

A CAIPI Approach to Increase Activation Detection for SMS Technique in fMRI

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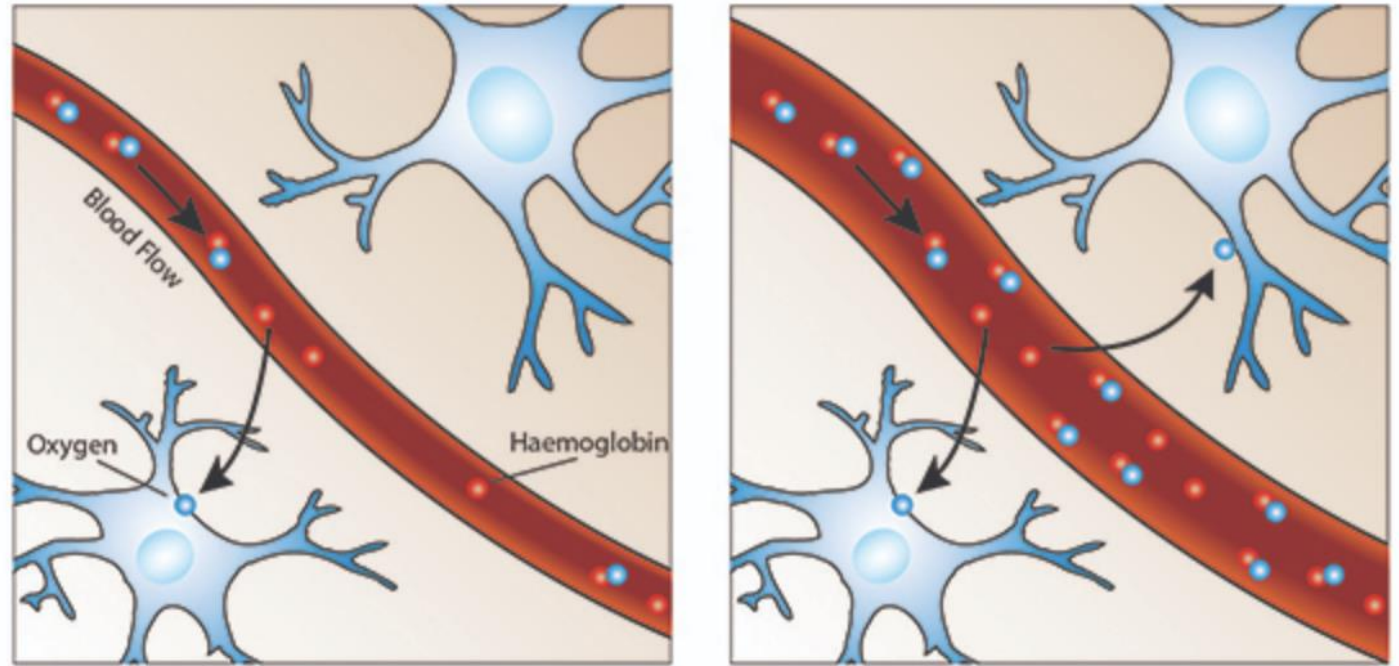
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1. Introduction

- **What is fMRI?**
 - Functional Magnetic Resonance Imaging
 - Non-invasive and safe tool
 - Rely on Blood Oxygen Level Dependence (BOLD) contrast signal

