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

COST Action TD1105

WGs and MC Meeting at ISTANBUL, 3-5 December 2014

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

GAS AND PARTICULATE MONITORS: ADVANCES AND SETBACKS

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WG 4.3

Alphasense Ltd. UK

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ESF provides the COST Office through a European Commission contract

Air Quality sensors: problems and progress

Inorganic gases

- Separating NO_2 and O_3
- improving ppb linearity
- improving humidity response

Particulates

- $PM_{2.5}$, PM_{10}, PM_1

VOCs

- PIDs: better sensitivity, longer lamp life
- Metal oxides: how low can we go?

Good air quality sensor:

Sensitivity

Selectivity

Stability (T, humidity, time)

and…..low cost!

Inorganic gases: NO_2 and O_3 (1/2)

The problem

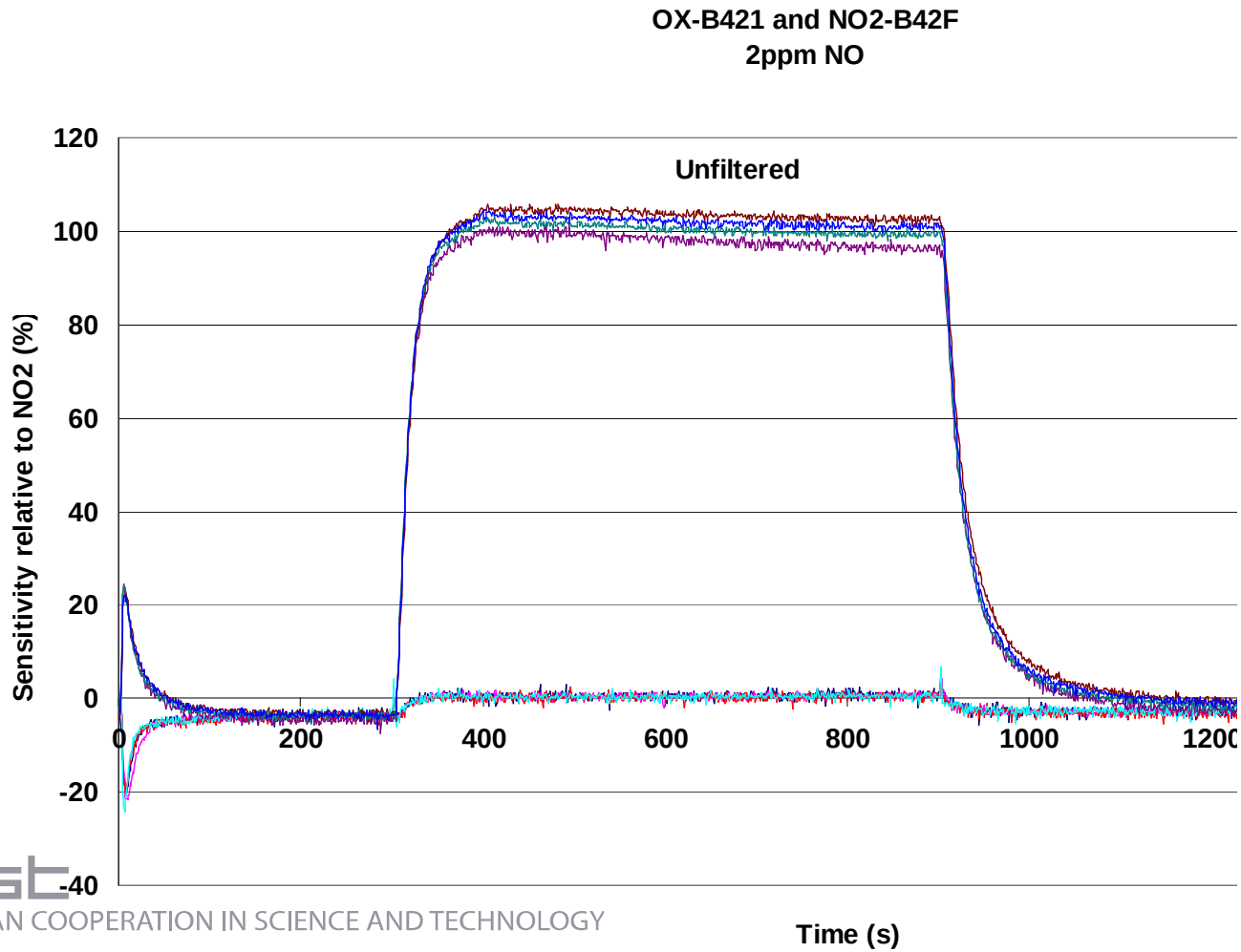
Both gases are strong oxidants, causing lung oxidative stress

WO_3 metal oxide is used to measure O_3, but thermal decomposition is the challenge

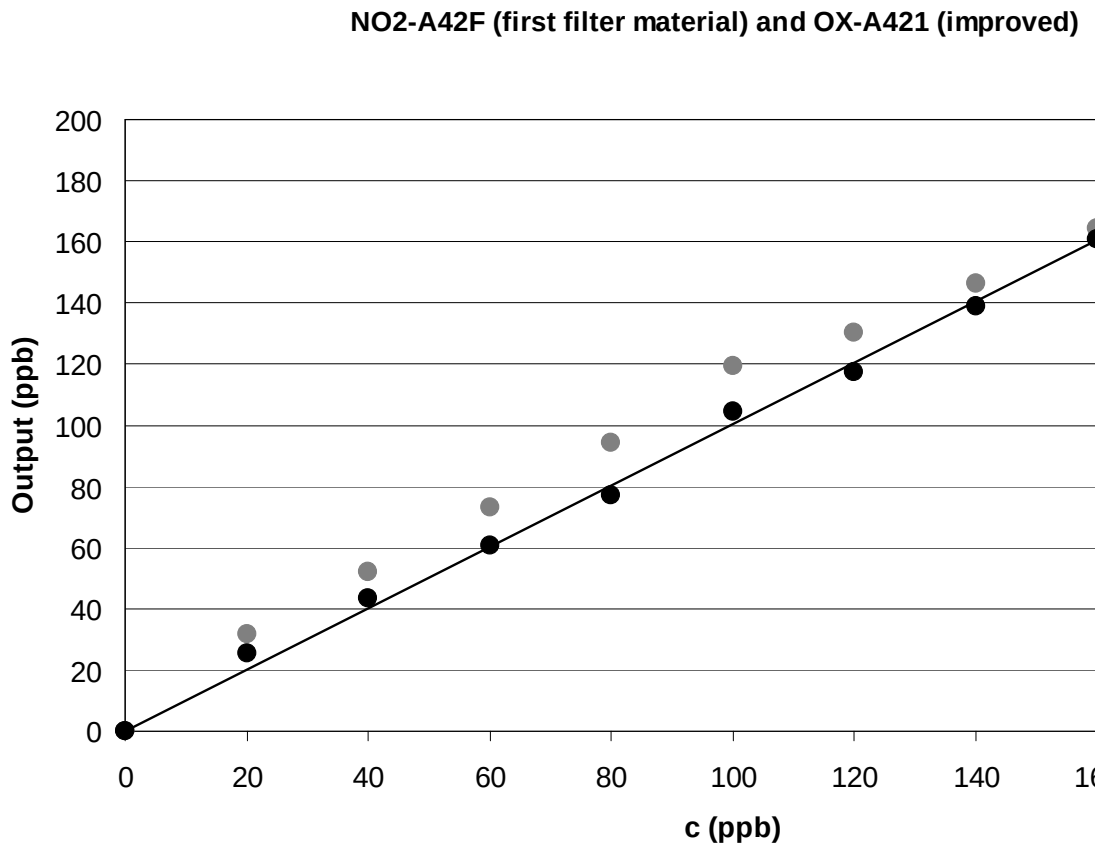
Graphite electrochemical cells measure both NO_2 and O_3, so we must scrub O_3 in one sensor, while measuring both gases in the second sensor to measure both NO_2 and O_3

