

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

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Honolulu, Hawai'i, USA 10-15 MAY 2025



Declaration of Financial Interests or Relationships

Speaker Name: **Hung Do, PhD MSEE**

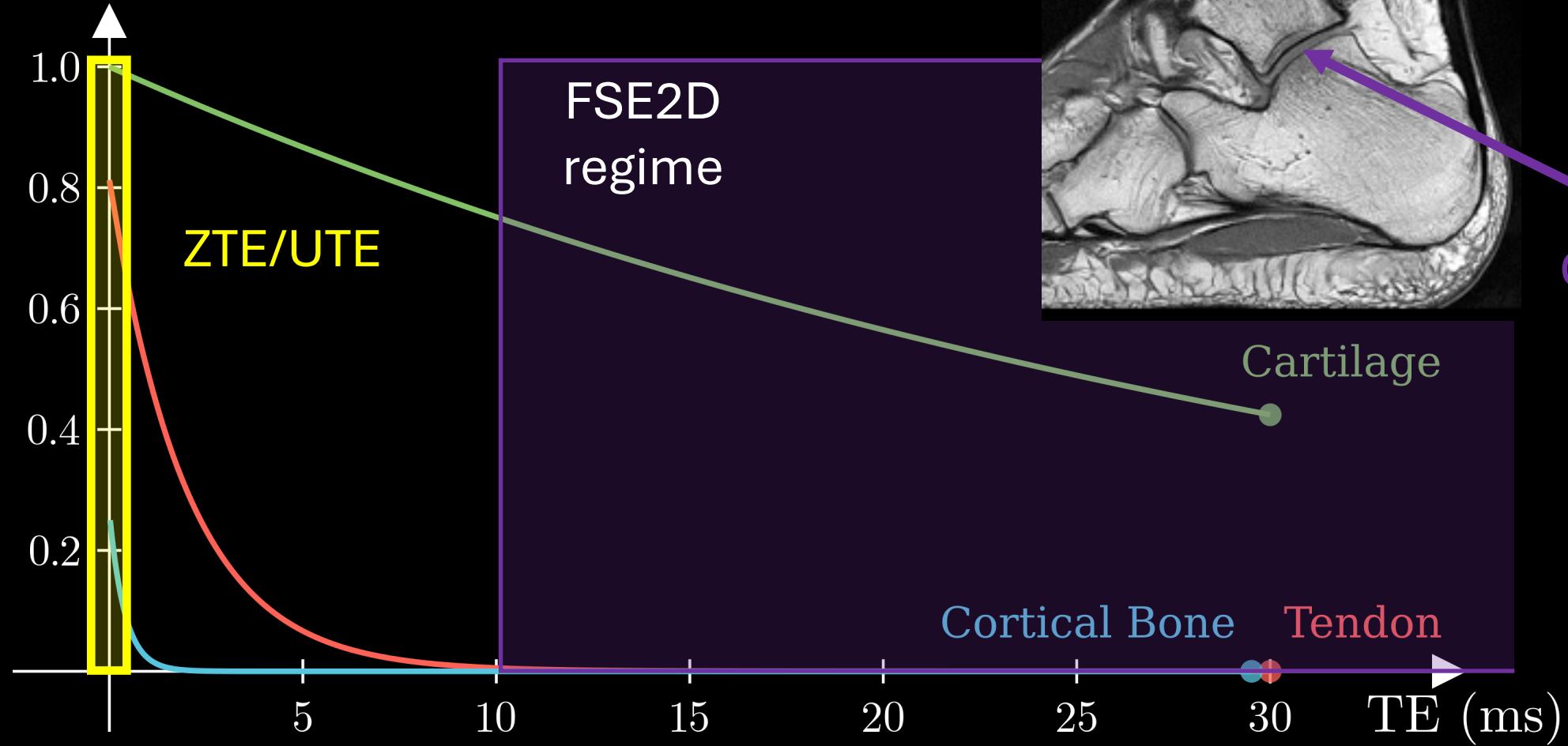
I have the following financial interest or relationship to disclose with regard to the subject matter of this presentation:

Company Name: **Canon Medical Systems USA, Inc.**

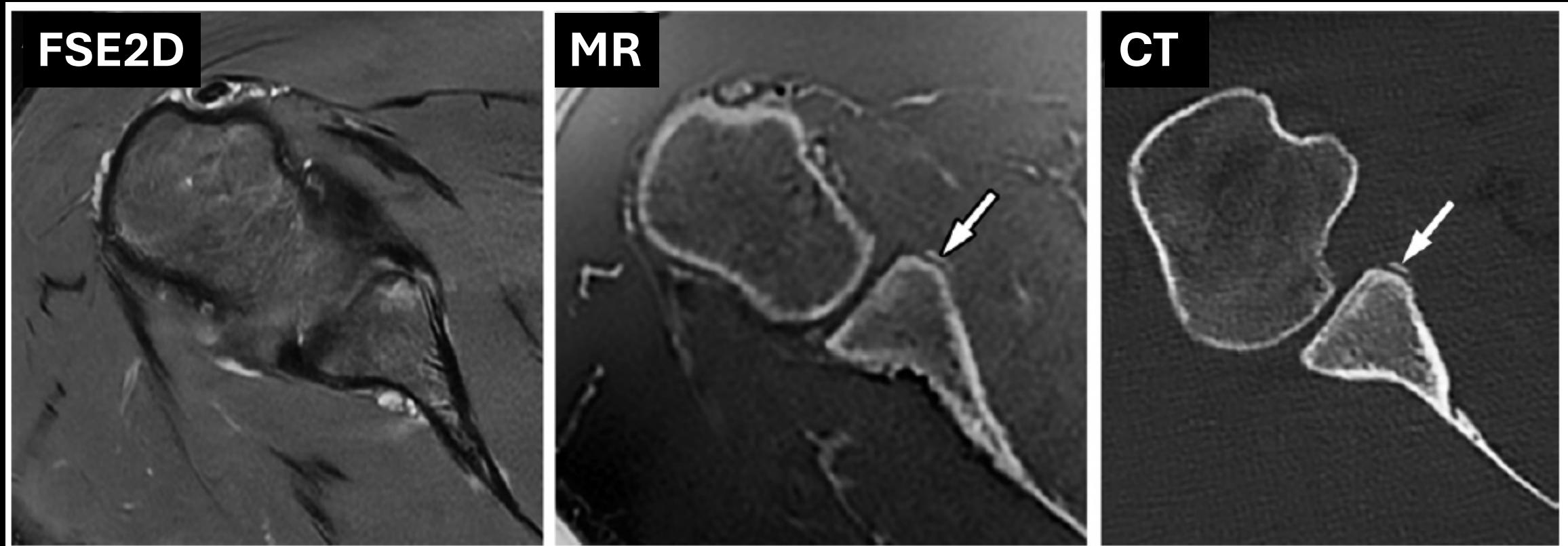
Type of Relationship: **Employee**

MSK Imaging

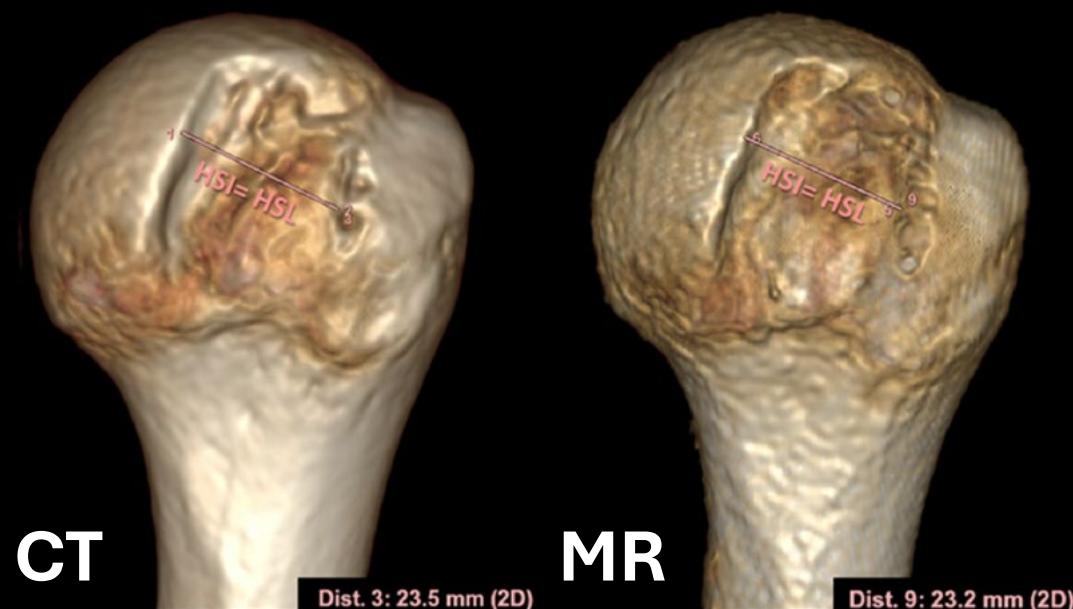
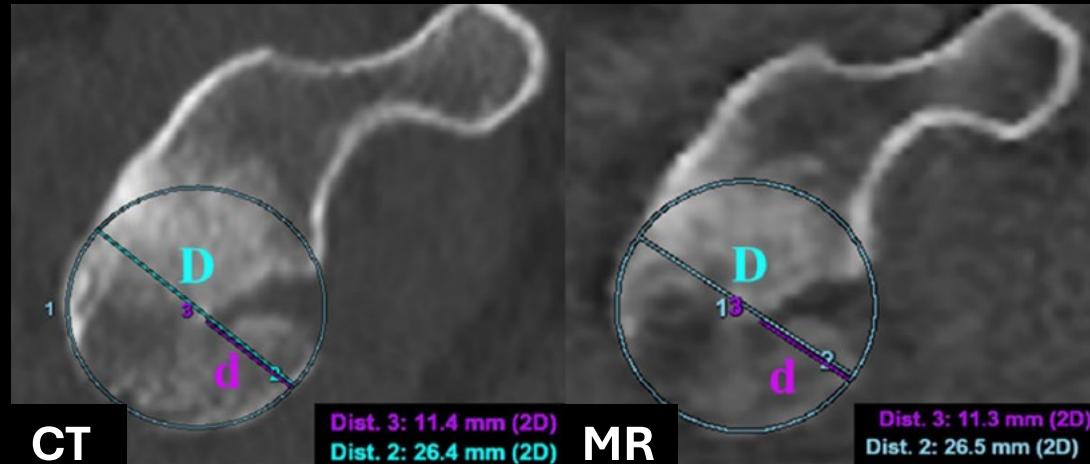
MR Signal (a.u.)



Bone Fracture Detection

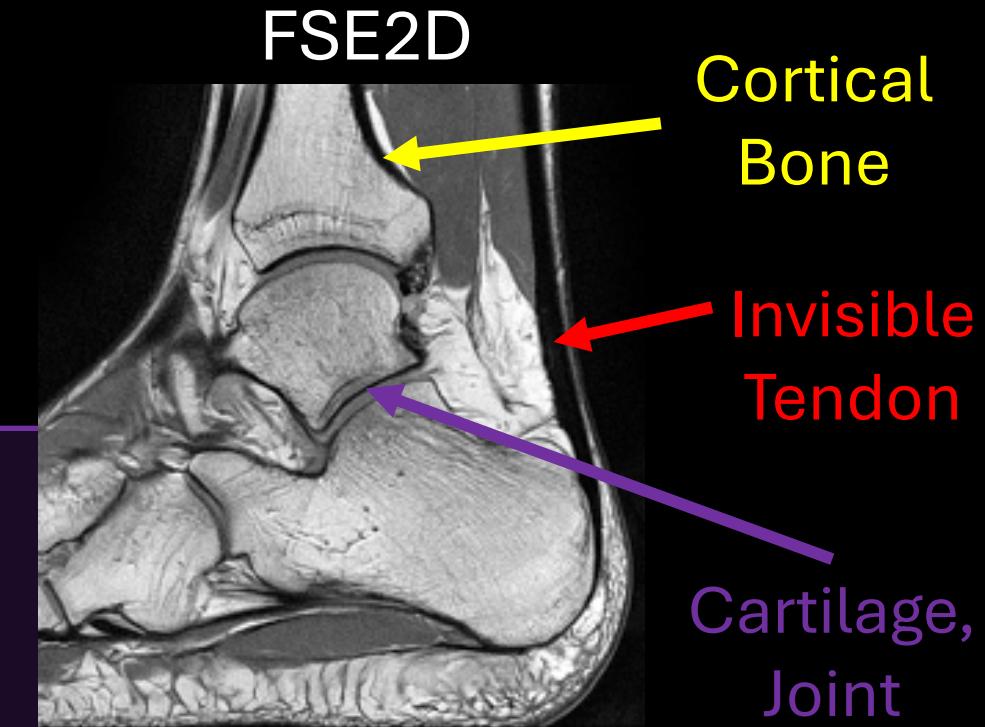
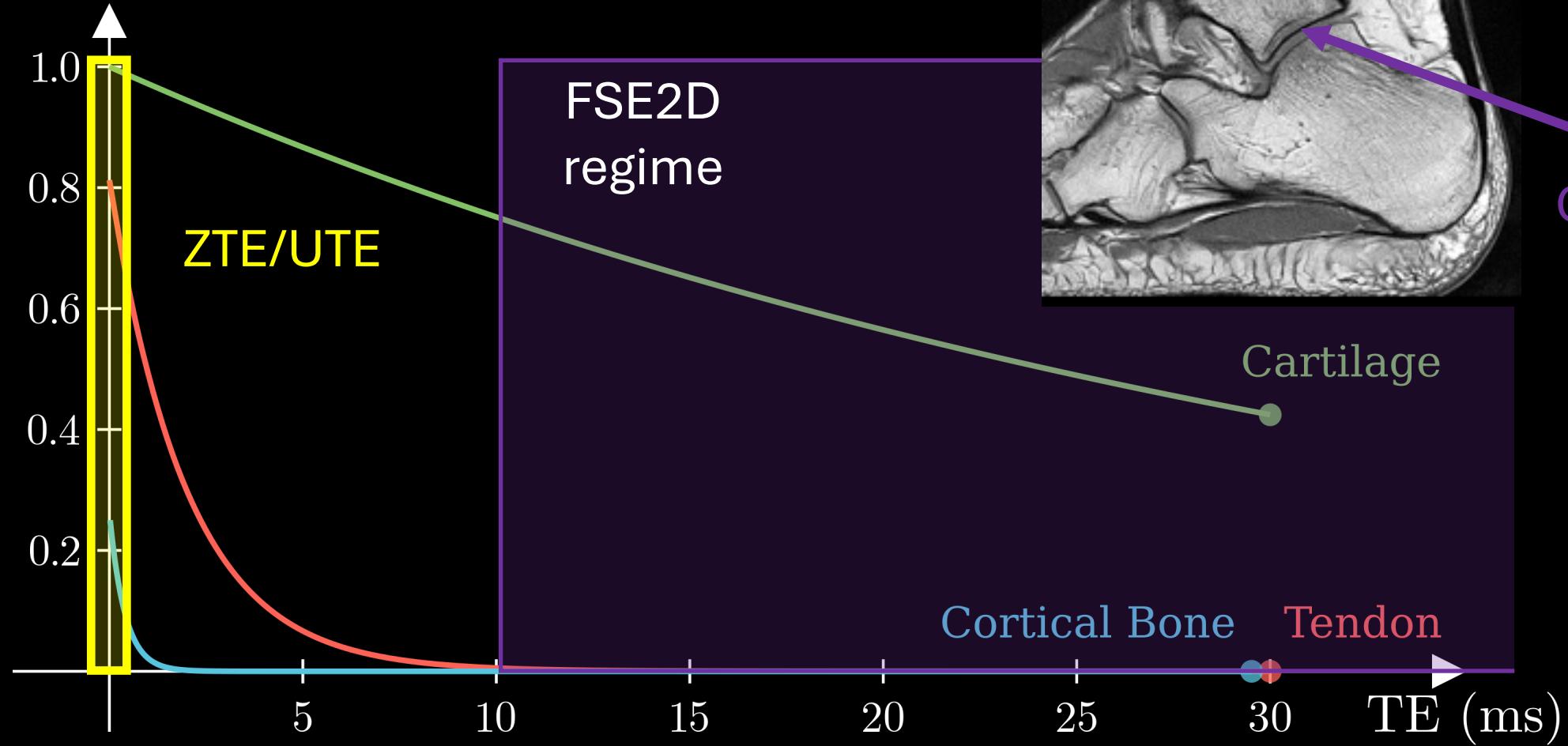


