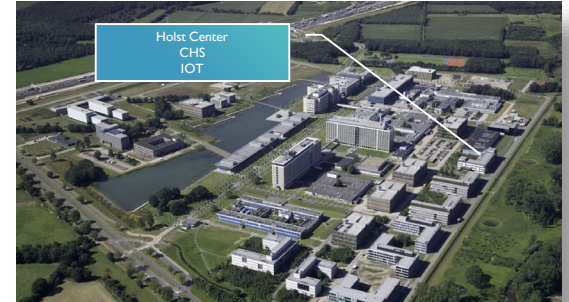
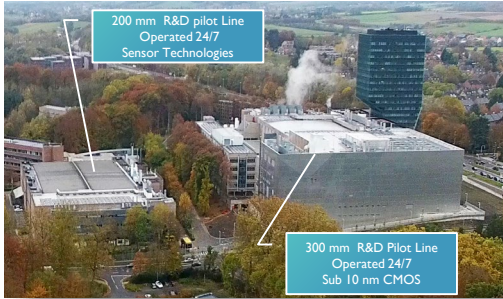




mtec

CONNECTED HEALTH FOR A BRIGHT FUTURE

NAVID SHAHRIARI



IMEC – LEUVEN - HQ

- ▶ World-leading R&D in **nano-electronics & digital technology**
- ▶ **3500** international R&D top talents
- ▶ Unique **€ 2B leading-edge semiconductor fabs**
- ▶ **€ 545M revenues: 70%** industry, **20%** regional gov't, **10 %** EU & regional programs
- ▶ Created **40 spin-off** companies and incubated **100+ start ups**

IMEC – NL

- ▶ Placed in the **High tech Campus**, the NL high-tech region of Eindhoven
- ▶ **12 years** of experience;
- ▶ Staff of over **100 researchers**, highly diverse and top talent
- ▶ Focused on **Connected Health** and **Internet of Things** innovations
- ▶ **Global** network of industrial and academic partners

IMEC R&D PLATFORMS

APPLICATION DOMAINS

SMART HEALTH



SMART MOBILITY



SMART CITIES



SMART INDUSTRIES

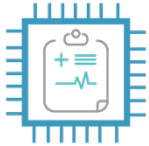


SMART ENERGY

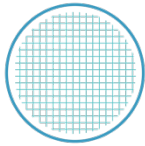


SEMICONDUCTOR & SYSTEM TECHNOLOGIES

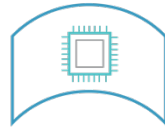
CORE CMOS



SENSOR TECHNOLOGY



FLEXIBLE TECHNOLOGY



PATTERNING TECHNOLOGY LOGIC TECHNOLOGY MEMORY TECHNOLOGY INTERCONNECT TECHNOLOGY 3D INTEGRATION OPTICAL I/O

DIGITAL TECHNOLOGY PLATFORMS

NETWORKING



DIGITAL PRIVACY & SECURITY

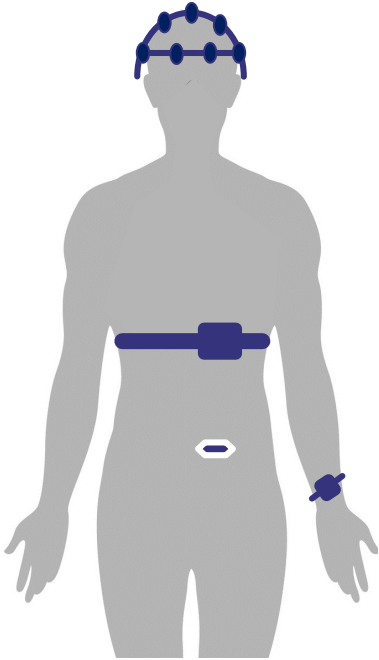


SOFTWARE & DATA MANAGEMENT SKILLS

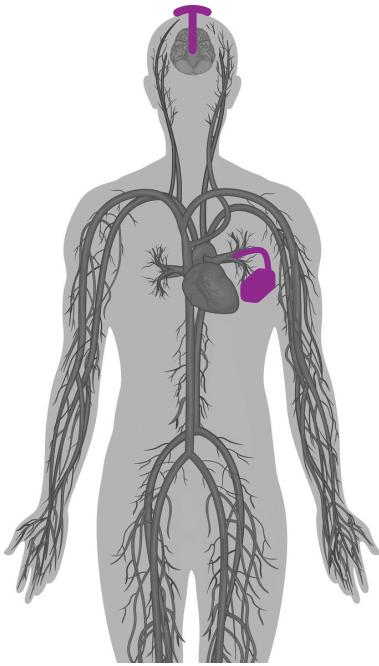




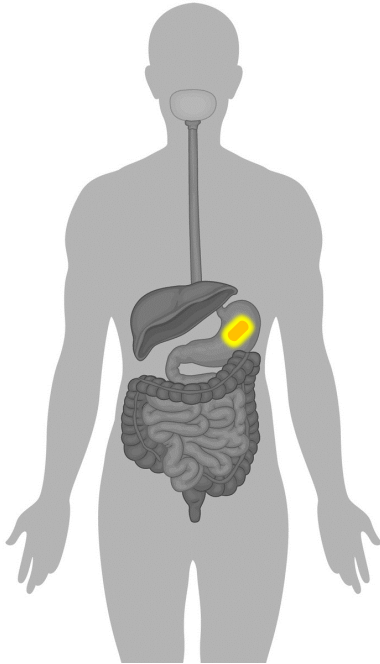
FORM FACTORS



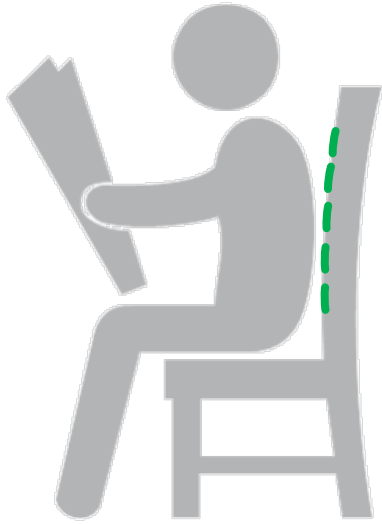
WEARABLE



IMPLANTABLE



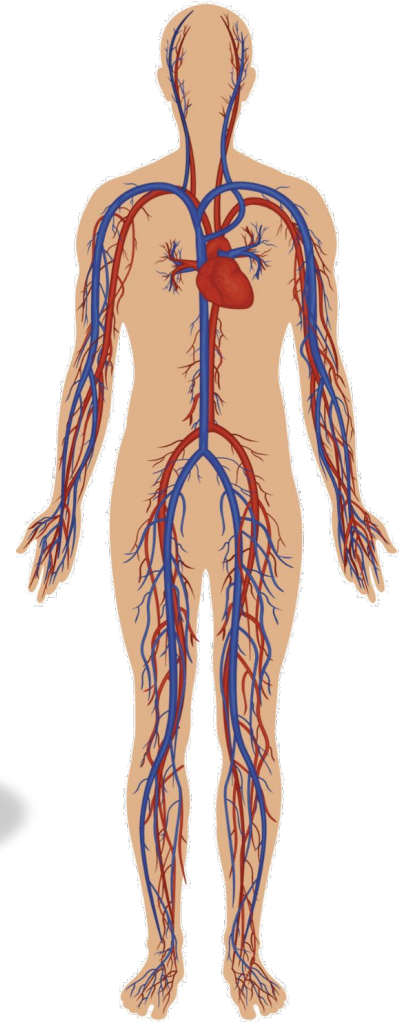
INGESTIBLE



NON-CONTACT

LET'S WEAR IT...

