

*Neural Information  
Processing Systems*  
in real-live neural circuits

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# Computational and Cognitive neurophysiology lab: The cellular networks of mnemonics

## Questions

What network dynamics predict behavior?

What dynamics are predictive of new learning?

What governs plasticity in the network?

## Methods

Optical imaging

High density electrophysiology

Behavioral manipulation

Circuit manipulation

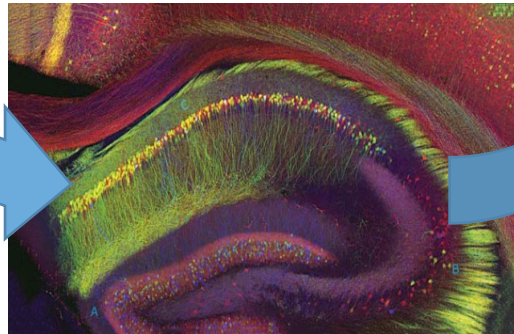
Neural decoding analysis

# Two directions of inference



**Top-down:**  
Use behavior  
parse neural dynamics

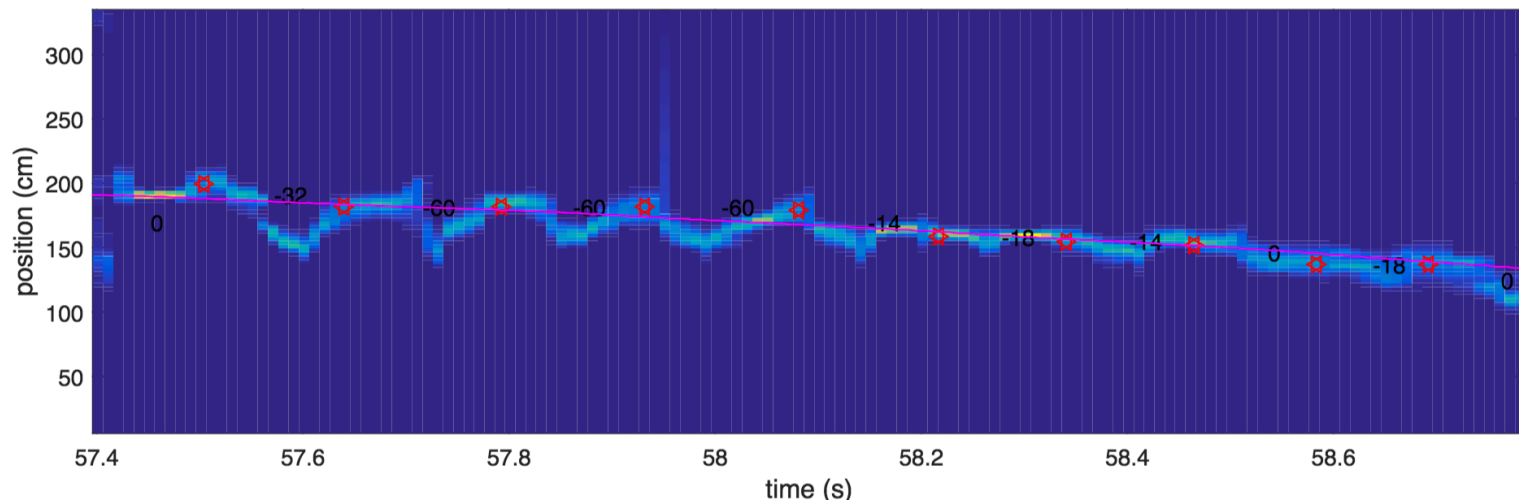
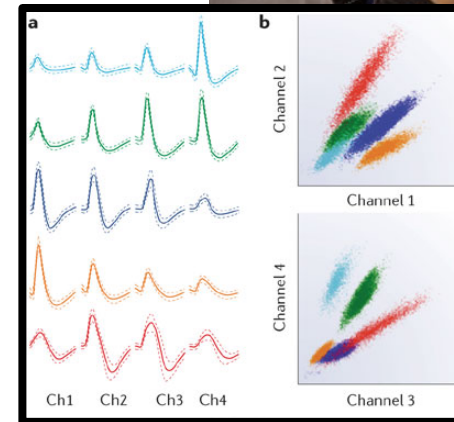
**Bottom up:**  
Use neural dynamics  
to parse behavior



