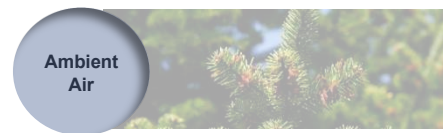


# Field-Ready Instrumentation for Directive (EU) 2024/2881: Meeting New Standards in VOCs Monitoring

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Atmos'Fair - October 15 & 16, 2025 - Lille, France



# Outline

- Latest Directive (EU) 2024/2881
- airmOzone system
- airmOzone + DET QMS : auto GCMS
- Conclusion



# Directive (EU) 2024/2881: ozone precursor

## Annexe VII section 3 of [Directive \(EU\) 2024/2881](#) : Measurement of Ozone Precursor Substances

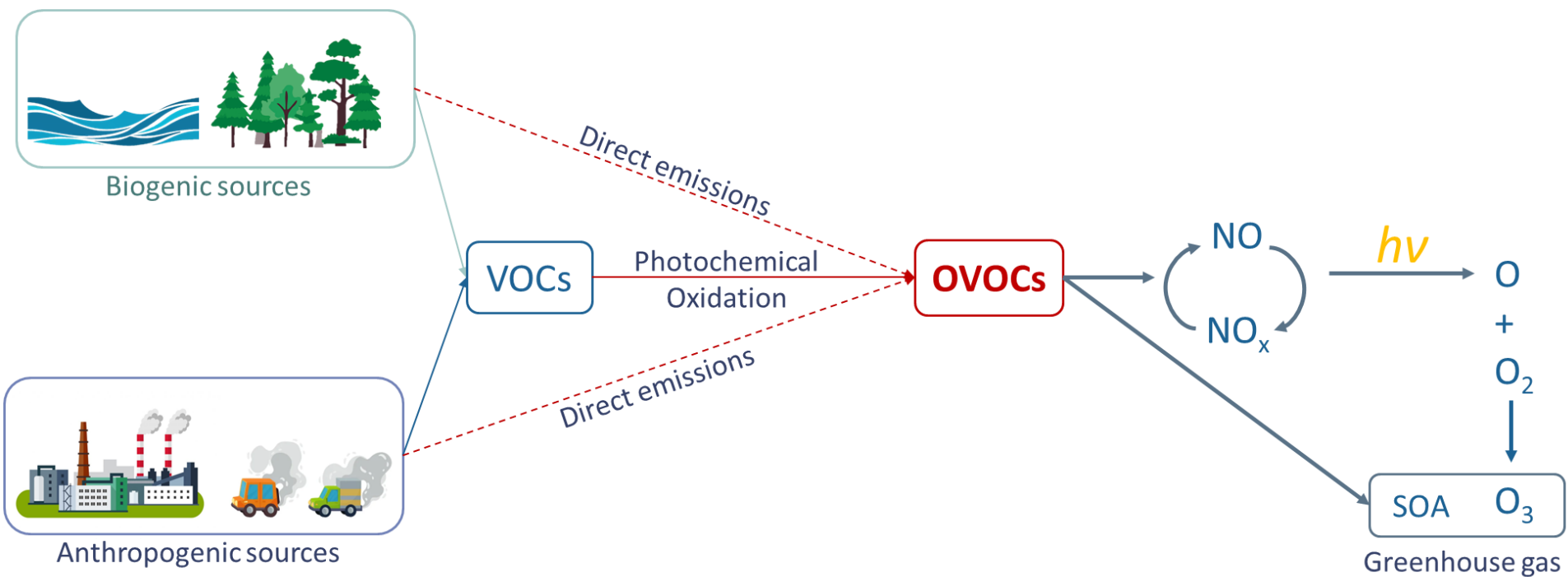
An evolution of the previous Directive 2008/50/EC ANNEX X.

Measurements at monitoring supersites and of mass concentration, chemical composition of PM2.5, **ozone precursor substances** and ultrafine particles.

- **Volatile Organic Compounds** (VOCs) play a critical role in the formation of ground-level ozone and secondary particulate matter.
- **VOCs** from emerging **urban sources**, such as everyday chemical products and cooking, play an increasing role in the formation of tropospheric ozone and secondary organic aerosols (SOA).
- These two pollutants have a direct impact on air quality, human health, and the climate.



# Ozone precursors



# VOC lists

- European new list 47 VOCs (2024)

- In Europe, ambient air legislation targets Benzene
  - With an annual limit value of  $5 \mu\text{g}/\text{m}^3$  (to be reduced to  $3.4 \mu\text{g}/\text{m}^3$  by 2030).



- US EPA lists

- PAMS 56: includes BTEX or 58 (including  $\alpha$ - and  $\beta$ -pinene);
- New PAMS 61: includes BTEX, 1-3 Butadiene,  $\alpha$ - and  $\beta$ -pinene;
- TO14: includes BTEX and chlorinated VOCs (Cl-VOCs);
- TO15: includes BTEX and chlorinated/brominated/oxygenated VOCs (Cl / Br / O-VOCs).



# List of VOC recommended for measurement in Directive (EU) 2024/2881

## airmoVOC C2-C6

- C2** Ethane  
Ethene = ethylene
- C3** Propane  
Propene  
isobutane = 2-méthyl propane
- C4** n-butane  
Acetylene  
trans-2-butène  
**1-butene**  
1,3-Butadiene  
cis-2-butène  
Iso-pentane = 2-methyl butane
- C5** n-pentane  
trans-2-pentene  
1-pentene  
cis-2-pentène  
2-methylpentane = i-Hexane
- C6** n-hexane  
**isoprene**

## airmoVOC C6-C12

- C4** **Methyl Ethyl Ketone = MEK\***  
**Methyl Vinyl Ketone = MVK\***
- C6** Benzene
- C7** n-heptane  
Toluene
- C8** 2,2,4-trimethylpentane = i-octane  
n-octane  
**Ethylbenzene**  
m-xylene  
p-xylene  
o-xylene
- C9** 1,3,5 trimethylbenzene  
1,2,4 trimethylbenzene  
1,2,3 trimethylbenzene
- C10** **p-Cymene**  
**Limonene**  
**β-myrcen**  
**α-pinene**  
**β-pinene**  
**camphene**  
**Δ3-carene**  
**1,8-Cineol = Eucalyptol**

## airmoF

Formaldehyde

## airmoOVOC

**CH3OH Methanol**  
**C2H6O Ethanol**  
**C3H6O Acetone**  
**C2H4O Acetaldehyde\***

IPA  
Ethylene Oxide



In black compounds included in previous [European directive 2008/50/EC](#)  
In blue compounds added in the [new directive 2024/2881](#)

\* Compounds which might have potential interfering compounds on standard column. Fully separated with **autoGCMS**



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# List of VOC recommended for measurement in Directive (EU) 2024/2881

## Alkanes:

Ethane  
Propane  
n-Butane  
i-Butane  
n-Pentane  
i-Pentane  
n-Hexane  
i-Hexane  
n-Heptane  
n-Octane  
i-Octane

## Aromatic hydrocarbons:

Benzene  
Toluene  
Ethyl benzene  
m+p-Xylene  
o-Xylene  
1,2,4-Trimethylbenzene  
1,2,3-Trimethylbenzene  
1,3,5-Trimethylbenzene

## Alkynes:

Acetylene

## Alkenes:

Ethene  
Propene  
1,3-Butadiene  
1-Butene  
trans-2-Butene  
cis-2-Butene  
1-Pentene  
2-Pentene

## Terpenes:

Isoprene  
p-Cymene  
Limonene  
β-Myrcene  
α-Pinene  
β-Pinene  
Camphene  
Δ<sup>3</sup>-carene  
1,8-Cineol

## Aldehydes:

**Formaldehyde**  
**Acetaldehyde**  
**Methacrolein**

## Alcohols:

**Methanol**  
**Ethanol**

## Ketones:

**Acetone**

Methyl ethyl ketone  
Methyl vinyl ketone

Analytical challenge:

- Light compounds
- Reactive compounds



## **airmoF**

Microfluidic device based on Hantzsch reaction

Specific to **formaldehyde**



## **airmoVOC:**

Auto-TD-GC-FID for light oxygenated compounds:

**Methanol**  
**Ethanol**  
**Acetone**  
**Acetaldehyde\***  
Ethylene oxide  
Isopropanol

*\*With DetQMS option*



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# Certified Air monitoring system

- **Certified successfully by NPL for all tests** according to European standard **EN 14662-3** on Benzene and 11 other compounds.  
*since July 2014 and 2015 version*
- Certified under EN 15267-2 for production management quality control.
- The **only rack-mounted automatic GC** selected by the **U.S. EPA**.
- **ISO 17025** compliant for **Benzene calibration**.





