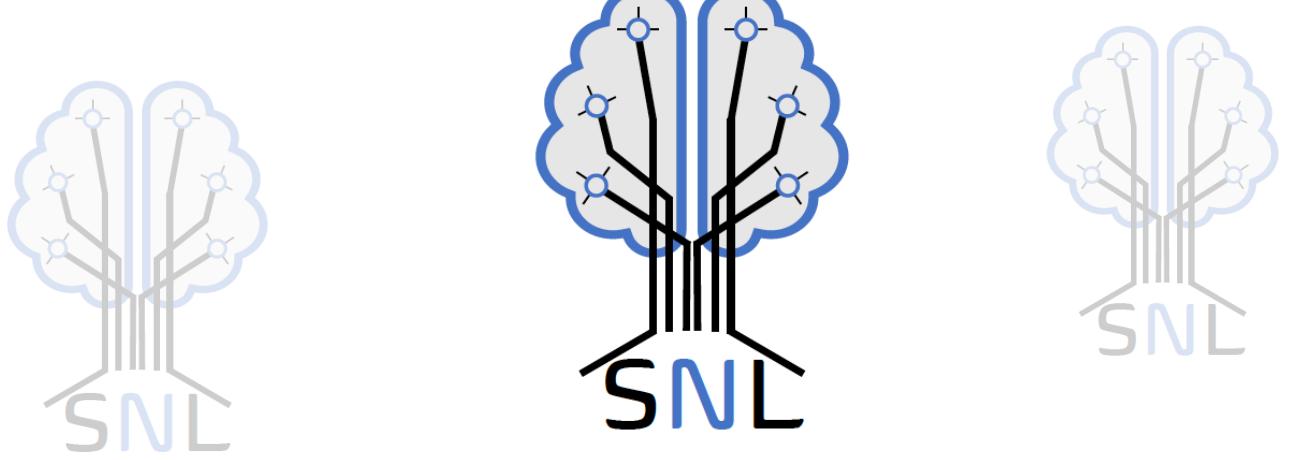


Role of Behavioral State-dependent Cortical Neurons in Local Processing



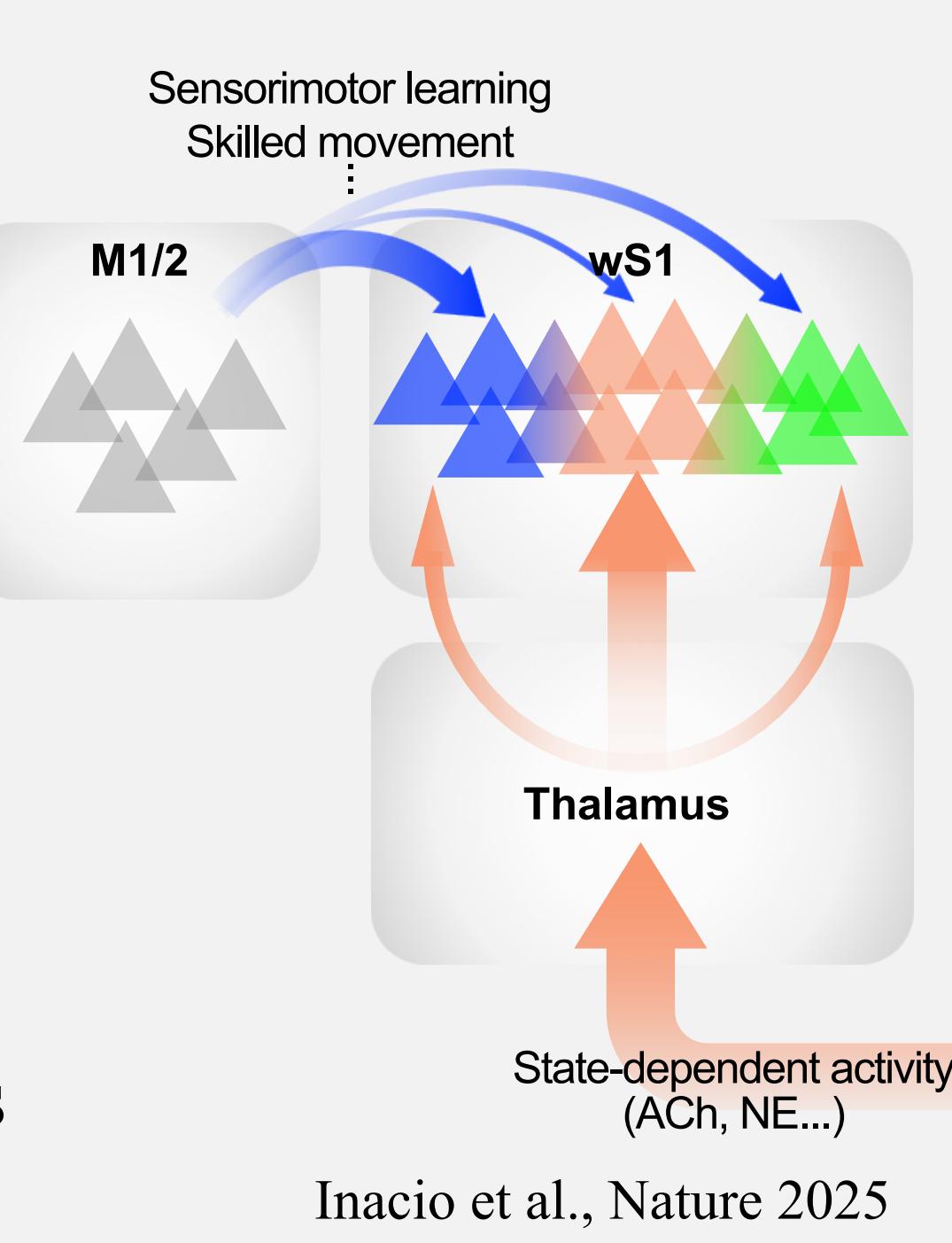
Lu Zhang, Mei Han, Ana Karen, Ana R Inácio, Soohyun Lee
National Institute of Mental Health, National Institute of Health, Bethesda, MD



