RSNA 2022 | Empowering Patients and Partners in Care | 108th Scientific Assembly and Annual Meeting

Eleven-min Comprehensive MSK MRI using DLR & multi-echo UTE

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RSNA 2022, Chicago, November 27, 2022

Canon

RSNA® 2022
November 27 to December 1

Empowering *Patients and Partners* in Care

Declaration of Financial Interests or Relationships

Speaker Name: Hung P. Do, PhD MSEE
Company Name: Canon Medical Systems USA, Inc.
Type of Relationship: Employer

Purposes

Multi-echo Ultrashort Echo-Time (UTE) to image tissues with short T2*,
those were invisible in routine Fast-Spin-Echo (FSE) clinical images.

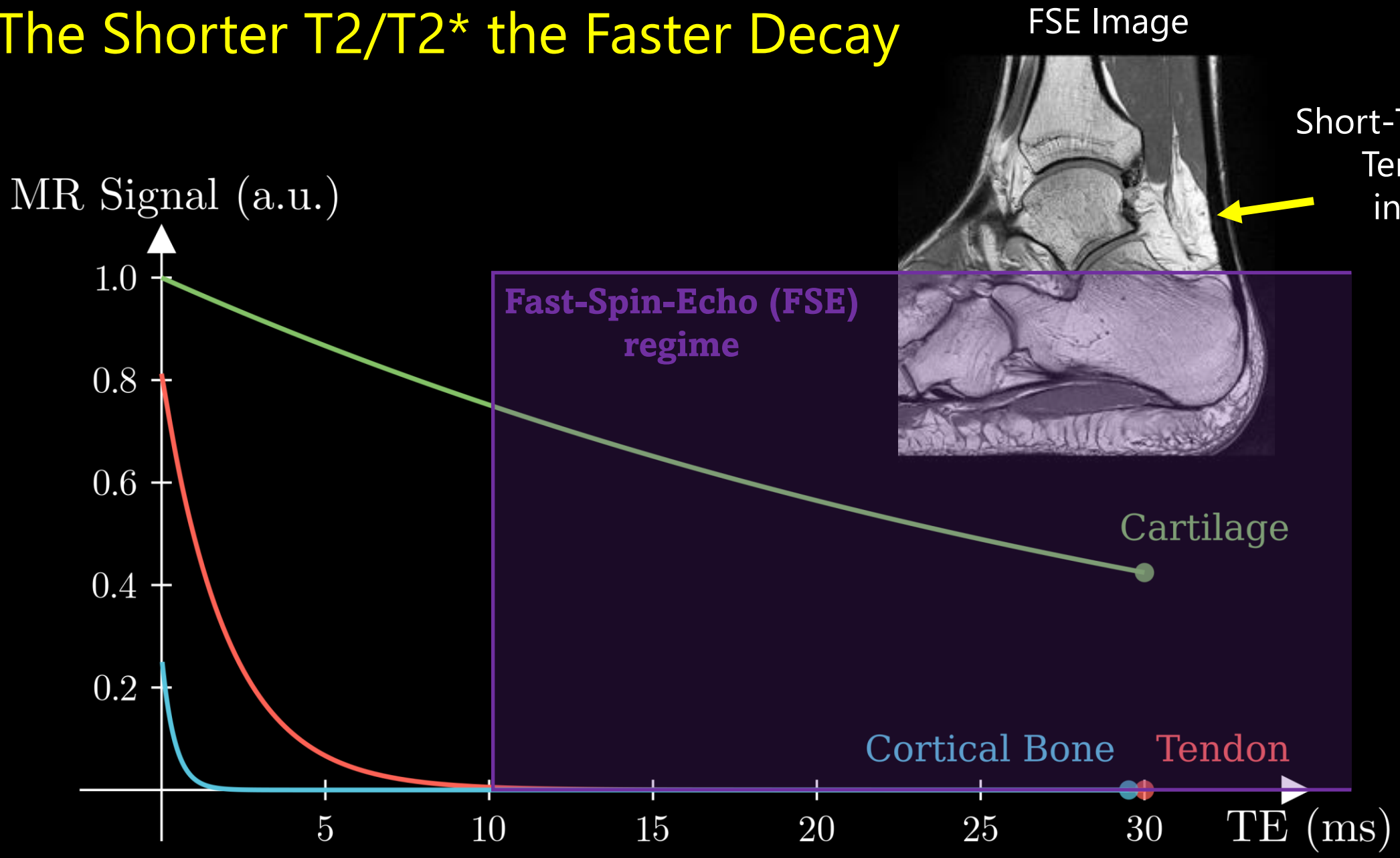
+

Deep Learning Denoising Reconstruction (DLR) to shorten the existing
FSE clinical protocol up to 2X without compromising image quality.

=

Comprehensive MSK MRI (FSE + multi-echo UTE)
without an increase in total scan time.

The Shorter T2/T2* the Faster Decay



PUBLICATIONS

Patient Education Publications

PDQ® +

Fact Sheets

NCI Dictionaries

Dictionary of Cancer Terms

Drug Dictionary

musculoskeletal

(MUS-kyoo-loh-SKEH-leh-tul)

Having to do with muscles, bones, tendons, ligaments, joints, and cartilage.

