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

Start date: 16/05/2012
End date: 15/05/2016
Year: *2 - Ongoing Action*

COST
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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

Construction and Built Environment: Future Horizons

17-19 June 2014, Brussels

Research for Future
Infrastructures in Europe
reFINE

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Vice-Chair of COST Action TD1105

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Outline

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

- **Background / Problem Statement:**
  - ✓ *Scientific context*
  - ✓ *Challenges addressed by the Action*

- **MoU Action's Objectives**

- **Action Research Directions:**
  - ✓ *Methodology and Innovation*

- **Working Groups**

- **Results versus Objectives:** *Significant Highlights*

- **Future Plans and Challenges:**
  - ✓*Expected Impact & Selected FP7-Projects*

- **Concluding Remarks**
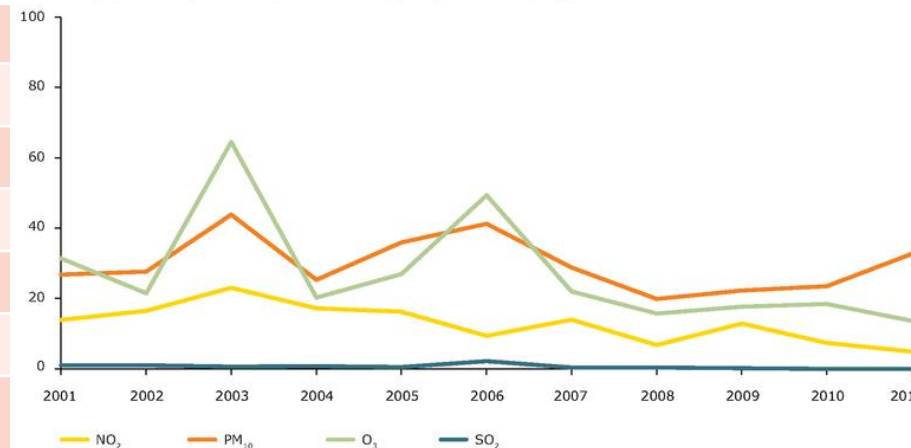
European Environment Agency, EEA Report 9/2013
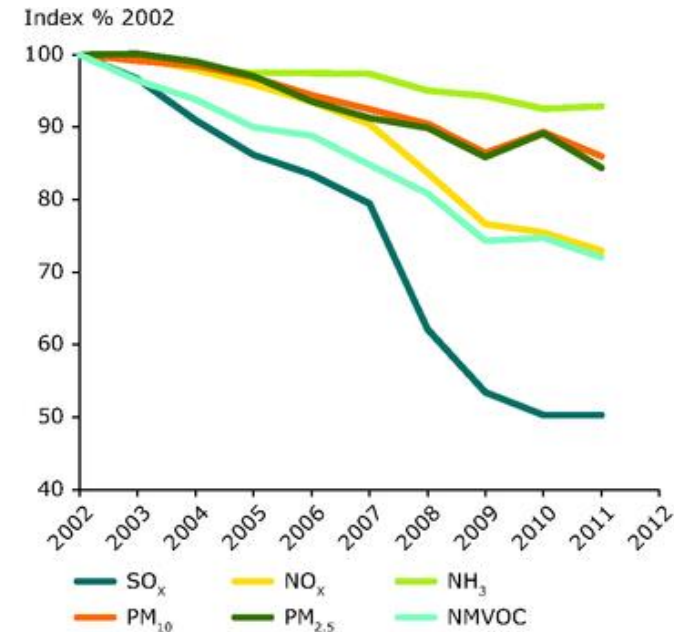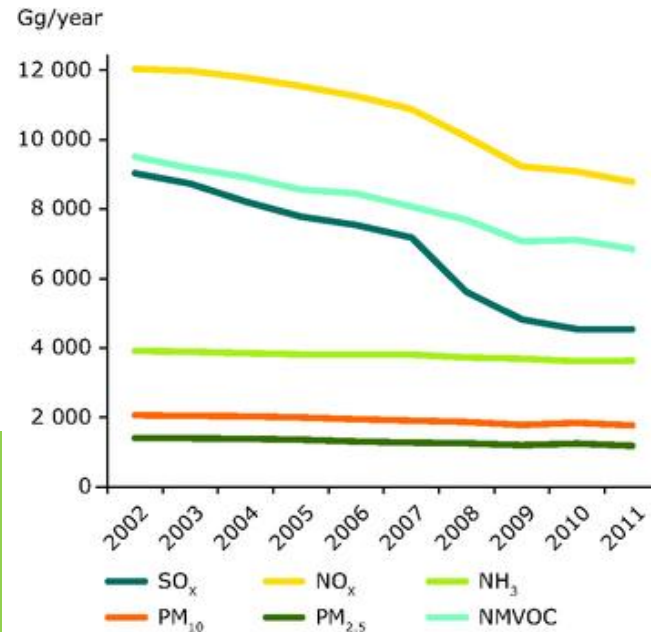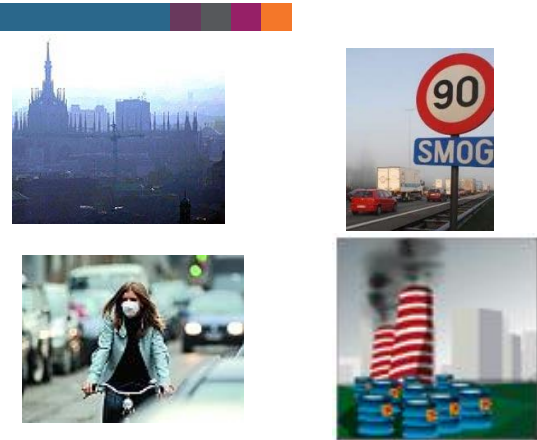
Some Environmental Emergencies:

1930 - Meuse Valley (Belgium)
1952 - Great London Smog (UK)
1954 - Los Angeles (USA)
1984 - Bhopal (India)
2005 - Teheran (Iran)
2006 - Hong Kong (China)
2008 - Shanghai, Peking (China)
2012 - Taranto (Italy)
....

**AMBIENT AIR QUALITY
EU DIRECTIVE 2008/50/EC
and Daughters**

Pollutant	Limit Level
NO_x	100, 200 ppb
CO	8 ppm
SO_2	130, 190 ppb
O_3	120 $\mu g/m^3$
PM_{10}	50 $\mu g/m^3$
BTEX	6 $\mu g/m^3$
PAH (BaP)	1 ng/m^3
$PM_{2.5}$	-

% of urban population exposed to air pollution exceeding acceptable EU air quality standard

cost
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Scientific context: Indoor/Outdoor Energy Efficiency (2/2)
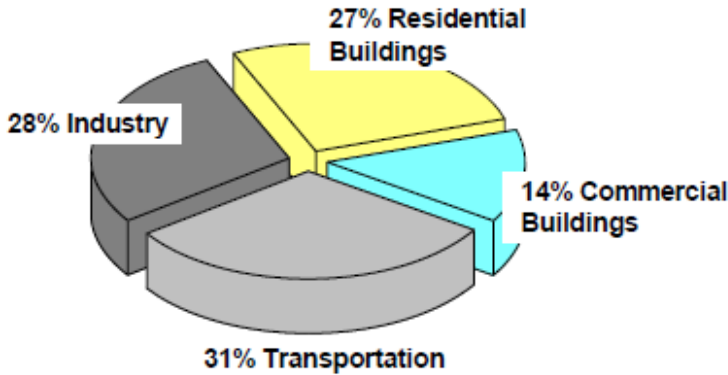
Primary energy consumption in the EU[1]
- 27% Residential Buildings
- 28% Industry
- 14% Commercial Buildings
- 31% Transportation

Figure 2 – Total Energy Consumption by End Use
Adapted from E Source, 2006

- Ventilation 4%
- Refrigeration 3%
- Space Heating 31%
- Water Heating 17%
- Cooling 15%
- Lighting 12%
- Other 9%
- Cooking 5%
- Office Equipment 4%

Source: Environmental Protection Agency's National Action Plan for Energy Efficiency Sector Collaborative on Energy Efficiency Hotel Energy Use Profile

[1] O. Seppanen,

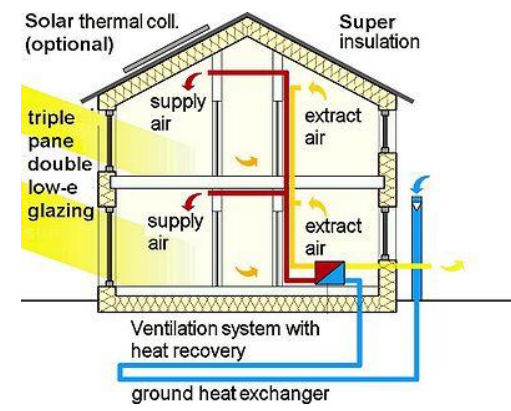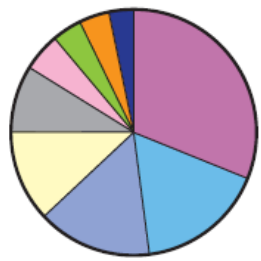*11th Conference on Indoor Air Quality 2008, Copenaghen, Denmark*

