European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

Microwave transduction for gas sensing: 2005 to present

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Summary

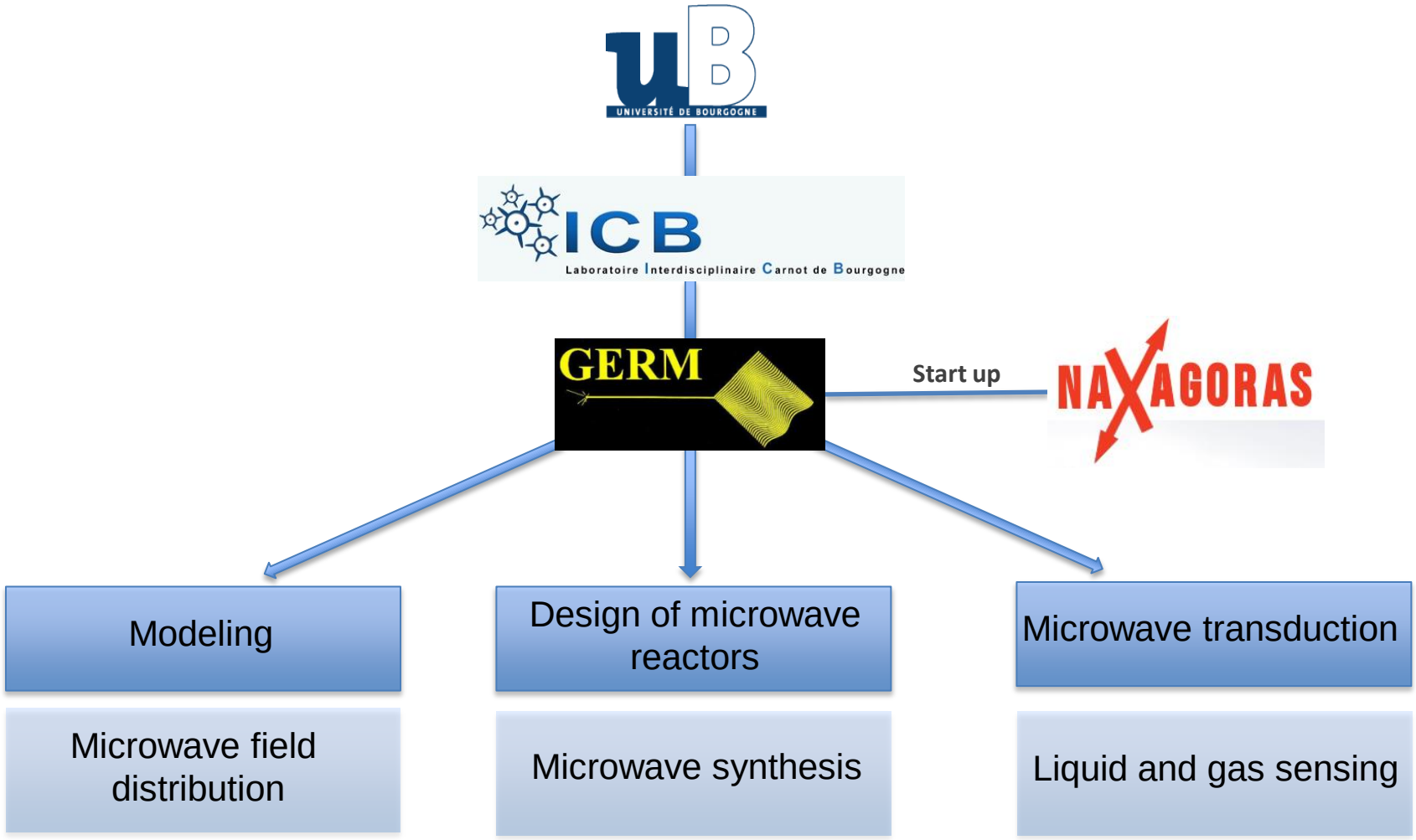
I. GERM research activities

II. Microwave transduction principle

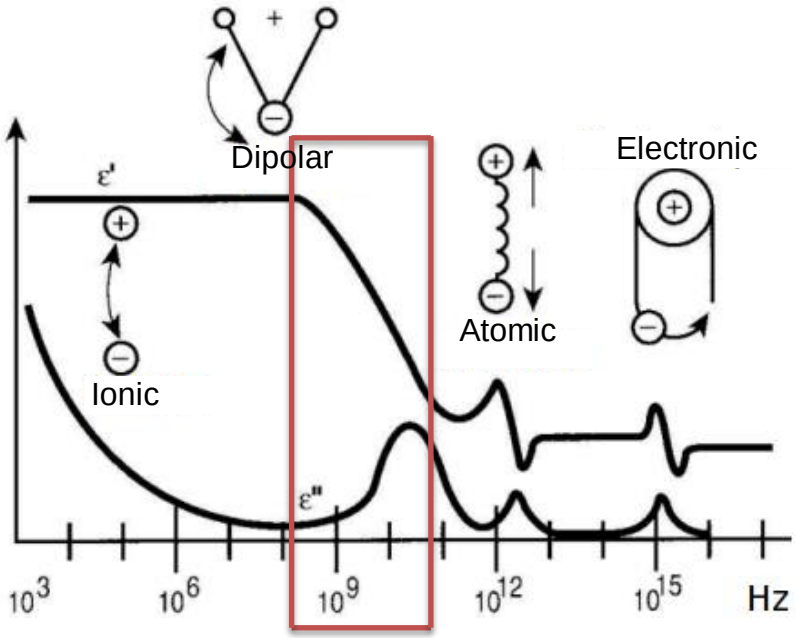
III. Microwave measurement devices and results

IV. Conclusion and perspectives

I. GERM research activities



II. Microwave transduction principle

