

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

Action Start date: 01/07/2012 - Action End date: 15/11/2016 - EXTENSION:
15/11/2016

OVERVIEW: Lessons Learned and Achieved Results

 **cost**
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



Michele Penza

Function in the Action: Action Chair

ENEA - Brindisi, Italy



FINAL MEETING - SIXTH SCIENTIFIC MEETING

Working Groups and Management Committee

organized by Academy of Sciences of the Czech Republic

J. Heyrovský Institute of Physical Chemistry

Prague, Czech Republic, 5 - 7 October 2016



COST is supported
by the EU Framework Programme

Meeting AGENDA

5 Oct. 2016 - Wednesday	
09:00 - 18:00	REGISTRATION
09:30 - 10:00	WELCOME SESSION
10:00 - 11:00	PLENARY SESSION 1: Invited Talks
11:00 - 11:30	<i>Coffee-Break</i>
11:30 - 13:00	PLENARY SESSION 2: Invited Talks
13:00 - 14:30	<i>Lunch</i>
14:30 - 16:00	WG1 Session
16:00 - 16:30	<i>Coffee-Break</i>
16:30 - 18:30	WG2 Session
18:30	<i>Gathering of Day</i>
20:30 - 23:00	<i>Social Dinner</i>
6 Oct. 2016 - Thursday	
09:00 - 18:00	REGISTRATION
09:00 - 11:00	WG3 Session
11:00 - 11:30	<i>Coffee-Break</i>
11:30 - 13:00	WG4 Session
13:00 - 14:00	<i>Lunch</i>
14:00 - 15:30	POSTER SESSION
15:00 - 15:30	<i>Coffee-Break during Poster Session</i>
15:30 - 18:00	SIG1-SIG4 Session
18:00 - 18:30	Inputs on Follow-up of EuNetAir
18:30	CONCLUSIONS
20:30	<i>Free Dinner</i>
7 Oct. 2016 - Friday	
09:00 - 11:00	Action WGs/SIGs GENERAL ASSEMBLY
11:00 - 11:30	<i>Coffee-Break</i>
11:30 - 13:00	9th MANAGEMENT COMMITTEE MEETING
13:00 - 14:30	<i>Lunch</i>
14:30	Meeting Closing

Outline

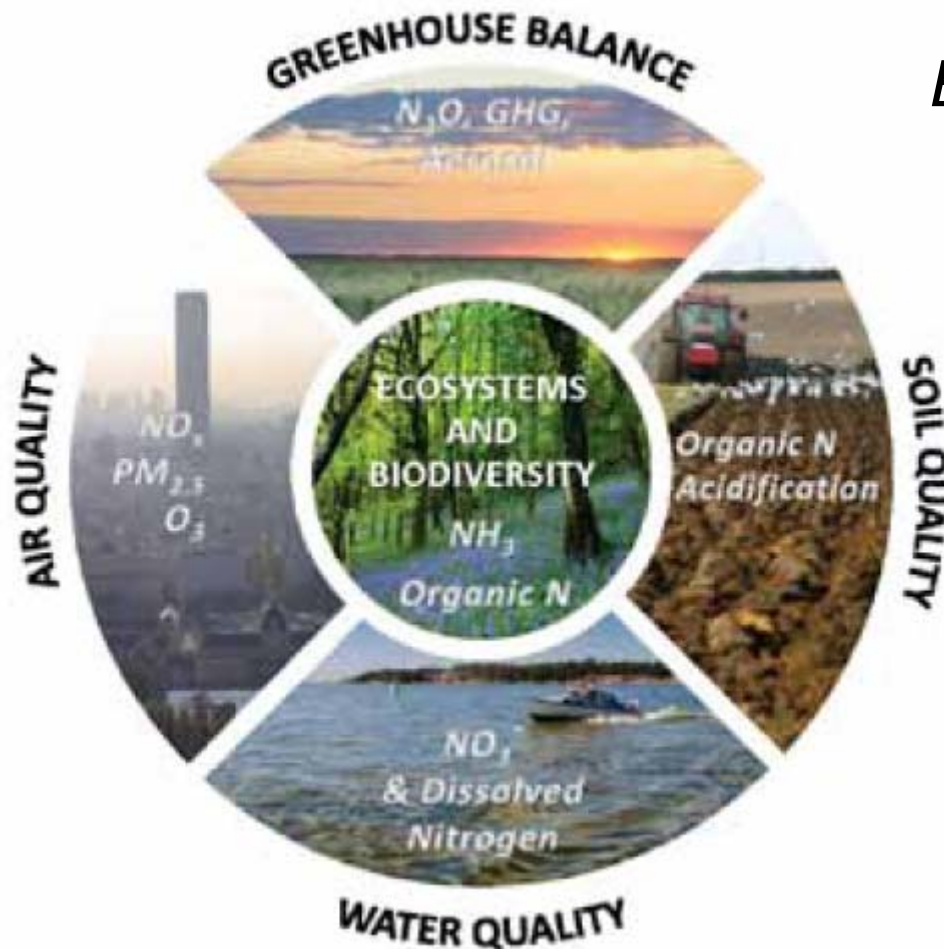
- **Background / Problem Statement:**
 - ✓ *Scientific context*
 - ✓ *Challenges addressed by the Action*
- **MoU Action's Objectives: *Main and Secondary***
- **Action Research Directions:**
 - ✓ *Methodology and Innovation*
- **Working Groups**
- **Results versus Objectives: *Significant Highlights***
- **Future Plans and Challenges: *Expected Impact***
- **Concluding Remarks**



Scientific context: **Environmental Sustainability** (1/3)

Nitrogen Pollution and the European Environment Implications for Air Quality Policy

EC In-Depth Report, September 2013



Excess reactive nitrogen represents a major environmental threat that is only now beginning to be fully appreciated. At a global level, humans have more than doubled the production and cycling of reactive nitrogen, leading to a plethora of impacts that interact across all global spheres: atmosphere, biosphere, hydrosphere and geosphere.

Sutton et al., 2009

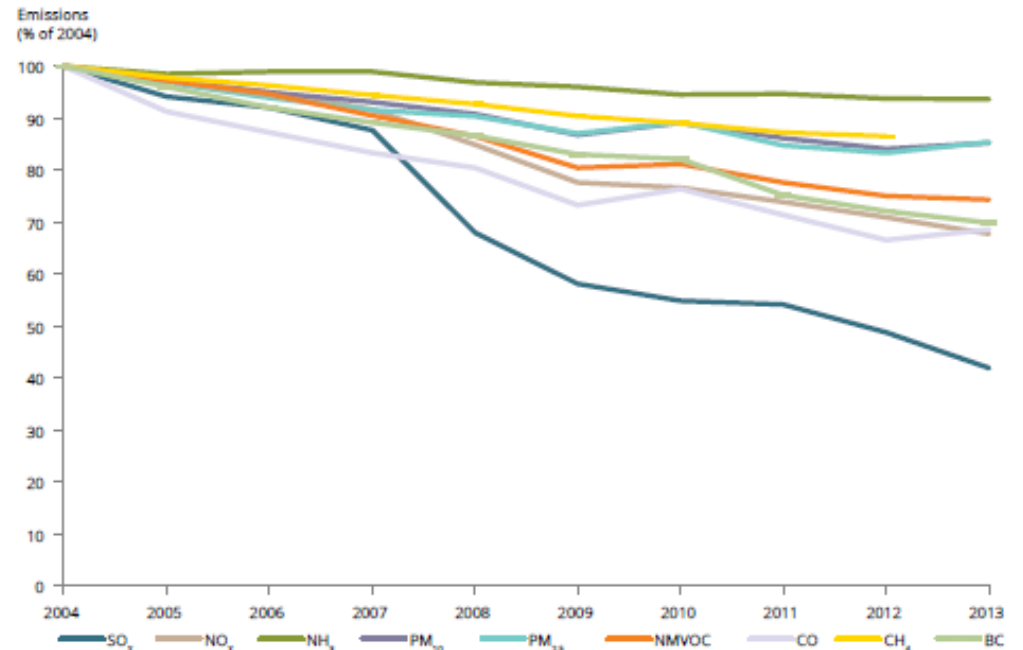
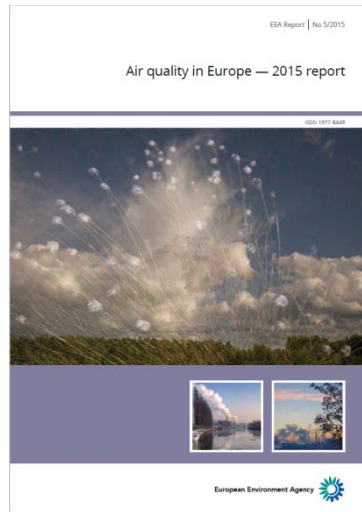
Nitrogen Pollution:
NO_x, N₂O, NH₃, NH₄, NO₂⁻, NO₃⁻, etc.

Source: Sutton and Billen, 2010

Scientific context: Air Quality Control (2/3)

European Environment Agency, EEA Report 5/2015

C. Guerreiro, NILU

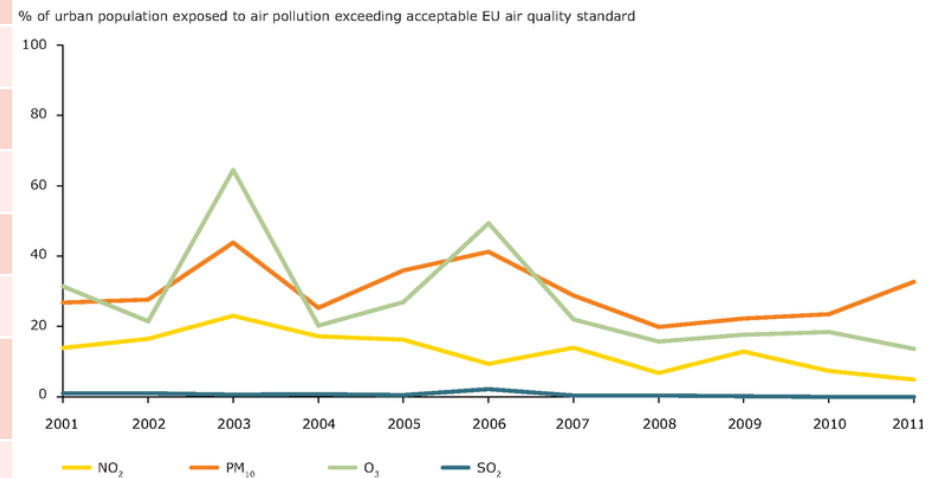


Some Environmental Emergencies:

- 1930 - Meuse Valley (Belgium)
- 1952 - Great London Smog (UK)
- 1954 - Los Angeles (USA)
- 1984 - Bhopal (India)
- 2005 - Teheran (Iran)
- 2006 - Hong Kong
- 2008, 2015 - Shanghai, Peking, CN
- 2012 - Taranto (Italy)
-

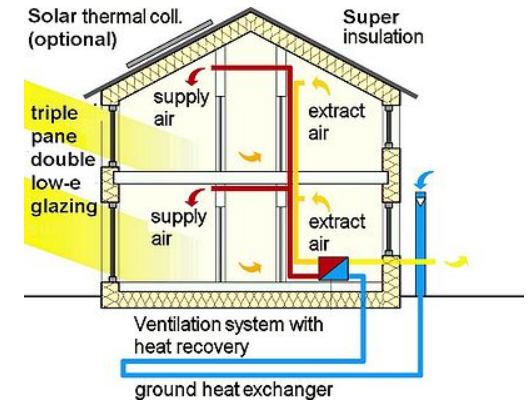
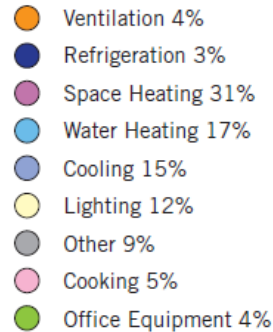
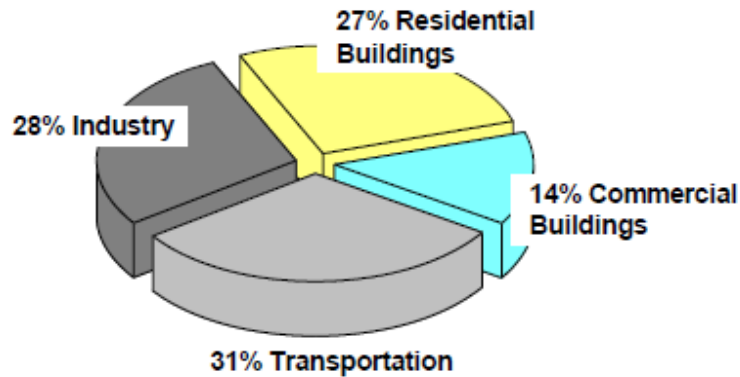
**AMBIENT AIR QUALITY
EU DIRECTIVE 2008/50/EC
and Daughters**

Pollutant	Limit Level
NO _x	100, 200 ppb
CO	8 ppm
SO ₂	130, 190 ppb
O ₃	120 µg/m ³
PM ₁₀	50 µg/m ³
BTEX	6 µg/m ³
PAH (BaP)	1 ng/m ³
PM _{2.5}	25 µg/m ³



Scientific context: Indoor/Outdoor Energy Efficiency (3/3)

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



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

Primary energy consumption in the EU¹

¹ O. Seppanen,

11th Conference on Indoor Air Quality
2008, Copenhagen, 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

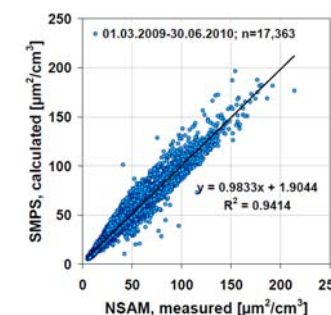
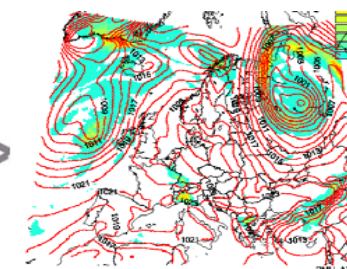
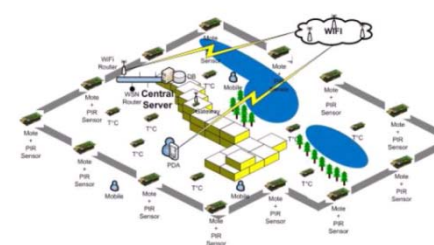
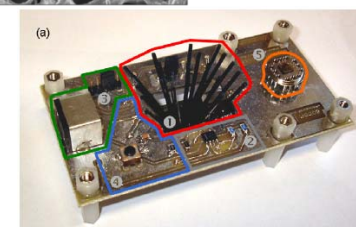
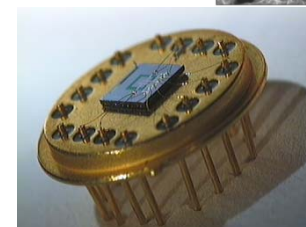
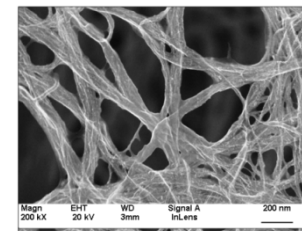
IAQ by WORLD HEALTH ORGANIZATION

Indoor Air		Typical Substances		Cure
Contamination Source	Emission Source	VOCs	Others	
• Human Being	• Breath	Acetone, Ethanol, Isoprene	demand controlled ventilation	
		CO ₂		
	• Skin Respiration & Transpiration	Humidity		
		Nonanal, Decanal, α-Pinene		
	• Flatus	Methane, Hydrogen		
	• Cosmetics	Limonene, Eucalyptol		
	• Household Supplies	Alcohols, Esters, Limonene		
• Combustion (Engines, Appliances, Tobacco Smoke)	Unburnt Hydrocarbons	permanent 5-10% ventilation		
	CO			
	CO ₂			
	Humidity			
• Building Material • Furniture • Office Equipment • Consumer Products	• Paints, Adhesives, Solvents, Carpets	Formaldehyde, Alkanes, Alcohols, Aldehydes, Ketones, Siloxanes		
	• 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**





Action's Objectives (1/2)

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.

