
IUIS Seminar

Health engineering and micro-nano-electronics

Sylvain FERUGLIO

Sept. 9, 2026

Outline

- ◉ My Lab
- ◉ Background
- ◉ Examples in SYEL
- ◉ Dev. for health



openclipart.org



Hardware and software interactions at LIP6/SU

- ◉ LIP6 = 18 teams for 480 persons
- ◉ 4 main teams close to Sensors, Electronics & Computer Science
 - ALSOC (ALgo. SOC)
 - CIAN (Integrated Circuits)
 - QI (Quantum Information)
 - **SYEL (Electronics System)**

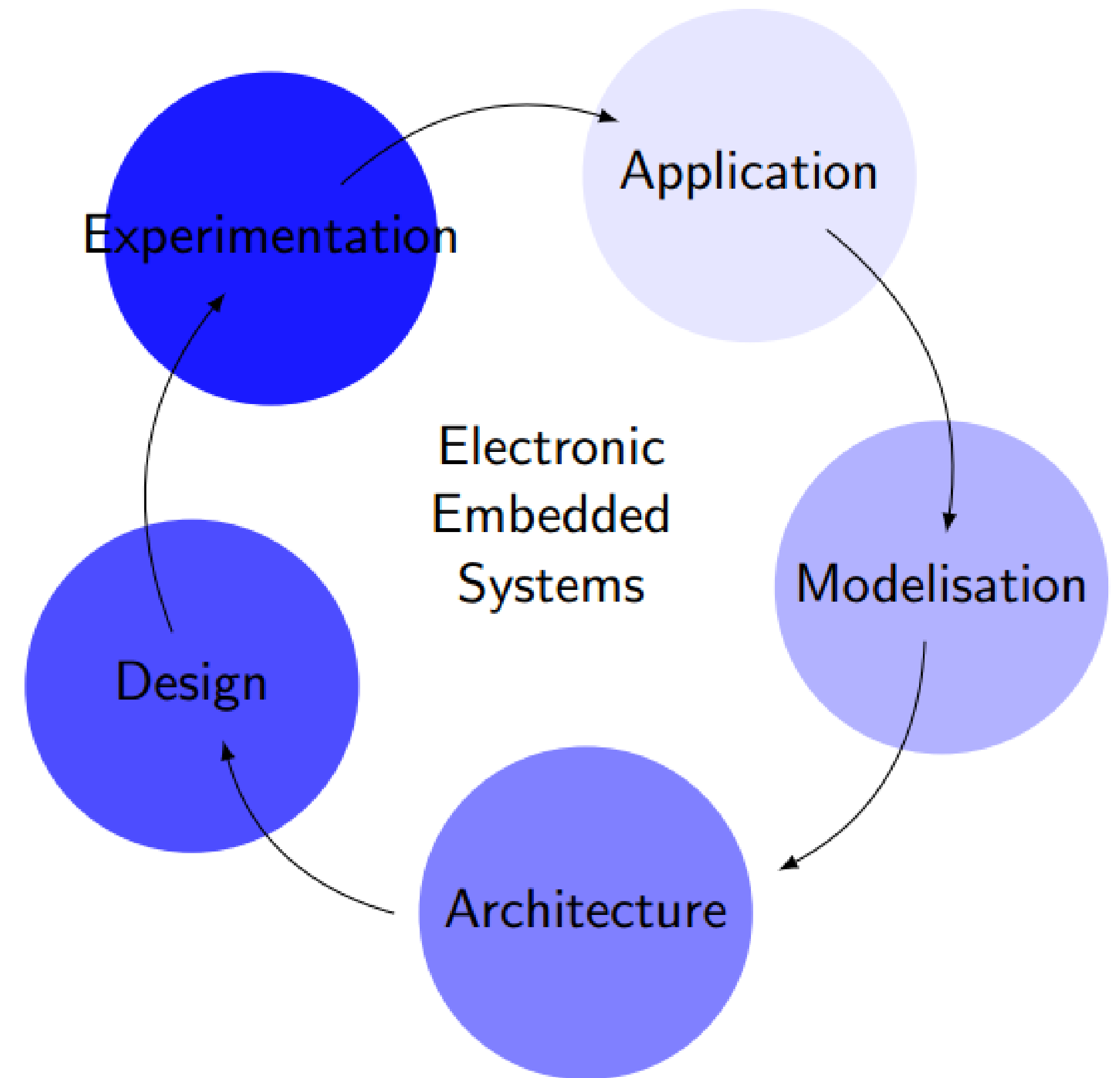
in conjunction with the other LIP6 teams

↳ A wide area: From Components to AI

My team

◉ SYEL

- Computational engineering at the frontier between electronics and computing
 - ✓ Smart system, mixed electronics, modelling of cyber-physical system, embedded AI, edge computing
- Composition
 - ✓ 7 teacher-researchers, 1 CNRS research officer, 1 associated researcher, 1 professor emeritus, 1 ATER
 - ✓ ~15 doctoral students, engineers and post-docs + LIP6 research engineers (CNRS and SU)
 - ✓ 3 doctors during 12⁺ months since 2022 with IUIS
 - 1 to come



- ◉ Full Professor at LIP6 - SU

- Research in Electronic & computer science, mainly applied for **Health**

✓ Member  ,  , ...

- Teacher at Polytech Sorbonne, Licence EEA, Master SESI + **IPS**

✓ Head of CMI master's students

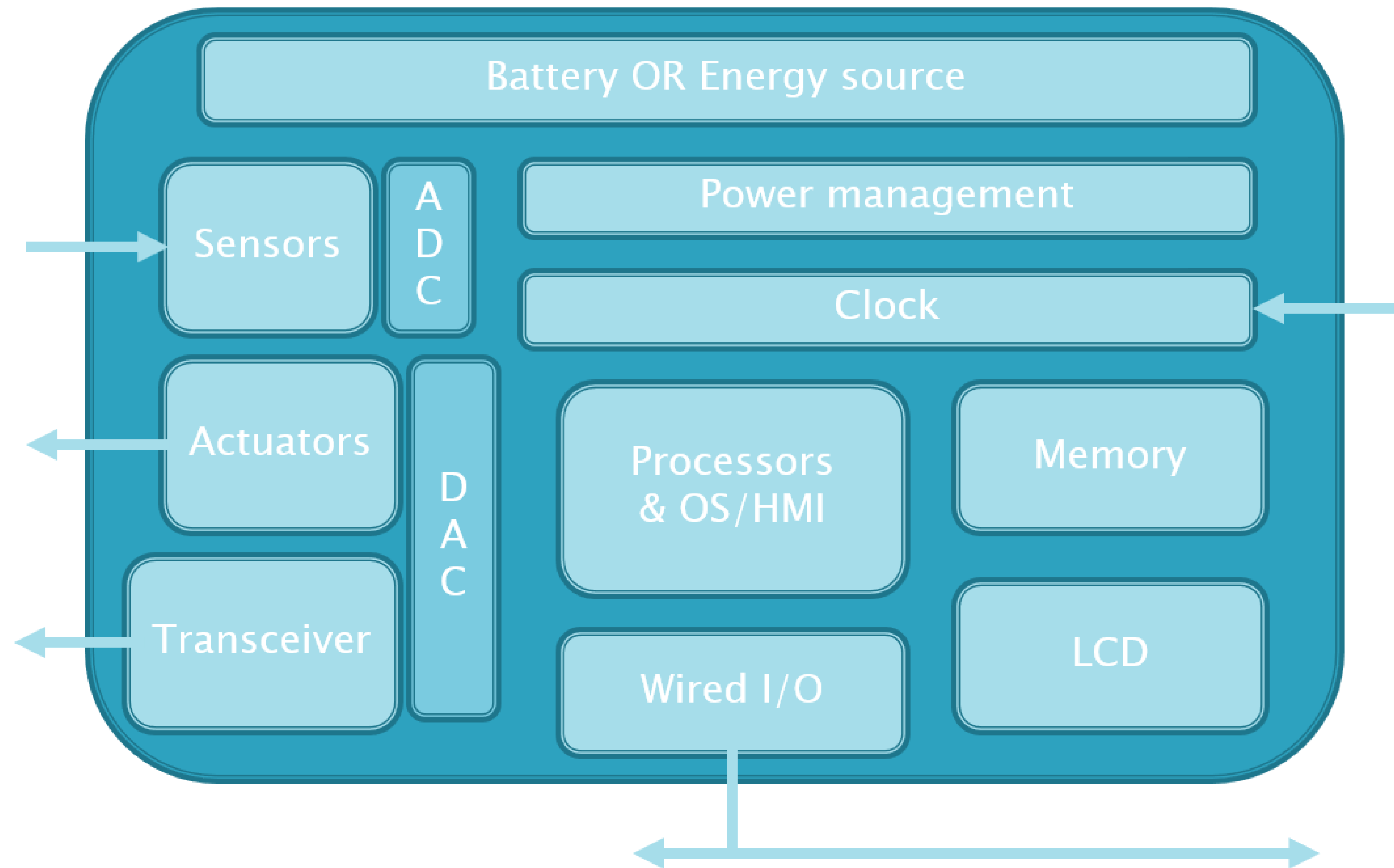
✓ Head of **CMS-I** students

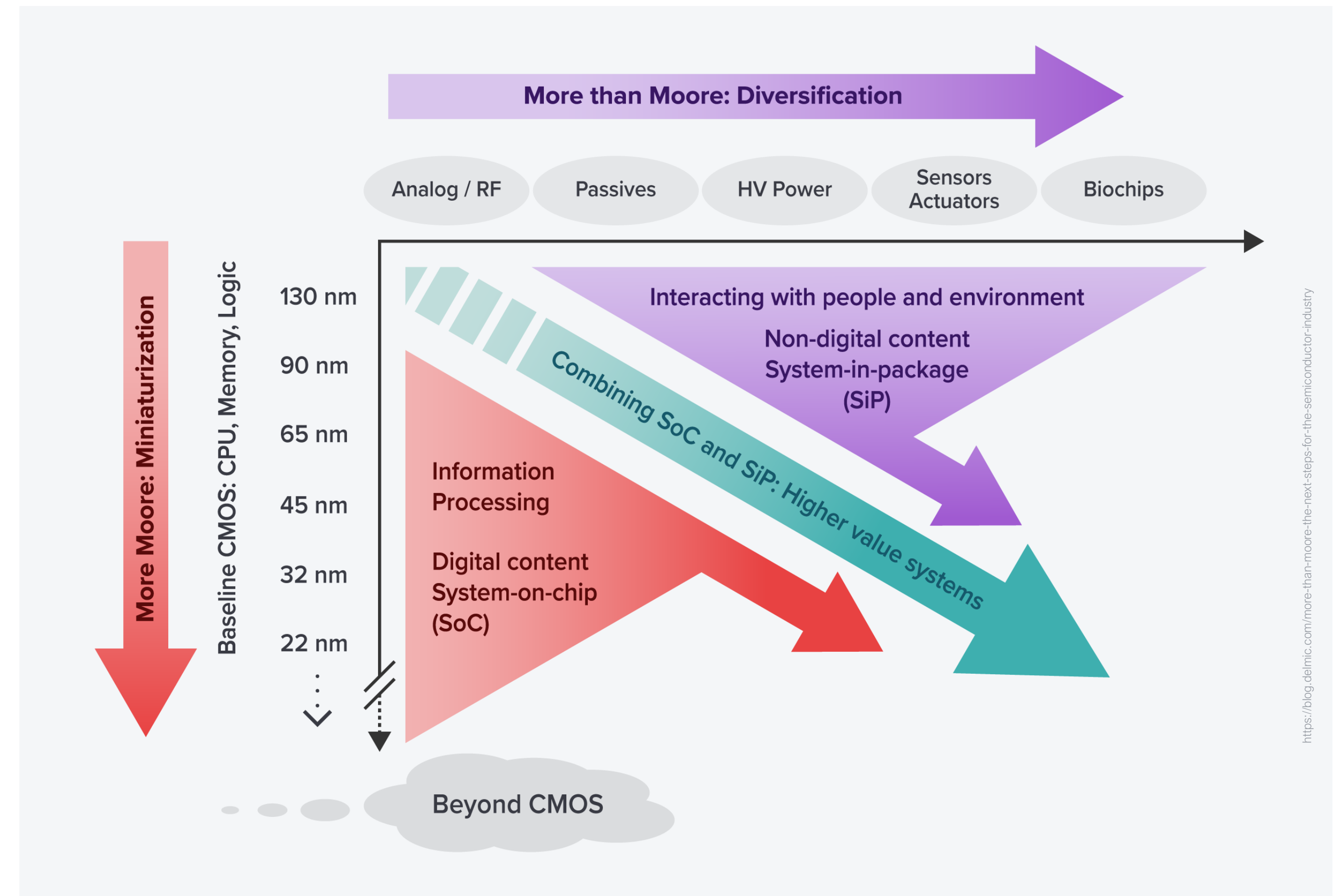
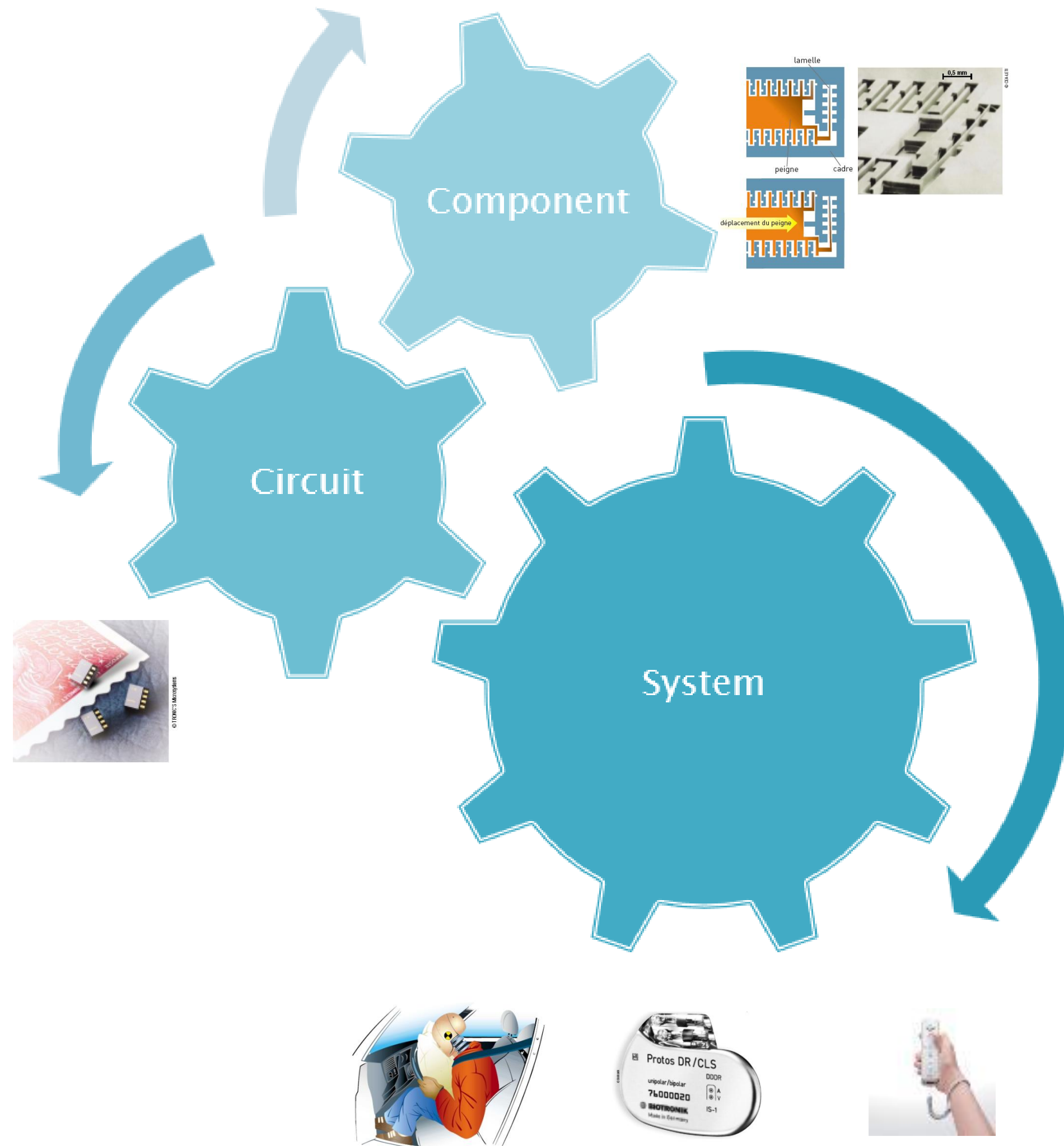
- Cursus Médecine Sciences – Ingénierie for **DFGSM2**

Background

Embedded System

= Sensors and/or Electronics + Computer Science





Sensors & Electronics

Everything & everywhere in modern world

- Various issues
 - ✓ Not only technical (vocabulary also)
- Multidomain → Heterogeneity
- Concepts and constraints often “neglected”
 - ✓ Consumption



✓ Environment

✓ Robustness

- Hardware & software

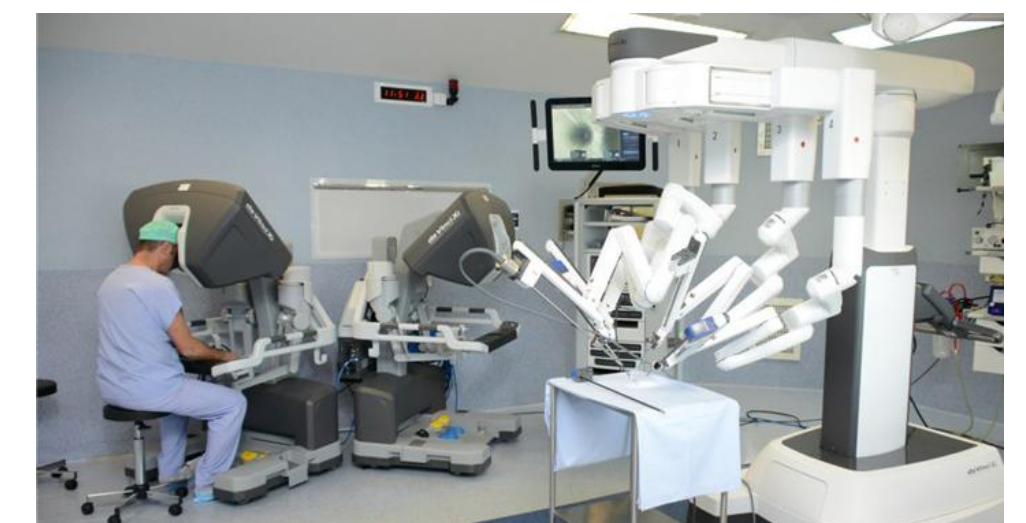
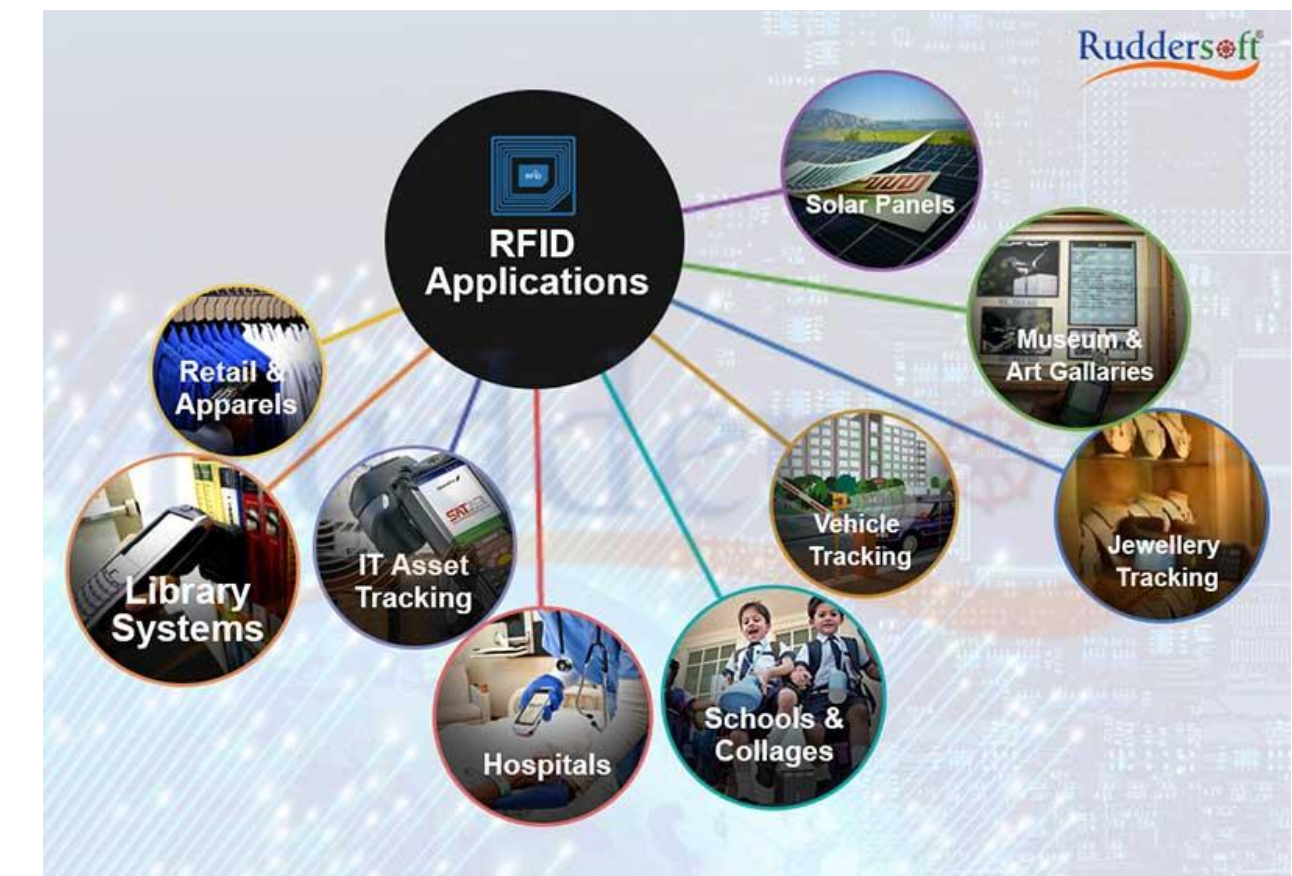
- Full-scale tests

✓ Real time and latencies

✓ Standards

✓ Deontology & ethics

✓ ...



