MANCHESTER 1824
The University of Manchester

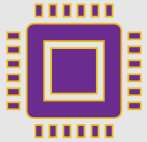
SpiNNaker: A Spiking Neural Network Architecture

Petruț Bogdan

petrut.bogdan@manchester.ac.uk

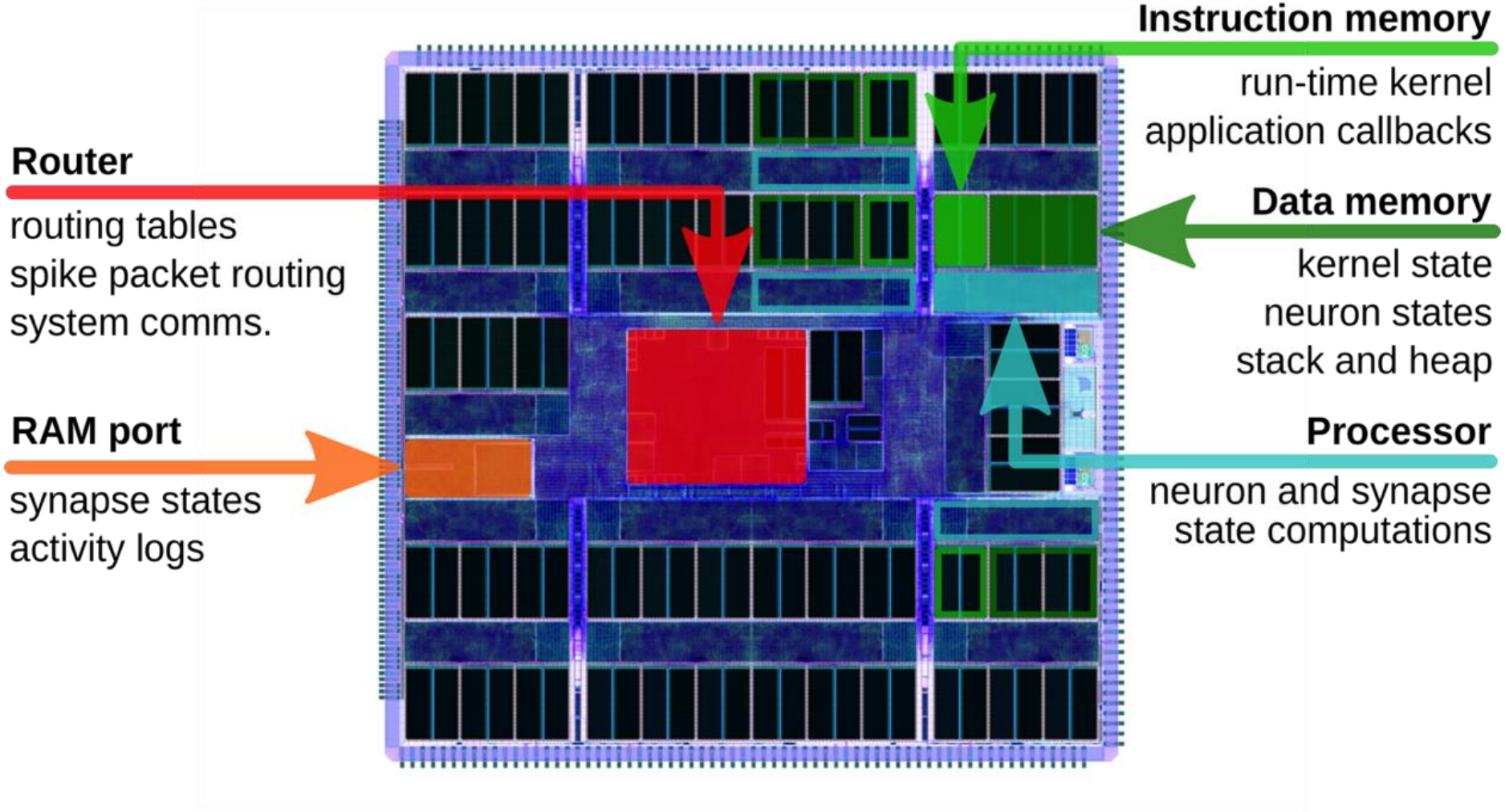
Bio-inspiration

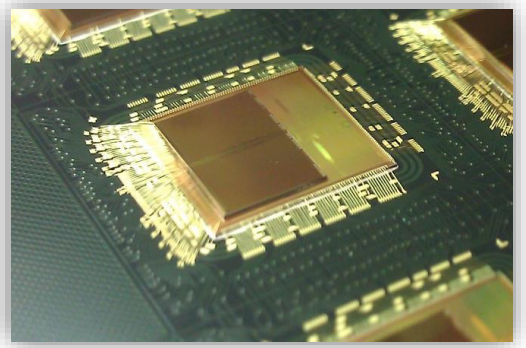
Can massively-parallel computing resources **accelerate our understanding of brain function**?

