E^2M – The Enhanced Environmental Mass Spectrometer: Case Studies by Using the Mobile MS

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Bruker Daltonics

E^2M – Enhanced Environmental Mass Spectrometer

E^2M – small, lightweight, rugged, sensitive

Measurement principle:	Quadrupole Mass Filter
Vacuum System:	Ion getter pump < 10^{-6} mbar
Electron source:	Electron Impact, 70 eV
Filament:	dual
Inlet:	Silicone membrane, heated
Mass range:	1 … 520 da
Scan rate:	7500 da/s, resolution 0.1 da
External Power Supply:	18 … 32 VDC
Power Consumption:	250 Watt (switch-on: 500 W)
Transputer Interface:	Ethernet (100 Mbit/s)
Dimensions:	436 x 368 x 442 (L x W x H)
Volume:	58 litres
Weight:	34 kg
Specification:	CE, IP42, IEC 61000, IEC 60068-2 and 2-2, CISPR 16-1 and 16-2, IEC 60068-2-6, -2-27

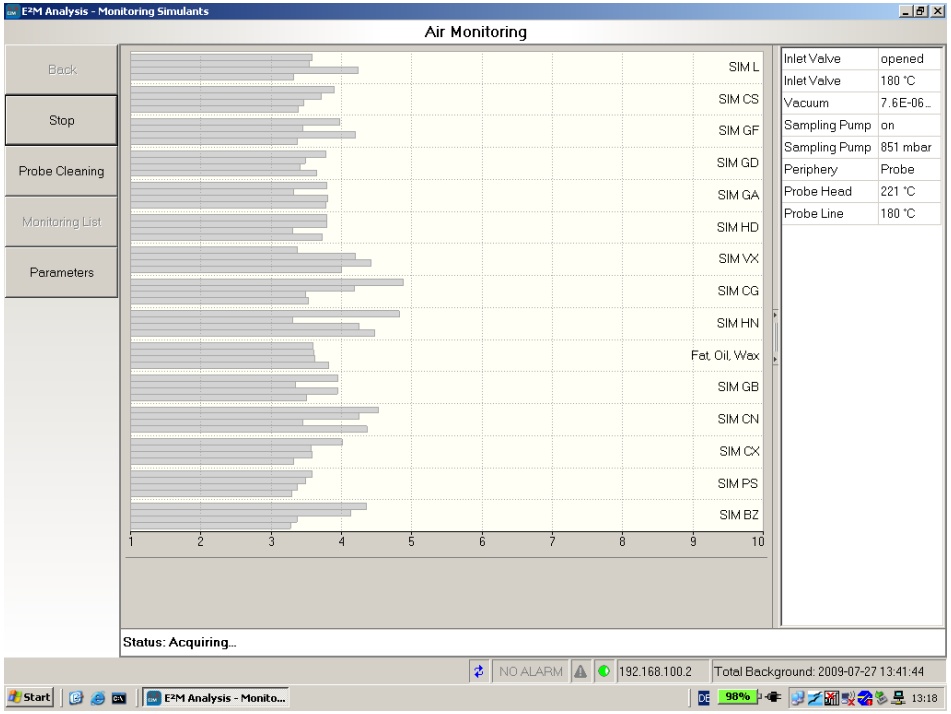
MS Monitoring System

Air / Surface Probe

- direct measurement of air and surface contaminations
- separately heated probe head and probe line
- programmable up to 240 °C
- 3.5 m length, flexible
- exchangeable probe head membranes

MS Monitoring System

- Several SIM libraries
- Up to 20 substances
- Vertical bar graph
- Colour coded signals
- Identification in alarm window



Bruker Detection

E²M Analysis - Monitoring Simulants

Air Monitoring

Back

Stop

Probe Cleaning

Monitoring List

Parameters

Inlet Valve	opened
Inlet Valve	180 °C
Vacuum	7.6E-06...
Sampling Pump	on
Sampling Pump	851 mbar
Periphery	Probe
Probe Head	221 °C
Probe Line	180 °C

Status: Acquiring...

NO ALARM | 192.168.100.2 | Total Background: 2009-07-27 13:41:44

Start | E²M Analysis - Monito... | DE 98% 13:18

E²M Analysis - Monitoring Simulants

Air Monitoring

Back

Stop

Probe Cleaning

Monitoring List

Parameters

Inlet Valve	opened
Inlet Valve	180 °C
Vacuum	7.4E-06...
Sampling Pump	on
Sampling Pump	851 mbar
Periphery	Probe
Probe Head	221 °C
Probe Line	180 °C

Alarm: Diethylmalonate (SIM HD), 5.33;

Status: Acquiring...

ALARM | 192.168.100.2 | Total Background: 2009-07-27 13:41:44

Start | E²M Analysis - Monito... | Unbenannt - Paint | DE | 98% | 13:19

E²M Analysis - Monitoring Simulants

Air Monitoring

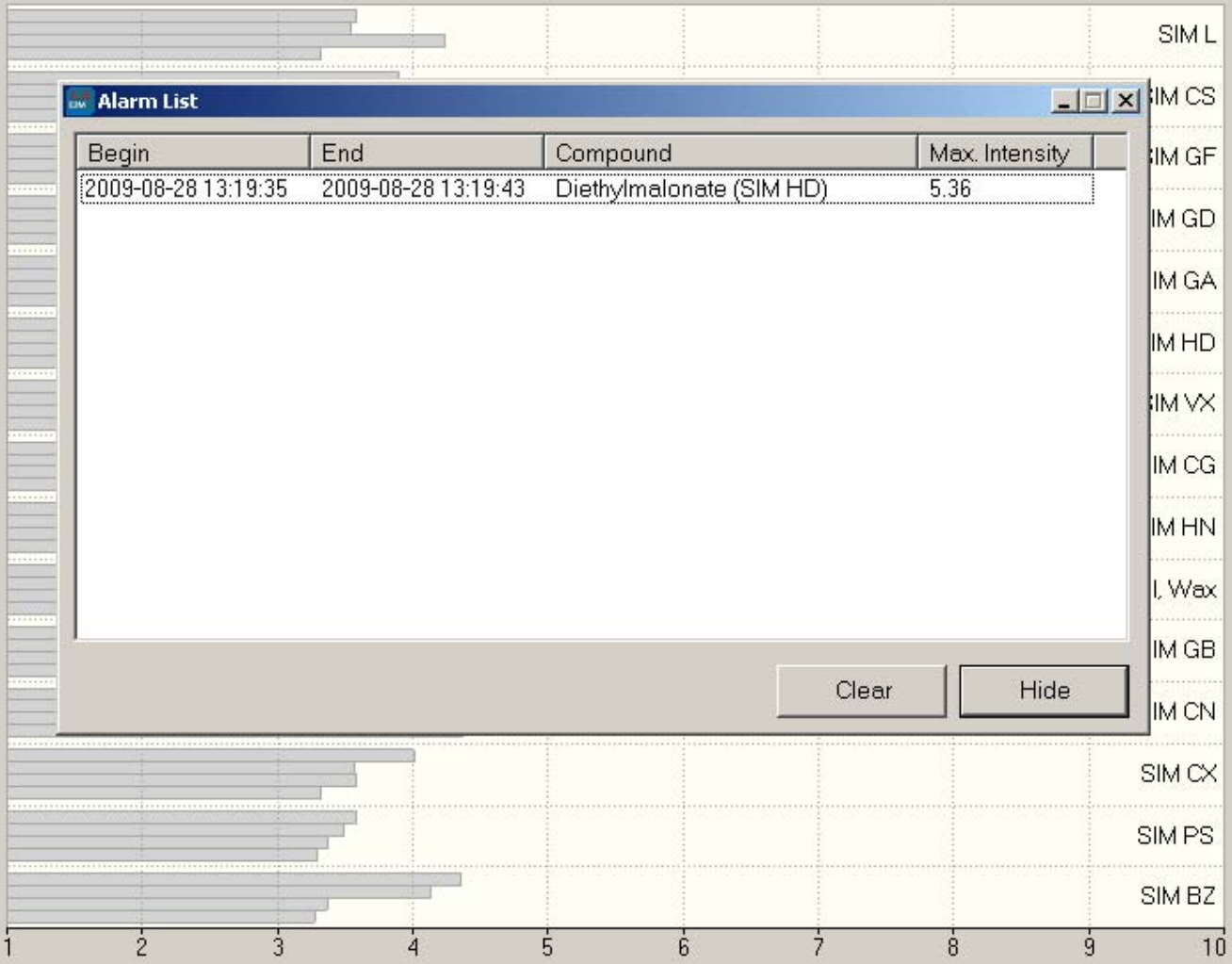
Back

Stop

Probe Cleaning

Monitoring List

Parameters



Alarm List

Begin	End	Compound	Max. Intensity
2009-08-28 13:19:35	2009-08-28 13:19:43	Diethylmalonate (SIM HD)	5.36

Clear

Hide

Inlet Valve	opened
Inlet Valve	180 °C
Vacuum	7.4E-06...
Sampling Pump	on
Sampling Pump	851 mbar
Periphery	Probe
Probe Head	221 °C
Probe Line	180 °C

Status: Acquiring...

