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

Paul Azuelos, Nathalie Lorrain, M. Guendouz, Parastesh Pirasteh, Jonathan Lemaitre, Isabelle Hardy, Joël Charrier, Monique Thual

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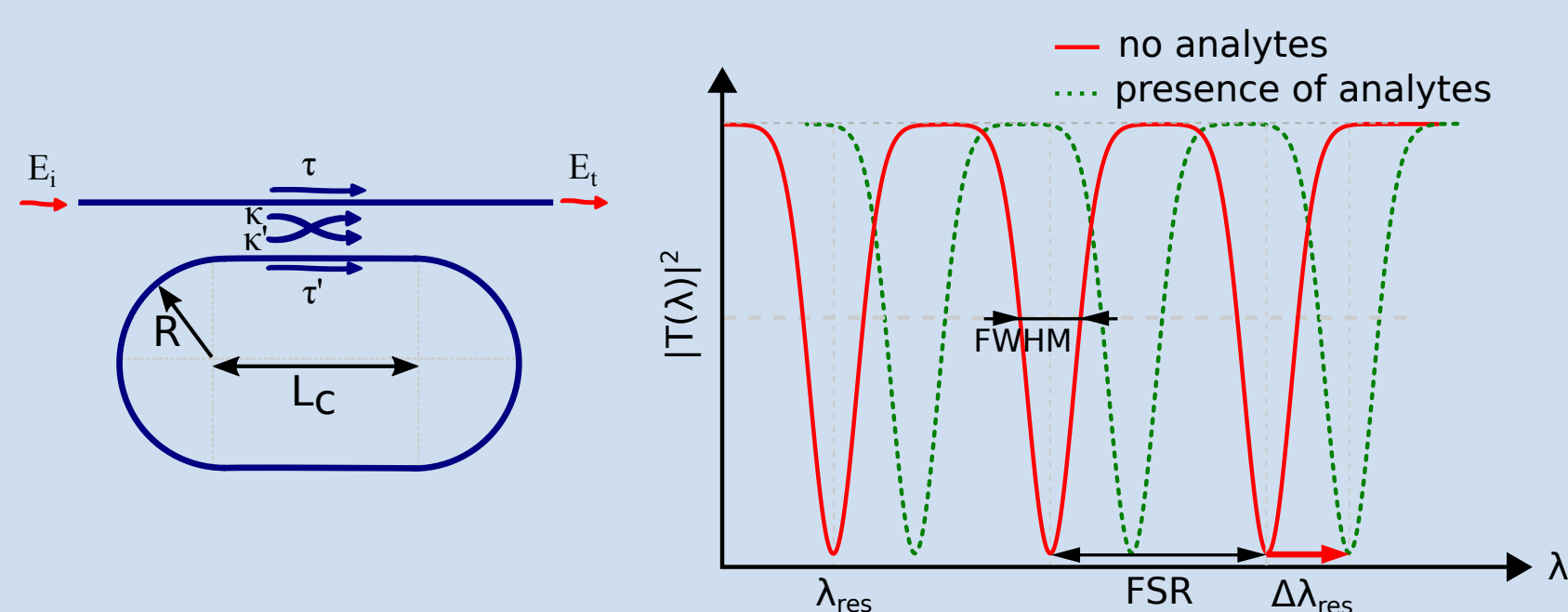
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Toward hybrid Polymer-Porous silicon waveguides for Vernier effect optical biosensors

Introduction on integrated MR

• Microresonator sensing

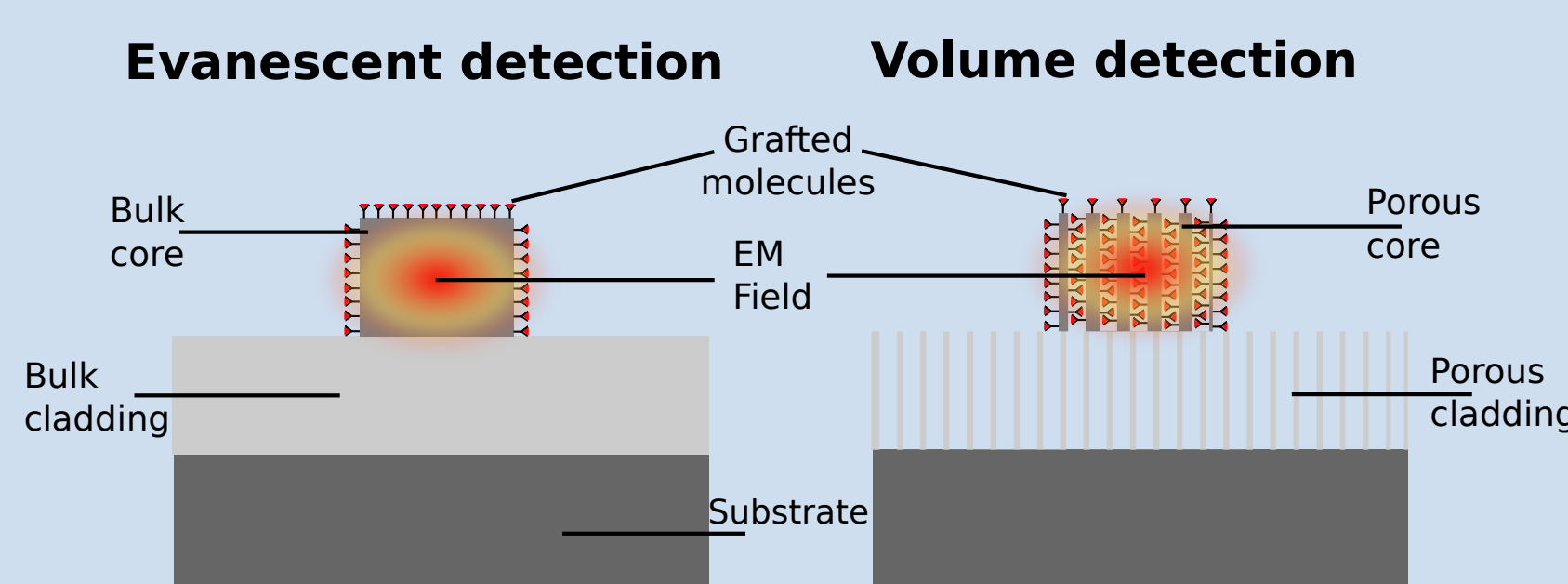


Sensor performance evaluation with **Sensitivity** and **Limit of Detection** :

