



Pioneering sensor and detector technology

Automotive Air Quality Sensors: industrial innovations to protect people's health

COST Action TD1105

3rd Management Committee Meeting

Barcelona, Spain, 21st June 2013

Outline

- Company Introduction
- Automotive Air Quality Sensors

→ Company Introduction

- Automotive Air Quality Sensors

Company Introduction

- Microchemical Systems: Founded in 1998
- SGX Sensortech: Established in 2012



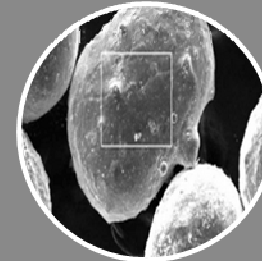
Pioneering sensor and detector technology



**Industrial
Safety**



**Environmental
Monitoring**



**Material
Analysis**



Company Introduction

Industrial



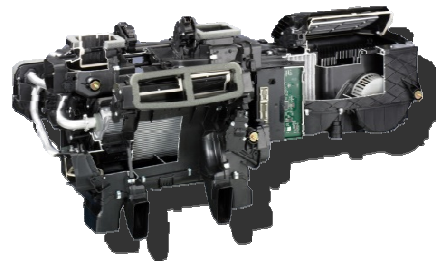
Portable
Gas
Detector



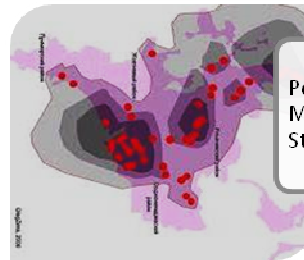
Automotive



Car HVAC
System



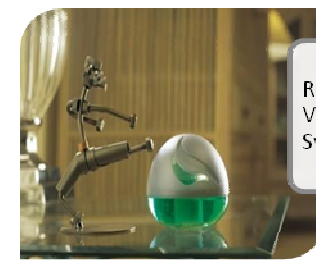
Environmental



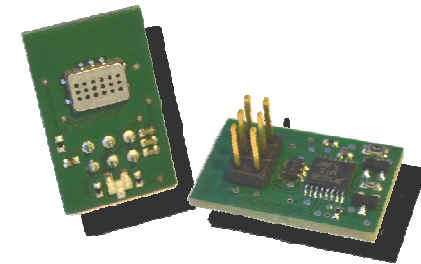
Pollution
Monitoring
Station



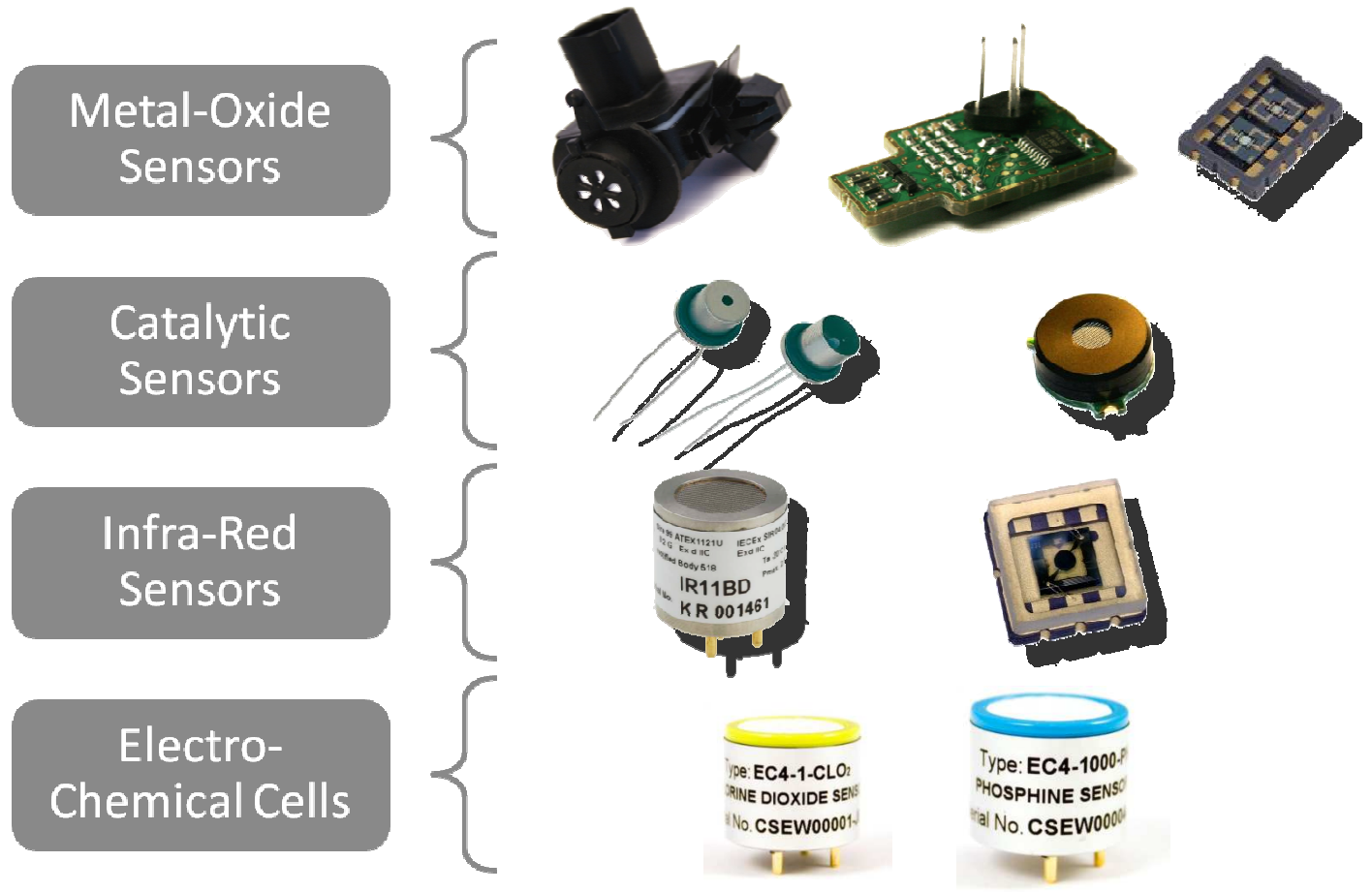
Consumer



Room
Ventilation
System



Company Introduction



Company Introduction

Infra-Red

Catalytic

Thermal

Electro-Chemical

Metal-Oxide

“The right sensor technology for the job”