# airmOzone system

Automatic analysis of all VOC compounds:

- airmoVOC **autoGCs** systems include :
  - **A pre-concentration trap** to detect down to 1 ppt;
  - GC **metallic capillary column** for precise VOCs speciation;
  - **FID detector** for selective measurement of carbon-based compounds;
  - **MS** in option for advanced on-site expertise.
- Gas generators for stand-alone solution requiring only electricity!
  - Including H<sub>2</sub> and zero air generators!
- airmoCAL MFC sampling and calibration system for:
  - **Multi-point checks or calibrations** using an external gas cylinder or internal certified permeation tubes.
  - **Zero checks.**
  - **Sample** selection.

**Carrier gas  
cylinder free !**



# airmOzone specificities vs single lab GC

- ✓ Two independent instruments for C2-C12 measurements
  - This configuration allows specific analytical conditions for each GC: C<sub>2</sub>–C<sub>6</sub> and C<sub>6</sub>–C<sub>12</sub>, including:
    - **Head column pressure;**
    - **Column temperature;**
    - **Trap desorption temperature;**
  - Optimized hardware
    - **Sample conditioning;**
    - **Specific sorbent material;**
- ✓ 30-minute analysis cycle (extendable to 60 min to improve separation & identification)
  - Key-advantage for identification of short-term events.
- ✓ Stand-alone and fully automatic system.

airmoVOC C2-C6 (4U)



airmoVOC C6-C12 (5U)



# Results - chromatogram

## airmoVOC C2C6 - analysis at 100 ppb

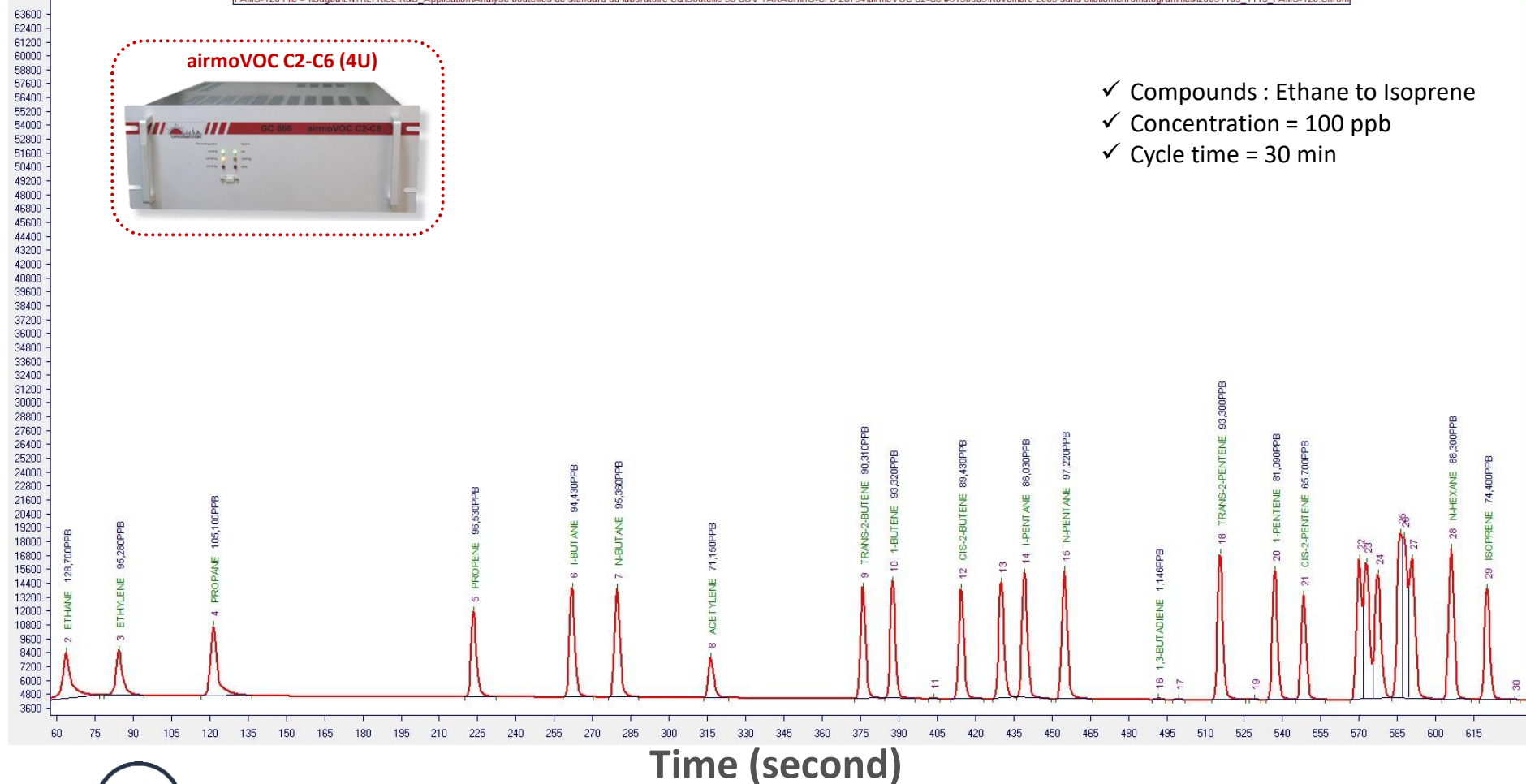
Retention Time = 403.54 s Detector value = -325

PAMS-120 File = \\Dagba\ENTREPRISE\RD\_Application\Analyse bouteilles de standard du laboratoire COI\Bouteille 58 COV TAKACHIHO-CPB 28754\airmoVOC C2-C6 #5130905\Novembre 2005 sans dilution\chromatogrammes\20051109\_1113\_PAMS-120.Chrom

airmoVOC C2-C6 (4U)

