

# Vision 2030 – Flagship Proposal Health-EU

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Dr. Peter Ramm

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Fachtagung Künstliche Intelligenz in der Medizintechnik, München, 11.10.2018



## HUMAN AVATARS TO PREVENT AND CURE DISEASES

**Call topic: FETFLAG-01-2018: Preparatory Actions for new FET Flagships**

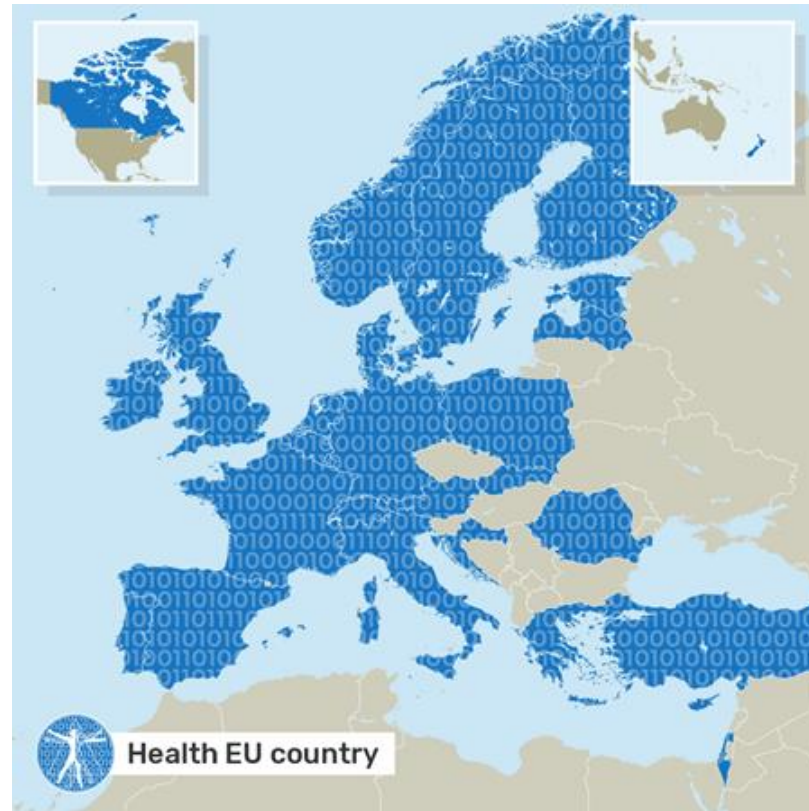
Imagine a revolutionary healthcare and disease management system in Europe, built on human avatars aiming at:

Empowering every citizen with a Human Avatar

enabling access to comprehensive personalized healthcare, healthy lifestyle and disease prevention

## Health EU Consortium

- 110 participating organisations from 29 countries
- Unifies 87 ERC grants, 308 FP7 or H2020 project coordinations and 633 large national programme leads.
- Medical Research Excellence Hospitals, as Institut Gustave Roussy, Charite



# The Health EU stakeholder community

(Large Industrial Partners: Bayer, Bosch, Infineon, Merck, Philips and STMicroelectronics)

- 3 chambers:
  - ❖ Chamber A: large industries
  - ❖ Chamber B: patient and professional organizations, hospitals, public and private insurance companies and regulatory bodies.
  - ❖ Chamber C: innovative SME's, start-up companies and start-up investors
- > 90 stakeholders



## Introduction

Is healthcare system sustainable today?

**4 BEuros** spent every day by European Union (EU) member states on intervention-based health care

**20%** of Europeans will be 65 or older by 2025, with many in ill health and dependent on the work of others

**75%** of the health cost due to human behavior

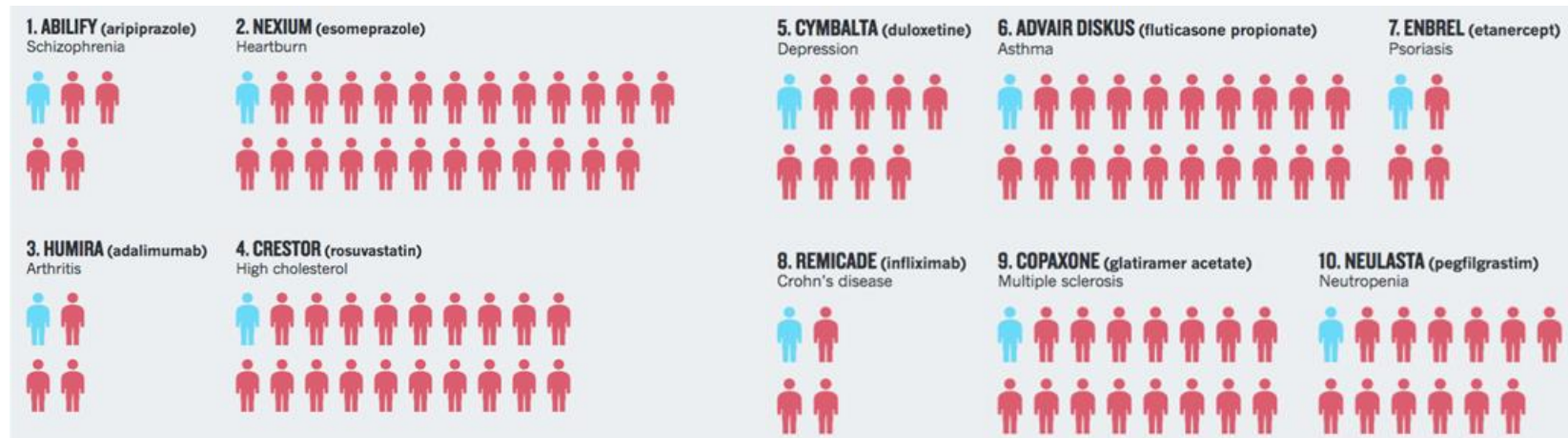
**3%** only of health budget on prevention



