IMEC R&D PLATFORMS

APPLICATION DOMAINS

SMART HEALTH

SMART MOBILITY

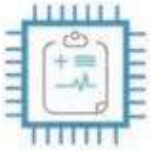
SMART CITIES

SMART INDUSTRIES

SMART ENERGY

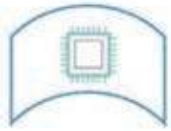
SEMICONDUCTOR & SYSTEM TECHNOLOGIES

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

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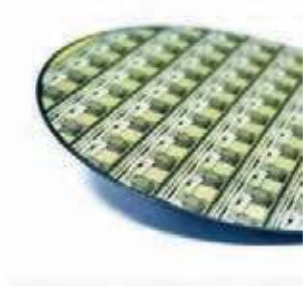
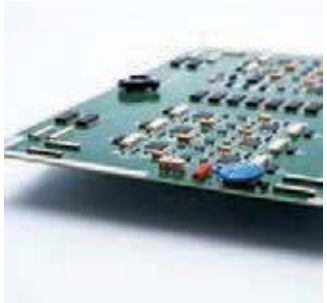
IMEC SERVICES

IC-LINK
CHIP PROTOTYPING

IMEC WAFER
MANUFACTURING



ASIC DESIGN
SERVICES



PCB PBA DESIGN
SERVICES

PRODUCT
PROTOTYPING

LIVING
LABS

OFFERS SINGLE POINT OF CONTACT
INTO THE IC VALUE CHAIN

FOUNDRY ACCESS TO >300 SMES
AND >700 UNIVERSITIES

TAPES-OUT >500 IC DESIGNS PER YEAR

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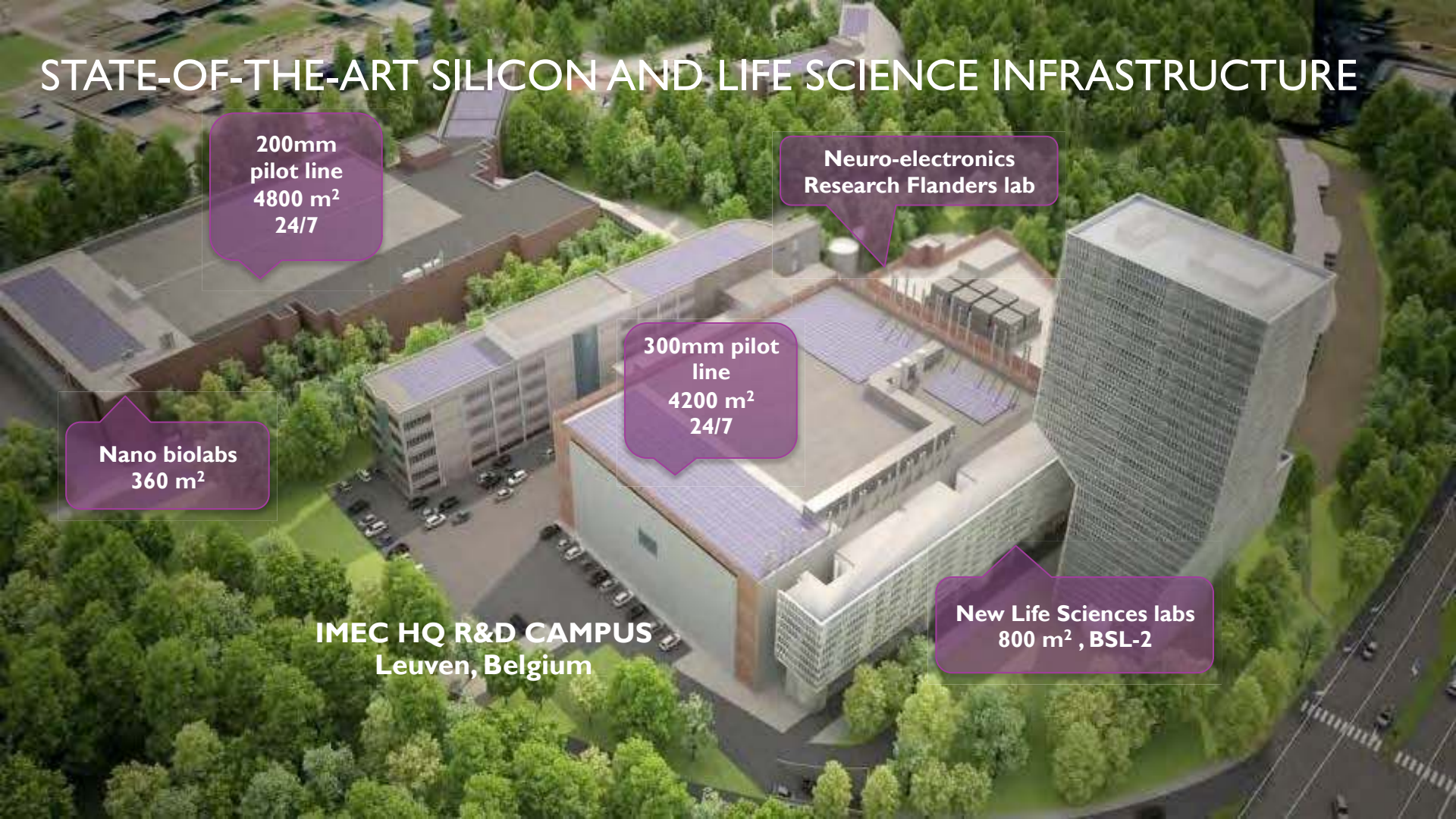
STATE-OF-THE-ART SILICON AND LIFE SCIENCE INFRASTRUCTURE

