How Quantum Magnetic Field Sensors enable a new type of Human-Machine-Interface

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08. October 2024

EPIC Technology Meeting at the Quantum Effects

Fast development and prototyping led us to 3 World Premiers

made possible by a strong expert team, partner landscape and IP portfolio.

2018
Foundation

2
Business Units

2.300
sqm Workspace in Stuttgart, Germany

>100
Q.ANTies

19
Nationalities

6
Publicly Funded Projects

110+
Patents

2
World Premiers [1,2]

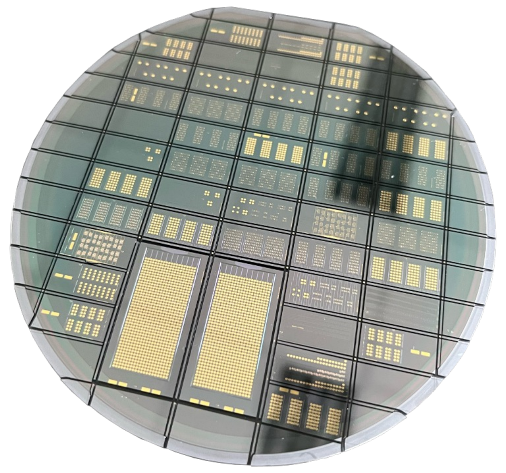
7
Coffee Machines[4]

[1] www.produktion.de/technik/zukunftstechnologien/quantentechnologie/erste-industriefaehige-quantensensoren-sind-im-einsatz-44-344.html
[2] qant.com/press-releases/q-ant-presents-the-potentials-of-quantum-technology-at-the-hannover-fair/
[4] Our fast pace took toll on 7 coffee machines thus far ;)

Q.ANT realizes the next level of data generation and data processing
in the business units Native Computing and Native Sensing.

Native Computing

Photonic Computation



Photonic chips and processors for ultra-efficient AI and HPC.

Native Sensing

Magnetometry

Sensor for measuring electrical human bio signals based on magnetic fields.

Gyroscopy

Sensor for attitude control and stabilization of mobile systems.