## 2018: imprecision medicine era

For every person they do help (BLUE) the ten highest growing drugs in USA fail to improve the conditions of 3 to 24 people (RED):

**IMPRECISION & HIGH COST!**

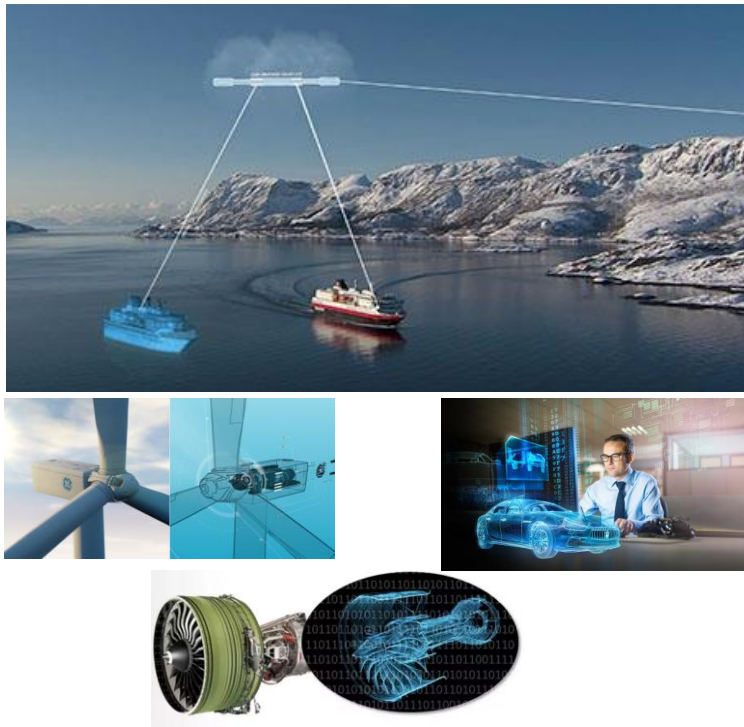


***Personalized medicine: Time for one-person trials***

*N.J. Schork, Nature, 2015.*

## 2030: From Object to Human Digital Twins

### Digital Twins of All Objects



### Digital Twins of All Humans



A True Precision and Prevention Healthcare System needed.

# Health EU FET Flagship

<https://www.health-eu>

- Health EU Unifying goal

Imagine a revolutionary healthcare and disease management system in Europe, built on human avatars aiming at:

**Empowering every citizen with a Human Avatar  
enabling access to comprehensive personalized  
healthcare, healthy lifestyle and disease prevention**