Action Research Directions: *Methodology* (2/2)

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 (STSMs) 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.

Action Research Directions: *Innovation* (1/1)

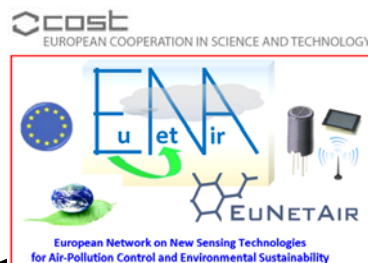
Innovation Highlights of COST Action TD1105 *EuNetAir*:

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**

COST Action TD1105 *EuNetAir*: Working Groups (1/5)

www.cost.eunetair.it



WG1:

Sensor Materials
&
Nanotechnologies

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*

Action (2012-2016) Size:

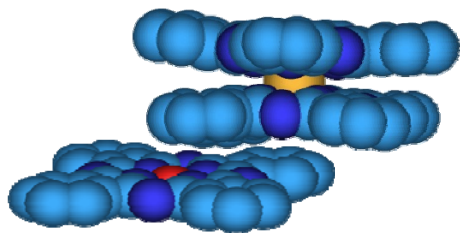
200 Experts from 120 Teams - 31 Countries

TD1105 *EuNetAir* **WG1**: Sensor Materials & Nanotechnologies (2/5)

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

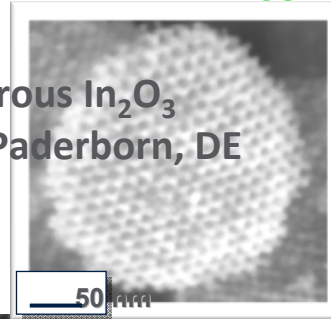
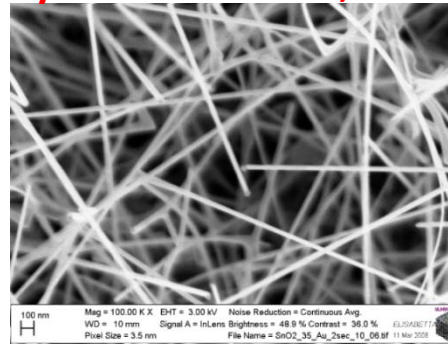
WG1 Vice Chair: Prof. Jyrki Lappalainen, Oulu Univ., FI

- **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.).

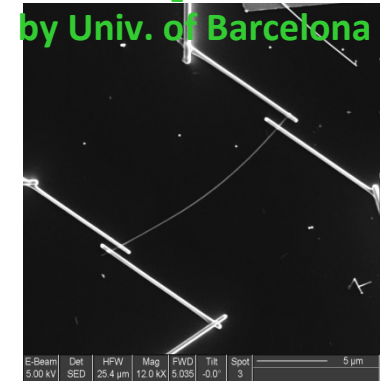


New molecular materials of polymer-macrocycles as transducers for polluting gas sensing by University of Bourgogne

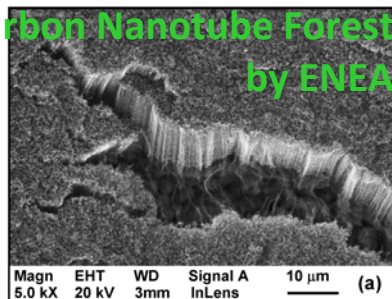
Mesoporous In_2O_3
by Univ. of Paderborn, DE
**Metal oxide (SnO_2)
Nanowires nets**
by Univ. of Brescia, IT



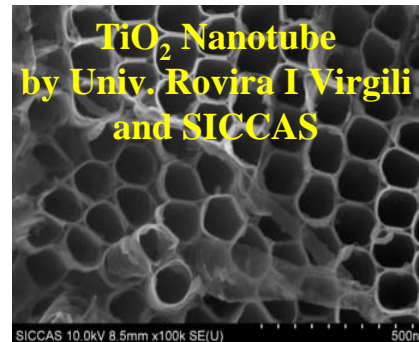
Self-heating SnO_2 Nanowires
by Univ. of Barcelona



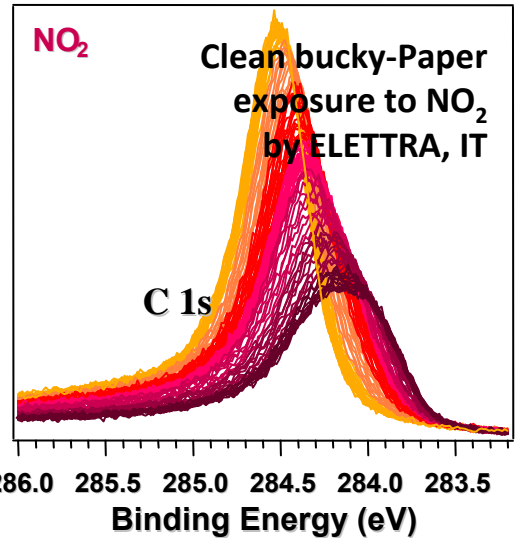
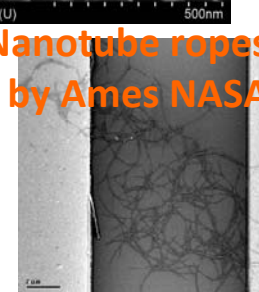
Carbon Nanotube Forest
by ENEA



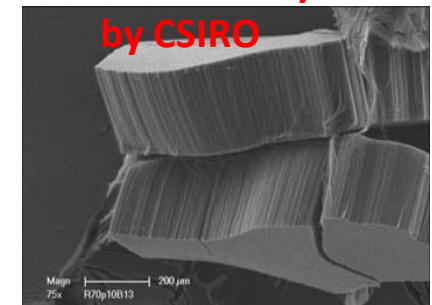
TiO_2 Nanotube
by Univ. Rovira I Virgili
and SICCAS



Carbon Nanotube ropes
by Ames NASA



Carbon Nanotube yarns
by CSIRO



TD1105 *EuNetAir* **WG2**: Sensors, Devices and Systems for AQC (3/5)

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

IT PATENT ENEA

Carbon Nanotube Gas Sensors

- 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.

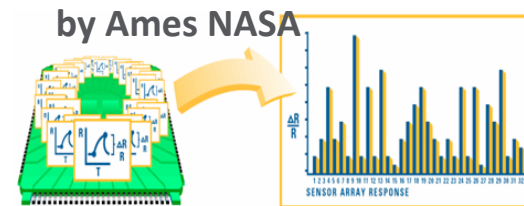


ASIC Circuits:
CMOS, SOI CMOS, Analogue
and Digital VLSI
Smart Signal Processing

Warwick University in collaboration with
Cambridge University, EPFL, PennState.

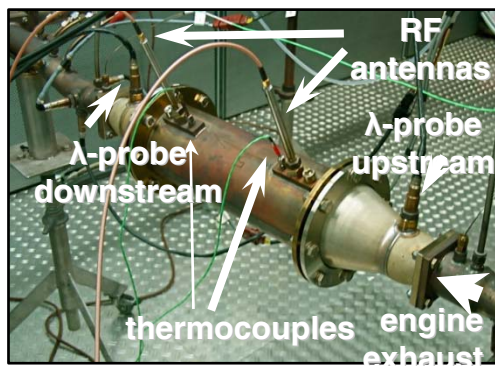


EnviroWatch mote by
Newcastle University



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

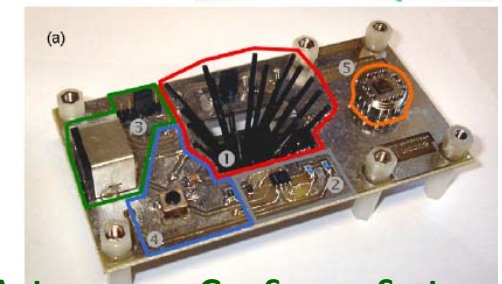
A versatile platform for the efficient development of gas detection systems based on automatic device adaptation by University of Saarland.



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 NO₂
GaN-based sensor concept



Autonomous Gas Sensor System by IREC and Univ. of Barcelona

TD1105 **WG3**: Environmental Measurements and Air-Pollution Modelling (4/5)

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.



Environmental measurements of PM and air pollution by CSIC, ES



AQ monitoring station by ARPA-PUGLIA, IT



AQ monitoring station by Aarhus University, DK



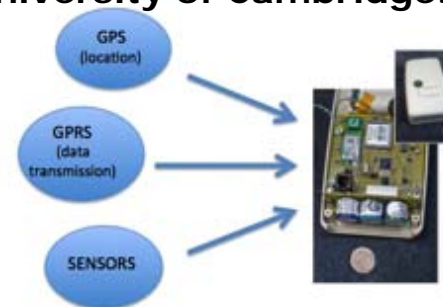
AQ monitoring station by Lithuanian EPA

by Aristotle University, EL

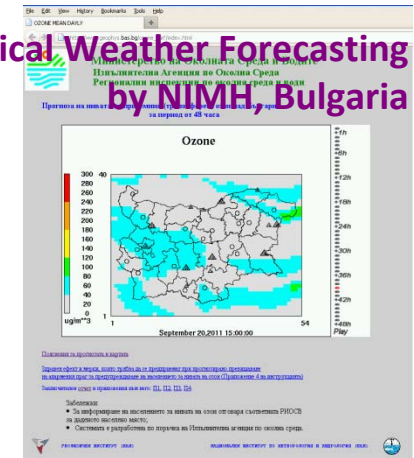


AirMerge system for Chemical Weather Models

Mobile and static sensor network configurations by University of Cambridge.



Chemical Weather Forecasting by NIMH, Bulgaria



AQ Modeling: Tracking routes by Aarhus University, DK



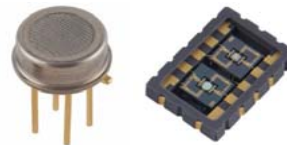
TD1105 *EuNetAir* **WG4**: Protocols and Standardisation Methods (5/5)

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

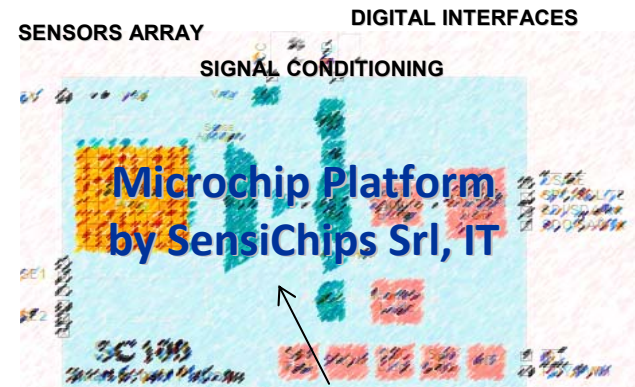
- **Sub-Working Group 4.1:**
Protocols, standards and methods for AQC by analyzers/instruments (no-sensors) technologies.
- **Sub-Working Group 4.2:**
Protocols, standards and methods for AQC by sensors (no-analyzers) technologies.
- **Sub-Working Group 4.3:**
Benchmarking of new products and market 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

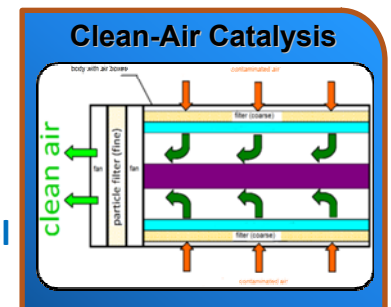
Dynamic olfactometry EN13725
by Univ. of Liege, Odometric SA,
Univ. of Bari, Lenviros srl.



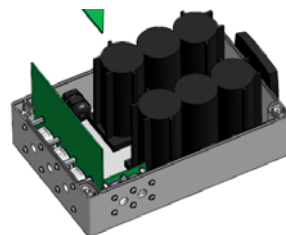
Packaged Sensors
by E2V, CH



New precision multi-parametric analytical tool



Becker Gruppe, DE



Battery-Powered Sensors by Alphasense Ltd, UK



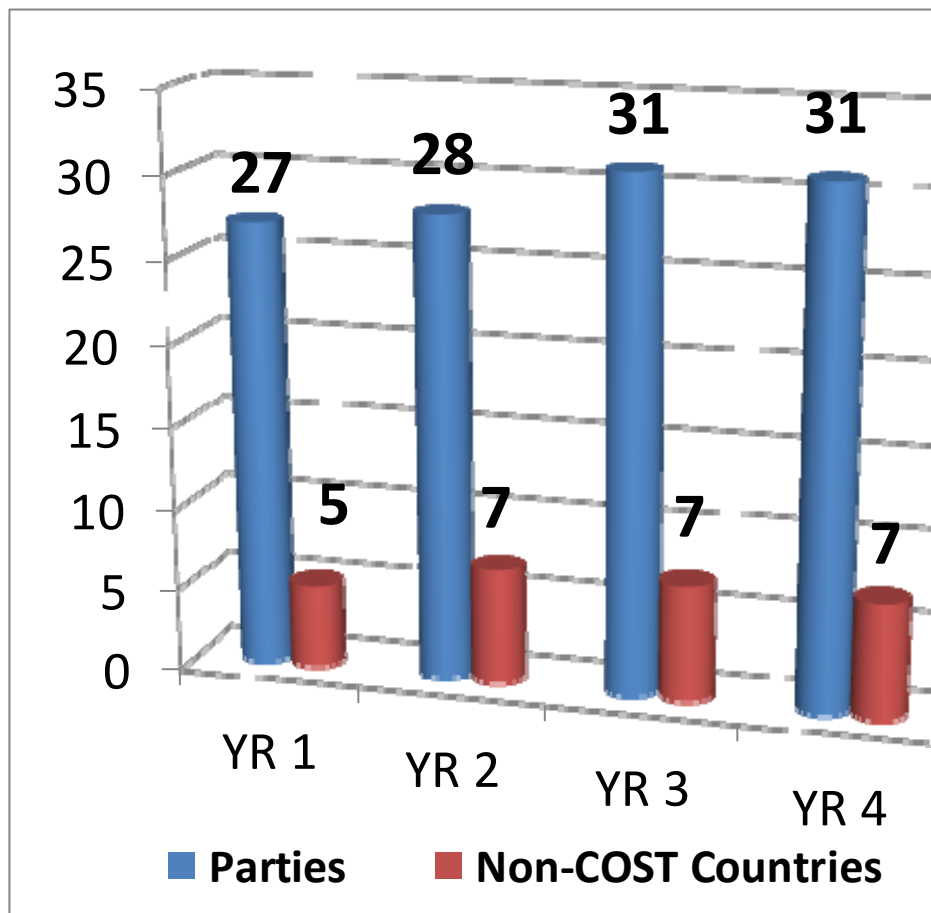
CO₂ IR sensor for alarm
System by SenseAir AB, Sweden

COST Action TD1105 ROADMAP (2012-2016)

