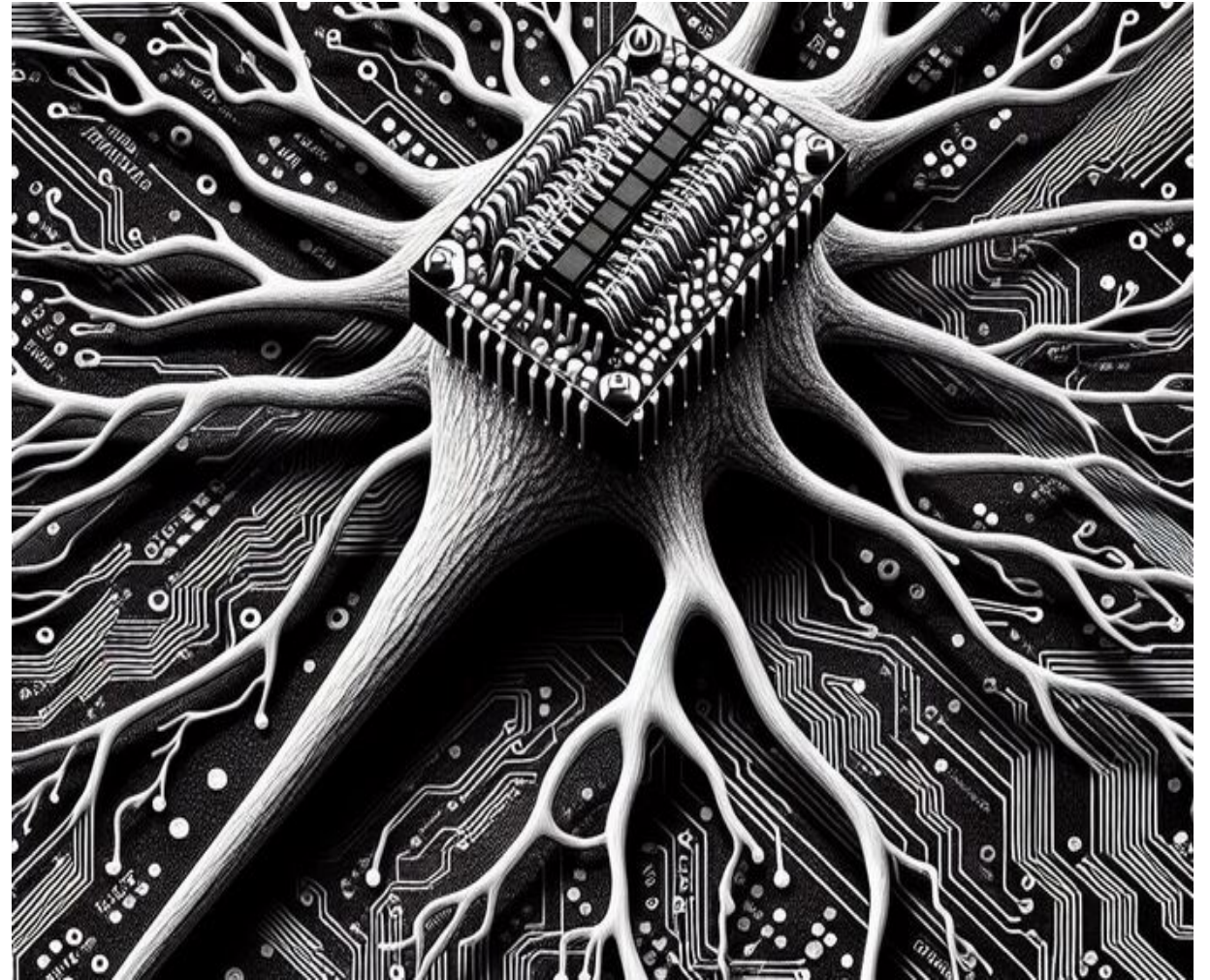


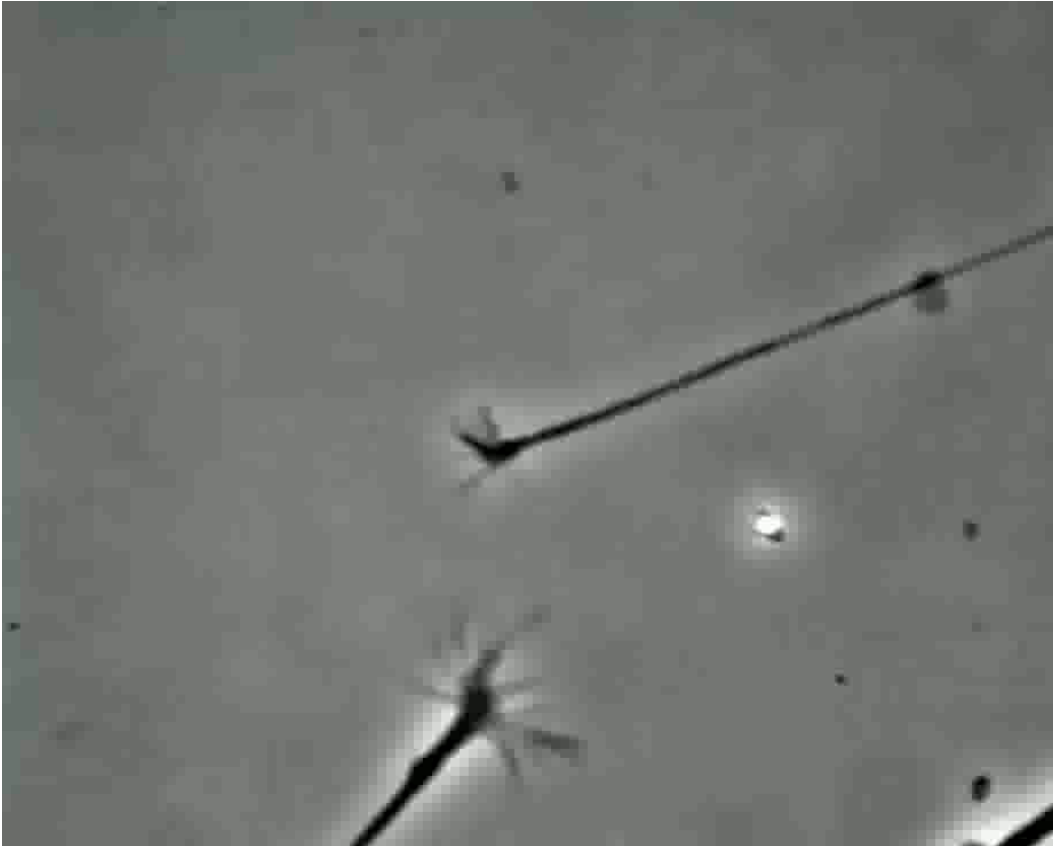
Gehirninspirierte Technologien für effiziente KI

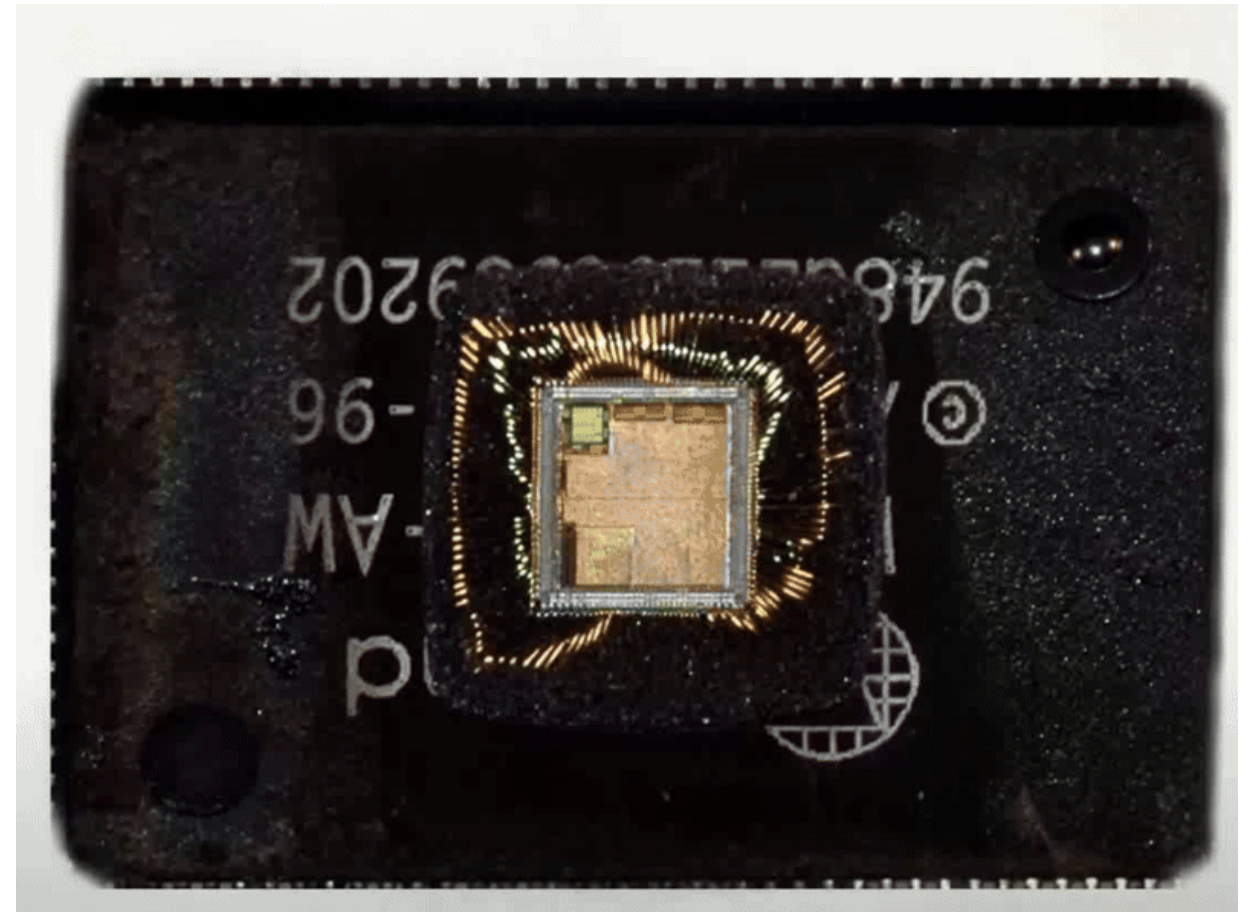
Prof. Dr. Cristian Axenie
Fakultät Informatik

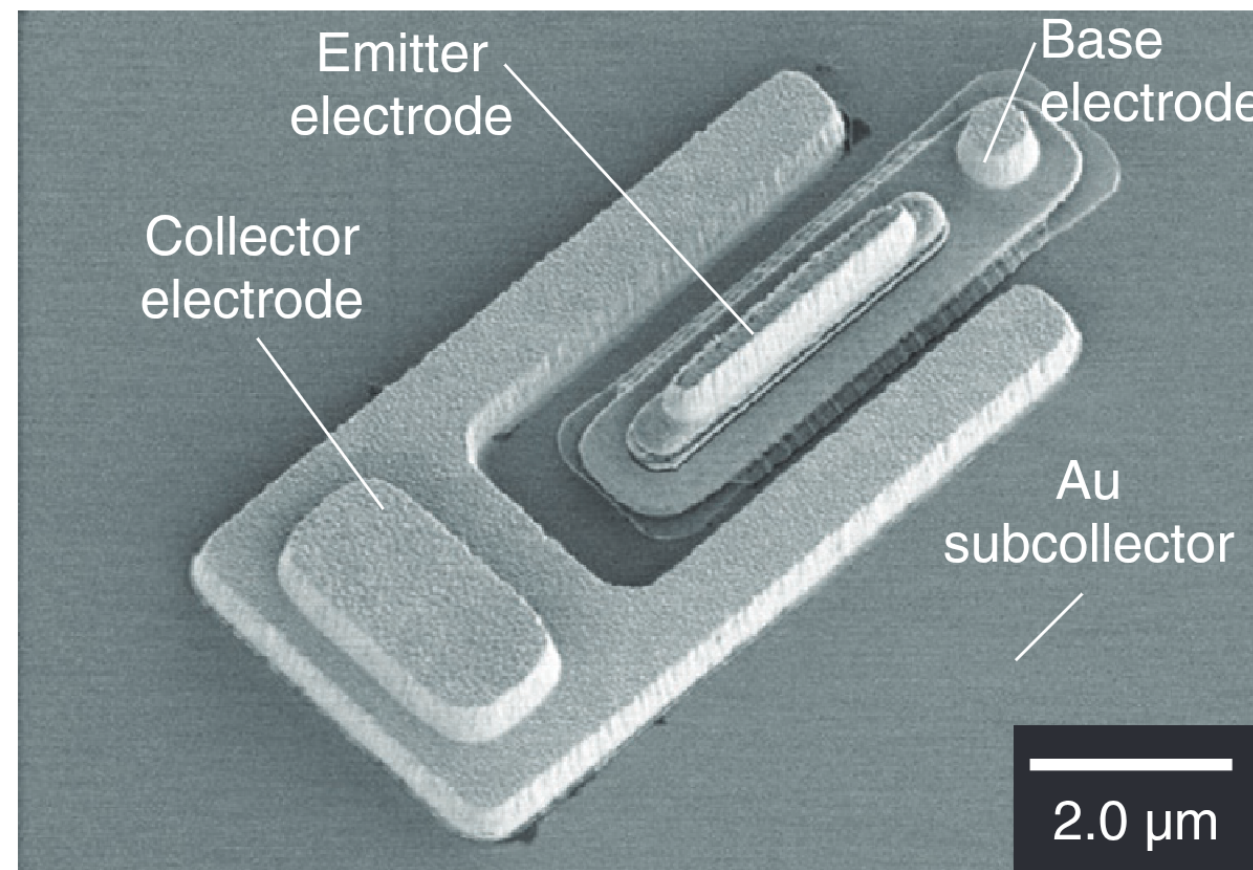
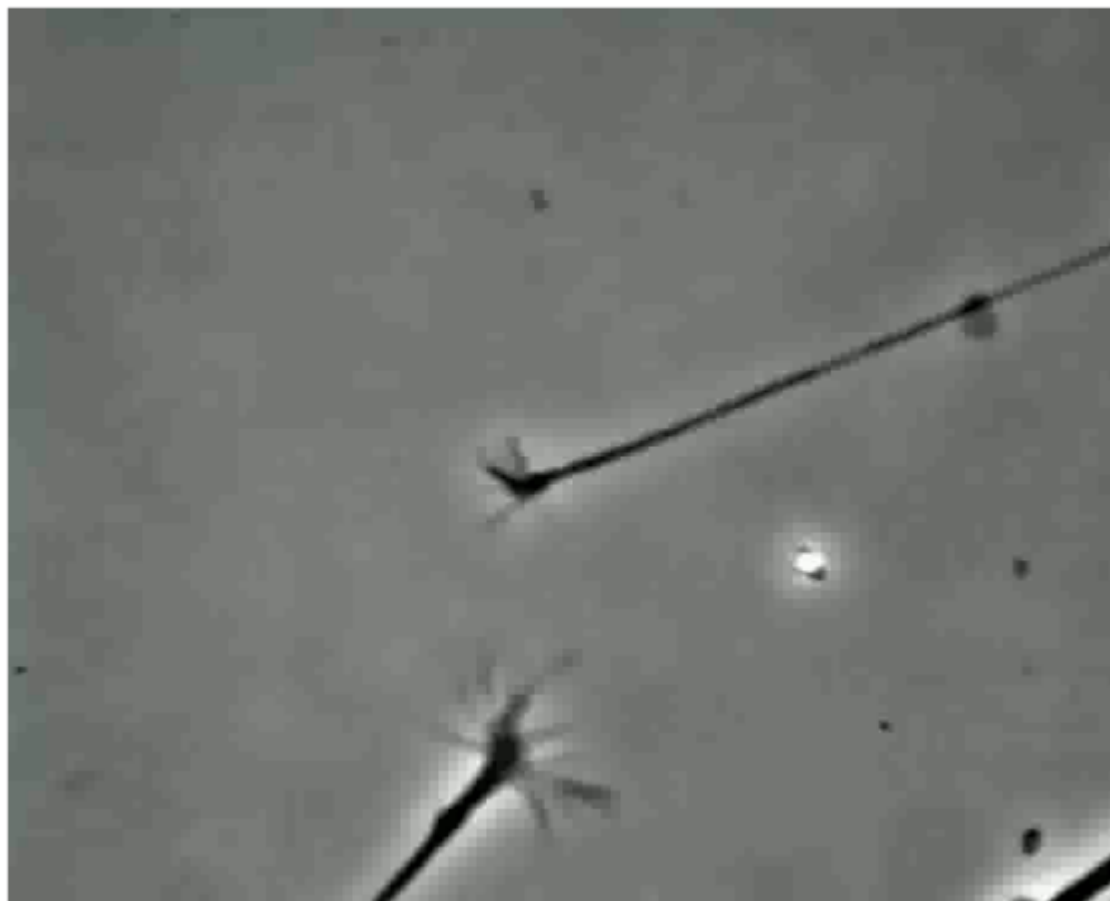




