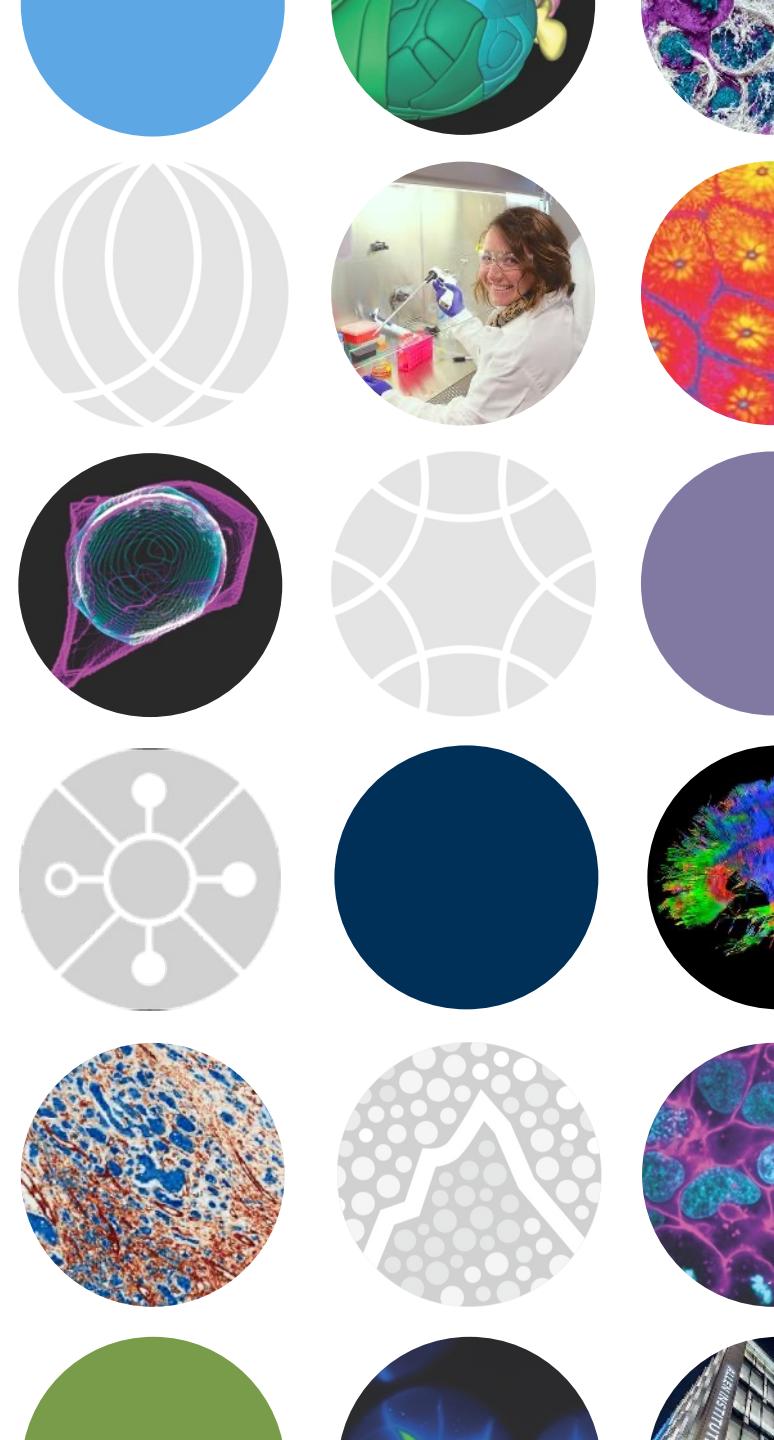


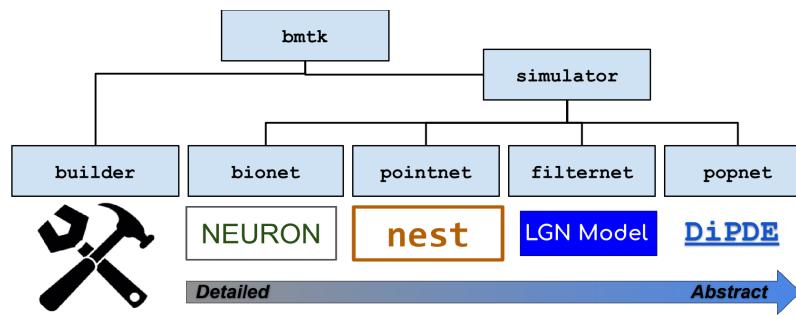


Allen Institute Modeling Software Workshop: Introduction

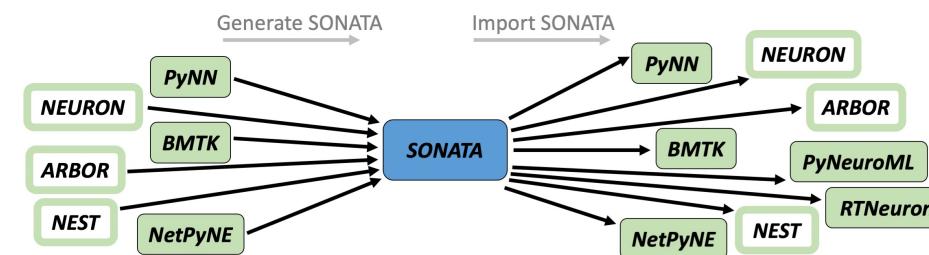


1U24NS124001: Advancing Bio-Realistic Modeling via the Brain Modeling ToolKit (BMTK), SONATA Data Format, and Visual Neuronal Dynamics (VND)

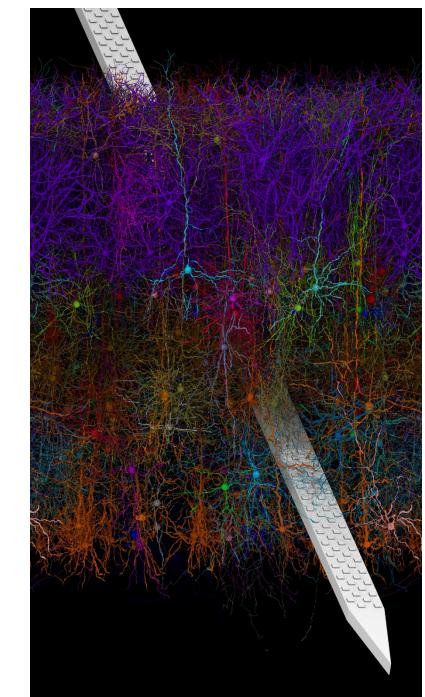
Model building and simulation: BMTK



Model exchange: SONATA



Visualization: VND



Allen Institute: BMTK and SONATA



Kael Dai



Xiao-Ping
Liu



Shinya Ito



Darrell Haufler



Anton Arkhipov



Kaitlyn
Casimo

Allen Institute: Communications



The Team

UIUC: VND



Barry Isralewitz



Mariano
Spivak



John Stone



Emad Tajkhorshid

Schedule for the Two Days

Monday, July 25, 2022

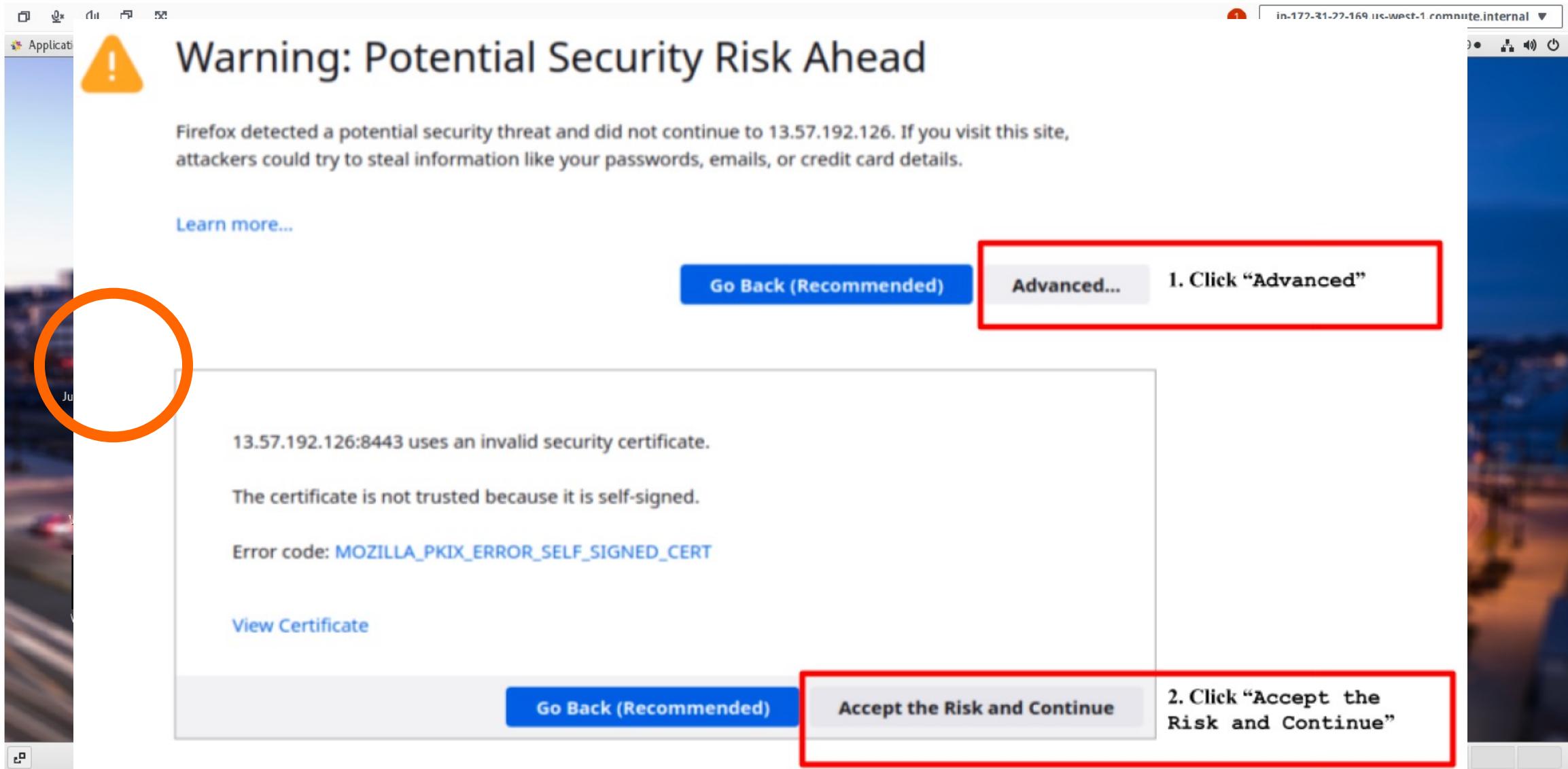
9 – 9:45 am	Introduction
9:45 – 10 am	Set up AWS
10 am – 12 pm	Demo of Tutorials
12 – 2 pm	Lunch, meet & greet
2 – 5 pm	Work on tutorials
5 – 5:30 pm	Tour of the Allen Institute
5:30 pm	Dinner