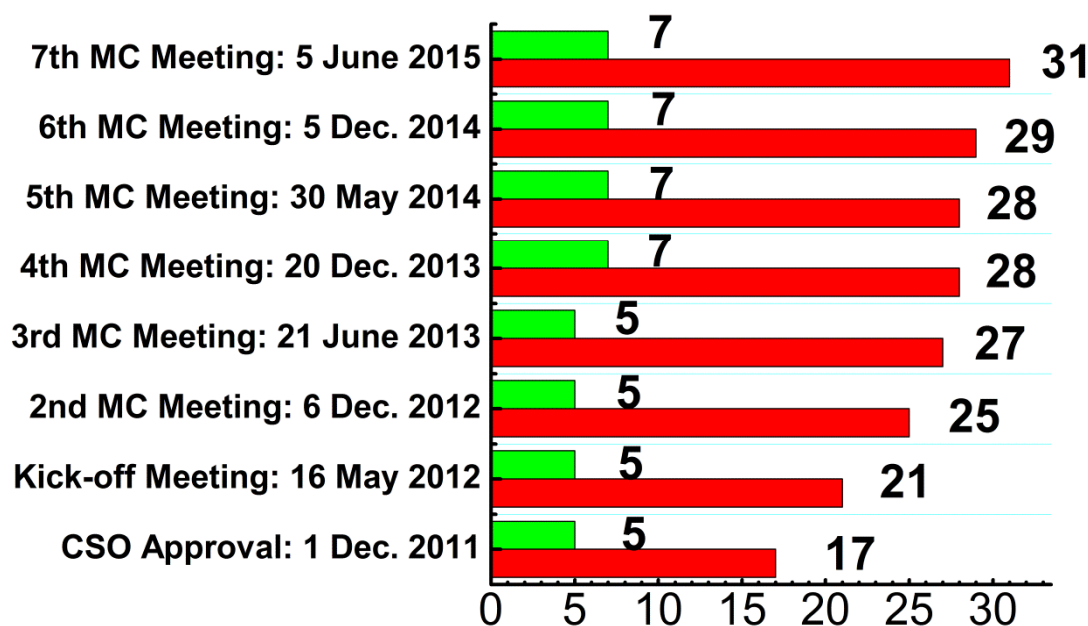
YEAR	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1	<p><u>M</u>: Kick-Off Meeting. MC Meeting 1.</p> <p><u>D</u>: MC setup and Action Workplan established</p>	<p><u>M</u>: Editorial Board for Leaflet, Brochure, Newsletter. Action website setup.</p> <p><u>D</u>: Definition of WGs and WGs Workplans</p>	<p>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

M: Milestones **D: Deliverables**

COST Action TD1105 EuNetAir: **Action Parties (31)**



Grant Holder:
 Eurice GmbH, Saarbrücken, Germany
GH Scientific Representatives:
 Corinna Hahn, MC Member
 Juliane Rossbach, MC Substitute



Non-COST Countries: NNC + IPC

COST Action TD1105 *EuNetAir*

31 COST Countries (Parties) have already signed Memorandum of Understanding (MoU)

PARTIES: 31

already accepted MoU

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

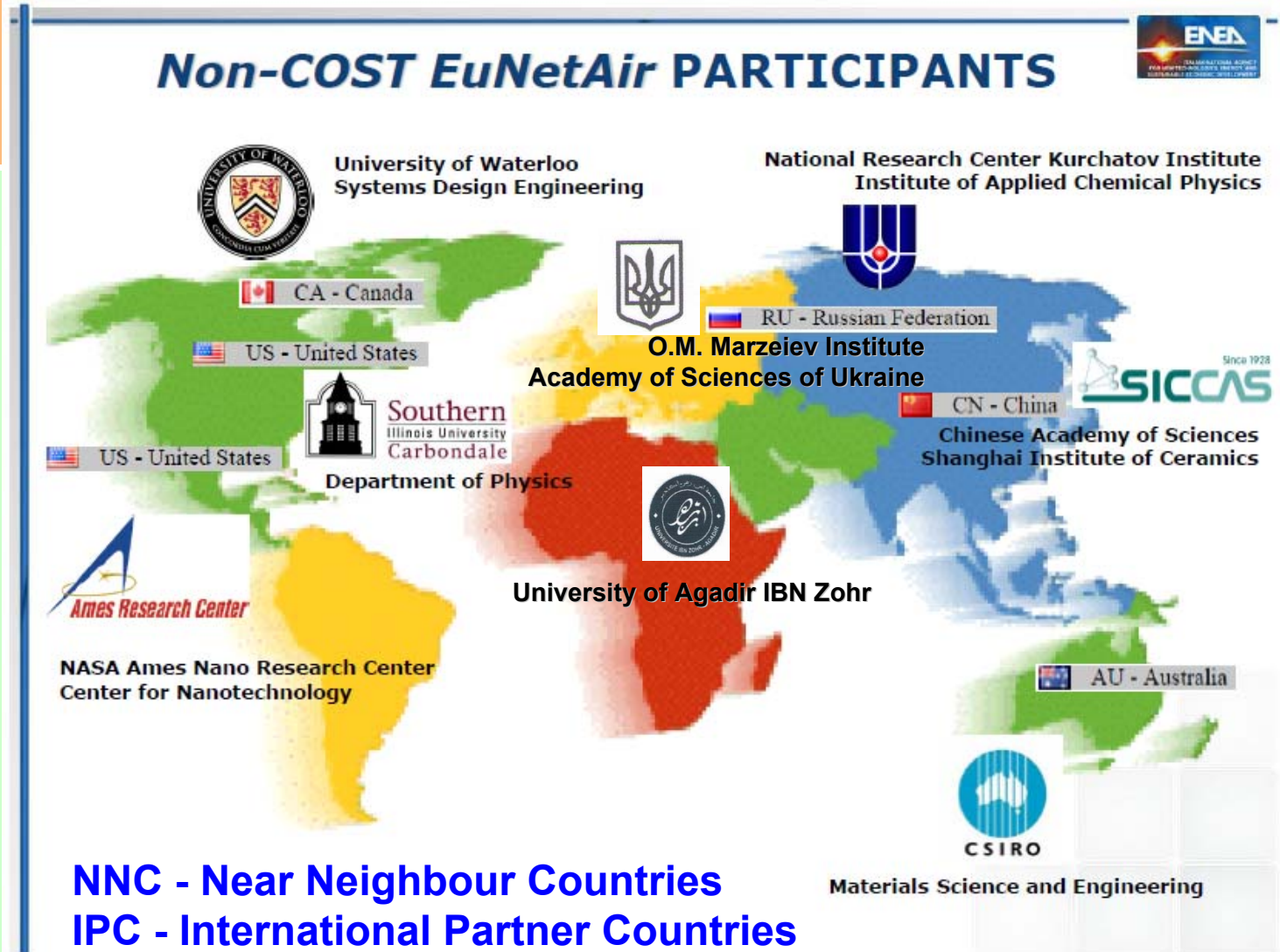


COST Action TD1105 *EuNetAir*:

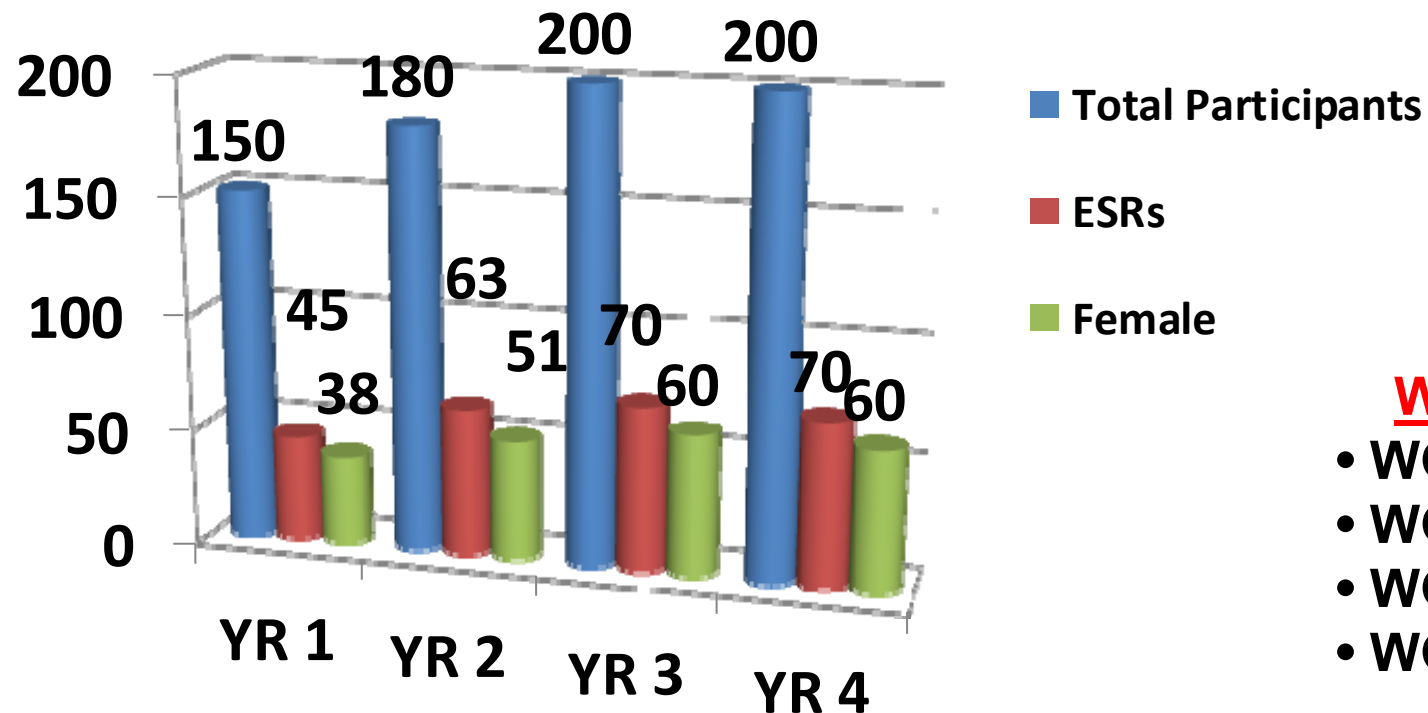
7 Non-COST Countries and 8 Non-COST Institutions

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).



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 4: Updating on Sept. 2016

- Total Number of Participants: 200 (80% active)
- Early Stage Researchers (ESRs): 70 (35%)
- Females: 60 (30%)
- MC Members: 58 - Male: 40 (69%); Female: 18 (31%)
- MC Substitutes: 33 - Male: 26 (79%); Female: 7 (21%)






Action Participating Organizations (1/5)

Pos.	Flag	Country	Action MC Organizations	Action WG Organizations
1		Austria	<ul style="list-style-type: none"> Materials Center Leoben Forschung GmbH 	
2		Belgium	<ul style="list-style-type: none"> VITO Université de Liège Odometric SA 	<ul style="list-style-type: none"> Université Catholique de Louvain
3		Bulgaria	<ul style="list-style-type: none"> National Institute of Meteorology and Hydrology - BAS Institute of Electronics - BAS 	<ul style="list-style-type: none"> Microsystems LTD
4		Croatia	<ul style="list-style-type: none"> Rudjer Boskovic Institute University of Zagreb 	
5		Czech Republic	<ul style="list-style-type: none"> Institute of Computer Sciences - Academy of Sciences of the Czech Republic J. Heyrovský Institute of Physical Chemistry - Academy of Sciences of the Czech Republic 	<ul style="list-style-type: none"> Institute of Photonics and Electronics AVCR
6		Denmark	<ul style="list-style-type: none"> Aarhus University Technical University of Denmark 	<ul style="list-style-type: none"> National Research Centre for Working Environment
7		Estonia	<ul style="list-style-type: none"> University of Tartu 	




Action Participating Organizations (2/5)

Pos.	Flag	Country	Action MC Organizations	Action WG Organizations
8		Finland	<ul style="list-style-type: none"> University of Oulu University of Helsinki Tampere University of Technology 	
9		France	<ul style="list-style-type: none"> Université de Bourgogne Université Blaise Pascal 	<ul style="list-style-type: none"> Ecoles des Mines de Douai CEA-CNRS ETHERA NanoSense
10		Germany	<ul style="list-style-type: none"> Saarland University Eurice GmbH University of Bayreuth IUTA eV 	<ul style="list-style-type: none"> WHO CC - Federal Environment Agency Siemens UST 3S GmbH University of Paderborn Alfred Becker Group MPI for Biogeochemistry University of Stuttgart Heidelberg University BAM DLR
11		Greece	<ul style="list-style-type: none"> Aristotle University of Thessaloniki University of Patras ATHENA/ISI FORTH 	<ul style="list-style-type: none"> University of Piraeus University of West Macedonia
12		Hungary	<ul style="list-style-type: none"> Hungary Meteorological Service Szechenyi Istvan University 	
13		Iceland	<ul style="list-style-type: none"> Agricultural University of Iceland 	






Action Participating Organizations (3/5)

Pos.	Flag	Country	Action MC Organizations	Action WG Organizations
14		Ireland	<ul style="list-style-type: none"> • Trinity College Dublin • University College Cork 	
15		Israel	<ul style="list-style-type: none"> • Technion Institute of Israel • AirBase Systems 	
16		Italy	<ul style="list-style-type: none"> • ENEA • University of Bari • University of Brescia • Sensichips srl 	<ul style="list-style-type: none"> • ARPA-Puglia • University of Trieste • ELETTRA • Lenviros srl • RED srl • NOVASIS srl • ARIANET srl • CNR, Institute of Atmospheric Science and Climate • CNR, Institute of Methodologies for Environmental Analysis • CNR, Institute of Environmental Pollutant Research
17		Latvia	<ul style="list-style-type: none"> • University of Latvia • Riga Technical University 	
18		Luxembourg	<ul style="list-style-type: none"> • Luxembourg Institute for Science and Technology - LIST 	

Action Participating Organizations (4/5)

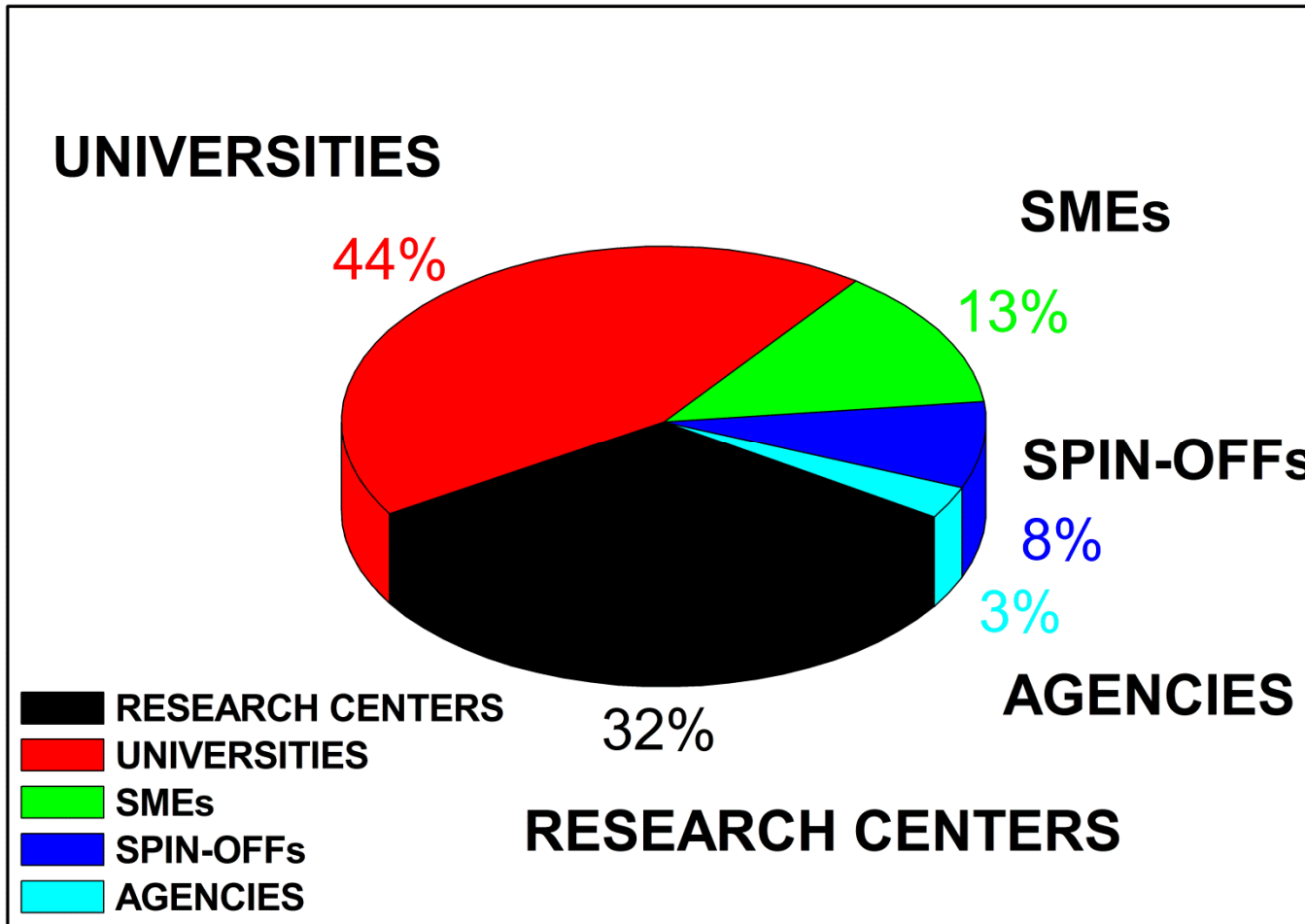
Pos.	Flag	Country	Action MC Organizations	Action WG Organizations
19		FYR of Macedonia	<ul style="list-style-type: none"> Ministry of Environment and Physical Planning University "St. Kliment Ohridski" 	
20		Netherlands	<ul style="list-style-type: none"> IMEC - Holst Centre ECN 	
21		Norway	<ul style="list-style-type: none"> NILU - Norwegian Institute for Air Research 	
22		Poland	<ul style="list-style-type: none"> Silesian University of Technology Warsaw University of Life Science 	<ul style="list-style-type: none"> Czestochowa University of Technology
23		Portugal	<ul style="list-style-type: none"> IDAD - Institute of Environment & Development University of Aveiro University of Coimbra National Health Institute 	<ul style="list-style-type: none"> University of Lisbon University of Porto LNEG - Laboratório Nacional de Energia e Geologia
24		Romania	<ul style="list-style-type: none"> IMNR - National R&D Institute for Nonferrous and Rare Metals SC IPA SA 	
25		Serbia	<ul style="list-style-type: none"> Institute of Public Health of Belgrade VINCA Institute 	
26		Slovenia	<ul style="list-style-type: none"> University of Ljubljana Aerosol doo 	

