

European Network on New Sensing Technologies for Air Pollution  
Control and Environmental Sustainability - *EuNetAir*  
COST Action TD1105

**INTERNATIONAL WG1-WG4 MEETING on**

***New Sensing Technologies and Methods for Air-Pollution Monitoring***

**European Environment Agency - EEA**

**Copenhagen, Denmark, 3 - 4 October 2013**

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 2: 2013-2014 (*Ongoing Action*)

**DEVELOPMENT OF A FORMALDEHYDE CHEMICAL SENSOR FOR  
INDOOR AIR QUALITY MONITORING AND ANALYSIS IN PASSIVE  
MODE**

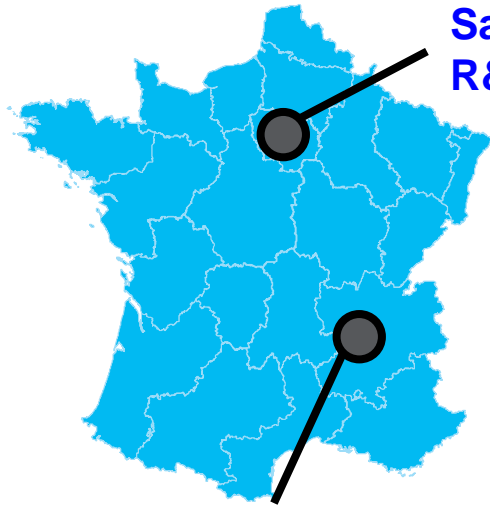


**Dr Katarzyna RAULIN**

WG4 member: Protocols & Standardisation Methods

**ETHERA / France**

# ETHERA created in 2010



**Saclay**  
R&D and Production

**Grenoble**  
Headquarter  
Commercial & Marketing

## Our markets

**Indoor Air Quality**  
*Environment Code*



**Public buildings**

IAQ monitoring



**Private buildings**

LEED building assessment

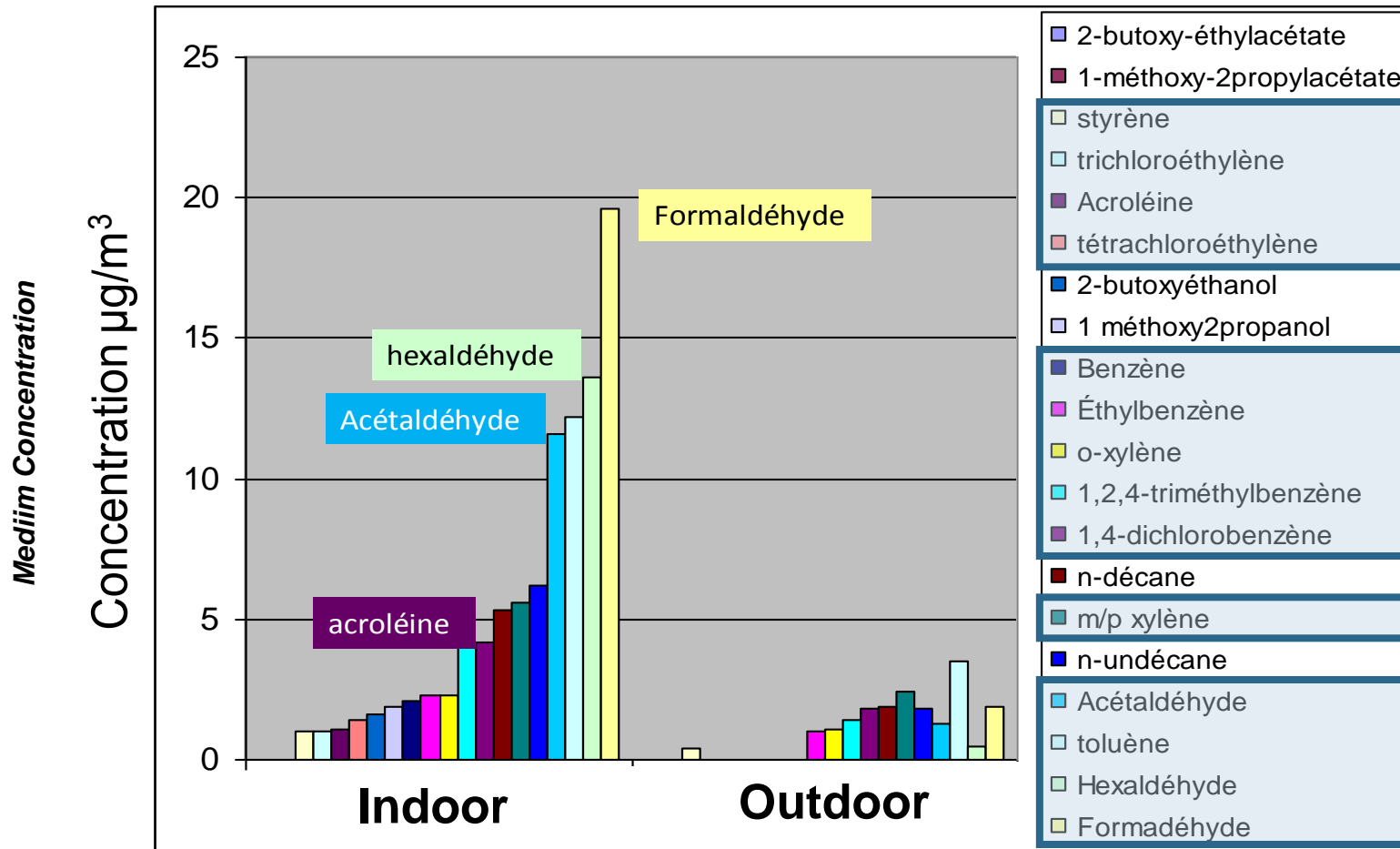
**Industrial Hygiene**  
*Labour Code*



**Industry**

Personal Exposure Limits  
assessment to chemical risk

# Indoor chemical pollution status



**Aldehydes +  
BTEX  
=  
> 80% of total  
chemical pollution**