SMART HEALTH PLATFORMS

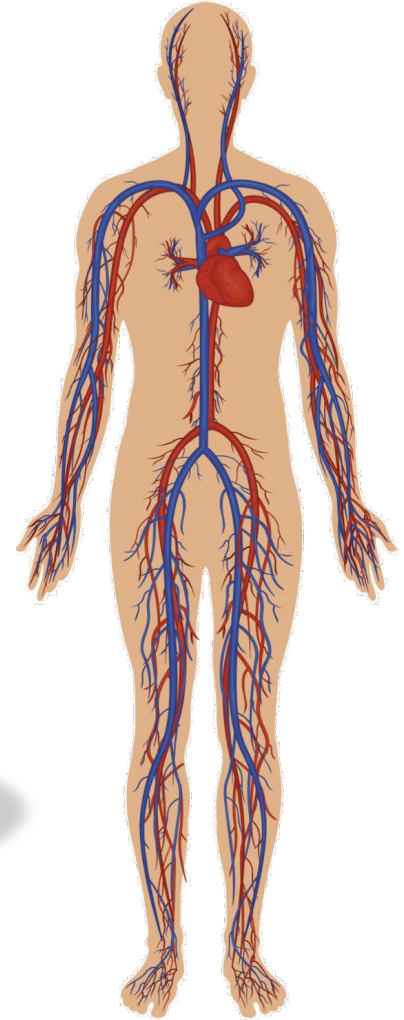


FDA
APPROVED

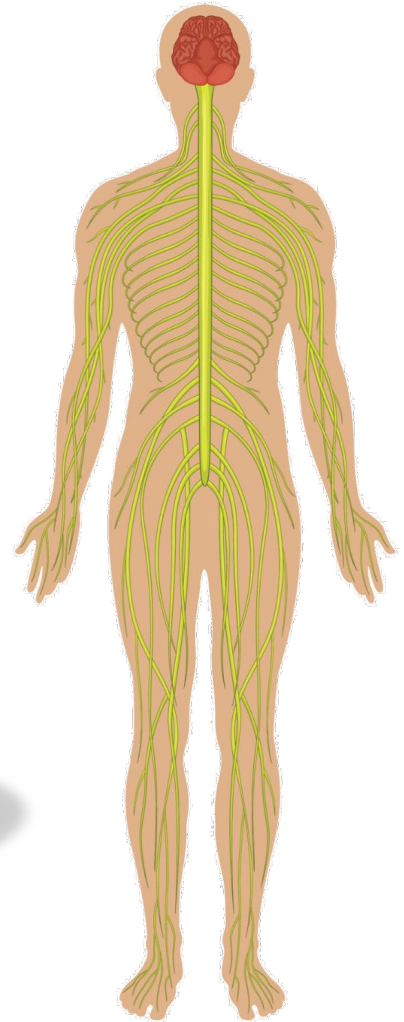
BioTelemetry
inc

umec

SMART HEALTH PLATFORMS



SMART HEALTH PLATFORMS

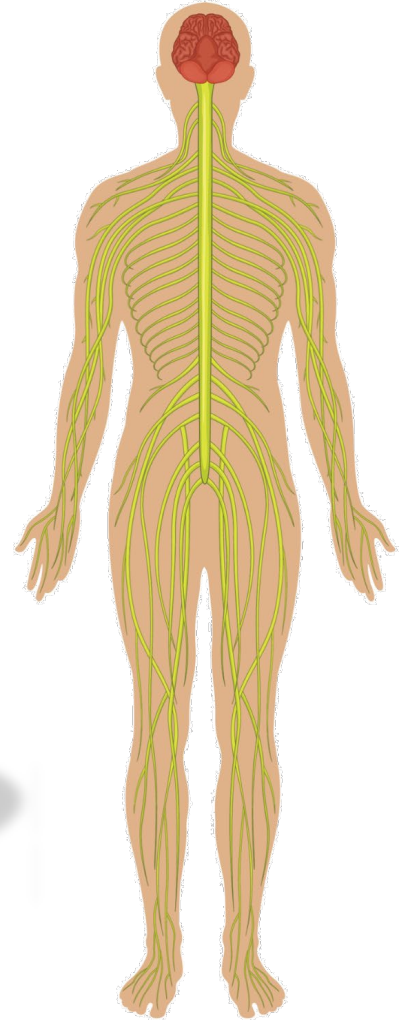


Pmda
JAPAN
APPROVED

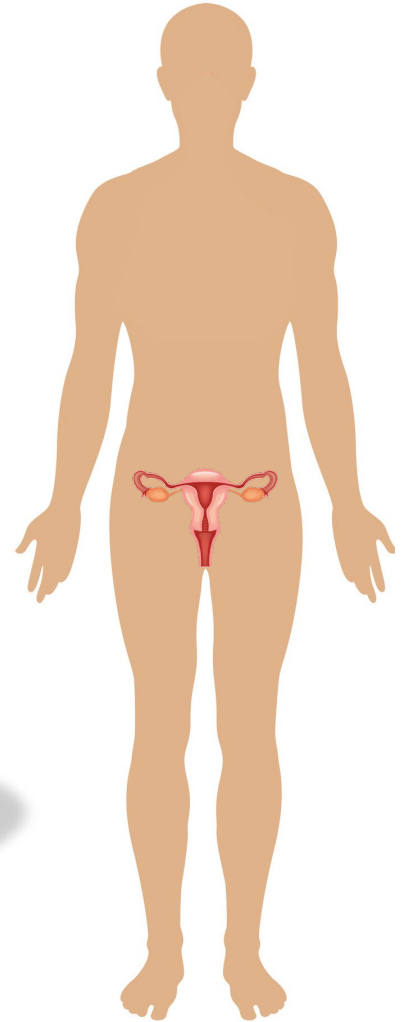
NIHON KOHDEN

umec

SMART HEALTH PLATFORMS



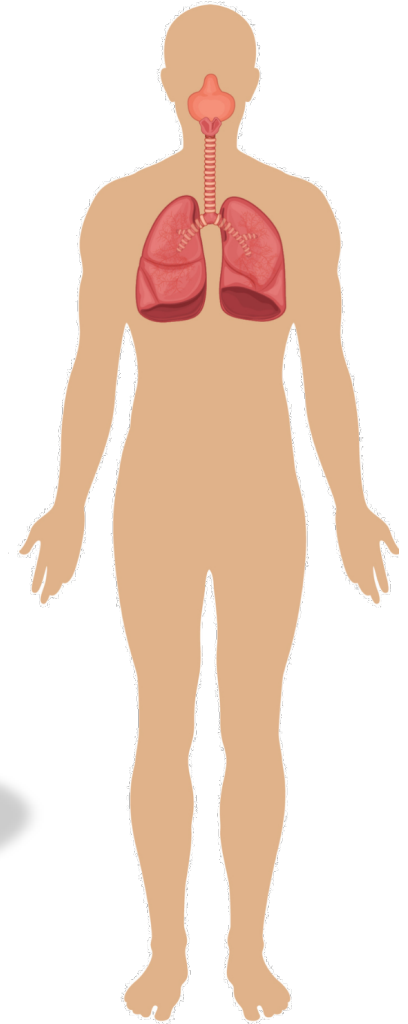
SMART HEALTH PLATFORMS



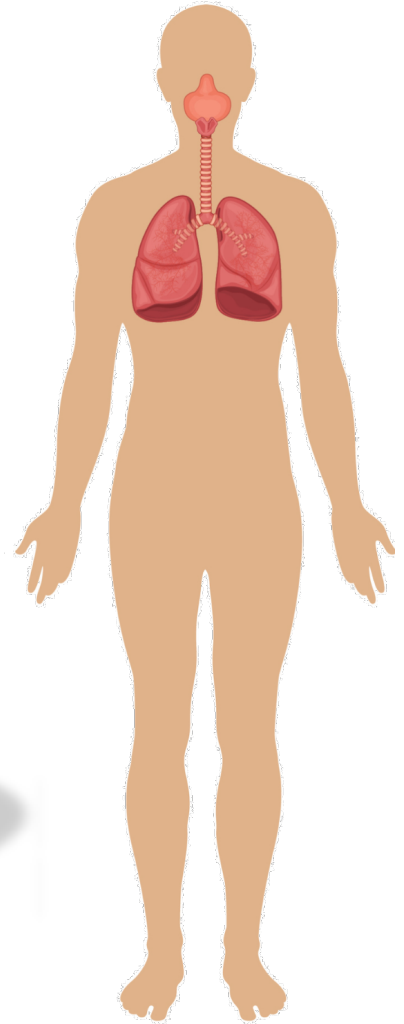