Eine Geschichte über Hardware und Wetware





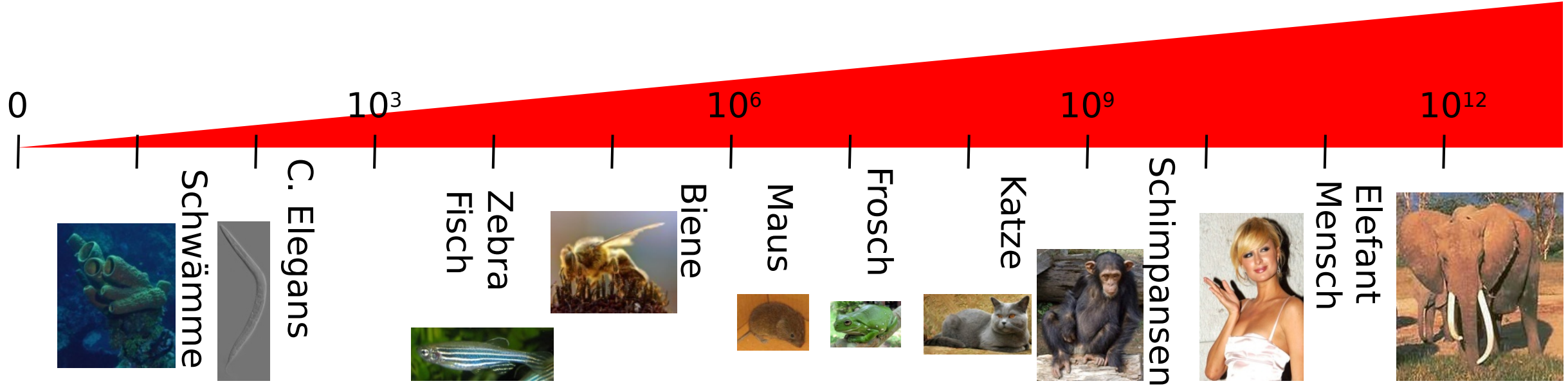




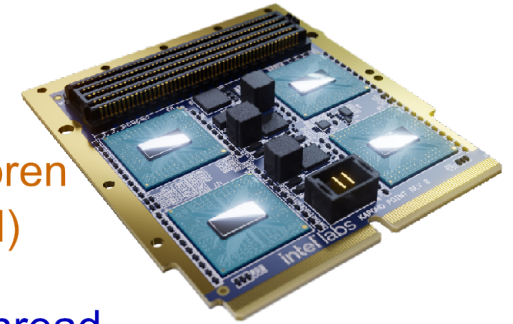
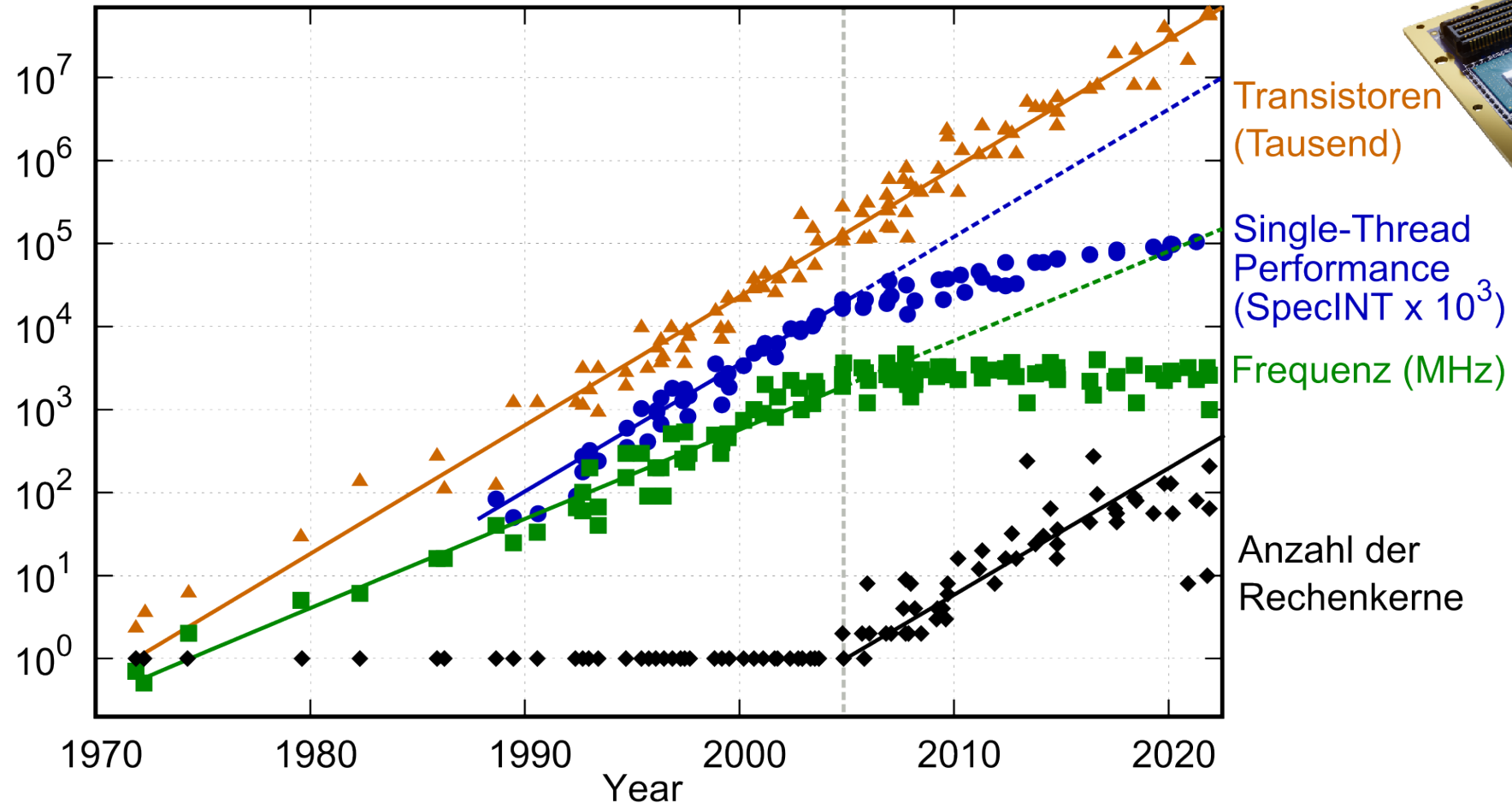
Von Zellen und Transistoren bis hin zu Systemen



Ist die Größe wichtig?

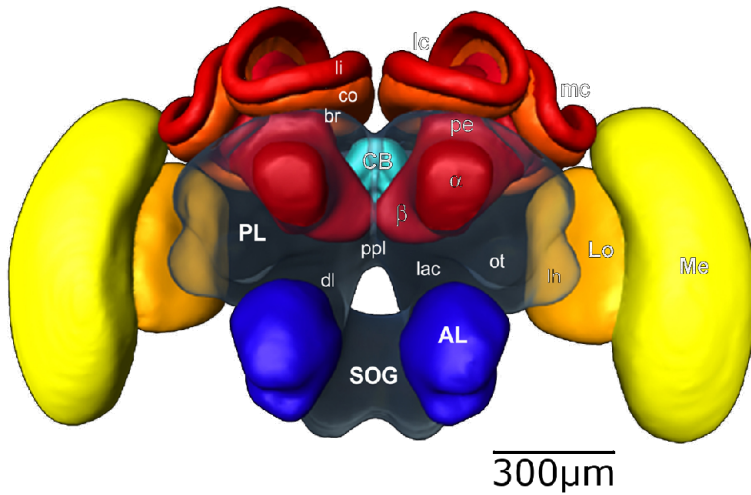


Ist die Größe wichtig?





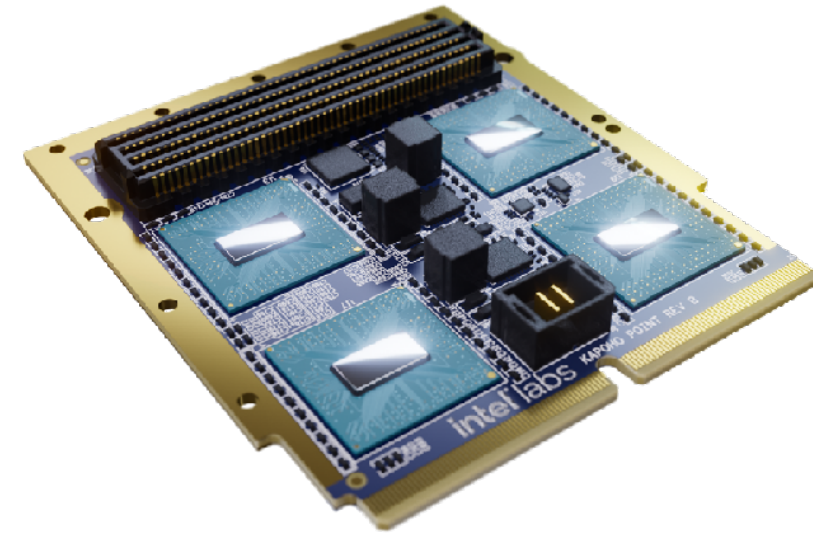
Ein erster Vergleich ...



Modified from: Rybak et al., Frontiers in Syst. Neuro.,
 DOI: <https://doi.org/10.3389/fnsys.2010.00030>

Bienengehirn

- ~1 Mio. Nervenzellen
- < 10 μW
- < 1mm³



Kapoho Point. Image rights: Intel.

Prozessor

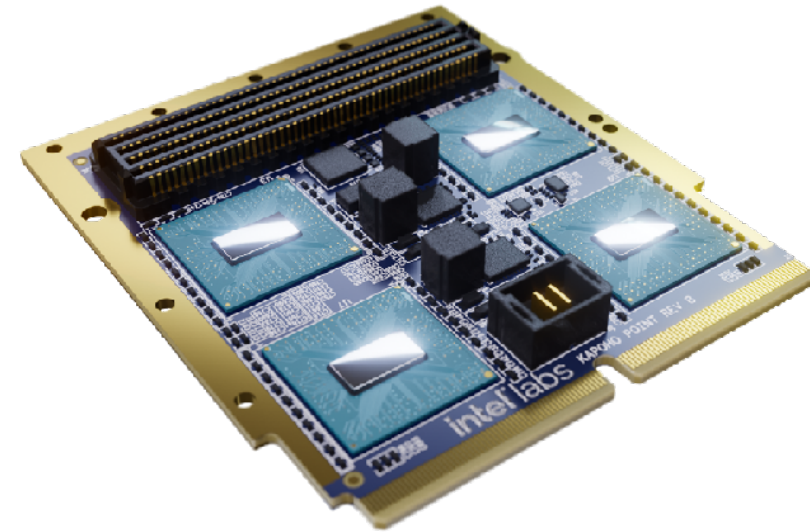
- 2,3 Milliarden Transistoren, ~1 Mio. Nervenzellen
- > 1 W = 1.000.000μW
- ~8 cm x 8 cm



Asus GeForce RTX 4090.
Image rights: gpu-monkey.com

Grafikkarte

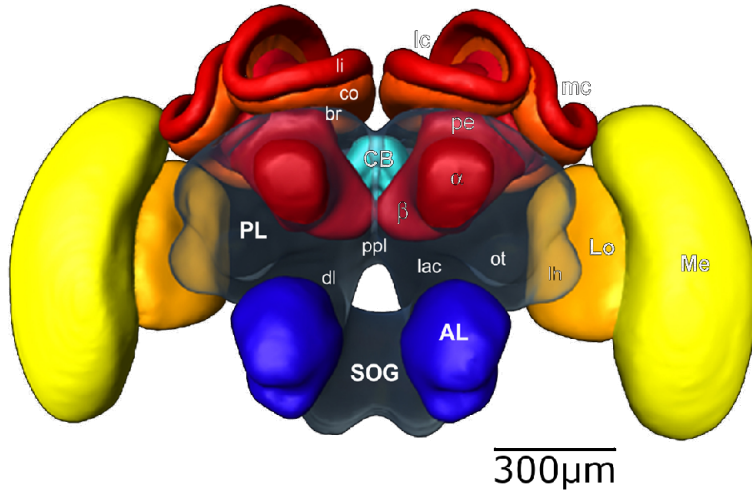
- ~86 000 Milliarden FLOPs/s
- 100-400 W
- 36 cm x 15 cm x 7cm



Kapoho Point. Image rights: Intel.

