

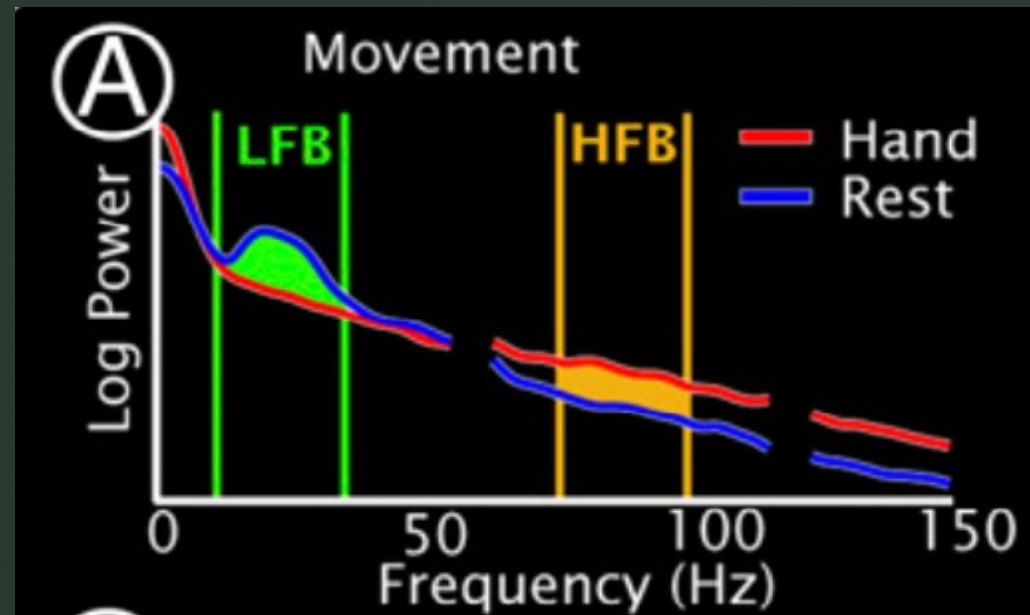
# Motor power modulations during imagined movements

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# Background

- relative power in **beta** frequency decreases within motor cortex during movement (event related desynchronization, ERD)
- relative power in **high gamma** frequency increases during movement (event related synchronization, ERS)



Miller et al. (2010)

# Aims

1. **Replicate** prior ERD/ERS findings
2. **Investigate** how power profiles during imagined and actual movements differ
3. **Design and build** ML pipeline to classify actual and imagined movements, with and without high gammas

# Hypotheses

- A. Similar ERD in beta frequency between actual and imagined
- B. Attenuated changes in high gamma frequency for imagined movements in comparison with actual movements
- C. Models without high gamma input will significantly underperform in the discrimination task

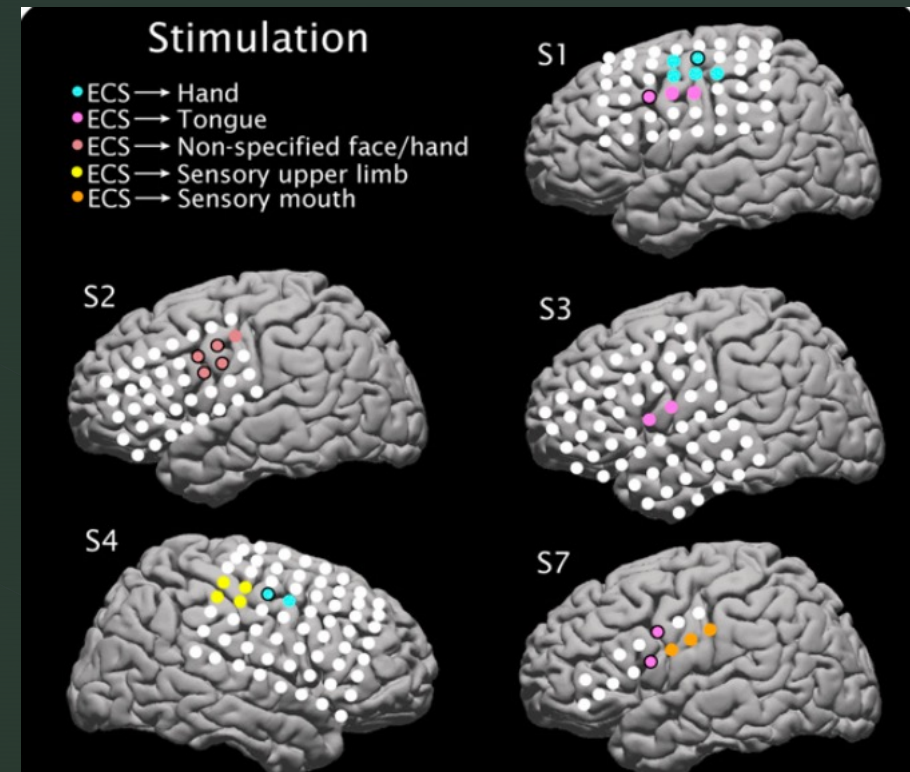
# Data

- ECoG recordings from subjects undergoing treatment for medically refractory epilepsy
- Two interleaved tasks at rate of once per second (1 Hz), alternating between task and rest, on-screen cue:
  - hand (synchronous flexion/extension of all fingers)
  - tongue (protrusion/retraction of tongue with mouth open)
- Two conditions: real movement, imagined movement
- Dataglove or EMG to verify absence of movement during imagined condition