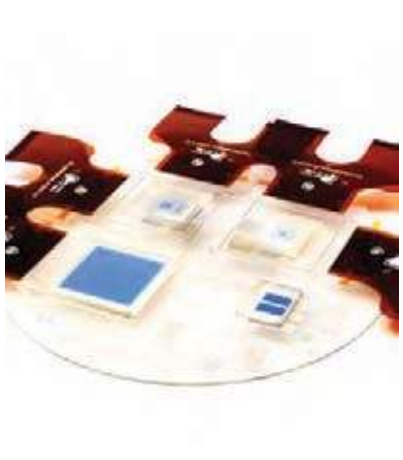


15 YEARS OF IMEC LIFE SCIENCE

MULTI-DISCIPLINARY AND BIOMEDICAL EXPERTISE

Silicon chip processing

>1B$ infrastructure
200mm and 300mm clean rooms
Std. 130nm down to 40nm
MEMS, in-line testing
We offer a flexible approach for custom integration, prototyping and manufacturing and transfer



Smart Electronics

Low-power circuit and instrumentation design,
Novel imager design and technology, photonics and optical design, hyperspectral filters, MEMS sensors, novel transducer technologies, wearable devices

Silicon-Bio materials

Bio-compatible materials such as Polymers, dielectrics, self-assembled monolayers, electrode materials, optical materials
Novel components such as optical and electrical biosensors, microfluidics, optical components

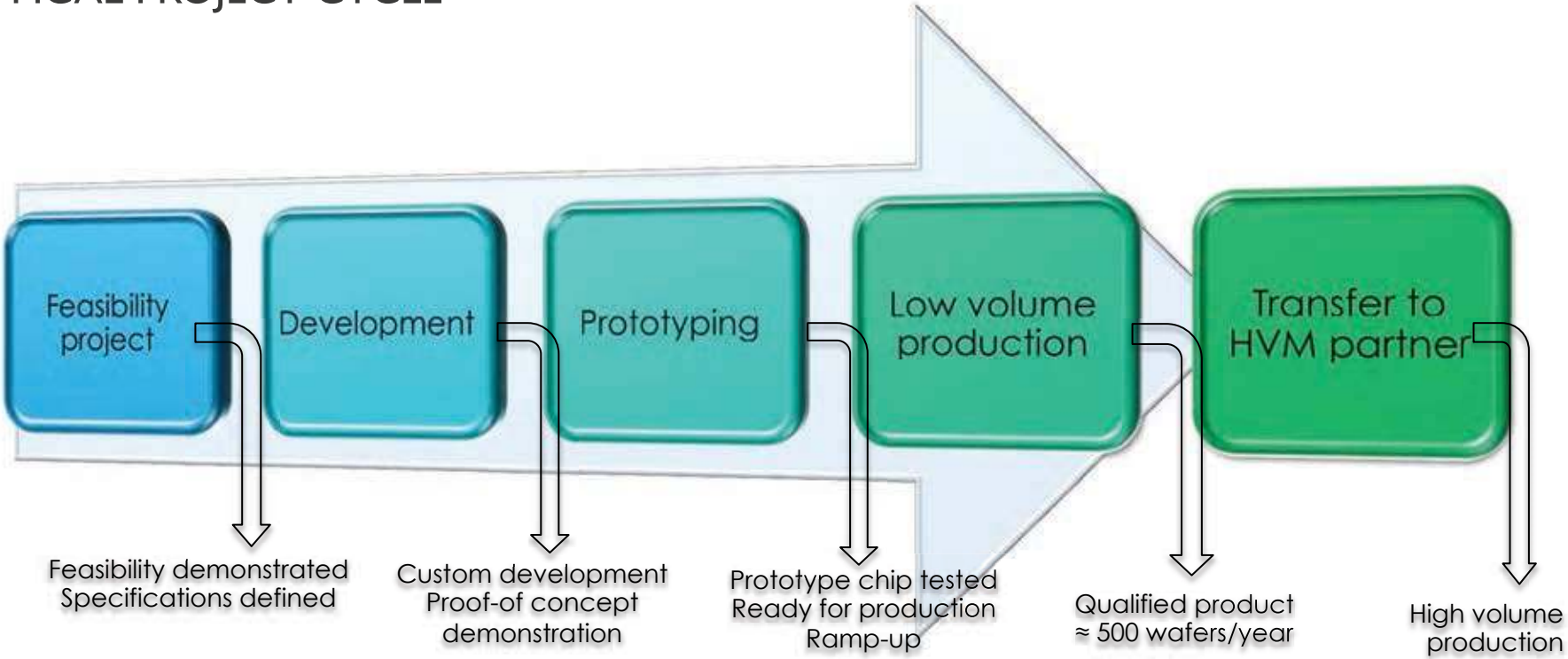
Biolabs

In-house testing capabilities:
Cell cultures, Animal testing, Blood testing, Molecular biology

Experienced researchers with a biology, chemistry or biomedical background, and >1000 m^2 of Biolabs

IMEC BRIDGES EARLY R&D TO LOW VOLUME TO HIGH VOLUME

TYPICAL PROJECT CYCLE



DRIVERS FOR NEW TECHNOLOGIES IN MEDTECH HARDWARE

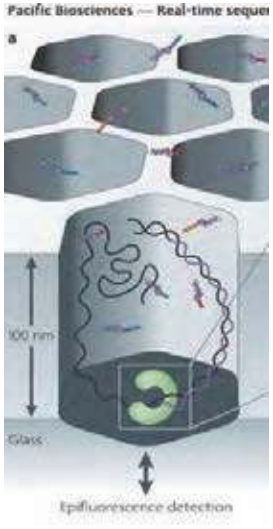
- Demand for Smarter Medical Devices – surgical tools, diagnostics, implants
- Internet-of-Everything reinforces greater connectivity of medical devices
- Greater focus on preventative health (not sick care)
- Emergence of humans interfacing with electronics

Image source: http://www.healthcareitnews.com/news/deloitte-consumers-using-more-healthcare-tech

