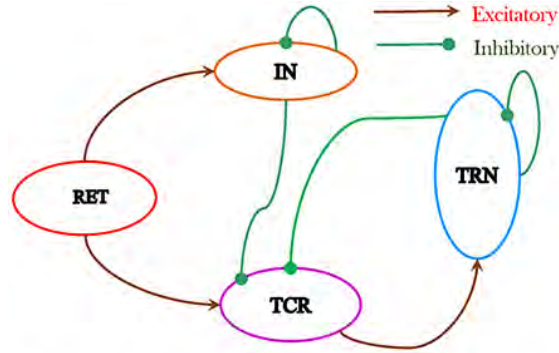
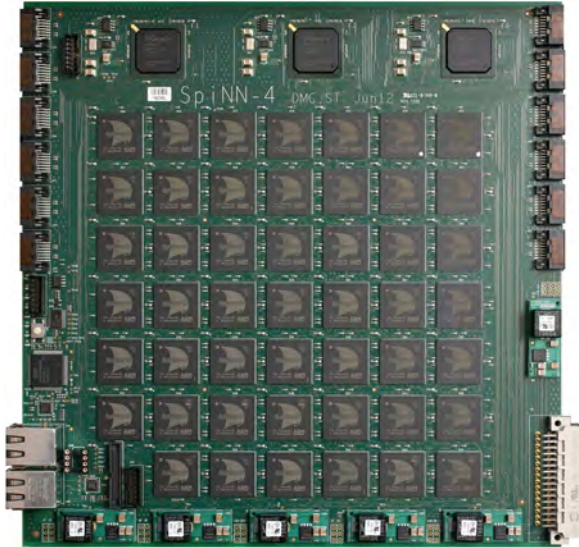


HBP Highlight : SpiNNaker-1

A Spiking Neural Network Model of the Lateral Geniculate Nucleus

SP9



RET: retina

TRN: thalamic reticular nucleus

TCR: thalamo-cortical relay

IN: interneurons

Simulate biologically plausible LGN dynamics on SpiNNaker

Synaptic layout of the model is consistent with biology

Sen-Bhattacharya, B., Serrano-Gotarredona, T., Balassa, L., Bhattacharya, A., Stokes, A. B., Rowley, A., ... & Furber, S. (2017)

A Spiking Neural Network Model of the Lateral Geniculate Nucleus on the SpiNNaker Machine

Frontiers in Neuroscience, 11, 454.

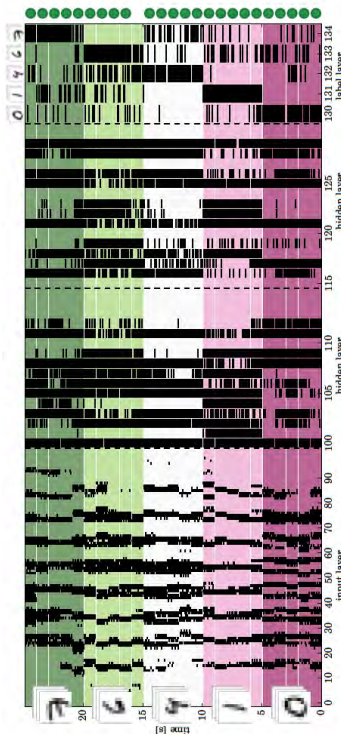
Model response is validated with existing literature reporting entrainment in steady state visually evoked potentials (SSVEP) - brain oscillations corresponding to periodic visual stimuli recorded via electroencephalography (EEG).



HBP Highlight : BrainScaleS-1

Hardware in the loop: Training a deep spiking network on the wafer system

SP9



A deep network on the BrainScaleS-1 wafer system

MNIST benchmark running a physical model machine

NOT A COMPUTER !

Schmitt, S., Klaehn, J., Bellec, G., Grübl, A., Guettler, M., Hartel, A., ... & Karasenko, V. (2017, May)

Neuromorphic hardware in the loop: Training a deep spiking network on the brainscales wafer-scale system

In Neural Networks (IJCNN), 2017 International Joint Conference on (pp. 2227-2234). IEEE.



