

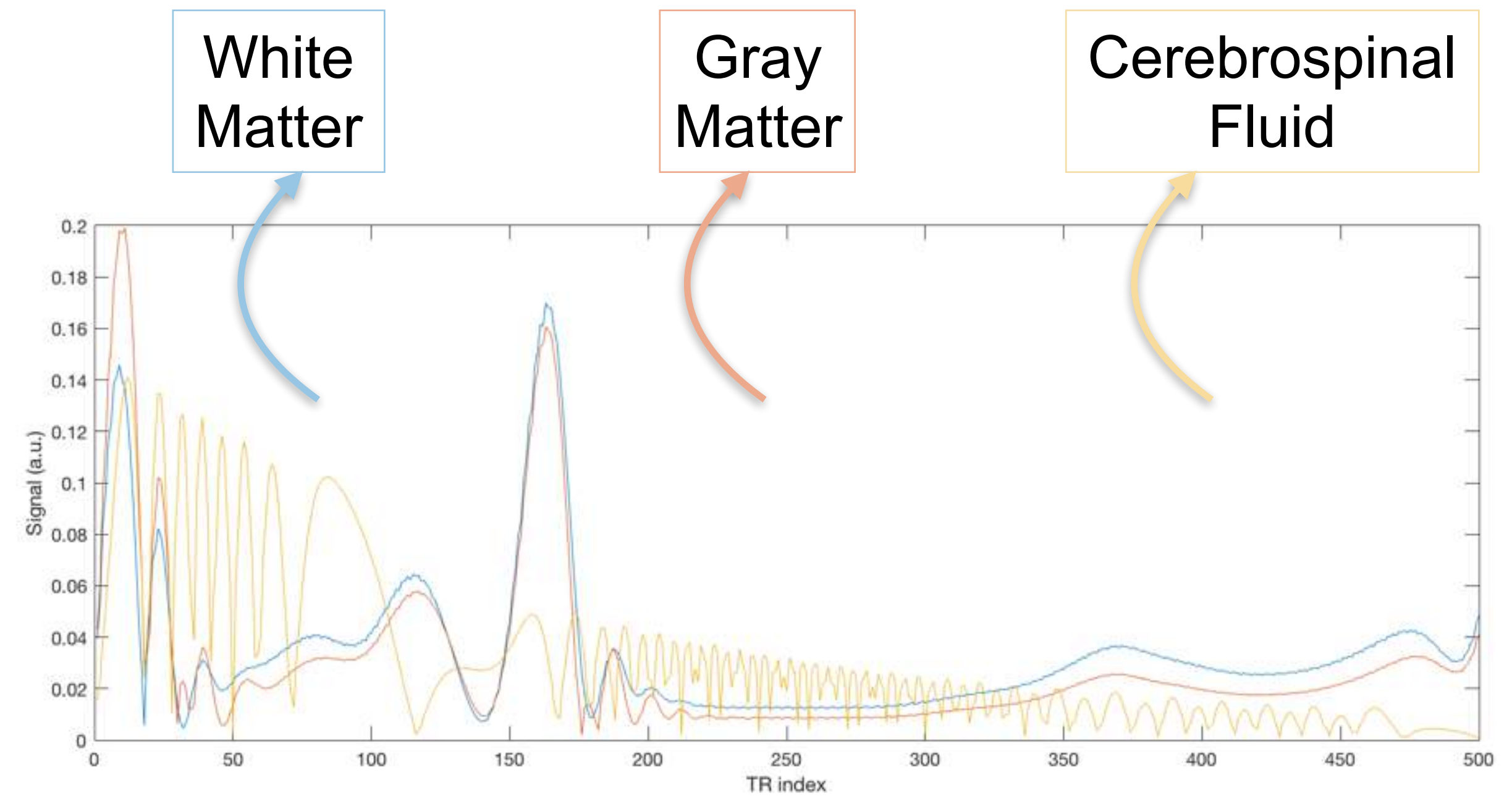
Image Space Simulation of Magnetic Resonance Fingerprinting

Irina Grigorescu

Supervisors: Dr Gary Hui Zhang, Dr Ivana Drobnjak

Aim: To investigate the impact of motion on an MRF experiment

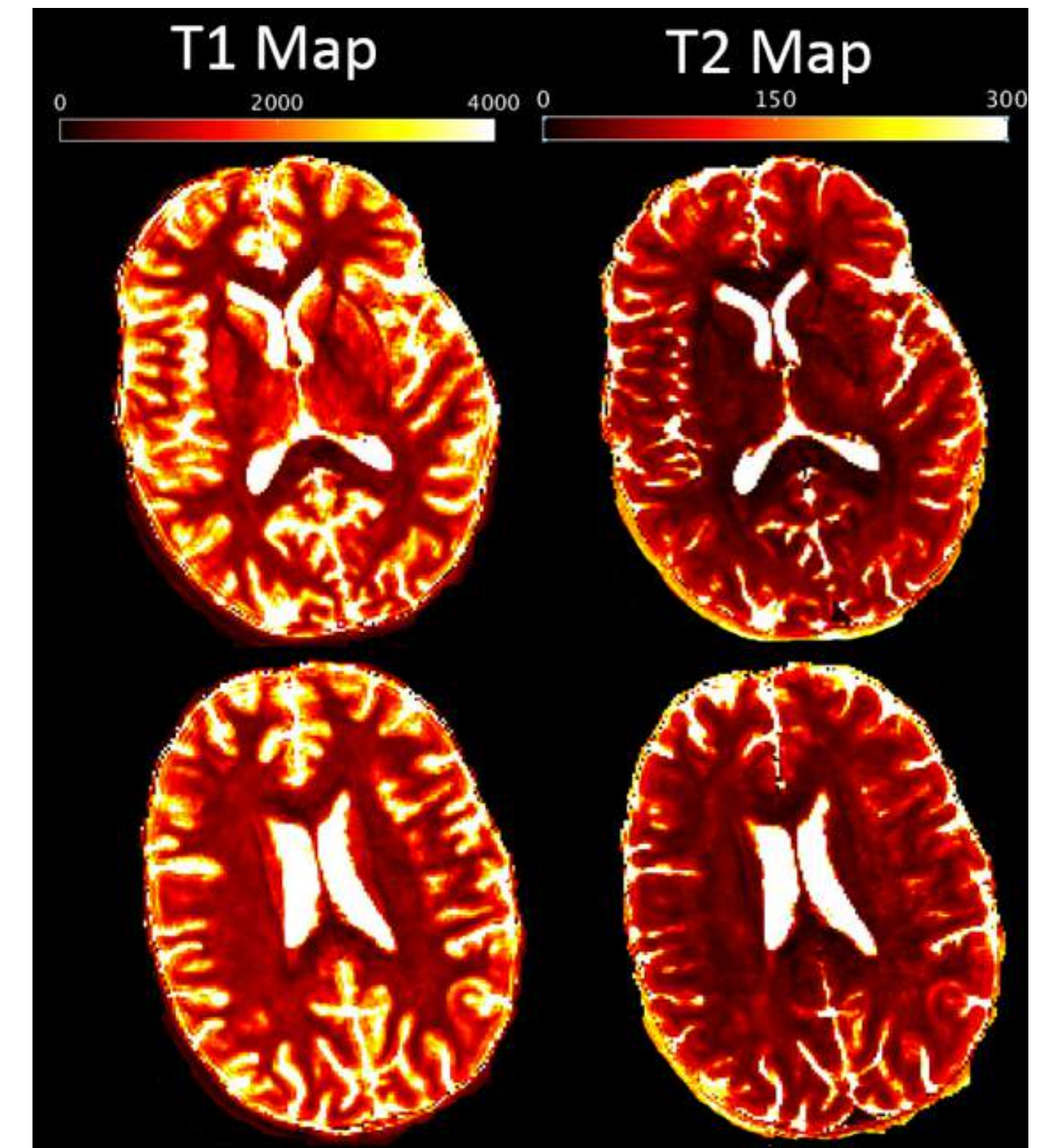
Aim: To investigate the impact of motion on an MRF experiment



Images courtesy of https://www.buzzfeed.com/sarahaspler/what-kind-of-fingerprint-do-you-have?utm_term=.ve1YveY7j#.wqoPRaPw1

Aim: To investigate the impact of motion on an MRF experiment

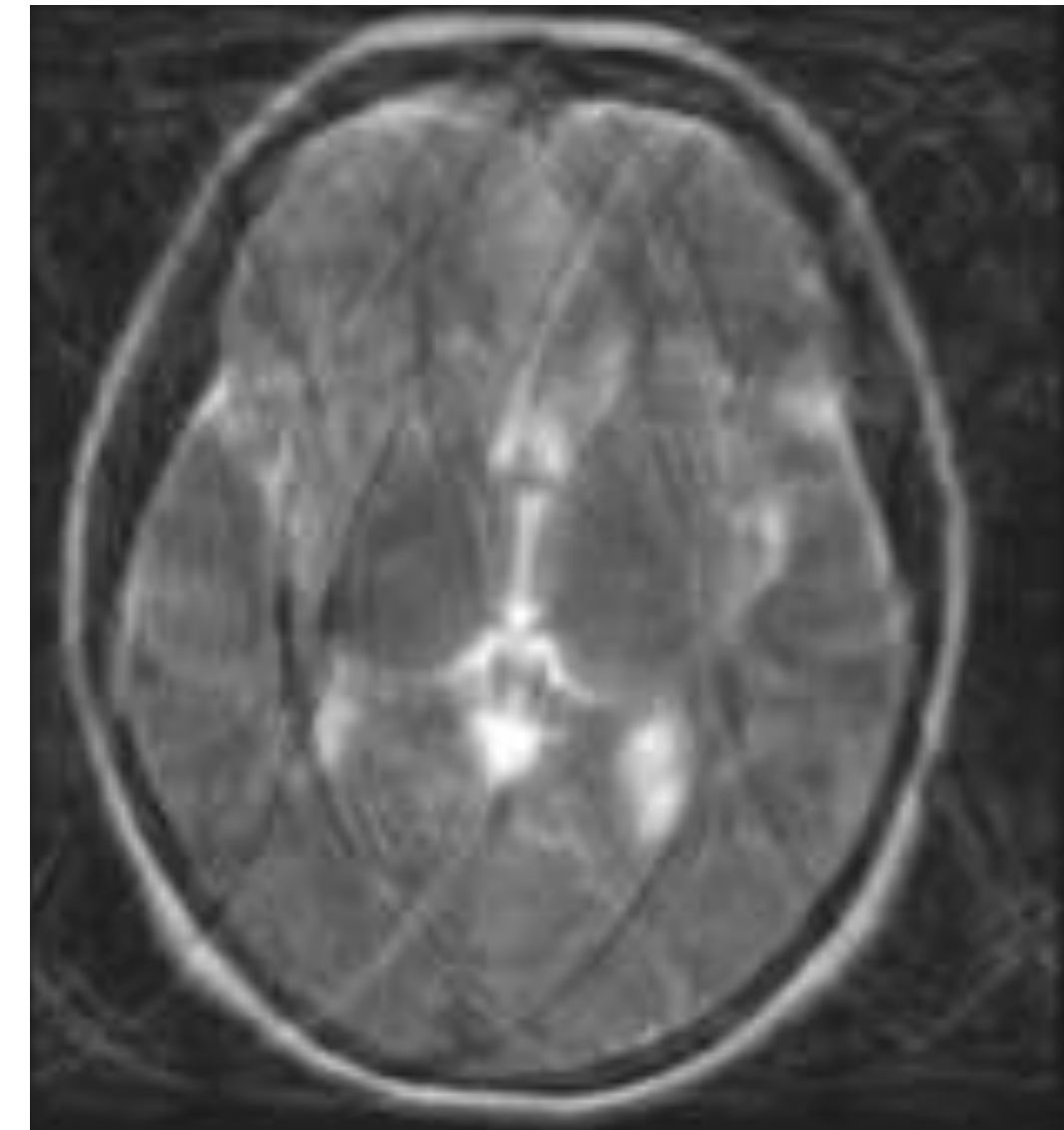
- It is a novel quantitative imaging technique which has the potential to detect and analyse early tissue changes.



Images courtesy of https://martinos.org/~berkin/mrf_3d.html

Aim: To investigate the impact of motion on an MRF experiment

- MRF is a relatively long sequence, thus proving to be prone to errors due to patient motion.



Images courtesy of Donald W. McRobbie, "MRI from Picture to Proton"

Aim: To investigate the impact of motion on an MRF experiment



VS



Proposed Methodology: Image Space simulation of the MRF pipeline



VS



The MRF Pipeline

The MRF Pipeline

Data Collection



Pattern Recognition



Information

The MRF Pipeline

Data Collection

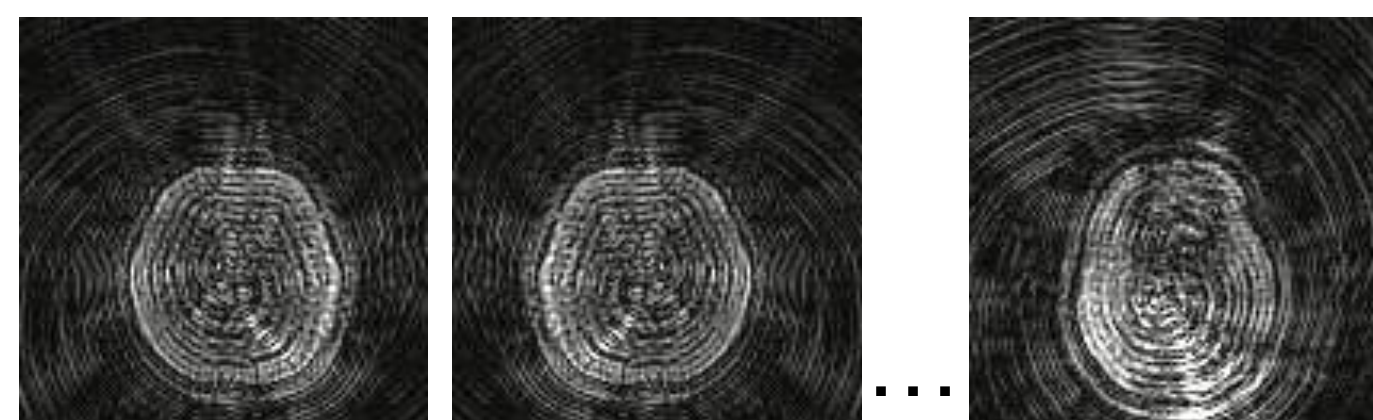


Pattern Recognition

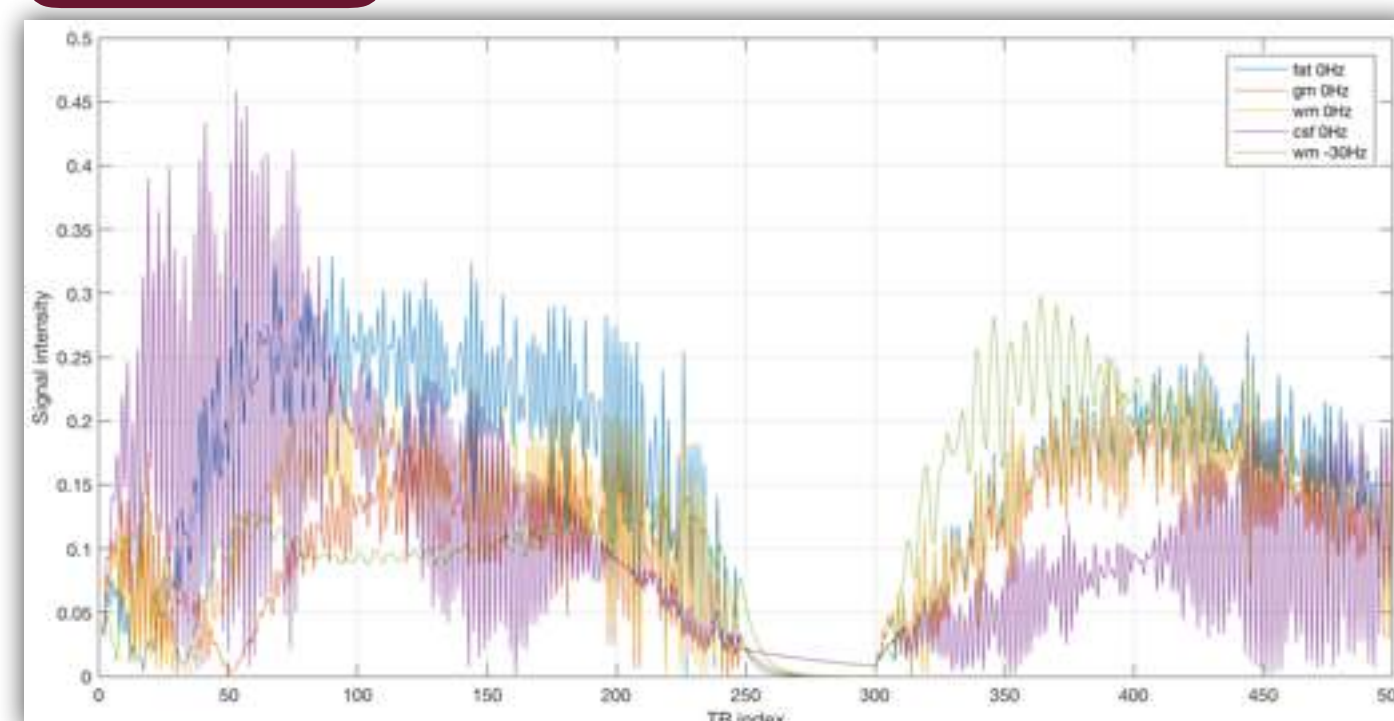


Information

Images



Dictionary



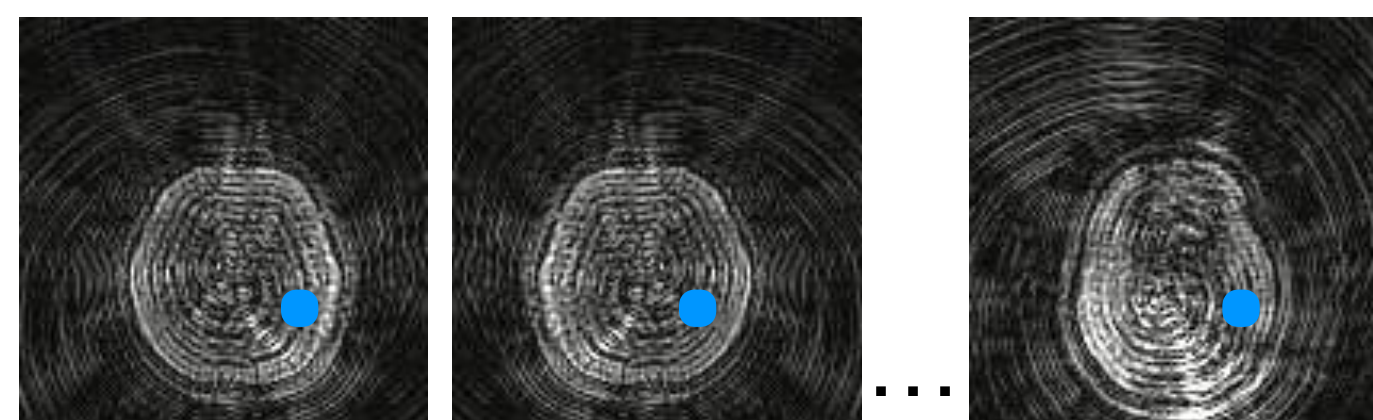
The MRF Pipeline

Data Collection

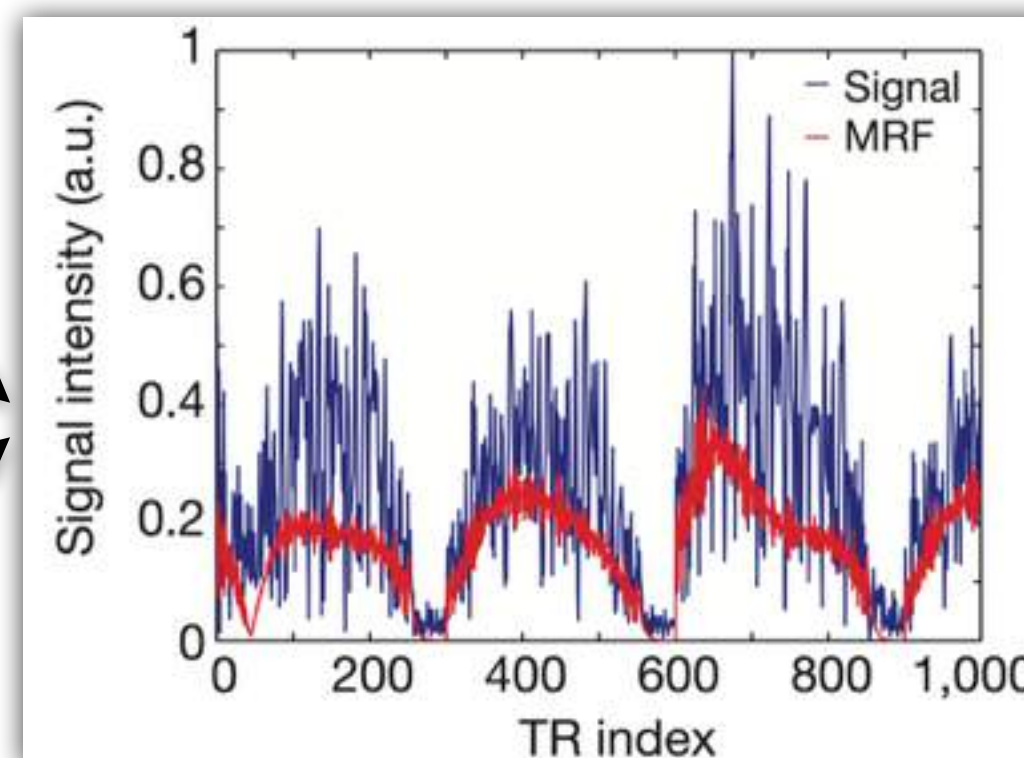
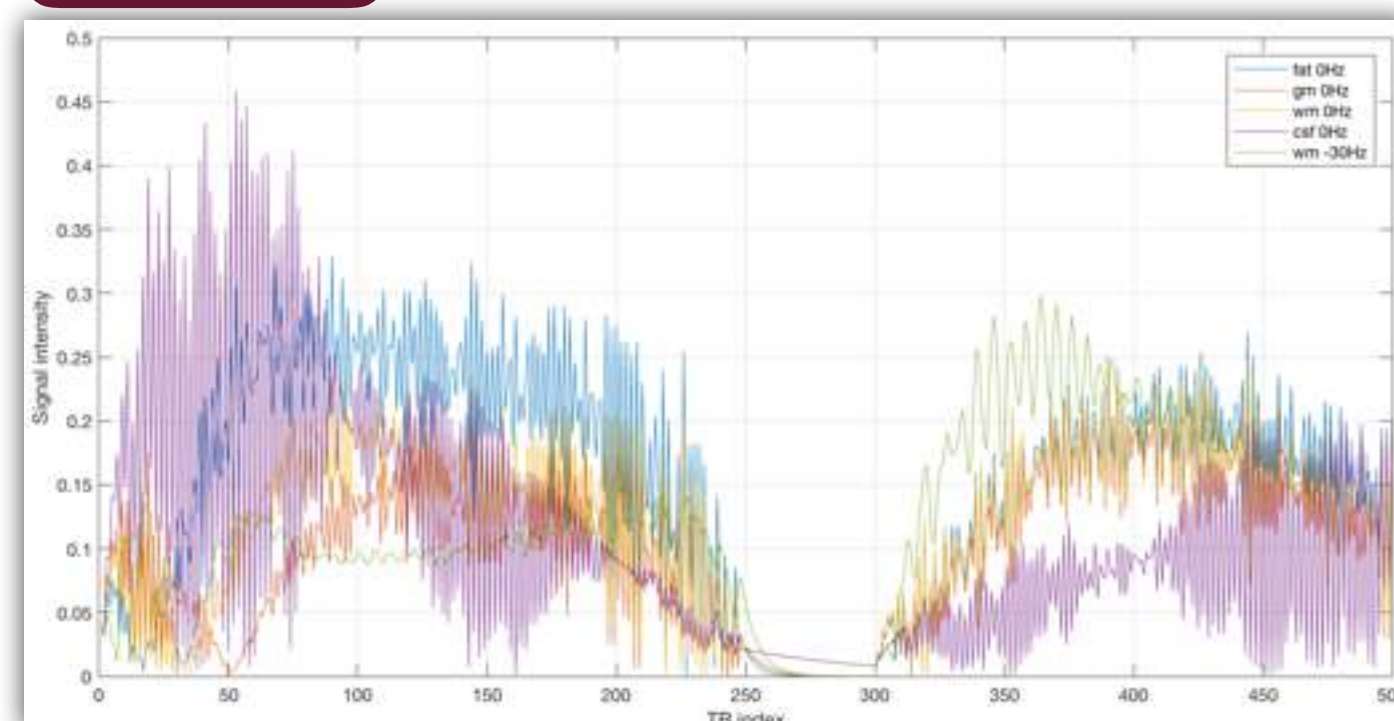
Pattern Recognition