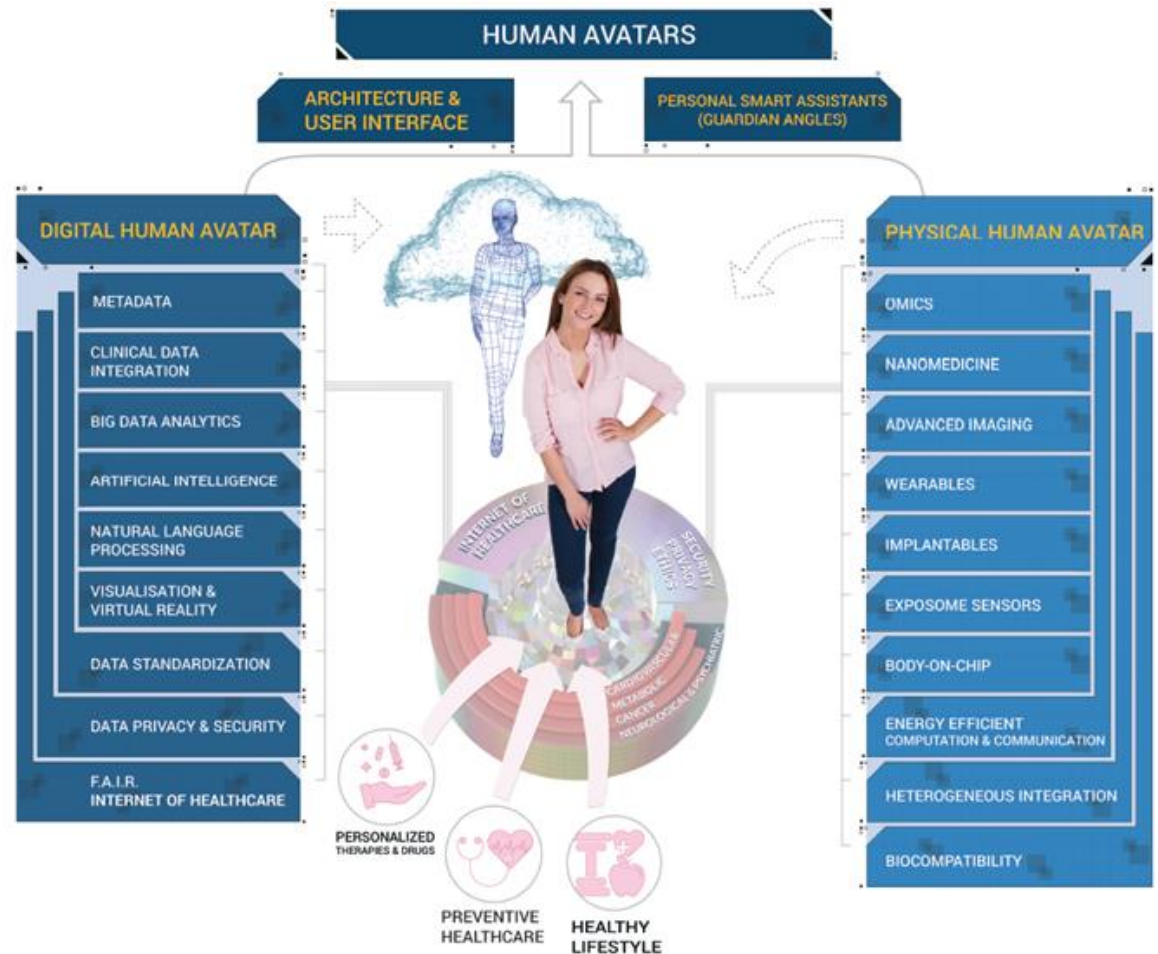
Health EU  
*Healthy You!*



# Health EU's Human Avatar Integrative Platform

Two components:

- **The Physical Human Avatar:** supported by data generator technology platforms
- **The Digital Human Avatar:** Big Data Analytics, Artificial Intelligence and data infrastructure



# Fraunhofer: Core Partner in HEALTH-EU



Fraunhofer is represented in the Strategic Board of Health EU (Peter Ramm) and Core Partner in 3 WPs

The Fraunhofer Research Institution for Microsystems and Solid State Technologies **EMFT**, develops application oriented system technologies, in particular in the field of microelectronics and microsystems engineering.

The Fraunhofer Institute for Interfacial Engineering and Biotechnology **IGB** offers R&D solutions in the fields of health, chemistry and process. The Fraunhofer Institute for Reliability and Microintegration **IZM** is regarded among the global leaders in microelectronics and microsystems packaging. The focus lies mainly on material, process and substrate development, characterization and simulation, advanced system engineering, assembly and interconnection technologies and environmental engineering.

The Fraunhofer Institute for Integrated Circuits **IIS** is one of Germany's most important industrial applied research facilities for the development of microelectronic systems. The scientists in the Division Engineering of Adaptive Systems **EAS**, located in Dresden, develop key technologies for the connected world of tomorrow. Major aspects are the design of reliable microchips and complex electronic systems as well as the corresponding design methods.

The Fraunhofer Institute for Biomedical Engineering **IBMT** acts as a device and technology developer in the areas of biomedical/medical engineering, medical biotechnology, biohybrid technology, bioprocessing & bioanalytics, cryo(bio)technology and nano(bio)technology, ultrasound technology, biomedical microsystems, neuroprosthetics & active implants, health information systems, (mobile) laboratory technology & automation.

The institute for Medical Image Computing **MEVIS** focuses on imaging and computer assistance for medical diagnosis and therapies. In close cooperation with clinical experts, the entire process from data acquisition via curation, analysis, interpretation, interaction and exploration is addressed. Applications include multi-centric image-based trials, clinical decision support, surgical risk analysis and planning based on biophysical modelling and numerical simulation, and intraoperative support including liver surgery, neurosurgery, and thoracic surgery.

# Enabling technologies for Human Avatars



Health EU



genomic, omic



advanced imaging



organs on chip



implantables



wearables



env. sensors





# 3D Heterogeneous Integration Platform

Key Partners: Infineon, Bosch, StMicro, CEA, IMEC, Tyndall and Fraunhofer

The implantables, wearables and environmental sensors for Human Avatars are smart systems which need

**3D heterogeneous integration or/and flexible substrate integration technologies**

to combine different technologies as e.g. innovative **MEMS, microfluidics and IC**



