airmOzone

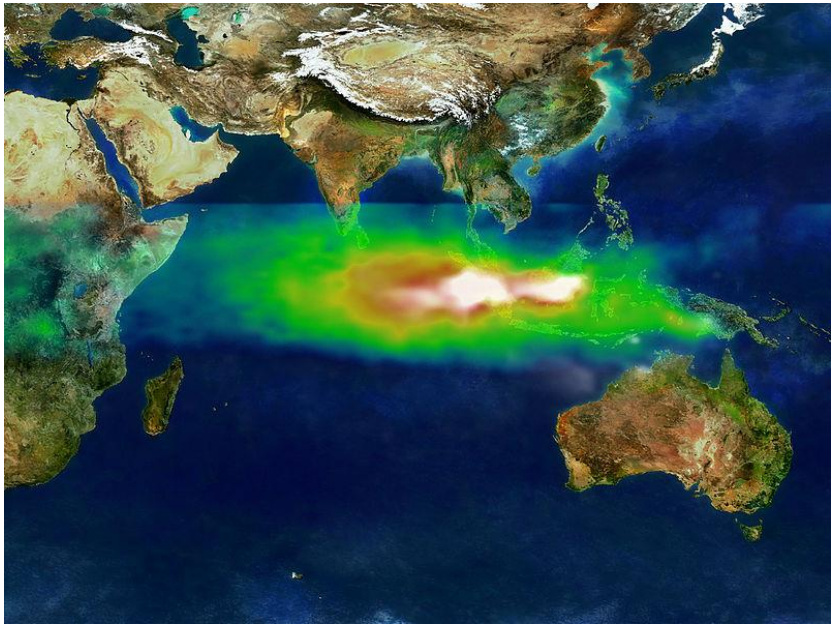
Chromatotec®

Outline

- Air monitoring market
- airmOzone
- Applications
- Conclusion

Air monitoring

- Ozone concentration has been multiplied by 5 in the last century in the middle latitudes of the northern hemisphere:
  - From 10 PPB in 1874
  - To approximately 50 PPB today (increase of 1.6% per year)
  - the trend is higher (2.4% a year) over the last decades.[1]
- In order to stop this global trend, directives have been written concerning the reduction of ozone precursors emissions (NOx and VOC) to define national emission maxima.



[1]The International Geosphere-Biosphere Program - World Climate Research Program
[2]http://visibleearth.nasa.gov/view_rec.php?id=1651

Air monitoring

- Different Regulations:
  - The Directive 2000/96/EC states that the level of Benzene shall be reduced to an annual average of 5 µg/m3 by 2010 for EU countries.
  - Regarding VOC, the European directive 2002/3/CE advises to analyze 31 VOC, continuously and 24 hours per day.
  - US Environmental Protection Agency suggests to analyze 56 VOC which constitute the PAMS program Photochemical Assessment Monitoring Stations
  - In Japan, 58 VOC are being monitored 56 VOC + Alpha and Beta pinene.

- Specific chromatotec® instruments have been designed to meet these new requirements in total compliance with EN 14 662-3.

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airmOzone :

- Cabinet : 33 U
  - AirmoCAL 4U
  - airmoVOC C6-C12 5U
  - 1U rack with mouse and key board
  - Chroma S 4U
  - airmoVOC C2-C6 4U
  - Hydroxychrom (H2 generator) 3U
  - airmoPURE (zero air generator) and 2 sampling pumps
- WHEELS

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VOCs analysis from C2 to C12:

- airmoVOC C6-C12 5U
- airmoVOC C2-C6 4U

Detection range: ppt to 100 ppb

Each instrument has:
- FID detector
- Traps to concentrate samples
- Column for separation

airmOzone

Mcert:

- airmoVOC C6-C12 5U

Mcert certification

EN 14 662-3.

Upgrade available for previous instruments

airmOzone

Mcert:

- airmoVOC expert

New micro FID
- 10 times more sensitive

MFC
- Sampling volume tunable from 50 ml up to 4L

Cold TRAP by Peltier effect
- Increase trapping efficiency

Purge for light compounds analysis

airmOzone

Sulfur compounds analysis:

- chromaS

Detection range: 4 ppb to 100 ppm

The instrument has:

- FPD detector
- Loop
- Column for separation

airmOzone

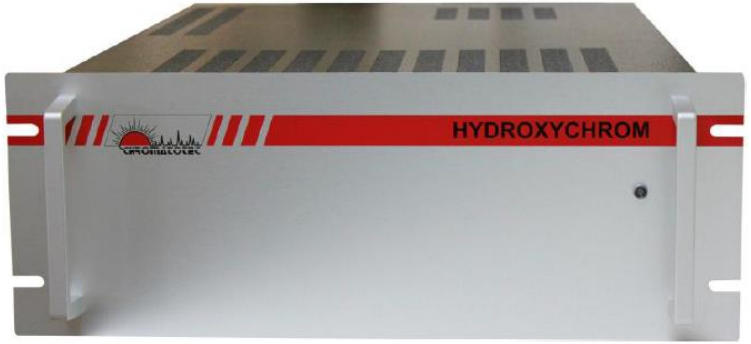
Calibration:

- airmoCAL with or without MFCs

Allows fully automatic calibration of instruments

airmOzone

Gas supply and pumps:



Air generator:

- •Total flow for airmOzone = 580 ml/min
- • Cooling box (Peltier effect) for C2C6: 13 ml/min
- • Dilution of permeation tube for calibration: 50 ml/min in continuous mode

H2 Generator

Flow rate:

- • 100 mL/min in standard
- • 160 mL/min in option

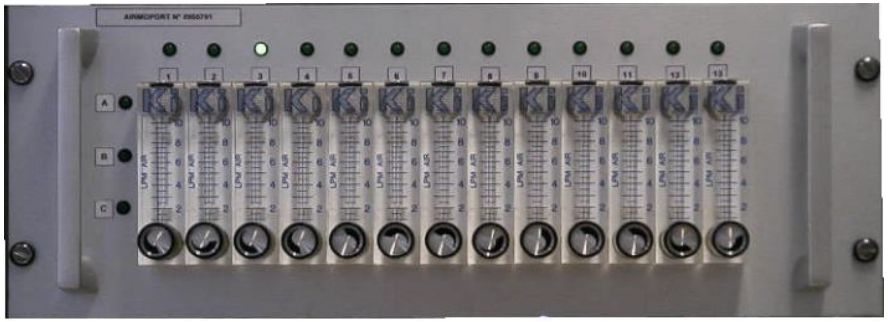
Purity :

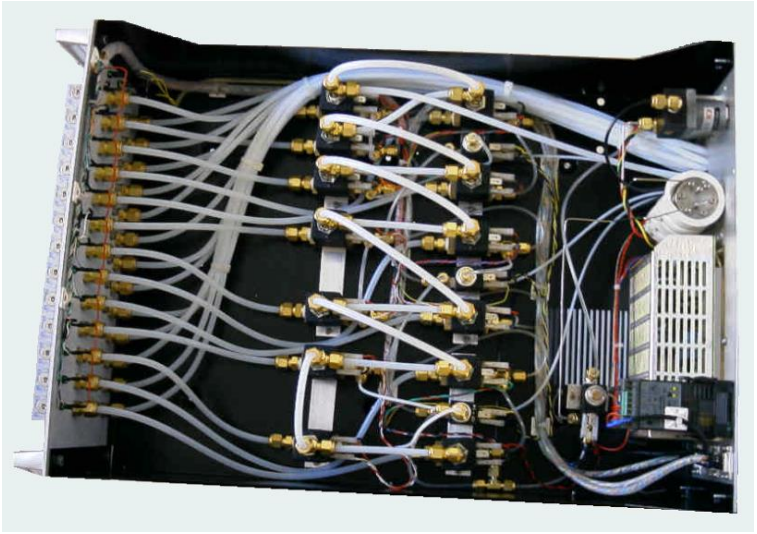
- • >99.9999% with continuous drying
- • Moisture : < - 60°DP
- • Hydrocarbons < 0.1 ppb

airmOzone

Multiplexer:

- Allows measurements of different samples





Example: Measurement of chemicals in big clean air room

airmOzone

airmOzone :

- Fully automatic
- Reliable
- Safe
- Turnkey solution
- Automatic transfer of the data
- Low maintenance

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- Applications
  - 30-minutes cycle time (European directive 2002/3/CE)
  - Road traffic application
  - 56 VOC: 30 minutes cycle
  - 88 compounds : PAMS TO14