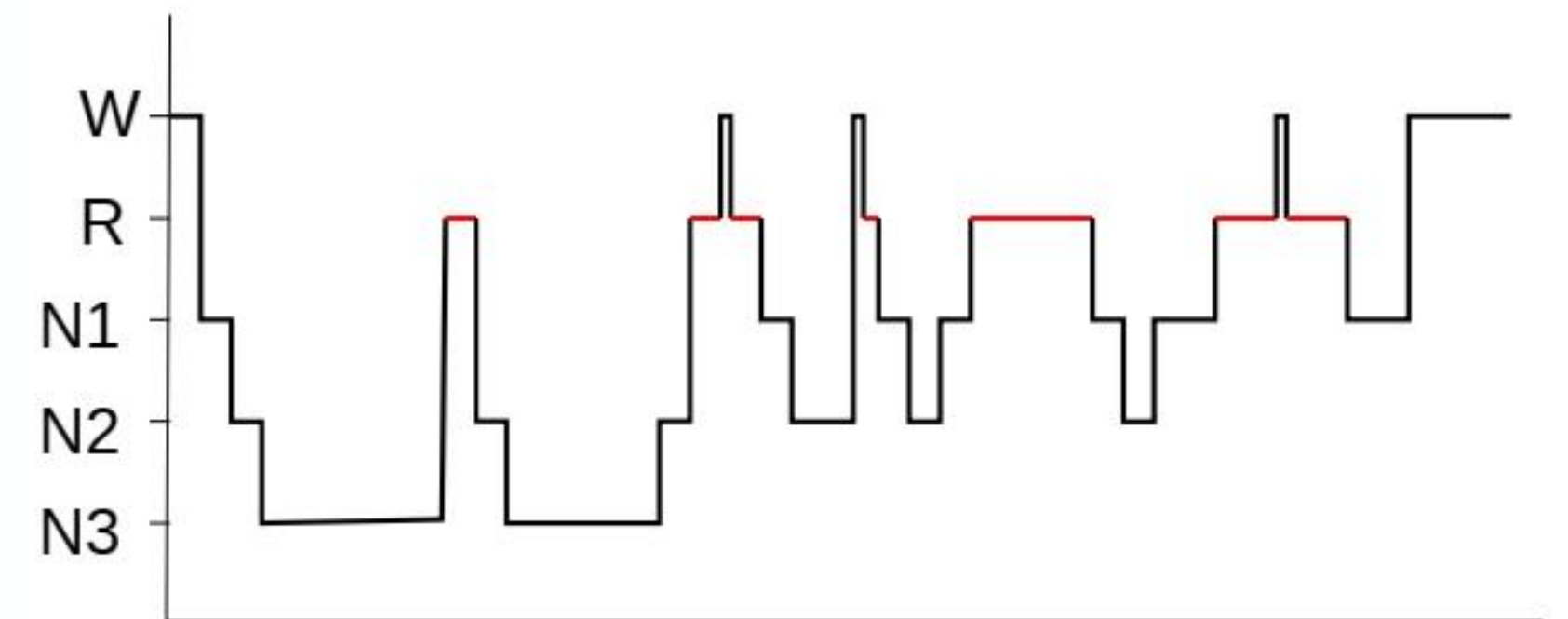
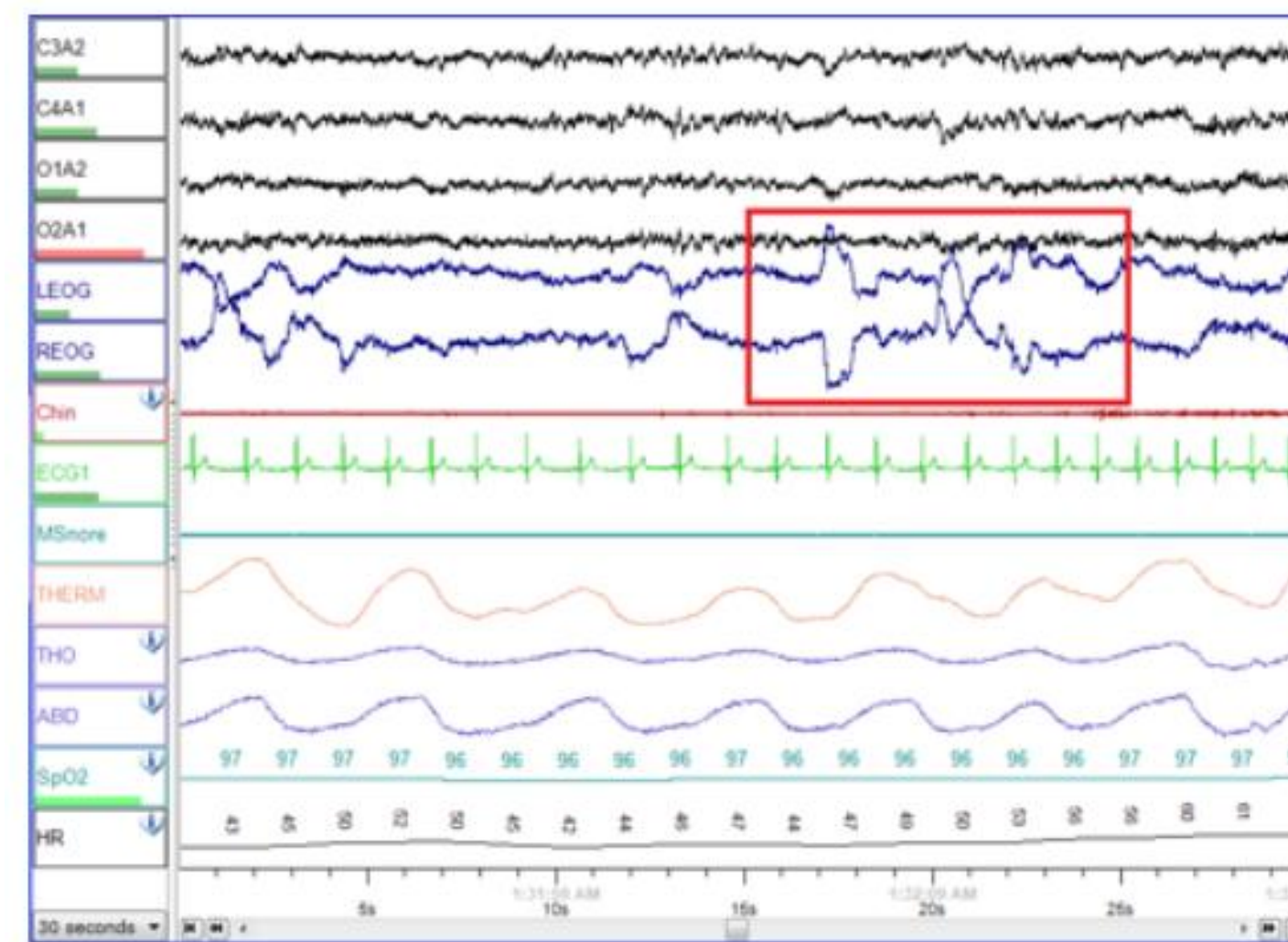
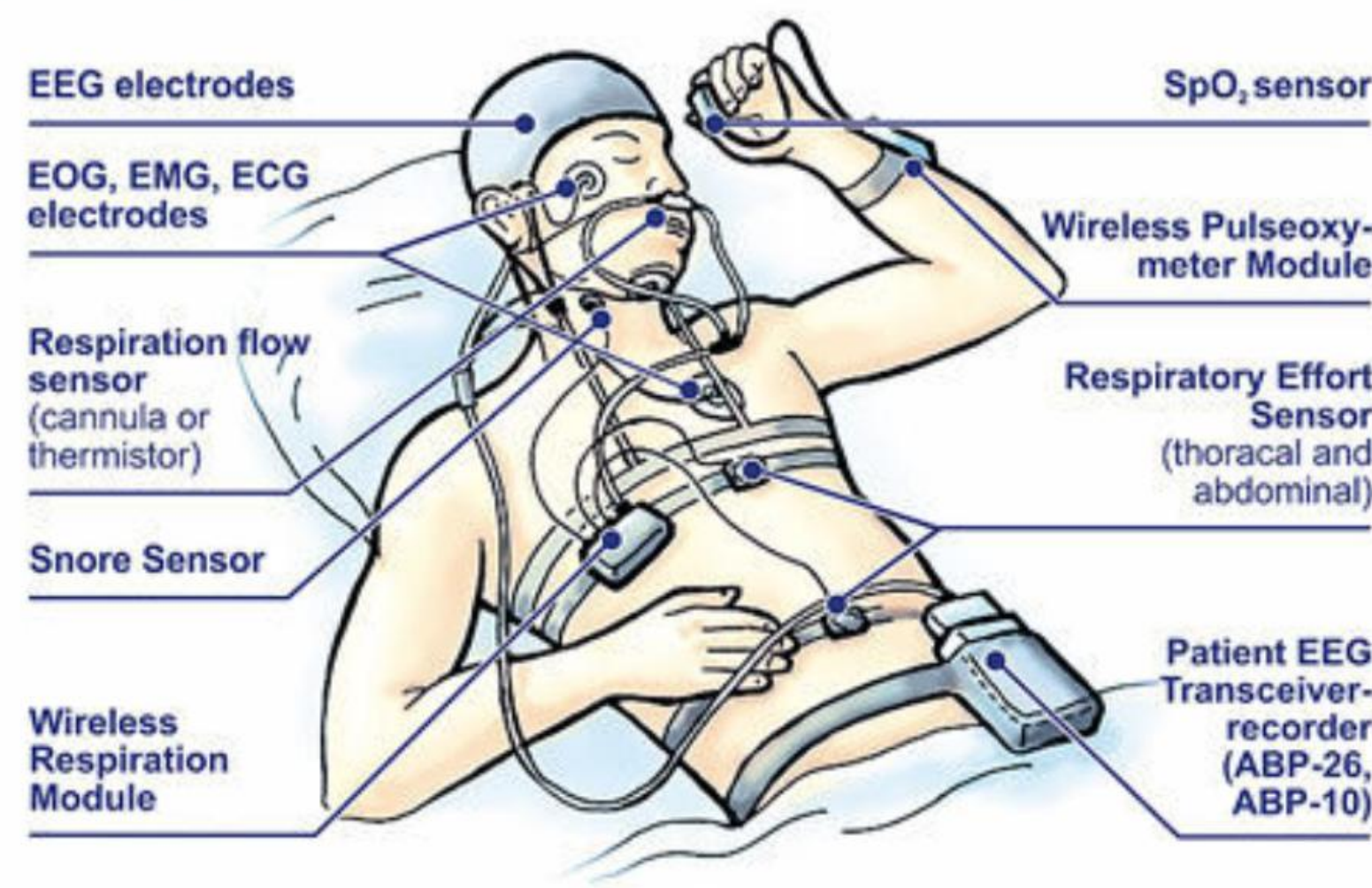
<https://www.gustaveroussy.fr/fr/chirurgie/chirurgie-robotique>

4 examples of biomed. project at SYEL

Sleep

◉ Automated embedded polysomnography

- Development of prediction models
 - ✓ Basic data acquisition (sensor of physiological signals & quiz) + Symbolic fusion → Expert System
- Collab.: APHP, other teams of LIP6

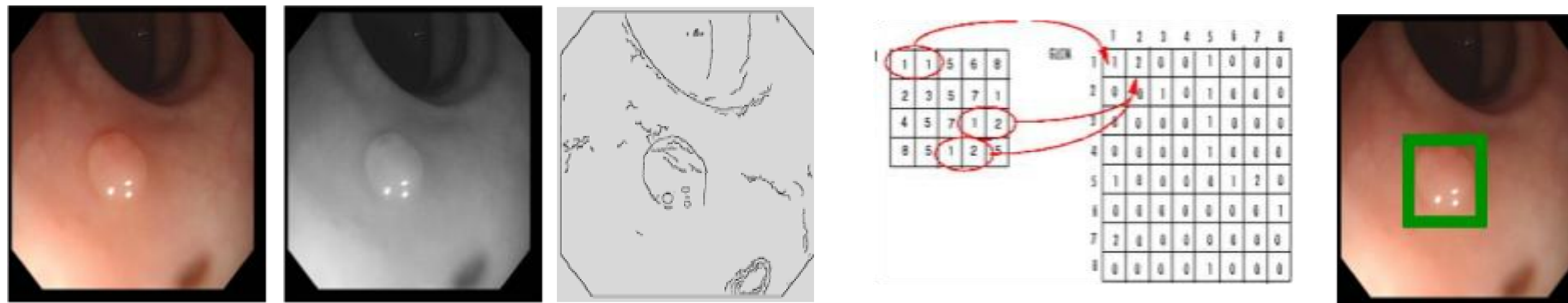
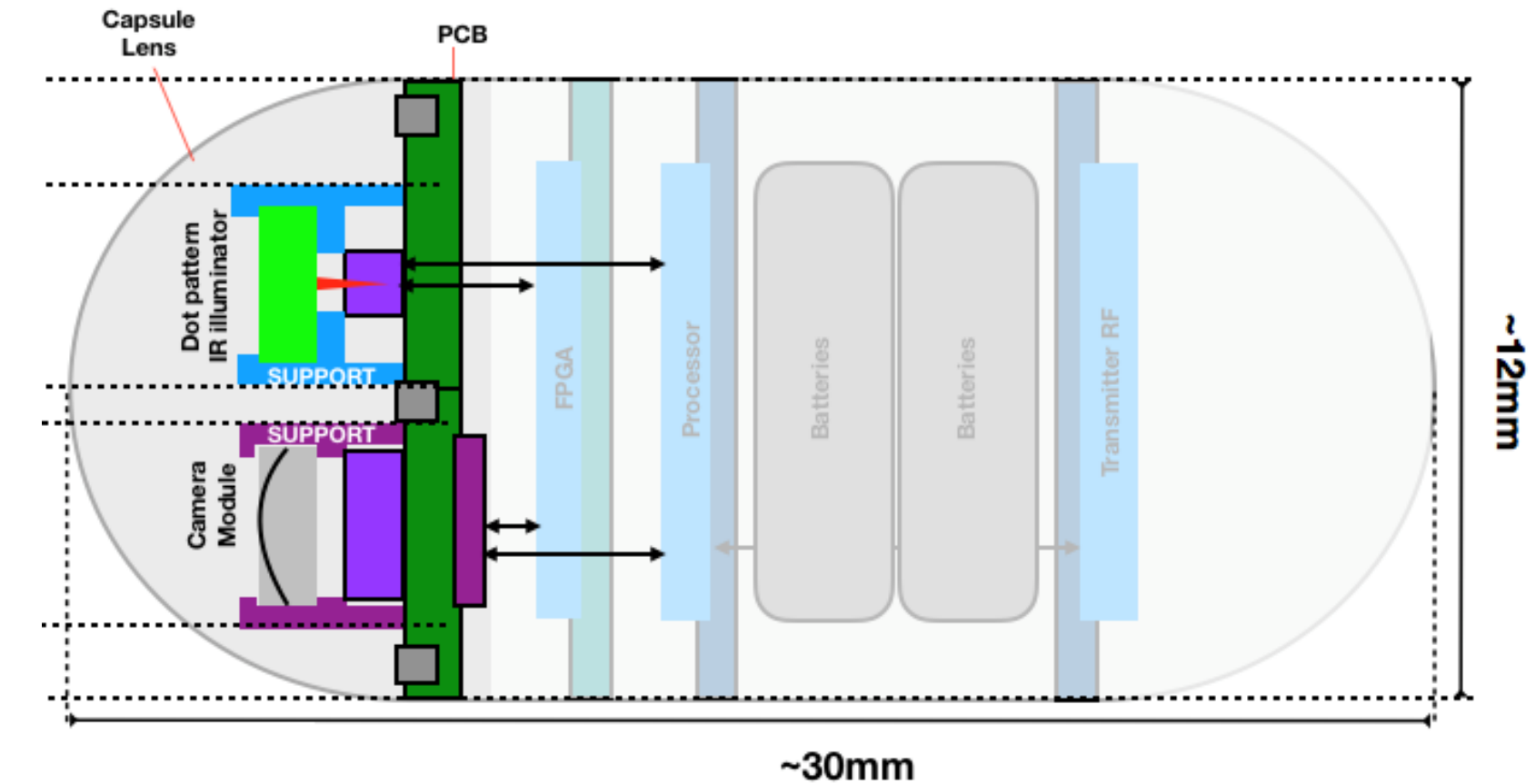
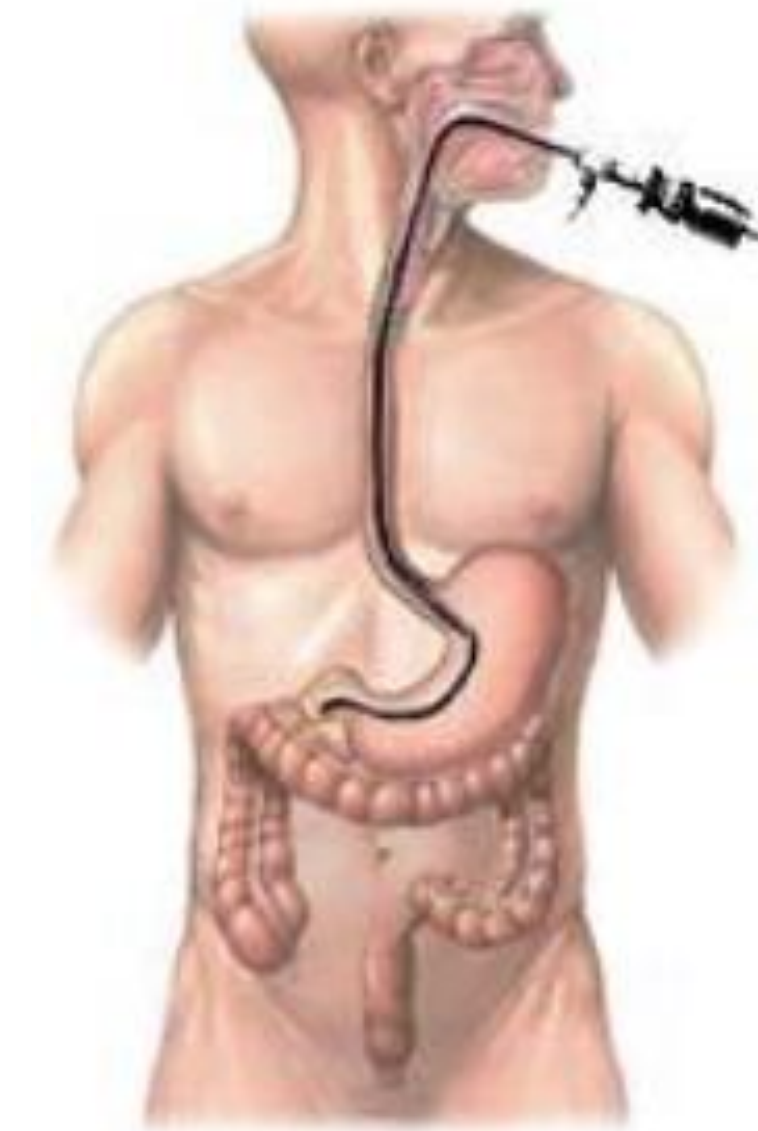


