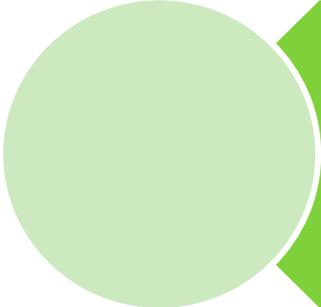


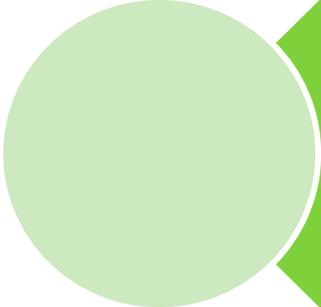
FÉDÉRATION DES MICRO NANO TECHNOLOGIES

AXE COMPOSANTS ET SYSTEMES POUR LA
BIOLOGIE ET LA SANTE

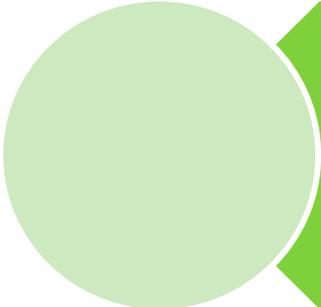
Valérie STAMBOULI, Edwige BANO

A light green circle with a white border is positioned to the left of the first text block.

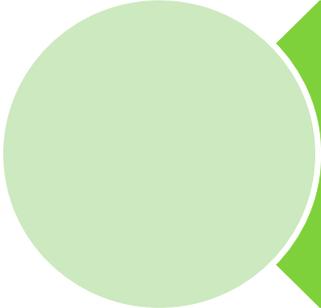
Biomatériaux pour
la santé

A light green circle with a white border is positioned to the left of the second text block.

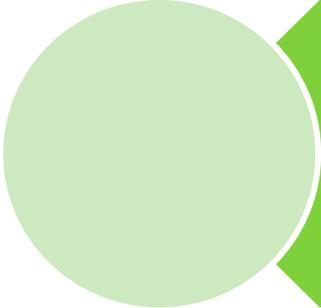
Outils de
diagnostic

A light green circle with a white border is positioned to the left of the third text block.

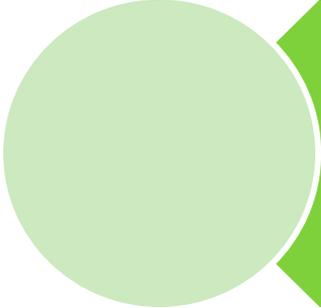
Systemes
implantables

A light green circle with a white outline is positioned to the left of the first text block.

Biomatériaux pour
la santé

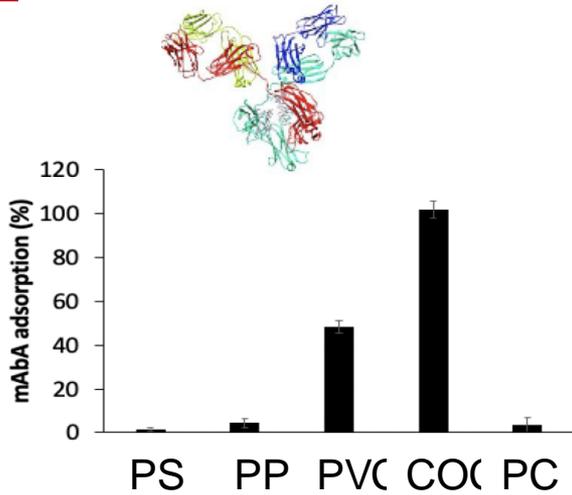
A light green circle with a white outline is positioned to the left of the second text block.

Outils de
diagnostic

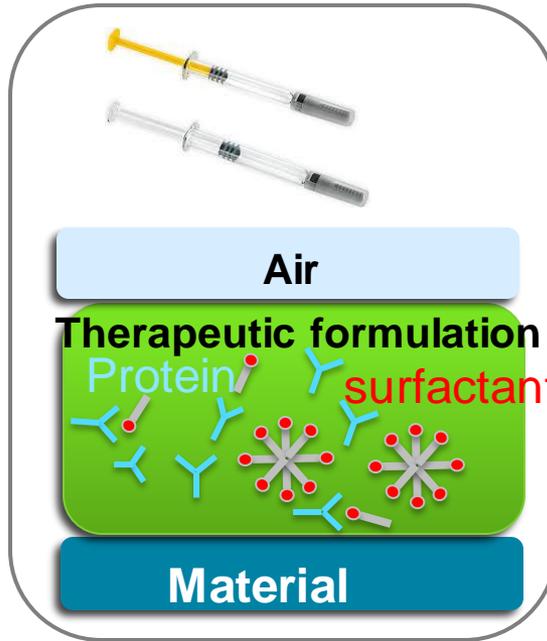
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Systemes
implantables

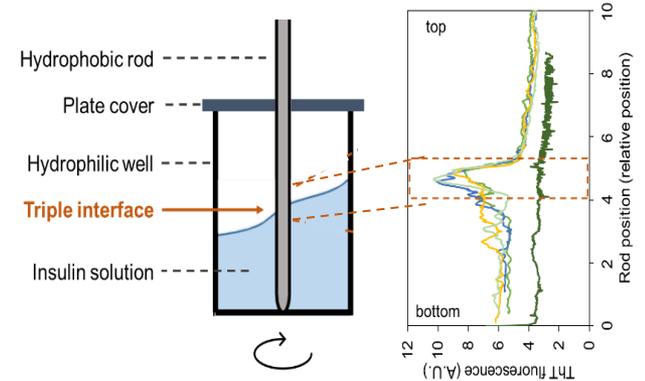
INTERFACE PROTEINE / SUBSTRAT



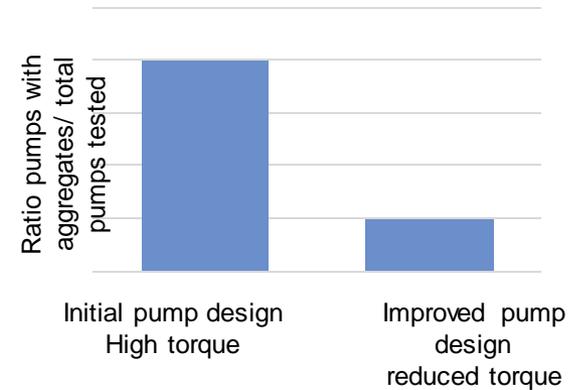
Effet du type de plastique sur l'adsorption des proteiness



Importance du surfactant



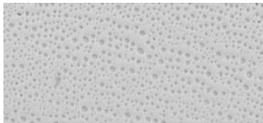
Agitation de l'interface triple → destabilisation des proteines



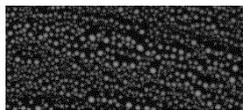
Reduction du couple de torsion → stabilisation des proteines



Silicone oil layer droplets on glass



RICM (436 nm)



Fluorescence NileRed

Stabilité du film de silicone

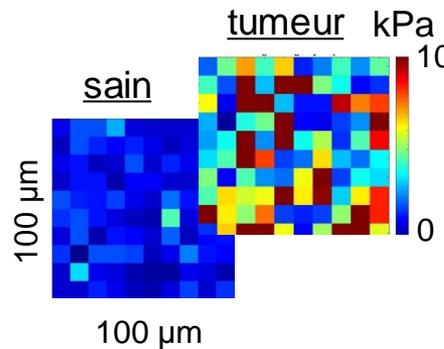
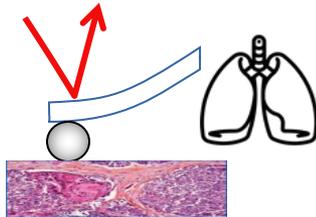
Concepteur et fabricant de dispositif médicaux sur mesure, sécurisés et connectés pour la préparation et l'administration de médicaments :