Glenoid Bone Loss Assessment



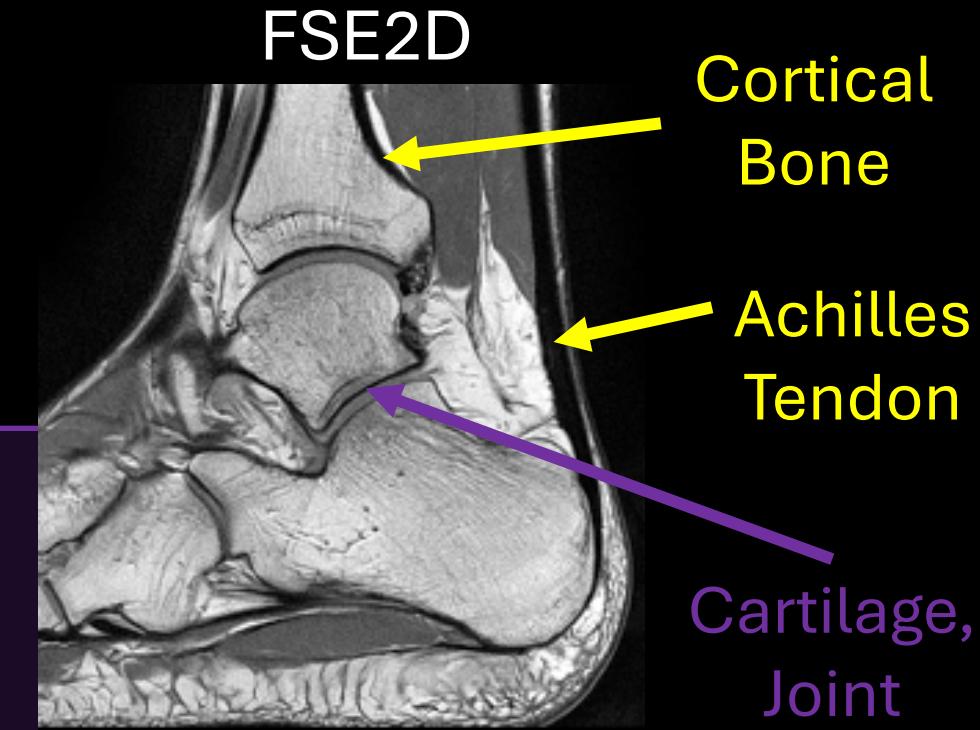
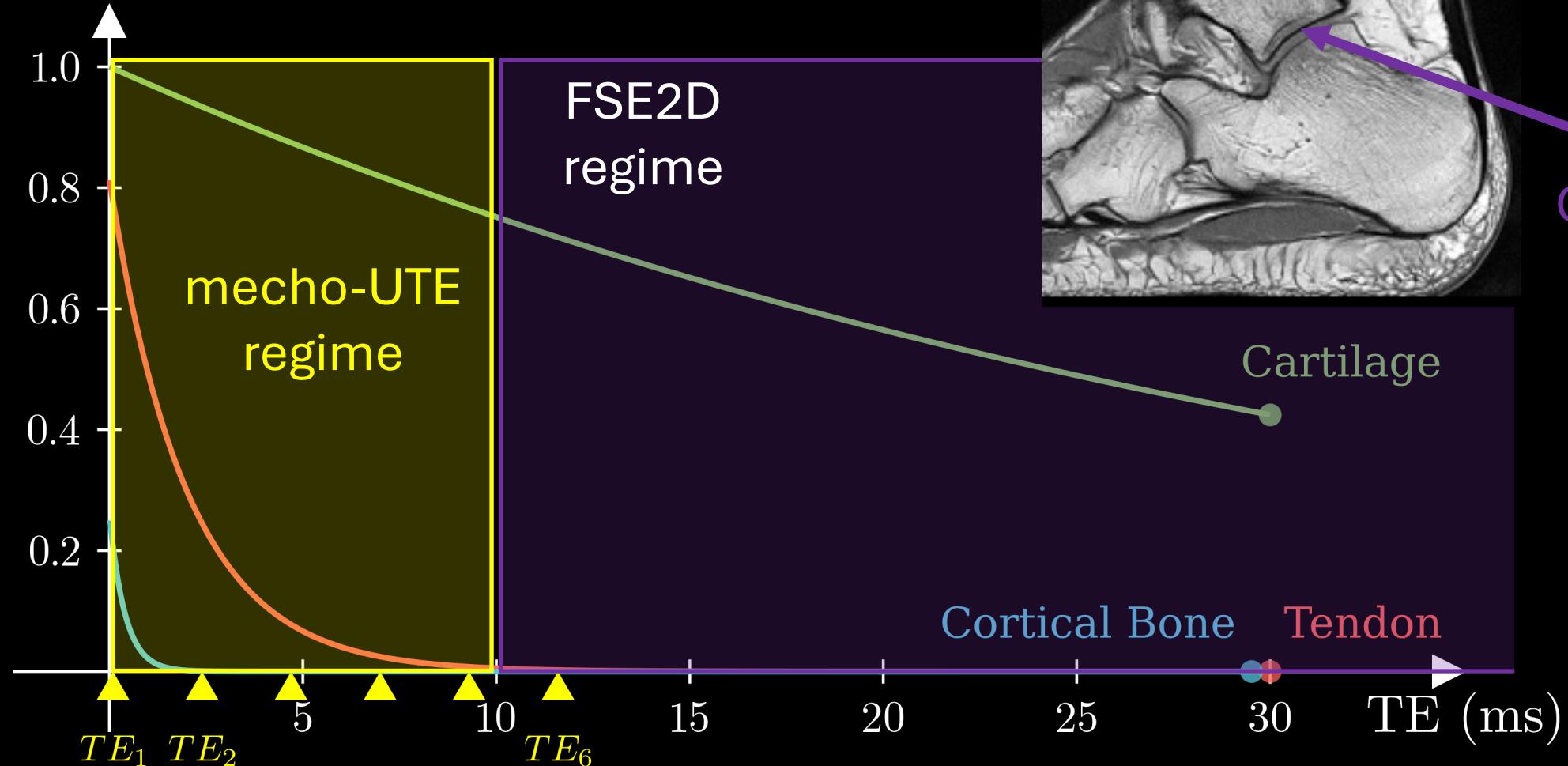
MSK Imaging

MR Signal (a.u.)



Comprehensive MSK

MR Signal (a.u.)

