

Moore4Medical

WP6

Continuous monitoring



Work package leader:
Jos Aarts



Tuomas Kiviniemi
project leader (Med.)



Juhani Airaksinen
prof. Cardiology



Tero Koivisto
project leader (Tech.)



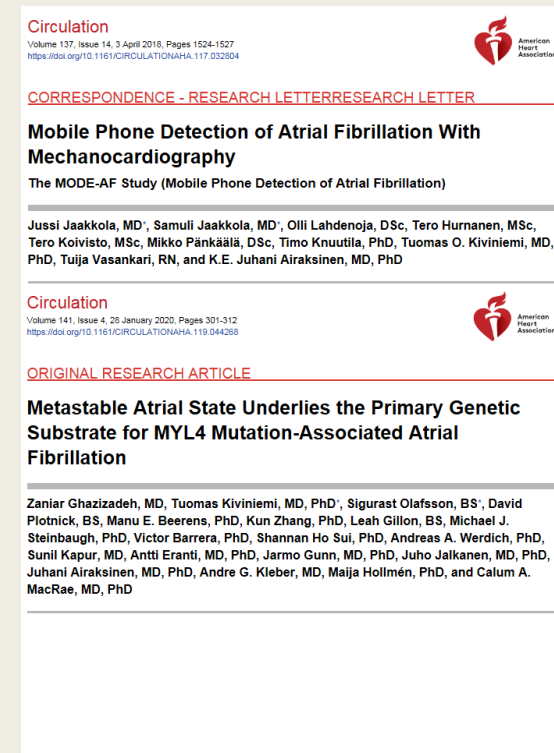
Olli Lahdenoja
algorithms



Health Campus at Turku, Finland. A significant Multidisciplinary Knowledge Hub working at the interface of clinical medicine, patient care and novel health technology. This Hub offers unique opportunities for research, innovation and corporate collaboration.

Combined expertise: Cardiology, clinical trials, algorithms and monitoring devices

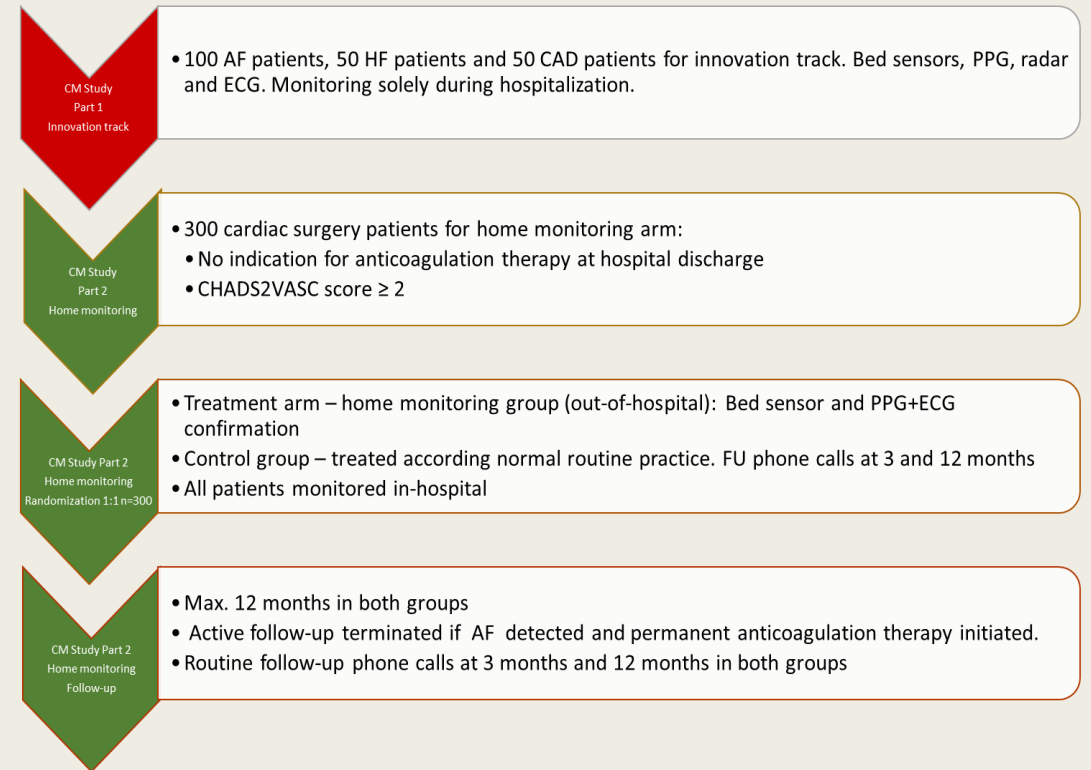
- CAREFIB Consortium at Turku Heart Center aims to reduce the burden of atrial fibrillation and its adverse outcome stroke in patients undergoing cardiac procedures. Healthtech's group mission is to discover, invent and innovate new solutions for saving lives and making life more liveable. Healthcare technology can empower you to improve your health: to analyze your physical condition and alert you of possible diseases. We create the tools for you to help yourself.
- <https://www.carefib.com/>
- <https://healthtech.utu.fi/>



MOORE4MEDICAL

Flow chart for randomized clinical trial

- Leading tasks 6.4. (clinical trials) and 6.5. (algorithms).
- Main partners all involved with clinical trials and algorithm development





Innovation for better care



Markus Merne
CEO, Project leader



Mika Hokkanen
Coordinator



Pasi Oksa
Proj SW man.



Kauko Valtonen
Proj. writer



Markku Metsävuori
CTO



Everon HQ in Turku / Åbo, Finland.

- Administrative
- R & D center
- Sales FI
- Group logistics

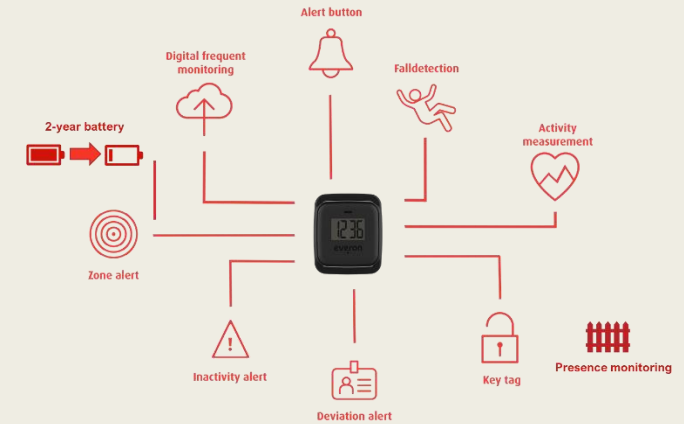
Everon's embedded knowledge

Everon focuses on welfare technology and is at the forefront of this technology to aid the daily lives within the care and health care sectors. We have recently introduced a new generation of wrist-top alert and measurement devices.

Everon has team power for the following tasks:

- HW development
- FW development
- SW development
- UI and application development

Everon also participates in “Applause” – H2020-Ecsel-2018-1-IA-two-stage project for developing algorithms for detection of heart failure using multimodal sensor patch. In that project our role is to develop the HW infrastructure that will be beneficial to Moore4Medical.



Everon's planned contribution

How do you see your role in the project?

-> We want to be central to the infrastructure relaying and communication detected deviations or alerts using our backend cloud based services.

What would you like to do?

-> create a strong solution together with the partners that we can market already after the project. Hence all clinical tests and approvals are important.

Who are your partners?

-> Main partners are UTU and Precordior to develop the algorithms for the backend

Who would you like to team up with?

-> Emfit, Hi Iberia, Philips Electronics Netherlands, University of Turku, Vitalsignum, Precordior, eRemoteA

-> We look forward to finding new interesting partners

What capabilities do you need?