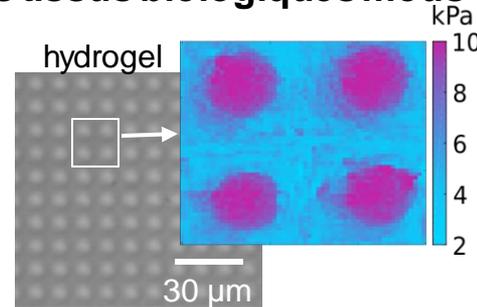
Prix à Pharmapack 2021

<https://eveon.eu/en/>

Tissus biologiques Imagerie mécanique



Fabrication 2D de supports mécano-mimétiques des tissus biologiques mous

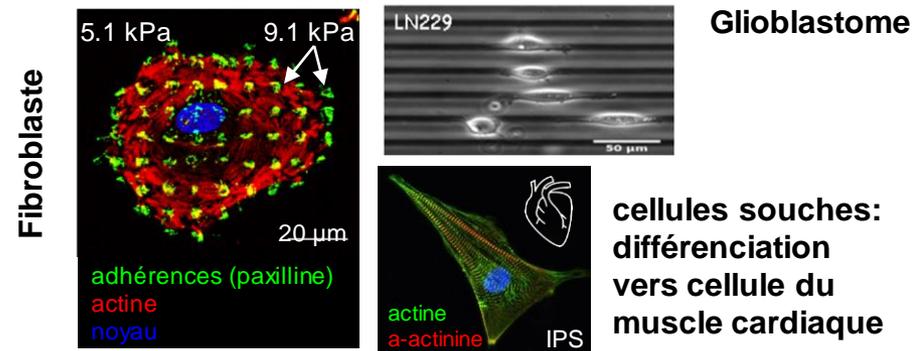


rigidité



Analyses cellulaires (cancer, cellules souches)

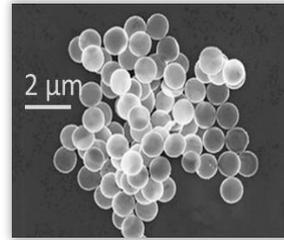
sur hydrogels texturés en rigidité



2018: **Cell&Soft**
Let's reinvent in vitro cell culture!

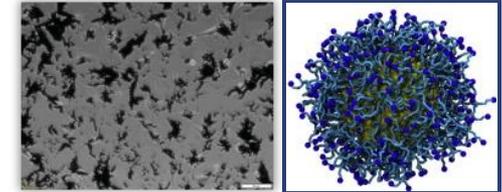
→ Vers une nouvelle activité innovante : impression 3D de substrats cellulaires (scaffold) mous (kPa versus 50-500 kPa) avec des fonctionnalités (magnétiques, diélectriques...)

CELLULE SOUS CHAMP MAGNÉTIQUE

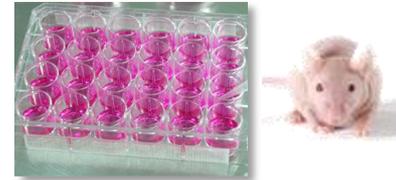


Particules Vortex

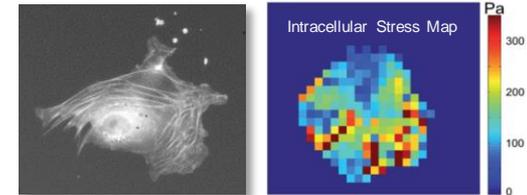
Toxicité /
Fonctionnalisation



Études in vitro /
in vivo



Cytosquelette -
Traction Force
Microscopy



Objectifs

- Activation de voies de signalisations, notamment celles liées aux canaux de transduction mécanosensibles

Domaines d'application

- Destruction de cellules cancéreuses par apoptose
- Modification de la motilité de cellules cancéreuses
- Activation des voies de différenciation cellulaire
- Recherche fondamentale sur le cytosquelette

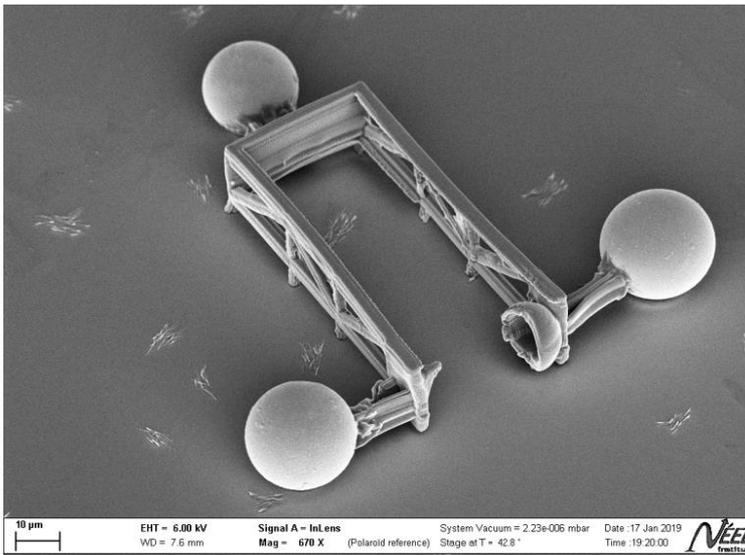
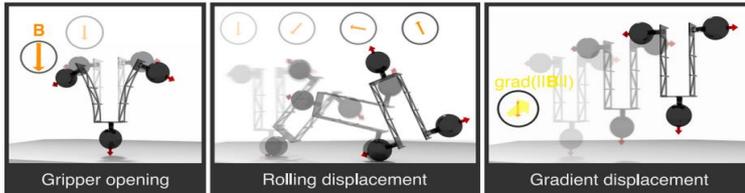
Collaborations / Projets actuels

BrainTech Lab; LTM / CNRS – Projet IRGA MagCell

Projet CDP EMagH (... + UGA, Institut Néel, CHUGA, GIN)