Tuesday, July 26, 2022

9 – 10:15 am	Presentations by Allen Institute scientists
10:15 am – 12 pm	Demo of Tutorials
12 – 2 pm	Lunch, small group discussions
2 – 5 pm	Work on tutorials
5 pm	Departure

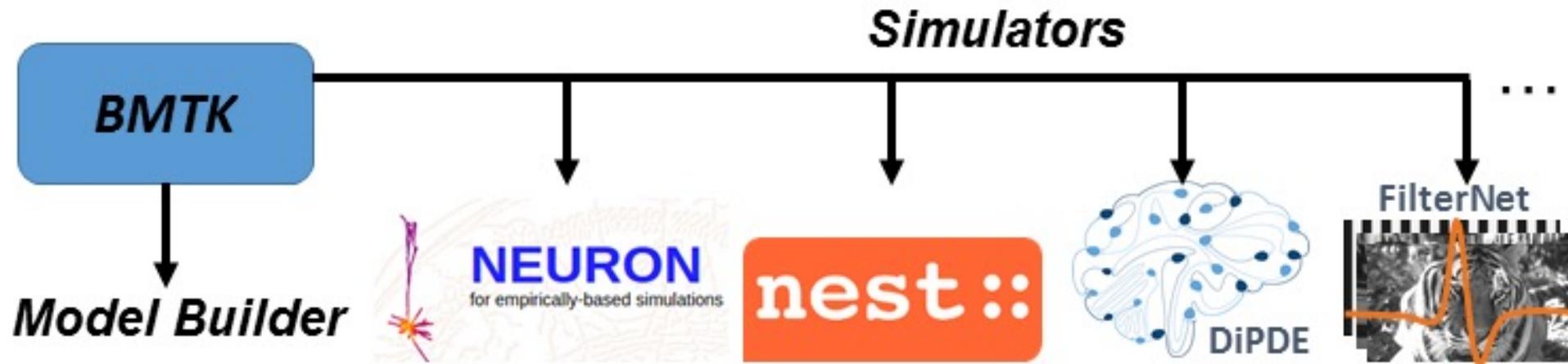
A few weeks after the workshop: Survey about BMTK, SONATA, and VND

Running the Workshop on AWS



Brain Modeling Toolkit

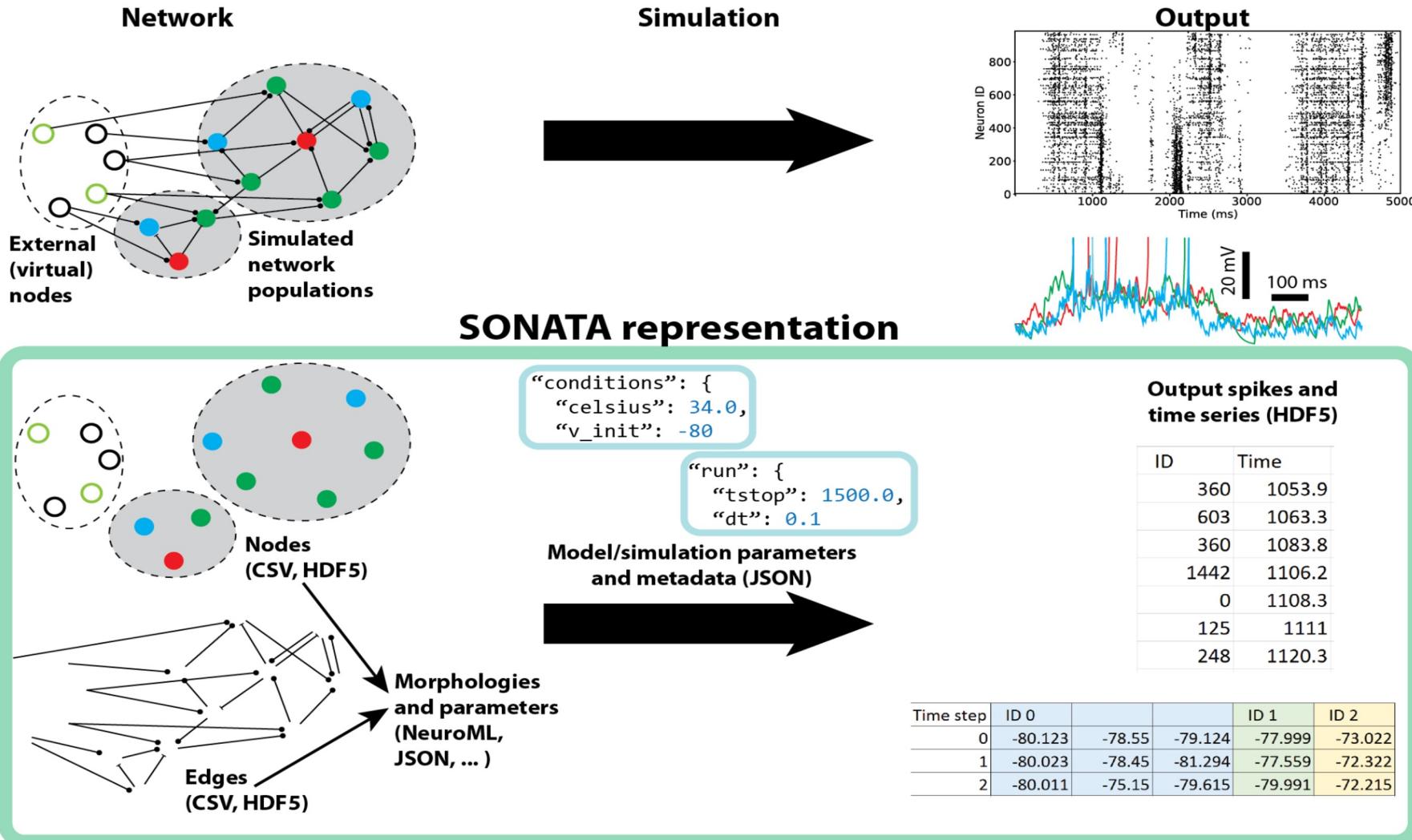
<https://alleninstitute.github.io/bmtk/>



- Model building
- Simulations (with parallelization)
- A unified interface across multiple levels of resolution

