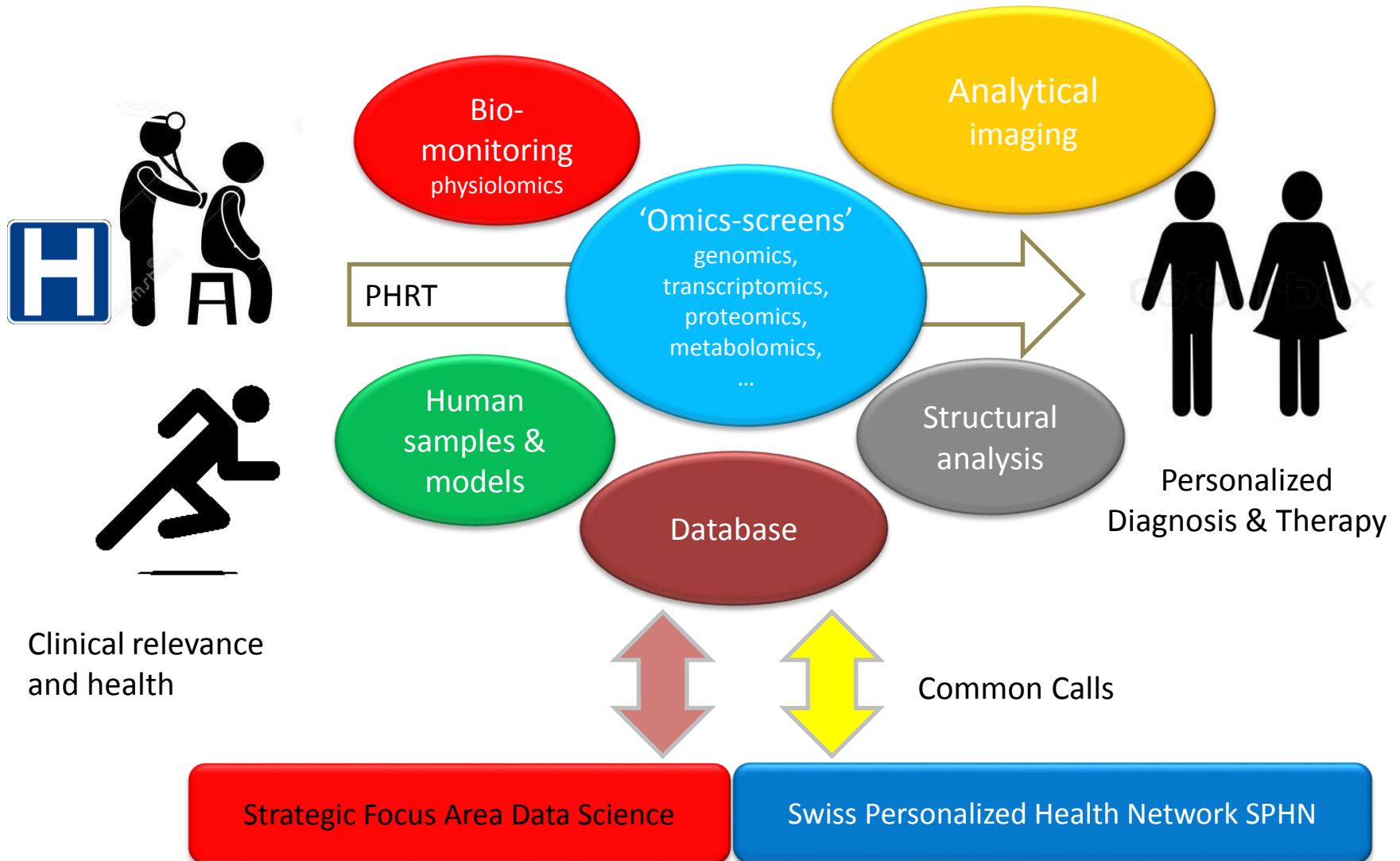




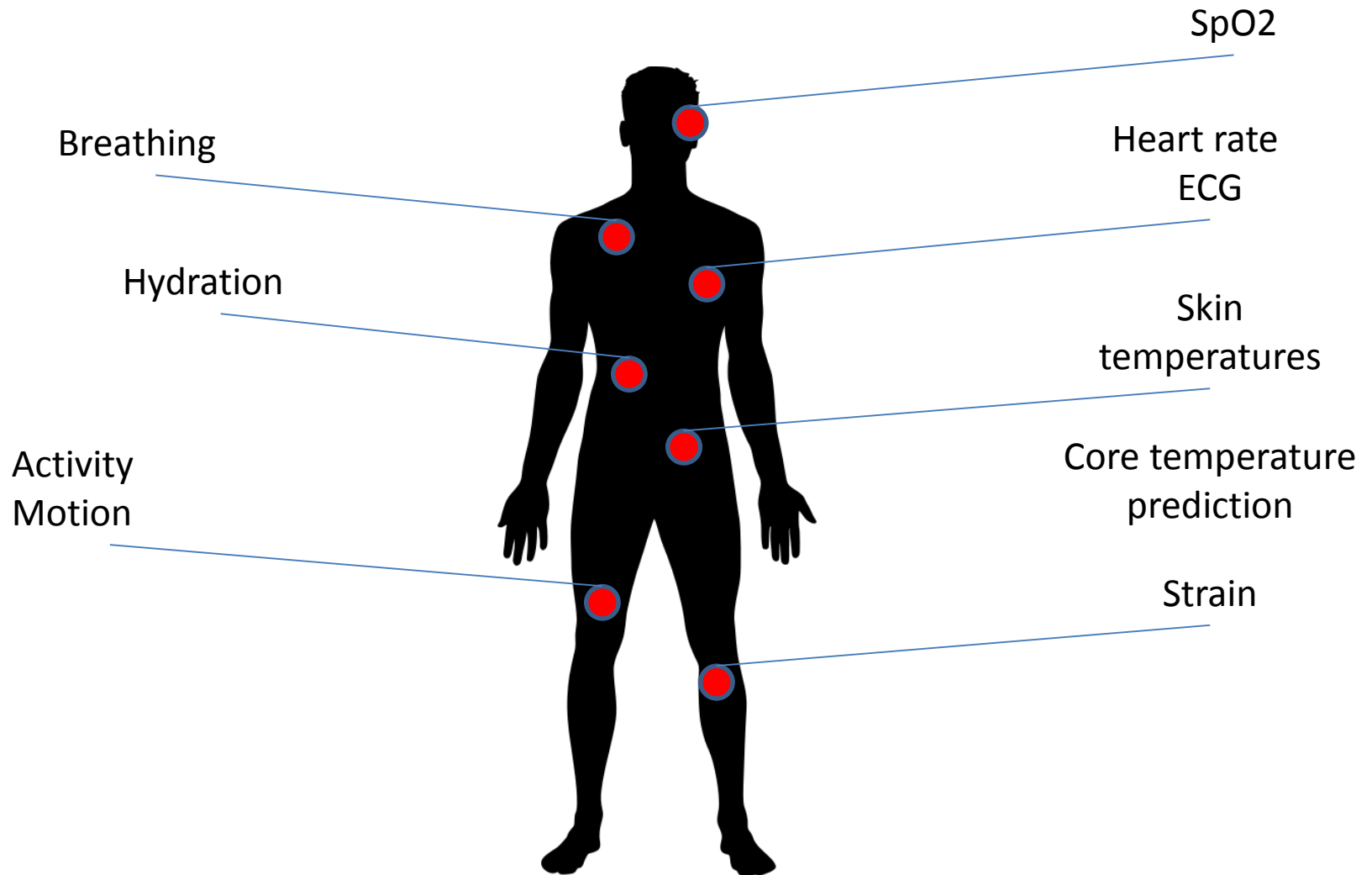
Sensorik – vom einfältigen Messpunkt zum smarten Monitoring von Mensch und Umwelt

Alex Dommann und René Rossi

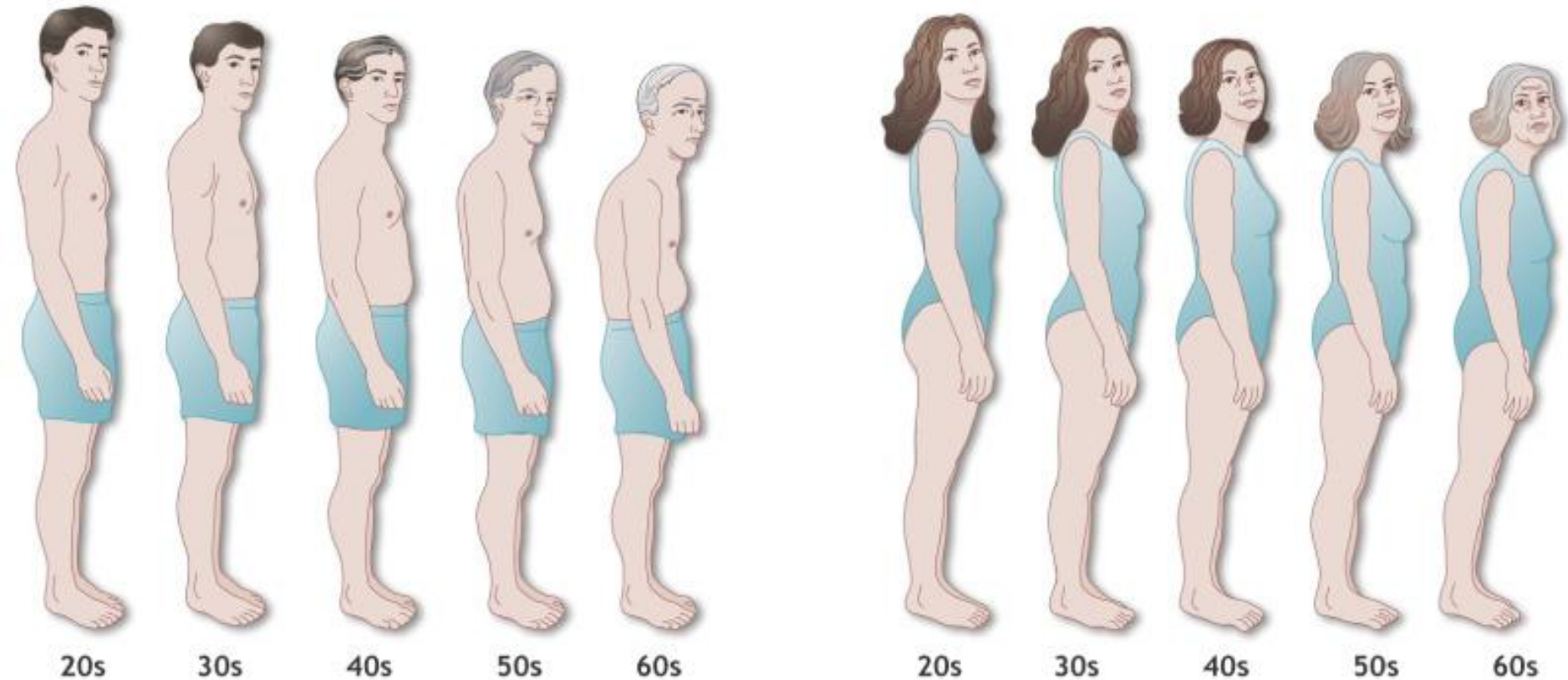
Personalized Health and Related Technologies PHRT



Non-invasive monitoring of body functions



We All Change in Many Ways



What are the different ways to look at human body composition?

- ✓ Medical (health)
- ✓ Anthropological
- ✓ Performance
- ✓ Appearance

Why is knowledge of body composition so important?

- ✓ Health and Disease
- ✓ Performance
- ✓ Appearance
- ✓ Longevity

Global strategy

- Multi-parameter physiological signal monitoring
- Wearable, during exercise, low power, highly integrated, inconspicuous, ...
- Vital-sign monitoring

Sleep monitoring



Sports



Aerospace



ICU & Anaesthesia



Aviation



Commercial products to fight obesity

Low-cost “gadgets”

- Level-detection pedometers
- Enhanced mobile phones functions

Complex wrist computers

- Heart rate measurements
- Position detection
- Speed and distance measurements

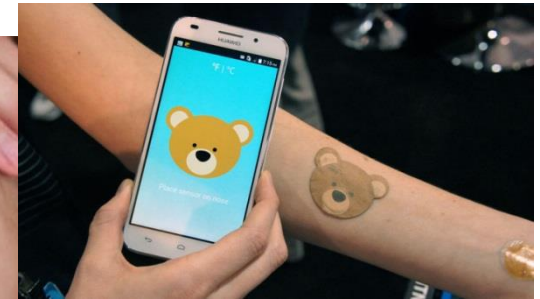
No easy-to-use and valuable biofeedback device for non-active persons



Some products



Kenzen (Hydration, endurance, calories)



eskin (temperature)