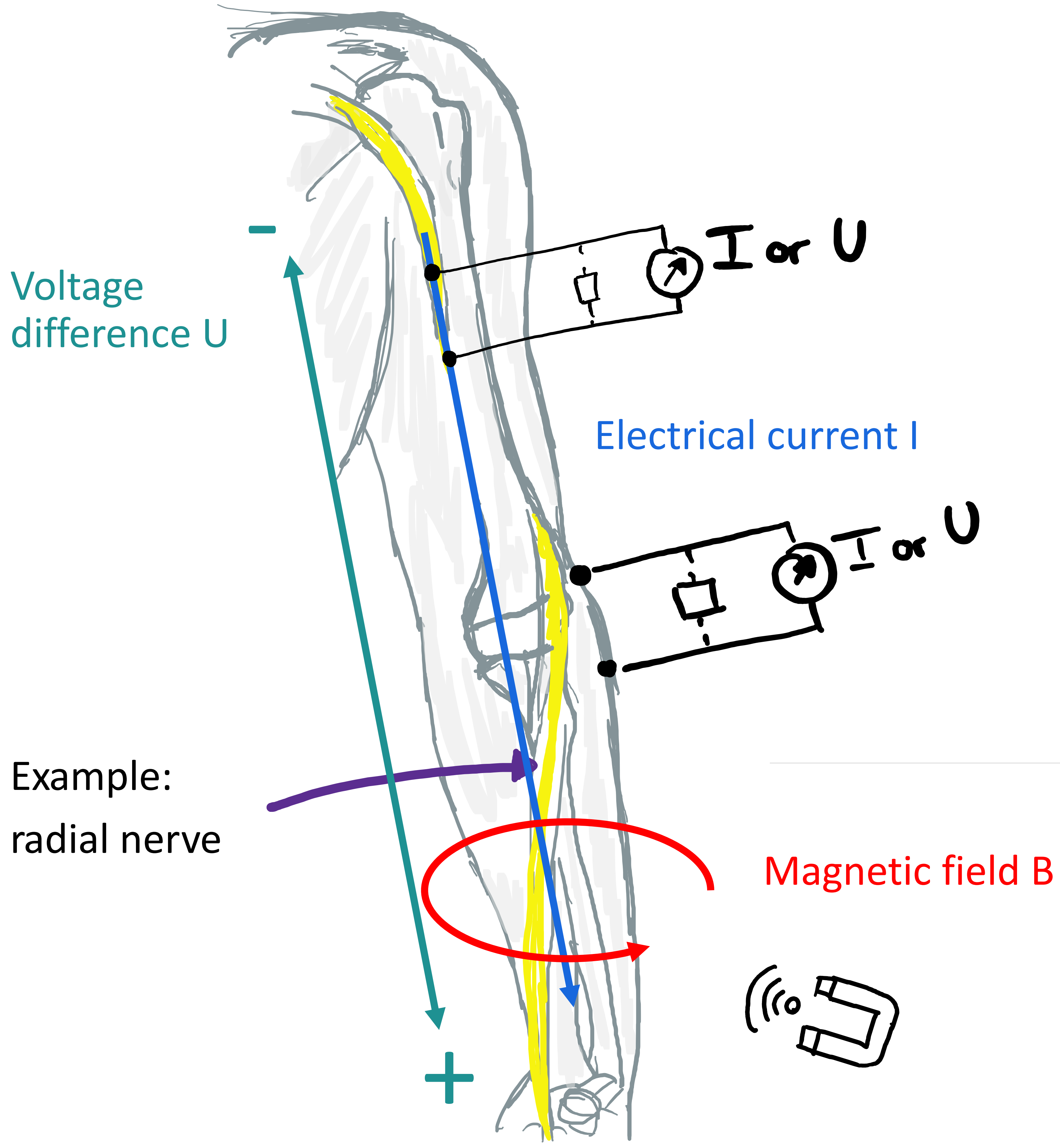
Particle Metrology

Sensor for positioning, analyzing and characterizing finest particles in gases, liquids and as powders.

Native Sensing

