



PMI SCIENCE  
PHILIP MORRIS INTERNATIONAL

# Assessment of the total volatile organic compounds in indoor air during the use of a new heat-not-burn product

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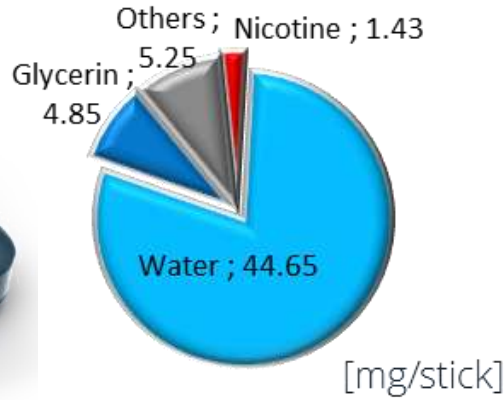
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Atmos'Fair

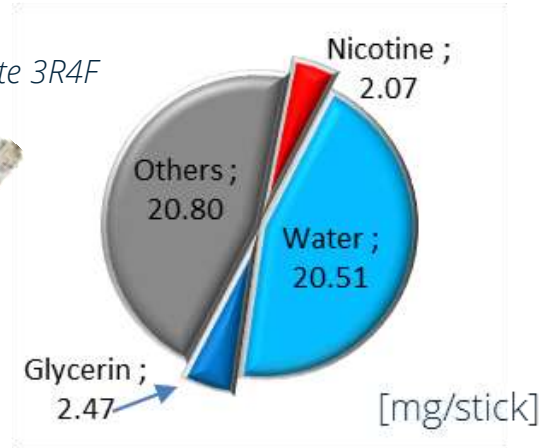
October 10<sup>th</sup> 2017, Lyon (France)

# PMI Tobacco Heating System v. 2.2 (THS 2.2) vs. cigarette

## Tobacco Heating System 2.2 *Commercialized under IQOS brand name*



## Cigarette *Reference cigarette 3R4F*

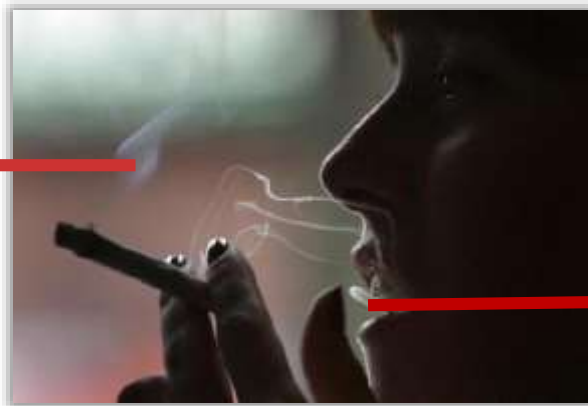


- Heating maintains the tobacco temperature below combustion, which creates an aerosol with a very different composition compared to cigarette smoke
- The mainstream aerosol is only generated when a puff is drawn → no sidestream

# Environmental Tobacco Smoke (ETS) / Environmental Aerosol (EA)

## Environmental Tobacco Smoke (ETS)

57-85% aged and diluted sidestream smoke



15-43% aged and diluted mainstream smoke exhaled by the user

When cigarettes smoking occurs, ETS was shown to be a significant contributor to indoor air pollution.

The use of THS 2.2 generates an **Environmental Aerosol (EA)**, markedly different from ETS regarding

- composition (no carbon-based solid particles, number of chemicals present/detected)
- range of concentrations of Harmful or Potentially Harmful Compounds (HPHCs)

# Indoor air quality (IAQ) room & sampling systems

## IAQ room:



- Temperature ( $23 \pm 3^\circ\text{C}$ ) & pressure controlled, humidity monitored (40-56 RH%)
- Air change: 0.5 to 12.2 per hour
- Ventilation: 37 to 879  $\text{m}^3/\text{h}$
- Air filtration (dust, microparticles, VOCs)
- Low-emission / washable furniture
- Fans to homogenize air