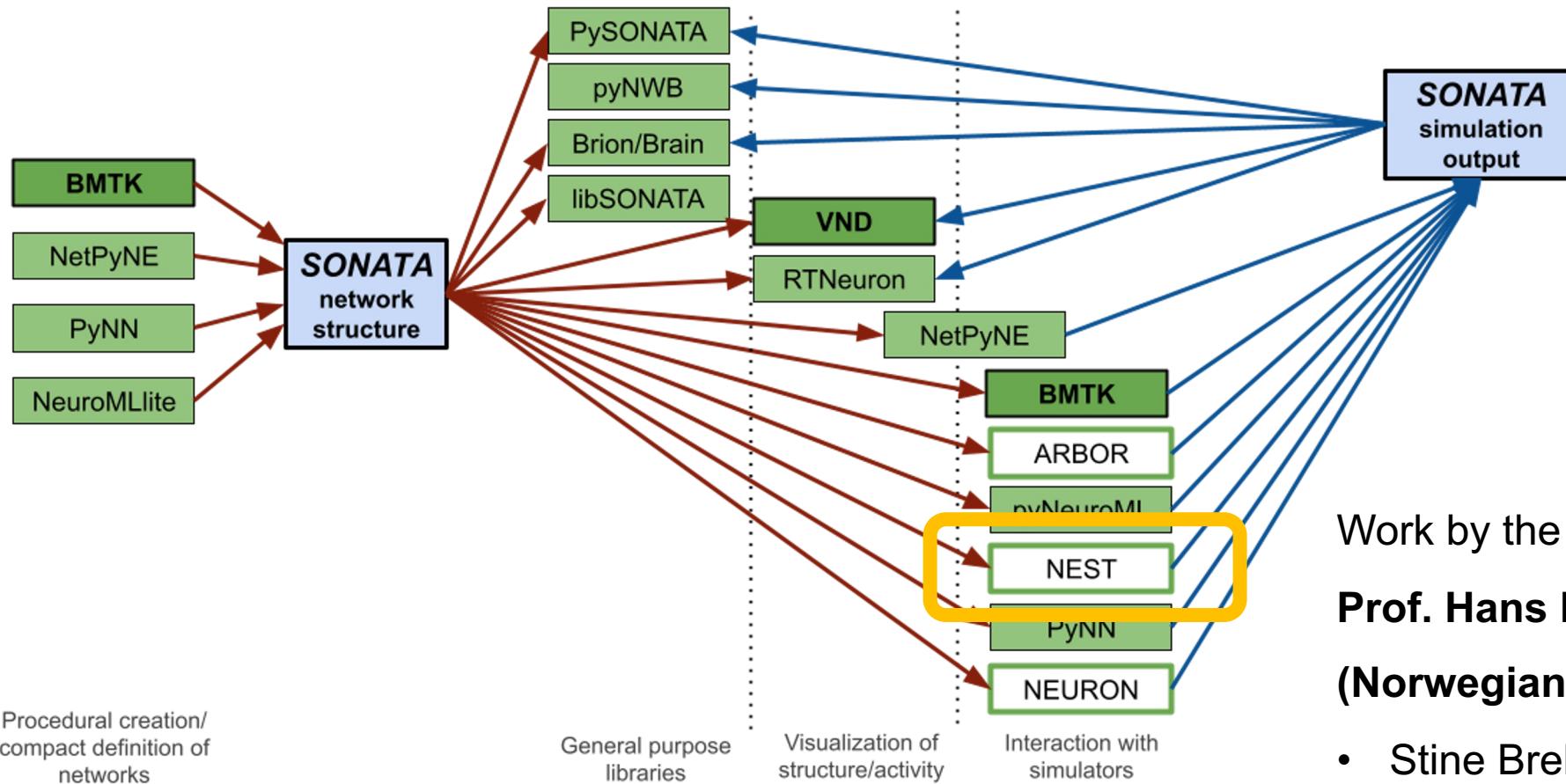
“Brain Modeling ToolKit: An open source software suite for multiscale modeling of brain circuits.”
Dai et al., *PLOS Comp. Bio.*, 2020

SONATA Data Format



"The SONATA data format for efficient description of large-scale network models."
Dai et al., *PLOS Comp. Bio.*, 2020

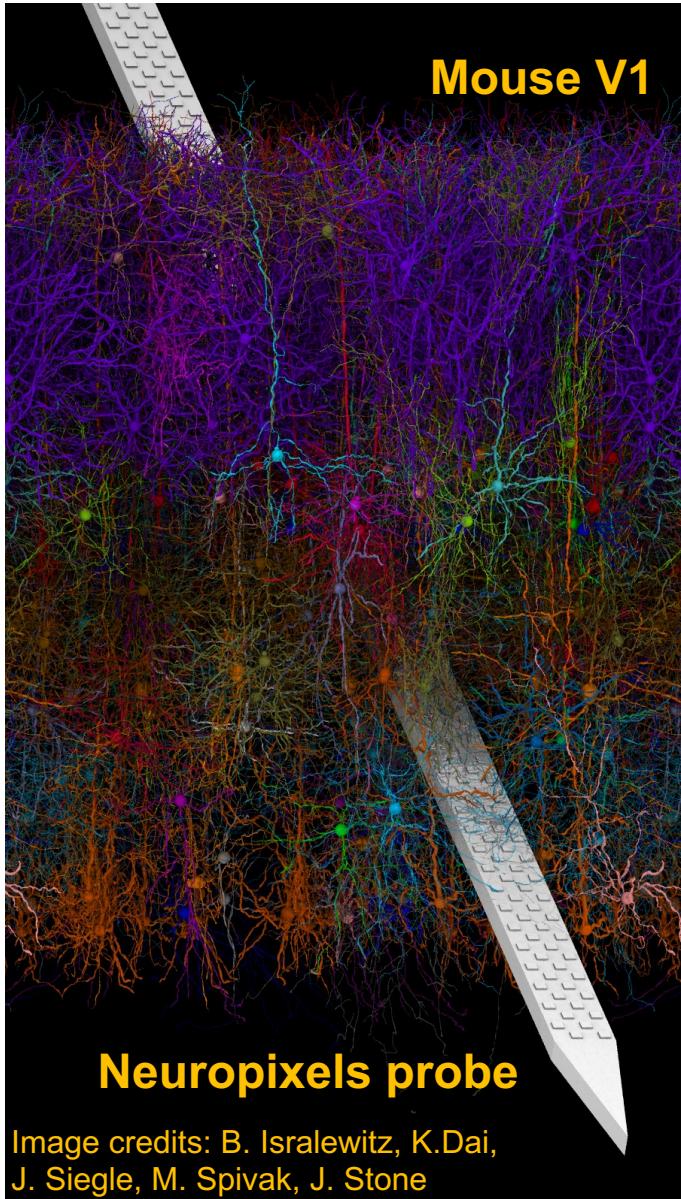
SONATA Ecosystem



Work by the group of
Prof. Hans Ekkehard Plessner
(Norwegian University of Life Sciences):

- Stine Brekke Vennemo
- Håkon Mørk
- Susanne Kunkel

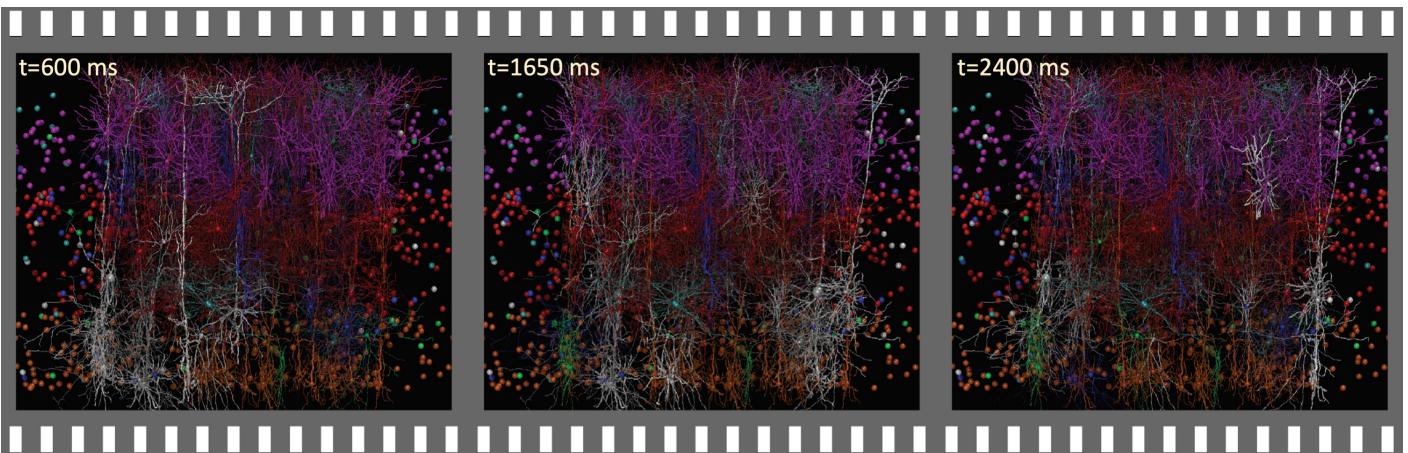
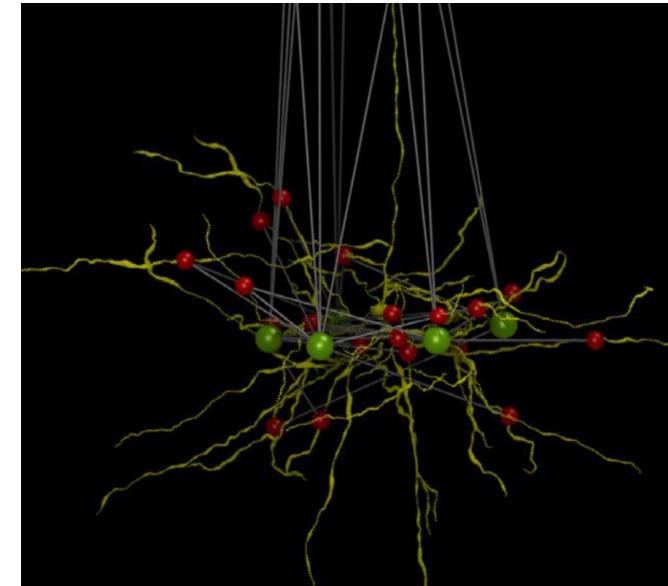
Visual Neuronal Dynamics (VND)



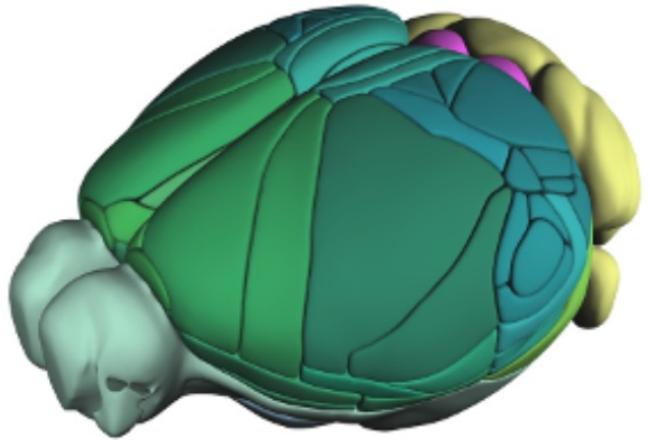
<http://www.ks.uiuc.edu/Research/vnd/>

2nd place winner in the 2021 BRAIN Initiative “Show us your BRAINs!” contest.