Prozessor

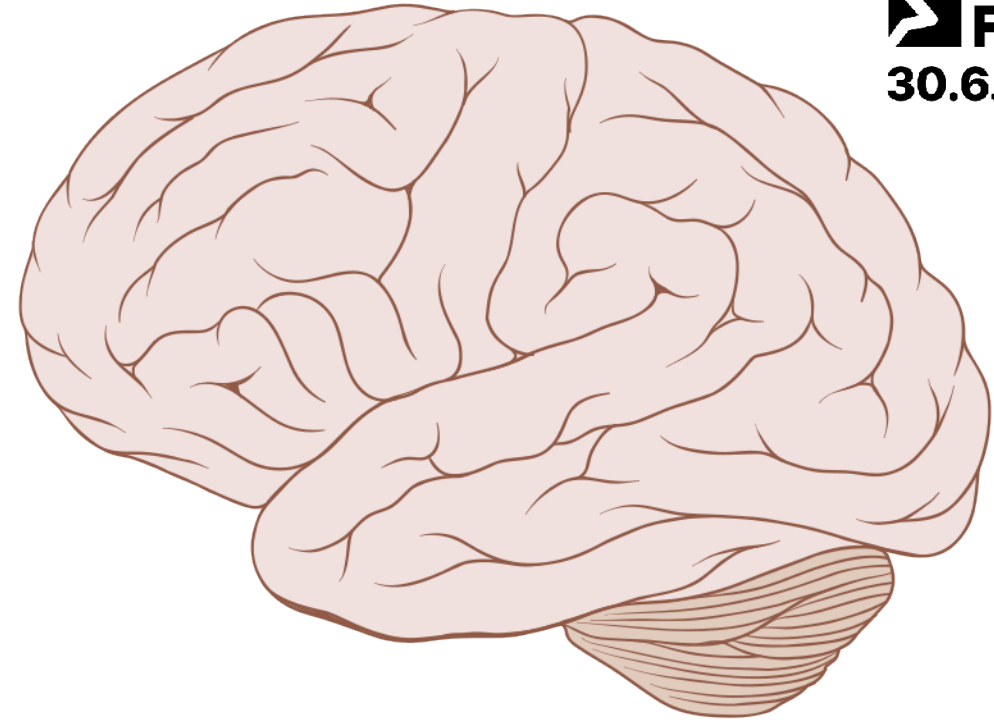
- ~1 Mio. Nervenzellen (2,3 Milliarden Transistoren)
- $> 1 \text{ W} = 1.000.000 \mu\text{W}$
- ~8 cm x 8 cm



Modified from: Rybak et al., Frontiers in Syst. Neuro.,
 DOI: <https://doi.org/10.3389/fnsys.2010.00030>

Bienengehirn

- ~1 Mio. Nervenzellen
- < 10 μ W
- < 1mm³

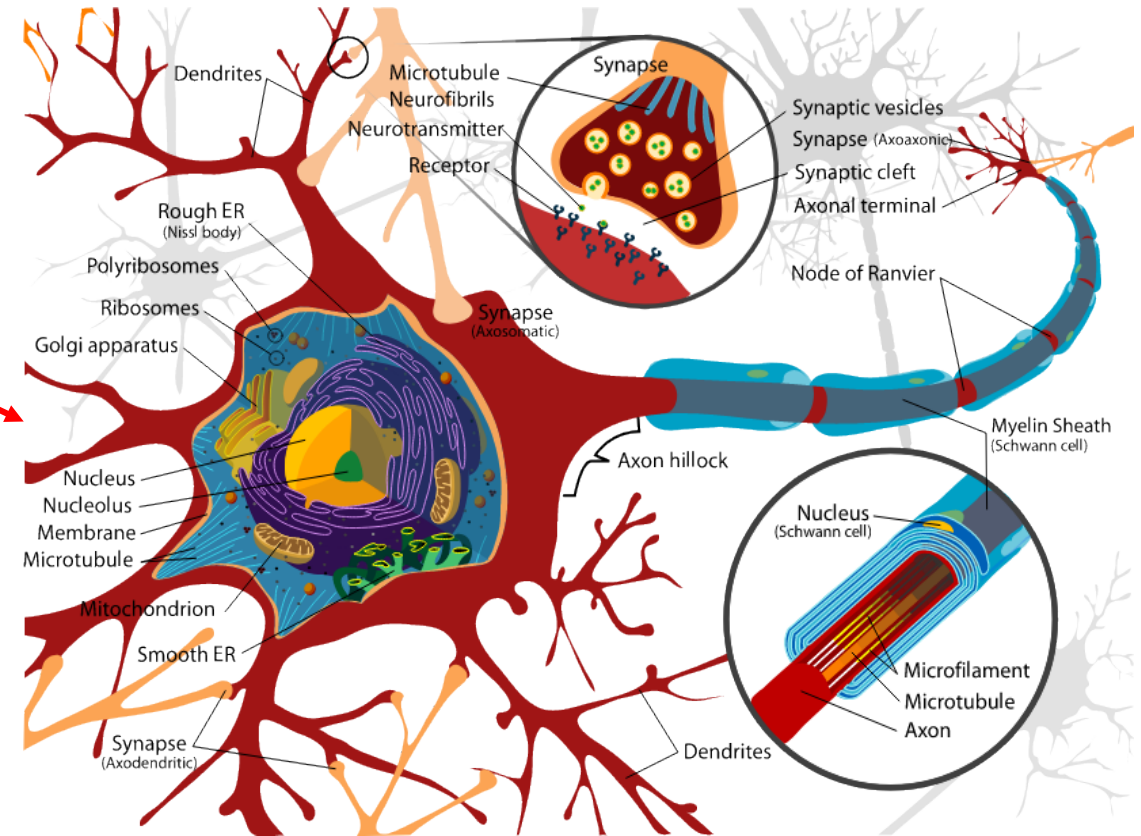
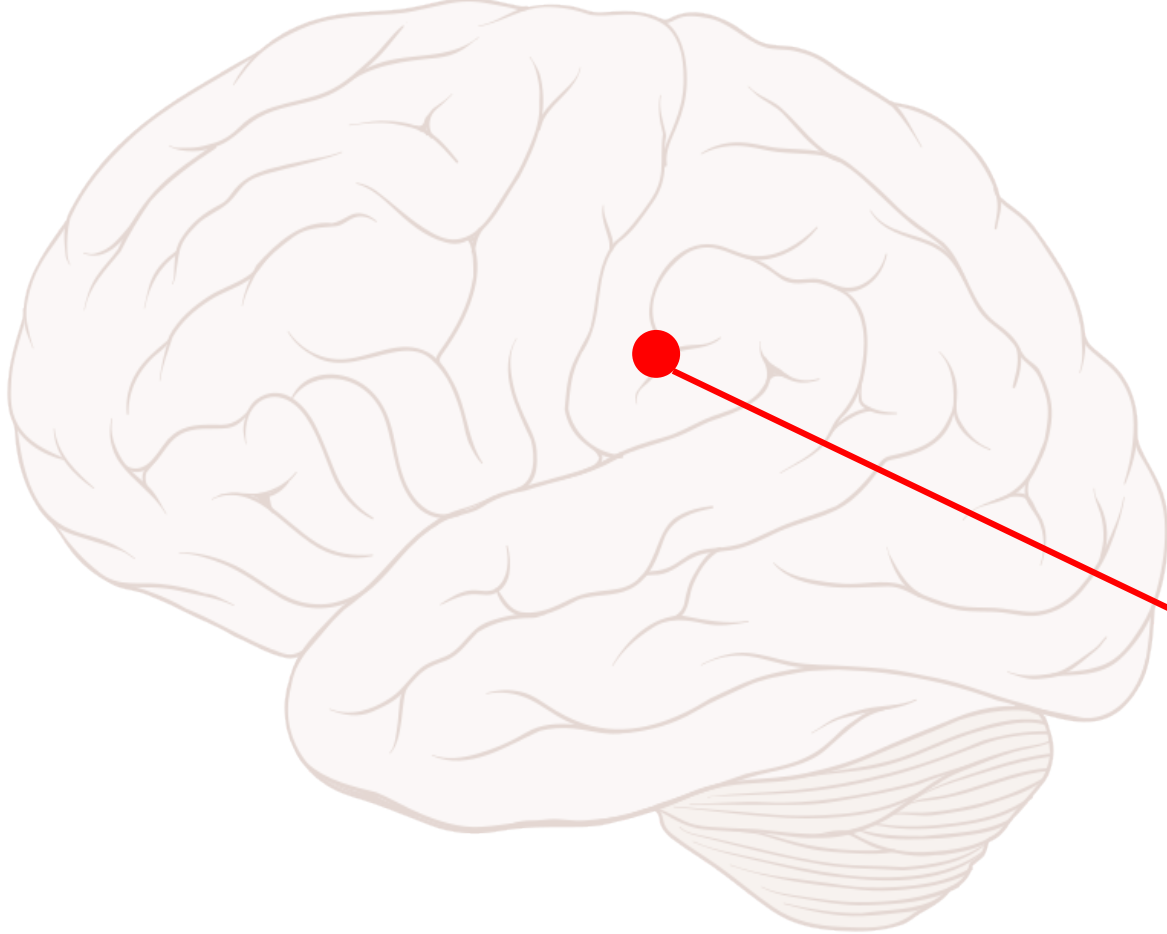