-> UX design, AI knowledge/platforms

Emfit Ltd, Finland

Staff: 20 employees

Locations: Jyväskylä, Finland; Austin, Texas, USA

Founded: 1990

Core team in the Moore4Medical project



PhD Timo Aittokoski
SW development



MSc Jukka Ranta
SW development

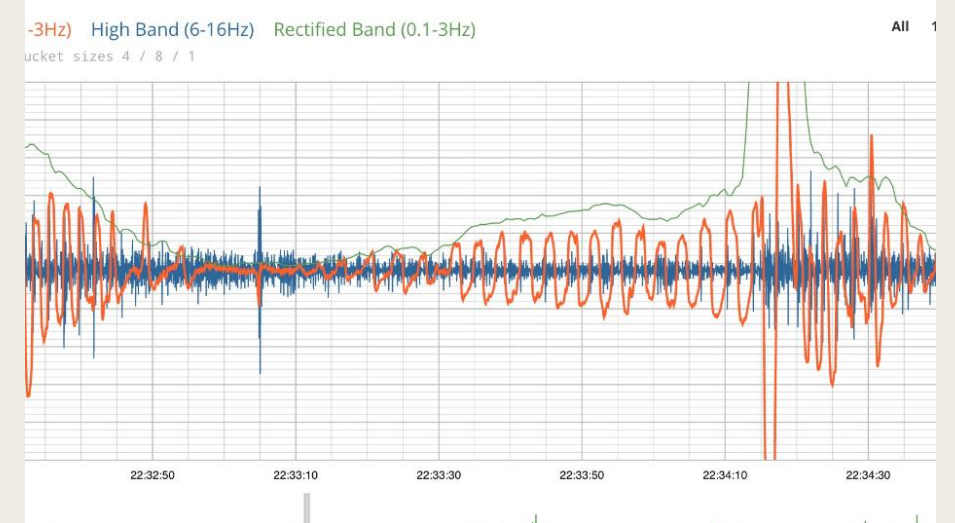


Heikki Räisänen, CEO
Administration



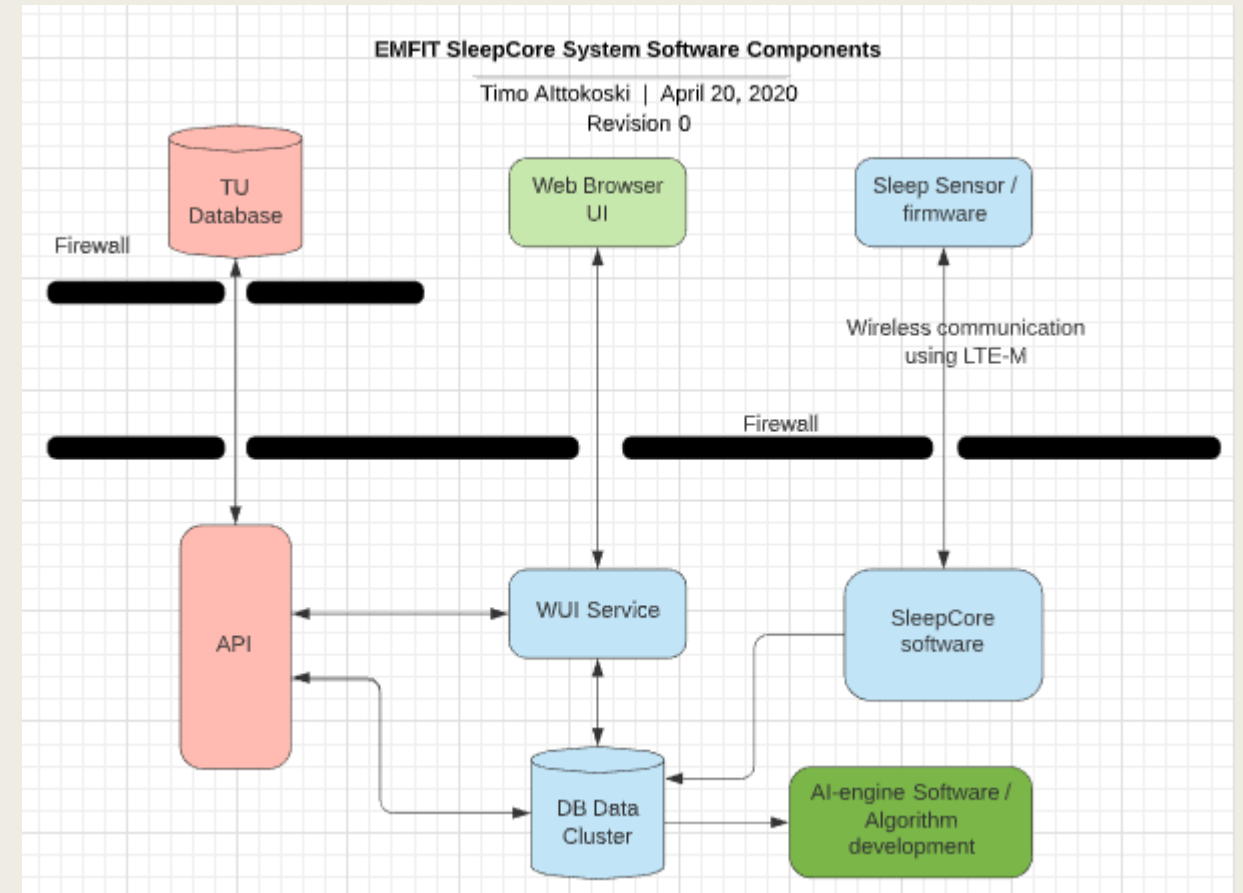
Emfit capabilities

- Development and manufacturing:
 - Contact-free (under-mattress) sleep sensing solutions
 - Wearable patient monitor for five university hospitals in the EU funded “Nightingale” project
- Sleep sensor applications:
 - Consumer sleep and recovery
 - Elderly care
 - Apnea scoring
 - Scientific and clinical research
 - Band-pass filtered sensor signal via API to end-point URL for further signal analysis



Emfit contribution

- In the project we collaborate especially with TU.
- We provide over the Internet operating under-mattress ballistocardiographs to the Turku University hospital cardiology post-operative patients
 - With our cloud based software system we will deliver band-pass filtered sensor signal files automatically to TU's database
- We wait from the project that we get ECG based annotations of AFIB (or other arrhythmias) to the data files.
 - We can use annotations to develop machine learning based algorithms for automatic AFIB detection from our sensor BCG-signal.



Remotea | Who is who and where



Jorma Kario
Project Director



Sami Isoaho
Executive chairman



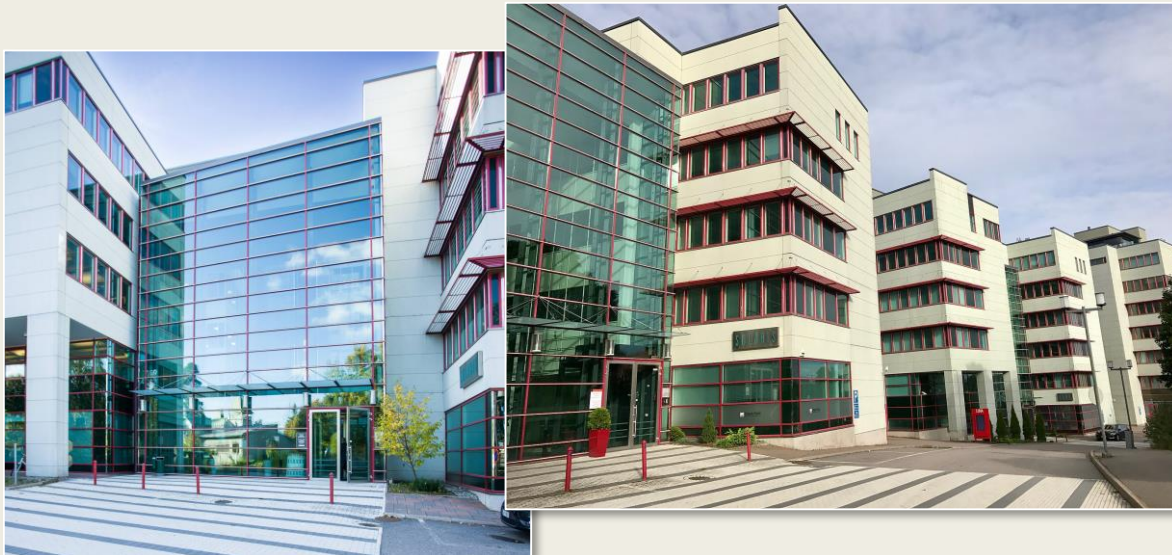
Kimmo Suotsalo
CTO



Patrick Francke
CBDO



Mikko Haikala
DEO



Perkkää Business Park in the heart of Espoo

Remotea | our capabilities

Remotea is a Finnish healthtech company specialized in cardiological software solutions.

Our solutions help patients to get treatment faster, healthcare to use their resources more efficiently and health and wellness operators to give more value to their customers.

We provide solutions from two perspectives – **diagnostics and screening**

SmartECG is a CE certified, class IIa medical software for viewing and analysing ambulatory ECG recordings. A typical use case is the diagnosis of patients referred to 24-hour Holter examination.

SmartECG Screening is a fast and cost efficient solution for analysing large amounts of long-term ECG data, speeding up the diagnosis of screened patients and flagging those who need to be examined more thoroughly by experts.

Remotea | our planned contribution

Remotea Oy will use in-hospital and out-of-hospital ECG data, as well as radar and membrane-based motion data, to develop together with UTU and Emfit new AI based algorithms for analysing ECG, radar, and membrane-based motion data, to be integrated into REA products. REA will be an end user for new algorithms and software for detection of cardiac anomalies, foremostly AFib detection

Precordior– Who is who and where



Tuomas Valtonen
Chief Operative
Officer



Juuso Blomster
Chief Executive
Officer



lisa Mattila
People & Operations
Coordinator



Our office is currently in the Pharma City building of the Kupittaa Technology Center in Turku, Finland

...but hoping to move soon downtown closer to this nice scenery by Aura river :)

Precordior – Our capabilities

(and our story)

- Precordior is a Finnish company founded in 2016 as a spin-off from the University of Turku.
- We are an ISO 13485 certified company producing **medical devices**, currently in CE Class IIa.
- Today we are 13 people but growing to ~20 by end of year.
- Our first product is the CardioSignal smartphone-based solution for detection of **atrial fibrillation** (AFib).
- In 2017 our AFib detection solution won the **Best Healthtech Smart Solution** award at the University Startup World Cup, Copenhagen.
- In 2019 our AFib detection solution won the **Health Innovation of the Year** title in Finland at the Health Awards gala, Helsinki.
- In 2020–2022 Precordior is receiving the highly competitive **EIC SME2 grant** by the European Commission (top 4% SMEs in EU).
- Next we will expand into detection of **heart failure** and **coronary artery disease** via bed monitoring or smartphone.
- We work with **passion** and have **fun**!



2019 – Winning Health Innovation of the Year title in Finland.



2020 – Winning the EIC SME2 grant

Moore4Medical

Precordior – Our planned contribution

How do you see your role in the project?

- Precordior will contribute to signal processing, data analysis and algorithm design for analysing mechanocardiography data from bed sensors.
- We are also responsible for the cloud-based integration of all WP6 demonstrators in task T6.9.

What would you like to do?

- Create an bed monitoring environment for detection of heart failure and coronary artery disease.
- Get to know our ecosystem partners better and find great new synergies.

Who are your partners?

- 3DB, CSEM, EVN, EMFIT, HIB, IRBLL, IMEC-BE, IMEC-NL, INIO, INL, UM, PEN, ST-I, REA, GEM, UTU, VIM

Who would you like to team up with?

- Any other partners in Moore4Medical working in digital health area.

What capabilities do you need?

- We are always interested in business cooperation within the medical tech market.
- New highly sensitive, low-power accelerometers and gyroscopes are also welcome!

Thales DIS Finland Oy (former Gemalto Oy)



Kari MIETTINEN

ePassport OS R&D Manager,
M4M Project Leader for Thales DIS Finland



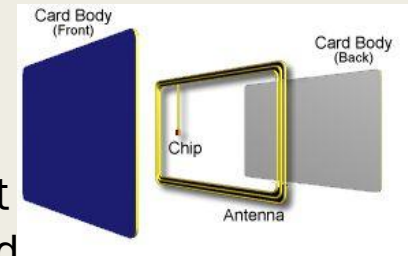
Center of excellence for Government Technologies, located in Vantaa, FINLAND. Activities on SALES & MARKETING, ADMINISTRATION, OPERATIONS (production), and R&D.

