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

COST Action TD1105

Final Meeting at PRAGUE (CZ), 5-7 October 2016

New Sensing Technologies for Air Quality Monitoring

NEW TRENDS AND CHALLENGES OF AIR POLLUTION MONITORING USING LOW-COST SENSORS: WHAT IDAD LEARNED?

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COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

IDAD - Institute of Environment and Development

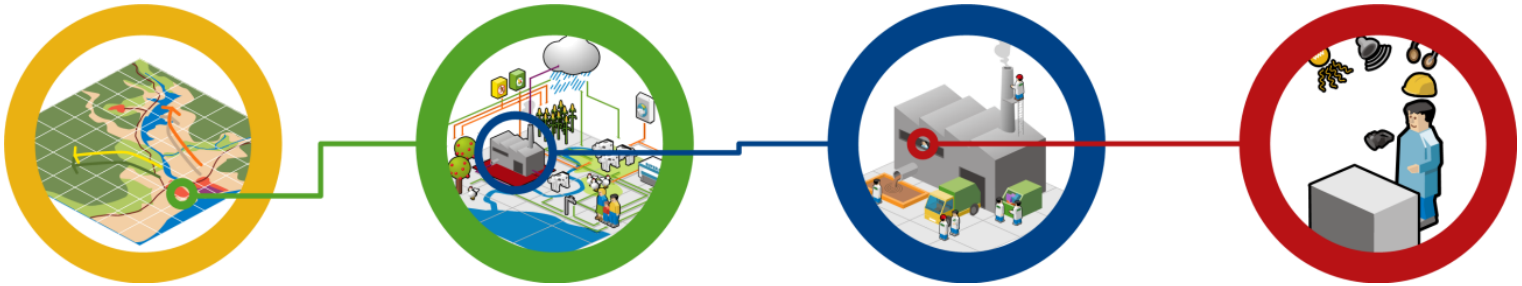
areas of activity

- **Air pollution**
- **Impact Assessment and Environmental Monitoring**
- **Sustainability**

Lab accreditation

ISO 17025:2005

IPAC acreditação
L0313
Ensaios



Integrated approach!

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Turning Research into Products and Services

Example of current activities:

Air quality monitoring

- Airports, Maritime Ports
- Urban, Industrial Areas
- Indoor air quality

Odours assessment/stack emissions/leakage emissions

- Industrial activities

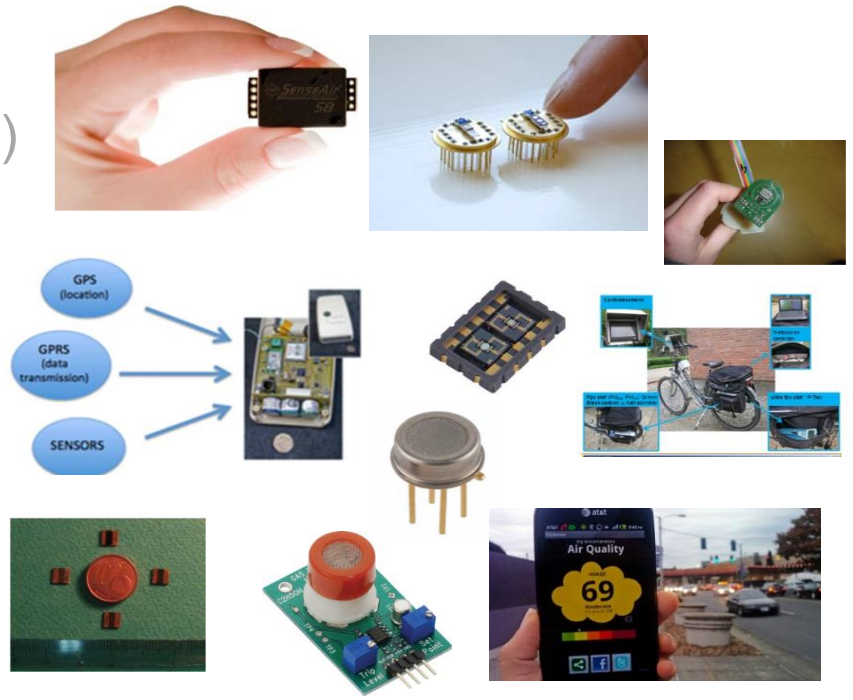
Dispersion modelling / air quality management

- Environmental assessment
- Information for decision makers

New Sensing Technologies for Air Quality Monitoring

Micro-sensors: What for?

- New monitoring services (Large area facilities, Urban, Refineries, Airports, Ports,…)
- Dense 2D grid (Visualization, mapping)
- Identification of emissions hotspots
- Concentration spatial profiling
- Data assimilation in modeling studies (Forecasting improvement)
- Low cost of investment, Low maintenance
- New markets!..



NEW TRENDS AND CHALLENGES OF AIR POLLUTION MONITORING USING LOW-COST SENSORS: WHAT IDAD LEARNED?

1. **Integration of micro-sensors in IDAD activities**
2. **Cooperation between COST partners**
3. **Improvement of IDAD's knowledge, ensuring at the same time the framework to test new sensor technologies for air pollution control**

Integration of micro-sensors in IDAD activities

Challenges of an air quality and noise sensor network on a maritime port

Case study on a Portuguese Port



- ✓ The movement of dry bulk cargo, ships and road vehicles are the main port activities with possible impacts on **air quality** through the emission of atmospheric pollutants.
- ✓ Ship operations and cargo handling in ports cause problems with disturbing **noise** in nearby dwellings.