Information

Images



Dictionary



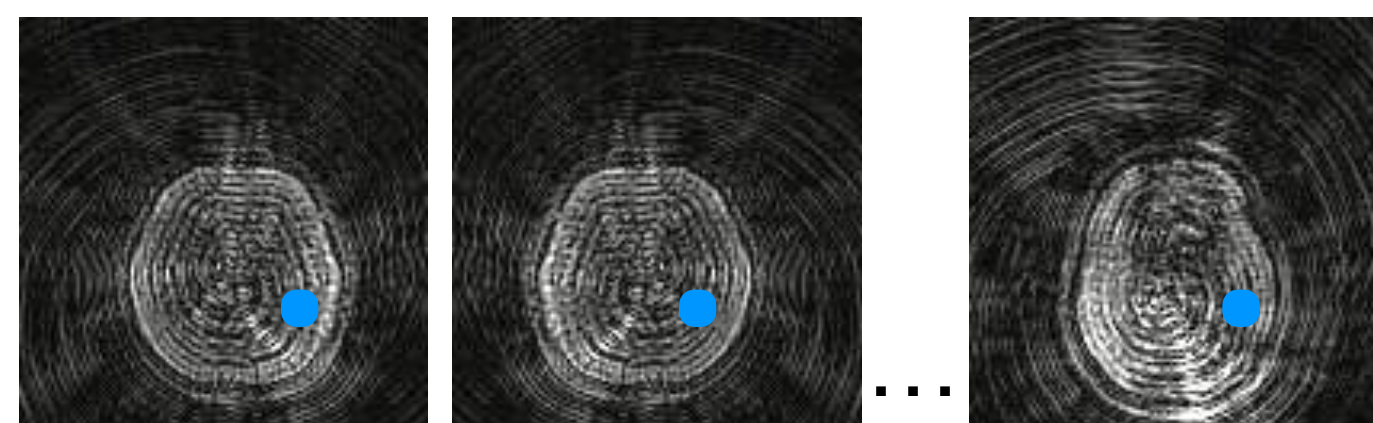
The MRF Pipeline

Data Collection

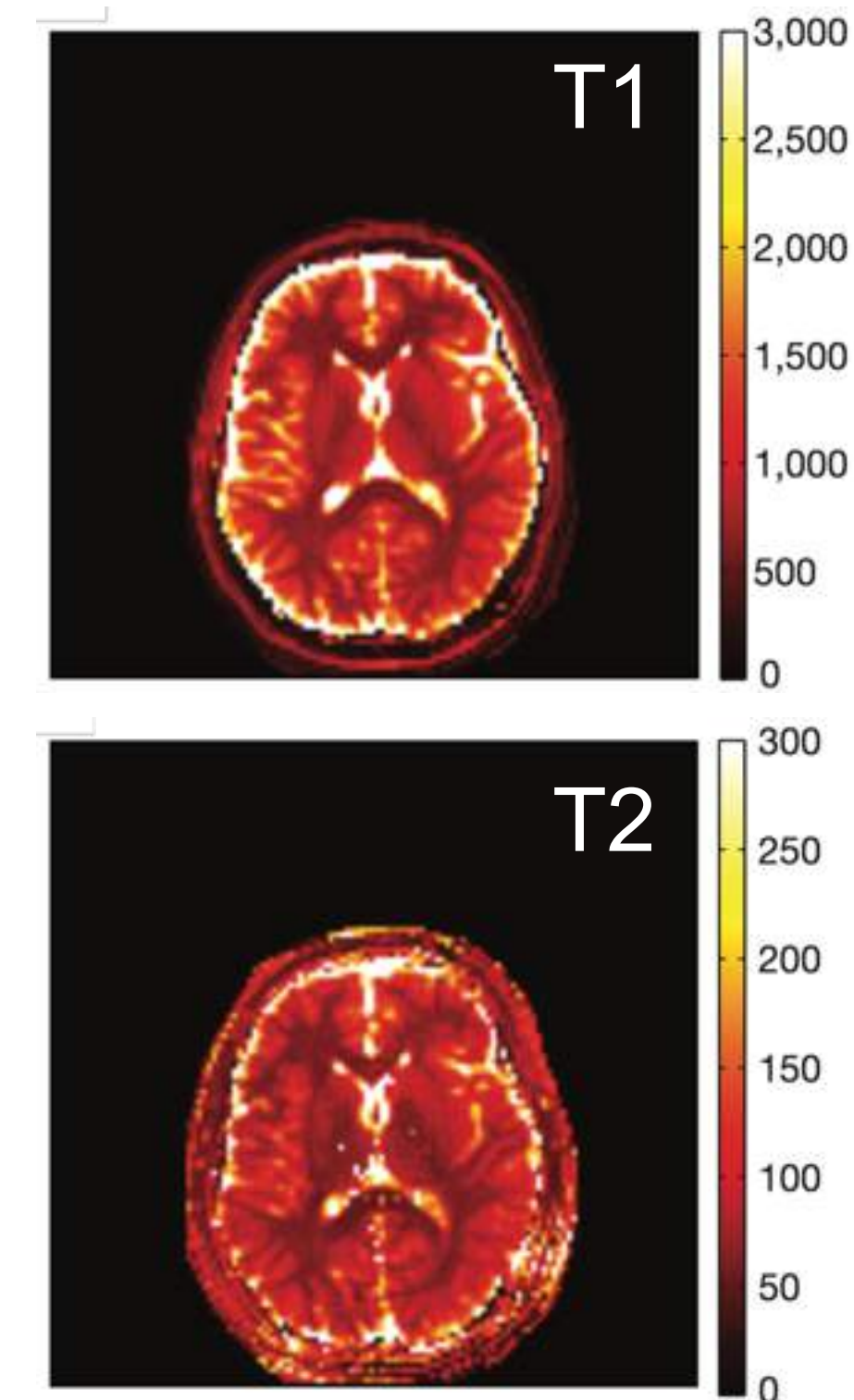
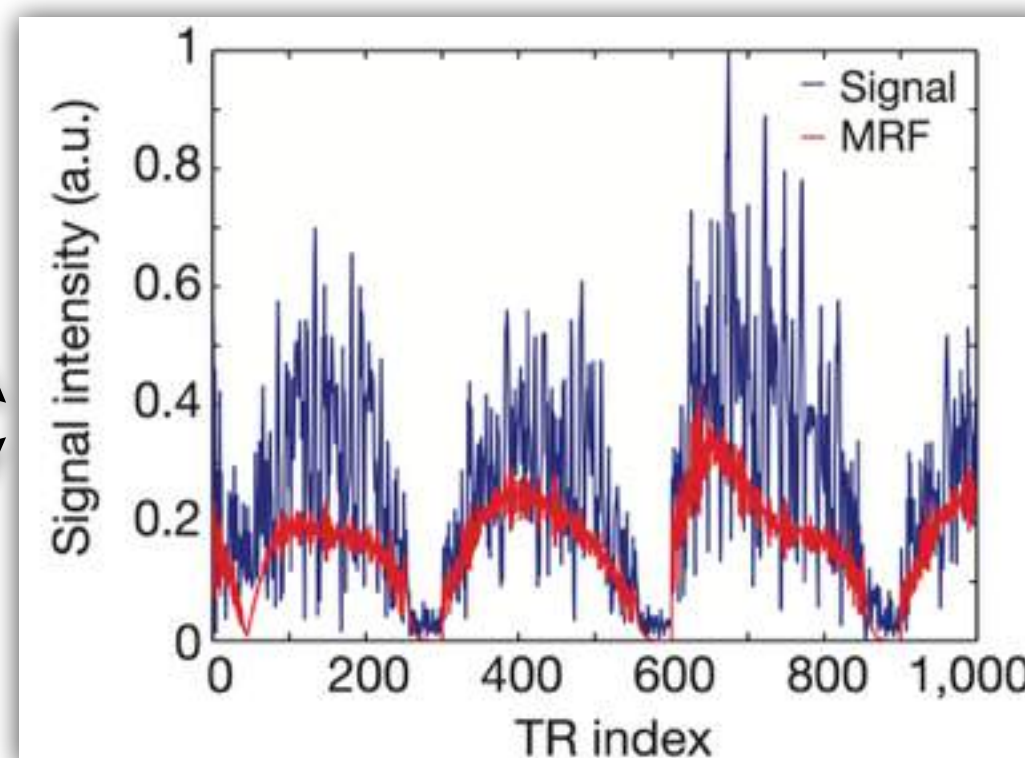
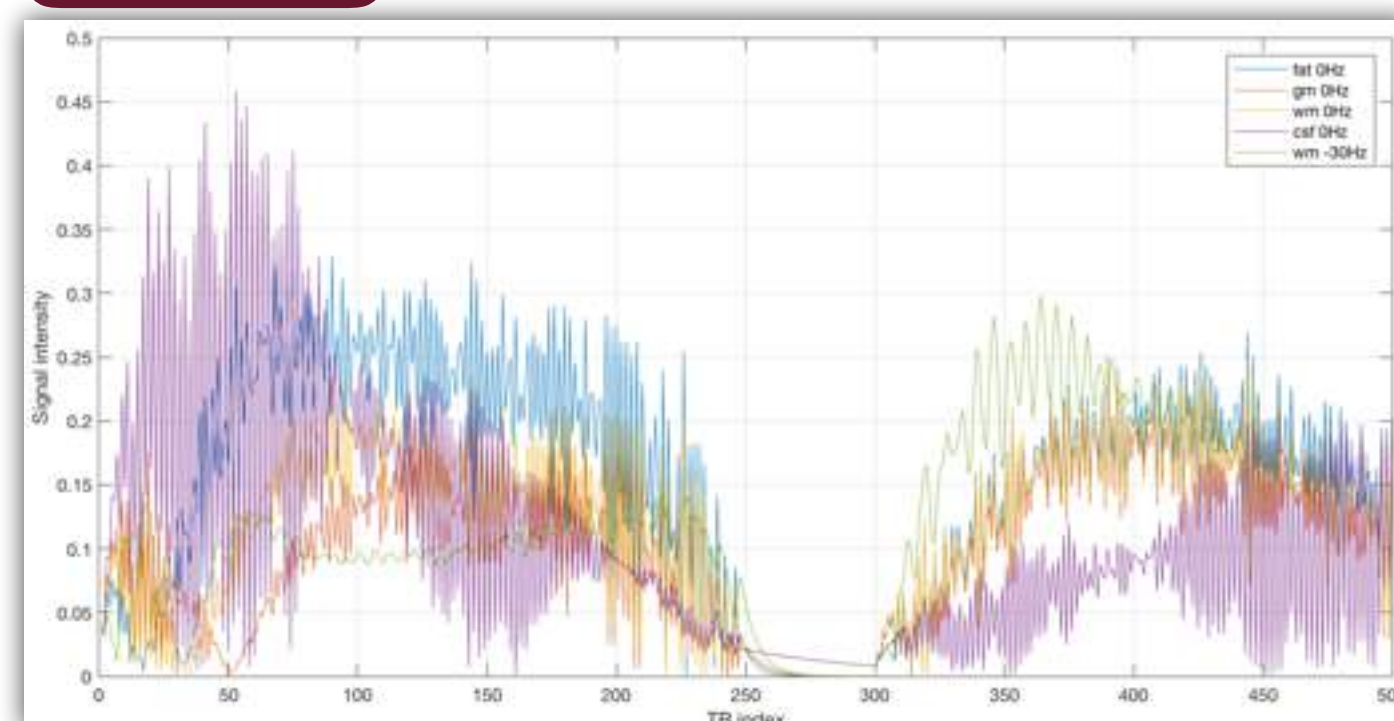
Pattern Recognition

Information

Images



Dictionary



Progress to Date: Simulated this pipeline

The MRF Pipeline

Data Collection

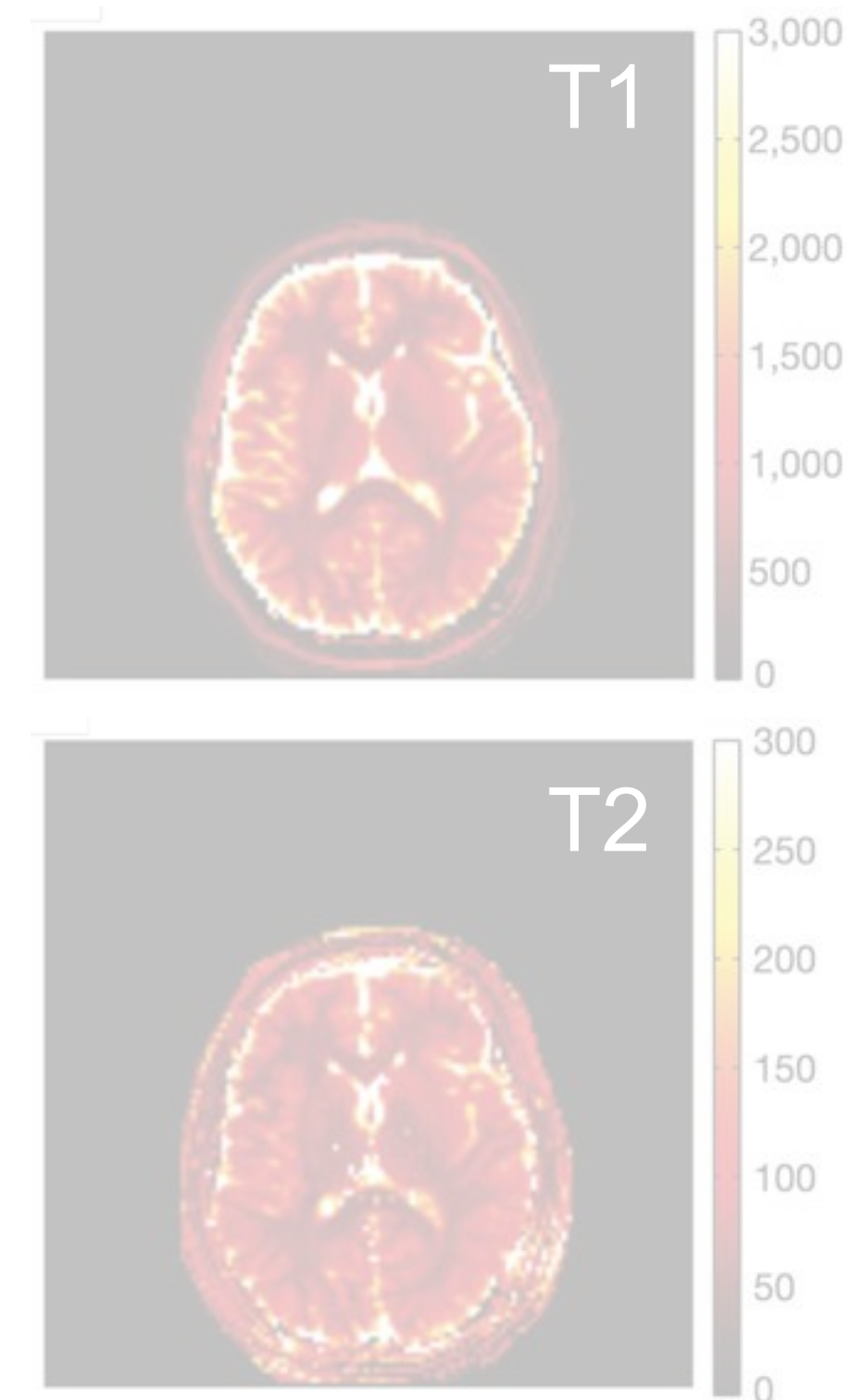
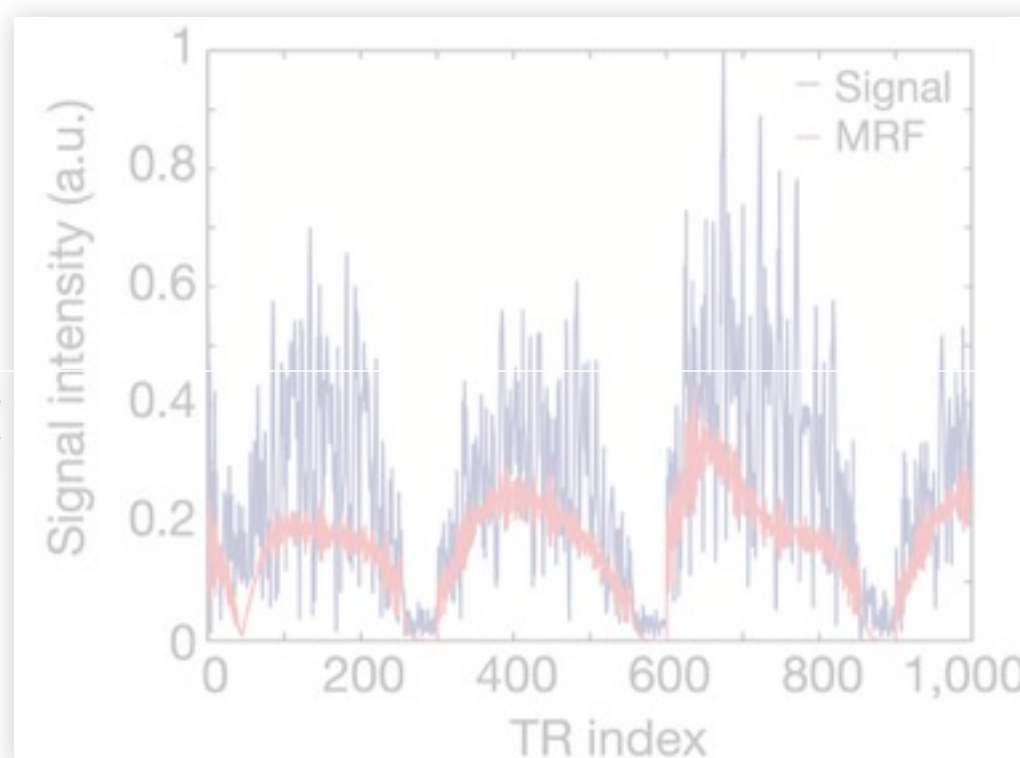
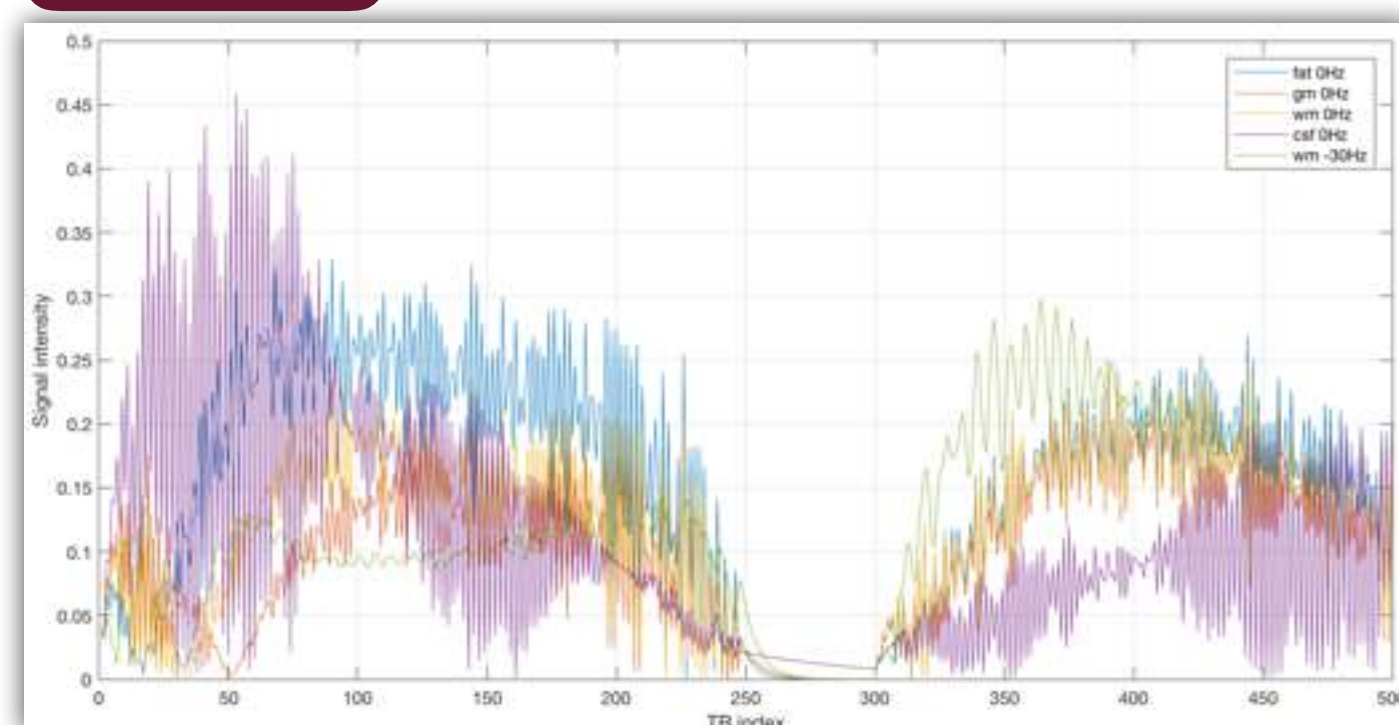
Pattern Recognition

