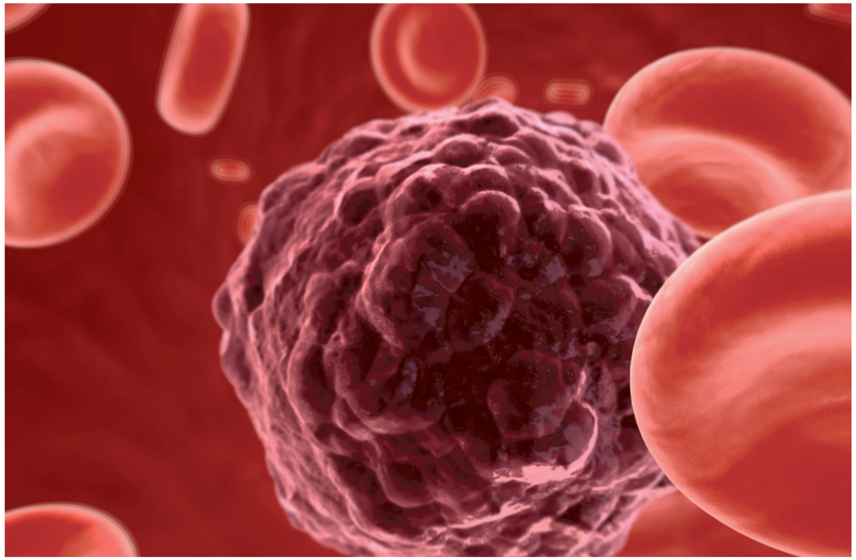
Smart Specialization strategies for innovation-driven growth

OECD "*Nanotech for Health*" case study - Flanders



25 February, 2013

EWI Smart Specialization Workshop

Part I : The rationale of NfH as strong potential for Flanders in a transition policy and as a potential for smart specialization

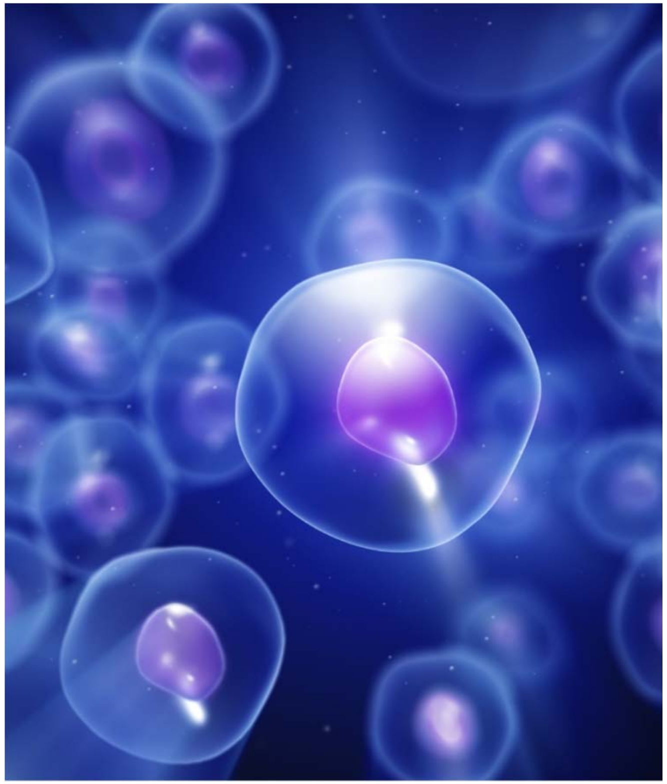
Part II : Dialogue with a strong sample of all stakeholders & preliminary outcome

Part III: A bundling of cluster expertise and eco-systems between FlandersBio & and DSP-Valley and the way forward

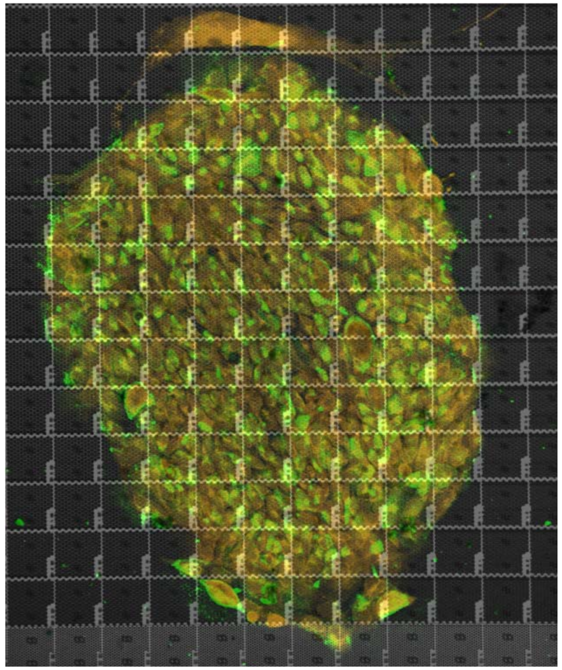
Part I: The rationale of NfH as strong potential for Flanders in a transition policy and as a potential for a smart specialization

Why NfH? A short positioning:

1. Some major trends
2. Nanotech for Health: an emerging and promising market
3. Fit with Flanders' Regional Innovation Policy
4. Approach and how to differentiate ?



First ... a short positioning



- NfH is a typical case of "***Radical Creation***" (*).

- It is an ***emerging market***, but with large ***growth potential***.
  (see also outcome driven health care & companion diagnostics)

- ***Very cross-sector & cross-disciplinary*** oriented.

- ***Strong scientific basis***, but ***still fairly disconnected***.

- NfH specialization offers strong ***basis for differentiation*** in the ***overall health focus***, present in almost all policy notes across the world.

- ***Need*** for ***smart specialization teams, methodology and criteria***.

(*) as compared to Modernization, Transition, Diversification (see also Prof. Foray, EPFL)

1 Some major trends & challenges

Trends

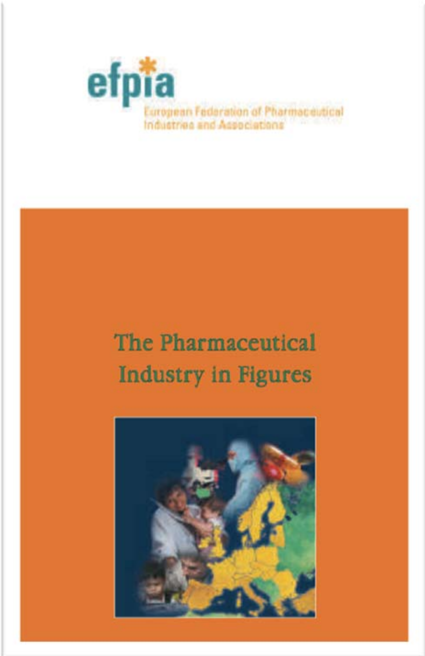
1. Continued growth in healthcare spending

- Already 11-17% of GDP
- It’s absolutely necessary to reconsider health care models

2. Pharma R&D model is being reconsidered

- ***Output (new drugs) declining*** despite *increased R&D spending*.
- ***Cost per new drug*** *galloping* ~$1.6B or more.
- ***Time*** from bench to bed is long
- Towards more ***personalized medi*****cine** and ***disease management***.
- More ***outcome driven approach*** under pressure of payors.
- Upcoming of ***companion diagnostics*** *(now barely 2% of all drugs)*.

Data & FACTS



EFPIA (http://www.efpia.eu/pharmaceutical-industry-figures-edition-2012)

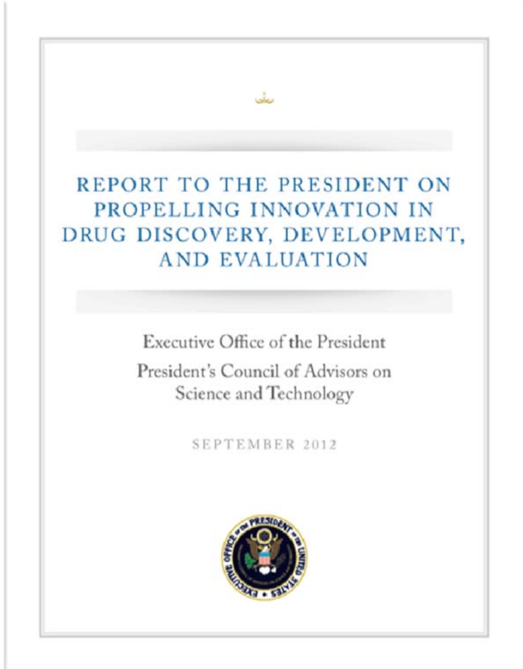

ANALYSIS

How to improve R&D productivity: the pharmaceutical industry's grand challenge

Steven M. Paul, Daniel S. Mytelka, Christopher T. Dunwiddie, Charles C. Persinger, Bernard H. Munos, Stacy R. Lindborg and Aaron L. Schacht

Abstract | The pharmaceutical industry is under growing pressure from a range of environmental issues, including major losses of revenue owing to patent expirations, increasingly cost-constrained healthcare systems and more demanding regulatory requirements. In our view, the key to tackling the challenges such issues pose to both the future viability of the pharmaceutical industry and advances in healthcare is to substantially increase the number and quality of innovative, cost-effective new medicines, without incurring unsustainable R&D costs. However, it is widely acknowledged that trends in industry R&D productivity have been moving in the opposite direction for a number of years. Here, we present a detailed analysis based on comprehensive, recent, industry-wide data to identify the relative contributions of each of the steps in the drug discovery and development process to overall R&D productivity. We then propose specific strategies that could have the most substantial impact in improving R&D productivity.

S.M. Paul, et al., *Nature Reviews Drug Discovery* **9**, 203 (2010)



PCAST Report to the President, September 2012

peumans@imec.be

New innovation paradigm in health care

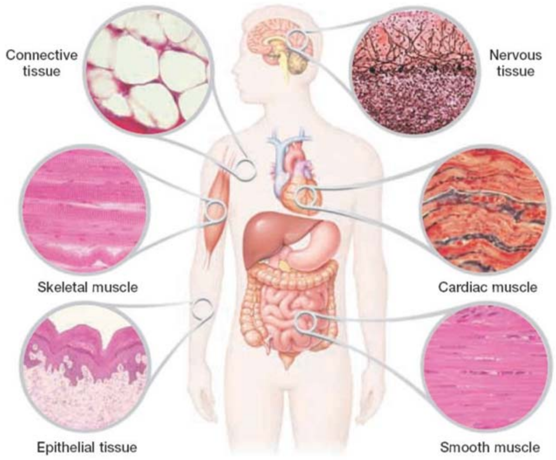
3 major innovation drivers are required ***simultaneously***:

- *increased performance*
- *increased efficacy*
- *reduced cost for the health care system*

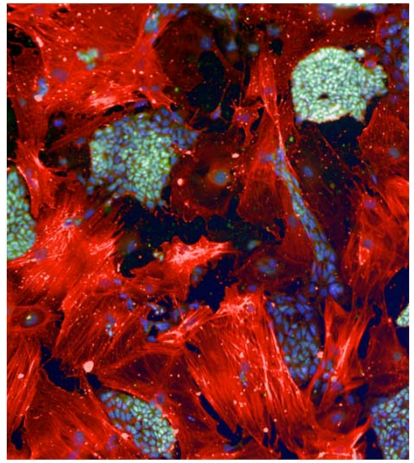
In part ***possible*** through:

- *extreme* ***integration*** leading to ***new functionalities*** & ***supporting platforms***
- *advanced* ***heterogeneous system integration***
- *strong insights in biomed/clinical & nanotech/systems* ***interface phenomena***
- *with platforms being* ***bio-medically spec'ed*** *(clinical relevance)* ***and (pre-)clinically validated.***

Some concrete illustrations



Tissue



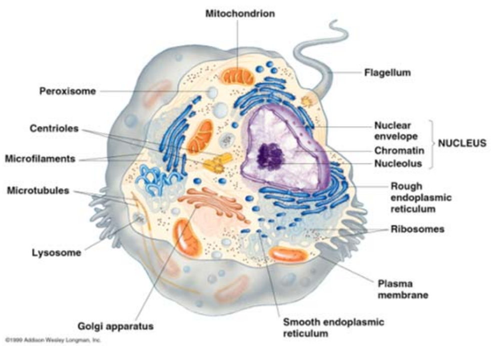
Cell cultures

In vivo probes

In vitro systems

Cyto-metry

Molecular diagnostics



Cells

Molecules

DNA, RNA, proteins, metabolites

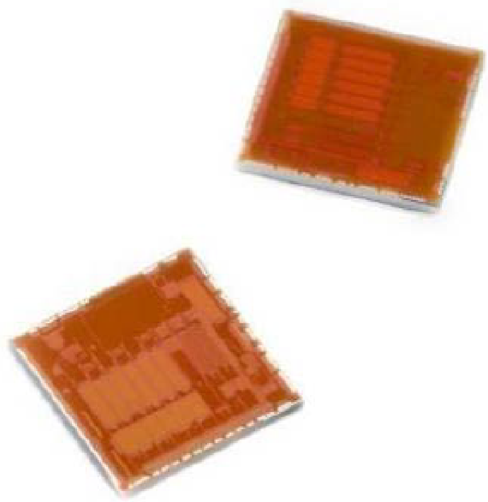
Imec Demonstrates Low-Power Intra-Cardiac Signal Processing Chip for Ventricular Fibrillation Detection

Published on February 20, 2013 at 1:48 AM

Imec demonstrated a low-power (20µW), intra-cardiac signal processing chip for the detection of ventricular fibrillation at this week's International Solid State Circuits Conference (ISSCC 2013) in San Francisco with Olympus.

An important step toward next-generation Cardiac Resynchronization Therapy solutions, the new chip delivers innovative signal processing functionalities and consumes only 20µW when all channels are active, enabling the miniaturization of implantable devices.

Robust and accurate Heart Rate (HR) monitoring of the right and left ventricles and right atrium is essential for implantable devices for Cardiac Resynchronization Therapy. And accurate motion sensor and thoracic impedance measurements to analyze intra-thoracic fluid are critical for improving clinical research and analysis of the intra-cardiac rhythm. Moreover, extreme low-power consumption is required to further reduce the size of cardiac implants and improve the patient's quality of life.



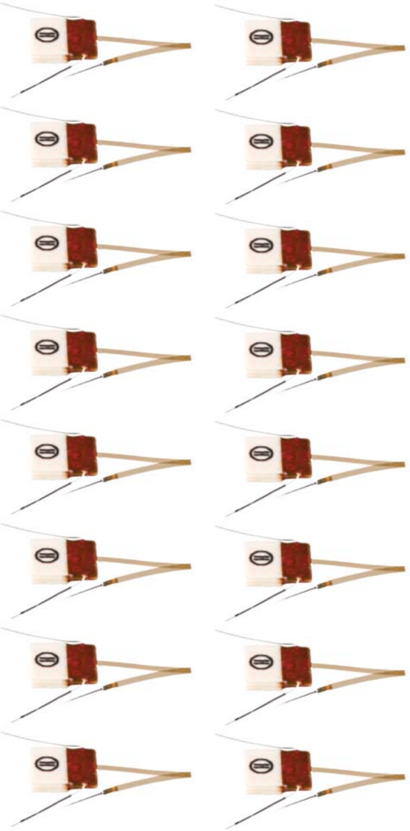
Imec's Low-Power Chip for Intra-Cardiac Ventricular Fibrillation Detection

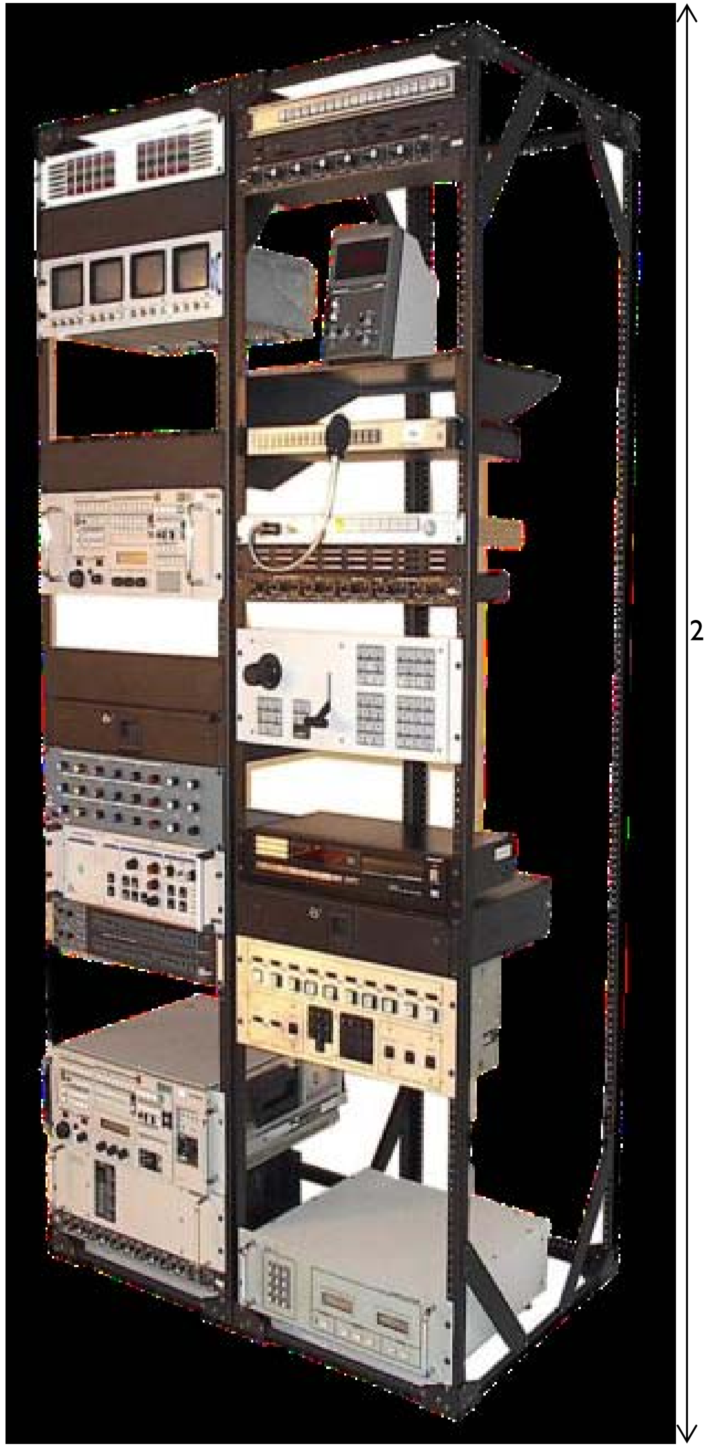
Imec's low-power integrated circuit features three power-efficient, intra-cardiac signal readout channels (or in short: ECG channels). Each of the three ECG channels is equipped with a precision ECG signal readout circuit with very low-power consumption and an analog signal processor to extract the features of the ECG signal for detection of ventricular fibrillation. The feature extractor achieves only 2ms latency to facilitate responsive Cardiac Resynchronization Therapy.

