POROUS SILICON-BASED BIOSENSOR FOR BACTERIAL DETECTION THROUGH THEIR LYSATE

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BACTERIA

Increasingly antibiotic resistant

Rare Bacterial Infection Leaves at Least 12 Dead in U.K.

By Iliana Magra

June 26, 2019

Every 15 minutes, someone in the US dies of a drug-resistant superbug

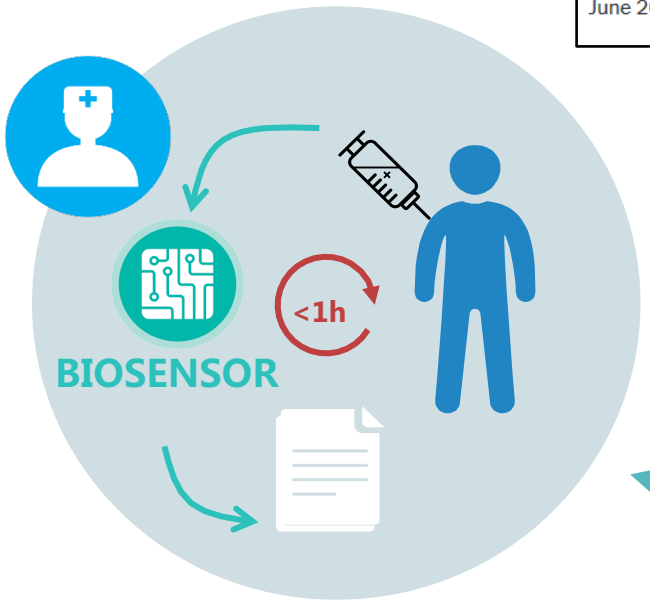
By Elizabeth Cohen and Nadia Kounang, CNN