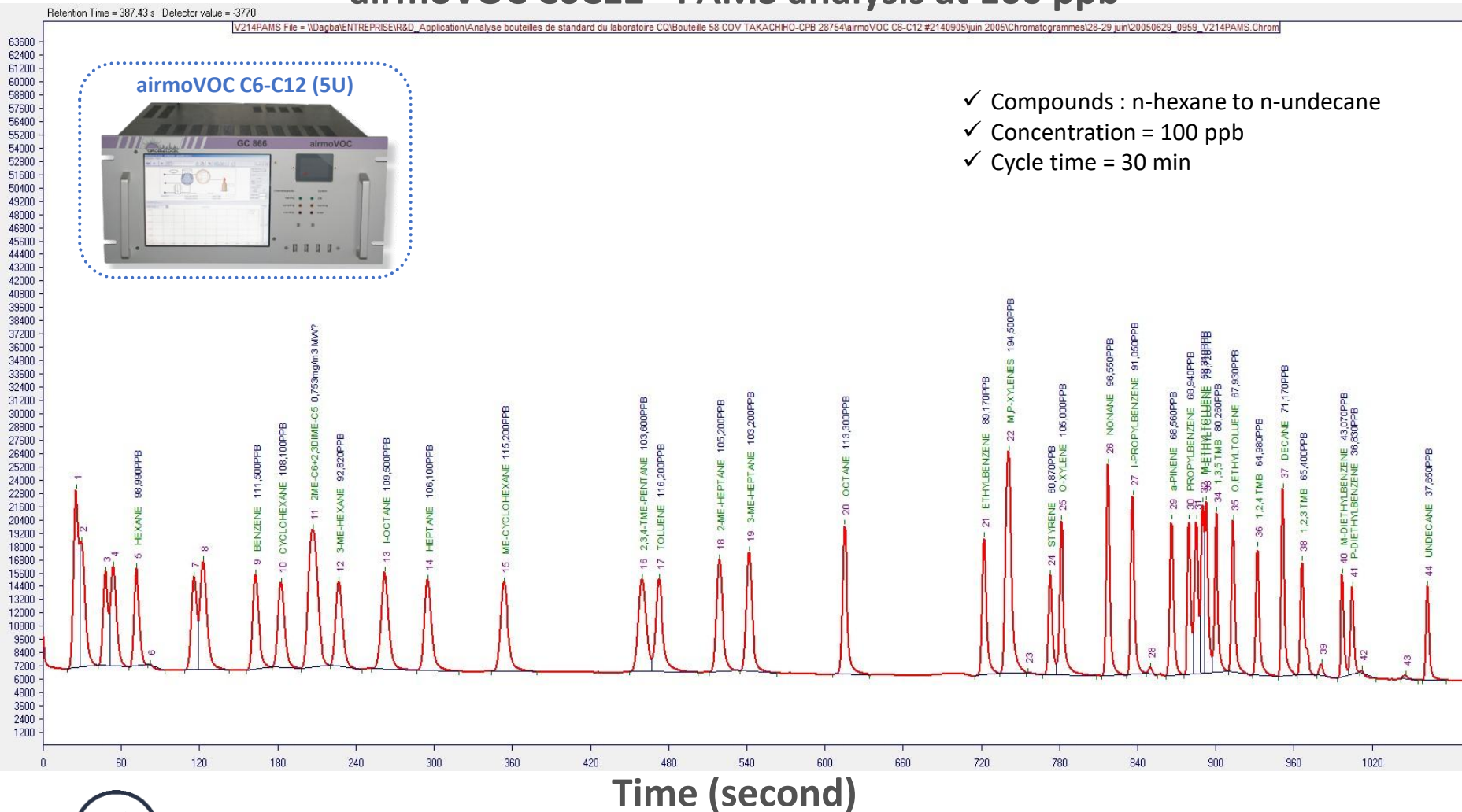


- ✓ Compounds : Ethane to Isoprene
- ✓ Concentration = 100 ppb
- ✓ Cycle time = 30 min



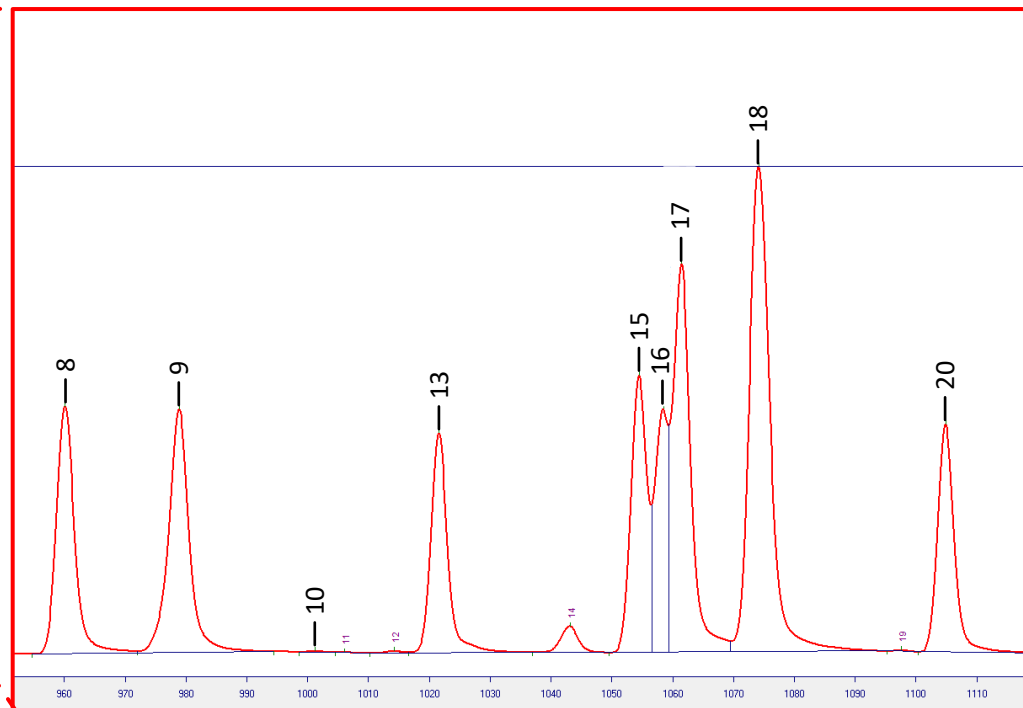
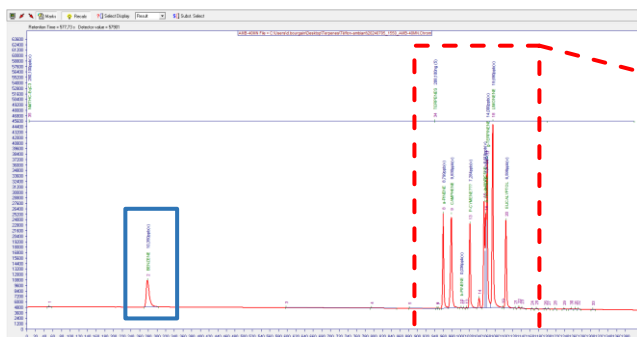
# Results - chromatogram

## airmoVOC C6C12 - PAMS analysis at 100 ppb



# Terpenes compounds analysis

## airmoVOC C6C12 - Terpenes analysis at 7 ppb



N°	Compounds
8	$\alpha$ -Pinène
9	Camphène
10	$\beta$ -Pinène
13	$\beta$ -Myrcène
16	$\Delta^3$ -Carène
17	p-Cymène
18	Limonène
20	1,8-Cinéol



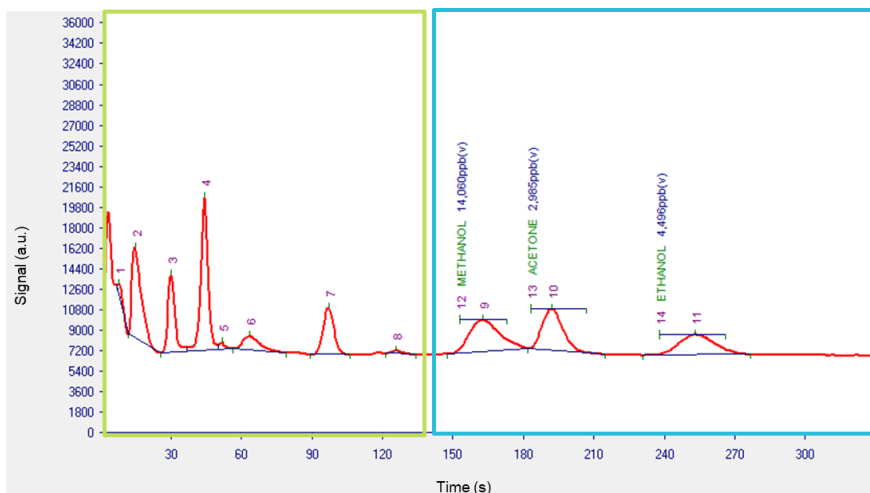
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# Light OVOC analysis

- **airmoOVOC:** separation of light oxygenated compounds

## ✓ Results

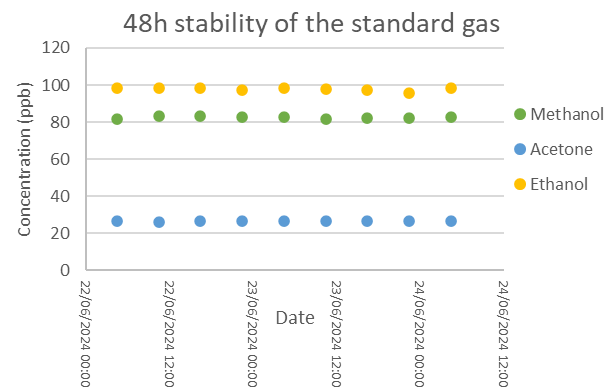


Light apolar compounds elute first.

Light polar compounds are separated and **free from any interference** from other hydrocarbons.

