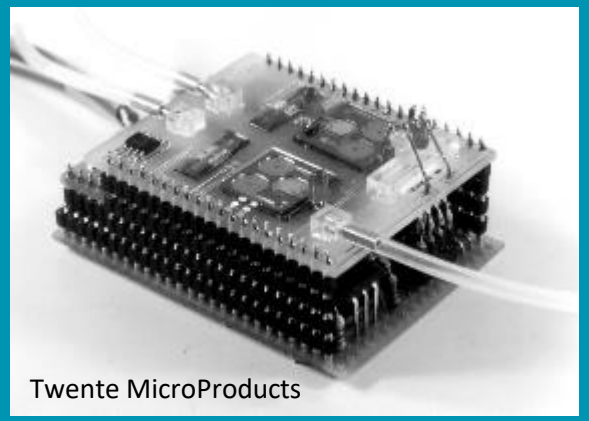
UNIVERSITY OF TWENTE. | TECHMED CENTRE

FROM SILICON TO SOLUTIONS

THE ROLE OF CHIPTECH IN MODERN MEDICINE

Wed. Nov 6 | 11-12am | Panel discussion with experts

MODERATOR: Twan Korthorst



1996

2024

EXPERT PANEL

Albert van den Berg

Professor Emeritus

Biomedical and Environmental Sensorsystems

University of Twente

Ronald Dekker

Principal Scientist

System in Package Devices

Philips Research

Parttime professor

Electronic Components, Technology and Materials

Technical University Delft

Martin Bennink

Lector

Applied Nanotechnology

Saxion University of Applied Sciences

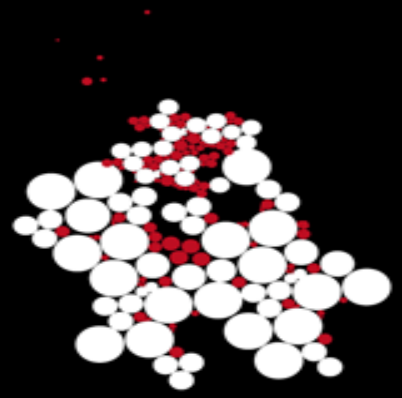
UNIVERSITY OF TWENTE.

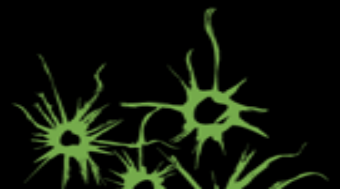
Labs on Chip and Organs on Chip

Albert van den Berg

BIOS/Lab-on-a-Chip group

University of Twente, The Netherlands

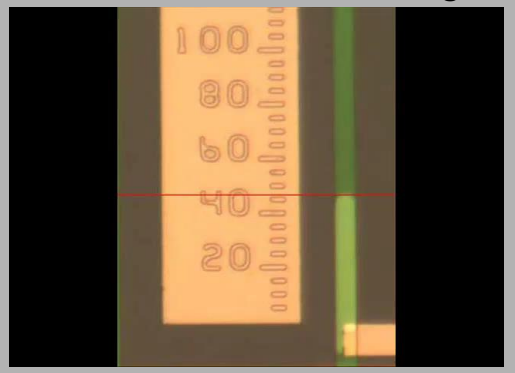




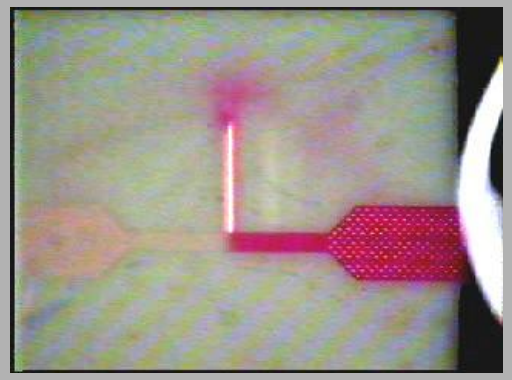
Techmed Event, November 6th, 2024

electrophoresis

electrochemical fl dosing



FlowFET



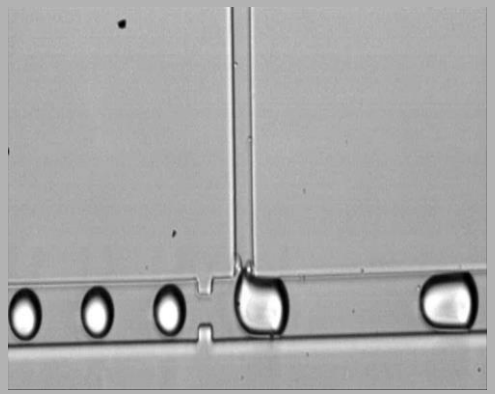
paper-based microfluidics

Whitesides

integrated microfluidics in PDMS

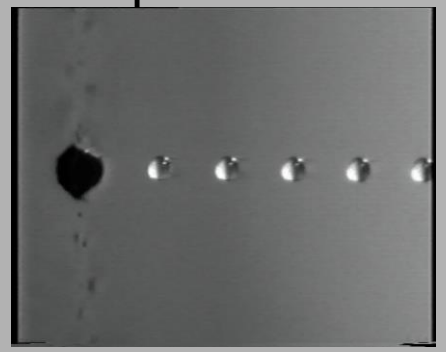
Quake

droplets in oil (200x slomo)



