Introducing the

VGA–100

Gas Chromatography Measurements in a New Light

VUV ANALYTICS

VGA-100 Gas Chromatography Detector

The world's first short wavelength spectroscopic GC detector technology

Virtually all gases absorb strongly in the vacuum ultraviolet (VUV). Optical investigations in the VUV have been limited to synchrotron facilities due to the experimental difficulties associated with short wavelengths.

VUV Analytics' patented and proprietary technologies create the most exciting advancement in molecular spectroscopy and gas analysis in decades. The **VGA-100** makes the VUV regime readily available to the general scientific community for the first time.

The **VGA-100** is a universal non-destructive mass sensitive GC detector. The strong absorption of the gas molecules in the VUV provide excellent sensitivity and the spectroscopic measurement combined with unique molecular absorption cross-sections provide unparalleled selectivity.

Everything you want in a GC detector

- ♦ Easy to Use
- ♦ Easy to Understand
- ♦ Easy to Maintain
- ♦ Predictable and Linear Response
- ♦ Broad Dynamic Range
- ♦ Low Cost of Ownership
- ♦ Robust and Reliable

Always Known to be Valuable
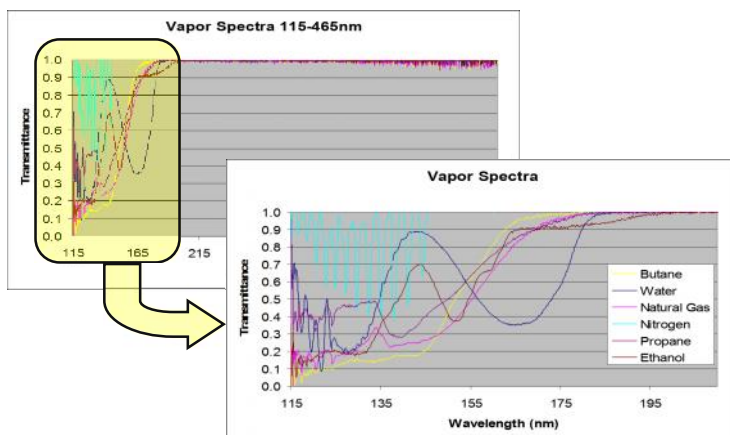
**Everything absorbs in the VUV!**

Once Taught to be Impractical

"The excitation energies associated with electrons forming most single bonds are sufficiently high that absorption by them is restricted to the so-called vacuum ultraviolet region (<185nm), where components in the atmosphere also absorb strongly. The experimental difficulties associated with the vacuum ultraviolet are significant; as a result.... no further discussion will be devoted to this type of absorption."

Principals of Instrumental Analysis,
By Douglas Skoog, Sixth Edition, 2006

Discover the Benefits of VUV

Optical absorption spectroscopy is a very well understood technique with a wide range of use cases. These include UV-VIS technologies for many liquid phase applications, as well as IR based techniques for many gas phase applications.

All gas phase molecules have unique absorption responses in the VUV, including most isomers. These are the result of the molecule's VUV absorption cross-sections, which are often hundreds of times stronger than in the IR. While some VUV cross-sections are largely featureless, many are very rich in structure. All have spectral responses which are excellent for highly sensitive detection and very precise quantitative determination.
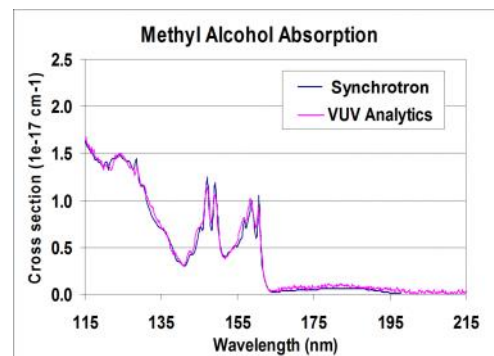
Powerful Spectroscopy, Functional Simplicity

The **VGA-100** continuously and rapidly acquires full spectroscopic absorption data from ~120nm to 240nm. This data is integrated across this entire range and presented as a single chromatographic response. Many absorption responses appear similar based on their compound class. This allows for "spectral filters" to be applied post-processing which integrate the absorption data across a more specific region of interest, which can reduce the impact of matrix backgrounds on the chromatographic response.
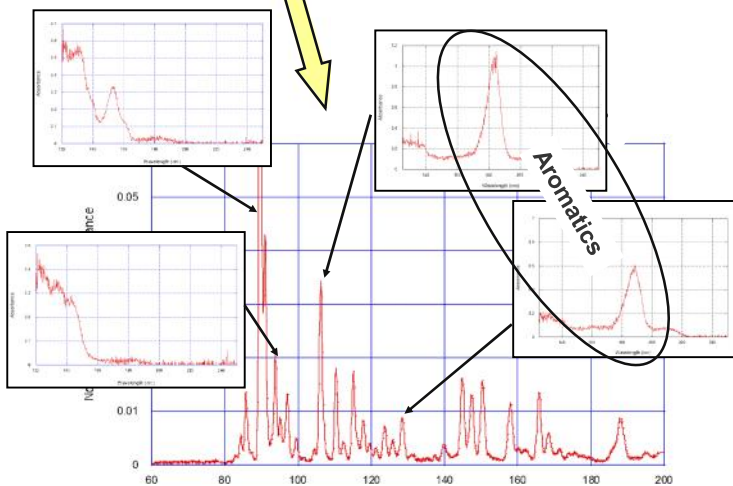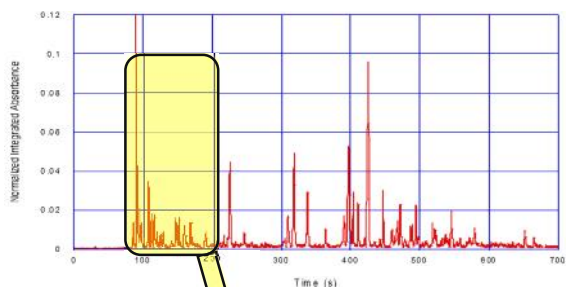
Unleaded Gasoline Analysis