- All compounds demonstrate good linearity from **2 to 100 ppb**;
- System stability on internal standard gas;
- **PAMS cylinder used to validate the lack of interferents.**

## ✓ Repetability

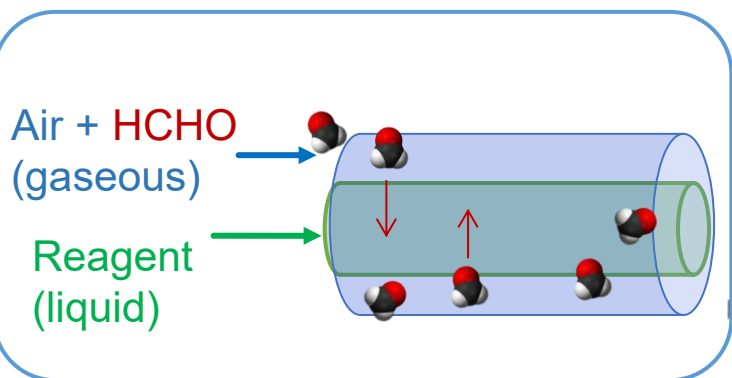


Compound	RSD on standard gas concentrations (%)	R <sup>2</sup>
Acetone	0.40	0.9986
Ethanol	0.94	0.9937
Ethylene Oxide	NA	0.9995
Methanol	0.69	NA

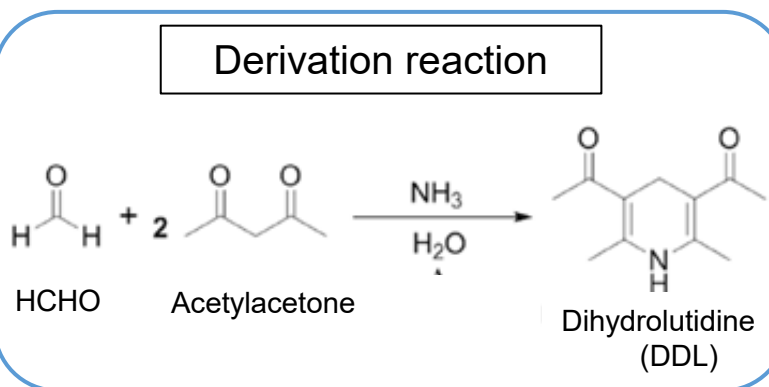


# Material and Methods - airmoF

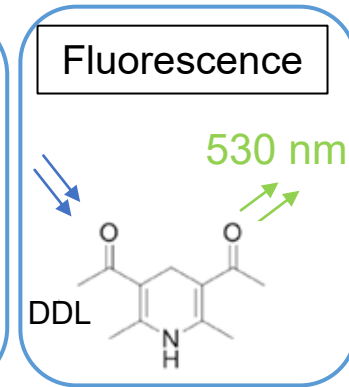
- airmoF: microfluidic device based on the Hantzsch reaction



1. Uptake

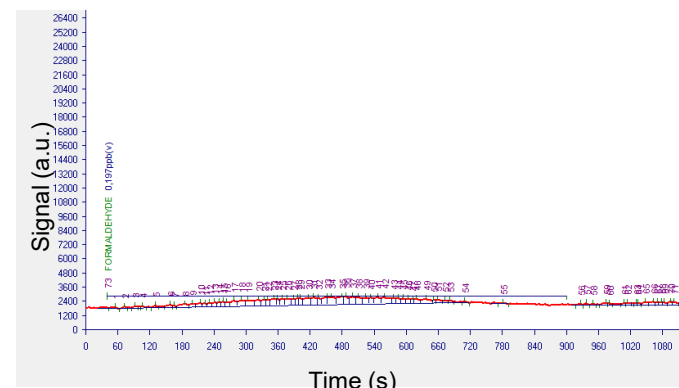


2. Reaction



3. Detection

- Continuous monitoring
- Formaldehyde specific
- Patented sampling device
- Auto-zero at each cycle
  - Prevent negative concentration (especially at trace level)
  - Example of trace level HCHO chromatogram



Résultat airmoF - [HCHO] = 0,197 ppb



# Best features airmOzone

- High data availability:
  - Automatic data processing
  - Low maintenance compared to lab GCs, even in tropical environments such as Thailand, Taiwan, Vietnam, Malaysia
  - Long-term sensitivity stability, thanks to the proven CHROMATOTEC FID detector — more than 5 years of consistent performance = more reliable data
  - Evolutive: more compounds can be added over time
- Full remote access capability with complete system control including: C<sub>2</sub>–C<sub>6</sub> autoGC, C<sub>6</sub>–C<sub>12</sub> autoGC, airmoCAL MFC, and HYDROXYCHROM.
- Compact and easy to install in the field (< 1m<sup>2</sup>)
- No carrier gas cylinder required!
- Customized options available such as: *automatically switch on a device (i.e., canister) to fill in a canister during pollution event when concentration exceeds limits.*





# User profiles

- Customers profiles

- Governmental agencies (EPA, INERIS)

- Meteorological institutes

- University and Research center like ACTRIS network

- Industrial consortium

- Petrochemical groups



# Example of installation: mobile van



**ReStart in less than 1 hour**  
**No need of tune after transport**



*Emergency mobile van for industrial area with full airmOzone MS*



*Emergency mobile van for waste water treatment plant in Paris with VOCs and sulfurs*



# Field Campaign



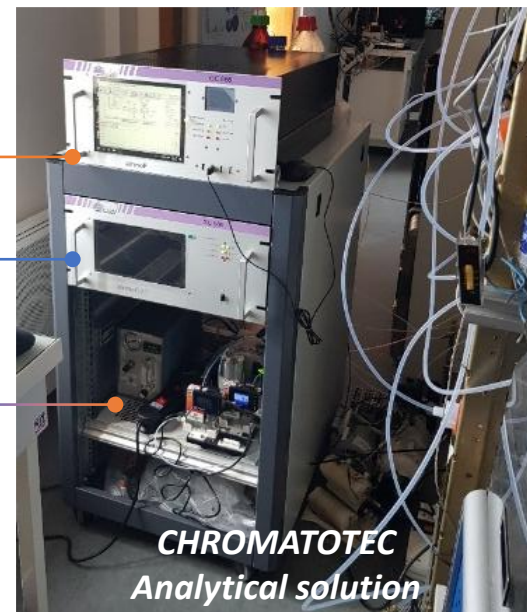
*OPGC - Sampling point*

- Both **airmoOVOC** and **airmoF** tested in real conditions
  - Systems deployed at the **Puy de Dôme research station (1465m)**
  - Continuous measurement from **July to September 2024**
  - Systems stability checked 1/day with **certified permeation tubes**
  - Sampling on **DNPH cartridge** – reference method for HPLC measurement (ISO 16003)