ALARM 192.168.100.2 Total Background: 2009-07-27 13:41:44

Start E²M Analysis - Monitorin... Screen2.bmp - Paint Alarm List 98% 13:21

GC/MS System

- 3 programmable **temperature gradients** (T_{max}: 240 °C)
- temperature controlled gas flow
- **GC-capillary** type: depends on application

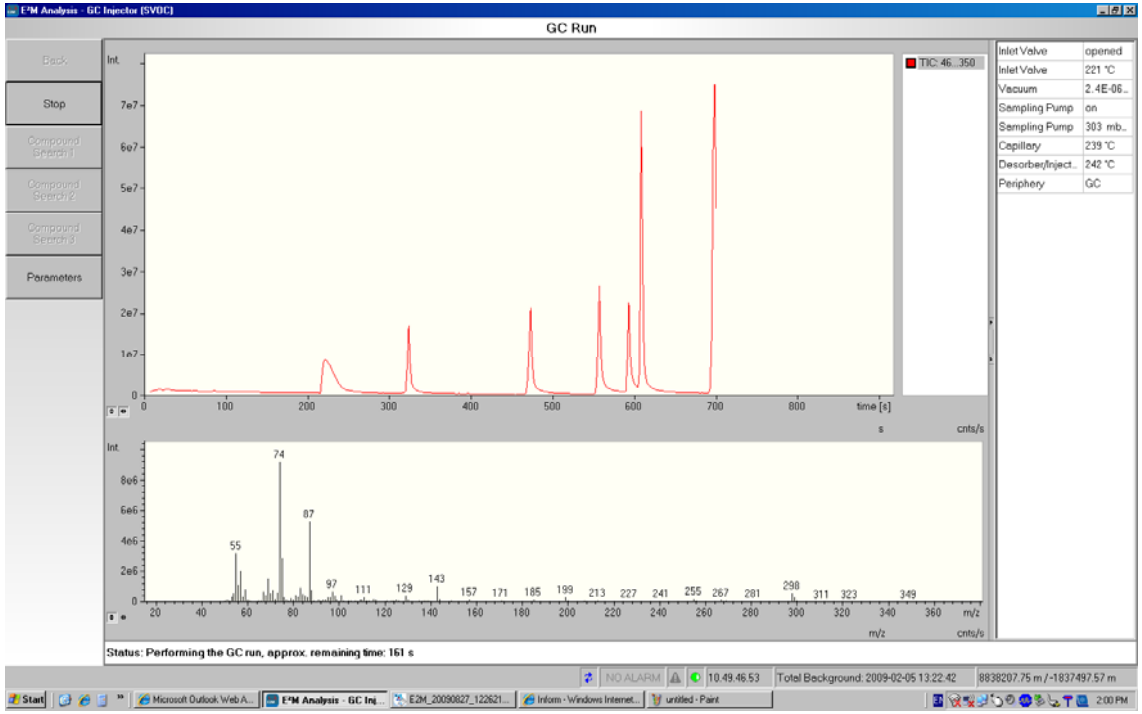
  Standard: HT-5, 15 m, ID 0.32 mm film thickness 0.5 µm

  DB-1, 15 m, ID 0.32 mm film thickness 5 µm
- **Injector:** a) Thermo desorber

  b) Split injector
- **Carrier gas:** ambient air

GC/MS System

- Chromatogram window
- Mass spectrum window
- Identification at the end of the run



Bruker Detection

E²M Analysis - GC Injector (SVOC)