@ A, Pinna

CYCLOPE

◉ Wireless capsule endoscopy

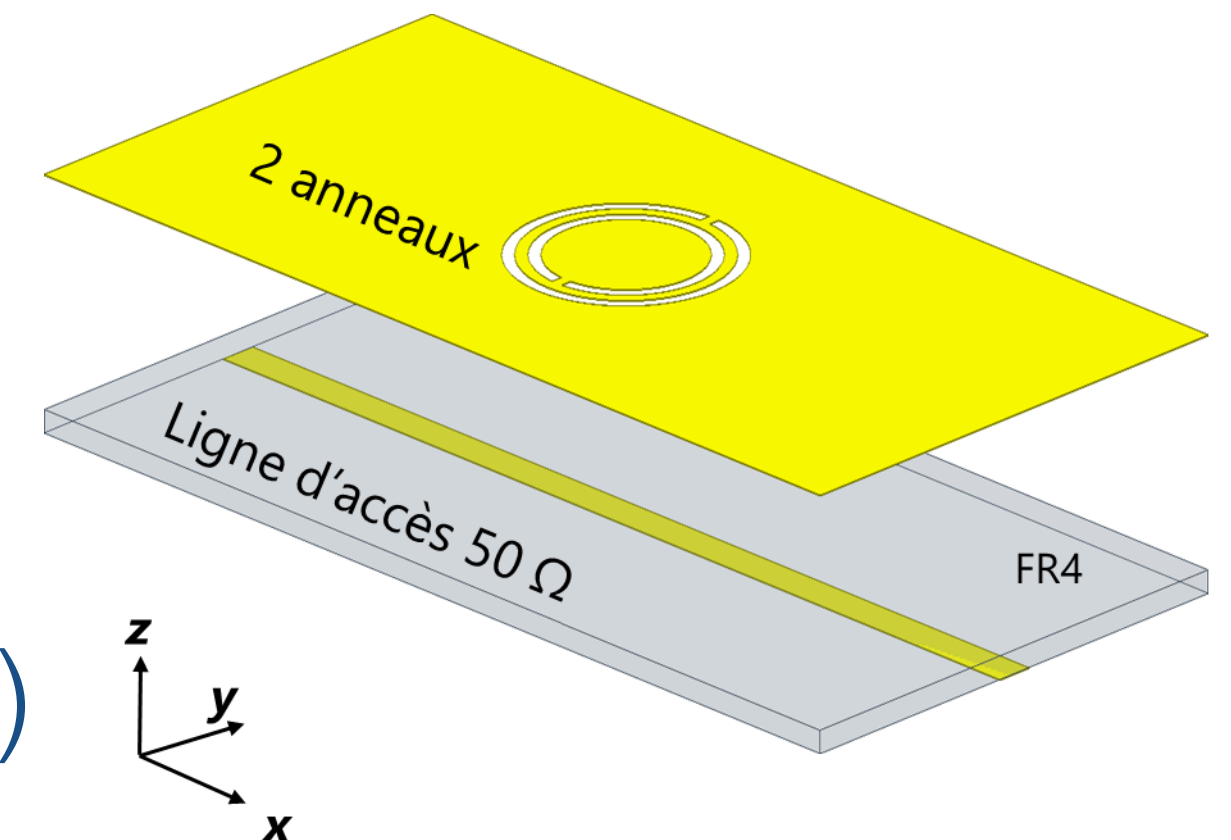
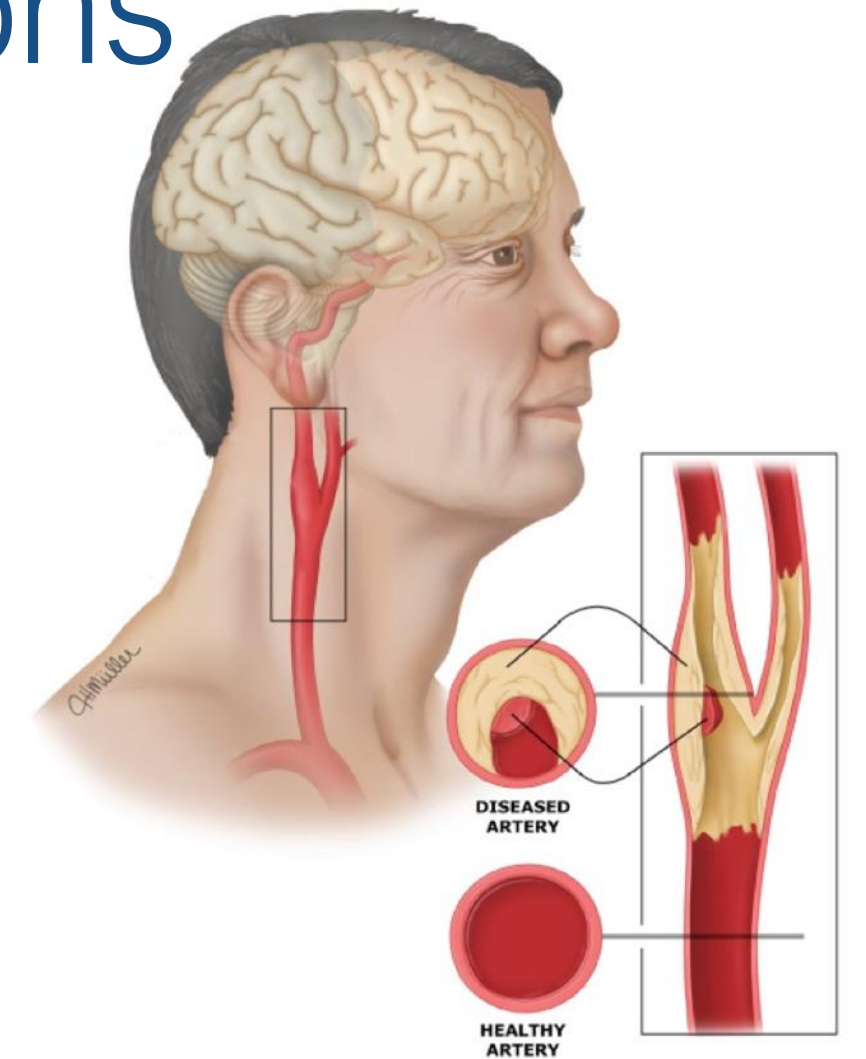
- Focus on polyp to detect colorectal cancer
 - ✓ 3D vision (visible + IR) and processing
 - ✓ Classification by AI on reconfigurable embedded system (FPGA)
- Collab.: APHP, int. company, other academic lab.



@ B. Granado

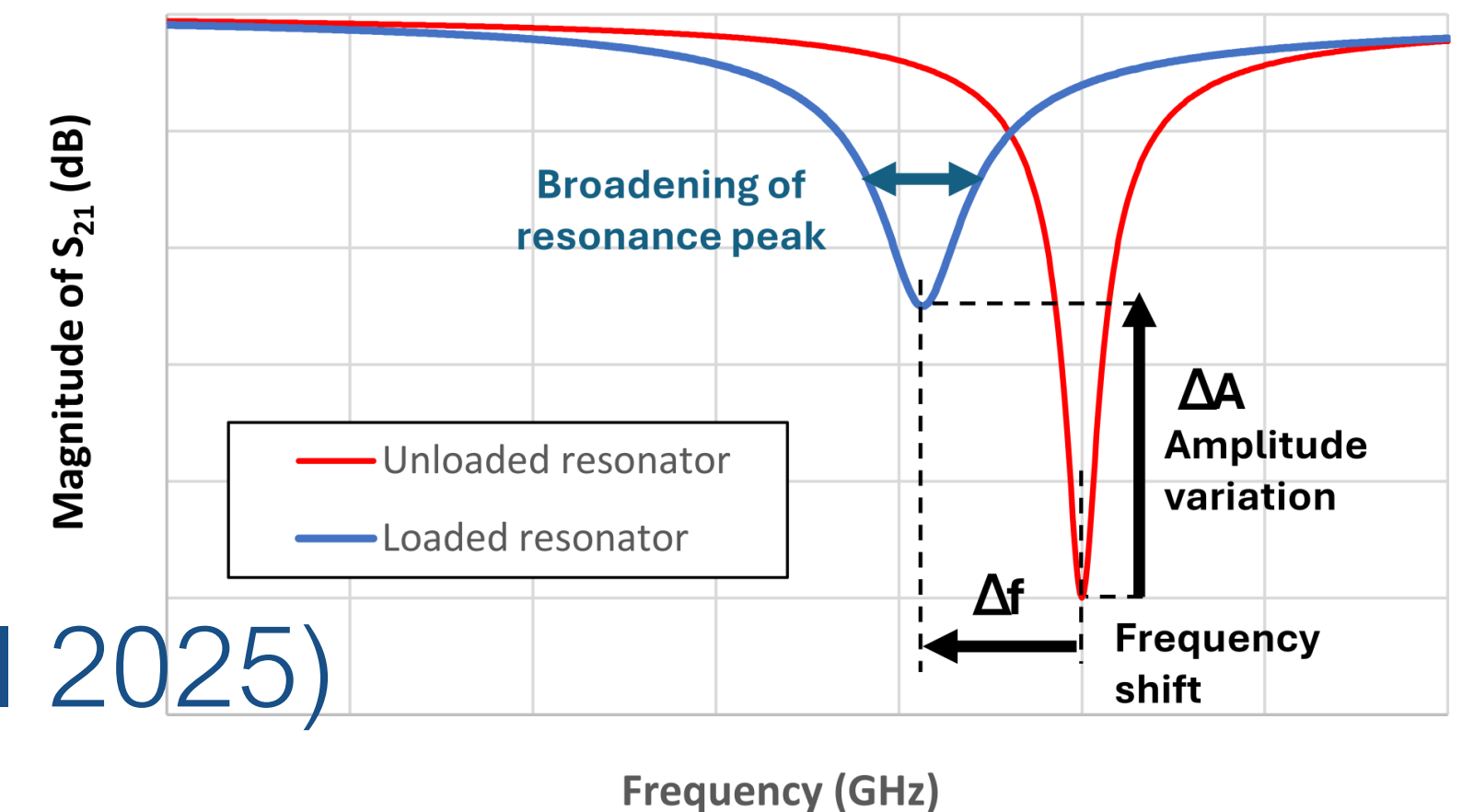
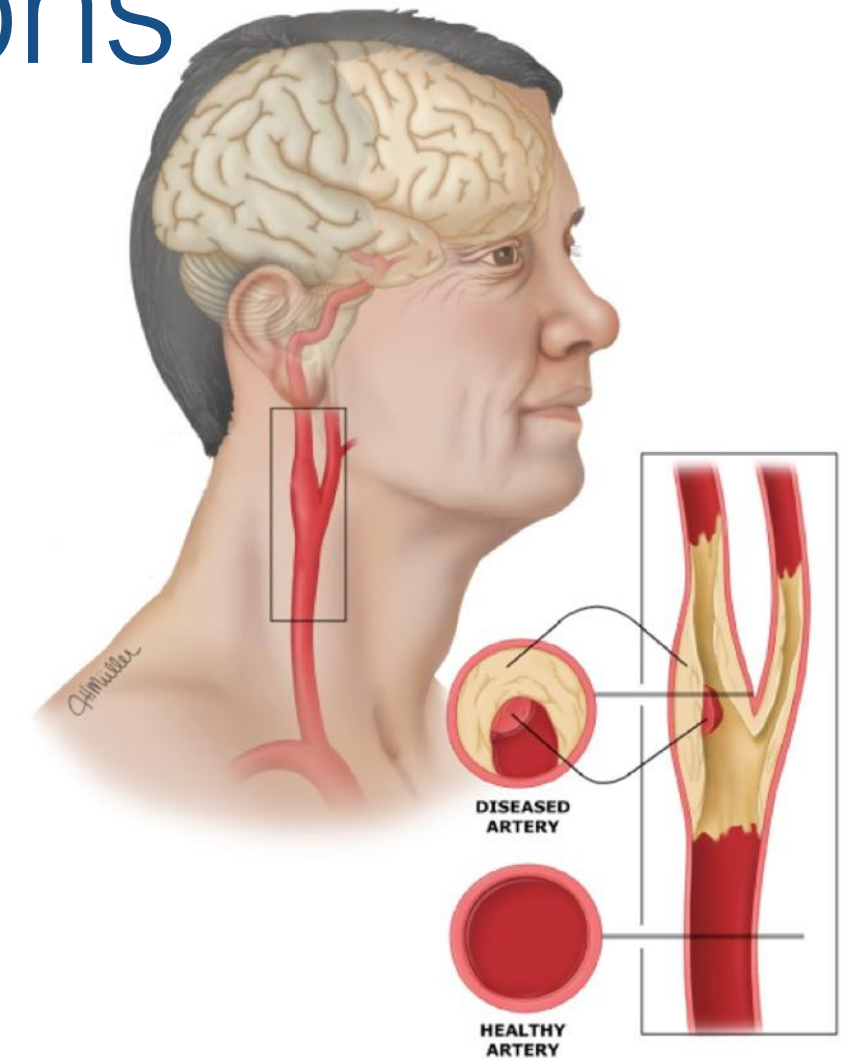
◉ Non-invasive diagnosis of carotid atheromatous lesions

- Plaque at risk or not
 - ✓ Optimized microwave Complementary Split Ring Resonator (CSRR) biosensor
 - From Geometry & Substrate
 - ✓ Characterization & modelling of biological tissues
 - ✓ Portable platform for the acquisition, processing & data analysis
 - Regression from HFSS database
- Collab.: APHP, CIAN/LIP6, GeePs (PhD of J. MASINI 2025)



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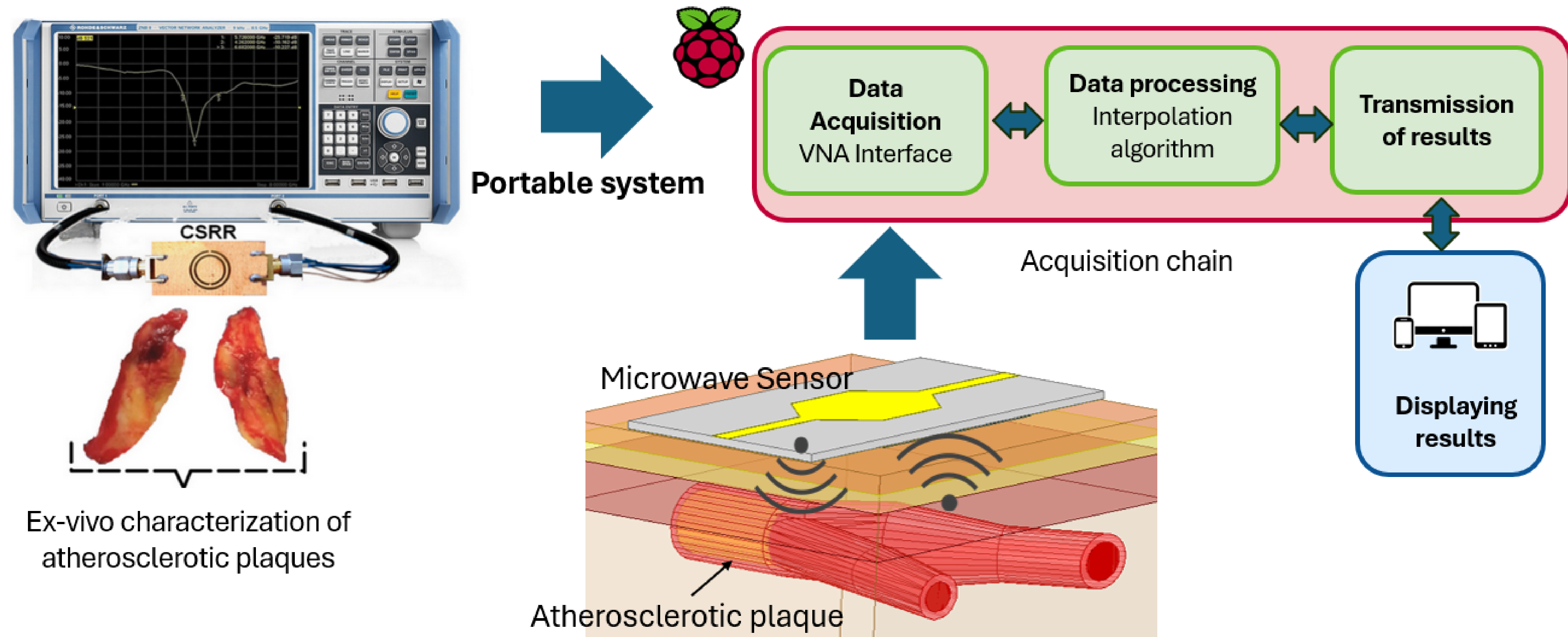
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Carot

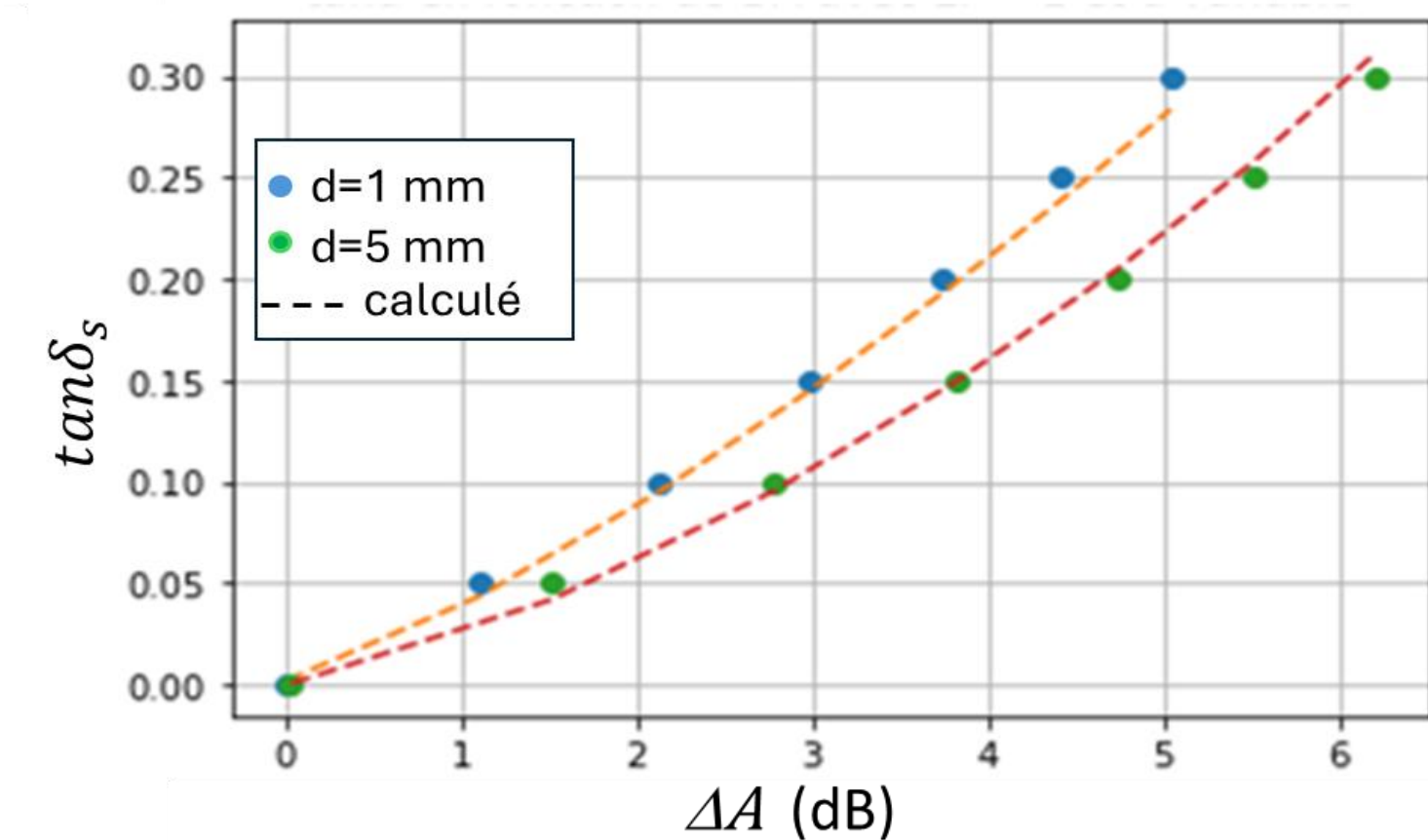
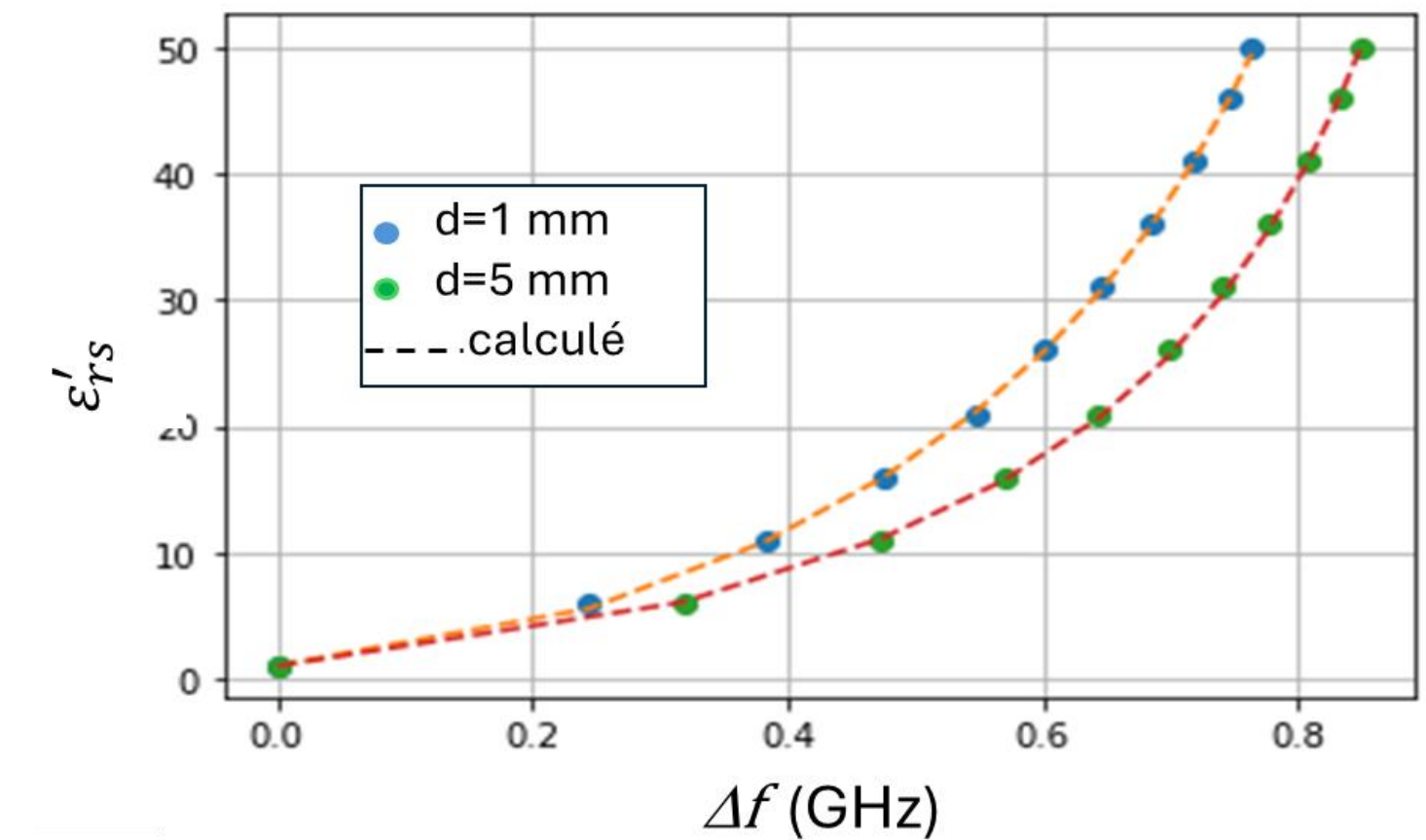
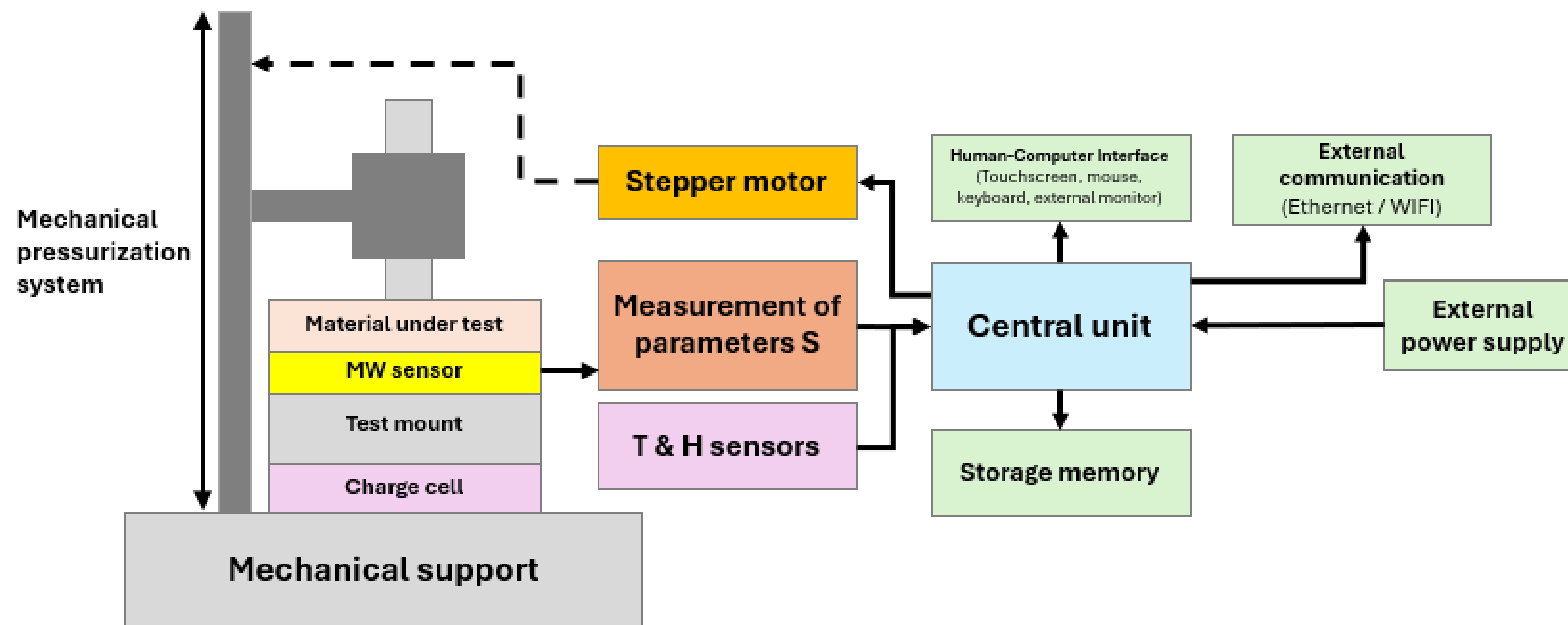
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• Realization



