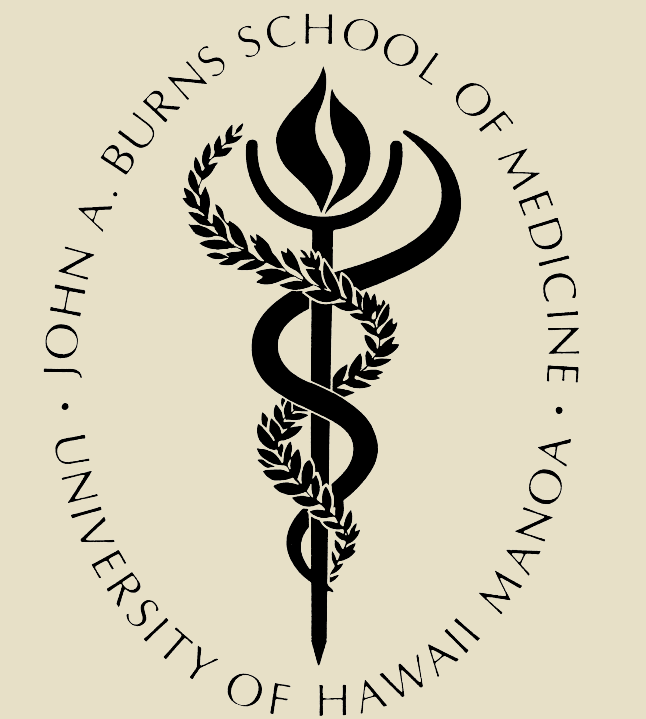


# Validation of the Impact of Increased Gradient Directions on Diffusion Tensor Imaging for White Matter Fiber Separation and Fractional Anisotropy Mapping

Matthew Alexander<sup>1,2</sup>, Danillo Maziero D.Sc.<sup>3</sup>, Andrew Stenger Ph.D.<sup>3</sup>