SILICON TECHNOLOGY IS INTEGRAL TO MEDICAL INNOVATION

CHIPS FOR DNA SEQUENCING

FOR GENOMICS AND PERSONALIZED HEALTH



SEQUEL SYSTEM
7x faster, 3x smaller, half the price

Rapid sequencing time: 0.5 to 6 hrs
Serially process up to 16 SMRT Cells in a single run with walkaway automation

SMRT CONSUMABLES
- Sample-to-sequencing in a day
- Cost-effective, scalable workflows
- Flexible protocols support a variety of sample types and insert sizes

Read the press release: http://www2.imec.be/be_en/press/imec-news/pacificbiosciences.html

Source: http://www.pacb.com
Copyright Pacific Biosciences

IMEC's SMART HEALTH PLATFORMS

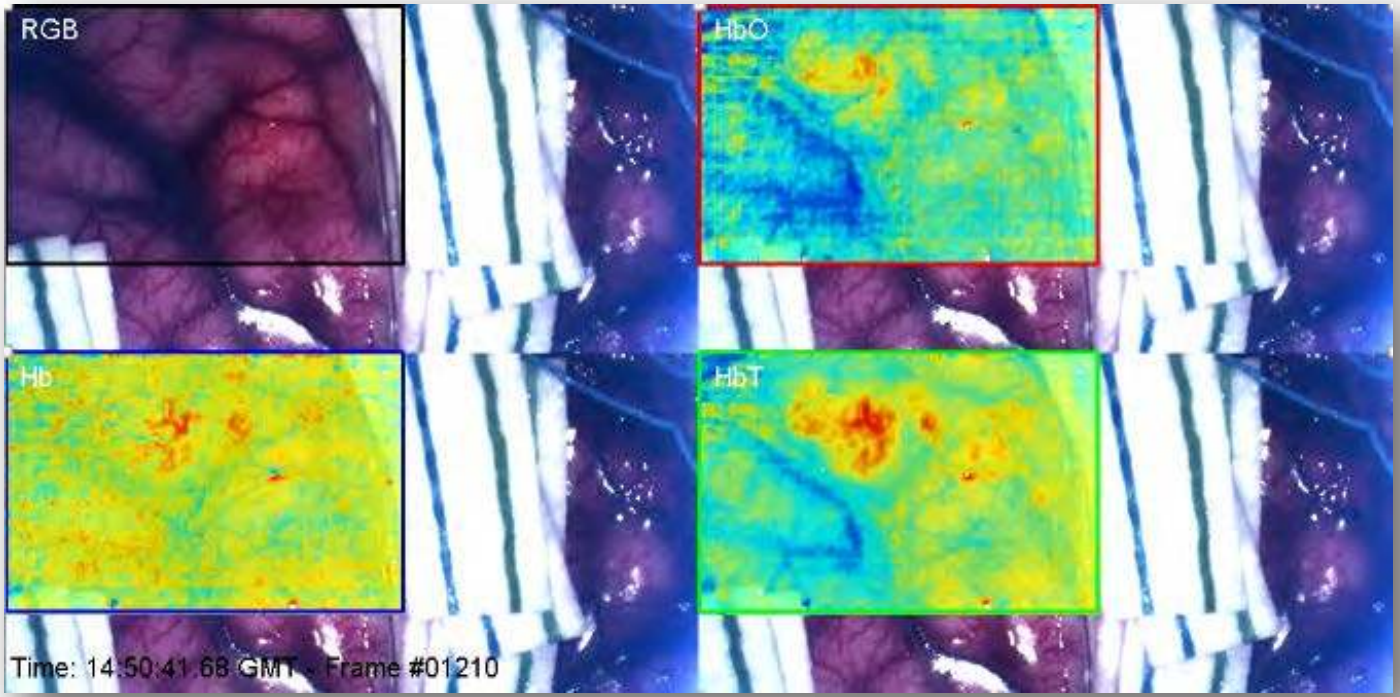
Genalyte

DISPOSABLE
SILICON
PHOTONICS
BIOSENSOR CHIPS

Source: http://www.genalyte.com
Copyright Genalyte

HYPERSPECTRAL IMAGING GUIDES SURGERY

REAL-TIME OXYGENATION MAP



Reconstructed Hb/HbO/HBT maps extracted from HSI snapshot mosaic
4x4 = 16 bands HSI sensor on an epileptic patient during brain surgery