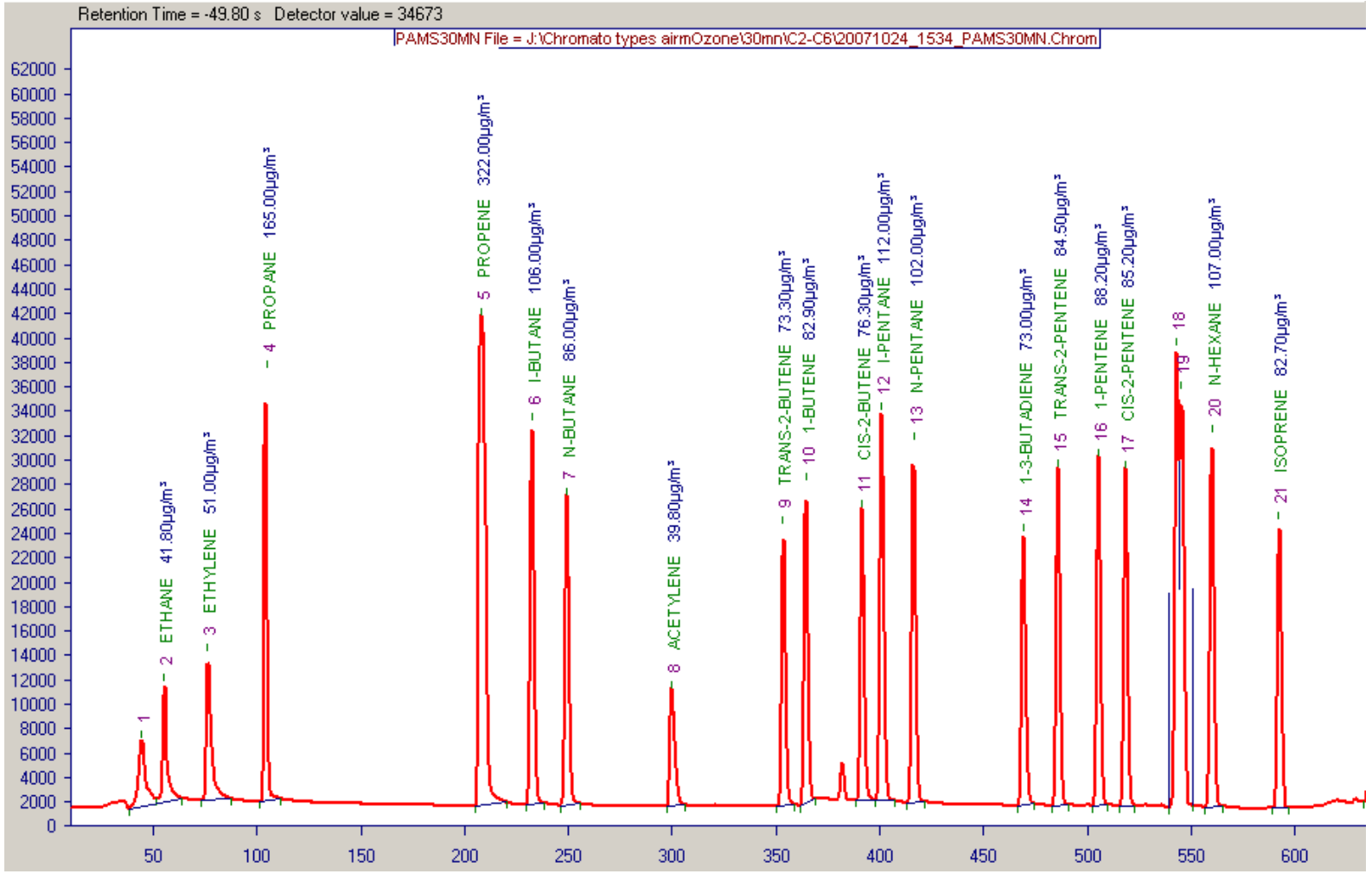
European directive 2002/3/CE

The European directive 2002/3/CE advises to analyze 31 VOC, continuously and 24 hours per day.

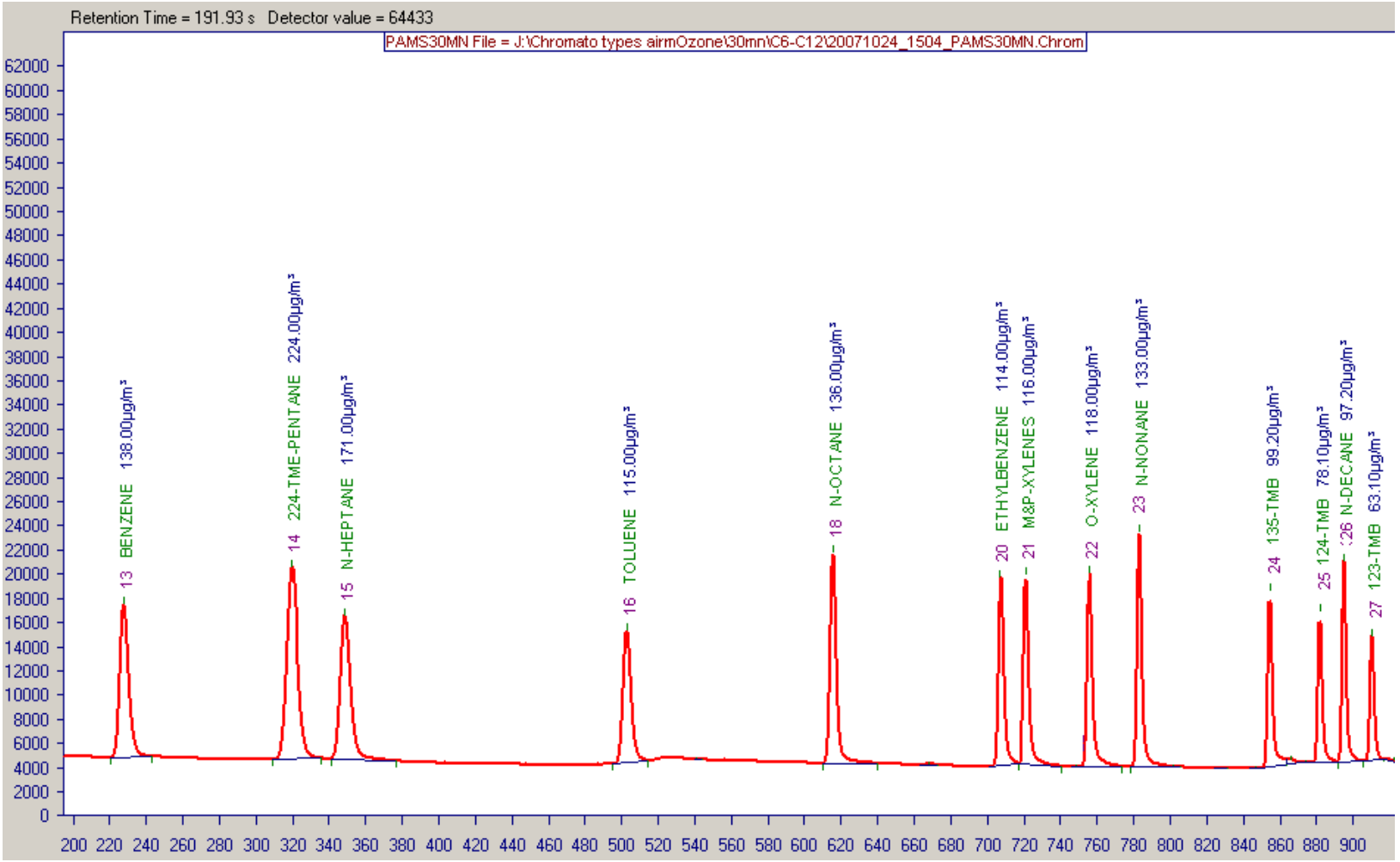
- Chromaotec® added for compounds to the analysis:
  - 3-Méthylpentane
  - N-Nonane
  - N-Decane

- The analysis cycle is 30 minutes

C2 to C6


Retention Time = -49.80 s Detector value = 34673
PAMS30MN File = J:\Chromato types airmOzone\30mn\C2-C6\20071024_1534_PAMS30MN.Chrom
1
2 ETHANE 41.80µg/m³
3 ETHYLENE 51.00µg/m³
4 PROPANE 165.00µg/m³
5 PROPENE 322.00µg/m³
6 I-BUTANE 106.00µg/m³
7 N-BUTANE 86.00µg/m³
8 ACETYLENE 39.80µg/m³
9 TRANS-2-BUTENE 73.30µg/m³
10 1-BUTENE 82.90µg/m³
11 CIS-2-BUTENE 76.30µg/m³
12 I-PENTANE 112.00µg/m³
13 N-PENTANE 102.00µg/m³
14 1-3-BUTADIENE 73.00µg/m³
15 TRANS-2-PENTENE 84.50µg/m³
16 1-PENTENE 88.20µg/m³
17 CIS-2-PENTENE 85.20µg/m³
18
19
20 N-HEXANE 107.00µg/m³
21 ISOPRENE 82.70µg/m³
62000
60000
58000
56000
54000
52000
50000
48000
46000
44000
42000
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
50
100
150
200
250
300
350
400
450
500
550
600