GC Run

Back

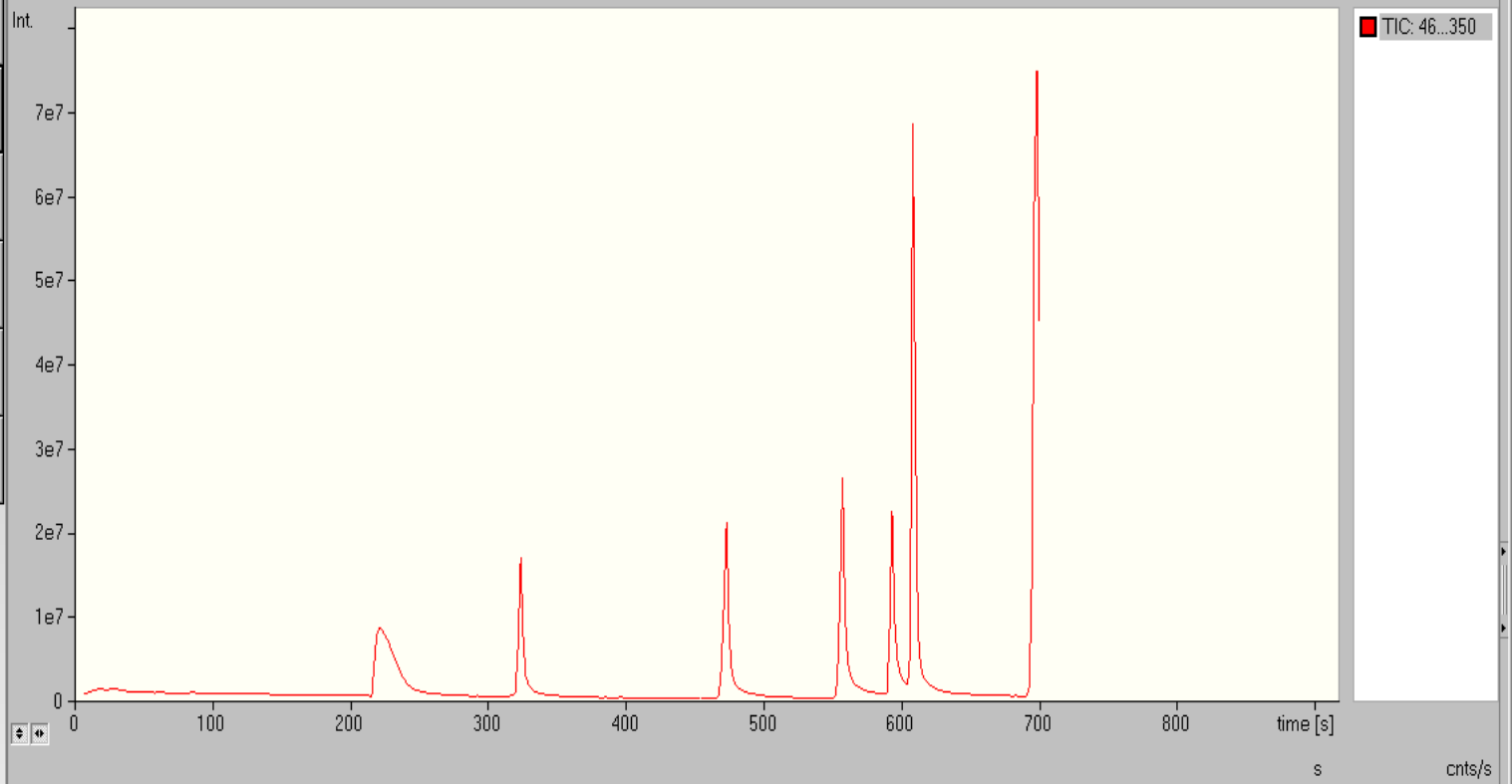
Stop

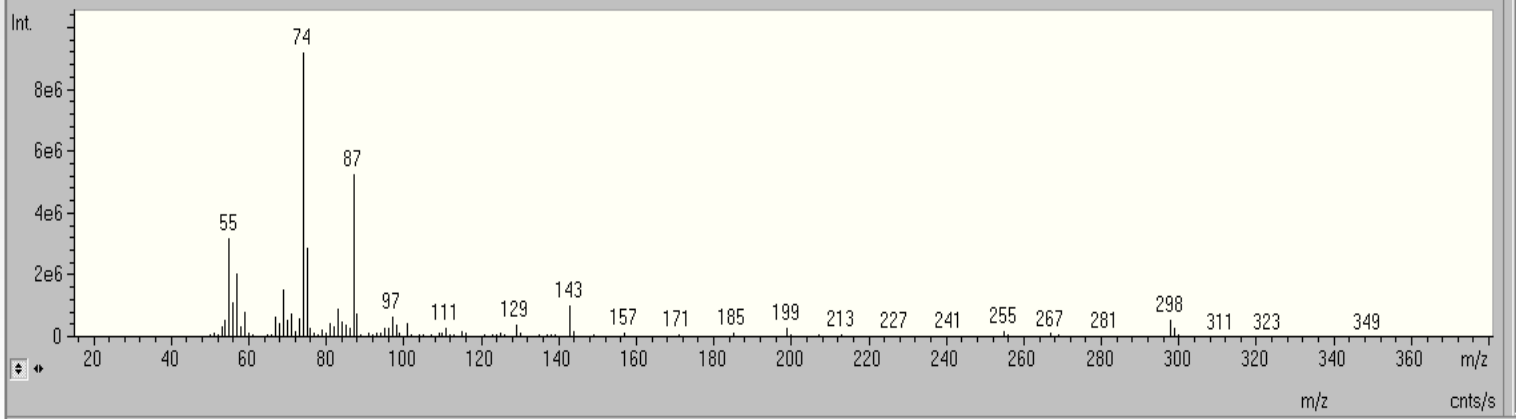
Compound Search 1

Compound Search 2

Compound Search 3

Parameters





Inlet Valve	opened
Inlet Valve	221 °C
Vacuum	2.4E-06...
Sampling Pump	on
Sampling Pump	303 mb...
Capillary	239 °C
Desorber/Inject...	242 °C
Periphery	GC

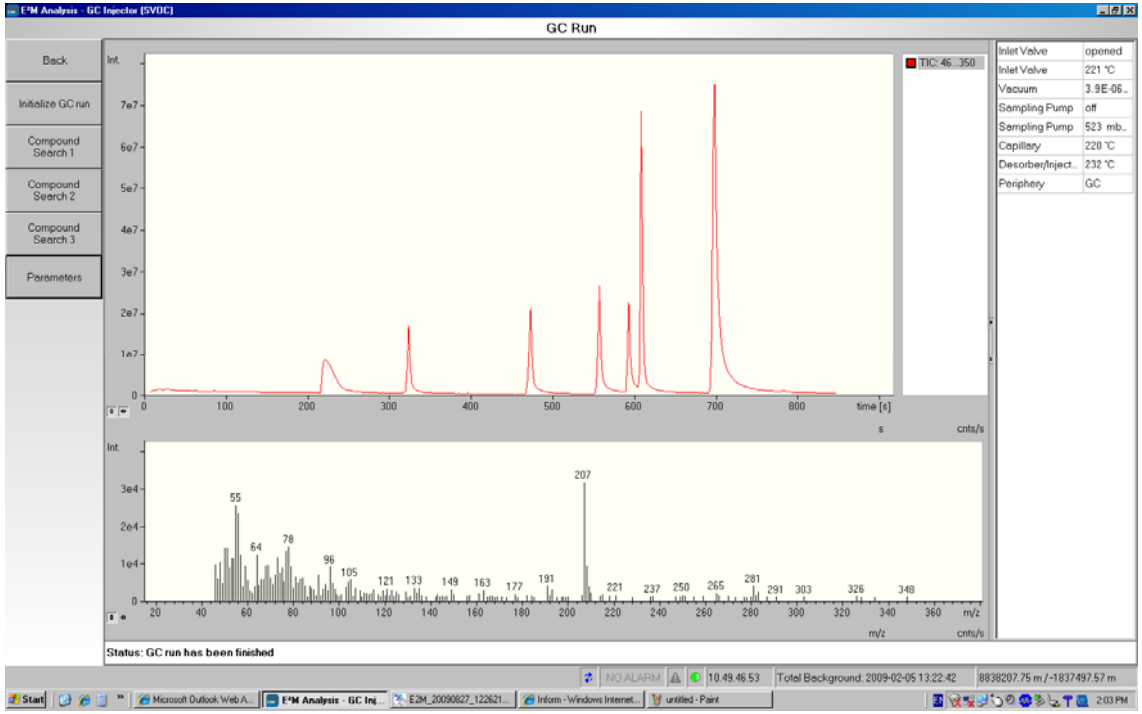
Status: Performing the GC run, approx. remaining time: 161 s

NO ALARM | 10.49.46.53 | Total Background: 2009-02-05 13:22:42 | 8838207.75 m / -1837497.57 m

Start | Microsoft Outlook Web A... | E²M Analysis - GC Inj... | E2M_20090827_122621... | Inform - Windows Internet... | untitled - Paint | 2:00 PM

GC/MS System – automated Identification

- Fully automated identification within seconds
- Up to 3 different identification procedures
- File information displayed
- Convertible to pdf files
- Copy CAS# available



Bruker Detection

E²M Analysis - GC Injector (SVOC)