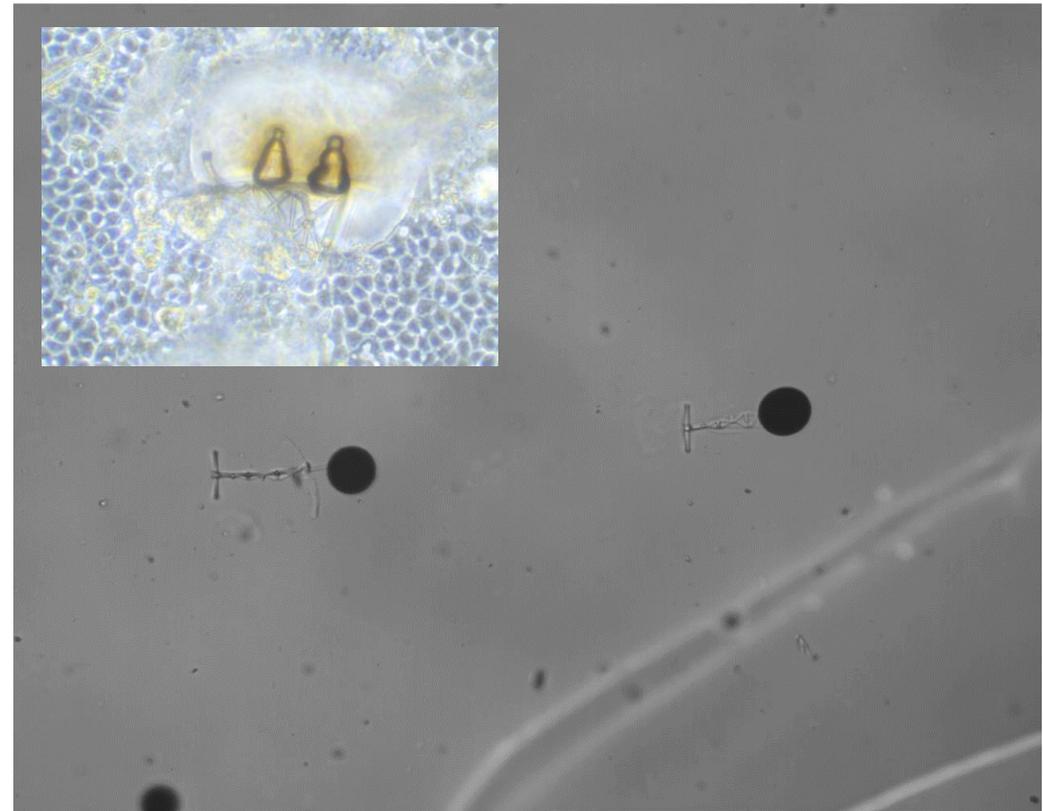
MICROBOTS MAGNETIQUES

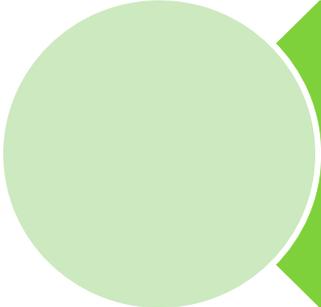
MICROPINCE pour la MANIPULATION DE CELLULES



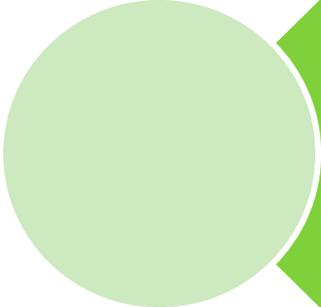
Vue dessus : Résine biocompatible et souple
(impression 3D) reliant 3 microbilles aimants

STRUCTURE HYBRIDE COLLAGENE POUR « Mécano transduction »

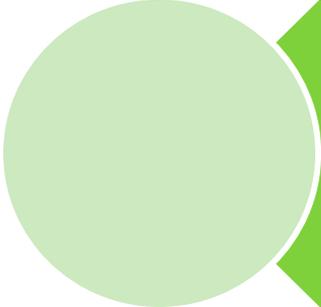


A light green circle with a thin white border, positioned to the left of the first text block.

Biomatériaux pour
la santé

A light green circle with a thin white border, positioned to the left of the second text block.

Outils de
diagnostic

A light green circle with a thin white border, positioned to the left of the third text block.

Systemes
implantables

Elaboration,
Intégration,
Fonctionnalisation de nanomatériaux

→ dispositifs miniaturisés d'analyses biologiques portables

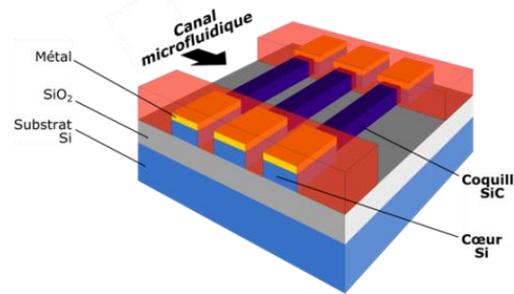
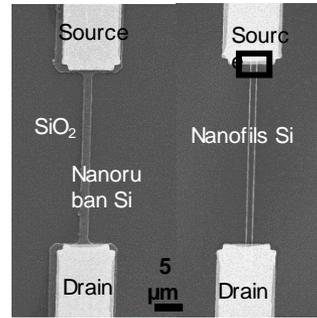
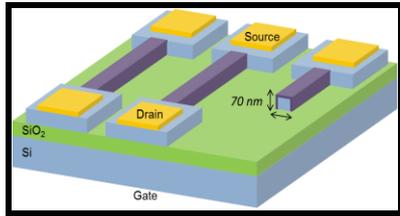


**Detection
électrique**



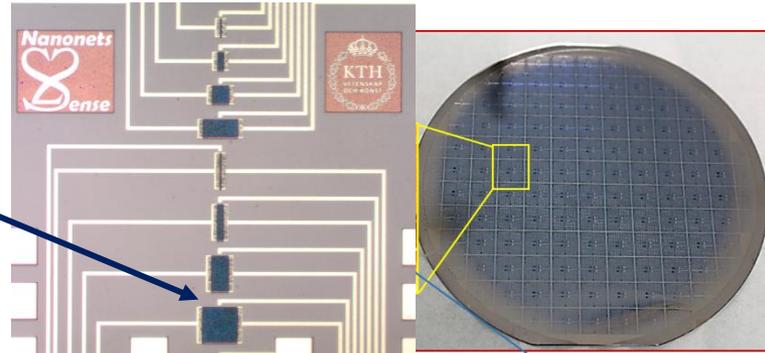
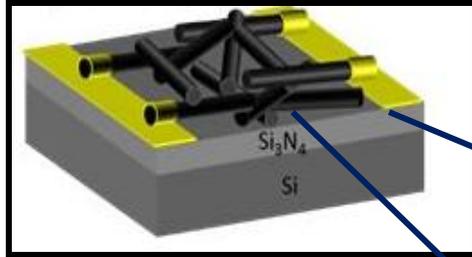
**Detection
optique**

DETECTION ELECTRIQUE



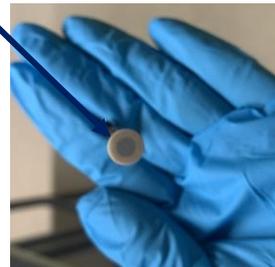
Detection d'ADN, pH

Réseau de Nanofil 1D obtenus par gravure Si, SiC



Detection d'ADN
Capteurs de gaz (acetone, ethanol)

Nanonet 2D obtenus par transfert Si, ZnO



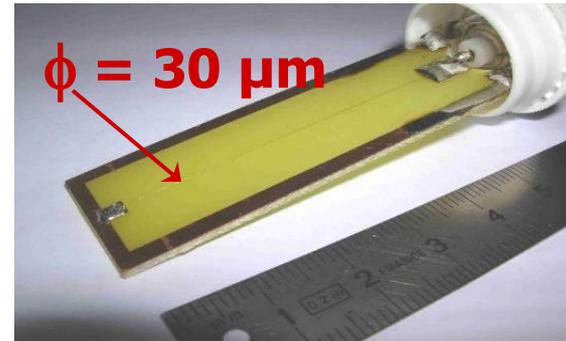
Capteur électrochimique :
detection de thrombine (5 nM)
considered as a marker of risk or presence of thrombosis



