#4309

Self-supervised IVIM parameter estimation with a physics based forward model

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Boston Children's Hospital
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Current limitations of IVIM parameter estimation

- Intravoxel incoherent motion model (IVIM) is estimated from DWI signal

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- Voxelwise NNLS based methods are already very sensitive to noise
- No “ground truth” for *supervised* neural network training

Current remedies to ill-posedness of IVIM estimates

- Spatially constrained methods [1]

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- Unsupervised (synthetic) voxelwise neural networks [3]

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[3] Barbieri et al. “Deep learning how to fit an intravoxel incoherent motion model to diffusion-weighted MRI”, MRM 2020

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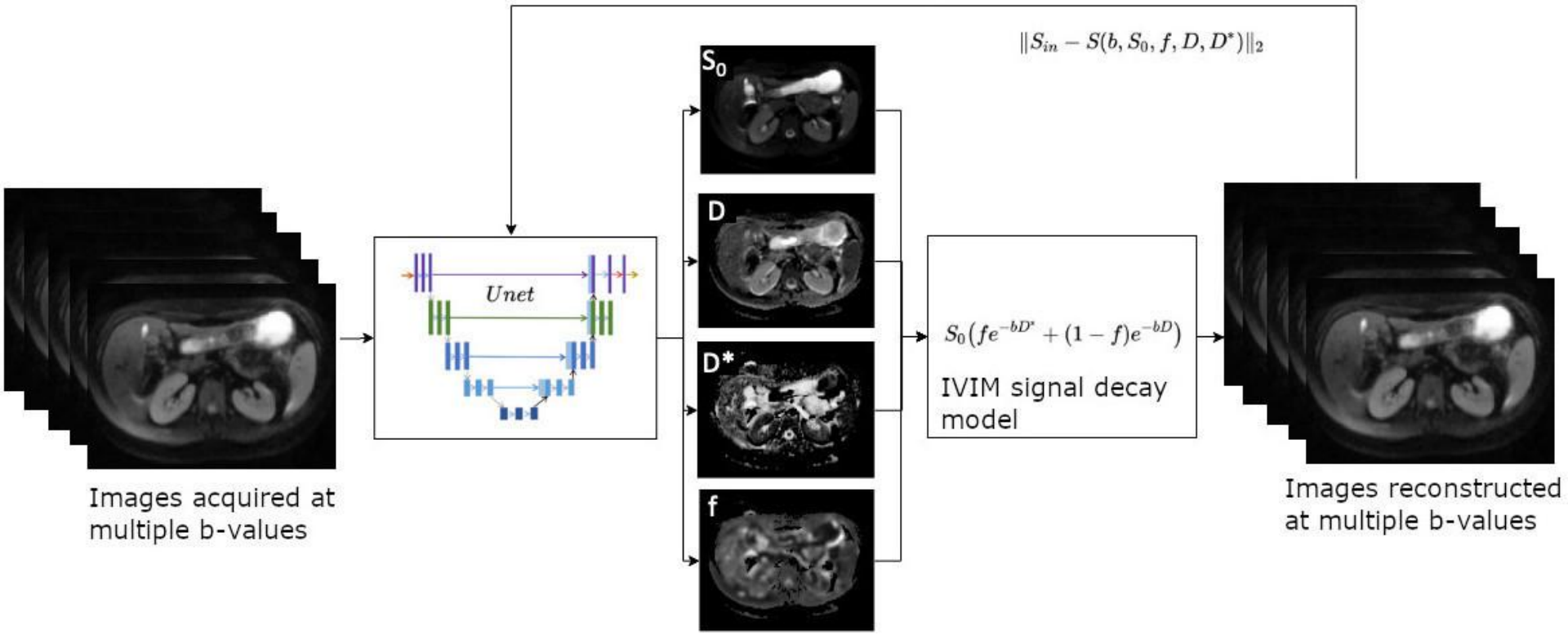
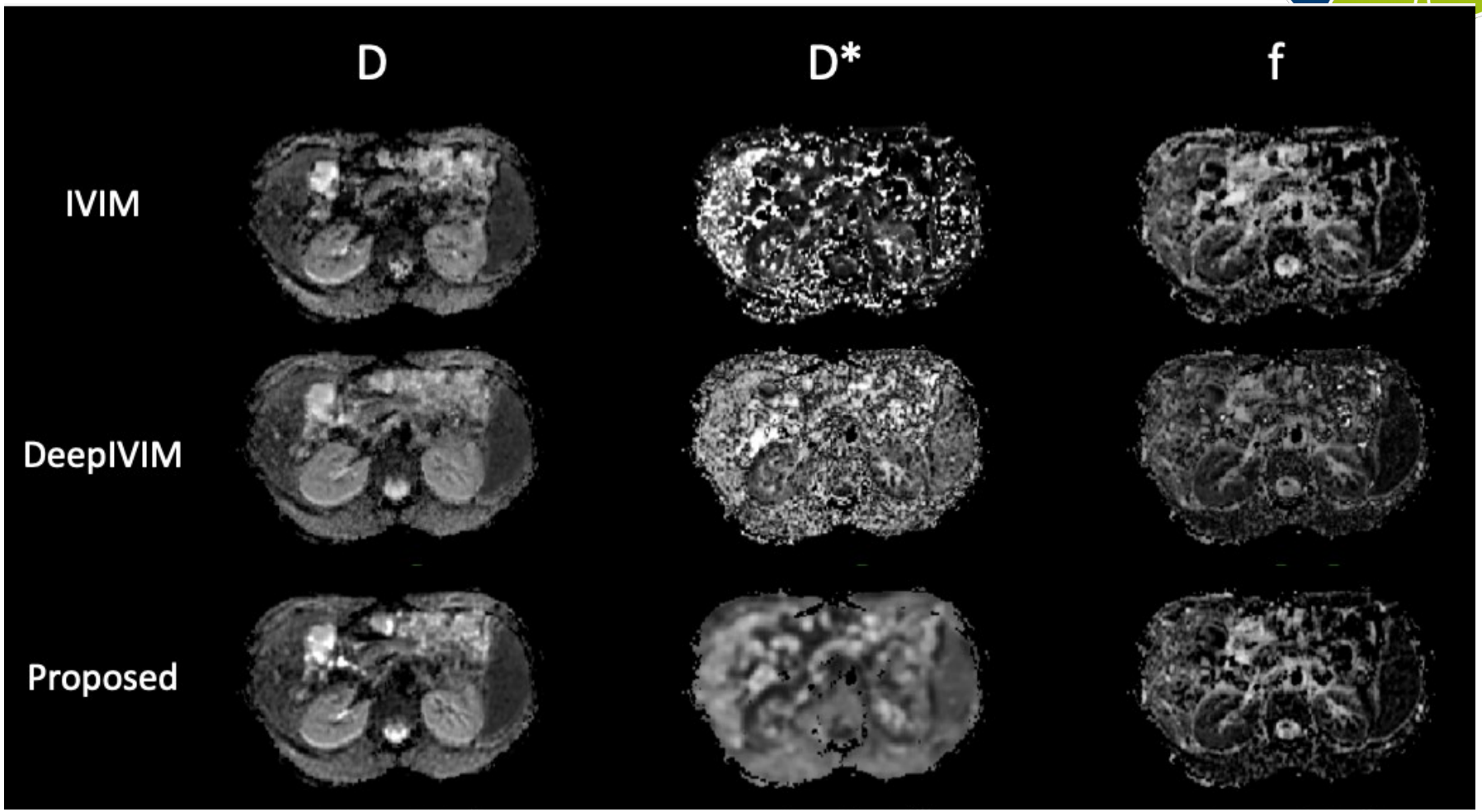


