

EASA CAQ III

EASA CAQII Stakeholder Workshop

Cologne, February 20-21th 2024



3



WP4: HEPA-Filter, Ground Aircraft Test & ECS-Sampling

CAQIII - Understanding cabin air quality

WP4: HEPA-Filter, Ground Aircraft Test & ECS-Sampling



CAQIII integrated HEPA filter testing:

- i) HEPA filter sampling strategy
- ii) HEPA filter sampling in aircraft (during flight)
- iii) HEPA filter sampling in aircraft (on ground)
- iv) HEPA filter sampling in laboratory (BACS)

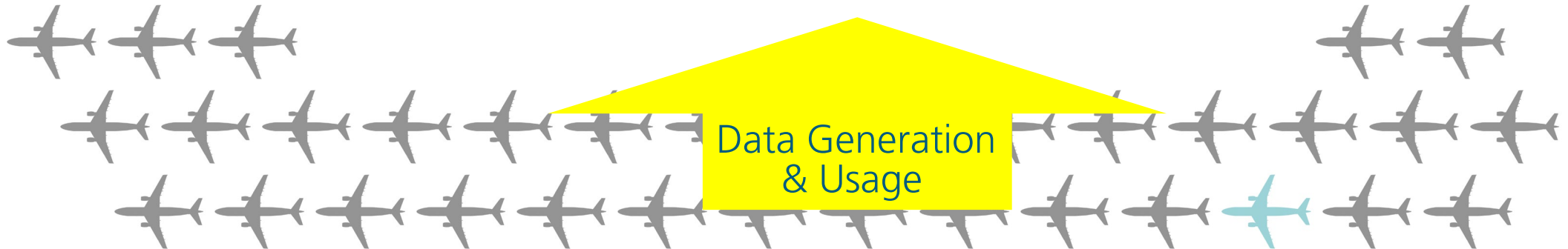


CAQIII - Understanding cabin air quality

i) HEPA Filter Sampling Strategy



$$\text{RISK} = \text{HAZARD} \times \text{FREQUENCY}$$

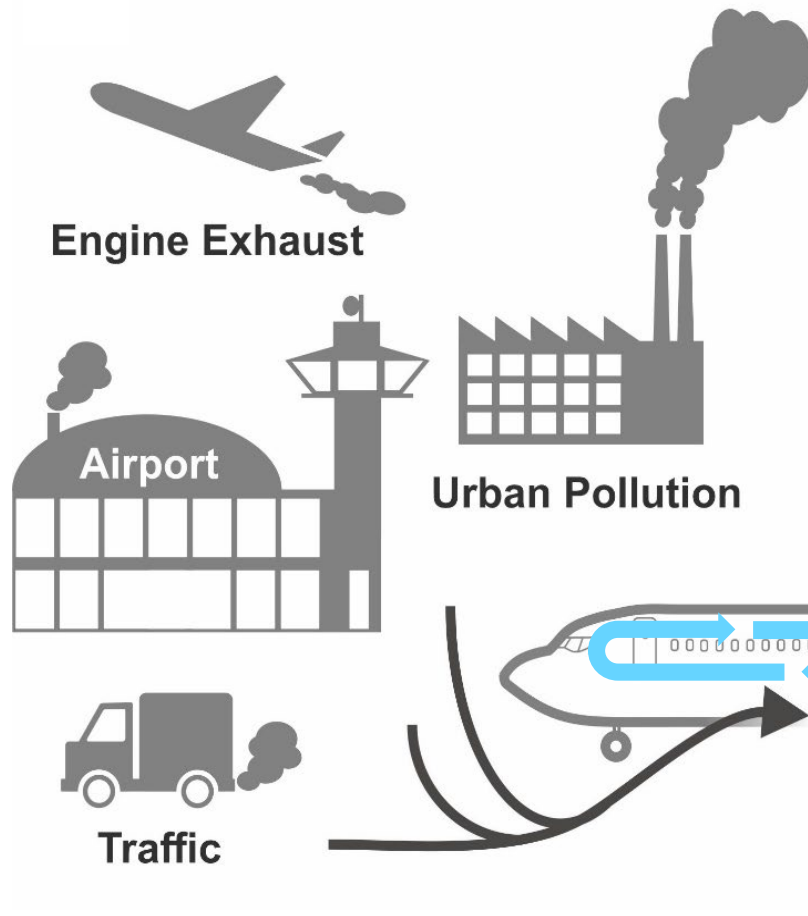


How can a reliable „Fume Event“ identification be done?

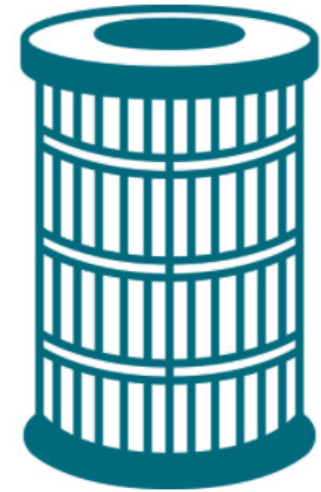
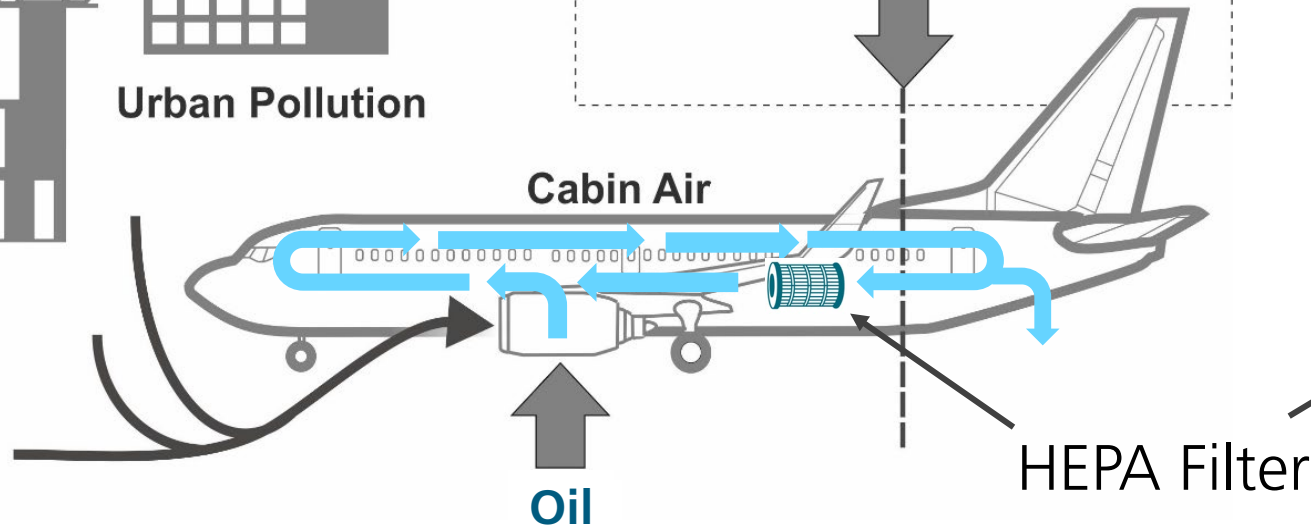
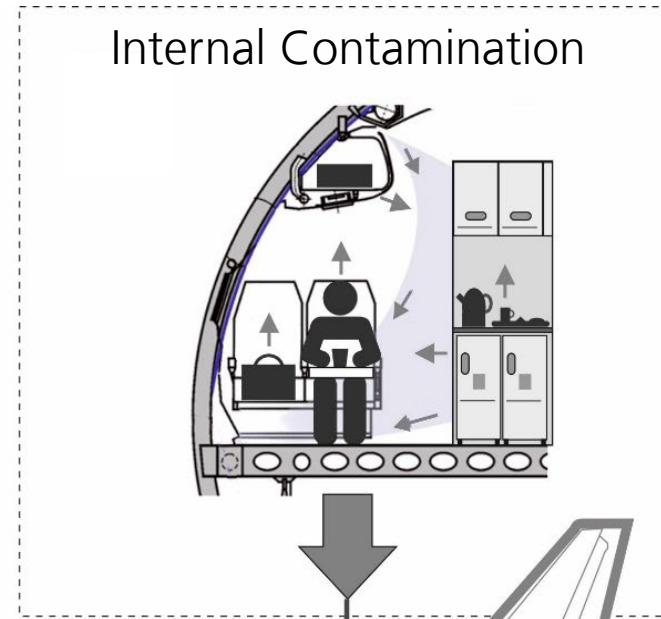
CAQIII - Understanding cabin air quality

i) HEPA Filter Sampling Strategy

External Contamination



Internal Contamination



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i) HEPA Filter Sampling Strategy – Duration of exposure and dose intake



Source: https://img.freepik.com/fotos-premium/stau-in-der-stadt-chaos-verkehrskollaps-in-der-stadt_1021945-577.jpg

<https://www.kulturbund-nordhausen.de/wp-content/uploads/2019/08/Landstra%C3%9Fen-in-Italien-1024x768.jpg>

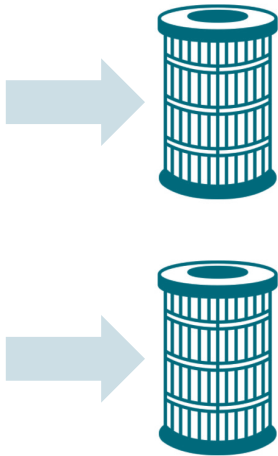
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i) HEPA Filter Sampling Strategy – B787 as negative control



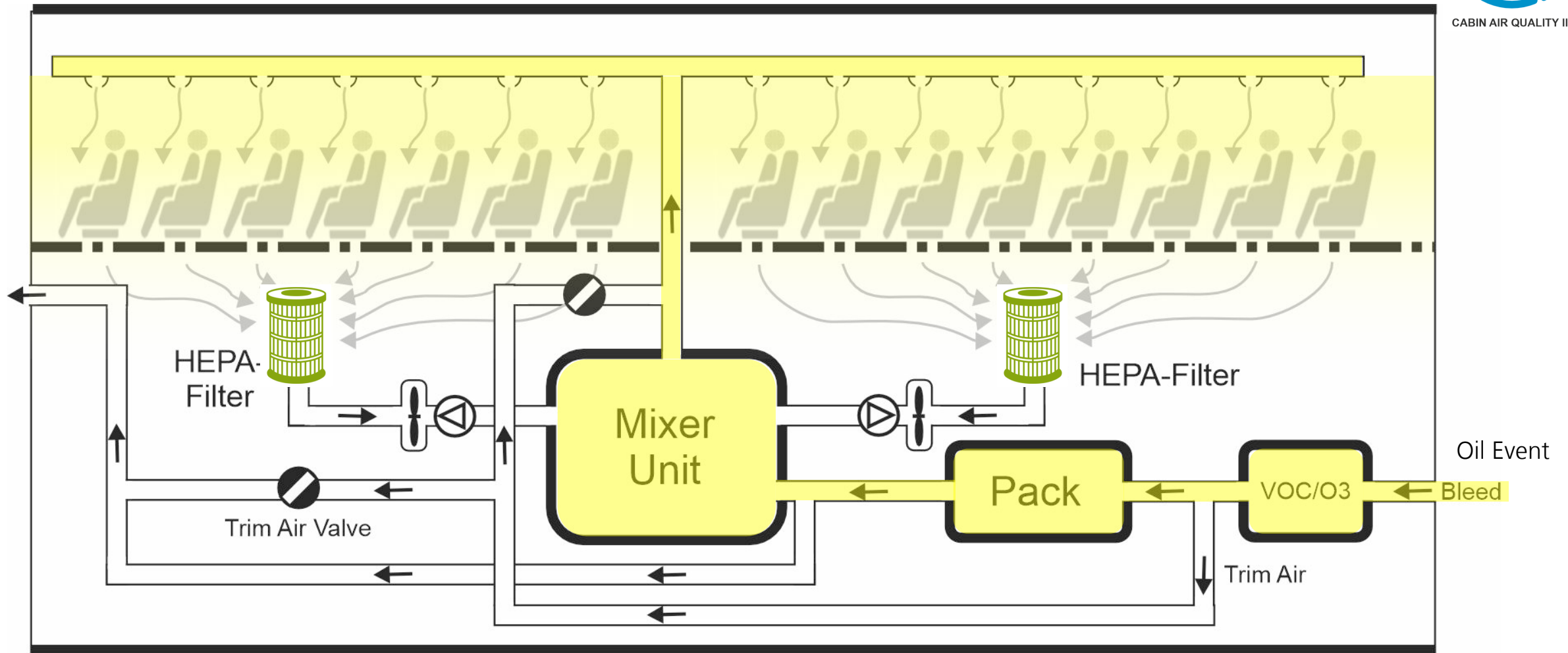
Source of Oil Contamination

A320	Airport ?%	+	Bleed Air 20%		Bleed Air 80%
B787 (no bleed)	Airport X%		0%		0%
	Airport (20%)			Cruise (80%)	



