



# Software Automation for Biologically Realistic Neuro Big Data Simulations



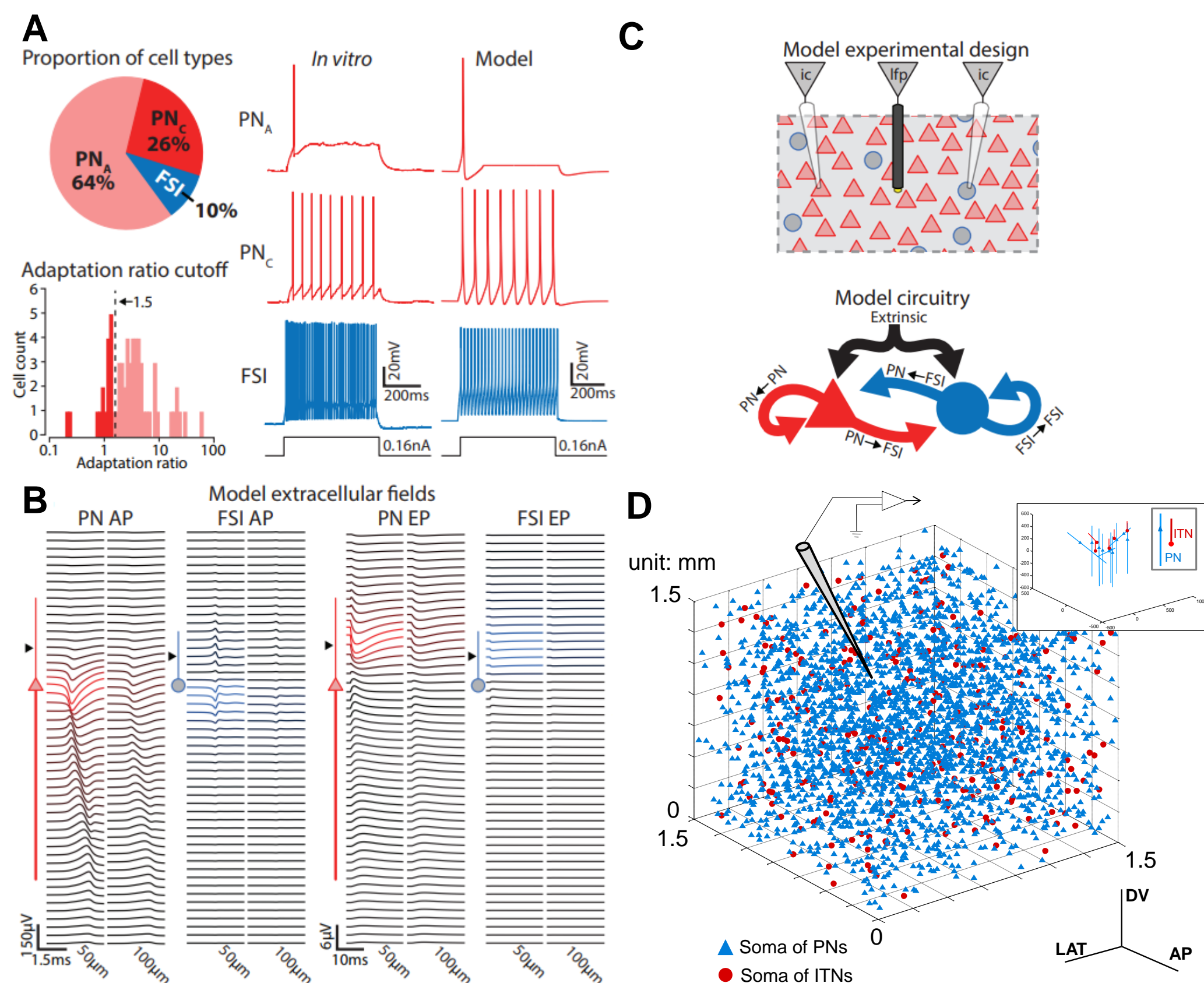
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## Introduction

