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VIAQ-19-06

FUTURE INTERIOR AIR QUALITY MONITORING SYSTEMS

A REAL TIME TOOL TO MONITOR ONBOARD AIR QUALITY

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Public

AGENDA

1 AQS (“AIR QUALITY SENSOR”) CONCEPT

2 USE CASES

3 THE PROJECT

4 “STAGE 4” OPEN POINTS

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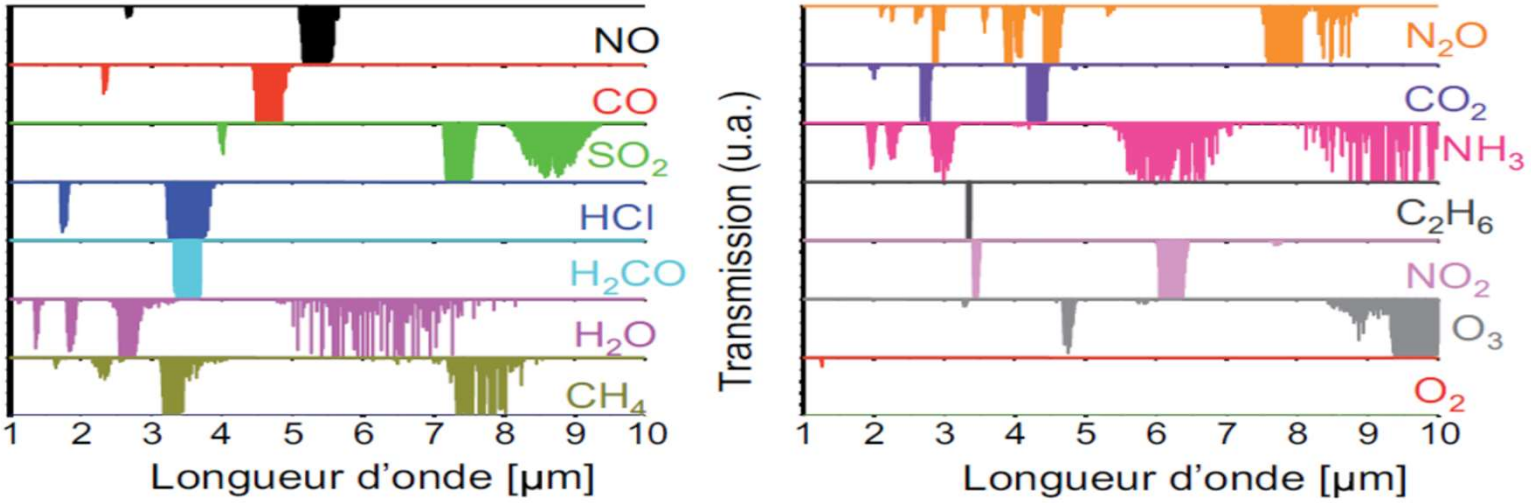
THE CONCEPT

Optical spectroscopy

- ✓ molecular absorption spectroscopy based on Beer Lamber law
- ✓ absorption bands specific to target gas

Mid Infrared range (from 2.5um)

- ✓ relies on molecule “fundamental” vibration
- ✓ exhibits strongest absorption level: X10 to X100 vs NIR



✓Multi gas measurement capabilities

✓Specific measurement: system optical design / concept related

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TARGET SPECIFICATION (ANALYTICS)

Gas	Range		Sensitivity (LLD)	Accuracy
CO (ppm)	2	500	2	+-1
CO2 (ppm)*	250	15000	250	+-125
NO2 (ppb)	20	400	20	+-10
NO (ppb)	20	800	20	+-10
Formaldéhyde (ppb)	40	500	40	+-20
O3 (ppb)	30	150	30	+-15
H20* (%)	0.1	5	0.1	TBD

*: Absolute concentration

LLD: Lower Limit of Detection

✓**Sensitivity values derived from Health WW recommendation related to long term exposure (1 year)**