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

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

• PSi for surface sensing



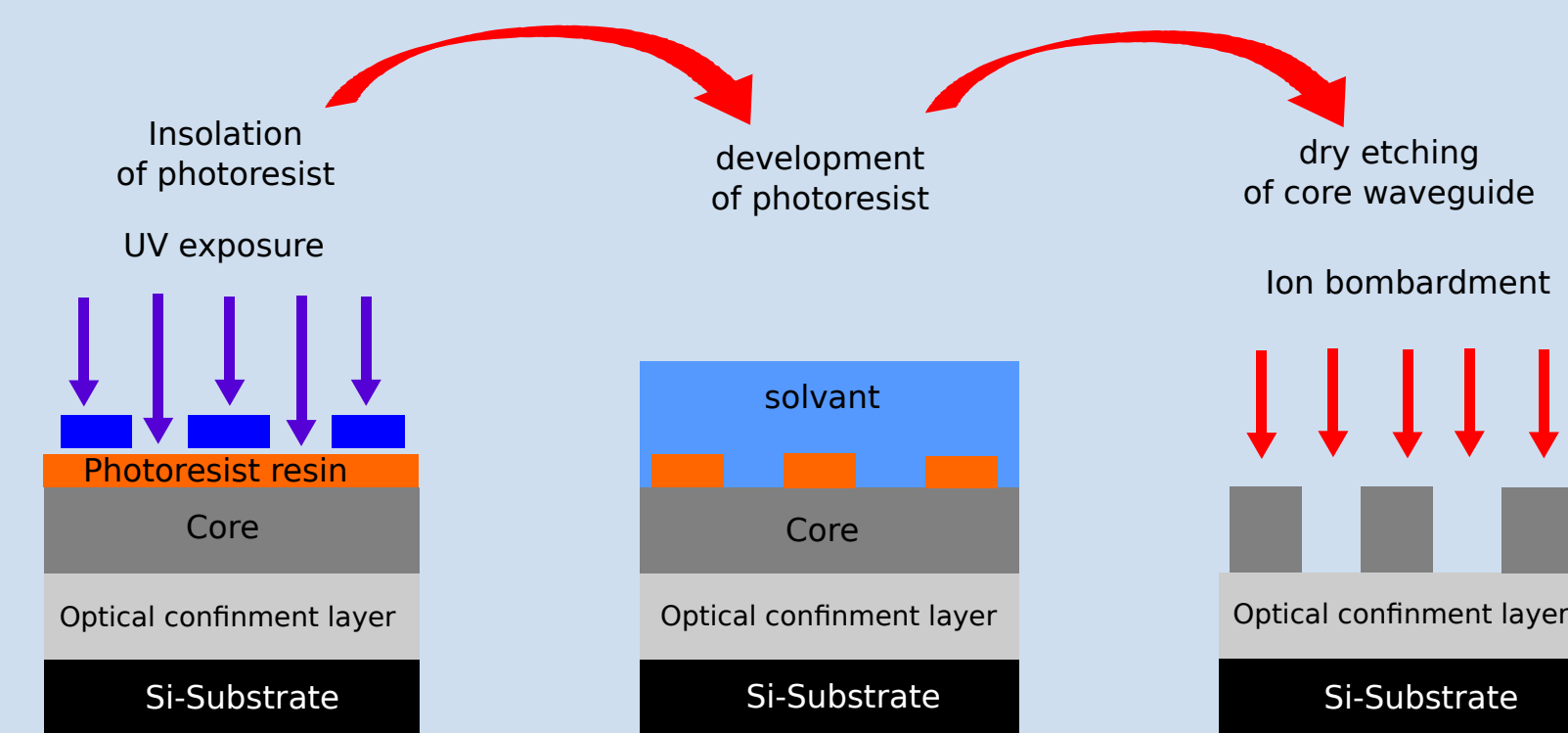
PSi advantage : High sensing sensitivity
Bulk material advantage : Low propagation losses

