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

COST Action TD1105

4th International Workshop *EuNetAir* on *Innovations and Challenges for Air Quality Control Sensors*

FFG - Austrian Research Promotion Agency - Austrian COST Association

Vienna, Austria, 25 - 26 February 2016

WHAT BRINGS FORMALDEHYDE'S CONTINUOUS MONITORING TO THE ANALYSIS OF BUILDING'S AIR QUALITY AND WAYS TO MANAGE/IMPROVE IT?

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Ethera / France

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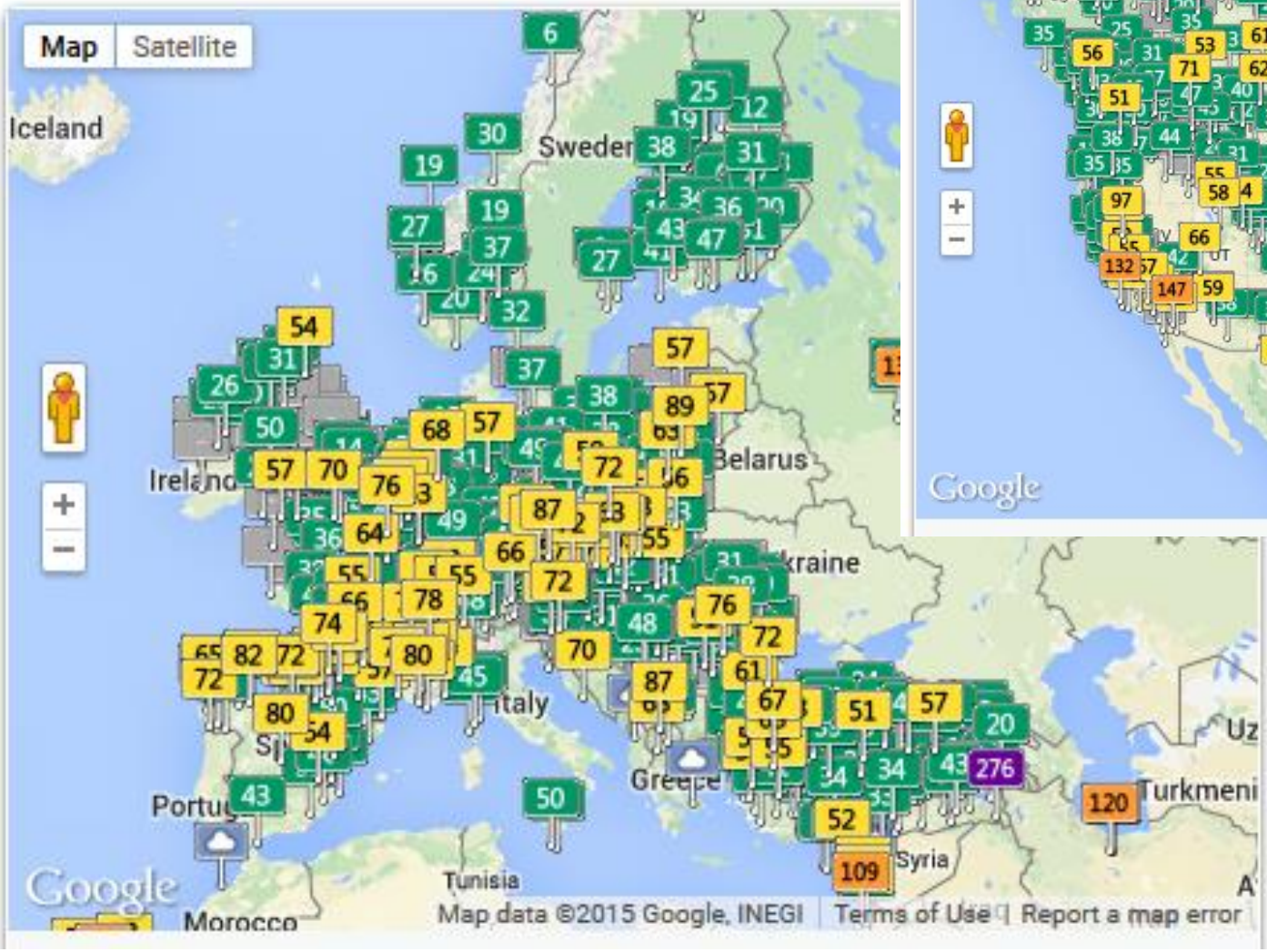
Outline

- Introduction on Indoor Air Quality
- Technology
- Characterization
- Application for building ventilation management