Company Introduction

Infra-Red

Catalytic

Thermal

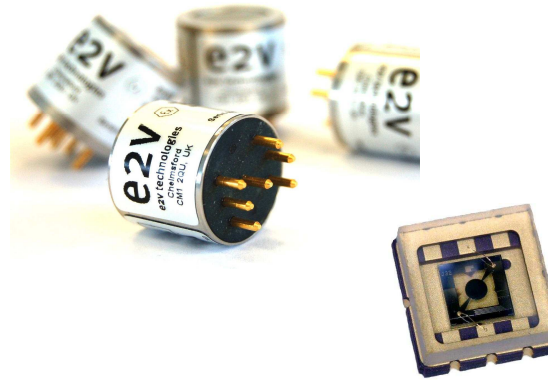
Electro-Chemical

Metal-Oxide

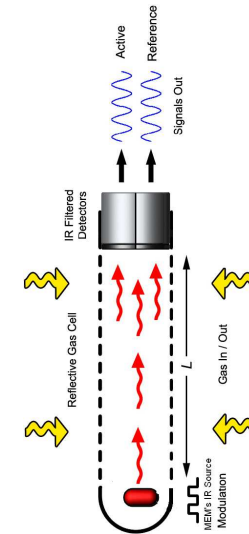
Gases

- CO₂, carbon dioxide
- C₂H₆O, ethanol
- HC, hydrocarbons
- NH₃

Products



Method

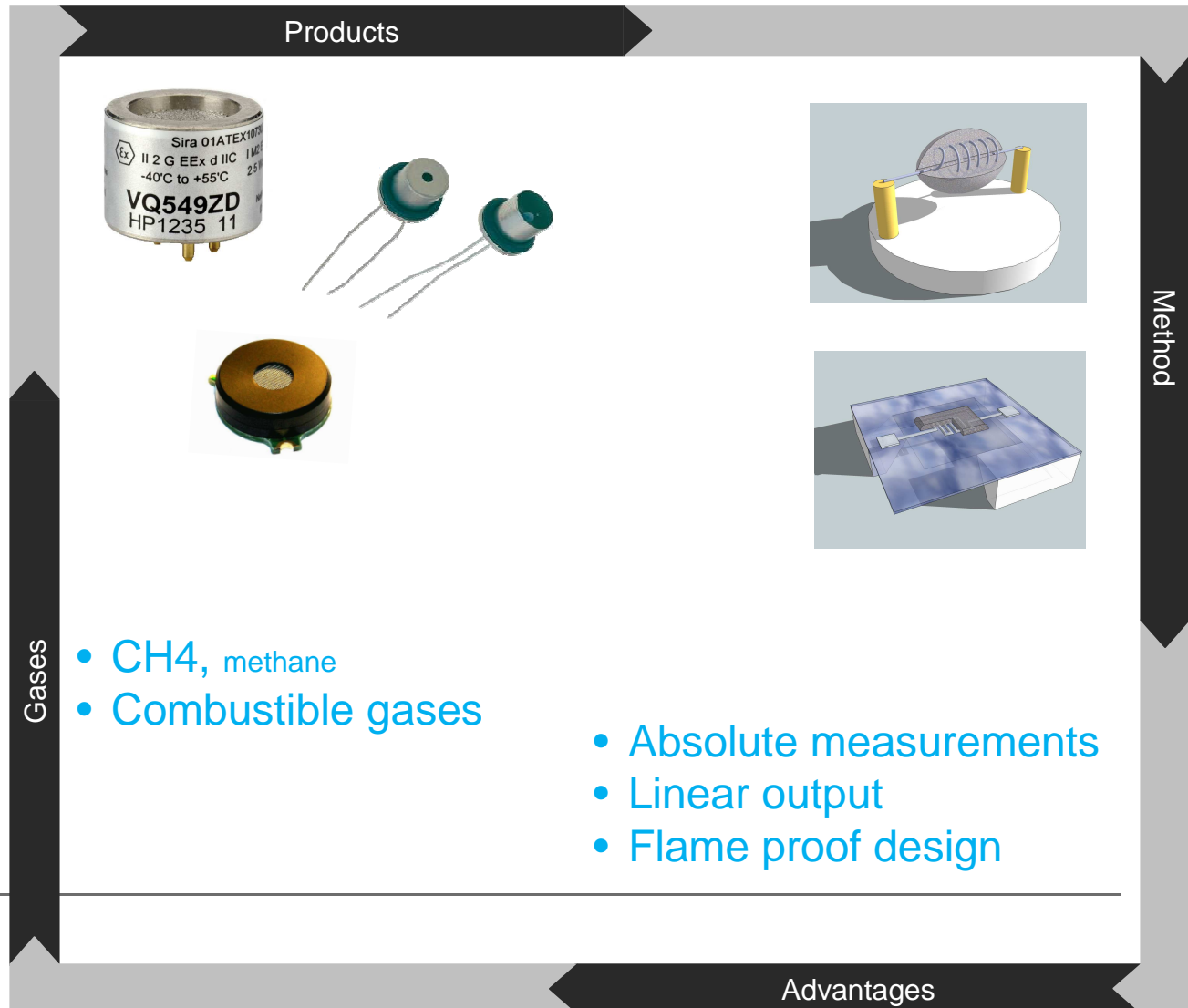


- Absolute measurements
- Selective gas detection
- Fail safe

Advantages

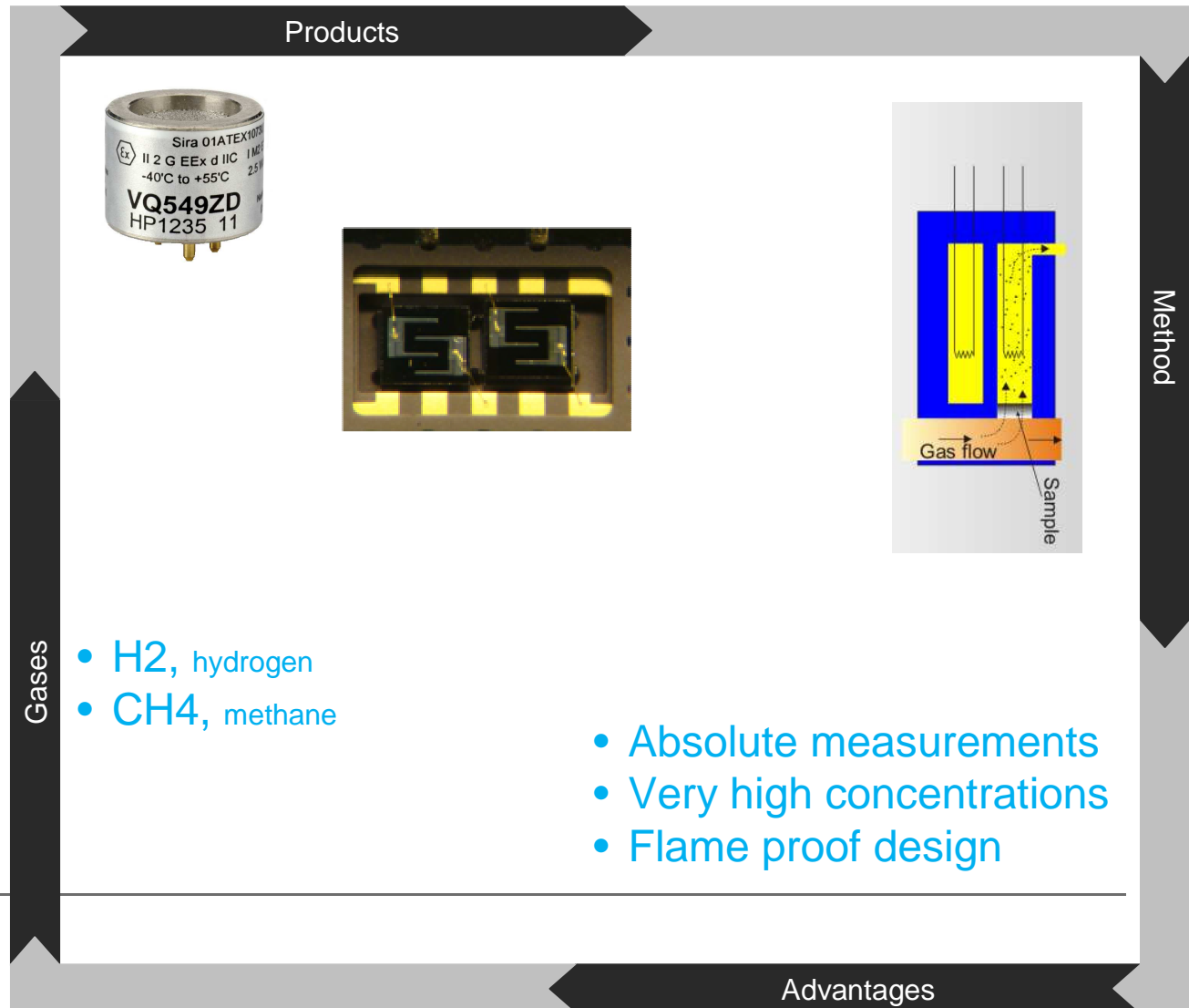
Company Introduction

Infra-Red
Catalytic
Thermal
Electro-Chemical
Metal-Oxide



Company Introduction

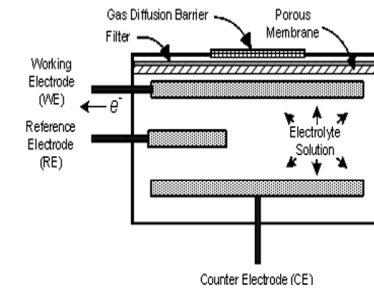
- Infra-Red
- Catalytic
- Thermal**
- Electro-Chemical
- Metal-Oxide



Company Introduction

- Infra-Red
- Catalytic
- Thermal
- Electro-Chemical**
- Metal-Oxide

Products



Method

Gases

- O₂, oxygen
- CO, carbon monoxide
- ClO₂, chlorine dioxide
- NO_x, nitrogen oxides
- SO_x, sulfur oxides
- H₂S, hydrogen sulfide
- PH₃, phosphine

- Absolute measurements
- Low power consumption
- Wide range of gases

Advantages

Company Introduction

Infra-Red

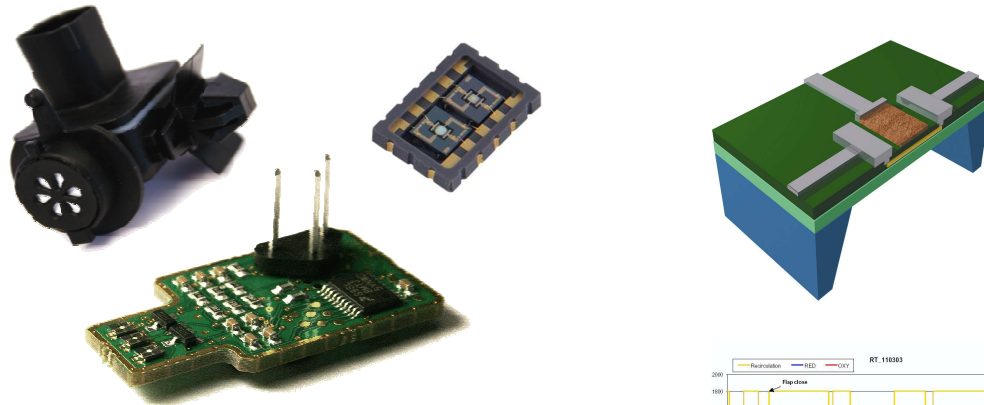
Catalytic

Thermal

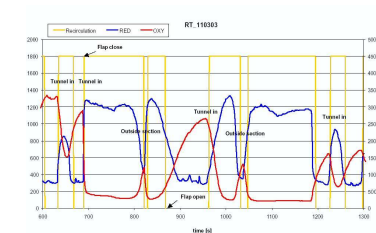
Electro-Chemical

Metal-Oxide

Products



- VOC, volatile organic compounds
- HC, hydrocarbons
- CO, carbon monoxide
- NO2, nitrogen dioxide
- NH3, ammonia
- O3, ozone



- High sensitivity
- Low cost
- Intelligent algorithms

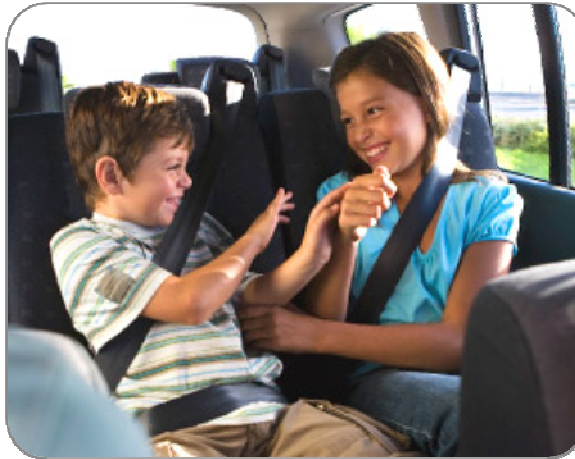
Gases

Method

Advantages

-
- Company Introduction
 - ➔ Automotive Air Quality Sensors

Automotive Air Quality Sensors



protecting people's health with smart gas sensors

Automotive Air Quality Sensors

Some numbers...

Automotive Air Quality Sensors

Some numbers...

It is estimated that over **1 billion** passenger cars travel the streets and roads of the world today.



Automotive Air Quality Sensors

Some numbers...