DETECTION ELECTRIQUE

High sensitivity Giant Magneto-Impedance (GMI) magnetic sensors

- Sensitive elements :
amorphous ferromagnetic **micro-wires**



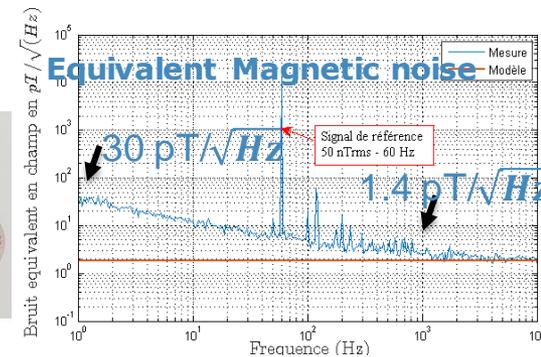
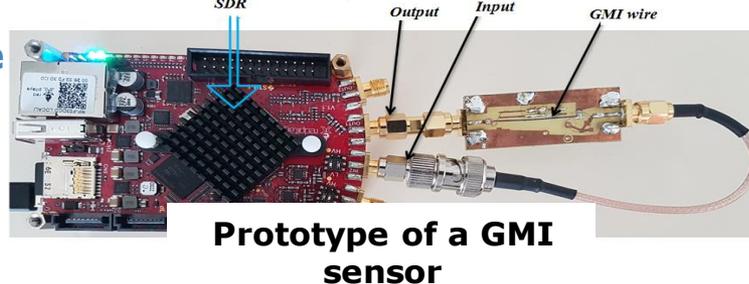
- **GMI** : large change of the μ -wire impedance with the applied magnetic field

- **High sensitivity**: current state of the art

- **Equivalent Magnetic noise**

- ~ 30 pT/ $\sqrt{\text{Hz}}$ @ 1Hz

- ~ 2 -3 pT/ $\sqrt{\text{Hz}}$ @ 100 Hz



- Possible further improvement and miniaturization

Potential biomedical applications

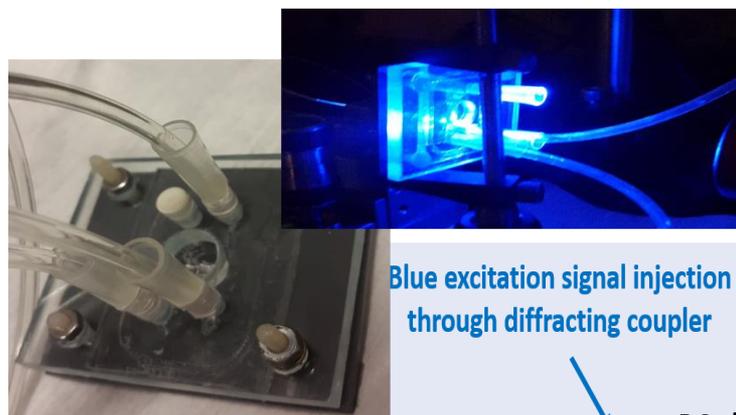
Magnetocardiography (MCG)

Detection of magnetic (micro/nano) particles

...

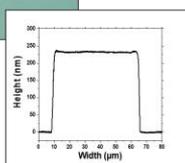
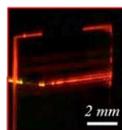
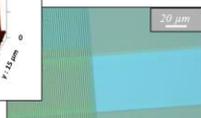
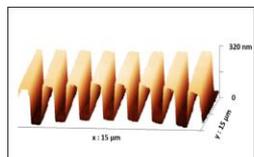
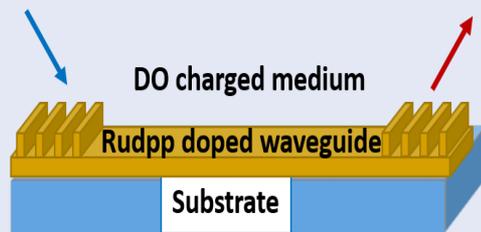
DETECTION OPTIQUE EN CONFIGURATION GUIDÉE

Elaboration par voie sol-gel de guide d'onde canal dopé avec un fluorophore (Rudpp) sensible à l'oxygène



Blue excitation signal injection through diffracting coupler

Red emission signal extraction through diffracting coupler



Mesures de fluorescence en mode guidé

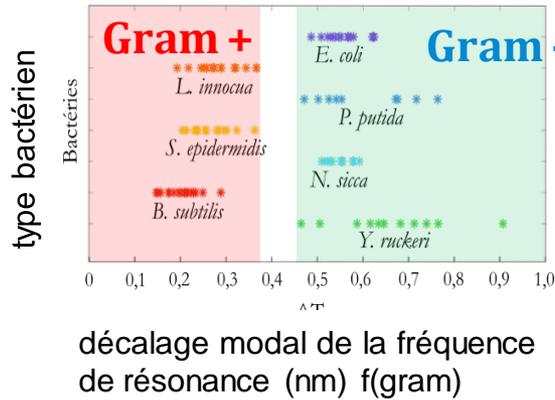
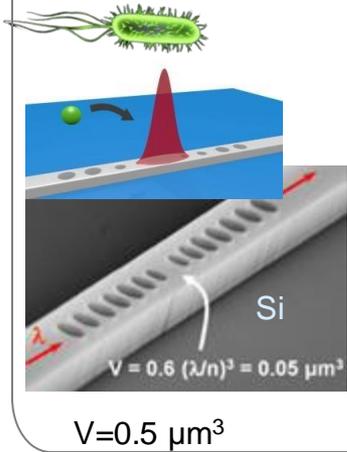


Oxygène dissous en solution aqueuse

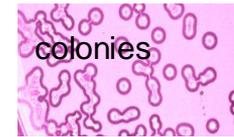
Vers mesure pH molécules biologiques

Identification de phénotypes bactériens

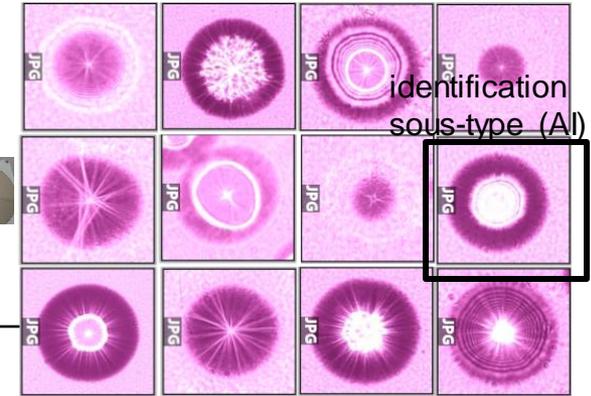
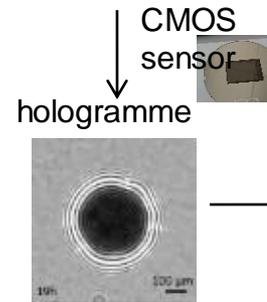
Guide d'onde : dispositif photonique de piégeage



Identification de types bactériens



bibliothèque d'hogrammes



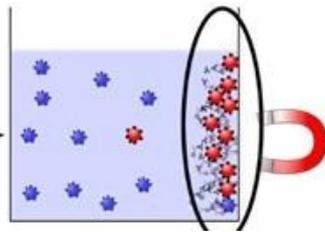
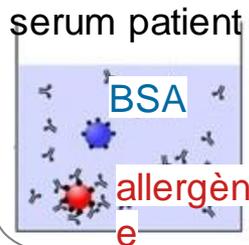
2021 :