Additionally, the chip includes unique features that improve the functionality of Cardiac Resynchronization Therapy devices. First, the low-power accelerometer readout channel enables rate adaptive pacing. Secondly, to handle intra-thoracic fluid analysis, the chip includes a 16-level digital sinusoidal current generator and provides 82db wide dynamic range bio-impedance measurement, in the range of 0.1Ω 4.4kΩ with 35mΩ resolution, and achieves best-in-class accuracy (>97%).

28
16-electrode probes

13
4-channel preamp+ADC





Typical neuroscience experiment:
450 electrodes, 52 channels

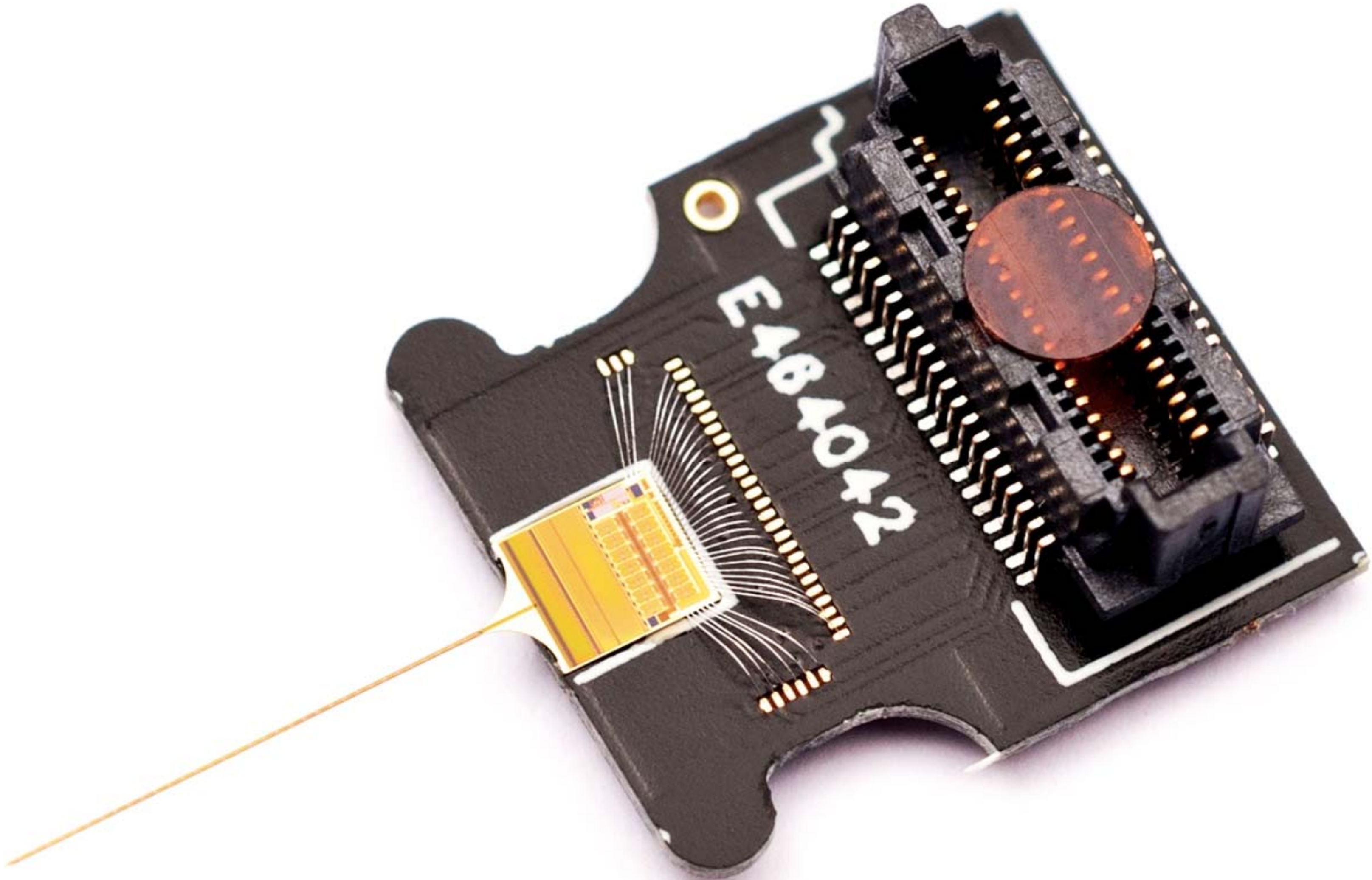
> 100 kg

28
16-electrode probes

13
4-channel preamp+ADC

CEREBRO

- 456 electrodes
- On-chip amplification, filters, analog-to-digital conversion for 52 channels
- Very-low-noise: 4 μVrms
- Recording + stimulation

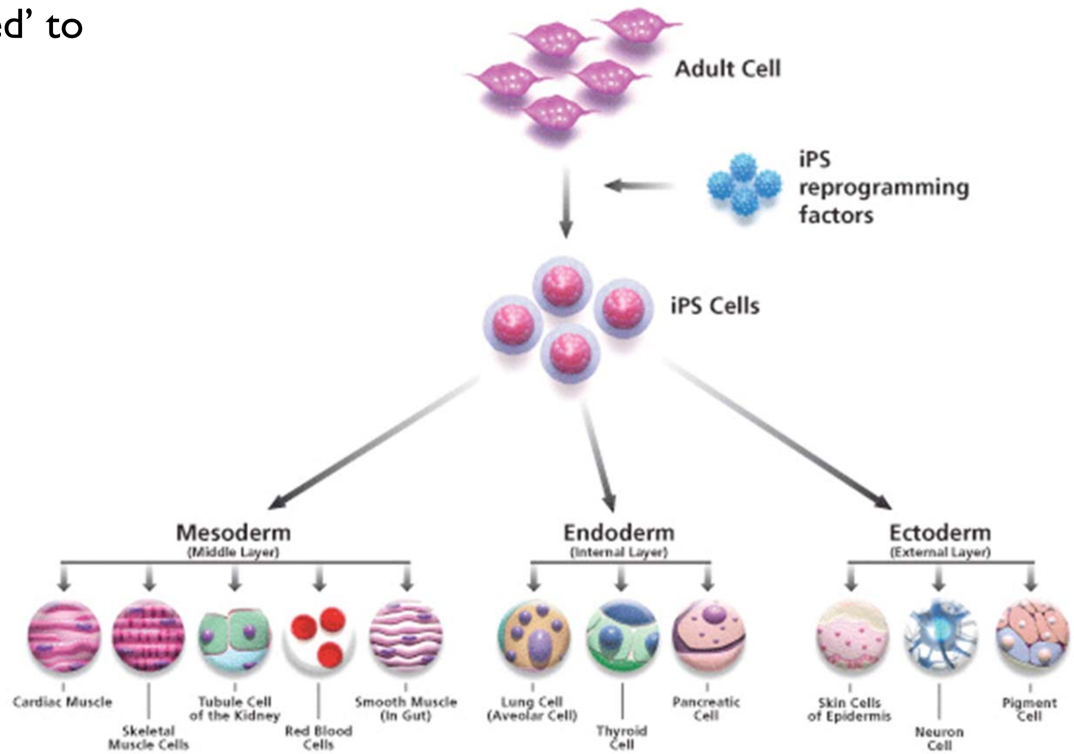

E484042

Potential of Induced pluripotent stem cells (iPSCs)

- Discovery by Takahashi and Yamanaka in 2006
- Cells from an adult can be 'reprogrammed' to become pluripotent
- Applications
  - Cell therapy
  - Drug screening
  - Disease model

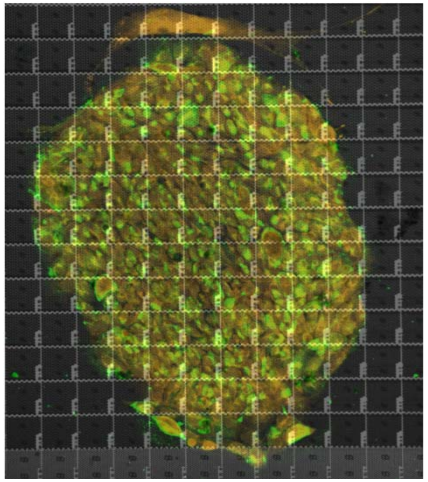
Sir John B. Gurdon
Gurdon Institute, Cambridge, UK

Shinya Yamanaka
Kyoto University, Japan



PRECISE REPROGRAMMING

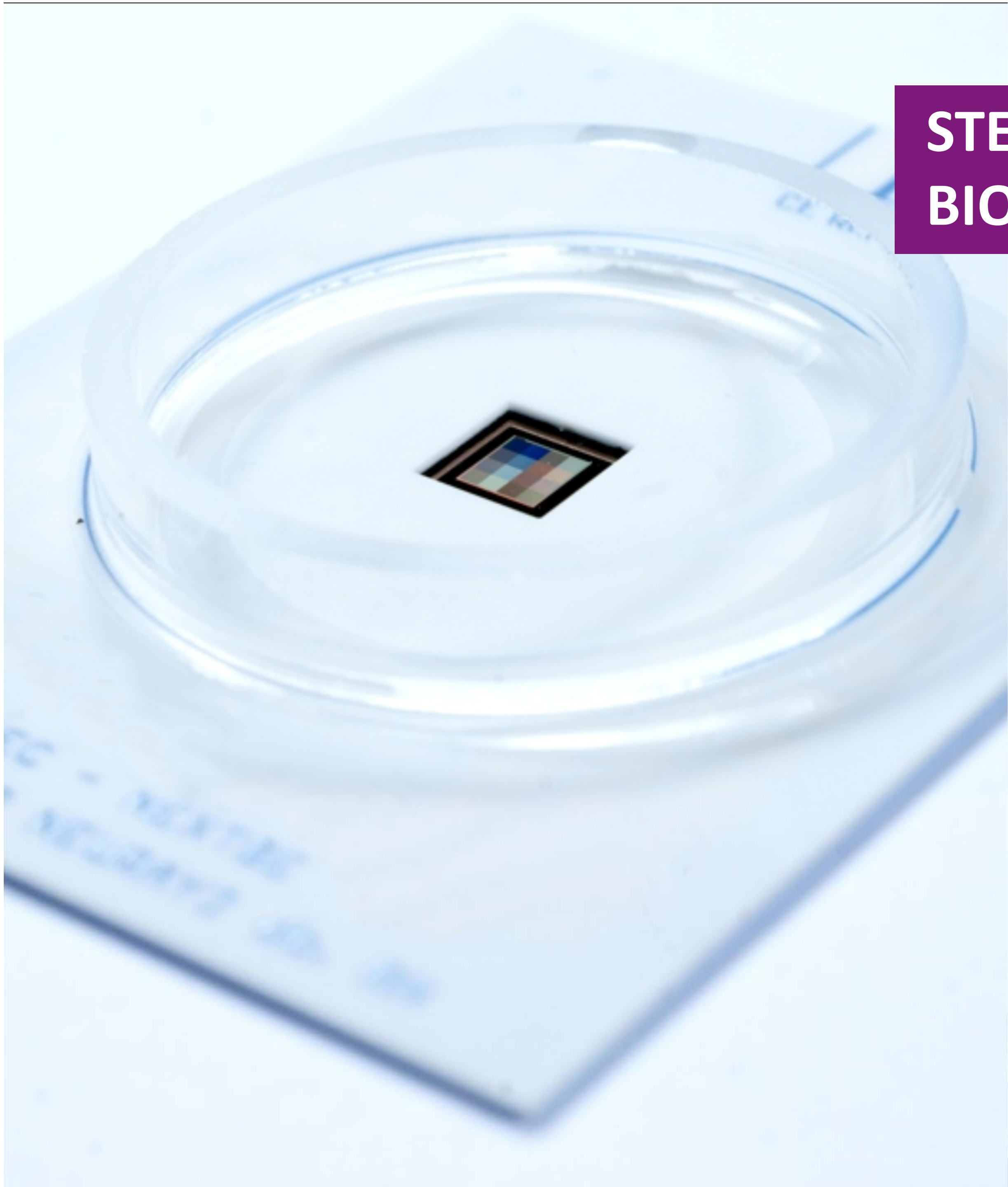
Challenges:



- Better understanding of ***biological process flow***;
- Need for further ***characterization methods & models***;
- Need for far more ***parametrical modeling***;
- Need for far more ***in-line metrology***;

→Essential for *up-scaling to reliable and homogeneous cell populations* fit for *toxicology studies*, *disease modeling* and *cell therapy* .

→***Can experience of semiconductors (nano-electronics) be useful?***
(need to put tens of B of transistors on a chip of less than 2 cm^2)



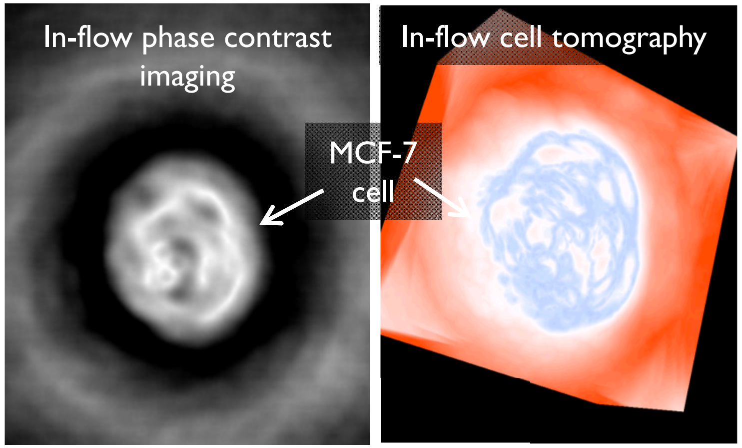
STEM CELL BIOREACTOR

- Growing cells & tissues on chips
- ***Two-way communication between electronics & cells***
- Expertise in electrode arrays on active CMOS for cell recording of neurons & cardiac cells

