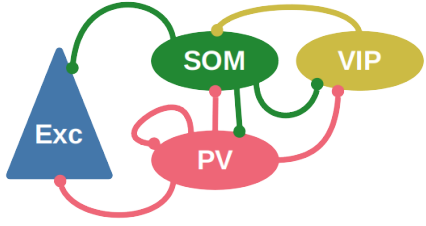
A CORTICAL MICROCIRCUIT MODEL WITH MULTIPLE INTERNEURON CLASSES

IAS 2021 Presentation

April 16, 2021 | Han-Jia Jiang | INM-6, Jülich Research Centre, Germany

INTRODUCTION

- We develop a model of mouse barrel cortex incorporating three major classes of inhibitory interneurons (PV, SOM, VIP) to study their contributions in network dynamics and sensory signal processings



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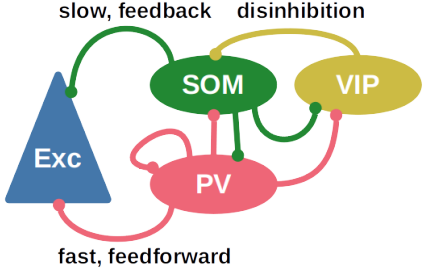

MODEL OVERVIEW

- Tool: NEST simulator (C++, python)
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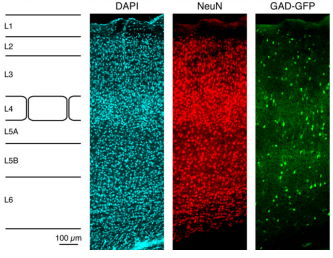

(Lefort et al., 2009, *Neuron*)

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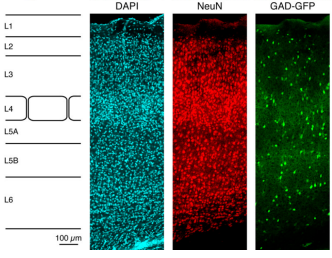

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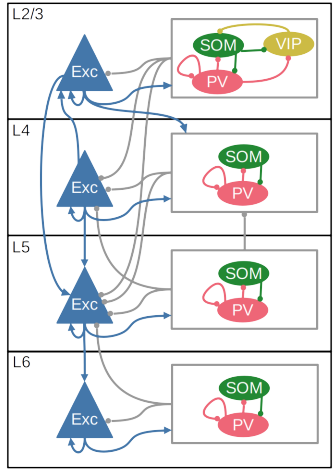

Figure: Overall multi-layer connectivity

MODEL PARAMETERS

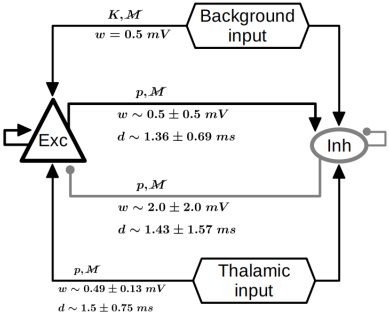

Figure: Connection parameters

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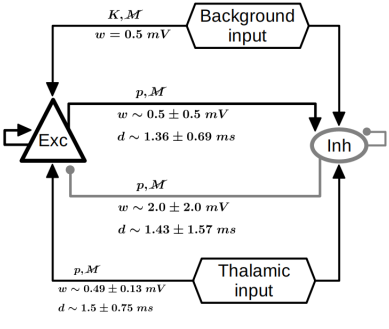

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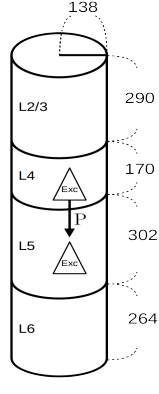

Figure: Dimensions (μm)

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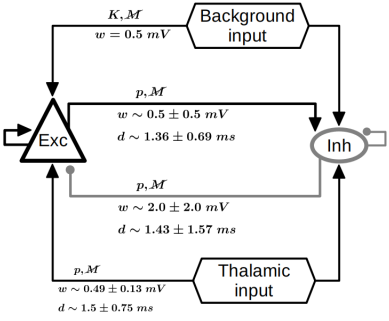

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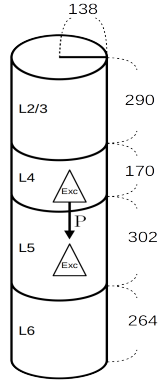