Shanghai 5 Feb 2015, 4pm!
Air pollution becomes visible


Paris, 20 March 2015
Not only in China


Mongolia
Sea of Okhotsk
Nepal
India
Zoom out


Map
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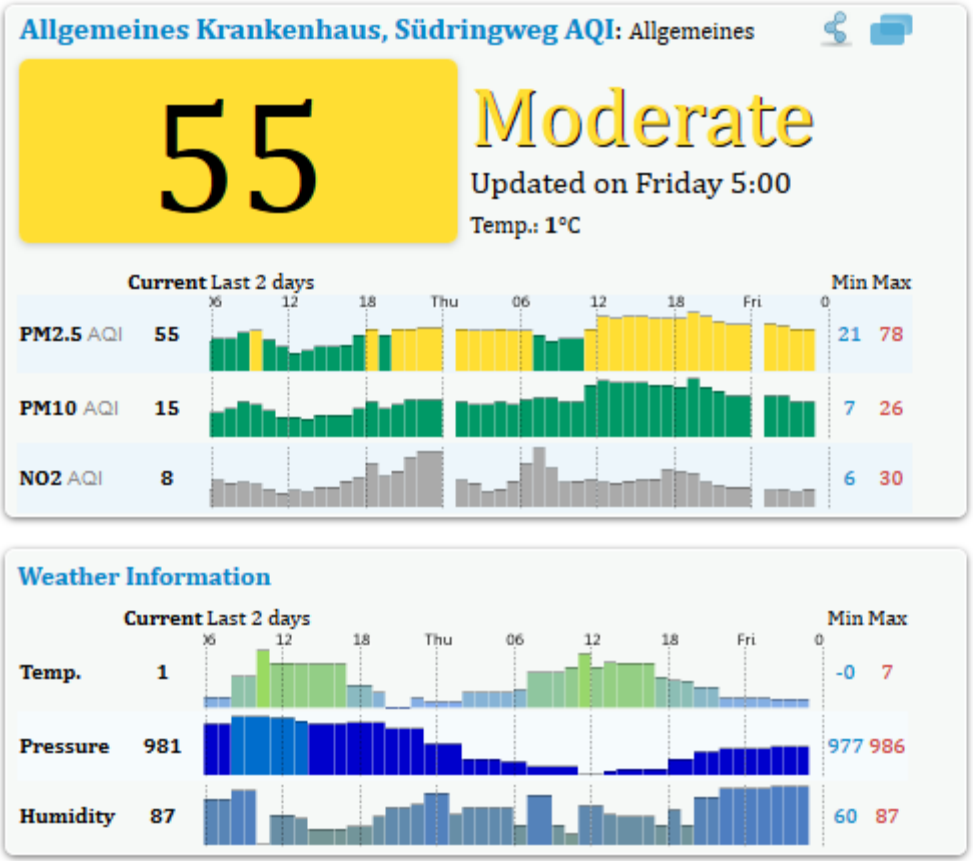
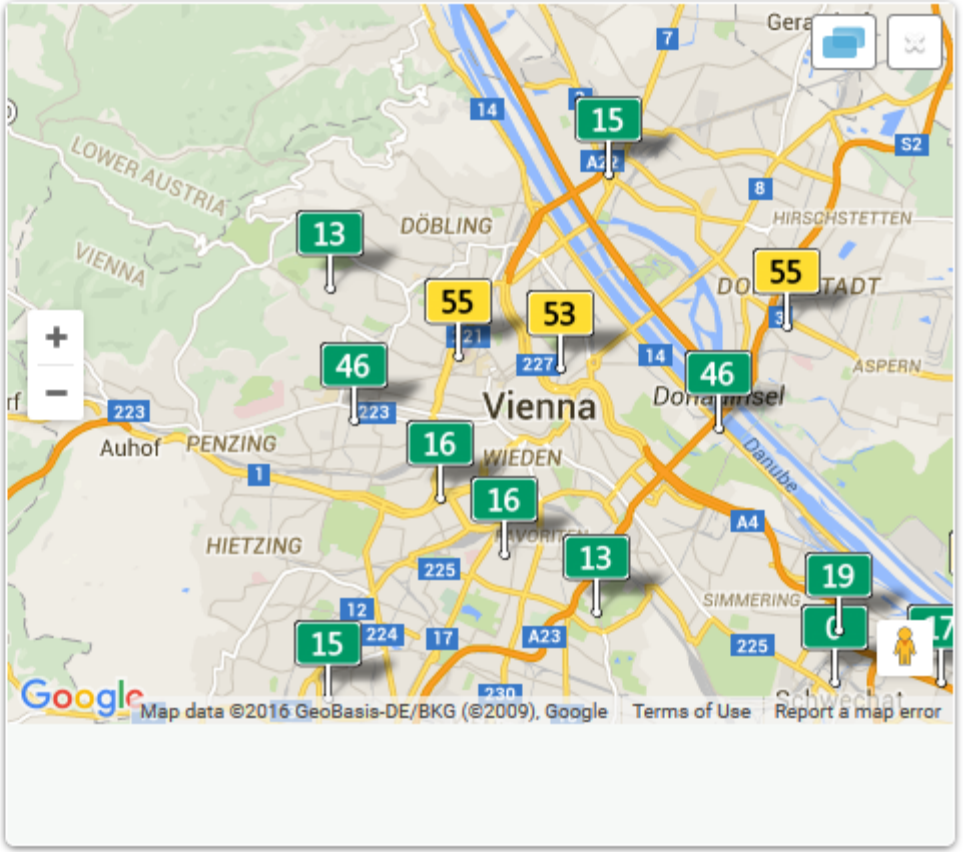

Allgemeines Krankenhaus, Südringweg AQI: Allgemeines
55
Moderate
Updated on Friday 5:00
Temp.: 1°C
Current Last 2 days
Min Max
PM2.5 AQI 55 21 78
PM10 AQI 15 7 26
NO2 AQI 8 6 30
Weather Information
Current Last 2 days
Min Max
Temp. 1 -0 7
Pressure 981 977 986
Humidity 87 60 87


Vienna
DÖBLING
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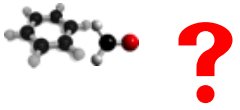
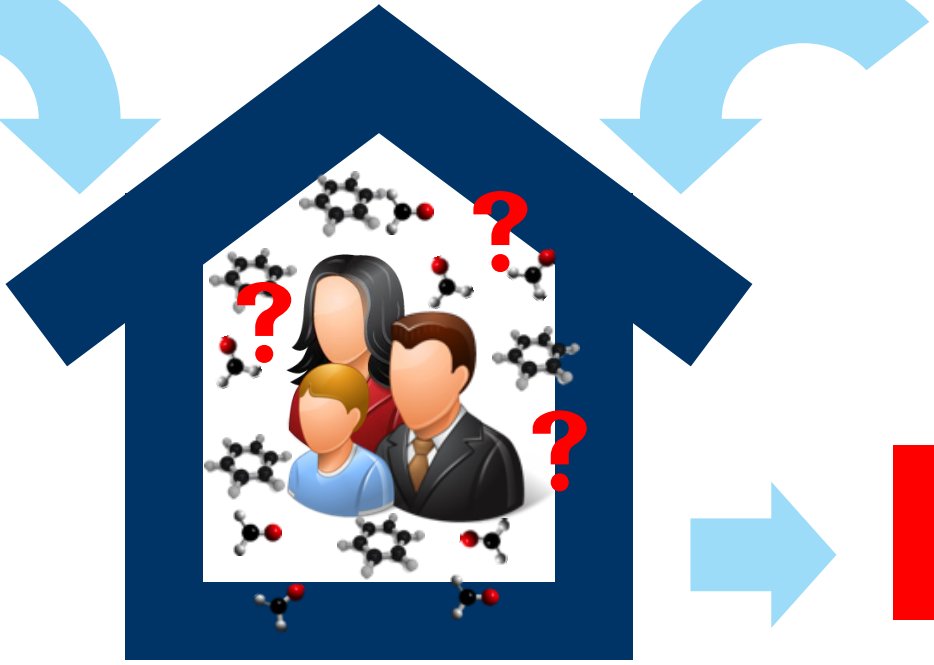
Protecting indoor from outdoor pollutant?

