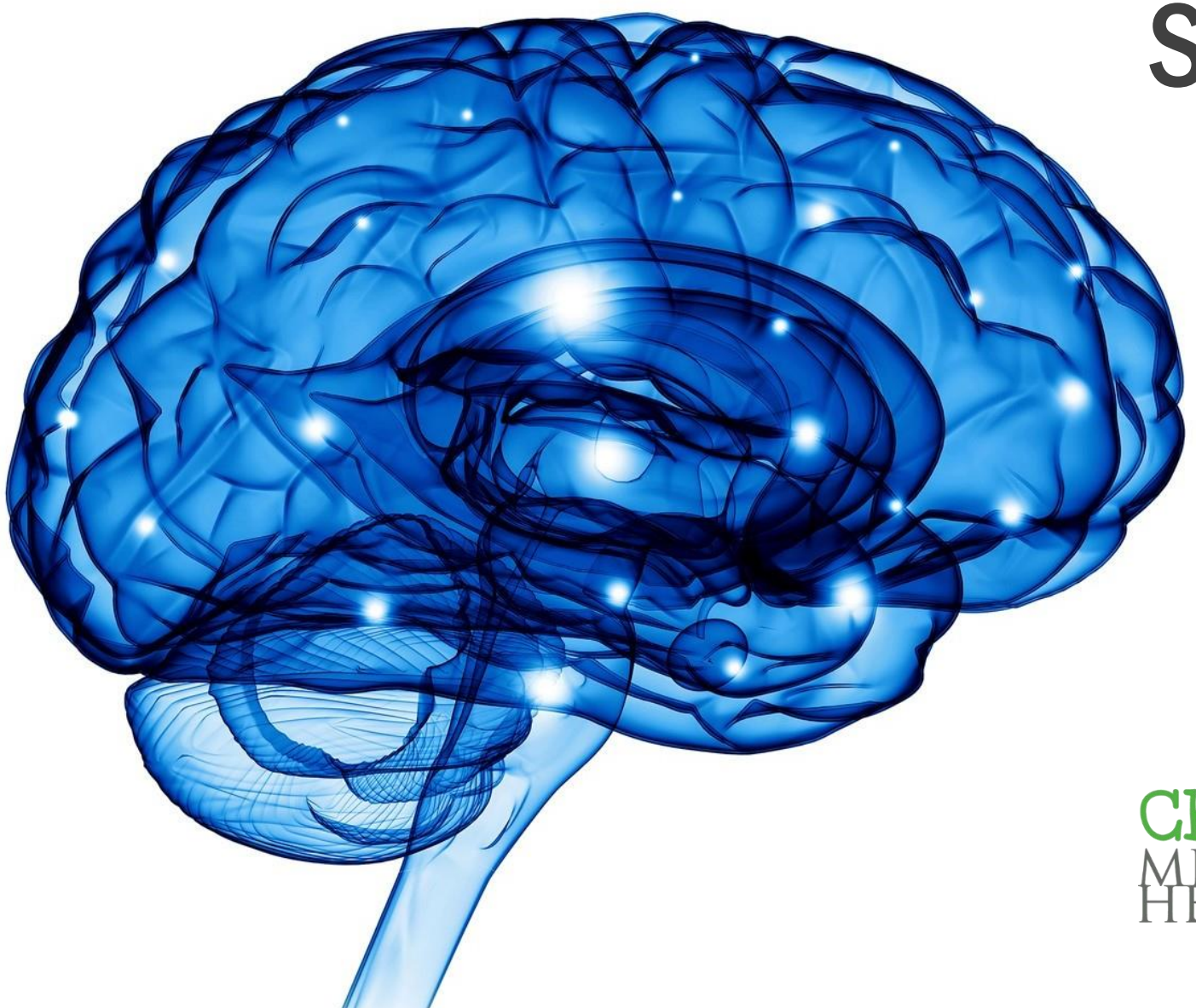

AI in Epilepsy: 2024 Source Localization

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Director, Texas Comprehensive Spasticity Center
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No Financial disclosures

- Funding:
  - NIH R01 NS126437 (Co-PI)

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Manish N. Shah, MD, FAANS

- A.B. Physics - Princeton University
- M.D. - Vanderbilt University
- Neurosurgery Residency, Washington University in St. Louis
- T.S. Park Pediatric Neurosurgery Fellowship, St. Louis Children's Hospital
- Faculty @ UTHouston since 2014
- NIH-funded neuroimaging laboratory

Role of Epilepsy Surgery

- 1/900 kids have medically refractory epilepsy; they wait until Adult epilepsy conference to be presented?
- Goals of presurgical evaluation:
  - Is patient a “good candidate” for resection?
  - localize or at least lateralize the Epileptogenic Zone (EZ)
  - Identify functional areas and proximity to EZ
  - determine need/location of invasive monitoring (iEEG, SEEG)
- Goals of resection:
  - Seizure freedom or reduction in seizure burden
  - Spare eloquent cortex as much as possible
  - Disrupt/reverse developmental arrest or regression, to improve long-term developmental outcome