Data

- 84 pediatric Crohn's disease patients
- 7 b-values of [0,50,100,200,400,600,800] s/mm^2
- Geometrically averaged over 6 diffusion gradients

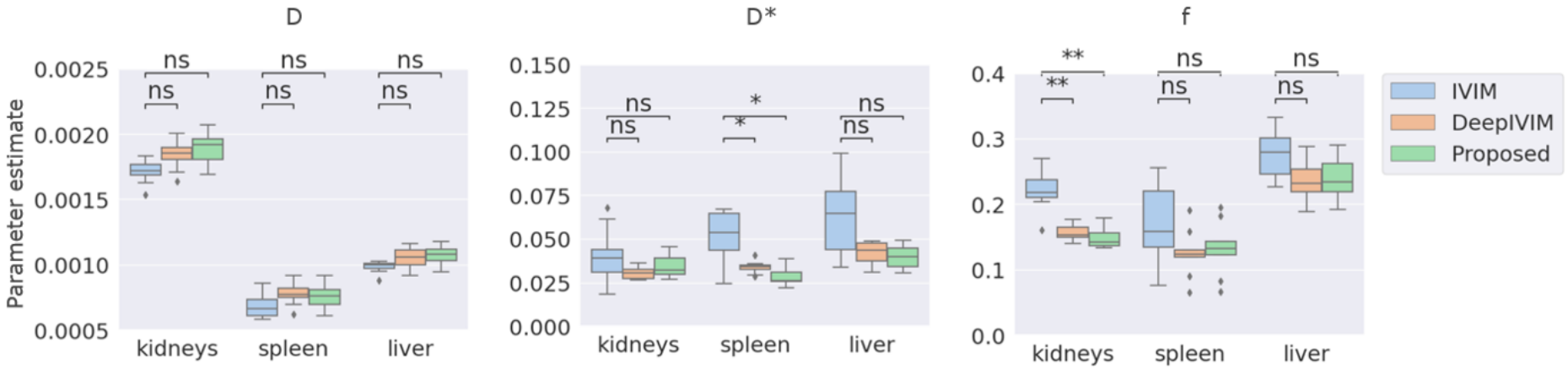
	DW-MRI
Type	ss EPI
FOV (mm^2)	300x260
Matrix	192x156
TR / TE (ms)	7500 / 77
Δz (mm)	5
Slices	36-44
NEX	1
Acq. Time (mins)	5.5

Evaluation on high SNR data



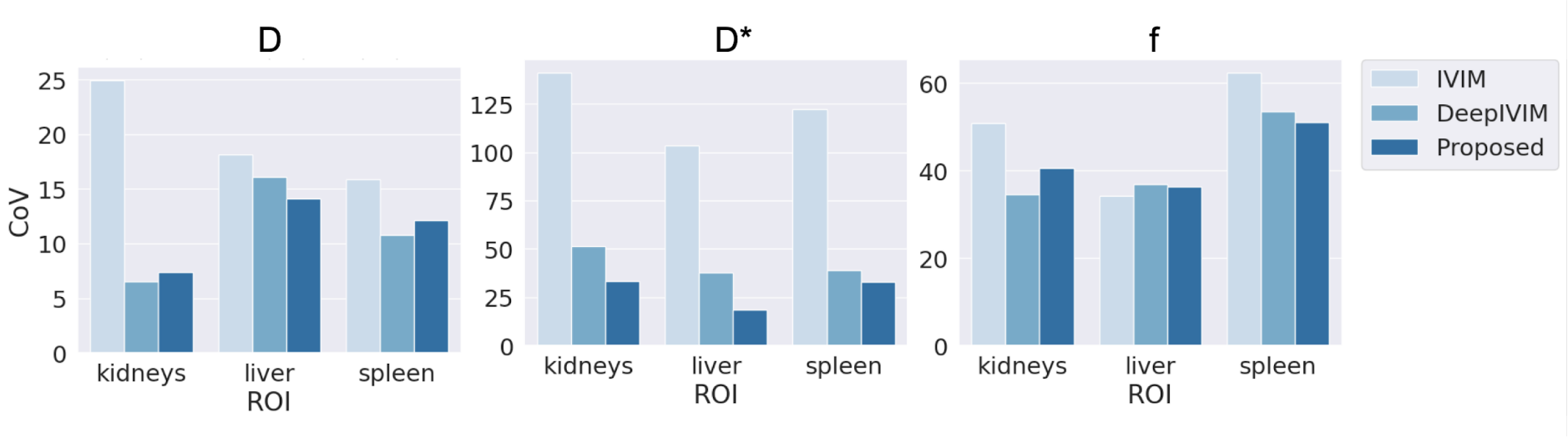
[IVIM] Powell et al. “The BOBYQA algorithm for bounded constrained optimization without derivatives.”, NA Report 2009
[DeepIVIM] Barbieri et al. “Deep learning how to fit an intravoxel incoherent motion model to diffusion-weighted MRI”, MRM 2020