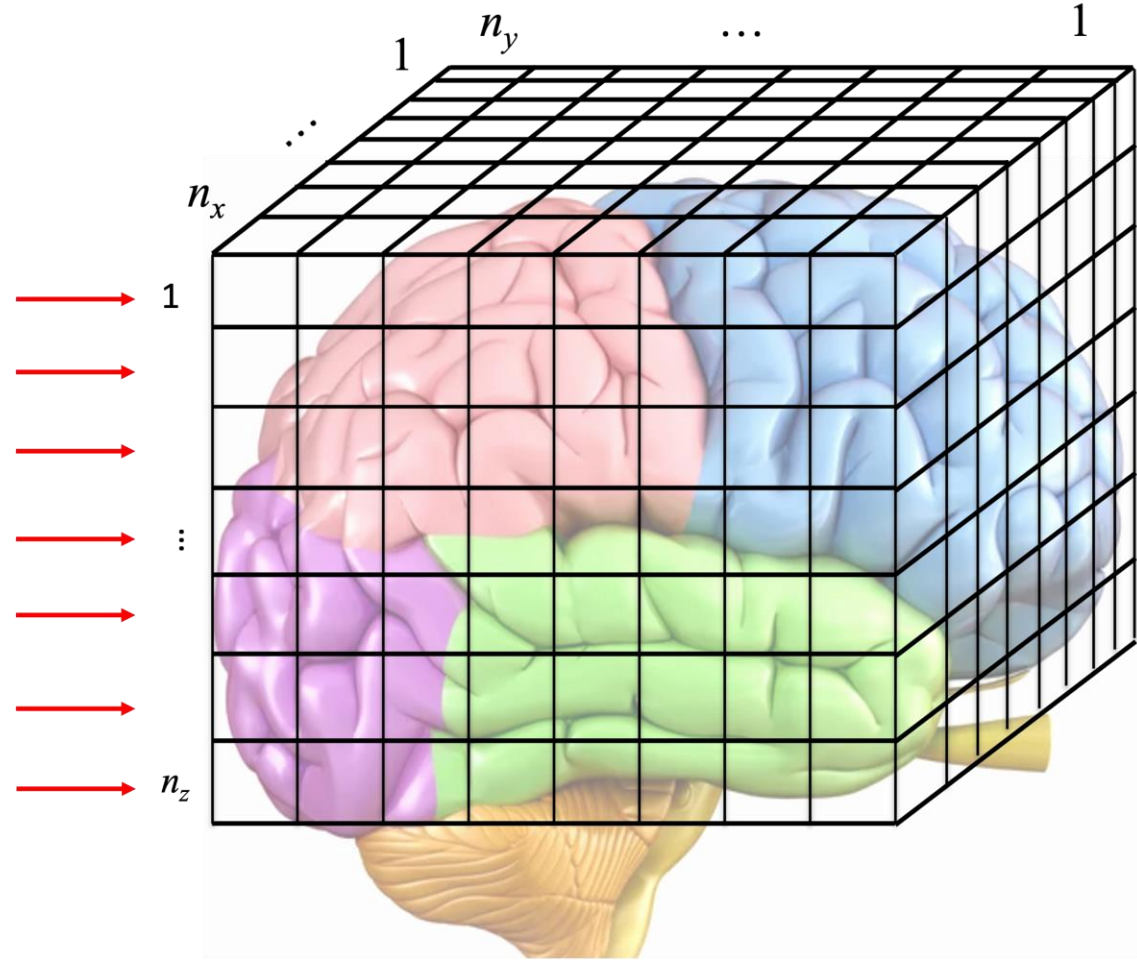


Volume Image



Resting

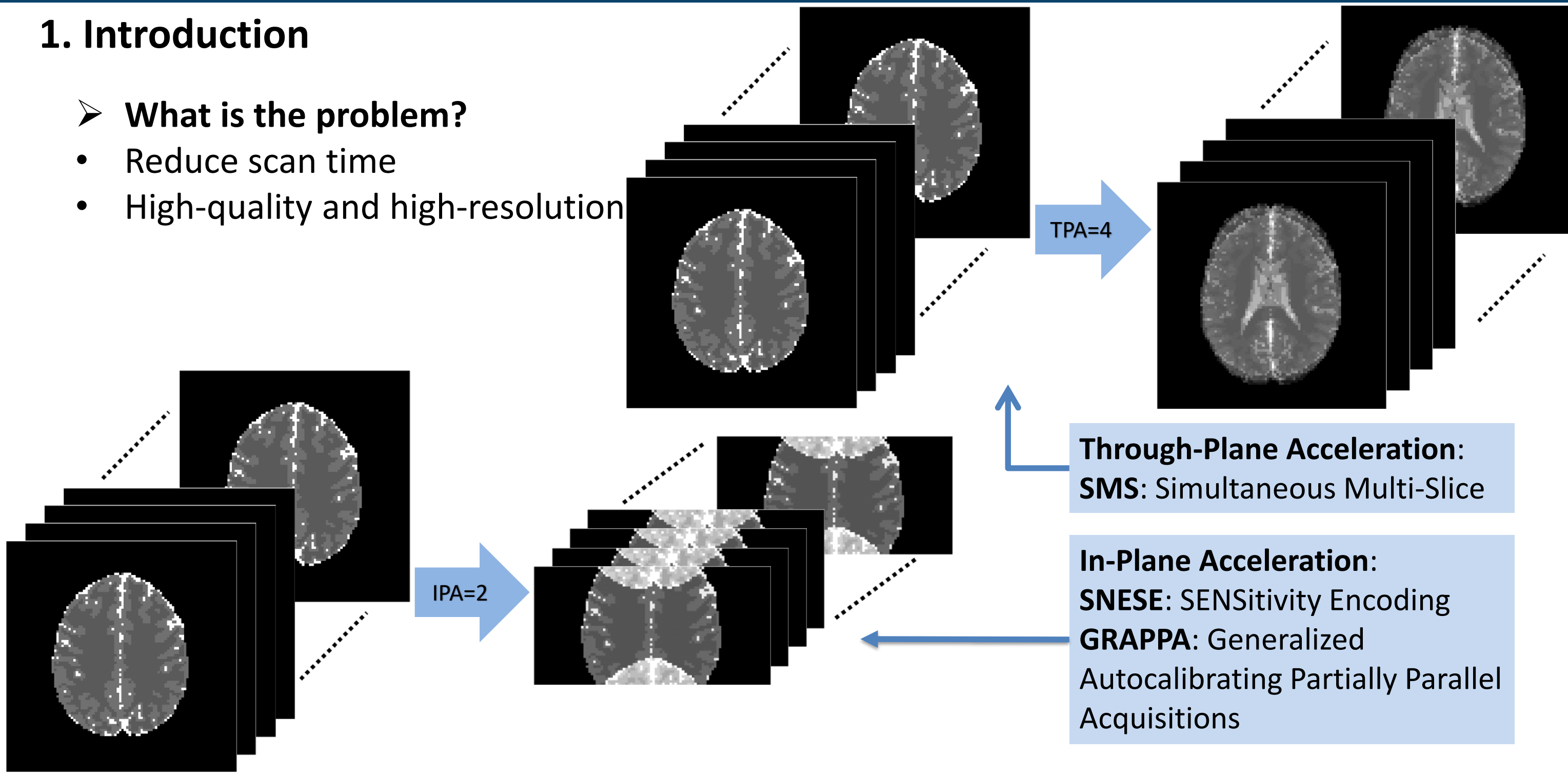
Activated



*<https://biic.ee.nthu.edu.tw/blog-detail.php?id=4>
 *From SMI 2024 Indianapolis talk by Dr. Daniel Rowe

1. Introduction

- **What is the problem?**
 - Reduce scan time
 - High-quality and high-resolution

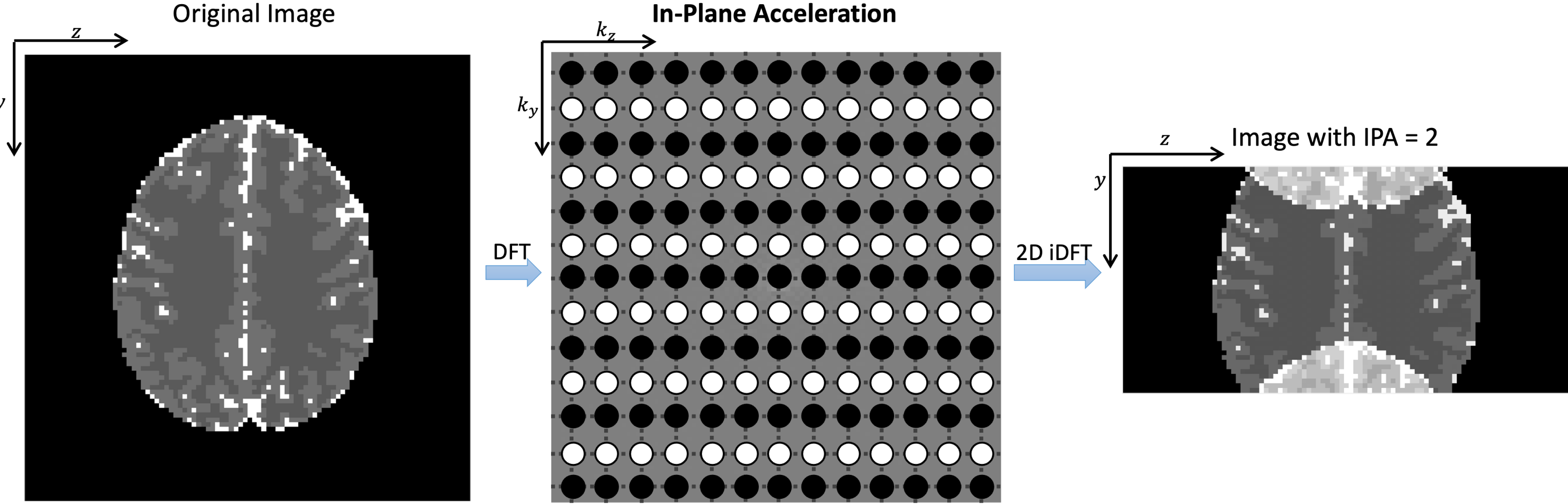


Through-Plane Acceleration:
SMS: Simultaneous Multi-Slice

In-Plane Acceleration:
SENSE: SENSitivity Encoding
GRAPPA: Generalized Autocalibrating Partially Parallel Acquisitions

2. mSPECS-IPA-CAIPI ➤ What is IPA?