Pediatric Epileptologists

Jeremy Lankford, MD

Michael Watkins, MD PhD

Shelley Varnado, MD

Gretchen Von Allmen, MD

Indira Kommuru, MD

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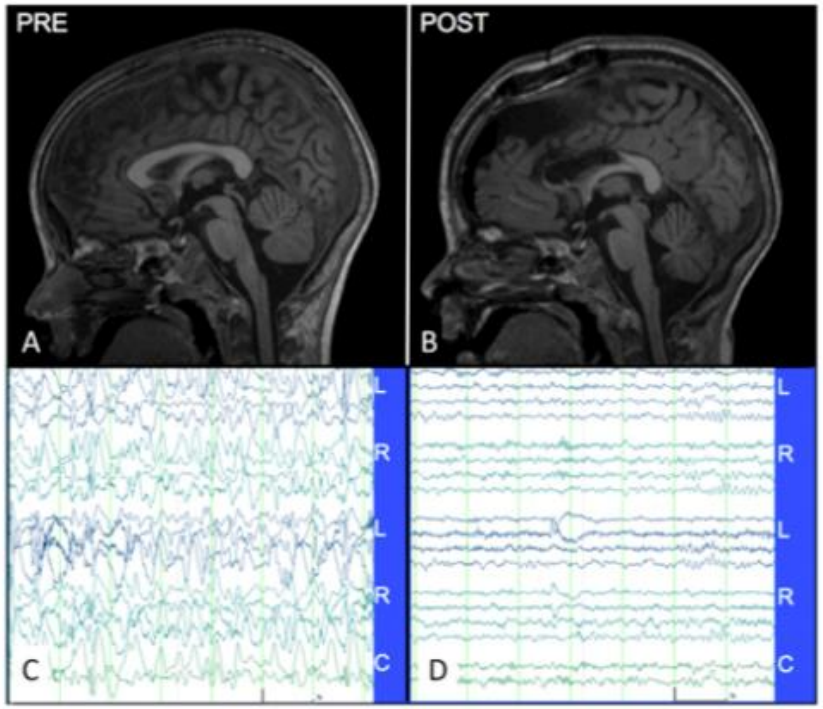
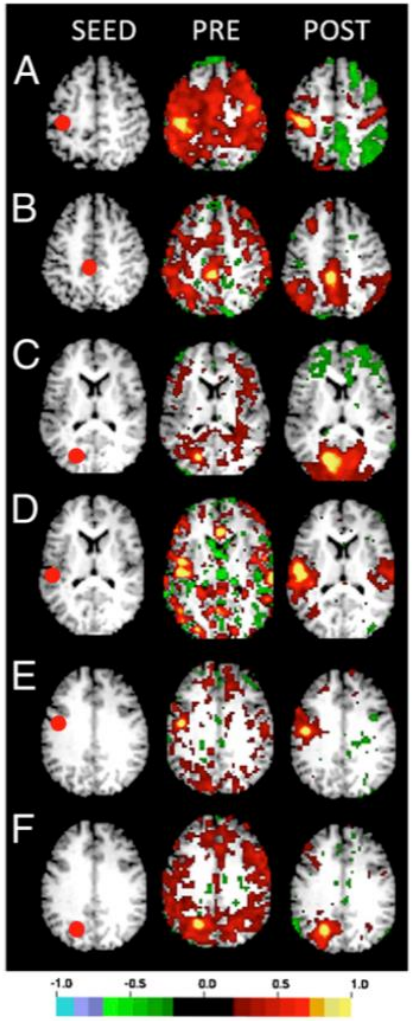
Epilepsy is a disorder of Brain Networks





Pizoli/Shah, et al, PNAS, 2011

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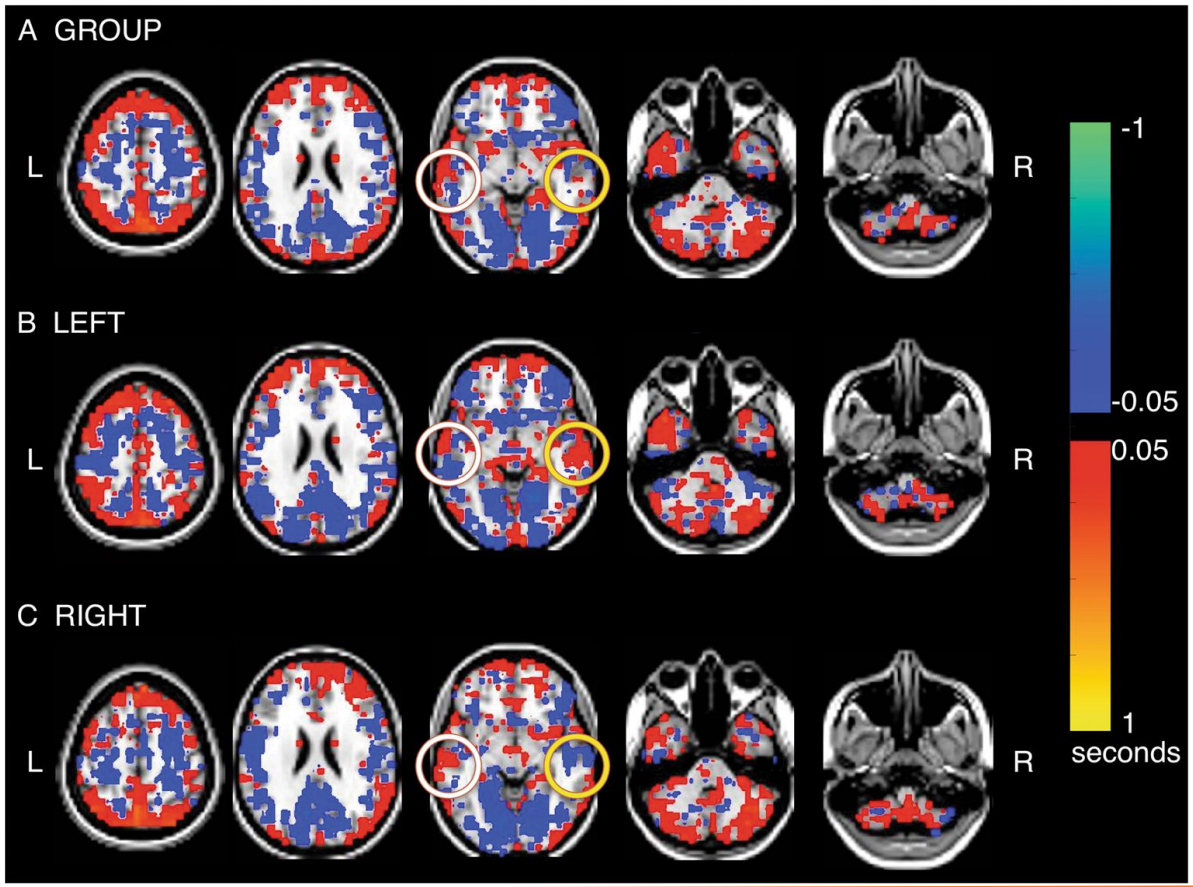
Resting state signal latency predicts laterality in pediatric medically refractory temporal lobe epilepsy