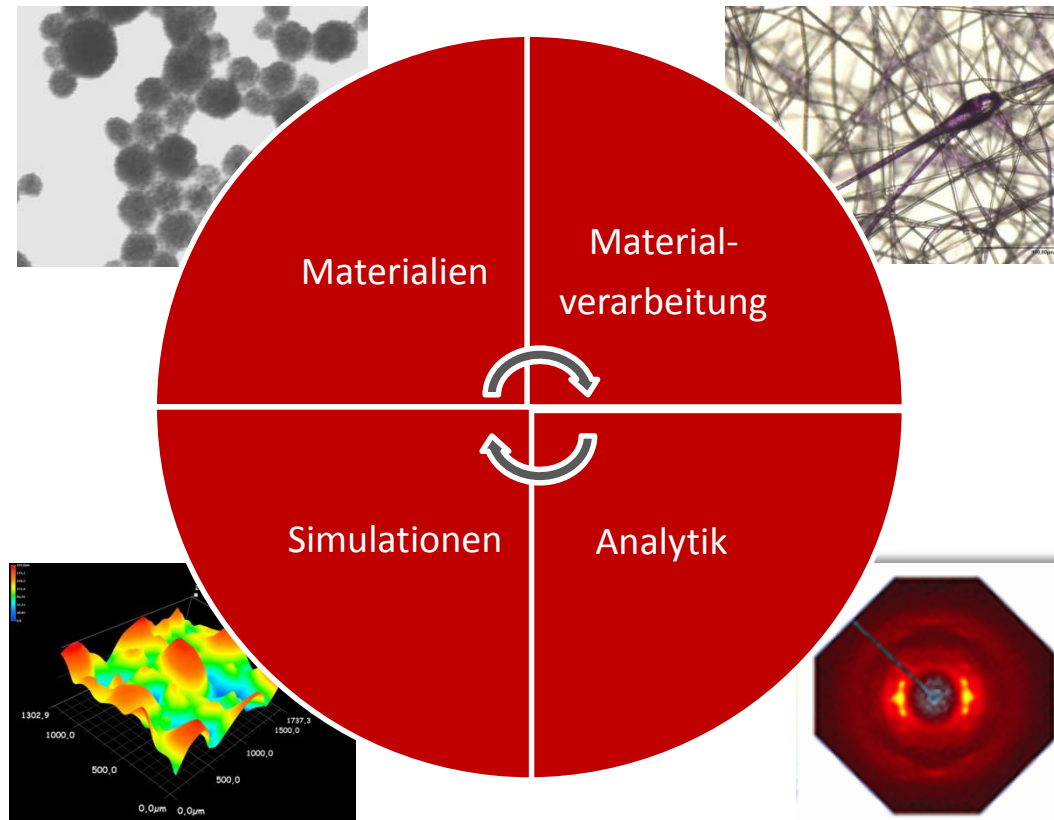


Apple (activity, heart rate, calories)

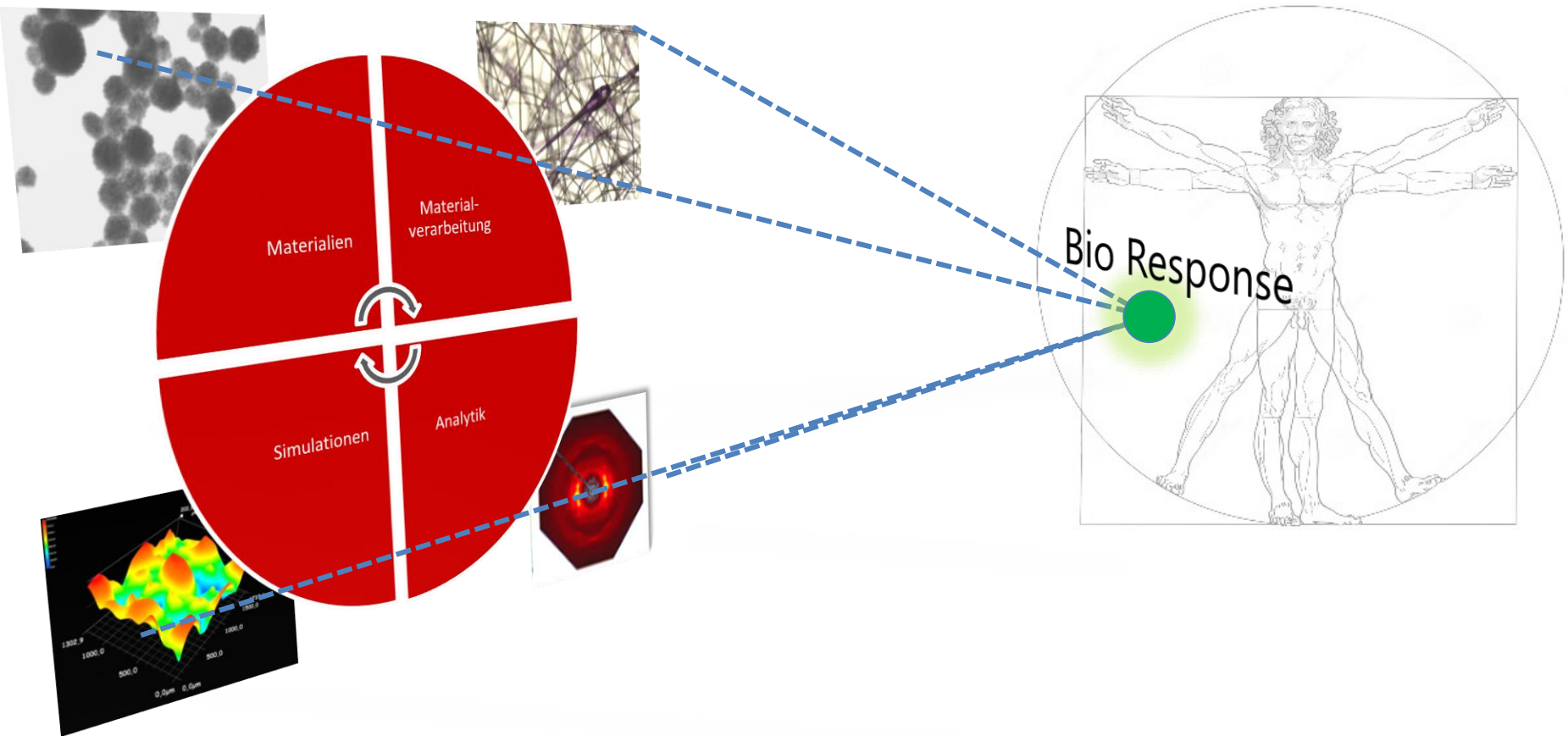


Polar (heart rate)

Empa – Materialforschung und Technologieentwicklungen



Forschungsschwerpunkt Gesundheit und Leistungsfähigkeit

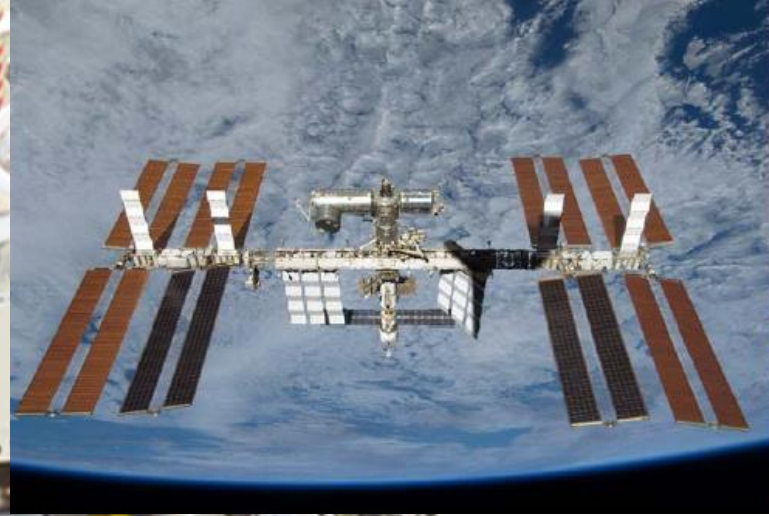


Materials

meet

Life

Monitoring von Astronauten



Intelligente Bekleidung: "Sensor-Shirts" warnen vor dem Austrocknen

Geschrieben von: Frank Joung



Forscher haben herausbekommen, wie man sich den Schweiß zunutzemacht. Ein neuartiges "Sensor-Shirt" ändert die Farbe, wenn der Sportler schwitzt – und signalisiert: Es wird Zeit, zu trinken.

Mitdenkende Socken?



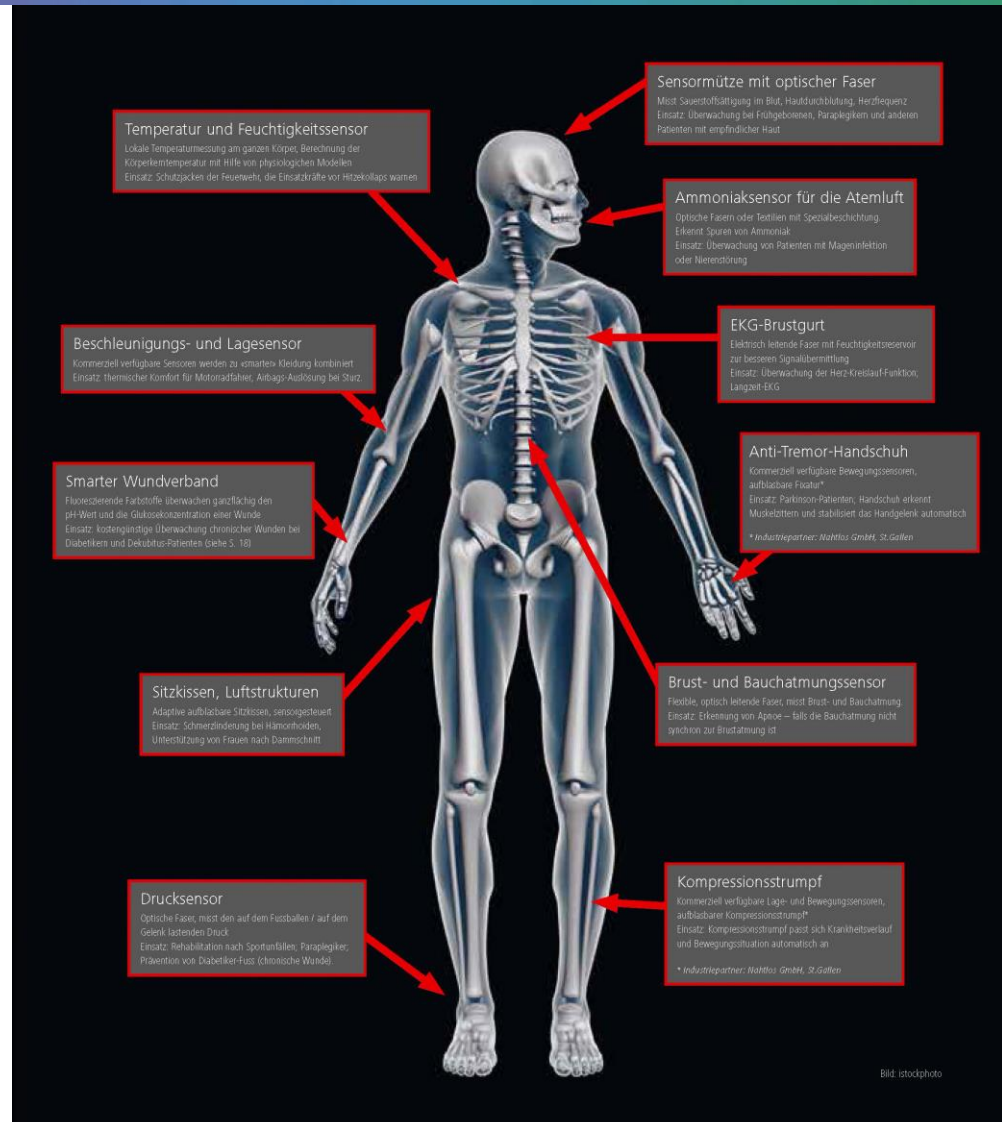


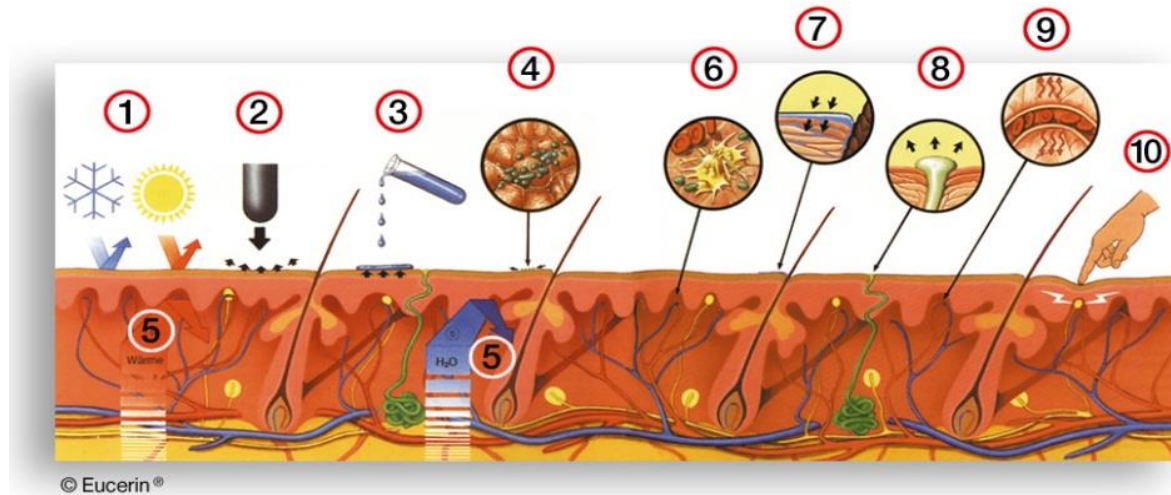
As the **U.S. Open** kicks into gear this week, keep an eye peeled for the young men who retrieve errant balls for the players. Several of the ball boys will be trying out **Ralph Lauren's** foray into wearable technology: a black compression jersey that uses a system of discreet sensors to track its wearer's biological and physiological profile. A double play with **OMSignal** a Montreal startup specializing in bio-sensing clothing, the **PoloTech Shirt** is the first item of tech apparel to emerge from a mainstream fashion label.

Sensorik hautnah

Viele Körperfunktionen, aber auch Krankheitssymptome können mittels Sensoren hochpräzise erfasst und behandelt werden. Die Empa ist spezialisiert auf Textilsensoren, die nicht nur Punkte, sondern grössere Flächen am menschlichen Körper überwachen.

Die Empa-Sensoren basieren auf optisch oder elektrisch leitenden Fasern und müssen eng auf der Haut aufliegen.