C6 to C12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PAMS30MN File = J:\Chromato types airmOzone\30mn\C6-C12\20071024_1504_PAMS30MN.Chrom
13 BENZENE 138.00µg/m³
14 224-TME-PENTANE 224.00µg/m³
15 N-HEPTANE 171.00µg/m³
16 TOLUENE 115.00µg/m³
18 N-OCTANE 136.00µg/m³
20 ETHYLBENZENE 114.00µg/m³
21 M&P-XYLENES 116.00µg/m³
22 O-XYLENE 118.00µg/m³
23 N-NONANE 133.00µg/m³
24 135-TMB 99.20µg/m³
25 124-TMB 78.10µg/m³
26 N-DECANE 97.20µg/m³
27 123-TMB 63.10µg/m³

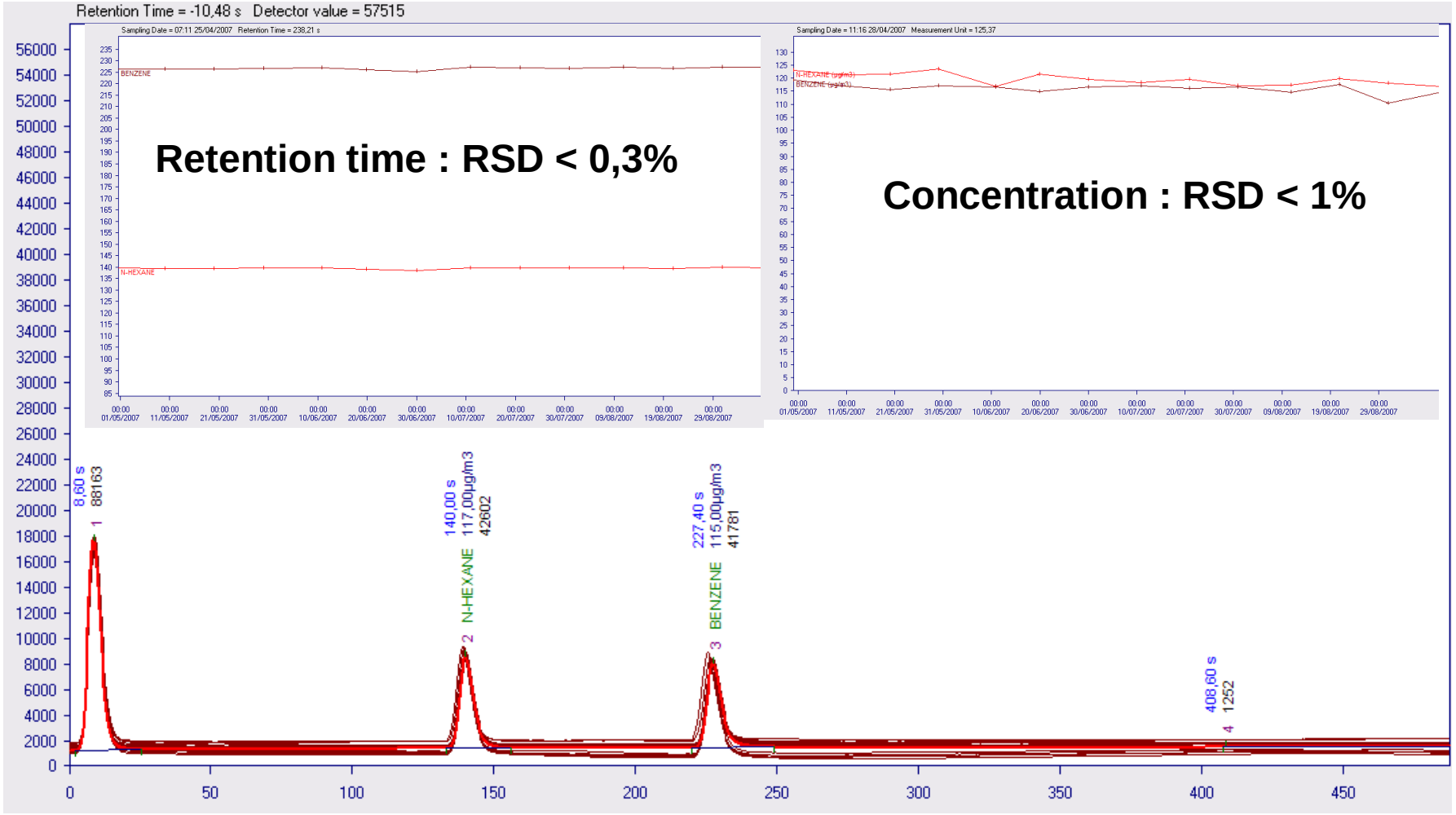
Outline

- Applications
  - 30-minutes cycle time (European directive 2002/3/CE)
  - Road traffic application
  - 56 VOC: 30 minutes cycle
  - 88 compounds : PAMS TO14