In 2012 more than **60 millions** of cars produced in the world
1 out of 4 cars is produced in China



Automotive Air Quality Sensors

Some numbers...

Research has shown that pollen and harmful substances inside a vehicle can be up to **6 times** more concentrated than outside.



Automotive Air Quality Sensors

Some numbers...

Research has shown that pollen and harmful substances inside a vehicle can be up to **6 times** more concentrated than outside of car cabin.

Typical Ratios of Average Concentrations to Background Levels by Mode

Pollutant	Pedestrians/Cyclists	Bus Users	Car Users
VOCs	2	3-4	4-6
Carbon Monoxide	2-2.5	3-4	4-5
Nitrogen Dioxide	1.5-2	2	3
Particulates	Some elevation - figures uncertain		

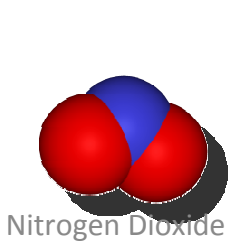
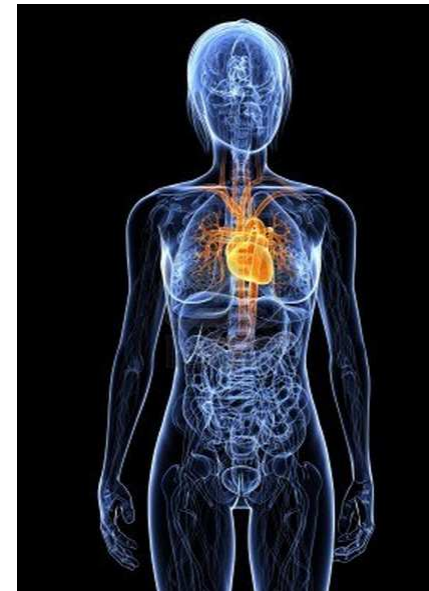
Automotive Air Quality Sensors

Pollutants present on the road (exhaust fumes) are mainly:

- Benzene
- 1,3 butadiene
- Carbon monoxide
- Lead
- NO₂
- PM₁₀
- SO₂
- Ozone (O₃)
- NO_x
- Polycyclic aromatic hydrocarbons.



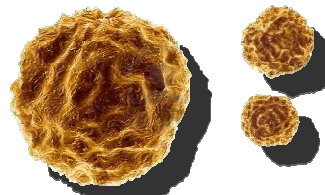
Automotive Air Quality Sensors



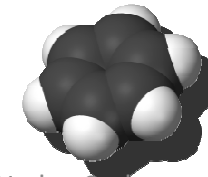
Nitrogen Dioxide



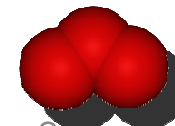
Carbon Monoxide



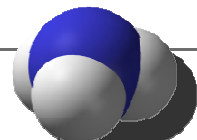
Particulate Matter



Hydro Carbons



Ozone



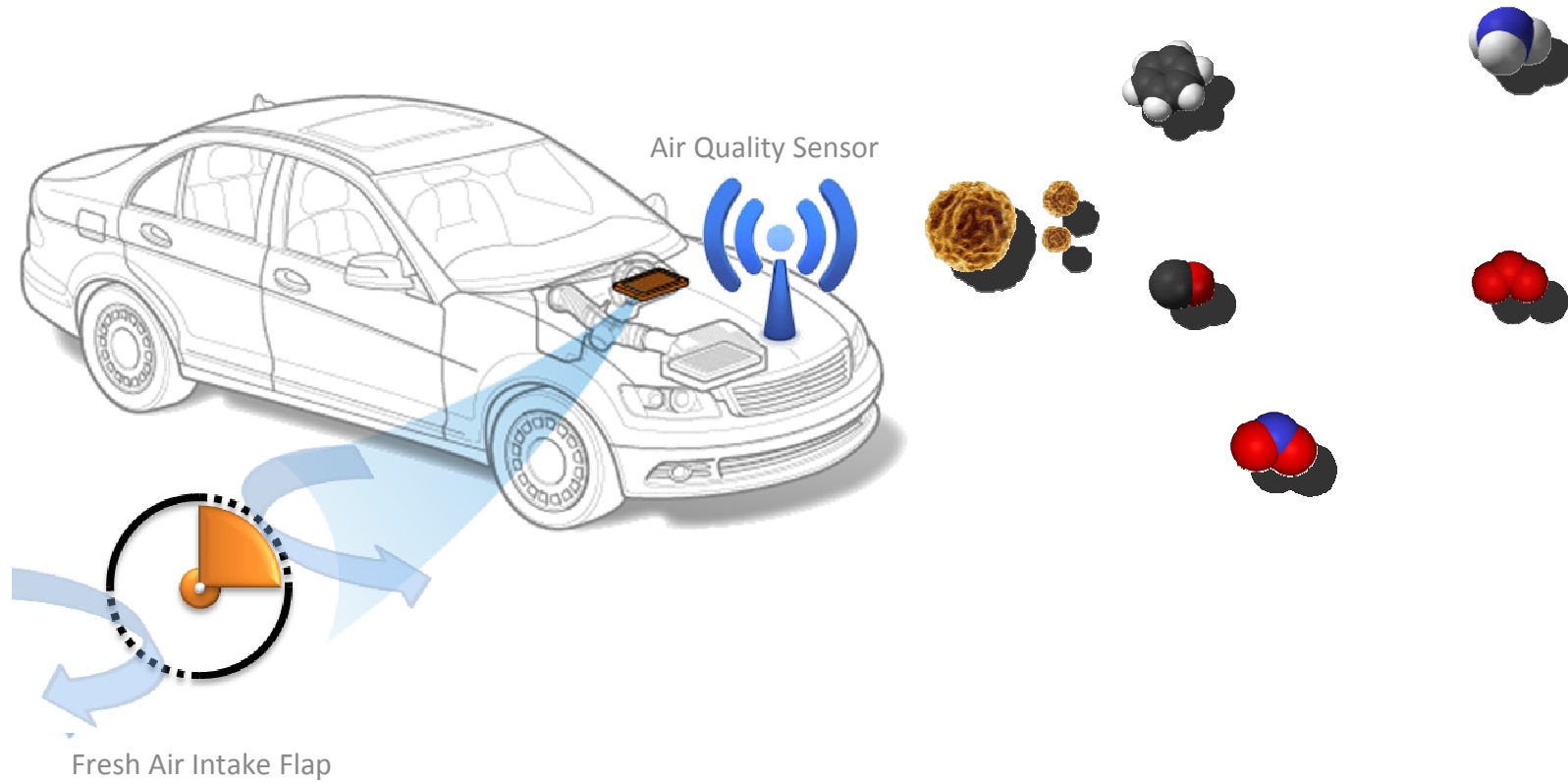
Ammonia

Automotive Air Quality Sensors

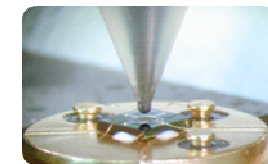
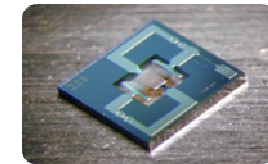
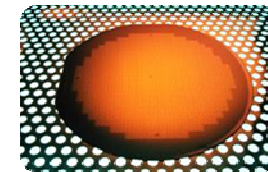
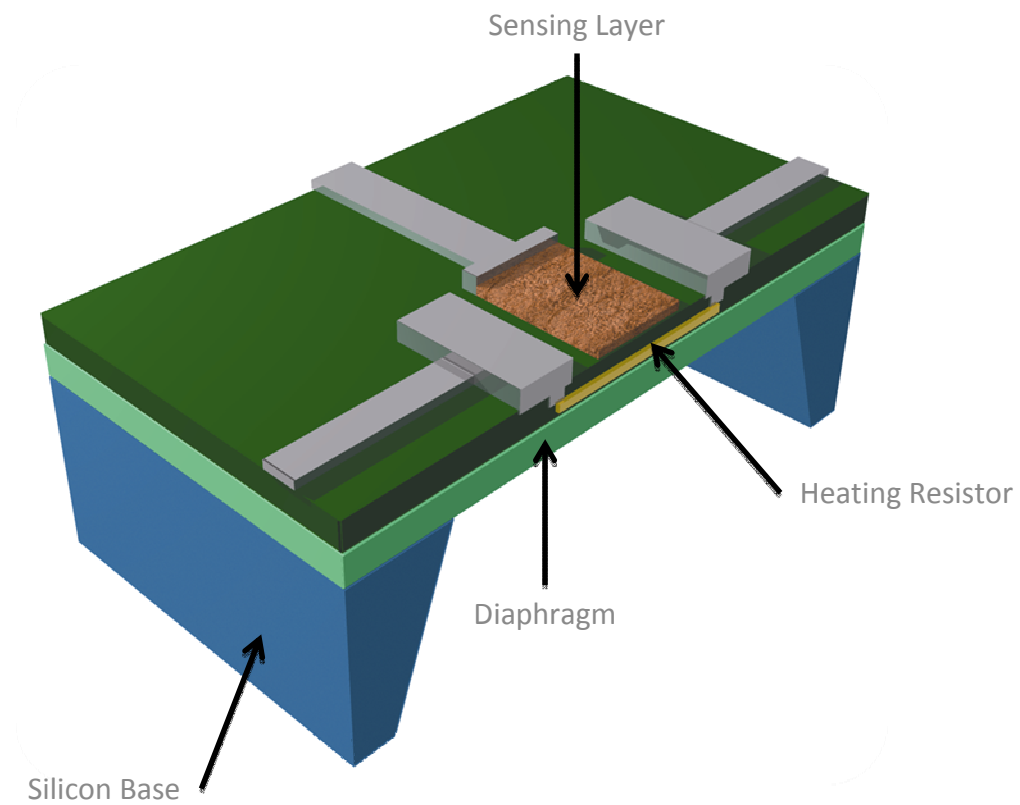
Car evolution and R&D to increase comfort feeling explain why around **10%** of produced cars are now equipped with Air Quality Sensors (AQS).