Porous silicon MR fabrication

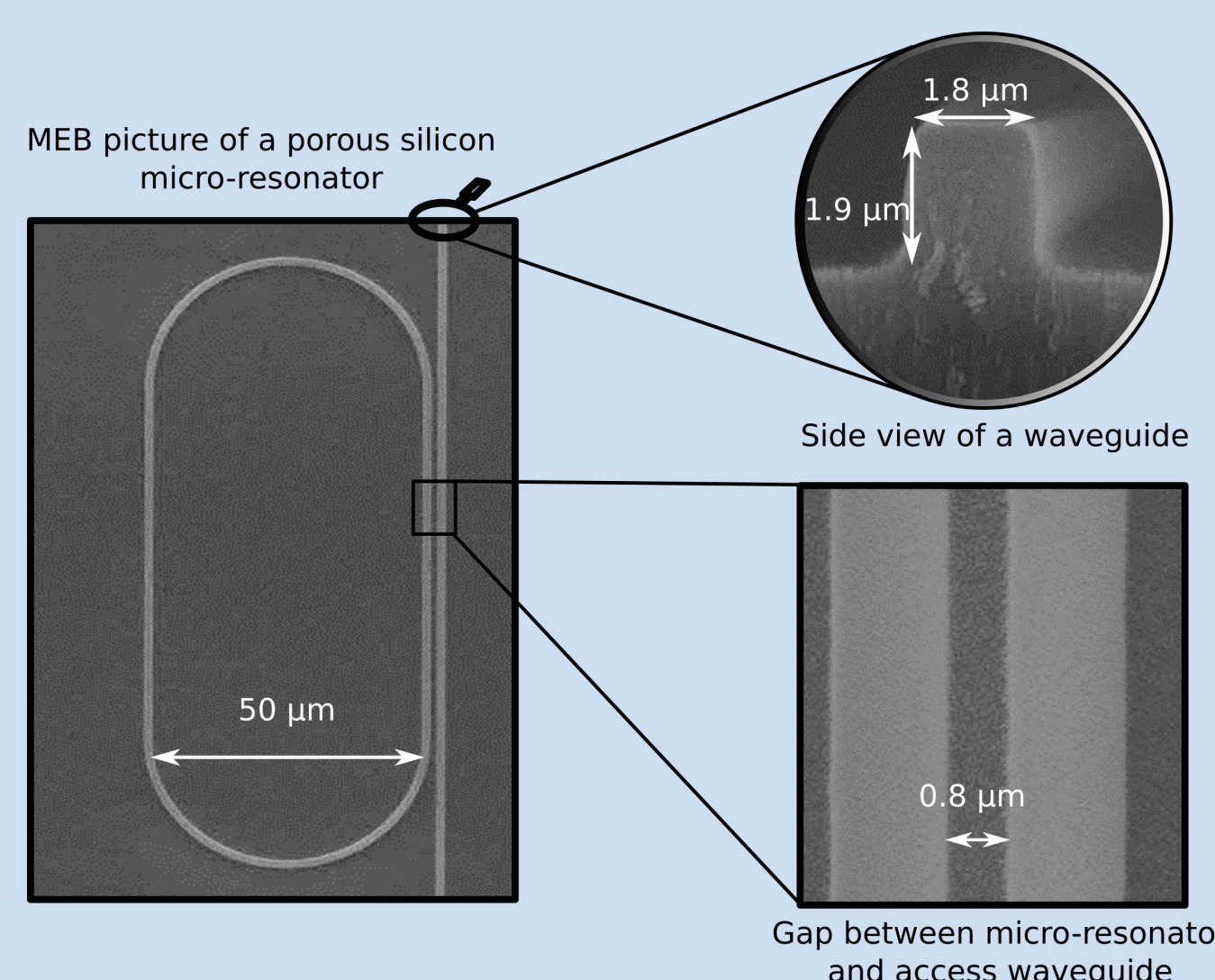
• Thermal treatment of PSi

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

• Photolithography and etching



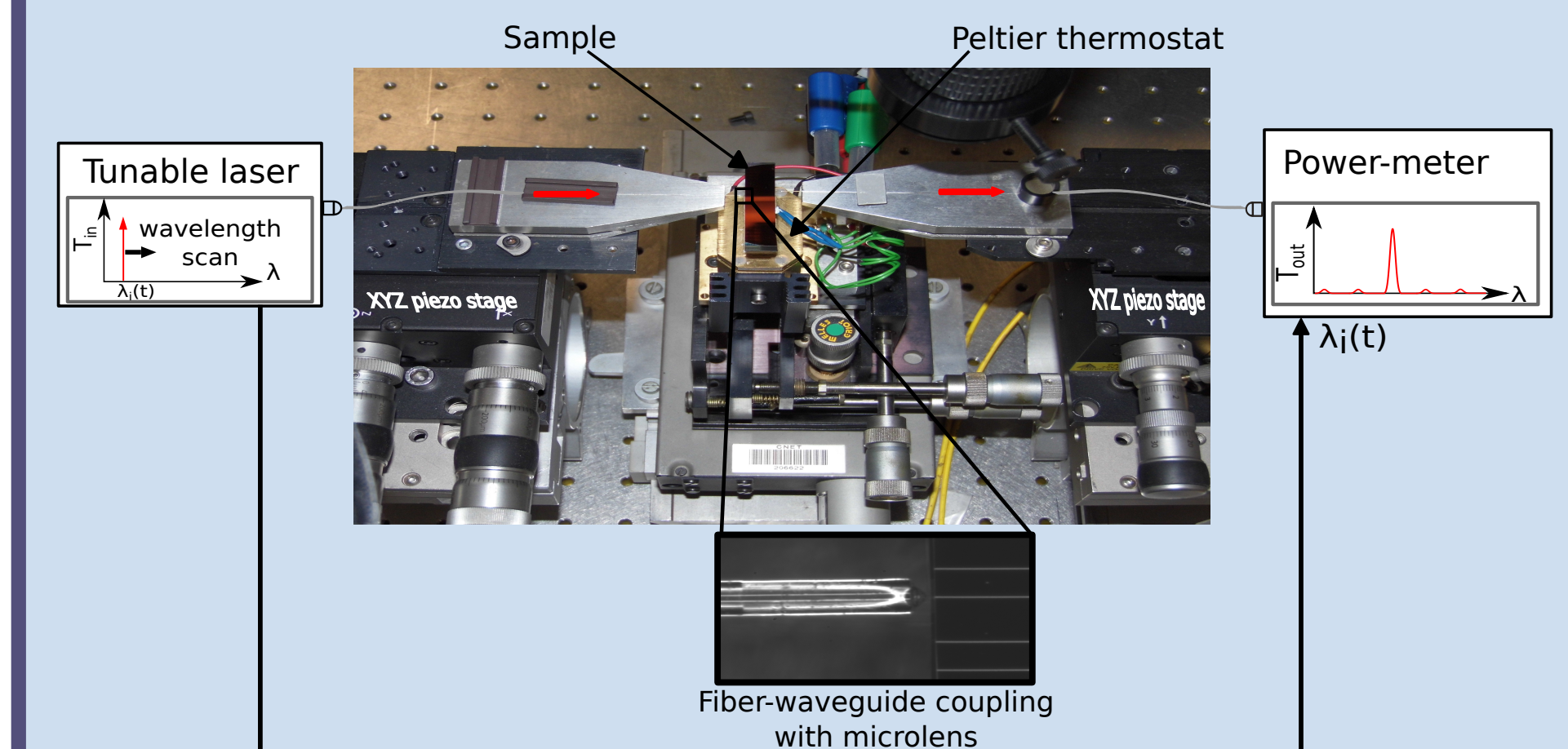