# Roadmap: Applications of 3D Integration

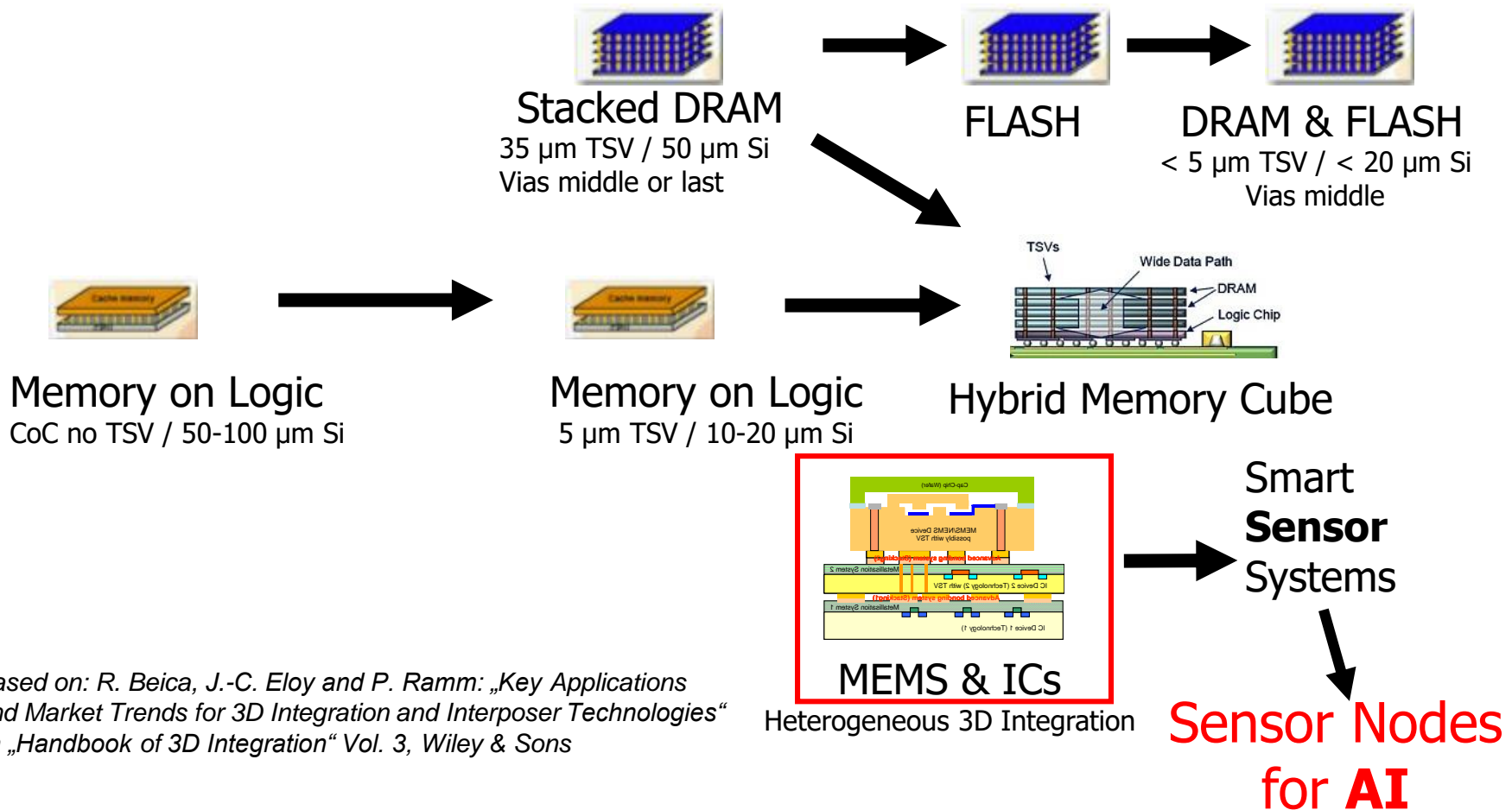
2009

2012

2015

2018

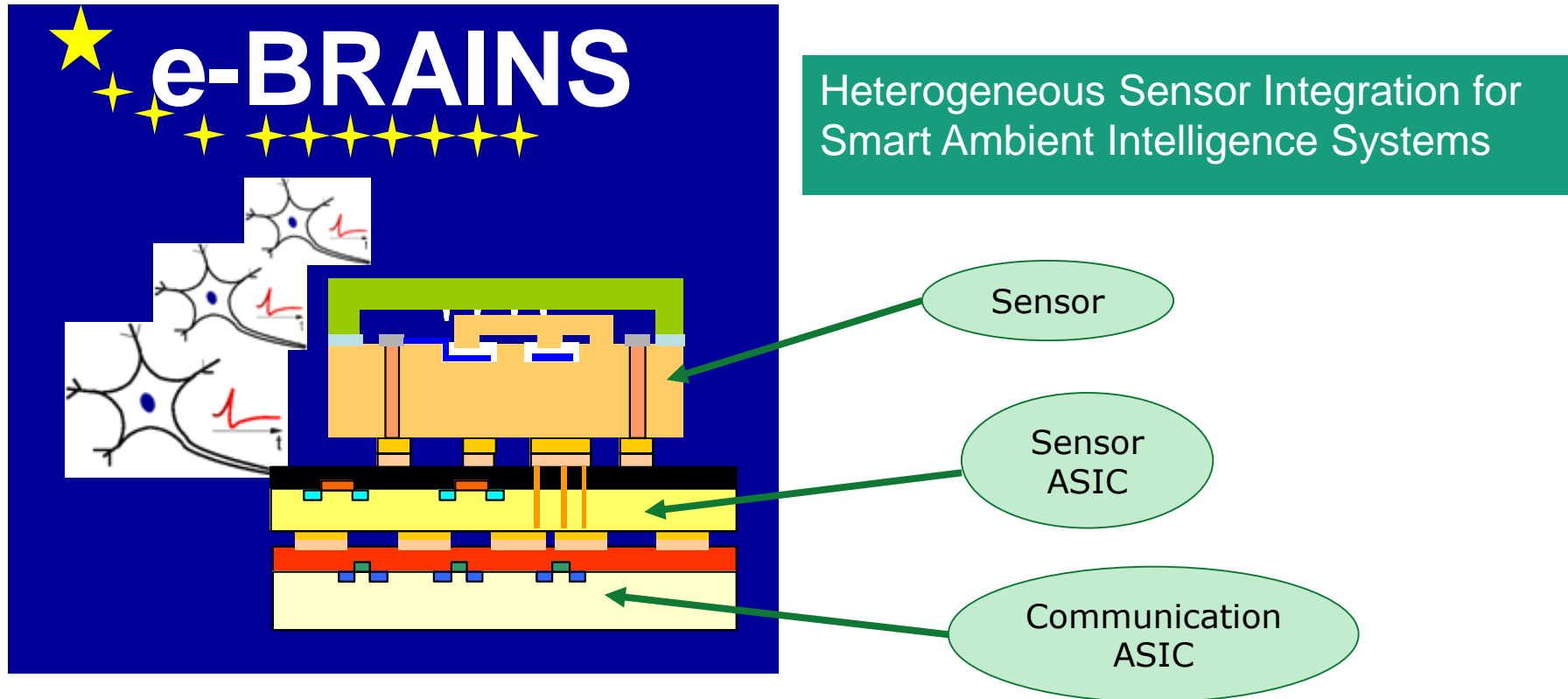
2021





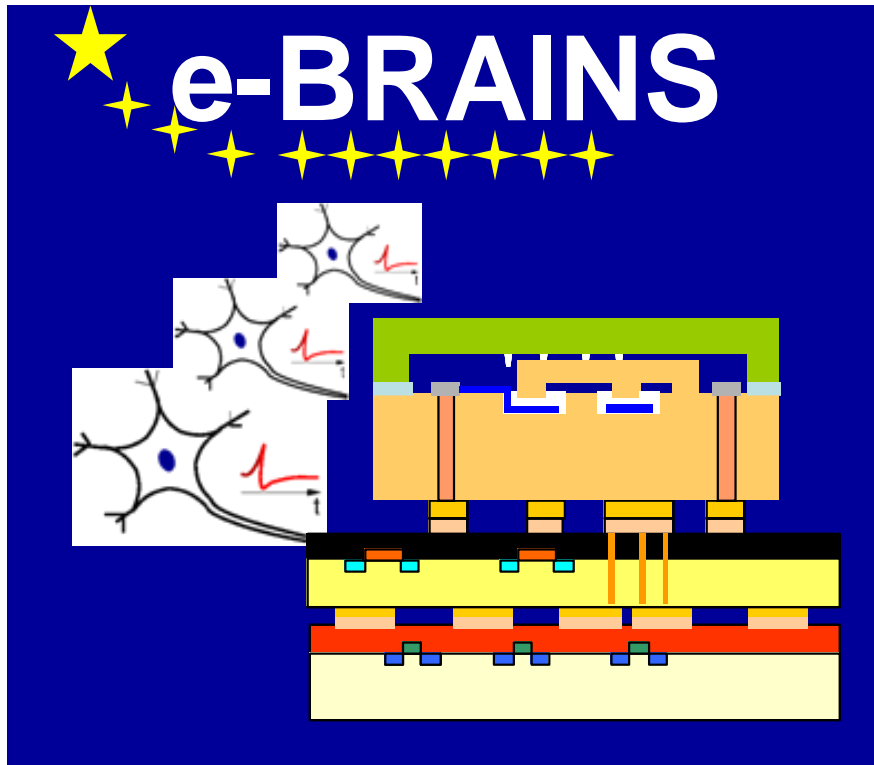
EC Press Release Feb 14, 2014 (ELG):

**New high growth areas, in particular Internet of Things (IoT) and the development of 'Smart-X' markets (e.g. smart homes, smart grids etc.). The target is to capture 60% of this emerging market by 2020.