absorption cross-sections of the gas molecules in the VUV regime. These can be easily generated on the instrument and stored in a library. Through regression fitting techniques, the instrument is able to resolve co-eluting analytes, identify eluting compounds or provide "goodness of fit" metrics to help reduce false negatives or positives.
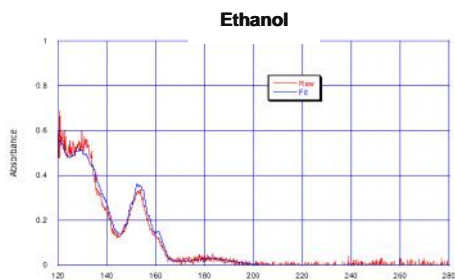
**Ethanol — Measured vs. Model**
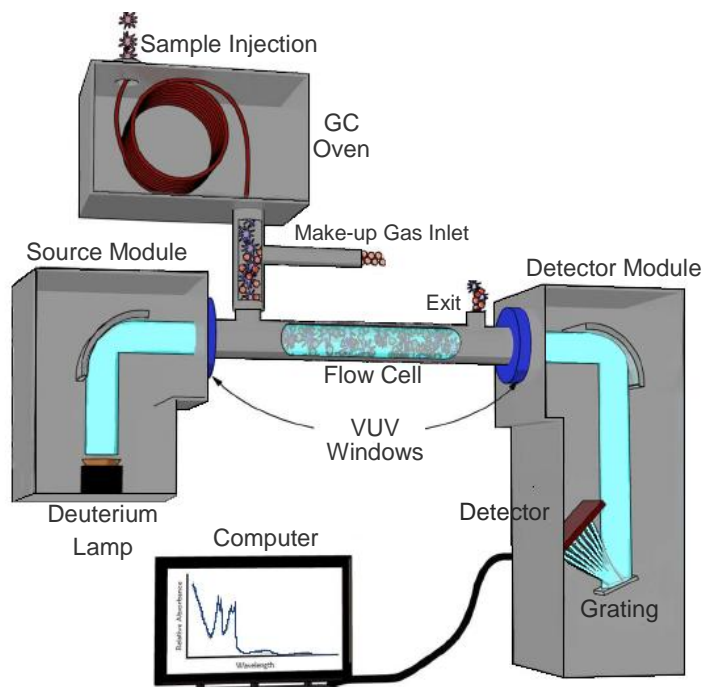
VGA-100 Measurement Overview

The **VGA-100** GC Detector can be easily integrated onto most any gas chromatography unit. The instrument's temperature controlled transfer tube slides into the GC oven's available mass spec port. The GC column is then connected via a common SilTite fitting. The instrument is compatible with any commonly used carrier gas (H2, N2, or He) and is able to use any of these as a make-up gas. Given that these are largely transparent in the VUV, the make-up gas can be dynamically controlled for peak width optimization without a loss of sensitivity. In addition, the small flow cell size (~80uL) and the potential for up to 100Hz sampling provides for excellent temporal resolution.

The **VGA-100** requires minimal facilities and maintenance. The instrument does not require any vacuum pumps, instead uses only a small purge gas to maintain a stable ambient environment. The **VGA-100** has only one moving component and the instrument uses a >2000 hour long life deuterium lamp, which makes it extremely reliable and results in an remarkably low cost of ownership.

VGA-100 Facilities Requirements:
- 13"(W) x 30"(L) x 17"(H)
- Weight ~100lbs.
- Universal AC input / full range
  - 90-264V AC; 47-63Hz,
  - <6amps @ 120V range
- 1/4" Swagelok Connections
  - N2, Argon, or He purge gas (<50mL/min)
  - CDA connection

