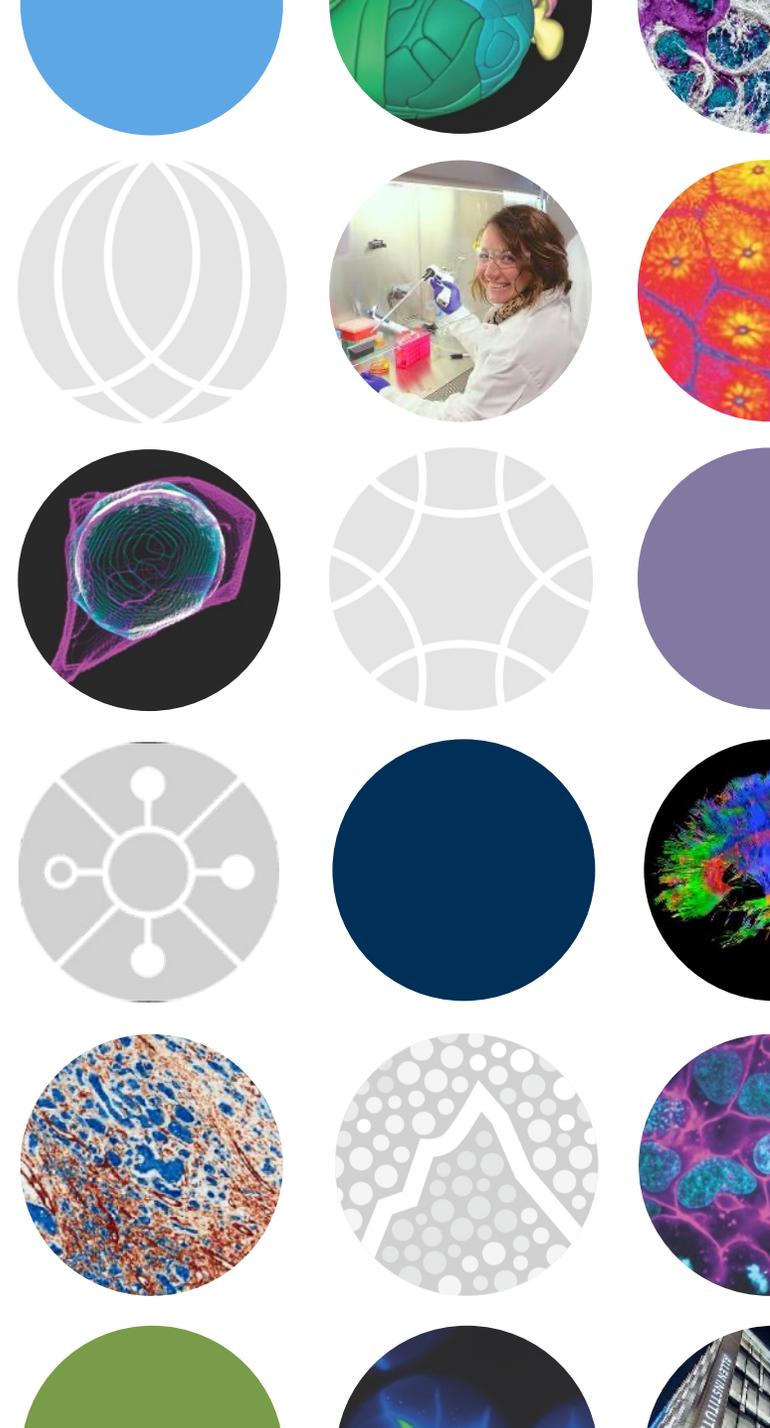


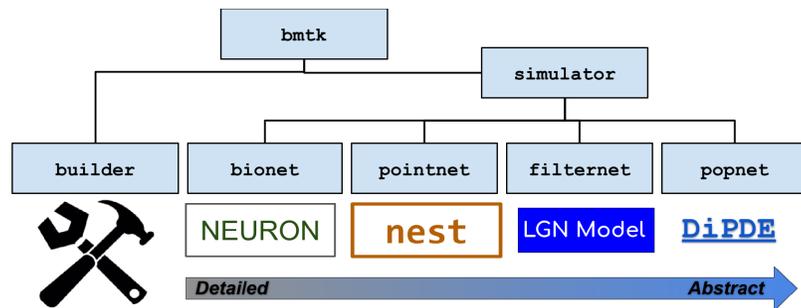


Allen Institute Modeling Software Workshop: Introduction

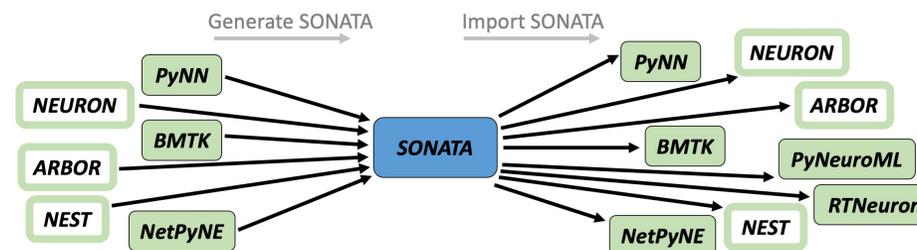


1U24NS124001: Advancing Bio-Realistic Modeling via the Brain Modeling ToolKit (BMTK), SONATA Data Format, and Visual Neuronal Dynamics (VND)

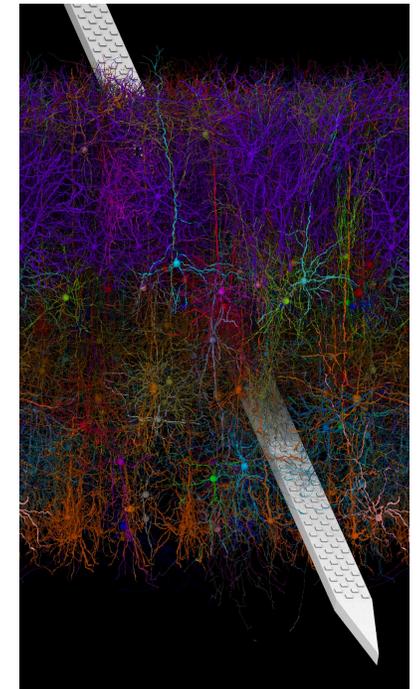
Model building and simulation: BMTK



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

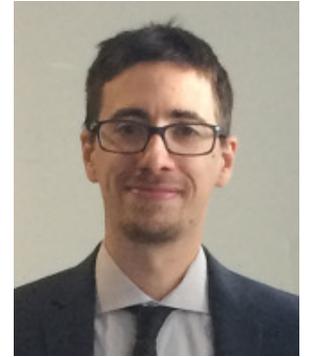


The Team

UIUC: VND



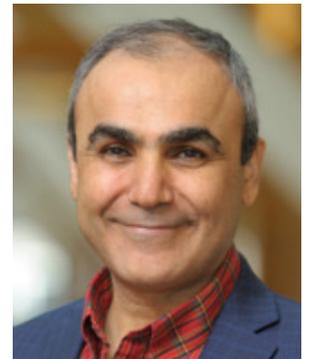
Barry Isralewitz



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

Warning: Potential Security Risk Ahead

Firefox detected a potential security threat and did not continue to 13.57.192.126. If you visit this site, attackers could try to steal information like your passwords, emails, or credit card details.

[Learn more...](#)

Go Back (Recommended) **Advanced...** 1. Click "Advanced"

13.57.192.126:8443 uses an invalid security certificate.

The certificate is not trusted because it is self-signed.

