



Workshop Series Summer 2023

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in Bioscience and Medicine

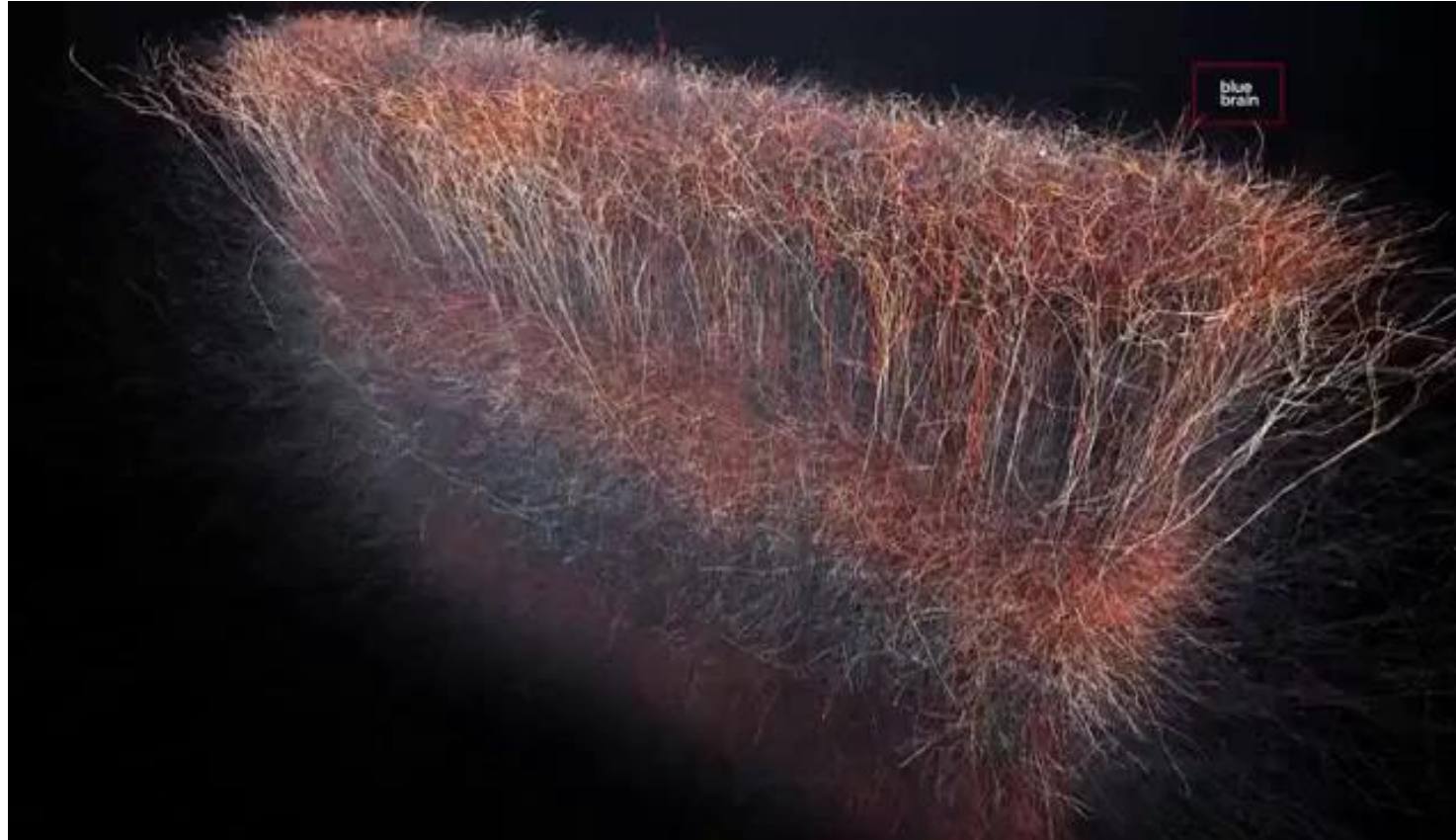
June 16<sup>th</sup>, 2023

# **Exploring Single Neuron Excitability with Mathematical and Computational Models**

By Niklas Brake and Nils Koch

Lecture 2: Firing Features and Extraction

# Part 1: Neuron firing features



EPFL <https://youtu.be/ZQTqv6HHHY>