Isomer Identification - Poly Aromatic Hydrocarbons
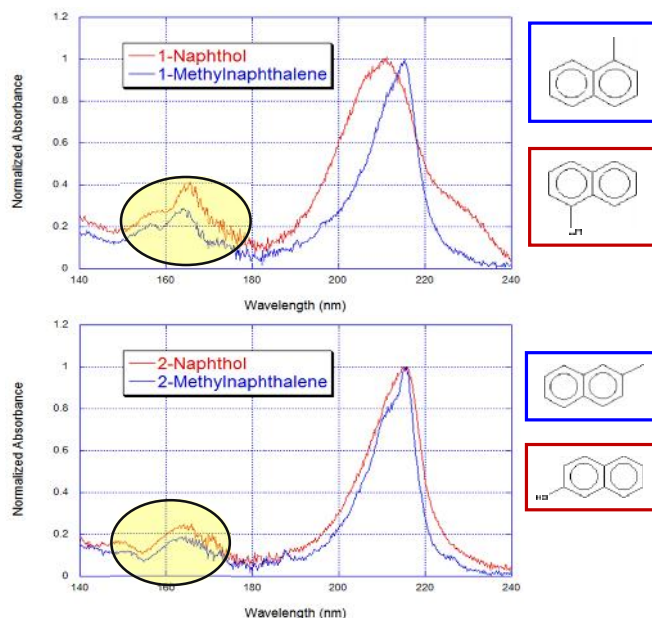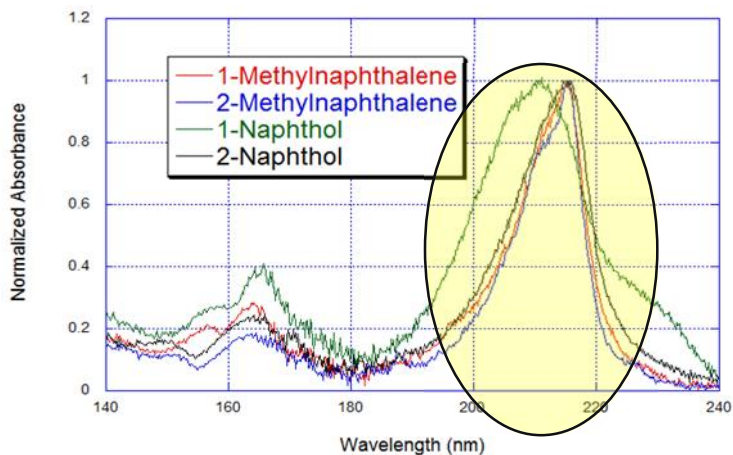
- All four compounds show similar class responses in the longer wavelengths
- The isomer pairs show similar class responses in the shorter wavelengths

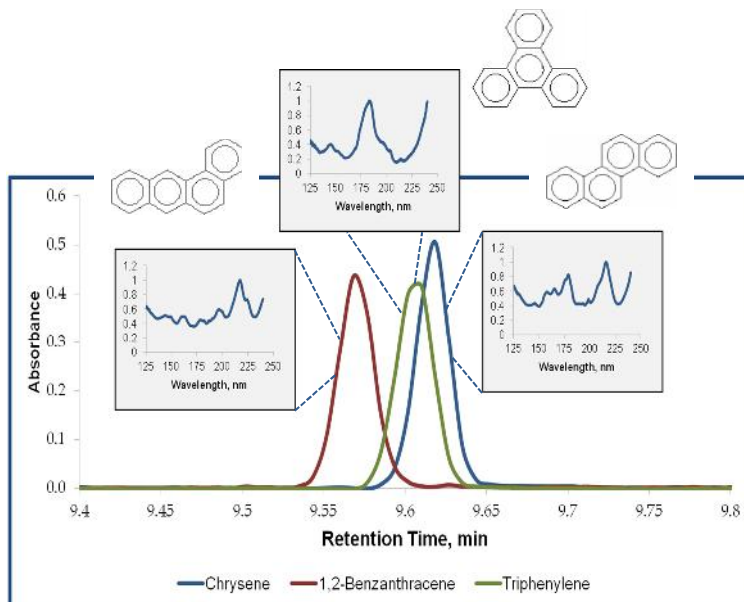## Isomer Identification and Separation - Xylenes
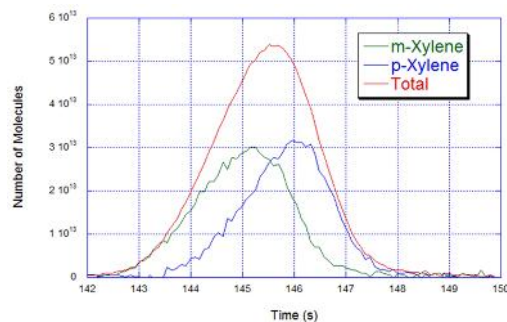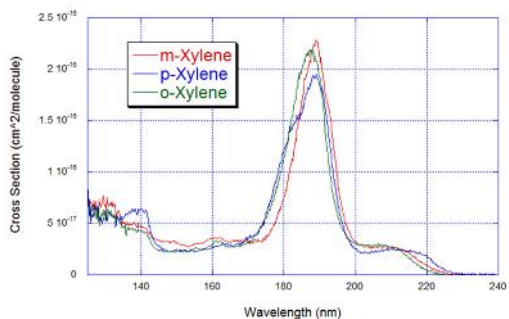
- Each of the xylene isomers is uniquely identifiable
- The co-eluting m– and p– xylene compounds are easily separated through spectral fitting

