



Contribution ID: 10 Contribution code: P2-2

Type: Poster & advertisement flash talk

## Modeling spiking networks with neuron-glia interactions in NEST

*Friday 24 June 2022 13:33 (3 minutes)*

Recent experimental evidence suggests an active roles of astrocytes in a number of brain functions and demonstrates coordinated neuronal and astrocytic activity in vivo [1]. In the cortex, astrocytes form non-overlapping domains, each containing several hundreds of neurons and ~100,000 synapses [2]. Astrocytic processes are in close contact with synaptic terminals and affect synaptic transmission, plasticity, and neuronal excitability [3, 4]. Understanding the role of astrocytic mechanisms in brain functions and dysfunctions requires open-access tools for model implementation, simulation, and analysis. In the past decade, hundreds of new models with some form of neuron-astrocyte interaction dynamics have been proposed. However, their implementation is rarely shared and not sufficiently documented to reproduce the findings [4, 5]. We developed a new module in the NEST simulator that allows efficient implementation and simulation of large neuron-astrocyte populations. This includes an astrocyte model with internal calcium dynamics, a synapse model to communicate between astrocytes and postsynaptic neurons, and user-friendly and efficient high-level connectivity functions, which allow probabilistic or deterministic pairing of neurons and astrocytes. This new module will improve the convenience, reliability, and reproducibility of computational studies involving neuron-astrocyte interactions.

### Acknowledgements

This work has been supported as a Partnering Project (AstroNeuronNets) to the European Union's Horizon 2020 Framework Programme for Research and Innovation under the Specific Grant Agreement No. 945539 (Human Brain Project SGA3). The work has also been supported by the Academy of Finland (decision Nos. 326494, 326495, 345280, and 318879).

### Preferred form of presentation

Poster & advertising flash talk

### Topic area

models and applications

### I agree to the copyright and license terms

Yes

### I agree to the declaration of honor

Yes

## References

- [1] Lines J et al. (2020) Astrocytes modulate sensory-evoked neuronal network activity. *Nat Commun.* 11:3689. doi:10.1038/s41467-020-17536-3.
- [2] Zisis E et al (2021) Digital reconstruction of the neuro-glia-vascular architecture. *Cereb. Cortex*, 2021; 00:1-18
- [3] Bazargani N and Attwell D. (2016) Astrocyte calcium signaling: the third wave. *Nat. Neurosci.* 19(2):182-9. doi: 10.1038/nn.4201
- [4] Linne M-L et al. (2022) Neuron–Glia Interactions and Brain Circuits. In: Giugliano, M., Negrello, M., Linaro, D. (eds) *Computational Modelling of the Brain. Advances in Experimental Medicine and Biology*, vol 1359. Springer, Cham. [https://doi.org/10.1007/978-3-030-89439-9\\_4](https://doi.org/10.1007/978-3-030-89439-9_4)
- [5] Manninen T et al. (2018) *Front. Neuroinf.* 12:20. doi.org/10.3389/fninf.2018.00020

## Speaker time zone

UTC+2

## Keywords

**Primary authors:** JIANG, Han-Jia (Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6) and JARA-Institute Brain Structure-Function Relationships (INM-10), Jülich Research Centre, Jülich, Germany; Institute of Zoology, Faculty of Mathematics and Natural Sciences, University of Cologne, Cologne, Germany); AĆIMOVIĆ, Jugoslava (Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland); MANNINEN, Tiina (Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland); STAPMANN, Jonas (Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6) and JARA-Institute Brain Structure-Function Relationships (INM-10), Jülich Research Centre, Jülich, Germany; Department of Physics, Faculty 1, RWTH Aachen University, Aachen, Germany); LEHTIMÄKI, Mikko (Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland); LINNE, Marja-Leena (Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland); DIESMANN, Markus (Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6) and JARA-Institute Brain Structure-Function Relationships (INM-10), Jülich Research Centre, Jülich, Germany; Department of Physics, Faculty 1, RWTH Aachen University, Aachen, Germany; Department of Psychiatry, Psychotherapy and Psychosomatics, School of Medicine, RWTH Aachen University, Aachen, Germany); VAN ALBADA, Sacha Jennifer (Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6) and JARA-Institute Brain Structure-Function Relationships (INM-10), Jülich Research Centre, Jülich, Germany; Institute of Zoology, Faculty of Mathematics and Natural Sciences, University of Cologne, Cologne, Germany)

**Presenter:** JIANG, Han-Jia (Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6) and JARA-Institute Brain Structure-Function Relationships (INM-10), Jülich Research Centre, Jülich, Germany; Institute of Zoology, Faculty of Mathematics and Natural Sciences, University of Cologne, Cologne, Germany)

**Session Classification:** Poster

**Track Classification:** Main track