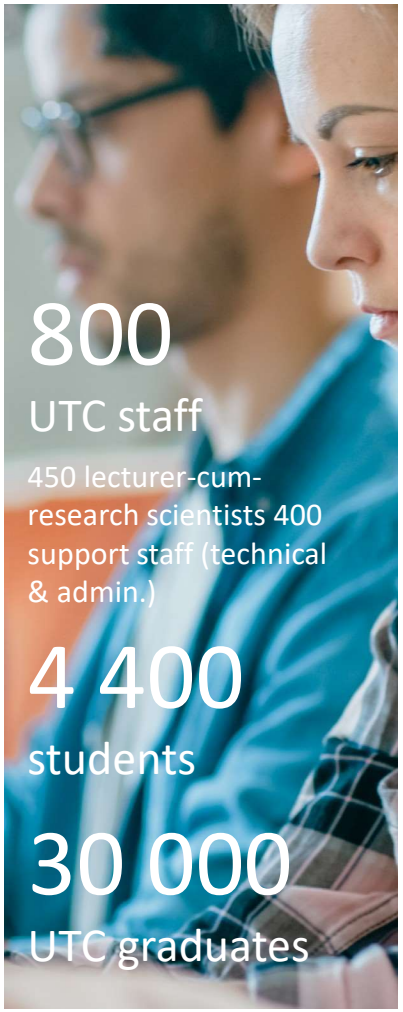
Technological and systemic approaches of biomechanics and bioengineering: *from fundamental science to patient bedside applications*

Claire Rossi - President

Bucharest – Sept 2024

UTC IN SHORT



UTC RANKINGS

Public post-Bac engineering schools

2nd

L'OBS — LE FIGARO étudiant 2023

Top 10

l'Etudiant — L'USINE NOUVELLE

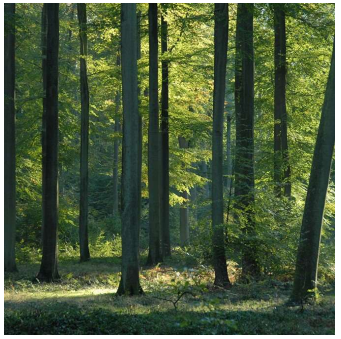
THE WORLD UNIVERSITY RANKINGS — 1201–1500 th World University Rankings 2023

Alliance Sorbonne Université | utc

THE CITY OF COMPIÈGNE,

OFFERS GOOD, HIGH-QUALITY LIFE-STYLE ONLY 40 MIN FROM PARIS

1 000 km Compiègne forest paths 3rd largest French forest (15 000 ha)



UTC IN SHORT

High flexibility in the training path / Project-based learning/

With an 'à la carte' choice of courses, a choice among 5 Majors in the engineering curriculum and its 5 Master's degrees, each student admitted to UTC is offered the opportunity to build his/her personalised educational path in line with his/her professional ambitions.

0,6 month
AVERAGE LEAD-TIME TO FIRST JOB

Research forming a continuum from fundamental to application/

8 UTC RESEARCH UNITS OF WHICH ARE JOINTLY MANAGED RESEARCH UNITS (WITH THE CNRS)

3 JOINT LABORATOIRES with industries

- AVENUES Multi-scale modelling for urban systems
- BMBI Biomechanics and Bio-engineering
- COSTECH Knowledge bases, organization and techno-intensive systems
- GEC Enzyme and cellular engineering (UTC/CNRS/UPJV-Amiens)
- HEUDIASYC Heuristics and diagnosis of complex systems
- LMAC Applied Mathematics Laboratory, Compiègne
- ROBERVAL Mechanical, energy and electrical engineering
- TIMR Integrated transformations of renewable matter (UTC/ESCOM)

UTC IN SHORT

Key aspects of research at UTC:

Strong connexion between research and engineer educatio

- Interdisciplinarity
- Collaboration with industry
- Applied research, innovation and incubators

We were pioneers in : AI, complex and autonomous systems, enzymatic and biomedical engineering,,,,