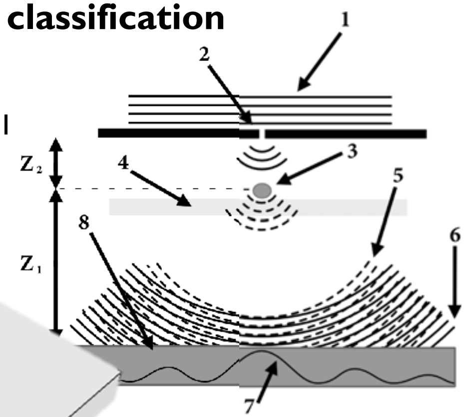
High-throughput imaging flow cytometer

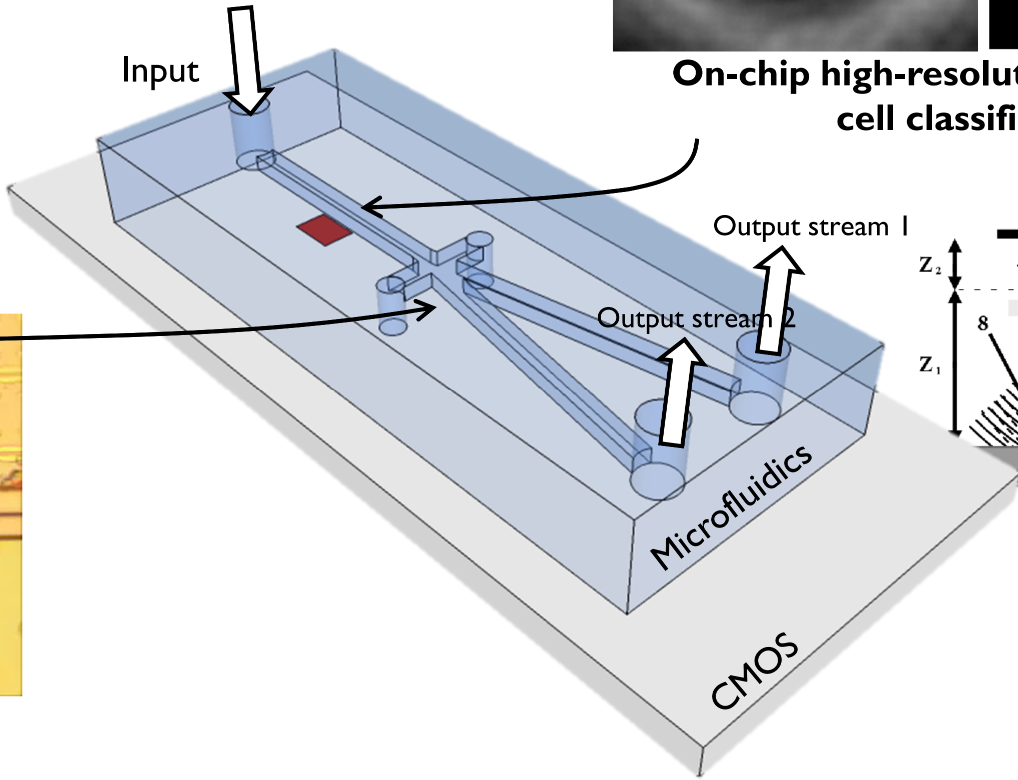
Scalable to 20,000,000 cells/s

>1000-fold improvement over current systems

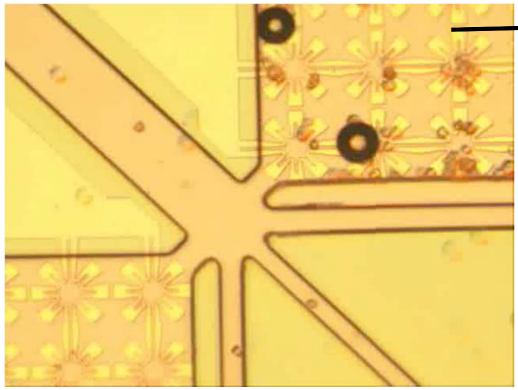


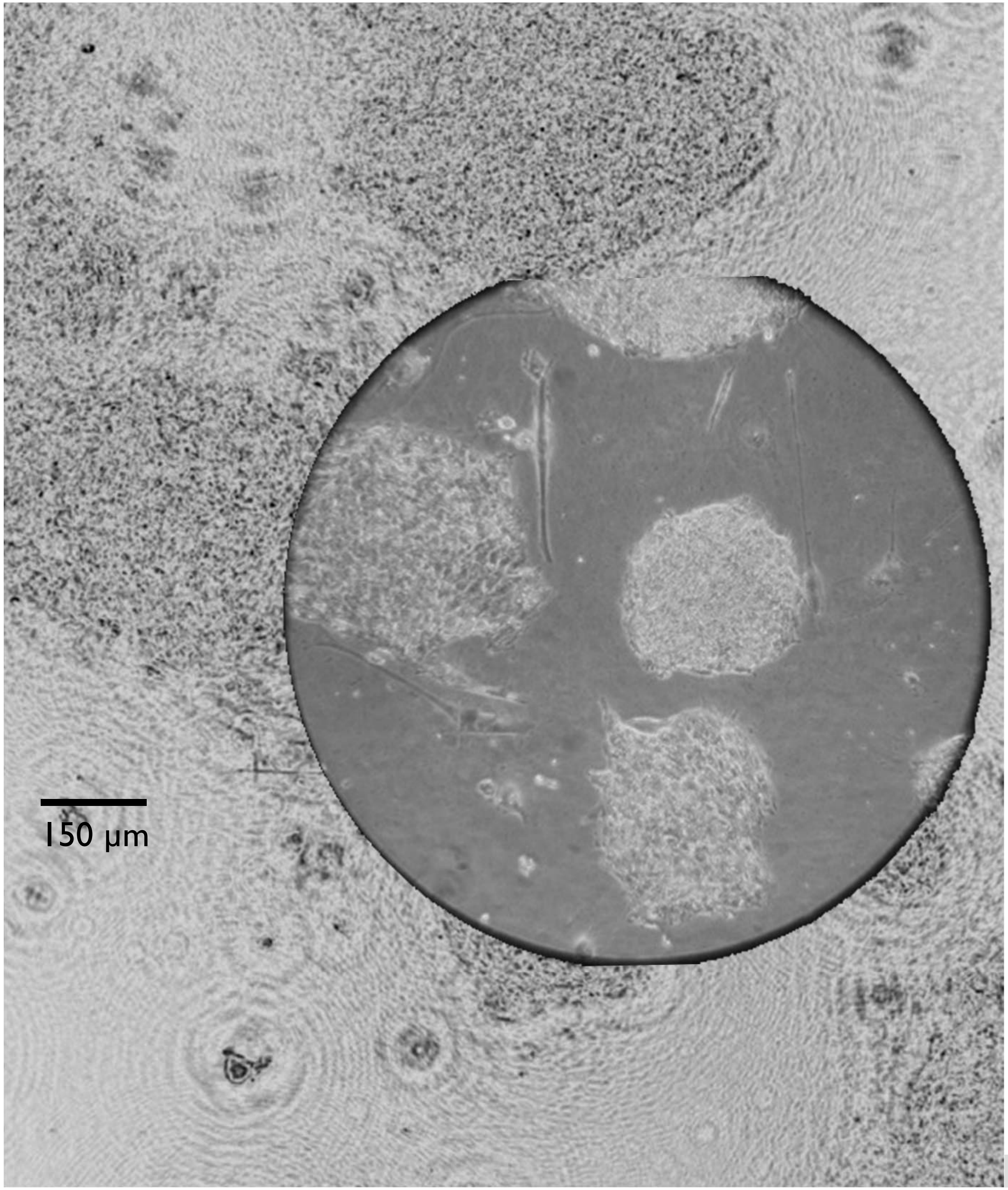
On-chip high-resolution imaging for cell classification





Fast microfluidic bubble-jet cell routing





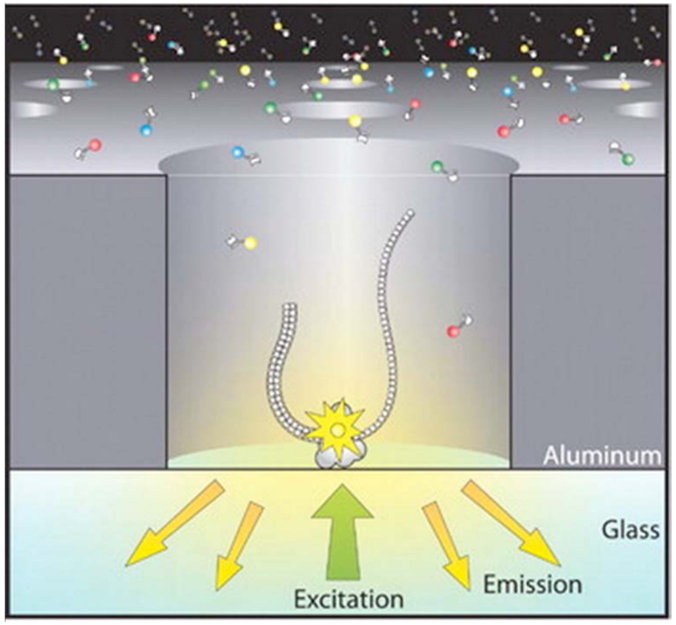
LENSLESS

Microscopic imaging over a large area *(<u>on-chip lens-free microscopes</u>)*

Biomedical applications:

- <u>Cell sorting & monitoring</u> (flow cytometry)
- <u>Molecular diagnostics</u> (biomarkers <u>assays)</u>
- DNA sequencing

Pacific Biosciences single molecule sequencing instrument

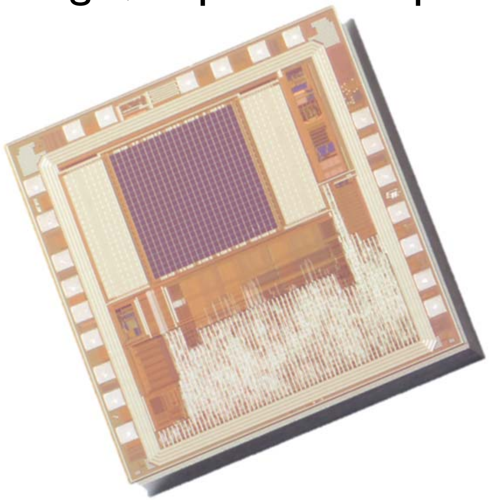


PACIFIC BIOSCIENCES™

Awesome chips

many $500k machines

single, disposable chip



increase in throughput of

560x

PACIFIC BIOSCIENCES™

imec

Home » News » In Sequence

PacBio Aims to Boost Throughput of SMRT Technology with Microchip Co-development Deal

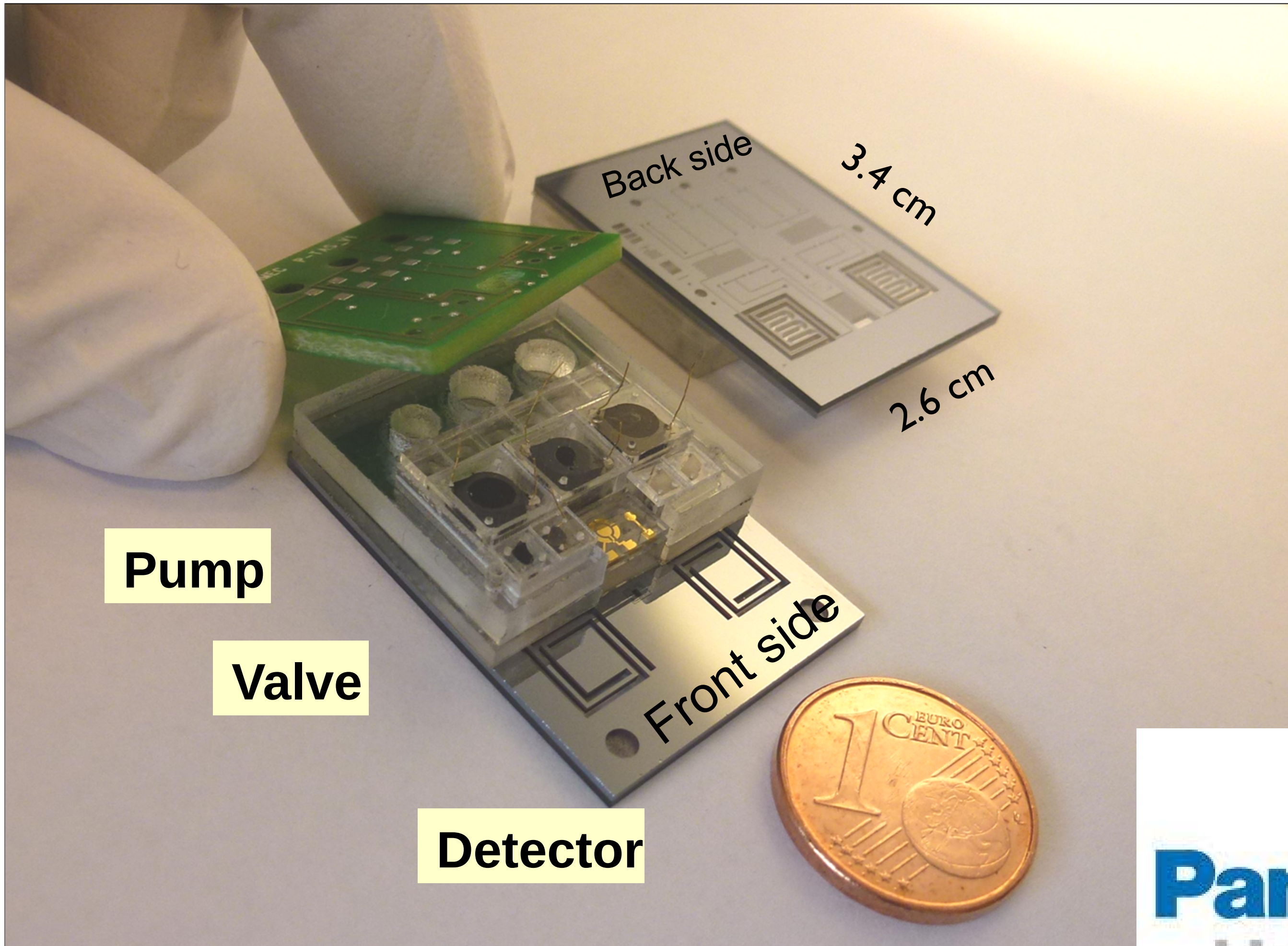
July 24, 2012

By Julia Karow

Pacific Biosciences and Imec, a Belgian non-profit nanoelectronics research firm, have partnered to develop advanced microchips for highly multiplexed single-molecule genetic analysis, the firms said this week.

imec inside

Sample prep & µPCR on a CHIP

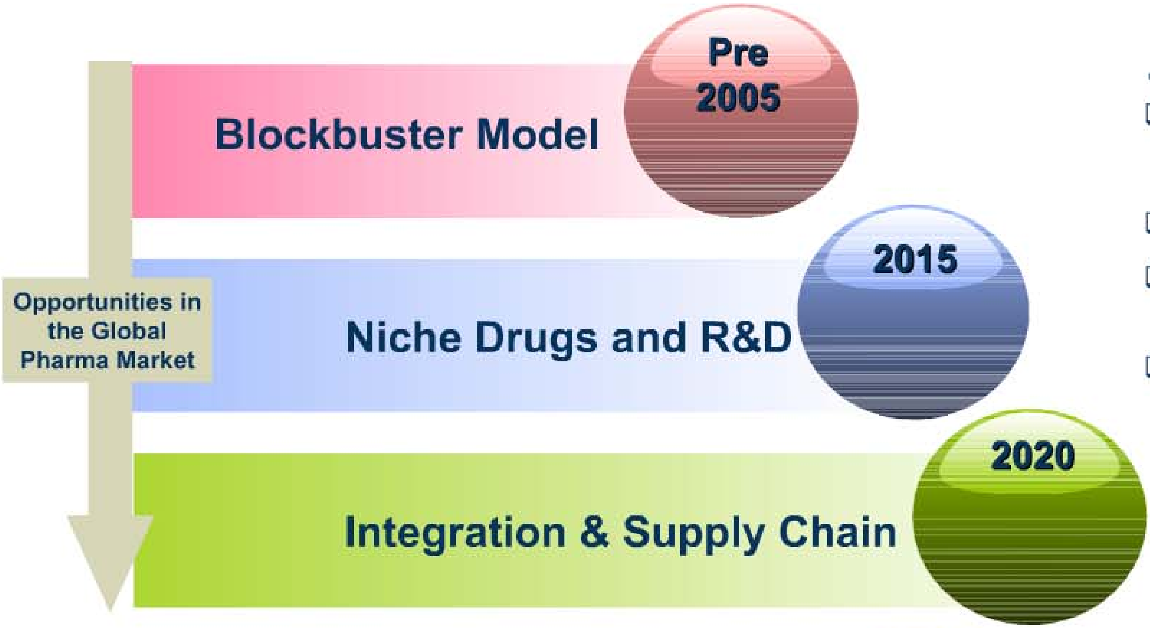


Panasonic
ideas for life

Diagnose most common diseases and monitor health using the world's most ubiquitous platform

2. Nanotech for Health: an emerging and promising market

Changes in the Global Environment require Pharma and Biotech companies to adapt to changing business models



2015

- ❑ Preventative Healthcare & Wellness
  - ✓ Astounding growth in the vaccines industry
- ❑ Marketing of Value Added Services
- ❑ Genomics and proteomics expected to reduce R&D times
- ❑ 'In life testing' will take over the current clinical trial process. Continuous data monitoring can be done by the regulators during the testing process. Clinical trials will eventually become shorter

2020

- ❑ Integrated packages of products and services
- ❑ Patient monitoring & compliance
- ❑ Pharma and medical devices providing sophisticated and efficacious solutions
- ❑ Integration of pharmaceuticals, diagnostics, medical devices, patient monitoring and healthcare IT
  - ✓ Will result in a high profile, risk free, user friendly, low cost and safe healthcare solution
- ❑ Supply chain functions will evolve to a revenue generating model. Products and services will be marketed through the supply chain
- ❑ Just –in time manufacturing, novel delivery methods and direct to consumer distribution will be adapted from other industries like the automotive industry
- ❑ Automated dispensing of drugs
- ❑ Smart cards / internet to store patients details

