

Brain Science in the Information Age

Karlheinz Meier

Heidelberg

THE BRAIN
FORUM 

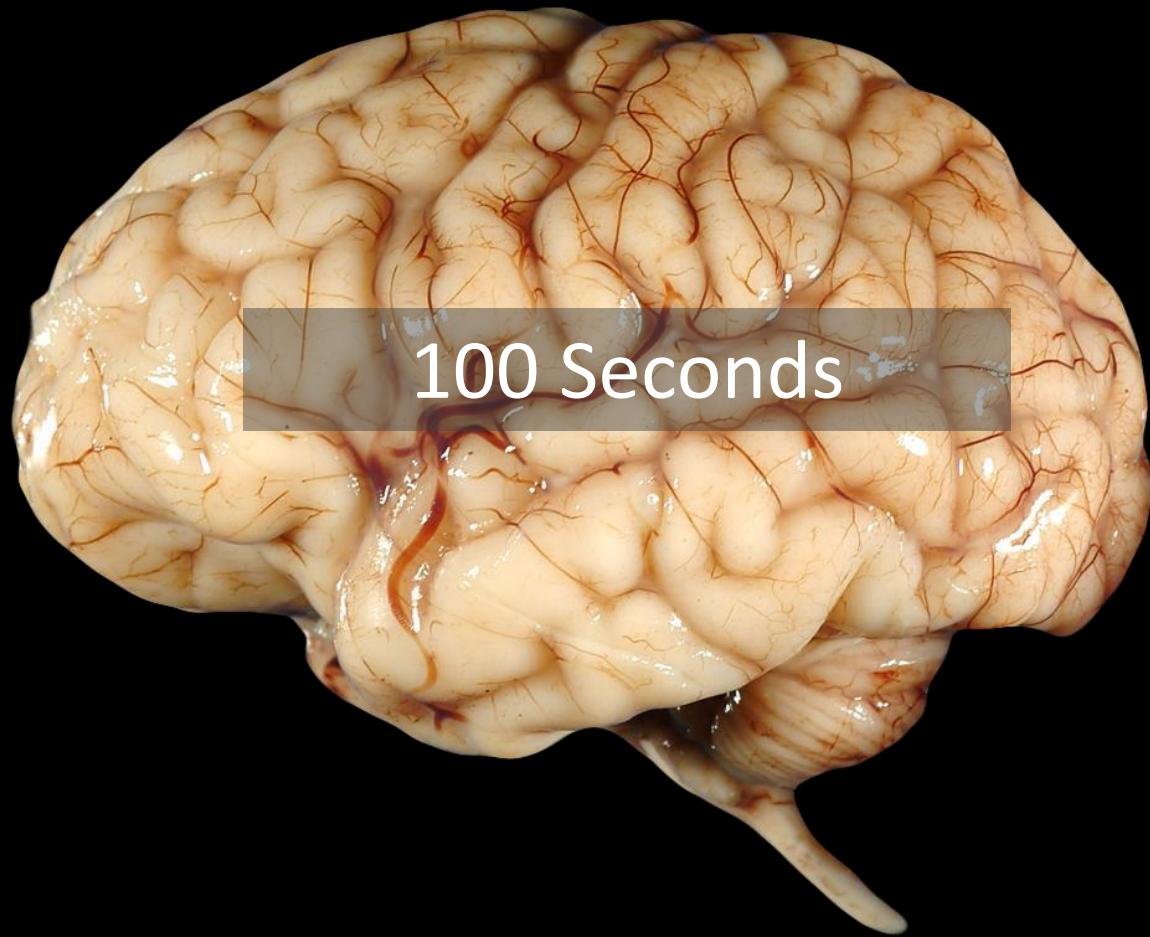
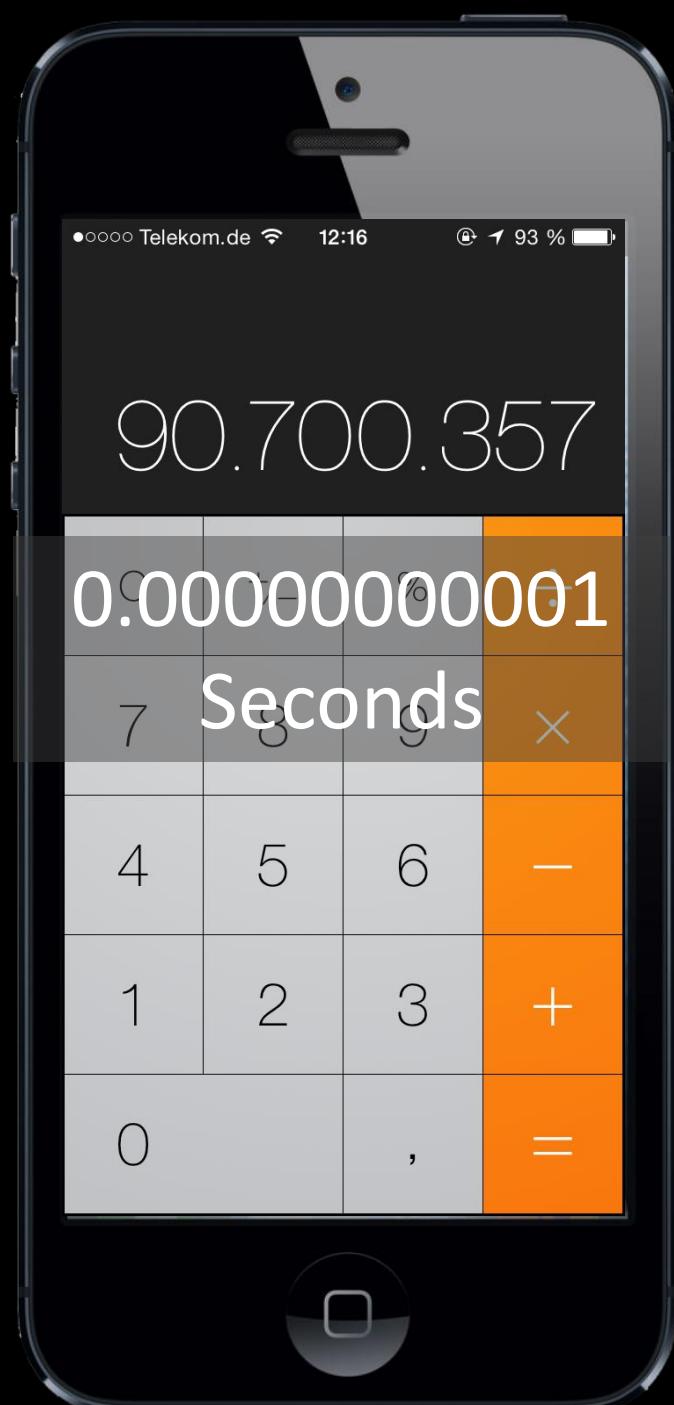
LAUSANNE,
SWITZERLAND

