

# Artificial membranes on chip for high-throughput studies of membrane proteins

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project Nanobiodrop founded by the Nanosciences Foundation



## **Introduction**

Aim of this project

Techniques

## **Current state of the project**

Electrophysiology

Microfabrication

## **Summary and Perspectives**

## **People and labs**

## Artificial membranes on chip for high-throughput studies of membrane proteins

Why “membrane proteins”?

Communication between cells

30% of the genome

50% of known drugs interact with membrane protein

Why “artificial membranes”?

Known and controlled environment

Easy to manipulate

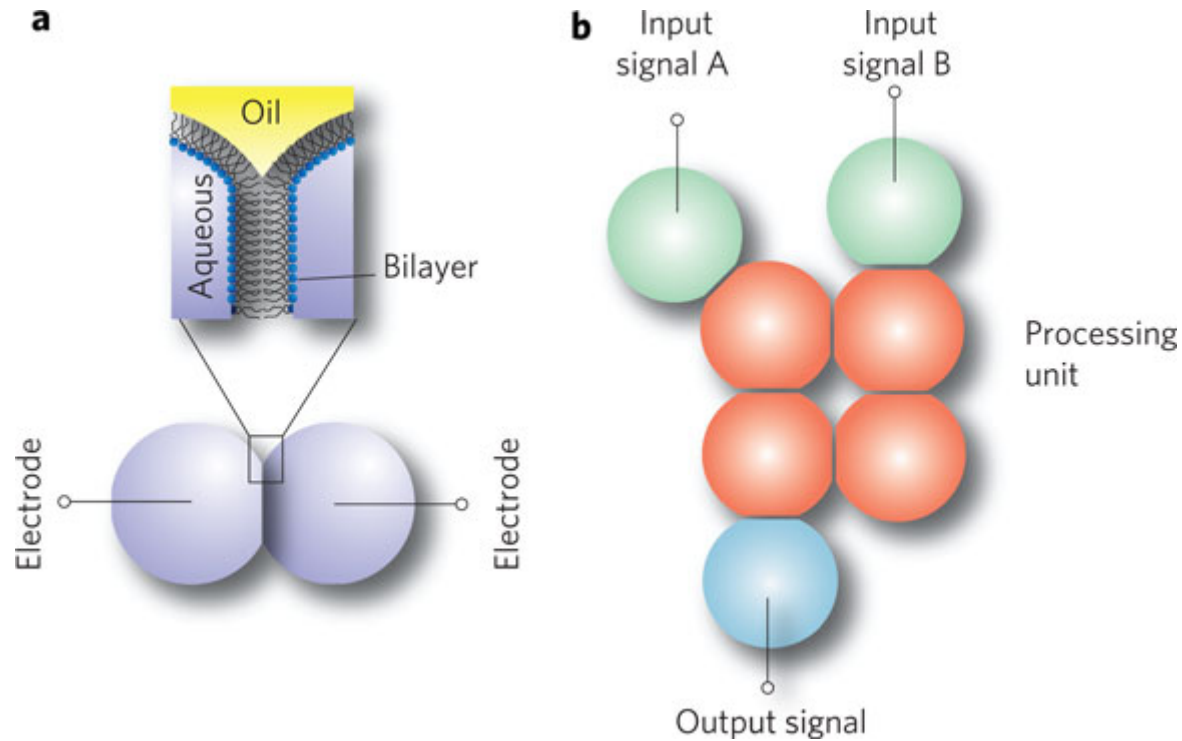
Why “on chip”?