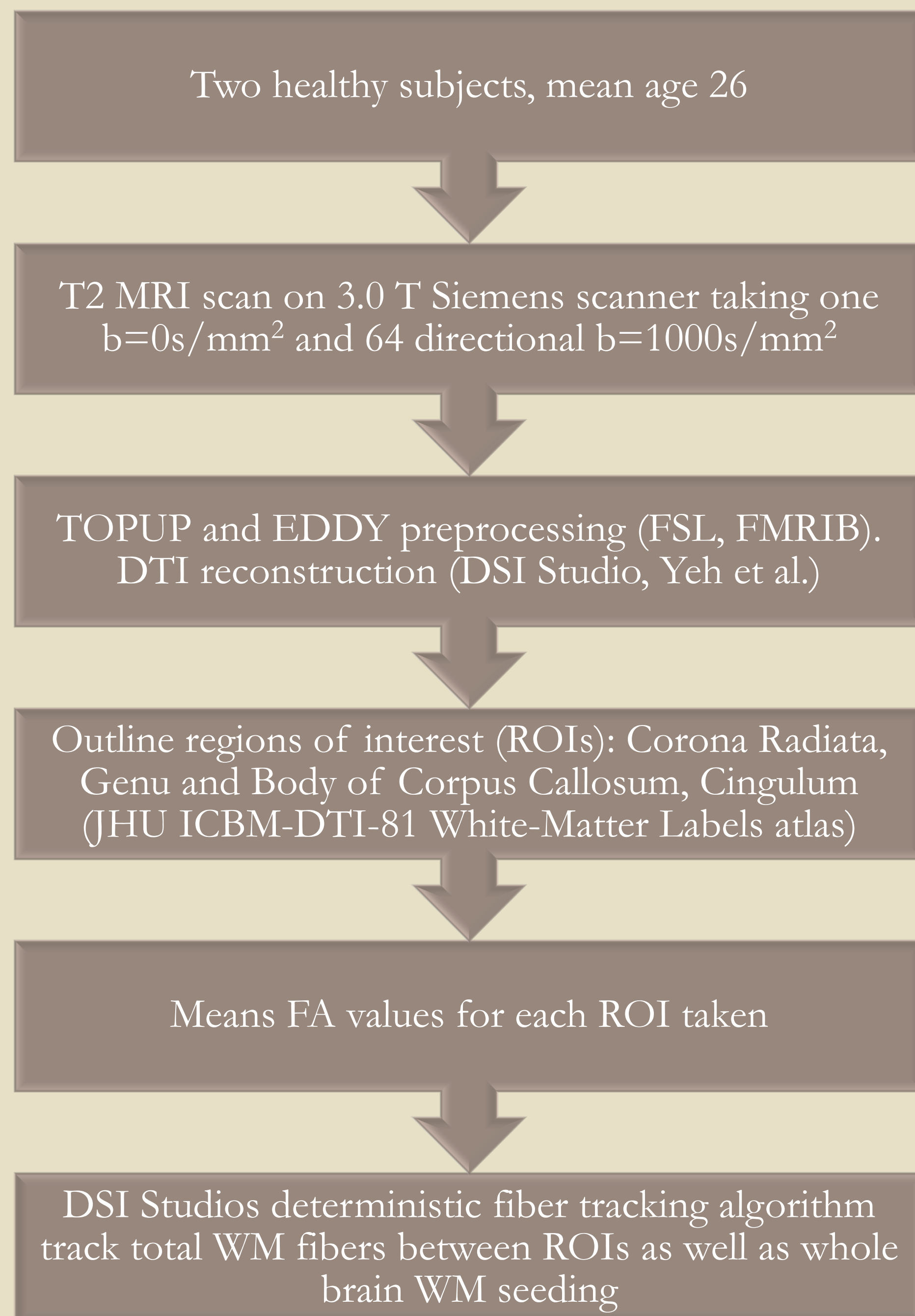
1. Brown University; 2. The Queen's Medical Center; 3. University of Hawaii at Manoa



## Introduction:

Diffusion Tensor Imaging (DTI) is a diffusion-weighted imaging (DWI) technique that allows for the measurement of the rate and direction of water diffusion. DTI reconstruction leads to various applications such as fractional anisotropy (FA) maps and fiber tractography to be used as quantifiable biomarkers in White Matter (WM) degradation. DTI requires a minimum of six diffusion-encoding gradient directions to estimate diffusion tensors through each voxel. Contention has been over how many directions are required to provide quality FA mapping and WM fiber tracking. This study looks to validate claims that 32 and even only 6 directions are sufficient parameters for successful DTI, FA, and fiber tract detection.