• PSi MR sensor



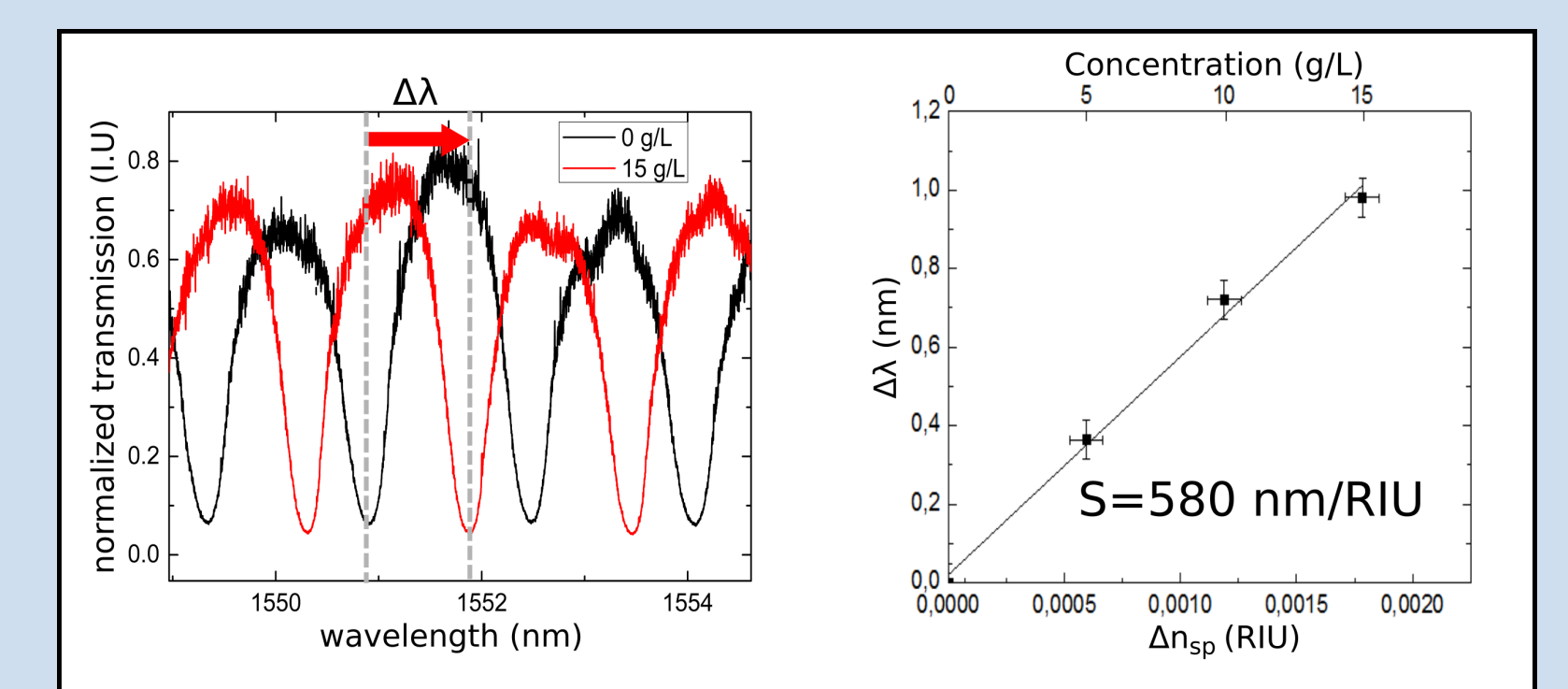
P+ Boron doped Si ($5m\Omega.cm^{-1}$) ; Current density applied : (Core/Cladding) ($50/80$) $mA.cm^{-2}$; HF sol. prop. HF(50%)/ethanol/water : 2:2:1.