INTRODUCTION

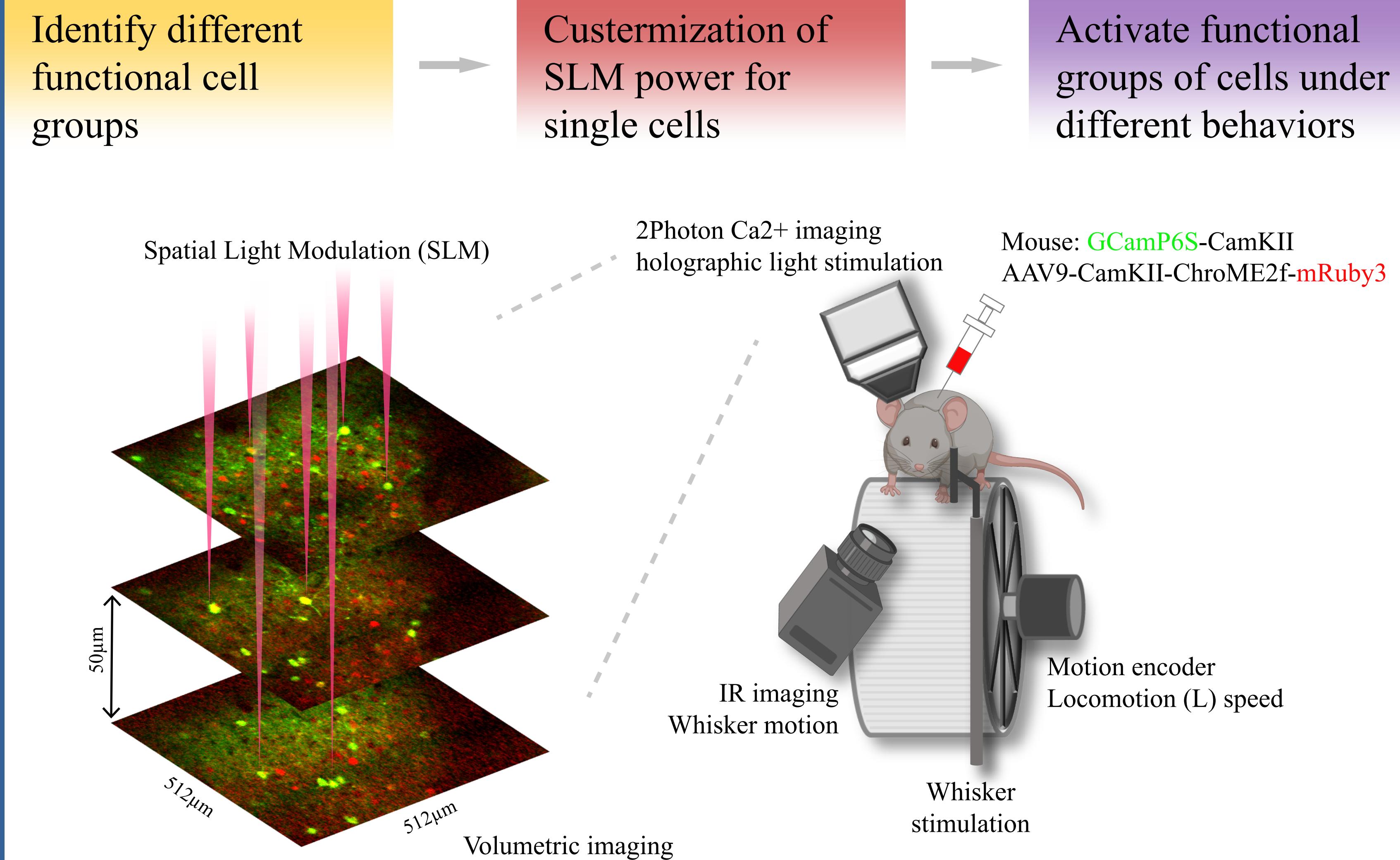
Our recent work reveals distinct brain-wide presynaptic wiring patterns among functional defined neuron populations in somatosensory cortex: **sensory cells** and **locomotion cells**. Sensory cells exhibit strong passive response with whisker stimuli, while the locomotion cells encode animal's locomotor state and active whisker motion.

