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

COST Action TD1105

2nd International Workshop *EuNetAir* on

New Sensing Technologies for Indoor and Outdoor Air Quality Control

ENEA - Brindisi Research Center, Brindisi, Italy, 25 - 26 March 2014

INDOOR AIR QUALITY ASSESSMENT: TOWARDS A BETTER PROTECTION OF PEOPLE

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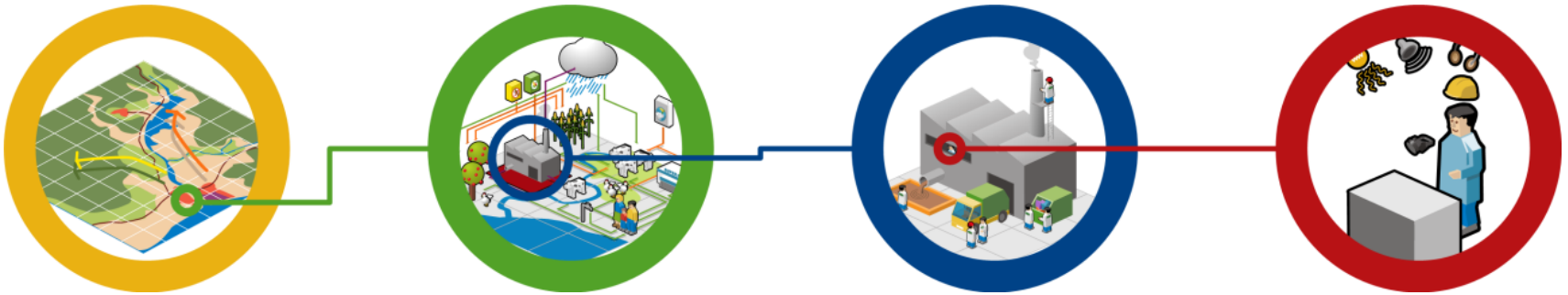
MC Member/ WG Member

IDAD - Institute of Environment and Development / Portugal

COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

IDAD - Institute of Environment and Development



Integrated approach!

Consultancy services

- Impact and Environmental Monitoring
- Air pollution
- Sustainability

Accredited Laboratory

ISO 17025:2005

IPAC acreditação
L0313
Ensaios

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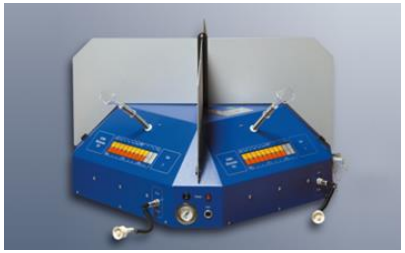
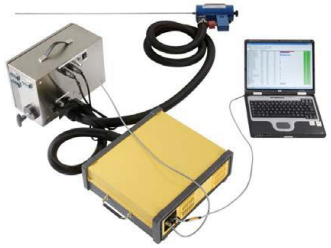
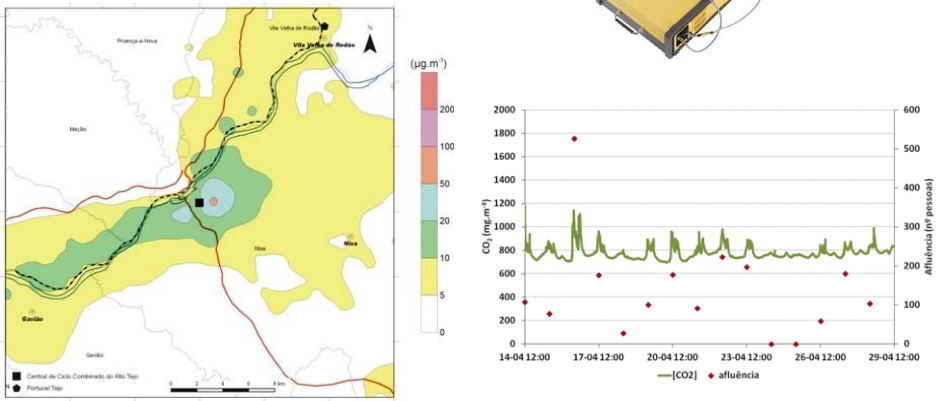
Air Pollution - IDAD activities







Examples of equipment and measurement outputs

- Stack emissions
- Ambient air quality
- Indoor air quality
- Odours assessment
- Inventories of air pollutants emissions
- Air quality modelling
- Air quality management

Impacts of Air Pollution – different scales

Global scale

- Climate change,…

Meso & Local scale

- Exposure to traffic emissions,…

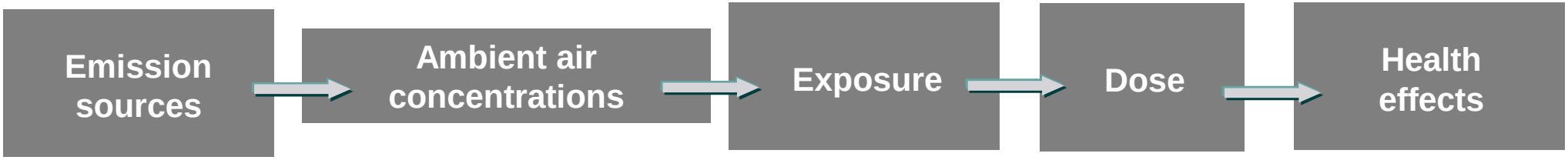
Micro-scale

- Impacts on indoor air quality!

Indoor air quality importance

We spend 80-90% of our time indoors!

