Neuroscience
scientific advisory board project updates

December 16th, 2022

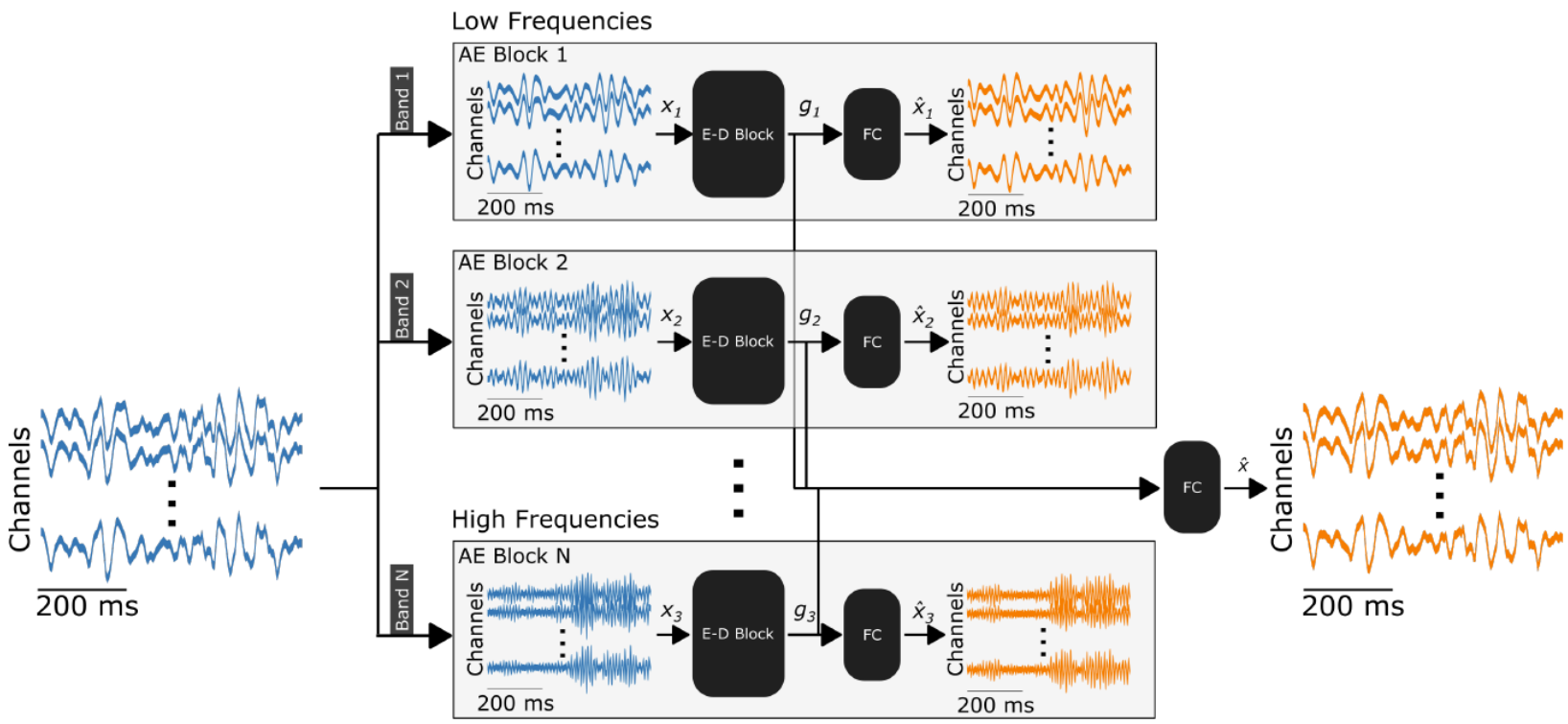
Progress on Algorithms to reconstruct/predict broad-band neural signals

- Found that existing autoencoder methods for neural data are band-limited to model size
  - Limits reconstructions of broad-band neural data such as micro-electricorticography

- Developed new Multi-block Recurrent Auto-Encoder (MRAE) to increase model bandwidth more efficiently

- **New finding:** band-limits may extend to other architectures like transformers