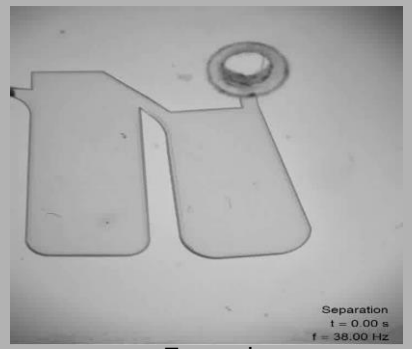
Weitz

droplets in air



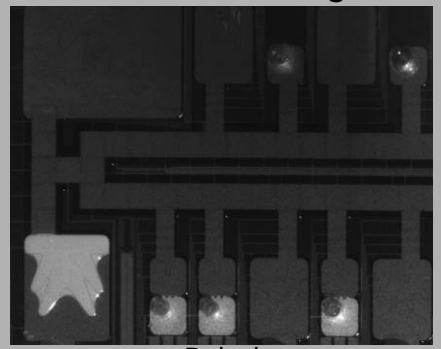
Laurell

centrifugal system



Zengerle

electrowetting

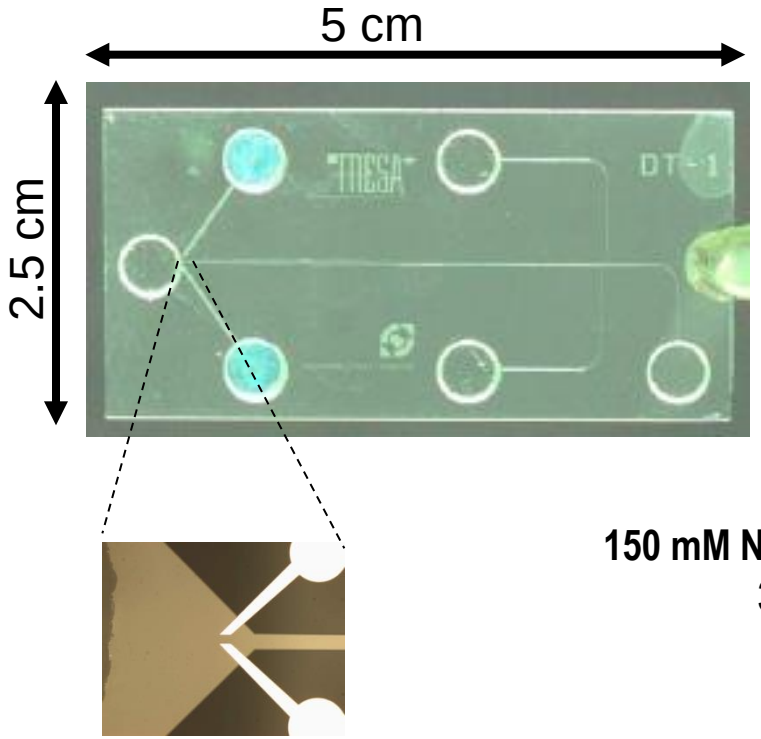


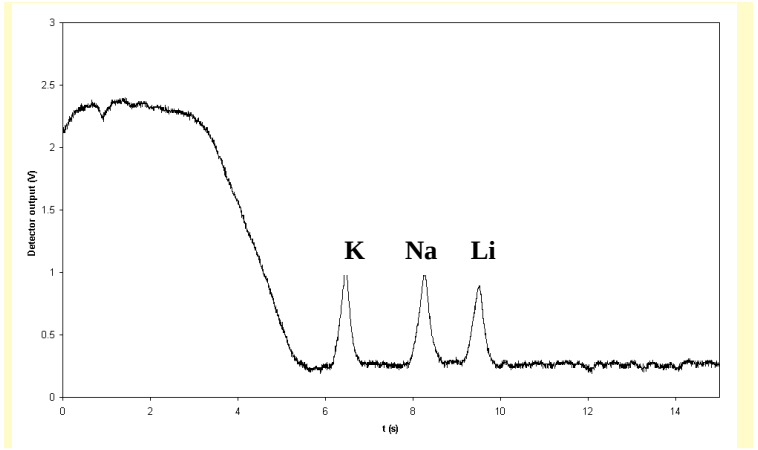
Delapierre

MESA+
INSTITUTE FOR NANOTECHNOLOGY

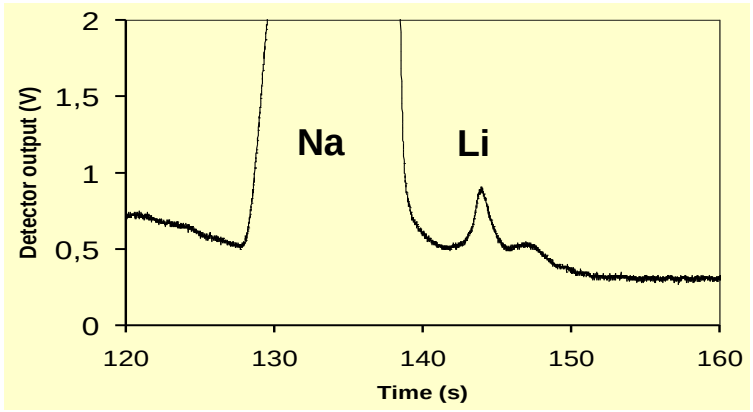
Lithium monitoring for manic depressive patients using CE

10 mM K, Na, Li
300 V/cm





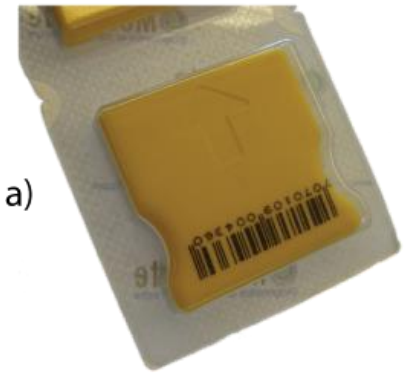
150 mM Na,1 mM Li
300 V/cm



E.X. Vrouwe *et al., Electrophoresis,* **26,** 3032-3042 ,(2005).
E.X. Vrouwe *et al., Clin. Chem*., **53(1**), 117-123, (2007).
A. Floris et al., *Lab Chip*, **10(14)**, 1799, (2010).