POLYTECHNIQUE MONTRÉAL
LE GÉNIE EN PREMIÈRE CLASSE

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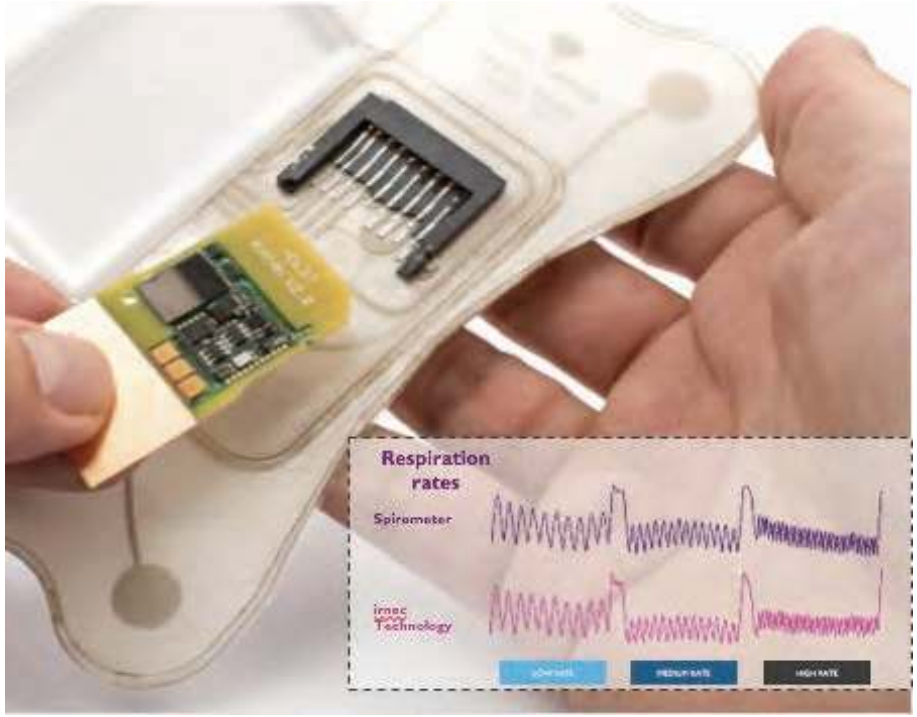
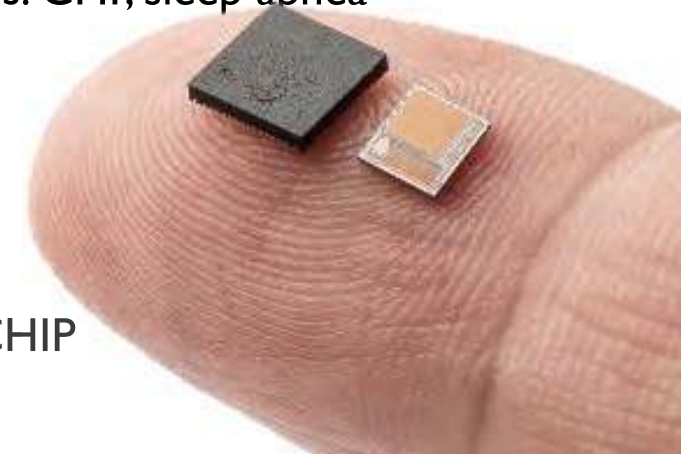
HEALTH PATCH ENABLES REMOTE PATIENT MONITORING



- Multi-parameter patch
  - Bio-impedance
  - Respiration
  - Posture
  - Activity
  - Heart rate
  - Heart rate/variability
- Applications: CHF, sleep apnea

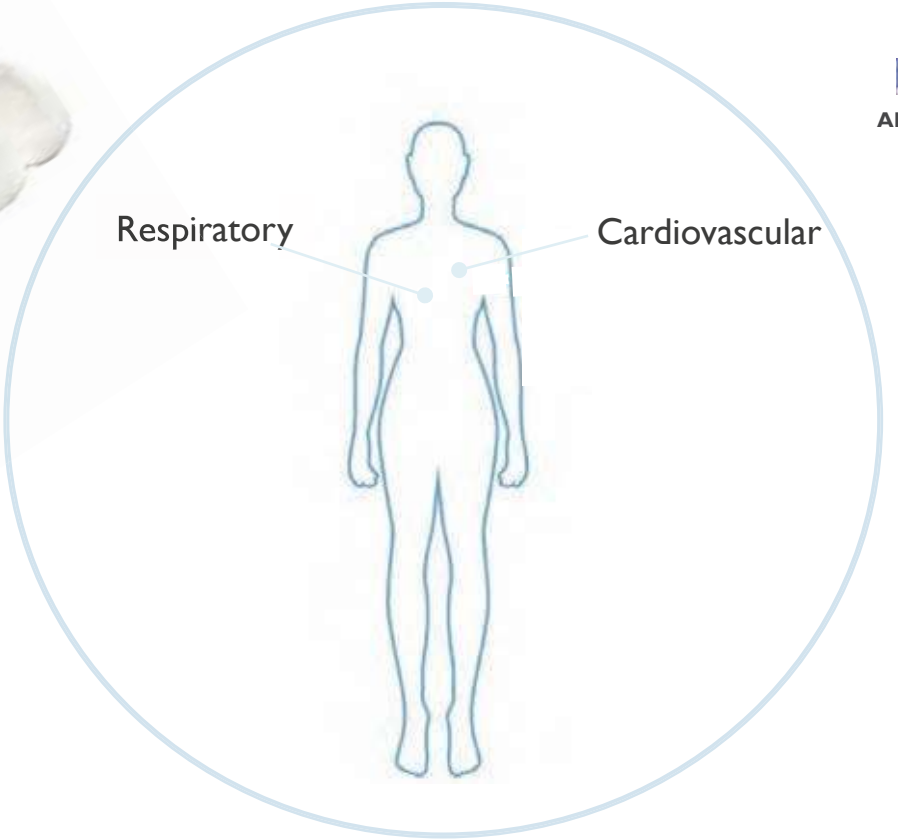


ULTRA LOW POWER MUSEIC CHIP

imec CONNECTED HEALTH SOLUTIONS
FOR DIAGNOSTICS AND DISEASE MANAGEMENT

SLEEP APNEA

CHF PATIENT MANAGEMENT



Mobile Cardiac Outpatient Telemetry

FDA APPROVED

BioTelemetry

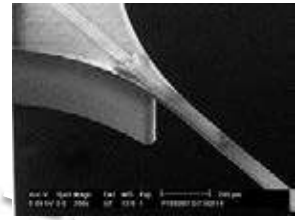
Cuff-less Blood Pressure monitoring

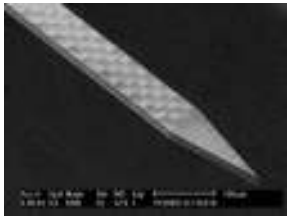
SAMSUNG

imec

HIGH-DENSITY NEUROPROBE FOR BRAIN RESEARCH

MICROMACHINING AND EXTREME SCALING





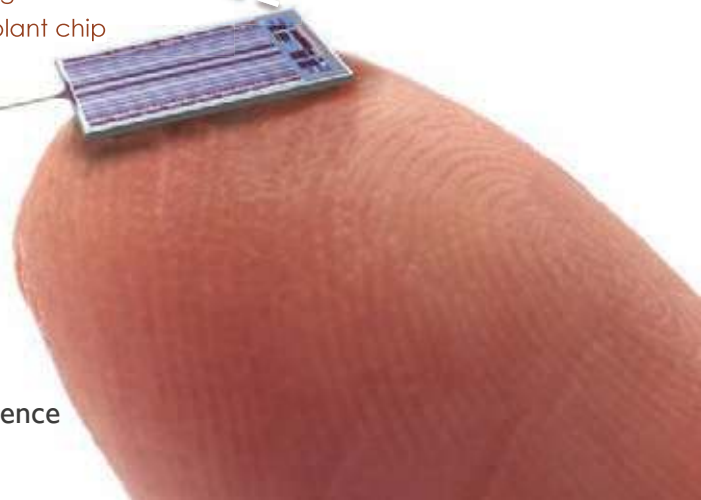
<100 um bending after **stress engineering**

