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## Toward hybrid polymer-porous silicon waveguides for Vernier-effect optical biosensors

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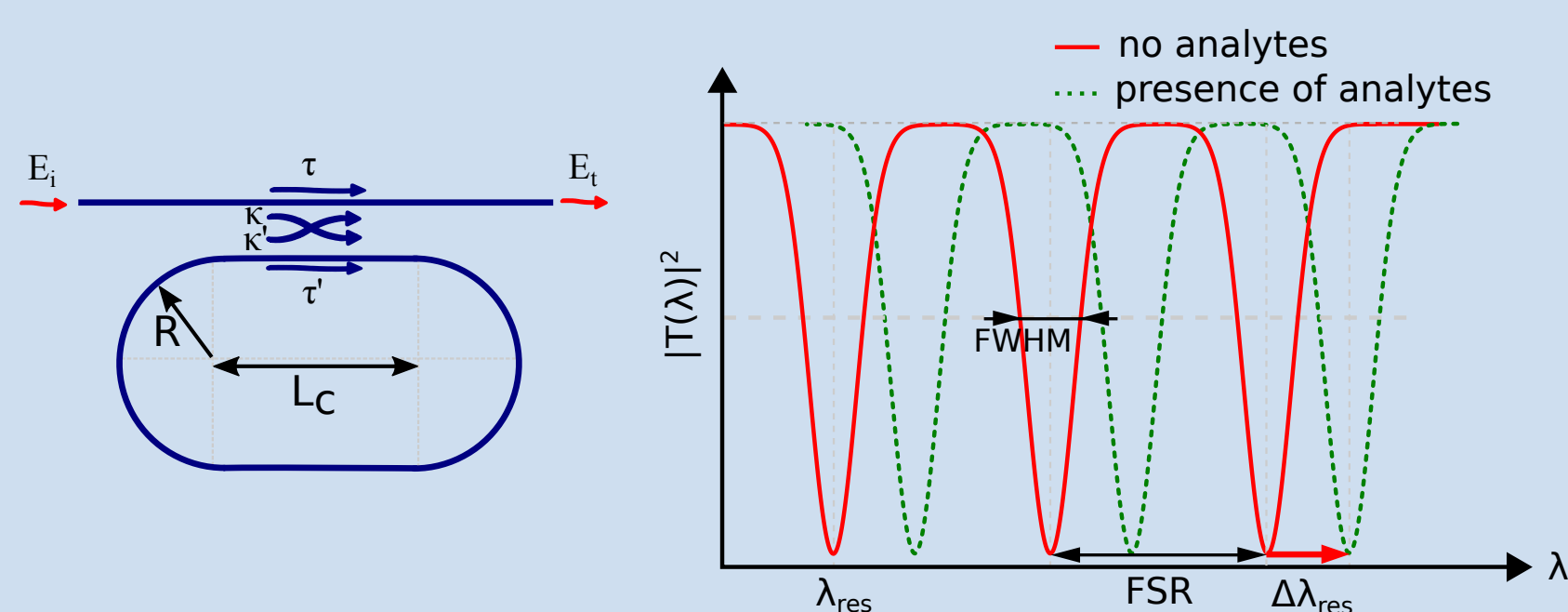
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# Toward hybrid Polymer-Porous silicon waveguides for Vernier effect optical biosensors

## Introduction on integrated MR

### • Microresonator sensing

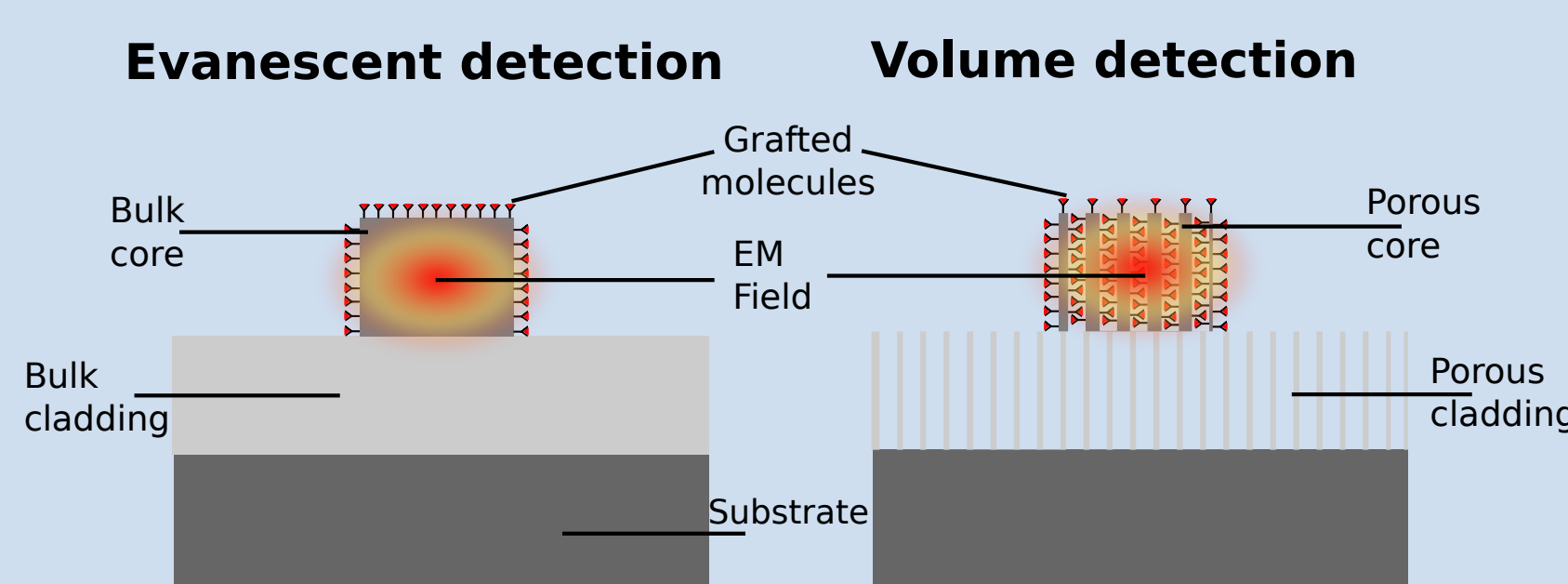


Sensor performance evaluation with **Sensitivity** and **Limit of Detection** :

$$S = \frac{\Delta\lambda_{res}}{\Delta C_{analytes}} \quad LOD = \frac{Noises}{S}$$