Enabling a new kind of human-machine-interface

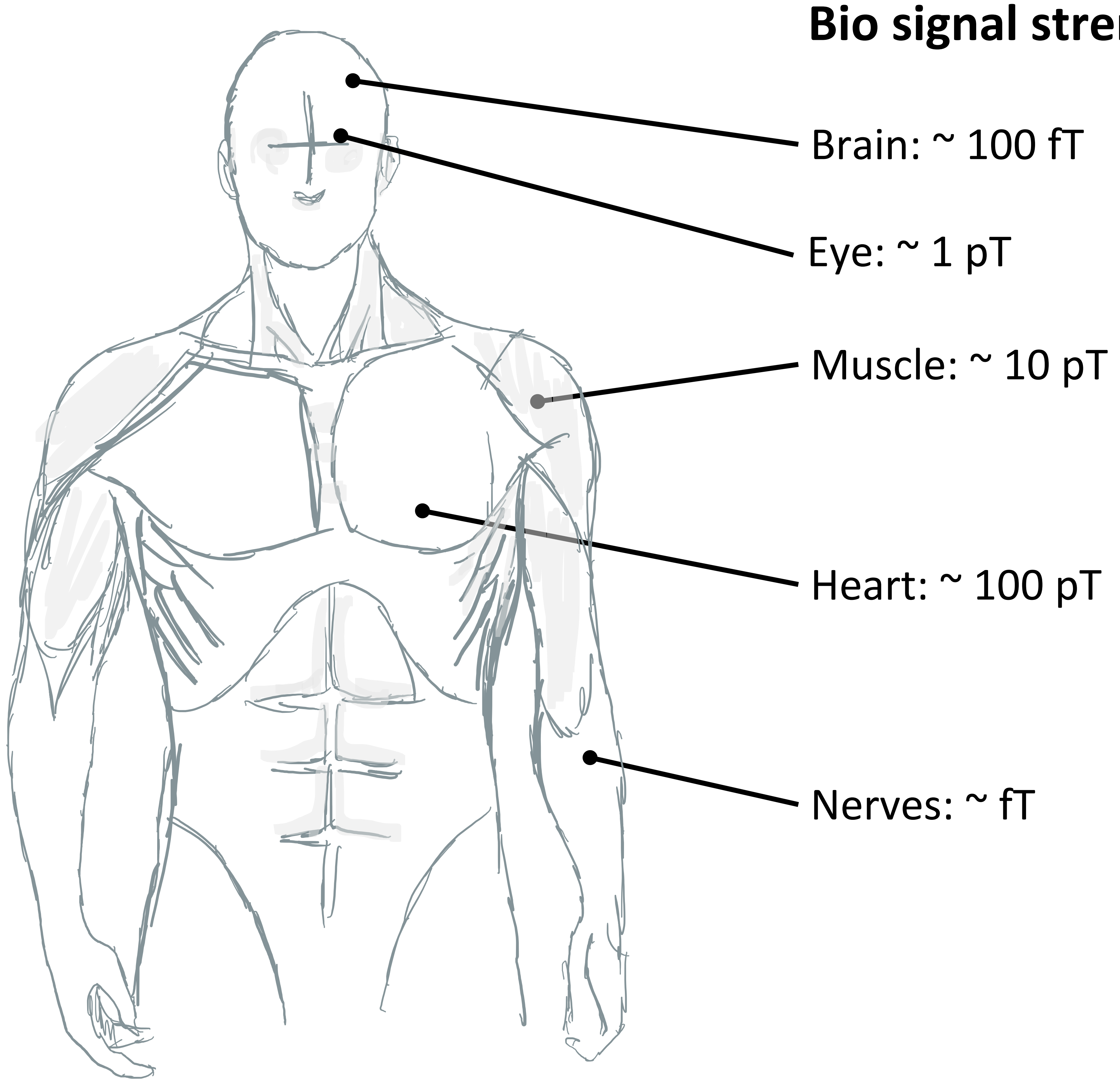
The most common bio signals are of electrical nature,
i.e. a change of current due to a change of electrical potential.