**airmoF**

**airmoOVOC**

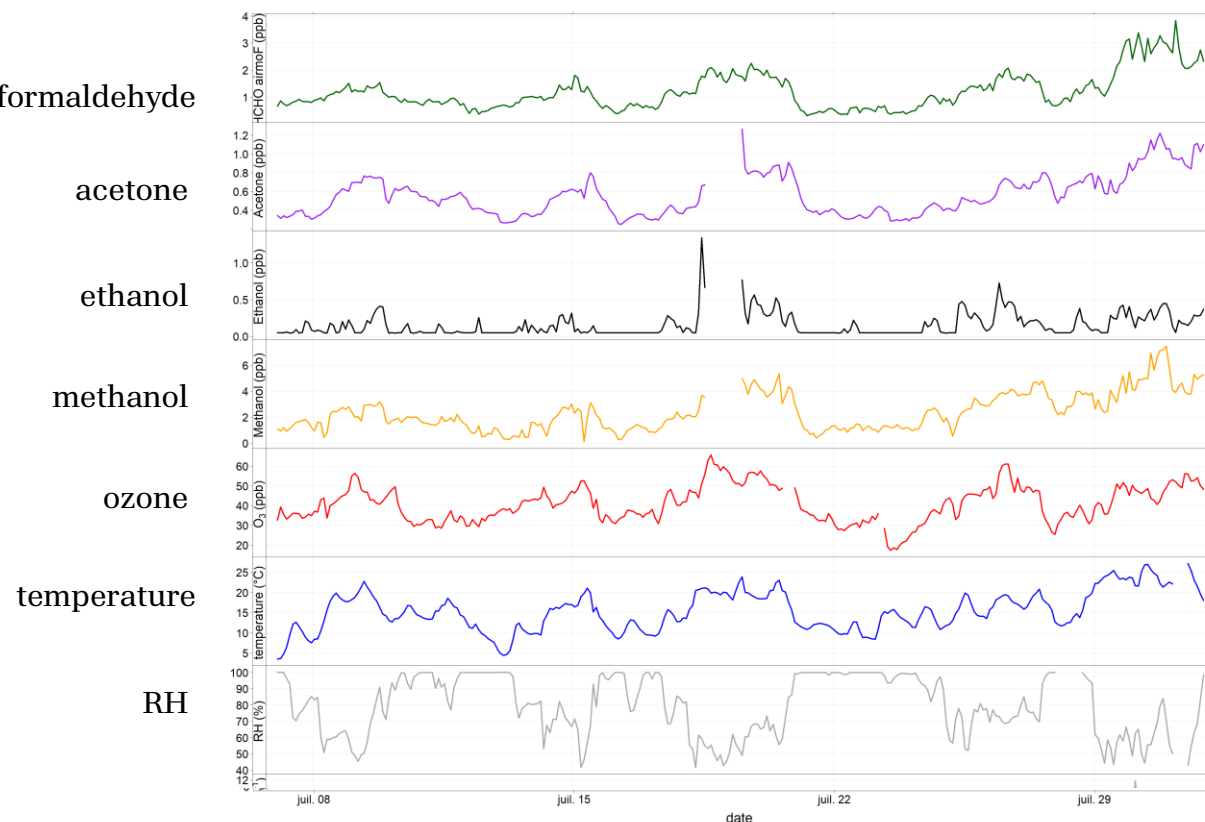
**Standard gas for  
OVOC & HCHO**



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# Field Campaign

Time series of OVOC and meteorological parameters



- Continuous monitoring during 3 months.
- Automatic identification & quantification at trace level (ppb & ppt level).
- Correlation between OVOC concentration, ozone concentration and temperature.





# Some sales reference

## Some airmOzone reference in the world:



More than 40 airmOzone



1 airmOzone in Mexico



1 airmOzone in Costa Rica



More than 25 airmOzone



More than 10 airmOzone



4 airmOzone in Middle East



More than 40 airmOzone



4 airmOzone in India



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# Some sales reference

French Air Quality Monitoring Network



IMT Lille Douai  
École Mines-Télécom  
IMT-Université de Lille



UNIVERSITÉ  
DU LITTORAL  
CÔTE D'OPALE

French Air Quality Monitoring Network

French Research center on atmospheric chemistry



Université  
d'ORLÉANS

air  
pays de  
la Loire  
[www.airpl.org](http://www.airpl.org)



Institut de Chimie et  
Procédés pour l'Énergie,  
l'Environnement et la Santé



université  
de BORDEAUX

Atmo  
NOUVELLE-AQUITAINE

Atmo  
OCCITANIE

AtmoSud

Inspirer un air meilleur



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# Best features airmOzone + MS

- ✓ Automatic quantification of compounds not fully separated by GC
- ✓ Field identification of unknown compounds using GC-MS with an embedded NIST database
  - Add new compounds to the analysis list
  - Allow RT adjustment without standard gas
- ✓ Quantification without standard through the combined use of FID and MS
- ✓ Automatic validation of results with VistaMS:
  - ✓ For both identification and quantification
- ✓ airmOzone can be upgraded to GC-MS directly in the field



*Example of single GCMS with gas generator*



# Conclusion

- Monitoring of VOCs using CHROMATOTEC airmOzone
  - Fully automatic system: with no **carrier gas cylinder required**
  - 30-minute analysis cycle, adjustable from 15 minutes to 1 hour
  - Automatic data processing and validation
  - Compact and transportable system (< 1m<sup>2</sup> footprint)
  - No risk of contamination during sampling VS lab analysis
  - Long-term sensitivity stability with the proven CHROMATOTEC FID detector
  - Adapted to both tropical and non-tropical environments
  - Solution approved and selected by U.S. EPA, RICARDO, NPL and researchers
  - MS option available for advanced expertise and quantification of unknown compounds
  - Existing airmOzone systems can be upgraded to GC-MS
  - Evolutive compound list: new compounds can be added over time

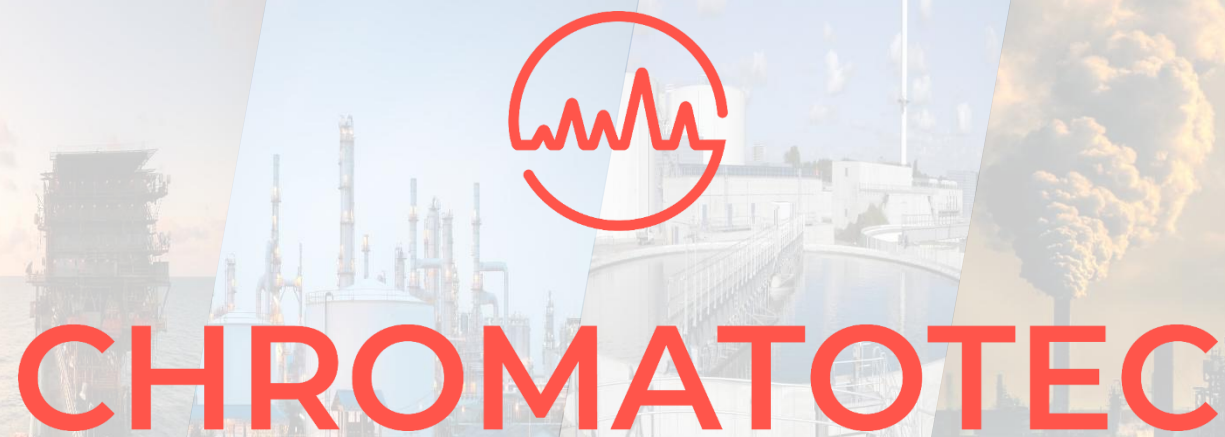


*Know more :*

[http://www.chromatotec.com/IMG/pdf/us\\_epa\\_report-3.pdf](http://www.chromatotec.com/IMG/pdf/us_epa_report-3.pdf)