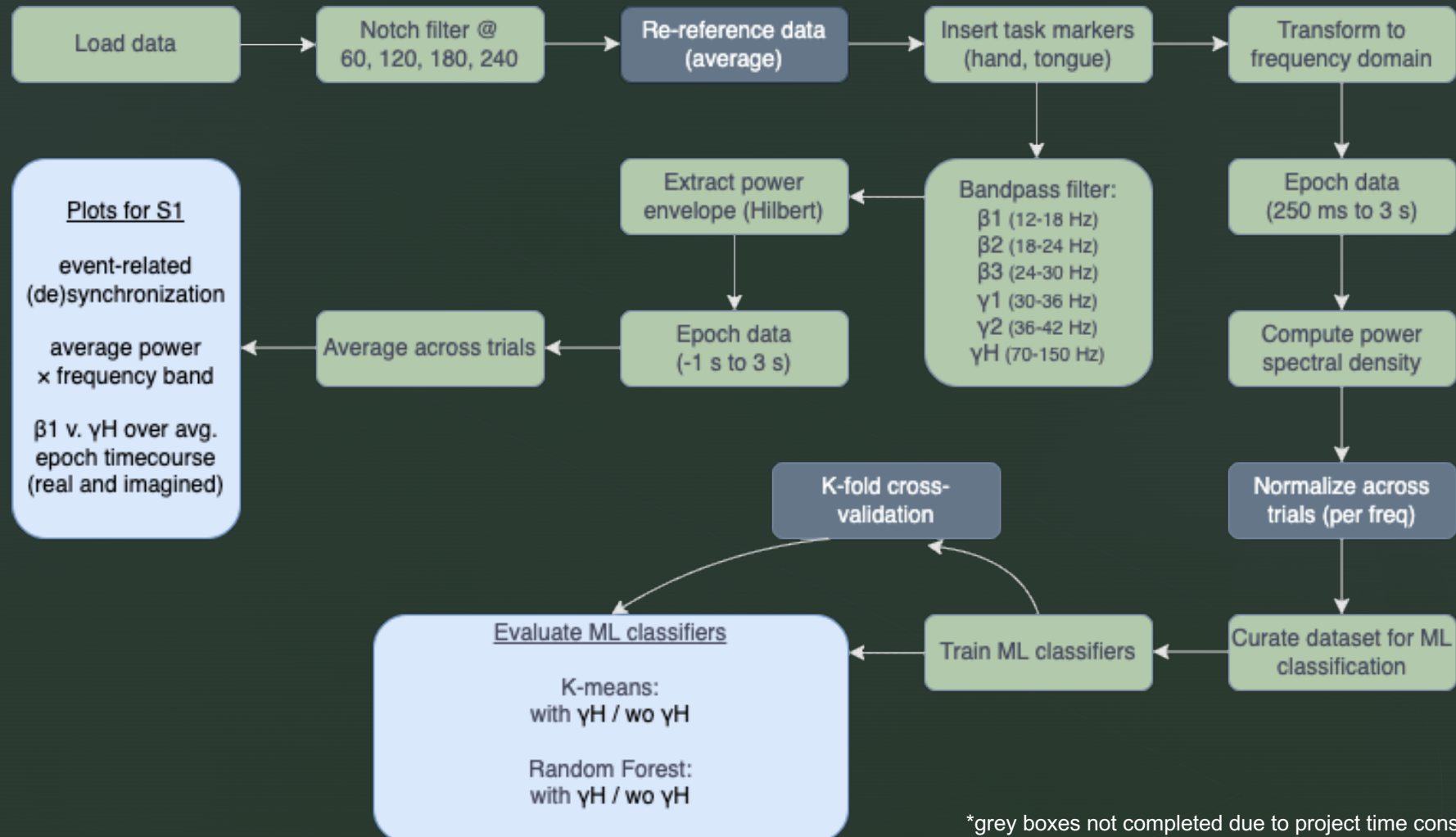
# Data

- Electrocortical mapping for five participants (for clinical purposes)
- Provides indication of electrodes where stimulation causes movement
- Analyzed S1