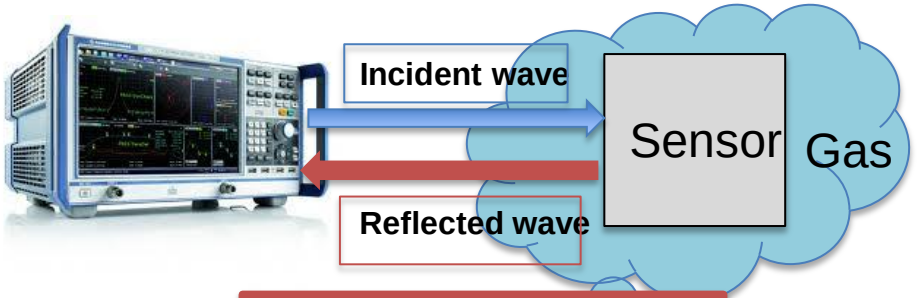


Micro waves

$\varepsilon = \varepsilon' + j\,\varepsilon''$

$$\varepsilon(\omega) = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1 + i\omega\tau} + \frac{\sigma}{i\omega\varepsilon_0}$$

Device



$$\Gamma(f) = \frac{\text{Reflected wave}}{\text{Incident wave}}$$

$$\Gamma(f) = \text{Re} + j\,\text{Im}$$

For one frequency ➡ One Γ(f)

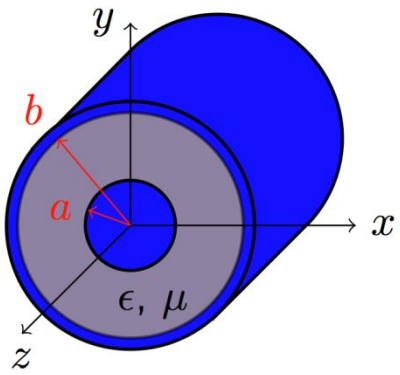
↳ Two informations
(A unique couple of Re and Im)