SnO_2 metal oxides measure both NO and NO_2

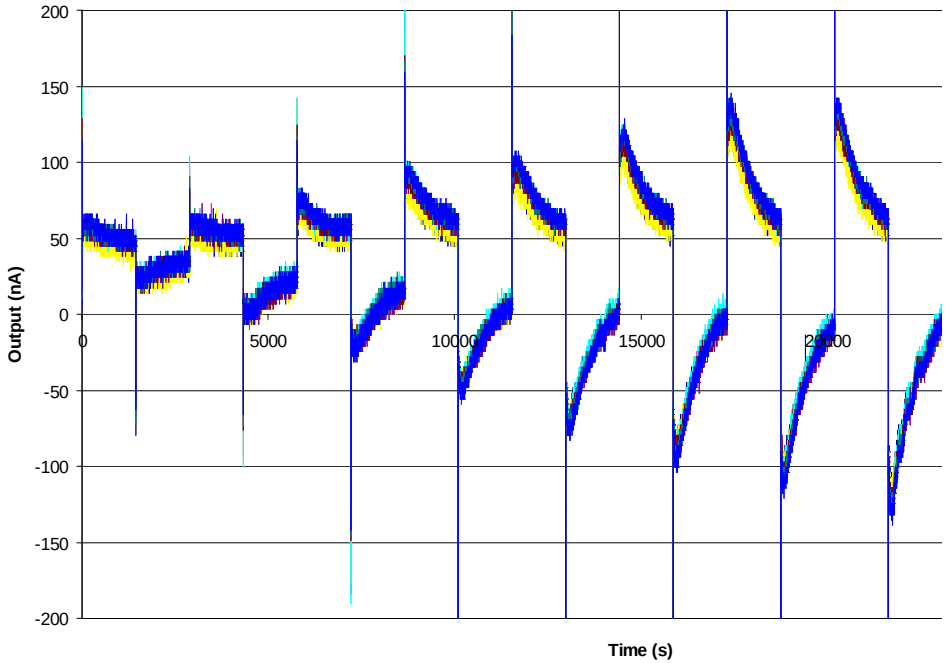
Inorganic gases: avoiding NO, while scrubbing O_3 (2/2)