Sensor characterisation

• Experimental setup

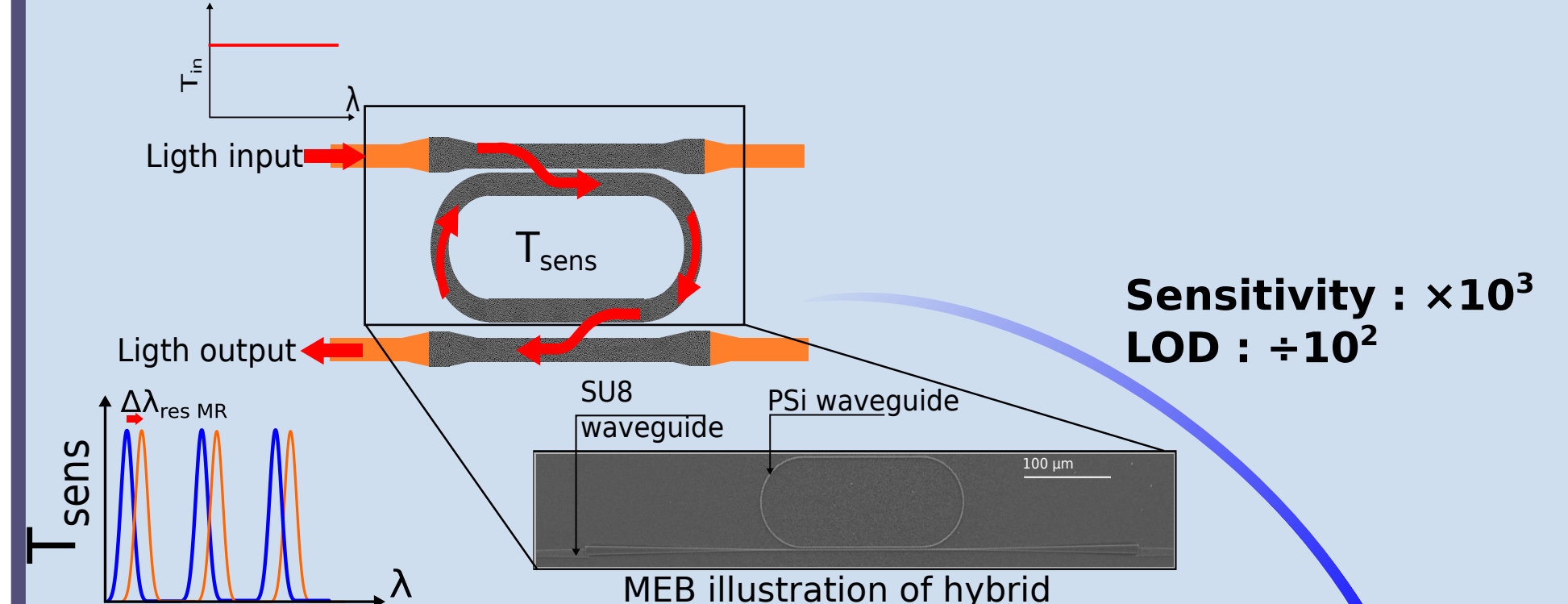


• PSi MR homogeneous sensitivity characterisation

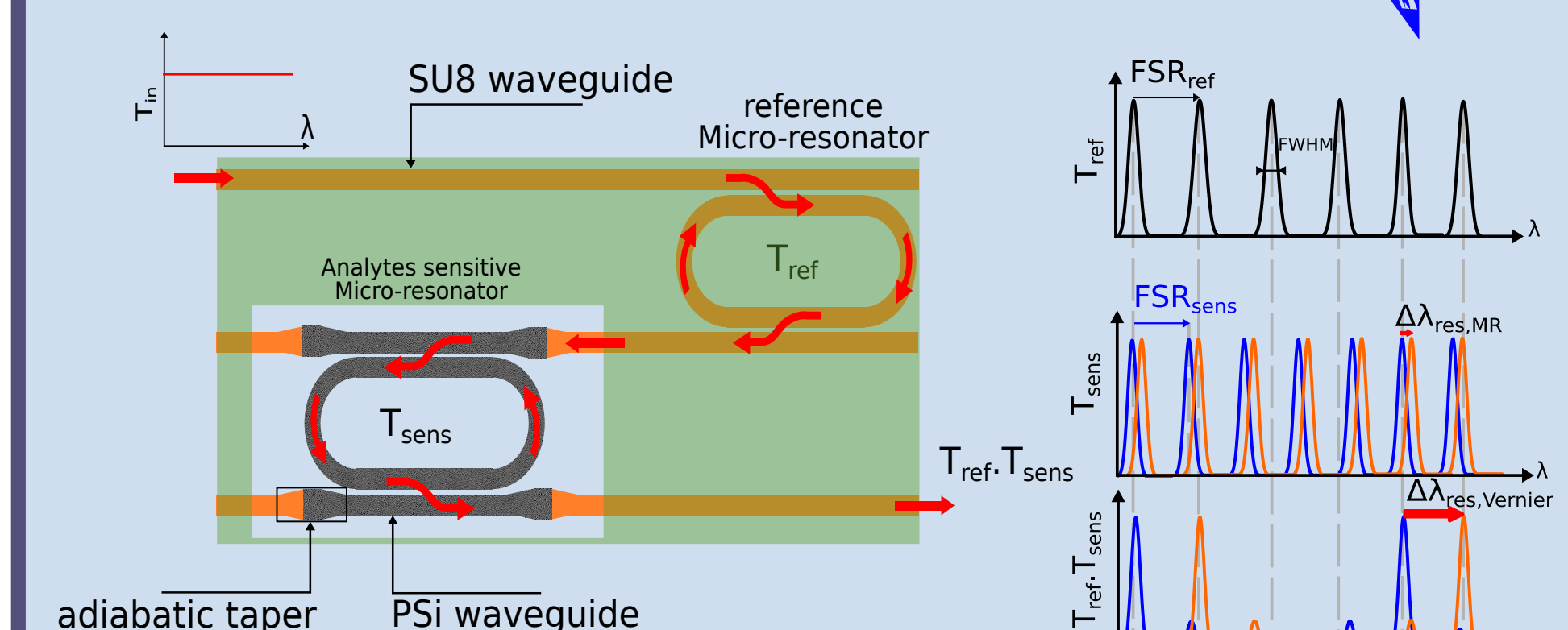


Toward hybrid Vernier effect

One micro-resonator