**



# e-BRAINS: Best-Reliable Ambient Intelligent Nanosensor Systems by Heterogeneous Integration

supported by the European Commission  
under support-no. ICT-257488



[www.e-brains.org](http://www.e-brains.org)

Dr. Peter Ramm

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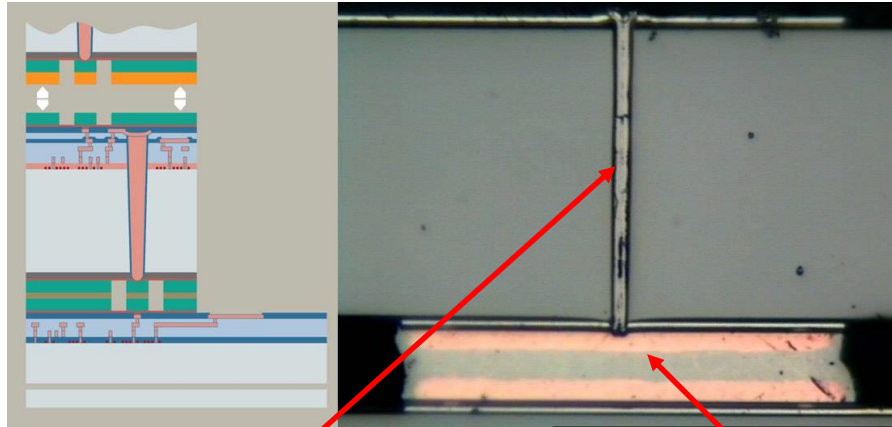
SIEMENS