2018

Manish N. Shah[1] · Anish Mitra[3] · Manu S. Goyal[3] · Abraham Z. Snyder[3,4] · Jing Zhang[1] · Joshua S. Shimony[3] · David D. Limbrick[2] · Marcus E. Raichle[3,4,5,6] · Matthew D. Smyth[2]



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Role of Resting State MRI Temporal Latency in Refractory Pediatric Extratemporal Epilepsy Lateralization

Manish N. Shah, MD,[1*] Ryan D. Nguyen, BS,[1] Ludovic P. Pao, BS,[1] Liang Zhu, PhD,[2] Travis S. CreveCoeur, BS,[3] Anish Mitra, PhD,[4] and Matthew D. Smyth, MD[3]

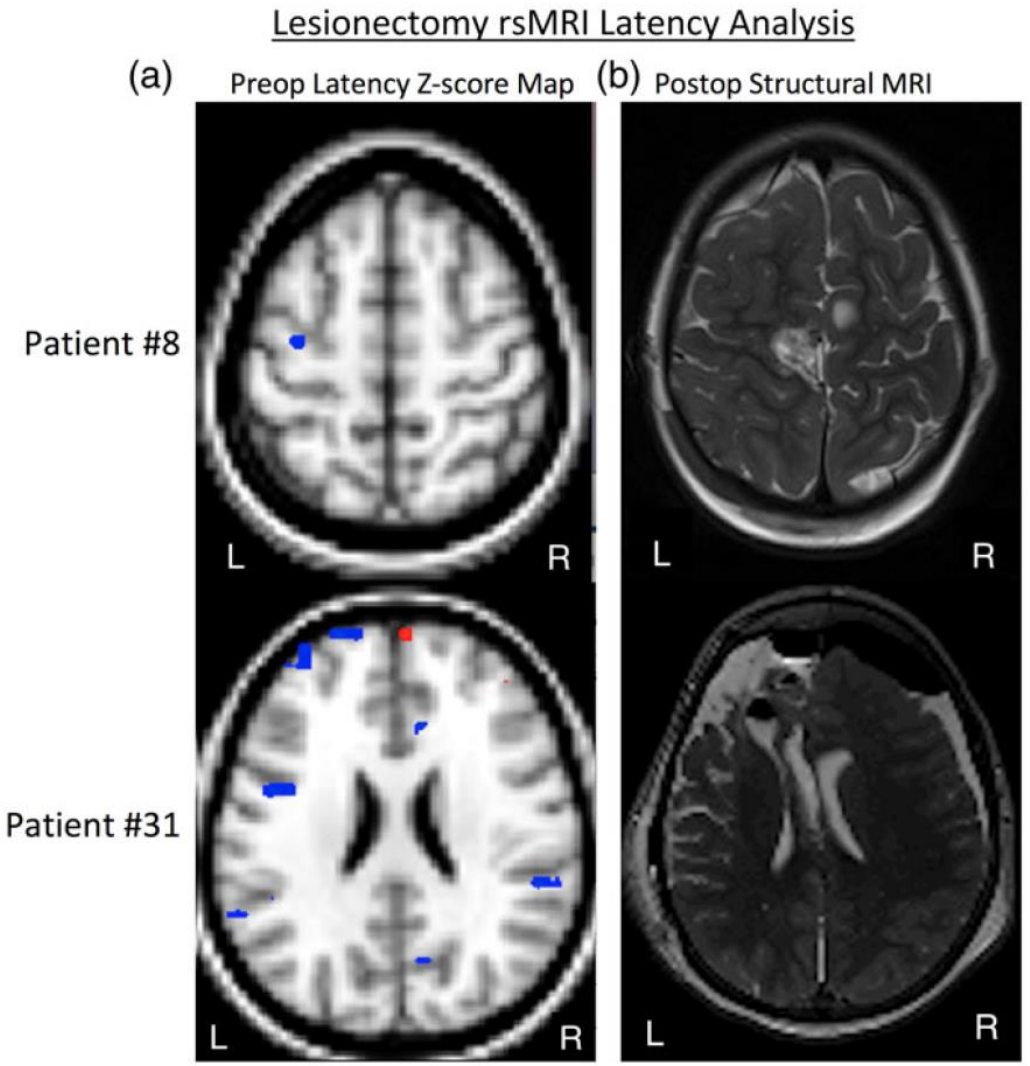

FIGURE 1: Two exemplary lesionectomy case preoperative latency analysis images qualitatively compared with postoperative structural MRI. Patient #8 underwent a left superior frontal lesion resection. Patient #31 underwent a left frontal polar resection. Type I error α_c = 0.001 cutoff was used in both patient latency images. Blue voxels are significantly early and red voxels are significantly late.