Many chemical + PM pollution sources

Uncontrolled source



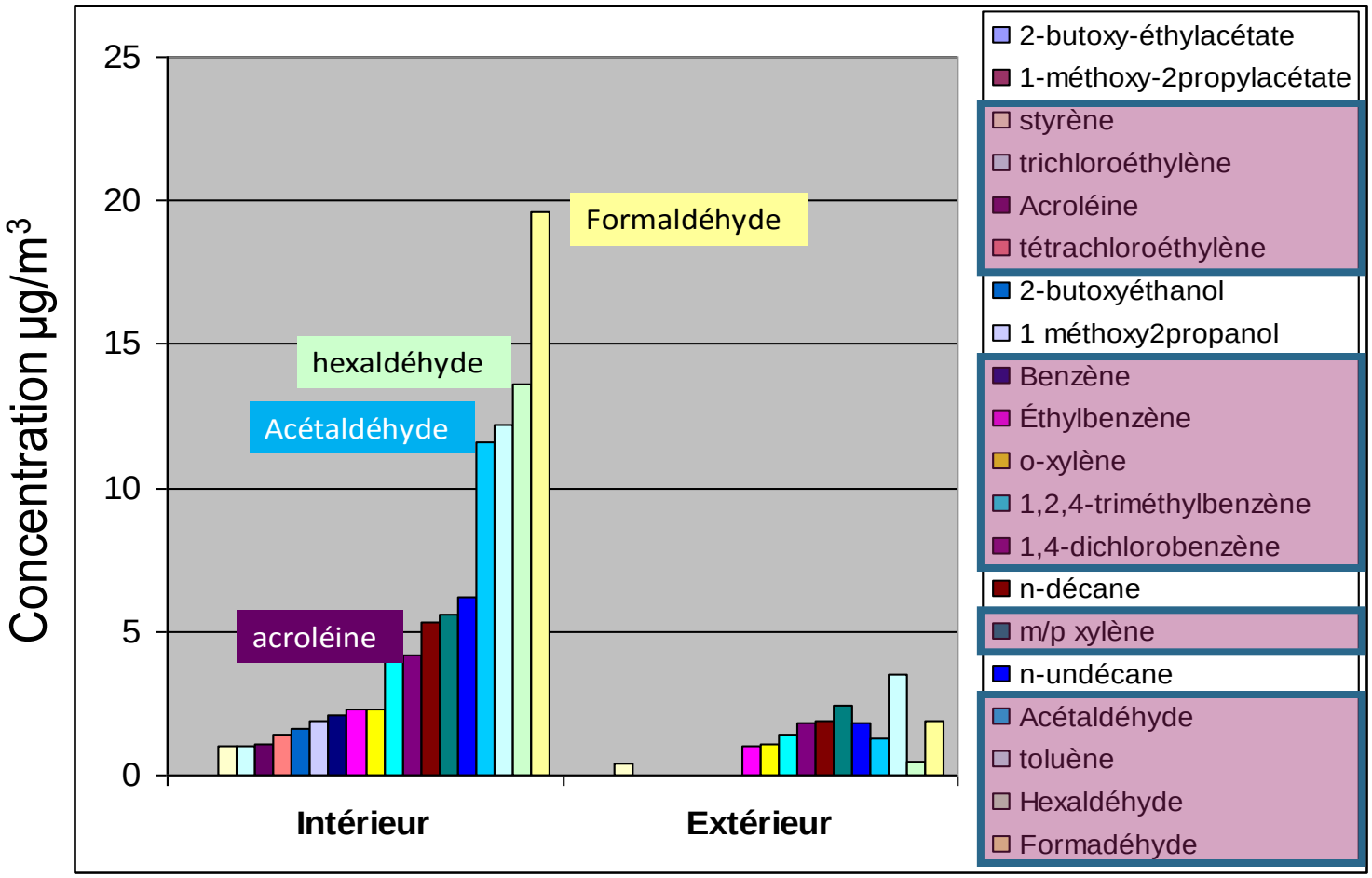


Human breath indoor air more than 80% of its time

+
ENERGY SAVING BUT…

Indoor air pollution is VOCs + CO2

Mediim Concentration

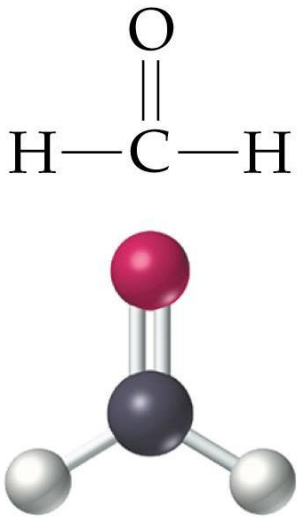


Aldehydes + BTEX = > 80% of total chemical pollution

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

Formaldehyde

The Reference indoor air pollutant



甲醛

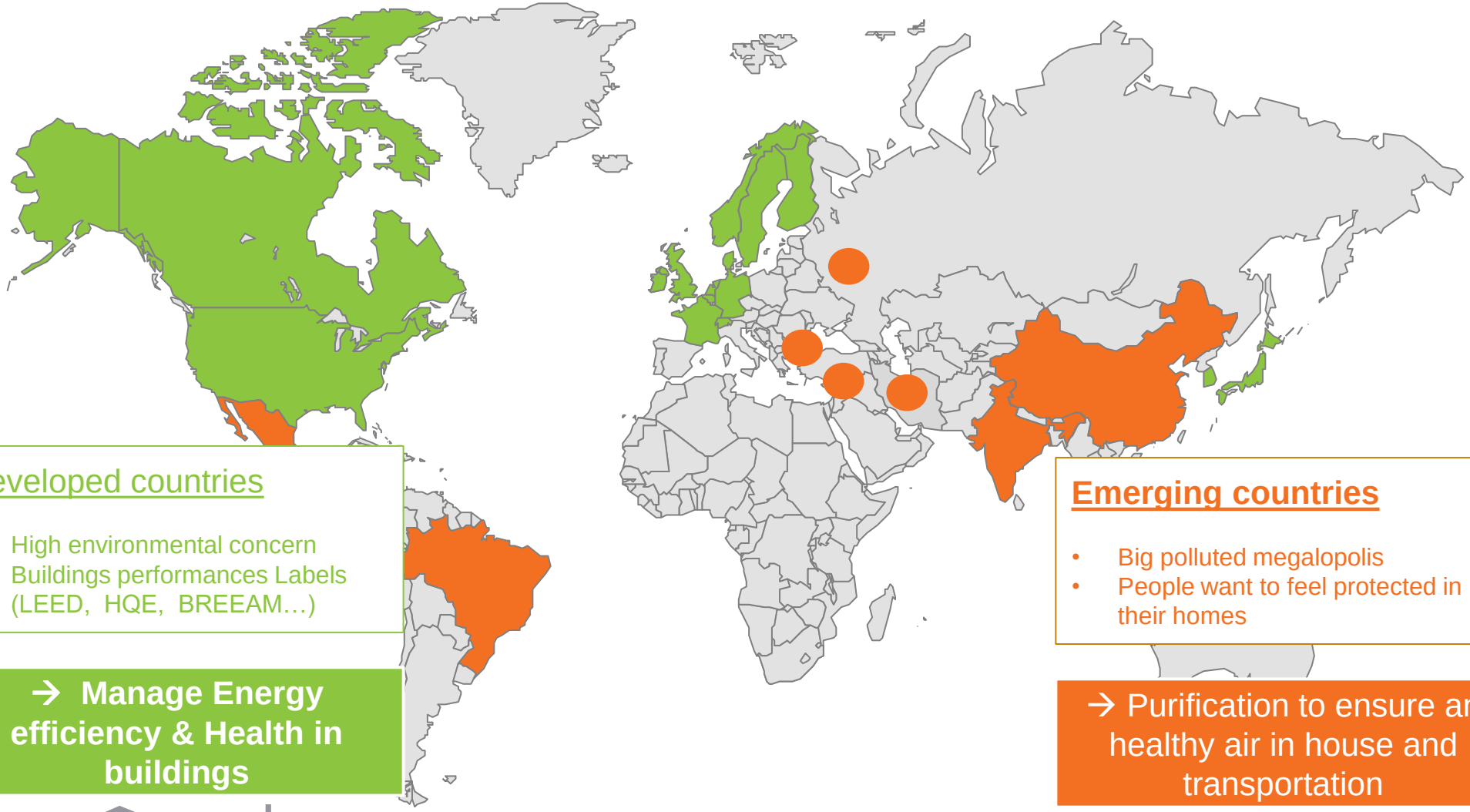
- Carcinogenic 1B category
- Most volatile VOC
- 20 ppb WHO target's value

- Widely used in building materials and home products
- UV cracked (sun exposure)
  - => no outdoor exposure

A lot of HCHO sources

- Materials :
  - Paints, floor covering, …
- Furnitures :
  - Table, chair, bed…, all composite wood's (HCHO is the standard glue)
- Products :
  - Cleaners, candles, perfumes,…

2 trends for Indoor air quality context : but One same goal : protect building air !