vermon



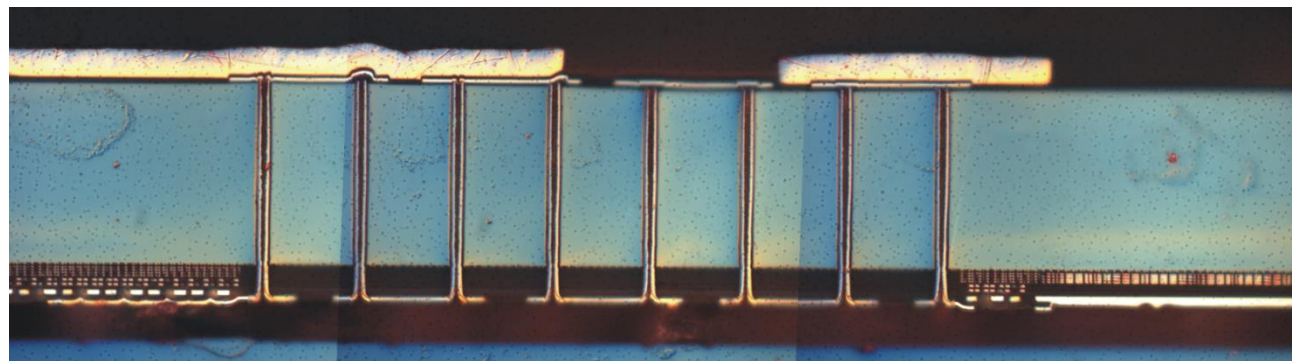
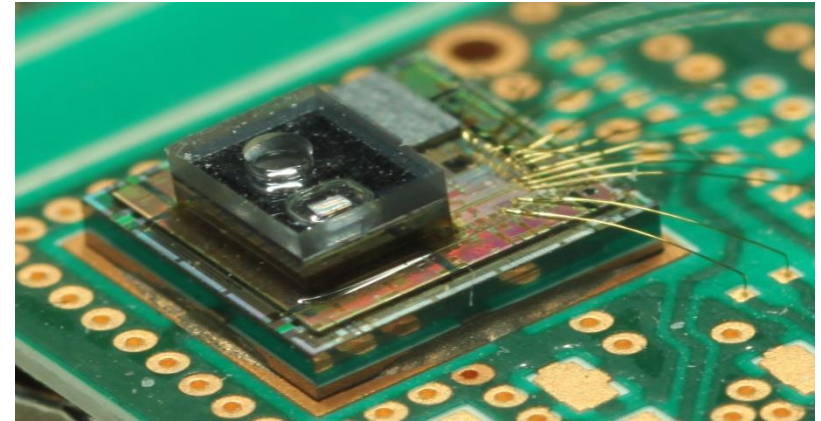
# Fraunhofer EMFT's „TSV-SLID“ – a robust 3D TSV Technology



**W-TSV**

***Cu-Sn SLID (Solid Liquid Interdiffusion)***

**Application: Pressure Sensor Grain**



**Post BEOL  
3D-Integration**

**Process control  
module (PCM)**

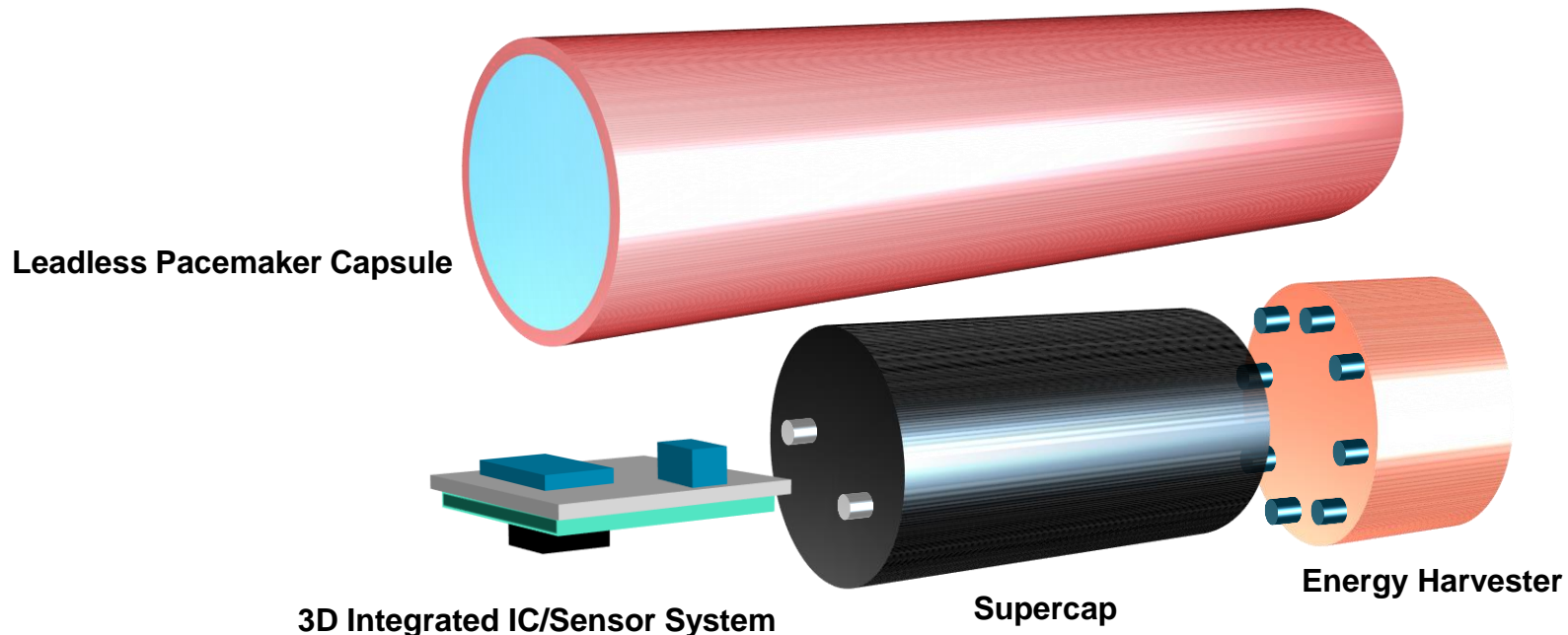
# 3D Heterogeneous Integration for Medical Applications e.g. Autonomous Implantables



Tyndall, SORIN, 3D-PLUS, KU Leuven, TUE, PSUD, Fraunhofer EMFT, ...