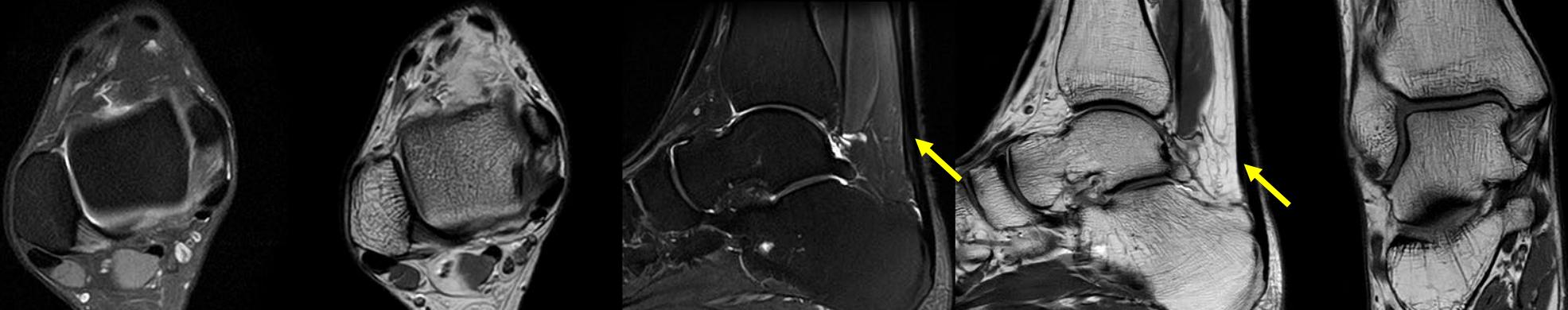


Cartilage

Cortical Bone

Tendon

Routine
FSE2D



AX PD FS

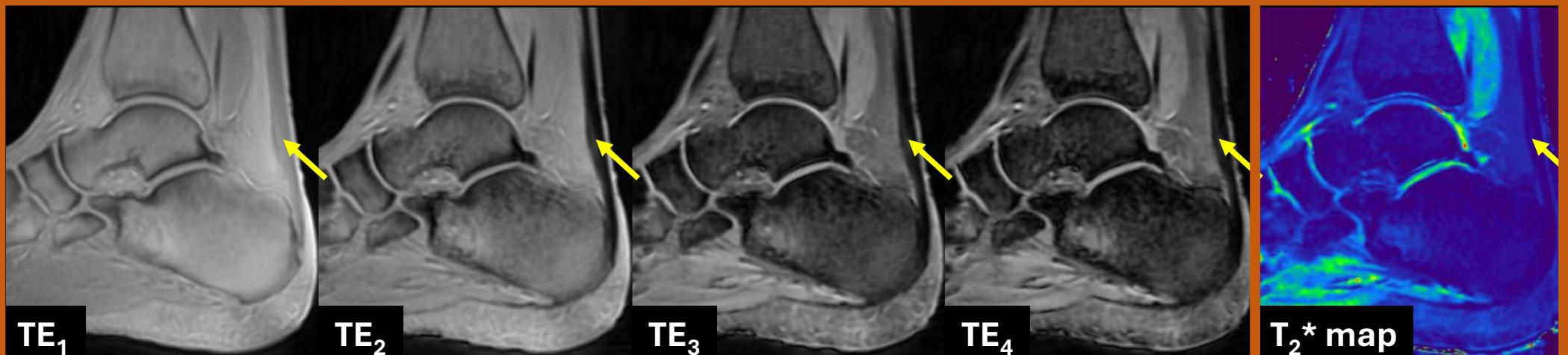
AX PD

SAG T2 FS

SAG PD

CORT1

3D
isotropic
4-mecho
UTE



TE₁

TE₂

TE₃

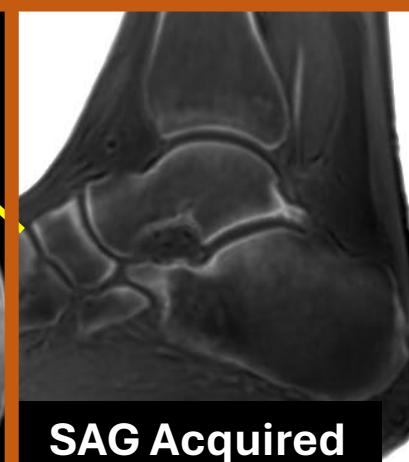
TE₄

T₂* map

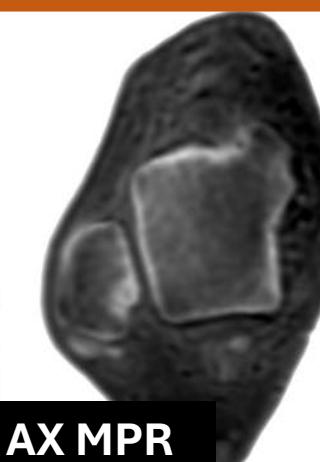


TE₁-TE₂

TE₁-TE₃



SAG Acquired

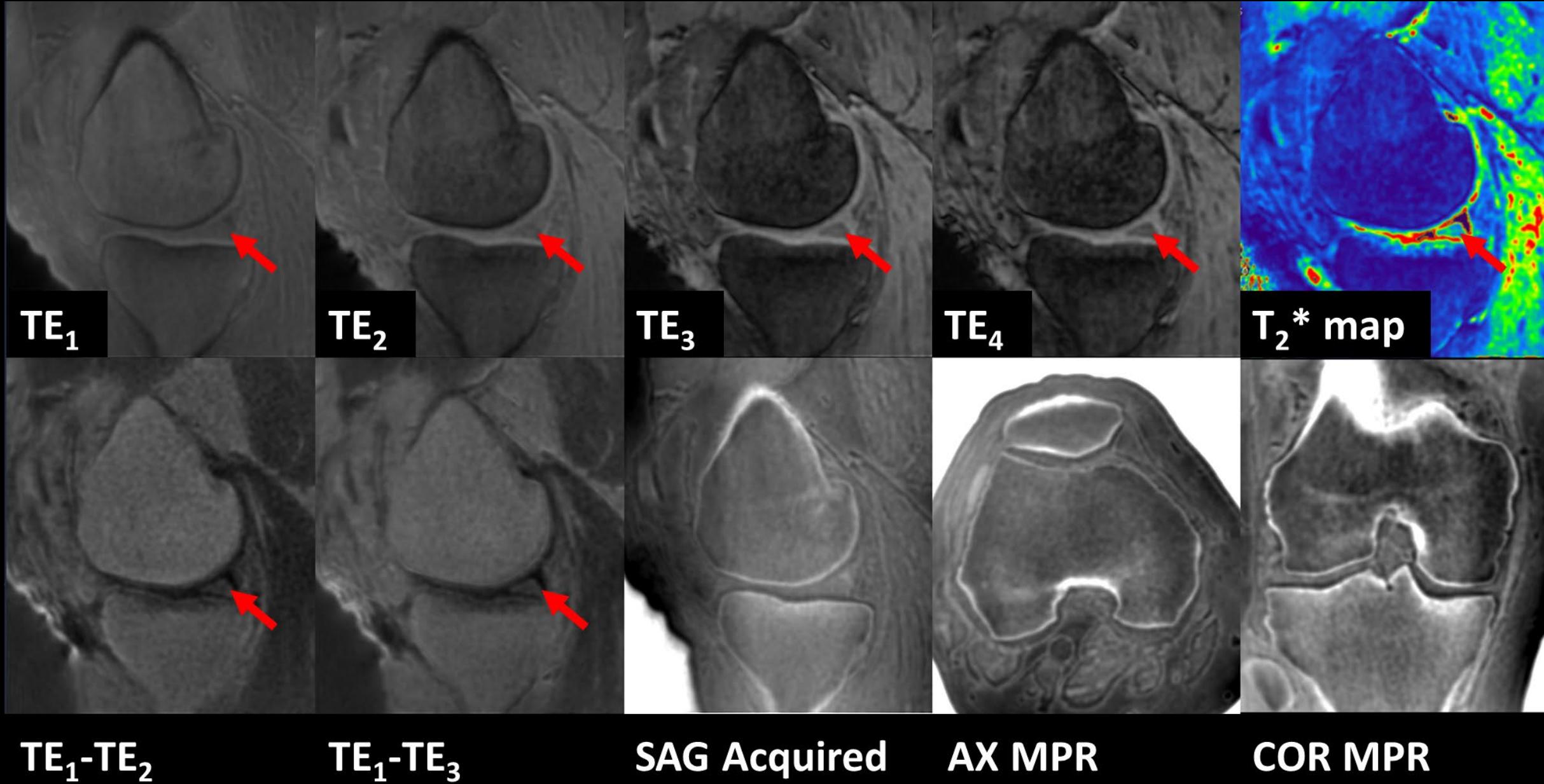


AX MPR



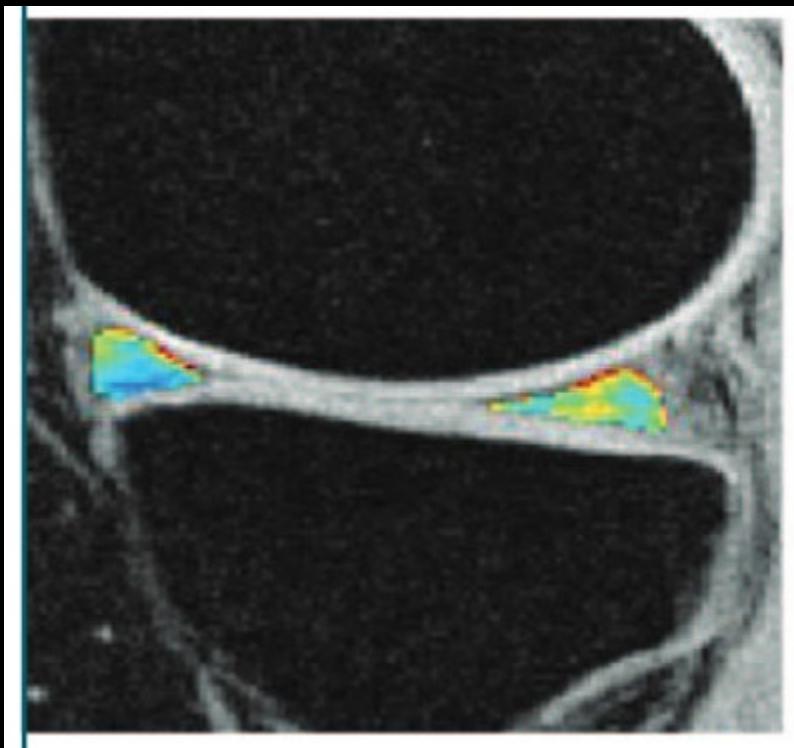
COR MPR

5-min 3D isotropic 0.8mm³

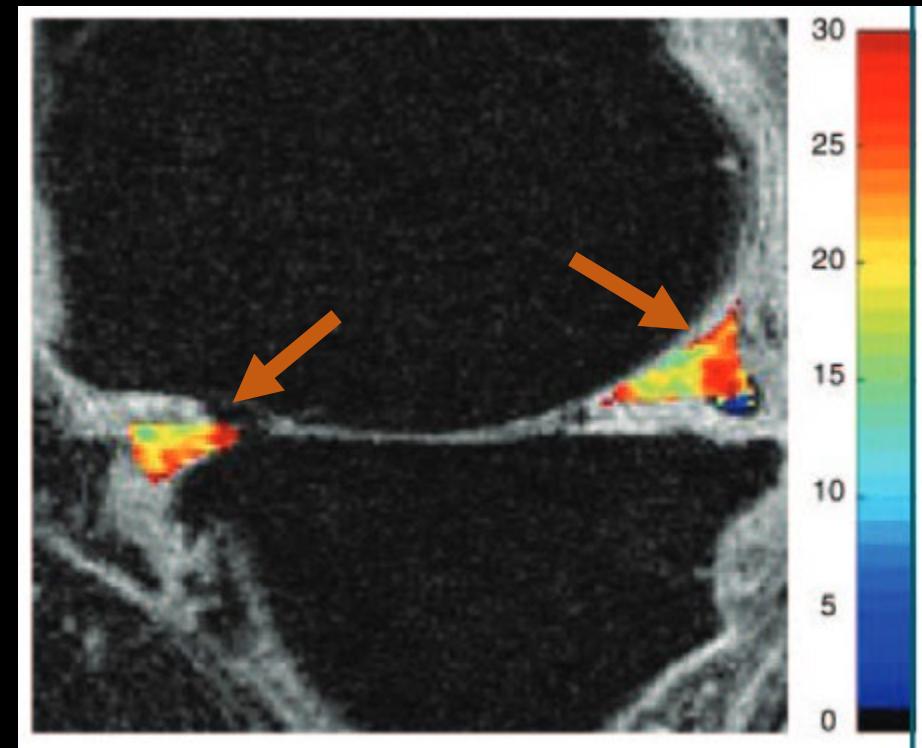


Increased T2* associated with Disease

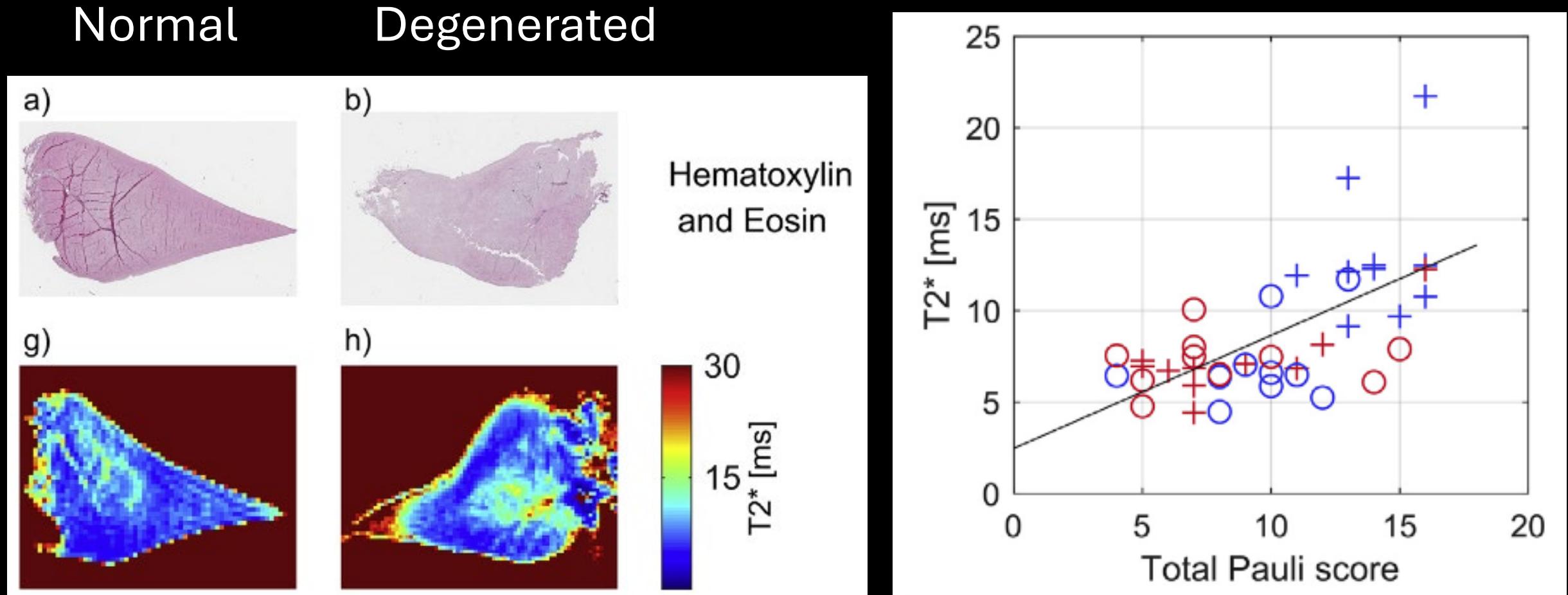
Healthy
Control



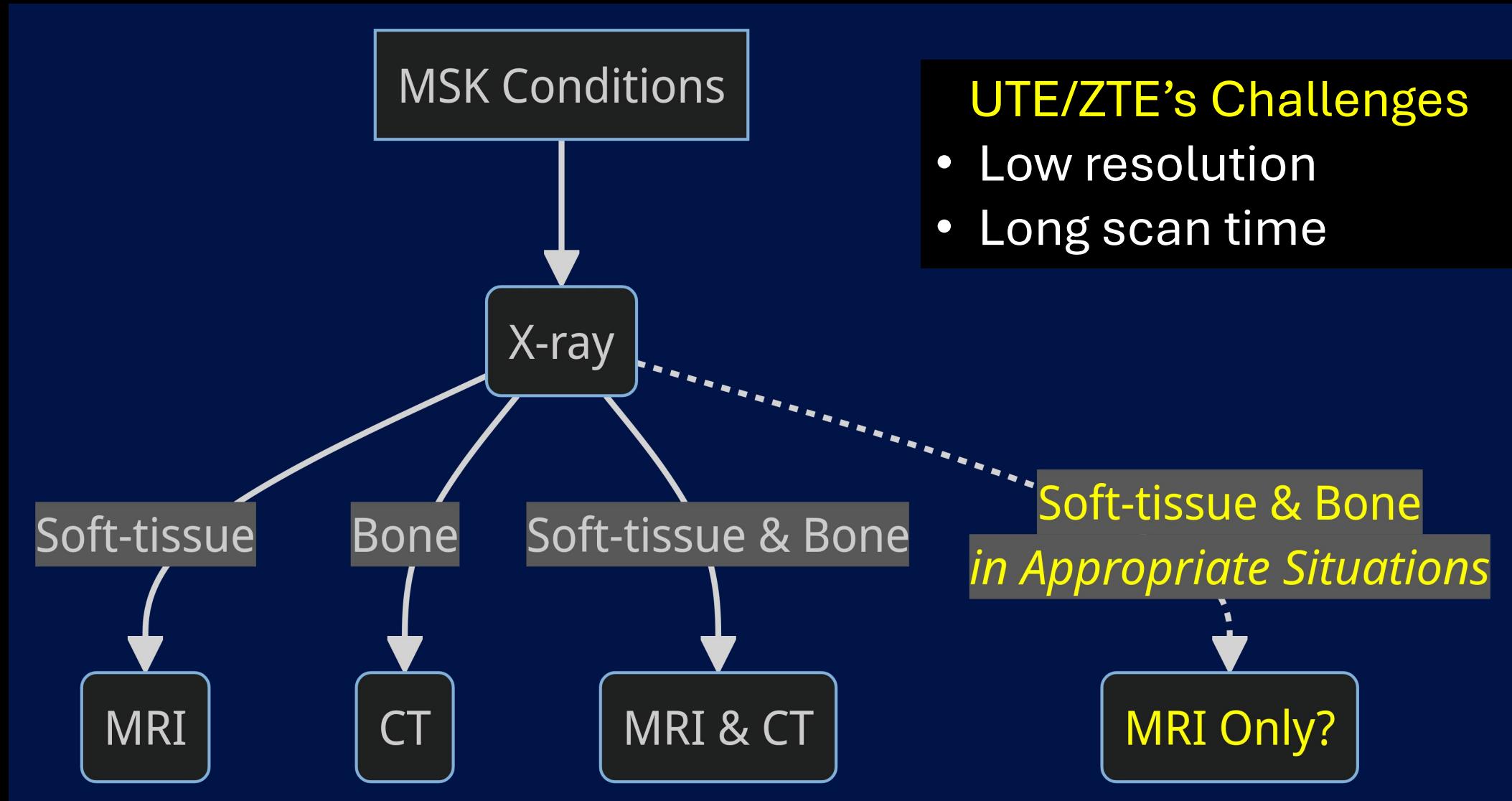
Patient with
osteoarthritis (OA)



Increased T2* is correlated with Disease Severity

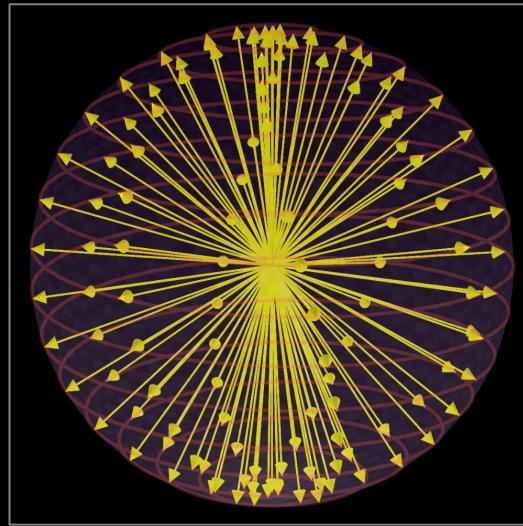


Goal: Accelerate Mecho-UTE using CG-SENSE & DLR

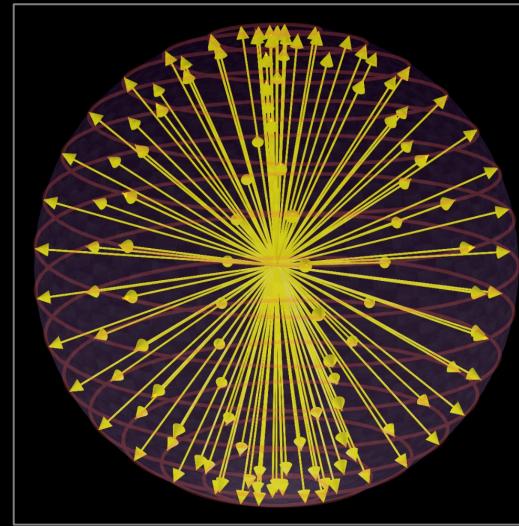


Methods: 5.8-min 3D-isotropic 0.8mm³ UTE

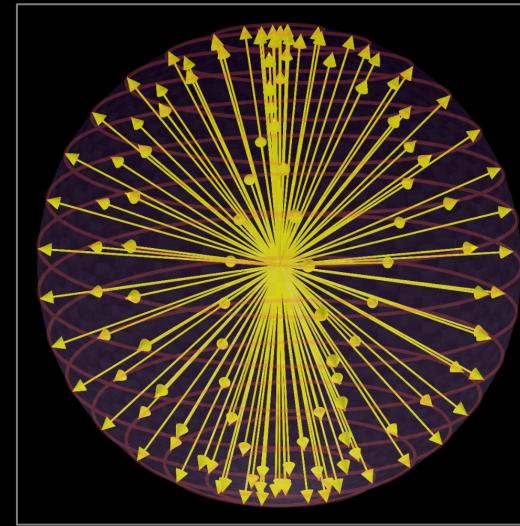
TE₁ = 0.096 (ms)



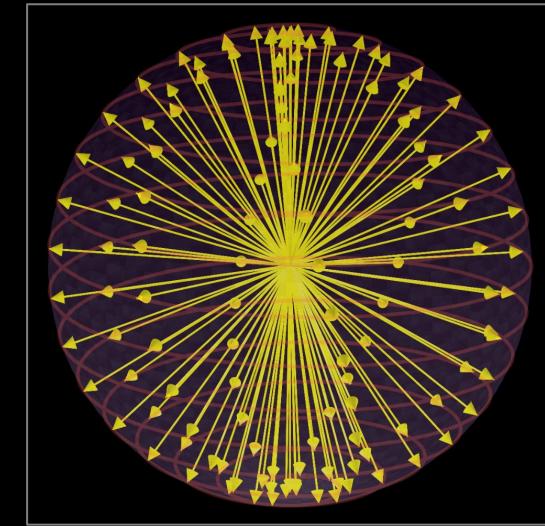
TE₂ = 2.396



TE₃ = 4.696

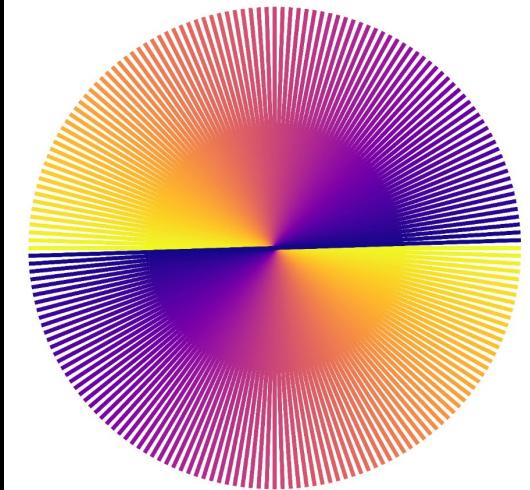


TE₄ = 6.996

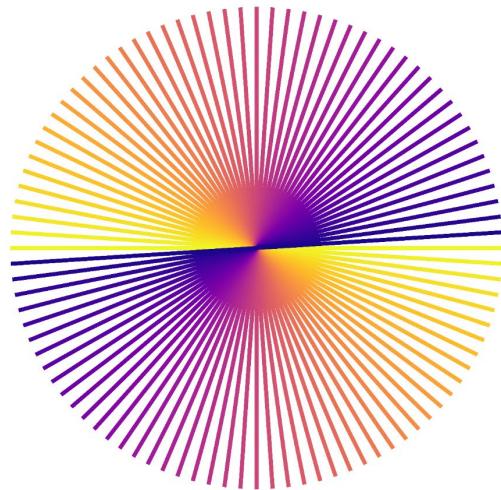


- One volunteer & 4 patients prior to surgery (Canon's 3T MRI) and CT
- Retrospectively under-sampled factors: 2, 3, 4, and 5 (i.e., **1.2-min**)
- Reconstructed with (1) Gridding (**GRID**) and (2) CG-SENSE+DLR (**DLR**)
- Full-Width at Half-Maximum (**FWHM**) & Relative Edge Sharpness (**RESH**)

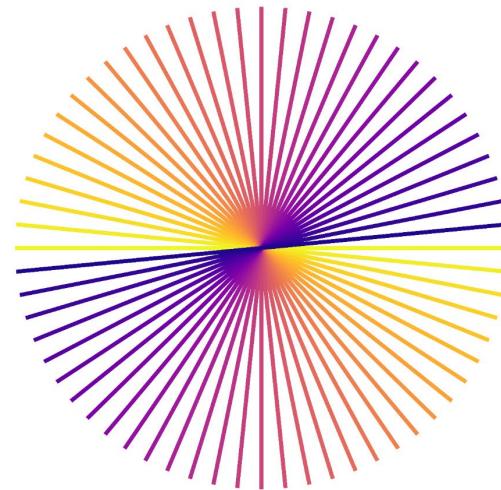
Acceleration: R=1
(96 spokes)



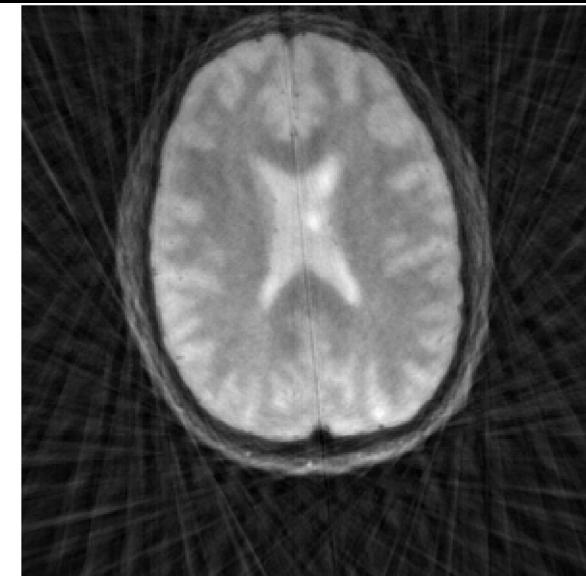
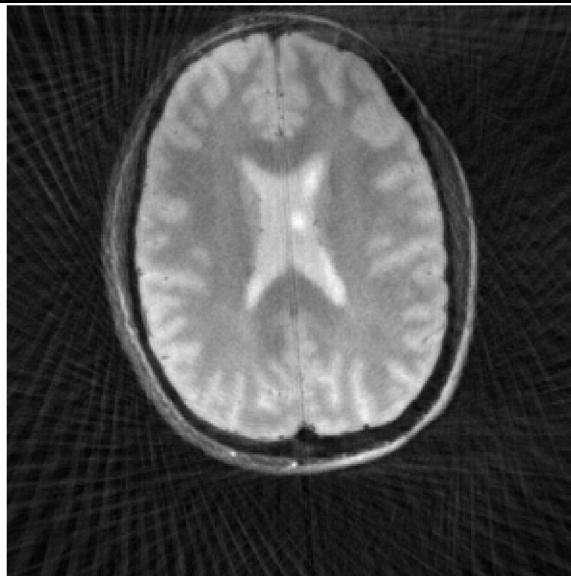
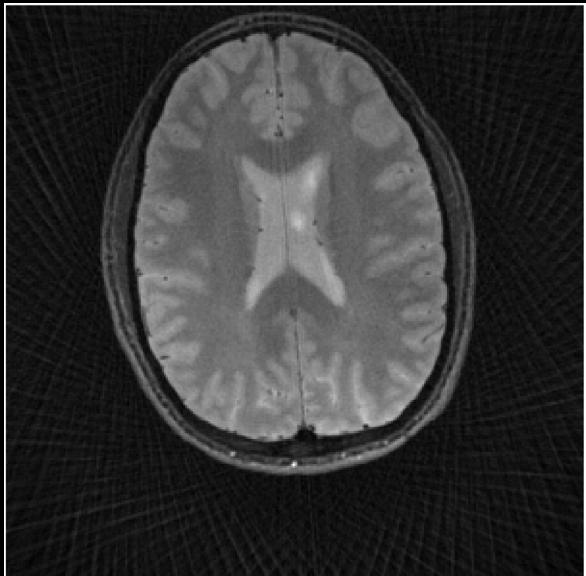
R=2
(48 spokes)