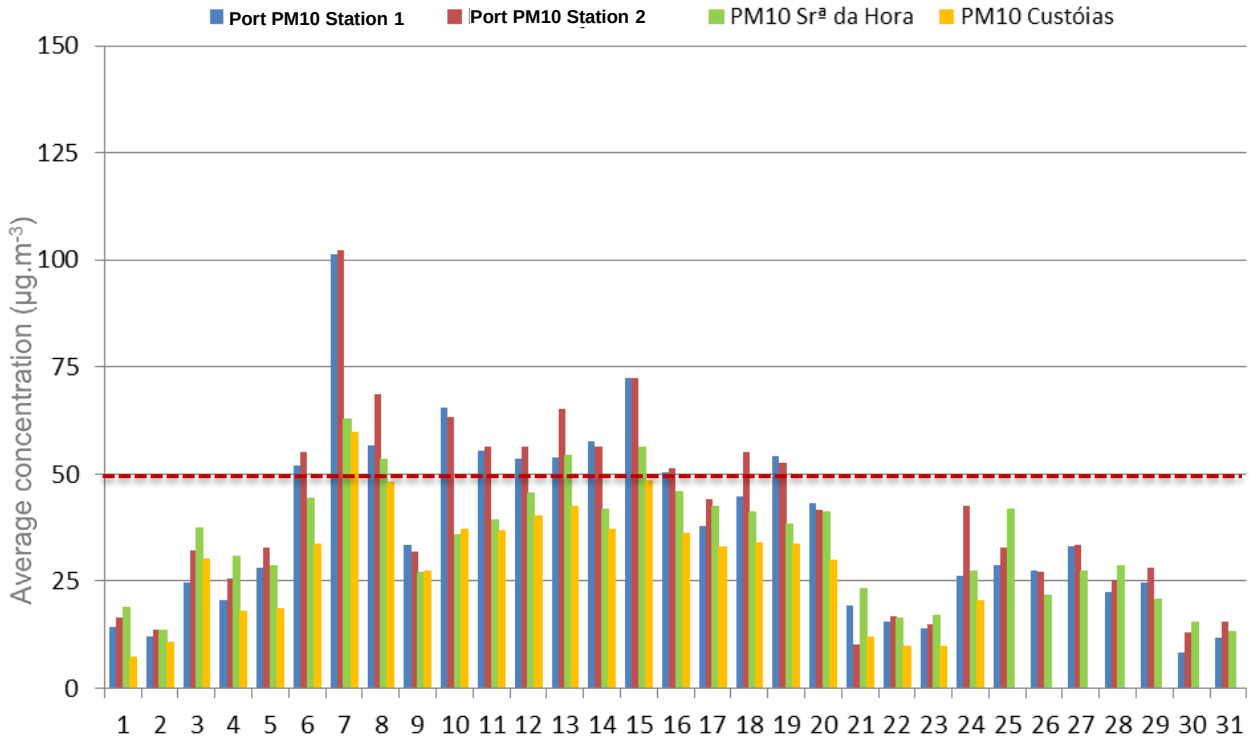
The impact of air quality and noise are particularly relevant in ports situated adjacent to urban areas, being the most common cause of complaints from the nearby residents

Integration of micro-sensors in IDAD activities

Challenges of an air quality and noise sensor network on a maritime port

Case study on a Portuguese Port

Custóias AQ station (urban background) and Srª da Hora station (traffic) from the National AQ network



- Increase of PM10 concentrations in port AQ stations vs national AQ network.
- Exceedance of PM10 concentrations at port AQ stations as result of port activities (dry bulk discharge, emissions from ships, machinery and road traffic).