- The basolateral amygdala (BLA) participates in the formation and expression of emotional memories. Although several brain regions that project to the BLA exhibit oscillations in the gamma (35-100 Hz) frequency band (Headley and Pare, 2013), BLA itself is also thought to be capable of generating gamma. However, the physiological mechanisms that support gamma rhythmogenesis in the BLA are unknown. Also, the relative contributions of the intrinsic mechanisms vs. extrinsic drive remain unclear.
- A 27,000-cell biophysical model of the BLA was developed to shed light on the role of intrinsic mechanisms and state-dependent extrinsic drive on the generation of gamma oscillations in BLA.
- To facilitate the operation of this model, we wrote software called SimAgent that interfaces with High Performance Computing resources, annotates jobs, and organizes results.

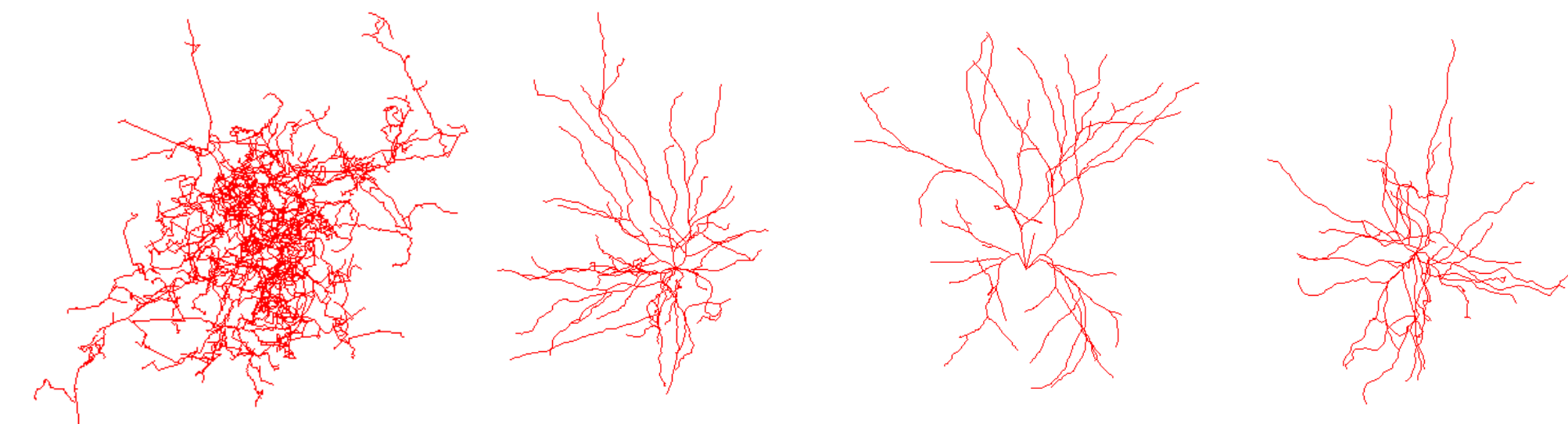
## Methods

- 24,300 principal neurons (PNs) and 2,700 interneurons (ITNs). Highly adaptive (type A) and non-adaptive (type C) PNs were in the proportion 9:1 (Headley, unpublished data).
- PNs and ITNs were randomly distributed in a cuboid structure (AP=1.4 mm, LAT=1.4 mm, and DV=1.4 mm; Paxinos and Watson, 1998), and 30% of the neurons were randomly rotated (McDonald, 1984).
- Connectivity was constrained using data in Woodruff and Sah (2007) and the Stoop Lab data (unpublished). Each PN received point-conductance noise (Destexhe et al., 2001). Line Source Approximation method was developed to calculate local field potentials (LFPs).