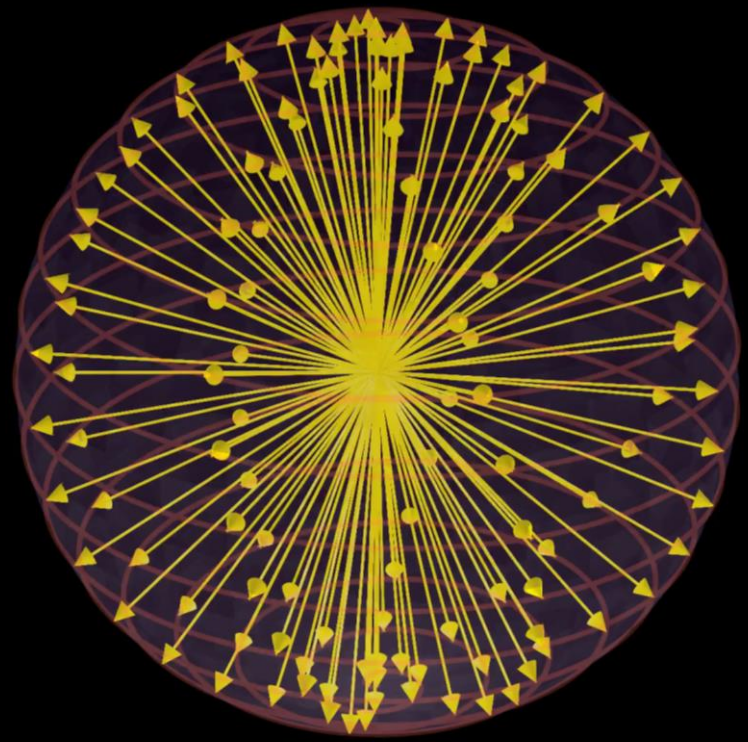
More Information

Cancers by Body Location/System: Musculoskeletal

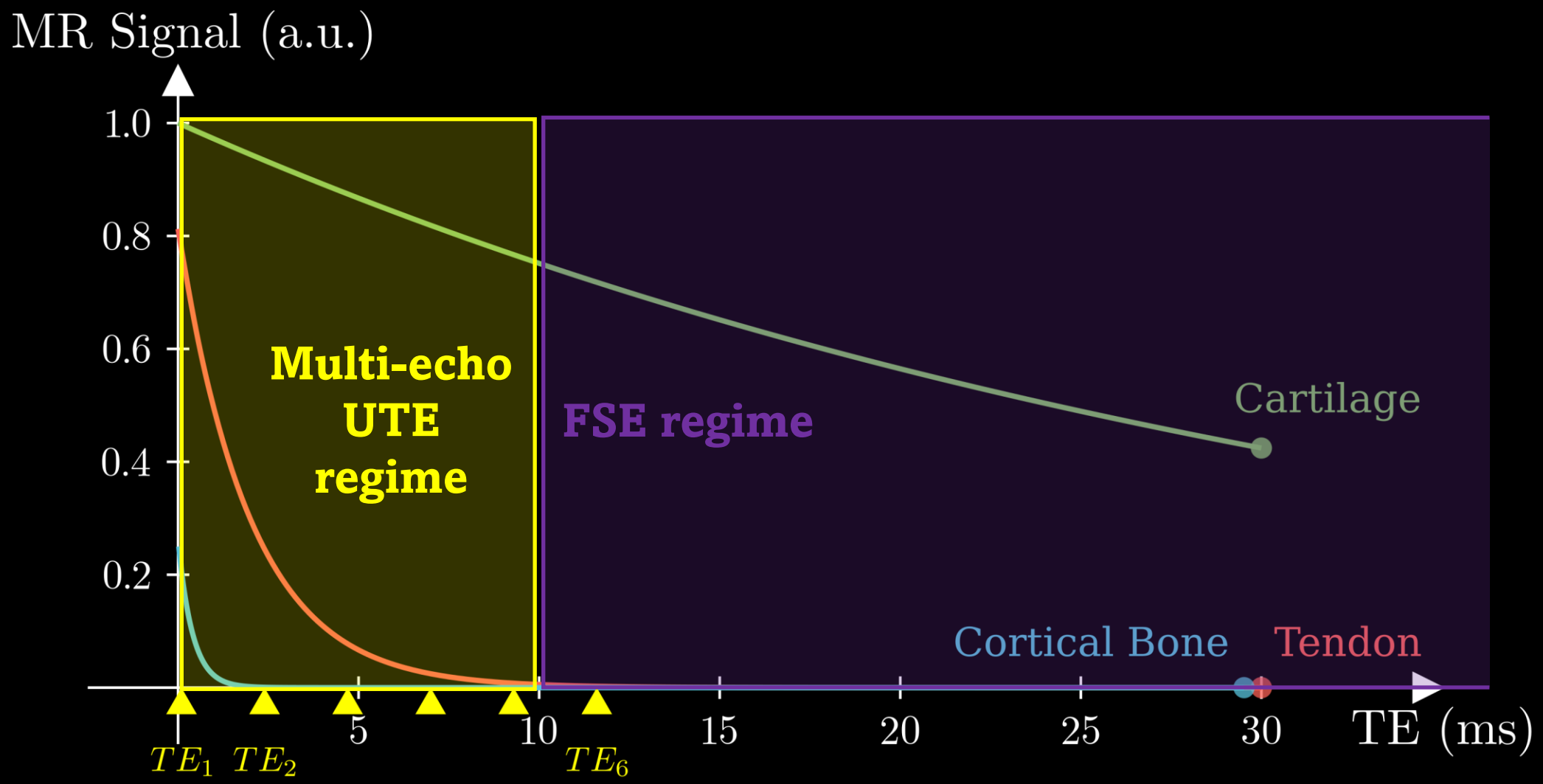
Search NCI's Dictionary of Cancer Terms

3D Center-out Radial Trajectories – Ultrashort Echo Time (UTE)