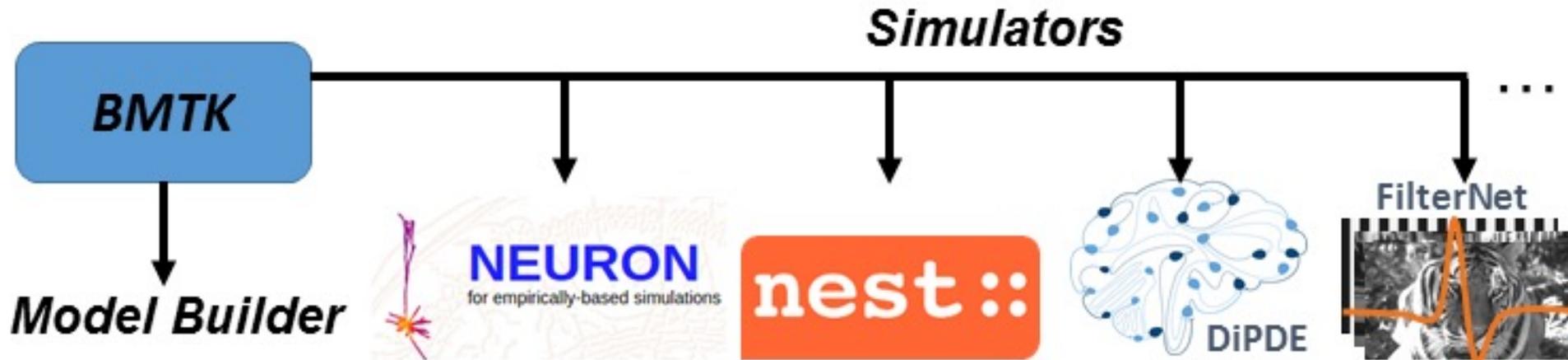
Error code: [MOZILLA_PKIX_ERROR_SELF_SIGNED_CERT](#)

[View Certificate](#)

Go Back (Recommended) **Accept the Risk and Continue** 2. Click "Accept the Risk and Continue"

Brain Modeling Toolkit

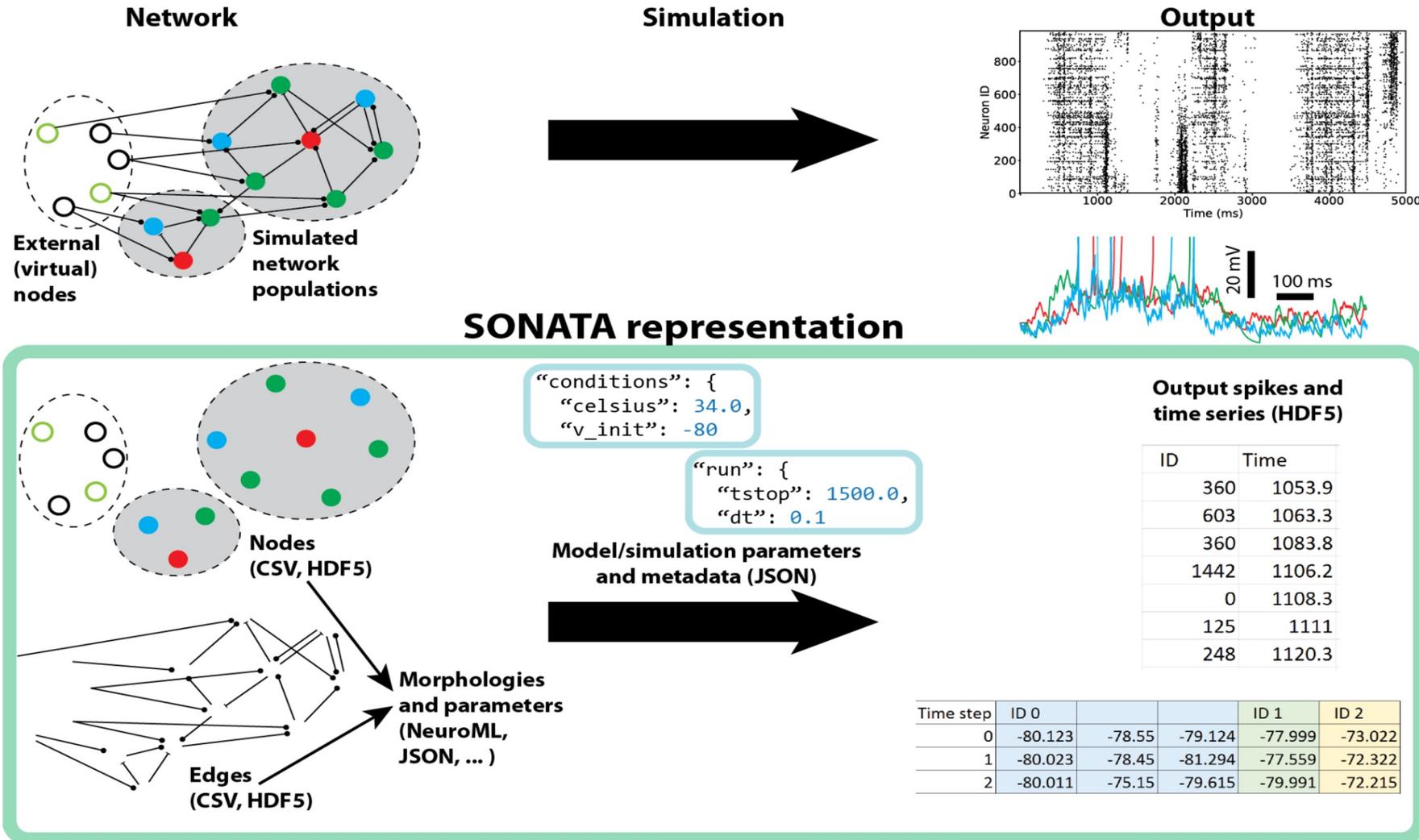
<https://alleninstitute.github.io/bmtk/>



- 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

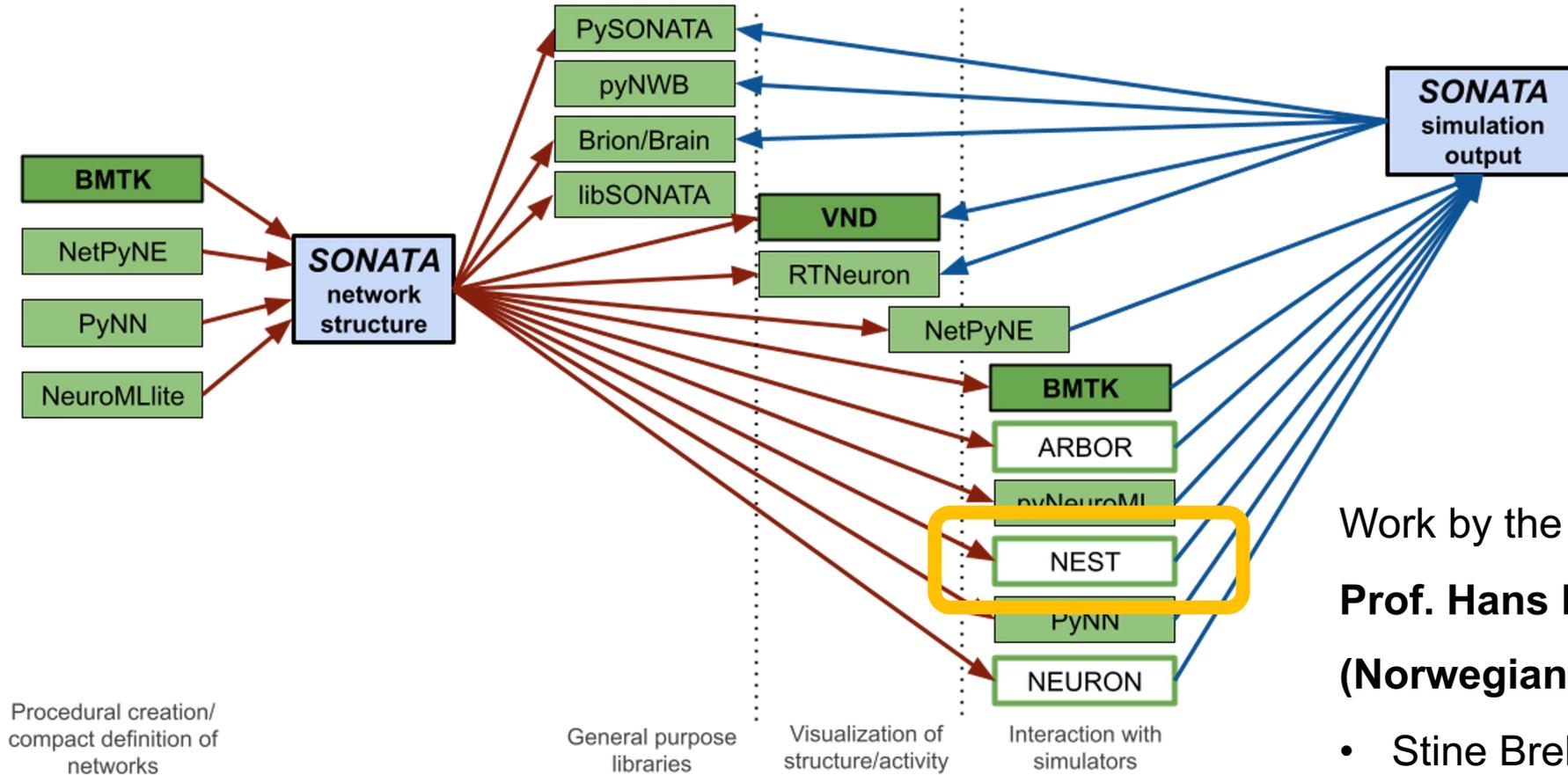
SONATA Data Format



“The SONATA data format for efficient description of large-scale network models.”

