Moving Towards Complete Cabin Air Filtration

Real Time Monitoring

GCAQE Aircraft Cabin Air Conference
September 2017

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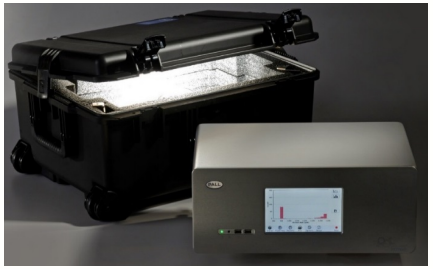
WHY ARE WE DOING THIS?

Background

Voice of Customer from many Airlines
identified a need to be able to trace the source of odors in the cabin.

Mature MEMS (Micro Electronic Mechanical System) technology proven for many years was leveraged to create cutting edge technology:

- Used to monitor moisture in air to part-per-trillion (PPTs) levels and for detection of explosives
- Can identify if fresh air supply is contaminated



Can be applied for Aerospace, Commercial and Military applications

Leveraging proven technology for Aerospace applications.

The Requirement

DOT/FAA/AM-15/20
Office of Aerospace Medicine
Washington, DC 20591

Federal Aviation Administration

Aircraft Cabin Bleed Air Contaminants: A Review

16. Abstract

The purpose of this paper is to describe potential health-related risks surrounding human exposure to bleed air contaminants generated during "fume events" inside pressurized aircraft. Information was obtained from available literature primarily in regard to carbon monoxide, carbon dioxide, ozone, volatile and semi-volatile organic compounds, and airborne particles.

The quality of air distributed throughout the cockpit and cabin during air transportation in a pressurized aircraft is critically important to human health. Since 1984, public law in the United States has directed research in cabin air quality, including investigation of health risks among individuals exposed to toxic fumes during flight.

Quantification of the potential health risks associated with exposure to bleed-air contaminants in cabin air is not possible without broad identification and measurement of the representative hazardous constituents of bleed air during contaminated air events. Such broad identification and measurement does not exist. Included in Public Law 112-95 is the directive to "assess bleed air quality on the full range of commercial aircraft operating in the United States." Carrying out such a mandate requires adequate funding to support required research.

Quantification of the potential health risks associated with exposure to bleed-air contaminants in cabin air is not possible without broad identification and measurement of the representative hazardous constituents of bleed air during contaminated air events

The Need

System	Number	Examples
APU	24	Oil, de-icing fluid
Avionics	13	Fan
Fire	9	
ECS	23	Fan
Electrical systems	33	Fan, other components
Electrical system of the cabin	21	Lights
external contamination	11	Dry ice, cigarettes, luggage
Coffee machine	11	Contamination / defect
ovens	24	Contaminations of foreign objects
System error	9	Leakages of hydraulic and fuel lines
Import of technical compounds	8	Glue, de-icing fluid
Engine	13	
Engine - washing	11	
Engine - oil overfill	3	
Engine - bird strike	10	
Other	5	Cannot be correlated to one of the above-mentioned groups
Not determined	42	
Unknown	386	
None	3	