VNA = 201 frequencies ➡ A signature

II. Microwave transmission lines

Coaxial line

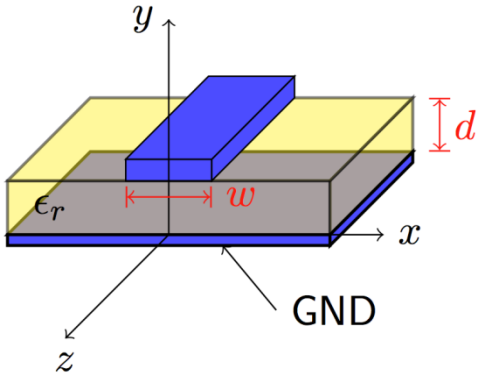
2005-2008: Thesis J. Jouhannaud



Volumic measurement

Microstrip line

2005-2008: Thesis J. Jouhannaud

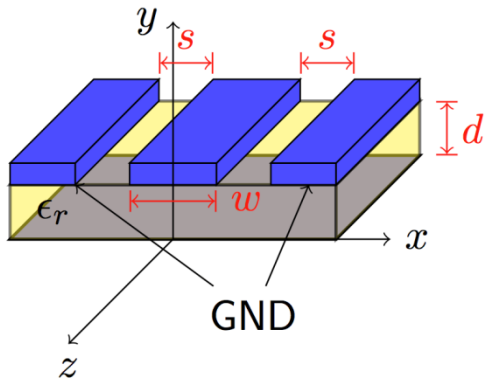


Volumic and surfacic measurement

Coplanar line

2009-20012: Thesis G.Barochi

2012-20013: ANR CAPBTX



surfacic measurement

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

III. Microwave static measurement device

VNA
(Vector Network Analyser)

Analyte gas

Incident wave

Reflected wave

Sensitive material
+
Transmission line

Exposition cell

Data transmission

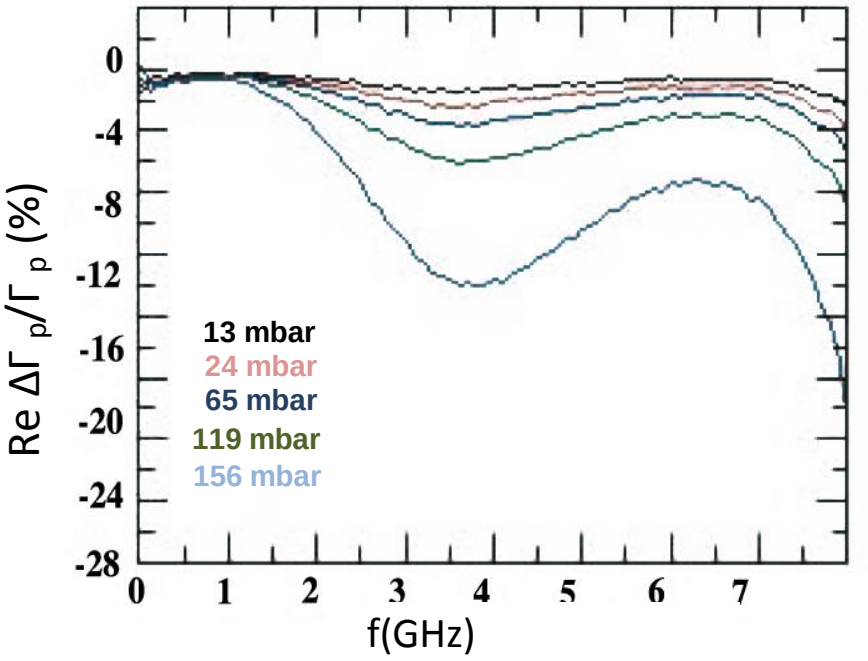
$$\frac{\Delta\Gamma}{\Gamma} = \frac{\Gamma_{gas} - \Gamma_{vacuum}}{\Gamma_{vacuum}}$$