## Class (11 methods, adapted from standards)

ISO measurement standards for ETS  
Tobacco-specific nitrosamines (TSNAs)

Aerosol formers

VOCs

Carbonyls

Inorganics

**Total Volatile Organic Compounds**

## Targets (23 analytes)

Nicotine, 3-ethenylpyridine, solanesol, gravimetry, UVP, FPM

NNN, NNK

Glycerin, propylene glycol

1,3-butadiene, isoprene, benzene, acrylonitrile, toluene

Formaldehyde, acetaldehyde, acrolein, crotonaldehyde

CO, NO, NO<sub>x</sub>

**TVOC value (in toluene equivalent)**

## Offline analyses:

Pumps with mass flow controllers



## Online analyses:

Sensors for gases



# How to measure the impact of THS 2.2 on indoor air quality ?

9:00	10:00	11:00	12:00	13:00	14:00	15:00
Preparation of the room	People present in the room		Break / room ventilated	Same people, product used according to study protocol		End of the sessions Start of the sample preparations / analyses



Background (BKG)  
How **people** contribute  
to indoor air pollution ?



EA or ETS  
How **product** contributes  
to indoor air pollution ?



# TVOC method – general considerations

## Reference method

- ISO 16000-6:2011 Indoor air - Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and gas chromatography using MS or MS-FID
- Adapted
- Validated/accredited (ISO 17025)



Quality Management  
System (ISO 17025)

## Analytes

Volatile organic compounds eluting on 5%-phenyl column between C6 and C16



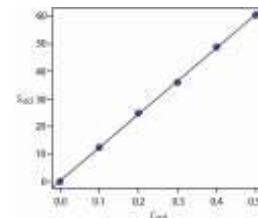
## Matrices

Background air (BKG)  
Environmental aerosol (EA) of heated tobacco product  
Environmental tobacco smoke (ETS) of cigarettes  
Environmental aerosol of e-cigarettes (to be validated)