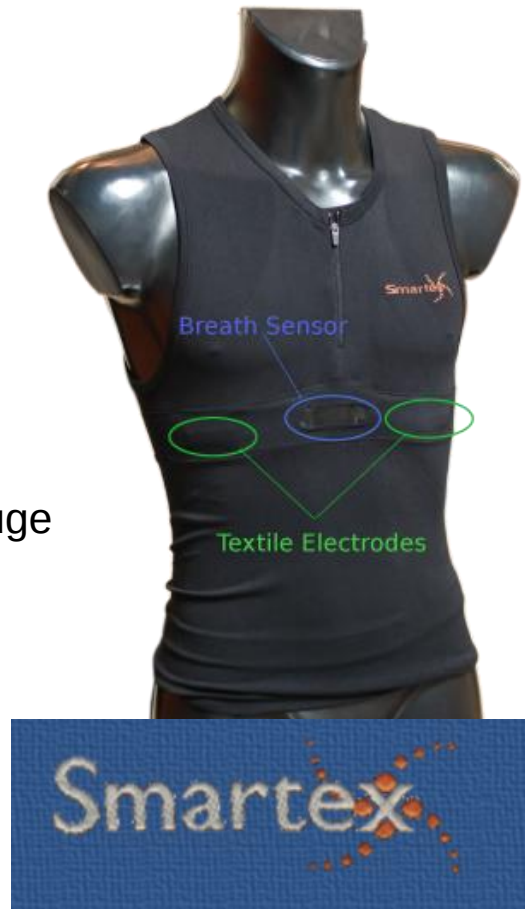


Protection from

- | | |
|-------------------------------------|---|
| ① cold, heat, radiation | ⑥ Defence against invading microorganisms |
| ② pressure, blows, abrasion | ⑦ Absorption of certain substances |
| ③ the action of chemical substances | ⑧ Perspiration |
| ④ invasion by microorganisms | ⑨ Circulatory and thermal regulation by means of the dermal vascular system |
| ⑤ heat and water loss | ⑩ Pressure, vibration, touch, pain, temperature sensory organs |

T-shirt for day monitoring

- Requirements
 - Heart rate
 - Breathing rate
 - Activity classification
 - Energy expenditure
 - Fall detector and alarm
- Design
 - Textile Electrodes
 - Respiration IPG or strain gauge
 - Data streaming & recording



ECG and IPG Textile Electrodes



Jack connector

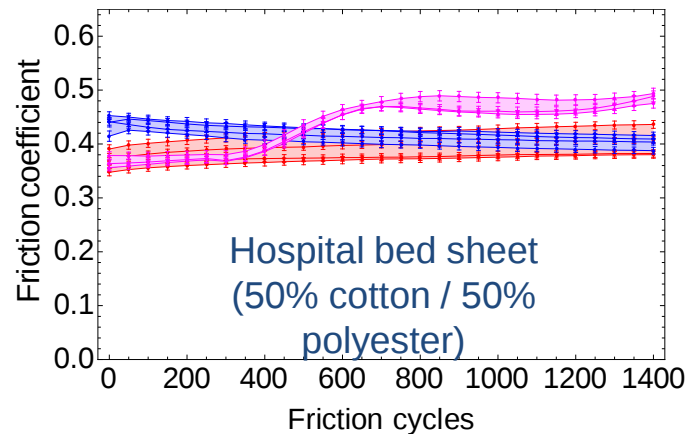
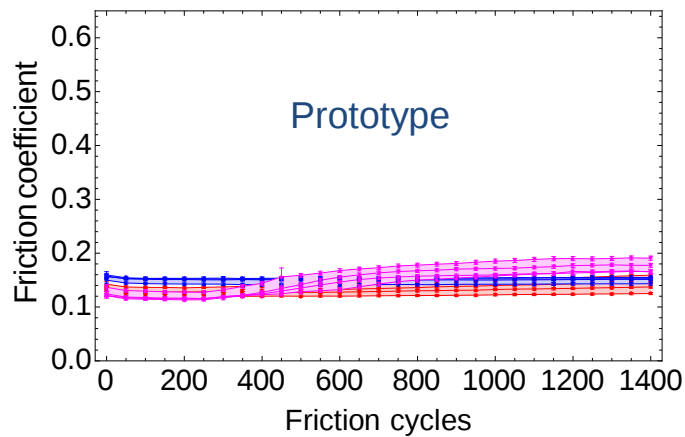
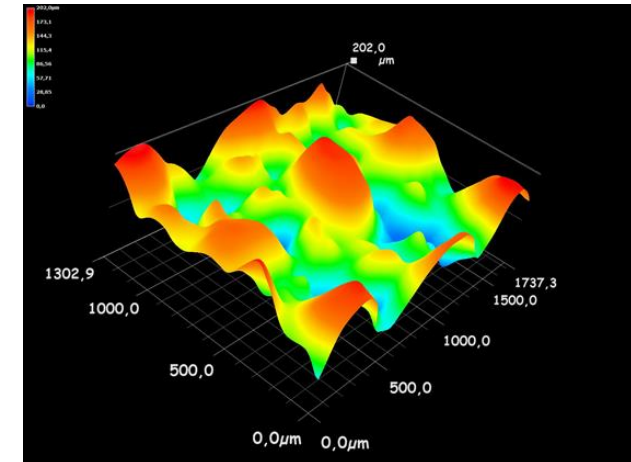


ECG textile Electrodes when
using Breath Strain Gauge

Decubitus Prevention



techtextil
innovationprize.2013



KTI/CTI
DIE FÖRDERAGENTUR FÜR INNOVATION
THE INNOVATION PROMOTION AGENCY

schoeller[®]
Switzerland

Patent pending

Applications

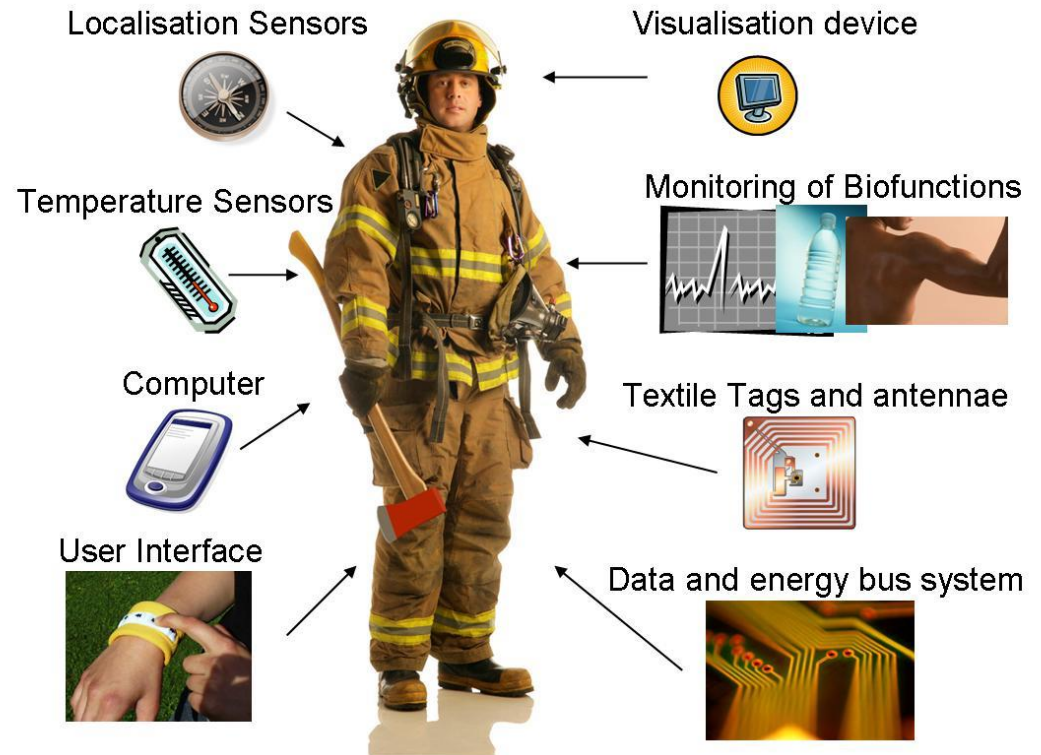
Low level of textile integration:

Customer needs:

- Textile haptics
- No special energy supply
- Wash fastness

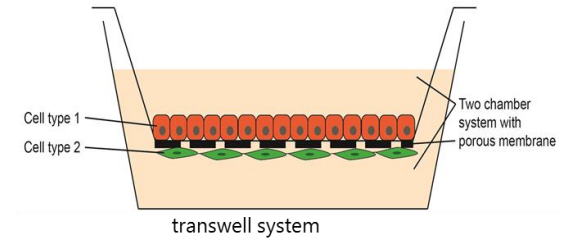
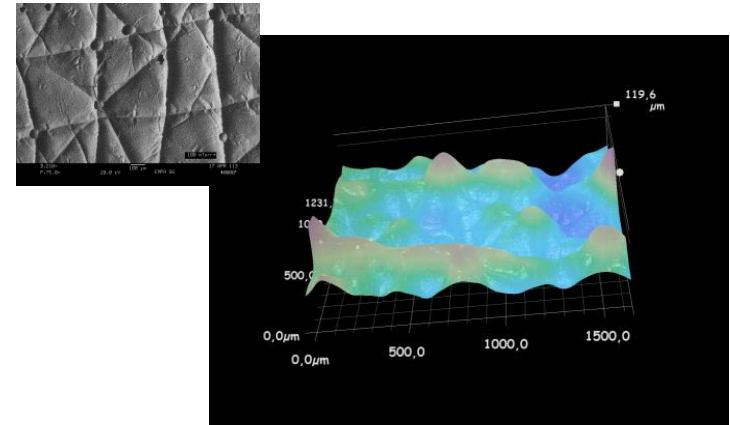
Industry needs:

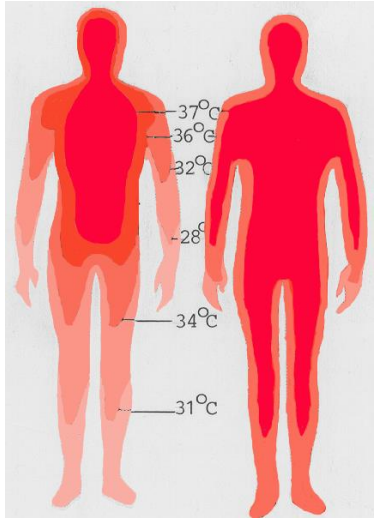
- Textile processing



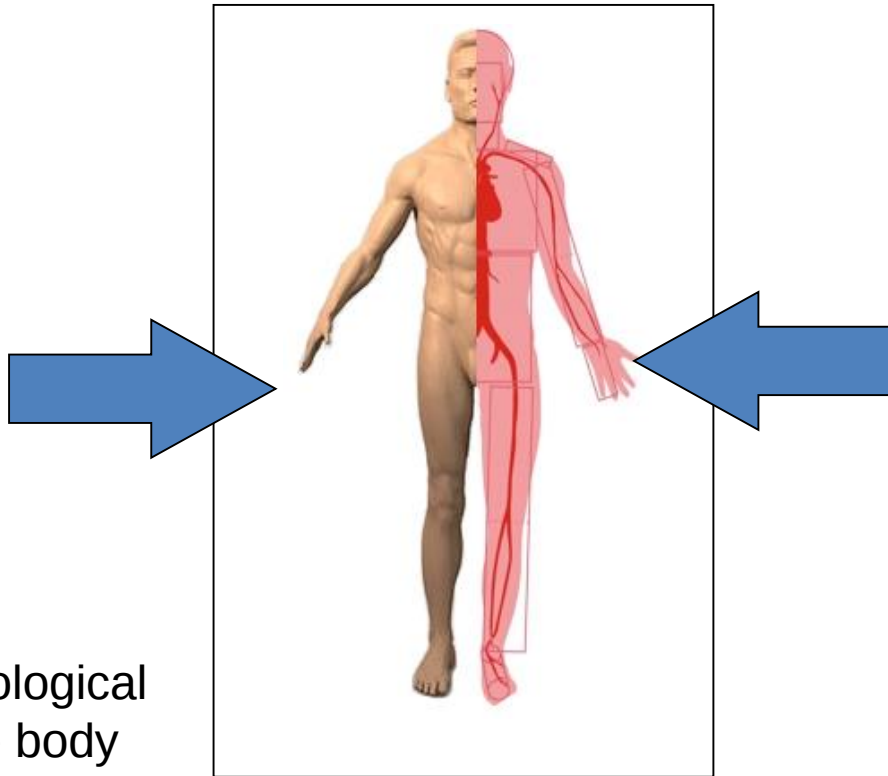
ITA, RWTH Aachen

Körper- und Organmodelle





Thermophysiological
model of the body



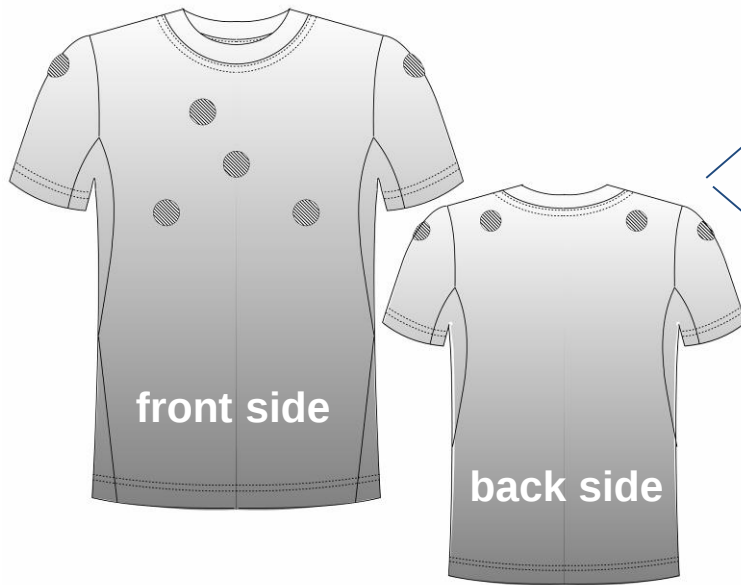
new generation
manikins



Human trials

Textile elektroden

MedTech Award 2006: ECG sensor shirt

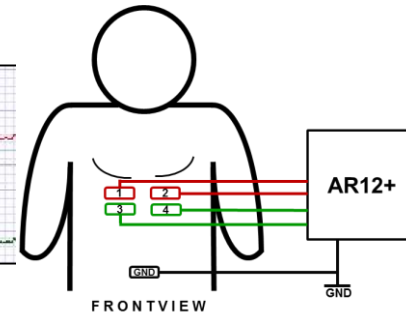


- Electrocardiogram (ECG) measurements
- Muscle stimulation



Long-term ECG measurements

Signal comparison: **textile electrode** x **gel electrode** (ca. 13s)