MANpower – Integration of Energy Harvesting and Storage for Perpetually Self-Powered Heterogeneous Systems – e.g. Leadless Pacemaker

→ **Low-Temperature 3D Processes** for Highest Reliability Requirements



Dr. Peter Ramm

# Further Development: Combination with Pressure Sensor Grain -> Smart Homeostatic Cardiac Implant System

Source: e-S<sup>3</sup>ense<sup>®</sup> Proposal  
(coordinated by Infineon)



**A Leadless pacemaker**  
Accelerometer  
AES integrated  
868 MHz radio, flexible from 300-900 MHz  
"zero losses" RF power transmitter  
advanced NFC (13.56 MHz) for in body pairing  
**Proprietary 2.4 GHz radio**  
Coin battery

**B Pressure sensor grain**  
AES integrated  
868 MHz radio, flexible 300-900 MHz  
RF harvester

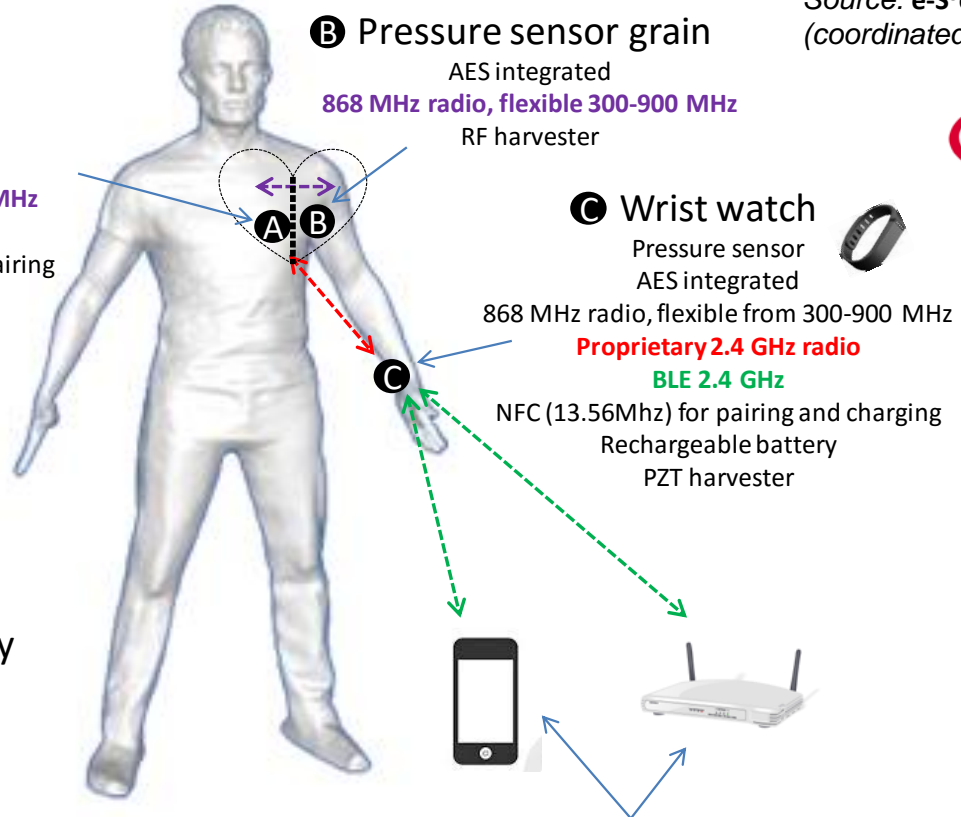
**C Wrist watch**  
Pressure sensor  
AES integrated  
868 MHz radio, flexible from 300-900 MHz  
**Proprietary 2.4 GHz radio**  
**BLE 2.4 GHz**  
NFC (13.56MHz) for pairing and charging  
Rechargeable battery  
PZT harvester

