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WP1

Implantable Devices

Work package leader:
Vasiliki Giagka

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TU Delft: Who is who and where

Vasiliki Giagka
assistant professor

Ronald Dekker
professor

Marta Saccher
PhD-student

Shinnosuke Kawasaki
PhD-student

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TU Delft, our capabilities

Section Bioelectronics provides circuits and systems for the successful monitoring, diagnosis and treatment of cortical, neural, cardiac and muscular disorders by means of electroceuticals.

Analog IC design for implants and neuromodulators
Wireless power transfer
Low power design
http://bioelectronics.tudelft.nl

Section ECTM
Microfabrication
MEMS and BiCMOS
emerging materials, innovative microstructures and devices
http://ectm.tudelft.nl

EKL clean room facilities
https://www.tudelft.nl/en/eemcs/research/facilities/else-kooi-lab/

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TU Delft, our contribution

- Will contribute to defining the system level specifications for the US powered neurostimulator (T1.1 and T1.3)
- Contribute to substituting the Bluetooth communication by an US communication link
- Offer existing output stage ASIC architectures as well as contribute to the overall system level design of the architecture topologies for efficient neurostimulator (T1.3)
- Co-ordinate (together with FIZM) the efforts in T1.5 for the development of the ultrasound neuromodulation cuff with integrated electrodes (T1.5)
- Work on the validation of the efficiency and selectivity of the newly designed ultrasound stimulating cuff (T1.5)
- Co-ordinate (together with FIZM) the benchmarking of ultrasound and inductive wireless power transfer for active implants (T1.6)

Fraunhofer IZM: Who is who and where

Vasiliki Giagka
Group leader

Christine Kallmayer
Group leader

Andra Velea
PhD-student

Lukas Holzapfel
R&D Engineer

Konstantina Kolovou-Kouri
PhD student

Barbara Pahl
R&D Engineer

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Fraunhofer IZM, our capabilities

Wafer Level System Integration
System Integration & Interconnection Technologies
Environmental & Reliability Engineering
RF & Smart Sensor Systems
https://www.izm.fraunhofer.de/en/abteilungen.html

3D Packaging on Component
Reliability, Evaluation, Tests and Optimization
Packaging for Power Electronics
Photonic Packaging
Packaging, assembly and testing for flexible implants

Smart Textiles
Stretchable Electronics
Thermoforming
Integration of Electronics into New Materials
Panel Level Packaging (PLP)
Fan-out Wafer- and Panel Level Packaging
Embedding PCB
Redistribution Technology

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Fraunhofer IZM, our contribution

- Will contribute to defining the system level specifications for the US powered neurostimulator (T1.1 and T1.3)
- Contribute to the system integration, assembly and encapsulation tailored to the demonstrator (T1.2)
- Develop new system integration, assembly and encapsulation techniques for the US powered neurostimulator (T1.3)
- Contribute to the mechanical and electrical validation of the inductively powered demonstrator (T1.4)
- Develop new system integration, assembly and encapsulation techniques for the newly designed ultrasound stimulating cuff (T1.5)
- Co-ordinate (together with TUD) the efforts in T1.5 for the development of the ultrasound neuromodulation cuff with integrated electrodes (T1.5)
- Work on the validation of the efficiency and selectivity of the newly designed ultrasound stimulating cuff (T1.5)
- Co-ordinate (together with TUD) the benchmarking of ultrasound and inductive wireless power transfer for active implants (T1.6)

AnSem, Who is who and where

Frederic Stubbe
project manager

Jan Crols
technical supervision

AnSem's main location is in the Research Park Haasrode in Leuven, Belgium.

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AnSem, our capabilities

- Turn-key ASIC solution for medical and industrial applications
- ASIC design and industrialisation for medical implant
  - *Cochlear implant, in-eye sensors, glucose monitoring, vision restoration, …*
  - *Key technologies:*
    - Inductive powering and data communication (includes longer range data communication)
    - Advanced power management for neural stimulation (includes SIMO DC-DC conversion, includes battery charging)
    - Sensing and neural stimulation
    - Use of high voltage BCD silicon technologies
    - Ultra-low power / low leakage circuit design for medical implants

AnSem, our planned contribution

- AnSem will develop the ASIC for the power harvesting of ultra-sound power
  - *Development of a simulation model based on provided impedance measurements information fro transducers*
  - *Study of existing realizations*
  - *Implementation of a prototype ASIC*
  - *Validation of the prototype ASIC*
- AnSem will study the possible concepts for a wireless communication link over the ultrasound power transfer link

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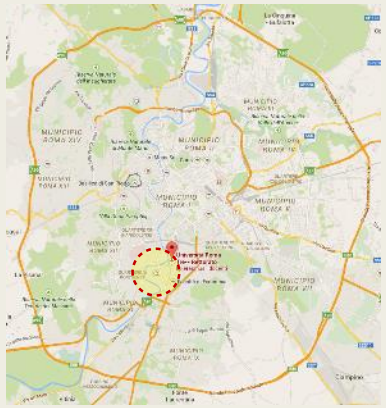
UNIROMA3 - Who is who and where

Alessandro Stuart Savoia
UNIROMA3 Unit Leader

Alessandro Neri
Head of Applied Electronics Section



Roma Tre University
Roma, Italy

Department of Engineering
Applied Electronics Section

Acousto-Electronics Lab
(ACULAB)

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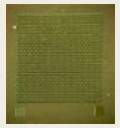
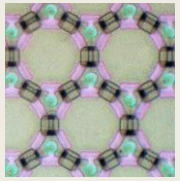
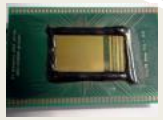
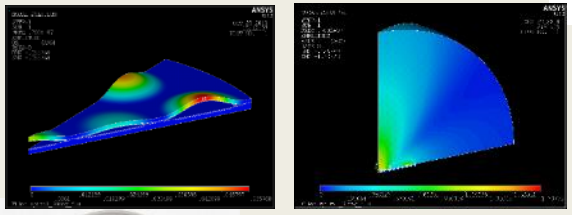
UNIROMA3 – our capabilities

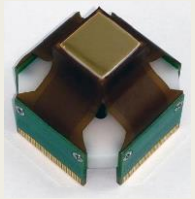
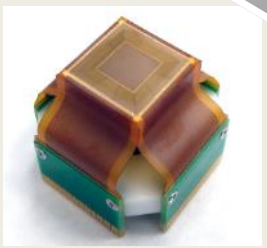
20-Year Experience on **Micromachined Ultrasonic Transducer** Development: from Design to System Integration

- MEMS ultrasonic transducer Design
- FEM and system-level modeling
- Microfabrication and packaging
- Acoustic materials
- Characterization
- Electronic front-end circuit design
- Probe development
- Ultrasound imaging system integration





- **1998** MUT research started
- **1999** Single-element CMUT transducer
- **2003** 64-element 1D probe
  First ultrasound imaging on clinical scanner
- **2004** 128-element 1D probe with embedded electronics
- **2007** 192-element 1D probe
  Reverse Fabrication Process
- **2009** High frequency 192-element 1D probe
- **2015** 256-element 1D probe
- **2016** 120+120-element 2D row-column probe
- **2018** 256-element 2D array with ASIC AFE

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UNIROMA3 – our planned contribution to WP4

UNIROMA3 will contribute to the design and simulation of the ultrasonic wireless link by developing:

- Design of PMUTs for the transmitter (based on STMs PMUT technology)
- MUT equivalent circuit modeling for system-level simulation
- Linear modeling of the propagation medium, by considering linear propagation, diffraction and attenuation

UNIROMA3 will mostly work together with:

- Philips
- STMicroelectronics
- …

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Lab. for Biomed. Microtechnol., IMTEK, ALU-FR

Thomas Stieglitz
project leader

Paul Čvančara
senior scientist

Benedict Szabo
PhD student

Campus of the Faculty of Engineering, Albert-Ludwig-University Freiburg, Freiburg, Germany.

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Laboratory for Biomedical Microtechnology
IMTEK – University of Freiburg

Prof. Dr.-Ing. Thomas Stieglitz

Laboratory for Biomedical Microtechnology,

Department of Microsystems Engineering - IMTEK

Bernstein Center Freiburg

BrainLinks-BrainTools, Research Cluster of Excellence (ExC 1086)

University of Freiburg

Patrick Kiele

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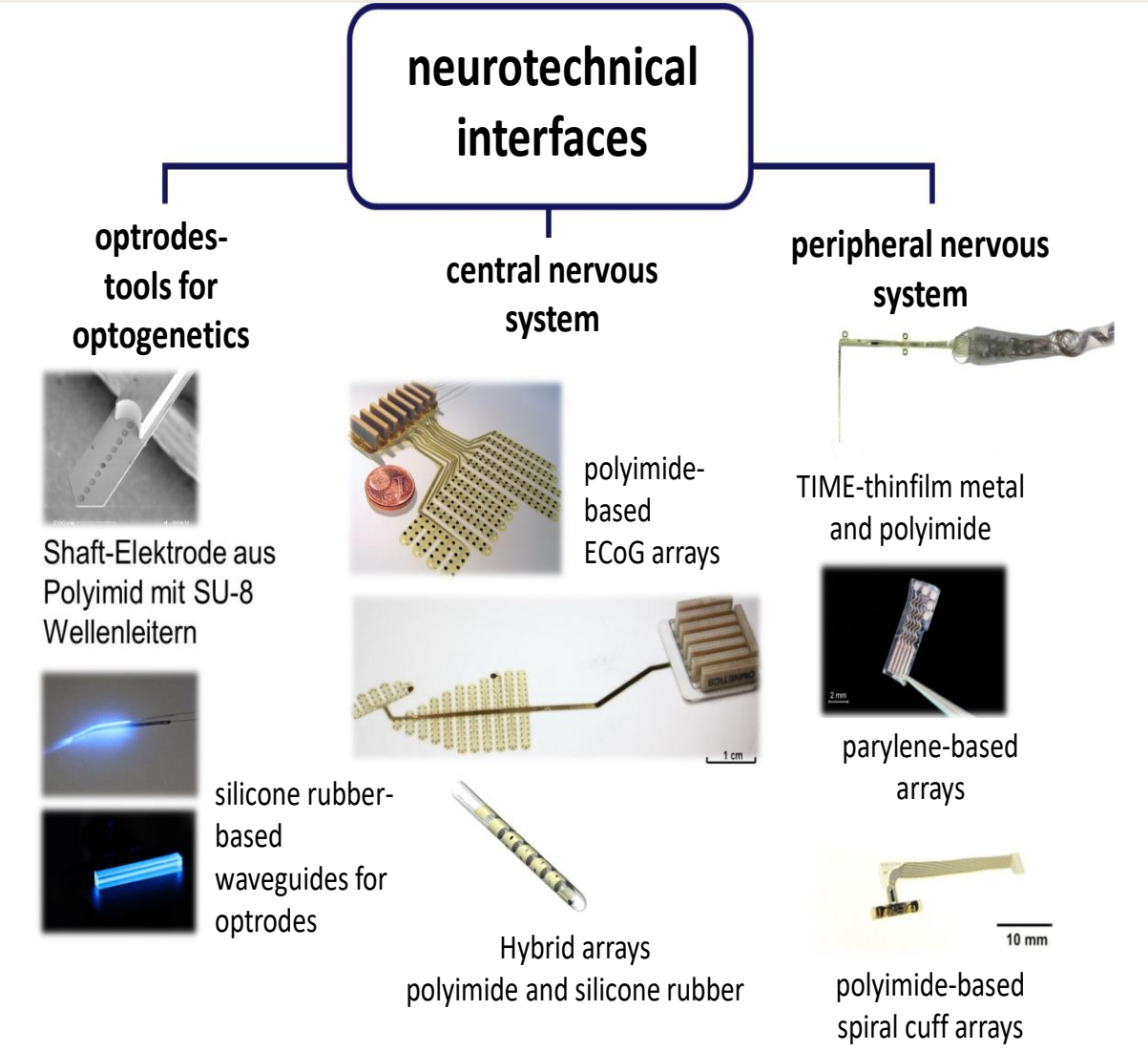
Tools for interfacing with the nervous system