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i) HEPA Filter Sampling Strategy

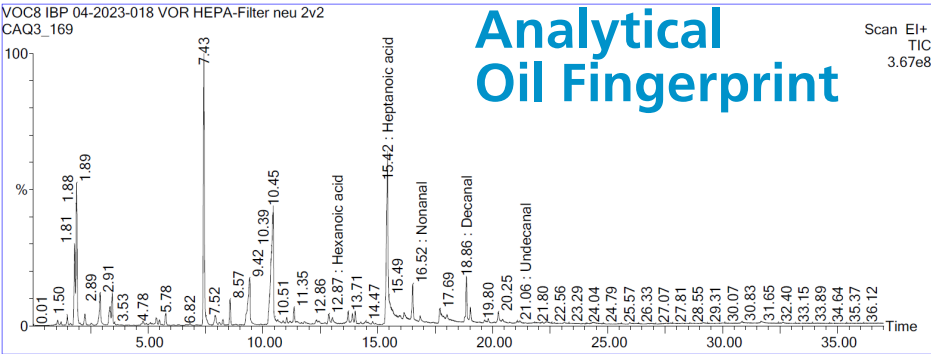
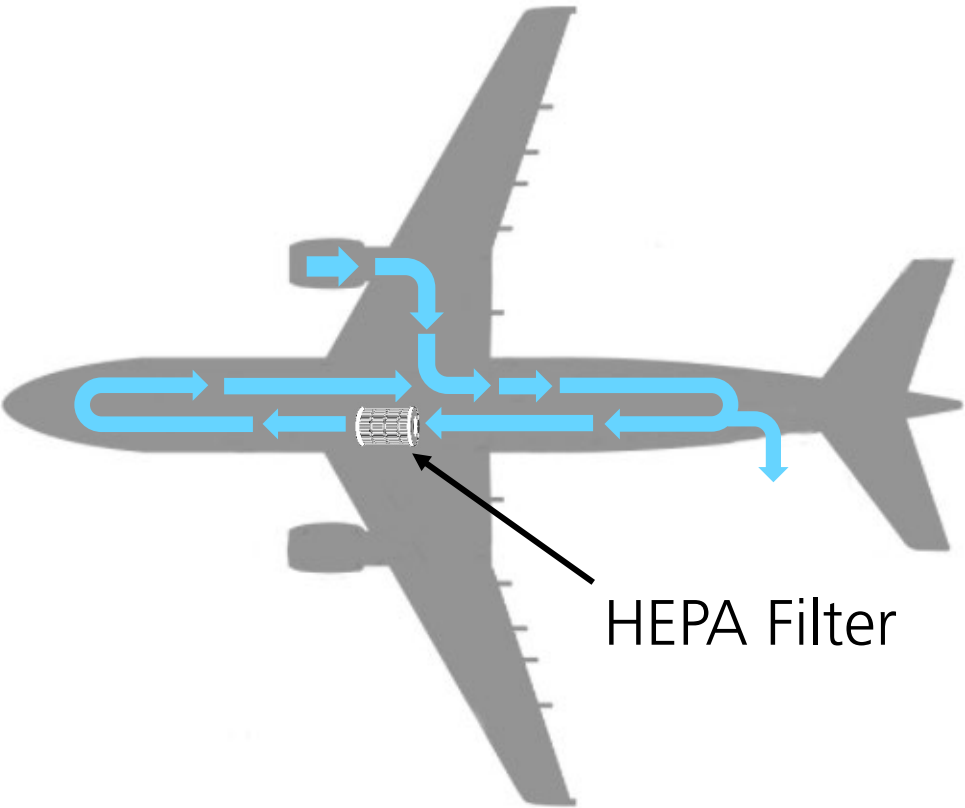


Introduction to the CAQIII project

HEPA Filter Sampling in Aircraft – ii In-Flight iii) Gr



ii) HEPA FILTER SAMPLING IN-FLIGHT



iii) HEPA FILTER SAMPLING ON GROUND

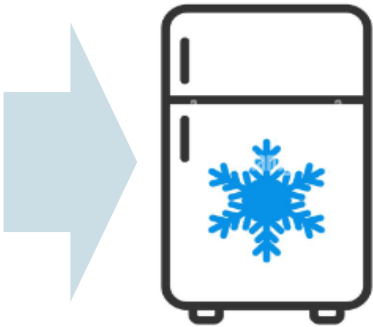
- Aircraft fume event simulation (Toulouse)

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HEPA Filter Preparation and Storage – How?



Size reduction
and long term
storage?



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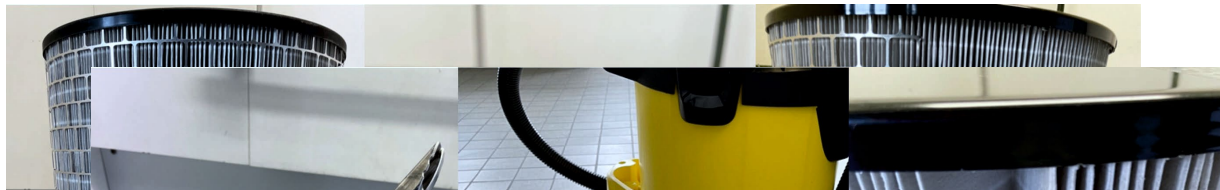
HEPA Filter Preparation and Storage (Operation Procedure)



LUFTHANSA GROUP



CABIN AIR QUALITY III



i) Dismantling Work

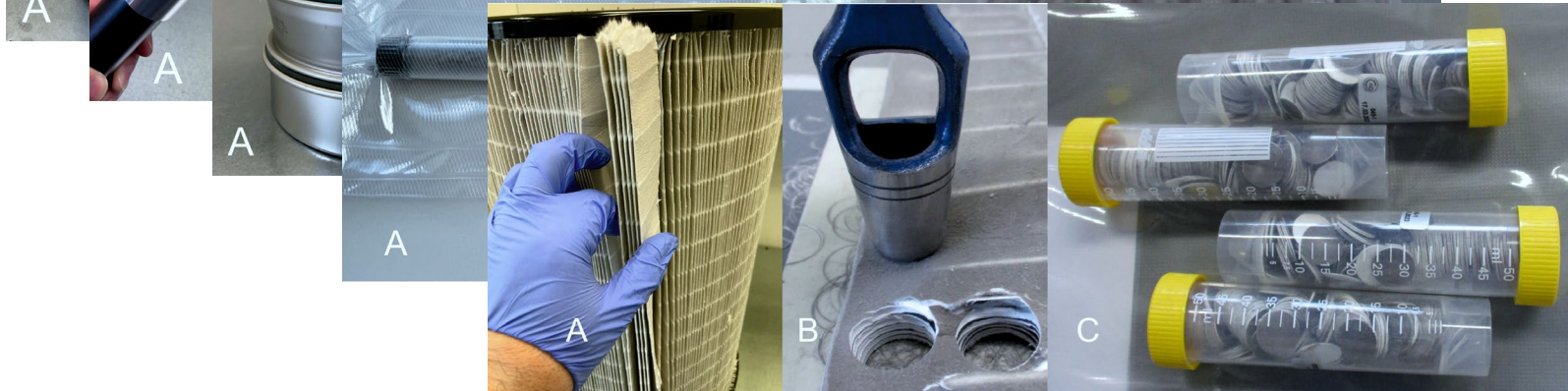
ii) Vacuuming



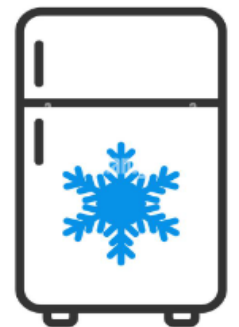
iii) Sieving Operation



iv) Storage of Dust Samples

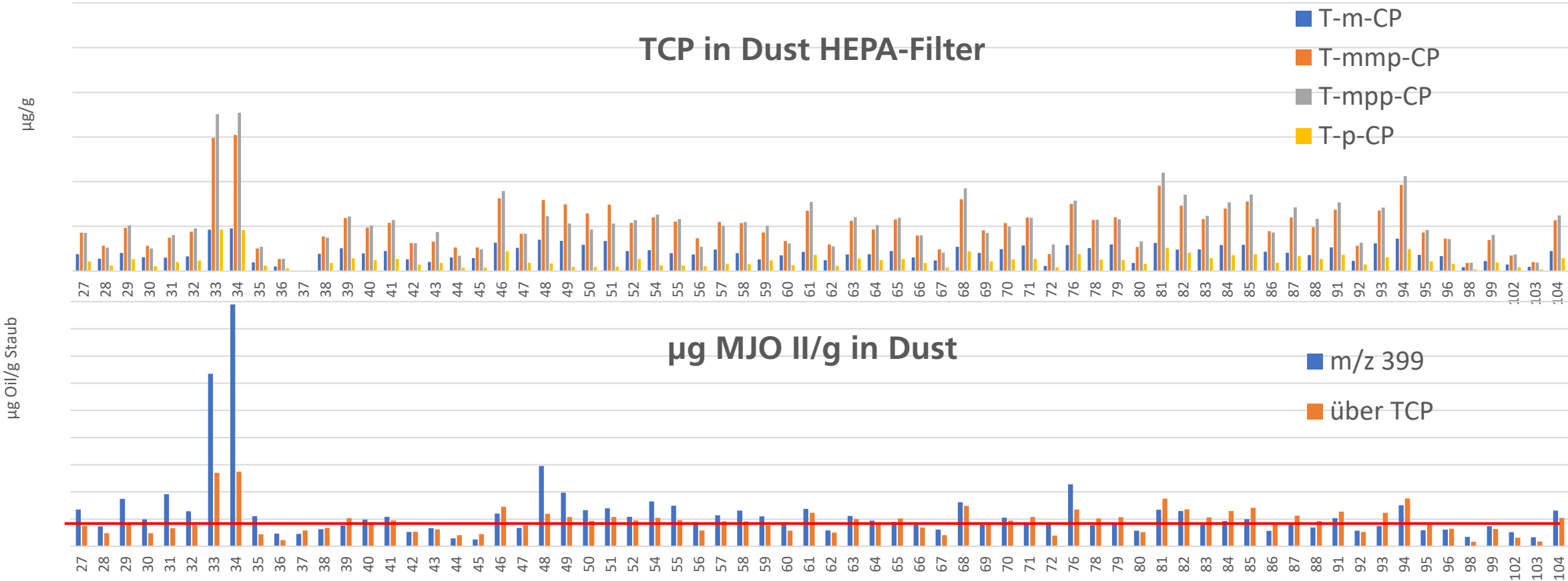


v) Storage of Punch Samples



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HEPA Filter Sampling in Aircraft – Oil Content HEPA Filter [$\mu\text{g/g}$ Dust] – A320