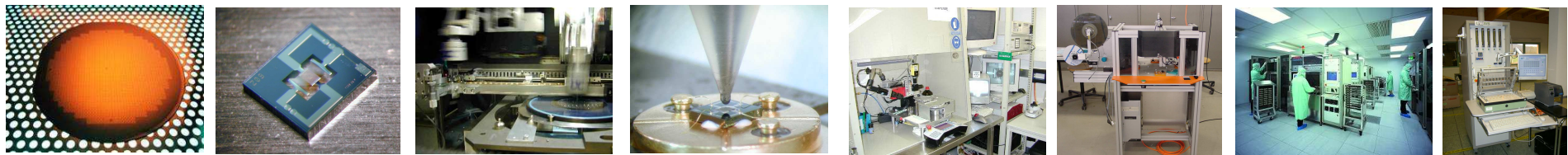
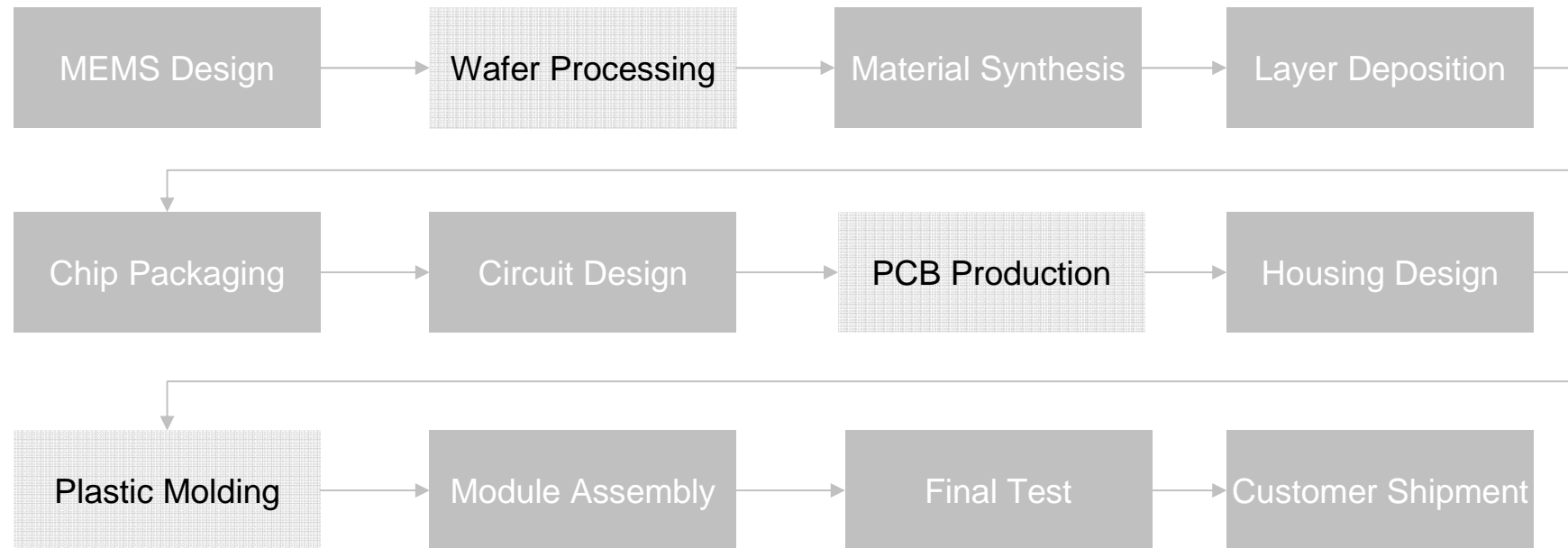
Automotive Air Quality Sensors



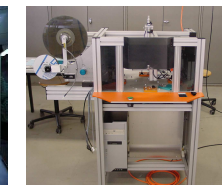
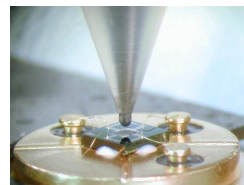
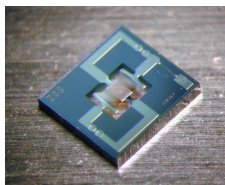
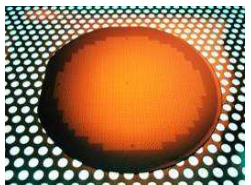
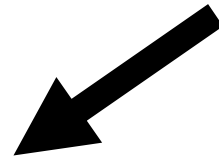
Automotive Air Quality Sensors



Automotive Air Quality Sensors



Automotive Air Quality Sensors



Automotive Air Quality Sensors

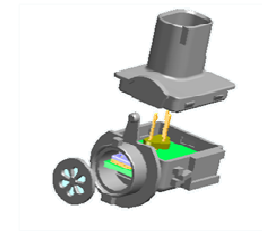
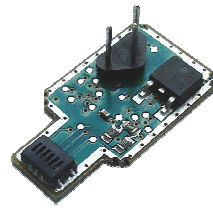
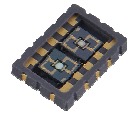
Customers and development partners...



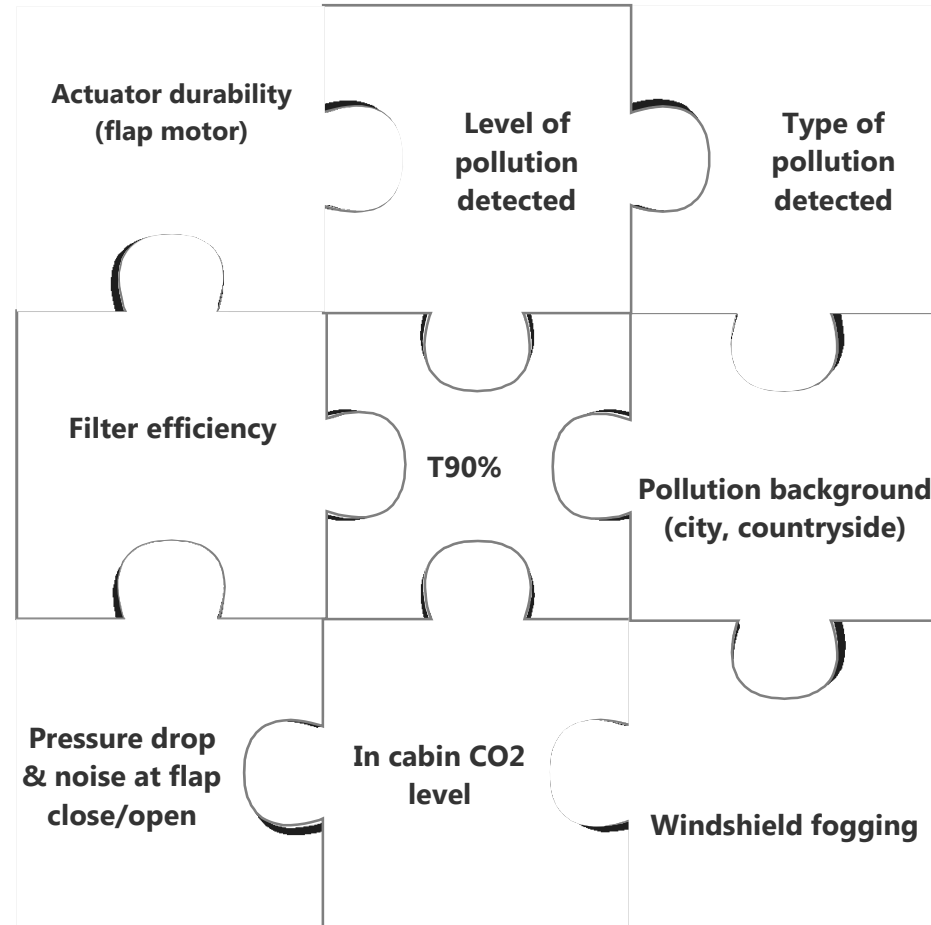
Automotive Air Quality Sensors

Key characteristics

- Sensitivity (low detection level)
- Selectivity
- Stability
- Response time
- Reproducibility
- Lifetime
- IP6K6K



Automotive Air Quality Sensors



Automotive Air Quality Sensors

Pollutants	ATMO level 2	ATMO level 5	ATMO level 9
NO2	40 µg/m3	110 µg/m3	275 µg/m3
SO2	40 µg/m3	160 µg/m3	300 µg/m3
O3	30 µg/m3	105 µg/m3	180 µg/m3
Particles	10 µg/m3	40 µg/m3	100 µg/m3

ATMO level 1-2: very clean
ATMO level 3-4: clean
ATMO level 5: average
ATMO level 6: mediocre
ATMO level 7-9: polluted
ATMO level 10: very polluted

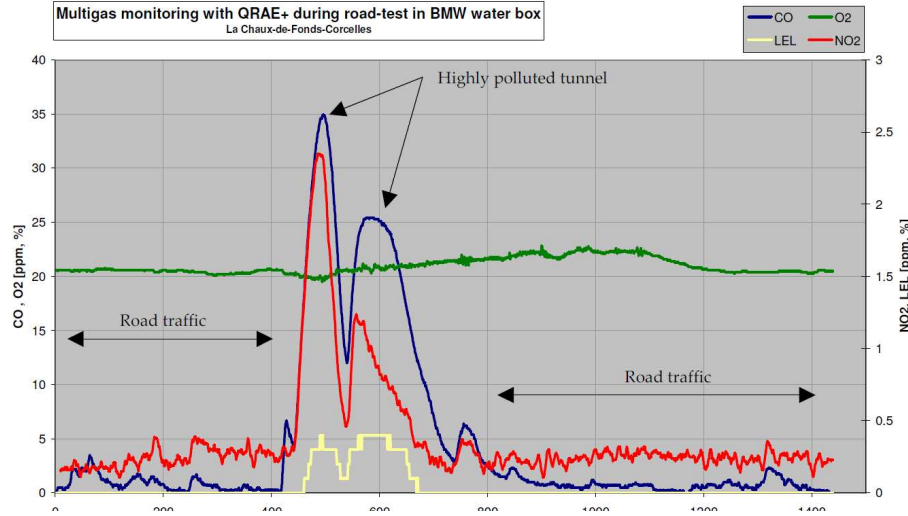
- Dispersion of base resistance
- Dispersion of base sensitivity
- Variation of resistance with T&RH
- Variation of resistance over time