Thales DIS Finland – our capabilities

- The **global Thales DIS Business Unit** (former Gemalto) offers a wide range of secured products, solutions and digital services in: Banking & Payment, Big Data Analytics, Enterprise Security, Government, IoT, Mobile, and Software Monetization.
- **Thales DIS Finland** is the center of excellence for *Government technologies*, producing roughly 10+ million ePassports per year. Other products include various eID cards, eResident permits, eTacho,...
- Our local R&D designs, implements and tests Thales ePassport Operating System, graphical design of the various ID products, embedded RF antenna and communication with the readers (upto 6.8Mbps). Roughly 1/3 of all the ePassports in the world has Thales Operating System.
- Our local software R&D has very long experience and expertise on embedded software development on secure microcontrollers. Our main product is the ePassport Operating System, conforming to ICAO and BSI standards. The OS and the chip of the ePassport are always security certified using CC (Common Criteria), at least on EAL5+ level. CC certification means very strict requirements for the logical and physical security of the actual development work.

Thales DIS Finland - planned contribution

- Our role: We will generally work on identity management where the trust is anchored in the secure element. This secure element can be used to authenticate the user to those medical services seen feasible in this project. We will provide these secure elements in the form factor of ID-1 cards (contactless secure chip+antenna+card body of credit card size) as many as needed.
- This secure element (medical ePassport), will offer secure storage (LDSv2) for medical data, strong authentication based on ePassport technology, and sensitive data management compliant with EU regulation regarding privacy. LDSv2 is a writeable & secure filesystem, and can contain the most critical/secure medical data of the patient (contents to be agreed during the project).
- Concerning the user authentication, we propose that M4M platform would support FIDO authentication framework, which is an open standard for simpler, stronger authentication using public key cryptography. In FIDO terminology, the FIDO2+CTAP2 compliant ePassport is an Authenticator providing Passwordless Second Factor Experience when the user is authenticating to a FIDO compliant service. The user (patient, doctor,...) simply puts his/her card close to NFC-enabled device (such as smart phone supporting FIDO), and authenticates to the desired medical service (provided by the platform) by typing his/her PIN code. See more info in <https://fidoalliance.org/>. During this project, we will add FIDO2 support in our ePassport.



Maastricht University (UM) - NL



Jos Aarts
Program leader



Enrico Toffoli
Electronics engineer
Project leader



Ralf Peters
Data scientist



Marcel van de Poll
Intensivist



Brightlands Maastricht Health Campus

Maastricht University

FHML | Faculty of Health, Medicine and Life Sciences

FSE | Faculty of Science and Engineering

MUMC+ | Maastricht University Medical Center

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UM: our capabilities

Department of Instrument Development, Engineering & Evaluation (IDEE, FHML | Dutch word for Idea)

A modular measurement and data management platform is operational for the fast development of wearable prototypes for clinicians and researchers within the Maastricht University Medical Center (MUMC+) to enlarge their medical scientific knowledge and together with companies make that available for validated care applications inside and outside the MUMC+. These applications usually comprise wearable sensors, data analysis, algorithms and feedback to the patient.

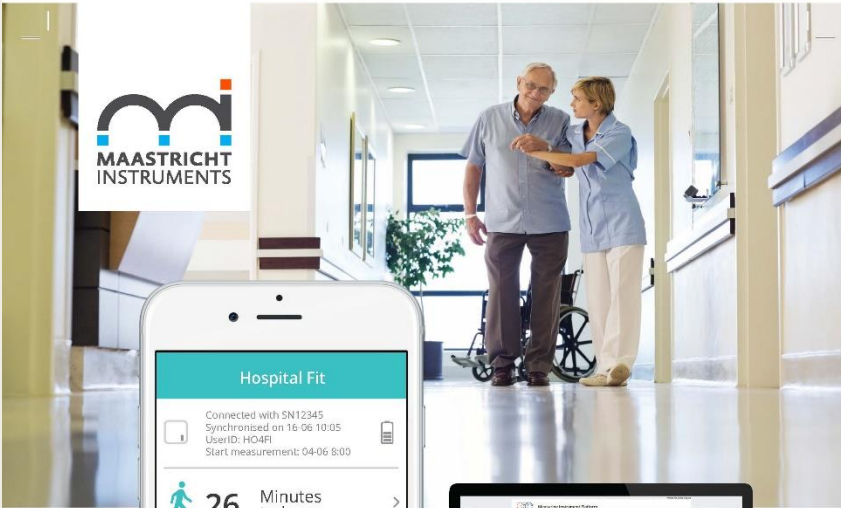
Department of Data Science and Knowledge Engineering (DKE, FSE)

Artificial Intelligence and Applied Mathematics, with applications in robotics and the biomedical domain. 10+ years of collaboration with cardiologists at UM on ElectroCardioGraphic (ECG) imaging.

Department of Intensive Care (ICU, FHML)

Provides clinical care in the immediate postoperative phase, among others to cardiac surgery patients where the incidence of de novo atrial fibrillation is high and cardiac rhythm is continuously monitored by conventional means. The department has working group on the clinical implementation of remote monitoring

UM: Examples



MAASTRICHT INSTRUMENTS

Hospital Fit

Connected with SN12345
Synchronized on 16-06-10:05
UserID: HQ4FI
Start measurement: 04-06-8:00

26 Minutes today

40% Recovery

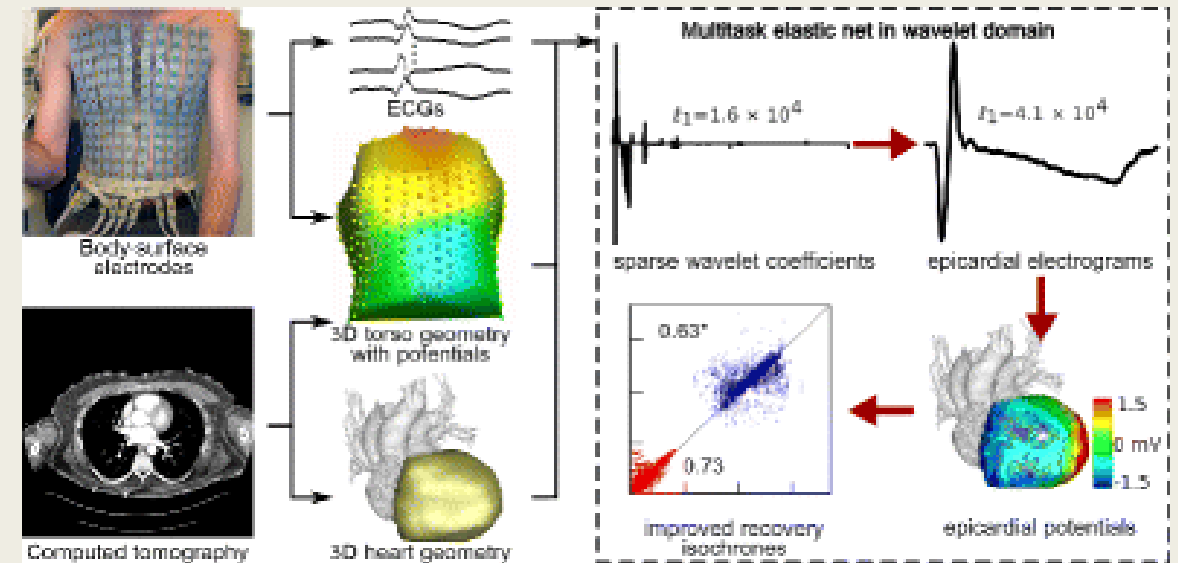
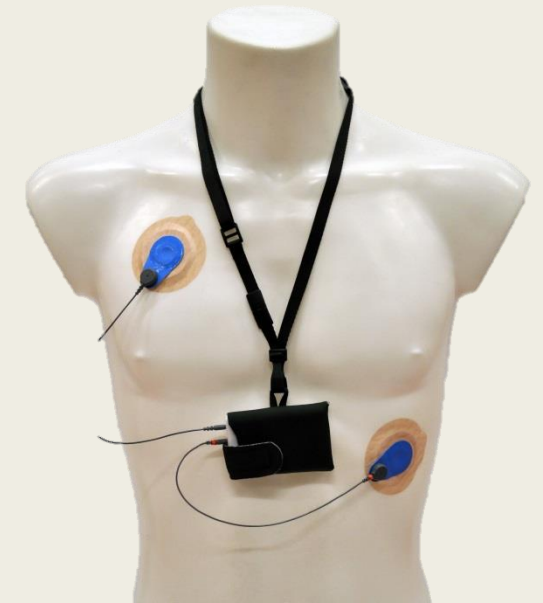
Show exercises

End measurement and export data

Switch patient

HOSPITAL+FIT

A digital health tool to support hospitalized patients and their physical therapists on their way to an active recovery.



UM: our planned contribution

Department of Instrument Development, Engineering & Evaluation (IDEE, FHML | Dutch word for Idea)

Develop, based on the modular platform an ultra-low power and secure motion sensor node and a secure ECG device with cardiac monitoring algorithms.

Partners: INL, Platform providers, Security tool providers, Hospitals

Department of Data Science and Knowledge Engineering (DKE, FSE)

Signal processing, detection, and machine learning, will be deployed to foster the development of cardiac monitoring algorithms and implement them into the ECG device.

Partners: ECG device and clinical data providers, algorithm development partners

Department of Intensive Care (ICU, FHML)

Gather in-hospital annotated cardiac monitoring patient data with a current golden standard monitor and the secure contactless bed-monitoring platform developed by all partners involved. This data will be transferred to all partners involved in cardiac monitoring algorithm development.