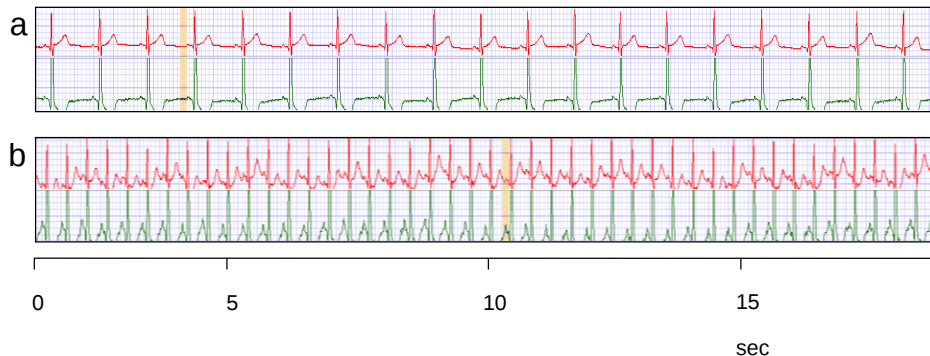
Skin irritation with typical gel electrodes
for several hours



Embroidered electrodes after long term wear test (10 days)

Textiler Sensor zur Langzeit-EKG-Messung

techtextil
innovationaward.2015



KTI/CTI
DIE FÖRDERAGENTUR FÜR INNOVATION
THE INNOVATION PROMOTION AGENCY

Kantonsspital
St.Gallen 

M. Brutsche
F. Baty
K. Baldwin
A. Van Gestel

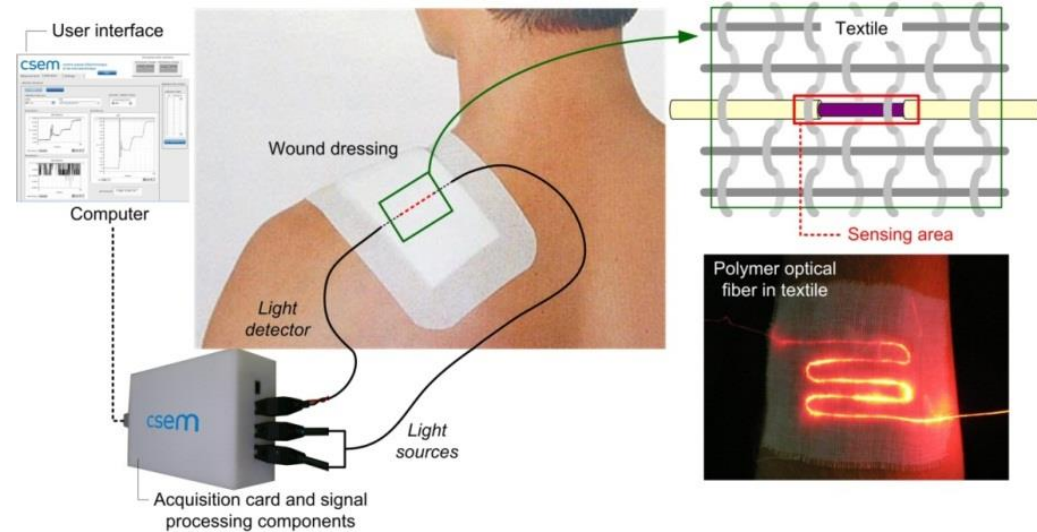
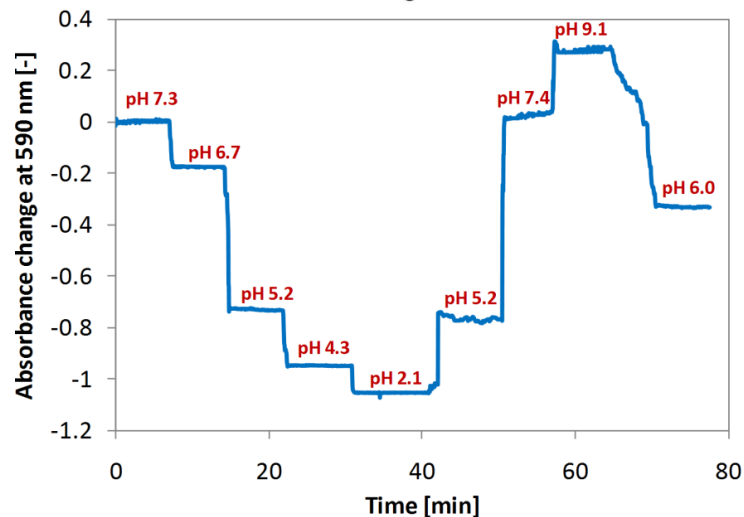
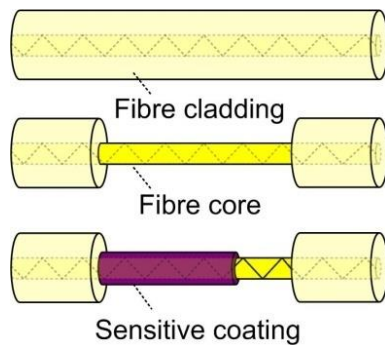
 **Empa**
Materials Science and Technology

R. Rossi
S. Annaheim
M. Weder

Optical fibres for Biosensors

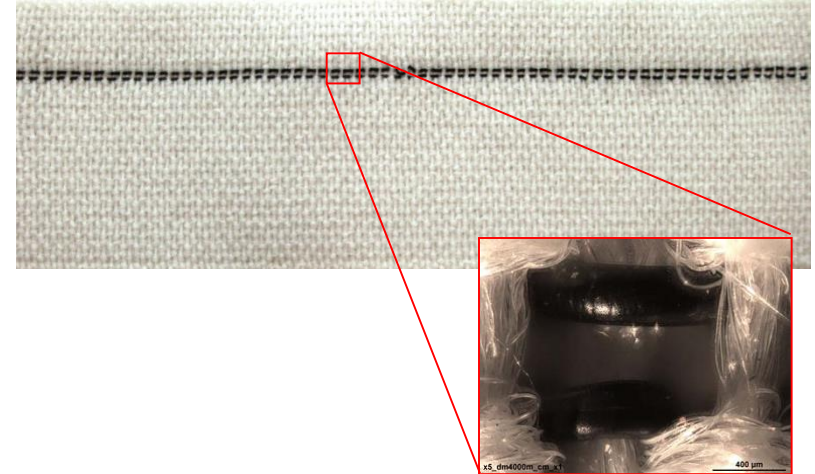
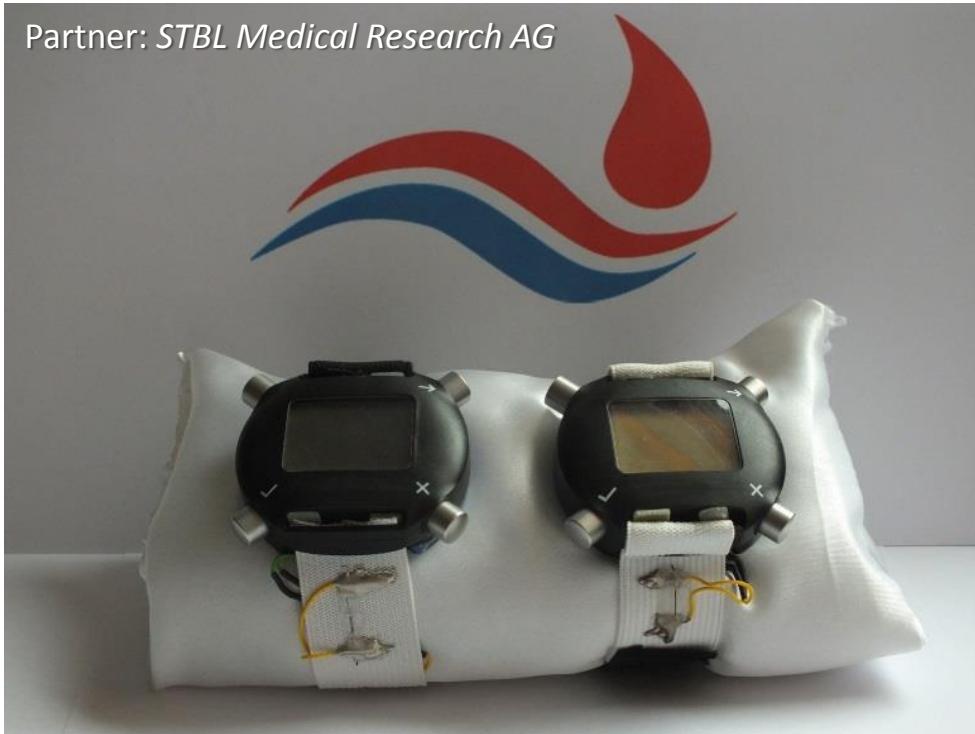
Wundmonitoring

pH sensitive optical Fibres

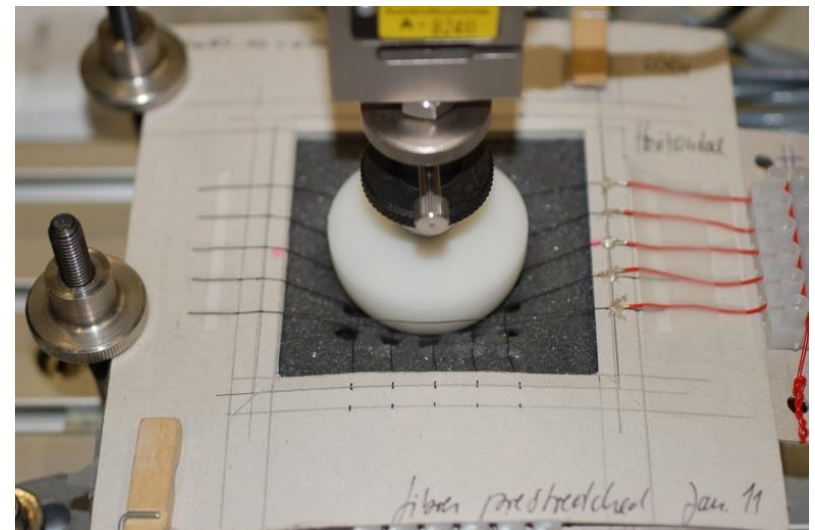


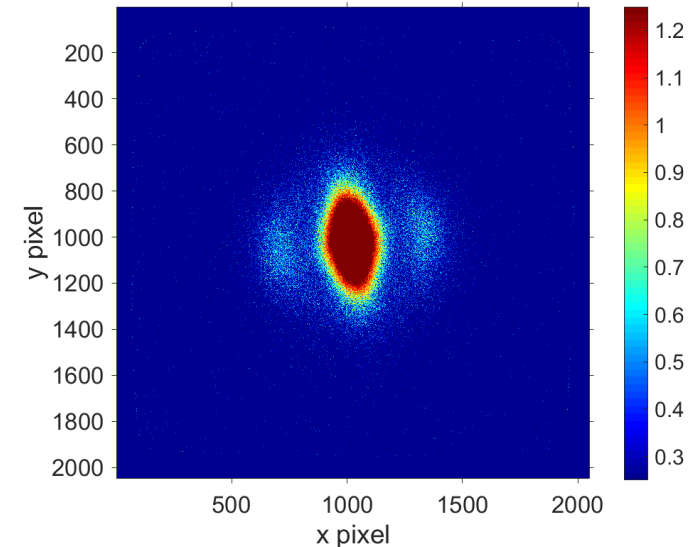
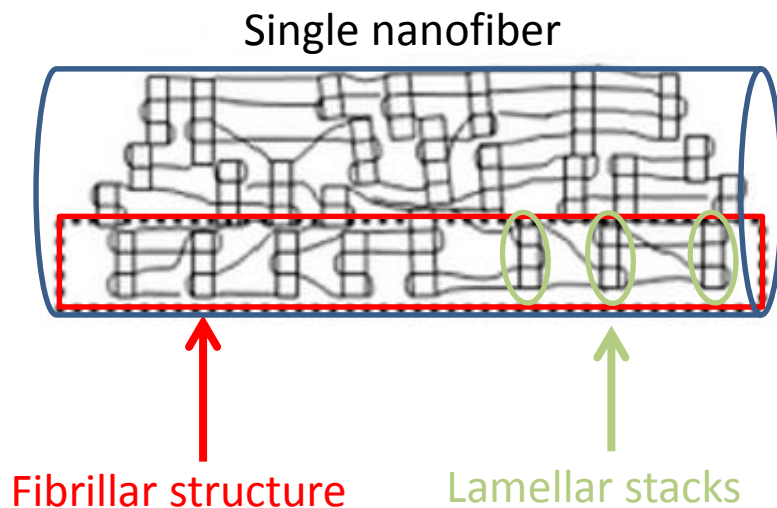
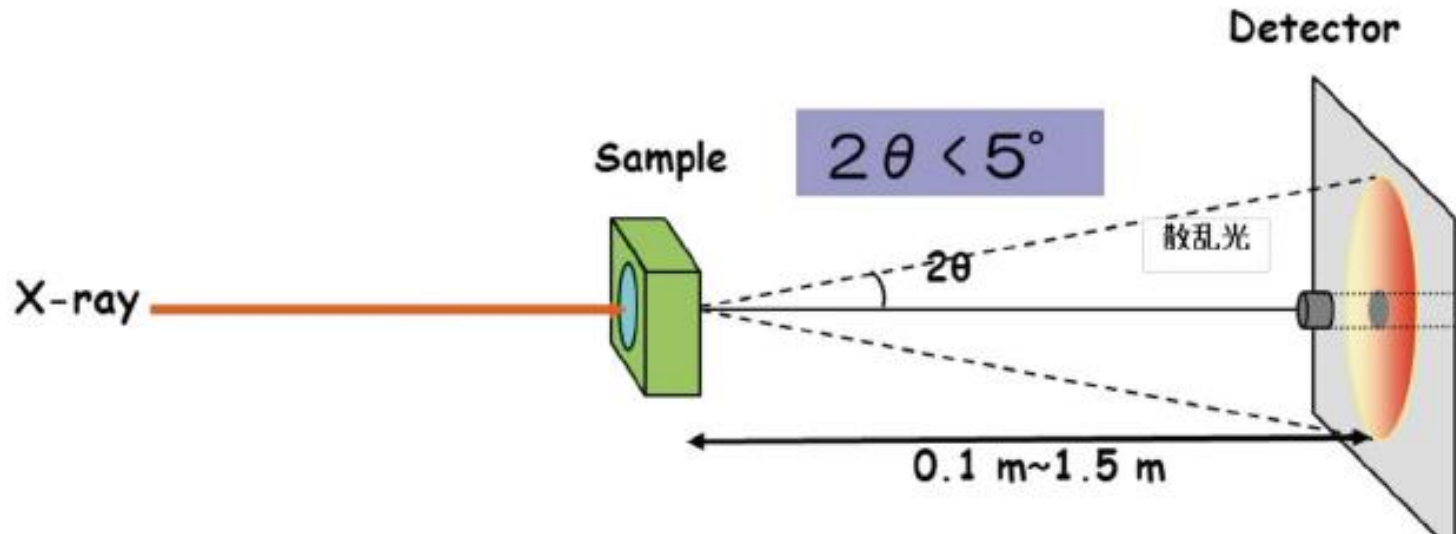
Wristband for blood pressure measurement