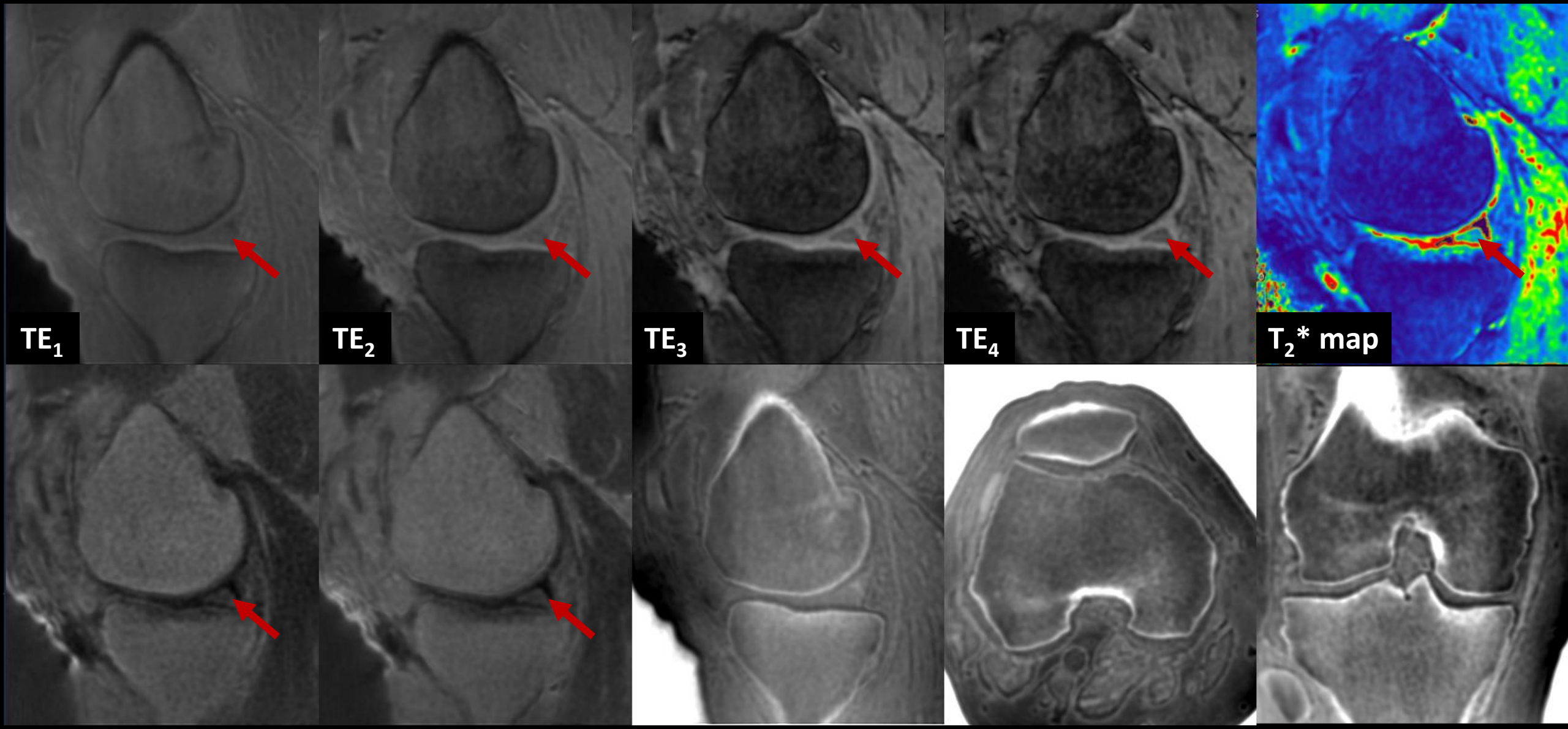
Minimum TE (TE_1) = 96μs



Multi-echo UTE



4-echo UTE – 0.8mm^3 3D isotropic – 4:46 min @3Tesla

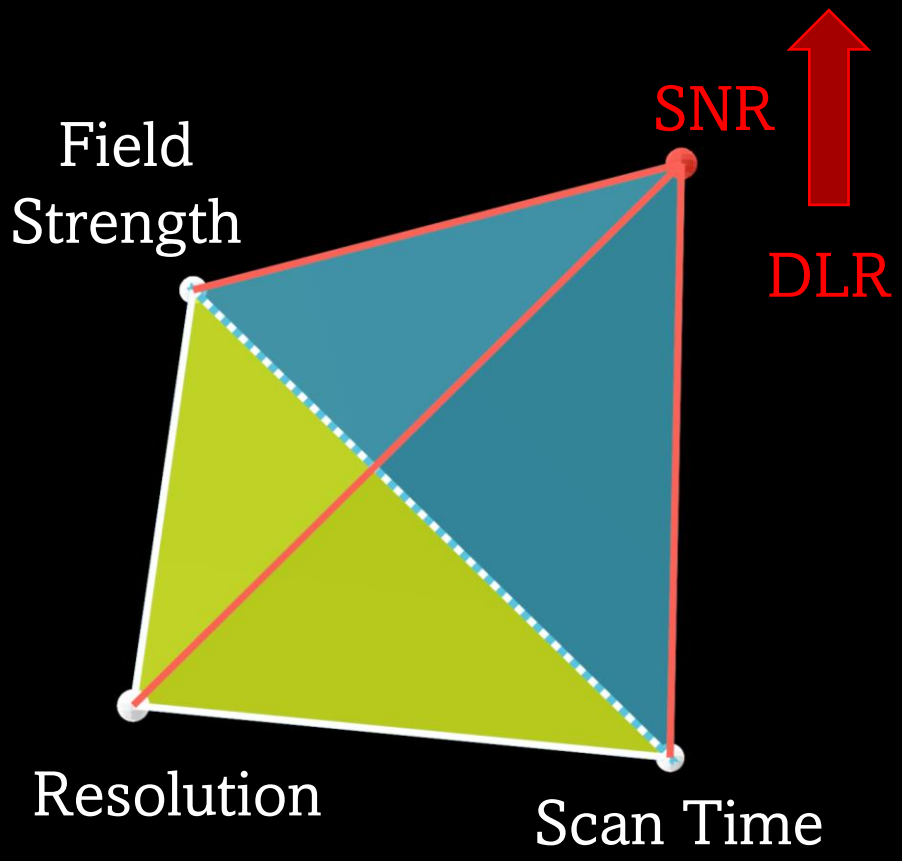


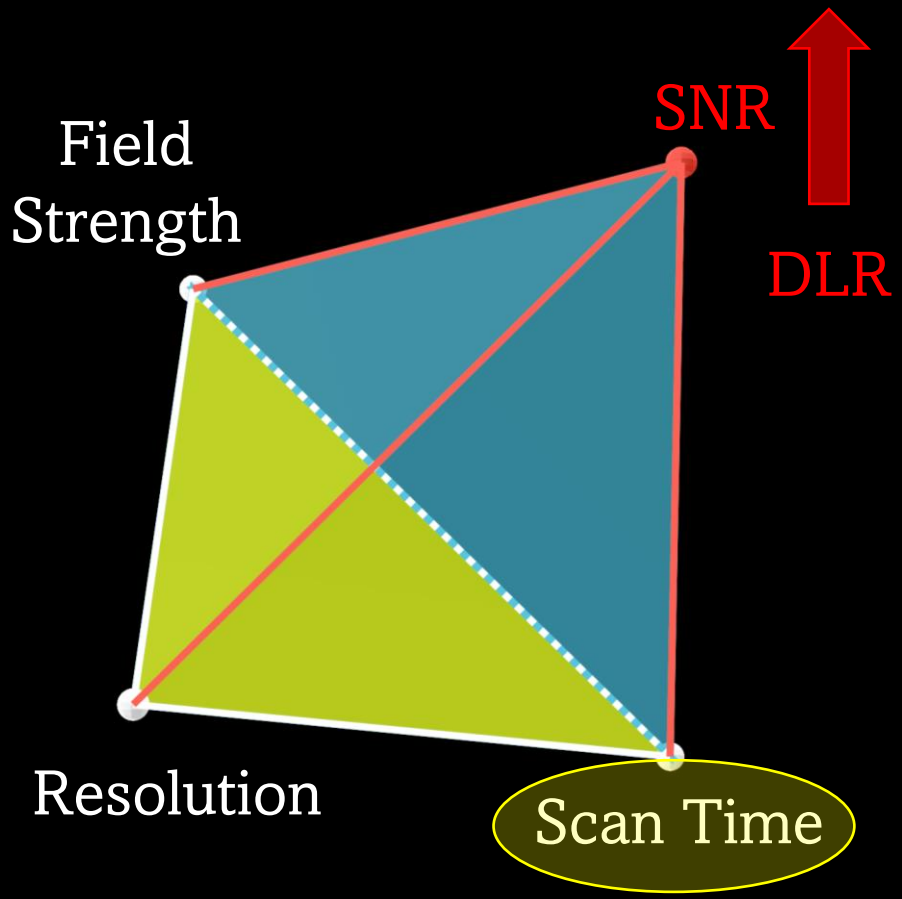
Shortening the clinical protocol using DLR