Air Pollution - from sources to health effects



Emission

Quantity of a pollutant released to the atmosphere

Concentration

Physical characteristic of the environment in a given place and time

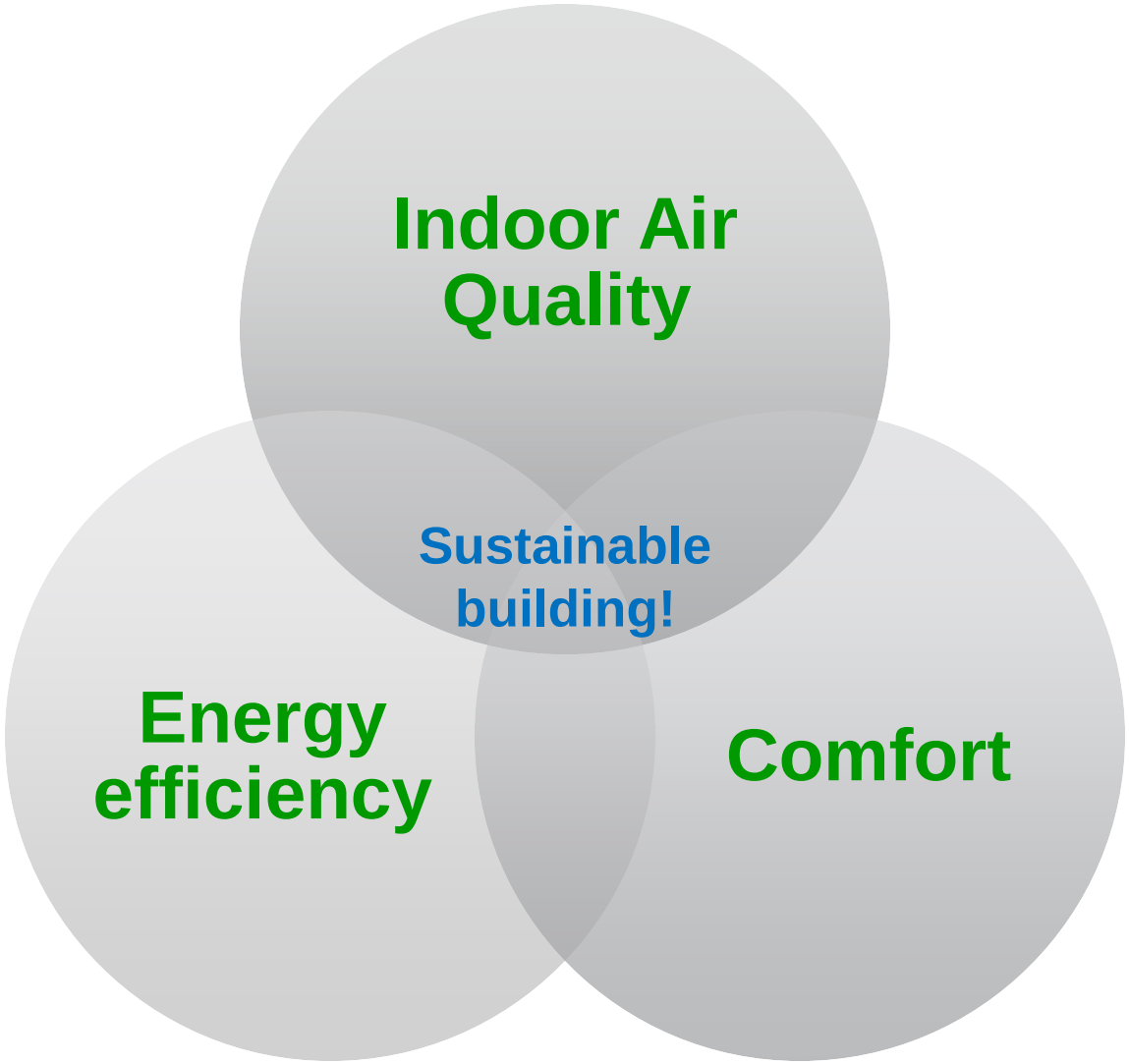
Exposure

Describes the interaction and contact with the pollutant

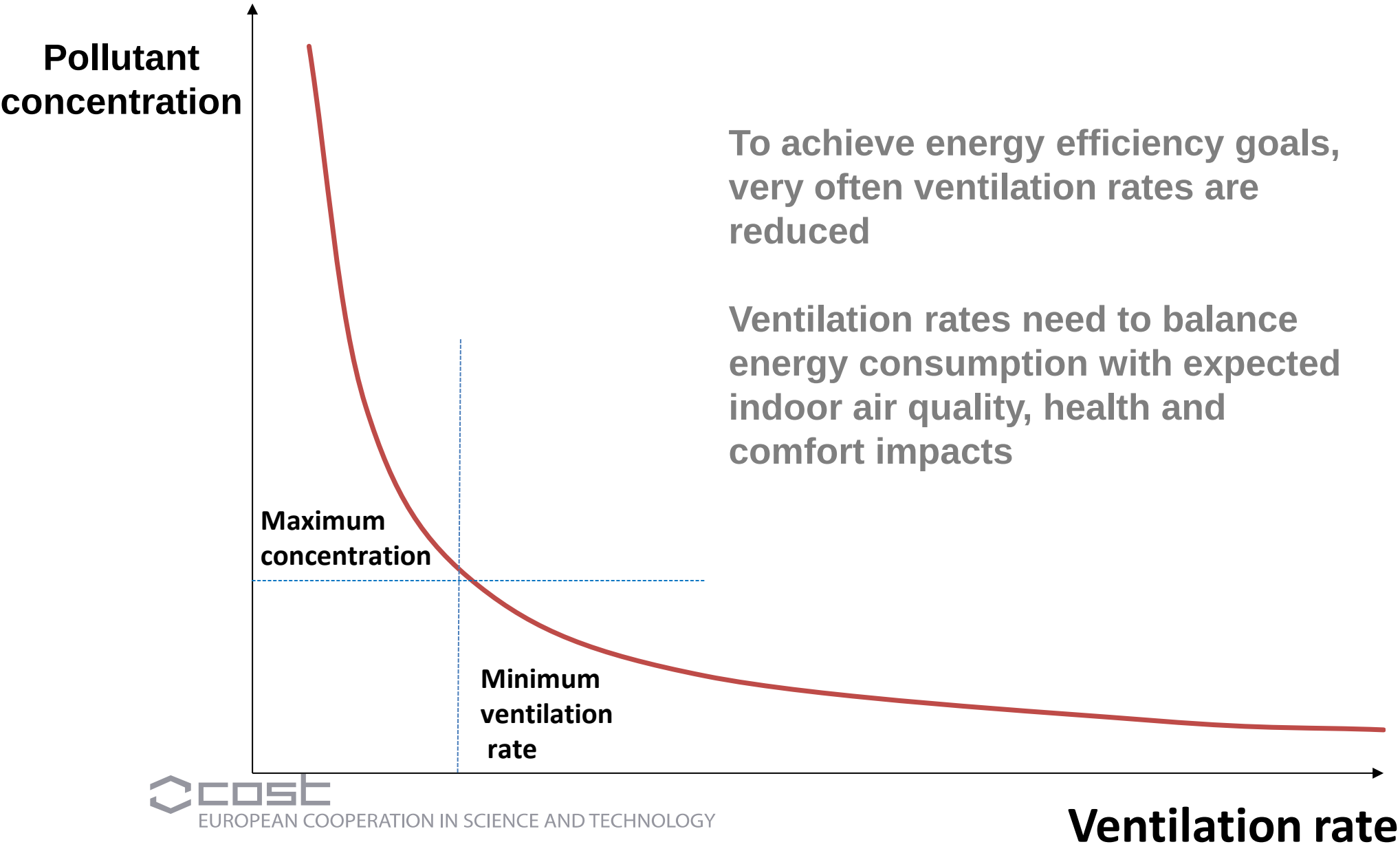
Dose

The amount of pollutant that crosses a specific barrier (skin, lung, digestive tract), usually expressed as the quantity of pollutant absorbed or deposited into the body per unit of time

