





# Biophysical Modeling on BrainScaleS-2

March 12, 2025 | Yannik Stradmann | Kirchhoff-Institute for Physics, Heidelberg University

# Neuromorphic systems made in Heidelberg

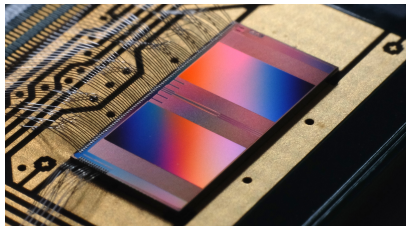
Spikey (2006)



BrainScaleS-1 (2010)



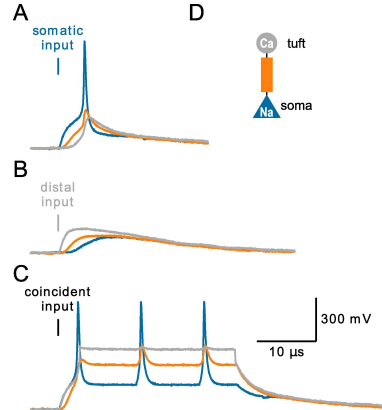
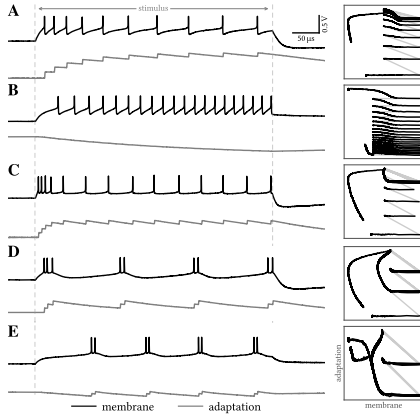
BrainScaleS-2 (2018)



- Hybrid neuromorphic system, 65 nm CMOS
- 1000× speedup compared to biology
- 512 multi-compartment AdEx neurons
- 512 × 256 synapse circuits
- Two general purpose SIMD processors



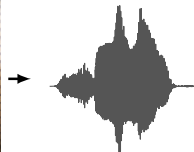
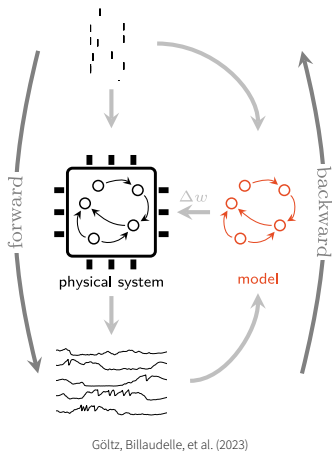
# High-fidelity emulation of complex neuron models



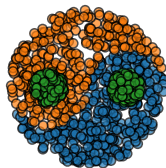
Billaudelle et al., 2022 29th IEEE International Conference on Electronics, Circuits and Systems (ICECS) (2022)

Kaiser et al., Neuroscience (2022)

# Gradient-based learning



Cramer, Stradmann, et al. (2022)



Kriener, Göltz, and Petrovici (2022)

7	2	1	0	4	1	4	9	5	9	0	6	9	0	1	5
9	7	8	4	7	6	6	5	4	0	7	4	0	1	3	1
4	4	6	3	5	6	0	4	1	9	5	7	8	9	3	
7	4	0	4	3	0	7	0	2	9	1	7	3	2	9	7
1	6	2	7	8	4	7	3	6	1	3	6	8	3	1	4
1	7	6	9	6	0	5	4	9	2	1	9	4	8	7	
3	9	7	4	4	9	2	5	6	7	6	7	9	0	5	
8	5	6	6	5	7	8	1	0	1	6	4	6	7	3	1
7	1	8	2	0	2	9	3	5	1	5	6	0	3	4	
4	6	5	4	6	5	4	5	1	4	4	7	2	3	2	7
1	8	1	8	1	8	5	0	8	9	2	5	0	1	1	1
0	9	0	3	1	6	4	2	3	6	1	1	3	9	5	

Göltz, Kriener, et al. (2021)

Cramer, Billaudelle, et al. (2022)

Arnold et al. (2024)

## Tutorials offered today



Bio-inspired modeling  
on BrainScaleS-2

Amani Atoui

**11:30, R 01.239**



Machine learning  
with BrainScaleS-2

Elias Arnold

**14:00, R 01.239**