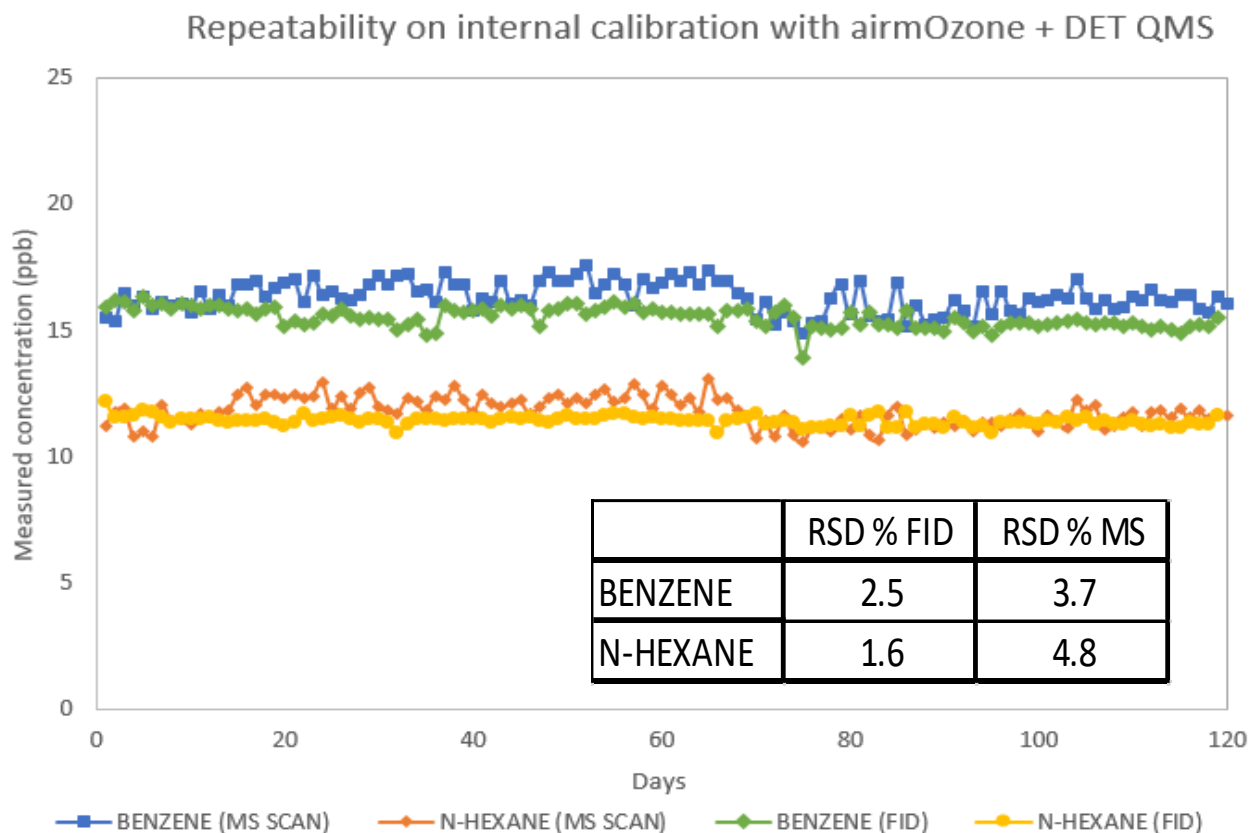






**THANK YOU FOR YOUR ATTENTION!**

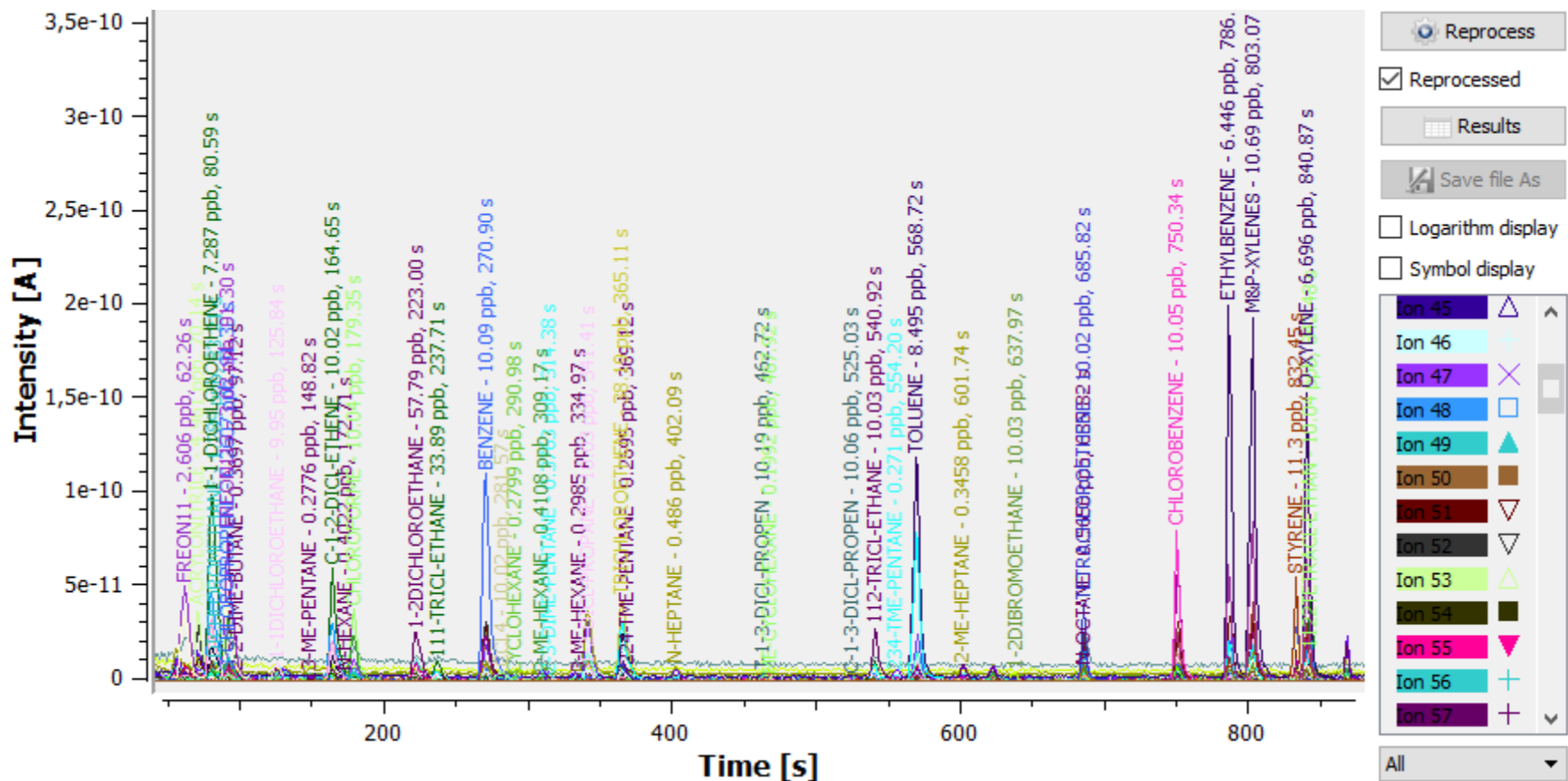
# Long term concentration drift



4 months without any tune or calibration !