Integration of micro-sensors in IDAD activities

Challenges of an air quality and noise sensor network on a maritime port

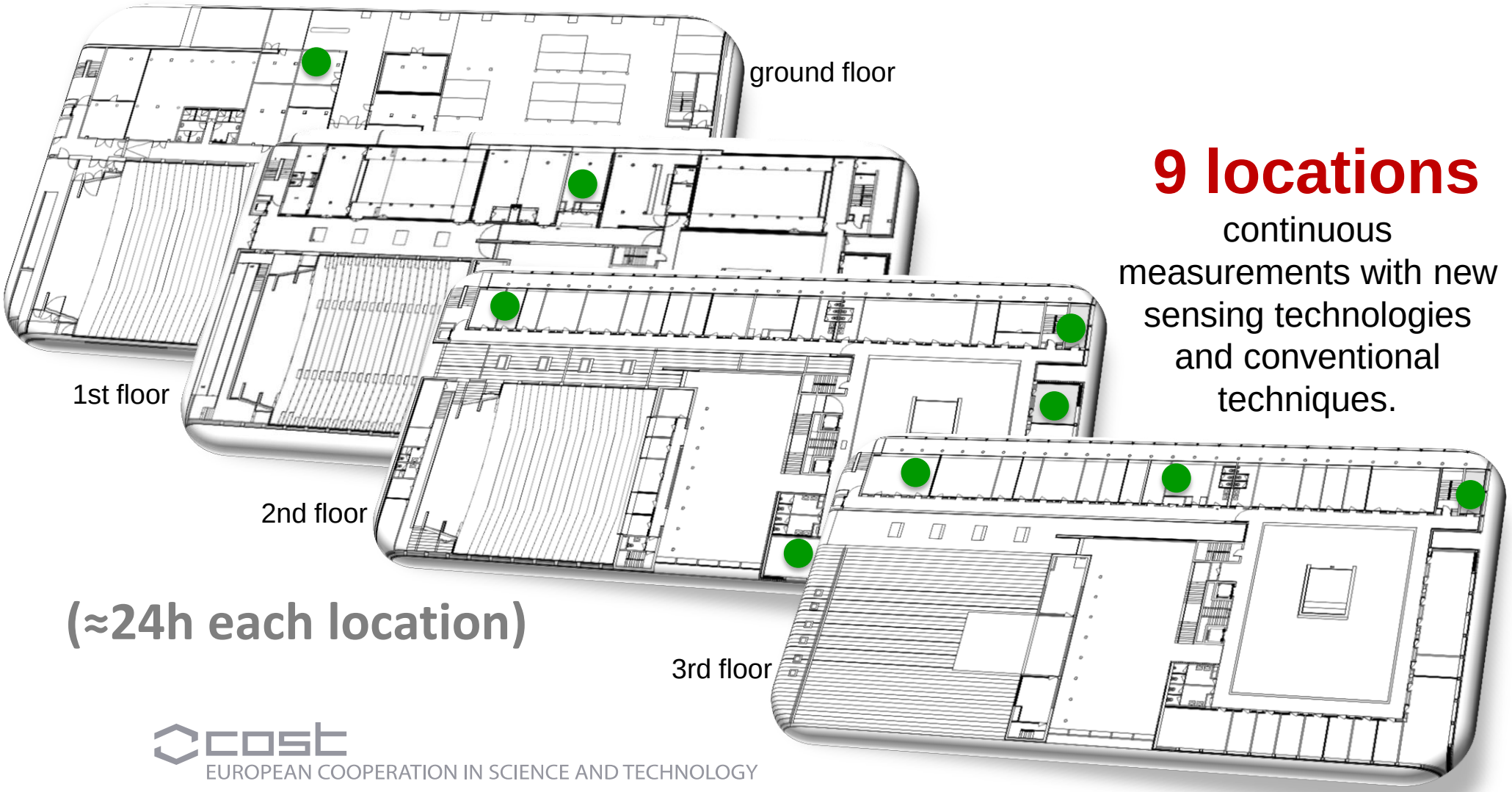
AQ and noise sensor network

A new air quality monitoring strategy with a wide network of air quality and noise sensors in the port area is being studied, allowing for real-time monitor in a large number of locations.

This network (15 sensor box) could be integrated in the smart management interface of Port authorities, crossing information with the type of vessels and cargoes, enabling real-time alerts with the adoption of effective prevention and mitigation procedures.

Integration of micro-sensors in IDAD activities

Indoor air quality assessment in a public building using micro-sensors and conventional methods