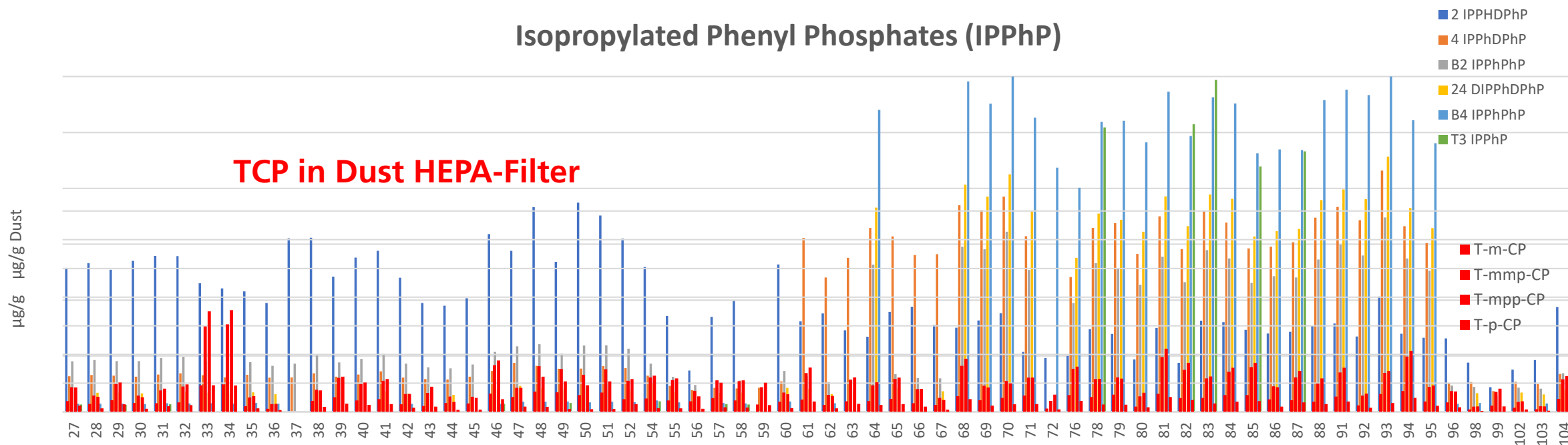
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HEPA Filter Sampling in Aircraft – IPPhP [$\mu\text{g/g}$ Dust] – A320



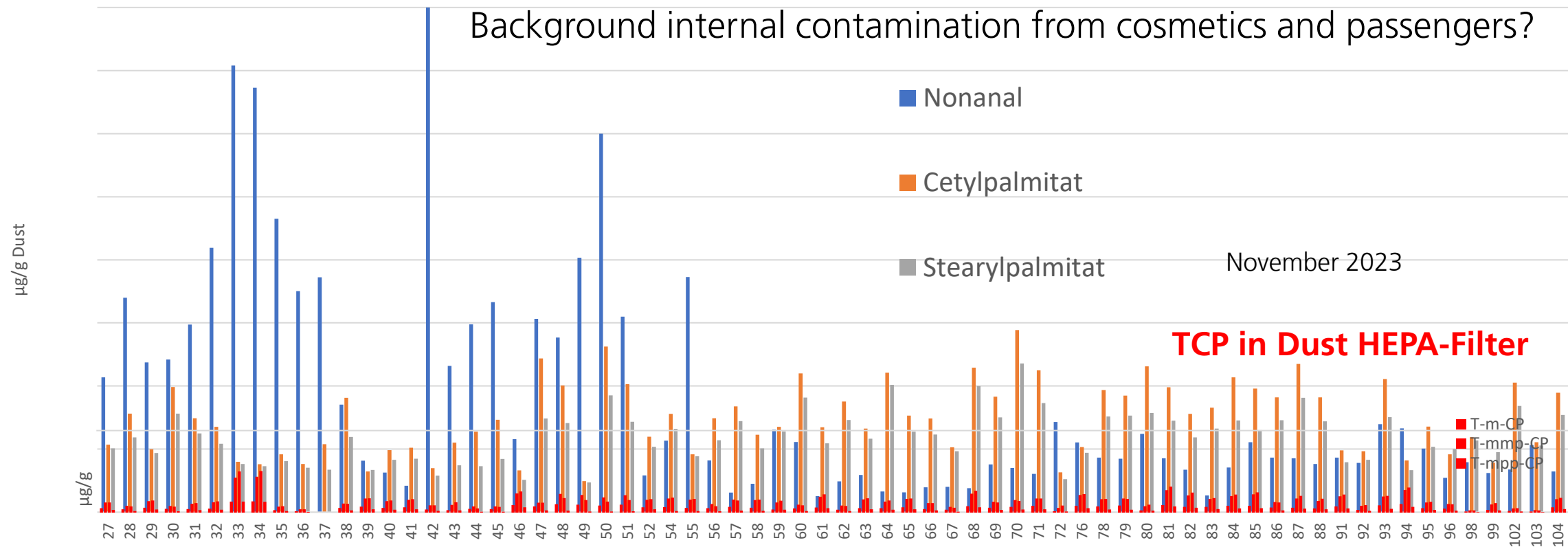
Background contamination from other Jet Oils?

Isopropylated Phenyl Phosphates (IPPhP)



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HEPA Filter Sampling in Aircraft – Cosmetics [$\mu\text{g/g}$ Dust] – A320

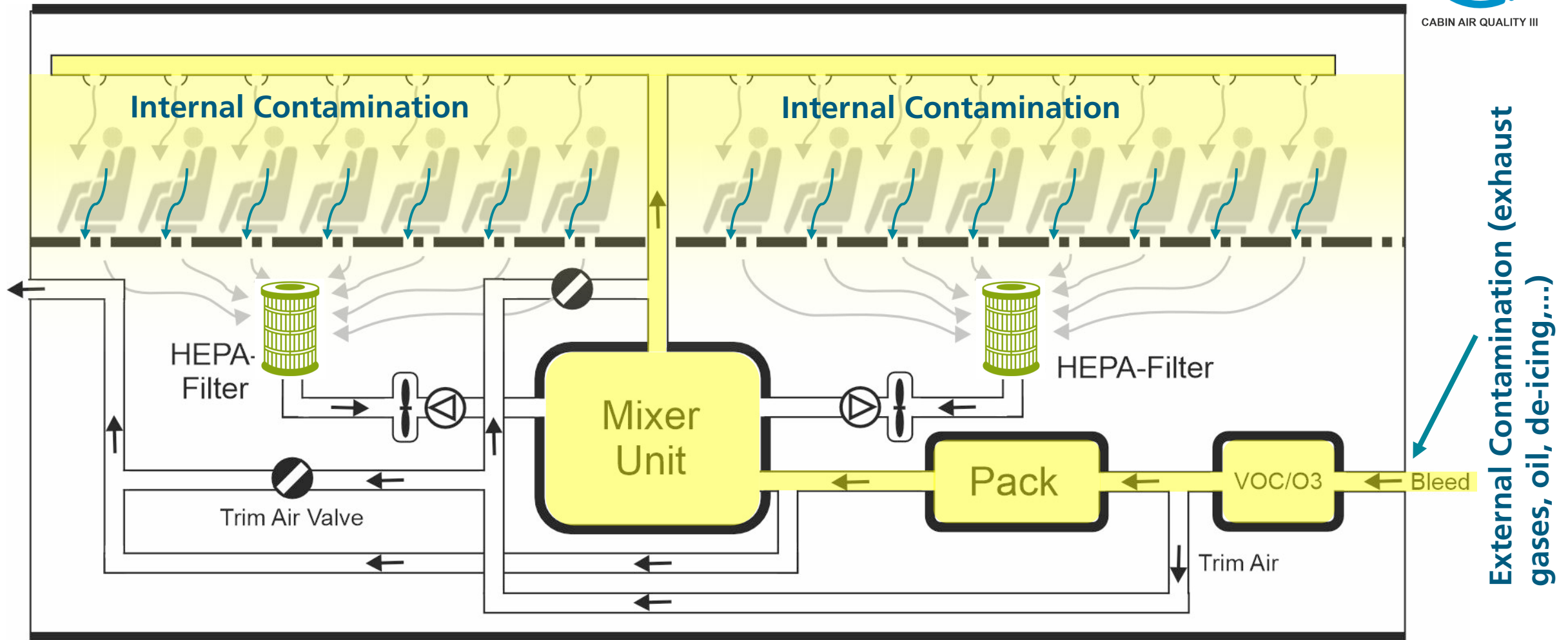


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i) HEPA Filter Sampling Strategy – Background Contamination