	Pro	Con
1. Direct measurement (I or U)	▪ easy measure-ment	▪ requires direct access through tissue
2. Indirect measurement (I or U)	▪ easy measurement	▪ very sensitive to conditions, like sweating, body hairs
3. Contactless measurement (B)	▪ contactless measurement ▪ insensitive/ less sensitive to sweating	▪ faint magnetic signals ▪ susceptible to external inter-ference signals

Interesting bio signals in humans

Bio signal strength



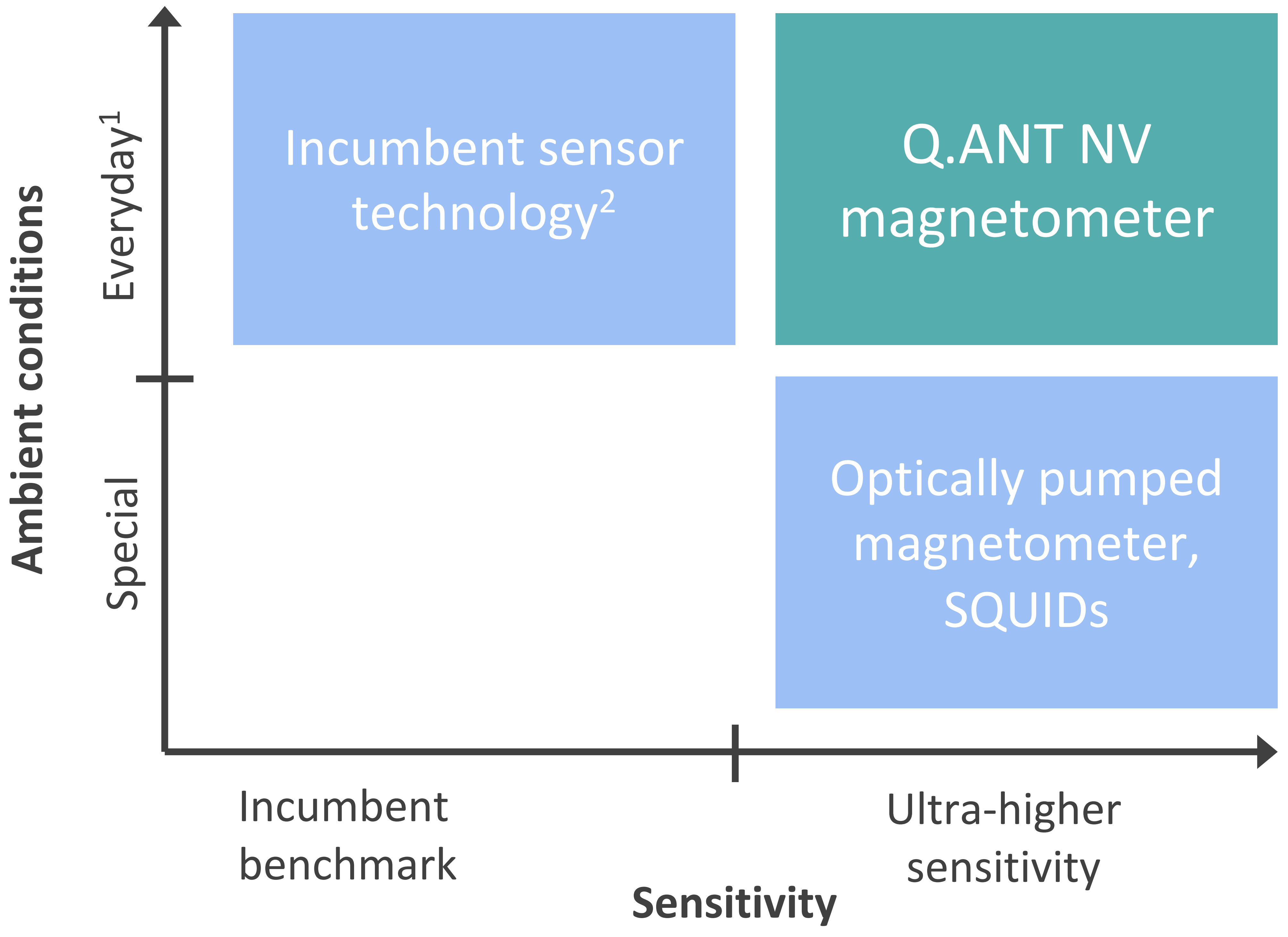
Fundamental system requirements

- High Magnetic field resolution
  < 30 pT /sqrt(Hz)
- Portable and usable under daily life conditions
  - Room temperature
  - Resilient against additional external signals
  - Low power consumption (< 1W)

Nitrogen vacancy magnetometers enable totally new real-life applications

by allowing for high sensitivity while running under everyday ambient conditions.