- Parallel imaging reconstruction technique: reduce the total scan time
- Fixed time block: proper time to T_2^* , imaging encoding time

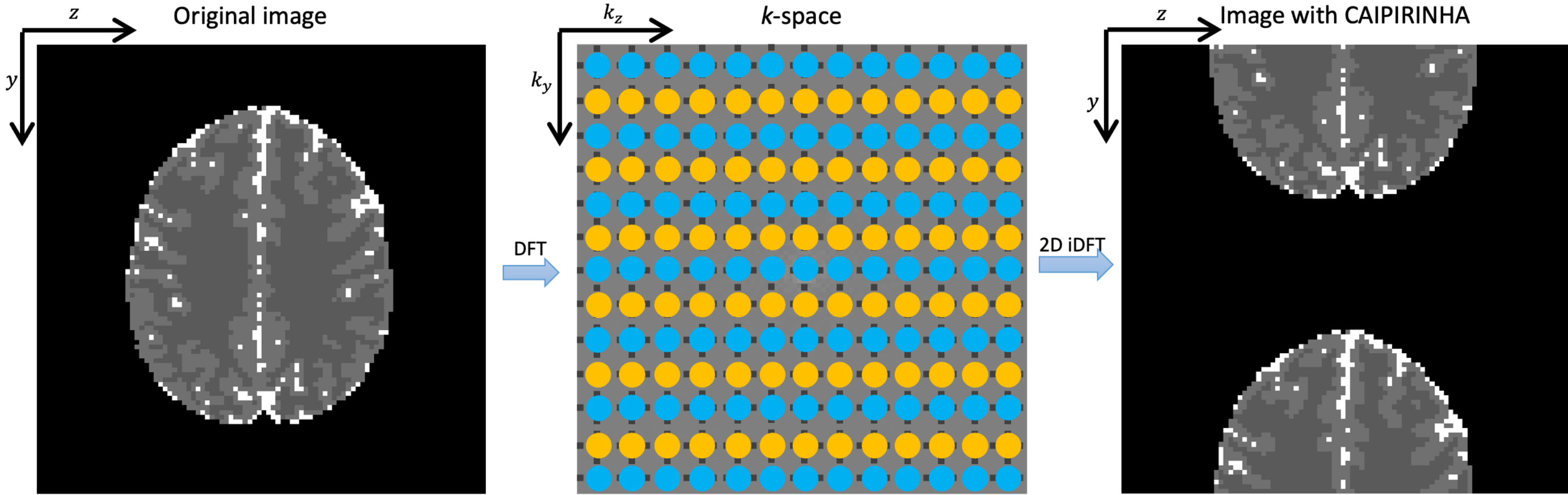


○ Data omitted in the k -space ● Data acquired in the k -space

2. mSPECS-IPA-CAIPI

- **What is CAIPI?**
 - CAIPIRINHA: Shift images along PE direction
 - CAIPIVAT: Shift images along PE and RO direction

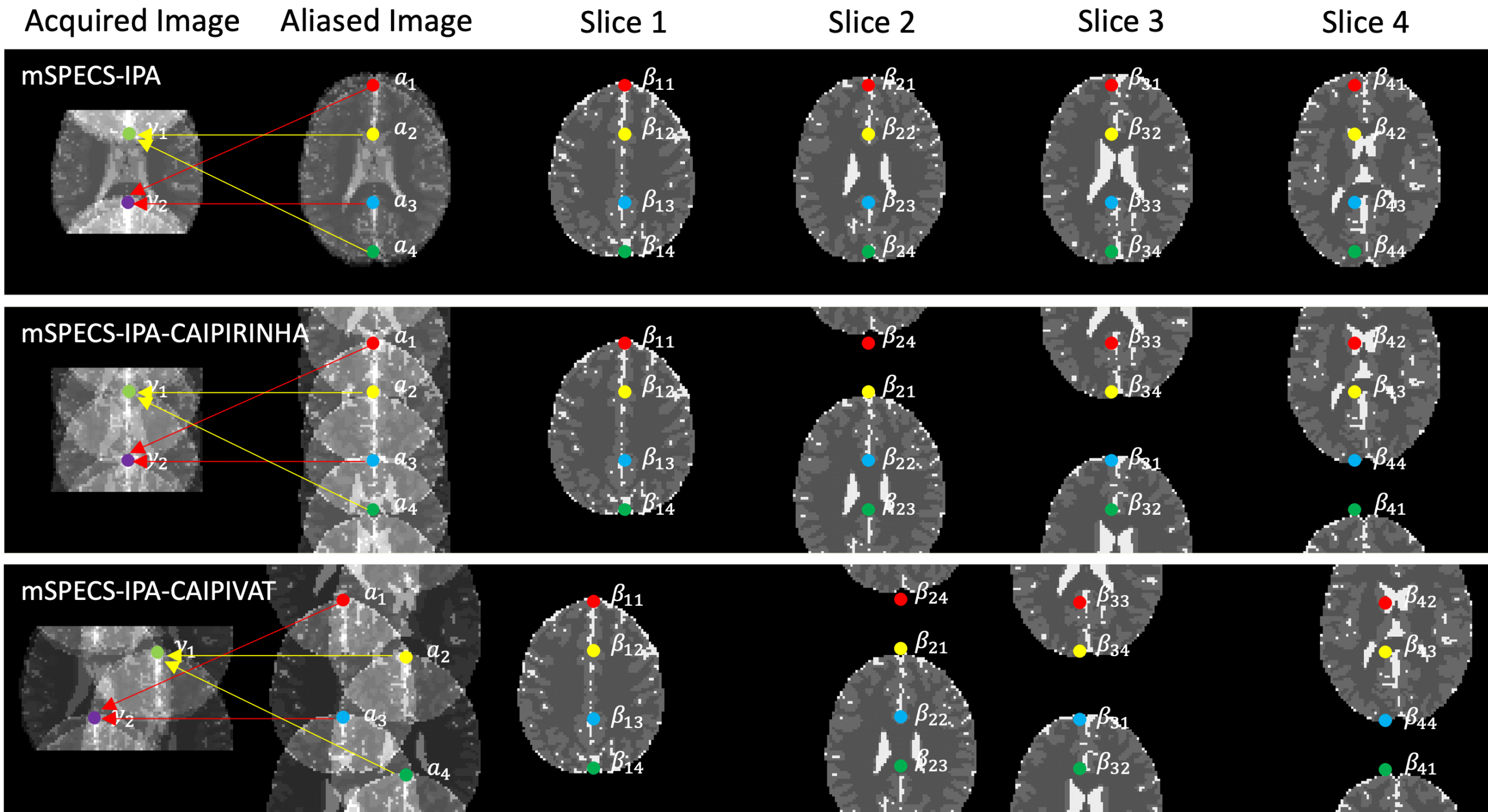
Achieved by a unique RF excitation with varying pulse phase in the MRI scanner.