384: Highest possible number of recording channels

966: Highest possible number of electrodes

20 µm: Thinnest, lightest for minimal tissue damage

The only true volume manufacturable brain implant chip



Applications

Brain research

In-vivo drug screening

Implants for closed-loop therapies

Future medical devices: Epilepsy, Parkinson's and Peripheral Nerve System

Funded by HHMI, Gatsby charitable foundation, Welcome trust, Allen institute of Brain Science

imec

SUPPORTING STARTUPS

- **IMEC.ISTART**
  - FORMATION & BUSINESS SUPPORT FOR TECHNOLOGY-BASED SMALL & MEDIUM-SIZED COMPANIES
- **IMEC.XPAND**
  - FUNDING IMEC BASED TECHNOLOGY COMPANIES

TRANS-ATLANTIC COLLABORATION IN MEDTECH

HOW TO CROSS THE ATLANTIC?

PACIFIC BIOSCIENCES

countless # of cases with US companies

Bilateral R&D and DoD contracts with US companies.

hhmi Howard Hughes Medical Institute

experience with US foundations: HHMI, Allen Institute, BMGF, CZI, ...

Bilateral R&D with US R&D centres sponsored by US foundations.

UF UNIVERSITY of FLORIDA

experience with US gov agencies: DARPA, NIH, IARPA, NSF, ...

IMPRESS:
Flex-embedded intra-muscular neuro-electronic implant.
Collaboration with U Florida, joint R&D grant by DARPA.

bloomlife

xpand from Flanders to US

Consumer health pregnancy tracking with data analytics.
Tech R&D started @ imec, HQ set up in US,
R&D site set up in Flanders, joint R&D grant by Flemish Gov.

xpand from US to Flanders

Sensory platform for medical & non-medical applications.
HQ and bio-tech R&D in US, *now* establishing R&D site in Flanders,
joint R&D grant by Flemish Gov.

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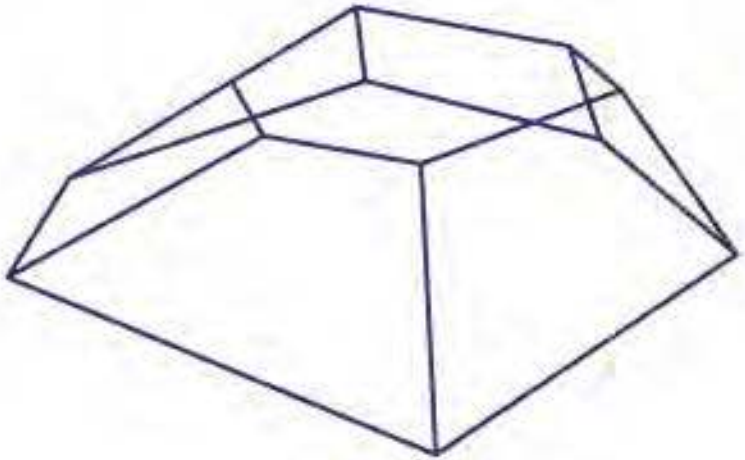
CONCLUSION



ITFHEALTH

NEW TECH PERSPECTIVES
FOR **HEALTH**

OCTOBER 19, 2018. SAN FRANCISCO. USA

imec

embracing a better life

Sunil Gangadharan PhD
Strategic Partnerships Manager, Americas
Imec
Sunil.Gangadharan@imec.be

Biosensing with Integrated Photonics: Building the Next Generation of Diagnostics

Benjamin L. Miller
Departments of Dermatology, Biochemistry and Biophysics,
Biomedical Engineering, and Optics
University of Rochester
Rochester, NY 14642 USA
Benjamin_miller@urmc.rochester.edu

Sensors: the ultimate A/D interface

SENSOR

The Prototype

- Large and heavy
- A CRT as the output?
- Why do you need one device for sensing, and another for communication?

The tricorder wasn't imaginative enough – and in many ways we're moving well beyond it

From high volume / low cost to low volume / high value

(Siemens)

(wikipedia)

Decreasing Volume / Increasing price point

(Genalyte)

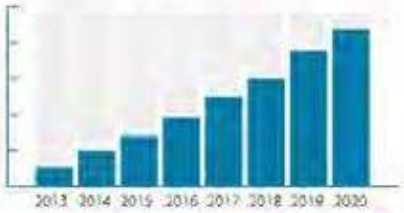
(www.wallpaperup.com)

Global Photonics Sensors Market

Segmentation and Forecast, 2013 - 2020

Global Photonics Sensors Market

Global Photonics Sensors Market is expected to reach $15.2 Billion by 2020



Growing at a CAGR of 16.9% (2014-2020)

Global Photonics Sensors Market By Technology

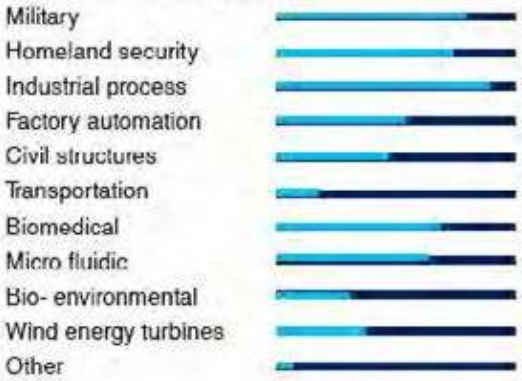
The comprehensive view on the % share of Technology segment (2020)

