

# StreamingAI

## Neuromorphic Embedded AI for the digital transformation of Austrian Industries.



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### MOTIVATION & GOALS

Streaming AI aims to drive low TRL, foundational research to develop AI for industrial applications. In contrast to conventional pre-trained, holistic, and resource-intensive AI,

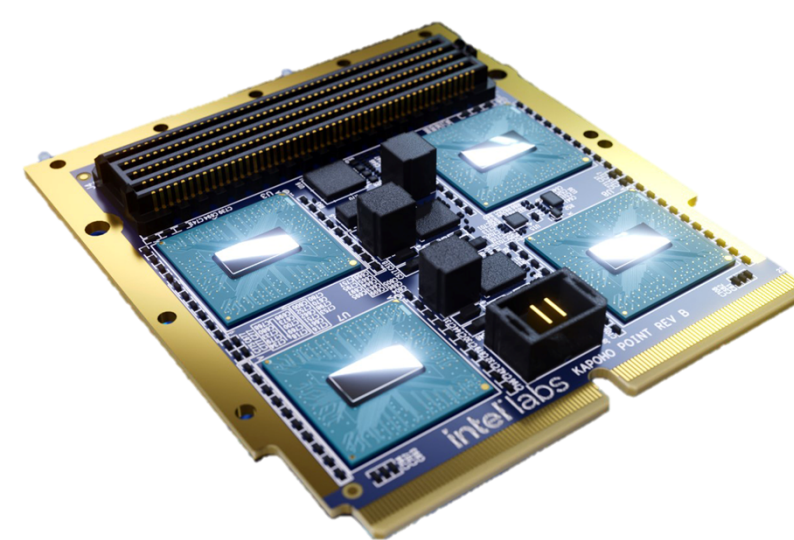
- streaming machine learning methods
- on-device machine learning methods are to be introduced,

thereby reducing dependence on mass training data and supporting ecological sustainability.

### NEUROMORPHIC SEQUENCE LEARNING

Is it possible to implement **multi-compartment** (MC) neurons and **spiking hierarchical temporal memory** (S-HTM) on **digital** neuromorphic hardware to the same **efficacy** as has been shown in **simulations** and **analog** hardware?

- Implement topology of **cortical columns**
- Use S-HTM **learning rules** (facilitate, depression, homeostasis)
- On **digital** neuromorphic hardware (**Intel Loihi2**)
- Achieve **sequence learning**



### CONTRIBUTION

#### Scientific contribution

Demonstrating multi-compartment neuron in future embedded AI hardware.

#### Economic contribution

Advancing to sequence learning in Streaming, Federated, Embedded-AI that is independent of large datasets