In this study, we investigate the specific contributions of locomotion cells to local processing and their influence on downstream targets within primary sensory cortex. To address this question, we monitor activities of excitatory neurons in layer 2/3 with two-photon calcium imaging, while selectively activate either locomotion cells or sensory cells with holographic light stimulation.



Inacio et al., Nature 2025

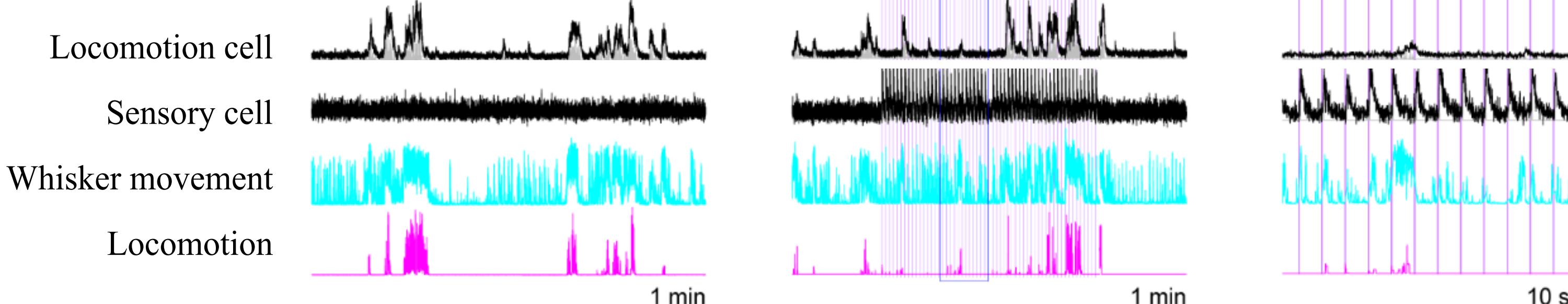
EXPERIMENTAL DESIGN AND METHODS



This experimental framework allows us to examine how targeted manipulation of specific behavioral-state-dependent neuronal populations modulates intra- and inter-group neuronal dynamics across different behavioral states.