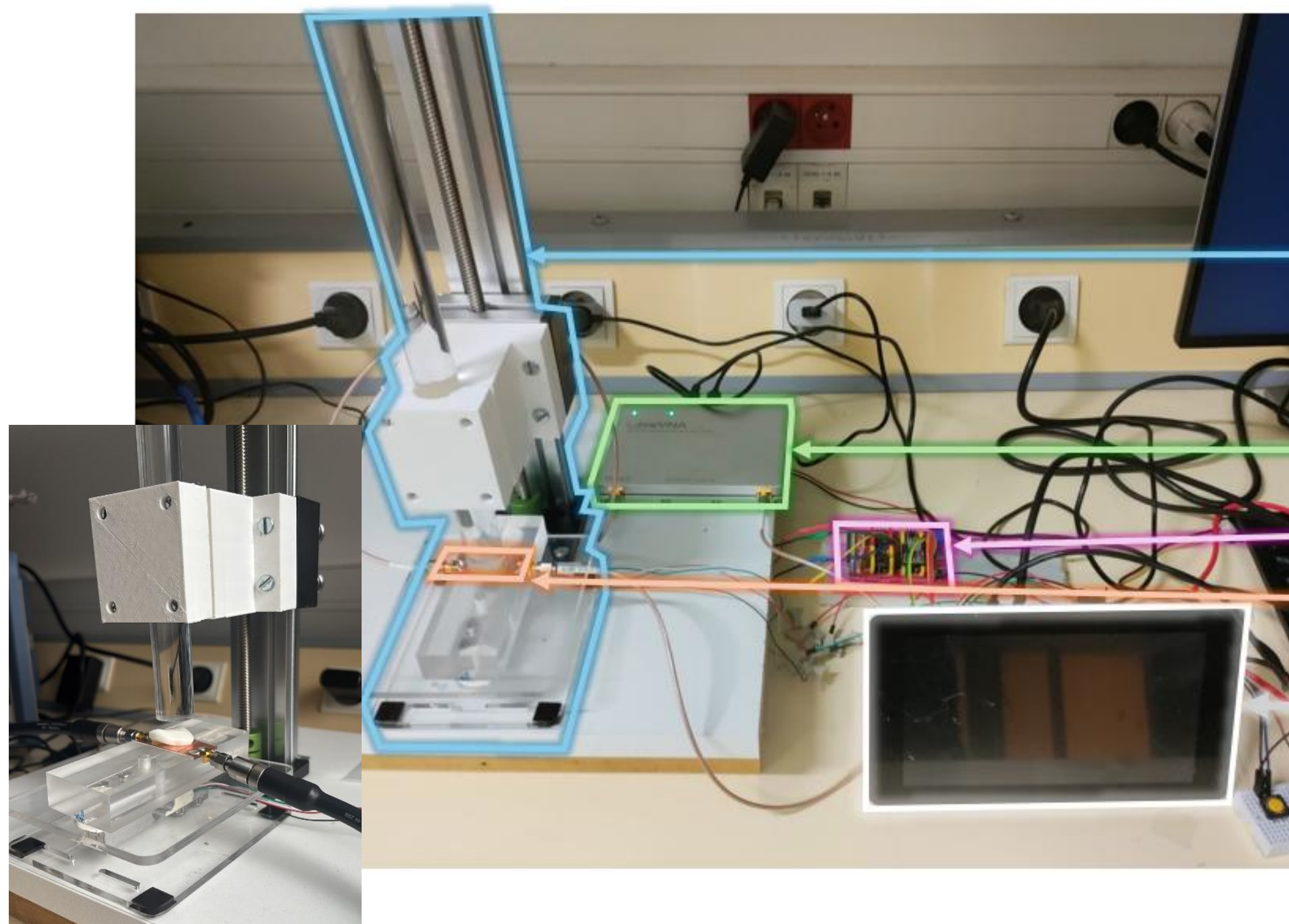
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• Testbench



◉ Non-invasive diagnosis of carotid atheromatous lesions

• Testbench



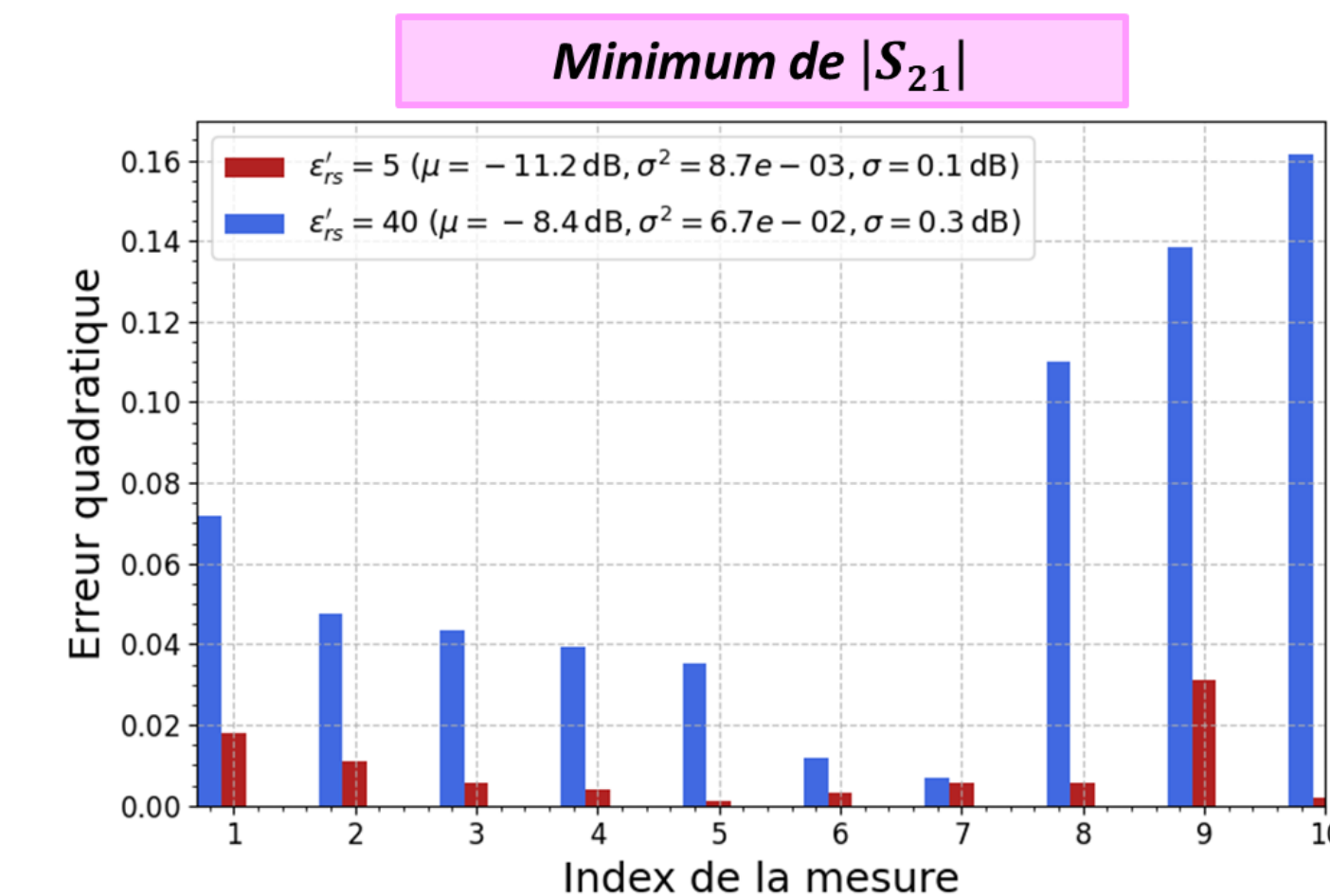
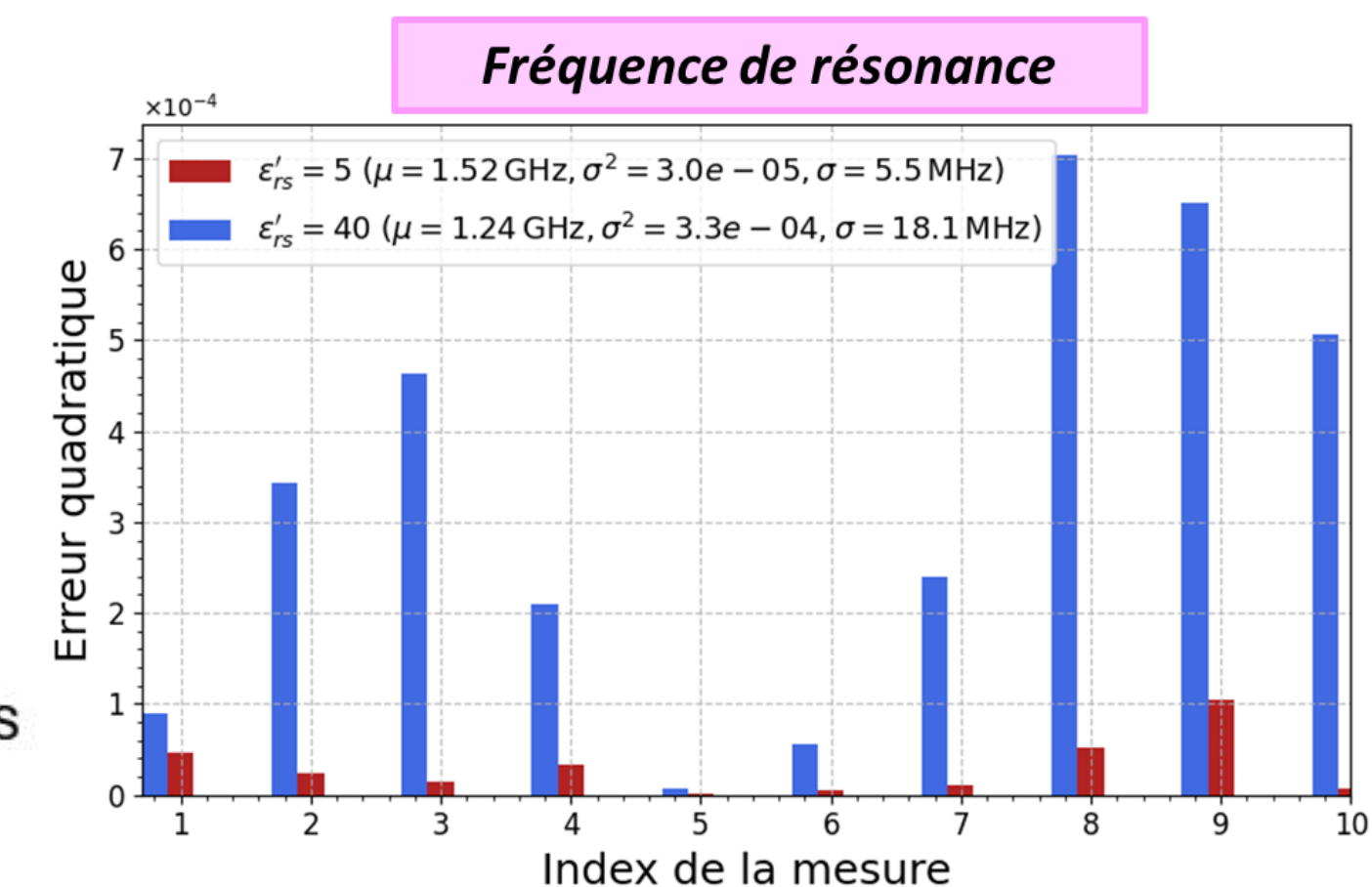
Mechanical system + Load cell
+ Temperature & humidity sensors

LibreVNA

Stepper motor driver

MW sensor

Raspberry Pi 4
+ Touch screen



◉ Next step

- Expand the database & improve our models
 - ✓ Edge-IA (≠Cloud)
- Move towards a miniaturized system
 - ✓ Additional sensors
- Find new biomedical applications of microwave sensors
 - ✓ Diabetes ? Osteoporosis ? ...



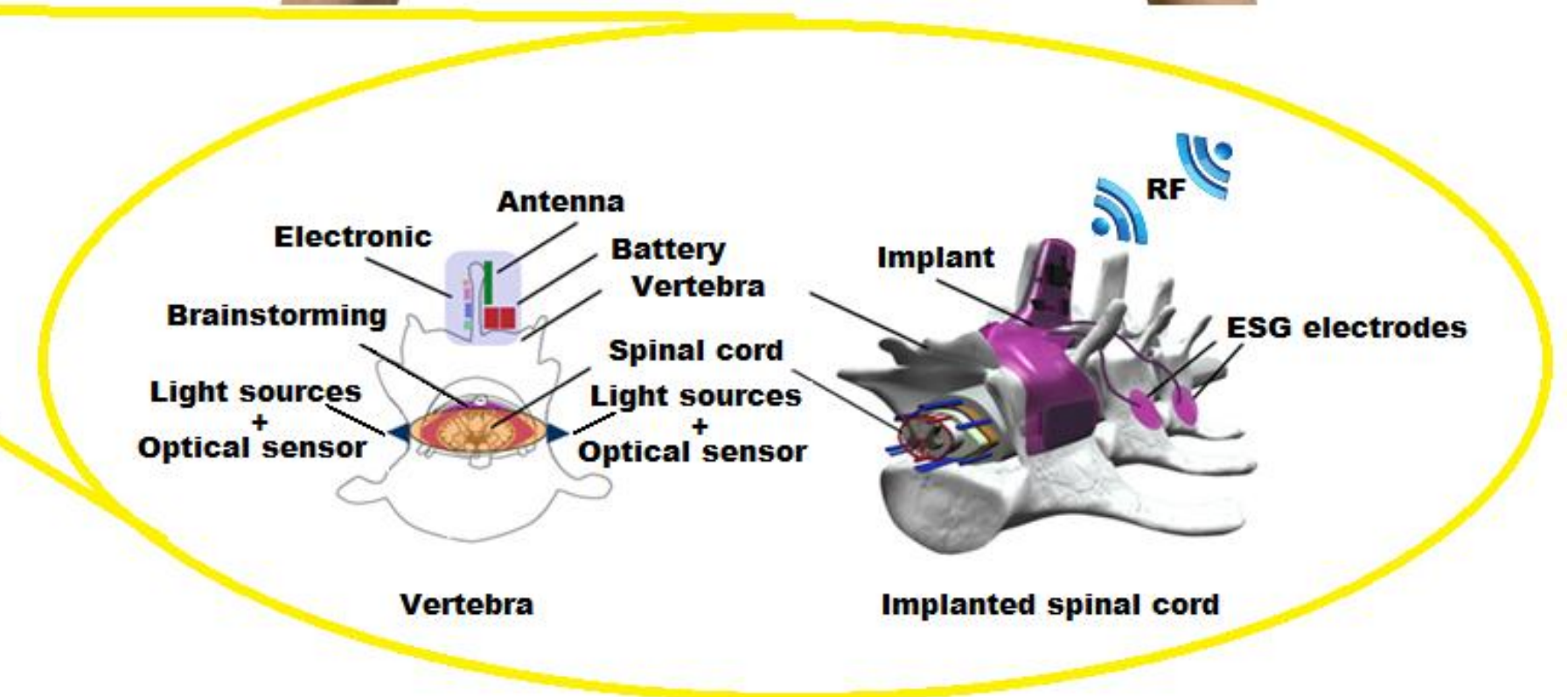
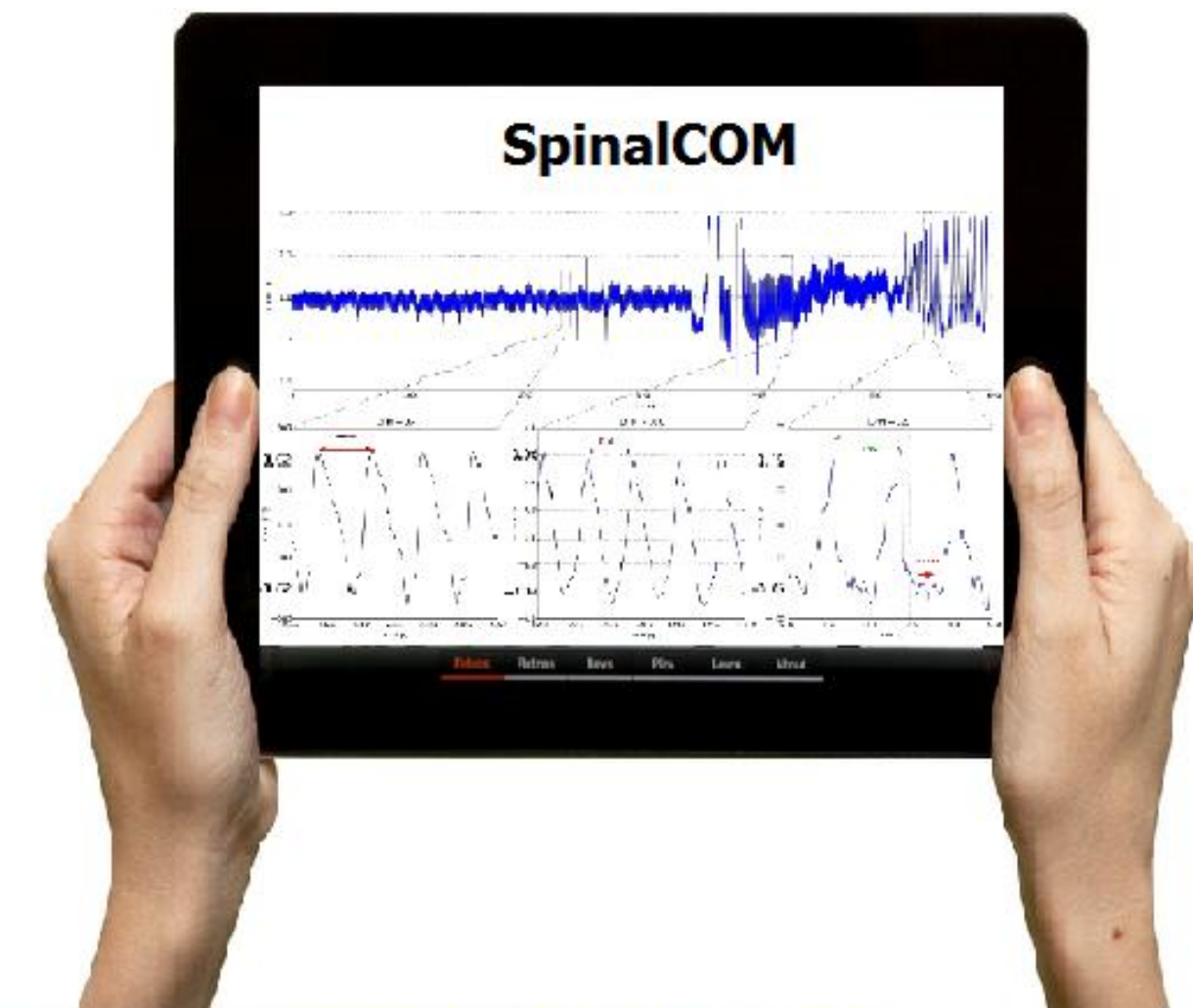
Gemini