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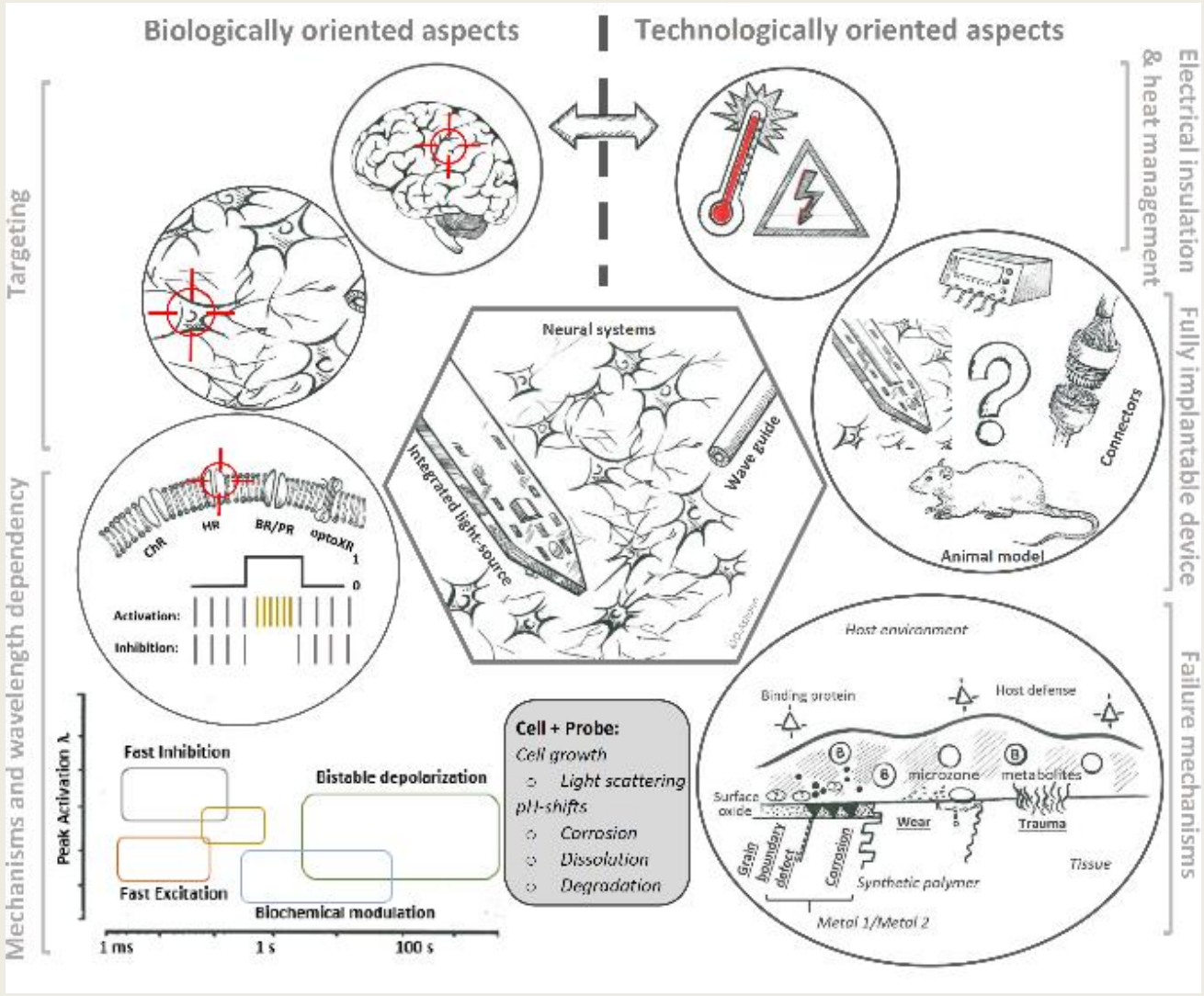
Aspects influencing probe design



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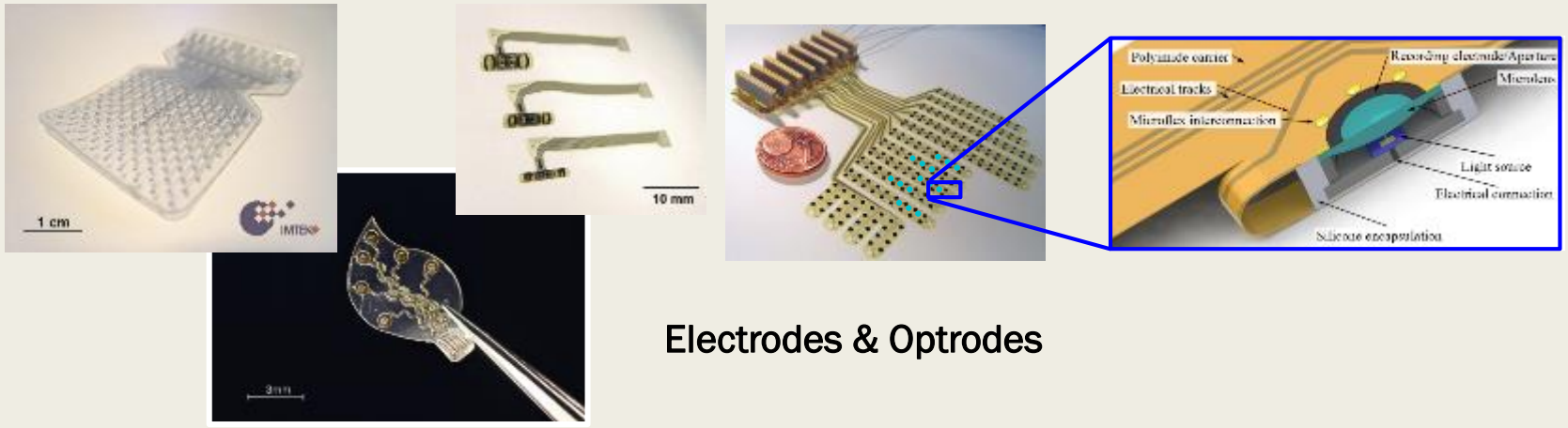
Expertise in Research



Electrodes & Optrodes

Implants & Systems

Applications
&
Treatments

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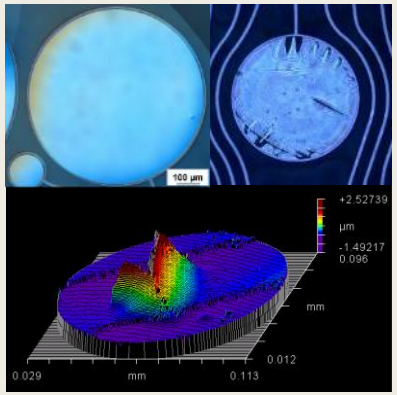
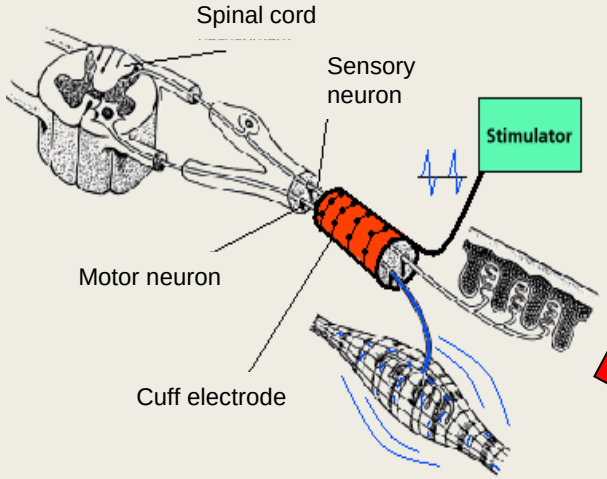
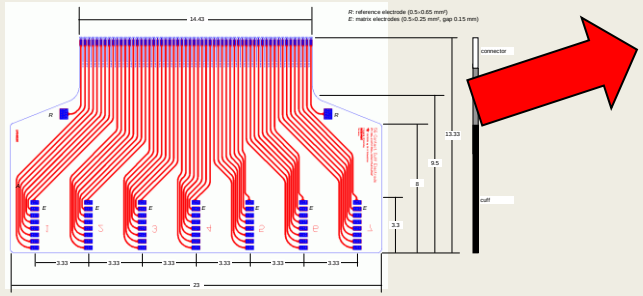
From ideas to clinical trials
Our planned contribution

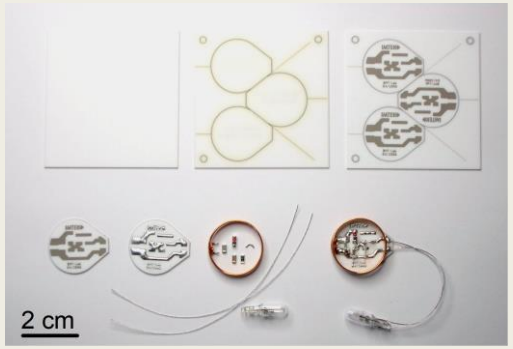


by CorTec GmbH & University of Freiburg

- Design, development and manufacturing
- ISO 13485:2016 accredited
- System test (*in vitro/ex vivo*)
- Technical assistance during implantation







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Laboratory for Biomedical Microtechnology

November 2015

In harmony with CorTec and neuroloop employees

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Thank you very much for your attention !

Campus of the technical faculty

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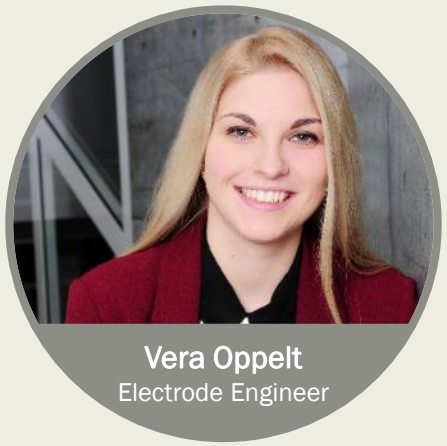
CorTec GmbH - Who is who and where

Dr. Jörn Rickert
CEO

Dr. Martin Schüttler
CEO/CTO



Vera Oppelt
Electrode Engineer

CorTec is a young company in the field of **medical engineering** located in Freiburg, Germany.

We make **personalized neurotherapy** available to industry, research and patients by providing the **next generation** of the technology behind.

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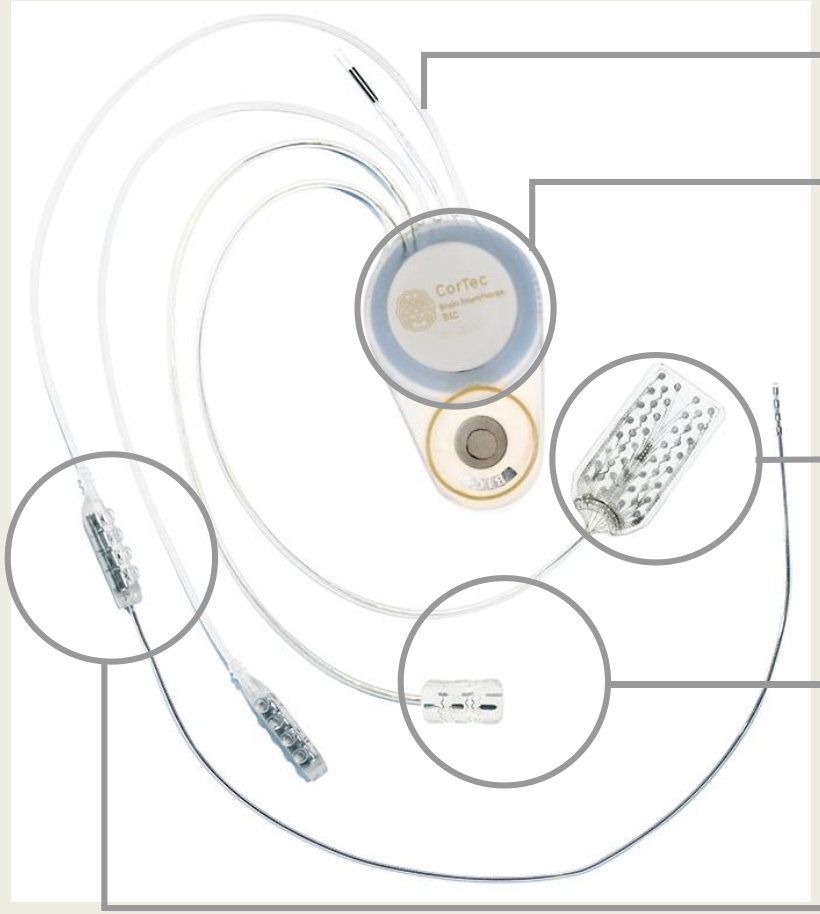
CorTec GmbH - our capabilities



Flexible wire supply

Hermetic Encapsulation

°AirRay Grid Electrodes

°AirRay Cuff Electrodes

High-channel implantable connectors

Super-soft,

high-performance,

high-channel

Electrodes made by laser-structuring

of silicone, parylene and metals

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CorTec GmbH - our planned contribution

Novel implantable cable connections and their evaluation, as well as contributions to the system integration of implantable devices for direct contacting and addressing of neurons in the target area

- Technology for system integration of ultrasonic chips for novel implant systems - Silicone Moulding Processes
- Highly flexible implantable cables for data and power transmission
- Test setups to determine the electrical and mechanical properties of the new implant systems - Pressure development in cuff electrodes and measurement of cable forces

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DYCONEX Who is who and where

Eckardt Bihler
project manager

Marc Hauer
R&D manager

Dyconex AG
manufacturing site for flex substrates
located in Bassersdorf, Switzerland
within close proximity of Zurich Airport