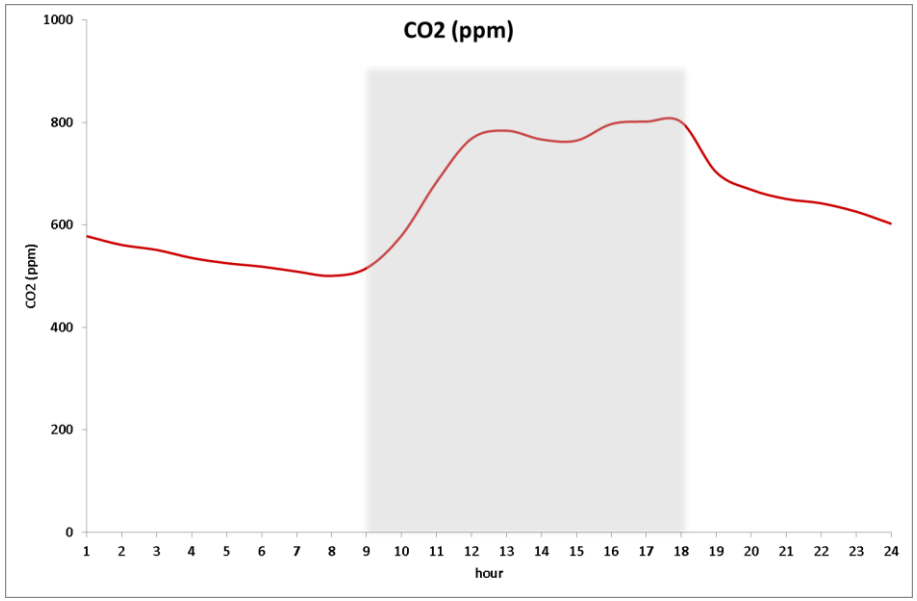


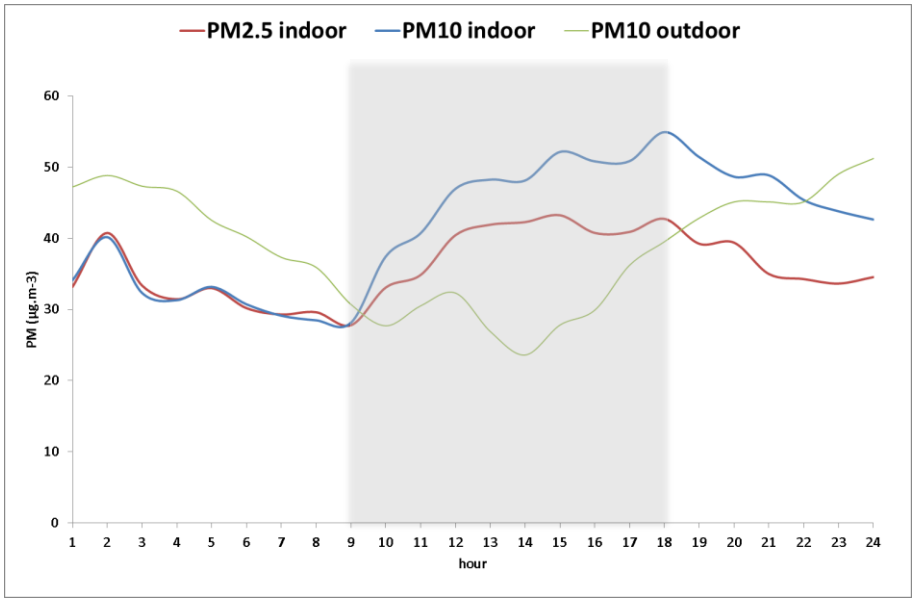
9 locations

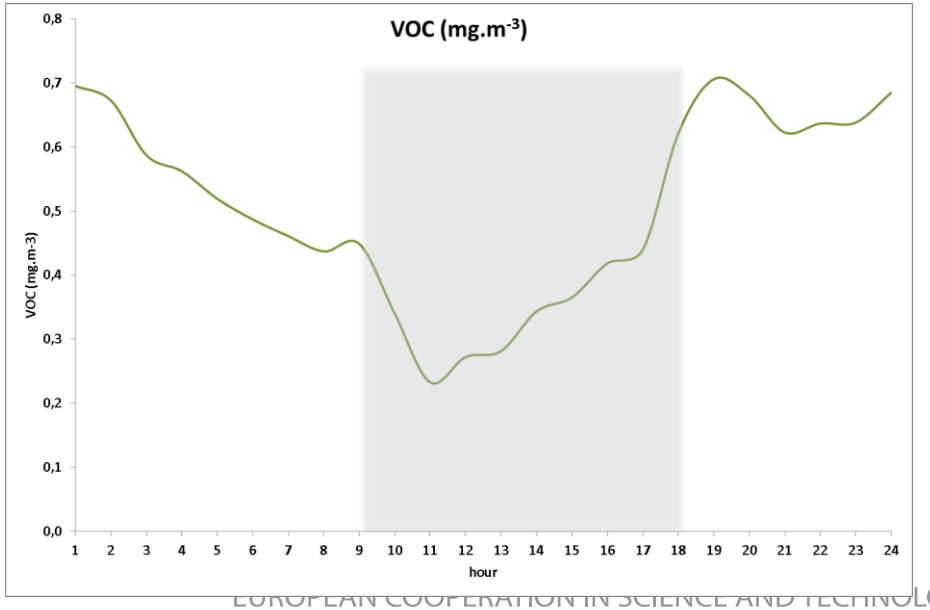
continuous measurements with new sensing technologies and conventional techniques.

(≈24h each location)

Results – average daily profile





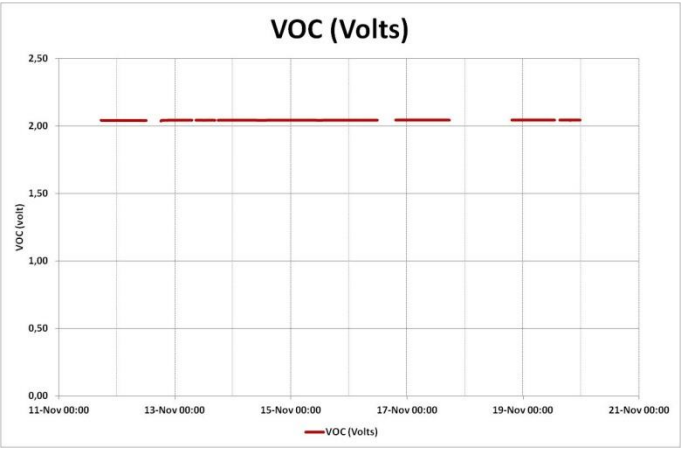


CO_2 - Correlation with building occupancy. Relatively high average baseline (low ventilation).

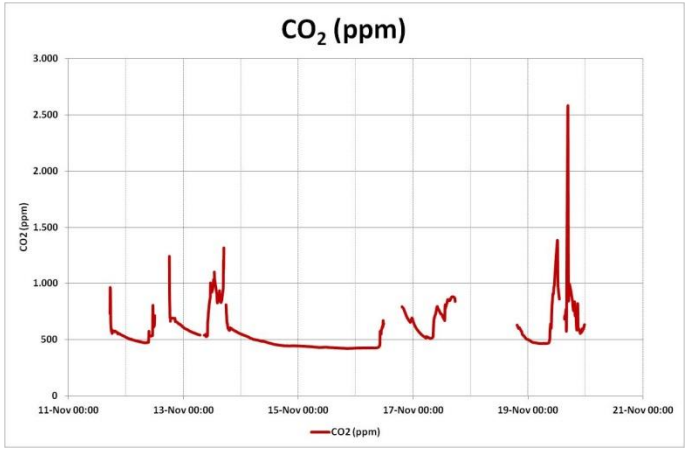
VOC - Higher concentrations during the night, after cleaning the spaces. Decrease after opening at the beginning of the day.