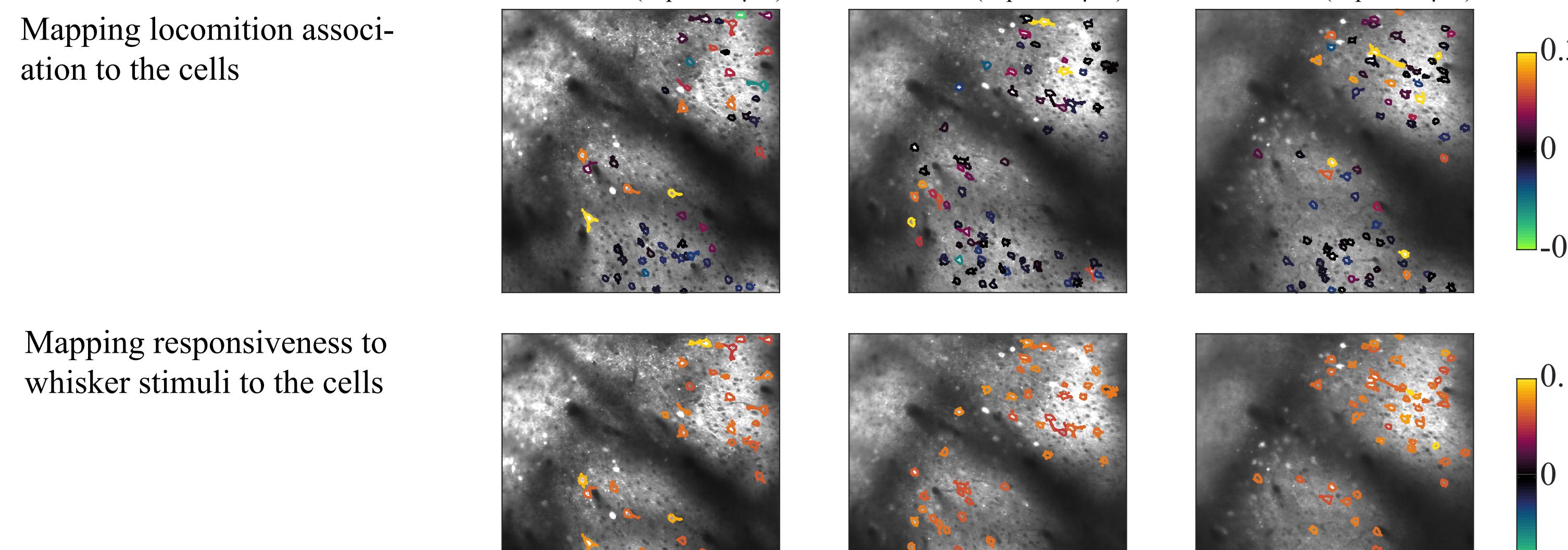
1 Neural activities during voluntary behavior

Diverse behavioral dependency of neural activities in primary somatosensory cortex

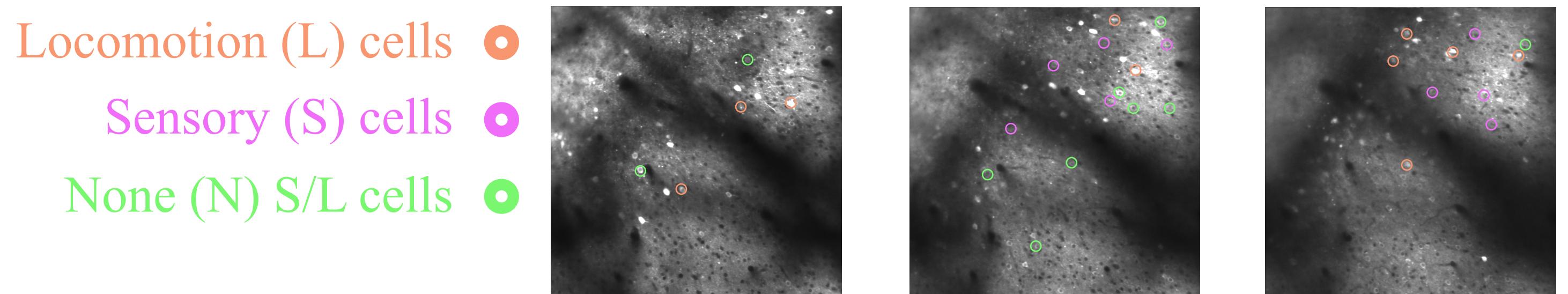


20 minutes recording during voluntary behavior, with 20 whisker stimulations.
Online processing of the imaging data using suite2p package