2018

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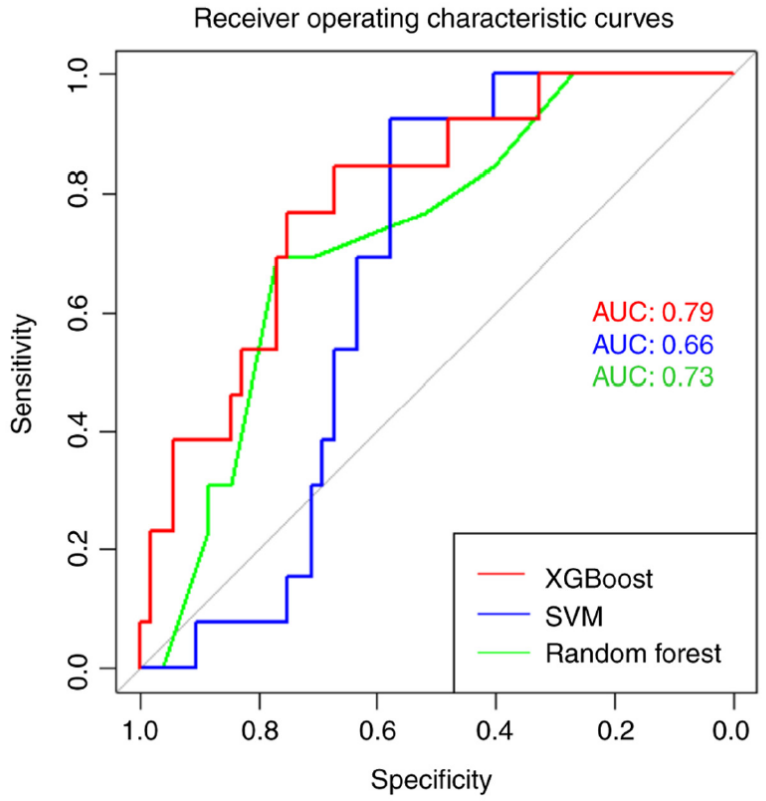
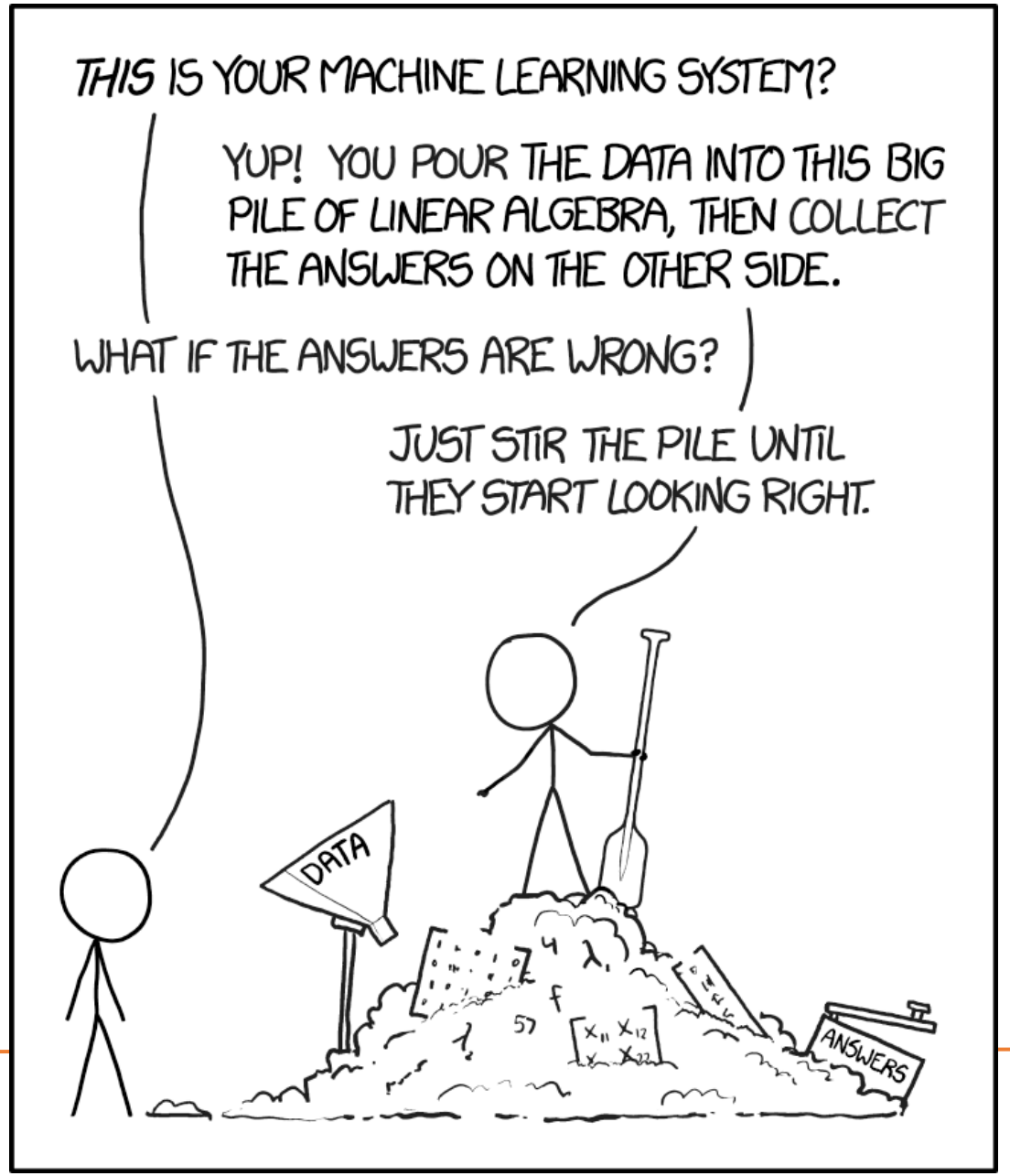
AI Classifier Comparison (2021)

A comparison of machine learning classifiers for pediatric epilepsy using resting-state functional MRI latency data