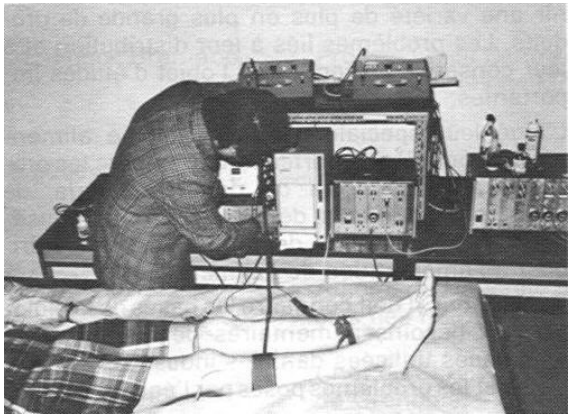
Le Courrier

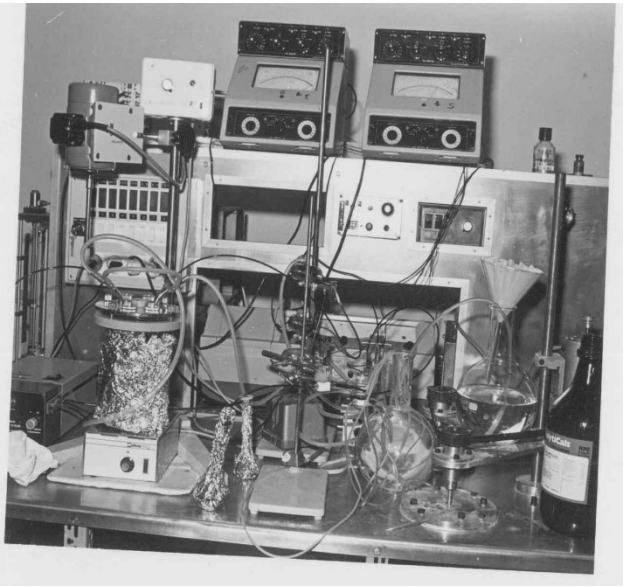
OISE

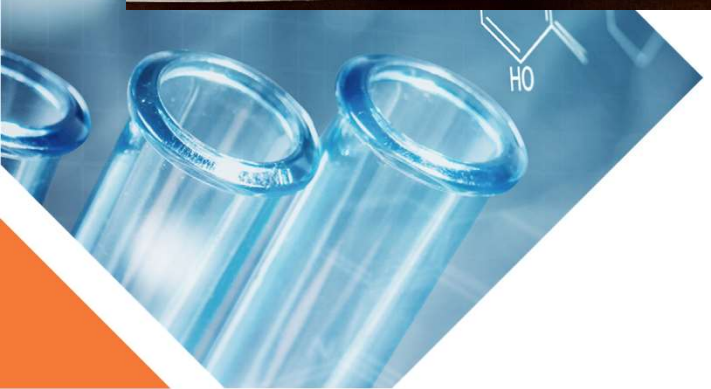
Les motards toujours en colère

Jean-Paul Barthes : en l'an 2000... on parlera à sa montre

Spécialiste de l'intelligence artificielle, cet enseignant-chercheur de l'U.T.C. ne navigue plus depuis longtemps à bord du « Nautilus ».



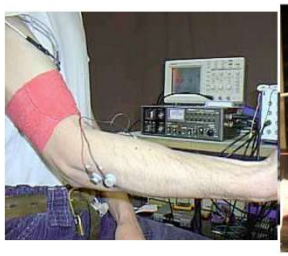


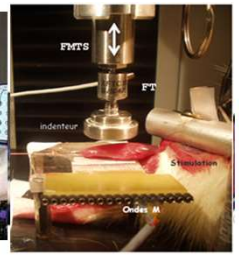


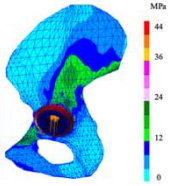
ALLIANCE SORBONNE UNIVERSITÉ | utc

BMBI: History of Biomechanics and Bioengineering at UTC

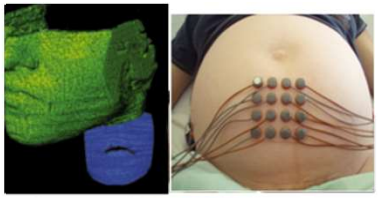
Biomechanics and muscular electrophysiology