~~Need for initial and periodic calibration > difficult, costly~~

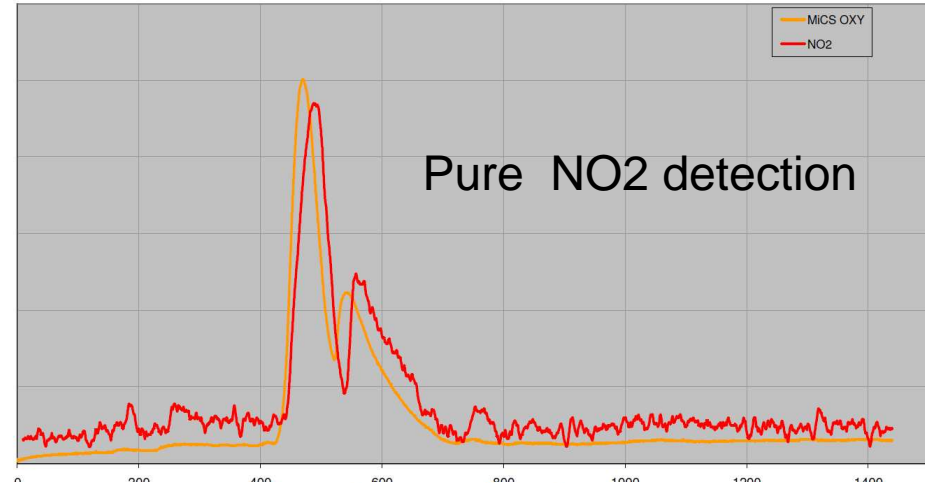
Need for fast detection of pollution peak, not absolute measurement

Automotive Air Quality Sensors

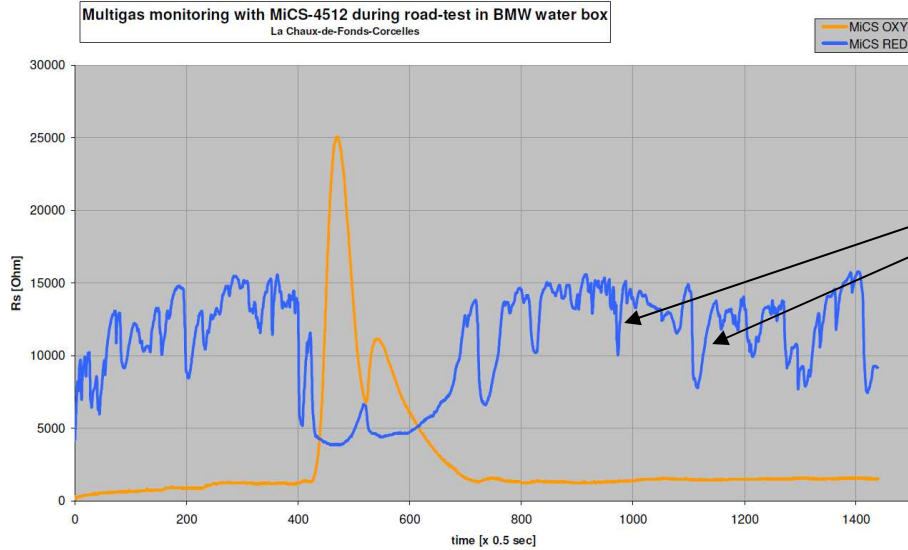
Multigas monitoring with QRAE+ during road-test in BMW water box
La Chaux-de-Fonds-Corcelles



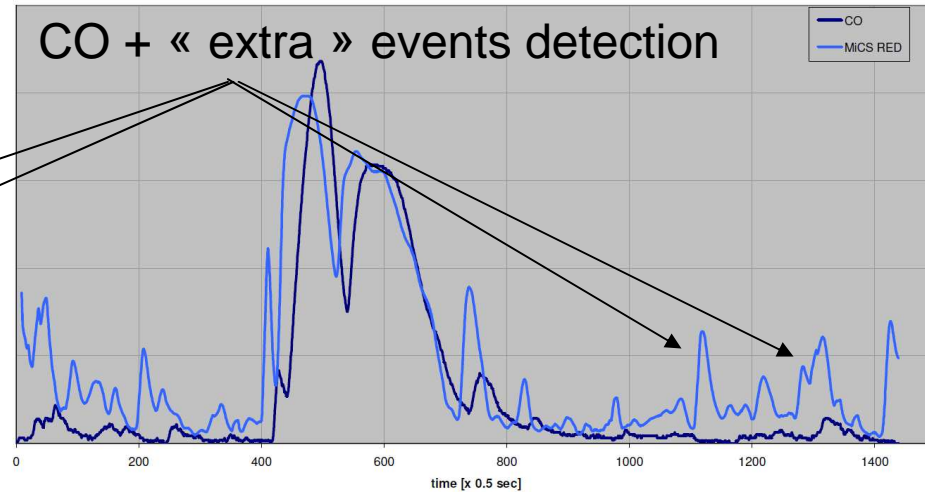
NO2 measurement vs MiCS OXY sensor



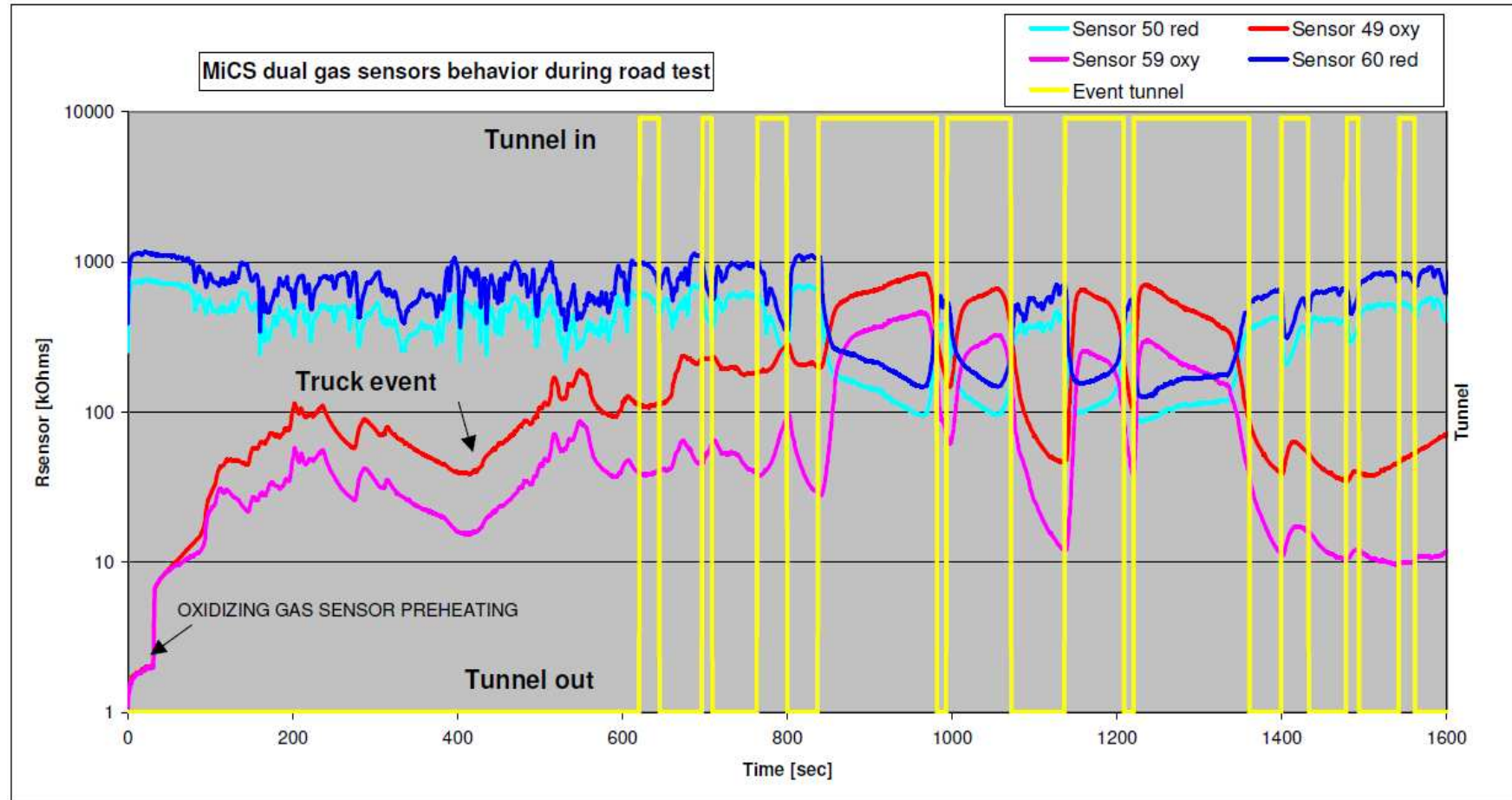
Multigas monitoring with MiCS-4512 during road-test in BMW water box
La Chaux-de-Fonds-Corcelles