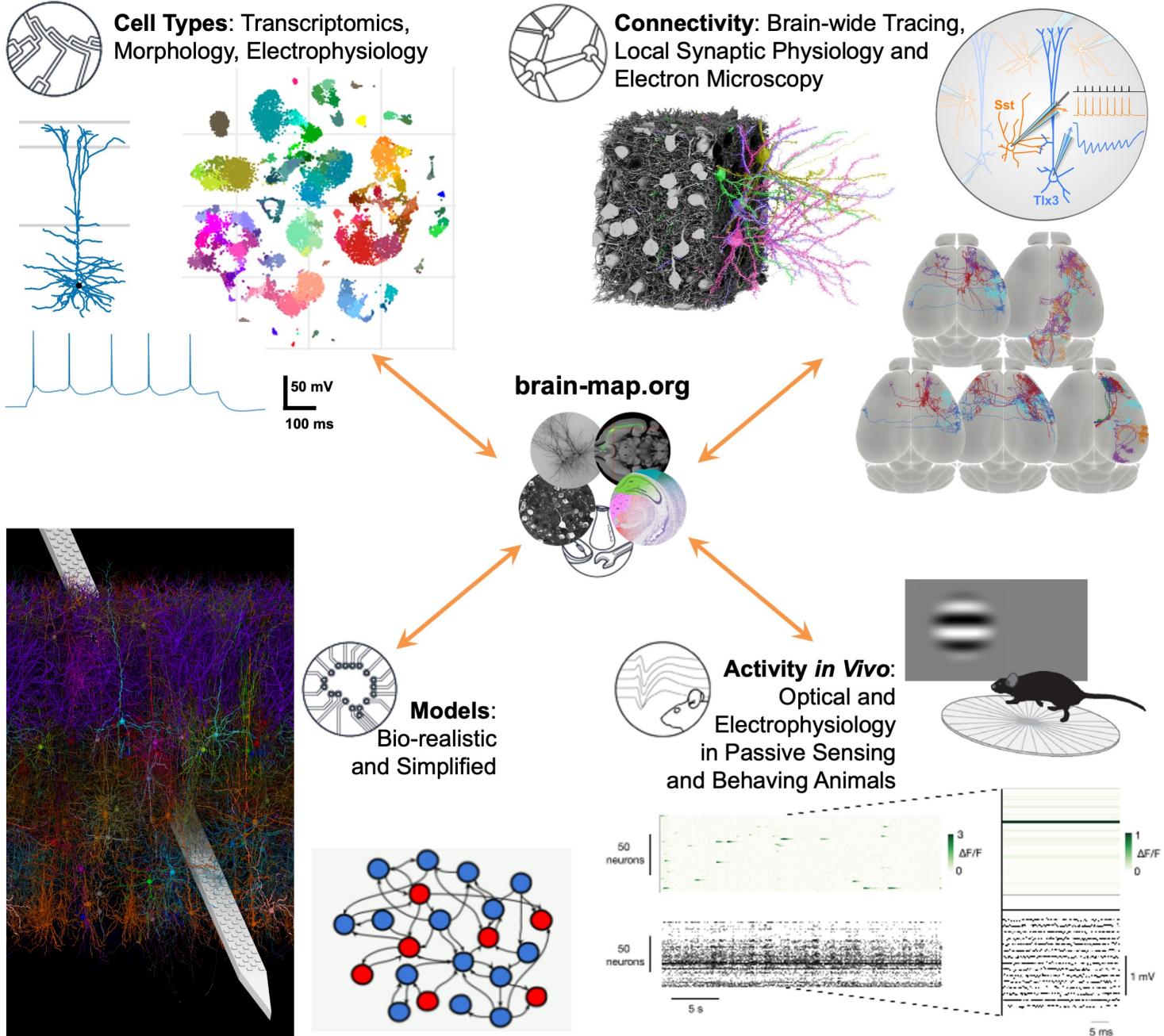
- Read SONATA files
- Efficient 3D visualization on regular computers and specialized hardware
- Movies of neural activity



Allen Institute Data and Models

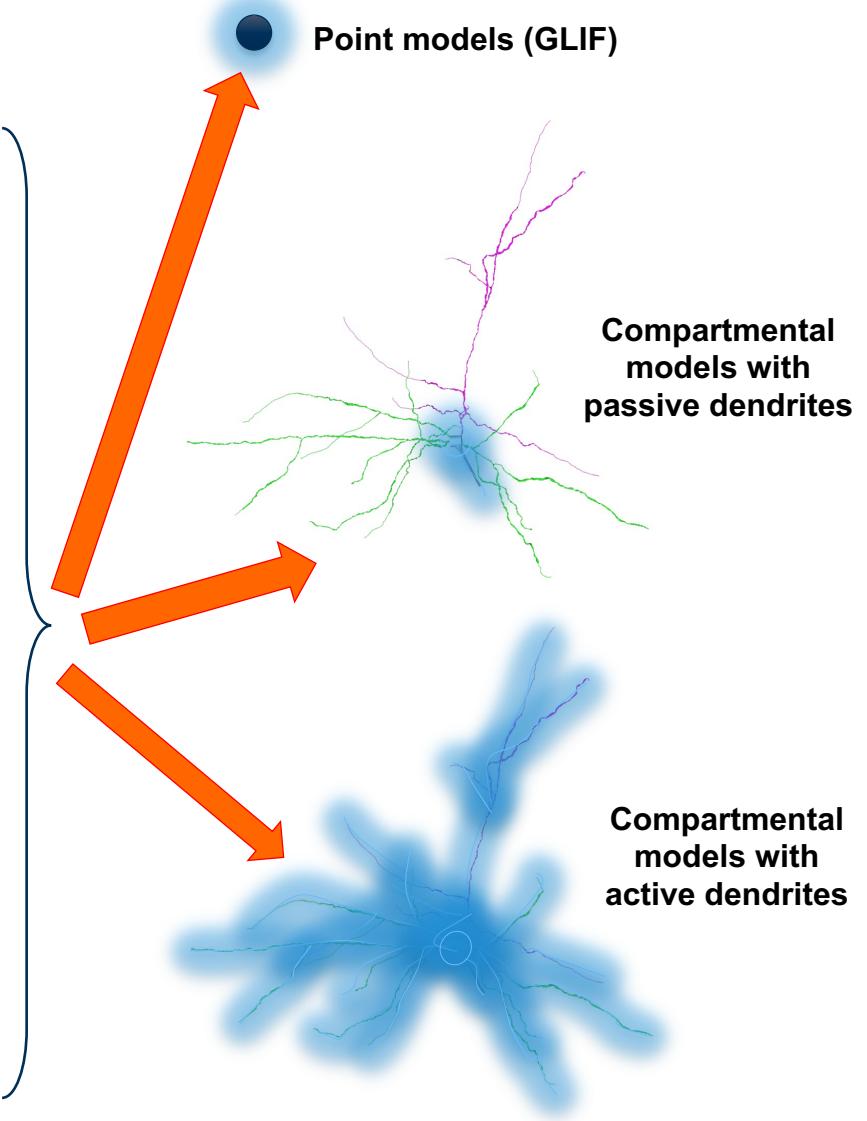
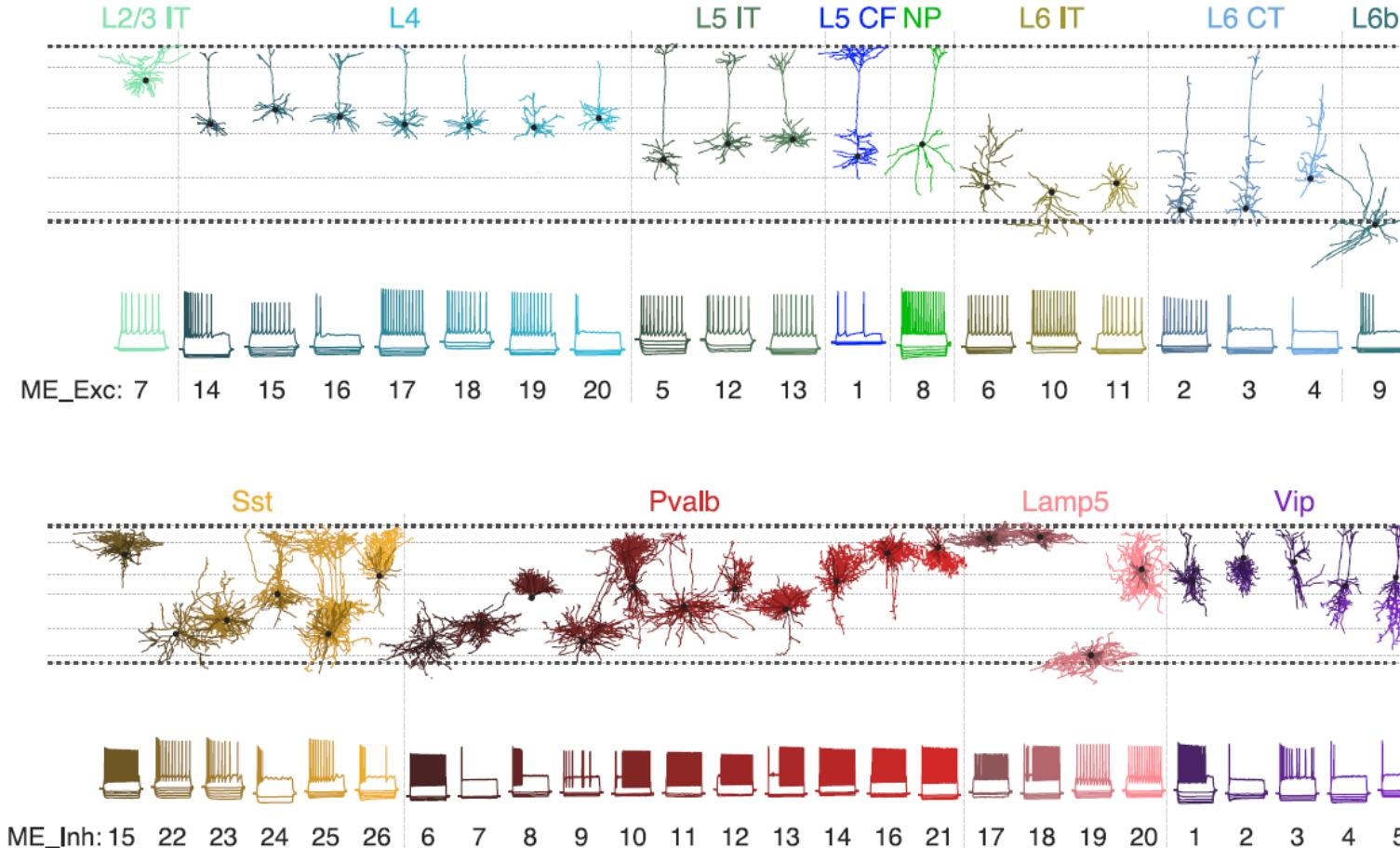