*Source: French Indoor Air Quality Observatory 2006 – Campaign based on 600 French representative dwellings*

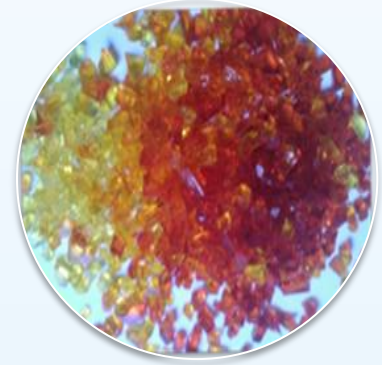
# ETHERA R&D



Development, validation and industrialisation of new chemical sensors for the measurement of indoor air pollutants



Development of new devices for indoor air quality control especially formaldehyde and trichloramine



Development of new devices for the purification of indoor air

# ETHERA research based on an innovative technology for IAQ measurement and treatment

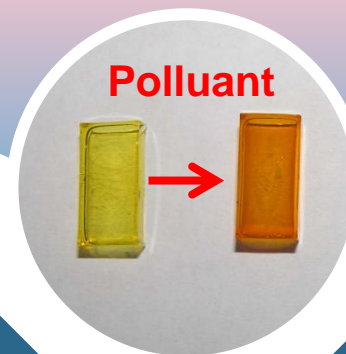
A nanoporous Sol-Gel material like a « sponge »

*Pollutant filtration and concentration*



Probe molecule integration

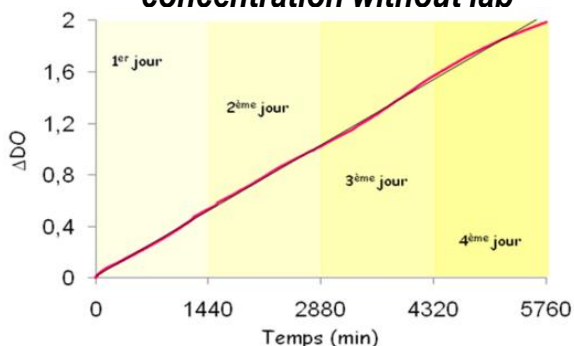
*Specific reaction with the pollutant creating a colorimetric reaction*



**MEASURE**

Direct optical detection

*Direct ultra-sensitive measurement of pollutant concentration without lab*



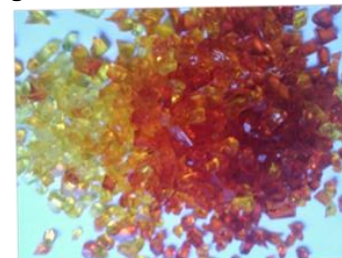
**A Simple, Sensitive and Selective technology**

- Manufacturing from an industrial Sol-Gel process
- Protected with 5 international patents
- A operational pilot production line

**EPURATION**

High trapping capacities

*Selective and efficient treatment of the pollutant with integrated saturation indicator*