bloomlife

umec

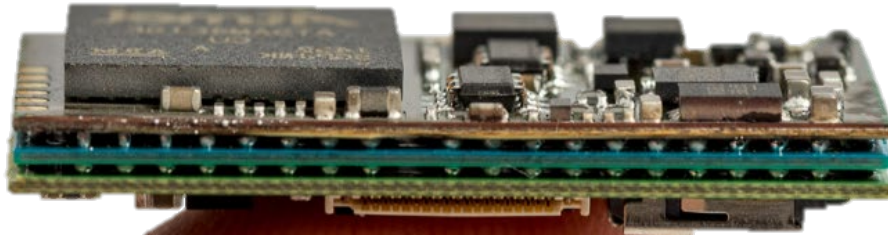
SMART HEALTH PLATFORMS



SMART HEALTH PLATFORMS

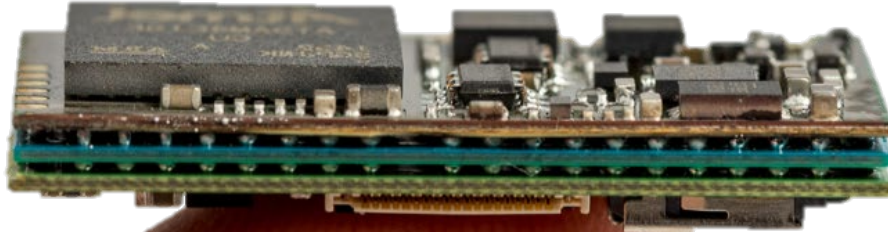


BUILDING ON OUR CIRCUIT INNOVATIONS



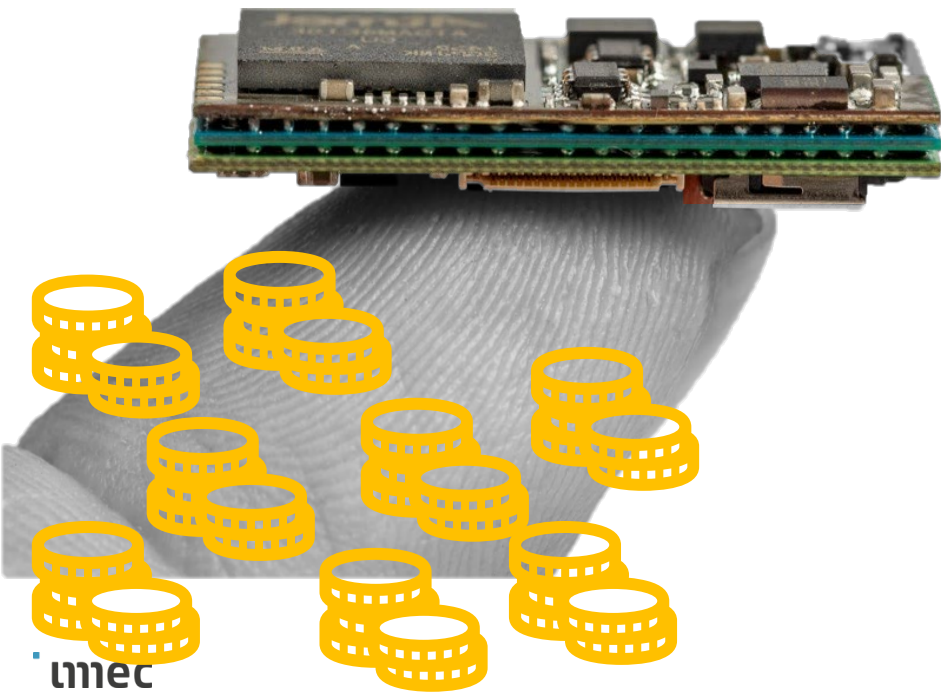
A VITAL SIGN MONITOR IN 1 CM³

TOWARDS A DISPOSABLE SOLUTION

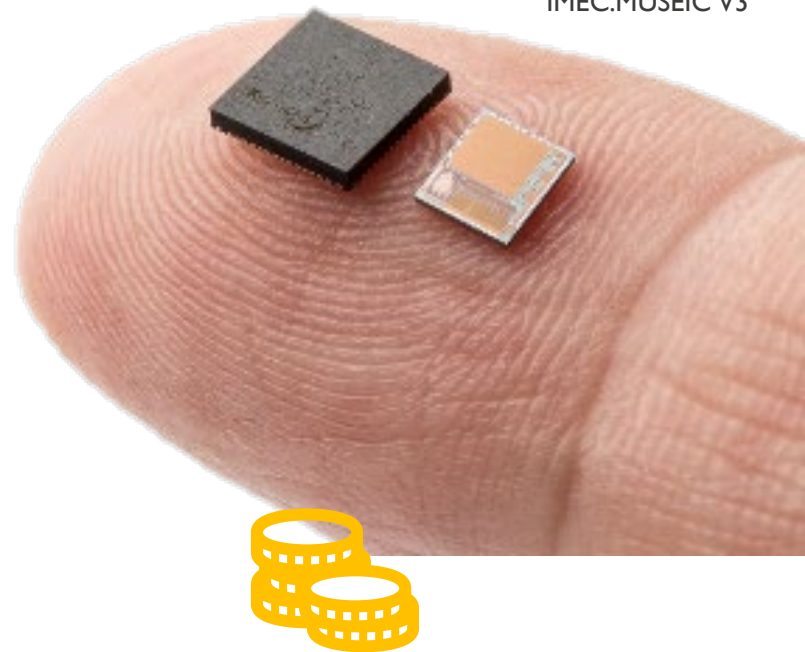


- Microcontroller
- Power management
- High-performance AFE
- Connectivity (BLE)
- On board storage