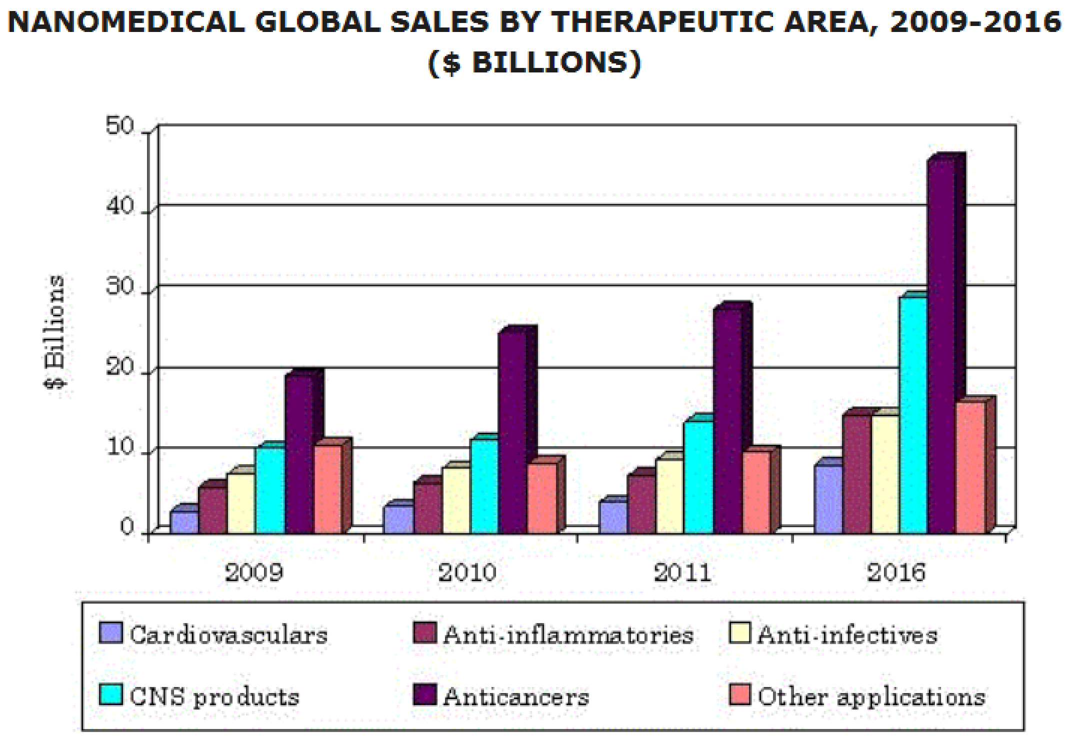
NfH global market in time perspective

Market Size (M€)	2015	2020	2025
In-vivo imaging	11	180	1900
In-vitro diagnostics	200	1700	4500
Nano-pharmaceuticals (*)	15	17000	34000
Nano-particle therapy	0	1000	3000
Cell differentiation drugs (*)	0	2000	6000
Nano devices	450	6000	12000
Smart biomaterials	50000	68000	80000

(*) Assuming 10 year development cycle

Source: EU / Nanomedicine ETP

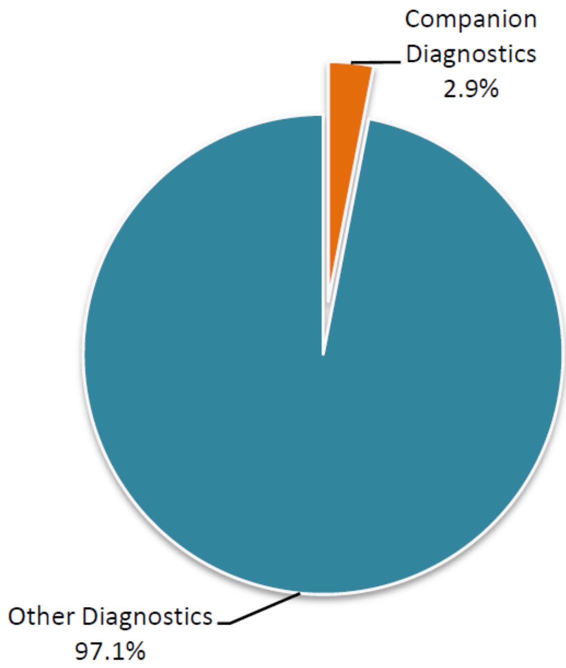
NfH market trends



Source: BCC Research

- The global nanomedicine market reached \$63.8 billion in 2010 and \$72.8 billion in 2011. The market is expected to grow to \$130.9 billion by 2016 at a compound annual growth rate (CAGR) of 12.5% between years 2011 and 2016.
- The central nervous system (CNS) products market reached \$11.7 billion in 2010 and \$14.0 billion in 2011. It is expected to grow to \$29.5 billion by 2016, a CAGR of 16.1% between years 2011 and 2016.
- The anticancer products market reached \$25.2 billion in 2010 and \$28.0 billion in 2011. It is expected to reach \$46.7 billion by 2016, a CAGR of 10.8% between years 2011 and 2016.

Companion diagnostics market



Companion diagnostics market:
1.3 B$ in 2011
3.5 B$ in 2015 (**22%CAGR**)

Source: Visiongain

NfH in the Flanders' landscape

Building on our strengths!

- Top-university R&D groups in NfH
- Top position in clinical infrastructure and clinical trials
- Top-position in biotech (VIB)
- Top-position in nano-electronics and nanotechnology (imec)
- ExaScienceLab geared towards Life Sciences
- NERF (VIB, imec, KULeuven, UA)
- Strong bio-pharma activity
- Strong and fast growing biotech community with leading players
- Emerging starters community in NfH (Biocartis, Trinean, Peira, Pepric, ...)

→ *opportunities to build further strategic alliances*.

ExaScience Lab

F L A N D E R S   E X A S C A L E   L A B

WAS LAUNCHED IN 2010 TO INVESTIGATE NEXT GENERATION

HIGH PERFORMANCE COMPUTING

IS A COLLABORATION BETWEEN:

INTEL, FLANDERS, IMEC, KU LEUVEN, U GENT,

VU BRUSSEL, U ANTWERPEN, U HASSELT

THE HIGH PERFORMANCE <u>LIFE SCIENCES</u> COMPUTING CENTER

IS A FOLLOW-UP OF THIS COLLABORATION

Integration of technologies, of technology cycles & roadmaps, of value chains

Strong differentiating opportunities in the area of health care (clinical, biomedical, biotech, ICT driven and nanotech driven, incl. NERF)

Large (Bio-)Pharma
(often nanotech adopters)

(established community)

Strongly growing
Biotech community
(often nanotech providers)

Strong R&D & clinical capabilities (top ranking internationally)

Unique R&D and clinical infrastructure

Integration of technologies, of technology cycles & roadmaps, of value chains

Strong differentiating opportunities in the area of health care (clinical, biomedical, biotech, ICT driven and nanotech driven, incl. NERF)

Large (Bio-)Pharma
(often nanotech adopters)

(established community)

Strongly growing Biotech community
(often nanotech providers)

Emerging NfH space
(nanotech providers & integrators)

Different nodes of ***2 value chains*** to be interconnected both *locally* and *internationally*

1. Bio-Pharma
2. Bio-tech
3. Bio-materials
4. Bio-instrumentation
5. Medical Devices
6. Medical systems & imaging
7. BAN & remote monitoring
8. Semiconductors for biomed applications
9. Design & embedded systems for biomed applications

Strong R&D & clinical capabilities (top ranking internationally)

Unique R&D and clinical infrastructure

Strong industrial opportunities & growth potential

See **Biocartis** as one example:

- Raised ***150 M€*** in start-up funding;

- Very ***strong international exposure***: was also nominated as most innovative company in the world in its segment by the International Economic Forum in Davos, 2012;

- Is launching a ***truly game changing product*** in molecular diagnostics;

- It has the DNA of a ***new era of NfH driven companies*** marrying the strength of both biomed and nanotech in-depth insight and expertise;

- Testifies that, amongst other reasons, the ***presence of VIB and imec were important*** elements in the decision to set-up manufacturing in Flanders.

Strong window for ***new class of bio-instrumentation/molecular diagnostics companies*** !

3. A fit with the Flanders innovation policy

Strong fit in both the Flanders & European policies
Strong contribution to major societal challenge

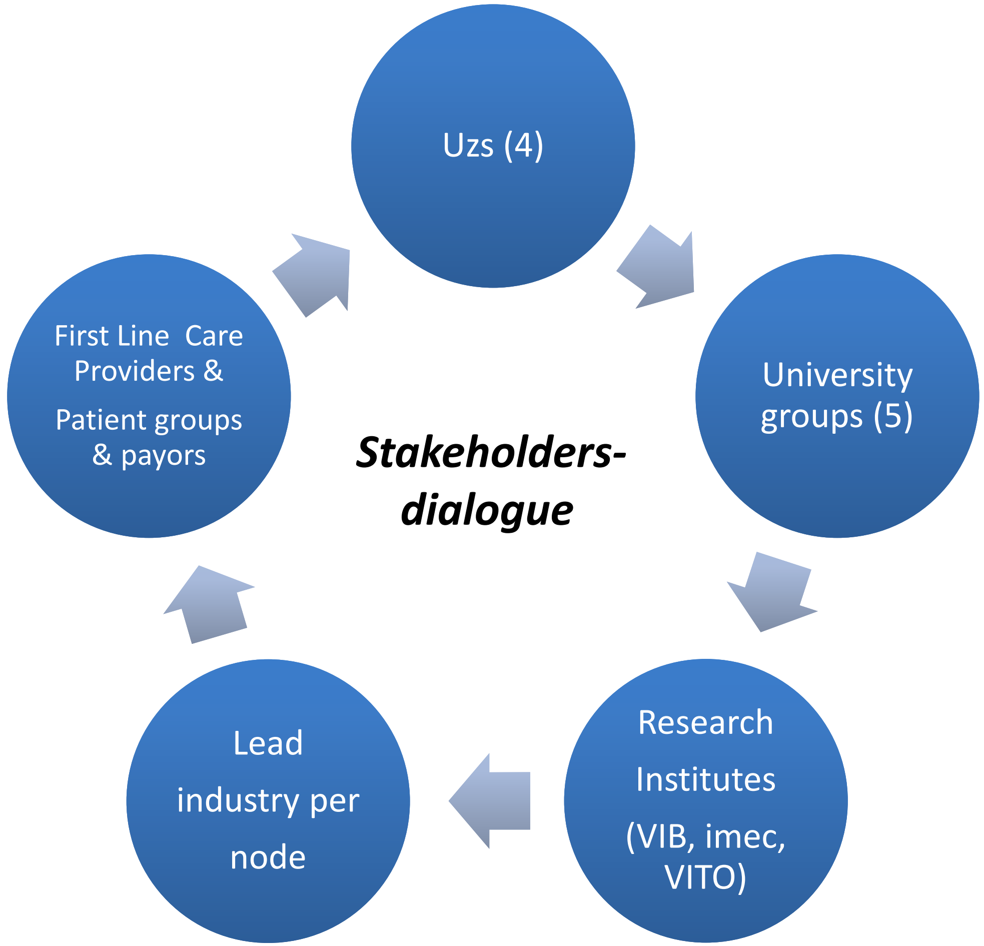
1. VRWI clusters
2. ViA
3. Pact 2020
4. iCentrum Vlaanderen
5. KETs

→ Basis for a ***"smart specialization"*** rooted in a strong and internationally recognized double pilar (industry: Pharma & biotech & academia/SOCs: VIB, imec, .../clinical infrastructure)

→ Can be 2nd pillar next to ICT in healthcare in Flanders Care.

4. The approach

Stakeholders dialogue



Stakeholders dialogue

1. 4 University hospitals
2. Two largest payors (impact only)
3. Domus Medica (impact only)
4. 5 universities
5. 3 SOCs (VIB, imec, VITO)
6. 30 companies spread over the different nodes (9) of the value chain

+

1. Initiated by imec & ECOOM
2. Strong collaboration with DSP-Valley & FlandersBio (interactions with industrial stakeholders)

+

Intense communication with Pharma.be & Essenscia

Part II : Dialogue with a strong sample of all stakeholders & preliminary outcome

1. Main questions
2. Data collection
3. Impact
4. Future specializations
5. Medapps: specializations versus impact
6. Nano/biotech: specializations versus impact
7. How to proceed from here?

ECOOM
Centre for R&D Monitoring
imec

1. Main questions

- Are the Flemish industrial and non-industrial actors aligned in their view on Nanotech for Health?
    - Impact assessment
    - Current and future specializations

- Are the Flemish actors specializing in domains that have a significant impact?
    - Medical Applications
    - Nano/biotechnologies

2. Data collection

Impact measurement

- Maps the ***<u>expected potential Impact</u>*** (*substantial improvements on performance, efficiency and substantial cost reduction*) of ***medical applications*** on different ***pathologies***, *seen by the* ***care provider and associated community*** (University Hospitals, Domus Medica, payors, Pharma).

- Maps the ***<u>expected potential Impact</u>*** (*same criteria*) of ***nano/biotechnologies*** on different ***medical applications*** , *seen by the* ***academic nano/biotech community*** (universities, VIB, imec)

- Maps the ***<u>expected potential Impact</u>*** (*same criteria*) of ***nano/biotechnologies*** on different ***medical applications***, *seen by the* ***industrial nano/biotech community*** (industrial lead players)

Specialization measurement

- Maps the ***specialization*** at the ***intersection*** of different ***medical applications*** and different ***pathologies***, seen by the ***care provider and associated community*** (University Hospitals, Pharma) at T0 and T+5

- Maps the ***specialization*** at the i***ntersection*** of different ***nano/biotechnologies*** and different ***medical applications***, seen by the ***academic nano/biotech community*** (universities, VIB, imec) at T0 and T+5

- Maps the ***specialization*** at the intersection of different ***nano/biotechnologies*** and different ***medical applications***, ***seen by the industrial nano/biotech community*** (industrial lead players) at T0 and T+5

3. Selected results: Impact

Which Medical Applications benefit most from Nano/biotech?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
1	DNA/RNA sequencing	Biochips (in vitro)	Biochips (in vitro)	(Electrically) Active implants
2	Biochips (in vitro)	Microfluidic devices	DNA/RNA sequencing	Stimulators
3	Basic Research into Molecular Mechanisms of Life	(Electrically) Active implants	Microfluidic devices	Electrical Activity Monitoring
4	Mass spectroscopy	Implantable monitors / Probes	Cell sorting / flow cytometry	Body area network devices
5	Advanced microscopy	Advanced microscopy	Vaccines	Implantable monitors / Probes (e.g. brain)
6	Systems Approaches	Stimulators	Advanced microscopy	DNA/RNA sequencing
7	Implantable monitors / Probes	DNA/RNA sequencing	Immunological assays (Elisa,...)	Microfluidic devices
8	Cellular Models	Molecular in vivo imaging	Transdermal / Intradermal / Intracutenous	Ultra sound
9	In Vivo Animal Models	Biochips (in vivo)	Pumps and implanted drug delivery systems	Pumps and implanted drug delivery systems
10	Body area network devices	Bioactive implants	Biochips (in vivo)	Artificial organs
11	Bioreactors	Cell sorting / flow cytometry	Bioreactors	Biochips (in vitro)
12	Stimulators	(Electrically & biologically) Passive implants	(Stem) Cell therapy	Surgical support
13	Cell sorting / flow cytometry	Immunological assays (Elisa,...)	Tissue engineering	Biochips (in vivo)
14	Ultra sound	Tissue engineering	Gene Therapy	Immunological assays (Elisa,...)
15	Endoscopic techniques	Engineered extracellular matrices (e.g. scaffolds)	Mass spectroscopy	Cell sorting / flow cytometry
16	(Electrically) Active implants	Body area network devices	Molecular in vivo imaging	Transnasal / Inhalation
17	Biochips (in vivo)	Pumps and implanted drug delivery systems	Transnasal / Inhalation	Smart chemotherapy
18	(Stem) Cell therapy	Optical & laser systems	Intravenous/ Intramuscular / Instraspinal	Endoscopic techniques
19	Electrical Activity Monitoring (EEG, EMG,....)	PET	Tissue cultures	Transdermal / Intradermal / Intracutenous
20	Tissue cultures	Electrical Activity Monitoring	Oral drug delivery systems	Hyperspectral imagers

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3	Basic Research into Molecular Mechanisms of Life	(Electrically) Active implants	Microfluidic devices	Electrical Activity Monitoring
4	Mass spectroscopy	Implantable monitors / Probes	Cell sorting / flow cytometry	Body area network devices
5	Advanced microscopy	Advanced microscopy	Vaccines	Implantable monitors / Probes (e.g. brain)
6	Systems Approaches	Stimulators	Advanced microscopy	DNA/RNA sequencing
7	Implantable monitors / Probes	DNA/RNA sequencing	Immunological assays (Elisa,...)	Microfluidic devices
8	Cellular Models	Molecular in vivo imaging	Transdermal / Intradermal / Intracutenous	Ultra sound
9	In Vivo Animal Models	Biochips (in vivo)	Pumps and implanted drug delivery systems	Pumps and implanted drug delivery systems
10	Body area network devices	Bioactive implants	Biochips (in vivo)	Artificial organs
11	Bioreactors	Cell sorting / flow cytometry	Bioreactors	Biochips (in vitro)
12	Stimulators	(Electrically & biologically) Passive implants	(Stem) Cell therapy	Surgical support
13	Cell sorting / flow cytometry	Immunological assays (Elisa,...)	Tissue engineering	Biochips (in vivo)
14	Ultra sound	Tissue engineering	Gene Therapy	Immunological assays (Elisa,...)
15	Endoscopic techniques	Engineered extracellular matrices (e.g. scaffolds)	Mass spectroscopy	Cell sorting / flow cytometry
16	(Electrically) Active implants	Body area network devices	Molecular in vivo imaging	Transnasal / Inhalation
17	Biochips (in vivo)	Pumps and implanted drug delivery systems	Transnasal / Inhalation	Smart chemotherapy
18	(Stem) Cell therapy	Optical & laser systems	Intravenous/ Intramuscular / Instraspinal	Endoscopic techniques
19	Electrical Activity Monitoring	PET	Tissue cultures	Transdermal / Intradermal / Intracutenous
20	Tissue cultures	Electrical Activity Monitoring	Oral drug delivery systems	Hyperspectral imagers

So:

- Wide agreement between Industry and Non-Industry on which Medical Applications are most impacted by Nano/biotech developments.