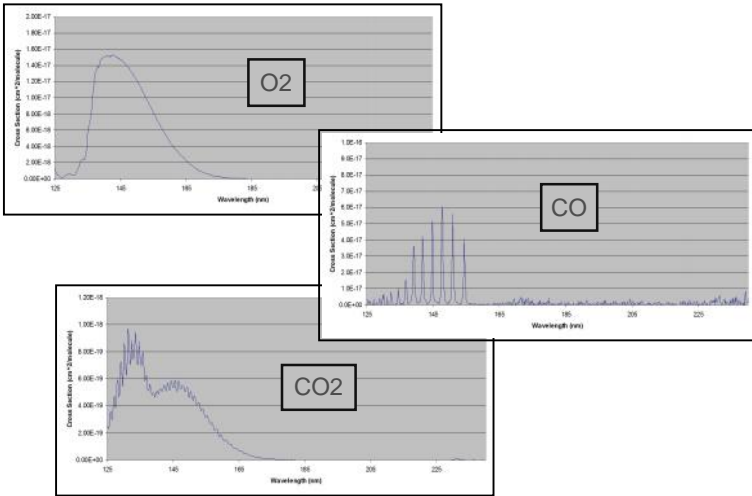## Distinguishing Isomers - Chlorinated Solvents
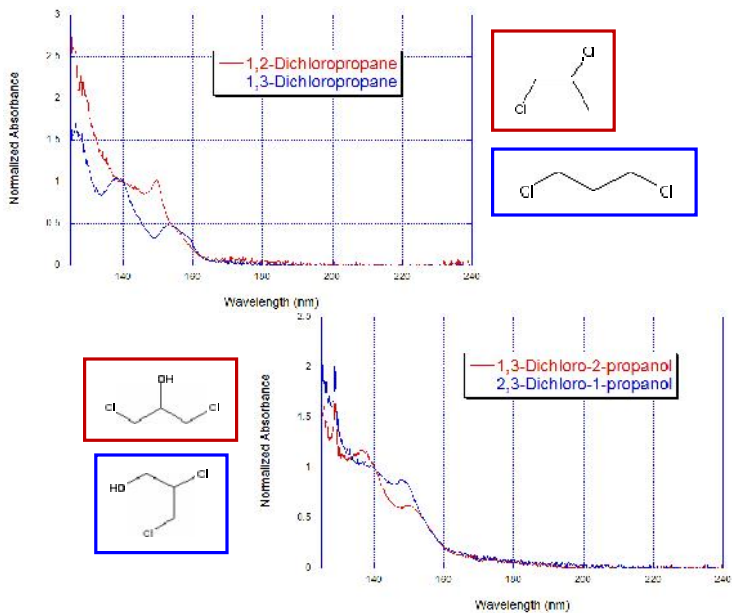
*Courtesy of The Dow Chemical Company

Isobaric PAH Separation

*Courtesy of The University of Texas at Arlington

Specialty Gas - No Separation

Component Standards

Measured Mix Gas
Simultaneously determined concentrations
CO2 = 275ppmv
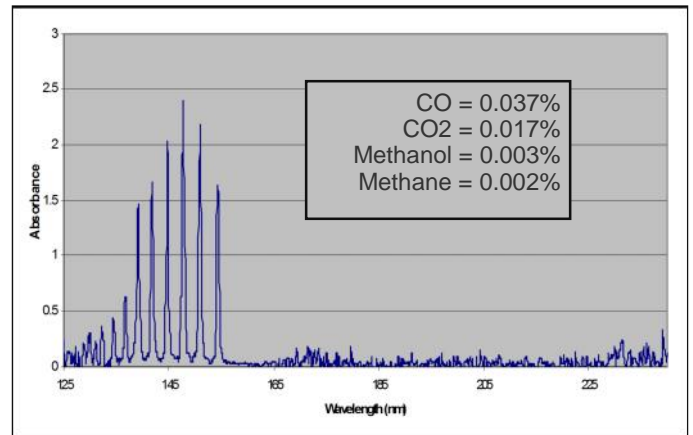CO = 4.5ppmv
O2 = 11ppmv
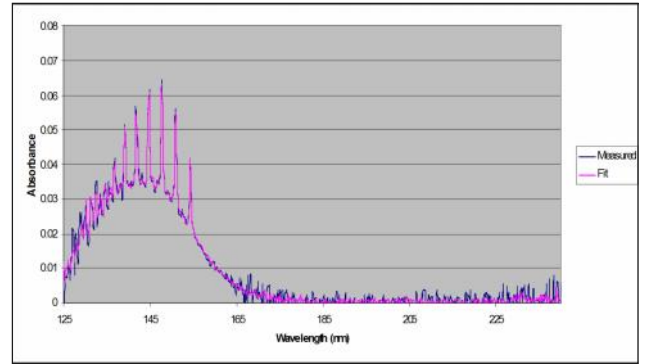
*Courtesy Air Liquide

## Specialty Gas - Diluted Gas Mixture; No Separation

Component Standards
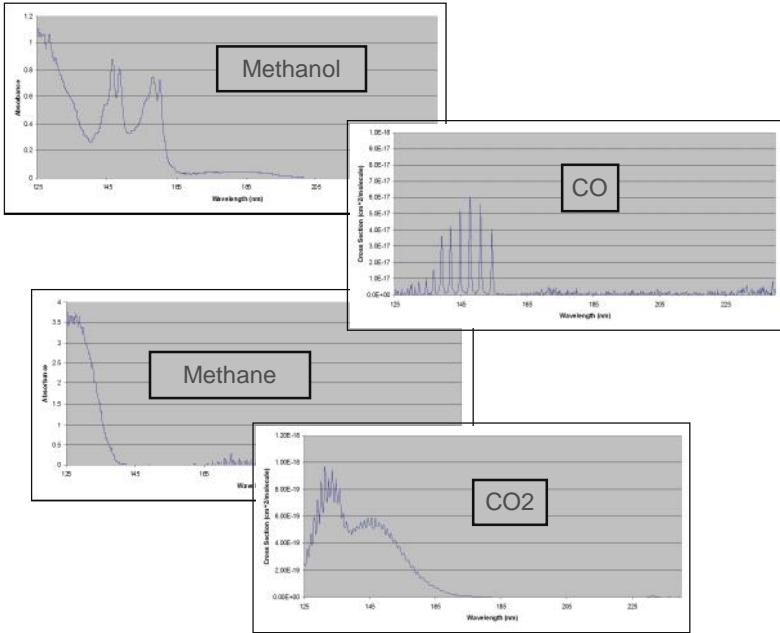
Measured Diluted Gas Mixture
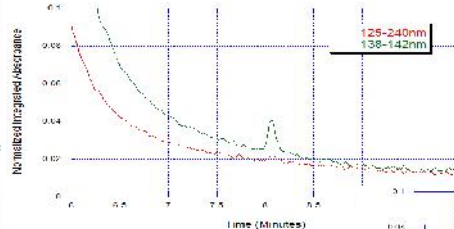Simultaneously determined concentrations