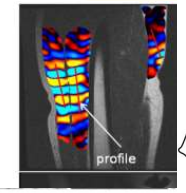




Solid biomechanics

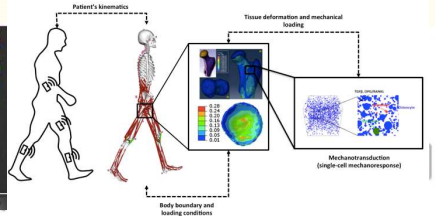


Multiphysics, multi-scale modeling



E-BioMed / Technology-Sport-Health platforms

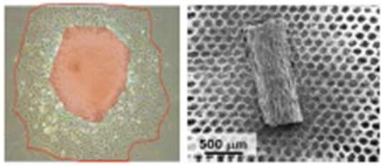
Artificial Intelligence



Personnalized characterization and modeling of the musculo-squeletal system

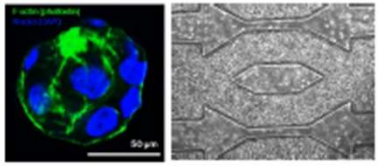
1982 **1992** **2014**

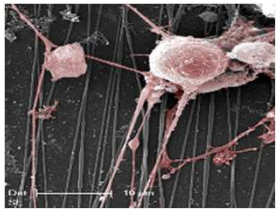
Artificial organs



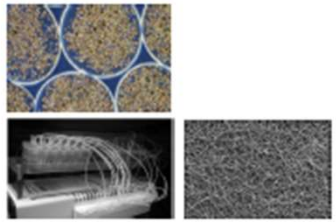
Cells, biomaterials

3D cultures

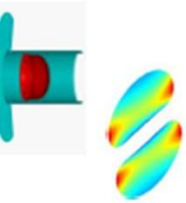


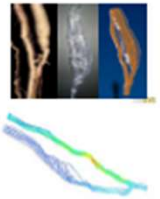


Tissue engineering



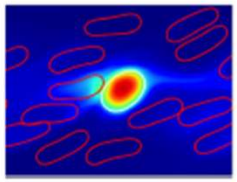
Cell-biomaterials bioreactors

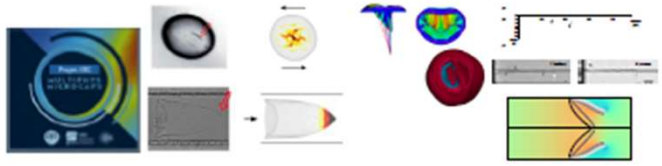




Modeling of blood rheology and flows

Microfluidics





Biological fluid-structure interactions

Biorheology

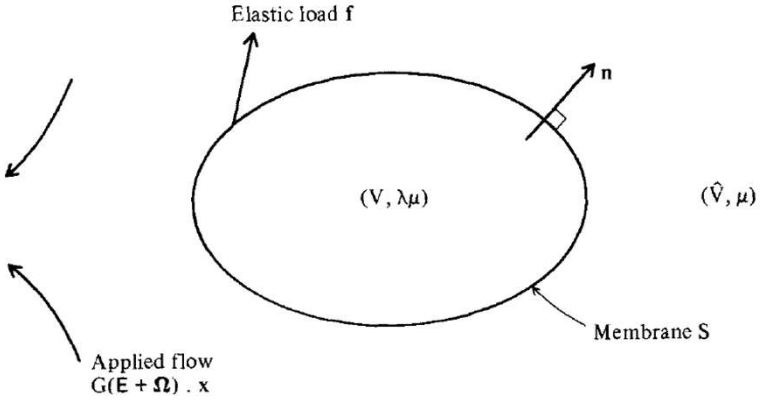
Originality of BMBI from the creation of UTC …… until today

From small deformation mathematical models

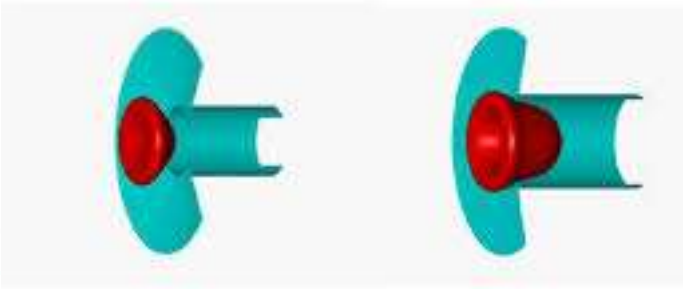
J. Fluid Mech. (1981), *vol.* 113, *pp.* 251–267
Printed in Great Britain

The time-dependent deformation of a capsule freely suspended in a linear shear flow

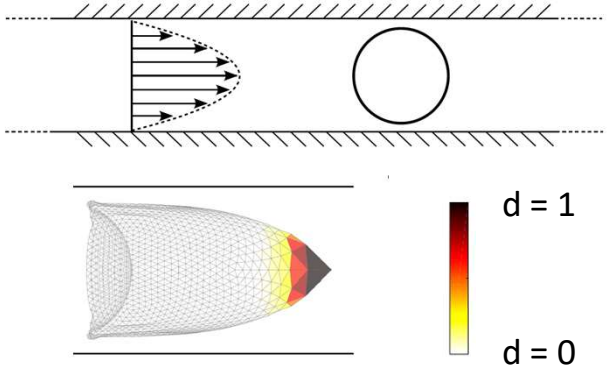
By D. BARTHÈS-BIESEL
Université de Technologie de Compiègne, France
AND J. M. RALLISON
Department of Applied Mathematics and Theoretical Physics, University of Cambridge, England