## Materials and Methods:



## Results:

T2 DWIs~

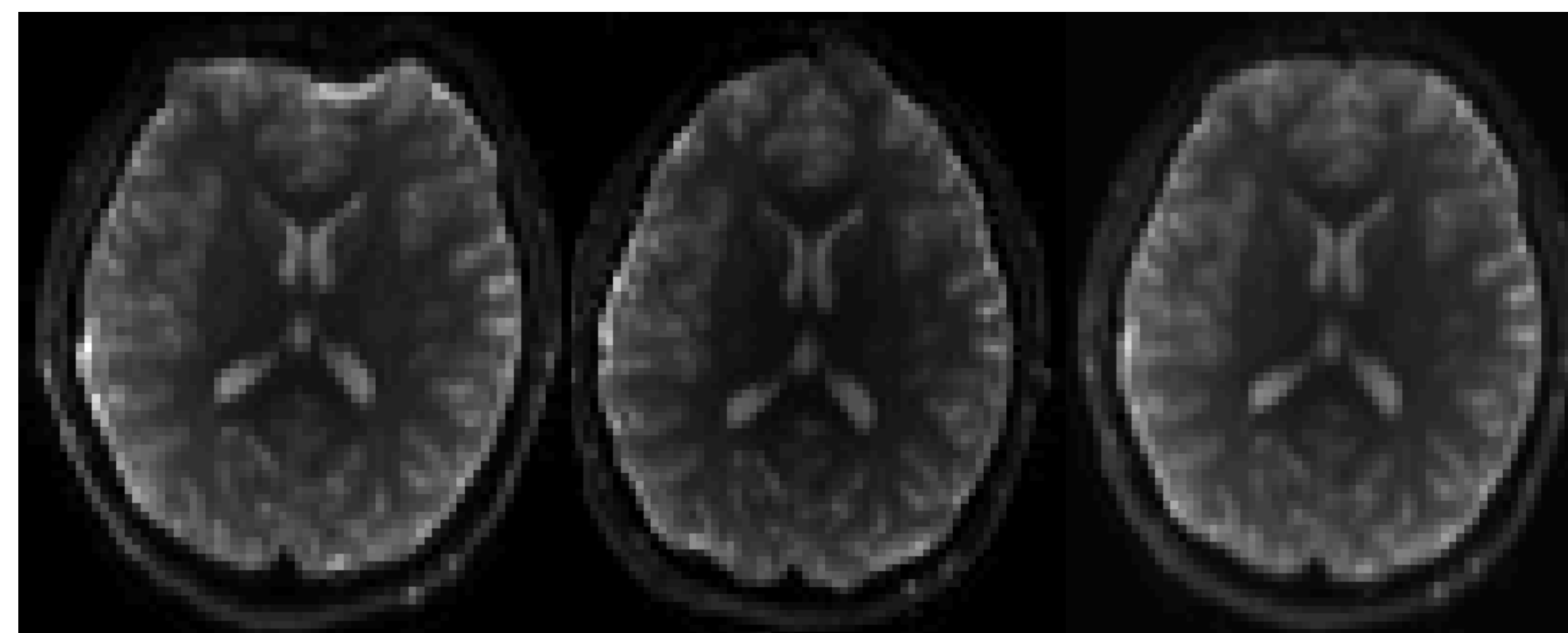


Fig. 1: Left: acquired A-P direction. Middle: acquired P-A direction. Right: TOPUP and EDDY corrected