41% Primary Energy consumed in Buildings:
- 2/3 in Residential Buildings
- 1/3 in Commercial Buildings

Energy Performance of Buildings EU Directive EPBD 2010/31/EC

IAQ by WORLD HEALTH ORGANIZATION

Indoor Air		Typical Substances		Cure
Contamination Source	**Emission Source**	**VOCs**	**Others**	
• Human Being	• Breath	Acetone, Ethanol, Isoprene		demand controlled ventilation
			CO_2	
			Humidity	
	• Skin Respiration & Transpiration	Nonanal, Decanal, α-Pinene		
			Humidity	
	• Flatus	Methane, Hydrogen		
	• Cosmetics	Limonene, Eucalyptol		
	• Household Supplies	Alcohols, Esters, Limonene		
	• Combustion (Engines, Appliances, Tobacco Smoke)	Unburnt Hydrocarbons		
			CO	
			CO_2	
			Humidity	
• Building Material • Furniture • Office Equipment • Consumer Products	• Paints, Adhesives, Solvents, Carpets	Formaldehyde, Alkanes, Alcohols, Aldehydes, Ketones, Siloxanes		permanent 5-10% ventilation
	• PVC	Toluene, Xylene, Decane		
	• Printers, Copiers, Computers	Benzene, Styrene, Phenole		

Table 1 – Typical Indoor Air Contaminants (VOCs and others)

Challenges addressed by Action TD1105 (1/1)

- **Nanomaterials for AQC sensors**
- Low-cost Gas Sensors
- **Low-power Sensor-Systems**
- **Wireless Technology (*Environmental Sensors Network*)**
- **Air Quality Modelling**
- **Environmental Measurements**
- **Standards and Protocols**

cost
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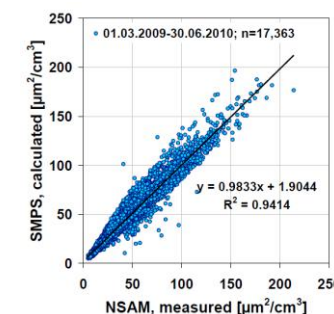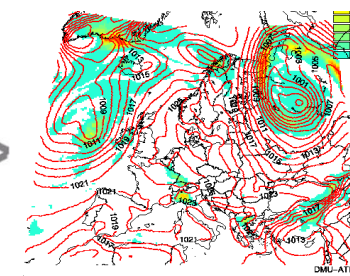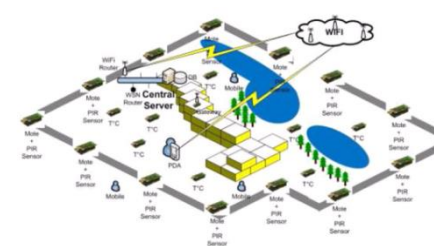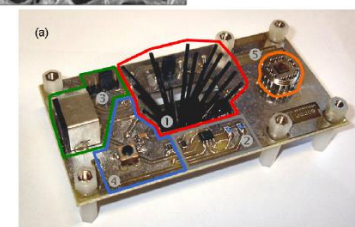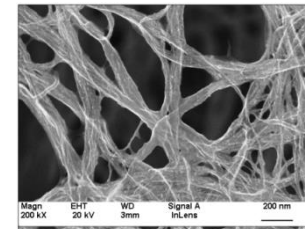
MoU **Main Objectives** of COST Action TD1105:

• *To establish* a *Pan-European multidisciplinary R&D platform* on new sensing paradigm for Air Quality Control (AQC) contributing to sustainable development, green-economy and social welfare.

• *To create* collaborative research teams in the ERA on the new sensing technologies for AQC in an integrated approach to avoid fragmentation of the research efforts.

• *To train* *Early Stage Researchers (ESRs)* and new young scientists in the field for supporting competitiveness of European industry by qualified human potential.

• *To promote* *gender balance* and involvement of ESRs in AQC.

• *To disseminate* *R&D results on AQC* towards industry community and policy makers as well as general public and high schools.

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

DELIVERABLES of COST Action TD1105. MoU areas of S&T cooperation include:

• **Workshops** *on sensor materials and nanotechnologies, sensor-systems for AQC, environmental measurements, air-pollution modelling, chemical weather forecasting, distributed computing, wireless sensor networks, protocols and pre-standardisation*; organization of open conferences to improve knowledge transfer and dissemination.

• **Training Schools** on sensor materials, technologies, processes, methods, modelling, forecasting, applications, environmental certification and validation, project management.

• **International ESRs exchange** and Scientists Mobility (**STSM**s) between partners involved in Action and Non-COST partnership at incoming/outcoming level.

• **New collaborative research actions** and research projects providing synergies between partners capabilities.

• **Participation** in Conferences, Short Courses, Mutual Publications, Reports, White Papers, Position Papers, etc.

• **Outreach** activities

• Enforcement of the **Gender Balance** agenda

• Coordinated **Dissemination** of the networking activities towards Academia, Industry and General Public.

COST Action TD1105 *EuNetAir*: 28 COST Countries (Parties) have already signed Memorandum of Understanding (MoU)

PARTIES:

already accepted MoU: 28 Countries

Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, The Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

COST Action EuNetAir PARTICIPANTS

COST Action TD1105 *EuNetAir*:
7 Non-COST Countries and 8 Non-COST Institutions

Non-COST Countries:
Australia, Canada, China, Morocco, Russia, Ukraine, USA

Non-COST Institutions:
CSIRO (**Australia**); University of Waterloo (**Canada**); Chinese Academy of Sciences, Shanghai Institute of Ceramics (**China**); University of Agadir IBN Zohr (**Morocco**); National Research Center Kurchatov Institute (**Russia**); O.M. Marzeiev Institute for Hygiene and Medical Ecology of Academy of Science of Ukraine (**Ukraine**); Southern Illinois University Carbondale, NASA Ames Research Center (**USA**).

Non-COST EuNetAir PARTICIPANTS

University of Waterloo — Systems Design Engineering

National Research Center Kurchatov Institute — Institute of Applied Chemical Physics

CA - Canada

US - United States

RU - Russian Federation

O.M. Marzeiev Institute — Academy of Sciences of Ukraine

CN - China

Chinese Academy of Sciences — Shanghai Institute of Ceramics

Southern Illinois University Carbondale — Department of Physics

US - United States

University of Agadir IBN Zohr

NASA Ames Nano Research Center — Center for Nanotechnology

AU - Australia

CSIRO — Materials Science and Engineering

NNC - Near Neighbour Countries
IPC - International Partner Countries

IN SCIENCE AND TECHNOLOGY

EuNetAir PARTICIPANTS

Country	Participants
AT - Austria	Materials Center Leoben Forschung GmbH
BE - Belgium	VITO, Universitè de Liège, Odometric S.A.
BG - Bulgaria	National Institute of Meteorology and Hydrology - BAS; Institute of Electronics - BAS
CH - Switzerland	Ecole Polytechnique Fèdèrale de Lausanne; e2v Microsensors S.A.; EnvEve S.A.; EMPA
CZ - Czech Republic	Academy of Sciences of the Czech Republic
DE - Germany	Institute of Energy and Environmental Technology; Saarland University; MPI for Biogeochemistry Univ. of Bayreuth; Univ. of Paderborn; Univ. Applied Sci. Ostwestfalen-Lippe; UST; Alfred Becker; 3S
DK - Denmark	Aarhus University; Technical University of Denmark - DTU
EL - Greece	Aristotle University; FORTH; Athena/ISI; University of Piraeus
ES - Spain	Catalonia Institute for Energy Research - IREC; Spanish National Research Council - CSIC; University Rovira i Virgili; University of Barcelona, Worldsensing S.L.
FI - Finland	University of Oulu; University of Helsinki; Tampere University of Technology
FR - France	University of Bourgogne; University Blaise Pascal; Ecole des Mines de Douai; CEA-CNRS; ETHERA
HU - Hungary	Hungarian Meteorological Service
IS - Iceland	Agricultural University of Iceland
MK - Republic of Macedonia	Ministry of Environment and Physical Planning
IE - Ireland	Trinity College Dublin; University College Cork
IL - Israel	AirBase Systems; TECHNION
RS - Serbia	Institute of Public Health of Belgrade; VINCA
IT - Italy	ENEA; ELETTRA; Univ. of Bari; Univ. of Brescia; Univ. of Trieste; Lenviros; Sensichips, ARPA-Puglia
LV - Latvia	University of Latvia
NL - Netherlands	IMEC - Holst Centre; ECN
NO - Norway	NILU - Norwegian Institute for Air Research
PL - Poland	Silesian University of Technology; Warsaw University of Life Science
PT - Portugal	Univ of Coimbra; Instit. of Environment & Development; National Health Institute; Univ of Lisbon
RO - Romania	National R&D Institute for Nonferrous and Rare Metals; SC IPA SA - Research & Development
SE - Sweden	Linkoping University; Chalmers University of Technology; SenSiC AB; SenseAir AB
SI - Slovenia	University of Ljubljana; Aerosol d.o.o.
UK - United Kingdom	Imperial College London; Newcastle University; University of Manchester; Cambridge; University of Warwick; University of Edinburgh; Cambridge CMOS Sensors; Alphasense
TR - Turkey	GEBZE Institute of Technology; Middle East Technical University of Ankara

