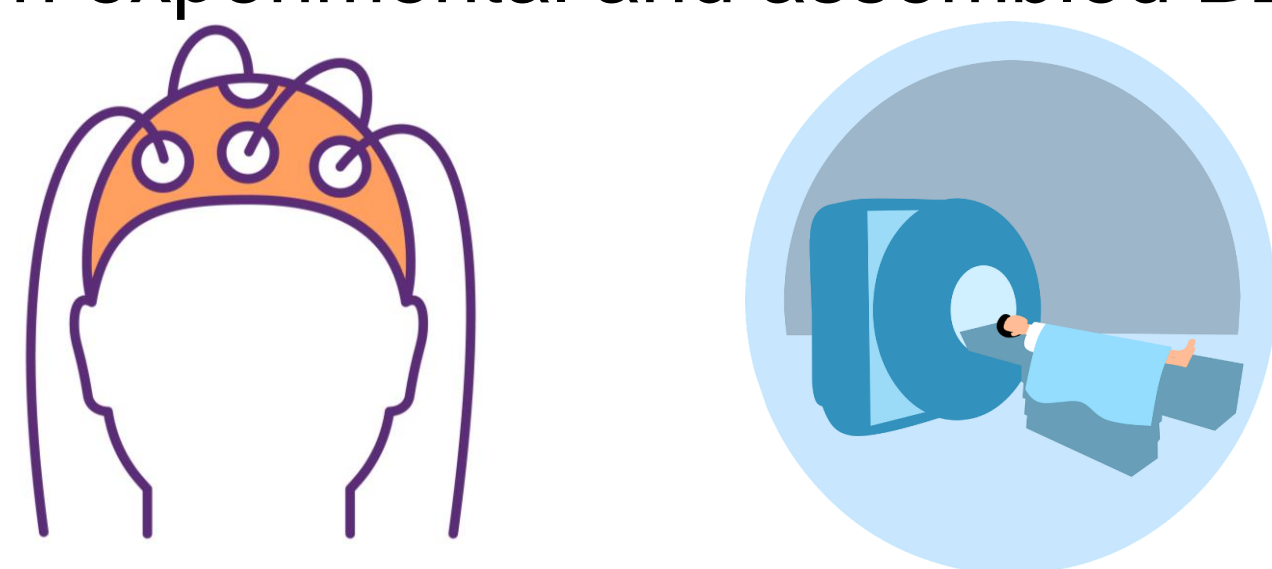


# Similarity of Subtracted Current Excitations in Off-Plane Magnetic Resonance