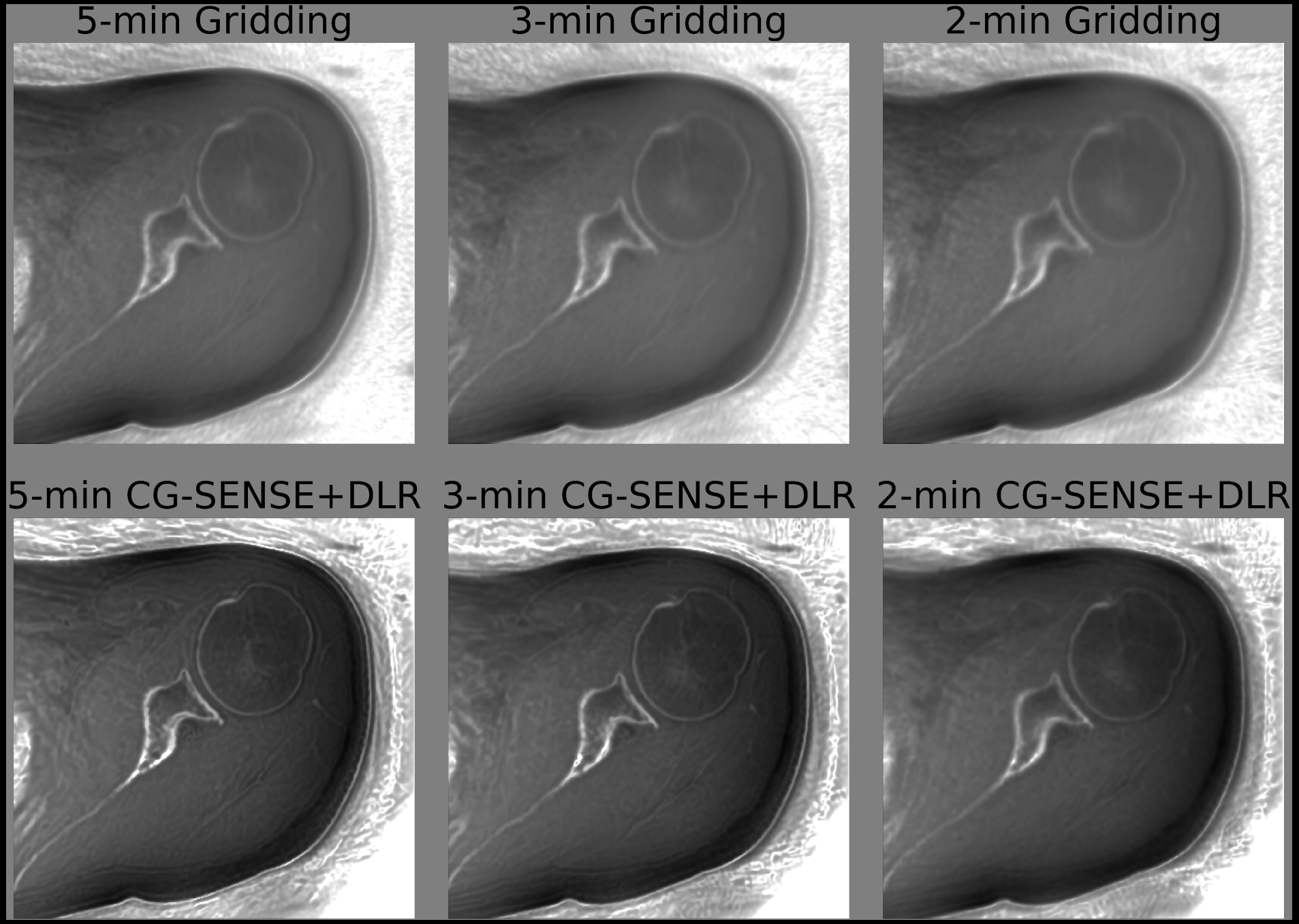
THE STEADMAN CLINIC AND STEADMAN PHILIPPON RESEARCH INSTITUTE