Updated 2052 GMT (0452 HKT) November 16, 2019

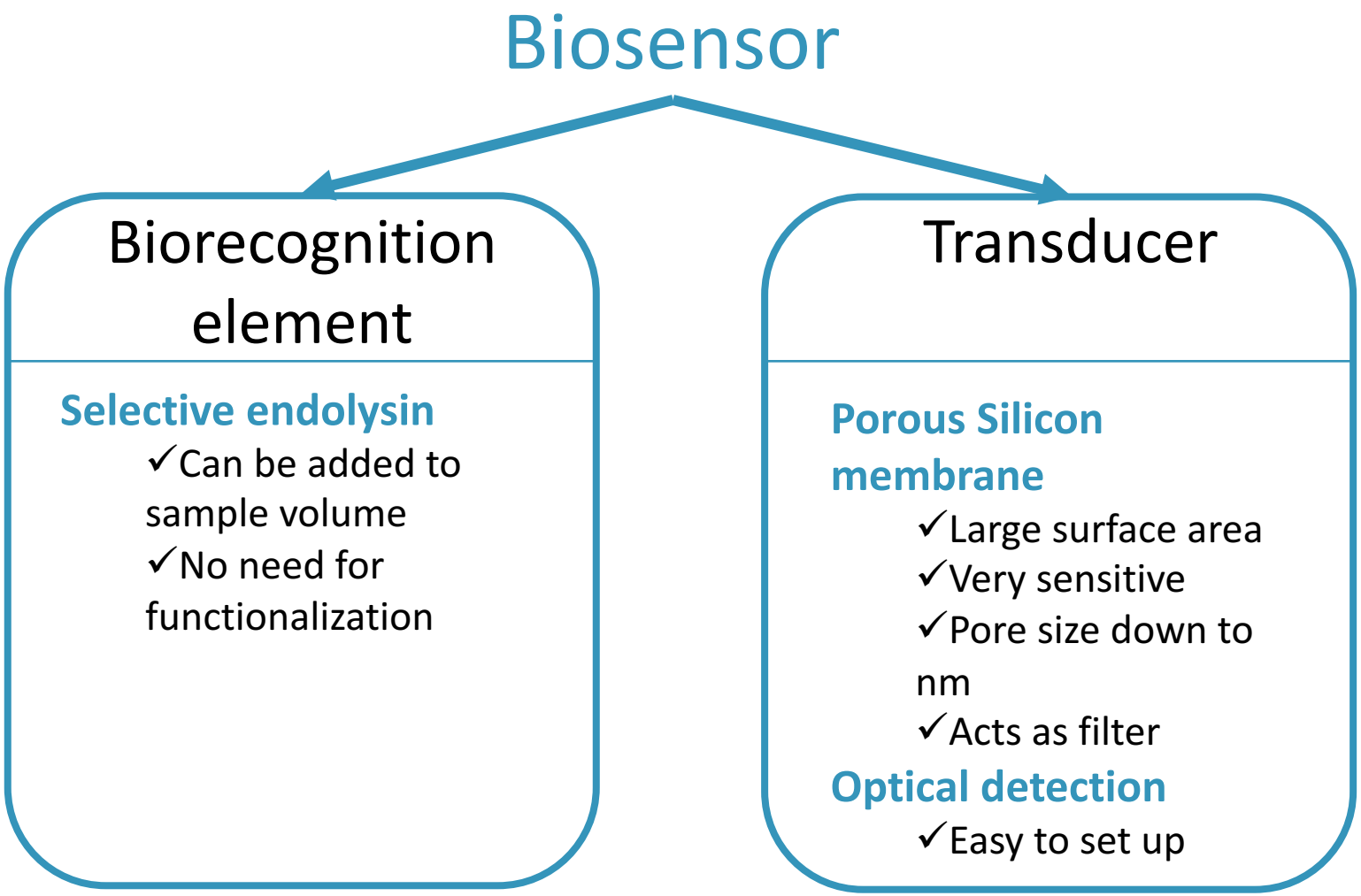
BBC News JULY 29, 2019

Drug-resistant superbug spreading in hospitals

Rapid
Cheap
No training

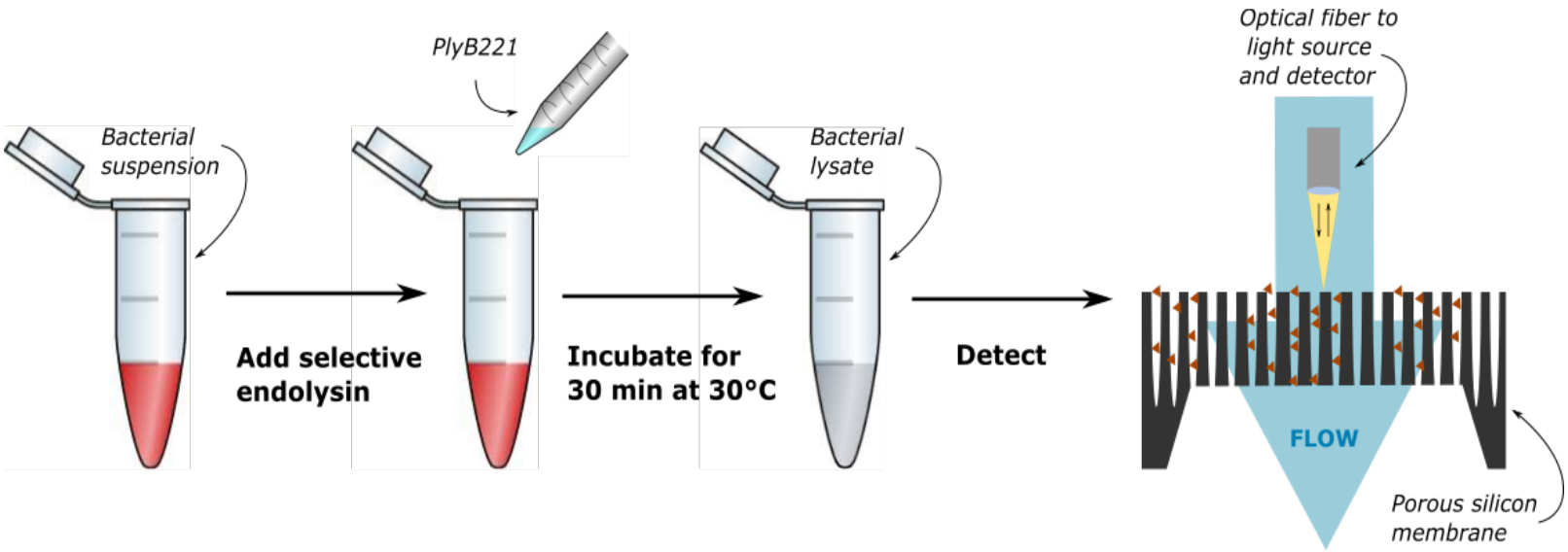


WHAT IS A BIOSENSOR ?



WORKING PRINCIPLE OF THE BIOSENSOR

1. Incubation of bacterial suspension with **selective lytic agent**
2. Permeation of lysate through the membrane, while **optically monitoring** the porous matrix

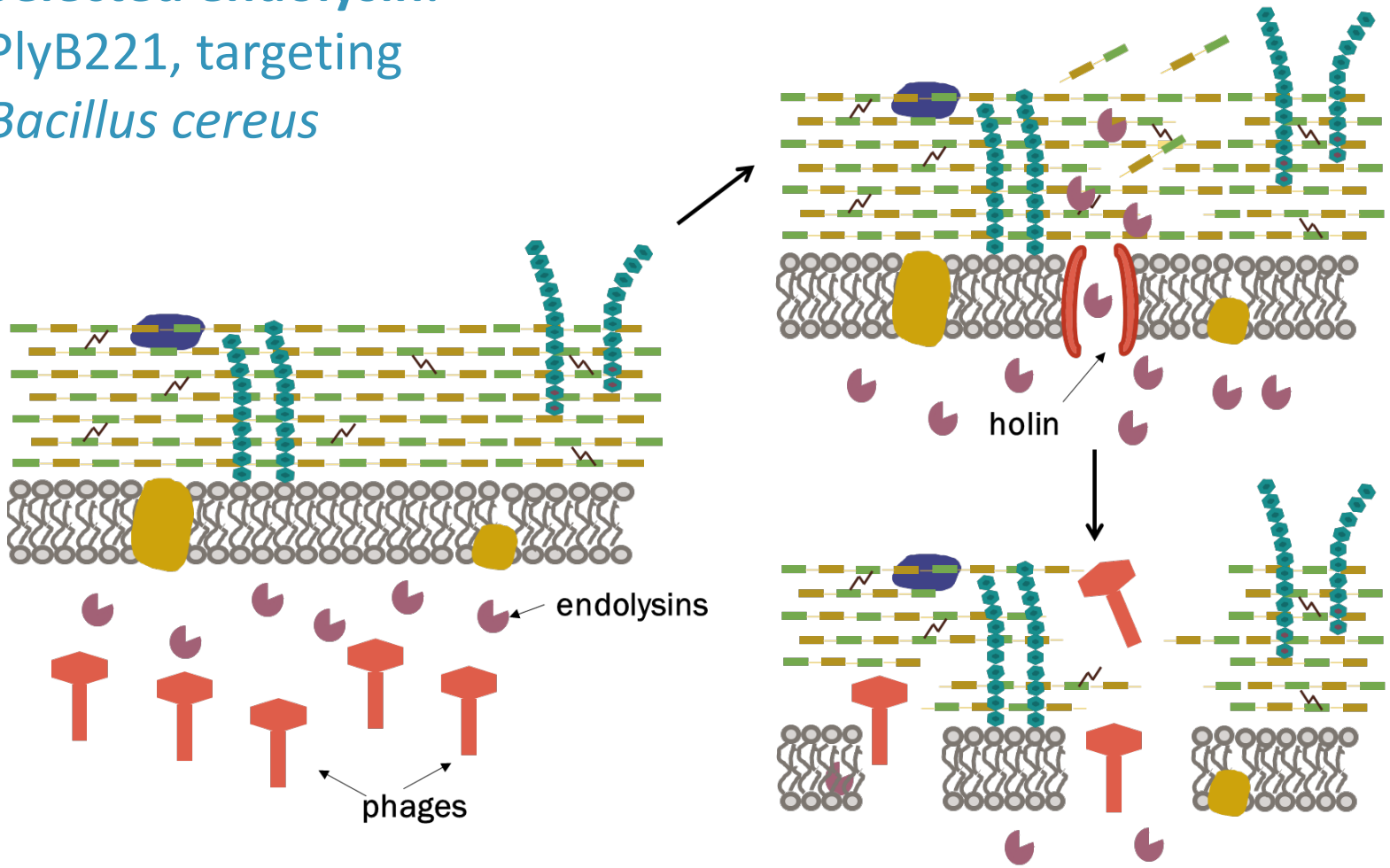


The Biorecognition Element: Endolysins

Selected endolysin:

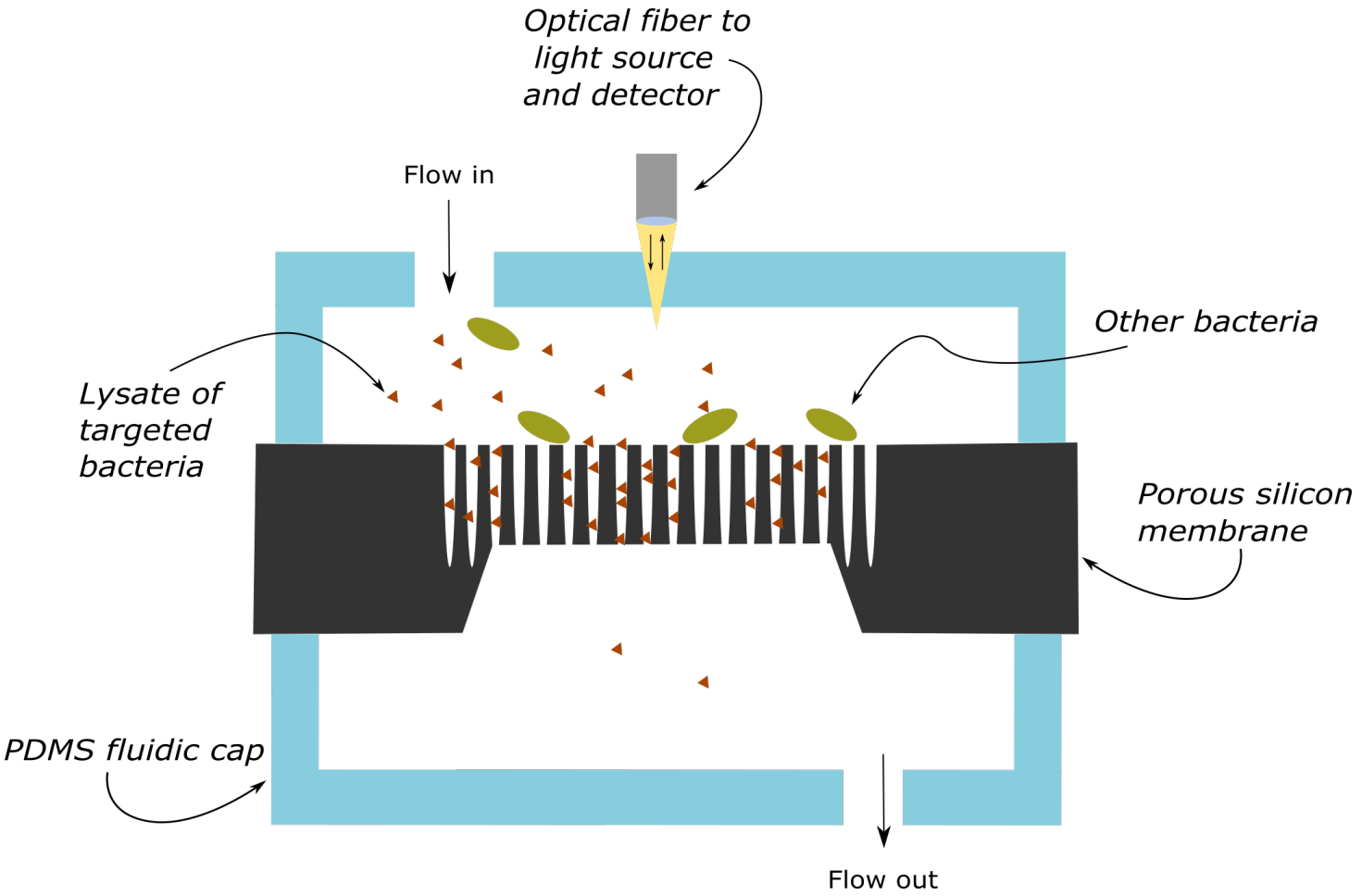
PlyB221, targeting

Bacillus cereus



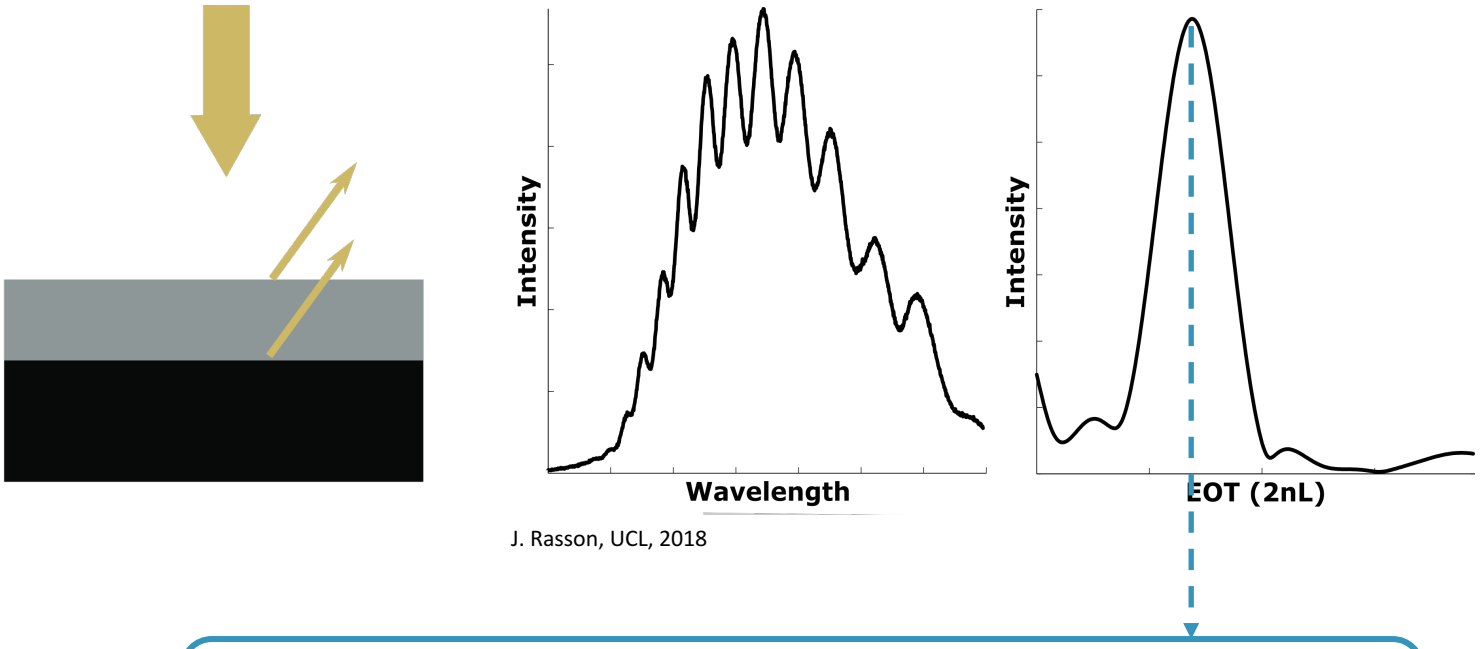
Illustrations from A. Leprince, 2019

Porous Silicon (PSi) Membrane



The Optical Detection Method

- **R**eflective **I**nterferometric **F**ourier **T**ransform **S**pectroscopy **(RIFTS)**