- With some notable exceptions that deserve further examination

Which Nano/biotechs have most impact on Medical Applications?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
1	Computational biology	Nanobodies/intrabodies	Cell culture techniques	Nanoscale sensor elements, nanowires
2	Systems Biology	Nanoscale sensor elements, nanowires	Small molecules	ULP wireless communication
3	3D integrated nanosystems	Quantum dots (e.g. imaging)	Proteomics	BAN system design
4	Micro- and nanofluidics	Nanoparticles: inorganic	Genomics and epi-genomics	Electronic nanodevices
5	bio-sensors (non-photonic)	Flexible and stretchable electronics	Electronic nanodevices	Nanosystems design
6	Nanobiophotonics	Drug delivery nanocoatings	High throughput data handling	Nanoscale optical imagers (e.g. hyperspectral)
7	Proteomics	Nanoparticles: organic	Nanoscale sensor elements, nanowires	NEMS
8	nanostructured cell adhesion surfaces	nanostructured cell adhesion surfaces	Micro- and nanofluidics	bio-sensors (non-photonic)
9	Transcriptomics	Nanobiophotonics	Monoclonal antibodies	nanoscale accoustic imagers (e.g. CMUT) and sensor arryas
10	Cell culture techniques	Cell culture techniques	bio-sensors (non-photonic)	Cell-chip interface
11	Electronic nanodevices	Magnetic nanoparticles	Nanobodies/intrabodies	3D integrated nanosystems
12	Nanosystems design	Bioactive nanocoatings	Bio-pharma (Non-MAB)	High throughput data handling
13	Genomics and epi-genomics	bio-sensors (non-photonic)	Genetics	Drug delivery nanocoatings
14	Nanobodies/intrabodies	Scaffolding technologies	Metabolomics	Flexible and stretchable electronics
15	Nanoscale optical imagers	Nucleotide based probes	Drug delivery nanocoatings (e.g. controlled release)	Genetics
16	Interactomics	Electronic nanodevices	Transcriptomics	algoritms for nanosystems
17	algoritms for nanosystems	Micro- and nanofluidics	Computational biology	Monoclonal antibodies
18	Cell-chip interface	Cell-chip interface	Nanoarrays	Bio-pharma (Non-MAB)
19	Electrophysiology	3D integrated nanosystems	algoritms for nanosystems	Nanobiophotonics
20	Nanoarrays	Small molecules	nanopowders (e.g. drug formulation)	Genomics and epi-genomics

Which Nano/biotechs have most impact on Medical Applications?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
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2	Systems Biology	Nanoscale sensor elements, nanowires	Small molecules	ULP wireless communication
3	3D integrated nanosystems	Quantum dots (e.g. imaging)	Proteomics	BAN system design
4	Micro- and nanofluidics	Nanoparticles: inorganic	Genomics and epi-genomics	Electronic nanodevices
5	bio-sensors (non-photonic)	Flexible and stretchable electronics	Electronic nanodevices	Nanosystems design
6	Nanobiophotonics	Drug delivery nanocoatings	High throughput data handling	Nanoscale optical imagers
7	Proteomics	Nanoparticles: organic	Nanoscale sensor elements, nanowires	NEMS
8	nanostructured cell adhesion surfaces	nanostructured cell adhesion surfaces	Micro- and nanofluidics	bio-sensors (non-photonic)
9	Transcriptomics	Nanobiophotonics	Monoclonal antibodies	nanoscale accoustic imagers (e.g. CMUT) and sensor arrays
10	Cell culture techniques	Cell culture techniques	bio-sensors (non-photonic)	Cell-chip interface
11	Electronic nanodevices	Magnetic nanoparticles	Nanobodies/intrabodies	3D integrated nanosystems
12	Nanosystems design	Bioactive nanocoatings	Bio-pharma (Non-MAB)	High throughput data handling
13	Genomics and epi-genomics	bio-sensors (non-photonic)	Genetics	Drug delivery nanocoatings
14	Nanobodies/intrabodies	Scaffolding technologies	Metabolomics	Flexible and stretchable electronics
15	Nanoscale optical imagers	Nucleotide based probes	Drug delivery nanocoatings	Genetics
16	Interactomics	Electronic nanodevices	Transcriptomics	algoritms for nanosystems
17	algoritms for nanosystems	Micro- and nanofluidics	Computational biology	Monoclonal antibodies
18	Cell-chip interface	Cell-chip interface	Nanoarrays	Bio-pharma (Non-MAB)
19	Electrophysiology	3D integrated nanosystems	algoritms for nanosystems	Nanobiophotonics
20	Nanoarrays	Small molecules	nanopowders (e.g. drug formulation)	Genomics and epi-genomics

So:

- Wide agreement between Industry and Non-Industry on which Nano/biotech developments have most impact on Medical Applications.

- With some notable exceptions that deserve further examination

Do the Medical Applications that benefit from Nanotech have an important impact on Pathologies?

	Medapp with highest impact on Pathologies	Medapp benefitting most from Nano/biotech
1	DNA/RNA sequencing	Biochips in vitro
2	Molecular in vivo imaging	DNA/RNA sequencing
3	(Stem) Cell therapy	Microfluidic devices
4	Oral drug delivery systems	Advanced microscopy
5	PET	Cell sorting / flow cytometry
6	Gene Therapy	Implantable monitors / Probes
7	MRI	(Electrically) Active implants
8	CT (incl. SPECT)	Biochips (in vivo)
9	Vaccines	Immunological assays (Elisa,...)
10	Endoscopic techniques	Stimulators
11	Biochips(in vitro)	Pumps and implanted drug delivery
12	Smart chemotherapy	Molecular in vivo imaging
13	Immunological assays (Elisa,...)	Tissue engineering
14	Surgical supplies and devices	Body area network devices
15	Ultra sound	Transdermal / Intradermal / Intracutenous
16	Clinical Trials	Mass spectroscopy
17	Biochips (in vivo)	Optical & laser systems
18	Parenteral drug delivery systems	Electrical Activity Monitoring (EEG, EMG,....)
19	Transdermal / Intradermal / Intracutenous	Vaccines
20	Pumps and implanted drug delivery	Gene Therapy

Do the Medical Applications that benefit from Nano/biotech have an important impact on Pathologies?

	Medapp with highest impact on Pathologies	Medapp benefitting most from Nano/biotech
1	DNA/RNA sequencing	Biochips in vitro
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3	(Stem) Cell therapy	Microfluidic devices
4	Oral drug delivery systems	Advanced microscopy
5	PET	Cell sorting / flow cytometry
6	Gene Therapy	Implantable monitors / Probes
7	MRI	(Electrically) Active implants
8	CT (incl. SPECT)	Biochips (in vivo)
9	Vaccines	Immunological assays (Elisa,...)
10	Endoscopic techniques	Stimulators
11	Biochips(in vitro)	Pumps and implanted drug delivery
12	Smart chemotherapy	Molecular in vivo imaging
13	Immunological assays (Elisa,...)	Tissue engineering
14	Surgical supplies and devices	Body area network devices
15	Ultra sound	Transdermal / Intradermal / Intracutenous
16	Clinical Trials	Mass spectroscopy
17	Biochips (in vivo)	Optical & laser systems
18	Parenteral drug delivery systems	Electrical Activity Monitoring (EEG, EMG,....)
19	Transdermal / Intradermal / Intracutenous	Vaccines
20	Pumps and implanted drug delivery	Gene Therapy

So:

- Many of the Medical Applications benefitting from Nano/biotech are of crucial importance for improving the treatment of various pathologies.

4. Selected results: Future specializations

For which Medical Applications will Flanders develop its Nano/biotech activities?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
1	Microfluidic devices	(Electrically) Active implants	Intravenous/ Intramuscular / Instraspinal	(Electrically) Active implants
2	Implantable monitors / Probes (e.g. brain)	Microfluidic devices	Parenteral drug delivery systems	Stimulators (neuromodulators, defibrilators, electroconvulsion)
3	Biochips (in vitro)	Advanced microscopy	Oral drug delivery systems	Artificial organs
4	Electrical Activity Monitoring	Engineered extracellular matrices (e.g. scaffolds)	Bioreactors	Electrical Activity Monitoring
5	Body area network devices	Implantable monitors / Probes	Immunological assays (Elisa,...)	Implantable monitors / Probes
6	(Electrically) Active implants	Bioactive implants	DNA/RNA sequencing	Ultra sound
7	Advanced microscopy	Biochips (in vitro)	Cell sorting / flow cytometry	Body area network devices
8	Engineered extracellular matrices (e.g. scaffolds)	Body area network devices	Advanced microscopy	Microfluidic devices
9	Bioactive implants	Electrical Activity Monitoring	Pumps and implanted drug delivery systems	Hyperspectral imagers
10	Molecular in vivo imaging	Molecular in vivo imaging	Tissue engineering	Endoscopic techniques
11	Tissue engineering	(Electrically & biologically) Passive implants	(Stem) Cell therapy	CT (incl. SPECT)
12	(Electrically & biologically) Passive implants	Tissue engineering	Vaccines	DNA/RNA sequencing
13	DNA/RNA sequencing	Gene Therapy	Microfluidic devices	Optical & laser systems
14	Immunological assays (Elisa,...)	Stimulators	Biochips (in vitro)	Pumps and implanted drug delivery systems
15	Basic Research into Molecular Mechanisms of Life	Transdermal / Intradermal / Intracutenous	Molecular in vivo imaging	Advanced microscopy
16	Cell sorting / flow cytometry	Optical & laser systems	(Electrically & biologically) Passive implants	MRI
17	Gene Therapy	Cell sorting / flow cytometry	Electrical Activity Monitoring	PET
18	Stimulators	Bioreactors	(Electrically) Active implants	Molecular in vivo imaging
19	Transdermal / Intradermal / Intracutenous	Immunological assays (Elisa,...)	MRI	Surgical support
20	Optical & laser systems	Oral drug delivery systems	PET	Bioactive implants

For which Medical Applications will Flanders develop its Nano/biotech activities?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
1	Microfluidic devices	(Electrically) Active implants	Intravenous/ Intramuscular / Instraspinal	(Electrically) Active implants
2	Implantable monitors / Probes	Microfluidic devices	Parenteral drug delivery systems	Stimulators
3	Biochips (in vitro)	Advanced microscopy	Oral drug delivery systems	Artificial organs
4	Electrical Activity Monitoring	Engineered extracellular matrices (e.g. scaffolds)	Bioreactors	Electrical Activity Monitoring
5	Body area network devices	Implantable monitors / Probes	Immunological assays (Elisa,...)	Implantable monitors / Probes
6	(Electrically) Active implants	Bioactive implants	DNA/RNA sequencing	Ultra sound
7	Advanced microscopy	Biochips (in vitro)	Cell sorting / flow cytometry	Body area network devices
8	Engineered extracellular matrices (e.g. scaffolds)	Body area network devices	Advanced microscopy	Microfluidic devices
9	Bioactive implants	Electrical Activity Monitoring	Pumps and implanted drug delivery systems	Hyperspectral imagers
10	Molecular in vivo imaging	Molecular in vivo imaging	Tissue engineering	Endoscopic techniques
11	Tissue engineering	(Electrically & biologically) Passive implants	(Stem) Cell therapy	CT (incl. SPECT)
12	(Electrically & biologically) Passive implants	Tissue engineering	Vaccines	DNA/RNA sequencing
13	DNA/RNA sequencing	Gene Therapy	Microfluidic devices	Optical & laser systems
14	Immunological assays (Elisa,...)	Stimulators	Biochips (in vitro)	Pumps and implanted drug delivery systems
15	Basic Research into Molecular Mechanisms of Life	Transdermal / Intradermal / Intracutenous	Molecular in vivo imaging	Advanced microscopy
16	Cell sorting / flow cytometry	Optical & laser systems	(Electrically & biologically) Passive implants	MRI
17	Gene Therapy	Cell sorting / flow cytometry	Electrical Activity Monitoring	PET
18	Stimulators	Bioreactors	(Electrically) Active implants	Molecular in vivo imaging
19	Transdermal / Intradermal / Intracutenous	Immunological assays (Elisa,...)	MRI	Surgical support
20	Optical & laser systems	Oral drug delivery systems	PET	Bioactive implants

So:

- Clear overlap of interests between industry and non-industry in some Medical Applications:
    - (Electrically) Active Implants: priority of DSP Valley, research centers and universities
    - Immunological assays: priority of FlandersBio; good position of research centers and universities
    - Microfluidic devices: priority of research centers and universities; good position of DSP Valley and FlandersBio
    - …

- But for some other Medical Applications, international collaboration will be necessary
    - Intravenous/ Intramuscular / Instraspinal; Artificial organs; Parenteral drug delivery systems: no non-industry priority
    - Engineered extracellular matrices: no industry priority

Which Nano/biotechs will Flanders develop for Medical Applications?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
1	Electronic nanodevices	Electronic nanodevices	Genomics and epi-genomics	ULP wireless communication
2	Cell-chip interface	bio-sensors (non-photonic)	Proteomics	High throughput data handling
3	bio-sensors (non-photonic)	Cell-chip interface	Genetics	Nanosystems design
4	3D integrated nanosystems	3D integrated nanosystems	Metabolomics	Nanoscale optical imagers
5	Cell culture techniques	Nanoscale sensor elements, nanowires	Electrophysiology	BAN system design
6	Nanosystems design	Cell culture techniques	High throughput data handling	Genetics
7	Nanoscale sensor elements, nanowires	Nanobiophotonics	Cell culture techniques	Electronic nanodevices
8	Nanobiophotonics	Nanoscale modelling	Nanobodies/intrabodies	algoritms for nanosystems
9	Nanobodies/intrabodies	Nanosystems design	Micro- and nanofluidics	Flexible and stretchable electronics
10	Nanoscale modelling	Surface characterization techniques	Computational biology	3D integrated nanosystems
11	Surface characterization techniques	Micro- and nanofluidics	Nanoparticles: inorganic	nanostructured cell adhesion surfaces
12	Monoclonal antibodies	Scaffolding technologies	bio-sensors (non-photonic)	Drug delivery nanocoatings
13	Flexible and stretchable electronics	NEMS	High throughput nanoscreening	Bioactive nanocoatings
14	Computational biology	Interface characterization techniques	Nanoparticles: organic	nanoporous drug delivery structures
15	Micro- and nanofluidics	Flexible and stretchable electronics	nanopowders	Nanoscale sensor elements, nanowires
16	Electrophysiology	Nanobodies/intrabodies	Quantum dots	NEMS
17	NEMS	Bioactive nanocoatings	Bio-pharma (Non-MAB)	bio-sensors (non-photonic)
18	Scaffolding technologies	Monoclonal antibodies	Monoclonal antibodies	Micro- and nanofluidics
19	Genomics and epi-genomics	Small molecules	Nanoarrays	Cell-chip interface
20	Interface characterization techniques	nanostructured cell adhesion surfaces	NEMS	Nanoparticles: inorganic

Which Nano/biotechs will Flanders develop for Medical Applications?