Détection sensible d'allergies

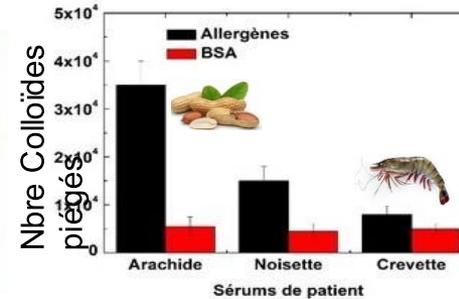
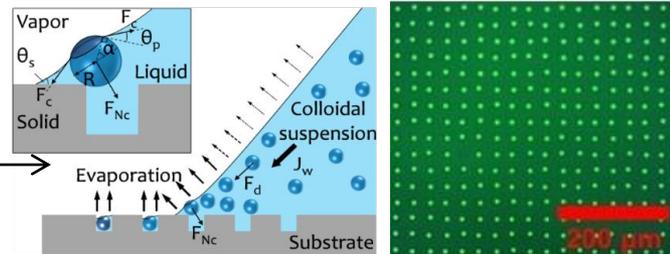


Dialmib

capture de colloïdes fonctionnalisés



dépôt organisé sur support 2D



DETECTION OPTIQUE :

Diagnostic immunologique : robuste, simple, rapide

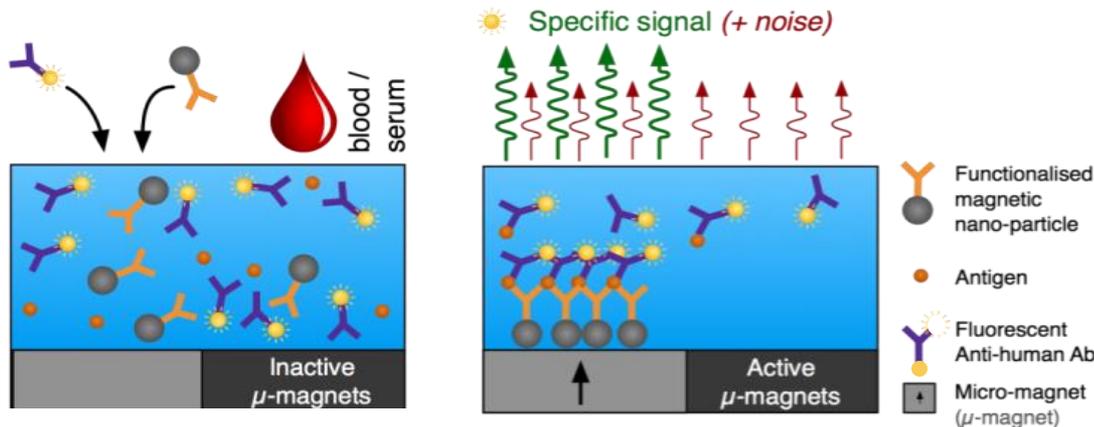
- micro-aimants intégrés + nanoparticules magnétiques
- 1 goutte de sang, 15 minutes, 1 seule étape
- Accélérer et simplifier les protocoles génériques
- Panel infectieux Hépatite B&C, Syphilis, HIV

Lecteur mobile rapide
(dépistage infectieux)



MagIA
diagnostics

Lecteur portable Cystatine
(auto-test insuffisants rénaux)



① Incubation

② Differential detection

Total analysis time: 5 - 15 min

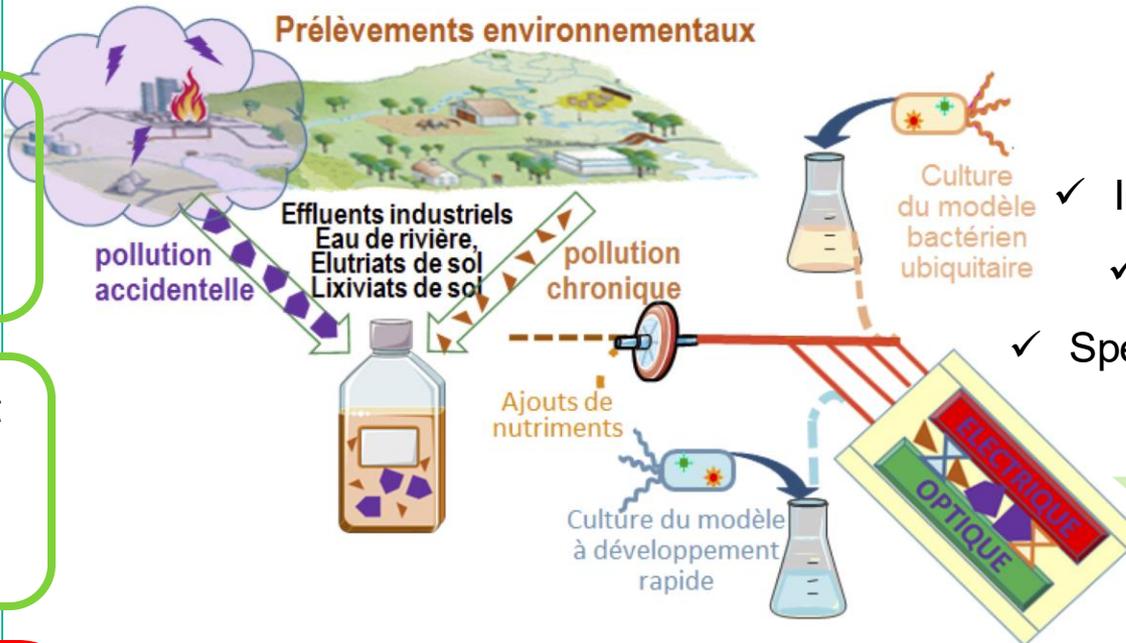
CAPTEUR INTÉGRÉ SUR VERRE POUR LA DÉTECTION DE VIABILITÉ BACTÉRIENNE EN MILIEU AQUEUX POLLUÉ

Evaluation des risques lors d'accidents industriels

Développement d'un capteur **intégré et robuste**

Mesures de la **toxicité des eaux en milieux contraints**
In-situ
Rapides
Fréquentes

Prélèvements environnementaux



Dépôt d'un projet à l'AAPG ANR 2022

- Réponse microbienne à un stress exogène
- Viabilité bactérienne
- Microbiologie environnementale
- Géochimie

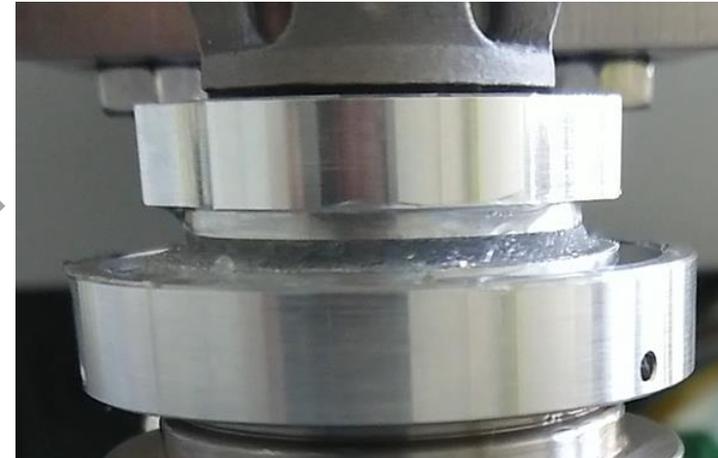
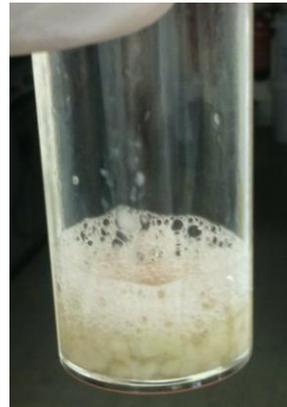
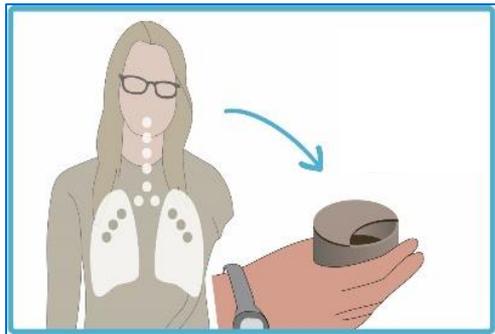
Substrat verre