● Data with phase modulation of π ● Data without phase modulation

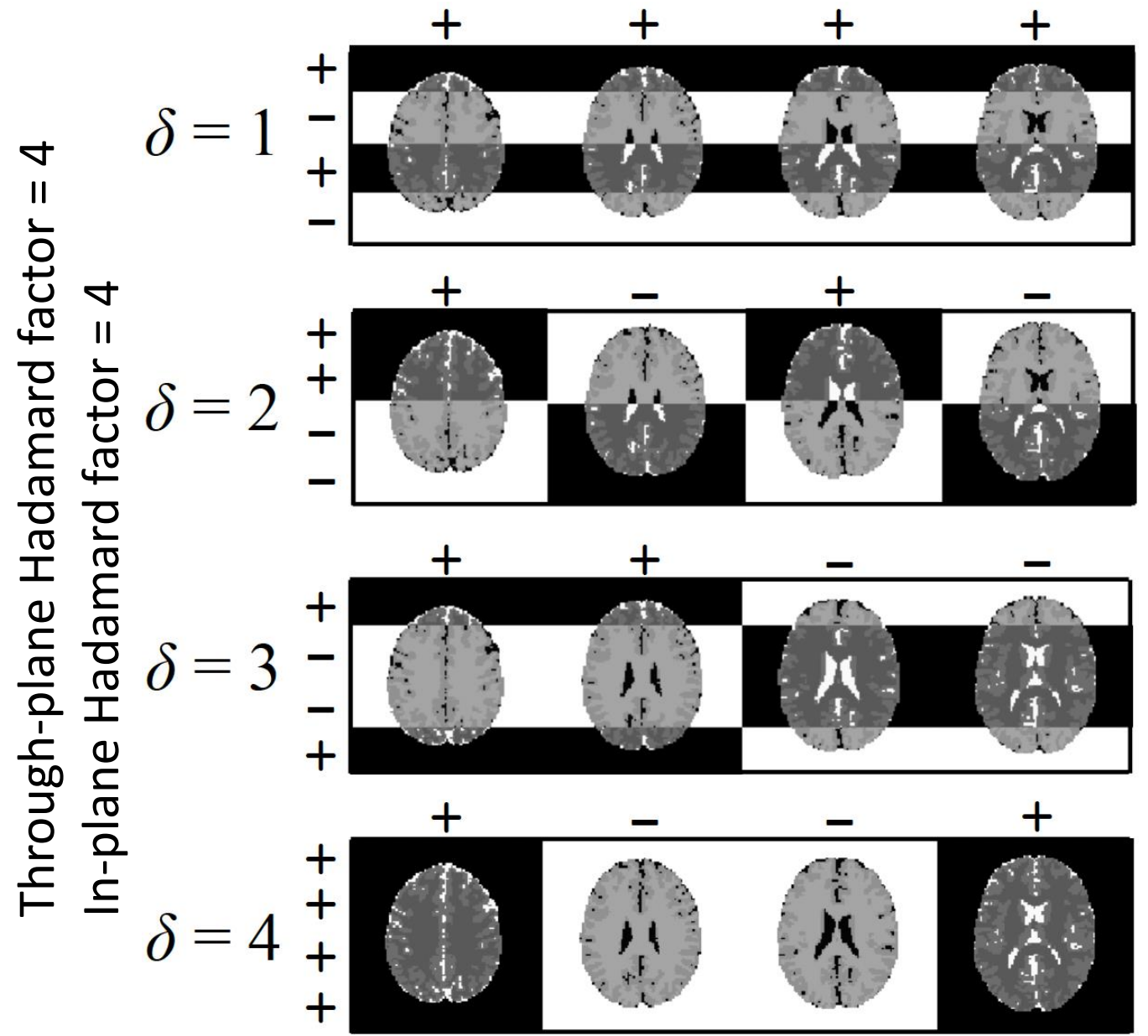
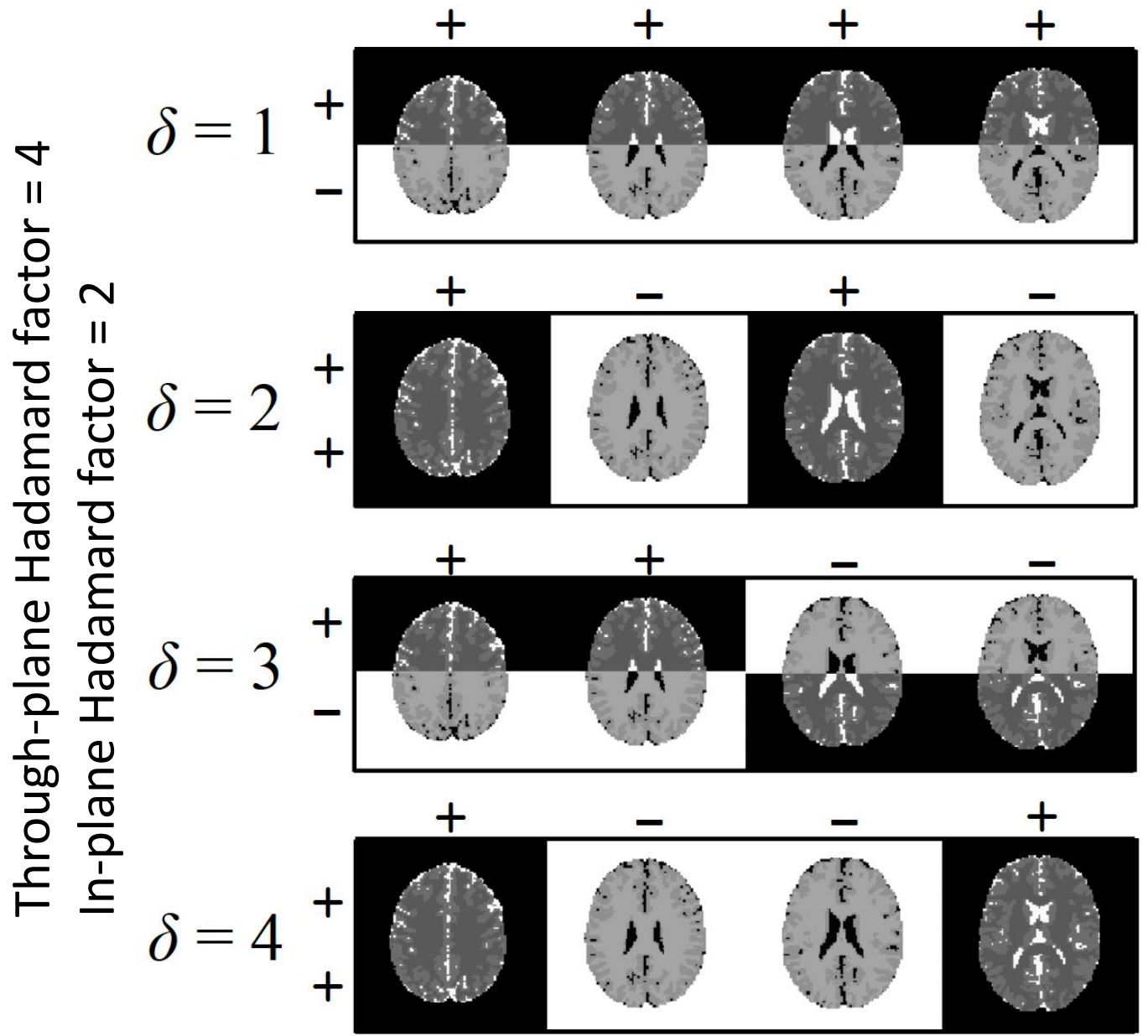
2. mSPECS-IPA-CAIPI