Transmitted technical causes

Source: BFU

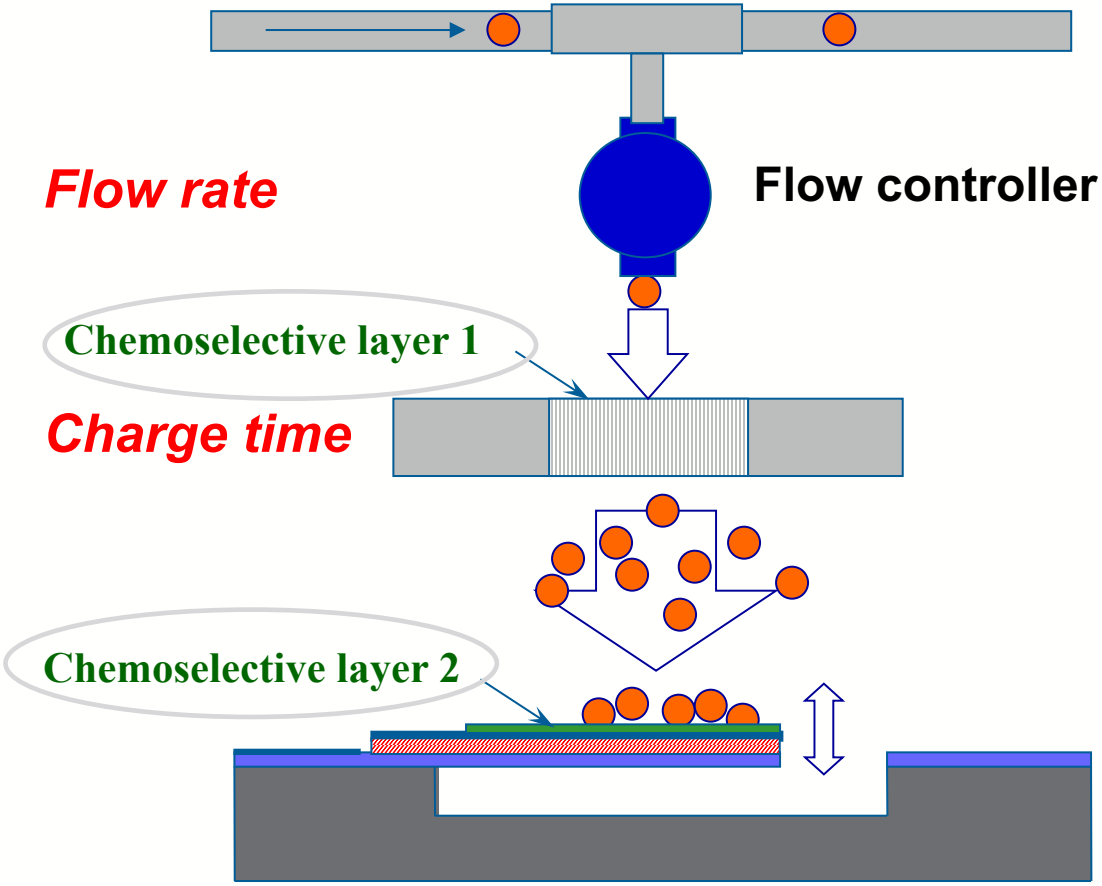
Key Features and Benefits

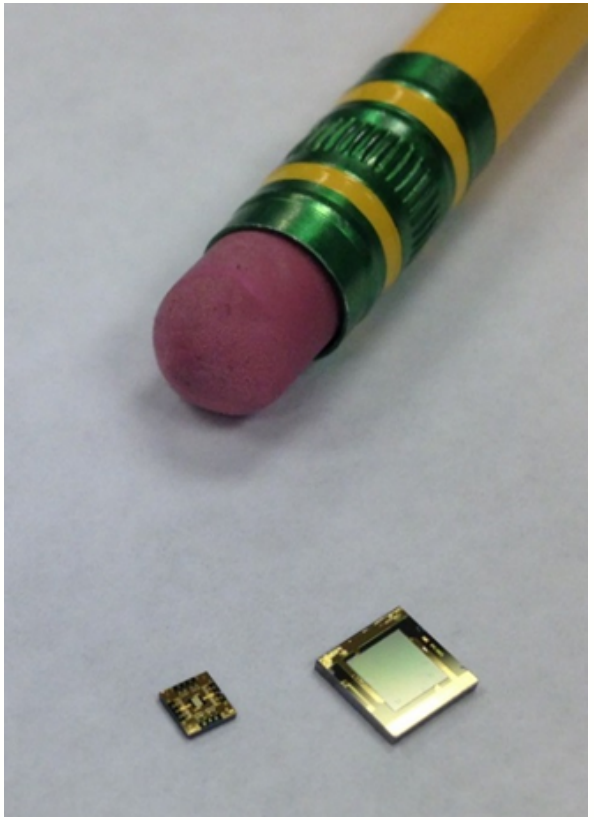
- **Identifies** presence and disappearance of fume event
- **Categorizes** the fume event based on prescribed conditions, e.g.:
  - Event #1 – Skydrol leak
  - Event #2 – Lube oil leak
  - Event #3 – Deicing Fluid
  - Event #4 – Other

- **Improves** efficiency of maintenance activities
- **Enables** predictive maintenance (identifying trend of VOC levels in line with impending failures)
- **Ensures** a pro-active approach by improving overall cabin air quality for crew and passengers