Menschliches Gehirn

- ~100 Milliarden Nervenzellen
- < 20 W
- ~1200 cm³ , ~1.3 Kg

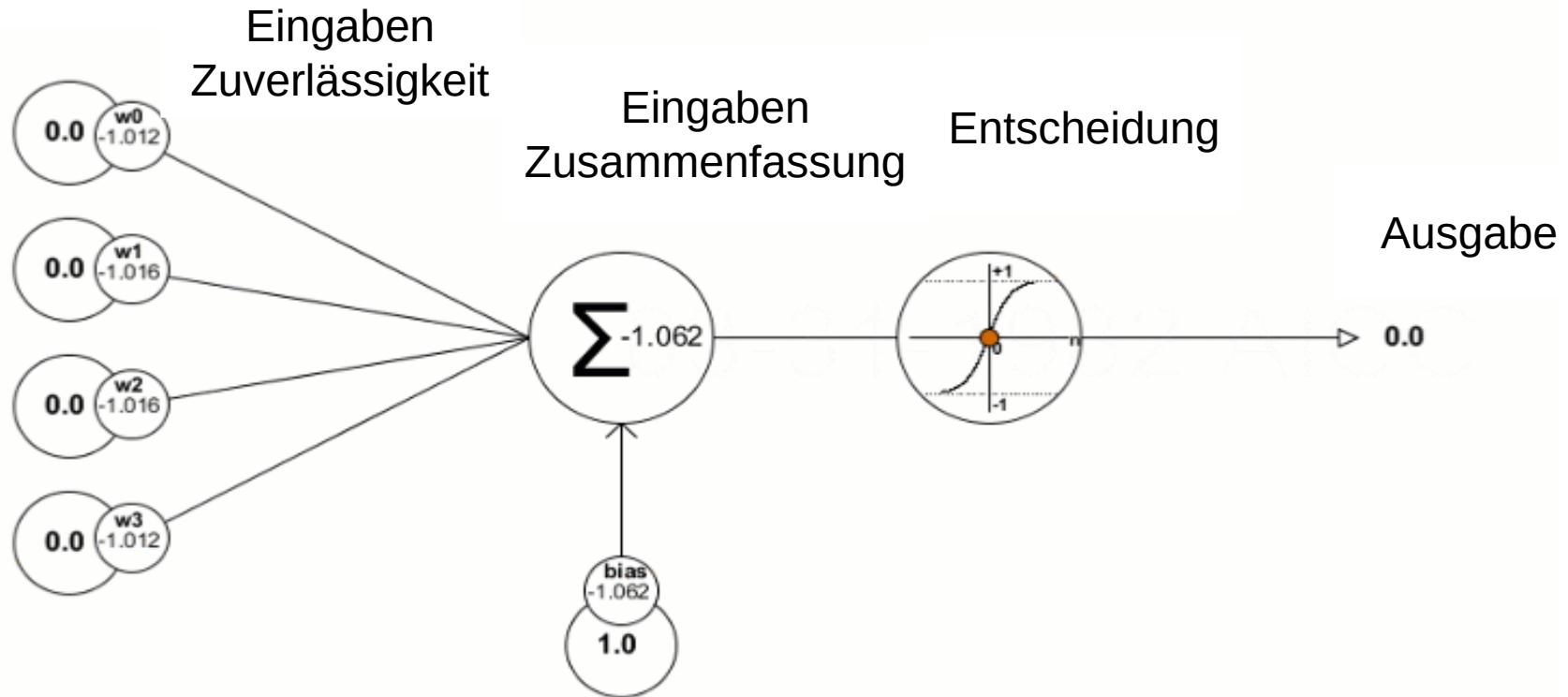


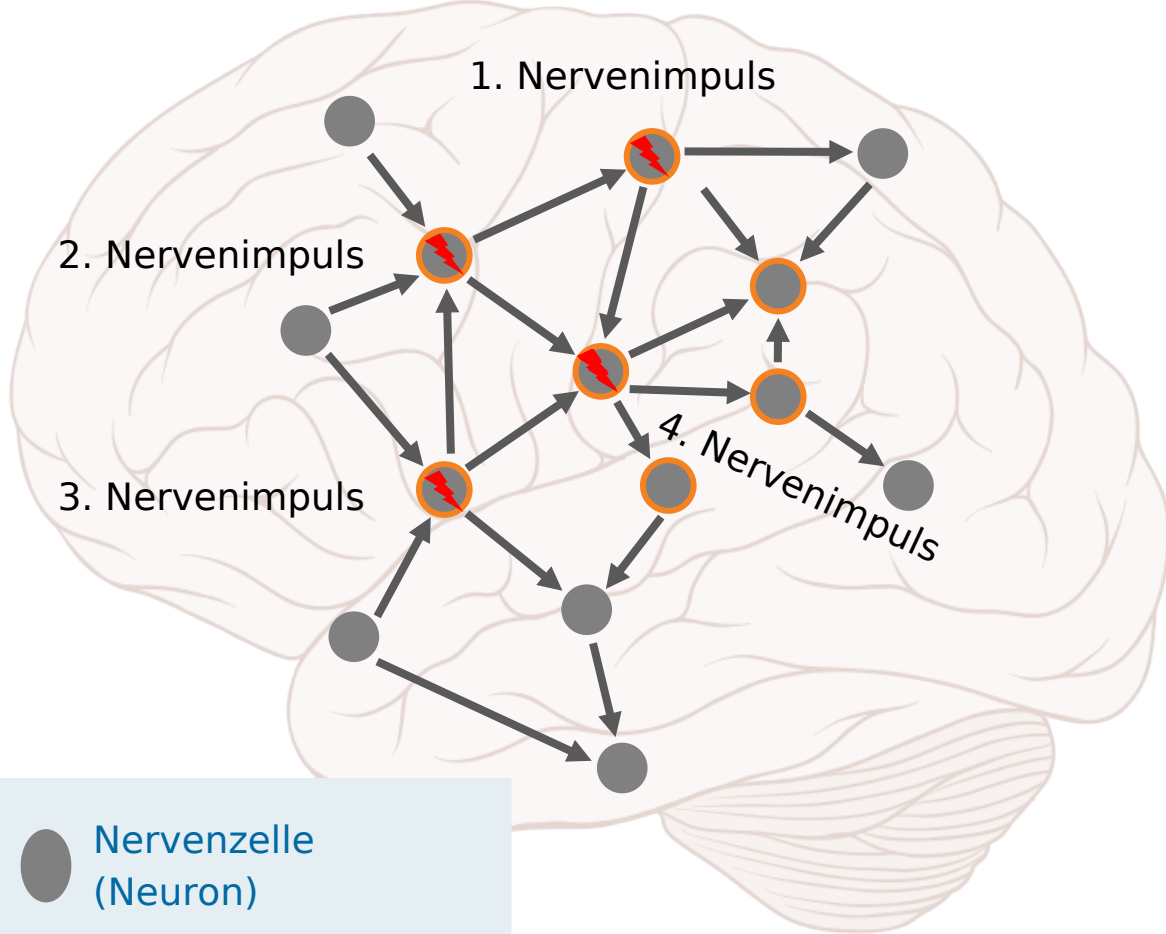
Romantischer Reduktionismus



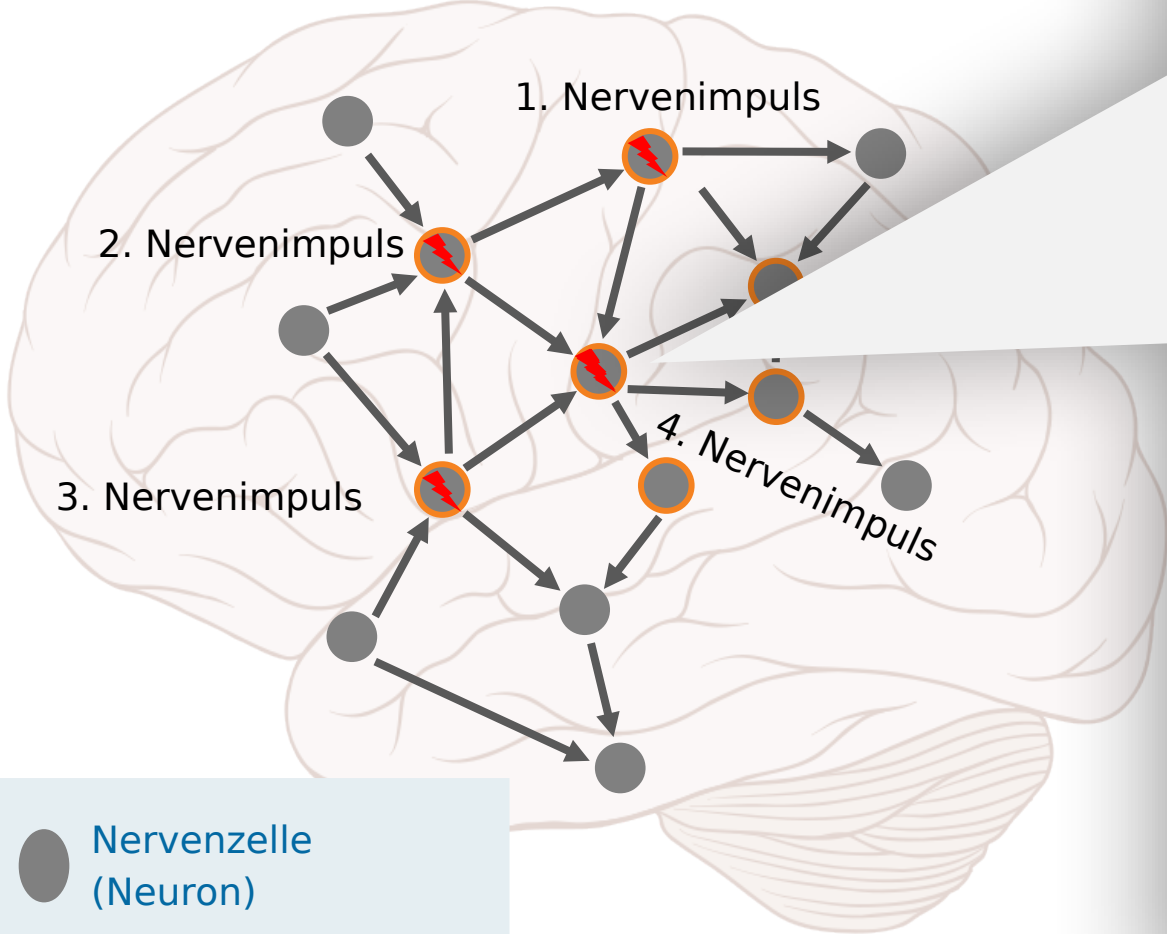


Eingaben

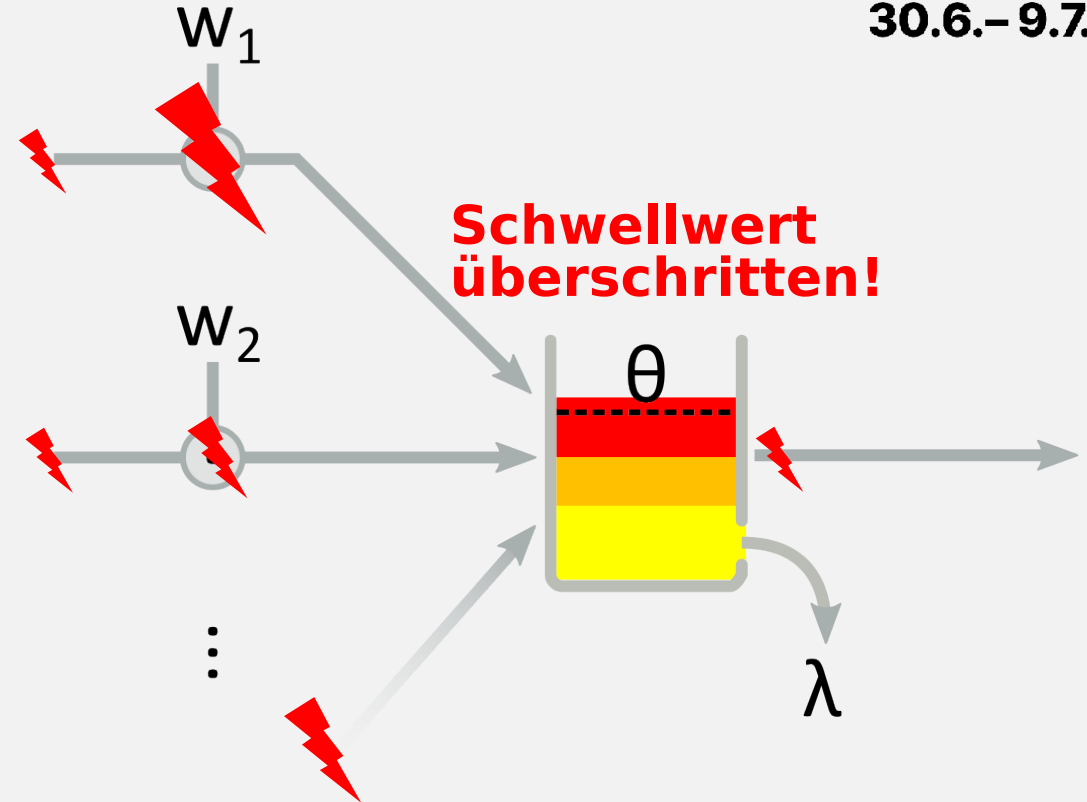




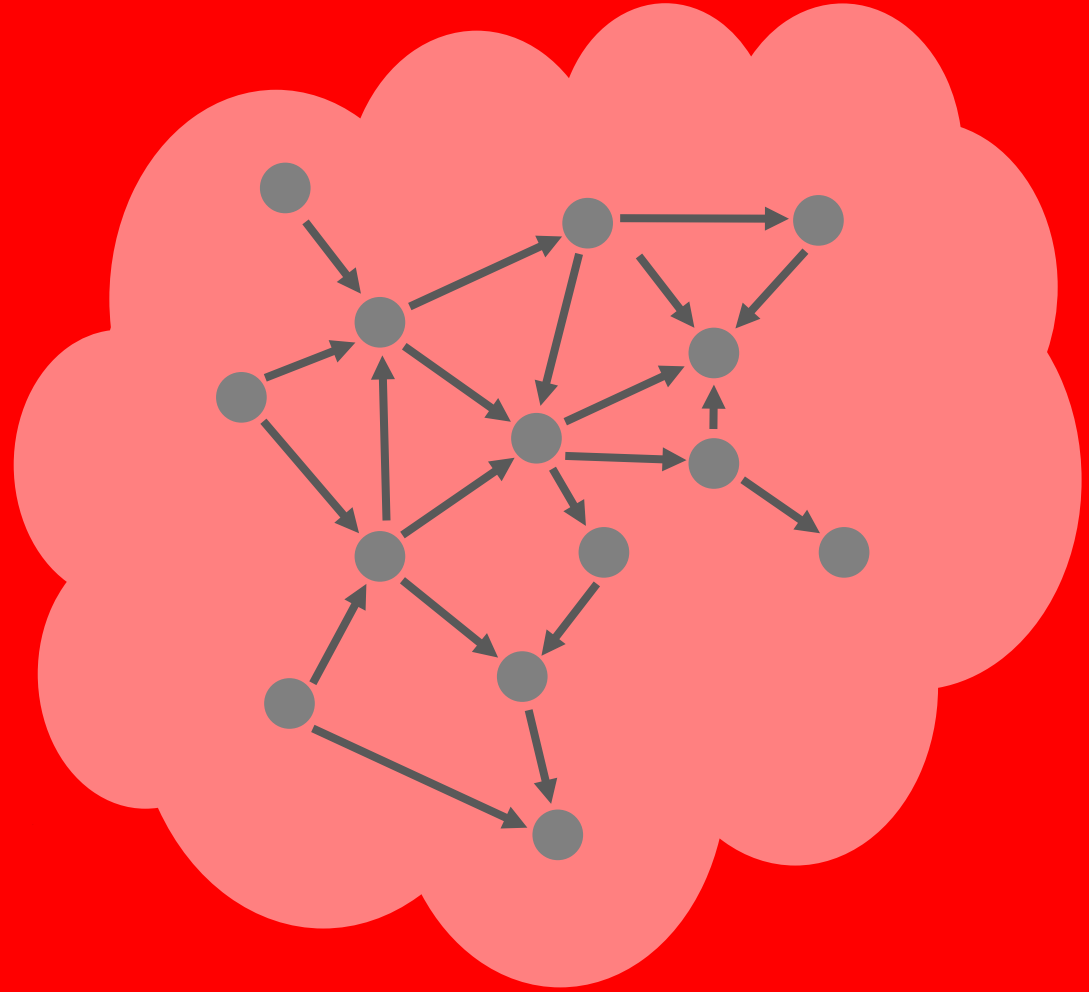
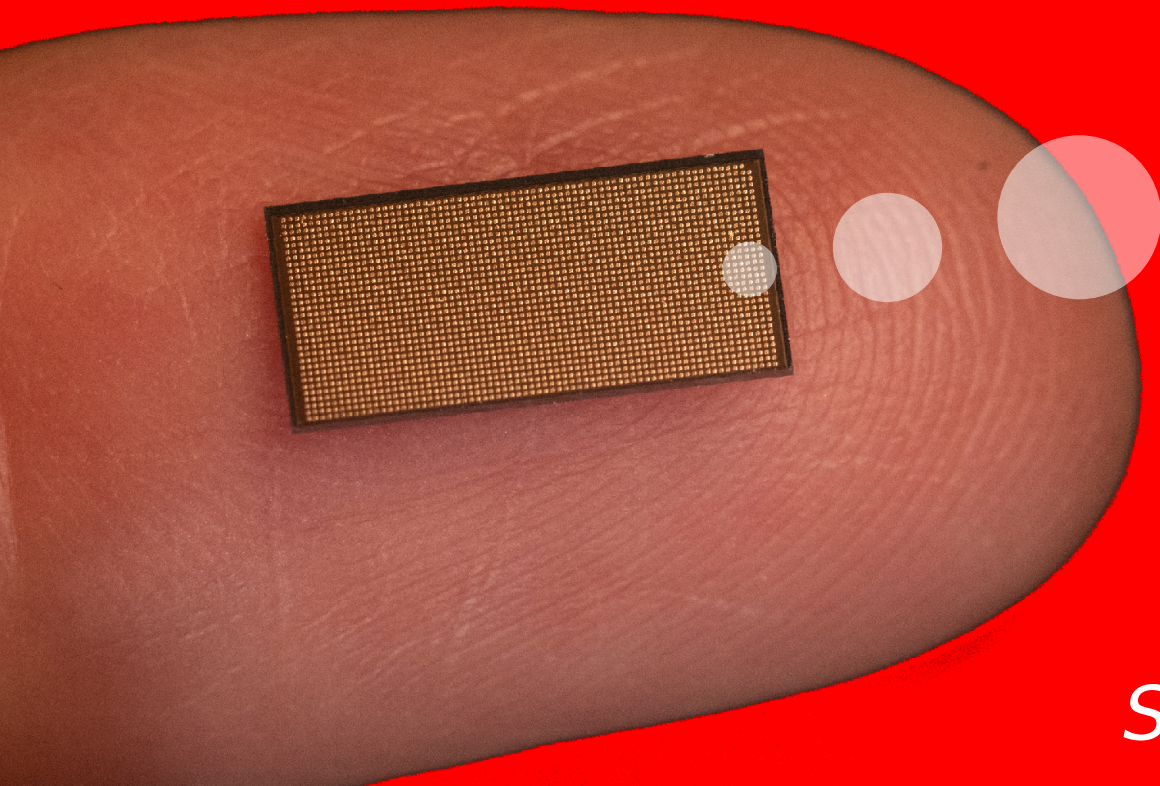
-  Nervenzelle
(Neuron)
-  Verbindung
(Synapse)
-  Nervenimpuls
(Spike)



-  Nervenzelle (Neuron)
-  Verbindung (Synapse)
-  Nervenimpuls (Spike)