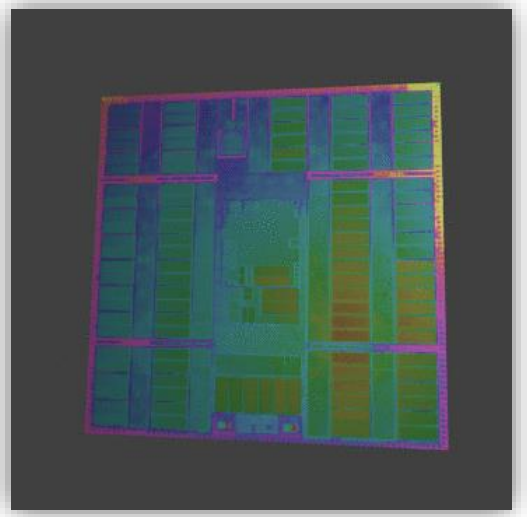


Can our growing understanding of brain function point the way to **more efficient parallel, fault-tolerant computation**?

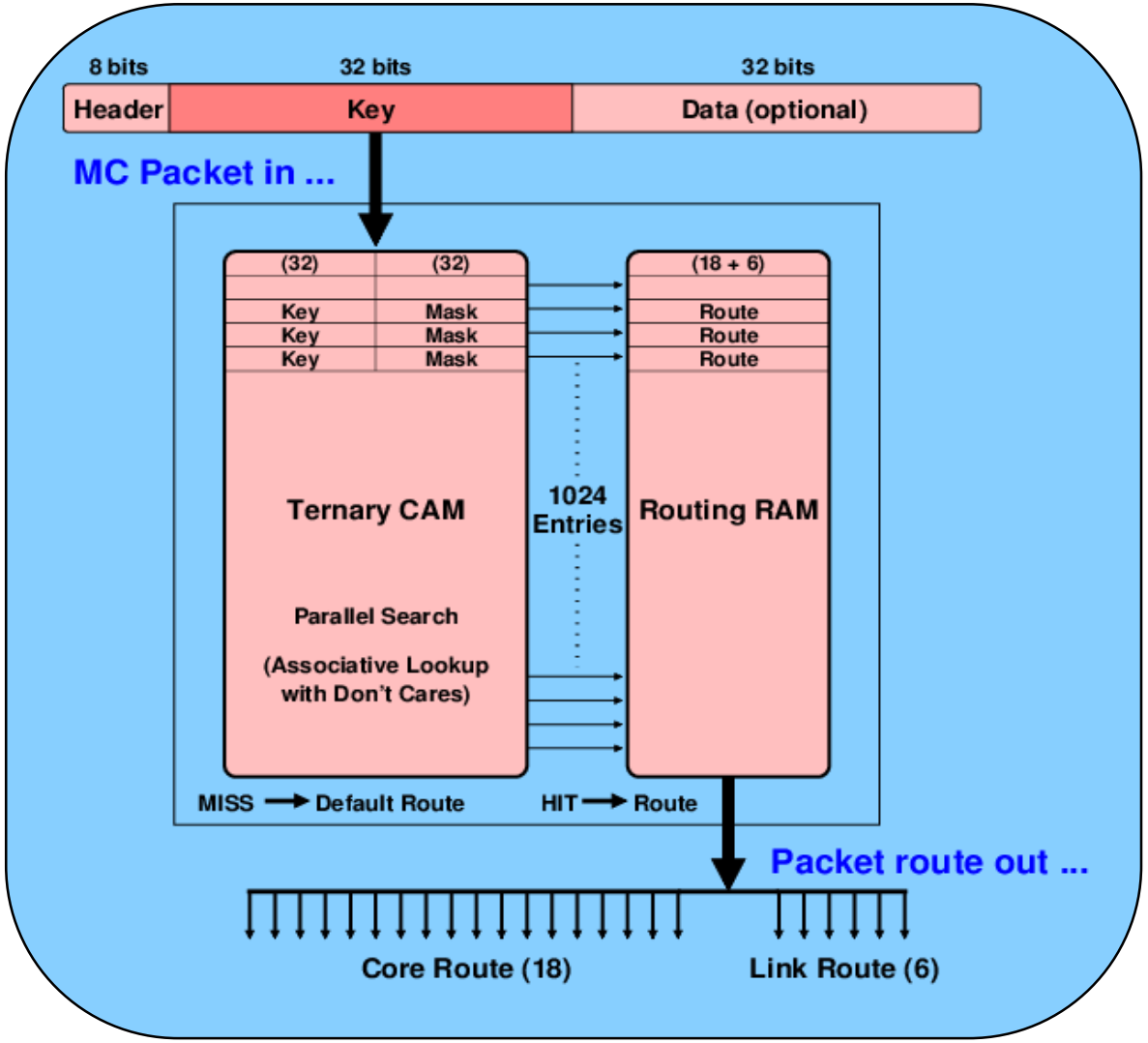
Chip resources