A VITAL SIGN MONITOR IN ONE SINGLE CHIP



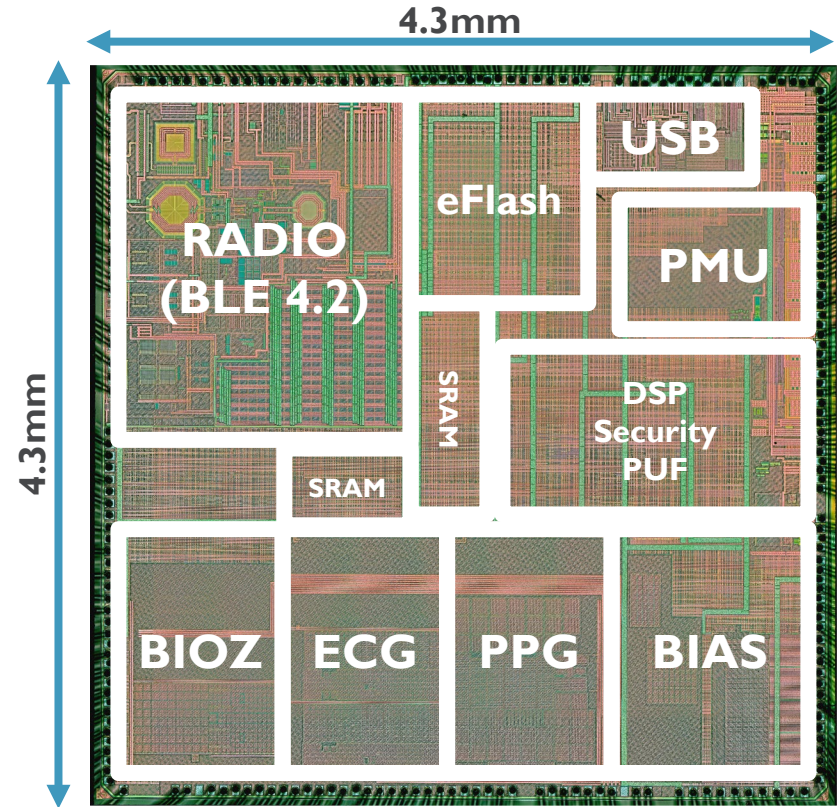
IMEC.MUSEIC V3



MUSEIC V3: BATTERY-POWERED WIRELESS SENSOR HUB

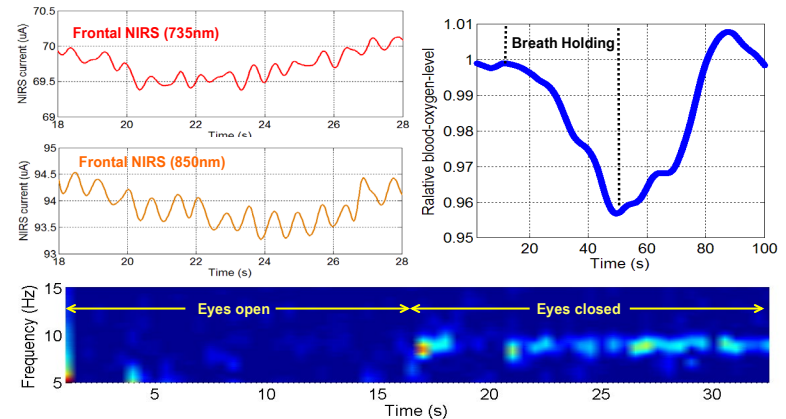
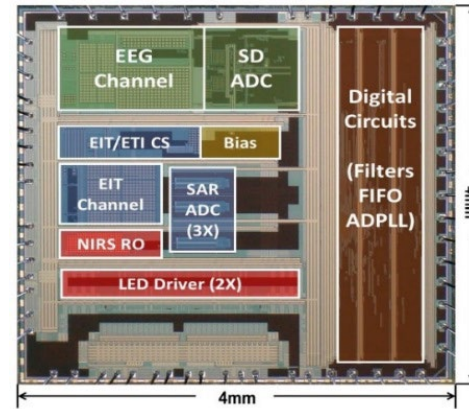
WORLD'S 1ST FULLY-INTEGRATED IC FOR WEARABLE HEALTH SOLUTIONS

- **Multi-modal analog** readout
- Integrated **power management** with support for novel battery-chemistries
- Industry-standard **connectivity**
- Flexible on-the-node **DSP capabilities**
- Built-in **security features**
- **<800uW** power consumption in a typical application!



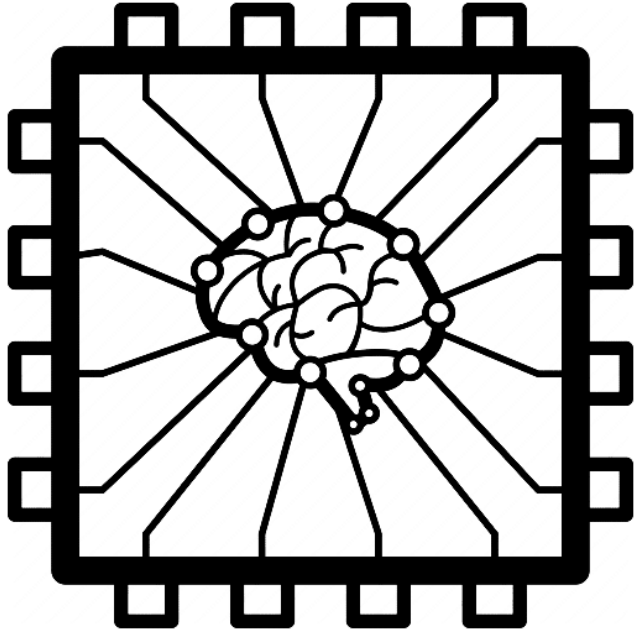
DAE V2: DIGITAL ACTIVE ELECTRODE FOR BRAIN MONITORING

- Digital **active electrode**: improved signal quality and simplified connectivity
- Optimized for **dry electrode** EEG recording
- Support for **fNIRS & ETI**
- Optimized for **highly-sensitive SiPM** fNIRS detectors
- **<700uW** power consumption per electrode (+ 1.5mW for the SiPM)



LET'S DIG IN...

DIGITAL NEURAL INTERFACES

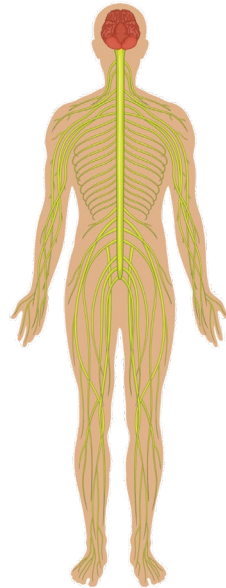


Chips that interface **directly with the nervous system** will enable:

- Understanding of the brain

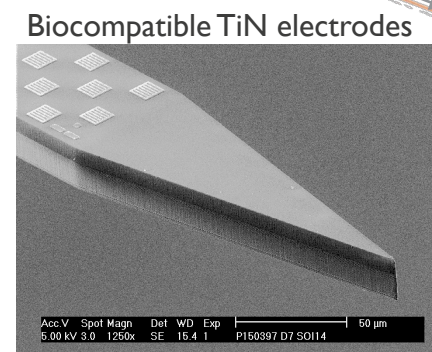
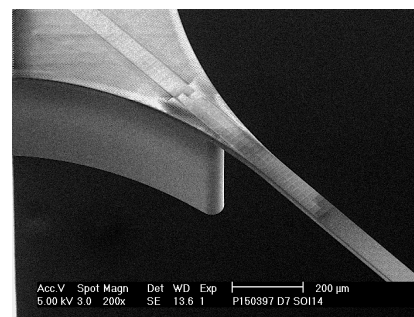
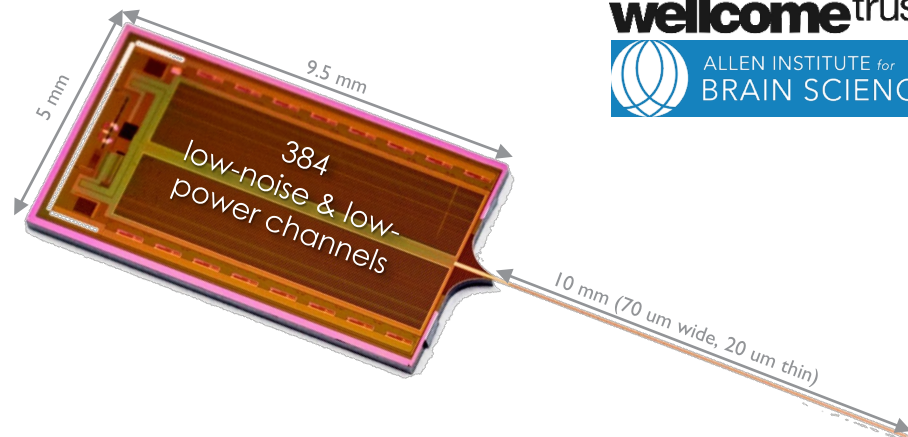
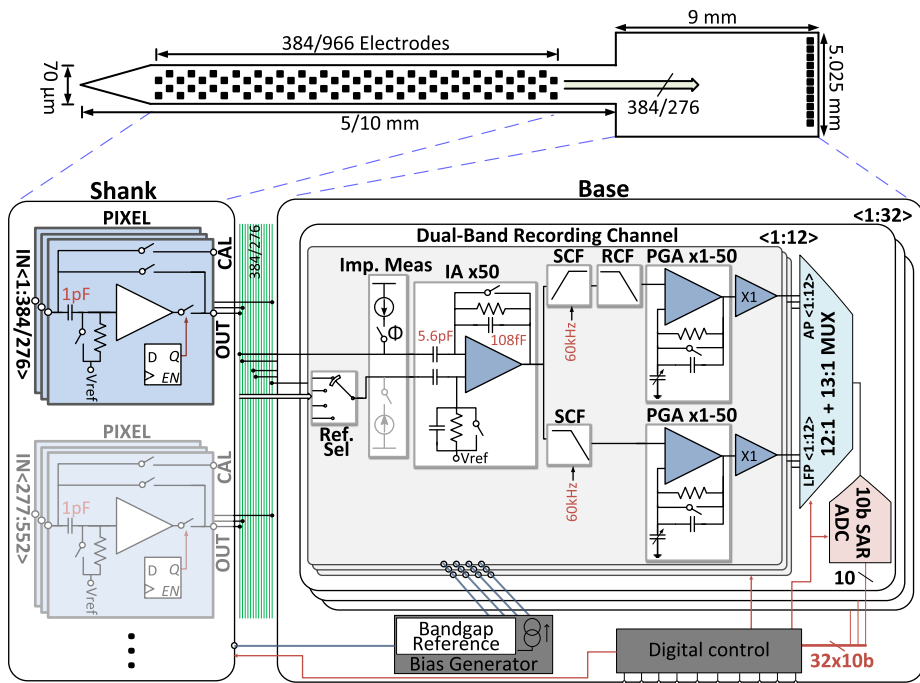
- Next generation of medical devices

- Brain machine interfaces



HIGH-DENSITY NEURAL RECORDING IMPLANT

384 CONCURRENT READOUTS IN A SINGLE ASIC

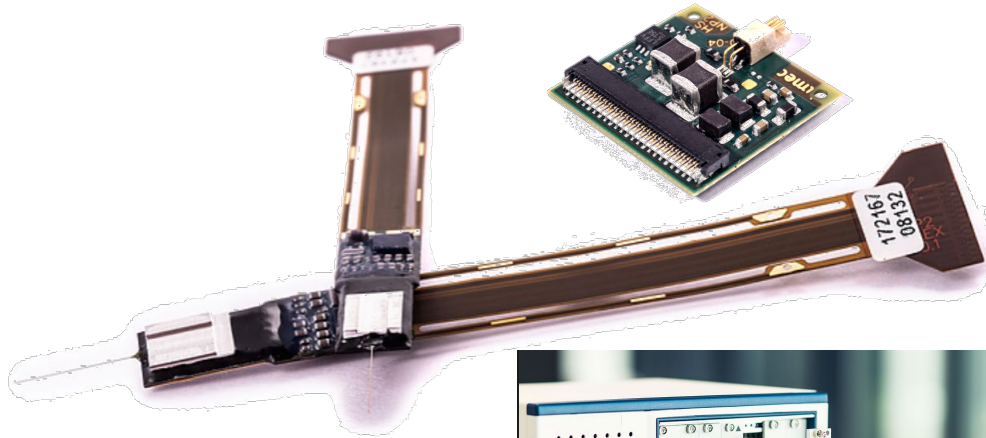


www.neuropixels.org

HIGH-DENSITY NEURAL RECORDING IMPLANT

MINIATURE & LIGHTWEIGHT SYSTEM DESIGN

Probe flexible packaging + acquisition system



Weight: 1.1 g
Data rate: 171.6 Mbps
Connects to: 5 m μ -coax

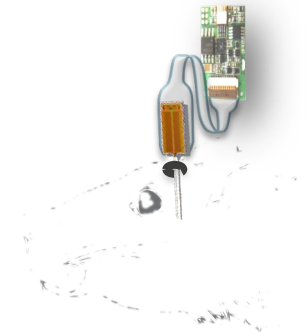
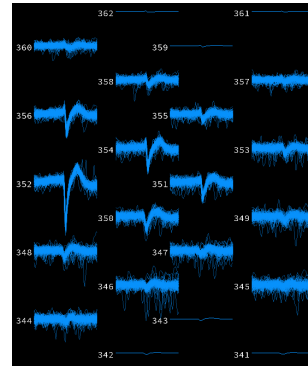