## Calibration / Quantification

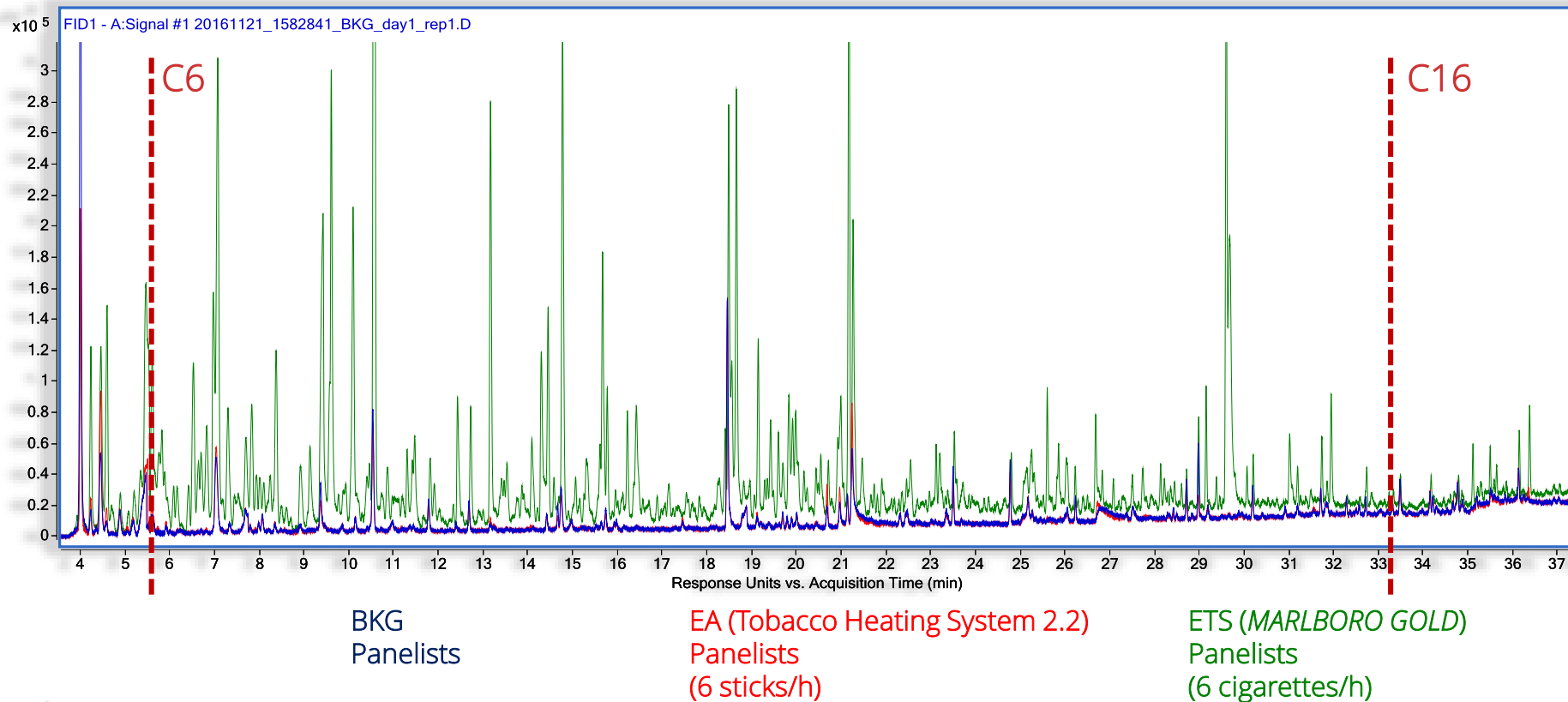
Calibration curve with toluene spiked on Tenax TA® tubes  
Quantification using FID response (toluene equivalent)



## TVOC value

Sum of concentrations from peaks above 7.2ng/tube (2µg/m<sup>3</sup>)