GC Run

Back

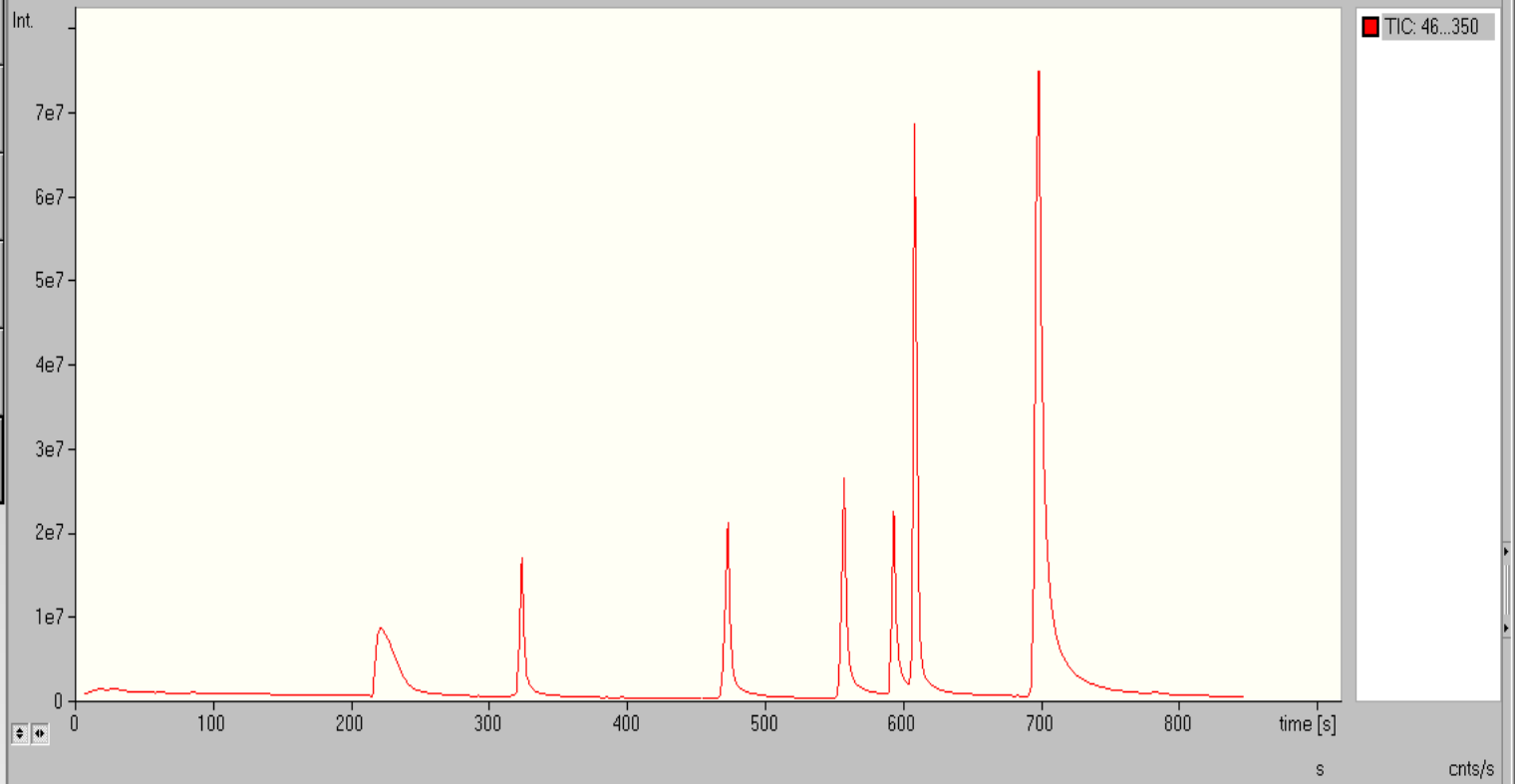
Initialize GC run

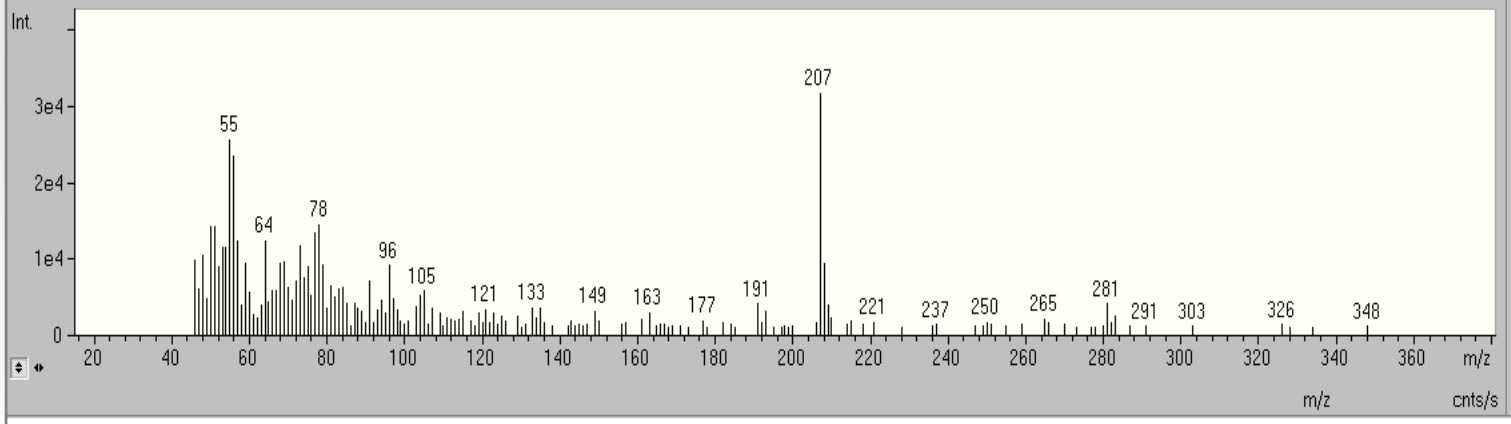
Compound Search 1

Compound Search 2

Compound Search 3

Parameters





Inlet Valve	opened
Inlet Valve	221 °C
Vacuum	3.9E-06...
Sampling Pump	off
Sampling Pump	523 mb...
Capillary	220 °C
Desorber/Inject...	232 °C
Periphery	GC

Status: GC run has been finished

NO ALARM | 10.49.46.53 | Total Background: 2009-02-05 13:22:42 | 8838207.75 m / -1837497.57 m

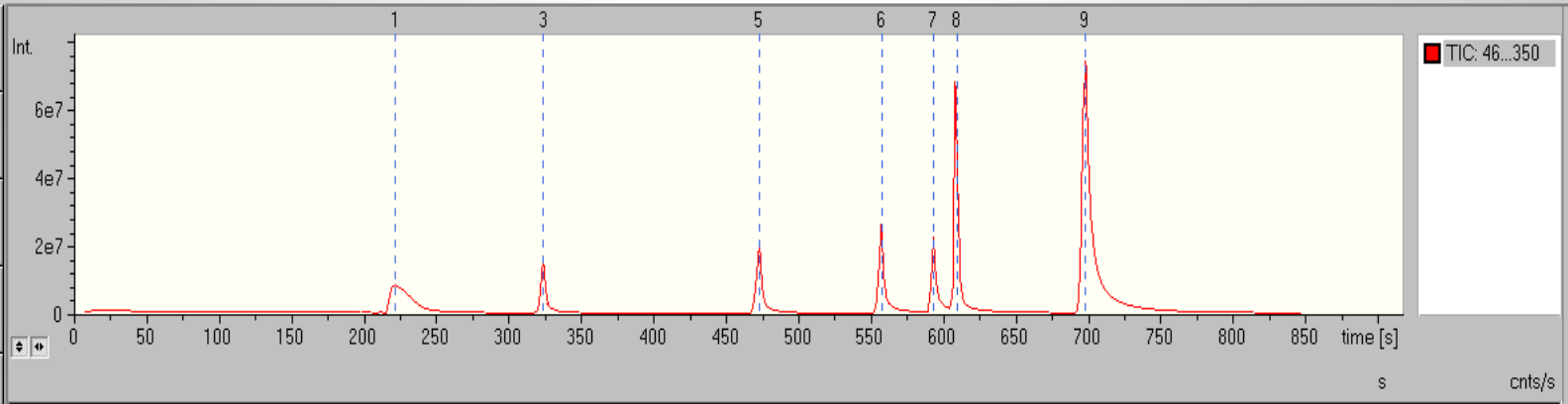
Start | Microsoft Outlook Web A... | E²M Analysis - GC Inj... | E2M_20090827_122621... | Inform - Windows Internet... | untitled - Paint | 2:03 PM

E²M Analysis - GC Injector (SVOC)

GC Run

Back | Initialize GC run | Compound Search 1 | Compound Search 2 | Compound Search 3 | Parameters

Report View | Previous | Next | Copy CAS # | PDF Report



Method	GC Injector (SVOC)
DataAnalysis Method	E2M_TIC_3Hit.m
Date/Time	8/28/2009 1:46:00 PM
Sample ID	Screenshot_2
Sampling Time [min]	0.0
Sampling Method	Injector
Operator	FRL
Organization	BDAL
Coordinates	8838207.75 m / -1837497.57 m
Location	Appli
Comment	injection 1 uL DB5-Mix

No.	Retention time [s]	Area	CAS #	Compound	Formula	Purity	Library
1	221.7	118...	756-79-6	Dimethyl methylphosphonate	C3H9O...	939.0	TIC
3	323.7	581...	123-25-1	Butanedioic acid, diethyl ester	C8H14...	965.0	TIC
5	472.8	846...	131-11-3	Dimethyl phthalate	C10H1...	928.0	TIC
6	557.3	800...	84-66-2	Diethyl Phthalate	C12H1...	922.0	TIC
7	593.2	491...	126-73-8	Tributyl phosphate	C12H2...	808.0	TIC
8	609.1	191...	132-65-0	Dibenzothiophene	C12H8S	890.0	TIC
9	697.9	394...	112-61-8	Octadecanoic acid, methyl ester	C19H3...	898.0	TIC

Status: Analysis is complete

NO ALARM | 10.49.46.53 | Total Background: 2009-02-05 13:22:42 | 8838207.75 m / -1837497.57 m

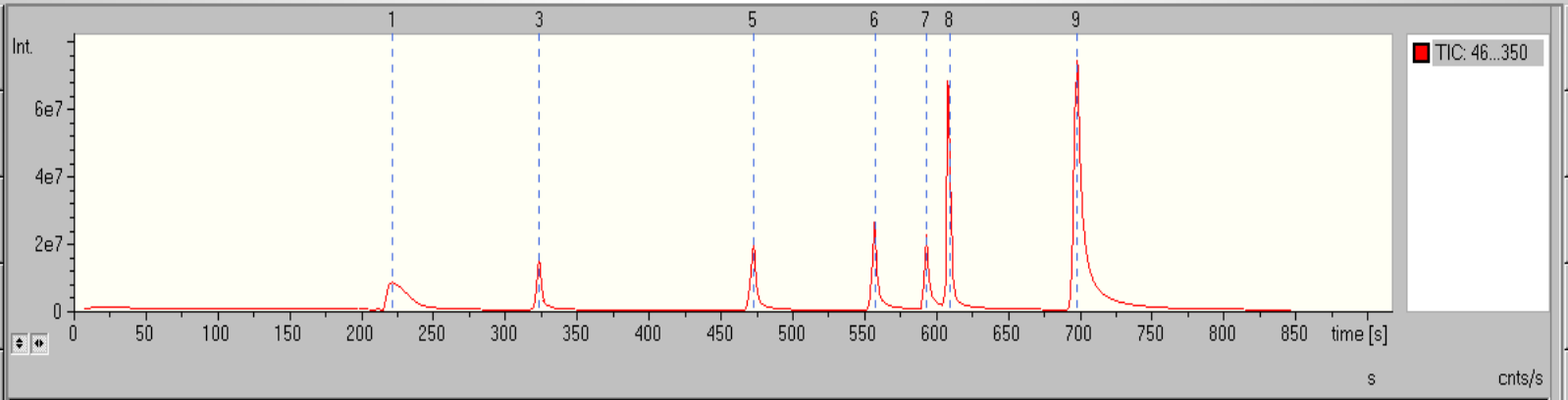
Start | Microsoft Outlook Web A... | E²M Analysis - GC Inj... | E2M_20090827_122621... | Inform - Windows Internet... | untitled - Paint | 2:04 PM