March 30 – April 1
2015

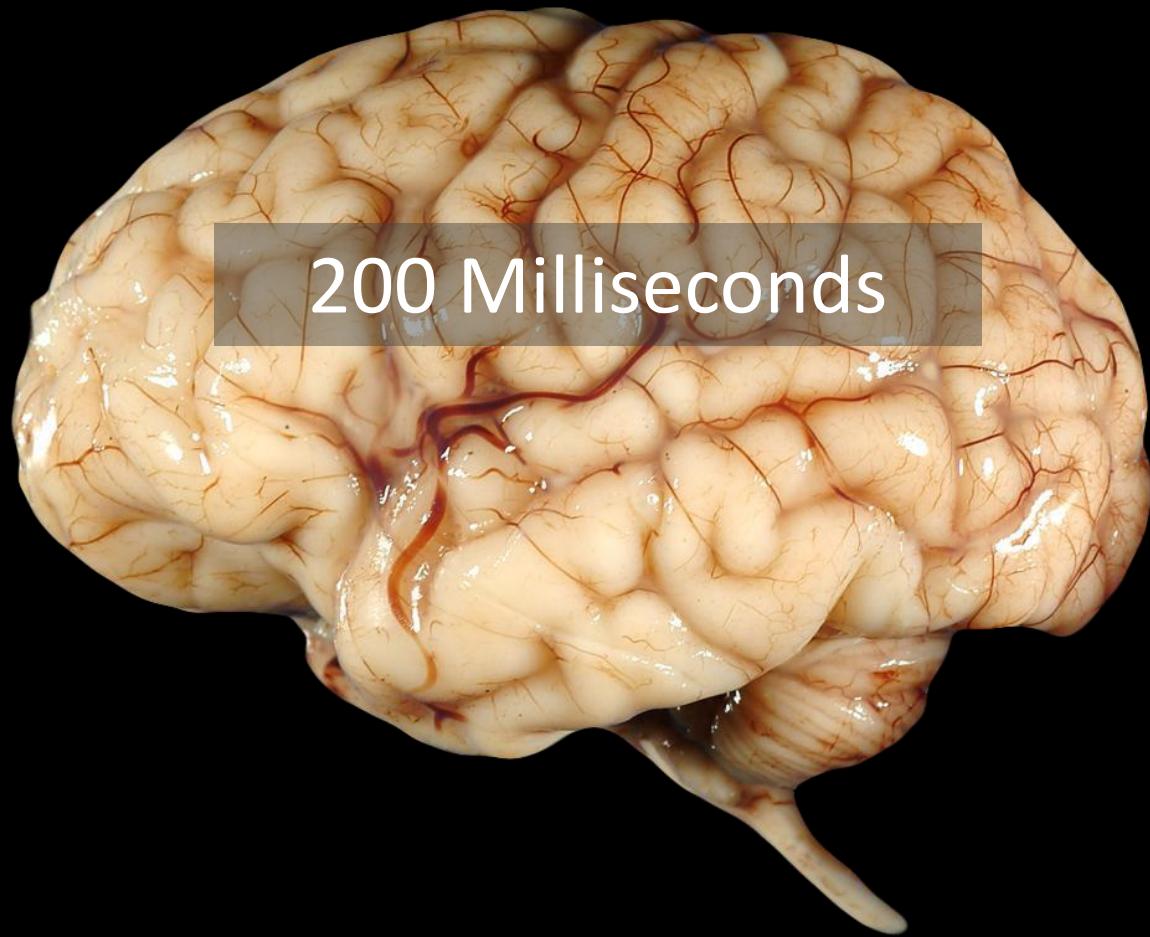
SWISSTECH CONVENTION CENTER

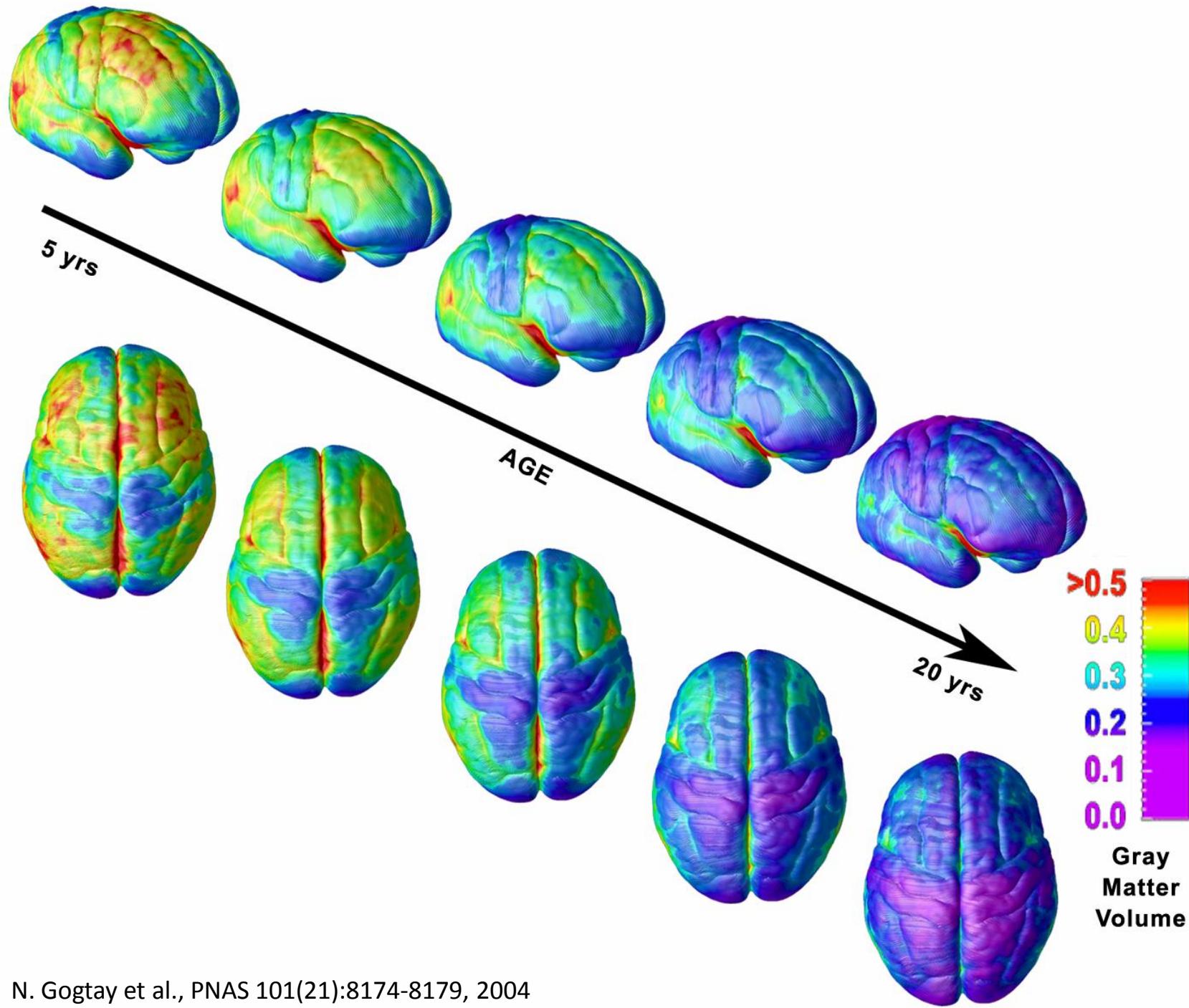
thebrainforum.org

$$3487 \times 26011 = ?$$









Bridging Scales

The K-Computer, Japan