DTI FA Maps~

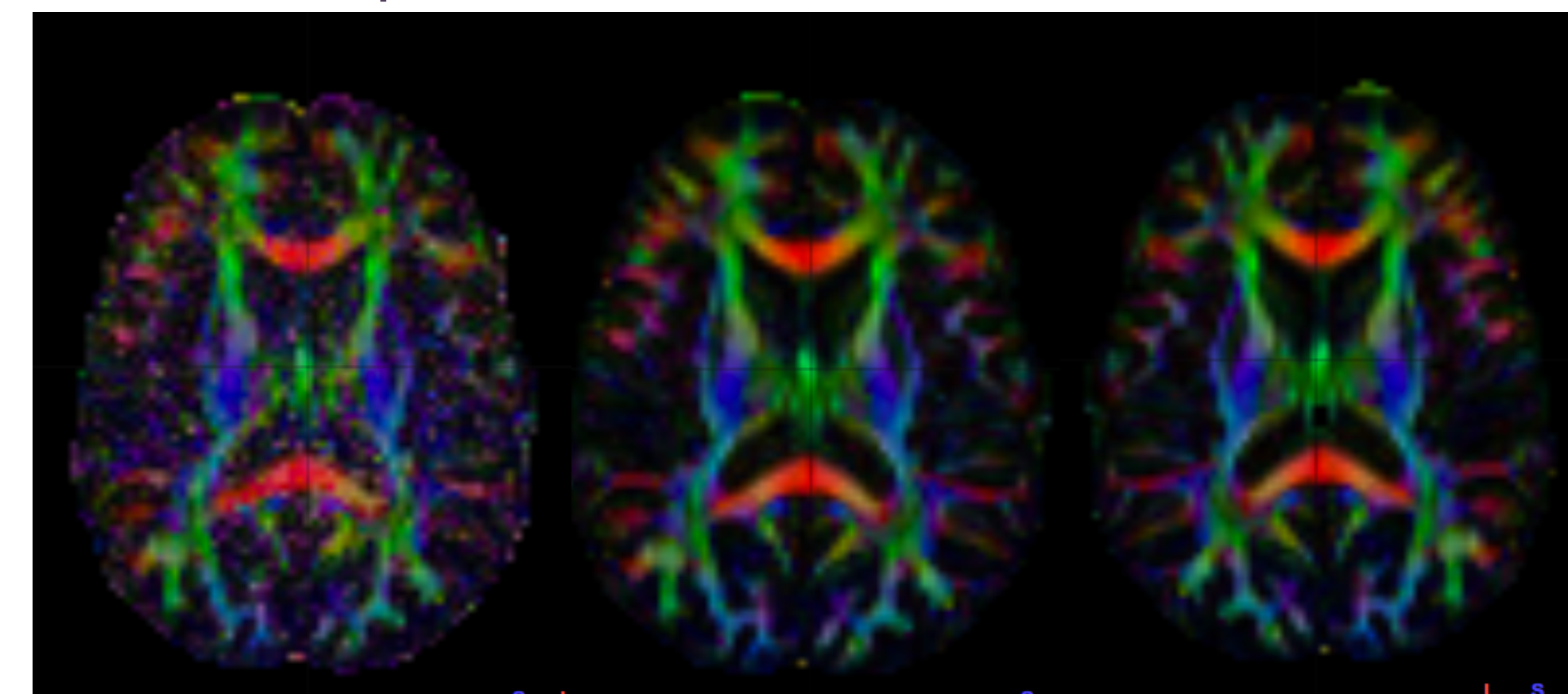


Fig. 2: From left to right, 6, 32, and 64 gradient directions.