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DYCONEX our capabilities

- Simplifying medical electrodes and catheters with flexible bio-compatible and bio-stable substrates:
  - *pure Gold artwork features*
  - *electrodes with Platinum and Platinum-Iridium surface finish*
  - *embedding of active and passive components*
  - *Substrate material: LCP (liquid crystal polymer) and Polyimide*
  - *3D forming and interconnect solutions available*
- Flexible substrates for attachment of PZT ceramic transducers (currently substantial business at Dyconex, supplying leading OEM for medical ultrasound probes)

DYCONEX our planned contribution

- LCP substrates for applications and demonstrators in WP1
  - *Neuro stimulation electrodes*
  - *Bio-electronic implants*
- Integration and encapsulation of piezoelectric transducers together with LCP substrates
- Evaluation of piezoelectric polymer films in comparison with PMUT and CMUT
  - *Specific interest in PVDF, P(VDF-TrFE) and PZT/polymer composites*

IMEC-BE-Ghent: Who is who and where

Maarten Cauwe
Technical Coordinator

Jan Vanfleteren
Project Lead

iGent administrative / office building (left) and separate clean room building (right) at Technology Park of Ghent University, Ghent-Zwijnaarde, BELGIUM

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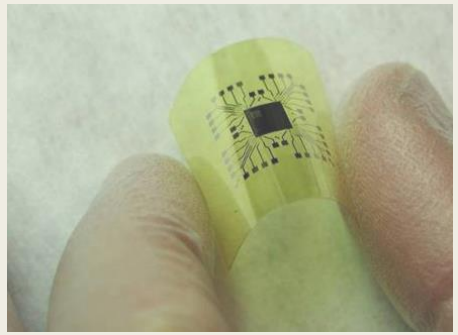
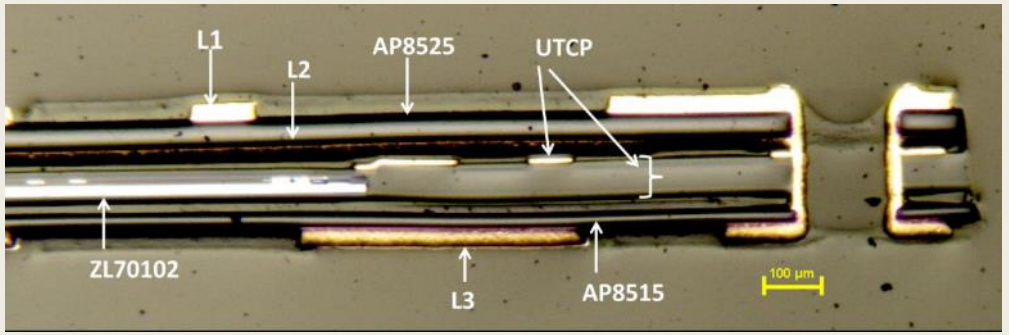
IMEC-BE-Ghent: our capabilities

- Ultrathin circuits : ultra-thin chip package (UTCP)

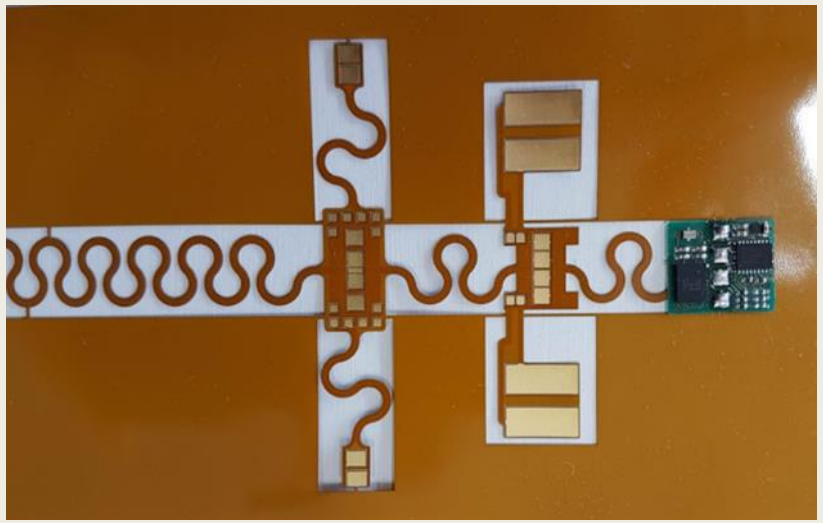


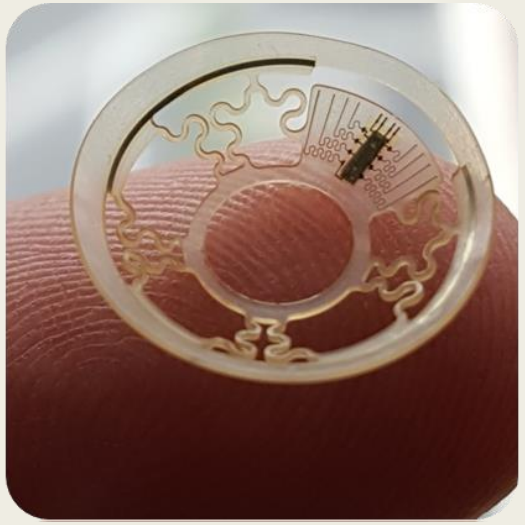
- total package thickness < 100µm
- thin chip in spin-on polyimide + thin-film fan-out



- UTCP embedding in standard PI Cu clad flex or rigid PCB
- interconnection by laser through hole drilling and via plating

- Stretchable circuits





- Stretchability based on elongation of meander shaped metal interconnects
- Large area PCB type (Cu) or fine pitch thin-film based (Cu, Au, …)
- Embedding polymers: hyperelastic (e.g. PDMS), soft thermoplastic (e.g. polyurethanes), hard thermoplastic (PP, PC, PET,….)

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IMEC-BE-Ghent: our planned contribution

Main contribution in task1.4 “Inductively powered conforming peripheral nerve interfaces” :

- exploration of use of UTCP technology variant for Salvia application :
  - *first using test dies, finally using the ICSense chip (need for bare die)*
  - *embedding in LCP flex in collaboration with Dyconex*
- conformable flex circuit could be made (slightly) stretchable if appropriate

ICsense: Who is who and where

Wim Vanacken
Program manager

Bram De Muer
CEO

Science Park Arenberg,
Leuven, Belgium

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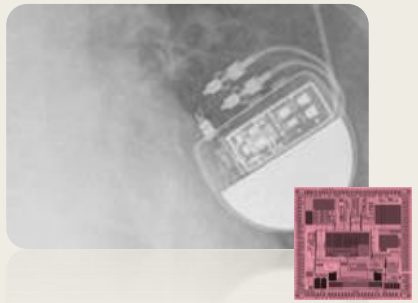
ICsense our capabilities

- ICsense is an ISO 9001/ ISO 13485 certified IC design company and ASIC supplier, specialized in high-performance analog, mixed-signal and high-voltage IC design
- For semiconductor and product companies in medical, consumer, automotive, industrial
- Founded in 2004
- Team of 85 people, 55 analog design engineers, 20 digital design engineers
  Largest independent mixed-signal IC design team in Europe
- Offering:
  - *Custom IC design services from building block to complete production ready ICs*
  - *ASIC design and supply: from idea to supply of the final ASICs*
- Medical ASIC examples: 40-channel DBS implant ASICs (e.g. InForMed), Cochlear implant ASICs, Spinal cord implant ASIC, Battery management for implanted rechargeable Li-Ion batteries, NFC- based wearable sensor ASIC, Impedance spectroscopy for cancer cell detection, X-ray detection ASIC chipsets, Sleep apnea, …



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ICsense our planned contribution

- WP1 Implantable device:
  - *Task 1.1, 1.4, 1.6*
  - *Inductive wireless power transfer:*
    - the definition, design, layout and bench testing of the inductive link power management ASIC
    - communication transceiver will require a novel architecture for power efficiency
    - the output stage (stimulation) will require special control and co-design with the power management part
  - *Close cooperation with Salvia BioElectronics and TUDelft*

Philips: Who is who and where





Rob van Schaijk Joost van Beek Paul Dijkstra Jacco Scheer Folkert Morsheim

Principal Architects Thin Film/MEMS/Assembly business development mgr.

Philips innovation services thin film facility

Philips innovation services micro devices facility

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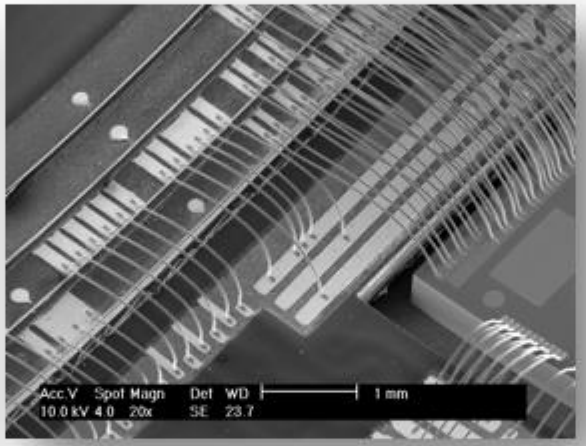
MEMS & Micro Devices: Facilities Development and manufacturing at Philips Innovation Services