Sustainable building



Indoor air quality and ventilation



To achieve energy efficiency goals, very often ventilation rates are reduced

Ventilation rates need to balance energy consumption with expected indoor air quality, health and comfort impacts

IAQ - Study case

HabitAr project

HabitAr
Estudo do Ar em Habitações Portuguesas

Sociedade Portuguesa Alergologia Imunologia Clínica

idad
Ambiente
Desenvolvimento

Methodology

557 homes distributed throughout mainland Portugal

Indoor air measurements from the master bedroom and kitchen;

Questionnaires to evaluate the inhabitants' state of health and characteristics of the houses

Statistical evaluation of the data, correlations…

Measurements performed by IDAD in cooperation with SPAIC (Society of Allergology and Clinical Immunology)

IAQ - Study case

HabitAr project

HabitAr
Estudo do Ar em Habitações Portuguesas

Sociedade Portuguesa Alergologia Imunologia Clínica

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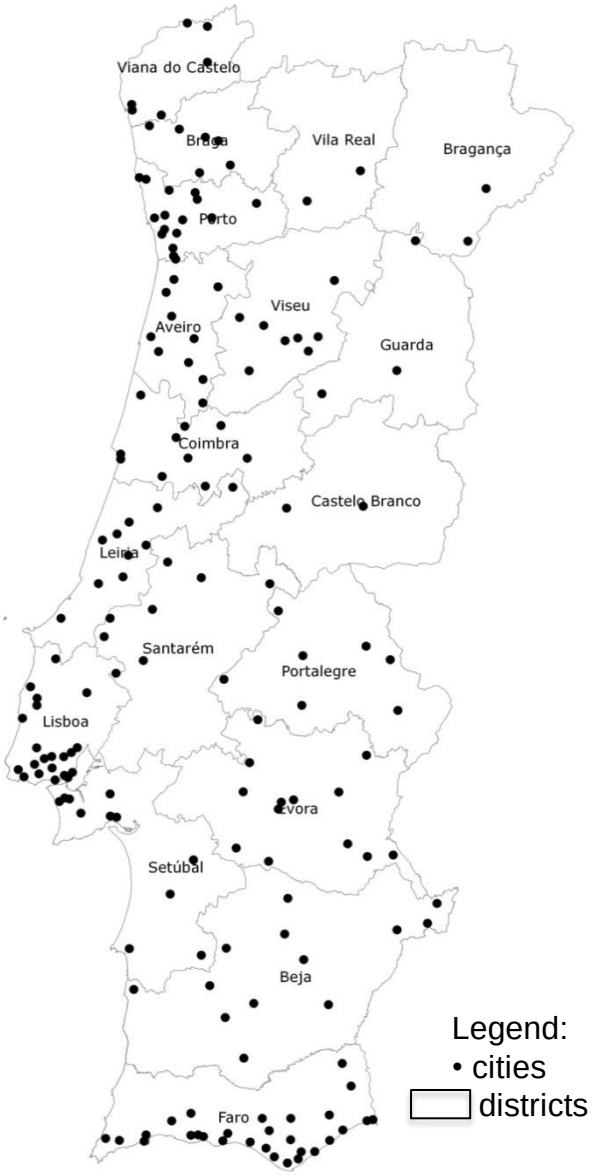
Ambiente
Desenvolvimento

- 557 homes
- Bedroom and kitchen (≈ 1100 measurements)
- December 2007 to July 2008
- Short-term measurements (≈15 min)
- Temp., HR, CO_2, PM10, VOC, CO, O_3, HCHO, SO_2, NO_2



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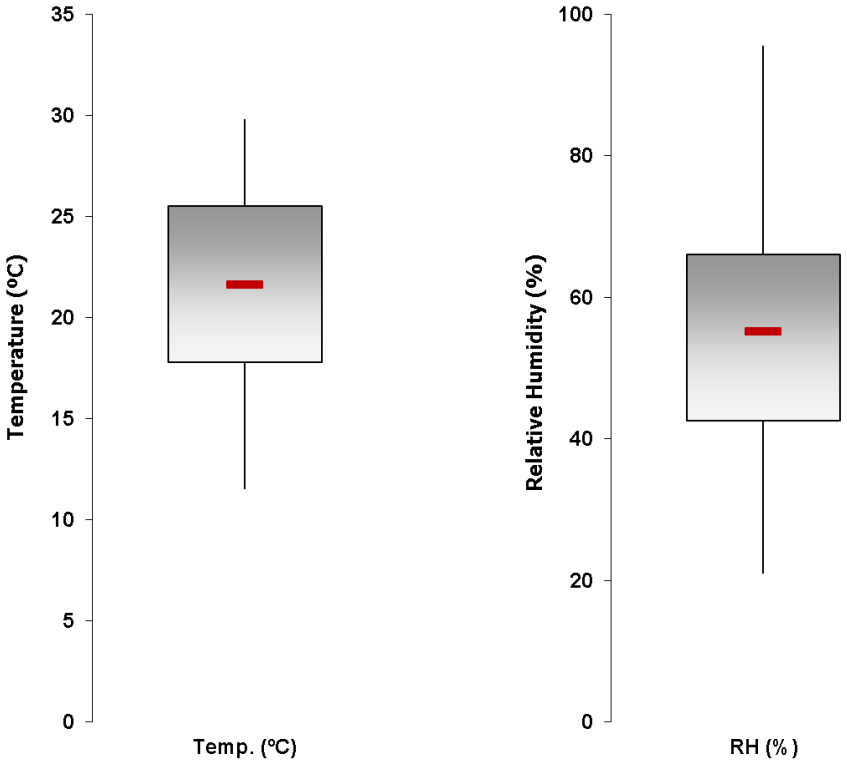
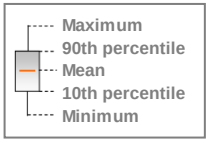
IAQ - Study case