Partner: *STBL Medical Research AG*

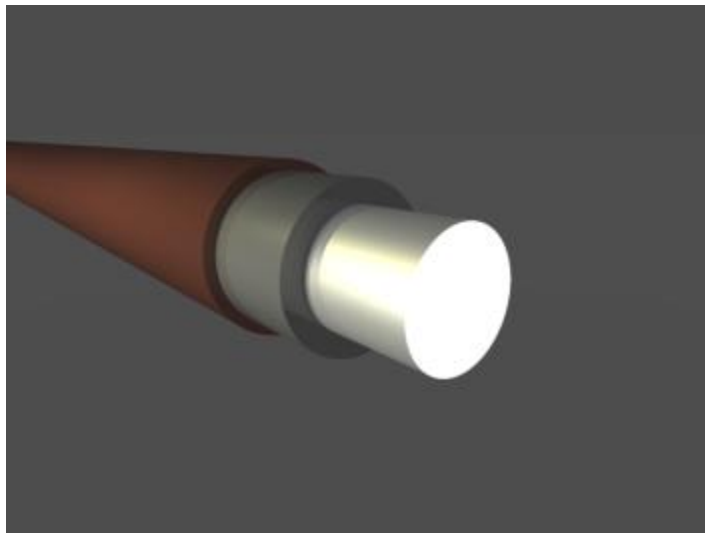
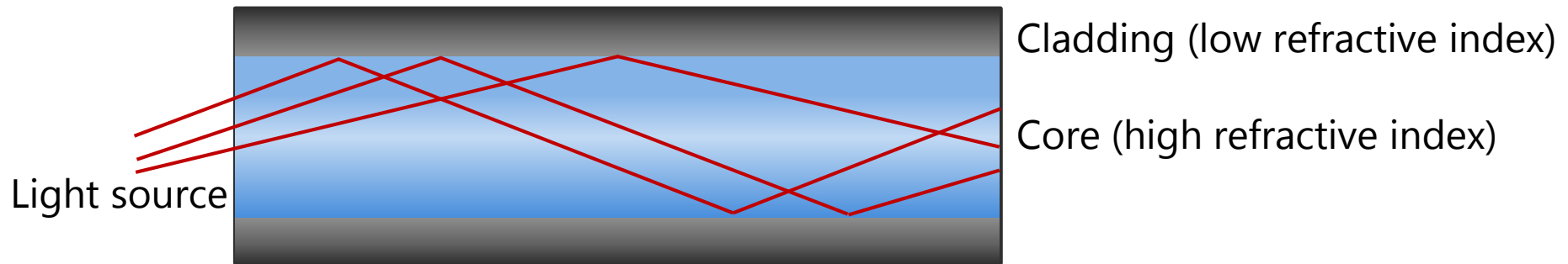


Pressure Sensor based on Piezo-resistive fibres





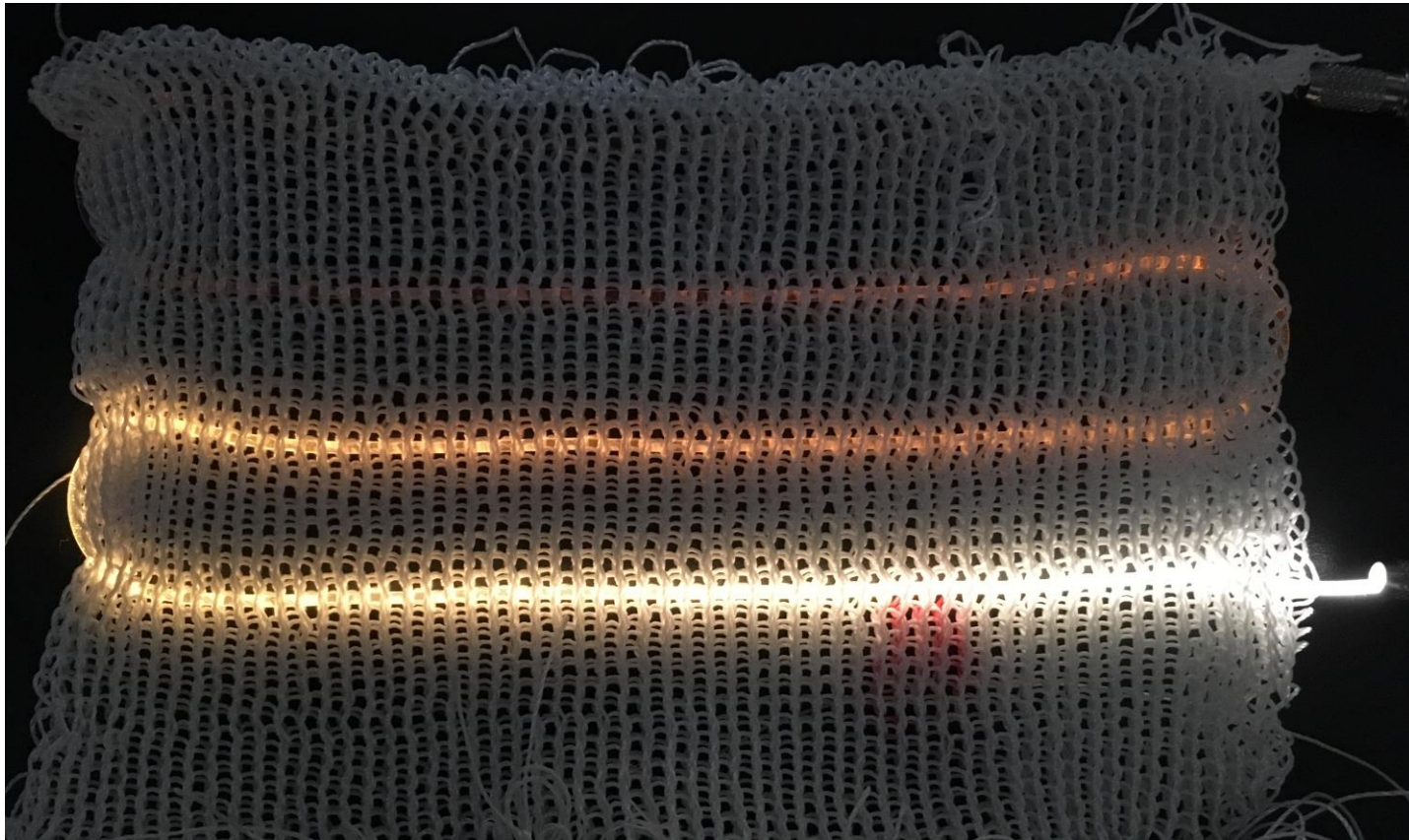
Polymer optical fibers (POF)



Core Material: normally PMMA

Cladding: fluorinated polymers

Gestrickte Sensoren

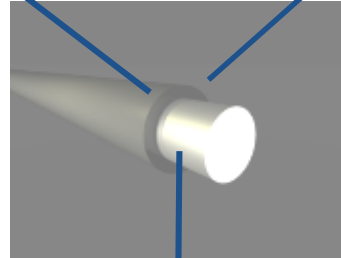


Flexible POF - applications

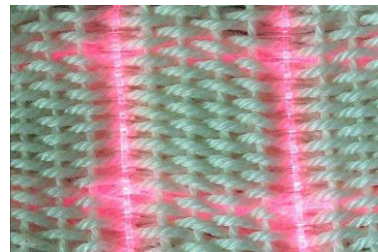
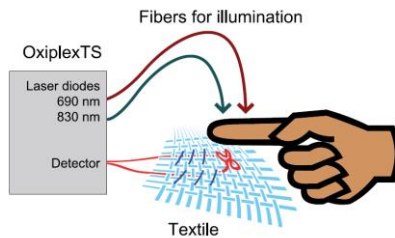


THERAPY

DESIGN

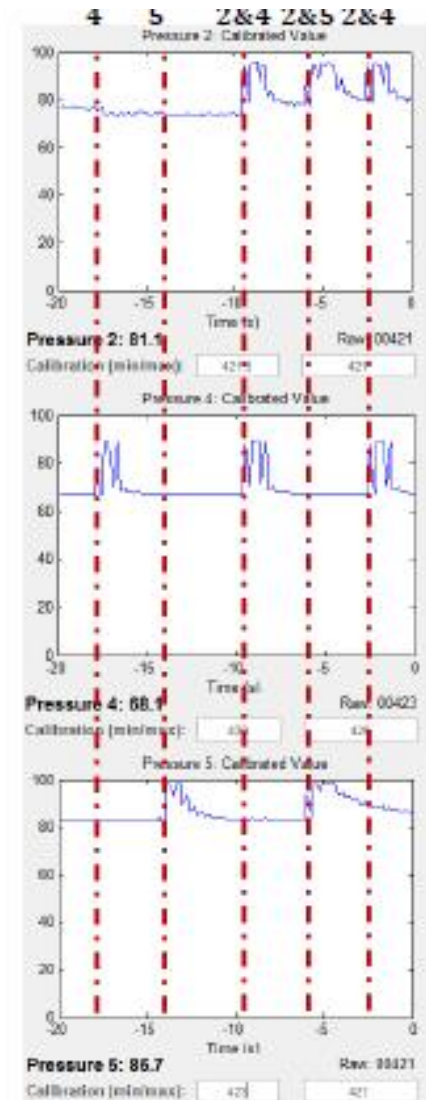
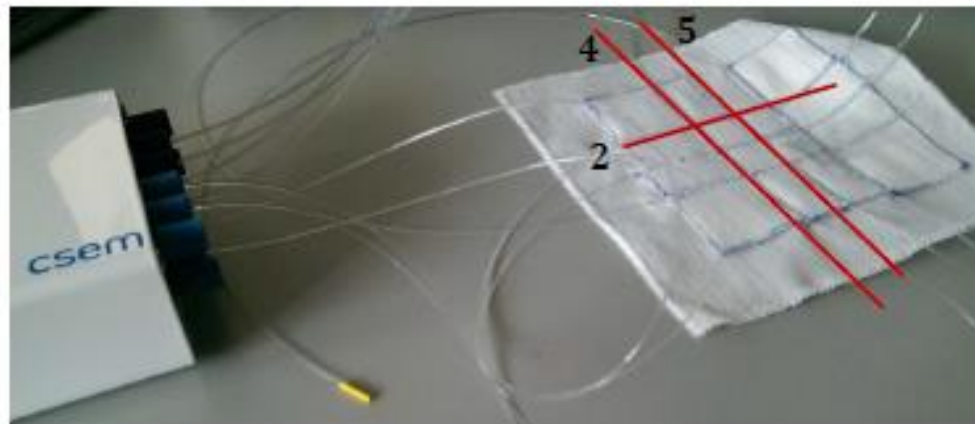
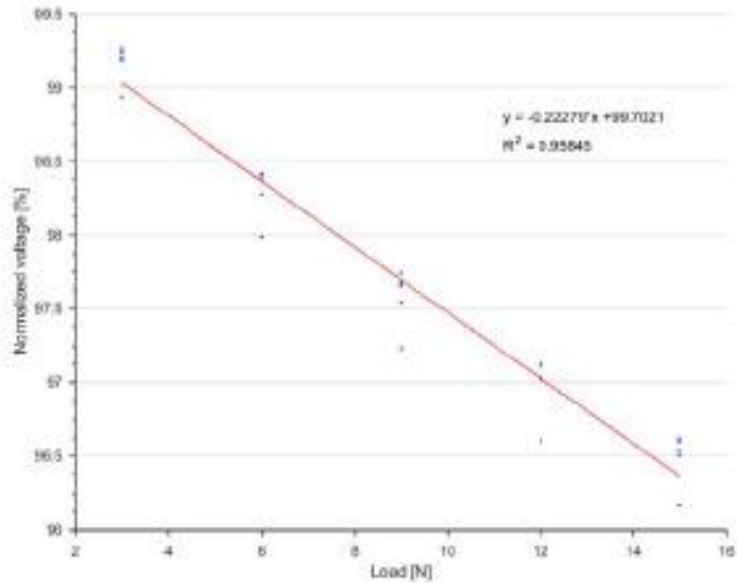


SENSORS

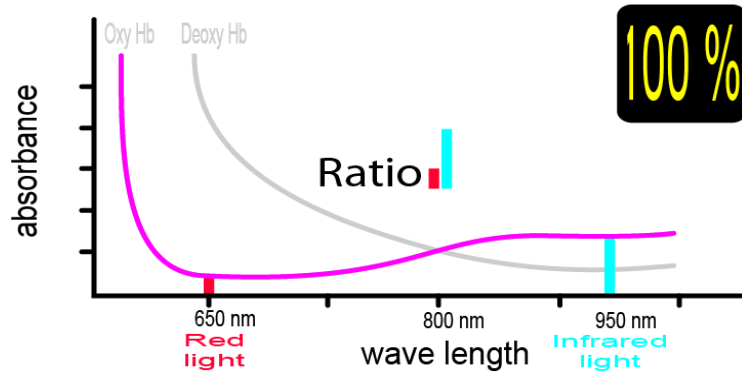


Patent US 7'274'844.
Selm et al. *J. Int. Mat. Sys. Struct.*, 2010, 21, 1061.
Quandt et al. *Adv. Healthcare Mater.*, 2015, 4, 330.