R=3
(32 spokes)

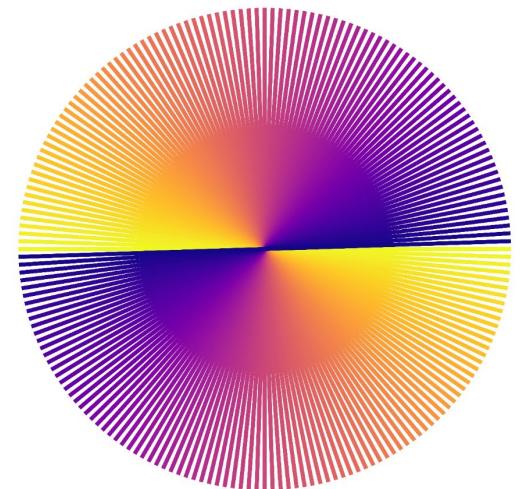


K-space
trajectory

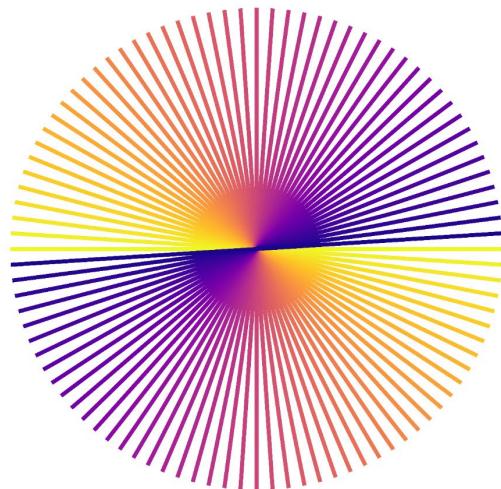


Gridding
reconstruction

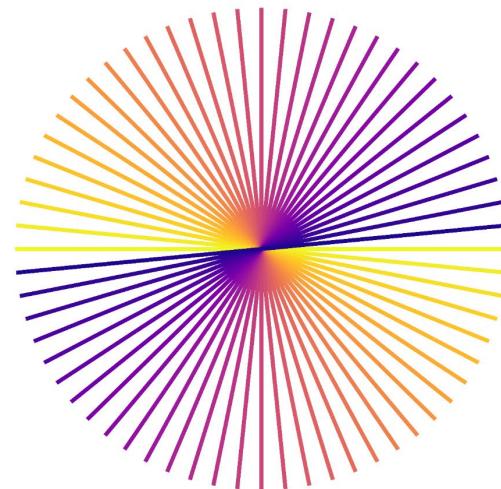
Acceleration: R=1
(96 spokes)



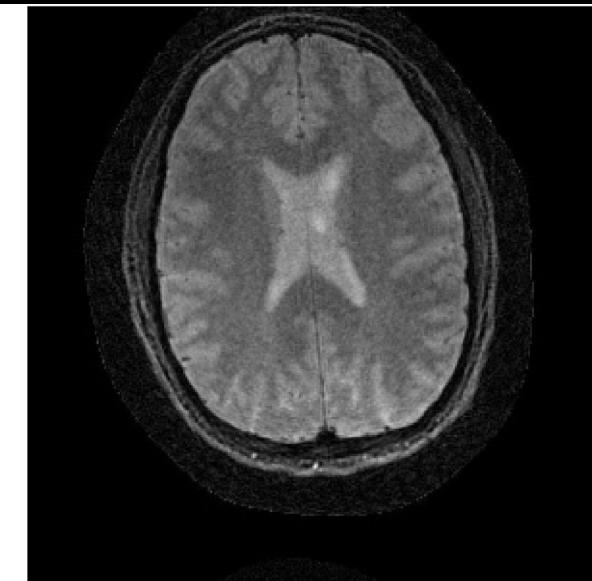
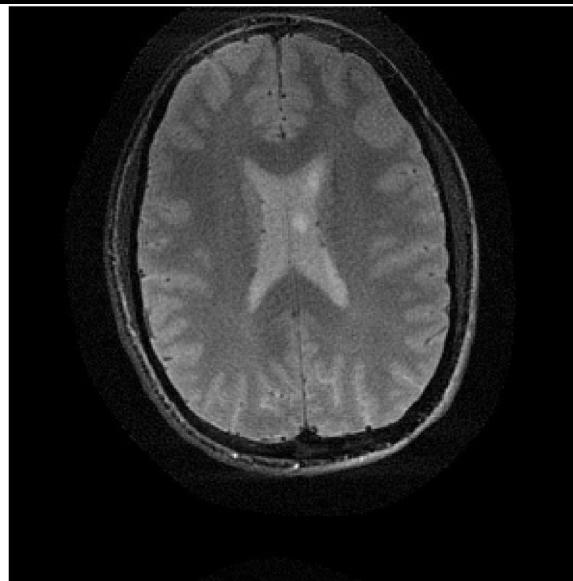
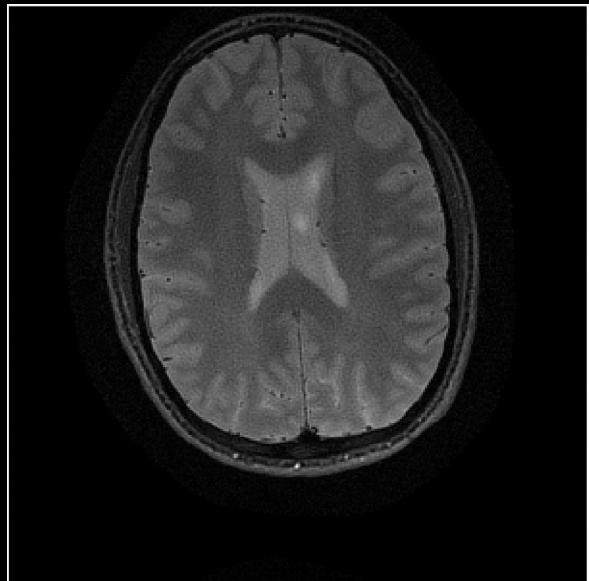
R=2
(48 spokes)



R=3
(32 spokes)

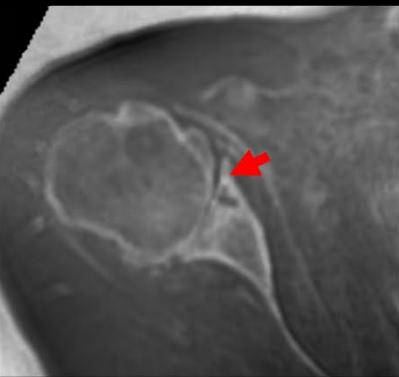


K-space
trajectory

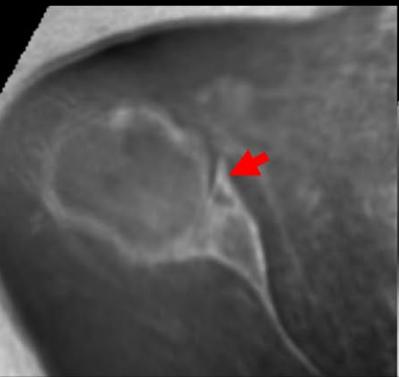


CG-SENSE
reconstruction

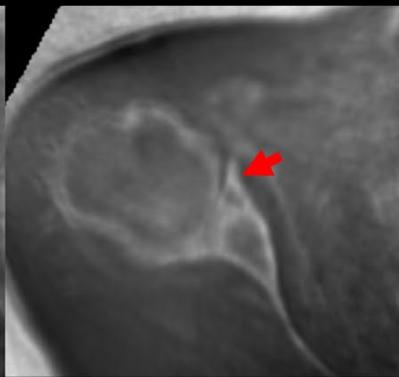
GRID: 5.8min



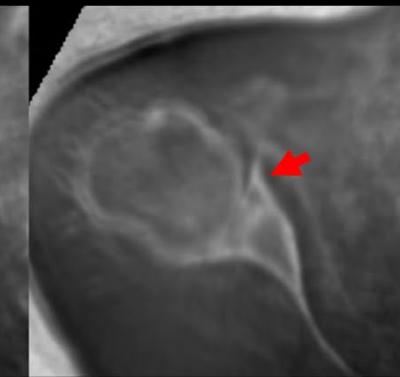
2.9min



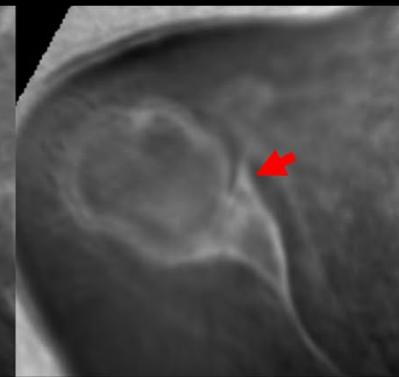
1.9min



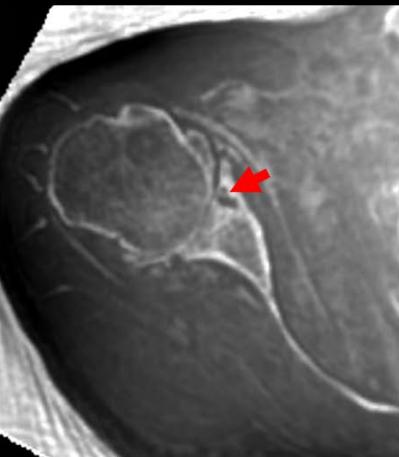
1.4min



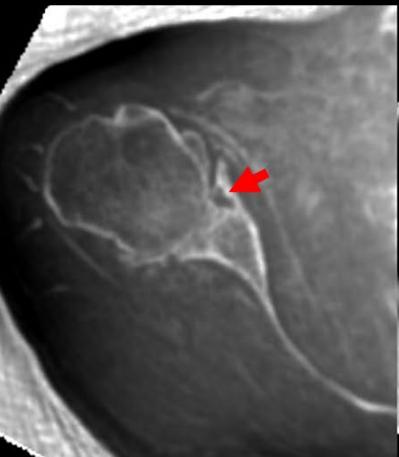
1.2min



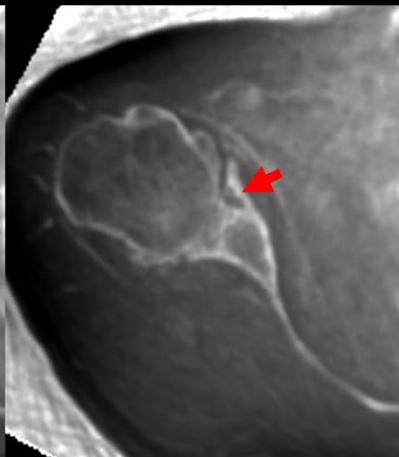
DLR: 5.8min



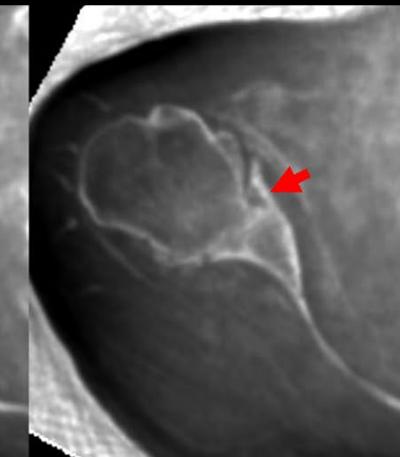
2.9min



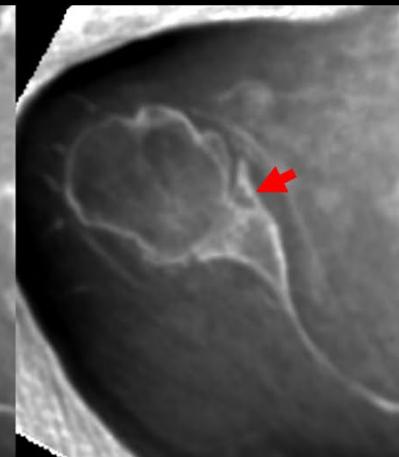
1.9min



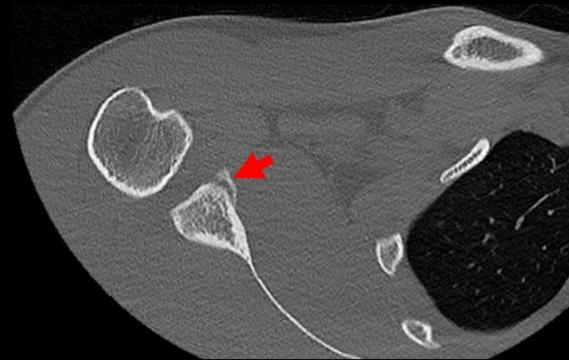
1.4min



1.2min



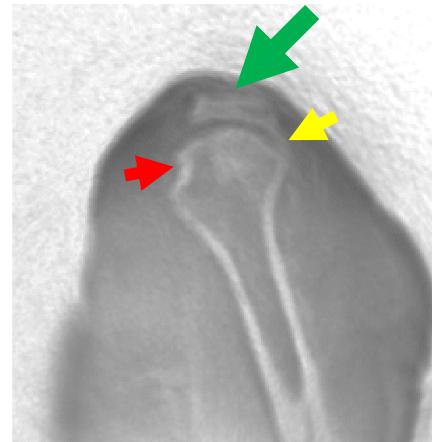
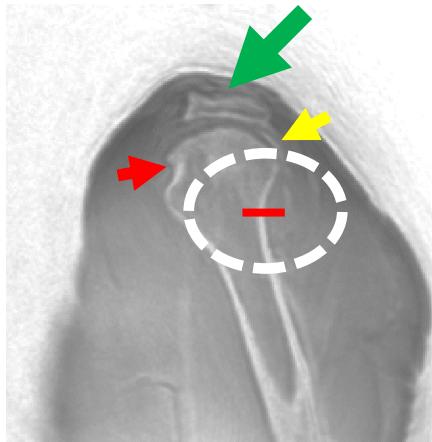
CT



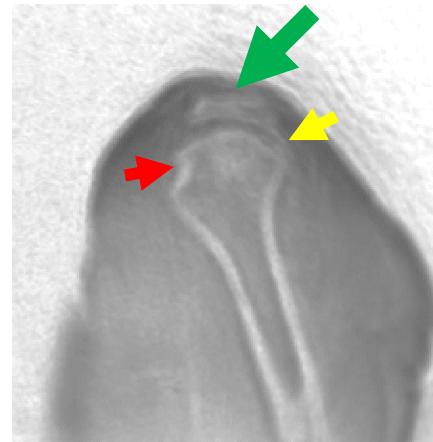
**Bony Bankart
Lesion**

Representative Reconstructions

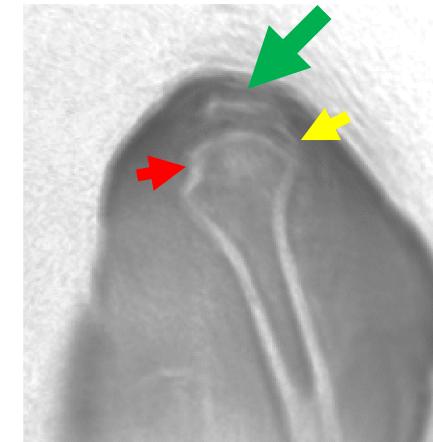
GRID: 5.8min 2.9min



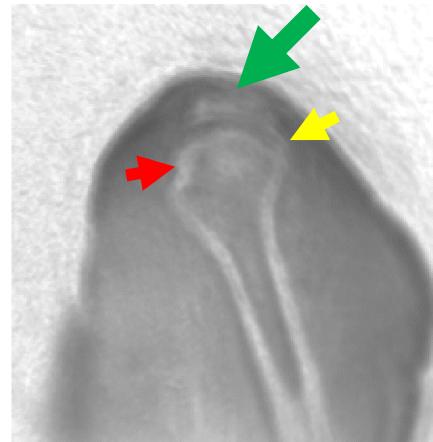
1.9min



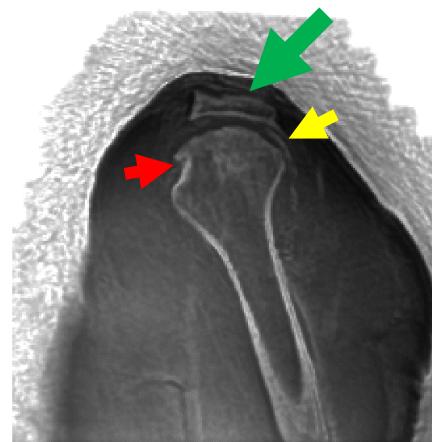
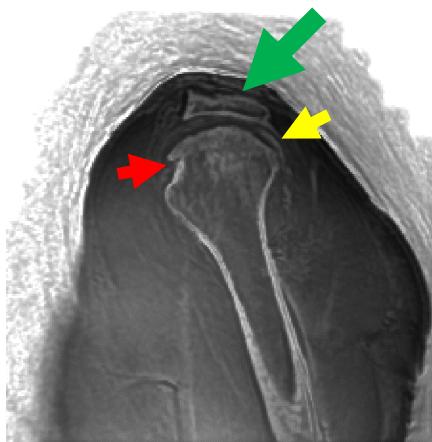
1.4min