Information

Images



Dictionary



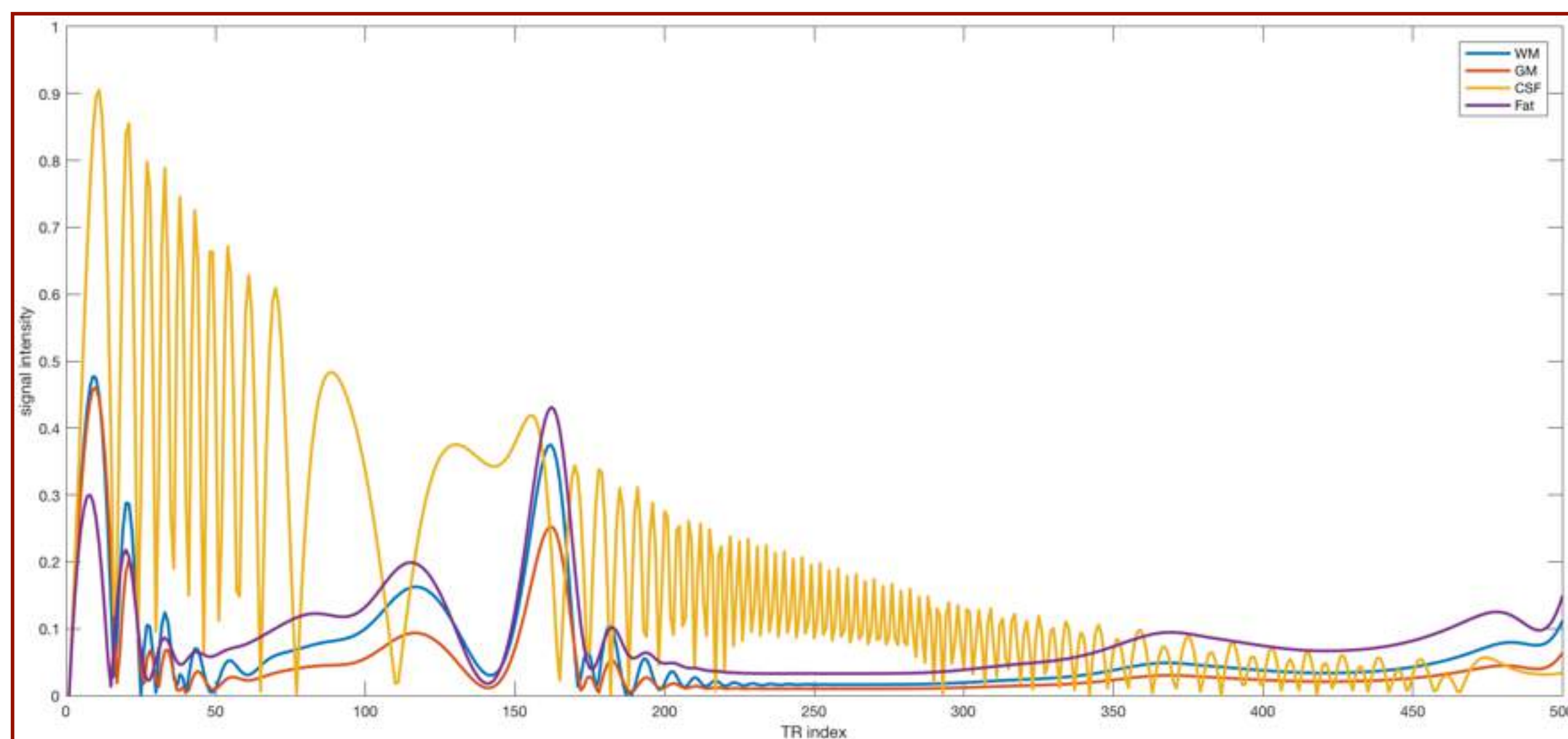
Progress to Date: Generated the Dictionaries for 2 types of sequences

bSSFP

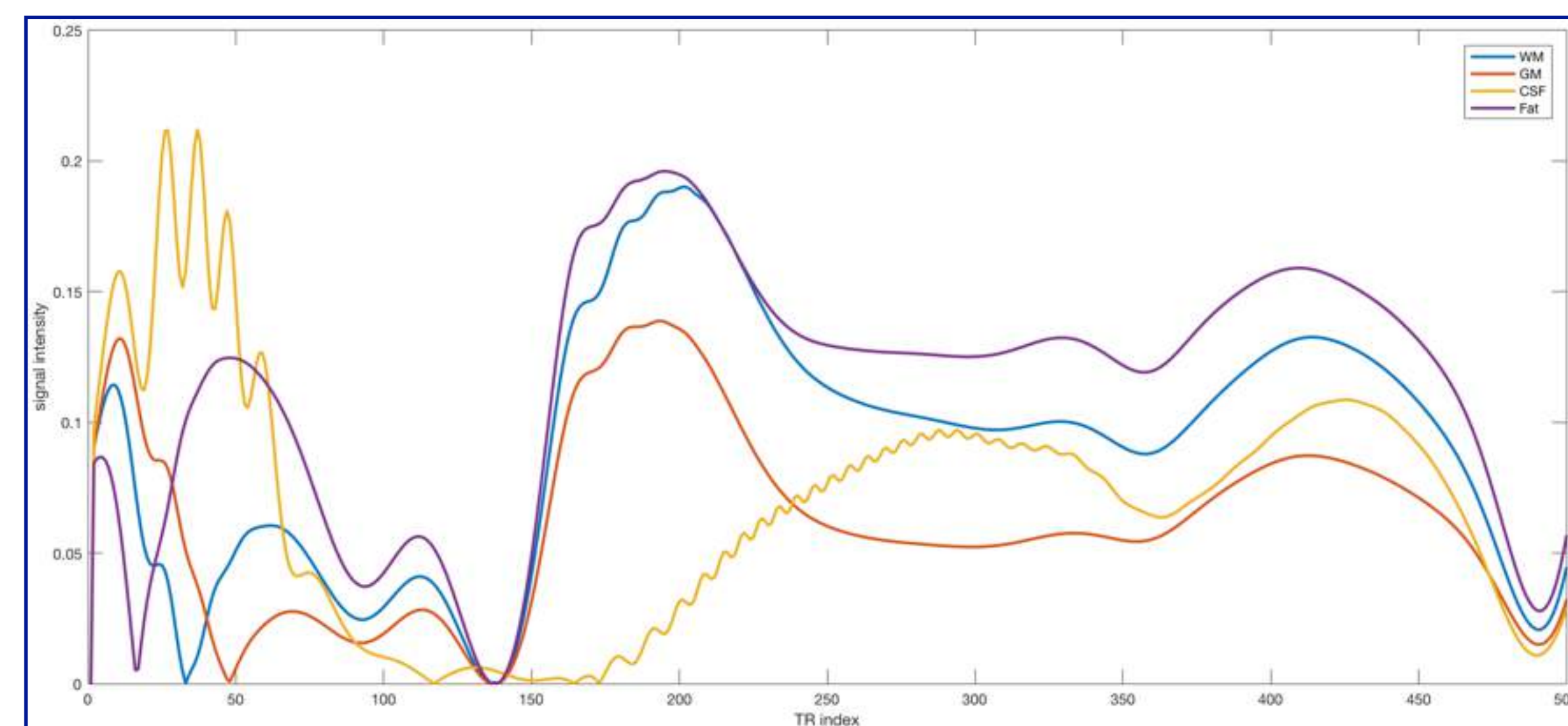
FISP

Progress to Date: Generated the Dictionaries for 2 types of sequences

bSSFP



FISP



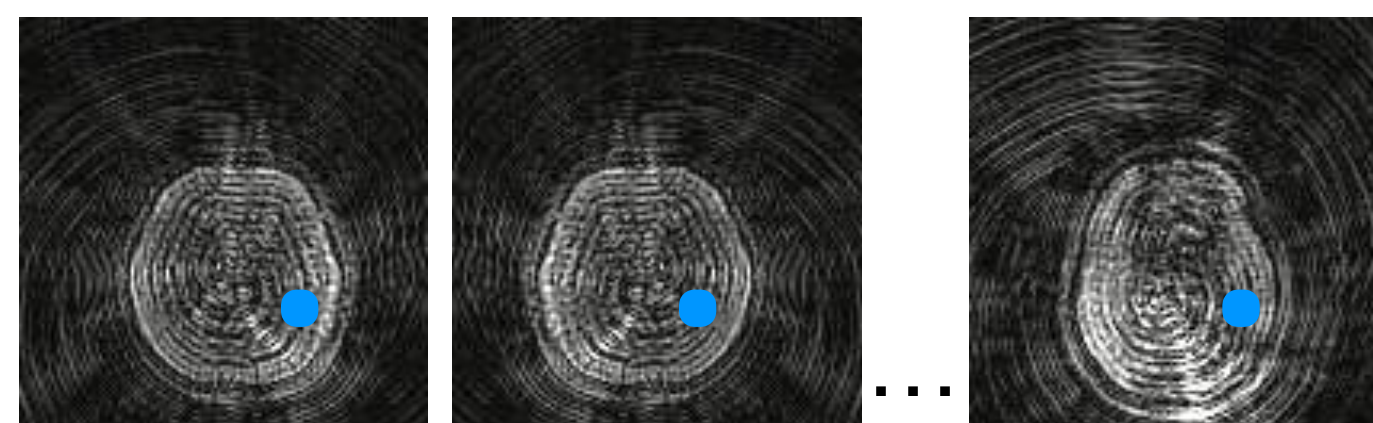
The MRF Pipeline

Data Collection

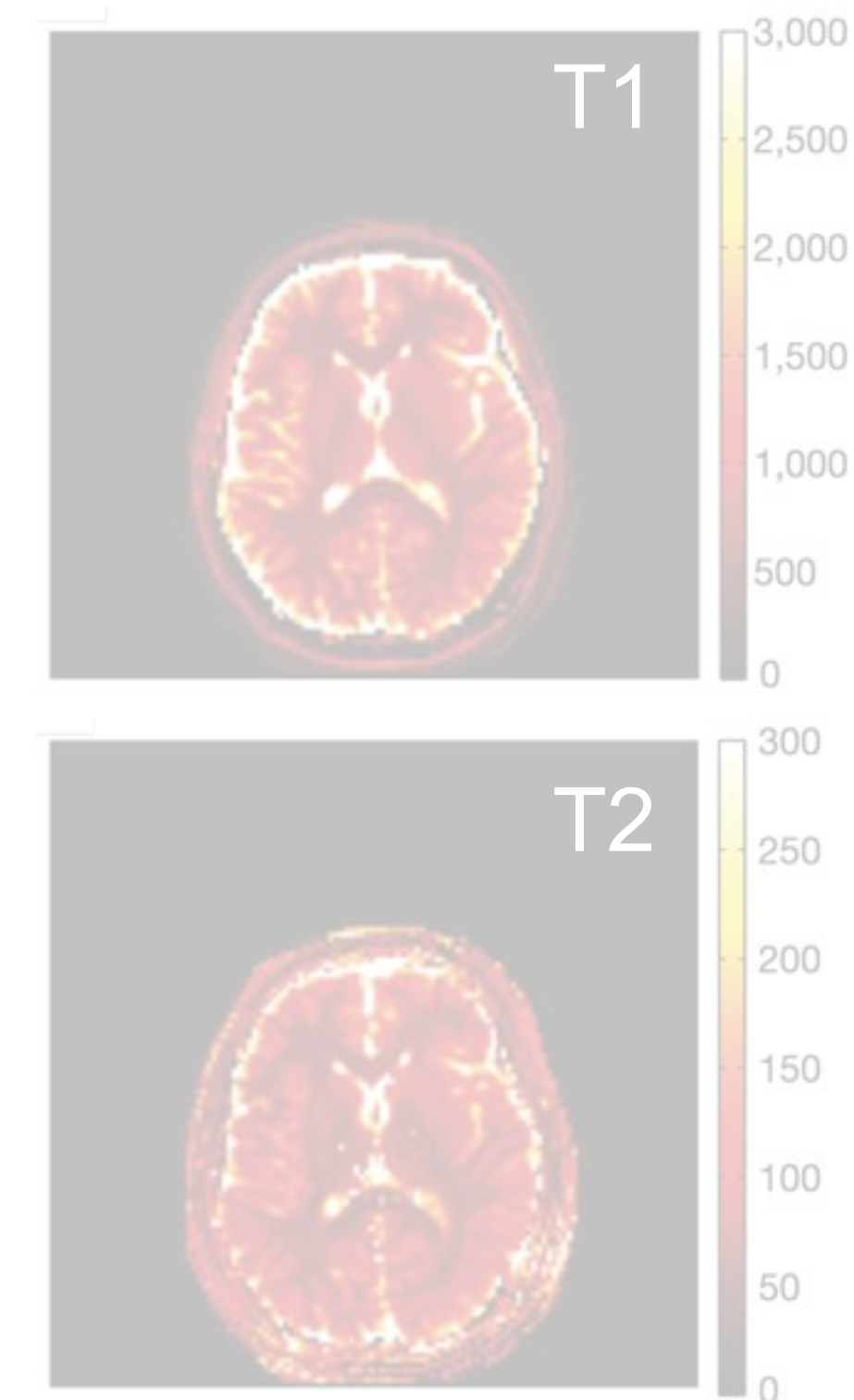
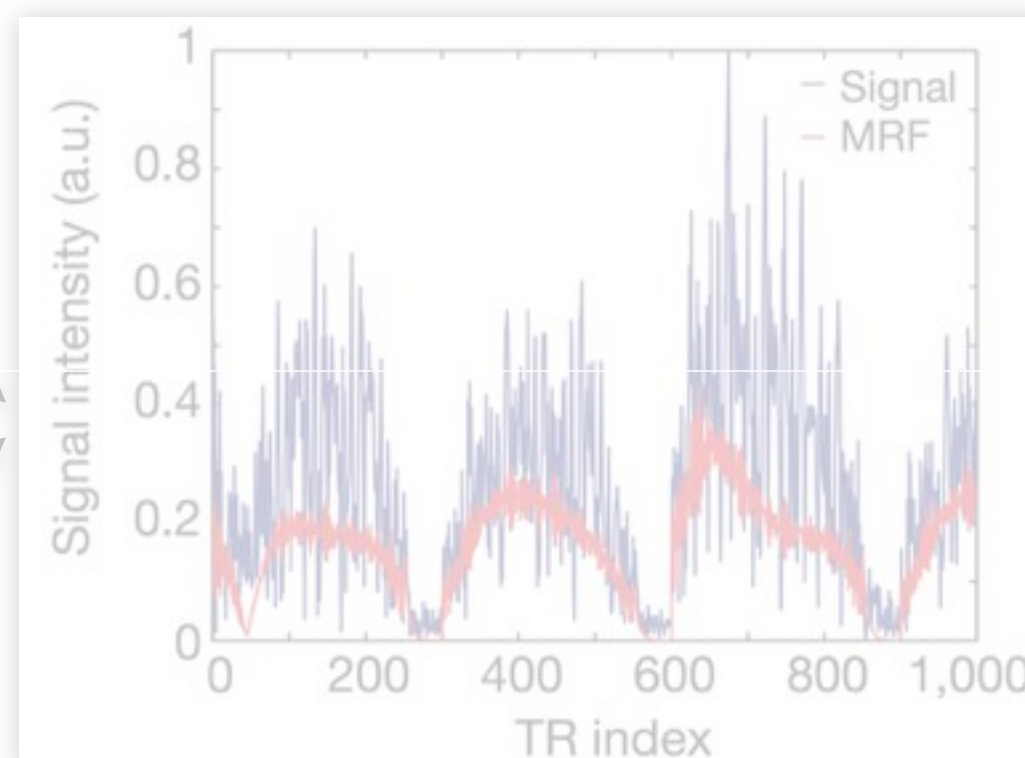
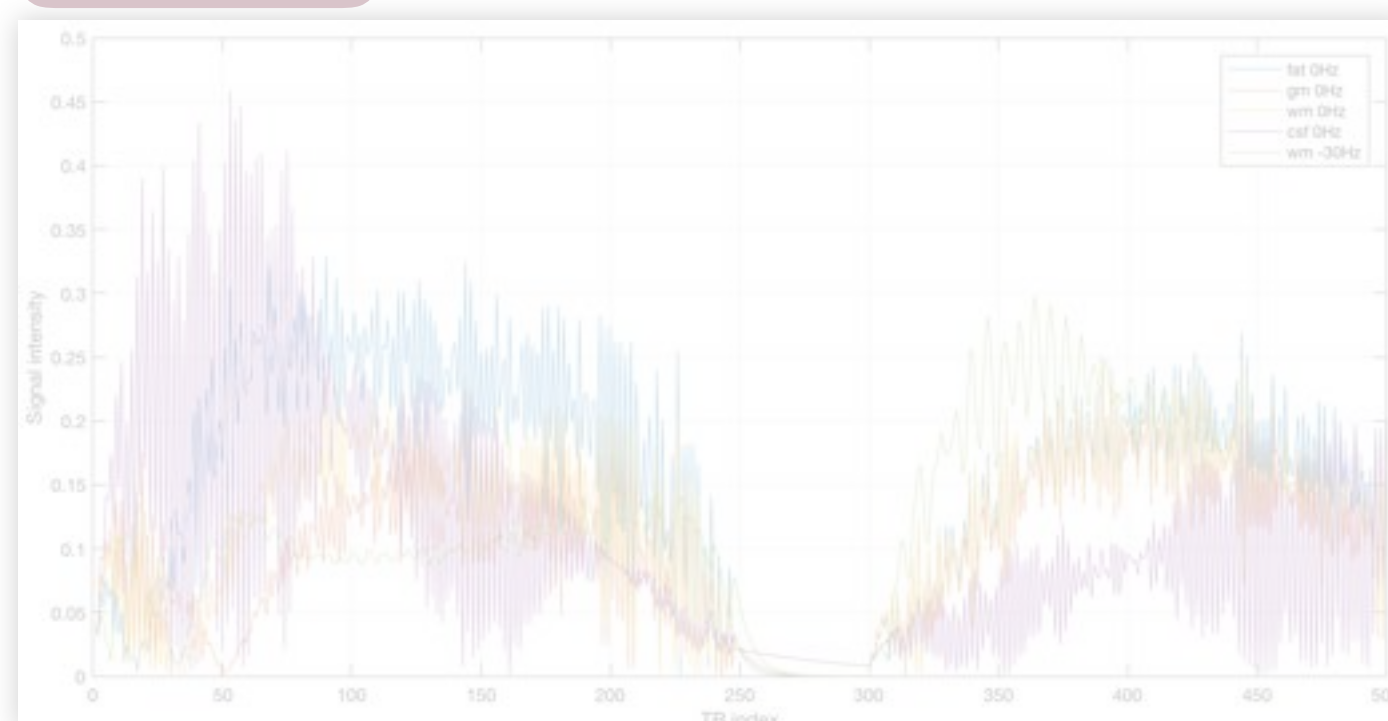
Pattern Recognition