Vernier effect : Cascaded micro-resonators

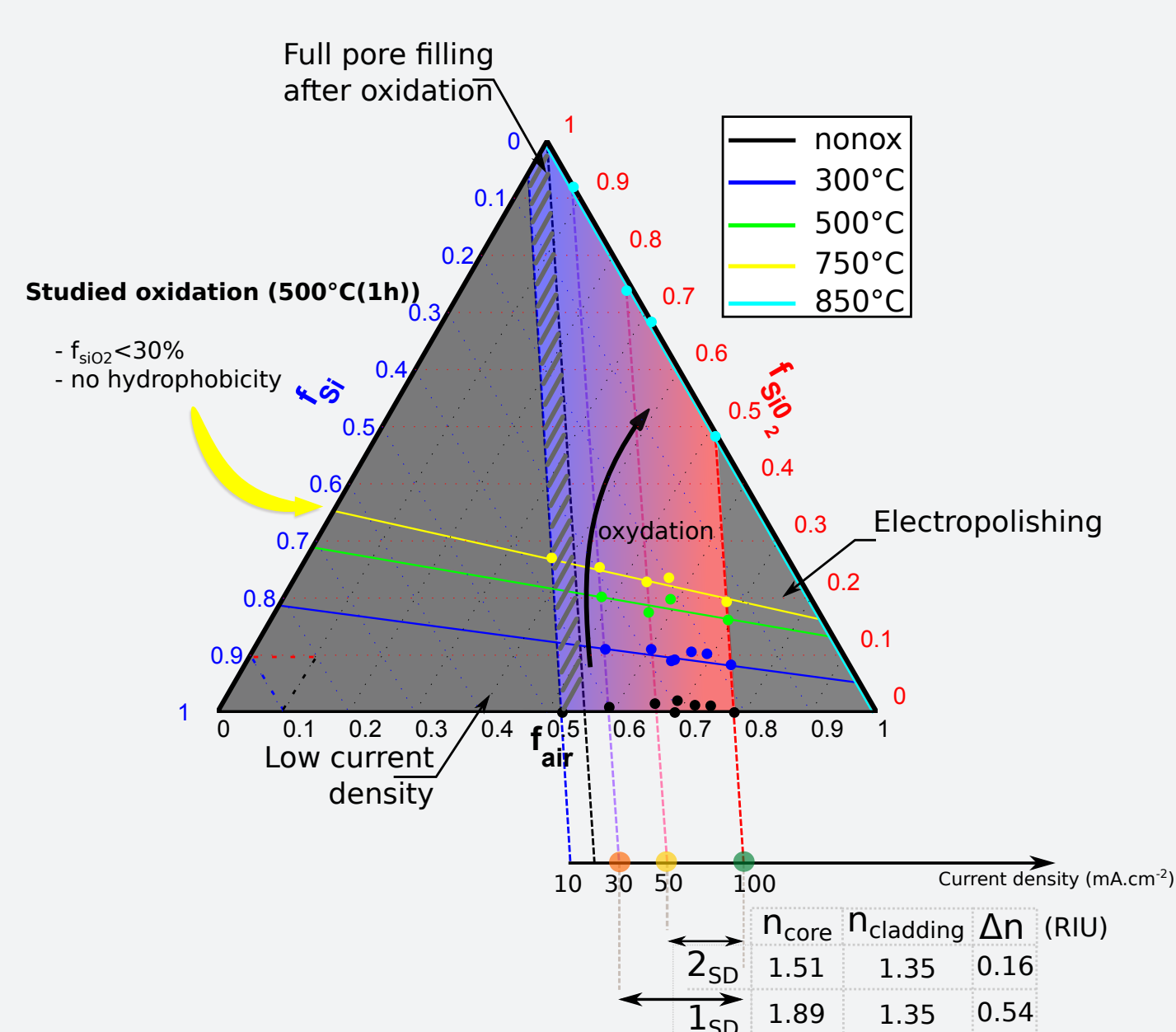


Vernier effect can improve sensor performances with a reference interferometer

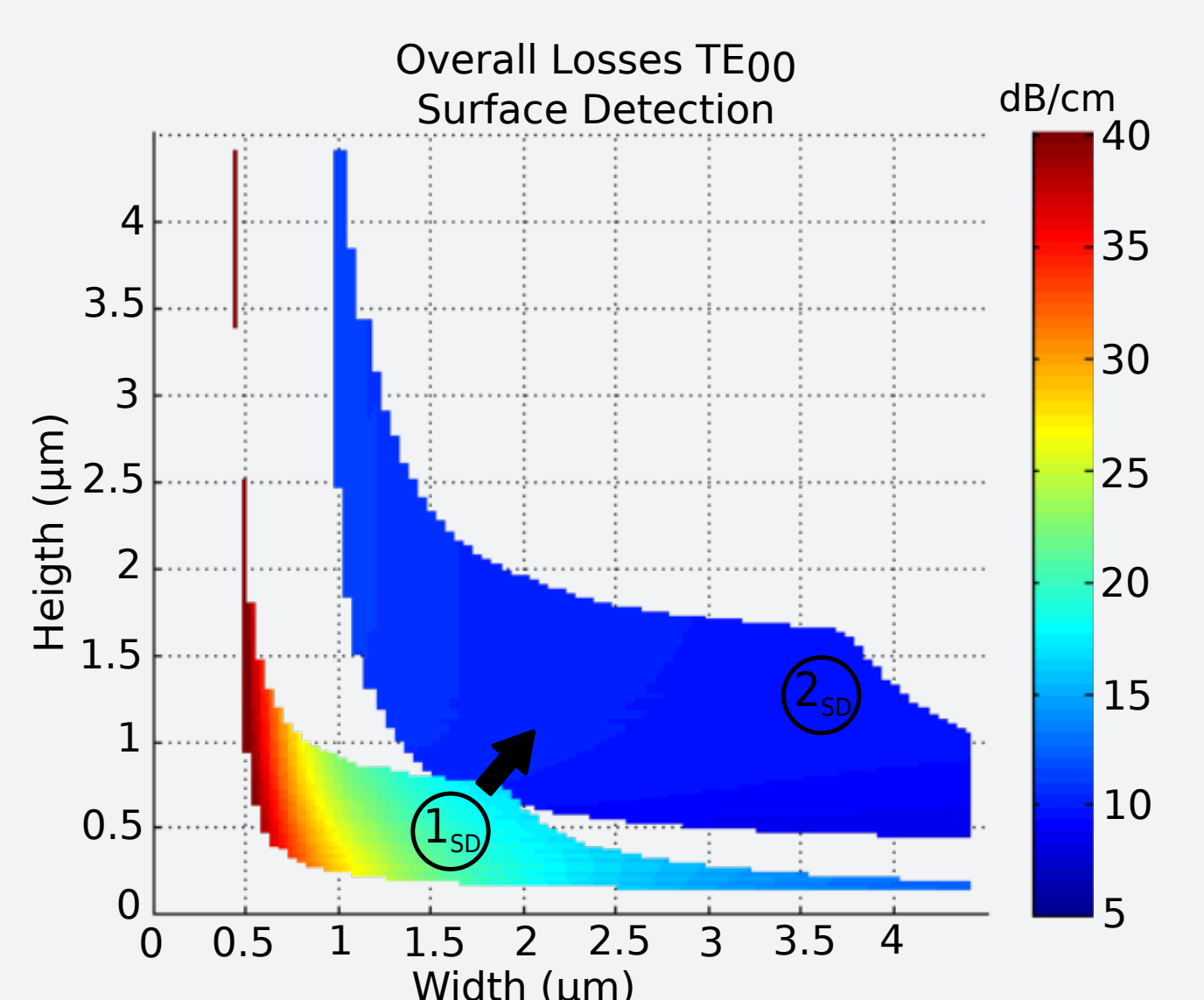
Optimization of ridge PSi waveguides dimensions