Electrical Impedance Tomography

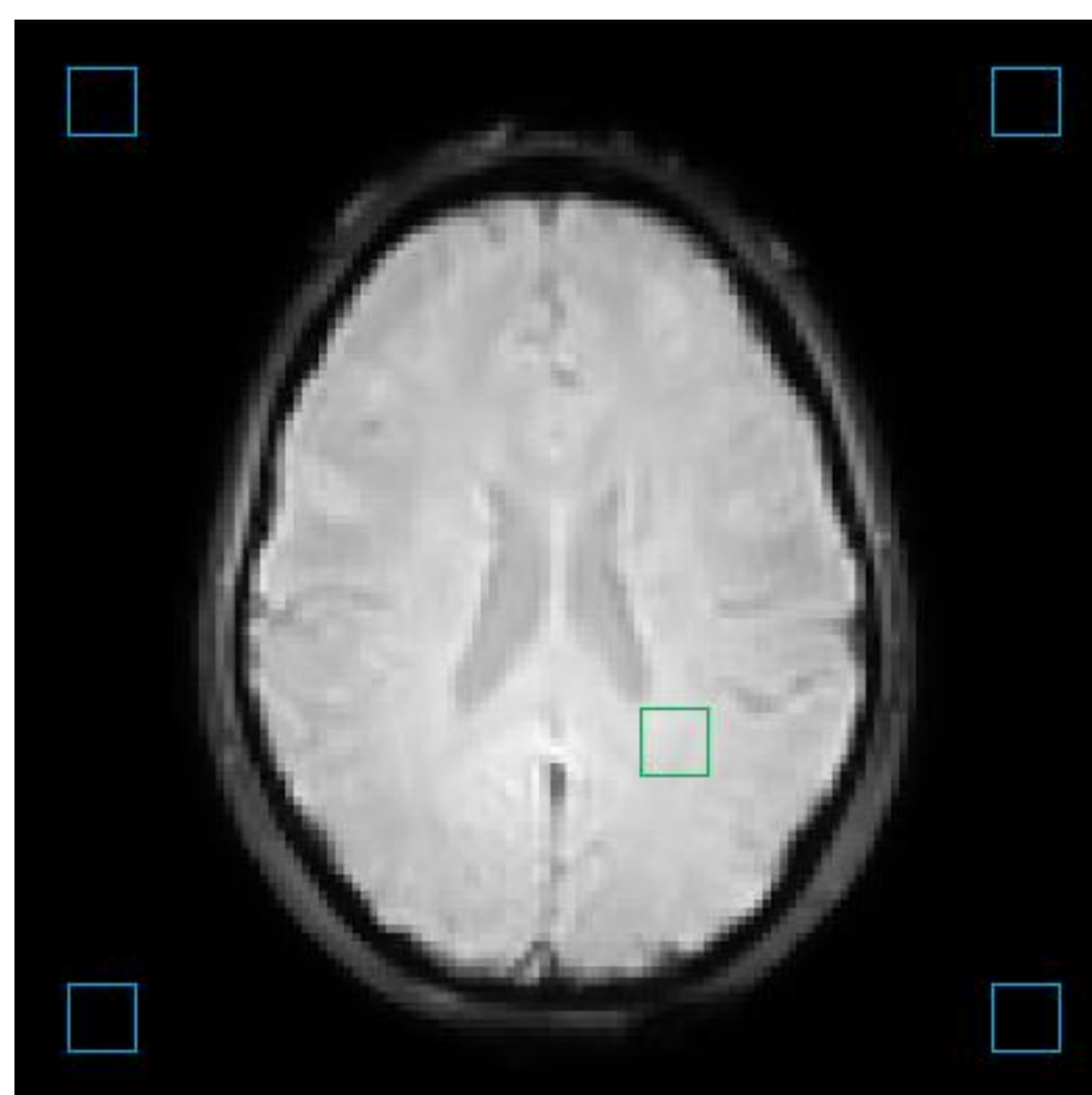
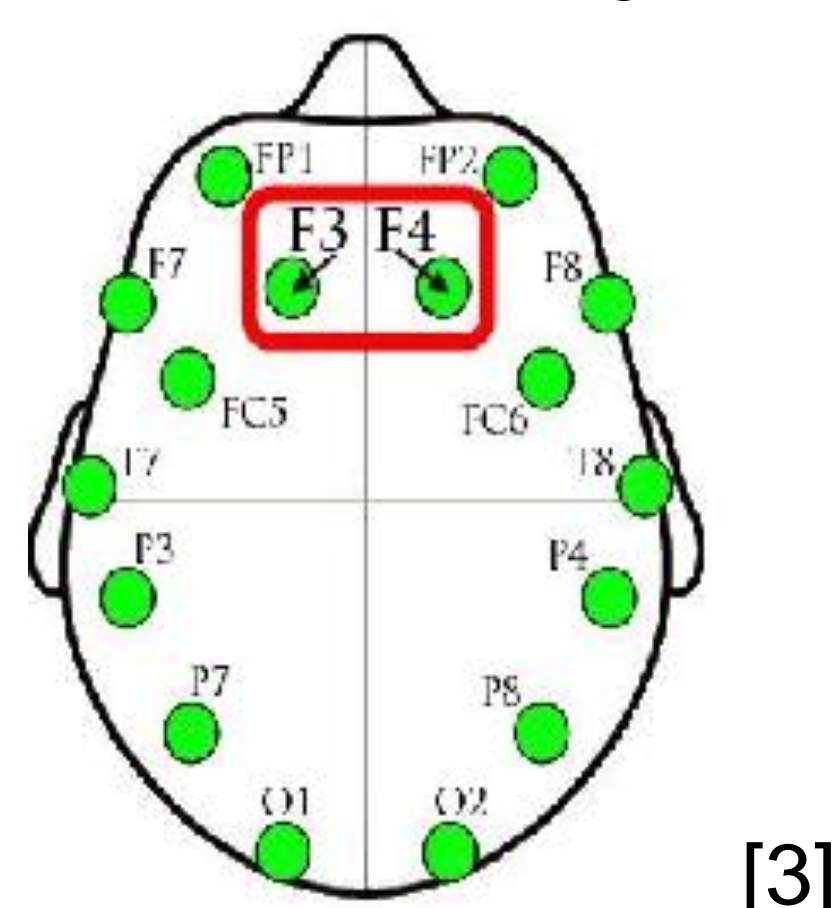
## INTRODUCTION