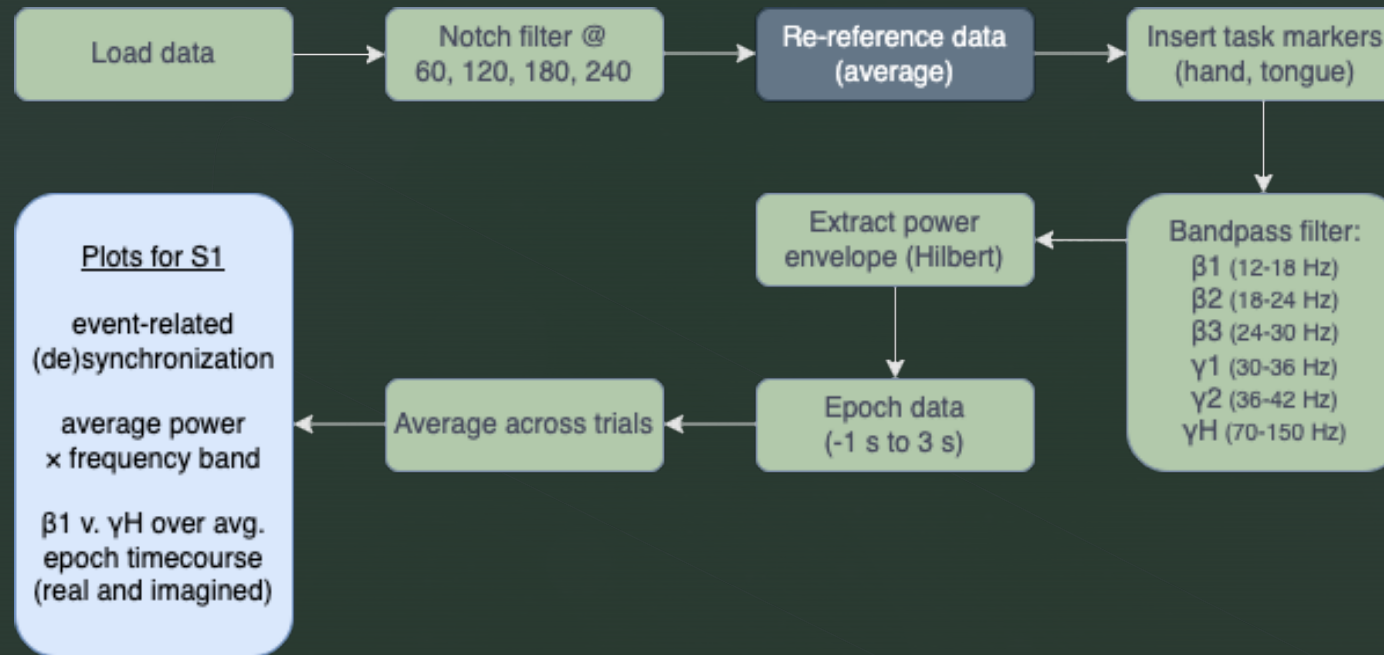
Miller et al. (2010)

# Methods



# Exploratory

## Aims 1 and 2



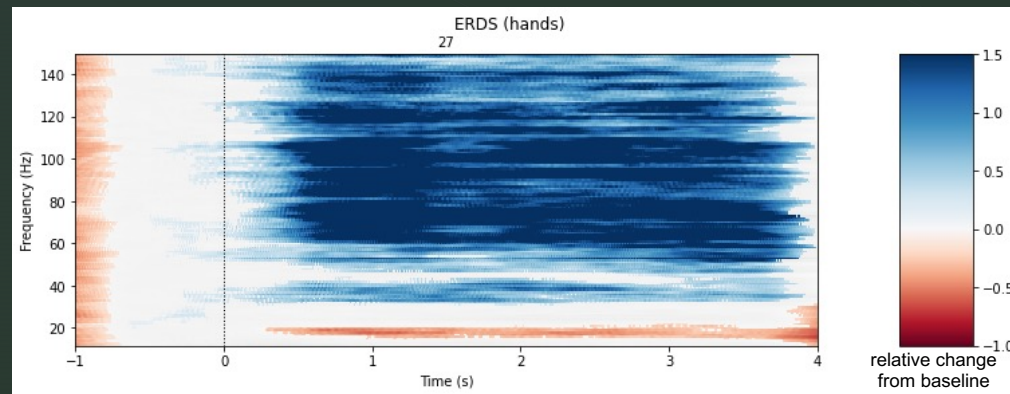
\*grey boxes not completed due to project time constraints