simulating 1 Billion very simple neurons on 65.000 processors
1% „Brain“ Size, 13 Megawatt, 1500x slower than biology

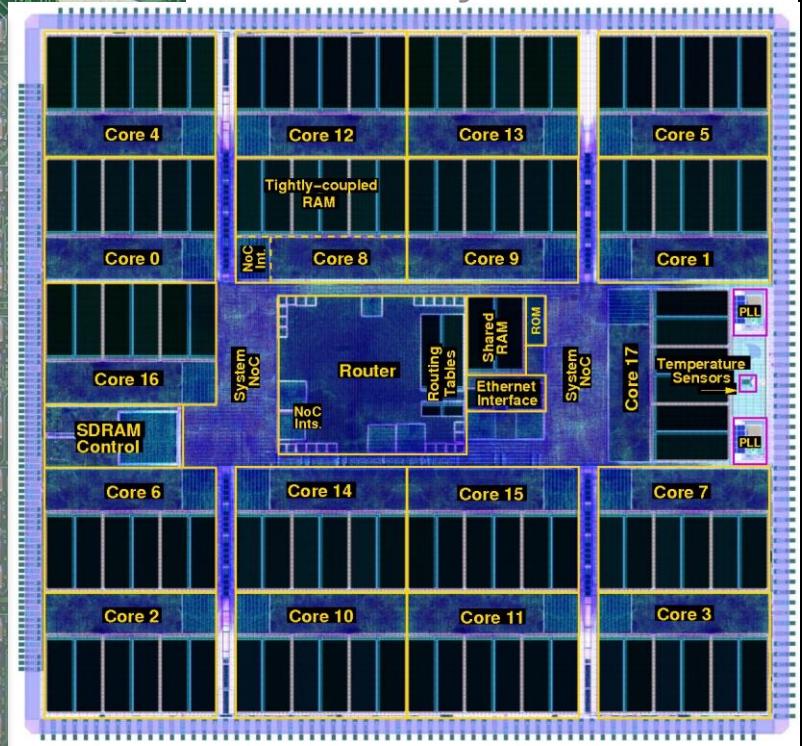
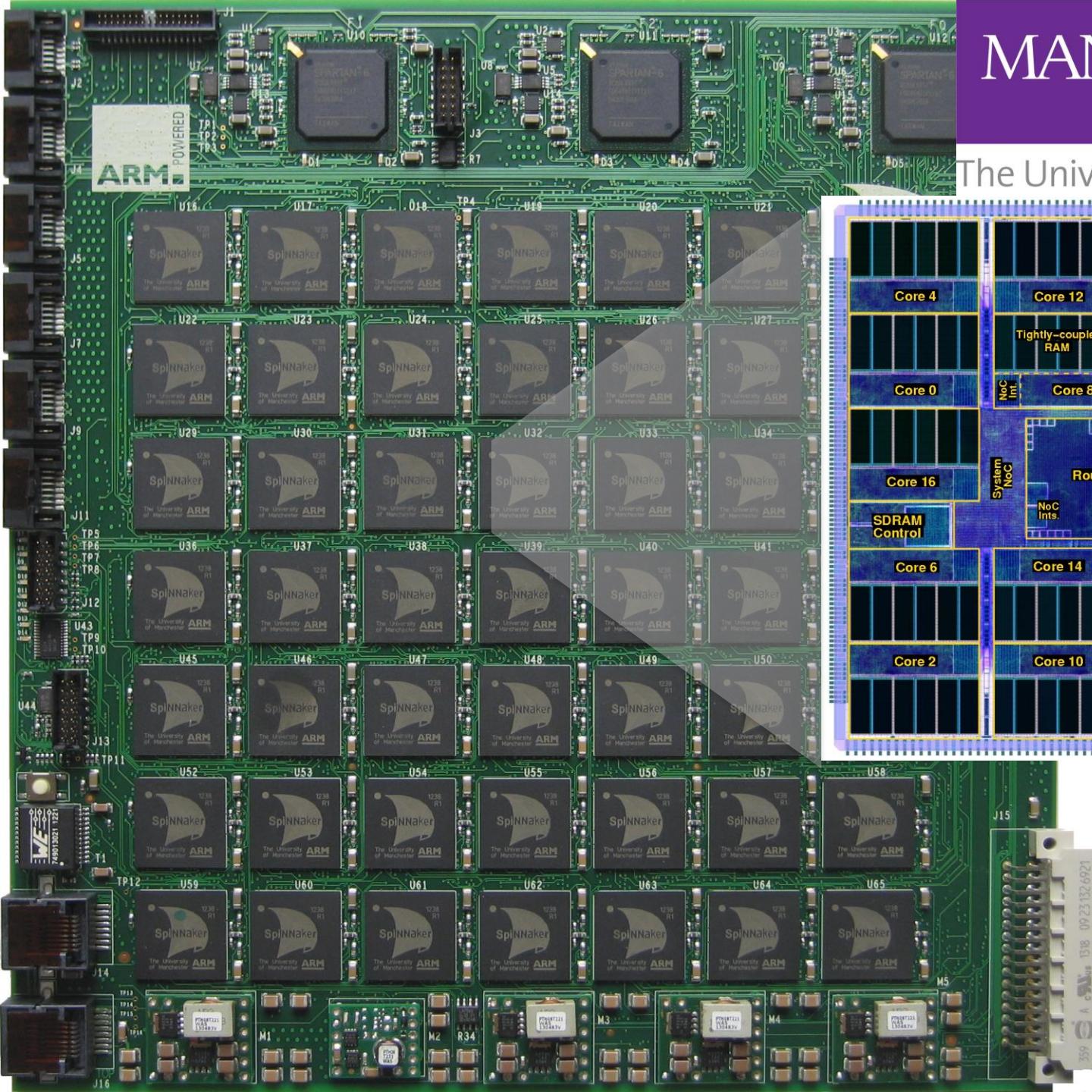
$$\text{Energy} = \text{Power} \times \text{Time}$$