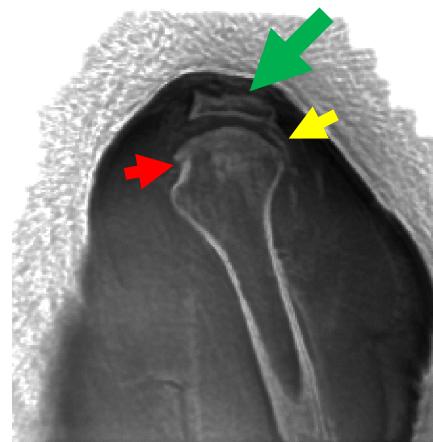
1.2min



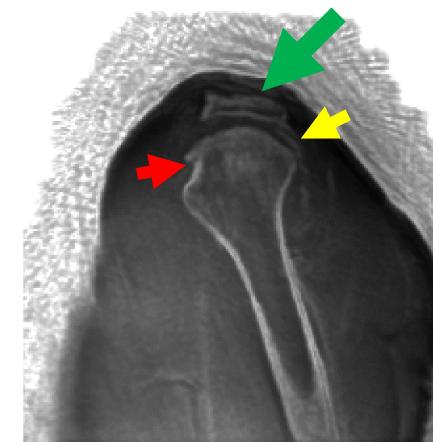
DLR: 5.8min 2.9min



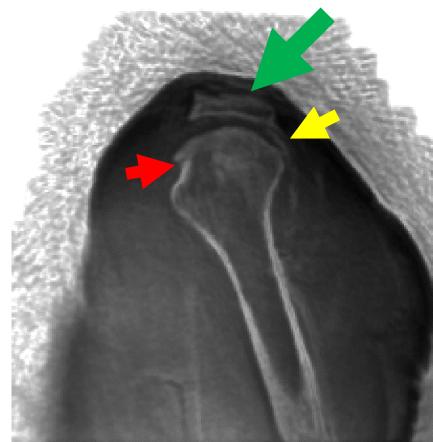
1.9min



1.4min

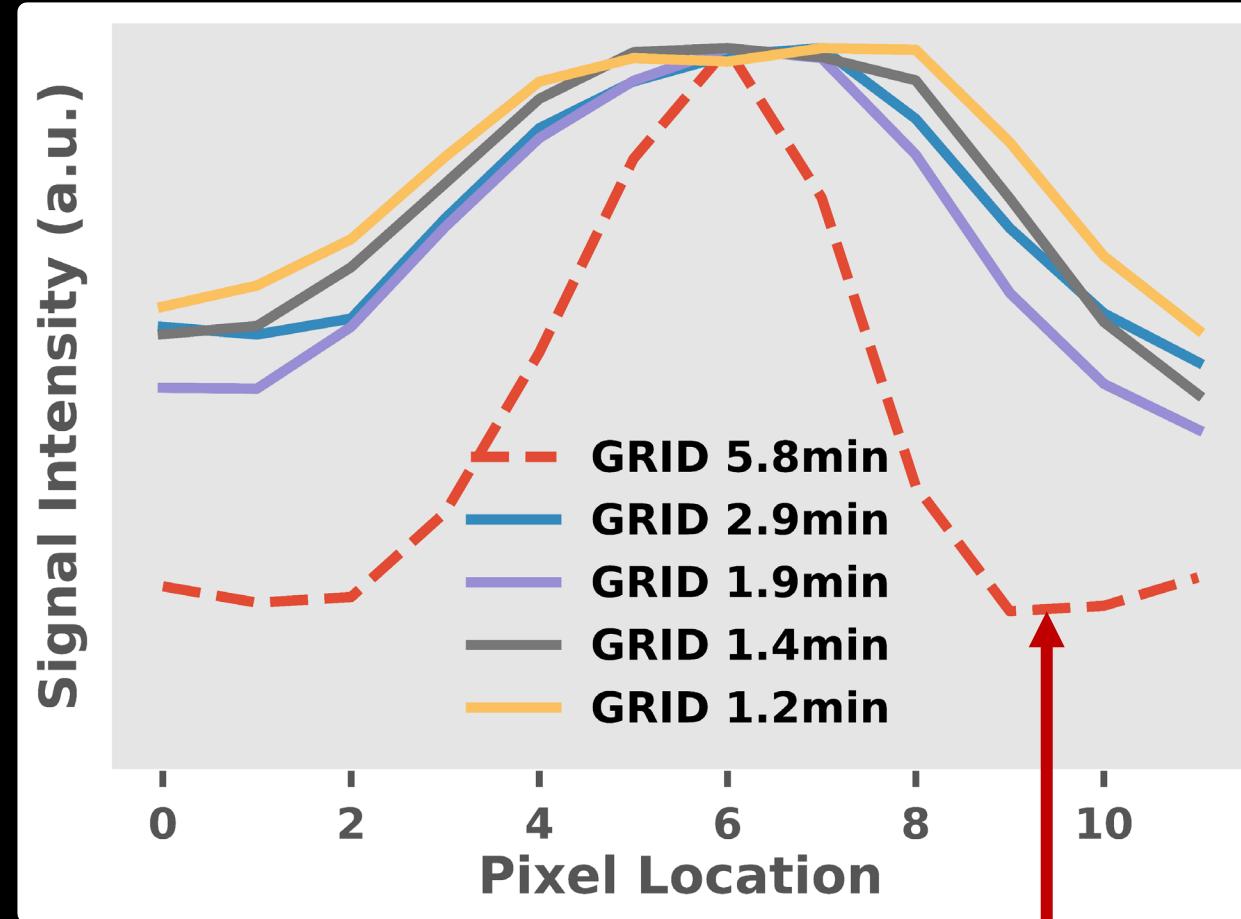


1.2min



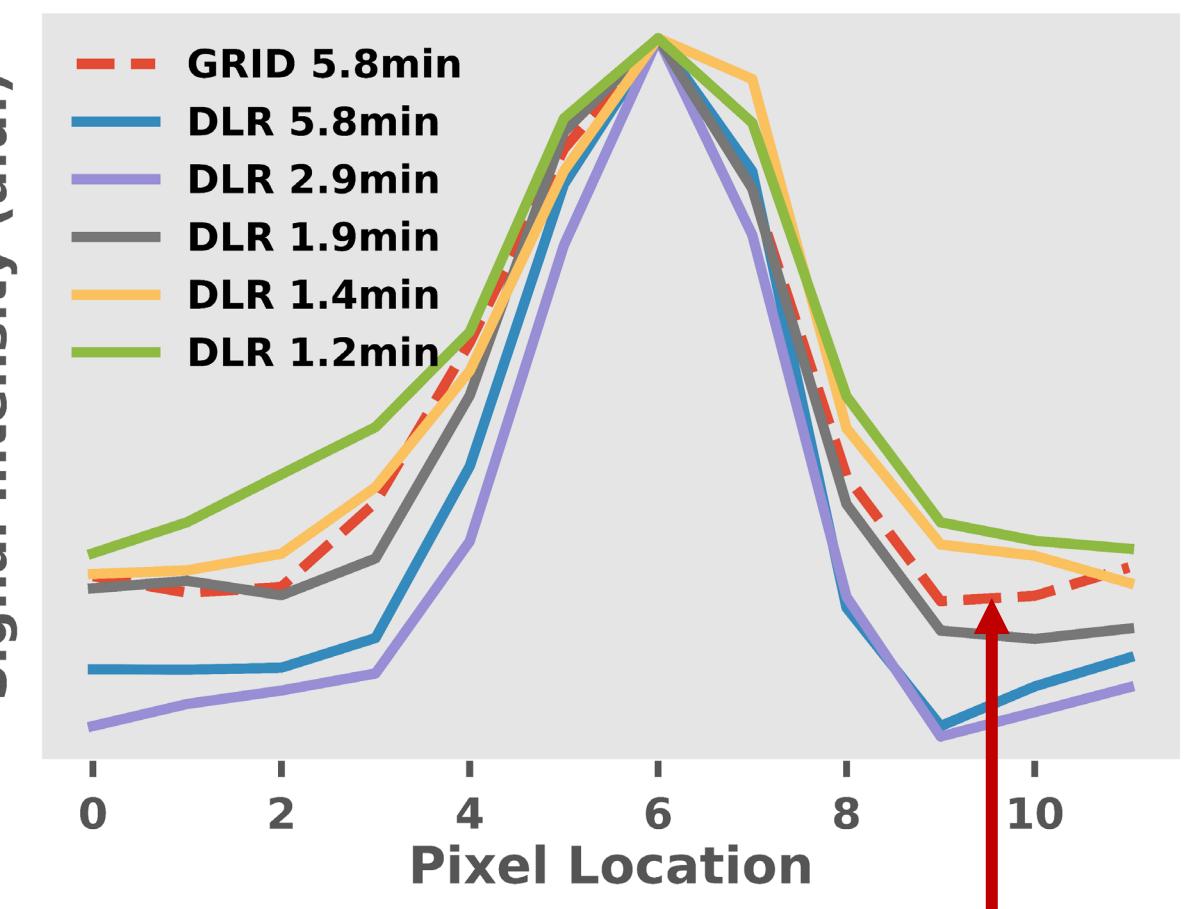
Representative Line Profiles

GRIDDING



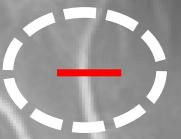
Line profile of a 5.8-min GRID

CG-SENSE + DLR



Line profile of a 5.8-min GRID

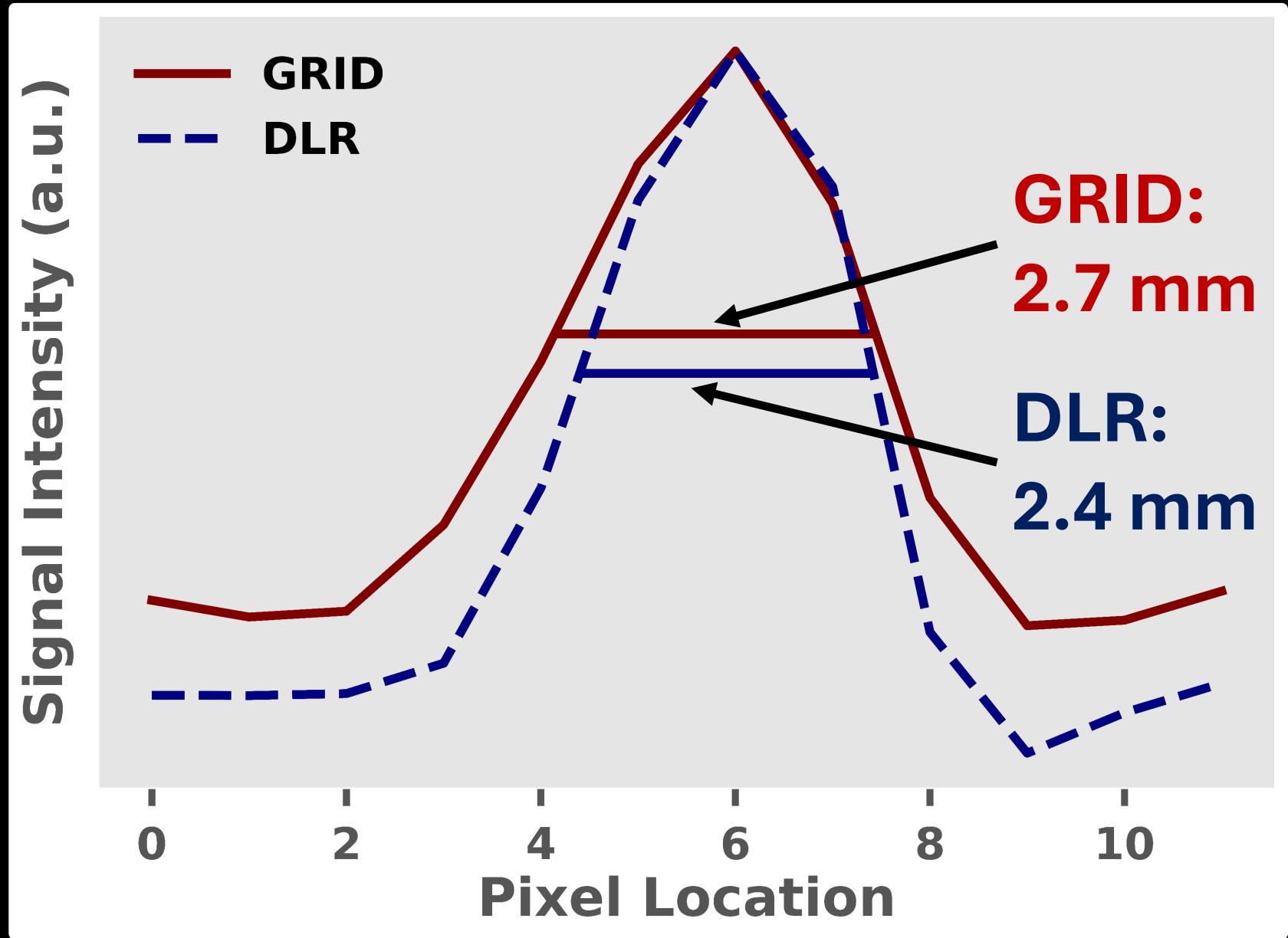
GRID



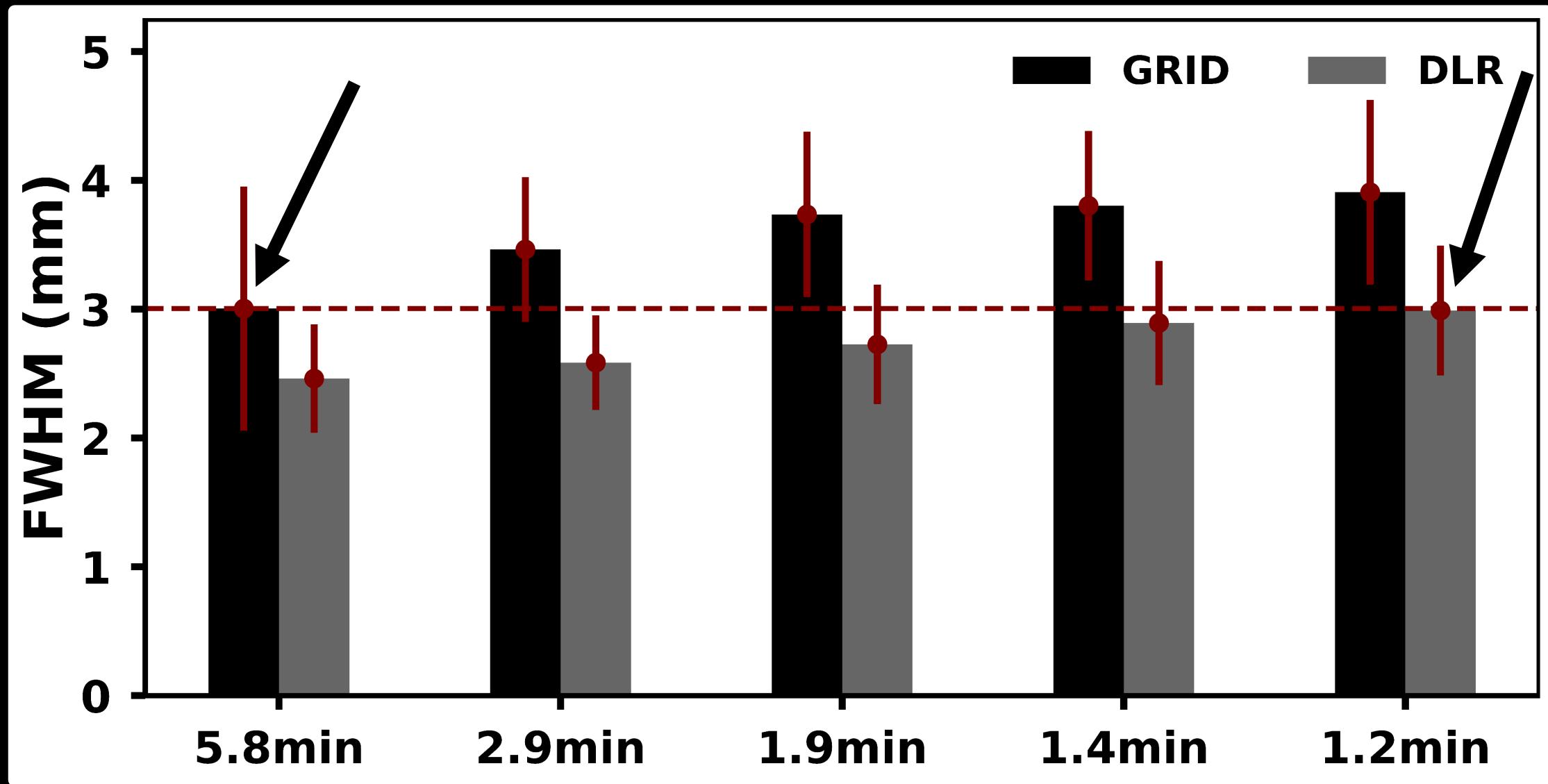
DLR

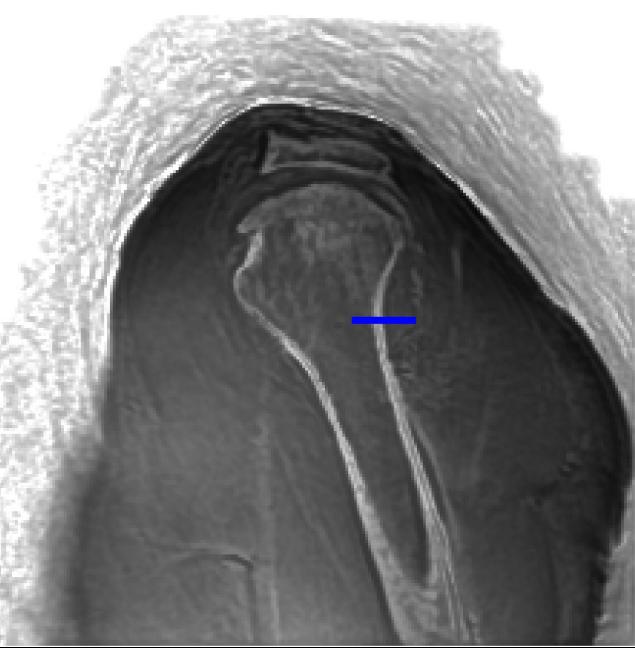


Full-Width at Half-Max (FWHM)