2 master students: spin-off

Medimate
Diagnostics at the point of care

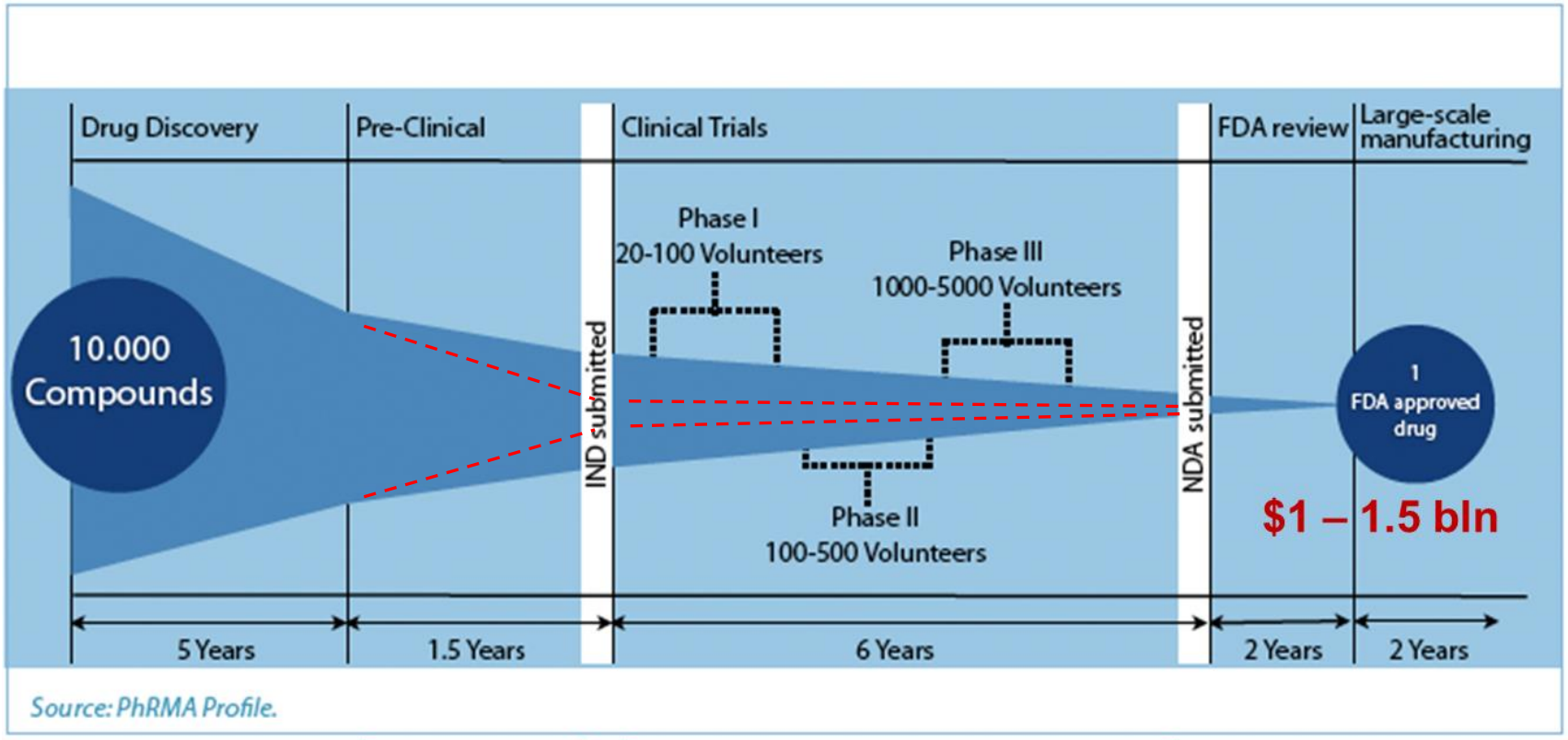
a) 

b) 

c) 

→ prefilled, ready to use, disposable chip
→ >50.000 produced so far

Drug development



Personalized medicine

Disease studies

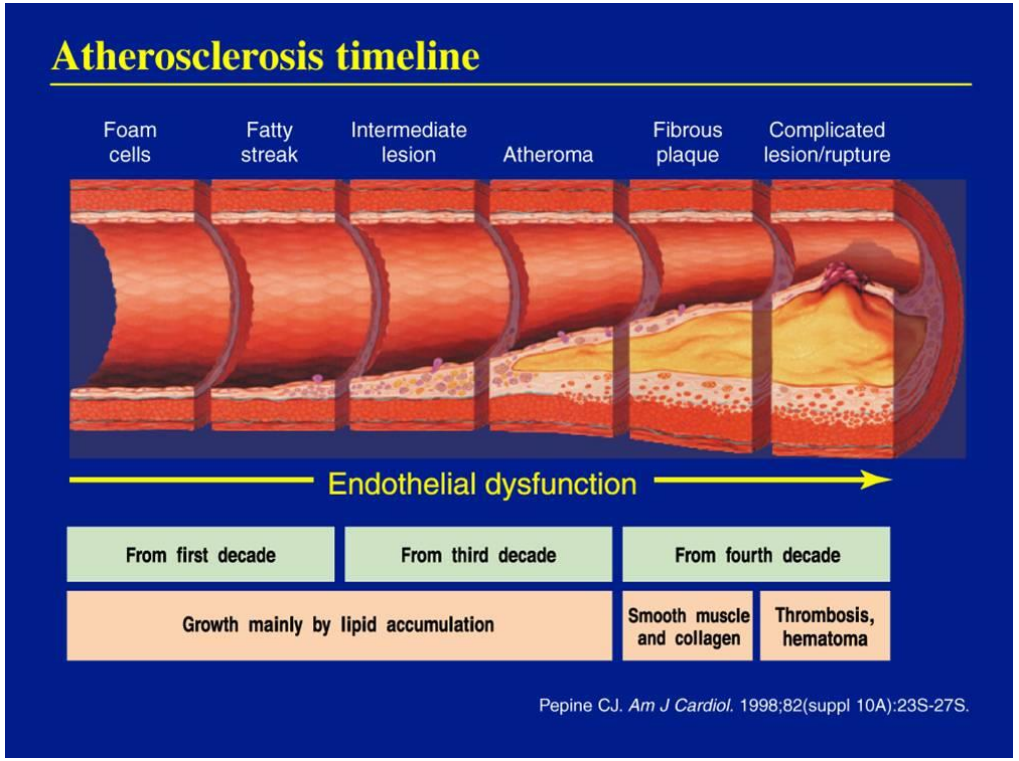
Atherosclerosis chip

Andries van der Meer

Hugo Albers

- Commonly referred to as hardening of the arteries. Characterized by plaque deposits that block the flow of blood.

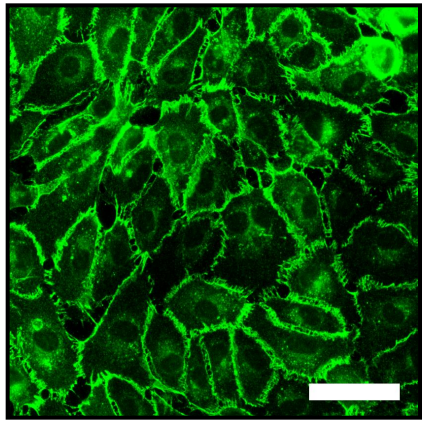
- Plaques can rupture causing sudden formation of blood clot (thrombosis). Thrombosis can also occur without plaque rupture.