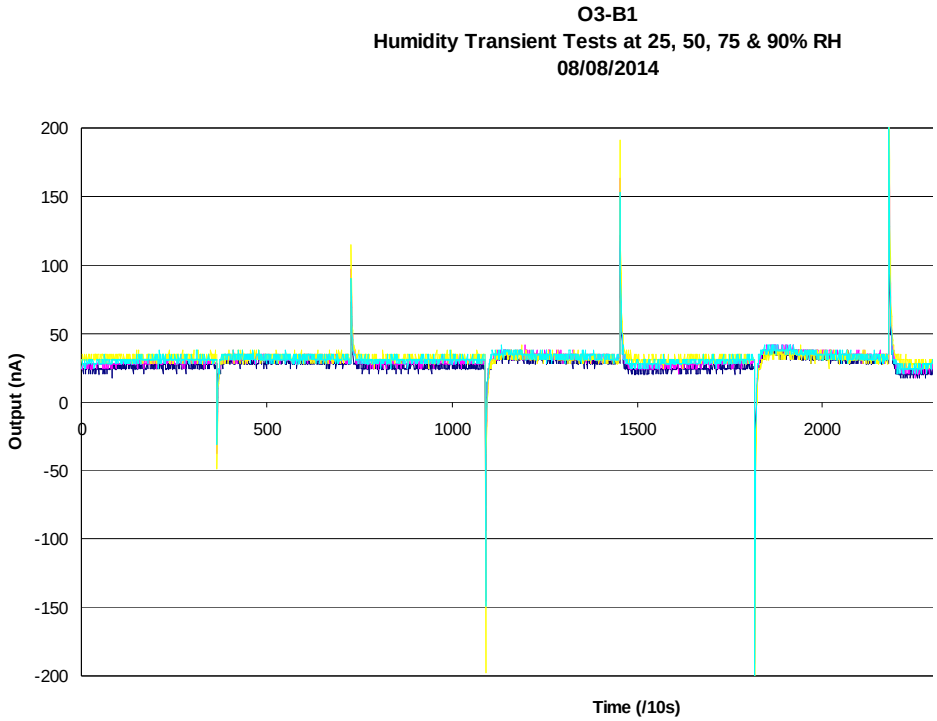


Linearity has been optimised by modifying the filter structure

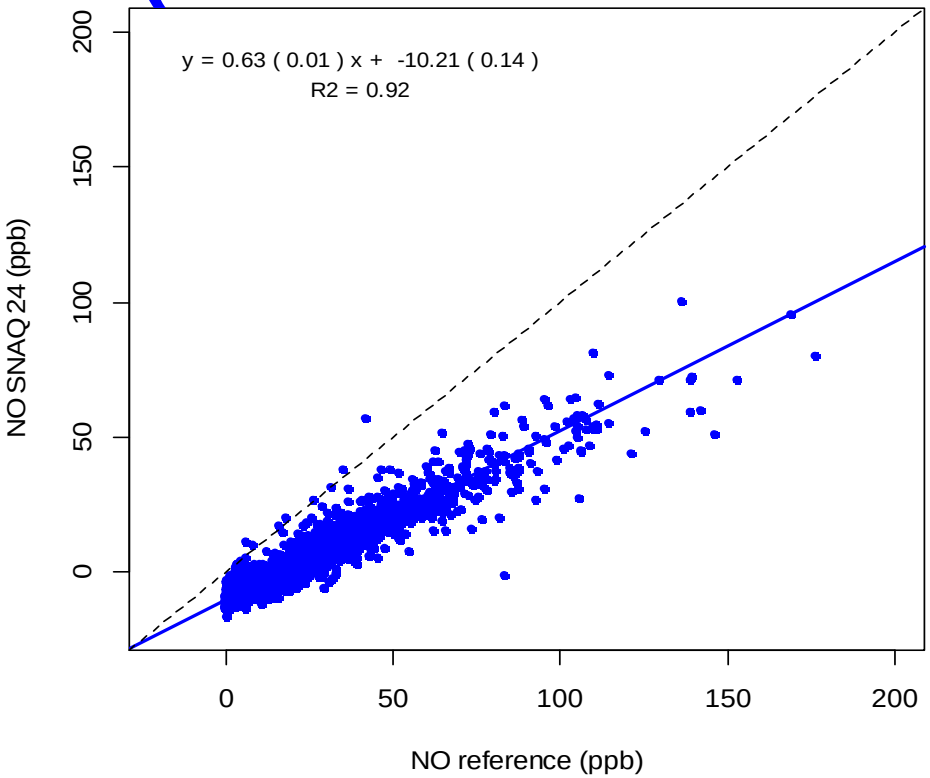


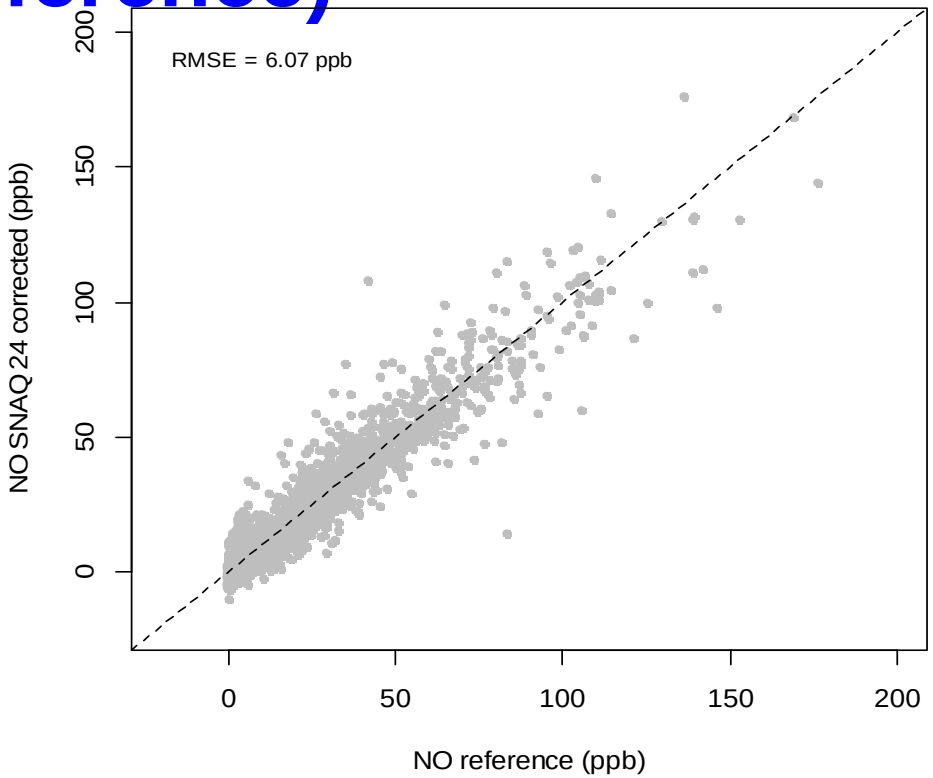
Humdity dependence for standard design and new design





NO is important for monitoring combustion and is very reliable (electrochemical *vs* reference)





Cambridge Heathrow network sensors

(Christoph Huelgin, EMPA)

VOCs
Real time measurement

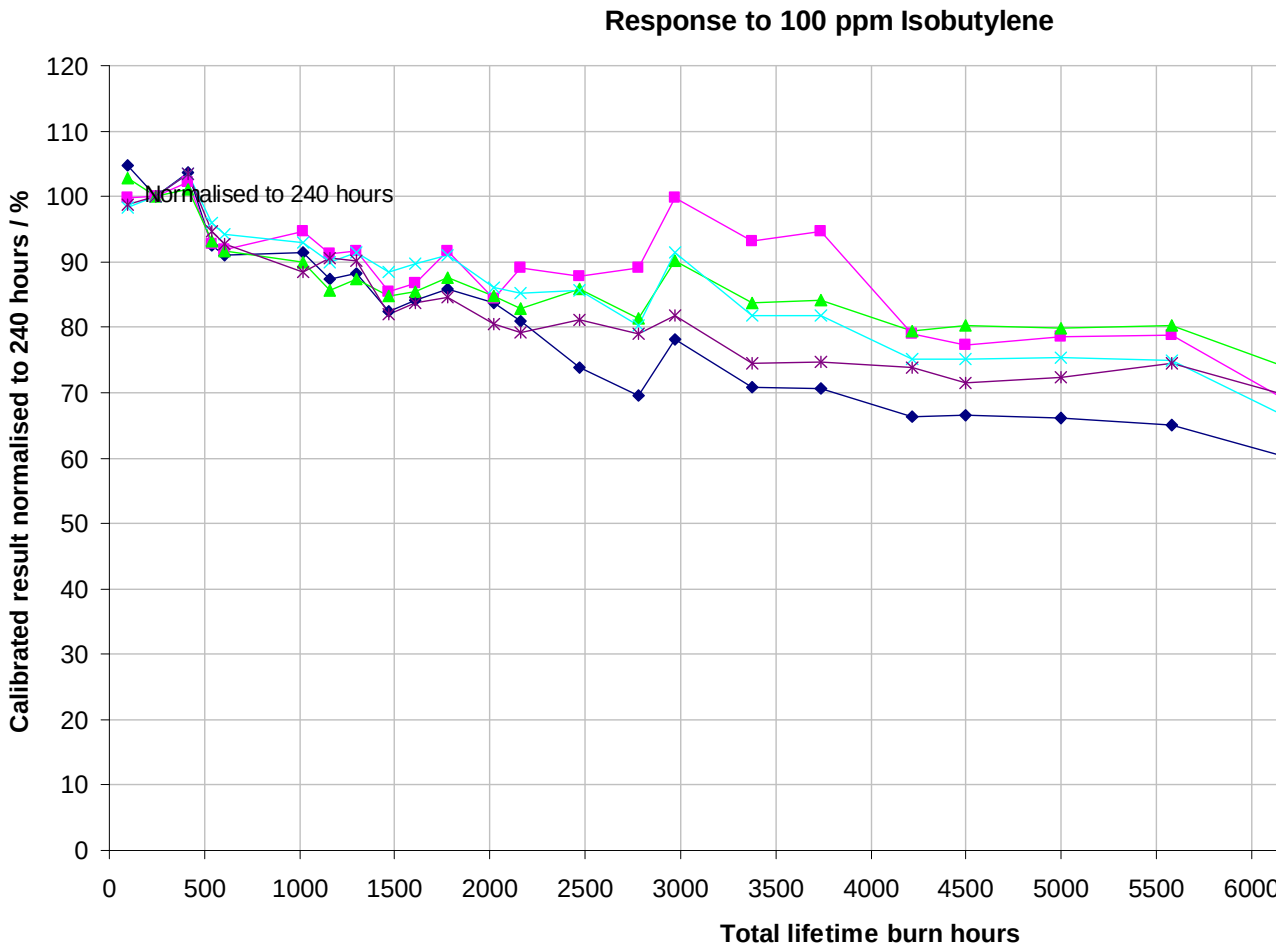
PID, Metal Oxides, not selective but affordable

Ion Mobility Spectroscopy (IMS): selective

TDLS: selective, but costly and specific to one or a few VOCs

VOC generator: 5+3 channel automated permeation tube/ DMFC system with rh control