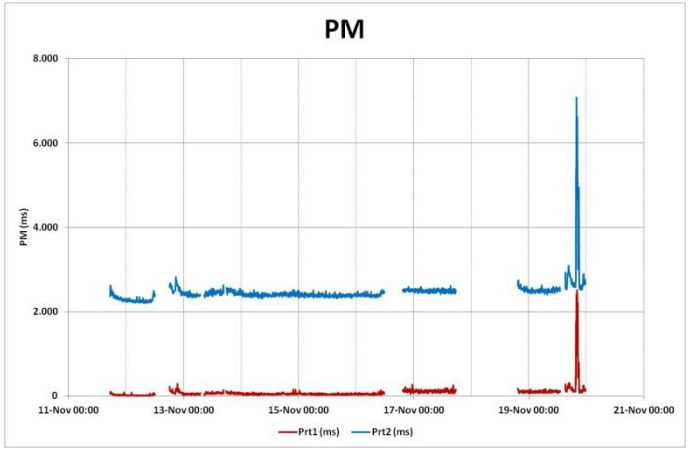
PM - Different indoor and outdoor profile. Importance of indoor sources for the PM concentration.

Results - raw data (low cost sensor)

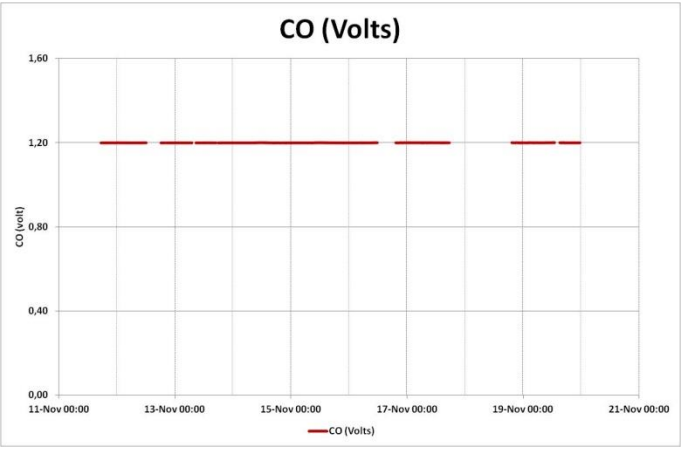


Sensor signal without variation

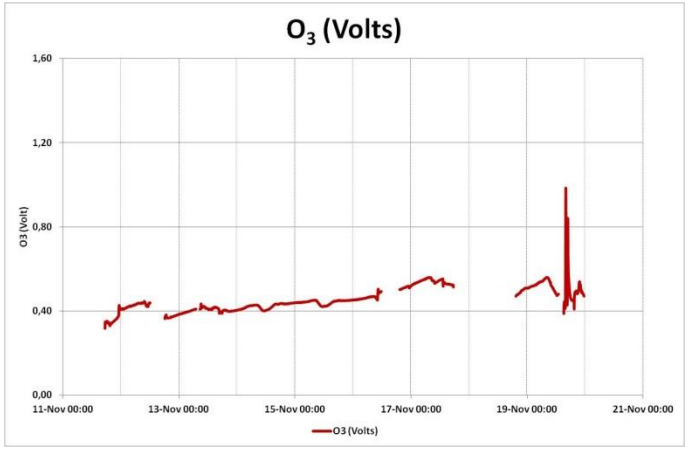


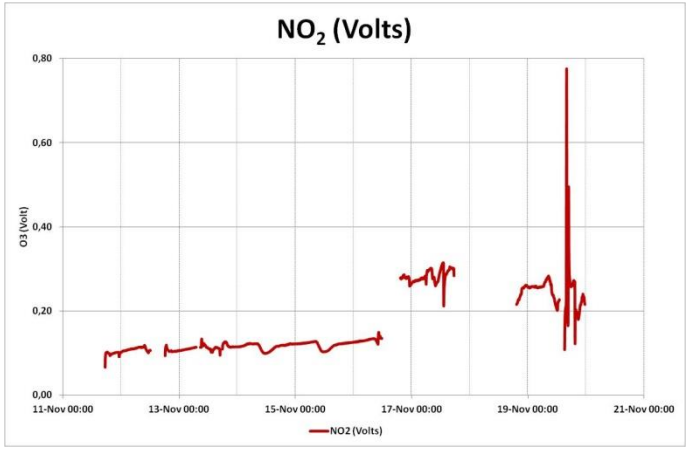


Sensors signal with variation and correlation with conventional equipment and time-activity pattern