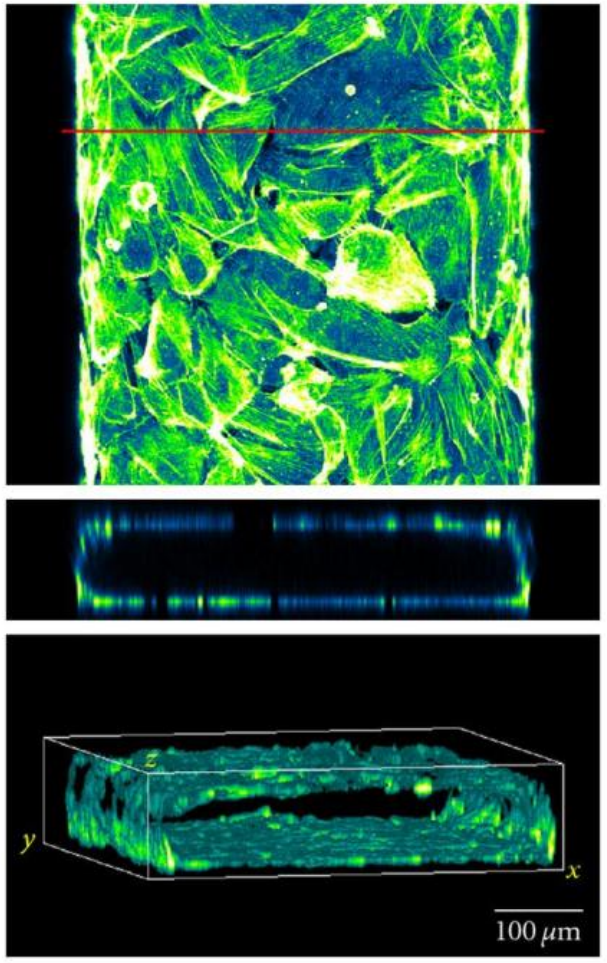
Outcome: CVD, CAD, PVD => Heart attack and stroke.

CAPILLARY-ON-A-CHIP

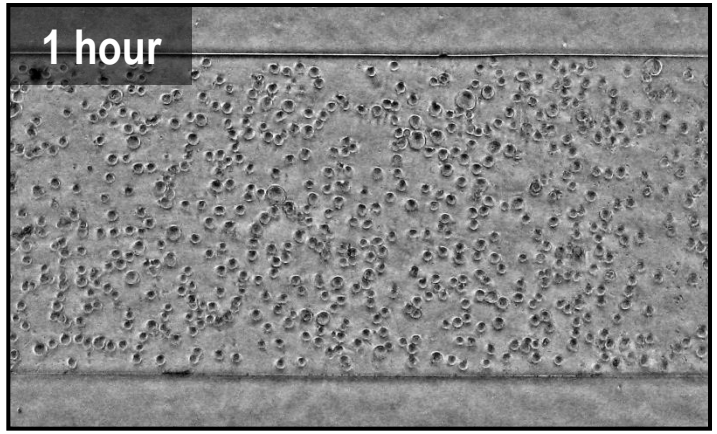
VE-Cadherin-FITC

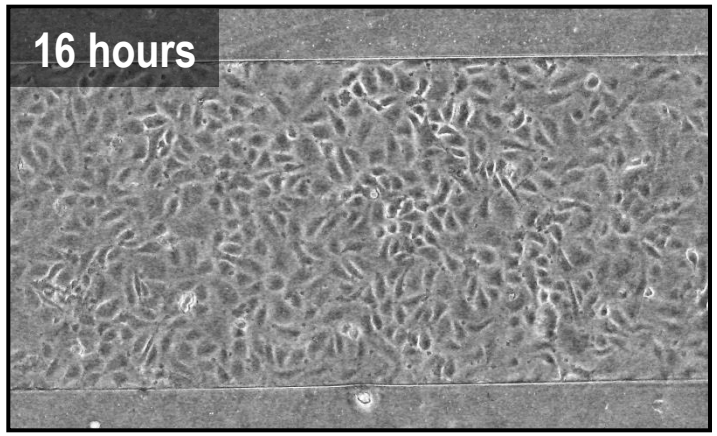


F-actin-FITC



Human endothelial cells in a channel, with 500 μm width, 60 μm height





“Micrometer-sized capillary”

Van der Meer, et al. J Biomed Biotech 2009:823148, 2009

Blood perfusion: thrombus formation

E. Westein et al., PNAS, (2013).

The MEMS ultrasound revolution

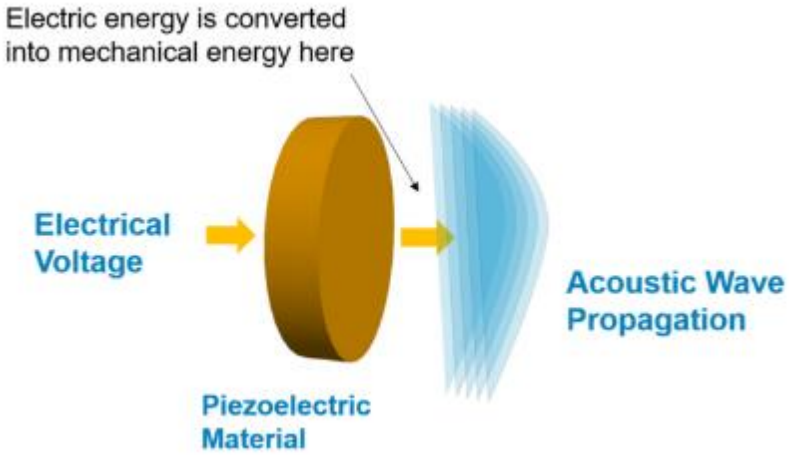
Ronald Dekker

PHILIPS

XIVER MEMS FOUNDRY

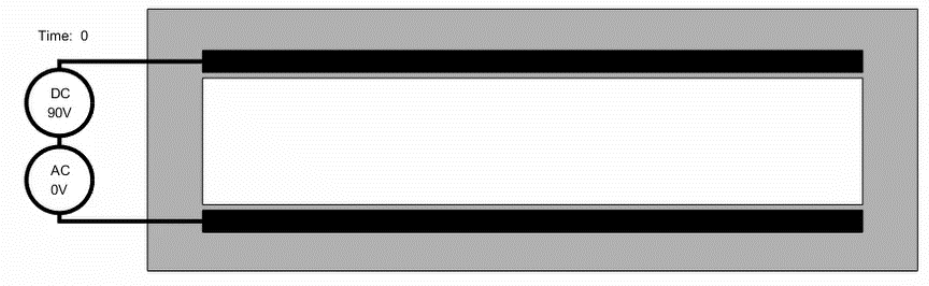
// PZT will (have to) become MEMS

Traditional piezo-ceramic



- 30 years proven technology
- Manual assembly
- Not scalable
- Expensive
- Not suitable for 2D arrays
- Narrow bandwidth