RYAN D. NGUYEN[1], MATTHEW D. SMYTH[2], LIANG ZHU[3], LUDOVIC P. PAO[1], SHANNON K. SWISHER[1], EMMETT H. KENNADY[1], ANISH MITRA[4], RAJAN P. PATEL[5], JEREMY E. LANKFORD[6], GRETCHEN VON ALLMEN[6], MICHAEL W. WATKINS[6], MICHAEL E. FUNKE[6] and MANISH N. SHAH[1]

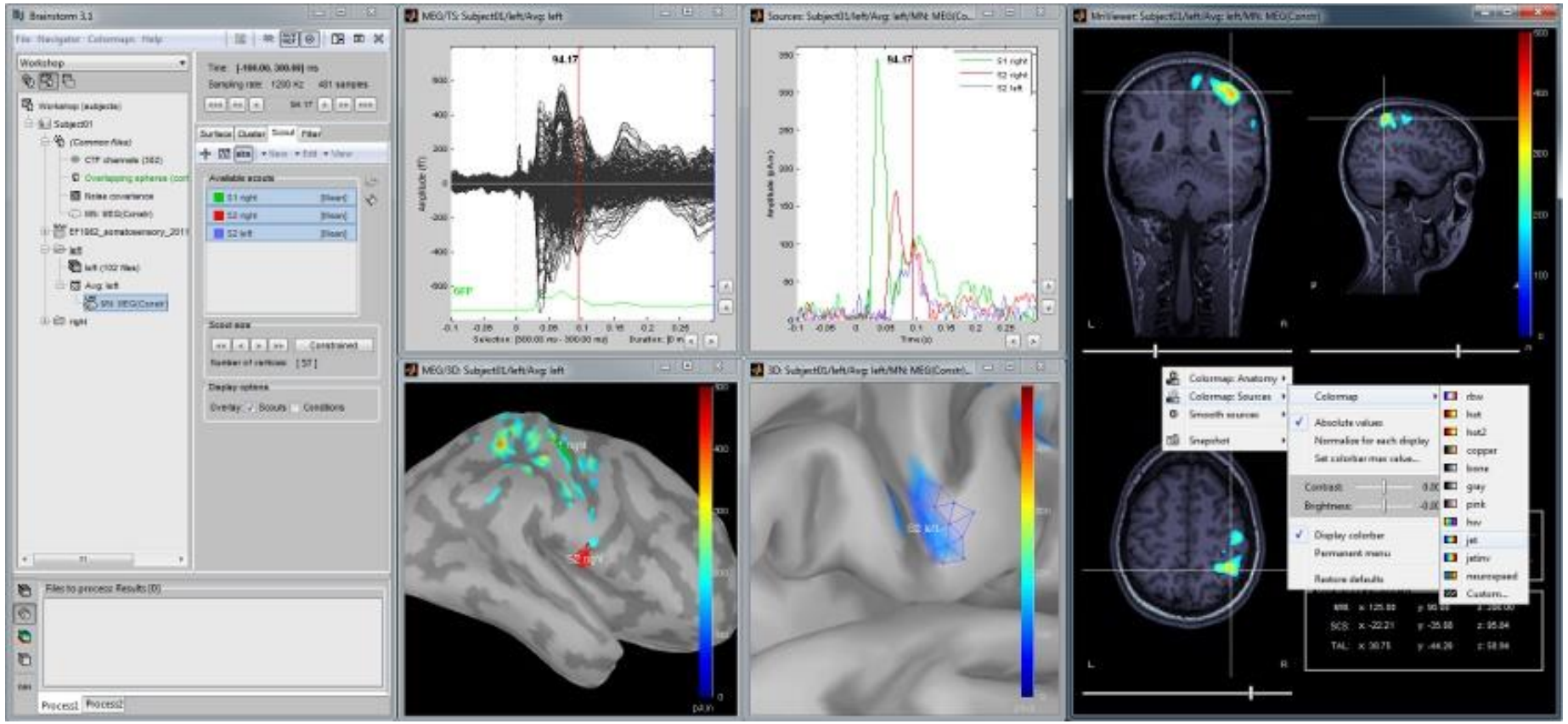


GIGO (XKCD)


THIS IS YOUR MACHINE LEARNING SYSTEM?
YUP! YOU POUR THE DATA INTO THIS BIG PILE OF LINEAR ALGEBRA, THEN COLLECT THE ANSWERS ON THE OTHER SIDE.
WHAT IF THE ANSWERS ARE WRONG?
JUST STIR THE PILE UNTIL THEY START LOOKING RIGHT.
DATA
ANSWERS

Tadel F, Baillet S, Mosher JC, Pantazis D, Leahy RM (2011)
Brainstorm: A User-Friendly Application for MEG/EEG Analysis
Computational Intelligence and Neuroscience, vol. 2011, ID 879716