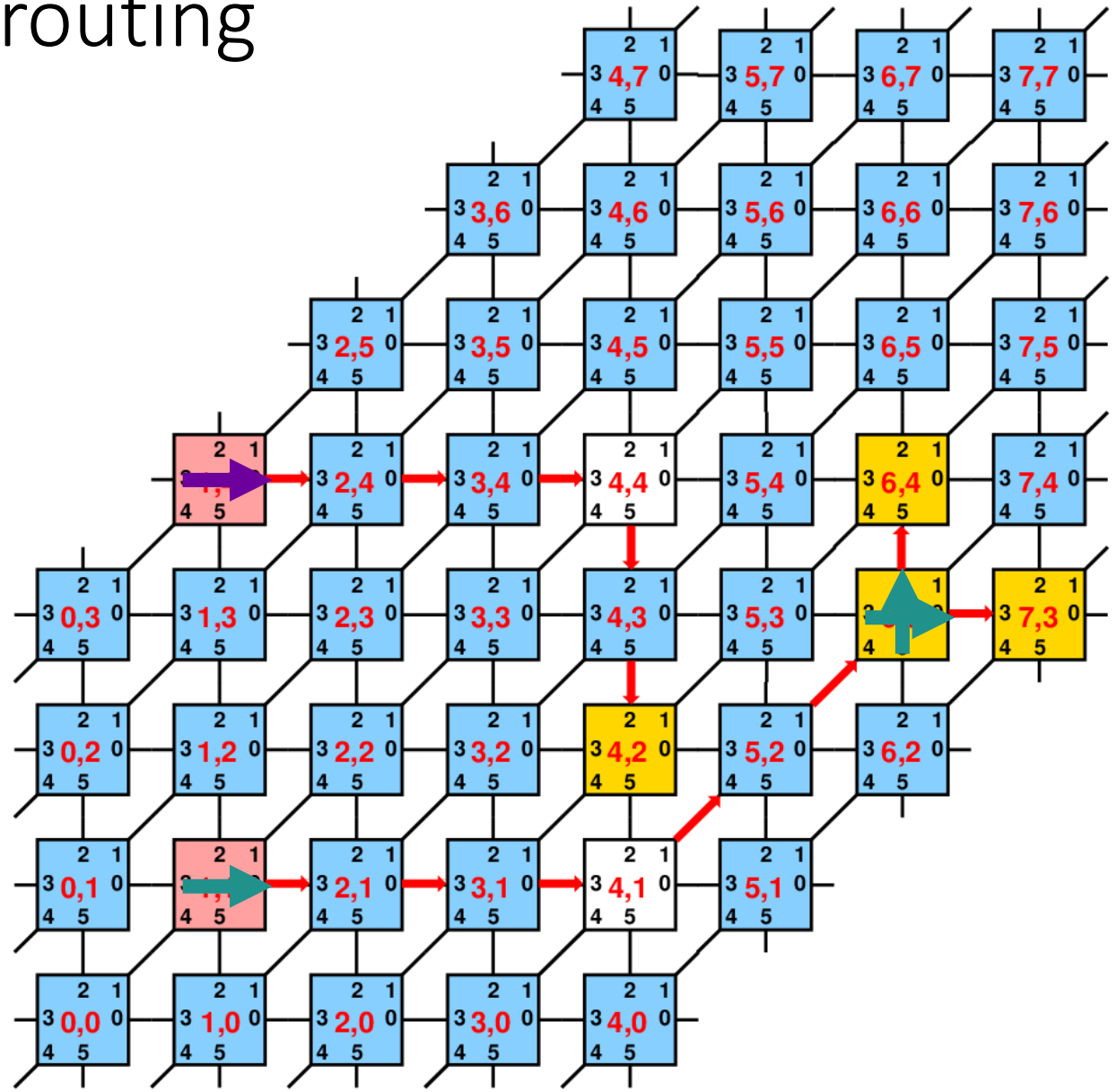






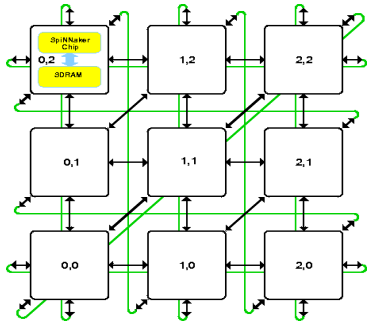
SpiNNaker Multicast routing

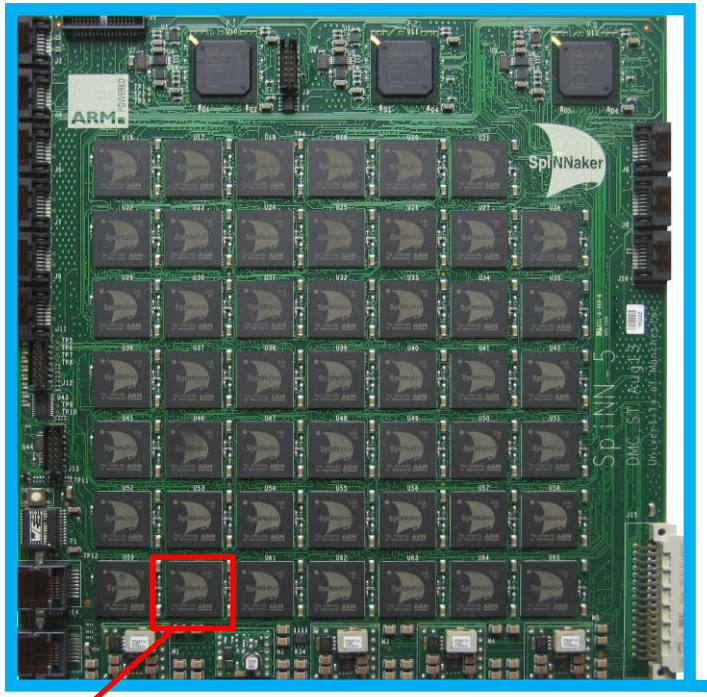




SpiNNaker machines

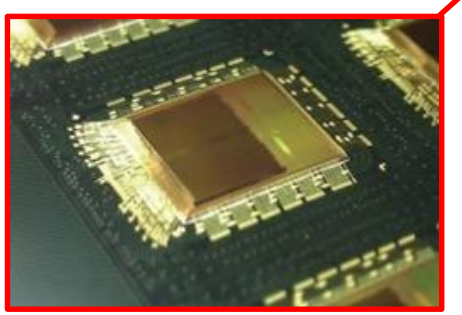
SpiNNaker board
(864 ARM cores)