Action Participating Organizations (5/5)

Pos.	Flag	Country	Action MC Organizations	Action WG Organizations
27		Spain	<ul style="list-style-type: none"> • IREC - Catalonia Institute for Energy Research • URV - Universitat Roviri i Virgili • UB - Universitat de Barcelona • Worldsensing SL 	<ul style="list-style-type: none"> • CSIC - IDAEA • CSIC - INM • Public Universitat de Navarra • Universidade de Santiago de Compostela
28		Sweden	<ul style="list-style-type: none"> • Linköping University • SenseAir AB • Chalmers University of Technology • SenSiC AB 	
29		Switzerland	<ul style="list-style-type: none"> • EPFL - Ecole Polytechnique Fédérale de Lausanne • SGX Sensortech • EMPA 	<ul style="list-style-type: none"> • ETH • EnvEve SA
30		Turkey	<ul style="list-style-type: none"> • GEBZE Institute of Technology • Middle East Technical University of Ankara • Nigde University 	<ul style="list-style-type: none"> • Bahcesehir University
31		United Kingdom	<ul style="list-style-type: none"> • Cambridge University • Alphasense Ltd • Imperial College London • University of Warwick 	<ul style="list-style-type: none"> • Manchester University • Newcastle University • Worcester University • Edinburgh University • Cambridge CMOS Sensors Ltd

Action Participation Statistics

EuNetAir COST PARTNERSHIP Sept. 2016



COST Parties: 31
COST Organizations: 123
UNIVERSITIES: 55
RESEARCH CENTERS: 39
SMEs: 16
SPIN-OFFs: 9
AGENCIES: 4

External Experts involved from International Organizations

International Organization	External Expert	Action Event
JRC - IES, Ispra	<i>Michele Gerboles</i>	<ul style="list-style-type: none"> • Rome, 3-5 Dec. 2012 • Barcelona, 20 June 2013 • Brescia, 10 Sept. 2014 • Linkoping, 3-5 June 2015 • Vienna, 25-26 October 2016
AQUILA Network	<i>Annette Borowiak</i>	<ul style="list-style-type: none"> • Duisburg, 4-6 March 2013
European Environment Agency (EEA)	<i>Valentin Foltescu</i> <i>Cristina Guerreiro (NILU)</i>	<ul style="list-style-type: none"> • Copenhagen, 3-4 Oct. 2013 • Vienna, 25-26 February 2016
US Environment Protection Agency (EPA)	<i>Tim Watkins</i>	<ul style="list-style-type: none"> • Cambridge, 18-20 Dec. 2013
UNECE	<i>Wenche Aas (NILU)</i>	<ul style="list-style-type: none"> • Copenhagen, 3-4 Oct. 2013
WHO Europe	<i>Michal Krzyzanowski</i> <i>Pierpaolo Mudu</i>	<ul style="list-style-type: none"> • Riga, 26-27 March 2015 • Prague, 5-7 October 2016
MIT, USA	<i>Marguerite Nyhan</i>	<ul style="list-style-type: none"> • Istanbul, 3-5 Dec. 2014
NASA Ames Research Center	<i>Meyya Meyyappan</i> <i>Jing Li</i>	<ul style="list-style-type: none"> • Rome, 3-5 Dec. 2012 • Lille, 26-30 May 2014
CSIRO, Australia	<i>Philip J. Martin</i>	<ul style="list-style-type: none"> • Barcelona, 20 June 2013
QUT, Australia	<i>Zorane Ristovski</i>	<ul style="list-style-type: none"> • Belgrade, 13-14 Oct. 2015

Country

MC Members (58): Male (69%) - Female (31%)

Austria	Dr. Anton KOCK
Belgium	Dr Jan THEUNIS; Dr Anne-Claude ROMAIN
Bulgaria	Dr Dimiter SYRAKOV; Dr Ivan NEDKOV
Croatia	Dr. Irena CIGLENECKI-JUSIC; Prof. Vedran BILAS
Czech Republic	Dr. Vera KURKOVA; Dr. Zdenek ZELINGER
Denmark	Prof. Ole HERTEL
Estonia	Prof. Raivo Jaaniso
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 Arngrimir 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; Dr. Gita SAKALE
Luxembourg	Dr. Arno GUTLEB
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; Dr. Milena JOVASEVIC-STOJANOVIC
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

**Kick-off Meeting
Brussels
16 May 2012**

**MANAGEMENT
COMMITTEE**

MC Chair: Michele Penza, ENEA, IT

MC Vice Chair: Anita Lloyd Spetz, Linkoping University, SE

Grant Holder: Eurice GmbH, Saarbrucken, DE

Country

MC Substitutes (33)

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 Dr. Daniela SCHONAUER-KAMIN
Germany	Dr. Thomas KULBUSCH Dr. Juliane ROSSBACH
Greece	Prof. George KIRIKIADIS Dr. Christos KOULAMAS
Hungary	Prof. Zoltan HORVATH
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 Dr. Ana Margarida COSTA
Romania	Dr. Cristina RUSTI; Dr. Marcel Adrian IONICA
Slovenia	Prof. Andrej DOBNIKAR
Spain	Prof. Albert ROMANO-RODRIGUEZ Dr. Jordi LLOSA
Sweden	Dr Mike ANDERSSON; Dr. Marina VOINOVA
Switzerland	Dr Christoph HUEGLIN
Turkey	Prof. Necmettin KILINC
UK	Prof. Julian GARDNER Dr Robin NORTH; Prof. Florin UDREA

Year 4: Scientific Planning of *EuNetAir* (1/2)

Meetings/Workshops/Training Schools managed

(Year 4: 1 July 2015 - 15 May 2016): **EXTENSION: 15 Nov. 2016**

- **WG1-WG4 Meeting** on *Air Quality Monitoring and Calibration: Horizons in Sensing Technologies, Methods and Modelling - Start of the 2nd EuNetAir Air Quality Joint-Exercise Intercomparison* organized by the VINCA Institute, Belgrade (**Serbia**), 13 - 14 Oct. 2015. Local organizer: Dr. Milena Jovasevic-Stojanovic, VINCA and Anka Cvetkovic, Public Health Institute of Belgrade
- The **4th International Workshop of the COST Action TD1105** on *Innovations and Challenges for Air Quality Control Sensors* at FFG (National AT COST Office), Wien (**Austria**), 25 - 26 February 2016. Local organizer: Dr. Anton Kock, MCL
- The **Action 4th International Training School** on *Modelling, Methods and Technologies for Air Quality Control* at Emdrup Campus in Copenhagen, by Aarhus University (**Denmark**), 19 - 22 April 2016. Local organizer: Prof. Ole Hertel, Aarhus University. Trainees: 13-15 expected. Trainers: 3-4 expected. **Deadline for Trainees Application: 10 March 2016**

Year 4: Scientific Planning of *EuNetAir* (2/2)

MC/WG Meetings managed

(Year 4: 1 July 2015 - 15 May 2016): EXTENSION: 15 Nov. 2016

- **5th SCIENTIFIC MEETING: WGs Meeting and 8th MC Meeting on New Sensing Technologies for Indoor Air Pollution Monitoring and Environmental Measurements** at Bulgarian Academy of Sciences, Sofia (Bulgaria), 16 - 18 Dec. 2015. Local organizers: Prof. Ivan Nedkov and Prof. Dimiter Syrakov, BAS
- **Special Session EuNetAir / Core-Group Meeting** to **EUROSENSORS 2015**, Freiburg (Germany), 6 - 10 September 2015

COST Session & Core-Group Meeting at EUROSENSORS 2015



The 29th European Conference on Solid-State Transducers

10:30 - 12:30 **Open Session COST: New Sensing Technologies for Air Quality Monitoring**
 Chairperson: *Michele Penza*, ENEA, Brindisi, Italy

10:30 - 10:50 **COST Action TD1105: European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability. Overview and Plans**
Michele Penza, Action Chair, ENEA, Brindisi, Italy

10:50 - 11:10 **Performance Evaluation of Amperometric Sensors for the Monitoring of O₃ and NO₂ in Ambient Air at ppb Level**
Laurent Spinelle, Manuel Aleixandre, Michel Gerboles, JRC, EC DG ENV, Institute for Environment and Sustainability, Ispra, Italy

11:10 - 11:30 **LTCC, New Packaging Approach for Toxic Gas and Particle Detection**
Anita Lloyd Spetz, M. Sobocinski, N. Halonen, D. Puglisi, J. Juuti, H. Jantunen, M. Andersson, Action Vice-Chair, Linköping University, Linköping, Sweden

11:30 - 11:50 **Low-Cost Fabrication of Zero-Power Metal Oxide Nanowire Gas Sensors: Trends and Challenges**
Jordi Samà^a, Juan Daniel Prades^a, Olga Casals^a, Guillem Domènech-Gil^a, Sven Barth^b, Isabel Gracia^c, Carles Cané^c, Francisco Hernández-Ramírez^{a,d}, Albert Romano-Rodríguez^a, Action MC Substitute, ^aUniversitat de Barcelona, Barcelona, Spain; ^bTechnical University Vienna (TUW), Institut for Material Chemistry, Vienna, Austria; ^cConsejo Superior de Investigaciones Científicas (CSIC), Institut de Microelectrònica de Barcelona (IMB-CNM), Bellaterra, Spain; ^dCatalonia Institute for Energy Research (IREC), Barcelona, Spain

11:50 - 12:10 **Integrated Sensor Systems for Indoor Applications: Ubiquitous Monitoring for Improved Health, Comfort and Safety**
Andreas Schuetze, WG2 Leader and MC Member, Saarland University, Saarbrücken, Germany

12:10 - 12:30 **Towards Disposable Sensing Platforms and Analytical Instruments for Air Quality Monitoring**
Danick Briand, Action MC Member, EPFL, Neuchâtel, Switzerland



12:30 **Closure of COST Action TD1105 EuNetAir Open Session**

WGs MEETING at Belgrade:

Air Quality Monitoring: Horizons in Sensing Technologies, Methods and Modelling

VINCA Institute & Public Institute of Health, **Belgrade** (Serbia), 13 - 14 Oct. 2015



Joint-Exercise Sensors-vs-Analyzers
Belgrade, October 2015 - running 2016



Local Co-Organizers:

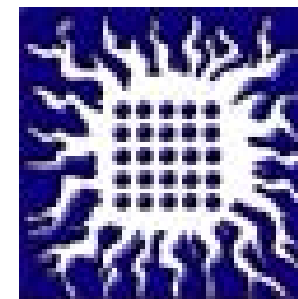
Dr. Milena Jovasevic-Stojanovic, RS MC Member,

Dr. Anka Cvetkovic, RS MC Member,

VINCA Institute and Public Institute of Health

Belgrade - (Serbia)

joined to WeBIOPATR 2015 Conference



5th SCIENTIFIC MEETING at Sofia: WGs + MC:

New Sensing Technologies for Indoor Air Pollution Monitoring and Environmental Measurements

Bulgarian Academy of Science, Sofia (Bulgaria), 16 - 18 Dec. 2015



Roundtable: Which Future for AQ Sensors

60 Participants:

Contributed/Invited /Keynote Talks

Poster Session

WG1-WG4 Meeting

SIG1-SIG4 Meeting

MC Meeting

Local Co-Organizers:

Prof. Ivan Nedkov, BG MC Member,

Prof. Dimiter Syrakov, BG MC Member,

BAS - Institute of Electronics

BAS - National Institute for Meteorology and Hydrology

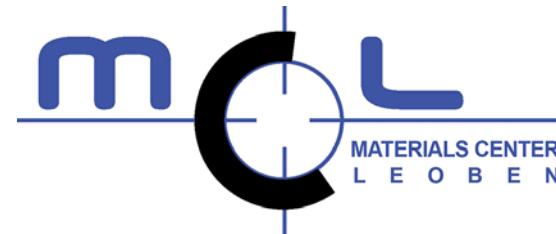
4th WORKSHOP EuNetAir at Vienna

Innovations and Challenges for Air Quality Control Sensors

hosted at FFG - Austrian COST Office, Vienna (Austria), 25 - 26 February 2016



organized by:



44 Participants from 18 Countries:
Contributed/Invited/Keynote Talks
Poster Session
SMEs and Industry participation

Local Co-Organizers:

Dr. Anton Kock, MCL, AT MC Member

Dr. Margit Malatschnig, Techkonnex-High-tech Promotion

4th TRAINING SCHOOL EuNetAir at Copenhagen

Modelling, Methods and Technologies for Air Quality Control

Aarhus University, Copenhagen (Denmark), 19 - 22 April 2016

5 ECTS PhD course by Department of Environmental Science, Aarhus University



21 Trainees from 13 Countries
11 Trainers (10 local + 1 foreign)

Local Organizer:

Prof. Ole Hertel, Aarhus University, DK MC Member

Year 5 (Extension): Scientific Planning of **EuNetAir** (1/1)

(Year 4: 1 July 2015 - 15 May 2016): **EXTENSION: 15 Nov. 2016**

- **DISSEMINATION MEETING at European Materials Research Society (EMRS) on Functional Materials for Environmental Sensors and Energy Systems** at EMRS Spring Meeting 2016, Lille (France), 2 - 6 May 2016. Symposium organizers: Michele Penza, Anita Lloyd Spetz, Albert Romano-Rodriguez and Meyya Meyyappan
- **CORE-GROUP MEETING at SENSOR+TEST 2016 on Novel Sensor Solutions for Indoor Air Quality** at AMA Conference 2016, Nuremberg (Germany), 10 - 12 May 2016. Symposium organizers: Michele Penza, Andreas Schuetze, Anton Kock and Mathias Holz.