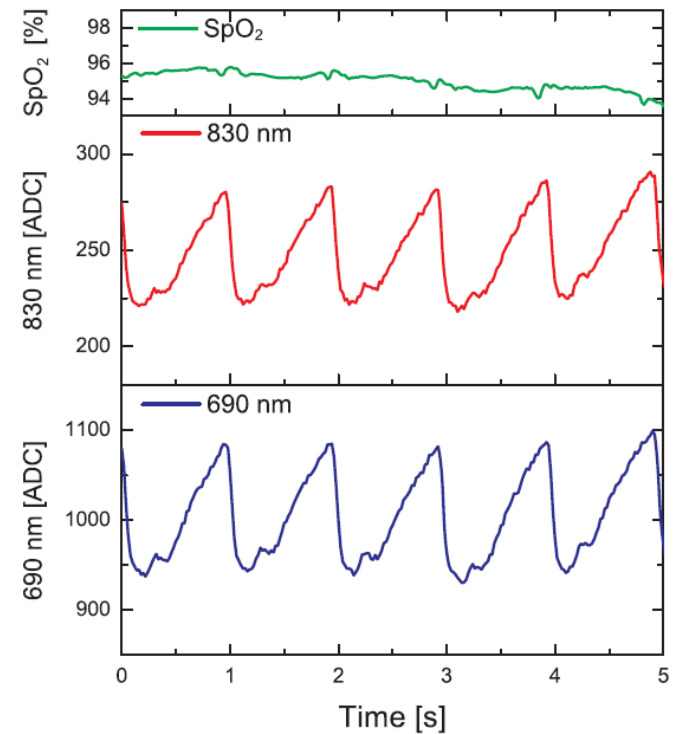
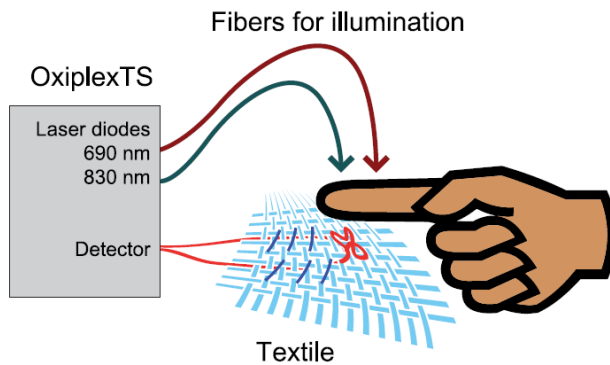
MESSPRINZIP



Photoplethysmography

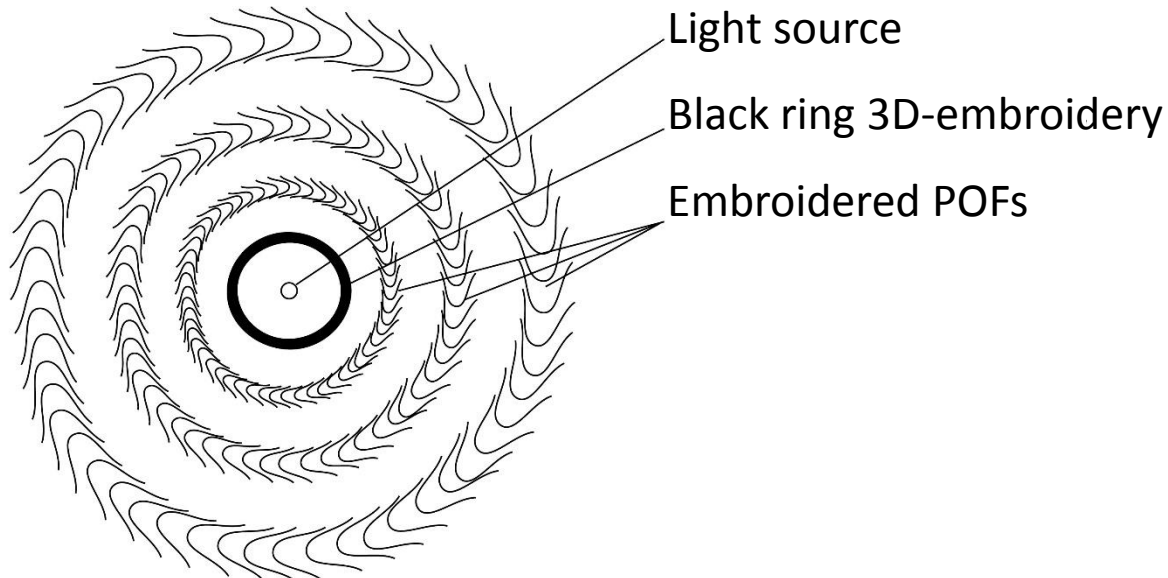
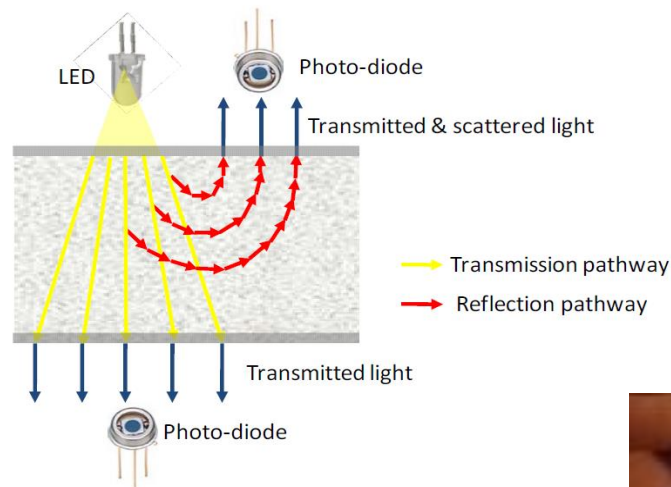


equipmentexplained.com



Rothmaier et al. *Optics Express*, 2008, 16, 12973-12986.

Photonic textiles for Photoplethysmography



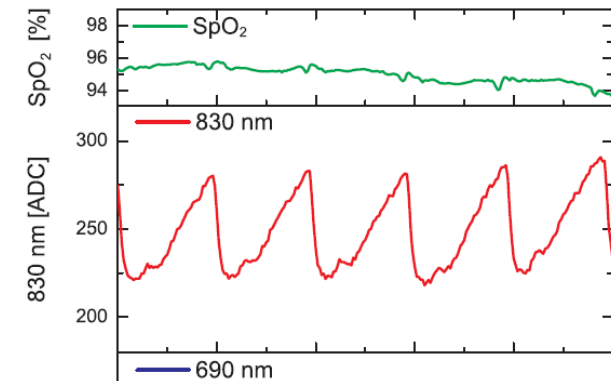
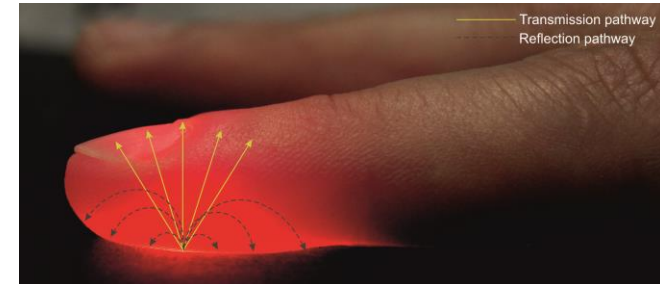
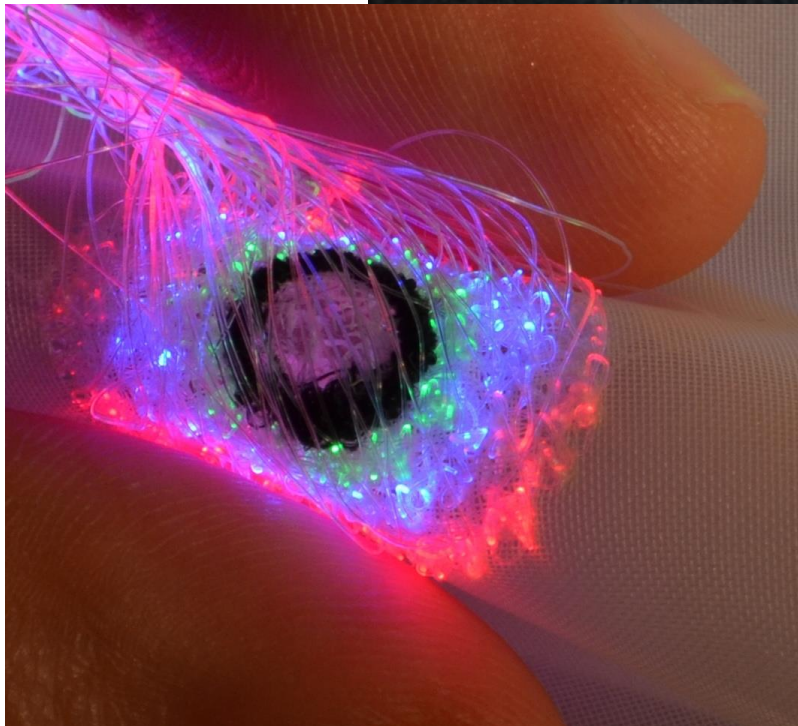
Technische Stickereien



UniversityHospital
Zurich



Schweizer
Paraplegiker
Zentrum





University Hospital
Zurich



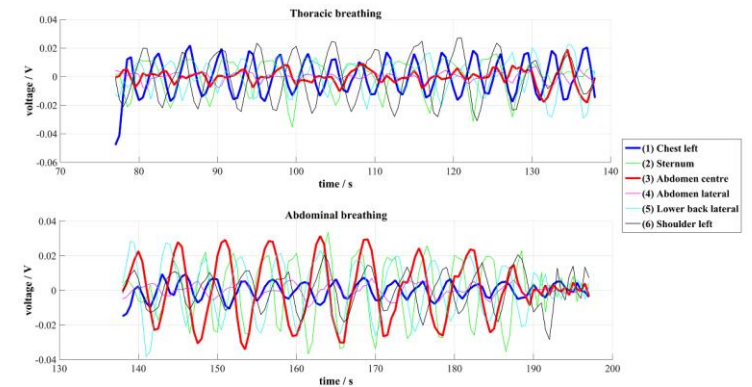
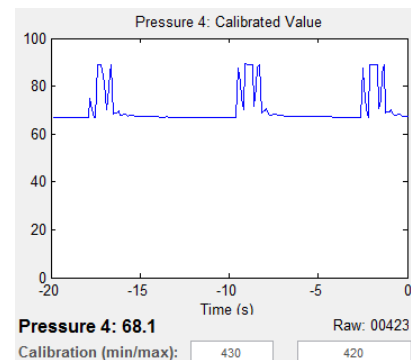
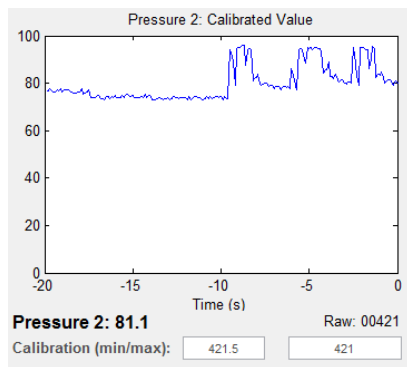
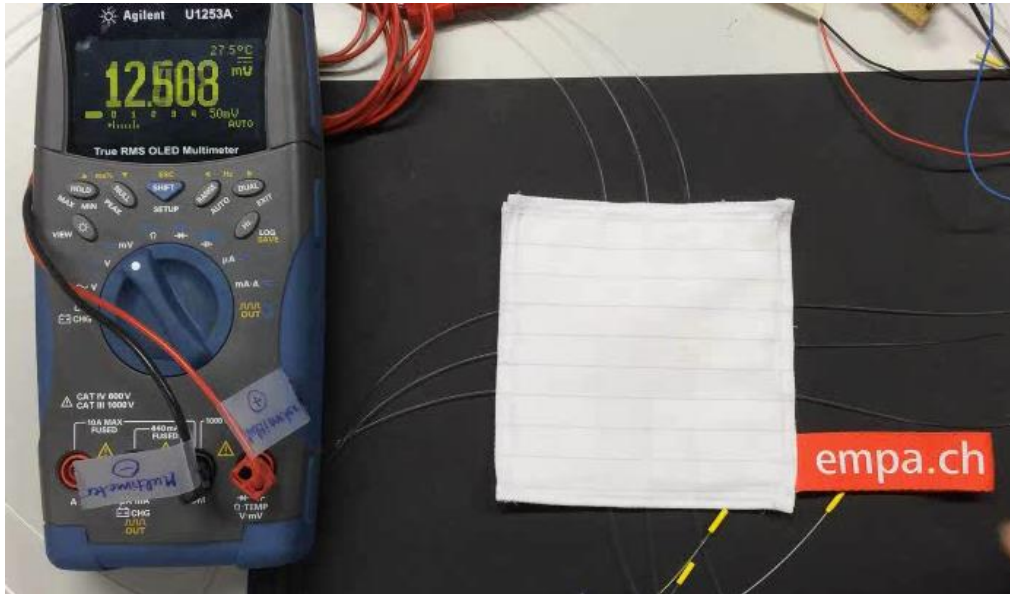
Empa