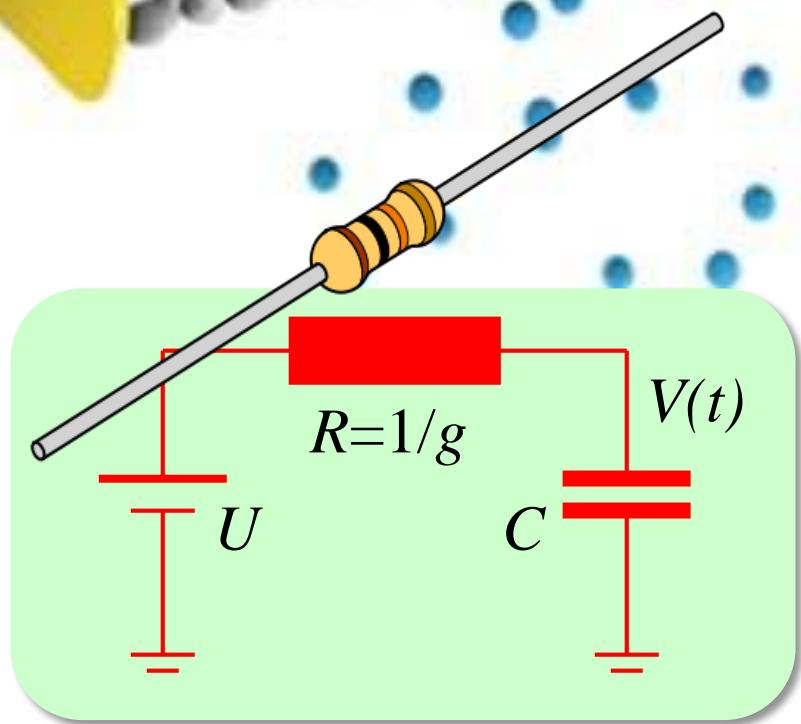
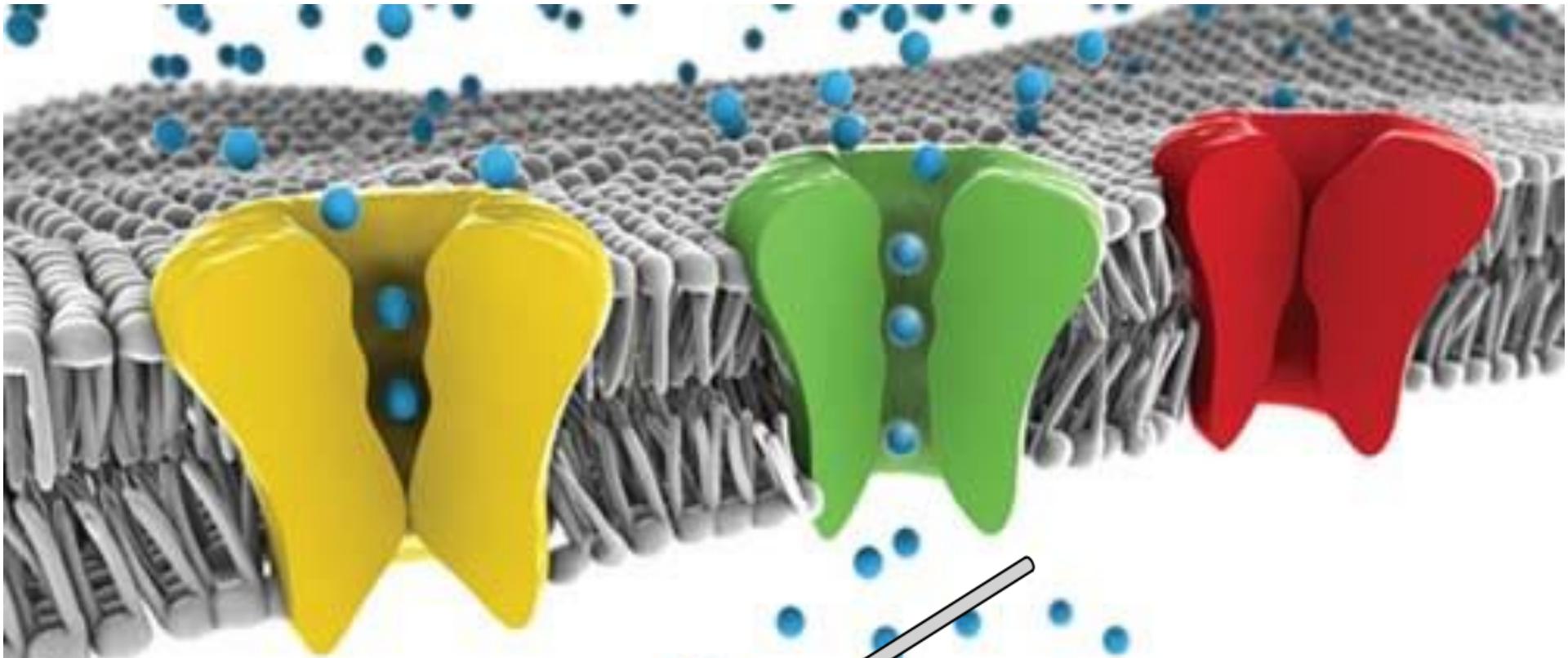
10 Billion times less energy efficient
Wait 4 years for a simulated day