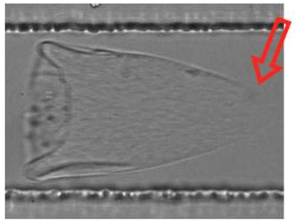


To 2D axisymmetric numerical models



To 3D multiphysics in-house models coupled with advanced experiments



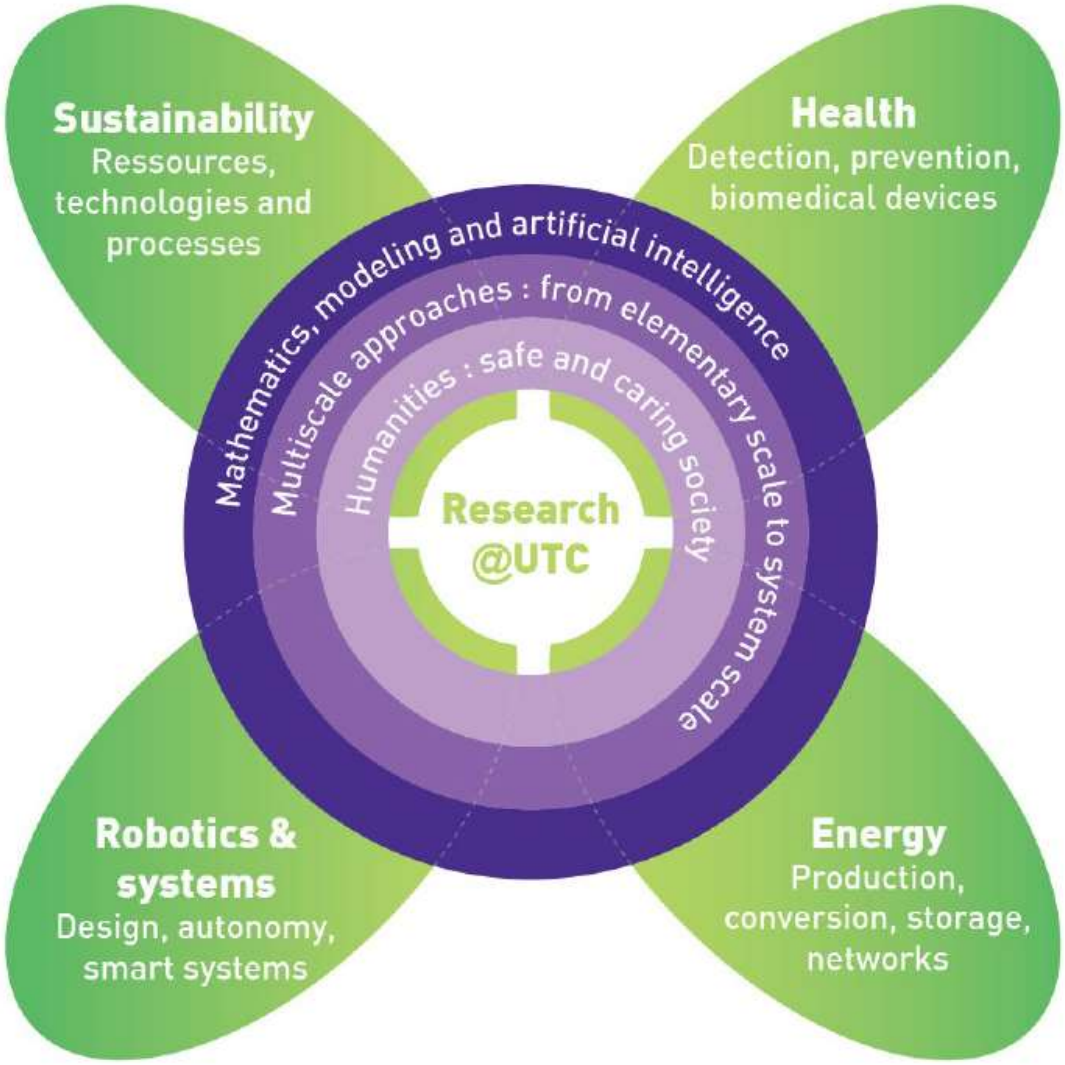


Damage due to the fluid-structure interactions

Contact : anne-virginie.salsac@utc.fr

UTC : Some strategical axes

Research



Institution

Ecological transition
and societal commitment

Humanities and social sciences

Interdisciplinary / transdisciplinary approaches

Innovation, valorisation
and Entrepreneurship

UTC : SHS laboratory input

Costech's research examines the way in which technological developments help to transform and reconfigure human activities, both individually and collectively.

A general perspective: overcoming the still commonly accepted opposition between technology and care. Care is pervaded with technology

From a disciplinary point of view: better articulating the ethics of care and the philosophy of technology

Two complementary questions:

1-Technology in care: How and to what extent is technology transforming and reconfiguring care activities and settings? (descriptive approach)

2-Care in technology: How can the values of care be implemented right from the start of the technological innovation and development process? (normative approach)

UTC : how to improve the environmental and social impact of biomedical techniques and treatments ?

70 000 Kidney Transplantation/year
3 M. patients under hemodialysis

90% in developed countries

Cost :
In France, 800 €/treatment
Machine : 30 k€
Life time = 12 years

Water need and waste :
400 L/tt
more than half is not in contact with patient

Single use blood lines → safety
Waste

Automation →
No need for nurse !

Efficient treatment
Patients feel in jail !