Main economic field : Health, Research, Industrie, Biodefense, Environnemental

### • PSi for surface sensing



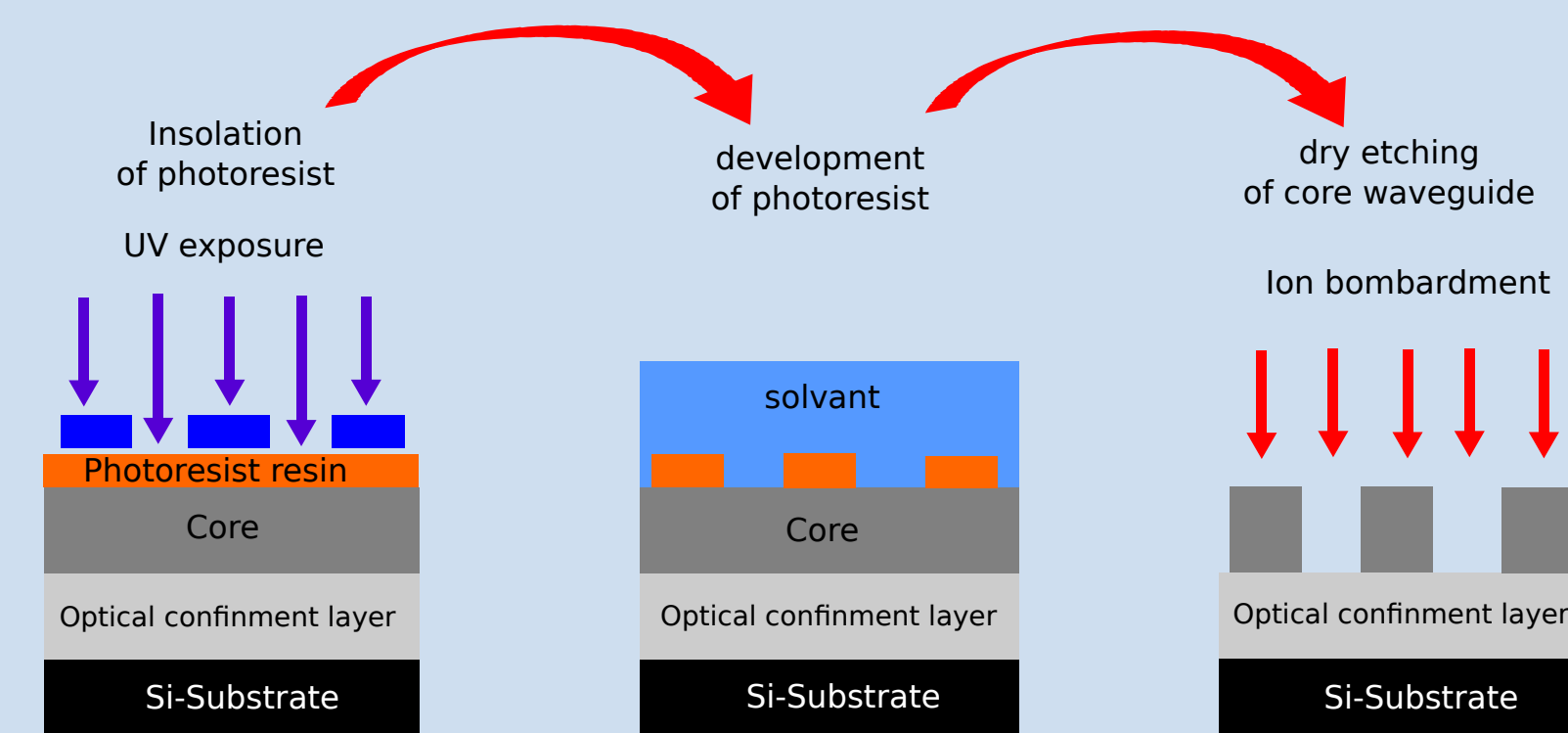
**PSi advantage** : High sensing sensitivity  
**Bulk material advantage** : Low propagation losses