E²M Analysis - GC Injector (SVOC)

GC Run

Back | Initialize GC run | Compound Search 1 | Compound Search 2 | Compound Search 3 | Parameters

Report View | Previous | Next | Copy CAS # | PDF Report



Method	GC Injector (SVOC)
DataAnalysis Method	E2M_TIC_3Hit.m
Date/Time	8/28/2009 1:46:00 PM
Sample ID	Screenshot_2
Sampling Time [min]	0.0
Sampling Method	Injector
Operator	FRL
Organization	BDAL
Coordinates	8838207.75 m / -1837497.57 m
Location	Appli
Comment	injection 1 uL DB5-Mix

No.	Retention time [s]	Area	CAS #	Compound	Formula	Purity	Library
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3	323.7	581...	123-25-1	Butanedioic acid, diethyl ester	C8H14...	965.0	TIC
5	472.8	846...	131-11-3	Dimethyl phthalate	C10H1...	928.0	TIC
6	557.3	800...	84-66-2	Diethyl Phthalate	C12H1...	922.0	TIC
7	593.2	491...	126-73-8	Tributyl phosphate	C12H2...	808.0	TIC
8	609.1	191...	132-65-0	Dibenzothiophene	C12H8S	890.0	TIC
9	697.9	394...	112-61-8	Octadecanoic acid, methyl ester	C19H3...	898.0	TIC

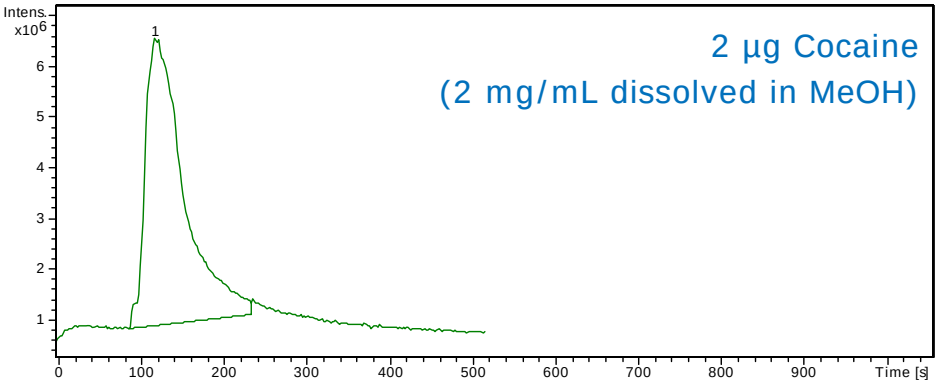
Status: Analysis is complete

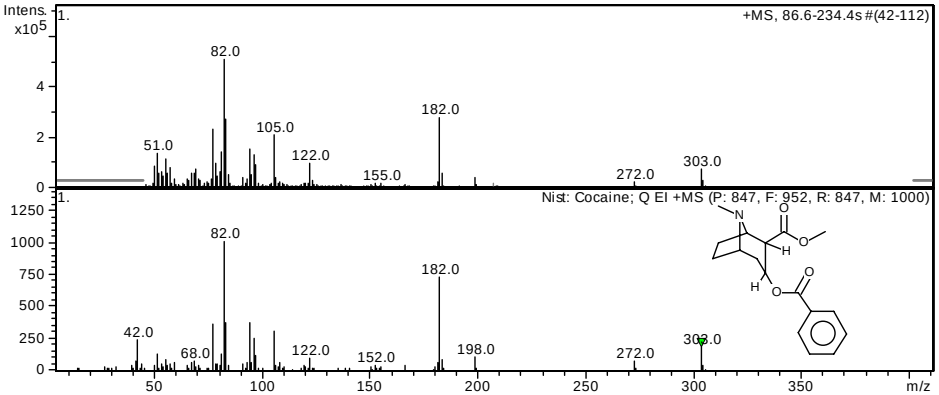
NO ALARM | 10.49.46.53 | Total Background: 2009-02-05 13:22:42 | 8838207.75 m / -1837497.57 m

Start | Microsoft Outlook Web A... | E²M Analysis - GC Inj... | E2M_20090827_122621... | Inform - Windows Internet... | Screen13.bmp - Paint | 2:04 PM