✓***: VITESCO suggestion**

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TARGET SPECIFICATION (ANALYTICS) JUSTIFICATION

Air quality guideline values

Pollutant	Air inside a vehicle	Air in populated areas											
	GOST 33554-2015*	RF*		WHO*		EU*		USA*	Korea*		
NO_2, µg/m³	200	200	40	200	40	200	40	100	190	110	57
NO, µg/m³	400	400	60	undefined		undefined		undefined	undefined		
PM_{10}, µg/m³	undefined	300	60	50	20	50	40	150	100	50	
$PM_{2,5}$, µg/m³	undefined	160	35	25	10	20		35	50	25	
O_3, µg/m³	undefined	160	30	100		120		140	200	120	
CO, mg/m³	5	5	3	undefined		10		41	11	29	10
SO_2, µg/m³	undefined	500	50	500	20	350	125	200	400	130	53
VOC CH_2O, µg/m³	50	50	10	undefined		undefined		undefined	undefined		
Benzene, µg/m³	undefined	300	100	undefined		5		undefined	5		

*Exposure time	10 minutes	30 minutes	1 hour	8 hours	24 hours	1 year

Short term

Long term

✓From VIAQ 8th: still valid or to be updated? Agreed within automotive community?

✓Are those thresholds health and drowziness related?

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TARGET SPECIFICATION

Parameter	Number
Ambiant temperature	-40°C< T amb < +85°C
Relative Humidity	5%< H rel < 95%
Voltage	9V < V < 16.5V
Power	< 1W
Interface	LIN or CAN
Dimension	10cmX5cmX5cm
Response time	< 1s
Number of operating hours	10 000 H
Number of measurement	100 000
Lifespan	10 year

✓ **Consistant with onboard automotive application**

✓ **Power and response time are correlated to measurement accuracy and sensitivity**

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REASON / MOTIVATION

✓ Visible Trend in awareness of in cabin-air-quality

EMISSIONS ANALYTICS

✓ No reliable measurement to monitor and compute an AQI „Air Quality Index“

✓ Reliability means:
- ✓ Absolute
- ✓ Specific
- ✓ Sensitive

$$a_i = \left(\frac{MAC_{CO\,amb} \times MAC_{CO\,w.zone}}{MAC_{i\,amb} \times MAC_{i\,w.zone}} \right)^{\frac{1}{2}} = \sqrt{\frac{60}{(MAC_{i\,amb} \times MAC_{i\,w.zone})}}$$

✓ Opportunity to take care of both internal and external sources of pollution and adpat to pollution pattern

✓ Opportunity to combine onboard existing sensing functionality (CO2 + Humidity) together with extra measurement features (gaseous pollutants)

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HARMFULNESS DIFFERENTIATION

> Negative impact on:

Comfort / Safety

- How: Short term exposure
  - 10s to 1min
- Effects
  - Bad feeling
  - Impair driver cognitive skills, drowziness
  - Impair vision (windshield fogging)
- Relevant compounds / parameters:
  - CO2
  - CO
  - NO
  - O3
  - Relative Humidity (fogging)
  - Bad odors molecule (toluene, NH3 and others??)

Health

- How: Long term exposure and cumulative effect
  - Hours
- Effects:
  - Asthma
  - Cardio vascular disease
  - Cancer
  - Negative impact on central nervous system
- Relevant compounds:
  - CO2, CO, NO, O3
  - NO2
  - *PM2.5 and smaller*
  - Some VOC / HC (toluene, formaldehyde and others??)

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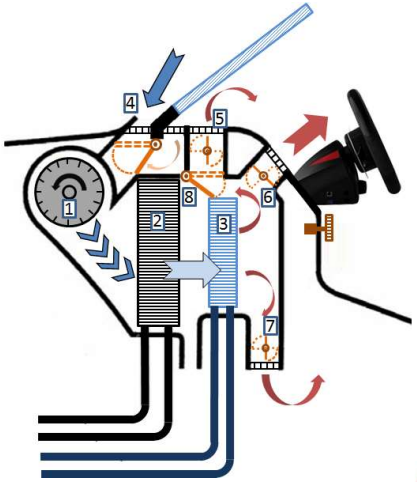
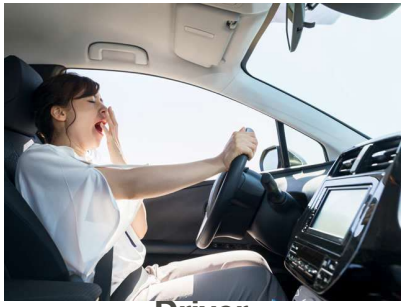
USE CASES

« WHY USING A MULTI GAS SENSOR ?»