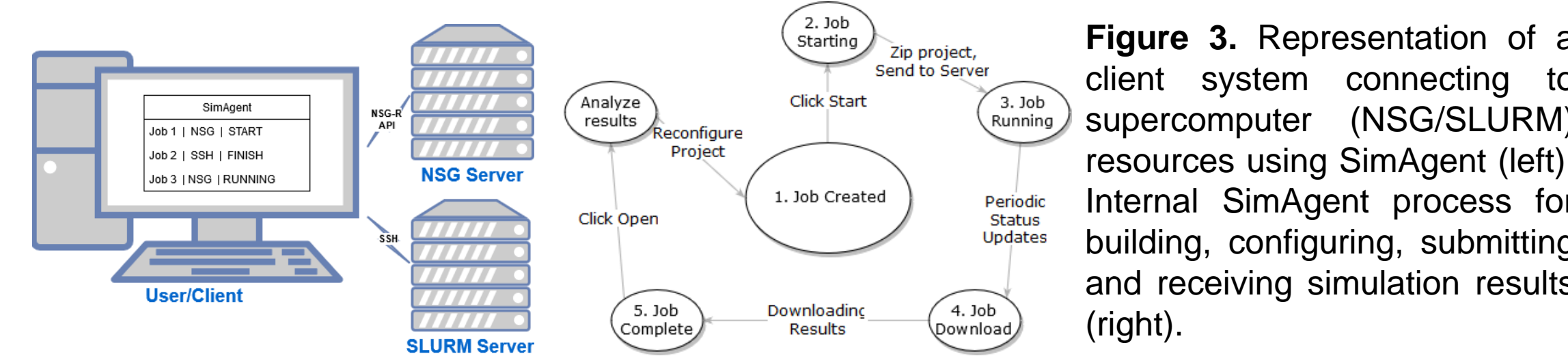
**A:** Model structure and single cell properties. **B:** Calculated LFPs of single Type-C PN and ITN in response to an excitatory synaptic current input. **C:** Cartoon of model design and connectivity. **D:** The model consists of 24,300 PNs and 2,700 ITNs, randomly distributed in cuboid-like structure. Inset plot shows placements and orientations of representative cells in the structure.

## Results & Discussion



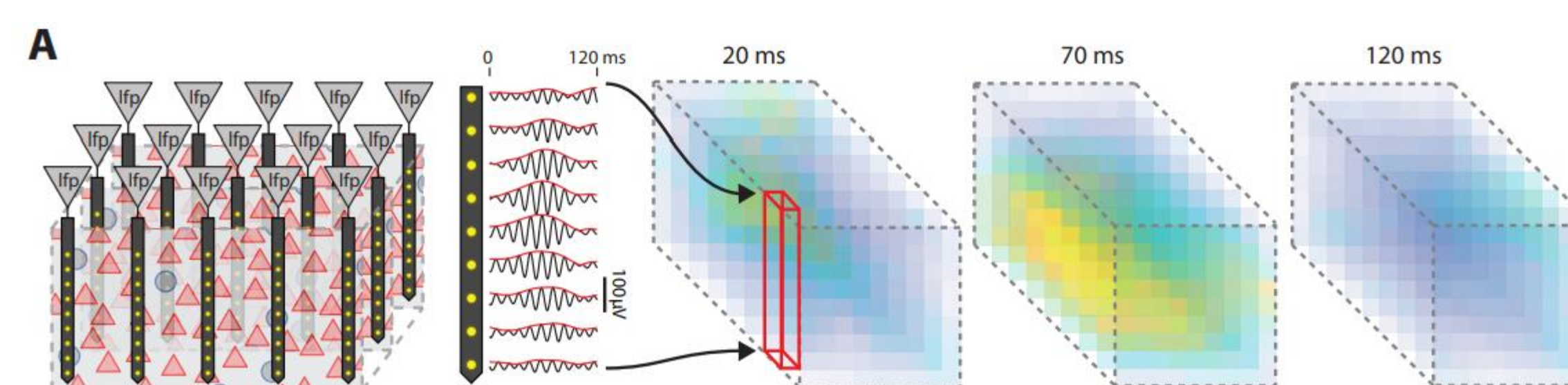
**Figure 2.** Reconstructed morphologies of principal cell and interneurons from the mouse basolateral amygdala. These morphologies are publicly available at neuromorpho.org. Many more cell types and animal species are available.