Microstrip line

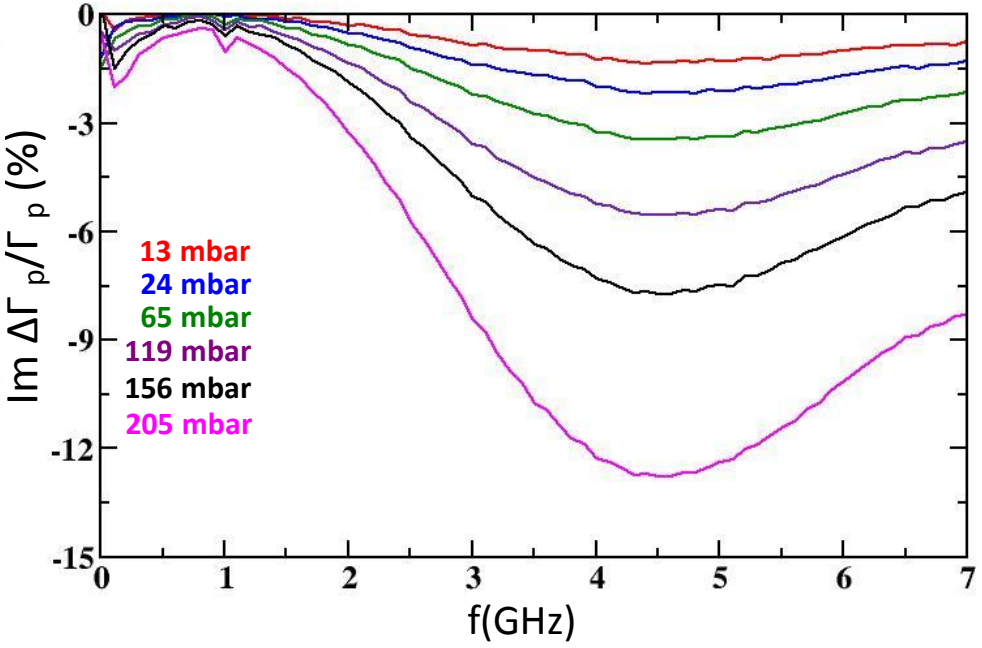
III. SnO_2/Methanol

Pressures of saturated methanol vapour

Re $\Delta\Gamma_p/\Gamma_p$ = f(f)

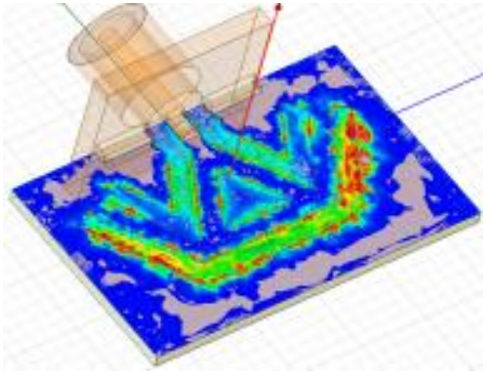


Im $\Delta\Gamma_p/\Gamma_p$ = f(f)