Microfluidics, small amount of protein

Automation and parallelisation

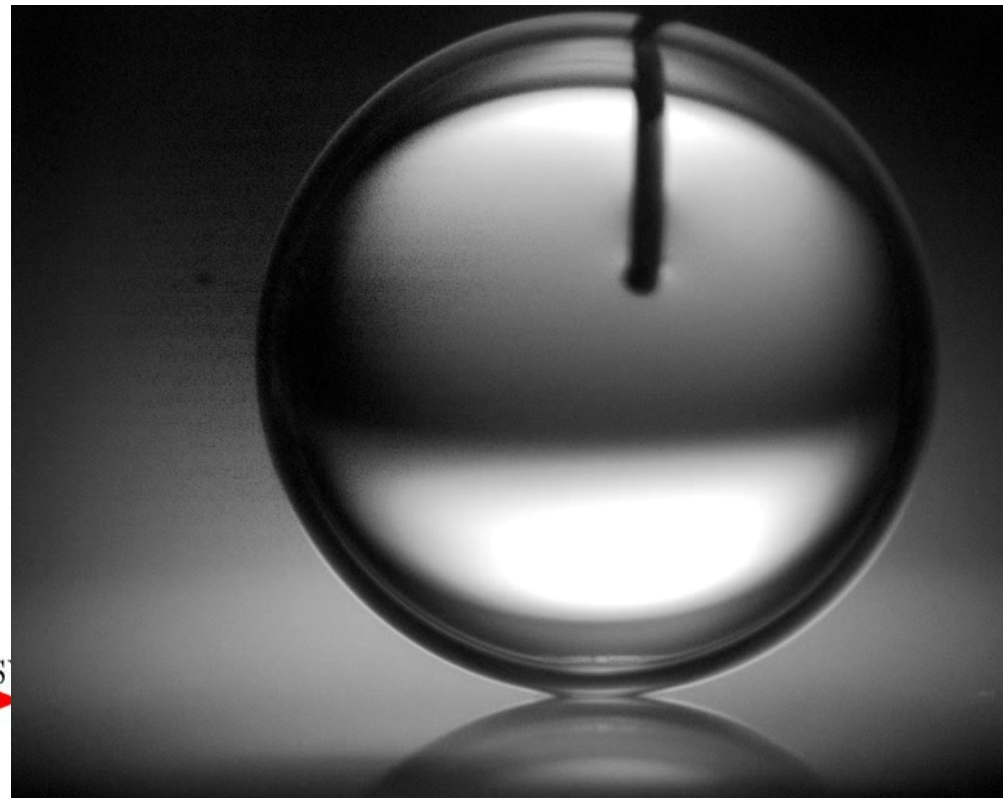
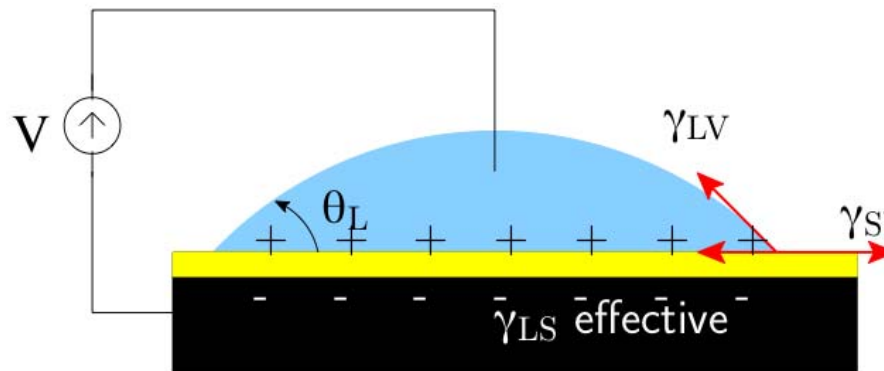
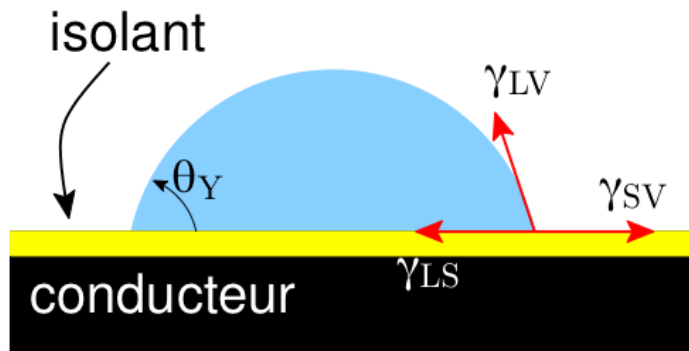
High-throughput and reproducibility