# Profil'air® product range : a modular approach

Badge for individual dosimetry  
PA-SDIxxx

- Personal Exposure Limits (TWA 8h)

Passive sampling

Ambiant diffuser  
PA-DFSxxx

- Long-term ambient measurements

Sensor

Optical reader module  
PA-MRF421

Dynamic exposure module  
PA-MEX001

- Personal Exposure Limits (STOEL 15min)
- Short-term ambient measurements

Active sampling

Pump module  
PA-MPO201

- Personal Exposure Limits (STOEL 15min)
- Short-term ambient measurements

Emission measurement chamber  
PA-CMExxx

- Emission source research

# Main research equipments

## 1 Passive measure development in controlled environments in laboratory

Generation of calibrated gas mixtures in environmental chamber

- [HCHO]
- T° (10 - 40°C),
- RH (20 – 80 %)
- Air velocity (0.1 - 2 m/s)

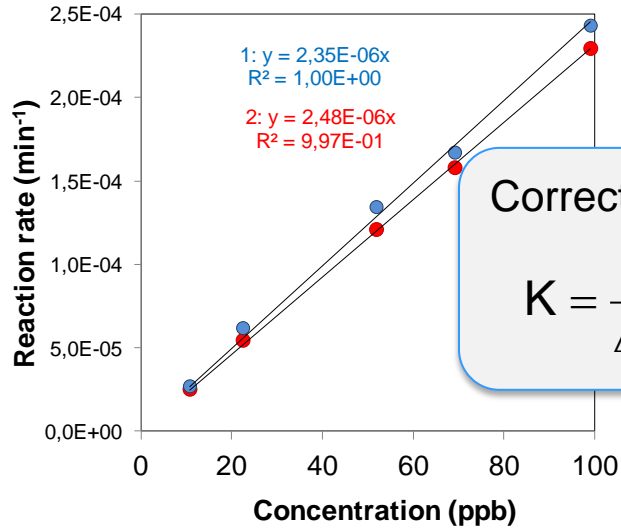


Generation of calibrated gas mixtures



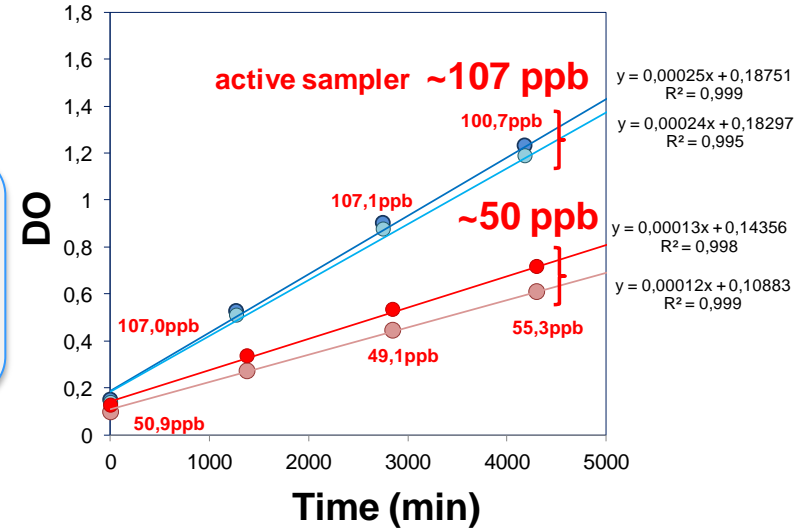
## 2 Validation of the passive measure in real conditions: measure campaigns in **nurseries** and schools of Grenoble

# Phase ①: Calibrated conditions



Correction coefficient

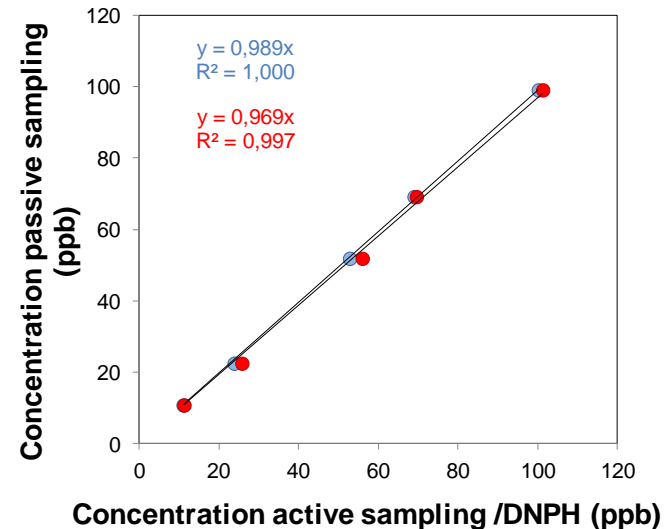
$$K = \frac{\Delta DO}{\Delta \text{time} \times [HCHO]}$$