## Porous silicon MR fabrication

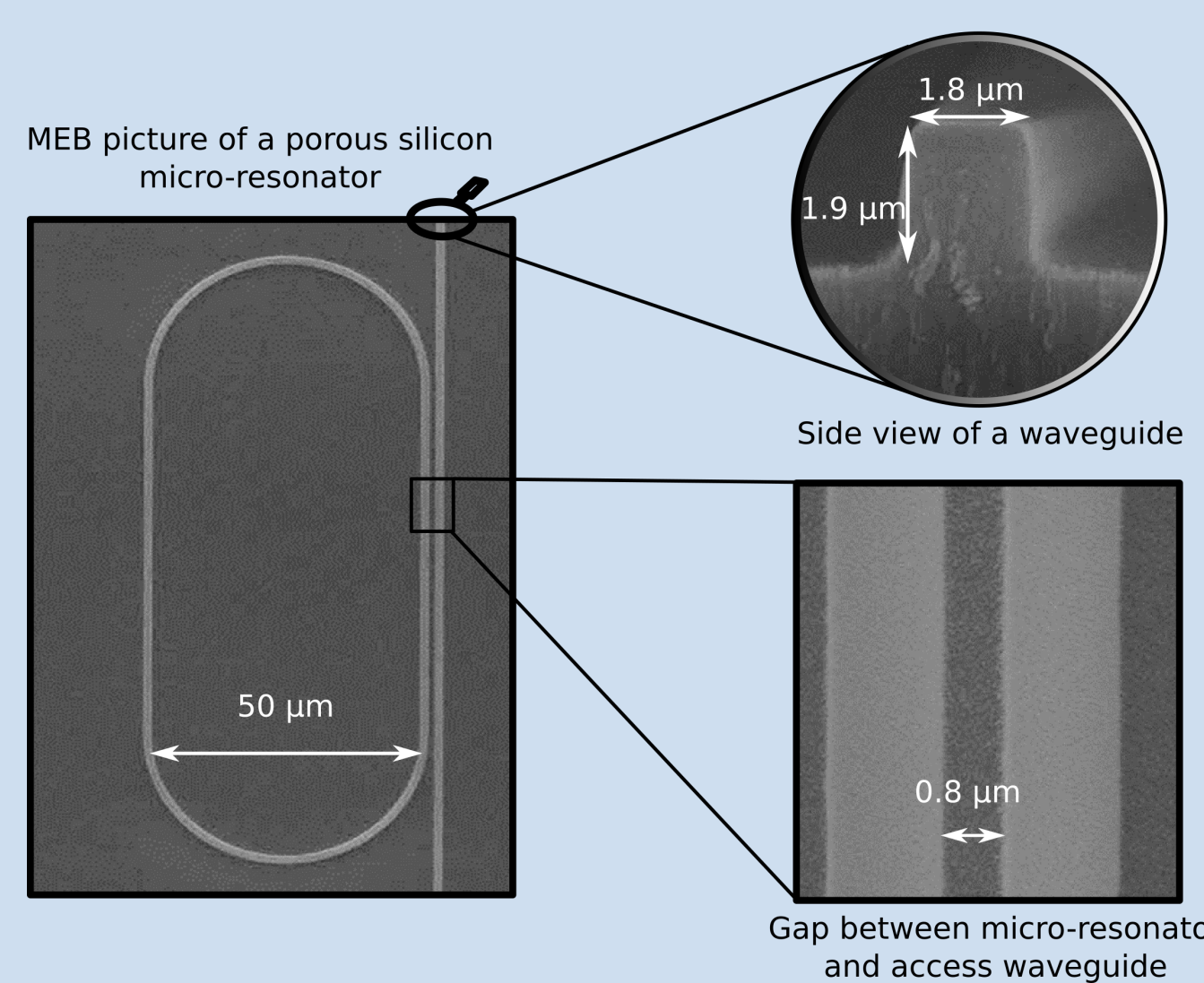
### • Thermal treatment of PSi

Partial oxidation remove native hydrophobicity, improve PSi layers stability in time and tune RI