Deep Learning Denoising Reconstruction (DLR)

Alleviating the fundamental tradeoffs …

$$SNR = \frac{Signal}{Noise}$$





2 Averages (2NAQ)

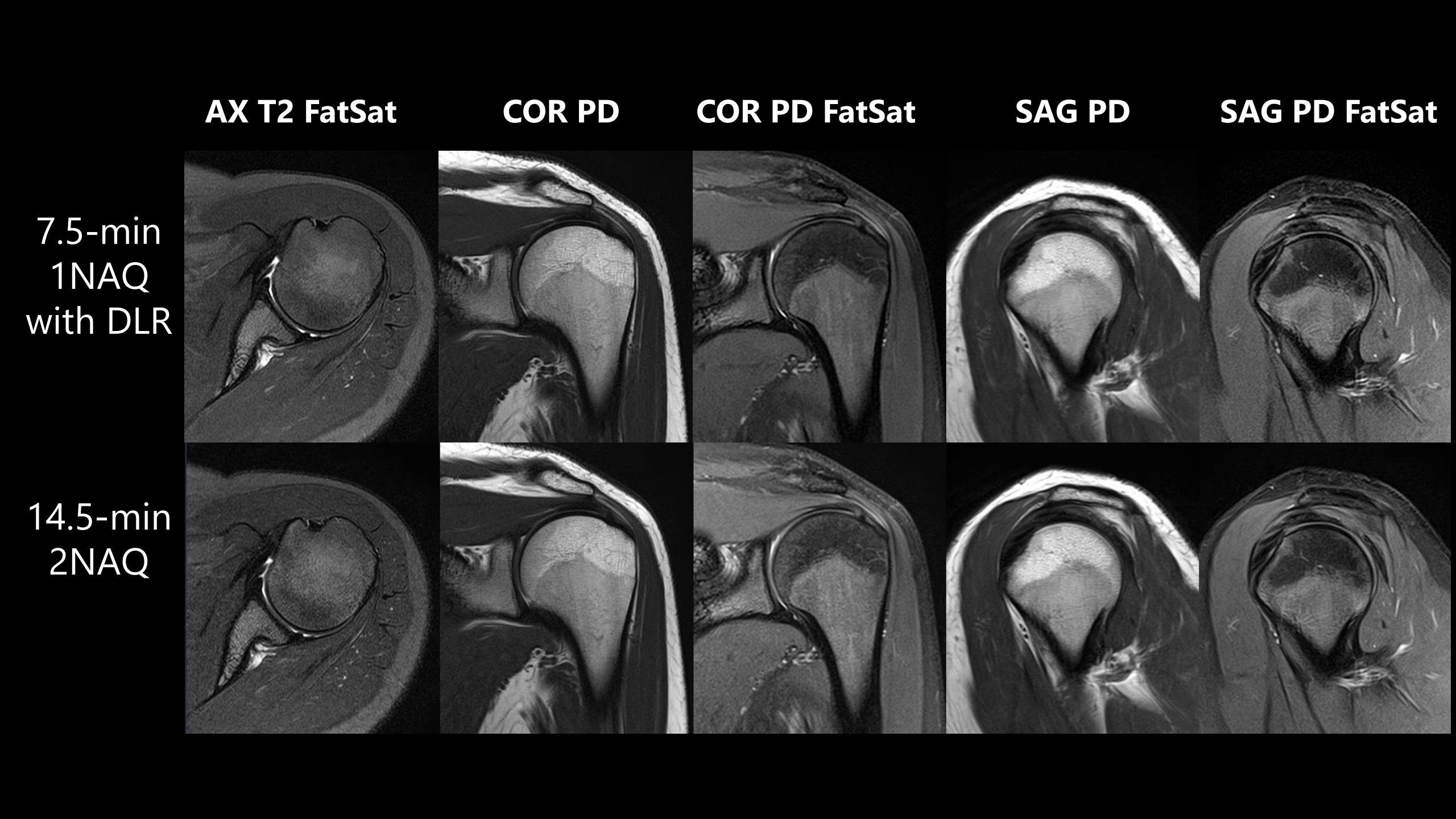
2X shorter time

1NAQ w/o DLR

DLR

1NAQ w/ DLR

How well DLR performs?