- **New directions**: exploring if multiband architecture also improves learned latent representations (e.g. improved clustering)

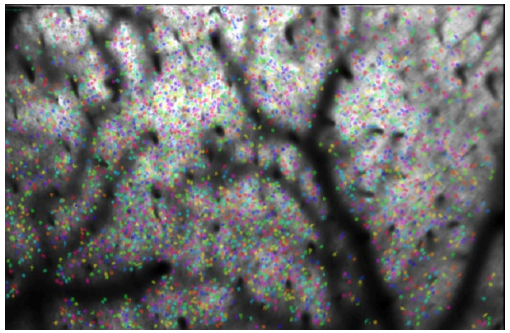


Nolan, Pesaran, Shlizerman & Orsborn, *bioarxiv 2022*

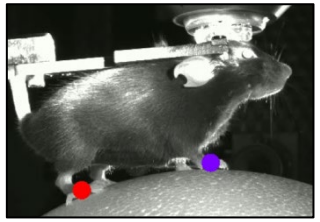
The **ultimate goal** of this A3D3 project is to optimize the parameters of intracortical microstimulation to replace proprioceptive information in lost due to injury and disease

Three main project components:

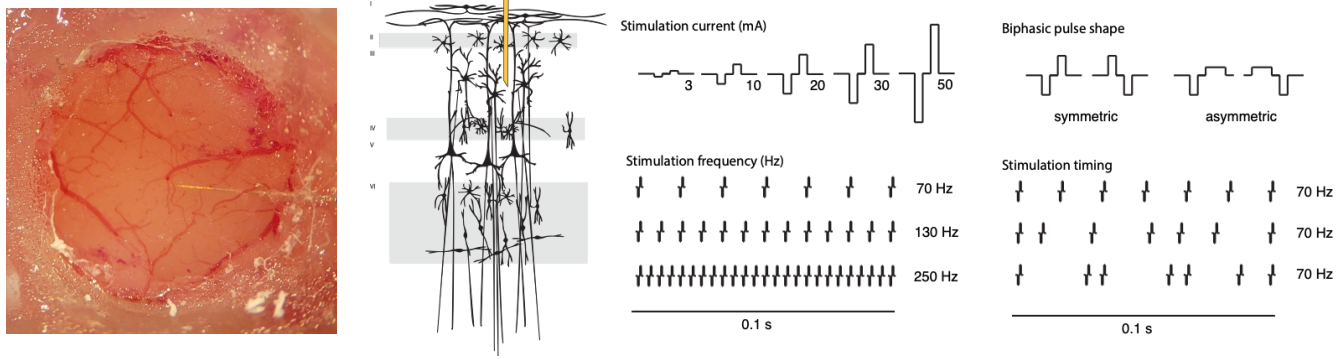
1. How is natural proprioception encoded in the brain?



3-layer LSTM



2. How can electrical stimulation manipulate neural activity patterns?



Stimulation patterns ⟷ Evoked neural activity

ANN (TBD)

3. How can electrical stimulation replicate neural activity during natural proprioception?

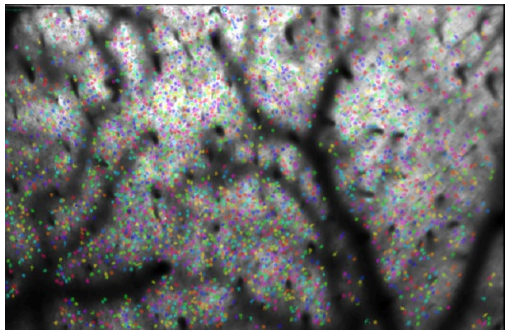
Proprioception ⟷ Neural activity ⟷ Stimulation patterns

3-layer LSTM ANN

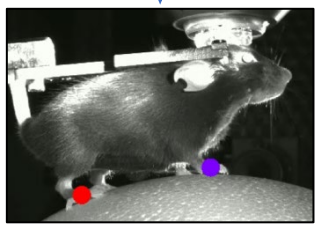
PURDUE UNIVERSITY

Ongoing results:

1) How is proprioception encoded in healthy animals?