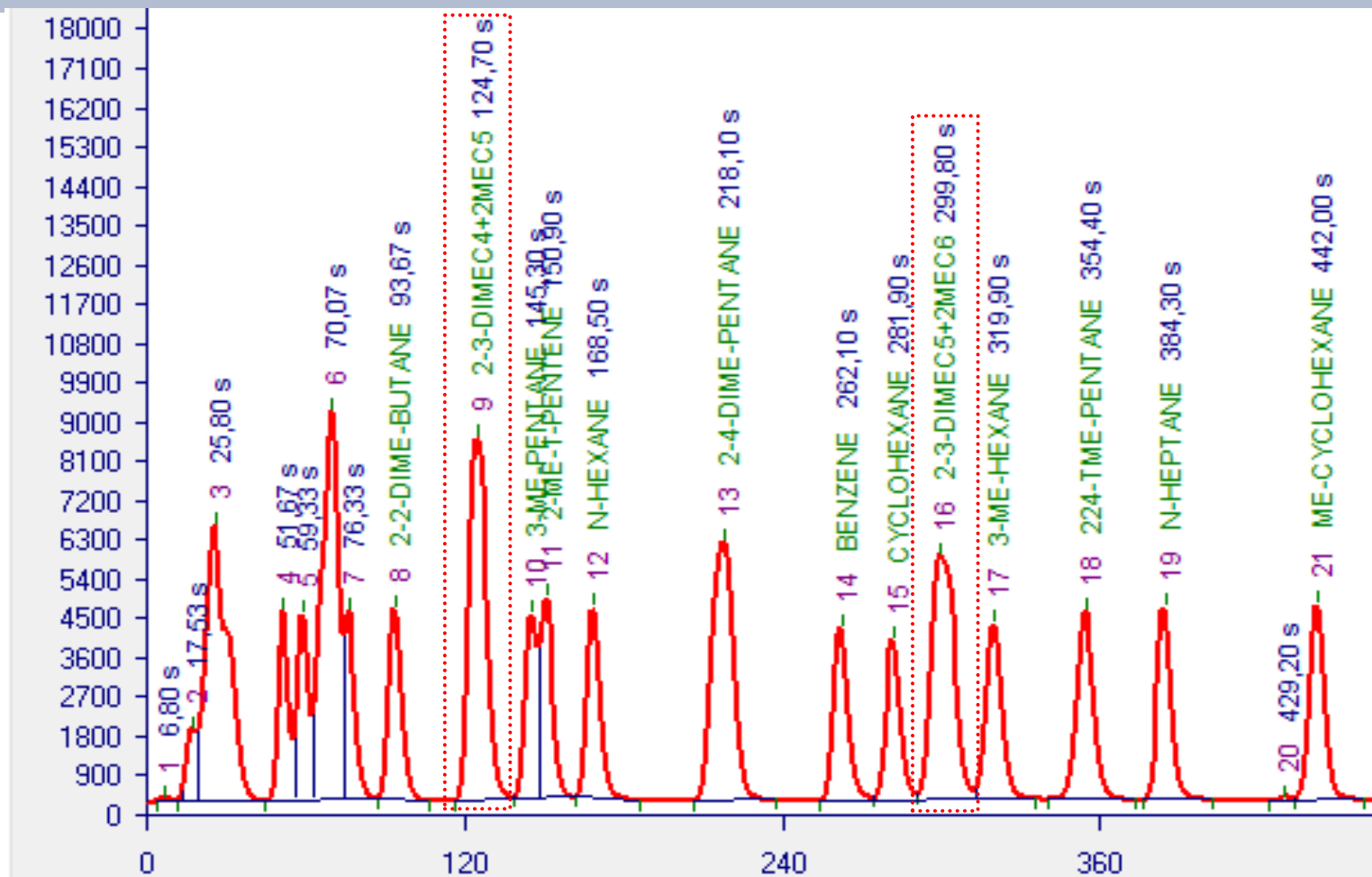
# GCMS Results display



- Curves for each ion with automatic substance identification and quantification
- Results for each ion at one time (Scan ions between 34-130 uma)



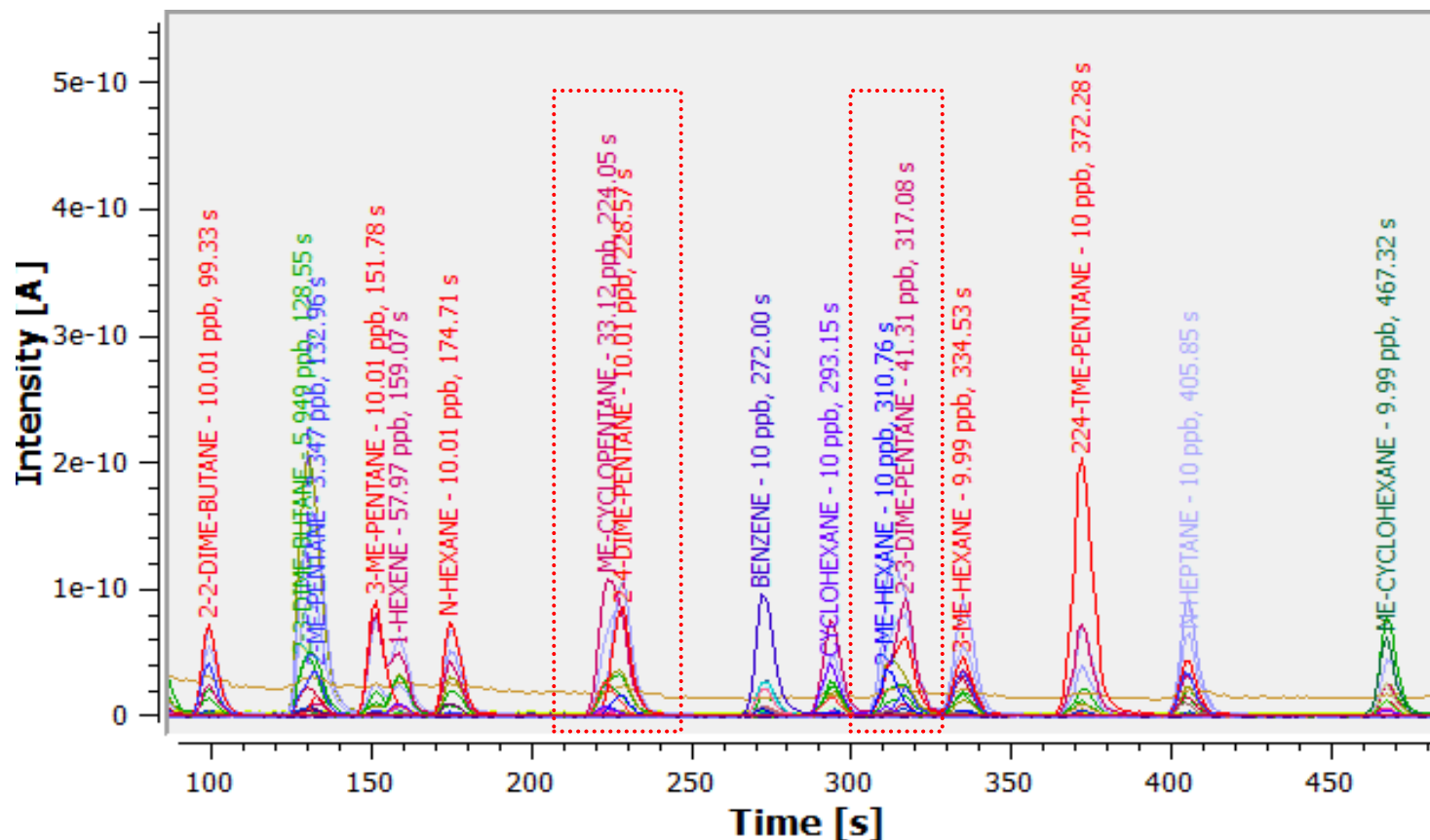
# GCMS Quantification of co-elutions with VistaMS



Co-elution on airmoVOC C6C12 on FID detector



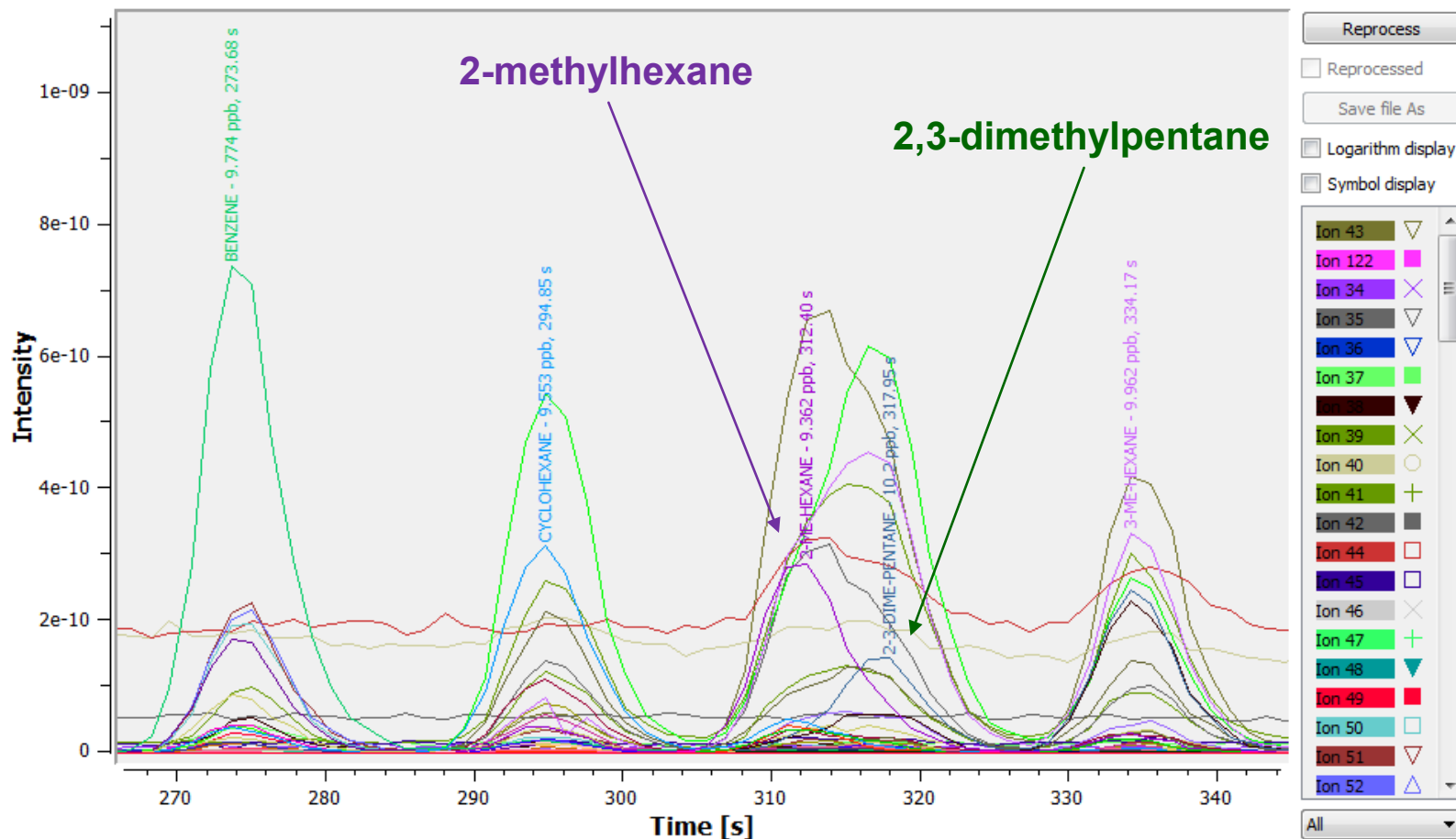
# GCMS Quantification of co-elutions with VistaMS