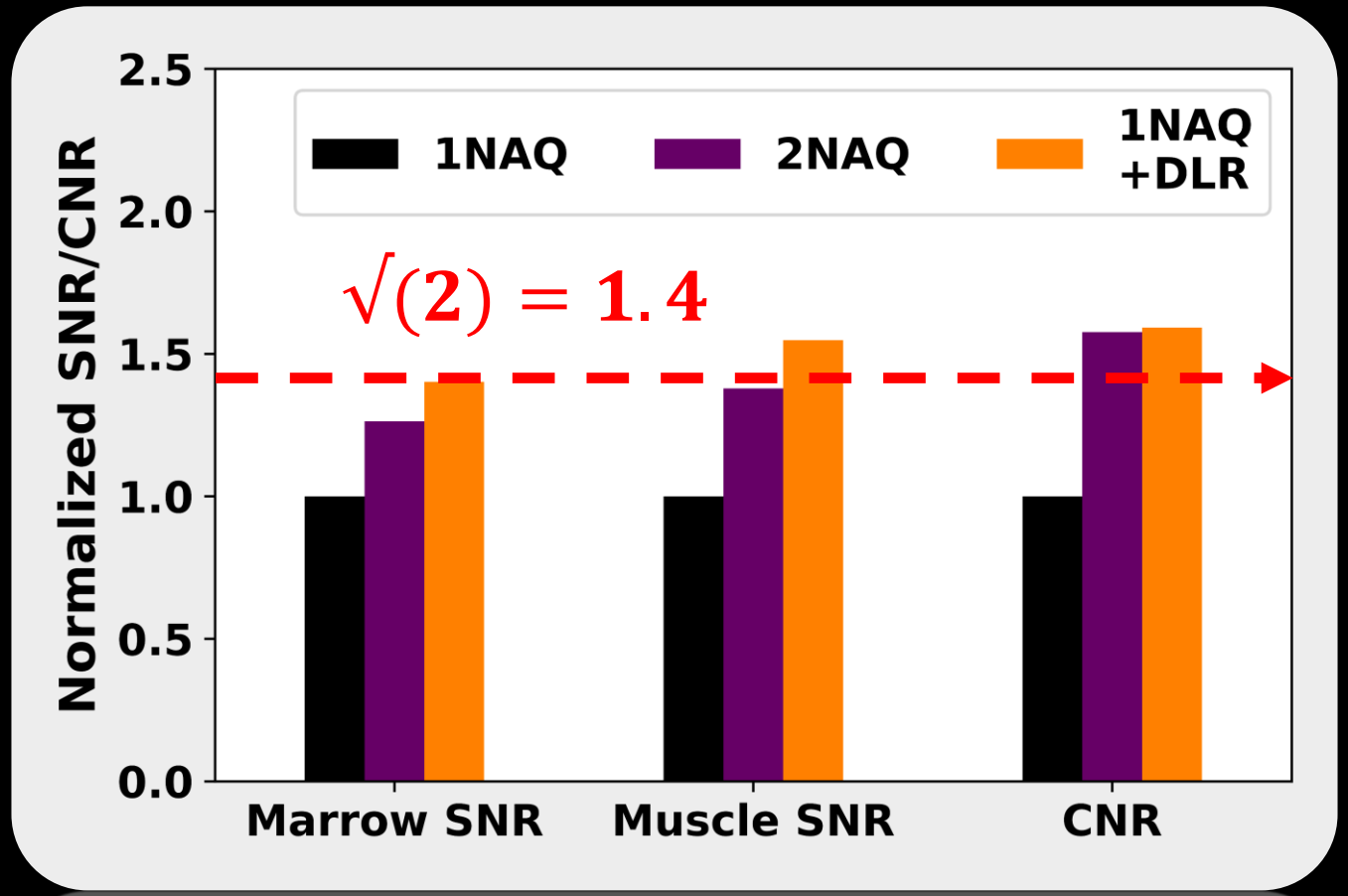

AX T2 FatSat
COR PD
COR PD FatSat
SAG PD
SAG PD FatSat
7.5-min
1NAQ
with DLR
14.5-min
2NAQ

With DLR
(wDLR)

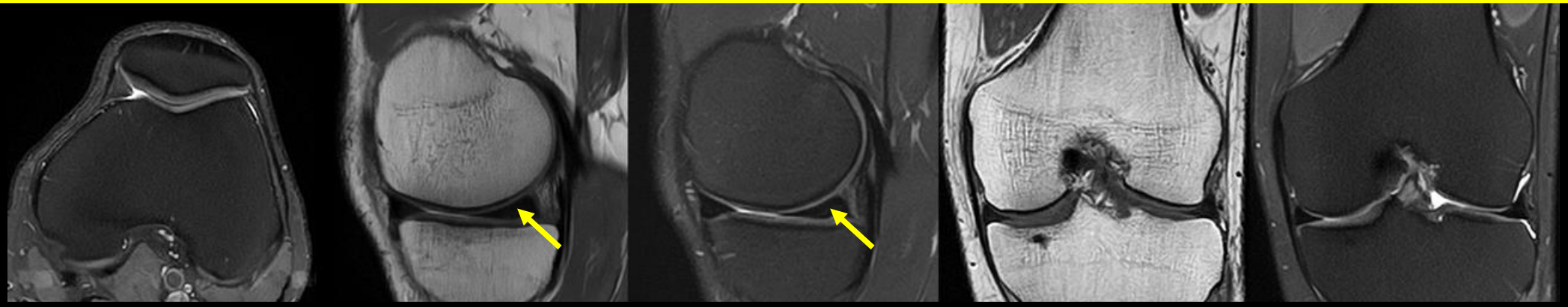
Without DLR
(w/oDLR)

Subtractions
wDLR - w/oDLR

Knee Data	Bone Marrow SNR	% Increase with DLR	Muscle SNR	% Increase with DLR	Bone Marrow to Muscle CNR	% Increase with DLR
5-min 1NAQ w/ DLR	9.91 ± 2.37		15.69 ± 5.64		11.99 ± 9.52	
5-min 1NAQ w/o DLR	7.07 ± 2.22	40.20%	10.20 ± 3.24	53.77%	7.53 ± 5.77	59.34%
10-min 2NAQ	8.93 ± 2.36	10.94%	14.60 ± 5.75	7.47%	11.87 ± 10.06	1.06%