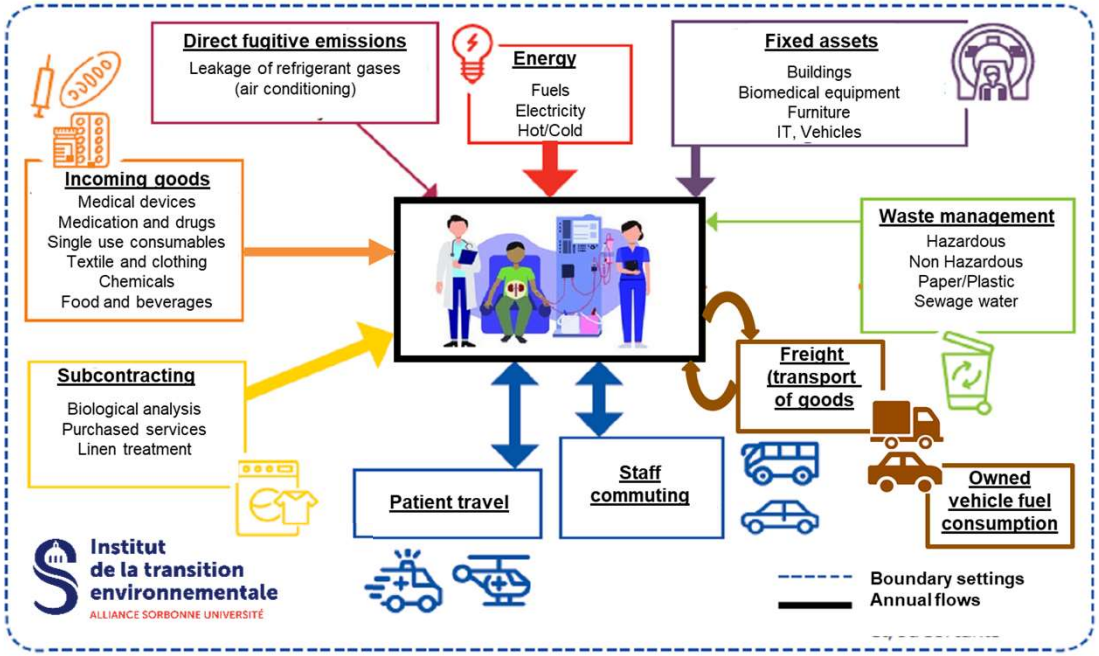
Example of artificial kidney

Contact : cecile.legallais@utc.fr

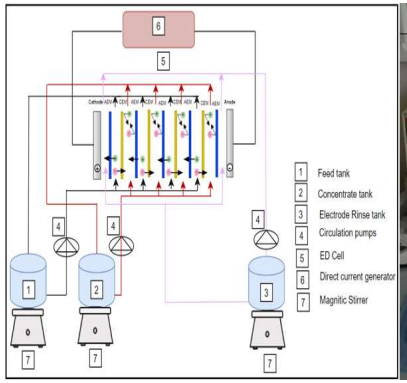
UTC : how to improve the environmental and social impact of biomedical techniques and treatments ?

Evaluate global carbon footprint (→PhD)

EHESP

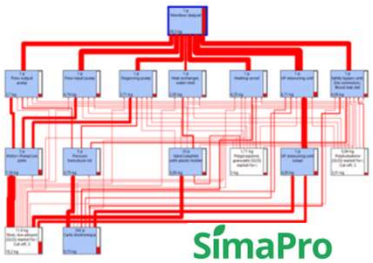


Treat/Recycle waste water (→PhD)



From lab to dialysis center

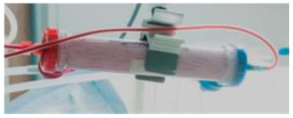
Life cycle analysis of hemodialysis machine