Backup slides

Prospective Data

GRIDDING

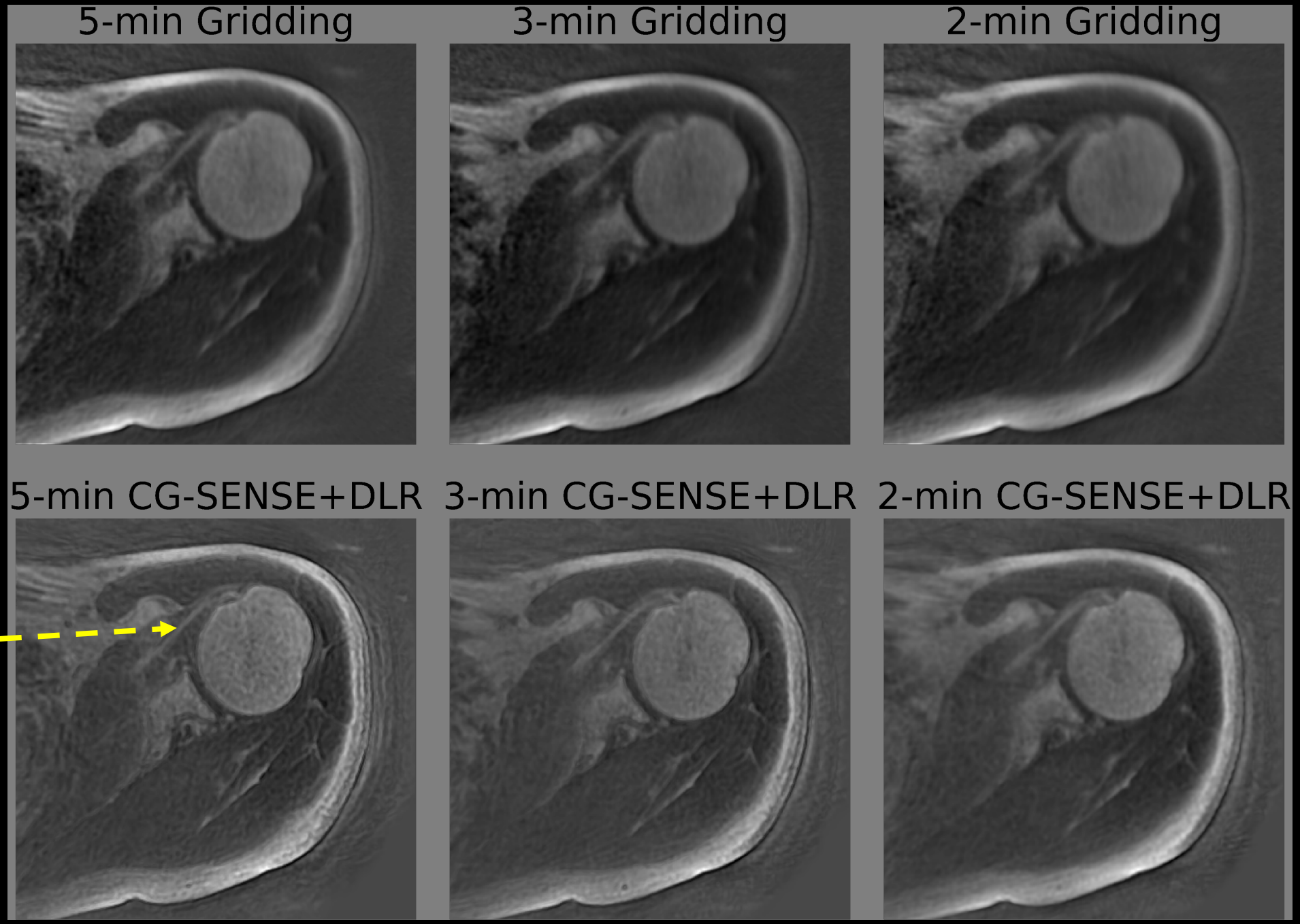