MEMS ultrasound transducer



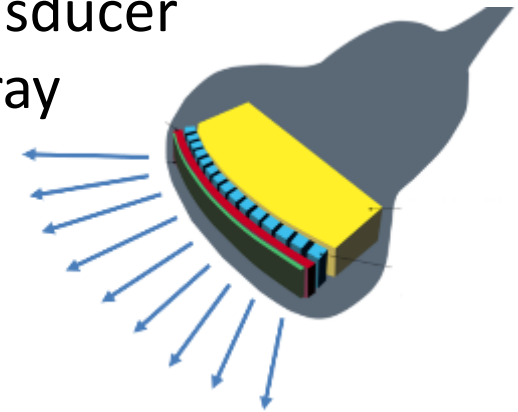
- Maturing fast
- Scalable to high volumes
- On ASIC → 2D arrays
- Wide bandwidth
- Tuneable

A huge opportunity for newcomers

A huge challenge for established players!

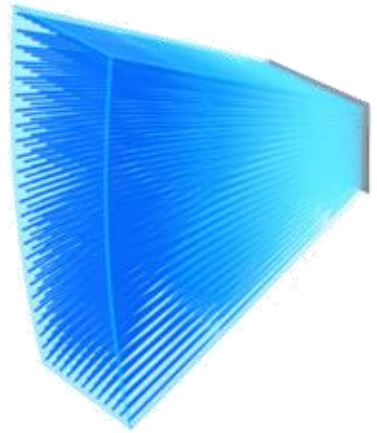
// 2D → 3D ultrasound

1D transducer array



3D ultrasound

2D ultrasound



2D transducer array

plane scan → volumetric data acquisition

// The MEMS US revolution

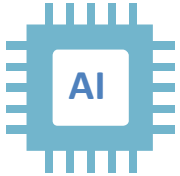
A paradigm shift in ultrasound imaging

3D volumetric data

+

Validated models

+



Artificial intelligence

+

Deep clinical knowledge

portable ultrasound for semiprofessionals and even consumers

// An example of AI in ultrasound

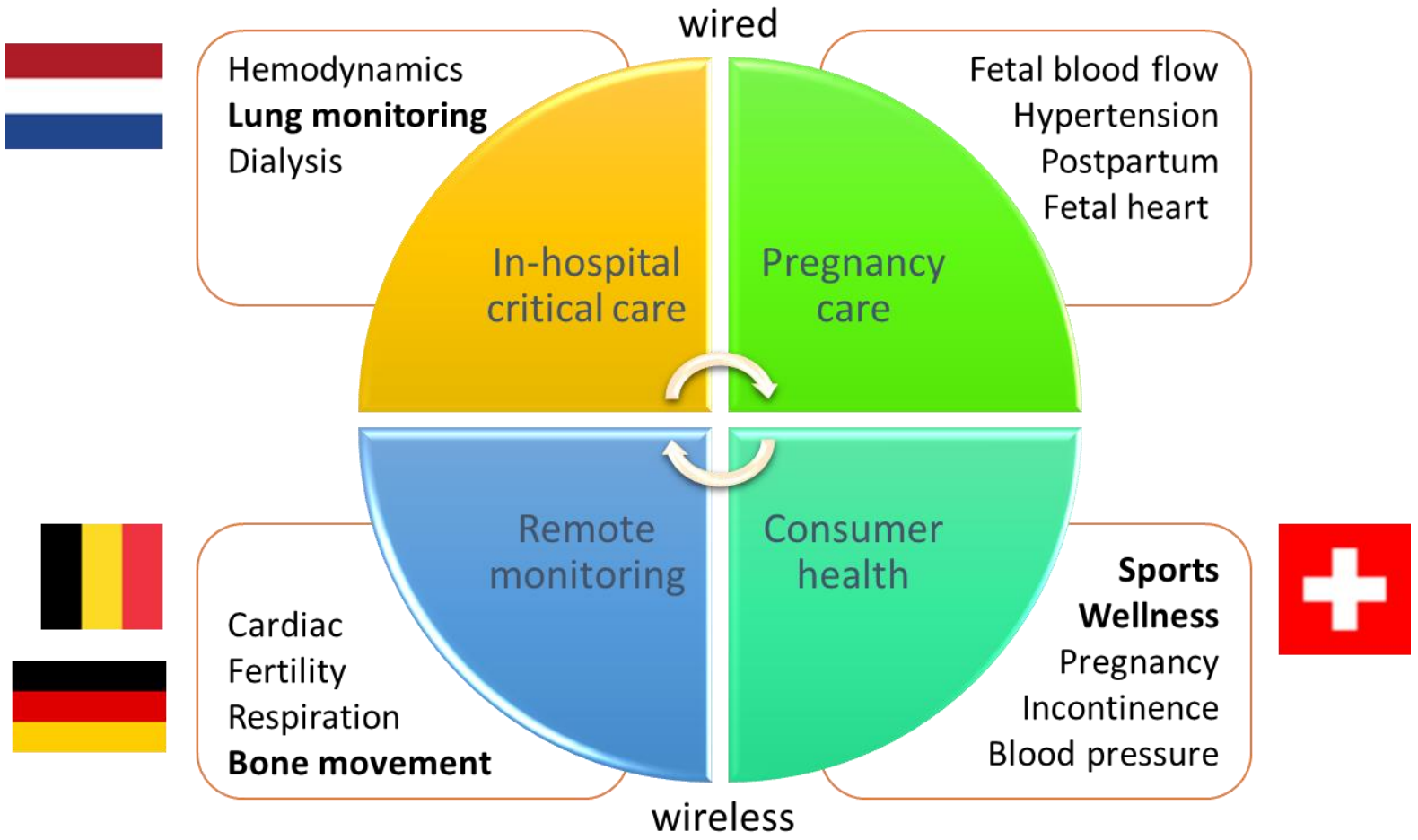
AI-assisted transthoracic echocardiography with a portable device (Lumify)

