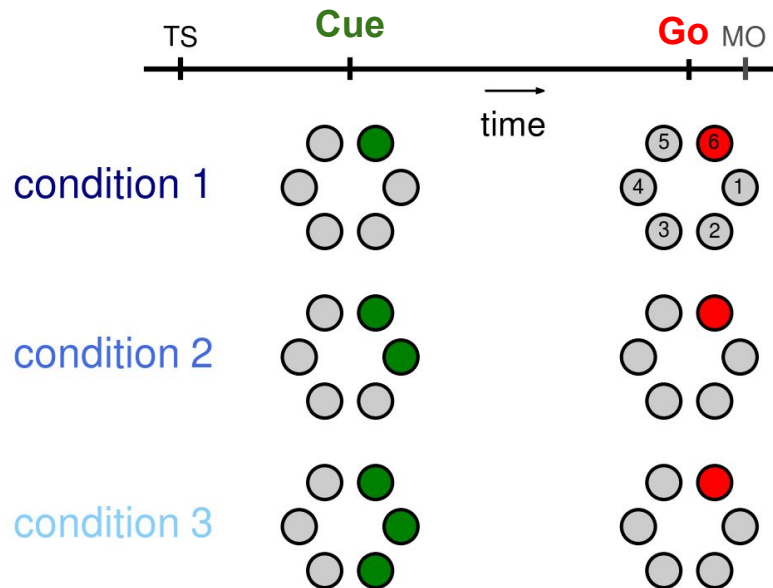
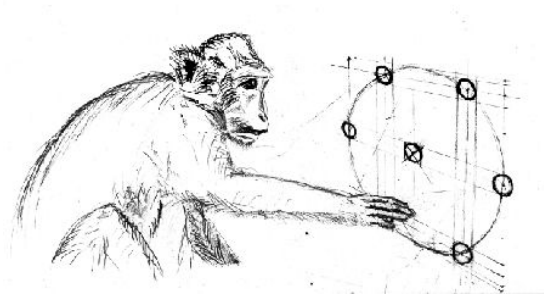


# Excitatory-inhibitory clustered networks for cortical decision-making

Felix J. Schmitt, 28.10.2022,

ISRC-CN<sup>3</sup> Autumn school 24-28 October 2022

# Data: delayed center-out reach task



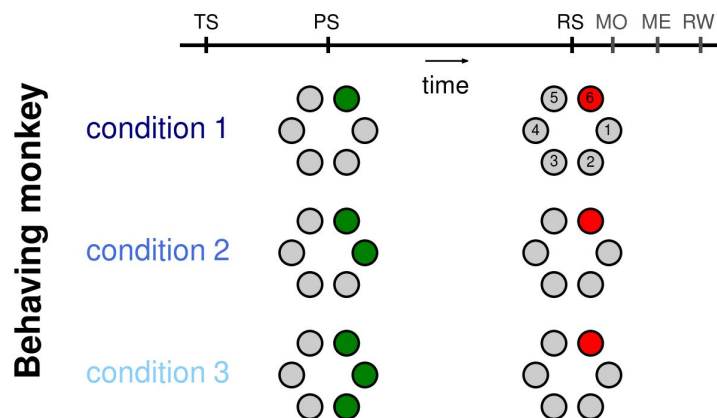
Data from Alexa Riehle's Lab,  
INT, Marseille

- Macaque monkeys (N=2)
- Delayed reach task
- Extracellular recordings of single units in motor cortex