MANCHESTER 1824

The University of Manchester



864 ARM Cores
Real Time

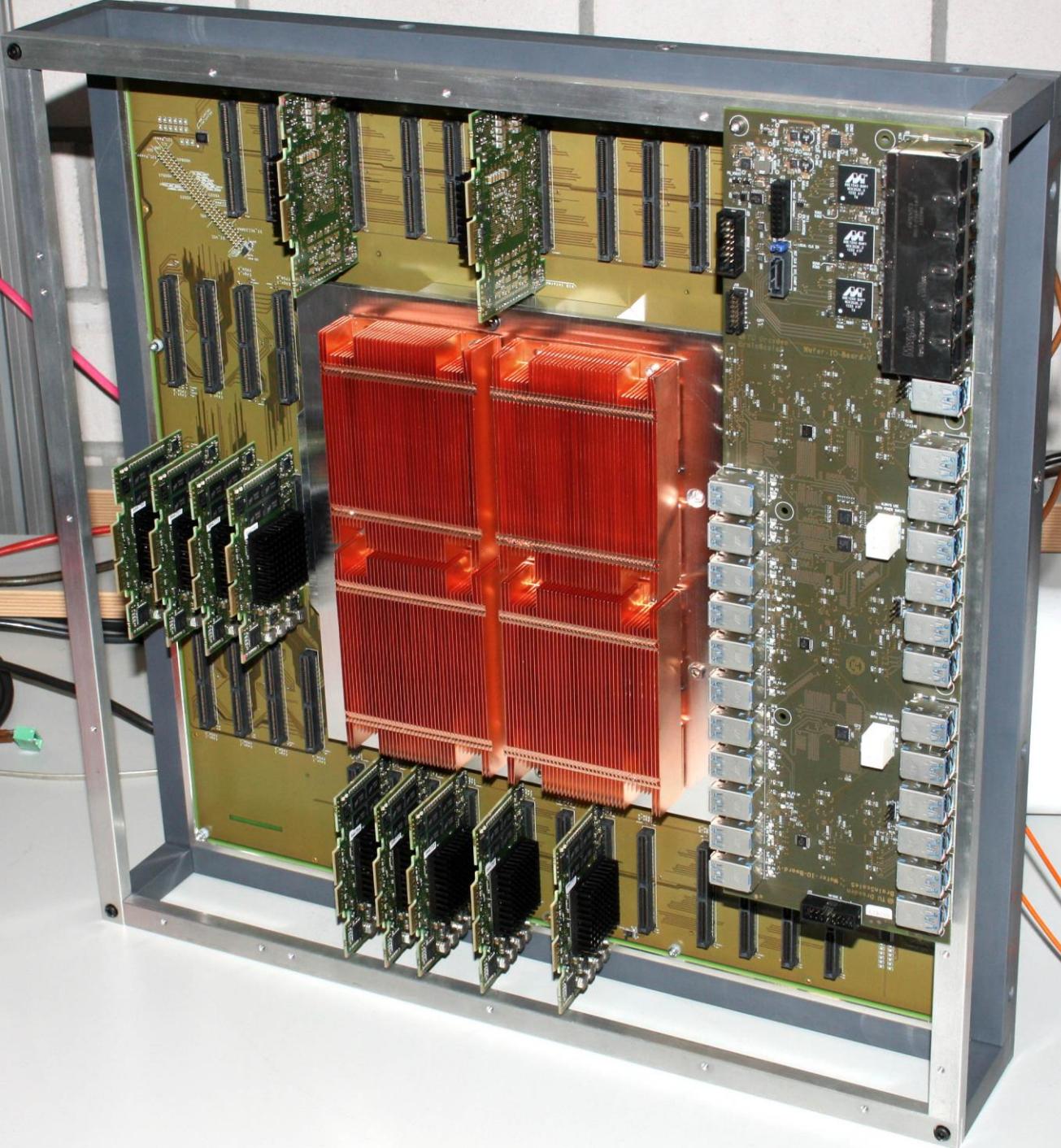




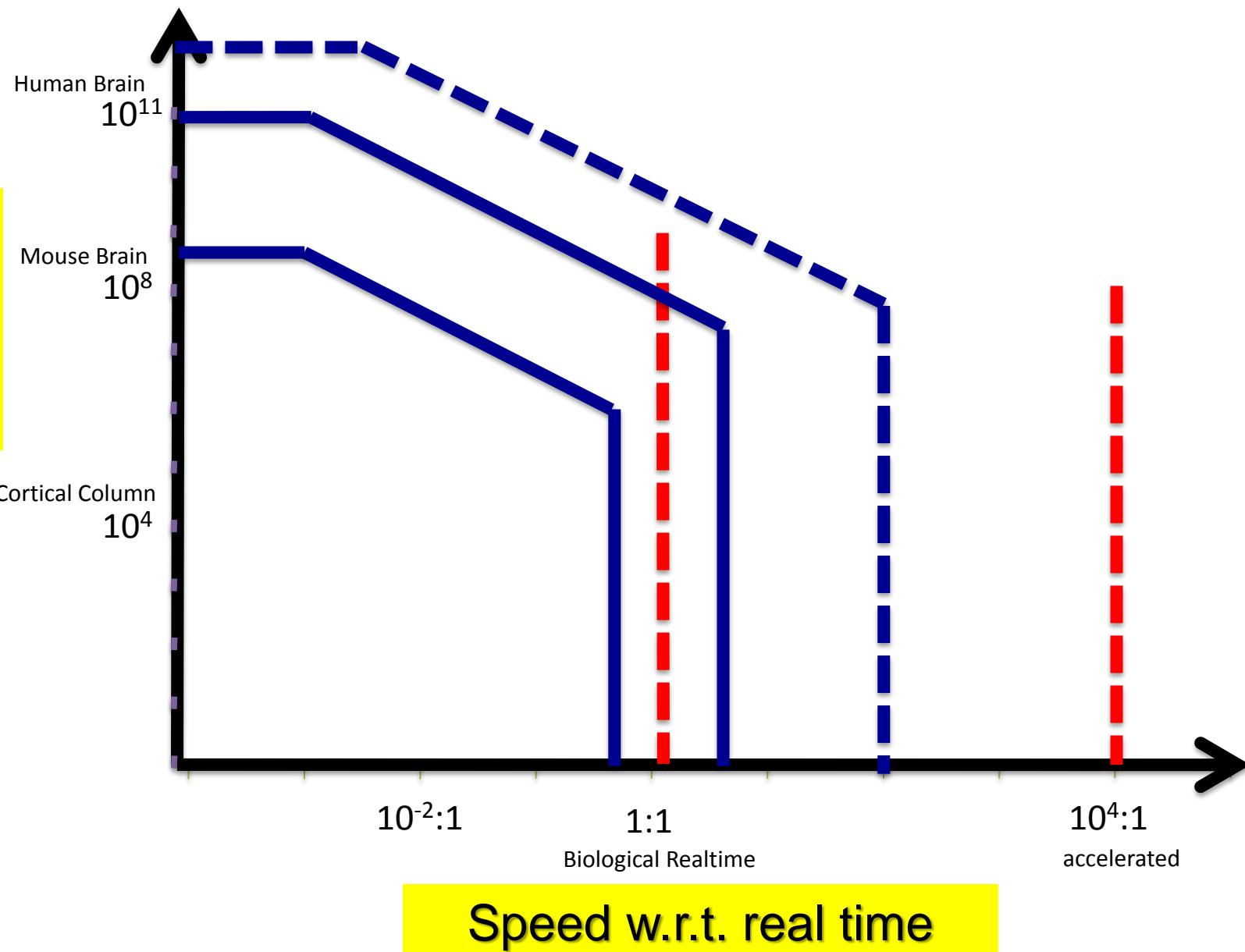
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ZUKUNFT
SEIT 1386