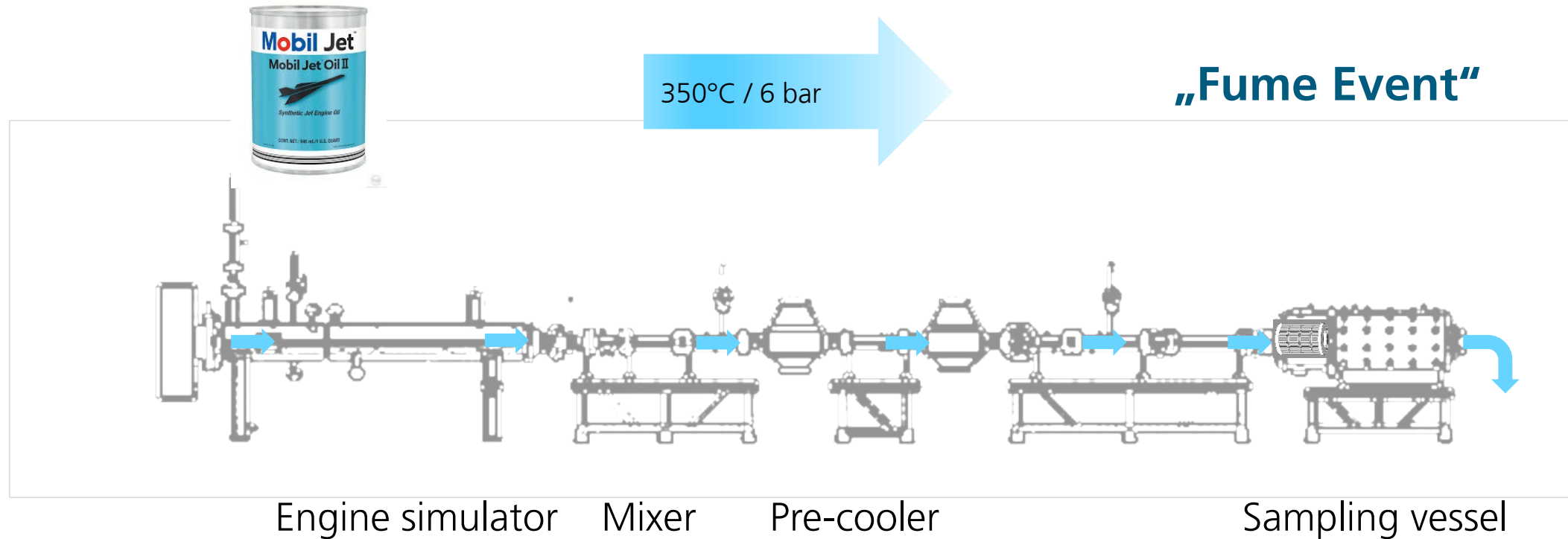


CABIN AIR QUALITY III



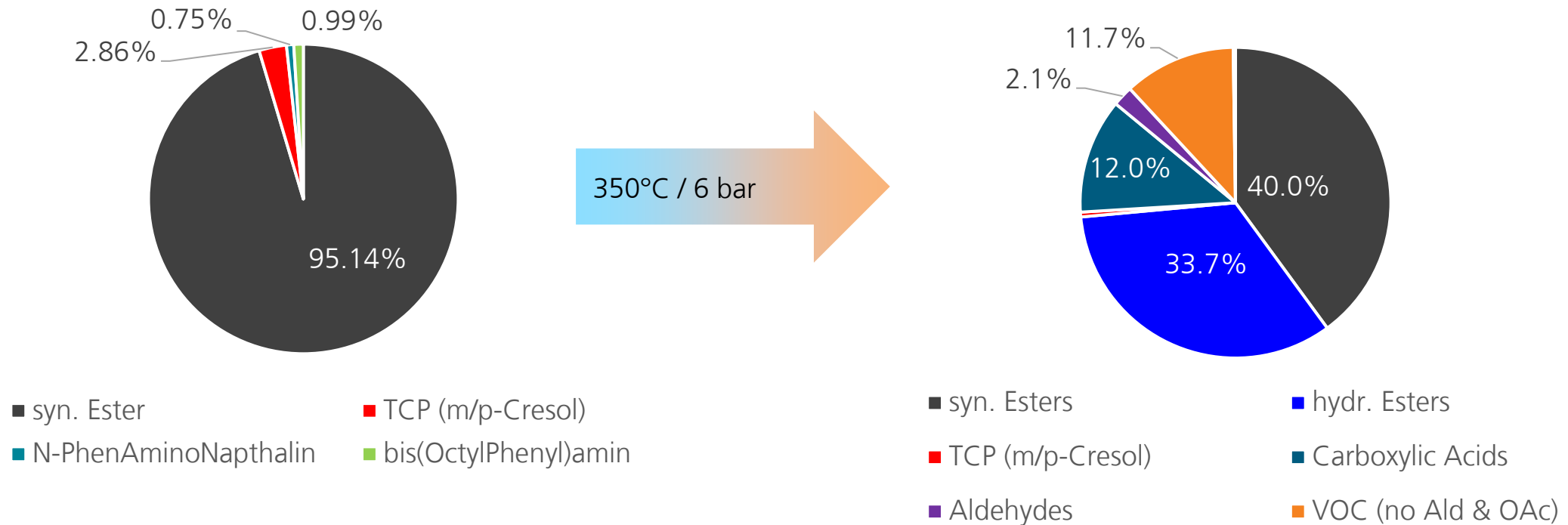
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iv) HEPA Filter Sampling in Laboratory (BACS)



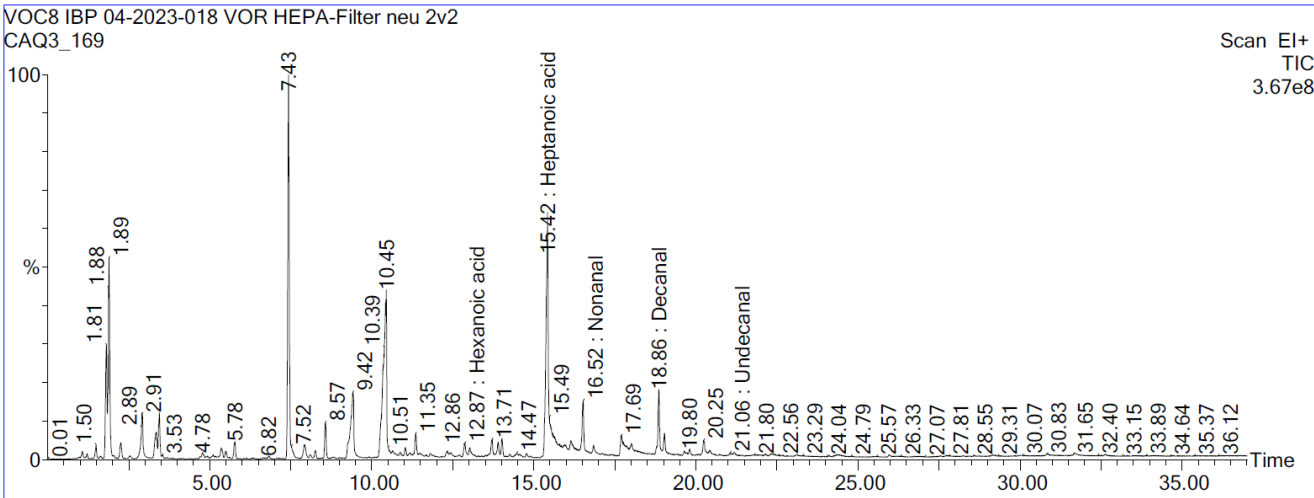
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Oil decomposition due to heat and pressure

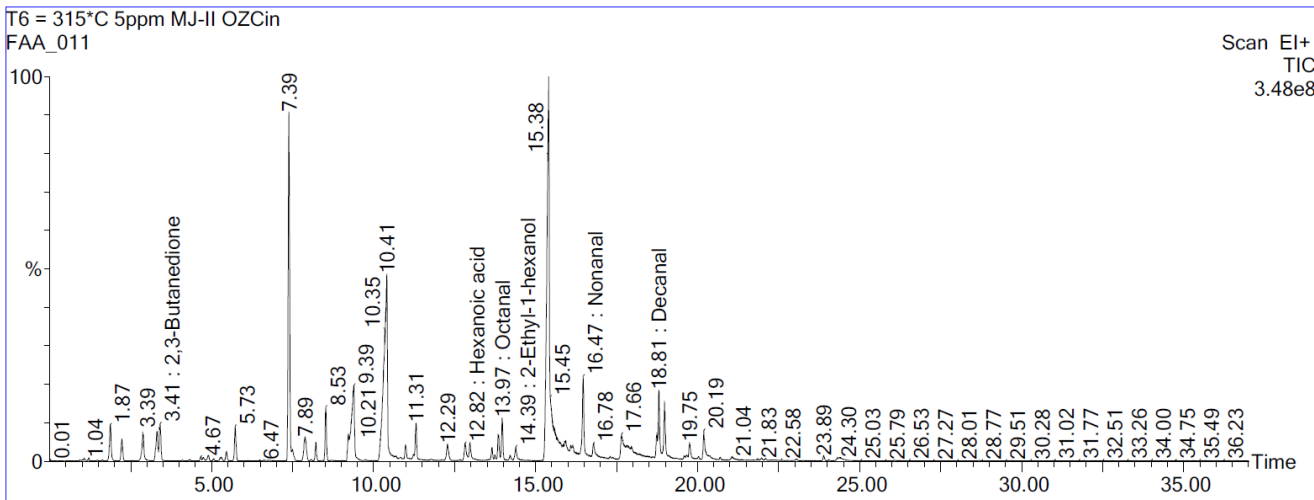


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Transferability of BACS to the Cabin Air: VOC Spectra from Mobil Jet Oil II



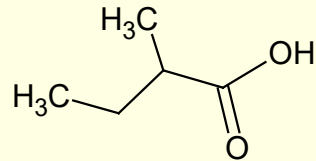
**BACS, IBP, Holzkirchen
Germany**



**B747, FAA Atlantic City
USA**

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BACS and B747 VOC Spectrum is dominated by Carboxylic Acids