### • Photolithography and etching



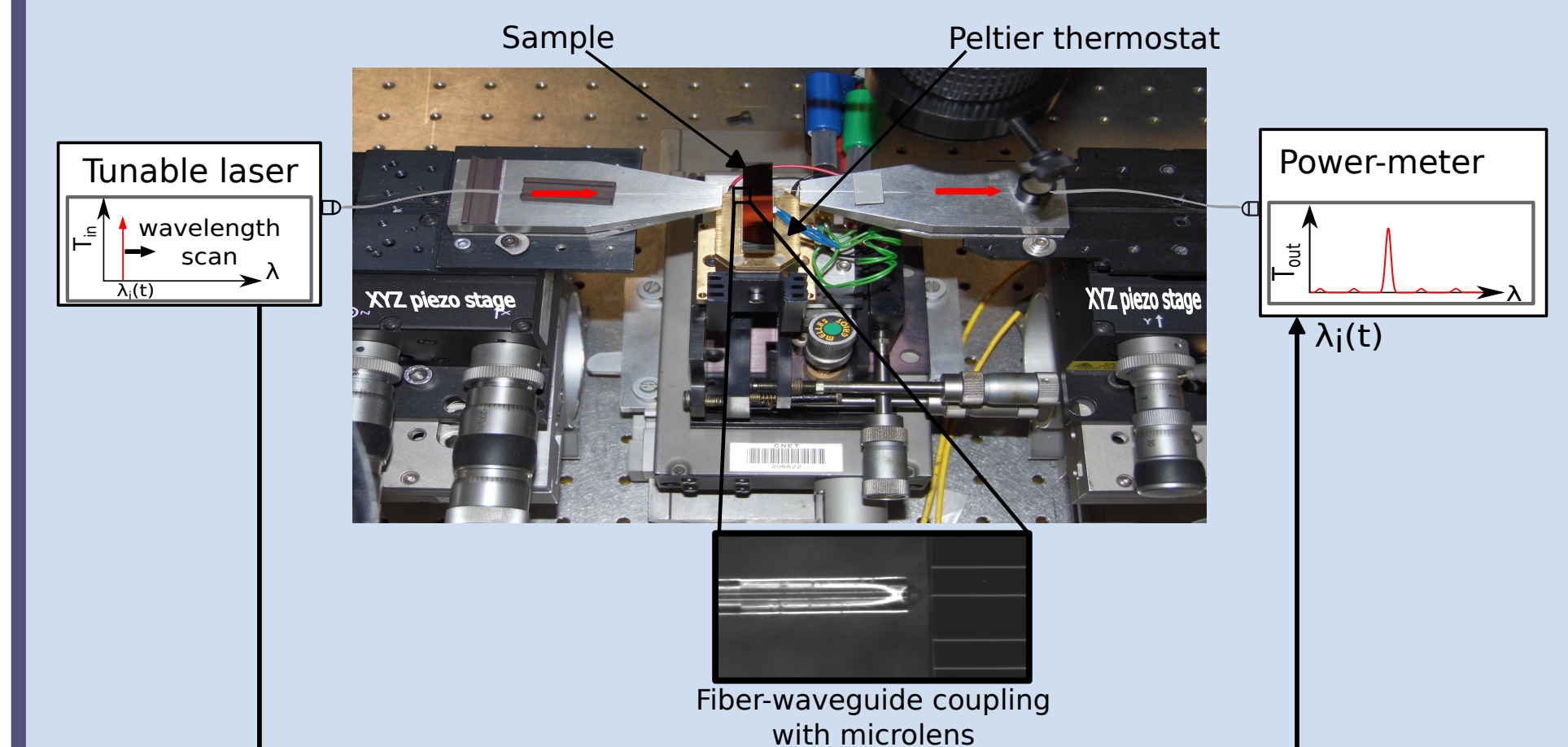
### • PSi MR sensor



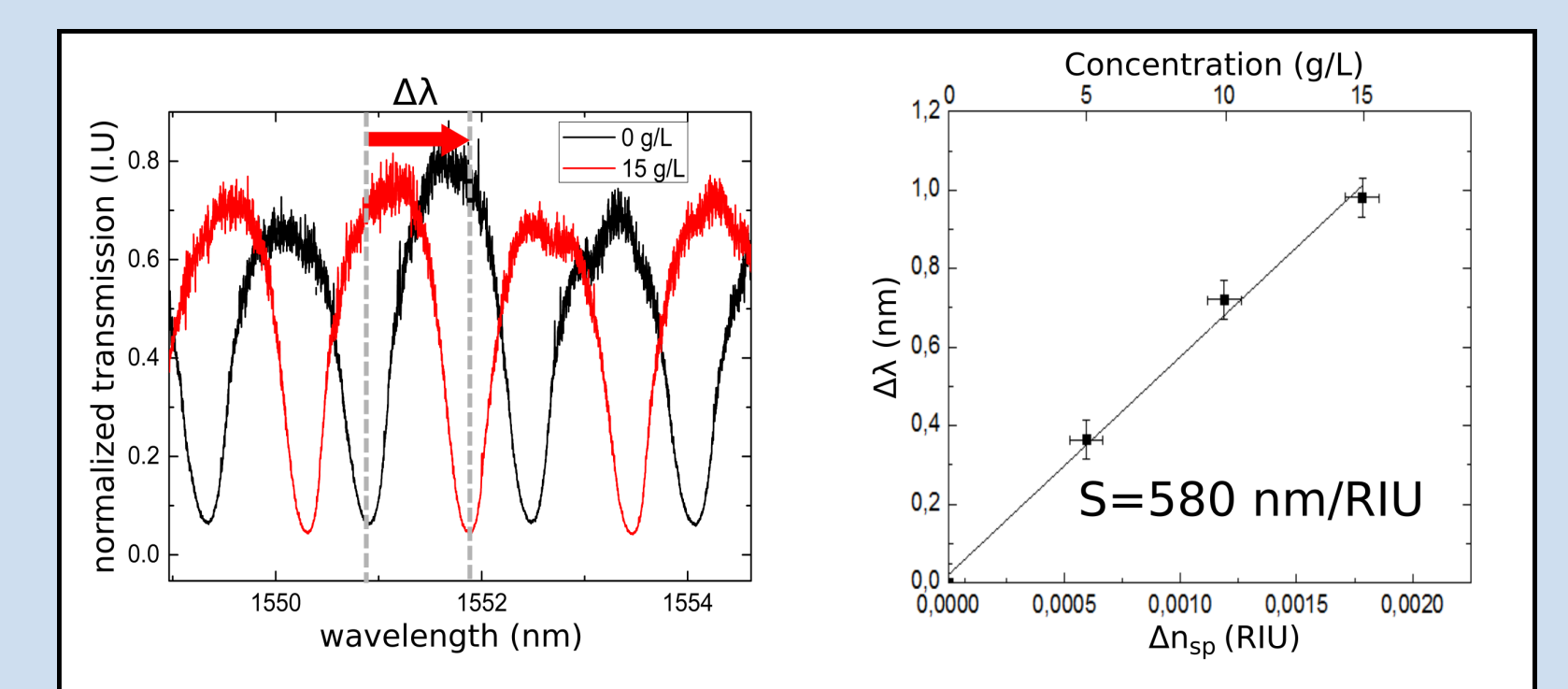
P+ Boron doped Si ( $5m\Omega.cm^{-1}$ ) ; Current density applied : (Core/Cladding) (50/80) mA.cm<sup>-2</sup> ; HF sol. prop. HF(50%)/ethanol/water : 2:2:1.