→ TX students + mentor from Mech. Eng. Dpt

Analysis of membrane reuse

- Historical perspectives
- Benefit/cost analysis
- Regulatory Affairs



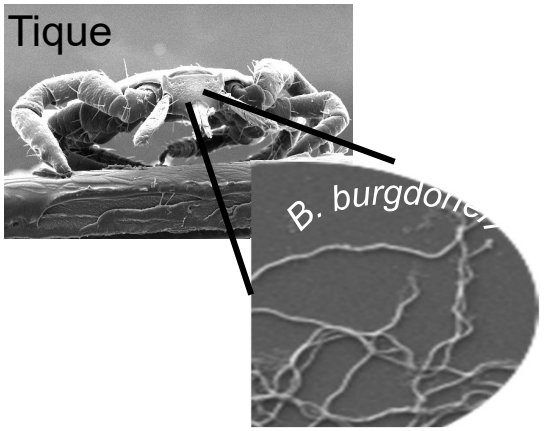
→ HuTech program

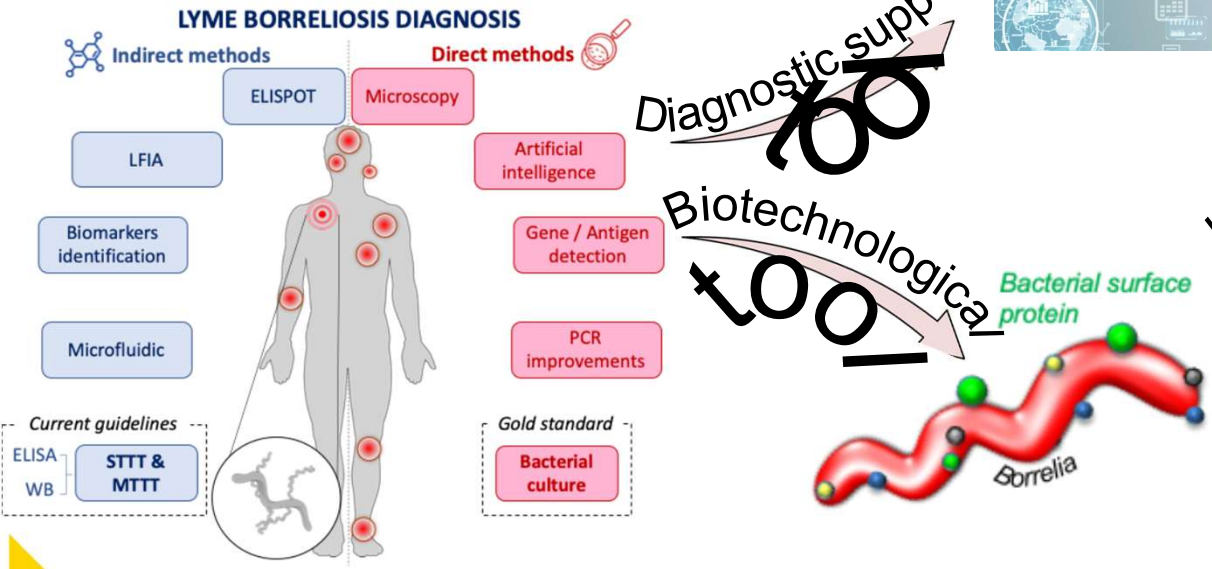
Contact : cecile.legallais@utc.fr

UTC : Multidisciplinary approaches for disease detections

Improved diagnosis of Lyme disease

"at the convergence of biotechnologies,
molecular modeling and IA"



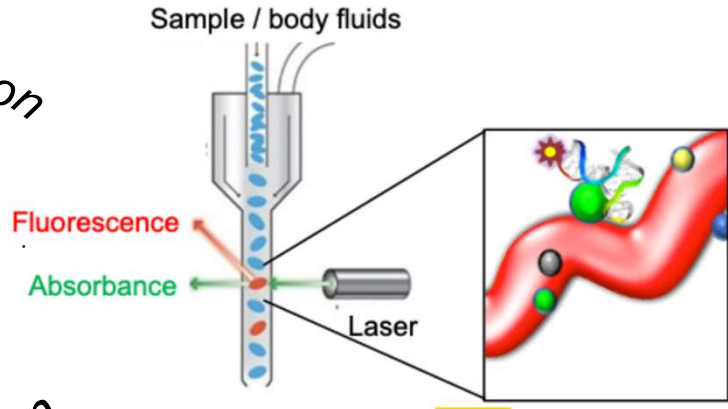


Diagnostic support tool

Biotechnological tool

In vitro selection

In silico design

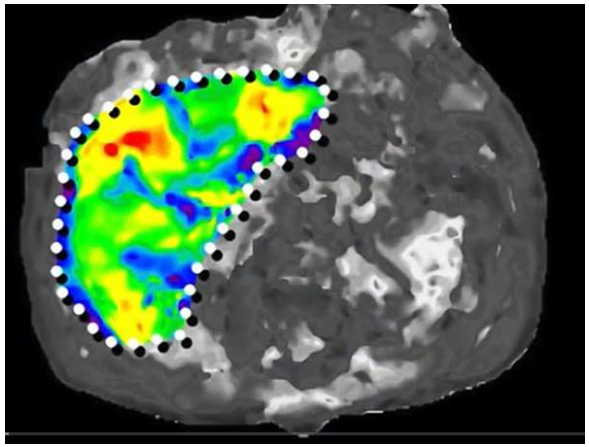


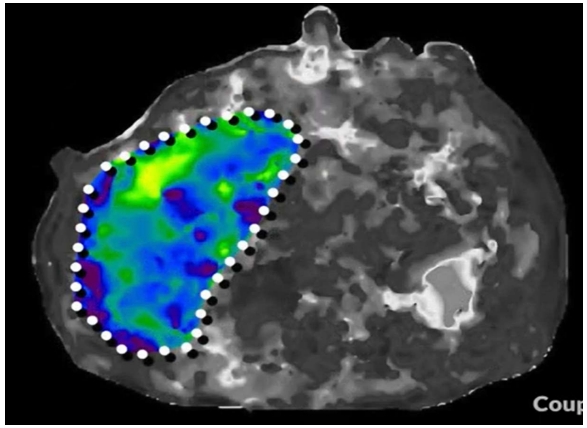
Contacts : severine.padiolleau@utc.fr / marc.shawky@utc.fr