ENEA

EuNetAir: List of Experts

180 EXPERTS from **28** COST Countries and **7** Non-COST Countries

AT - Austria
Dr. Anton KOCK
Dr. Stefan DEFREGGER

BE - Belgium
Prof. Anne-Claude ROMAIN
Dr. Jan THEUNIS
Dr. Julien DELVA

BG - Bulgaria
Dr. Dimiter SYRAKOV
Dr. Ivan NEDKOV

CH - Switzerland
Dr. Danick BRIAND
Dr. Marco BRINI
Dr. Christine ALEPEE
Dr. Nicolas MOSER
Dr. Christoph HUEGLIN

CZ - Czech Republic
Dr. Vera KURKOVA
Dr. Roman NERUDA
Dr. Zdenek ZELINGER

DE - Germany
Dr. Thomas A. J. KUHLBUSCH
Dr. Ulrich QUASS
Prof. Andreas SCHUETZE
Dr. Tilman SAUERWALD
Prof. Ralf MOOS
Dr. Daniela SCHONAUER-KAMIN
Dr. Thorsten WAGNER
Dr. Olaf KIESEWETTER
Dr. Thorsten CONRAD
Dr. Thomas BECKER
Prof. Wrenger Burkhard
Dr. Jost Valentin Lavric
Dr. Corinna HAHN

DK - Denmark
Prof. Ole HERTEL
Dr. Lise Lotte SORENSEN
Prof. Anja BOISEN
Dr. Silvan SCHMID

EL - Greece
Prof. Kostas KARATZAS
Prof. George KIRIAKIDIS
Dr. Christos KOULAMAS
Prof. George PAPADOPOULOS
Prof. Tatiana TAMBOURATZIS

ES - Spain
Prof. Juan Ramon MORANTE
Dr. Francisco HERNANDEZ
Dr. Xavier QUEROL
Dr. Mar VIANA
Prof. Eduard LLOBET
Dr. Radu IONESCU
Prof. Albert ROMANO
Dr. Juan Daniel PRADES
Dr. Jordi LLOSA

FI - Finland
Prof. Heli JANTUNEN
Prof. Jyrki LAPPALAINEN
Dr. Jari JUUTI
Prof. Kaarle HAMERI
Prof. Jorma KESKINEN

FR - France
Prof. Marcel BOUVET
Prof. Jerome BRUNET
Prof. Alain PAULY
Dr. Jean SUISSE
Dr. Amadou NDYAE
Dr. Thu-Hoa THRAN-THI
Dr. Philippe KARPE
Prof. Jerome ROSSIGNOL
Prof. Nadine LOCOGE

HU - Hungary
Dr. Zita FERENCZI
Dr. Krisztina LABANCZ

IS - Iceland
Dr. Arngrimur THORLACIUS

IE - Ireland
Dr. Francesco PILLA
Prof. John WENGER

IT - Italy
Dr. Michele PENZA
Dr. Marco ALVISI
Dr. Saverio DE VITO
Dr. Andrea GOLDONI
Dr. Magda BRATTOLI
Dr. Annamaria DEMARINIS
Dr. Gianluigi DE GENNARO
Dr. Luigi BARBIERI
Prof. Giorgio ASSENNATO
Dr. Roberto SIMMARANO
Prof. Giorgio SBERVEGLIERI

MK – Rep. of Macedonia
Dr. Igor ATANASOV
Dr. Ljujpcho GROZDANOSVKI

NL - Netherlands
Dr. Sywert BRONGERSMA
Dr. Ernie WEIJERS
Dr. Rene OTJES

PL - Poland
Dr. Monika KWOKA
Prof. Stanislaw GAWRONSKI
Prof. Jacek SZUBER

PT - Portugal
Prof. Bernadete RIBEIRO
Prof. Carlos BORREGO
Dr. Joao Paulo TEIXEIRA
Prof. Cristina MAGUAS
Dr. Miguel COUTINHO
Dr. Ana Margarida COSTA

SE - Sweden
Prof. Anita LLOYD SPETZ
Dr. Marina VOINOVA
Dr. Mike ANDERSSON
Dr. Donatella PUGLISI
Dr. Ulf THOLE
Prof. Ingrid BRYNTSE

IL - Israel
Dr. Liad ORTAR
Prof. Hossam HAICK

UK - United Kingdom
Prof. Julian GARDNER
Prof. Roderic JONES
Prof. Krishna PERSAUD
Prof. John POLAK
Dr. Robin NORTH
Dr. Jeff NEASHAM
Dr. Fabio GALATIOTO
Prof. Florin UDREA
Dr. John SAFFELL
Prof. John LEE

NO - Norway
Dr. Nuria Castell-BALAGUER
Dr. Philippe SCHNEIDER

RO - Romania
Dr. Roxana Mioara PITICESCU
Dr. Marcel IONICA
Dr. Cristina RUSTI
Dr. Radu Adrian IONICA

TR - Turkey
Prof. Zafer Ziya OZTURK
Prof. Mehmet Fatih DANISMAN

RS - Serbia
Anka CVETKOVIC
Milena JOVASEVIC-STOJANOVIC

SI - Slovenia
Rahela ZABKAR
Grisa MOCNIK
Branko STER

LV - Latvia
Prof. Iveta STEINBERGA

MANAGEMENT COMMITTEE

Kick-off Meeting at Brussels on 16 May 2012

Country	MC Members (52): *Male (73%) - Female (27%)*
Austria	Dr. Anton KOCK
Belgium	Dr Jan THEUNIS; Dr Anne-Claude ROMAIN
Bulgaria	Dr Dimiter SYRAKOV; Dr Ivan NEDKOV
Czech Republic	Dr. Vera KURKOVA; Dr. Zdenek ZELINGER
Denmark	Prof. Ole HERTEL
Finland	Prof. Kaarle HAMERI; Prof. Jyrki LAPPALAINEN
France	Prof. Marcel BOUVET; Prof. Jerome BRUNET
Germany	Prof. Andreas SCHUETZE; Dr Corinna HAHN
Greece	Prof. George PAPADOPOULOS; Prof. Kostas KARATZAS
Hungary	Ms Krisztina LABANCZ; Dr Zita FERENCZI
Iceland	Dr Arngrimur THORLACIUS
Ireland	Dr. Francesco PILLA; Prof. John WENGER
Israel	Dr. Liad ORTAR; Prof. Hossam HAICK
Italy	Dr Michele PENZA; Prof. G. SBERVEGLIERI; Dr. G. DE GENNARO
Latvia	Dr Iveta STEINBERGA
Macedonia Rep.	Dr. Igor ATASANOV; Dr. Ljupcho GROZDANOVSKI
Netherlands	Dr Sywert BRONGERSMA; Dr. Ernie WEIJERS
Norway	Dr Nuria CASTELL BALAGUER; Dr. Philipp SCHENEIDER
Poland	Dr Monika KWOKA; Prof. Janislaw GAWRONSKI
Portugal	Prof. Bernadete RIBEIRO; Prof. Carlos BORREGO
Romania	Dr Marcel IONICA; Dr Roxana Mioara PITICESCU
Serbia	Dr. Anka CVETKOVIC
Slovenia	Dr Grisa MOCNIK; Dr Rahela ZABKAR
Spain	Prof. Juan Ramon MORANTE; Prof. Eduard LLOBET VALERO
Sweden	Prof. Anita LLOYD SPETZ; Prof. Ingrid BRYNTSE
Switzerland	Dr Danick BRIAND; Dr. Nicolas MOSER
United Kingdom	Dr John SAFFELL; Prof. Roderic JONES
Turkey	Prof. Zafer ZIYA OZTURK; Prof. Mehmet Fatih DANISMAN

Country	MC Substitutes (30)
Austria	Dr Stefan DEFREGGER
Belgium	Dr Julien DELVA
Czech Republic	Dr. Roman NERUDA
Denmark	Dr. Lise Lotte SORENSEN
Finland	Prof. Jorma KESKINEN
France	Dr Jean SUISSE; Prof. Alain PAULY
Germany	Dr. Daniela SCHONAUER-KAMIN; Dr. Thomas KUHLBUSCH; Dr. Juliane ROSSBACH
Greece	Prof. George KIRIKIADIS; Dr. Christos KOULAMAS
Italy	Dr. Roberto SIMMARANO; Dr. Marco ALVISI; Dr. Saverio DE VITO
Macedonia Rep.	Dr. Beti ANGELEVSKA
Netherlands	Dr. Rene OTJES
Poland	Prof. Jacek SZUBER
Portugal	Dr. Joao Paulo TEIXEIRA
Romania	Dr. Cristina RUSTI; Dr. Marcel Adrian IONICA
Slovenia	Prof. Andrej DOBNIKAR
Spain	Prof. Albert ROMANO-RODRIGUEZ; Dr. Jordi LLOSA
Sweden	Dr Ulf THOLE; Dr. Marina VOINOVA
Switzerland	Dr Christoph HUEGLIN
UK	Prof. Julian GARDNER; Dr Robin NORTH; Prof. Florin UDREA

WG1 PRIORITIES: Sensor Materials and Nanotechnology

WG1-Leader:	• Prof. Juan Ramon Morante, IREC, Barcelona, Spain • Prof. Jyrki Lappalainen, University of Oulu, Finland (*Rome and Cambridge Meeting WG1 Chair*)
WG1 Composition:	3 Sub-WG Leaders and 30 Members