- Magnetic Resonance Electrical Impedance Tomography (MREIT) is an MRI protocol that allows for the measurement of electrical properties of biologic tissue at frequencies lower than 1kHz [1]
- The magnetic flux density ( $B_z$ ) from the scan allows for non-invasive measurement of the tissue's conductance
- Assessing the Signal to Noise Ratio (SNR) of the data is key in determining if the data is high enough quality for further analysis [2]
- The structure and intensity of the current excitation manifests in the  $B_z$  scan data which allows for direct analysis of the current's pathway through the brain
- Utilizing the superposition property of current and multiple electrode combinations, the presence and similarity of current excitation can be compared between experimental and assembled  $B_z$  images



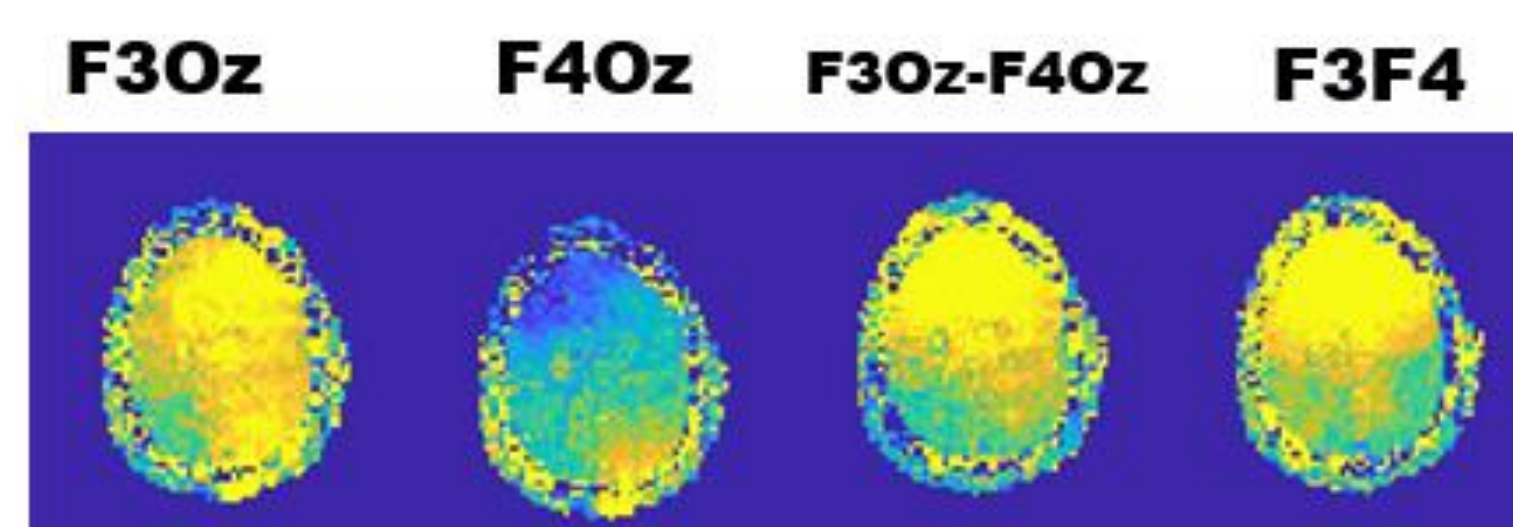
## SNR METHODS

- MREIT data previously collected for 12 subjects utilizing either a 50 or 150ms repetition time and 1.5mA of applied current producing 24 head MRI slices
- Electrode positions at F3, F4 and Oz locations
- Three electrode combinations and one control
  - F3F4
  - F3Oz
  - F4Oz
  - No Current (NC)
- Signal to Noise Ratio calculated from magnitude data as a ratio of means using the anterior portion of the left lateral ventricle as a reference location for signal source and average of four air space segments for noise



## CURRENT SUBTRACTION METHODS

- NC scan signal subtracted from current excited scans to reduce presence of non-excitation signal
- Replicates and runs of F3F4, F3Oz, and F4Oz scans combined into single average images for each electrode combination per subject
- Property of superposition means a like image can be produced by combining F3Oz and F4Oz should produce an image similar to F3F4