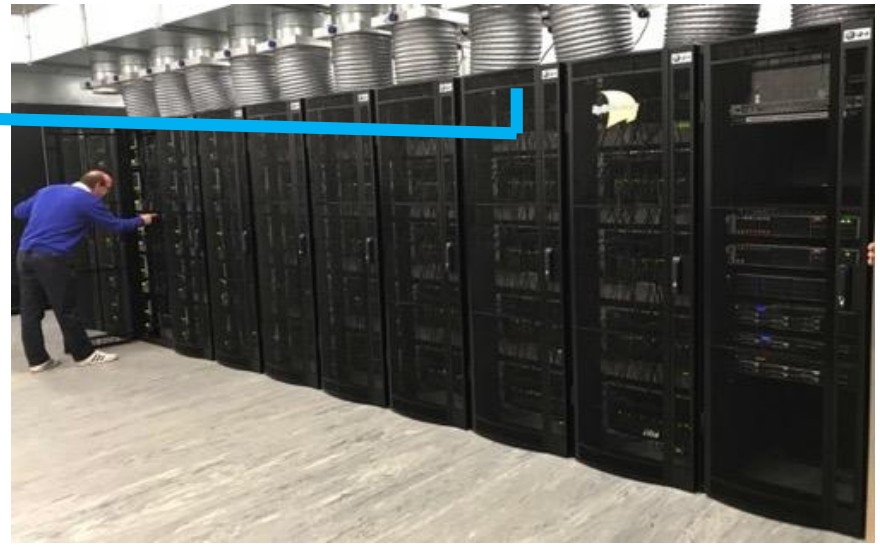


- HBP platform
  - 1M cores
  - 11 cabinets (including server)
- Launch 30 March 2016
  - then 500k cores
  - 112 remote users
  - 6,103 SpiNNaker jobs run

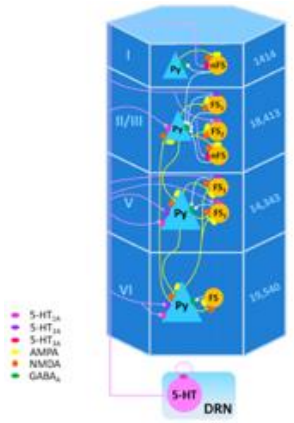
SpiNNaker chip
(18 ARM cores)

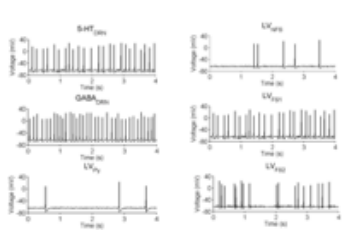


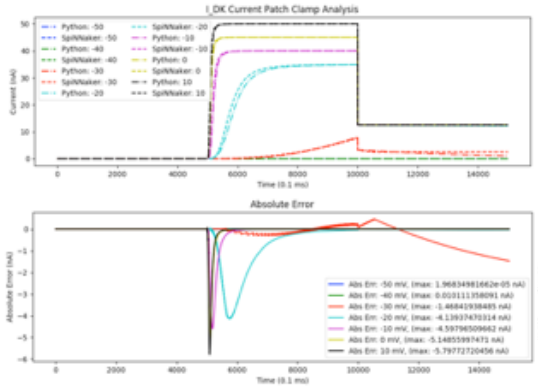
SpiNNaker racks
(1M ARM cores)