Neuromorphic Computer

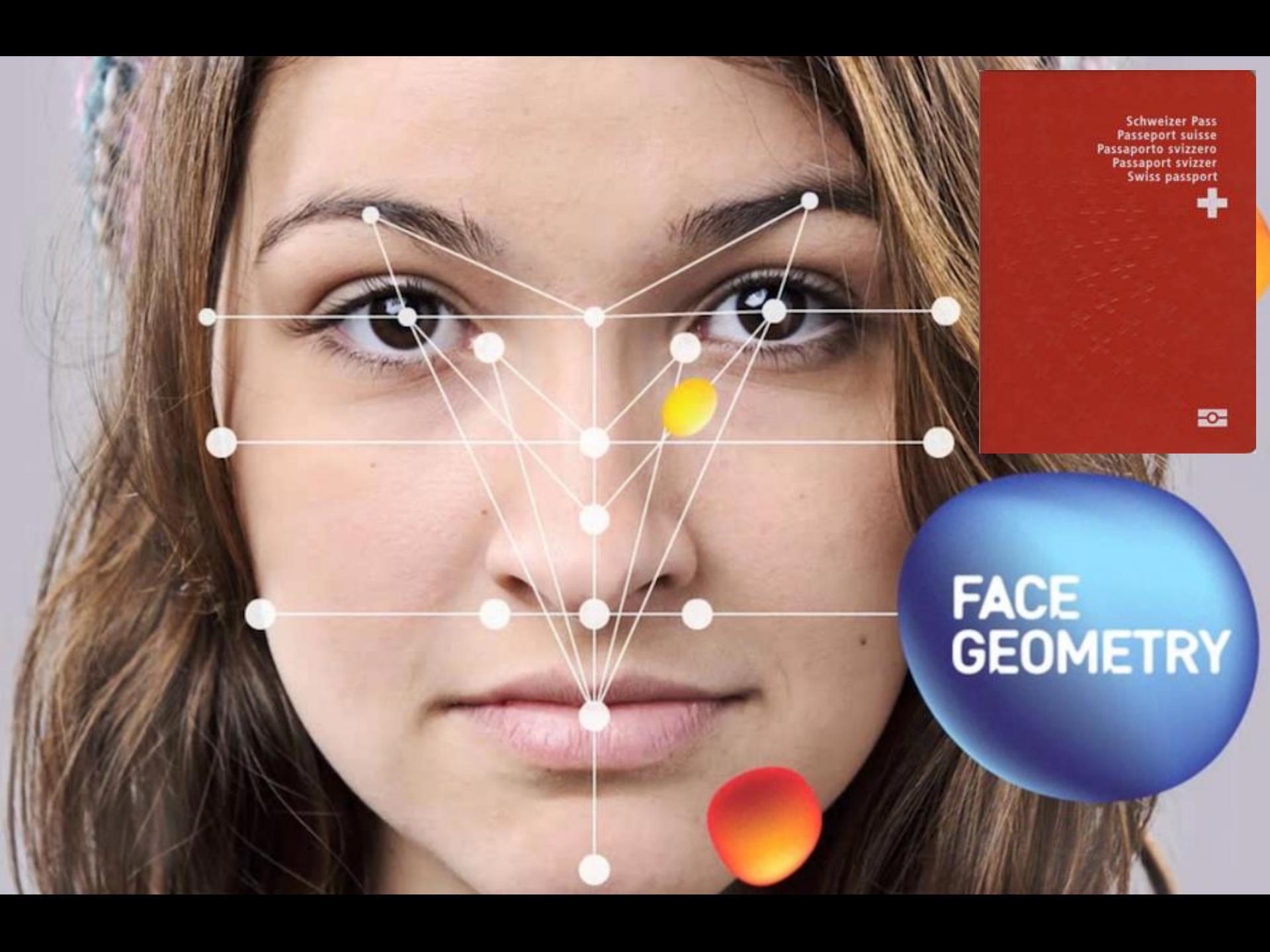
- 200.000 Neurons
- 50 Millionen Synapses
- 10.000 times faster than Biology