CG-SENSE & DLR



Prospective Data

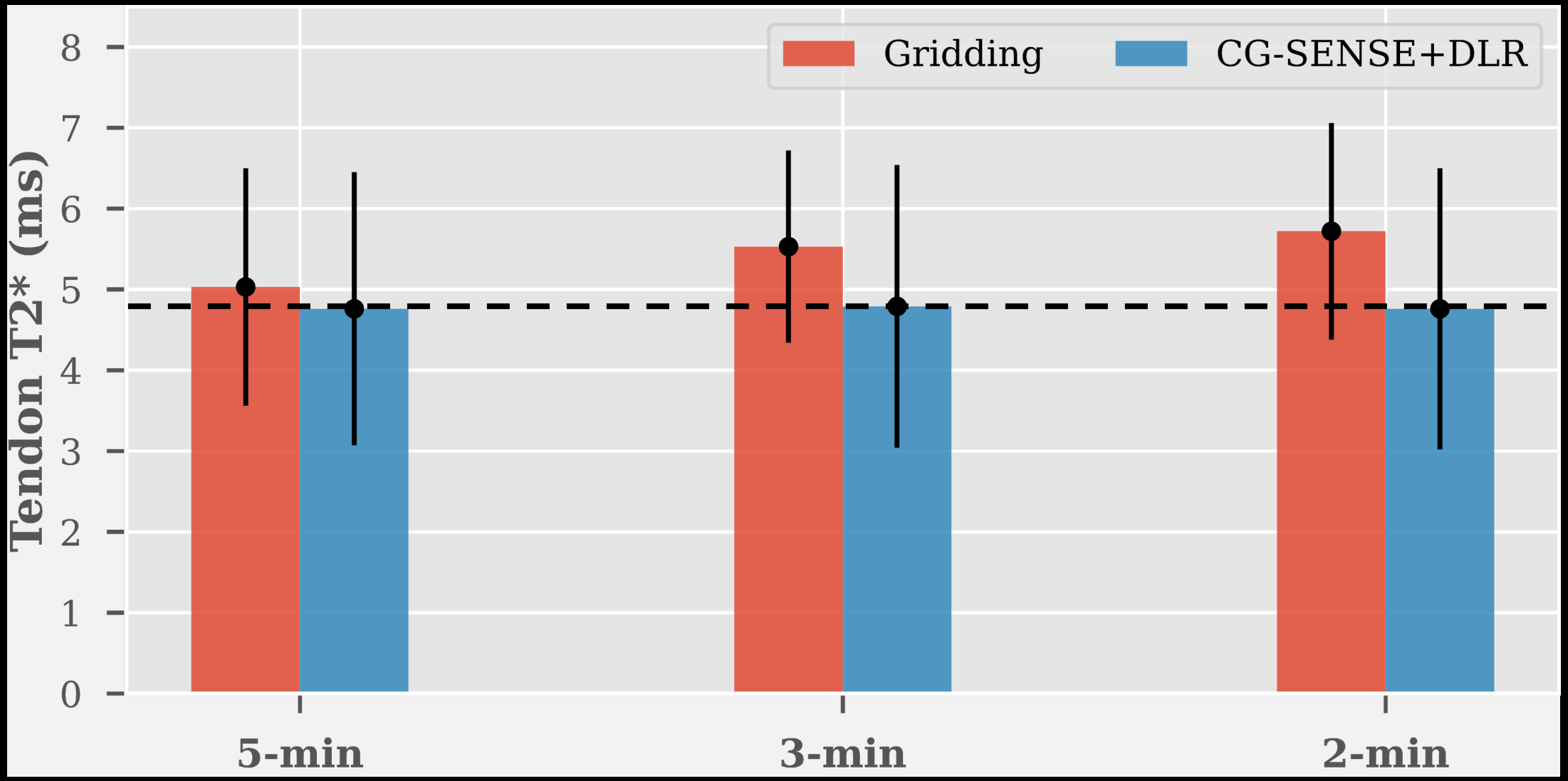
Visualization of Ultrashort-T2 Tissues