# Typical results (chromatographic profiles)



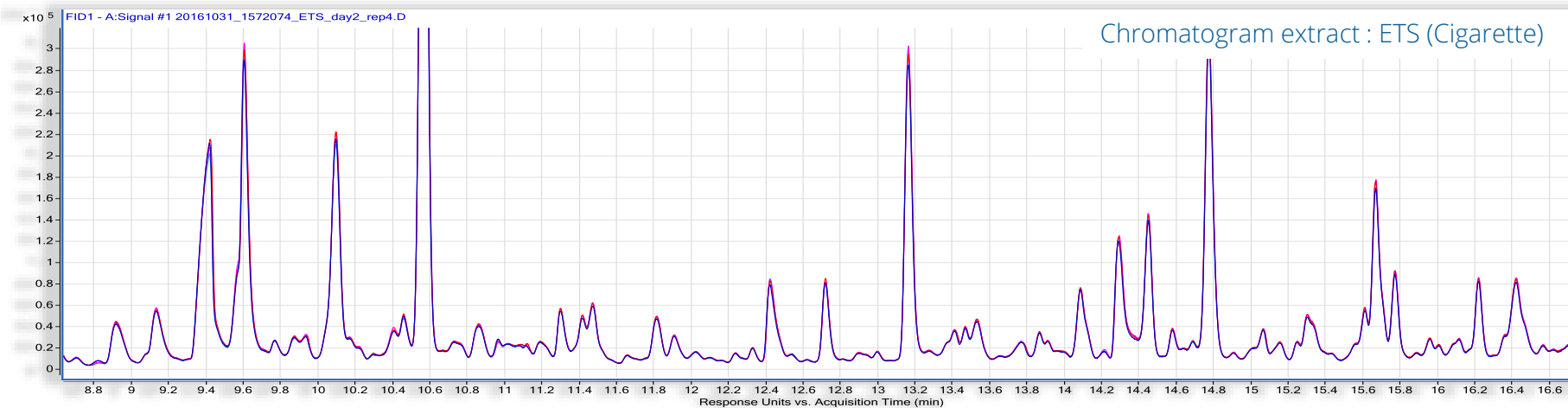


# Analytical method – critical aspects

Parameter	Measures
Control of TENAX TA® tubes	Every tube conditioned and checked before use
Replacement of instrument seals/filters	Replacement of seals/filters required after ~500 injections <ul style="list-style-type: none"><li>▪ 50-80 bakeout cycles</li><li>▪ Alternative : seals and particles filters heated @ 300°C under vacuum for 2 hours</li></ul>
Storage of tubes	Brass caps with PTFE ferrules for storage Other type of caps led to contaminations
Control of cap seals	Visual control and elimination of defective caps
Dedicated laboratory	Strict limitations of chemicals use or storage in the dedicated laboratory (sample preparation and instrumental analysis)
Limitation of cross-contaminations from previous sessions	High ventilation for 1 hour between successive sessions High ventilation overnight Cleaning of the sampling room every week
Control of contaminations from panelists	Same panelists for background (morning) and products (afternoon) sessions Imposed set of cosmetics. Limitations of food & beverages.



# Method robustness



Overlay of 4 sampling replicates (FID signal)

Tube conditioning + sampling + instrumental analysis → **Robust**

# Example : impact of cosmetics on indoor air

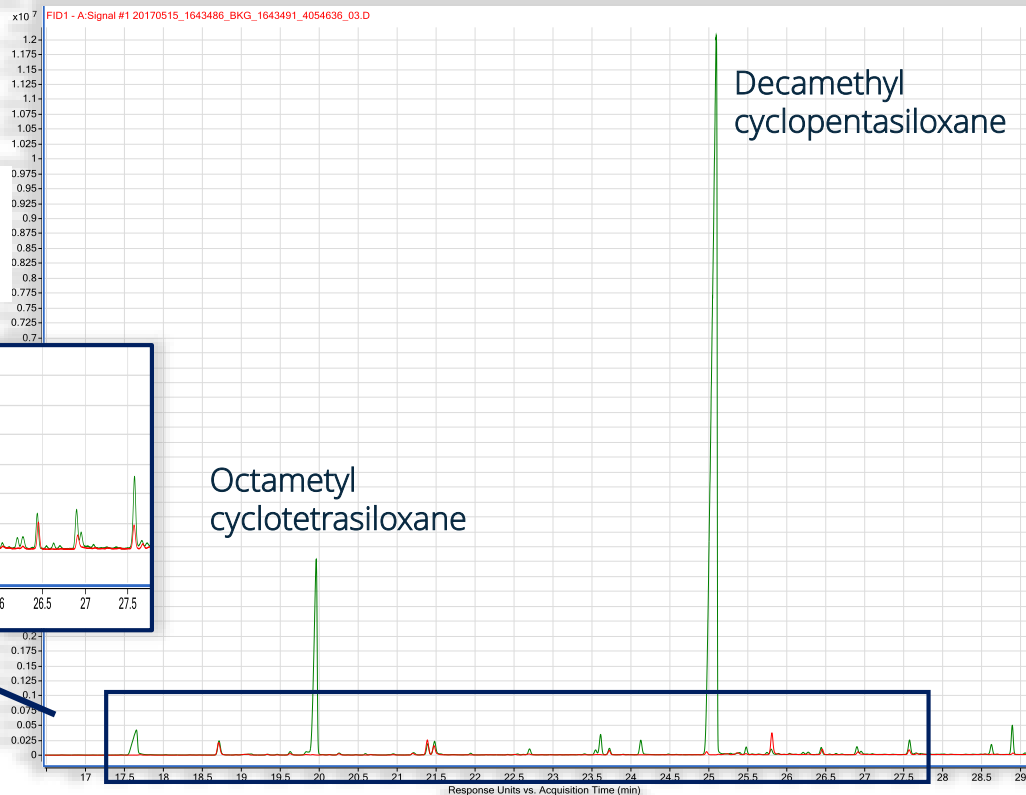
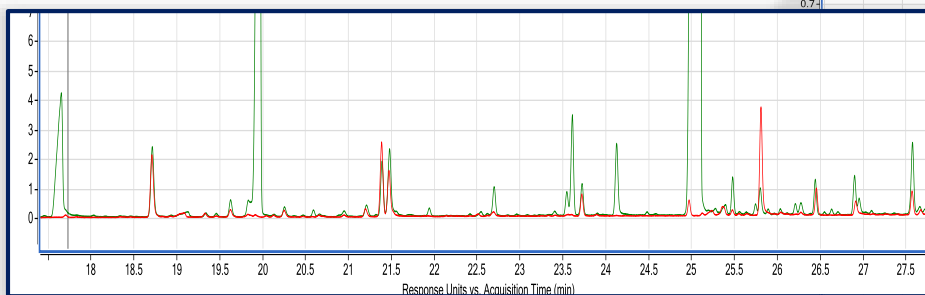
TVOC-value [ $\mu\text{g}/\text{m}^3$ ]