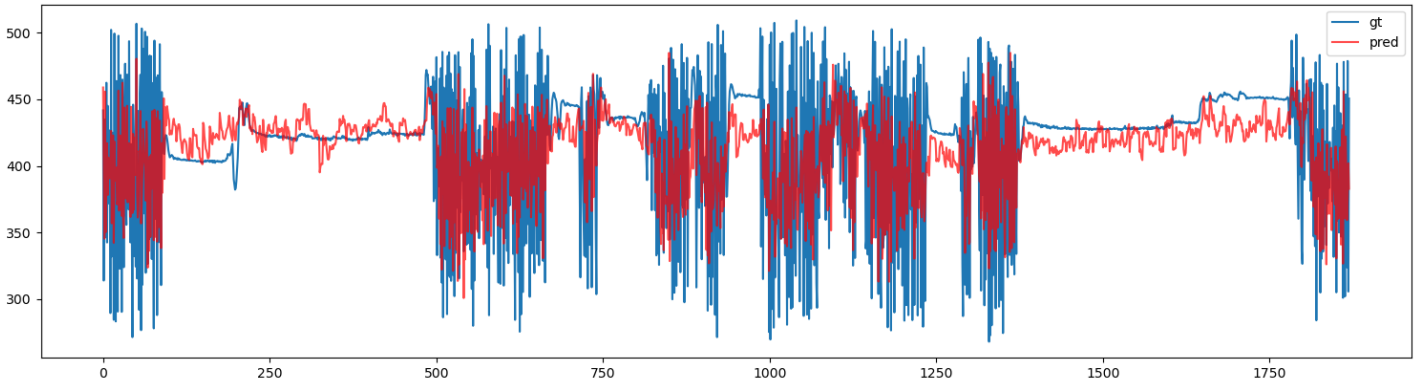


3-layer LSTM

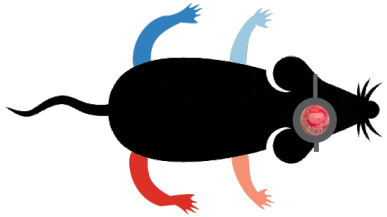


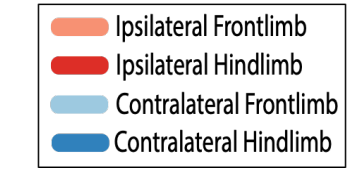
3-layer LSTM to go from neural activity (input) to animal movement (output)

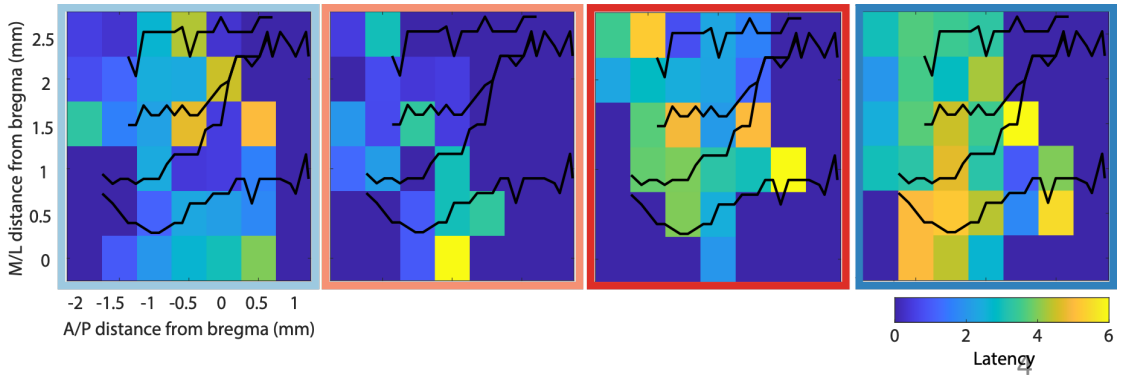
Model validation (0.25 R^2)