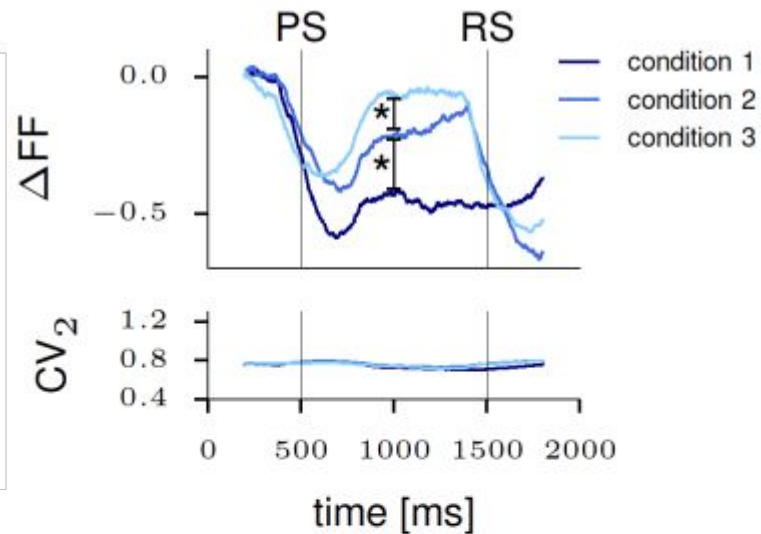
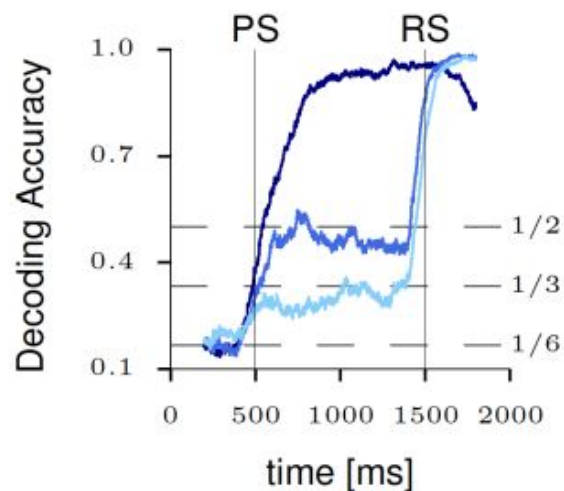
[Rickert et al. 2009]

# Task uncertainty reflected in neural responses

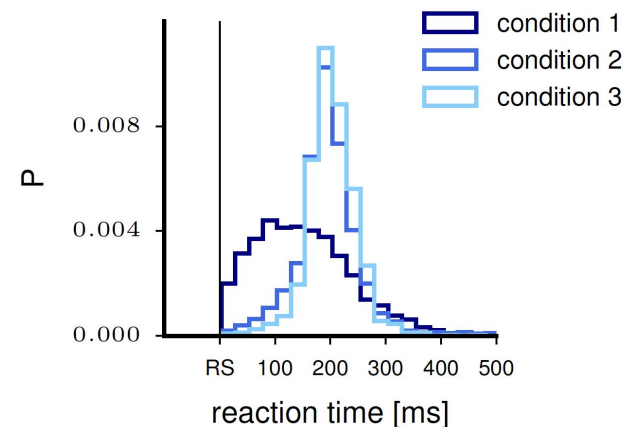
## Trial-to-trial variability and irregularity



## Directional encoding



## Reaction times



# Task uncertainty reflected in neural responses

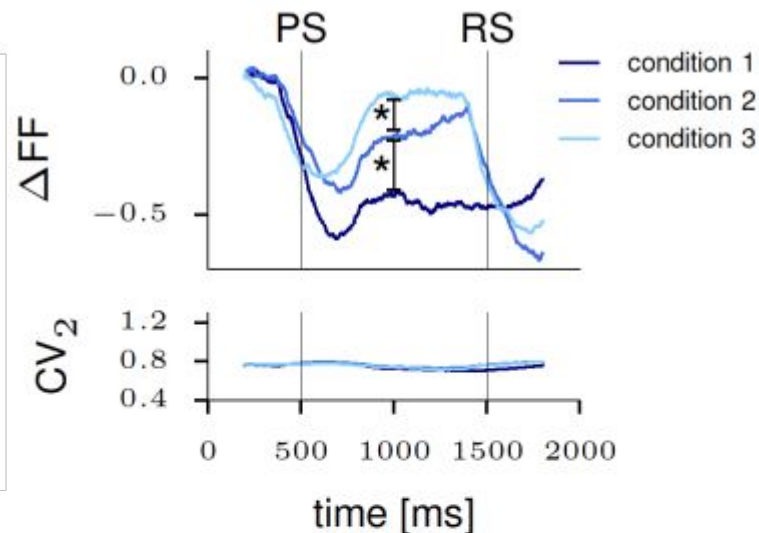
Trial-to-Trial variability:

$$FF = \frac{Var(count))}{Mean(count))}$$

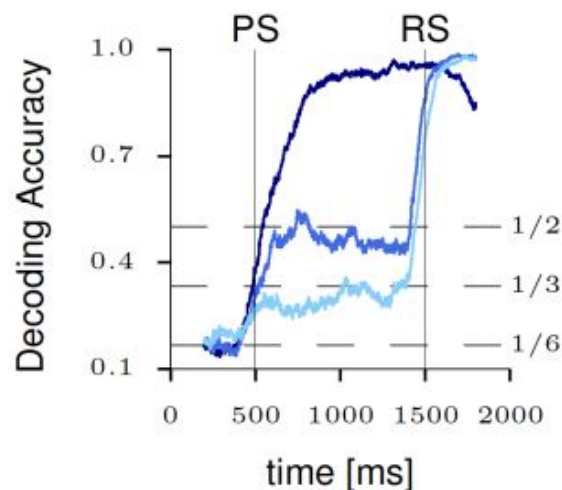
Spike timing irregularity:

$$CV = \frac{\sqrt{Var(ISI))}}{Mean(ISI))}$$

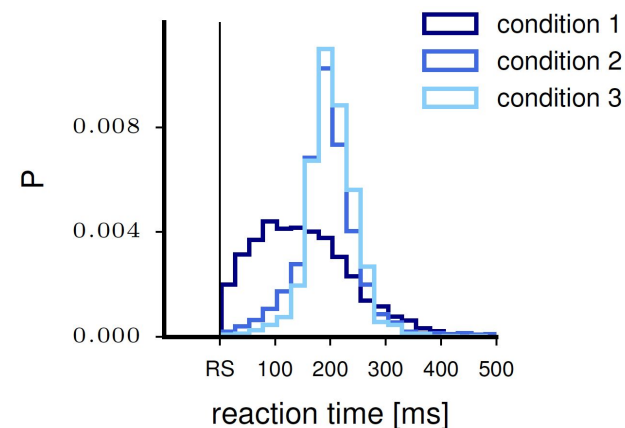
Trial-to-trial variability and irregularity