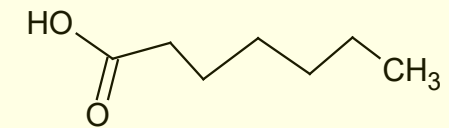
Methylbutyric acid C5

+

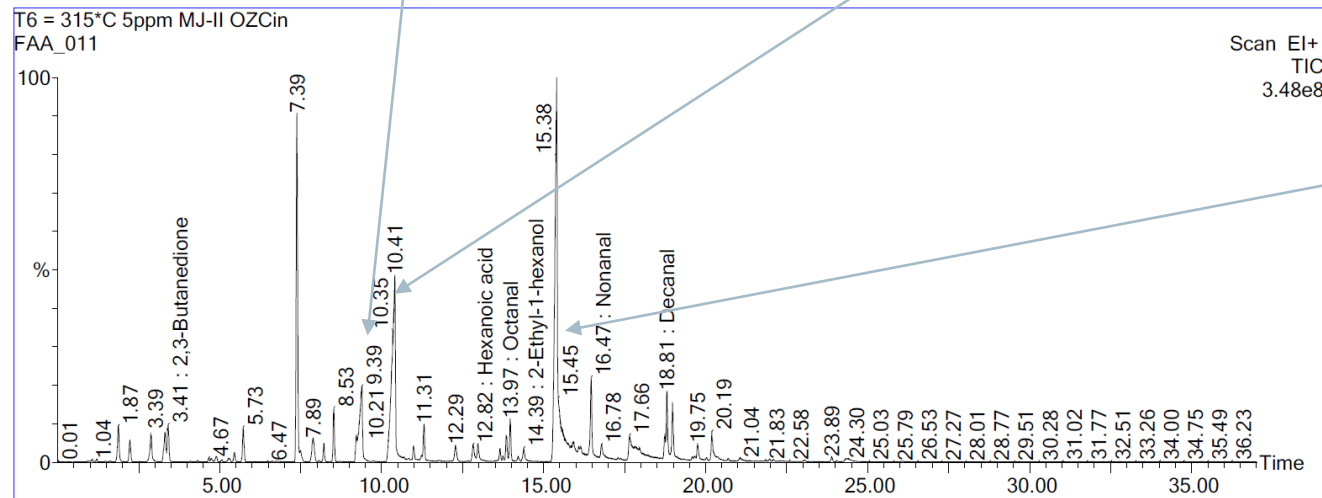


Pentanoic acid C5

„old socks or wet dog“

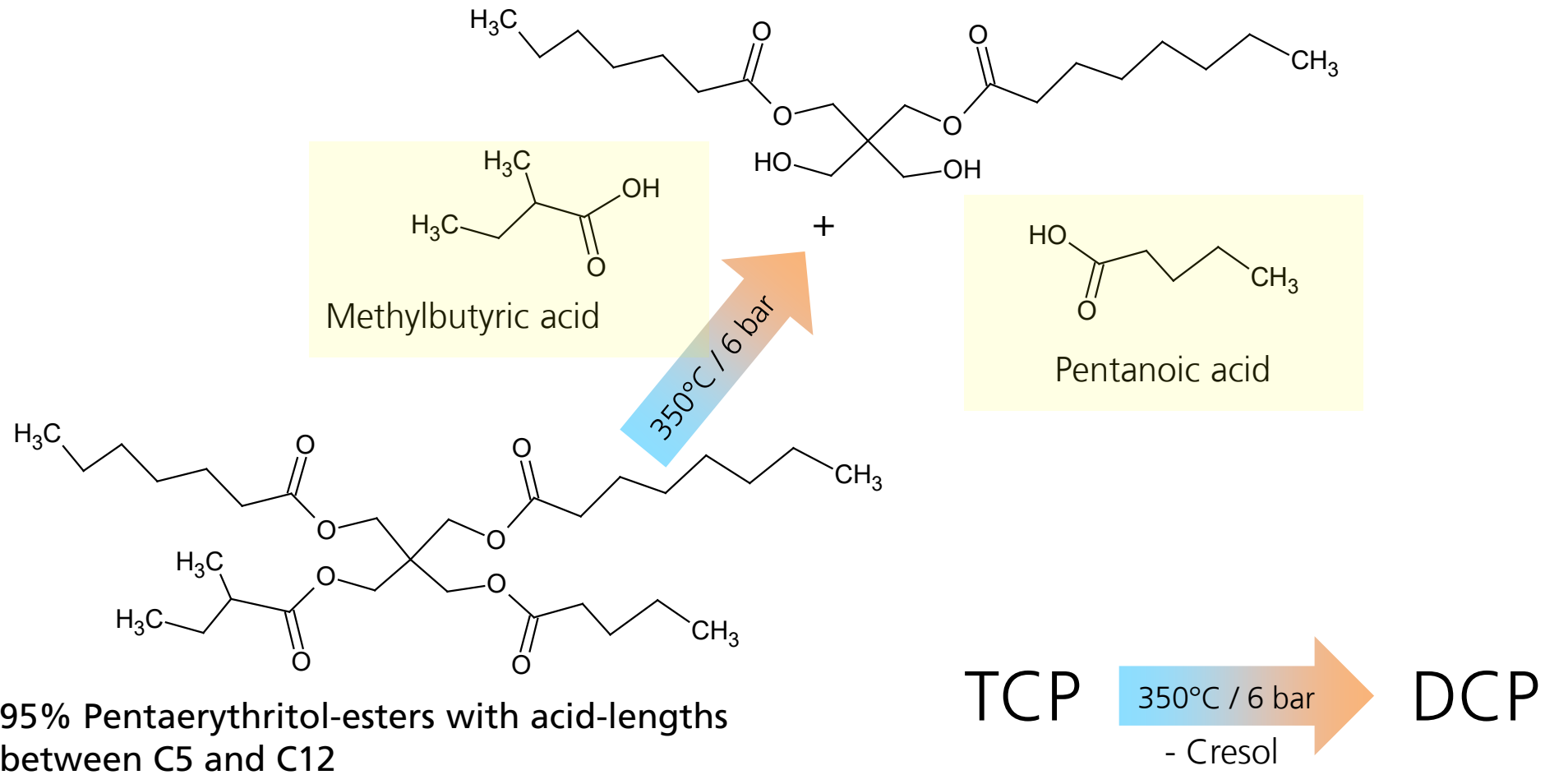


Heptanoic acid C7



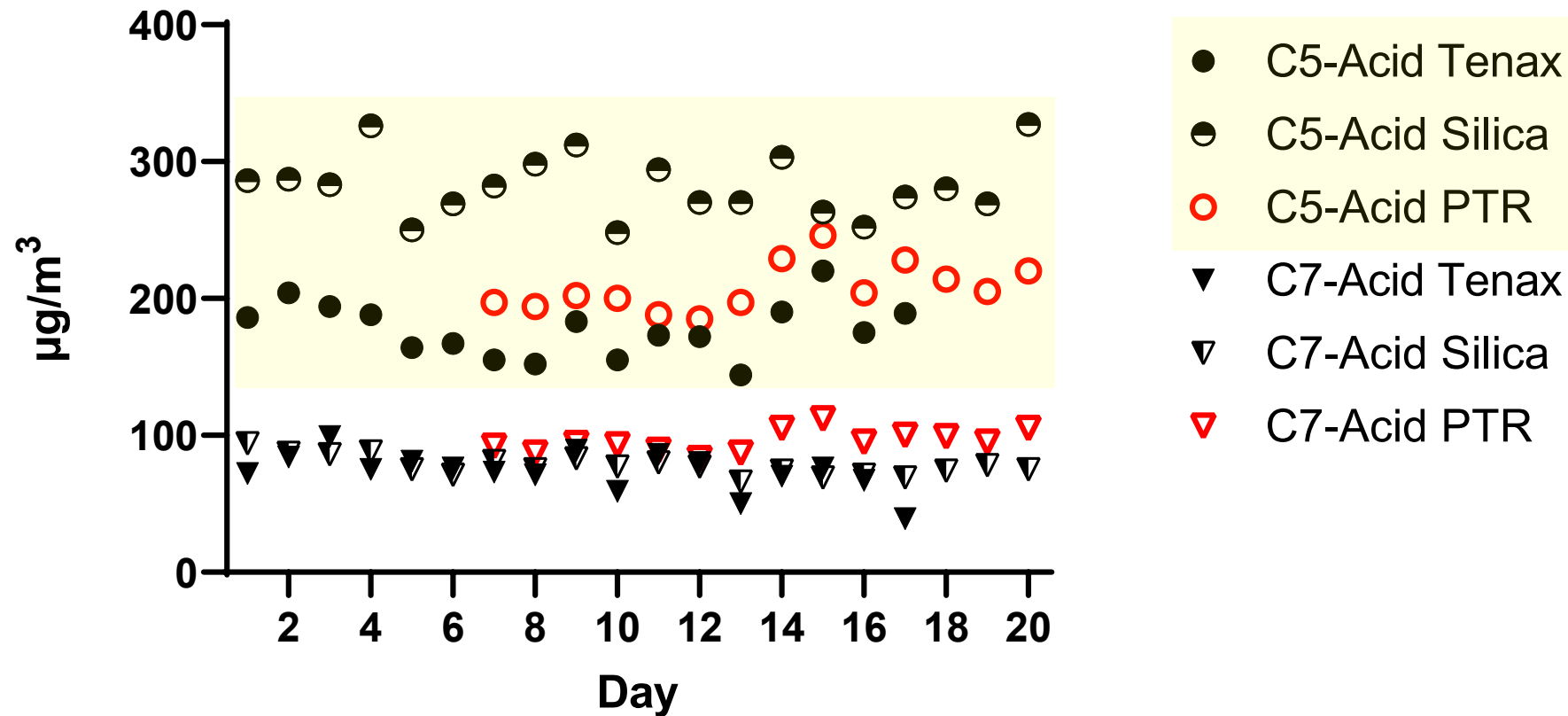
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Synthetic esters and partially hydrolyzed esters from MJO II



CAQIII - Understanding cabin air quality → What and How Much?

BACS: Comparison of ON-line (PTR-MS) and OFF-line Analytical Methods



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i) HEPA Filter Sampling Strategy



Reliable „Fume Event“ Identification?



$$\text{RISK} = \text{HAZARD} \times \text{FREQUENCY}$$



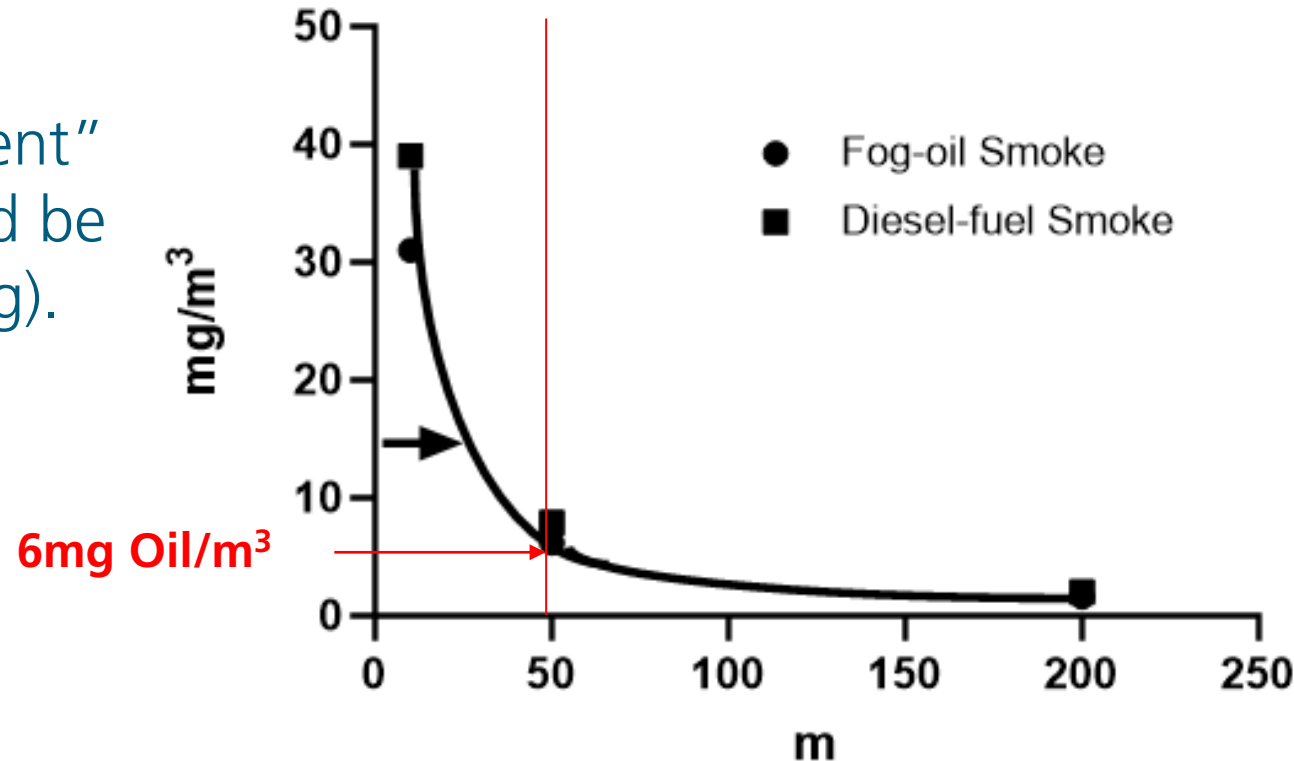
How much oil has a HEPA filter after a “Fume Event”?

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i) HEPA Filter Sampling Strategy

Consideration:

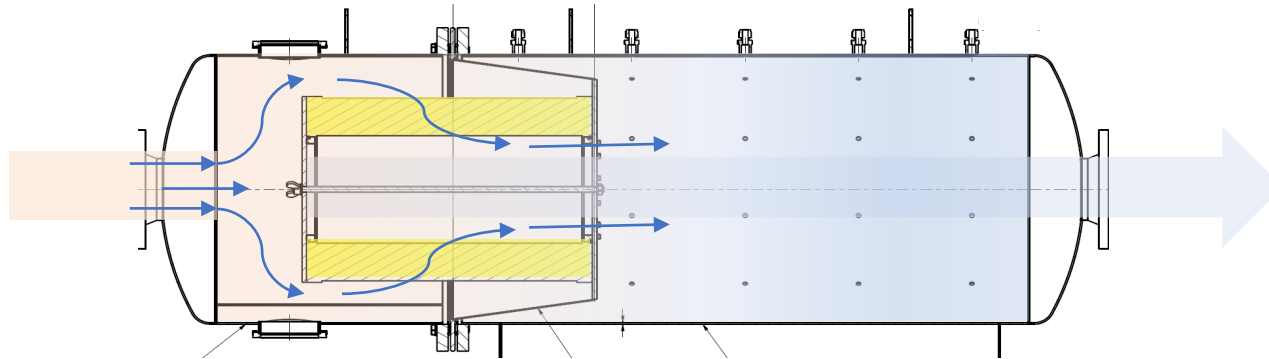
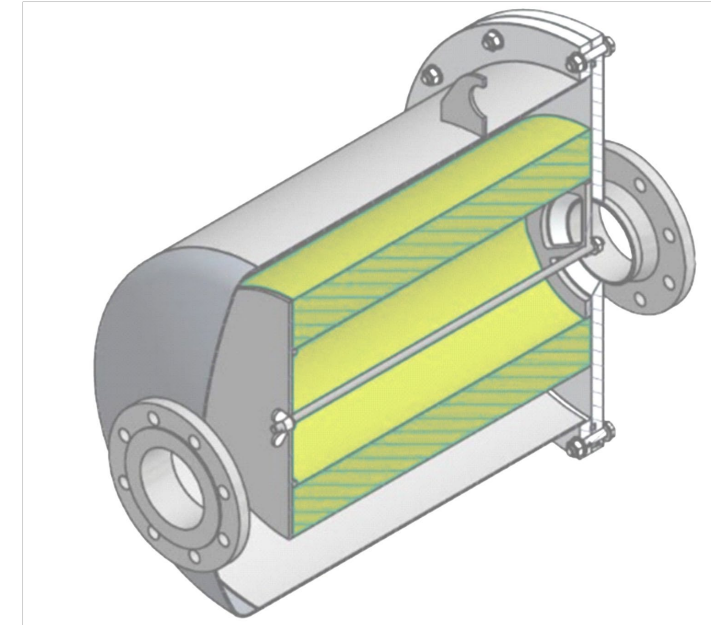
1.5 min "Fume Event"
at 5 ppm oil should be
detectable (200 mg).



