

Highly accelerated quantitative MRI for discovery of novel AD biomarkers MPnRAGE meets INR reconstruction

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Introduction

- Current Alzheimer's disease diagnostics are either invasive or costly.
- Quantitative MRI offers a non-invasive and absolute route to detect early tissue microstructure changes.
- Long scan times currently limit quantitative MRI use in neuroimaging protocols for dementia patients.
- We develop a fast MPnRAGE¹ acquisition and reconstruction framework for clinically feasible quantitative T1 mapping and multiple inversion time (TI) contrast images.

Methods

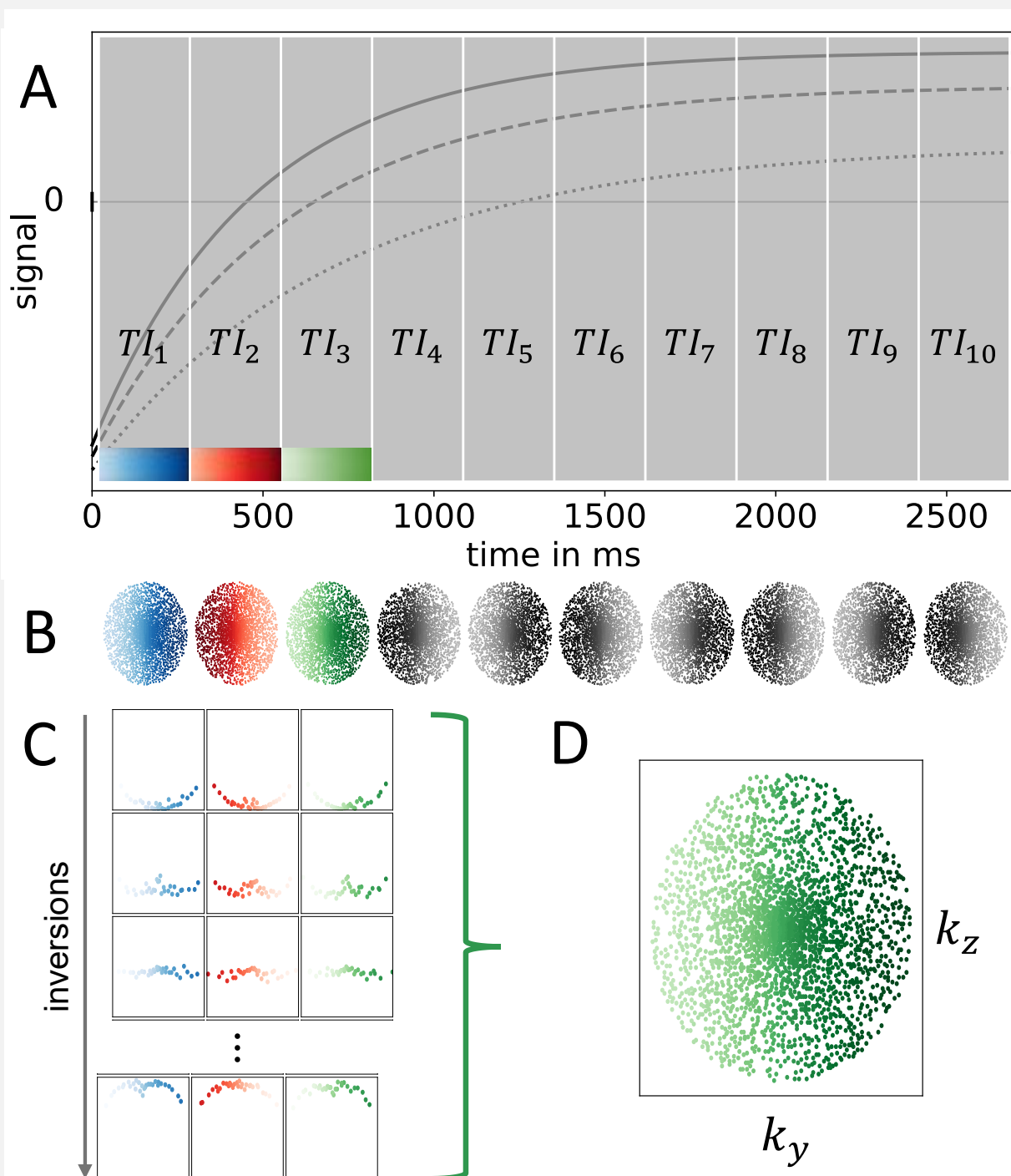
MRI Acquisition:

- MPnRAGE contrast images differ in contrast but share anatomical information.
- Complementary undersampling is applied across inversion-time contrasts to leverage this redundant anatomical information.
- Central k-space is densely sampled to preserve contrast information. Outer k-space is sampled using complementary Poisson disk patterns.