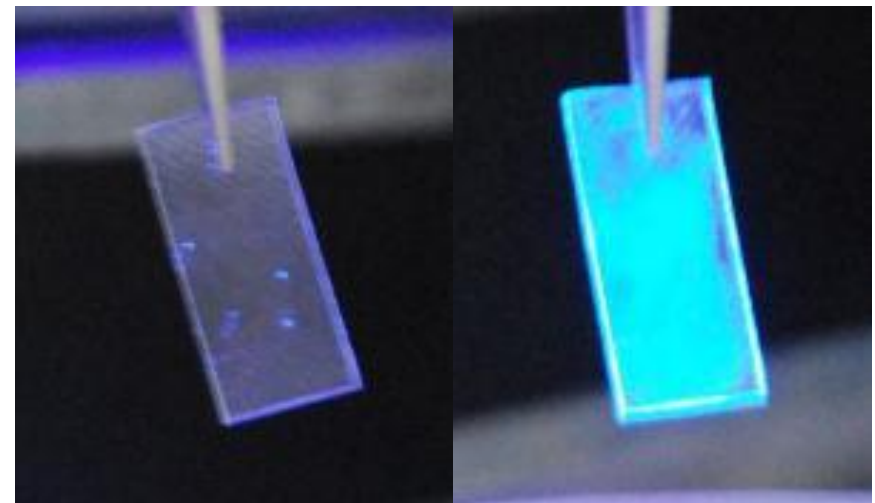
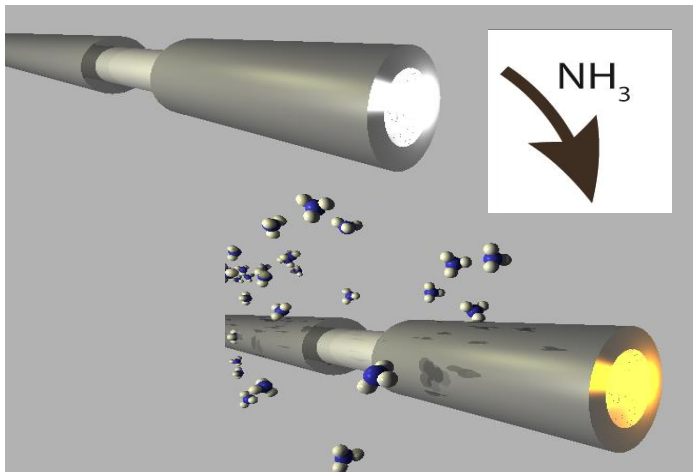
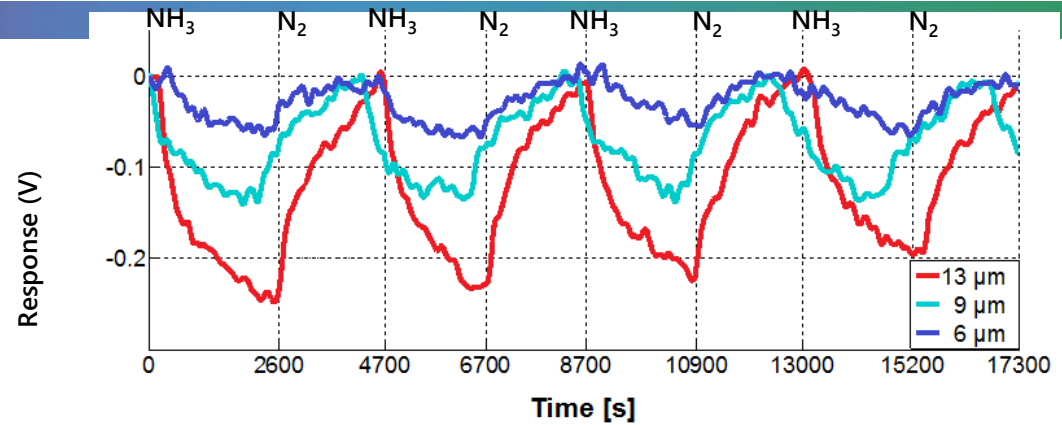
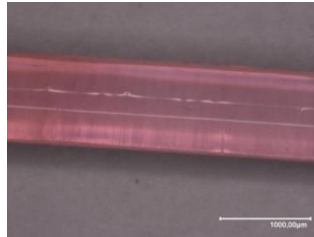
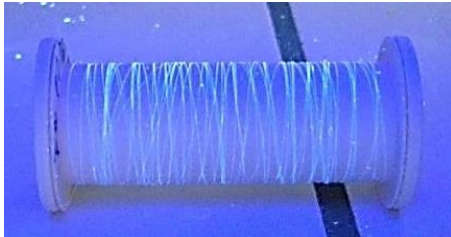
Materials Science and Technology

csem



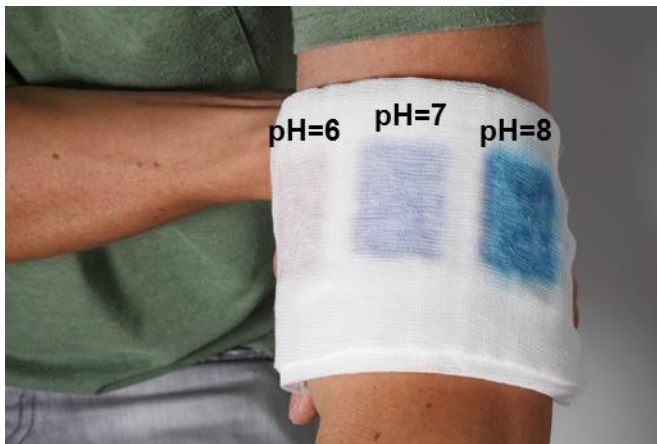
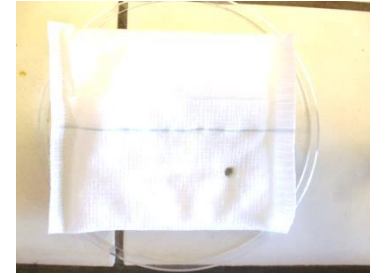
Schweizer
Paraplegiker
Zentrum



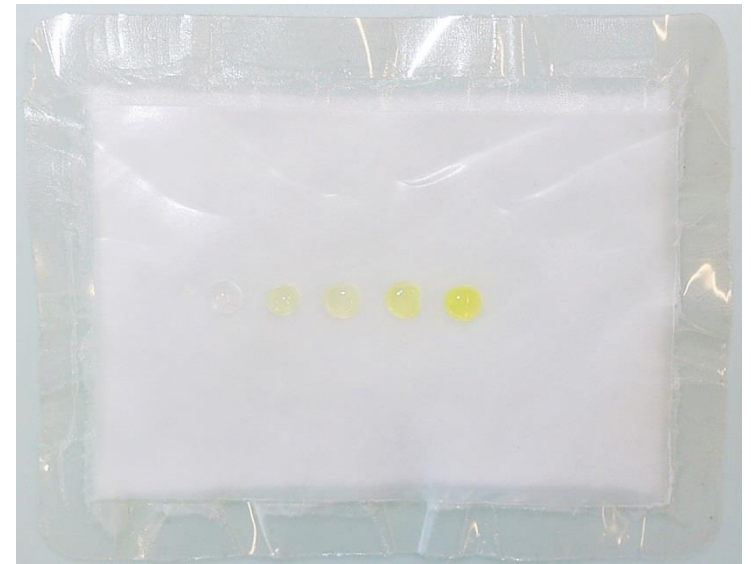


Widmer, S. et al.. Analyst 2014, 139, 4335

"Smart" wound pads



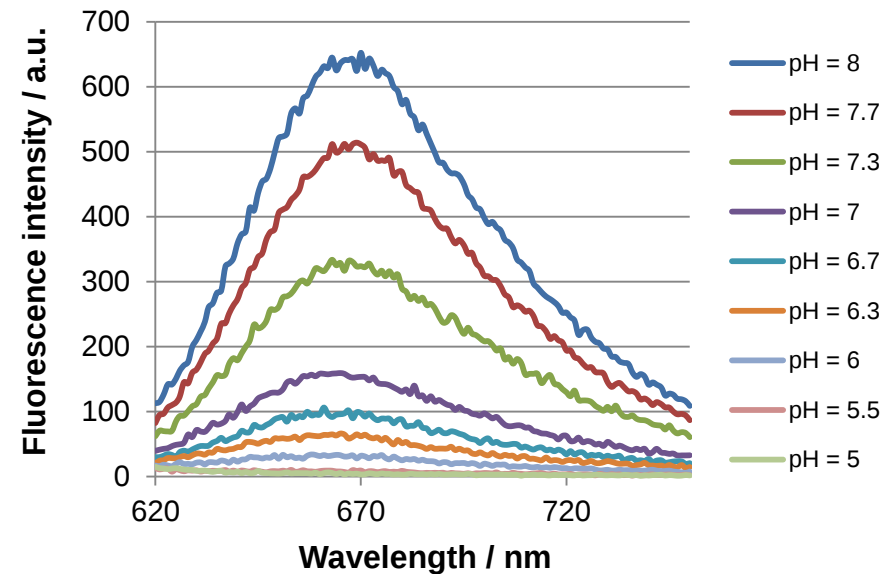
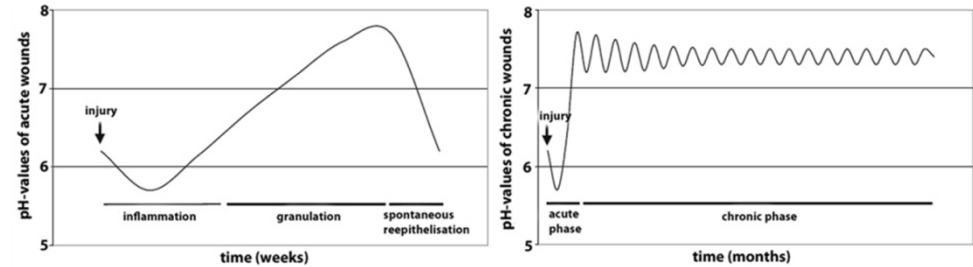
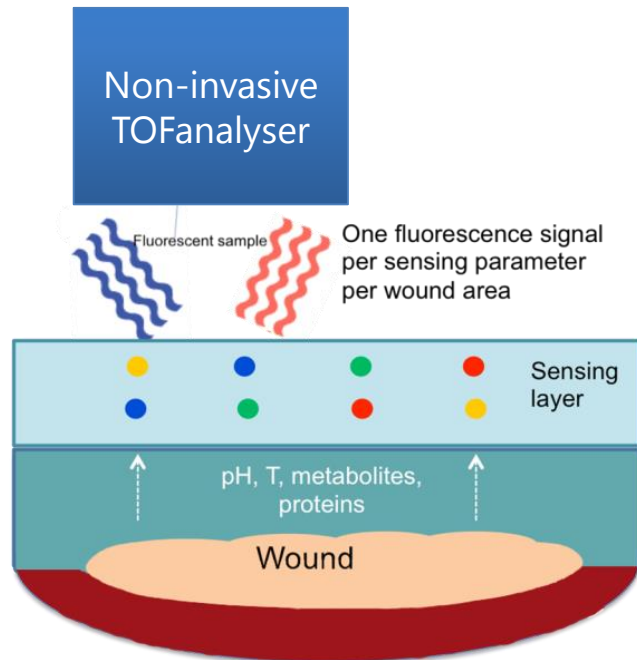
pH detection



Glucose detection

pH sensing for wound monitoring

Sensing Wound PAD – Cross section



Intelligenter Glukosesensor

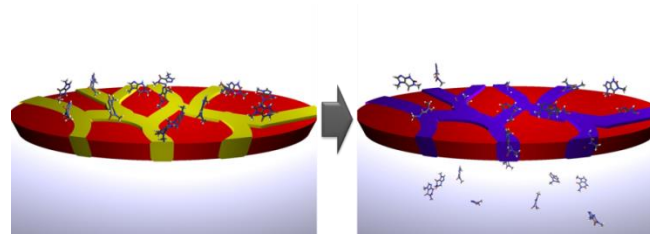


UniversitätsSpital
Zürich



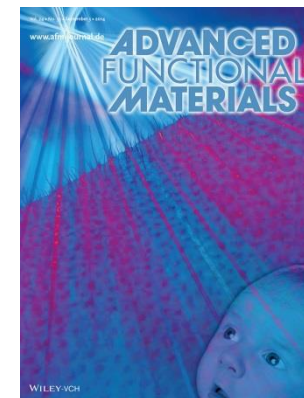
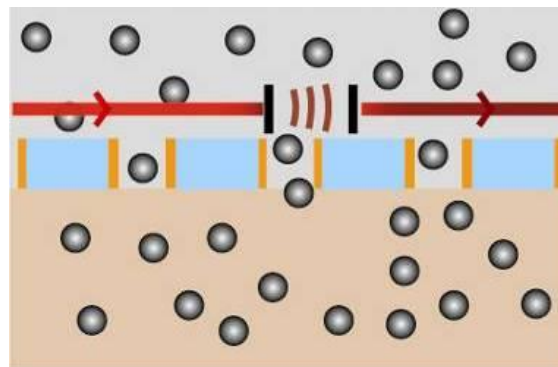
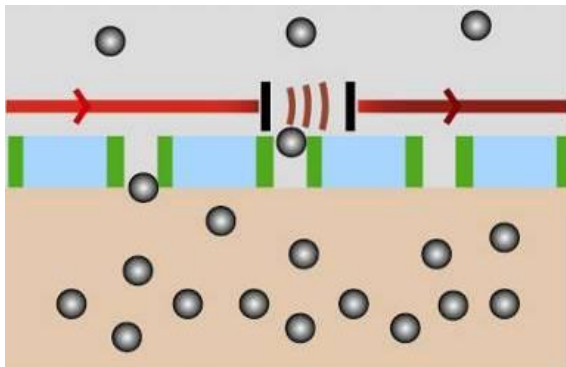
Empa