- **6th SCIENTIFIC MEETING: WGs Meeting and 9th MC Meeting on New Sensing Technologies for Outdoor Air Quality Monitoring** at Academy of Sciences of the Czech Republic, Prague (Czech Republic), 5 - 7 October 2016. Local Organizers: Prof. Zdenek Zelinger, Dr. Vera Kurkova, Dr. Roman Neruda, ASCR

EuNetAir at EMRS Spring Meeting 2016 in Lille

Symposium X: Functional Materials for Environmental Sensors and Energy Systems

hosted at Lille Congress Center, **Lille** (France), 2 - 6 May 2016



200 Participants - 160 Abstracts:

**Contributed/Invited Talks
2 Poster Sessions**



Symposium Organizers:

Dr. Michele Penza, ENEA, Action Chair

Prof. Anita Lloyd Spetz, Linkoping University, Action Vice-Chair

Prof. Albert Romano-Rodriguez, Barcelona University, MC Member

Dr. Meyya Meyyappan, NASA Ames Research Center, IPC Member

EuNetAir at SENSOR+TEST 2016 in Nuremberg

Session: Novel Sensor Solutions for Indoor Air Quality Control

hosted at **NCC - AMA Conference 2016, Nuremberg** (Germany), 10 - 12 May 2016



www.eunetair.it



www.cluster-essc.eu



www.multisensorplatform.eu



www.iaqsense.eu



www.sensindoor.eu



40+ Participants to Special Session:
Contributed/Invited Talks
SMEs and Industry participation

Organizers:

Dr. Michele Penza, ENEA, Action Chair

Dr. Anton Kock, MCL, AT MC Member

Dr. Mathias Holz, Nanoanalytik GmbH, WG Member

Prof. Andreas Schuetze, DE MC Member

**EuNetAir at 2nd Consultation Meeting on
the Global Platform on Air Quality and Health**

WHO Geneva, 18-20 August 2015, *Meeting Report - DRAFT 23.09.2015*



**World Health
Organization**

Session 3, cont. Low cost AQ monitoring

- Portable Sensor-Systems for Air Quality Monitoring: The case-study of EuNetAir (*M. Penza* – remote presentation)
- Experiences of USEPA (*T. Watkins* – remote presentation)

Discussion: Perspectives for application of low cost sensors for AQ monitoring

EuNetAir at **WEBINAR on CLIMATE ADAPT**

Copenhagen, 16 Dec. 2015, 11:30-13:00 (CET) **Webinar**

European Environment Agency



Hereby I would like to invite the European climate change adaptation research community and related funding organisations to a second webinar on the progress in and the development of the European Climate Adaptation Platform (Climate-ADAPT). I would also like to invite the national reference centres on climate change impacts, vulnerability and adaptation in EEA member countries and experts from the European Commission, international organisations, transnational initiatives and cities networks on adaptation.

André Jol

EEA Head of Group Climate change impacts, vulnerability and adaptation

EU funded research initiatives:

Climate-KIC (Innovation Pillar, Policy), Cost Action (Actions ES1404, TD 1105, ES1102, ES1106)

EuNetAir at ISES 2016 Meeting

International Society of Exposure Science



European ISES Chapter

<http://ises2016.org/>

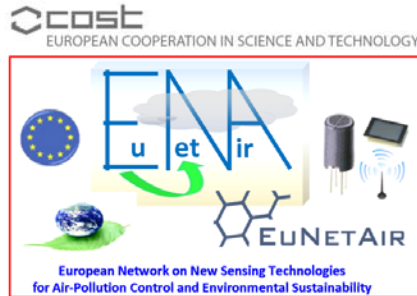
Tu-SY-F4: Advancing Exposure Science to Address Complex Environmental Issues

Chair: Annette Guiseppi-Elie, US Environmental Protection Agency, Research Triangle Park, NC, United States

Title of Talk: **Advancing exposure science through technology: Focus on sensors**

Speaker: Tim Watkins¹ and Michele Penza², ¹US EPA, RT Park, NC, USA; ²ENEA, Italy

COST Action TD1105 *EuNetAir*: Snapshot of Outcome

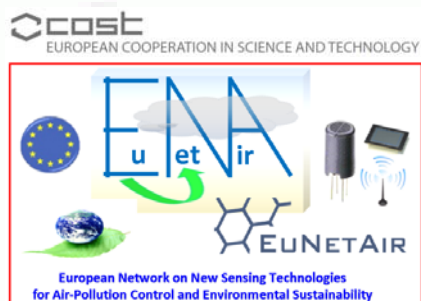


16 May 2012 - 15 November 2016

- **N.r of Workshops: 4**
- **N.r of Training Schools (+ Short Course): 4 (+ 2)**
- **N.r of Working Groups Meetings: 4**
- **N.r of Focus Group & Dissemination Meetings: 11**
- **N.r of Scientific Meetings: 6**
- **N.r of Management Committee Meetings: 9**
- **N.r of funded STSMs: 43**

COST Action TD1105 *EuNetAir*: Workshops

4th Workshop: Innovations and Challenges for Air Quality Control Sensors



3° Workshop EuNetAir
Riga, 26-27 March 2015



4° Workshop EuNetAir
Vienna, 25-26 February 2016



1° Workshop EuNetAir
Barcelona, 20 June 2013



The 17th International Conference
on Solid State Sensors,
Actuators and Microsystems



2° Workshop EuNetAir
Brindisi, 25-26 March 2014



COST Action TD1105 *EuNetAir*: Training Schools

 **cost**
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



3° Training School EuNetAir
Hyytiälä (Helsinki), 2-8 May 2015



4° Training School EuNetAir
Copenhagen, 19-22 April 2016



2° Training School EuNetAir
Saarbrücken, 31 Mar - 02 Apr 2014



UNIVERSITÄT
DES
SAARLANDES

EuNetAir at ISOCS 2014
Les Houches, 9-14 Feb. 2014

EuNetAir at ISOCS 2015
Tonale (Brescia), 8-13 March 2015



1° Training School EuNetAir
Barcelona, 13-15 June 2013

COST Action TD1105 *EuNetAir*: WG Meetings

 **cost**
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



WG Meeting EuNetAir at EEA
Copenhagen, 3-5 October 2013



European Environment Agency



WG Meeting EuNetAir by IUTA
Fraunhofer Inhaus, Duisburg, 4 - 6 Mar 2013



WG Meeting EuNetAir by VINCA
Belgrade, 14-15 October 2015

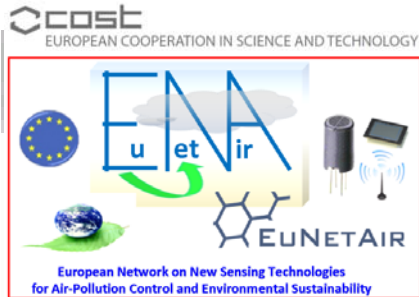


WG Meeting EuNetAir by IDAD
Aveiro, 13-15 October 2014



COST Action TD1105 *EuNetAir*:

Focus Group Meetings and Dissemination Events



EuNetAir at **SENSOR+TEST 2016**
Nuremberg, 12 May 2016

EuNetAir at **EUROSENSORS 2015**
Freiburg, 9 Sept. 2015

EuNetAir at **ISOEN 2015**
Dijon, 28 June 2015

EuNetAir at **EMRS 2016**
Lille, 3 May 2016

EuNetAir at **IEEE SENSORS 2014**
Valencia, 3 Nov. 2014

Focus Group **EuNetAir**
Berlin, 17 Apr. 2015



EuNetAir at **SGS 2012**
Cracow, 13 Sept. 2012



Focus Group **EuNetAir**
Munich, 29 Apr. 2015



EuNetAir at **EUROSENSORS 2014**
Brescia, 10 Sept. 2014

EuNetAir at **ISQL 2012**
Halkidiki, 29 Sept. 2012



EuNetAir at **TCM 2012**
Hersonissos, 21 Oct. 2012



COST Action TD1105 *EuNetAir*: Scientific Meetings (MCM)

 **cost**
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



4° Scientific Meeting (7° MC)
Linköping, 3-5 June 2015



2° Scientific Meeting (4° MC)
Cambridge, 18-20 Dec. 2013



Kick-off Meeting at COST
Brussels, 12 May 2012



5° MC Meeting at EMRS
Lille, 30 May 2014



6° Scientific Meeting (9° MC)
Prague, 5-7 Oct. 2016



1° Scientific Meeting (2° MC)
Rome, 4-6 Dec. 2012

5° Scientific Meeting (8° MC)
Sofia, 16-18 Dec. 2015



3° MC Meeting
Barcelona, 21 June 2013



3° Scientific Meeting (6° MC)
Istanbul, 3-5 Dec. 2014

COST Action TD1105 *EuNetAir*: Short History



GREETINGS from BRUSSELS

6 October 2011



oc-2011-1-9706: European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability - EuNetAir

Dear Dr. Michele PENZA,

I am glad to inform you that your proposal has been allocated to the ESSEM Domain and [shortlisted to be approved by the COST Committee of Senior Officials on the 1st December.](#) **Please check/modify the attached draft MoU according to the instructions given below using track changes option in Microsoft Word and return the document to me by Wednesday, the 19th of October at the latest.**

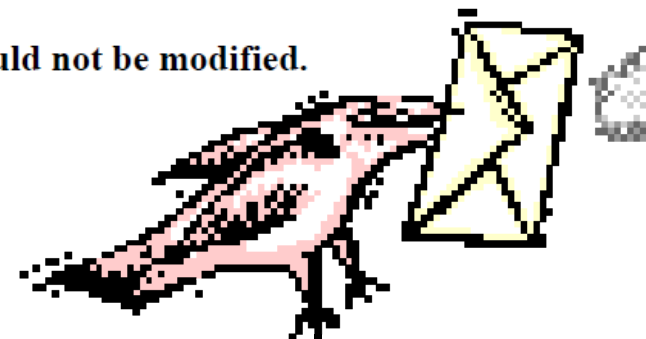
Can you also send me one/two representative picture(s) about the topic of your proposal by Wednesday the 19th of October?

Please be aware that the content of the proposal should not be modified.

Best wishes,

Basak

Dr. Basak Kisakurek
Science Officer | Earth System Science and Environmental Management
COST Office | Avenue Louise 149
1050 Brussels | Belgium
Tel: +32 (0) 2 533 38 31 | Fax: +32 (0) 2 533 38 90
basak.kisakurek@cost.eu | www.cost.eu



COST Action TD1105 *EuNetAir*: Short History



**COST ACTION TD1105 *EuNetAir*
Kick-off Meeting at COST Office
16 May 2012, Brussels (Belgium)**



**COST ACTION TD1105 *EuNetAir*
First Scientific Meeting at ENEA
4 - 6 December 2012, Rome (Italy)**

COST Action TD1105 *EuNetAir*: Short History



COST ACTION TD1105 *EuNetAir*
3rd Management Committee Meeting at IREC
21 June 2013, Barcelona (Spain)



COST ACTION TD1105 *EuNetAir*
Second Scientific Meeting
Queens' College - University of Cambridge
18 - 20 December 2013, Cambridge (UK)

COST Action TD1105 *EuNetAir*: Short History



**COST ACTION TD1105 *EuNetAir*
5th Management Committee Meeting
at European Materials Research Society
30 May 2014, Lille (France)**



**COST ACTION TD1105 *EuNetAir*
Third Scientific Meeting
at Bahcesehir University - GEBZE Technical University
3 - 5 December 2014, Istanbul (Turkey)**

COST Action TD1105 *EuNetAir*: Short History



COST ACTION TD1105 *EuNetAir*
Fourth Scientific Meeting
at Linköping University
3 - 5 June 2015, Linköping (Sweden)



COST ACTION TD1105 *EuNetAir*
Fifth Scientific Meeting
at Bulgarian Academy of Sciences
16 - 18 December 2015, Sofia (Bulgaria)

COST Action TD1105 *EuNetAir*: Short History



**Group Picture at Final Meeting
Prague, 5-7 October 2016**

To be added !!



**The Czech Academy
of Sciences**

**COST ACTION TD1105 *EuNetAir*
Spring Meeting 2016 Symposium X
at European Materials Research Society
2 - 6 May 2016, Lille (France)**

COST Action TD1105 *EuNetAir*: Significant Achievements

- Joint-exercise *Sensors-vs-analyzers* in real city environment and related joint-publication in **ATMOSPHERIC ENVIRONMENT** (IF = 3.45). Online: <http://www.sciencedirect.com/science/article/pii/S1352231016307610>
- Report on *Innovation in Sensor Technology for Air Quality Control*
- Funded international (**3**) and national (**>10**) research projects in air quality control
- **5** Special Issues of archival papers and conference proceedings
- Organization of international conferences (**>3**) and symposia (**>5**)
- Invited Talks (**>20**) and Plenary Talks (**>5**) of the EuNetAir members
- International Participation in Conference Steering Committee of EuNetAir members (**>30**)
- Advising of EC in the field of sensor-systems (ESSC)

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

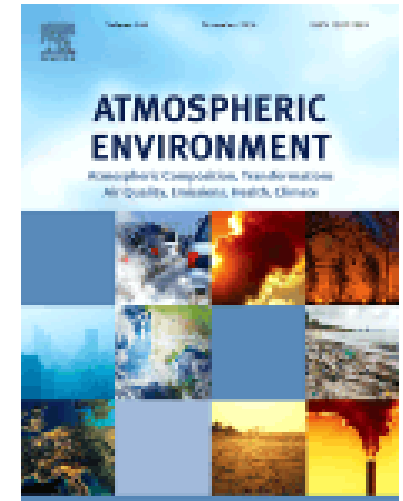
Original Research Article

In Press, Accepted Manuscript, Available online 22 Sept. 2016

C. Borrego^{a,b}, A. M. Costa^a, J. Ginja^a, M. Amorim^a, M. Coutinho^a, K. Karatzas^c, Th. Sioumis^c, N. Katsifarakis^c, K. Konstantinidis^c, S. De Vito^d, E. Esposito^d, P. Smith^e, N. André^f, P. Gérard^f, L. A. Francis^f, N. Castell^g, P. Schneider^g, M. Viana^h, M.C Minguillón^h, W. Reimringerⁱ, R.P. Otjes^j, O. v.Sicard^k, R. Pohle^k, B. Elen^l, D. Suriano^m, V. Pfister^m, M. Prato^m, S. Dipinto^m, M. Penza^m

Highlights

- Several air quality microsensors were tested against reference methods.
- Significant differences in the results depending on the platform and on the sensors.
- Promising results were observed for O₃, CO and NO₂ sensors.
- The sensors can improve spatiotemporal resolution of data to complement existing air quality monitoring networks.