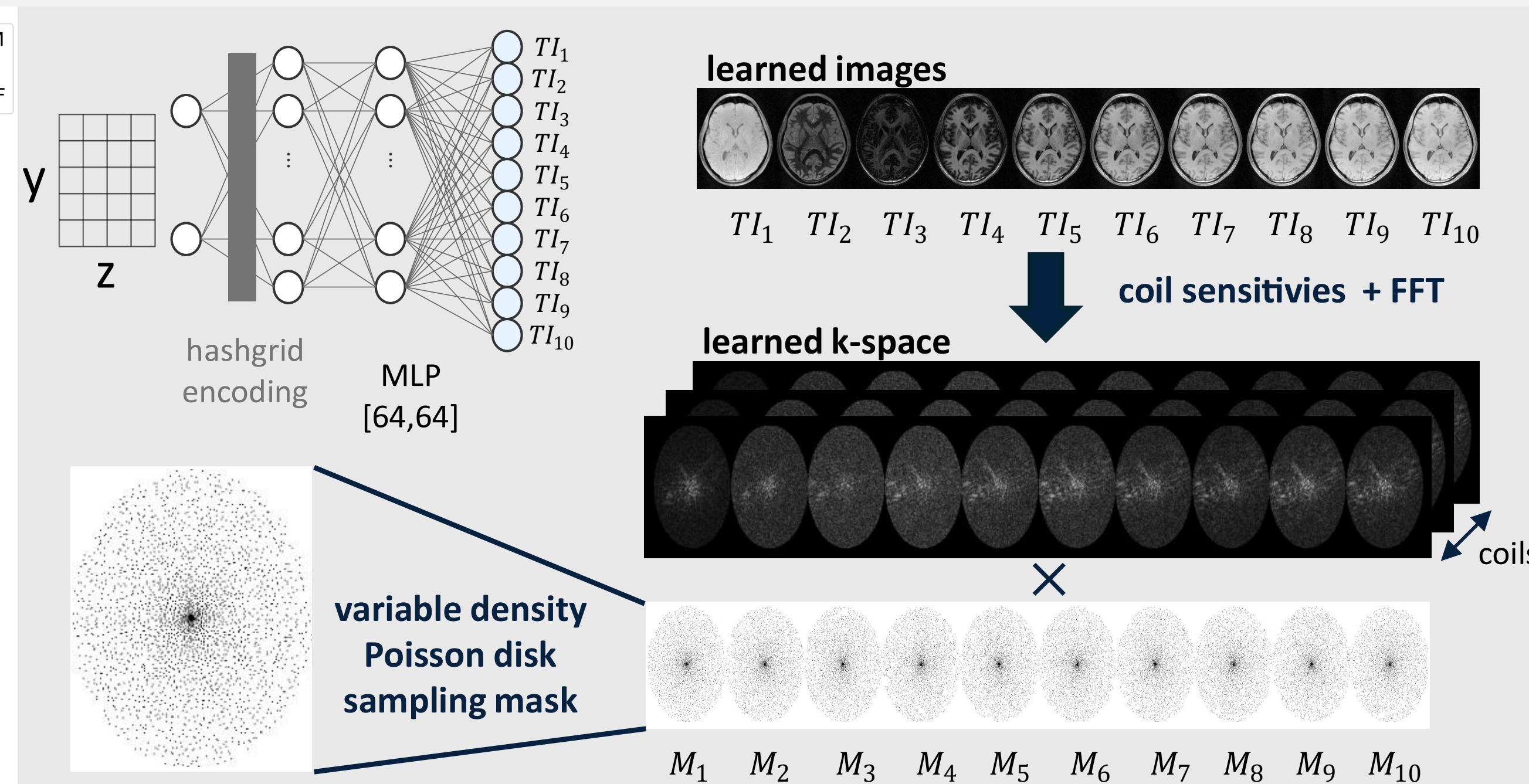
Reconstruction:

- Complementary data are jointly reconstructed using an implicit neural representation (INR) network which is self-supervised and scan-specific not needing any training data.