Drug Detection

Direct application of the Air/Surface Probe





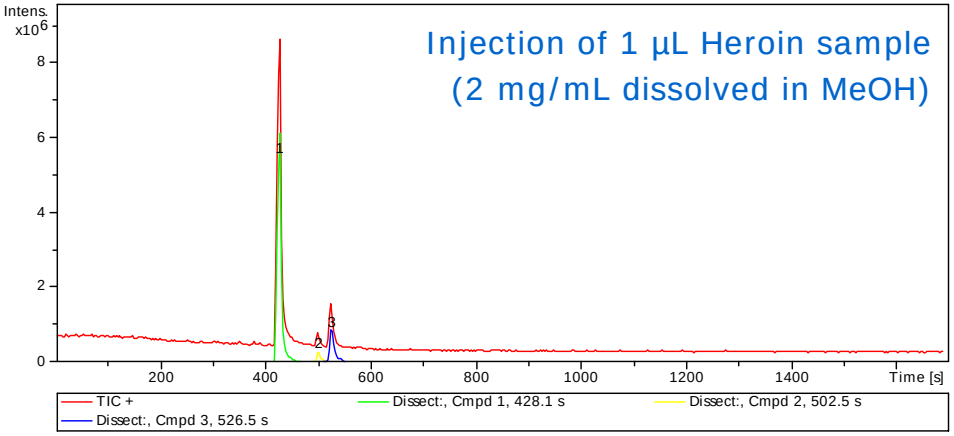
Cocaine sample

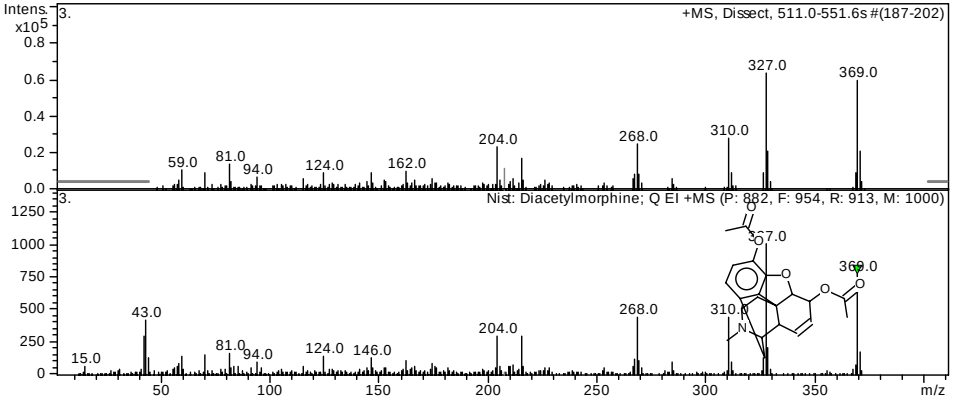
Air/Surface Probe

Identified substances

#	RT [s]	Area	Compound Name	Library	CAS#	Purity‘
1	119.8	304612217	Cocaine	Nist	50-36-2	847

GC/MS of Asian Heroin sample



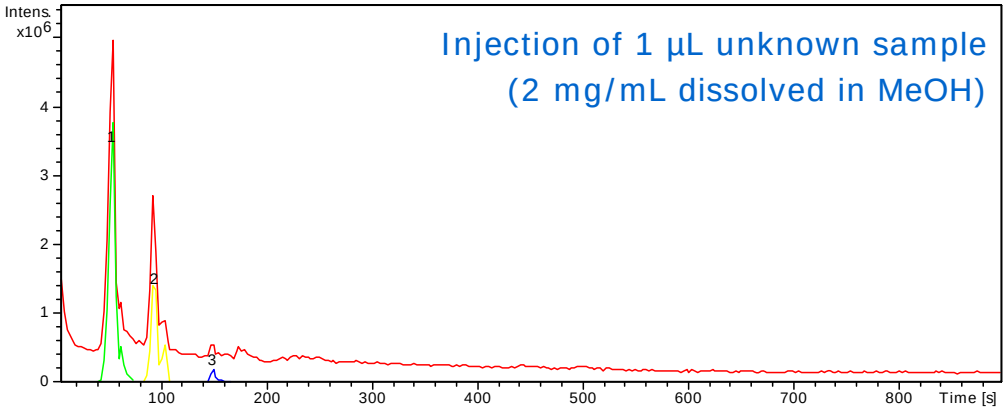


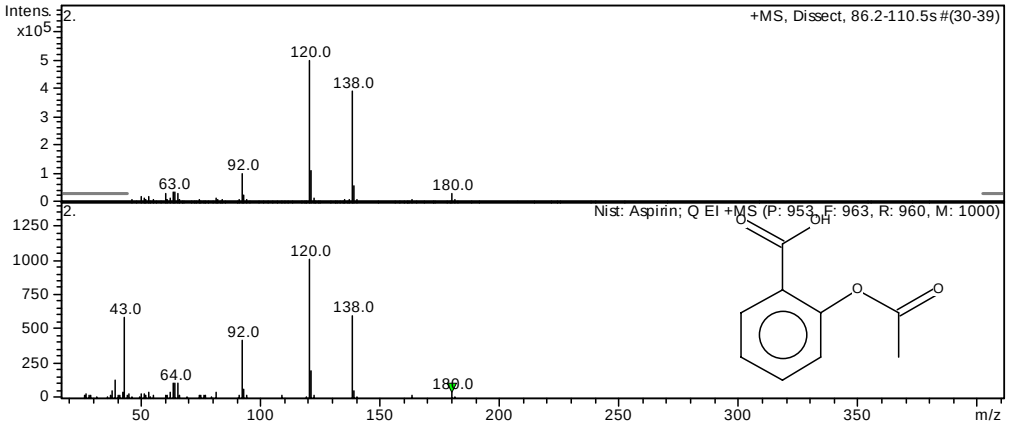
Asian Heroin

Identified substances Asian Heroin

#	RT [s]	Area	Compound Name	Library	CAS#	Purity
1	428.1	55787740	Novocaine	Nist	59-46-1	941
2	502.5	1991596	Acetylcodein	Nist	6703-27-1	716
3	526.5	8490099	Diacetylmorphine (Heroin)	Nist	561-27-3	882

Unknown Sample confiscated by Police





Unknown sample confiscated by the police and suspected of being a drug

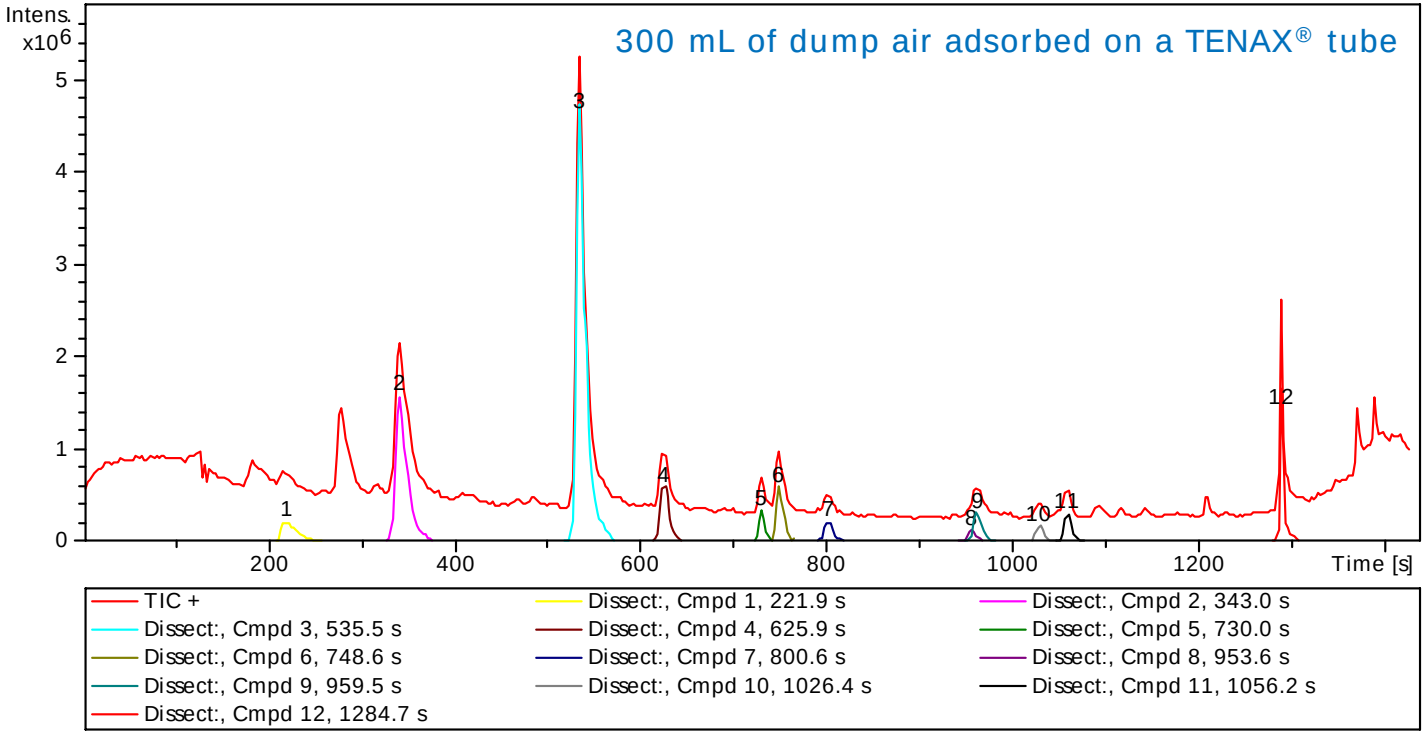
Identified substances unknown sample

#	RT [s]	Area	Compound Name	Library	CAS#	Purity'
1	55.6	27522076	Salicylic Acid	Nist	69-72-7	9562
2	95.5	12232044	Aspirin	Nist	50-78-2	953
3	150.8	1072028	Caffeine	Nist	58-08-2	710