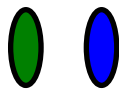
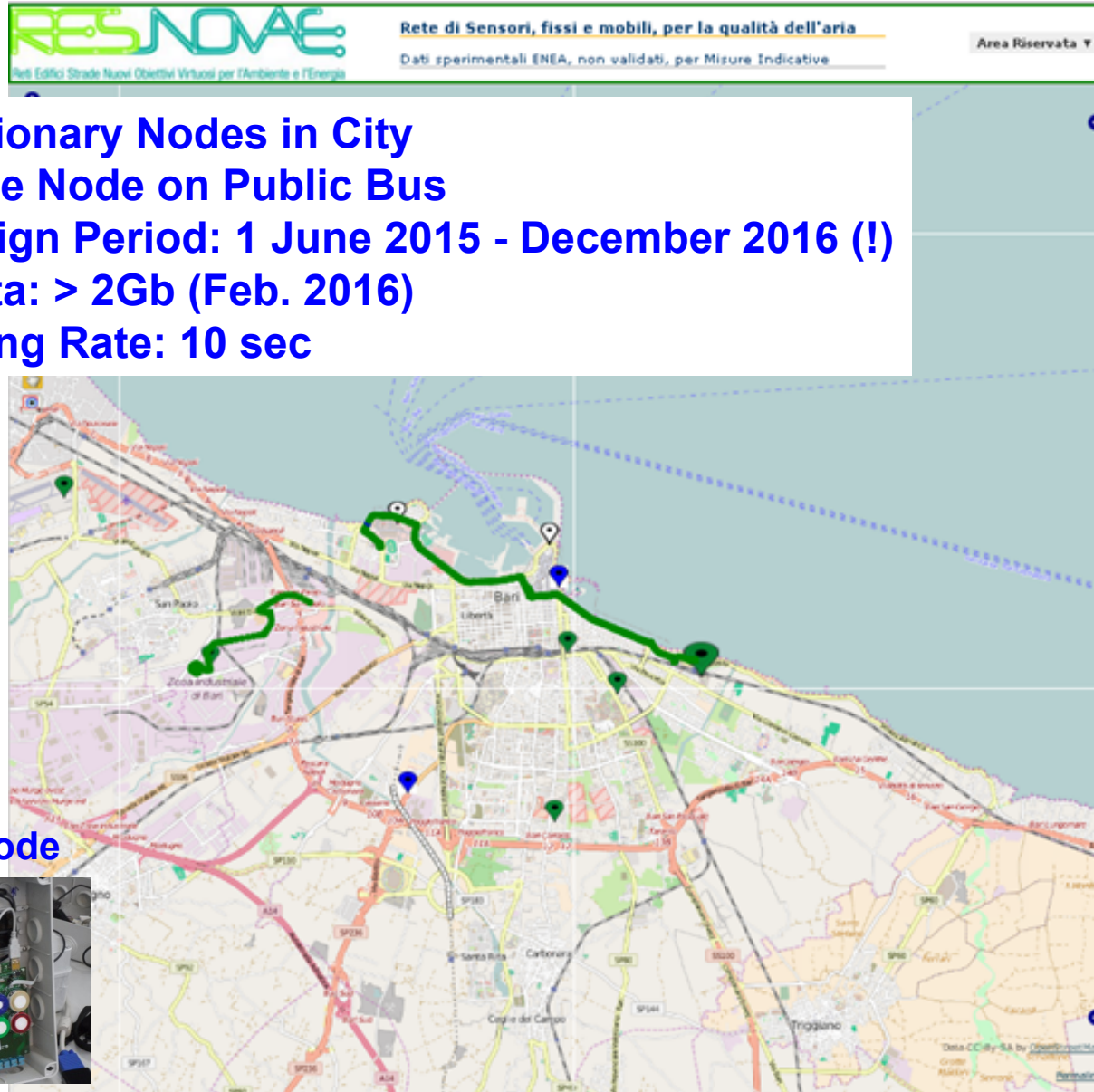


IT NATIONAL PROJECT RES-NOVAE: OUTDOOR APPLICATIONS

AQ ENEA Sensors Fixed Nodes Network distributed in Bari (Italy)
Urban Control Center (UCC) collects data from City.

Smart City Bari

- 10 Stationary Nodes in City
- 1 Mobile Node on Public Bus
- Campaign Period: 1 June 2015 - December 2016 (!)
- Big Data: > 2Gb (Feb. 2016)
- Sampling Rate: 10 sec



AirBOX
Sensor-Node



IT NATIONAL PROJECT RES-NOVAE: OUTDOOR APPLICATIONS

Smart City Bari

AQ ENEA Sensors Fixed Nodes Network distributed in Bari (Italy)



Centro Ricerche Brindisi

ENEA Sensors Lab OpenVPN Status Monitor



N7: ON BUS

nea NasusPI - Connection up, pingable. 12 clients, 603847607 bytes in, 314525951 bytes out

[172.17.0.1 tun]

Username / Hostname	VPN IP Address	Remote IP Address	Port	Location	Recv	Sent	Connected Since	Last Ping	Time Online
nasuspi-5	172.17.0.6	37.19.108.20	52428		73065	73872	23/02/2016 15:28:09	23/02/2016 15:28:16	3:01:40
nasuspi-8	172.17.0.9	62.19.56.54	24059		16932314	8252487	14/02/2016 02:06:33	23/02/2016 18:26:23	9 days, 16:23:16
nasuspi-2	172.17.0.3	62.19.60.187	50059		61118723	29838611	19/01/2016 15:31:29	23/02/2016 18:22:13	35 days, 2:58:20
nasuspi-12	172.17.0.13	5.170.133.155	21548		3986071	2173688	22/02/2016 12:31:11	23/02/2016 18:26:45	1 day, 5:58:38
nasuspi-3	172.17.0.4	5.170.159.213	49326		50720954	24762444	25/01/2016 14:59:28	23/02/2016 18:18:43	29 days, 3:30:21
nasuspi-13	172.17.0.14	62.19.60.37	28028		10410773	4378176	19/02/2016 15:22:35	23/02/2016 18:19:49	4 days, 3:07:14
nasuspi-6	172.17.0.7	5.170.100.125	44309		60155115	28671705	21/01/2016 09:35:05	23/02/2016 18:27:28	33 days, 8:54:44
airbox-one	172.17.0.20	192.168.172.238	38932	RFC1918	2992201	3165714	18/02/2016 09:20:28	18/02/2016 09:20:28	5 days, 9:09:21
nasuspi-1	172.17.0.2	62.19.59.82	13710		16883240	8246839	14/02/2016 02:05:49	23/02/2016 18:17:56	9 days, 16:24:00
nasuspi-9	172.17.0.10	62.19.59.173	34552		9107149	4258171	18/02/2016 19:48:32	23/02/2016 18:26:32	4 days, 22:41:17
nasuspi-4	172.17.0.5	62.19.57.93	34803		25405866	12317796	09/02/2016 06:27:37	23/02/2016 18:25:51	14 days, 12:02:12
nasuspi-10	172.17.0.11	5.170.246.120	20180		17242918	8314106	14/02/2016 02:06:27	23/02/2016 18:18:10	9 days, 16:23:22



N1: ENEL



N2: ENEA



N3: PERONI



N4: AMTAB



N6: AIRPORT



N8: POLIBA



N9: COFELY



N10: City Office



N12: FAIR



N13: PORT

AIR-SENSOR BOX: *Proof-of-Concept by ENEA*

MicroSensors for Urban Air Quality Monitoring

Wireless Sensor-Node Network for Air Quality Monitoring

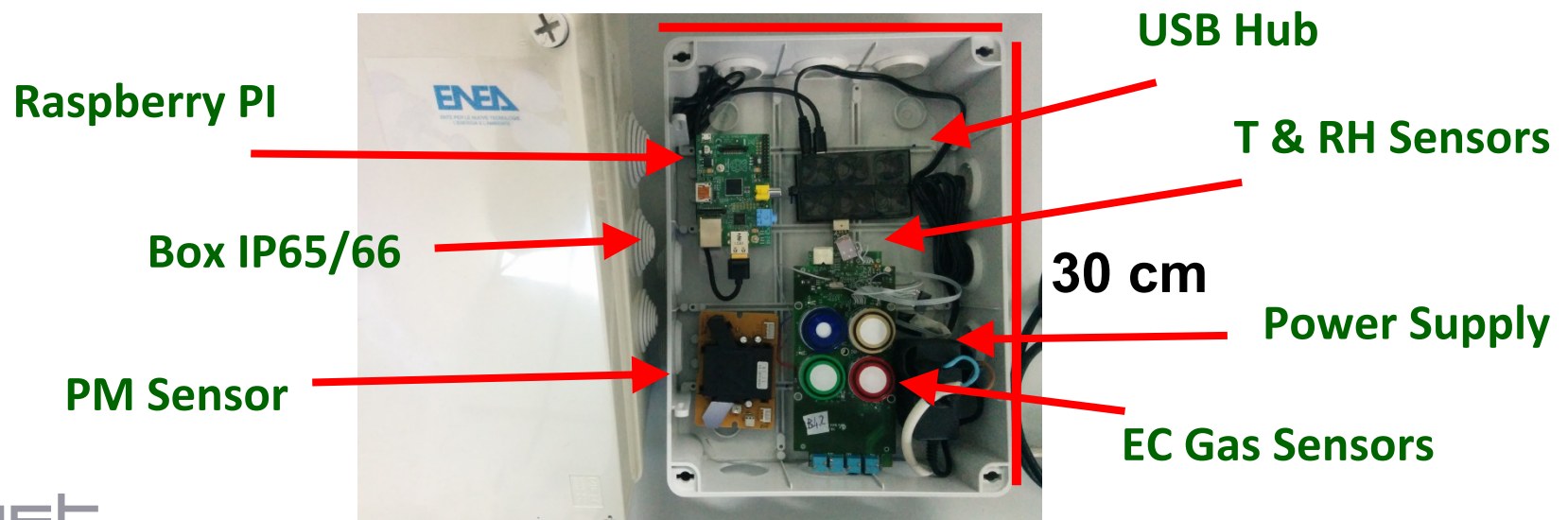
- Hardware:

A. AQ Multiparametric Sensor Node: NO₂, O₃, CO, SO₂, PM₁₀, T, RH

B. Electronics: Raspberry PI, Modem GSM, SIM Card, Wi-Fi

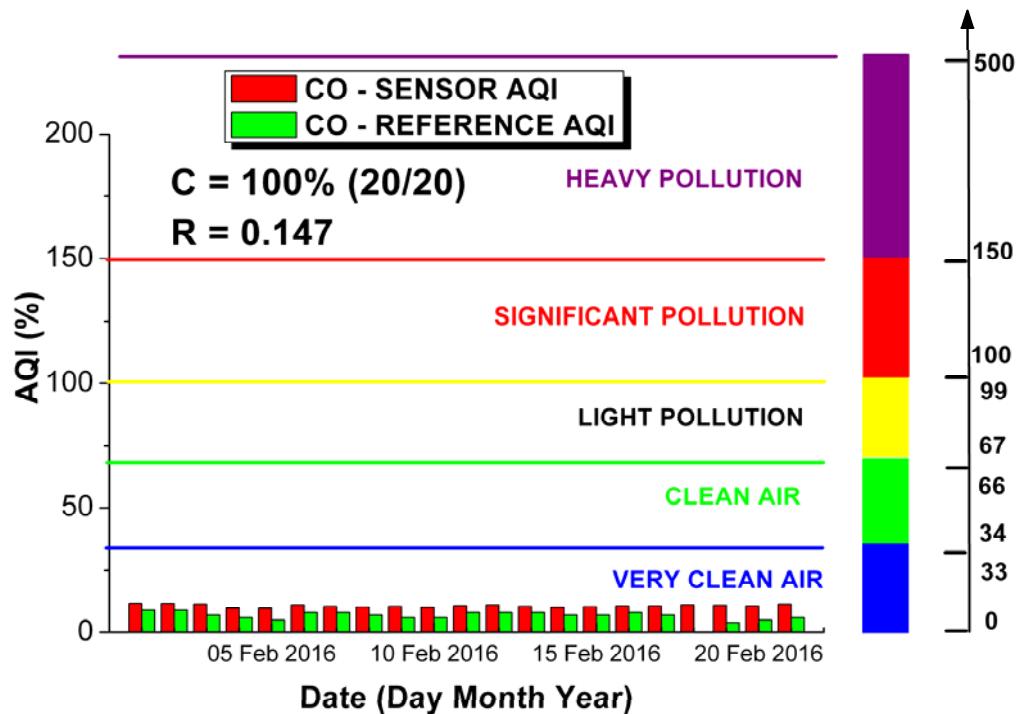
C. Database: saving data in real-time on a server (*IBM Italia collaboration*)