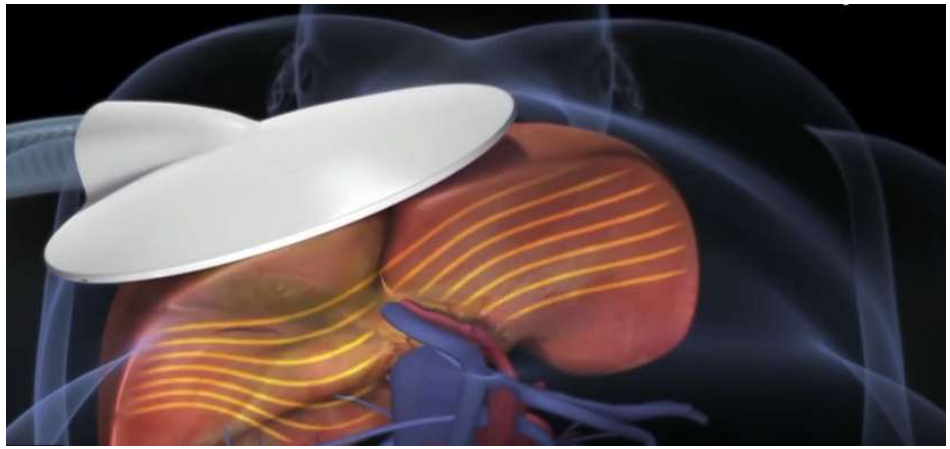
UTC : Developping new **non-invasive diagnostic tools**

gnetic resonance elastography

"ERM is a sonar to detect healthy and diseased tissue in organs. We obtain a map of the rigidity of the tissue, complementary information to the anatomical images"







After the liver, exploration of application on :

- lungs (pulmonary fibrosis, COVID) in order to benefit patients
- muscles (Duchenne muscular dystrophy, sports)
- brean (Alzheimer….),

Contact : sabine.bensamoun@utc.fr

UTC : Developping new **non-invasive diagnostic tools**

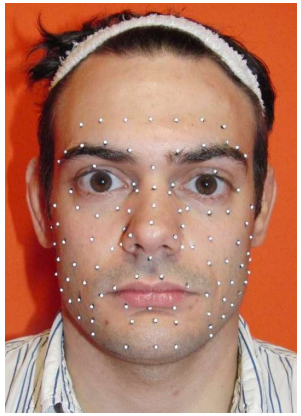
gnetic resonance elastography

Contacts : sabine.bensamoun@utc.fr

UTC : Technology helping social and psychological reintegration of people suffering from severe disfigurements

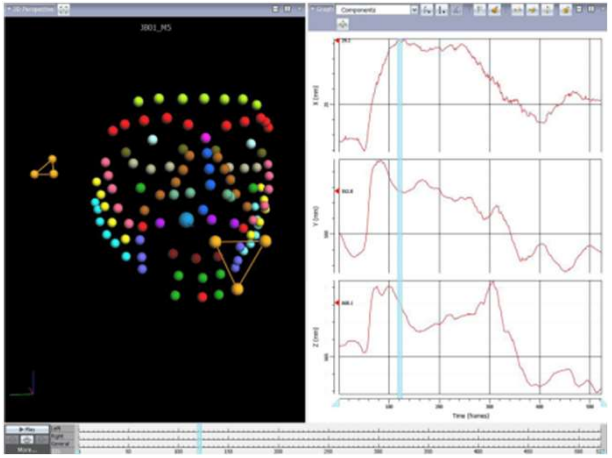
Reconstructive medicine / Facial reconstruction

“Technological expertise to improve the processes related to the transplant, including the creation of 3D modeling tools to plan surgical interventions, as well as the development of devices to aid post-operative rehabilitation. ”

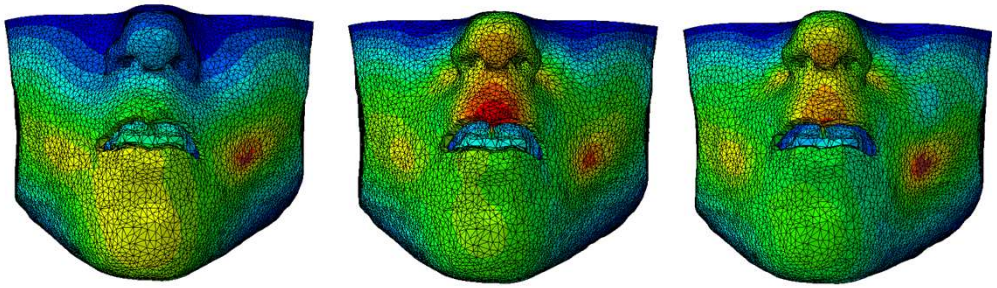


Quantifying facial expression

Equipment Facial motion capture (Equipex FIGURES, FEDER)