	VIB, VITO, IMEC	Universities	FlandersBio	DSP Valley
1	Electronic nanodevices	Electronic nanodevices	Genomics and epi-genomics	ULP wireless communication
2	Cell-chip interface	bio-sensors (non-photonic)	Proteomics	High throughput data handling
3	bio-sensors (non-photonic)	Cell-chip interface	Genetics	Nanosystems design
4	3D integrated nanosystems	3D integrated nanosystems	Metabolomics	Nanoscale optical imagers
5	Cell culture techniques	Nanoscale sensor elements, nanowires	Electrophysiology	BAN system design
6	Nanosystems design	Cell culture techniques	High throughput data handling	Genetics
7	Nanoscale sensor elements, nanowires	Nanobiophotonics	Cell culture techniques	Electronic nanodevices
8	Nanobiophotonics	Nanoscale modelling	Nanobodies/intrabodies	Algoritms for nanosystems
9	Nanobodies/intrabodies	Nanosystems design	Micro- and nanofluidics	Flexible and stretchable electronics
10	Nanoscale modelling	Surface characterization techniques	Computational biology	3D integrated nanosystems
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12	Monoclonal antibodies	Scaffolding technologies	bio-sensors (non-photonic)	Drug delivery nanocoatings
13	Flexible and stretchable electronics	NEMS	High throughput nanoscreening	Bioactive nanocoatings
14	Computational biology	Interface characterization techniques	Nanoparticles: organic	nanoporous drug delivery structures
15	Micro- and nanofluidics	Flexible and stretchable electronics	nanopowders	Nanoscale sensor elements, nanowires
16	Electrophysiology	Nanobodies/intrabodies	Quantum dots	NEMS
17	NEMS	Bioactive nanocoatings	Bio-pharma (Non-MAB)	bio-sensors (non-photonic)
18	Scaffolding technologies	Monoclonal antibodies	Monoclonal antibodies	Micro- and nanofluidics
19	Genomics and epi-genomics	Small molecules	Nanoarrays	Cell-chip interface
20	Interface characterization techniques	nanostructured cell adhesion surfaces	NEMS	Nanoparticles: inorganic

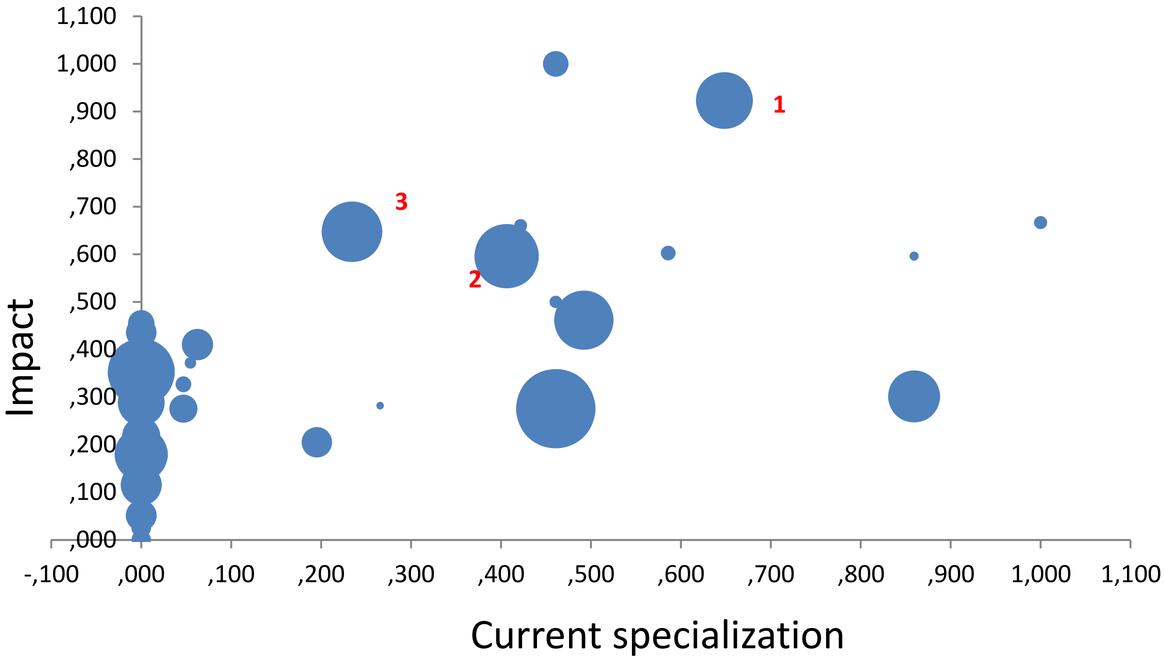
So:

- Overlap of interests between industry and non-industry in some Nano/biotechnologies:
    - Nanosystems design: priority of DSP Valley; good position of research centers and universities
    - Cell culture techniques: priority of FlandersBio, research centers and universities
    - …

- But for some other Nano/biotechnologies, international collaboration will be necessary
    - Genetics; High throughput data handling; Proteomics; Metabolomics; Electrophysiology; ULP wireless communication; Nanoscale optical imagers; BAN system design: no non-industry priority
    - Cell-chip interface: no industry priority

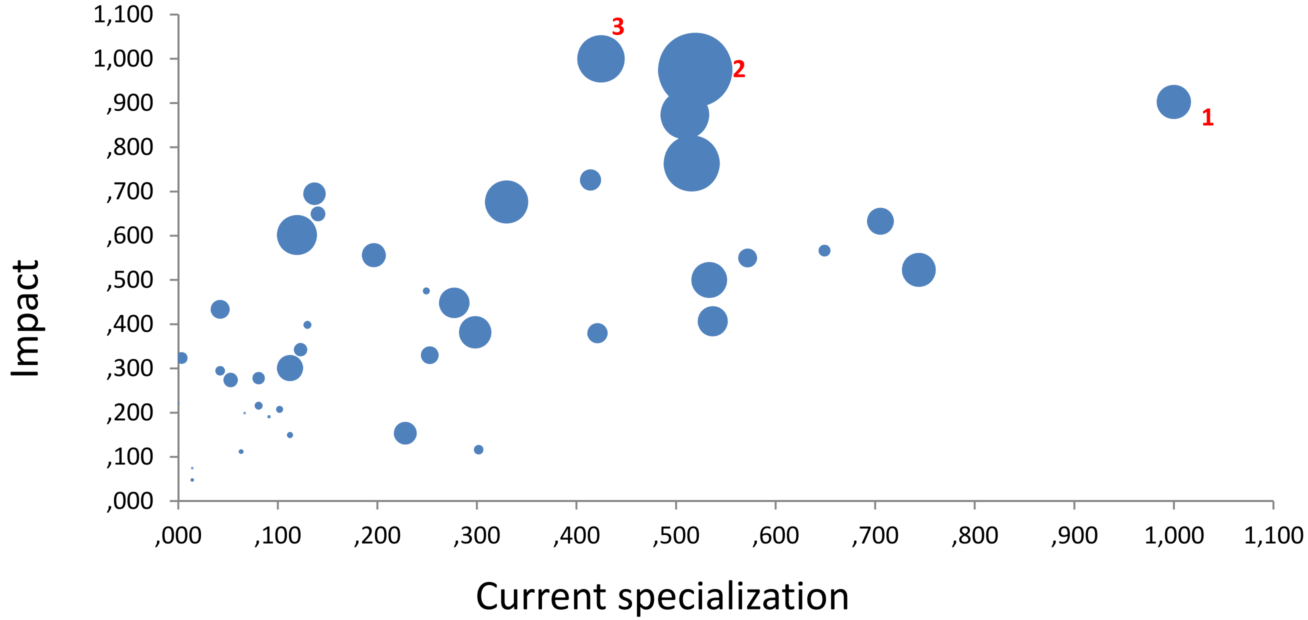
5. Selected results for Medapps: Specializations vs. Impact

Research Centers: Medapps



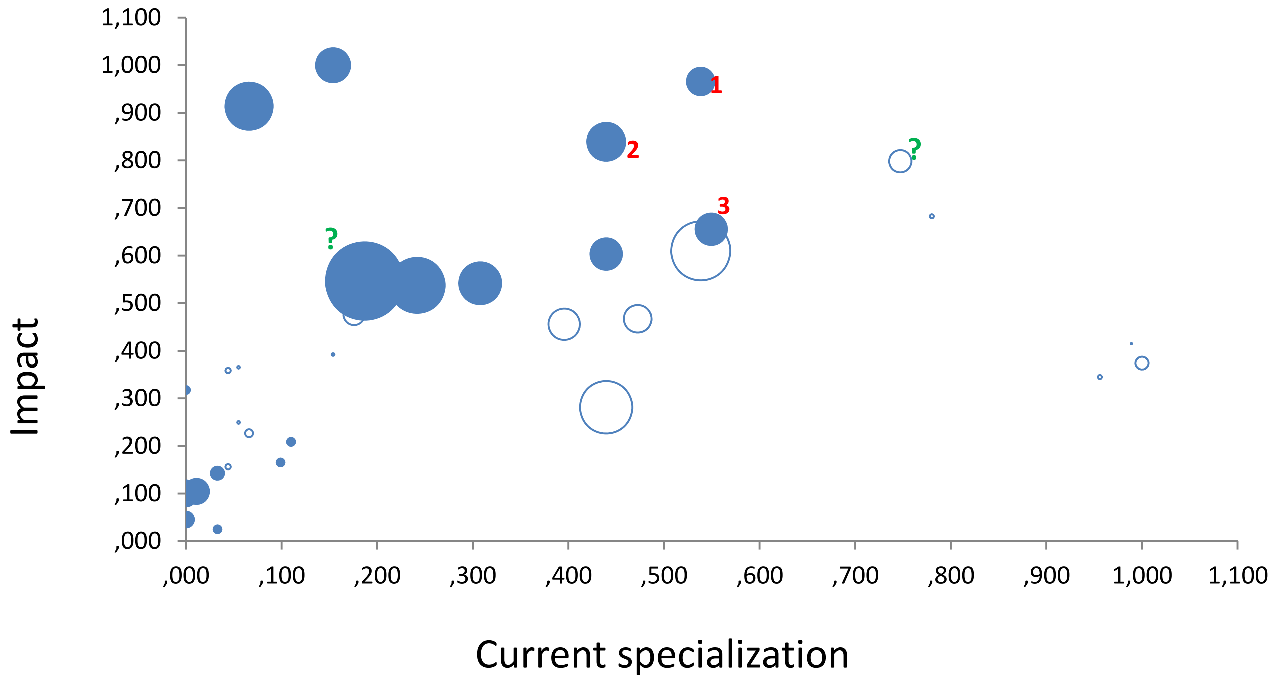
	Research Centers' Impact * Spec 5
1	Biochips (in vitro)
2	Implantable monitors / probes
3	Advanced microscopy

Universities: Medapps



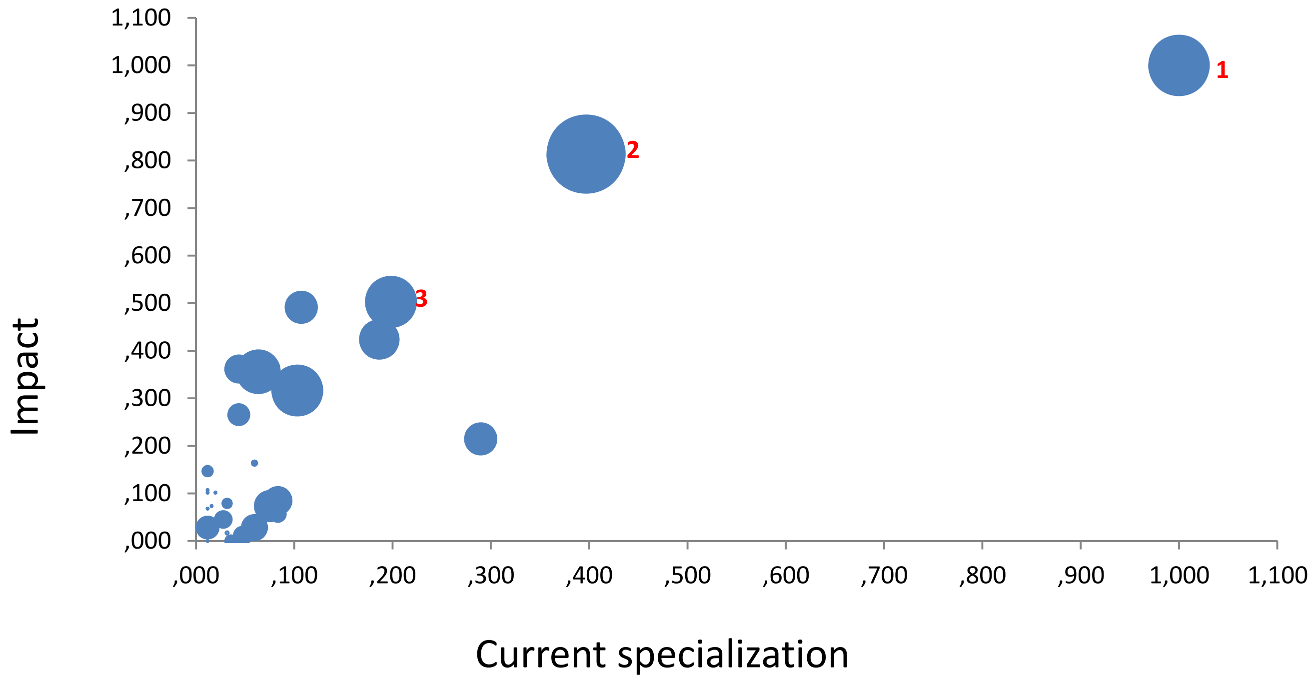
	UN Impact * Spec 5
1	(Electrically) Active implants
2	Microfluidic devices (e.g. for point-of-care)
3	Biochips (i.e. DNA & protein arrays)

FlandersBio: Medapps



	FlBio Impact * Spec 5
1	DNA/RNA sequencing
2	Cell sorting / flow cytometry
3	Immunological assays

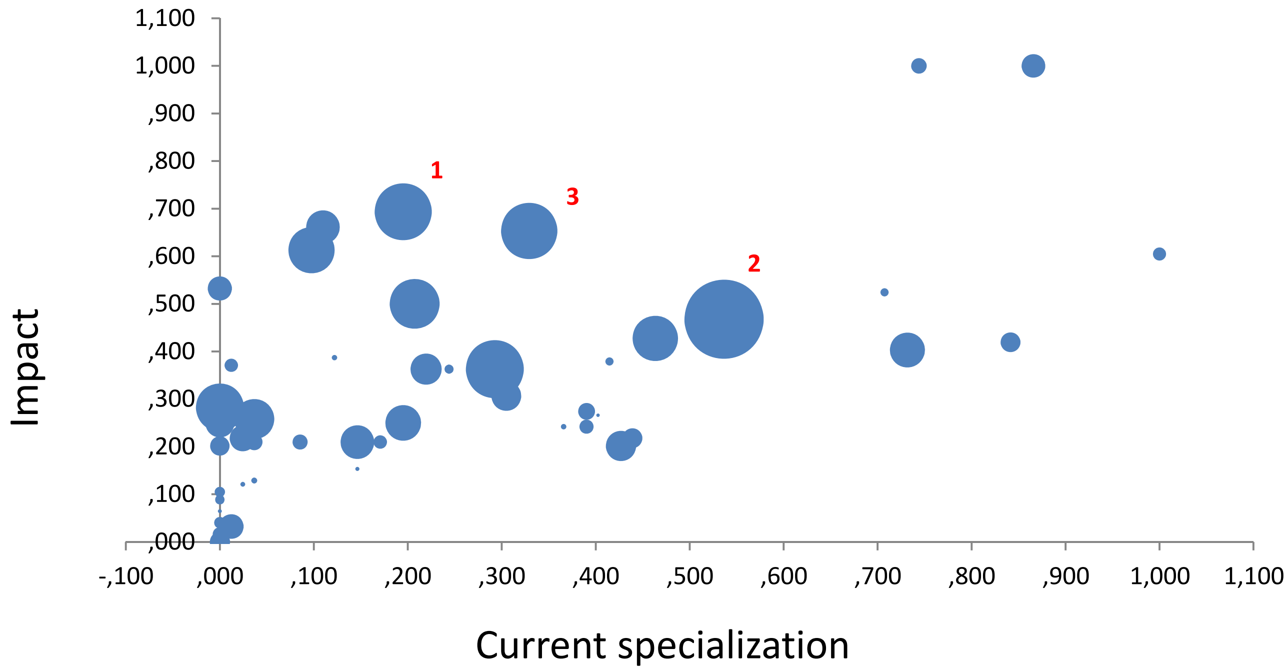
DSP Valley: Medapps



	DSP Impact * Spec 5
1	(Electrically) Active implants
2	Stimulators
3	Electrical Activity Monitoring

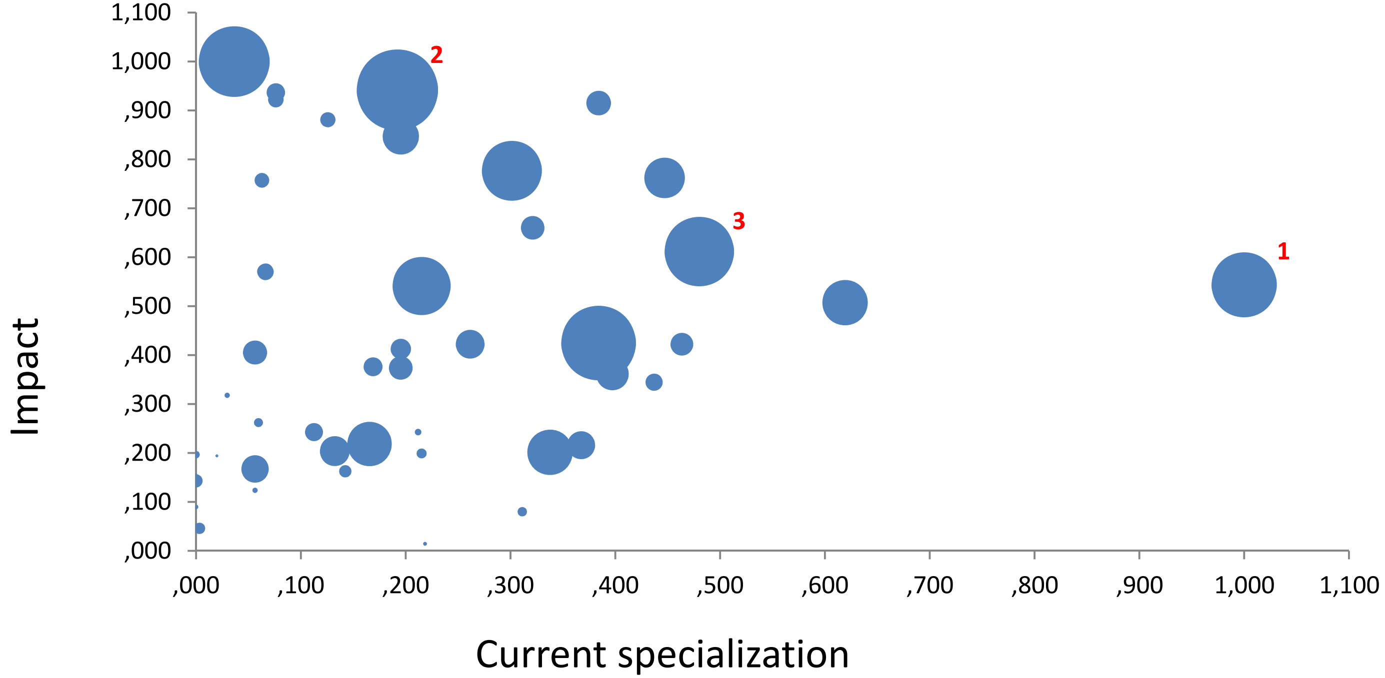
6. Selected results for Nano/biotech: Specializations vs. Impact