## Sensor characterisation

### • Experimental setup

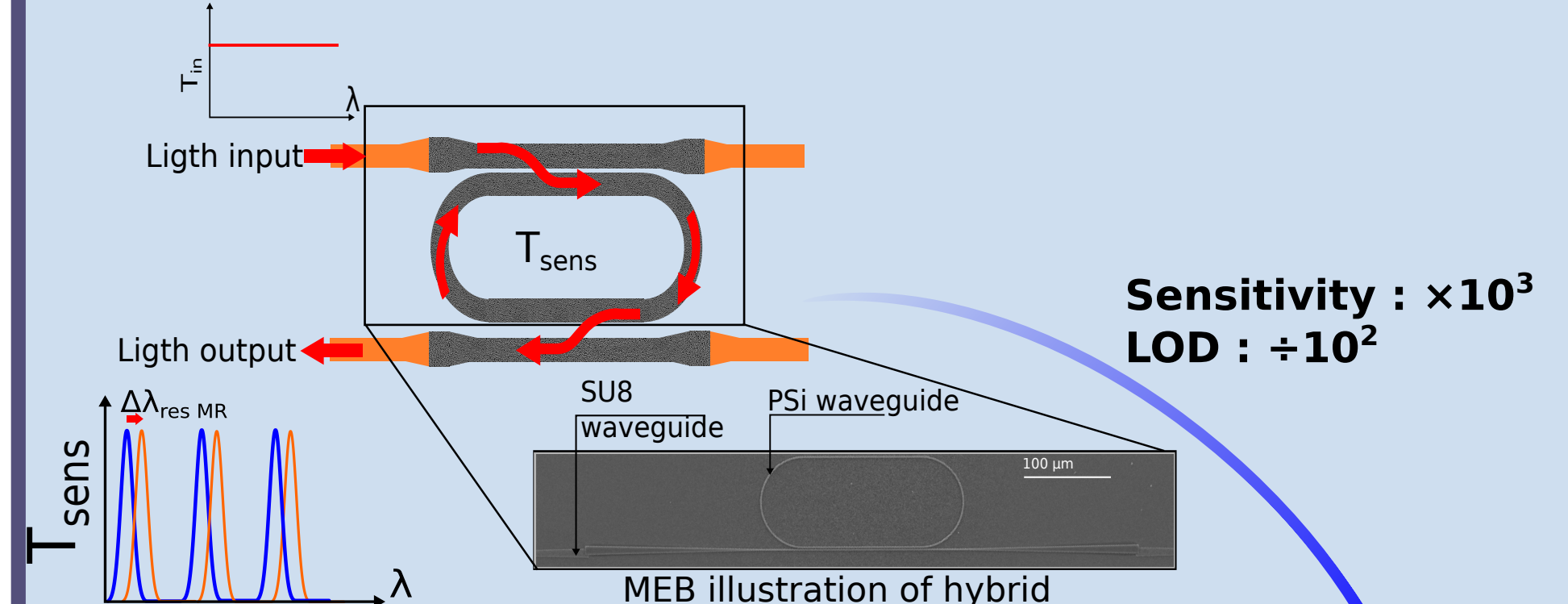


### • PSi MR homogeneous sensitivity characterisation

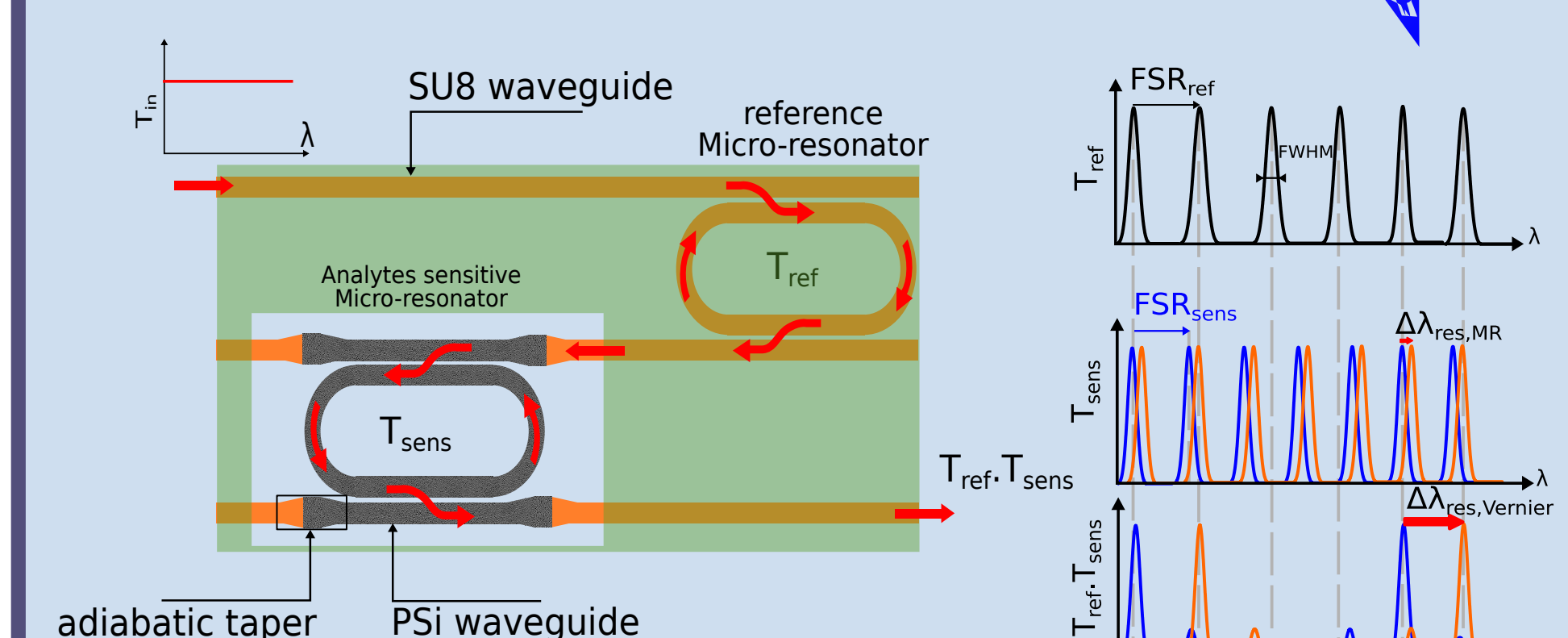


## Toward hybrid Vernier effect

### One micro-resonator