Voxel Aliasing Situation



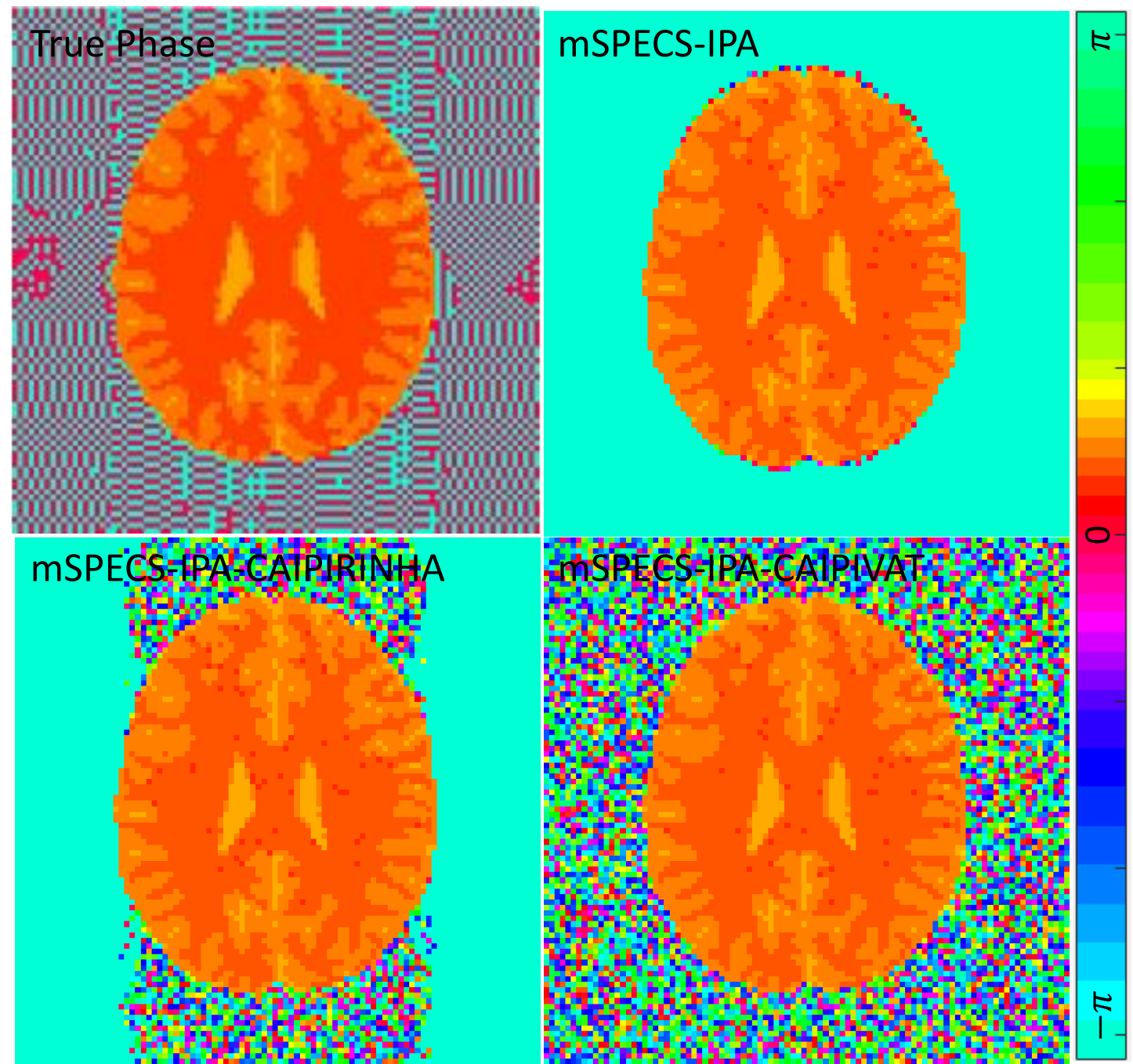
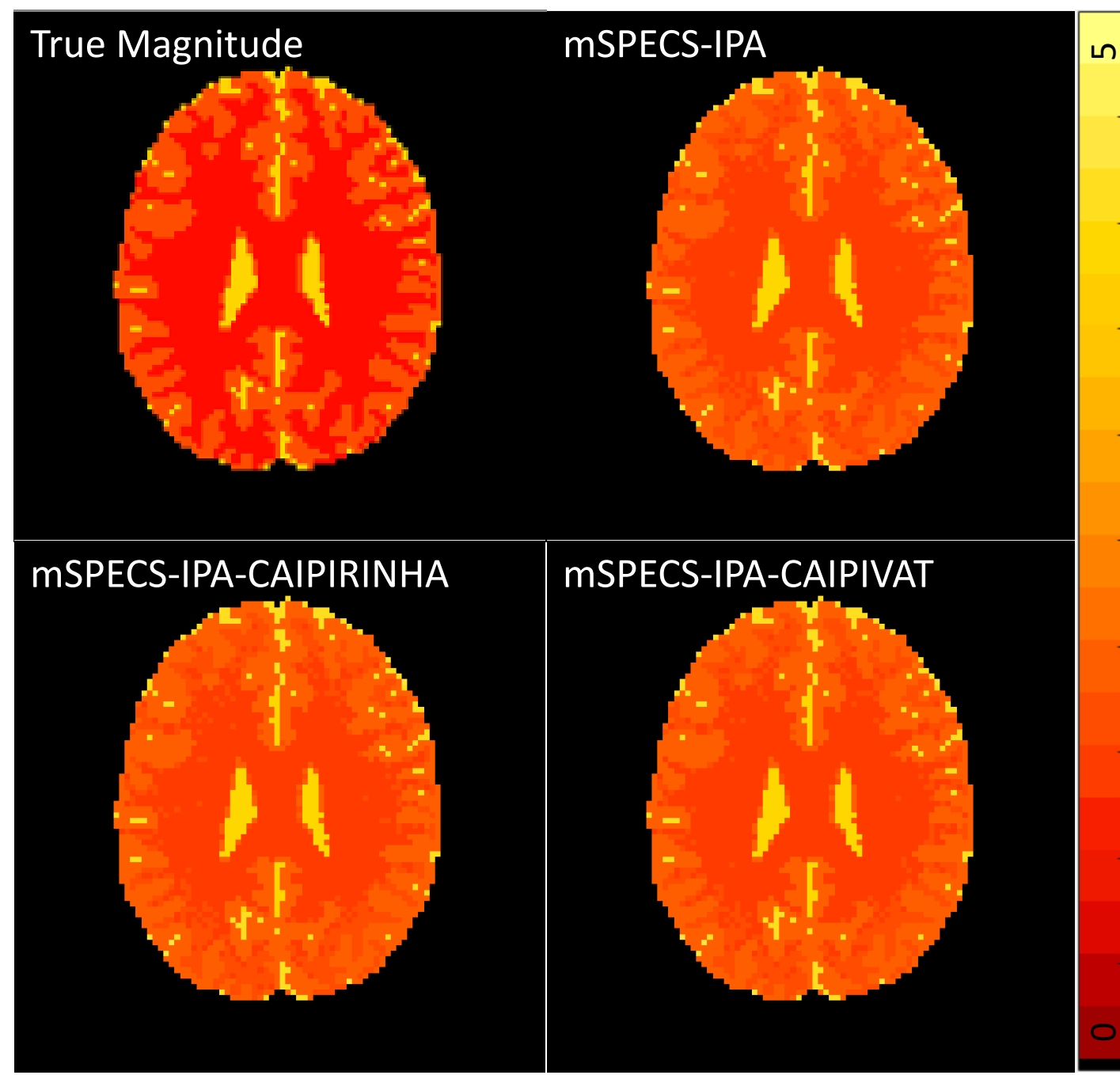
2. mSPECS-IPA-CAIPI