MEMS Foundry
Micro-fabrication
2650 m2 Clean room

ISO13485 certified for development & manufacturing

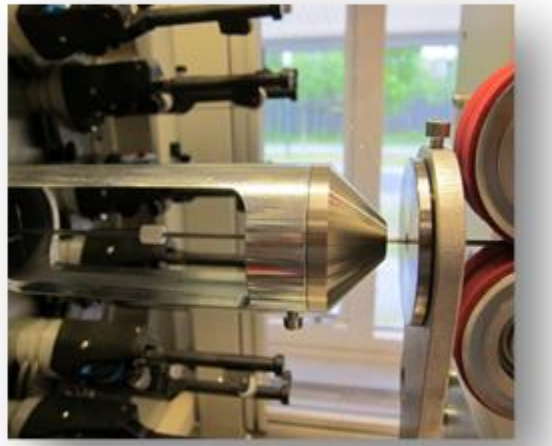
High Tech Campus-Eindhoven



Greenhouse/Micro Assembly
die/board level
3500 m2

ISO13485 certified for development & manufacturing

'Strijp' -Eindhoven



Smart catheters,
in- and on-body devices
Workshop, 300 m2

ISO13485 certified for development

High Tech Campus--Eindhoven

Philips Innovation Services

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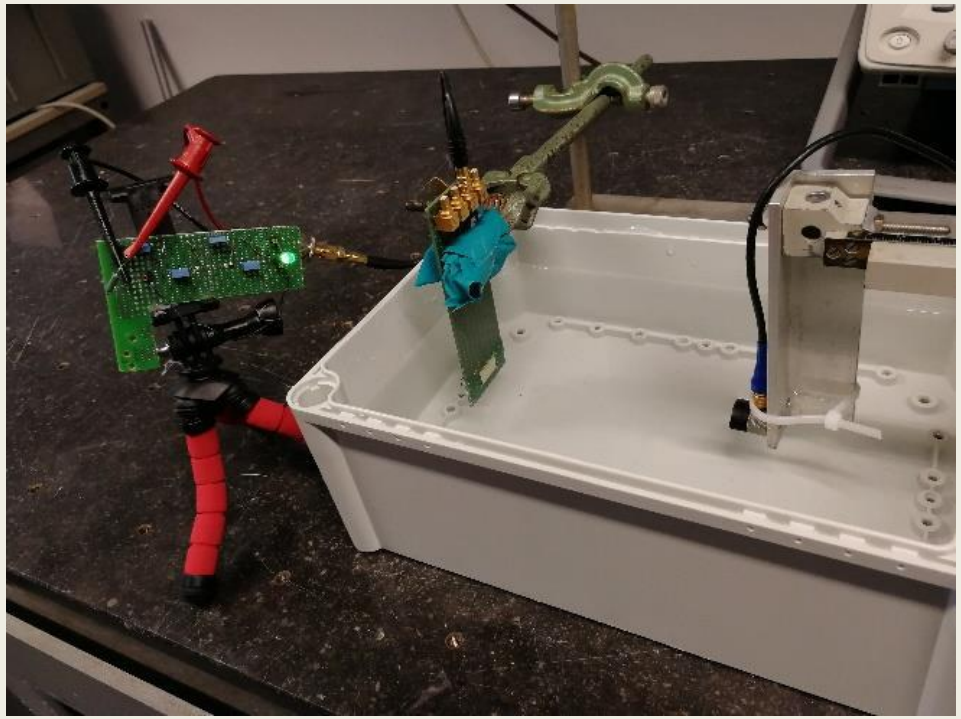
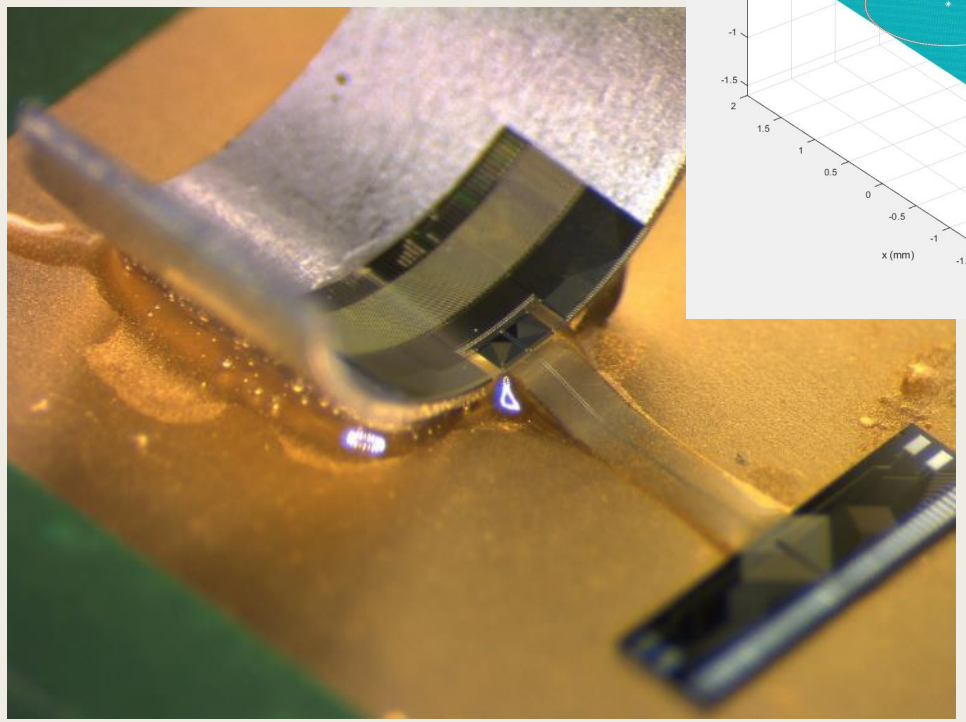
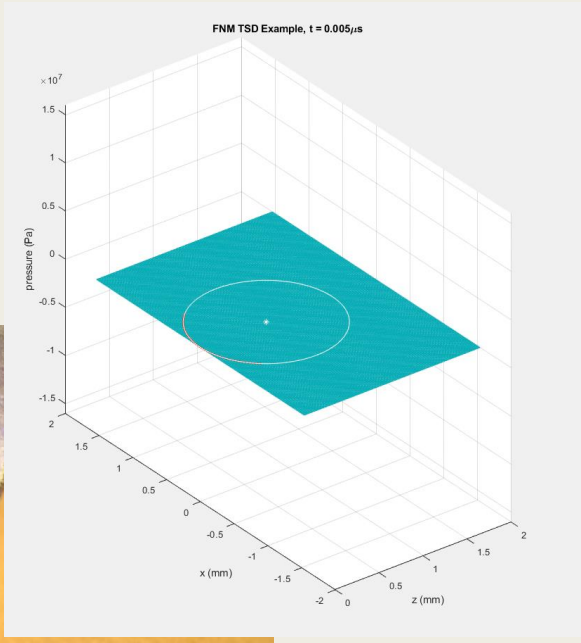
Our planned contribution

Technology provider for CMUT ultrasound power transfer and US nerve stimulation



Transmission of US power for powering of deep implants





Re-use of IVUS technology for stimulation of neurons with US

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Picosun Oy

Riina Ritasalo
Project Manager @Picosun

Tom Blomberg
R&D team leader @Picosun

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Picosun: our capabilities and contribution

- Picosun is one of the leading experts in ALD (atomic layer deposition) of thin films.
- Picosun can use this method to encapsulate medical implants.
- Hermetic sealing of the device to protect it from the corrosive environment of human body and vice versa is a key step to enable long life time for the smart medical devices.
- ALD-thin films are non-toxic and excellent barriers against the ions that are present in human body. These biocompatible and corrosion resistant layers could be used in future medical devices and implants.
- Picosun will work in WP1, Implantable devices, for device encapsulation.

picosun AGILE ALD

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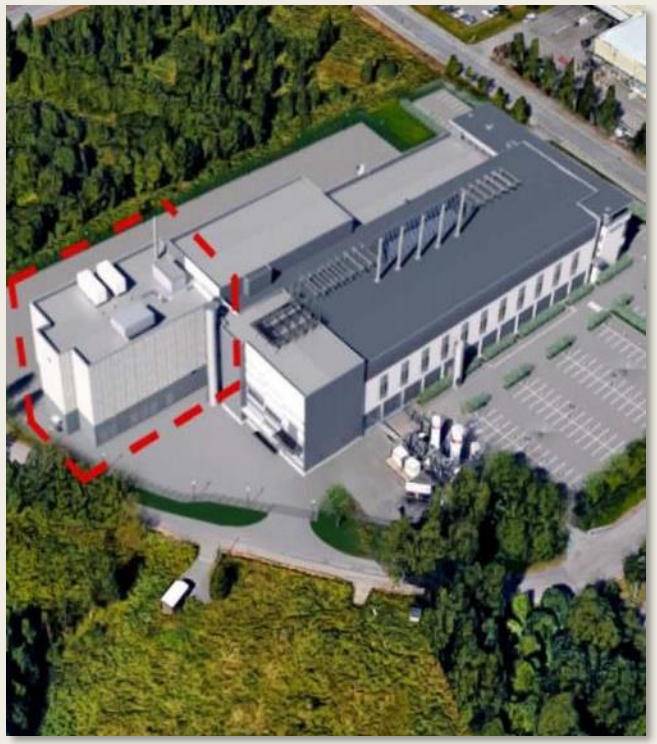
Okmetic Oy , Finland> Who is who and where

Katja Parkkinen
Main contact
katja.parkkinen@okmetic.com
+ 358 50 428 5484

Heikki Holmberg
Secondary contact
heikki.holmberg@okmetic.com
+ 358 50 590 5459



OKMETIC

High-performance silicon wafers for demanding applications

- Headquarter and main fab located in Vantaa, Finland, 10 min from Helsinki airport

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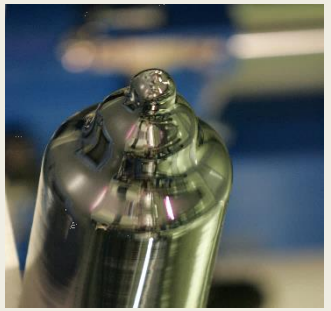
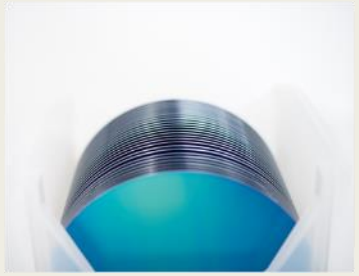
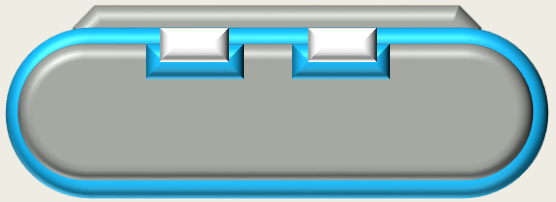
< Okmetic Oy , Finland> our capabilities

- World’s 6th biggest wafer manufacturing company in the world
- World's leading supplier of sensor wafers for most of the top 30 MEMS manufacturers
- Main products different kind of SOI wafers etc. patterned SOI, double SOI, engineered 6 and 8 inch SSP and DSP wafers
- Sales little over 108 M€ last year
- Okmetic is located in Vantaa with about 450 employees.
- Large investment program to expand the capacity in Finland continue at least to 2021
- In this project Okmetic utilizes the new patterning capabilities obtained by fab expansion 2019







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< Okmetic Oy , Finland > our planned contribution

OKMETIC role in the project

- Develop new piezo on insulator substrate product beyond state of art
- Develop engineering samples of piezo on insulator wafers by external supply chain
- Improve beyond state of art substrates for PMUT (to VTT fabricate)
- Provide engineered SOI and C-SOI® for Philips Innovation Services sensor development

OKMETIC partners and capabilities

- Our partners are VTT and Philips Innovation Services
- Okmetic would like to team up for ST Micro Electronics related to piezomaterials
- Okmetic needs VTT and Philips Innovation Services sensor fabrication capabilities

VTT Who is who and where

Tomi Salo
Research Team Lead
M4M Project Owner @ VTT

Cyril Karuthedath
Research Scientist
M4M Project Manager @ VTT

Micronova is the largest R&D cleanroom in the Nordic countries, and Finland's National Research Infrastructure for micro- and nanotechnology. The facility is run jointly by VTT and Aalto University. We develop innovative enabling technologies, and apply them to practical micro- and nanosystems.

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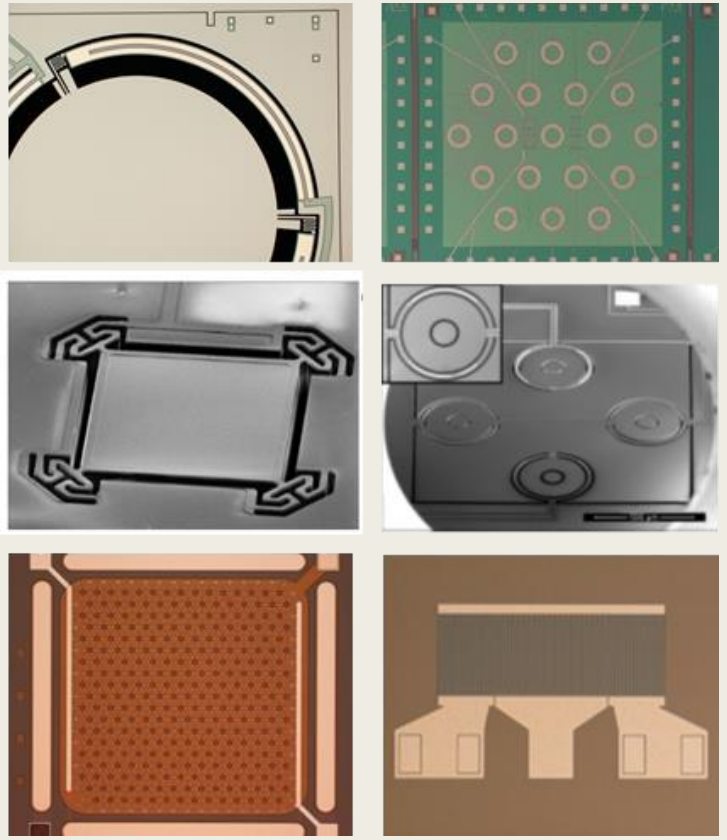
VTT's MEMS Capabilities

Creates state-of-the art MEMS components.

- Customer development projects
- EU funded projects
- Creation of spin-off companies

Contribution from materials and process development via components to systems.

- Pre-studies
- Design, modelling
- Process development
- Prototyping
- Electronics design
- Characterisation, testing
- Small scale production
- Tech transfer
- Licensing



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VTT's Contribution

- Collaboration with Consortium
  - Design and fabricate PMUTs for demonstrating ultrasound power transfer
    - Further improve maturity of air and water coupled PMUTs and piezo platforms
  - PMUT-ASIC integration

- Collaboration with Okmetic
  - VTT will utilize Okmetic SOI and CSOI wafers for PMUT development
  - Collaborate in developing and demonstrating Piezo-on-Insulator wafers

- Collaboration with Picosun
  - Continue on-going collaboration in testing ALD coatings on VTT devices
  - Characterize the effects of ALD passivation on PMUTs

OSYPKA AG

Bart Kootte
Electronics layout

Benjamin Burg
Device design

Thorsten Göttsche
CTO, Project leader

OSYPKA
Technology for an active life

Facility in Rheinfelden, Germany, near Basle: Development and production. Two more facilities near Denver (CO), USA and Odry, CZ.