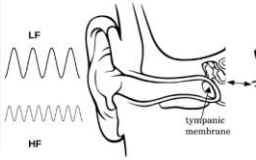


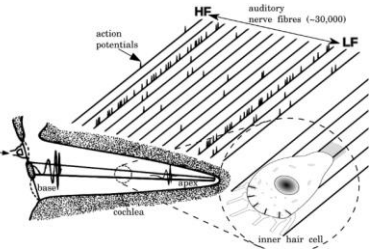
Application range







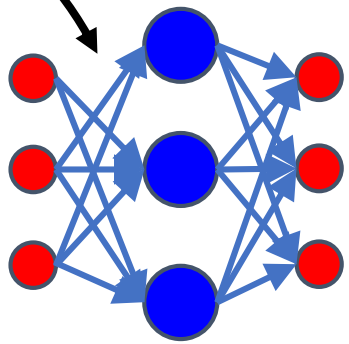


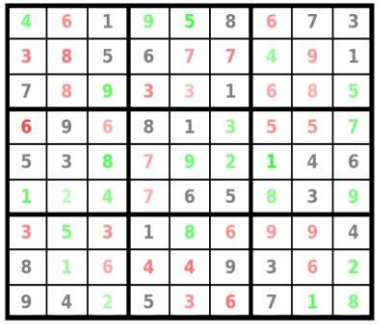


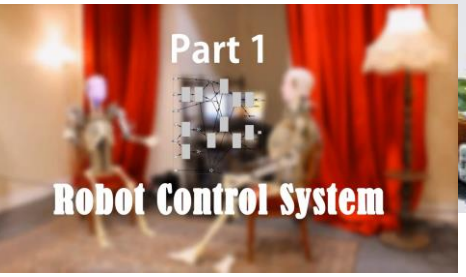
Computational Neuroscience

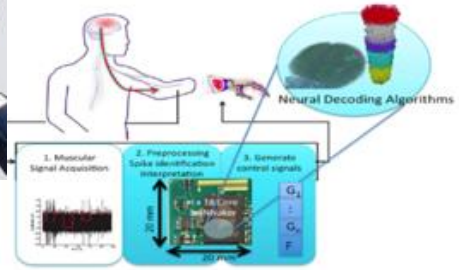
Neurorobotics

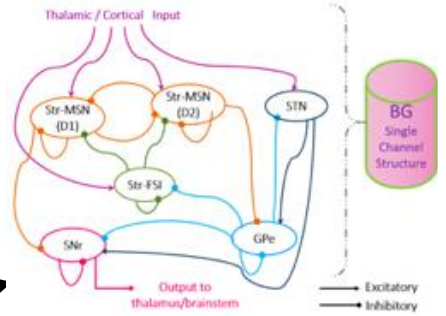
Theoretical Neuroscience

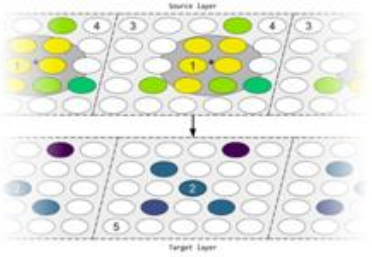