Sans fonctionnalisation de surface

Sans croissance des modèles bactériens

Objectifs :

Suivi des propriétés rhéologiques du mucus de patients atteints de Mucoviscidose
Miniaturisation d'un banc (1m^3) pour obtenir un appareil portatif (1dm^3) au chevet du patient



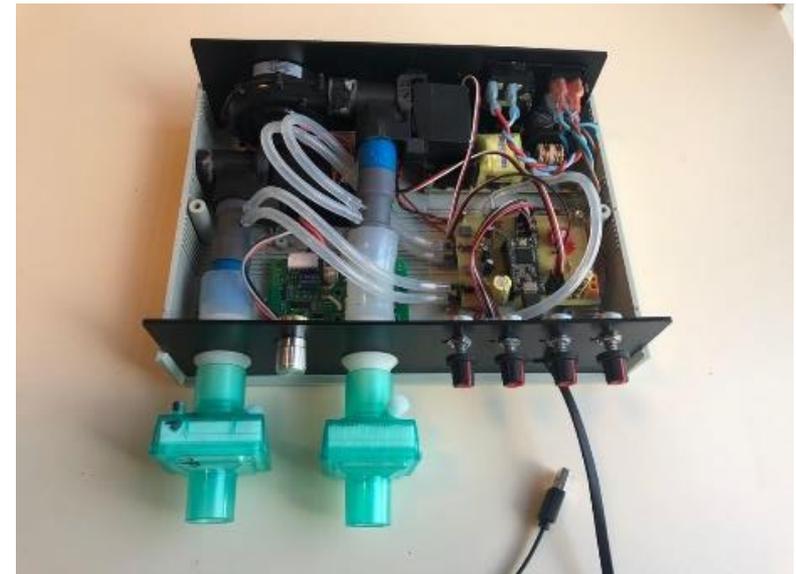
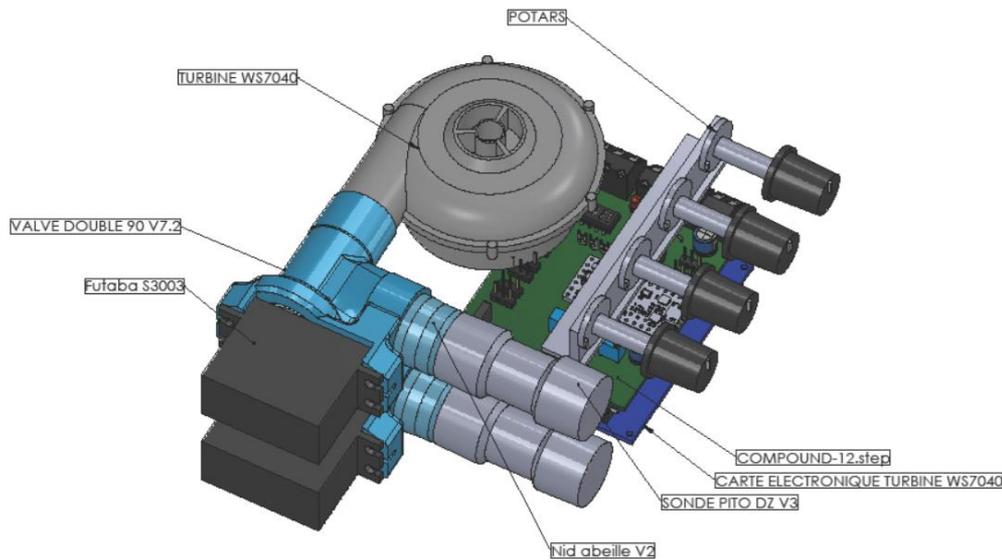
Spécifications :

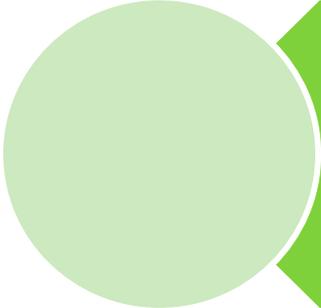
- Fréquence (1Hz-10kHz)
- Grandes déformations (10^4 %)
- Control de la température (0-140°C)
- Modules de cisaillement et compression du mucus
- Actionneurs piézoélectriques

RESPIRATEUR BAS COUT

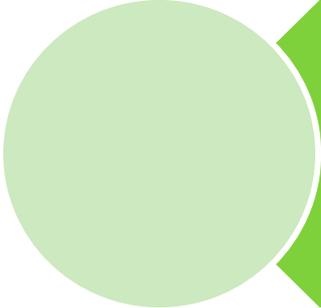
Bas coût
Low-tech
Appareil Open-source

=> *Mauritanie et Tiers monde*

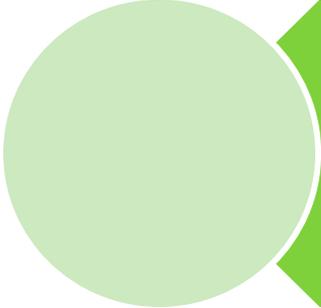


A light green circle with a white outline, positioned to the left of the first text block.

Biomatériaux pour
la santé

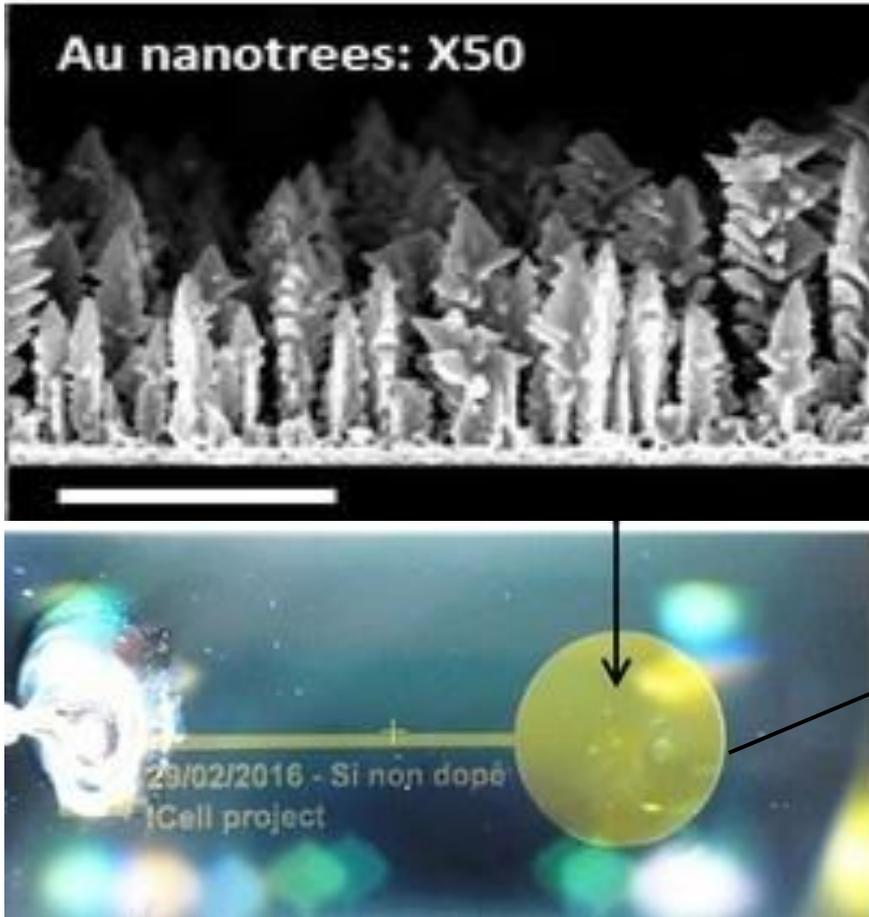
A light green circle with a white outline, positioned to the left of the second text block.