- Detailed morphological reconstructions are now available to generate more detailed single cell models. These cells alone present a big data challenge since creating and simulating them can create voluminous and heterogeneous data ranging from activation/inactivation variables, transmembrane currents and voltages.
- We plan to integrate these detailed single cell models into our network model to further expand the biological realism and explore questions related to local field potential, dendritic integration, etc.

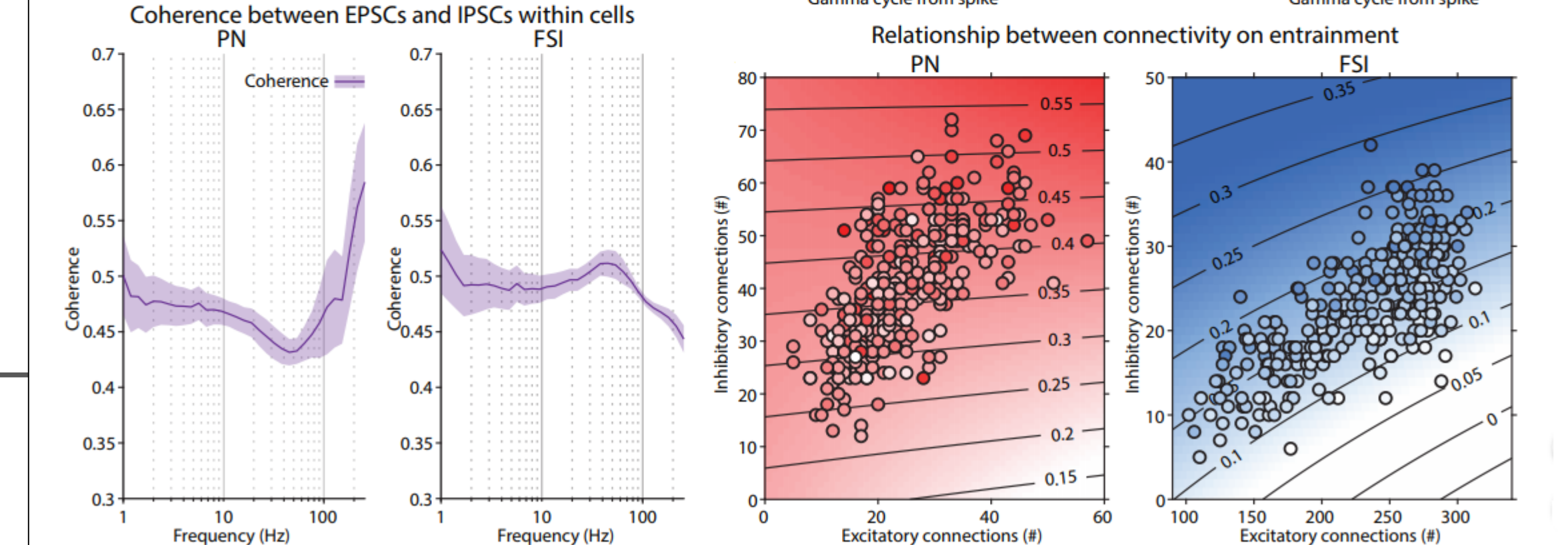
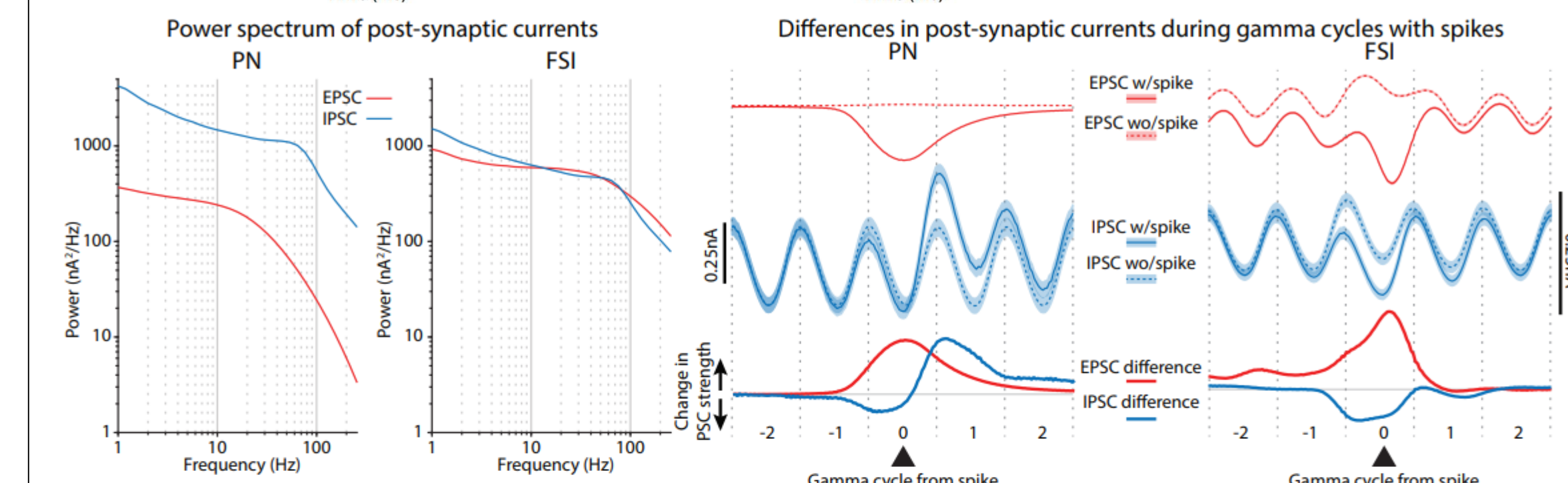
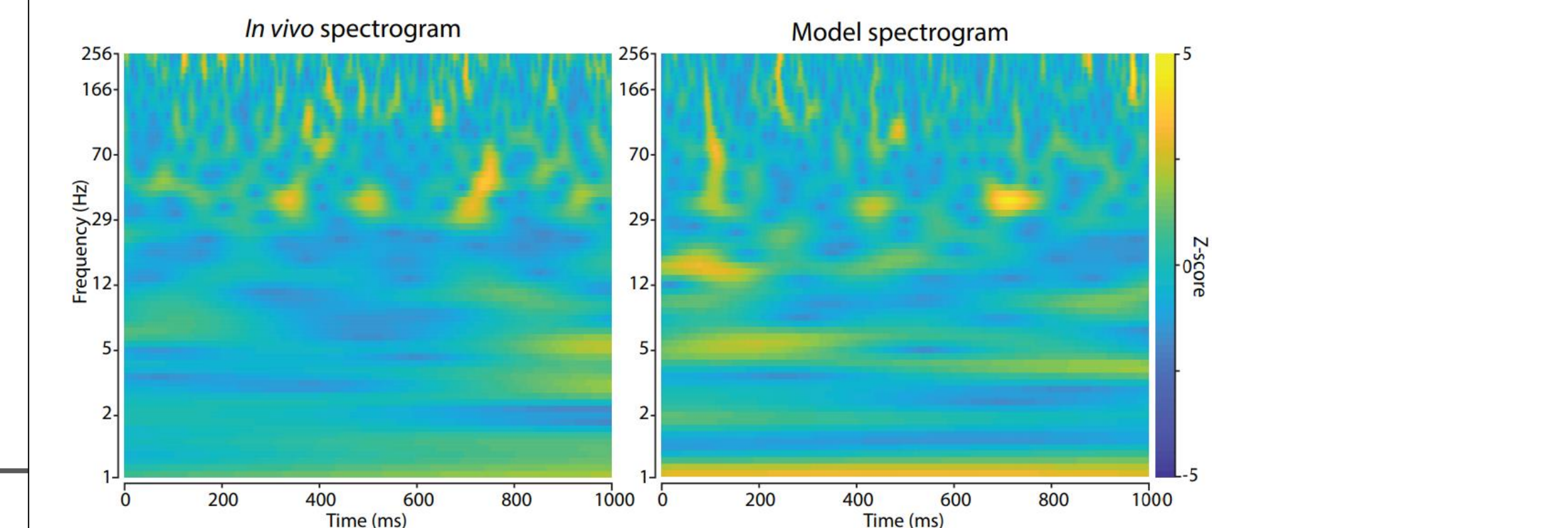
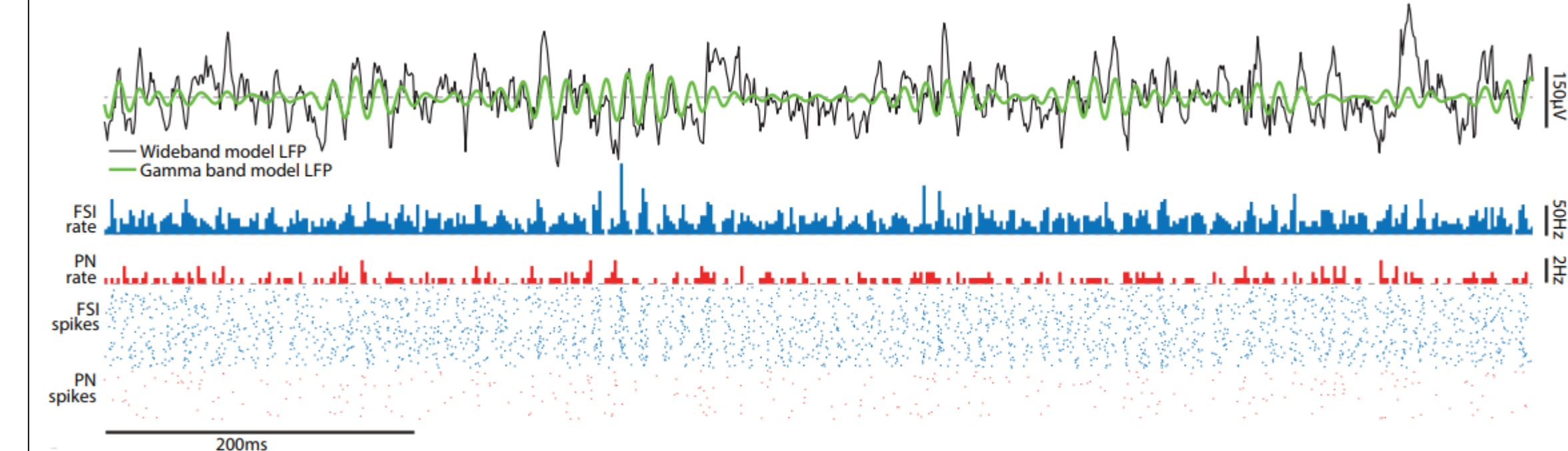


**Figure 3.** Representation of a client system connecting to supercomputer (NSG/SLURM) resources using SimAgent (left). Internal SimAgent process for building, configuring, submitting and receiving simulation results (right).

- In addition to the single neuron module described above, the students also developed a software module for automating network models, titled 'SimAgent', that directly interfaced the student laptop with NSG resources to run network simulations.
- SimAgent has two core functions, automated job submission and parameter sweep. The automated job submission feature is a point and click interface that accepts any neuron or python program directory, submits the program to run remotely and watches it until completion with live updates to the user. The parameter sweep feature allows the same functionality with the added ability to specify sections of code to automatically change with each run. Users can specify a range of values for a parameter to take on, run each simulation in a parallel configuration and determine the optimal output for their needs. It currently supports connections to the NSG-R restful API and connections using SSH to servers running Slurm.



## Results & Discussion



## References

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## Acknowledgments

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