**D Mobile unit or router**  
**BLE 2.4 GHz**  
NFC (13.56MHz) for pairing and charging  
Phone battery

Proprietary 2.4GHz:  
-120 to -130 dBm sensitivity

BLE 2.4GHz:  
-97dBm sensitivity

Alternative A-B: MICS 402 MHz  
Alternative A-C: The flexible 868 MHz radio





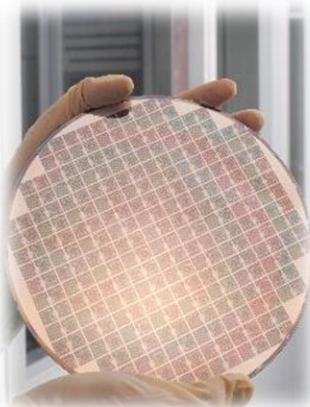
# Competences at Fraunhofer EMFT

## Sensors and Actuators for People and the Environment

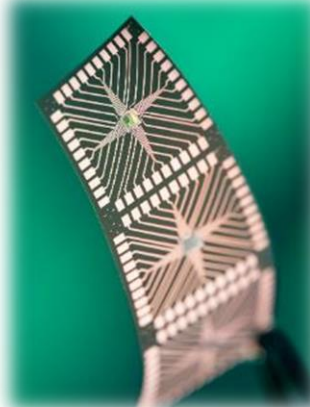
### Sensor-materials



### Si-Technologies Devices & 3D Integration



### Flexible Systems



### Mikro Dosing Systems



### Circuits & Systems



Safety and  
Security



Production  
and Services



Communication  
and Information



Energy and  
Resources

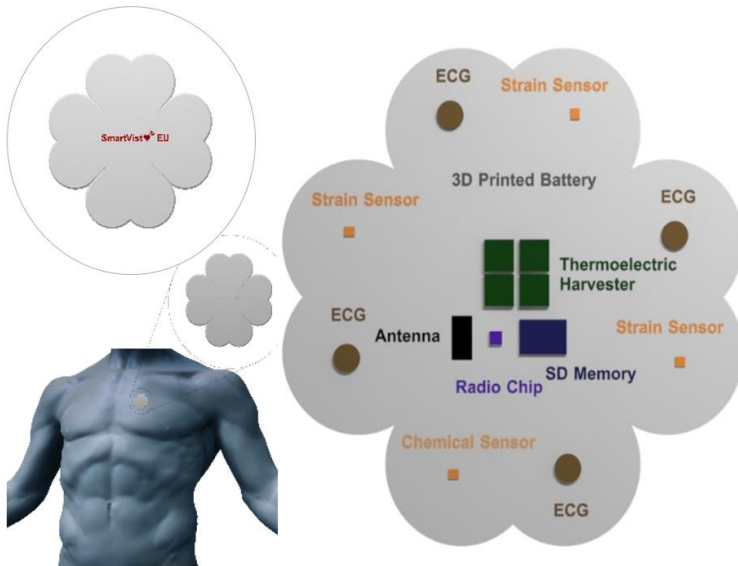


Health and  
Environment

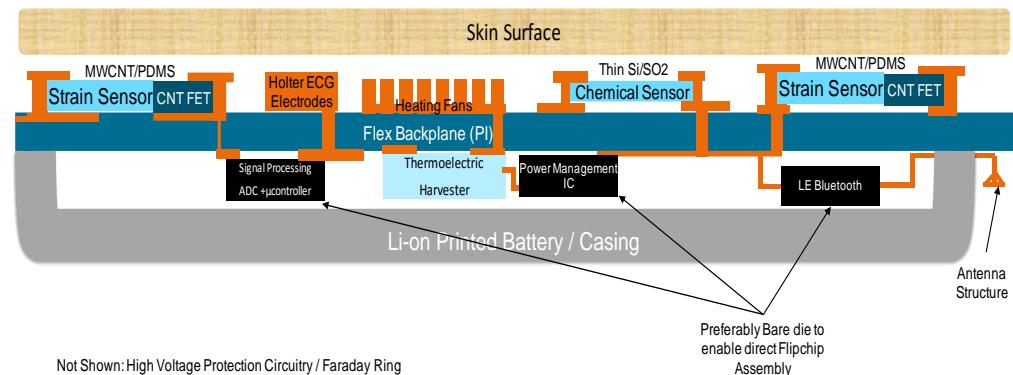


Mobility and  
Transportation

# SmartVista: Smart Autonomous Multi Modal Sensors for Vital Signs Monitoring (H2020-ICT-07-2018)



Tyndall, Novosense, CNRS, Analog Devices, EMFT



The SmartVista program will develop a flexible platform by integrating nanomaterials based sensors with ultra-high sensitivity to monitor ECG, respiratory flow, oxygen flow, the chemical analysis of human sweat composition and temperature powered by body heat energy conversion strategy through high efficiency thermoelectric generator to prolong the life of the printed battery. Additionally, the Roll-to-Roll manufacturing process of these patches will be developed to demonstrate the future scalability of this technology.

# Summary

- Today's European healthcare system is not sustainable - A True Precision and Prevention Healthcare System needed
  - > proposed Flagship **Health EU**: Empowering every European citizen with a **Human Avatar** for
    - **Personalized healthcare**
    - Healthy lifestyle
    - Disease **prevention**
- Human Avatar (HA) with two components
  - **Digital HA**: Big Data, **Artificial Intelligence** and data infrastructure
  - **Physical HA**: supported by data generator **technology platforms**
- Key objectives:
  - Exploit Organ-on-Chip, nanomedicine and **smart sensor** technologies
  - Enabling **Artificial Intelligence** with a specific data infrastructure and a subclass of IoT called **Internet-of-Health** (IoH)
  - Designed with embedded **security, privacy and ethics**
- Technologies for Physical HA
  - Autonomous wearables/implantables, imaging, nanomedicine etc
  - **Heterogeneous Integration**

# Thank You For Your Attention !



## Fraunhofer EMFT

Hansastraße 27d

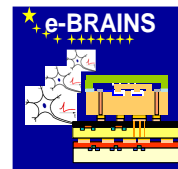
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Healthy You!

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