CO = 0.037%
CO2 = 0.017%
Methanol = 0.003%
Methane = 0.002%

Parameter	1-sigma uncertainty	Relative uncertainty
CO_2	2.23 ppm	1.3%
CO	0.237 ppm	0.064%
Methane	0.139 ppm	0.82%
Methanol	0.335 ppm	1.2%

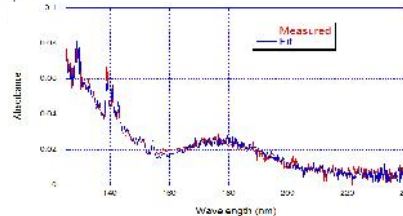## Phosphine Case Study — H2S lost in the tail of the phosphine
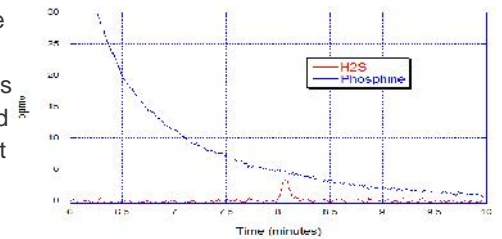
1) Start with compound absorption cross-sections
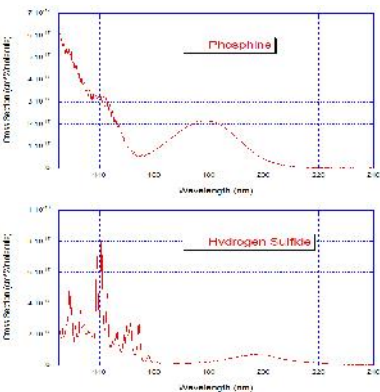
2) Measure chromatograms of total absorption and one using an H2S optimized spectral filter

4) Phosphine and H2S concentrations are measured with excellent precision

3) Total absorption response is fitted using co-eluting analyte models

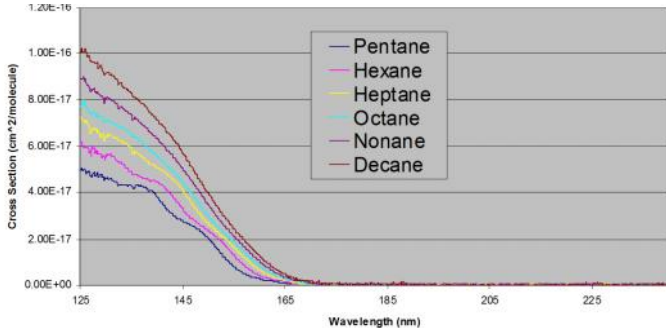| Parameter	1-sigma uncertainty	Relative uncertainty
Phosphine	0.027 ppm	0.58%
H2S	0.021 ppm	0.62%

*Courtesy of
Consci Analytical Services
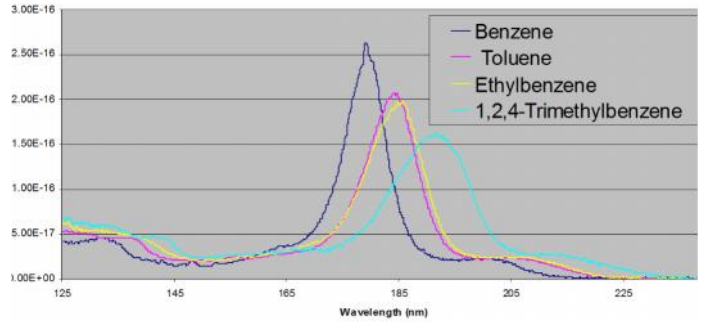
Detailed Hydrocarbon Analysis & Classes
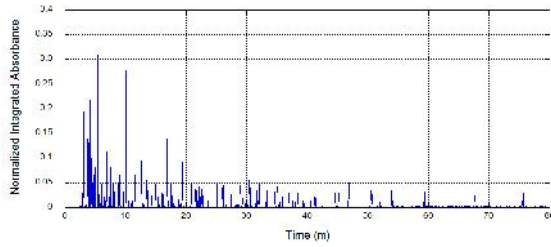
Sample:Restek DHA PIONA Blend
Column: Restek Rxi-1ms 30m
0.5μL Injection volume
20:1 Split ratio
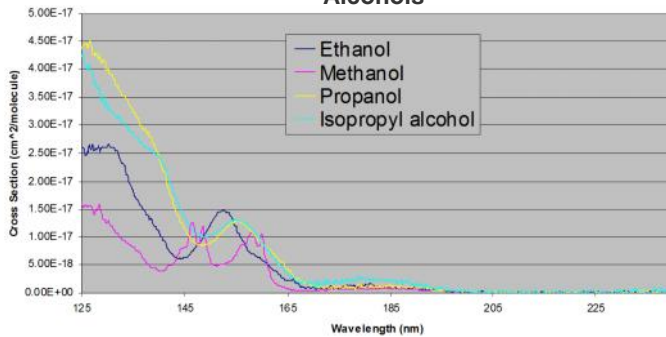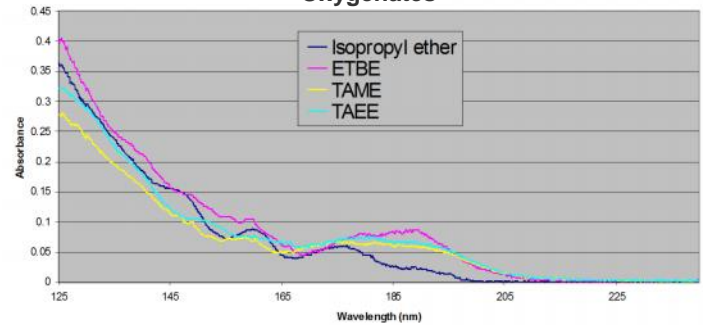Oven temp: 30° C hold 5 min ramp 1.5 °/min to 150° C