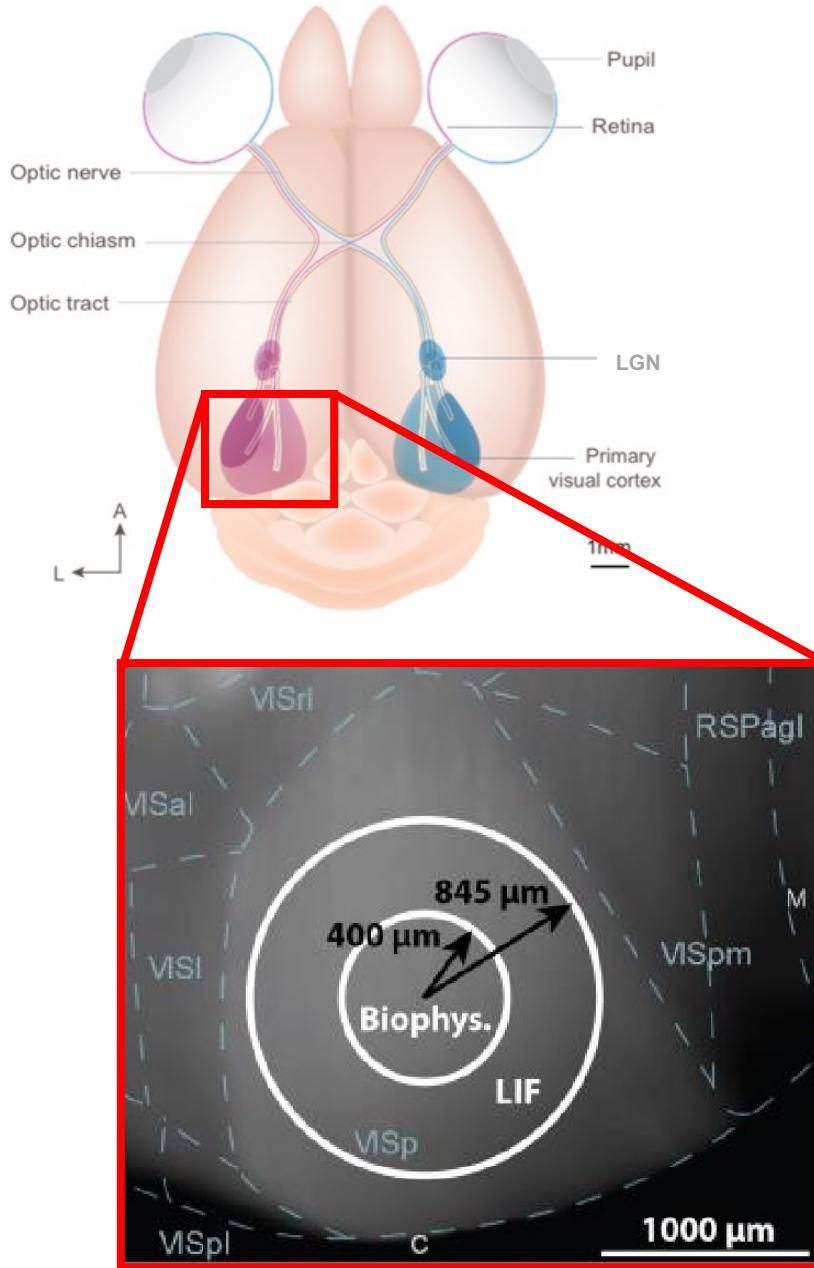
Reference atlas, gene expression atlas, connectivity atlas...



Building Blocks: Cell Types

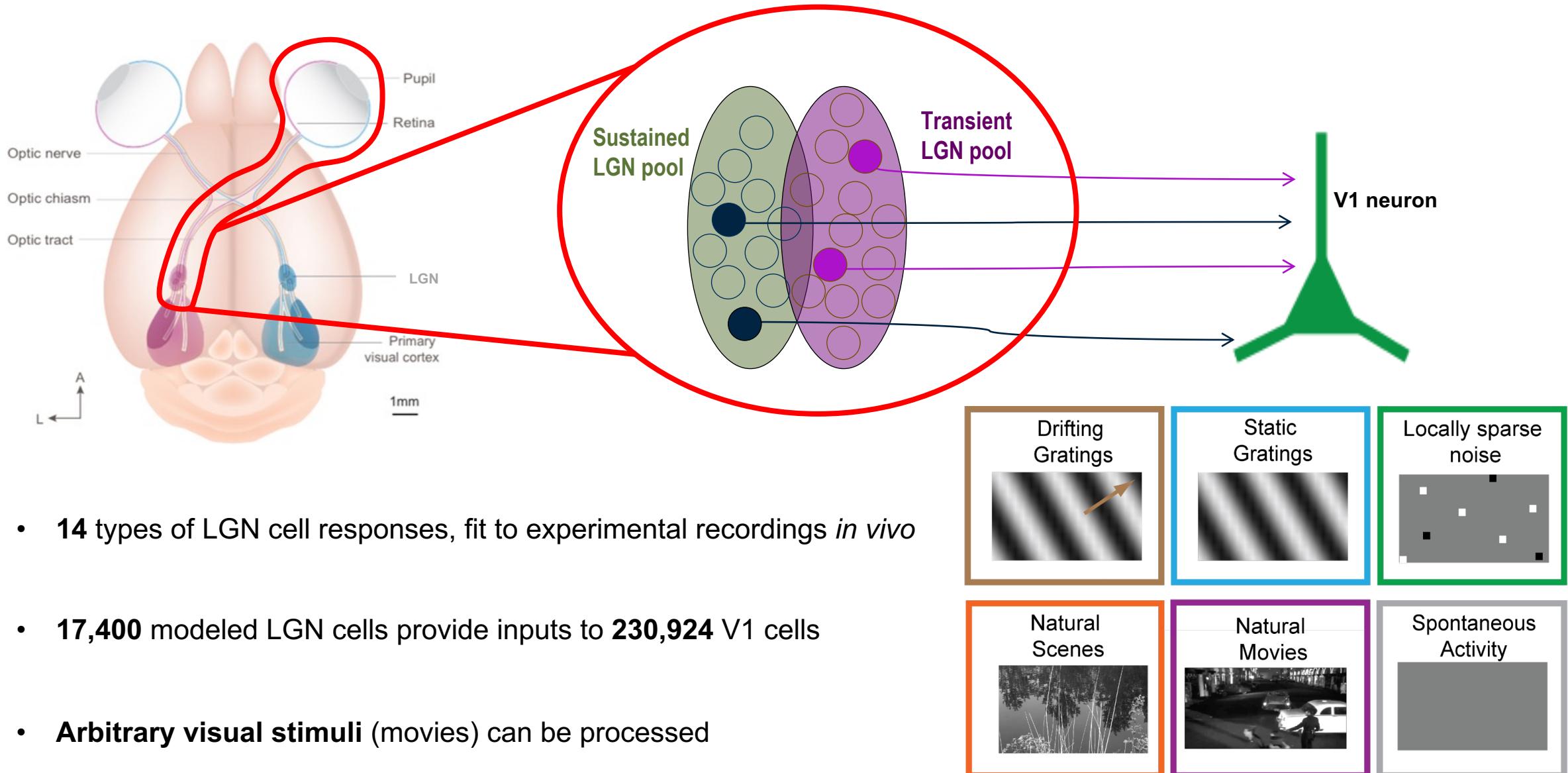
- Transcriptomics
- Electrophysiology
- Morphology