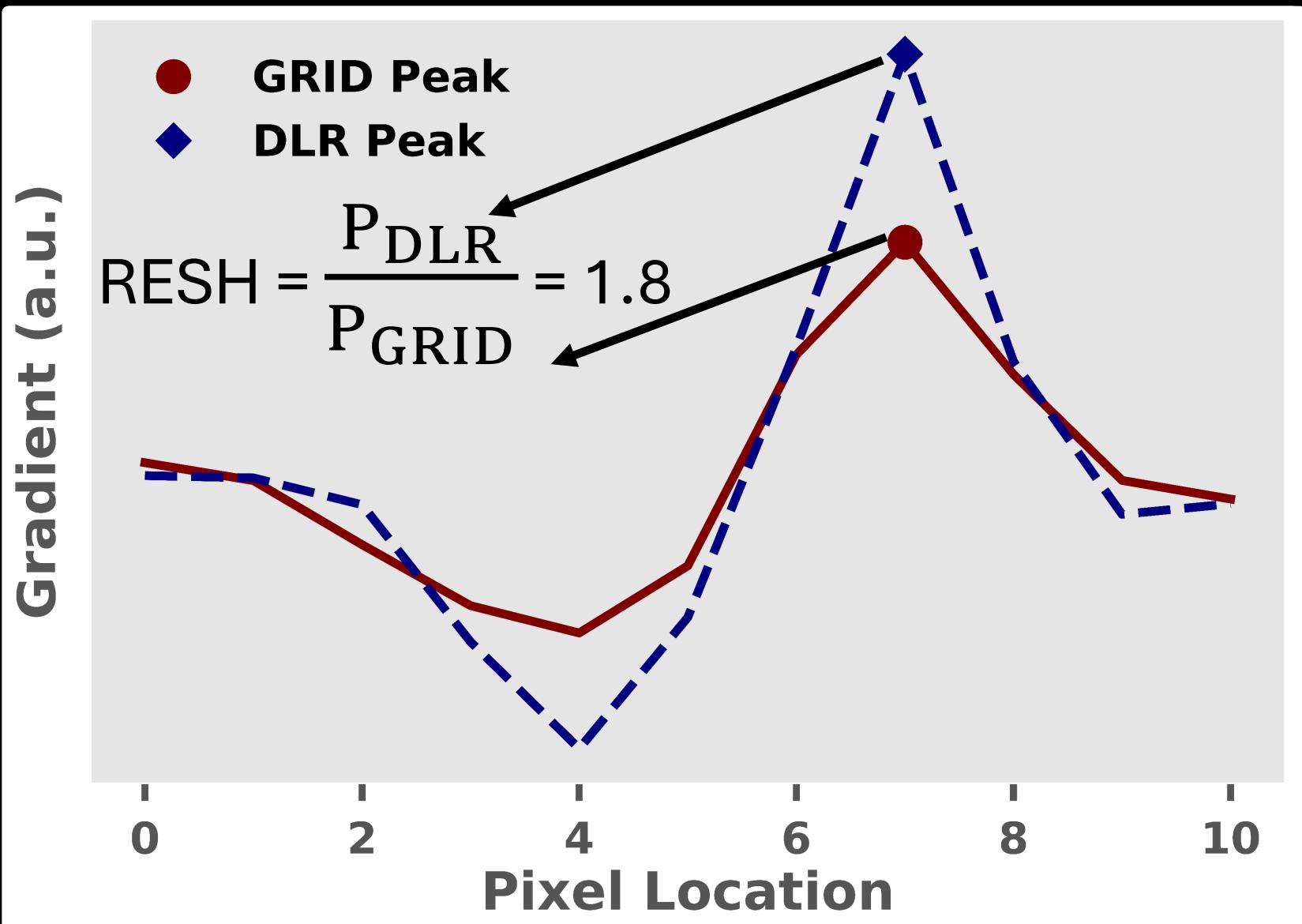


Images are 24% higher resolution with DLR

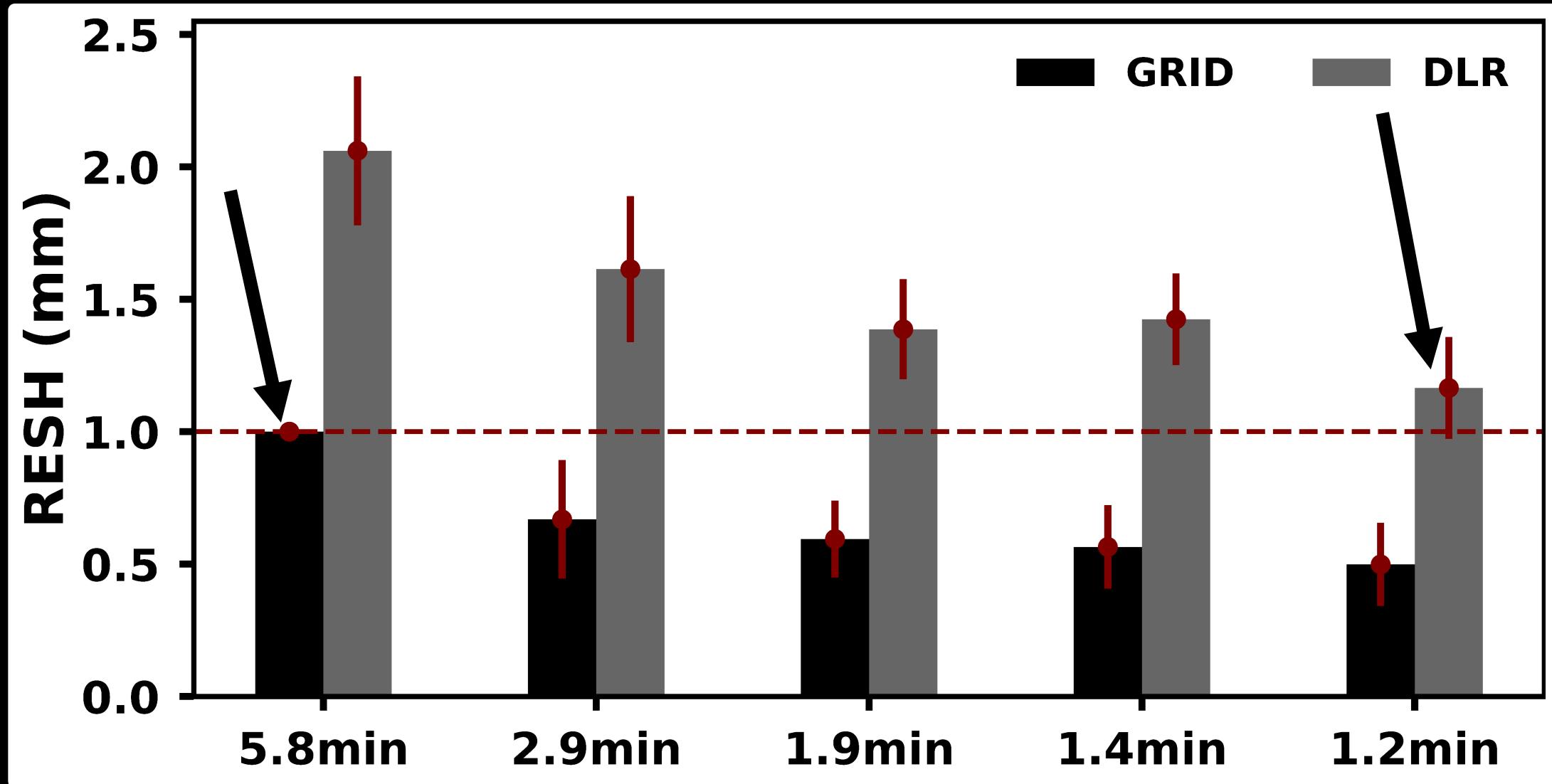


GRID**DLR**

Relative Edge Sharpness (RESH)



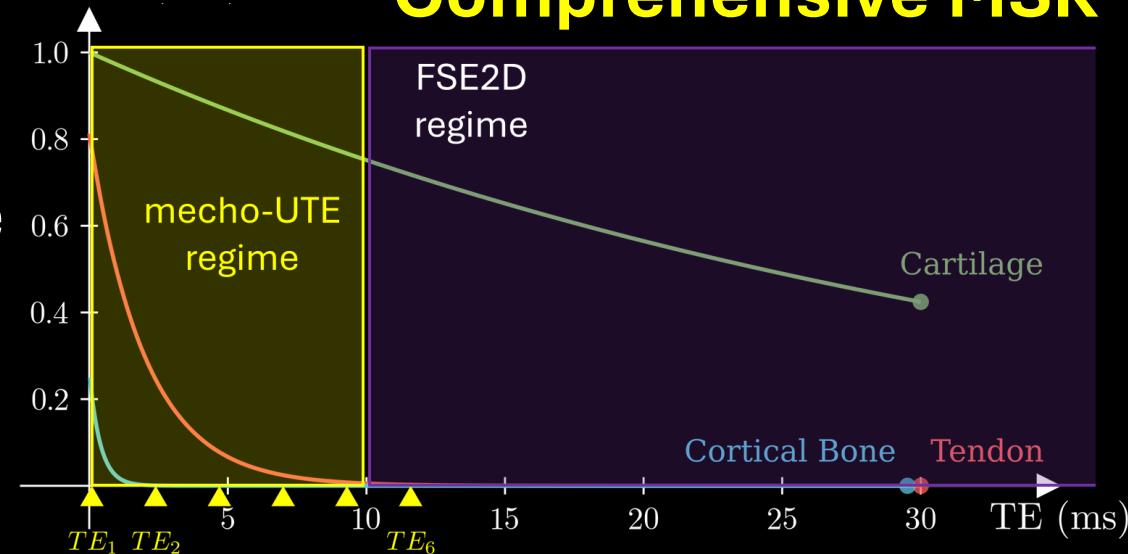
Images are 2.3 times Sharper with DLR



Conclusions

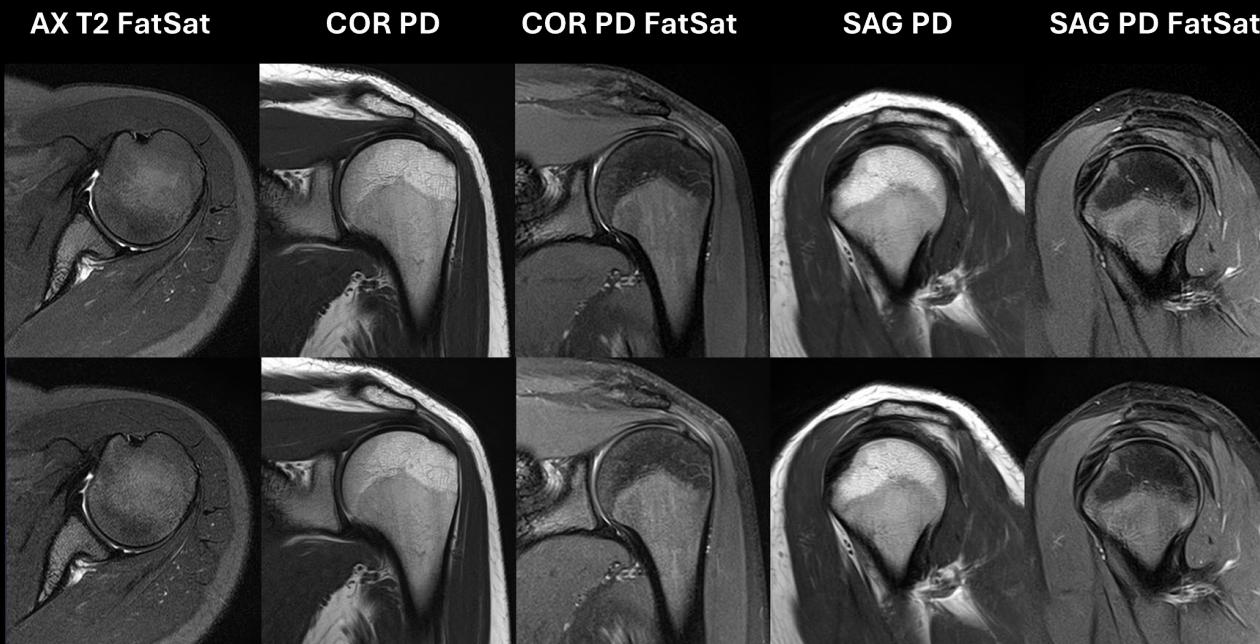
- Feasibility of <2-min 3D-iso mecho UTE
- 10-12-min one-stop-shop comprehensive MSK. Reduce logistics & costs, and eliminate radiation exposure (pediatric)

Comprehensive MSK



**7.5-min
1-Average
with DLR**

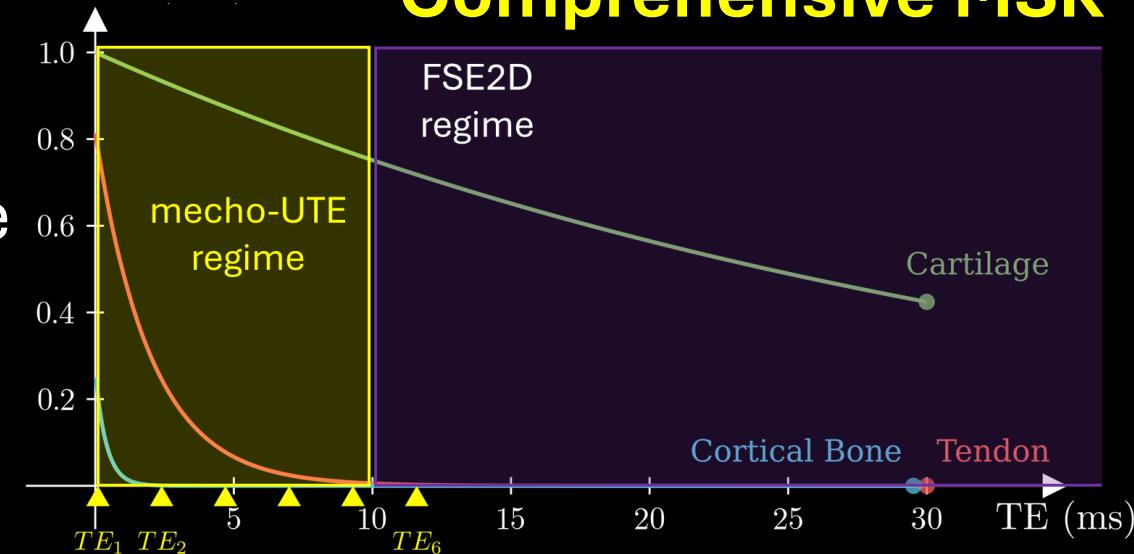
**14.5-min
2-Average
w/o DLR**



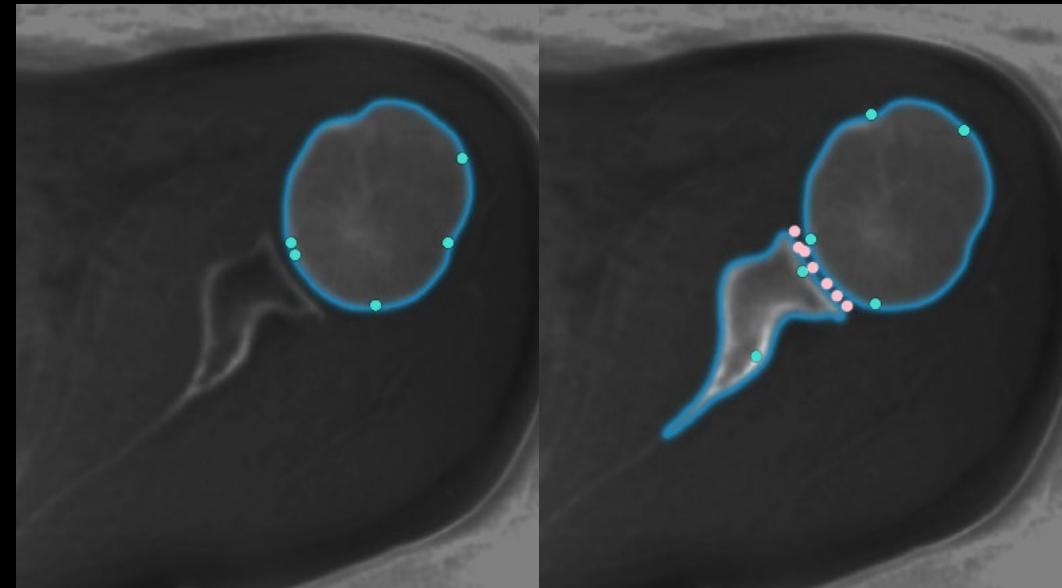
Conclusions

- 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



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



Conclusions

- This study demonstrates the feasibility of a <2-min 3D-isotropic 4-mecho UTE using CG-SENSE and Deep Learning-based Denoising Reconstruction.
- In combination with FSE2D, it enables a 10-12-min one-stop-shop MR-only comprehensive MSK imaging. When appropriate, it can reduce logistics & costs, and eliminate radiation exposure for patients, especially children, pregnant women, and those requires multiple CT exams.
- Future work:
 - To study on a larger patient cohort; to implement automatic bone segmentation for 3D rendering; and to further improve resolution & sharpness using DL-based super-resolution reconstruction

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Matthew T. Provencher², Scott Tashman², Charles P. Ho²

Thank you for your attention!