◉ Communicating implant for the multimodal imaging of the SC

- Functional status of the SC in real time

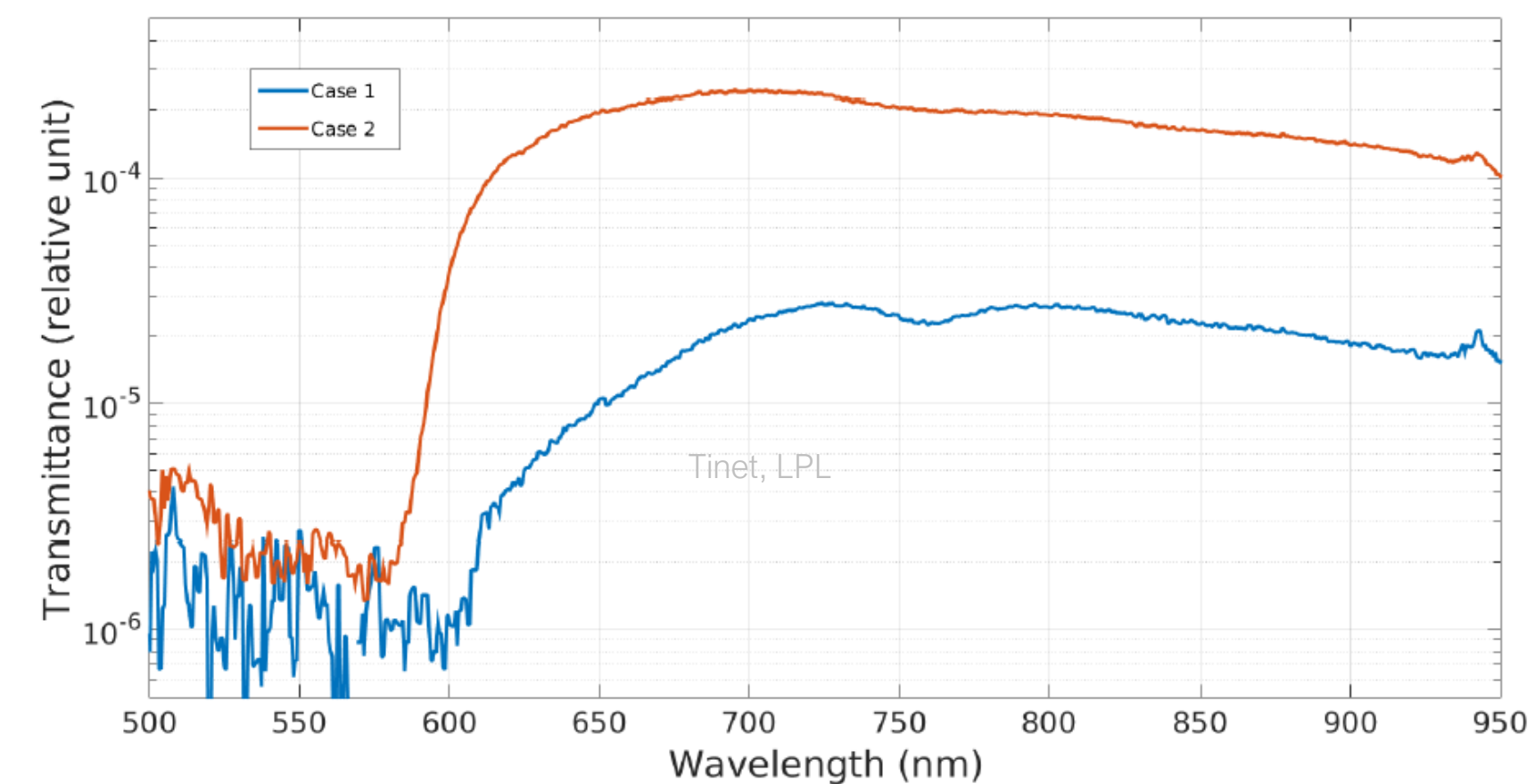
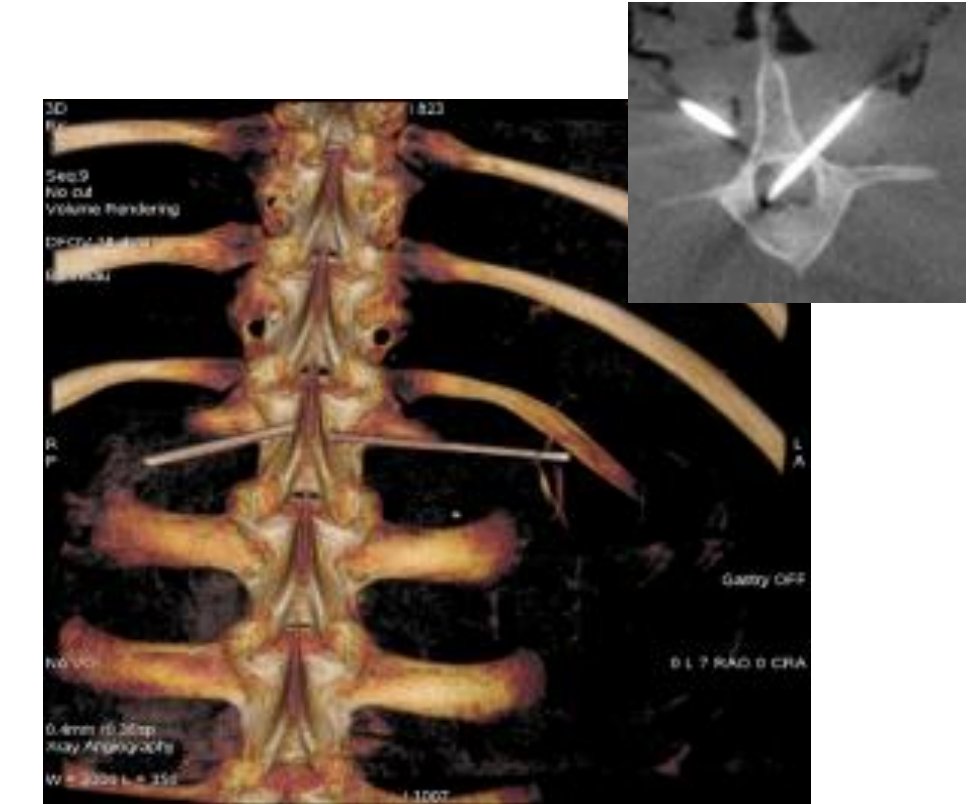
- ✓ Low-power, high resolution wireless embedded system + data analysis & prediction
- ✓ Diffuse Optical Imagery + ElectroSpinoGraphy + ...

- Collab.: APHP, some academic lab.



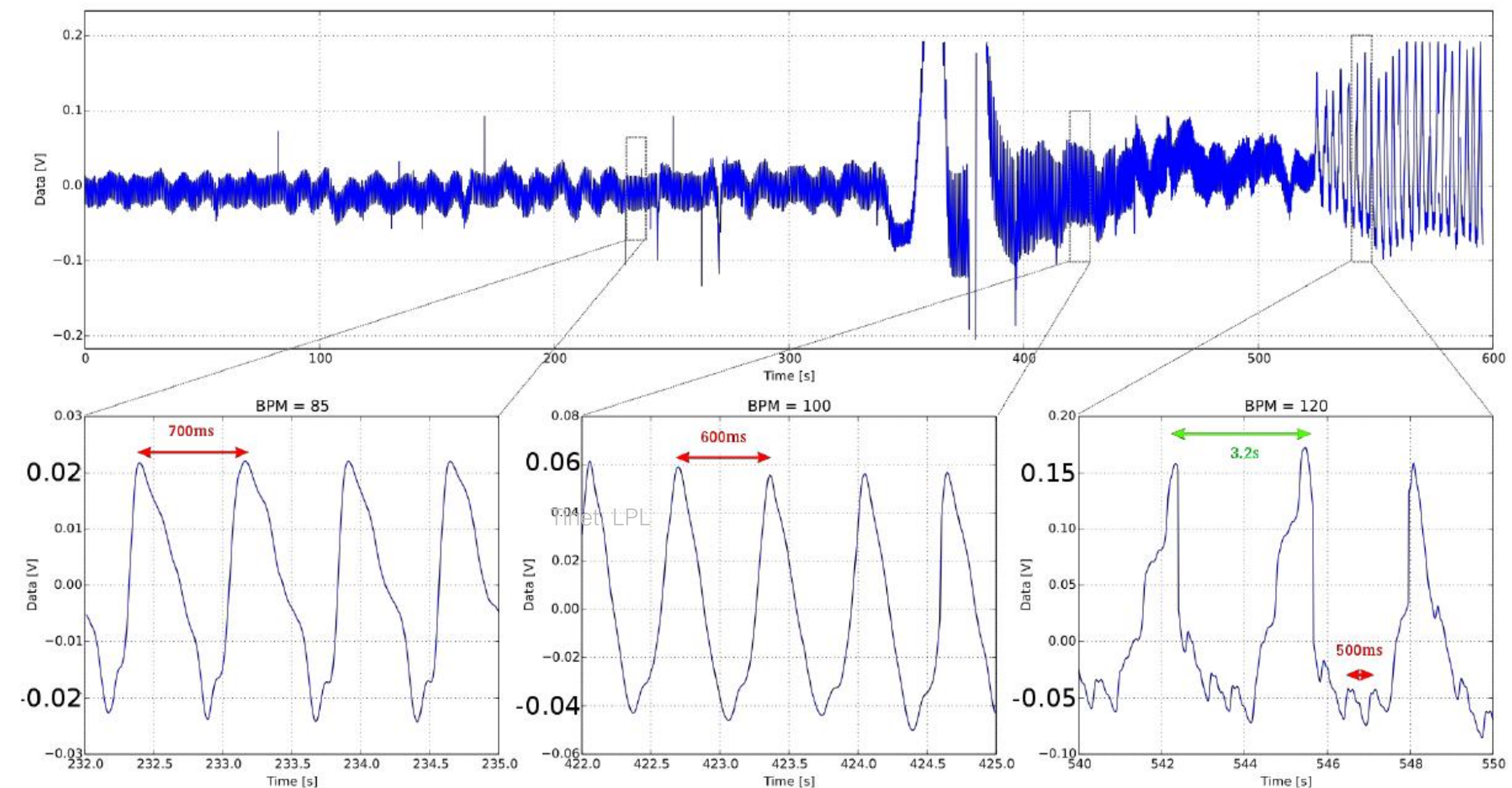
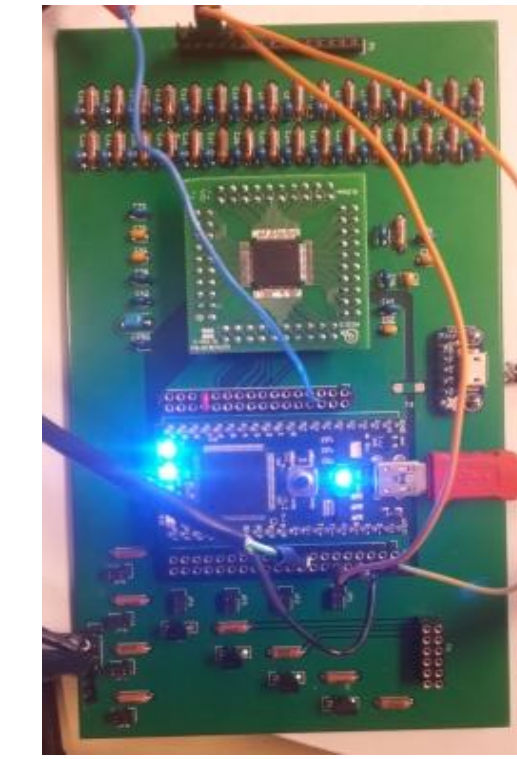
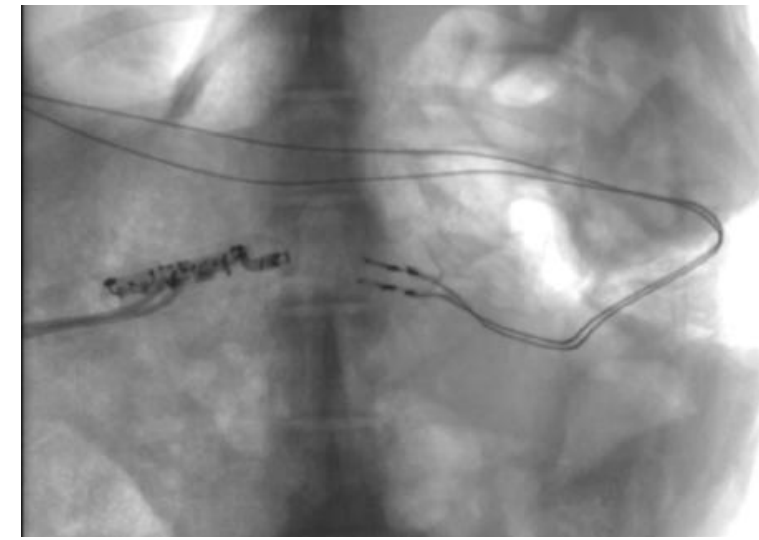
Contributions

- Precious in-vivo data
- POC made on pig model
- Original electronics
- Multidomain modelling
- Extracting key parameters from noisy signals