For More Details See Table of Contents

Global Photonics Sensors Market by Product Type

The comprehensive view on the % share of Type segment (2020)

Global Photonics Sensors Market By Application



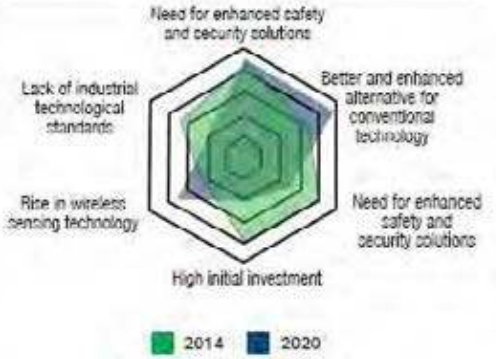
The comprehensive view on the % share of Application segment (2020)

Global Photonics Sensors Market by Geography

Europe is expected to be highest revenue generating region by 2020

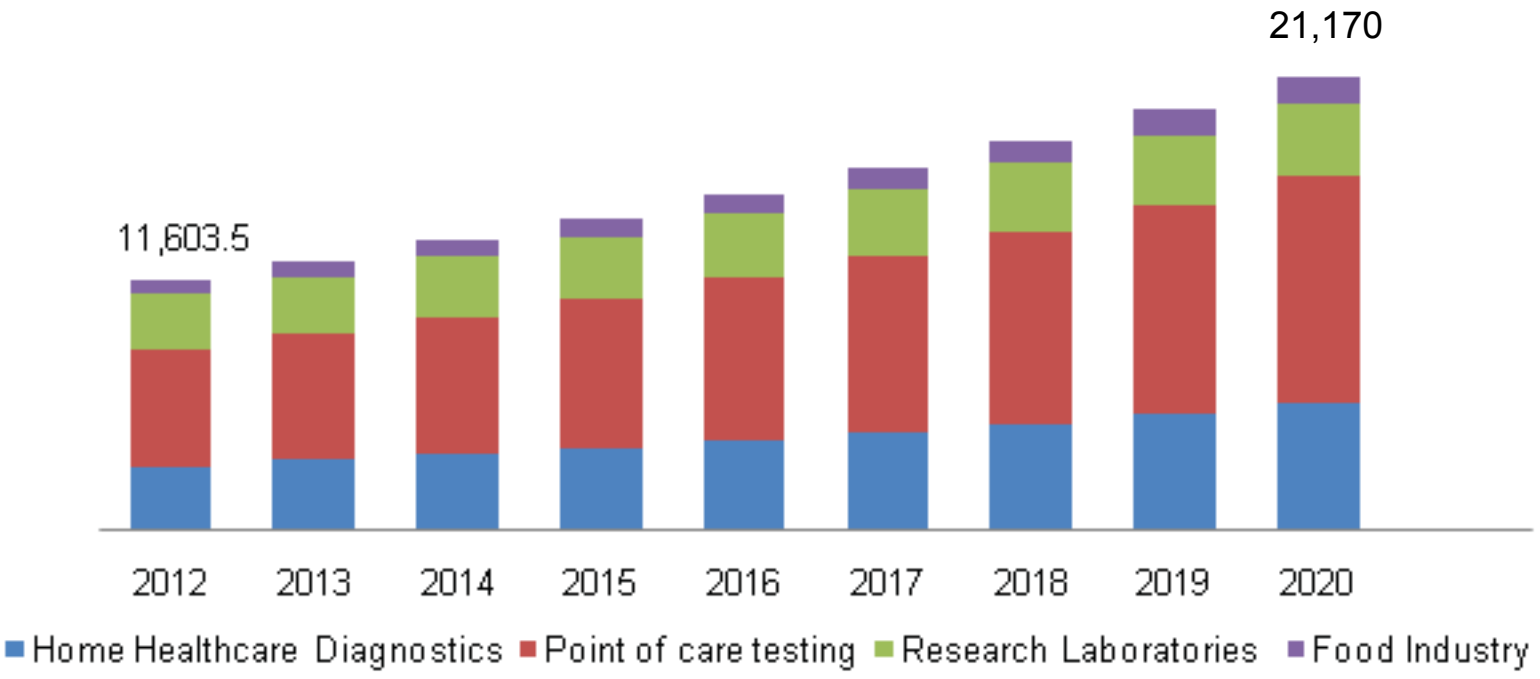
North America, Asia Pacific, LAMEA

Top Impacting Factors



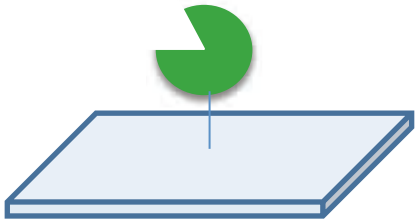
https://www.alliedmarketresearch.com/photonics-sensor-market