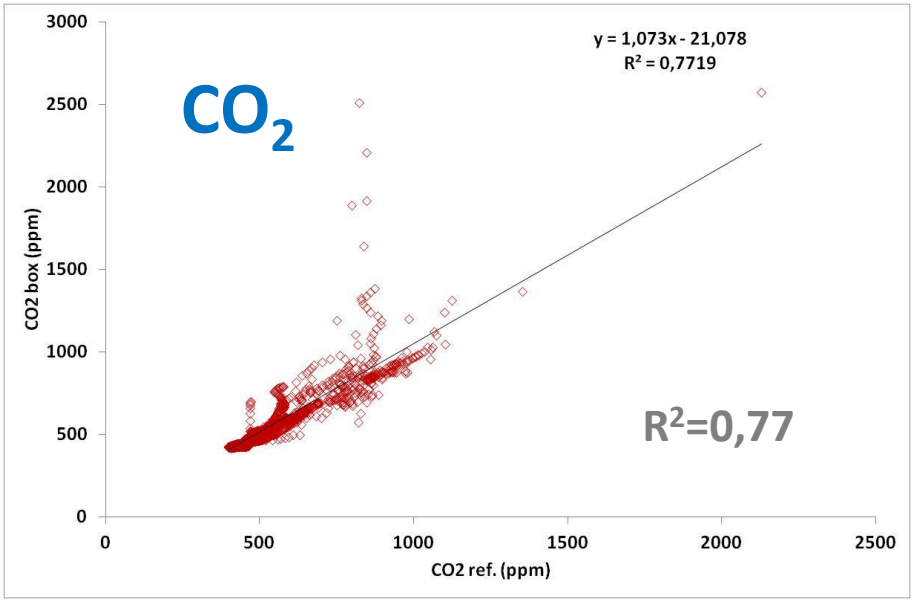
Sensor signal without variation

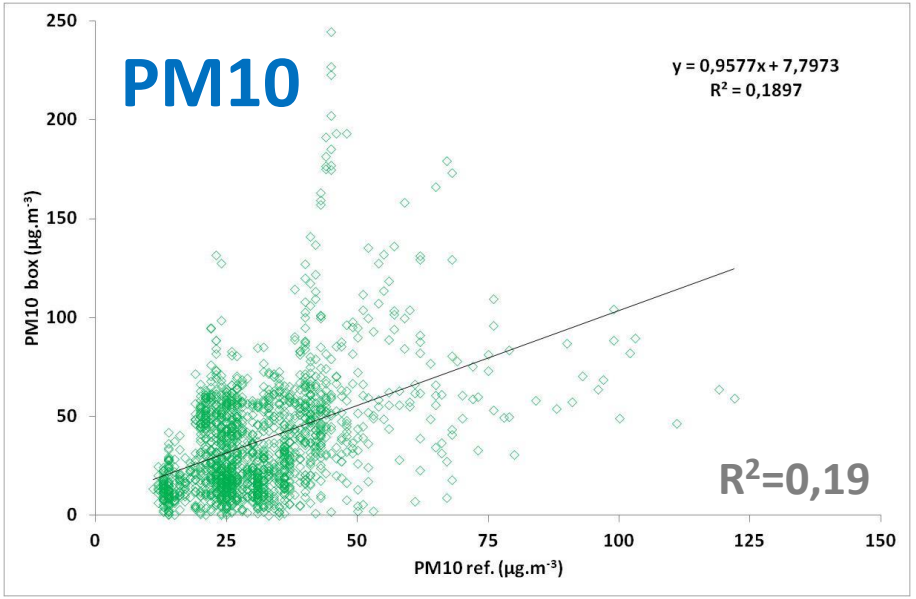




Sensors with the same variation profile (possible cross sensitivity) R^2=0.8

Results – correlations





CO_2 - Strong correlation between micro-sensors and reference equipment (R^2=0,77)

PM - poor correlation between micro-sensors and reference equipment (R^2=0,2)

VOC – sensor with no data/correlation (possible saturation)

Cooperation between COST partners

Short-Term Scientific Mission: IDAD/SGX

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

O_3

NOx

SO_2

BTEX

Sampling time

Winter - October 2013 / Jan. 2014

Summer - July 2014 / Sept. 2014

(≈7 days each location)

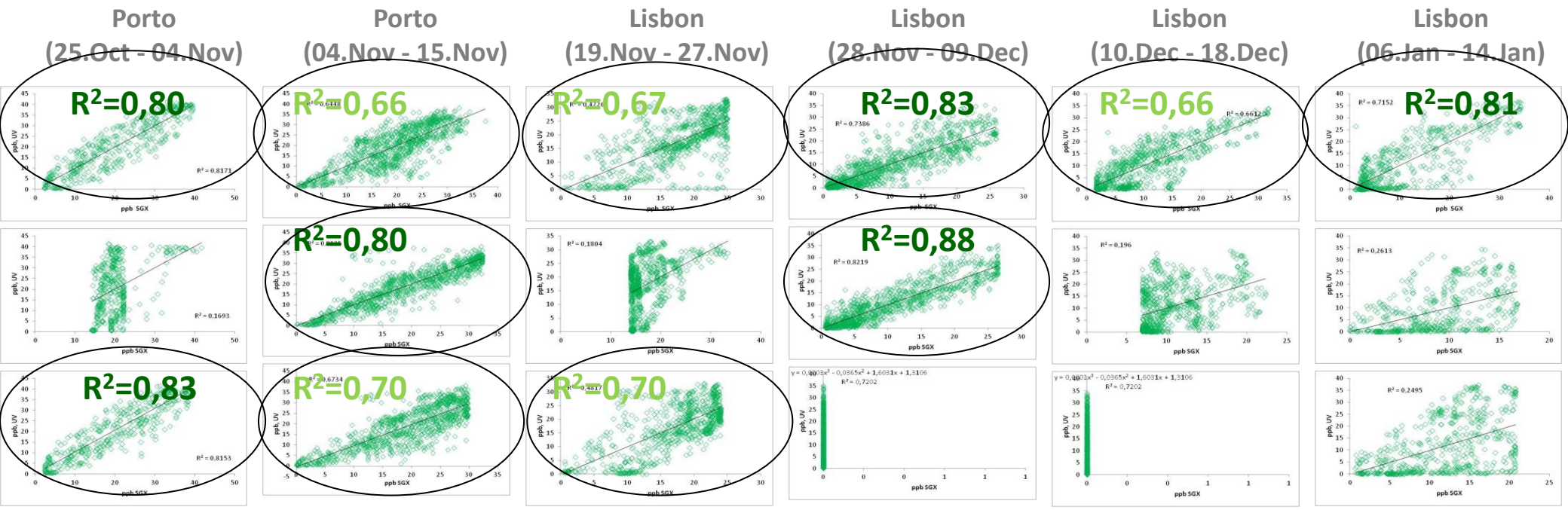
Parallel measurements with SGX micro sensors

3 - CO/VOC

3 - O_3

2 - NO_2

Results - O_3 correlation (ppb_{UV} vs $ppb_{MiCs-2614}$)



Measurements with correlations > 0,8

Different behaviour in each location/sensor.