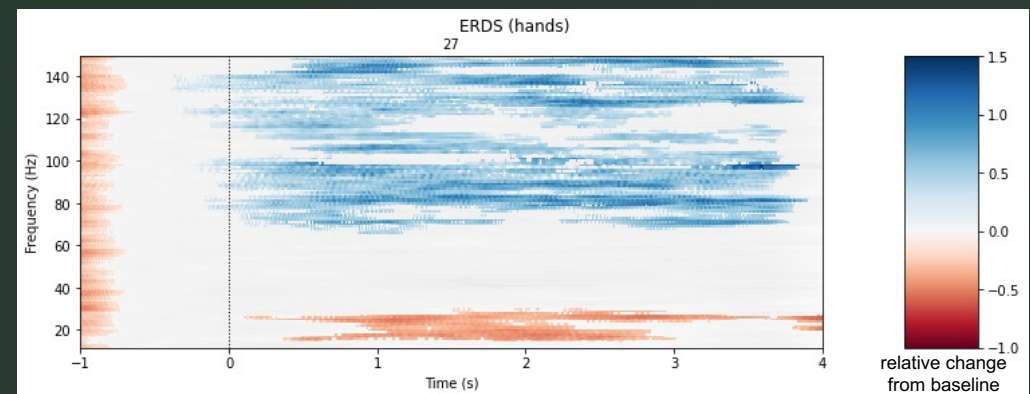
# Aim 1:

## Replicate prior ERD/ERS findings

actual movement



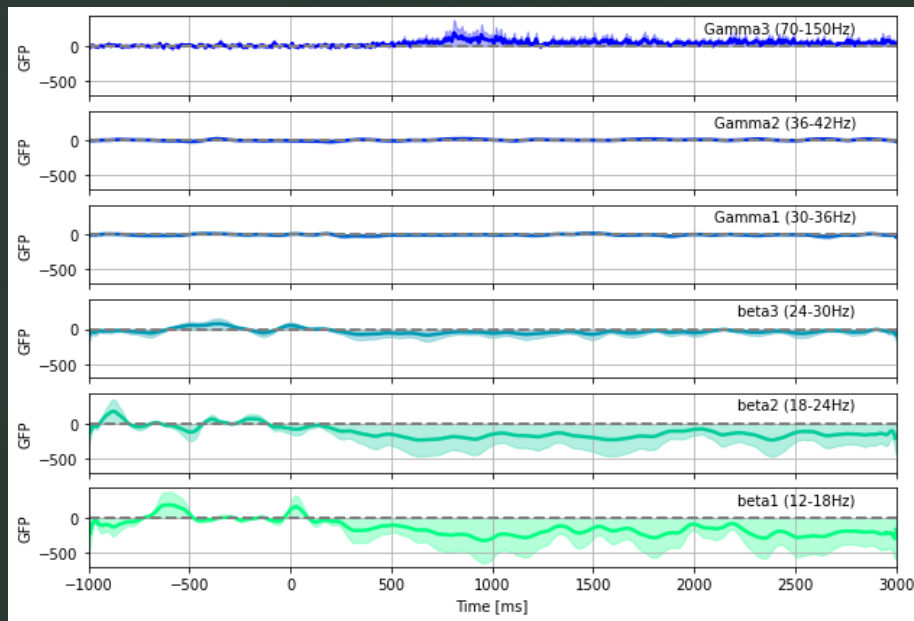
imagined movement



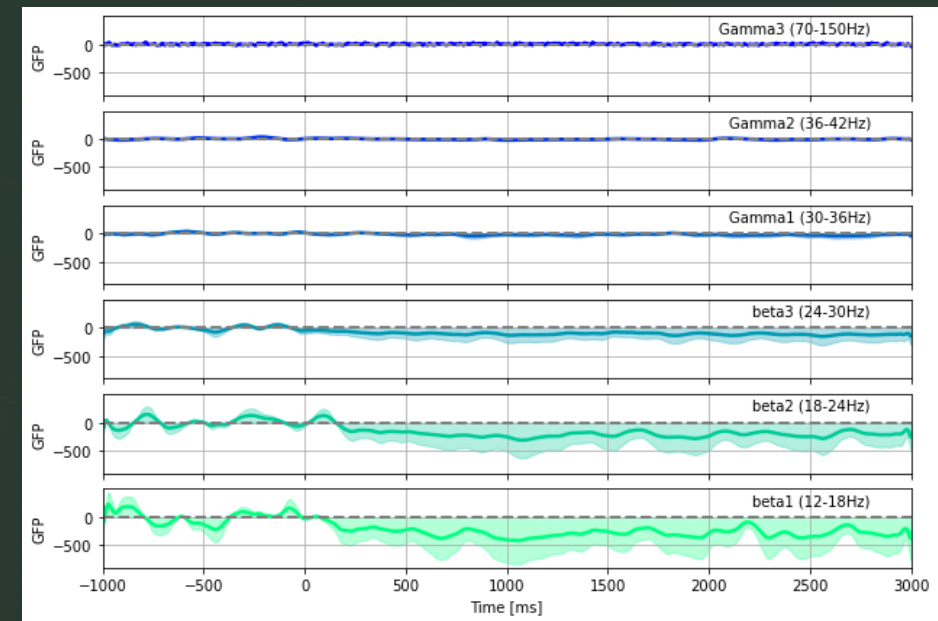
# Aim 1:

## Replicate prior ERD/ERS findings

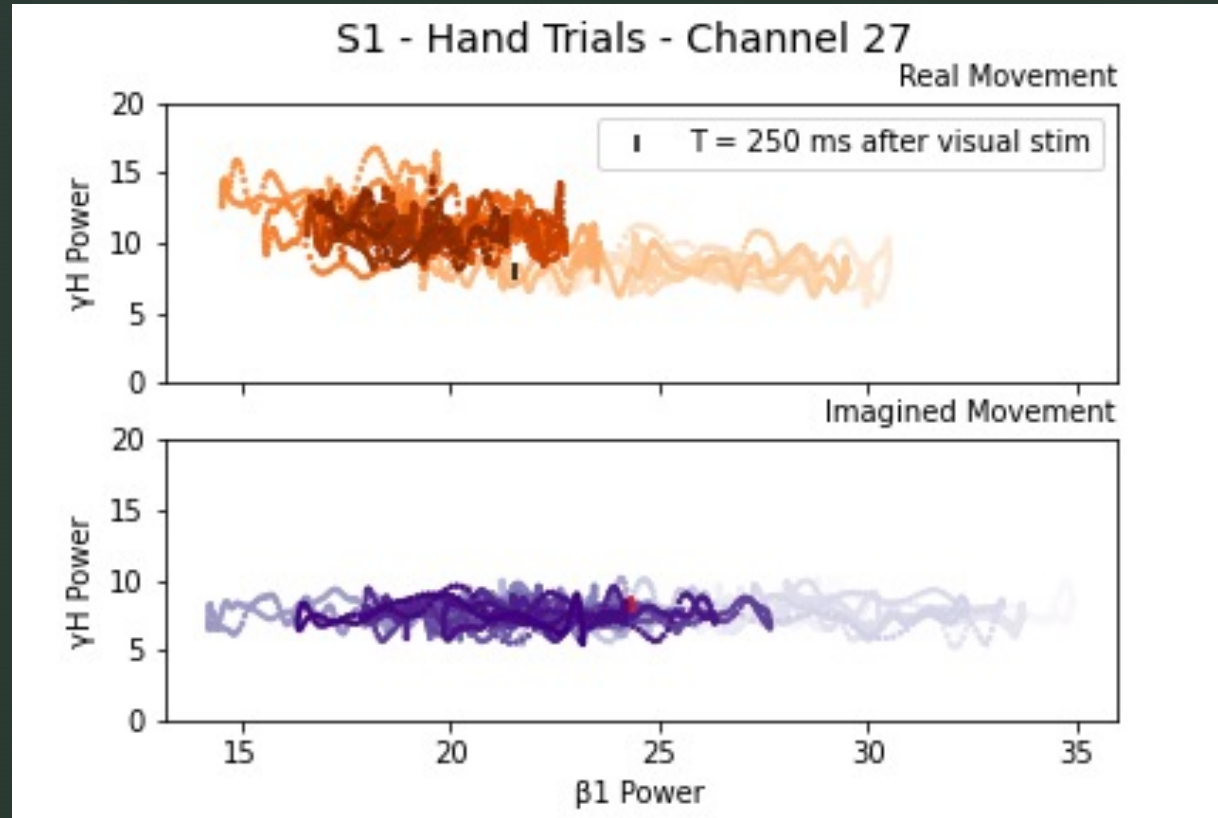
actual movement