Research Centers: Nano/biotech



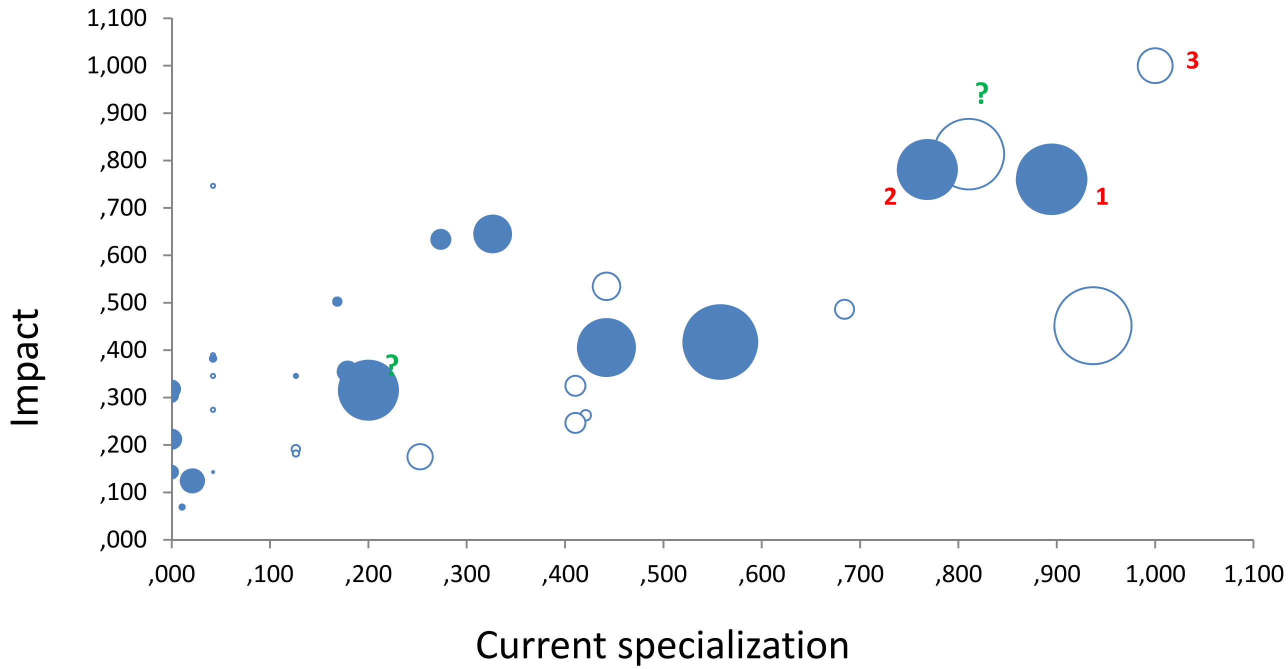
	Research Centers' Impact * Spec 5
1	3D integrated nanosystems
2	Electronic nanodevices
3	Bio-sensors (non-photonic)

Universities: Nano/biotech



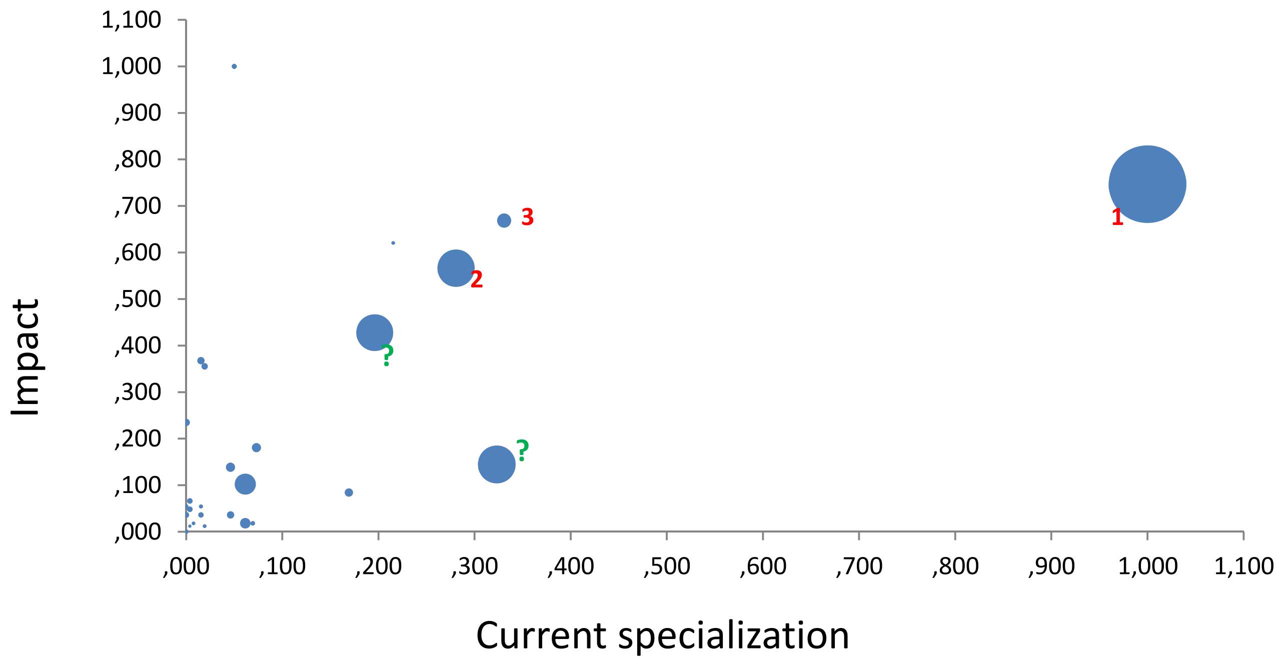
	UN Impact * Spec 5
1	Electronic nanodevices
2	Nanoscale sensor elements, nanowires
3	Bio-sensors (non-photonic)

FlandersBio: Nano/biotech



	FlBio Impact * Spec 5
1	Genomics and epi-genomics
2	Proteomics
3	Cell culture techniques

DSP Valley: Nano/biotech



	DSP Impact * Spec 5
1	ULP wireless communication
2	Nanosystems design
3	BAN system design

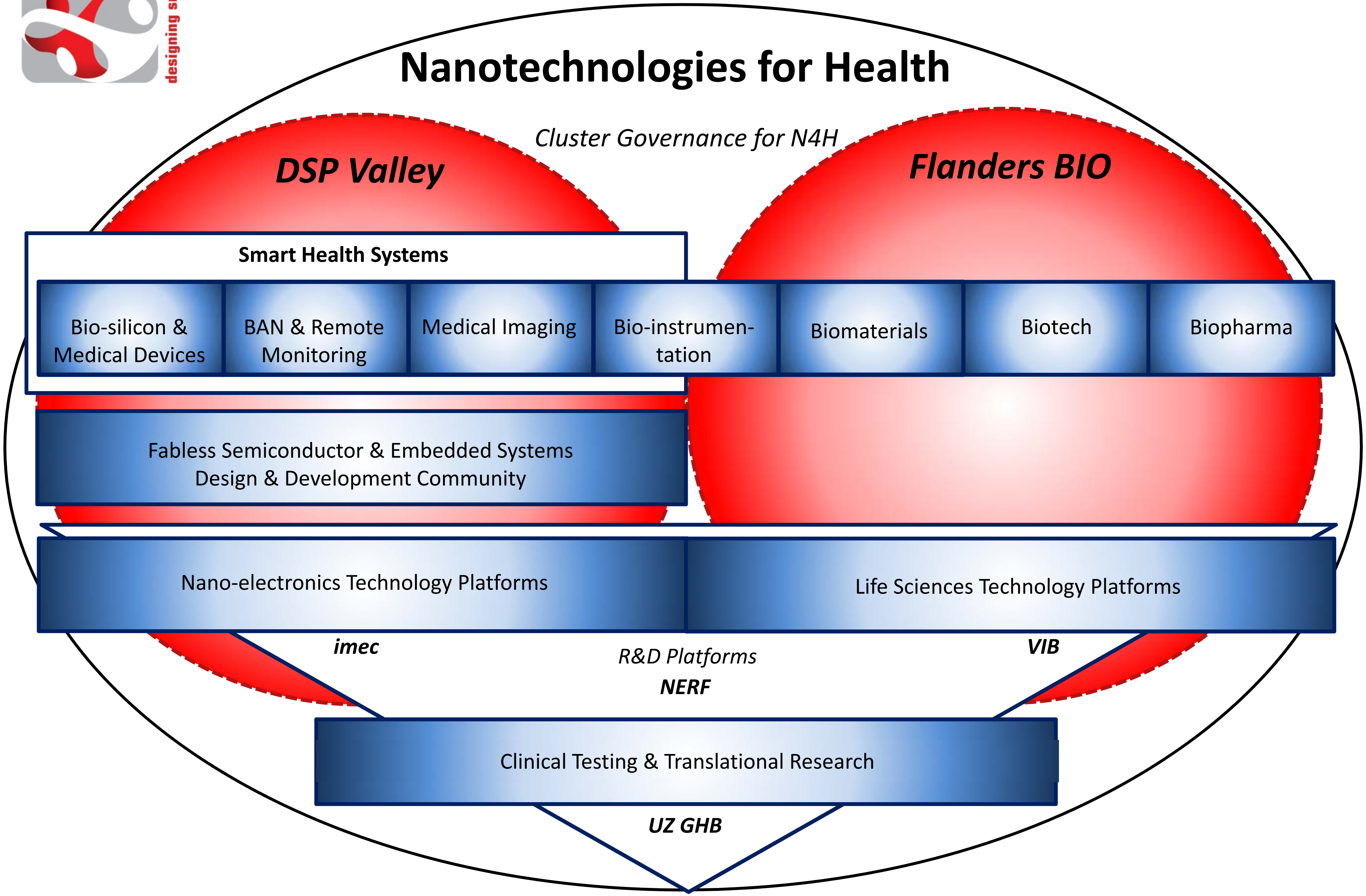
Part III: A bundling of cluster expertise and eco-systems between FlandersBio and DSP-Valley and the way forward.

Integration and communication about NfH

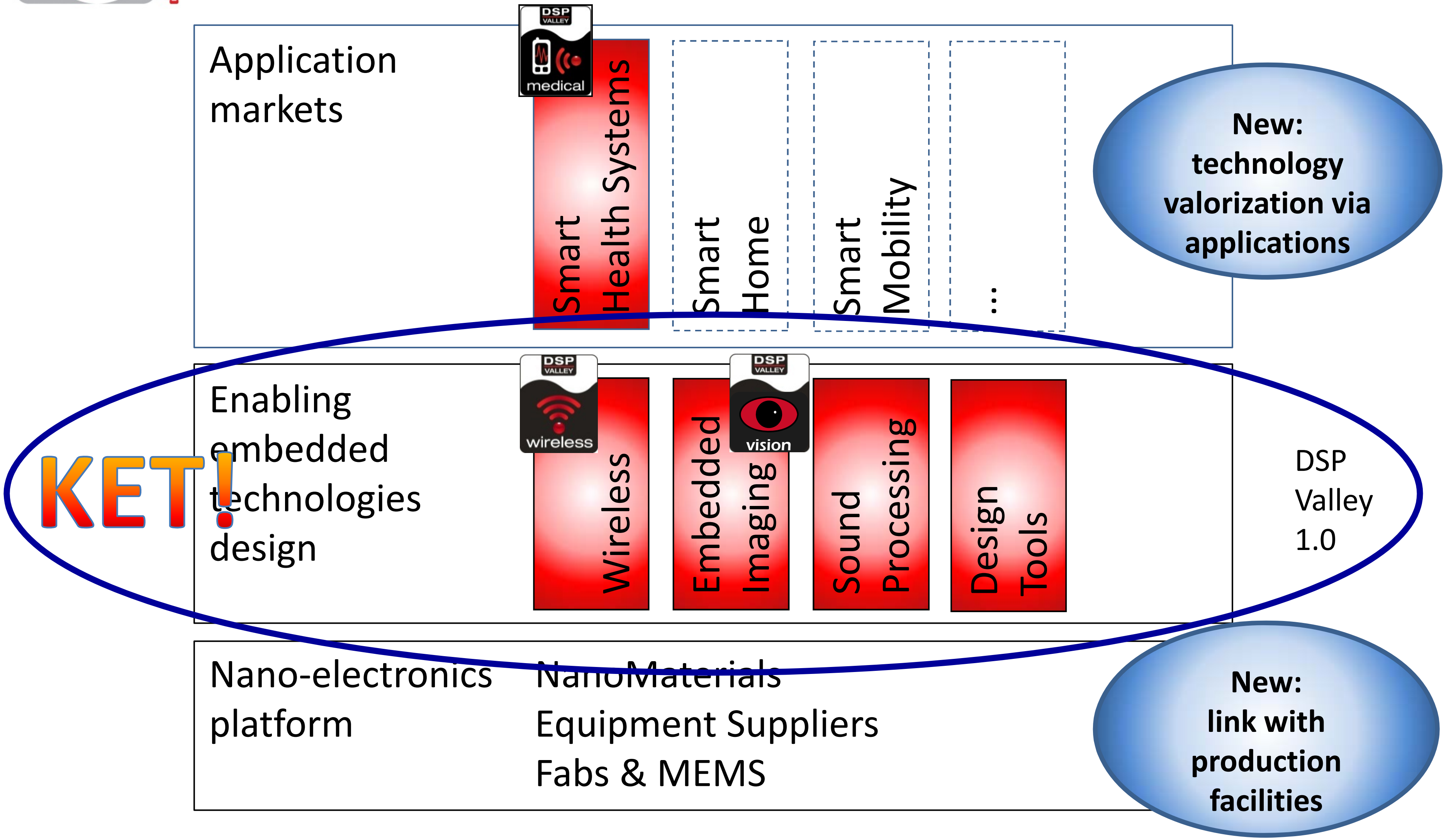
1. EWI- Workshop on Smart Specialization – including case NfH (Febr. 2013)
2. Joint-event Pharma.be, FlandersBio & EFPIA (February 2013)
3. 2nd Belgian Pharmaceutical Conference (April 2013)
4. Knowledge for Growth event (May 2013)
5. Feedback to providers data NfH questionnaire (tbd)