Partners: Secure In-hospital bed-monitoring platform providers, Algorithm development partners

Philips Research



Sieger Swaving
project leader



Ad de Beer
project coordinator



Ronald Dekker
project writer



Alberto Bonomi
data scientist



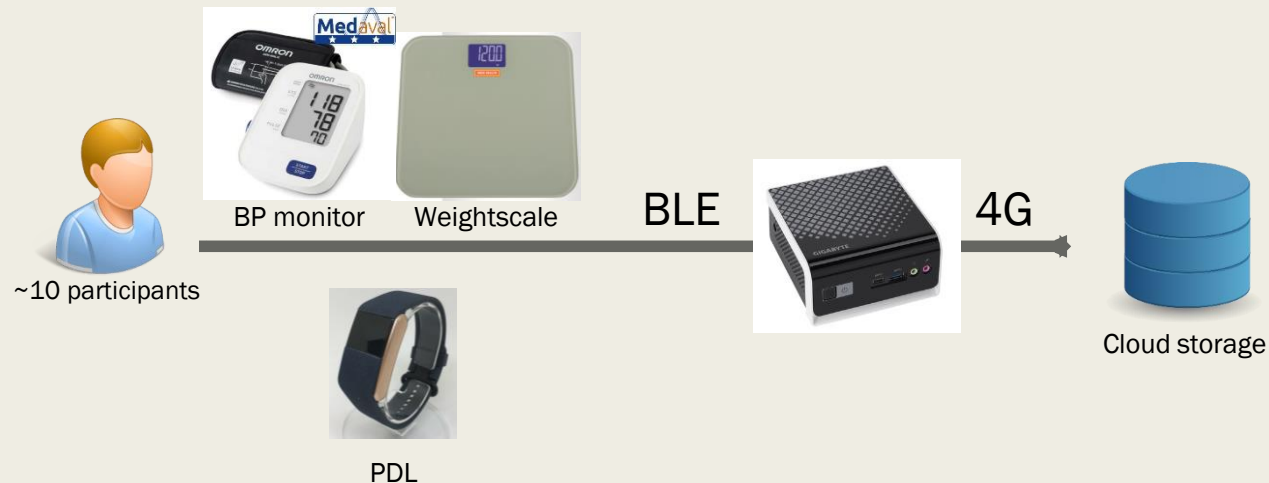
Reinder Haakma
solution lead



Building HTC4 at the High Tech Campus Eindhoven, housing the MEMS foundry of Philips Innovation Services and technology research groups.

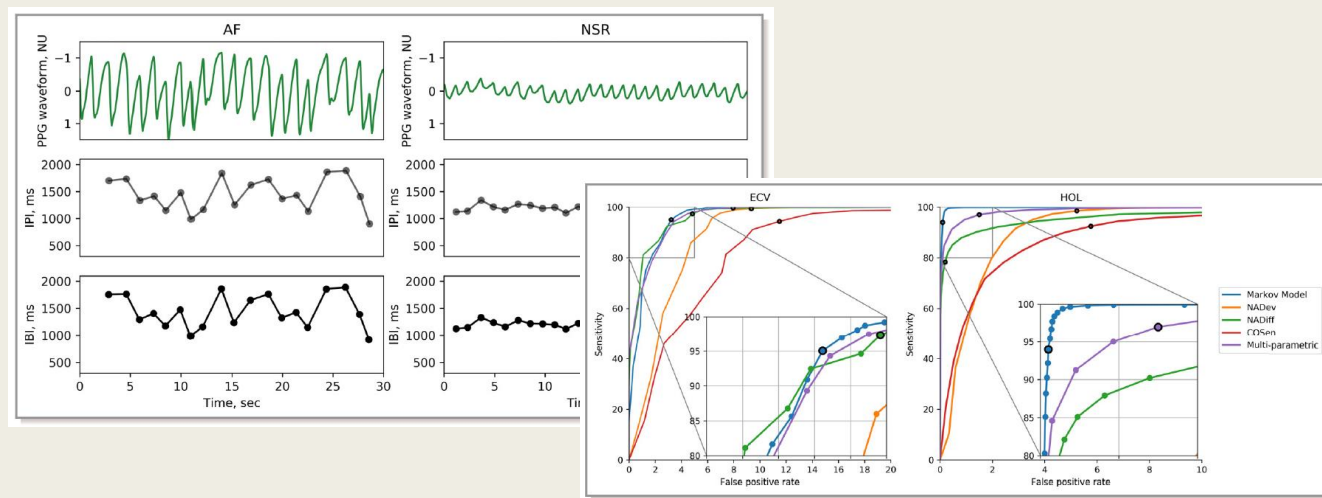
Remote physiological monitoring & analytics

Enabling data collection at home using connected health devices and research prototypes



Wrist-based Sleep onset, sleep staging, and Afib detection using motion and PPG signals

Deterioration detection algorithms for EWS at home based on vital signs



Moore4Medical

Enabling PPG-based Afib detection at home

Maturing technology for home monitoring of wrist PPG over long-term periods and validating off-line detection of Afib episodes for evaluating other biosensors, bed- and environmental-sensing technologies for arrhythmia detection.

Task 6.1 Bed monitoring design and specifications

- Contribute to the requirements for prototype and demonstrator specifications by leveraging on clinical collaborations

Task 6.2 Out-of-hospital system development

- Development and extension of a system for reliable and user-acceptable data collection at home
- Provisioning patients with a hub for data and device management and enable long-term monitoring

Task 6.3 In-hospital bed-monitoring platform with full security

- Participating in patient data collections for validating the wrist-based PPG-based metrics for Afib detection

Task 6.5 Algorithm development

- Generate algorithms for providing ground truth of Arrhythmia at home based on validated PPG-based algorithms

Task 6.9 Application demonstrators

- Demonstrator for out-of-hospital monitoring

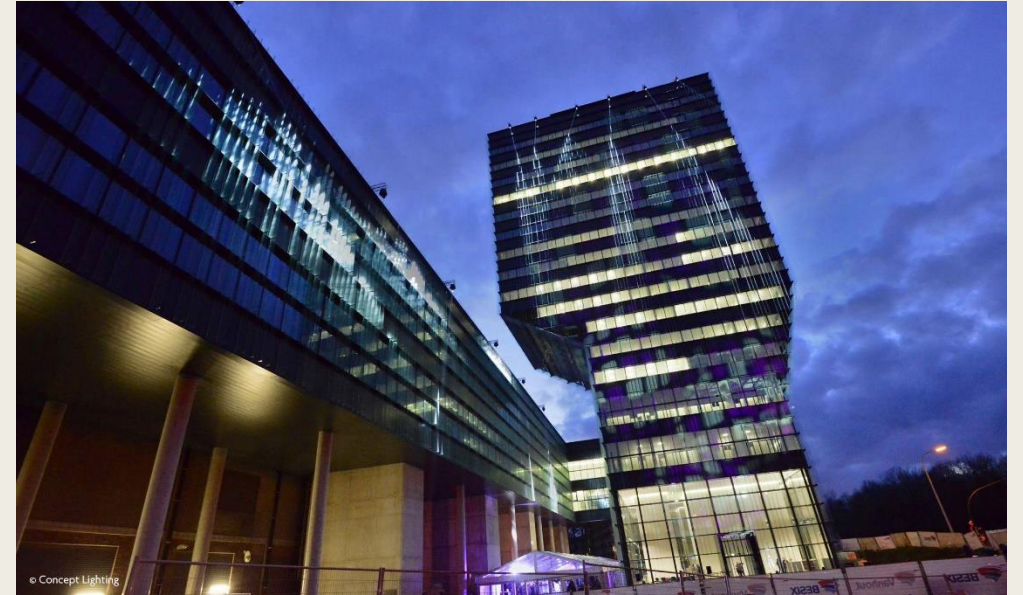
IMEC-NL



Arjan Breeschoten
R&D



Martijn Hijdra
R&D



IMEC research center Eindhoven is connected with the international imec organization, a [world-leading R&D hub](#) in nanoelectronics and digital technologies that boasts more than 4000 researchers, a 12,000 m² cleanroom, and a global ecosystem of universities and companies across the value chain.

We combine our microchip technology expertise with artificial intelligence and data science to develop applications that target local and global needs

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IMEC BLUETOOTH SECURE HIGH ACCURACY RANGING



<30cm accuracy (10x improved) in **multi-path environments** on a **standard BLE radio**



Body-blocking mitigation algorithms



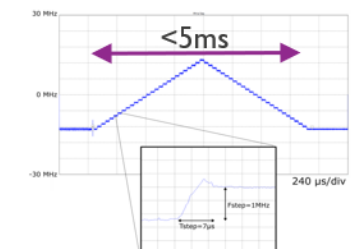
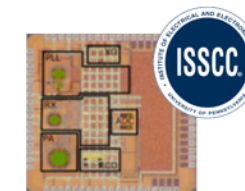
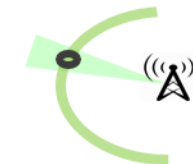
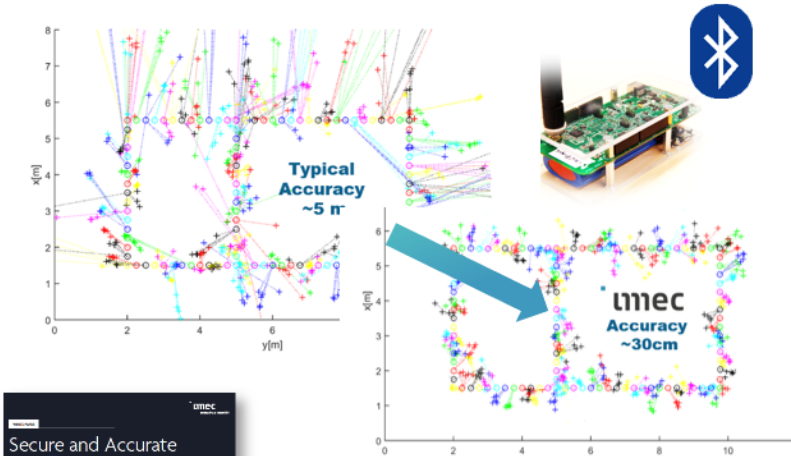
Secure distance bounding for **relay attack mitigation**



Single-anchor localization with joint distance and angle estimation (direction finding /AoA)



Silicon IP for **next-gen ultra-fast <5ms** (>10x improved) and phase-coherent **1-way-ranging**



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IMEC-NL planned contribution

- IMEC-NL wants to be a technology provider for Distance Bounding with BLE
- Technology:
 - Distance Bounding via Bluetooth Low energy
 - One to many fast distance bounding
- Integrate Distance Bounding in devices connected around a patient
 - Personal security storage device
 - Patient Bed sensors
 - Measurement devices
 - Hospital equipment
 - Home environment
- Ranging platform evaluation in different environments

Holst Centre/TNO



Jeroen van den Brand
Department Head



Edsger Smits
Program manager



Holst Centre is an Open Innovation research centre founded by TNO and IMEC NL and is located on the High Tech Campus in Eindhoven. Building HTC31 at the High Tech Campus Eindhoven.