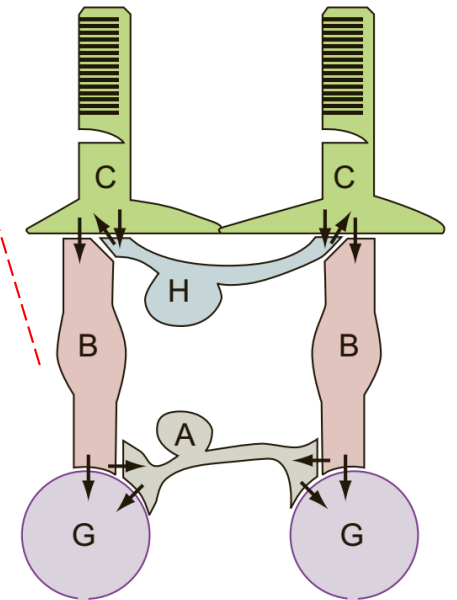
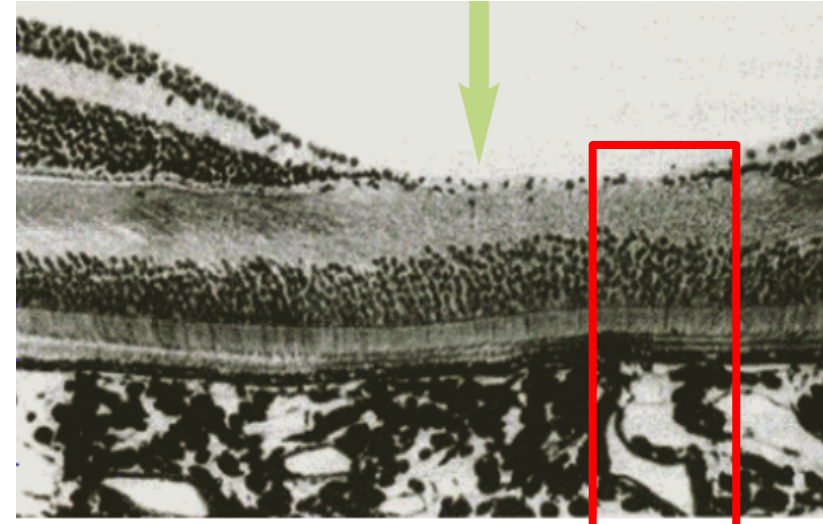
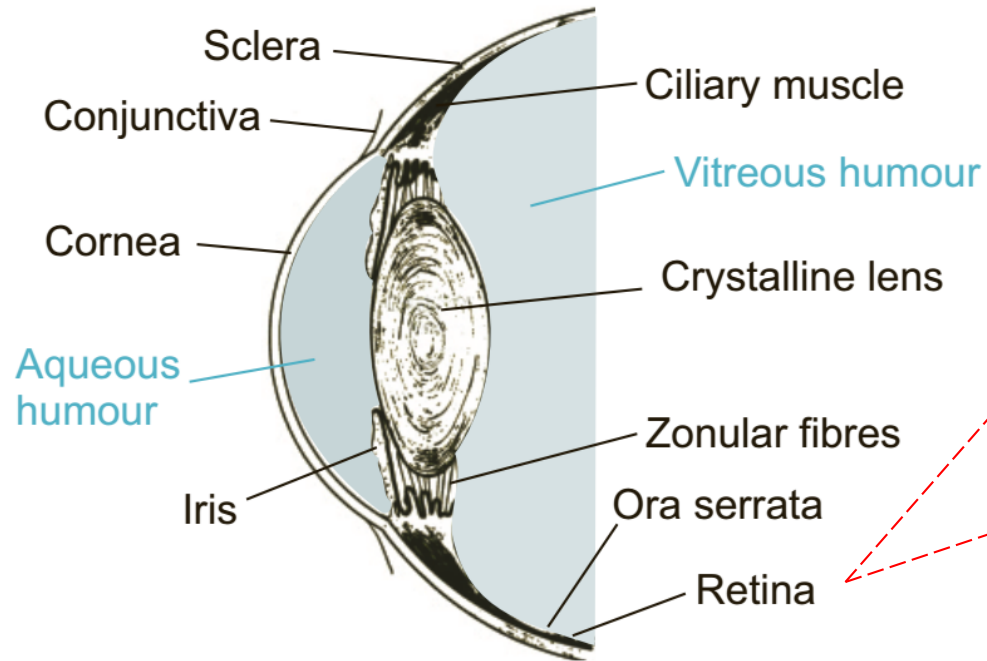


Der Neuromorphic Computing Ansatz:



*Spezialisierte Computerchips für
Künstliche Neuronale Netze!*

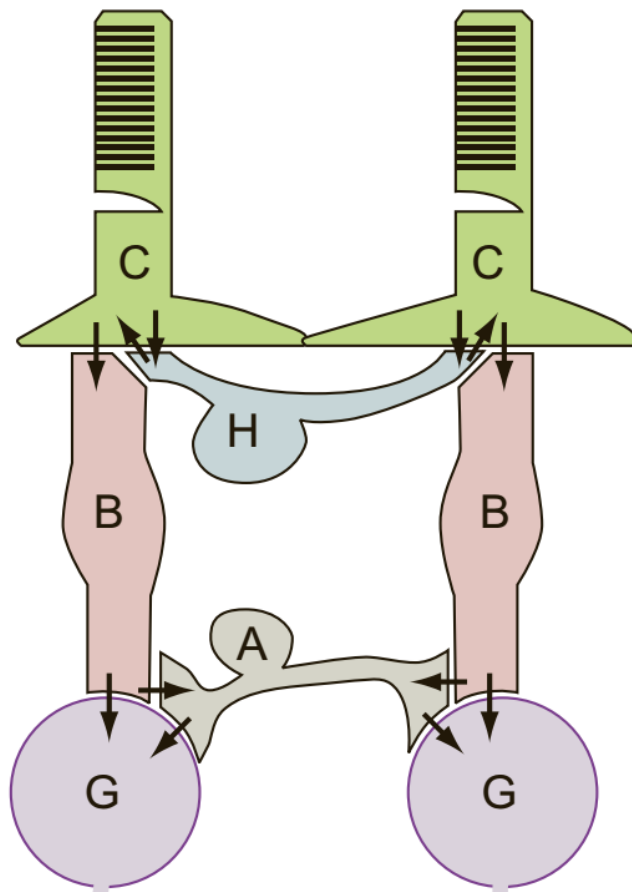
Neuromorphe Sensorik



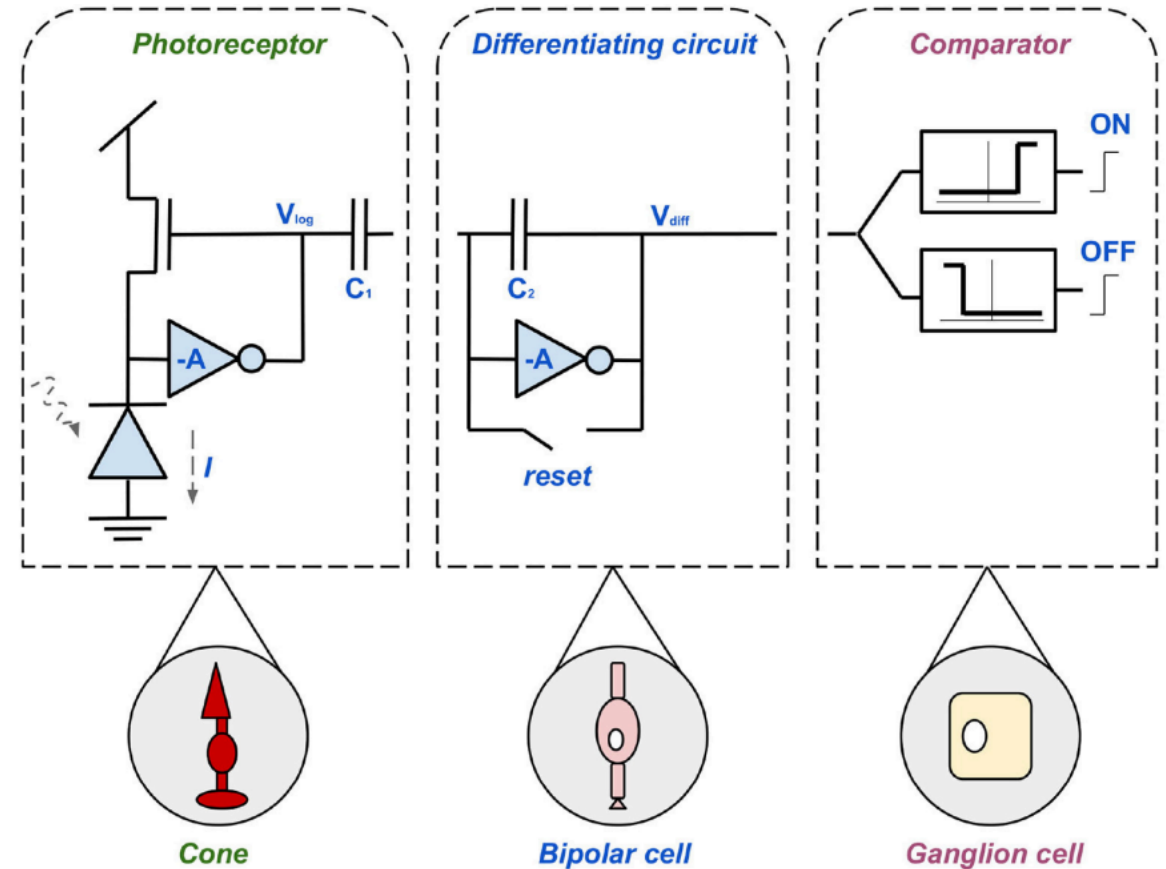
Stäbchen, Zapfen, Ganglien



Neuromorphe Sensorik

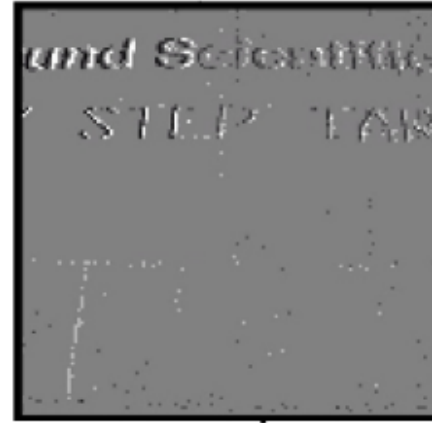
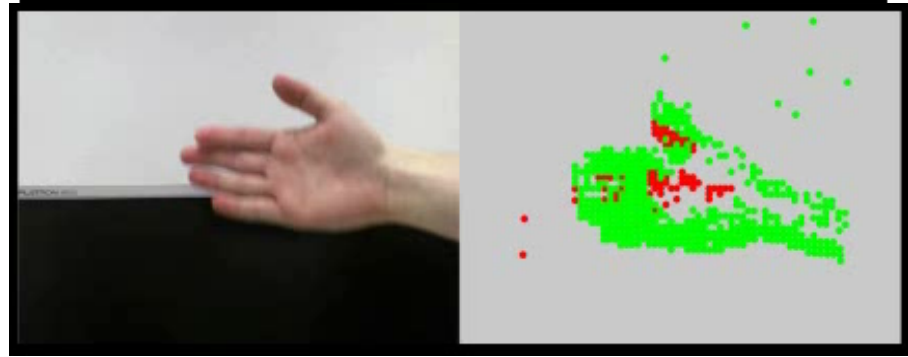


Stäbchen, Zapfen, Ganglien





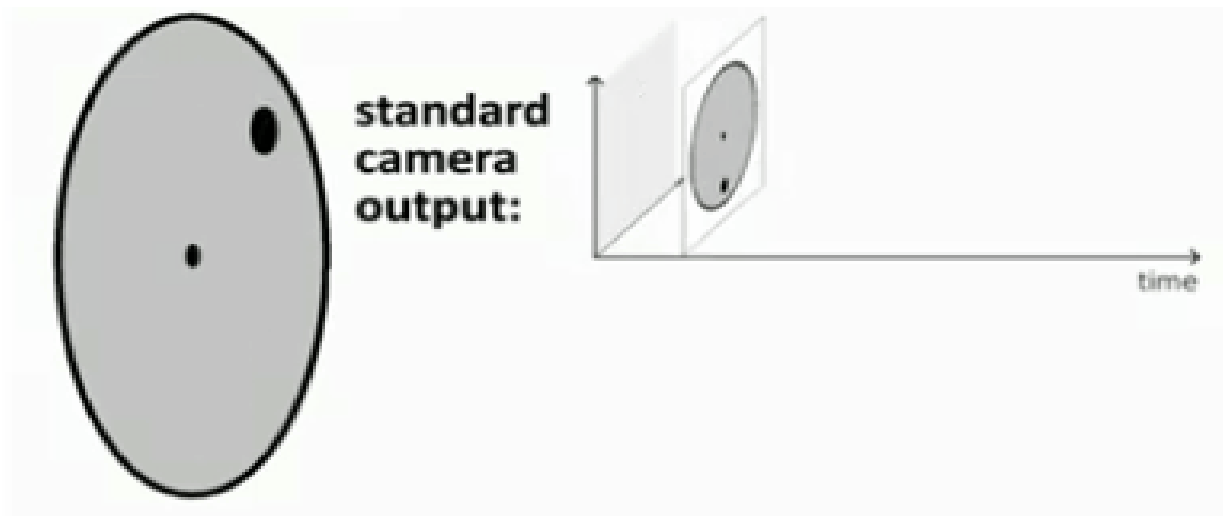
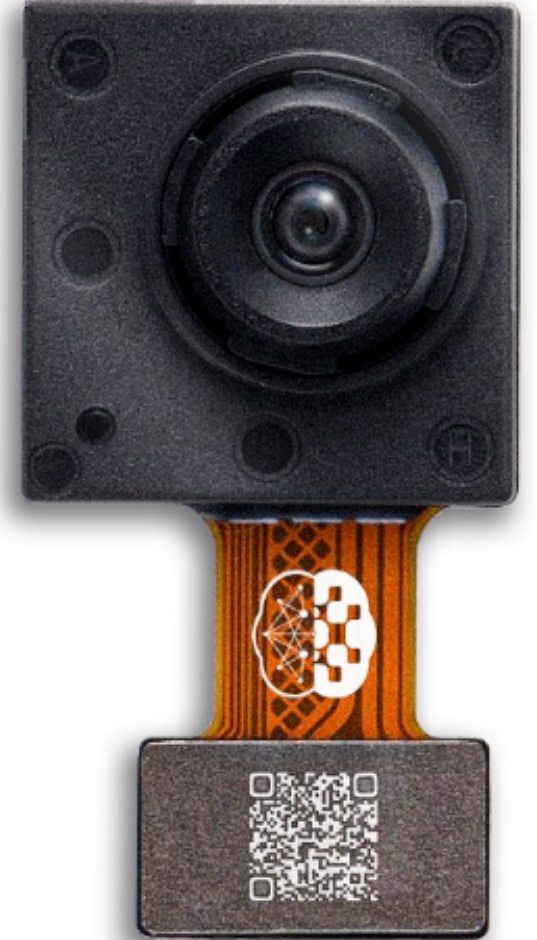
Neuromorphe Sensorik