PRIORITY #1:	**Metal Oxides (MOX)**: Thin Films, Nanoparticles, Nanowires, Nanotubes, Nanoneedles, Nanoporous Forms of Materials (ZnO, SnO_2, WO_3, TiO_2, InO_x, NiO, and magnetic materials Fe_3O_4, doped dielectrics $BaSrTiO_3$, etc.)
PRIORITY #2:	**Carbon Nano MATerials (CNMAT):** Nanotubes, Nanoparticles, Graphene, 1D and 2D-nanostructures and their functionalization and doping
PRIORITY #3:	**Molecular, Organic/Inorganic Materials**: Heterostructures (semiconductors, polymers) and Schottky junctions
PRIORITY #4:	**Processing of low-cost sensors on flexible substrates**: •Printing techniques, inkjet printing, spin coating, droplet casting, etc. •Template assisted growth of nanostructures
PRIORITY #5:	**Other sensitive materials**: biomaterials, enzymes, antibodies, etc.
PRIORITY #6:	**Chemical modifications** of the sensor materials with tuned properties to address selectivity and specific applications
PRIORITY #7:	**Combination of different approaches** and defining the state-of-art of the best available technologies, for example, to realize smart sensor structures

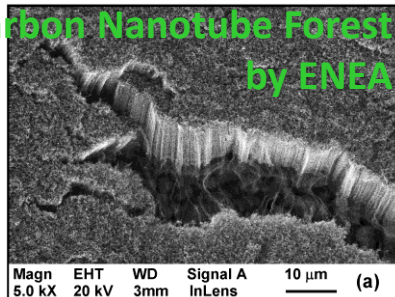*WG1 Chair: Prof. Juan Ramon Morante, IREC, Spain*

- **Sub-Working Group 1.1:** Metal oxides nanostructures for AQC gas sensors.

- **Sub-Working Group 1.2:** Carbon nanomaterials for AQC gas sensors.

- **Sub-Working Group 1.3:** Emerging sensor materials (organic/inorganic, hybrid, nanocomposites, polymers, functional, etc.).

New molecular materials of underlined polymer-macrocycles as transducers for polluting gas sensing by University of Bourgogne

Mesoporous In_2O_3 by Univ. of Paderborn, DE

Metal oxide (SnO_2) Nanowires nets by Univ. of Brescia, IT

Self-heating SnO_2 Nanowires by Univ. of Barcelona

50 nm

NO_2

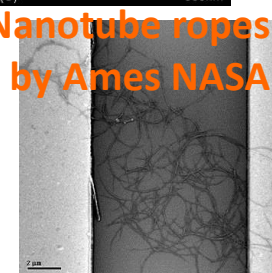Clean bucky-Paper exposure to NO_2 by ELETTRA, IT

C 1s

Binding Energy (eV)
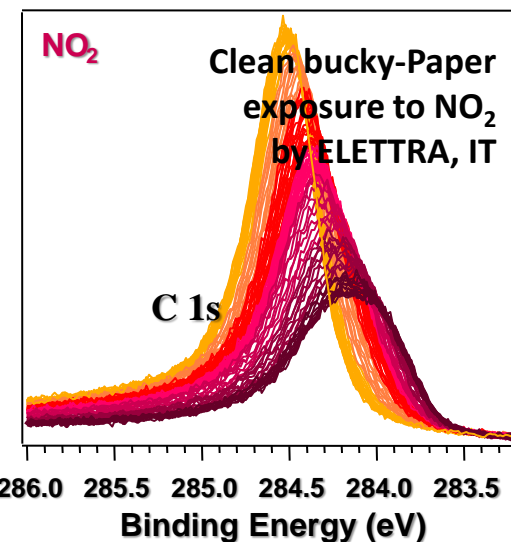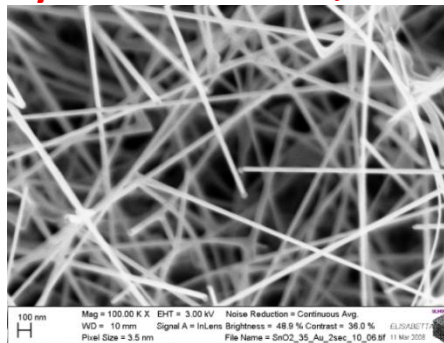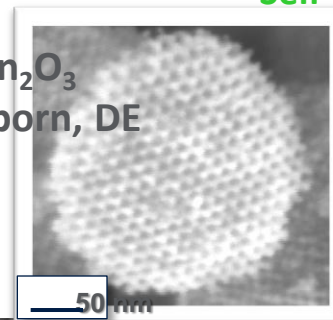
Carbon Nanotube Forest by ENEA

TiO_2 Nanotube by Univ. Rovira I Virgili and SICCAS

Carbon Nanotube yarns by CSIRO

Carbon Nanotube ropes by Ames NASA

WG2 PRIORITIES: Sensors Devices and Sensor-Systems for AQC

WG2-Leader:	Prof. Andreas Schuetze, Saarland University, Germany
WG2 Composition:	4 Sub-WG Leaders and 45 Members

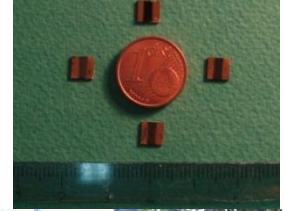|	
PRIORITY #1:	**Versatile μ-transducers for integration of various nanomaterials:** ✓Allow application specific adaptation and low cost ✓Low power (down to μW range for single nanowire)
PRIORITY #2:	**Dynamic operation of Sensors** to gain more than one signal from a single sensor for higher selectivity and stability as well possible self-monitoring at the sensor module level: ✓Well-know but not yet standard: temperature cycling, Electrical Impedance Spectroscopy (EIS) ✓New methods: RF, optical, excitation (gas sensitive solar cell), pulsed polarization, mass and dissipation in Quartz Crystal Microbalance (QCM) ✓Modelling of interaction of sensing layer and gas/dust/aerosol
PRIORITY #3:	**Selective filters** integrated in sensors or sensor modules
PRIORITY #4:	**Dosimeter approach:** integrating sensor response
PRIORITY #5:	**Nanoparticle detection** for dust and aerosols
PRIORITY #6:	**Intelligent Sensor Modules for NO_x, O_3, NH_3, H_2S, SO_2, VOC:** ✓Electronics combined with sensor elements
PRIORITY #7:	**Intelligent Sensor Nodes and heterogeneous networks:** ✓Data pre-processing and processing (in node and/or in network: parallel and distributed computing) ✓Energy efficient communication

WG2 Chair: Prof. Andreas Schuetze, Saarland University, Germany

- **Sub-Working Group 2.1:**

  Gas sensors and new transducers.

- **Sub-Working Group 2.2:**

  Portable gas sensor-systems.

- **Sub-Working Group 2.3:**

  Wireless technology and AQC sensors network.

- **Sub-Working Group 2.4:**

  Intelligence algorithms and distributed computing for networked AQC gas sensors.

IT PATENT ENEA
Carbon Nanotube Gas Sensors

ASIC Circuits: CMOS, SOI CMOS, Analogue and Digital VLSI Smart Signal Processing

Warwick University in collaboration with Cambridge University, EPFL, PennState.
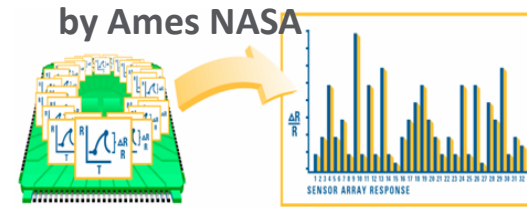
by Ames NASA

Using pattern matching algorithms, the data is converted into a unique response pattern

EnviroWatch mote by Newcastle University

A versatile platform for the efficient development of gas detection systems based on automatic device adaptation by University of Saarland.

RF antennas

λ-probe upstream

λ-probe downstream

thermocouples

engine exhaust

Direct status measurement of automotive catalysts by radio-frequency technique by University of Bayreuth, DE.

Environmental Sensor demo by IMEC, NL

Low-ppb sensitivity for NO_2 GaN-based sensor concept

(a)

Autonomous Gas Sensor System by IREC and Univ. of Barcelona

WG3 PRIORITIES: Environmental Measurements and Air-Pollution Modelling

WG3-Leader:	Prof. Ole Hertel, Aarhus University, Denmark
WG3 Composition:	3 Sub-WG Leaders and 35 Members

PRIORITY #1:	**Environmental Measurements**: ✓Various portable sensor-systems to be explored as *personal sensors* and *wearable sensors* in the life of every day (e.g., bikes, pedestrians, cars, smart cities, etc.) ✓Sensors for air quality monitoring at outdoor applications ✓Sensors for air quality monitoring at indoor applications (e.g., green buildings, low CO_2 emissions, offices, schools, air-ventilation systems, HVAC devices, open spaces, indoor energy efficiency, etc.) ✓Wireless sensors and wireless sensor networks
PRIORITY #2:	**Air Quality Modelling:** ✓Air-pollution dispersion modelling at local, urban, regional and global range ✓Chemical weather forecasting (gases, vapors and particulate matter)
PRIORITY #3:	**Synergistic Negative Health Effects of Human Exposure to Air-Pollution:** ✓Smoke from domestic wood stoves ✓Allergenic pollen from trees, grasses and new invasive species ✓Airborne allergenic material (skin tissue, hair, etc.) released from livestock ✓Fungal spores from agriculture and other sectors ✓Airborne PM natural sources (sea spray, soil dust) ✓Long-range transported organic & inorganic PM including agricultural emissions ✓Pesticides applied in Europe farming ✓Radon & ElectroMagnetic Field (EMF) in domestic buildings ✓Toxic gases and VOCs as air-pollutants at indoor and outdoor level

WG3 Chair: Prof. Ole Hertel, Aarhus University, Denmark

- **Sub-Working Group 3.1:**

  Environmental measurements at laboratory and in field air-quality stations.