Directional encoding

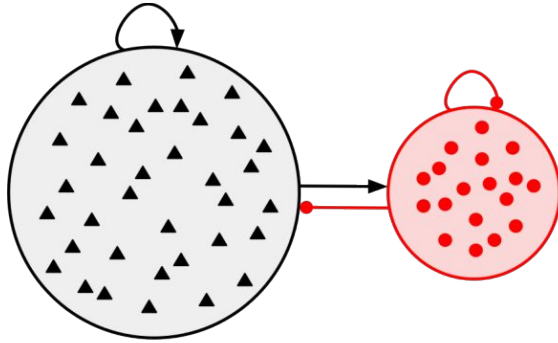


Reaction times

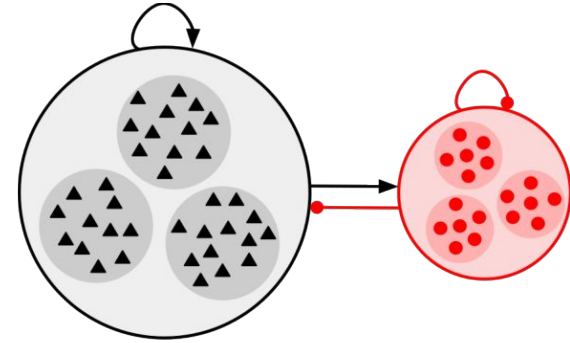


# Network model

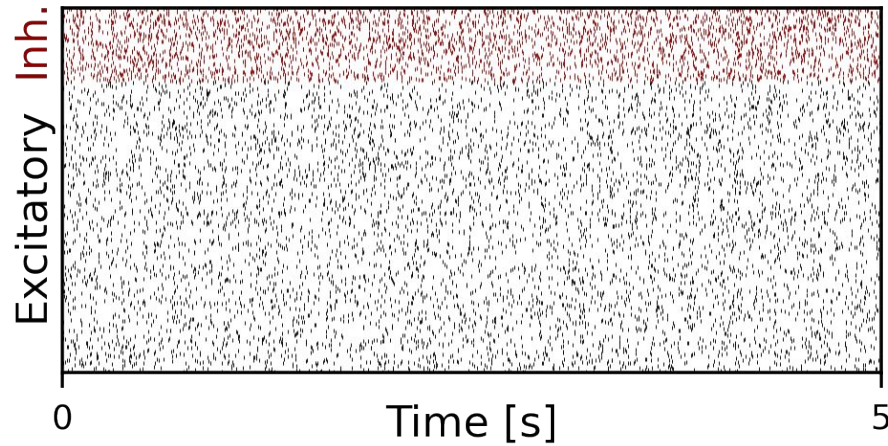
A Random Balanced Network



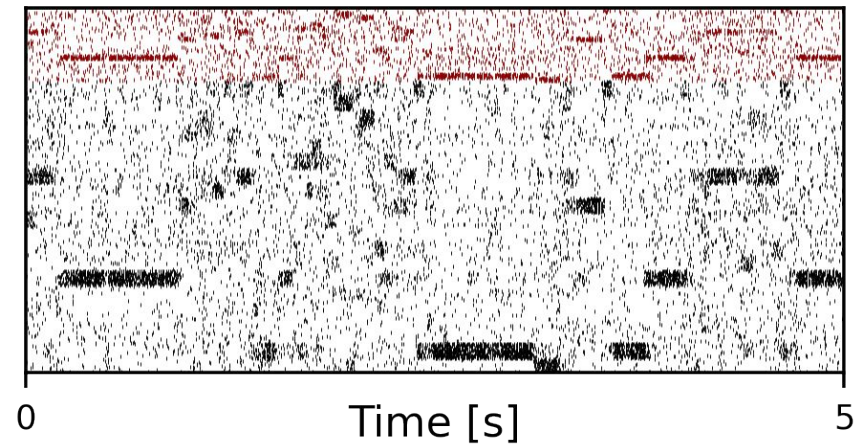
B E/I Clustered Network



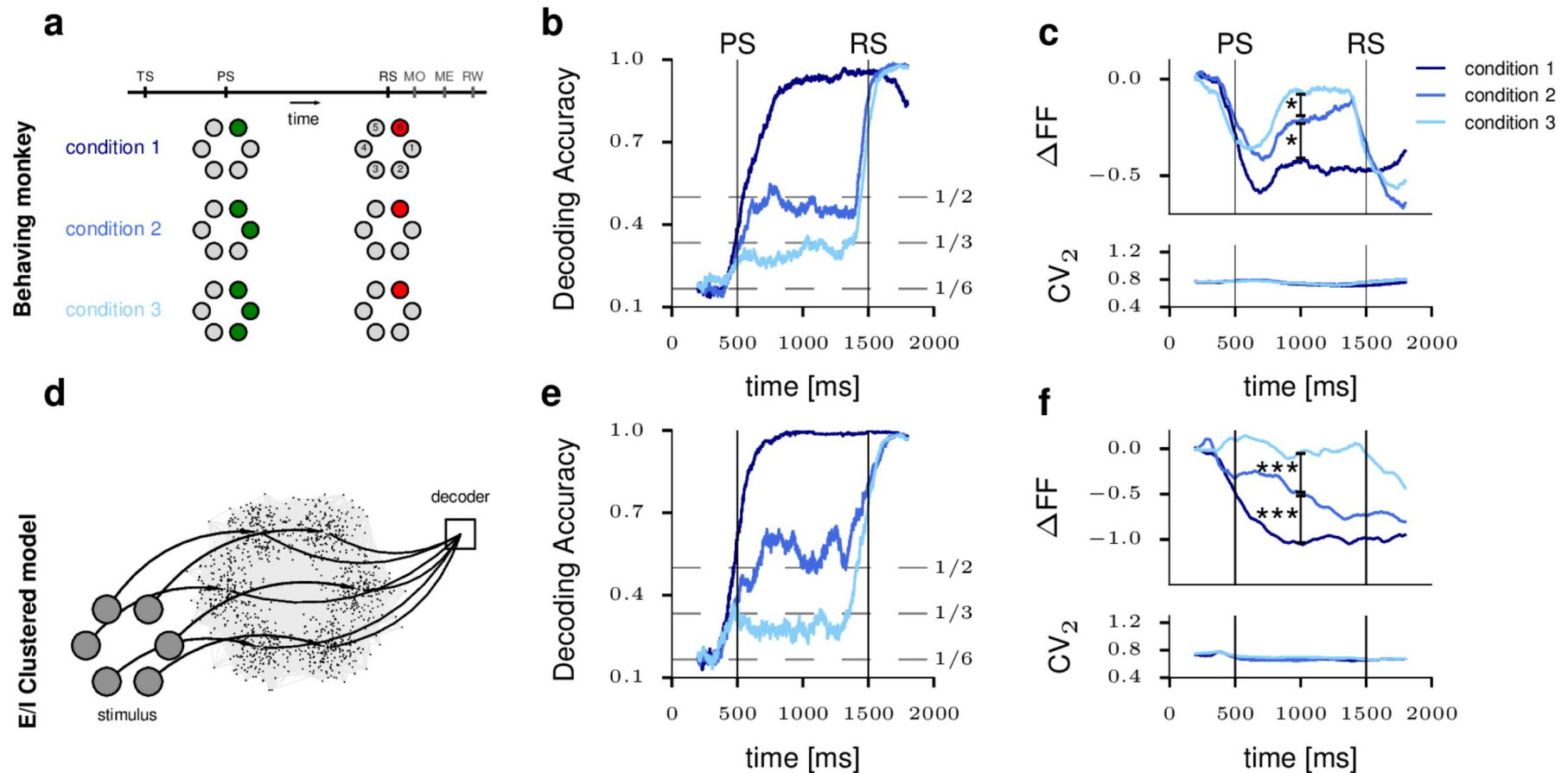
C



D



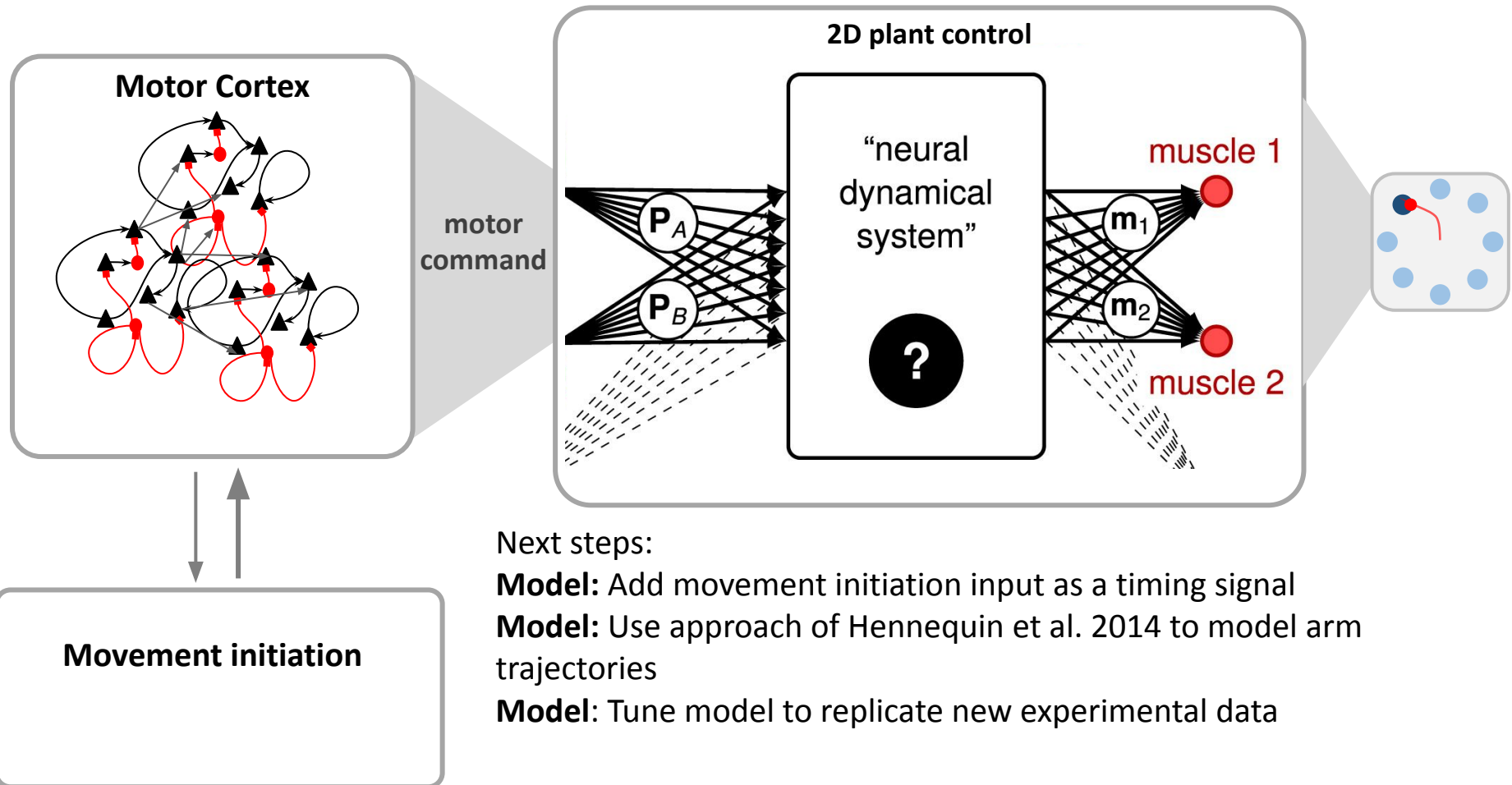
# E/I clustered network as a model of motor cortex





# Outlook

## Spiking Neural Network

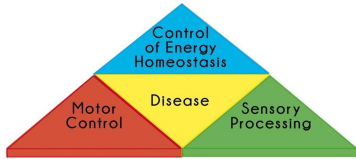


Next steps:

**Model:** Add movement initiation input as a timing signal

**Model:** Use approach of Hennequin et al. 2014 to model arm trajectories

**Model:** Tune model to replicate new experimental data



# Thank you for your attention.

[Rostami et al. 2022]

Rostami, V., Rost, T., Riehle, A., van Albada, S. J., & Nawrot, M. P. (2022). Excitatory and inhibitory motor cortical clusters account for balance, variability, and task performance. *bioRxiv*.

[Schmitt et al. 2022]

Schmitt, F.J., Rostami V., Nawrot, M.P. (revised) Efficient parameter calibration and real-time simulation of large scale spiking neural networks with GeNN and NEST.

[Rickert et al. 2009]

Rickert, J., Riehle, A., Aertsen, A., Rotter, S., Nawrot, M.P. (2009). Dynamic Encoding of Movement Direction in Motor Cortical Neurons. *Journal of Neuroscience*, 29.

[Hennequin 2014]

Hennequin, G., Vogels, T.P., Gerstner, W. (2014). Optimal control of transient dynamics in balanced networks supports generation of complex movements. *Neuron*, 82.



# E/I clustered network: parameter space

- Integrate-and-fire neuron with exponential PSC
- Network:  
**20,000 exc.** **5,000 inh.**  
neurons  
20 clusters