Ultra-high sensitivity under everyday conditions

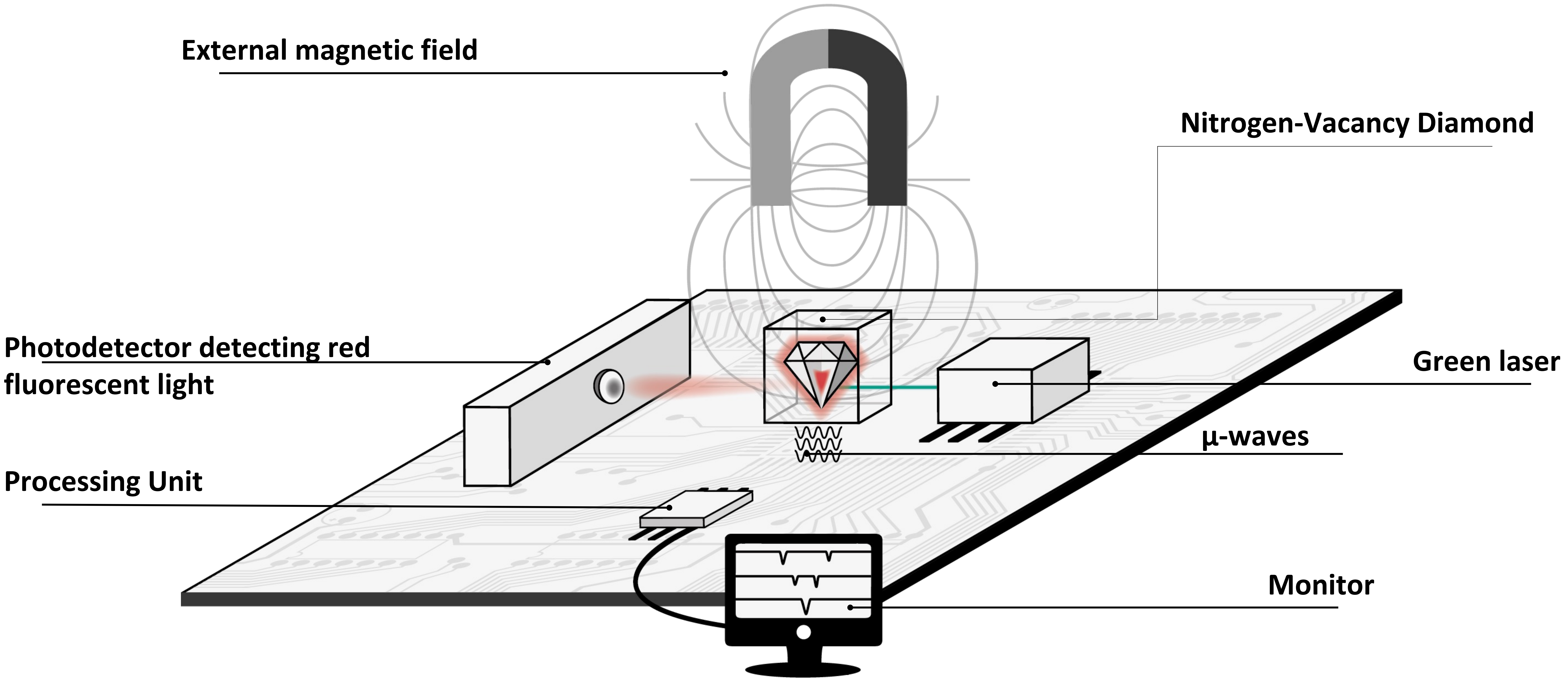


Our sensor allows to address new applications & markets

- The Q.ANT NV magnetometer works with synthetically grown diamond material, adding magnetically sensitive Nitrogen-Vacancy (NV) centers
- Competing magnetic sensing technology has either lower sensitivity or requires very special ambient operating conditions.
- Only NV magnetometers offer highest magnetic field sensitivity without any additional measures to provide a controlled environment, the key for later mass market applications
- The higher sensitivity region refers to magnetic fields below 100 pico-Tesla. Everyday conditions refer to a normal environment whereas special ambient condition summarizes measures like magnetic shielding or cryogenic temperatures

Working principle of NV diamond magnetometers

Detection of red fluorescence under irradiation with green light and resonant microwaves



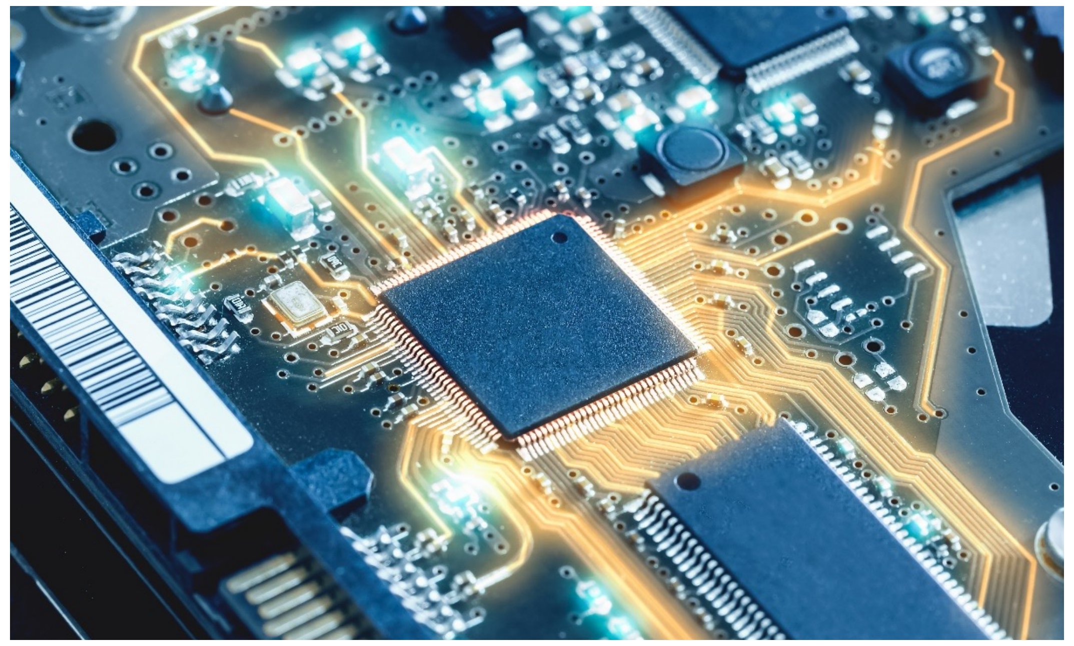
Application areas of Diamond Magnetometers