J. Rasson, UCL, 2018

Effective Optical Thickness (EOT) = 2nL

FABRICATION

Porous Silicon Anodization

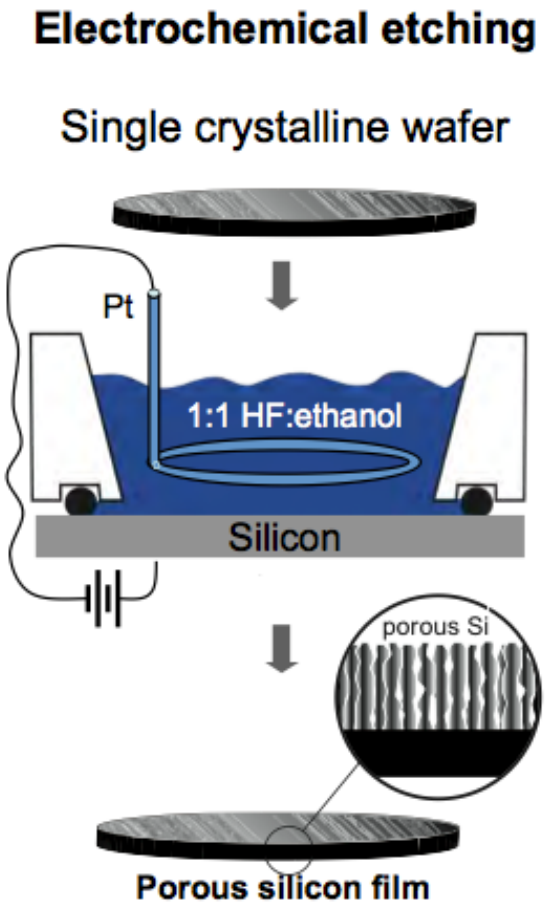
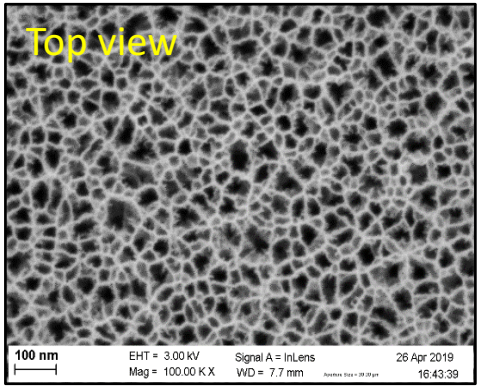


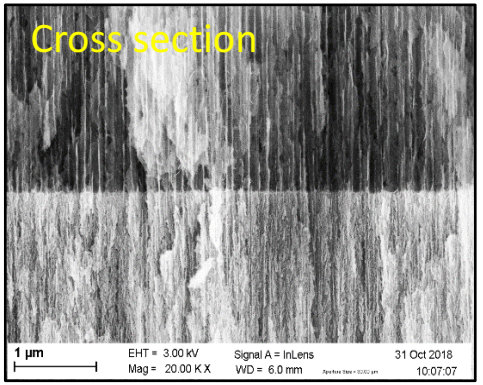
Illustration from Summer School for Nanotechnology 2019 presentation by Michael Sailor