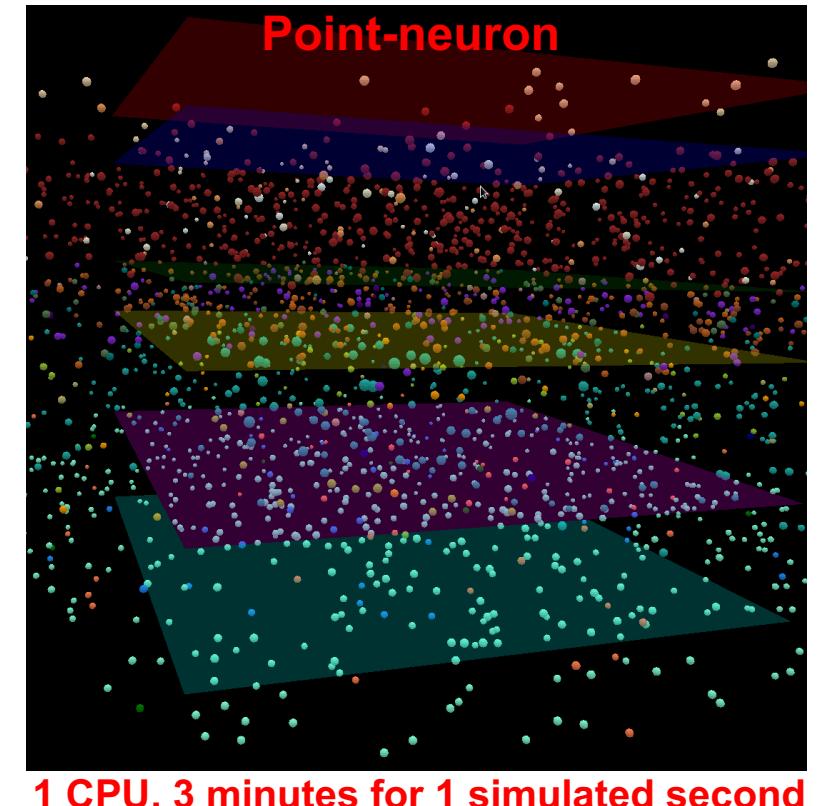
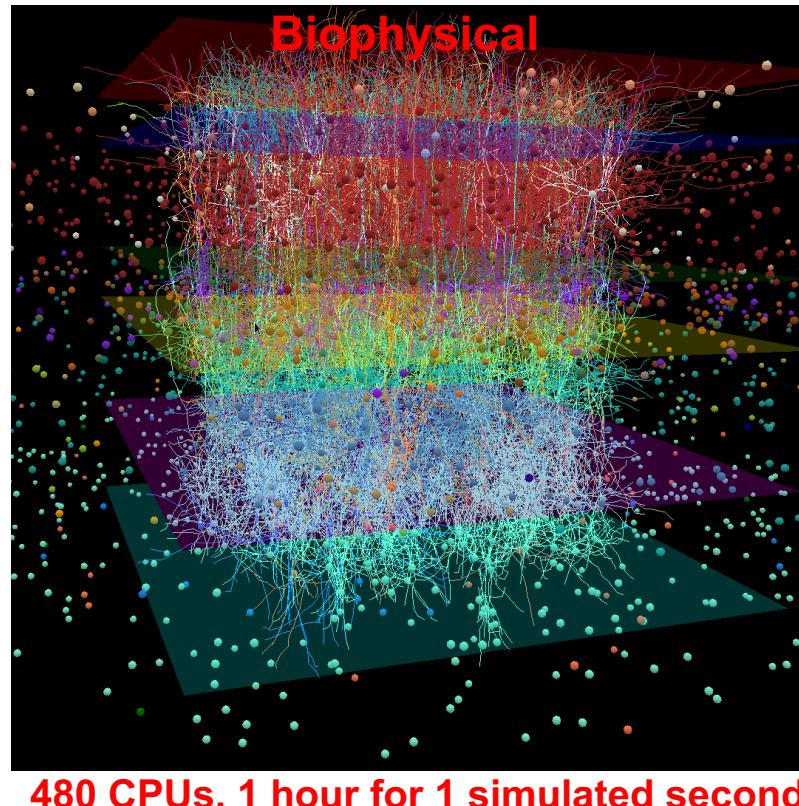
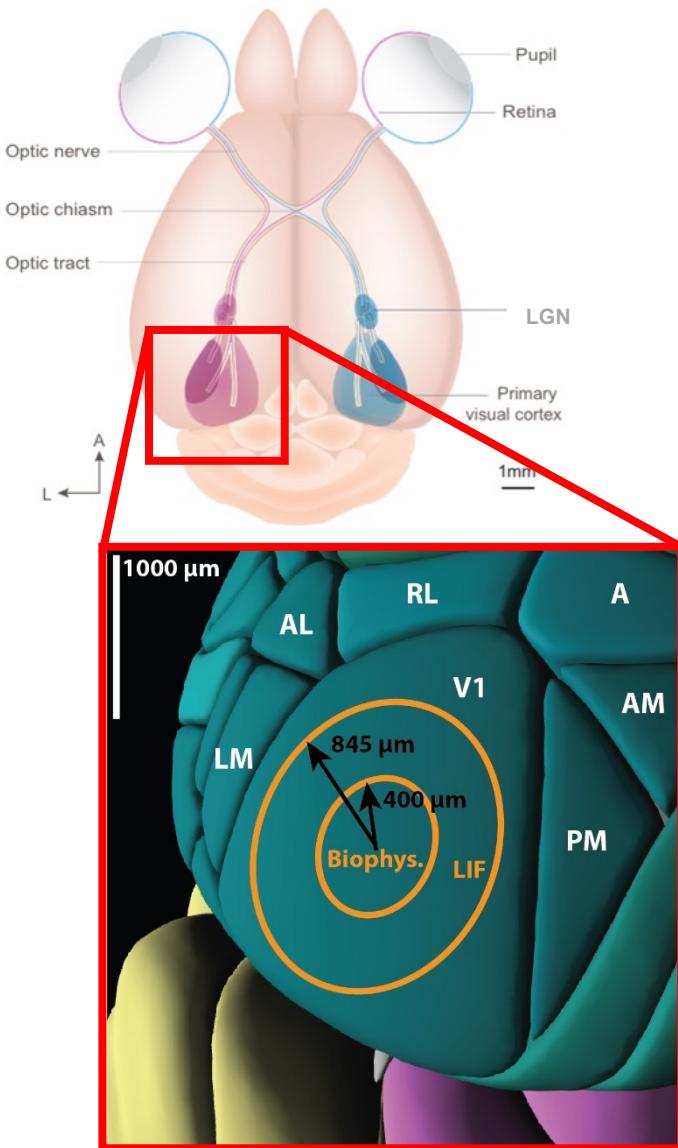


- 17 cell classes
- 51,978 biophysical neurons
- 230,924 cells total
- 114 unique biophysical neuronal models
- 178,946 point neurons

Filter-based Visual Inputs into the V1 model



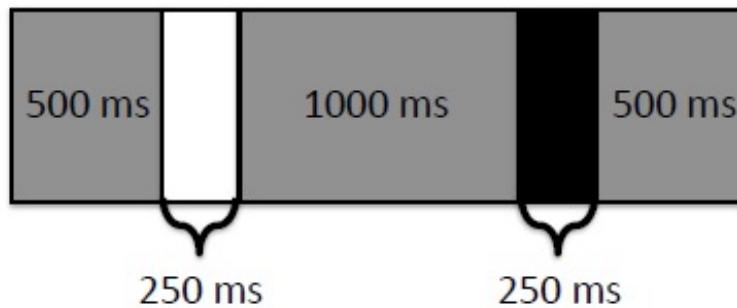
Models of the Mouse Primary Visual Cortex (V1)