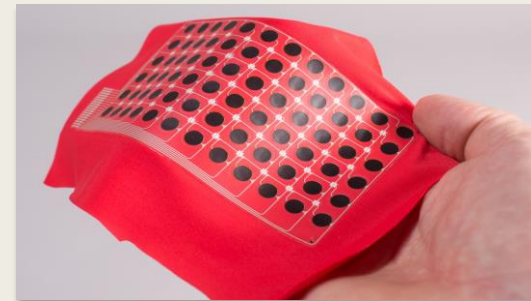
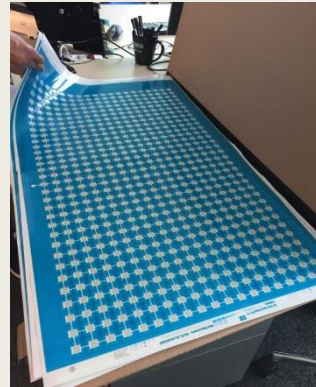
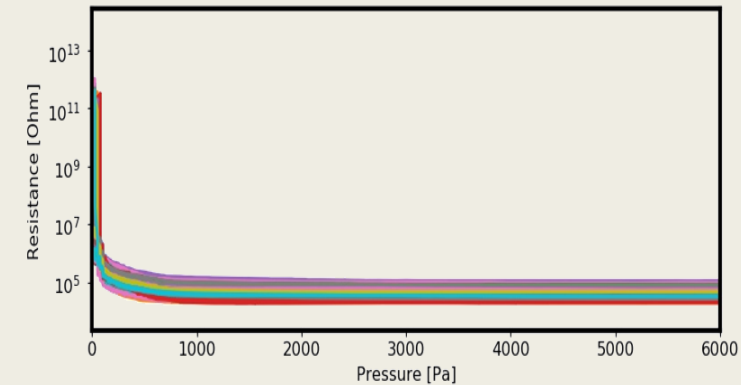
Holst Centre/TNO our capabilities

Printed electronics for example for:

- Large Area Sensor
- Stretchable circuits
- Printed Sensors (pressure, temperature, piezoelectrics)
- Hybrid printed

Large area pressure sensors

- Technology scalable
Demonstrated on 90 x 60 cm
- Acceptable uniformity
- High sensitivity From 100 Pa to 10 KPa



Holst Centre/TNO our planned contribution

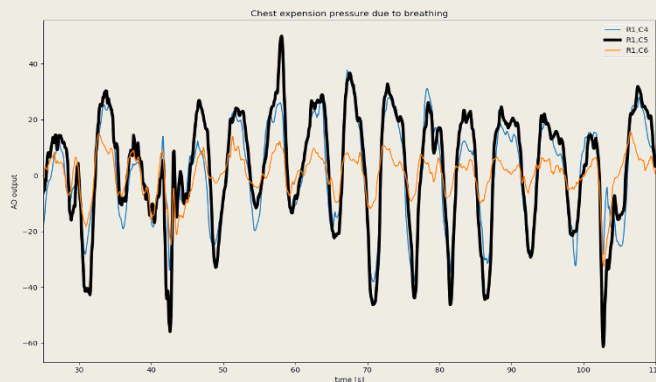
Posture detection

- Example of feasible application
- Posture detection: example using pressure mats
- Person: detection, localization and motion
- Identification: through body shape classification

Breathing rate (BR) detection

- Pressure sensors at right location enables breathing rate detection.
- Could provide complementary data to that of the membrane sensor proposed in this project.

Time domain



Frequency domain

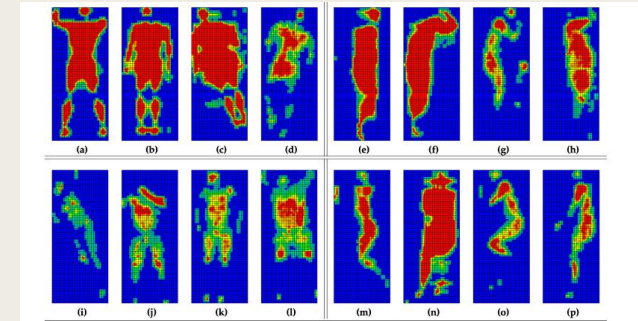


Fig. 5. Body pressure distribution images of 4 postures: supine (a) to (d), left (e) to (h), prone (i) to (l), and right (m) to (p). Different variants of the same posture have been recorded in the dataset, where the body and limbs orientation and location on the mattress have changed between frames belonging to the same posture.

Output Class	Target Class				Target Class			
	Supine	Prone	Right	Left	Supine	Prone	Right	Left
Supine	98.3% 165	0.0% 0	0.0% 0	0.0% 0	95.8% 120	0.0% 0	0.0% 0	0.0% 0
Prone	0.0% 0	99.3% 149	0.0% 0	0.0% 0	0.0% 0	99.2% 128	1.0% 1	0.0% 0
Right	1.7% 3	0.7% 1	100.0% 154	0.0% 0	3.2% 4	0.8% 1	99.0% 100	3.3% 4
Left	0.0% 0	0.0% 0	0.0% 0	100.0% 166	0.0% 0	0.0% 0	0.0% 0	96.7% 116

Fig. 6. Training (a) and testing (b) confusion matrices of the selected classifier model, showing the classification accuracy and confusion for each of the 4 classes in terms of percentage (%) and number of samples.

Moore4Medical

CSEM: Who is who and where in WP6 :: csem



Damian Vizár
Data Security
Engineer
Security activity
leader



**Alexandra-Mihaela
Olteanu**
Security & privacy
Engineer



John Farserotu
EU Program
Coordinator



**Philippe
Dallemagne**
Embedded
Comm. Expert



Ricard Delgado
Sector Head
TEE activity
coordinator

Lead of the E2E security and privacy activity in WP6
Lead of Task 6.7 “Tools and methodologies for E2E security and privacy”
Resp. D6.4 “E2E security and privacy toolkit”

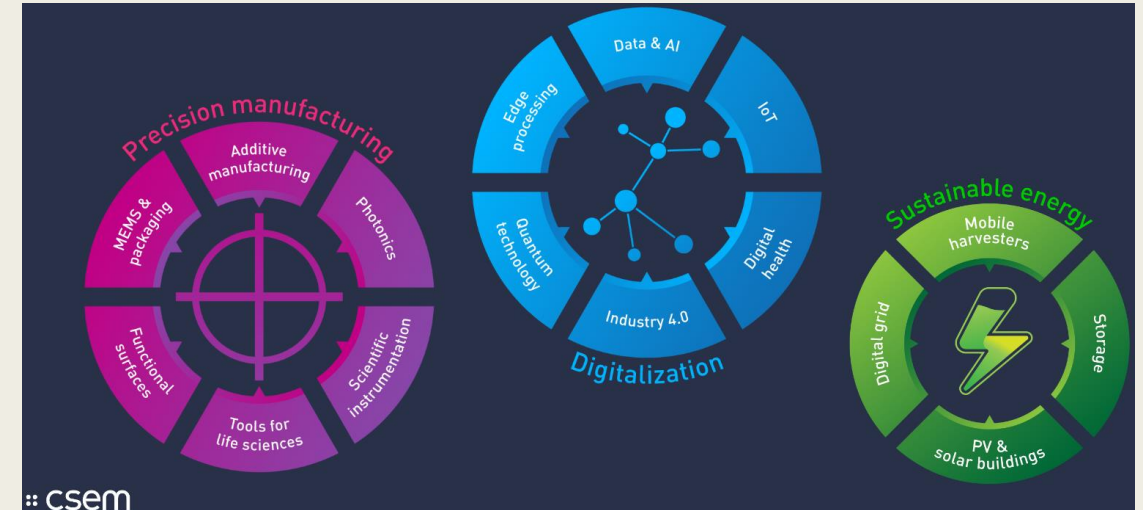
CSEM our capabilities



CSEM is a private research & technology organisation.

CSEM develops economic value through the **creation** of innovative technologies and integration of these technologies into systems and products for the benefit of industry and citizens.

- 500 employees in Switzerland, mostly researchers and engineers
- Active in: Digitalisation, Sustainable Energy and Precision manufacturing



For WP6: Competences in ultra low power wireless embedded systems, security and privacy for complex, sensitive & critical applications (healthcare, aerospace, industry 4.0, etc.)

Examples of projects, products

- H2020 ACTIVAGE (running – grant ID 732679): a European Large Scale Pilot on Smart Living Environments. CSEM is contributing to security & privacy by design.
- Cleansky AMPWISE (running): ultra low power wireless sensor network for return current monitoring in airframe structures
- CSEM PRIVACY_RIO: Privacy preservation for IoT
- Spin-off creation, including in healthcare (AVA, Sense, etc.)

CSEM our planned contribution



- **CSEM Role: Security & privacy (S&P) activity coordinator & embedded security+privacy expertise**
 - Unifying vision: patient-centric end2end security platform
- **CSEM technical contribution**
 - Lightweight cryptography, Key management, Privacy-preserving processing in TEE (Trusted Execution Environment)
- **Partners: Security cluster**, i.e., Inpher SARL, 3db Access AG (CH), IMEC (NL), Thales DIS Finland (FI), Instituto de Telecomunicacoes, PDMFC (PT), ITAV, INIO, GEM
 - Required capabilities: scenario, implementation, integration, tests and validation
 - Team up with the end-users.

3db Access, Zurich, Switzerland



Boris Danev (CEO)
Project leader



David Barras (CTO)
Project technology



Building CAB hosts the Department of Computer Science of ETH Zurich.

Hardware laboratory of 3db Access is located in this historical building together with other hardware spin-offs.

3db Access: Our capabilities

Who we are

- *Pioneer of secure low power single-chip UWB technology*
- *Mass production UWB IP in the automotive industry*
- *The only scientifically proven secure distance measurement UWB solution*
- *Lowest power consumption with 10x less than any other competing UWB chips*
- *Smallest UWB IC (silicon area) , including both RF and Modem*
- *Co-shaping the UWB regulation and standardization since 2012*

Our capabilities

- *10 Employees in 2 Locations (Switzerland and Bulgaria)*
- *5 PhDs and 5 MSc specialized in analog and digital UWB transceiver design*
- *Strong expertise in Security, IC Design and RF Module hardware prototyping*

3db Access: Our planned contribution

How do you see your role in the project?

- We will be involved in WP6 Continuous Monitoring

What would you like to do?

- Develop standard-compliant IEEE 802.15.4z UWB Distance Bounding (Secure Ranging) for patent authentication and proximity verification in the model of trust and wearables/nearables
- ASIC design and integration of security primitives
- Integration of UWB Secure Ranging IC in the patent-centric model of trust

Who are your partners?