Whole Brain WM Tractography~

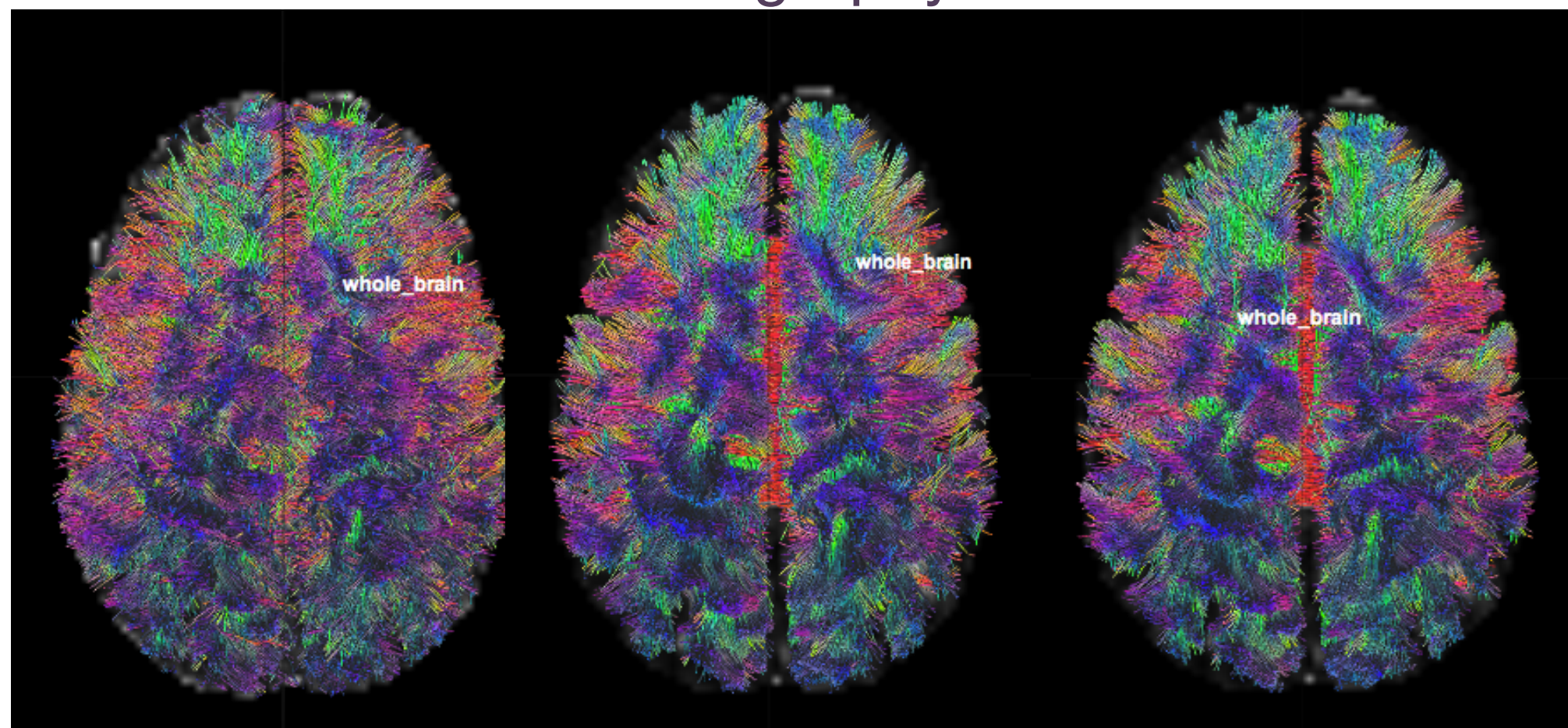


Fig. 3: From left to right, 6, 32, and 64 gradient directions