PID Lamp life: was 2,000 hours, now 10,000 hours and 1-2 ppb resolution

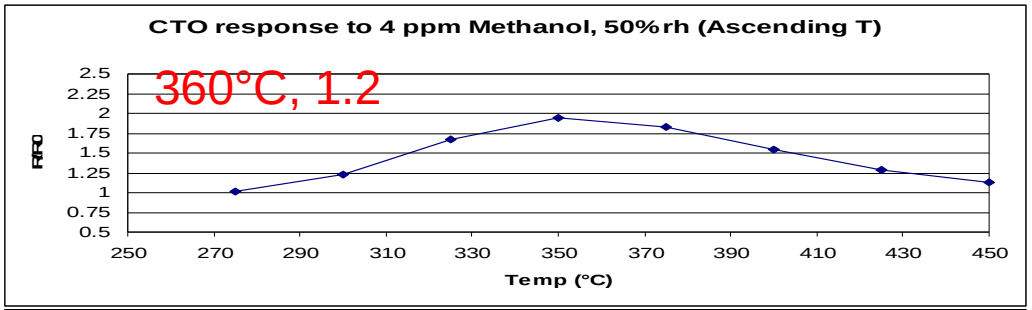


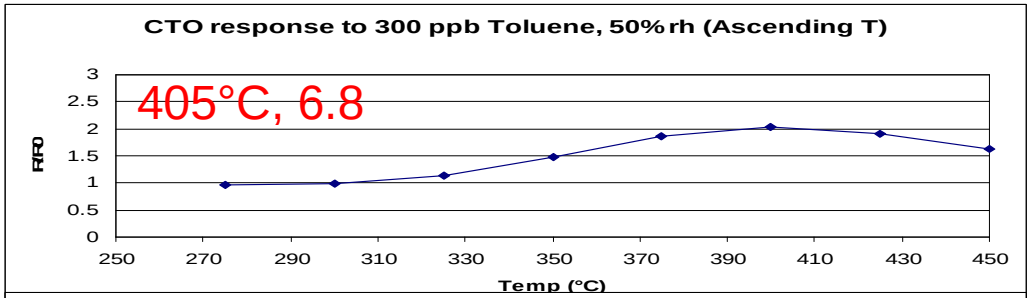
Metal Oxides: p-type

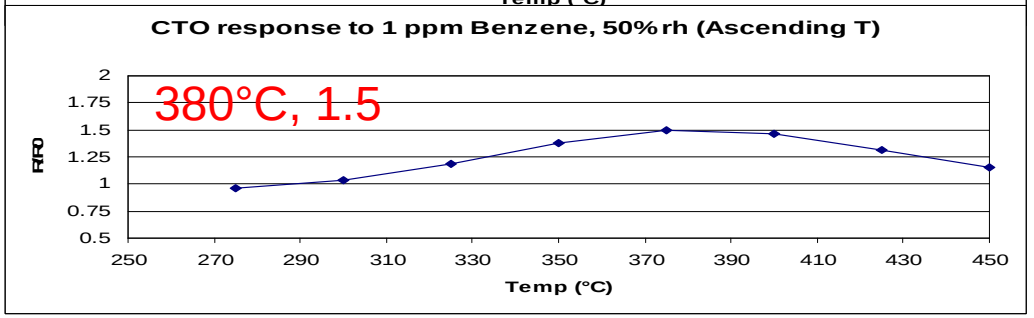
Sensitivity, LoD: CTO

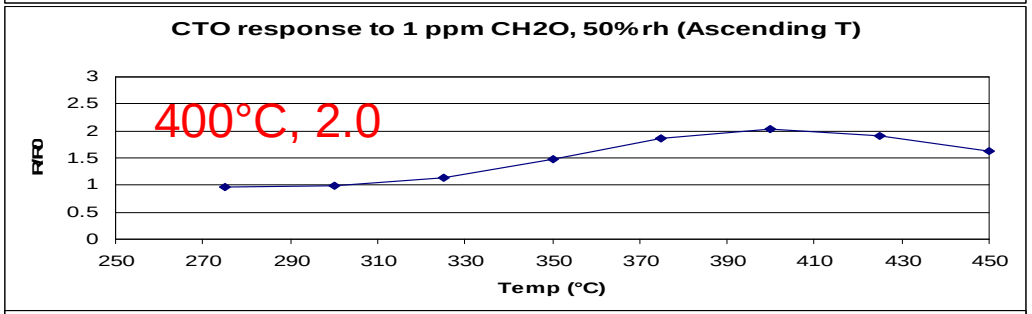
normalised to 1 ppm

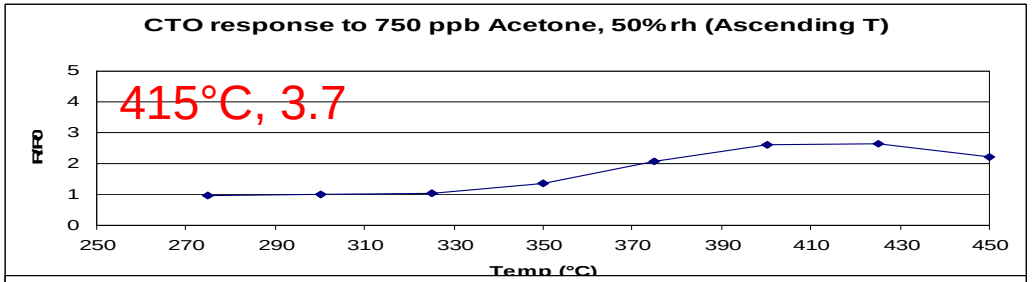
T_{max}, $R/R_o(T_{max})$