PRINCIPLES OF OPERATION

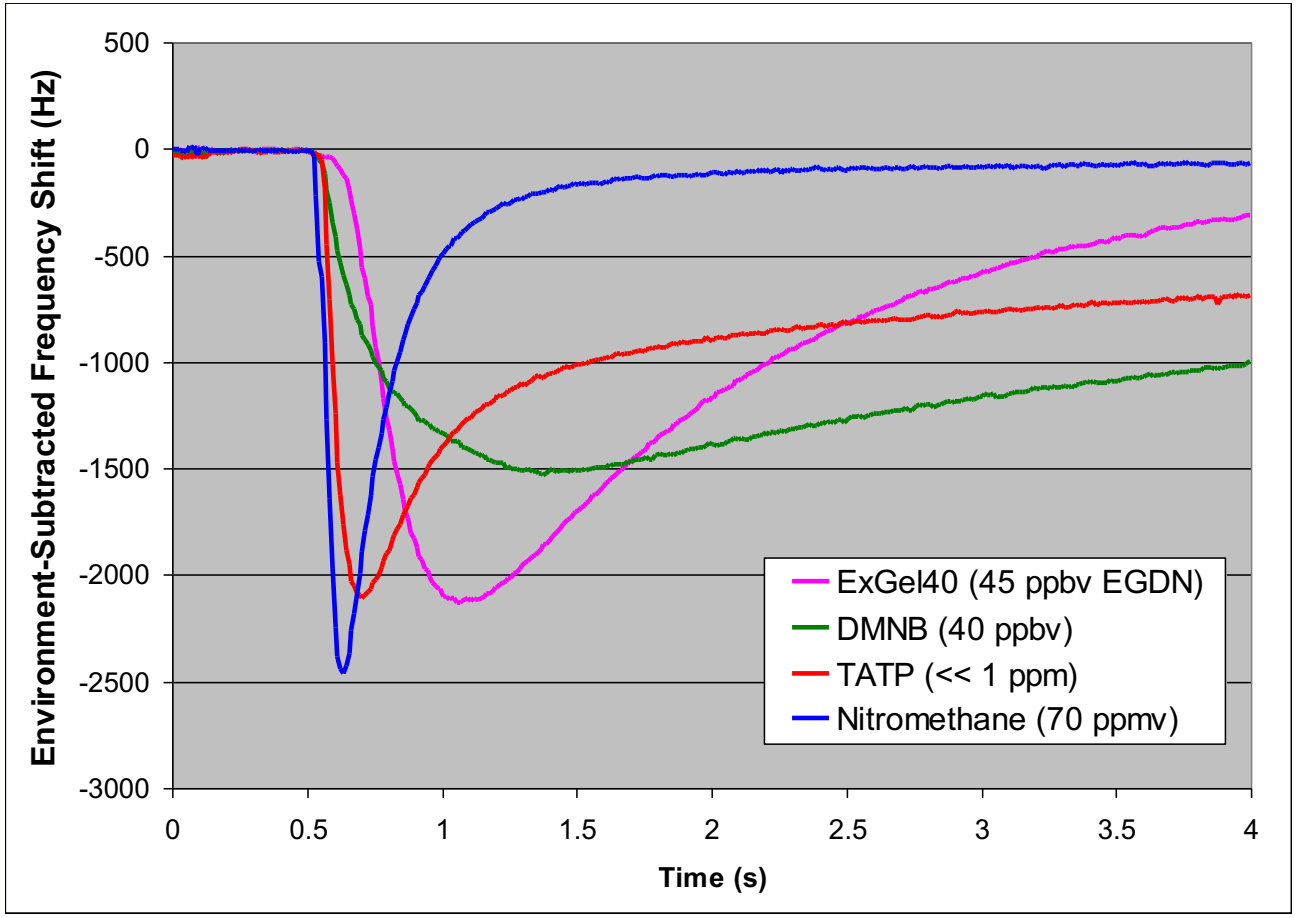
Principle of Operation





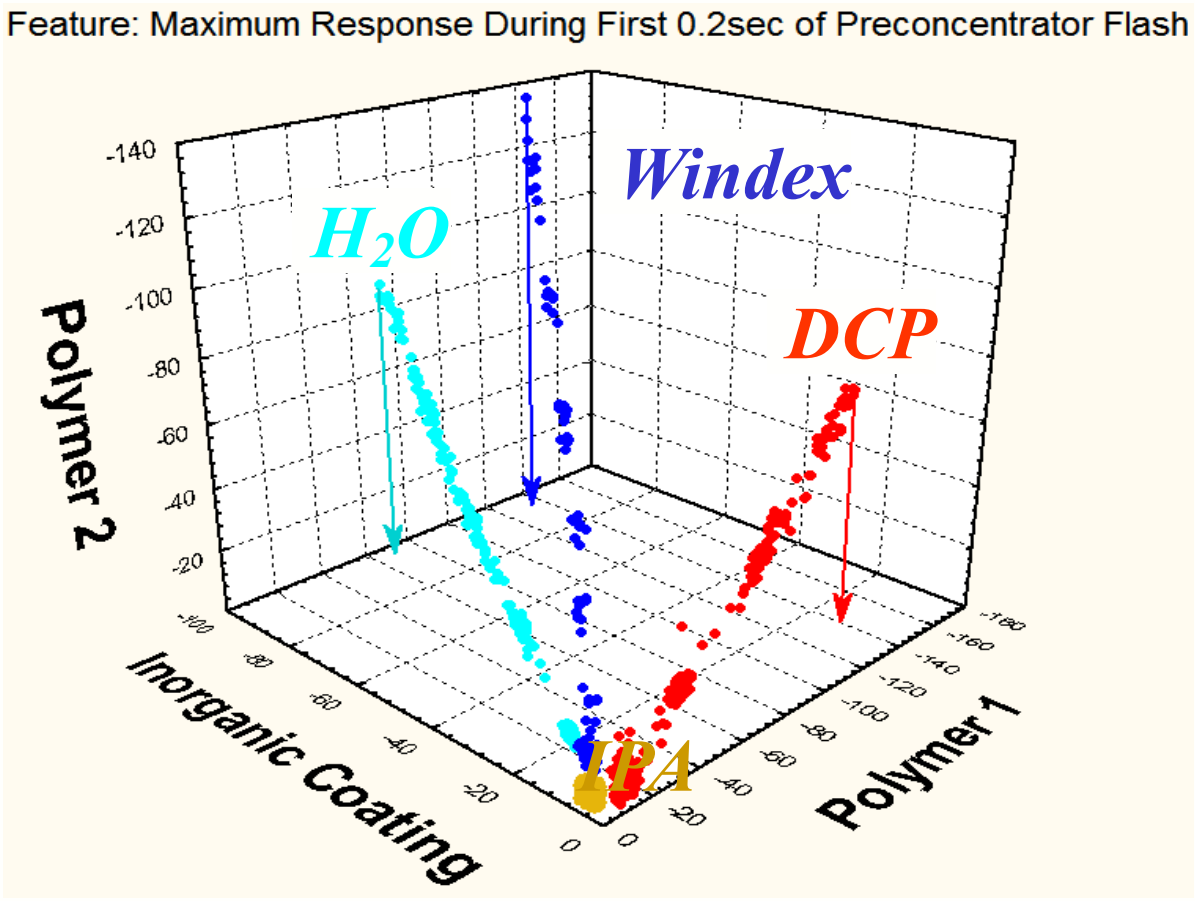
Response “speed” Helps Identify Analytes