Developed countries

- High environmental concern
- Buildings performances Labels (LEED, HQE, BREEAM…)

→ **Manage Energy efficiency & Health in buildings**

Emerging countries

- Big polluted megalopolis
- People want to feel protected in their homes

→ Purification to ensure an healthy air in house and transportation

Existing HCHO measurement methods

DNPH : Reference method

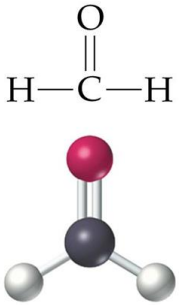
(Absorbant cartridge exposed for 15 minutes (pump) or several days (passive). Shipped to a lab for chromatography anaysis.)

- ++ : accuracy, sensitivity (ppb), specificity
- - - : timeframe, cost, equipment, provides only average values

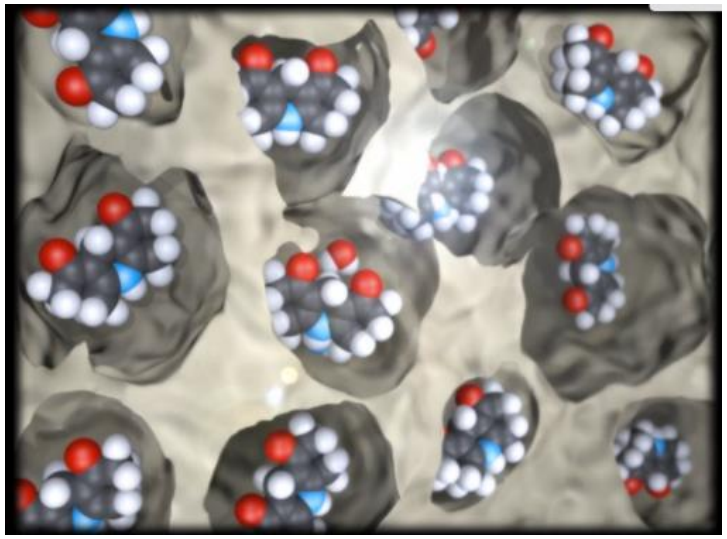
Electrochemical / PID technologies :

- ++ : Continuous immediate reading, electronic signal (connected)
- - - : Sensitivity, interferent,

A nanoporous material with Optical properties



Capacity to concentrate very low level (ppb) of chemicals : 600m2 of air exchange per gram of material

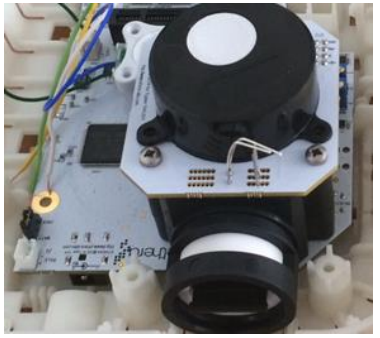


SiO2 matrix
+ probe molecule

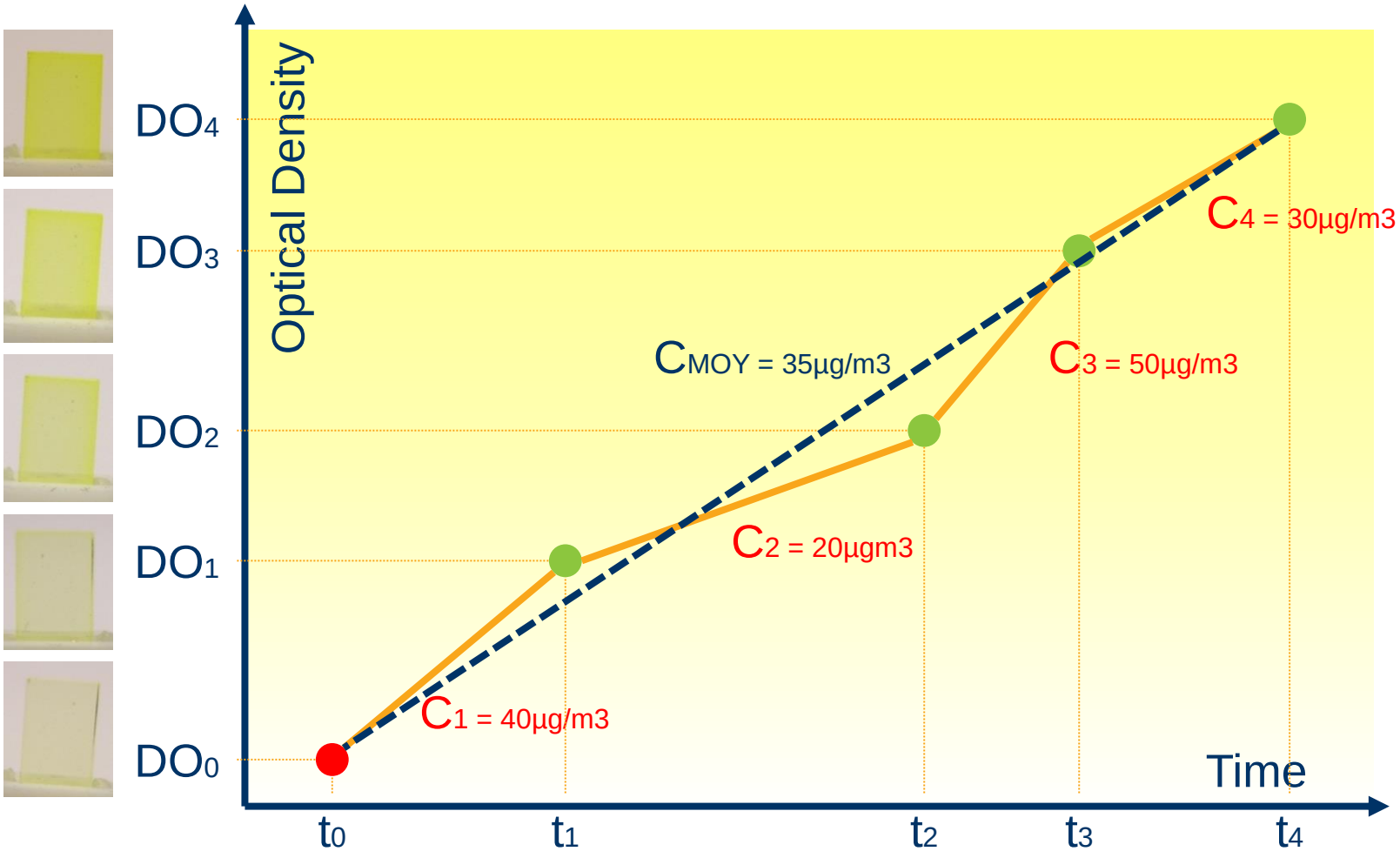
Specific and sensitive detection (ppb)

Direct immediate optical measurement

ANALYSIS



Nanoporous glass Optical Density



From a diagnostic product

To a monitoring tool….