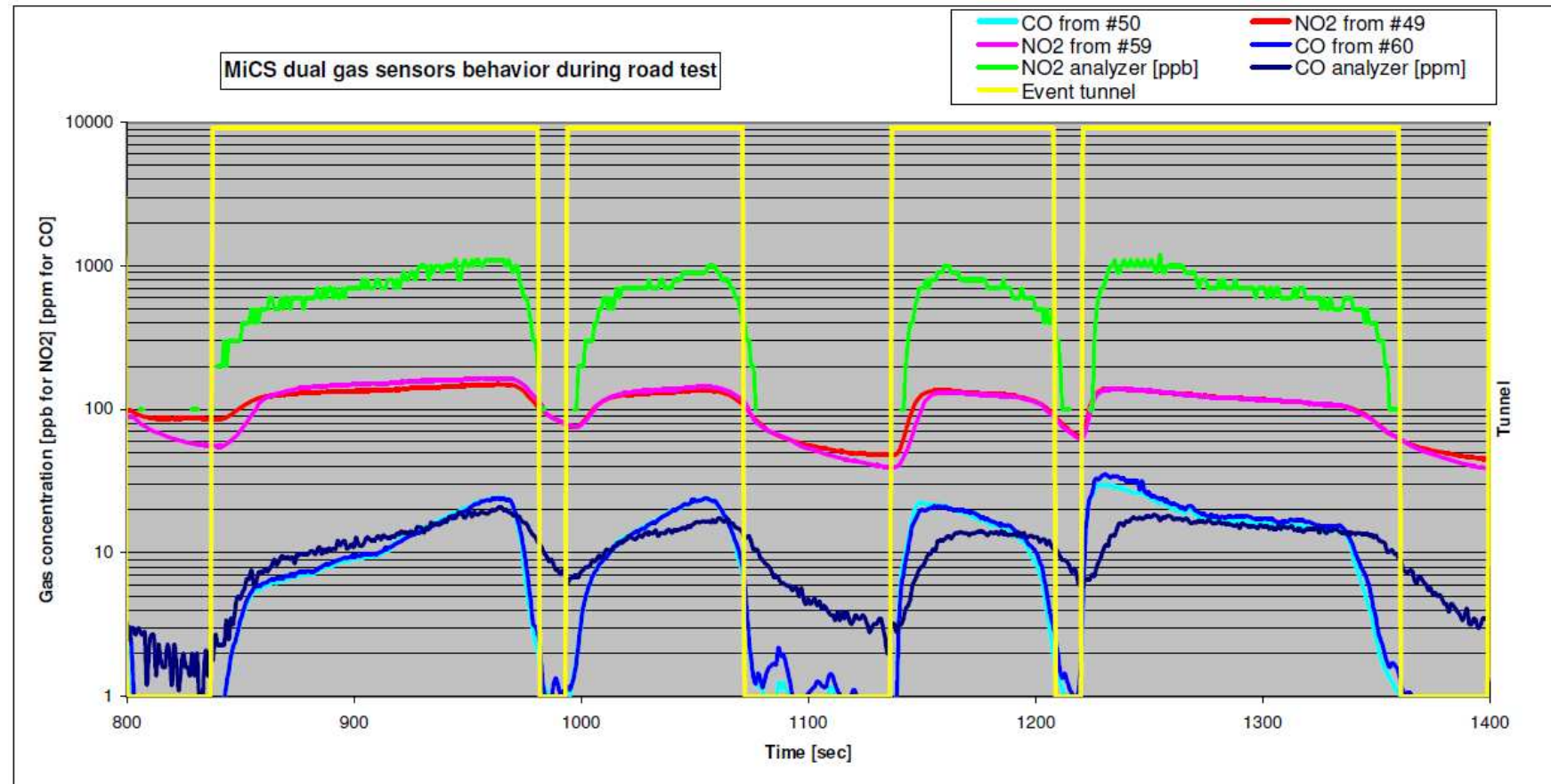
CO measurement vs MiCS RED sensor



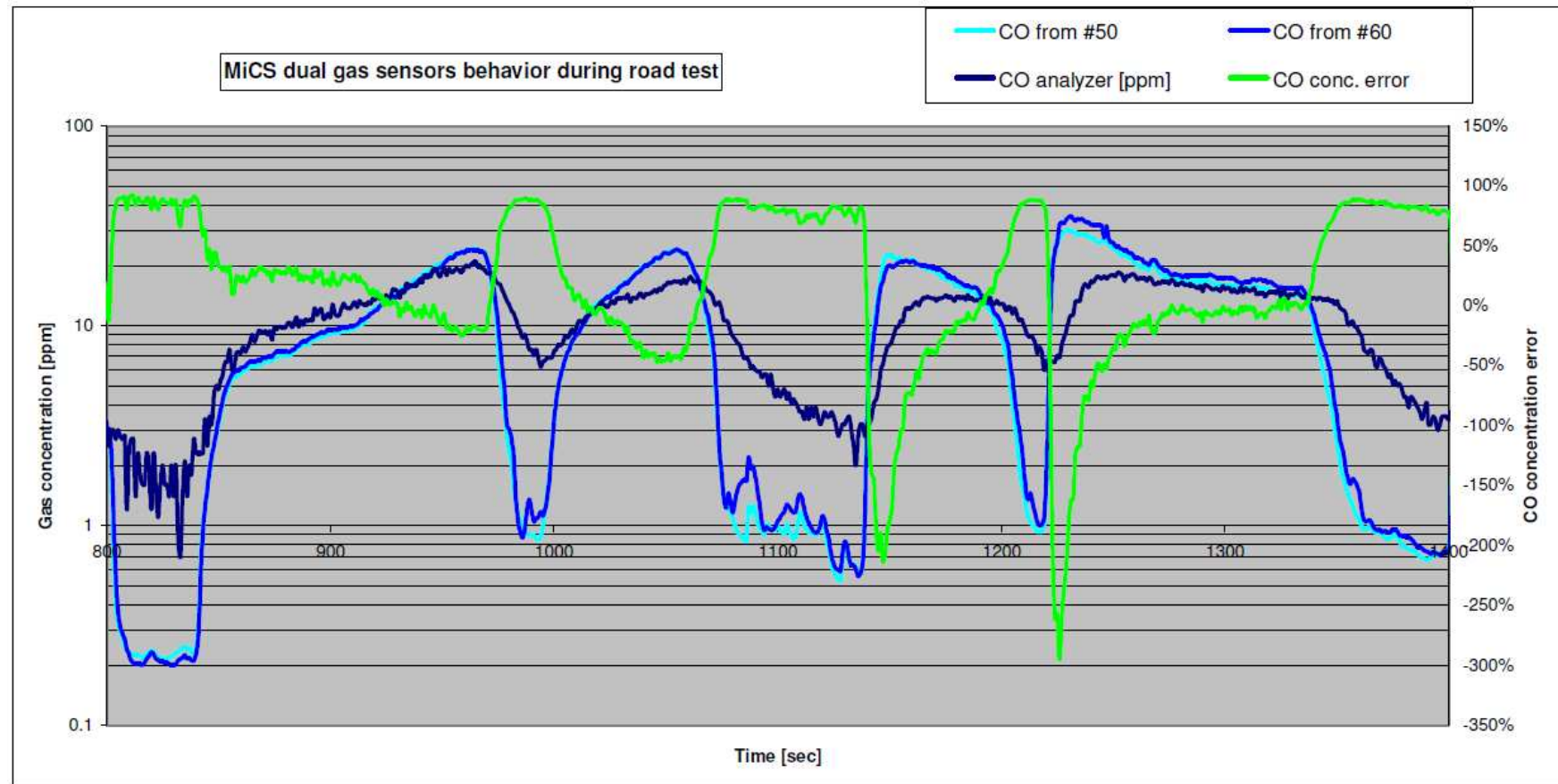
Automotive Air Quality Sensors



Automotive Air Quality Sensors



Automotive Air Quality Sensors



Automotive Air Quality Sensors

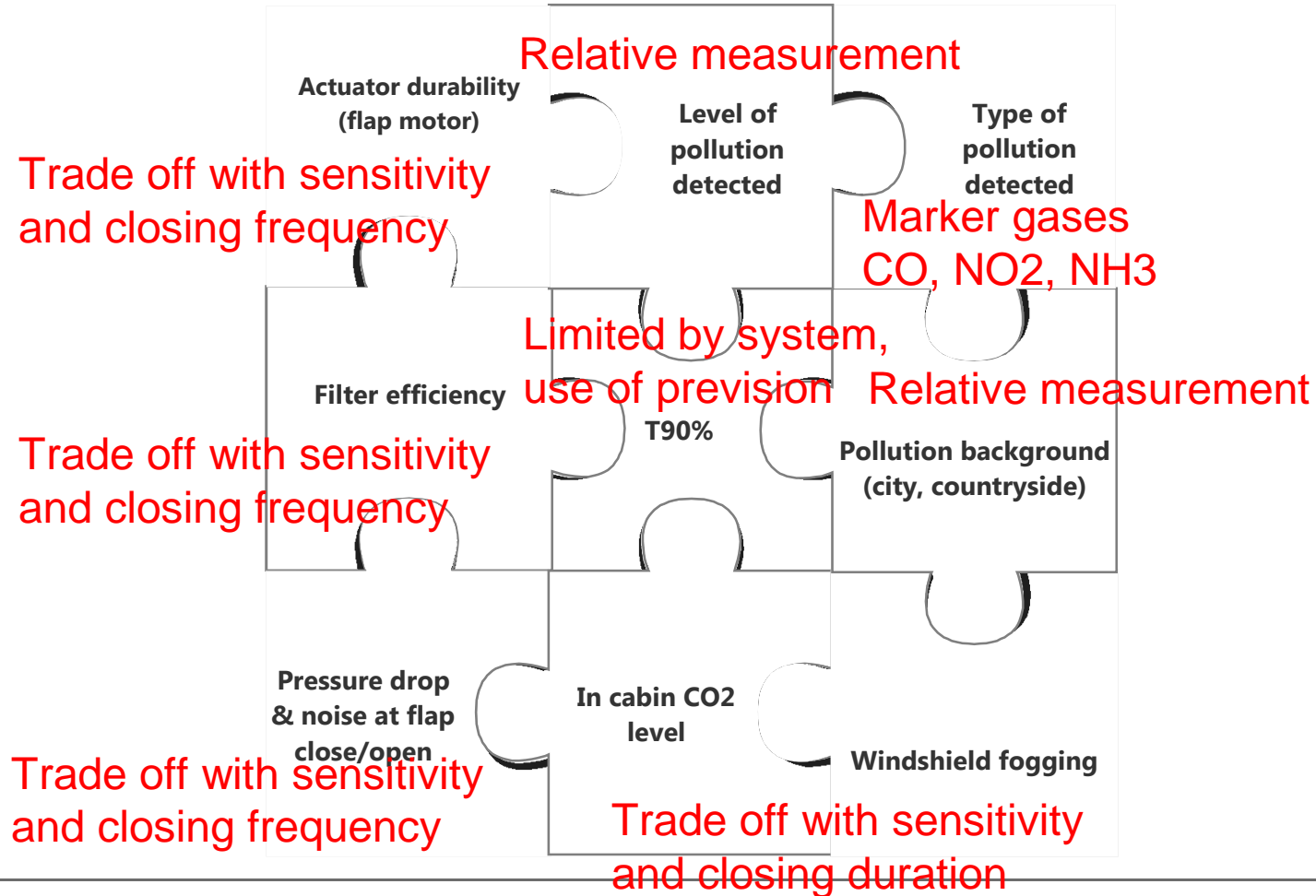
Pollution level calculation

Pollution levels are calculated by using relative changes of sensor signal compared to a moving average reference.