Road traffic application

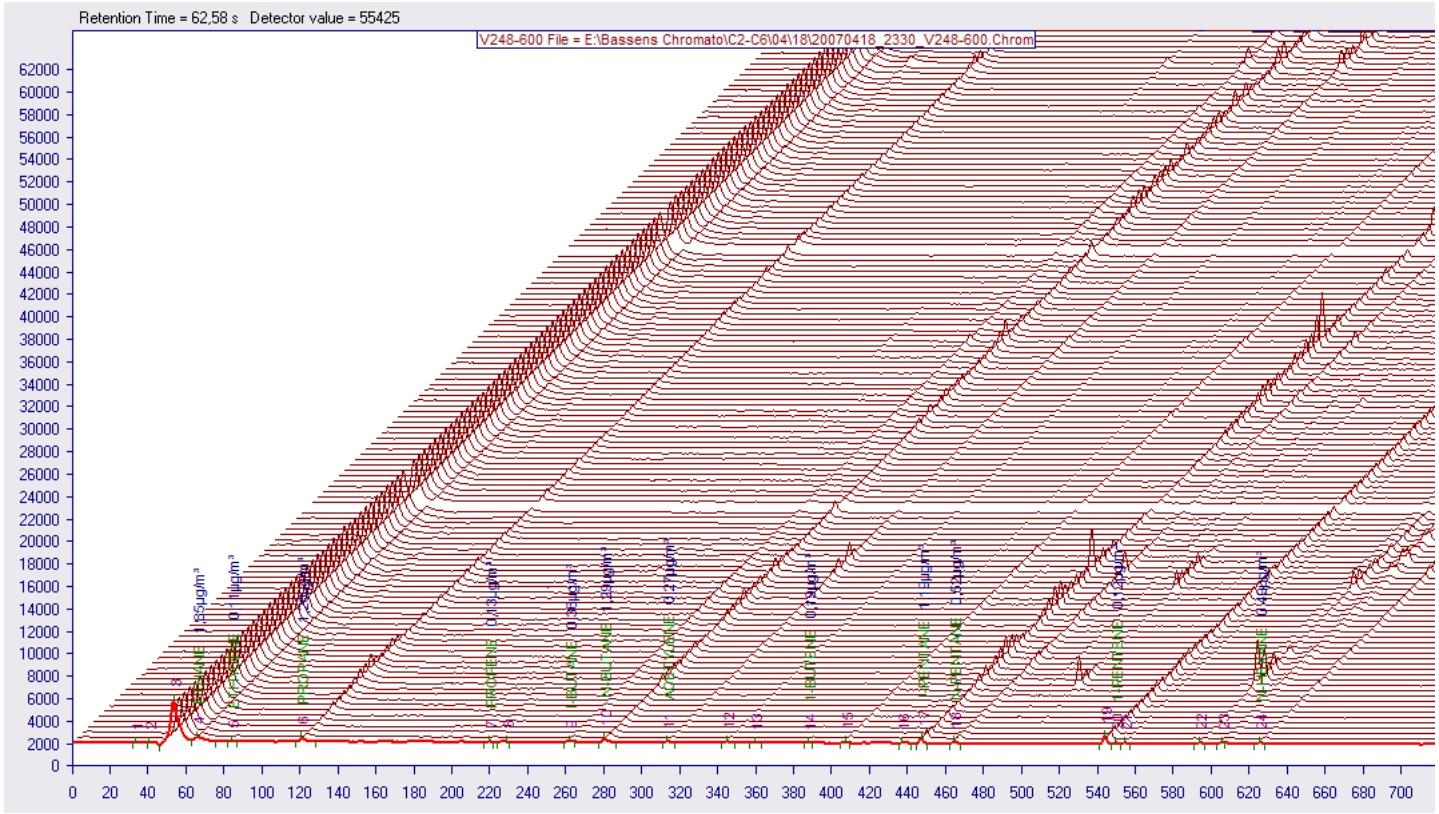
- Timestamp measurement
- Automatic transfer of data
- Stability
- Reliability
- accuracy