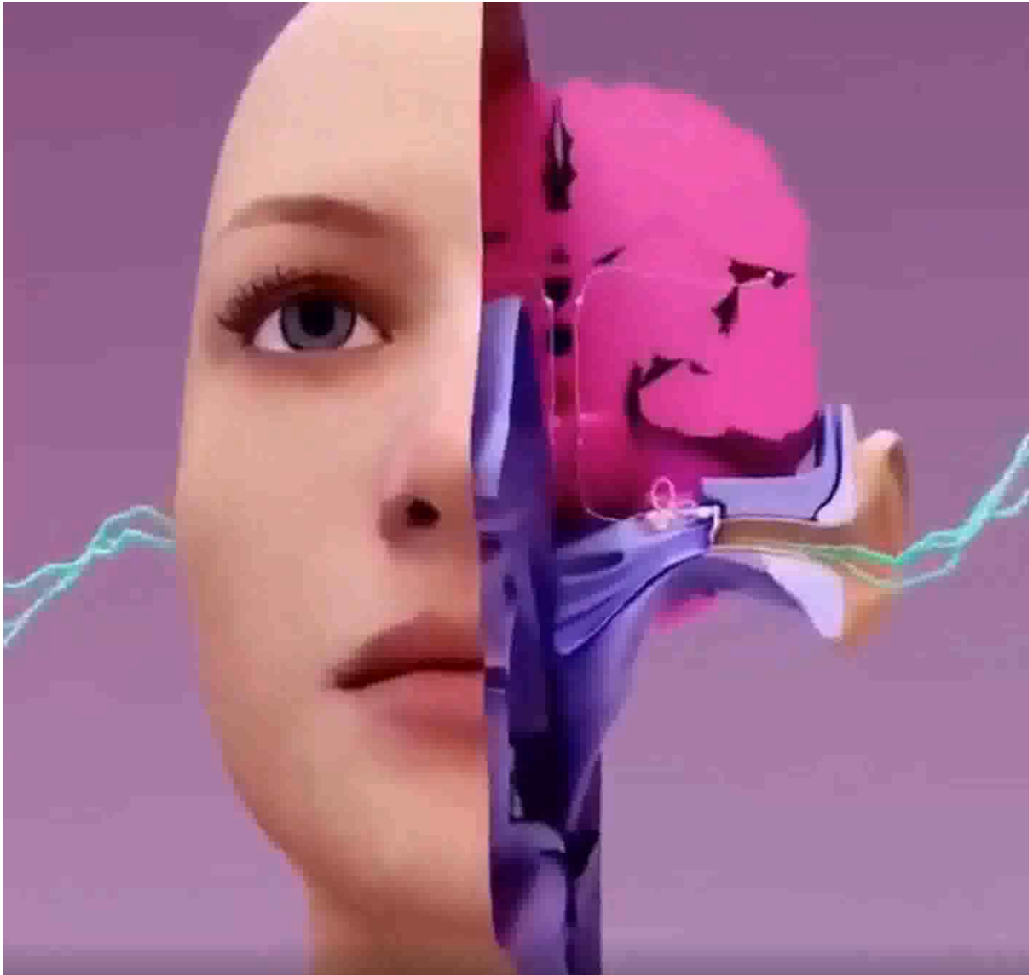
780 lux : 5.8 lux



Edmund 0.1 density chart
Illumination ratio=135:1

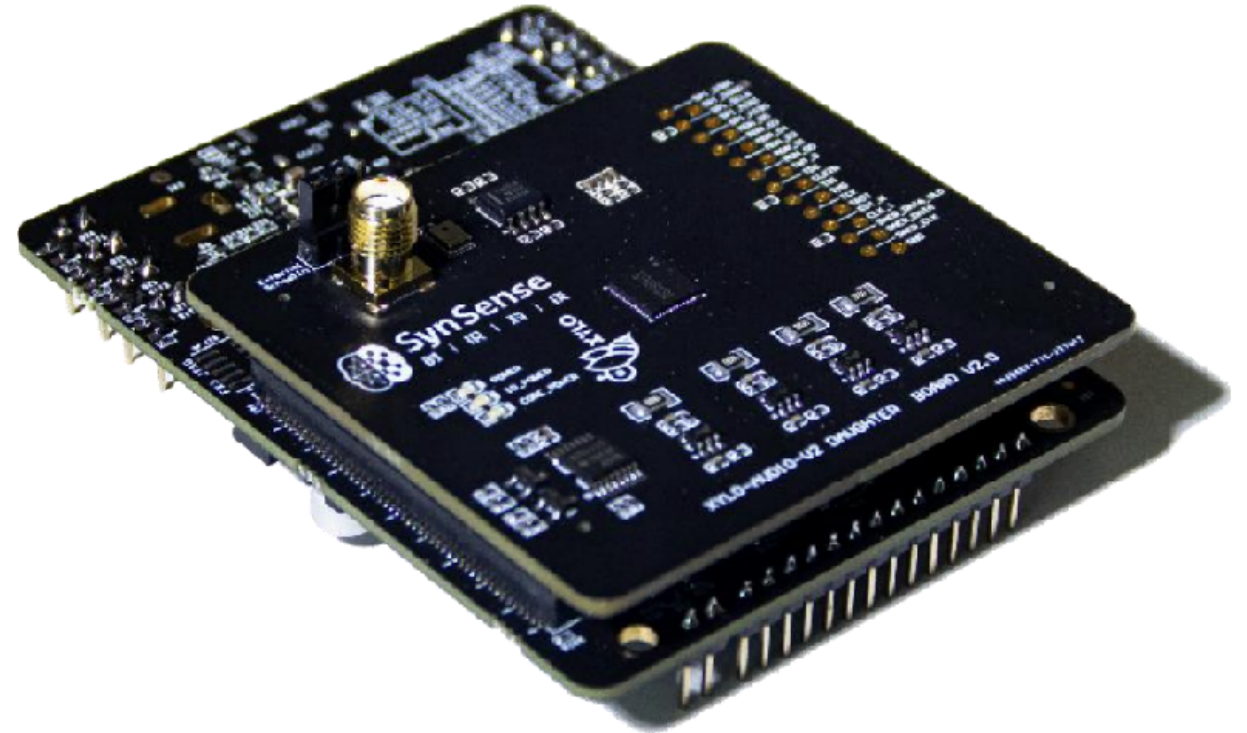
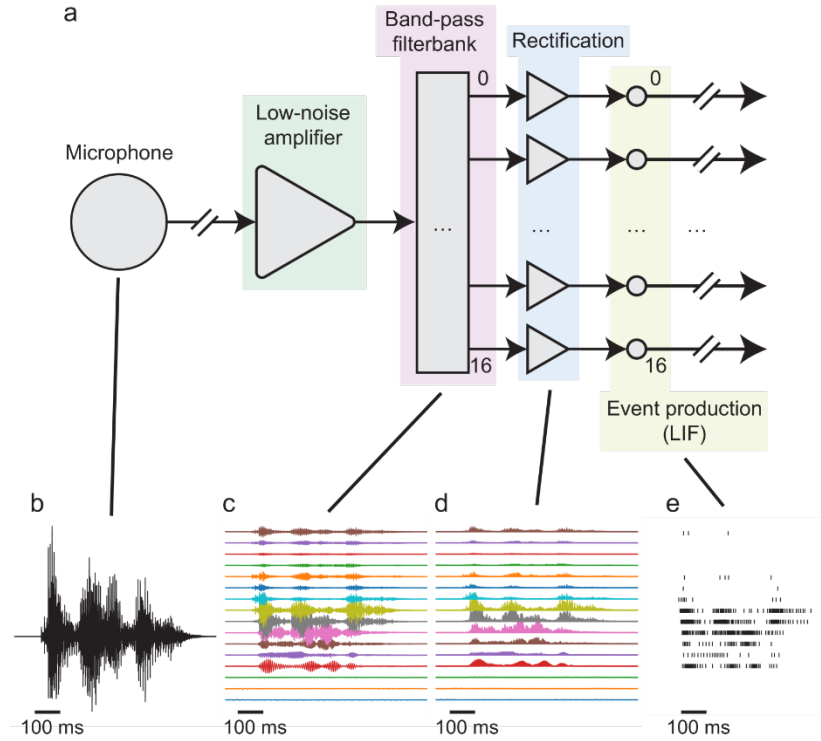


Neuromorphe Sensorik



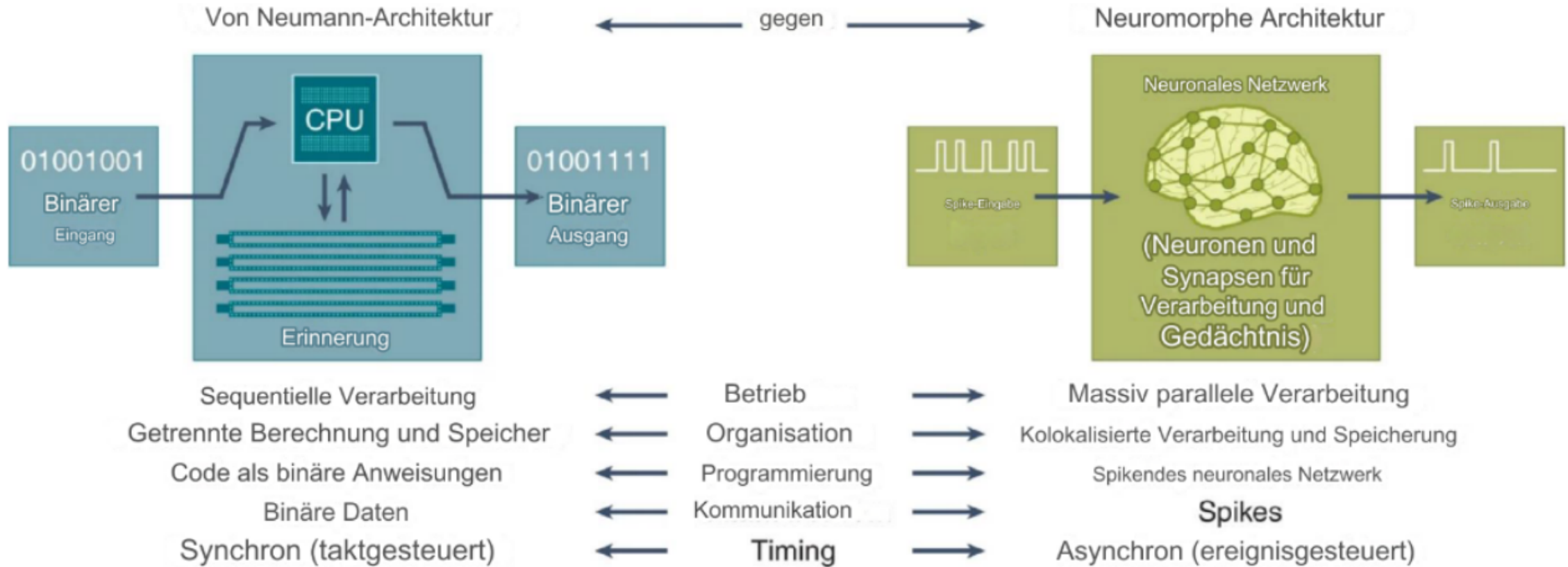


Neuromorphe Sensorik

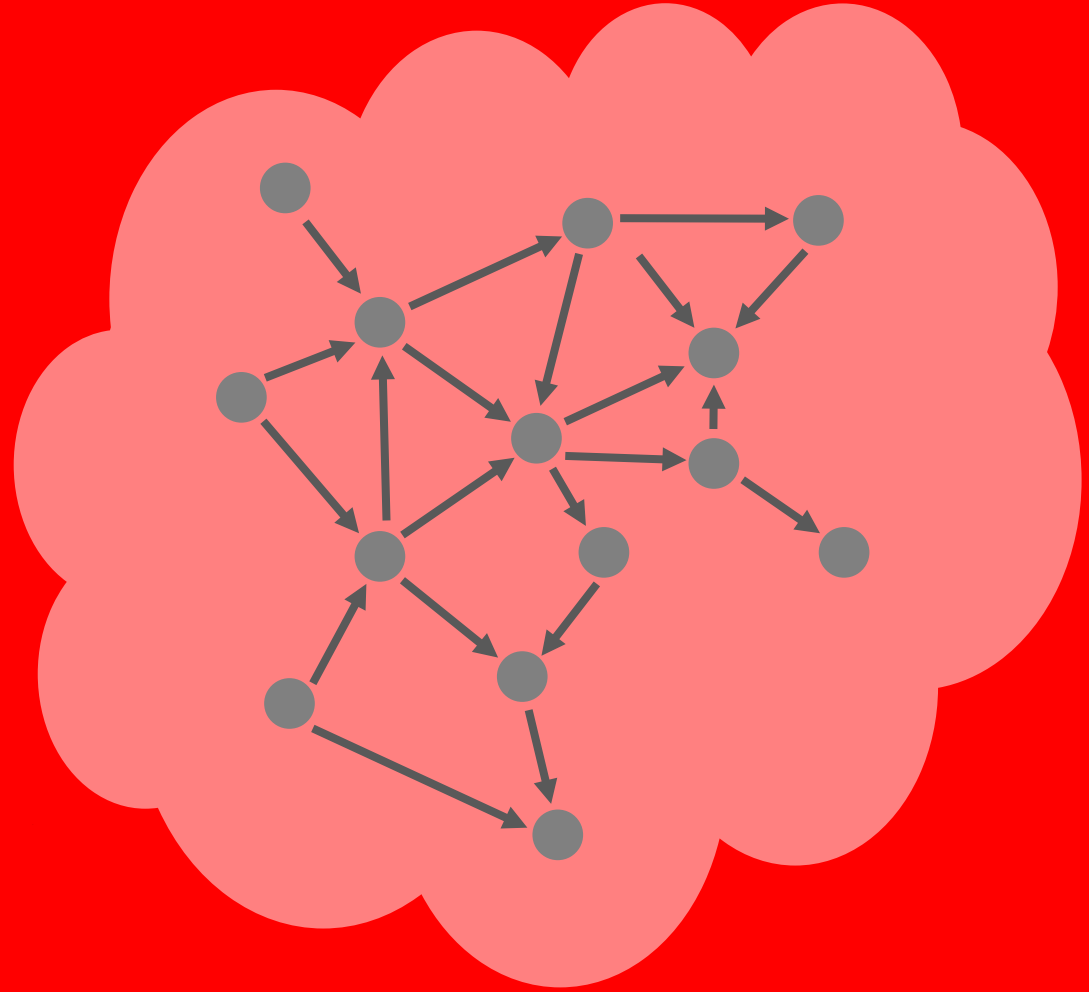
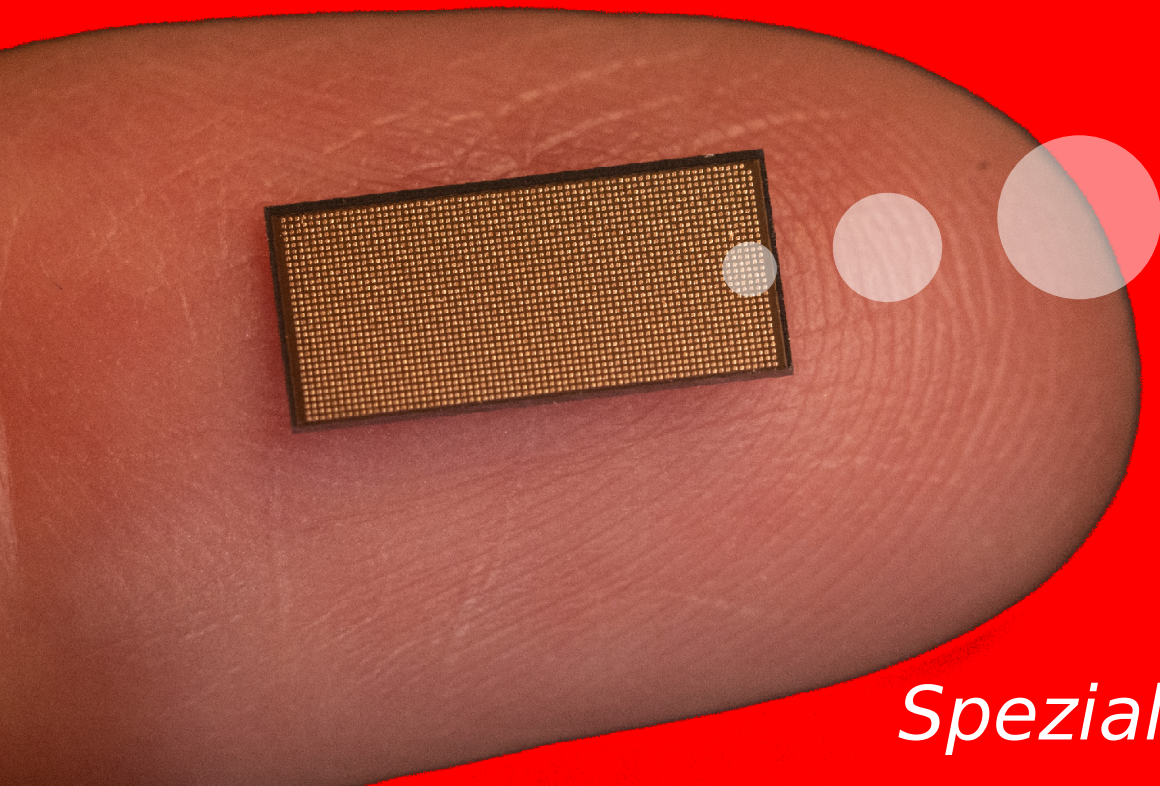