$$Si + 2h^+ + 6HF \rightarrow SiF_6^{2-} + H_2 + 4H^+$$

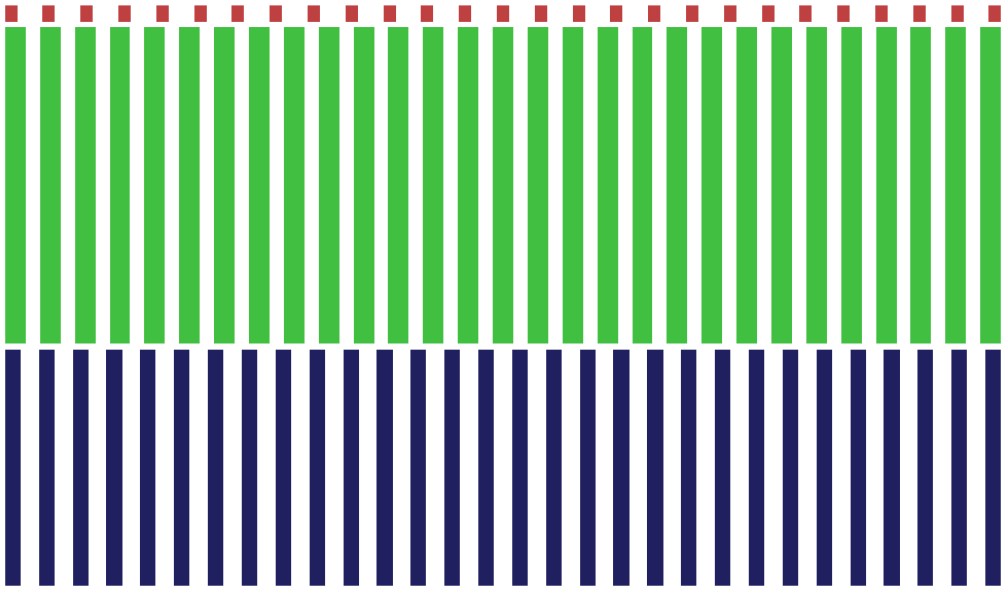
Use of an **HF**-based electrolyte

Based on **hole conduction** through the Si bulk





POROUS STRUCTURE



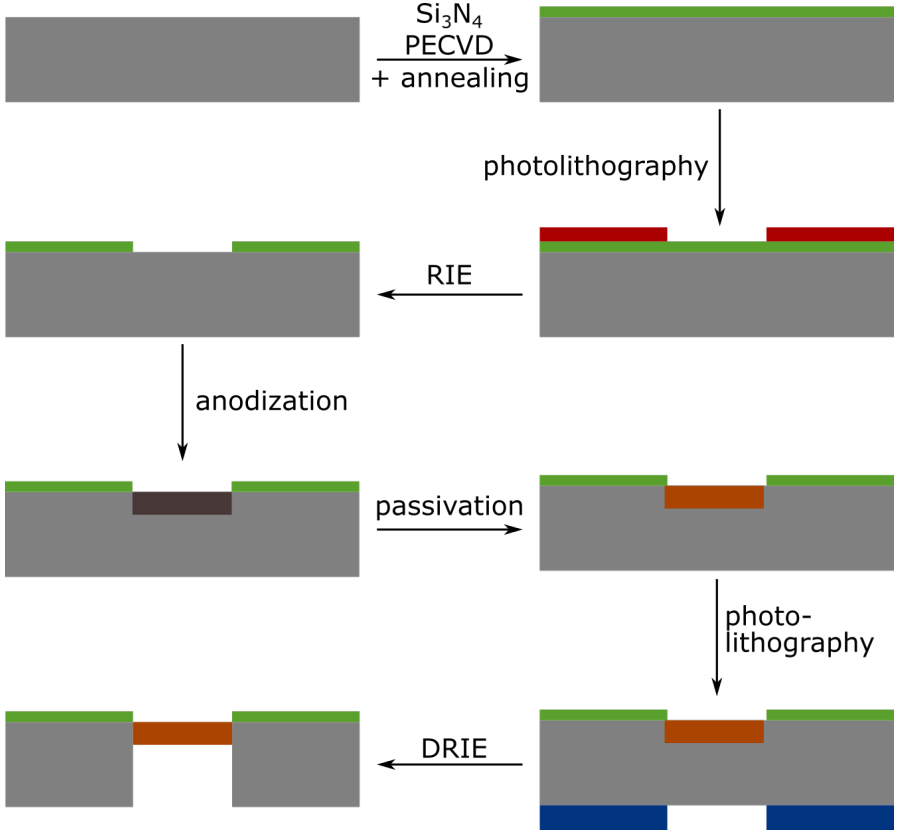
Sensing layer

Contrast layer

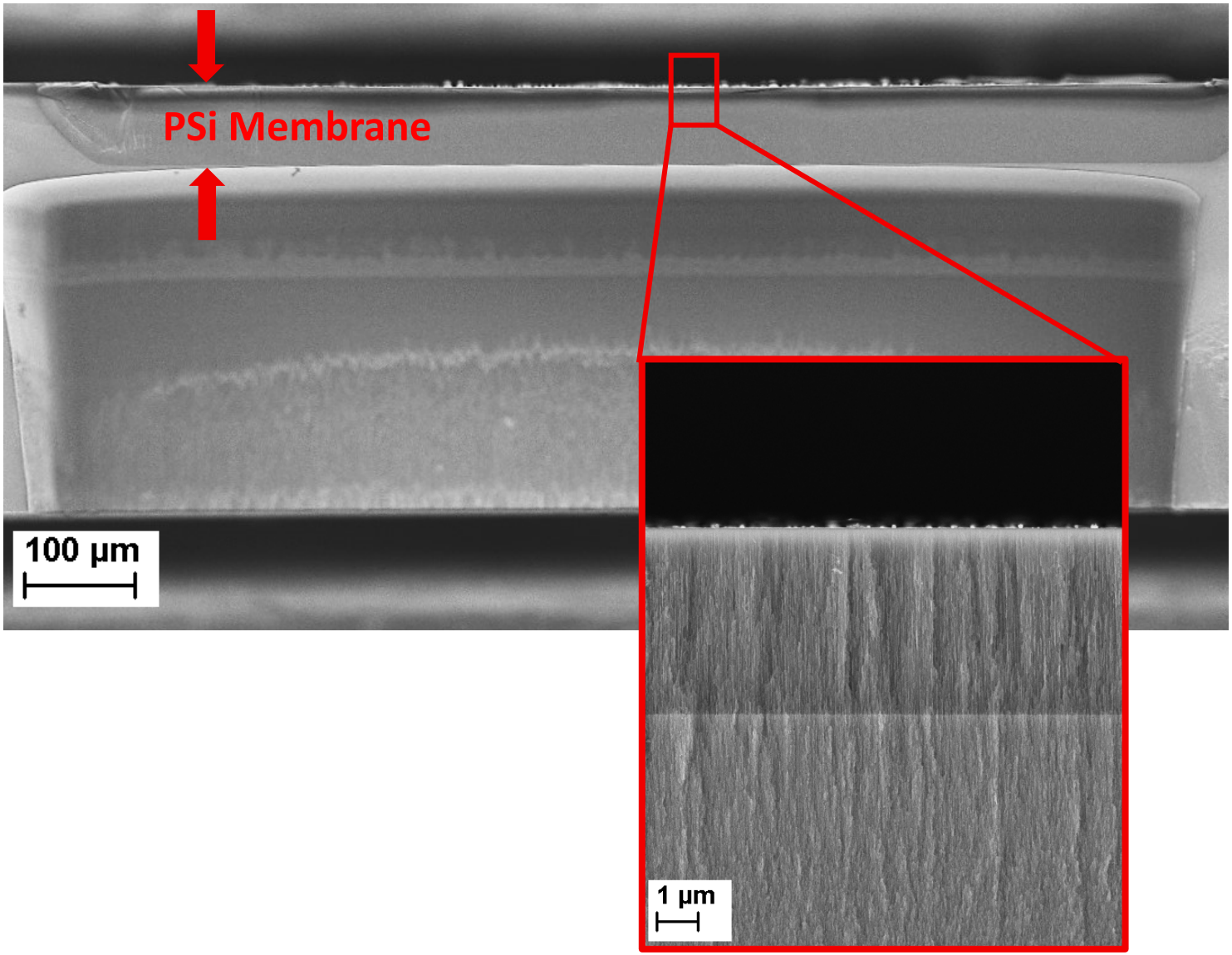
Mechanical support layer

Layer	Current density [mA/cm^2]	Time [s]	Pore diameter [nm]	Thickness [µm]	Porosity [%]
Sensing layer	200	50	41.1 ± 20.4	4.1 ± 0.7	75.4
Contrast layer	50	1500	14.6 ± 7.8	22.8 ± 6.8	48.5
Support layer	1000	2000	25.5 ± 10.4	- *	- *