Stability



timestamp calibrations

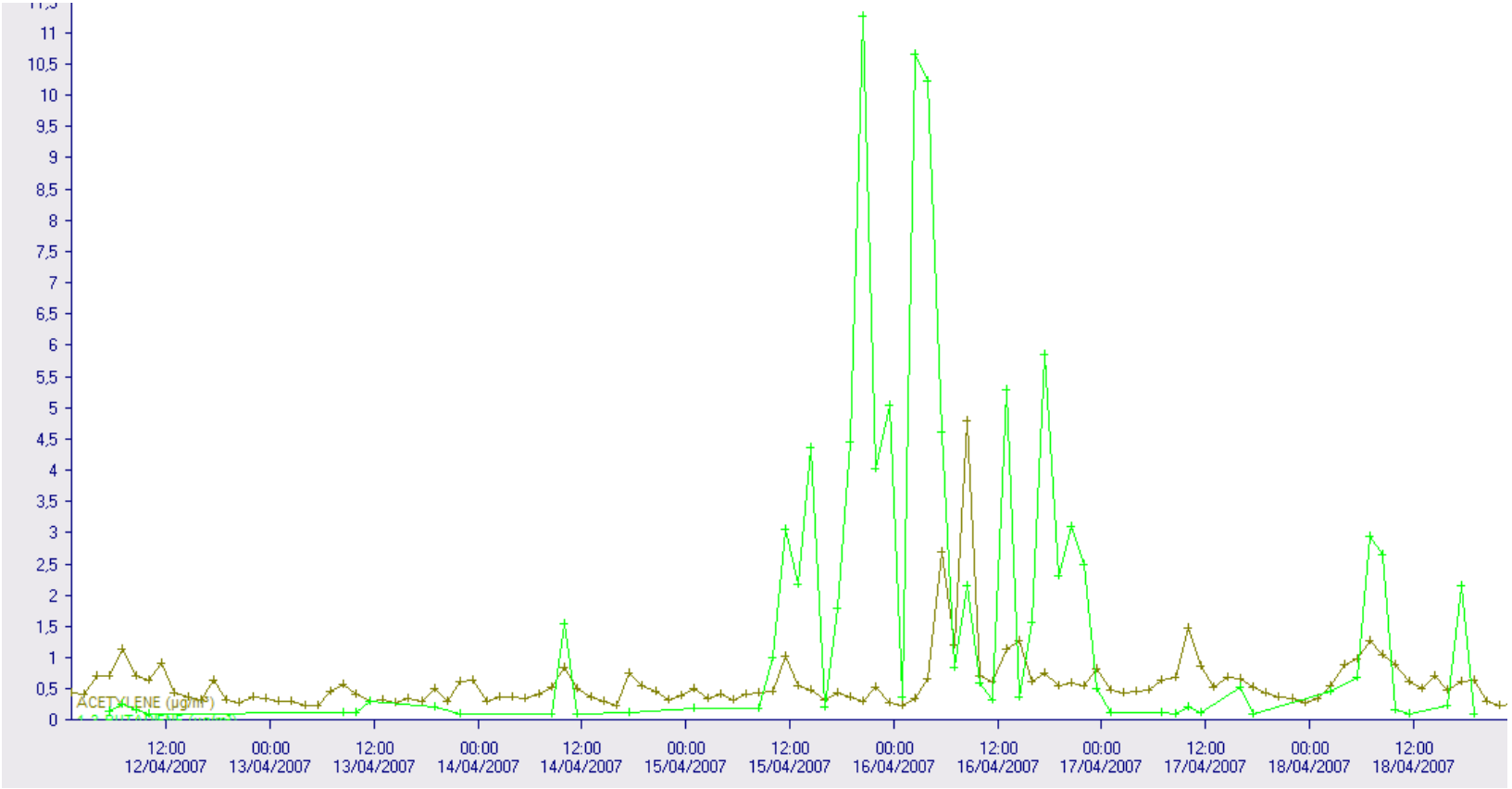
Week of analyses



The fixed station we equipped has been running for more than six months in total autonomy.

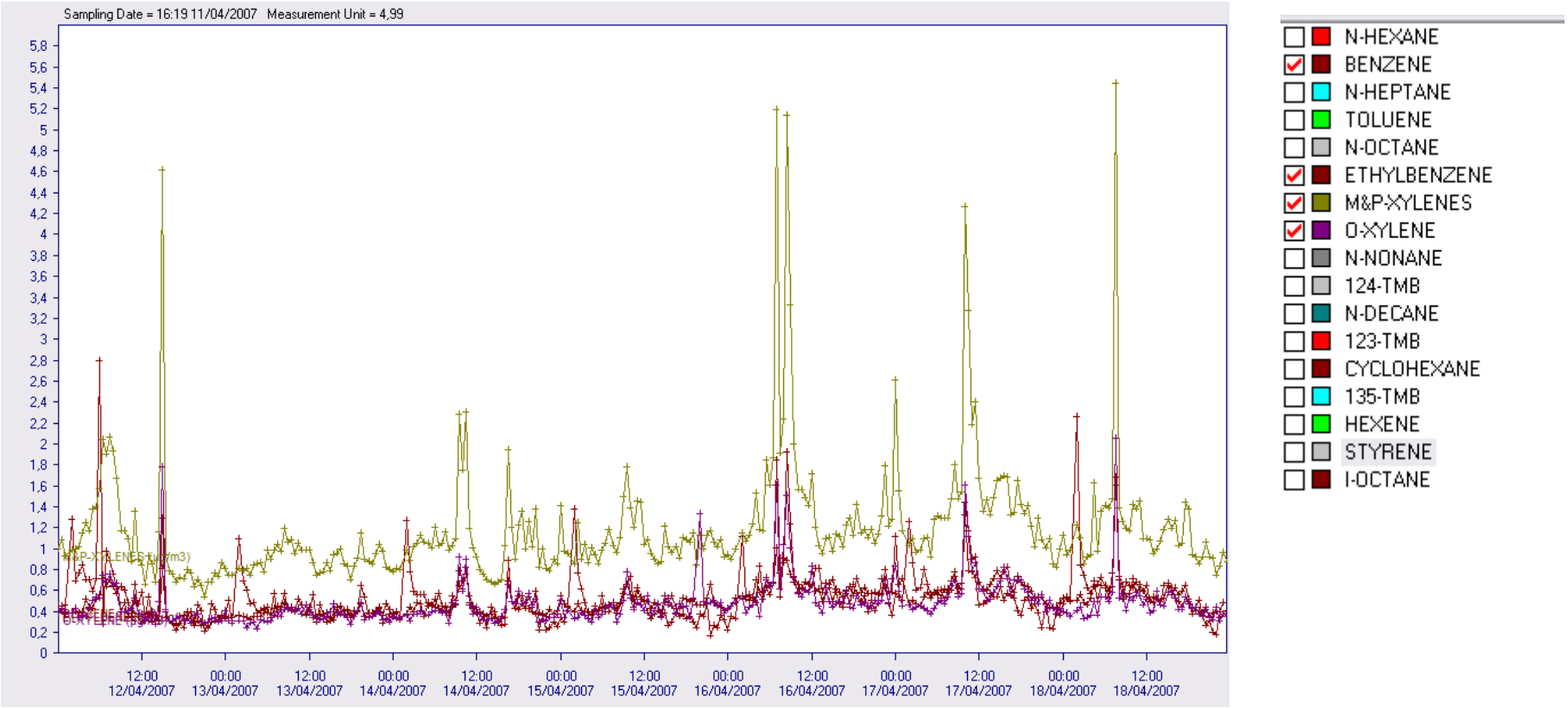
Here is 1-week analytical data in ambient air (April 12 to 18, 2007) viewed with our display software PEAK VIEWER:

airmoVOC C2-C6 : Follow-up of acetylene concentration (in µg/m3) over one week (April 12 to 18, 2007) : Trend Area function of data processing Peak Viewer software.