Information

Images



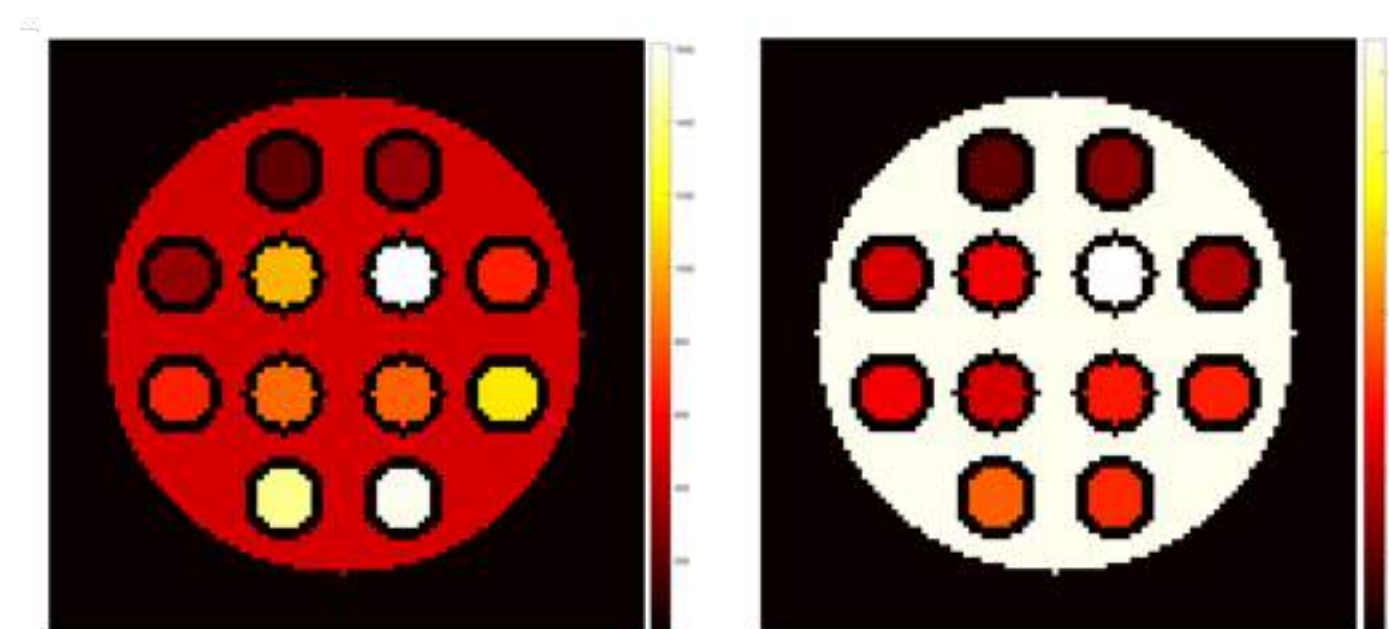
Dictionary



Progress to Date: Simulated the Image Space Acquisition for bSSFP

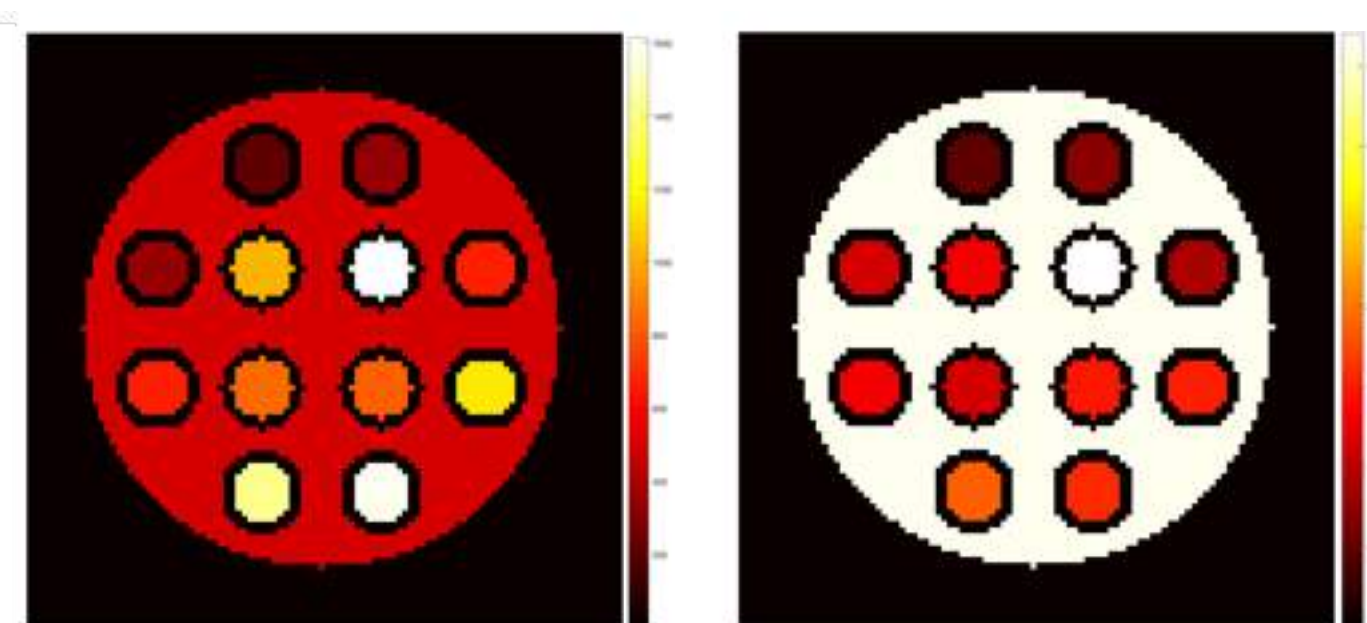
Progress to Date: Simulated the Image Space Acquisition for bSSFP

Input Object



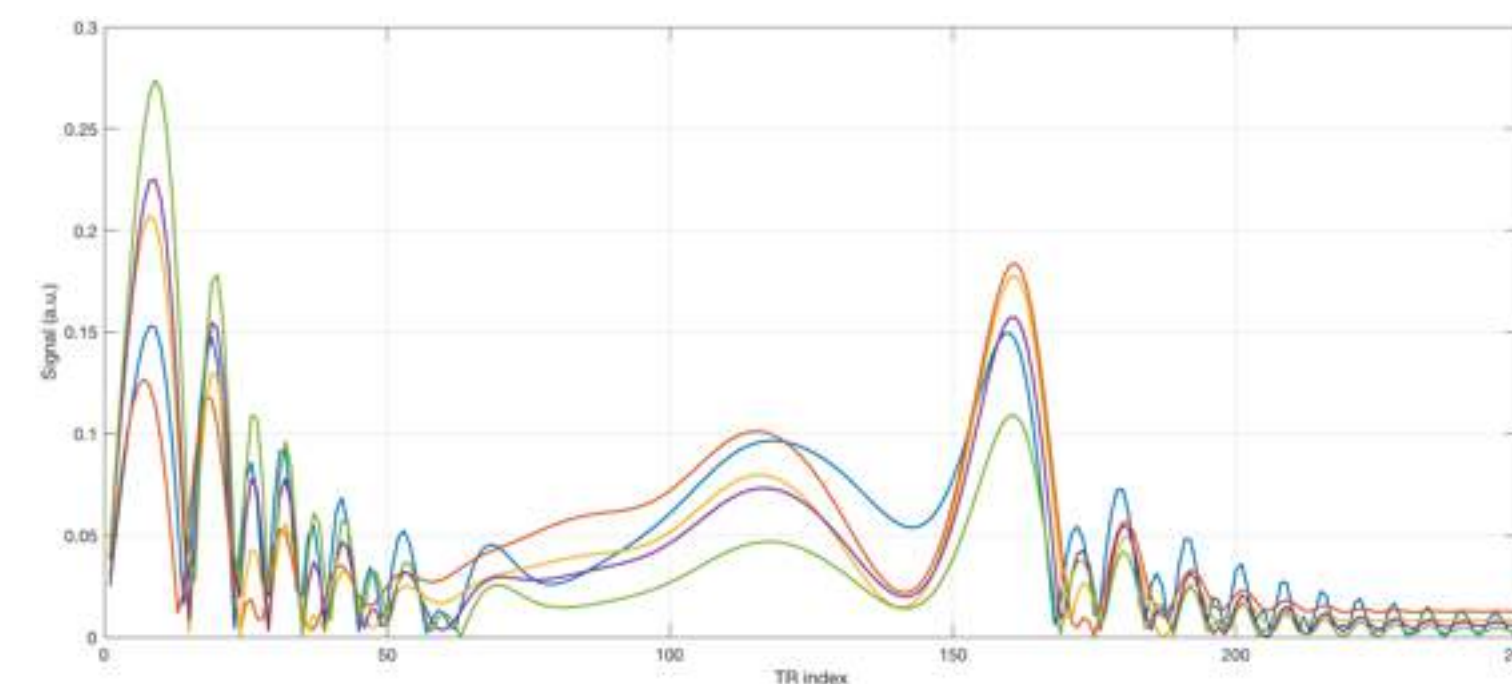
Progress to Date: Simulated the Image Space Acquisition for bSSFP

Input Object



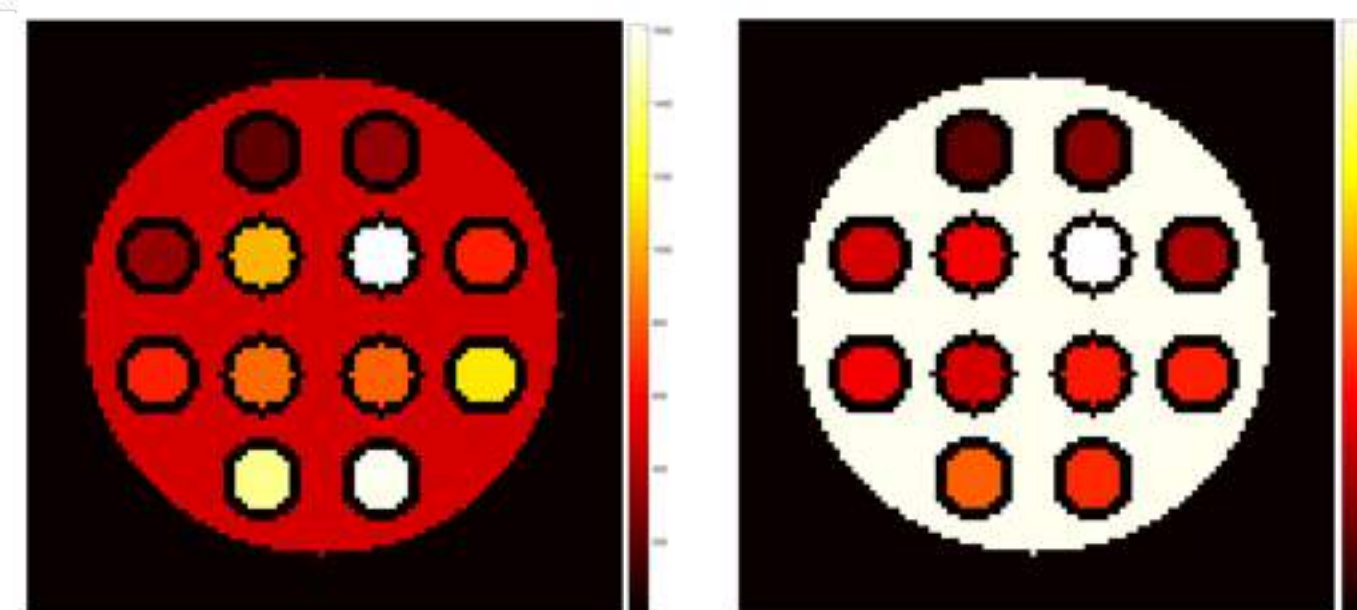
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bSSFP Sequence



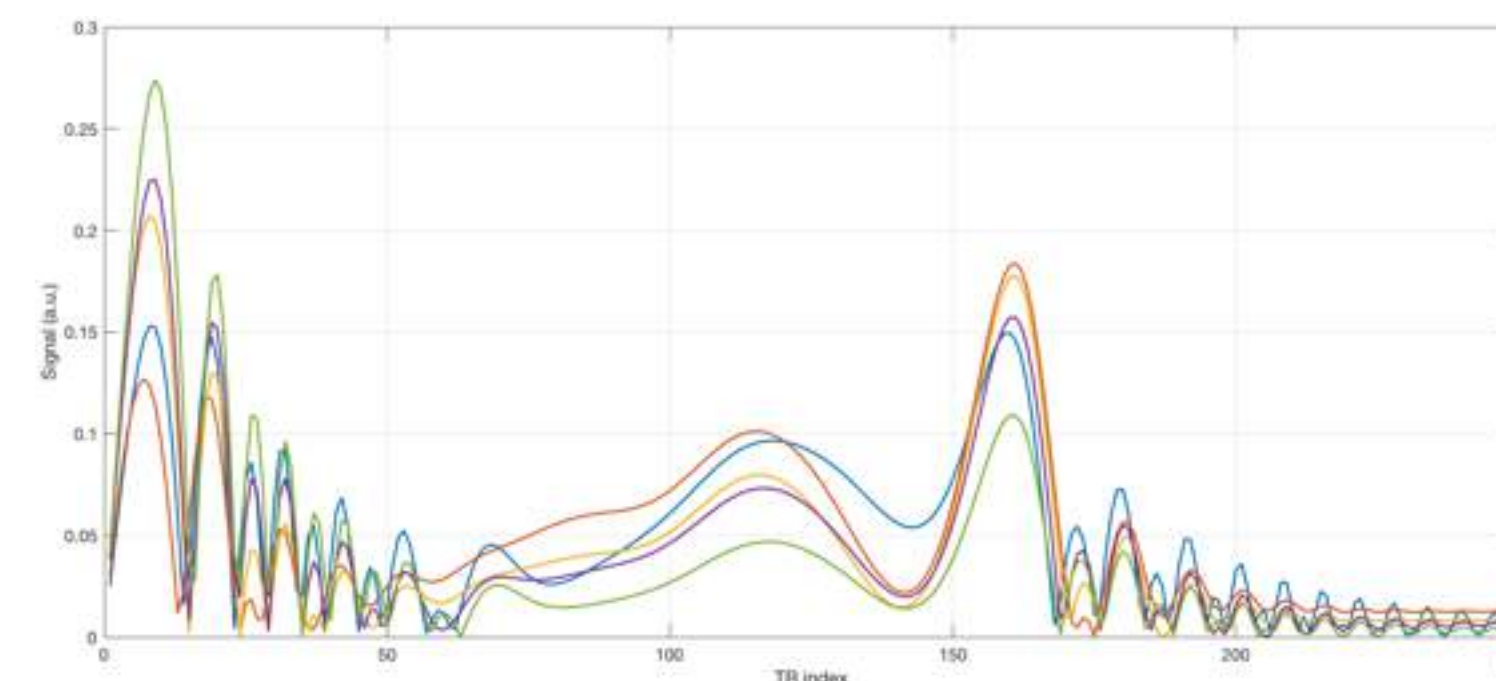
Progress to Date: Simulated the Image Space Acquisition for bSSFP

Input Object

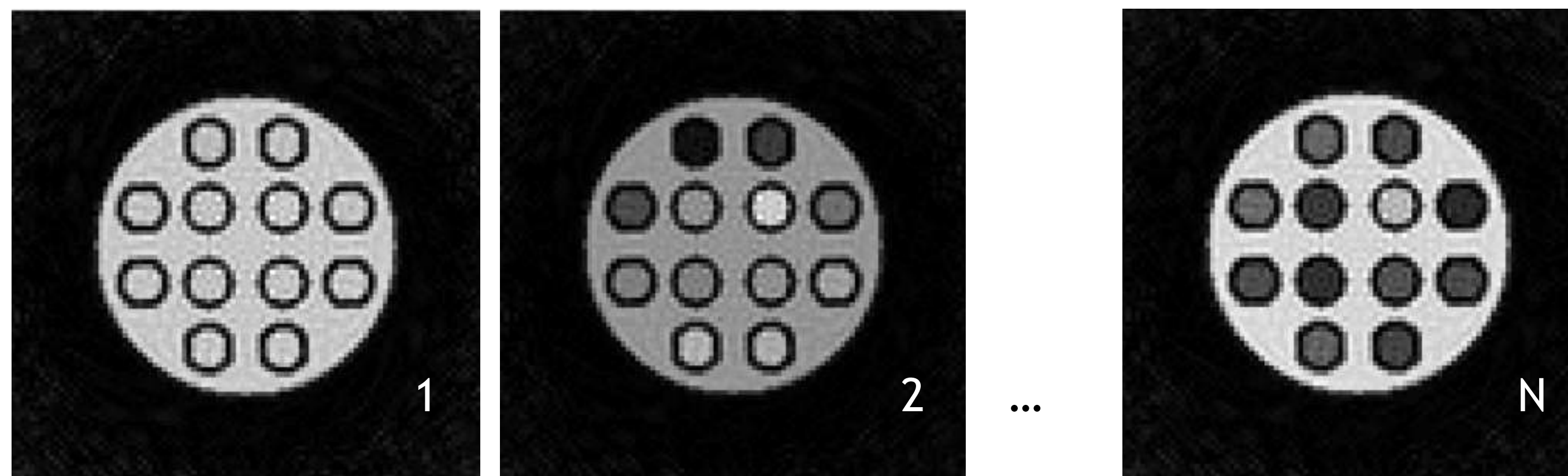


+

bSSFP Sequence



Images



The MRF Pipeline

Data Collection

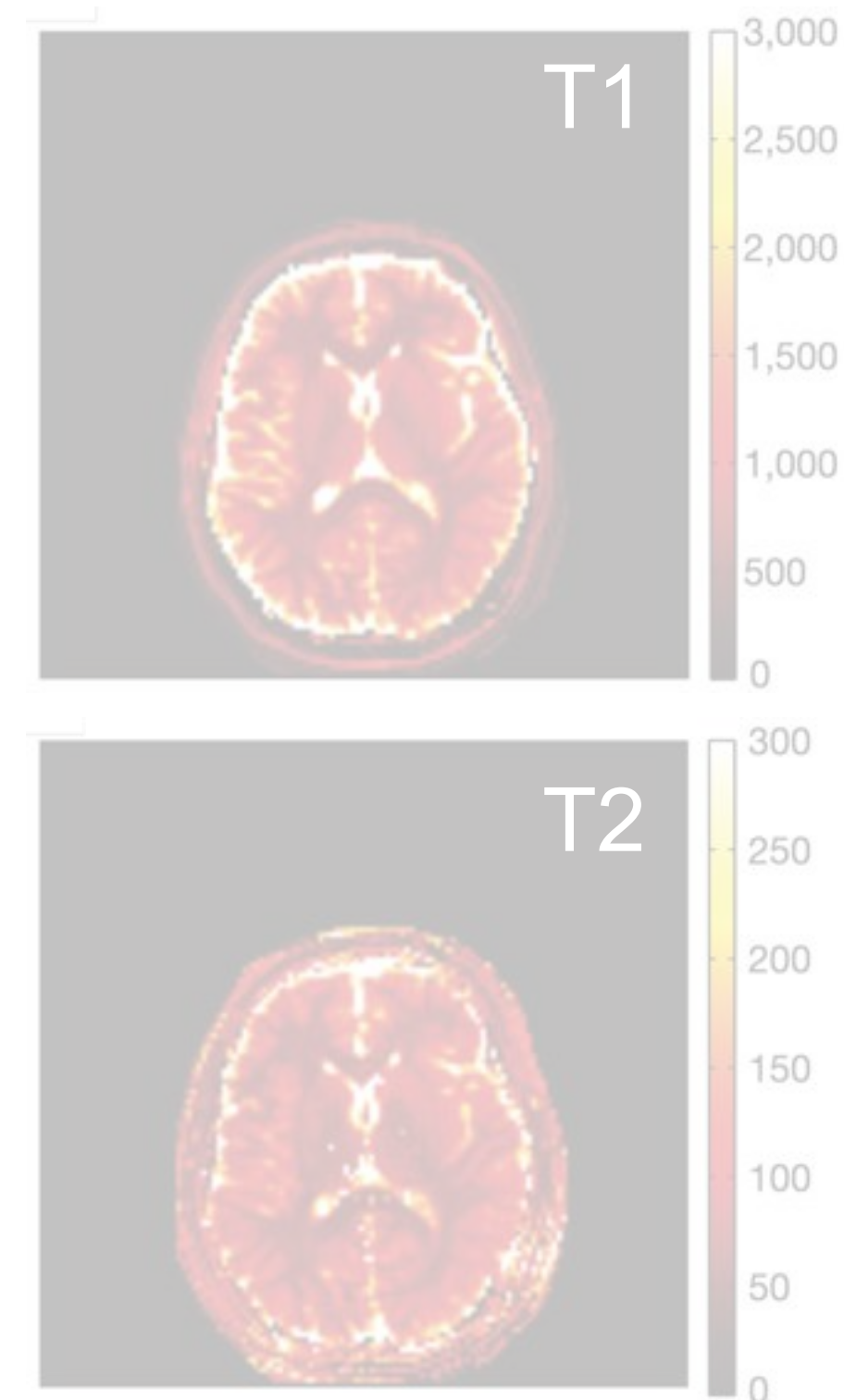
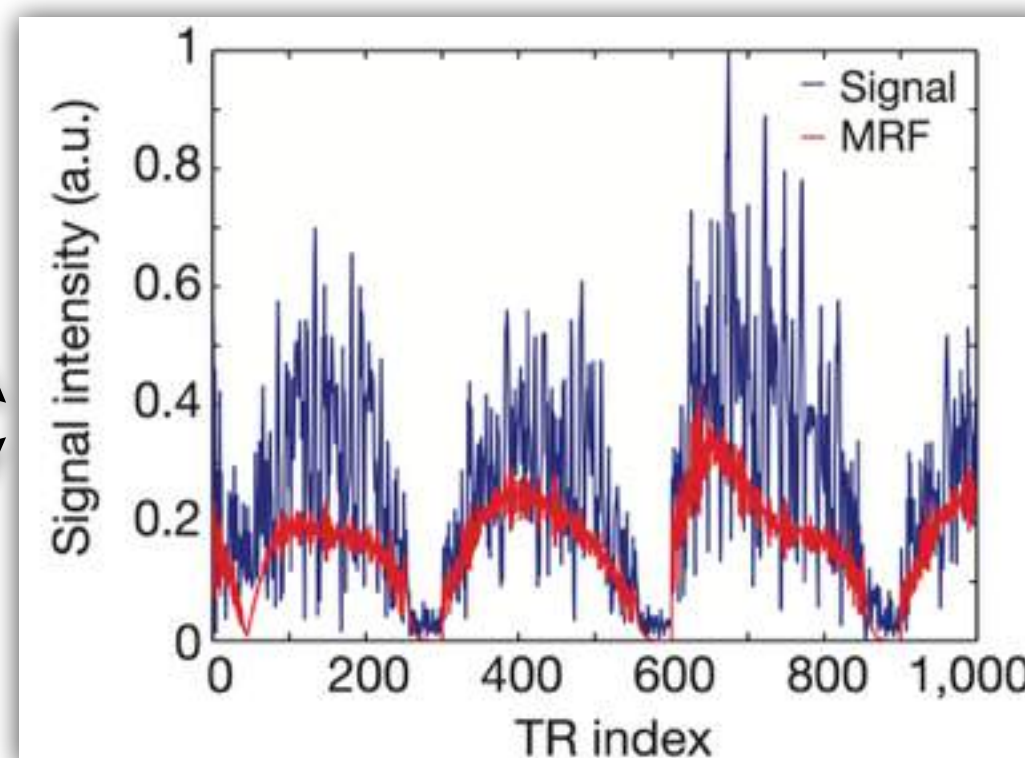
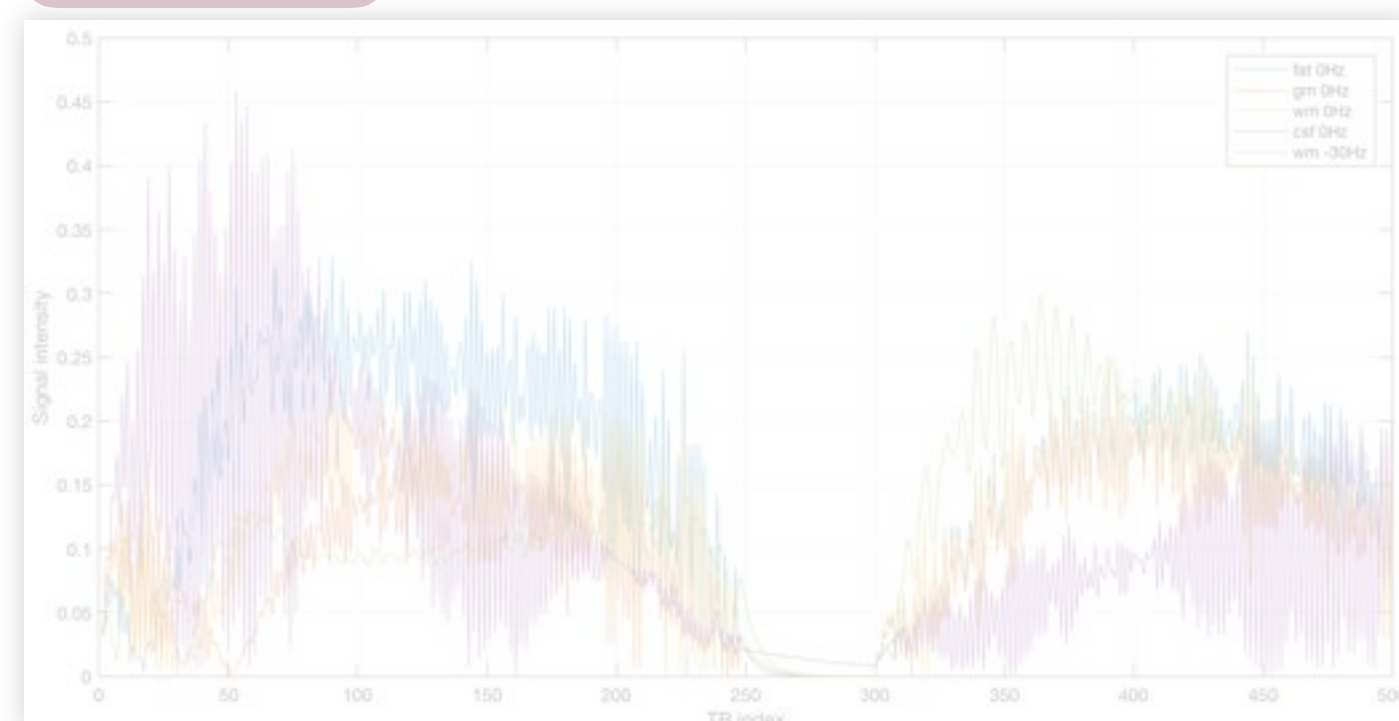
Pattern Recognition