Dai et al., *PLOS Comp. Bio.*, 2020

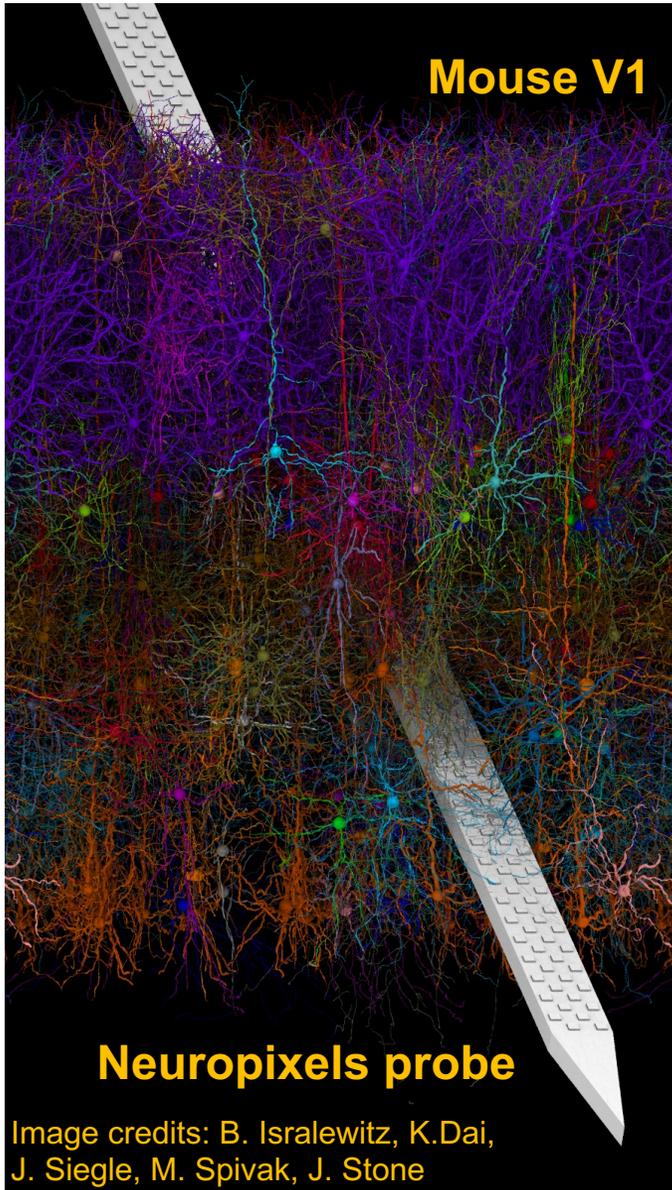
SONATA Ecosystem



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

- Stine Brekke Vennemo
- Håkon Mørk
- Susanne Kunkel

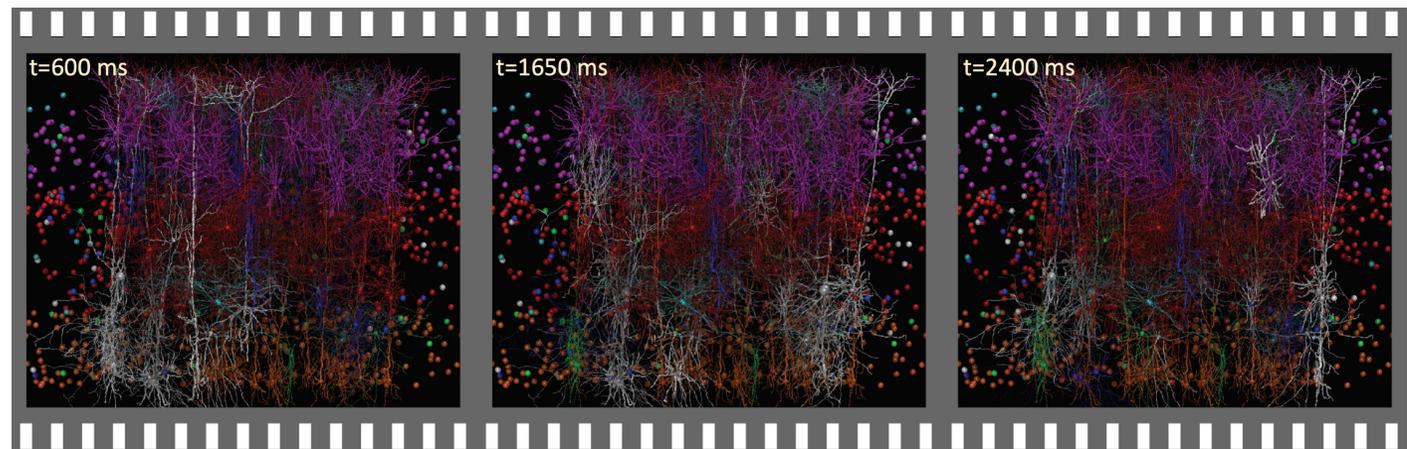
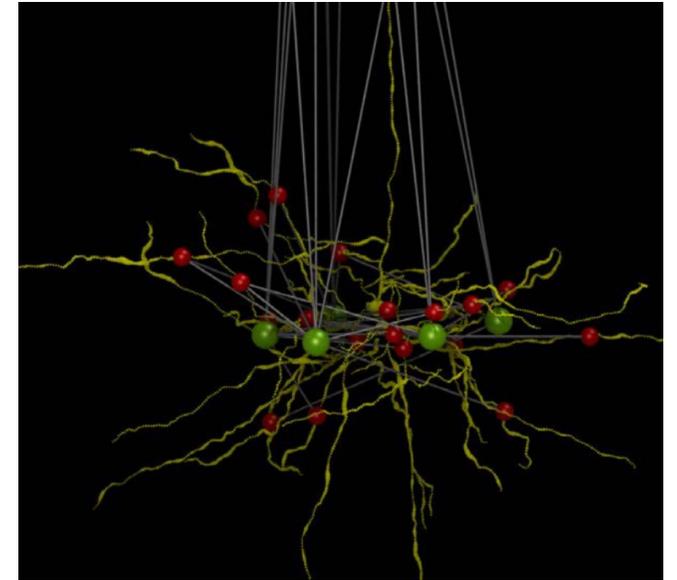
Visual Neuronal Dynamics (VND)



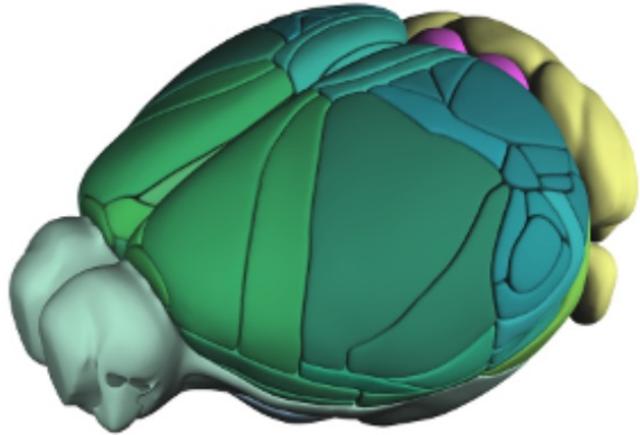
<http://www.ks.uiuc.edu/Research/vnd/>

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

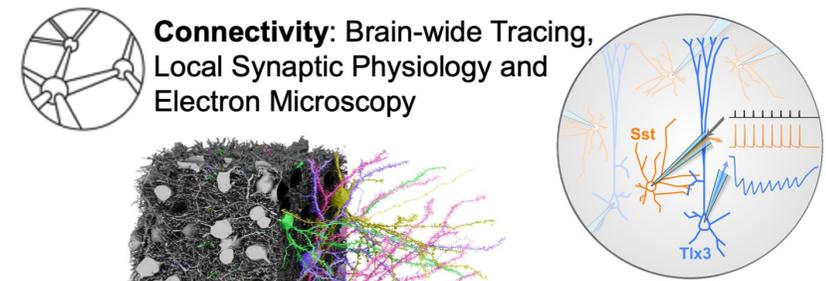
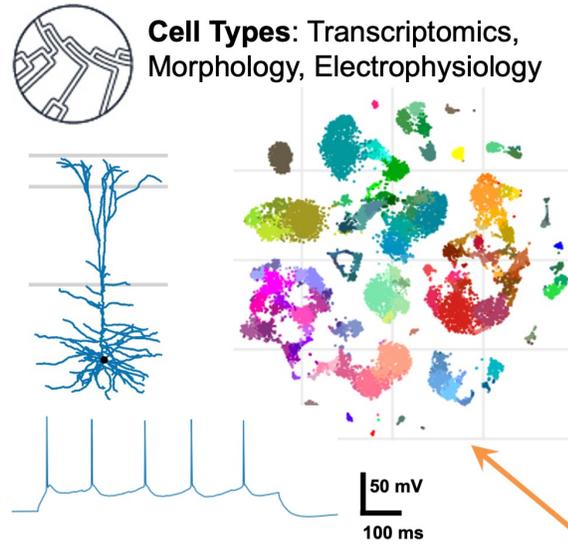
- Read SONATA files
- Efficient 3D visualization on regular computers and specialized hardware
- Movies of neural activity



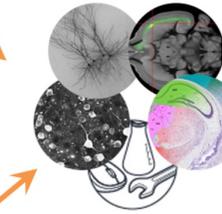
Allen Institute Data and Models



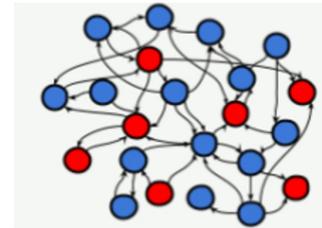
Reference atlas, gene expression atlas, connectivity atlas...