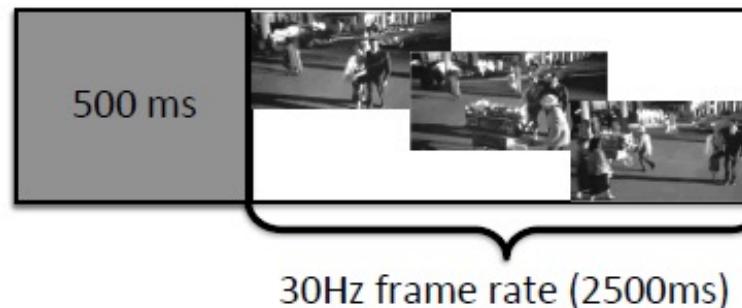
- 230,924 cells total, **17 cell classes**
- **One-to-one** mapping between the biophysical and point-neuron models
- Models are **freely available**: <http://portal.brain-map.org/explore/models>

Responses to Various Visual Stimuli

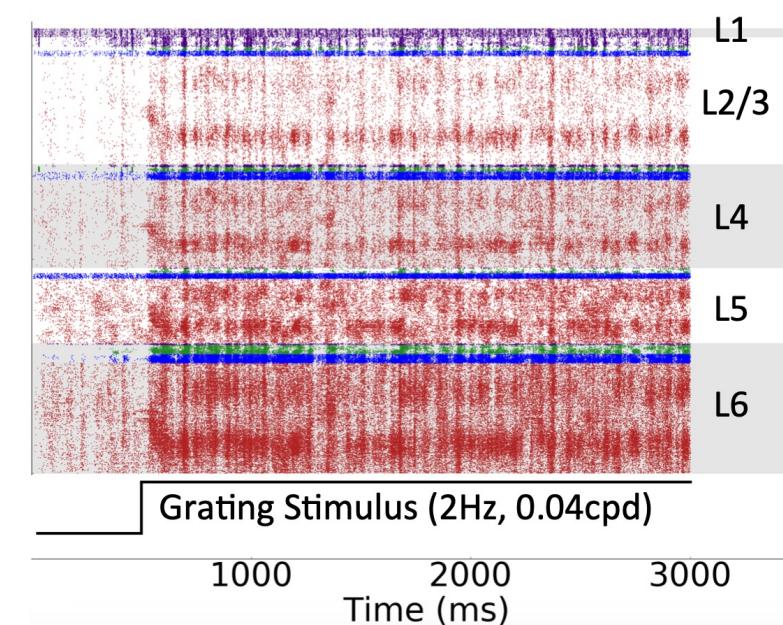
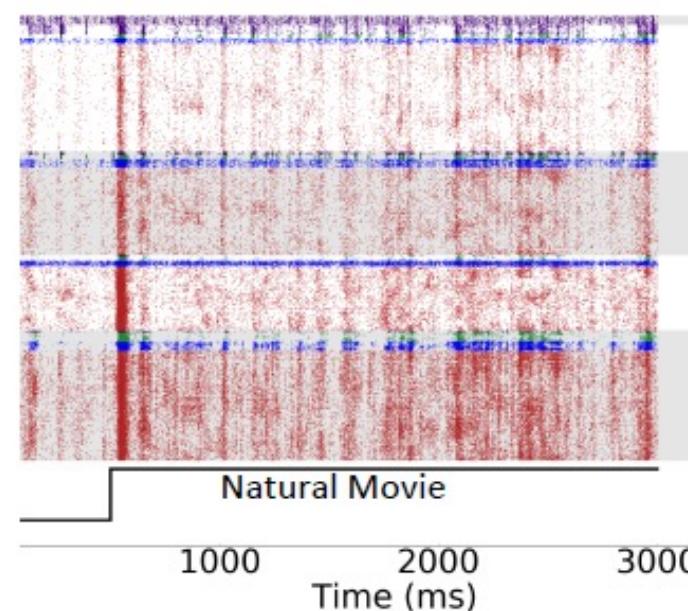
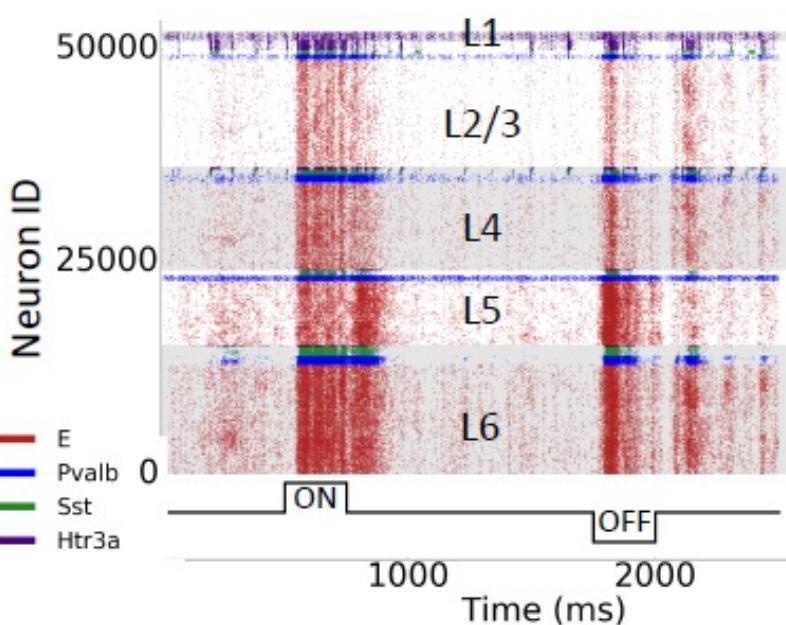
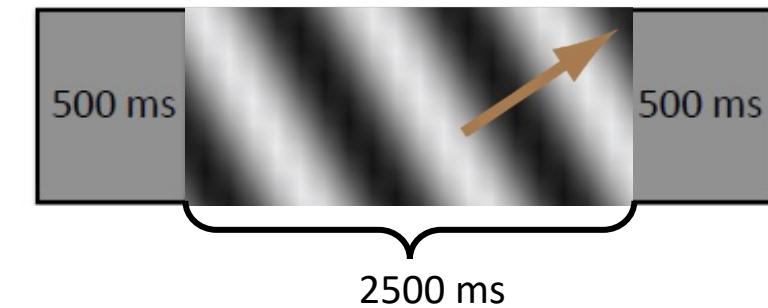
Flashes Stimulus



Natural Movie Stimulus



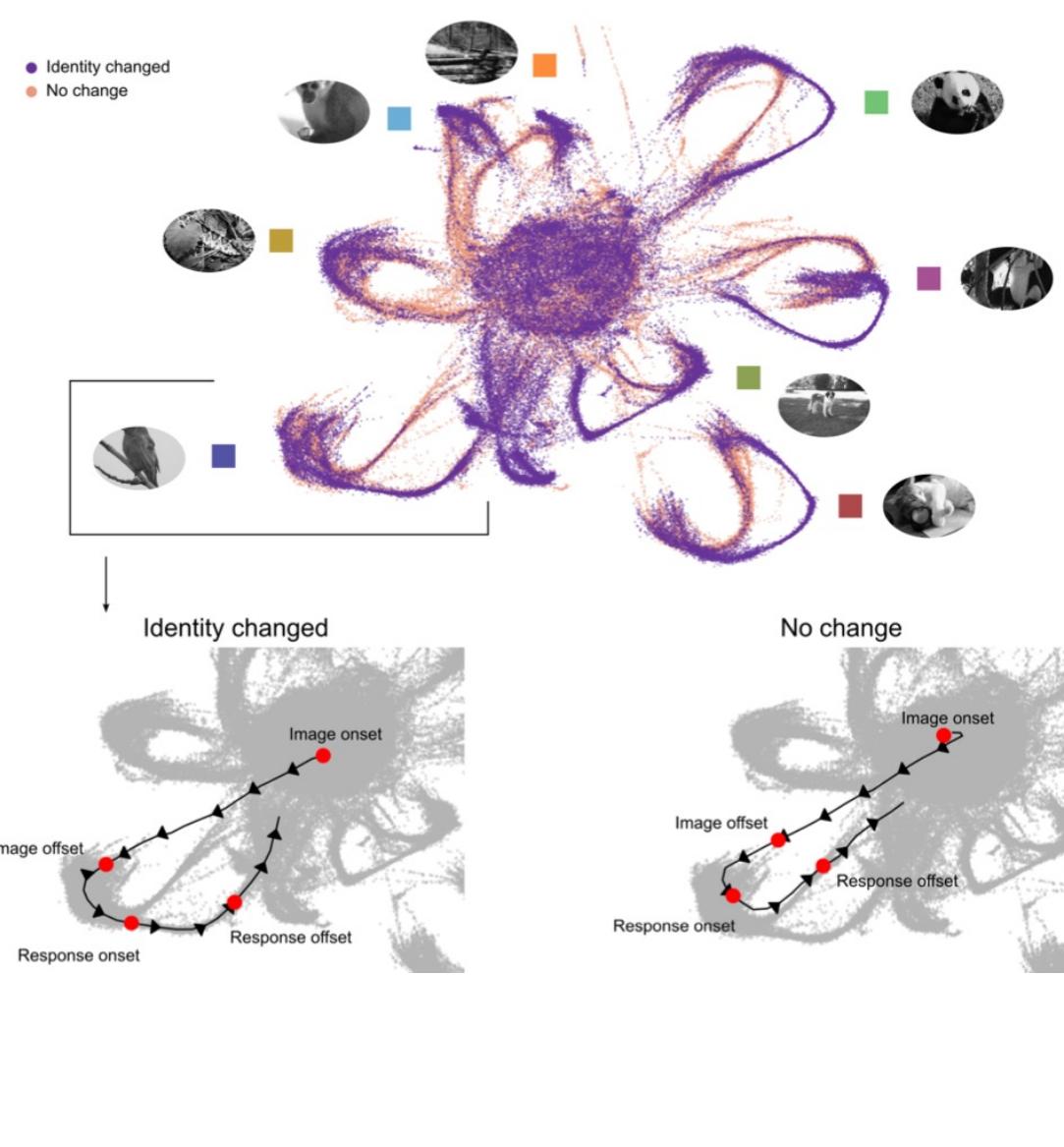
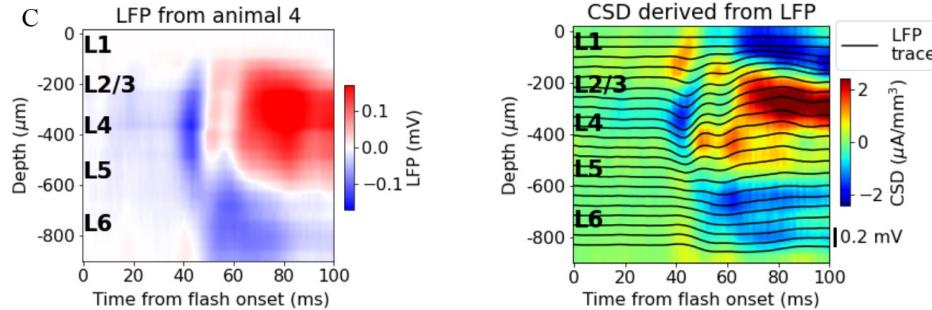
Drifting Grating Stimulus