## Droplet interface bilayers

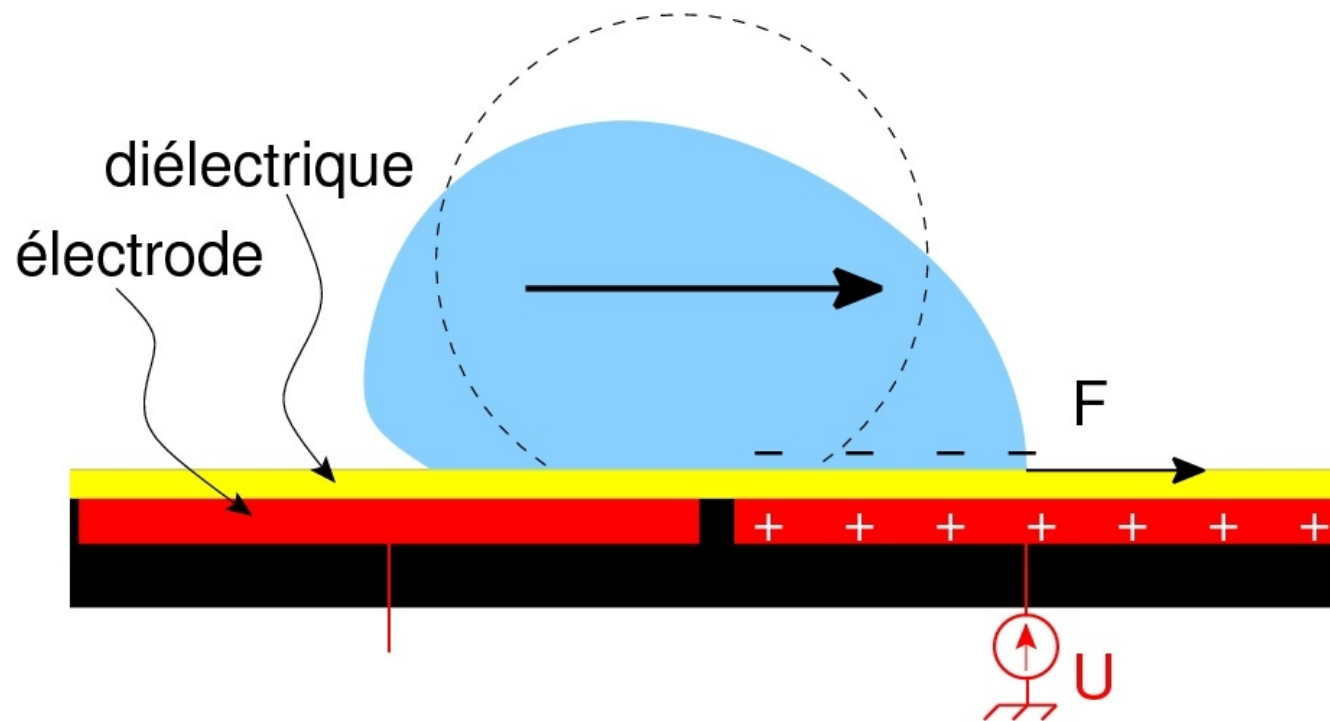


Bayley *et al.*, Droplet Interface Bilayers, *Mol. Biosyst.* 2008

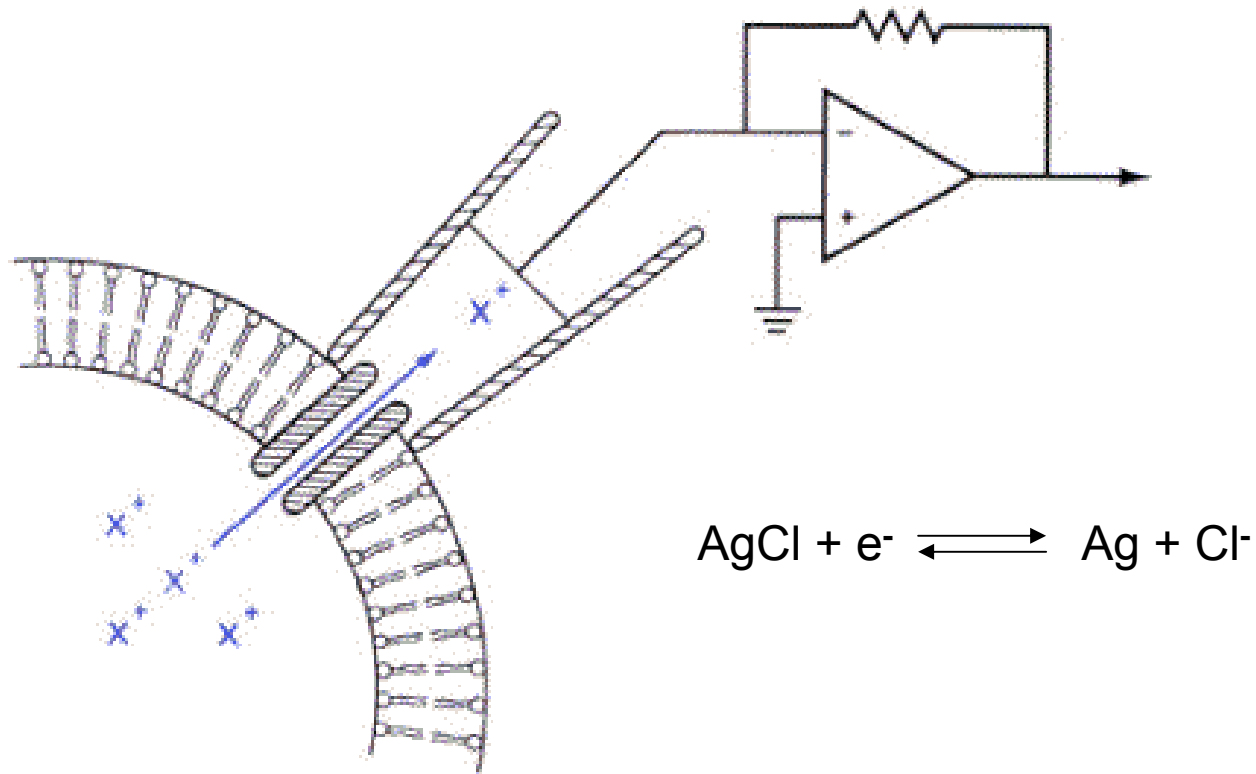