The biosensor market alone: $21 BN in 2020

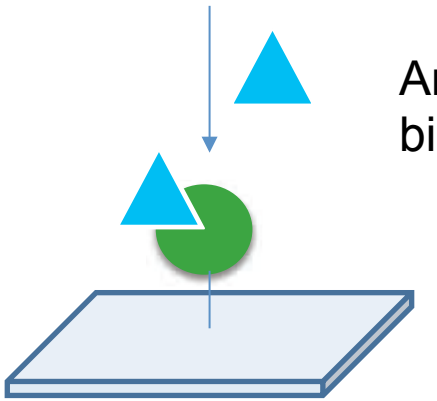


http://www.grandviewresearch.com/industry-analysis/biosensors-market

Biosensing: the basics

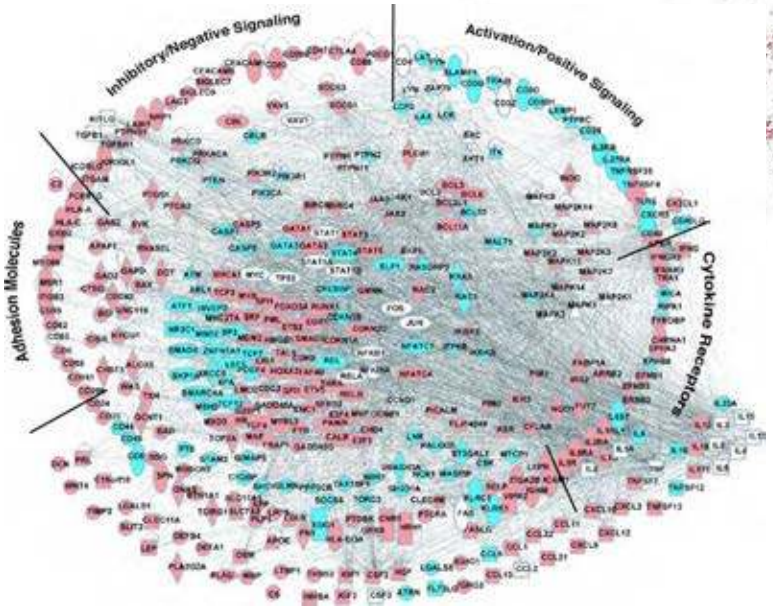


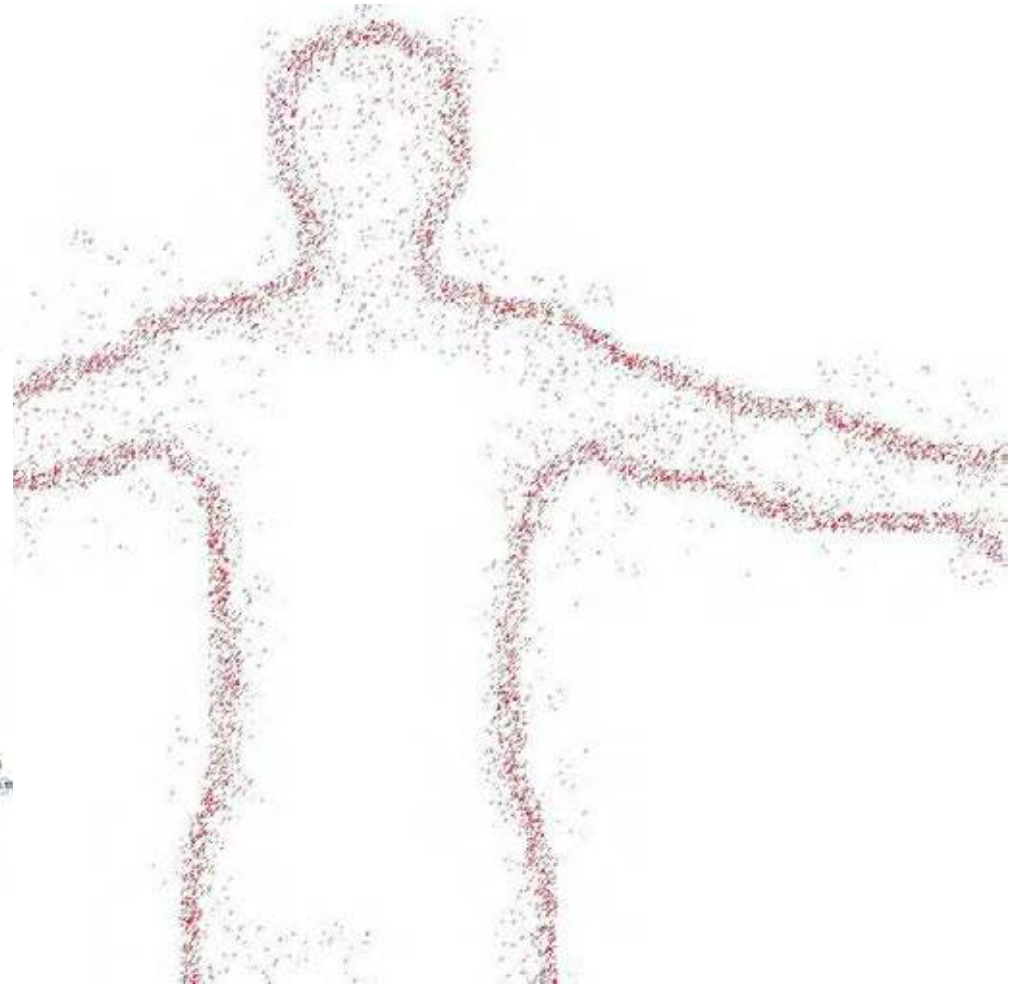
Optically responsive material



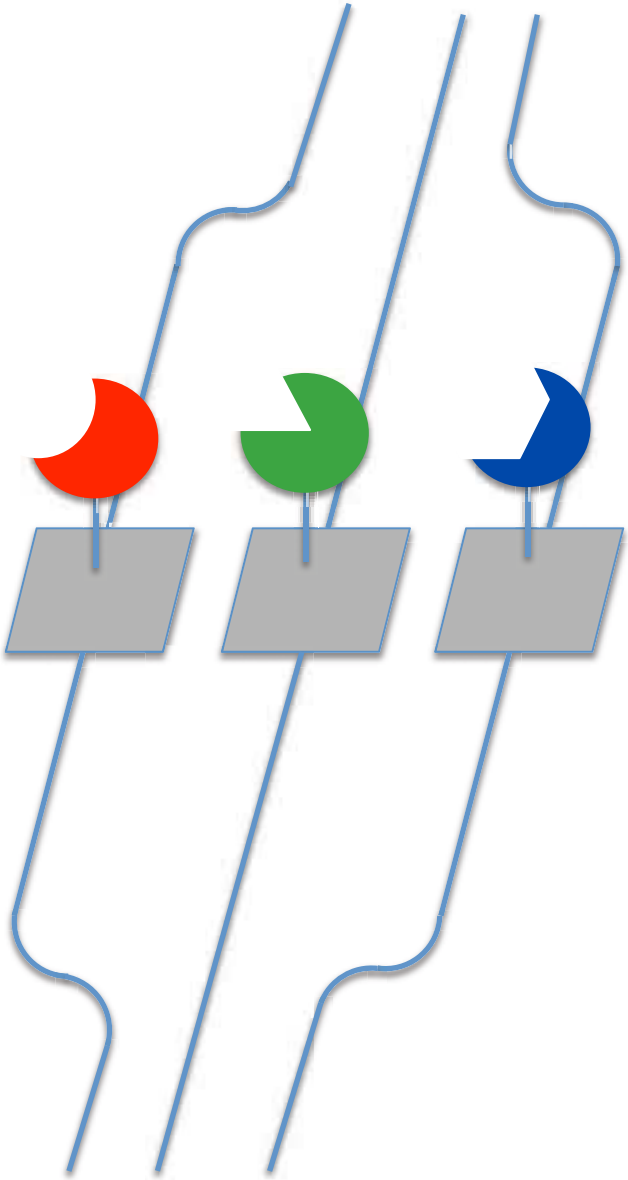
Analyte of interest (chem / bio)

SIGNAL.
- Intensity change
- Spectral signature
- Shift in a spectral feature


Inhibitory/Negative Signaling
Activation/Positive Signaling
Adhesion Molecules
Cytokine Receptors



The promise of Label-Free Detection