- Response of 1 resonator to 4 different analytes



Analytes are Identified in Feature Space

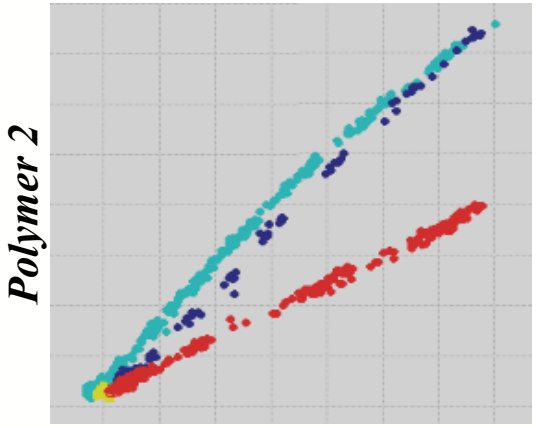
Feature: Maximum Response During First 0.2sec of Preconcentrator Flash



Maximum exposures:

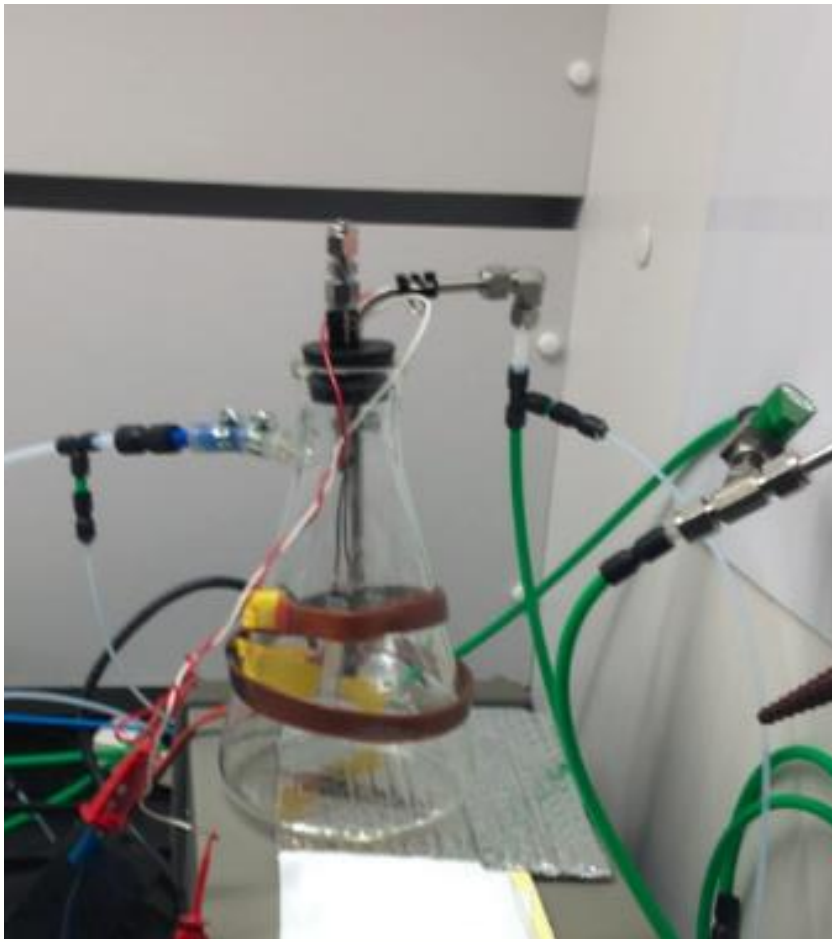
DCP:	***100 ppm***
IPA	***10% of saturation***
Water:	***60% RH***
Windex:	***50% Saturation***