How much oil has a HEPA filter after a "Fume Event"?

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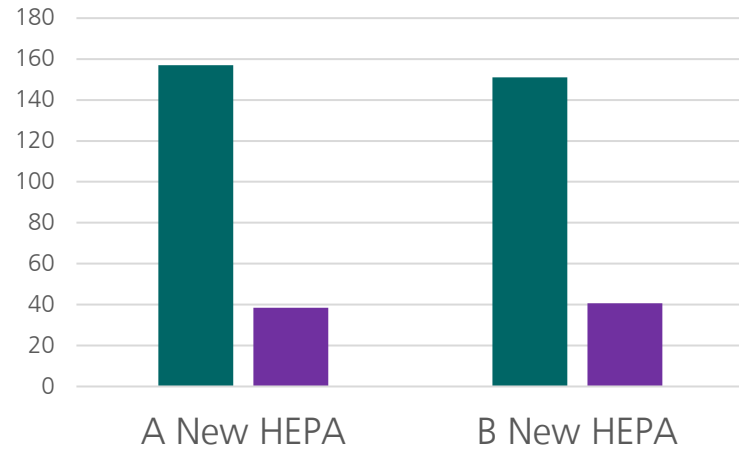
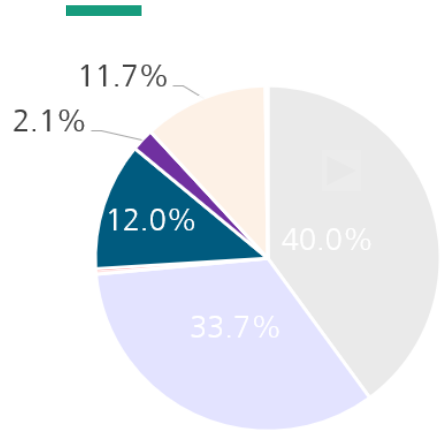
iv) HEPA Filter Sampling in Laboratory (BACS)



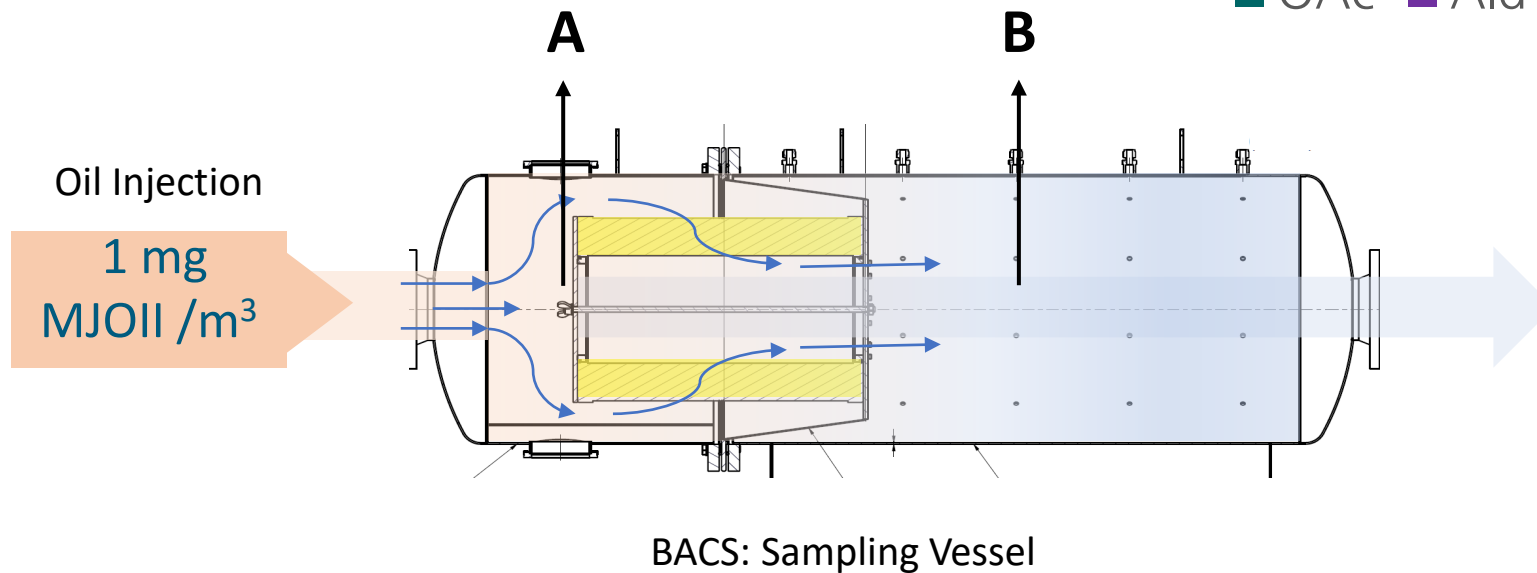
BACS: Sampling Vessel

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Carboxylic Acids & Aldehydes



■ OAc ■ Ald

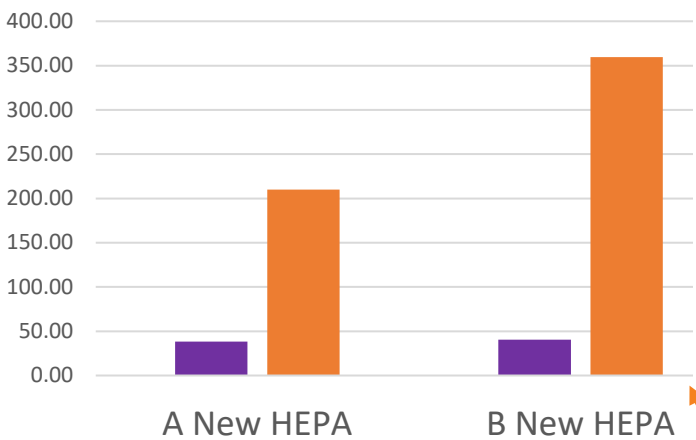
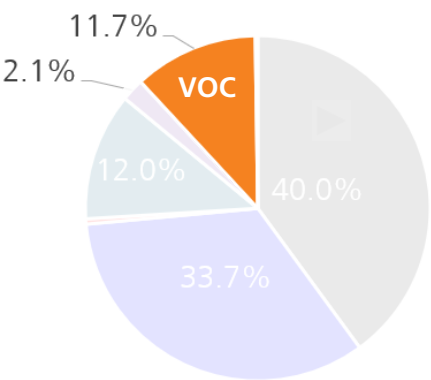


First Conclusions:

- ✓ OAc and Ald do pass HEPA filter
- ✓ Fluctuation of Ald unclear

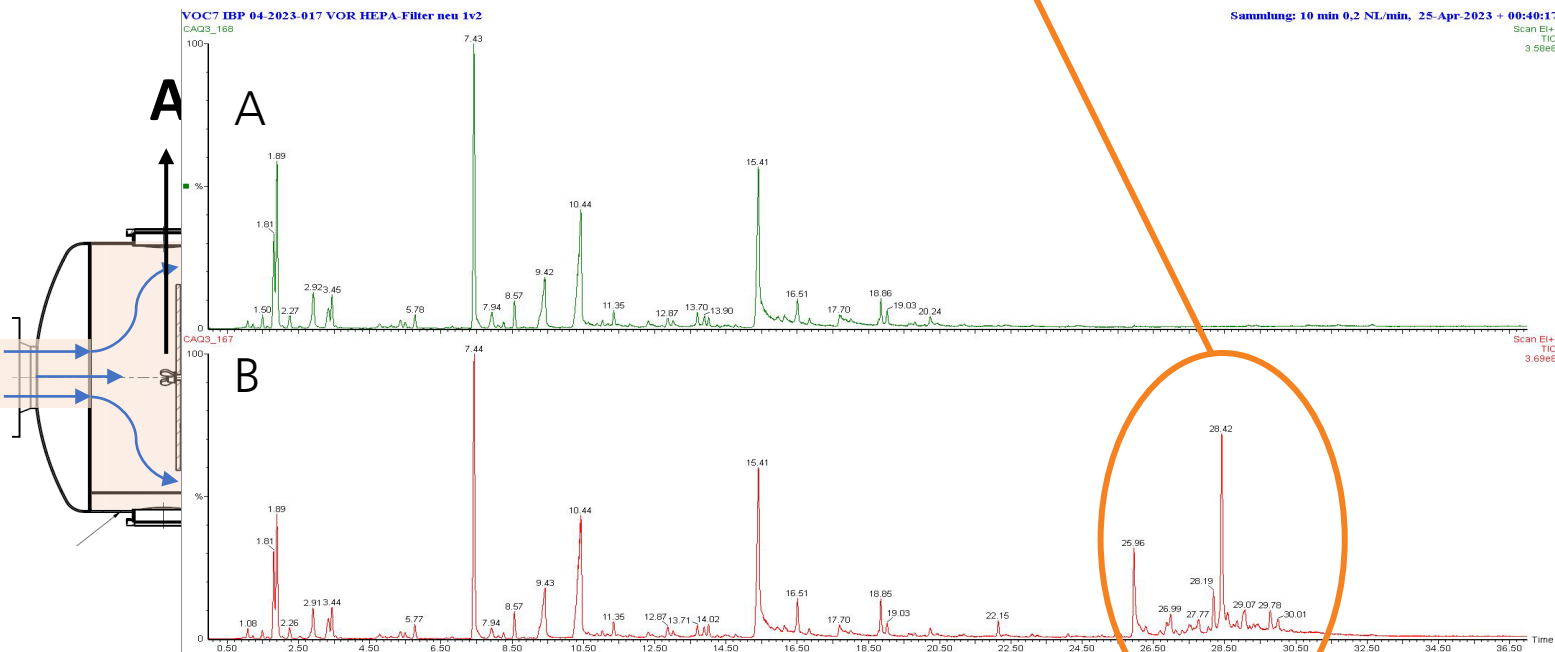
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VOC



Oil Injection

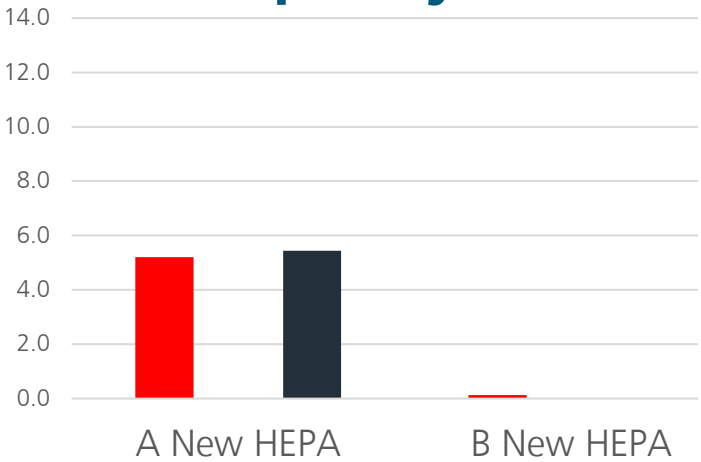
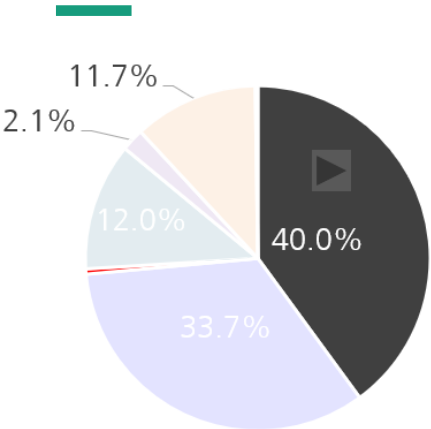
1 mg
MJOL /m³