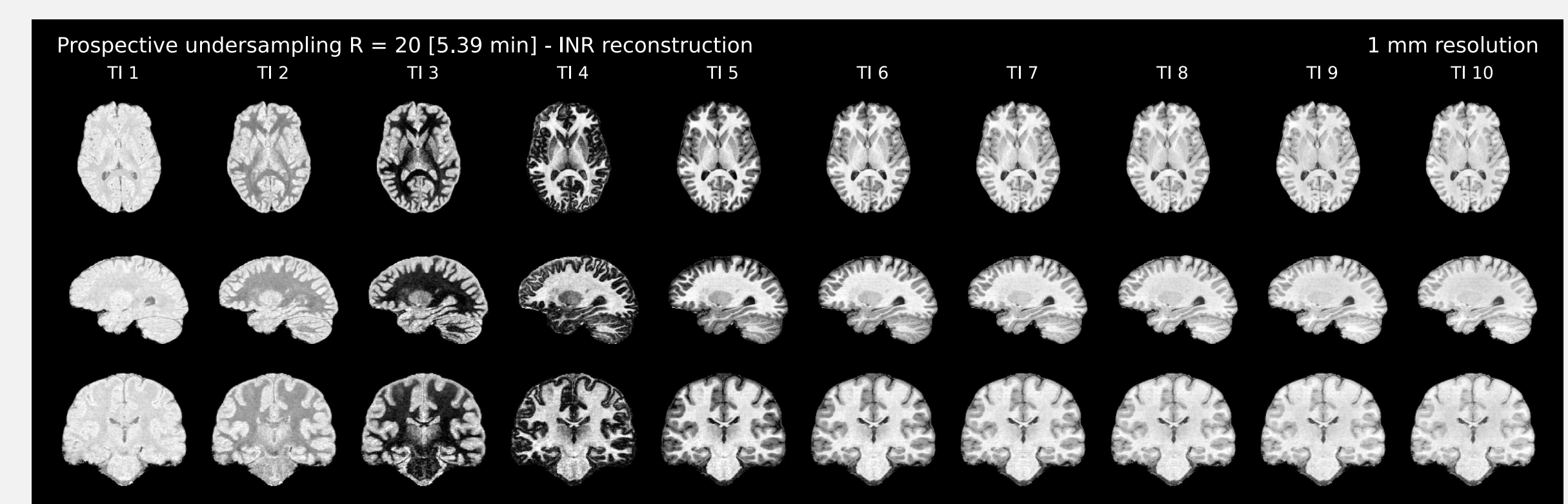
Complementary undersampling



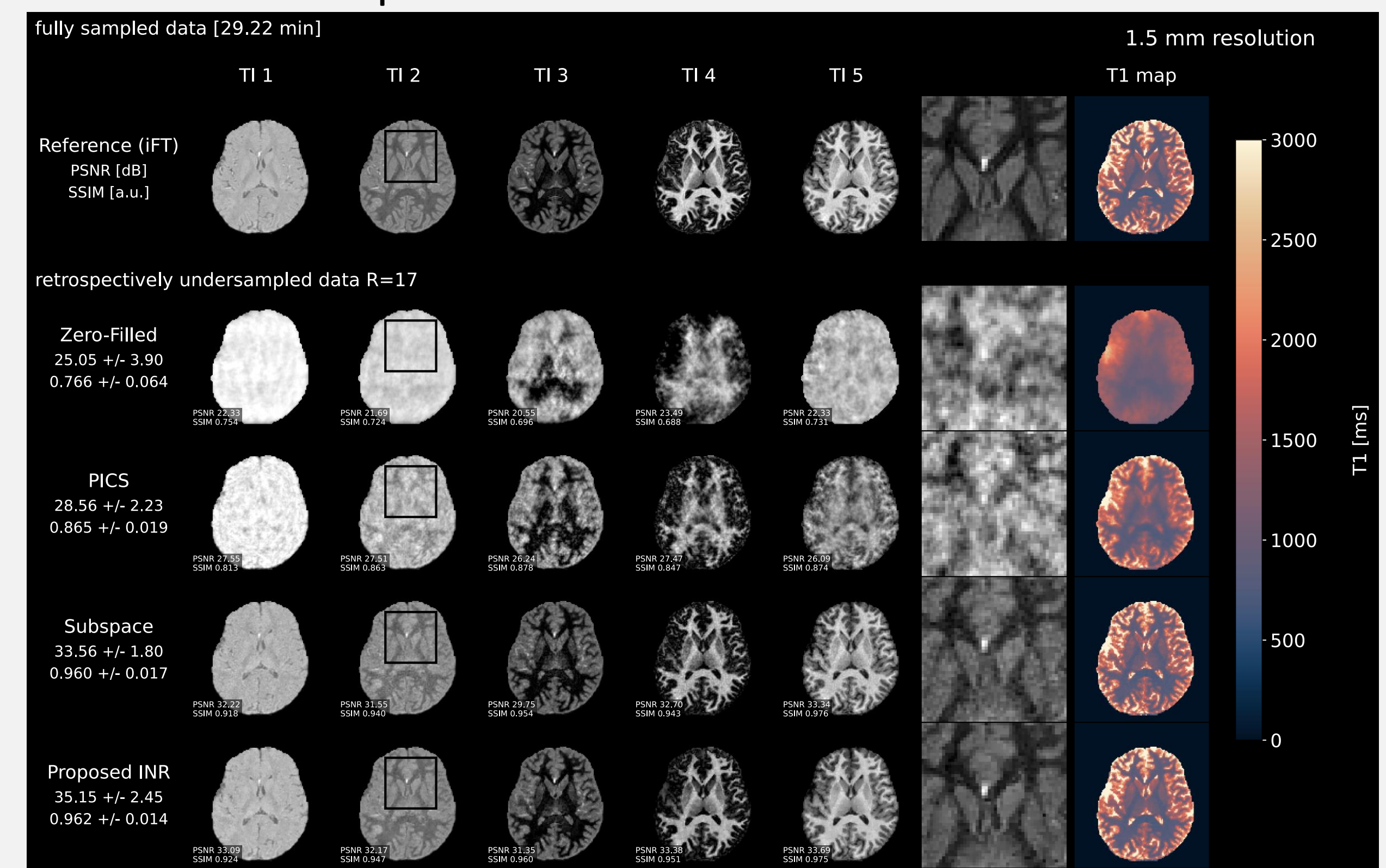
Joint INR reconstruction



Results



Scan time was reduced from 29.22 min to 5.39 min for 10 TI images at 1.5 mm isotropic resolution.



Conclusion

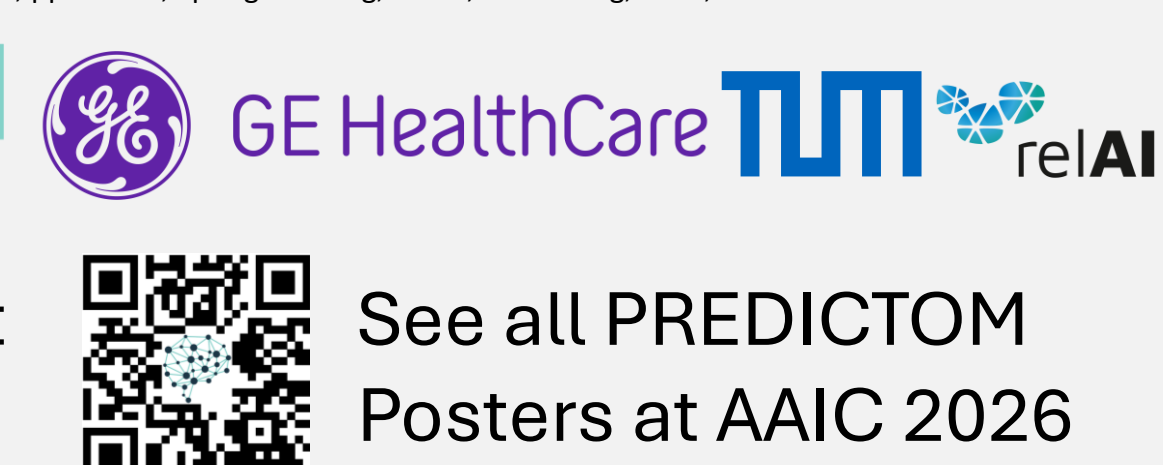
MPnRAGE is included in the advanced PREDICTOM MRI protocol and can be leveraged for future MRI biomarker discovery for early Alzheimer's disease detection.

References

1. MPnRAGE: A technique to simultaneously acquire hundreds of differently contrasted MPnRAGE images with applications to quantitative T1 mapping. Kecskei S, Samsonov A, Hurley SA, Dean DC, Field A, Alexander AL. Magn Reson Med. 2016 Mar;75(3):1040-53.
2. INR Meets Multi-contrast MRI Reconstruction. Niessen N, Pirkel CM, Solana AB, Eichhorn H, Spieker V, Huang W, Sprenger T, Menzel MI, Schnabel JA, s.l.: Reconstruction and Imaging Motion Estimation, and Graphs in Biomedical Image Analysis: First International Workshop, RIME 2025, and 7th International Workshop, GRAIL 2025, pp. 23-33. Springer-Verlag, Berlin, Heidelberg, 2025, 2025.



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