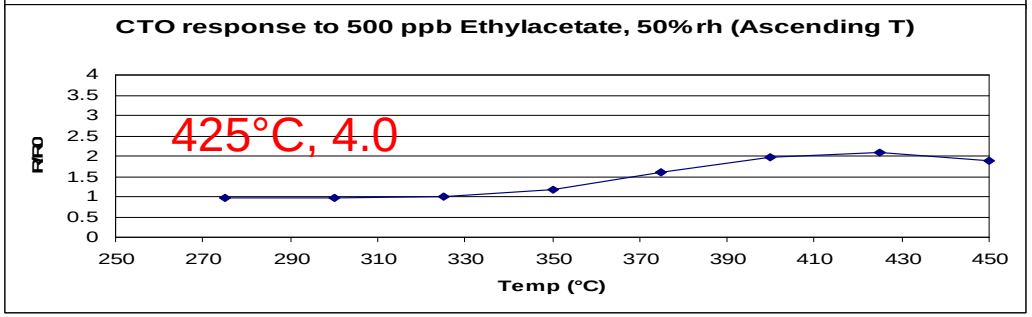


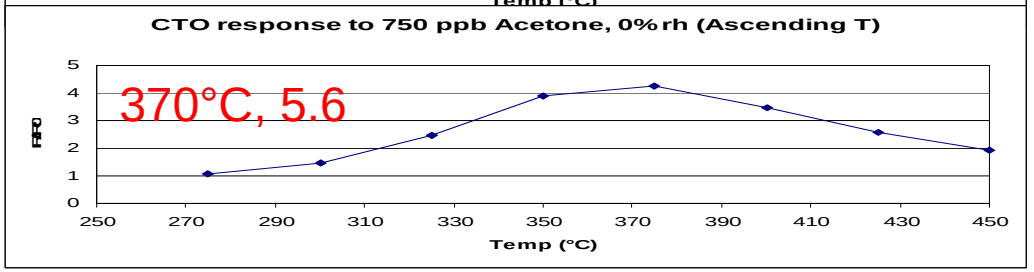






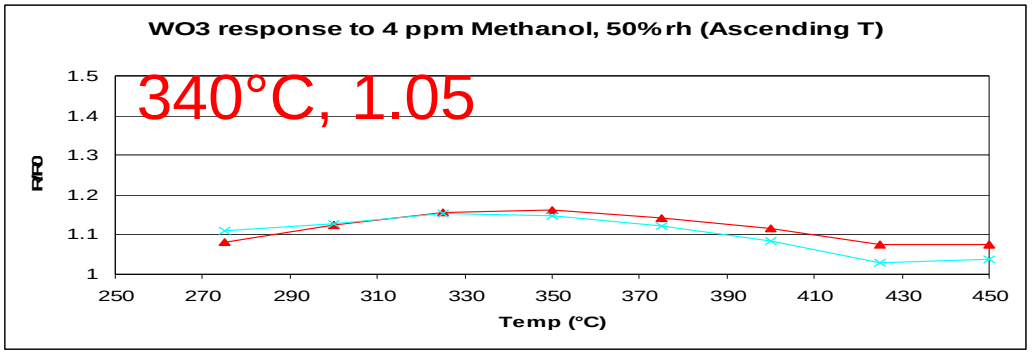


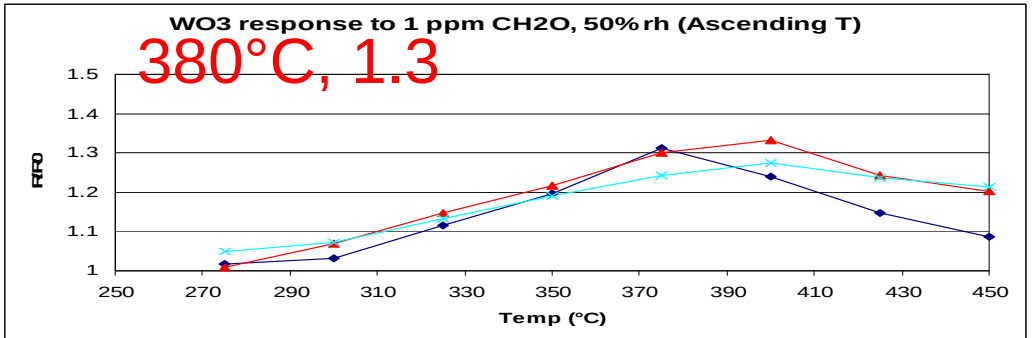


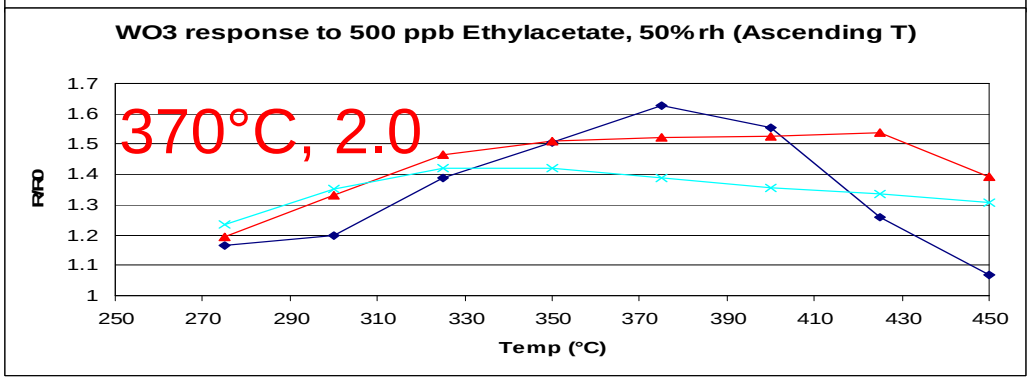


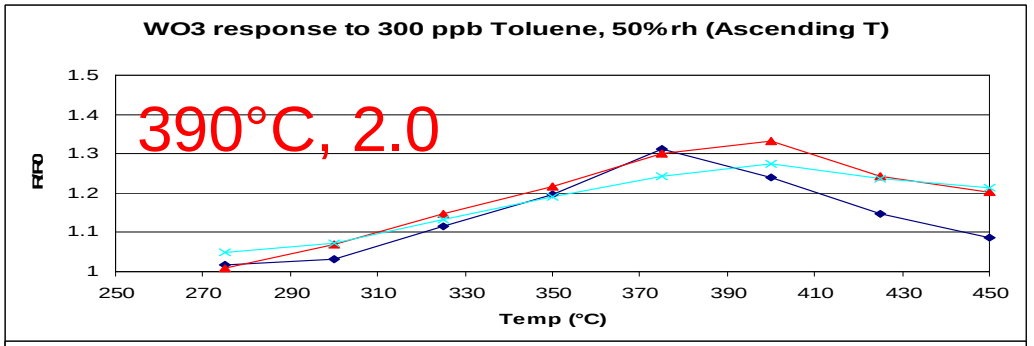
Metal Oxides: n-type

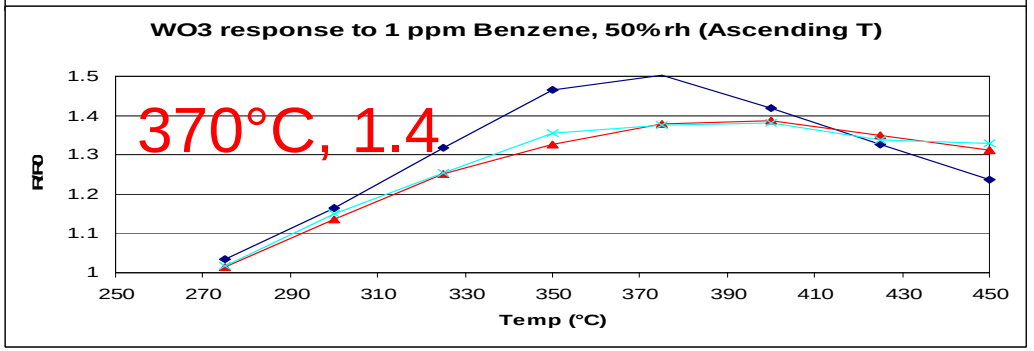
Sensitivity, LoD: WO_3 **normalised to 1 ppm**