Losses evaluation in PSi waveguides

• Choice of PSi porosity and oxidation rate

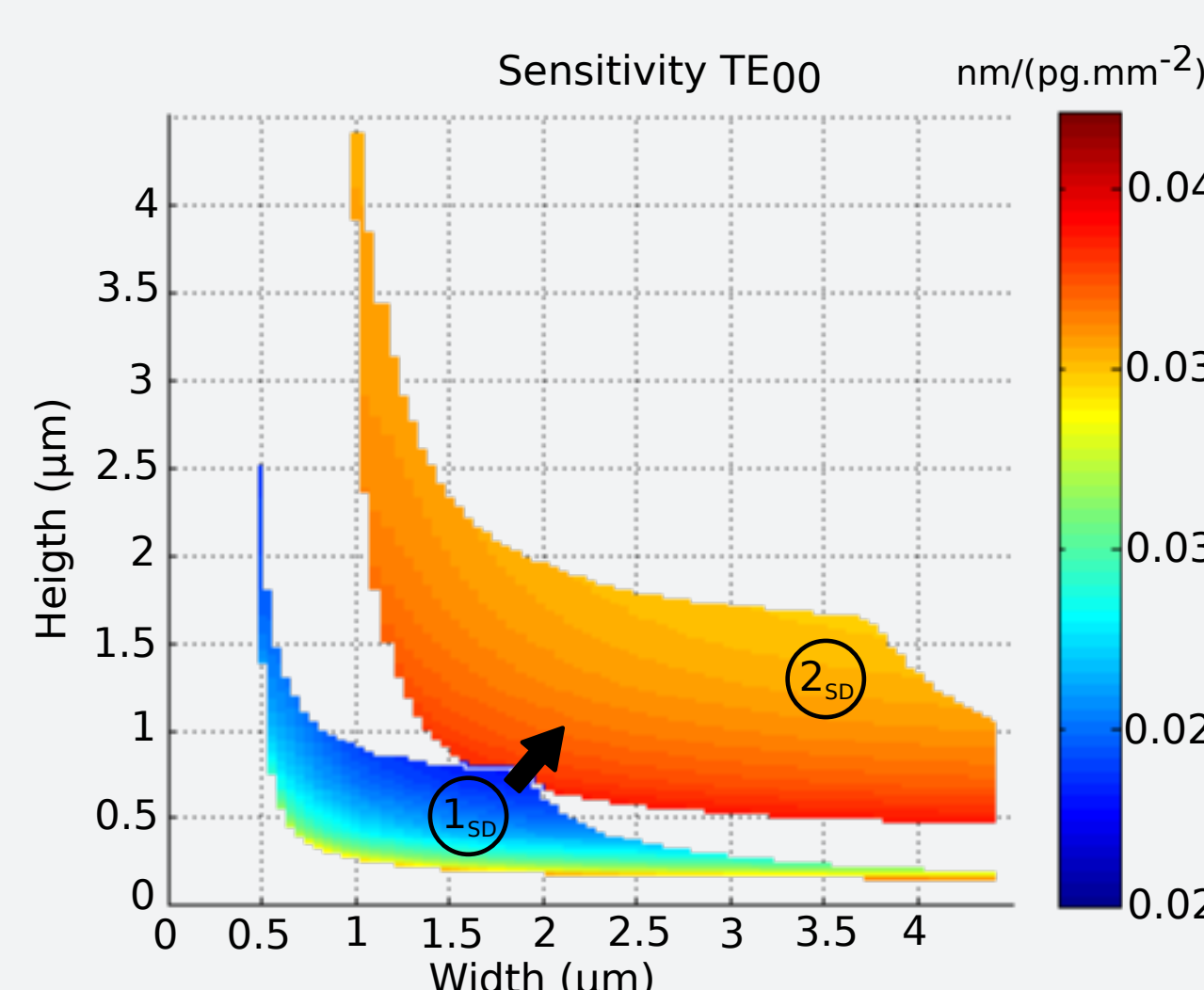


• Determination of losses with waveguide dimensions

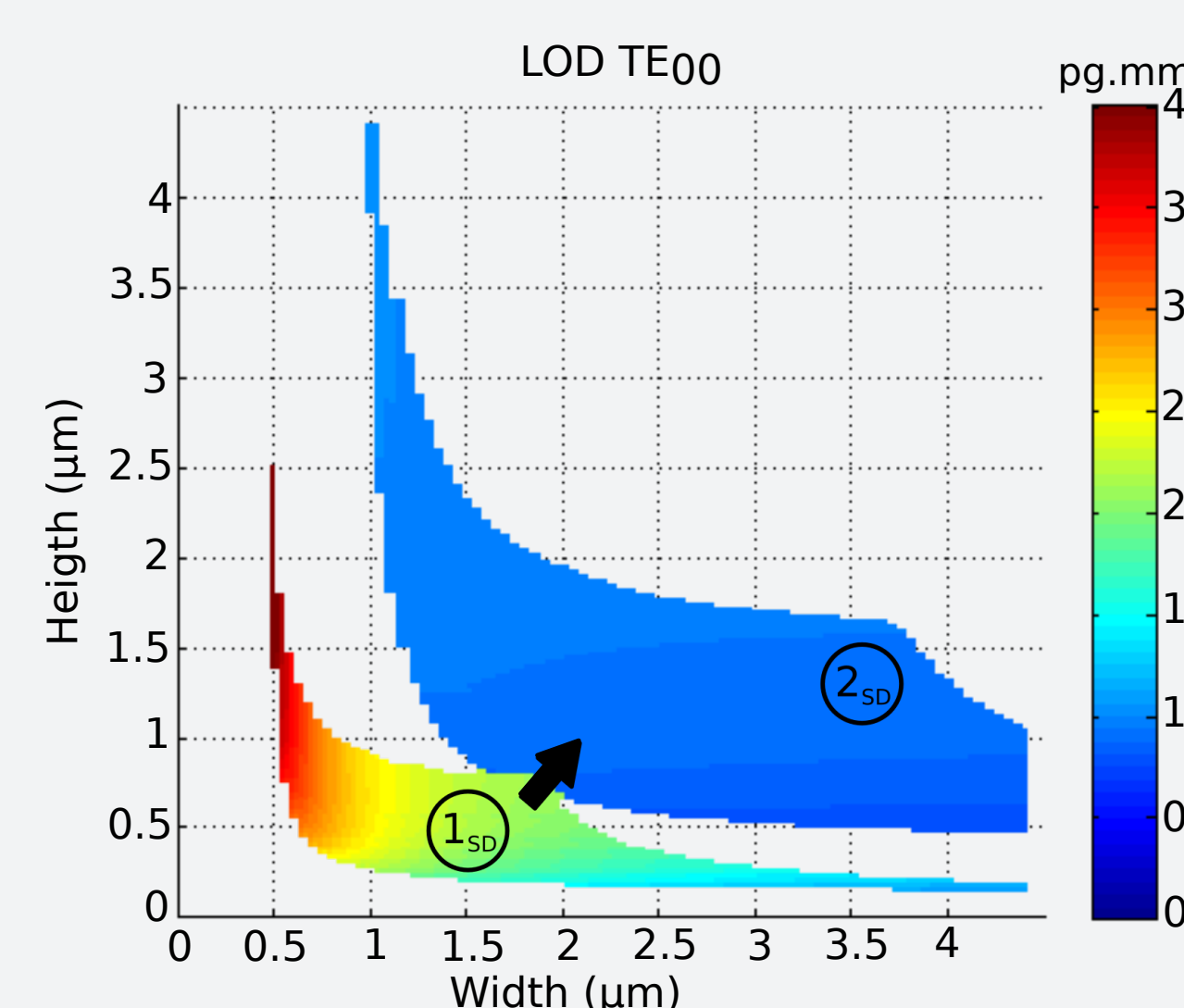


Sensitivity and Limit of detection

• Sensitivity of PSi MR