Results

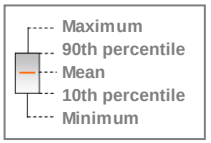




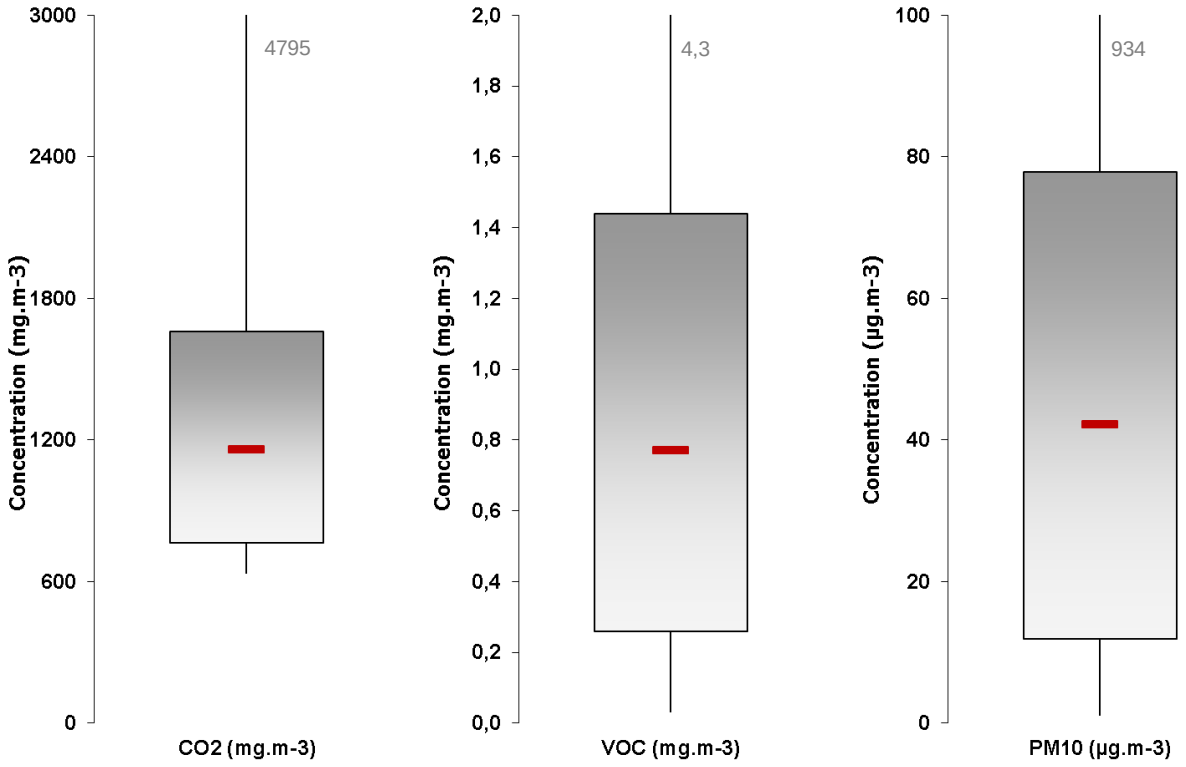
Thermal comfort parameters (Temperature, Relative humidity)

Around 60% of the houses visited had at least one measured value above the reference values.
Temperature: -mean 21.6ºC -min 11.5 -max 29.8 -10thp 17.8 -90thp 25.5ºC
HR: -mean 55.1% -min 21.0 -max 95.5 -10thp 42.6 -90thp 66.0%

IAQ - Study case



Results



Carbon dioxide (CO_2) lim>1800 mg.m^3 (7.6%)

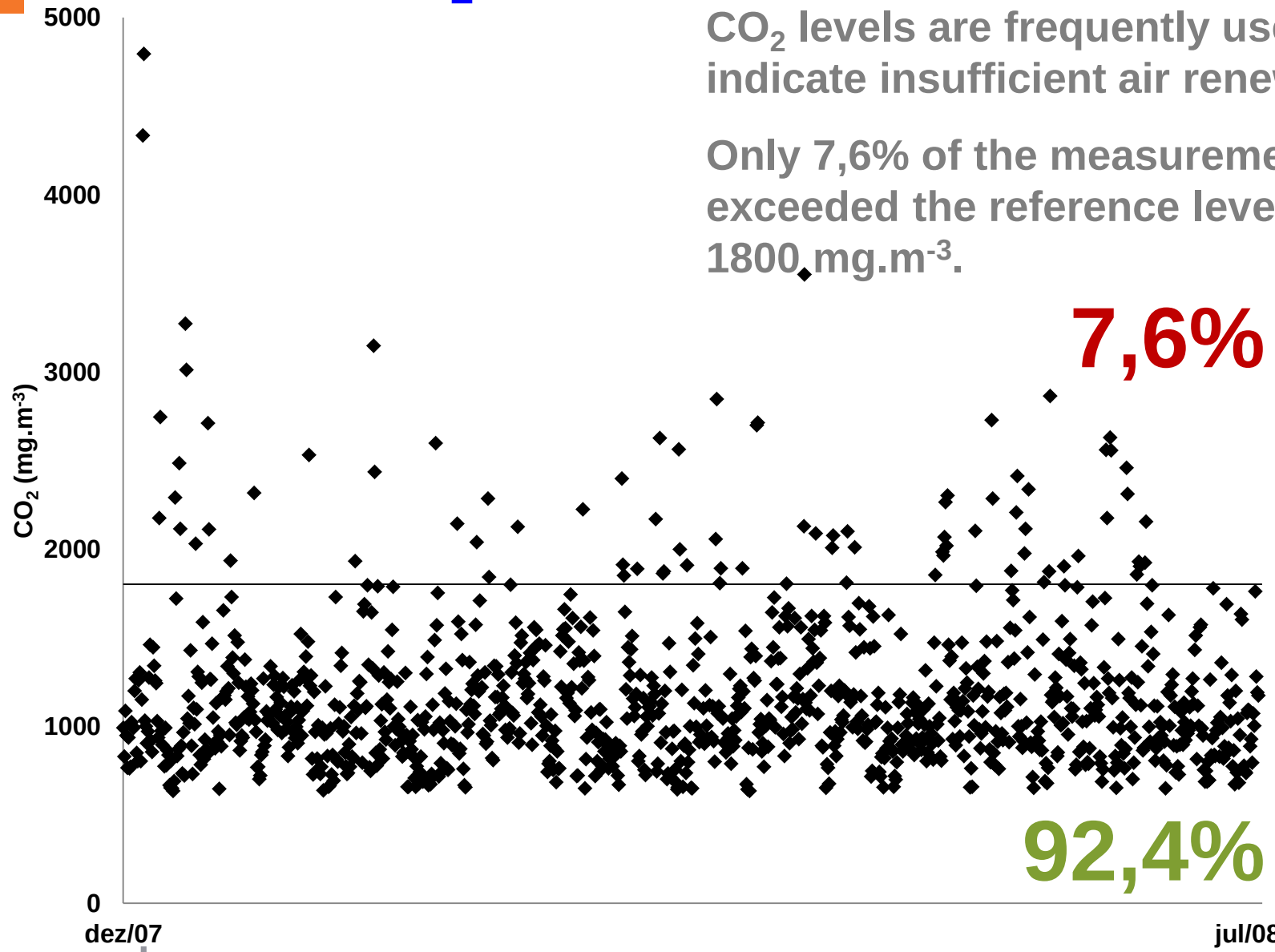
Particulate matter (PM10) annual lim > 50 µg.m^{-3} (23%)