Electrowetting



Electrowetting



Electrophysiology method



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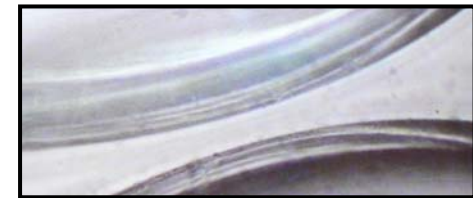
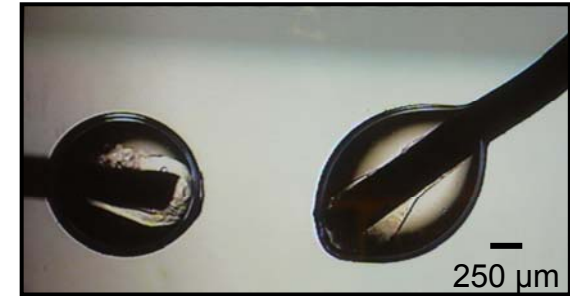
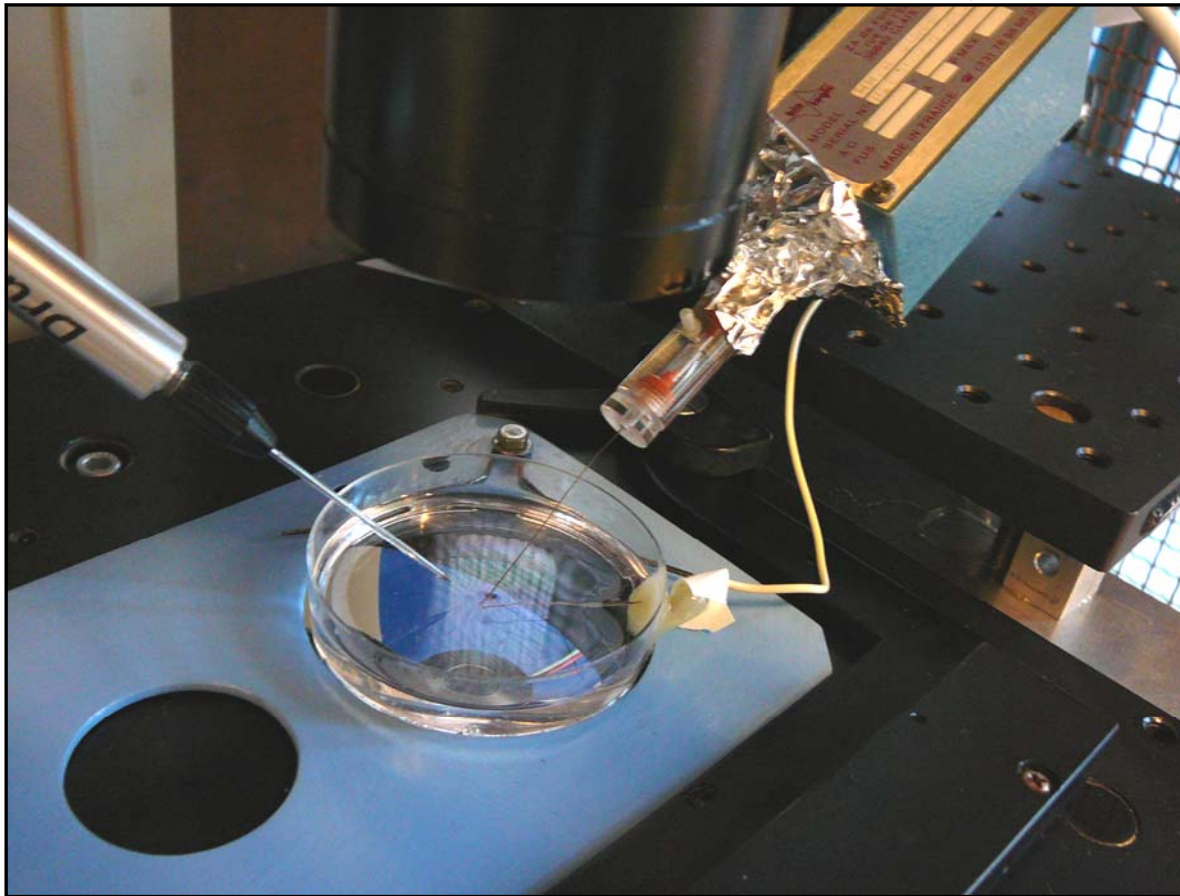
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# Current state of the project: Electrophysiology