➤ Net Hadamard Aliasing



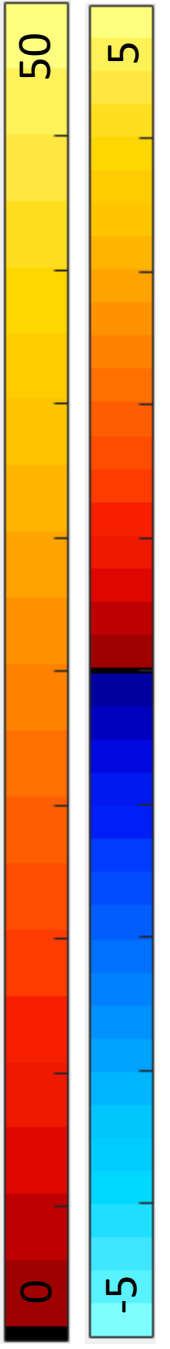
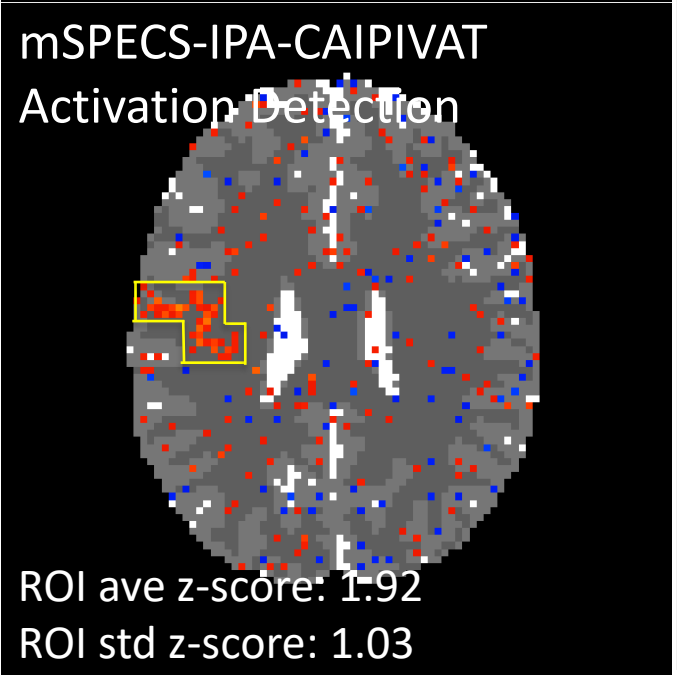
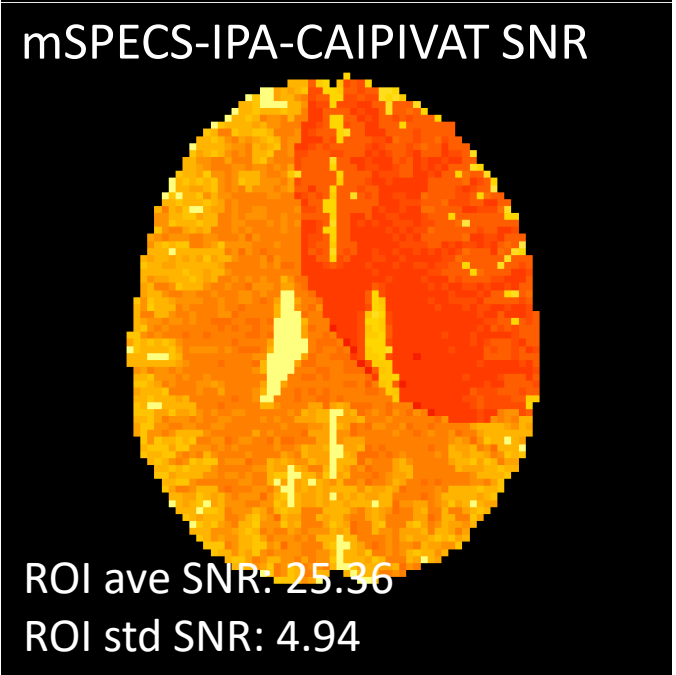
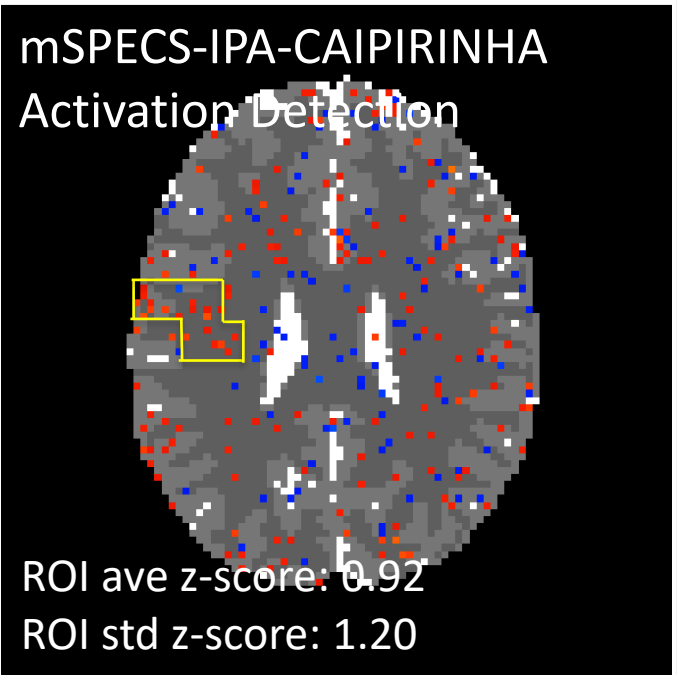
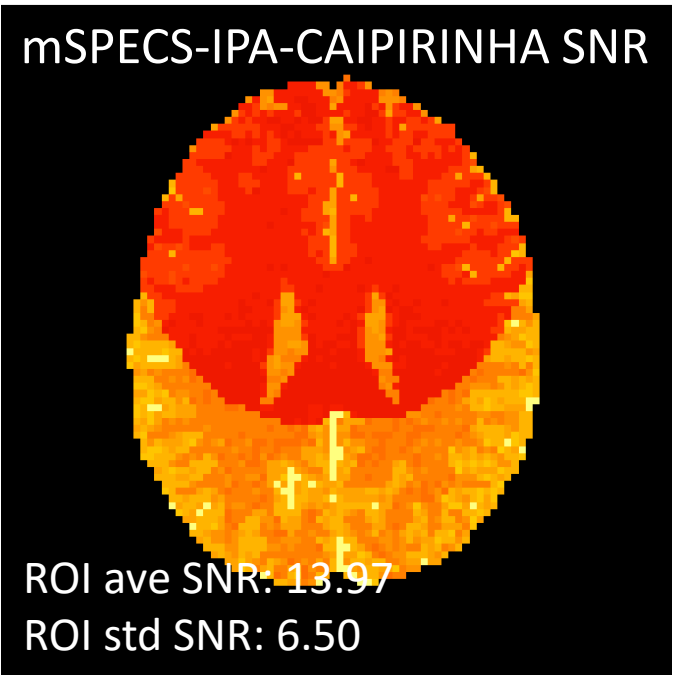
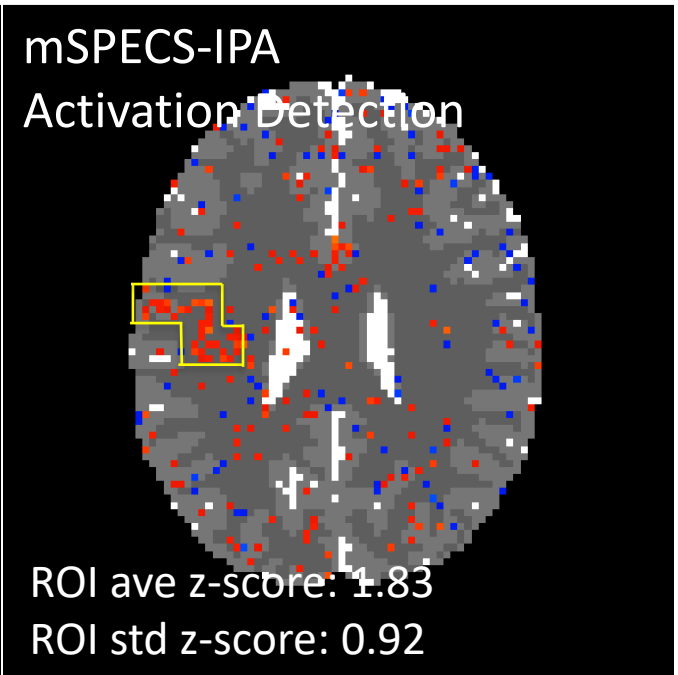
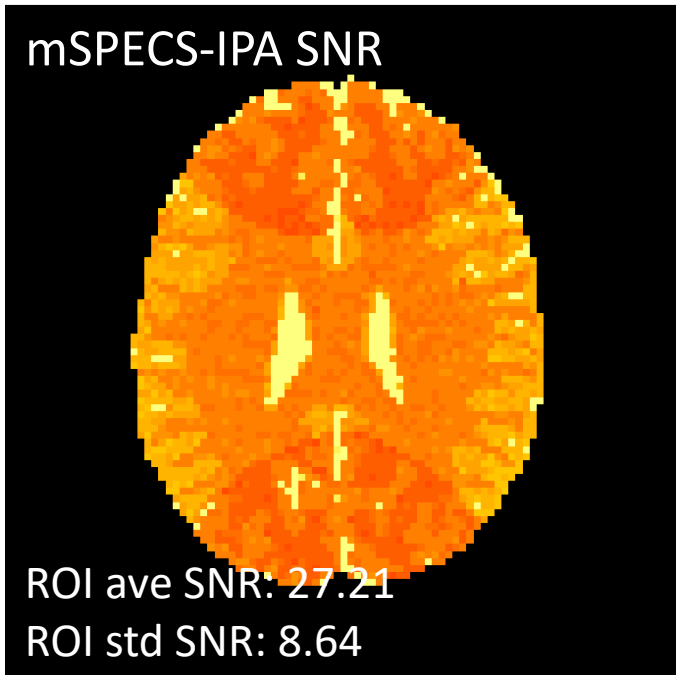
3. Simulation Study