HVAC
Control

Passenger /
Driver Health
Management



Driver
drowziness
management

Passanger
Comfort

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USE CASES

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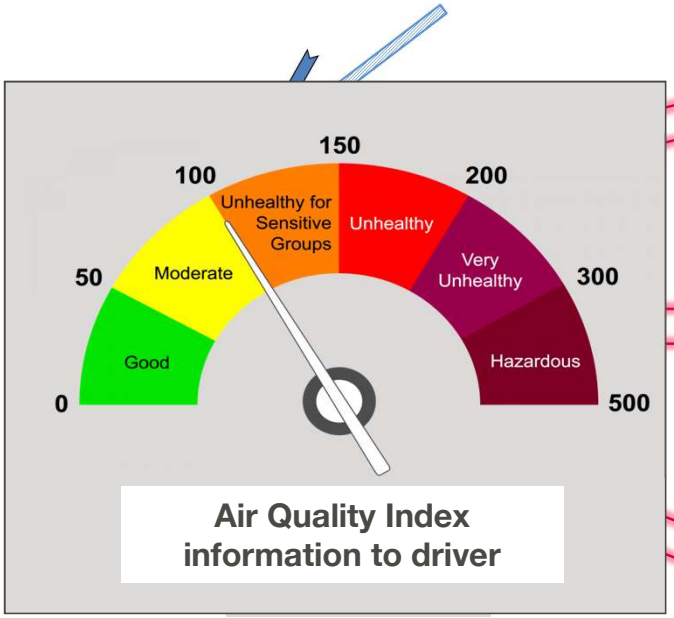

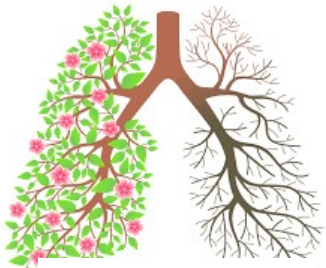

Passenger / Driver Health Management

Driver drowziness management

Passanger Comfort

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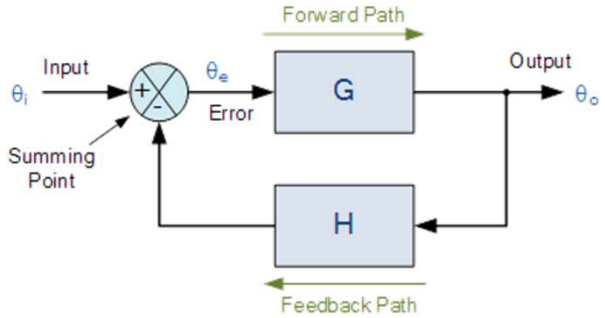
USE CASES: DETAILS (SUGGESTON)

« HOW USING A MULTI GAS SENSOR INFORMATION ?»

> Sensor information can be an **entry point** to close loop air cleaning devices (In cabin sensor):

- > Air fractional recirculation:
  - > Air Exchange Ratio (AER)
- > Purification devices:
  - > Ionizer
  - > Activated carbon filters
  - > Others ??



> **Close loop** on different output:

- > Air Quality Index « Health » related
- > Air Quality Index « Safety » related
- > Power consumption (HVAC):
  - > HVAC compressor load vs circulation mode type (fresh air / recirculation)

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USE CASES: DETAILS

« HOW USING A MULTI GAS SENSOR INFORMATION ?»

> Real time monitoring of air purification devices:

> Air filters (activated carbons and others ??):
> Efficiency (breakthrough)

> Ionizer:
> O_3 production

> Others: ??