Adaptation of a patch clamp setup

Amplifier



Two aqueous droplets in an oil bath



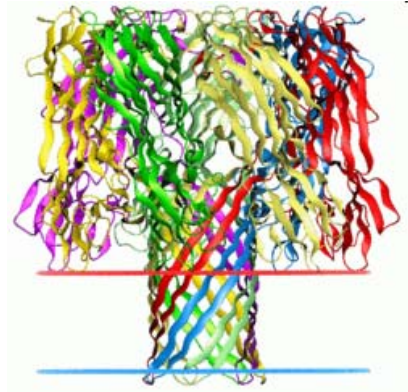
The two droplets in contact



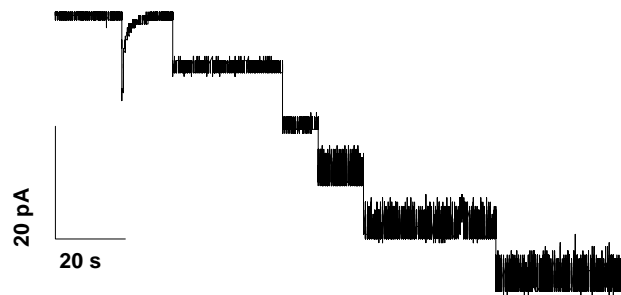
Lipid bilayer between two droplets (quelques nm)

## Current state of the project: Electrophysiology

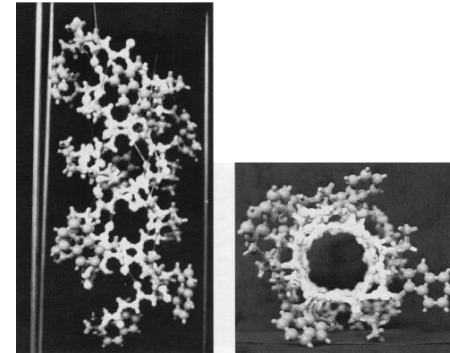
Proof of concept: Measurement of the insertion of two porins ( $\alpha$ -Hemolysin and gramicidin)



$\alpha$ -Hemolysin



Two droplets of 500nL of DPhPc 2mg/mL (Hepes 5mM, KCl 250mM, pH7). Injection of 2 $\mu$ g/mL  $\alpha$ -Hemolysin. ( $V_m$  = -50mV)



Gramicidin A

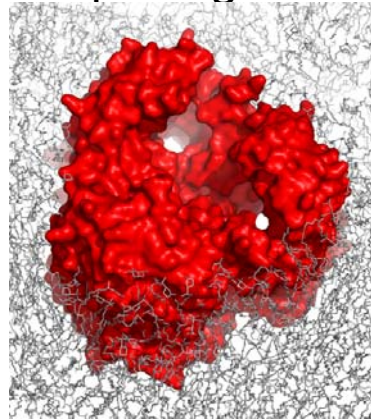


Two droplets of 500nL of DPhPc 2mg/mL (Hepes 5mM, KCl 250mM, pH7). Injection of 0.2 $\mu$ g/mL Gramicidin A. ( $V_m$  = -50mV)

# Current state of the project: Electrophysiology

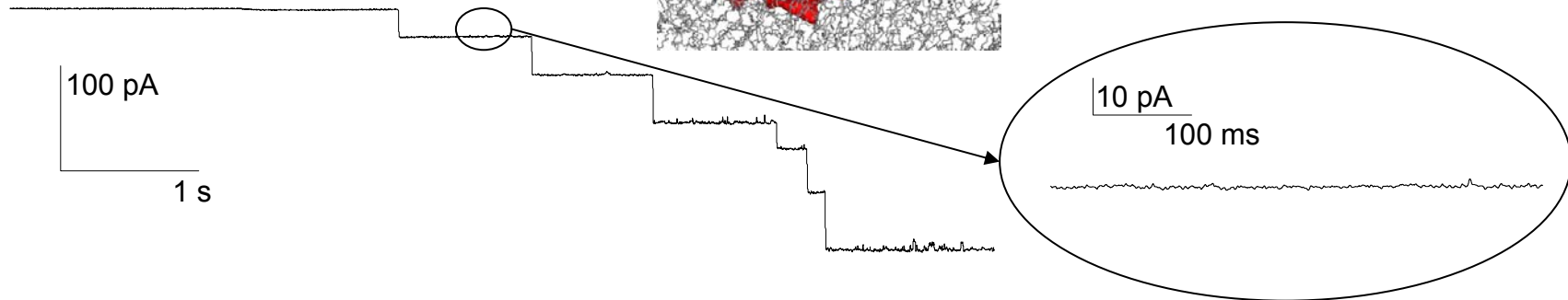
Study of OmpPst1, a porin from the pathogenic bacteria *Providencia stuarti*