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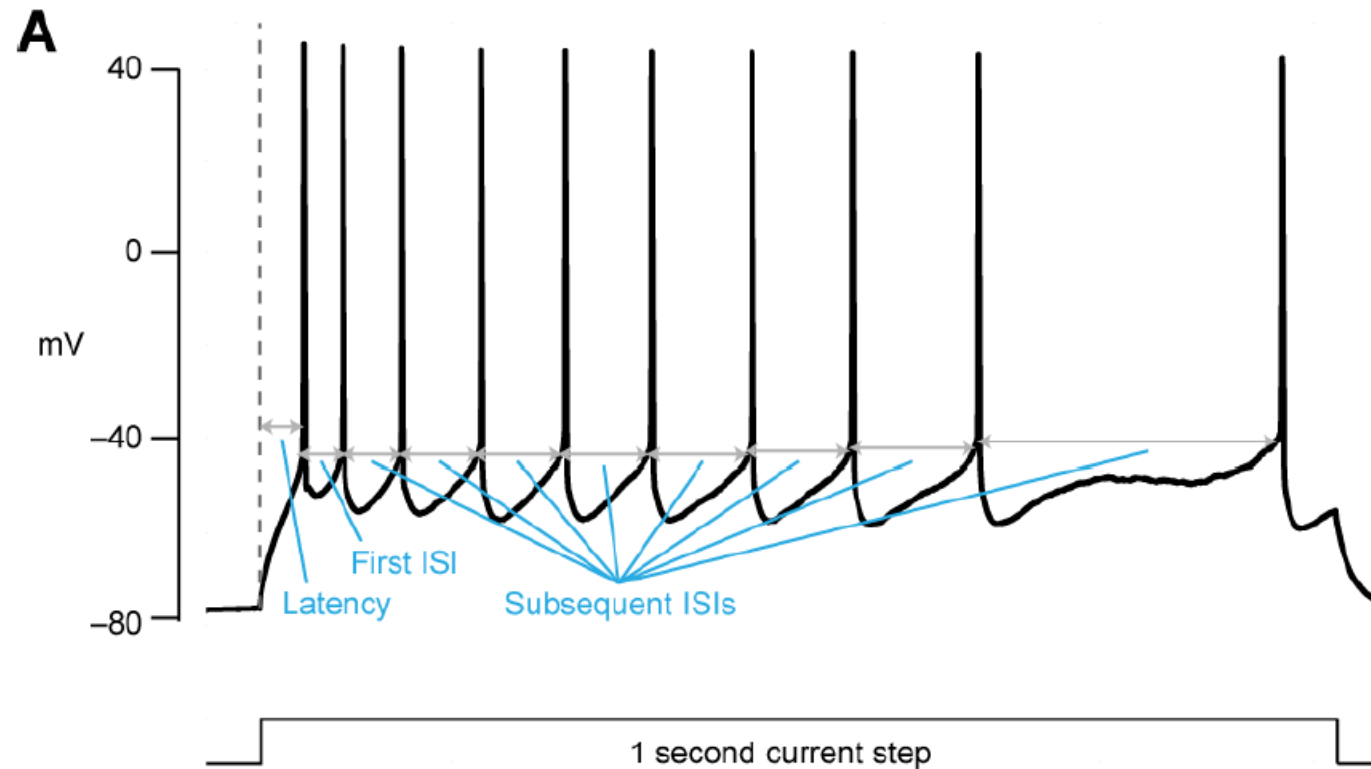


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# Part 1: Neuron firing features

## Inter-spike-intervals and firing patterns



Allen Brain Electrophysiology Overview

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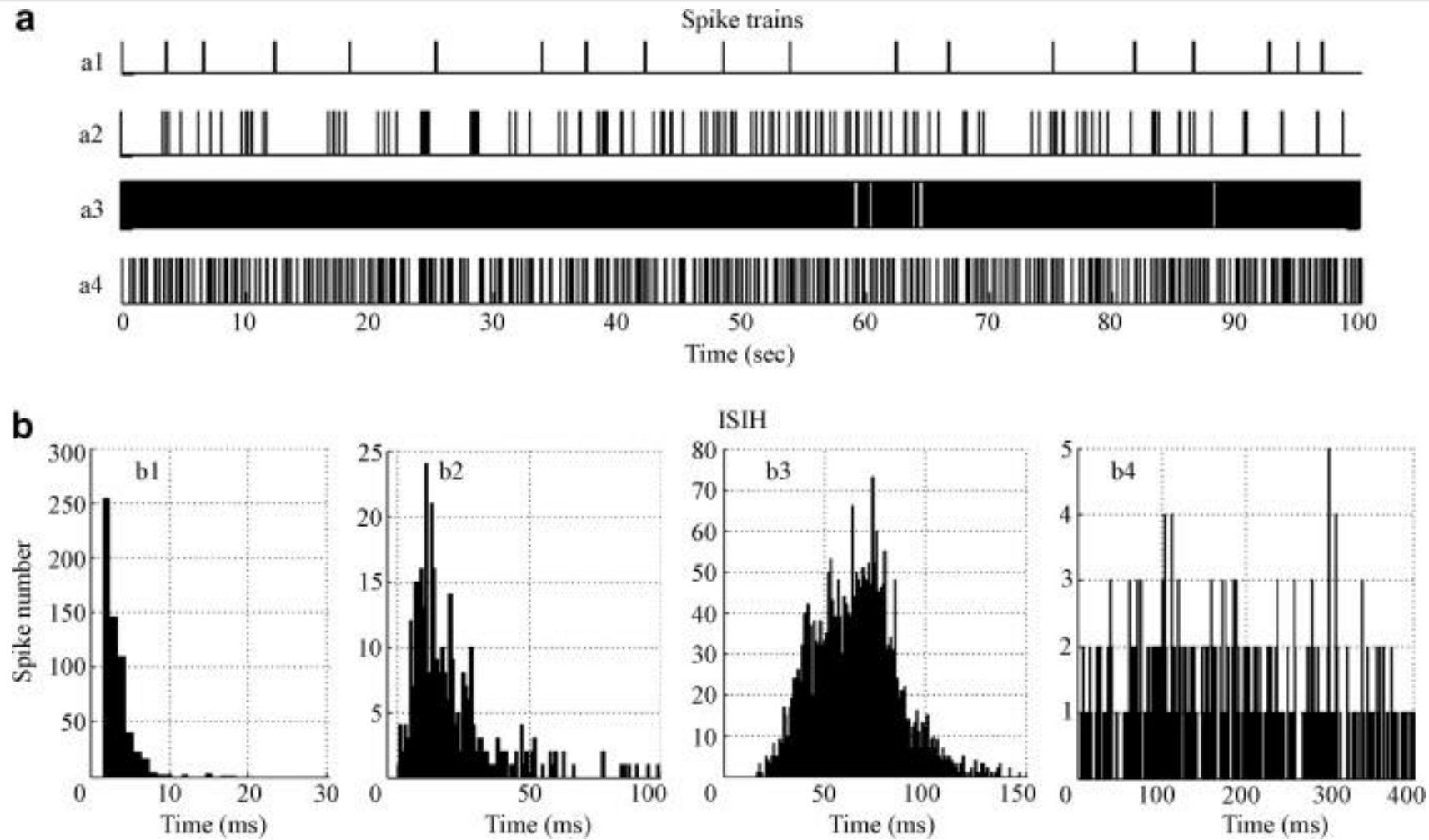
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# Part 1: Neuron firing features