Evaluation on high SNR data



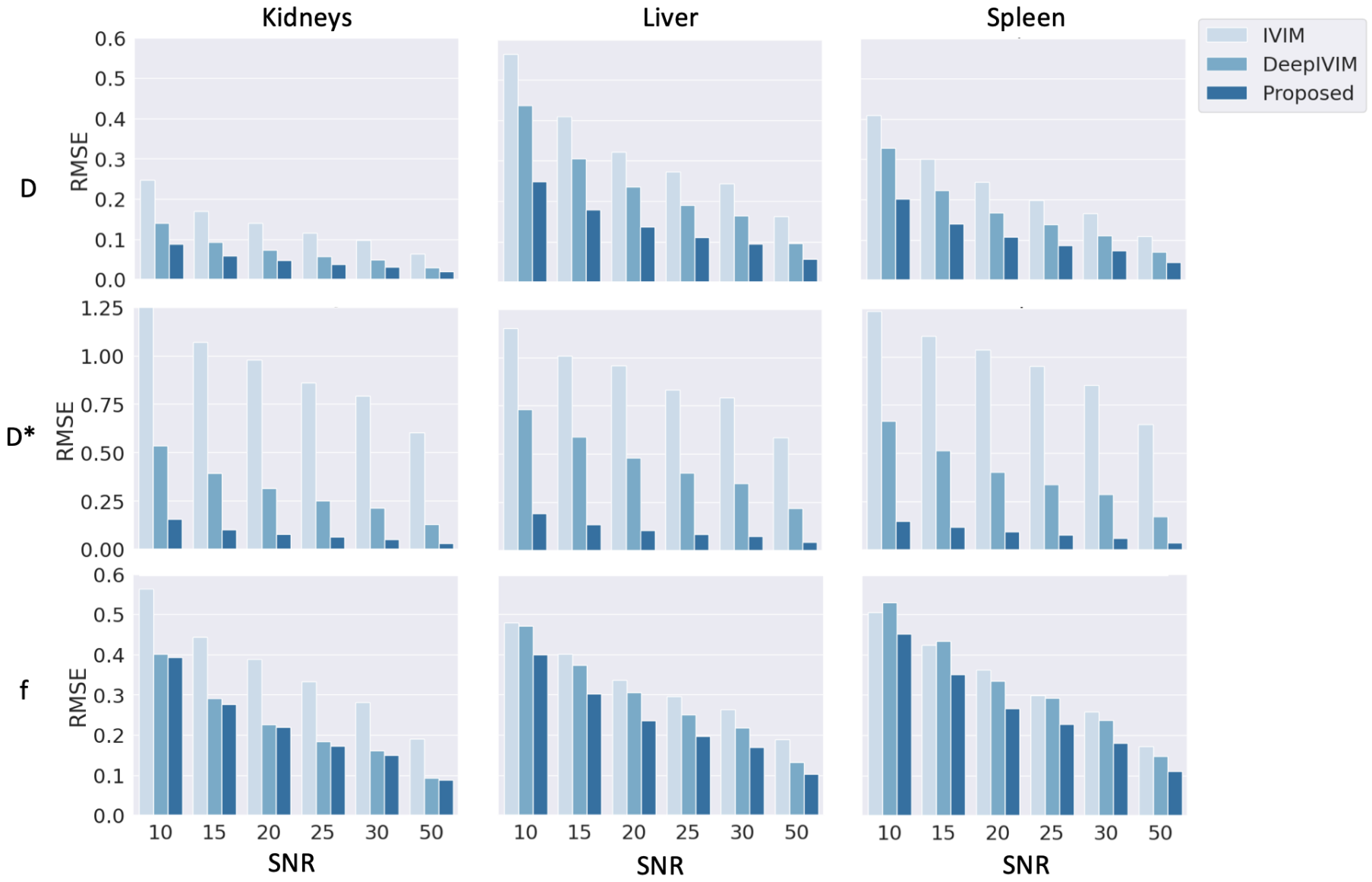
ns = non significant, * / ** = significant at 95% / 99% CI

Evaluation of repeatability on intrasession test-retest



- 6,4,4,3,3 repetitions for 5 healthy volunteers respectively
- 12 voxel ROI

Evaluation on data with decreasing SNR



Conclusions

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- A self-supervised 2D CNN for IVIM parameter estimation
- No ground truth NNLS estimates required
- Increased robustness to low SNR signal
- Enables investigation for reduction of diffusion gradients (& scan time)

Questions?

- serge@crl.med.harvard.edu
- Multicomponent models of diffusion, perfusion and relaxation - Wed 19 May, 19:00 UTC

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