Some cases with erratic behaviour, saturation, problems with electricity stability.

Global correlation could be improved with more detailed analysis of the data.

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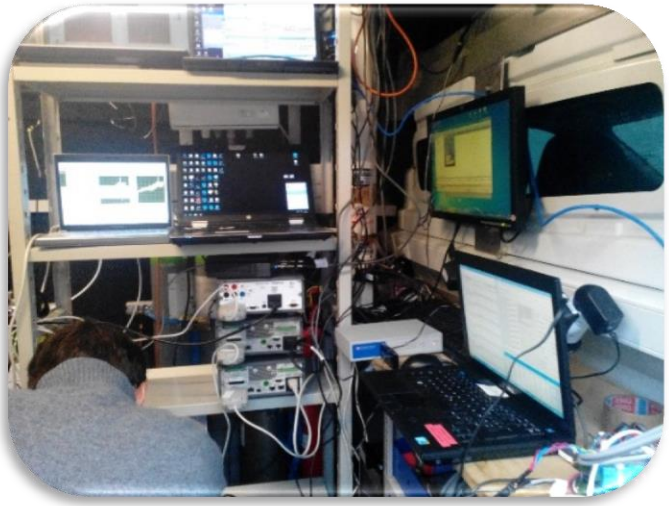
* MiCs – Metaloxide Sensors

Cooperation between COST partners

1st EuNetAir Air Quality Joint-Exercise: Assessment of Micro-Sensors versus Reference Methods



Cooperation between COST partners

Urban traffic location in **Aveiro** city centre

15 teams from research centres, universities and companies from **12 COST Countries**

130 sensor boxes

IDAD Air Quality Mobile Laboratory with standard equipment and **reference** analysers

Micro-sensors systems installed side-by-side at IDAD Air Quality Mobile Laboratory

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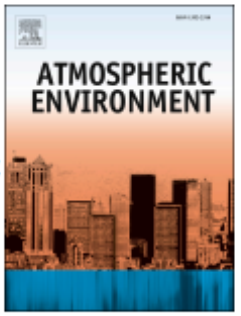
Cooperation between COST partners

Accepted Manuscript



Assessment of air quality microsensors versus reference methods: The EuNetAir joint exercise

C. Borrego, A.M. Costa, J. Ginja, M. Amorim, M. Coutinho, K. Karatzas, Th. Sioumis, N. Katsifarakis, K. Konstantinidis, S. De Vito, E. Esposito, P. Smith, N. André, P. Gérard, L.A. Francis, N. Castell, P. Schneider, M. Viana, M.C. Minguillón, W. Reimringer, R.P. Otjes, O.v. Sicard, R. Pohle, B. Elen, D. Suriano, V. Pfister, M. Prato, S. Dipinto, M. Penza

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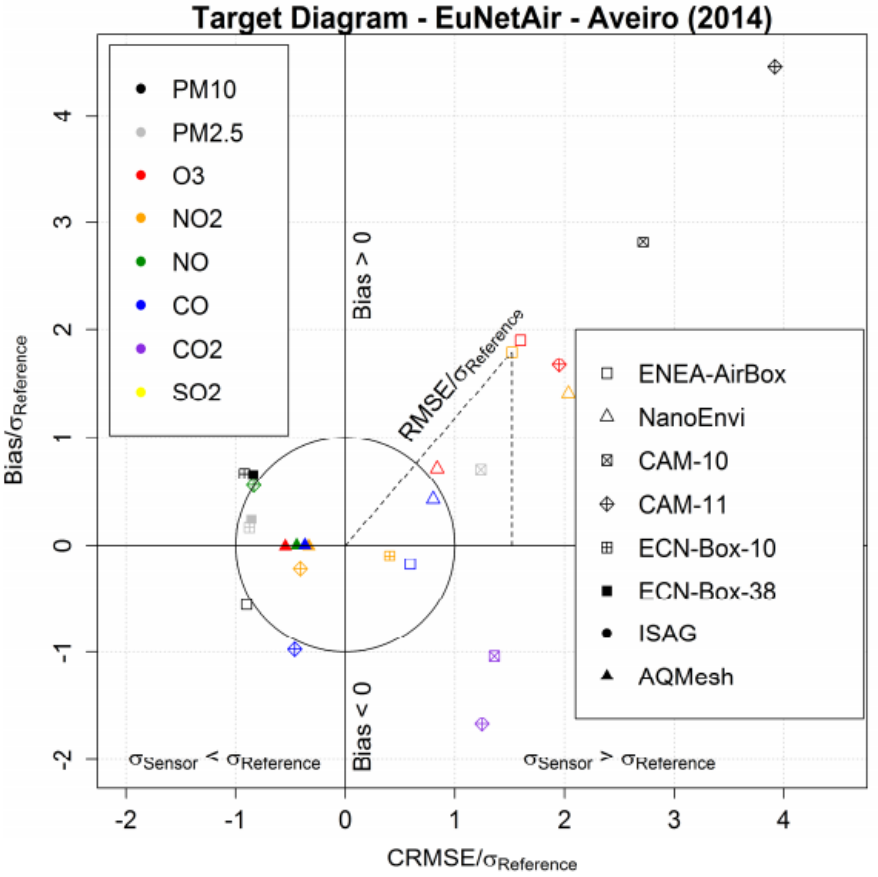
1st EuNetAir Air Quality Joint-Exercise:

Assessment of Micro-Sensors versus Reference Methods

- **Promising results in part of the measurements,** between micro-sensors and standard method;
- **Most fall within (or in the border of) the target circle** showing RMSE inside the standard deviation of reference measurements;
- **Some of sensors failed during the exercise and the results of others will be used for additional research:**
  - relative humidity and temperature interference, communication failures;
  - instability and reactivity caused by interfering gases.
- **Additional analysis is being prepared for a second publication.**



Inside target circle: O_3, NO_2, NO, CO, PM2.5

CONCLUSIONS and CHALLENGES

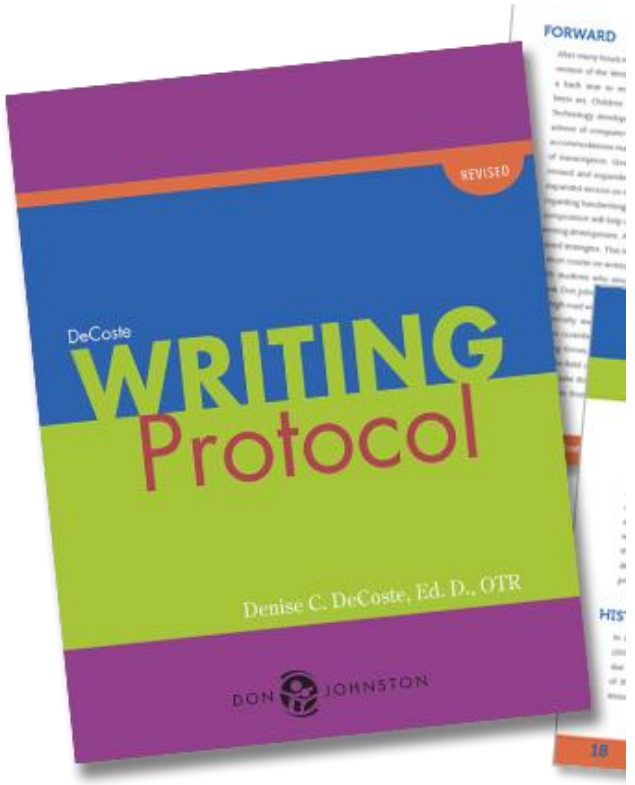
- Up to now, air pollution monitoring use **complex, expensive and stationary equipment**, which limits who gathers data, why data are collected and how data are accessed.

- Conventional AQ measuring equipment have an important role for **regulatory purposes**!

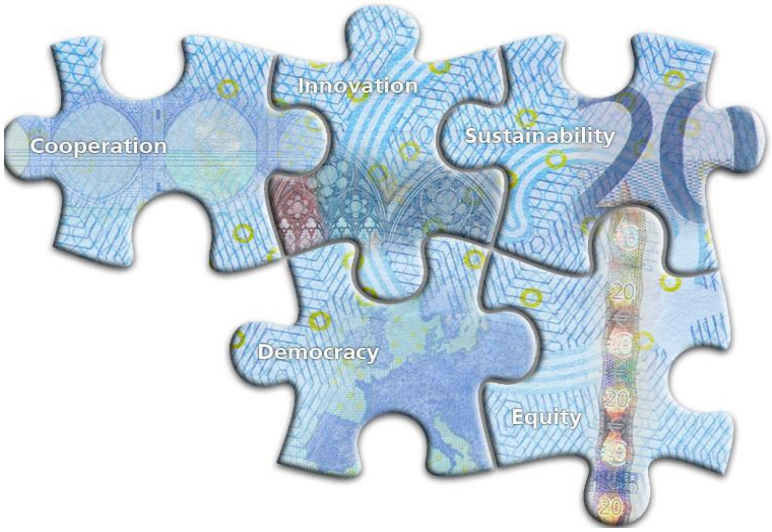
- The **pattern is changing** with the development of advanced low-cost, easy-to-use and portable sensor-systems, which will allow expanded use by communities and individuals, new and enhanced applications and increased data availability and access.

CONCLUSIONS and CHALLENGES

- Need for **more research** in the effects due to combined exposure to air pollutants and objective methods for their evaluation, including development of validated monitoring tools/modelling tools.
- Data communication, data management and **evaluation protocols** are a relevant part of the sensors systems.
- A **new strategy** for environmental monitoring based on air quality modelling scenarios/sensors networks allows to prepare for critical situations and possible crisis management.



CONCLUSIONS and CHALLENGES



- The raise of awareness on AQ and IAQ issues and the development of low-cost sensing technologies allowed to look to other potential utilizations of monitoring data.
- The use of new sensing technologies for AQ and IAQ assessment could be seen as a valuable contribution to create **healthy and comfortable living environments**!
- The **close multidisciplinary cooperation** provided by COST TD1105 created an important cooperative network allowing to explore new sensing technologies for low-cost air pollution assessment, including field and laboratory experiments, and transferring the results into new AQ strategies and services!

Thank you!

Carlos Borrego
www.ua.pt/idad