The HBP Computing Strategy



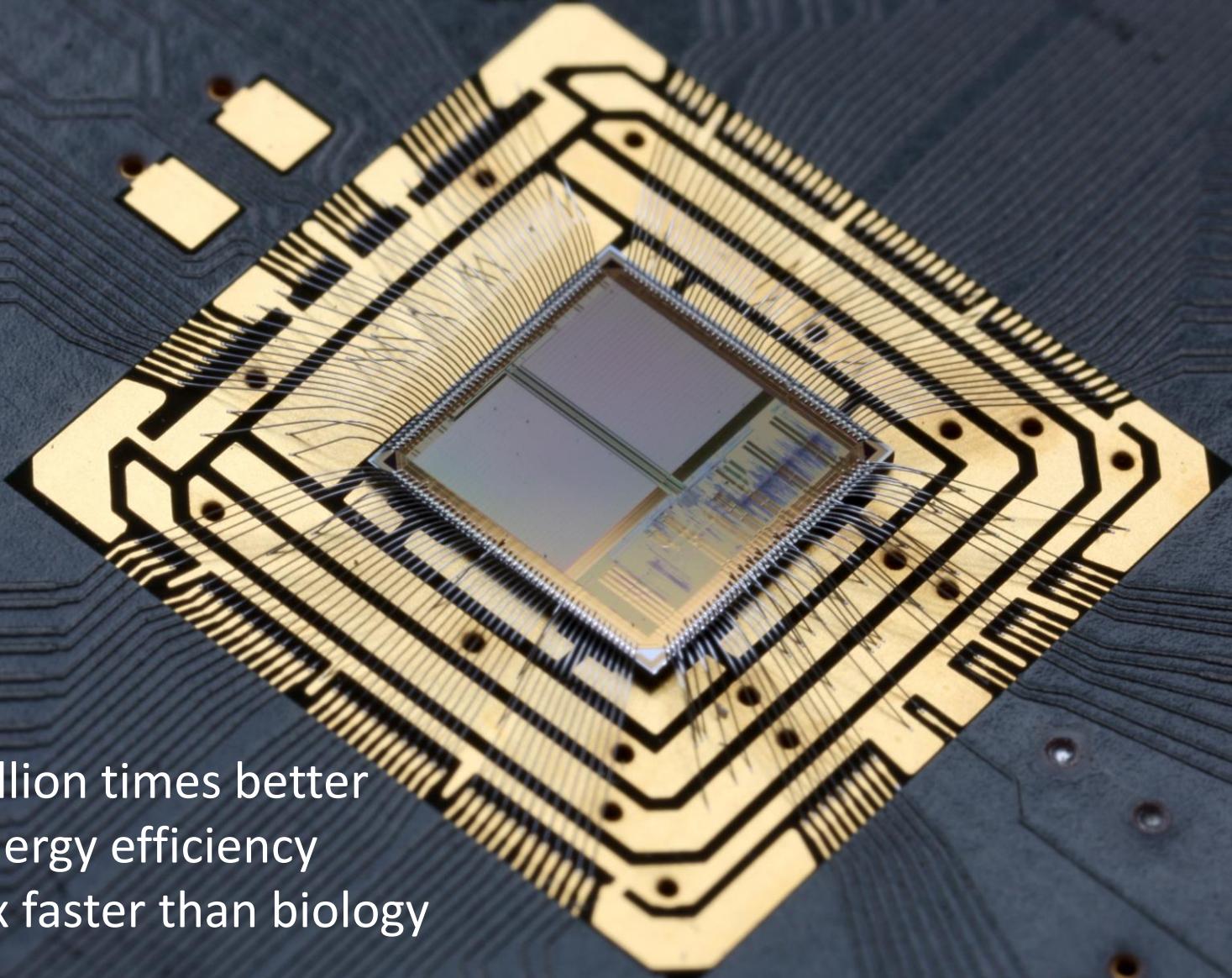




Schweizer Pass
Passeport suisse
Passaporto svizzero
Passaport svizzer
Swiss passport



**FACE
GEOMETRY**



1 Million times better
energy efficiency
10.000x faster than biology

Schmuker, M. et al., "A neuromorphic network for generic multivariate data classification."
Proceedings of the National Academy of Sciences (2014): 201303053.