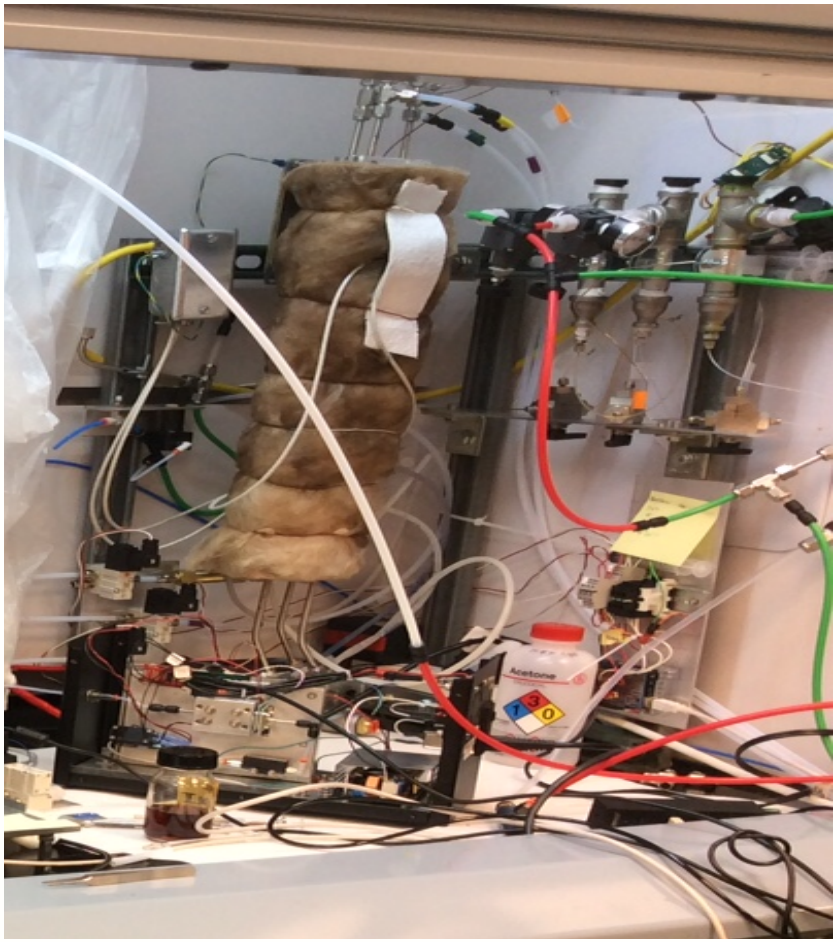
2D Projection



PROVING THE TECHNOLOGY

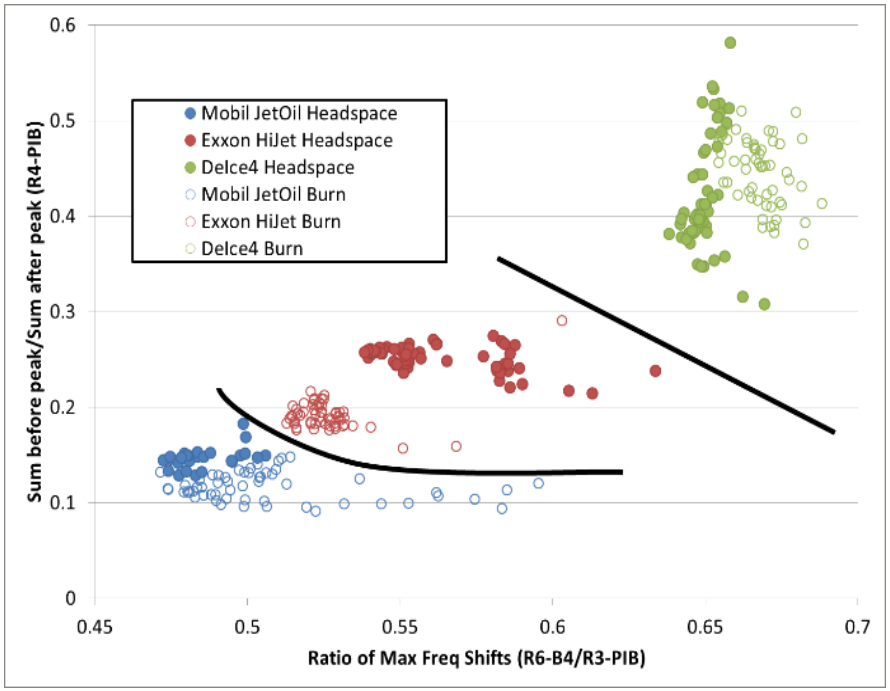
Lab Tests of Simulated Fume Events

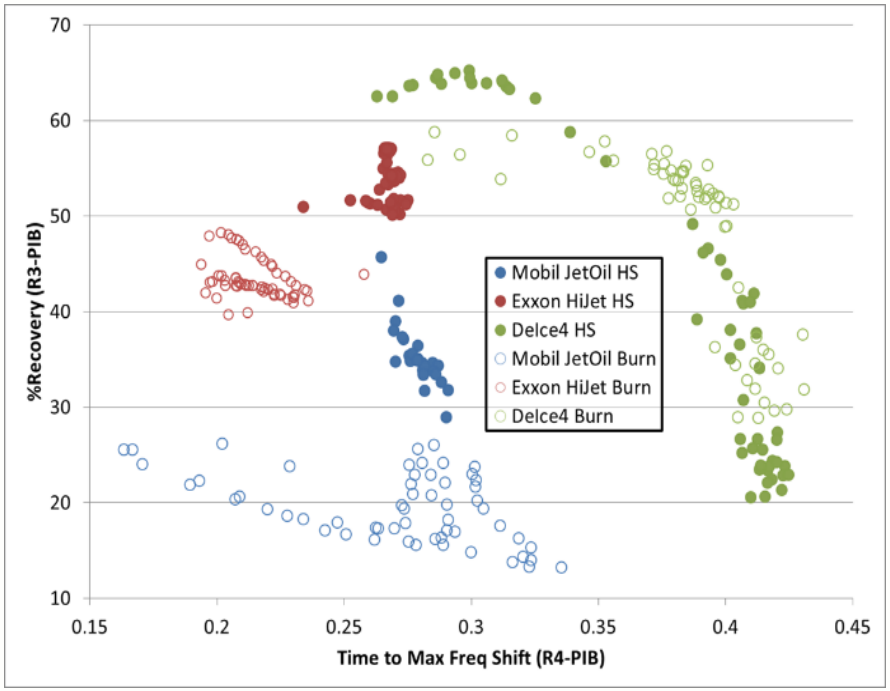




Lab Trials