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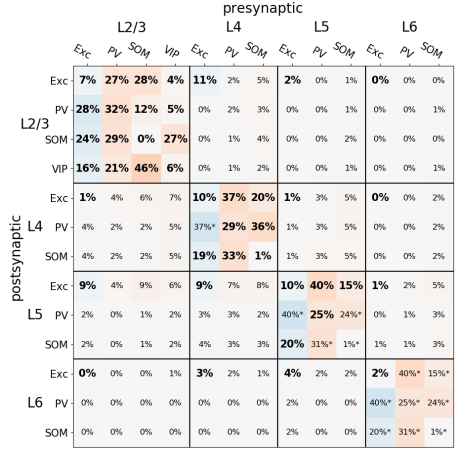

Figure: Connection probabilities

NETWORK GROUND STATE

- The simulated population firing rates are comparable to *in vivo* data
  (Yu et al., 2019, *Neuron*)

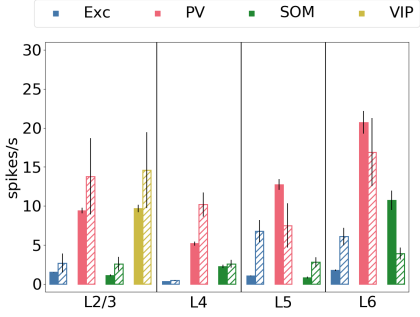

Figure: Population firing rates (filled) compared to *in vivo* data (hatched)

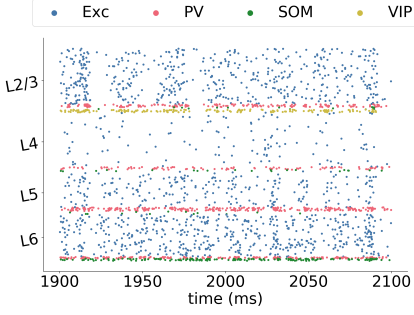

Figure: Raster plot

NETWORK DYNAMICS

- The L2/3 network responses to activation of PV, SOM, and VIP cells show their respective roles of inhibition and disinhibition

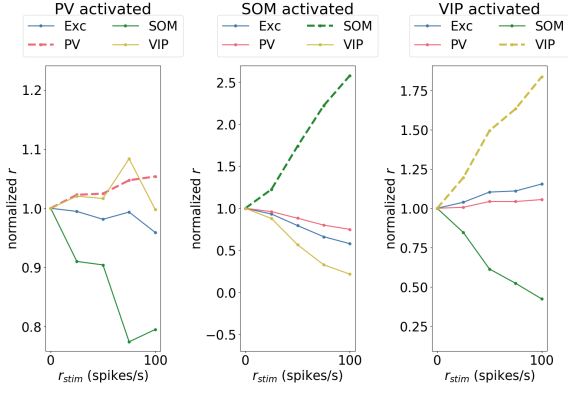

Figure: L2/3 network responses (normalized firing rates) to cell-type-specific stimulations

FUTURE WORKS

- Mechanistic and theoretical analysis
- Neurotransmitter effects (ACh)

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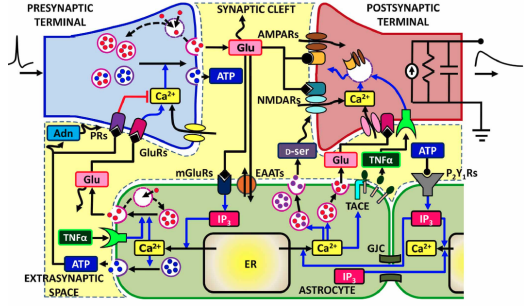
- Neurotransmitter effects (ACh)
- Neuron-astrocyte interactions
  (to be developed in NEST)
  - Ca^{++}, IP_3, slow inward current
  - tripartite synapse
  - networks of $\sim$ 10000 cells

  collaborator: Prof. Dr. Marja-Leena Linne, Tempere University



De Pittà et al., 2012, *Frontiers in Comutational Neuroscience*

ACKNOWLEDGEMENT

- Affiliations
  - Institute of Neuroscience and Medicine (INM-6), Jülich Research Centre, Jülich, Germany
  - Institute for Zoology, University of Cologne
- Supervisors
  - Prof. Dr. Markus Diesmann
  - Jun. Prof. Dr. Sacha van Albada

Thank you for listening!

Human Brain Project

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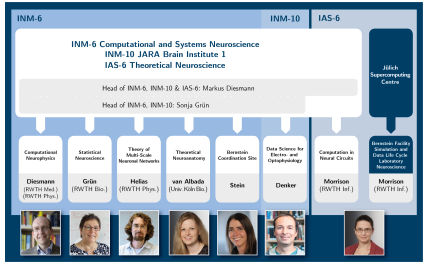
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

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