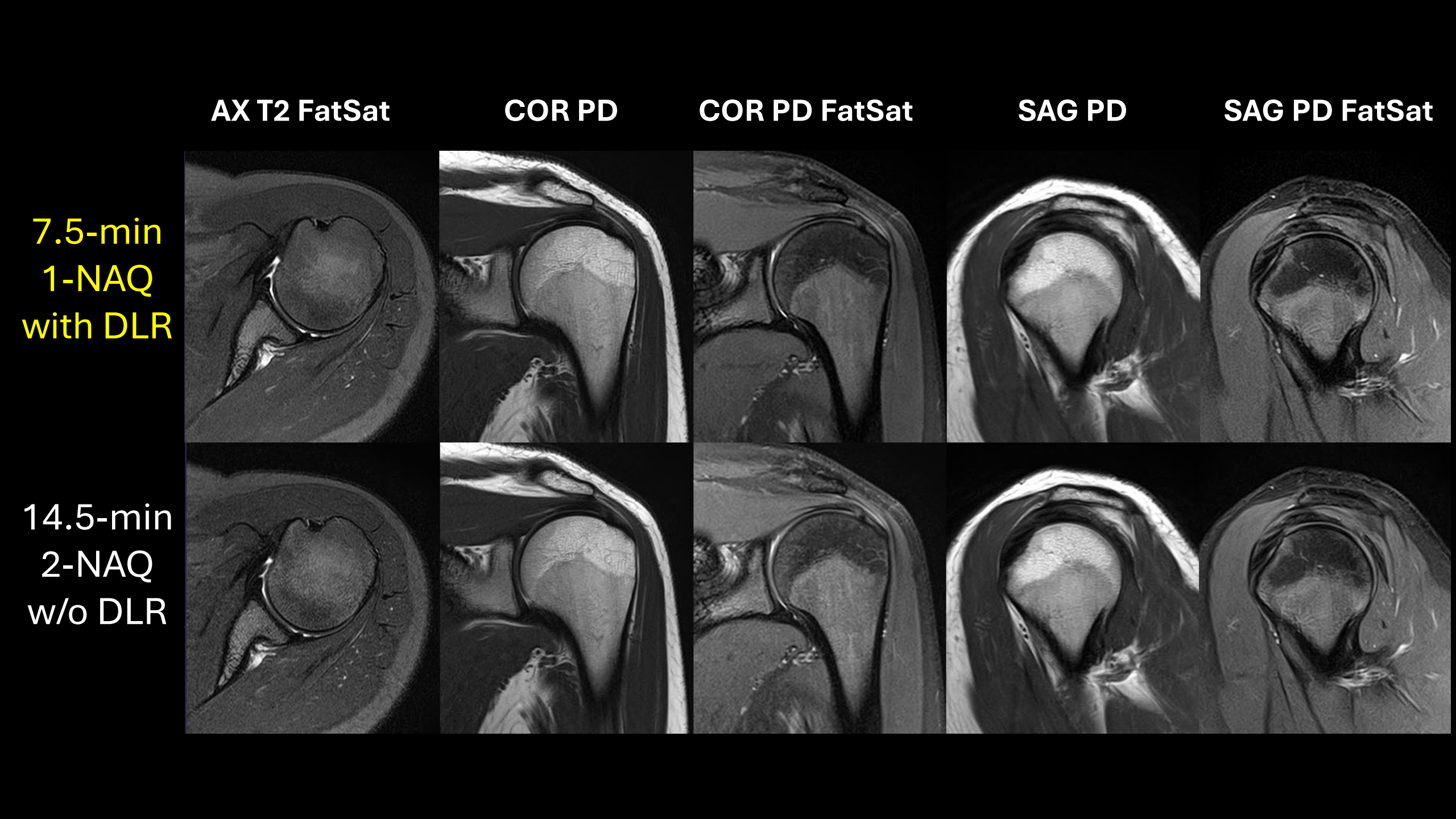
Tendon



Prospective Data

Tendon's T2* Measures