Motion simulation software (Equipex FIGURES, FEDER)



Contacts : frederic.marin@utc.fr / khalil.ben-mansour@utc.fr

UTC : Innovation center / Technological plateforms

"a dedicated place where **students, researchers, companies** work on innovation"

"Technology Sport Heath"

"Food Science"

From idea to market

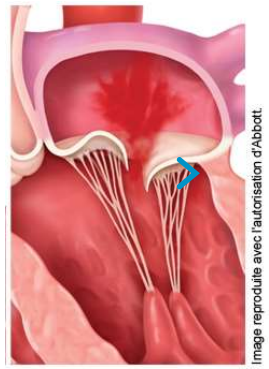
Competitions

Start-ups

E-BioMed: "Connected biomedical devices"

Renovalve: mini invasive repair of mitral valve

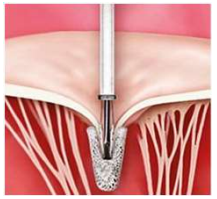
Mitral insufficiency (MI)



Bllood leak
-> Abnormal reflux

Standard treatment:
open heart surgery

Only repair percutaneous
alternative: Mitraclip



Non satisfactory results for secondary MI patients

New implant

Developed *via* student projects

RENOVALVE

→ 2 patents (2018, 2024)

Maturation financed by:

SATT LUTECH

MARLE 3D MEDLAB + cistec MEDICAL

Up coming co-maturant

Current service provider

IMMR Accelerating your innovative research

Animal tests

At the end: clinical tests

Contact : anne-virginie.salsac@utc.fr

Renovalve: mini invasive repair of mitral valve

Contact : anne-virginie.salsac@utc.fr

UTC : A culture of innovation and entrepreneurship for a strong societal impact

Impact

In the spirit of several years of development and action research in partnership with the Costech Lab, Bip Pop is a digital platform for coordinating the involvement of citizens by local authorities, to prevent isolation linked to loss of autonomy due to age, health or disability

LA FRANCE S'ENGAGE

Cofinancé par l'Union européenne

Contact : anne.guenand@utc.fr

UTC : A culture of innovation and entrepreneurship for a strong societal impact

Revival Bionics, the prosthetics start-up of the future

"Fully compensating for the disability of individuals who are amputees or paralyzed in the lower limbs is the driving force behind Revival Bionics."

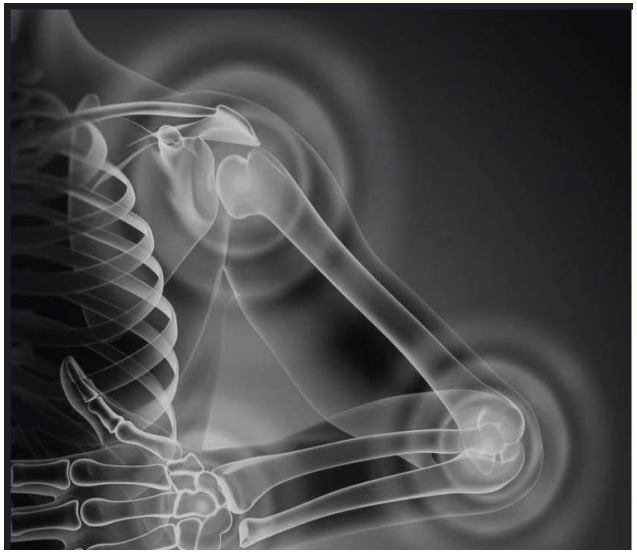
Source : https://interactions.utc.fr

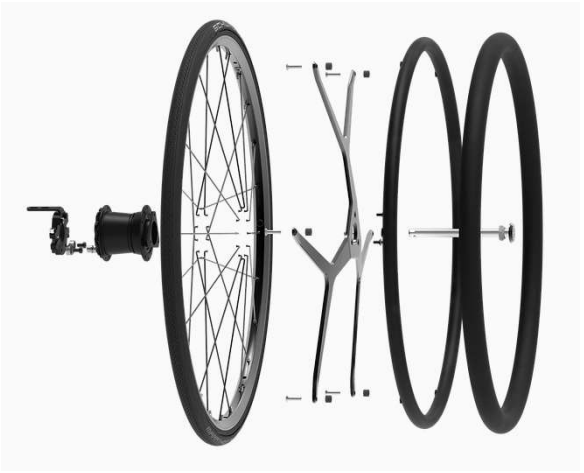
Contact : www.revivalbionics.com/

UTC : A culture of innovation and entrepreneurship for a strong societal impact

Dreeft : The first braking system for manual wheelchairs

EPPUR





Source : www.eppur.eu

Contact : www.eppur.eu/contact

www.utc.fr

UTC News & Updates : https://interactions.utc.fr

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Région Hauts-de-France

Cti Commission des titres d'ingénieur

CONFÉRENCE DES GRANDES ÉCOLES

HR EXCELLENCE IN RESEARCH