- AC Fluid Headspace and Simulated Fume Events -

- Demonstrated detection & classification





Alpha prototype trial in A320 cabin

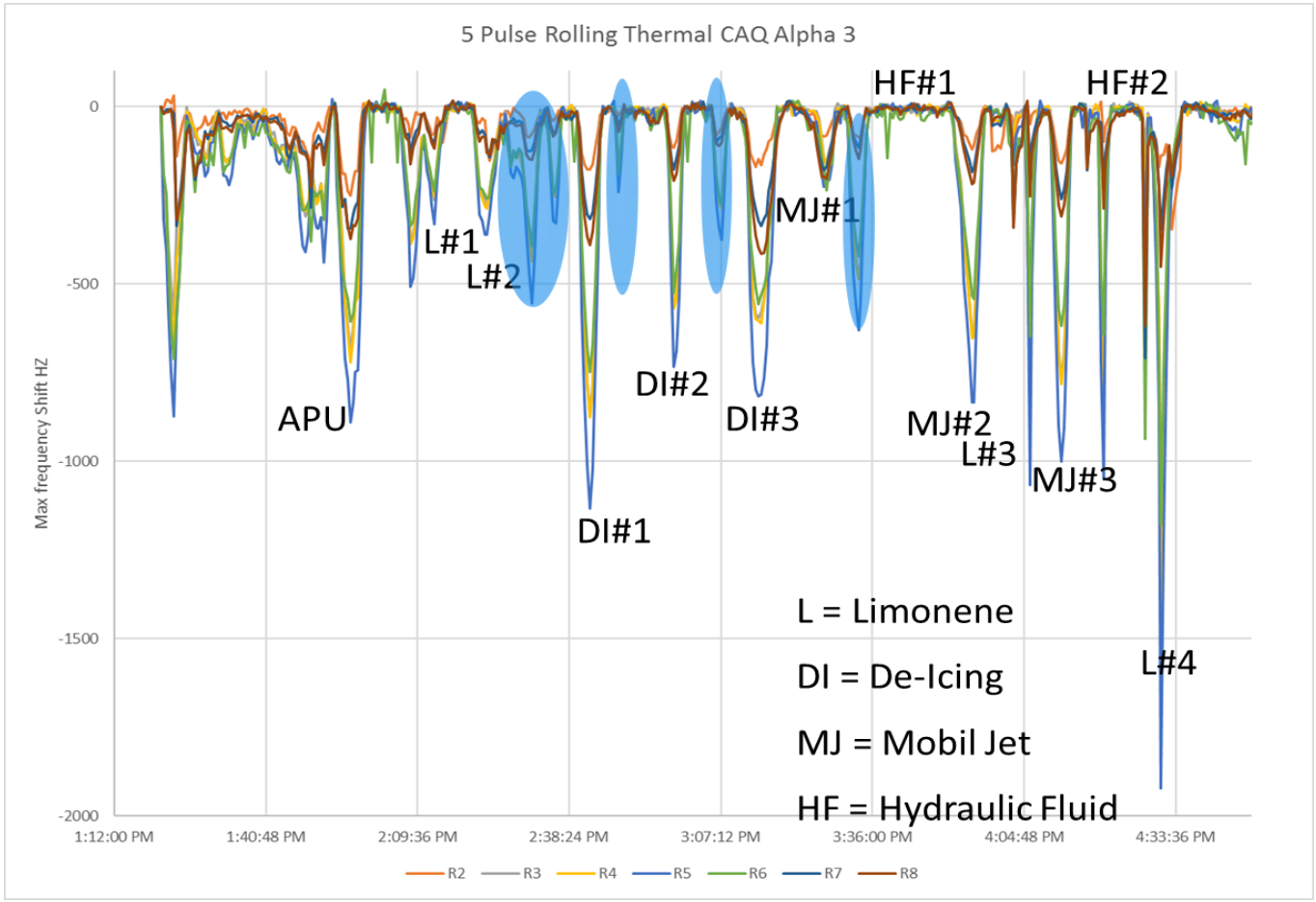
3 PROTOTYPES
assembled and tested on A320 in hanger