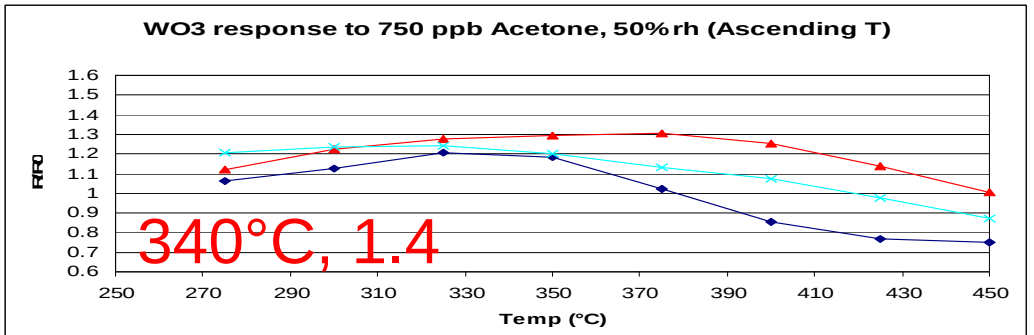


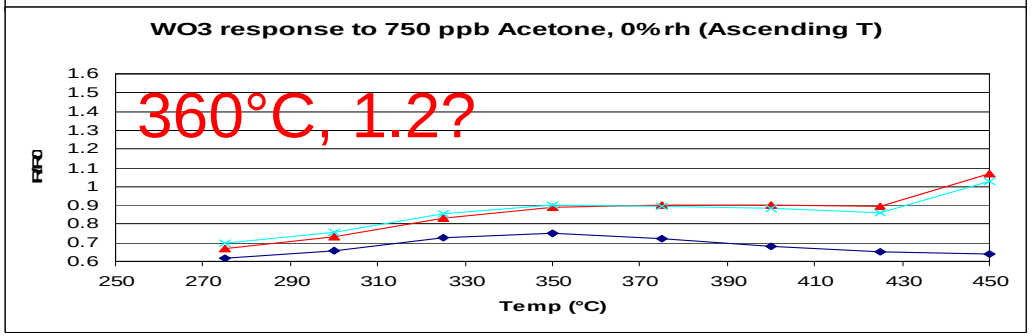










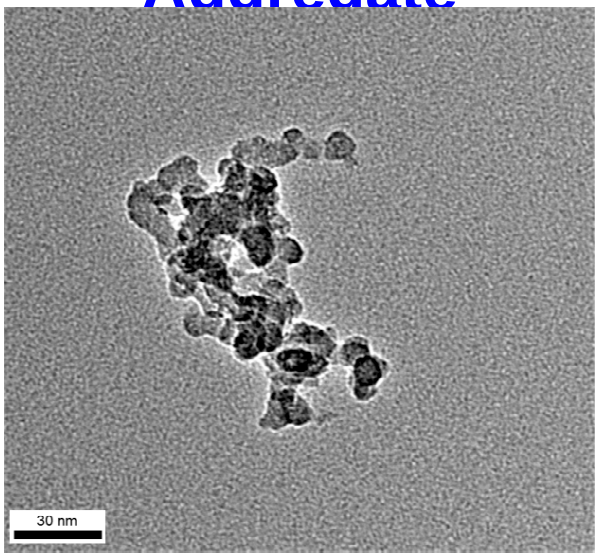


Particulates

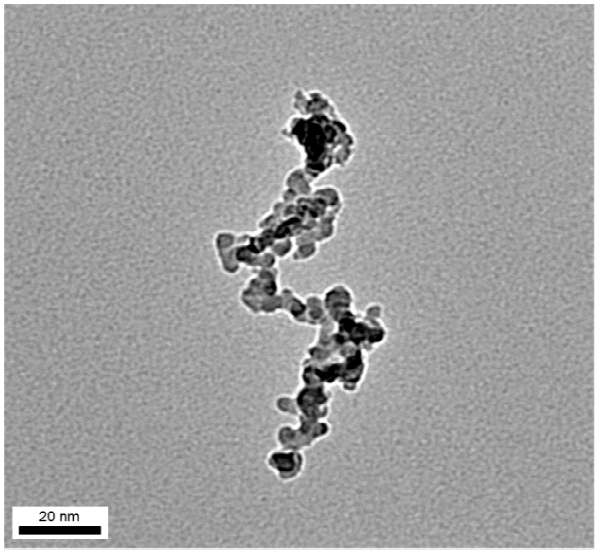
- Well-known health dangers
- Urban air and IAQ problem
- PM_{10}? Now $PM_{2.5}$ and soon Ultrafines <300nm (PN, not PM?)

TEM Images – Aggregated nanoparticles

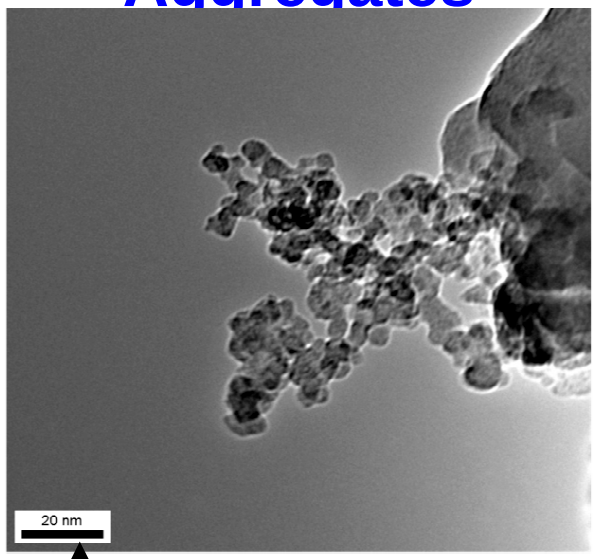
15 nm Aggregate



15 nm Aggregate



30 nm Aggregates



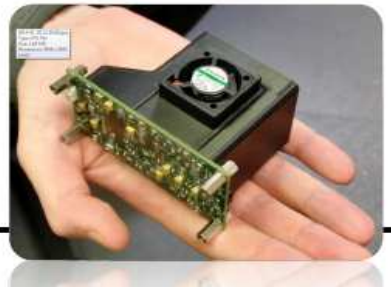
20nm

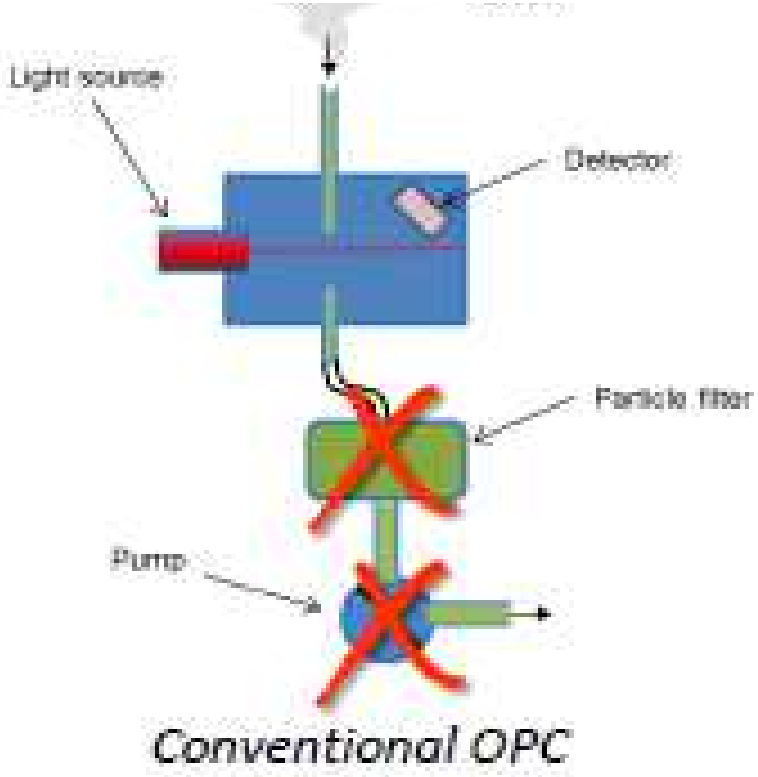
DUST2014, Castellaneta Marina (TA), Italy, 1-6 June 2014

A LOW-COST OPTICAL PARTICLE COUNTER FOR NETWORKED DEPLOYMENT

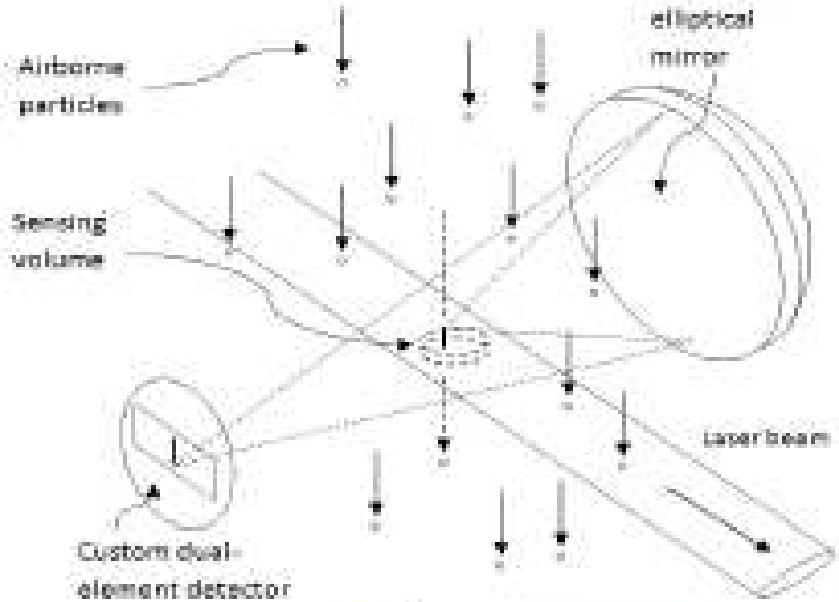
Paul H. Kaye[1], Warren R. Stanley[1], Edwin Hirst[1], John Saffell[2] and Zbigniew Ulanowski[1]

1. Centre for Atmospheric and Instrumentation Research, University of Hertfordshire, Hatfield AL10 9AB, UK.
2. Alphasense Ltd., Great Notley CM77 7AA, U.K.