“Seeing the Unseeable”
... first-ever image of a black hole^[1]

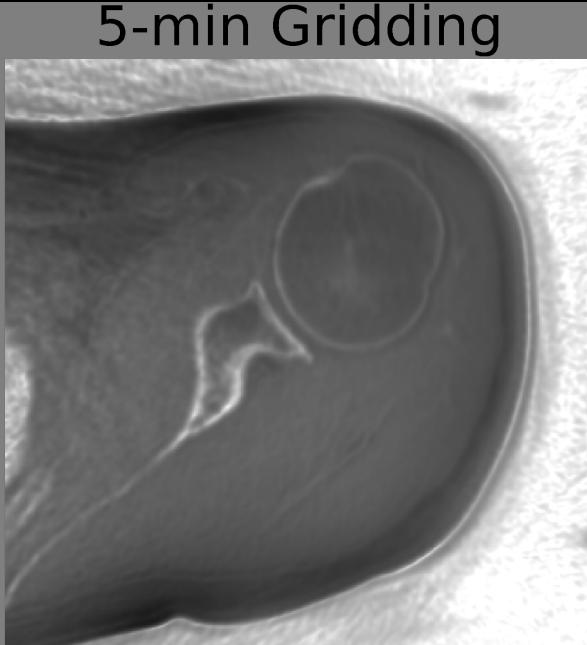


THE STEADMAN CLINIC
AND
STEADMAN PHILIPPON
RESEARCH INSTITUTE

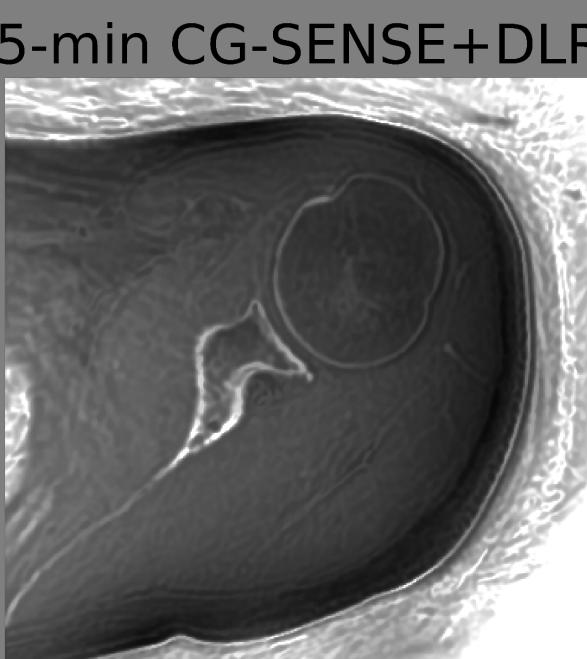
Backup slides

Prospective Data

GRIDDING



CG-SENSE & DLR

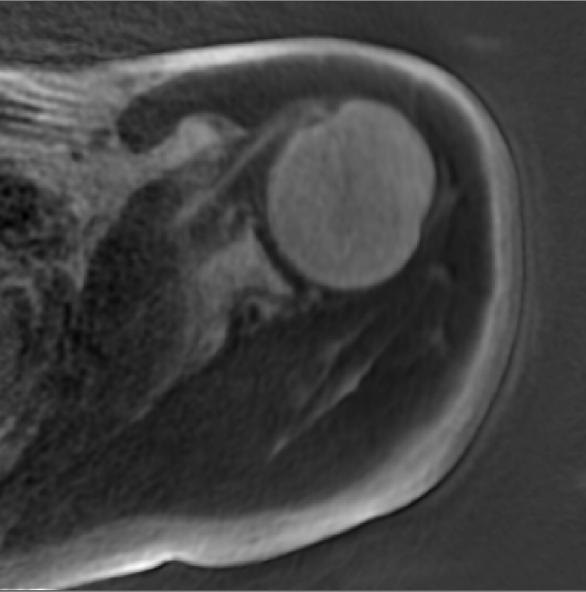


Prospective Data

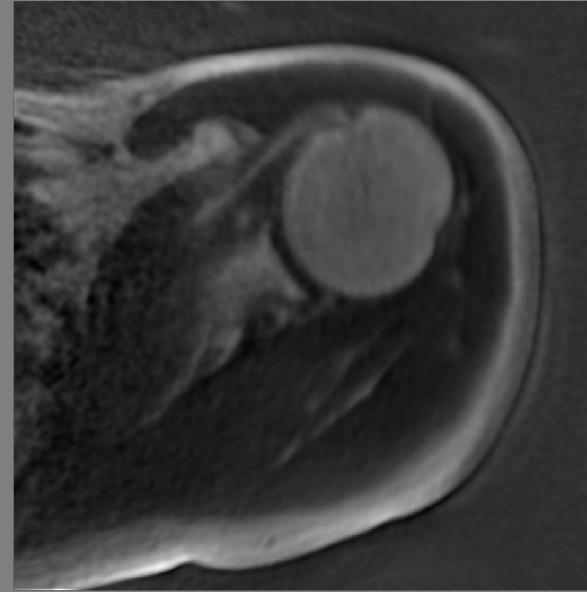
Visualization of
Ultrashort-T2
Tissues

Tendon - - - - →

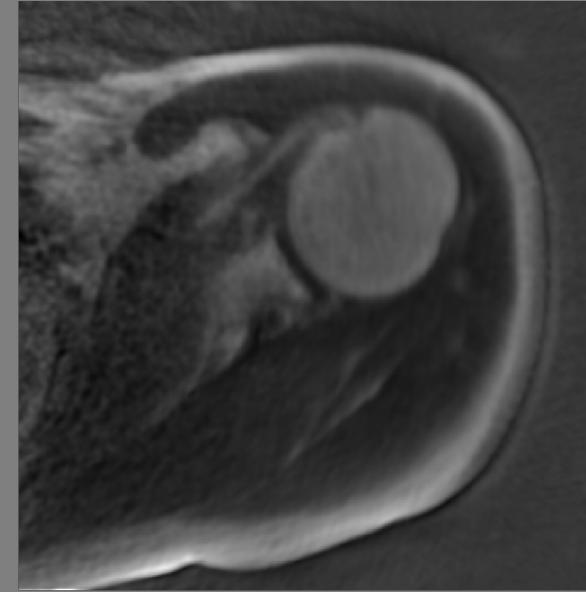
5-min Gridding



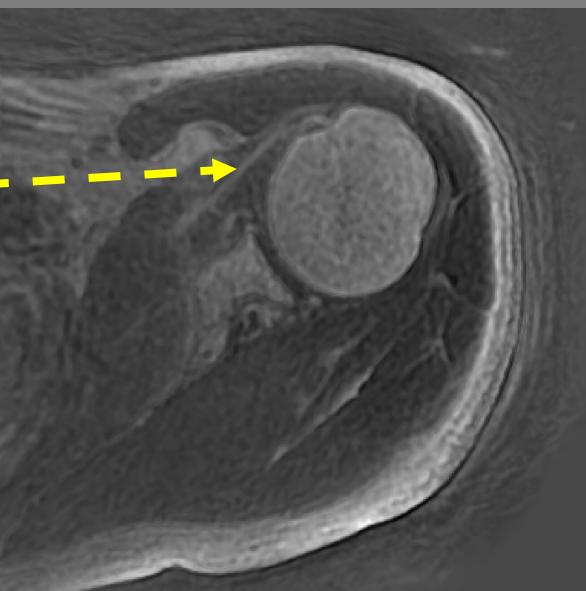
3-min Gridding



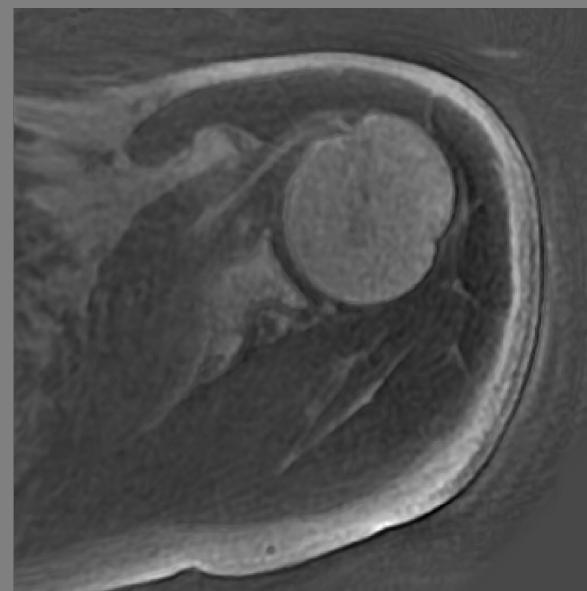
2-min Gridding



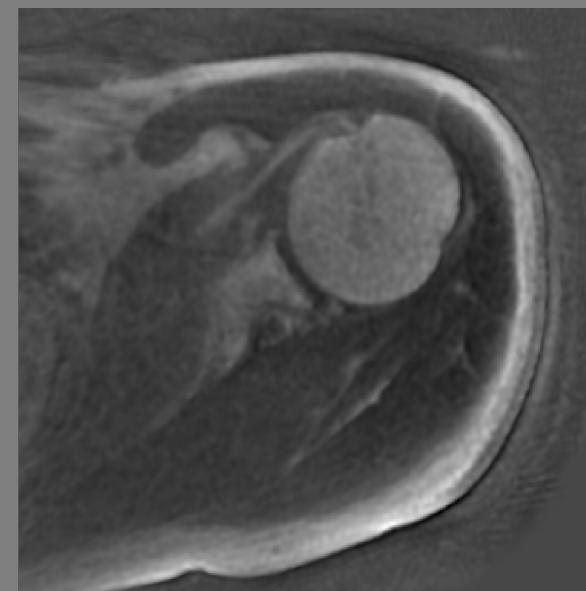
5-min CG-SENSE+DLR



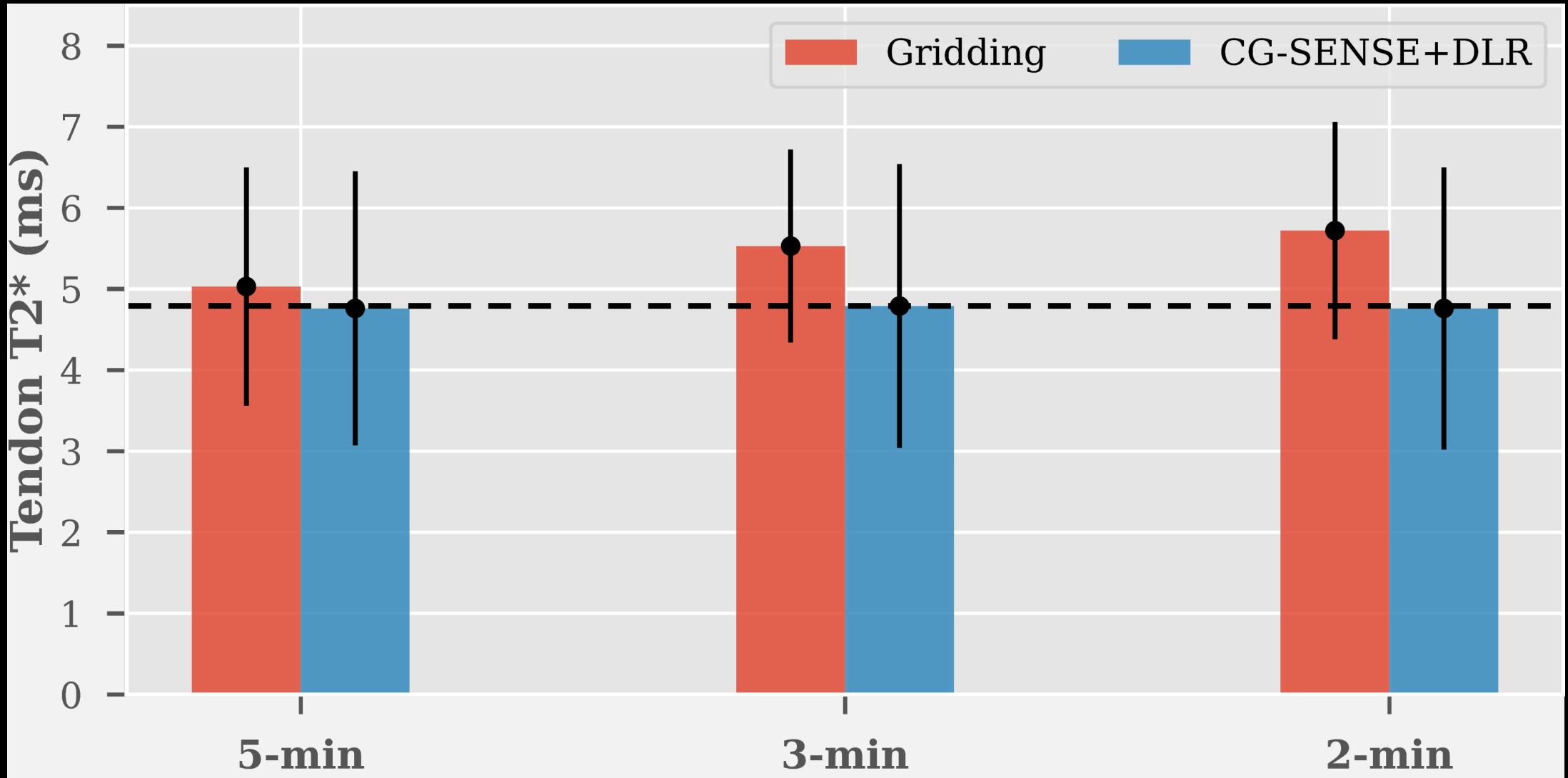
3-min CG-SENSE+DLR



2-min CG-SENSE+DLR



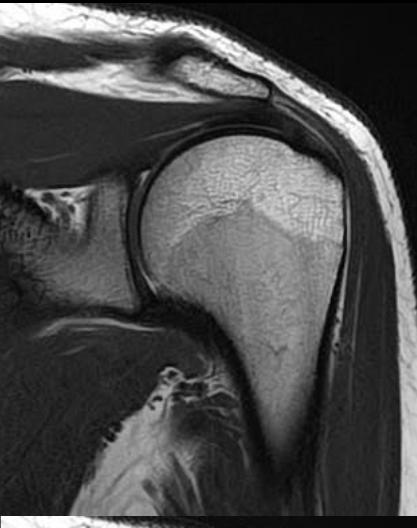
Prospective Data Tendon's T2* Measures



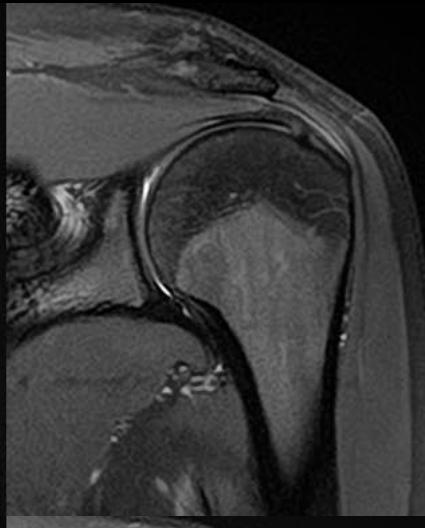
AX T2 FatSat



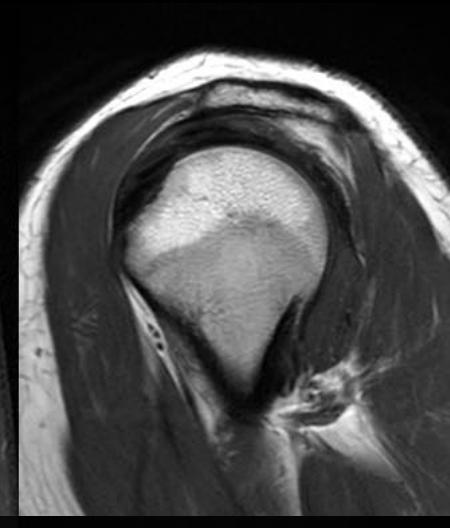
COR PD



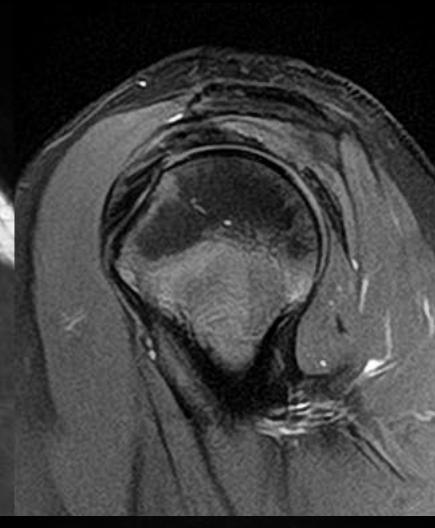
COR PD FatSat



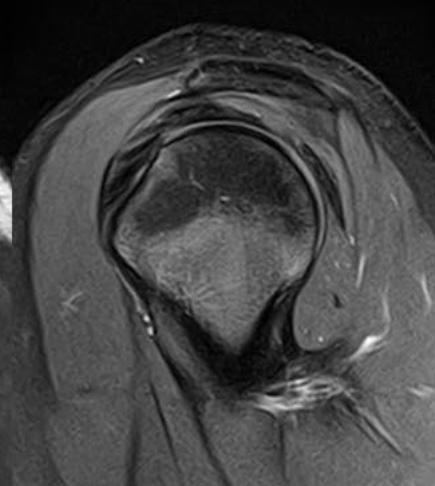
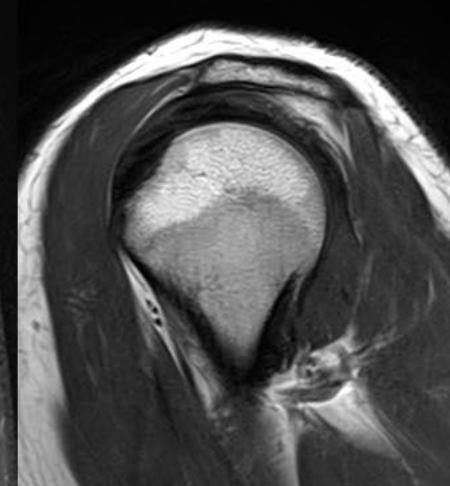
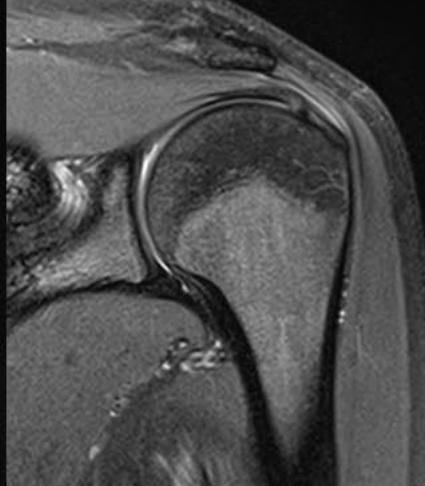
SAG PD