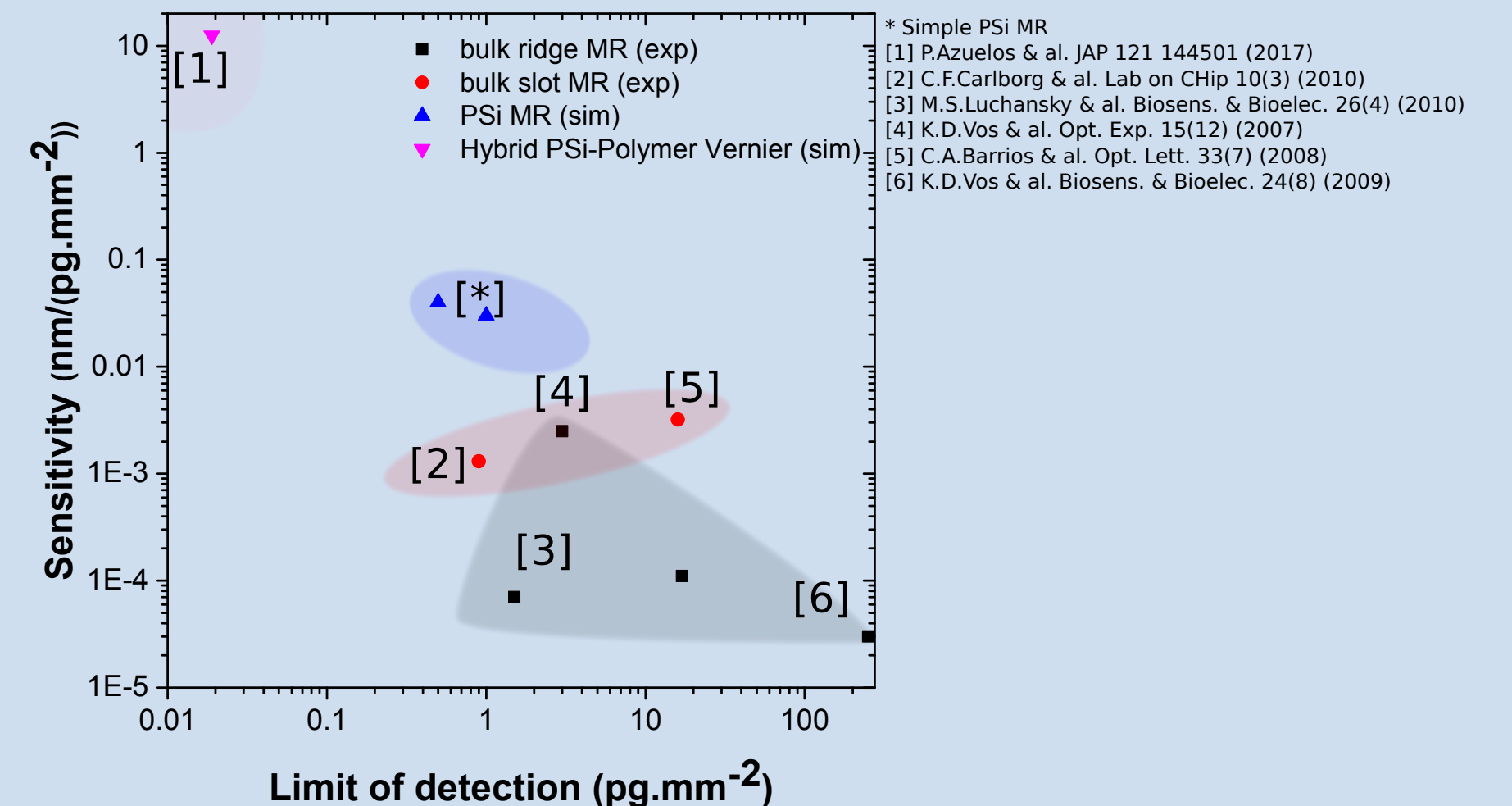
• Limit of detection



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

Conclusion and Perspective

• MR integrated sensor sensitivity and LOD



• Perspectives

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