DSP-Valley 2.0

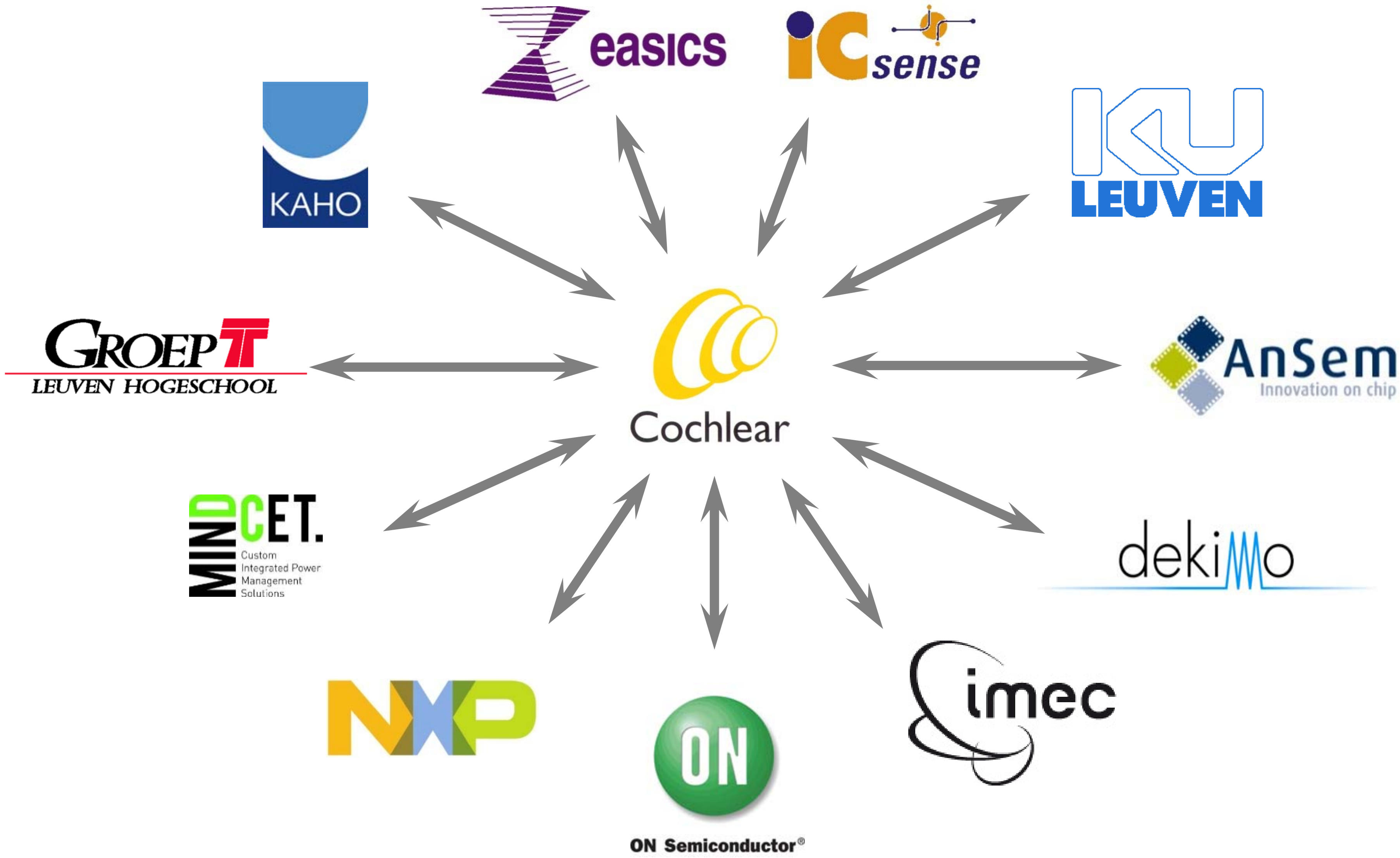
Slimme Specializatie: N4H



DSP Valley 2.0

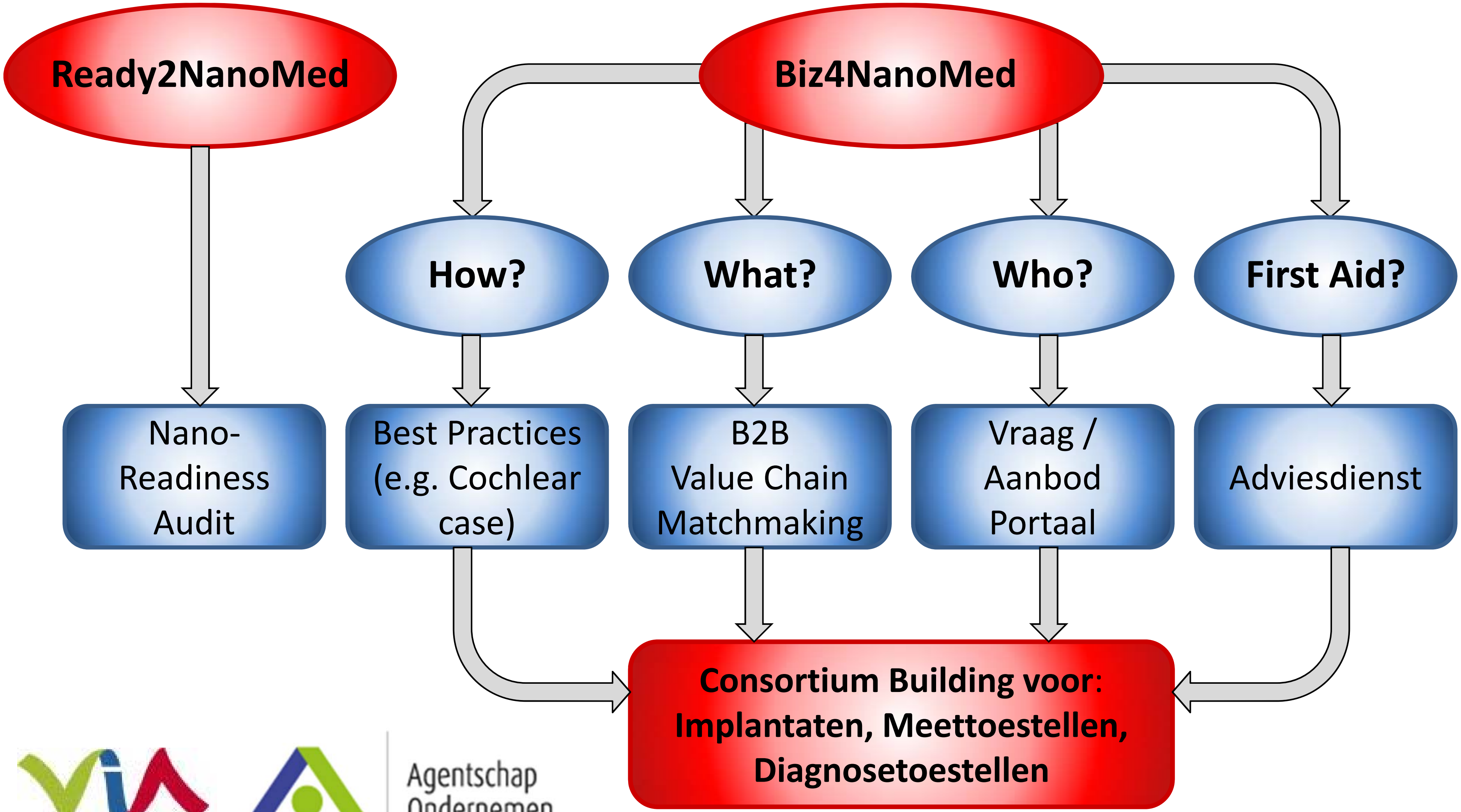


De Inspiratie



“GENEESS”

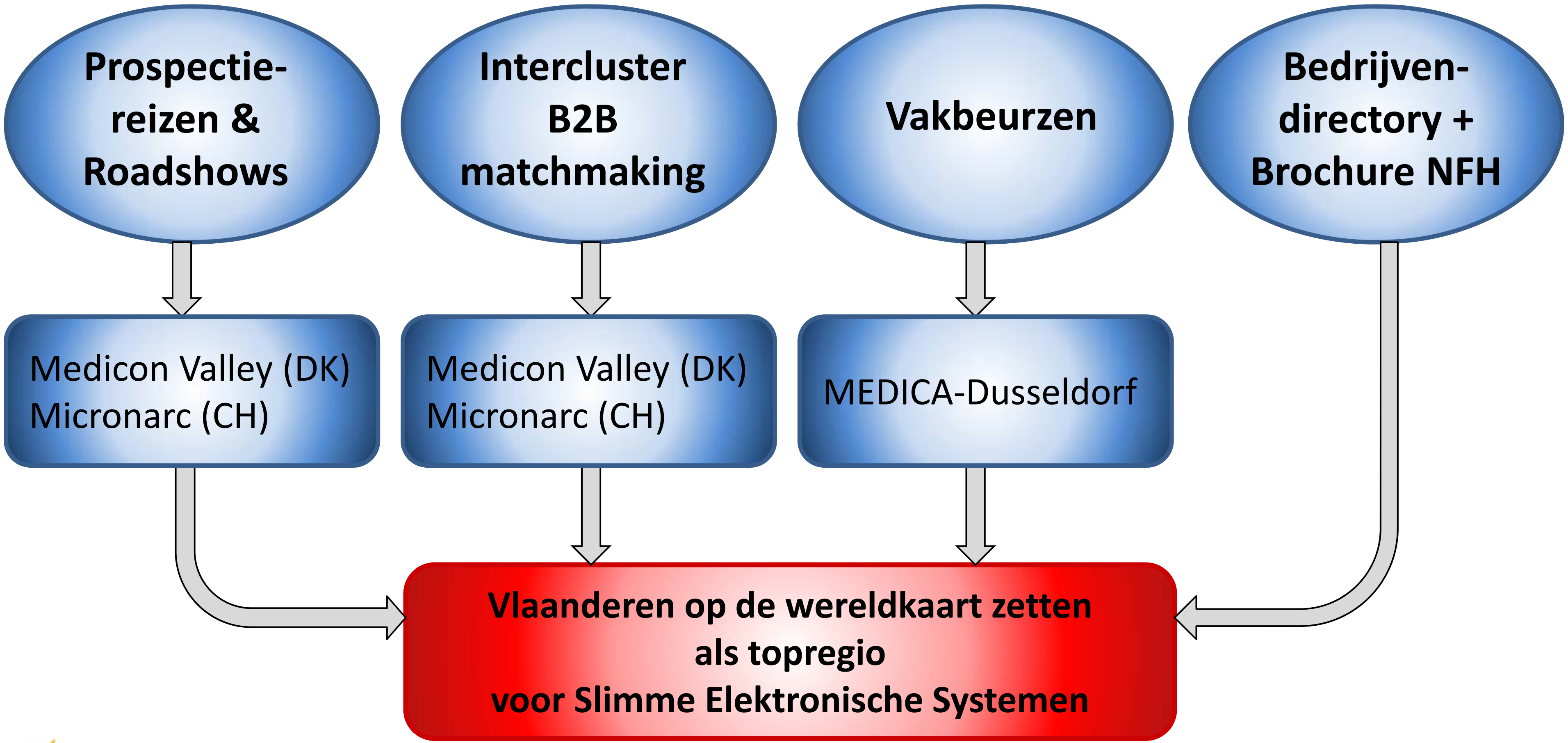
Gezonder door Nano-Elektronica en Slimme Specializatie



Agentschap Ondernemen

"NEfSS"

Nano-Elektronica for Smart Systems



Flanders Investment & Trade

Conclusie

Enquête N4H Vlaanderen

Base-line Studie Smart Spec.

DSP Valley SIG Medical Devices

NEfSS

GENEESS

ROADMAP ?

DSP Valley wil actieve cluster-bijdrage leveren in N4H S3

Flanders Investment & Trade

FlandersBio

FlandersBio, facts & figures

- Founded in 2004 by the industry
- Private not-for-profit organization
- > 260 members (industry & academic)
- Strategic goals:
    - **Achieve sustainable economic growth**
    - **Stimulate knowledge transfer**
    - Create supportive regional environment
    - Ensure sufficient talent pool
    - Increase public awareness

FlandersBio' s research partners

Strategic research centres with an economic focus

VIB (1996)

- Biotechnology
  - >1300 researchers
  - Universities Antwerpen, VUB, UGent, KU Leuven
- International liasons with pharma & biotech industry
- www.vib.be

IMEC (1984)

- Nanotechnology
  - > 2000 employees
  - HQ: Leuven
- International liasons with industry
- www.imec.be

NERF (2011)

- Focus: Neuroelectronics research
- Joint collaboration between VIB, imec, KU Leuven

KATHOLIEKE UNIVERSITEIT LEUVEN

UNIVERSITEIT GENT

Universiteit Antwerpen

Vrije Universiteit Brussel

universiteit hasselt

FlandersBio – Life Science companies

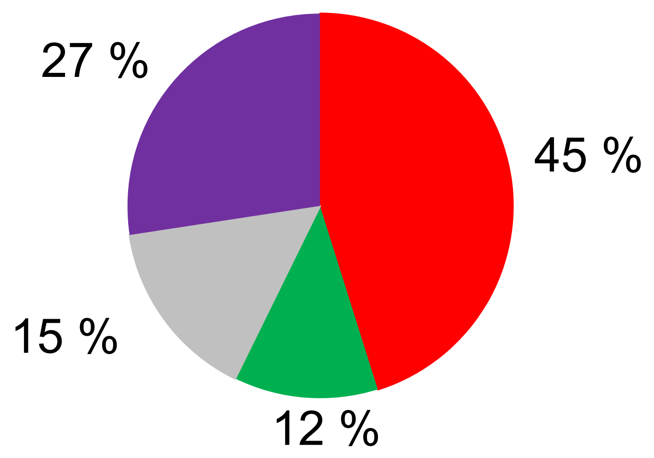
50% (124) of FlandersBio members are life science companies with R&D activities

Medical biotech: Diagnostics & therapeutics

Plant biotech: Agriculture and food

Industrial biotech Bioprocessing

Enabling technologies



72% active in medical and enabling technologies

-> potential pool of companies that could benefit from activities in Nanotech for Health

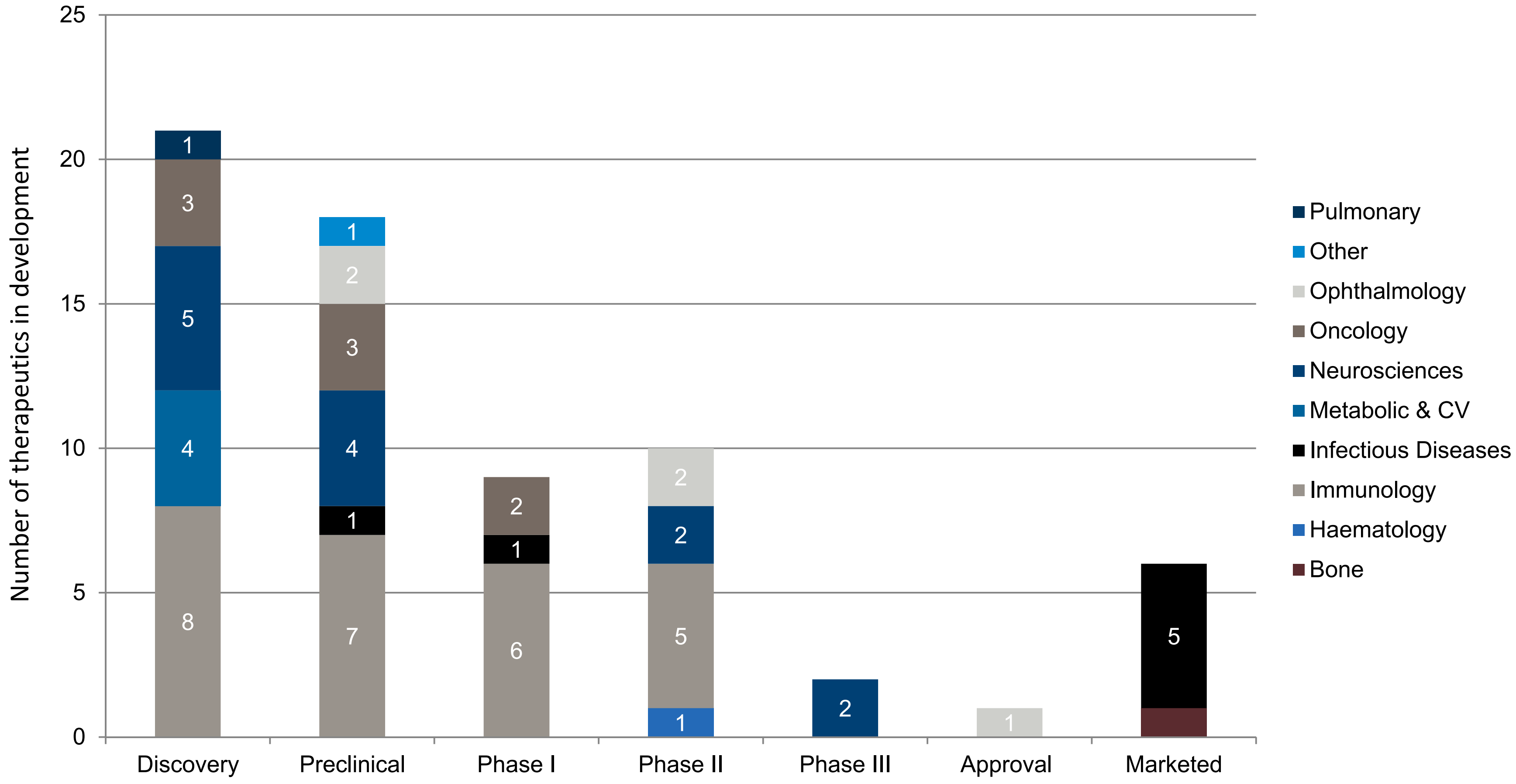
Life science companies are successful in partnering

- **> € 7 bn** total potential value of deals signed since 2005
- **> € 930 m** received by Flemish companies so far

  (upfront, milestone payments and R&D collaborations)

Abbott A Promise for Life · Boehringer Ingelheim · gsk GlaxoSmithKline · Lilly · MERCK SERONO · MSD · NOVARTIS · Roche · SERVIER

Pipeline of SME healthcare companies in Flanders



PersoMed: joint initiative of FlandersBio & Eurasanté

- Progress in genomics, imaging, proteomics and pharmacogenetics has progressively brought medicine closer to the individual patient
- Goal: adapt treatment to better suit each patient's profile and risk factors
- Partners: Eurasanté (F) and FlandersBio (B)
- Objectives of the project:
  - Stimulate and facilitate cross-border R&D partnerships
  - Set up a long-lasting cross-border support framework
  - Supply tools to tackle standards and regulatory issues
  - Supply information on the foreseen impact of personalised medicine on healthcare systems.

Belgian participation in *nanotech for health* EC funded projects FP6 & FP7

Partner	Coordinator of projects	Non-coordinating partner in projects	Projects per domain				
			Nanodiagnostics	Drug delivery	Regenerative therapy	Bio-oriented materials	ERC
Imec	1	0		Nano3T			
KU Leuven	0	2	Vibrant	cosmophos-nano		Psy-nano-si	
U Gent	0	3		Sonodrugs, Meditrans			Electrotalk
U Antwerpen	0	1	NAD				
ULB	0	1	Vibrant				
U Liège	0	2	Adonis		Cornea		
Centexbel	0	1				Bacteriosafe	
Eurogentec	0	1			Cellprom		
Materialise	0	1			Hippocrates		
ERI of Catalysis	1	0				ECAMM	
IBBT (→ iMinds)	0	1	SUBLIMA				