### Vernier effect : Cascaded micro-resonators

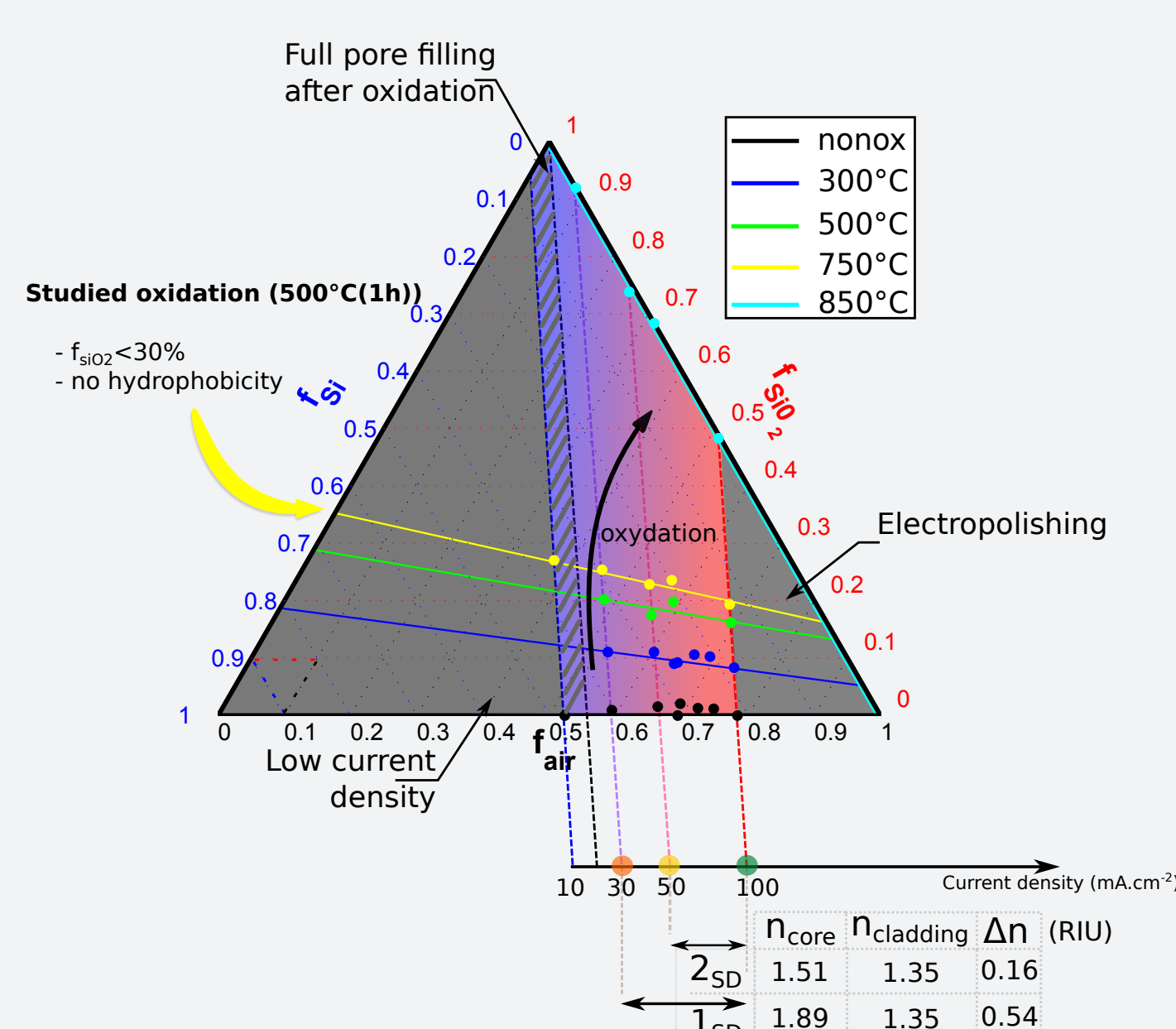


Vernier effect can improve sensor performances with a reference interferometer

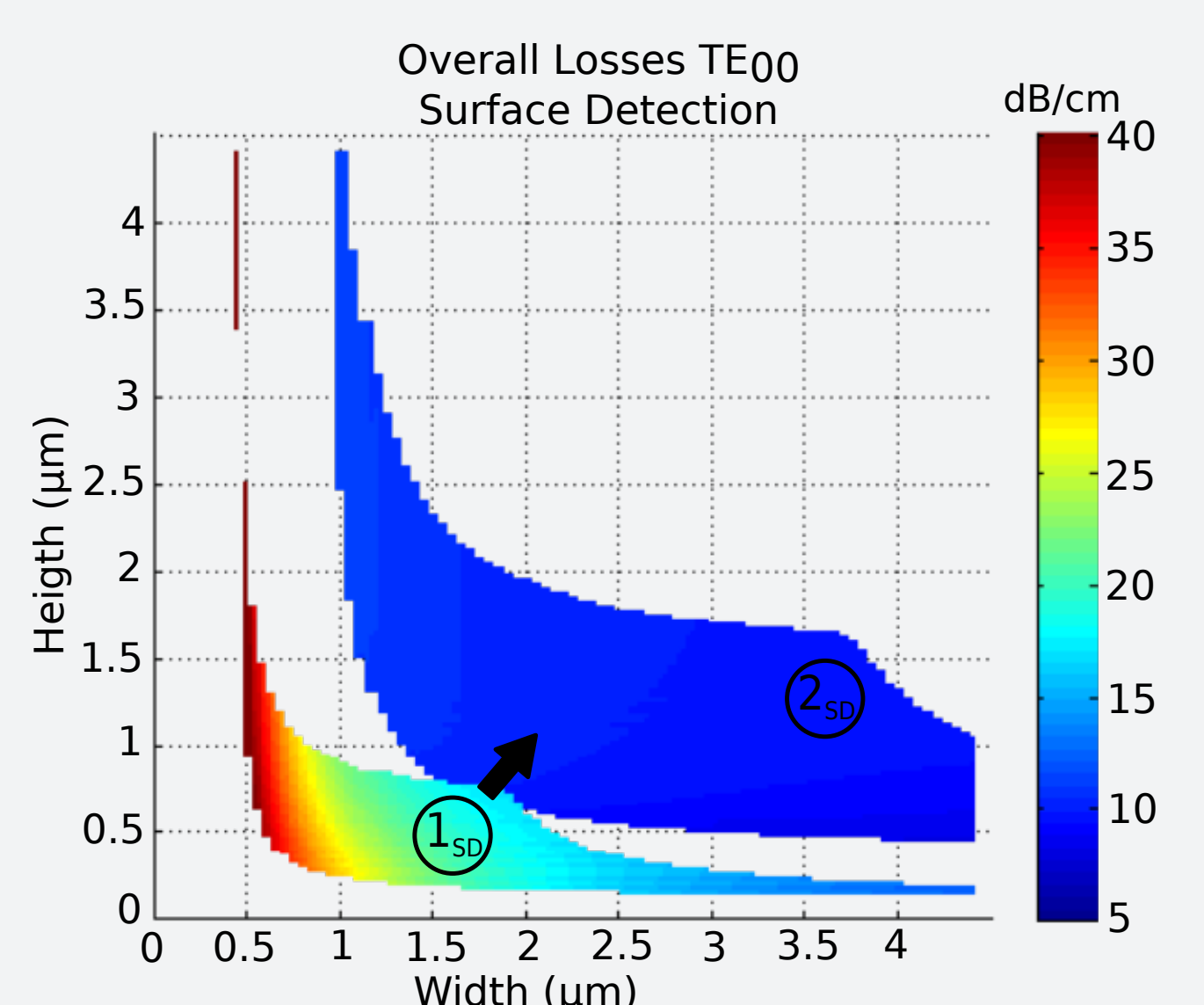
## Optimization of ridge PSi waveguides dimensions