✓ **Linearity** : sensor response is linear as a function of the formaldehyde concentration of 4.5 days

✓ **Linearity** : sensor response is linear as a function of time (1, 2, 3 and 4,5 days)

✓ **Correlation passive/active** : Very good correlation between passive and active ETHERA measures

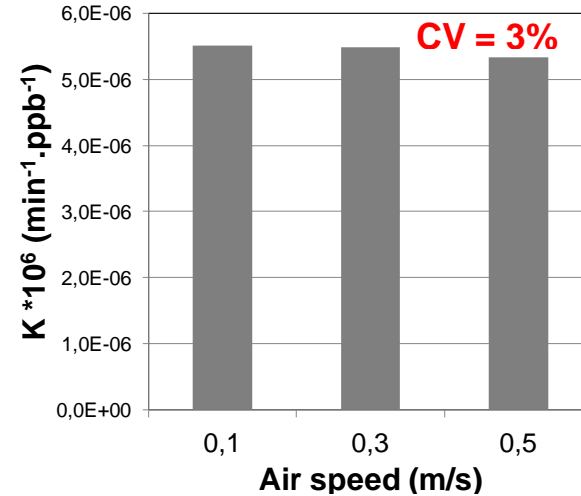




# Phase ①: Calibrated conditions

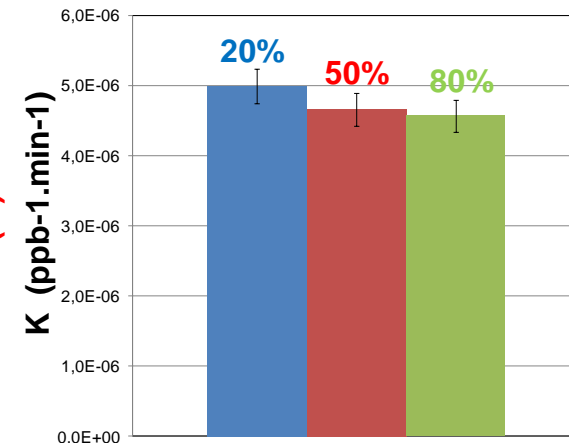
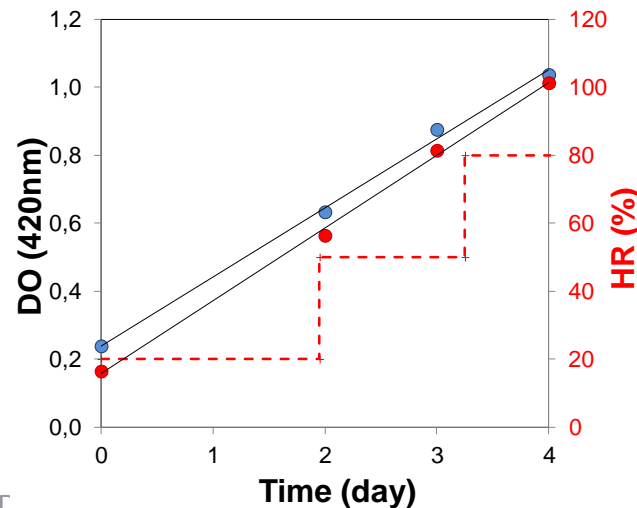
## Air speed

- Passive exposition on 1 day
- 50 % RH, 20°C, [HCHO] = 24 ppb
- ✓ Low effect of the speed from 0.1 to 0.5 m/s



## Variable relative humidity

- 4.5 days à 28ppb de HCHO
- 20°C, 0,1 m/s à
- 20, 50 et 80% RH
- ✓ Little disruption of moisture on sensors



# Phase ①: Calibrated conditions

## Study of potential interfering gaz

In presence of 50 ppb formaldehyde or not of:

- Toluene (500 and 2000 ppb)
- Acetaldehyde / Acroleine / Hexanal
- Acetone (some ppm in static)
- (other vapors: HNO<sub>3</sub>, acetic acid, H<sub>2</sub>O<sub>2</sub>...)