Information

Images

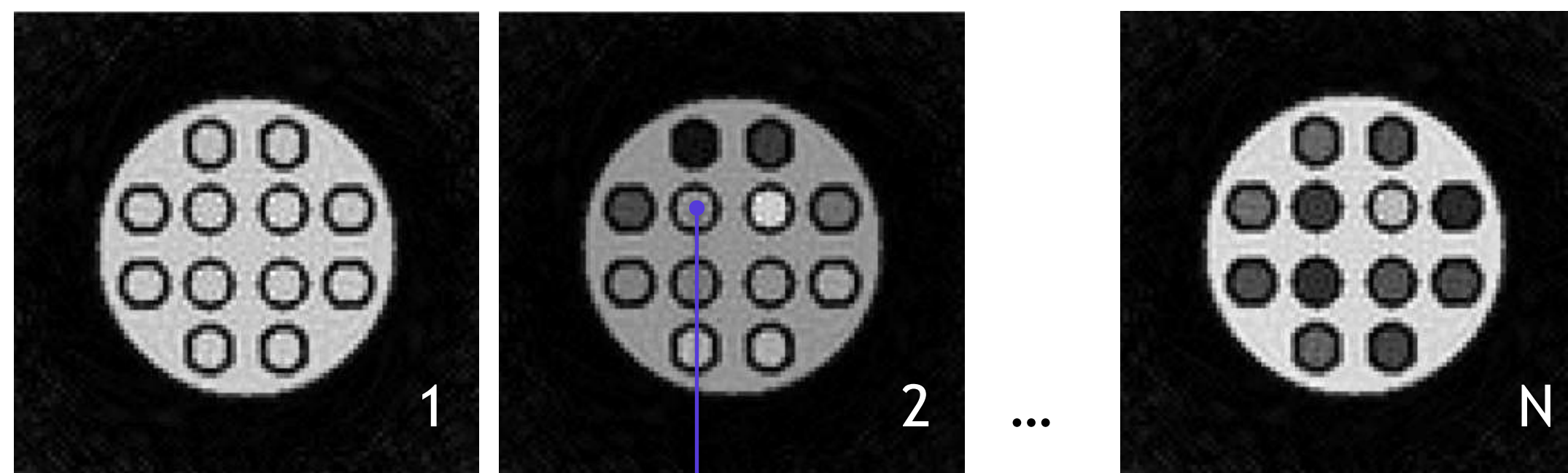


Dictionary

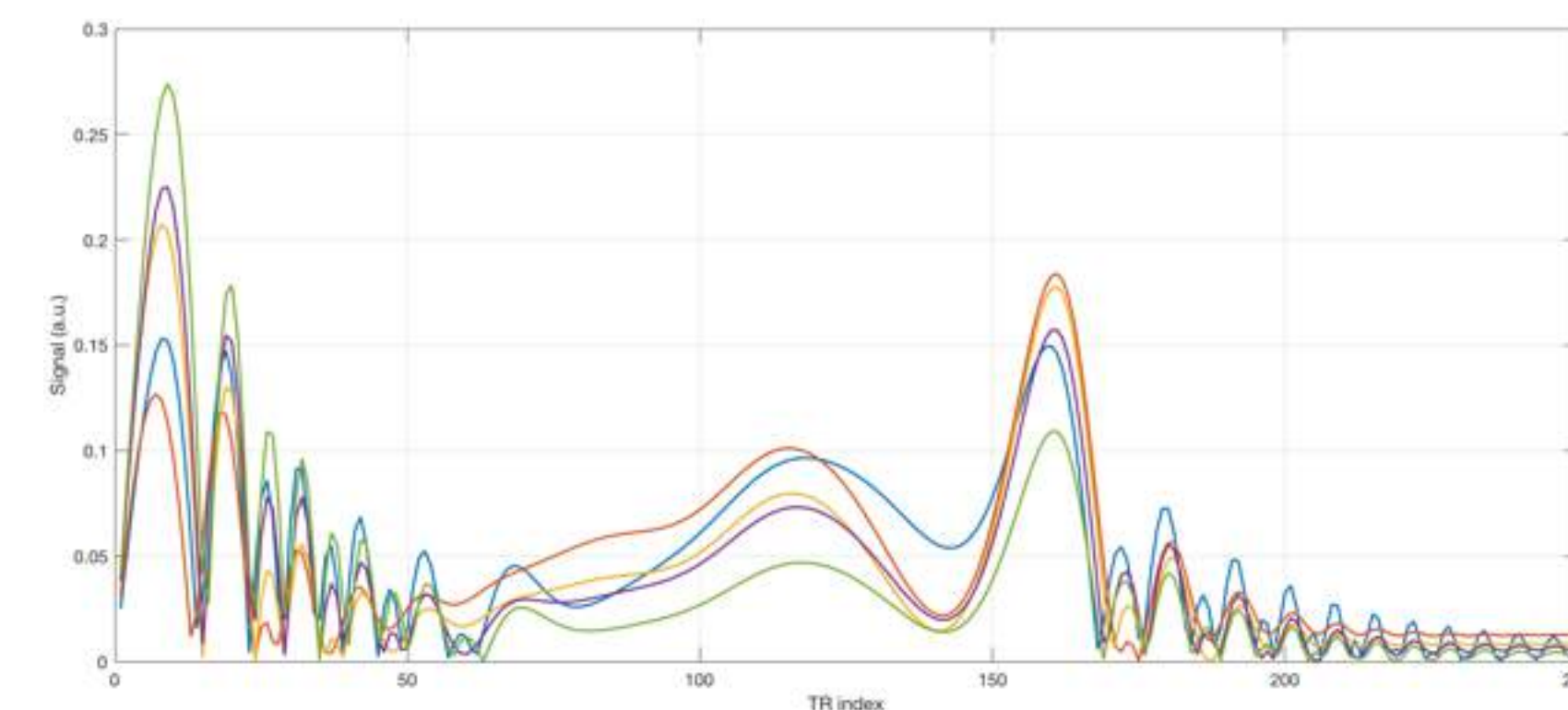


Progress to Date: Pattern Matching between images and dictionary

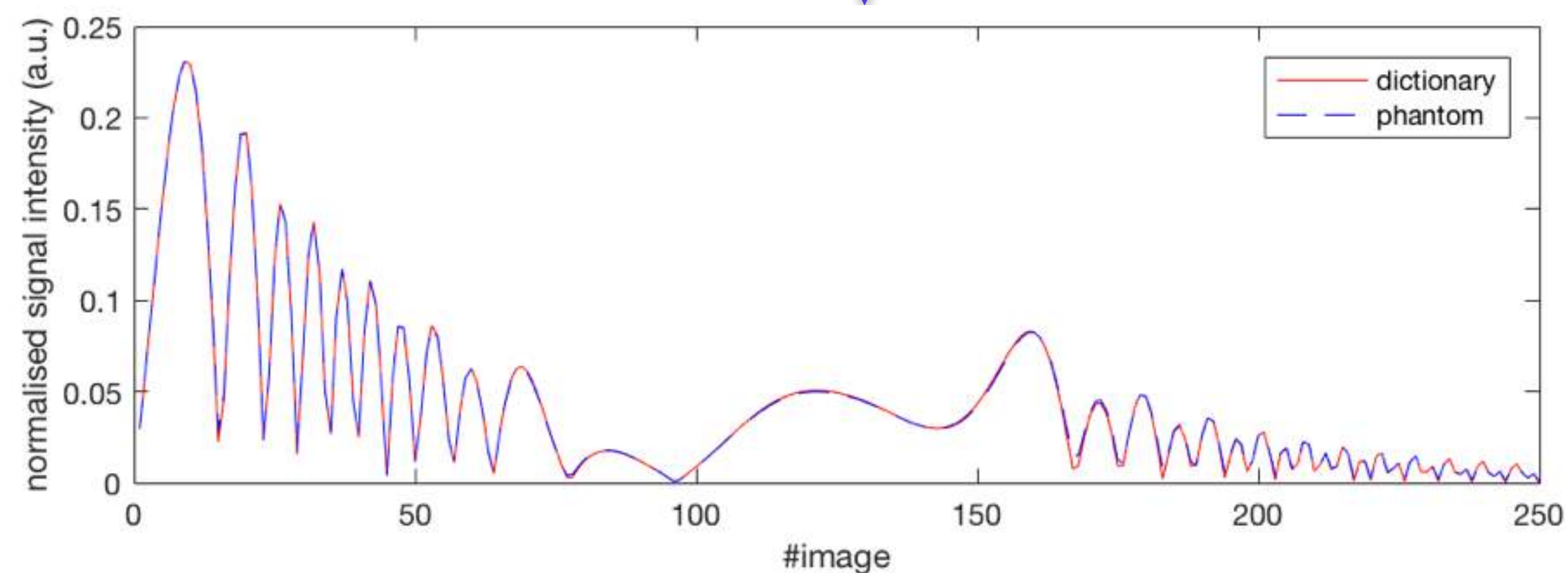
Images



Dictionary

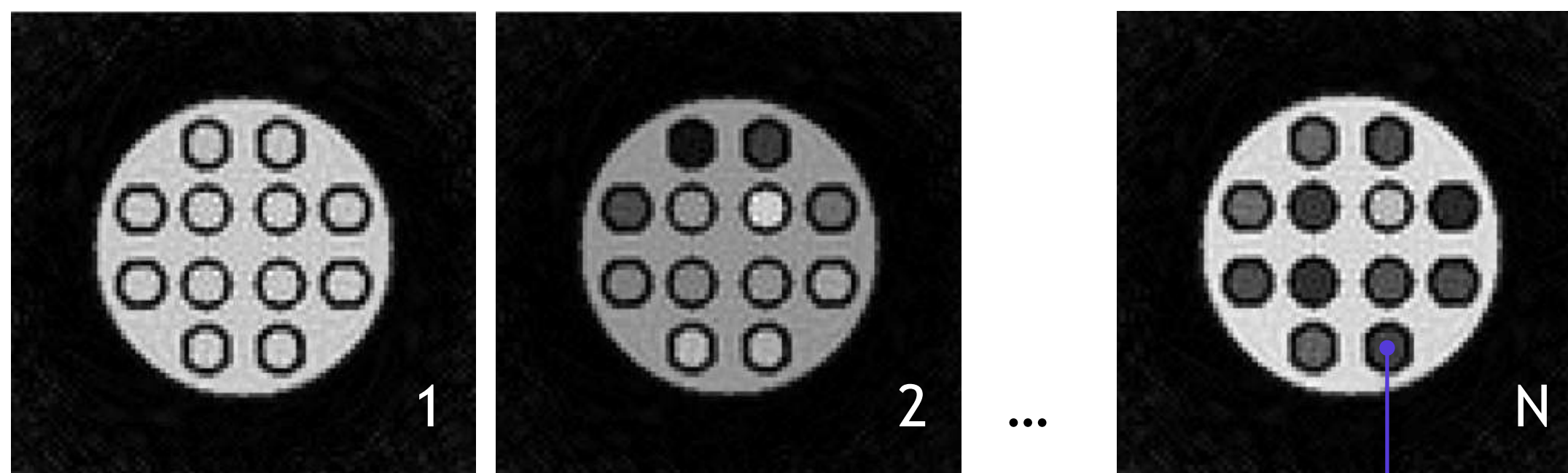


Vector dot-product

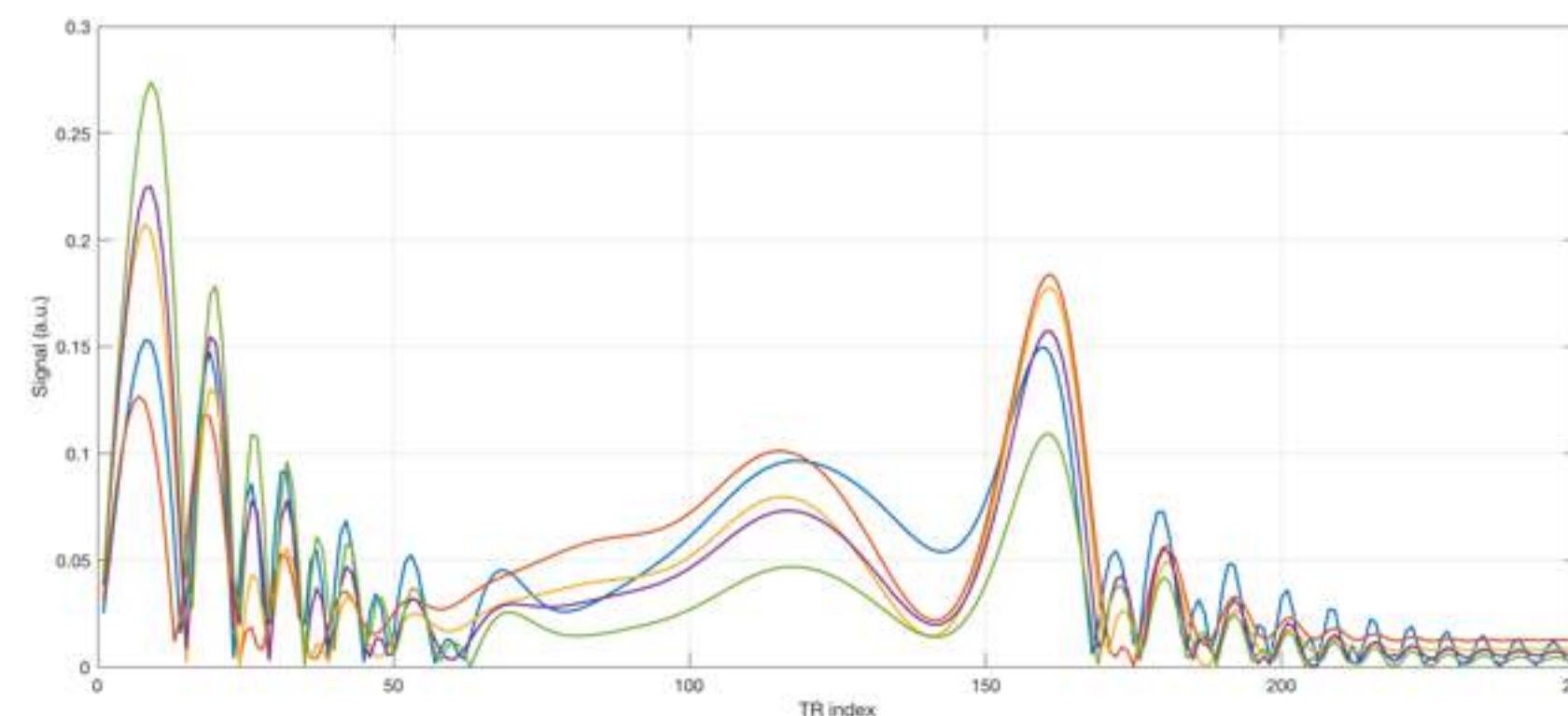


Progress to Date: Pattern Matching between images and dictionary

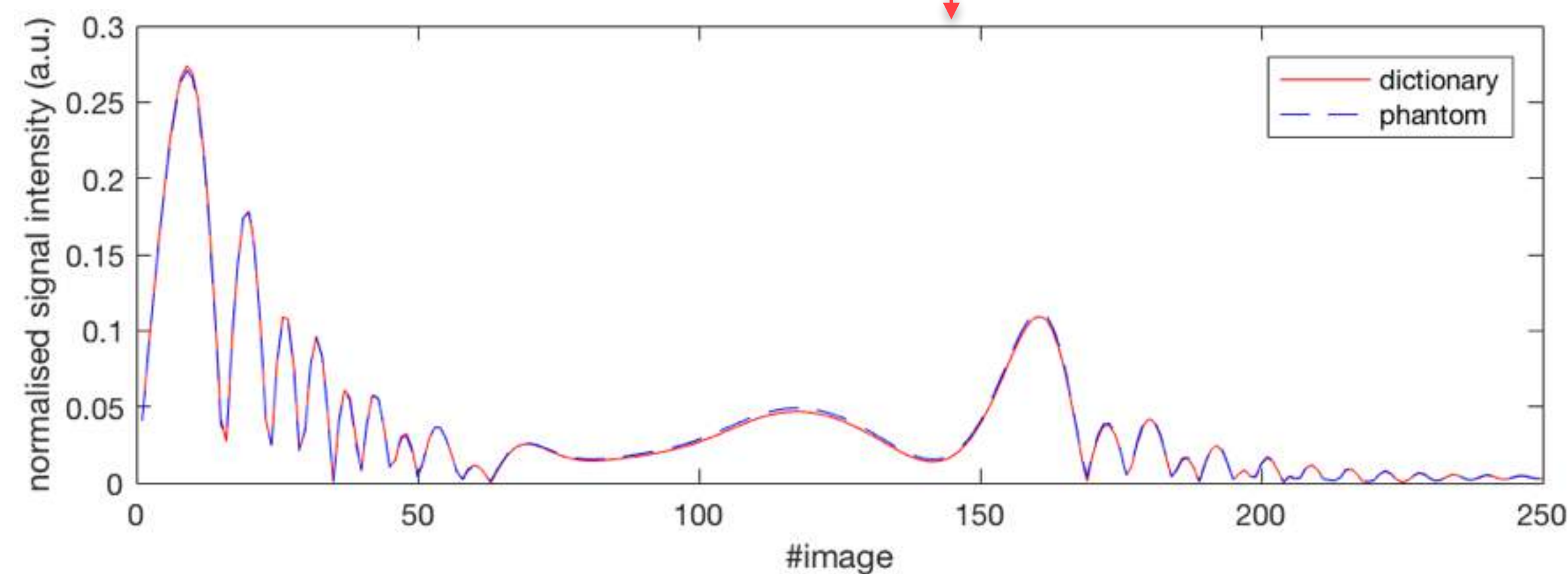
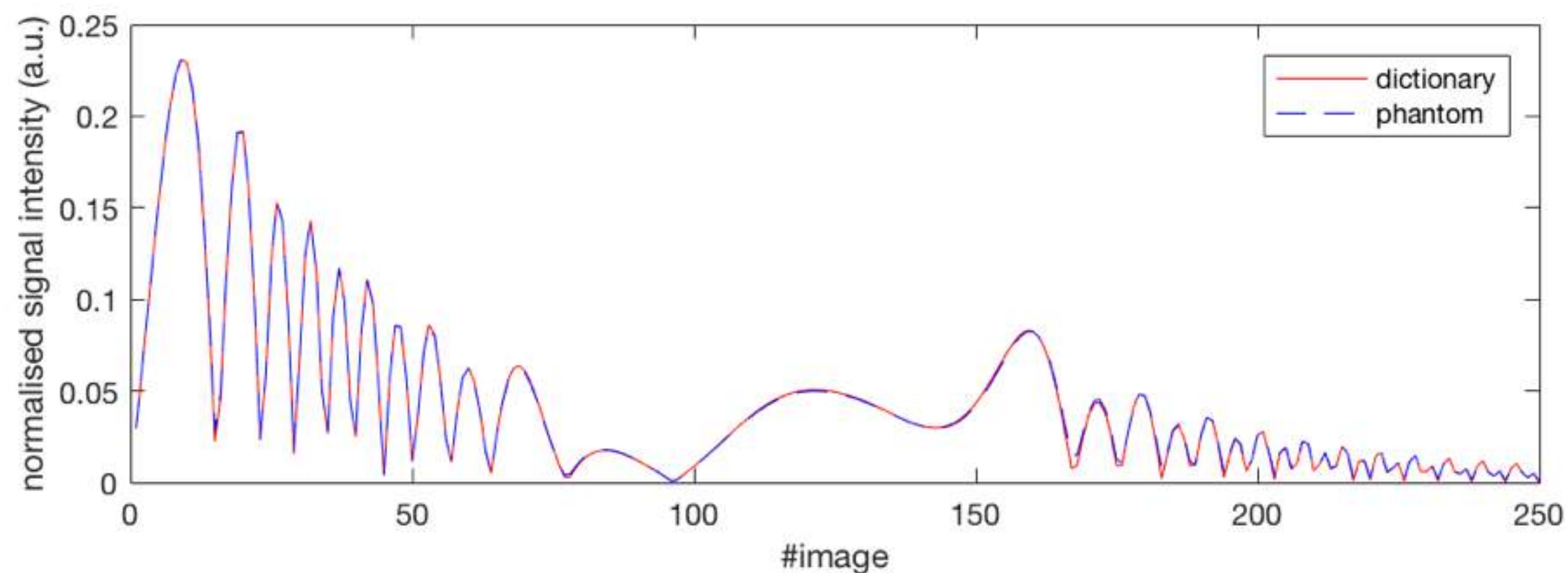
Images