AQS algorithms take part of manufacturer know-how and have been optimized based on a large amount of field tests.

These algorithm parameters are adapted during final road test with car manufacturer to fit with HVAC control unit and comfort definition level.

Automotive Air Quality Sensors



Automotive Air Quality Sensors

Key characteristics

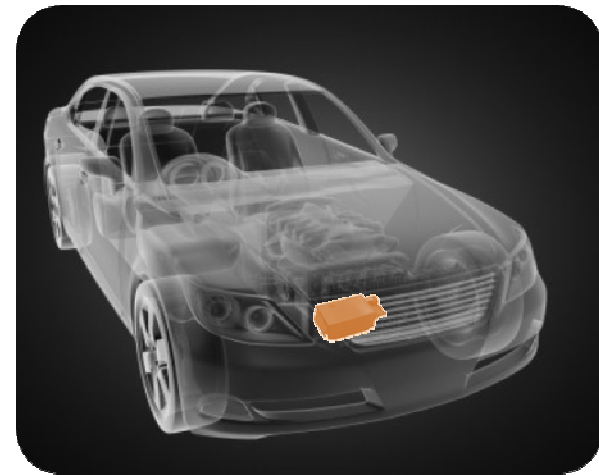
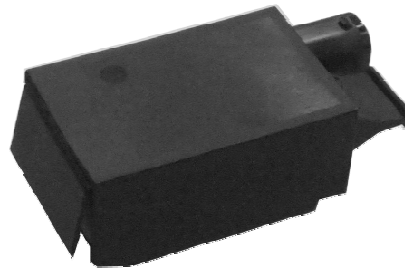
- Sensitivity OK with use of relative change
- Selectivity OK maximum of events to be detected
- Stability OK with use of relative change

- Response time OK with use of relative change
- Reproducibility OK with use of relative change

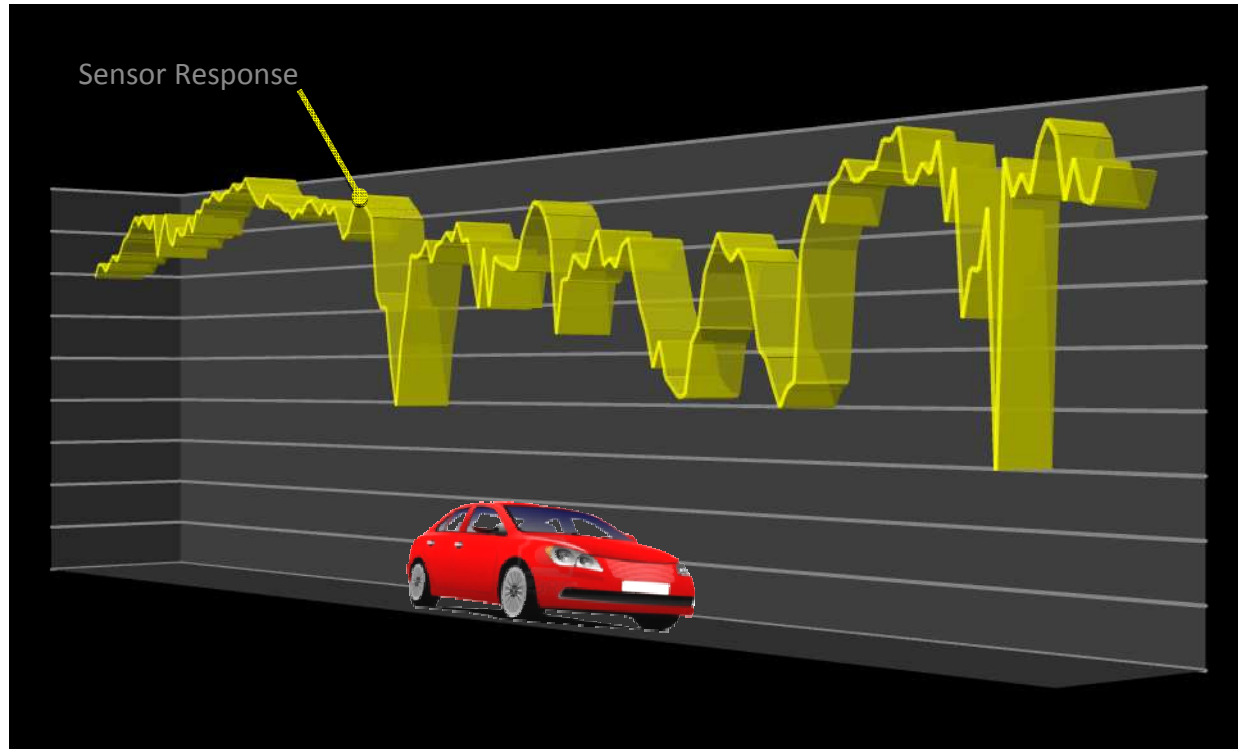
- Lifetime OK, 6000 hours over 10 years
- IP6K6K OK by design

Automotive Air Quality Sensors

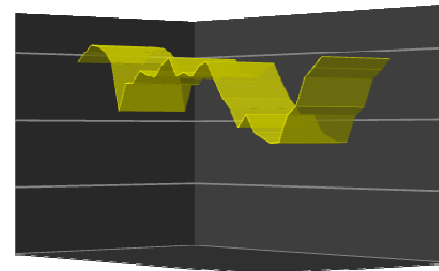
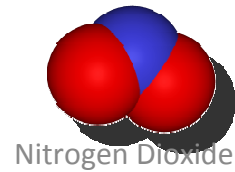
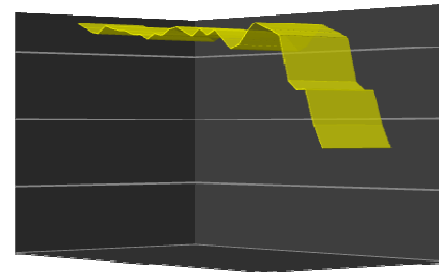
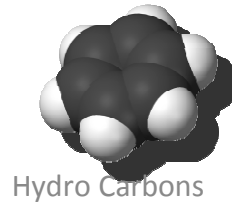
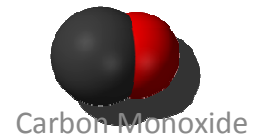
Single Gas Sensor