Letter | Published: 08 November 2017

Fully integrated silicon probes for high-density recording of neural activity

James J. Jun, Nicholas A. Steinmetz [...] Timothy D. Harris

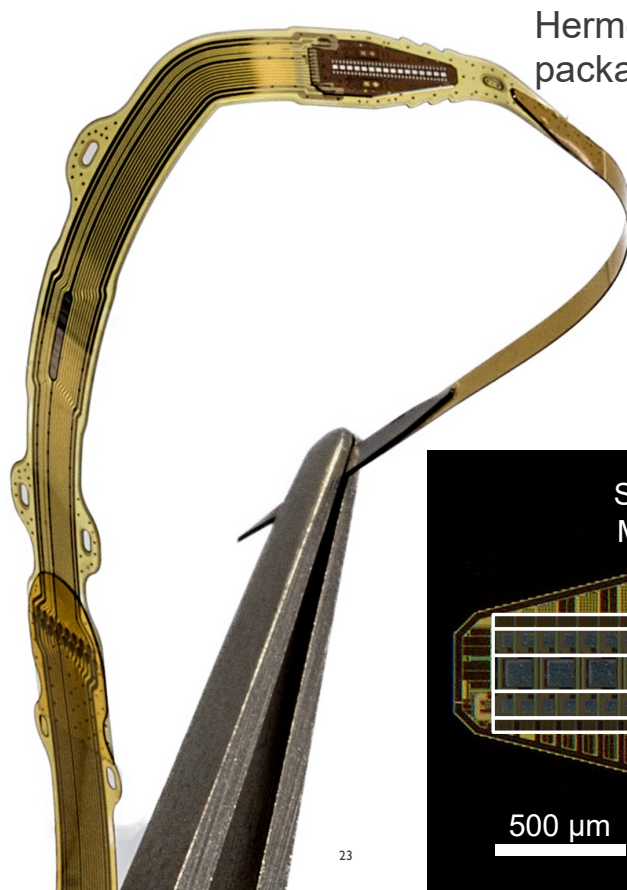
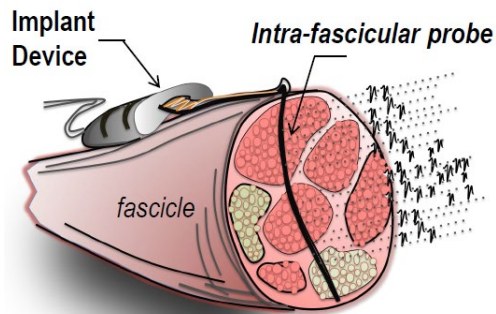
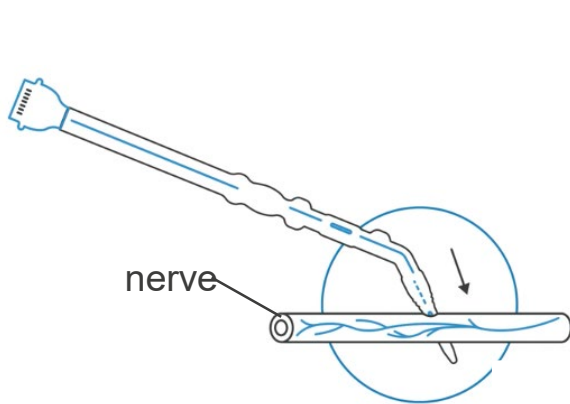
Nature 551, 232–236 (09 November 2017) | [Download Citation](#)



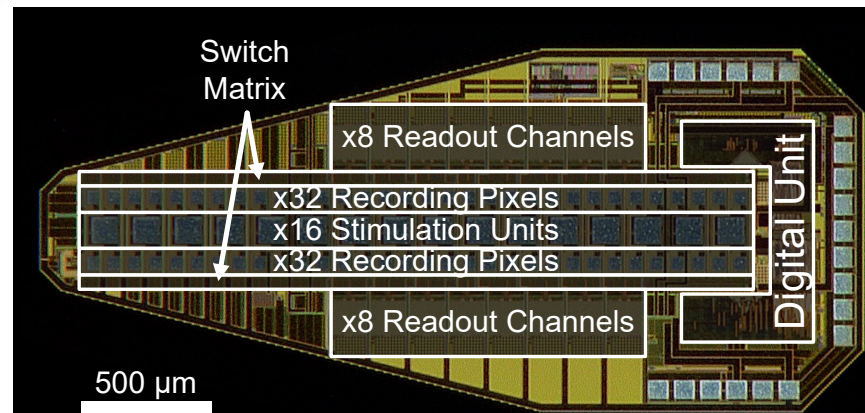
In vivo validation

PERIPHERAL NERVE IMPLANT

ELECTRICAL STIMULATION & RECORDING



16 readout channels
16 stimulation channels
64 IrOx electrodes



LET'S EAT IT...

Taking GI care further, together

Medtronic is proud to partner with you as we work towards our shared goal of better management of small bowel conditions. We're dedicated to helping you obtain a more comprehensive view, so you have the actionable information you need to assess, treat, and monitor your patients.

Visit us at medtronic.com/gi



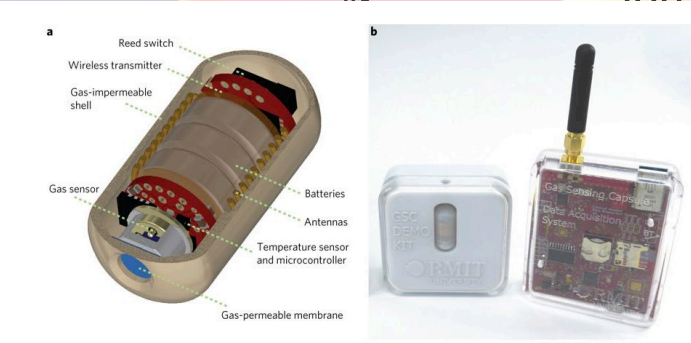
SMARTPILL™ MOTILITY CAPSULE

The SmartPill™ motility capsule assists in localizing transit abnormalities to a specific GI region by collecting data from the entire GI tract. As the SmartPill™ motility capsule travels through the patient's GI tract, it measures pressure, pH and temperature to provide you with valuable diagnostic information, including gastric emptying and total GI transit times in your patients.



<https://www.medtronic.com/content/dam/covidien/library/us/en/product/endoscopy-products/pillcam-sb-3-brochure.pdf>