Chen, Lin & Deng, Yong & Luo, Weihua & Wang, Zhen & Zeng, Shaoqun. (2009). Detection of bursts in neuronal spike trains by the mean inter-spike interval method. Progress in Natural Science - PROG NAT SCI. 19.

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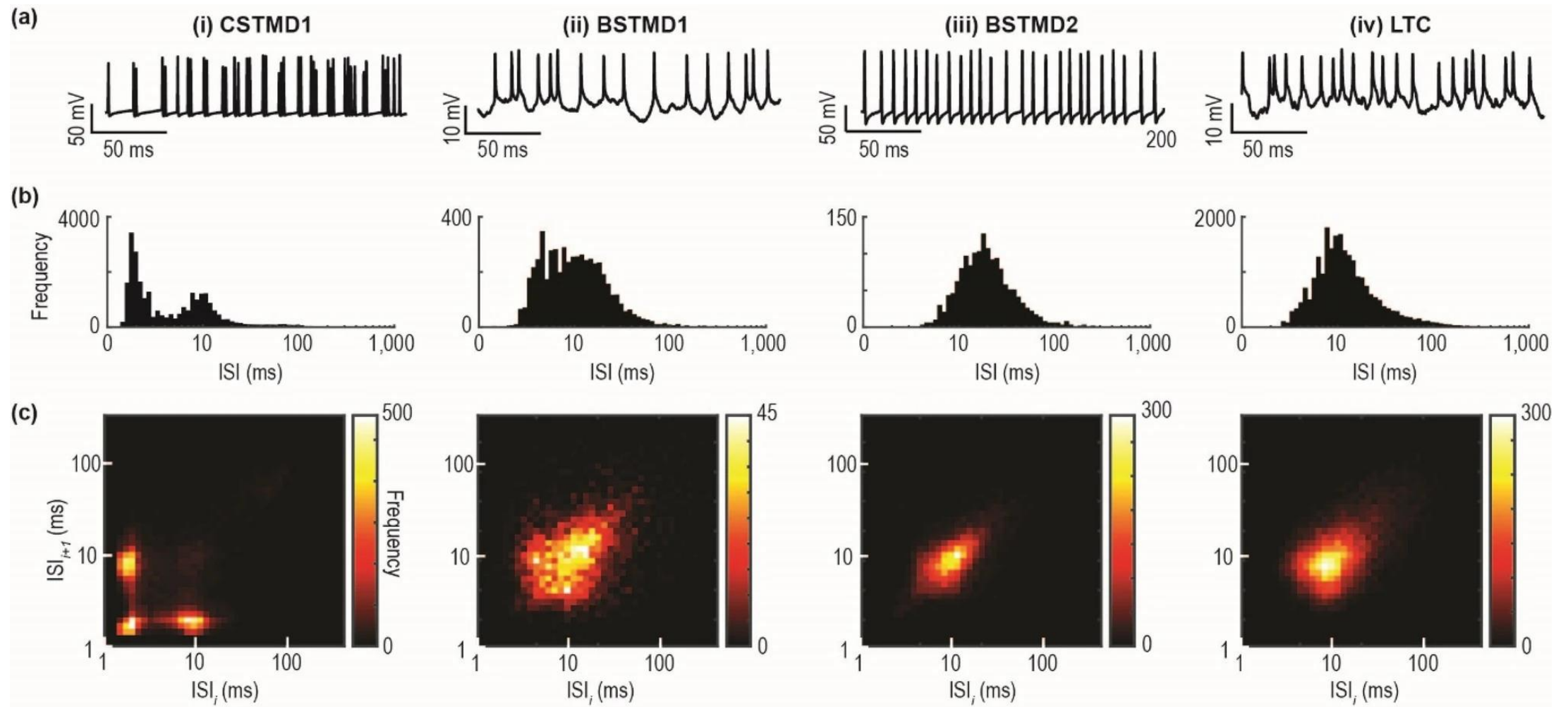
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# Part 1: Neuron firing features



Fabian, J.M., Wiederman, S.D. Spike bursting in a dragonfly target-detecting neuron. *Sci Rep* **11**, 4005 (2021).