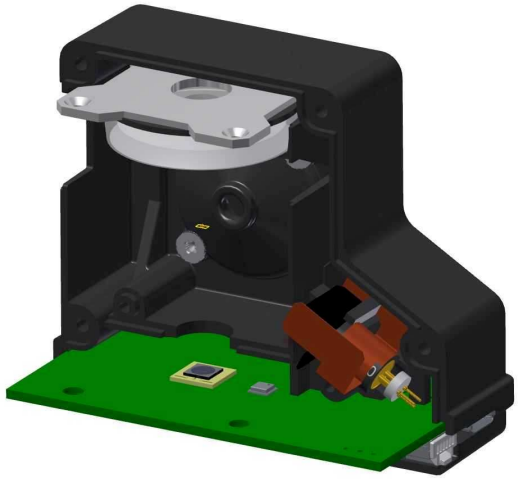
Conventional OPC



New low-cost OPC-N1

Optical Particle Counter

OPC-N2: PM_1, $PM_{2.5}$, PM_{10}



-0.38 to 17 µm

-Particle size histogram each second
-PM calculated every second

-Aerodynamic flow, fan control for clean optics in dirty environments

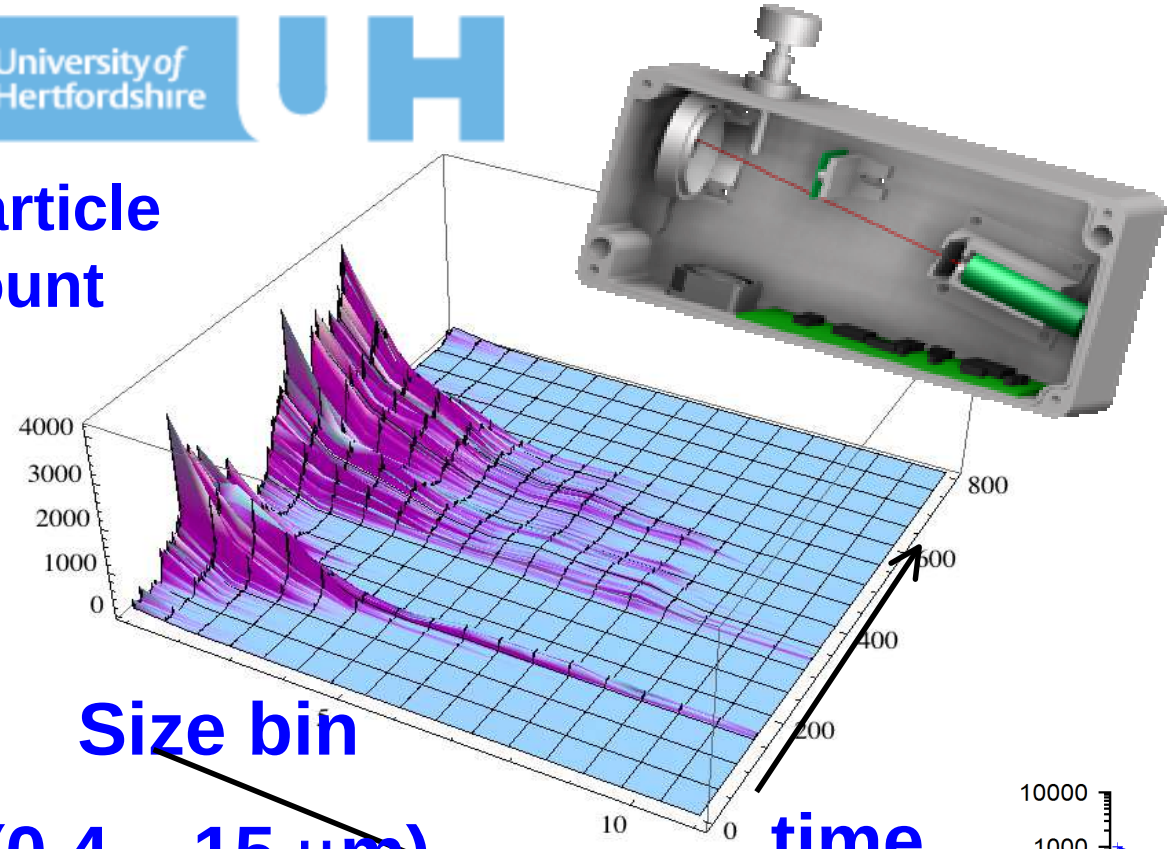
Operated at Heathrow for 22 months

70g weight, 130mA/5V, €325

Other measurements: size speciated PM

University of Hertfordshire

Particle count

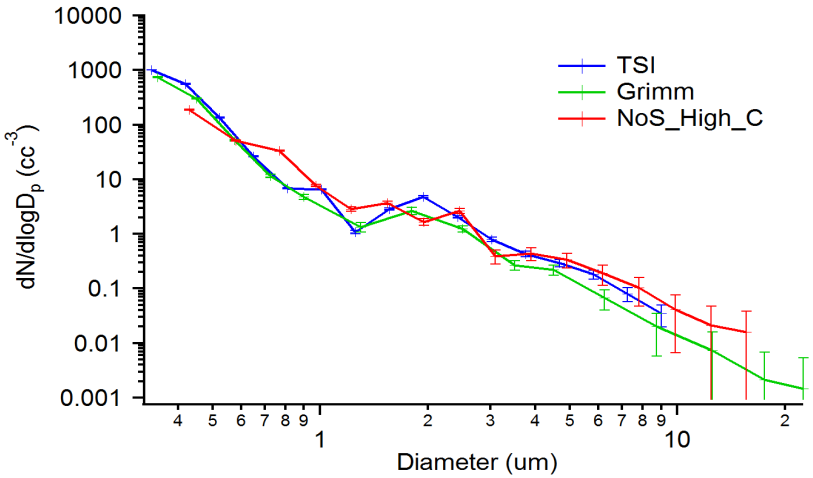


Size bin

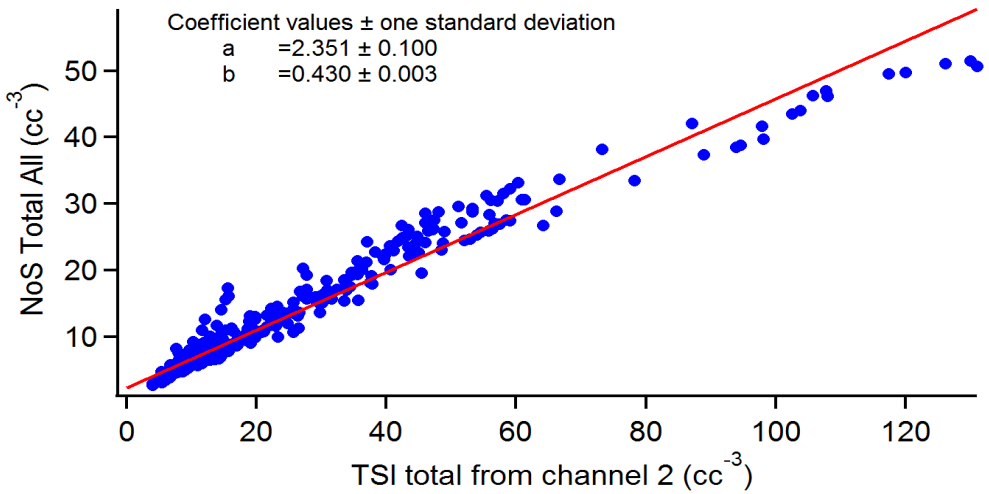
(0.4 – 15 μm)