- **Sub-Working Group 3.2:**

  Air-quality modelling and chemical weather forecasting.

- **Sub-Working Group 3.3:**

  Harmonisation of environmental measurements.

by Aristotle University, EL

AirMerge system for Chemical Weather Models

Mobile and static sensor network configurations by University of Cambridge.
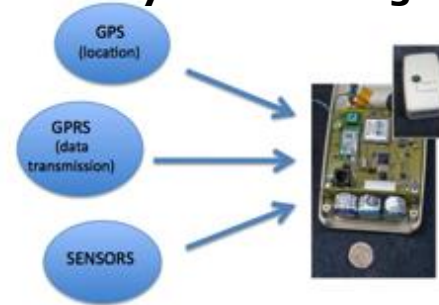
Chemical Weather Forecasting by NIMH, Bulgaria
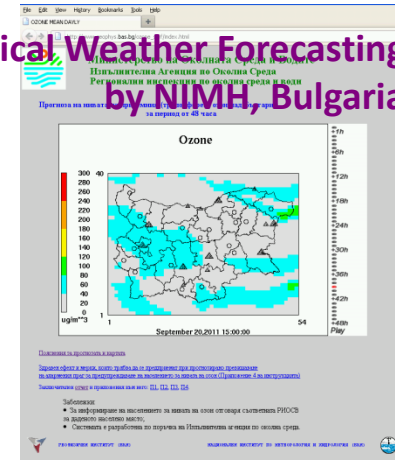
AQ Modeling: Tracking routes by Aarhus University, DK

Industrial
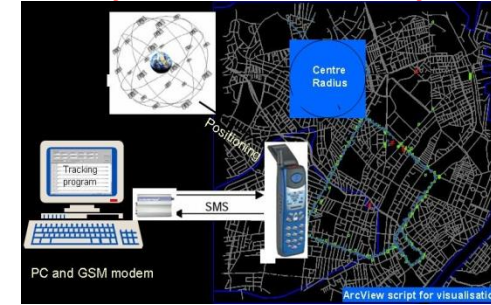
Environmental measurements of PM and air pollution by CSIC, ES

AQ monitoring station by ARPA-PUGLIA, IT

Rural

AQ monitoring station by Aarhus University, DK

Urban/Street

AQ monitoring station by Lithuanian EPA

18

WG4 PRIORITIES: Protocols and Standardisation Methods

WG4-Leader:	**Prof. Ingrid Bryntse, SenseAir SA, Delsbo, Sweden**
WG4 Composition:	**3 Sub-WG Leaders and 25 Members**

PRIORITY #1:	**Odorants:** ✓H_2S and organic thiols (mercaptans) ✓Odour monitoring
PRIORITY #2:	**Particulate Matter (PM):** ✓PM_{10}, $PM_{2.5}$, Ultrafine PM ✓Black Carbon (BC)
PRIORITY #3:	**VOC, Indoor Air:** ✓CH_2O methanal (formaldehyde) ✓C_6H_6 (Benzene) and other BTX (Benzene, Toluene, Xylene)
PRIORITY #4:	**Inorganic Gases:** •NO_2 (nitrogen dioxide) & O_3 (ozone), analysed simultaneously •CO_2 (carbon dioxide) (ventilation indicator and greenhouse gas)
PRIORITY #5:	**Aiming at Low-cost Sensors:** ✓Small sensor with simple PCB: **€100** (OEM manufacturer price to a customer which use in their system) ✓Sensor modules: **€300**
PRIORITY #6:	**Laboratory and Field Testing at National Accredited Test Laboratories**

WG4 Chair: Prof. Ingrid Bryntse, SenseAir AB, Sweden

- **Sub-Working Group 4.1**: Protocols, standards and methods for AQC by analyzers/instruments (no-sensors) technologies.

- **Sub-Working Group 4.2**: Protocols, standards and methods for AQC by sensors (no-analyzers) technologies.

- **Sub-Working Group 4.3**: Benchmarking of new products and market of commercial AQC sensors.

European Directive 2008/50/EC: Ambient Air Quality

EU standard EN 13725/2003: Dynamic Olfactometry

Protocols and Standardised Methods for Gas Sensors

Guidelines of Best Transducers applied to specific gases

Dynamic olfactometry EN13725 by Univ. of Liege, Odometric SA, Univ. of Bari, Lenviros srl.
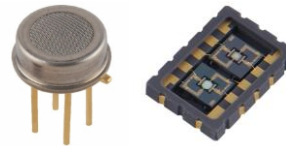
Packaged Sensors by E2V, CH

SENSORS ARRAY — DIGITAL INTERFACES

SIGNAL CONDITIONING

Microchip Platform by SensiChips Srl, IT

SC 100
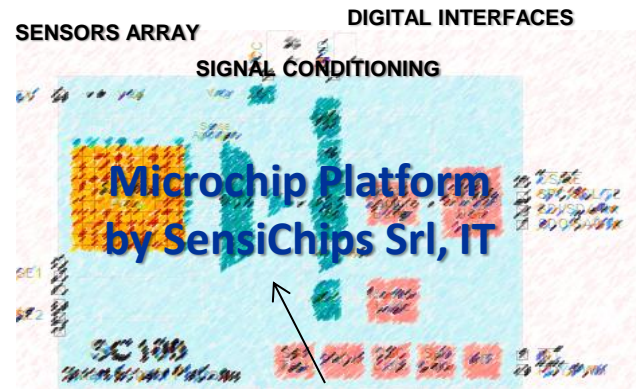
New precision multi-parametric analytical tool

Clean-Air Catalysis

clean air
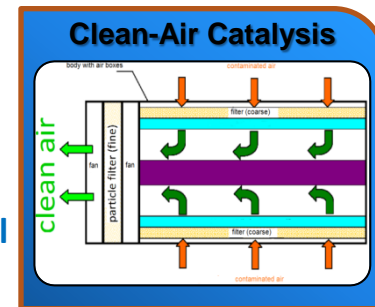
Becker Gruppe, DE
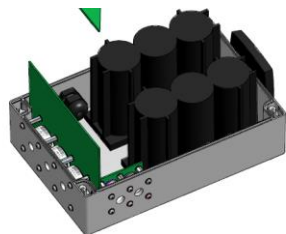
Battery-Powered Sensors by Alphasense Ltd, UK

CO_2 IR sensor for alarm System by SenseAir AB, Sweden

ENA
Eu Net Air
EuNetAir
European Network on New Sensing Technologies
for Air-Pollution Control and Environmental Sustainability
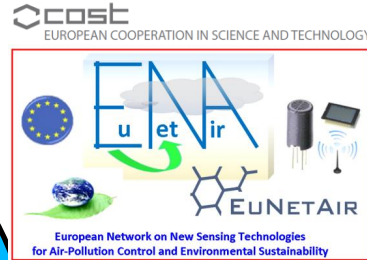
WG1:
Sensor Materials & Nanotechnologie

WG2:
Sensors, Devices & Systems for AQC

WG4:
Protocols & Standardisation Methods

WG3:
Env. Measurements & Air Pollution Modelling

INTERDISCIPLINARY SPECIAL INTEREST GROUPS

MANAGEMENT COMMITTEE:

CORE-GROUP & STEERING COMMITTEE

- *Editorial Board*
- *Dissemination*
- *Training Schools*
- *Gender Balance*
- *Early Stage Researchers (ESR)*
- *Short-Term Scientific Mission (STSM)*
- *Intellectual Property Rights (IPR)*
- *Local Organizing Committee (LOC)*

- **SIG 1**: *Network of Spin-offs*
- **SIG 2**: *Smart Sensors for Urban Air Monitoring in Cities*
- **SIG 3**: *Guidelines for Best Coupling Air Pollutant-Transducer*
- **SIG 4**: *Expert comments for the Revision of the Air Quality EU Directive*

EuNetAir INNOVATION on AIR QUALITY MONITORING

**Autonomous Gas Sensor System
by IREC and Univ. of Barcelona**

11 cm

19 cm
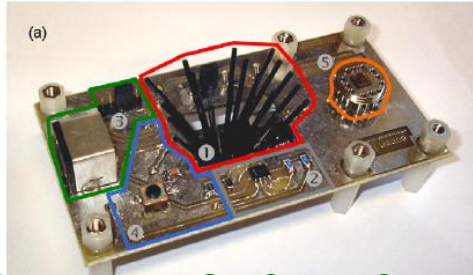
**Autonomous EC Gas AQ Sensor System
by ENEA, Italy**