23 cm

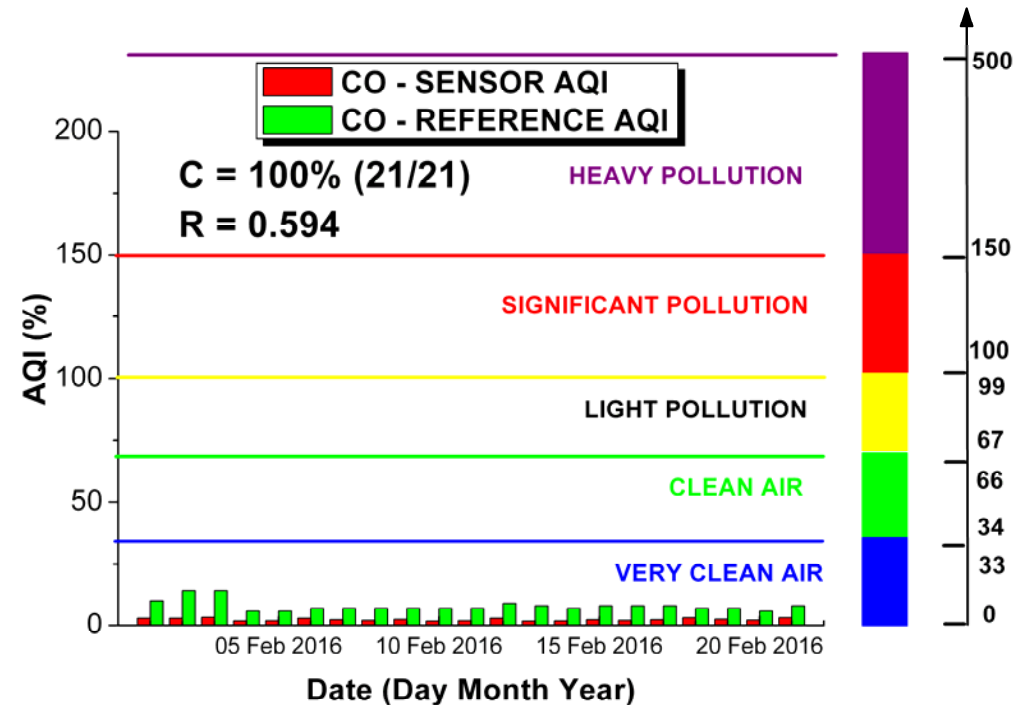


CITY SENSORS NETWORK: AQI from Nodes

CO
Node 2: ENEA
AQI Sensor vs. AQI Reference
1 - 21 February 2016



CO
Node 6: Bari AIRPORT
AQI Sensor vs. AQI Reference
1 - 21 February 2016

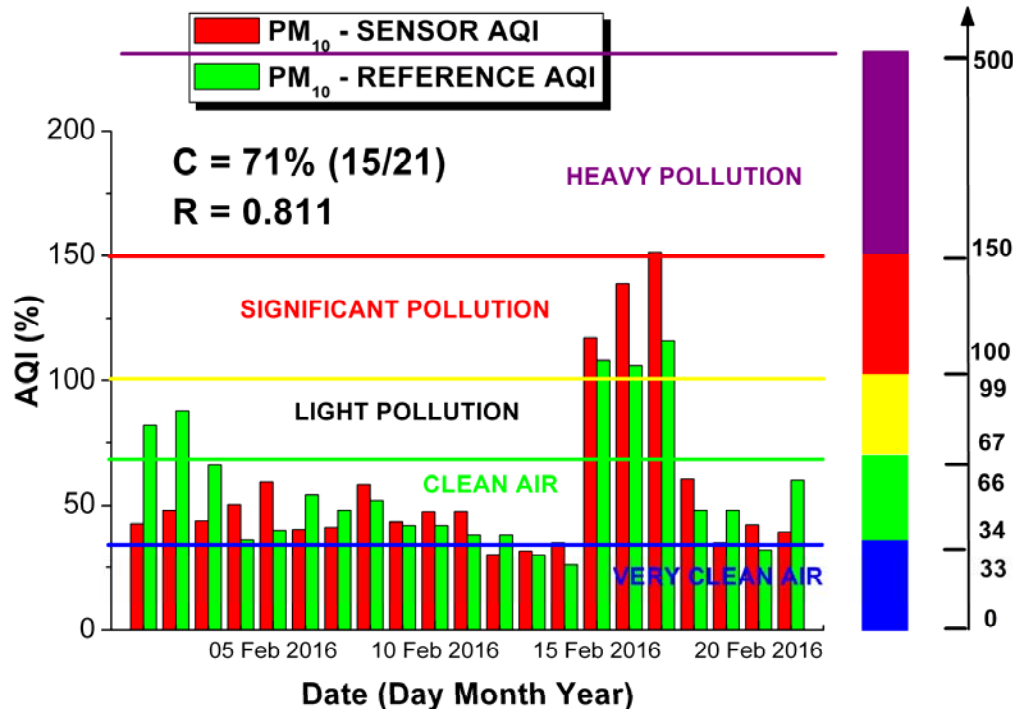


R = Correlation Coefficient
C = Classification Index

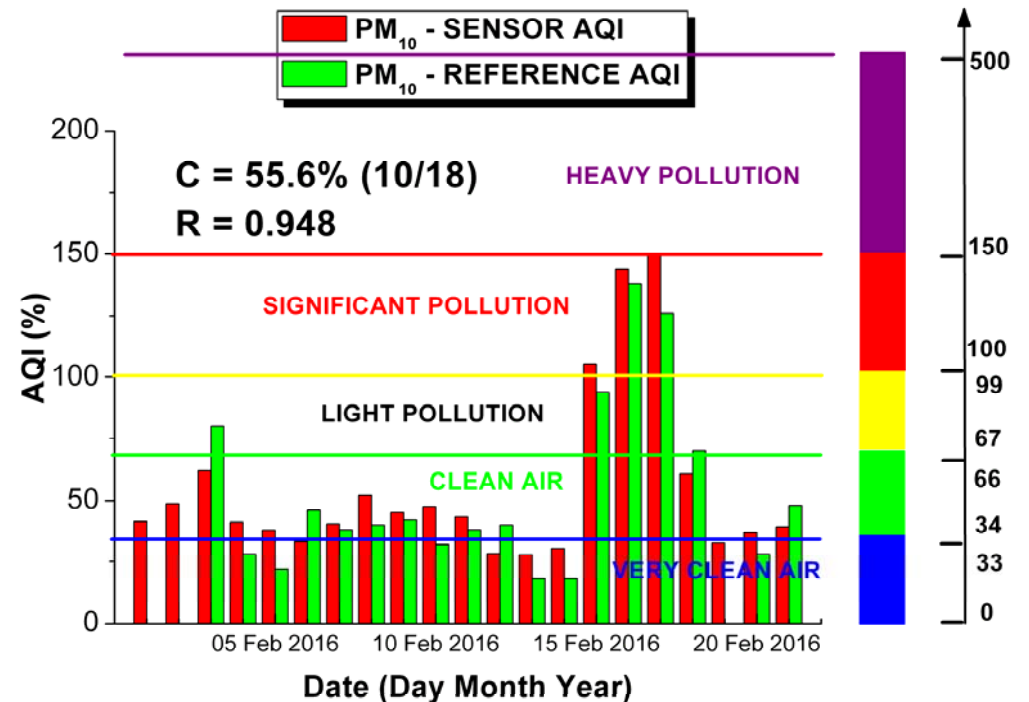
Courtesy by ENEA

CITY SENSORS NETWORK: AQI from Nodes

PM₁₀
Node 2: ENEA
AQI Sensor vs. AQI Reference
1 - 21 February 2016



PM₁₀
Node 6: Bari AIRPORT
AQI Sensor vs. AQI Reference
1 - 21 February 2016



R = Correlation Coefficient
C = Classification Index

Courtesy by ENEA

Aveiro Joint-Exercise Intercomparison & WG Meeting

13 - 27 October 2014: Starting Joint-Exercise (2 weeks duration)

14 - 15 October 2014: EuNetAir WG1-WG4 Meeting

EuNetAir Air Quality Joint-Exercise Intercomparison 2014

Local Organizers: Prof. Carlos Borrego and Dr. Ana Margarida Costa (IDAD)

Air Quality Monitoring campaign at Aveiro (Portugal) city centre 2014



Continuous measurements: CO, benzene, NO_x, SO₂, PM₁₀, VOC

Temperature, humidity, wind velocity, wind direction, solar radiation, precipitation

COST partners (15 teams joined from 12 COST Countries) installed their microsensors side-by-side to compare performance with referenced equipment in the Air-Quality Mobile Laboratory

COST Action TD1105 *EuNetAir*: Aveiro INTERCOMPARISON

New Sensing Technologies and Modelling for Air-Pollution Monitoring



1ST EuNetAir Air Quality Joint-Exercise Intercomparison

• Micro-sensors typologies and monitored pollutants:

- Electrochemical sensors:

- NO, NO₂, CO, O₃, SO₂

- Optical sensors:

- PM1, PM2.5, PM10

- Metal Oxide Semiconductor based sensors (MOS):

- NO₂, COV, CO, O₃, SO₂

- Non dispersive infrared technology sensors (NDIR):

- CO₂

- Photoionization detection sensors (PID):

- COV_t

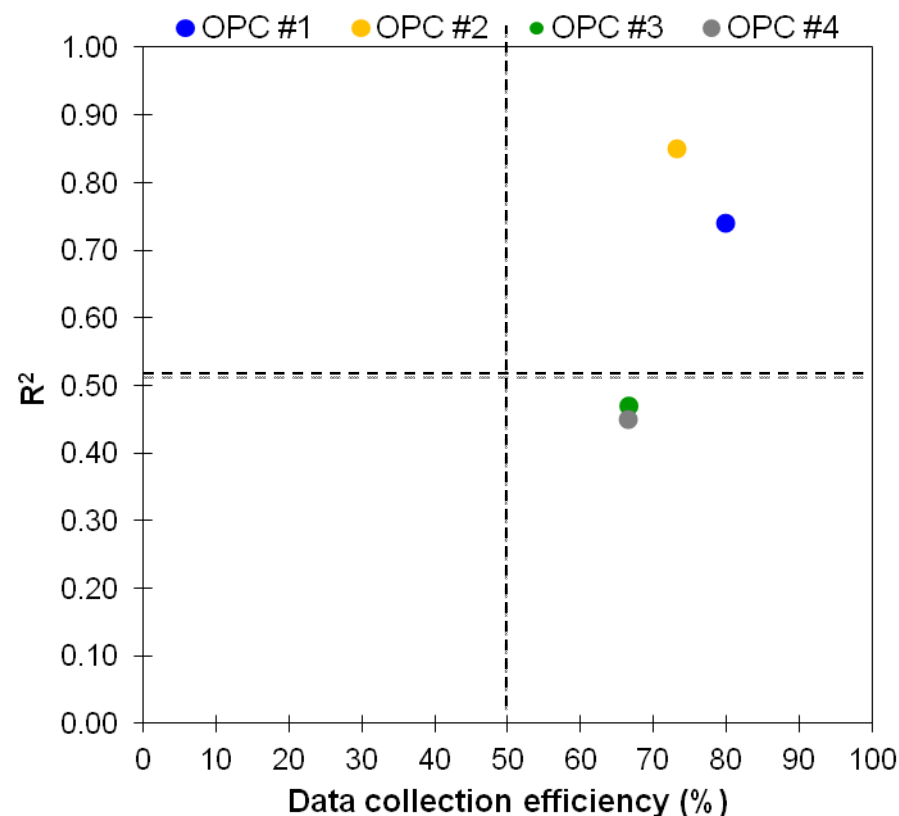
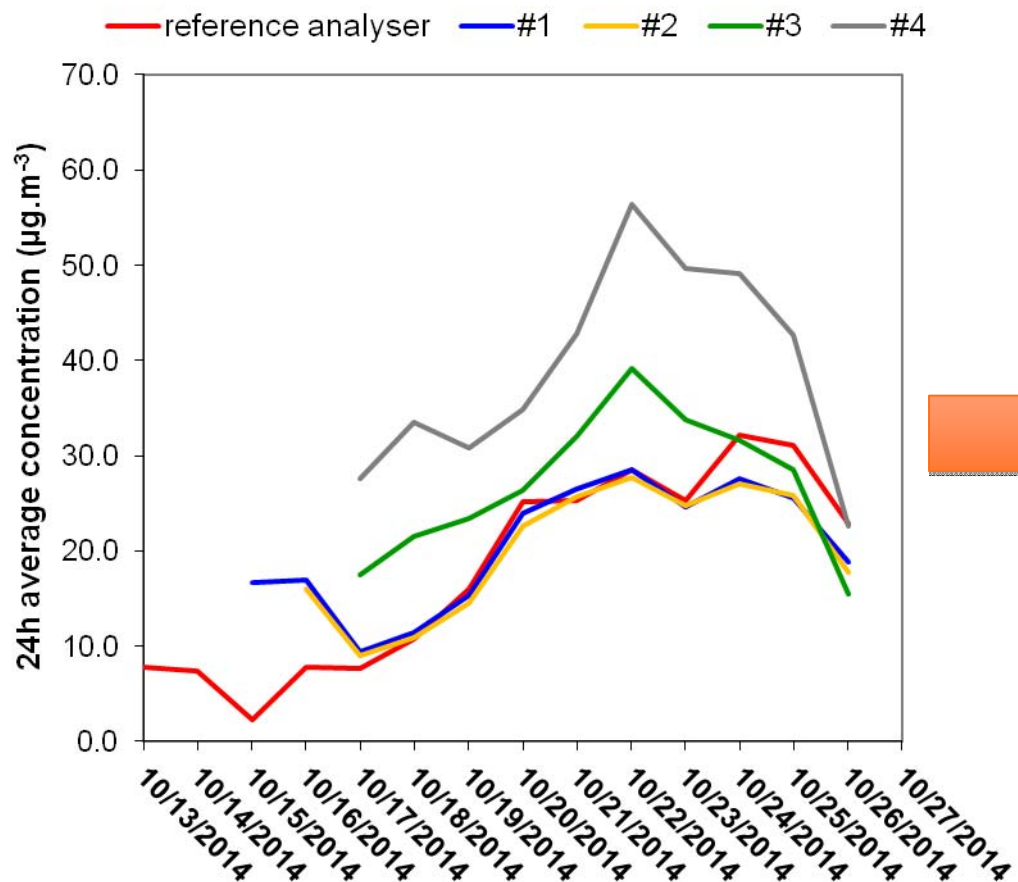


Carlos Borrego, IDAD, Aveiro, Portugal

Assessment of micro-sensors vs. reference methods

Carlos Borrego, IDAD, Aveiro, Portugal

- **PM2.5:**

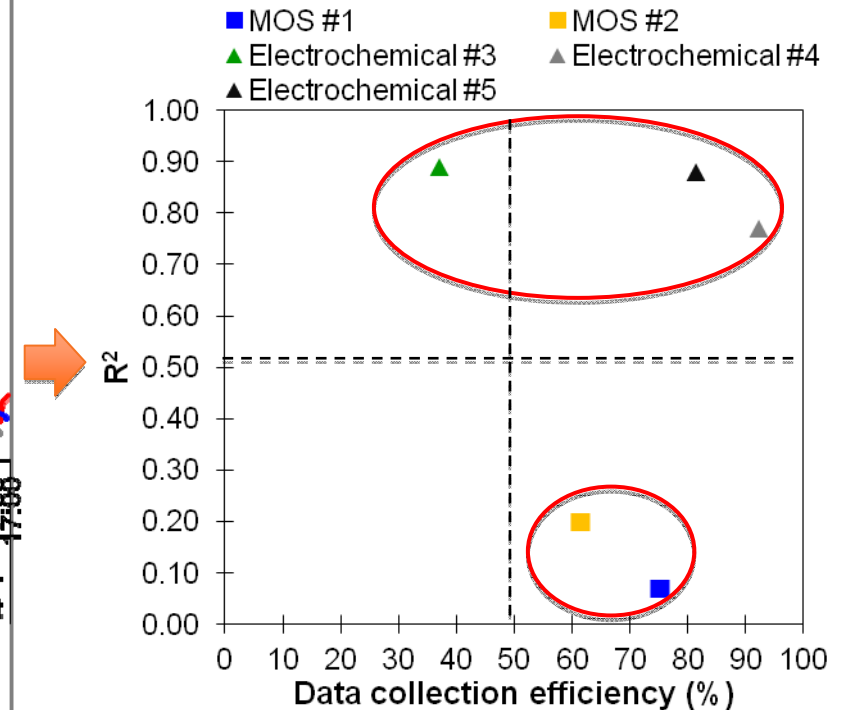
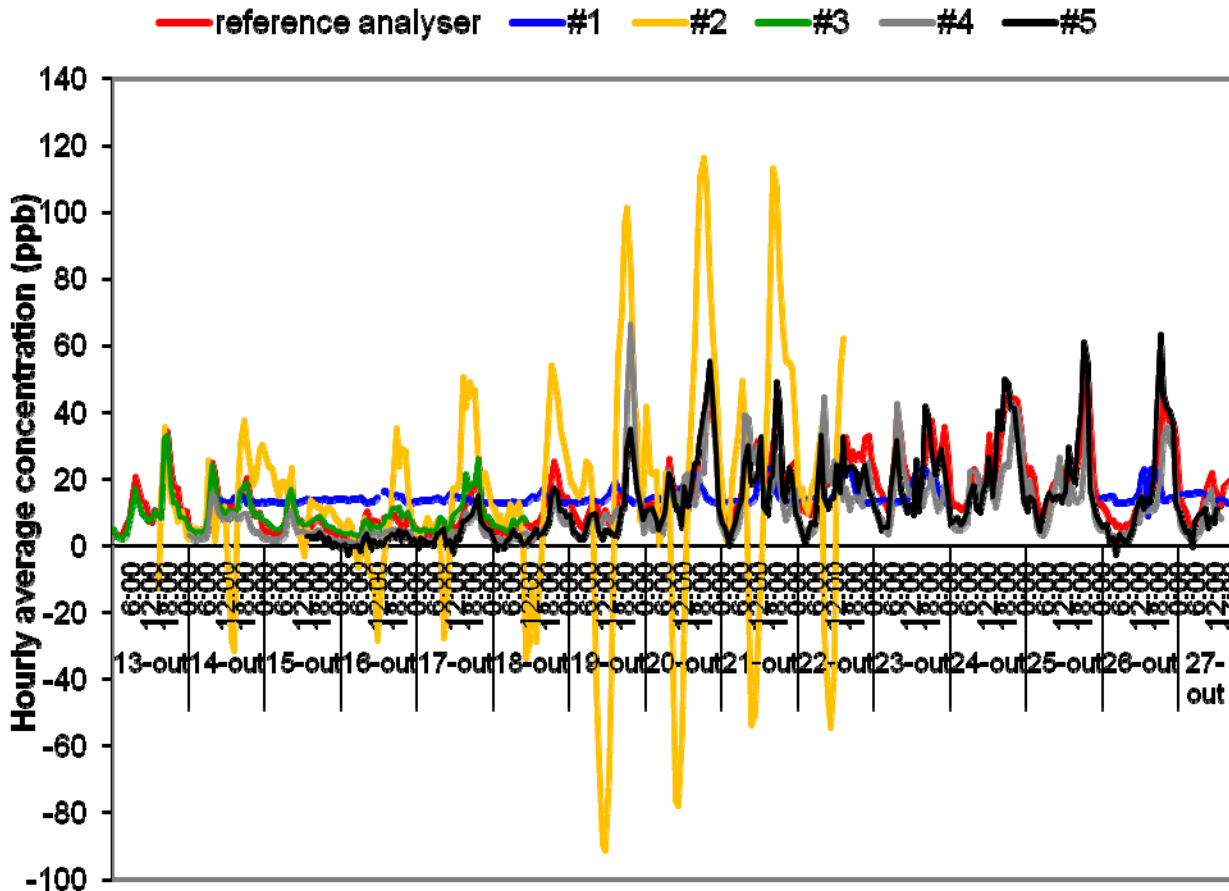


- The optical (OPC) sensors for PM2.5 presented correlations varying between 0.45-0.85 and data collection efficiencies in the range of 67-80%.