SAG PD FatSat

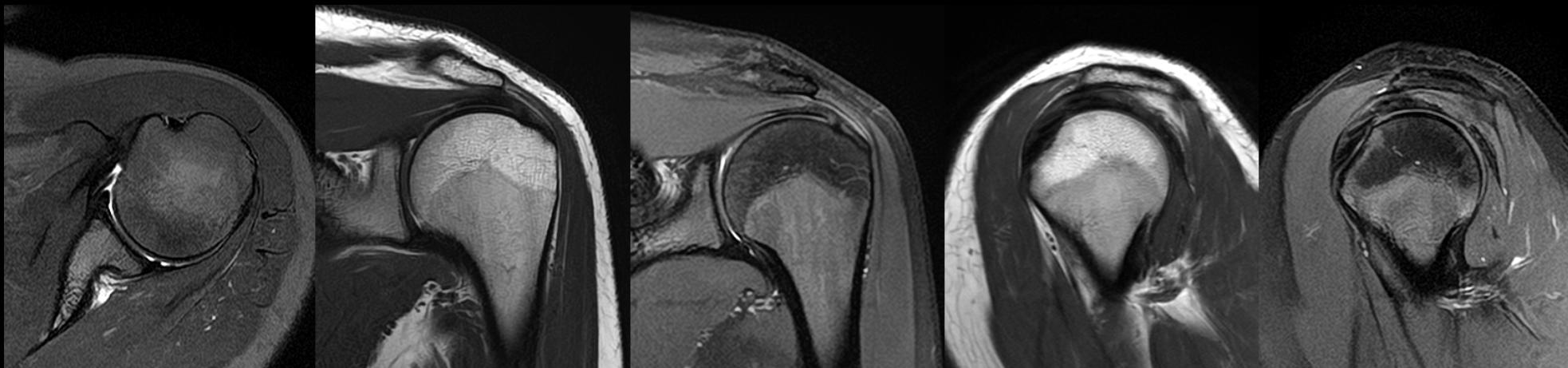


7.5-min
1-NAQ
with DLR

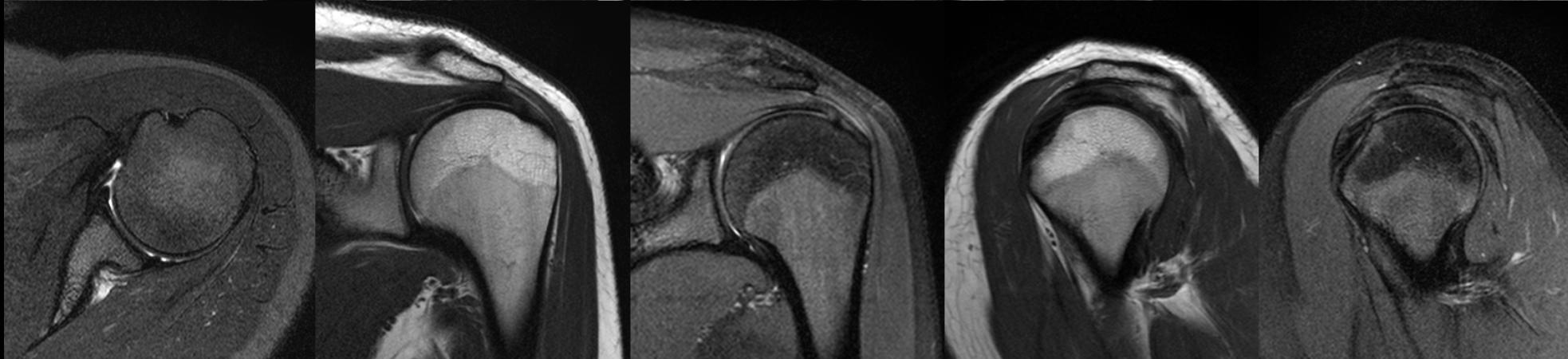


14.5-min
2-NAQ
w/o DLR

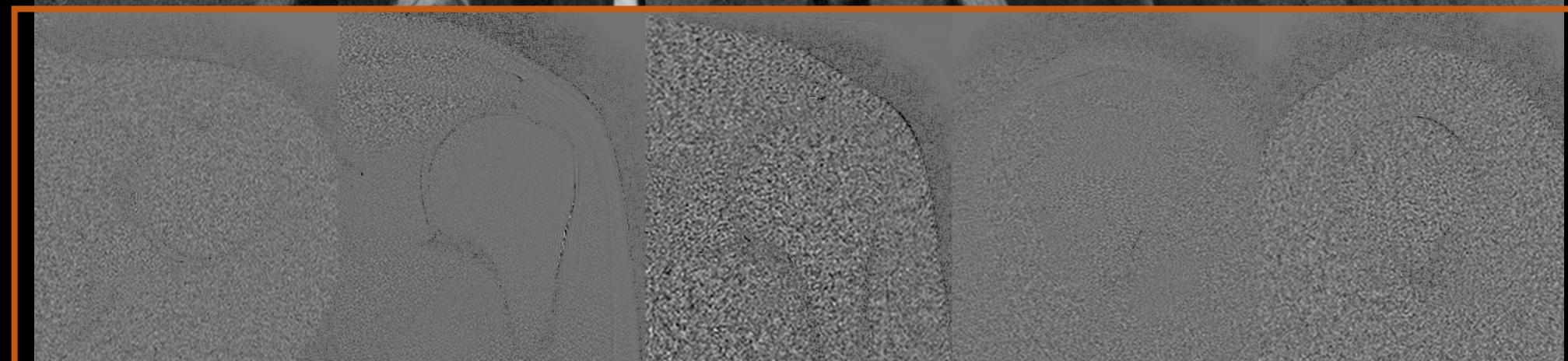
7.5-min
1-Average
with DLR

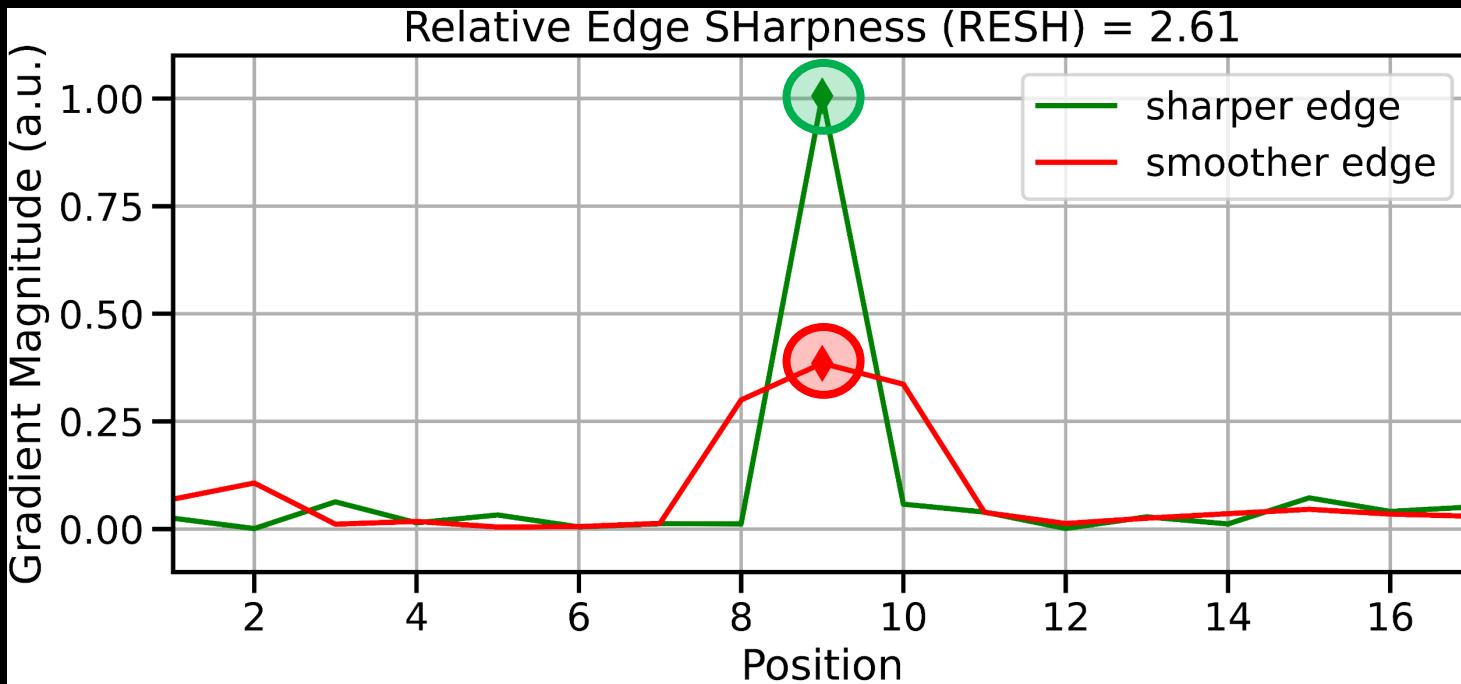
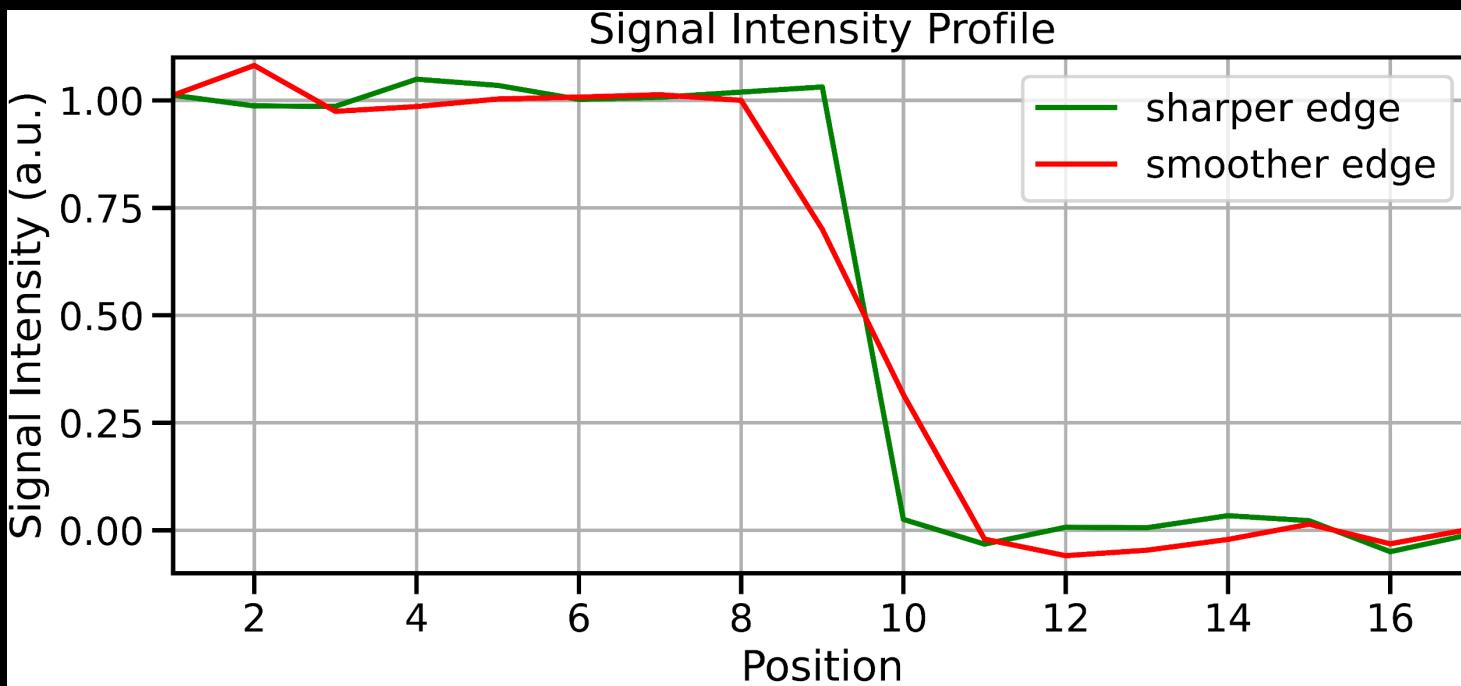


7.5-min
1-Average
w/o DLR



Differences





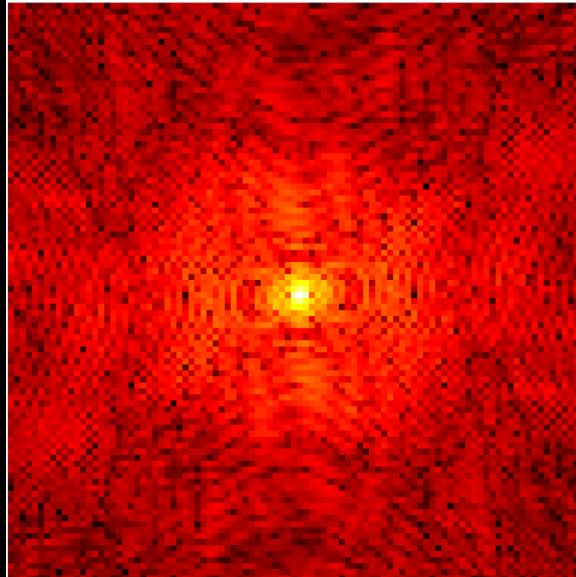
SENSE

*Sensitivity Encoding:
Parallel Imaging for
Cartesian k-space*

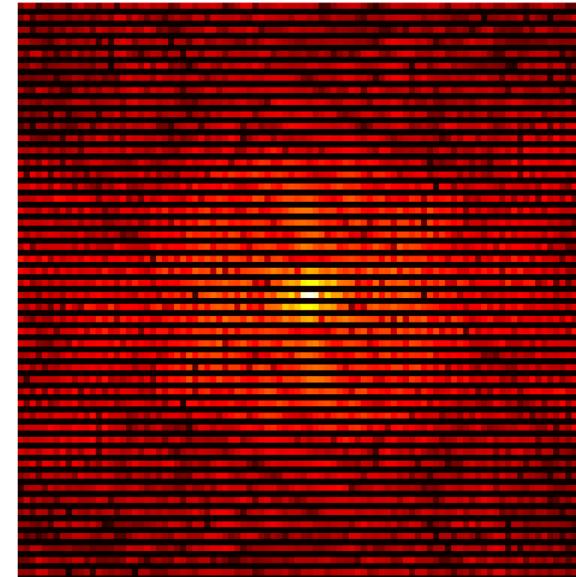
Cartesian
kspace

Cartesian
image space

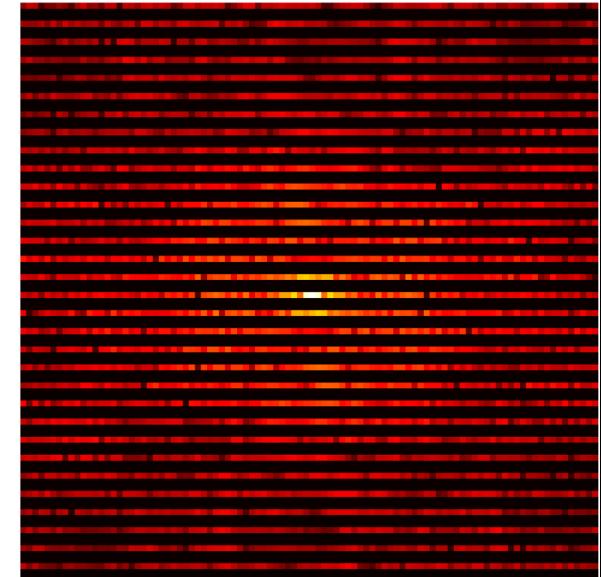
Acceleration: R=1



R=2



R=3



$$\frac{FOV}{2}$$