Volatile Organic Compounds (VOC) lim>0.6 mg.m^{-3} (50%) comfort>0.2 mg.m^{-3} (94%)

Around 60% of the houses visited had at least one measured value above the reference values.

The majority of the exceedances were VOC, CO_2 and PM10

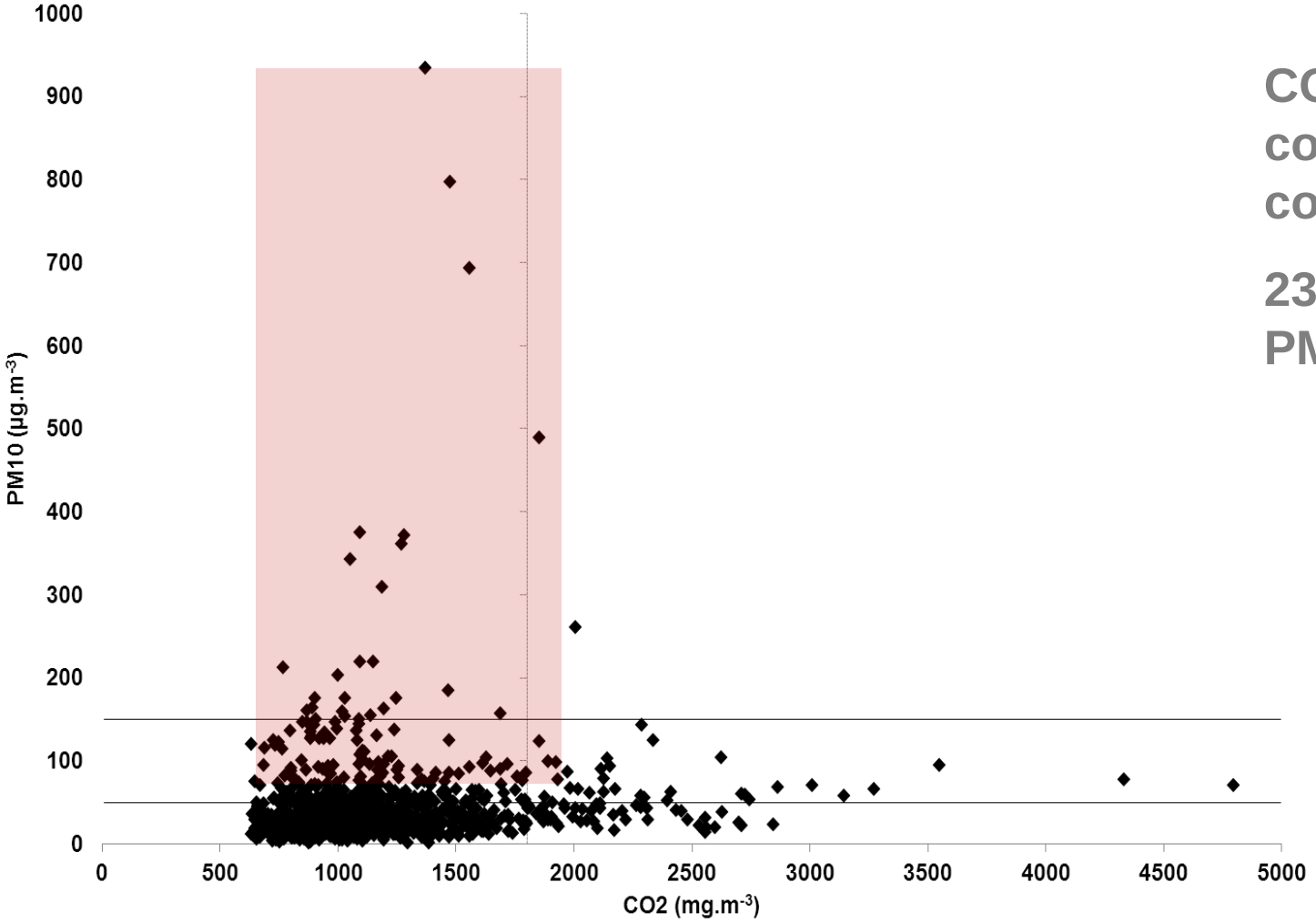
CO_2 concentration



CO_2 levels are frequently used to indicate insufficient air renewal

Only 7,6% of the measurements exceeded the reference level of 1800 $mg.m^{-3}$.