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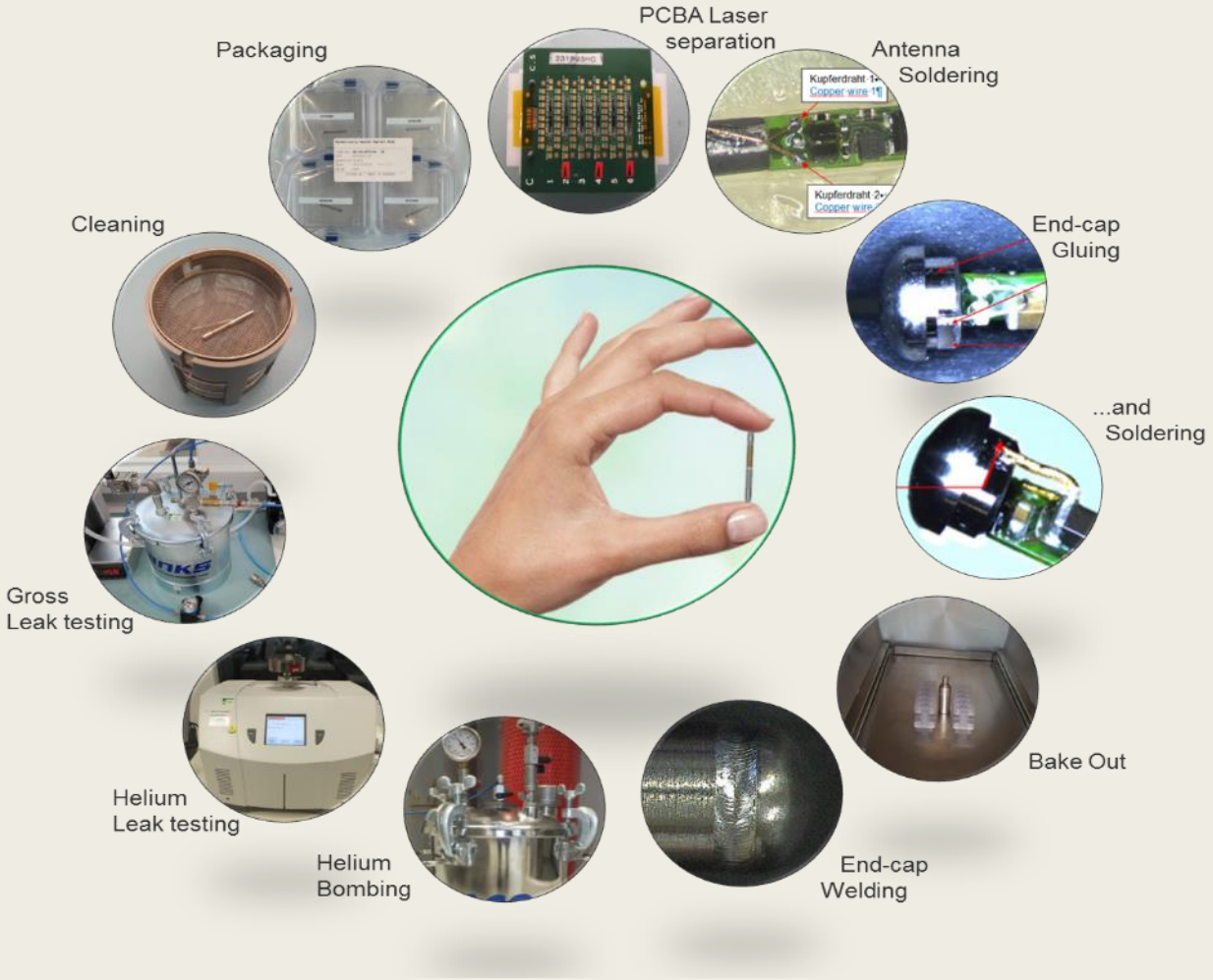
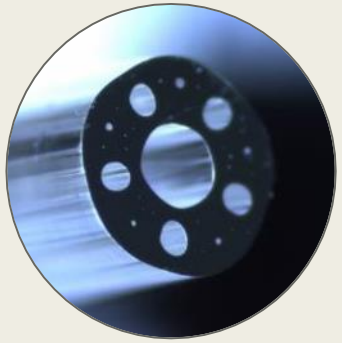
OSYPKA AG - our capabilities

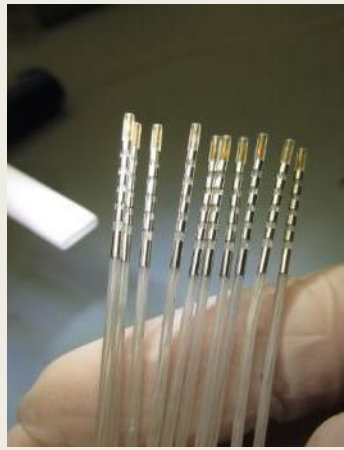
- IPG encapsulation
- Lead design and manufacturing
- PCB layout
- AIMD testing
- Catheter assembly

In detail:

– Thermoplast extrusion
– Thermoplast injection molding
– Silicone injection molding
– Laser structuring
– CNC milling
– Coil winding
– Clean room assembly
– Electronics integration







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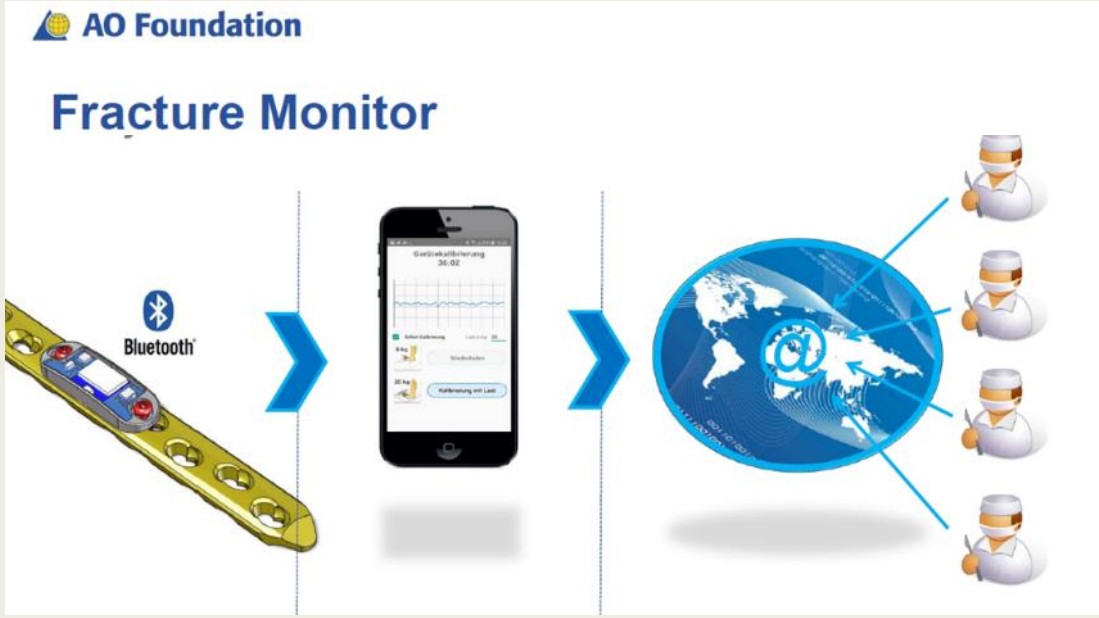
OSYPKA AG - our planned contribution

US-powered implantable Fraction Monitor (Demo leader)
Learnings beside realization of demonstrator

- US power transfer platform; bench-mark RF
- Encapsulation technology for US powered implants



Our tasks:

- Definition of requirements
- Overall device design
- Electronics layout
- Device integration
- Functionality testing

Contribution from others needed for:

- Design and simulation of ultrasonic wireless link (UNIROMA3, PEN, ST-I, OSY)
- Optimisation of transmitting and receiving transducers for efficient wireless power transfer (PEN, OKM, VTT, ST-I, UNIROMA3, TYN)
- Design of the power management and output stage ASIC (ANSEM, INESC)
- Design of the transmitter electronics for US power link (ST-I, UNIROMA3)

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Multi Channel Systems (MCS) – Who is who and where?

Karl-Heinz Boven
CEO

Jannis Meents
Head of Research Projects

Christoph Jeschke
Head of Hardware development

multichannel systems
Innovations in Electrophysiology

Multi Channel Systems MCS GmbH
A subsidiary of Harvard Bioscience

Aspenhaustrasse 21
72770 Reutlingen
Germany
Fon +49-7121-90925-0
Fax +49-7121-90925-11
sales@multichannelsystems.com
www.multichannelsystems.com

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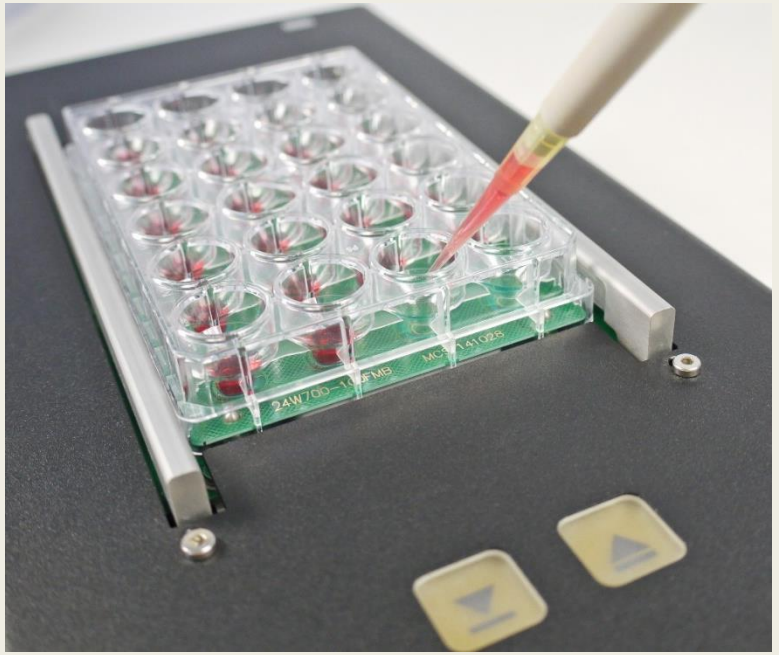
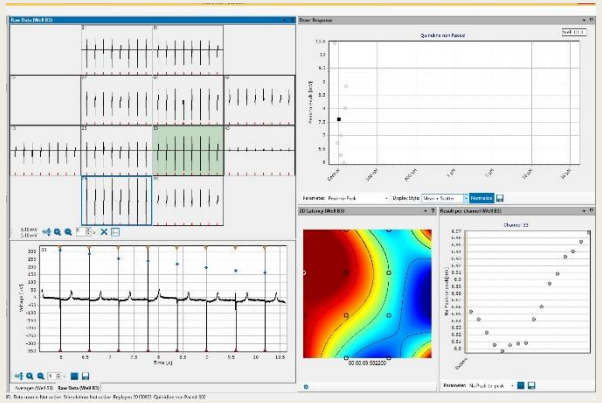
Multi Channel Systems (MCS) – Our capabilities

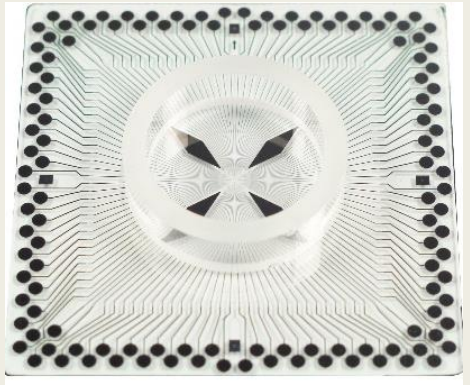
- Highly customized measurement systems for the E-Phys world
- Multiwell-MEA-System

  https://www.multichannelsystems.com/products/multiwell-mea-system
- Fluidics: Peristaltic Perfusion System

  https://www.multichannelsystems.com/products/pps2
- Years of experience in the field of electronics for inductive power- and bi-directional data transfer
- Data processing and transfer to the PC (USB or wireless) for data recording and further analysis
- Firmware development
- Windows Software development







Jannis Meents (jmeents@multichannelsystems.com)

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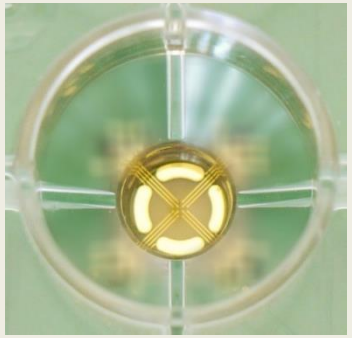
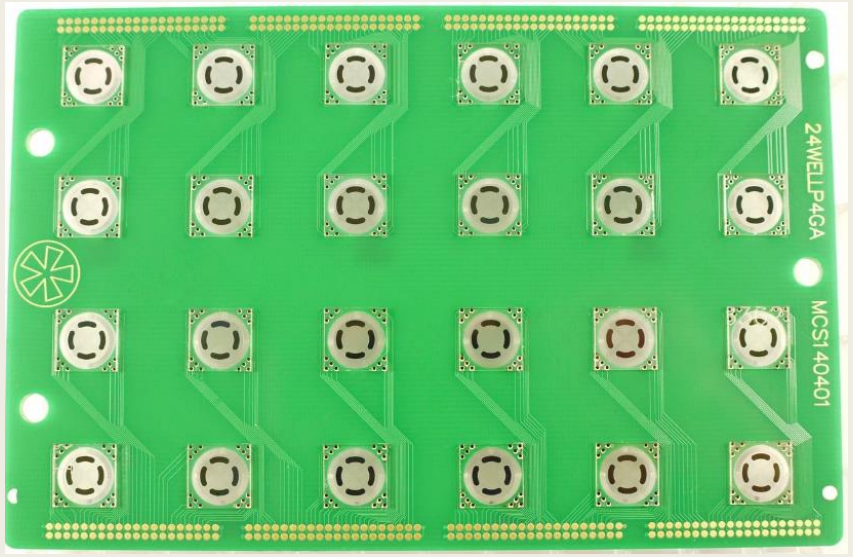
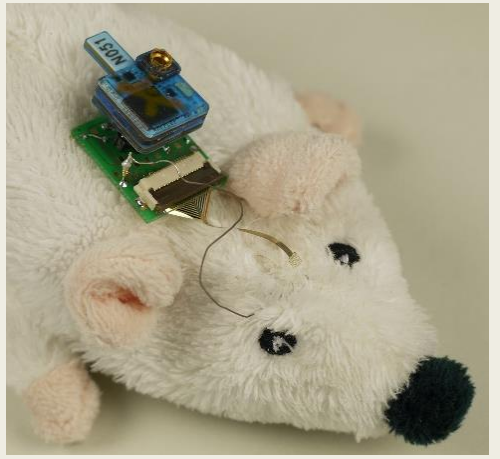
Multi Channel Systems (MCS) – Our planned contribution

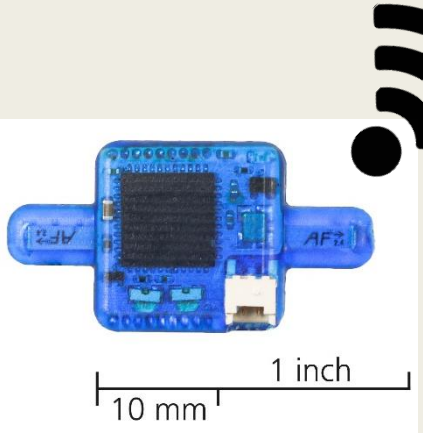
- Share our expertise in the areas of
  - *Multiwell-Systems and MW-Plates*
  - *Wireless (Inductive) Power Transfer*
  - *Wireless data transmission*
  - *Control of pumps for microfluidics*





- Plan, develop and fabricate custom electronics or test systems needed for WP1 & WP2.
- Develop custom software needed for WP1 & WP2.
- Provide technical assistance for potential in-vivo experiments.
- Provide existing MCS hardware/systems for the consortium if needed.