(J.P. Colletier and C. Nasrallah)



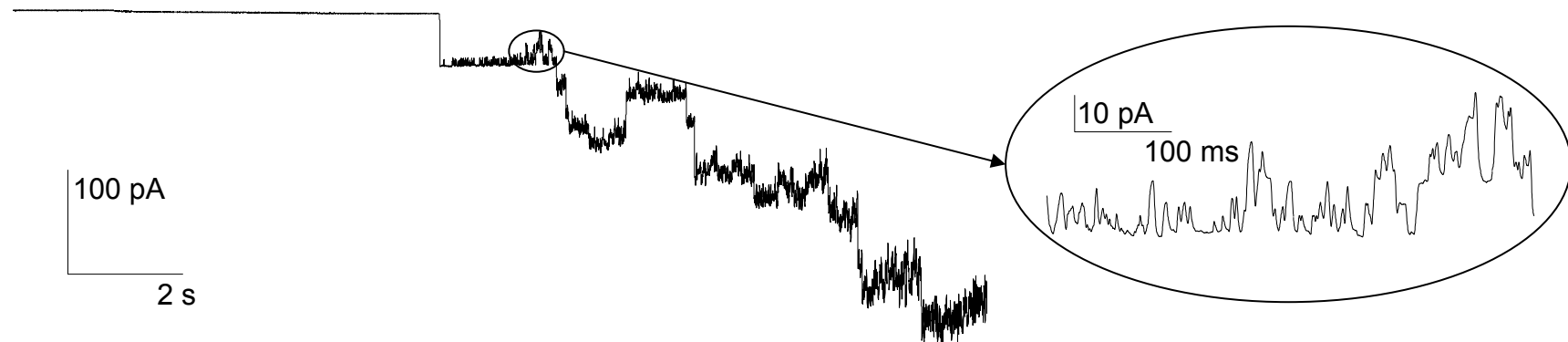
Before ampicillin injection

( $V_m = -20\text{mV}$ )