FUME EVENTS
simulated by spraying / burning fluids in cargo hold

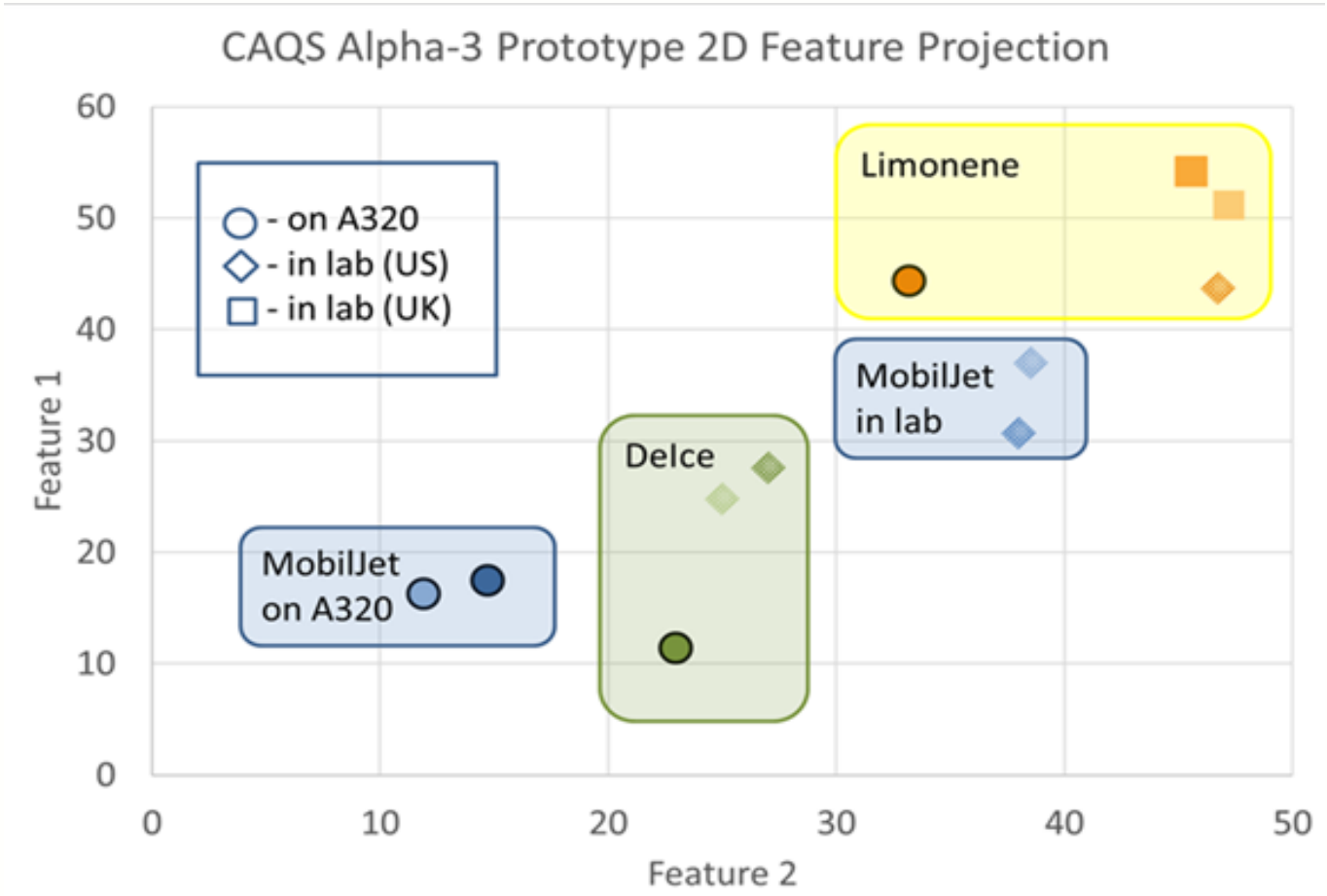
VAPORS AND FUMES
drawn through HEPA filter and circulated through cabin

The support
of Airlines and OEMs
has been and continues
to be vital to the success
of this initiative.

Alpha Prototype Trial
- A320 Cabin -



2D Representation of Sensor Responses Classified by Fluid



WHERE ARE WE
AND
WHAT NEXT

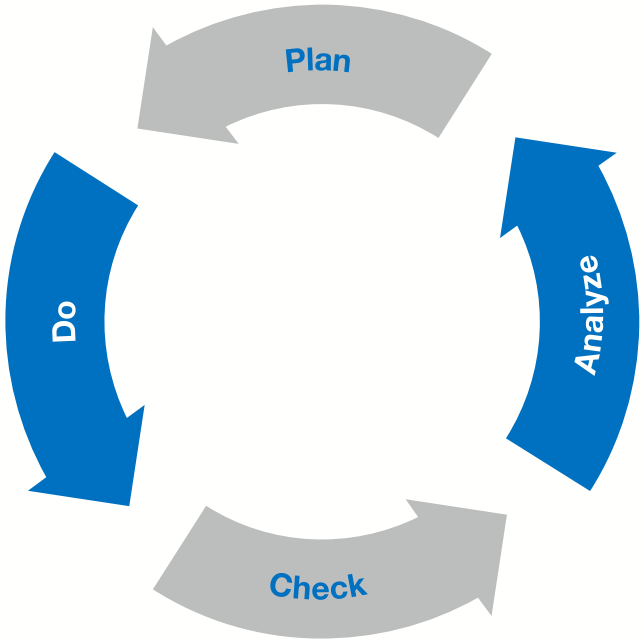
Current Status
- Plan / Do / Check / Analyze -

PLAN

Flight trial units in manufacture and software and pattern recognition algorithms on plan

DO

Prototypes respond to ~1ppm vapor challenges and/or burns of limonene, turbo oil and de-icing fluid



CHECK

Sensors were reusable and recovered from ~1ppm simulated fume event concentrations within minutes

Analyze

- How representative are simulated fume events to actual fume events?
- How representative was the in-hanger trial cabin environment to actual in-flight cabin environments?

Act

- Complete development and manufacture of flight test units
  - 10 units planned
  - 6 committed
- Flight test - Cabin Air Quality sensor prototype
  - Measure the dirty and variable cabin “background”
  - Measure actual fume events
    - Data will be used to finalize pattern recognition algorithms
- Agree output on the production standard
  - Several inputs from different airlines
- Finalize production standard and release to the market
  - 2nd Half 2018

Finally - True Cabin Air Filtration!

- Available 2018!

Thank you! Any questions?

THANK YOU

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