Wireless sensor network for air-quality monitoring
around Heathrow airport
by University of Cambridge and Alphasense Ltd, UK

Anemometer

GPS

OPC inlet

Optical particle counter

GPRS

CO$_2$

USB memory

PID (VOCs)

T, RH

Electrochemical cells: NO, CO, NO$_2$, SO$_2$, O$_3$

Power cable

Electrodes

1130μm ±30μm

1030μm ±30μm
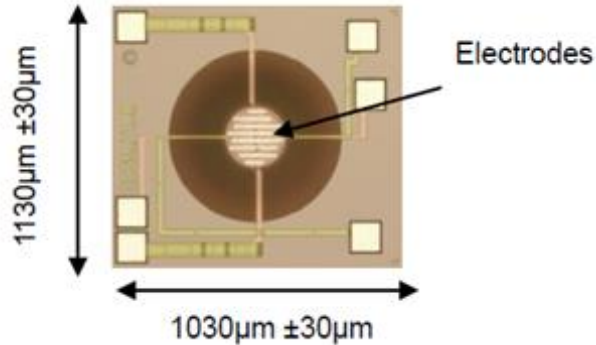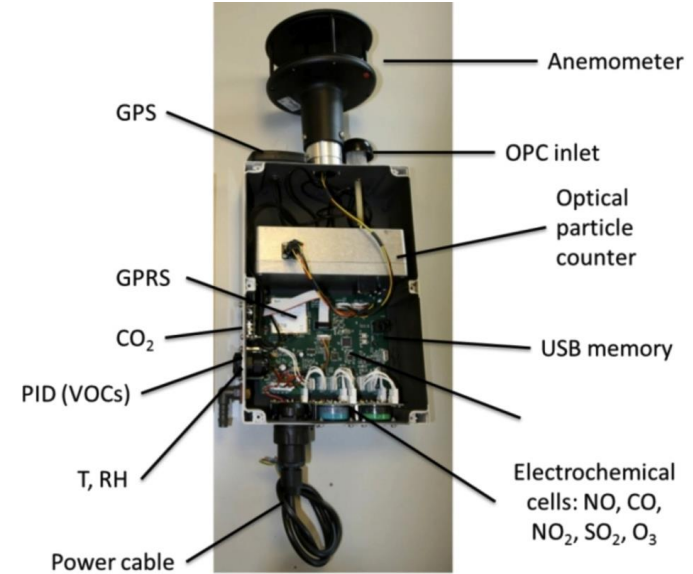
**Miniaturized CMOS Sensor
by CCMOS Sensors Ltd and Warwick University**

**Air Quality Bike (Aeroflex) for Mobile AQ Measurements
by VITO, Belgium**

**A low-cost modular sensor platform
combining IR spectrometry and
MOX gas sensors for IAQ monitoring
(CO$_2$, VOC) and medical applications
by 3S GmbH and Saarland
University, Germany**

3S Gas sensing solutions

SenseAir S8 004-0-0... 0700AEE0

**Non-Dispersive Infra Red (NDIR) Gas
Sensors (CO2) by SenseAir, Sweden**
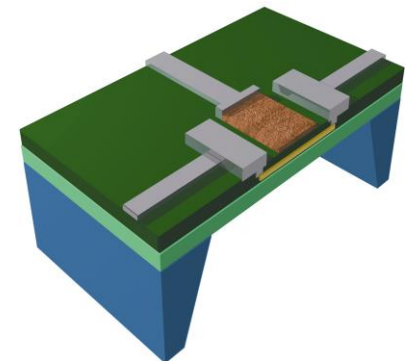
**SGX-Sensortech MOX Gas Sensors
for Automotive AQ Measurements
by SGX-Sensortech, Switzerland**

cost
EUROPEAN COOPERATION IN SCIENCE

COST Action TD1105 ROADMAP (2012-2016)

YEAR	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1	**M**: **Kick-Off Meeting**. **MC Meeting 1**. **D**: MC setup and Action Workplan established	**M**: Editorial Board for Leaflet, Brochure, Newsletter. Action website setup. **D**: Definition of WGs and WGs Workplans	**M**: **MC Meeting 2**. WGs Meeting 1. **D**: Scientific activities, ESR/STSM program, Dissemination	**M**: **Workshop 1**. **Training School 1**. State-of-Art on AQC. **D**: Evaluation and Activity Report. Scientific strategies
2	**M**: **MC Meeting 3**. WGs Meeting 2. Update Action website. **D**: Scientific activities. Liason with EU Programs	**M**: Editorial Board meeting. ESR/STSM. **D**: Dissemination. Newsletter. Reporting	**M**: **MC Meeting 4**. WGs Meeting 3. **Workshop 2**. **Training School 2**. **D**: S&T strategies	**M**: **International Conference 1**. Edit. Board. ESR/STSM. **D**: Dissemination. Reporting
3	**M**: **MC Meeting 5**. WGs Meeting 4. **D**: Dissemination. Strategies & Activities	**M**: Edit. Board: State-of-art AQC. ESR/STSM **D**: Dissemination. Strategies. Reporting	**M**: **MC Meeting 6**. WGs Meeting 5. **Workshop 3**. **Training School 3**. **D**: S&T strategies	**M**: Edit. Board: Newsletter. ESR/STSM **D**: Dissemination. Reporting
4	**M**: . **MC Meeting 7**. WGs Meeting 6. **D**: S&T strategies. Link to EU programs, Industry	**M**: **Workshop 4**. **Training School 4**. **D**: Dissemination. ESR/STSM. S&T strategic activity.	**M**: WGs Meeting 7. **D**: S&T strategies and activities. ESR/STSM. Dissemination	**M**: **International Conference 2**. **MC Meeting 8**. **D**: Final Evaluation. Reporting

M: *Milestones*   **D**: *Deliverables*

Aveiro Joint-Exercise Intercomparison

13 October 2014 (Starting Joint-Exercise): 2 weeks duration !

14 - 15 October 2014 (EuNetAir WG1-WG4 Meeting)

EuNetAir Air Quality Joint-Exercise Intercomparison 2014

Air quality campaign at Aveiro (Portugal) city centre 2014

**Continuous measurements: CO, benzene, NOx, SO2, PM10, VOC
Temperature, humidity, wind velocity, wind direction, solar radiation, precipitation**

COST partners are invited to install their microsensors side-by-side with Mobile Laboratory Air-Quality standardised equipment

OUTREACH ACTIVITIES from Action TD1105 (1/1)

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

Action website:

www.cost.eunetair.it

hosted by ENEA

Dr. Marco Alvisi, *Webmaster Coordinator*

Sebastiano Dipinto, Valerio Pfister, Gianfranco Zingarelli, *Webmaster Team*

Social Scientific ESRs Network (SSEN) by LinkedIn

Moderator(s): Mar Viana, Mariacruz Minguillon
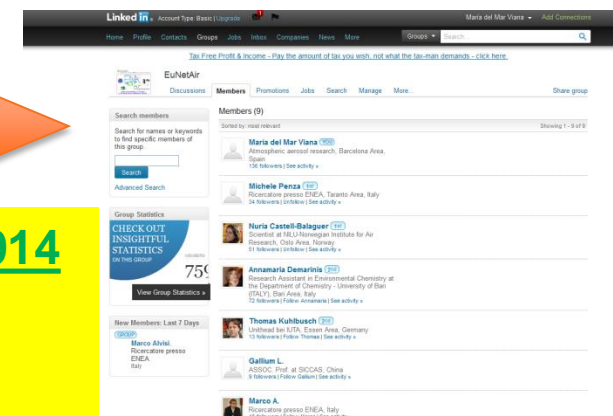
3° CALL for Short Exchange Visits to be launched on July 2014
(STSM - Short Term Scientific Mission)

Dr. Jan Theunis, STSM Coordinator EuNetAir

Issue 1: published on Dec. 2012 ✓

Issue 2: published on June 2013 ✓

Issue 3: published on December 2013 ✓

Issue 4: planned on June 2014 ✎

Prof. Ralf Moos, *Editor-in-Chief*

Dr. Daniela Schonauer-Kamin, *Editorial Board Manager*

EuNetAir Newsletter

COST EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST Action TD1105 Iss. 1/Dec 2012

Opening Editorial

Editorial Activities: WGs MEETING at EEA

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

- **Special Issue Urban Climate (*Elsevier*)**

New Sensing Technologies and Methods for Air-Pollution Monitoring

Proceedings of the Action EEA Meeting open to external contributors.