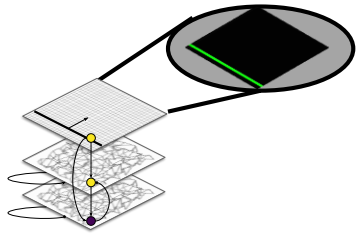




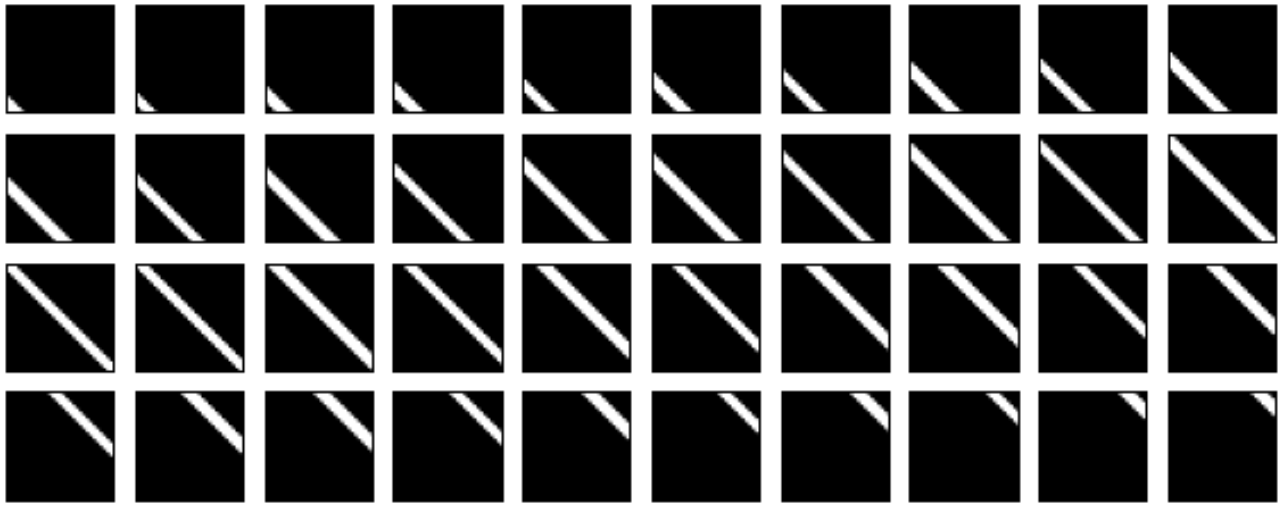


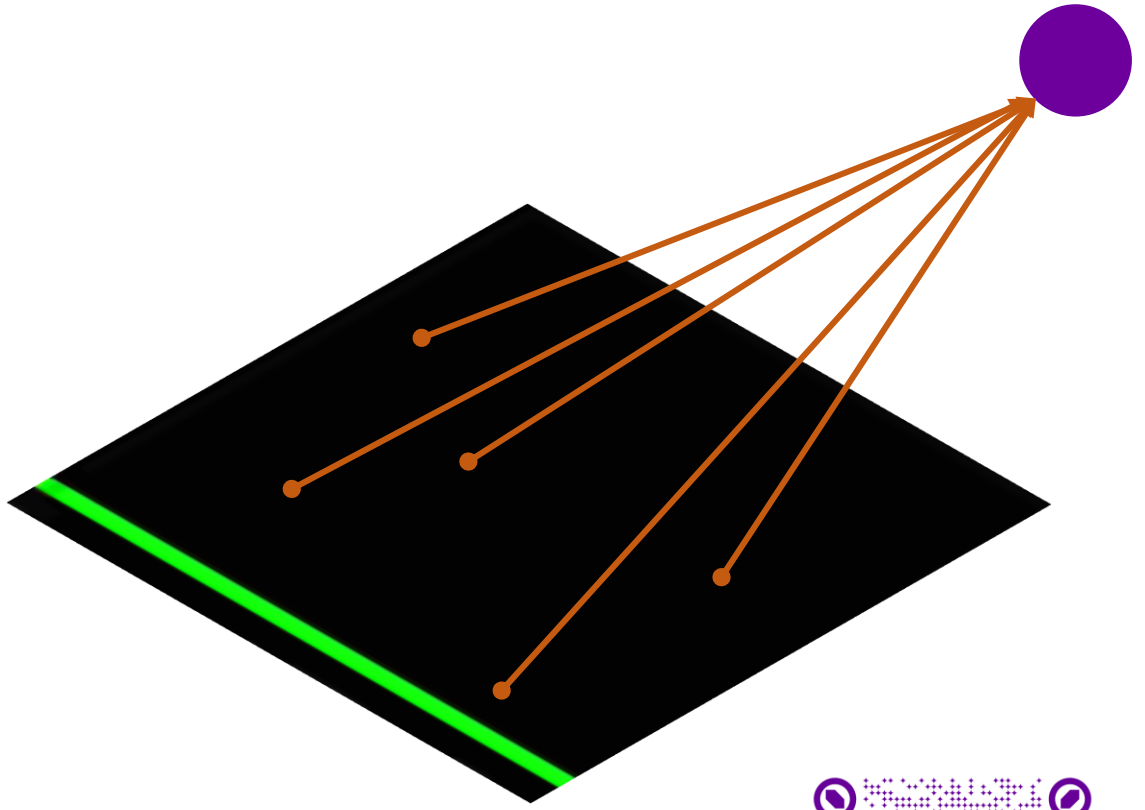






Focus: structural plasticity for motion detection





Bogdan et. al (2019, EMiT Conference)
Bogdan (2019, Thesis)

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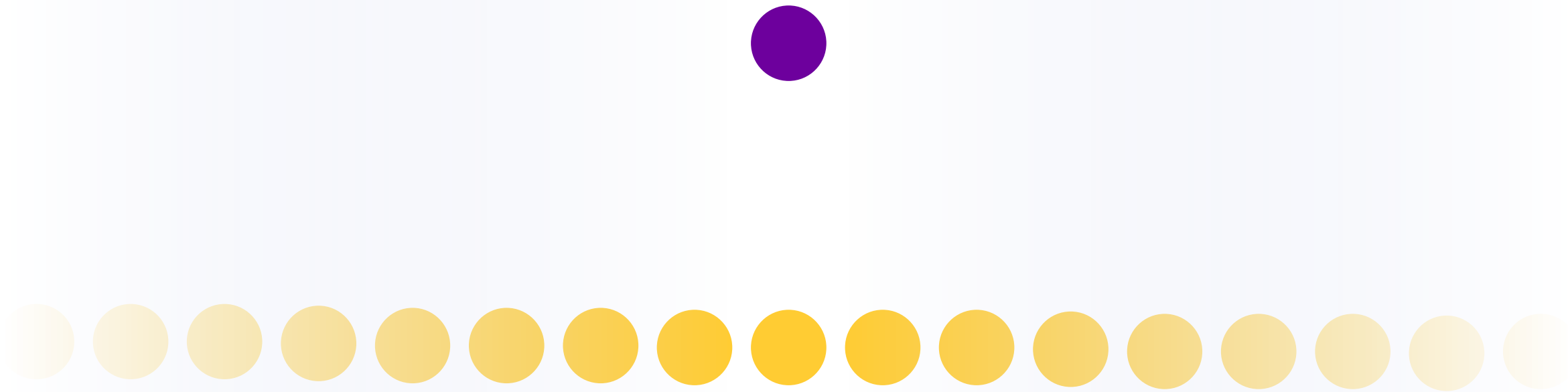
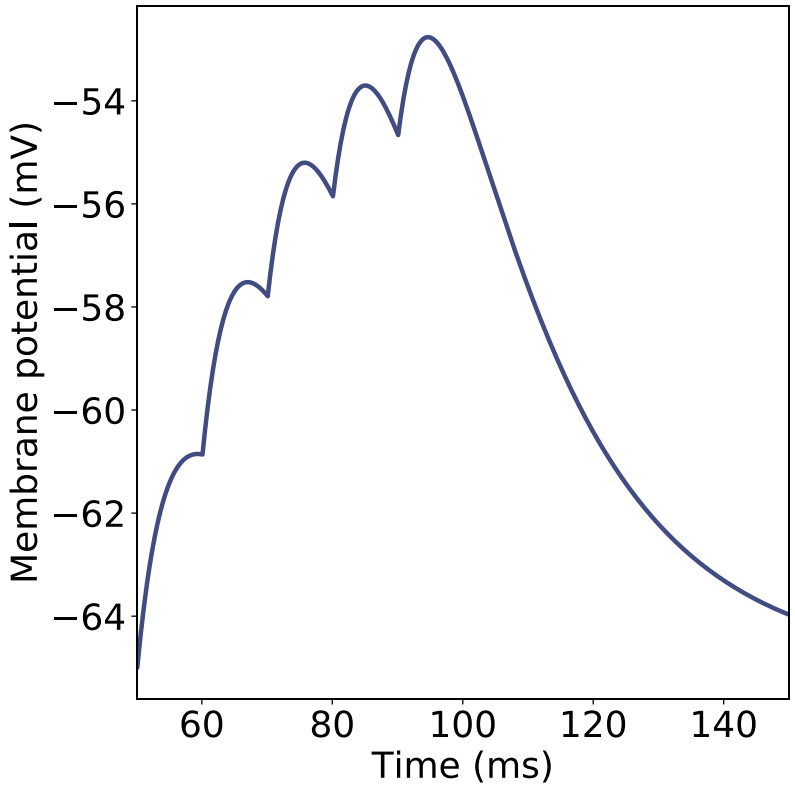
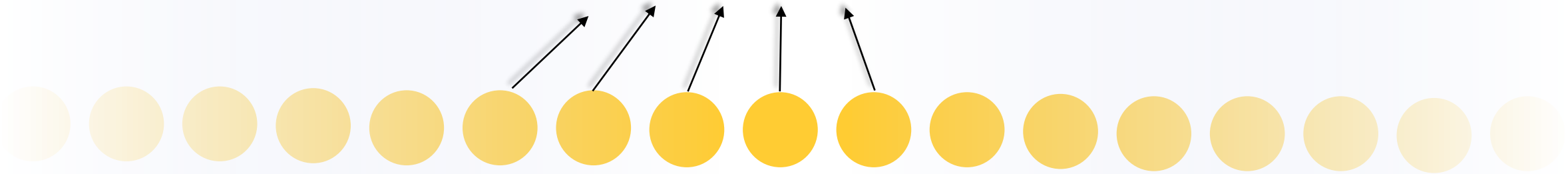
Intuition