The use-cases are widespread

Medical Technology

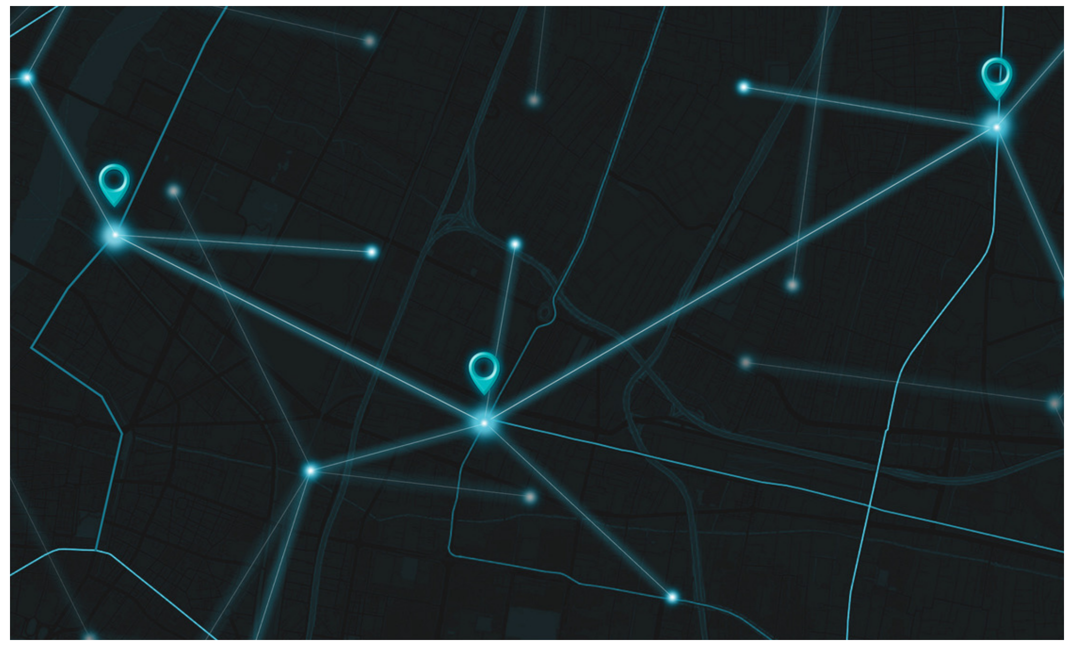
- Early detection of brain diseases
- MMG-based prosthesis control
- MEG-based measurement of neuronal brain activity for Human-Machine interaction

Component and material analysis



- Current imaging in integrated circuits for quality control or fault analysis
- Detection of defects in the material structure of components
- Characterisation of magnetic materials and nanoparticles

Localization



- Indoor and outdoor automated guided vehicles
- Localization applications in automotive
- GPS-independent navigation

Geophysics

- Exploration of magnetic fields in the Earth's interior to study plate tectonics
- Detection and mapping of mineral deposits
- Characterization of magnetic materials and minerals

Imagine a world where we could sense bio-signals under everyday conditions

How can these use case examples be made reality?

Use-case examples:

Prosthetics

Locally resolved measurement of muscle signals for the control of prostheses and exoskeletons.

Rehabilitation & intensive care

Continuous measurement of muscular and neuronal function during rehab or in intensive care units.