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# Part 1: Neuron firing features

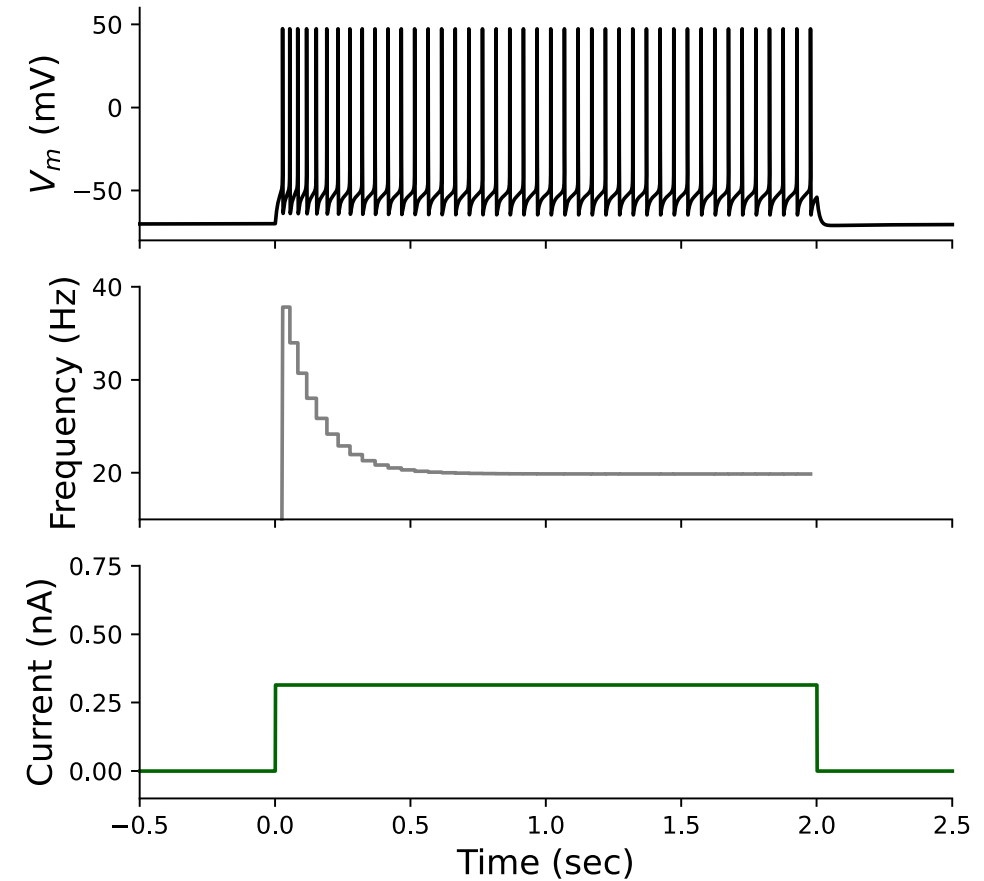
## Firing Frequency

$$F = \frac{\# \text{ spikes}}{\Delta t}$$

$$F_i = \frac{1}{ISI_i}$$

$$\bar{F} = \frac{1}{ISI}$$

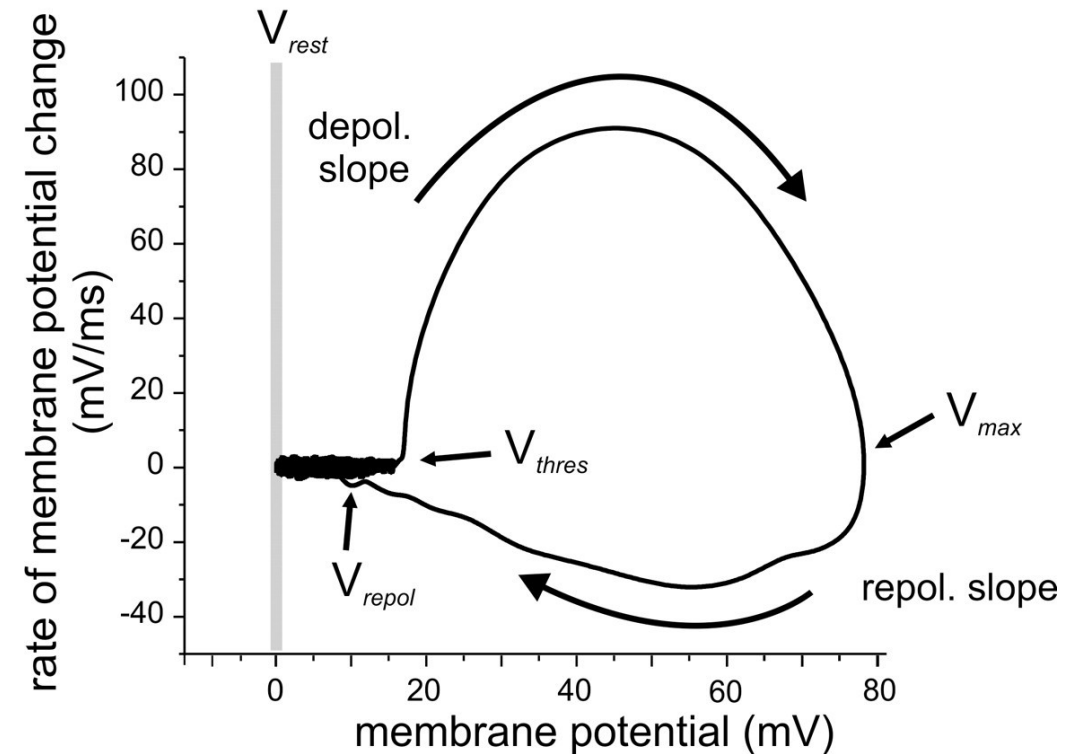
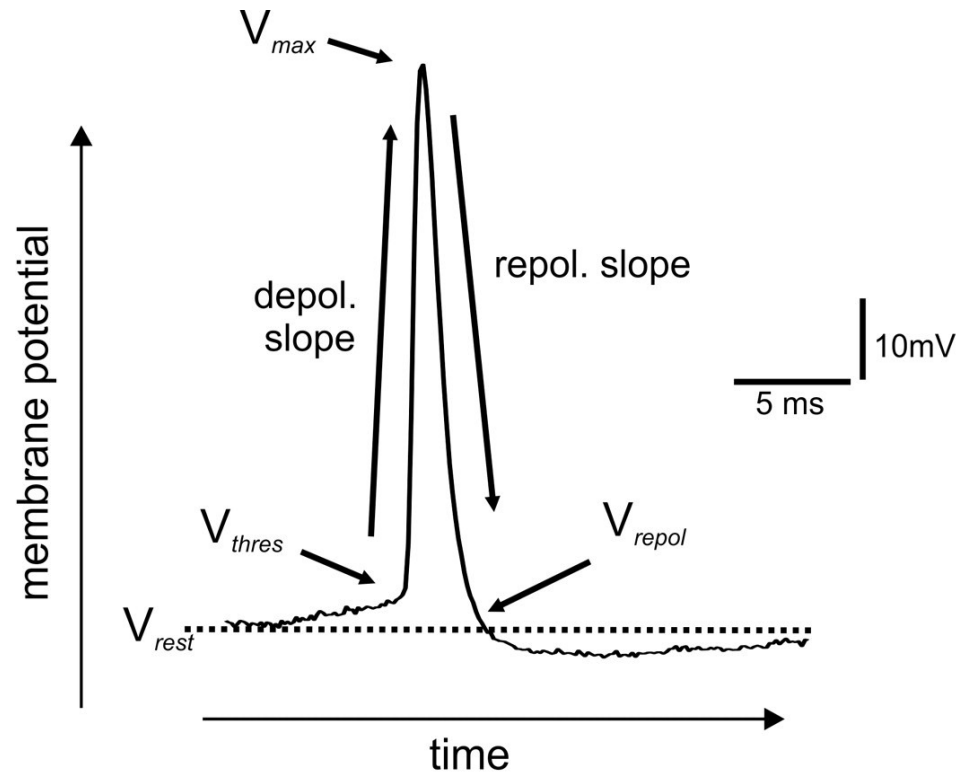
## Spike Frequency Adaptation





# Part 1: Neuron firing features

## AP phase plots



Trombin, Federica & Gnatkovsky, Vadym & de Curtis, Marco. (2011). Changes in action potential features during focal seizure discharges in the entorhinal cortex of the in vitro isolated guinea pig brain. *Journal of neurophysiology*. 106. 1411-23.