III. Coplanar transmission line

2009-Now



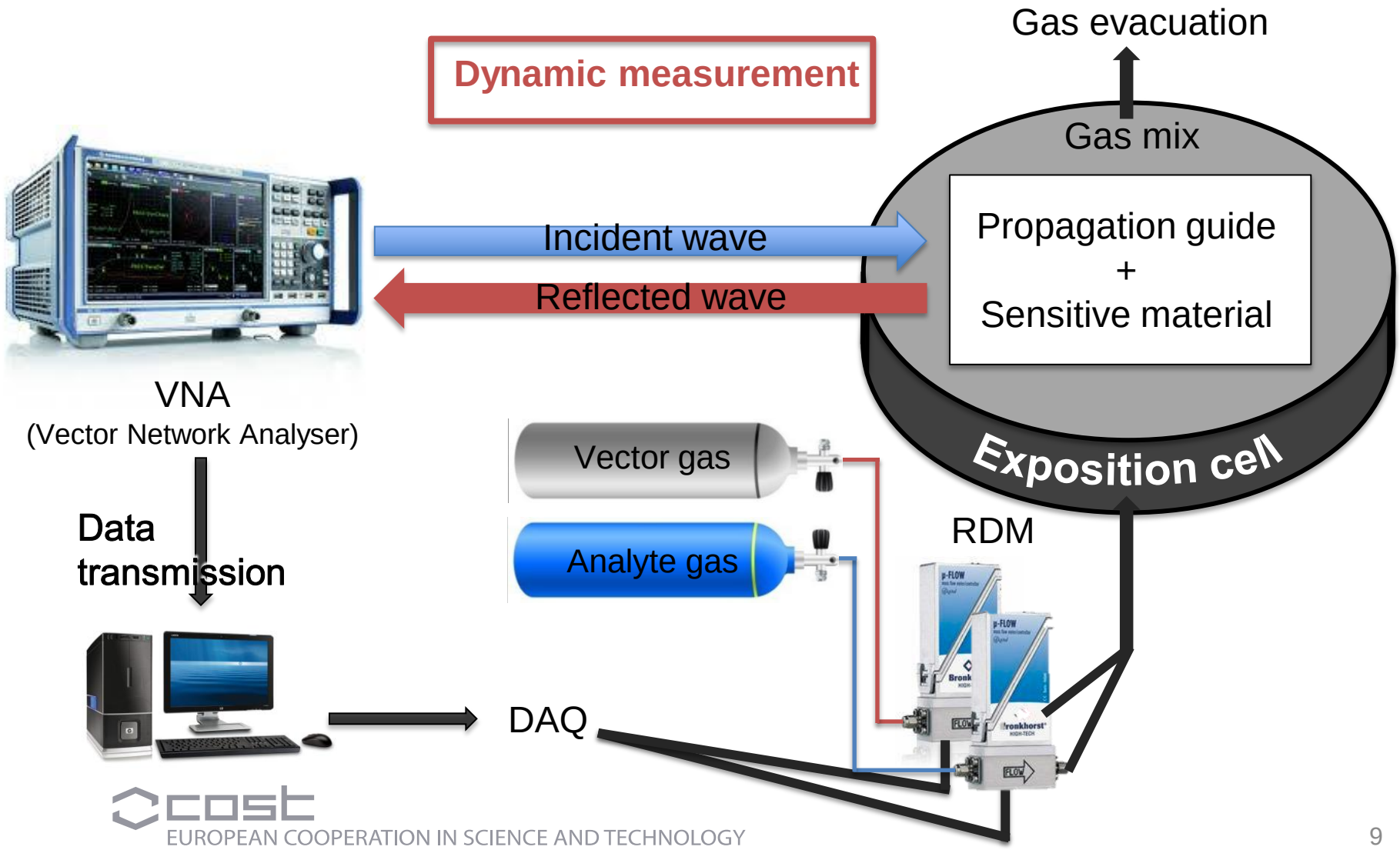
Coplanar design by HFSS©

Coplanar wave guide

Coating:
- Spin coating
- Deep coating
- Thermal evaporation
- Physical Vapor deposition