Linear Alkanes

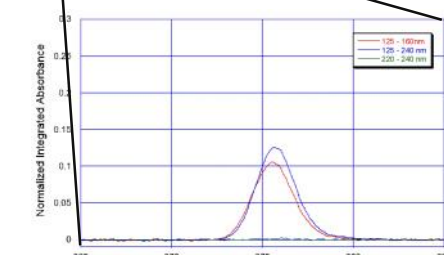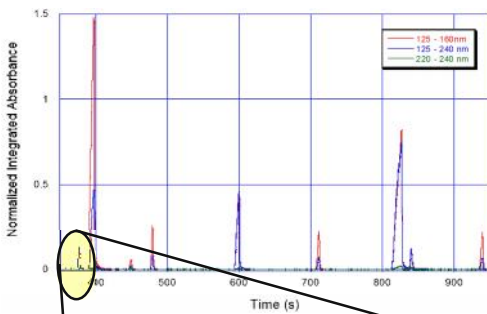Legend: Pentane, Hexane, Heptane, Octane, Nonane, Decane

Aromatics

Legend: Benzene, Toluene, Ethylbenzene, 1,2,4-Trimethylbenzene

Alcohols

Legend: Ethanol, Methanol, Propanol, Isopropyl alcohol
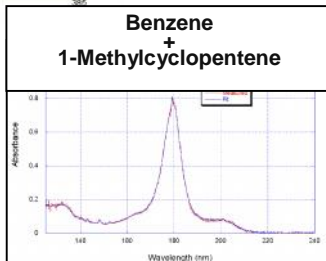
Oxygenates
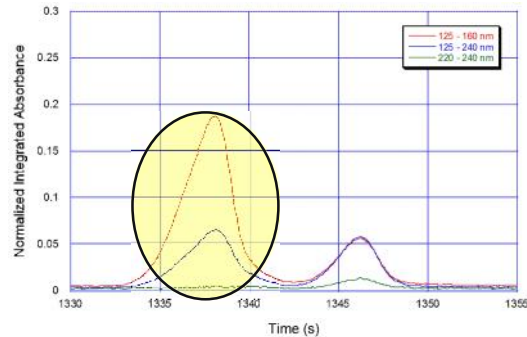

Legend: Isopropyl ether, ETBE, TAME, TAEE

ASTM 6730 Component Standard - Co-Eluting Peaks

Asymmetry of the spectral filter peaks, indicates the presence of co-eluting peaks of differing compound classes

Benzene only

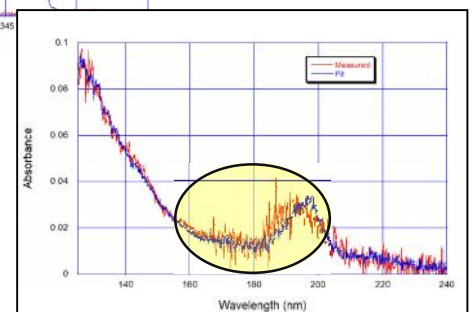**Benzene + 1-Methylcyclopentene**

ASTM 6730 - Goodness of Fit Red Flag

Asymmetry of the spectral filter peaks, indicates the presence of co-eluting peaks of differing compound classes
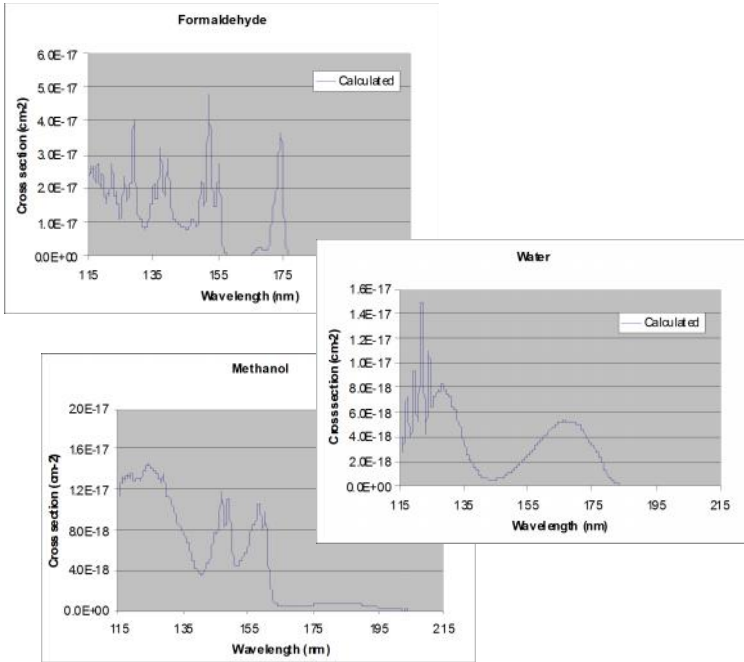
Undecane