By over-lapping follow-ups of concentrations of various compounds over the same period of time, it is possible to identify sources of pollution by their emission profile. Follow-up of concentrations can be displayed using the Trend function: Trend Result with Peak Viewer software.

airmoVOC C6-C12 : Follow-up of concentration on a few compounds (in µg/m3) over one week (April 12 to 18, 2007) : Trend Area function of data processing Peak Viewer software.



56 VOC

- PAMS:
  - Photochemical Assessment Monitoring Stations (PAMS)
  - 56 compounds

- The Environmental Protection Agency (EPA) set forth requirements for more extensive ozone and ozone precursor monitoring in areas where levels were considered to be non-attainment. In these areas, the States have established ambient air monitoring sites called Photochemical Assessment Monitoring Stations (PAMS) which collect and report detailed data for volatile organic compounds, nitrogen oxides, ozone and meteorological parameters

56 VOC

C2 to C6

1 Ethane = C2
2 Ethene / ethylene
3 Propane = C3
4 Propene
5 isobutane (2-méthyl propane)
6 N-butane = C4
7 Acetylene
8 trans-2-butène
9 1-butene
10 cis-2-butène
11 Cyclopentane
12 isopentane (2-methyl butane)
13 N-pentane =C5
14 trans-2-pentene
15 1-pentene
16 cis-2-pentène
17 2,2-dimethylbutane
18 methylcyplopentane
19 2,3-dimethylbutane
20 2-methylpentane
21 3-methylpentane
22 N-hexane =C6
23 Isoprene
24 2-methyl-1-pentene

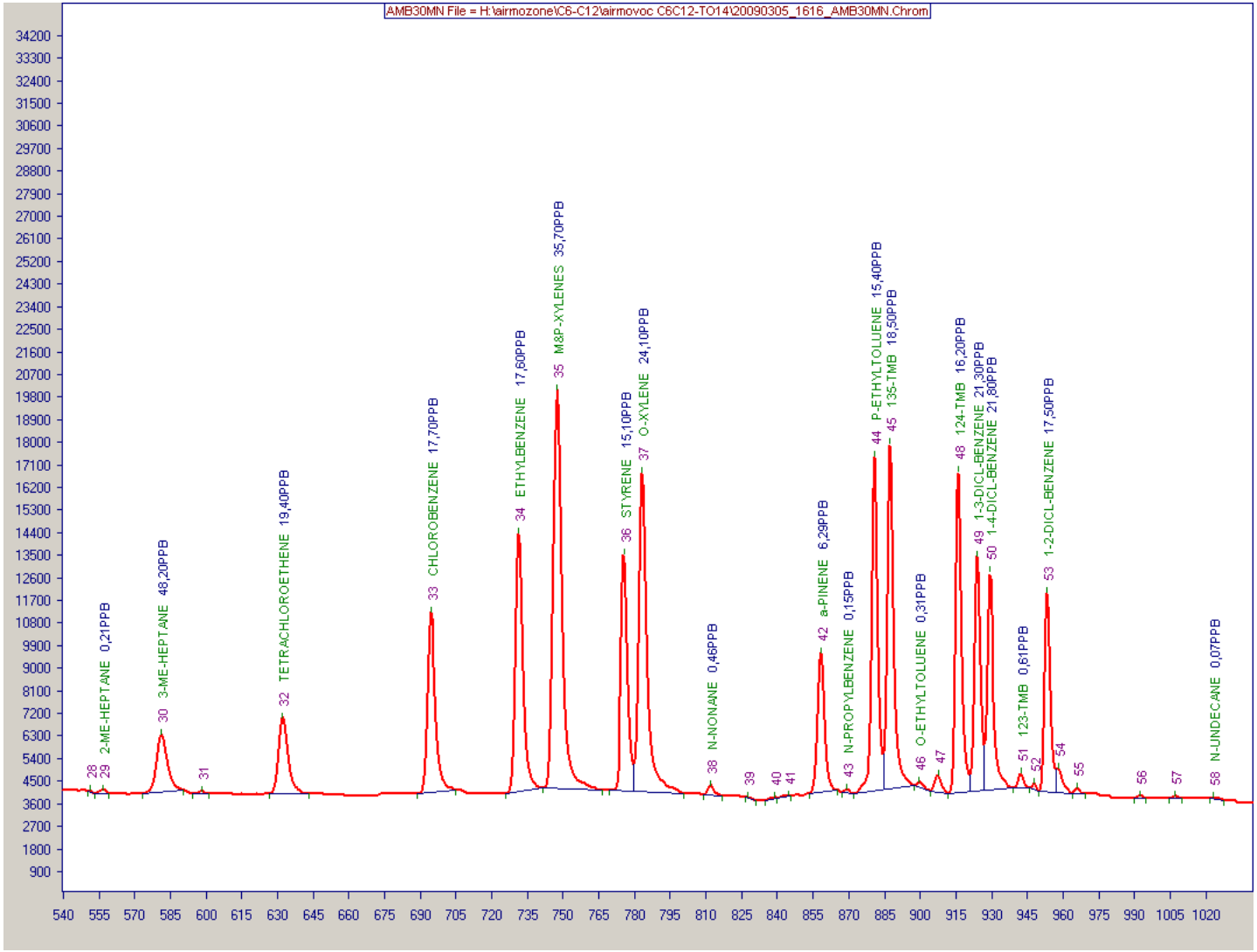
C6 to C12

25 2,4-dimethylpentane
26 Benzene
27 Cychohexane
28 2-methylhexane
29 2,3-dimethylpentane
30 3-methylhexane
31 2,2,4-trimethylpentane
32 N-heptane =C7
33 Methylcyclohexane
34 2,3,4-trimethylpentane
35 Toluene
36 2-methylheptane
37 3-methylheptane
38 N-octane =C8
39 Ethylbenzene
40 m-xylene
41 p-xylene
42 Styrene
43 o-xylene
44 N-nonane =C9
45 Iso propylbenzene
46 N-propylbenzene
47 m-ethyltoluene
48 p-ethyltoluene
49 1,3,5 trimethylbenzene
50 o-ethyltoluene
51 1,2,4 trimethylbenzene
52 N-Decane =C10
53 1,2,3 trimethylbenzene
54 m-diethylbenzene
55 p-diethylbenzene
56 N-Undecane