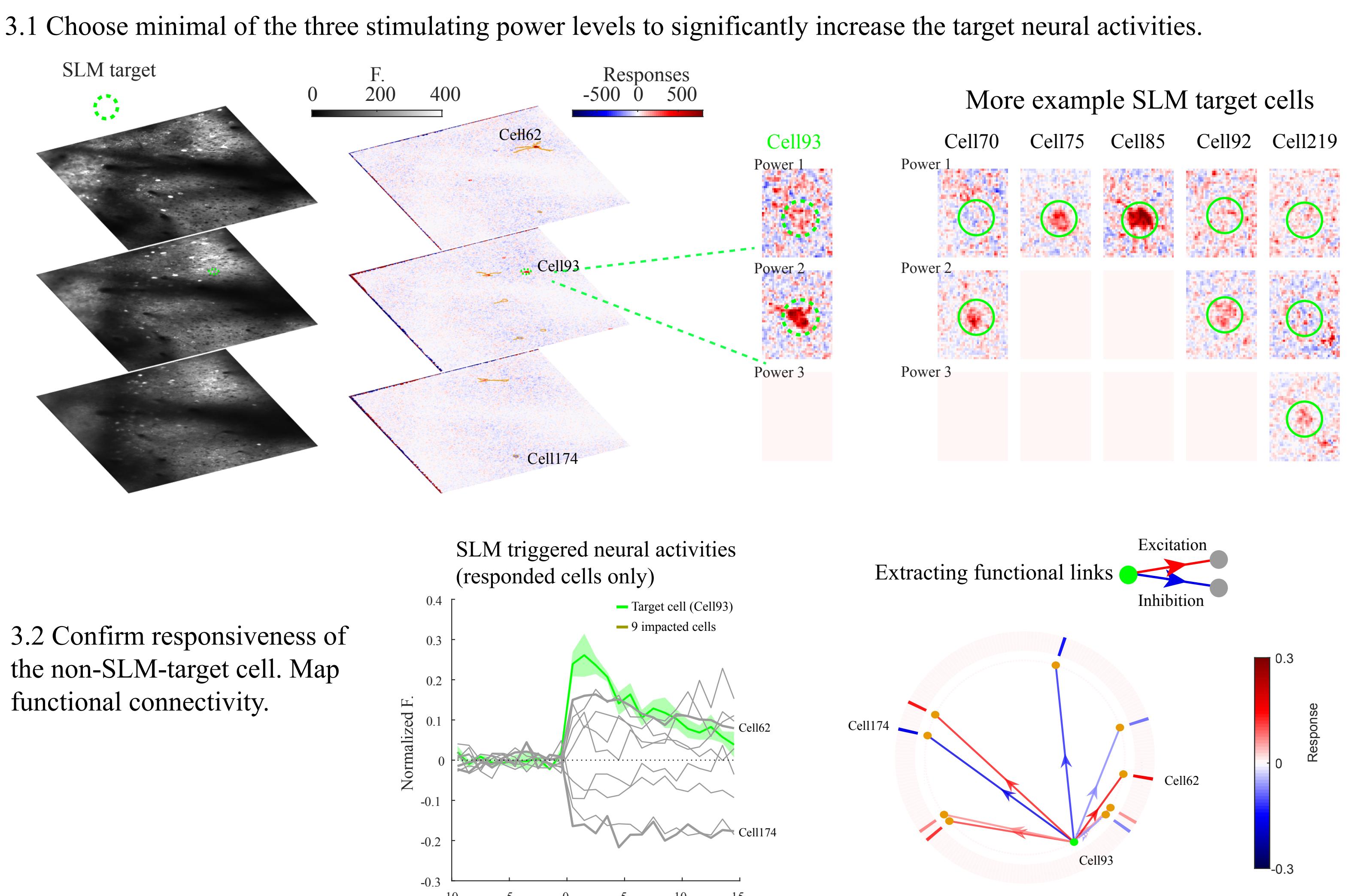
2. Identify behavioral dependency of all cells