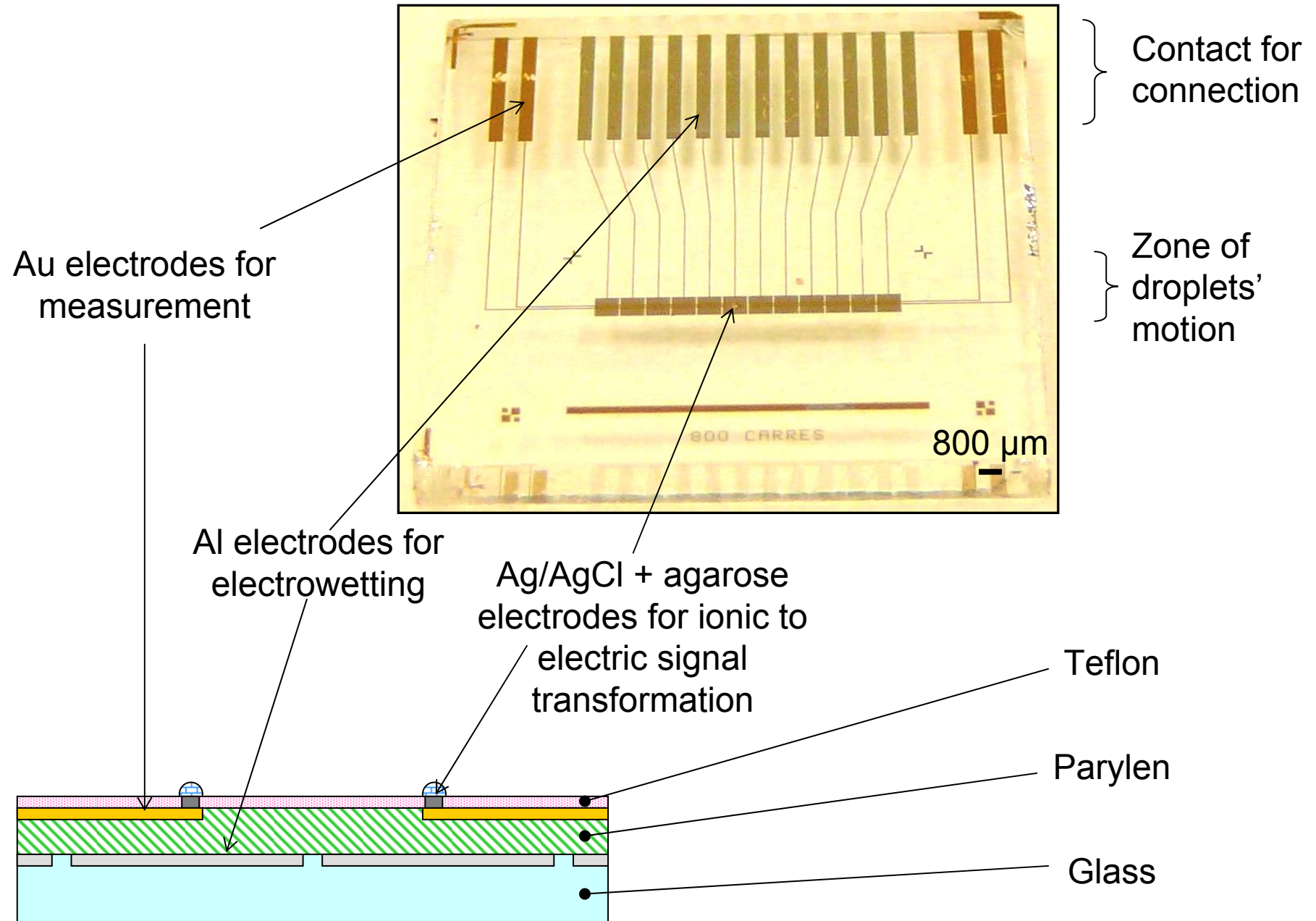


After injection of ampicillin (12.5mg/mL)

( $V_m = -20\text{mV}$ )



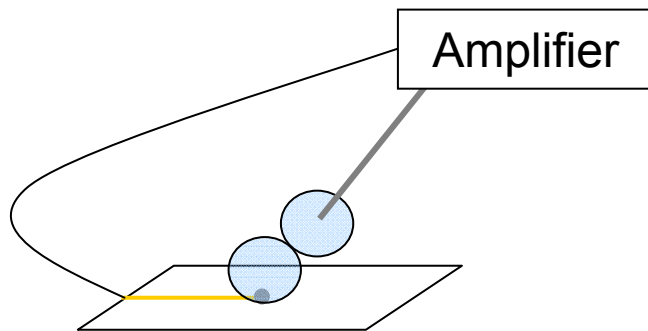
# Current state of the project: Microfabrication



## Current state of the project: Microfabrication

The conduction through the Ag/Au electrode has been validated:

Setup



$\alpha$ -Hemolysin insertions



Current measured between a chip and a wire electrode

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## Summary:

- Electrophysiological measurements across droplet interface bilayers
- Moving droplets by electrowetting
- Create membrane at droplet interface on chip
- Functional Ag/AgCl electrodes on chip

## Perspectives:

- Electrophysiological measurements on chip
- Finish the ongoing project on OmpPst1
- Project on amyloids
- Set up *in vitro* transcription translation (IVTT) in droplets to study other proteins
- Design new chip geometry for screening

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Michel Vivaudou, Eva Pebay-Peyroula: Head of project

Jean Revilloud, Lydia Caro: Initiation to electrophysiology

Jacques-Philippe Colletier, Chady Nasrallah: Amyloid and OmpPst1 porin projects



Benjamin Cross: Head of project, electrowetting and initiation to microfabrication

Bruno Fernandez, Sébastien Dufresnes, Emmanuel Andre: training and help in microfabrication (Nanofab, institut Néel)

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**Thank you  
for your attention**