# Meet the data

- Electrophysiology

- Multiple-individual neurons
  - Millisecond precision
  - 10's – 100's of isolated neurons
- What can be decoded?
  - Behavioral state of the animal (position / head direction / goal)
  - Animal day dreams



# Meet the data

- Electrophysiology

- Local field potentials

- Multiple distinct spectral bands (i.e., like radio channels)

- Each represents distinct scale of system interaction

- Examples:

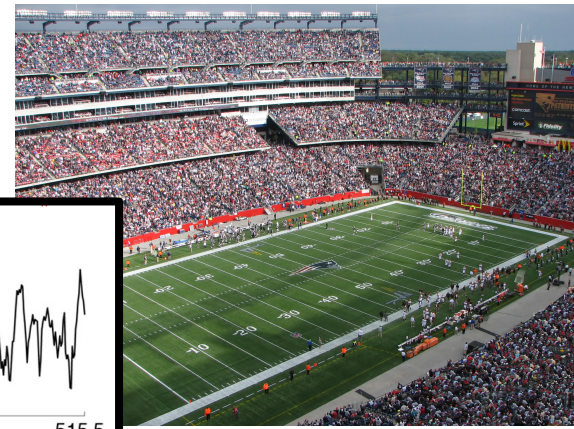
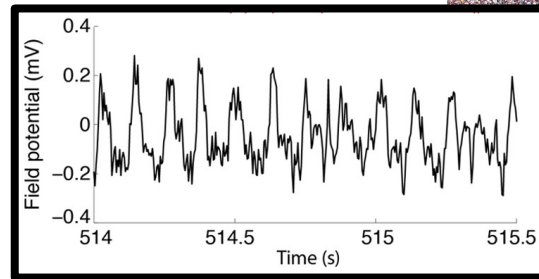
- > 250 Hz – 100's of local cells (among the fastest)

- > 2 Hz – Millions of cells throughout brain (among the slowest)

- What can be decoded?

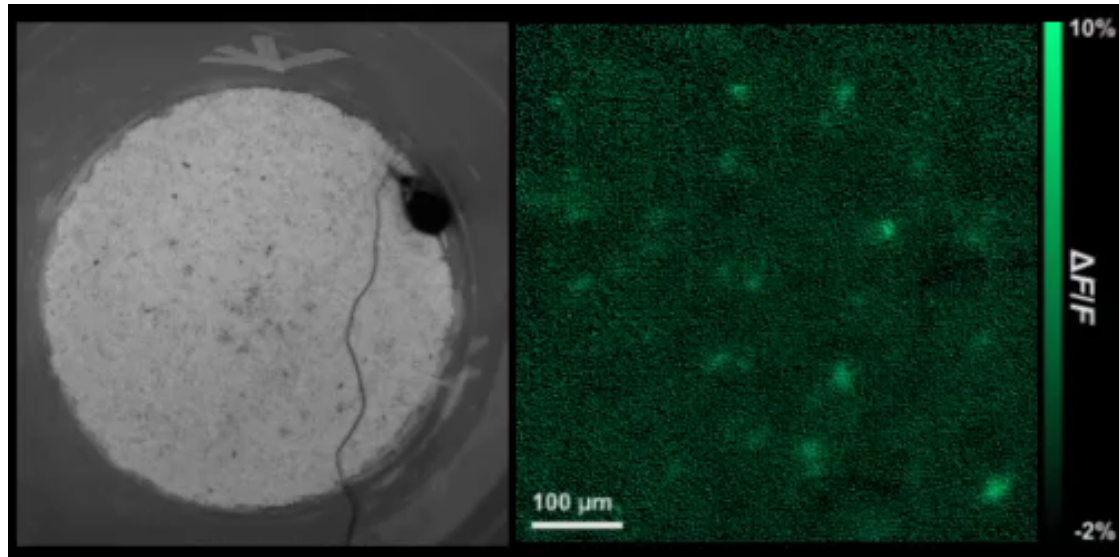
- Varies with each spectral band

- Functional coupling between brain areas



# Meet the data

- Optical imaging
  - Unit activity
    - Sub-second resolution ( $\sim 100$  ms)
    - 100's - 1000's of neurons
  - Diffuse signaling by specific project pathways





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