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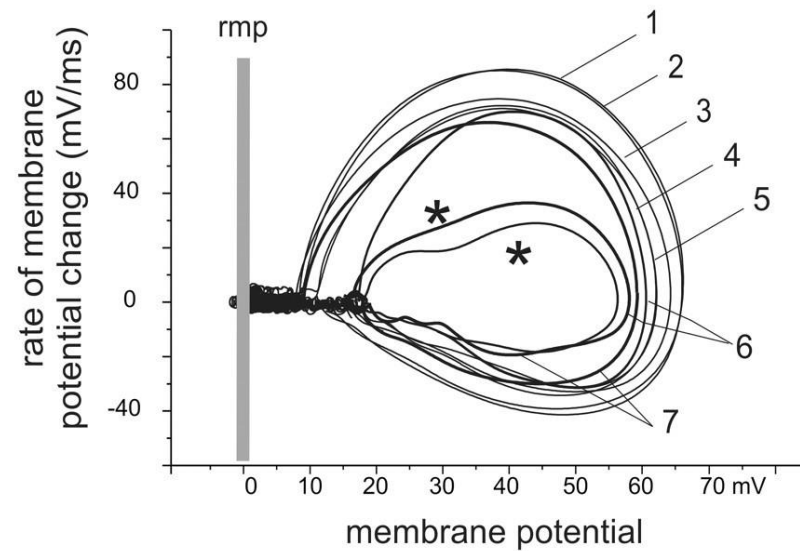
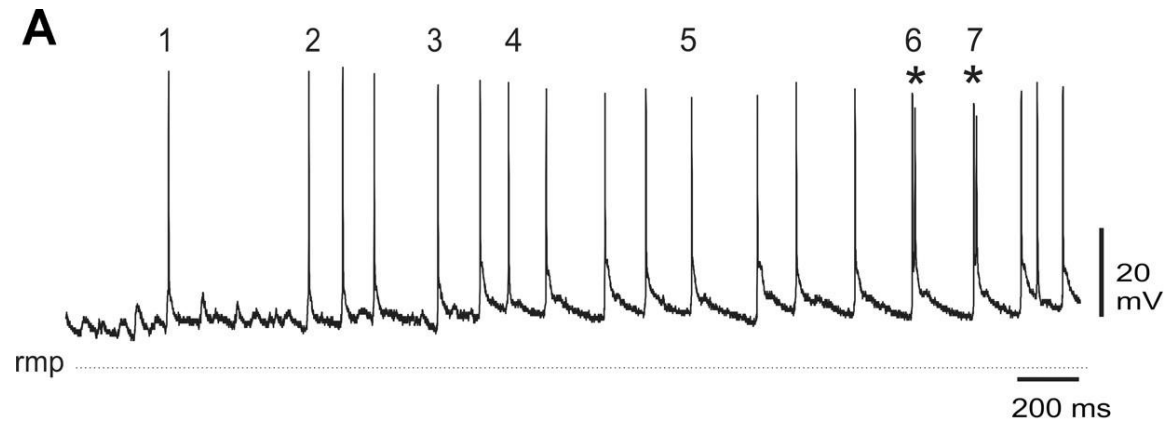
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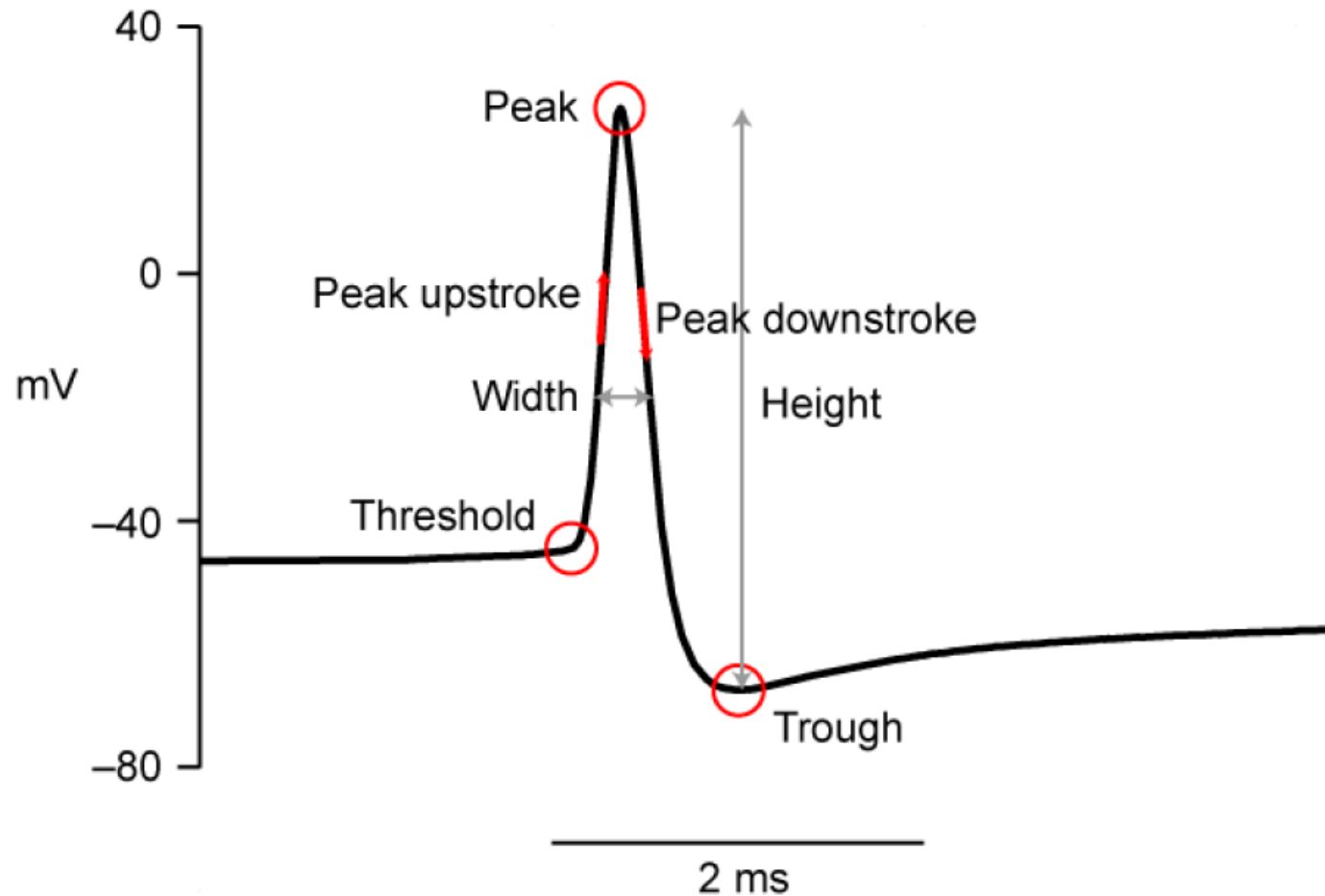
Trombin, Federica & Gnatkovsky, Vadym & de Curtis, Marco. (2011). Changes in action potential features during focal seizure discharges in the entorhinal cortex of the in vitro isolated guinea pig brain. *Journal of neurophysiology*. 106. 1411-23.