52

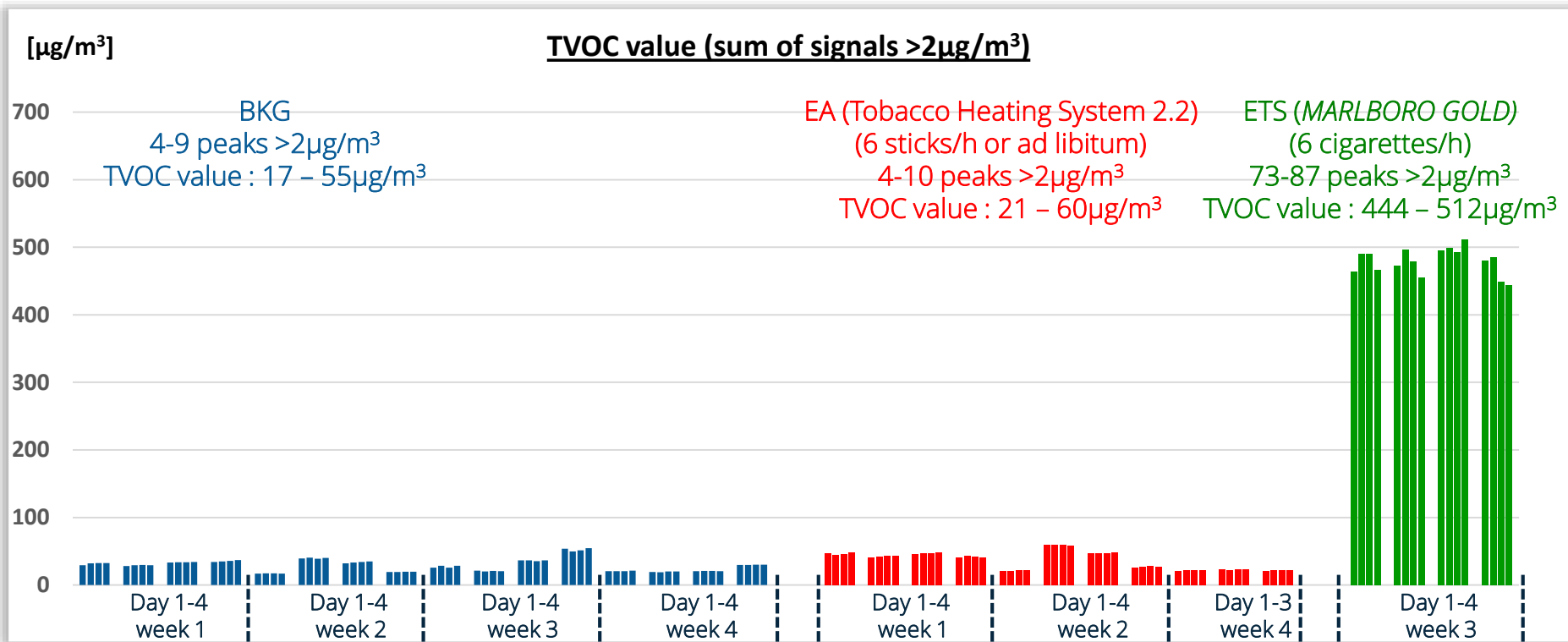
Panelists with imposed cosmetics  
# peaks  $> 2\mu\text{g}/\text{m}^3$  : 10