Through-plane Acceleration factor = 4, In-plane Acceleration factor = 2
Net Hadamard Aliasing = 4×4



3. Simulation Study

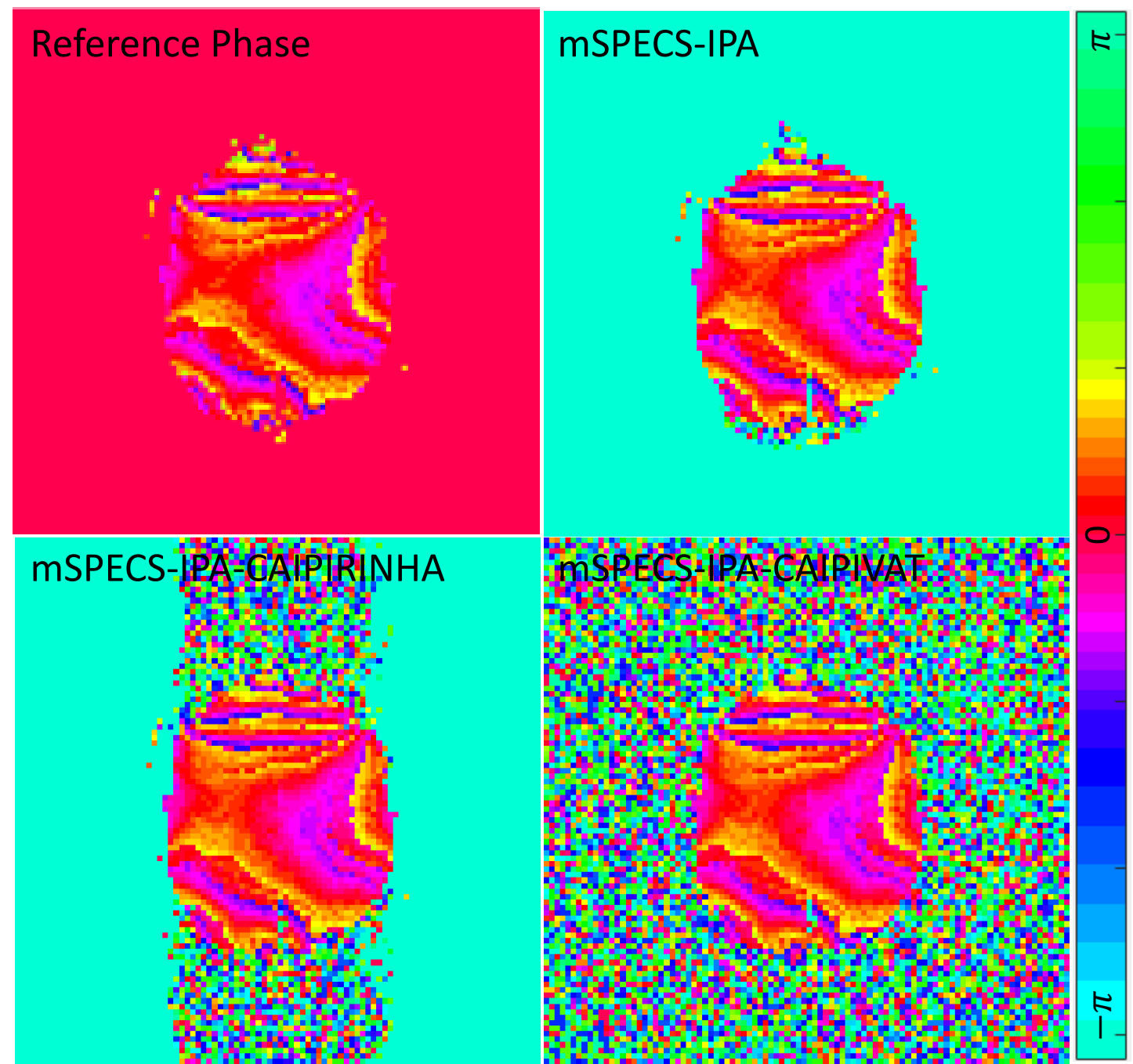
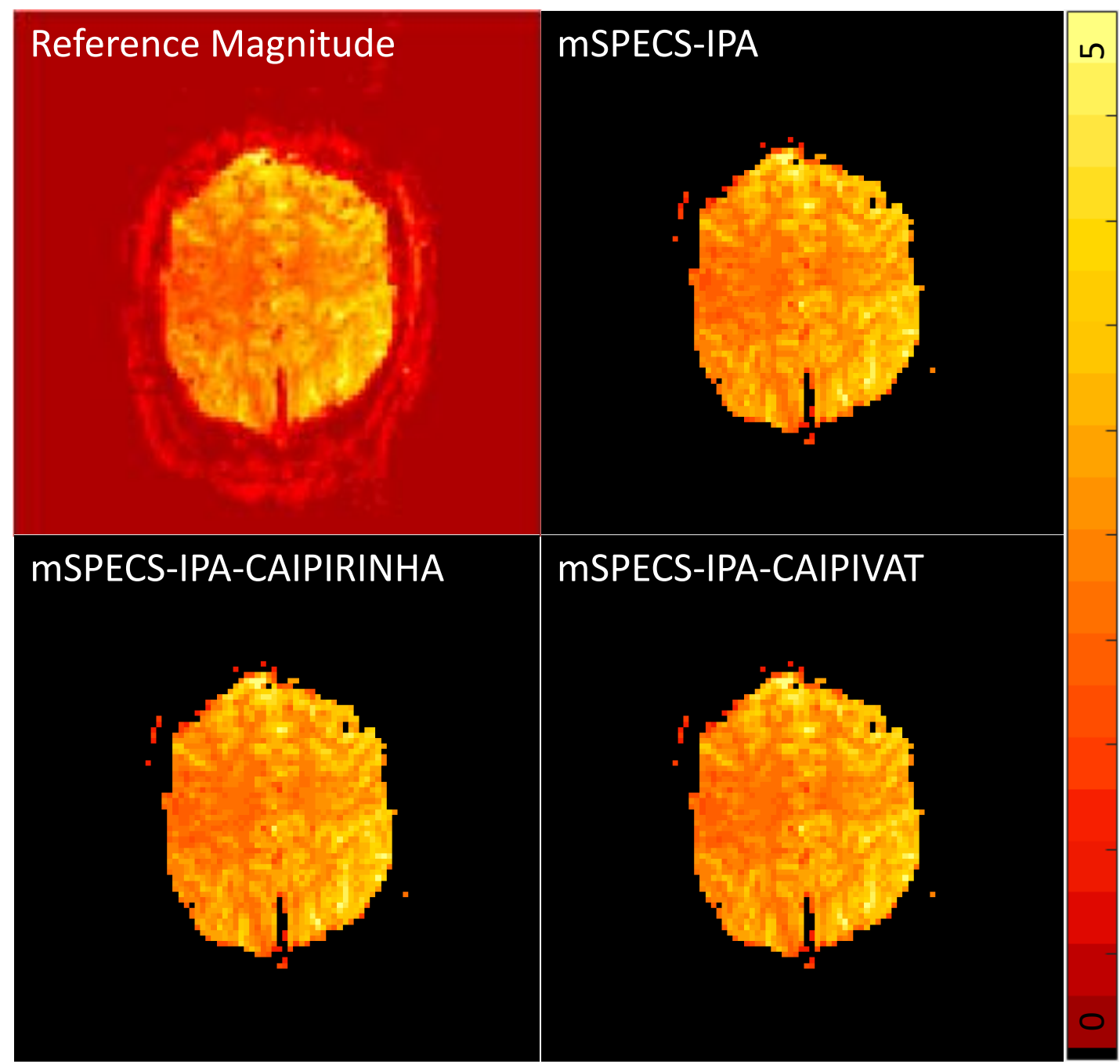
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$$SNR = \frac{\beta_0}{\sigma} \text{ and } CNR = \frac{\beta_1}{\sigma}$$