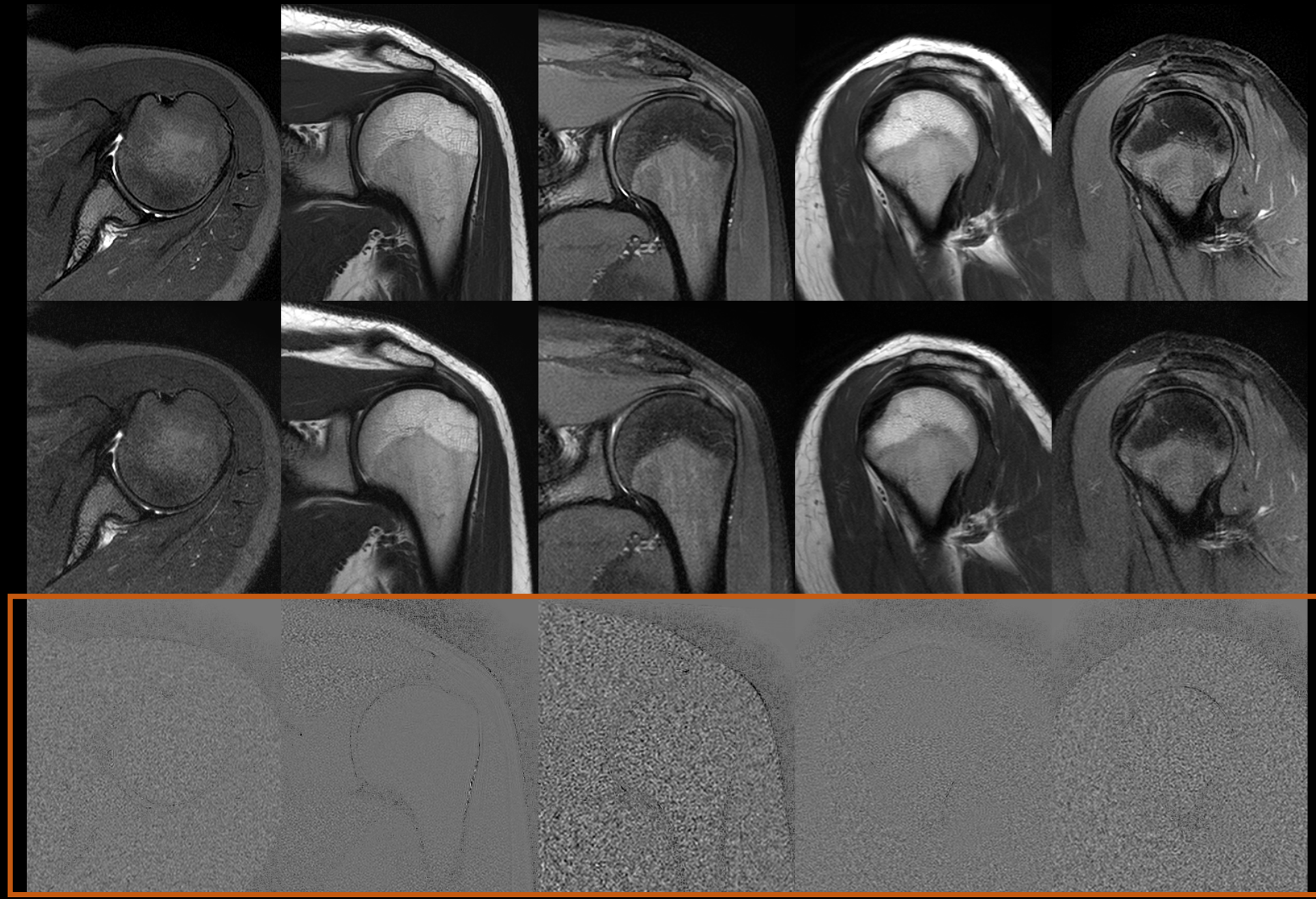


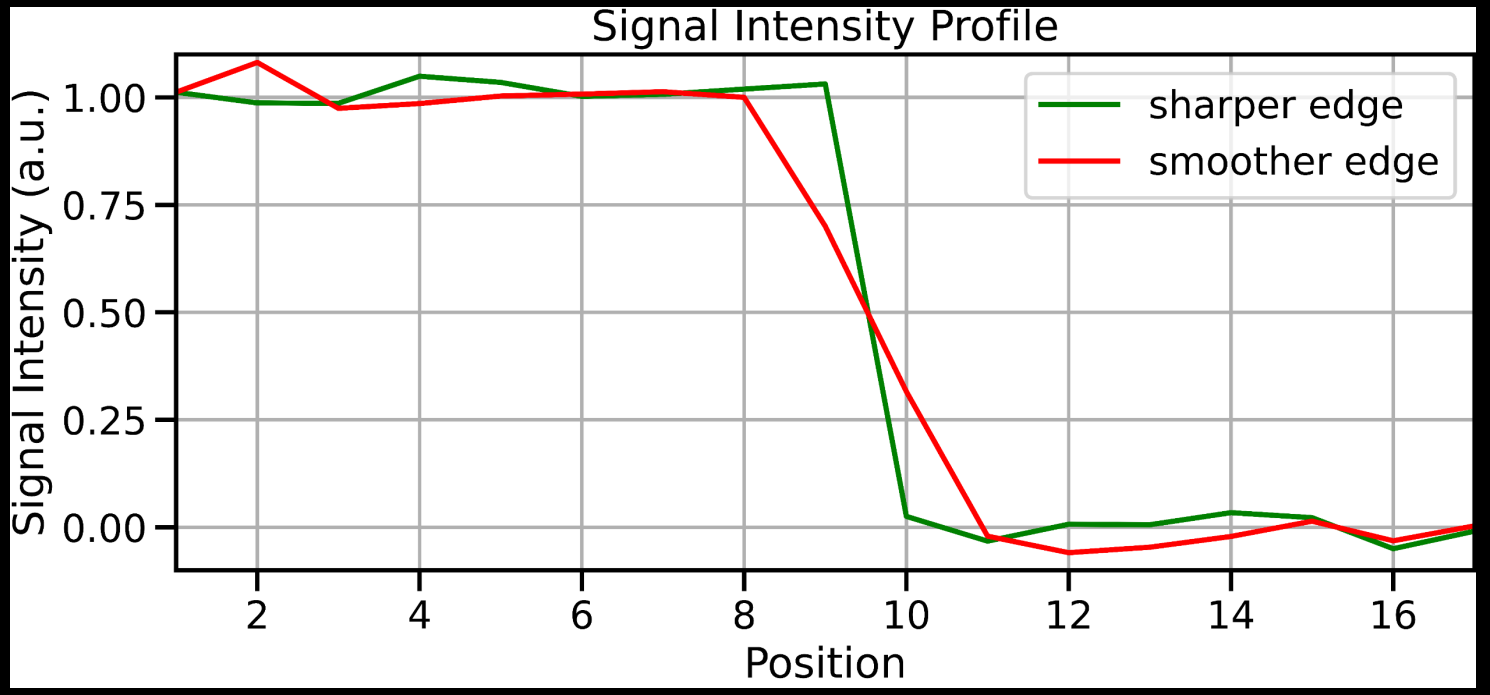

AX T2 FatSat
COR PD
COR PD FatSat
SAG PD
SAG PD FatSat
7.5-min
1-NAQ
with DLR
14.5-min
2-NAQ
w/o DLR