Jannis Meents (jmeents@multichannelsystems.com)

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IMT: Who is who and where

Carmen Moldovan
WP1

Bogdan Firtat
WP2

IMT: Main Building (left) and the new facility – CENASIC (right)

Location: 126A Erou Iancu Nicolae, Bucharest, Romania

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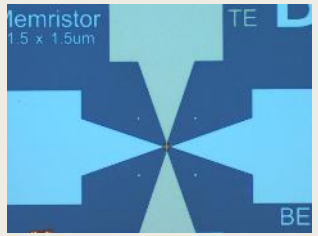
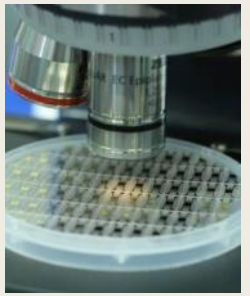
IMT: our capabilities

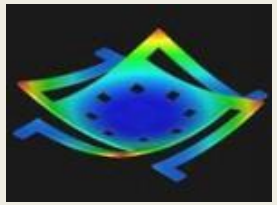
- The National Institute for Research and Development in Microtechnologies – IMT Bucharest was set up in 1996, and it is coordinated by the Ministry of Education and Research, acting basically as an autonomous, nonprofit research organisation.
- IMT is involved in research and development of micro- nano-biotechnologies and nano-electronics.
- The main competences are in closed connections to KETs and target the following research fields:
  - *Electronic Micro-and Nano-devices;*
  - *Photonic Micro-and Nano-devices;*
  - *Micro- electro-mecanical systems (MEMS), micro-and nano-fluidics;*
  - *Micro-nano-devices and systems for bio-medical applications (BioMEMS);*
  - *Advanced Materials and nanotechnologies*

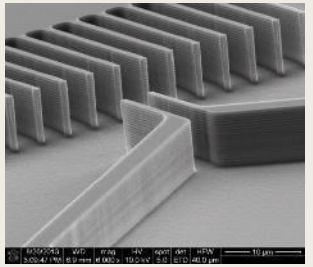




Laboratory of Microsystems for Biomedical and Environmental Applications, CINTECH Research Center

- Micro-nanosensors (chemoresistive, resonant gas sensors, accelerometers, microarrays, nanowire based ISFET), biosensors (electrodes, ISFET), microprobes for neuronal electrical activity recording: simulations/modelling, technological development and characterisation.
- MEMS devices for energy harvesting and sensors
- Microfluidic platforms - Simulation, modelling and fabrication
- Multisensor and microsystems integration; MicroPlatforms
- Signal conditioning; Data acquisition, processing and analysis;
- Autonomous and portable systems;





Main interests: bio – chemo sensors, MEMS technology, implantable devices, signal processing and data acquisition, energy piezoharvesters, Autonomous and portable systems, flexible electronics IoT for ICT, Space, Health and Environment

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IMT: our planned contribution

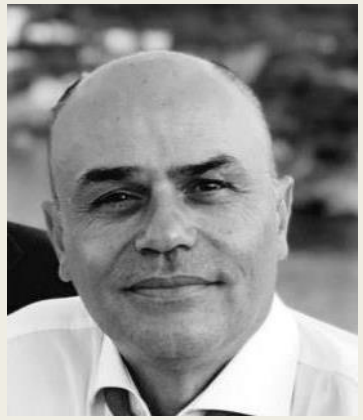
- Task 1.1 Definition of system level specifications for ultrasound and inductive wireless links;
- Task 1.2 Ultrasound for efficient wireless power transfer: *system integration, assembly and encapsulation tailored to the demonstrator*;
- Task 1.3 Ultra-high frequency nerve stimulation: *system integration, assembly and encapsulation techniques*;
- Task 1.5 Innovation track: *peripheral nerve interfaces with increased spatial selectivity; develoment of a nerve stimulation cuff consisting of a ring of multiple high frequency CMUT transducers that are able to focus US energy in spot with a diameter less than 100um. The US stimulation cuff will be* ***complemented by an electrode cuff for recording****. System specification ultrasound stimulation with electrical recording cuff; Signal processing for focusing cuffs & simulation efficiency; Cuff system integration (electronics breadboard, mechanical with ultrasound transducers, electrode, and dummy ASIC).*
- Task 1.6 Benchmarking of ultrasound and inductive wireless power transfer for implants: *In a final bench mark, ultrasound powering for active implants will be compared to a best-in class inductively powered implant*.

IMT will contribute on piezoelectric MEMS packaging, assembly and biocompatible coatings of devices and to the benchmarking of ultrasound and inductive wireless power transfer using its modeling, and testing of wireless power transfer to implanted cuff electrodes; electrodes fabrication and integration, biocompatibility studies and stability tests.

STMicroelectronics key contacts

Fabio Quaglia

ST project leader



Andrea di Matteo

ST project coordinator

STMicroelectronics is one of the world's largest semiconductor companies with net revenues of US$ 9.56 billion in 2019, with a operating margin of 38.7 % and a net income of US$ 1.03 billion. Offering one of the industry's broadest product portfolios, ST serves customers across the spectrum of electronics applications with innovative semiconductor solutions by leveraging its vast array of technologies, design expertise and combination of intellectual property portfolio, strategic partnerships and manufacturing strength.

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STMicroeletronics

ST-I R&D infrastructures includes:

- Si process technology laboratories in Agrate Brianza (MB) / Cornaredo (MI), fully equipped with simulation tools and equipments for on wafer and in package device characterization and testing and for physical analyses
- Packaging technology laboratories in Agrate Brianza (MB), equipped with simulation and testing tools
- Integrated circuits design and verification tools
- Laboratories for electronic system development, characterization and testing
- Tools for algorithms development in electronic systems

1. ENIAC KET 2012: LAB4MEMS “LAB FAB for smart sensors and actuators MEMS”
2. ENIAC KET 2013: LAB4MEMS II “Micro-Optical MEMS, micro-mirrors and picoprojectors”
3. H2020 ICT-03-2016: INSPEX “Integrated Smart Spatial Exploration System”.
4. H2020 ECSEL IA Project Arrowhead-Tools H2020 ECSEL IA Project 826452, 2018.
5. ENIAC Call 2012-1 DeNeCor “Devices for NeuroControl and NeuroRehabilitation”

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STMicroelecronics planned contribution into WP1

- PMUT array for energy delivery co-design, together with UniRoma3.
- PMUT wafer micro-fabrication
- PMUT assembly on rigid or flex support (std electronic support)
- PMUT electro-mechanical test (Impedance spectroscopy, Laser Doppler Vibrometer)

Tyndall National Institute – Cork, Ireland

Paul Galvin
Group Head

Des Brennan
Senior Researcher

Eamonn Hawe
Country Coordinator

Conor O'Mahony
WP3 Lead

Fjodors Tjulkins
Researcher

Ryan Sebastian
Researcher

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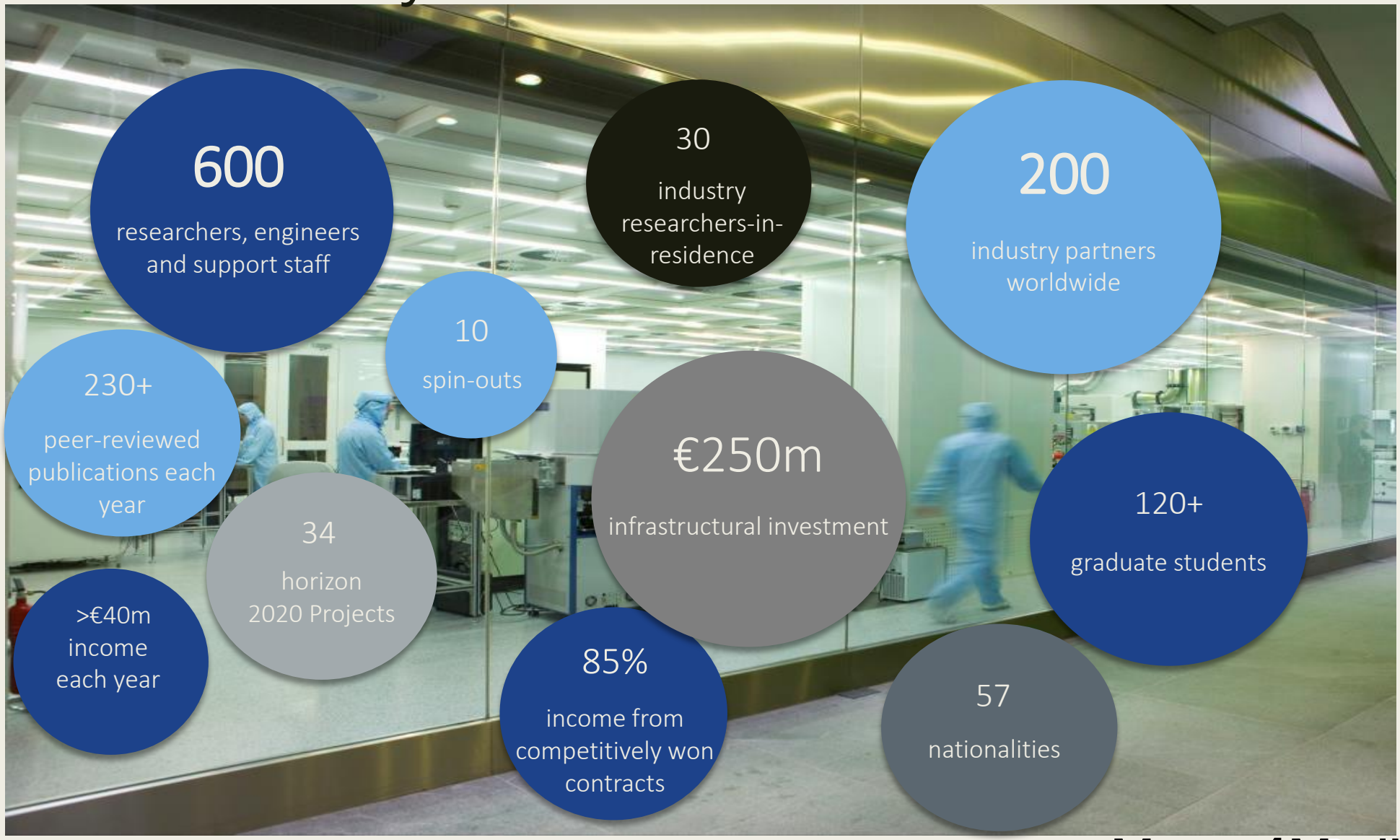
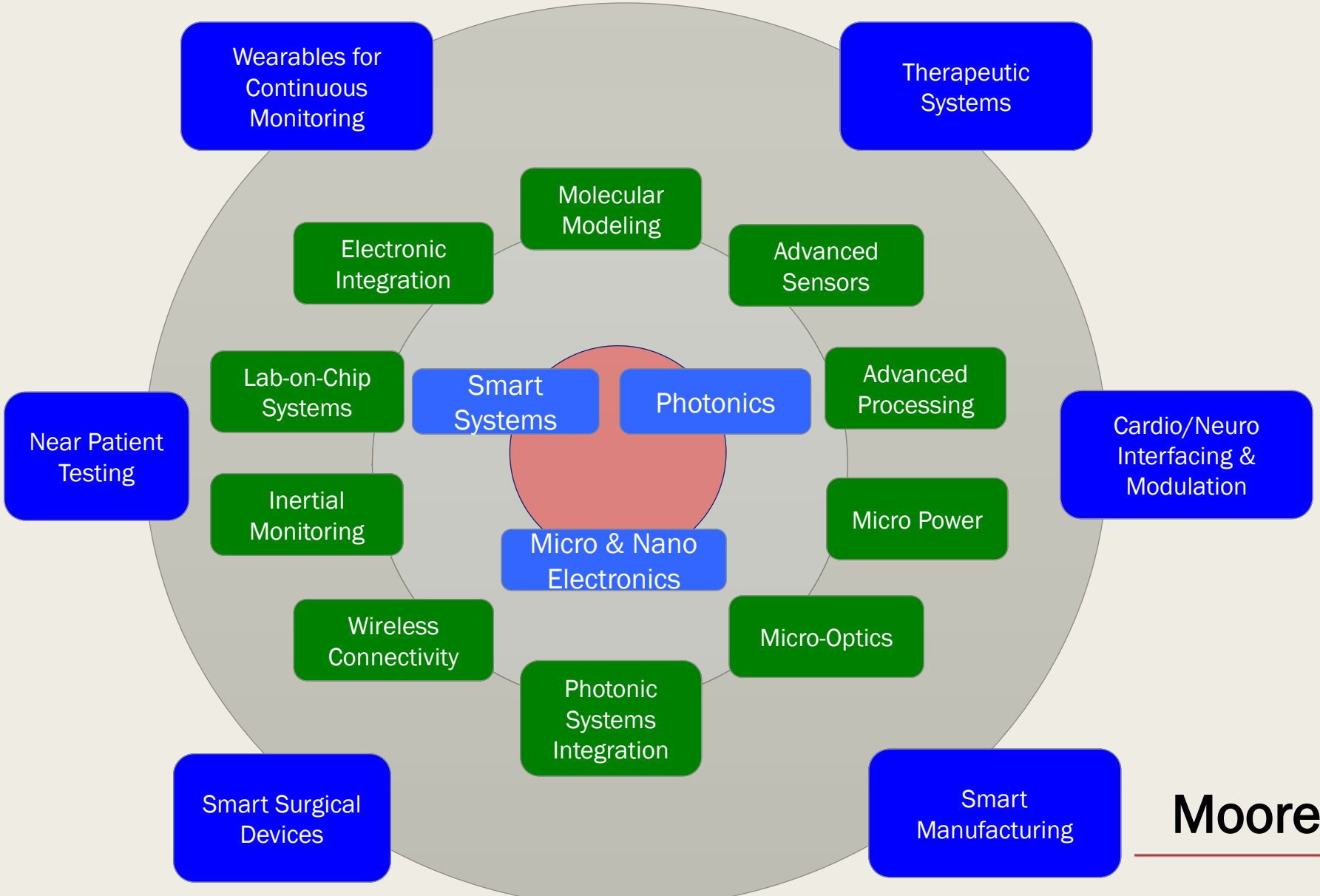
Tyndall in numbers