<https://www.medtronic.com/covidien/en-us/products/motility-testing-system.html>

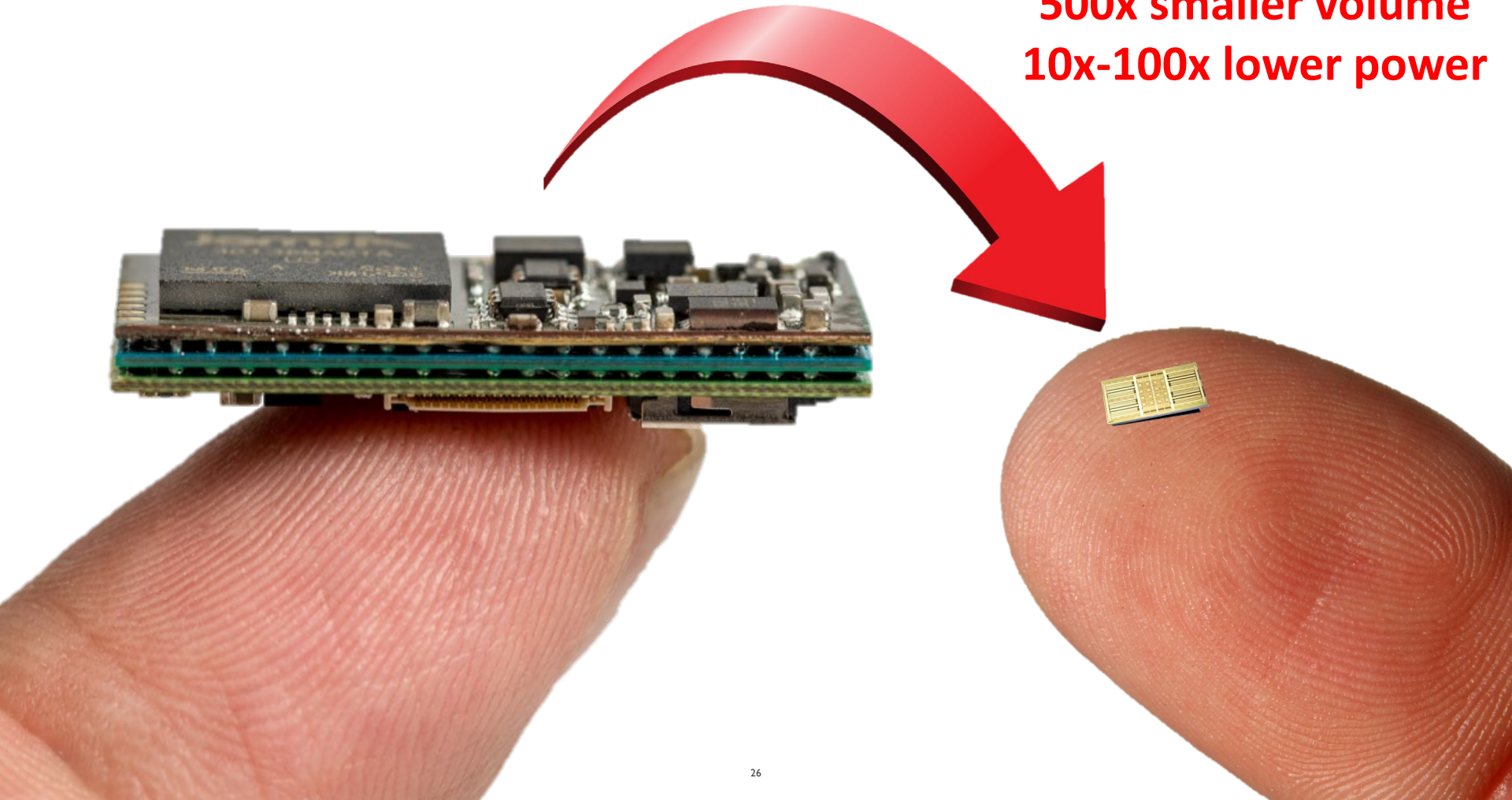


Kouroush Kalantar-Zadeh et al., "A human pilot trial of ingestible electronic capsules capable of sensing different gases in the gut", Nature Electronics vol 1, pp79–87

Word cloud containing terms: cancer, ulcers, enzymes, helicobacter pylori, colon transit, epithelial cells, serotonin, Metabolic concentrations, slow waves, glycopolteins, gastrin, dietary metabolites, h mucosa, endorphins, antimicrobial agents, gastric pre, gastric emptying, cytokine, blood cells, intake, contractility, motility testing system, electrogastrogram, lipase, nce.

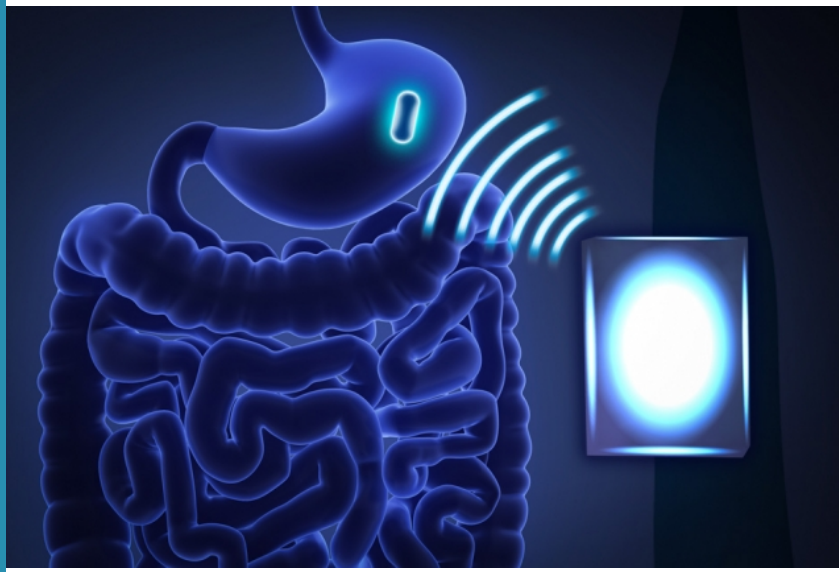
Need for wholistic sensing of digestive processes & nutritional uptake

500x smaller volume
10x-100x lower power





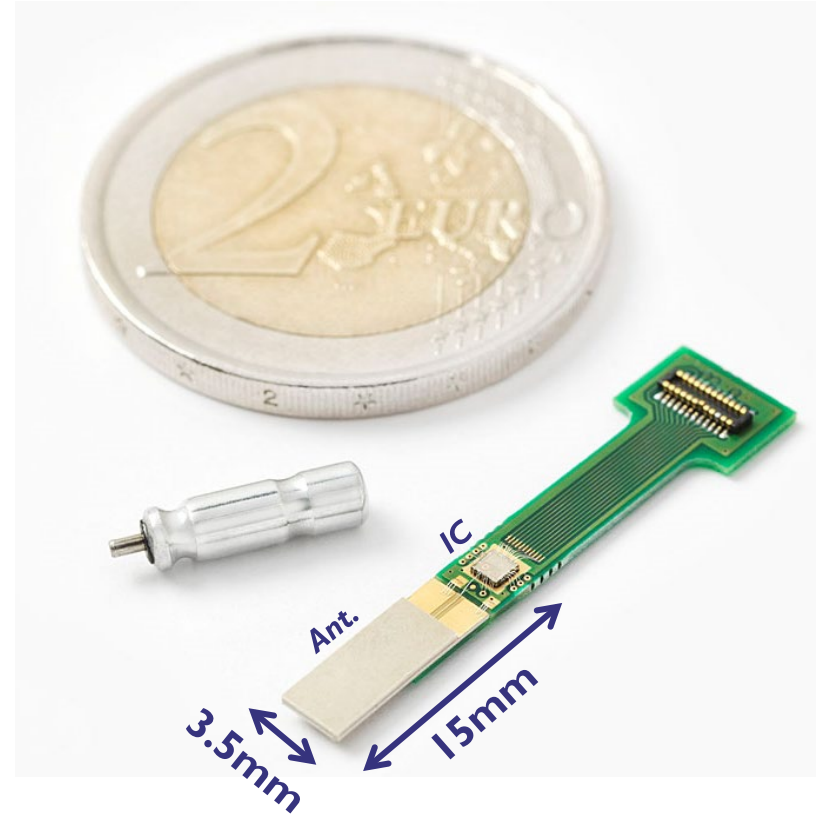
50x smaller area
10x larger distance



MINIATURIZED CONNECTIVITY

MINIMICS: SMALLEST IMPLANTABLE RADIO

spec	MiniMICS
Technology	40nm
Carrier / modulation	400MHz / GFSK
Crystal-less	YES
RX sensitivity	-90dBm
RX max power consumption	1.5mW
TX output power	-6dBm
TX max power consumption	3.1mW
Data rate	300kbps
On-chip tunable imp. match	YES
Area (IC + ant.)	3.5mm x 15mm

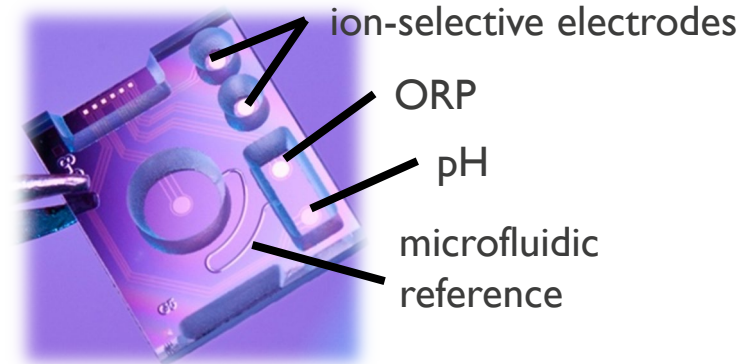
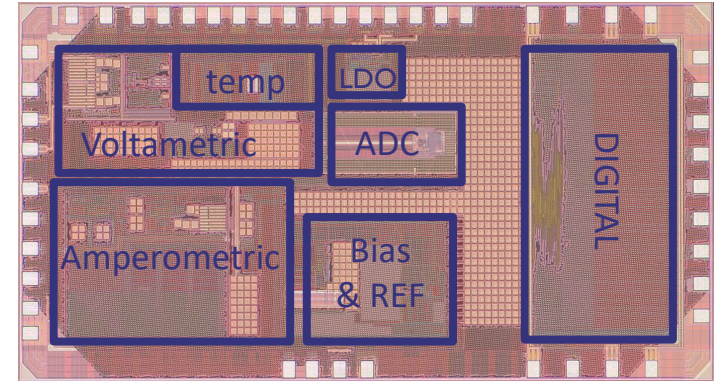