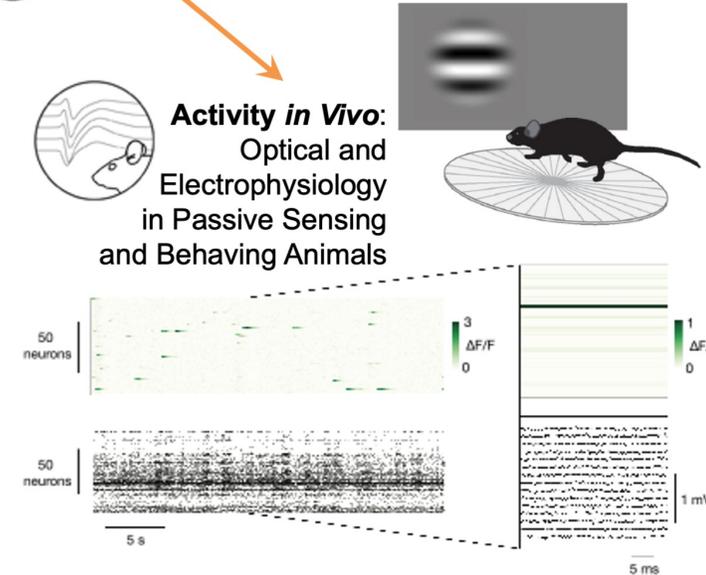
brain-map.org



Models: Bio-realistic and Simplified

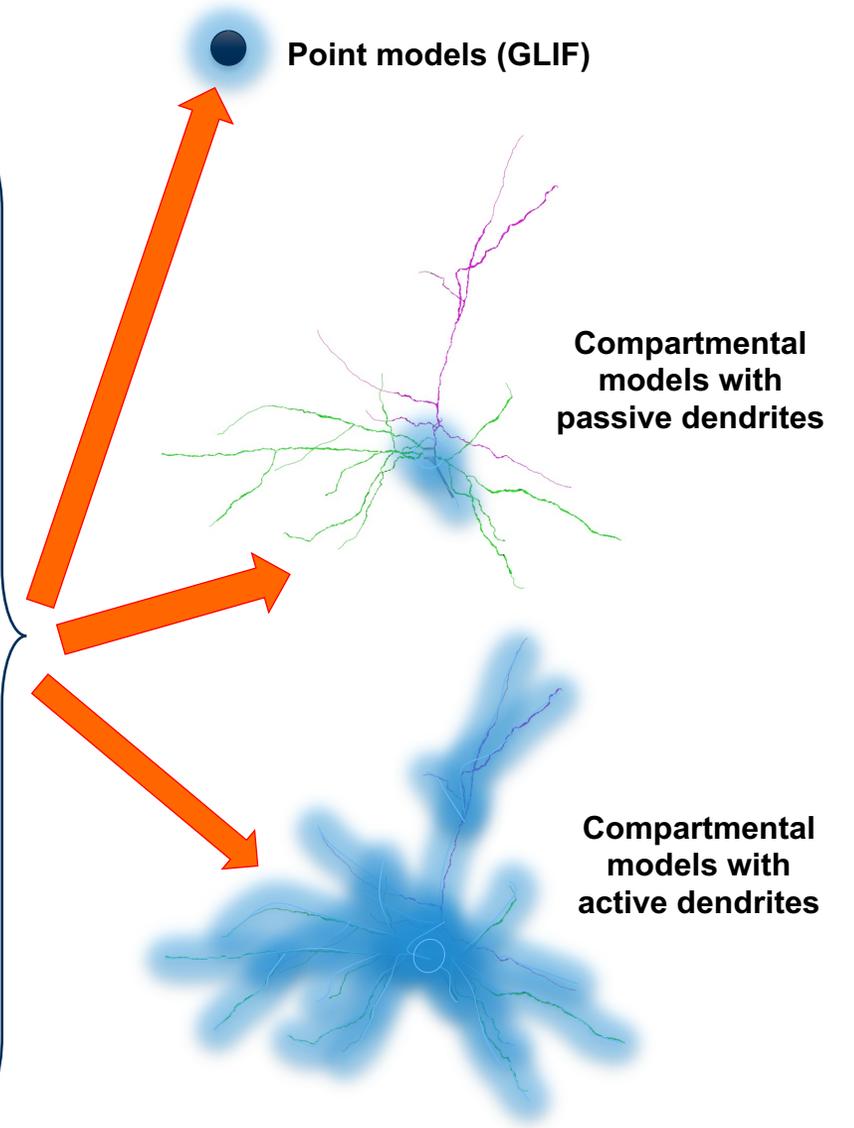
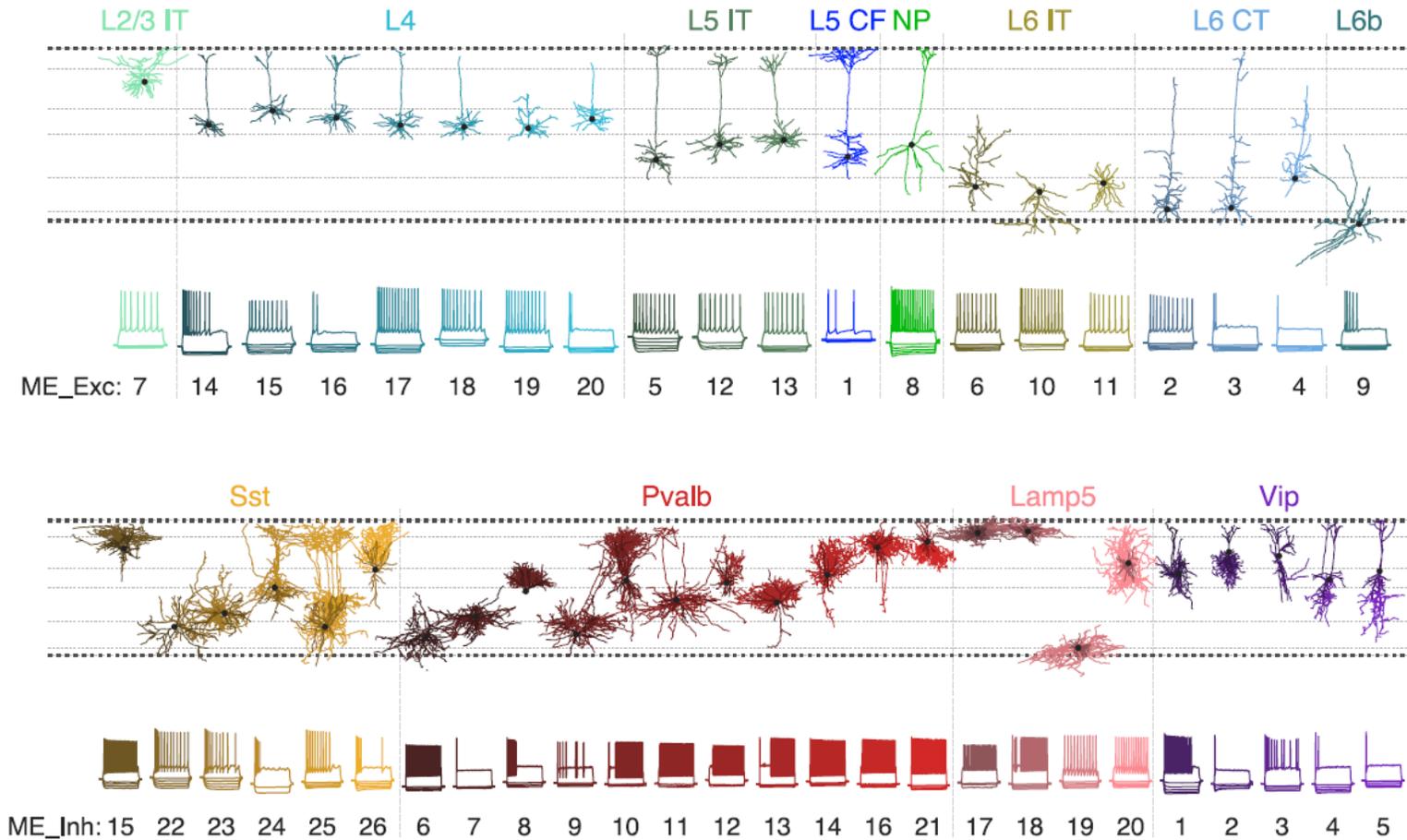