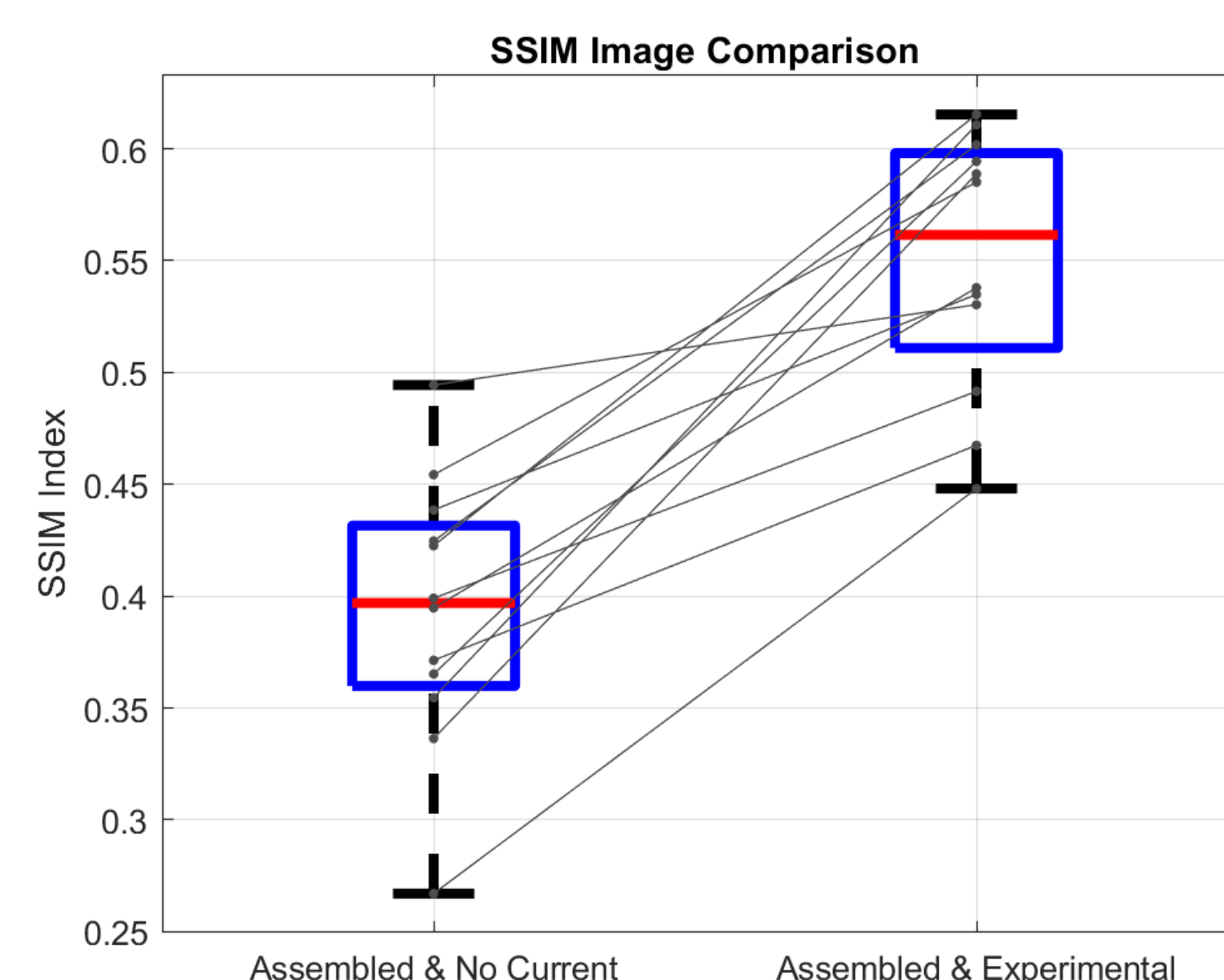


$$F3 - F4 \approx (F3 - Oz) - (F4 - Oz)$$

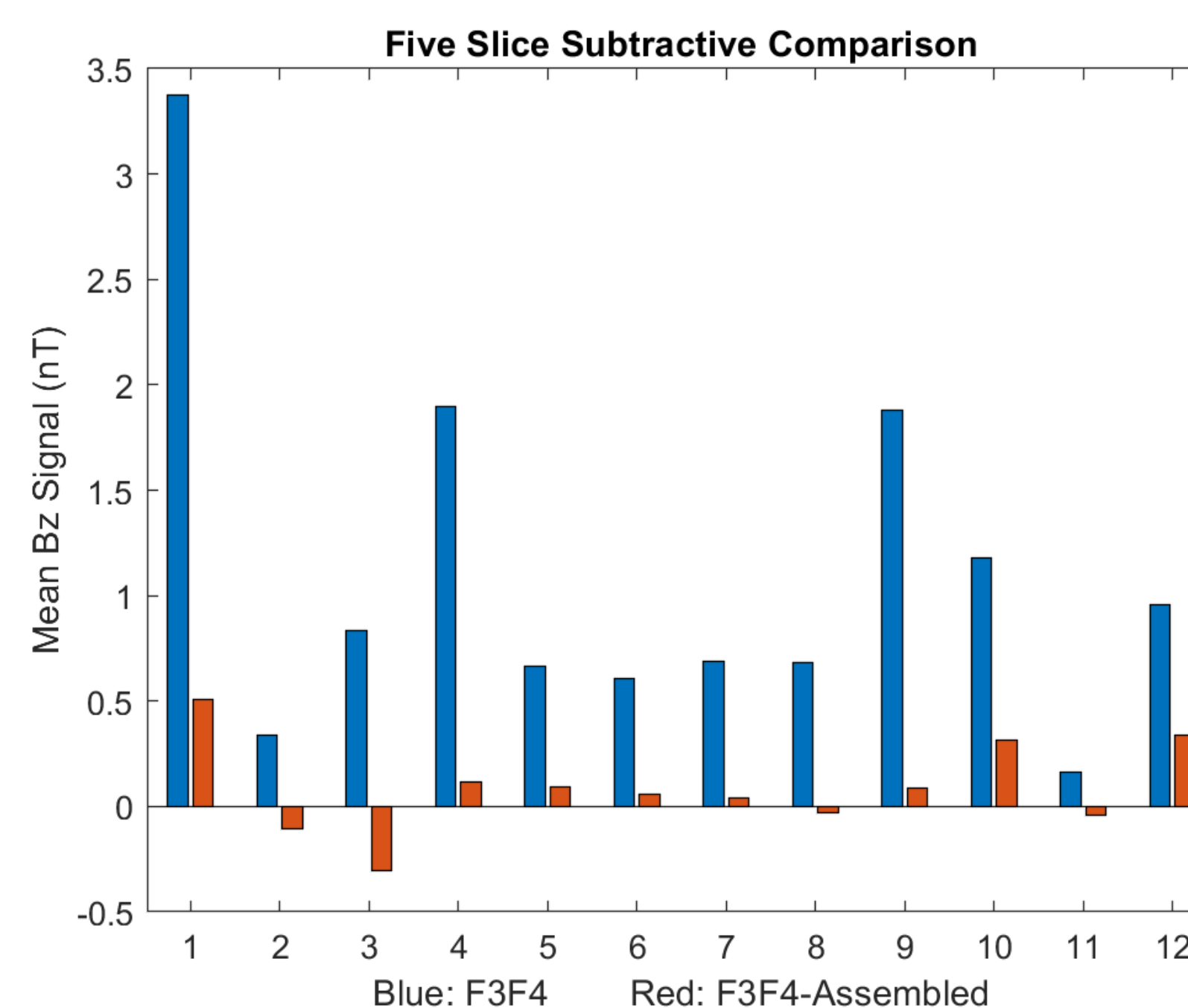
$$F3 - F4 \approx F3 - Oz - F4 + Oz$$

$$F3 - F4 \approx F3 - F4$$

## SIMILARITY RESULTS

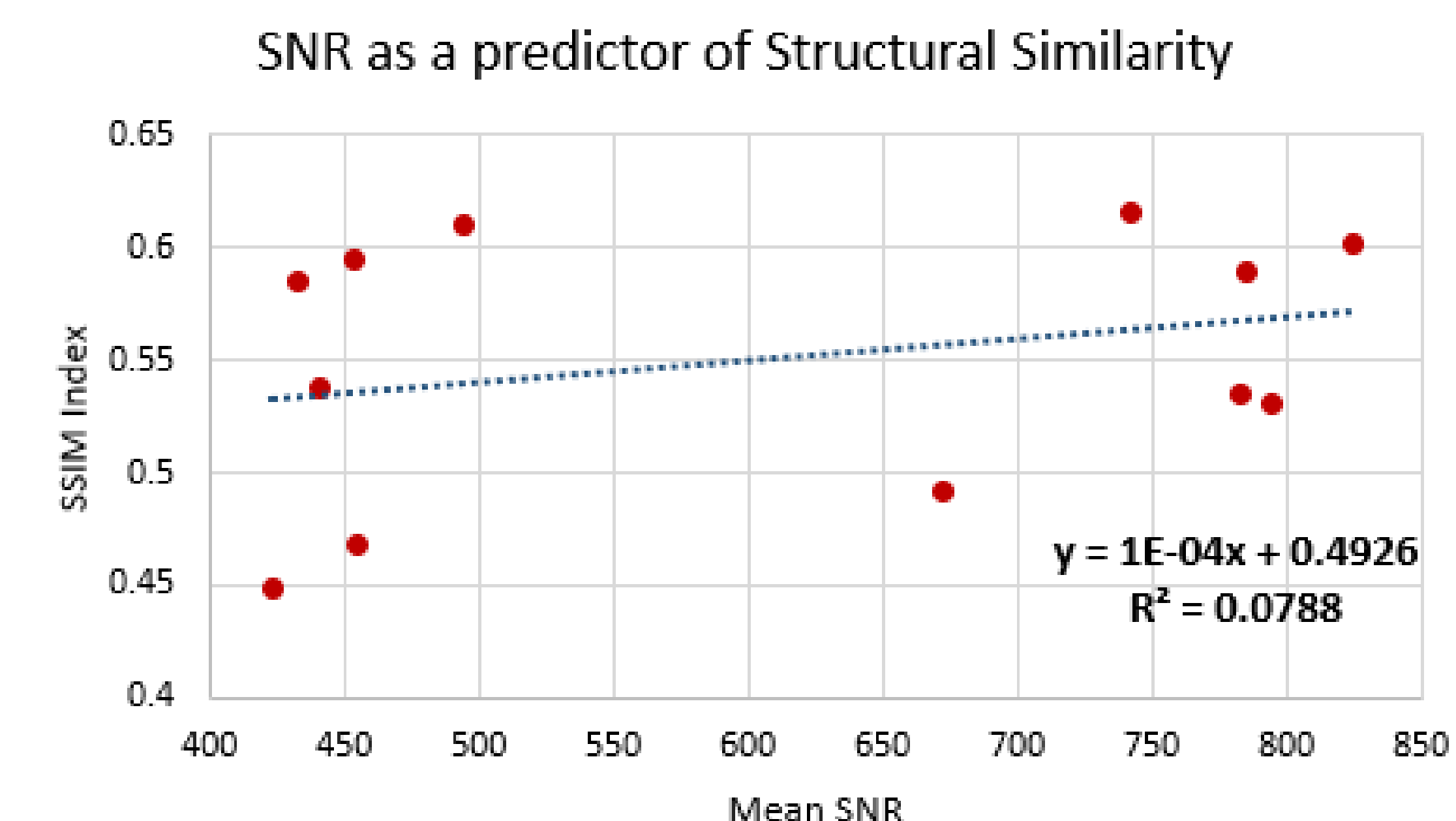


- SSIM compares the luminance, contrast, and structure of images [4]
- Slices 19 through 23 further isolated to frontal lobe region of scan for comparison
- One tailed t-Test with  $\alpha=0.05$  and  $p=1.73e-5$  that was able to reject the null hypothesis



- Measured average  $B_z$  amplitude across sliced 19 through 23
- One tailed t-Test with  $\alpha=0.05$  and  $p=1.47e-4$  that was able to reject the null hypothesis

## LINEAR REGRESSION RESULTS



## SUMMARY, CONCLUSIONS AND FUTURE DIRECTIONS

- SNR and subtraction similarity methods were used to investigate quality and current similarity of head MREIT scans
- Two separate measure of similarity showed statistically significant increased similarity between F3F4 and F3Oz-F4Oz
  - SSIM index demonstrated similarity of current excitation across frontal lobe
  - Comparison of mean  $B_z$  demonstrated similarity of magnitude and location of current excitation across multiple MREIT slices
- The linear regression analysis of a relationship between mean SNR and SSIM index did not demonstrate a strongly correlated relationship
- Future Directions:
  - Re-analysis after applying correction for electrode lead interference in  $B_z$  data
  - Implementation of refined automated workflow to reduce manual data processing and analysis for future experiments
  - Larger research goal of Dr. Sadleir and her lab to utilize this data set in conjunction with a neural network trained on modeled data

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