1,2,3,5-Tetramethylbenzene

Ghost Peak?
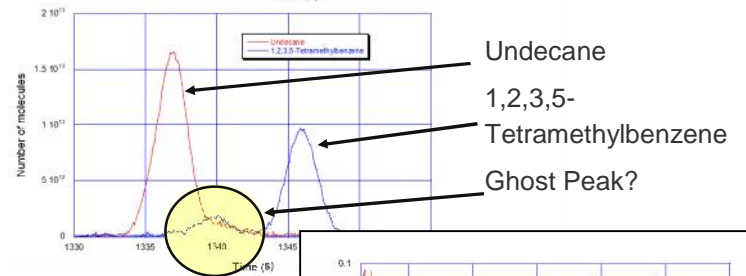
Analysis of the fitting clearly shows the presence of a third additional compound
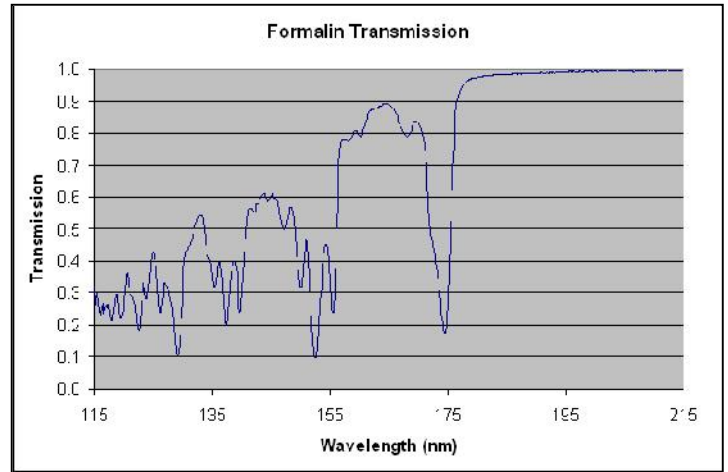
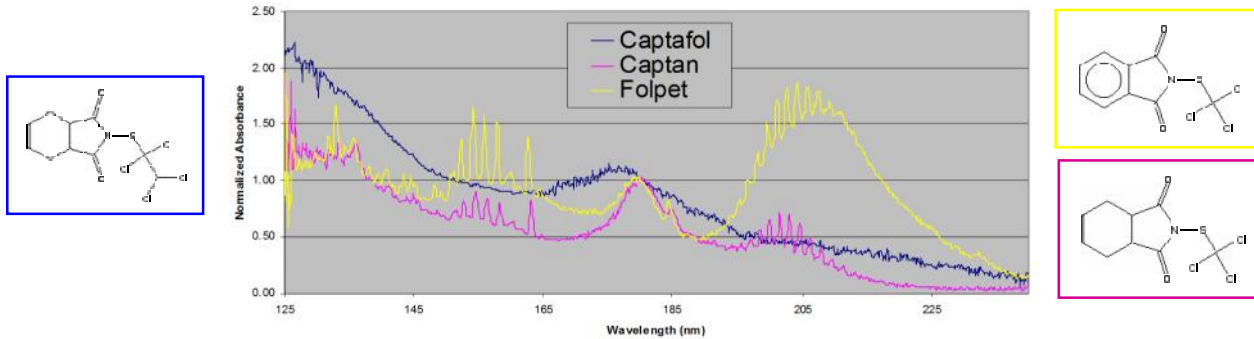# Formaldehyde - Formalin Headspace "No Separation"

Component Standards

Simultaneously determined concentrations

|	Molecules/cm3	PPM	Mass (ng)
Water	2.67E+15	102	878.8
Methanol	4.74E+13	1.8	27.7
Formaldehyde	8.16E+12	0.3	4.5

Pesticides - Highly Volatile Compounds "The Big Three"