Dictionary



Vector dot-product



The MRF Pipeline

Data Collection

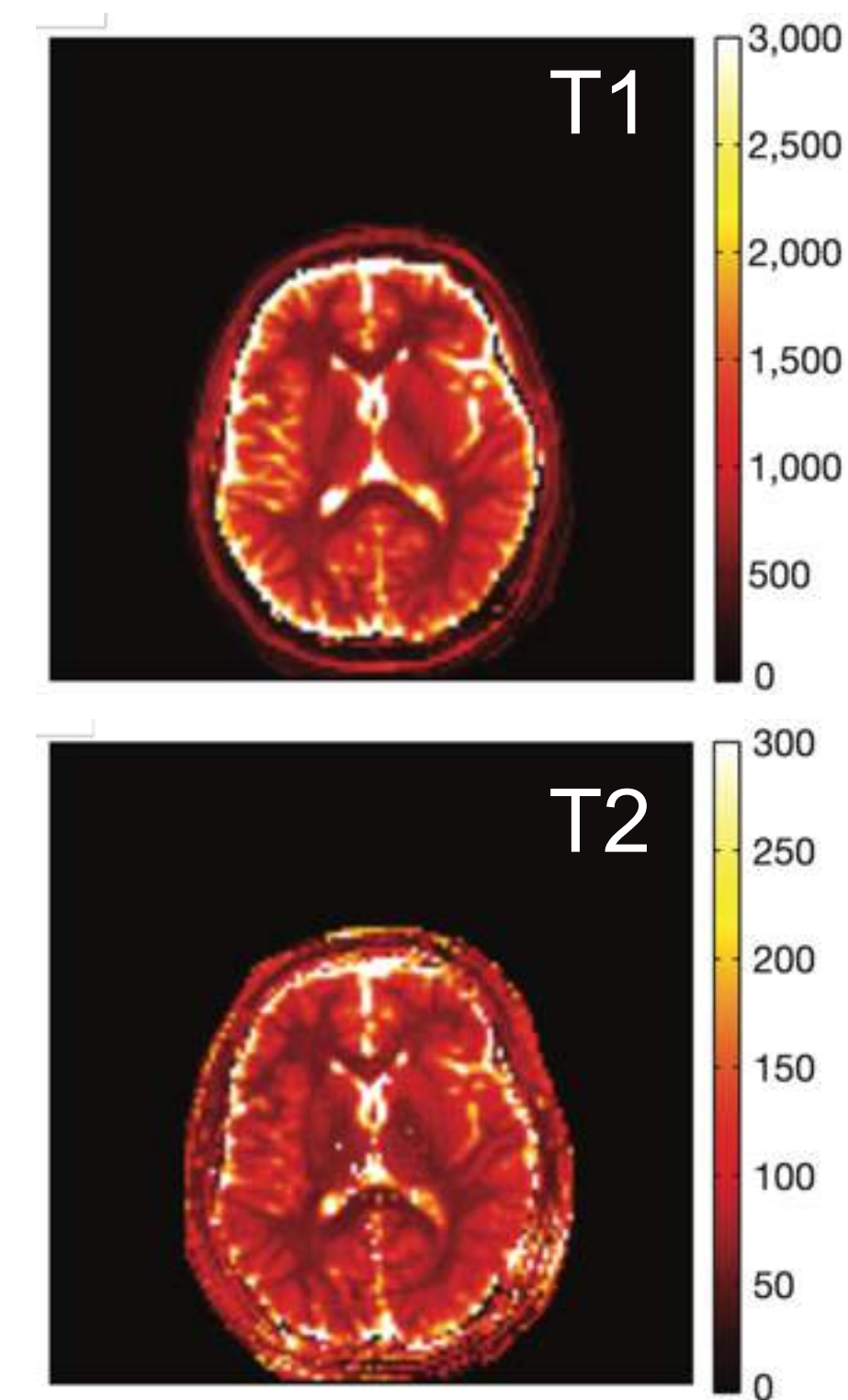
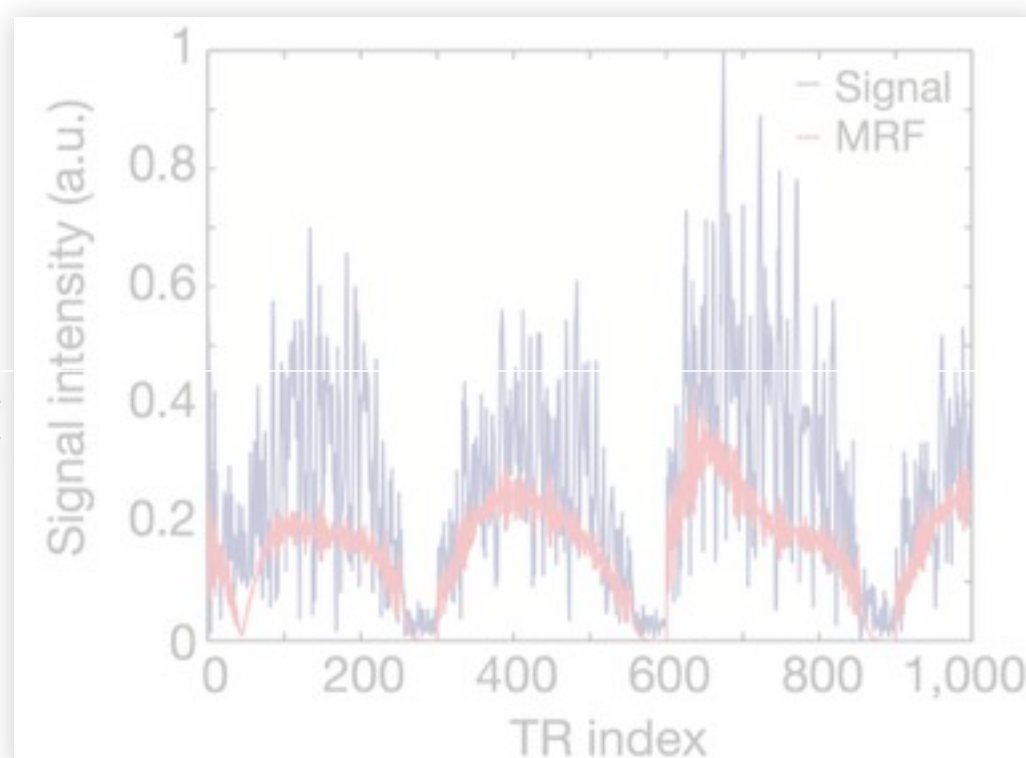
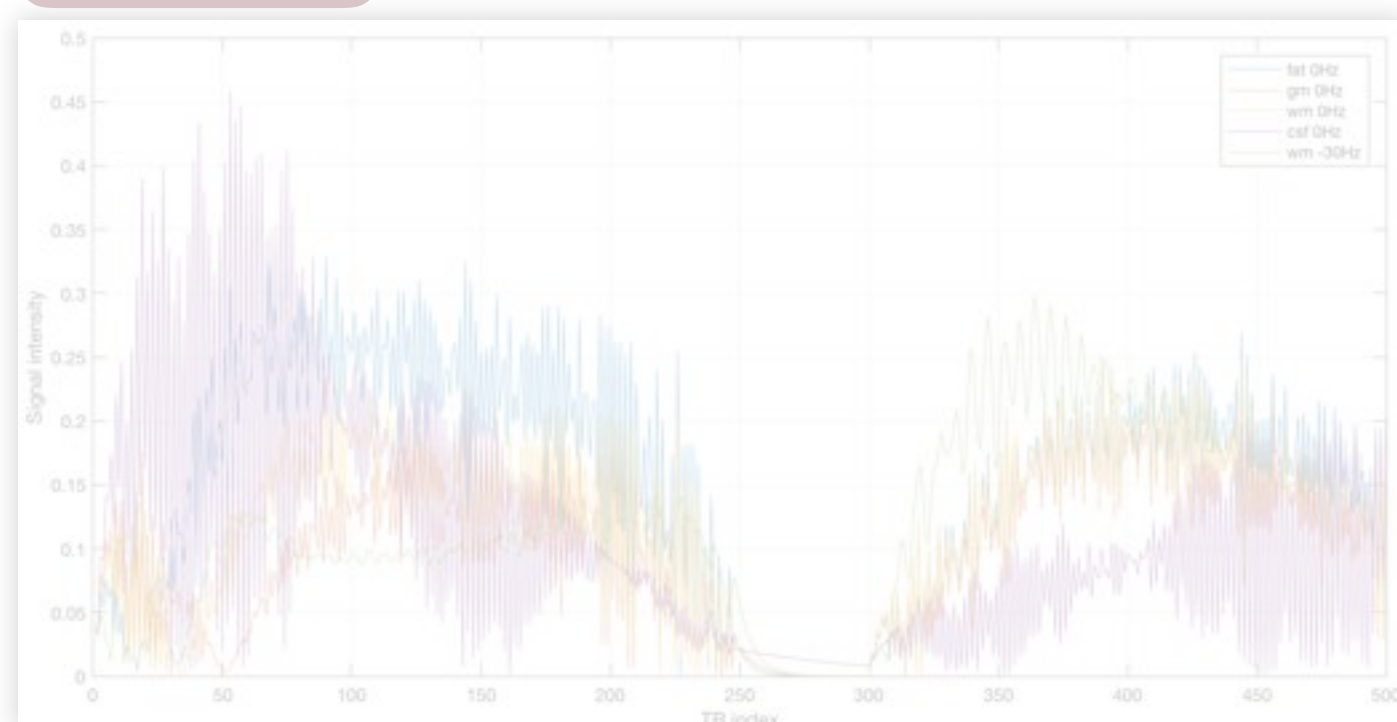
Pattern Recognition