- Crystal-less operation allows for extremely small footprint
- Adaptive antenna impedance matching network ensures reliable operation with miniature antenna

MINIATURIZED SENSING

ELECTRO-CHEMICAL SENSING

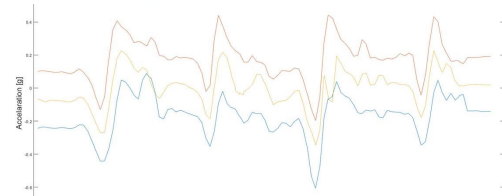
- **Voltametric/potentiometric readout**
 - Measure electrolytes with ion-selective electrodes
 - Local pH sensing from pH0 – pH10
- **Amperometric readout**
 - Measure digestive gases
 - & certain neurotransmitters like DO, DNO
- **Temperature sensor**
 - Real-time sensor calibration
 - Core body & local temperature (inflammation)
- **High performance in a small package at ultra-low power**



FIRST SENSOR DEMONSTRATOR

SMALL ENOUGH TO BE FITTED VIA BIOPSY CHANNEL OF GASTROSCOPES

- **Fully flexible miniature sensor fits in biopsy channel of gastroscopes**
 - $\varnothing = 3.5\text{mm}$
 - Length = 27mm (flexible)
- **Gastric slow wave potential recording**
 - Up to 60mVpp with $<1\mu\text{Vrms}$ noise
 - 64 – 512Sps
- **Gastric peristalsis and pressure recording**
 - Strain and tissue facing pressure sensing
 - $\pm 100\text{mmHg}$ with $<2\text{mmHg}$ error
 - 10Sps
- **Core body temperature**



Simulated stomach contraction

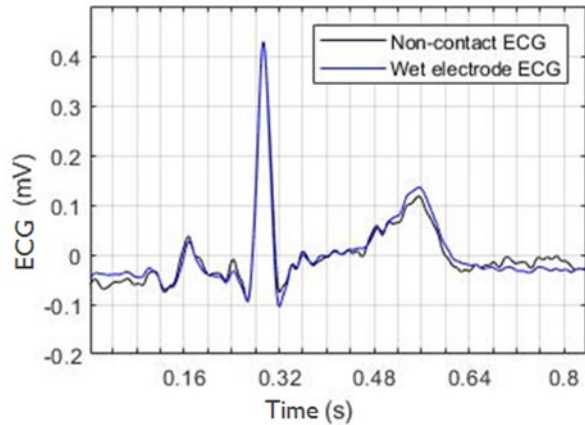
LET'S KEEP SOME DISTANCE

FROM WEARABLES TO INVISIBLES



CAPACITIVE-COUPLED VITAL SIGN SENSING

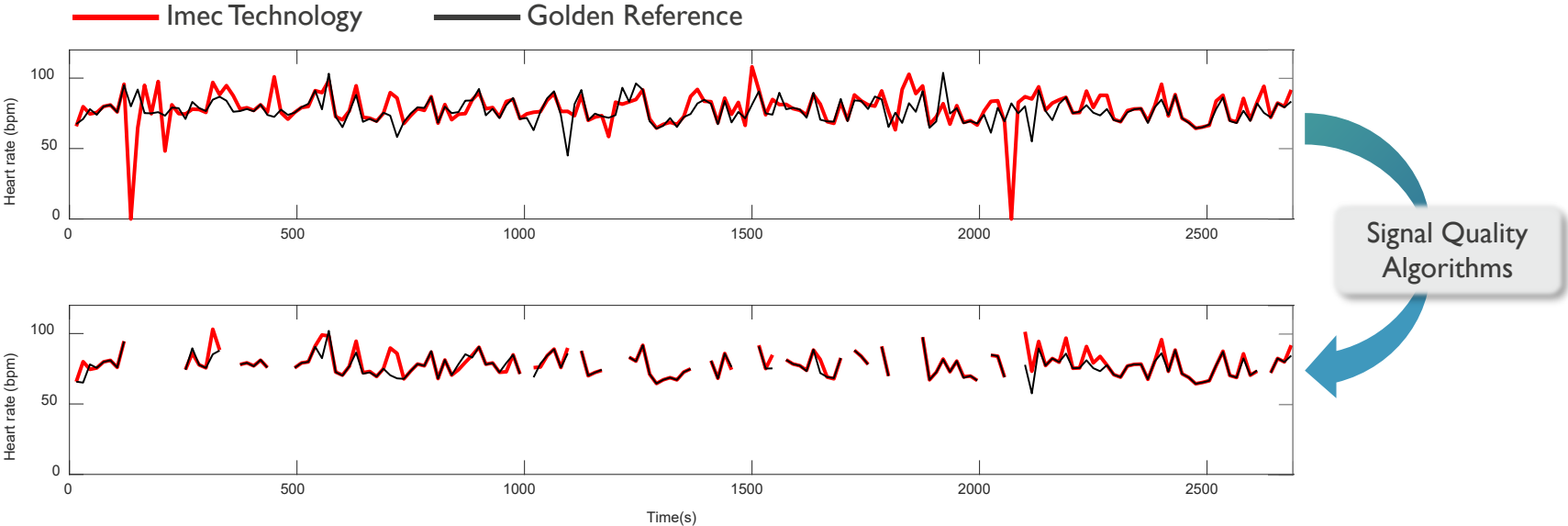
EARLY DEMONSTRATOR



>90% correlation in
decent coupling scenarios



CAPACITIVE ECG WHILE DRIVING – CITY AND HIGHWAY TRAFFIC



Mean absolute procentual error on individual R-R intervals

10%  **3%**

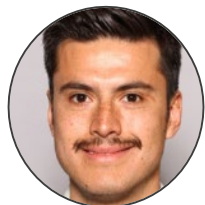
w/o motion artifact algorithm

w/ motion artifact algorithm

UPCOMING PRESENTATIONS

WANT TO KNOW MORE?

VISIT THE IMEC BOOTH (# BI 651), IN HALL BI



Emmanuel Rioz Velazques, PhD (imec, OnePlanet Research Centre)

Digital Health: Tracking Mental Stress and Mood Using Wearable Data and Machine Learning



Andim Stassen, PhD (imec)

CMOS Compatible SiN Photonics Platform for Life Science Applications



Thomas Pauweleyn, PhD (imec)

Microfluidic, CMOS Microelectrode Array-based Organ-on-chip System: a Platform for Personalized Medicine

WANT TO KNOW MORE?

VISIT THE IMEC BOOTH (# BI 651), IN HALL BI



Tom Vanhoutte (imec.xpand)

Smart Investments in Health



Soukaina Adnane (imec spin-off Onera)

Introducing the Next Generation of Sleep Diagnostics



Carl Smets (imec spin-off Spectricity)

How Hyperspectral Sensing Technologies can Help Enabling Wearables for Health Diagnostics

**Small, Smart and Connected.
Technologies for the next generation of
medical implantable devices.**

Download at www.imec-int.com/implantables



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embracing a better life