; HEPA filter

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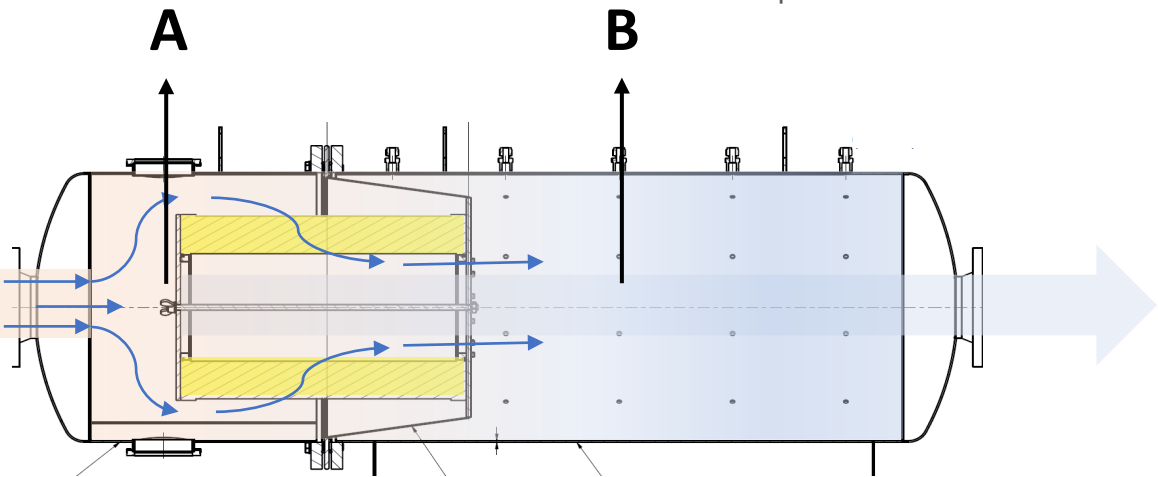
Esters & TCP



■ Sum pm-TCP

■ syn. Esters /50

Oil Injection
1 mg
MJOL /m³



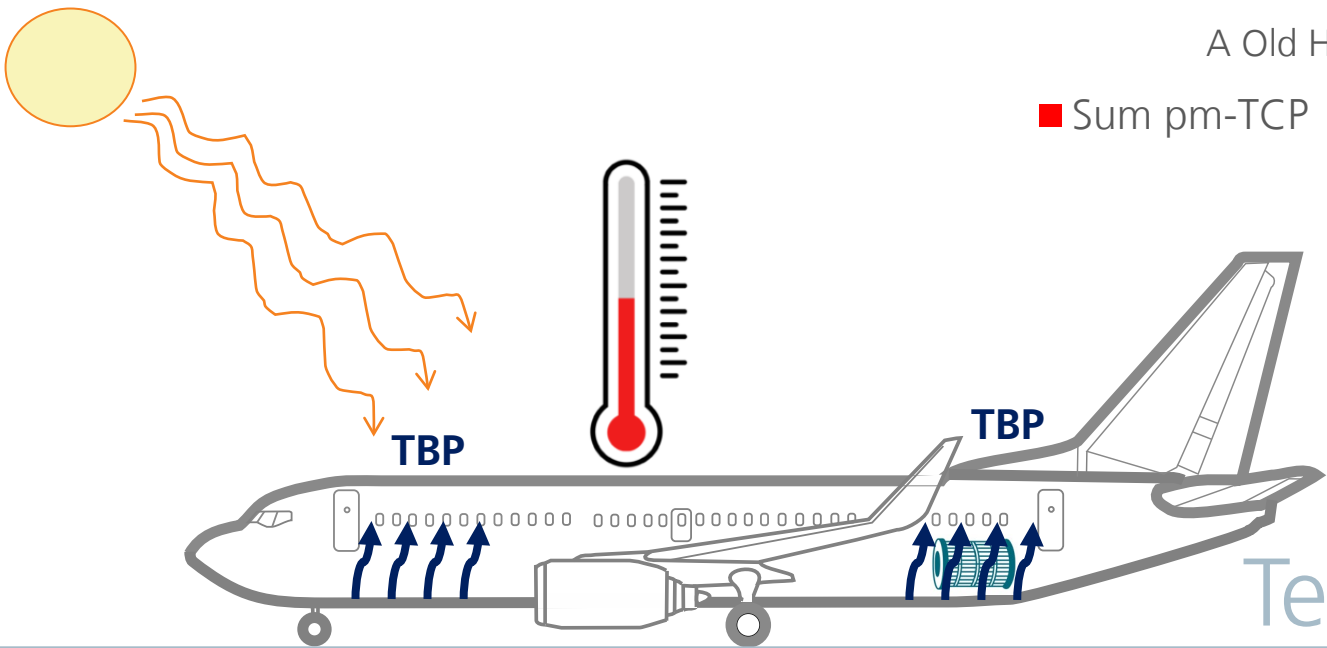
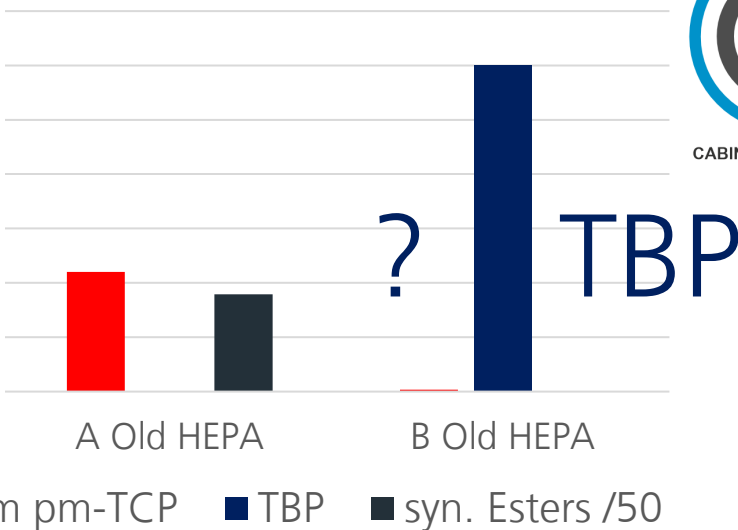
BACS: Sampling Vessel

First Conclusions:

- ✓ Oil particulates and TCP do not pass HEPA Filter

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Teruel HEPA-Filter Sampling

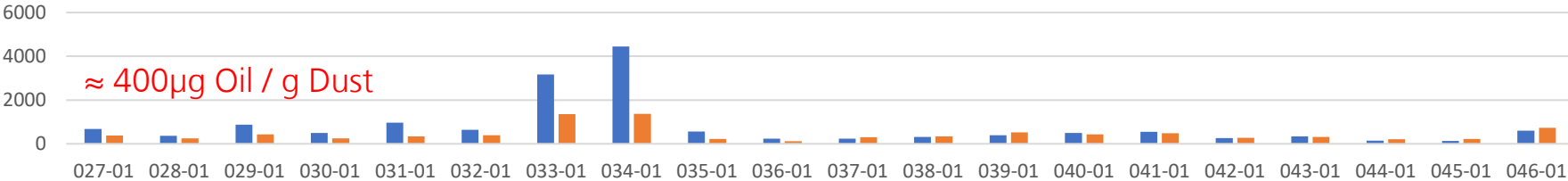
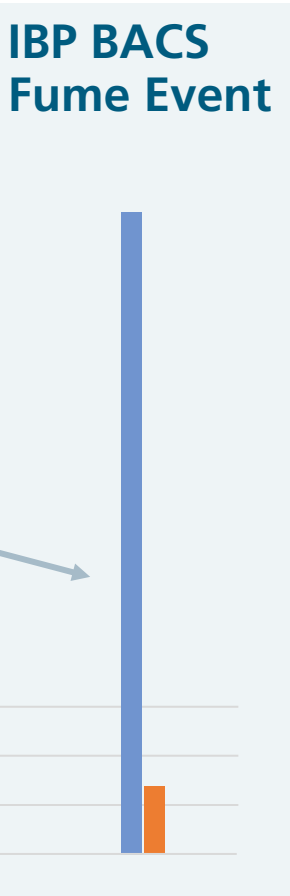


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In-Flight HEPA-Filter Sampling – Oil Content HEPA Filter [$\mu\text{g/g}$ Dust]



Consideration:
1.5 min “Fume Event”
at 5 ppm oil should be
detectable (200 mg).



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WP4: HEPA-Filter, Ground Aircraft Test & ECS-Sampling

		2022				2023				2024			
		1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4	1/4	2/4	3/4	4/4
WP2/WP4 (sub-section)	CAC-Event Simulation & chemical characterization	Holzkirchen											
3.1.2.1	Stability of air flow in the sampling vessel over 2-4 h (at 6 bar and 350°C) when inlet mass flow controller is set to 200 m³/h												
3.1.2.2	Stability of oil dosing over 6-8 working days												
3.1.2.5	HEPA Filter "Fume Event" Test (WP4); 3 used HEPA (from A320 aircraft Teruel); oil pattern analysis												
WP3 (sub-section)	Toxicity Tests / Biomonitoring	Holzkirchen											
3.2.5.1	Dose range finding (DRF) experiment to verify the suitability of the chosen concentration of 6 mg/m³ for exposure tests (dilution)												
3.2.5.2	Complete (toxicity) test plan for defined laboratory tests OECD (2018), Test No. 412: Sub-acute Inhalation Toxicity: 28-Day Study												
WP4 (sub-section)	Ground Aircraft Test (Airbus)	Toulouse											
3.4.3.1	Ground test in Toulouse with artificially provoked fume event (similar to FACTS project) HEPA Filter "Fume Event" Test												
3.4.3.1	Interface to FAA project												

iii) HEPA Filter Sampling in Aircraft (on ground)



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iii) HEPA Filter Sampling in Aircraft (on ground)



FACTS ground test:

- First broad analytical spectrum of realistic oil smell event
- Confirmation of most prominent oil breakdown products

CAQIII ground test:

- Will use the proven concept from FACTS ground test
+ improvements

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iii) HEPA Filter Sampling in Aircraft (on ground)