Information

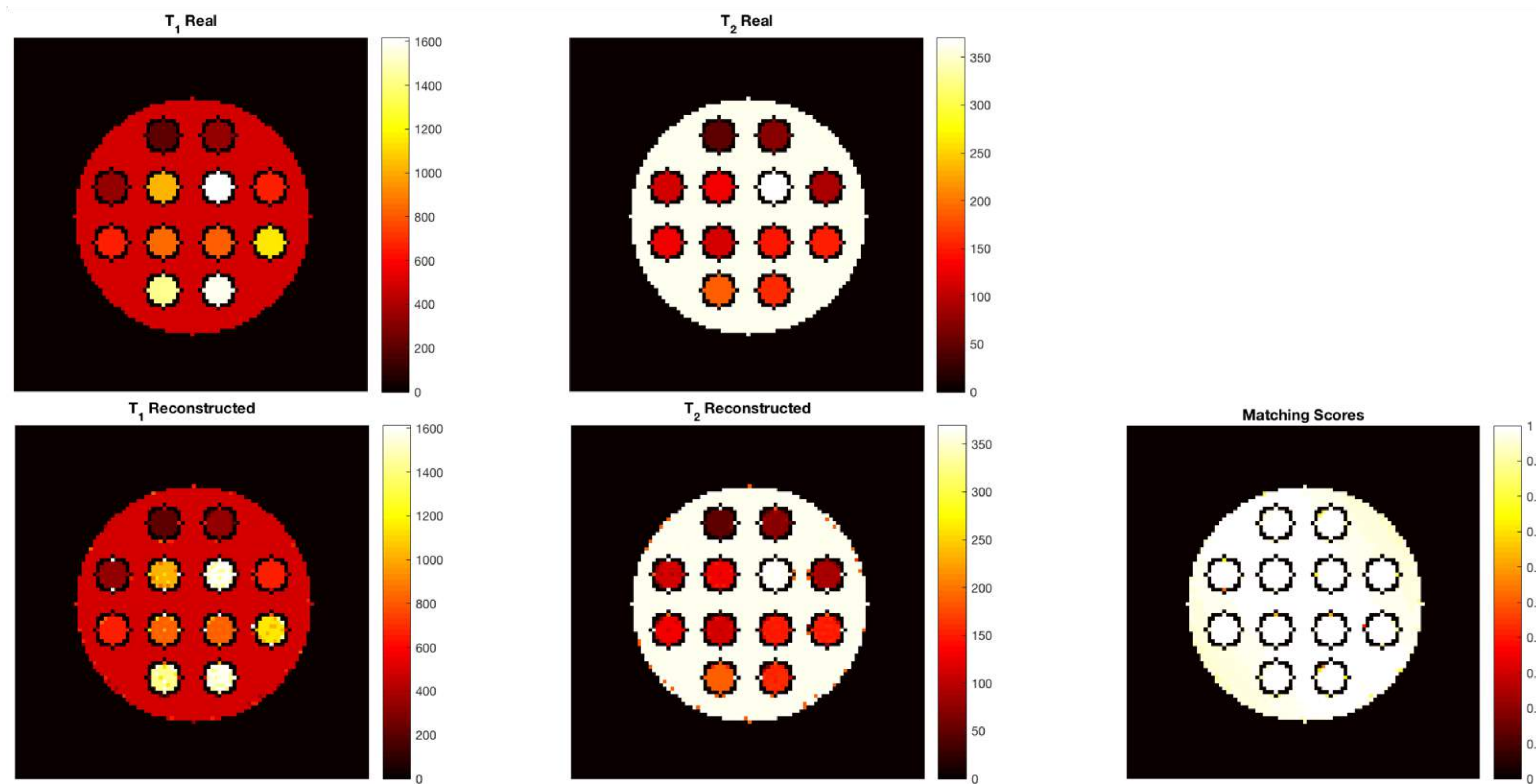
Images



Dictionary

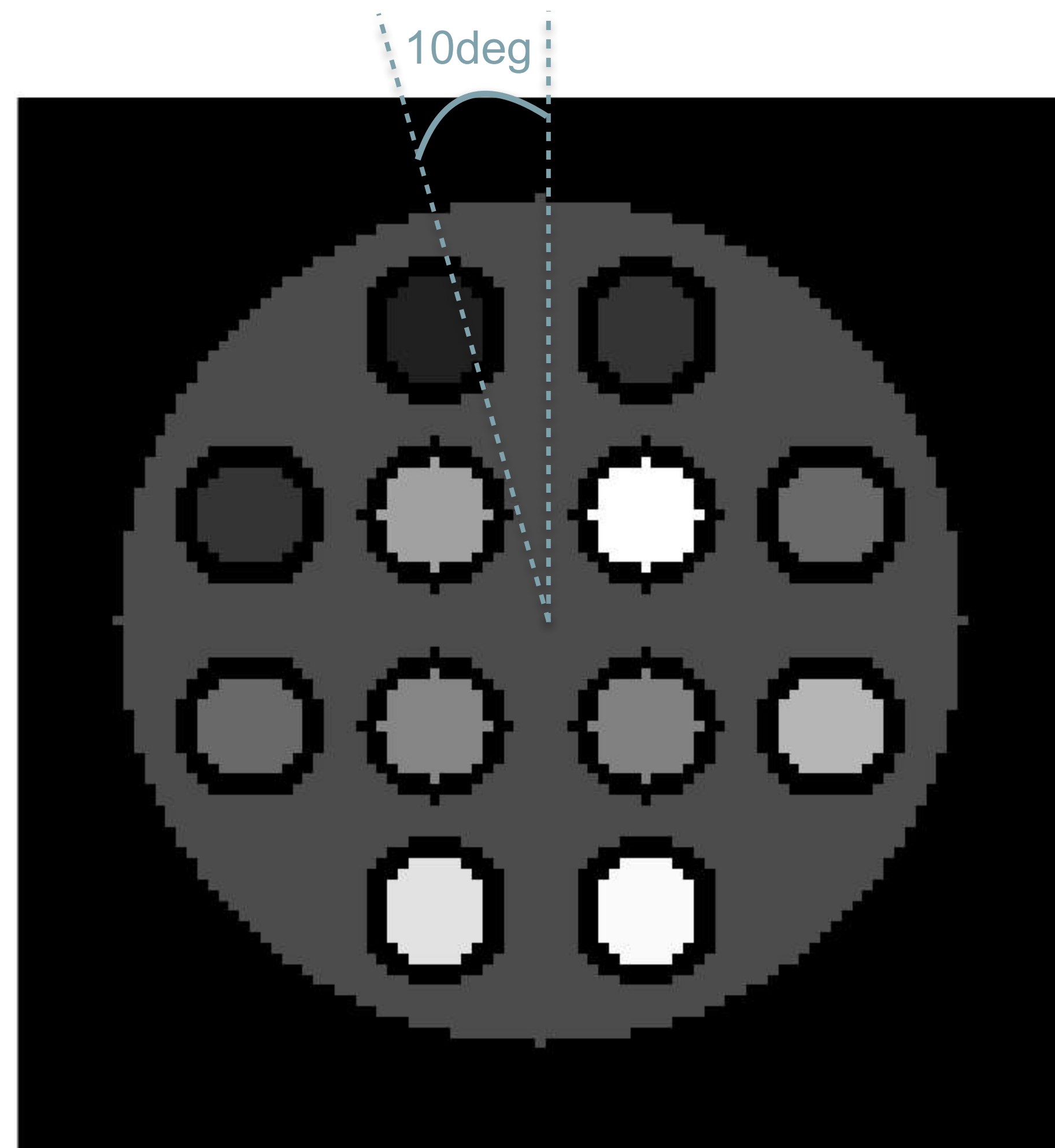


Progress to Date: Created the quantitative maps for motion free data

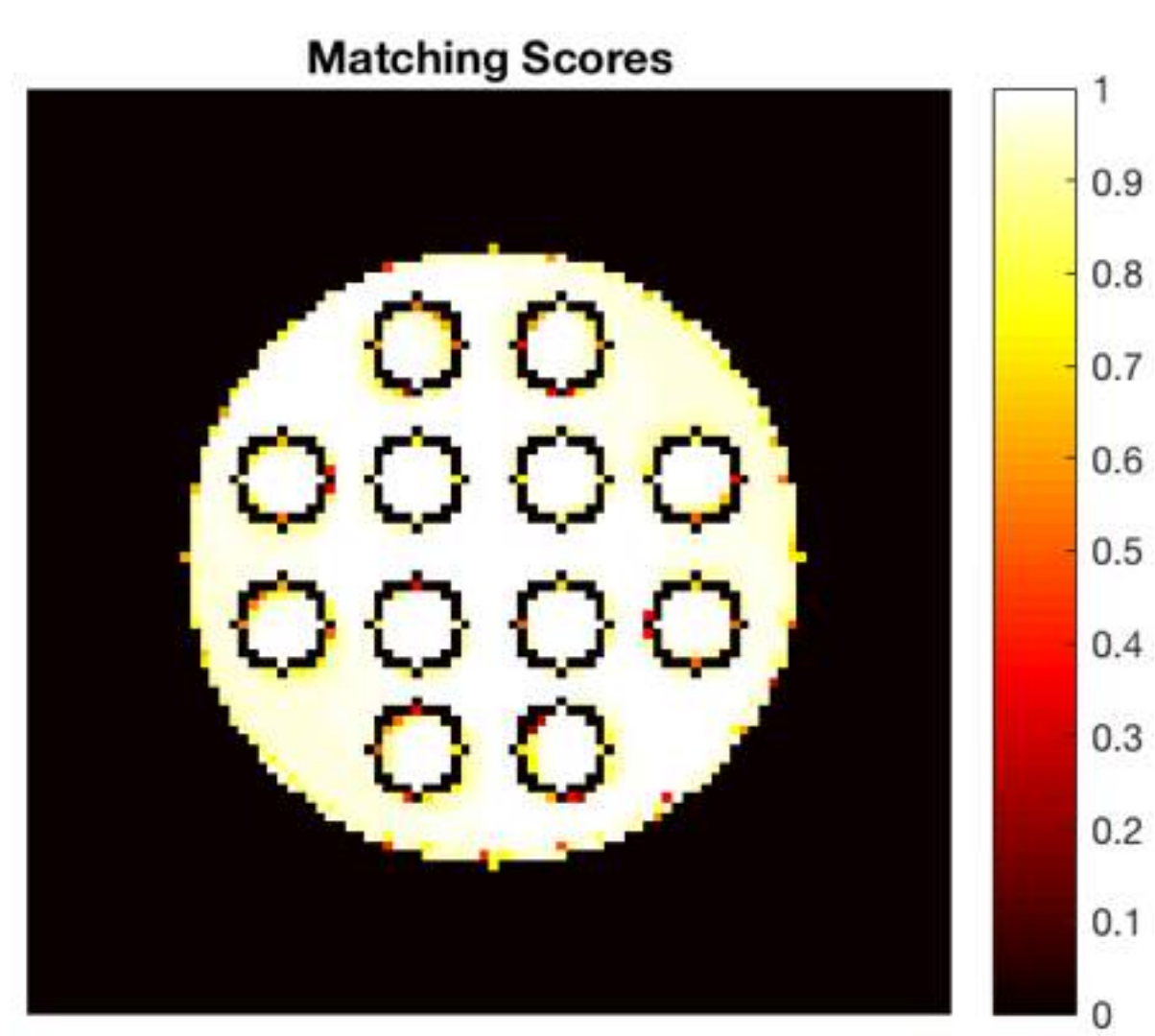
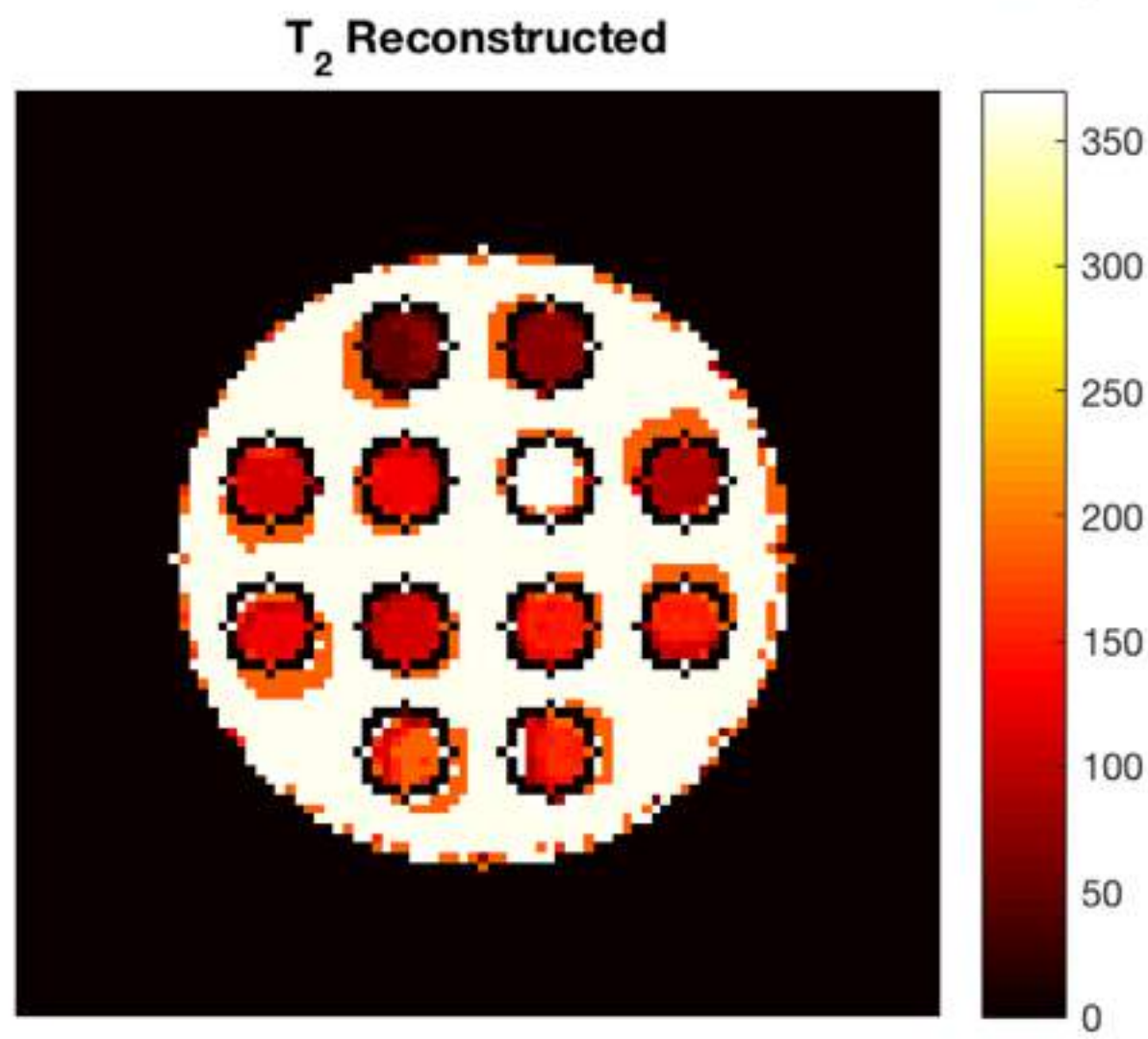
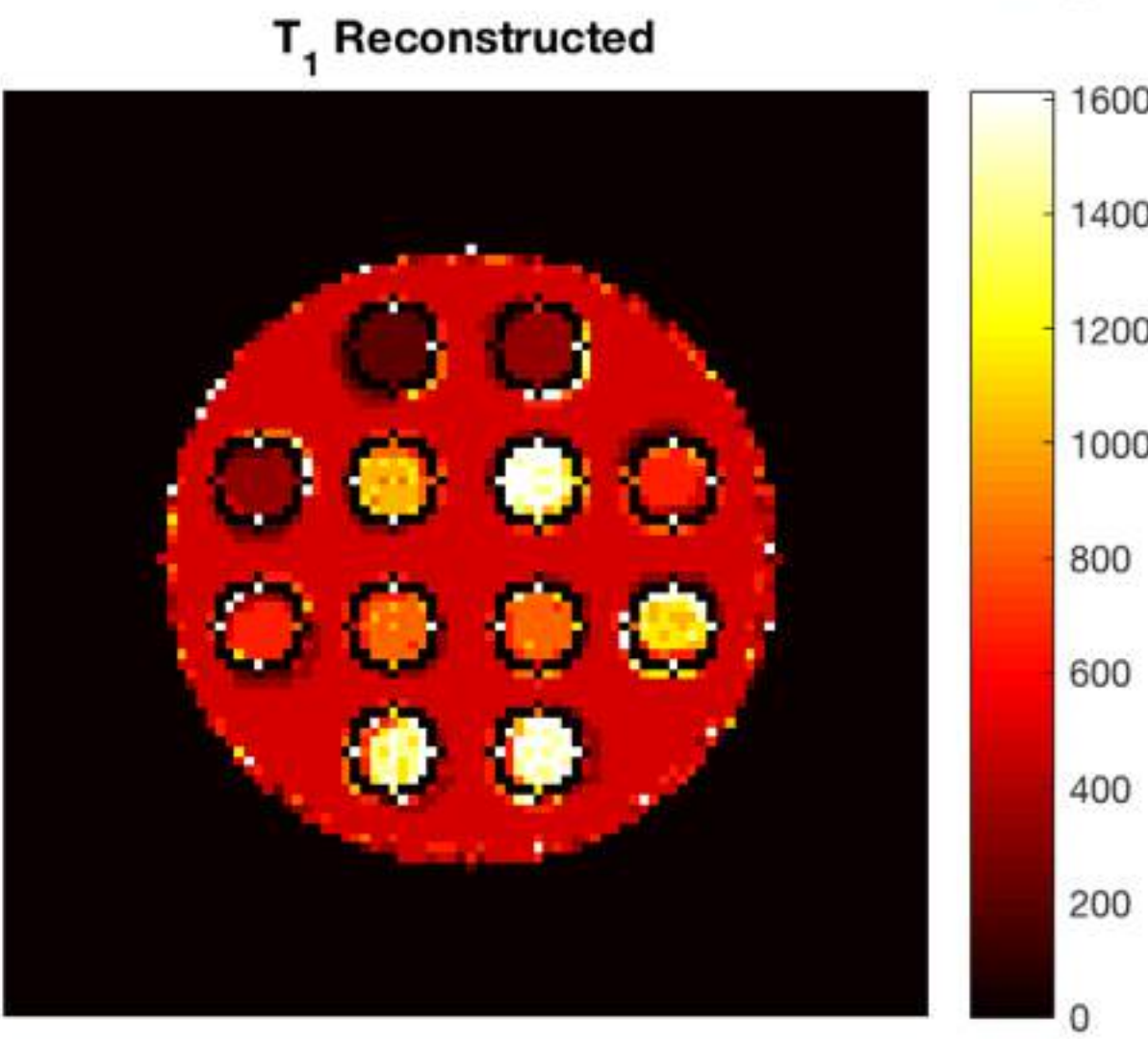
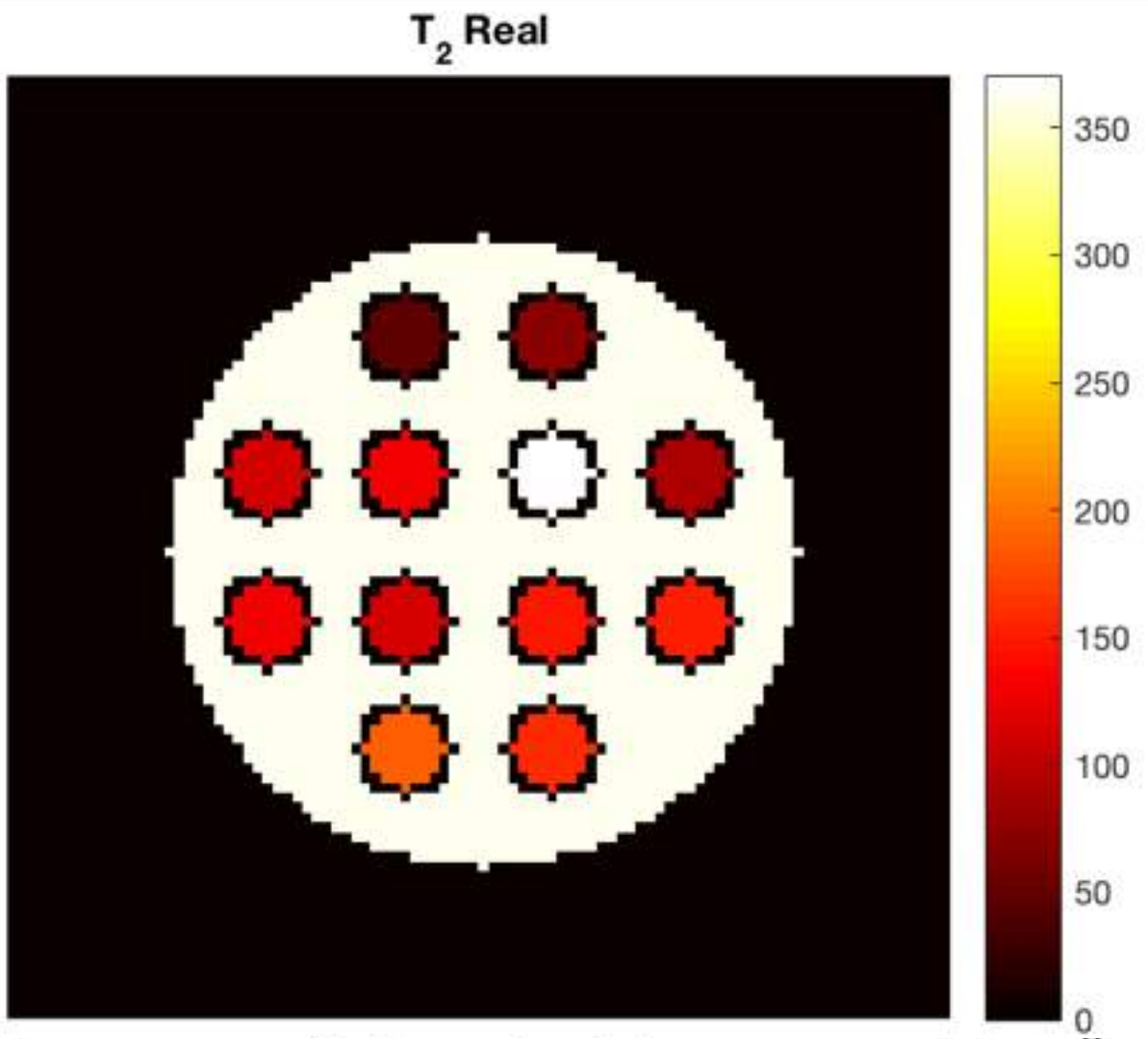
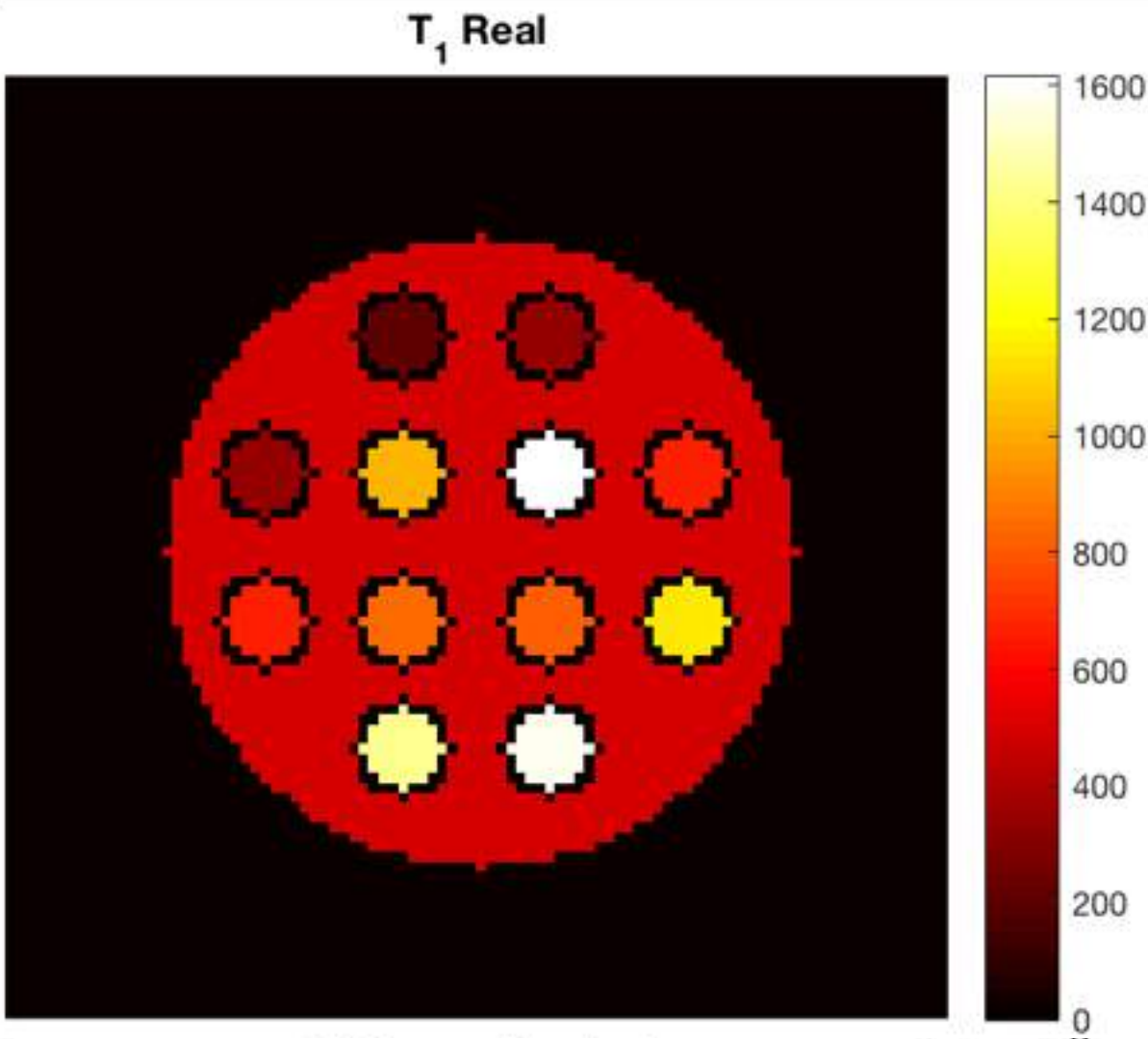


Adding Motion

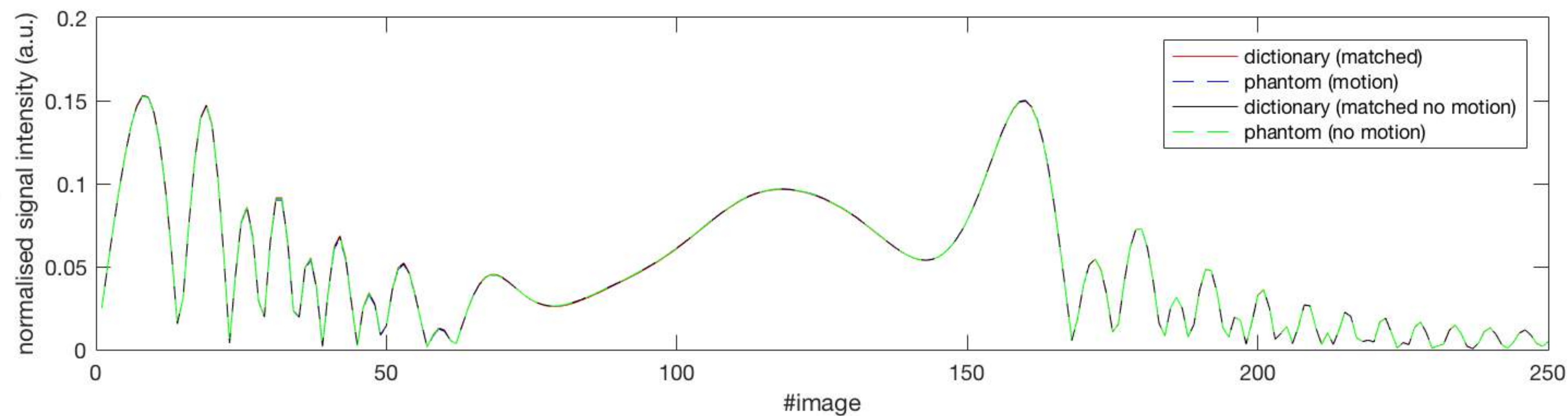
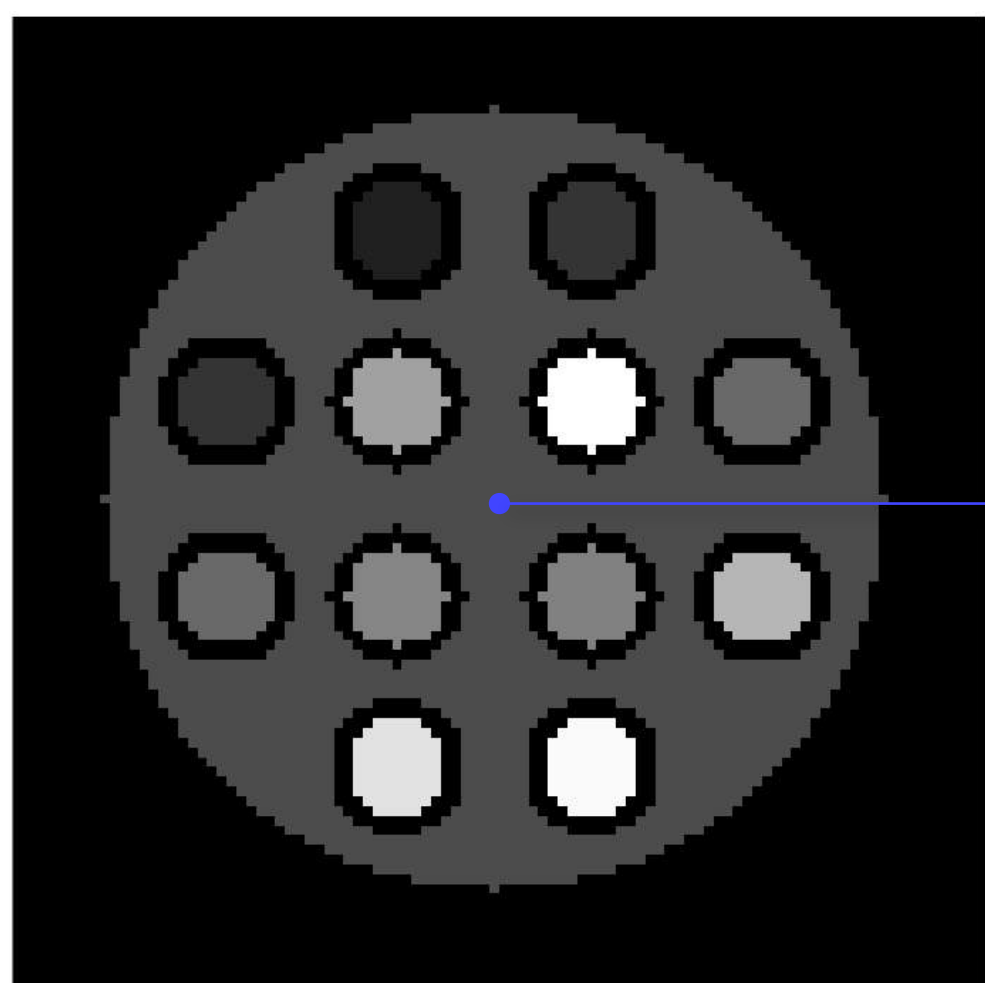
Progress to Date: In-plane rigid motion simulations