CO_2 vs PM10

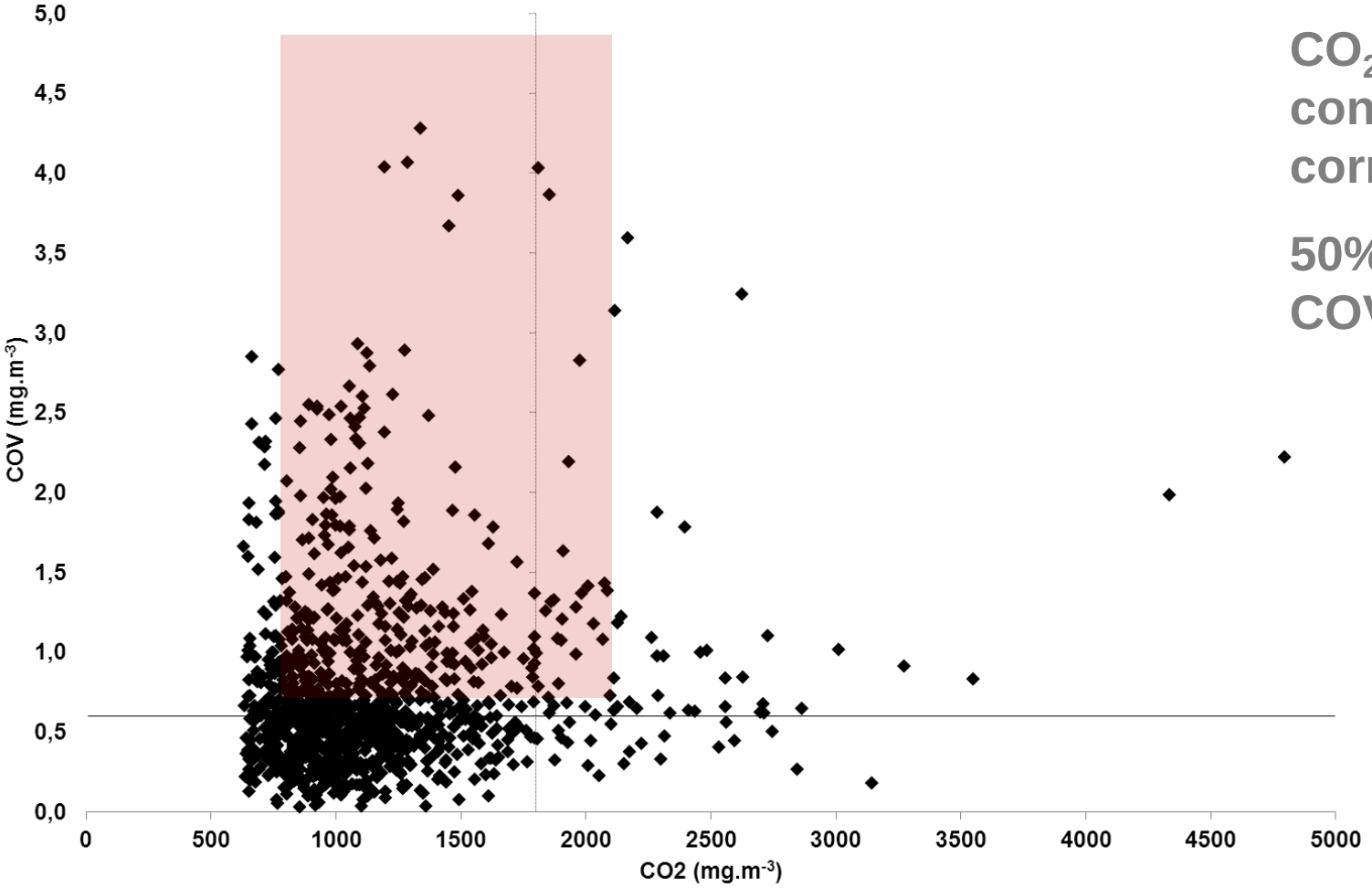


CO_2 and PM10 concentration without correlation (r^2=0,019)

23% exceedances for PM10 (> 50 µg.m^{-3})

87% exceedances were recorded with CO_2<1800 mg.m^{-3}

CO_2 vs VOC



CO_2 and VOC concentration without correlation (r^2=0,013)

50% exceedances for COV (> 0,6 mg.m^{-3})

88% exceedances were recorded with CO_2<1800 mg.m^{-3}

CONCLUSIONS

- Confirmation of the importance of some sources with relevant contribution to indoor air quality such as:
  - **tobacco smoke** or **fireplaces**;
  - individual strategies of **ventilation**;
  - and **ambient air quality**.

- Around **60%** of the houses visited had at least one measured value above the reference values (CO_2, VOC, PM10, comfort parameters).

CONCLUSIONS

- About 90% of the exceedances were recorded with CO_2 levels below 1800 $mg.m^{-3}$, this being the level usually used to indicate insufficient air renewal;

- Result: CO_2 levels should be considered with precaution as an indicator of indoor air quality;

- An intervention in indoor air quality based on the concentration of CO_2 disregard possible exceedance for PM10 and VOC.

CONCLUSIONS

- When there was at least one smoker, there was a positive correlation with higher VOC ($p = 0,009$) and PM10 ($p < 0,001$) concentrations;

- Cumulative diagnosis of asthma and/or rhinitis without correlation with evaluation of the pollutants ($p > 0,216$);

- Positive association between asthma and rhinitis symptoms over the past year and exposure in homes with higher concentrations of pollutants ($p < 0,01$);

Other developments…

- Identification of opportunities for intervention and improvement of indoor air, especially in housing conditions, control of emission sources of pollutants or adoption of new ventilation strategies in dwellings;

- **Need for raising awareness** about the impact of individual behaviour in indoor air quality;

- The use of **new sensing technologies** for indoor air quality assessment could be seen as a valuable contribution to modify individual attitudes**!**

idad

Ambiente | Desenvolvimento

Evaluation of micro-sensors against standard methods for air quality control during field campaigns

idad Ambiente Desenvolvimento 1993-2013 20 anos

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EuNetAir

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

SGX SENSORTECH

Evaluation of micro-sensors against standard methods for air quality control during field campaigns

Monitoring points

2 Porto

4 Lisbon

Data measured

T, RH, WD, WV, R, PP

PM10

CO

O3

NOx

SO_2

BTEX

Sampling time

October 2013 - January 2014

(≈7 days each location)