1217

Panelists using/applying alternative  
cosmetics in the room  
# peaks  $> 2\mu\text{g}/\text{m}^3$  : 26

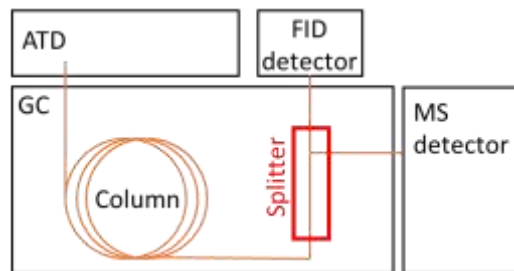


# Typical results (TVOC values)



# Compounds identification – preliminary results

Use of splitter after separation column  
 → FID : quantification  
 → MS : identification



Compiled list of compounds eluting between C6 and C16 and quantified by FID more than once above  $2\mu\text{g}/\text{m}^3$  for the sessions with EA (THS 2.2) and/or the corresponding BKG

#	Compound	RT (min)	Detected in BKG	> $2\mu\text{g}/\text{m}^3$ in BKG	Detected in EA (THS 2.2)	> $2\mu\text{g}/\text{m}^3$ in EA (THS 2.2)
1	Benzene (co-eluted with 1-butanol)	7.0	Yes	Yes	Yes	Yes
2	Propylene glycol	9.4	Yes	Yes	Yes	Yes
3	Toluene	10.6	Yes	Yes	Yes	Yes
5	Ethylbenzene (co-eluted with unknown)	14.5	Yes	Yes	Yes	Yes
6	p-xylene/m-xylene	14.8	Yes	Yes	Yes	Yes
8	Benzaldehyde	18.5	Yes	Yes	Yes	Yes
9	Hexanoic acid (to be confirmed)	18.9	Yes	Yes	Yes	Yes
11	Terpene-type compound (to be confirmed)	21.1	Yes	Yes	Yes	No
12	Benzyl alcohol	21.2	Yes	Yes	Yes	Yes
13	Nonanal	23.5	Yes	No	Yes	Yes
14	Decamethylpentasiloxane	24.8	Yes	Yes	Yes	Yes
15	2-phenoxyethanol	26.7	Yes	Yes	Yes	Yes

# Summary and conclusions

Indoor air quality facility and analytical platform have been implemented in Philip Morris International R&D

- 11 methods, 23 analytes, validated and ISO 17025 accredited

## TVOC method:

- adapted from ISO 16000-6
- parallel FID/MS detection allows robust quantification and compounds identification
- several parameters are crucial to ensure solid datasets, e.g.
  - imposed cosmetics for panelists during studies
  - sampling room management (incoming air filtration, ventilation between sessions, limitations of food & beverages,...)
  - strict control of trapping tubes, instrument and related consumables (storage and control of tube blanks, caps, seals,...)
  - dedicated lab for sample preparation

Applying TVOC method for an **indoor air quality study** with THS 2.2 shows that:

- VOC (C6-C16) analysis of EA (THS 2.2) are qualitatively and quantitatively similar to BKG
- Low concentrations and variety of compounds are contributing to TVOC value for BKG and EA of THS 2.2

# Thank you for your attention !