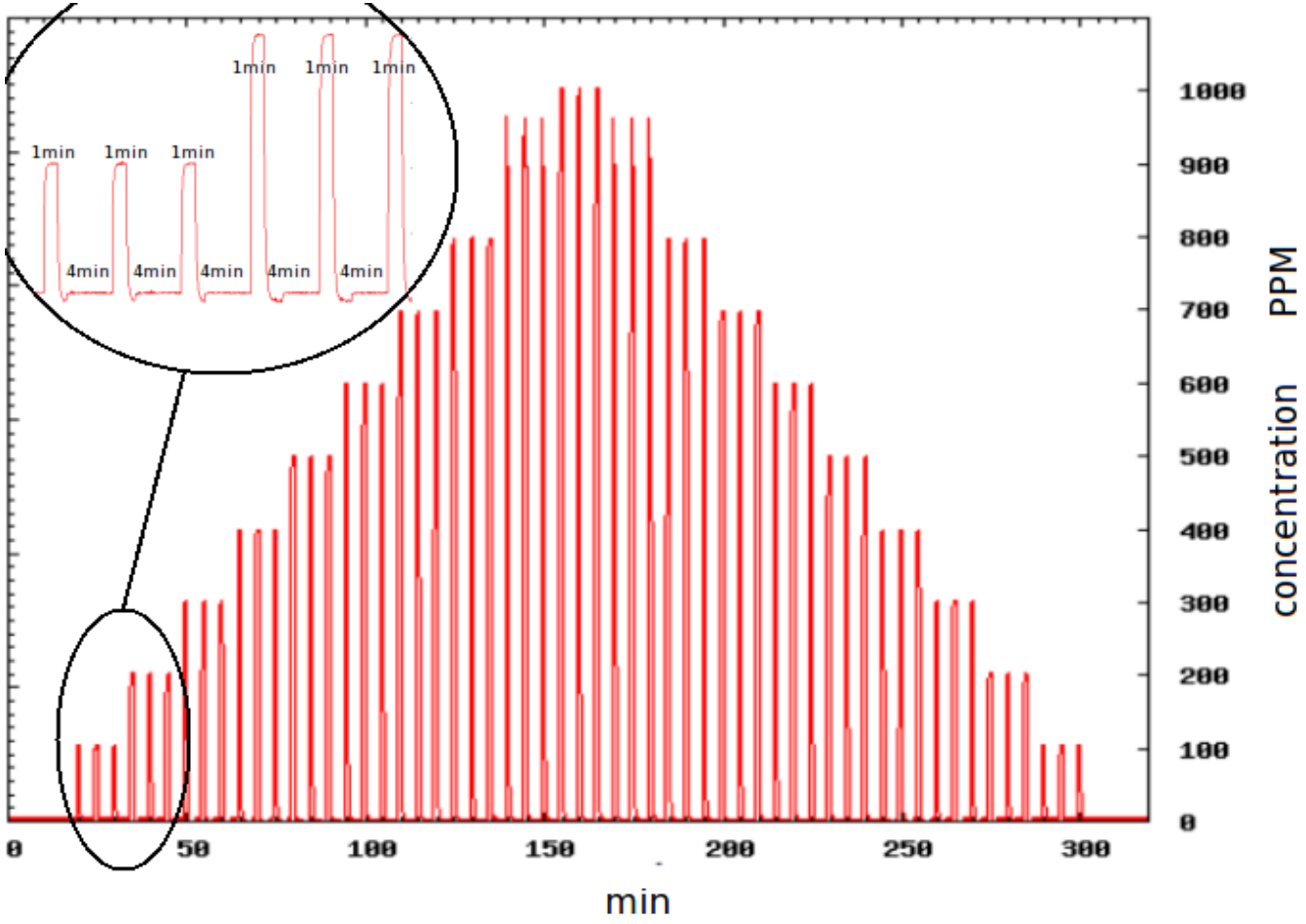
- Easy to produce
- Reproducible
- Wide possibilities for coatings