Parallel measurements with SGX micro sensors

3 - CO/VOC

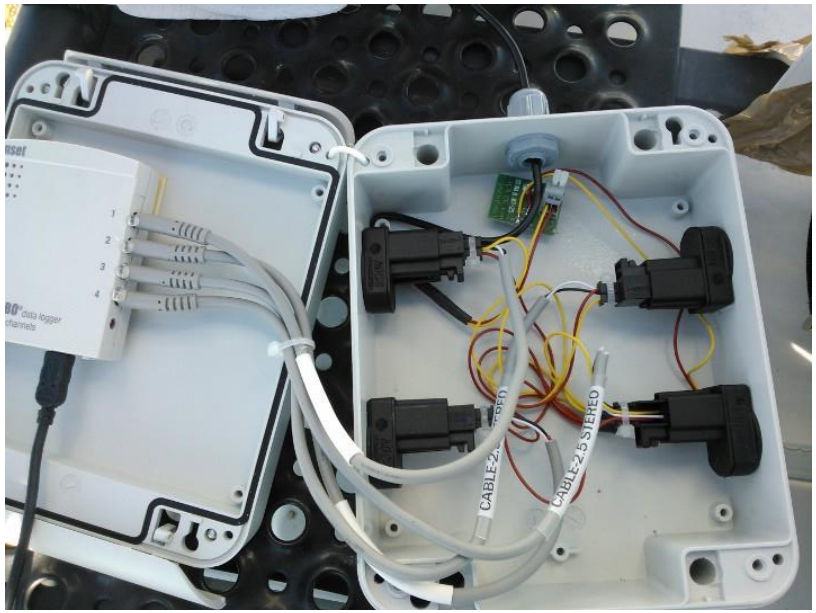
3 - O_3

2 - NO_2

IDAD mobile laboratory

PM10	Environnement MP101M	ISO 10473:2000: Measurement of the mass of particulate matter on a filter medium **– Beta-ray absorption method**
Carbon Monoxide	Environnement CO11M	EN 14626:2005: Ambient air quality – Standard method for the measurement of the concentration of carbon monoxide by **nondispersive infrared spectroscopy**
NOx	Environnement AC31M	EN 14611:2005: Ambient Air Quality – Standard method for the measurement of concentration of nitrogen dioxide and nitrogem monoxide by **chemiluminescence**
Benzene	Environnement VOC71M	EN 14662:2005: Standard method for measurement of benzene concentrations (**gas chromatography)**
Ozone	Environnement O341M	EN14625:2005: Ambient air quality – Standard method for the measurement of the concentration of ozone by **ultraviolet photometry**
SO_2	Environnement AF21M	EN 14212:2005: Ambient Air Quality – Standard method for the measurement of concentration of sulphur dioxide by **ultraviolet fluorescence**

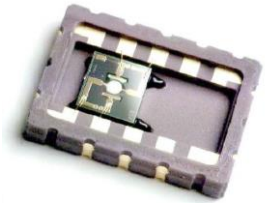
SGX sensors

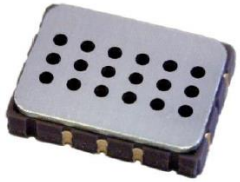


Ozone – MiCS-2614

CO/VOC – MiCS-5524

NO_2 – MiCS-2714

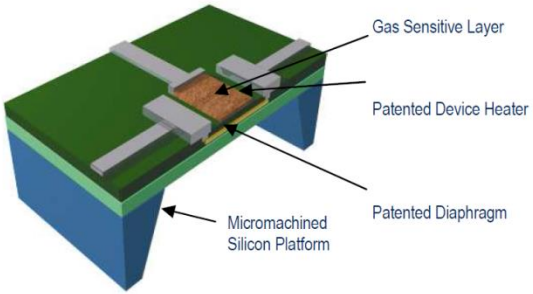




MOS sensors

Metal Oxide Semiconductor

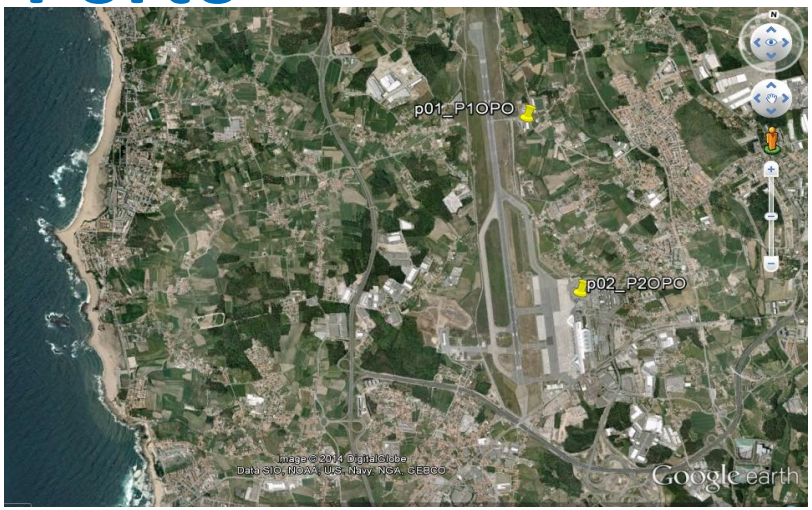
- The gas sensor is a micro-machined structure equipped with a sensitive resistance (R_S) placed on top of a heating resistance (R_h).
- The resistance of a semi-conductor changes with the concentration of the pollutant being monitored.
- The concentration is calculated as the measured resistance (R_S) adjusted by the calibration and temperature compensation parameters.