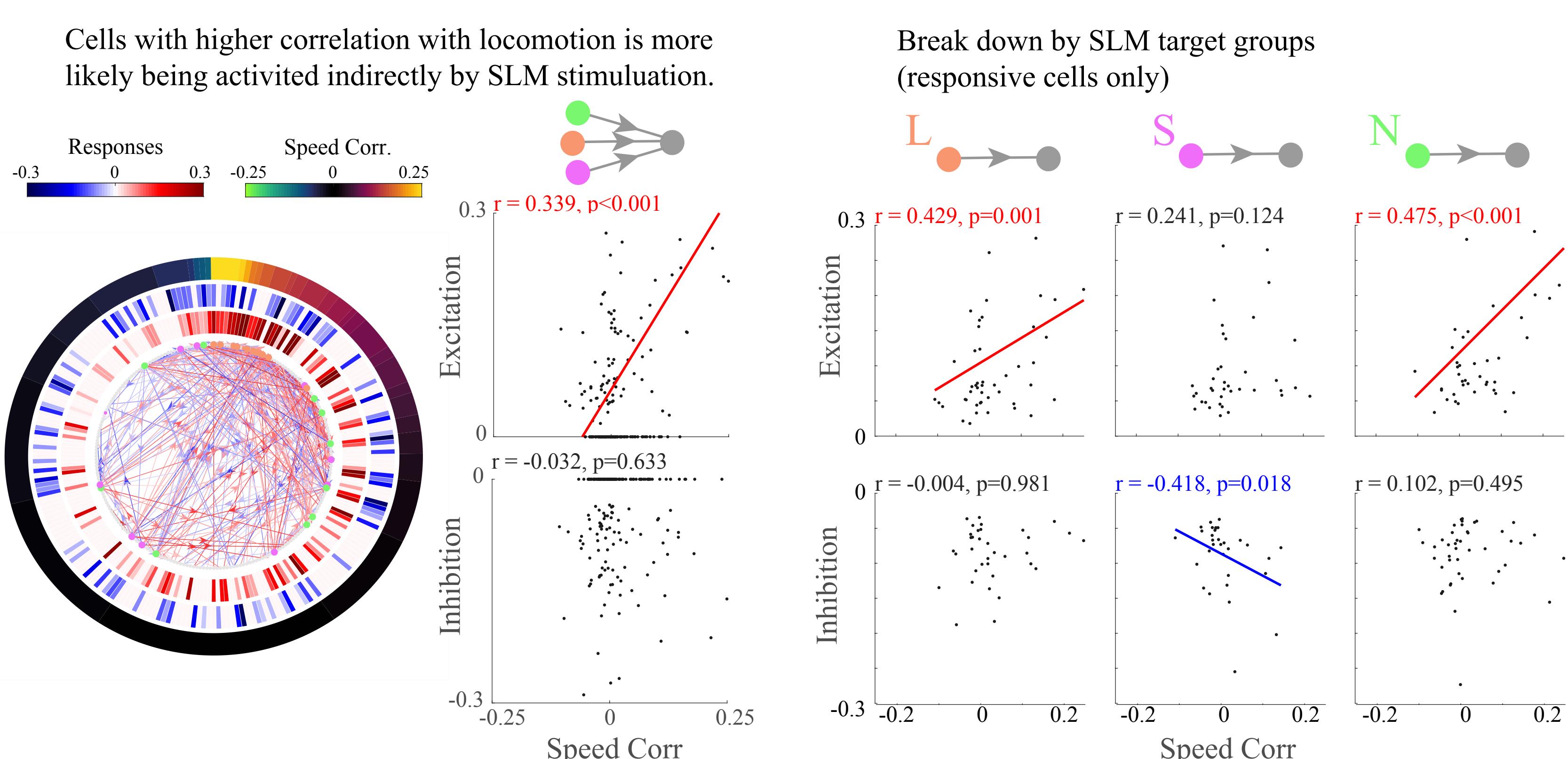
Identify three group of cells (10 cells/group) as SLM targets