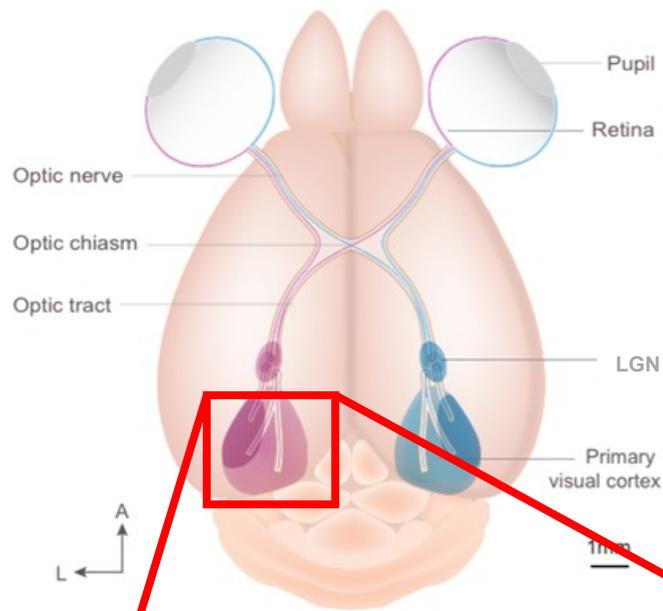
Activity in Vivo: Optical and Electrophysiology in Passive Sensing and Behaving Animals



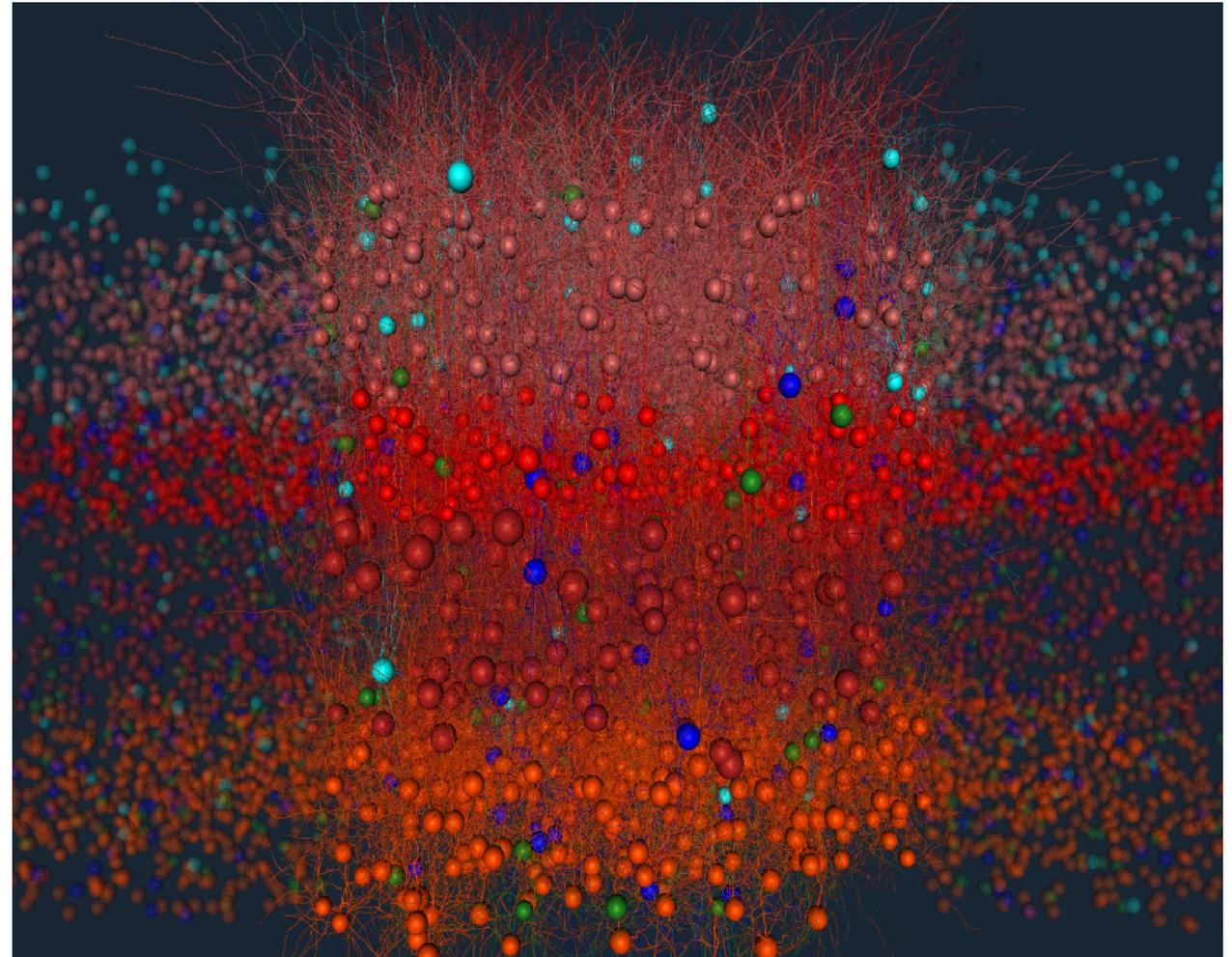
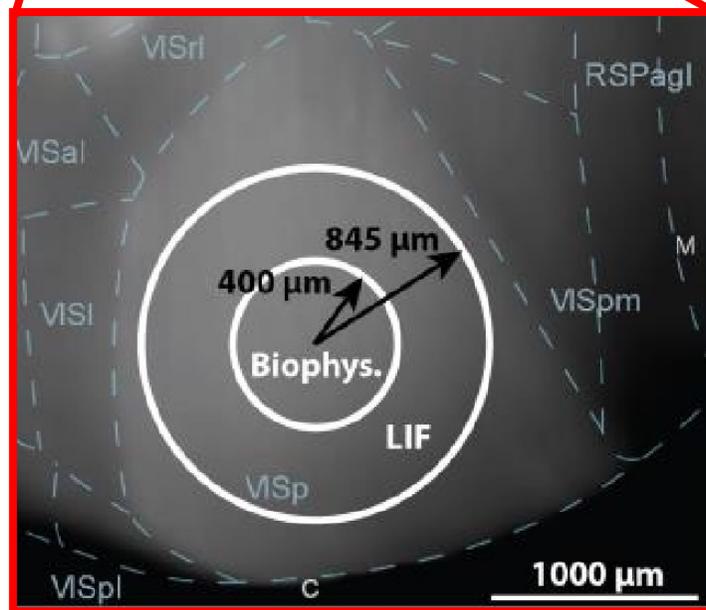
Building Blocks: Cell Types