Automotive Air Quality Sensors



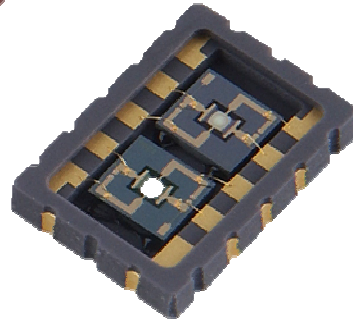
Automotive Air Quality Sensors



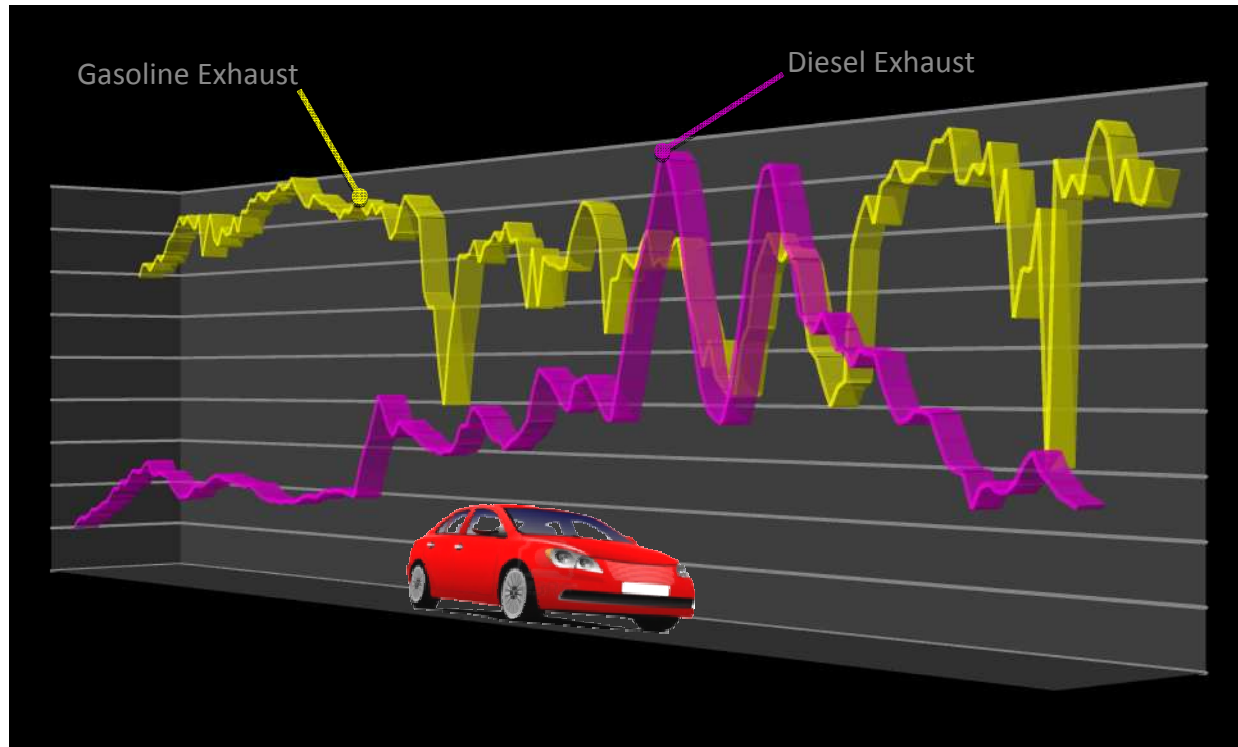
Automotive Air Quality Sensors



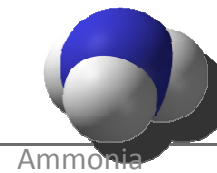
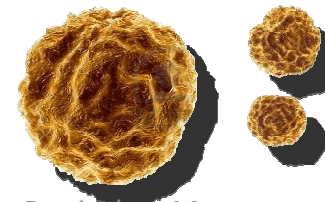
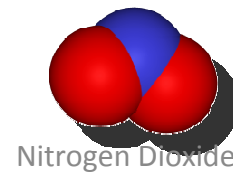
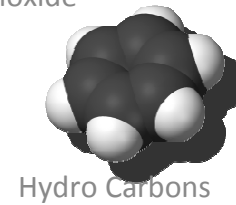
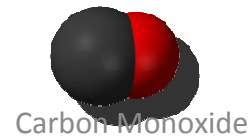
Dual Gas Sensor



Automotive Air Quality Sensors

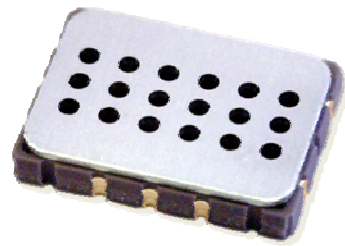
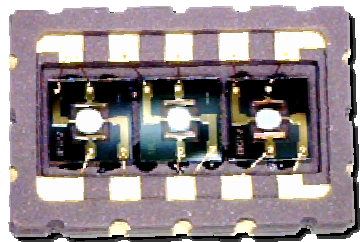


Automotive Air Quality Sensors

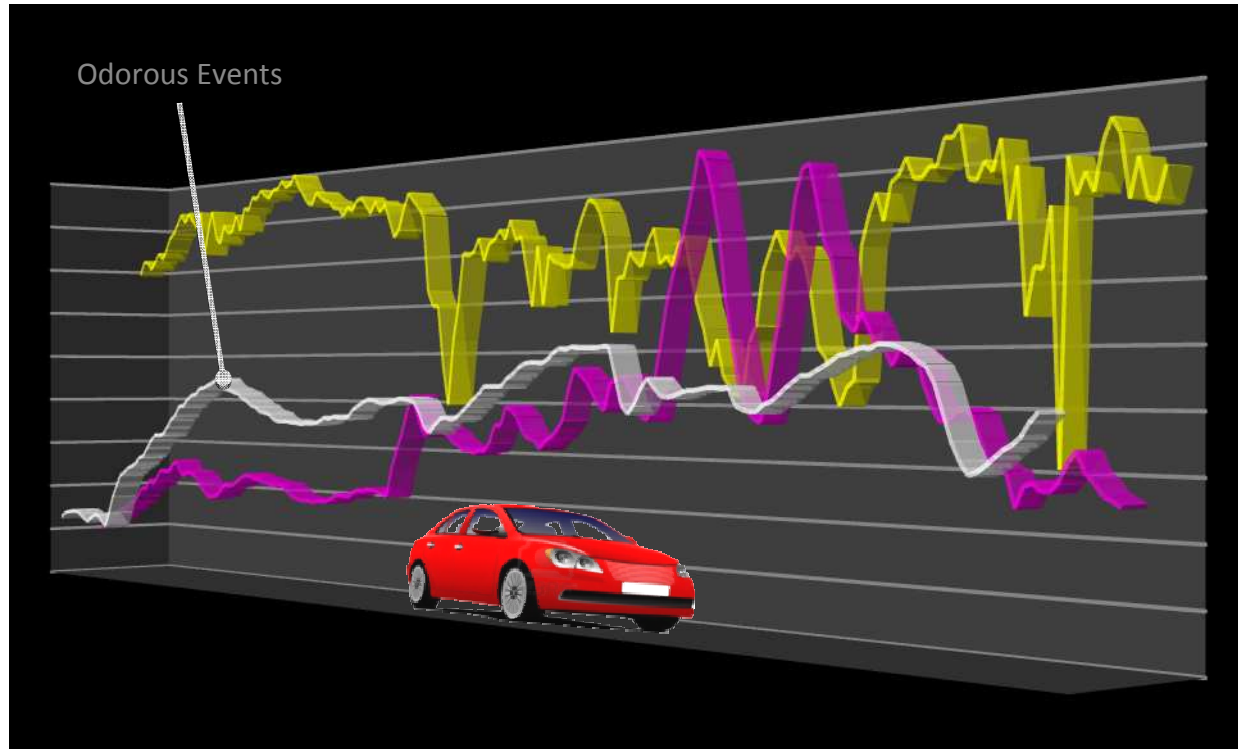


Automotive Air Quality Sensors

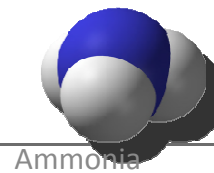
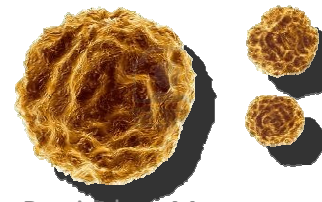
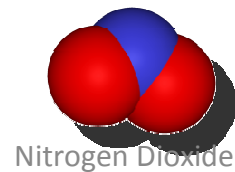
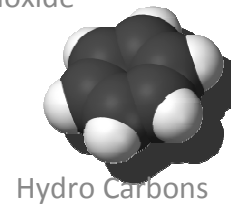
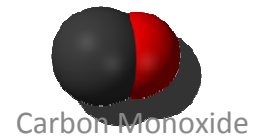
Triple Gas Sensor



Automotive Air Quality Sensors



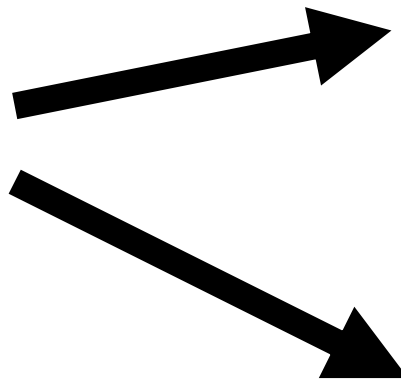
Automotive Air Quality Sensors



Automotive Air Quality Sensors

NEXT....

SGX Sensortech has developed a very small MEMS sensor (5 x 5 mm) that can be integrated into compact electronics (roof or HVAC control panel) to sense cigarette smoke and other odours and activate cabin filtration (interior plasma filter) or fresh air flow.

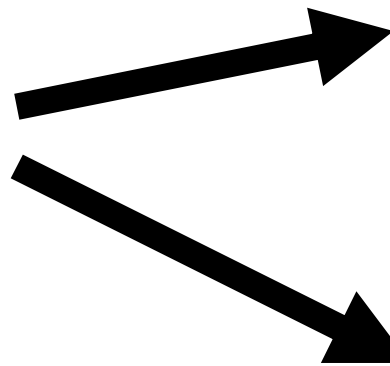
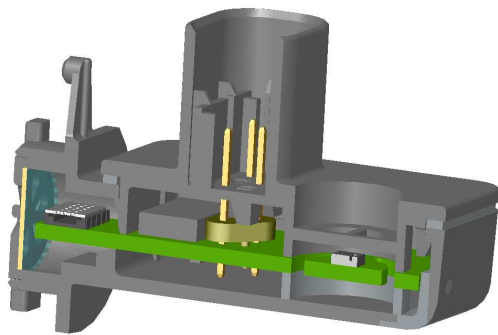


Automotive Air Quality Sensors

NEXT....

New version of triple sensor AQS (CO, NO₂, NH₃) combined with T&RH sensor.

1. Use of dew point information to optimize HVAC compressor control and therefore reduce fuel consumption.
2. Combined sensor (less components).



Fuel reduction



Less components



Automotive Air Quality Sensors

SUMMARY

1. AQS allows reducing car users exposure to harmful gases (road test done by car manufacturers with analyzers in/out car cabin showed > 80% reduction of **pollution peaks** entering in the cabin.

Automotive Air Quality Sensors

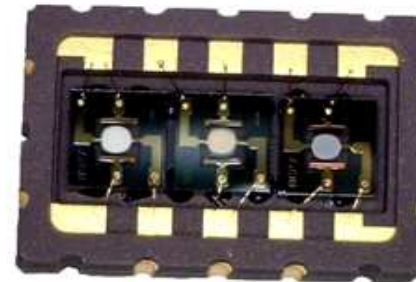
SUMMARY

1. AQS allows reducing car users exposure to harmful gases (road test done by car manufacturers with analyzers in/out car cabin showed > 80% reduction of **pollution peaks** entering in the cabin.
2. **Low cost metal-oxide gas sensors** are well adapted to **pollution peak detection** automotive application (high sensitivity, low response time)

Automotive Air Quality Sensors

SUMMARY

1. AQS allows reducing car users exposure to harmful gases (road test done by car manufacturers with analyzers in/out car cabin showed > 80% reduction of **pollution peaks** entering in the cabin.
2. Low cost **metal-oxide** gas sensors are well adapted to **pollution peak detection** automotive application (high sensitivity, low response time)
3. Use of **multichip** with independent heaters and specific sensing layer and operating temperature allows to **increase the type of pollution events detected** (comfort enhancement).



Thank you for your attention



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