// New ultrasound markets

Market descriptor	Global device market size (B$)	Market phase	Benefits MEMS	Application opportunities	Market start (est)
Interventional Ultrasound	2.5-3.0[1]	Mature-growing	Miniaturization, performance, volume manufacturability, cost, performance	IVUS/FFR/ICE/TEE/EUS/EBUS-TBNA/Laparoscopes	1990-2000
POC out-of-hospital to in-hospital	1.5-2.0[2] 6-8[3]	Developing-growing	Cost, volume manufacturability, Ease of use (3D for UI), performance, ROHS compliant	UltraPortable Ultrasound	2018-2025
Wearable Ultrasound	12-18[4] 30-40[5]	Strong venture/PPP investment pull	Cost, (flat) form factor, volume manufacturability, ease of placement, autonomous (3D for UI) use, performance, ROHS compliant	Lung monitoring, Fetal monitoring, Musculoskeletal monitoring, OB screening, Cardiac output, Dialysis, Cerebral perfusion, Bladder monitoring …	2027-2032
Consumer Ultrasound	600-800[6]	Pre-Embryonic	Cost, volume manufacturability, autonomous use (3D for UI), ROHS compliant	Smartphone add-on: Pregnancy, bladder, body-fat, muscle, vascular, wrist (ID) heart-beat, skin, microvasculature	2030-2040

1. Global market size today growing at ~8-11 % CAGR. Data derived from Clarivate DRG overviews
2. Philips internal market evaluation.
3. Butterfly 2021 estimate 40 M potential users at 50 % adoption and 5 year lifetime gives ~4 M handhelds sold annually at ~1.5 keuro per device.
4. 1st order estimate: Patch connected to Lumify based back-end. Philips re-usable estimates 30-50 M re-usable patches for 1 M back-end devices annually at 300 $ per patch and 3 keuro per device
5. Butterfly 2021 estimate (>>) 100M patches each year and 10 M devices at 200 $ per patch and 1 keuro per device
6. 1.8 B Smartphones sold each year estimated at ~$300-400 average price. Small CMUT components 1 per device at 1$ component revenue.

// Wearable ultrasound applications



Bold: use cases addressed in Xecs project SonoSkin

Applied Nanotechnology

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Saxion
University of Applied Sciences

One of the largest institutions of higher education in the Netherlands (3 locations: Enschede, Deventer & Apeldoorn)

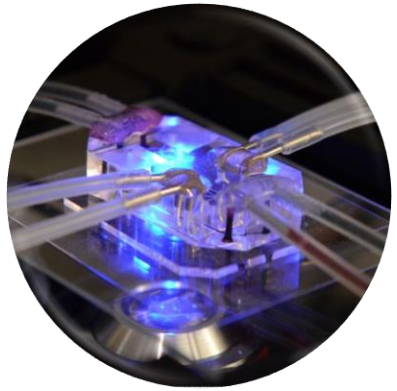
~27,000 students (3,500 int., 74 nationalities), 2,800 employees

Research is organized in **40 different research groups** and together they add to the research agenda focused on **Living Technology** (interplay between technology and society)

Research is organized into 5 different priorities:
- Health, wellbeing and technology
- Safety, security and digitalisation
- Circular innovation and energy transition
- Key enabling technologies (KETs)
- Social and economic innovation methodologies (KEMs)

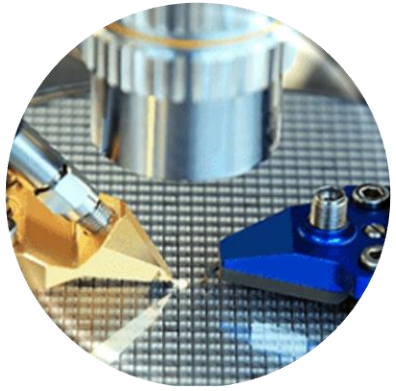
interdisciplinary and practice-oriented research

Research topics



Lab and organ-on-chip

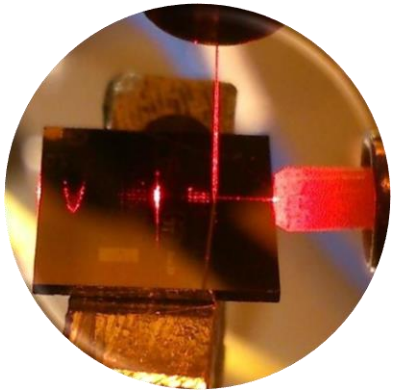
Molecular sensing (POCT)