Building spatial and temporal maps of limb representation across the brain



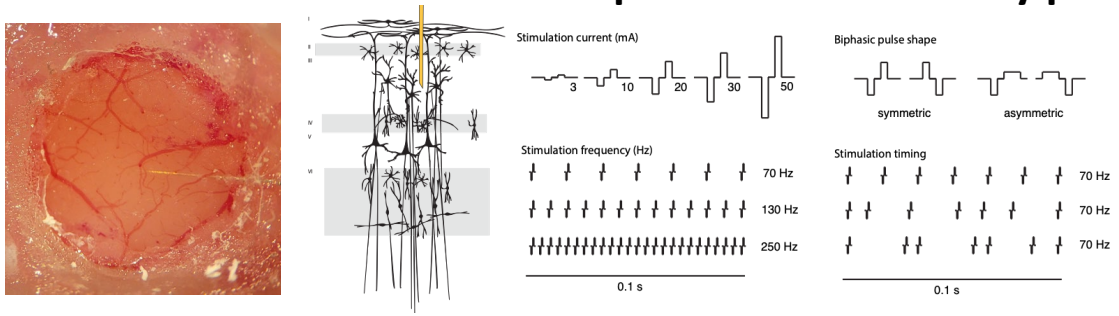




* Conference presentation at Society for Neuroscience, 2022
* Manuscript in progress, target submission date 01/2023

Ongoing results:

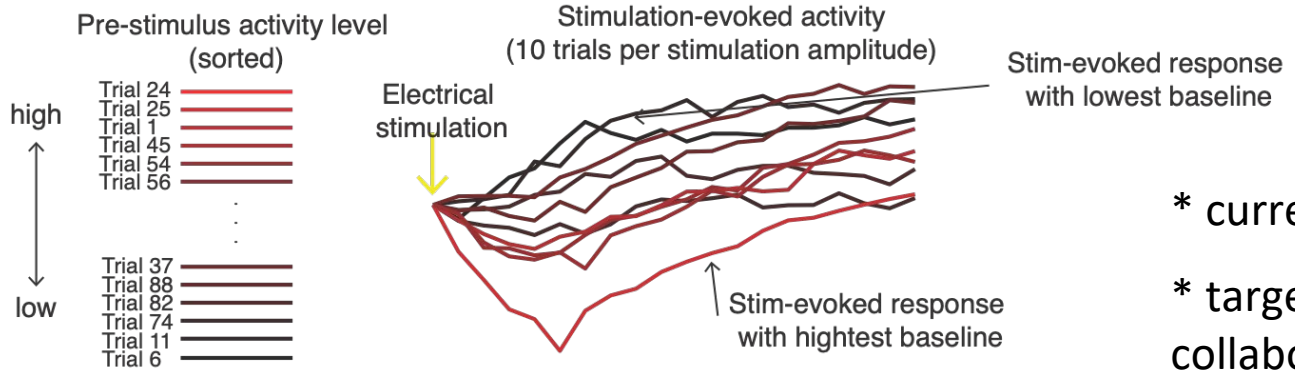
2. How can electrical stimulation manipulate neural activity patterns?



Stimulation patterns ⟺ Evoked neural activity

ANN

Most important results: neural activity evoked by stimulation depends on ongoing activity patterns —> need closed-loop experiments and incorporate extra features into model



* currently under review at *Neuron*

* target for within A3D3 collaboration (Pan & Mia)

Key Products

- Poster presentations
  - Nolan, Pesaran, Shlizerman, & Orsborn, AI@UW workshop, University of Washington, May 2022
  - Lipton & Dadarlat, Society for Neuroscience Conference, Nov. 2022
  - Lipton & Dadarlat, Neural Control of Movement Conference, July 2022
- Papers
  - Nolan, Pesaran, Shlizerman & Orsborn, "Multi-block RNN autoencoders enable broadband ECoG signal reconstruction", *bioarxiv 2022*
  - Le, Shlizerman, "STNDT: Modeling Neural Population Activity with a Spatiotemporal Transformer", Arxiv 2022
  - Dadarlat, Canfield, & Orsborn, "Neural plasticity in sensorimotor brain-machine interfaces" *Annual Reviews of Biomedical Engineering*, in press
  - Dadarlat et al., "Activity-dependent spatiotemporal recruitment of inhibition and excitation in the mammalian cortex during electrical stimulation" *under review at Nueron*