*Peer-review process (***http://ees.elsevier.com/uclim/***)*

- ***Guest Editors*:**

✓ Michele Penza, ENEA, Italy

✓ Anita Lloyd Spetz, Linkoping University, Sweden

✓ Ole Hertel, Aarhus University, Denmark

✓ Ulrich Quass, IUTA eV, Germany

- Deadline for submission: 28 February 2014 (**Close**)

- Number of Submissions: ***21 Manuscripts***

- Expected Publication: *Fall 2014 (Nov-Dec 2014)*
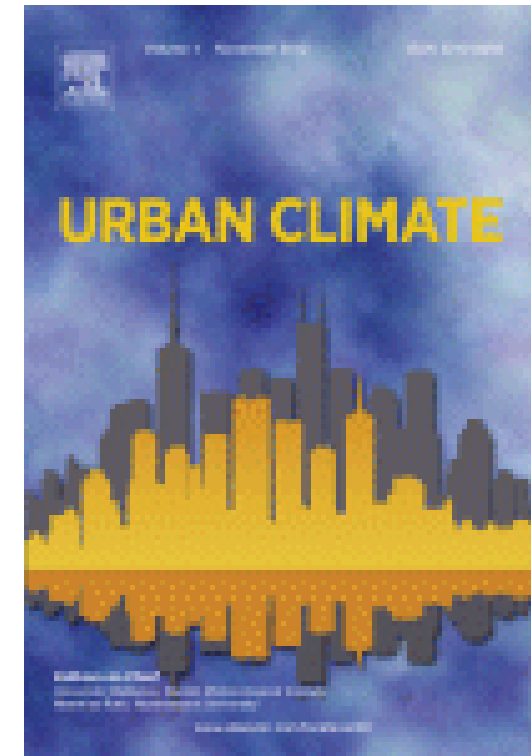
Editorial Activities: Symposium at EMRS

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

- **Special Issue _Journal of Sensors and Sensor Systems_ (_Copernicus Publications_)**

Advanced Functional Materials for Environmental Monitoring and Applications

Proceedings of Symposium B EMRS Spring Meeting 2014, 26-30 May 2014, Lille (FR)

*Peer-review process (**www.journal-of-sensors-and-sensor-systems.net**)*

- _**Guest Editors**_:

✓ Michele Penza, ENEA, Italy

✓ Anita Lloyd Spetz, Linkoping University, Sweden

✓ Albert Romano-Rodriguez, Barcelona University, Spain

✓ Yongxiang Li, Chinese Academy of Sciences, China

✓ Meyya Meyyappan, NASA Ames Research Center, USA

- Deadline for submission: **30 June 2014**

- Expected Publication: *Fall 2014 (Nov-Dec 2014)*

Journal of Sensors and Sensor Systems

JSSS | Volume 1 | Issue 1 | 2012
www.journal-of-sensors-and-sensor-systems.net

AMA

SOME FP-7 PROJECTS ON AIR QUALITY: OUTDOOR

Project Acronym	Title of Project / Coordinator / Email
CITI-SENSE FP7-ENV-2012	*Development of Sensor-based Citizens' Observatory Community for Improving Quality of Life in Cities* **Coordinator**: Alena Bartonova, NILU, Kjeller, Norway **Email**: alena.bartonova @nilu.no
AIRMONTECH FP7-ENV-2012	*Air Pollution Monitoring Technologies for Urban Areas* **Coordinator**: Thomas Kuhlbusch, IUTA eV, Duisburg, Germany **Email**: tky @iuta.de
OMNISCIENTIS FP7-ENV-2013	*A Living Lab Approach to Develop Sustainable Environmental Governance* **Coordinator**: Anne-Claude Romain, Universitè de Liege, Belgium **Email**: acromain @ulg.ac.be
EVERYAWARE FP7-ICT-FET2012	*Enhance Environmental Awareness through Social Information Technologies* **Coordinator**: Vittorio Loreto, ISI Foundation, Torino, Italy **Email**: vittorio.loreto @isi.it
MACPOLL FP7-EMRP-2012	*Metrology for Chemical Pollutants in Air* **Coordinator**: Annarita Baldan, VSL B.V., Delft, The Netherlands **Email**: abaldan @vsl.nl

SOME FP-7 PROJECTS ON AIR QUALITY: INDOOR

Acronym	Title of Project / Coordinator / Email
SENSINDOOR FP7-NMP-2013	*Nanotechnology-based Intelligent multi-Sensor System with Selective Pre-concentration for IAQ Control* **Coordinator**: *Andreas Schuetze, Saarland University, Germany* **Email**: *schuetze @lmt.uni-saarland.de*
MSP FP7-ICT-2013	*Multi-Sensor Platform for Smart Building Management* **Coordinator**: *Anton Kock,* Materials Center Leoben*, Austria* **Email**: *Anton.Koeck @mcl.at*
INTASENSE EeB-ENV-2011	*Integrated Air Quality Sensor for Energy Efficient Environment Control* **Coordinator**: *Robert Bell, C-Tech Innovation Ltd, Chester, UK* **Email**: *rob.bell @ctechinnovation.com*
CETIEB FP7-ICT-2011	*Cost-Effective Tools for Better Indoor Environment in Retrofitted Energy Efficient Buildings* **Coordinator**: *Jurgen Frick, University of Stuttgart, Germany* **Email**: *Juergen.Frick @mpa.uni-stuttgart.de*
OFFICAIR FP7-ENV-2010	*On the Reduction of Health Effects from Combined Exposure to Indoor Pollutants in Modern Offices* **Coordinator**: *John Bartzis, University of Western Macedonia,Greece* **Email**: *bartzis @uowm.gr*

Interdisciplinary Networking with other COST Actions (1/1):

- **COST Action ES1004** - *European framework for online integrated air quality and meteorology modelling*. Speaker Peter Suppan (KIT, Germany) at Action TD1105 *EuNetAir* meeting (Rome, 4-6 Dec 2012); Speaker Nicolas Moussiopoulos (International Hellenic University, Greece) at Action TD1105 *EuNetAir* meeting (Duisburg, 4-6 March 2013); Speaker Stefano Galmarini (JRC-Ispra, Italy) at Action TD1105 *EuNetAir* meeting (Duisburg, 4-6 March 2013).

- **COST Action ES1002** - *Weather Intelligence for Renewable Energies* (WIRE). Collaboration on devices, systems and methods for indoor/outdoor energy efficiency and weather information for forecasting the energy production. Preliminary exchange between both Action Chairs and Vice-Chairs.

- **COST Action MP0901** - *Designing Novel Materials for Nanodevices: From Theory to Practice*. Collaboration on nanostructured materials for sensors, devices and systems to be applied to indoor/outdoor energy efficiency and air-pollution monitoring. Prof. Eduard Llobet (Universitat Roviri I Virgili, Spain) continues his research activities from Action MP0901 as joined member to *EuNetAir*.

- **COST Action IC1102** - *Versatile, Integrated, and Signal-aware Technologies for Antennas*. Collaboration on wireless sensors and sensor networks for air-pollution monitoring. Preliminary exchange between both Action Chairs at European Parliament in Brussels on 29 January 2013 during COST-event "*How can networking in Science and technology help SMEs meet the Innovation Union goals* ?".

- **COST Action ES0802** - *Unmanned Aerial Systems (UAS) in Atmospheric Research*. Collaboration on sensors, devices, systems and methods for air-pollution monitoring at real outdoor scenario. Prof. Burkhard Wrenger (University of Applied Sciences Ostwestfalen-Lippe), Dr. J. Valentin Lavric and Dr. Martin Kunz (Max Planck Institute for Biogeo chemistry) continue their research activities from Action ES0802 as joined members to *EuNetAir*.

- **COST Action ES0602** - *Chemical Weather Forecasting and Information Systems*. Collaboration on information systems and methods for chemical weather forecasting and air-pollution monitoring at real outdoor scenario. Prof. Kostas Karatzas (Aristotle University Thessaloniki, Greece), Dr. Dimiter Syrakov (Bulgarian Academy of Sciences), Dr. Zita Ferenczi and Dr. Krisztina Labancz (Hungarian Meteorological Institute, Hungary) continue their research activities from Action ES0602 as joined members to *EuNetAir*.

CONCLUSIONS

The COST Action TD1105 *EuNetAir* is proposed to solve problems and strengthen the area of:

- **Air Quality Control**

- **Environmental Sustainability**

- **Indoor/Outdoor Energy Efficiency**

- **Climate Change Monitoring**

- **Health Effects of Air-Pollution**

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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

Expected Impact by Action TD1105

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

- **European Leadership on AQC Science & Technology**

- **Development of Green-Economy**

- **Support to Sustainable Development**

- **Support to Monitoring System of Clean Air for Europe**

- **Fostering Research & Innovation on New Sensing Technologies for Environmental Monitoring**

MC Chair:	**Dr. Michele Penza, ENEA, IT** michele.penza@enea.it
MC Vice Chair:	**Prof. Anita Lloyd Spetz** **Linkoping University, SE** spetz@ifm.liu.se
Grant Holder:	**Dr. Corinna Hahn** **Eurice GmbH, DE** c.hahn@eurice.eu
Scientific Secretary:	**Dr. Annamaria Demarinis Loiotile** annamaria.demarinis@uniba.it
Science Officer:	**Dr. Deniz Karaca** deniz.karaca@cost.eu
Administrative Officer:	**Dr. Andrea Tortajada** andrea.tortajada@cost.eu
Rapporteur ESSEM:	**Prof. Kostantinos Kourtidis (GR)** kourtidi@env.duth.gr
Rapporteur MPNS:	**Prof. Joaquim Manuel Vieira (PT)** jvieira@cv.ua.pt
Rapporteur CMST:	**Prof. Antonio Lagana (IT)** lagana05@gmail.com

ACKNOWLEDGEMENTS

KICK-OFF MEETING of Action TD1105
COST Office, Brussels, 16 May 2012

TD1105 MANAGEMENT COMMITTEE

THANK YOU VERY MUCH FOR YOUR KIND ATTENTION !

www.cost.eunetair.it

Link of COST Action TD1105 EuNetAir:

http://www.cost.eu/domains_actions/essem/Actions/TD1105?