Testing and probing

Nanoforensics

E-waste



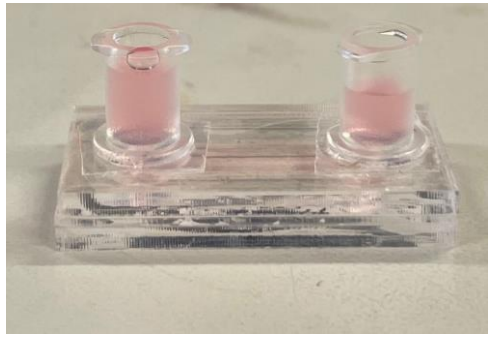
Precision assembly

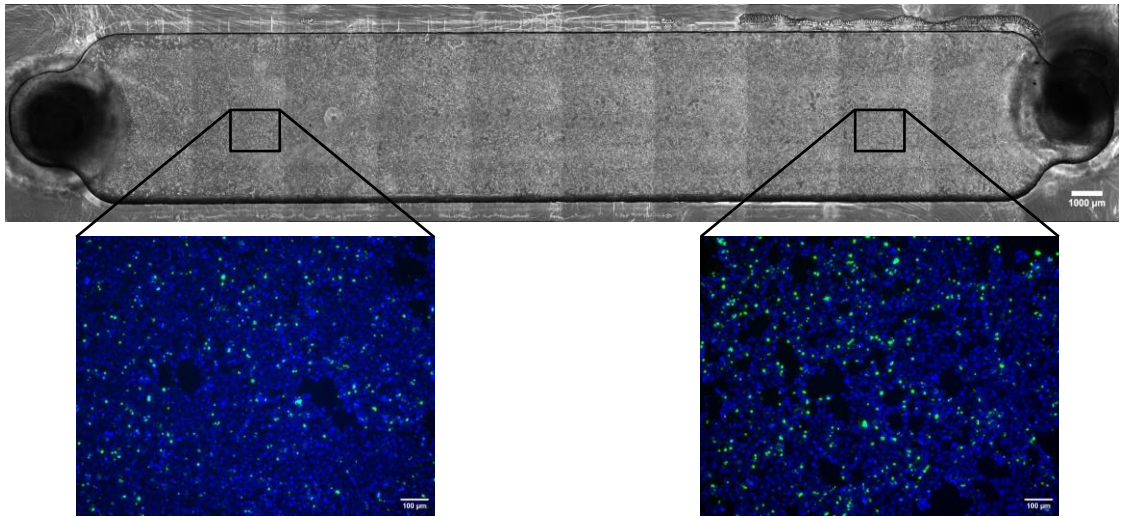
Functional nanostructures

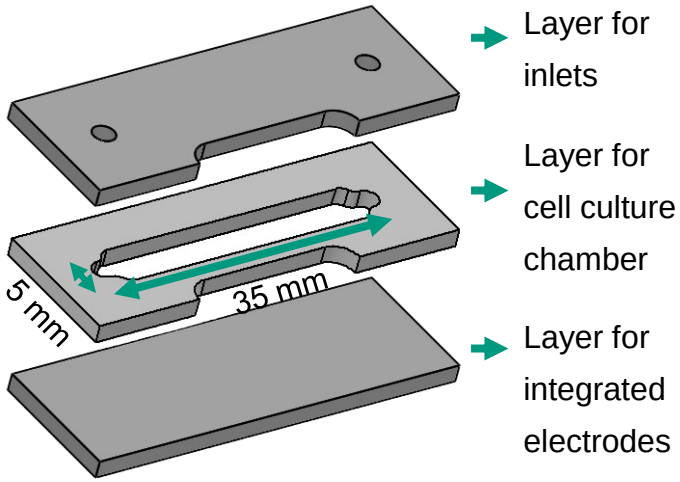
Societal embedding

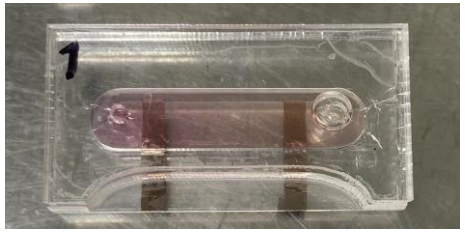
Development of a Heart-on-a-Chip device

- HL-1 cardiomyocytes are cultured in a PMMA chip
- Live/dead staining → 98% alive









Integration of electrodes to measure impedance and pace the cells

CYTOCYPHER

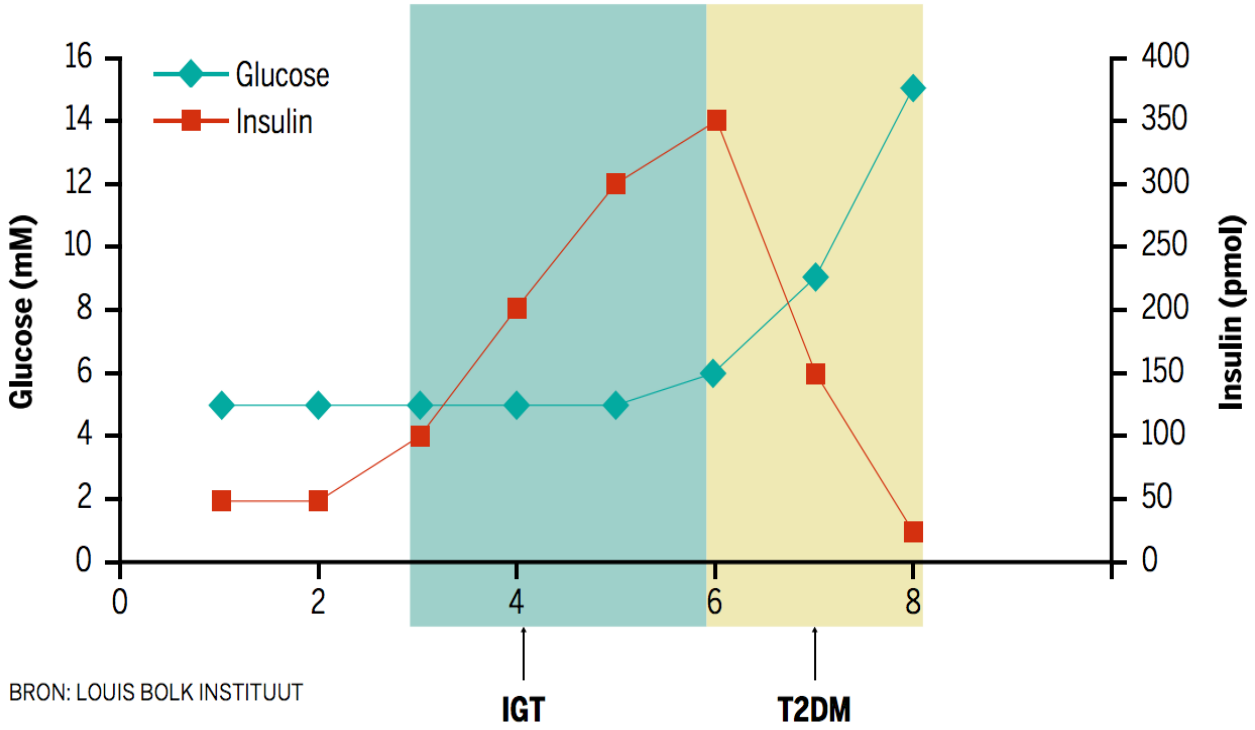
Locsense

micronit microtechnologies

Applied NANO TECHNOLOGY

SAXION

Measuring insulin (next to glucose)