- Transcriptomics
- Electrophysiology
- Morphology

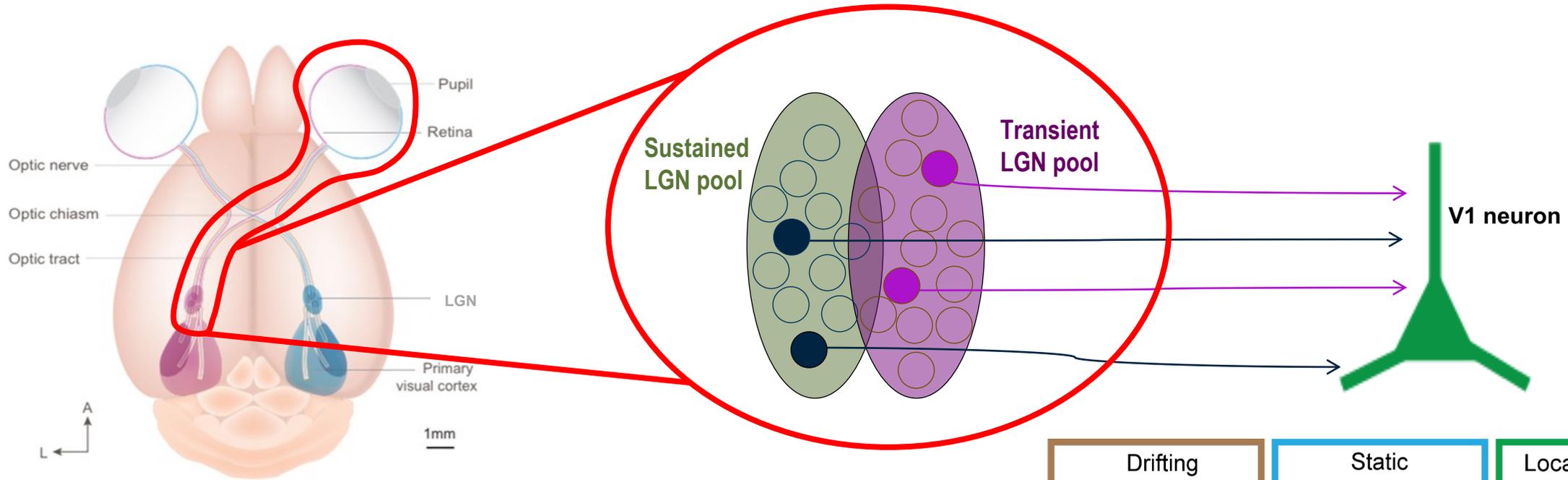




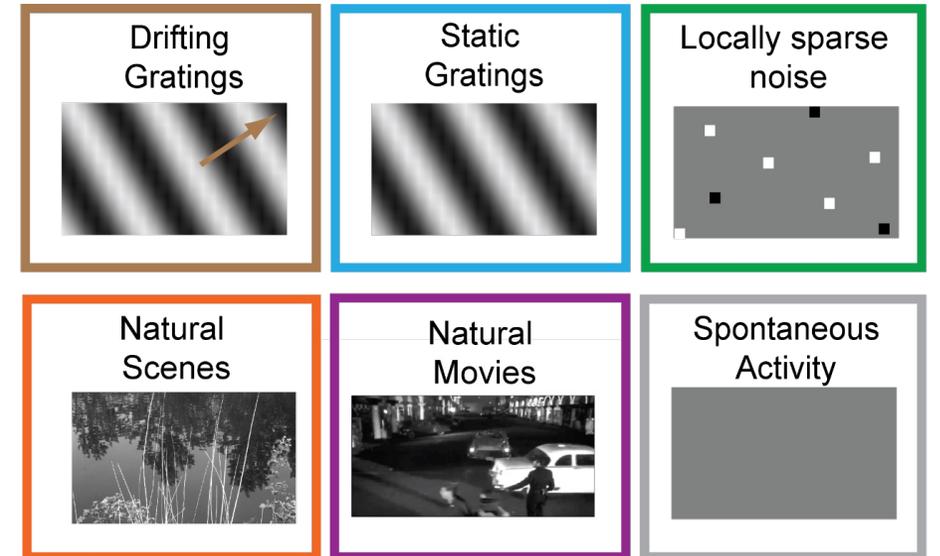
- **17 cell classes**
- **51,978** biophysical neurons
- **230,924** cells total
- **114** unique biophysical neuronal models
- **178,946** point neurons



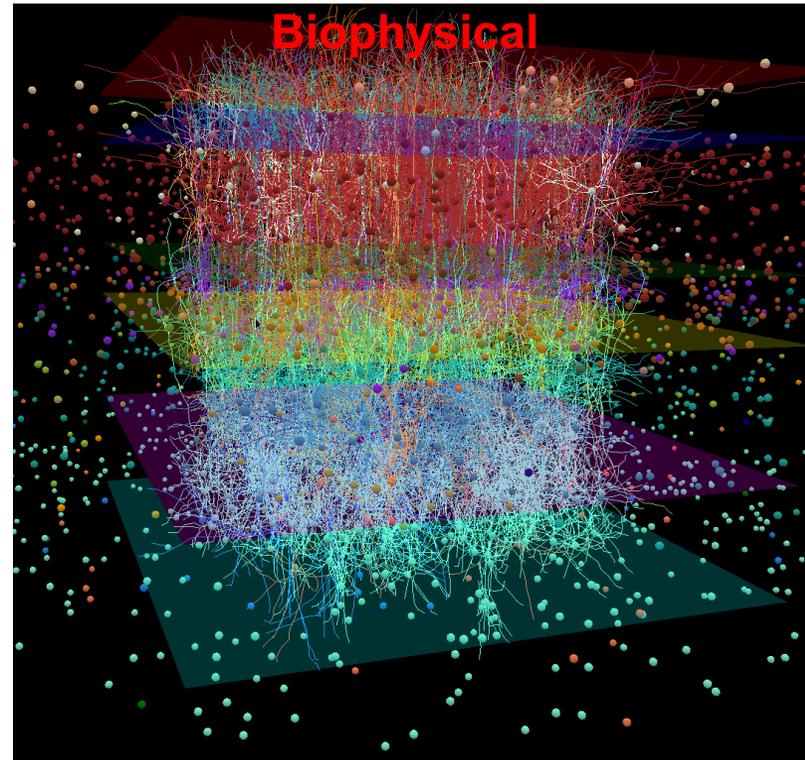
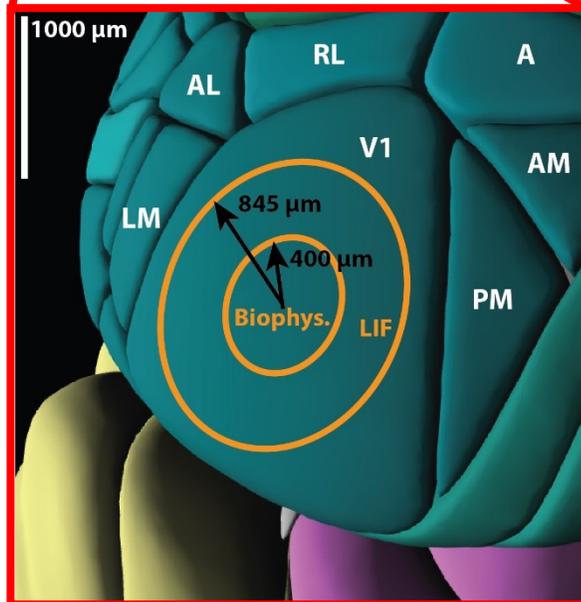
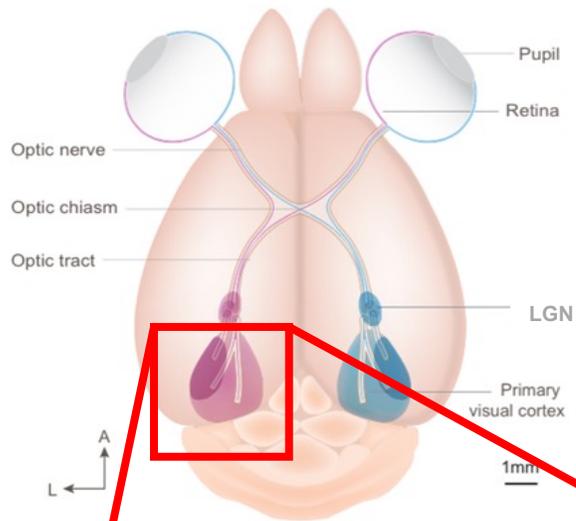
Filter-based Visual Inputs into the V1 model



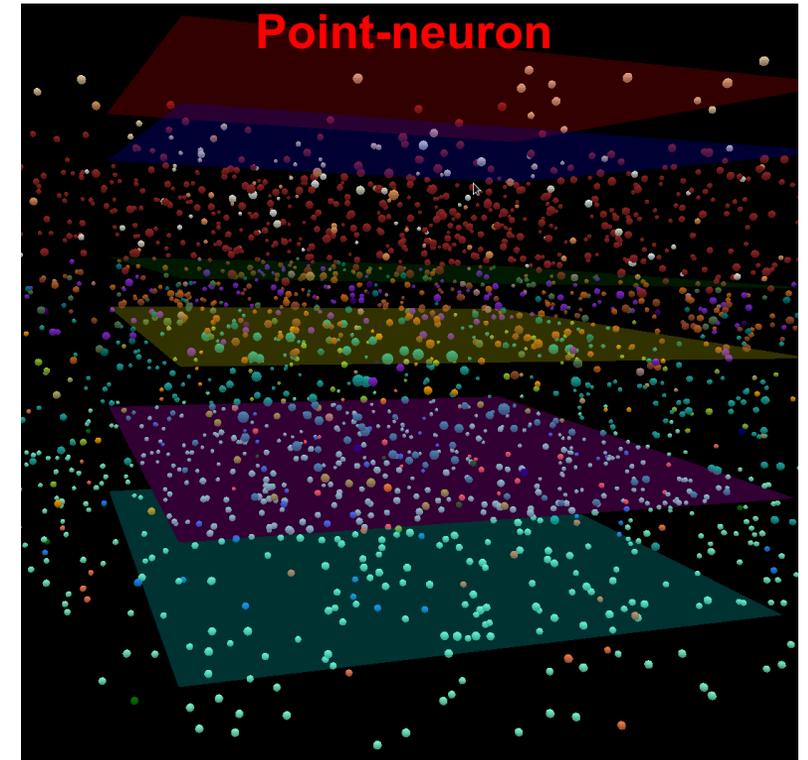
- **14** types of LGN cell responses, fit to experimental recordings *in vivo*
- **17,400** modeled LGN cells provide inputs to **230,924** V1 cells
- **Arbitrary visual stimuli** (movies) can be processed