Empathic Car

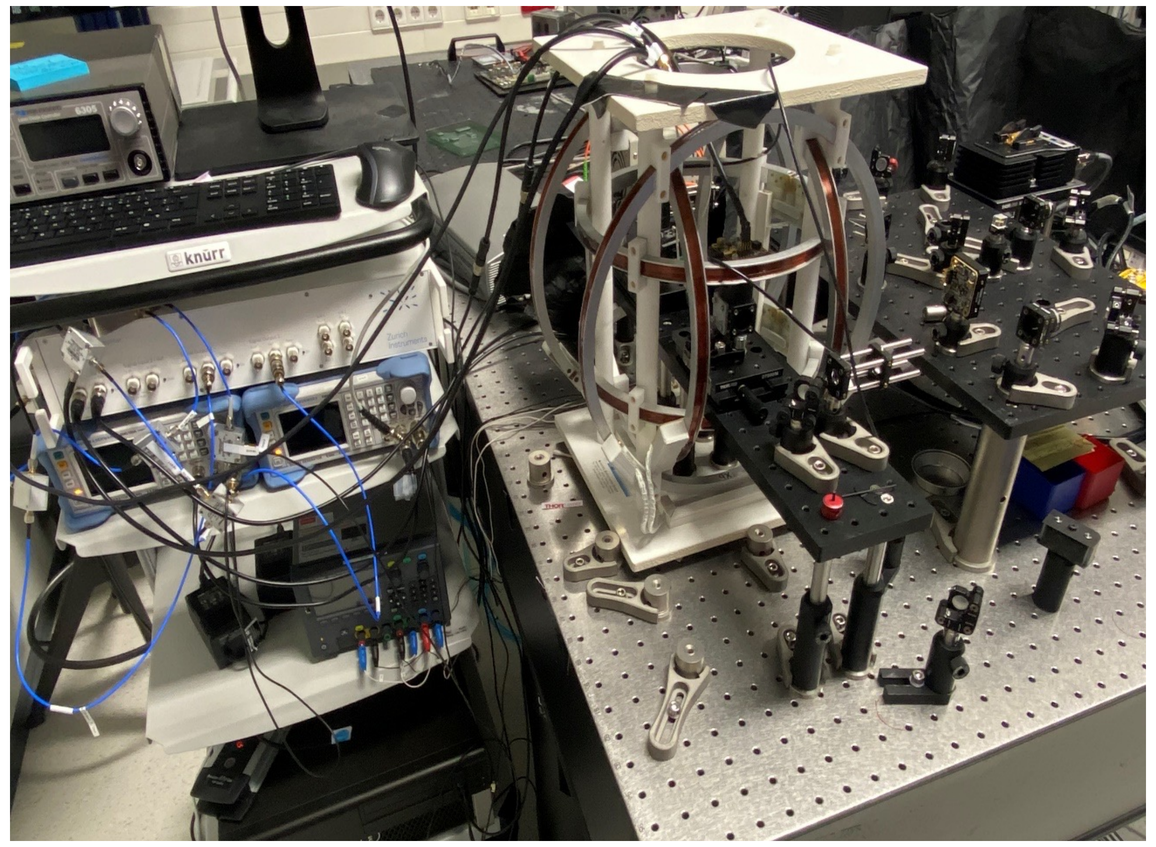
Realization of the empathic car by adjusting drive modes and interior based on muscle excitement signals.

Training feedback

Give direct feedback on muscular excitement to adjust training sequences and monitor training effect.

With leading edge R&D and product development, Q.ANT is on a fast track

Reaching the sensitivity for muscle signal analysis in 2024



	2022: Proof-of-concept	**2023: Functional prototype**	**2024: Bio-signal sensitivity**
	Table-top lab experiment	Fully functional magnetometer	Prosthesis control demo
Size:	432000 ccm	1000 ccm	160 ccm (sensor head)
Sensitivity:	30000 pT/ $\sqrt{\mathrm{Hz}}$	250 pT/$\sqrt{\mathrm{Hz}}$	20 pT/ $\sqrt{\mathrm{Hz}}$
Purpose:	In-house proof of concept	Proof of system integration while improving sensitivity	Proof of muscle signal detection
Business:	-	First sales to academic customers	Several business opportunities with R&D customers

Q.ANT

Q.ANT established and invested into valuable partnerships

enabling early proof-of-concepts and to minimizing financial risks.

Academic partners

Fraunhofer IPA	Proof of concept study prosthesis control with Q.ANT sensors.
Eberhard Karls Universität Tübingen	Proof of concept study muscle diagnosis tool with Q.ANT sensors. Funded by QSENS.
Universität Stuttgart	Basic concept evaluation for magnetometer operation. Funded by QSENS.

Development partners

deveritec	Electronics development and manufacturing.
Hahn Schickard	Bias field generation.
Toptica eagleyard	Laser development.

Funding

QSens	Bring quantum sensing into products.
Gefördert vom Bundesministerium für Bildung und Forschung	Magnetometers for industrial applications.

Pilot Customers

Universität Stuttgart	Proof of concept study prosthesis control with Q.ANT sensors.

Your LOGO

Be a pilot customer and talk to us about purchasing options.

Get in contact with us!

Visit our booth here at Quantum Effects.

Visit us in Hall C2, Booth 2B32

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