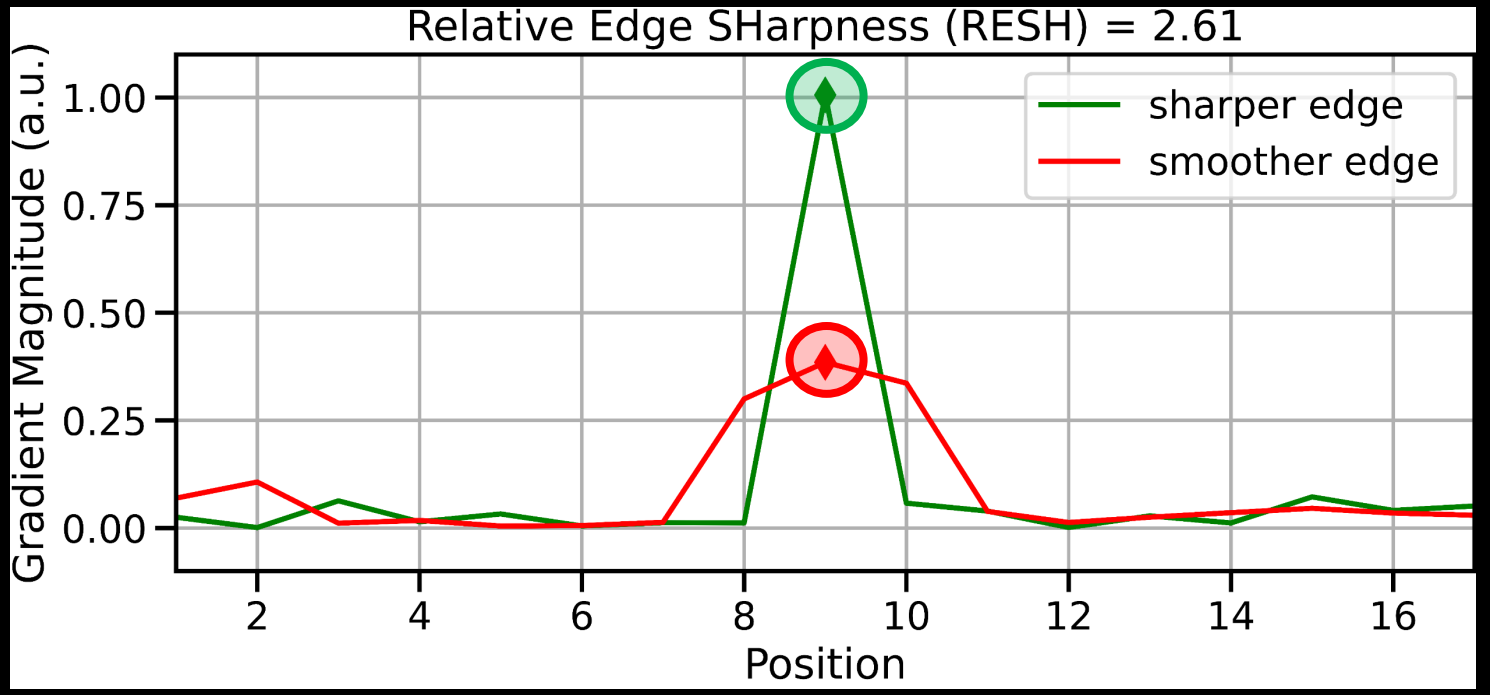
7.5-min
1-Average
with DLR

14.5-min
2-Averages
w/o DLR

Subtractions




Signal Intensity Profile
Signal Intensity (a.u.)
1.00
0.75
0.50
0.25
0.00
2
4
6
8
10
12
14
16
Position
sharper edge
smoother edge