Source Localization with Brainstorm



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Analysis Overview

Data Importing

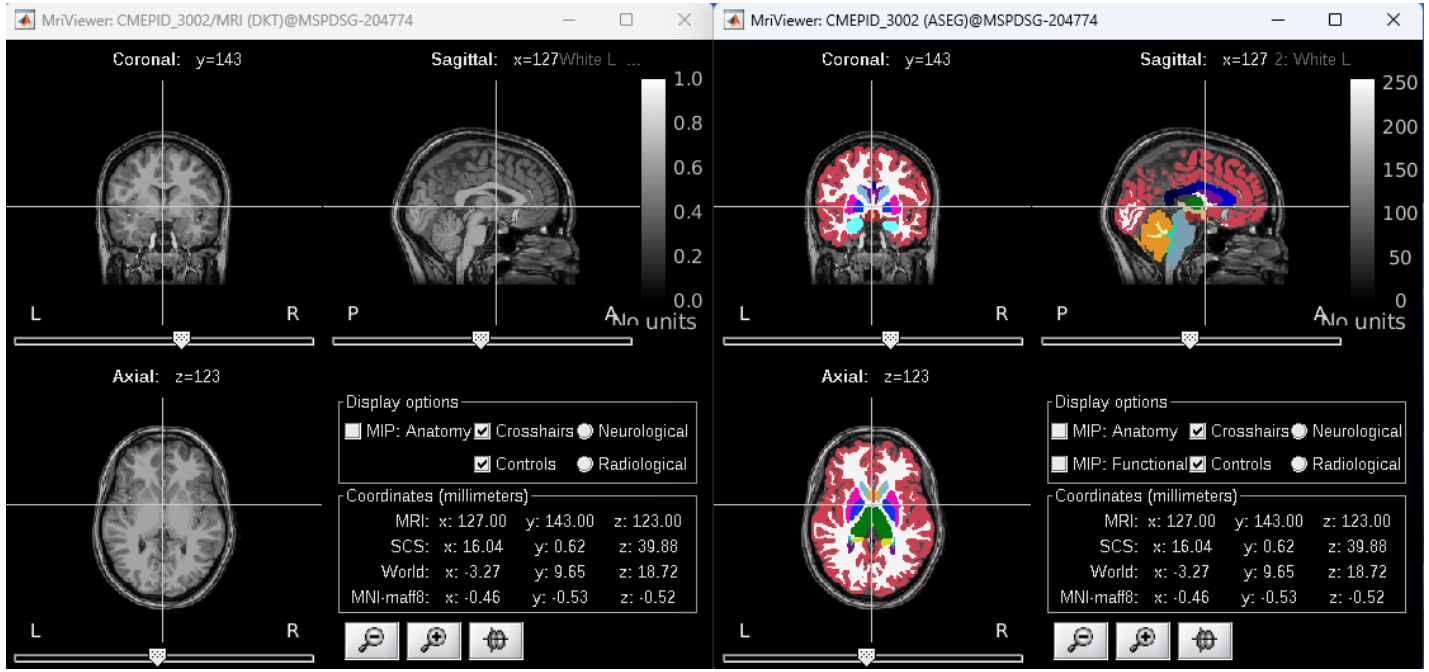
1) Import subject anatomy
2) Align MEG data with anatomy
3) Extract epileptic MEG activity

Source Localization

1) Generate head model from subject anatomy
2) Compute sources
3) Model sources as dipoles

Data Import: *Subject Anatomy*

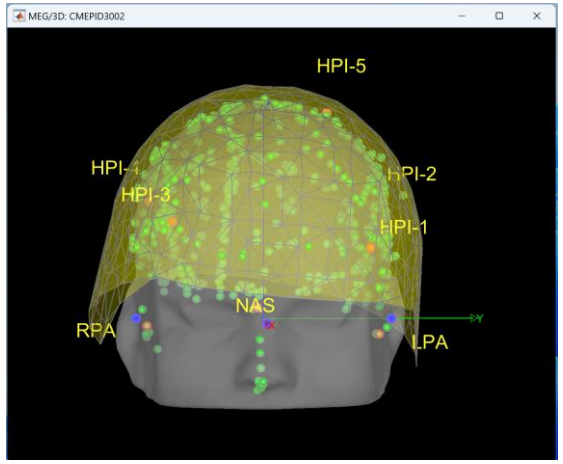
- Load Freesurfer segmentations into Brainstorm.



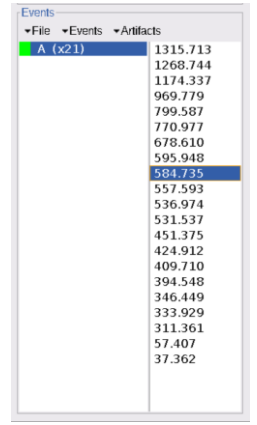
Data Import: *MEG Data*

- Import & anatomically co-register MEG data.
  - *Sensor position (A)*
  - *Recordings (B)*
  - *Epileptic spike annotations (C)*
  - *Use first 10s for noise estimation (D)*