- CSEM

Who would you like to team up with?

- CSEM (Lightweight crypto, Security)
- Gemalto (Secure element/Identity Management)

What capabilities do you need?

- System level integration, software security, secure element

Inpher – Iraklis Leontiadis – Senior Researcher



Iraklis Leontiadis



EPFL Innovation Park is housing start-ups, SMEs, research teams and innovation cells from major companies in the fields of information technology, computing, health and nutrition, engineering, transport, telecommunications or materials.

In a spirit of scientific collaboration, the EPFL Innovation Park offers unparalleled exposure to the wide range of new technologies being developed in the research units of the EPFL, UNIL and the CHUV.

Moore4Medical

The logo for Moore4Medical, featuring the company name in a bold, sans-serif font, followed by a red heartbeat line graphic.

Secret Computing

Inpher enables privacy-preserving machine learning and analytics via secure multiparty computation and other privacy-preserving techniques, which keep data encrypted while it is processed.

With Secret Computing®, data scientists power advanced analytics and AI applications on distributed data sources without ever exposing or transferring sensitive data across departments, organizations, or jurisdictions.

During the computation, Secret Computing® ensures that data privacy and security are retained in accordance with your organization's privacy requirements. (Yes, it's GDPR compliant.)

Privacy Preserving Computations

Inpher will provide its expertise in privacy preserving computation between distrustful parties.

E.x: Two hospitals hold clinical data and want to perform a joint computation

Inpher would collaborate with data analysts to explore the algorithms need to run on data and data owners.

STMicroelectronics key contacts



Fabio Quaglia
ST project leader



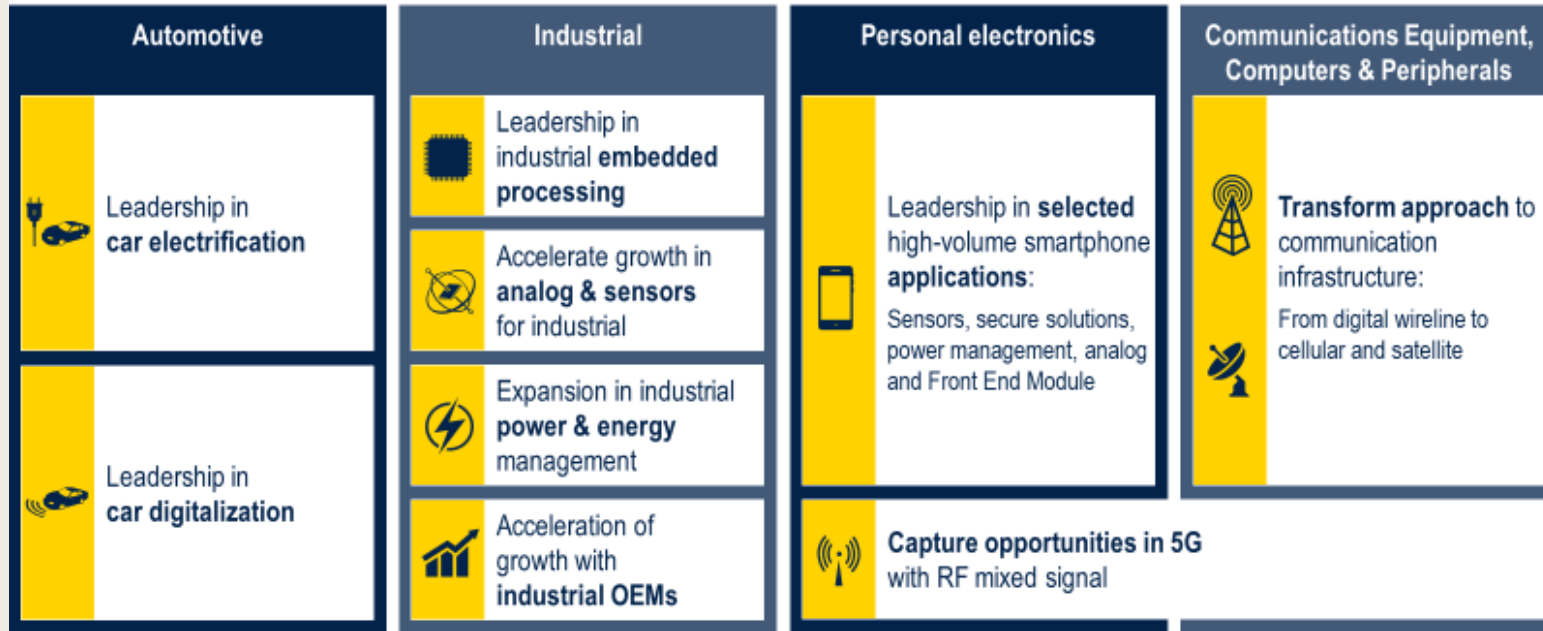
Andrea di Matteo
ST project coordinator



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.

STMicroelectronics

Our strategic objectives



16

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”

Moore4Medical



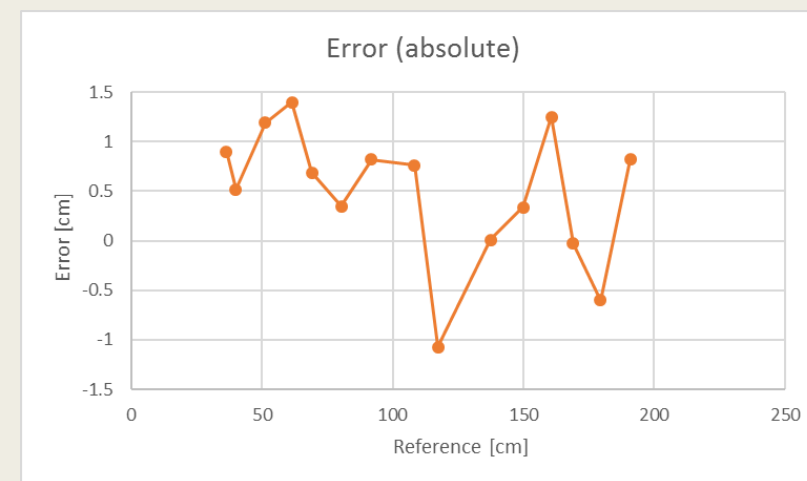
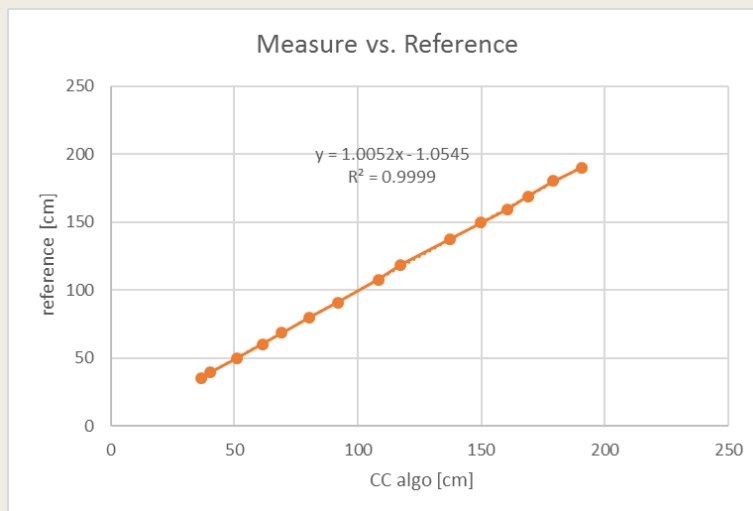
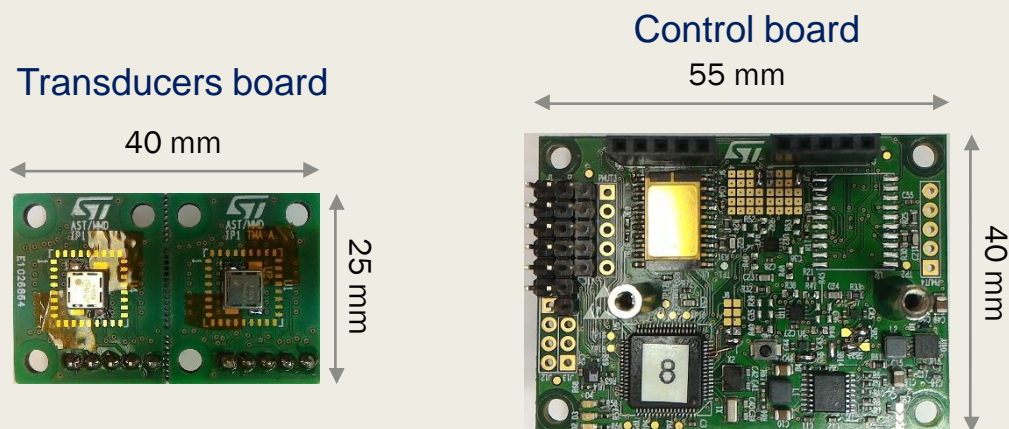
STMicroelectronics capabilities into M4M

- PMUT technology and process flow
- PMUT FEM and LEM characterization and modelling
- PMUT design for wide spread of application (consumer, industrial and medical)
- PMUT wafer micro-fabrication
- PMUT standard test (no application-specific test)
- ASIC design and realization (BCD or CMOS technology)
- PMUT dice assembly, electronic device packaging (no application-specific encapsulation)
- Ultrasound module for ToF

Ultrasound Module for ToF-based analysis

Features

- Made by 2 boards:
 - Control board, 55x40mm
 - Transducer boards, 25x40mm
- Power consumption
 - Idle state, 42mW
 - Measuring state, 60mW
- Measuring performance
 - Range
 - 2m range, $\pm 80^\circ$ FoV
 - 5m range, $\pm 25^\circ$ FoV
 - Accuracy/Repeatability: $< 1\text{cm}$



- Distance measure setup:
 - Target: 35x35 cm cardboard
 - Single measurement (no averaging)
 - Reference: tape measure

IMEC-BE



Björn Debaillie
Program manager IoT
IMEC representative (WP6)



Tom Torfs
Principle scientist CHS
IMEC technical lead (WP6)

“Technology has the power to improve lives. IMEC pushes the technology boundaries forward.”



IMEC is a world-leading independent research center in nano-electronics and digital technology. Headquartered in Belgium, IMEC has distributed R&D groups in Flanders, the Netherlands, Taiwan, USA, and offices in China, India and Japan.