Ground Air and Air from a Dump at a Fur Manufacturing Site

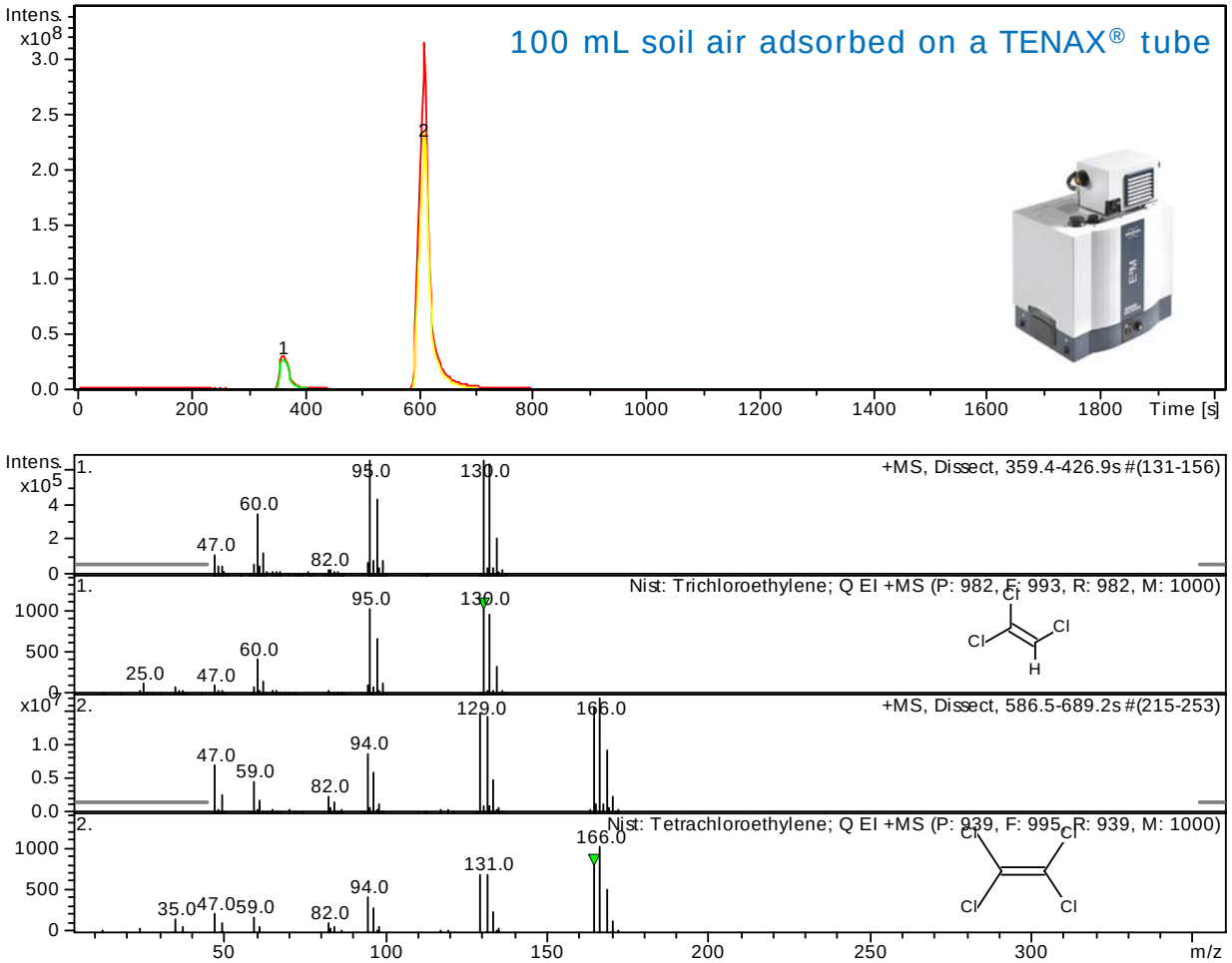
Derelict building at a fur manufacturing company

Trapping of air from a dump at a TENAX® tube



Identified substances in air from a dump

#	RT [s]	Area	Compound Name	Library	CAS#	Purity'
1	221.9	3739195	Carbon disulfide	Nist	75-15-0	979
2	343.0	23245934	Furan, tetrahydro-	Nist	109-99-9	816
3	535.5	56298844	Toluene	Nist	108-88-3	977
4	625.9	6321778	Tetrachloroethylene	Nist	127-18-4	960
5	730.0	2585451	Ethylbenzene	Nist	100-41-4	915
6	748.6	5263568	Benzene, 1,3-dimethyl-	Nist	108-38-3	996
7	800.6	2026941	p-Xylene	Nist	106-42-3	912
10	1026.4	1494777	Benzene, 1,3,5-trimethyl-	Nist	108-67-8	919
11	1056.2	2559744	Benzene, 1,3-dichloro-	Nist	541-73-1	948
12	1284.7	8775766	Naphthalene	Nist	91-20-3	986



Sampling of ground air (down to 7 m)

E²M in a car

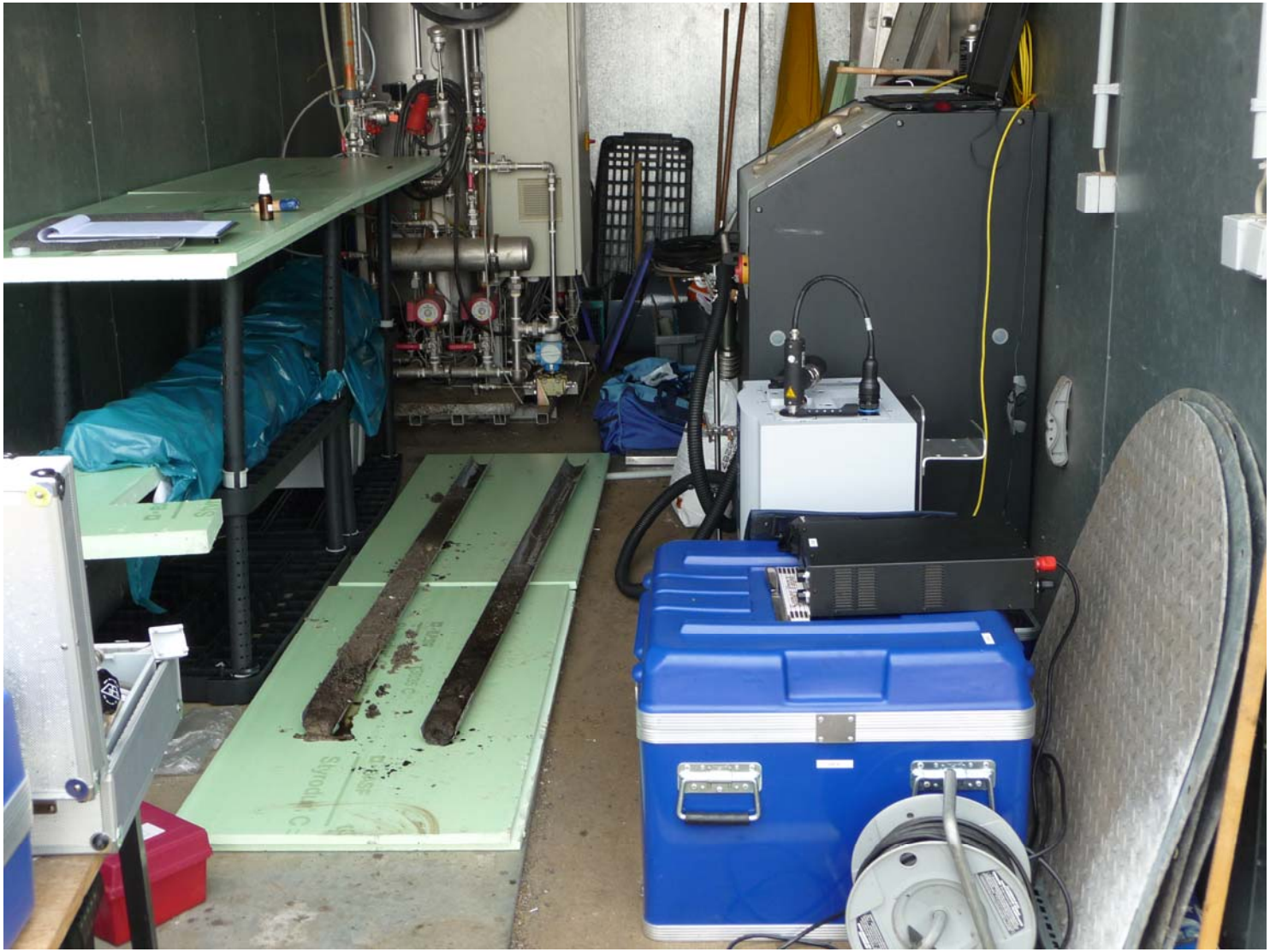
Identified substances in ground air

#	RT [s]	Area	Compound Name	Library	CAS#	Purity'
1	365.1	545080091	Trichloroethylene	Nist	79-01-6	985
2	610.3	5053466991	Tetrachloroethylene	Nist	127-18-4	918