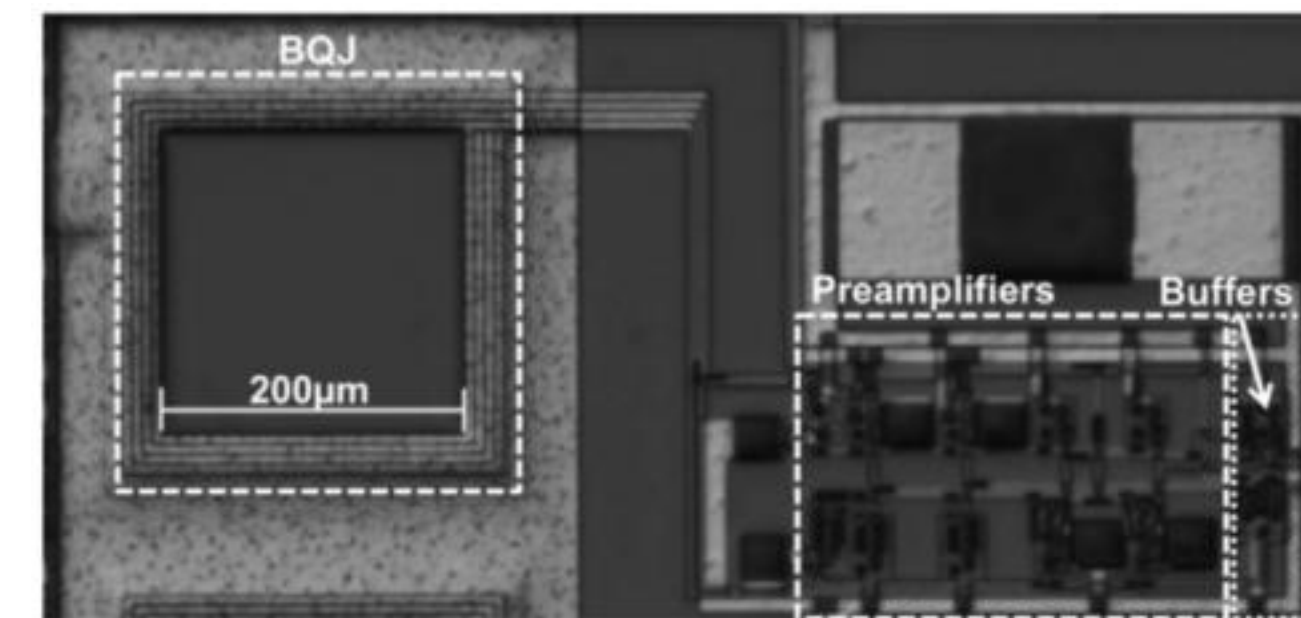
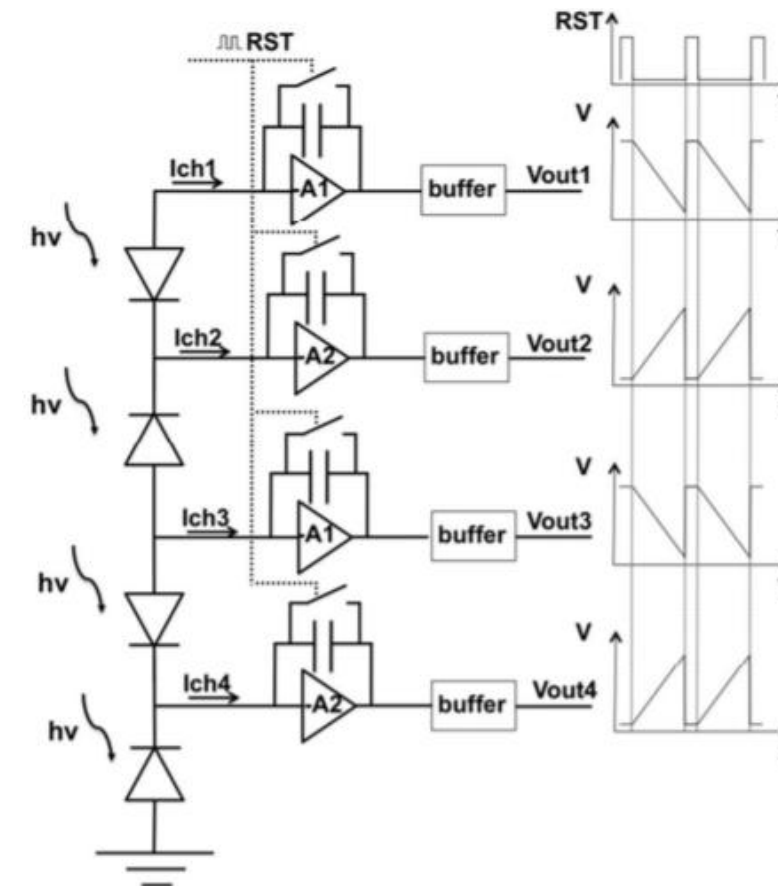
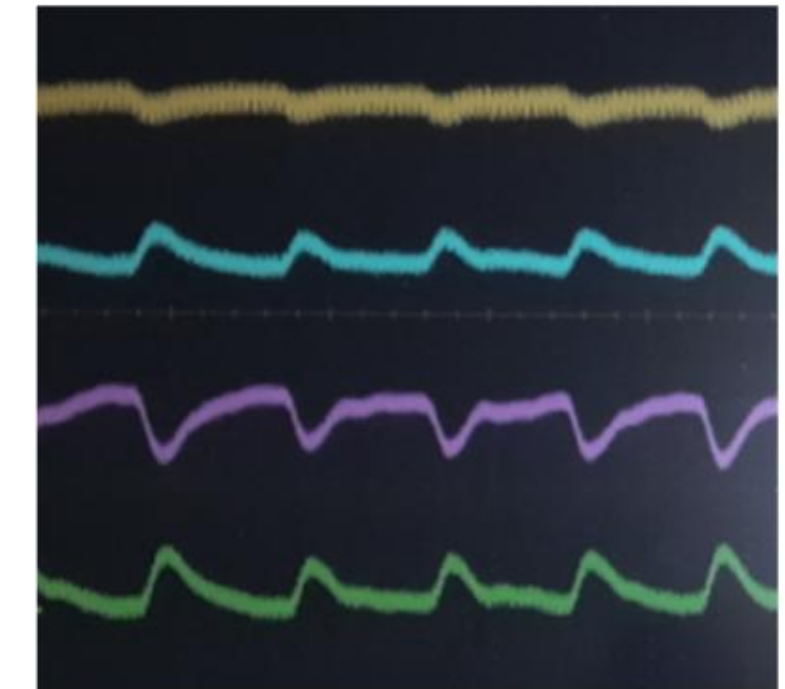
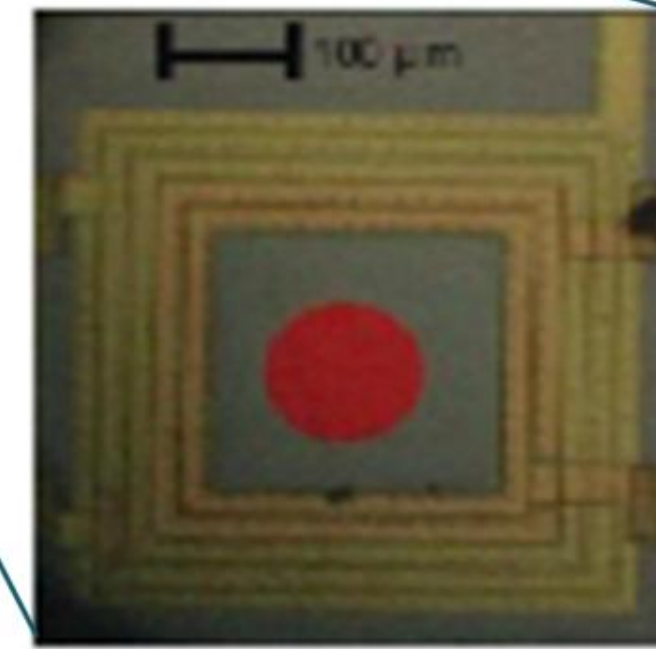
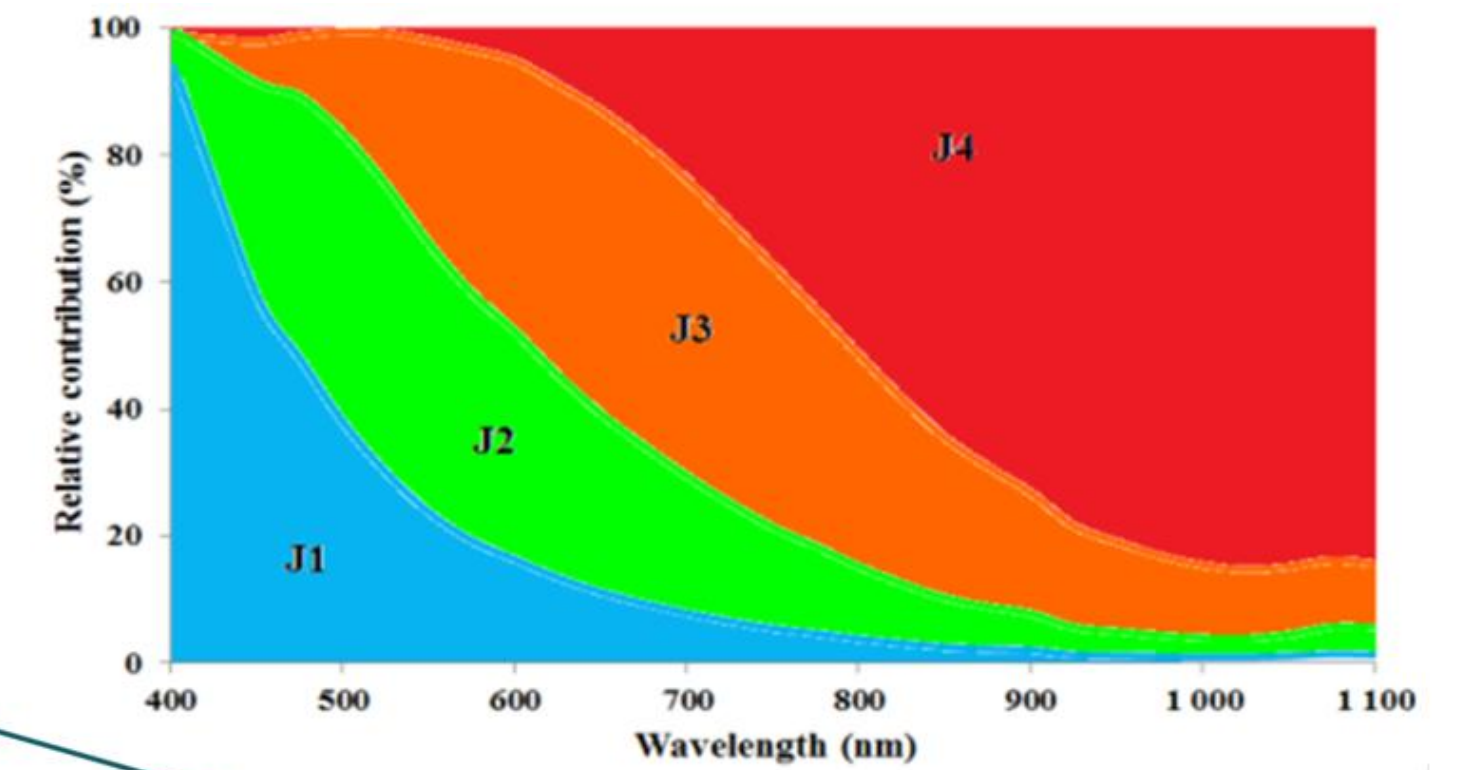
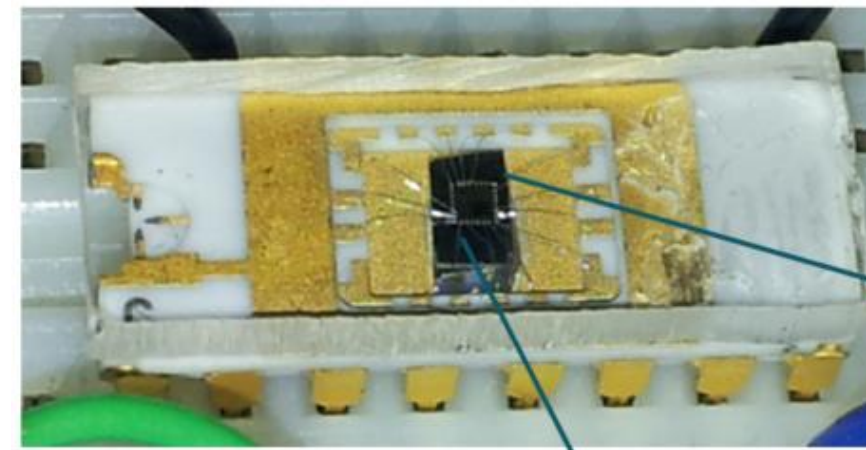
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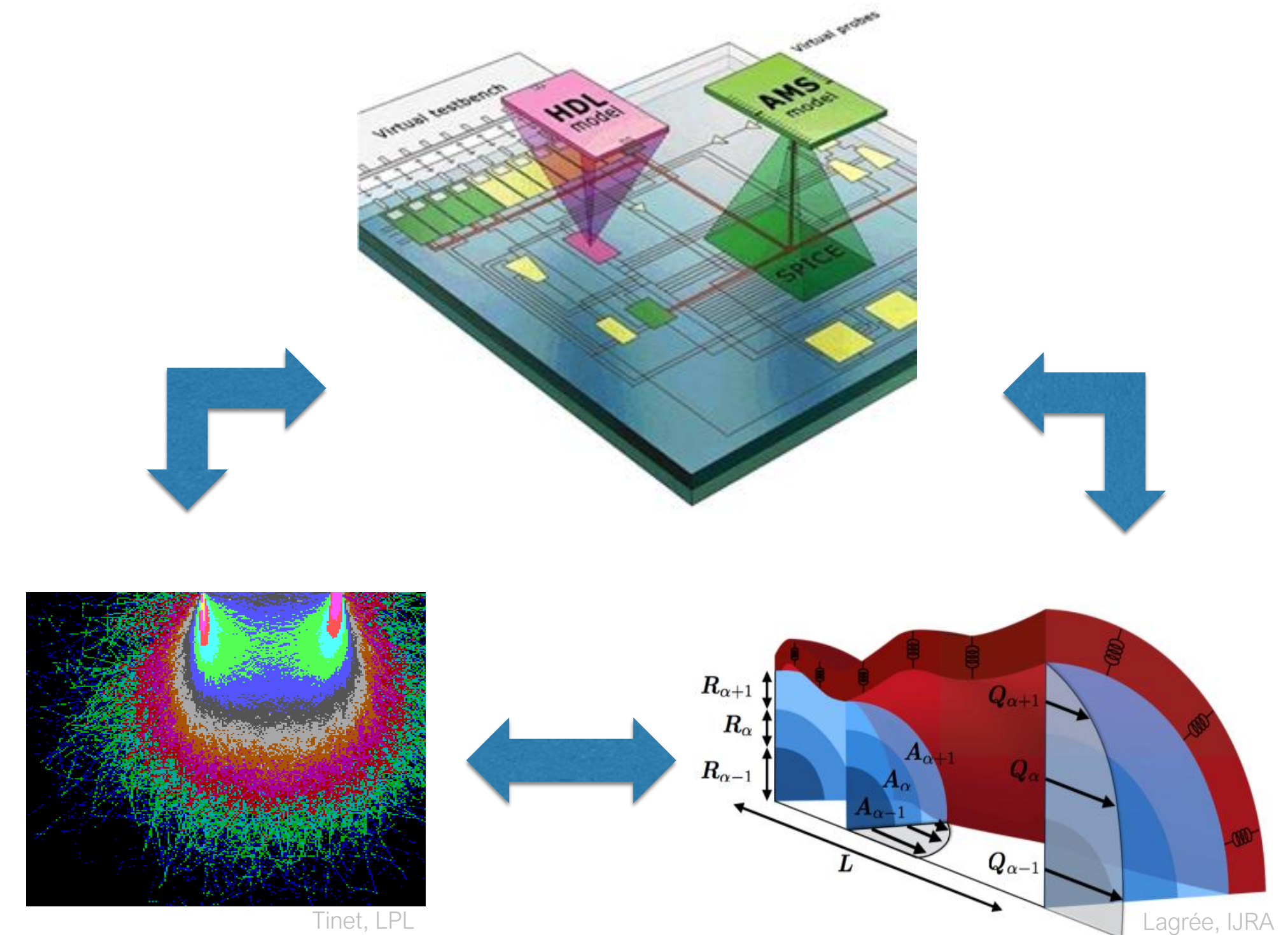
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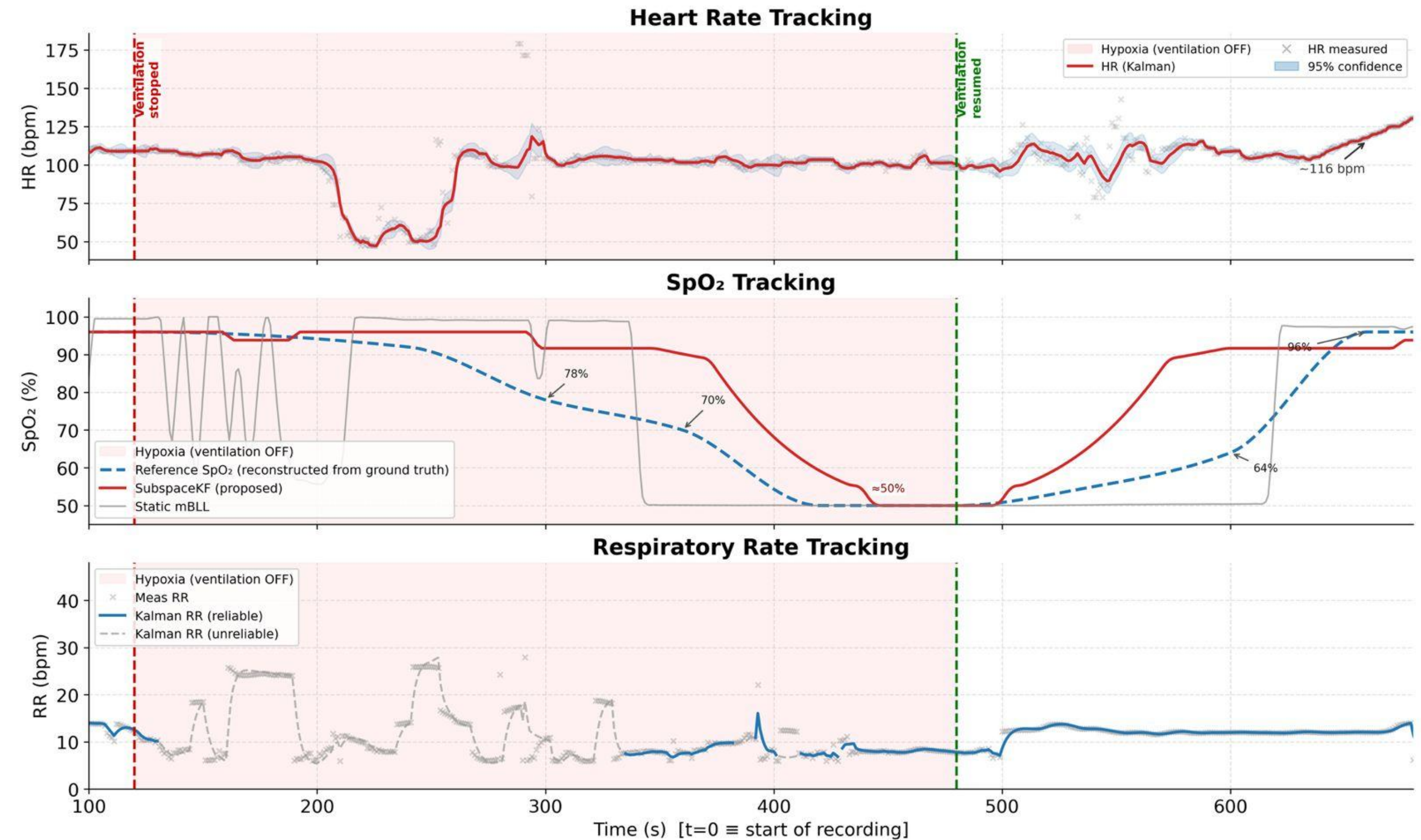
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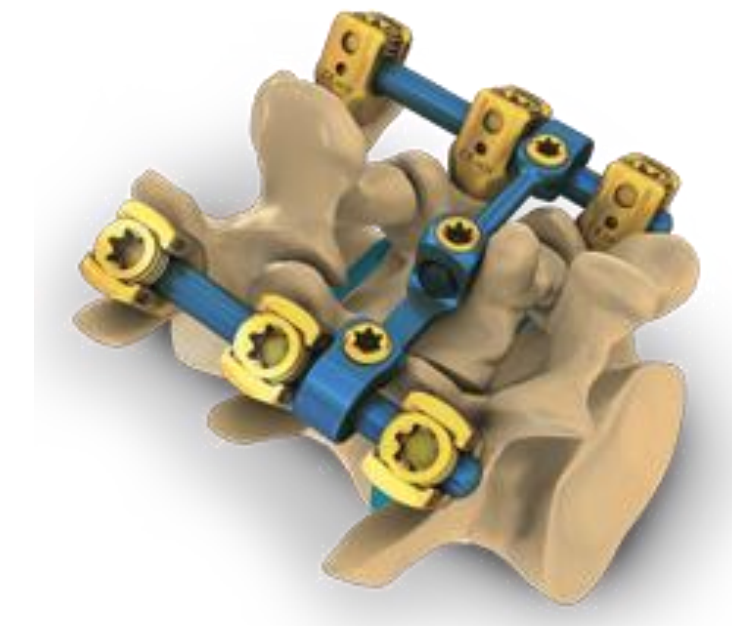
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◦ Perspectives

- Toward smart implant
 - ✓ Per- and post-operative medical device
- Co-design approach
 - ✓ Realization → System > Circuit > Component : **ASIC**
 - ✓ Modelling → Virtual Prototyping
- And collaborate



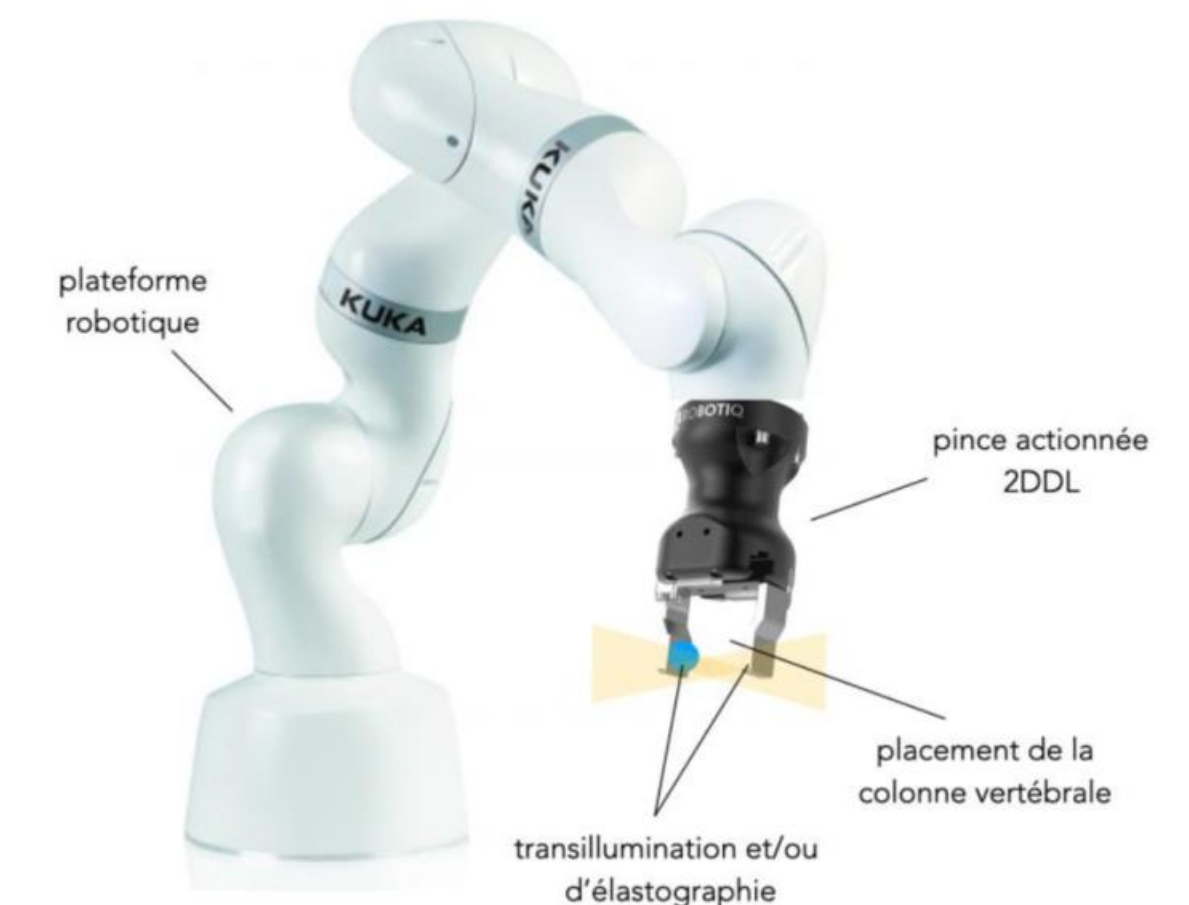
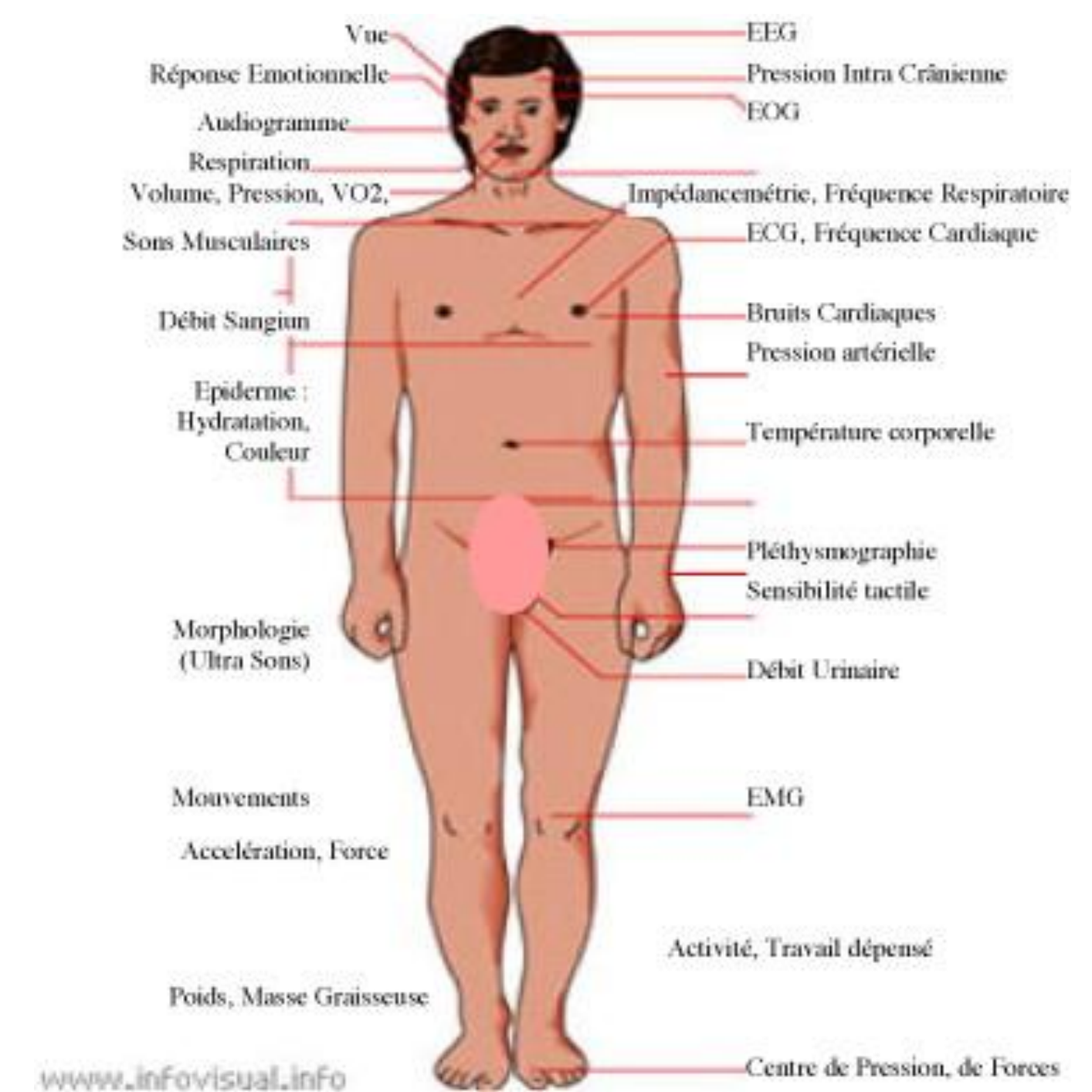
clariance-spine.com



tweaktown.com

... And many other projects

- ◉ Related to biomedical engineering, health and environment
 - From sensors and electronics (analog and digital)
 - To frugal AI, with signal and data processing, prediction
- & in other domains (transport, noise and signal integrity, ...)