Models of the Mouse Primary Visual Cortex (V1)



480 CPUs, 1 hour for 1 simulated second

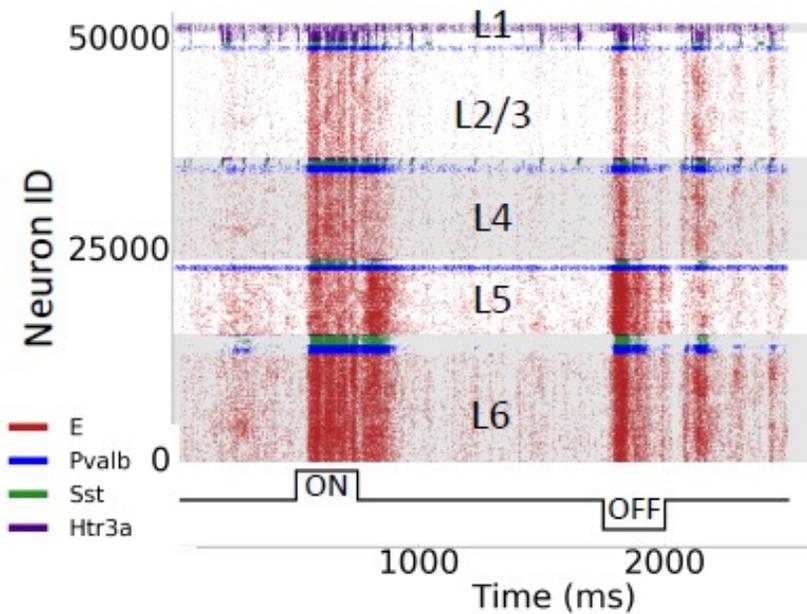
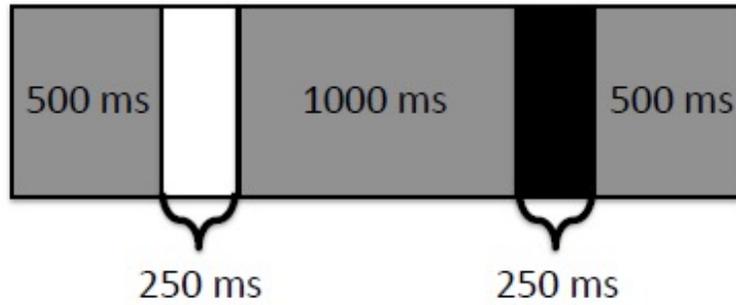


1 CPU, 3 minutes for 1 simulated second

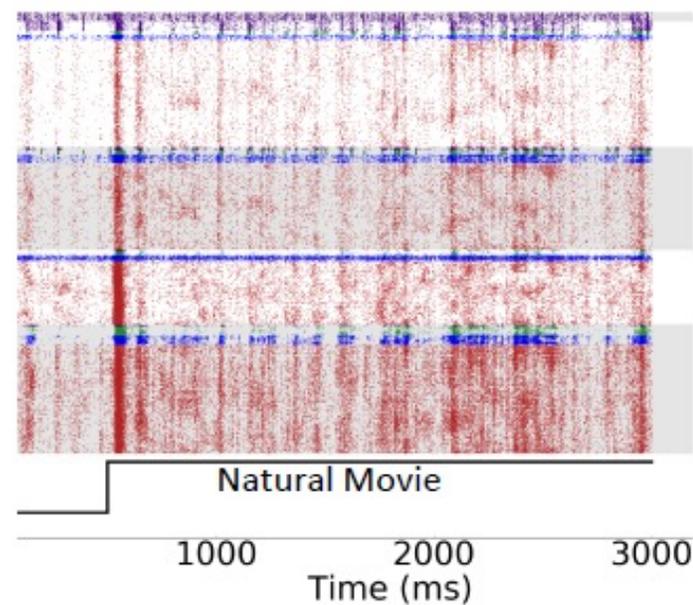
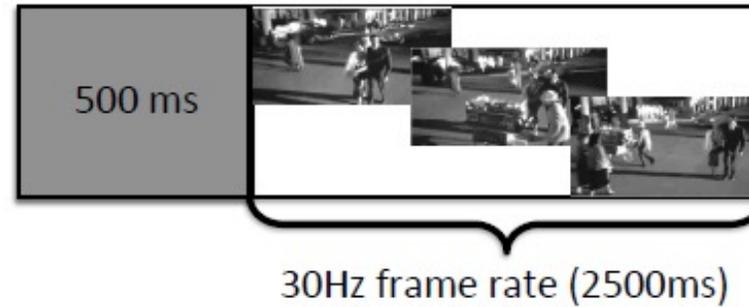
- **230,924** cells total, **17 cell classes**
- **One-to-one** mapping between the biophysical and point-neuron models
- Models are **freely available**: <http://portal.brain-map.org/explore/models>

Responses to Various Visual Stimuli

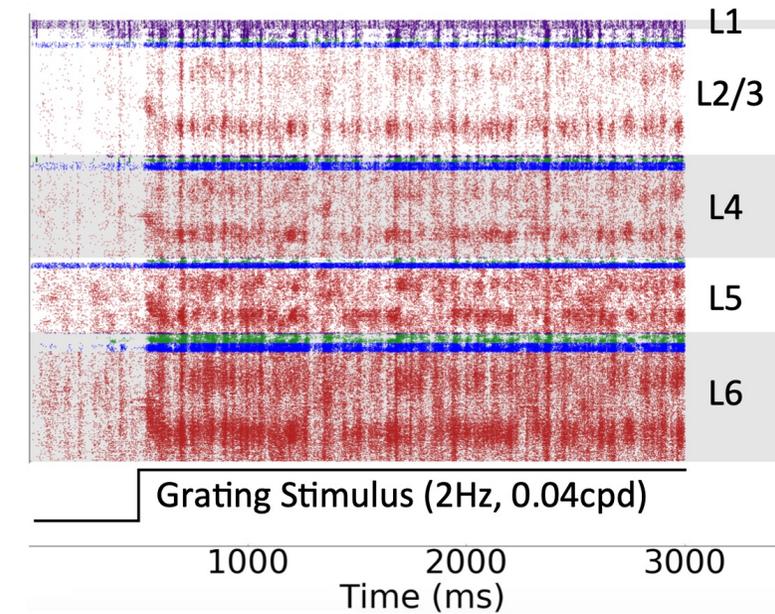
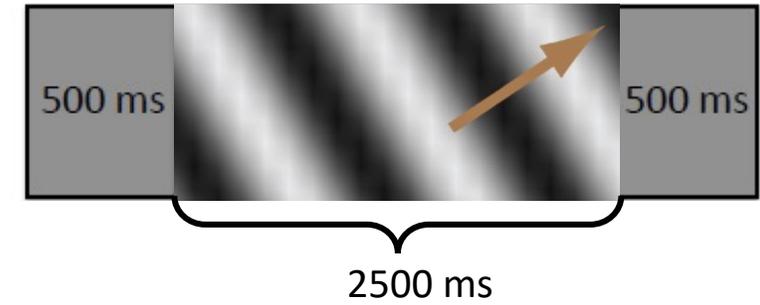
Flashes Stimulus