- We need to combine the exposure chamber…
- and the reading chamber

NEMo : Next Environmental Monitoring

- Continuous measurement
  - HCHO,
  - CO2,
  - light VOCs,
  - T°, RH, P

- The tool to simplify Indoor Air diagnosis/monitoring (one-button start)
- Provides automated reports
- Option for certified calibration procedure
- Embedded communicating capacities

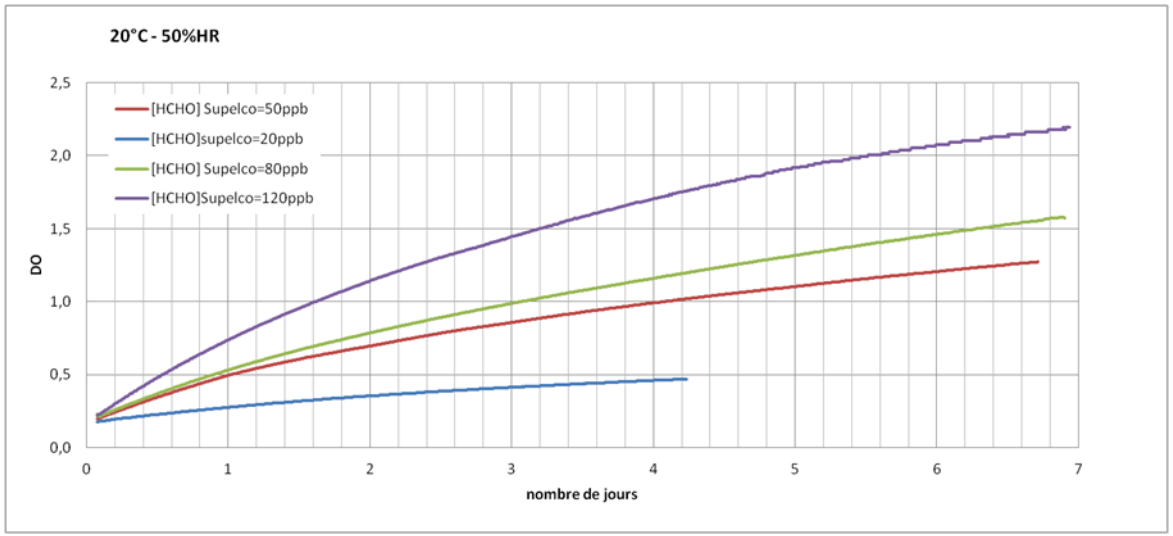
Characterization

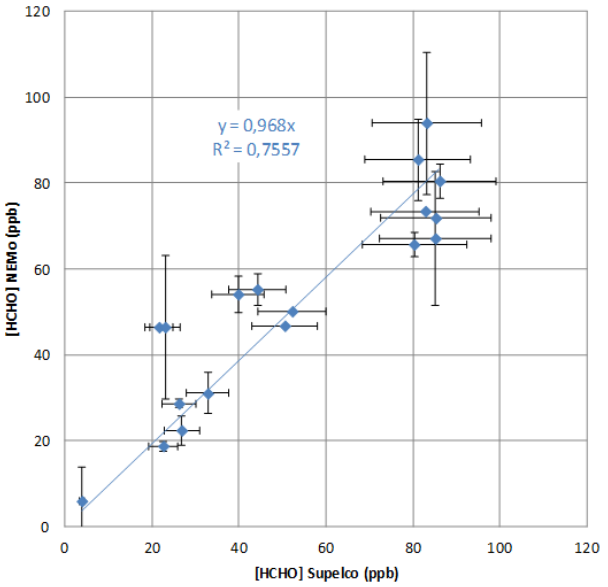
Atmospheric Simulation Chamber (ASC), 1m3
Pressure, T° (10 - 40°C), RH (20 – 80 %), air velocity (0,1 - 2 m/s), calibrated gas control

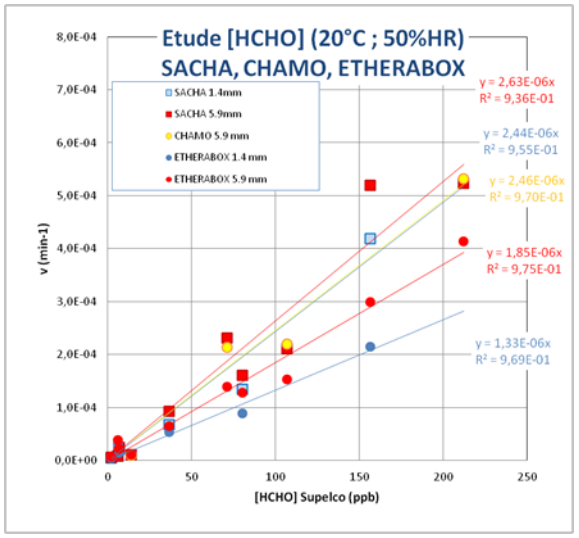
Classical characterization work

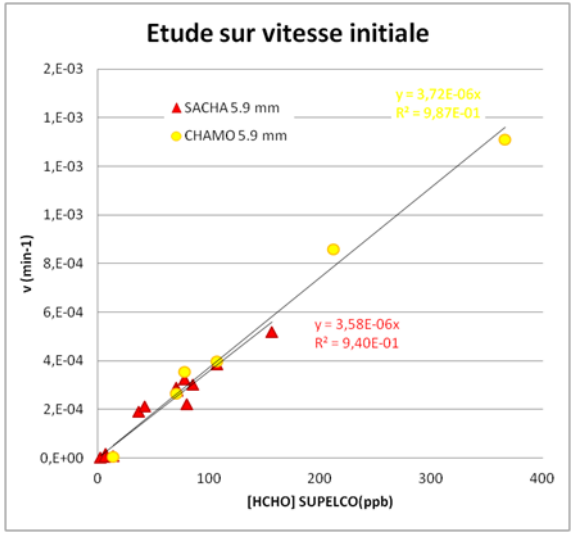
- Experimentally reproduce specific conditions : T°, RH, [HCHO]
- Compensate/calibrate data to optimize system's response
  - Linearity
  - Limit of detection & quantification
  - Repetability
  - Reproductibility
  - Uncertainty
  - Drift
  - Behavior in parameter's changes (Rapid vs progressive)
  - Influence of parameters : T°, Relative Humidity, Interferent,
- Just a 12 month work…

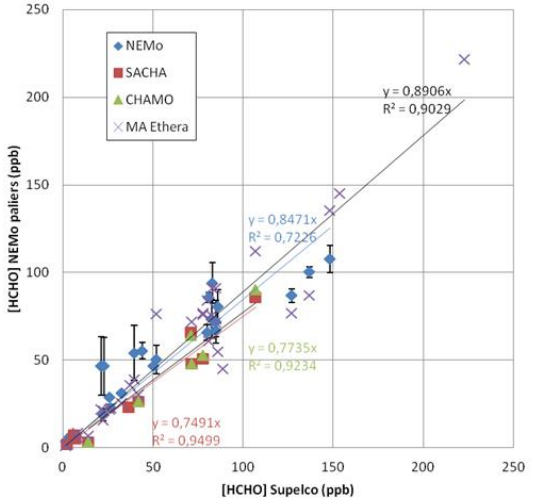
12 month…


20°C - 50%HR
[HCHO] Supelco=50ppb
[HCHO]supelco=20ppb
[HCHO] Supelco=80ppb
[HCHO]Supelco=120ppb
DO
nombre de jours