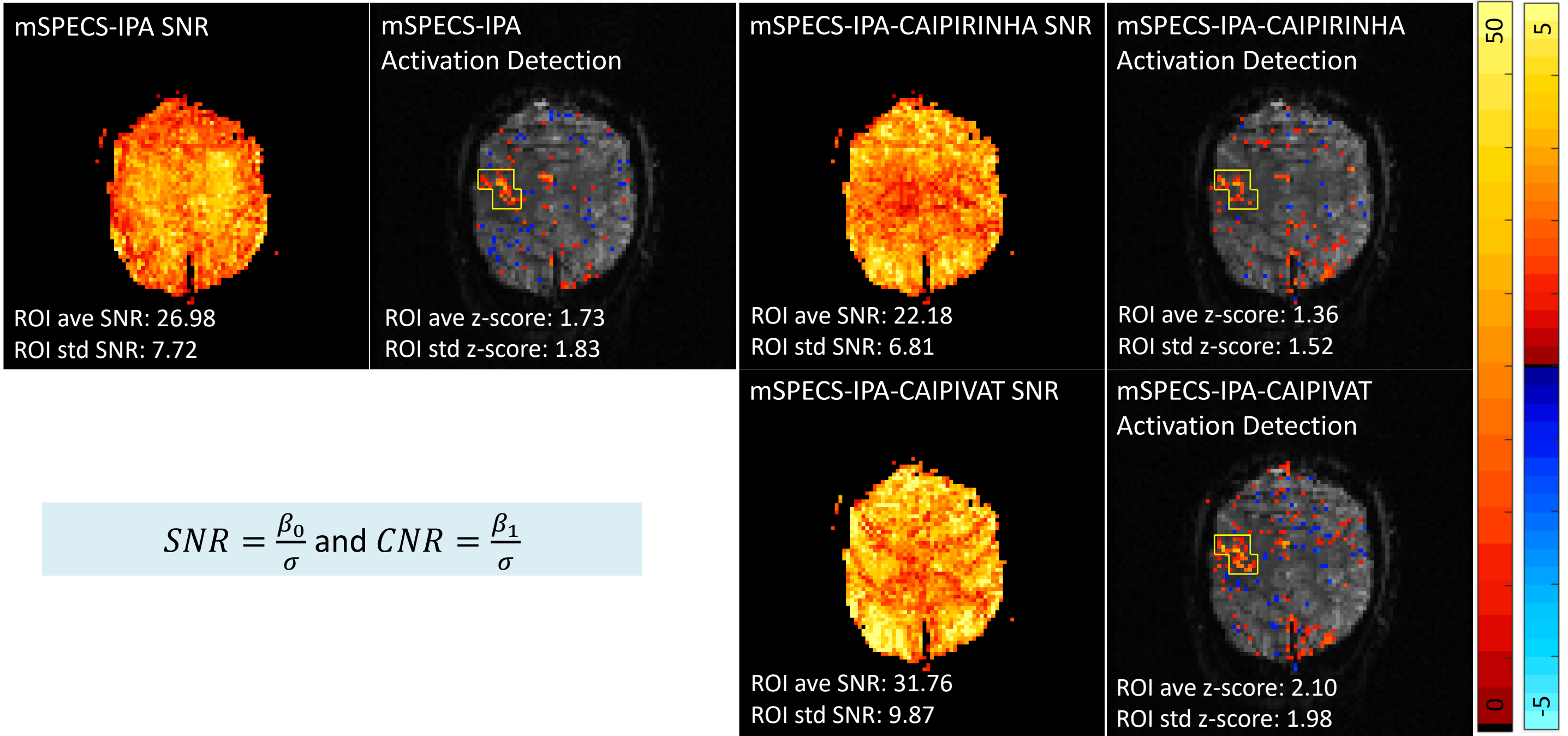
4. Experimental Study

Through-plane Acceleration factor = 4, In-plane Acceleration factor = 2
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4. Experimental Study

Through-plane Acceleration factor = 4, In-plane Acceleration factor = 2
Net Hadamard Aliasing = 4 x 4



Bibliography

1. Felix A Breuer, Martin Blaimer, Robin M Heidemann, Matthias F Mueller, Mark A Griswold, Peter M Jakob. *Controlled aliasing in parallel imaging results in higher acceleration (CAIPIRINHA) for multi-slice imaging*. Magn Reson Med 2005 Mar;53(3):684-91.
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Thank you!