Outils de
diagnostic

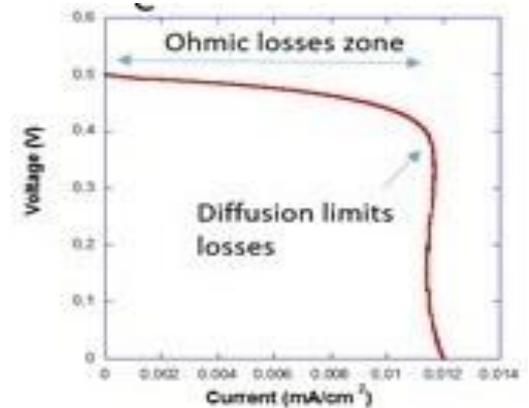
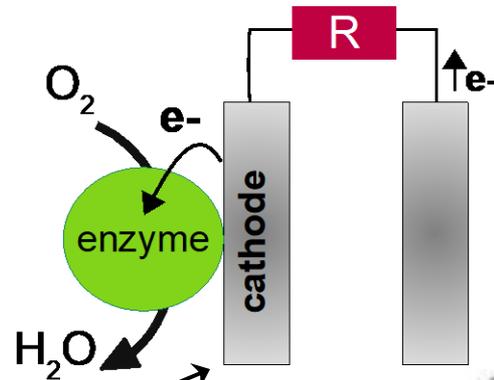
A light green circle with a white outline, positioned to the left of the third text block.

Systemes
implantables

Electrodes pour biopiles enzymatiques



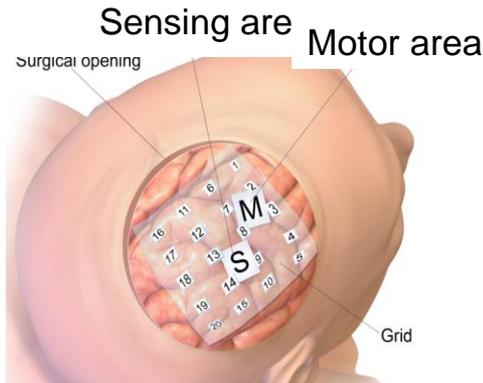
caractéristique cathode enzymatique



Fabrication of silicon carbide long-lifetime neural interfaces

Contexte :

- Electrocorticography (ECoG)
- Or
- Intracranial electroencephalography (iEEG)



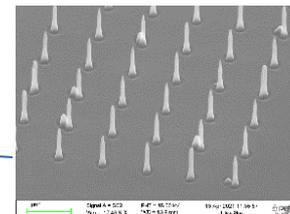
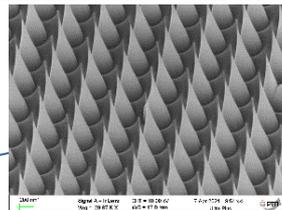
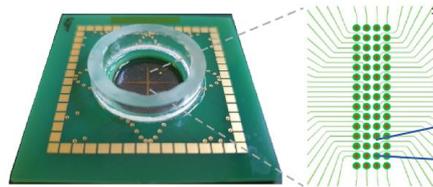
Problématique des électrodes actuelles :

- Mélange de matériaux : Métaux, polymères, silicium
- Réactions suite à implantations in-vivo
- implant in-vivo peu stable

Besoin d'interfaces neurales à longue durée de vie

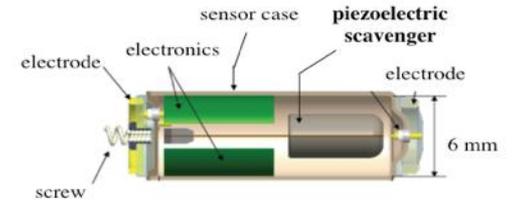
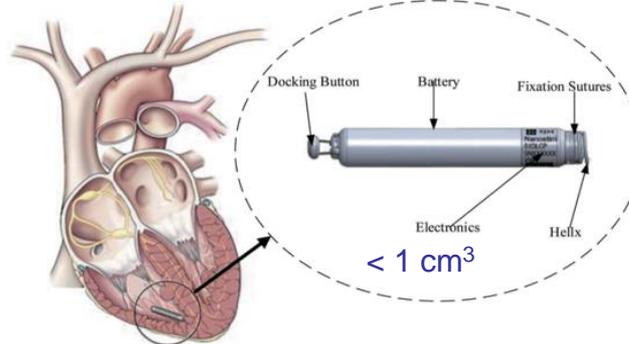
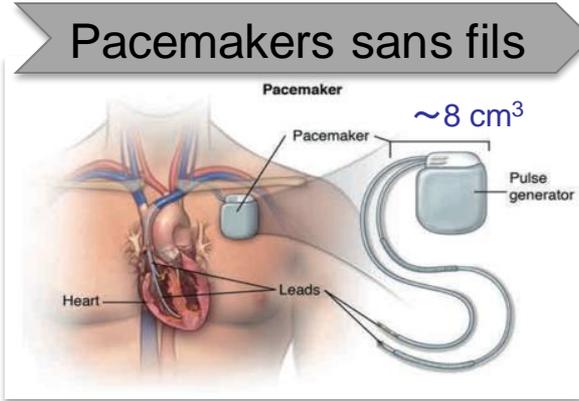
Objectif : Fabriquer et caractériser une Matrice de Micro Electrodes (MEAs)