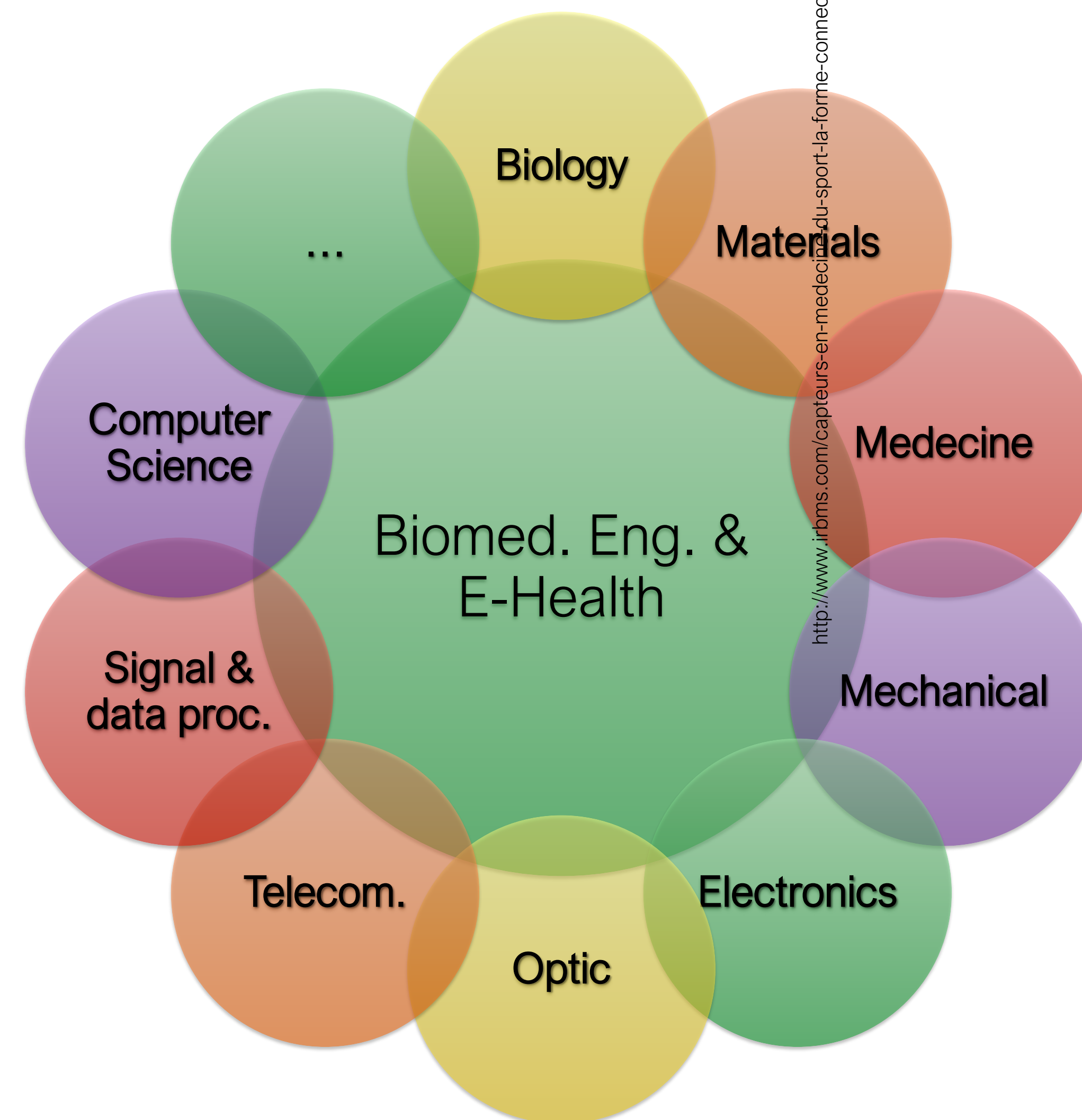


SpinalMED2 project

Dev. for health

Engineering for Health

◉ Multidisciplinary



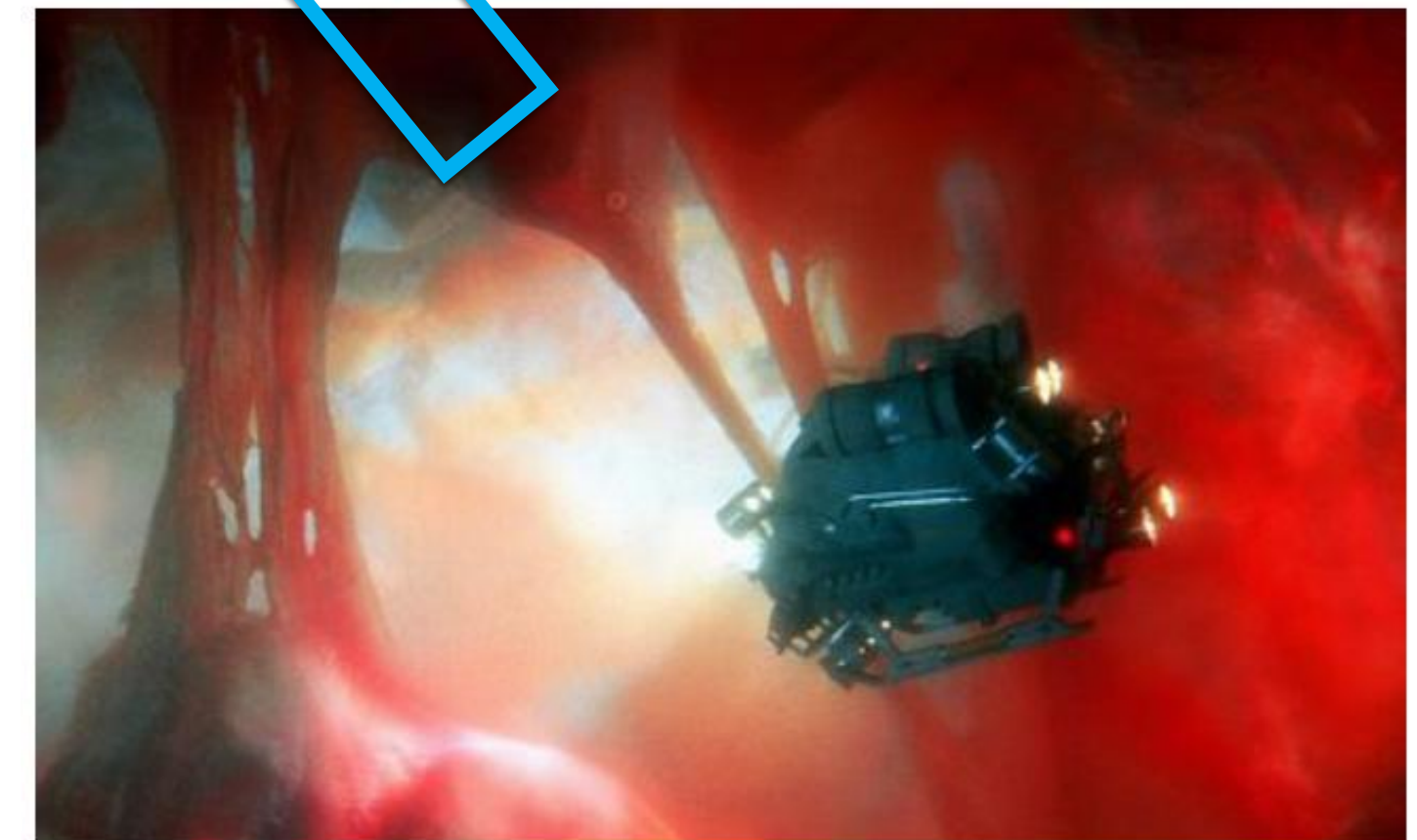
Engineering for Health

- ◉ Multidisciplinary
- ◉ Constraint
 - Ethics
 - Standards
 - Environment

➔ Towards the medicine of tomorrow



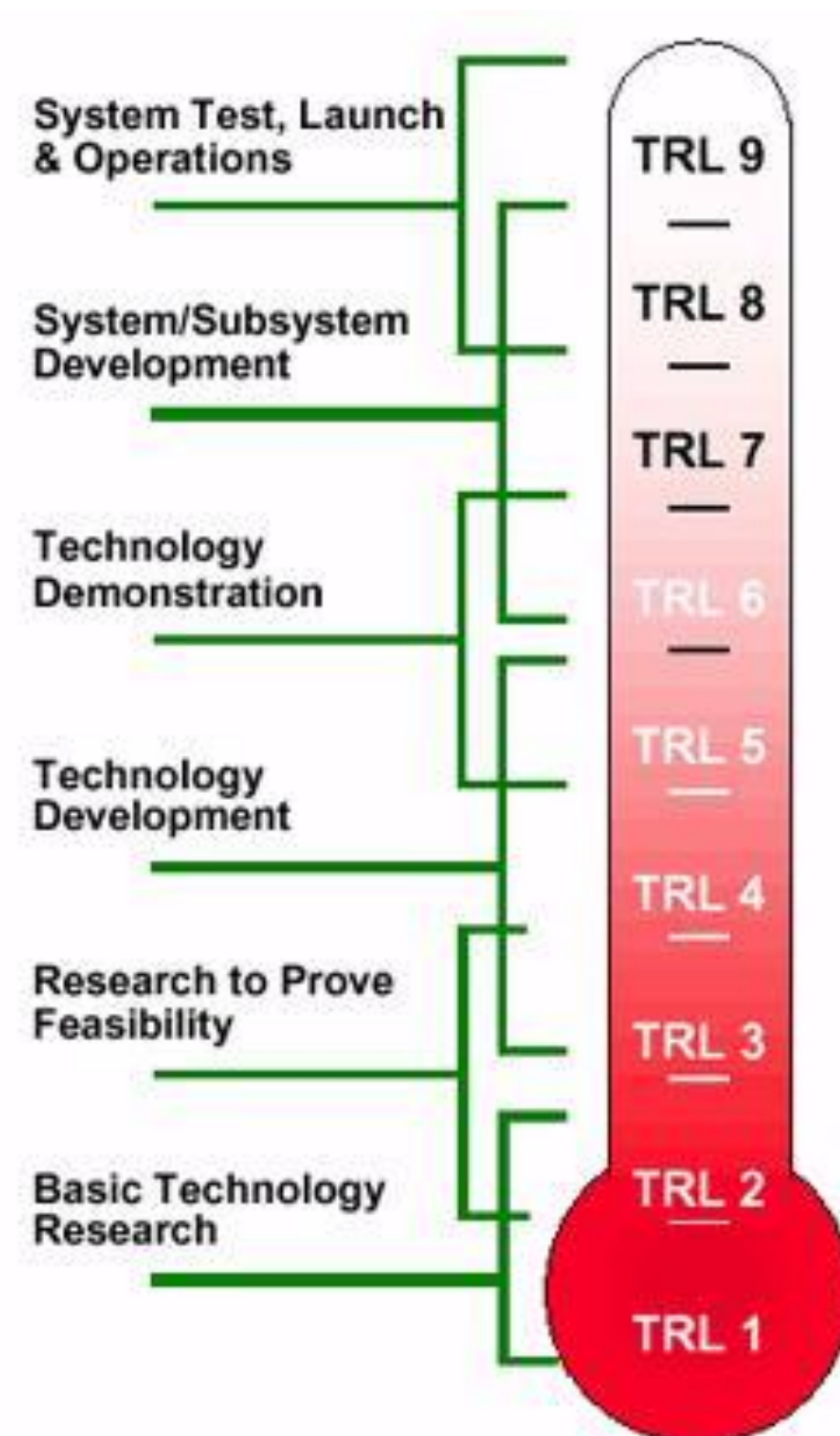
<http://www.irbms.com/capteurs-en-medicine-du-sport-la-forme-connectee>



Innerspace, 1987

From idea to product

◉ Stations of crosses

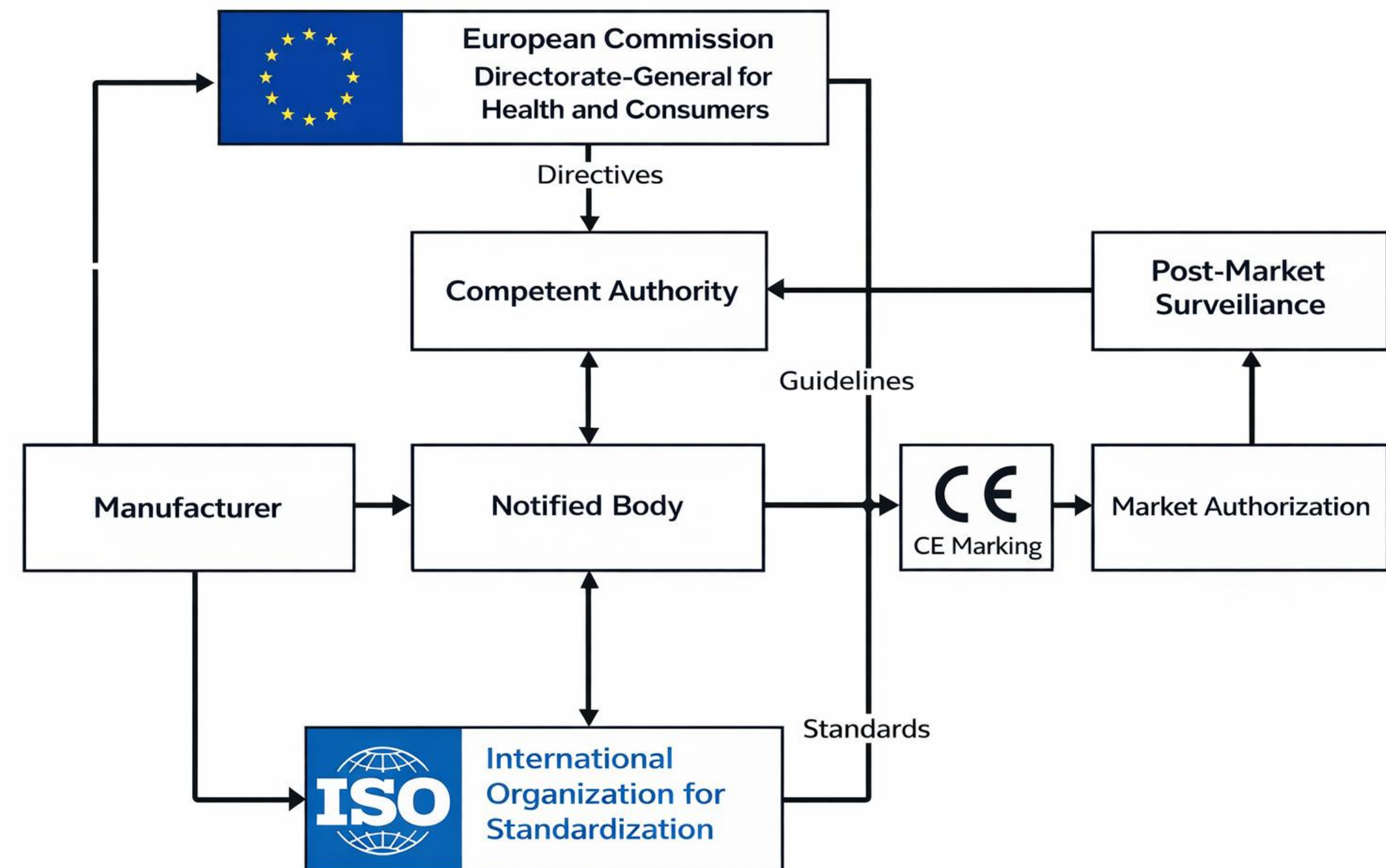
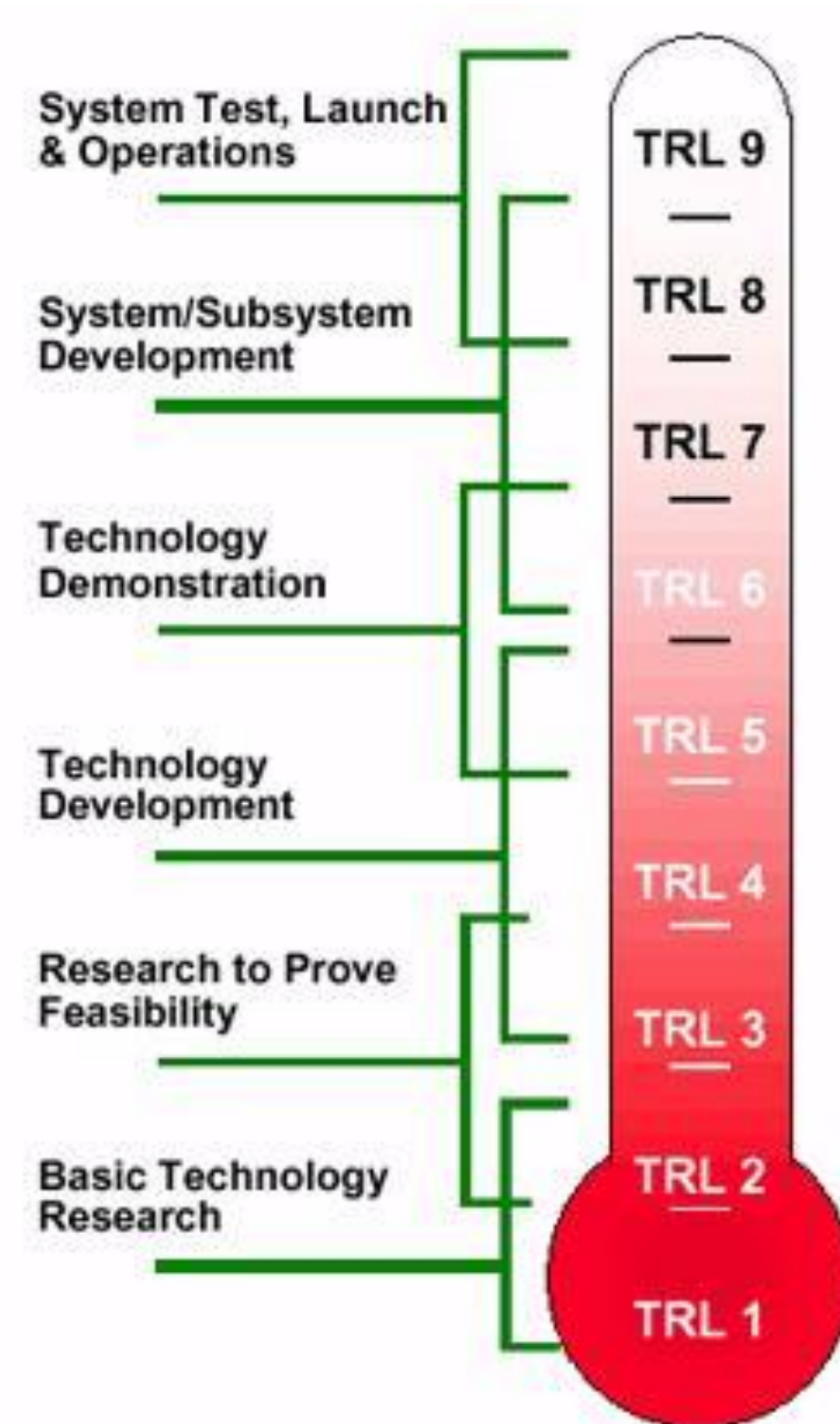


Wikipédia



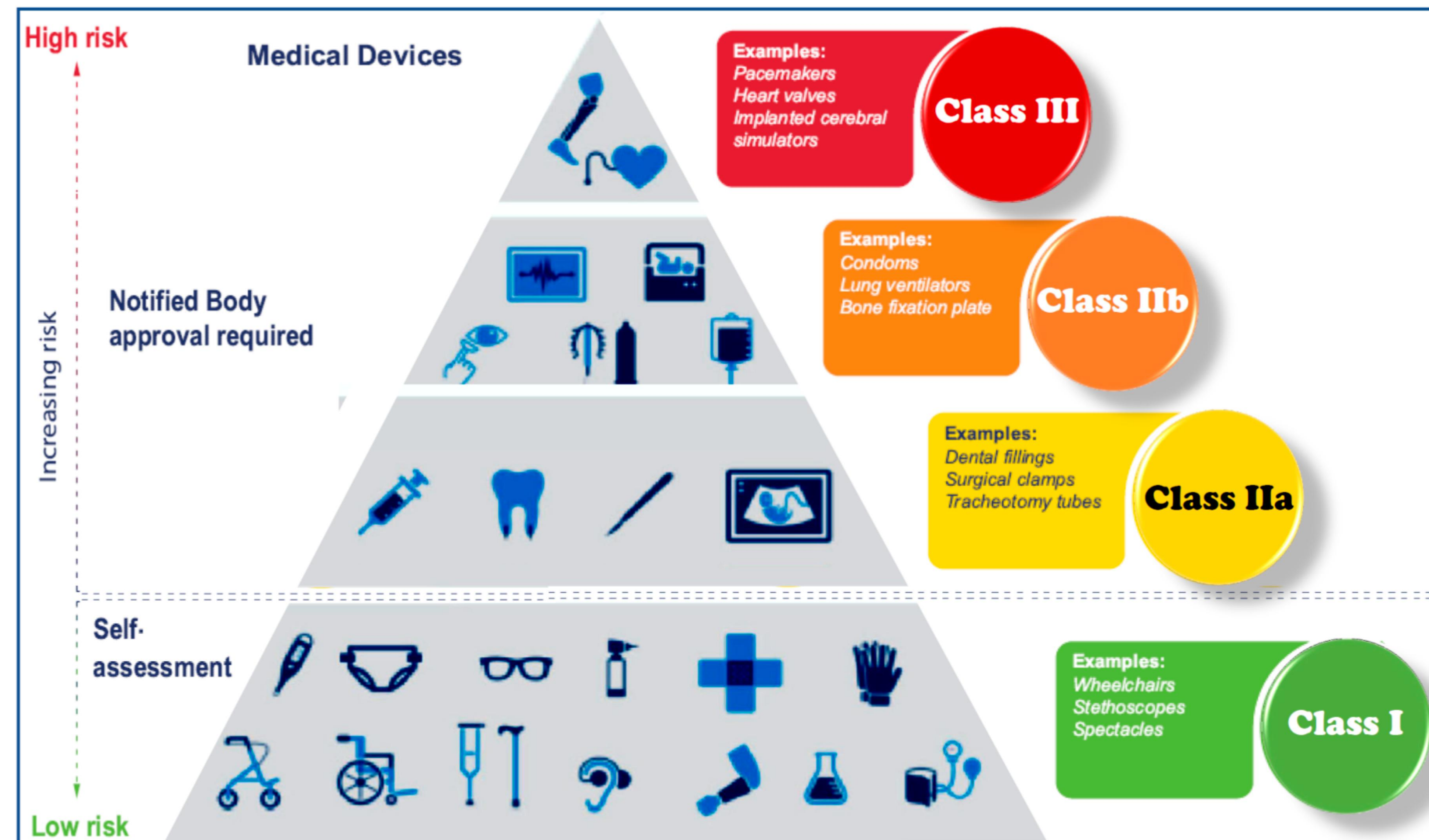
From idea to product

◉ Stations of crosses



Regulations for medical devices

- Directives 2017/745 for MD since 2021 (before 93/42/EEC)