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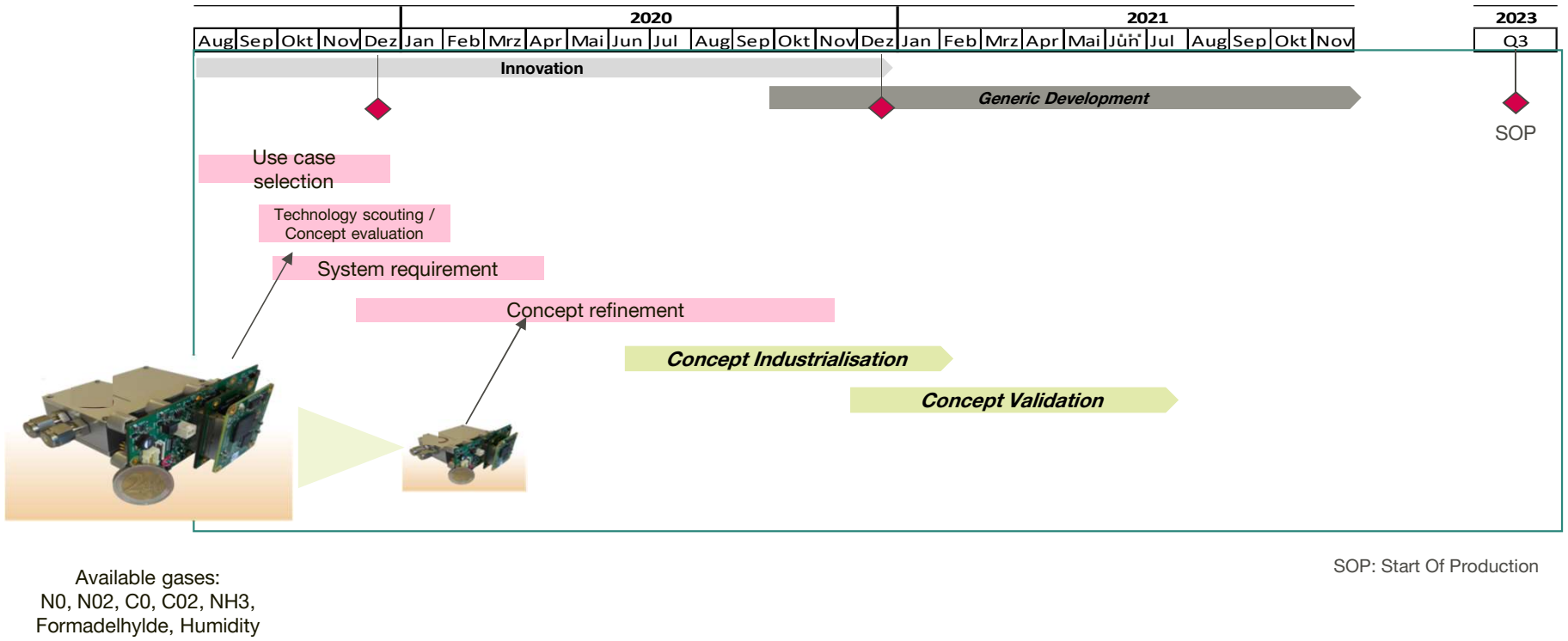
DEVELOPMENT SCHEDULE



Available gases:
N0, N02, C0, C02, NH3, Formadelhylde, Humidity

SOP: Start Of Production

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KEY QUESTIONS TO BE ADRESSED WITHIN STAGE4

> QUESTIONS ARE REQUESTED TO DRIVE SENSOR SPECIFICATION and DEVELOPMENT

> WHICH ARE THE MOST RELEVANT GASEOUS POLLUTANT TO BE CONTROLLED?

> WHICH ARE THE LOWEST CONCENTRATION TO BE CONTROLLED?

> DOES AQI (Air Quality Index) CALCULATION NEED TO BE UPDATED?

$$a_i = \left(\frac{MAC_{CO\,amb} \times MAC_{CO\,w.zone}}{MAC_{i\,amb} \times MAC_{i\,w.zone}} \right)^{\frac{1}{2}} = \sqrt{\frac{60}{(MAC_{i\,amb} \times MAC_{i\,w.zone})}}$$

> DOES AQI CALCULATION AGREED WITHIN SCIENTIFIC COMMUNITY AND BETWEEN VIAQ MEMBERS?

> IS AN AQI DIFFERENTIATION BETWEEN HEALTH AND COMFORT/SAFETY RELEVANT?

LET'S DISCUSS!

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