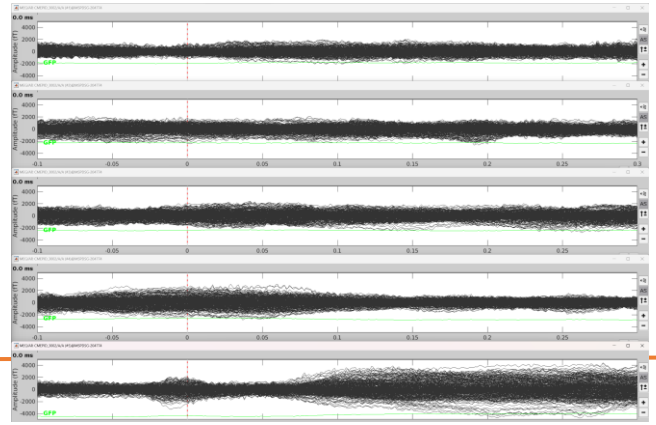
A



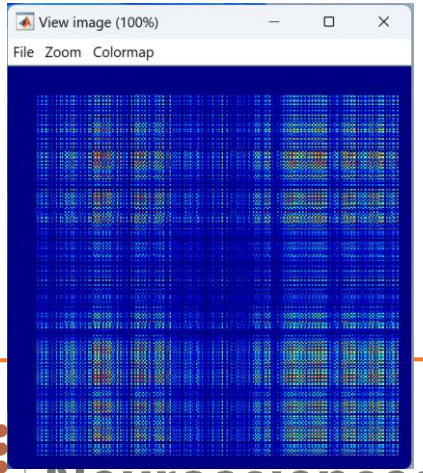
C



B



D

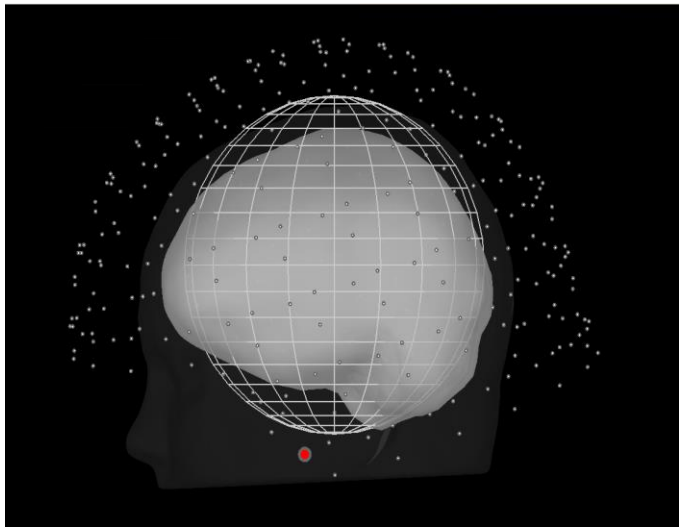


Source Localization: *Head Modeling*

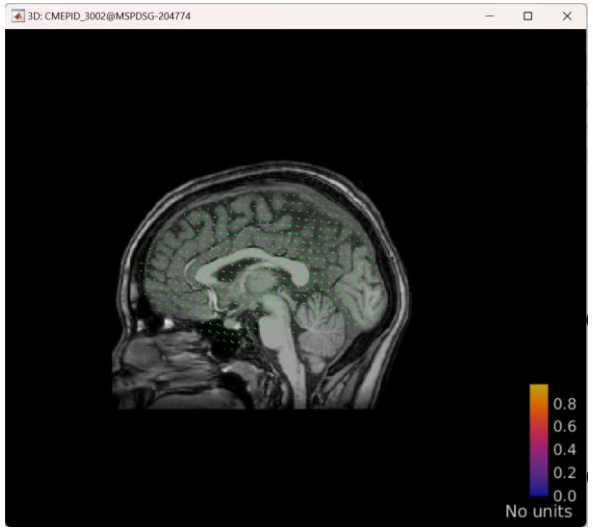
- Approximate brain, skull, and scalp as series of overlapping spheres. *(A)*

- Approximate source space as 3D grid of vectors dispersed throughout brain *(B)*