III. Microwaves measurement device

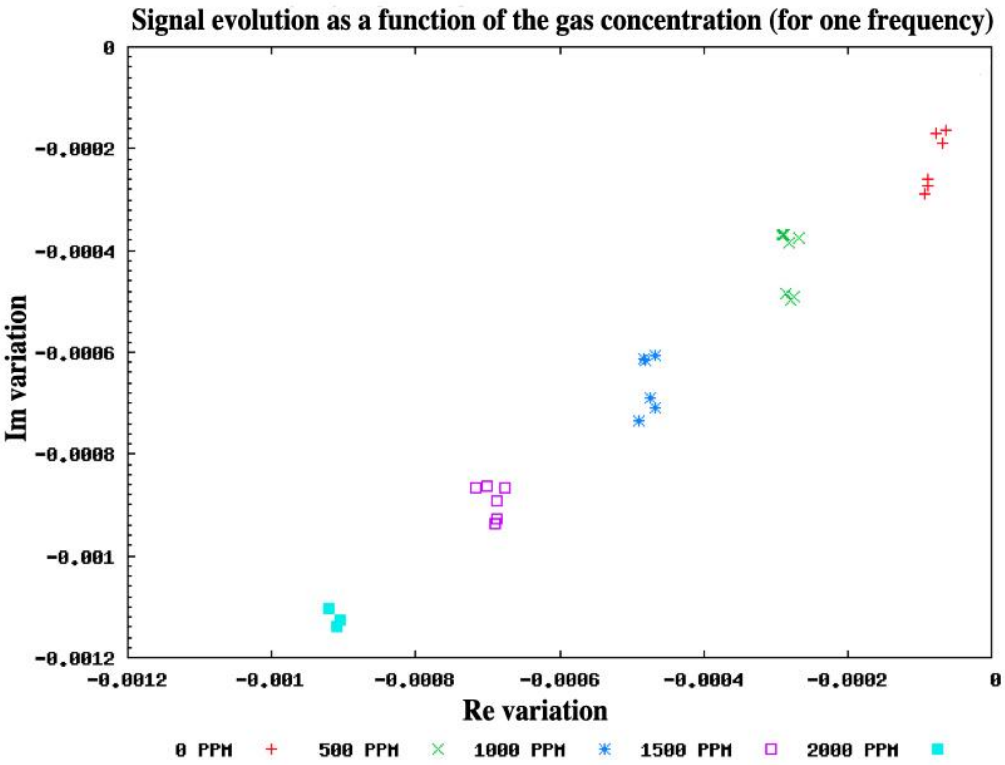


III. Exposition protocol

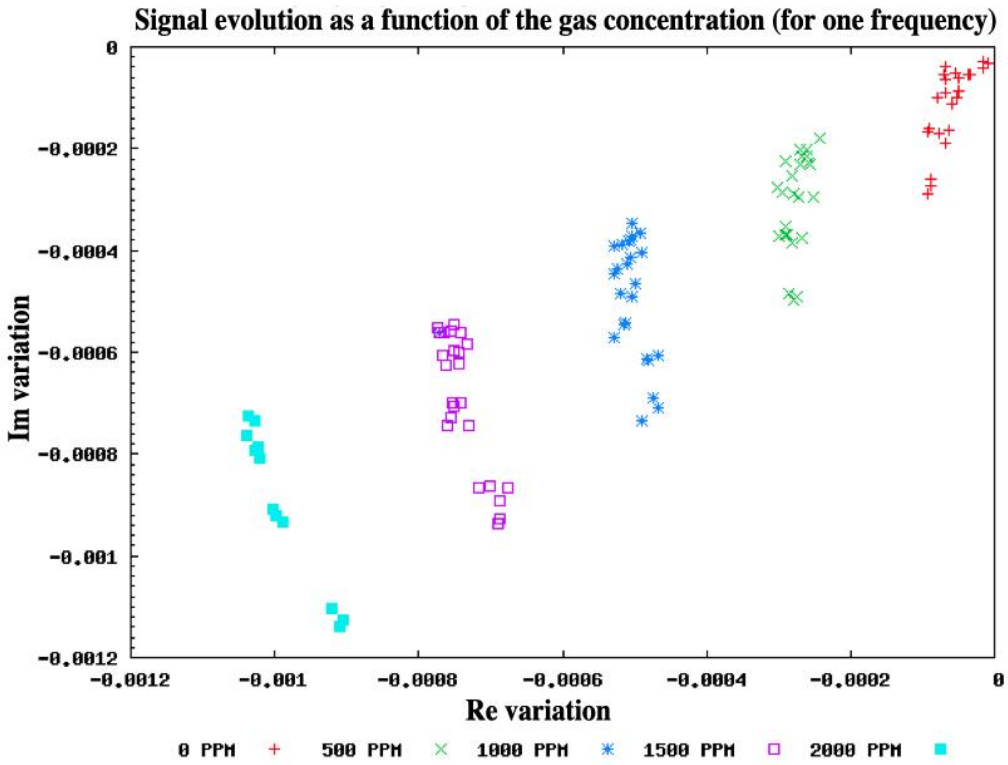
Example of an exposition cycle



III. PcCo / Toluene



1 cycle



3 cycles

IV. Conclusions and perspectives

- Quantitative measurement
- Ambiant temperature
- Low cost sensor production
- Wide variety of coating protocols
- Use of conductive and non conductive sensitive materials

- Interaction modeling
- Humidity effect
- Test with various sensible materials