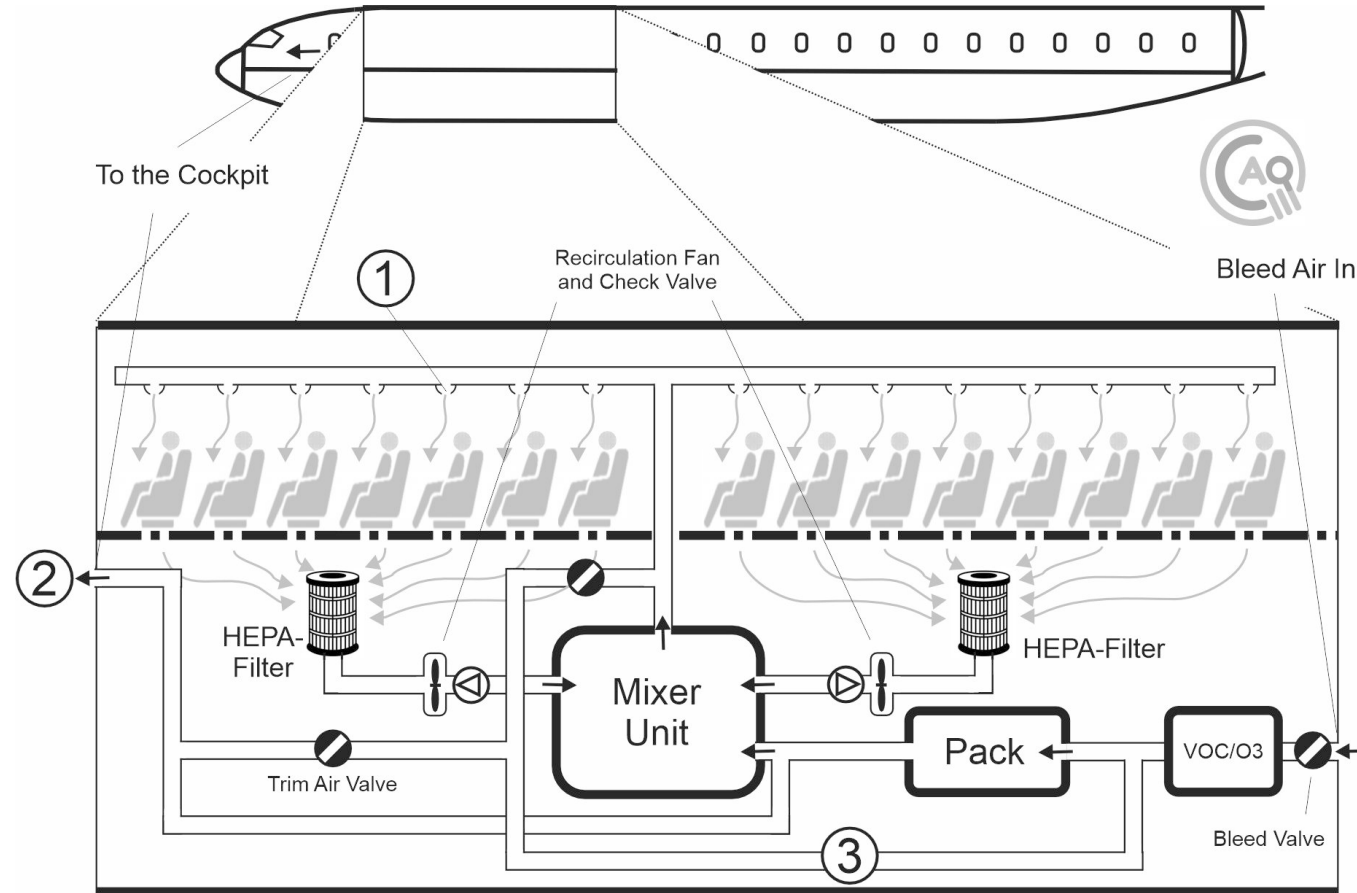


CAQIII ground test improvements:

- Best possible reduction of background contamination
- Improved analytical methods
- Improved sampling concept
- Analysis of HEPA filters

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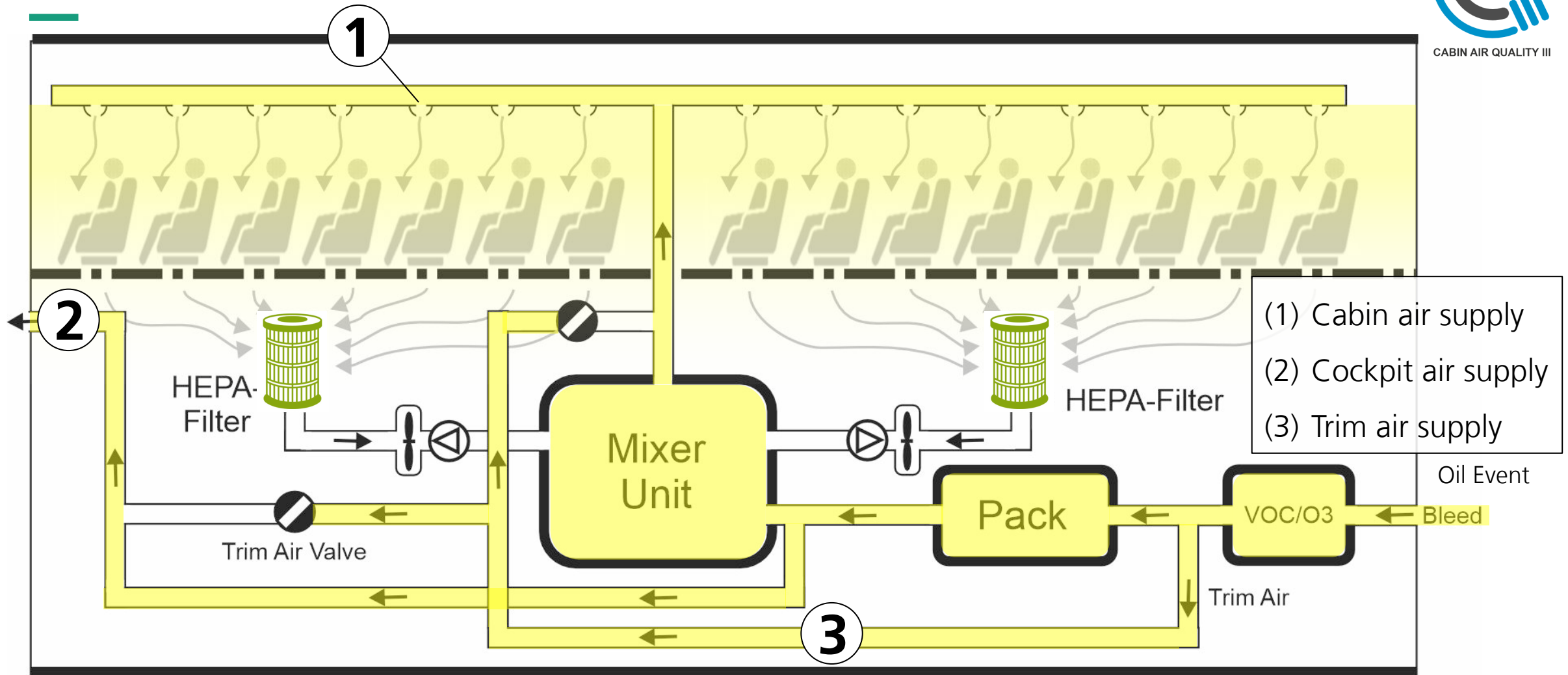
iii) HEPA Filter Sampling in Aircraft (on ground)



- (1) Cabin air supply
- (2) Cockpit air supply
- (3) Trim air supply

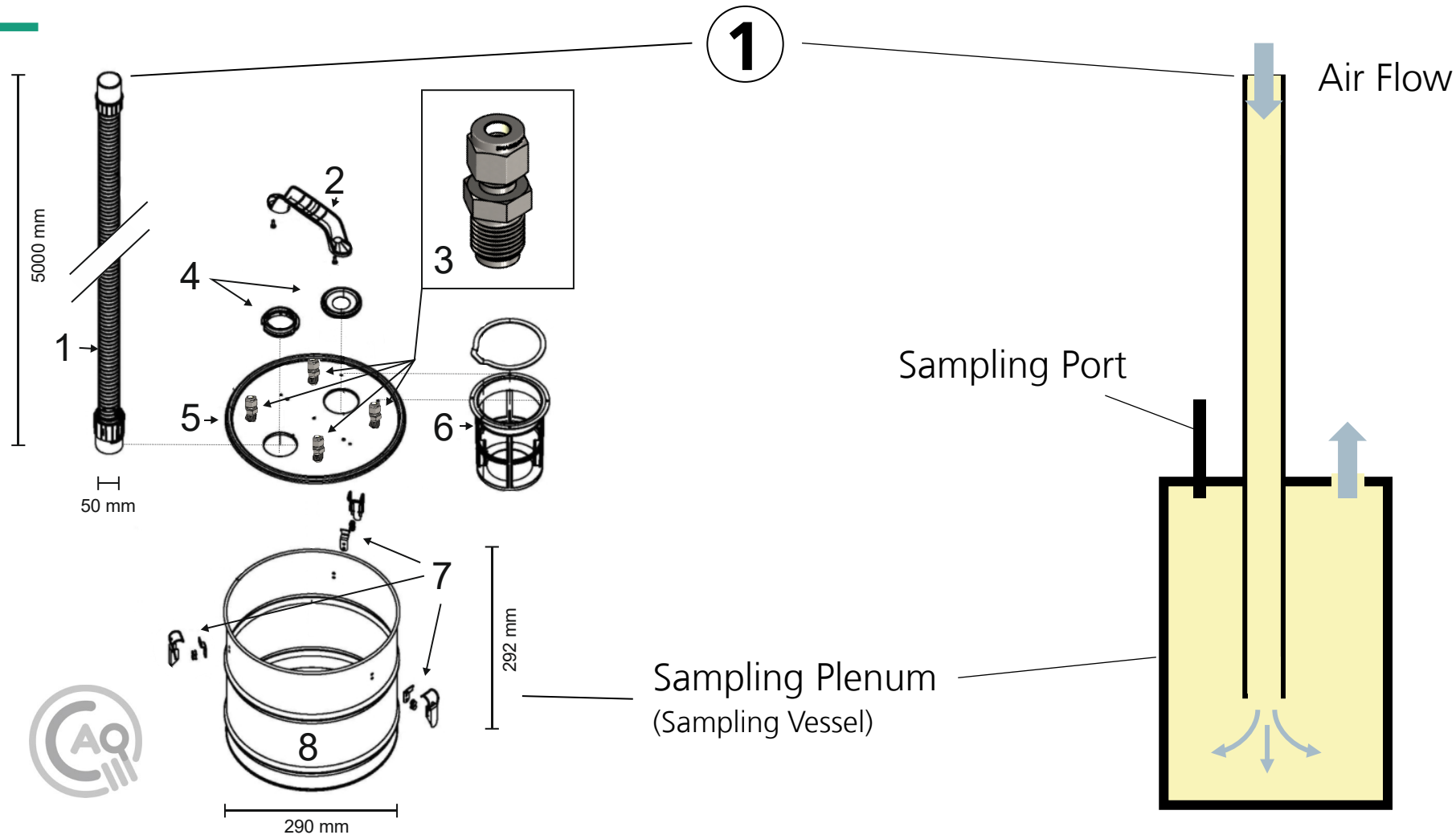
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iii) HEPA Filter Sampling in Aircraft (on ground)



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iii) HEPA Filter Sampling in Aircraft (on ground) – Improved Sampling



- (1) Cabin air supply
- (2) Cockpit air supply
- (3) Trim air supply



Sensor / Method / Contaminant	1. Cabin	2. Cockpit	3. Trim
Online instrumentation			
Proton-Transfer-Mass Spectrometer (installed in supply duct)	-	✓	-
Aerotracer (Ion Mobility Spectrometer)	✓	✓	✓
Pressure	✓	✓	✓
Temperature	✓	✓	✓
Relative Humidity	✓	✓	✓
Ultra-Fine Particulates (size distribution)	TBC	✓	✓
Ultra-Fine Particulates (particle number)	✓	✓	✓
Offline sampling			
VOCs / ISO 16000-6	✓	✓	✓
Organophosphates / ISO 16000-31	✓	✓	✓
Aldehydes / ISO 16000-3	✓	✓	✓
Organic Acids / VDI 4301 Blatt 7: 2018-10	✓	✓	✓

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WP4: HEPA-Filter, Ground Aircraft Test & ECS-Sampling

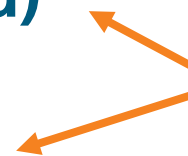


CAQIII integrated HEPA filter testing:

- HEPA filter sampling in aircraft (during flight)
- HEPA filter sampling in aircraft (on ground)
- HEPA filter sampling in laboratory (BACS)



Fume Event simulation



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CALL: Please send us your B787 HEPA filters (it is waste anyway)



★ ★ ★

**CAQ III
NEEDS YOUR B787
HEPA FILTER**

★ ★ ★

„Journalists report plane crashes, not planes that take off.“

Steven Pinker 2015



Thank you for
your attention!