imagined movement



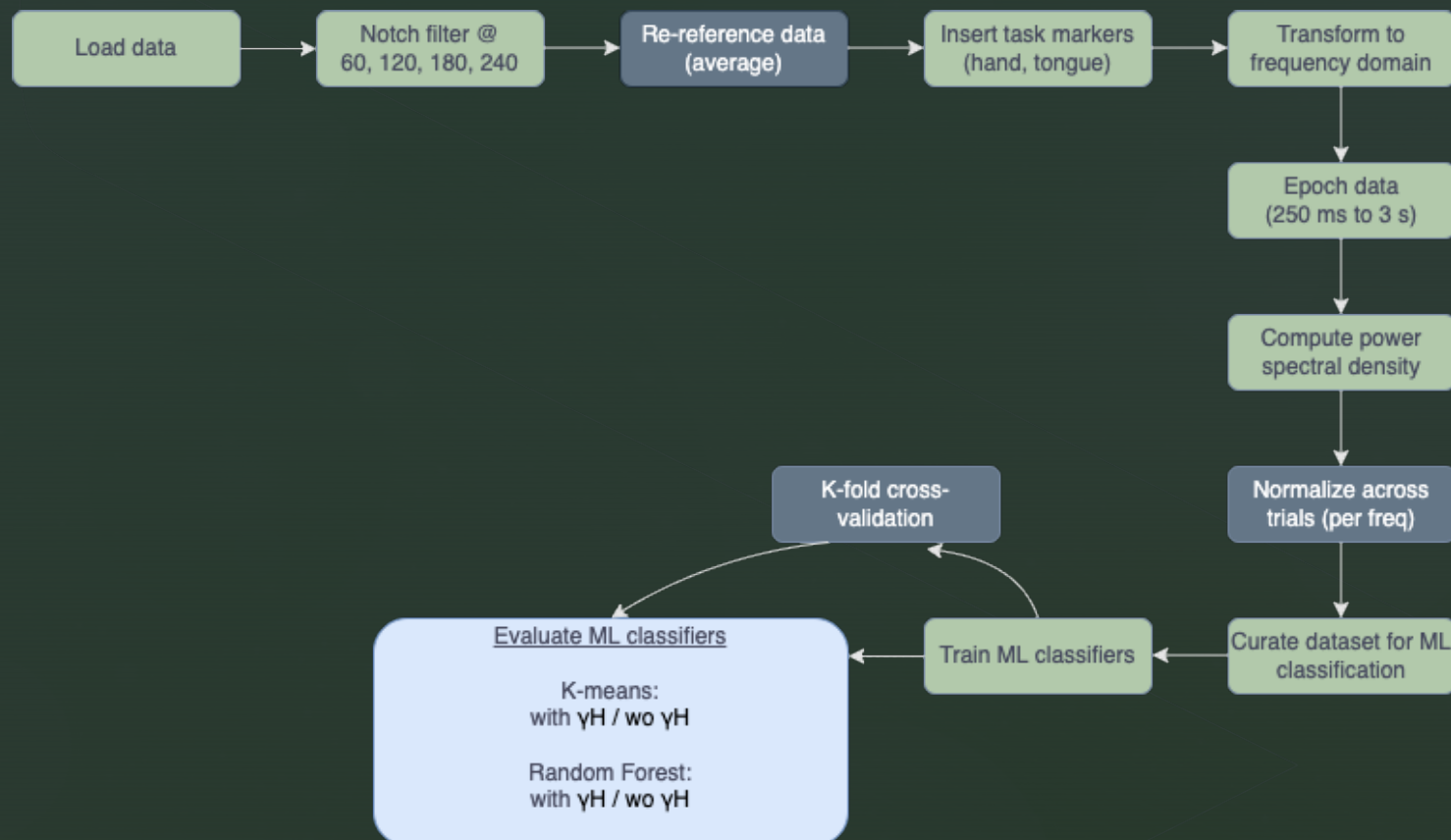
## Aim 2: Investigate real v. imagined power