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

33

MoU **Secondary Objectives** of COST Action TD1105:

• *To provide* a *platform between scientists* in the field of materials, nanotechnology and sensor-systems and other scientists such as environmental protection engineers, public agencies managers, stakeholders, decision-makers, aiming to improve best practices in AQC and explore the potential role of new generation of low-cost sensing devices.

• *To investigate* *sensing mechanisms* of functional nano-materials for gas measurement and identification of the best available nano-materials, providing concepts and harmonising pre-standardised methods; based on available datasets from partners.

• *To assess* *degradation rates and lifetime* of sensor elements in defined environmental conditions and evaluate interactions of sensitive materials with outdoor/indoor pollutants; based on datasets from ongoing and historical field deployments of low-cost sensors.

• *To investigate* *the best available technology* for sensor deployment, communication, power supply and data storage, analysis and display.

MoU Secondary Objectives of COST Action TD1105:

• *To monitor* real-world environmental conditions with *experimental campaigns* to assess composition of *indoor air* (buildings: house and office) and *outdoor air* (urban areas and industrial sites) and to investigate how such data can be utilised in air pollution modelling.

• *To approach* *standardisation of methods* for air quality measurements, e.g. harmonisation of test procedures, chemical analysers, post processing, protocols, etc..

• *To disseminate* *knowledge* on functional materials and sensor-systems for AQC; to aid better focusing of Europe's resources by coordinated efforts in AQC and environmental sustainability to strengthen Europe's competitiveness and scientific excellence improving capacity building and networking to tackle global challenges in a big market in the mid-long term.

SLIDES BAKEUP

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

COST Action TD1105 EuNetAir: Action participants
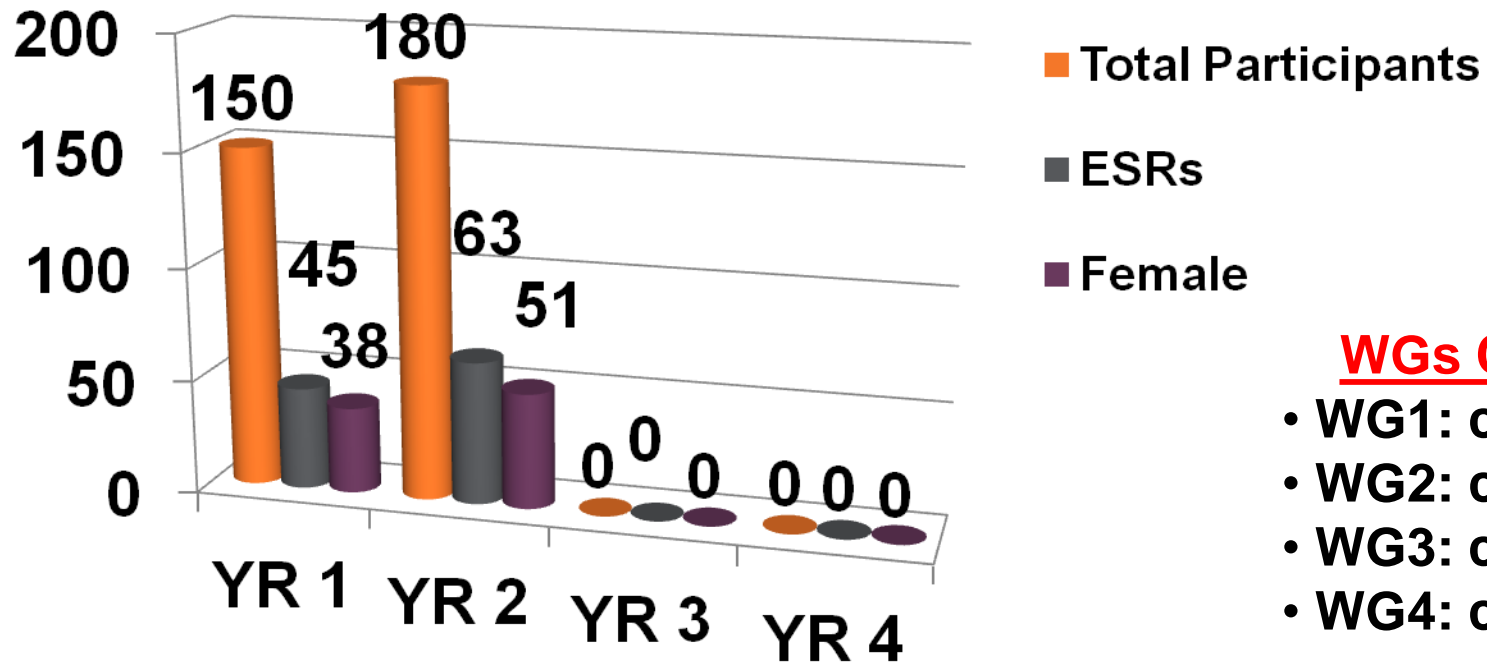
WGs Composition:
- WG1: ca. 30 participants
- WG2: ca. 45 participants
- WG3: ca. 40 participants
- WG4: ca. 25 participants

Summary YEAR 2: 1 July 2013 - 30 June 2014
- **Total Number of Participants:** 180 (**80% active**)
- **Early Stage Researchers (ESRs):** 63 (**35%**)
- **Females:** 51 (**28%**)
- **MC Members:** 52 - Male: 38 (**73%**); Female: 14 (**27%**)
- **MC Substitutes:** 30 - Male: 24 (**80%**); Female: 6 (**20%**)

Innovation Highlights of COST Action TD1105 *EuNetAir*:

The Working Program includes multidisciplinary Research at integrated approach and trans-domain multi-scale level:

- **Nanomaterials** for low-cost AQC sensors
- Improved **gas sensor systems** and low-power sensing microdevices
- **Wireless sensor networks** and distributed intelligence
- **Air-quality modelling** and chemical weather forecasting
- **New protocols**, standards and methods for AQC sensors
- **Harmonisation** of environmental measurements
- **Guidelines** for AQC systems and transducers
- **Environmental sustainability and energy efficiency**

European Network on New Sensing Technologies
for Air-Pollution Control and Environmental Sustainability
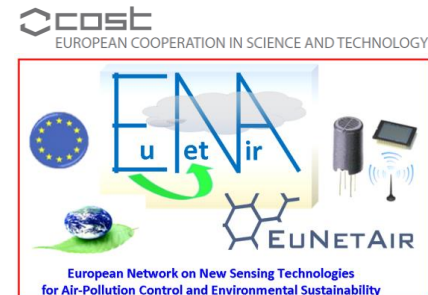
Results vs. Objectives

Cooperative original research and significant breakthroughs from EuNetAir

- Development of a **portable sensor-system based on a single nanowire** of metal oxides at low powered (sub-microWatt) for air pollution detection (CO, NO2). Universitat de Barcelona (Prof. Albert Romano-Rodriguez, Dr. J. Daniel Prades, Spain) and IREC (Prof. Juan Ramon Morante, Spain).
- Development of **p-type metal oxide gas sensing elements** for the detection of H_2 and aldehydes. FORTH (Prof. George Kiriakidis, Greece) and University of Brescia (Prof. Giorgio Sberveglieri, Italy) in close collaboration with University of Tuebingen (Dr. Nicolae Barsan, Germany).
- **Miniaturized sensor based on CMOS-SOI technology with USB-port** and microstructured active material for ubiquitous air quality measurements and portable methods. Cambridge University (Prof. Florin Udrea, UK) and Warwick University (Prof. Julian Gardner, UK).
- **A low-cost modular sensor platform combining IR spectrometry** based on microstructured Fabry-Perot Filters and MOX gas sensors for indoor air quality monitoring (CO_2, VOC) and medical applications. Prof. Andreas Schuetze (Saarland University, Germany).
- **Air Quality Bike (Aeroflex)** for mobile air quality measurements developed by VITO (Dr. Jan Theunis, Belgium) including participatory sensing by *City-Guards* measuring air quality in Antwerp during six months by a portable gas sensor-system.
- **Wireless sensor network for air-quality monitoring around Heathrow airport** (London, UK) based on at least 50 nodes consisting of gas sensors (CO, CO2, NOx, O3, SO2, VOC), particulate matter (PM10, PM2.5) detectors and environmental parameters monitoring (temperature, humidity). University of Cambridge (Prof. Rod Jones, UK) and Alphasense Ltd (Dr. John Saffell, UK).
- **Consultation on *Assessing human exposure to air pollution in health assessment studies in Europe*** from Prof. Ole Hertel (Aarhus University, Denmark) to a request of European Environment Agency.
- **Software Tool applied to Air-Quality Modelling** at local and large scale for real case-studies in Europe. University of Ljubljana (Prof. Rahela Zabkar, Slovenia).
- Development of **commercial miniaturized low-cost sensor-systems for air-quality monitoring**. Dr. Nicolas Moser (SGX-Sensortech Ltd, Switzerland).
- **A low-cost NDIR platform for sub-ppm gas detection and CO2 sensing for indoor/outdoor monitoring**. Prof. Ingrid Bryntse (SenseAir SA, Sweden).