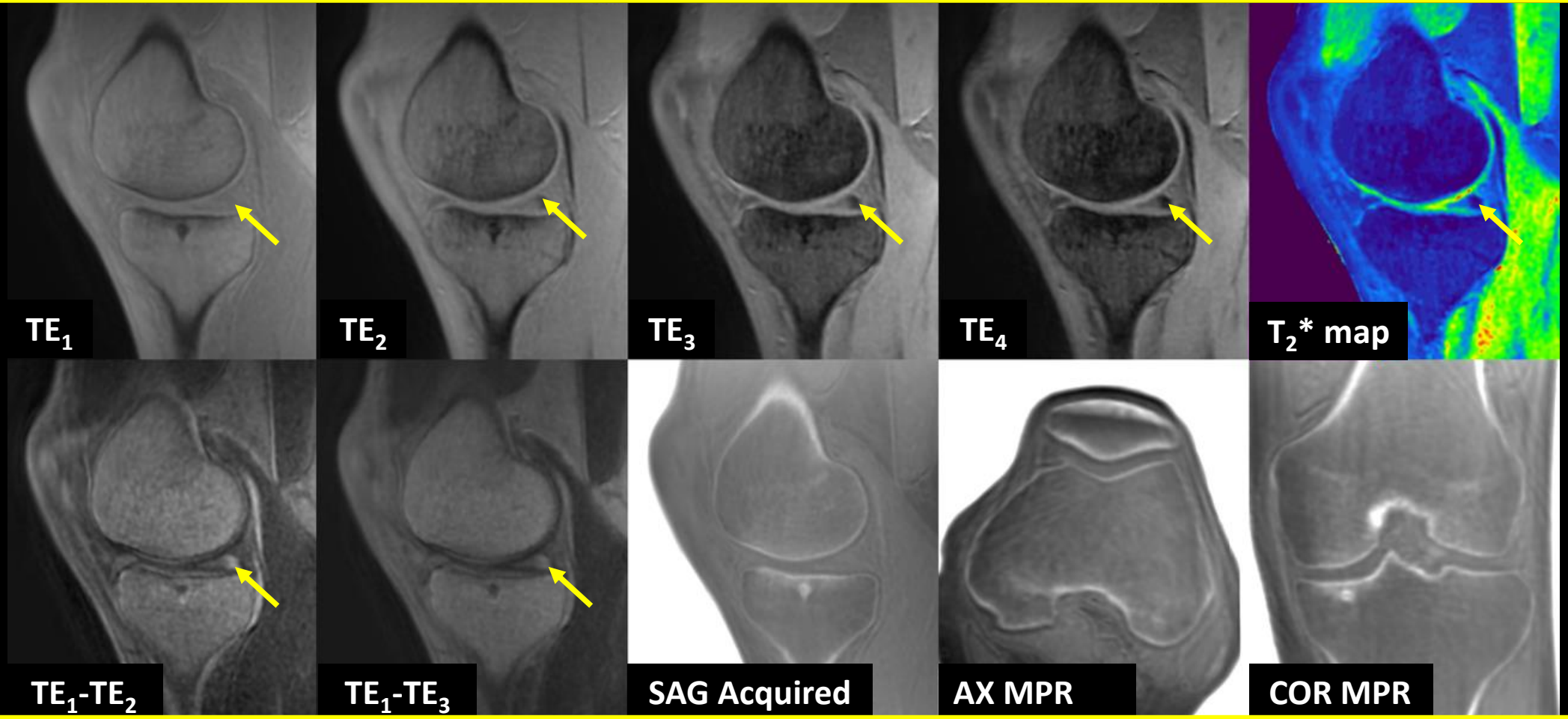


5-min
1NAQ
with DLR

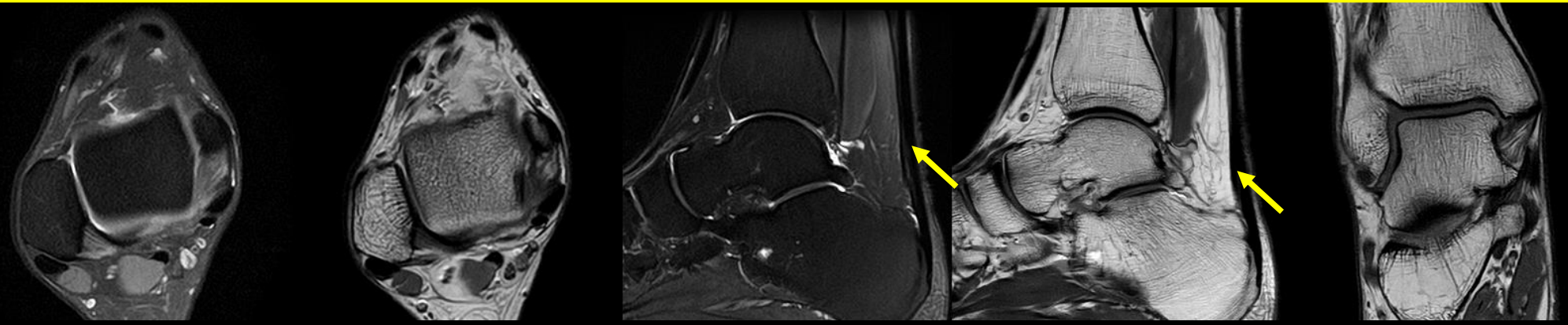


AX PD FS | SAG PD | SAG T2 FS | COR T1 | COR PD FS

6-min
m-echo
UTE

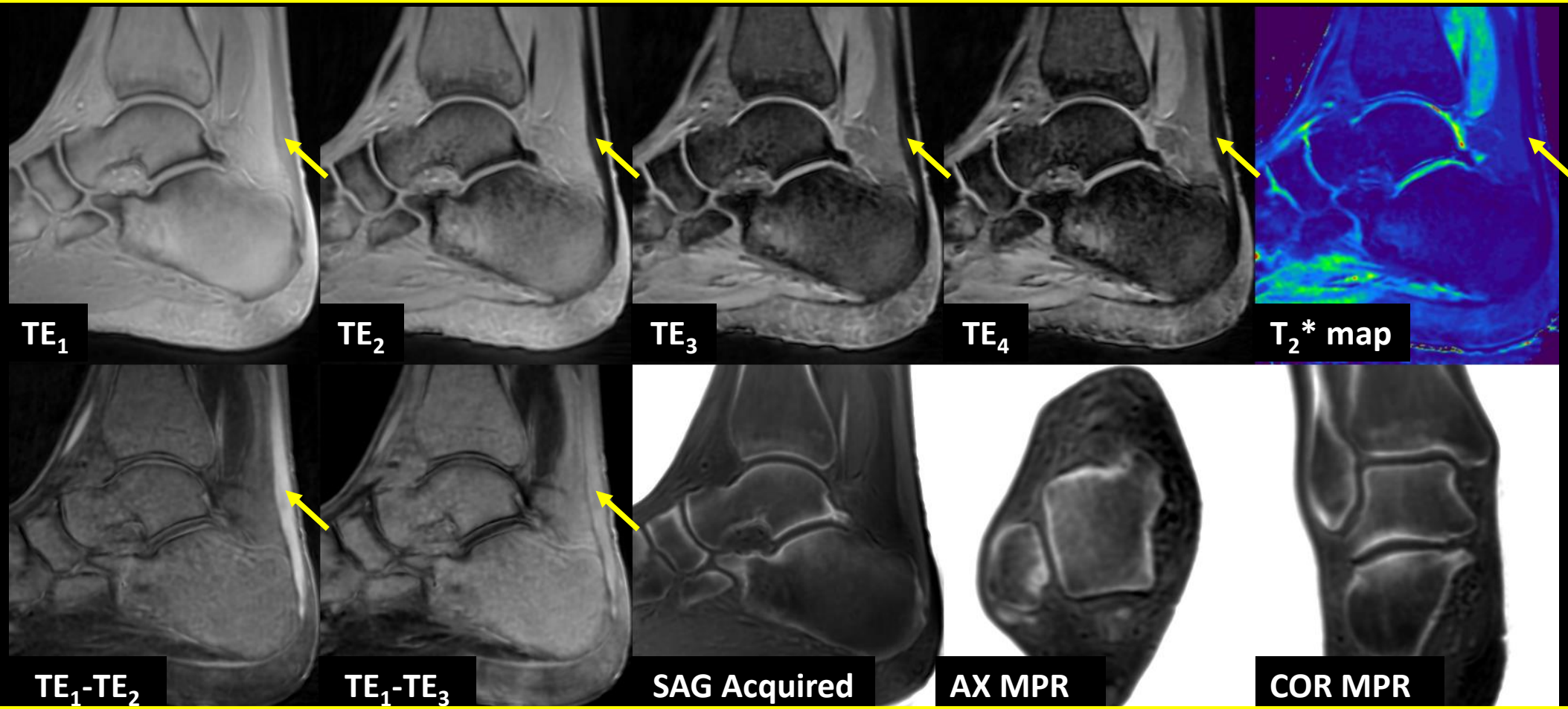


5-min
1NAQ
with DLR

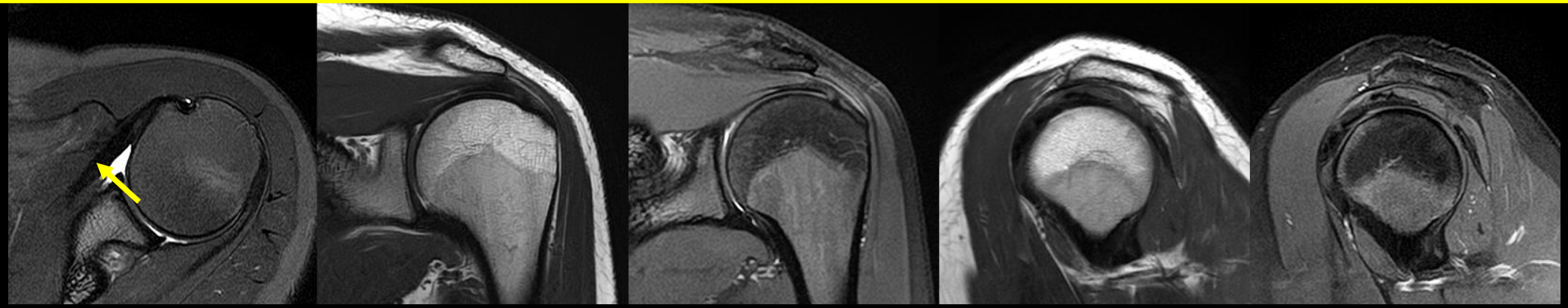


AX PD FS | AX PD | SAG T2 FS | SAG PD | COR T1

6-min
m-echo
UTE

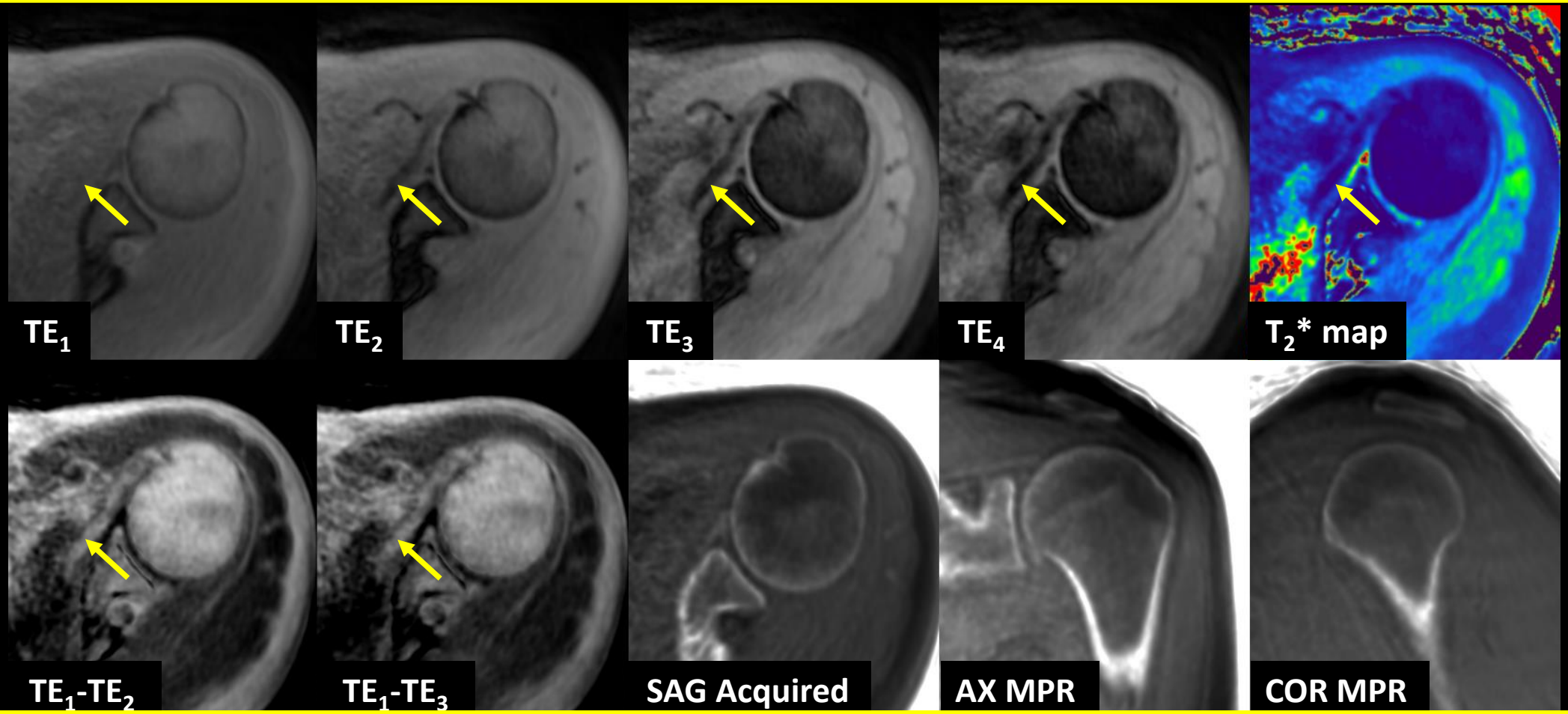


7.5-min 1NAQ with DLR



AX T2 FS | COR PD | COR PD FS | SAG PD | SAG PD FS