IMEC-BE's capabilities in WP6

The IoT unit develops connectivity and sensing technologies (hardware & software) for mobility, human sensing and sustainable environments. These technologies push the boundaries in 6G, smart buildings, automated vehicles, ...

The CHS unit develops solutions for connected health & diagnostics using a multidisciplinary expertise ranging from custom chip design, to systems and algorithms all the way to biomedical engineering and clinical trials.

Focused expertise of IoT and CHS units

- *In-depth expertise of IoT on disruptive mm-wave radar technologies and machine learning*
- *In-depth expertise of CHS on signal processing algorithms, data analysis and health assessment*

Involvement in related funded projects

- *Smart Highway (BE 2018-2020). IMEC develops driver monitoring technology.*
- *SECREDas (EU 2018-2012). IMEC develops driver performance monitoring technologies.*

IMEC-BE's planned contribution in WP6

Provide innovative sensing technologies and analytics for unobtrusive vital signs monitoring

- *Vital signs: heartbeat and respiration rate and variability*
- *Sensing: contactless via mm-wave radar*
- *Lying or sitting patient*
- *Outputs sequence of vital signs with quality/reliability indication*

Research challenges

- *Detect and capture relevant chest micro-movements with mm-wave radar*
- *Distill heartbeat and respiration signals from radar data*
- *Extract heartbeat and respiration rate and variability*

Benefits for the consortium

- *Reliable vital signs data for further fusion and analysis*
- *Unobtrusive and contactless measurement system for patient monitoring*

Needs to perform activities

- *Access to hospital infrastructure and patients for validation, training and long-term measurements*
- *GDPR-compliant data management system*

Involvement and collaboration

- *Task 6.1 Bed monitoring design and specifications*
- *Task 6.3 In-hospital bed-monitoring platform with full security*
- *Task 6.5 Algorithm development*
- *Task 6.9 Application demonstrators*



International Iberian Nanotechnology Laboratory Systems Engineering Group



João Piteira
Group Leader



Álvaro Geraldes
AMS IC designer



Carlos Marques
System Architect



State-of-the-art research facilities, exclusively dedicated to nanoscience: nanocharacterization, system & IC design solutions, biological sciences, nanofabrication & processes and nanomaterial synthesis.

The INL campus is set in a 38,000 m² area of land in **Braga**, close to the Gualtar campus of **Minho University**



International Iberian Nanotechnology Laboratory



Your Science
and Innovation
Partner!

The world's only
intergovernmental institute for
nanotechnology
and one of the most modern
R&D&I infrastructures in the
world!

Today with representation in
Scandinavia, Israel, Dubai,
HongKong, Shanghai, Austin,
Boston and Brussels

38 000 dedicated sqms 100 MEuro Investment

Class 100 Central Micro and Nanofabrication
Cleanroom of circa 1000 m²

Today: 440 employees from 42 countries

NanoStart Up Programme

Nanoincubator

INL IP Ventures

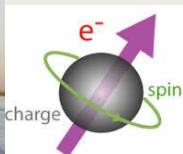
Scale Travels Programme

Moore4Medical



INL ICT Cluster – Driving technologies

Spintronics



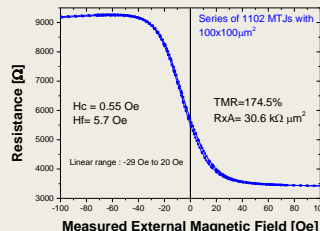
Pico-Tesla Magnetometers

High sensitivity magnetoresistive sensors For application in biological, medical (MCG) and industrial applications (Automotive).

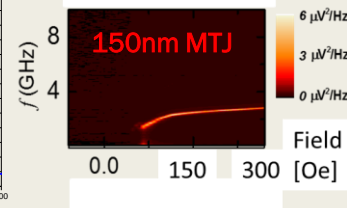
TMR Sensors



Detection Limit
30pT/Hz @ 4Hz

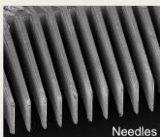


Nano-Oscillators



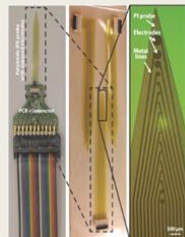
High frequency, large power oscillators for applications in digital electronics, communications and novel RF devices.

MEN



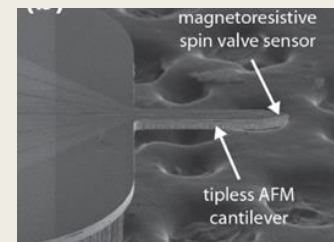
Flexible Electronics

Development of polyimide based flexible interconnects and devices.



Magnetic sensors encapsulated in Polyimide

High resolution magnetic imaging AFM tip



Hybrid Spintronic - MEMS Devices

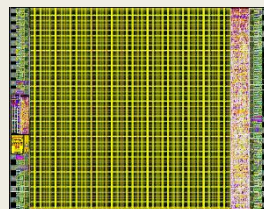
Hybrid devices integrating two heterogeneous technologies to achieve new functionalities.

System Eng

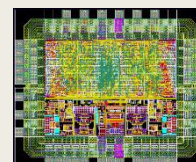


MEMS/Spintronics-CMOS Integration

IC circuit design for high density integration of magnetic sensors (magnetic imaging and histology)



High Resolution 2-axes MEMS accelerometer/inclinometer

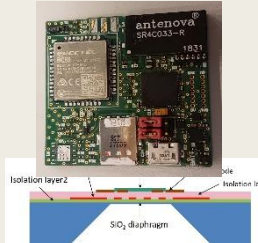


System Integration & IoT

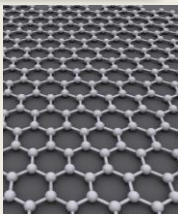
Portable handheld Potentiostat platform with multiplex sensor capabilities.



IoT Gas Sensor

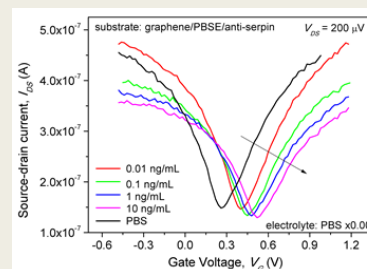


2D Devices



CVD deposition of Graphene

Development of a graphene compatible clean-room process for 200 mm wafer fabrication.



Graphene FET Biosensors

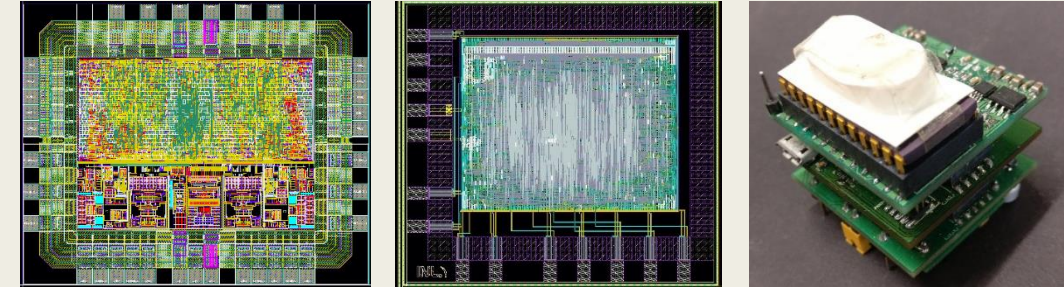
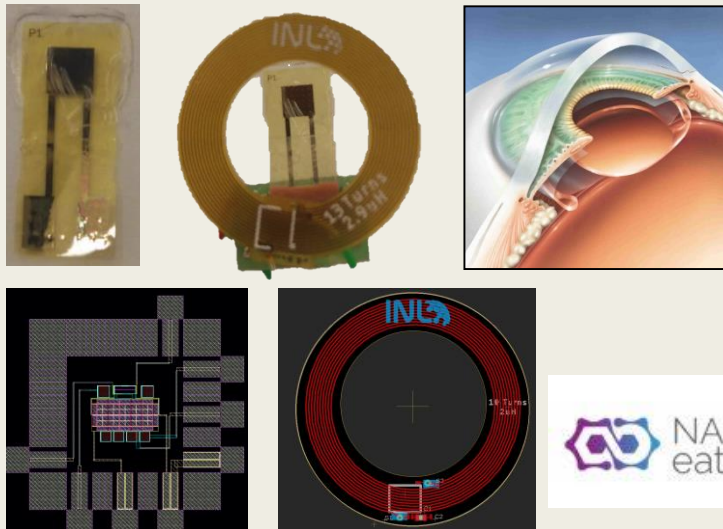
High sensitivity 2D system for chemical and biological detection with ultra-low concentrations.

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INL Project examples

IOP monitoring application w/ design and fabrication of a CMOS oscillator and PMG and its integration with coil and pressure sensor (INL polyimide process)

- Single coil topology for wireless power and data transfer (LC Tank timebase)
- Single coil for data transfer only and no power transfer – relaxation oscillator (RC timebase)



High Resolution 2-axes MEMS accelerometer /inclinometer and low power ASIC

- Pull-in time based MEMS device with sensitivity of up to $0.164 \mu\text{s}/\mu\text{g}$ and a noise density below $6.5 \mu\text{g}/\text{sqrt}(\text{Hz})$
- A low power ASIC to do the programming, control and the capacitive readout of MEMS device
- Used also in medical applications BCG (Ballistocardiogram) and SCG (Seismocardiogram)¹

[1] Leitão, F.; Moreira, E.; Alves, F.; Lourenço, M.; Azevedo, O.; Gaspar, J.; Rocha, L.A. High-Resolution Seismocardiogram Acquisition and Analysis System. Sensors 2018, 18, 3441.