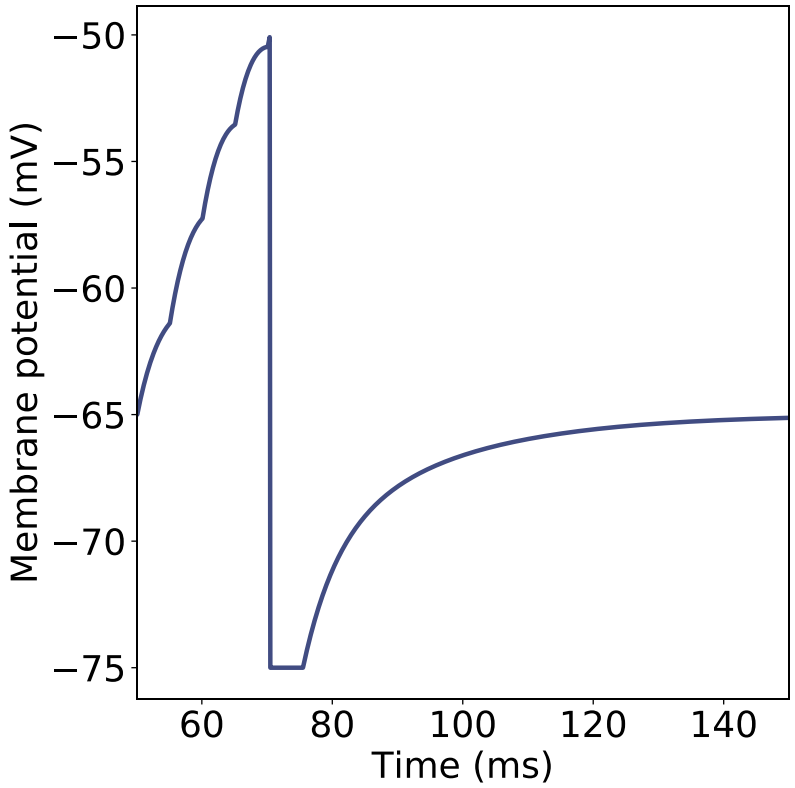
Intuition



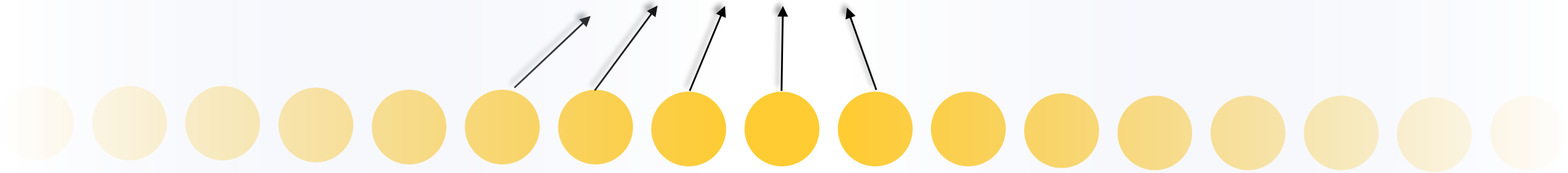
Homogenous delays



Intuition



Heterogeneous delays



Structural plasticity in the wild

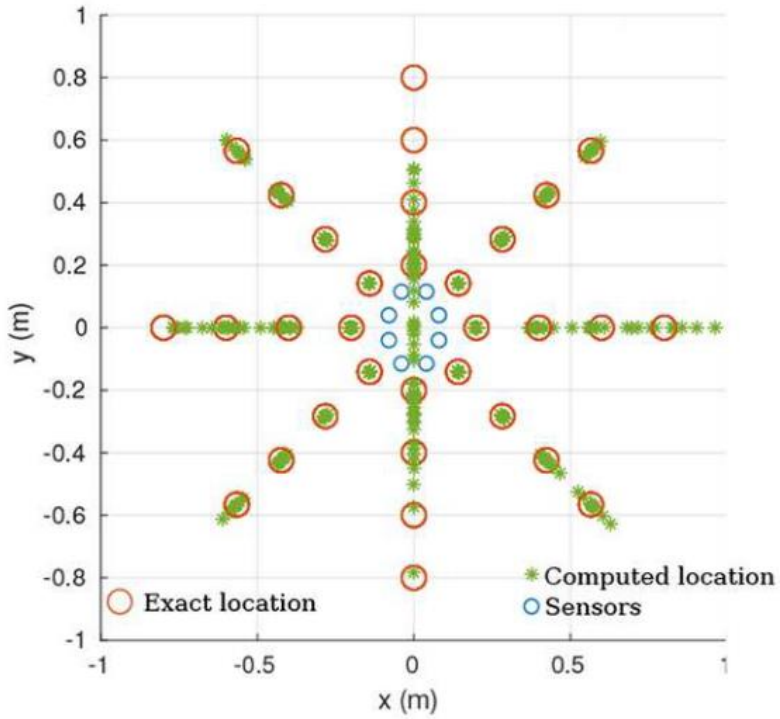
frontiers in Neuroscience

ORIGINAL RESEARCH
published: 19 May 2020
doi: 10.3389/fnins.2020.00420

Event-Based Computation for Touch Localization Based on Precise Spike Timing

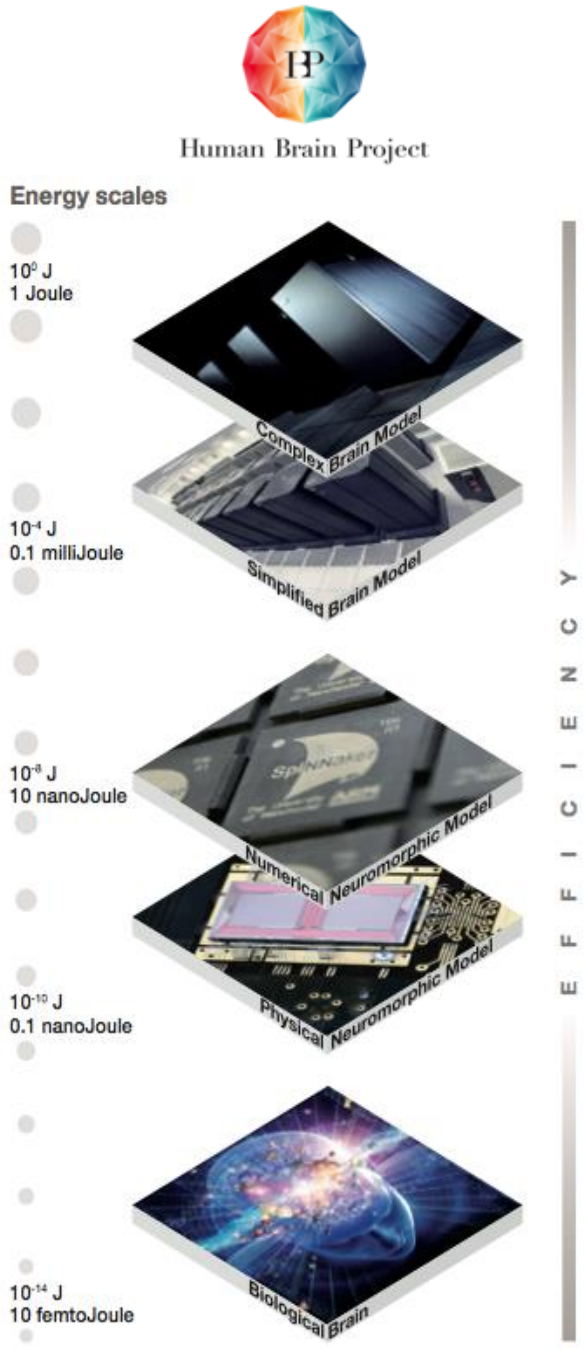
Germain Haessig[1], Moritz B. Milde[2], Pau Vilimelis Aceituno[3,4], Omar Oubari[5], James C. Knight[6], André van Schaik[2], Ryad B. Benosman[5,7,8] and Giacomo Indiveri[1]*

[1] Institute of Neuroinformatics, University of Zurich and ETH Zurich, Zurich, Switzerland, [2] International Centre for Neuromorphic Systems, MARCS Institute, Western Sydney University, Penrith, NSW, Australia, [3] Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, [4] Max Planck School of Cognition, Leipzig, Germany, [5] Institut de la Vision, Sorbonne Université, Paris, France, [6] Centre for Computational Neuroscience and Robotics, School of Engineering and Informatics, University of Sussex, Brighton, United Kingdom, [7] University of Pittsburgh, Pittsburgh, PA, United States, [8] Carnegie Mellon University, Pittsburgh, PA, United States



Summary

- Building **neuromorphic hardware** to make **computation more efficient**, and to **advance our understanding of the brain**
- SpiNNaker is a 1-million ARM core digital neuromorphic machine currently in use to explore **theoretical and computational neuroscience** simulations and **neurorobotics applications**
- Various models of synaptic and structural plasticity are and can be implemented on this platform; **digital substrate offers flexibility** in exchange for efficiency
- Structural plasticity is a cool learning mechanism that can be used to grow synapses with different synaptic delays to optimize neuron responses to movement



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Thank you!

@pabmcr

petrut.bogdan@manchester.ac.uk

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Human Brain Project

Engineering and Physical Sciences Research Council

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