- Souple
 - Biocompatible
 - Longue durée de vie
- Full SiC



SYSTEMES IMPLANTABLES

Pacemakers sans fils



Composants

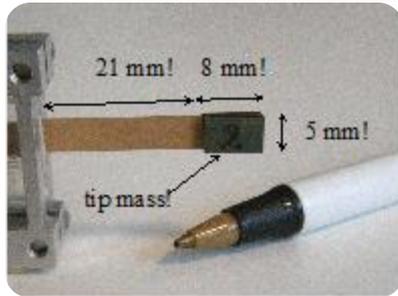
Circuits

Système Intégré

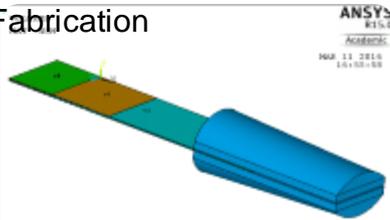
Microgénérateur Piézoélectrique

Power Management

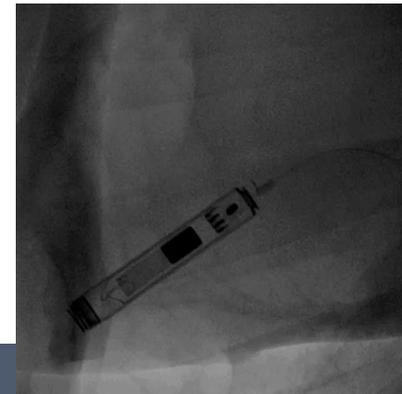
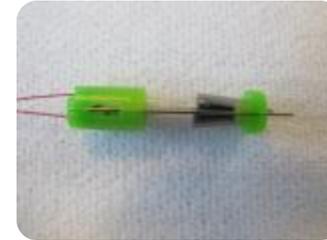
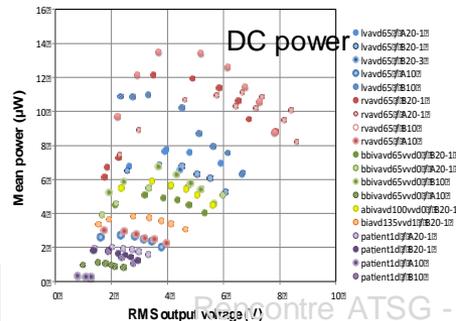
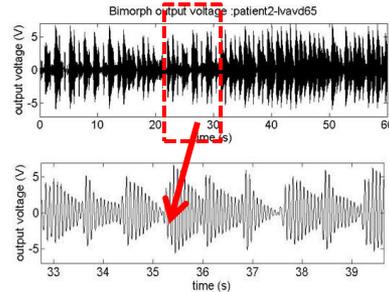
Pacemaker sans fils



Procédé de Fabrication



Fiabilité 1 Milliard de Cycles



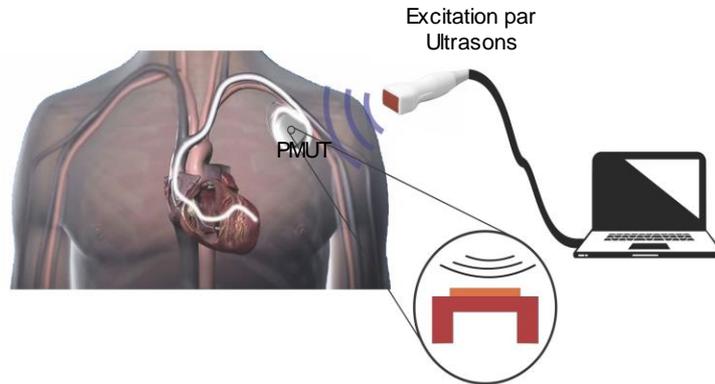
SYSTEMES IMPLANTABLES - PERSPECTIVES **FMNT**

Composants

Circuits

Système Intégré

PMUT for US - WPT

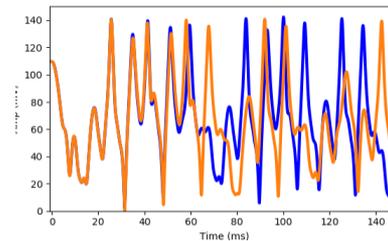
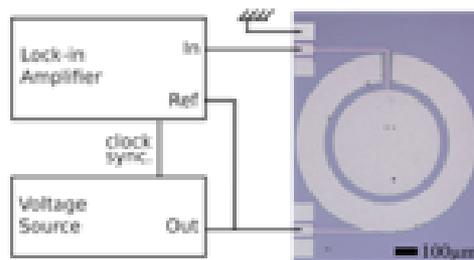


Conception d'un système de recharge par ultrasons pour implants médicaux



Stage FMNT – X. Xu 2020
P. Tacyniak – PhD 2021-2024

PMUT for chaos generation and cryptographic application



Conception de nouveau composants MEMS pour la cryptographie.
Communication sécurisée

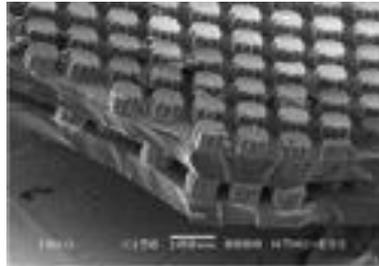


Stage FMNT – 2022
IRS Chamaleon – 2019-2021

SYSTEMES IMPLANTABLES - PERSPECTIVES **FMNT**



Stretchable Electroactive Polymers (Piezoelectret) for Medtech applications

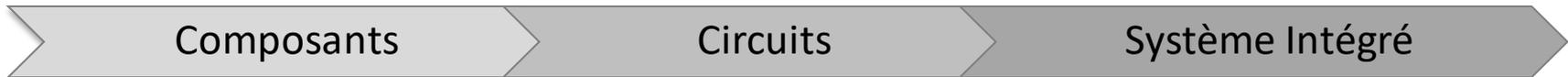


Ag NW as electrodes

Integration of stretchable sensors for wearable devices

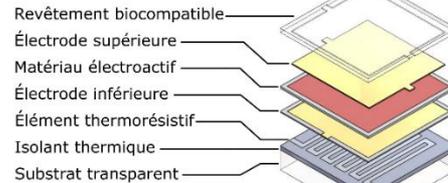
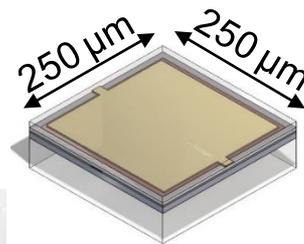


Stages FMNT – 2018 et 2019



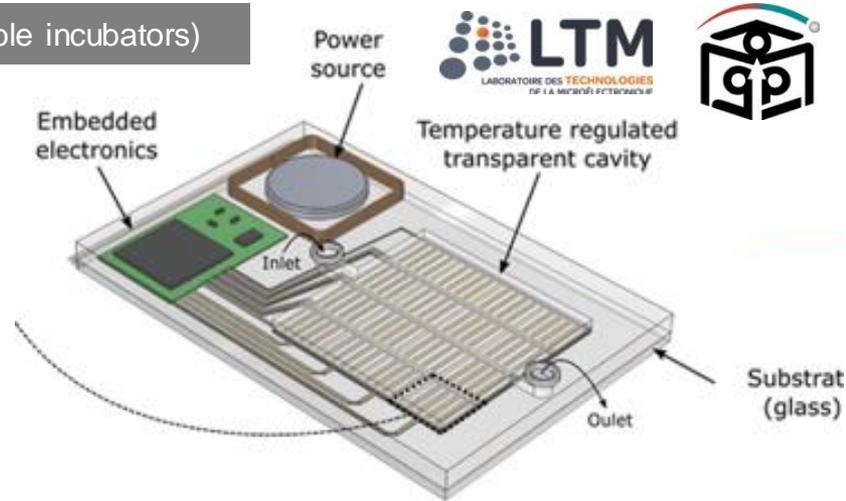
Thermodynamic matrix sensor for Medtech applications (Portable incubators)

New ferroelectric stacks with HZO – Sustainable electronic



NEED for IOT

Stage FMNT – 2020



QUESTIONS ?



MERCI POUR VOTRE ATTENTION