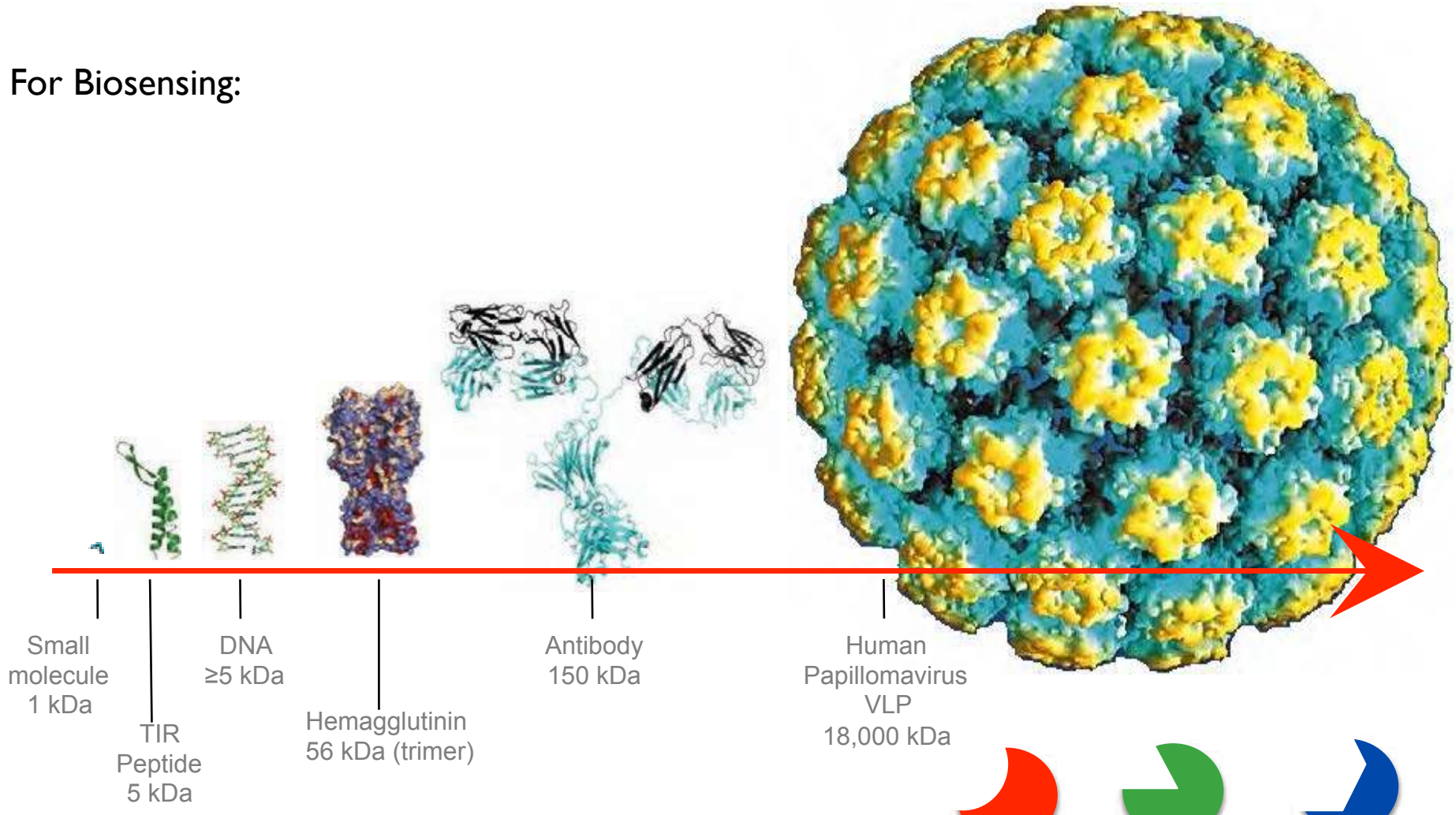


- A capture molecule (or responsive chemical coating) on one sensor element is not affected by other sensor elements

- For the first time, this allows for detection of many targets as simply as one, given an ability to put many elements on chip (easy), an ability to address them all independently (easy), and an ability to make them different chemically (harder, depending on scale)

Photonic sensors can gain specificity through chemical interactions

For Biosensing:



(Similar strategies possible for chemical sensing)
(and don't forget spectroscopy!)