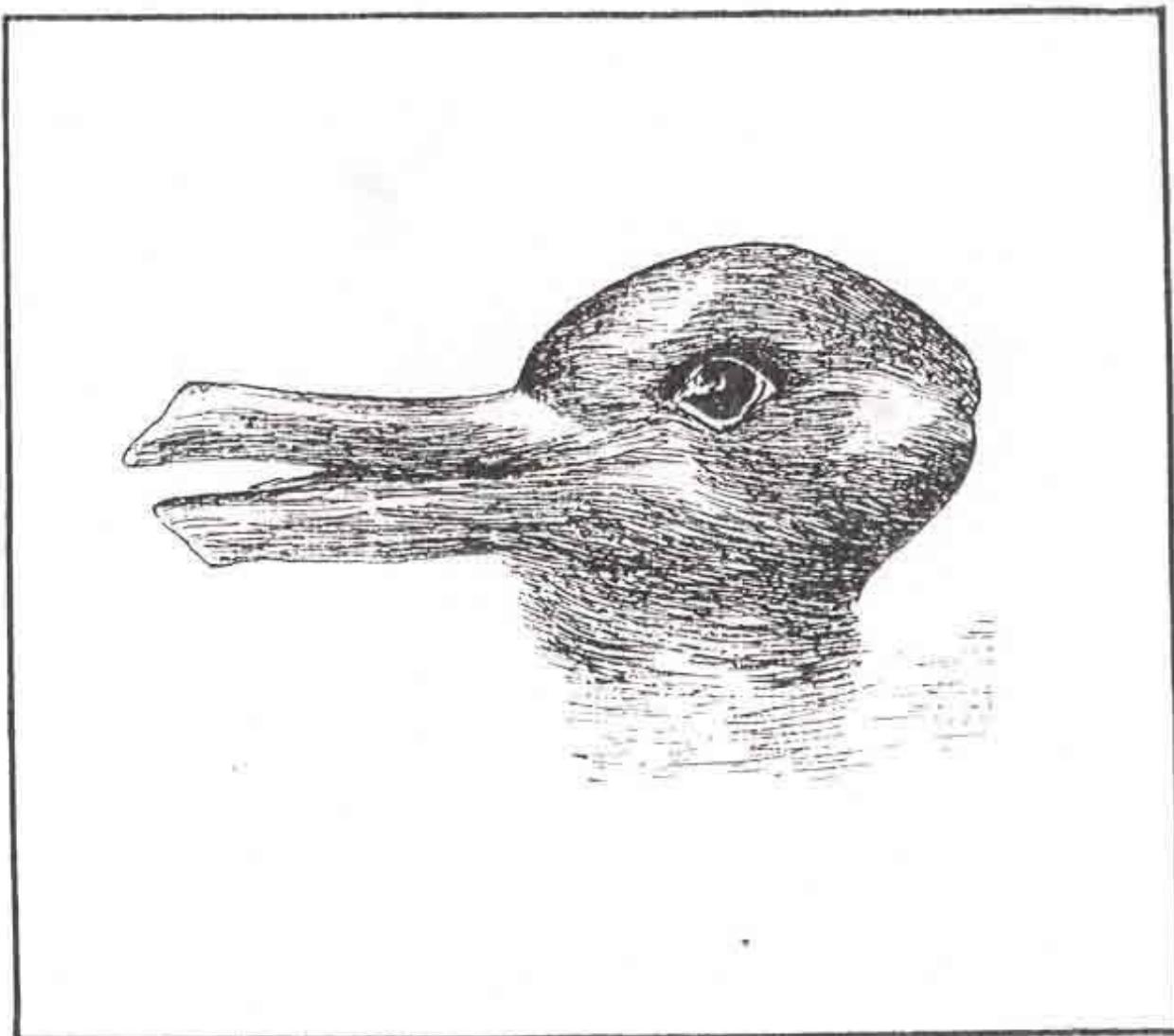
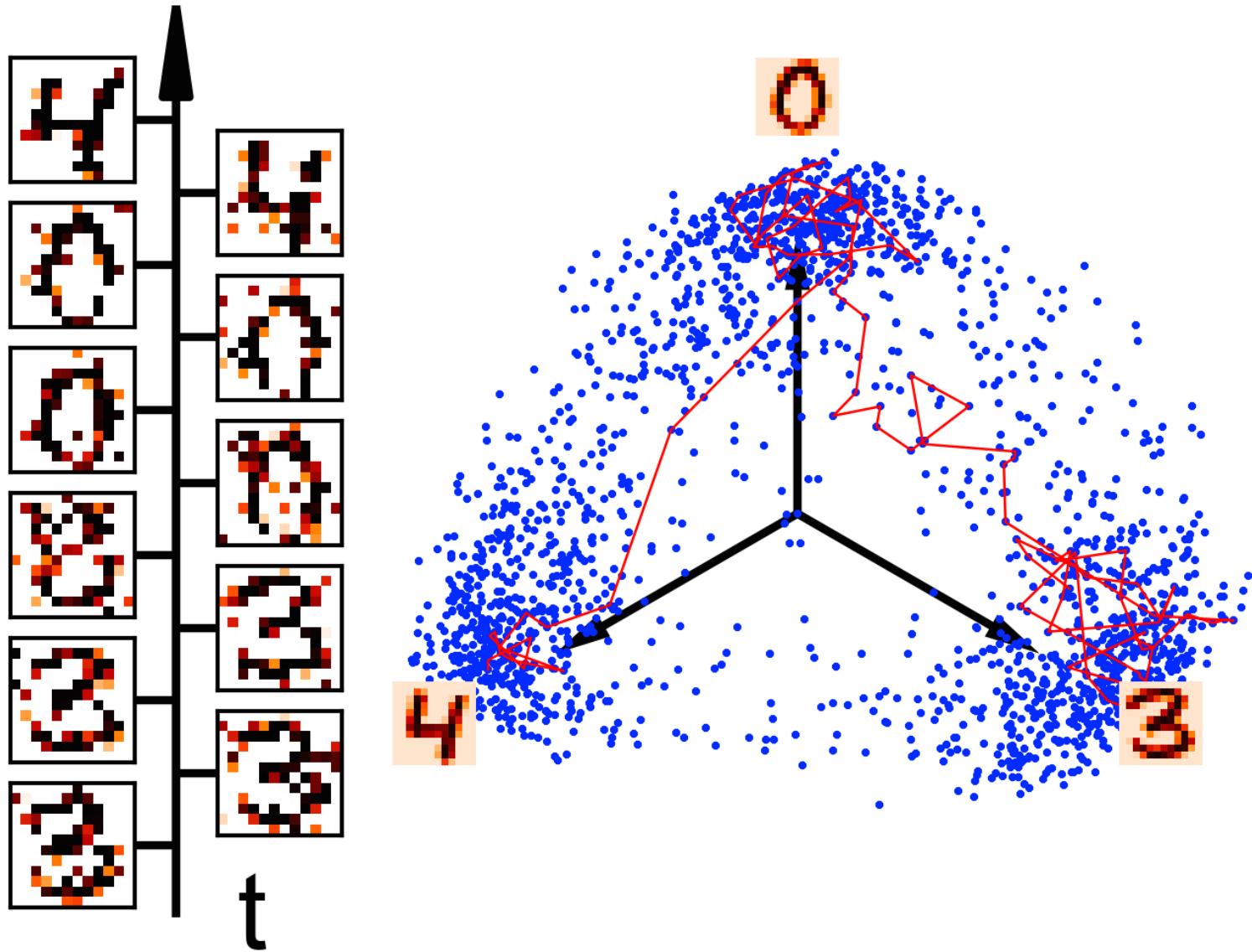


FIG. 20.—Do you see a duck or a rabbit, or either? (From Harper's Weekly, originally in *Fliegende Blätter*.)





Petrovici, Mihai A., et al. "Stochastic inference with deterministic spiking neurons." *arXiv preprint arXiv:1311.3211* (2013).

Growing Number of Projects in the EU and the US

Five Complementary Approaches to Neuromorphic Computing

- Commodity microprocessors (SpiNNaker, HBP) Soft-binary-code
- Custom fully digital (IBM Almaden) Hard-binary-code
- Custom Mixed-Signal (BrainScaleS, HBP) Physical model (accelerated)
- Custom subthreshold analog cells (Stanford) Physical model (real time)
- Custom Hybrid (Qualcomm) Hybrid

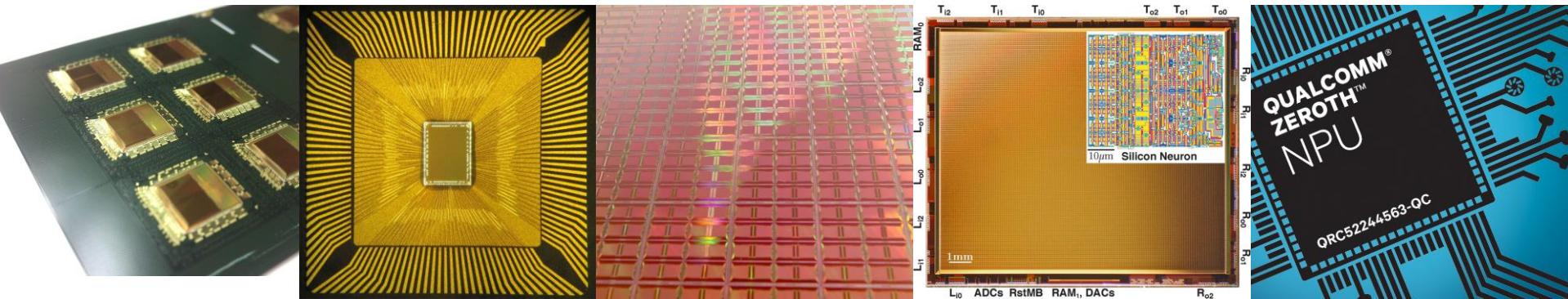
Anything in common ?

Massively parallel

Asynchronous communication

Configurability

COMPLEMENTARITY OF APPROACHES ESSENTIAL !





Human Brain Project



EPSRC

Engineering and Physical Sciences
Research Council