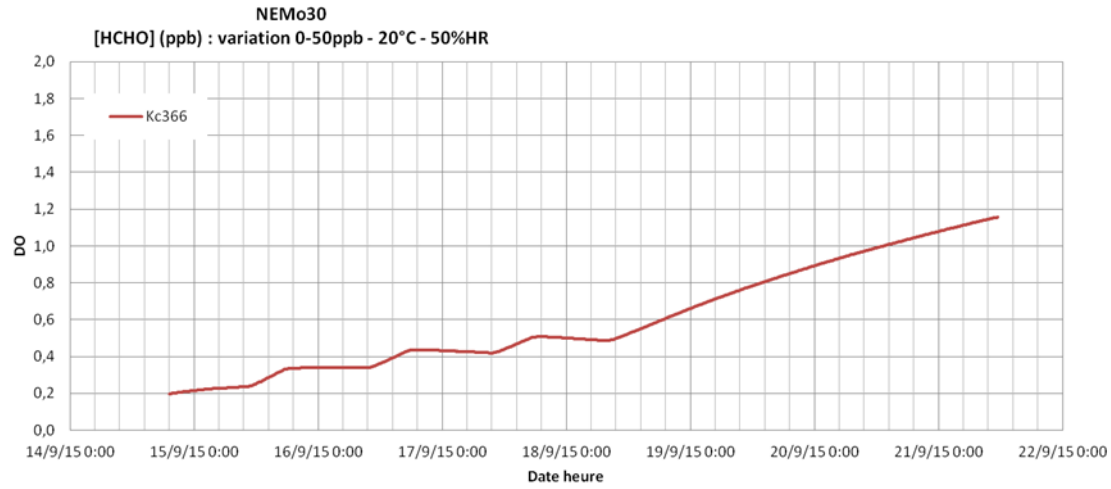

y = 0,968x
R² = 0,7557
[HCHO] NEMo (ppb)
[HCHO] Supelco (ppb)

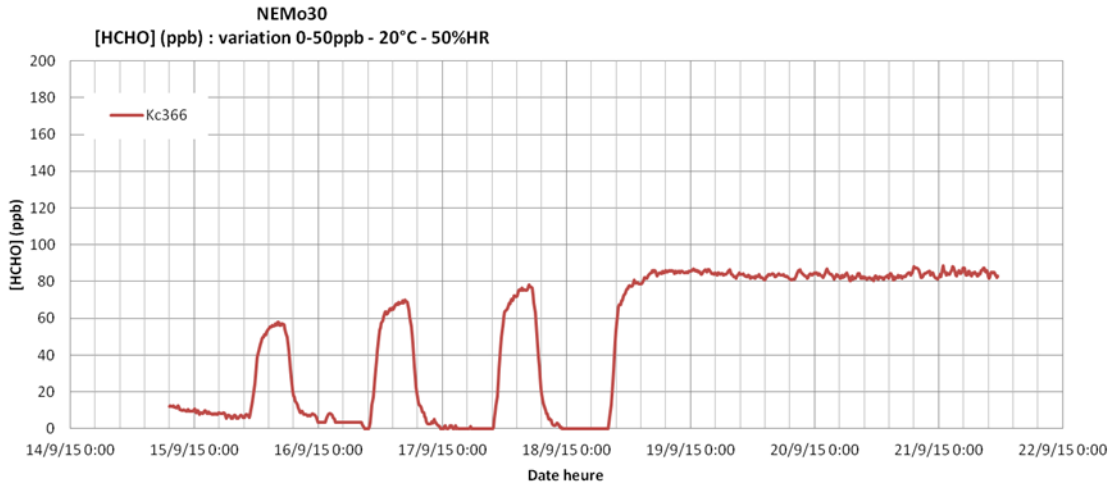

Etude [HCHO] (20°C ; 50%HR)
SACHA, CHAMO, ETHERABOX
SACHA 1.4mm
SACHA 5.9mm
CHAMO 5.9 mm
ETHERABOX 1.4 mm
ETHERABOX 5.9 mm
y = 2,63E-06x
R² = 9,36E-01
y = 2,44E-06x
R² = 9,55E-01
y = 2,46E-06x
R² = 9,70E-01
y = 1,85E-06x
R² = 9,75E-01
y = 1,33E-06x
R² = 9,69E-01
v (min-1)
[HCHO] Supelco (ppb)


Etude sur vitesse initiale
SACHA 5.9 mm
CHAMO 5.9 mm
y = 3,72E-06x
R² = 9,87E-01
y = 3,58E-06x
R² = 9,40E-01
v (min-1)
[HCHO] SUPELCO(ppb)


NEMo
SACHA
CHAMO
MA Ethera
y = 0,8906x
R² = 0,9029
y = 0,8471x
R² = 0,7226
y = 0,7735x
R² = 0,9234
y = 0,7491x
R² = 0,9499
[HCHO] NEMo paliers (ppb)
[HCHO] Supelco (ppb)