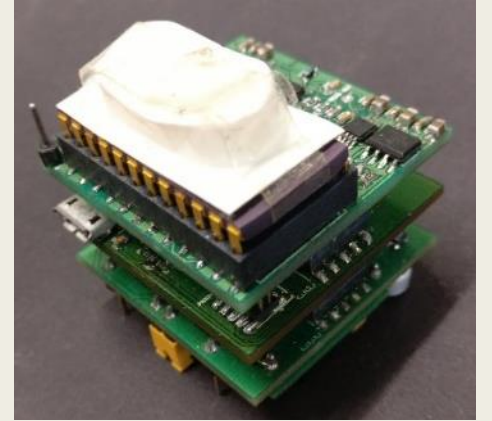


INL our planned contribution

Task 6.3. INL adapts its ultralow noise accelerometer to the intelligent node for measuring bed motion upon which the person is resting

Smart bed motion sensor nodes that communicate with one another and other supporting devices such as the bed-top ultrasound system;

- 3 axis accelerometer (INL currently supports 2-axis)
- Design a new ASIC device with a new readout algorithm (Time to digital conversion) improving device specifications (Resolution vs. BW)
- Main target specifications for the accelerometer compliant with current accelerometer design
 - Review application requirements and get feedback from task 6.1 Specifications
- Packaging devices for assembly from prototype to commercial part
- Build 15-20 nodes



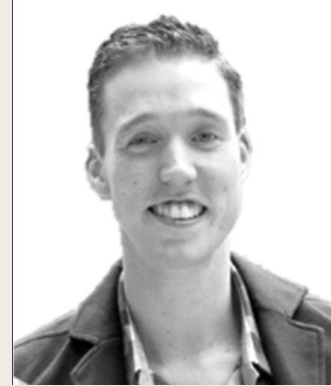
ITAV – Who is who and where



Georgios Mantas
cybersecurity expert



Maria Papaioannou
PhD student



Marcus J. M. de Ree
PhD student



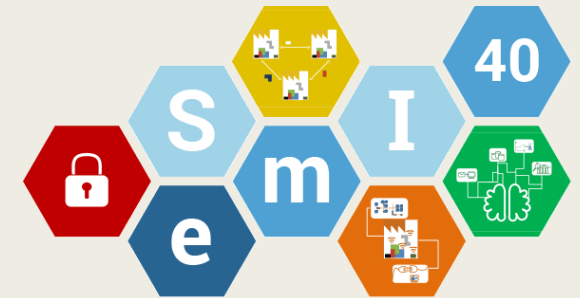
Joaquim Bastos
team leader



IT-Aveiro 1, headquarters of Instituto de Telecomunicações, inside the University of Aveiro campus, in Portugal. It hosts several labs, such as RF and Networking labs.

ITAV – Capabilities

- RTO with core expertise in design and implementation of diverse secure communication systems, as well as the integration of the respective components
 - *Secure and efficient wireless technologies and their optimization or customization to specific use cases, applications and scenarios*
- Group of researchers with expertise in secure, reliable and efficient wireless communication solutions and techniques
 - *End-to-end security, including key management and distribution schemes, as well as lightweight privacy-preserving authentication mechanisms*
- Networking labs with testbeds and multiple IoT prototypes, including wearables, some of which resulting from previous European R&I projects



MobITrust ● ● ●



Moore4Medical 

ITAV – Planned contribution

- ITAV contributes to WP6 with 20 PM of allocated effort
 - *Task 6.6: Security and Privacy design and specifications*
 - Contribute to a reference architecture for privacy-preserving authentication and ePR compliant identity management system for IoT, in the specific M4M use cases, assuring GDPR compliance
 - *Task 6.7: Tools and methodologies for E2E security and privacy*
 - Design privacy-preserving cryptographic solutions based on PKI with short-lived keys, or pseudonymization techniques, to avoid the transmission of large data constants and traceability
 - *Task 6.8: Smart, open E2E security and privacy platform*
 - Contributes to the implementation, testing and validation of proposed solutions, with the eventual integration of developed crypto libraries in platform demonstrators
- ITAV, as technology enabler/provider, will work with PDMFC, and possibly with CSEM and Thales, with who it shares common interests and can collaborate in complementary ways
- Access to additional IoT/wearable testbed development platforms for implementation, testing and validation of ITAV's most promising solutions developed within M4M

PDMFC – Who is who and where



Nuno Pedrosa
Cybersecurity
Engineer



Paulo Correia
Security Analyst



Francisco Loureiro
Privacy Researcher
- DPO

Luis Campos
R&D Director



PDMFC - Lisbon,
Headquarters of PDMFC – Portugal
(one of 6 offices around the world).
The Privacy and Cybersecurity lab is
located at the headquarters.

PDMFC – Capabilities

- Research oriented company with core expertise in design and implementation of tools for Anonymization, Security information and event management, Identity and Access management, Vulnerability Testing, Sandbox Environments, among others
- The Cybersecurity and Privacy team is (currently) composed of 28 members with expertise in multiple areas (mentioned above)
- Cybersecurity and Privacy lab was created 8 years ago (resulting from an EU-funded project) and has designed and produced over 20 security/privacy tools, currently being used in major clients such as mobile operators (Vodafone), Public Administrations (Portuguese and Mozambique Ministries of Justice), banks, hospitals, insurance companies, etc



PDMFC – Planned contribution

- PDMFC contributes to WP6
 - *Task 6.6: Security and Privacy design and specifications*
 - Contribute to a reference architecture for privacy-preserving authentication and ePR compliant identity management system for IoT, in the specific M4M use cases, assuring GDPR compliance
 - *Task 6.7: Tools and methodologies for E2E security and privacy*
 - Design privacy-preserving cryptographic solutions based on PKI with short-lived keys, or pseudonymization techniques, to avoid the transmission of large data constants and traceability
 - *Task 6.8: Smart, open E2E security and privacy platform*
 - Contributes to the implementation, testing and validation of proposed solutions, with the eventual integration of developed crypto libraries in platform demonstrators
- PDMFC, as tool developer and solutions integrator, will work with ITAV, and hopefully (at least) with CSEM and Thales, with who it shares common interests and can collaborate in complementary ways
- We will make all our tools/solutions freely accessible to all partners



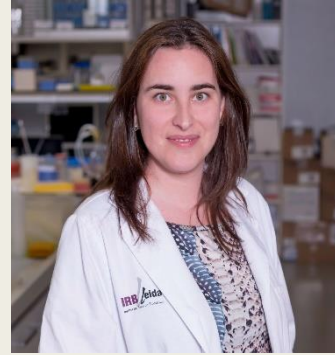
Fran Valenzuela
project leader



Maria Masbernat



Manuel Sánchez
PI Precision Medicine



Esther Rubinat
Researcher



Joan Blanco
Researcher



Francesc Rubí
Researcher



Blanca Manuel
Primary Health Care



Building at the Health Science Campus of the
University of Lleida, Spain.

Capabilities

Institute for Biomedical Research in Lleida (IRBLLEIDA) is a non-profit research organization created in 2004 as a result of a collaboration agreement between the Catalan Health Institute (ICS), Dr. Pifarré Foundation and the University of Lleida (UdL).

It boosts synergies between the basic, the clinical and the epidemiological research carried out in the region of Lleida with the aim of improving clinical practice for the benefit of the entire population.

Capabilities

IRBLLEIDA is an autonomous legal body that brings together in a unique and single research institution, researchers from the Faculty of Medicine of UdL, Faculty of Nursing and Physiotherapy of UdL, the Arnau de Vilanova University Hospital (HUAV), Regional Services of the Ministry of Health-ICS Lleida, and the Hospital Santa Maria-GSS (HSM).

At the present, IRBLLEIDA accounts for more than 300 researchers working in 5 major research areas: Cancer (clinical and molecular research), Systems Biology, Neurosciences (Neurodegeneration and Developmental Neurobiology), Ageing and Age-related diseases (diabetes, cardiovascular disease, cardio-metabolic syndrome, sleep apnoea, etc.), Pharmacoepidemiology and Nutrition.

Capabilities



Manuel Sánchez De La Torre

RESPONSABLE DEL GRUPO
Doctor

ResearcherID:
<http://www.researcherid.com/rid/B-5578-2009>
973702216
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Gerard Torres Cortada
Investigador Principal



Mireia Dalmases Cleries
Investigador Principal



Anabel Lourdes Castro Grattoni
Investigador en formación



Nuria Nadal Braque
Investigador



Ester Sapiña Beltran
Investigador en formación



Andrea Zapater Matute
Investigador en formación



Alicia Sánchez De La Torre
Investigador



Ivan Benitez Iglesias
Investigador

Planned contribution

As clinical research institution our main participation will be in trials monitoring adults living in the community with cardiovascular risk factors and sleep disorders: hypertension, diabetes, obesity or sleep apnoea (50 patients) (WP6).

IRBLleida will also contribute to development of user applications enabling the interaction user-platform.

We will also support dissemination of the project in all levels of health systems (professionals, patients and caregivers).

HI iberia - Who is who and where



Inmaculada Luengo
Financial coordinator
Head of R&D Department



Elena Muelas
Project Leader



HI-Iberia group is a technological consultancy founded in 1999. It is composed of three different SMEs:

- HOWARD INGENIERIA (High level consultancy)
- HI-IBERIA INGENIERIA Y PROYECTOS (Software development)
- SEAPLACE (Naval engineering)

HI-Iberia headquarters are located in Madrid and R&D department is located in our office in the north area (near Santiago Bernabeu Stadium)

HI iberia - our capabilities

HI Iberia is an established participant of European R&D space, and is currently involved in many R&D European projects (H2020, ECSEL, EUREKA) coordinating several of them. Particularly, the R&D department at HI Iberia has interest in the following fields: Security and citizen well-being; active and assisted living; embedded systems and simulation environments.

Main areas of expertise in e-health and projects in the area:

- User profiling
- Contextual generation based on smart phone and sensor data (Big Data techniques)
- User interfaces for usability and accessibility
- Multidevice applications development
- AI applied to NLP, NLi
- Knowledge discovery (ML and DL)
- Semantic frameworks (ontologies)
- Recommendation engines for personalized advice, guidance and follow-up of end users (ML and DL)

Telemonitoring solution recently launched into market



Moore4Medical



Hi iberia - our planned contribution

Hi Iberia will participate in the development of AI and DL algorithms that will use as input the data from devices and sensors in the patient side to infer new knowledge, and support the diagnosis and detection of cardiovascular diseases at home and sleep disorders. This data analysis will be use also for postoperative situations in order to optimize the resources and the continuous monitoring of the patient. To offer a common interface for accessing to the results obtained through Moore4Medical platform, HIB will work in the development of user applications enabling the interaction user-platform.

Who are your partners?

We will work in close collaboration with IRBLLeida as end users of the Spanish pilots.

Who would you like to team up with?

Of course, we would like to team up with all the partners involved in WP6 and specially with sensors manufactures for future agreements.

What capabilities do you need?

We need the set of sensors integrated in the project and all data inputs to be analyzed.