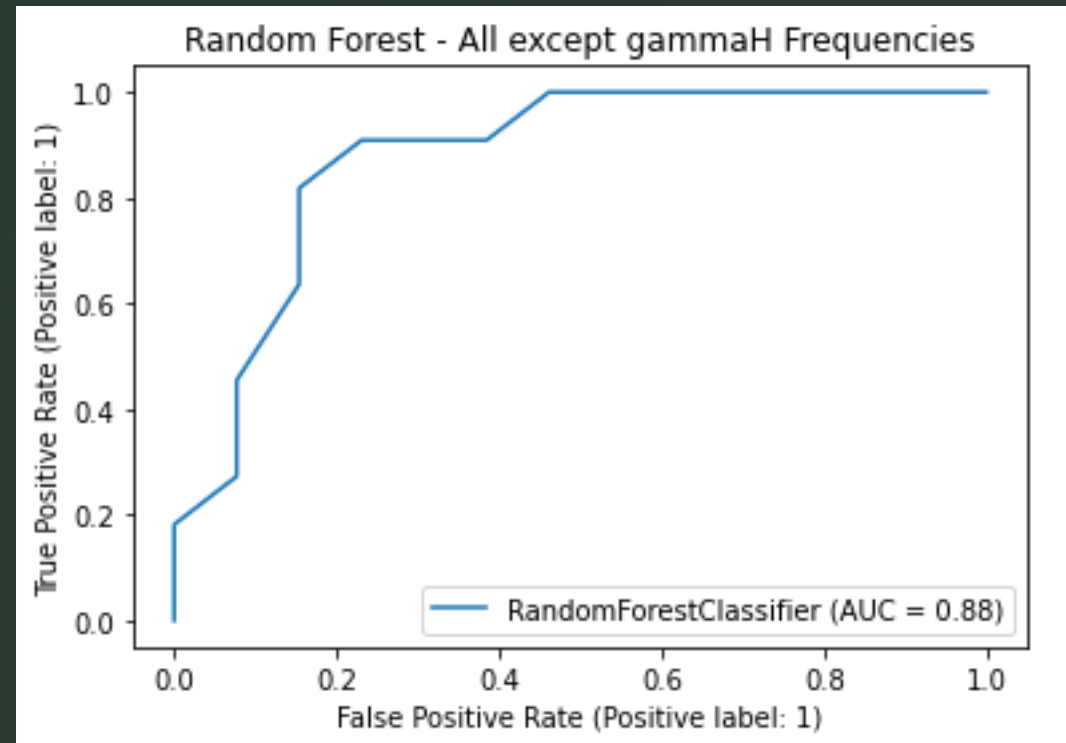
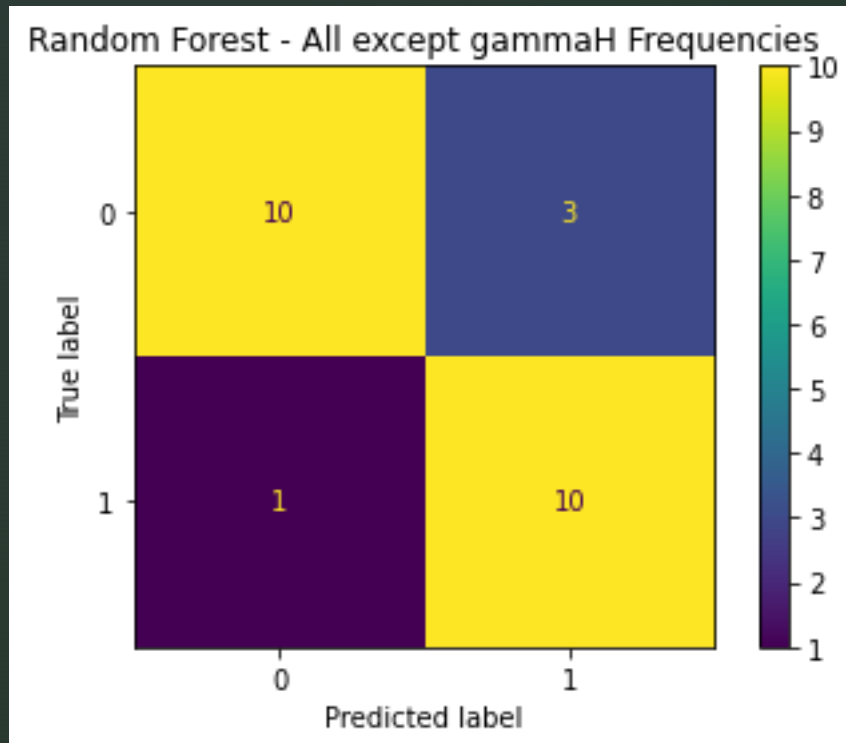
color (light > dark) indicates time course over epoch window (-1000 to 3000 ms)

## Aim 3

To what extent do lower frequency bands distinguish actual versus imagined movement?