### Losses evaluation in PSi waveguides

#### • Choice of PSi porosity and oxidation rate

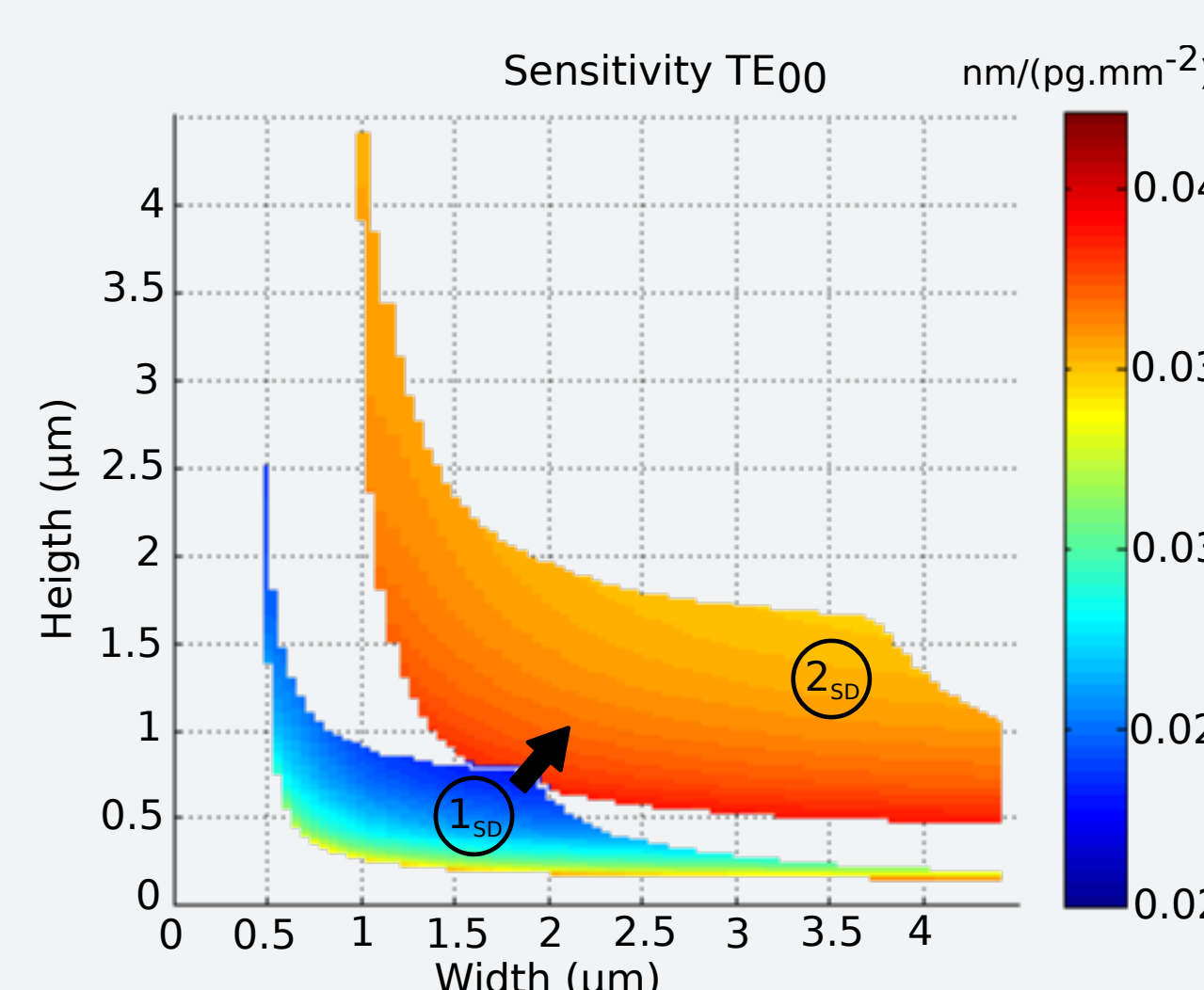


#### • Determination of losses with waveguide dimensions

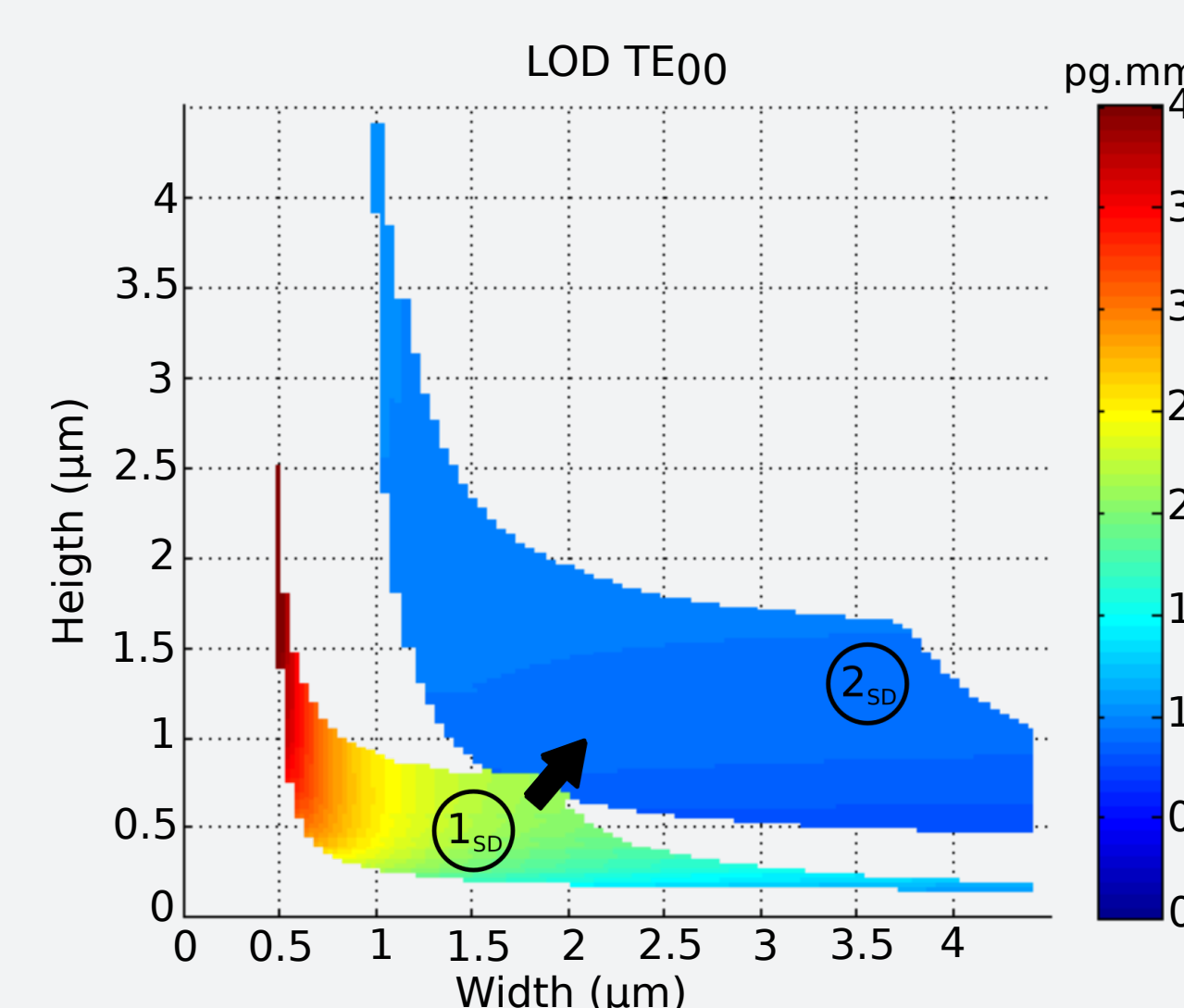


### Sensitivity and Limit of detection

#### • Sensitivity of PSi MR



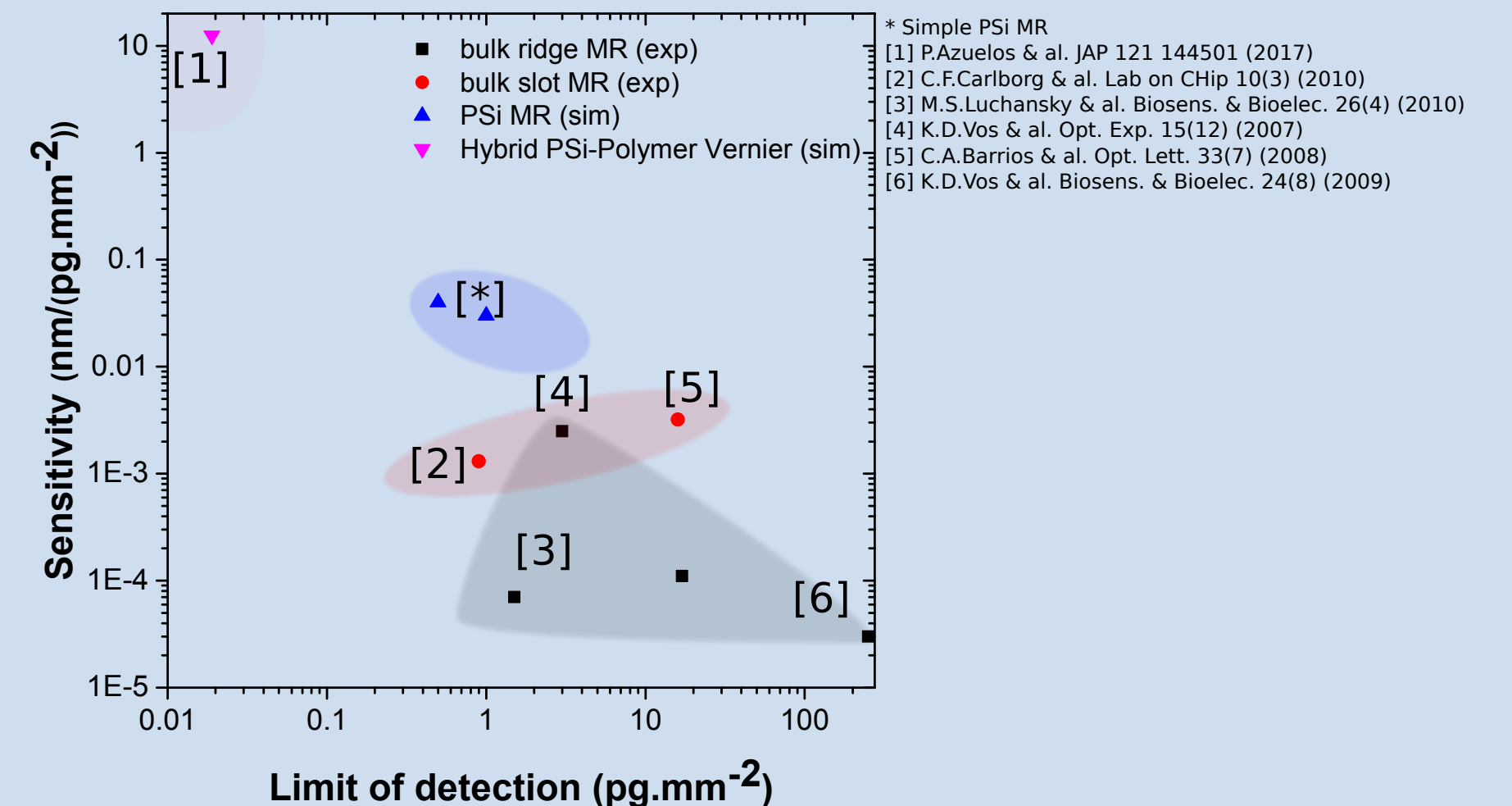
#### • Limit of detection



Optimized performances :  
 $S=0.04 \text{ nm}/(\text{pg}.mm^{-2})$   
 $LOD=0.5 \text{ pg}.mm^{-2}$

## Conclusion and Perspective

### • MR integrated sensor sensitivity and LOD



### • Perspectives

- Hybrid PSi-polymer fabrication process optimization
- Microfluidics
- Experimental functionalization