Tyndall Key Enabling Technologies

Underpinning innovation in Medtech & Pharma



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Tyndall planned contribution

WP1 Tasks

Number	Name	Role
1.1	Definition of system level specifications for ultrasound and inductive wireless links	In this task Tyndall will input into the system level specifications for the Ultrasound powered prototype including operation frequency, depth in body, required power, maximum form factor. The work plan will also be refined.
1.2	Ultrasound for efficient wireless power transfer	Tyndall will input into the optimisation of transmitting and receiving transducers for efficient wireless power transfer
1.3	Ultra-high frequency nerve stimulation	Tyndall to work closely with and contribute to those partners designing the various components including ASICs and PMUT. Tyndall will evaluate the various components and select the most suitable for the Implantable demonstrator. Tyndall will play a role in system integration, assembly and encapsulation techniques.
1.4	Inductively powered conforming peripheral nerve interfaces	None
1.5	Innovation track: peripheral nerve interfaces with increased spatial selectivity	Tyndall will work on system integration including: (electronics breadboard, mechanical with ultrasound transducers, electrode, and dummy ASIC), along with signal processing.
1.6	Benchmarking of ultrasound and inductive wireless power transfer for implants	Tyndall will integrate and assemble the various components into a suitable form factor and before carrying out lab based test and characterisation at Tyndall laboratories

Salvia BioElectronics - who is who and where

Zameed SahebAli
Director Product Development

Stijn Boere
Sr. Mechanical Engineer

Steve Gee
Sr. Electronic Design Engineer

Daniel Schobben
COO

Building HTC41, High Tech Campus Eindhoven

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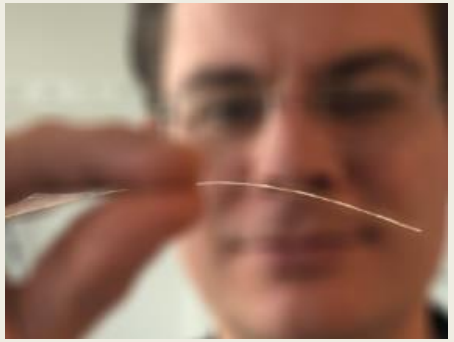
Salvia BioElectronics – our capabilities

Our capabilities include:

- Device architecture and design
- Electronic power system design
- Pulse generation electronics
- Accelerated lifetime tests
- (Pre)clinical and cadaver studies



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Salvia – our planned contribution

- Task 1.4 Conforming peripheral nerve interfaces (task leader: SAL)
- Partners: ICsense (ICS), Dyconex (DYC), Picosun (PIC), IMEC (IMEC-BE), University of Freiburg (ALU), Cortec (CTC), Fraunhofer IZM (FIZM)
- An implant is developed that can be positioned underneath the skin. The implant uses a novel electrode configuration and circuit design to effectively power implant, and to use this energy to effectively stimulate nerves.
- Subtasks:
  - *Development of substrate and assembly techniques (FIZM, DYC, PIC, IMEC-BE);*
  - *Design of the power management and output stage ASIC (ICS);*
  - *Design of the electronics (ICS);*
  - *Neural activation modelling (SAL);*
  - *Active interface design (SAL);*
  - *Mechanical and electrical validation (FIZM, SAL, IMEC-BE).*

INESC-ID Lisboa: Who is who and where






jorge.fernandes
Researcher
Ass.Prof. IST

taimur.Rabuske & diogo.brito
Post-Doc Researchers

joao.silva & goncalo.rodrigues & hanna.busse
PhD Students

...@inesc-id.pt

Instituto Superior Técnico (Alameda Campus)
Universidade de Lisboa

INESC-ID Lisboa
R&D Institute

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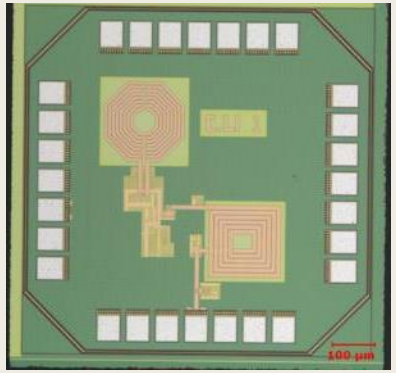
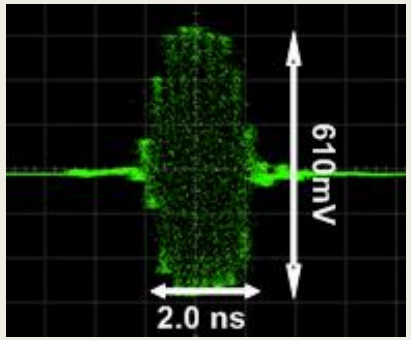
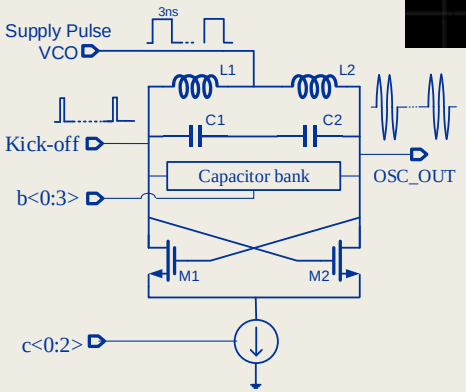
INESC-ID Lisboa: our capabilities

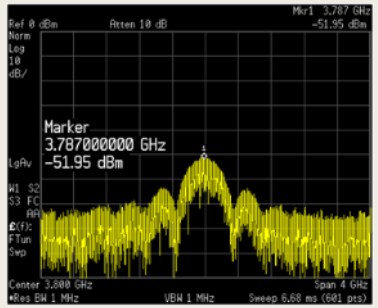
Analog and RF ASIC Design

IR-UWB

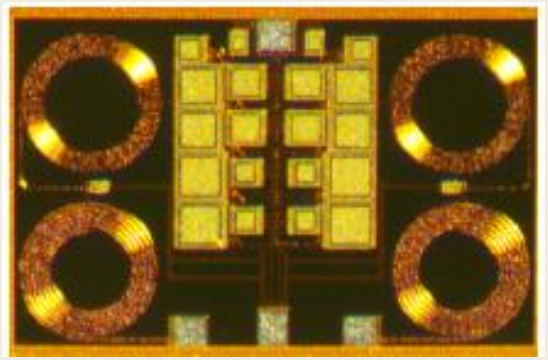


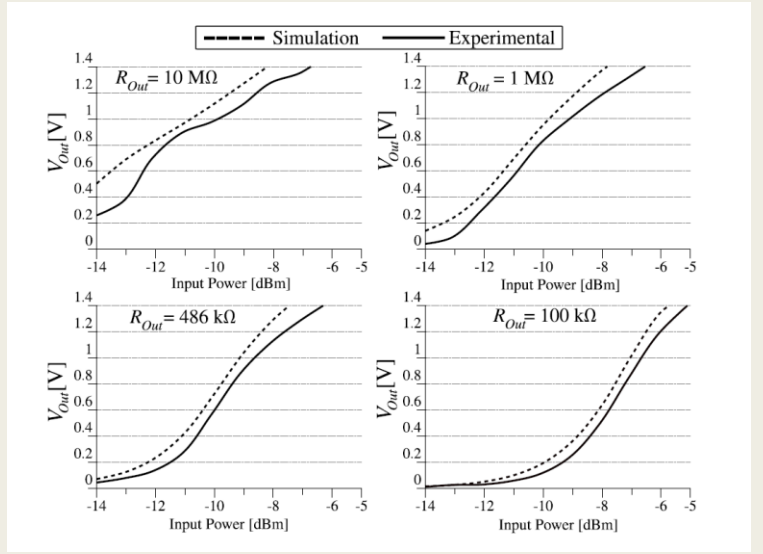


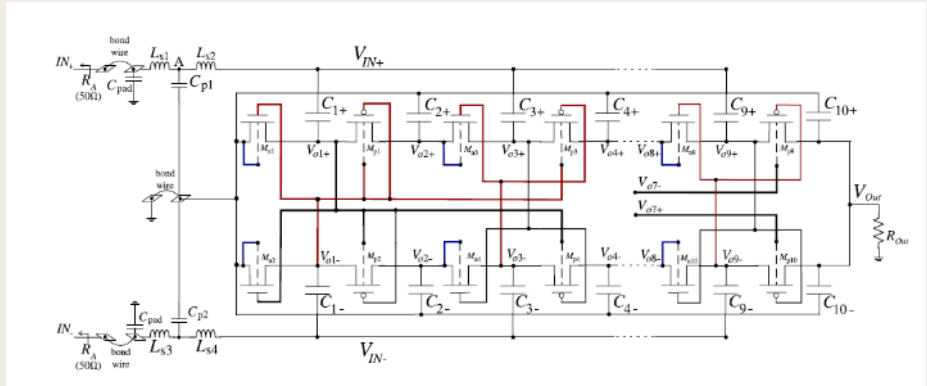




Power Harvesting







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INESC-ID Lisboa: our planned contribution

How do you see your role in the project?

ASIC Design @ WP1 Implantable devices

What would you like to do?

US Wireless Power Transfer / Ultra-high Frequency Nerve Stimulation

Who are your partners?

TUD, OSY, ANS, SGT

Who would you like to team up with?

Whoever feels that can contribute ☺

What capabilities do you need?