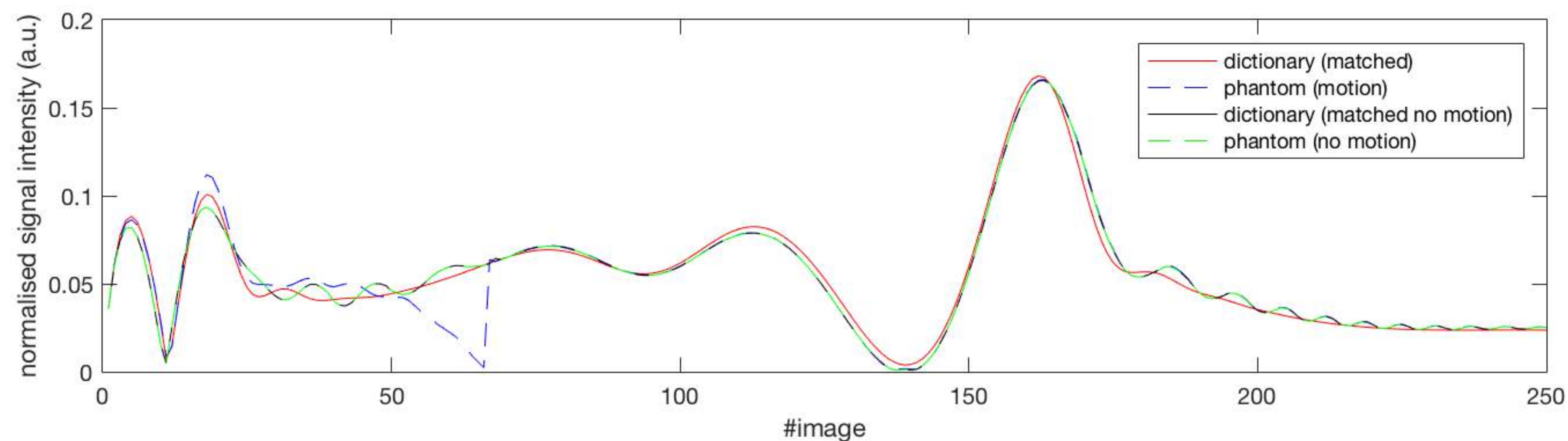
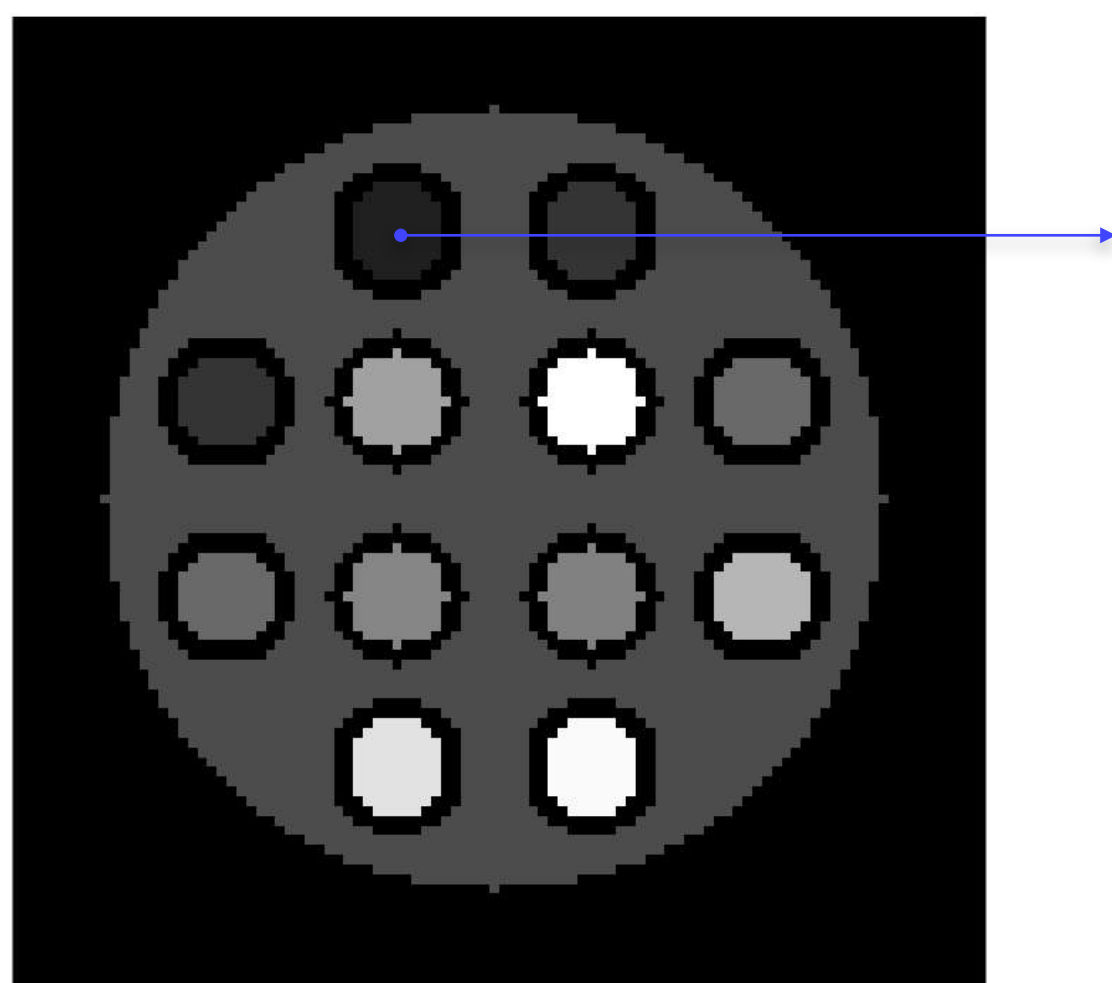
Progress to Date: Quantitative maps for motion corrupted data



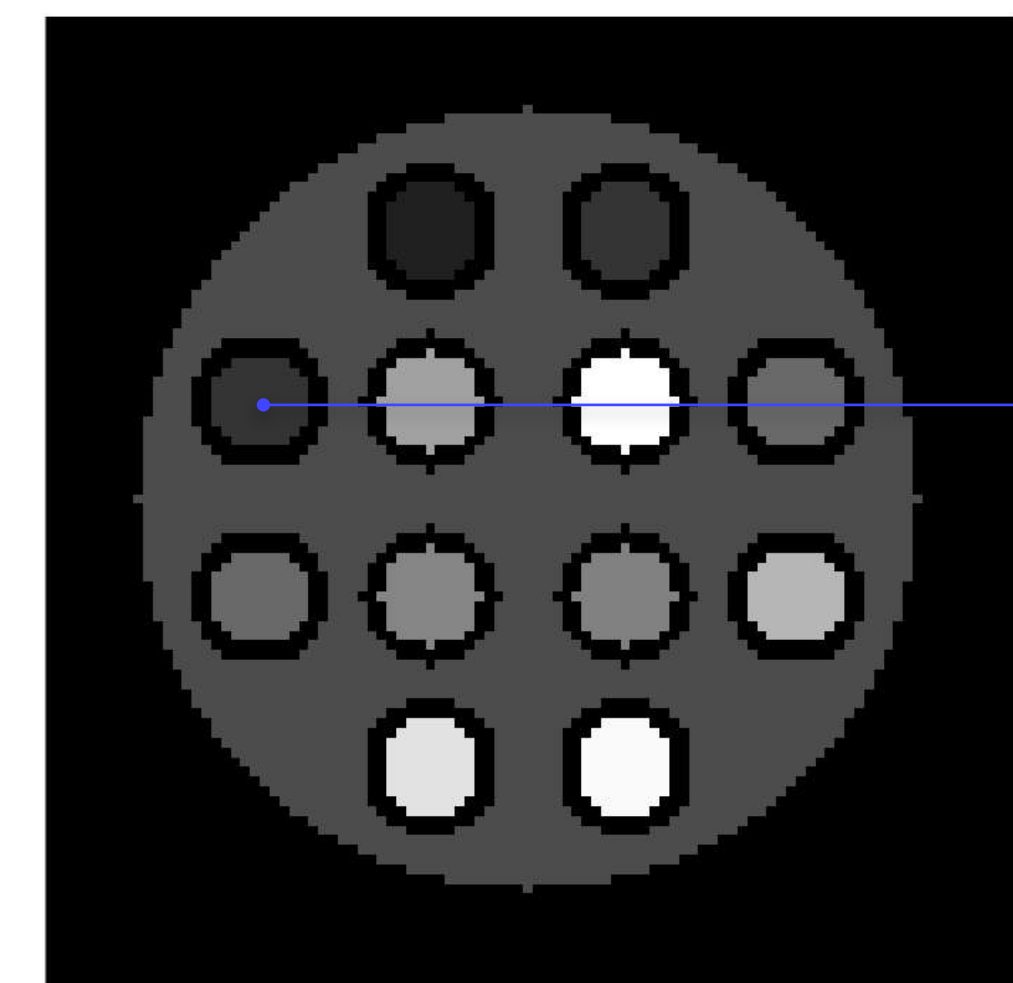
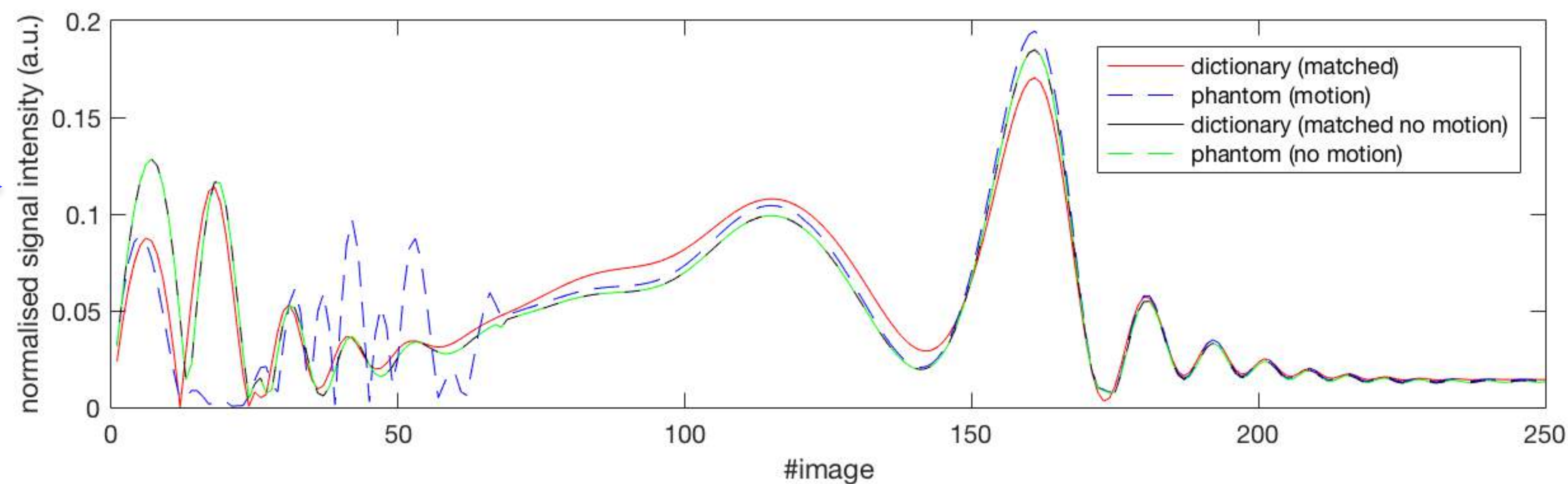
Progress to Date: Looking at individual voxels (motion corrupted)



Progress to Date: Looking at individual voxels (motion corrupted)



Progress to Date: Looking at individual voxels (motion corrupted)



Conclusions and Future Work

Conclusions

- Put in place the building blocks for a simulation framework.
- Investigated the impact of in-plane continuous rotation at the beginning of a scan.

Future Work

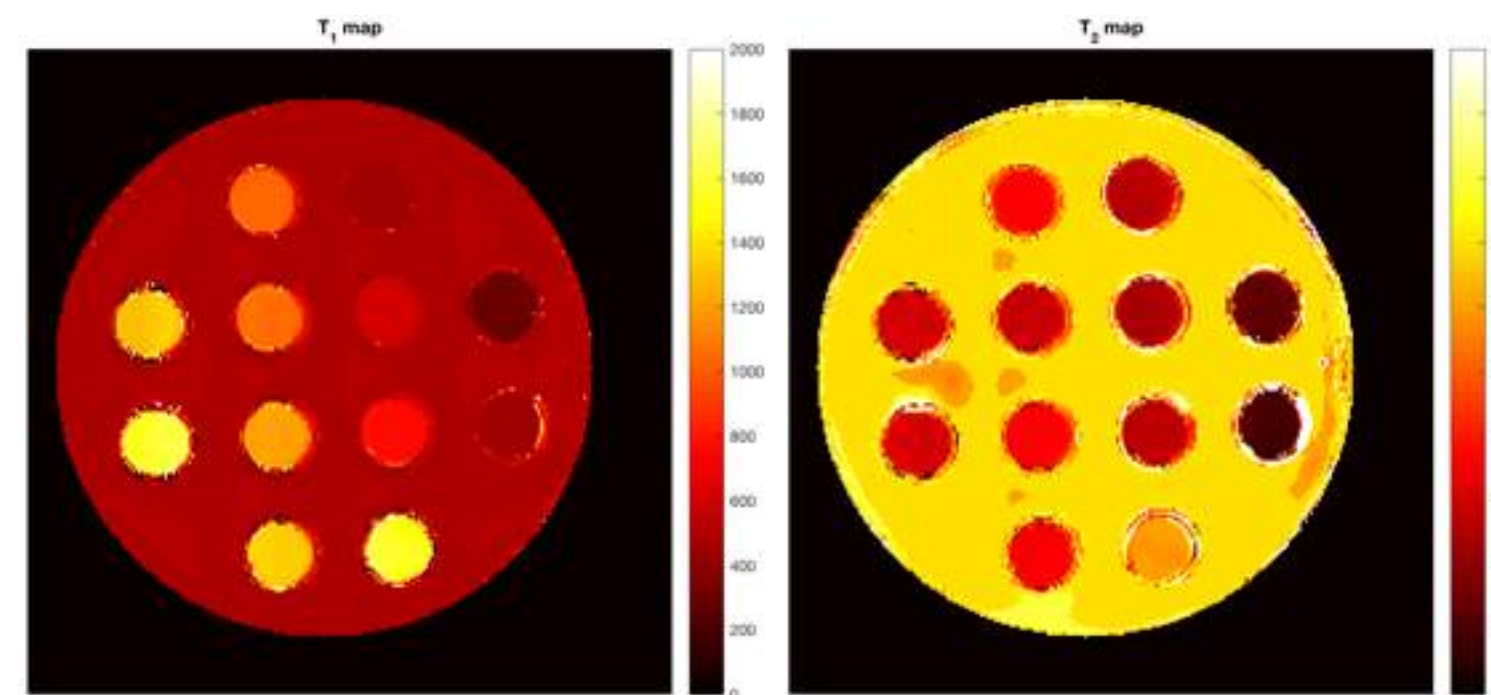
- Continue with motion-corrupted MRF-bSSFP experiments
 - Through-plane motion
 - In-plane and through-plane motion

Future Work

- Continue with motion-corrupted MRF-bSSFP experiments
- Extend to MRF-FISP
 - Bring the simulation time to more reasonable time scales.

Future Work

- Continue with motion-corrupted MRF-bSSFP experiments
- Extend to MRF-FISP
- Validate Simulation
 - Against real data



Future Work

- Continue with motion-corrupted MRF-bSSFP experiments
- Extend to MRF-FISP
- Validate Simulation
- Investigate the impact of motion on an MRF-FISP experiment

Thank you!

Dictionary Generation

Tissue Parameters

$T_1 = [20:10:3000, \ 3250:250:5000]ms$
 $T_2 = [10: \ 5: \ 300, \ 350: \ 50:2200]ms$

+

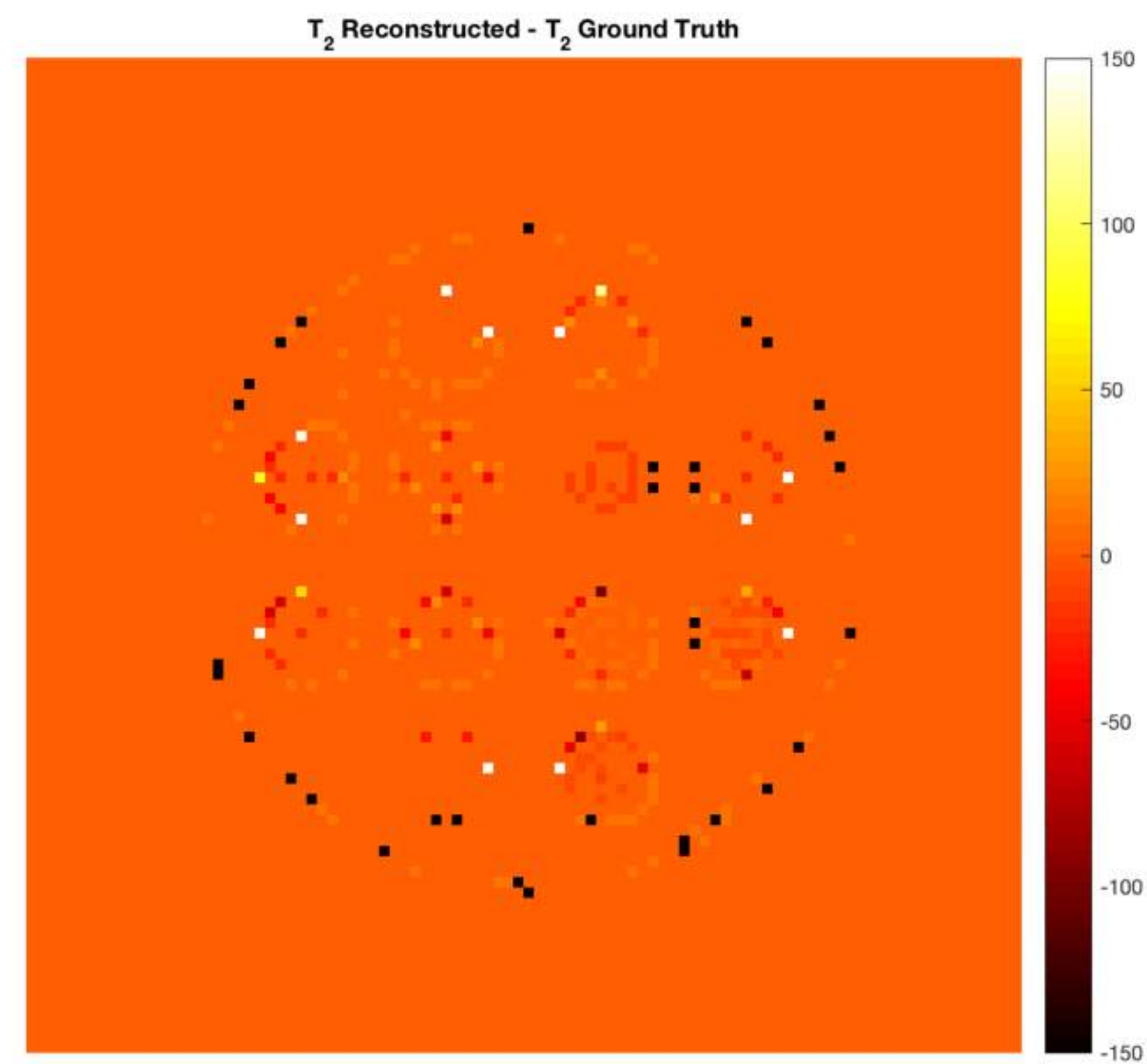
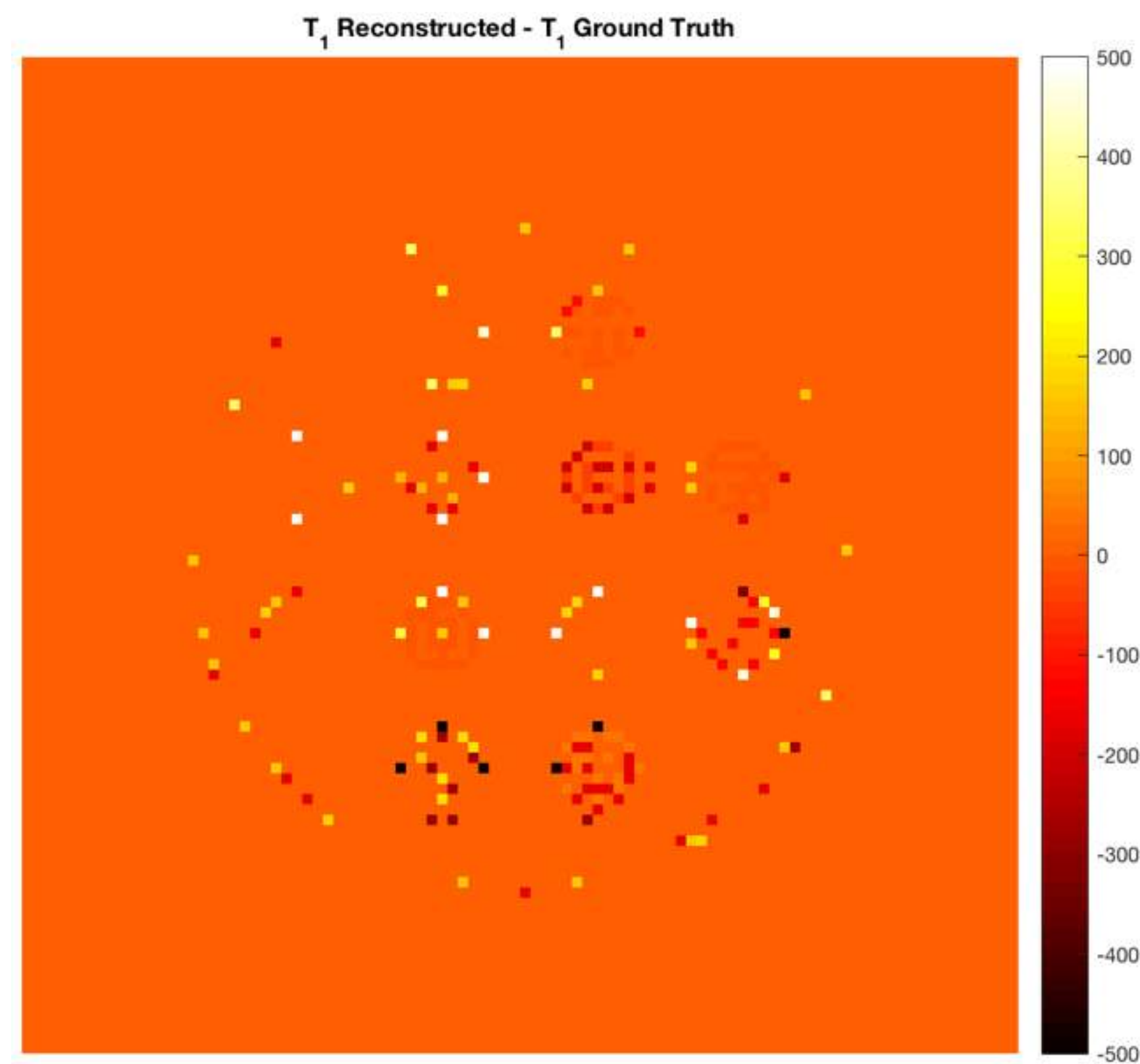
Bloch Equations

Extended Phase Graph

||

Two dictionaries: 24198 fingerprints each

Quantitative Maps



Quantitative Maps