Separation on airmoVOC C6C12 on MS detector



# GCMS Quantification of co-elutions with VistaMS



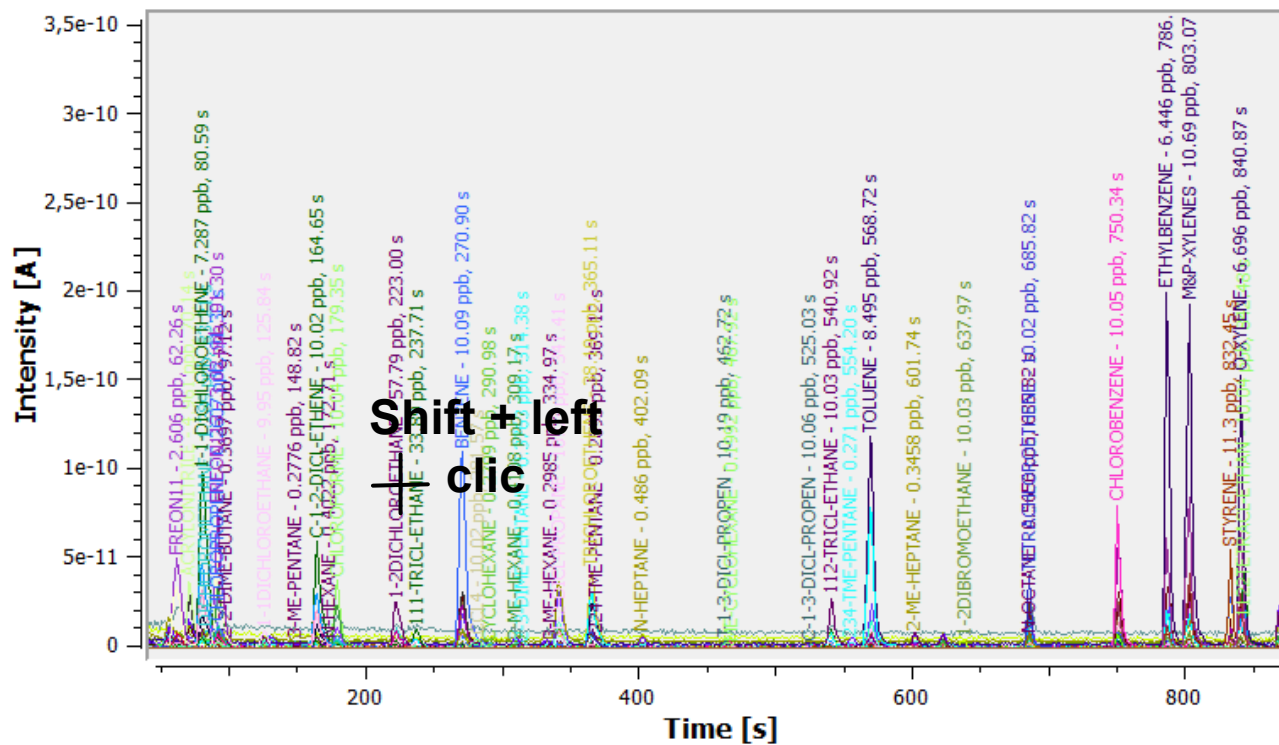
Separation on airmoVOC C6C12 on MS detector



## GCMS: Identification of unknown compounds

- ▶ Identification and quantification of unknown compounds (not in the list) in **SCAN\* mode at low ppb or ppt level**

- Automatic comparison by Vista MS with embedded CHROMATOTEC library or **NIST** library



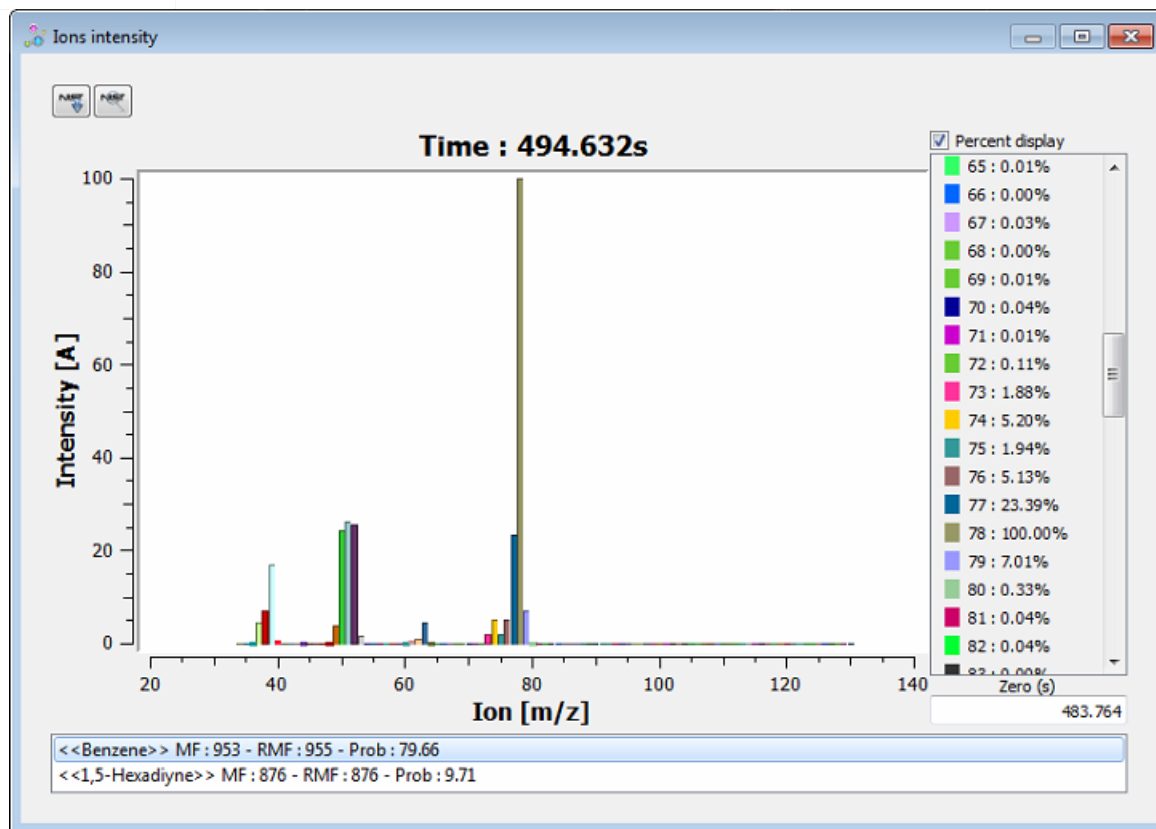
\* SCAN=All ions



# GCMS: Identification of unknown compounds



traceable mass spectrum at 10 ppb or lower



**MF**= Match Factor

**RMF**= Reverse March Factor

**Prob**= Probability (%)

For MF and RMF:

max value 999 perfect match Min value 0 for no match

> 900: excellent match

800 to 900: good match

700 to 800: fair match