Starting variations

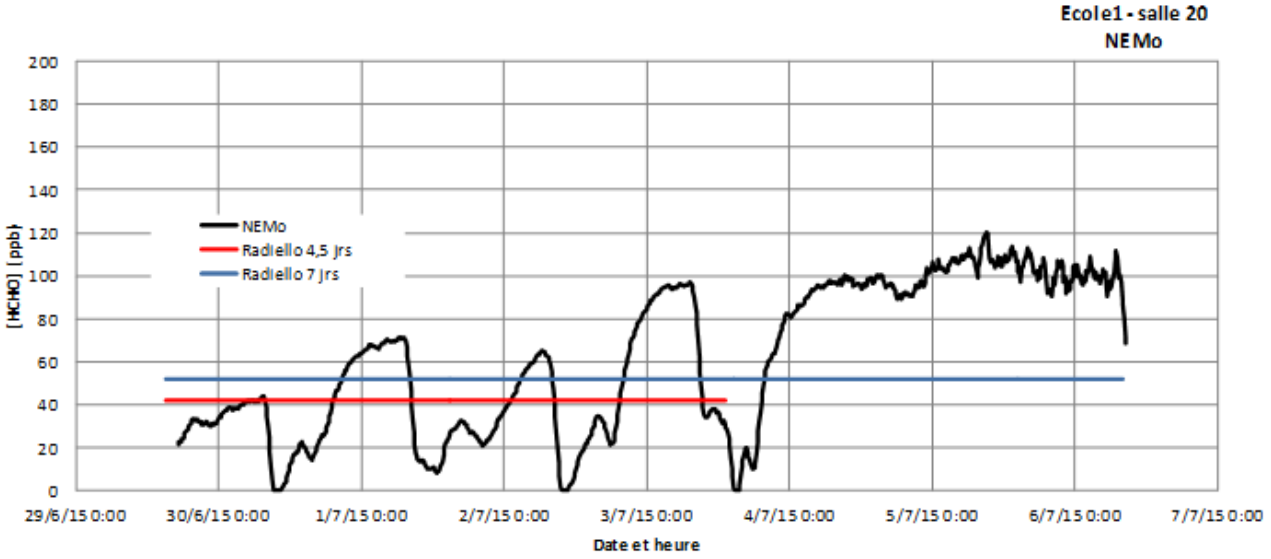


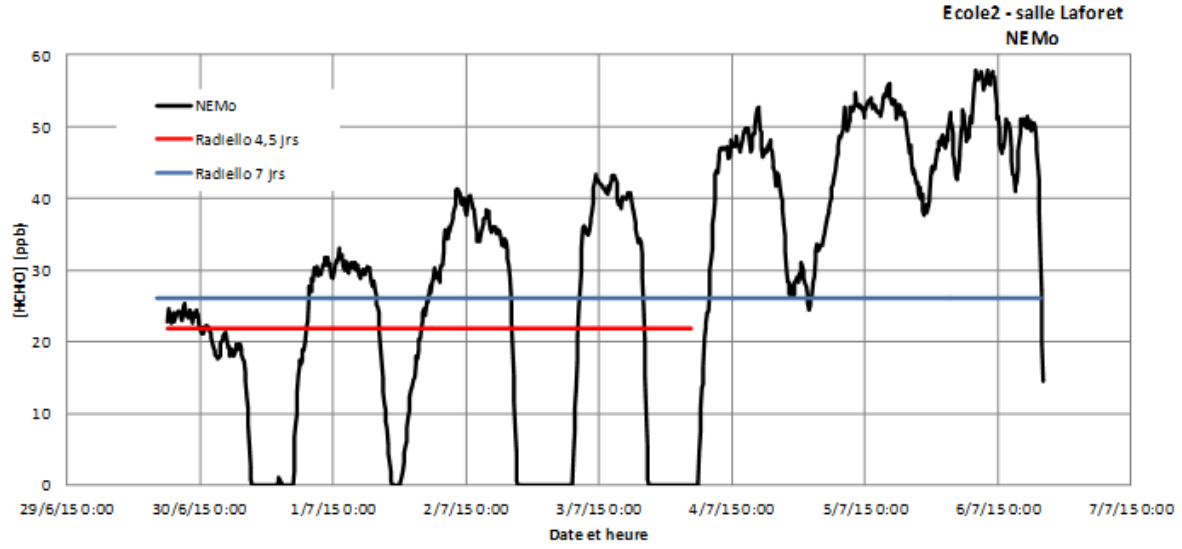


Performances summary for 7 days of use

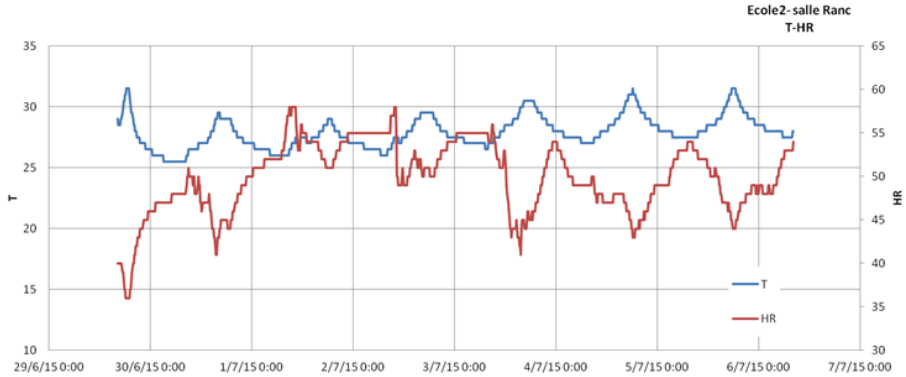
- Linearity from 0 to 100ppb : a=0,97 R2=0,76
- Reproducibility : from 6 to 9%
- Repetability : from 9 to 11%
- LoD : 1,5 ppb
- LoQ : 4,9 ppb
- Drift : compensated