88 compounds

Di chloro di fluoro Methane * = 1
Chloro Methane * = 2
1,2-di chloro tetra fluoro Ethane *
Vinyl chloride = chloro Ethylene= 3
1.3-butadiene = 5
Bromomethane
Ethyl chloride = chloro Ethane *
tri chloro fluoro Methane * = 4
Acrylonitrile **
1.1-di chloro Ethylene = 6
Di chloro Methane * = 7
3-chloro-1-propene = allyl chloride
Tri chloro tri fluoro Ethane * = 8
1.1-dichloro Ethane *
c-1.2-dichloro Ethylene
Chloroform = Tri Chloro Methane *
1.2-dichloroethane *
1.1.1-trichloroethane *
Benzene
Carbon tetrachloride *
1.2-dichloropropane *
Trichloroethylene
t-1.3-dichloropropene
c-1.3-dichloropropene
1.1.2-trichloroethane *
Toluene = methylbenzene
1.2-dibromoethane
Tetrachloroethylene
Chlorobenzene
Ethylbenzene
m+p-xylene =dimethylbenzene
Styrene
o-xylene+1,1,2,2tetrachloroEthane*
4-ethyltoluene (P)
1.3.5-TMB
1.2.4-TMB
1.3-dichlorobenzene**+benzylchloride**
1.4-dichlorobenzene
1.2-dichlorobenzene
1.2.4 -trichlorobenzene
hexachloro-1,3-butadiene

TO14 compounds


AMB30MN File = H:\airmozone\C6-C12\airmovoc C6C12-TO14\20090305_1616_AMB30MN.Chrom
28 29 2-ME-HEPTANE 0,21PPB
30 3-ME-HEPTANE 48,20PPB
31
32 TETRACHLOROETHENE 19,40PPB
33 CHLOROBENZENE 17,70PPB
34 ETHYLBENZENE 17,60PPB
35 M&P-XYLENES 35,70PPB
36 STYRENE 15,10PPB
37 O-XYLENE 24,10PPB
38 N-NONANE 0,46PPB
39
40
41
42 a-PINENE 6,29PPB
43 N-PROPYLBENZENE 0,15PPB
44 P-ETHYLTOLUENE 15,40PPB
45 135-TMB 18,50PPB
46 O-ETHYLTOLUENE 0,31PPB
47
48 124-TMB 16,20PPB
49 1-3-DICL-BENZENE 21,30PPB
50 1-4-DICL-BENZENE 21,80PPB
51 123-TMB 0,61PPB
52
53 1-2-DICL-BENZENE 17,50PPB
54
55
56
57
58 N-UNDECANE 0,07PPB
34200 33300 32400 31500 30600 29700 28800 27900 27000 26100 25200 24300 23400 22500 21600 20700 19800 18900 18000 17100 16200 15300 14400 13500 12600 11700 10800 9900 9000 8100 7200 6300 5400 4500 3600 2700 1800 900
540 555 570 585 600 615 630 645 660 675 690 705 720 735 750 765 780 795 810 825 840 855 870 885 900 915 930 945 960 975 990 1005 1020

Prices

A52022-56	33U	*** Cabinet airmOzone C2-C12 for PAMS 56 = A51022 + XXX916 + XXX922 + XXX041 + XXX031**	94 000 EUR
A52022-88		* Cabinet airmOzone C2-C12 PAMS / TO14 to analyse 88 compounds =A51022 + XXX916 + XXX922D+XXX041 + XXX031	99 000 EUR
A52022-502		* Cabinet airmOzone Purge & Trap ,502-2 Method = A51022 + XXX916 + XXX922 + XXX041+XXX031+X Purge FID	102 900 EUR
A53022-S		* Cabinet airmOzone C2-C12 PAMS , Complete Unit to analyse 56 VOC compounds and 8 sulfurs = A51022 + XXX916 + XXX922 + XXX041 + XXX031 + chromaS	123 300 EUR
XXX041		* Installation in a 19" cabinet	5 200 EUR

Conclusion

- **airmOzone** :
  - **fully automated with gas generator (H2/AIR/CALIBRATION)**
  - **data transfer to a data logger or by modem or ethernet**
  - **stability and repeatability (from 0 to 100 ppb, areas and retention times)**
  - **Linearity (from 0 to 100ppb) (see doc airmoBTX / airmoVOC C6-C12, Linearity and repeatability Test).**
  - **in compliance with EN 14 662-3, no interferences (see doc : List of the 10 potential interfering compounds with Benzene) …**
  - **TUV approval on BTEX in 1996**
  - **List of 56 PAMS : airmOzone A52022- PAMS**
  - **List of 31 VOC of European list : airmOzone A52022- CE**
  - **List of up to 88 compounds for TO14/PAMS : airmOzone A52022- TO14/PAMS**
  - **88 compounds : 35 on airmoVOC C2C6 (with cyclohexane on C6C12) and 53 on C6C12 with 124 TriChloroBenzene HexaClhloro13Butadiene and C12 (N-DODECANE)**
  - **airmOzone TO14 for 44 compounds is also available : TO14 compounds react with FID**

Cyclo Hexane, 22Di Methyl Butane, Methyl Cyclopentane, 2 and 3 Methyl pentane can be analyzed on the two instruments

Case study

The case study airmOzone can be download at:

http://www.chromatotec.com/IMG/pdf/case_study_airmozone_31et56_cov_fr_210408.pdf

Thank you for your attention !