ZERO-POWERED BIOSENSORS

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- World-leading research in **nano-electronics** driving chip scaling
- Applied to **healthcare** and **energy**
- **Bridging** between university and industry
- **Unique business model** bringing the **whole eco-system** together on a neutral place for pre-competitive research
Located in Belgium, The Netherlands, Taiwan, China, India

2011 data
- Total revenue 300M€, 5% ↑
- 1800 R&D publications
- 130 patents awarded & 130 patents submitted

Collaboration with all major companies and universities in the field

2000 employees
- 400 industrial residents
- 200 PhD students
GLOBAL NETWORK

SYSTEM COMPANIES

MEMORY IDM
LOGIC IDM
FOUNDRIES
FABLITE
FABLESS

EQUIPMENT SUPPLIERS
MATERIAL SUPPLIERS
SOFTWARE SUPPLIERS
What can nano-electronics bring to the medical world? Some examples:

- Body Area Networks for ambulatory monitoring and care
- Wetware sensors and actuators for diagnostics and cure
- Research for advancing our understanding of the brain
HEALTH PATCH

- Long battery life-time
  - 7 days – 24h/day
- Reliable in daily life
  - Motion artifact correction
- Multi parameter:
  - ECG, heartbeat
  - Accelerometer
  - Bio-impedance
  - Skin temperature
  - Bio-chemical sensing
- Multiple application fields
  - Arrhythmia
  - Overweight control: energy expenditure analysis and activity tracking
  - Depression: activity tracking
  - Epilepsy: onset prediction
EPILEPTIC SEIZURE DETECTION

▸ Through ECG instead of EEG
  - More comfortable
  - Less stigma

▸ Clinical study design
  - 10 subjects previously diagnosed with major epileptic seizures with heart rate changes
  - Monitoring at night, for 1-4 weeks per subject
  - Results verified by clinical staff

▸ Preliminary results
  - Seizures are detected, with good Sensitivity
  - Device is accepted by patients and nurses
EMOTION MONITORING

- Measuring the Autonomous Nervous Response (ANS), i.e. physiological arousal
  - ECG
  - Respiration
  - Skin temperature
  - Galvanic Skin Response

- Valence determined through EEG (right/left alpha ratio → 80% accurate)

- Applicable for all types of stress disorders
EMOTION MONITORING

Trier Social Stress Test – Reference Cortisol & questionnaire

ECG

Respiration

Galanic sign response

Arousal over time

Raw Data

Fluctuations during the game

Approaching chessmate

Bad move!
**VERY HIGH THROUGHPUT IMAGING FLOW CYTOMETER**

- Records images of cells in flow using lensfree imaging
- Fast sorting of cells
- Many applications
  - Quality analysis of iPSC
  - Detection of circulating tumor cells (CTCs)
Very high throughput imaging flow cytometer

- Scalable to 20,000,000 cells/s through highly integrated parallel microfluidic channels → CTC analysis in <1 min
- Disposable fluidics
- Sorted cells stay viable

On-chip high-resolution imaging for cell classification

Fast microfluidic bubble-jet cell routing
EXTREMELY PERSONAL DIAGNOSTICS

- Diagnose most common diseases and monitor health using the world’s most ubiquitous platform: the smartphone
- Low cost
  - Instrument cost: 0$
  - Disposable cost: 0.5-10$
  - Data processing: in cloud
- Even applicable as consumer companion diagnostics tool
EXTREMELY PERSONAL DIAGNOSTICS

**Today**

- High-level data processing
- Low-level data processing and process flow
- Heating/cooling
- Actuation (fluid pumping and valve actuation)
- Detection

- Fluidics (valves, reagent storage, ...)

- Instrument 10K-100K$

**Tomorrow**

- Data, visualization and communication using smartphone (the ubiquitous instrument)
- More functionality using microfabricated precision Silicon fluidics
- Microfabricated disposable 0.5-10$
- Molded disposable 10-20$

- PC

- Smartphone/cloud

- TRL4

**Microscopic scale**

- Faster heating and reactions
- More parallel handling: multi-analysis easy
- Less reagent
- Cheaper, hence no contamination (disposable)

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INTEGRATED NEUROPROBES

- In vivo
- Highly integrated
  - Active probes + signal conditioning electronics integrated onto single chip
  - Many electrodes per shaft (e.g. 456)
  - In-probe amplification, on-chip filtering and analog-to-digital conversion → very low noise (4 μVrms)
  - Thinned silicon shaft (50μm) → flexible
- Recording and stimulation
- Many applications
  - Research: increase understanding
  - Clinical (cortical & DBS): less side effects
INTEGRATED NEUROPROBES

Switching to silicon roadmap brings Moore’s scaling law to neuroprobes:
55% more electrodes every 2 years
+ optical and chemical interfacing

Adapted from: Stevenson et al., Nat. Neurosci. 14(2), 2011

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Unique firing pattern codes for position on the race track
INTEGRATED NEUROPROBES: READING A RAT’S MIND

cell activity
overall
ongoing

behavior
INTEGRATED NEUROPROBES: READING A RAT’S MIND

When stopped: replay/planning at 10x speed
During sleep: fast replay of daily experiences supporting memory consolidation
ELECTRONICS FOR LIFE SCIENCES BUSINESS MODEL: DUAL CORE

DUAL CORE / DUAL SITE

Technology users
- Hospitals
- Clinical Labs
- Pharma
- CROs
- Biotech

Technology builders
- Foundries
- IDMs
- Materials suppliers
- In vivo & medical device manf.
- Devices, assays, reagents
- Specialty and high performance materials
- Medical devices including interventional approaches
- Semiconductor/electronics design & manf.

Dual Core Program Offering (With dedicated SoW)

Px out-post

Px out-post

Contract research for biotech and pharma

Full spectrum of ownership across drug dev value chain

Diagnostic testing and screening services

Use of living systems to develop or make products including - omics, recombinant tech and therapies