# Part 2: Automated feature extraction

## Firing features and automated extraction



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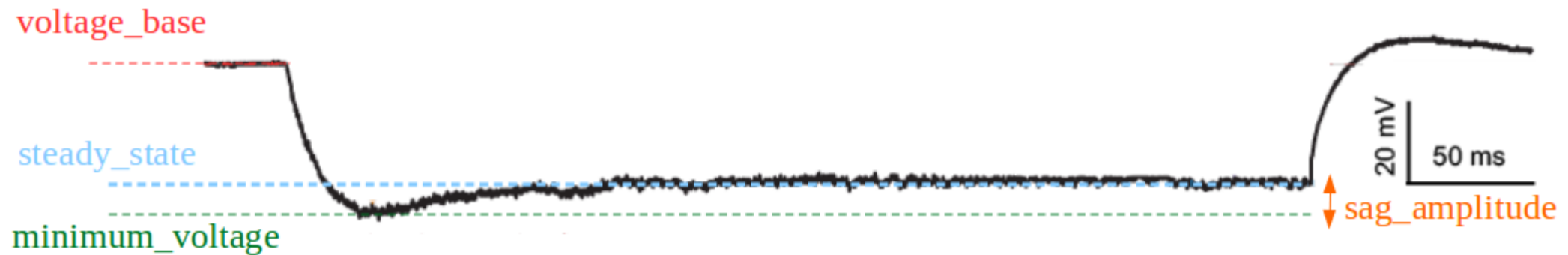
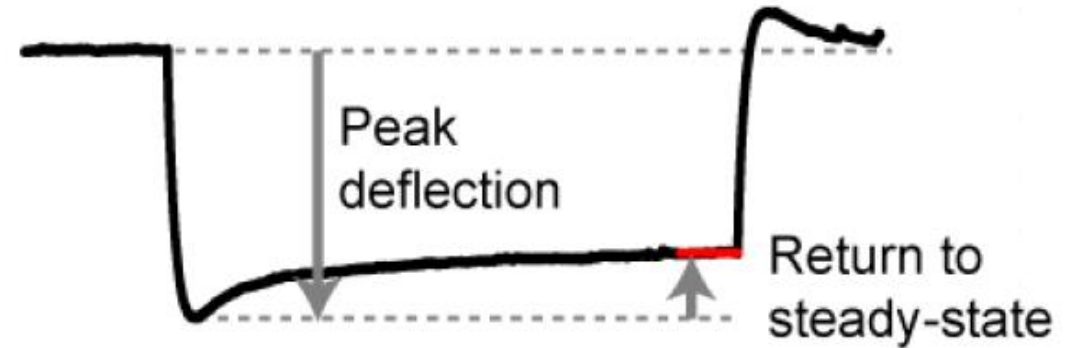
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# Part 2: Automated feature extraction

Hyperpolarizing current injections

- Sag and  $I_h$



<https://efel.readthedocs.io/en/latest/eFeatures.html>



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# Part 3: Open access data



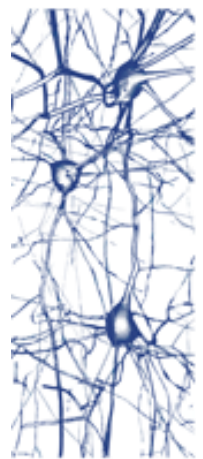
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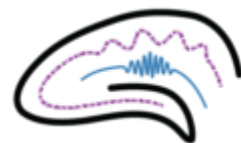
**Blue  
Brain  
Project**