US CMUT

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SILICONGATE - who is who and where

Floriberto Lima

CEO

Marcelino Santos

CTO

Tiago Moita

Lab Head

Lisbon site

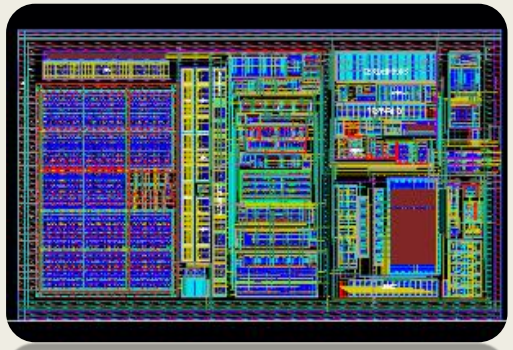
- SILICONGATE designs and license power management IPs and complete Power Management Units (PMUs)
- Started in Portugal in 2008 by already very experienced power management engineers (coming from previous Chipidea)
- Large portfolio of power management IPs, mainly in TSMC, UMC and Global Foundries, in major nodes down to 12nm
- Close connection to university facilitates human resources selection and training

Moore4Medical

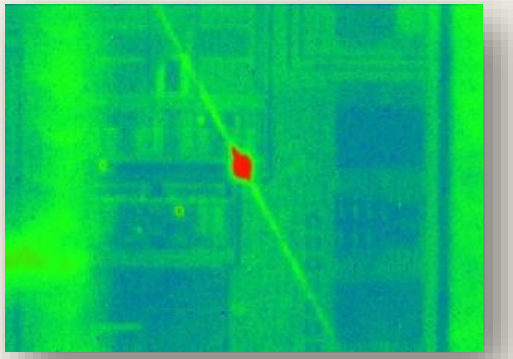
SILICONGATE – our capabilities

Power Management IP - Ultra low power (sub µA PMU)

Typical PMU includes:



- **PMU controller** – power mode control and power up sequence + OTP
- **DCDCs** –high efficiency power conversion
- **LDOs** – low noise voltage regulation
- **RTC** – time keeping and periodic task management
- **Oscillators** – clock for RTC, digital logic, etc
- **ADC** – temperature, voltage and current monitoring
- **Battery charger** – charges the battery and switches the supply between external and battery
- **Testing** – automatic characterization test data acquisition, processing and reporting
- **Debugging** – photoemission for detection of leakage and abnormal current down to the µA



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SILICONGATE - our planned contribution

- Silicongate participates exclusively in WP1 on
  - **Tasks 1.2** - Ultrasound for efficient wireless power transfer and (Task leader: OSY) – action: Design of the power management and output stage ASIC (with ANSEM, INESC-ID);
  - **Task 1.6** - Benchmarking of ultrasound and inductive wireless power transfer for implants (Task leader: TUD) - action: Design voltage regulators for the different power management ASICs for the implant
- Role: Silicongate role is IP provider
- To do: design power management IP targeting M4M needs
- Natural partners: ANSEM and INESC-ID share action in task 1.2, Osypka as the task leader; TUD as leader of task 1.6
- Main need: specifications of the power management IP to design

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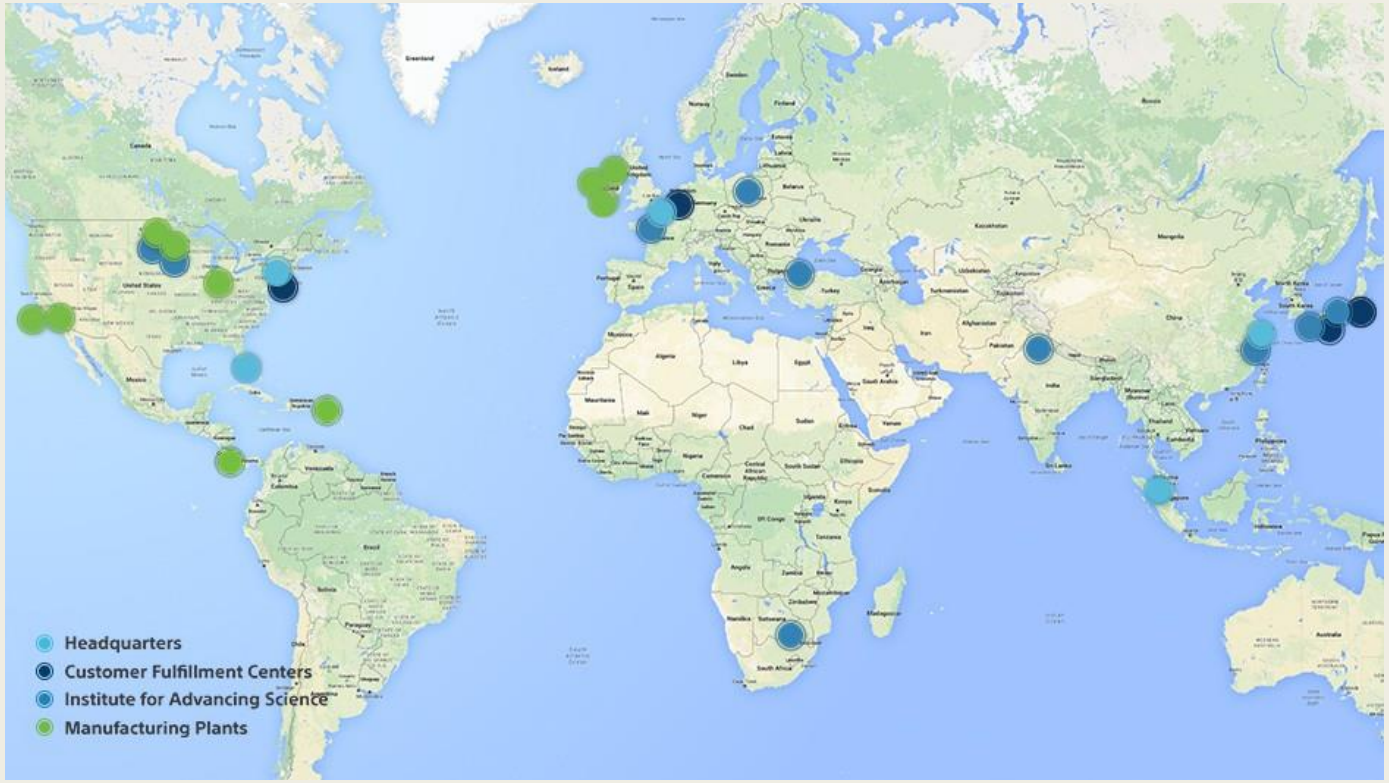

- 25,000 Employees Globally
- over 13k products and a revenue of 10Billion in a range of areas
- 3 Plants in Ireland – Clonmel, Cork, Galway

Sean Cooney

Patrick McCallion

Daniel Canavan

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Overview of Boston Scientific Clonmel

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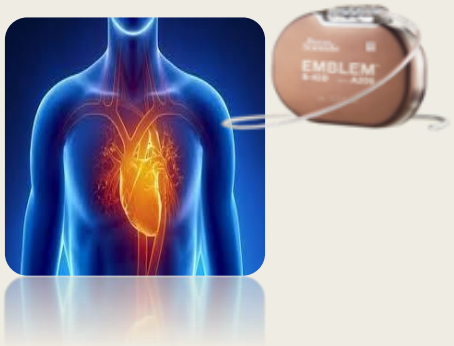
Pacemakers

BSC share 16% #3

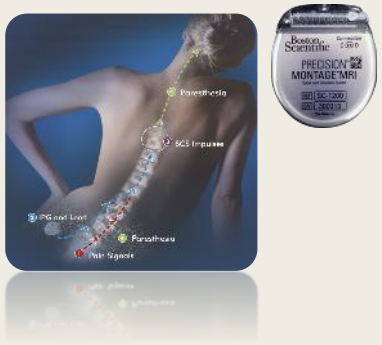
Annual volume 175,000



Defibrillators

BSC share 27% #2

Annual volume 115,000



Spinal Cord Stimulation

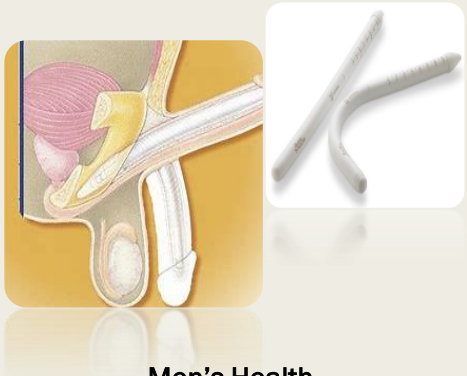
BSC share 29% #2

Annual volume 30,000

Deep Brain Stimulation

BSC share 15% #2

Annual volume 6,000



Men's Health

BSC share 75% #1

Annual volume 3,000

- >1000 Employees:
  - 550 Product Builders
  - 300 Operations and Quality
  - 50 New Product Development

- Building: 180K sq. ft. Cleanroom space: 53K sq. ft.

- Annual Value of Production
  - $277 M

- Cardiac Rhythm Management
- Neuromodulation
- Urology
- Capital Equipment Repair

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Site Capabilities

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Men's Health

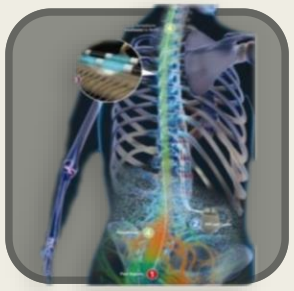
Supply Chain

- Procurement
- Planning
- SAP/MES BPLs
- WW Distribution
- Delayed customisation

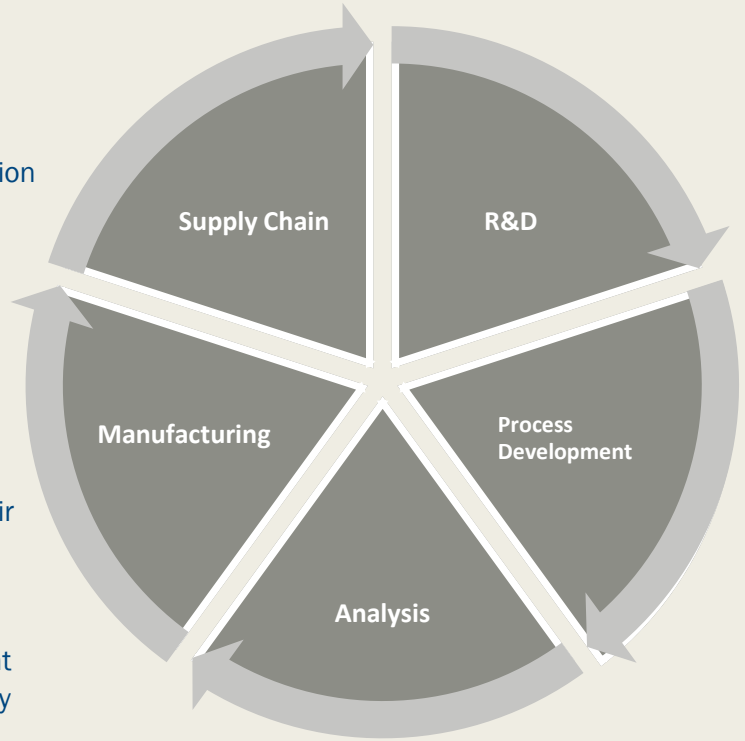
Chronic Pain

Manufacturing

- Compliance culture
- Preventative quality
- Capital equipment Repair
- Product transfers and acquisitions
- Product launches
- Continuous improvement
- Manufacturing regulatory



Spinal Cord Stimulators



Analysis

- Electrical development lab
- Design verification lab
- Material testing lab
- Microbiological lab

R&D

- Mechanical design
- Electronics Hardware design
- Firmware Development
- Software/UI Development
- Motor Control/Pumps/Fluidics
- Industrial design
- R&D Sustaining

Process Development

- Complex tooling/mould design
- New Technology Development
- New Product Introduction
- Manufacturing Optimization
- Test system design/development
- Automation / Robotic solutions
- Product data management solutions

Pacemakers/ Defibrillators

Parkinson's Disease

Deep Brain Stimulators

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Key Technologies

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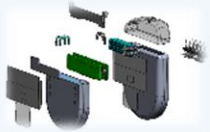
Core Technologies



Complex Electronic Manufacturing

PCB Assembly

Electrical Test

Hermetic Laser Welding

Laser Surface Modification

Epoxy Overmoulding

ETO Sterilization

Precision Moulding

Inkjet Printing

Parylene Coating

Resistance Welding

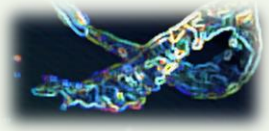
Auto-inspection

Mass Spectrometry Leak testing

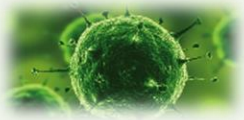
Adhesive Bonding

Enabling Technologies

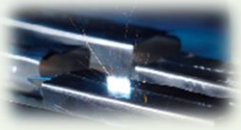
Additive Mfg



Fluidics/Pumps



Ultrathin Film Coatings



Laser Processing

Data Analytics

Motors

Pallet Sterilization

Planned Contribution

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- Provide information on the current state of the art, business cases and economic viewpoints, target device specifications, use-case scenarios, and insights into human factors.
- Development of the first ultrasonically powered ultra-high frequency deep neural tissue stimulating implant.
- Test and validation of the developed implant
- Benchmarking against best in class Boston Scientific inductively powered implants.