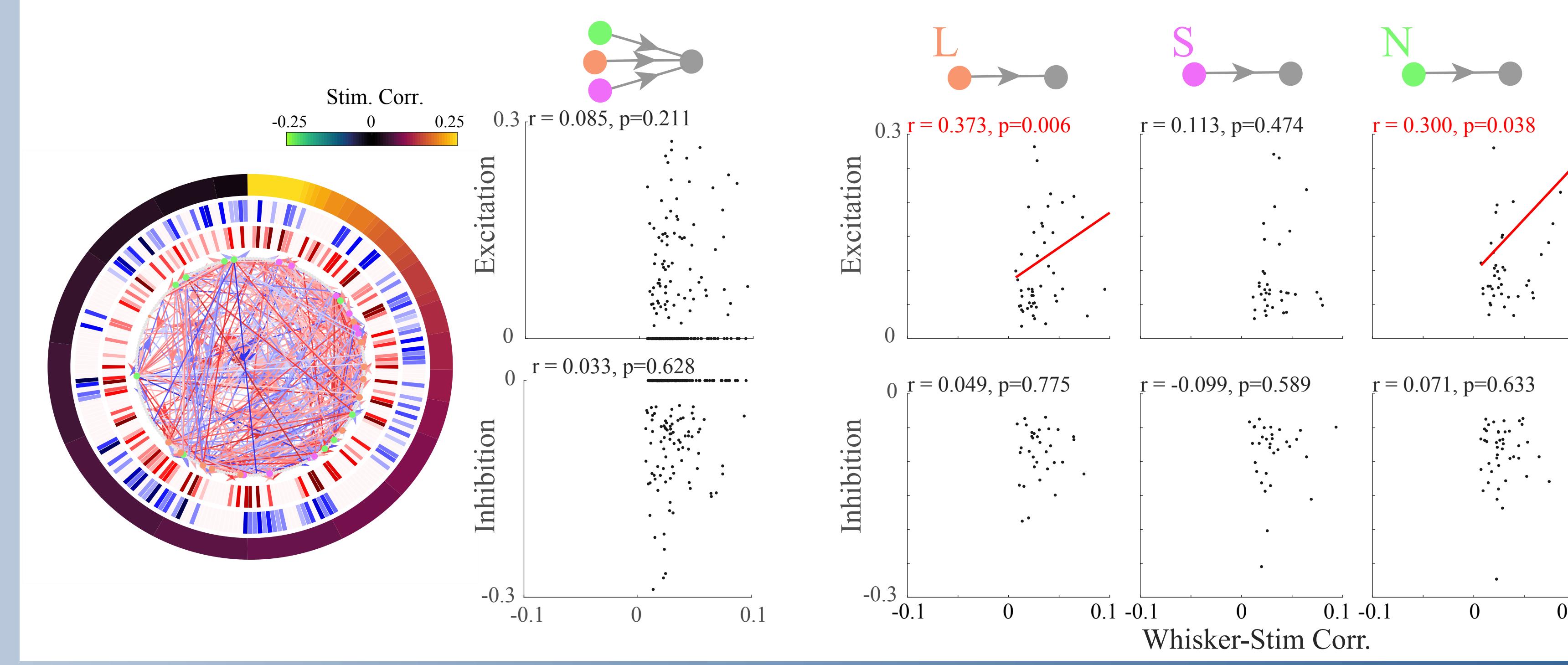
3 Customization of SLM power for single cells