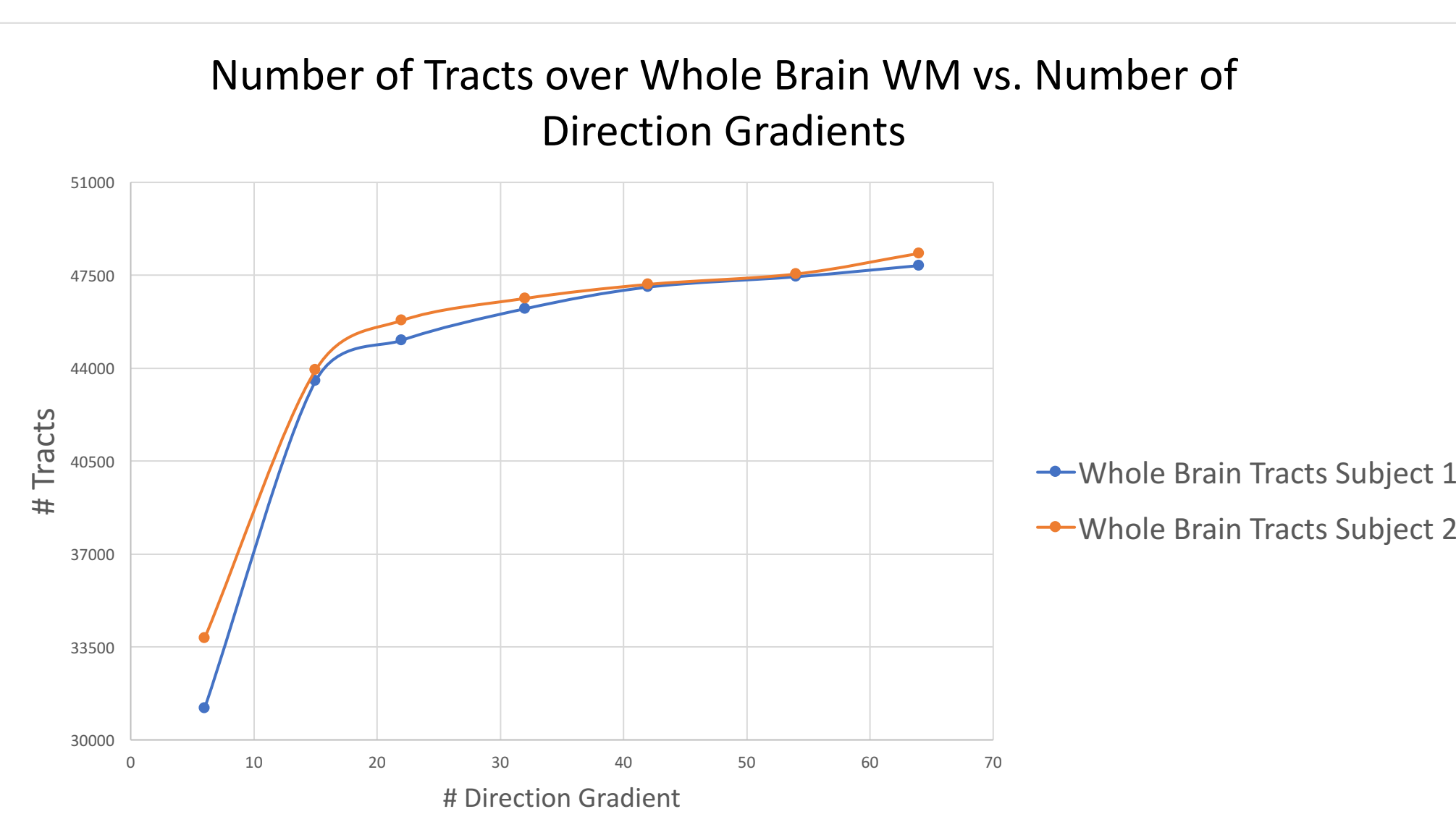


Fig. 4: Subjects 1 and 2's total whole brain WM tracts as a function of diffusion gradient directions