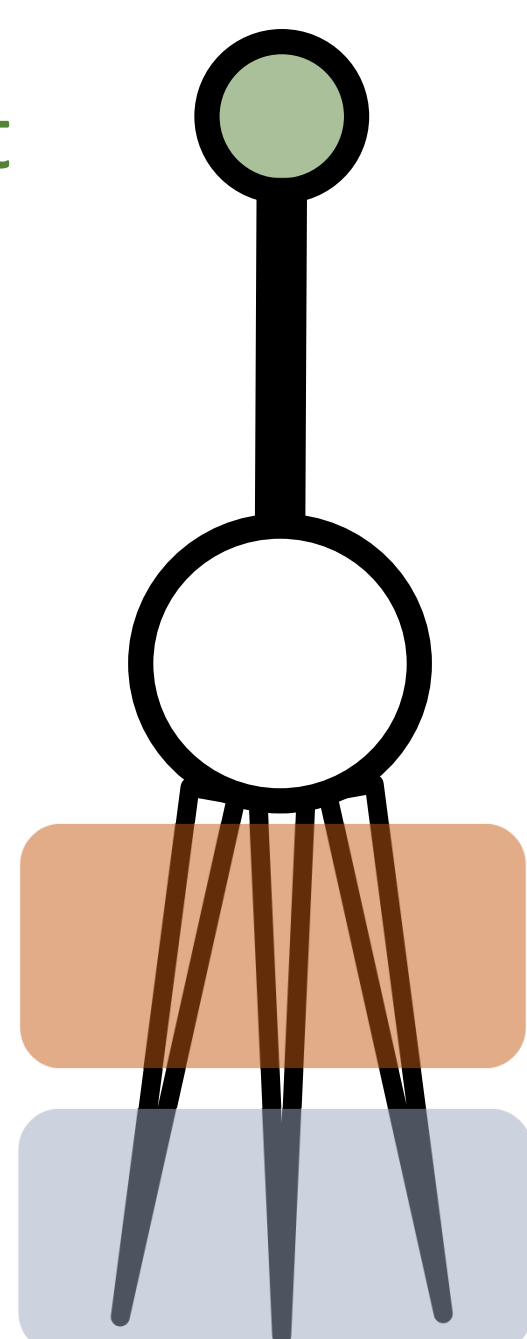
### MULTI-COMPARTMENT NEURON

Apical tuft

Soma

Proximal

Distal

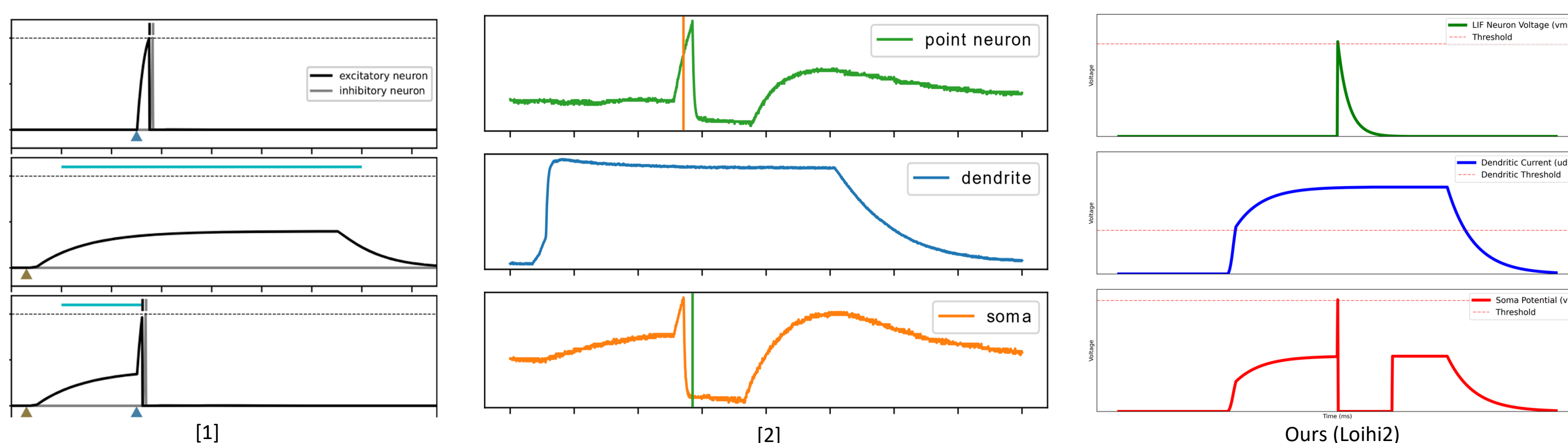


Biological Inspiration  
*Neocortical pyramidal neurons*

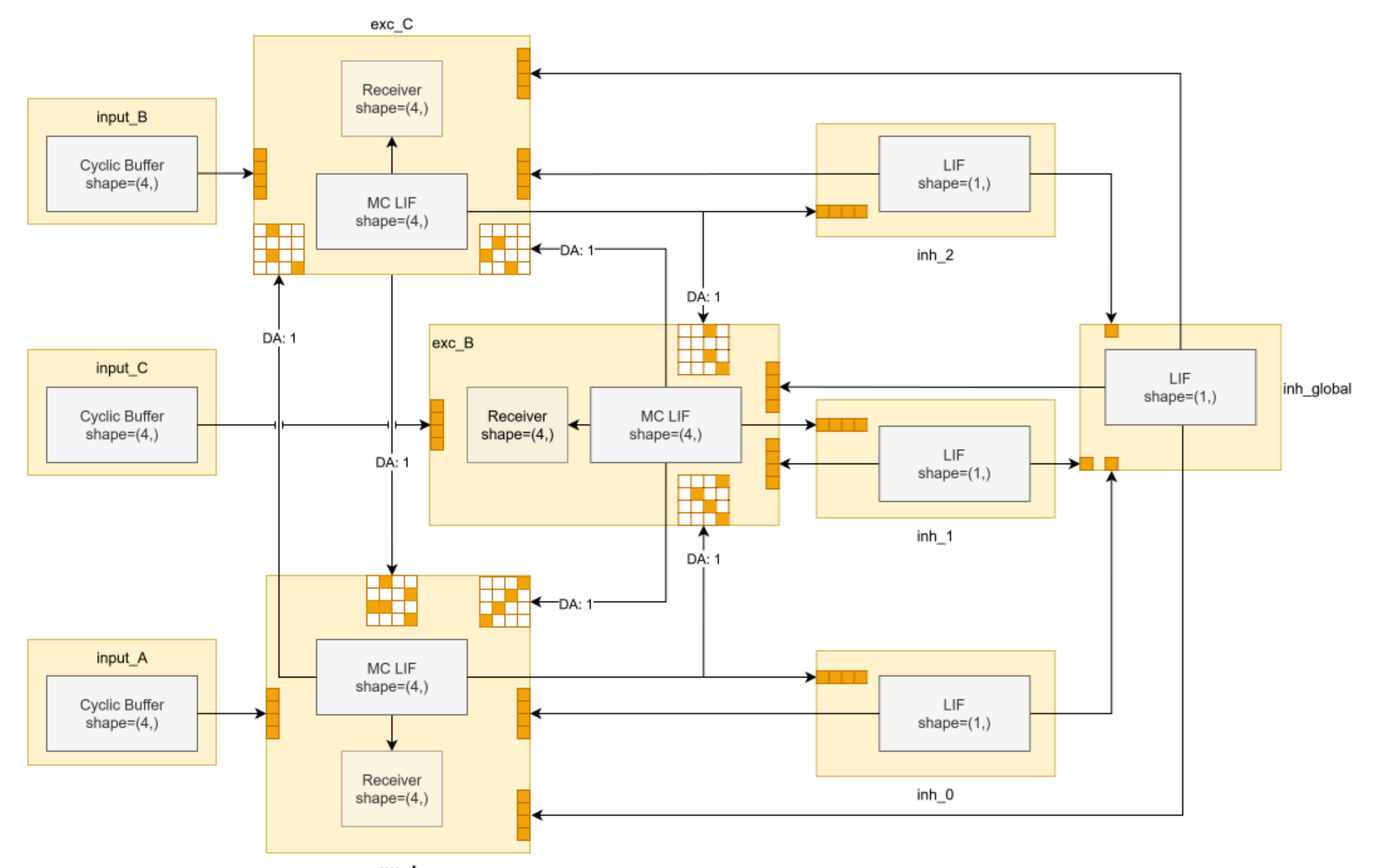
Dendritic compartments lead to different depolarization outcomes at the soma:

- additive integration of input spike
- sustained plateau potential over time

### DYNAMICS COMPARISON



### HARDWARE IMPLEMENTATION



The MC neuron on **Loihi2** has **dynamics** more similar to the **BSS-2** implementation by [2]. However due to **no noise** beyond inaccuracies caused by differing simulation details, it can be treated the same as in the **NEST** simulation by [1].

- [1] Y. Bouhadjar, D. J. Wouters, M. Diesmann, und T. Tetzlaff, „Sequence learning, prediction, and replay in networks of spiking neurons“, *PLoS Comput Biol*, Bd. 18, Nr. 6, S. e1010233, Juni 2022
- [2] R. Dietrich, P. Spilger, E. Müller, J. Schemmel, und A. C. Knoll, „Sequence Learning with Analog Neuromorphic Multi-Compartment Neurons and On-Chip Structural STDP“, in *Machine Learning, Optimization, and Data Science*, G. Nicosia, V. Ojha, S. Giesselbach, M. P. Pardalos, und R. Umeton, Hrsg., Cham: Springer Nature Switzerland, 2025, S. 207–230

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