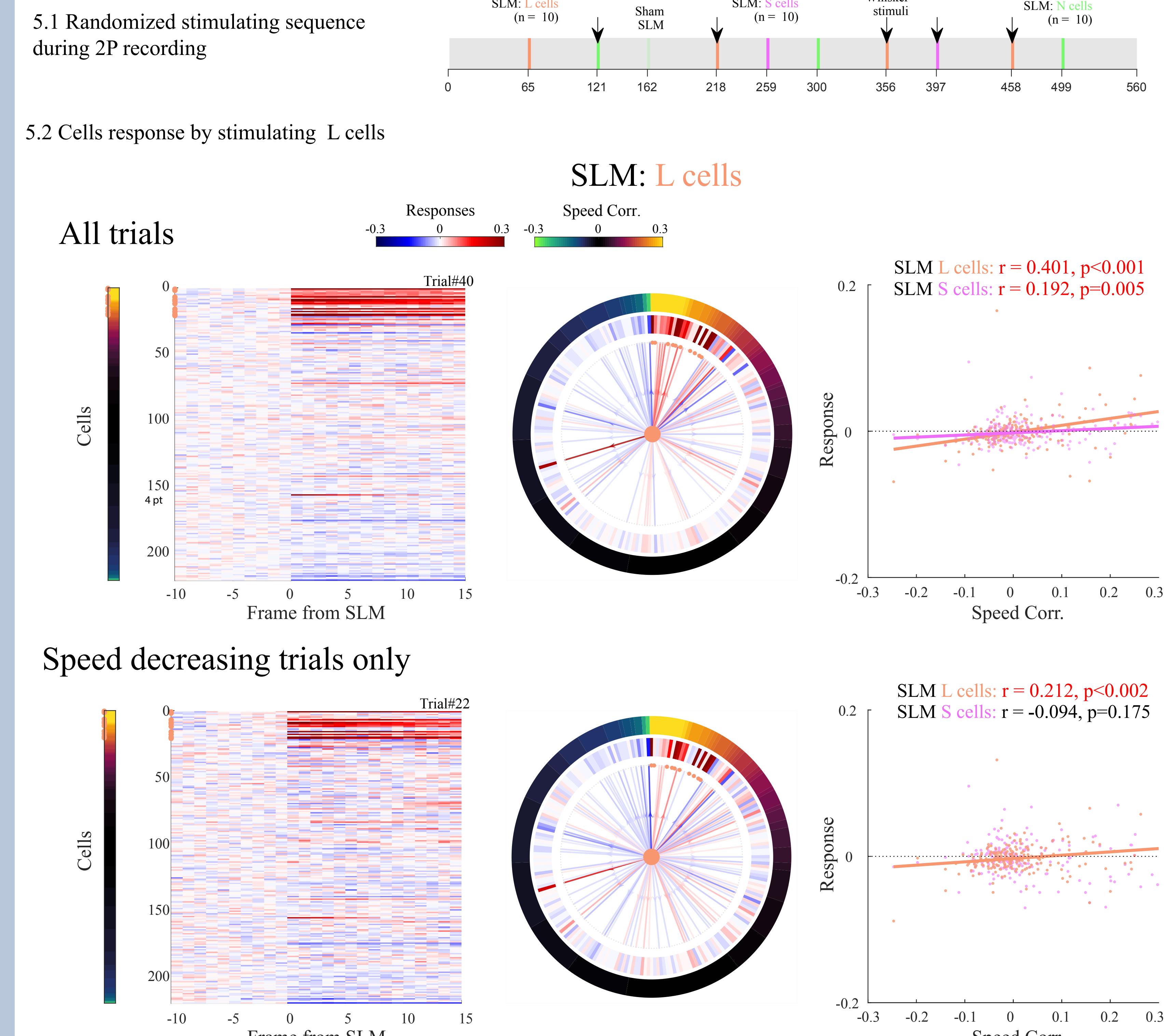
4 Integrative inputs from all cells to locomotion cells



Much weaker activation dependency on whisker triggered cell responses.



5 Enhanced activities of locomotion-associate neurons by stimulating L group



SUMMARY

- We developed an experimental framework to examine how targeted manipulation of specific behavioral-state-dependent neuronal populations modulates intra- and inter-group neuronal dynamics across different behavioral states.
- Primary results show locomotion-associated cells received local inputs broadly from other cell populations, with notably stronger inputs coming from L-cell group. Such connectivity pattern was not observed in sensory cells.
- Optogenetic stimulation of a specific group of locomotion-associated cells significantly excited cells positively correlated with locomotion and simultaneously inhibited cells negatively correlated with locomotion.

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