Materials Science and Technology



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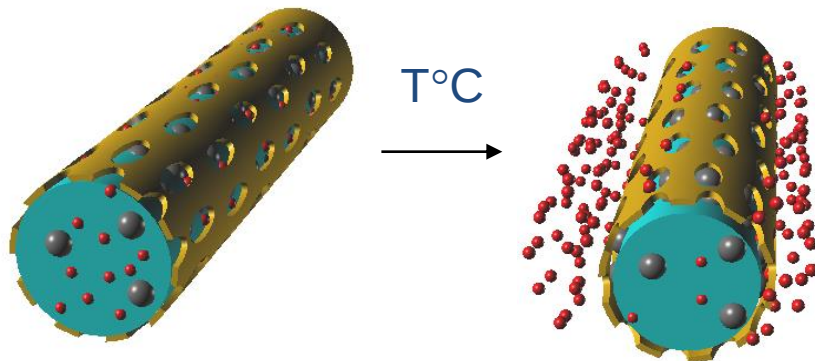
Light-responsive membrane



FNSNF

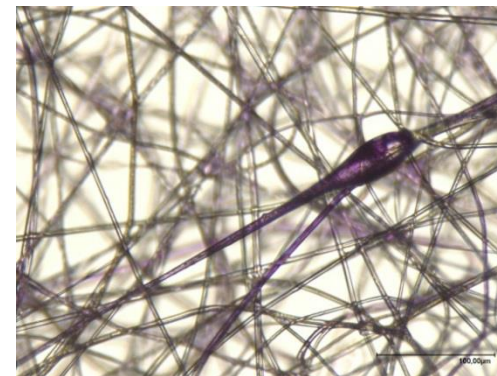
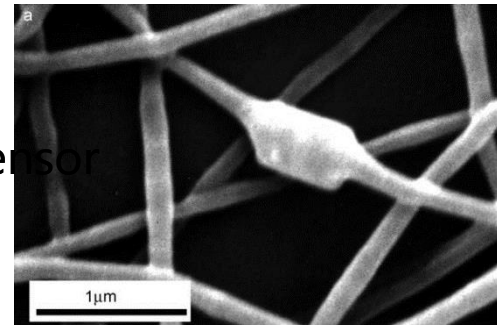
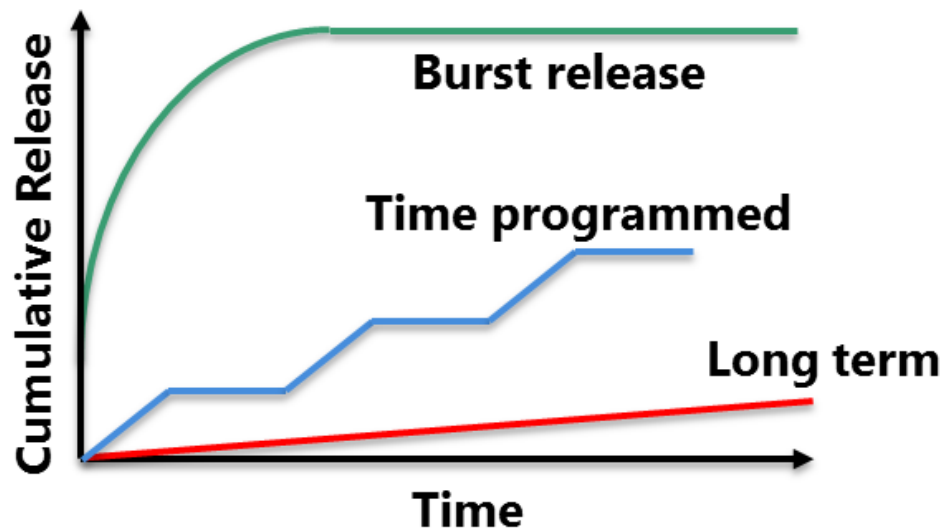
FONDS NATIONAL SUISSE
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

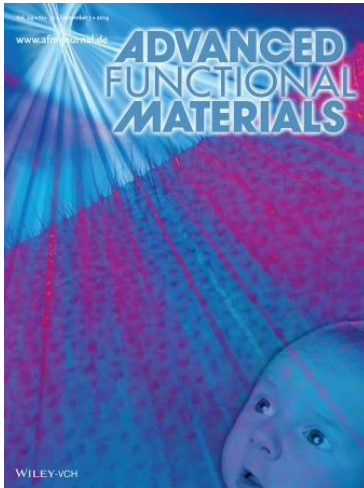
Faserbasierte Substanzabgabesysteme



15 Industrie-
partner

Textiler EKG-Sensor





Light-responsive membrane

Pflaster statt Spritzen für Frühchen und Diabetiker



DÜBENDORF. Anstelle von schmerzhaften Spritzen könnten künftig Pflaster zum Einsatz kommen. In diese werden Medikamente integriert, die der Patient über die Haut aufnimmt. Dafür haben Forscher der Empa eine spezielle Membran entwickelt. Diese lässt Wirkstoffe durch, sobald sie mit UV-Licht bestrahlt wird. Danach ist die Membran für mehrere Stunden durchlässig. Während dieser Zeit erhält der Patient eine gleichmässige Dosierung des Medikaments. Die Membran lässt sich aber auch verschliessen, indem sie mit sogenanntem Weisslicht bestrahlt wird.

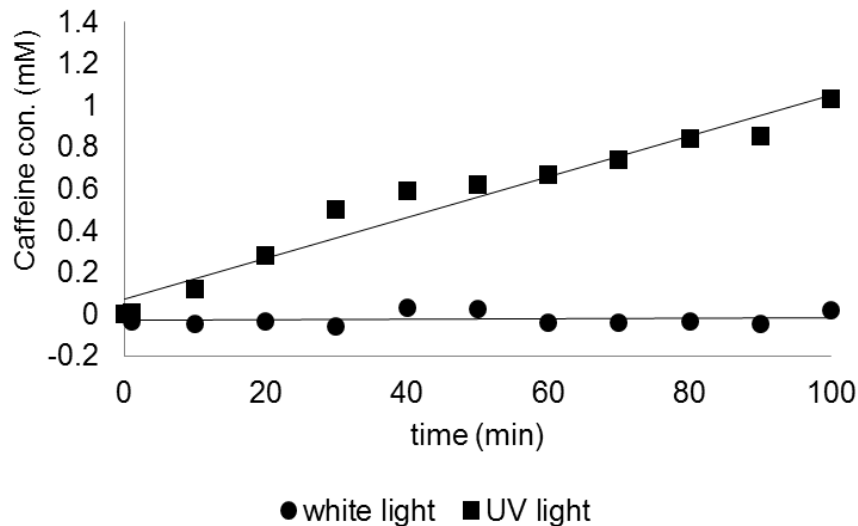
Nützen könnten solche Pflaster zum Beispiel zu früh geborenen Kindern. Ihnen wird in den ersten Tagen nach der Geburt Koffein gespritzt, um einen möglichen Atemstillstand zu verhindern. «Er-



Frühchen wie dieses sollen bald weniger Schmerzen leiden. ISTOCK

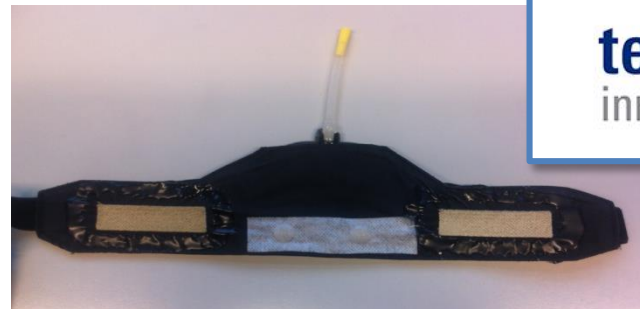
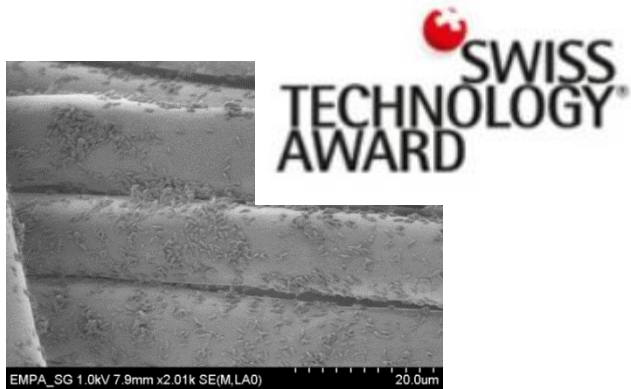
setzt man die Spritzen durch Pflaster, erspart das den Frühchen Schmerz und Stress», sagt Empa-Forscher Luciano Boesel. Eine weitere Anwendung sieht er beispielsweise bei Diabetes-Patienten. Diese

müssen sich heute regelmässig Insulin spritzen. In Zukunft könnten sie sich das Medikament verabreichen, indem sie ein Insulin-Pflaster mit einer tragbaren Lampe aktivieren. **kww**

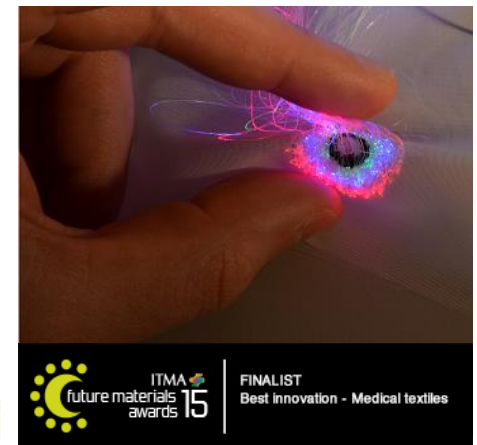


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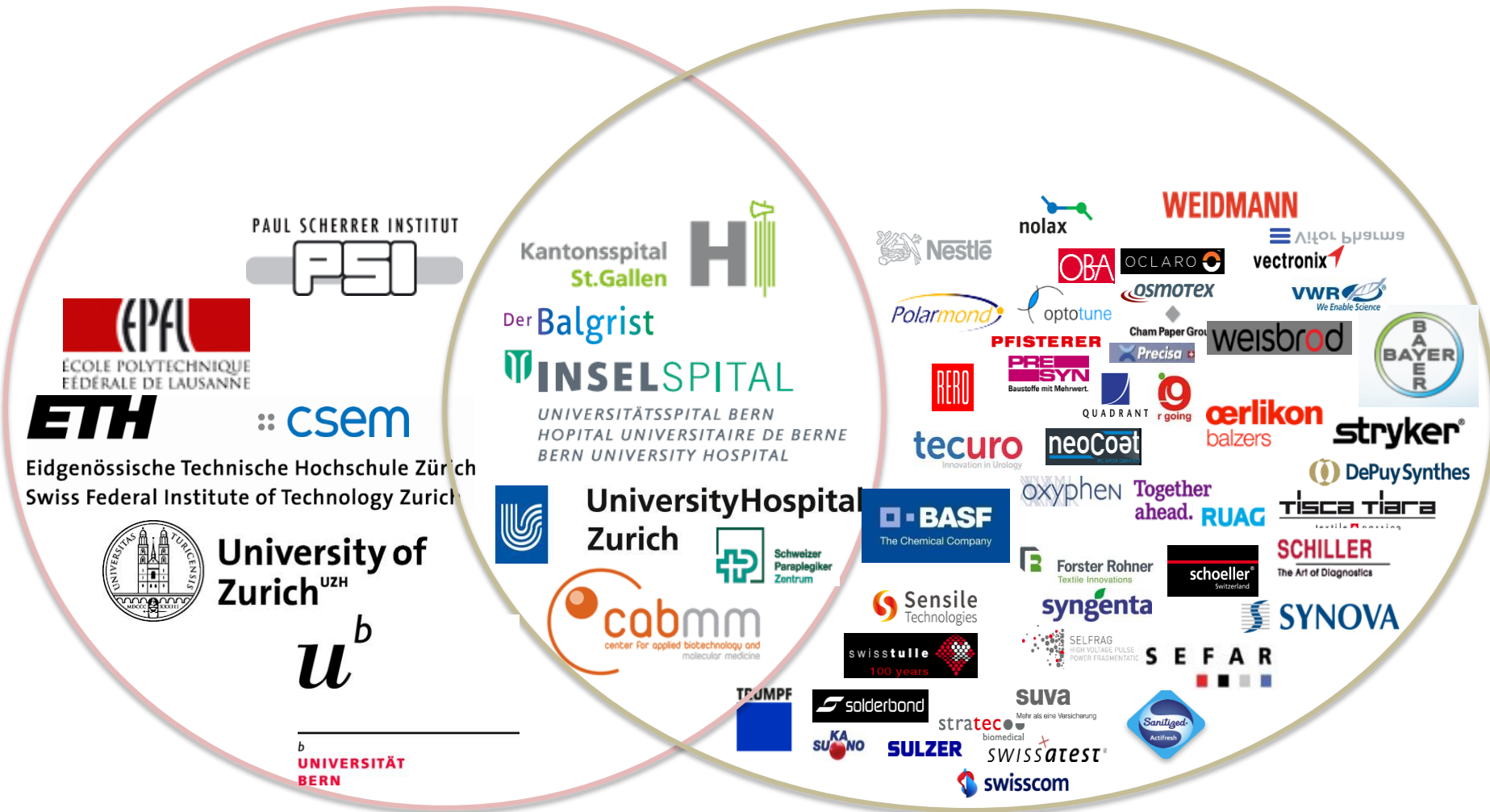
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