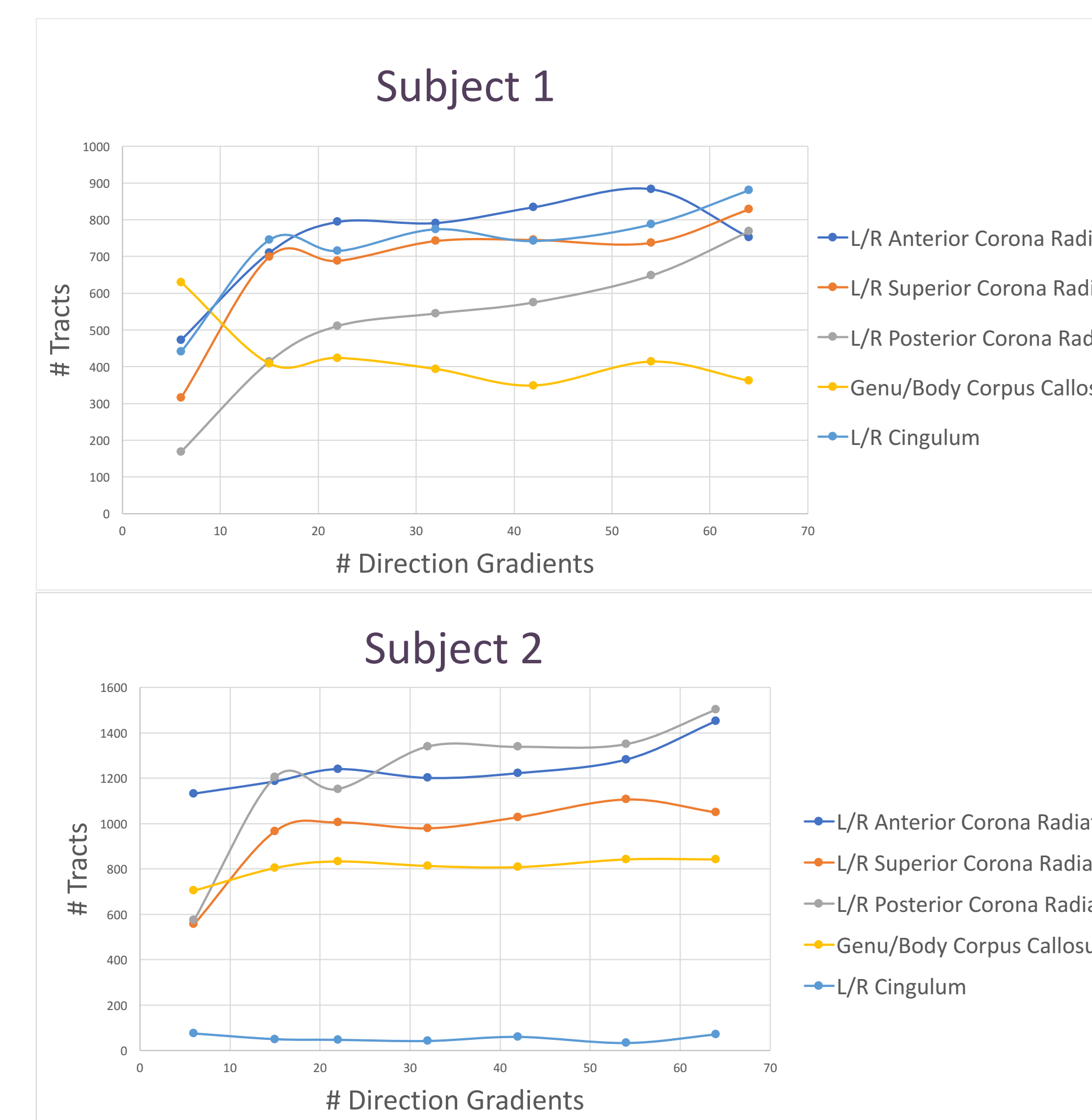


Fig. 5: Total tracts between ROIs as a function of diffusion gradient directions

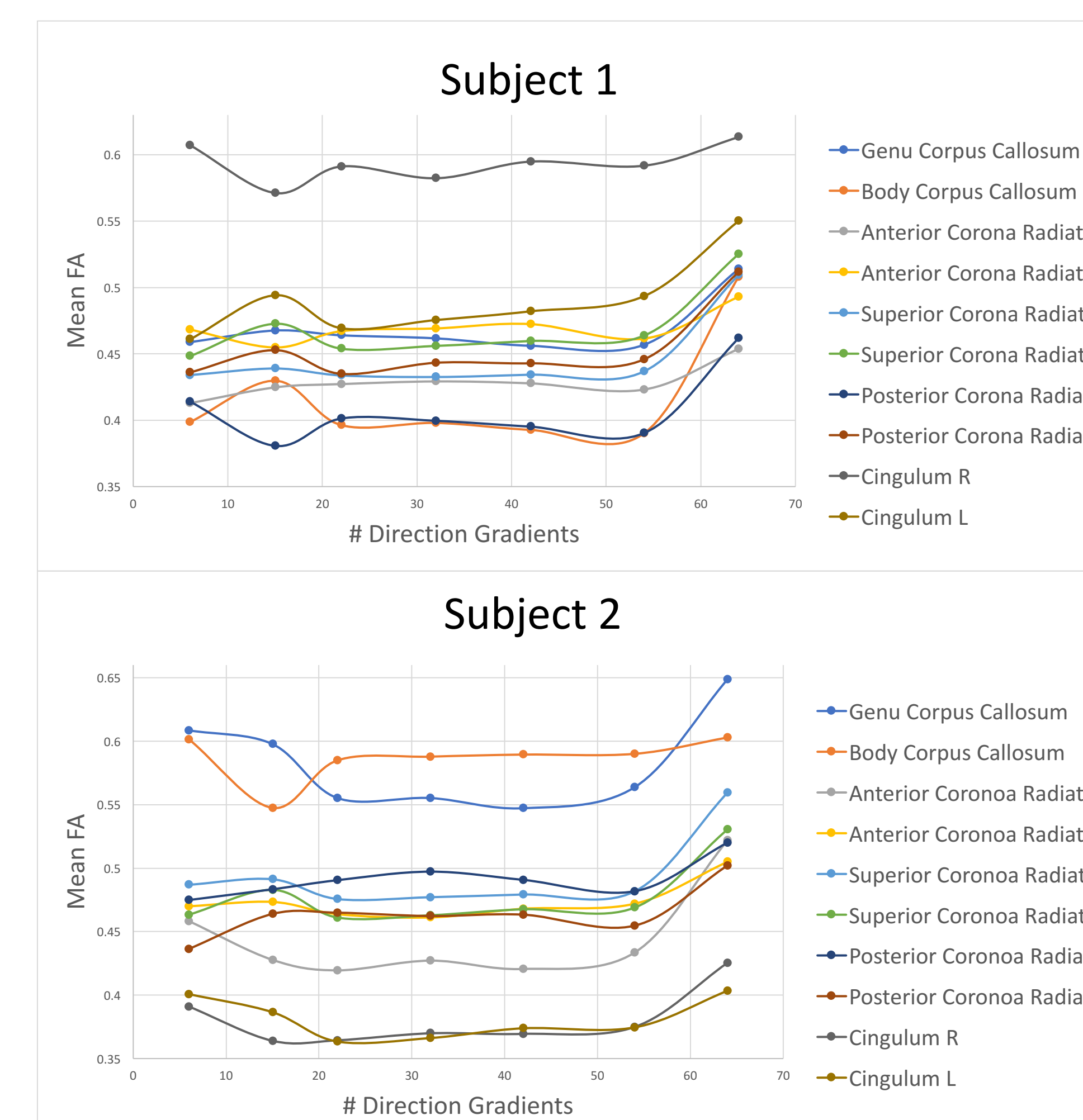


Fig. 6: ROIs Mean FAs as a function of diffusion gradient directions

## Conclusions:

**Qualitatively:**  
 -TOPUP and EDDY preprocessing improves T2 MRIs for DWI  
 -Initial results strongly suggest FA mapping and WM fiber tractography rendering was impaired at 6 direction gradients but relatively unaffected at 32 directions.

**Quantitatively:**  
 -WM fiber tracts were significantly decreased at 6 direction gradients but plateaued at 32 directions for both whole brain and inter-ROI tracking.  
 -Mean FA increases at 64 direction gradients although further analysis with increased subjects needs to be completed for statistically significant results.

## Literature cited:

C. Lebel, T. Benner, C. Beaulieu Six is enough? Comparison of diffusion parameters measured using six or more diffusion-encoding gradient directions with deterministic tractography. *Magn. Reson. Med.*, 68 (2) (2012), pp. 474-483

M. Jenkinson, C.F. Beckmann, T.E. Behrens, M.W. Woolrich, S.M. Smith. *FSL. NeuroImage*, 62:782-90, 2012

Yeh, Fang-Cheng, et al. "Deterministic diffusion fiber tracking improved by quantitative anisotropy." (2013): e80713. *PLoS ONE* 8(11): e80713. doi:10.1371/journal.pone.0080713

## Acknowledgments:

This work was greatly supported by the University of Hawaii MRI Research Center and The Queen's Medical Center's Summer Research Internship with special thanks to Christoph Rettenmeier Ph.D., Todd Seto M.D., Lori Tsue, and Sherry Chan.

## Contacts:

Please email [matthew\\_alexander@brown.edu](mailto:matthew_alexander@brown.edu).