Sensor Fabrication Process

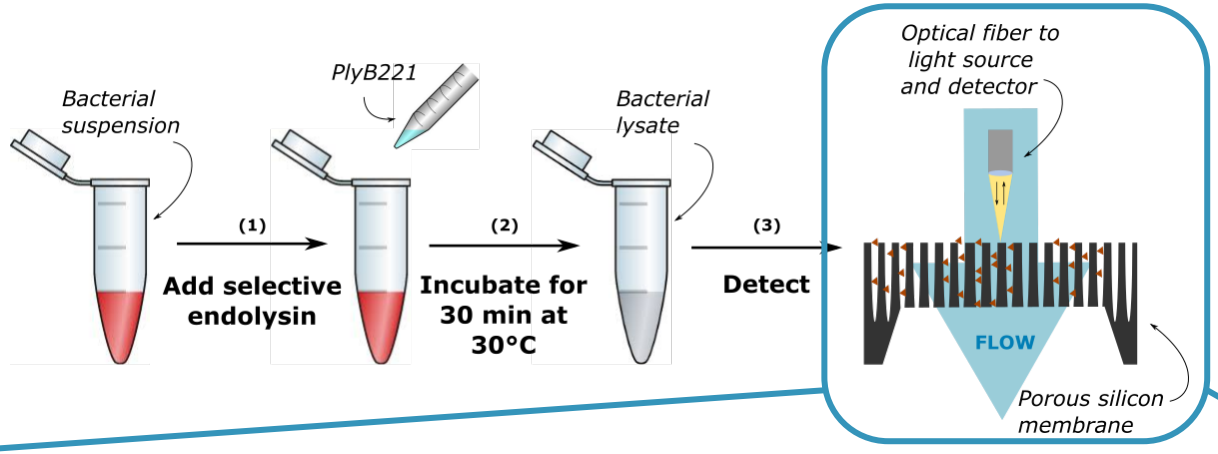


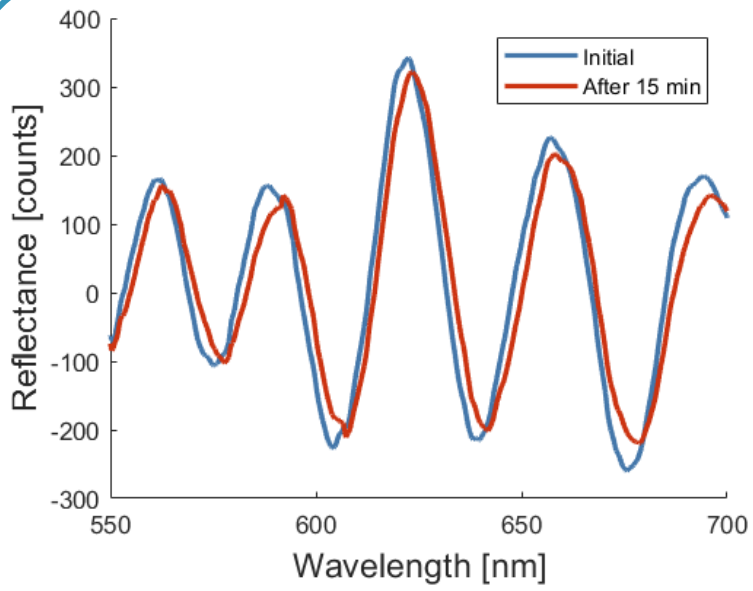
Sensor Characterization

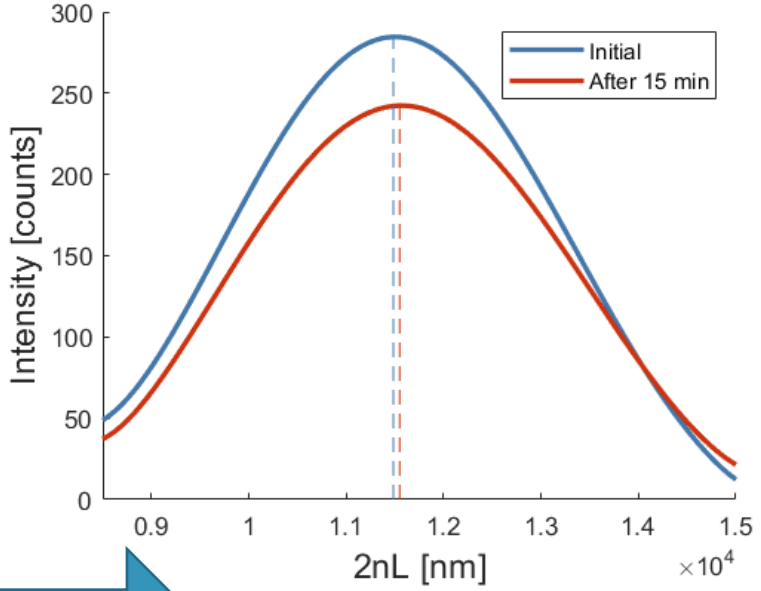


Bacteria Detection

DETECTION PROTOCOL & RIFTS



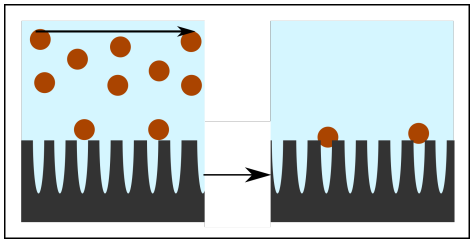




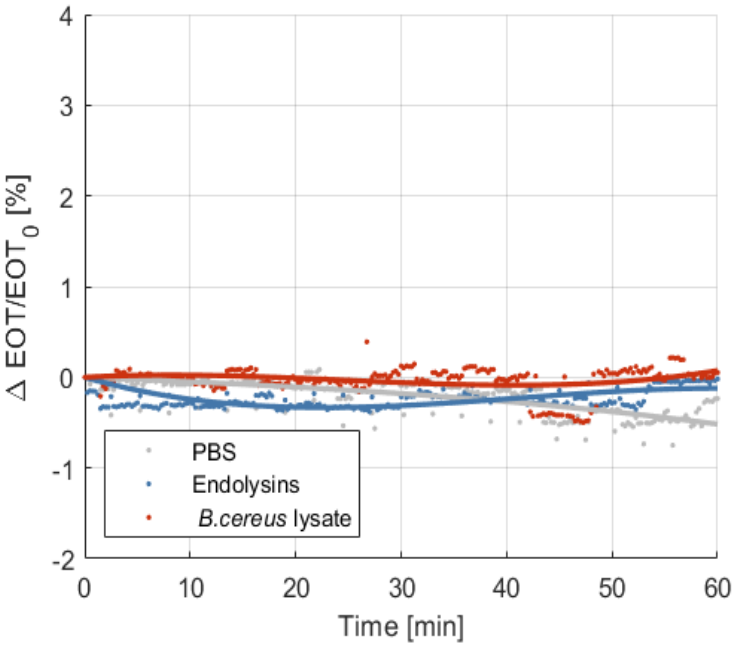
Fourier transform

ARE PSI MEMBRANES BETTER THAN PSI LAYERS?