A

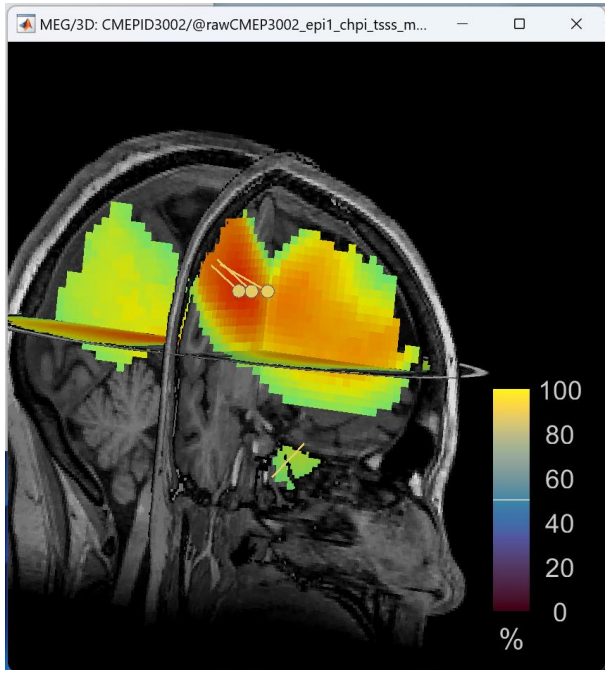


B

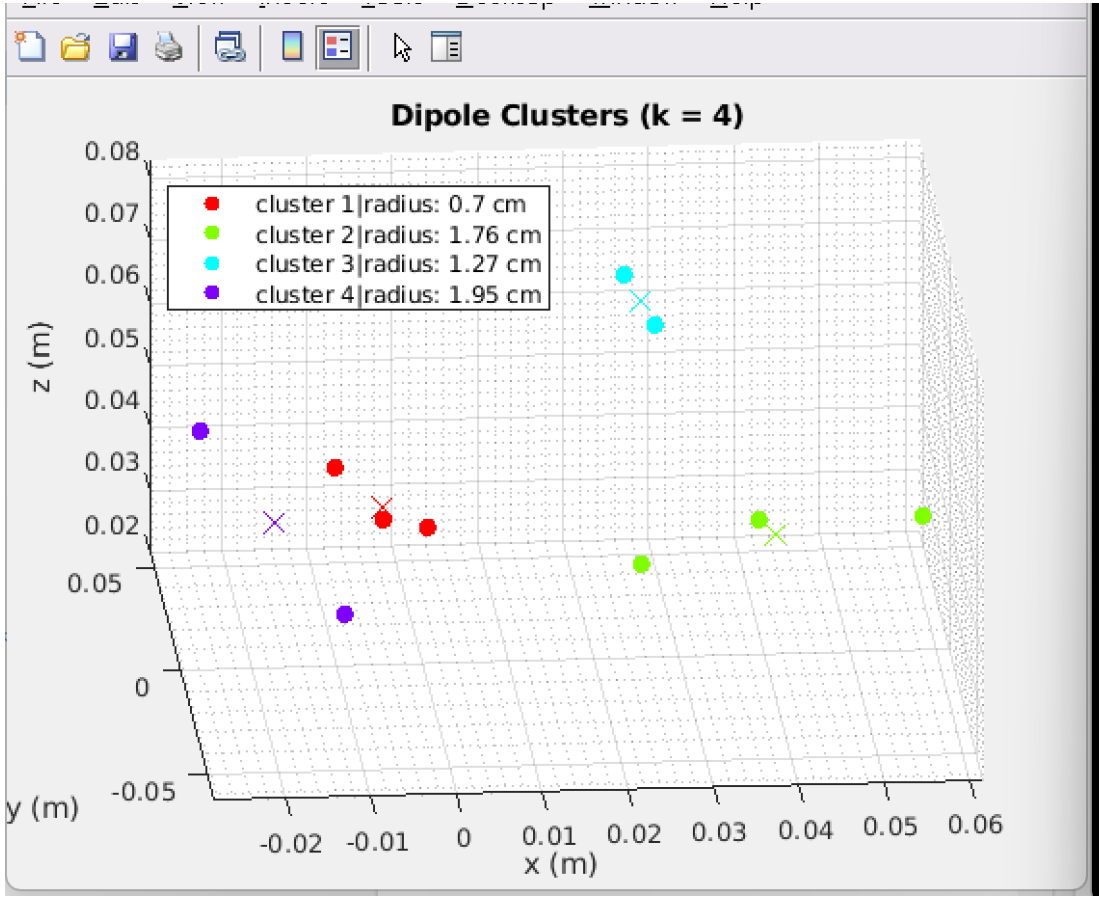


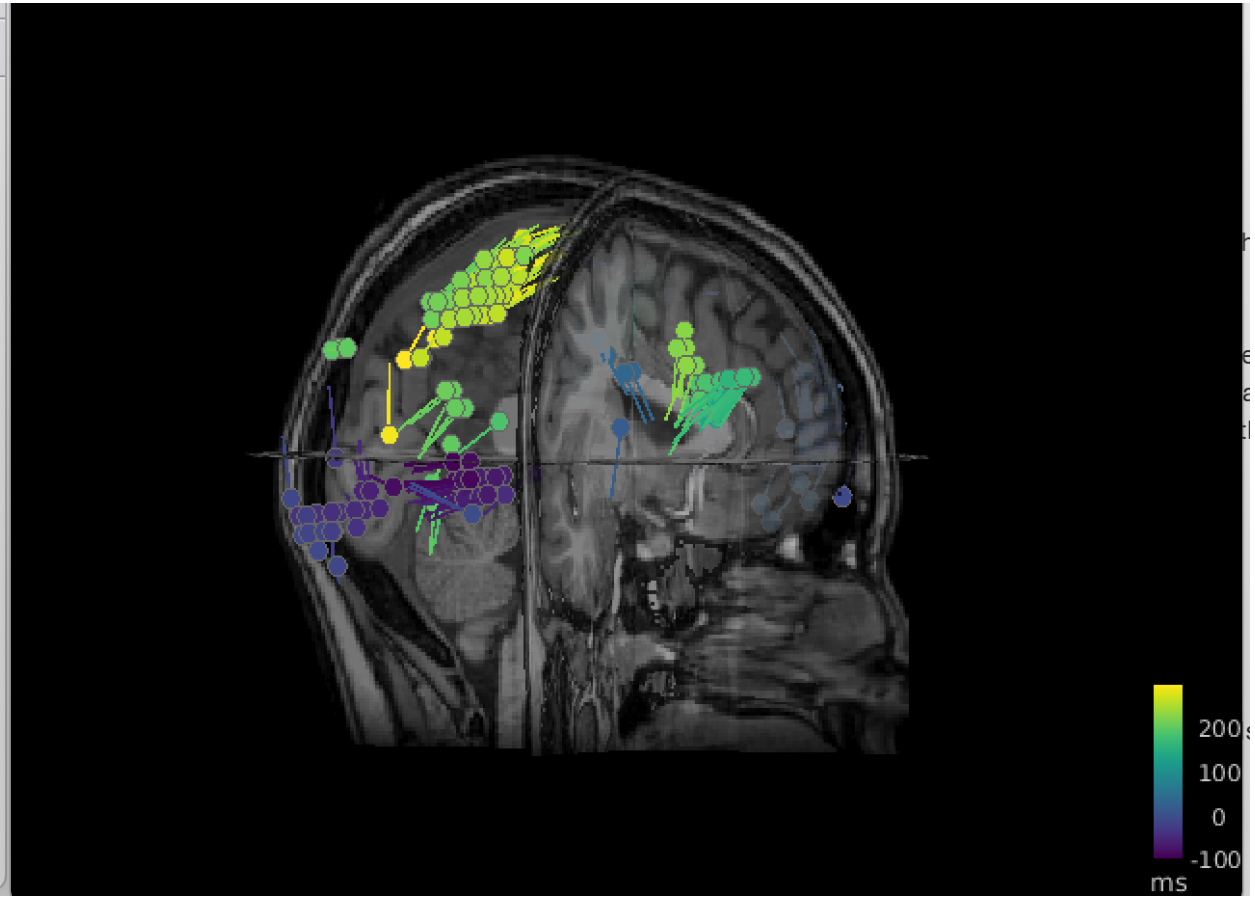
Source Localization: *Source Computation & Dipole Production*

- Evaluate source space for activity during epileptic events.
- Estimate dipoles that best fit the source space during epileptic events.



Final Product (spatial and temporal clustering)





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Future Directions

- More Sophisticated Clustering
  - AI
- More Data
- More Outcomes

Thanks ANT CONGRES

- SHAH LAB!!!
  - Arya Shetty
  - Yash Vakilna
  - Jonathan Hendricks
  - Ryan Nguyen
  - Shannon Swisher
  - Emmett Kennady
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  - Alberto Rosas
  - Trey Sickler

- Sam Lhatoo and John Mosher
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  - David Sandberg, MD
  - Stephen Fletcher, DO
  - Bangning Yu, MD PhD
- Alisse Pratt, Anne Crocker, William Radcliffe
- Vianey + Reyna + Paula
- PEMU Staff and EEG Technologists

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