Neuromorphe Computer



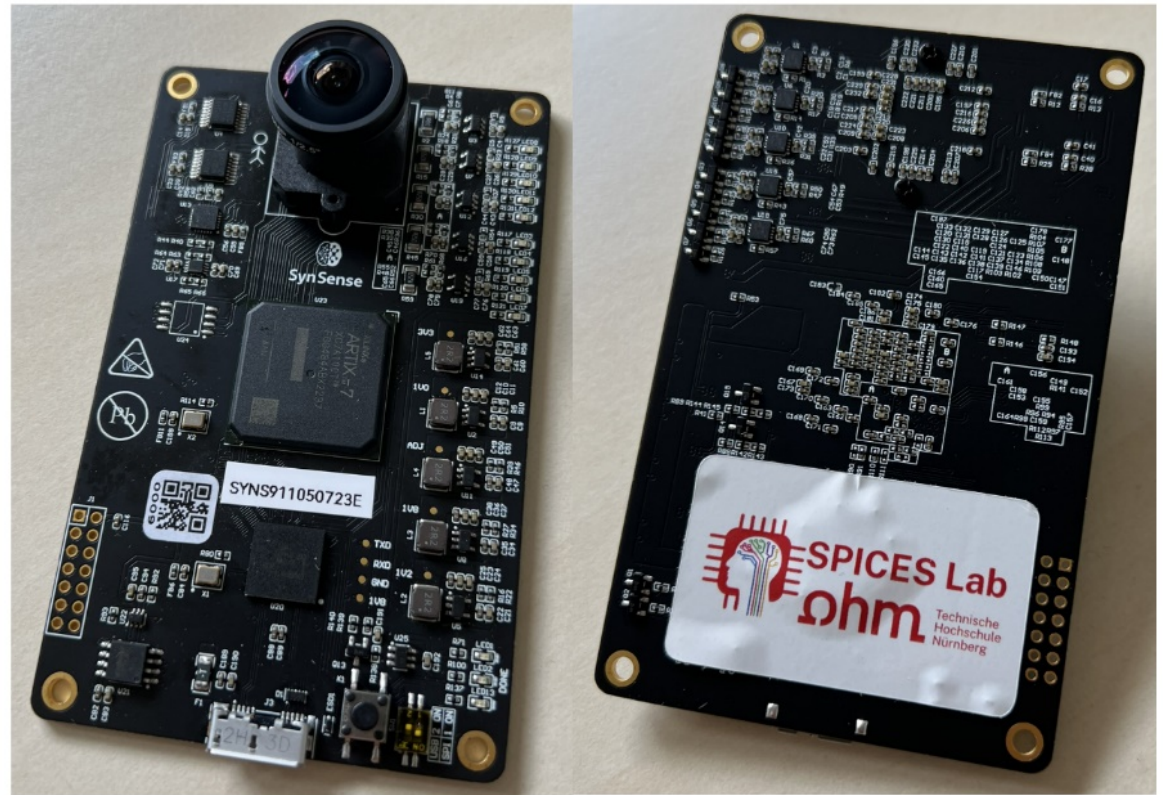
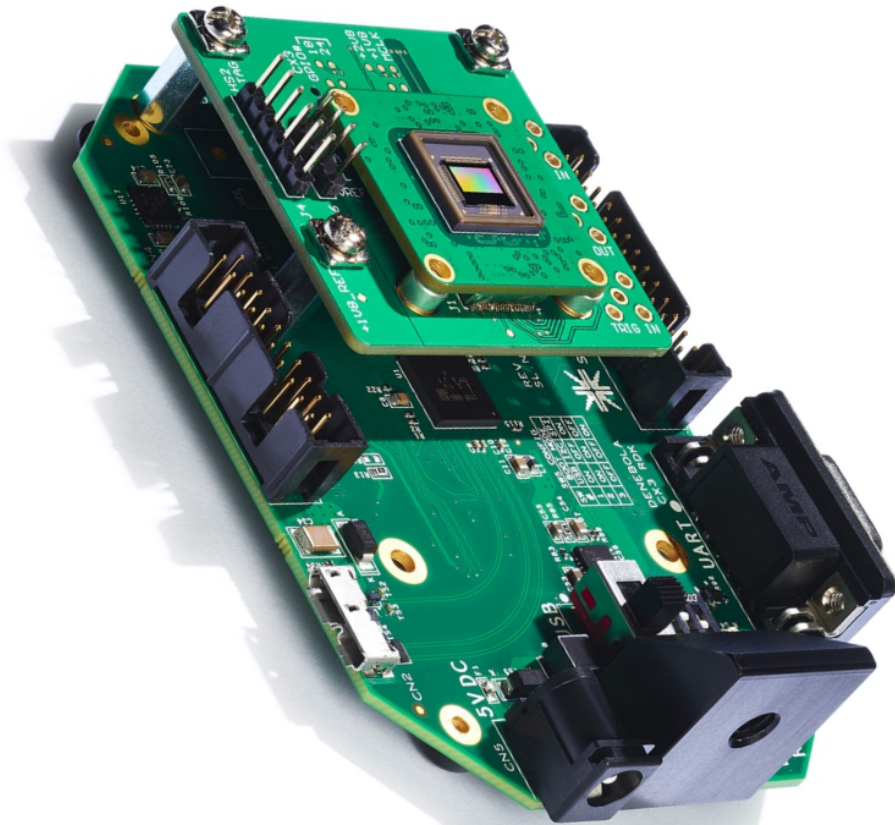
Der *Neuromorphic Computing* Ansatz:



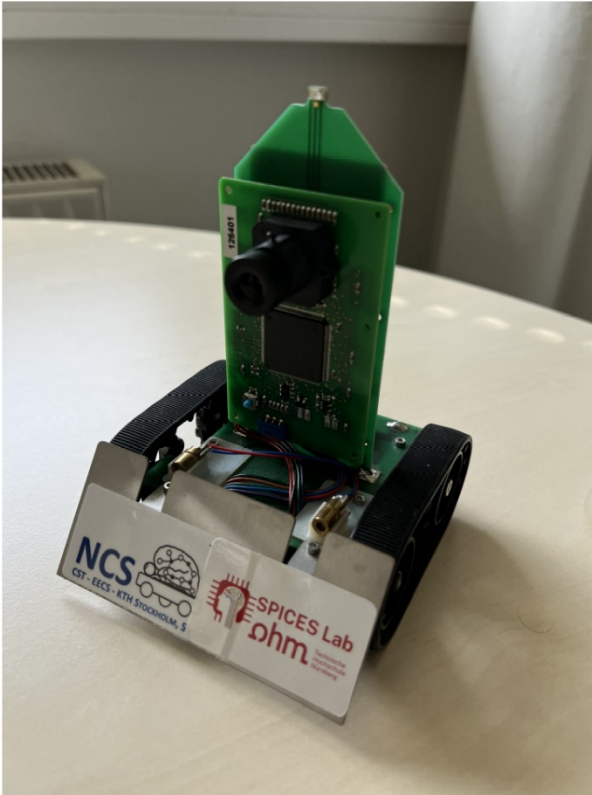
*Spezialisierte Computerchips und Sensorik
für Effiziente KI !*



Kognitive Neuromorphe Systemtechnik



Kognitive Neuromorphe Systemtechnik



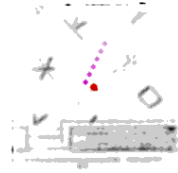
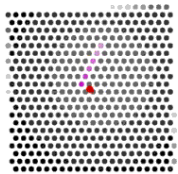


Kognitive Neuromorphe Systemtechnik

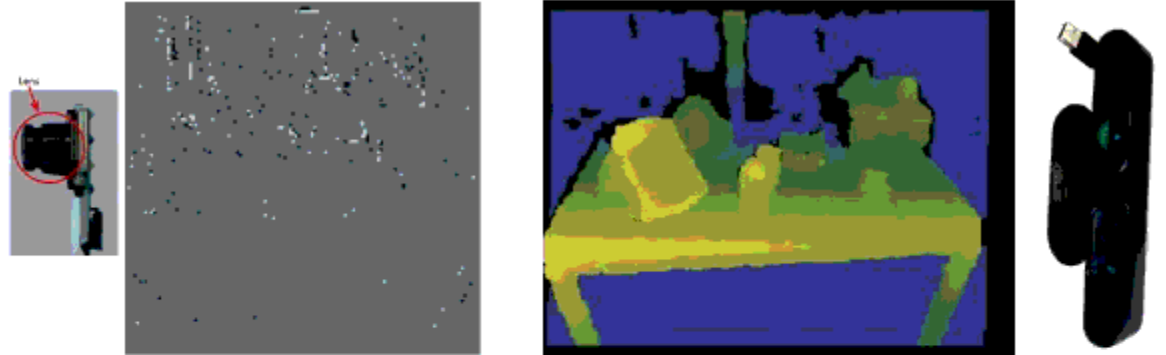
SLAM und Sensor Fusion



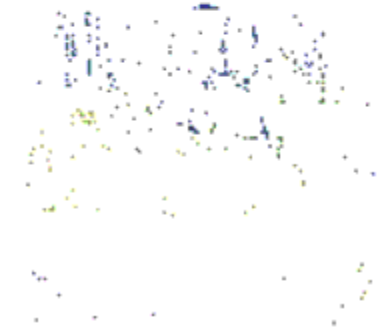
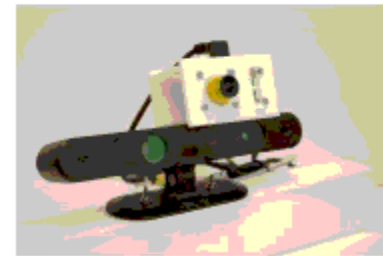
Neuromorphic vision for mobile robot SLAM



We combine a Dynamic Vision Sensor with a depth sensor

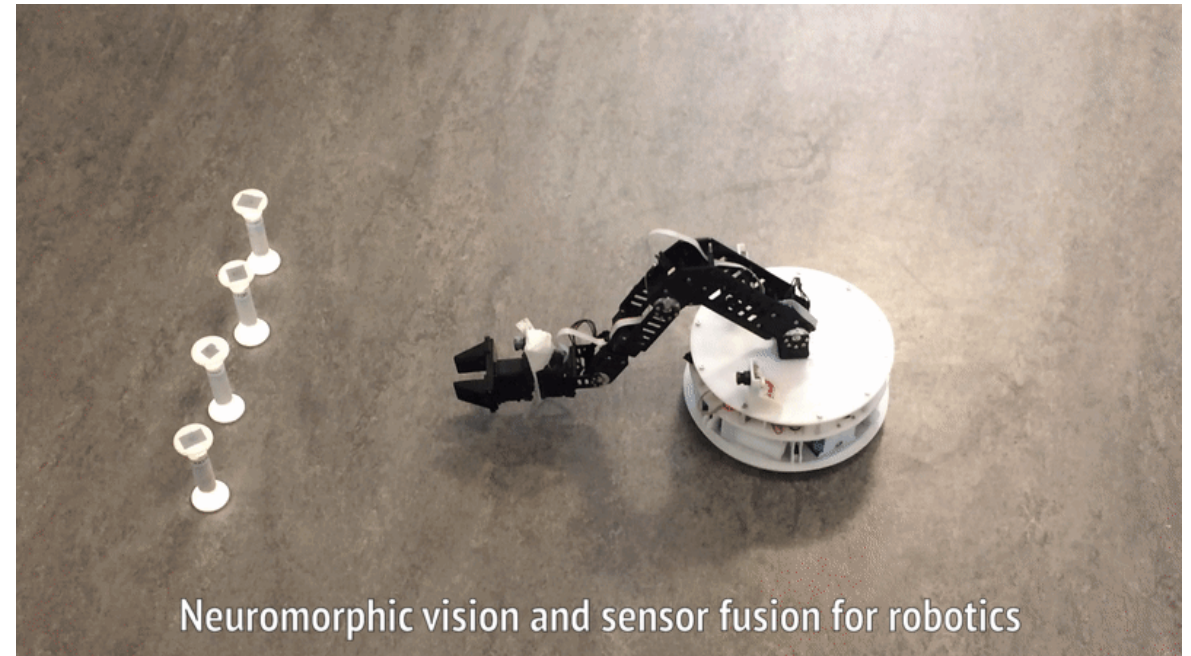
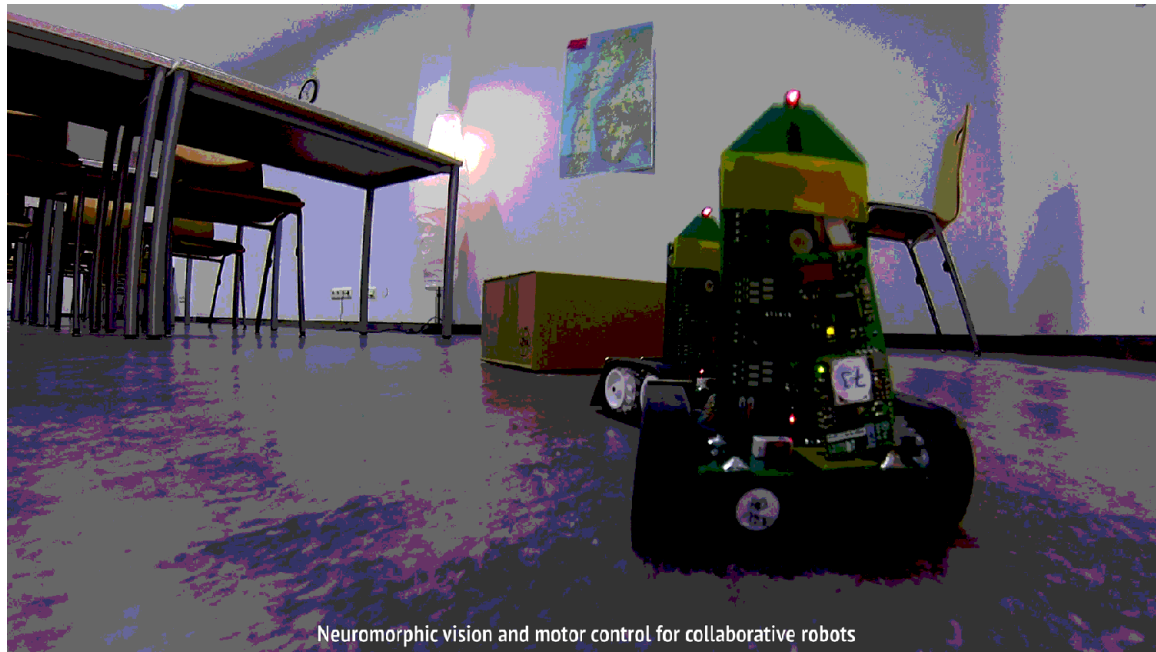


to an D-eDVS sensor producing a sparse stream of 3D point events.