Applications of the Published V1 Model

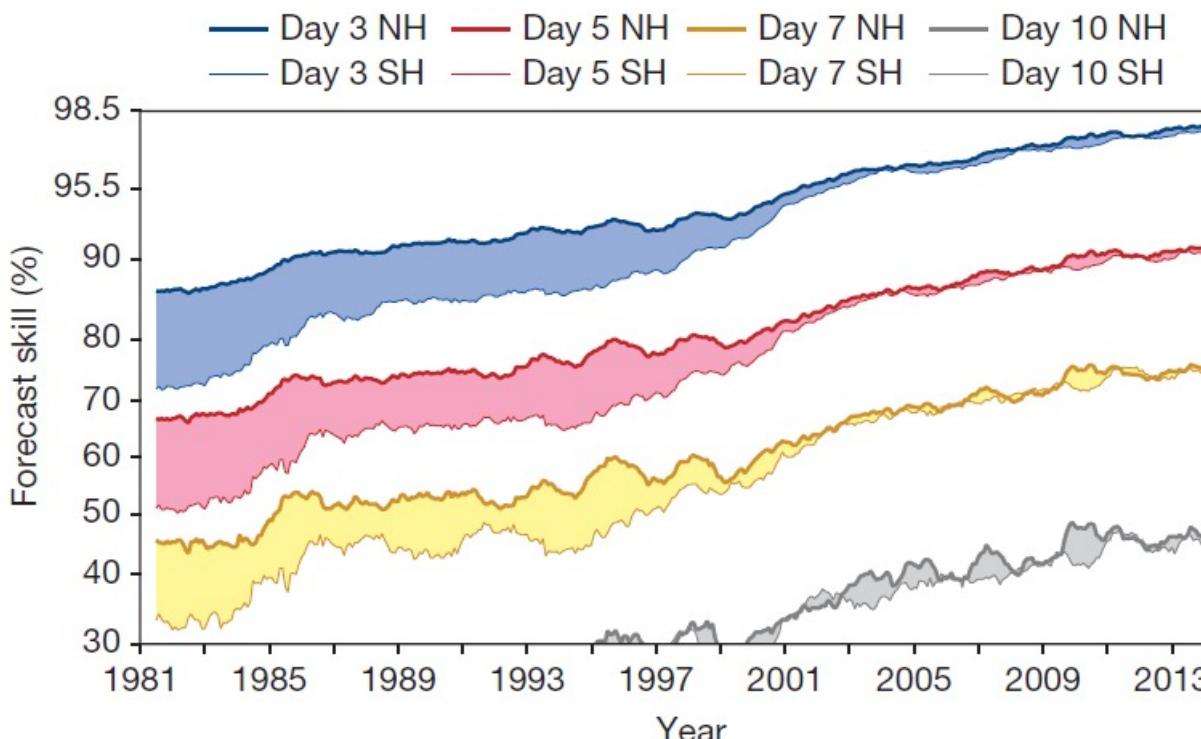
1. Giacopelli et al. [On the structural connectivity of large-scale models of brain networks at cellular level](#). *Sci. Rep.* 11, 4345 (2021).
2. Stöckl et al. [Probabilistic skeletons endow brain-like neural networks with innate computing capabilities](#). *bioRxiv* 2021.05.18.444689 (2021)
3. Chen et al. [Analysis of visual processing capabilities and neural coding strategies of a detailed model for laminar cortical microcircuits in mouse V1](#). *bioRxiv* 2021.12.07.471653 (2021)
4. Jabri, T. & MacLean, J. N. [Large-scale algorithmic search identifies stiff and sloppy dimensions in synaptic architectures consistent with murine neocortical wiring](#). *bioRxiv* 2021.11.13.468127 (2021)
5. Scherr, F. & Maass, W. [Analysis of the computational strategy of a detailed laminar cortical microcircuit model for solving the image-change-detection task](#). *bioRxiv* 2021.11.17.469025 (2021)
6. Schneider et al. [Transcriptomic cell type structures in vivo neuronal activity across multiple time scales](#). *bioRxiv* 2022.07.10.499487 (2022)

Also: simulating LFP and CSD (with Einevoll Lab, U. Oslo), studying criticality (Hengen Lab, Wash U St. Louis), etc.



Weather Modeling

- Forecast skill for 3-10 days has been increasing by about one day per decade
- “The unusual path and intensification of hurricane Sandy in October 2012 was predicted 8 days ahead, the 2010 Russian heat-wave and the 2013 US cold spell were forecast with 1–2 weeks lead time, and tropical sea surface temperature variability following the El Nino/Southern Oscillation phenomenon can be predicted 3–4 months ahead.”

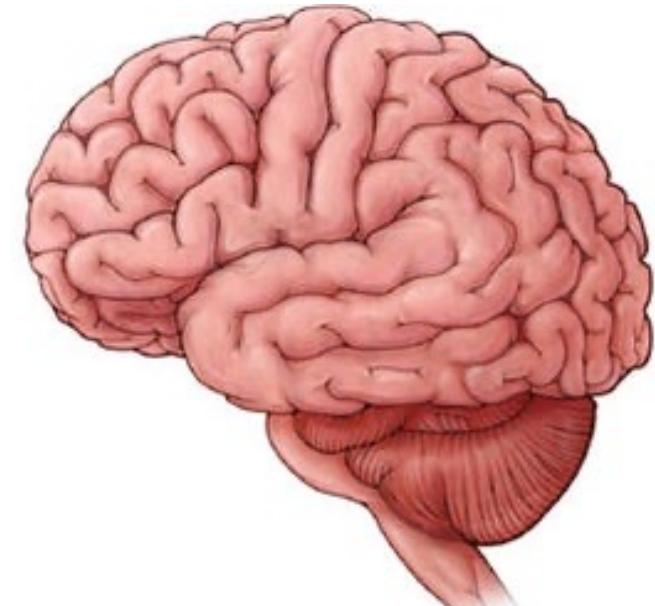
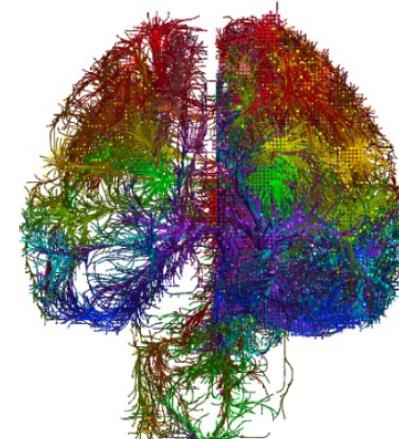
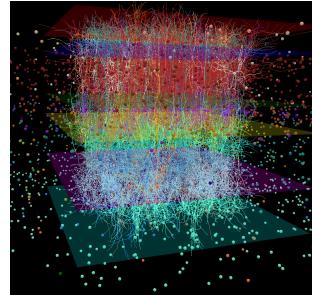
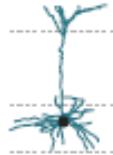


Why?

- Steady advances in algorithms modeling atmospheric physics and chemistry
- Increases in computing power
- The skill is objectively evaluated daily and globally, so that success and failure of forecasts is accurately known and pathways to improve predictive skill can be effectively tested

Towards Multipurpose Models of Cortical Circuits

- New datasets will increase the accuracy and predictive power of models
- Tools are available
- Models are available
- For many applications, computational expense is affordable
- Multi-purpose models, together with theory and experiments, help advance our knowledge of the brain



THANK YOU

We wish to thank the Allen Institute founder, Paul G. Allen, for his vision, encouragement, and support.