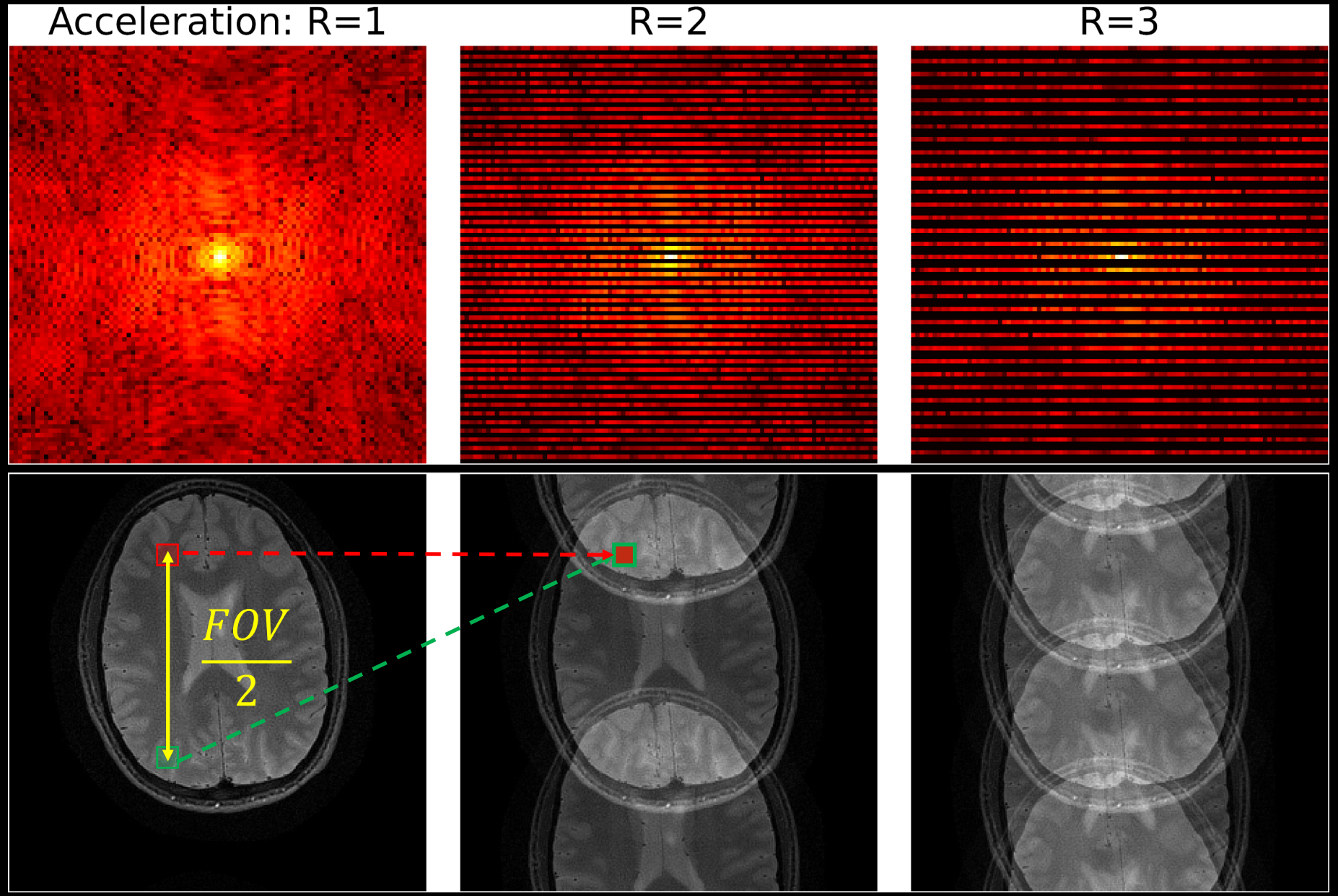

Relative Edge SHarpness (RESH) = 2.61
Gradient Magnitude (a.u.)
1.00
0.75
0.50
0.25
0.00
2
4
6
8
10
12
14
16
Position
sharper edge
smoother edge

SENSE

Sensitivity Encoding: Parallel Imaging for Cartesian k-space

Cartesian kspace

Cartesian image space



Pruessmann et al., Magn Reson Med. 1999;42:952-962.