ALLEN INSTITUTE *for*  
**BRAIN SCIENCE**



**EBRAINS**



**BuzLabDB**



**DANDI**



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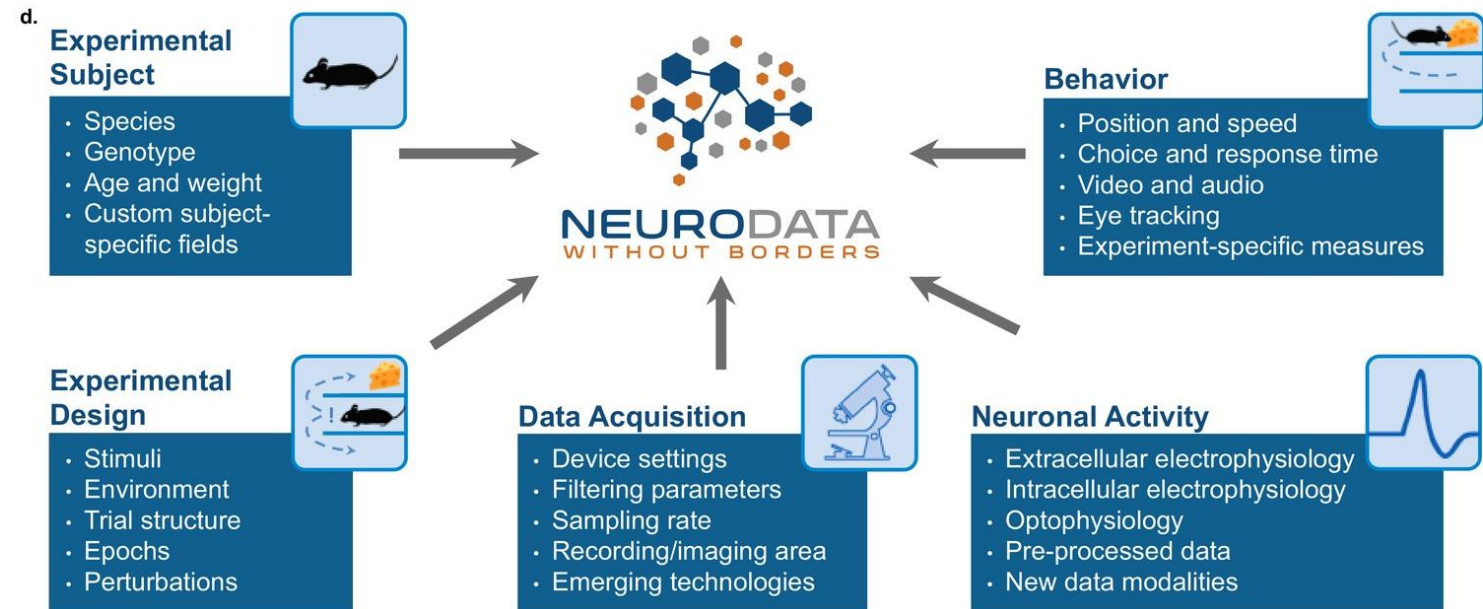
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# Part 3: Open access data

## Distributed Archives for Neurophysiology Data Integration

- Dandiset: organized collection of files
  - With file level and dataset level metadata generated from an experiment or a project



Oliver Rübél, Andrew Tritt, Ryan Ly, Benjamin K Dichter, Satrajit Ghosh, Lawrence Niu, Pamela Baker, Ivan Soltesz, Lydia Ng, Karel Svoboda, Loren Frank, Kristofer E Bouchard (2022) The Neurodata Without Borders ecosystem for neurophysiological data science eLife 11:e78362

<https://dandiarchive.org/>

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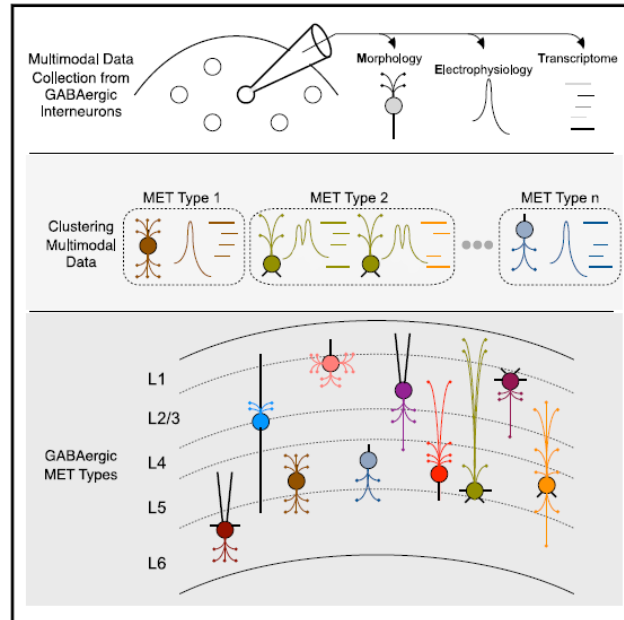
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# Part 3: Open access data

Cell

## Integrated Morphoelectric and Transcriptomic Classification of Cortical GABAergic Cells

### Graphical Abstract



### Article

#### Authors

Nathan W. Gouwens, Staci A. Sorensen, Fahimeh Baftizadeh, ..., Jim Berg, Gabe J. Murphy, Hongkui Zeng

#### Correspondence

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stacis@alleninstitute.org (S.A.S.),  
gabem@alleninstitute.org (G.J.M.)

#### In Brief

GABAergic cortical interneurons of the mouse visual cortex can be defined into 28 types based on their morphological, electrophysiological, and transcriptomic properties and are distinguished by their layer-specific axon innervation patterns.

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Patch-seq recordings from mouse visual cortex DOI: 10.48324/dandi.000020/0.210913.1639

ID: 000020 0.210913.1639 Contact Gouwens, Nathan File Count 4435 File Size 141.9 GB

Created September 13, 2021 Last update September 13, 2021 Licenses: spdx:CC-BY-4.0 Access Information: dandi:OpenAccess

Whole-cell Patch-seq recordings from neurons of the mouse visual cortex from the Allen Institute for Brain Science, released in June 2020. The majority of cells in this dataset are GABAergic interneurons, but there are also a small number of glutamatergic neurons from layer 2/3 of the mouse visual cortex.

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**Break: 10:00 – 10:15**



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