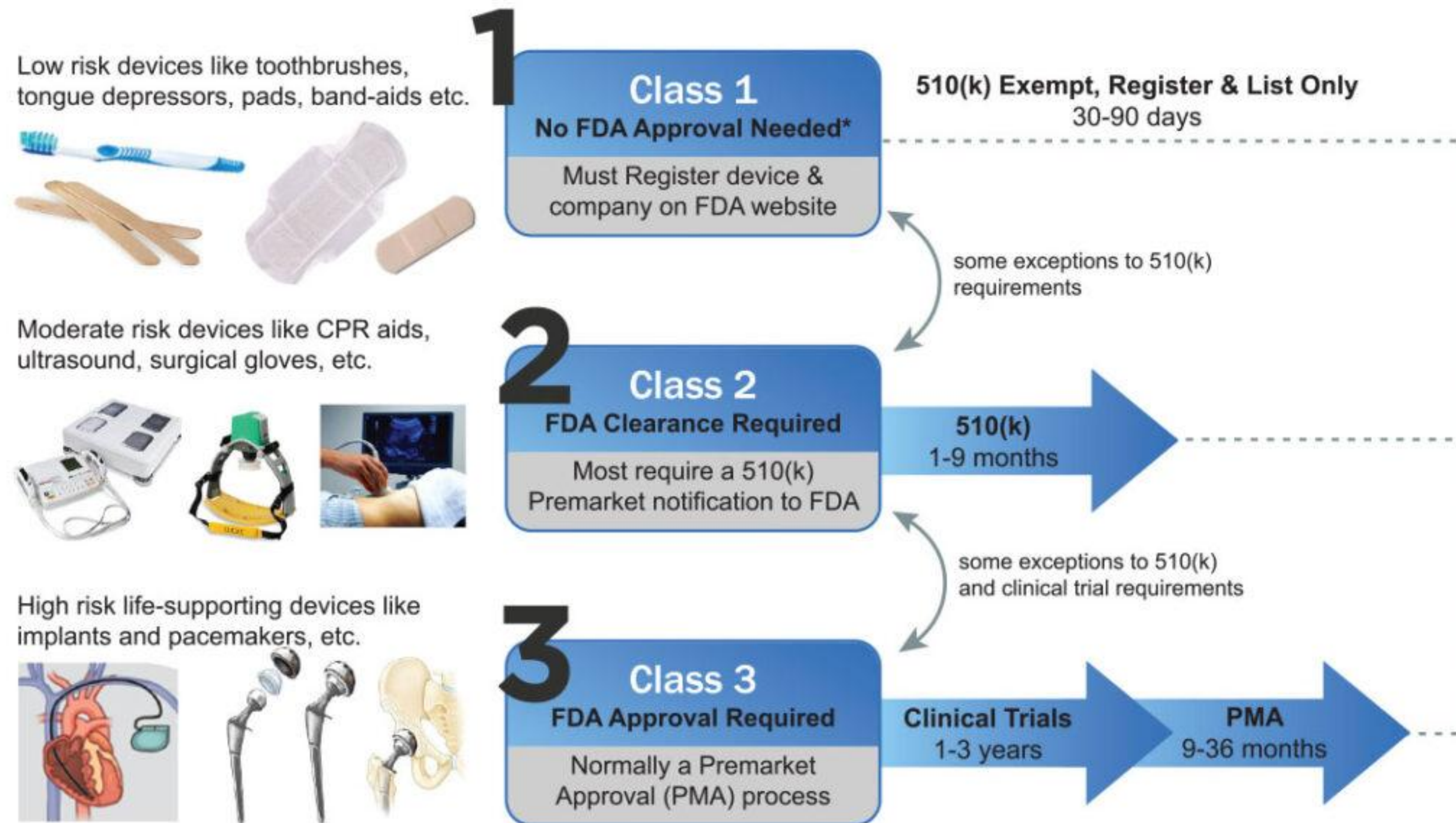


<https://www.mdpi.com/2227-9717/9/5/865>

Regulations for medical devices

U.S. FDA Medical Device Classes

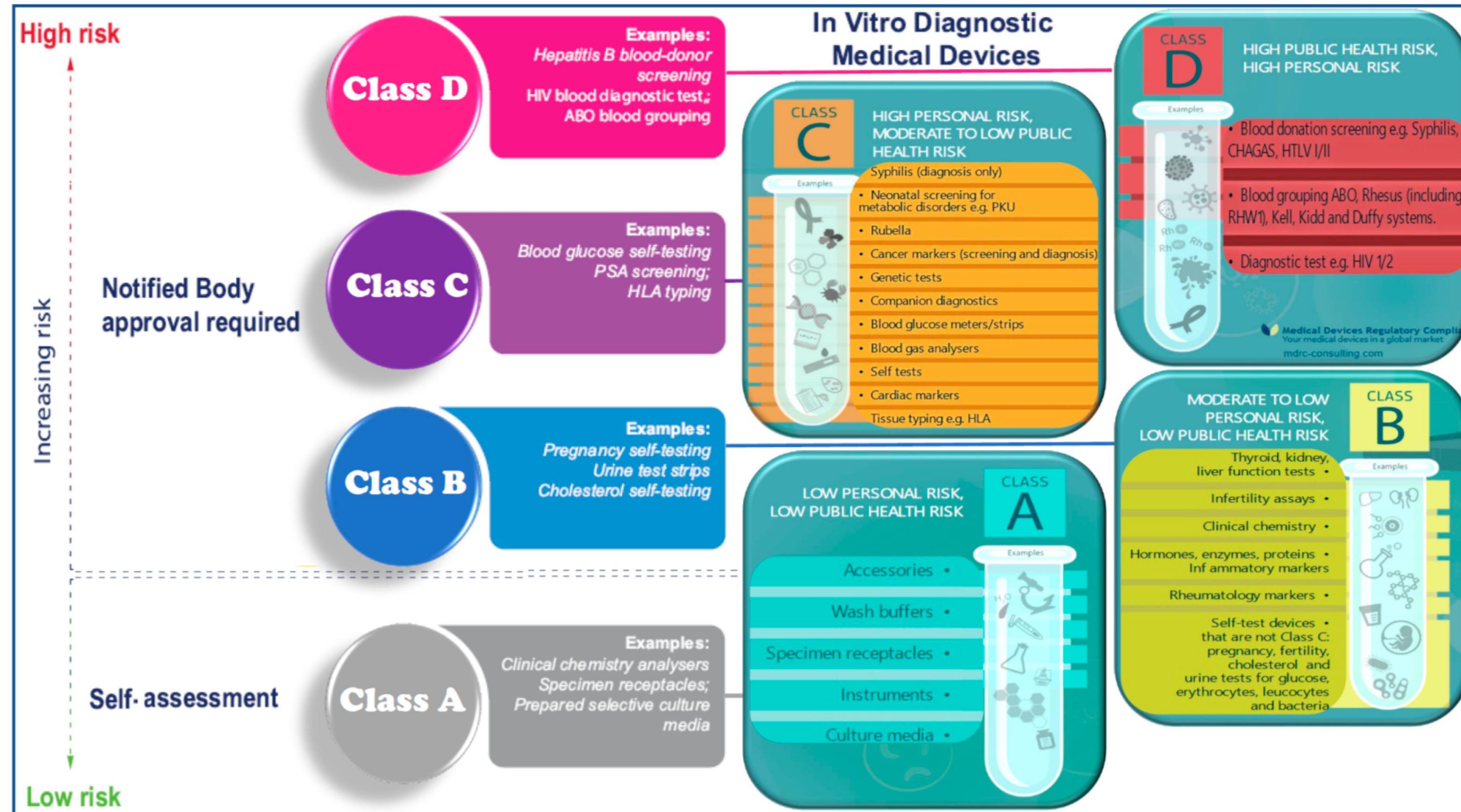
Class 1 devices do not require FDA approval, but you will need to Register and List the Device.



[angelanjohnson.com](https://www.instagram.com/angelanjohnson.com)

Regulations for medical devices

- Directives 2017/746 for in-vitro diagnostic MD since 2021 (before 98/79/EC)



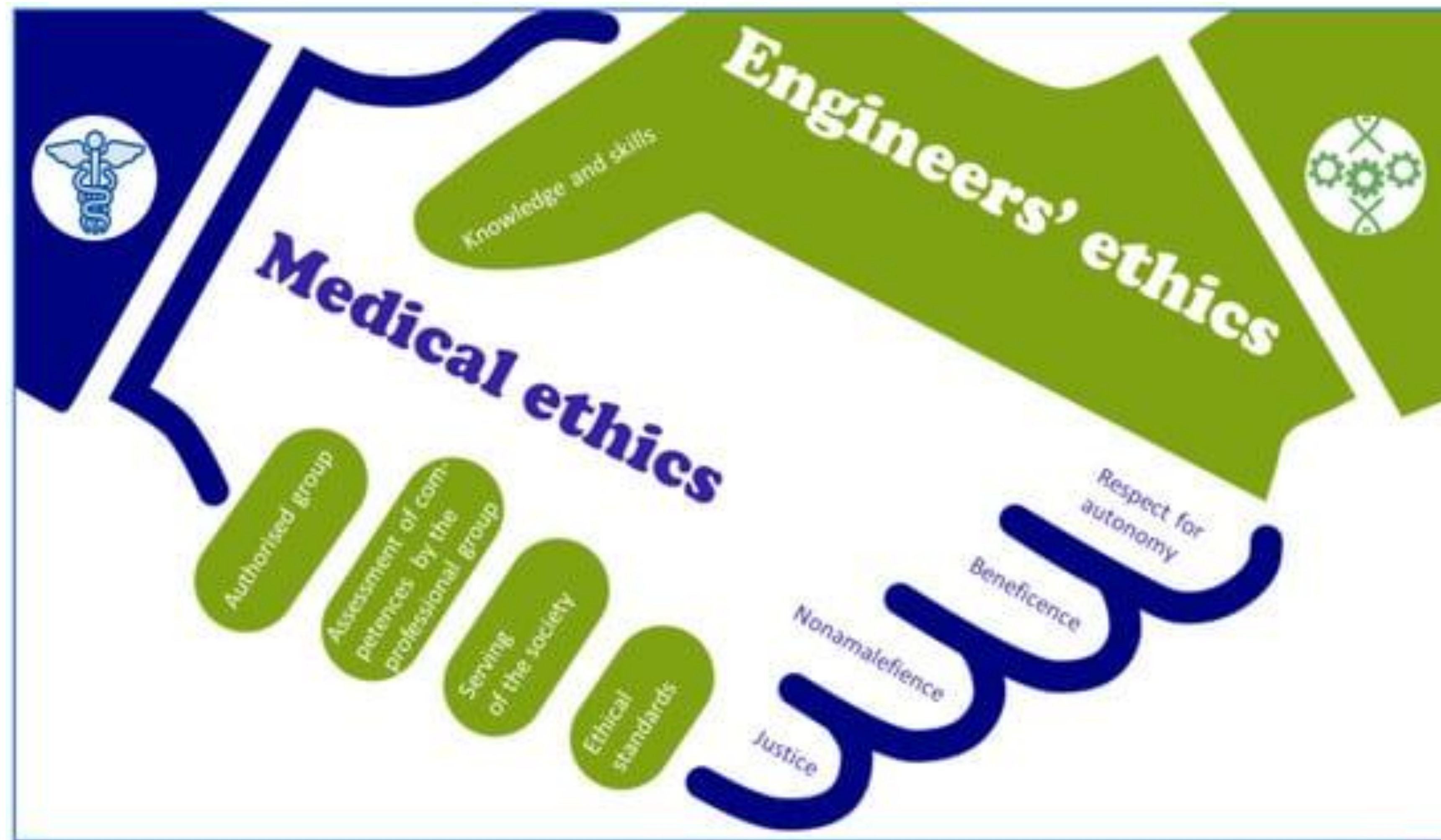
<https://www.mdpi.com/2227-9717/9/5/865>

◉ United Nations



<https://www.un.org/sustainabledevelopment/fr/objectifs-de-developpement-durable/>

A necessity



<https://www.mdpi.com/2227-9717/9/5/865>

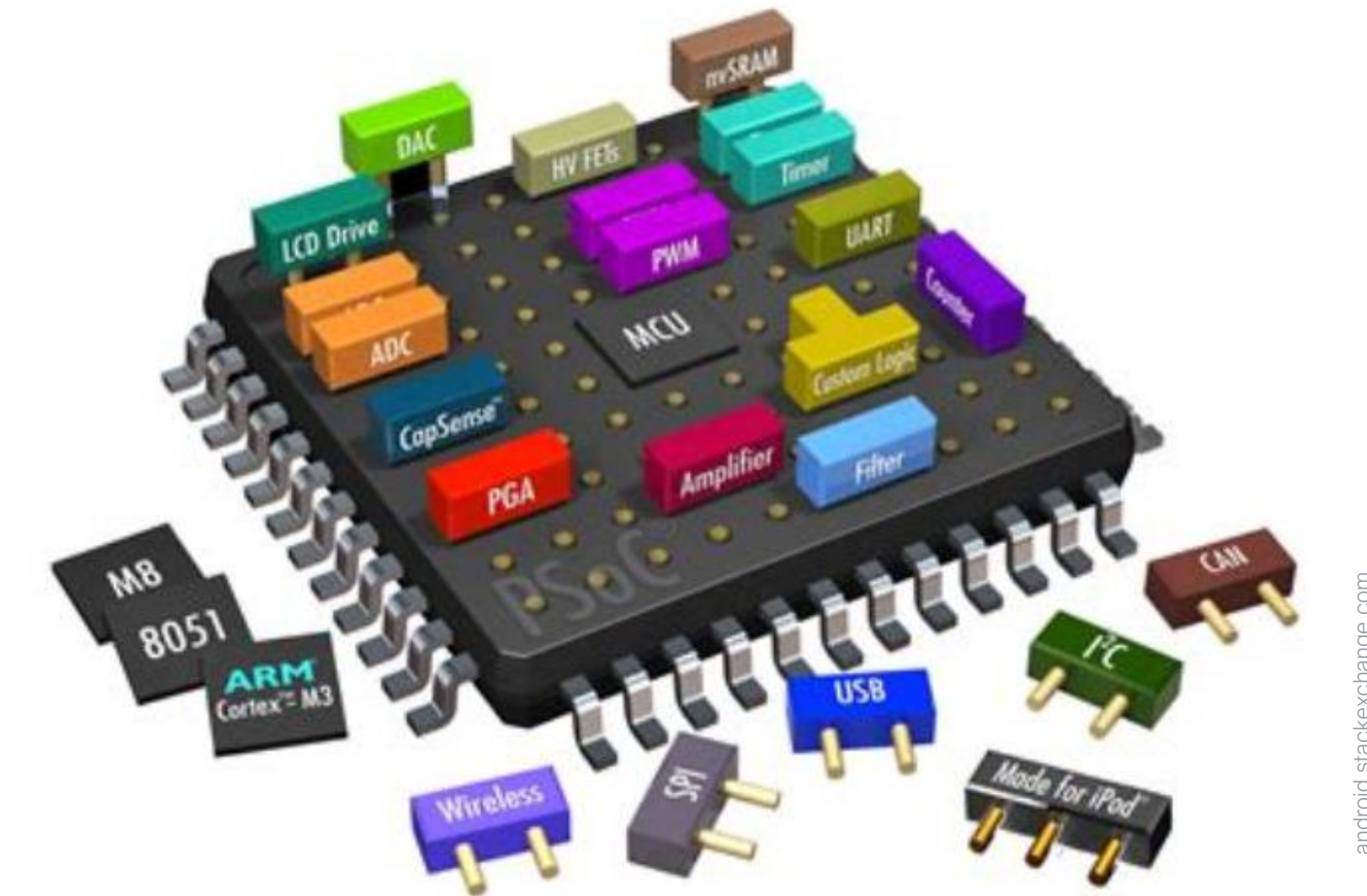
◉ Durable MD, fine! But above all safety & security with

- Management of complexity / heterogeneity
- Frugal (consumption / lifespan)
- Sterilization ?

↪ Choice of **methodology of research**

- ✓ Virtual prototyping (in-silico VS in-vivo)
- ✓ Interoperable & Reusable → Versatile dev.
 - Co-design approach = Hardware + Software together
- ✓ Refinement of needs

↪ Dialogue & Collaborations



Needs

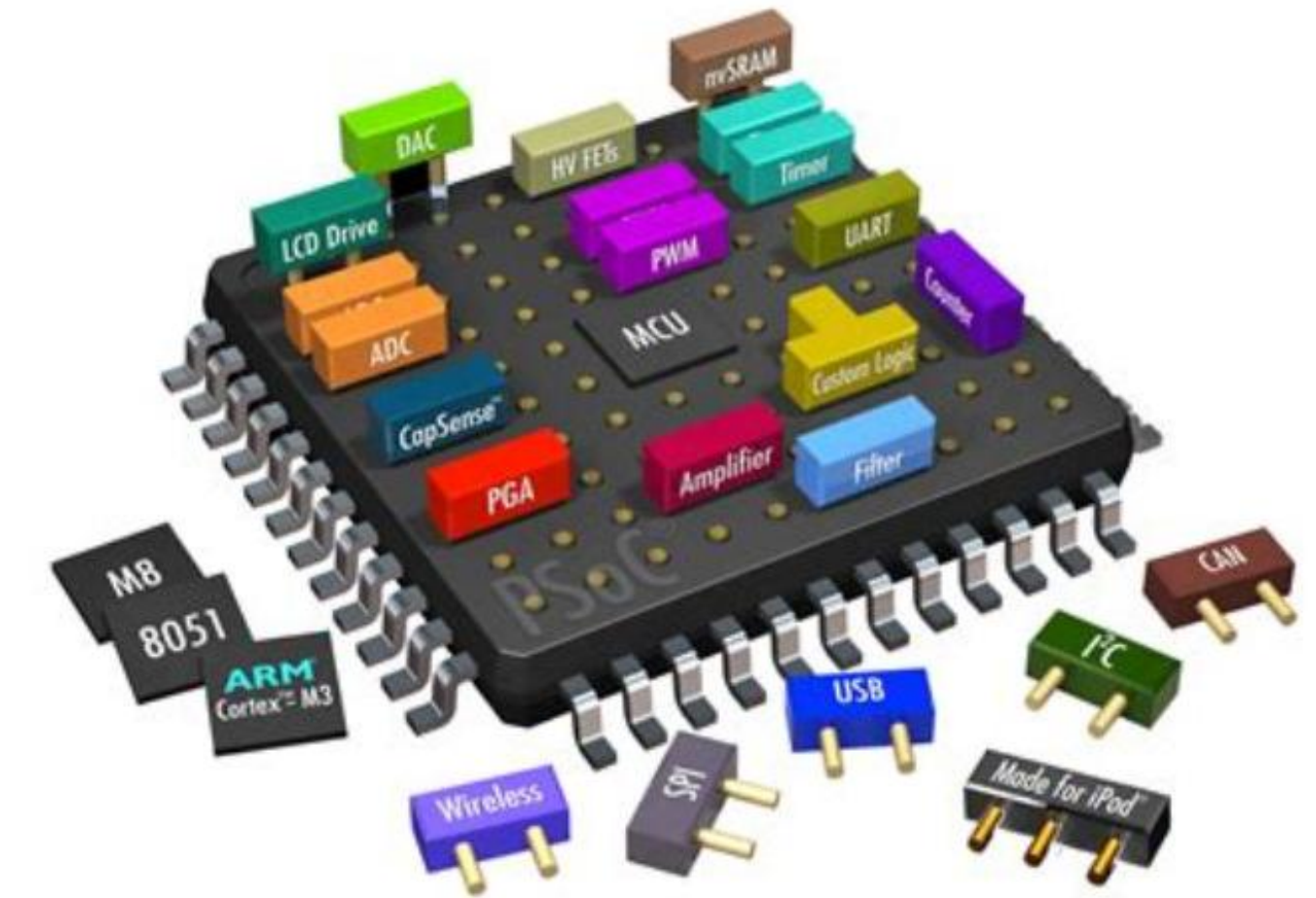
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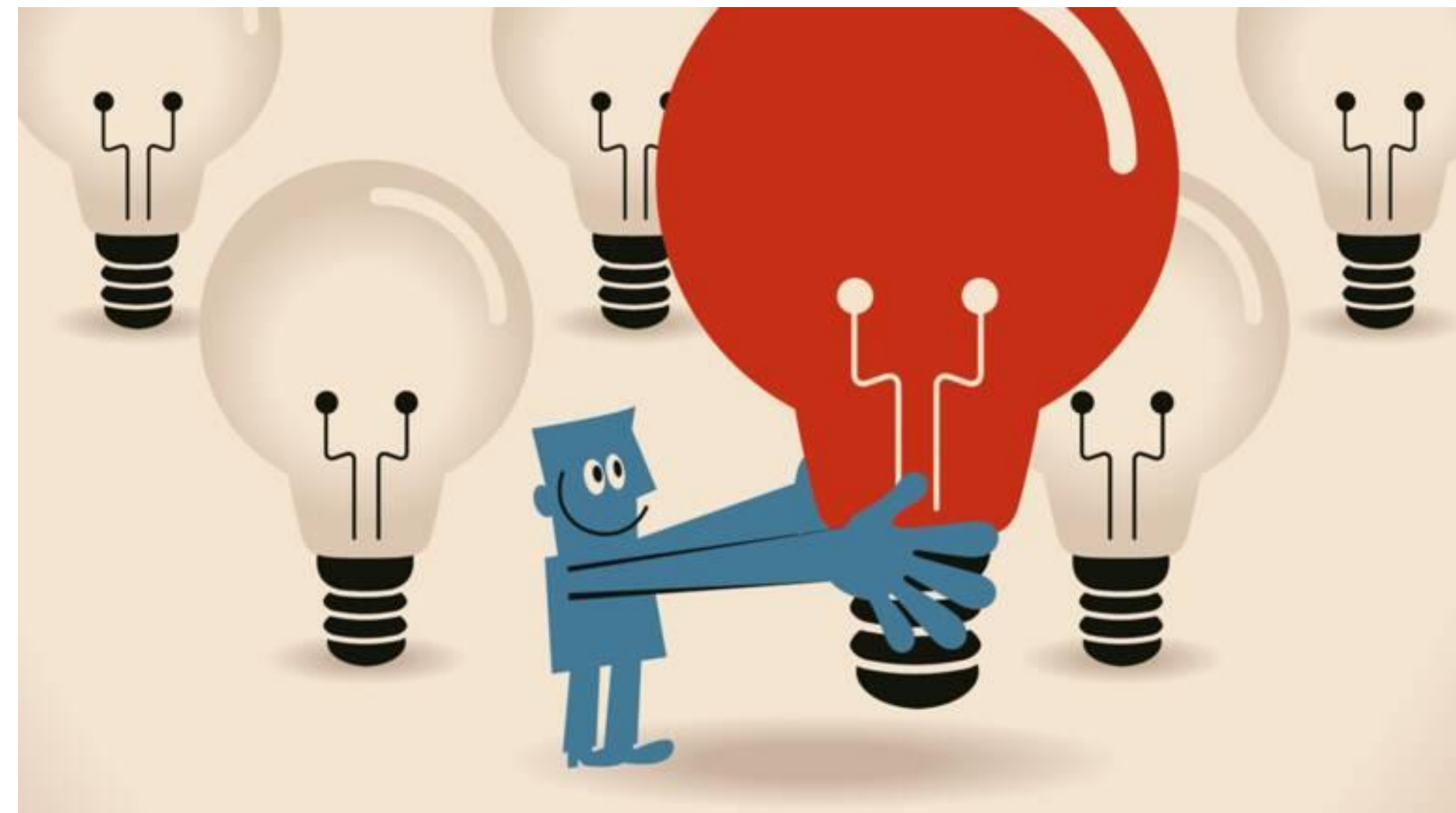
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Thank you for your attention!

◉ Questions ?



capital.fr

sylvain.feruglio@sorbonne-universite.fr