Soil Samples from a Drill Core at a former Chemicals Industry Site

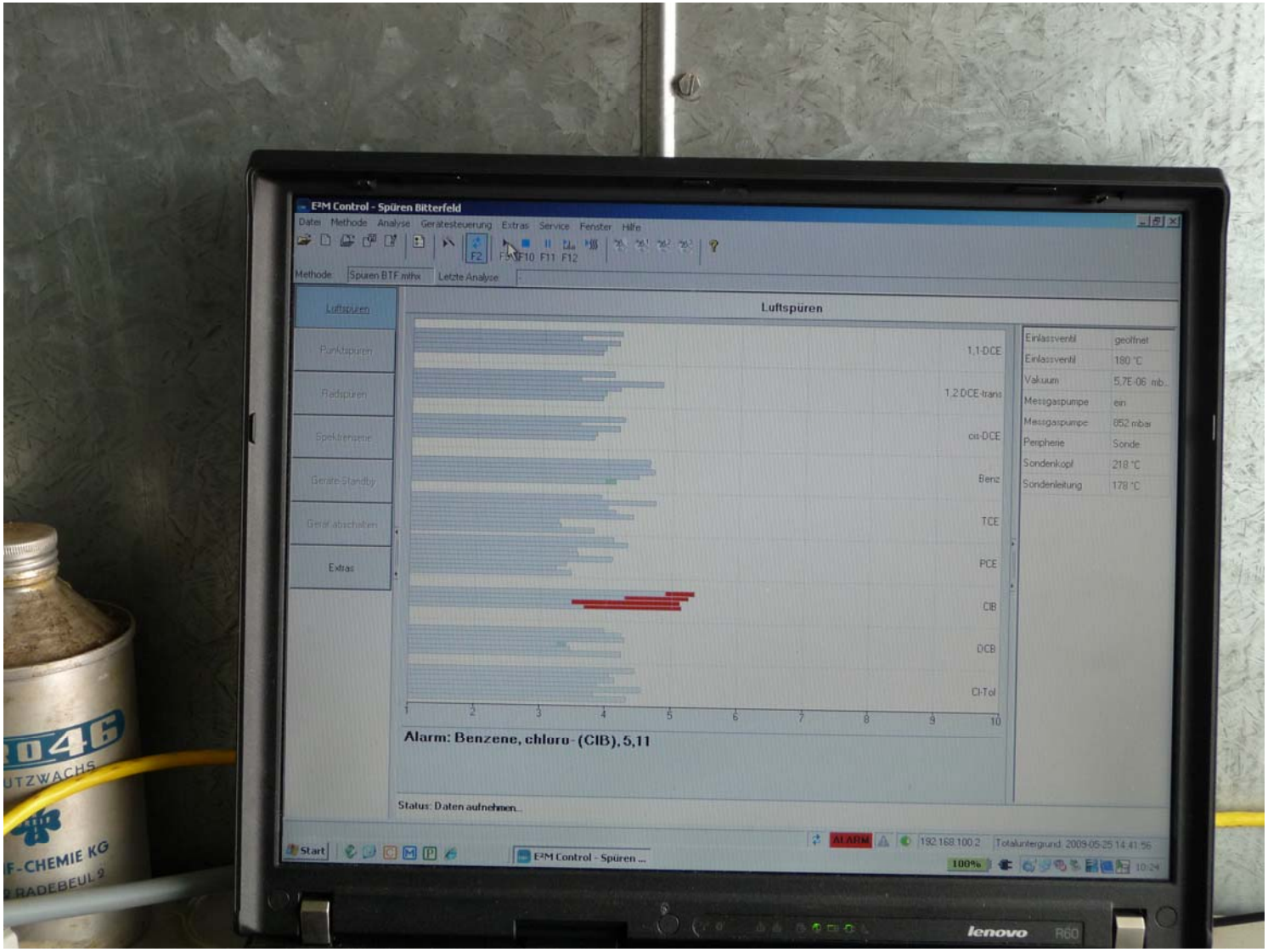
Bore drilling at former chemicals industry site

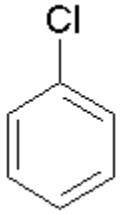
Core sample



Core samples and instruments at laboratory container

Direct application of the air/surface probe to a core sample

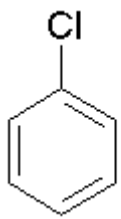


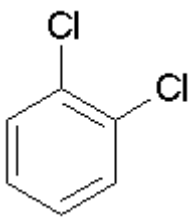


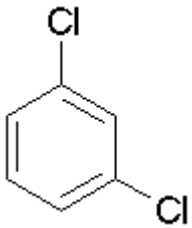
Direct identification of Chlorobenzene by SIM analysis

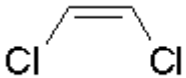
Identified substances in core samples at former chemicals industry site:

- Big amount of Chlorobenzene
- Trace amounts of Methylene chloride
  cis-Dichloro ethylene
  1,2-Dichlorobenzene
  1,3-Dichlorobenzene





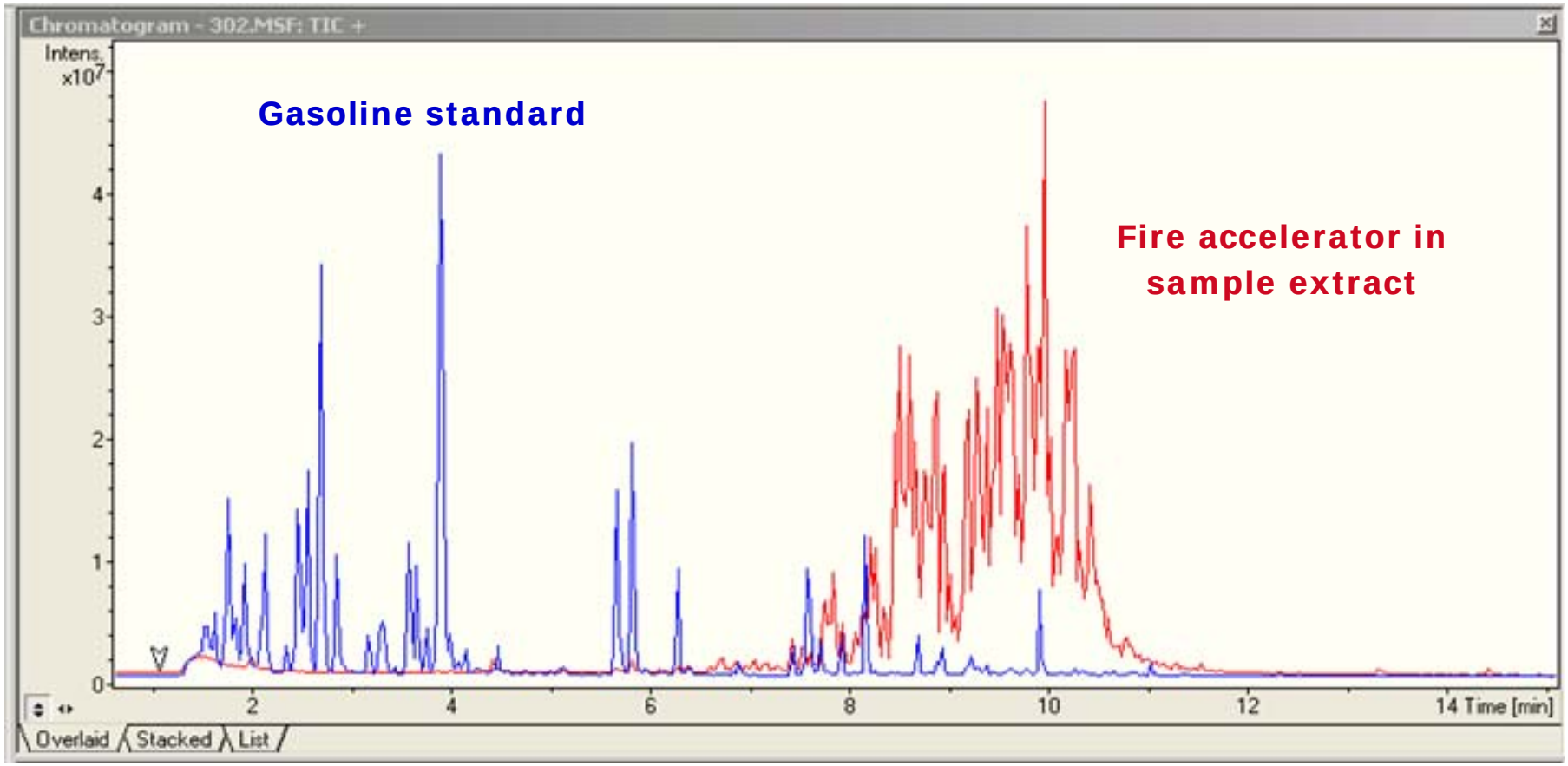




Fire inquest –
arson or spontaneous ignition

Burnt down sports hall

Area, where the tracking dog gave the alarm



Comparison of gasoline standard and extract of soil, where the dog gave alarm

www.cbrn-bdal.com