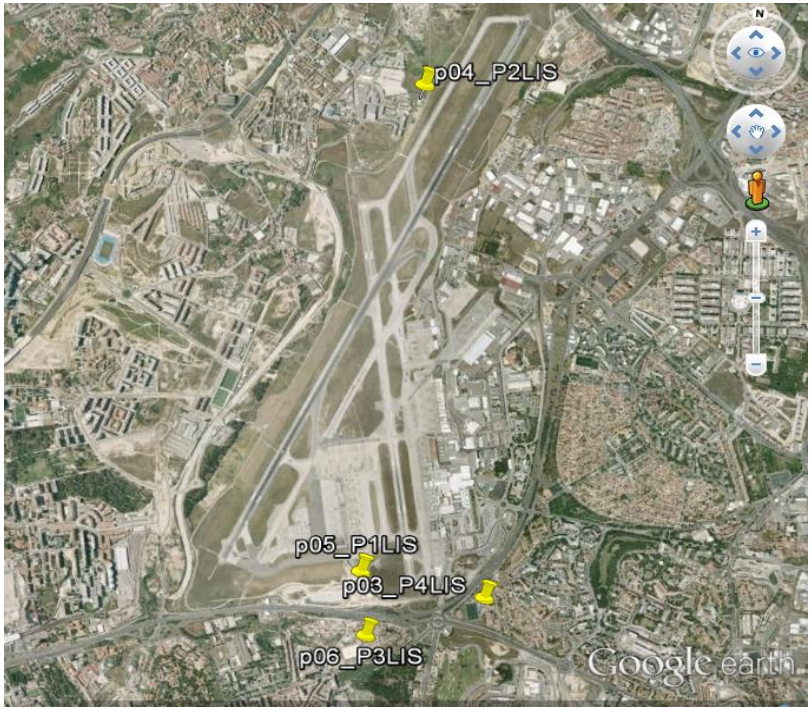
Ozone sensor chip in ceramic package

Chip size	1.7 x 1.9 mm
Package size	5 x 5 mm

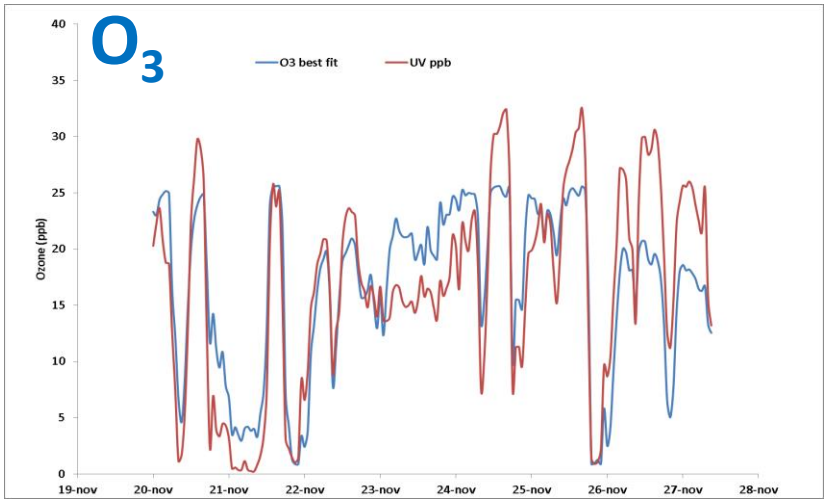
Porto



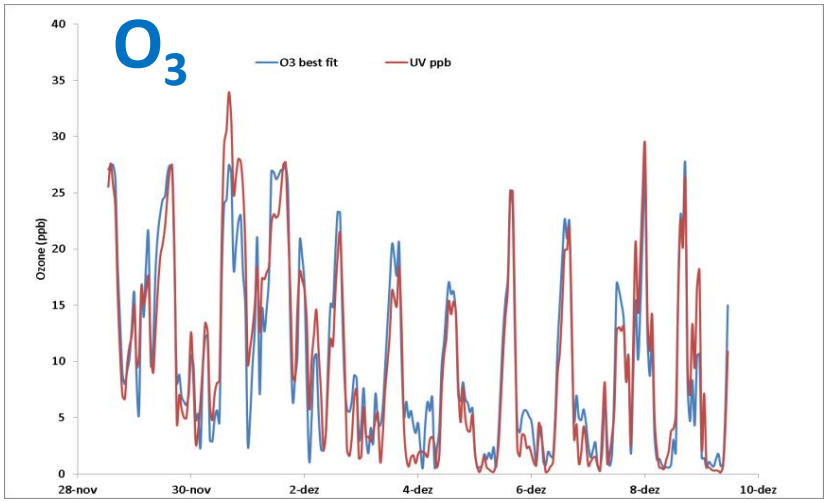
Lisboa



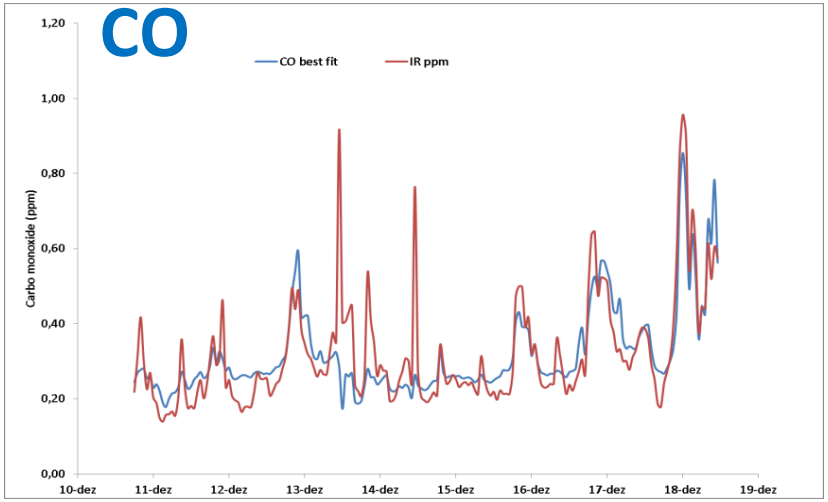
Examples of preliminary correlations



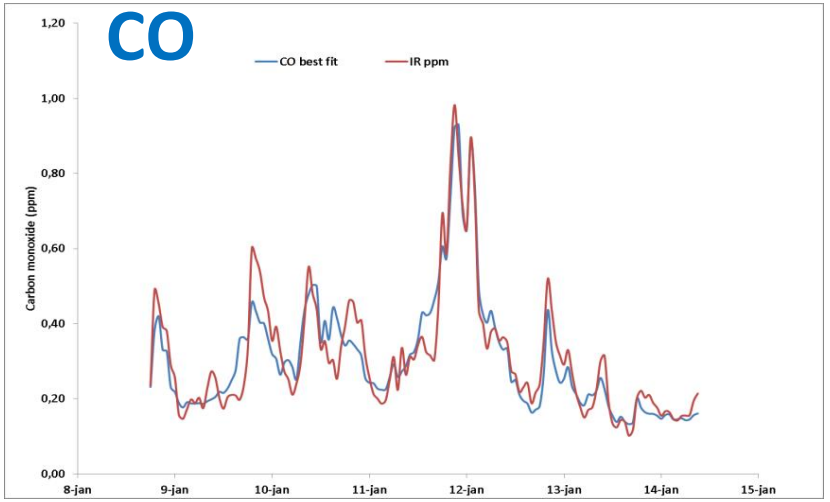
•R^2=0,70



•R^2=0,88



•R^2=0,64



•R^2=0,87

Comments (preliminary evaluation)

- Strong correlation in a significant part of the measurements, between micro-sensors and standard methods (≈0,7 to 0,9);
- Some cases with saturation, erratic behaviour.

Next steps

- More detailed analysis of the data;
- Evaluation of influences in the error/uncertainty (RH, other pollutants,..);
- Identification of protocols/guidelines for procedures;
- Additional field campaigns / different concentrations / different weather conditions;

EuNetAir Air Quality Joint-Exercise Intercomparison 2014

Air quality campaign at Aveiro city centre

postpone from April to October 1-3? 2014

- Continuous measurements PM10, PM2.5, CO, NOx, SO_2, O_3, CO_2 , VOC (BTEX)
- Temperature, humidity, wind velocity, wind direction, solar radiation, precipitation
- Traffic flow measurements with traffic cameras

EuNetAir Air Quality Joint-Exercise Intercomparison 2014

Air quality campaign at Aveiro city centre

postpone from April to October 1-3? 2014

Objectives

- **To evaluate AQ micro-sensors measurements against standardised AQ methods**
- **To study and assess protocols and methods devoted to low-cost gas sensors for AQC with definitions of guidelines for standards**
- **To develop guidelines for AQ micro-sensors comparison against standardised AQ methods**
- **To establish joint publications and networking activities (e.g. meeting on results, others)**

All COST partners are invited to install their micro-sensors side by side with our air quality standardised equipment

If necessary you can send us your equipment by mail

Aveiro