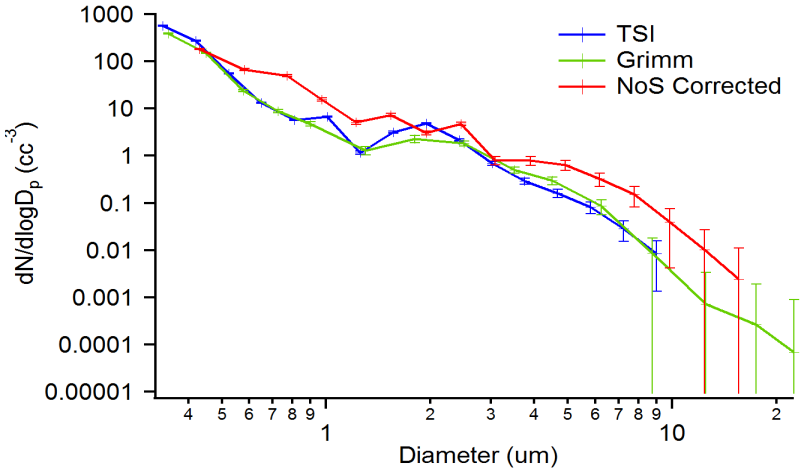
time

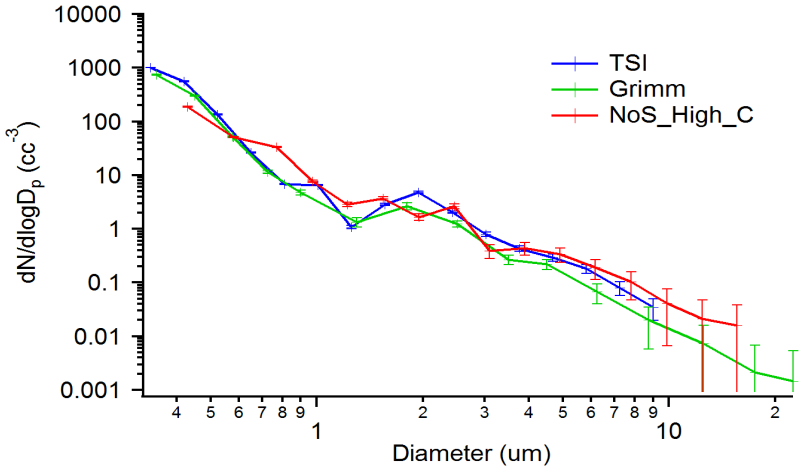
Comparison with reference instruments (Paul Kaye, Paul Williams)

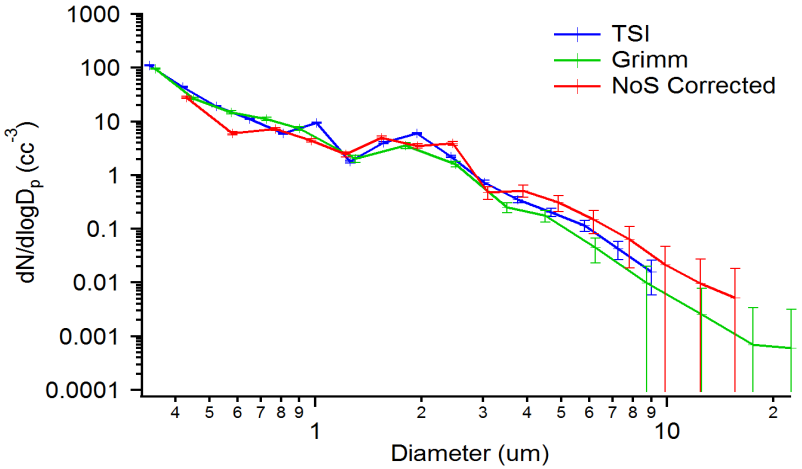


Size speciated PM: inlet calibration









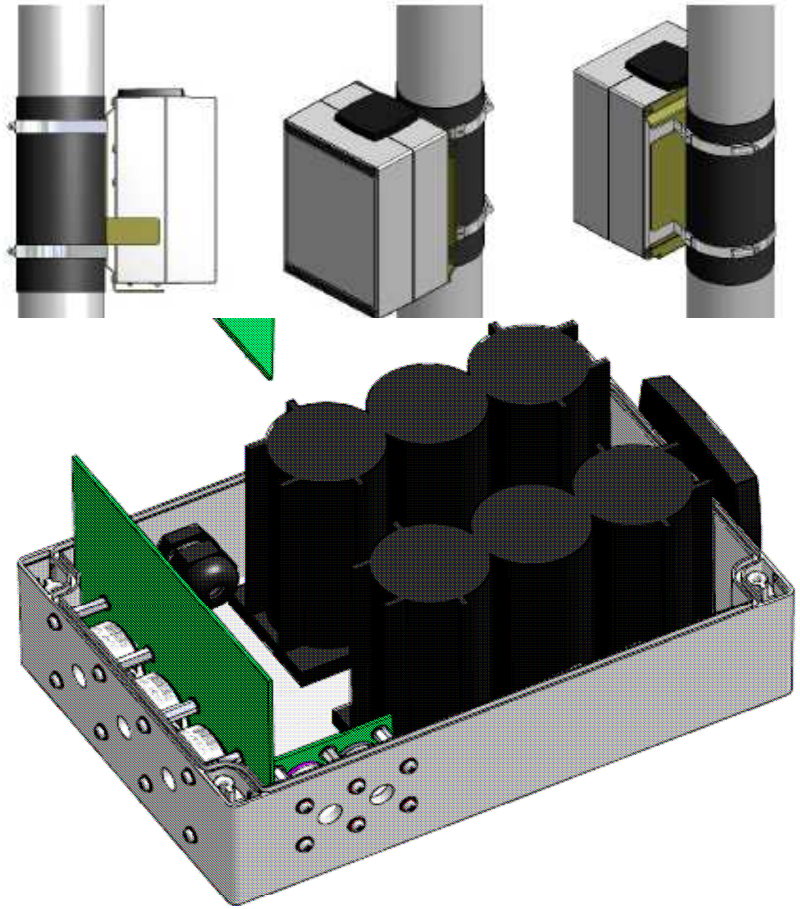
Dominated by small aerosol sizes

Urban air and IAQ motes

- Boxes? Motes?
- Wired, wireless, solar powered
- Modular to adapt tp specific IAQ, urban, rural and nuisance odour networks

Fixed Site Motes 2010-2014

City-wide network in Cambridge 2010



High density network at

Heathrow airport 2011-2013

PID

FP7 project to detect bomb factories: 14 gas/ VOC sensors 2011-2013

COMMONSENSE

Indoor motes