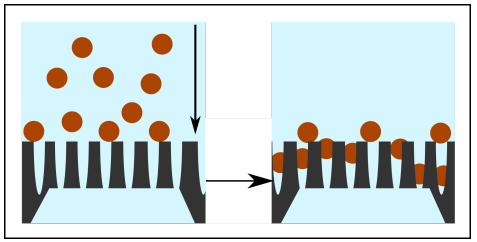
PSi layer: current studies on biosensing



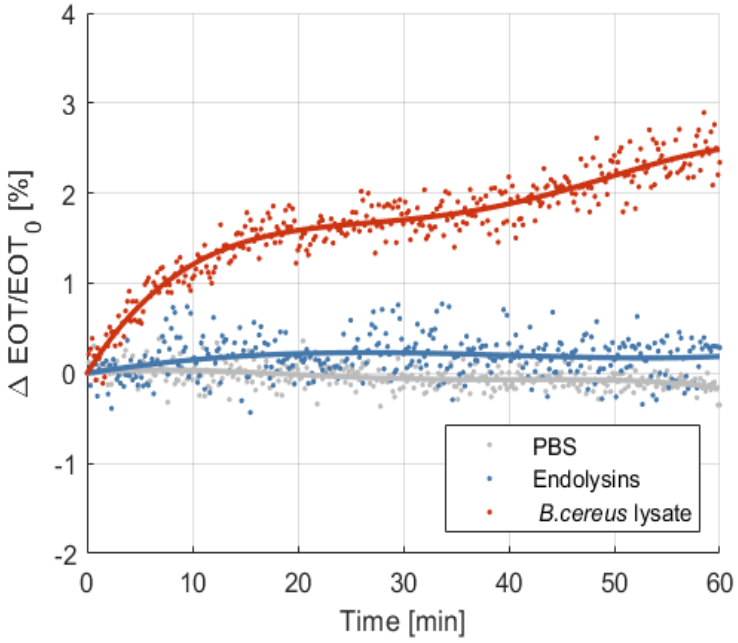
FLOW OVER



PSi membranes: emerging biosensor

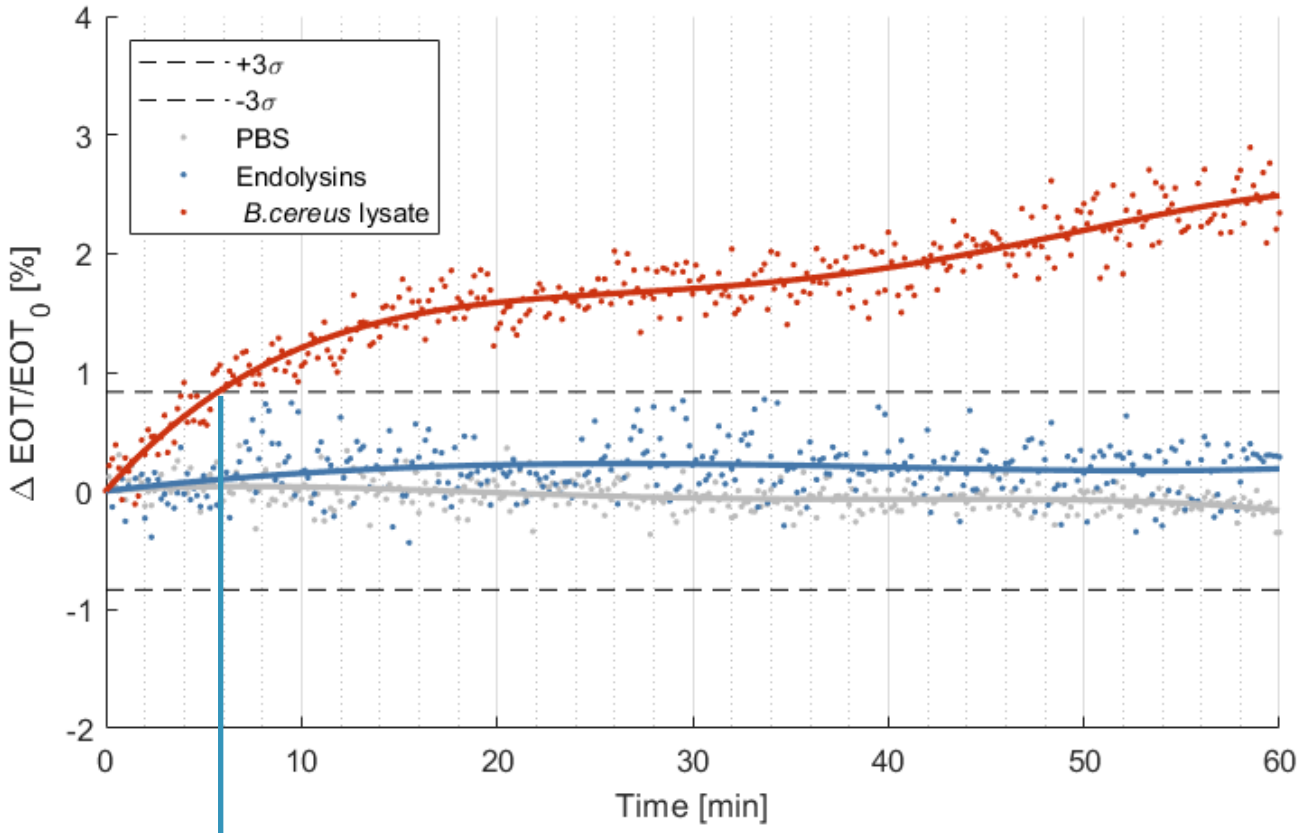


FLOW THROUGH



Targeted bacteria= 10^6 CFU/ml of *B. cereus*, lysed by PlyB221

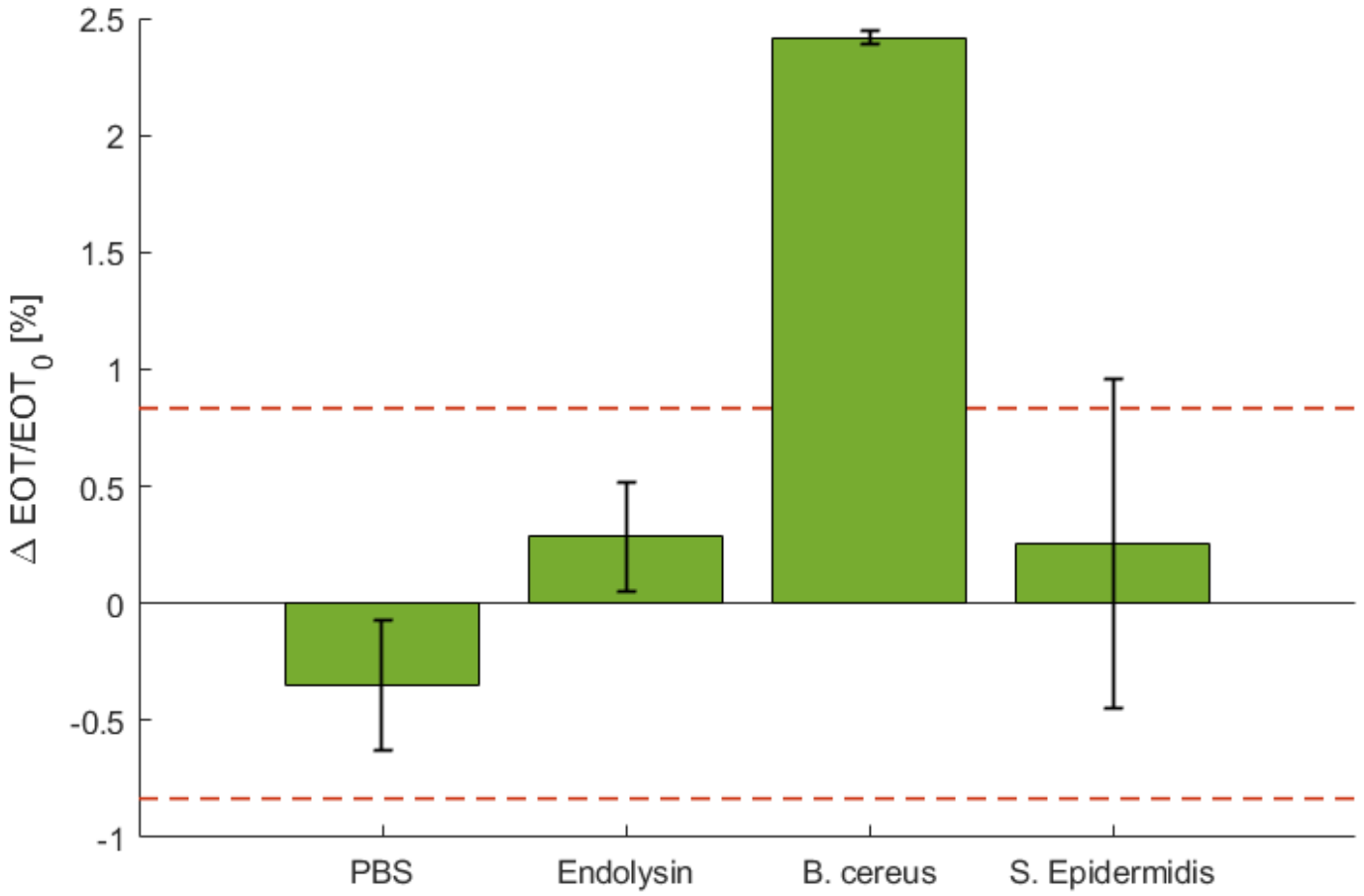
How Quickly Can We Detect Bacteria ?



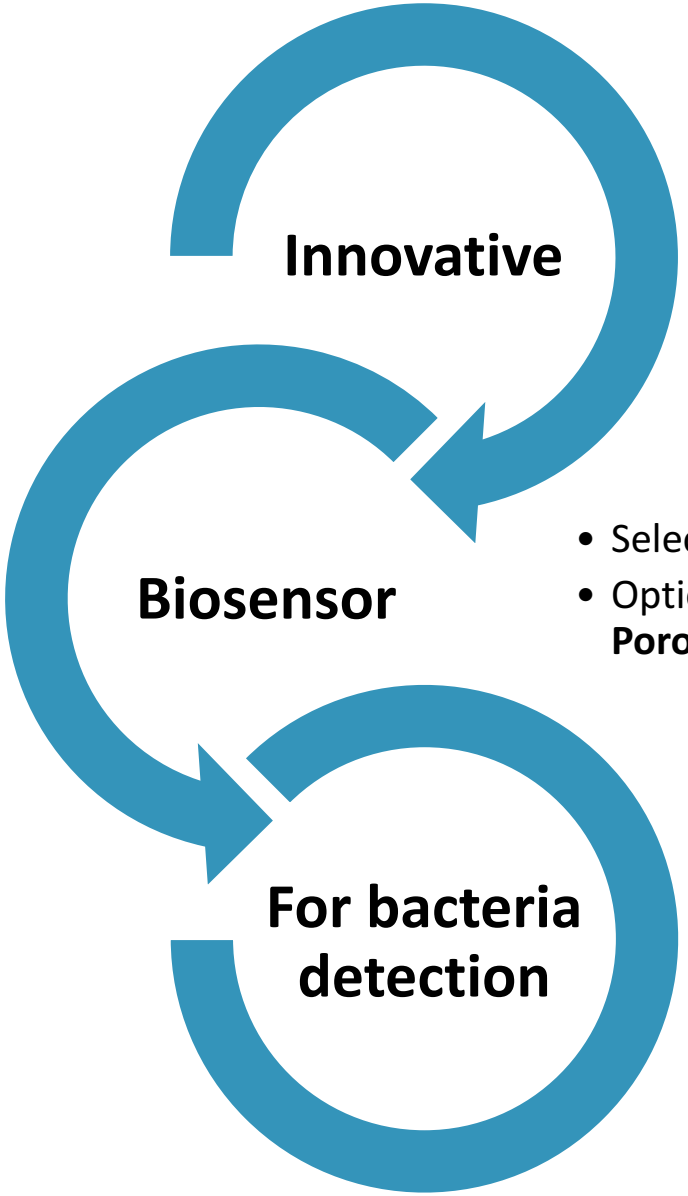
Significant increase after 6 min !

Targeted bacteria= 10^6 CFU/ml of B. cereus, lysed by PlyB221

Is This Biosensor Selective ?



Conclusion



- Easy fabrication and **low cost** of production
- Possiblity for **multi-strain** bacteria sensor

- Selective **endolysins**
- Optically monitored **Porous Silicon** membranes

- Detection of **10^6 CFU/ml** *B. cereus* lysate **in less than 10 min**
- **Selective** with respect *to S. epidermidis*

THANK YOU !

Questions ?

Email me at roselien.vercauteren@uclouvain.be !