Kognitive Neuromorphe Systemtechnik

Neuromorphe Robotik

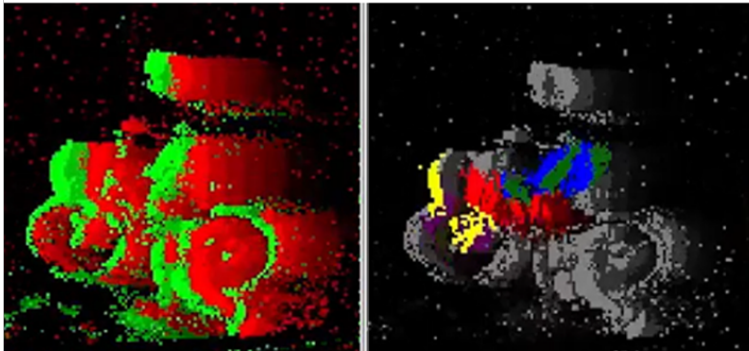




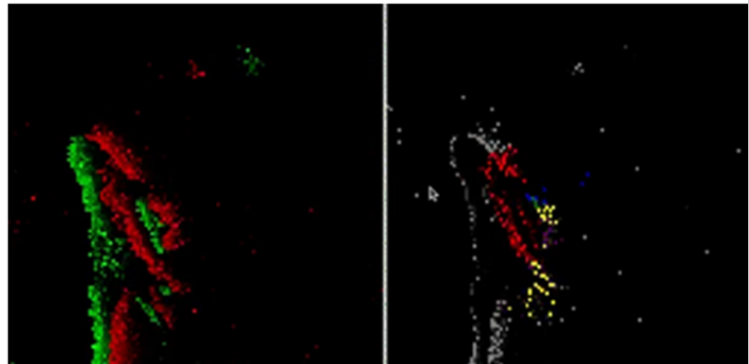
Kognitive Neuromorphe Systemtechnik

Projekt SPIDER: Spiking Perception and processing for Intelligent Detection of pEdestrians on urban Roads

Bicyclists tracking



Pedestrians tracking



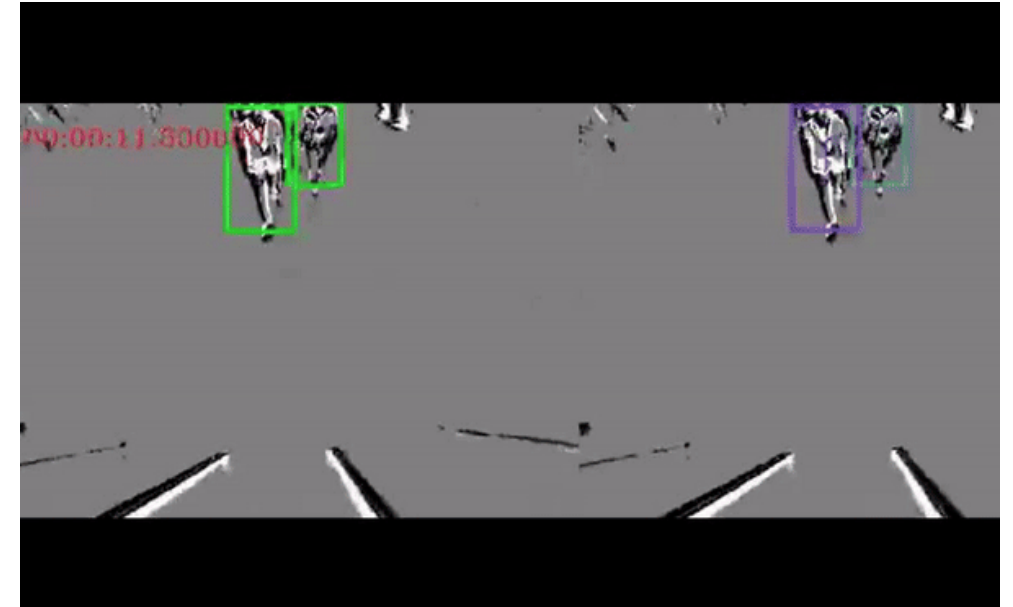
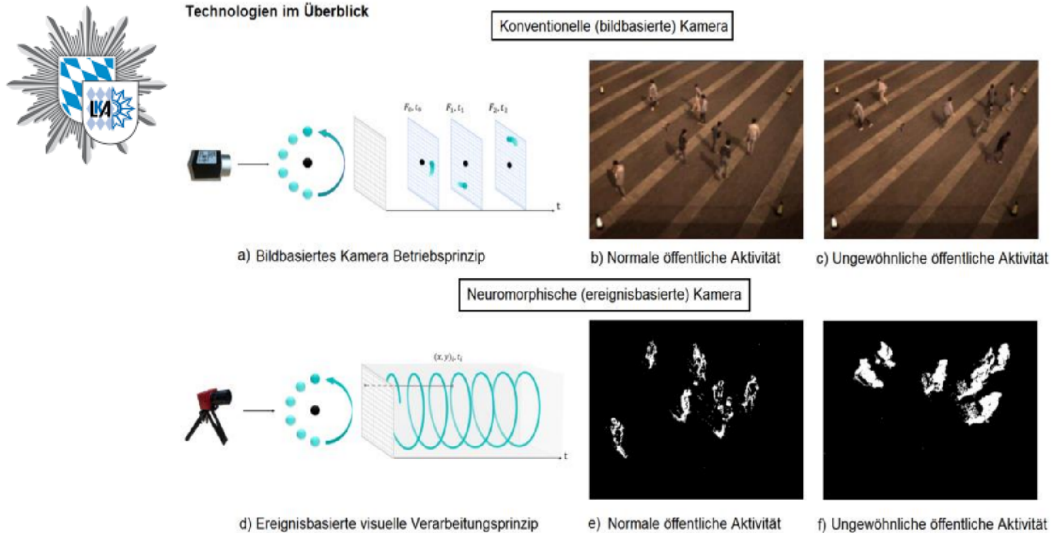


Kognitive Neuromorphe Systemtechnik

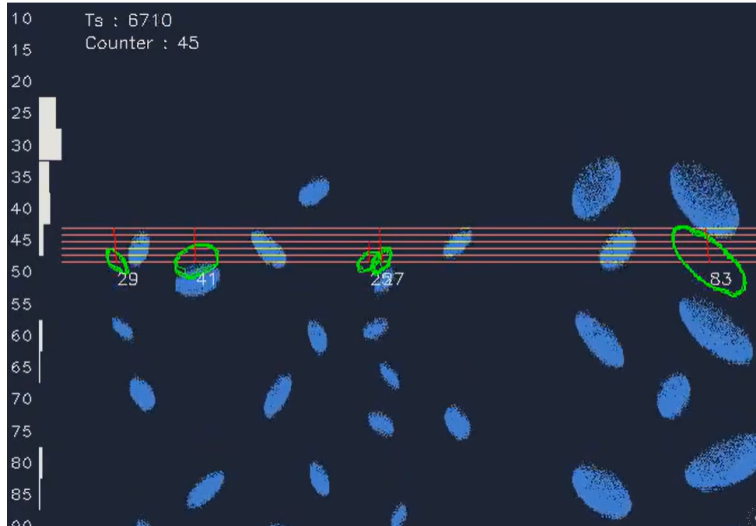
Projekt SPLAENDOUR (Spiking Perception and Processing for Low-latency Abnormal EveNt Detection in Open Urban Regions / Spike-basierte Perzeption und Verarbeitung für die Erkennung von abnormalen Ereignissen mit niedriger Latenzzeit in städtischen Gebieten)

Bayerisches
Landeskriminalamt

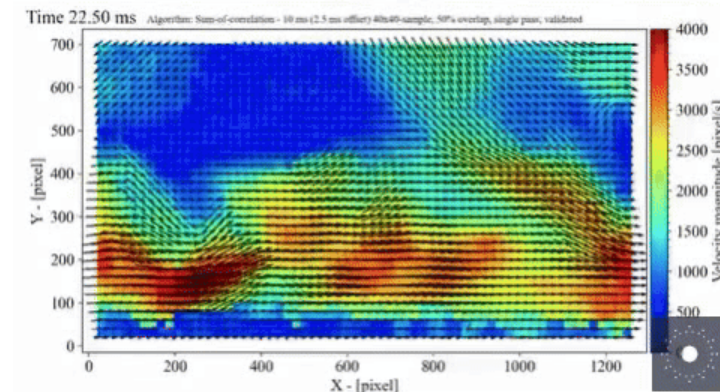
intel
labs®



Projekt MOMENT4PARTICLE (Monitoring and Measurement using Neuromorphic Technologies 4 Particle processing)

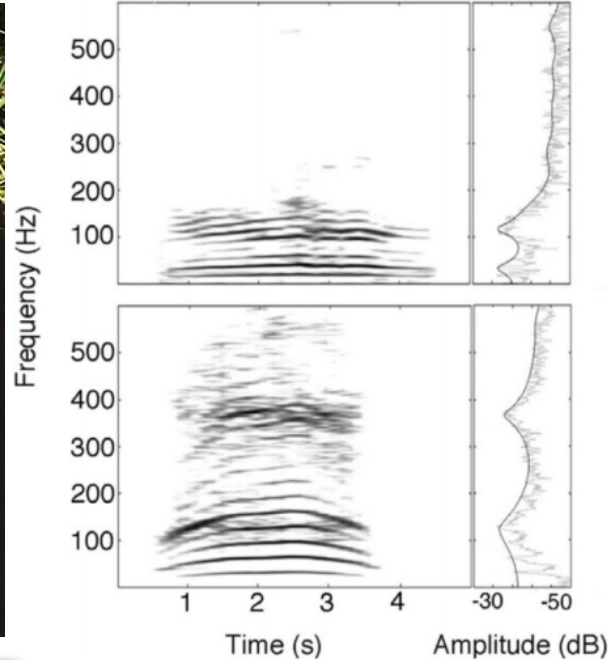


Zählen und Anzeigen der Objekte, die vor der Kamera vorbeiziehen. Die Objekte werden pro Linie gezählt (standardmäßig werden 4 horizontale Linien verwendet), und wir erwarten, dass sich die Objekte von oben nach unten bewegen, wie beim freien Fall. Jedes Objekt wird gezählt, wenn es eine der horizontalen Linien überquert.



Kognitive Neuromorphe Systemtechnik

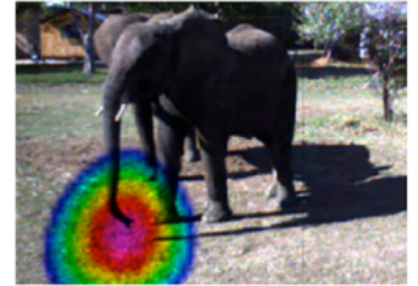
Projekt AMBION (Bioacoustic Networks using Neuromorphic Technologies)



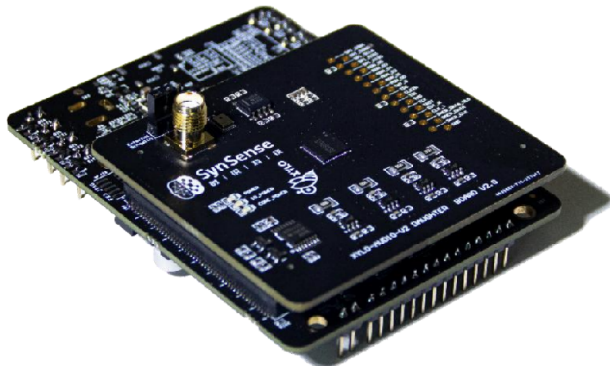
Neuromorphic Audio
Sparse representation of elephants' vocalisations spectrogram



Neuromorphic Camera
Sparse visual representation of elephants' activity and context
White=pixels becoming brighter
Blue = pixels becoming darker



Conventional Camera
Images/snapshots of elephants' activity and context

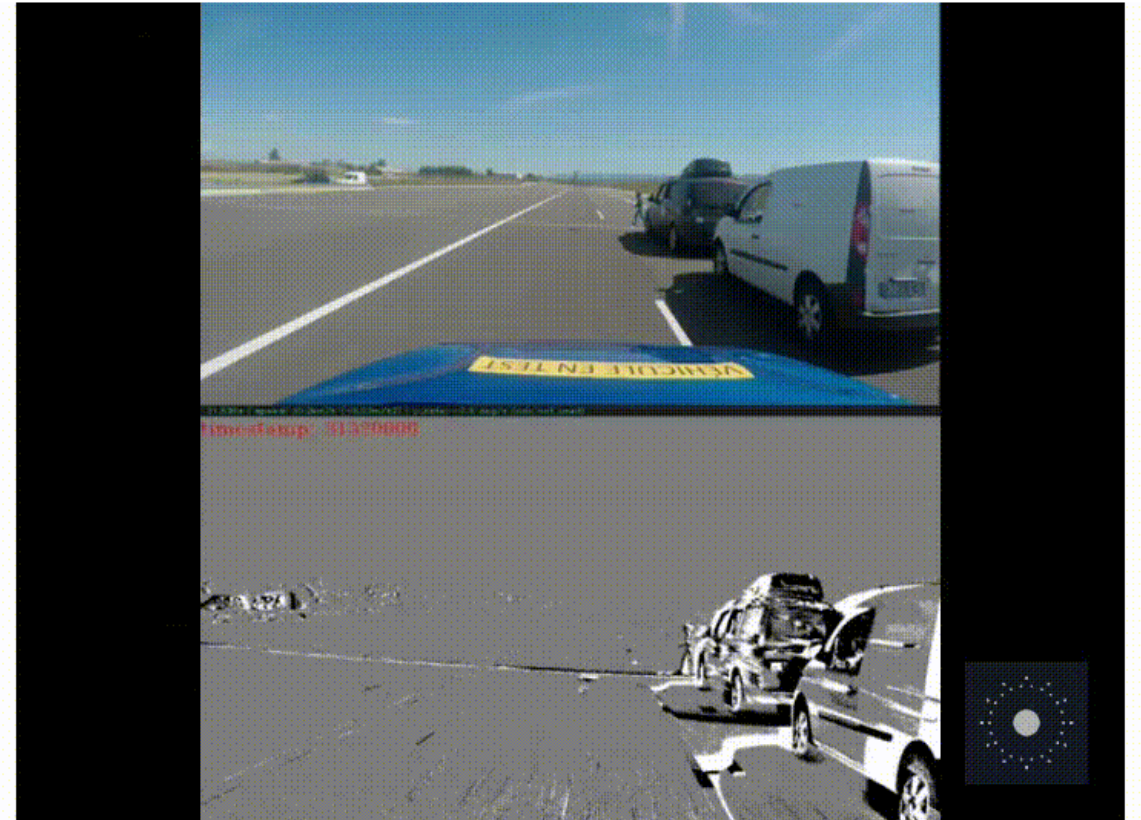




Kognitive Neuromorphe Systemtechnik

Erkennung und Verfolgung mit hohem Dynamikbereich

Schnelle Erkennung und Verfolgung





Gehirninspirierte Technologien für effiziente KI

Prof. Dr. Cristian Axenie
Fakultät Informatik