♦ VUV measurements do not require compound ionization, which often degrades highly volatile compounds
♦ Common compound class presents similar general absorption responses
♦ Functional group adds unique absorption response, including strong vibrational components
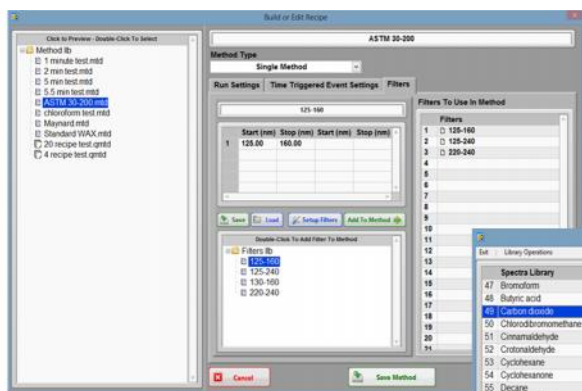
Sulfur Compound Speciation
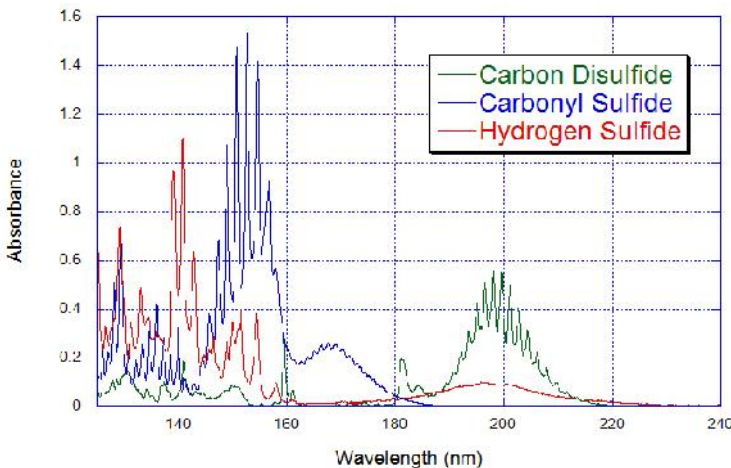
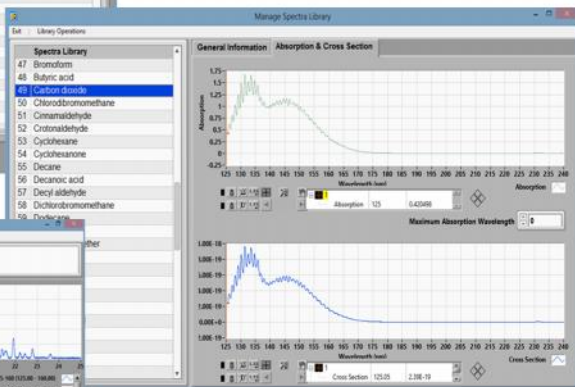*CS2 and COS Courtesy of Air Liquide

Other Miscellaneous Compounds
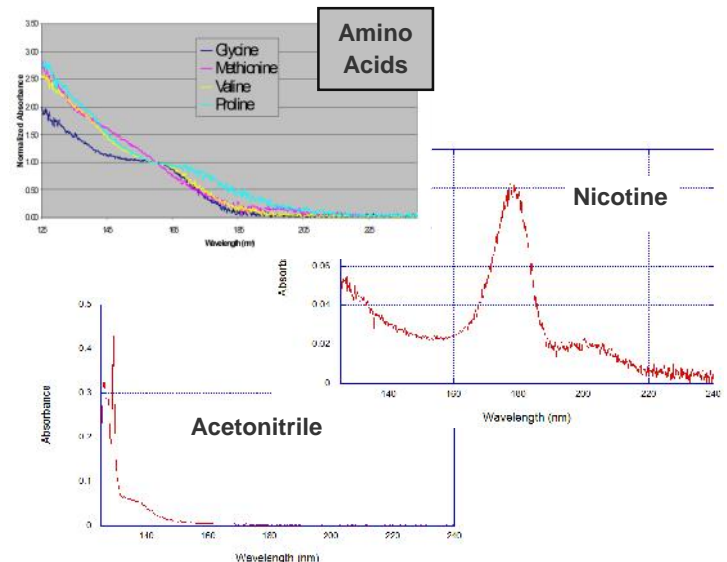
Powerful Software, Intuitive Interface

Method Selection / Edit
- ♦ Library based user-defined methods
- ♦ Spectral filter settings
- ♦ Start / stop trigger settings
- ♦ Acquisition settings
- ♦ Make-up gas flow / timing sequence

Materials Library
- ♦ Stored absorption cross-sections
- ♦ Absorption spectra
- ♦ General Information
  - ◊ Retention Indices
  - ◊ Chemical & Physical property information
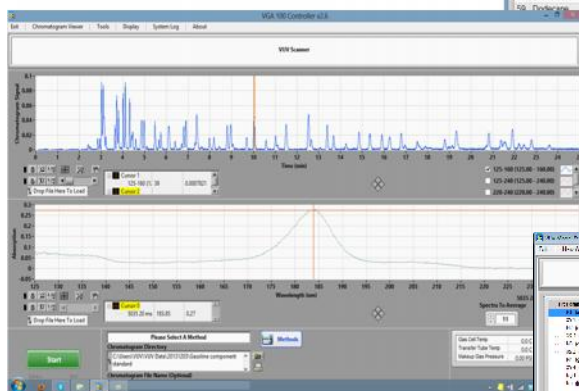
Runtime Screen
- ♦ Chromatogram per spectral filter
- ♦ Measured absorption spectra
- ♦ Peak processing tool kit
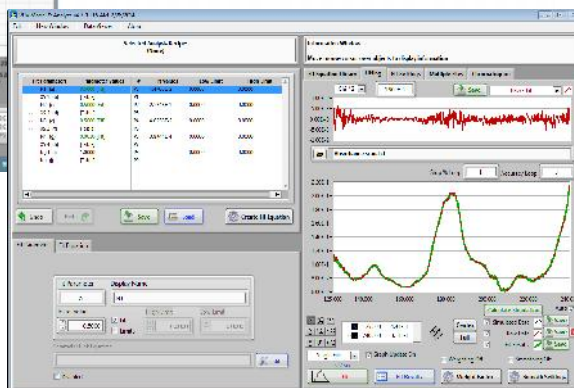
Spectra Fitting Engine
- ♦ Spectral fitting and match routines
- ♦ Goodness of Fit metric determinations

V U V   A N A L Y T I C S

"**New directions in science are launched by new tools much more often than by new concepts.**"

Freeman Dyson
Theoretical Physicist & Mathematician
Professor Emeritus Princeton University

Contact Us

VUV Analytics, Inc.
Austin, Texas
(512) 333-0860
info@vuvanalytics.com

Visit us on the web at
www.vuvanalytics.com