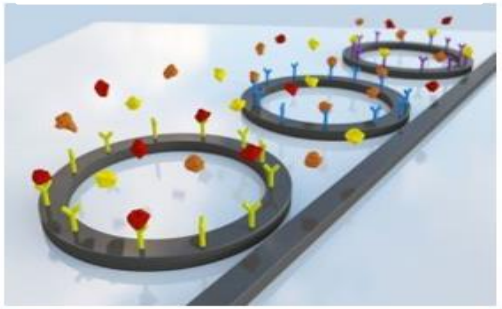
1.3 nm

Insulin

Measuring insulin gives a much more complete picture of the stage of progression towards diabetes, and enables early detection and diagnosis of “prediabetes”

Integrated photonic chips as sensors

Micro ring resonators coated with antibodies



Blood sample (using finger prick)

Photonic chip (1 x 1 cm)

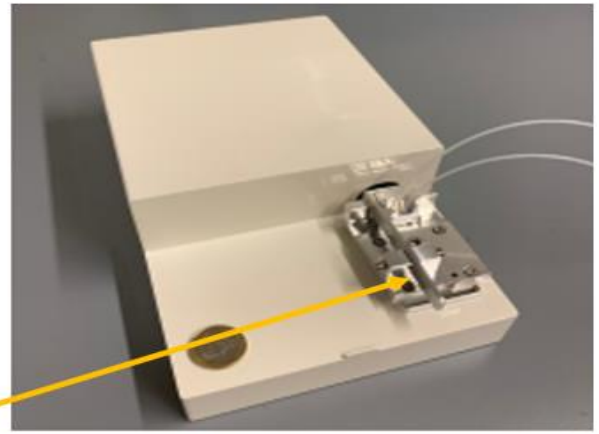
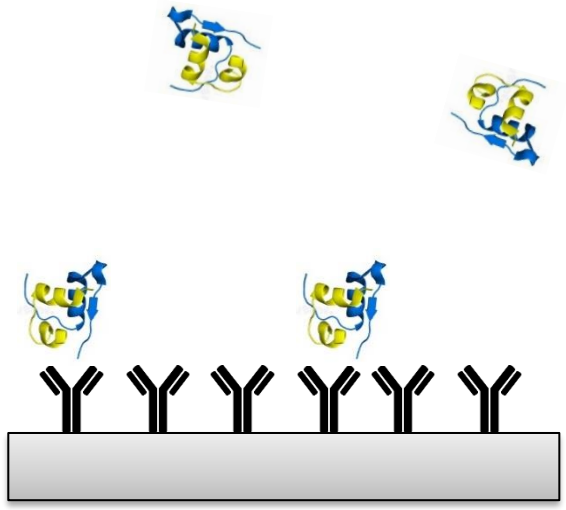
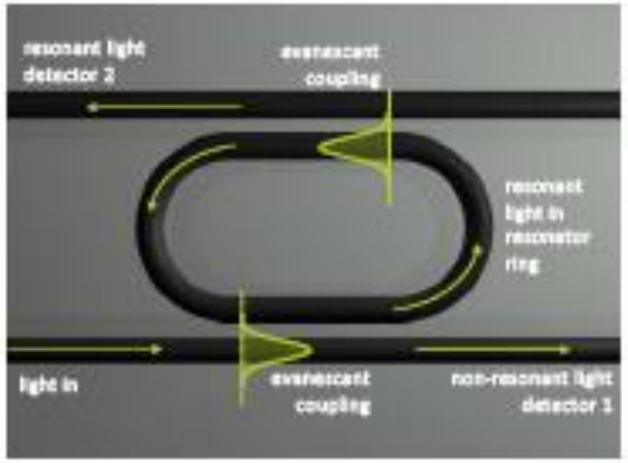


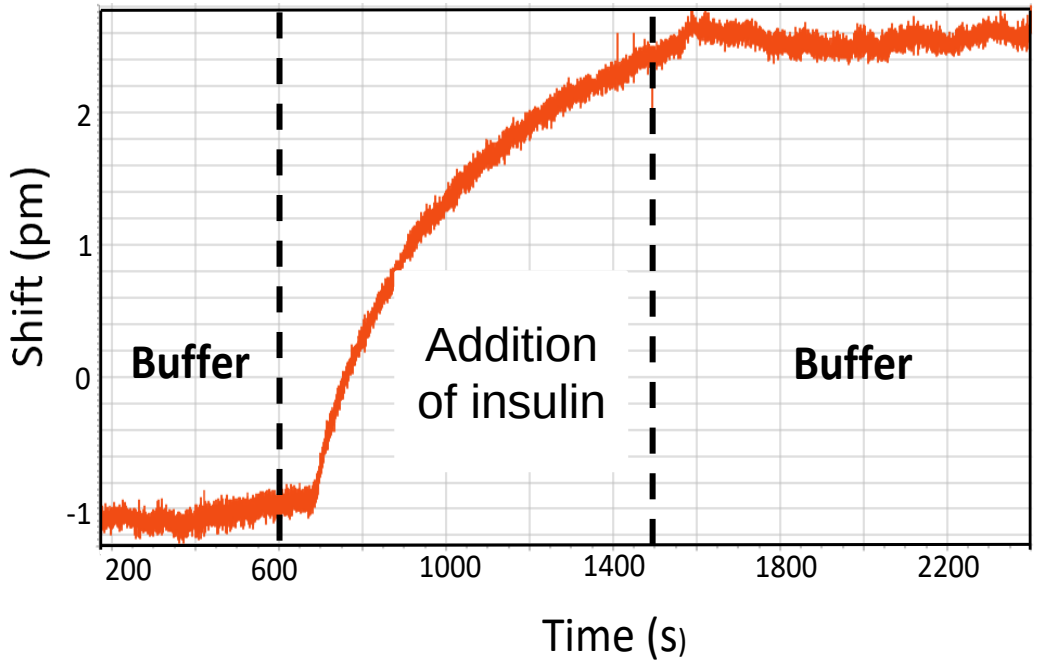
Table-top read-out device

Use of integrated photonic chips (socalled microring resonators) to detect the presence of insulin in a blood sample.

Detection principe







Signal is the wavelength at which the microring is resonating. When anything binds to the surface, this wavelength changes proportionally.

Thank you

Contact details:

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UNIVERSITY OF TWENTE. | TECHMED CENTRE

THE TECHMED EVENT

BRIDGING PAST AND FUTURE: FIVE YEARS OF MEDTECH ADVANCEMENTS AND BEYOND