Assessment of micro-sensors vs. reference methods

Carlos Borrego, IDAD, Aveiro, Portugal

- NO_2 :



- Electrochemical sensors showed a greater correlation with the reference method and in most cases a higher efficiency collecting data than metal oxide semiconductor (MOS) sensors.

CURRENT STATUS in AIR QUALITY SENSORS



AQD: Data Quality Objectives (DQO)

	SO ₂ , NO ₂ /NO /NO _x , CO	Benzene	O ₃
Uncertainty for fixed measurements	15 %	25 %	15 %
Uncertainty for indicative measurements	25 %	30 %	30 %
	diffusive samplers, <i>micro-sensors</i>		

Michel Gerboles, JRC-Ispra, IES

FUTURE TRENDS in AIR QUALITY SENSORS

European Policy for the use of sensors

- Micro-sensors:
 - - **for now**: not mentioned, not foreseen in European legislation for regulatory purposes
 - - **European Members States** shall demonstrate that the Data Quality Objective for Indicative Methods is met (*national projects*).
- **For now**, the European Commission mainly observes the results of some Research projects related to micro-sensors: *MACPoll*, *AIRMONTECH*, *FP7- ENV.2012.6.5-1* (air quality monitoring in a "Smart City" context with community involvement, *S3-EURUSSIA*, *KEY-VOCs*, *MSP*, *SENSIndoor*, *CITI-SENSE*, ***COST Action TD1105***, ***EuNetAir***, etc. ...)

Open Questions of the Air Quality Sensors



- Lower Accuracy compared to Reference Methods
- Cross-sensitivity and low Selectivity
- Low Stability and Drift to be corrected periodically
- Calibration needs periodically (e.g., at least 1 calibration/month)
- Regular Maintenance of the in-field AQ sensor nodes
- Data Quality Objective (European Directive 2008/50/EC) to be addressed for ***Indicative Measurements*** by demonstration of the equivalence to use microsensors for AQ monitoring

Advantages and Benefits of the Air Quality Sensors

- Low-cost for deployment in Cities at high spatial-temporal resolution
- Suitability for personal exposure studies
- Suitability for emission source information
- Outdoor monitoring of gases (NO_2/NO , O_3 , CO , SO_2 , H_2S , tVOCs, CO_2 , NH_3 , etc.)
- Outdoor monitoring of particulate matter (PM_{10} , $\text{PM}_{2.5}$, $\text{PM}_{1.0}$, UFP)
- Indoor monitoring of gases (CO , VOCs, benzene, formaldehyde, naphthalene, toluene, etc.) and PM (PM_{10} , $\text{PM}_{2.5}$, $\text{PM}_{1.0}$)
- Combination of sensors with modelling for micro-scale analysis (1-2 mt resolution)

OUTREACH ACTIVITIES from Action TD1105



Action website:
www.cost.eunetair.it

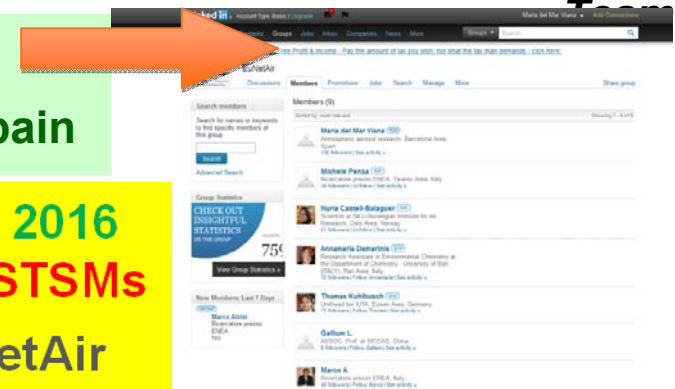
hosted by ENEA

Dr. Marco Alvisi, Webmaster Coordinator

Sebastiano Dipinto, Valerio Pfister, Gianfranco Zingarelli, Webmaster

Social Scientific ESRs Network (SSEN) by LinkedIn

Members: >100 - Moderators: M. Viana, M. Minguillon, CSIC, Spain



Short Term Scientific Mission Year 4: 4 Funded by 15 Nov. 2016
 STSMs funded by EuNetAir in 2012-2016: 43 Beneficiaries/STSMs

Dr. Jan Theunis, VITO, Belgium, STSM Coordinator EuNetAir



- Issue 1: published on Dec. 2012 ✓
- Issue 2: published on June 2013 ✓
- Issue 3: published on Dec. 2013 ✓
- Issue 4: published on June 2014 ✓
- Issue 5: published on Dec. 2014 ✓
- Issue 6: published on June 2015 ✓
- Issue 7: published on Dec. 2015 ✓
- Issue 8: published on Sept. 2016 ✓

Leaflet 1: Jan 2013
 Leaflet 2: Sept 2016

Brochure 1: Jan 2013
 Brochure 2: Sept 2016

Prof. Ralf Moos, Univ. of Bayreuth, DE, Editor-in-Chief
 Dr. Daniela Schonauer-Kamin, Editorial Board Manager

Video/Interview: www.cost.eunetair.it - Section VIDEO

- **Alena Bartonova**, Coordinator FP7 Project CITI-SENSE, NILU, Kjeller, Norway
- **Margurite Nyhan**, The Senseable City Lab, MIT, Boston, USA
- **Hans-Guido Muecke**, Manager at WHO CC and Federal Environment Agency
- **Oliver von Sicard**, Researcher at Siemens AG, Munich
- **Thu-Hoa Tran-Thi**, Research Director on Indoor Sensors, CEA-CNRS, France
- **Tim Watkins**, Deputy Director US EPA Air, Climate & Energy Programme, USA
- **Andrea C. Ferrari**, Chairman of Executive Board of Graphene Flagship, UK
- **Cristina Guerreiro**, Coordinator of EEA AQ Report 2012-2013, Norway
- **Meyya Meyyappan**, Chief Scientist, NASA Ames Research Center, USA
- **Michele Penza**, Action Chair at RAI3 Italian TV Show GeO&GeO, Italy



Editorial Activities: **WGs MEETING** at EEA

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

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

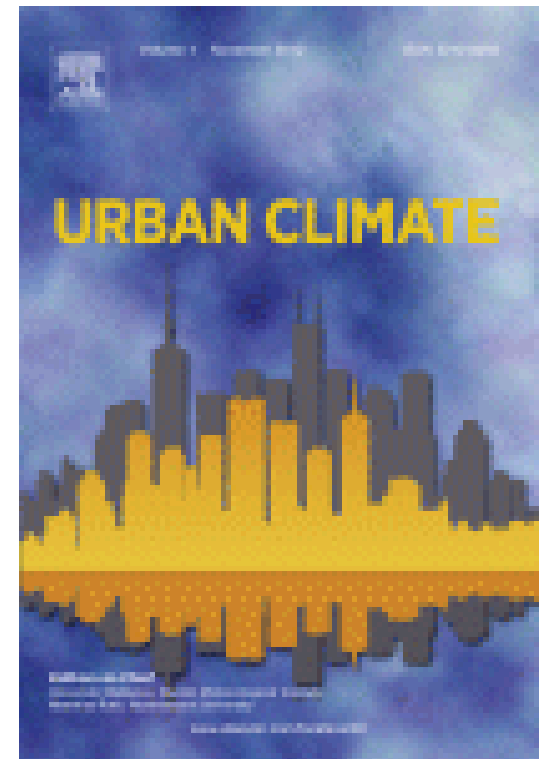
New Sensing Technologies and Methods for Air-Pollution Monitoring

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: **22 Manuscripts**
- Publication: **December 2015, Issued Vol. 14 (2015)**



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: **31 July 2014**
- Online Publication: **February 2015 (Open Access)**



Editorial Activities: Linkoping Meeting Proceedings published at open access AMA Science.org

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

Proceedings of Linkoping Meeting, 3-5 June 2015, Linkoping(Sweden)

Quality check (<http://www.ama-science.org/proceedings/listing/2113?start=0>)

•Guest Editors:

- ✓ Michele Penza, ENEA, Italy
- ✓ Anita Lloyd Spetz, Linkoping University, Sweden
- ✓ Donatella Puglisi, Linkoping University, Sweden
- ✓ Andreas Schuetze, Saarland University, Germany
- Online Publication with DOI: **October 2015 (Open Access)**
- **16 Papers Published**



Symposium planned at EMRS Spring Meeting 2016

Lille (France), 2 - 6 May 2016

Functional Materials for Environmental Sensors and Energy Systems

Proceedings of Symposium EMRS Spring Meeting 2016 to be published under peer-review process in **Beilstein Journal of Nanotechnologies** (IF 2015: 2.6)

• **Peer-review process** Open Access journal without publication fee (<http://www.beilstein-journals.org/bjnano>).

• Symposium Organizers:

- ✓ Michele Penza, ENEA, Italy
- ✓ Anita Lloyd Spetz, Linkoping University, Sweden
- ✓ Albert Romano-Rodriguez, Barcelona University, Spain
- ✓ Meyya Meyyappan, NASA Ames Research Center, USA

• **Deadline for abstract submission: 22 January 2016**

• **166 Abstracts Received (Top-8 over 31 Symposia)**

• **Open Access BJNANO Publication expected on December 2016**



BEILSTEIN JOURNAL OF NANOTECHNOLOGY



MATERIALS RESEARCH SOCIETY
Advancing materials. Improving the quality of life.

Symposium PM4 at 2016 MRS Fall Meeting & Exhibit **Boston (USA), 27 November - 2 December 2016**

Novel Materials, Fabrication Routes and Devices for Environmental Monitoring

• **Symposium Organizers:**

<http://www.mrs.org/fall2016>

- ✓ Michele Penza, ENEA, Italy
- ✓ Ruby Ghosh, Michigan State University, USA
- ✓ Albert Romano-Rodriguez, Barcelona University, Spain
- ✓ Meyya Meyyappan, NASA Ames Research Center, USA

• **Deadline for abstract submission: 16 June 2016**

• **Symposium Programme online: 65 Talks + 15 Posters**



2016 **MRS**[®]
FALL MEETING & EXHIBIT
November 27 – December 2, 2016 | Boston, Massachusetts

CALL FOR PAPERS

Abstract Deadline: June 16, 2016

REMINDER: In fairness to all potential authors,
late abstracts will not be accepted.

www.mrs.org/fall2016

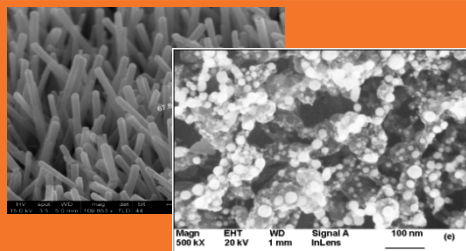
Symposium PM4: Novel Materials, Fabrication Routes and Devices for Environmental Monitoring

Expected Impact by Action TD1105

- **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**

COST Action EuNetAir: CHALLENGES

MATERIALS & GAS SENSORS



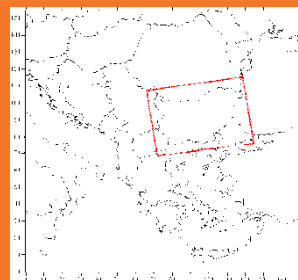
MOX by UNIBS IREC UB SICCAS
CNT by ENEA NASA URV CSIRO

AQC SENSORS & SYSTEMS



GasFET by EPFL, Switzerland

AQ MODELLING

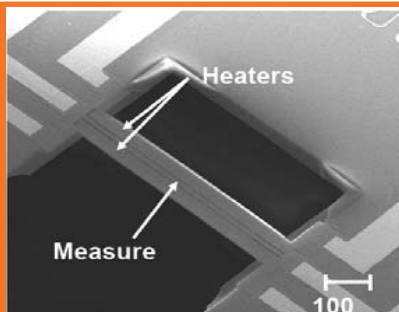


CMAQ Calculations
by NIMH, BG

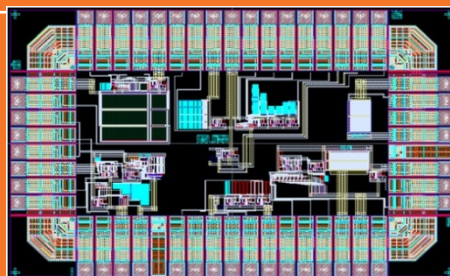
STANDARDS & PROTOCOLS



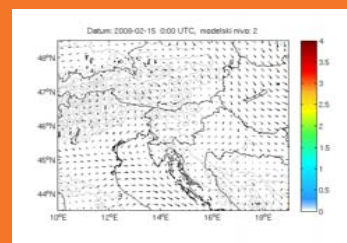
Dynamic Olfactometry (EN 13725/2003) by Univ. of Bari and Lenviros srl, IT



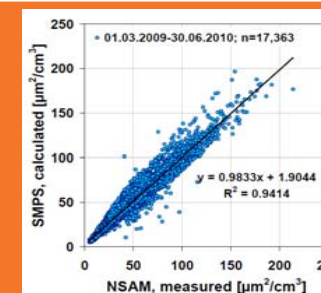
Cantilever Sensor by DTU, DK



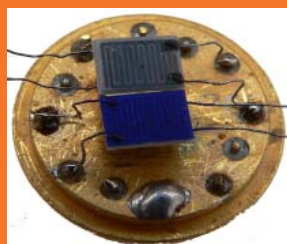
ASIC Circuit: CMOS SOI
by WARWICK & CCMOS Ltd, UK



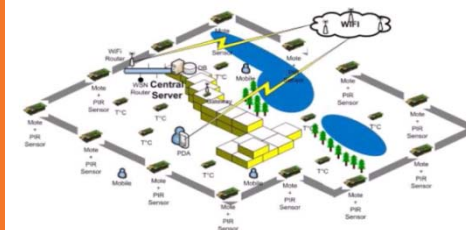
AQ Modelling dispersion in meteorological mesoscale by University of Ljubljana, SL



Particle Surface Area Measurements by IUTA eV, DE



Phtalocyanine Gas Sensors
by CNRS UBP-LASMEA, FR



WIRELESS SENSORS NETWORK
by ISI, Greece



Chemical Weather Forecasting and Information System
by Hungarian Meteo Service

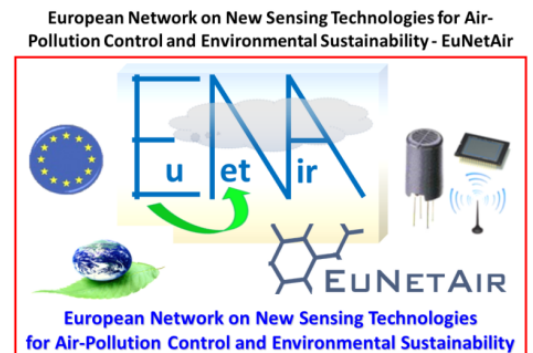


HARMONISATION:
Definition of protocols and standards for gas sensing measurements and gas sensors

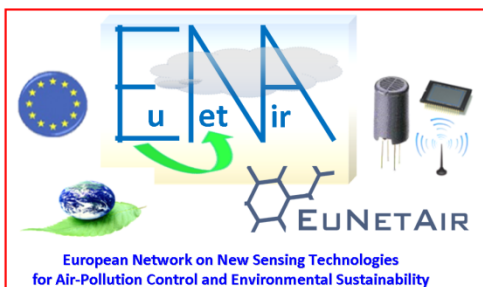
CONCLUSIONS

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

- Air Quality Control
- Environmental Sustainability
- Indoor/Outdoor Energy Efficiency
- Climate Change Monitoring
- Health Effects of Air-Pollution



Contact Details



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