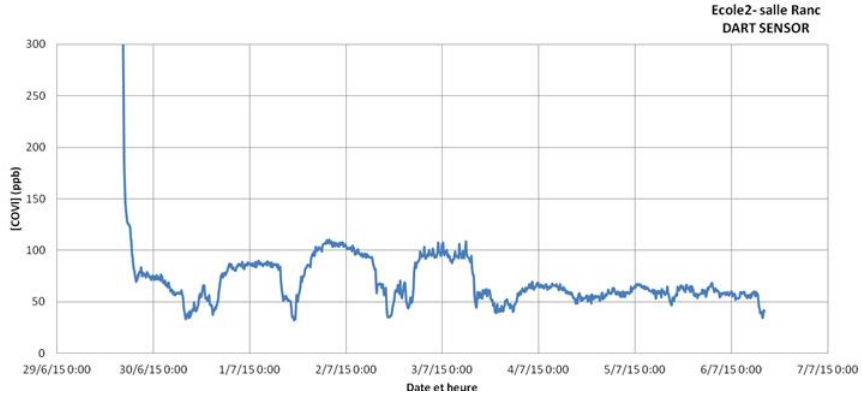
Field monitoring experiments

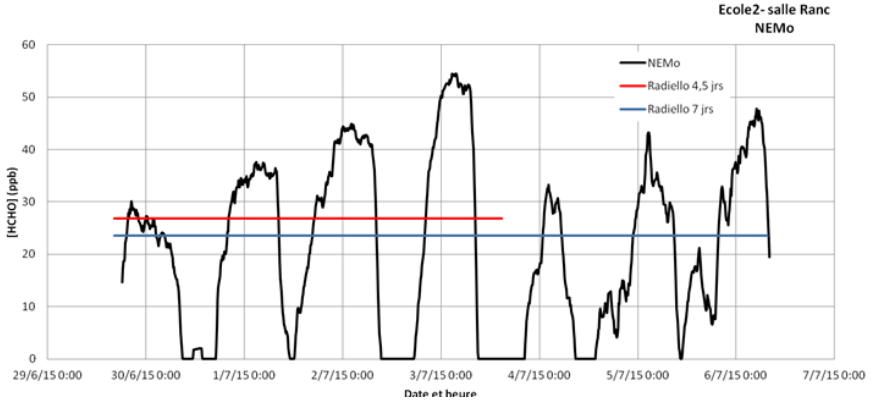


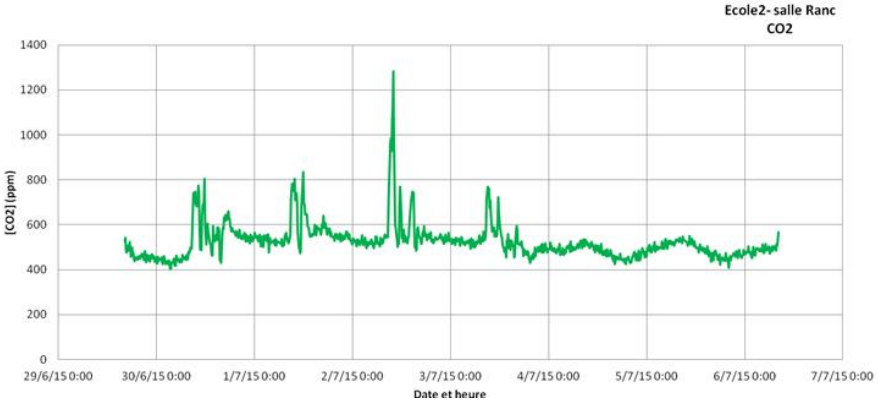


Occupation periods correlated with CO2







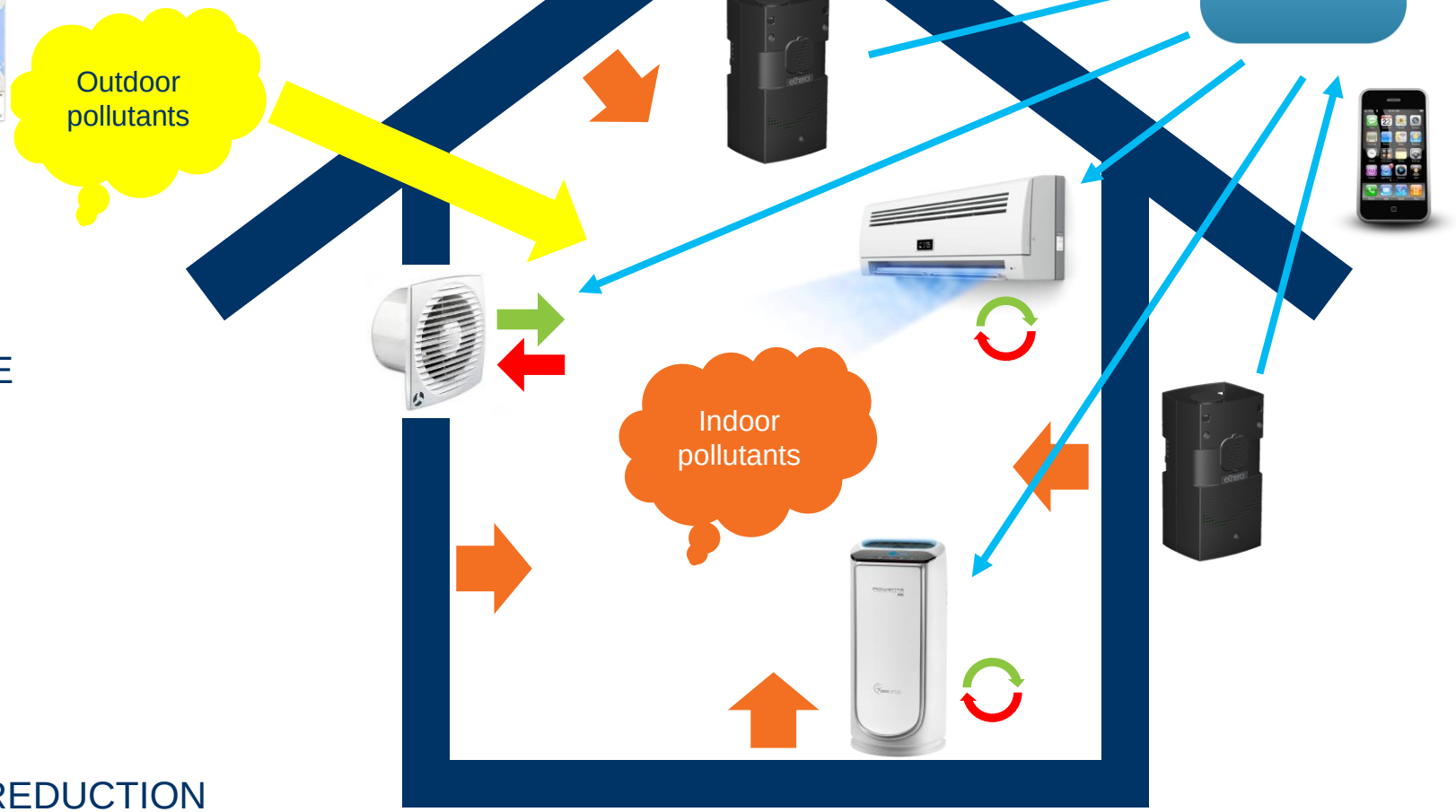


CONCLUSIONS

- Energy savings is a major priority for a sustainable behavior, and limiting building air exchanges between in/outdoor contribute to it.
- But then, indoor air can reach amazing concentration of hazardous pollutant.
- Ventilating buildings (fresh air) can be a major improvement of Indoor Air Quality when out door pollutant is controlled.
- Monitoring HCHO can help to optimize pollutant's level and energy savings, by managing buildings ventilation systems

Smart systems for smart buildings

Different strategies depending on indoor/outdoor pollutant



VENTILATE

PURIFY

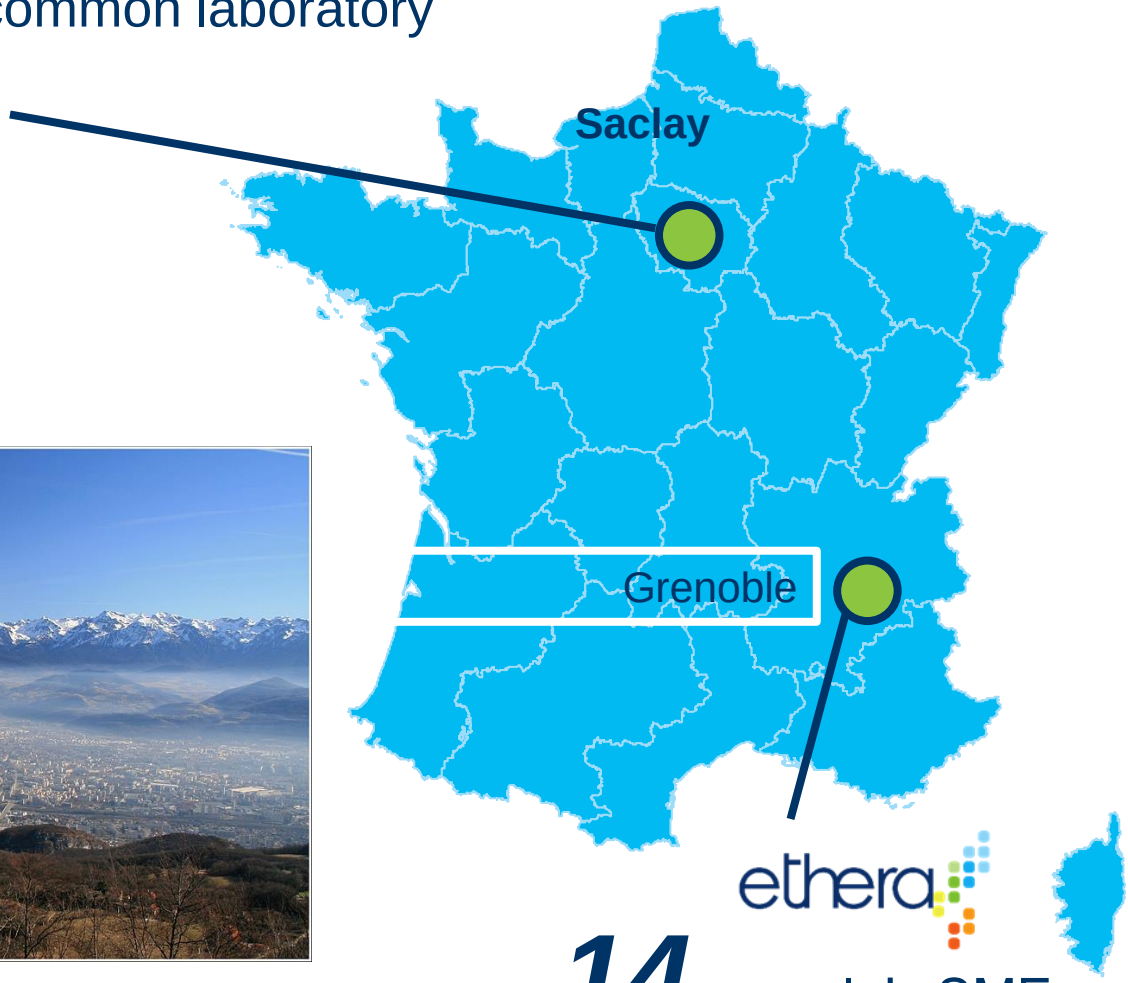
CONFORT

ENERGY REDUCTION

Thank you for your attention

frederic.hammel@ethera-labs.com

10 years of research in a common laboratory



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14 people's SME