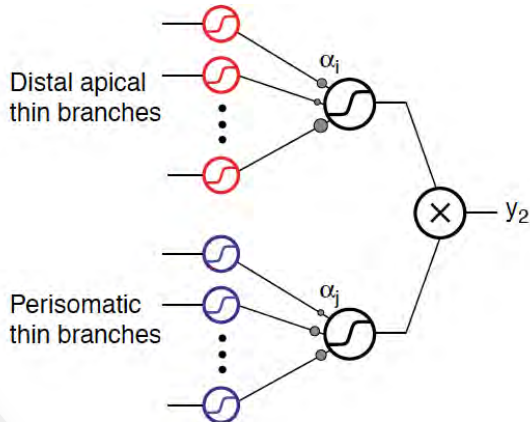
HBP Highlight : BrainScaleS-2

First implementation of active, non-linear dendrites in neuromorphic hardware

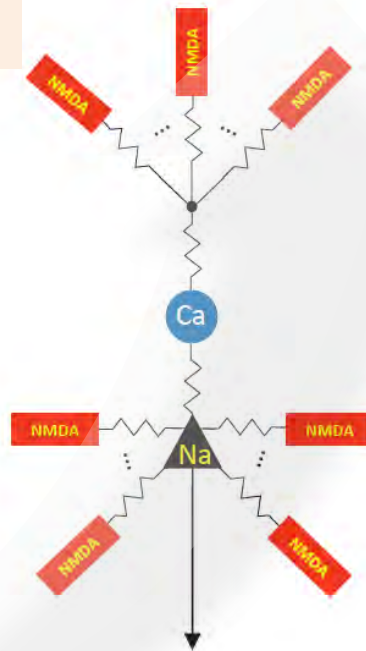
SP9

CA1 pyramidal cell

NMDA integration and
Ca coincidence
in CMOS hardware



multiplicative interaction
between proximal and distal
integration regions



Structured neurons

- Multicompartment neurons
- Active, non-linear dendrites,
- Backpropagating APs
- NMDA, Ca plateau potentials

Applications

- Neural backpropagation learning
- HTM temporal prediction

Schemmel, J., Kriener, L., Müller, P., & Meier, K. (2017)

An Accelerated Analog Neuromorphic Hardware System Emulating NMDA-and Calcium-Based Non-Linear Dendrites

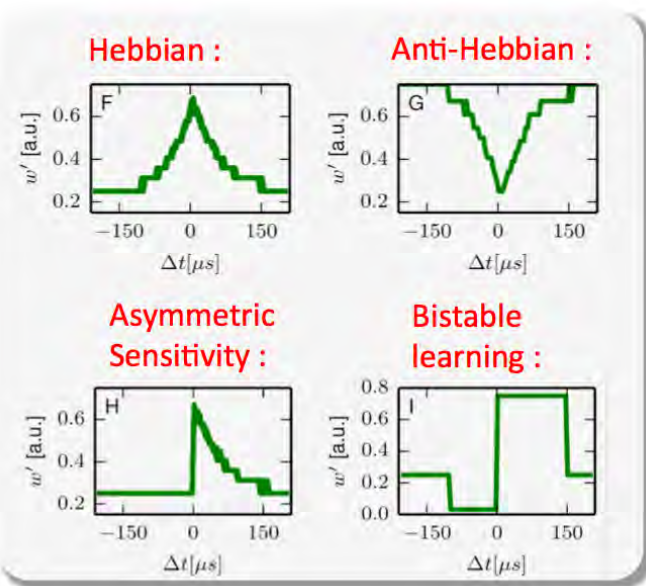
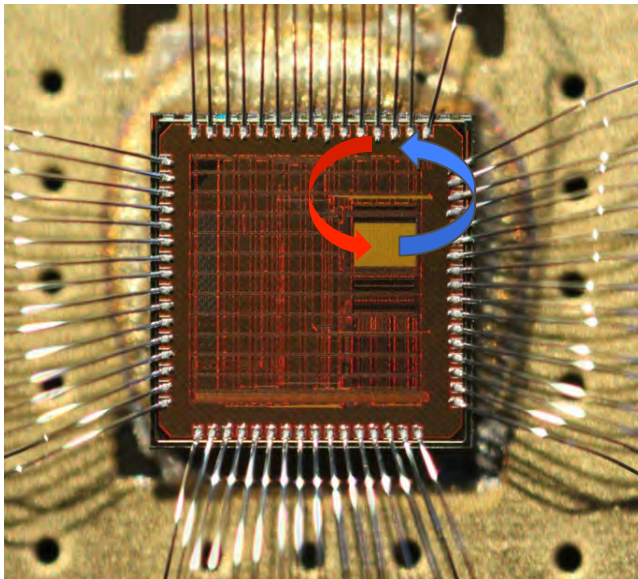
arXiv preprint arXiv:1703.07286.

Dendrites: bug or feature?, Michael Häusser and Bartlett Mel, 2013

HBP Highlight : BrainScaleS-2

A flexible, local on-chip plasticity processor in neuromorphic hardware

SP9



- Biological time-scales from ms to years, accelerated by a factor 1000
- Input : timing correlations, rates, membrane potentials, external signals
- Change : synaptic weights, neuromodulation, network structure

Friedmann, S., Schemmel, J., Grübl, A., Hartel, A., Hock, M., & Meier, K. (2017)

Demonstrating hybrid learning in a flexible neuromorphic hardware system

IEEE transactions on biomedical circuits and systems, 11(1), 128-142.

On-chip learning loops

Flexible learning rules
(examples)