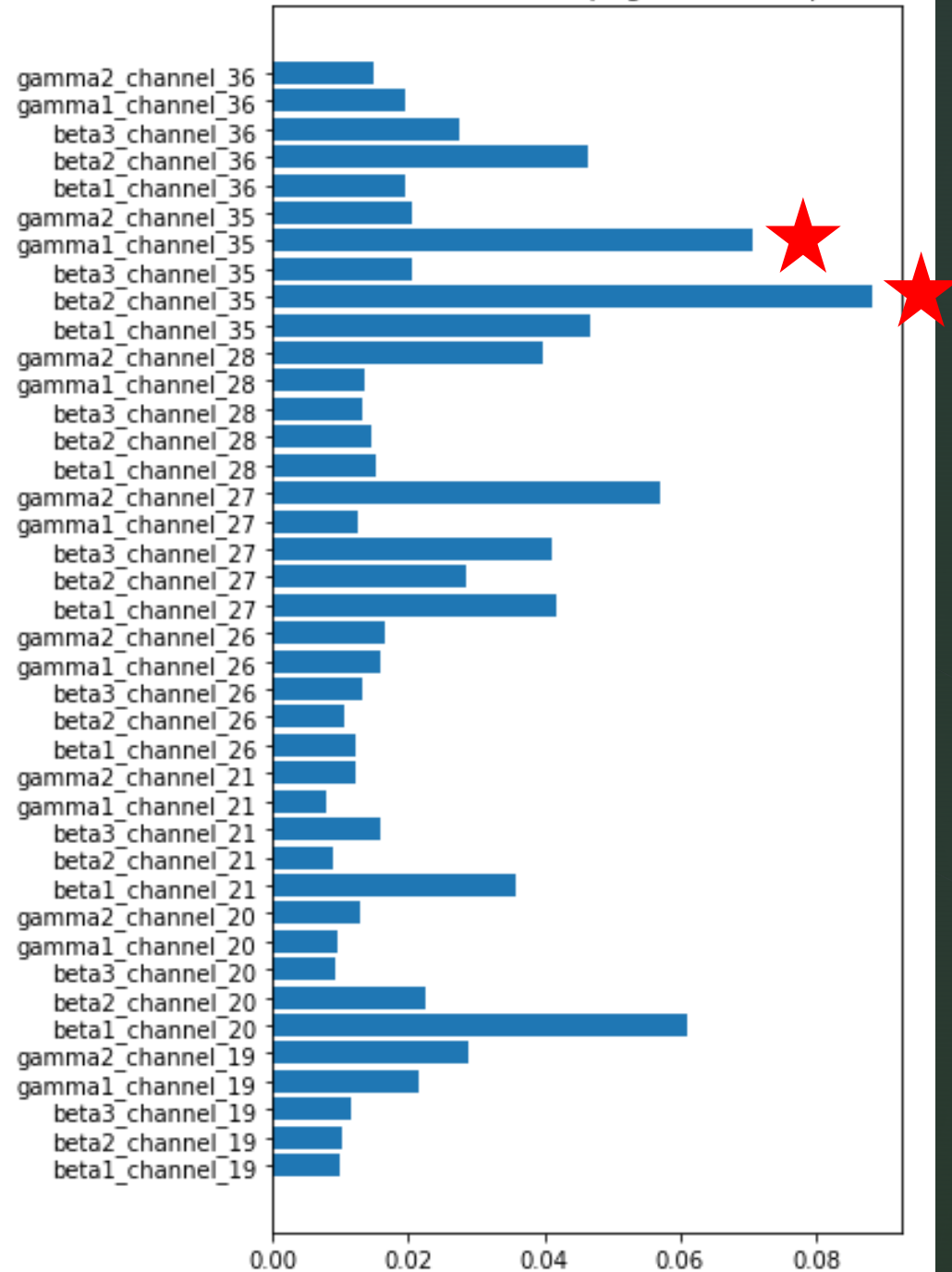


## Aim 3: Classify without high gamma








Random Forest - All except gammaH Frequencies



**Aim 3:**  
**Classify without high  
gamma**

# Conclusions

1. Similar ERD in beta frequency between actual and imagined 
2. Attenuated changes in high gamma frequency for imagined movements in comparison with actual movements 
3. Low frequency only models will significantly underperform in the discrimination task 

Better performance than anticipated  
(but models with high gamma still  
perform better...)

# Limitations

- specific subject population reduces generalizability of findings
- project time constraints led us to simplify our preprocessing:
  - did not re-reference data to the average
  - did not perform ICA or other methods to identify and remove noisy (or epileptic) epochs in the channels we analyzed
- project time constraints led us to simplify our analyses:
  - did not z-score across trials within bands before classification
  - single randomized split for training/test (no thorough cross-validation)

# Code Availability

<https://github.com/jessb0t/motorImagery>

# References

- Gramfort, A., Luessi, M., Larson, E., Engemann, D. A., Strohmeier, D., Brodbeck, C., Goj, R., Jas, M., Brooks, T., Parkkonen, L., & Hämäläinen, M. S. (2013). MEG and EEG data analysis with MNE-Python. *Frontiers in Neuroscience*, 7(267):1–13.
- Harris, C.R., Millman, K.J., van der Walt, S.J. et al. (2020). Array programming with NumPy. *Nature* 585, 357–362.
- Hunter, J.D. (2007). Matplotlib: A 2D Graphics Environment, *Computing in Science & Engineering*, 9(3):90-95.
- Miller, K. J., Schalk, G., Fetz, E. E., den Nijs, M., Ojemann, J. G., & Rao, R. P. N. (2010). Cortical activity during motor execution, motor imagery, and imagery-based online feedback. *PNAS*, 107(9), 4430–4435.
- Miller KJ. A library of human electrocorticographic data and analyses. *Nat Hum Behav*. 2019 Nov;3(11):1225-1235.
- Unterweger, J., Seeber, M., Zanos, S., Ojemann, J. G., & Scherer, R. (2020). ECoG Beta Suppression and Modulation During Finger Extension and Flexion. *Frontiers in Neuroscience*, 14, 35.
- Code for creation of the GFP graphics based on the detailed example provided here:  
[https://mne.tools/stable/auto\\_examples/time\\_frequency/time\\_frequency\\_global\\_field\\_power.html](https://mne.tools/stable/auto_examples/time_frequency/time_frequency_global_field_power.html)



# Thanks!



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Project TA



Anis Zahedifard, Pod TA



Dr. Jason Ritt,  
Project Mentor



Neuromatch  
Organizers and  
Volunteers