Natural Movie Stimulus



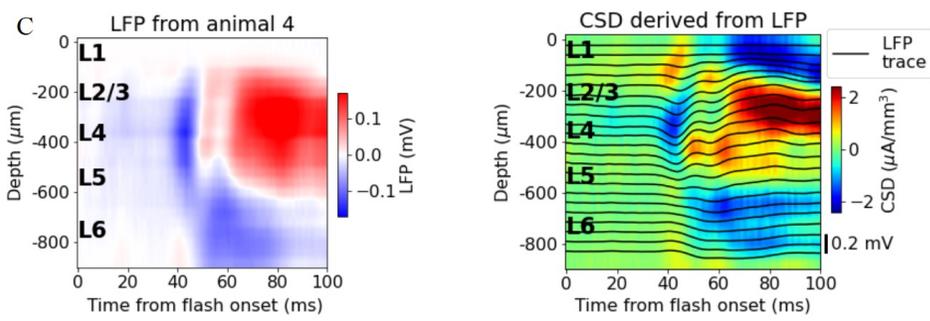
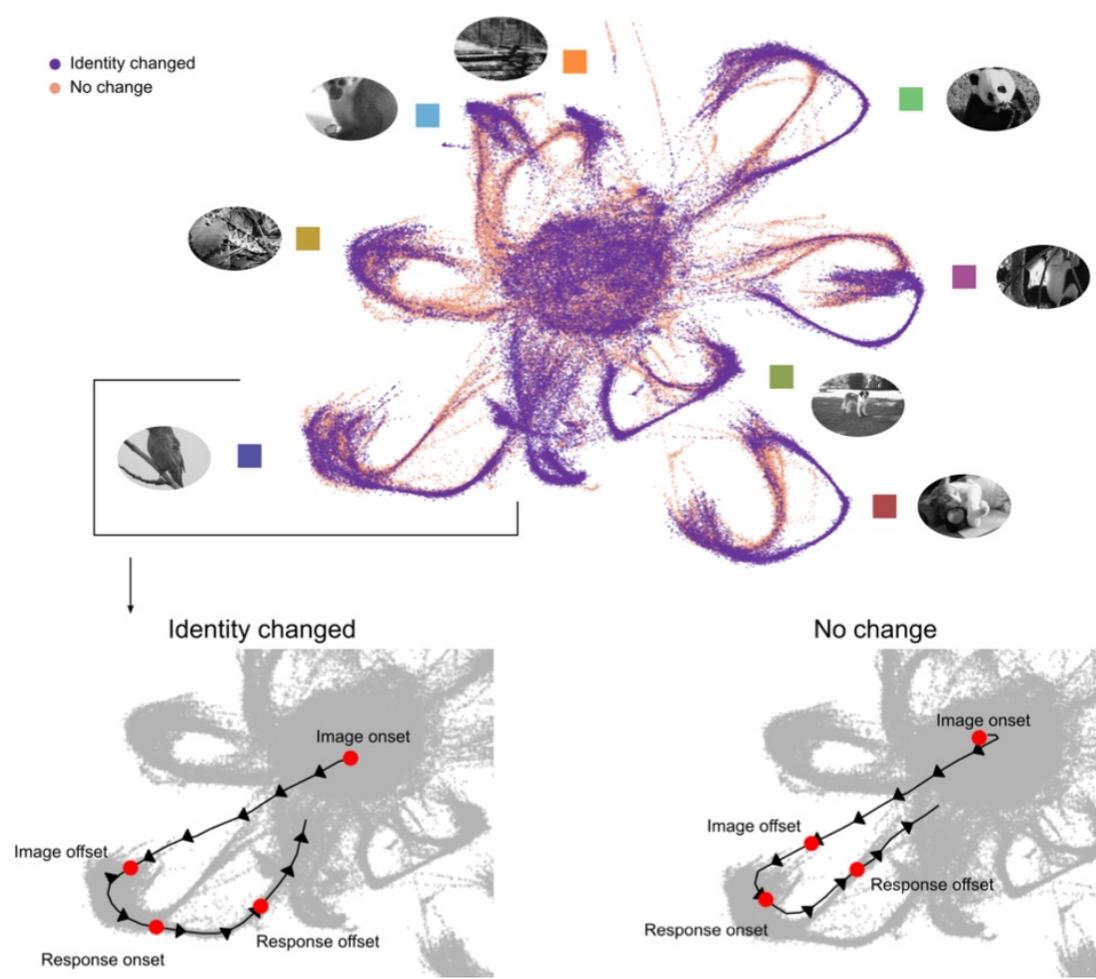
Drifting Grating Stimulus



Applications of the Published V1 Model

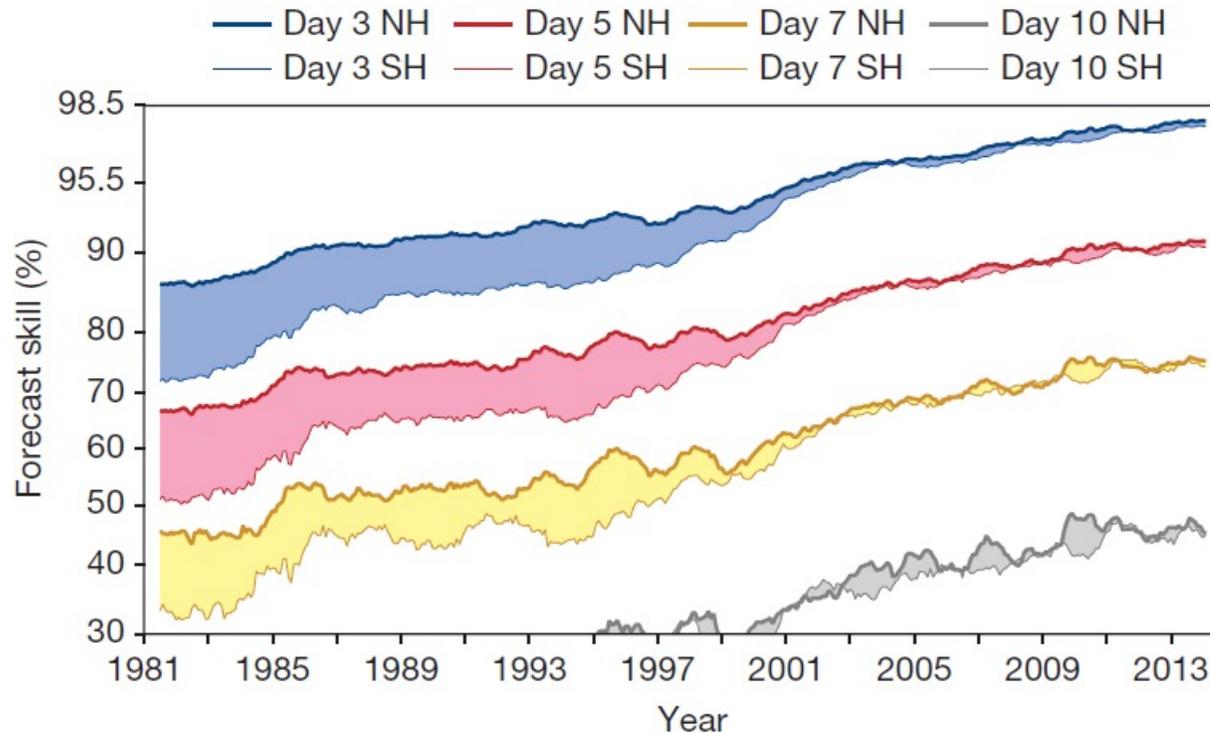
1. Giacomelli et al. [On the structural connectivity of large-scale models of brain networks at cellular level](#). *Sci. Rep.* 11, 4345 (2021).
2. Stöckl et al. [Probabilistic skeletons endow brain-like neural networks with innate computing capabilities](#). *bioRxiv* 2021.05.18.444689 (2021)
3. Chen 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.”

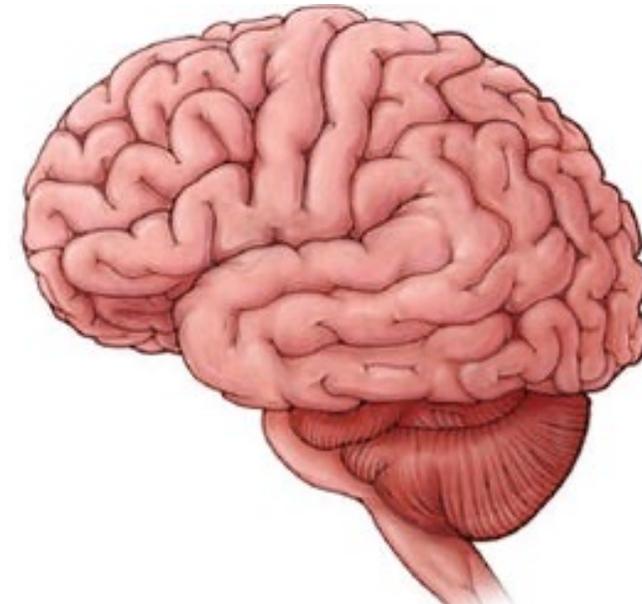
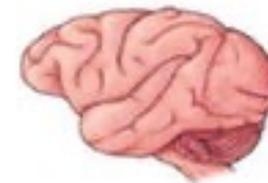
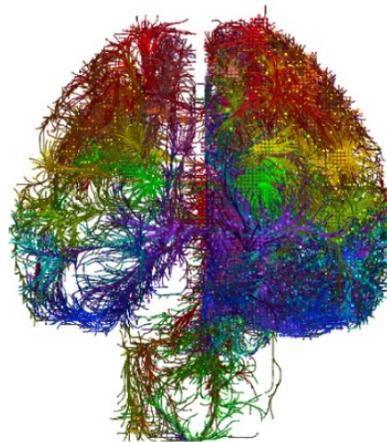
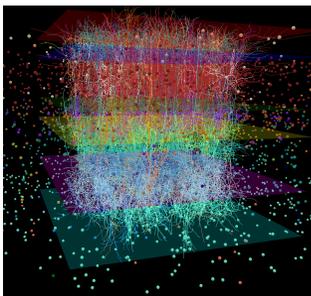
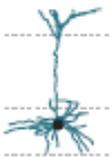


Why?

- 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.