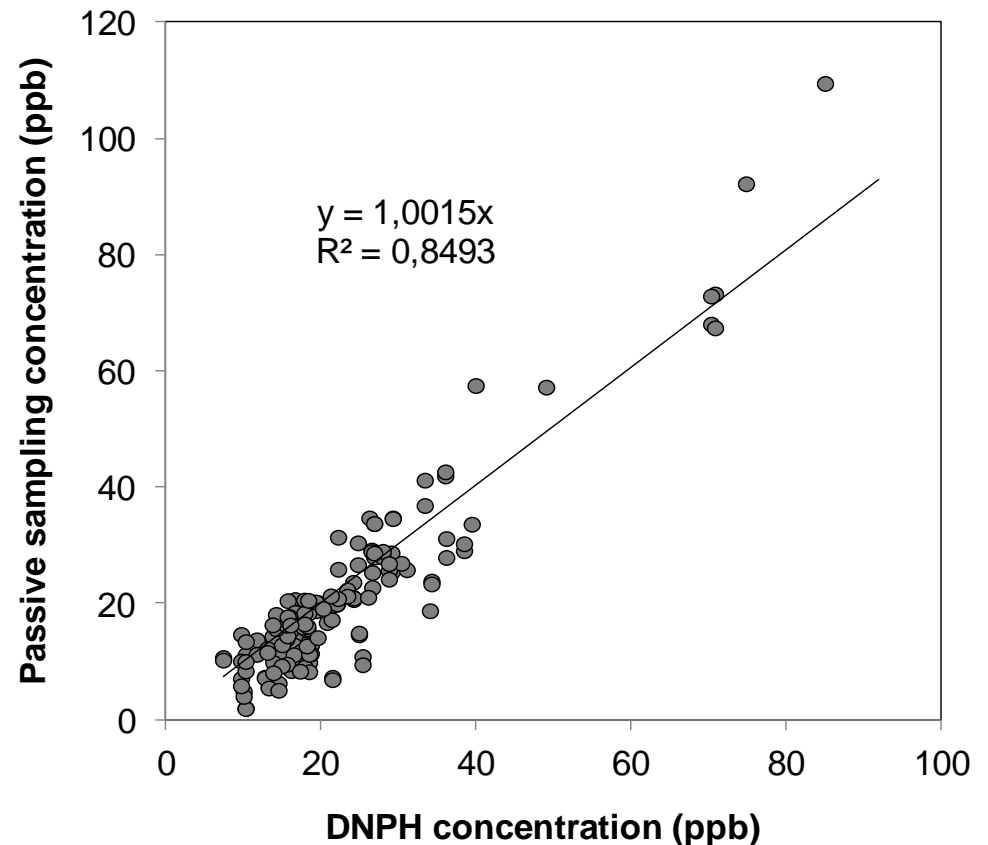
✓ **No effect on measure with a mixture of acetaldéhyde, acroleine, hexanal in the presence of formaldehyde except with acetaldehyde >100 ppb**

✓ **No significant influence of toluene and acetone on the measure in the presence of formaldehyde**

# Phase ②: Real conditions

The passive sensor ETHERA was calibrated in real situations compared with the Radiello® measures according to the humidity

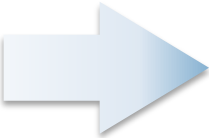
- ✓ Good correlation for the campaign between Radiello®/ ETHERA :  
average = 21%  
Absolute deviation < 5 ppb
- ✓ Standard deviation inter-laboratory on Radiello®: approximately 18 %
- ✓ Low standard deviation variation (CV = 8 %) according to the humidity



# Performance of the method

	Result
Reproducibility (45 ppb, 50% RH, 24 hrs)	3.6%
Repeatability (45 ppb, 50% RH, 24 hrs)	1.9%
Detection limit (4.5 days of exposition)	0.2 ppb
Quantification limit (4.5 days of exposition)	0.8 ppb
Average accuracy / DNPH or ETHERA active measure	3%

## Performance comparable to a chromatographic analysis

- 
- ✓ **Selective**
  - ✓ **Sensitive(ppb)**
  - ✓ **Simple**
  - ✓ **Non destructive**

# Profil'air® roadmap : planned activities

*A progressive gas extension*



profil'air



*Chamber for emission measurements*



**2012**

*Formaldehyde*



*Trichloramine*

*Badge for personal exposures*



**2013**

*CO<sub>2</sub>, T°, HR*



*Ambiant diffuser*



**2014**

*Aldehydes*



*BTEX*