5-min m-echo UTE



Discussions

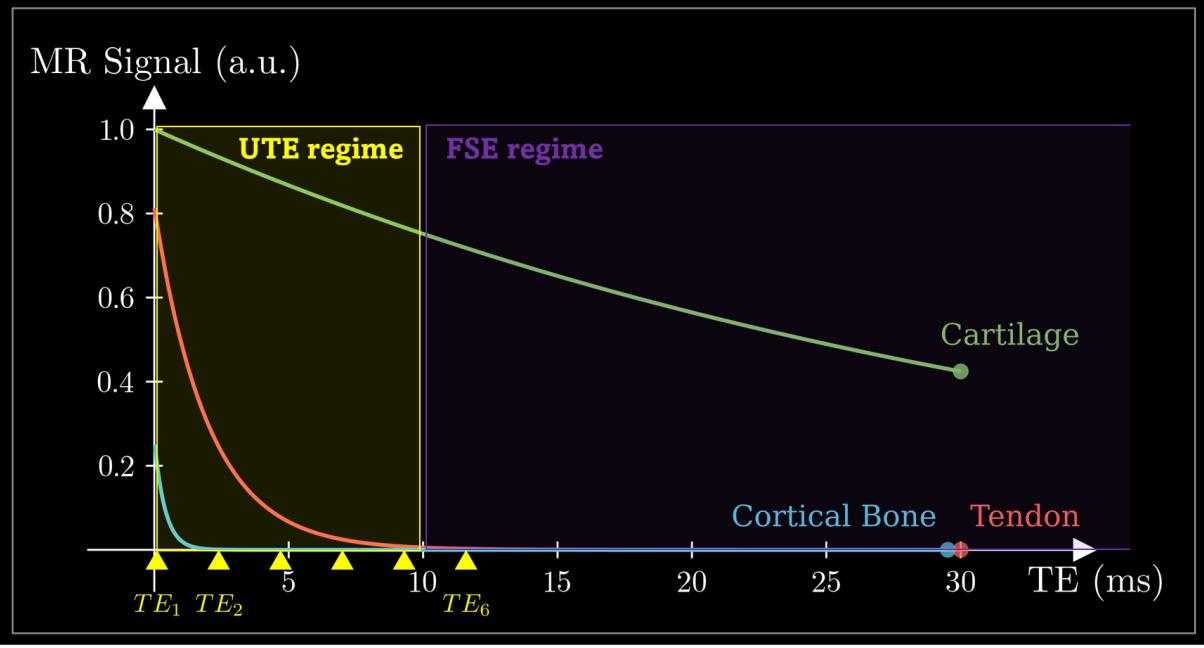
Limitations

- Healthy volunteers with a small sample size

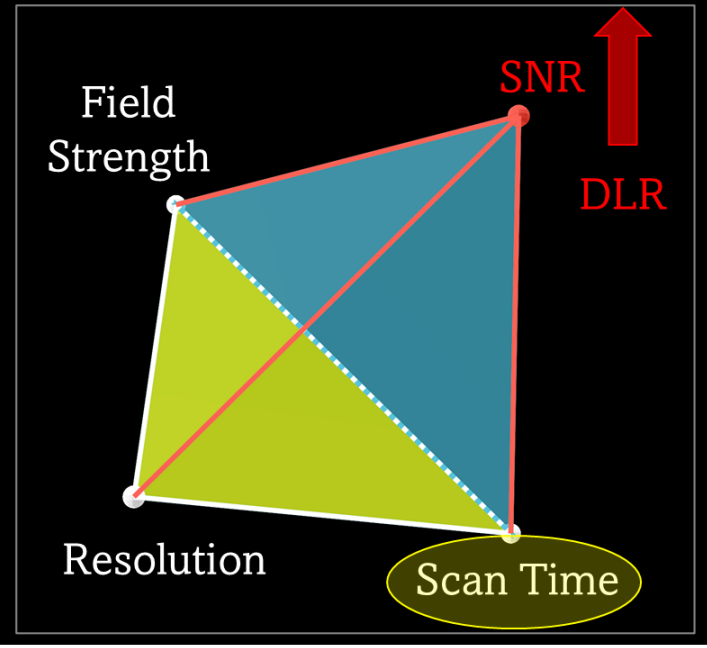
Future research directions

- Prospective clinical evaluation
- Using CS and DLR to shorten the scan time and/or increase the resolution of the UTE sequence

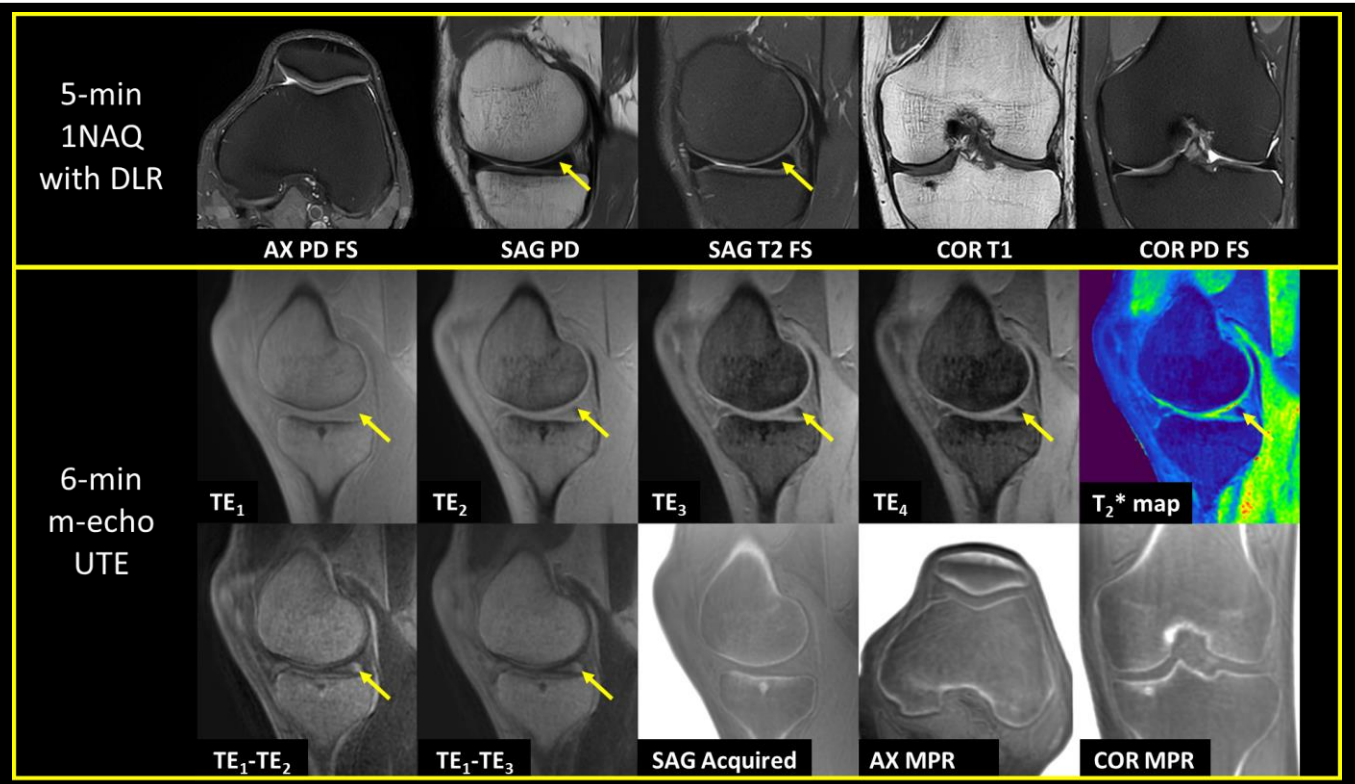
Summary


MR Signal (a.u.)
1.0
0.8
0.6
0.4
0.2
UTE regime
FSE regime
Cartilage
Cortical Bone
Tendon
5
10
15
20
25
30
TE (ms)
TE_1 TE_2
TE_6

+


Field Strength
SNR
DLR
Resolution
Scan Time

=


5-min 1NAQ with DLR
AX PD FS
SAG PD
SAG T2 FS
COR T1
COR PD FS
6-min m-echo UTE
TE_1
TE_2
TE_3
TE_4
T_2* map
TE_1-TE_2
TE_1-TE_3
SAG Acquired
AX MPR
COR MPR

"See the Unseeable[1]"

The first-ever image of a black hole.
(@M87 Galaxy)

Thank you!

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